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NOVICE:
a Radiation Transport/Shielding Code

Users Guide

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INTRODUCTION

INTRODUCTION list tables that list processors

****
The INTRODUCTION is a collection of tables that list the various input and analysis processors in the NOVICE code.
****

****
Discussion
****

A more detailed introduction is contained in the SUMMARY appendix. That summary includes a discussion about all the input and analysis processors.

The NOVICE code uses Monte Carlo methods and/or approximate kernels to perform particle transport and shielding calculations. Allowed particles are listed in Table 1 (INTPAR).

The NOVICE users guide is organized as a series of appendices arranged alphabetically by keyword. Most of the keywords correspond to header lines that precede specific input data.

Appendices that describe convenience features are listed in Table 2 (INTSYS). The DATA appendix should be scanned first to get familiar with header line, option, and free field input capabilities.

Table 3 (INTENE) lists appendices that describe particle energies, spectra, response functions, and macroscopic material properties.

Appendices that discuss geometry are listed in Table 4 (INTGEO). Specifically the GEOMETRY appendix gives an overview and should be reviewed first. More advanced geometry modeling techniques, used less frequently, are listed in Table 5 (INTADV).

The data implied by Tables 2 (INTSYS) through 5 (INTADV) constitute a data base. These data can be input in any order. Repetitive use of an input processor such as SPECTRA simply adds more data of that type.

Table 6 (INTANA) lists specific analysis procedures. The PICTURE procedure is recommended for geometry consistency checkout.

The NOVICE code defaults data not supplied by the user. The default data are given in Table 7 (INTDEF).

On many computer systems, input lines are prepared as a data set or catalogued file. Table 8 (INTBAT) shows a typical batch run on a personal computer using the OS/2 operating system with MYDATA.TXT as input. Table 9 (INTINT) indicates a typical interactive job submittal on a personal computer using the DOS operating system.

Table 1: (INTPAR) Allowed Particle Types

Z,A: Code Identifier	Particle Name	Energy Range	Cross Sections
0,1	neutron	(1) thermal to 18 MeV	(2) BUGLE93
0,-1	gamma ray	(1) .01 MeV to 14 MeV	(2) BUGLE93
0,0	photon	(3) 100 eV to 100 GeV	(2) NIST
-1,0	electron	(4) 100 eV to 100 GeV	calculated and NIST
1,0	positron	(4) 100 eV to 100 GeV	calculated and NIST
1,1	proton	(4) 10 keV to 100 GeV	calculated
Z> 1,A> 1	heavy ions, alphas, cosmic rays	(4) 10 keV/amu to 100 GeV/amu	calculated

(1) coupled neutron-gamma library with fixed group structure

(2) libraries as distributed by the Radiation Shielding Information Center, Oak Ridge National Laboratory.

(3) extrapolation is used for energies outside this range

(4) no explicit limits on energy range

Table 2: (INTSYS) System Convenience Features

COMMAND, discusses command line parameters
DATA, describes the header line logic, options field, free field inputs, and data entry options.
DUMP, provides formatted dump of the input data base for debugging purposes.
END, terminates data scanning until the next header line
ERROR, for interactive processing, instructs code to ignore inputs that caused errors.
FILES, allows the user to change the default names of input and output files
GET, allows the user to insert files into the input data stream.
GRAPHICS, discusses graphics modes, file formats, printing
LABEL, provision for entering a problem title
LIBRARY, discusses preparation and use of the 'library.dat' file
MENU, discusses use of the current MENU system
OPTIONS, describes options beyond the usual A through Z
PRINT, provision for omitting extensive lists of input and lists of data base tables.
PUT, provides for saving portions of the input stream for later recall e.g., using GET.
SAVE, saves the data base for subsequent reuse.
START, starts a problem from a previous SAVE file.
UNITS, provides for non standard input units such as inches instead of centimeters.
HELP, displays portions of the users guide on the screen during interactive runs.
STOP, terminates all data scanning
CRASH, clears program memory between independent runs.
PRESET, discusses CONFIG.NOV file for presetting file names and graphics modes.
PLOT, displays data and calculated figures on screen with optional hardcopy output.

Table 3: (INTENE) Particle Dependent Data

SPECTRA, describe the input of particle spectra. Both analytic functions and tabular data are accepted

RESPONSE, describes the input of user tabulated response functions. Energy deposition response (rads) is obtained automatically for every material in the problem

MATERIAL, provides information on material compositions, i.e., partial densities of constituent elements.

PARTICLES, gives the user some latitude in selecting energy groups

Table 4: (INTGEO) Geometry Modeling Processors

DETECTOR, input of detector points. Also volume, surface, or line detectors in rectangular, cylindrical, or spherical coordinates

SOURCE, input of point, line, surface or volume sources in rectangular, cylindrical, or spherical coordinates.

GEOMETRY, a discussion of the 3D modeling logic used by the code

OVERLAP, discusses overlap options available for simplifying some mockups

DESIGN, description of 3D material geometry composed of boxes, cylinders, annuli, cones, spheres, and other simple shapes

SIMPLE, allows simple inputs to describe material meshes in rectangular, cylindrical, or spherical coordinates

ROTATE, describes specific inputs for translation, rotation, and reflection of geometric inputs. These data apply to source and detector geometries as well as material geometry.

MAGIC, allows combinatorial description of 3D geometry, i.e.,body descriptions and regions composed of body intersections and unions

MEVDP, geometry inputs in the format of the 'Modified Elemental Volume Dose Program'

MCNP, geometry inputs or outputs in LANL MCNP format

SECTOR, geometry inputs in AFWL SECTOR code format.

Table 5: (INTADV) Advanced Geometry Modeling

BAYS, inputs specific to mockup of spacecraft bays as engineered by JPL for deep space probes

ADDRESS, used to set internal pointers prior to input of a geometry subset, so the subset can be duplicated without knowing code assigned numbering.

CATIA, a general modeler using DESIGN, MAGIC, and MCNP primitives with embedded rotate/translate commands.

DUPLICATE, describes capabilities for duplicating prior subsets of sources, detectors, and material geometry.

SURFACE, input of quadric surfaces with recognition of simple forms such as planes, cones, cylinders, and spheres.

REGION, input of material regions by listing boundary surfaces

ESABASE, geometry inputs in ESABASE format

SYSTEMA, geometry inputs in SYSTEMA format

ARRAYS, provides a mechanism for changing material designation of regions without changing geometry descriptor lines.

Table 6: (INTANA) Analysis Procedures

In the following list, terms such as (dfgmrs) indicate the parts of the data base that are used:

d=detectors	f=fixed source	g=3D geometry
m=materials	r=responses	s=spectra

EXECUTE(dfgmrs), signifies the end of user data base inputs. Default values are supplied for required data that were not input. Cross section tables are generated. Data base summary tables are then printed. EXECUTE must precede any of the other analysis procedure, defaulted if it doesn't.

PICTURE(g), checks for geometric overlaps and generates printed geometry pictures.

ADJOINT,K(mrs), generates 1D attenuation kernels for electrons, bremsstrahlung, and heavy charged particles using semi-analytic Monte Carlo

ADJOINT(dfgmrs), calculates electron, bremsstrahlung, and heavy charged particle transport in 3D geometries using adjoint Monte Carlo

SIGMA(dfgms), approximate 3D space radiation analysis using tabulated 1D attenuation kernels and ray tracing/sectoring.

GCR(mrs), calculates 1D galactic cosmic ray transport or 3D transport (dgmr).

SHIELD(mrs), calculates electron, bremsstrahlung, and heavy charged particle transport in multi-layer 1D geometries by numerical integration.

PULSE(m), calculates pulse height spectra (soft error rates) for rectangular, cylindrical, or spherical sensitive volumes using numerical integration and chord length distributions.

FASTER(dfgmrs), 3D neutral particle transport using multigroup cross sections and forward/adjoint Monte Carlo.

BETA(dfgmrs), 3D charged particle transport using analog Monte Carlo

KERNEL(dfgmrs), 3D neutral particle transport using point kernel and approximate Greens function method.

XRAY(mrs), 1D or 3D (dfgmrs) photon attenuation (no scattering), only suitable for low energy spectra.

SOCODE(m), calculates weight optimized shielding.

Table 7: (INTDEF) Default Input Data

```
*MATERIALS

   ALUMINUM   2.7   13  0  1/

   SILICON    2.33  14  0  1/

   WATER      1.0   1  0  -2   8 0 -1/

*SPECTRUM

  'GEO160W' ELECTRON INP 365.25 SCALE  .04  5.5/ Stassinopolous

  5.5      5.       4.       3.       2.       1.5      1.
  .9       .8       .7       .6       .5       .4       .3
  .2       .1       .07      .04     / tabulation energies

  3.14e+4  3.14e+5  3.45e+7  2.79e+8  3.03e+9  9.30e+9  3.77e+10
  5.32e+10 7.51e+10 1.08e+11 1.59e+11 2.34e+11 4.01e+11 6.87e+11
  1.28e+12 2.61e+12 3.17e+12 3.85e+12/ integral, per day

  'AL FLARE' PROTON EXP 2.45E+10 NUMBER  .1 1.E+5 26.5/

*DESIGN

   1 ALUMINUM   2.7    SPHERE    0 .5   0 .5   0 .5/

*SOURCE

  'POINT 0,0,0'  0  0  0/  IGNORED IF DOING ADJOINT CALCS

*DETECTOR

  'POINT 0,0,0'  0  0  0/
```

Table 8: (INTBAT) NOVICE Batch Run

If the file novice.dat exists then

```
novice90
```

will run that input file in batch mode.

To run a specific input file in bach mode use:

```
novice90 i=filename
```

where filename is that input file.

Table 9: (INTINT) NOVICE Interactive Run

To start NOVICE in interactive mode, use the command:

```
novice90 i=*
```

If the file novice.dat does not exist, then the command:

```
novice90
```

will also start actively. Also, if the command:

```
novice90 i=datafile
```

is used, NOVICE will start interactively if 'datafile' does not exist.

To start interactively with the menu screen use:

```
novice90 i=**
```

ADDRESS

ADDRESS, index modifiers for material/geometry inputs

```
*****************************************************************
This input processor sets internal counters for sources,
detectors, materials, regions, and surfaces. After invoking
ADDRESS, the user can refer to sources, detectors, etc., entered
thereafter by their count relative to this input.
*****************************************************************
```

Input Record List:

Header and options field: *add,DMRSV/

- D, detectors (present,D=d), modifier = (last value,d)
- M, materials
- R, regions
- S, surfaces
- T, transformations
- V, sources

Input Examples

Example 1:

```
*address,dmrsv/ set all modifiers to current values
```

Example 2:

```
*address,r=197  add 197 to region  indices
         s=53  / add  53 to surface indices
```

List of input files:

novice.dat: default input file

++++++++++++++++++++
List of output files:
++++++++++++++++++++
output.new: default output file

****
Input Record Description
****

==========
Header Line
==========

The header line must contain *ADD in columns 1 through 4. If any options are used, at least one must be on this line and the option field must be terminated by a slash.

==========
Options Field (d m rst v)
==========

D, implies detectors

Let the lower case letter denote the counter modifier set by the code. Using D as an example:

If D is absent, d is set to zero (no counter modification)

If D or D=0 is entered, d is set to the current detector count

If D=d is entered, where d is nonzero, then this is the modifier

M, implies materials, see D option above.

R, implies regions, see D option above.

S, implies surfaces, see D option above.

V, implies sources, see D option above.

****
Data Record Description
****

There is no other input after the header/options.

****
Discussion
****

This processor is used in conjunction with *DUPLICATE when duplicating subsets of the geometry. Additional examples are given under DUPLICATE.

ADJOINT

ADJOINT, 3D and 1D Monte Carlo, Charged Particles

****
This analysis procedure controls adjoint Monte Carlo electron, bremsstrahlung, and heavy charged particle transport.
****

****
Input Record Description:
****

==========
Header line
==========

*ADJOINT, options/

=======
Options
=======

K, 1D kernel generation for slab and spherical shields

H=h, h is the number of histories per energy group. If h is flagged with a minus sign, all output goes to the screen or NOVICE.SUM.

The number of histories per group defaults to 16 if not input

B, if absent, electron transport (or other charged particles as indicated by the Z option)

B=2, bremsstrahlung transport only

B=4, bremsstrahlung and electron transport

Z=z, atomic number of the charged particle being transported

The absence of Z indicates electrons.

Q, charge stopping calculation only. With the M option, pulse heights are stopping particles only.

R,uncouple large energy loss events from primary electron track ala its

C, isotropic secondary source from photons (if all spectra are photons, the code assumes a photon-electron problem) The default is an angular secondary source with 20 polar bins. The incident photons are assumed to be a plane wave traveling in the positive z direction. However, if the user inputs a *SOURCE distribution, the program does an explicit sampling of photons from this distribution and also performs detailed transport of the photons including Compton scattering, pair production, and fluorescence production.

F, fixed volume source option. The electron spectra are assumed to have a one to one correspondence with the materials. This option would be used to model beta decay sources.

G, source distribution option. There should be one *SOUrce distribution per *SPEctrum. Only the angular distribution of the SOUrce distribution is used. (SOUrce polar angle cosines are the direction cosines of the initial source particles. DETector cosines are the direction of adjoint particles, i.e., direction of tracking and opposite to particle flow direction.) If G is entered without a value, then the particle scoring is weighted with an exponential distribution (normalized) of the form exp(-(1-c3)/(1-cmin)) where c3 is the z-axis direction cosine of the particle at the exterior of the geometry and cmin is the lower bound input for the polar angle cosine distribution (all other source distribution data is not used). If G=1 is entered, the particle is scored for the SPEctrum/SOUrce combination only if the particle direction at the exterior of the geometry is within the limits for both the azimuthal angle and the polar angle cosine (spatial distributions of the source are ignored).

O, if present, production and transport of low energy knock-on electrons is performed. In the absence of the O option, the low energy knock-ons are modeled only to the extent that they decrease the primary electron energy. (Hard coded at O=1) Currently (May 91), the O=1 option is always used but can be turned off by entering O.

U, do not score pulse heights (M option) from particles which re enter the sensitive volume. U=1, pulse heights (M option) are calculated for particles that leave the volume rather than particles entering. U=2, same (M option) except reentry of the particles into the sensitive volume is not allowed.

I, calculate integral LET spectrum

W, for protons and M>0 option, include spallation effects. Use *PULSE in place of M>0 as a post processing procedure.

D=d, add d to log of brem source falloff over electron range

A, for K option, perform analog photon transport

L, steps max for heavy ions and electrons. The internal setting is 3*LOGANA where the step size is 1/LOGANA fractional energy loss.

V, steps per group for K option scoring (1 for electron and 3 for heavies builtin)

T, write entrance to major subprograms to screen (debug option)

T, trace option, writes line at selected points in calculation. Debug aid.

T=t only runs group t.

T=-t, runs group t without debug print.

J, debug print while running; J=1 for average physics parameters; J=2 for debug print statements.

M, pulse height distribution (no K option) calculation.

N,(rea,,-1,1) explicit knocks, knock or primary, no low e knock

S, separate output of contributions from particles crossing specific shield regions (no K option)

S=1 is input, then the crossing check is by region and surface. (no K option) If used, E option cannot be used.

E, separate output of contributions from particles entering outside surfaces of the geometry. E=e defines storage for up to 'e' entrance region/surface combinations. Default is 2. (no Koption)

E, if used, S option cannot be used.

P, if present, save (MATRIX.DAT file) response kernels (and spectra if requested by the X/Y options). also save all responses (unless P=p, then only p saved) in the format used by *SIGMA processor. This output will be surrounded by the other outputs on MATRIX.DAT -- the other outputs can be deleted to produce an attenuation data file for SIGMA. K option only.

X, output sensitivity to particle source group is printed K option only.

Y, output sensitivity to energy at detector is printed (0,1,2) = (integral, group, differential). K option only.

&a, if present, only use first two spectra for importance setup

&b, if present, weighted group-to-group for electron-electron, else analog

&c, if present, weighted group-to-group electron-electron, else analog

&d, if present, debug outputs(limited including some start tables)

&e, per cent error for automatic termination of a detector

&f, if present, attenuation photon spectrum

&g, if present, always ray trace on each electron step (no look ahead)

&h, gives maximum number of histories to plot on screen

&i, gives minimum energy group for particle trajectory plots

&j, gives maximum energy group for particle trajectory plots

&k, gives minimum collision for particle trajectory plots

&l, gives maximum collision for particle trajectory plots

&m, if present, generate a unique restart for each detector point

&n, photon scattering probability in adjpho

&o, (real,,0,1) fraction of time to do scattering in detect

&p, if present, plot particle trajectories

&q, if present, in new scoring reflect at x=0, y=0

&r, if present, half dimensions of particle plot on screen

&s, time between restart files

&t, maximum time for computer run

&u, index of spectrum for terminate on percent error, default 1

&v, index of response for terminate on percent error, default 1

&w, index of detector for terminate on percent error, default 1

&x, if present, preselect electron group before transport for photon

&y, if present, use group weighting for electro-photon transfer

&z, scales scattering ratio in adjoint photon

****
Data Record Description:
****

==========
M option: Solid angle bin boundaries.
==========

(omit if M option not selected).

Input four numbers per angular bin. These numbers are the azimuthal limits of the bin,>= -pi to <= pi and the polar cosine limits, -1 to 1 range. The code supplies a final 4pi bin, i.e.,if the user inputs

,/

the 4pi bin is the only angular bin

==========
M Option: Energy Loss Channel Boundaries
==========

(omit if M option not selected), in MeV or MeV/amu for heavy charged particles. A single record is input.

==========
M Option: Sensitive Volume Definitions.
==========

Omit if M option was not selected.

Each sensitive volume is defined by listing the regions comprising the sensitive volume. Each list is terminated by a slash. After all sensitive volumes are defined the input is terminated by an empty list, i.e. ,/

==========
M Option: Coincidence/Anti-Coincidence Volumes, paired input.
==========

==========
M Option: Threshold for Sensing, paired input.
==========

(omit if M option not selected) Multiple paired record input. The first record contains a list of volume indices, unsigned or positive for coincidence, and negative for anti-coincidence. The second record contains a threshold for sensing particle interactions in the volumes (MeV). The last two records must be

,/,/

==========
S=0 Option: Shield Crossing Region Indices.
==========

(omit if S option not selected). The shield region indices are listed in a single record.

==========
S=1 Option: Region Crossing Indices, paired input
==========

==========
S=1 Option: Surface Crossing Indices, paired input
==========

If the S=1 option is used, then shield crossings require two records, the first giving region indices and the second giving surface indices. A region index with a zero surface gets crossings for all surfaces, and a surface index with a zero region index gets crossings for all regions.

==========
Detector Indices.
==========

A single record listing the detectors to be run.

==========
K=0 Option: Shield Thicknesses.
==========

(supply only if the K option was selected). The shield thicknesses are listed with grams/square centimeter units.

==========
K=k Option: Box Wall Thicknesses.
==========

,t1 t2 ... tn/ box wall thicknesses

==========
K=k Option: Box Interior Dimensions.
==========

D1 D2 D3/ max half dimensions of the box INCLUDING WALLS

The following data is repeated k times, each time produces another set of detector points

==========
K=k Option: Detector Point Rotation/Replication.
==========

NAX,NROT/ where NAX is the axis the base set of detectors is rotated around and NROT is the multiple of PI/2 for the rotation.

==========
K=k Option: Cavity Dimensions for Replicated Detectors.
==========

d1 d2 d3/ the cavity half dimensions for this detector set.

==========
K=k Option: Baseline Wall Thicknesses, Replicated Detectors.
==========

t1 t2 t3/ the basic wall thickness before added thicknesses

****
Discussion:
****

The K option consists of patches to a 3D routine with the following assumptions: transport is in the material contained in region 1, only one detector point should be listed to be run, and it should be in region 1. The default geometry and detector suffice.

The K option also allows for running multiple points inside an empty box. The detector points are entered in the normal inputs. The user selects this option by specifying K=k where k is the number of sets of detector points (K=1 selects only the input detector point set). The following inputs are then provided

,1/ detector number--NOT USED but input anyway

The I option has special meaning with the K=k option and allows for an extension of the box face (corresponding with Van Gunten's experimental configuration). I haven't used it since I put it in the code six years ago and don't quite know how it works. Therefore, call me if you think the I option might be useful.

The adjoint tracking routines generate a restart file every 16 histories per group, i.e., the code starts a history in each energy group 16 times. Two restart files are generated for each run of 32 or more histories/group and are saved alternately as RESTRT19.DAT and RESTRT20.DAT (two files guards against system or power failure while writing the file). To restart from an old restart, rename the most current restart file OLDRUN.DAT (based on time and date of creation) and resubmit the problem without change to the data file (except for increasing the history count, if desired).

++++++++++++++
Output Tables:
++++++++++++++

A typical interactive stream for setup of a 3D adjoint run is shown in Table 10 (ADJPHO). This table was generated during the setup of a photon secondary electron problem so the expected value photon dose is also indicated in the table.

Output lines produced while running histories are given in Table 11 (ADJRUN). For interactive runs, these lines go to the screen. For batch runs, these lines are in the NOVICE.SUM file.

Normal 3D bremsstrahlung flux and response outputs are shown in Table 12 (ADJBRE).

Typical electron flux/response outputs are given in Table 13 (ADJELE). The format is similar to the bremsstrahlung format except for the additional lines giving charge stopping information. At the bottom of the table are entrance tallies requested with the E option.

Pulse height outputs produced for the M option have the typical format shown in Table 14 (ADJPHD). Pulse heights are obtained by source group (for a unit source) and weighted by spectra.

Three dimensional runs produce several output files in addition to the normal output. Table 15 (ADJDCF) indicates the AFWLDCF.DAT file format used for interfacing to an AFWL data processor.

Table 16 (ADJMAT) indicates the MATRIX.DAT file format, a triangular array of flux by primary particle source group.

Table 17 (ADJEFK) indicates the format of the EFKOUT.DAT file which contains a summary of the total response functions.

The Table 18 (ADJPLT) indicates the format of the pulse height summary file GOPLOT.DAT produced from a pulse height analysis run.

The K-option produces output tables with a different format.

The most abbreviated output format simply gives response versus thickness for five simple geometries as shown in Table 19 (ADJKOP).

Alternatively, the user can ask for outputs versus source energy (the X-option), with the resulting output format indicated in Table 20 (ADJKXX).

The user can also request outputs versus flux (scoring) energy (the Y-option) with the output format shown in Table 21 (ADJKYY).

Finally, the user can request outputs versus both source and flux energy (X and Y options) with the output formats shown in Table 22 (ADJKXY).

The K-option can also produce a summary file giving response versus thickness (P-option) with output going to the MATRIX.DAT file and with the format indicated in Table 23 (ADJSIG).

++++++++++++++
Output Figures:
++++++++++++++

Data plotted directly from the PLOT.DAT file generated during an ADJOINT calculation are show in Figure 1 (ADJP16), a pulse height distribution.

Figure 2 (ADJPNE) is a typical photon spectrum plot.

Figure 3 (ADJENE) indicates a calculated electron flux spectrum.

Bremsstrahlung dose versus thickness, from the K option, is shown in Figure 4 (ADJKB2).

The corresponding electron dose versus thickness is given in Figure 5 (ADJKEL).

Table 10: (ADJPHO) In/Out Photon/Electron Setup

```
INPUT *HEADER,OPTIONS/
Line   1:*ADJOINT,M/
ADJOINT*******************************************************************

ENTER DEFCCC FOR ADJOINT DATA INPUTS
INPUT SOLID ANGLE BOUNDARIES, AZIMUTH THEN POLAR COSIN
Line   2:,-3.1416 3.1416 -1 0 -3.1416 3.1416 0 1/
INPUT ENERGY LOSS BOUNDARIES
Line   3:.001 LI30*1/
             ARRAY ORDER CHANGED TO DECREASING
             *INFO*INFO*INFO*INFO*INFO*INFO*INFO*INFO*INFO*INFO*INFO*
INPUT REGIONS COMPRISING SENSITIVE VOLUME(S)

UNIT  12 OPENED JUMP.DAT
Line   4:,1/,/
         DATA INTERPRETATION STARTING AT COLUMN  4 OF LINE    4
INPUT COINCIDENCE, ANTI-COINCIDENCE VOLUMES, THRESHOLD
Line   5:,1/,.00005/
Line   6:,/,/

UNIT  12 CLOSED , STATUS = DEL

ENTER DEFEEE TO ALLOCATE STORAGE FOR ADJOINT ARRAYS

ENTER DEFDDD TO SET UP PULSE HEIGHT INFORMATION
INPUT LIST OF DETECTOR INDICES/
Line   7:,1/

ENTER DEFAAA TO CALCULATE ELECTRON-ELECTRON XSECTS

ENTER DEFBBB FOR MORE XSECTS

ENTER ADJSET TO CHECK FOR OLDRUN/RESTART

NON EXISTANT FILE: OLDRUN.DAT

ENTER DEFPHO TO SETUP PHOTON-ELECTRON SOURCES

UNIT  22 OPENED FLUXES.DAT

PHOTON ENERGY DEPOSITION, RADS, FOR SPECTRUM  1   DEBRIS_GAM
RAD DOSE MATERIAL  1      SILICON IS 7.05E-11 PHOTON E (MEV) ABOVE    3.1623
RAD DOSE MATERIAL  1      SILICON IS 2.72E-10 PHOTON E (MEV) ABOVE    1.0000
RAD DOSE MATERIAL  1      SILICON IS 4.00E-10 PHOTON E (MEV) ABOVE     .3162
RAD DOSE MATERIAL  1      SILICON IS 4.22E-10 PHOTON E (MEV) ABOVE     .1000
RAD DOSE MATERIAL  1      SILICON IS 4.22E-10 PHOTON E (MEV) ABOVE     .0316
RAD DOSE MATERIAL  1      SILICON IS 4.22E-10 PHOTON E (MEV) ABOVE     .0100
RAD DOSE MATERIAL  2       HGCDTE IS 9.27E-11 PHOTON E (MEV) ABOVE    3.1623
RAD DOSE MATERIAL  2       HGCDTE IS 2.97E-10 PHOTON E (MEV) ABOVE    1.0000
RAD DOSE MATERIAL  2       HGCDTE IS 4.99E-10 PHOTON E (MEV) ABOVE     .3162
RAD DOSE MATERIAL  2       HGCDTE IS 6.54E-10 PHOTON E (MEV) ABOVE     .1000
RAD DOSE MATERIAL  2       HGCDTE IS 6.54E-10 PHOTON E (MEV) ABOVE     .0316
RAD DOSE MATERIAL  2       HGCDTE IS 6.54E-10 PHOTON E (MEV) ABOVE     .0100
```

Table 11: (ADJRUN) Outputs While Running

```
START HISTORY, GROUP    1    1
START HISTORY, GROUP    1    2
  :
START HISTORY, GROUP    1   40
NUMRAY,NUMSEG,NOTEST,NOFAIL    1019    1019       0       0    1019    1019
START HISTORY, GROUP    2    1
START HISTORY, GROUP    2    2
  :
START HISTORY, GROUP    2   40
NUMRAY,NUMSEG,NOTEST,NOFAIL    1055    1055       0       0    2074    2074
START HISTORY, GROUP    3    1
START HISTORY, GROUP    3    2
  :
START HISTORY, GROUP   16   40
NUMRAY,NUMSEG,NOTEST,NOFAIL    1074    1074       0       0   17599   17599

UNIT  19 OPENED RESTART.U19

UNIT  19 CLOSED , STATUS = KEEP
   16 HISTORY RESTART ON UNIT  19

UNIT  29 OPENED EFKOUT.DAT
-------------------------------------------------------------------------------
  21=SUR   5=BOD   5=REG   2=MAT   1=SOU   2=DET   2=PAR   1=SPE   4=RES  0=ERR
-------------------------------------------------------------------------------
                  1         2         3         4         5         6         7
         12345678901234567890123456789012345678901234567890123456789012345678901234567890
INPUT *HEADER,OPTIONS/
Line   8:*STOP
```

Table 12: (ADJBRE) Brem Flux Outputs (3D)

```
     450526 RANDOM NUMBERS USED

KILLS     0     0     0     0     0     1     0     0     0     0
KILLS     0     0     1   202  1738     4    38     0     0     0

MASS PATH (GM/SQCM) MIN, AVE, MAX =  2.7065E+00  4.0661E+00  1.4149E+01

SOURCE SPECTRUM   1,FISSION_BETA,      PHOTON,   XYZ=0,0,0

GROUP    E-MAX     E-MIN     E-AVE   #/(SQCM*MEV)   #/(SQCM*GRP)  # > EMIN/SQCM
    1 1.00E+01  7.94E+00  8.37E+00    8.85E-09 35    1.82E-08 35    1.82E-08 35
    2 7.94E+00  6.31E+00  6.96E+00    3.87E-07 26    6.33E-07 26    6.51E-07 25
    3 6.31E+00  5.01E+00  5.53E+00    4.10E-06 18    5.32E-06 18    5.97E-06 16
    4 5.01E+00  3.98E+00  4.37E+00    2.19E-05 15    2.26E-05 15    2.86E-05 12
    5 3.98E+00  3.16E+00  3.54E+00    9.44E-05 12    7.73E-05 12    1.06E-04  9
    6 3.16E+00  2.51E+00  2.83E+00    2.46E-04 10    1.60E-04 10    2.66E-04  7
    7 2.51E+00  2.00E+00  2.22E+00    5.26E-04  9    2.72E-04  9    5.37E-04  6
    8 2.00E+00  1.58E+00  1.79E+00    1.28E-03  9    5.25E-04  9    1.06E-03  5
    9 1.58E+00  1.26E+00  1.41E+00    1.83E-03  9    5.97E-04  9    1.66E-03  5
    :
   31 1.00E-02  7.94E-03  9.85E-03    1.18E-11 99    2.42E-14 99    4.56E-02  5

UNIT  22 OPENED FLUXES.DAT

22 FILE BEING OPENED TO EXTEND
        ALUMINUM RESPONSE  7.64E-12  3
         SILICON RESPONSE  8.60E-12  4
     NUMBER FLUX RESPONSE  4.56E-02  5
     ENERGY FLUX RESPONSE  1.28E-02  3

PARTICLE CURRENT,       PHOTONS/SQCM
       X-COSINE    Y-COSINE    Z-COSINE     BACKWARD      FORWARD      NET=F-B
X    1.0000E+00  0.0000E+00  0.0000E+00  1.13E-02 10  1.12E-02  8 -1.26E-04 99
Y    0.0000E+00  1.0000E+00  0.0000E+00  1.06E-02  8  1.26E-02 11  2.00E-03 81
Z    0.0000E+00  0.0000E+00  1.0000E+00  9.88E-03  8  1.20E-02 11  2.13E-03 72
MAX -4.3026E-02  6.8408E-01  7.2814E-01  1.49E-02 12  1.78E-02 15  2.93E-03 99

NUMBER FLUX DATA, /(SQCM*MEV), FOR PARTICLES ENTERING

----ENERGY (MEV) DATA----    1= REGION    1= REGION    1= REGION    1= REGION
GROUP   MAXIMUM   MINIMUM    4=SURFACE    2=SURFACE    6=SURFACE    3=SURFACE
    1  1.00E+01  7.94E+00  1.79E-09 66  4.03E-10 73  1.30E-09 66  2.40E-09 99
    2  7.94E+00  6.31E+00  7.70E-08 56  1.92E-08 47  1.43E-07 58  4.25E-09 68
    :
   31  1.00E-02  7.94E-03  1.18E-11 99  5.25E-27  0  6.56E-25  0  1.01E-23  0
        ALUMINUM RESPONSE  1.38E-12  9  1.14E-12 10  1.40E-12 12  1.37E-12  9
         SILICON RESPONSE  1.53E-12  9  1.27E-12 10  1.61E-12 13  1.56E-12 10
     NUMBER FLUX RESPONSE  7.99E-03 11  6.69E-03 12  9.24E-03 17  7.65E-03 11
     ENERGY FLUX RESPONSE  2.48E-03  9  2.02E-03  9  2.03E-03 11  2.19E-03  9
```

Table 13: (ADJELE) Electron Flux Outputs (3D)

```
UNIT  23 OPENED AFWLDCF.DAT

23 FILE BEING OPENED TO EXTEND

UNIT  24 OPENED MATRIX.DAT

24 FILE BEING OPENED TO EXTEND

    1455435 RANDOM NUMBERS USED

KILLS     0     0     0     0     0     0     0     0     0     0
KILLS     0     0     0   402  1441    20   121     0     0     0

MASS PATH (GM/SQCM) MIN, AVE, MAX =  2.7335E+00  4.1562E+00  6.3345E+00

SOURCE SPECTRUM   1,FISSION_BETA,    ELECTRON,   XYZ=0,0,0

GROUP    E-MAX     E-MIN     E-AVE   #/(SQCM*MEV)   #/(SQCM*GRP)  # > EMIN/SQCM
    3 6.31E+00  5.01E+00  5.09E+00    8.38E-07 58    1.09E-06 58    1.09E-06 58
    4 5.01E+00  3.98E+00  4.29E+00    7.41E-06 35    7.63E-06 35    8.72E-06 31
    5 3.98E+00  3.16E+00  3.52E+00    3.92E-05 21    3.21E-05 21    4.08E-05 18
    6 3.16E+00  2.51E+00  2.79E+00    1.31E-04 19    8.53E-05 19    1.26E-04 14
    7 2.51E+00  2.00E+00  2.25E+00    2.47E-04 22    1.27E-04 22    2.53E-04 13
    8 2.00E+00  1.58E+00  1.80E+00    4.01E-04 15    1.65E-04 15    4.18E-04 10
    :
   31 1.00E-02  7.94E-03  9.38E-03    2.11E-04 25    4.34E-07 25    2.20E-03  5
            PARTICLES STOPPED PER CUBIC CM OF     ALUMINUM  1.03E-02 25
                   ESTIMATED DOSE INCREMENT BELOW E CUTOFF  4.86E-13 25
            PARTICLES STOPPED PER CUBIC CM OF      SILICON  9.39E-03 25
                   ESTIMATED DOSE INCREMENT BELOW E CUTOFF  4.98E-13 25
        ALUMINUM RESPONSE  5.99E-11  5
         SILICON RESPONSE  6.19E-11  5
     NUMBER FLUX RESPONSE  2.20E-03  5
     ENERGY FLUX RESPONSE  2.37E-03  6

PARTICLE CURRENT,     ELECTRONS/SQCM
       X-COSINE    Y-COSINE    Z-COSINE     BACKWARD      FORWARD      NET=F-B
X    1.0000E+00  0.0000E+00  0.0000E+00  6.21E-04 11  5.48E-04 12 -7.32E-05 99
Y    0.0000E+00  1.0000E+00  0.0000E+00  4.90E-04 10  5.06E-04 11  1.63E-05 99
Z    0.0000E+00  0.0000E+00  1.0000E+00  5.44E-04 11  5.00E-04 13 -4.43E-05 99
MAX -8.4063E-01  1.8671E-01 -5.0842E-01  8.06E-04 13  8.94E-04 12  8.71E-05 99

NUMBER FLUX DATA, /(SQCM*MEV), FOR PARTICLES ENTERING

----ENERGY (MEV) DATA----    1= REGION    1= REGION    1= REGION    1= REGION
GROUP   MAXIMUM   MINIMUM    4=SURFACE    2=SURFACE    6=SURFACE    3=SURFACE
    3  6.31E+00  5.01E+00  0.00E+00  0  0.00E+00  0  5.63E-07 73  0.00E+00  0
    4  5.01E+00  3.98E+00  7.39E-07 76  1.48E-06 70  0.00E+00  0  2.45E-06 60
    5  3.98E+00  3.16E+00  7.80E-06 61  0.00E+00  0  4.64E-06 55  6.38E-06 48
    :
```

Table 14: (ADJPHD) Pulse Height Outputs (3D)

```
     170675 RANDOM NUMBERS USED

KILLS      0      0      0      0      0      0      0      0      0      0
KILLS      0      0      0      0    640      0      0      0      0      0

MASS PATH (GM/SQCM) MIN, AVE, MAX =  0.0000E+00  3.8215E-02  1.7959E-01

UNIT  25 OPENED GOPLOT.DAT

-------------------------------------------------------------------------------
COINCIDENCE/ANTI-COINCIDENCE VOLUME LIST    1
AZIMUTHAL LIMITS -3.1416E+00  3.1416E+00 FROM X TO Y
, POLAR COSINE LIMITS -1.0000E+00  0.0000E+00 FROM +Z-AXIS
SOURCE   CHANNEL TOP-MEV/AMU  1.0000E+00  7.9433E-01  6.3096E-01  5.0119E-01
 GROUP   CHANNEL LOW-MEV/AMU  7.9433E-01  6.3096E-01  5.0119E-01  3.9811E-01
   1  1.0000E+01  7.9433E+00 2.90E-09 96 0.00E+00  0 0.00E+00  0 0.00E+00  0

-------------------------------------------------------------------------------
COINCIDENCE/ANTI-COINCIDENCE VOLUME LIST    1
AZIMUTHAL LIMITS -3.1416E+00  3.1416E+00 FROM X TO Y
, POLAR COSINE LIMITS -1.0000E+00  0.0000E+00 FROM +Z-AXIS
SOURCE   CHANNEL TOP-MEV/AMU  1.5849E-01  1.2589E-01  1.0000E-01  7.9433E-02
 GROUP   CHANNEL LOW-MEV/AMU  1.2589E-01  1.0000E-01  7.9433E-02  6.3096E-02
  15  3.9811E-01  3.1623E-01 0.00E+00  0 6.34E-11 96 2.08E-10 96 0.00E+00  0
  16  3.1623E-01  2.5119E-01 7.90E-14 96 4.48E-10 93 5.29E-10 64 7.54E-12 96
  17  2.5119E-01  1.9953E-01 1.10E-10 96 5.74E-10 63 1.47E-09 56 7.58E-10 68
  18  1.9953E-01  1.5849E-01 1.59E-10 73 2.24E-10 57 1.35E-09 50 9.75E-10 45
  19  1.5849E-01  1.2589E-01 2.05E-10 96 6.58E-10 58 1.34E-09 54 3.07E-09 32
  20  1.2589E-01  1.0000E-01 0.00E+00  0 5.29E-10 88 3.49E-10 47 1.37E-09 26
  21  1.0000E-01  7.9433E-02 0.00E+00  0 4.28E-10 95 2.02E-10 64 8.51E-10 36
  22  7.9433E-02  6.3096E-02 0.00E+00  0 0.00E+00  0 8.74E-11 96 5.59E-10 56
  23  6.3096E-02  5.0119E-02 0.00E+00  0 0.00E+00  0 0.00E+00  0 8.63E-11 63
   1SPECTRUM,   DEBRIS_GAM   4.96E-11 92 2.48E-10 40 5.31E-10 41 6.75E-10 27

-------------------------------------------------------------------------------
COINCIDENCE/ANTI-COINCIDENCE VOLUME LIST    1
AZIMUTHAL LIMITS -3.1416E+00  3.1416E+00 FROM X TO Y
, POLAR COSINE LIMITS -1.0000E+00  0.0000E+00 FROM +Z-AXIS
SOURCE   CHANNEL TOP-MEV/AMU  6.3096E-02  5.0119E-02  3.9811E-02  3.1623E-02
 GROUP   CHANNEL LOW-MEV/AMU  5.0119E-02  3.9811E-02  3.1623E-02  2.5119E-02
   3  6.3096E+00  5.0119E+00 0.00E+00  0 0.00E+00  0 0.00E+00  0 8.25E-10 96
   4  5.0119E+00  3.9811E+00 0.00E+00  0 0.00E+00  0 0.00E+00  0 1.88E-09 96
   8  1.9953E+00  1.5849E+00 0.00E+00  0 0.00E+00  0 1.17E-09 96 0.00E+00  0
  15  3.9811E-01  3.1623E-01 0.00E+00  0 0.00E+00  0 0.00E+00  0 2.73E-10 96
  16  3.1623E-01  2.5119E-01 6.44E-10 88 0.00E+00  0 5.21E-10 95 8.56E-11 67
  17  2.5119E-01  1.9953E-01 1.43E-09 40 5.20E-10 93 7.06E-10 74 9.80E-10 42
  18  1.9953E-01  1.5849E-01 1.61E-09 40 4.51E-10 47 9.69E-10 73 8.91E-10 50
  19  1.5849E-01  1.2589E-01 1.44E-09 54 1.10E-09 31 9.06E-10 37 1.20E-09 37
   :
  27  2.5119E-02  1.9953E-02 0.00E+00  0 0.00E+00  0 1.98E-13 96 1.78E-11 63
   1SPECTRUM,   DEBRIS_GAM   6.92E-10 26 3.64E-10 21 5.36E-10 27 5.10E-10 25
```

Table 15: (ADJDCF) AFWLDCF.DAT Output File (3D)

```
       31

CM
1.000E+01 7.943E+00 6.310E+00 5.012E+00 3.981E+00 3.162E+00 2.512E+00 1.995E+00
1.585E+00 1.259E+00 1.000E+00 7.943E-01 6.310E-01 5.012E-01 3.981E-01 3.162E-01
2.512E-01 1.995E-01 1.585E-01 1.259E-01 1.000E-01 7.943E-02 6.310E-02 5.012E-02
3.981E-02 3.162E-02 2.512E-02 1.995E-02 1.585E-02 1.259E-02 1.000E-02
       16
  XYZ=0,0,0
   ALUMINUM      PHOTON
0.000E+00 0.000E+00 0.000E+00
3.325E-10 1.590E-10 9.538E-11 7.215E-11 4.048E-11 1.582E-11 2.063E-11 1.093E-11
4.704E-12 3.996E-12 7.216E-13 1.545E-12 2.668E-12 4.724E-15 9.512E-14 0.000E+00
0.000E+00 0.000E+00 4.074E-14 2.281E-13 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 3.083E-44 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
6.852E+01 2.520E+01 1.751E+01 1.421E+01 2.280E+01 1.921E+01 1.864E+01 2.514E+01
3.886E+01 4.447E+01 7.676E+01 5.921E+01 5.897E+01 9.700E+01 9.700E+01 0.000E+00
0.000E+00 0.000E+00 9.700E+01 9.700E+01 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
1.800E-13 4.272E-14 0.000E+00 1.068E-23 0.000E+00 9.297E-31 4.757E-27 3.882E-29
0.000E+00 9.541E-31 0.000E+00 0.000E+00 0.000E+00 8.594E-33 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 6.325E-36 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
9.700E+01 9.700E+01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
       16
  XYZ=0,0,0
    SILICON      PHOTON
0.000E+00 0.000E+00 0.000E+00
3.465E-10 1.752E-10 1.010E-10 7.738E-11 4.731E-11 1.685E-11 2.345E-11 1.264E-11
5.662E-12 4.790E-12 8.734E-13 1.889E-12 3.435E-12 6.224E-15 1.127E-13 0.000E+00
0.000E+00 0.000E+00 5.331E-14 2.966E-13 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 4.064E-44 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
6.834E+01 2.593E+01 1.740E+01 1.451E+01 2.463E+01 1.932E+01 1.939E+01 2.609E+01
4.014E+01 4.636E+01 7.903E+01 6.076E+01 5.933E+01 9.700E+01 9.700E+01 0.000E+00
0.000E+00 0.000E+00 9.700E+01 9.700E+01 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
2.093E-13 4.967E-14 0.000E+00 1.242E-23 0.000E+00 1.081E-30 5.531E-27 4.514E-29
0.000E+00 1.109E-30 0.000E+00 0.000E+00 0.000E+00 9.993E-33 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 7.355E-36 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
9.700E+01 9.700E+01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
       16
  XYZ=0,0,0
NUMBER FLUX      PHOTON
0.000E+00 0.000E+00 0.000E+00
5.516E-01 8.374E-01 3.941E-01 2.799E-01 1.693E-01 8.926E-02 1.608E-01 1.082E-01
3.991E-02 3.044E-02 5.408E-03 1.200E-02 1.399E-02 3.678E-06 1.441E-03 0.000E+00
  :
```

Table 16: (ADJMAT) MATRIX.DAT Output File (3D)

```
 1.00E+01 7.94E+00 6.31E+00 5.01E+00 3.98E+00 3.16E+00 2.51E+00 2.00E+00
 1.58E+00 1.26E+00 1.00E+00 7.94E-01 6.31E-01 5.01E-01 3.98E-01 3.16E-01
 2.51E-01 2.00E-01 1.58E-01 1.26E-01 1.00E-01 7.94E-02 6.31E-02 5.01E-02
 3.98E-02 3.16E-02 2.51E-02 2.00E-02 1.58E-02 1.26E-02 1.00E-02 7.94E-03
 5.25E-04
 4.10E+01
 4.22E-03 3.47E-04
 5.12E+01 5.32E+01
 6.93E-04 3.13E-03 6.58E-04
 7.45E+01 4.51E+01 4.02E+01
 5.60E-03 4.72E-03 1.50E-03 2.24E-04
 7.40E+01 4.20E+01 5.55E+01 6.64E+01
 1.91E-02 4.94E-03 4.11E-04 2.19E-03 0.00E+00
 9.63E+01 5.20E+01 8.90E+01 3.80E+01 0.00E+00
 1.84E-02 2.97E-03 1.02E-02 2.30E-03 1.59E-03 3.01E-04
 6.84E+01 6.70E+01 4.10E+01 5.70E+01 5.22E+01 9.70E+01
 1.50E-02 1.86E-02 8.68E-03 7.29E-03 9.44E-04 0.00E+00 0.00E+00
 8.90E+01 9.40E+01 6.00E+01 3.50E+01 7.90E+01 0.00E+00 0.00E+00
 2.55E-02 2.67E-02 5.31E-03 9.57E-03 3.09E-03 1.21E-03 0.00E+00 0.00E+00
 9.05E+01 5.90E+01 6.84E+01 4.83E+01 5.31E+01 8.20E+01 0.00E+00 0.00E+00
 4.08E-01 2.99E-02 1.94E-02 1.25E-02 4.87E-03 0.00E+00 6.02E-04 0.00E+00
 0.00E+00
 9.70E+01 9.00E+01 5.32E+01 4.70E+01 4.82E+01 0.00E+00 9.70E+01 0.00E+00
 0.00E+00
   :
 1.63E-13 3.88E-14 0.00E+00 9.69E-24 0.00E+00 8.44E-31 4.32E-27 3.52E-29
 0.00E+00 8.66E-31 0.00E+00 0.00E+00 0.00E+00 7.80E-33 0.00E+00 0.00E+00
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 0.00E+00 5.74E-36 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 9.70E+01 9.70E+01 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
C    XYZ=0,0,0,     ALUMINUM,       PHOTON,   5.9333E-09
 4.98E-01 3.93E-01 3.18E-01 2.62E-01 2.16E-01 1.79E-01 1.49E-01 1.25E-01
 1.05E-01 8.75E-02 7.28E-02 5.99E-02 4.86E-02 3.89E-02 3.09E-02 2.42E-02
 1.89E-02 1.49E-02 1.21E-02 1.05E-02 1.03E-02 1.19E-02 1.61E-02 2.41E-02
 3.81E-02 6.18E-02 1.01E-01 1.65E-01 2.68E-01 4.32E-01 6.94E-01 1.10E+00
C    XYZ=0,0,0,      SILICON,       PHOTON,   6.6750E-09
 4.75E-01 3.72E-01 2.99E-01 2.46E-01 2.02E-01 1.67E-01 1.38E-01 1.16E-01
 9.67E-02 8.08E-02 6.73E-02 5.53E-02 4.49E-02 3.60E-02 2.86E-02 2.25E-02
 1.76E-02 1.40E-02 1.15E-02 1.03E-02 1.06E-02 1.28E-02 1.79E-02 2.74E-02
 4.39E-02 7.16E-02 1.17E-01 1.93E-01 3.14E-01 5.06E-01 8.11E-01 1.28E+00
```

Table 17: (ADJEFK) EFKOUT.DAT Summary File (3D)

```
    ELECTRON,  DEBRIS_GAM,     SILICON, NOVA 1986 ERA
1.72E-10
5.00E+00
    ELECTRON,  DEBRIS_GAM,      HGCDTE, NOVA 1986 ERA
1.11E-10
5.00E+00
    ELECTRON,  DEBRIS_GAM, NUMBER FLUX, NOVA 1986 ERA
2.79E-03
5.00E+00
    ELECTRON,  DEBRIS_GAM, ENERGY FLUX, NOVA 1986 ERA
7.69E-04
5.00E+00
```

Table 18: (ADJPLT) GOPLOT.DAT PHD File (3D)

```
CHANNEL TOP-MEV/AMU  1.5849E-01  1.2589E-01  1.0000E-01  7.9433E-02
CHANNEL LOW-MEV/AMU  1.2589E-01  1.0000E-01  7.9433E-02  6.3096E-02
  1    DEBRIS_GAM   4.96E-11 92 2.48E-10 40 5.31E-10 41 6.75E-10 27
CHANNEL TOP-MEV/AMU  6.3096E-02  5.0119E-02  3.9811E-02  3.1623E-02
CHANNEL LOW-MEV/AMU  5.0119E-02  3.9811E-02  3.1623E-02  2.5119E-02
  1    DEBRIS_GAM   6.92E-10 26 3.64E-10 21 5.36E-10 27 5.10E-10 25
CHANNEL TOP-MEV/AMU  2.5119E-02  1.9953E-02  1.5849E-02  1.2589E-02
CHANNEL LOW-MEV/AMU  1.9953E-02  1.5849E-02  1.2589E-02  1.0000E-02
  1    DEBRIS_GAM   7.80E-10 19 8.98E-10 33 5.61E-10 28 7.27E-10 24
CHANNEL TOP-MEV/AMU  1.0000E-02  7.9433E-03  6.3096E-03  5.0119E-03
CHANNEL LOW-MEV/AMU  7.9433E-03  6.3096E-03  5.0119E-03  3.9811E-03
  1    DEBRIS_GAM   3.82E-10 23 1.29E-10 35 2.22E-10 45 9.18E-11 38
CHANNEL TOP-MEV/AMU  3.9811E-03  3.1623E-03  2.5119E-03  1.9953E-03
CHANNEL LOW-MEV/AMU  3.1623E-03  2.5119E-03  1.9953E-03  1.5849E-03
  1    DEBRIS_GAM   1.47E-10 89 1.39E-10 51 1.10E-10 60 1.52E-10 41
CHANNEL TOP-MEV/AMU  1.5849E-03  1.2589E-03
CHANNEL LOW-MEV/AMU  1.2589E-03  1.0000E-03
  1    DEBRIS_GAM   4.38E-11 72 1.21E-10 67
CHANNEL TOP-MEV/AMU  1.5849E-01  1.2589E-01  1.0000E-01  7.9433E-02
CHANNEL LOW-MEV/AMU  1.2589E-01  1.0000E-01  7.9433E-02  6.3096E-02
  1    DEBRIS_GAM   1.69E-11 73 3.16E-10 49 4.96E-10 35 4.90E-10 22
CHANNEL TOP-MEV/AMU  6.3096E-02  5.0119E-02  3.9811E-02  3.1623E-02
CHANNEL LOW-MEV/AMU  5.0119E-02  3.9811E-02  3.1623E-02  2.5119E-02
  1    DEBRIS_GAM   5.62E-10 25 3.67E-10 17 5.44E-10 36 4.97E-10 19
CHANNEL TOP-MEV/AMU  2.5119E-02  1.9953E-02  1.5849E-02  1.2589E-02
CHANNEL LOW-MEV/AMU  1.9953E-02  1.5849E-02  1.2589E-02  1.0000E-02
  1    DEBRIS_GAM   7.05E-10 14 8.29E-10 25 4.91E-10 22 4.65E-10 33
CHANNEL TOP-MEV/AMU  1.0000E-02  7.9433E-03  6.3096E-03  5.0119E-03
CHANNEL LOW-MEV/AMU  7.9433E-03  6.3096E-03  5.0119E-03  3.9811E-03
  1    DEBRIS_GAM   5.83E-10 26 1.44E-10 34 3.25E-10 42 1.30E-10 32
CHANNEL TOP-MEV/AMU  3.9811E-03  3.1623E-03  2.5119E-03  1.9953E-03
CHANNEL LOW-MEV/AMU  3.1623E-03  2.5119E-03  1.9953E-03  1.5849E-03
  1    DEBRIS_GAM   1.02E-10 45 5.93E-11 59 1.81E-10 69 6.04E-11 57
CHANNEL TOP-MEV/AMU  1.5849E-03  1.2589E-03
CHANNEL LOW-MEV/AMU  1.2589E-03  1.0000E-03
  1    DEBRIS_GAM   4.17E-11 85 1.54E-10 43
CHANNEL TOP-MEV/AMU  1.5849E-01  1.2589E-01  1.0000E-01  7.9433E-02
CHANNEL LOW-MEV/AMU  1.2589E-01  1.0000E-01  7.9433E-02  6.3096E-02
  1    DEBRIS_GAM   6.64E-11 87 5.64E-10 42 1.03E-09 36 1.17E-09 21
CHANNEL TOP-MEV/AMU  6.3096E-02  5.0119E-02  3.9811E-02  3.1623E-02
CHANNEL LOW-MEV/AMU  5.0119E-02  3.9811E-02  3.1623E-02  2.5119E-02
  1    DEBRIS_GAM   1.25E-09 25 7.31E-10 16 1.08E-09 30 1.01E-09 21
CHANNEL TOP-MEV/AMU  2.5119E-02  1.9953E-02  1.5849E-02  1.2589E-02
CHANNEL LOW-MEV/AMU  1.9953E-02  1.5849E-02  1.2589E-02  1.0000E-02
  1    DEBRIS_GAM   1.48E-09 14 1.73E-09 27 1.05E-09 18 1.19E-09 18
CHANNEL TOP-MEV/AMU  1.0000E-02  7.9433E-03  6.3096E-03  5.0119E-03
CHANNEL LOW-MEV/AMU  7.9433E-03  6.3096E-03  5.0119E-03  3.9811E-03
  1    DEBRIS_GAM   9.65E-10 18 2.73E-10 28 5.48E-10 42 2.21E-10 31
CHANNEL TOP-MEV/AMU  3.9811E-03  3.1623E-03  2.5119E-03  1.9953E-03
CHANNEL LOW-MEV/AMU  3.1623E-03  2.5119E-03  1.9953E-03  1.5849E-03
  1    DEBRIS_GAM   2.49E-10 64 1.98E-10 39 2.91E-10 64 2.12E-10 41
CHANNEL TOP-MEV/AMU  1.5849E-03  1.2589E-03
CHANNEL LOW-MEV/AMU  1.2589E-03  1.0000E-03
  1    DEBRIS_GAM   8.55E-11 53 2.76E-10 35
```

Table 19: (ADJKOP) K-opt Response Outputs (1D)

```
     390867 RANDOM NUMBERS USED
KILLS      0      0      0      0      0      0      0      0      0      0
KILLS      0      0      0    404      0     13     79      0      0      0

UNIT  24 OPENED MATRIX.DAT

FISSION_BETA SPECTRUM,    ELECTRON RESPONSE FOR     ALUMINUM
TRANSPORT IN MATERIAL   1,    ALUMINUM
   G/SQCM      MILS      SPHERE   SPH SHELL      2*SLAB   DUBL SLAB   BACK SLAB
4.000E-03 5.833E-01 3.12E-08  0 3.08E-08  0 2.38E-08  2 2.96E-08  0 3.87E-08  1
5.036E-03 7.343E-01 3.06E-08  0 3.01E-08  0 2.29E-08  2 2.88E-08  0 3.76E-08  1
6.340E-03 9.244E-01 2.99E-08  0 2.95E-08  0 2.15E-08  2 2.79E-08  0 3.60E-08  2
7.981E-03 1.164E+00 2.93E-08  0 2.88E-08  0 2.05E-08  2 2.71E-08  0 3.44E-08  2
1.005E-02 1.465E+00 2.87E-08  0 2.82E-08  0 1.97E-08  2 2.65E-08  0 3.33E-08  2
1.265E-02 1.844E+00 2.81E-08  0 2.74E-08  0 1.90E-08  3 2.59E-08  0 3.21E-08  2
1.592E-02 2.322E+00 2.75E-08  0 2.68E-08  0 1.82E-08  3 2.53E-08  0 3.10E-08  2
2.005E-02 2.923E+00 2.69E-08  0 2.61E-08  0 1.70E-08  3 2.46E-08  0 2.97E-08  1
2.524E-02 3.680E+00 2.64E-08  0 2.55E-08  0 1.63E-08  3 2.39E-08  1 2.86E-08  2
3.177E-02 4.633E+00 2.58E-08  0 2.48E-08  0 1.54E-08  4 2.31E-08  1 2.72E-08  1
4.000E-02 5.833E+00 2.52E-08  0 2.40E-08  0 1.44E-08  4 2.23E-08  1 2.57E-08  2
5.036E-02 7.343E+00 2.46E-08  0 2.34E-08  0 1.33E-08  4 2.12E-08  1 2.42E-08  2
6.340E-02 9.244E+00 2.39E-08  0 2.27E-08  0 1.25E-08  5 2.02E-08  1 2.26E-08  2
7.981E-02 1.164E+01 2.32E-08  0 2.19E-08  0 1.14E-08  5 1.90E-08  1 2.08E-08  1
1.005E-01 1.465E+01 2.25E-08  1 2.08E-08  1 1.06E-08  5 1.77E-08  1 1.89E-08  1
1.265E-01 1.844E+01 2.15E-08  1 1.95E-08  1 9.50E-09  5 1.62E-08  2 1.70E-08  2
1.592E-01 2.322E+01 2.05E-08  1 1.80E-08  1 8.35E-09  6 1.45E-08  2 1.49E-08  2
2.005E-01 2.923E+01 1.94E-08  1 1.62E-08  2 7.40E-09  7 1.28E-08  3 1.31E-08  3
2.524E-01 3.680E+01 1.79E-08  1 1.43E-08  2 6.44E-09  6 1.11E-08  3 1.13E-08  3
3.177E-01 4.633E+01 1.63E-08  1 1.22E-08  3 5.44E-09  7 9.36E-09  4 9.47E-09  4
4.000E-01 5.833E+01 1.45E-08  1 1.01E-08  3 4.02E-09  7 7.08E-09  5 7.10E-09  5
5.036E-01 7.343E+01 1.23E-08  1 7.76E-09  4 3.02E-09  8 5.29E-09  5 5.29E-09  5
6.340E-01 9.244E+01 9.97E-09  2 5.49E-09  5 2.14E-09  9 3.75E-09  6 3.75E-09  6
7.981E-01 1.164E+02 7.58E-09  2 3.69E-09  6 1.44E-09  9 2.49E-09  6 2.49E-09  6
1.005E+00 1.465E+02 5.28E-09  3 2.22E-09  7 8.60E-10 12 1.49E-09  8 1.49E-09  8
1.265E+00 1.844E+02 3.25E-09  3 1.13E-09  9 4.43E-10 14 7.82E-10  8 7.82E-10  8
1.592E+00 2.322E+02 1.74E-09  5 5.12E-10 11 1.97E-10 16 3.43E-10 10 3.43E-10 10
2.005E+00 2.923E+02 7.44E-10  5 1.70E-10 14 7.09E-11 19 1.24E-10 12 1.24E-10 12
2.524E+00 3.680E+02 2.30E-10  8 3.57E-11 14 1.33E-11 22 2.58E-11 16 2.58E-11 16
3.177E+00 4.633E+02 4.83E-11  9 5.13E-12 19 1.77E-12 27 3.53E-12 23 3.53E-12 23
4.000E+00 5.833E+02 4.91E-12 10 2.97E-13 34 6.67E-14 37 2.08E-13 37 2.08E-13 37

FISSION_BETA SPECTRUM,    ELECTRON RESPONSE FOR      SILICON
TRANSPORT IN MATERIAL   1,    ALUMINUM
   G/SQCM      MILS      SPHERE   SPH SHELL      2*SLAB   DUBL SLAB   BACK SLAB
4.000E-03 5.833E-01 3.22E-08  0 3.18E-08  0 2.46E-08  2 3.06E-08  0 4.00E-08  1
5.036E-03 7.343E-01 3.16E-08  0 3.11E-08  0 2.36E-08  2 2.98E-08  0 3.88E-08  1
6.340E-03 9.244E-01 3.09E-08  0 3.04E-08  0 2.22E-08  2 2.88E-08  0 3.72E-08  2
7.981E-03 1.164E+00 3.02E-08  0 2.97E-08  0 2.12E-08  2 2.80E-08  0 3.55E-08  2
1.005E-02 1.465E+00 2.96E-08  0 2.91E-08  0 2.04E-08  2 2.73E-08  0 3.43E-08  2
   :
```

Table 20: (ADJKXX) K-opt Source E Outputs (1D)

```
     781461 RANDOM NUMBERS USED

KILLS     0     0     0     0     0     0     0     0     0     0
KILLS     0     0     0   404     0    20    72     0     0     0

ONE SOURCE PARTICLE IN GROUP   1, ENERGY FROM  7.9433E+00 TO  1.0000E+01 MEV
    ELECTRON RESPONSE FOR     ALUMINUM
TRANSPORT IN MATERIAL   1,    ALUMINUM
   G/SQCM      MILS      SPHERE   SPH SHELL      2*SLAB   DUBL SLAB   BACK SLAB
4.000E-02 5.833E+00 2.65E-08  8 2.65E-08  8 2.28E-08 16 2.59E-08 14 3.02E-08 15
6.340E-02 9.244E+00 2.65E-08  8 2.65E-08  8 2.08E-08 19 2.30E-08 19 2.54E-08 18
1.005E-01 1.465E+01 2.79E-08  9 2.79E-08  9 2.18E-08 19 2.41E-08 19 2.50E-08 19
1.592E-01 2.322E+01 2.42E-08 14 2.42E-08 14 2.19E-08 19 2.42E-08 19 2.54E-08 19
2.524E-01 3.680E+01 2.52E-08 17 2.57E-08 17 2.43E-08 18 2.82E-08 18 2.98E-08 17
4.000E-01 5.833E+01 2.03E-08 19 2.04E-08 19 1.99E-08 21 2.24E-08 17 2.38E-08 17
6.340E-01 9.244E+01 2.42E-08 19 2.59E-08 18 1.59E-08 22 2.09E-08 16 2.18E-08 16
1.005E+00 1.465E+02 2.85E-08 12 3.18E-08 10 1.83E-08 20 2.38E-08 14 2.38E-08 14
1.592E+00 2.322E+02 2.42E-08 15 2.98E-08 10 1.57E-08 22 1.92E-08 19 1.92E-08 19
2.524E+00 3.680E+02 3.28E-08 11 2.81E-08 14 1.12E-08 25 1.58E-08 18 1.58E-08 18
4.000E+00 5.833E+02 2.53E-08  9 2.82E-09 28 6.03E-10 65 1.52E-09 51 1.52E-09 51

ONE SOURCE PARTICLE IN GROUP   2, ENERGY FROM  6.3096E+00 TO  7.9433E+00 MEV
    ELECTRON RESPONSE FOR     ALUMINUM
TRANSPORT IN MATERIAL   1,    ALUMINUM
   G/SQCM      MILS      SPHERE   SPH SHELL      2*SLAB   DUBL SLAB   BACK SLAB
4.000E-02 5.833E+00 2.59E-08  8 2.59E-08  8 2.40E-08 11 2.53E-08 12 2.84E-08 11
6.340E-02 9.244E+00 2.59E-08  8 2.59E-08  8 2.24E-08 13 2.47E-08 14 2.86E-08 13
1.005E-01 1.465E+01 2.56E-08 12 2.56E-08 12 1.91E-08 18 2.30E-08 17 2.56E-08 15
1.592E-01 2.322E+01 2.40E-08 14 2.40E-08 14 1.77E-08 21 2.06E-08 17 2.36E-08 15
2.524E-01 3.680E+01 2.46E-08 15 2.51E-08 15 1.76E-08 23 2.10E-08 22 2.31E-08 20
4.000E-01 5.833E+01 2.73E-08 13 2.94E-08 12 1.75E-08 18 2.17E-08 15 2.39E-08 14
6.340E-01 9.244E+01 2.29E-08 16 2.58E-08 15 2.65E-08 13 3.00E-08 11 3.09E-08 12
1.005E+00 1.465E+02 2.29E-08 13 3.26E-08 10 2.18E-08 17 2.56E-08 15 2.56E-08 15
1.592E+00 2.322E+02 3.48E-08 10 3.62E-08 12 1.25E-08 25 1.75E-08 16 1.75E-08 16
2.524E+00 3.680E+02 3.40E-08  6 1.23E-08 20 3.88E-09 29 6.72E-09 24 6.72E-09 24
4.000E+00 5.833E+02 3.17E-09 17 5.75E-10 51 0.00E+00  0 1.83E-10 75 1.83E-10 75

ONE SOURCE PARTICLE IN GROUP   3, ENERGY FROM  5.0119E+00 TO  6.3096E+00 MEV
    ELECTRON RESPONSE FOR     ALUMINUM
TRANSPORT IN MATERIAL   1,    ALUMINUM
   G/SQCM      MILS      SPHERE   SPH SHELL      2*SLAB   DUBL SLAB   BACK SLAB
4.000E-02 5.833E+00 2.80E-08 10 2.80E-08 10 2.48E-08  9 2.61E-08 10 3.30E-08  8
6.340E-02 9.244E+00 2.80E-08 10 2.80E-08 10 2.61E-08  9 2.61E-08  9 3.11E-08  7
1.005E-01 1.465E+01 2.64E-08  9 2.64E-08  9 2.61E-08  9 2.69E-08 10 3.12E-08 10
1.592E-01 2.322E+01 2.77E-08 10 2.77E-08 10 3.06E-08 12 3.30E-08 11 3.66E-08 11
2.524E-01 3.680E+01 2.68E-08 13 2.87E-08 13 2.63E-08 12 2.94E-08 11 3.33E-08 12
   :
```

Table 21: (ADJKYY) K-opt Flux E Outputs (1D)

```
    1172690 RANDOM NUMBERS USED

KILLS      0      0      0      0      0      0      0      0      0      0
KILLS      0      0      0    409      0     19     68      0      0      0

FISSION_BETA SPECTRUM
    ELECTRONS/SQCM-SUM AT  4.00E-02 GM/SQCM,
                           1.48E-02 CM,  5.83E+00 MILS OF     ALUMINUM
     E-MAX    E-MIN      SPHERE   SHELL SPH      2*SLAB   DUBL SLAB   BACK SLAB
  1.00E+01 7.94E+00 2.80E-04 14 2.80E-04 14 2.24E-04 15 2.24E-04 15 2.24E-04 15
  7.94E+00 6.31E+00 2.64E-03  7 2.64E-03  7 1.81E-03 15 1.83E-03 15 1.83E-03 15
  6.31E+00 5.01E+00 1.10E-02  8 1.10E-02  8 7.88E-03 12 8.15E-03 11 8.25E-03 11
  5.01E+00 3.98E+00 3.20E-02  6 3.20E-02  6 2.26E-02  9 2.38E-02  7 2.42E-02  7
  3.98E+00 3.16E+00 7.25E-02  3 7.25E-02  3 5.46E-02  7 5.83E-02  4 5.97E-02  4
  3.16E+00 2.51E+00 1.35E-01  2 1.35E-01  2 1.01E-01  5 1.08E-01  3 1.10E-01  3
  2.51E+00 2.00E+00 2.11E-01  2 2.11E-01  2 1.48E-01  6 1.65E-01  3 1.73E-01  3
  2.00E+00 1.58E+00 2.98E-01  1 2.97E-01  1 2.15E-01  5 2.42E-01  2 2.58E-01  3
  1.58E+00 1.26E+00 3.86E-01  1 3.85E-01  1 2.75E-01  5 3.22E-01  2 3.45E-01  3
  1.26E+00 1.00E+00 4.74E-01  1 4.72E-01  1 3.23E-01  5 4.01E-01  1 4.29E-01  2
  1.00E+00 7.94E-01 5.52E-01  0 5.51E-01  0 3.75E-01  5 4.72E-01  1 5.06E-01  2
  7.94E-01 6.31E-01 6.23E-01  0 6.21E-01  0 3.98E-01  5 5.35E-01  1 5.81E-01  2
  6.31E-01 5.01E-01 6.86E-01  0 6.83E-01  0 4.20E-01  5 5.88E-01  1 6.44E-01  2
  5.01E-01 3.98E-01 7.40E-01  0 7.36E-01  0 4.55E-01  5 6.37E-01  1 7.00E-01  1
  3.98E-01 3.16E-01 7.84E-01  0 7.78E-01  0 4.83E-01  5 6.76E-01  1 7.46E-01  1
  3.16E-01 2.51E-01 8.19E-01  0 8.11E-01  0 5.02E-01  4 7.06E-01  1 7.84E-01  1
  2.51E-01 2.00E-01 8.48E-01  0 8.38E-01  0 5.17E-01  4 7.30E-01  1 8.17E-01  1
  2.00E-01 1.58E-01 8.69E-01  0 8.57E-01  0 5.26E-01  4 7.48E-01  1 8.42E-01  1
  1.58E-01 1.26E-01 8.86E-01  0 8.71E-01  0 5.30E-01  4 7.62E-01  1 8.59E-01  1
  1.26E-01 1.00E-01 8.98E-01  0 8.81E-01  0 5.32E-01  4 7.73E-01  1 8.72E-01  1
  1.00E-01 7.94E-02 9.08E-01  0 8.89E-01  0 5.34E-01  4 7.80E-01  1 8.82E-01  1
  7.94E-02 6.31E-02 9.14E-01  0 8.94E-01  0 5.34E-01  4 7.86E-01  1 8.88E-01  1
  6.31E-02 5.01E-02 9.19E-01  0 8.98E-01  0 5.35E-01  4 7.90E-01  1 8.93E-01  1
  5.01E-02 3.98E-02 9.22E-01  0 9.01E-01  0 5.35E-01  4 7.92E-01  1 8.97E-01  1
  3.98E-02 3.16E-02 9.24E-01  0 9.03E-01  0 5.35E-01  4 7.94E-01  1 8.99E-01  1
  3.16E-02 2.51E-02 9.26E-01  0 9.04E-01  0 5.35E-01  4 7.95E-01  1 9.00E-01  1
  2.51E-02 2.00E-02 9.27E-01  0 9.05E-01  0 5.35E-01  4 7.96E-01  1 9.01E-01  1
  2.00E-02 1.58E-02 9.28E-01  0 9.06E-01  0 5.35E-01  4 7.97E-01  1 9.02E-01  1
  1.58E-02 1.26E-02 9.28E-01  0 9.06E-01  0 5.36E-01  4 7.98E-01  1 9.03E-01  1
  1.26E-02 1.00E-02 9.29E-01  0 9.07E-01  0 5.36E-01  4 7.98E-01  1 9.03E-01  1
  1.00E-02 7.94E-03 9.29E-01  0 9.07E-01  0 5.36E-01  4 7.98E-01  1 9.04E-01  1
STOP/CC    ALUMINUM 5.47E+00  9 4.95E+00 10 0.00E+00  0 4.83E+00 10 6.13E+00 11
STOP/CC     SILICON 4.98E+00  9 4.51E+00 10 0.00E+00  0 4.40E+00 10 5.58E+00 11
SUMMED,    ALUMINUM 2.60E-08  0 2.50E-08  0 1.38E-08  4 2.22E-08  1 2.55E-08  1
SUMMED,     SILICON 2.68E-08  0 2.58E-08  0 1.43E-08  4 2.30E-08  1 2.64E-08  1
SUMMED, NUMBER FLUX 9.29E-01  0 9.07E-01  0 5.36E-01  4 7.98E-01  1 9.04E-01  1
SUMMED, ENERGY FLUX 1.26E+00  1 1.25E+00  1 8.38E-01  4 1.05E+00  1 1.13E+00  2

FISSION_BETA SPECTRUM
    ELECTRONS/SQCM-SUM AT  6.34E-02 GM/SQCM,
                           2.35E-02 CM,  9.24E+00 MILS OF     ALUMINUM
     E-MAX    E-MIN      SPHERE   SHELL SPH      2*SLAB   DUBL SLAB   BACK SLAB
  1.00E+01 7.94E+00 1.97E-04 19 1.97E-04 19 1.25E-04 23 1.25E-04 23 1.25E-04 23
    :
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Table 22: (ADJKXY) K-opt Source & Flux E (1D)

```
    1567840 RANDOM NUMBERS USED

KILLS     0     0     0     0     0     0     0     0     0     0
KILLS     0     0     0   402     0    25    69     0     0     0

ONE SOURCE PARTICLE IN GROUP   1, ENERGY FROM  7.9433E+00 TO  1.0000E+01 MEV
    ELECTRONS/SQCM-SUM AT  4.00E-02 GM/SQCM,
                           1.48E-02 CM,  5.83E+00 MILS OF     ALUMINUM
     E-MAX    E-MIN      SPHERE   SHELL SPH      2*SLAB   DUBL SLAB   BACK SLAB
  1.00E+01 7.94E+00 9.45E-01  6 9.45E-01  6 7.57E-01 14 7.57E-01 14 7.57E-01 14
  7.94E+00 6.31E+00 9.45E-01  6 9.45E-01  6 7.57E-01 14 8.58E-01 14 8.58E-01 14
  3.98E+00 3.16E+00 9.45E-01  6 9.45E-01  6 7.57E-01 14 8.58E-01 14 8.86E-01 14
  1.58E+00 1.26E+00 9.45E-01  6 9.45E-01  6 7.57E-01 14 8.58E-01 14 8.99E-01 14
  1.00E+00 7.94E-01 9.45E-01  6 9.45E-01  6 7.57E-01 14 8.58E-01 14 9.07E-01 14
  6.31E-01 5.01E-01 9.45E-01  6 9.45E-01  6 7.57E-01 14 8.58E-01 14 9.12E-01 14
  2.51E-01 2.00E-01 9.45E-01  6 9.45E-01  6 7.57E-01 14 8.58E-01 14 9.14E-01 14
  2.00E-01 1.58E-01 9.45E-01  6 9.45E-01  6 7.57E-01 14 8.58E-01 14 9.16E-01 14
  6.31E-02 5.01E-02 9.45E-01  6 9.45E-01  6 7.57E-01 14 8.58E-01 14 9.16E-01 14
  2.00E-02 1.58E-02 9.45E-01  6 9.45E-01  6 7.57E-01 14 8.58E-01 14 9.16E-01 14
  1.58E-02 1.26E-02 9.45E-01  6 9.45E-01  6 7.57E-01 14 8.58E-01 14 9.16E-01 14
SUMMED,    ALUMINUM 2.52E-08  6 2.52E-08  6 2.02E-08 14 2.29E-08 14 2.44E-08 14
SUMMED,     SILICON 2.61E-08  6 2.61E-08  6 2.10E-08 14 2.37E-08 14 2.53E-08 14
SUMMED, NUMBER FLUX 9.45E-01  6 9.45E-01  6 7.57E-01 14 8.58E-01 14 9.16E-01 14
SUMMED, ENERGY FLUX 8.48E+00  6 8.48E+00  6 6.79E+00 14 7.52E+00 14 7.64E+00 13

ONE SOURCE PARTICLE IN GROUP   1, ENERGY FROM  7.9433E+00 TO  1.0000E+01 MEV
    ELECTRONS/SQCM-SUM AT  6.34E-02 GM/SQCM,
                           2.35E-02 CM,  9.24E+00 MILS OF     ALUMINUM
     E-MAX    E-MIN      SPHERE   SHELL SPH      2*SLAB   DUBL SLAB   BACK SLAB
  1.00E+01 7.94E+00 9.46E-01  6 9.46E-01  6 5.69E-01 22 5.69E-01 22 5.69E-01 22
  7.94E+00 6.31E+00 9.46E-01  6 9.46E-01  6 6.69E-01 21 7.70E-01 19 7.70E-01 19
  3.98E+00 3.16E+00 9.46E-01  6 9.46E-01  6 6.69E-01 21 7.70E-01 19 8.25E-01 18
  1.58E+00 1.26E+00 9.46E-01  6 9.46E-01  6 6.69E-01 21 7.70E-01 19 8.38E-01 18
  1.00E+00 7.94E-01 9.46E-01  6 9.46E-01  6 6.69E-01 21 7.70E-01 19 8.46E-01 18
  6.31E-01 5.01E-01 9.46E-01  6 9.46E-01  6 6.69E-01 21 7.70E-01 19 8.51E-01 18
  2.51E-01 2.00E-01 9.46E-01  6 9.46E-01  6 6.69E-01 21 7.70E-01 19 8.53E-01 18
  2.00E-01 1.58E-01 9.46E-01  6 9.46E-01  6 6.69E-01 21 7.70E-01 19 8.55E-01 18
  6.31E-02 5.01E-02 9.46E-01  6 9.46E-01  6 6.69E-01 21 7.70E-01 19 8.55E-01 18
  2.00E-02 1.58E-02 9.46E-01  6 9.46E-01  6 6.69E-01 21 7.70E-01 19 8.55E-01 18
  1.58E-02 1.26E-02 9.46E-01  6 9.46E-01  6 6.69E-01 21 7.70E-01 19 8.55E-01 18
  1.00E-02 7.94E-03 9.46E-01  6 9.46E-01  6 6.69E-01 21 7.70E-01 19 8.55E-01 18
STOP/CC    ALUMINUM 0.00E+00  0 0.00E+00  0 0.00E+00  0 0.00E+00  0 1.73E-01 97
STOP/CC     SILICON 0.00E+00  0 0.00E+00  0 0.00E+00  0 0.00E+00  0 1.58E-01 97
SUMMED,    ALUMINUM 2.52E-08  6 2.52E-08  6 1.78E-08 21 2.05E-08 19 2.26E-08 18
SUMMED,     SILICON 2.62E-08  6 2.62E-08  6 1.85E-08 21 2.12E-08 19 2.34E-08 18
SUMMED, NUMBER FLUX 9.46E-01  6 9.46E-01  6 6.69E-01 21 7.70E-01 19 8.55E-01 18
SUMMED, ENERGY FLUX 8.48E+00  6 8.48E+00  6 5.82E+00 20 6.54E+00 19 6.77E+00 19

ONE SOURCE PARTICLE IN GROUP   1, ENERGY FROM  7.9433E+00 TO  1.0000E+01 MEV
    ELECTRONS/SQCM-SUM AT  1.00E-01 GM/SQCM,
                           3.72E-02 CM,  1.47E+01 MILS OF     ALUMINUM
     E-MAX    E-MIN      SPHERE   SHELL SPH      2*SLAB   DUBL SLAB   BACK SLAB
  1.00E+01 7.94E+00 8.84E-01  9 8.84E-01  9 5.72E-01 22 5.72E-01 22 5.72E-01 22
    :
```

Table 23: (ADJSIG) K-opt MATRIX.DAT File (1D)

```
C FISSION_BETA      ELECTRON      ALUMINUM (comes from matrix.dat)
 4.00E-03 5.04E-03 6.34E-03 7.98E-03 1.00E-02 1.26E-02 1.59E-02 2.00E-02
 2.52E-02 3.18E-02 4.00E-02 5.04E-02 6.34E-02 7.98E-02 1.00E-01 1.26E-01
 1.59E-01 2.00E-01 2.52E-01 3.18E-01 4.00E-01 5.04E-01 6.34E-01 7.98E-01
 1.00E+00 1.26E+00 1.59E+00 2.00E+00 2.52E+00 3.18E+00 4.00E+00
 1.48E-03 1.87E-03 2.35E-03 2.96E-03 3.72E-03 4.68E-03 5.90E-03 7.42E-03
 9.35E-03 1.18E-02 1.48E-02 1.87E-02 2.35E-02 2.96E-02 3.72E-02 4.68E-02
 5.90E-02 7.42E-02 9.35E-02 1.18E-01 1.48E-01 1.87E-01 2.35E-01 2.96E-01
 3.72E-01 4.68E-01 5.90E-01 7.42E-01 9.35E-01 1.18E+00 1.48E+00
 5.83E-01 7.34E-01 9.24E-01 1.16E+00 1.47E+00 1.84E+00 2.32E+00 2.92E+00
 3.68E+00 4.63E+00 5.83E+00 7.34E+00 9.24E+00 1.16E+01 1.47E+01 1.84E+01
 2.32E+01 2.92E+01 3.68E+01 4.63E+01 5.83E+01 7.34E+01 9.24E+01 1.16E+02
 1.47E+02 1.84E+02 2.32E+02 2.92E+02 3.68E+02 4.63E+02 5.83E+02
 3.12E-08 3.06E-08 2.99E-08 2.93E-08 2.87E-08 2.81E-08 2.75E-08 2.69E-08
 2.64E-08 2.58E-08 2.52E-08 2.46E-08 2.39E-08 2.32E-08 2.25E-08 2.15E-08
 2.05E-08 1.94E-08 1.79E-08 1.63E-08 1.45E-08 1.23E-08 9.97E-09 7.58E-09
 5.28E-09 3.25E-09 1.74E-09 7.44E-10 2.30E-10 4.83E-11 4.91E-12
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 1.00E+00 1.00E+00
 1.00E+00 1.00E+00 1.00E+00 1.00E+00 1.00E+00 1.00E+00 2.00E+00 2.00E+00
 3.00E+00 3.00E+00 5.00E+00 5.00E+00 8.00E+00 9.00E+00 1.00E+01
 3.08E-08 3.01E-08 2.95E-08 2.88E-08 2.82E-08 2.74E-08 2.68E-08 2.61E-08
 2.55E-08 2.48E-08 2.40E-08 2.34E-08 2.27E-08 2.19E-08 2.08E-08 1.95E-08
 1.80E-08 1.62E-08 1.43E-08 1.22E-08 1.01E-08 7.76E-09 5.49E-09 3.69E-09
 2.22E-09 1.13E-09 5.12E-10 1.70E-10 3.57E-11 5.13E-12 2.97E-13
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 1.00E+00 1.00E+00
 1.00E+00 2.00E+00 2.00E+00 3.00E+00 3.00E+00 4.00E+00 5.00E+00 6.00E+00
 7.00E+00 9.00E+00 1.10E+01 1.40E+01 1.40E+01 1.90E+01 3.40E+01
 2.38E-08 2.29E-08 2.15E-08 2.05E-08 1.97E-08 1.90E-08 1.82E-08 1.70E-08
 1.63E-08 1.54E-08 1.44E-08 1.33E-08 1.25E-08 1.14E-08 1.06E-08 9.50E-09
 8.35E-09 7.40E-09 6.44E-09 5.44E-09 4.02E-09 3.02E-09 2.14E-09 1.44E-09
 8.60E-10 4.43E-10 1.97E-10 7.09E-11 1.33E-11 1.77E-12 6.67E-14
 2.00E+00 2.00E+00 2.00E+00 2.00E+00 2.00E+00 3.00E+00 3.00E+00 3.00E+00
 3.00E+00 4.00E+00 4.00E+00 4.00E+00 5.00E+00 5.00E+00 5.00E+00 5.00E+00
 6.00E+00 7.00E+00 6.00E+00 7.00E+00 7.00E+00 8.00E+00 9.00E+00 9.00E+00
 1.20E+01 1.40E+01 1.60E+01 1.90E+01 2.20E+01 2.70E+01 3.70E+01
 2.96E-08 2.88E-08 2.79E-08 2.71E-08 2.65E-08 2.59E-08 2.53E-08 2.46E-08
 2.39E-08 2.31E-08 2.23E-08 2.12E-08 2.02E-08 1.90E-08 1.77E-08 1.62E-08
 1.45E-08 1.28E-08 1.11E-08 9.36E-09 7.08E-09 5.29E-09 3.75E-09 2.49E-09
 1.49E-09 7.82E-10 3.43E-10 1.24E-10 2.58E-11 3.53E-12 2.08E-13
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 1.00E+00 1.00E+00 1.00E+00 1.00E+00 1.00E+00 1.00E+00 1.00E+00 2.00E+00
 2.00E+00 3.00E+00 3.00E+00 4.00E+00 5.00E+00 5.00E+00 6.00E+00 6.00E+00
 8.00E+00 8.00E+00 1.00E+01 1.20E+01 1.60E+01 2.30E+01 3.70E+01
 3.87E-08 3.76E-08 3.60E-08 3.44E-08 3.33E-08 3.21E-08 3.10E-08 2.97E-08
 2.86E-08 2.72E-08 2.57E-08 2.42E-08 2.26E-08 2.08E-08 1.89E-08 1.70E-08
 1.49E-08 1.31E-08 1.13E-08 9.47E-09 7.10E-09 5.29E-09 3.75E-09 2.49E-09
 1.49E-09 7.82E-10 3.43E-10 1.24E-10 2.58E-11 3.53E-12 2.08E-13
 1.00E+00 1.00E+00 2.00E+00 2.00E+00 2.00E+00 2.00E+00 2.00E+00 1.00E+00
 2.00E+00 1.00E+00 2.00E+00 2.00E+00 2.00E+00 1.00E+00 1.00E+00 2.00E+00
 2.00E+00 3.00E+00 3.00E+00 4.00E+00 5.00E+00 5.00E+00 6.00E+00 6.00E+00
 8.00E+00 8.00E+00 1.00E+01 1.20E+01 1.60E+01 2.30E+01 3.70E+01
C FISSION_BETA      ELECTRON       SILICON
  :
```

Figure 1: (ADJP16) Pulse Height Distribution

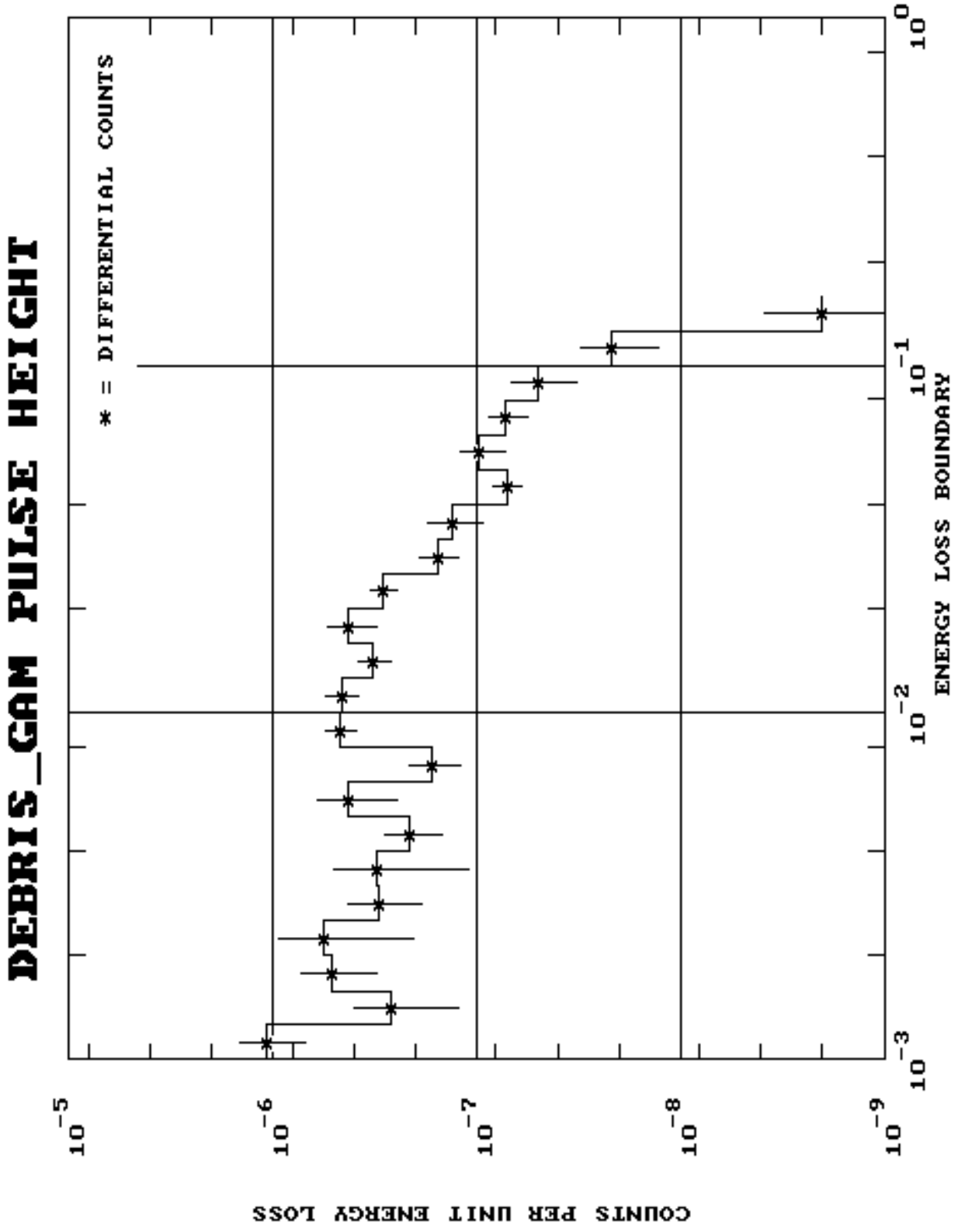


Figure 2: (ADJPNE) Bremsstrahlung Flux

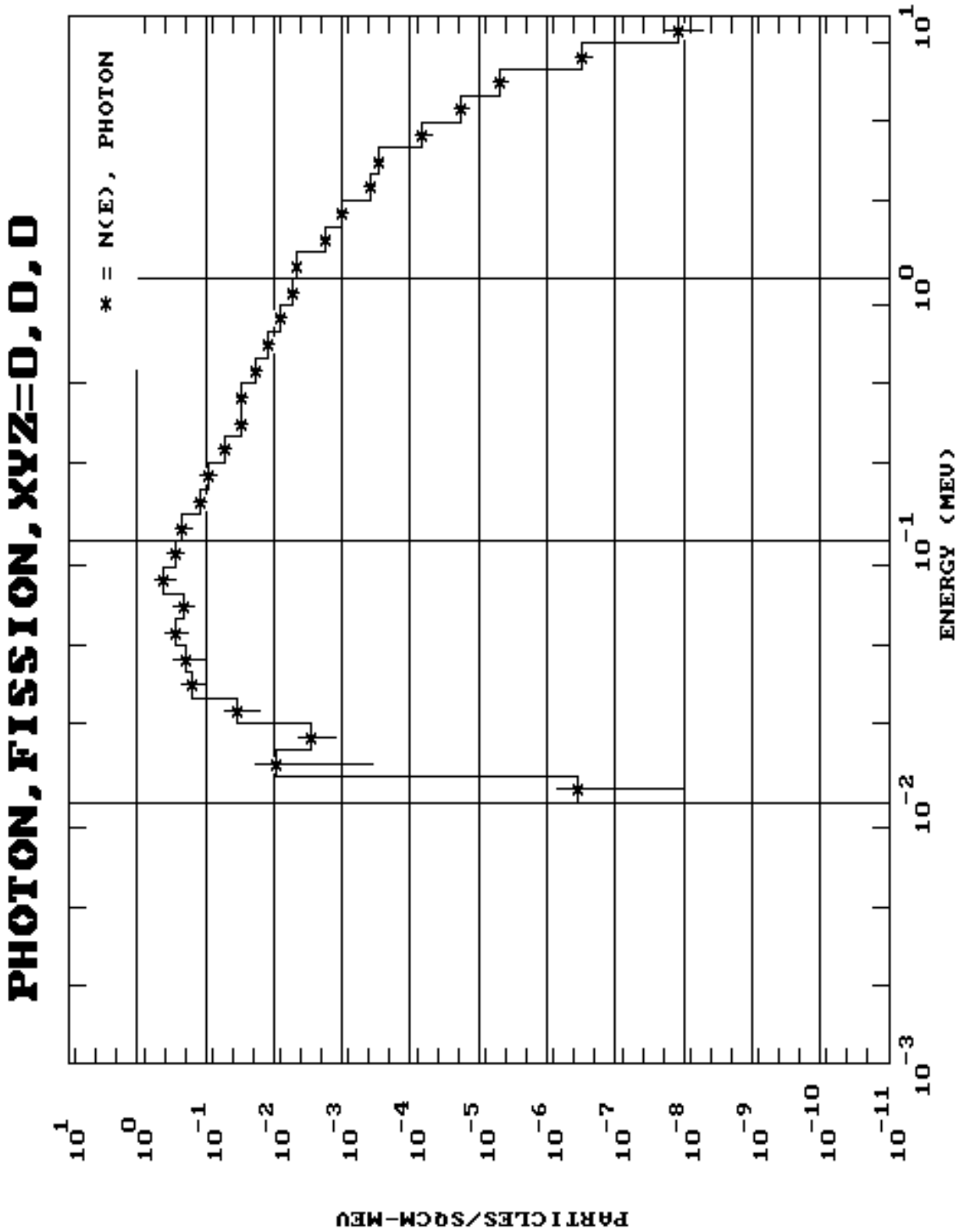


Figure 3: (ADJENE) Differential Electron Flux

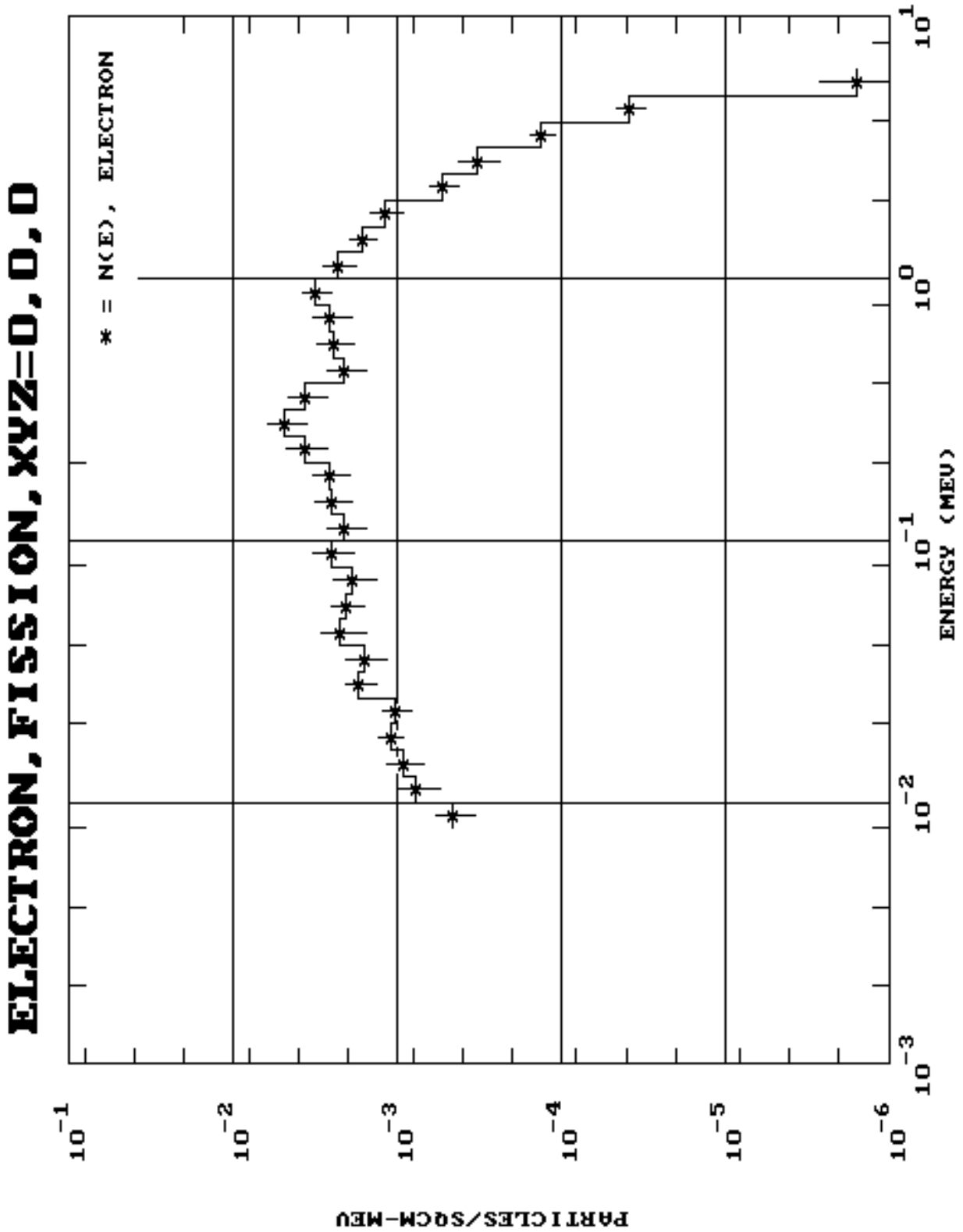


Figure 4: (ADJKB2) Brem Dose Versus Thickness

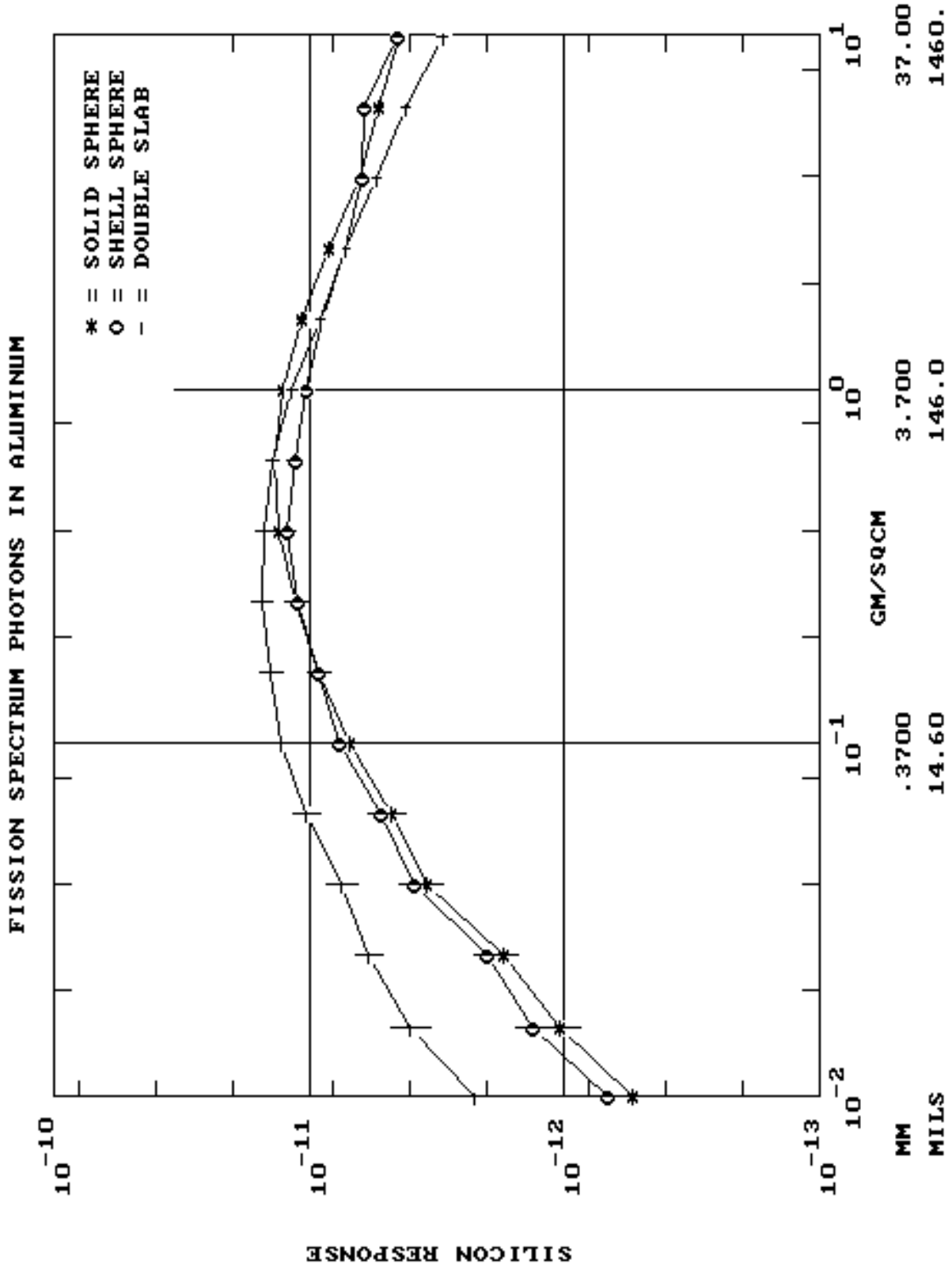
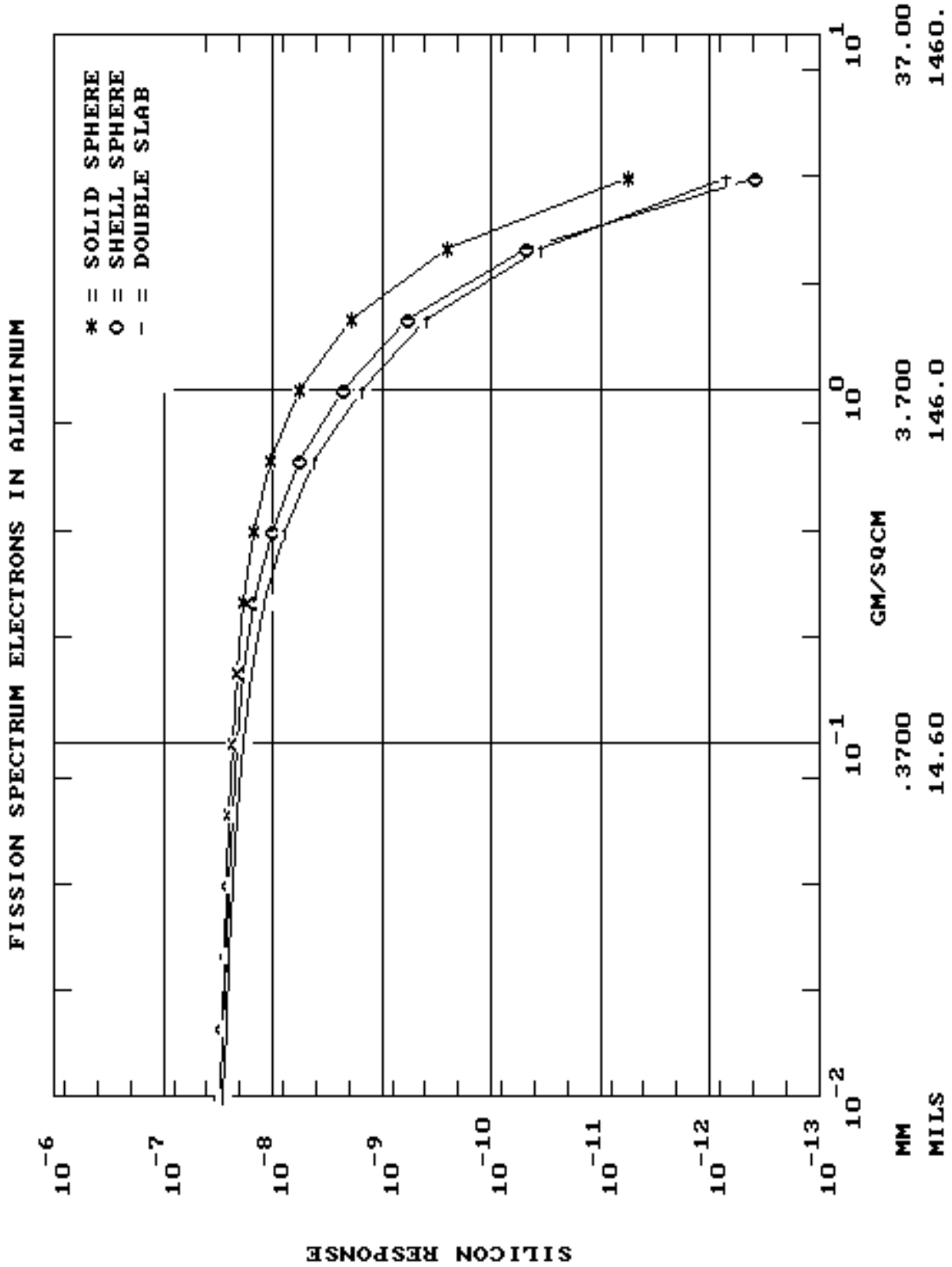


Figure 5: (ADJKEL) Electron Dose Vs. Thickness



ARGUMENT

ARGUMENT sets values for replacement data items.

****
This input provides for use of variable names and their replacment.
****

****
Input Data Description:
****

==========
Header line
==========

Contains *ARG in columns 1 through 4.

=======
Options
=======

This processor has no options.

==========
Argument Definition
==========

All argument names start with a percent sign, %.

All of the currently defined arguments are deleted if a single input line is entered with only a percent sign.

Each argument starts on a new line. The line contains two fields. The first field is the argument name which must start with a percent sign. The second field is the value to be used when the argument is seen on a data line. The fields are separated by a blank space or an equal sign. The remainder of the line can be used for comments if a dollar sign follows the second field.

****
Example:
****

%material1=aluminum replace all occurences of %material1 with the aluminum.

If the same name is reused, the old value for the second replacement field is replaced by the new value.

Blanks in the second replacement field are ignored unless the replacement is enclosed in double quotes (capital single quote, not two consecutive single quotes).

The purpose is left to the user's imagination. A possibility is to simplify parametric studies.

ARRAY

ARRAY, array input of materials, densities, and controls.

****
This input allows changing the composition and/or density of materials in regions without changing the geometry descriptor lines. This input can be supplied before and after the EXECUTE line.
****

****
Input Record Description:
****

==========
Header Line
==========

Contains *ARR in columns 1 through 4.

==========
Options Field
==========

A, array input consists of pairs of (index,value(index))

A, absent then input is the entire array

****
Data Record Description
****

==========
Array Name and Doublet Input (A option)
==========

With the A option, input and repeat as needed

```
'name' i a(i )  i a(i ) .../
        1   1    2   2
```

==========
Array Name and All Element Input (no A option)
==========

If the A option is absent, input and repeat as needed

'name' a(1) a(2) a(3) .../

++++++++++++++
Input Examples:
++++++++++++++

Example 1:
     *array,a/,mat 7 iron 13 iron/ set regions 7 & 13 = iron

Example 2:
     *array/,rho 100*1/ set first 100 region densities to 1

****
Discussion
****

The allowed 'names' are

MAT or MTL, then the array is the composition index for regions. For non void compositions, the region material density is set to the reference material density.

If composition names rather than indices are entered, the list length can be no longer than 64 material names of 256 characters total.

RHO or DEN, then the array is the density of the material in the region, or a scale factor if array elements are flagged minus. If the region has a zero material index, the material index is set to 1.

BAYS

BAYS, modeling of a spacecraft bus at JPL

****
This input simplifies the description of certain spacecraft designs that have multiple similar bays.
****

****
Input Record Description:
****

==========
Header line
==========

Contains *BAY in columns 1 through 4.

=======
Options
=======

O, overlap option, see OVERLAP for discussion

U, absent, all bays have same wall thicknesses

U, present, each bay has wall thicknesses input

A, if present, THETAZ (on next first input line) is in degrees.

L=l, longeron added thickness (top and bottom longerons have the same thickness). The longerons are on the top and bottom of bays and are used to attach the bays to each other, i.e. the longerons span the edges of adjoining bays.

I=i, edge length of the longeron at the inner face of the bays. This is the edge length along one of the two bays being joined.

J=j, edge length of the longeron at the outer face of the bays. This is the edge length along one of the two bays being joined.

D=d, length of upper and lower flanges on the inner shear plate face. These flanges are formed when the upper and lower plates of the bay are bent at a 90 degree angle for attachment to the inner face of the bay.

F=f, length of the upper and lower flanges on the outer shear plate. These flanges are formed when the upper and lower plates of the bay are bent at a 90 degree angle for attachment to the outer face of the bay.

C=c, clearance of the smeared bay interior from the shear plates and the top and bottom plates.

V, if present, enclose each bay, including longerons and doublers in an encompassing void region. This option should speed up ray tracing but may cause problems for subsystems mounted on the outside of the bays.

****
Data Record Description:
****

Repeat from here as needed.

==========
Basic Dimensions
==========

,NBAYS,THETAZ,FMIN,FMAX,HMIN,HMAX ,FUDGE /

NBAYS, number of bays, flag minus for clockwise numbering

THETAZ, radians, angle at first bay. THETAZ is the maximum azimuth of the first bay if the bays are generated clockwise. THETAZ is the minimum azimuth of the first bay if the bays are generated counter clockwise.

FMIN, cm, distance to inside face

FMAX, cm, distance to outside face

HMIN, cm, z coordinate of bottom

HMAX, cm, z coordinate of top

FUDGE, cm, if zero, bay interiors are left empty

==========
Smeared Bay Materials, Paired with next record
==========

A single record giving the material for each bay.

==========
Smeared Bay Weights, Paired with previous record
==========

A single record giving the weight of each bay.

With paired record logic, the data can be supplied as:
,MTL/,WGT/ or ,/MTL , WGT , MTL , WGT ,.../
--- --- 1 1 2 2

where MTL denotes the material vector (material for each bay) and
---
WGT is the weight vector (weight for each bay) in grams.

==========
Common Bay Description (no U option)
==========

Bay walls, all bays the same, no U option.

,MTW,RHO,T1,T2,T3,T4,T5,T6/

MTW, bay wall material

RHO, bay wall density, grams/cc, or a density scale factor if flagged minus

T1,T2,..., cm, thicknesses of walls in order: inner face, outer face, minimum azimuth, maximum azimuth, bottom, top

Unique Bay Descriptions (U option)

Bay walls, bays are different, U option.

,MTW,RHO,T1,T2,T3,T4,T5,T6/

MTW, bay wall material

RHO, bay wall density, grams/cc, or a density scale factor if flagged minus

T1,T2,..., cm, thicknesses of walls in order: inner face, outer face, minimum azimuth, maximum azimuth, bottom, top

Discussion

Note that all bay interiors are void if FUDGE is zero, and that individual bay interiors are void if their weight is zero.

Output Figures

The visualization of BAY geometry may clarify some of the variables.

Figure 6 (BAYSUM) gives a perspective view of an eight bay configuration along with cross sections.

Figure 7 (BAYVYZ) is a cross section through a single bay parallel to the inboard face.

Figure 8 (BAYVXY) is a cross section through the longerons of a bay indicating the thickened portions where bays are joined together.

Figure 9 (BAYVZX) is a cross section going from inboard to outboard and from minimum to maximum axial coordinate. Here it is possible to see how the exterior face is joined to the top and bottom faces and how the exterior face is also joined to the top and bottom faces.

Finally, Figure 10 (BAYPRO) gives a single perspective view of an eight bay configuration.

Figure 6: (BAYSUM) BAY Generator Summary

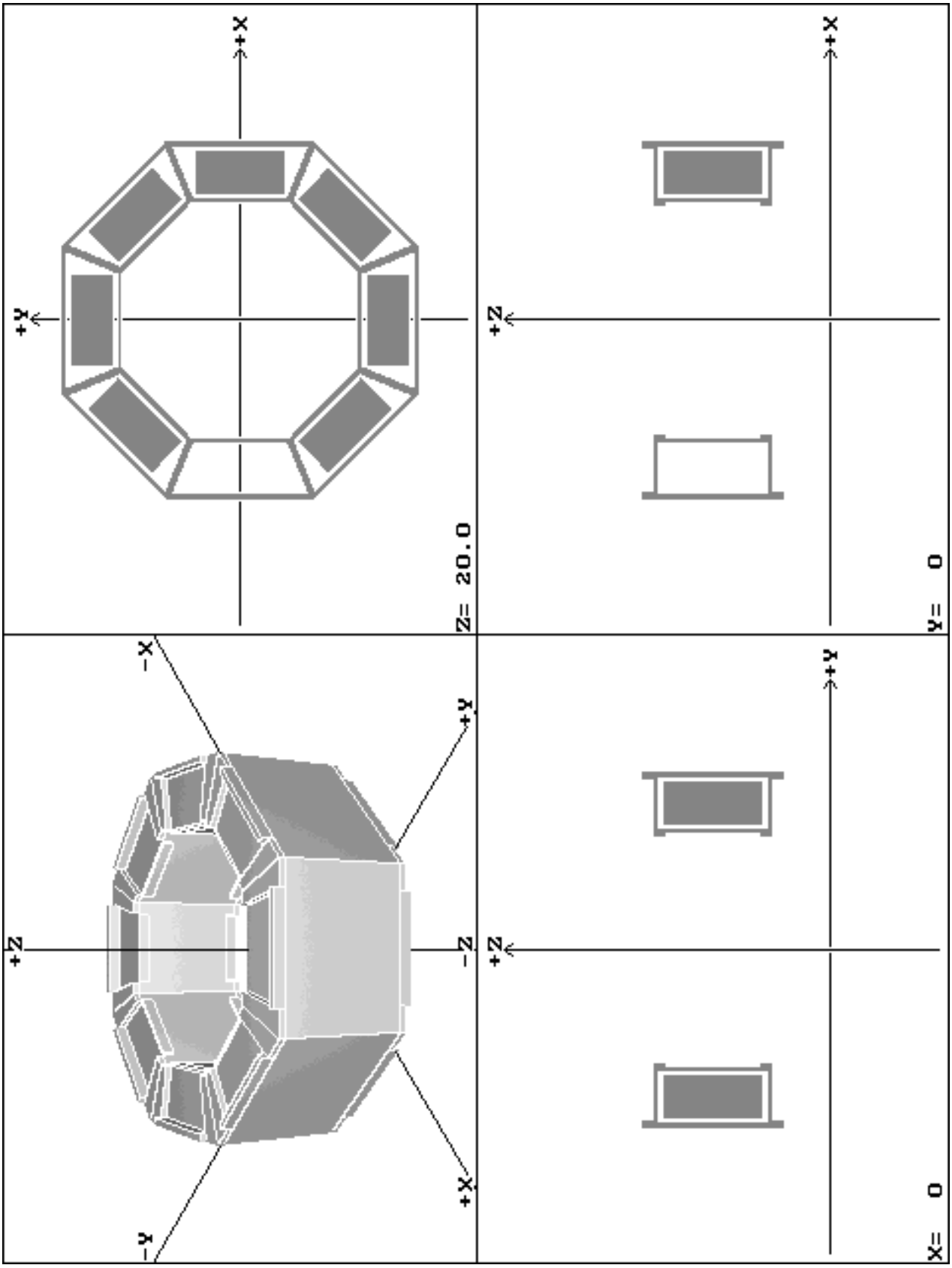


Figure 7: (BAYVYZ) YZ Cross Section, Single Bay

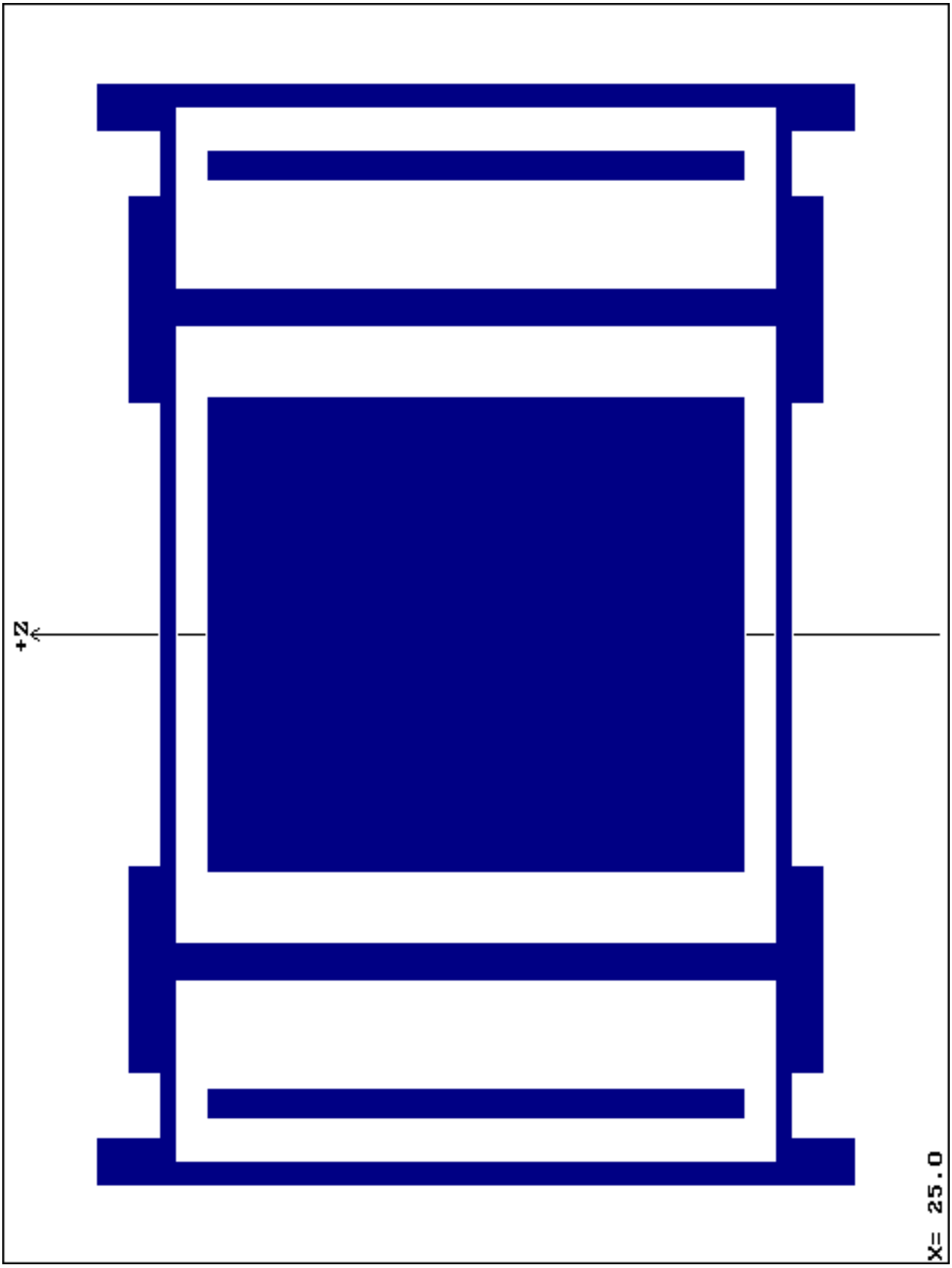


Figure 8: (BAYVXY) XY Cross Section, Longerons

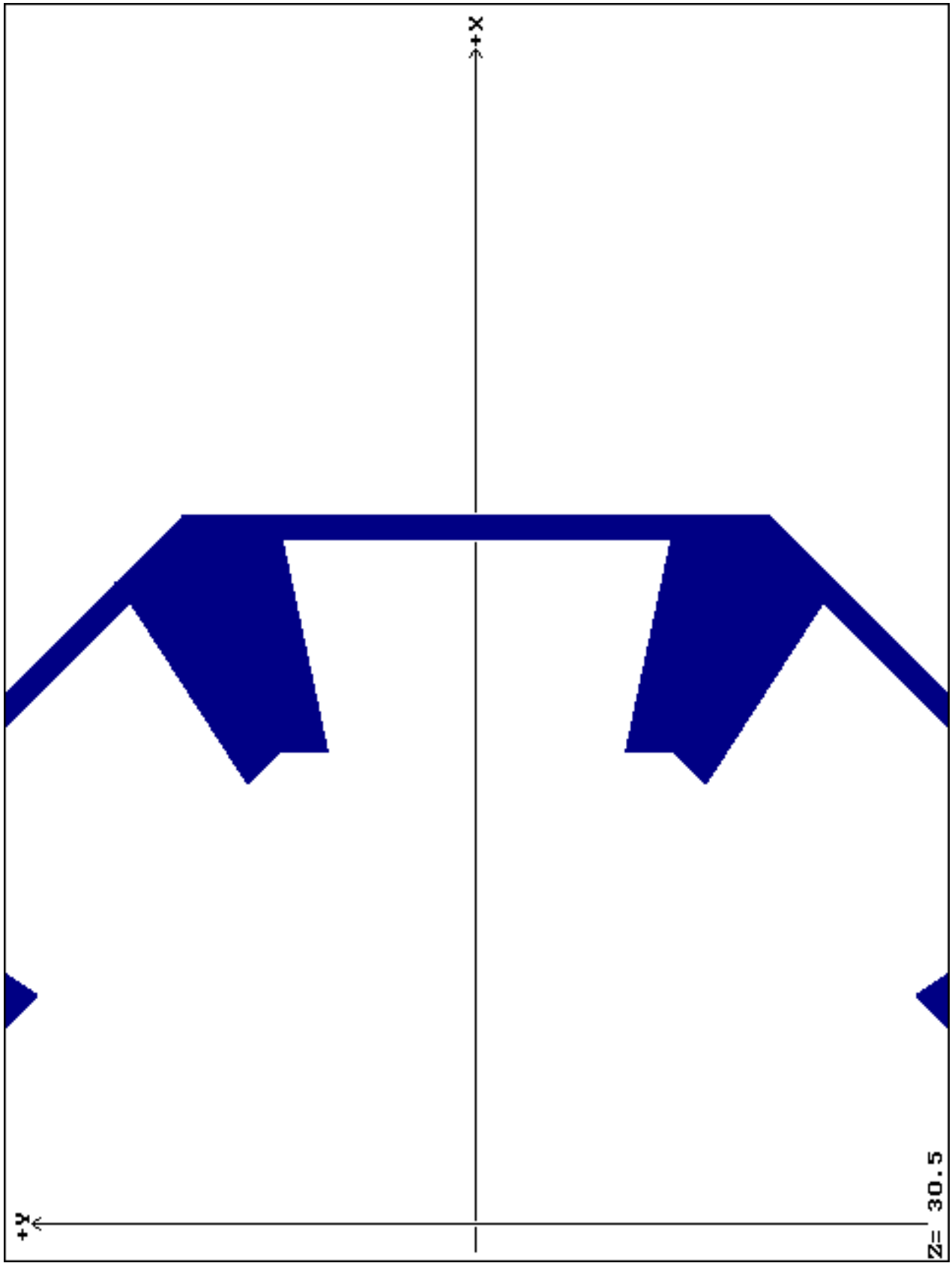


Figure 9: (BAYVZX) ZX Cross Section, Single Bay

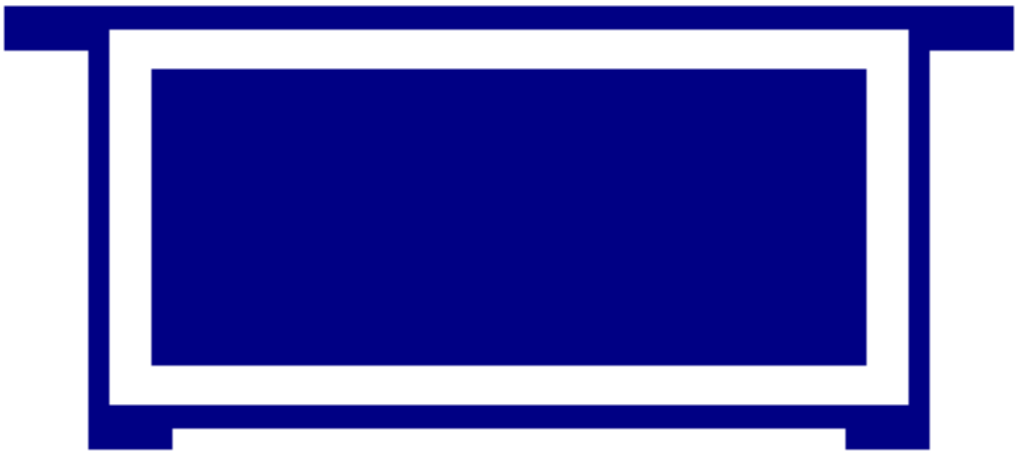
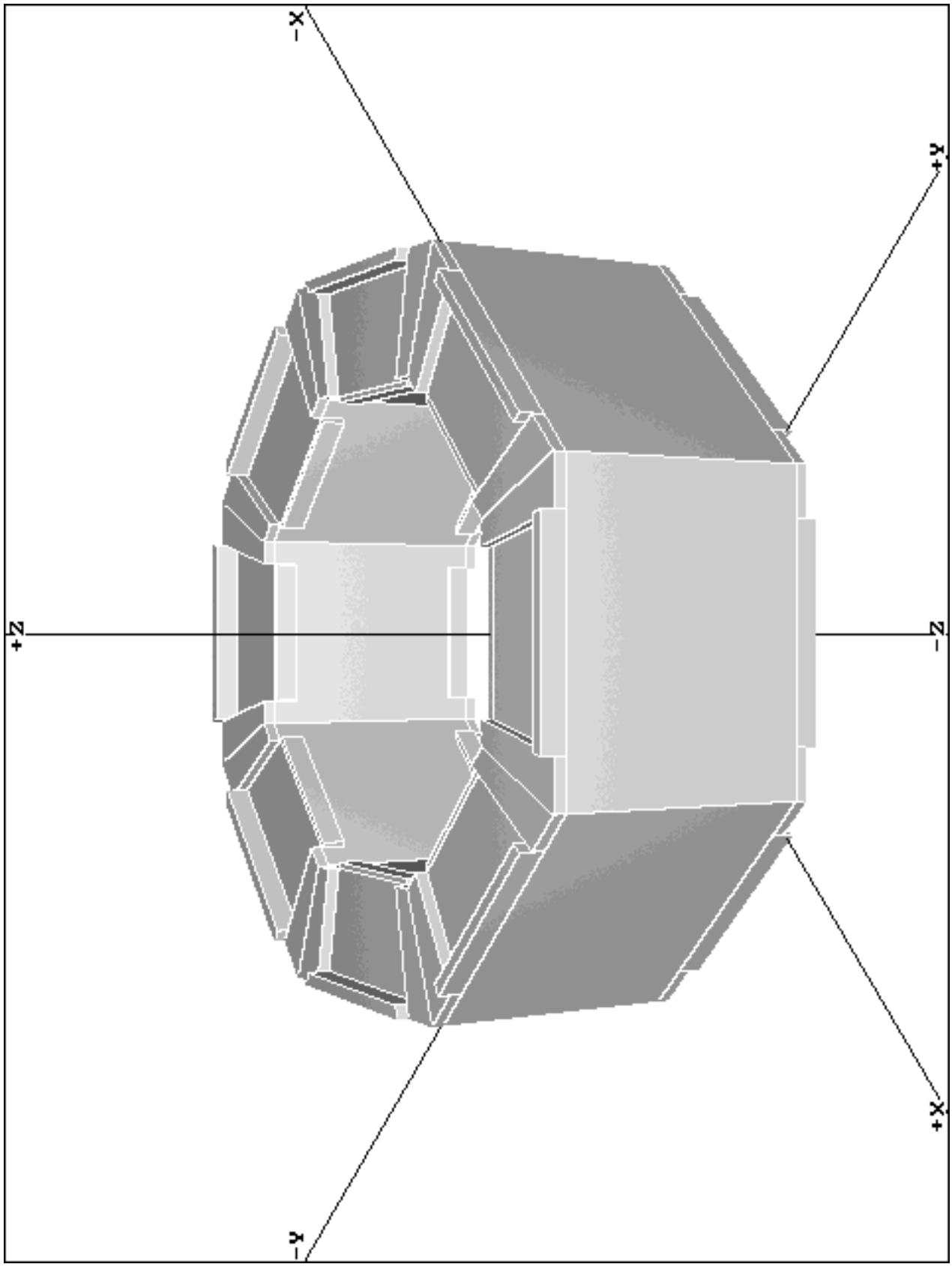


Figure 10: (BAYPRO) Projected View of BAY Model



BETA

BETA, forward Monte Carlo for charged particles.

****
This analysis procedure calculates electron/bremsstrahlung and heavy charged particle transport in 3D geometries using Monte Carlo methods. The source must by mocked up explicitly using SOURCE. Only surface and volume detectors are implemented.
****

****
Input Data Record Description:
****

==========
Header line
==========

Contains *BET in columns 1 through 4.

=======
Options
=======

E=e, particle energy (default is 1.0 MeV)

E, (if P option) perform separate calculations for each energy group.

A=a, cosine of initial direction relative to z-axis (default is 1.0)

X=x, initial z coordinate (default position is origin)

Y=y, sample initial position and direction from source distribution number y.

F, debug output p option

H=h, number of histories (default is 16)

L=l(lower case L), maximum number of steps in particle tracking, the default is 200

G, Gaussian option on angular straggling

I, separate calculations for each energy group p option

M, Pulse height analysis. If M=m, m > 0, then the deposition by particle for the first m regions is saved on the formatted file PROTEL.SUM (unit31) along with the usual summary pulse height outputs.

M, (if P option) if present, save the deposited energy per particle file for photons on MATRIX.NEW file.

N, Noise input for broadening pulse heights

O, maximum nuber of photon collisions p option

W, Energy loss straggling

S, Multiple source energies

S=s, (if P option) s is the index of the source spectrum

T, Histories to save file

D, distribute direction cosine from 'a' to 1. (and energy if S option)

D, (if P option) debug writes one line per particle collision.

P, must be present for a photon problem.

Q, save fluxes on matrix.dat file p option

R, output detailed flux for region r only

Z=z, atomic number of particle (absent for electron or photon)

K=k, maximum number of steps or collisions per particle, photon primary.

K=k, (if P option) k is the maximum number of photon collisions.

U (spectrum) source spectrum index u option

V, if present or V=0, print depositions in MeV*sqcm/gm using region volumes in the computation. If V=1, use the region thickness as the volume (correct when using unit weight histories on parallel slabs approximating semi-infinite geometries). If V=v (and v less than 0), then the volume used is the code volume multiplied by the absolute value of v.

B, analytic estimation of bremsstrahlung flux. B=1, sample bremsstrahlung production while conserving total particles. B=2, sample bremsstrahlung production while conserving mean energy.

J, debug print while running; J=1, average value physics; J=2, debug print statements.

C=c, (if P option) c is the photon weight cutoff.

&p plot particles while tracking

****
Data Record Description:
****

==========
Loop Control
==========

This processor has up to six loops through particle energy and direction. If the discrete energy and direction are selected, options E and A above, only one loop is made. If option S is selected, three loops are made. In the first loop, a problem is first run with particles at energies specified on the 'Energy and Interval Width' line. In the second loop, a problem is run with energies randomly spread over the energy width above and below these energies. In the third loop, a problem is run with energies at the listed energies plus 1/2 the width. The particles all have the direction specified by the A option. If the D=d option is also selected, three additional loops are also made with the same energy definitions and with initial directions uniform between D=d and D=1.0 direction cosines. For monoenergetic, monodirectional particles, input: ,1/

==========
Noise Widths (N option)
==========

Omit this input unless N option. Input one record containing noise widths (one sigma) for sensitive volumes.

==========
Particle Energies (S option)
==========

Particle energies in MeV or MeV/amu.

==========
Particle Energy Widths (S option)
==========

Widths around particle energies in MeV.

Omit this input if not S option. Supply two records. First record contains particle energies. Second record contains the interval for spreading the energies both above and below the energies listed in the previous record.

==========
Detector Definition (M option)
==========

Omit this input if not M option. Input multiple records, one per detector channel. Last record is ,/. Each record contains triplets giving region number (flagged minus for anti coincidence) and min and max deposition for tripping the channel. Multiple triplets per channel may be used if needed.

++++++++++++
Output Tables
++++++++++++

Typical BETA input (for a proton telescope) and outputs while running histories are shown in Table 24 (BETSUM).

Electron and bremsstrahlung flux output formats are indicated in Table 25 (BETOUT).

Primary photon output table formats are shown in Table 26 (BETOUP).

The format of pulse height analysis outputs is indicated in Table 27 (BETPHD).

Pulse height outputs are also saved in a file PROTEL.SUM with the format indicated in Table 28 (BETSAV).

Finally, primary photon problems produce an output file MATRIX.DAT with the form shown in Table 29 (BETSUP).

Table 24: (BETSUM) Input and Running Outputs

```
INPUT *HEADER,OPTIONS/
Line   1:*BETA,DA=.999,Z=1,G,L=50,W,M,N,X=-1,S=5,H=20/

BETA-----------------------------------------------------------------------
INPUT LOOP SELECTS,0,1=N,Y
Line   2:1 0 0 0 0 0/
INPUT NOISE PARAMETERS
Line   3:0. .060 0 .100 0 .093 0 .093 0 .093/ noise data
INPUT PARTICLE ENERGY BOUNDARIES
Line   4:C 8.00 5.945 4.415 3.46 2.775 2.325 1.945 1.405/
Line   5:C 2.0 2.11 0.95 0.96 0.41 0.49 0.27 0.81/ deltas
Line   6:C 9 7 4.89 3.94 2.98 2.57 2.08 1.81 1/
Line   7:6.7 6.6 6.5 6.4 6.3/
INPUT PARTICLE ENERGY WIDTHS
Line   8:8*0/
INPUT CHANNEL PARAMETERS
         DATA INTERPRETATION STARTING AT COLUMN  4 OF LINE    8
Line   9:2 .477 1.600 4 -1,.490/
Line  10:2 1.600 .945 4 .490 1.006 6 -1 .496/
Line  11:2 .741 .945 4 1.006 1.700 6 -1 .496/
Line  12:2 .741 .653 4 .951 1.700 6 1.282 .496 8 -1 .486/
Line  13:4 .671 .951 6 1.282 2.600 8 -1 .486/
Line  14:6 1.340 2.600 8 .486 2.400/
Line  15:6 .765 1.340 8 2.400 5.668 /
Line  16:2 .263 100 6 .610 .765 8 3.154 5.668 /
Line  17:*STOP
              *END OR HEADER LINE TERMINATED INPUT
              *INFO*INFO*INFO*INFO*INFO*INFO*INFO*INFO*INFO*INFO*INFO*
N,E,X,C     1 6.700E+00 0.000E+00 0.000E+00-1.000E+00
                        0.000E+00 0.000E+00 1.000E+00
N,E,X,C     2 6.700E+00 0.000E+00 0.000E+00-1.000E+00
                        0.000E+00 0.000E+00 1.000E+00
N,E,X,C     3 6.700E+00 0.000E+00 0.000E+00-1.000E+00
                        0.000E+00 0.000E+00 1.000E+00
N,E,X,C     4 6.700E+00 0.000E+00 0.000E+00-1.000E+00
                        0.000E+00 0.000E+00 1.000E+00
N,E,X,C     5 6.700E+00 0.000E+00 0.000E+00-1.000E+00
                        0.000E+00 0.000E+00 1.000E+00
N,E,X,C     6 6.700E+00 0.000E+00 0.000E+00-1.000E+00
                        0.000E+00 0.000E+00 1.000E+00
N,E,X,C     7 6.700E+00 0.000E+00 0.000E+00-1.000E+00
                        0.000E+00 0.000E+00 1.000E+00
N,E,X,C     8 6.700E+00 0.000E+00 0.000E+00-1.000E+00
                        0.000E+00 0.000E+00 1.000E+00
N,E,X,C     9 6.700E+00 0.000E+00 0.000E+00-1.000E+00
                        0.000E+00 0.000E+00 1.000E+00
N,E,X,C    10 6.700E+00 0.000E+00 0.000E+00-1.000E+00
                        0.000E+00 0.000E+00 1.000E+00
N,E,X,C    11 6.700E+00 0.000E+00 0.000E+00-1.000E+00
                        0.000E+00 0.000E+00 1.000E+00
 :
```

Table 25: (BETOUT) Electron/Bremsstrahlung Output

```
REGION  DEPOSITION    STOPPING      N-FLUX      E-FLUX   N-CURRENT   E-CURRENT
     1 4.49E+00  1-1.09E-01  0 1.09E+00  1 1.35E+01  0 1.03E+00  1 1.30E+01  0
       4.14E-02  6 1.08E+00 29 BREMSSTRAHLUNG DEPOSITION
       4.53E+00  1 TOTAL DEPOSITION
       1.68E+00  1 MEV*SQCM/GRAM
TOTAL  4.49E+00  1-1.09E-01 18
TOTALB 4.14E-02  6 1.08E+00 29
TOTALS 4.53E+00  1 9.69E-01 30
LEAK   1.04E+01  0 1.11E+00  1
LEAK-B 1.02E+00  0 6.51E-01  4
LEAK-T 1.15E+01  0 1.76E+00  2
```

BREMSSTRAHLUNG FLUXES FOR REGION 1

GROUP	E-MIN	E-MAX	FLX/MEV	ERR	FLX/GRP	ERR	FLX-SUM	ERR
1	1.58E+01	2.00E+01	2.00E-06	99	8.20E-06	99	8.20E-06	98
2	1.26E+01	1.58E+01	7.62E-04	11	2.49E-03	11	2.49E-03	11
3	1.00E+01	1.26E+01	1.83E-03	8	4.73E-03	8	7.22E-03	9
4	7.94E+00	1.00E+01	3.64E-03	7	7.49E-03	7	1.47E-02	8
5	6.31E+00	7.94E+00	4.86E-03	8	7.94E-03	8	2.26E-02	8
6	5.01E+00	6.31E+00	7.86E-03	8	1.02E-02	8	3.28E-02	8
7	3.98E+00	5.01E+00	1.02E-02	9	1.05E-02	9	4.33E-02	8
8	3.16E+00	3.98E+00	1.72E-02	8	1.41E-02	8	5.74E-02	8
9	2.51E+00	3.16E+00	2.15E-02	10	1.40E-02	10	7.14E-02	8
10	2.00E+00	2.51E+00	3.13E-02	10	1.61E-02	10	8.75E-02	8
11	1.58E+00	2.00E+00	2.78E-02	13	1.14E-02	13	9.90E-02	9
12	1.26E+00	1.58E+00	3.68E-02	14	1.20E-02	14	1.11E-01	9
13	1.00E+00	1.26E+00	5.08E-02	14	1.32E-02	14	1.24E-01	10
14	7.94E-01	1.00E+00	5.90E-02	17	1.21E-02	17	1.36E-01	10
15	6.31E-01	7.94E-01	1.05E-01	17	1.72E-02	17	1.53E-01	11
16	5.01E-01	6.31E-01	1.24E-01	18	1.61E-02	18	1.70E-01	12
17	3.98E-01	5.01E-01	1.83E-01	20	1.89E-02	20	1.88E-01	12
18	3.16E-01	3.98E-01	1.65E-01	22	1.35E-02	22	2.02E-01	13
19	2.51E-01	3.16E-01	3.32E-01	23	2.16E-02	23	2.24E-01	14
20	2.00E-01	2.51E-01	2.86E-01	34	1.48E-02	34	2.38E-01	15
21	1.58E-01	2.00E-01	1.87E-01	41	7.66E-03	41	2.46E-01	16
22	1.26E-01	1.58E-01	3.55E-01	40	1.16E-02	40	2.58E-01	17
23	1.00E-01	1.26E-01	7.92E-01	39	2.05E-02	39	2.78E-01	19
24	7.94E-02	1.00E-01	5.37E-01	53	1.11E-02	53	2.89E-01	20
25	6.31E-02	7.94E-02	1.07E+00	49	1.74E-02	49	3.07E-01	22
26	5.01E-02	6.31E-02	9.17E-01	74	1.19E-02	74	3.18E-01	23
27	3.98E-02	5.01E-02	8.70E-01	51	8.97E-03	51	3.27E-01	24
28	3.16E-02	3.98E-02	1.75E+00	48	1.44E-02	48	3.42E-01	25
29	2.51E-02	3.16E-02	7.51E-01	67	4.88E-03	67	3.47E-01	26
30	2.00E-02	2.51E-02	3.95E-02	43	2.04E-04	43	3.47E-01	26
31	1.58E-02	2.00E-02	9.49E-02	86	3.90E-04	86	3.47E-01	26
32	1.26E-02	1.58E-02	9.72E-02	81	3.17E-04	81	3.48E-01	26
33	1.00E-02	1.26E-02	5.59E-01	88	1.45E-03	88	3.49E-01	26
34	7.94E-03	1.00E-02	4.00E-01	99	8.23E-04	99	3.50E-01	26
35	0.00E+00	7.94E-03	6.98E-01	39	5.54E-03	39	3.55E-01	27

Table 26: (BETOUP) Photon Primary Output

UNIT 15 CLOSED , STATUS = KEEP

DEPOSITION, MEV/GRAM, FOR REGION 1, 2.8830E-01 GRAMS

EMAX-MEV	EMIN-MEV	MEV/GRAM	MEV	ERR	# FLUX &	ERR	E FLUX &	ERR
1.40E+00	1.30E+00	2.39E-03	6.90E-04	87	7.30E-02	87	9.86E-02	87
1.00E+00	9.00E-01	6.96E-05	2.01E-05	87	2.85E-03	87	2.63E-03	87
9.00E-01	8.00E-01	1.89E-04	5.46E-05	87	8.17E-03	87	7.07E-03	87
8.00E-01	7.00E-01	2.80E-05	8.06E-06	60	1.35E-03	59	1.02E-03	60
6.00E-01	5.00E-01	1.82E-04	5.24E-05	87	1.15E-02	87	6.19E-03	87
5.00E-01	4.00E-01	1.44E-04	4.15E-05	87	1.03E-02	87	4.70E-03	87
3.00E-01	2.50E-01	2.89E-04	8.32E-05	47	2.59E-02	47	7.27E-03	48
2.50E-01	2.00E-01	5.87E-06	1.69E-06	76	5.11E-04	76	1.16E-04	76
2.00E-01	1.50E-01	1.19E-04	3.42E-05	45	8.62E-03	47	1.54E-03	49
1.50E-01	1.25E-01	6.00E-05	1.73E-05	81	2.99E-03	80	3.86E-04	79
1.25E-01	1.00E-01	4.14E-05	1.19E-05	85	1.61E-03	85	1.81E-04	85
1.00E-01	9.00E-02	1.56E-06	4.49E-07	84	4.50E-05	84	4.20E-06	84
9.00E-02	8.00E-02	3.42E-06	9.87E-07	84	8.39E-05	84	7.18E-06	84
8.00E-02	7.00E-02	2.87E-08	8.27E-09	87	5.73E-07	87	4.40E-08	87
7.00E-02	6.00E-02	3.32E-06	9.58E-07	87	4.79E-05	87	3.13E-06	87
6.00E-02	5.00E-02	1.05E-06	3.03E-07	87	1.14E-05	87	6.47E-07	87
5.00E-02	4.00E-02	4.13E-09	1.19E-09	87	2.77E-08	87	1.24E-09	87
3.00E-02	2.50E-02	5.73E-14	1.65E-14	87	1.39E-13	87	3.60E-15	87
	TOTAL	3.53E-03	1.02E-03	61	1.47E-01	46	1.30E-01	68

DEPOSITION, MEV/GRAM, FOR REGION 2, 5.2125E-04 GRAMS

EMAX-MEV	EMIN-MEV	MEV/GRAM	MEV	ERR	# FLUX &	ERR	E FLUX &	ERR
1.40E+00	1.30E+00	2.12E-03	1.10E-06	30	5.97E-02	30	8.05E-02	30
1.30E+00	1.20E+00	1.03E-03	5.39E-07	56	3.11E-02	56	3.86E-02	56
1.20E+00	1.10E+00	7.54E-04	3.93E-07	51	2.42E-02	51	2.77E-02	51
1.10E+00	1.00E+00	1.15E-04	5.99E-08	50	4.01E-03	50	4.13E-03	50
1.00E+00	9.00E-01	1.23E-04	6.41E-08	31	4.73E-03	31	4.34E-03	31
9.00E-01	8.00E-01	1.11E-04	5.80E-08	36	4.56E-03	36	3.88E-03	36
8.00E-01	7.00E-01	2.04E-04	1.06E-07	9	9.26E-03	9	7.00E-03	9
7.00E-01	6.00E-01	1.25E-04	6.50E-08	35	6.52E-03	36	4.23E-03	35
6.00E-01	5.00E-01	1.20E-04	6.27E-08	29	7.37E-03	30	4.06E-03	29
5.00E-01	4.00E-01	1.18E-04	6.16E-08	30	8.66E-03	30	3.98E-03	30
4.00E-01	3.00E-01	1.34E-04	6.97E-08	44	1.38E-02	43	4.60E-03	44
3.00E-01	2.50E-01	1.07E-04	5.58E-08	55	1.40E-02	56	3.78E-03	55
2.50E-01	2.00E-01	1.15E-04	6.00E-08	6	1.86E-02	6	4.20E-03	6
2.00E-01	1.50E-01	5.69E-05	2.96E-08	16	1.30E-02	13	2.21E-03	15
1.50E-01	1.25E-01	6.36E-06	3.32E-09	46	1.94E-03	47	2.63E-04	46
1.25E-01	1.00E-01	7.70E-06	4.01E-09	42	3.08E-03	44	3.36E-04	43
1.00E-01	9.00E-02	9.15E-08	4.77E-11	86	4.20E-05	86	4.09E-06	86
9.00E-02	8.00E-02	4.07E-07	2.12E-10	61	2.16E-04	60	1.83E-05	61
8.00E-02	7.00E-02	2.80E-08	1.46E-11	84	1.64E-05	84	1.23E-06	84
:								
2.00E-02	1.50E-02	3.23E-32	1.69E-35	0	2.56E-30	0	4.27E-32	0
	TOTAL	5.25E-03	2.73E-06	24	2.25E-01	14	1.94E-01	25

Table 27: (BETPHD) Pulse Height Output Format

REGION	DEPOSITION		STOPPING		N-FLUX		E-FLUX		N-CURRENT		E-CURRENT	
1	1.16E-01	3	0.00E+00	0	9.33E-04	0	6.20E-03	0	9.33E-04	0	6.20E-03	0
2	3.33E-01	1	0.00E+00	0	2.99E-03	0	1.92E-02	0	2.99E-03	0	1.92E-02	0
3	1.35E-03	18	0.00E+00	0	4.00E-03	0	2.50E-02	0	4.00E-03	0	2.50E-02	0
4	3.89E-01	1	0.00E+00	0	3.36E-03	0	2.04E-02	0	3.36E-03	0	2.04E-02	0
5	2.17E-03	8	0.00E+00	0	4.00E-03	0	2.34E-02	0	4.00E-03	0	2.34E-02	0
6	8.61E-01	1	0.00E+00	0	6.58E-03	0	3.58E-02	0	6.57E-03	0	3.57E-02	0
7	1.79E-03	15	0.00E+00	0	4.01E-03	0	2.00E-02	0	4.00E-03	0	2.00E-02	0
8	4.99E+00	0	1.00E+00	0	2.19E-02	0	6.84E-02	1	2.17E-02	0	6.81E-02	1
9	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0
10	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0
11	6.67E-04	40	0.00E+00	0	4.00E-03	0	2.50E-02	0	4.00E-03	0	2.50E-02	0
12	1.62E-03	30	0.00E+00	0	4.00E-03	0	2.35E-02	0	4.00E-03	0	2.34E-02	0
13	1.49E-03	32	0.00E+00	0	4.01E-03	0	2.00E-02	0	4.00E-03	0	2.00E-02	0
14	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0
15	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0
TOTAL	6.70E+00	0	1.00E+00	0								
LEAK	0.00E+00	0	0.00E+00	0								

DT	VL	RG	EZERO	EMIN	EMAX	CNTS	CNTS	ELOW	EAVE	EHGH
8	1	6	6.700E+00	7.650E-01	1.340E+00	20	20	7.997E-01	8.613E-01	9.263E-01
8	2	8	6.700E+00	2.400E+00	5.668E+00	20	20	4.867E+00	4.991E+00	5.078E+00
8	1	6	6.700E+00	7.650E-01	1.340E+00	19	19	7.916E-01	8.738E-01	9.908E-01
						MISS	1	7.316E-01	7.316E-01	7.316E-01
8	2	8	6.700E+00	2.400E+00	5.668E+00	19	20	4.870E+00	4.985E+00	5.117E+00
9	1	2	6.700E+00	2.630E-01	1.000E+02	1	20	2.781E-01	3.281E-01	3.623E-01
9	2	6	6.700E+00	6.100E-01	7.650E-01	1	1	7.316E-01	7.316E-01	7.316E-01
						MISS	19	7.916E-01	8.738E-01	9.908E-01
9	3	8	6.700E+00	3.154E+00	5.668E+00	1	20	4.870E+00	4.985E+00	5.117E+00

REGION	DEPOSITION		STOPPING		N-FLUX		E-FLUX		N-CURRENT		E-CURRENT	
1	1.20E-01	3	0.00E+00	0	9.33E-04	0	6.11E-03	0	9.33E-04	0	6.11E-03	0
2	3.42E-01	1	0.00E+00	0	2.99E-03	0	1.89E-02	0	2.99E-03	0	1.89E-02	0
3	2.31E-03	13	0.00E+00	0	4.00E-03	0	2.46E-02	0	4.00E-03	0	2.45E-02	0
4	4.02E-01	2	0.00E+00	0	3.36E-03	0	2.00E-02	0	3.36E-03	0	2.00E-02	0
5	2.11E-03	15	0.00E+00	0	4.00E-03	0	2.29E-02	0	4.00E-03	0	2.29E-02	0
6	8.51E-01	1	0.00E+00	0	6.58E-03	0	3.50E-02	0	6.57E-03	0	3.49E-02	0
7	2.25E-03	14	0.00E+00	0	4.01E-03	0	1.96E-02	0	4.00E-03	0	1.95E-02	0
8	4.87E+00	0	1.00E+00	0	2.09E-02	1	6.36E-02	1	2.08E-02	1	6.32E-02	1
9	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0
10	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0
11	1.09E-03	20	0.00E+00	0	4.00E-03	0	2.46E-02	0	4.00E-03	0	2.46E-02	0
12	1.31E-03	16	0.00E+00	0	4.00E-03	0	2.29E-02	0	4.00E-03	0	2.29E-02	0
13	1.25E-03	24	0.00E+00	0	4.01E-03	0	1.96E-02	0	4.00E-03	0	1.95E-02	0
14	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0
15	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0
TOTAL	6.60E+00	0	1.00E+00	0								
LEAK	0.00E+00	0	0.00E+00	0								

DT	VL	RG	EZERO	EMIN	EMAX	CNTS	CNTS	ELOW	EAVE	EHGH
8	1	6	6.600E+00	7.650E-01	1.340E+00	20	20	7.977E-01	8.511E-01	9.271E-01
8	2	8	6.600E+00	2.400E+00	5.668E+00	20	20	4.756E+00	4.875E+00	4.972E+00
8	1	6	6.600E+00	7.650E-01	1.340E+00	18	18	7.804E-01	8.626E-01	9.566E-01
						MISS	2	7.558E-01	7.603E-01	7.648E-01

:

Table 28: (BETSAV) Pulse Height PROTEL.SUM File

```
DT VL RG     EZERO      EMIN      EMAX CNTS CNTS      ELOW      EAVE      EHGH
 8  1  6 6.700E+00 7.650E-01 1.340E+00   20   20 7.997E-01 8.613E-01 9.263E-01
 8  2  8 6.700E+00 2.400E+00 5.668E+00   20   20 4.867E+00 4.991E+00 5.078E+00
 8  1  6 6.700E+00 7.650E-01 1.340E+00   19   19 7.916E-01 8.738E-01 9.908E-01
                                       MISS    1 7.316E-01 7.316E-01 7.316E-01
 8  2  8 6.700E+00 2.400E+00 5.668E+00   19   20 4.870E+00 4.985E+00 5.117E+00
 9  1  2 6.700E+00 2.630E-01 1.000E+02    1   20 2.781E-01 3.281E-01 3.623E-01
 9  2  6 6.700E+00 6.100E-01 7.650E-01    1    1 7.316E-01 7.316E-01 7.316E-01
                                       MISS   19 7.916E-01 8.738E-01 9.908E-01
 9  3  8 6.700E+00 3.154E+00 5.668E+00    1   20 4.870E+00 4.985E+00 5.117E+00
 6.7000E+00  8.4566E-02  3.0047E-01 -8.6761E-04  3.4856E-01  6.5518E-04
 7.9969E-01 -1.0449E-03  4.8667E+00  0.0000E+00  0.0000E+00 -2.4924E-03
-4.9554E-04 -1.0152E-03  0.0000E+00  0.0000E+00
 6.7000E+00  1.1634E-01  3.3293E-01  1.3456E-03  3.8886E-01  2.1740E-03
 8.6130E-01  1.7888E-03  4.9915E+00  0.0000E+00  0.0000E+00  6.6696E-04
 1.6204E-03  1.4894E-03  0.0000E+00  0.0000E+00
 6.7000E+00  1.4300E-01  3.7340E-01  3.9238E-03  4.5483E-01  3.7941E-03
 9.2632E-01  4.3766E-03  5.0776E+00  0.0000E+00  0.0000E+00  2.7431E-03
 1.0131E-02  8.7481E-03  0.0000E+00  0.0000E+00
 6.7000E+00  0.0000E+00  6.0000E-02  0.0000E+00  1.0000E-01  0.0000E+00
 9.3000E-02  0.0000E+00  9.3000E-02  0.0000E+00  9.3000E-02  0.0000E+00
 0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 6.7000E+00  3.3164E-02  5.1710E-02  2.5278E-03  5.3901E-02  1.8620E-03
 7.8031E-02  2.7862E-03  1.2810E-01  0.0000E+00  0.0000E+00  2.8368E-03
 5.0353E-03  4.9906E-03  0.0000E+00  0.0000E+00
 6.7000E+00  3.3164E-02  7.9208E-02  2.5278E-03  1.1360E-01  1.8620E-03
 1.2140E-01  2.7862E-03  1.5830E-01  0.0000E+00  9.3000E-02  2.8368E-03
 5.0353E-03  4.9906E-03  0.0000E+00  0.0000E+00
DT VL RG     EZERO      EMIN      EMAX CNTS CNTS      ELOW      EAVE      EHGH
 8  1  6 6.600E+00 7.650E-01 1.340E+00   20   20 7.977E-01 8.511E-01 9.271E-01
 8  2  8 6.600E+00 2.400E+00 5.668E+00   20   20 4.756E+00 4.875E+00 4.972E+00
 8  1  6 6.600E+00 7.650E-01 1.340E+00   18   18 7.804E-01 8.626E-01 9.566E-01
                                       MISS    2 7.558E-01 7.603E-01 7.648E-01
 8  2  8 6.600E+00 2.400E+00 5.668E+00   18   20 4.759E+00 4.877E+00 5.043E+00
 9  1  2 6.600E+00 2.630E-01 1.000E+02    2   19 2.968E-01 3.487E-01 3.983E-01
                                       MISS    1 2.471E-01 2.471E-01 2.471E-01
 9  2  6 6.600E+00 6.100E-01 7.650E-01    2    2 7.558E-01 7.603E-01 7.648E-01
                                       MISS   18 7.804E-01 8.626E-01 9.566E-01
 9  3  8 6.600E+00 3.154E+00 5.668E+00    2   20 4.759E+00 4.877E+00 5.043E+00
 6.6000E+00  9.6251E-02  2.7457E-01 -1.4926E-04  3.4018E-01 -1.8896E-04
 7.9766E-01 -7.8974E-04  4.7556E+00  0.0000E+00  0.0000E+00 -8.7043E-04
-1.2549E-04 -2.0418E-03  0.0000E+00  0.0000E+00
 6.6000E+00  1.1982E-01  3.4173E-01  2.3088E-03  4.0230E-01  2.1125E-03
 8.5113E-01  2.2545E-03  4.8747E+00  0.0000E+00  0.0000E+00  1.0935E-03
 1.3114E-03  1.2502E-03  0.0000E+00  0.0000E+00
 6.6000E+00  1.4694E-01  3.8335E-01  4.2306E-03  4.5880E-01  4.4289E-03
 9.2708E-01  5.7175E-03  4.9720E+00  0.0000E+00  0.0000E+00  3.7496E-03
 3.3374E-03  3.9168E-03  0.0000E+00  0.0000E+00
 6.6000E+00  0.0000E+00  6.0000E-02  0.0000E+00  1.0000E-01  0.0000E+00
 9.3000E-02  0.0000E+00  9.3000E-02  0.0000E+00  9.3000E-02  0.0000E+00
 0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 :
```

Table 29: (BETSUP) Photon Summary, MATRIX.DAT

```
C DEPOSITION, DEP ERR, FLUX, AND FLX ERR FOR REGION   1
C SINGLE PHOTON SOURCE WITH ENERGIES BETWEEN  1.4000E+00  1.3000E+00
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 0.00E+00 0.00E+00 0.00E+00 0.00E+00
C DEPOSITION, DEP ERR, FLUX, AND FLX ERR FOR REGION   2
C SINGLE PHOTON SOURCE WITH ENERGIES BETWEEN  1.4000E+00  1.3000E+00
 2.54E-02 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 3.19E-04
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 2.72E-07
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 0.00E+00 0.00E+00 0.00E+00 2.57E-02
 2.61E+01 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 8.70E+01
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 8.70E+01
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 0.00E+00 0.00E+00 0.00E+00 2.61E+01
 7.04E-01 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 1.64E-02
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 9.54E-05
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 0.00E+00 0.00E+00 0.00E+00 7.20E-01
 2.60E+01 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 8.70E+01
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 8.70E+01
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 0.00E+00 0.00E+00 0.00E+00 2.61E+01
C DEPOSITION, DEP ERR, FLUX, AND FLX ERR FOR REGION   3
C SINGLE PHOTON SOURCE WITH ENERGIES BETWEEN  1.4000E+00  1.3000E+00
 2.02E-02 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 2.01E-04
 0.00E+00 0.00E+00 1.74E-04 6.33E-06 2.17E-04 2.78E-08 4.36E-06 1.14E-06
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 0.00E+00 0.00E+00 0.00E+00 2.08E-02
 1.74E+01 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 8.70E+01
 0.00E+00 0.00E+00 5.22E+01 7.30E+01 8.22E+01 8.70E+01 6.44E+01 8.64E+01
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 0.00E+00 0.00E+00 0.00E+00 1.72E+01
 6.04E-01 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 1.08E-02
 0.00E+00 0.00E+00 1.48E-02 5.70E-04 1.92E-02 1.81E-06 2.28E-04 5.09E-05
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 0.00E+00 0.00E+00 0.00E+00 6.50E-01
 1.73E+01 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 8.70E+01
 0.00E+00 0.00E+00 5.20E+01 7.30E+01 8.22E+01 8.70E+01 6.30E+01 8.64E+01
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 0.00E+00 0.00E+00 0.00E+00 1.74E+01
 :
```

CATIA

CATIA, general geometry modeling

****
This input processor provides a more general description of
geometries including unions and intersections to arbitrary level.
Inputs may include: surfaces, bodies, movements, and regions.
Logic for save/retrieve is not completed.
****

****
Input Record Description:
****

======
Header
======

Contains *CAT in columns 1 through 4.

The *CAT in columns 1 through 4 are required.

=======
Options
=======

O=o, overlap option, see OVERLAP section of the users guide.

H (real,,eps,inf) if box lims identical use= -eps, default 1 micron

D=d, debug print option, D=1 is most detailed

****
Data Record Description:
****

==========
Operation and Data List
==========

each data record has the general form:

operation list_of_data/ (THE SLASH TERMINATES THE RECORD)

where the operation (op) is taken from the list surface, body,
global, local, region, save, get, end.

Alternatively, the op field may be omitted and the op field from the preceding input record is used.

==========
Save/End/Get Operations
==========

The save command has the form

SAVE name

where 'name' is a unique name given by the user to a set of input lines. All lines after the SAVE line through the line

END name are saved on the file CATIA.LIB. These lines can be recalled by the input line:

GET name

The value of 'name' must be unique. The lines between SAVE and END cannot contain embedded SAVE/GET/END commands.

==========
Relocation Operations
==========

The global and local commands give information for relocating the geometry. Global indicates that each of these relocations is specified in the reference coordinate system and each command assumes the object is where prior commands said to put it. Local indicates the the relocation information is given in the local coordinate system, wherever that may be due to previous relocation commands.

The integer after the word global or local specifies the index of a prior saved relocation set. A 1 (one) indicates the basic do-nothing rotation/translation matrix. A negative index means the inverse of the specified matrix is used. A 0 (zero) indicates an operation applied to the currently active reloction matrix.

Valid operations following the integer are:

translate followed by the x,y, and z translations.

xyrotate followed by the rotation origin and angle in degrees

yzrotate followed by the rotation origin and angle in degrees

zxrotate followed by the rotation origin and angle in degrees

reflect followed by the coordinates of a point in the reflection plane followed by the coordinates of a point along the normal from the first point.

move followed by a translation matrix followed by up to three pairs of axis and angle, e.g. x 30 z 10 y 20 would mean rotate by 30 degrees around x followed by 10 degrees around z, then 20 degrees around y. If the operation is 'global' each operation is specified in the reference frame, and if 'local' each operation is specified in the current local frame (after the preceding operations).

restore, followed by no input simply picks up the previously saved relocation matrix indicated by the integer.

save, followed by no input saves the current rotation matrix

multiple operations can be entered. Only the first one should contain the index of a base relocation matrix. Operations after the first should have a 0 (zero) for the base matrix.

==========
Surface Operations
==========

Surfaces can be entered using the surface names and data lists indicated in Table 30 (CATSUR). Alternate formats are indicated in Table 31 (CATMCN) and correspond to forms in the MCNP code.

A final surface input actually defines a body. The surface name is 'list' and the following data are indices of previously entered surfaces followed by the word 'point' followed by the x,y, and z coordinates of any point in the body. If the word 'point' and the coordinates are omitted, then the list of surfaces must be signed according to whether the body is inside or outside the surface, positive or no sign if inside the surface and negative if outside the surface. If the point is input, then if the surface surface indices entered as positive numbers are understood to be user indices of the input lines, and any indices entered as negative numbers are understood to be the surface indices assigned by the code. The volumes defined by the surfaces are combined using intersection logic.

==========
Body Operations
==========

Bodies can be entered using the names and data lists indicated in Table 32 (CATDES). Alternate forms, derived from the MAGI combinatorial geometry modeling in the Applicon/Synthavision code are given in Table 33 (CATMAG).

A final body input defines a higher level body. The body name is 'list' and is followed by a listing of other body numbers with no sign if the new body is inside the listed body or signed minus if the new body is outside the listed body (inside the listed body complement).

==========
Region Operations
==========

The first datum following the region index is either a material number or name. A void region as the name 'void' or the material number 0. For non void regions, the default density is the supplied in the *materials section. For any other density, follow the material name or number by an = or @ followed by the desired density in g/cc or by a scale factor flagged with a minus sign.

After the material composition information, the data list describes the body (or bodies and surfaces) that make up the region. The listed information is understood to be the indices of bodies. Any surface indices must be be preceded by the word 'surface' (or the letter 's'). All following indices are interpreted as surfaces until the word 'body' (or the letter 'b') is encountered. Then bodies are assumed again. This flip/flop between surfaces and bodies can be made as needed.

Alternatively, the region can be described using any of the body names and dimensions used in describing bodies.

The logic for describing the region geometry can be complex. Parentheses can be used to group bodies and surfaces. The volume of other regions can be deleted from this region by entering #n where n is the other region index. The symbol # (read as 'not in') can also precede an open parenthesis, and is interpreted to mean the complement of the geometry described between the open and close parentheses.

Surfaces and bodies, when listed, can be unsiged or signed negative. Negatively signed surfaces and bodies are understood to mean the complement of the surfaces and bodies.

Composite volumes are created by taking the intersections of the listed surfaces and bodies. Unions can also be obtained by inserting a colon (':') or ampersand ('&') between elements in the lists.

Parentheses can always be used to modify the default interpretation of lists. List elements at the same level are first intersected and then unioned if there are any colons between elements.

Examples for lists

a b : c means (a intersect b) union c

a (b:c) means a intersect (b union c)

The code does unions by using the complement of intersected complements (see the GEOmetry section of this guide). Therefore the above examples can also be written as:

a b & c = -(-(a b) -c) = #(#(a b) -c)

a (b&c) = a -(-b -c) = a #(-b -c)

All three forms can be entered and have the same meaning.

Remember that #n where n is a number, specifically means the complement of region n -- not body n or surface n. For surfaces and bodies, the minus sign is used to indicate complements. The # can only be used on surfaces/bodies that are enclosed in parentheses -- just before the open paren.

Final Comment on Lists

The data on 'surface n list' lines, on 'body n list' lines, and on 'region n material@rho' lines are all interpreted by the same processor. The only difference is that on surface inputs, lists of indices are interpreted as surfaces until changed by the body keyword. On both body and region inputs, lists of indices are interpreted as body indices until changed by the surface keyword.

++++++++++++
Input Tables
++++++++++++

Table 30 (CATSUR) lists surfaces from the SURFACE processor.

Table 31 (CATMCN) lists surfaces from the MCNP processor.

Table 32 (CATDES) lists bodies from the DESIGN processor.

Table 33 (CATMAG) lists bodies from the MAGIC processor.

Table 30: (CATSUR) Basic Surfaces

Type	Constant List	
EXP	a a a a a ... a / 0 1 2 3 4 j	expanded quadric
XPL	a /	x=a plane
YPL	a /	y=a plane
ZPL	a /	z=a plane
YZP	y z y z / 0 0 1 1	plane parallel x axis
ZXP	z x z x / 0 0 1 1	plane parallel y axis
XYP	x y x y / 0 0 1 1	plane parallel z axis
XCO	y z r x r x / 0 0 1 1 2 2	x cone
YCO	z x r y r y / 0 0 1 1 2 2	y cone
ZCO	x y r z r z / 0 0 1 1 2 2	z cone
XCY	y a z b / 0 0	x cylinder
YCY	z a x b / 0 0	y cylinder
ZCY	x a y b / 0 0	z cylinder
SPH	x a y b z c / 0 0 0	ellipsoid
XXP	a b /	x-a= +- b
YYP	a b /	y-a= +- b
ZZP	a b /	z-a= +- b
XHE YHE ZHE	helicoids, not implemented	
XTO YTO ZTO	torroids, not implemented	

Table 31: (CATMCN) MCNP Derived Surfaces

name	equation	input data
P	0 = Ax + By + Cz - D	A,B,C,D
PX	0 = x - D	D
PY	0 = y - D	D
PZ	0 = z - D	D
SO	0 = x**2 + y**2 + z**2 - R**2	R
S	0 = (x-X)**2 + (y-Y)**2 + (z-Z)**2 - R**2	X,Y,Z,R
SX	0 = (x-X)**2 + y**2 + z**2 - R**2	X,R
SY	0 = x**2 + (y-Y)**2 + z**2 - R**2	Y,R
SZ	0 = x**2 + y**2 + (z-Z)**2 - R**2	Z,R
CPX	0 = (y-Y)**2 + (z-Z)**2 - R**2	Y,Z,R
CPY	0 = (x-X)**2 + (z-Z)**2 - R**2	X,Z,R
CPZ	0 = (x-X)**2 + (y-Y)**2 - R**2	X,Y,R
CX	0 = y**2 + z**2 - R**2	R
CY	0 = x**2 + z**2 - R**2	R
CZ	0 = x**2 + y**2 - R**2	R
KPX	0 = (y-Y)**2 + (z-Z)**2 - T(x-X)**2	X,Y,Z,T,+-1
KPY	0 = (x-X)**2 + (z-Z)**2 - T(y-Y)**2	X,Y,Z,T,+-1
KPZ	0 = (x-X)**2 + (y-Y)**2 - T(z-Z)**2	X,Y,Z,T,+-1
KX	0 = y**2 + z**2 -T(x-X)**2	X,T,+-1
KY	0 = x**2 + z**2 -T(y-Y)**2	Y,T,+-1
KZ	0 = x**2 + y**2 -T(z-Z)**2	Z,T,+-1
SQ	0 = A(x-X)**2 + B(y-Y)**2 + C(z-Z)**2 +2D(x-X) + 2E(y-Y) + 2F(z-Z) + G	A,B,C,D,E,F,G
GQ	0 = Ax**2 + By**2 + Cz**2 + Dxy + Eyz + Fzx + Gx + Hy + Jz + K	A,B,C,D,...,K
TX	0 = -1 + ((x-X)/B)**2 +(sqrt((y-Y)**2+(z-Z)**2) - A)/C)**2	X,Y,Z,A,B,C
TY	0 = -1 + ((y-Y)/B)**2 +(sqrt((x-X)**2+(z-Z)**2) - A)/C)**2	X,Y,Z,A,B,C
TZ	0 = -1 + ((z-Z)/B)**2 +(sqrt((x-X)**2+(y-Y)**2) - A)/C)**2	X,Y,Z,A,B,C

X , one, two or three pairs of points for (x,r)

Y , pairs for (y,r), surface is rotated around y axis

Z , pairs for (z,r), surface is rotated around z axis

Table 32: (CATDES) Basic Bodies

name	Dimension Data, (...)==> optional data
HOL	X1 X2 Y1 Y2 Z1 Z2 (x1 x2 y1 y2 z1 z2)/ (x1 ... z2) are optional inner box
XCYlinder	Y0 Ry Z0 Rz X1 X2 (Y1 Y2 Z1 Z2) /
YCYlinder	Z0 Rz X0 Rx Y1 Y2 (Z1 Z2 X1 X2) /
ZCYlinder	X0 Rx Y0 Ry Z1 Z2 (X1 X2 Y1 Y2) /
ELLipsoid	X0 Rx Y0 Ry Z0 Rz (X1 X2 Y1 Y2 Z1 Z2) /
XANulus	Y0 R1 Z0 R2 X1 X2 (Y1 Y2 Z1 Z2) /
YANulus	Z0 R1 X0 R2 Y1 Y2 (Z1 Z2 X1 X2) /
ZANulus	X0 R1 Y0 R2 Z1 Z2 (X1 X2 Y1 Y2) /
XCOne	Y0 Z0 R1 X1 R2 X2 (Y1 Y2 Z1 Z2) /
YCOne	Z0 X0 R1 Y1 R2 Y2 (Z1 Z2 X1 X2) /
ZCOne	X0 Y0 R1 Z1 R2 Z2 (X1 X2 Y1 Y2) /
THEtabox	$\overline{X}$ $\overline{Y}$ $\overline{Z}$ A L W H/ A in degrees
PIE	R S A B H Z/ A and B in degrees
MIDpointbox	$\overline{X}$ $\overline{Y}$ $\overline{Z}$ L W H/
ROTatedbox	Z A R L W H/ A in degrees
CAKe	R1 R2 Z1 Z2 A B/ A and B in degrees
RHOllowbox	$\overline{X}$ $\overline{Y}$ $\overline{Z}$ A L W H T1 (T2 T3 ... T6) / A in degrees.

Table 33: (CATMAG) MAGI Derived Bodies

```
Body     Description of input data
*** box
box, vertex and 3 orthogonal length vectors
*** right parallelapiped
rpp, vector to corner, vector to diagonal corner
*** right angle wedge, also known as 'WED'
raw, vertex and 3 orthogonal length vectors, first 2 lengths
     form the legs of the right triangle, l3 is the thickness
*** arbitrary polyhedron
arb, 8 vertex points followed by 6 face descriptors
     unused faces =0. and at end of list, unused vertices=0,0,0
*** sphere
sph, vertex and radius
*** ellipse, this form has been removed
ell, coordinates of foci and length of major axis (change this)
*** tjordan form of ellipse
tel, center and three length vectors along
     the semiminor axes. (the first two establish the
     orthogonal bases. the third is used for length only.)
*** right circular cylinder
rcc, vertex, height vector, and radius
*** truncated cone
trc, vertex, height, and two radii (vertex on larger base?)
*** truncated elliptical cone (or cylinder if ratio = 1)
tec, vertex of larger base, length vector to other base,
     unit vector normal to base, unit vector along the
     major axis of the ellipse, semi major and semi minor
     axis lengths in large base, and ratio of smaller base
     axis to larger base axis.
*** solid torus (no hole)
sto, vertex, unit normal along axis, radius of gyration,
     radius along gyr radius, radius along axis.
*** torus
tor, same as sto
*** arbitrary segmented line
asl, connected line segments in a plane extruded
     vertex=local origin, thickness (must be positive),
     number of points, local x unit vector, local y unit,
     n sets of (x,y,r,f) where r is the radius of curvature
     between this point and the next (for circular arcs
     or fillets), and f defines the shape
     0., linear segment
     1., slope is continuous at beginning point
     2., slope is continuous at end point
     3., slope is continuous at both ends
     4., circular arc convex with center inside linear seg
     5., circular arc concave with center inside linear seg
     6., circular arc convex with center outside linear seg
     7., circular arc concave with center outside linear seg
     order points clockwise, last point auto connected to 1st
     points go clockwise, automatic connection of last to 1st
*** revolved line segment
rev, same input as asl, all y vals > 0,
```

COMMAND

COMMAND, discusses data on the command line

****
The COMMAND processor describes data entered on the command line including file names and paths to directories.
****

****
Discussion
****

This section documents data entered on the command line, e.g.:

```
NOVICE p=d:\new\
```

would set a path for output files created by the run (the directory must already exist).

On an IBM/MVS mainframe/system, the command line data is assumed to be in the input stream following the SYSIN line, e.g., between the lines:

```
//SYSIN DD *

/*
```

On a PC or workstation, the command line information can be read from a file by using the command:

```
NOVICE *=FILENAME
```

The following are recognized command line arguments:

*=name_of_a_file_containing_command_line_information

C=name_of_a_non-standard_CONFIG.NOV_file

E=a_3_character_extension_for_file_names_ending_with_.*

I=name_of_the_input_data_file

K=name_of_the_file_for_saving_keyboard_inputs

L=alternate_path_for_library_files

N=problem_name, default for .dat .out .sum .run .err .key

O=output_file_name

P=path_for_output_files_from_this_run

Q=path_for_output_files_from_previous_run

R=name_of_novice.run_file, fixed inputs before going interactive

S=name_of_novice.sum_file

T=time_limit (seconds, default 3.17+7)

U=path_for_user_files

V=temporary_path

W=name_of_old_save.dat file

X=name_of_new_save.dat file

Y=name_of_old_start.dat file

Z=name_of_new_start.dat file

Default file names are given in the CONFIG.NOV file. In the last quarter of 1995, the file naming was changed to allow for automatic addition of a path. The reason for this change was to allow multiple users on a mainframe to create unique output file names.

In CONFIG.NOV, the following characters can preceed a file name and indicate special directories (paths):

* indicating the path to library files (L parameter on the command line).

+ indicating the path to new files created by this run (P parameter on the command line).

- indicating the path to old files from the previous run (Q parameter on the command line).

& indicating the path to user files saved in a specific directory (U parameter on the command line).

% indicating a temporary path (V parameter on the command line).

On a PC or workstation, the user can specify the paths on the command line by:

```
NOVICE U=userpath P=newpath Q=oldpath L=librarypath
```

On an IBM mainframe running MVS, the paths (and other command line variables) are in the JCL (Job Control Language statements) between the lines:

```
//SYSIN DD *

/*
```

When using a command line file, each parameter is on a separate line, e.g.:

```
u=r2736.user.

p=r2736.960316.152736.

q=r2736.960317.101527.
```

The same logic can be simulated on the PC using the command line

```
NOVICE *=commandargs
```

Command line data are then taken from the file 'commandargs'

On the mainframe, it is assumed that the path for new files would be based on the date and time that the run stream is created, e.g., a run started 1996 March 17 at 9:15:36 a.m. would use a path of the form: username.960317.091536..

Paths should end with an appropriate special character ('\' on the PC, '/' on unix workstations, '.' on IBM/MVS) and ':' on a power pc.

CRASH

CRASH, clears data areas between independent problems.

****
The CRASH processor deletes all previous inputs so that an independent problem can be run.
****

****
Input Record Description
****

======
Header
======

*CRA in columns 1 through 4.

=======
Options
=======

A, reset units etc.

V, replace old save/start with new save/start, generate new save/start names

****
Data Record Description
****

There are no other data records.

CSG

CSG, output Constructive Solid Geometry for ACCEPT, QAD, or MORSE.

****
The CSGBODY processor outputs NOVICE geometry in CSG format for input to the QAD, ACCEPT, or MORSE codes. Presently limited to rectangular bodies described using the *SIMPLE processor.
****

****
Input Record Description
****

==========
Header Line
==========

The header line must contain *csg in columns 1 through 4. If any options are used, at least one must be on this line and the option field must be terminated by a slash.

==========
Options Field
==========

A, prepare file for ACCEPT code.

E=e, electron cutoff energy for ACCEPT output.

M, if present, output regions in order of material (voids last). If M=m, then ACCEPT format assumed and for material 1, cell division is indicated using ZSUB and the subdivision line contains m/10000, (m-10000*(m/10000))/100, m-100*(m/100), i.e., for nx, ny, and nz subdivisions in the cell use M=10000*nx+100*ny+nz, e.g, if nx,ny,nz = 3,7,12, then input 30712.

S=s, photon stretching factor for ACCEPT output.

V, if present, output volume information for ACCEPT.

Discussion

The output is contained in the CSGBODY.NEW file.

DATA

DATA, input formats for data files

****
This section, DATA, of the users guide describes data preparation including in-line conversion options and data interpolation options.
****

****
Discussion
****

Data input is divided into several sections. Each input section is signaled by a header line of the form

*name,options/

where the asterisk must be in column one, the name must start in column two, and the first three characters of the name must be present.

Upper and lower case letters are both allowed and can be used in any combination, i.e., the input is not case sensitive on alphabetic characters.

Data base inputs are scatter loaded as provided by the user. The various data base input sections can be reused, as needed, to describe the data base.

The *EXECUTE line signifies the user has finished loading the data base. The scatter loaded data is then collected into specific subsets describing materials, geometry, spectra, etc..

The header line may not involve any options. It can then be written as

*name

with the rest of the line blank, or as

*name/

with the rest of the line used for comments, or

 *name/,data/

i.e., the /, combination says the data starts on the header line. For example

*LABEL/,'1D KERNELS FOR ELECTRON/BREM IN COPPER'/

Options, if present, may start on the header line and may continue over several lines. The option field starts with the first comma or blank column on the header line. Options consist of the 26 alphabetic letters A through Z.

If options do not involve numerical values, they can be adjacent to each other, and/or separated by blanks

*name,ABH/ or *name H A B/

If the option has a numerical value, it must be written in the form

A=a

where a denotes the numerical value. This string must not have embedded blanks. The numerical value must be followed by a blank, comma, slash, or dollar sign.

The doller sign,, says that the rest of the line contains comments. The option field continues on the next physical line, e.g.,

*ADJOINT,Z=26 $ IRON NUCLEUS TRANSPORT

**H=64 $ 64 HISTORIES PER ENERGY GROUP

**S/ SHIELD REGION INDICES ARE BEING INPUT

Note that if the option field continues across multiple lines, these lines must have asterisks in columns 1 and 2

Data after the header line, if any, is free field. The data is supplied as logical records which must be terminated by a slash. Each logical record starts on a new line (line) unless the slash terminating the previous record is followed by a comma.

Data items are separated by a comma and/or one or more blanks. Provision is made for commenting the data using either the dollar sign (rest of the line ignored) or a 'comment line' with a C in column one and column two blank.

A line that starts with C* or c* in columns 1 and 2 is interpreted as a comment line or as a data set separator on a library data file (see GET writeup).

Alphanumeric data strings must be enclosed in quotes and cannot contain quotes. The quotes can be omitted if the string consists of letters and numbers only, no special characters or embedded blanks.

Many data items are of the form

```
x x x ...x /,f(x ) f(x ) f(x )...f(x ) /
 1 2 3    n     1     2     3       n
```

The input descriptions refer to this type of input as

```
 , x / , f(x) /
   -       -
```

i.e., two data vectors of the same length. Provision is made reading this type of data as logical pairs. The user inputs

```
,/, x  f(x ) x  f(x ) ...  x  f(x )  /
     1    1   2    2        n    n
```

i.e., the first record is blank (no entries).

Frequently the data vector f(x) is a relative distribution that has a constant value. This distribution is set to all 1's if

```
,x x ... x /,/
  1 2     n
```

is input, i.e., the second data vector, as input, has zero length.

The input process allows repeats written in the form n*x and means n values of x, e.g., ,3*0,

is equivalent to 0,0,0, or ,,,,

Two types of interpolation are allowed. Logarithmic is written as:

```
x  LIn*x
 1      n+1
```

For example 10,LI30*.01

results in 31 stored numbers logarithmically spaced from 10 to .01 where, in general

```
x = x exp((i-1) ln(x   /x )/n )
 i   1              n+1  1
```

for i=1,2,...n+1

Power law interpolation is written as

```
x  aIn*x
 1      n+1
```

For example 0 1I10*1 results in eleven stored numbers linearly spaced from 0 to 1

In general, power law interpolation is performed as:

$$x_i = (x_1^a + (i-1)(x_{n+1}^a - x_1^a)/n)^{(1/a)}$$

for i=1,2,...,n+1

Several other input strings allow for conversion of data, e.g., CD10 results in a stored datum of the cosine of 10 degrees. The special input strings are listed in Table 34 (DATSTR) following this discussion.

Input strings also limited inline calculations where the entire string must be inclosed by parentheses, and each datum must be inclosed by parentheses, e.g.,

((PI)/(4))

The datum enclosed in parentheses can utilize any of the special forms (except interpolation) in Table 34 (DATSTR). Only the +,-,*,/ operations are allowed between data. Hierarchy is simply left to right unless altered by additional parenthesis levels.

++++++++++++
Input Tables
++++++++++++

Table 34 (DATSTR) lists special data strings.

++++++++++++
Output Tables
++++++++++++

A typical input/output stream is shown in Table 35 (DATINP).

The final portion of a NOVICE run is given in Table 36 (DATOUT).

Table 34: (DATSTR) Special Data Strings

Input String	Stored Datum
a**b	a^b
PI	3.1415926536
LTx	$\log_{10}(x)$
LNx	ln(x)
ETx	10^x
ENx	exp(x)
SDx	sin(pi*x/180)
SNx	sin(x)
CDx	cos(pi*x/180)
CNx	cos(x)
TDx	tan(pi*x/180)
TNx	tan(x)
RDx	pi*x/180
n*a	a stored n times
x_1 LIn*x_{n+1}	logarithmic interpolation
x_1 aIn*x_{n+1}	power law interpolation, for example: a=1 gives linear interpolation a=2 gives quadratic interpolation (equal intervals in delta x^2)

Table 35: (DATINP) Typical Data Input Stream

```
NOVICE Code, Copyright 1989, Thomas M. Jordan
Experimental and Mathematical Physics Consultants

THIS IS A BATCH NOVICE RUN

INPUT DATA WILL BE TAKEN FROM THE FILE         NOVICE.DAT

SUMMARY OUTPUTS WILL BE WRITTEN TO THE FILE    NOVICE.SUM

INPUT DATA TABLES & LARGE OUTPUTS ARE FILED AS NOVICE.OUT
                                                                    PAGE   1

READING ASCII CHARACTER FILE ASCII.NUM ON UNIT  34
--------------------------------------------------------------------------------
   0=SUR   0=BOD   0=REG   0=MAT   0=SOU   0=DET   0=PAR   0=SPE   0=RES  0=ERR
--------------------------------------------------------------------------------
                  1         2         3         4         5         6         7
         1234567890123456789012345678901234567890123456789012345678901234567890
INPUT *HEADER,OPTIONS/
Line   1:*GET/,'D:NOVICEGETFILES.DAT'/
         DATA INTERPRETATION STARTING AT COLUMN  6 OF LINE    1

UNIT   4 OPENED D:NOVICEGETFILES.DAT
--------------------------------------------------------------------------------
   0=SUR   0=BOD   0=REG   0=MAT   0=SOU   0=DET   0=PAR   0=SPE   0=RES  0=ERR
--------------------------------------------------------------------------------
                  1         2         3         4         5         6         7
         1234567890123456789012345678901234567890123456789012345678901234567890
INPUT *HEADER,OPTIONS/
Line   2:*FILES,L/
Line   3:9 'D:LPSDATXLIBE.DAT'
         DATA INTERPRETATION STARTING AT COLUMN  3 OF LINE    3
Line   4:10 'D:LPSDATMLIBE.DAT'
         DATA INTERPRETATION STARTING AT COLUMN  4 OF LINE    4
Line   5:15 'D:LPSDATPRATHE.DAT'
         DATA INTERPRETATION STARTING AT COLUMN  4 OF LINE    5
Line   6:30 'D:LPSDATDLC31.DAT'
         DATA INTERPRETATION STARTING AT COLUMN  4 OF LINE    6
              END OF INPUT ON UNIT  4

UNIT   4 CLOSED , STATUS = KEEP
Line   7:*END
              *END OR HEADER LINE TERMINATED INPUT
              *INFO*INFO*INFO*INFO*INFO*INFO*INFO*INFO*INFO*INFO*INFO*
```

Table 36: (DATOUT) Typical Problem Termination

```
INPUT *HEADER,OPTIONS/
Line 153:*STOP

UNIT  13 OPENED START.DAT

SAVE FILE BEING WRITTEN AS: START.DAT

UNIT  13 CLOSED , STATUS = KEEP

            EXPERIMENTALANDMATHEMATICALPHYSICSCONSULTANTSEXPE
            RIMENTALANDMAT                                ERIME
            NTALANDMATHEM                                MENTAL
            ANDMATHEMATI          CONSULTANTSEXPERIMENTALANDM
            ATHEMATICAL          SULTANTSEXPERIMENTALANDMATHE
            MATICALPHY                              MATHEMATI
            CALPHYSIC                              HEMATICALP
            HYSICSCO          XPERIMENTALANDMATHEMATICALPHYSI
            CSCONSU          RIMENTALANDMATHEMATICALPHYSICSCO
            NSULTA                               PHYSICSCONSUL
            TANTS                               SICSCONSULTANT
            SEXPERIMENTALA          ICALPHYSIC          TSEXP
            ERIMENTALANDM            HYSICS            XPERIM
            ENTALANDMATH              SC              RIMENTA
            LANDMATHEMA                              ENTALAND
            MATHEMATIC                              ALANDMATH
            EMATICALP          U        P          NDMATHEMAT
            ICALPHYS          ANT    ERI          ATHEMATICAL
            PHYSICS          SEXPERIMEN          EMATICALPHYS
            ICSCON          PERIMENTAL          TICALPHYSICSC
            ONSUL          IMENTALAND          ALPHYSICSCONSU
            LTANTSEXPERIME                               ULTAN
            TSEXPERIMENTA                               ANTSEX
            PERIMENTALAN          CALPHYSICS          SEXPERI
            MENTALANDMA          PHYSICSCON          PERIMENT
            ALANDMATHE                              IMENTALAN
            DMATHEMAT                              NTALANDMAT
            HEMATICA          NSULTANTSEXPERIMENTALANDMATHEMA
            TICALPH          LTANTSEXPERIMENTALANDMATHEMATICA
            LPHYSI          NTSEXPERIMENTALANDMATHEMATICALPHY
            SICSC          EXPERIMENTALANDMATHEMATICALPHYSICS
            CONSULTANTSEXP                               SCONS
            ULTANTSEXPERI                               NSULTA
            NTSEXPERIMEN          EMATICALPH          LTANTSE
            XPERIMENTAL          TICALPHYSI          NTSEXPER
            IMENTALAND          ALPHYSICSCONSULTANTSEXPERIMEN
            TALANDMAT          HYSICSCONSULTANTSEXPERIMENTALA
            NDMATHEM          ICSCONSULT          MENTALANDMA
            THEMATI          CONSULTANT          TALANDMATHEM
            ATICAL                               ANDMATHEMATIC
            ALPHY                               MATHEMATICALPH
            EXPERIMENTAL AND MATHEMATICAL PHYSICS CONSULTANTS
            POST OFFICE BOX 3191       GAITHERSBURG, MD 20885
         *****************THE NOVICE PROGRAM-1989****************
         ***************GENERATION DATE 1989 SEP 30**************
```

DEMO

DEMO simplifies the presentation of code demonstrations.

****
The DEMO processor puts text information on screen and, if the run is interactive, allows the user to skip part of a run.
****

****
Input Data Description:
****

==========
Header line
==========

Contains *DEM in columns 1 through 4.

=======
Options
=======

n, if present, no skip is allowed (skip is a user prompt)

N=n, if the user requests skip, then the code skips to the line starting with 'n', where n is a quoted character string.

r, if present, do not center the information accompany this command.

T=t, if batch mode, pause for t seconds to allow reading the info.

p, if present and an interactive run, pause until the user hits a key.

****
Data Record Description:
****

Input consists of up to 16 lines, maximum of 64 columns each.

DESIGN

DESIGN, geometry modeling using simple shapes.

****
The DESIGN processor provides for description of simple shape regions.
****

****
Input Data Record Description:
****

==========
Header line
==========

Contains *DES in columns 1 through 4.

=======
Options
=======

A, systema geometry option

B, esabase geometry option

C, systema corner detector points

D, systema center detector points

O,overlap option, see OVERLAP appendix

J, compatibility with other code versions (different formats)

W, region weight (grams), not density, is input

E, alternate inputs for BOX regions

U, alternate format for hollow box regions (a thickness is input for each wall in the order -x, +x, -y, +y, -z, +z.

Q, special QAD/ACCEPT interface option.

Four initial records, x spacing, y spacing, z spacing, y staggers

Prepare product innards first (for auto sub zone in accept)

```
  i.e., out loop is z spacing

           next loop is x spacing and reflects

             next loop is y spacing, x/z stagger

               inner loop is design object
```

So all copies of item 1 get produced first; e.g. product. Then all copies of item 2; e.g., tote walls. Then all copies of item 3; e.g., tote corner braces.

F, systema face detector points

G, wireframe geometry output file

H (real,,eps,inf) if box lims identical use =-eps, default 1 micron

I, flags output of sur,bod,reg,... counts to slot data

K (material) default material for esabase/systema

P (real,,eps,inf) proton spectrum scale factor

R (real,,eps,inf) electron spectrum scale factor

S (real,,eps,inf) solar flare spectrum scale factor

T (real,,eps,inf) optimal thick value if 0 otherwise

Z, debug

&d, debug

Also, envelope monitored, and if item with user index of 9999, then envelope of each set is created; y-envelope of line is created; item envelopes deleated from y-envelope +x and -x envelopes created and y-envelopes deleted from +x and -x envelopes.

****
Data Record Description:
****

Repeat from here as needed.

==========
Region Description
==========
One line (record) is input for each region and contains:
I M RHO NAME D /
-
where

I, is a user assigned region number. This number is greater than 0 unless multiple volumes are needed to define the region--see notes at the end of this section

M, material index, O or 'void' if void. The material name can also be input. If the *materials section has been input, the material names list is scanned for a match. If not found, then the MTLIBE.DAT file is scanned for a match. If no match is found, then the name is added to the library and the name is assumed to be a chemical formula. If this is not the case, then input a quoted string containing the name followed by a blank followed by the chemical formula.

RHO, gm/cc, material density, scale factor if flagged minus, weight if W option was used. Input 0 (zero) if the material is void.

NAME, numeric or alphabetic name of the region shape

D dimensions of the volume
-

Volume names and the data vector D are given in the table and
-
figures described later.

If I, the region index, is flagged minus, multiple volumes are used to define the region. Volumes after the first have the inputs

I,NAME,D /
-

where the previous definitions apply. The last body of a multiple body input has a positive value of I. All others have I flagged minus.

The code logic is that the final body is the first body less any portions of the other bodies that overlap the first. DO NOT USE multiple bodies with body type 18.

The data strings required for this input processor are listed in the table.

The optional inputs (x_1 x_2 y_1 y_2 z_1 z_2) for design shapes 1 through 12 all have similar logic. Note that the optional data occurs in pairs, e.g., z_1 and z_2. The logic is

if $z_1 = z_2$, then both z_1 and z_2 are ignored

if z_1 is greater than z_2, z_1 and z_2 are interchanged

if z_1 is less than or equal to the minimum z coordinate in the body, then z_1 is ignored

if z_1 is greater than or equal to the maximum z coordinate in the body, then z_1 is ignored

if z_1 is within the body, then z coordinates less than z_1 are deleted from the body

if z_2 is outside the body, z_2 is ignored

if z_2 is within the body, then z coordinates greater than z_2 are deleted from the body .

++++++++++++
Input Tables
++++++++++++

Parameters used to define geometry are indicated in Table 37 (DESDAT). Additional modeling forms are listed in Table 38 (DESNEW). Several input options, Table 39 (DESMAP), allow automatic definition of detector points on a uniform mesh which can then be called out for calculations in *SIGMA with output isodose contours using *ISODOSE.

++++++++++++
Input Figures
++++++++++++

The geometric shapes are shown in Figures 11 (DESBOX) through 27 (DESHOL).

The effect of the optional inputs is shown schematically in Figure 28 (DESCUT).

A more specific example for an ellipsoid in Figure 29 (DESCUS).

Table 37: (DESDAT) Design Shapes and Dimensions

```
#  name         Dimension Data, (...)==> optional data

O  BOX          X1 X2 Y1 Y2 Z1 Z2 /
          or    Xmid Xdel Ymid Ydel Zmid Zdel /   if E option

1  XCYlinder    Y0 Ry Z0 Rz X1 X2 (Y1 Y2 Z1 Z2) /
2  YCYlinder    Z0 Rz X0 Rx Y1 Y2 (Z1 Z2 X1 X2) /
3  ZCYlinder    X0 Rx Y0 Ry Z1 Z2 (X1 X2 Y1 Y2) /

4  SPHere
4  ELLipsoid    X0 Rx Y0 Ry Z0 Rz (X1 X2 Y1 Y2 Z1 Z2) /

7  XANulus      Y0 R1 Z0 R2 X1 X2 (Y1 Y2 Z1 Z2) /
8  YANulus      Z0 R1 X0 R2 Y1 Y2 (Z1 Z2 X1 X2) /
9  ZANulus      X0 R1 Y0 R2 Z1 Z2 (X1 X2 Y1 Y2) /

10 XCOne        Y0 Z0 R1 X1 R2 X2 (Y1 Y2 Z1 Z2) /
11 YCOne        Z0 X0 R1 Y1 R2 Y2 (Z1 Z2 X1 X2) /
12 ZCOne        X0 Y0 R1 Z1 R2 Z2 (X1 X2 Y1 Y2) /

13 THEtabox     X̄ Ȳ Z̄ A L W H/ A in degrees

14 PIE          R S A B H Z/ A and B in degrees

15 MIDpointbox  X̄ Ȳ Z̄ L W H/

16 ROTatedbox   Z A R L W H/ A in degrees

17 CAKe         R1 R2 Z1 Z2 A B/ A and B in degrees

18 HOLlowbox    X̄ Ȳ Z̄ A L W H T1 (T2 T3 ... T6) /
T1 is thickness of all walls unless U option. A in degrees

19 XBOX         X1 X2 Y1 Y2 Z1 Z2 TX1 TX2 ... TZ2 W NB MTL RHO/
20 YBOX         If W is 0, void interior. If W > 0, wall weight
21 ZBOX         is subtracted.  Then if NB=0, smeared interior.
If NB > 0, weight put on NB boards perpendicular to X,Y, or Z
axis. Interior mtl/den=MTL/RHO if input, else wall values.

22 NSIdebox     #SIDES X_ Y_ Z_CENTER X_ Y_ Z_SIDE  X_ Y_ Z_TOP/

23,24,25 XYBoard,YZB,ZXB ==> (XI,XJ,XK)=(X,Y,Z),(Y,Z,X),(Z,X,Y)
               mtl,rho,name,XImin,XImax,XJmin,XJmax,XKmin,XKmax
               ,XIdel,#XI,XJdel,#XJ,XKdel,#XK(or BACK,FRONT,BOTH)
              (,mtl,rho,GROund,XIin,XIout,XJin,XJout,XKin,XKout)
              (,mtl,rho,PACkage,WIin,WIout,WJin,WJout,HKin,HKout)/
```

Table 38: (DESNEW) Design Shapes Added in 1998

```
 #  name        Dimension Data, (...)==> optional data

 6  SHEll     x0 Rx y0 Ry z0 Rz xN xX yN yX zN zX rx ry rz /
              if no cutters (xN ... zX) use 6*0
              if ry,rz not input, set to Ry*rx/Rx and Rz*rx/Rx

26  XPOly     Xmin Xmax Y1 Z1 Y2 Z2 ... Yn Zn / x extrusion
              n sided polygon, code connects n to 1 for closure.
27  YPOly     Ymin Ymax Z1 X1 Z2 X2 ... Zn Xn / y extrusion
28  ZPOly     Zmin Zmax X1 Y1 X2 Y2 ... Xn Yn / z extrusion

29  XPErp     Xmin Xmax Y0 Z0 A1 D1 A2 D2 ... An Dn /
              (Y0,Z0) is local origin, angles measured from
              y towards z in degrees, no check for closure.
              Sides are perpendicular to radial at angle.
30  YPErp     Ymin Ymax Z0 X0 A1 D1 A2 D2 ... An Dn /
              angles measured from z towards x.
31  ZPErp     Zmin Zmax X0 Y0 A1 D1 A2 D2 ... An Dn /
              angles measured from x towards y.

32  UNIon        not used
33  INTersect    not used
34  COMplement   changes sign on body list index
35  MINus        stores negative of body index after first (default)
36  SAVe         not used
37  CALl         not used

38  XSEgments  R, H, X0, Ri, Y1 Z1 Y2 Z2 ... Yn Zn /
39  YSEgments  R, H, Y0, Ri, Z1 X1 Z2 X2 ... Zn Xn /
40  ZSEgments  R, H, Z0, Ri, X1 Y1 X2 Y2 ... Xn Yn /
This one generates a cylinder along a piecewise linear centerline
in a plane.  For ZSEgements, R is the radius of the cylinder,
simple if H is 0, Z0 is the height (unchanging) and X1 Y1 ...
Xn,Yn are points on the centerline.  The code generates
cut planes at each end of the line segments.  If closed (Xn Yn =
X1 Y1), all angles bisect segment angles.  If not closed, the end
planes of the first and last segments are perpendicular to the
centerline at those ends.  If H is non zero, then two cylinders
are generated, the second with center at Z0+H and tangent planes
are used to construct a cross section that encloses the cylinders
and the space between.  This area is then swept along the
tabulated centerline.  If Ri not 0, inner (same logic) deleted.

41  GAP      Rinner, Router, Thickness, Top_elevation (z),
             Width_hot_lower, Width_hot_upper, Depth_hot,
             Width_cold, Angle_cold / default Angle_cold=30
42  SPLit    splits cylinder, cone, sphere, gap body types
43  XREv     A1 A2 X0 Y0 Z0 R1 H1 R2 H2 ... Rn Hn/ X revolution
44  YREv     A1 A2 X0 Y0 Z0 R1 H1 R2 H2 ... Rn Hn/ Y revolution
45  ZREv     A1 A2 X0 Y0 Z0 R1 H1 R2 H2 ... Rn Hn/ Z revolution
```

Table 39: (DESMAP) Electronics Box Dose Mapping

```
#  name        Dimension Data, (...)==> optional data

Extended XBOX, YBOX, and ZBOX descriptions (98Jun04)

XBOX        X1 X2 Y1 Y2 Z1 Z2 $ min/max x, min/max y, min/max z
YBOX        TX1 TX2 TY1 TY2 TZ1 TZ2 $ min/max x,y,z wall thicks
ZBOX        W NB MTL RHO        $ weight, #, material, density
            (Xoffset #X Yoffset #Y Zoffset #Z) / auto detectors
            note: densities must be explicit, not -1, for weights.

The above apply if W >= 0.  If W=0 & NB=0, interior is void;
W>0 and NB=0, smeared interior (wall weight subtracted from W).
Xoffset, etc., distance of detectors from inner walls; #X, etc.,
number of equally spaced detectors in X direction.  W>0 and
NB>0, weight smeared on NB equally spaced boards; boards same
material and density as walls unless MTL and RHO are input.

If W=0 and NB>0, then new definitions: Let K=1,2,3 denote XBOX,
YBOX, ZBOX; (K,I,J)=(1,2,3); (2,3,1); (3,1,2); User inputs
XBOusr, YBOusr, or ZBOusr.  'usr' is a user label for the box.
For each board, code labels as usr01, usr02, ...

So data reads as:
       index MTLBOX RHOBOX      $ usual design index, material
       XBOusr (or YBOusr or ZBOusr) $ board perpendicular axis
       X1 X2 Y1 Y2 Z1 Z2        $ box min/max outside dimensions
       TX1 TX2 TY1 TY2 TZ1 TZ2  $ box wall thicknesses
       0                        $ box weight, 0 for this format
       NB MTL RHO               $ #, material,density of boards
       XImin XImax XJmin XJmax  $ transverse limits/dimensions
       XKwall XKthick           $ distance from wall, thickness
      ,XIdel,#XI,XJdel,#XJ,XKdel,#XK(0,1,2,3=NONE,BACK,FRONT,BOTH)
      (,mtl,rho,GROund,XIin,XIout,XJin,XJout,XKin,XKout)
      (,mtl,rho,PACkage,WIin,WIout,WJin,WJout,HKin,HKout)/
The total number of data for the most general input is 50.

The code generates:
    Box walls
      Box interior
        NB boards
           Board material
           Ground plane (optional) sandwiched in board
           Detector Points (optional)
             1 side or both
               #XI by #YI on each side of each board
               Package for each detector (optional)
i.e., boards are generated like XYBoard ... inputs:
       XBOusr, boards are YZBoard named BOusr01, BOusr02, ...
       YBOYbc, boards are ZXBoard, same names
       ZBOZbc, boards are XYBoard, same names
where 'usr' are 3 user input characters; detectors are named
BOusrbbkjjii where bb is 01, 02, ...; k is 1 (back) or 2 (front),
jj is the index in the XJ direction, and ii in XI direction.
All detectors on board bb can be run using the shorthand:
'BOusrbb#*' with dose contours generated using *ISO processor.
```

Figure 11: (DESBOX) BOX Parameters

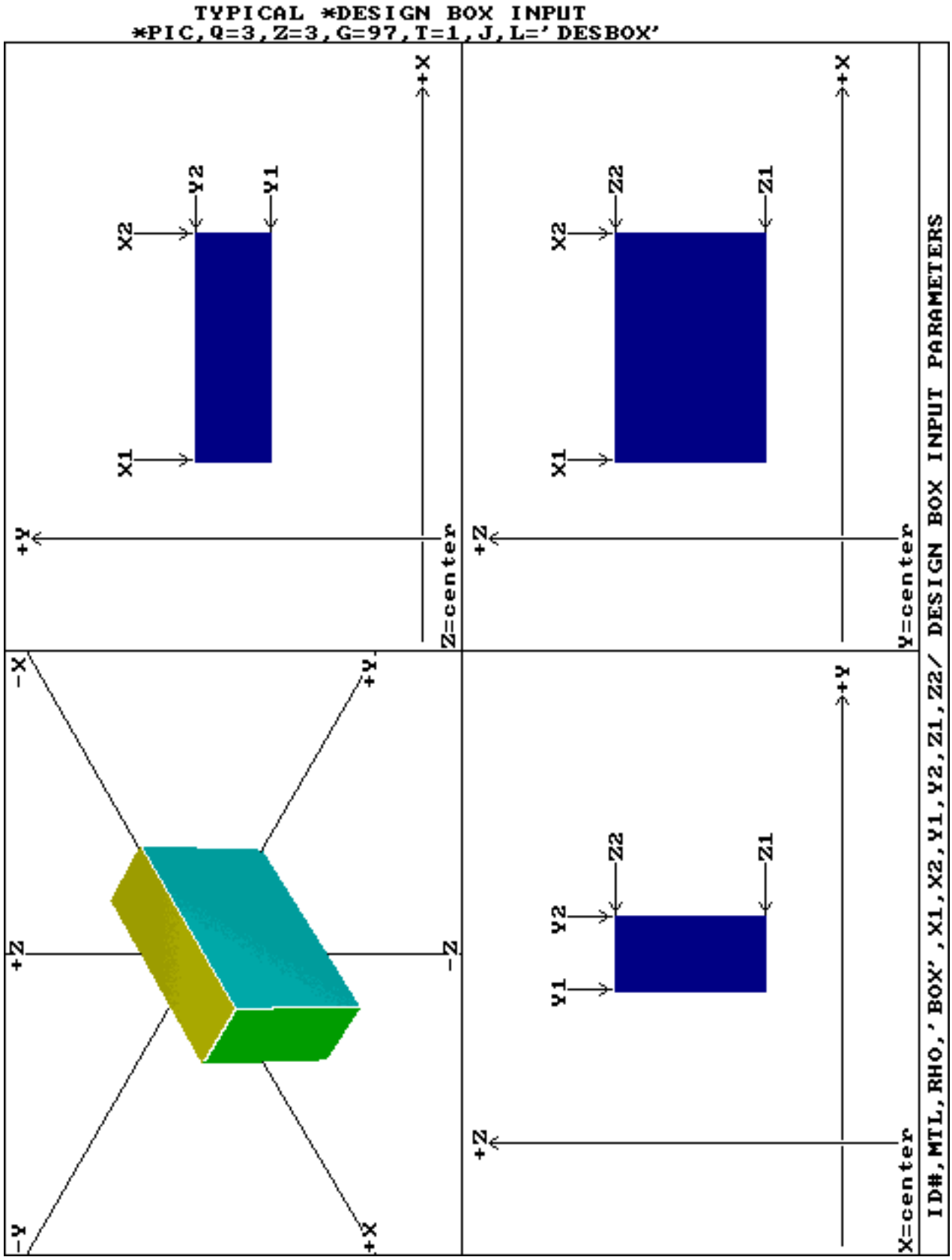


Figure 12: (DESXCY) XCYLinder Parameters

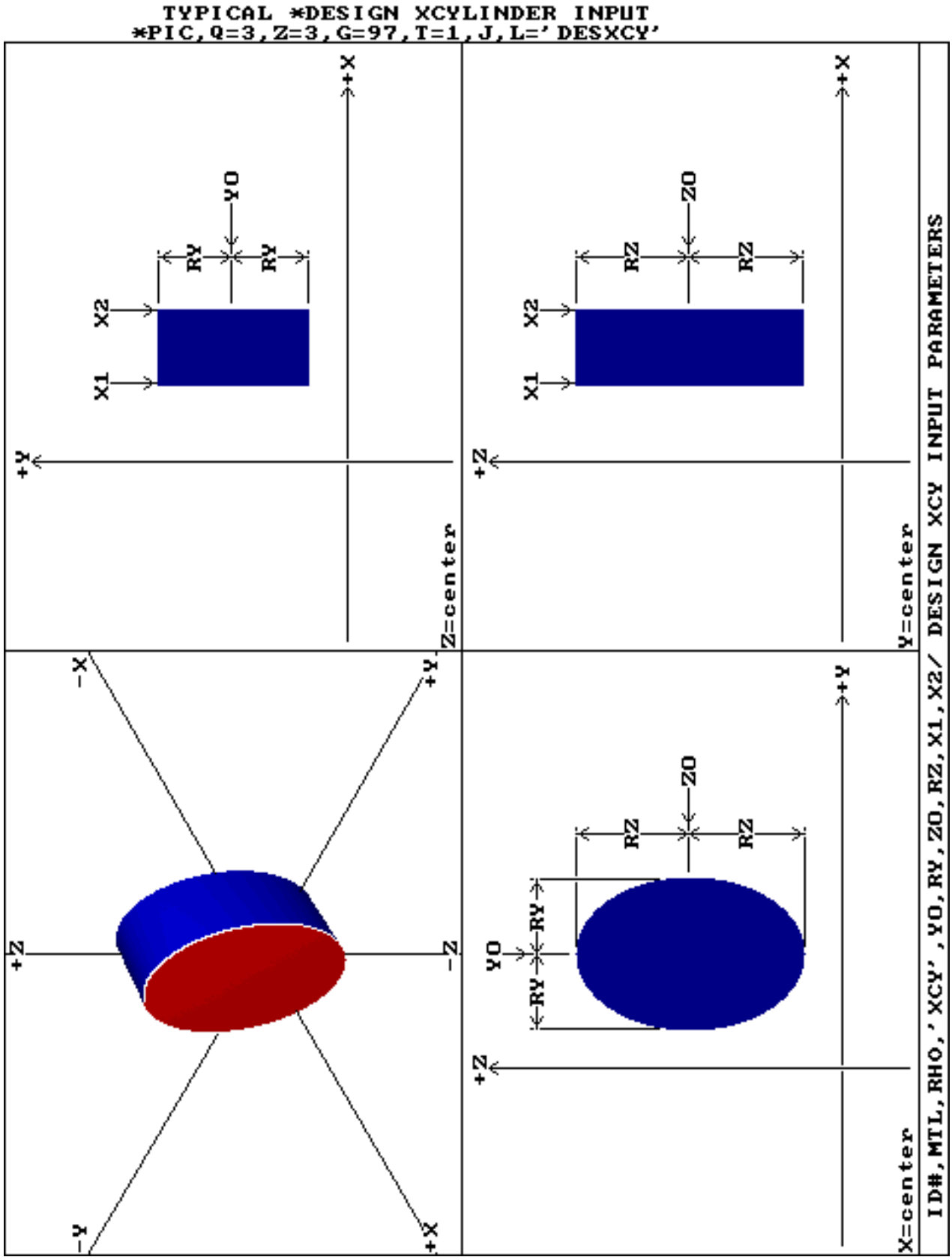


Figure 13: (DESYCY) YCYLinder Parameters

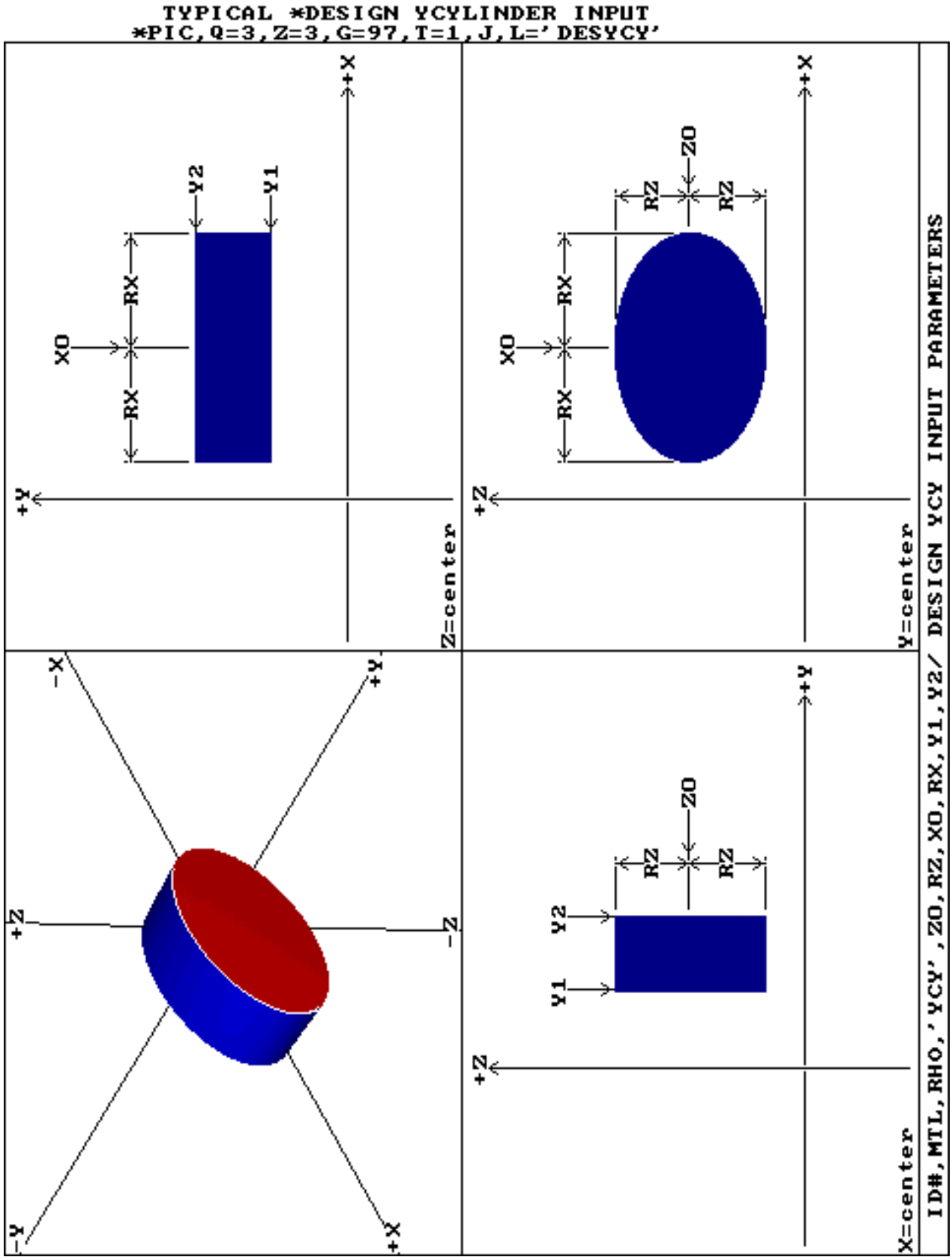


Figure 14: (DESZCY) ZCYLinder Parameters

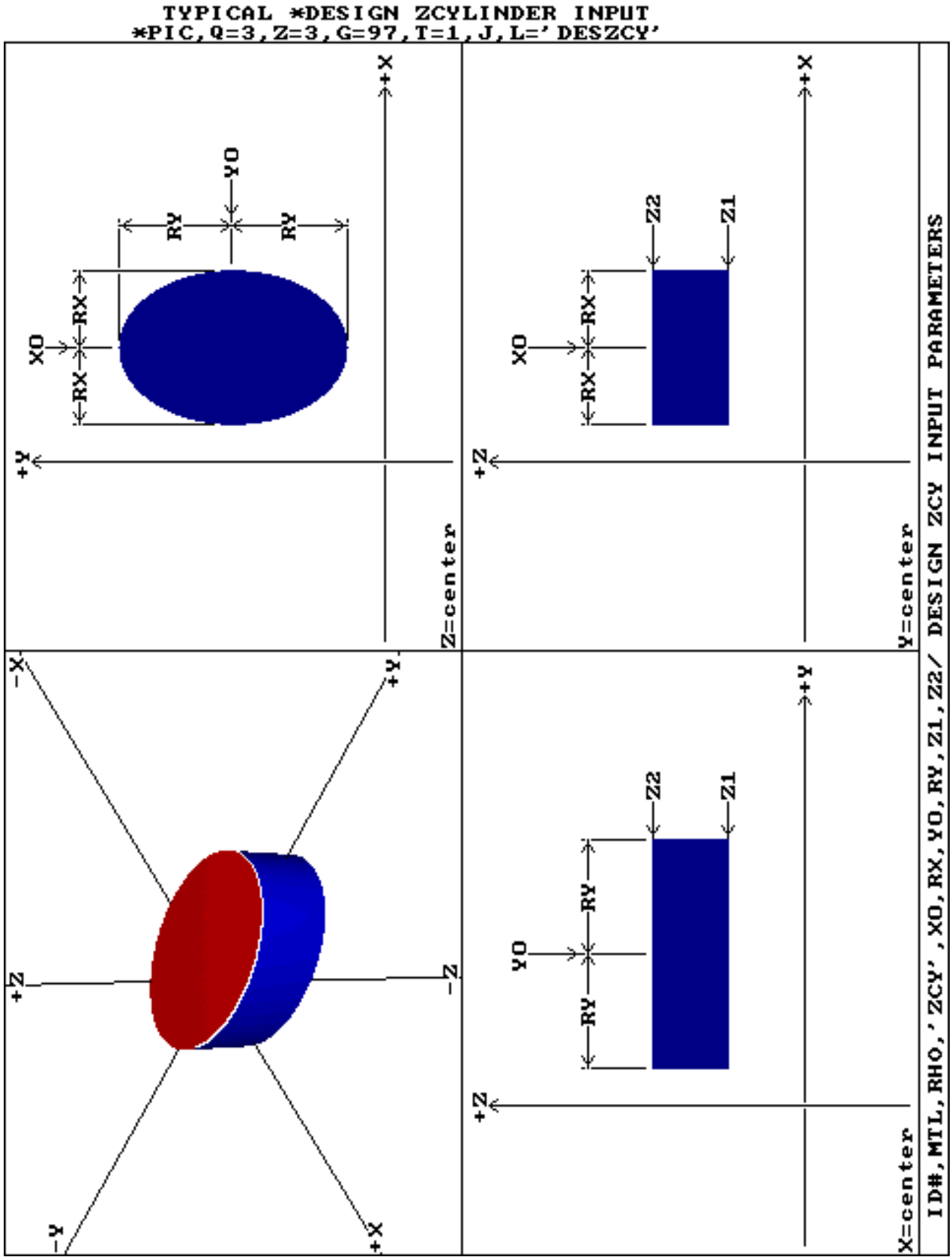


Figure 15: (DESSPH) SPHere Parameters

TYPICAL *DESIGN SPHERE INPUT
*PIC,Q=3,Z=3,G=97,T=1,J,L='DESSPH'

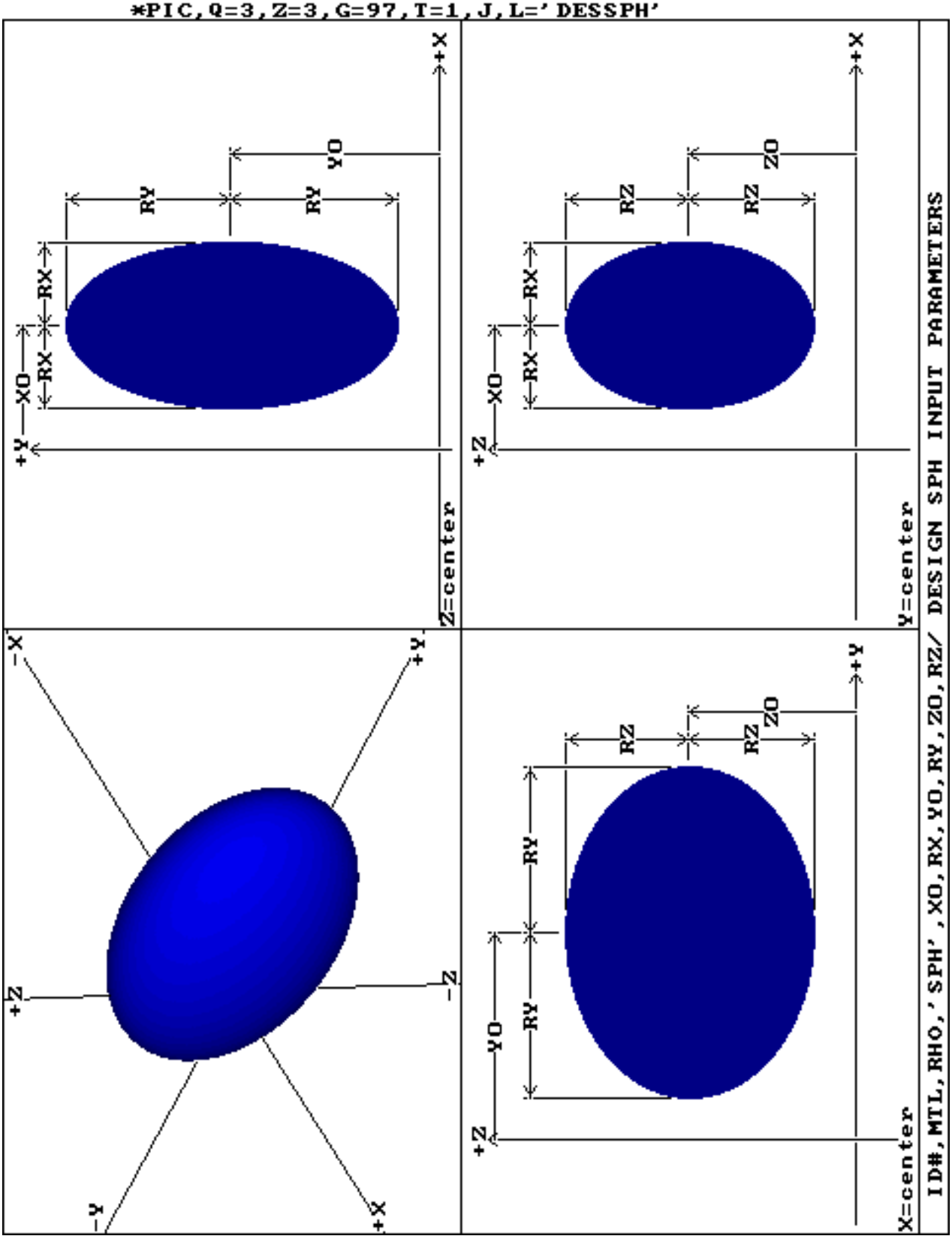


Figure 16: (DESXAN) XANnulus Parameters

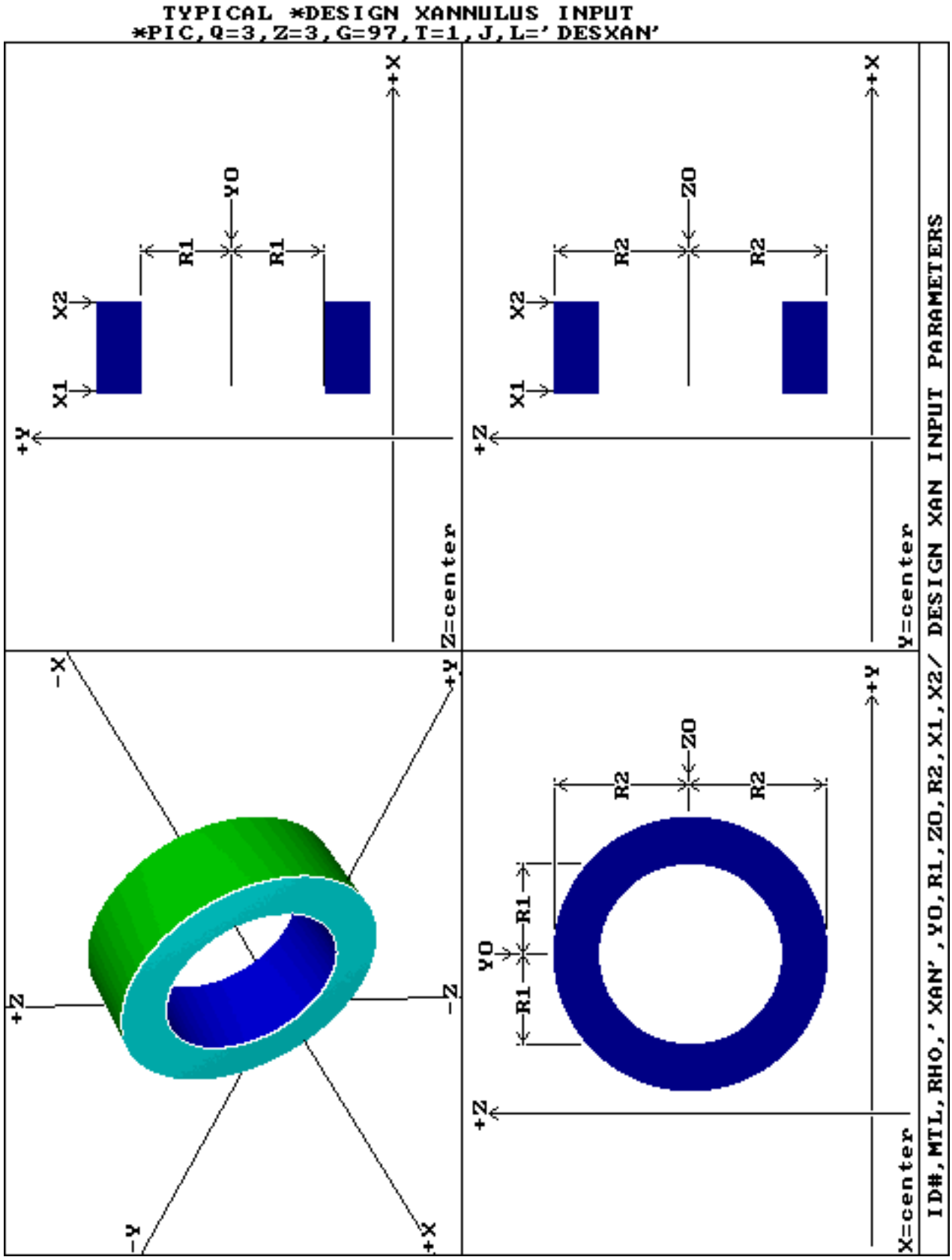


Figure 17: (DESYAN) YANnulus Parameters

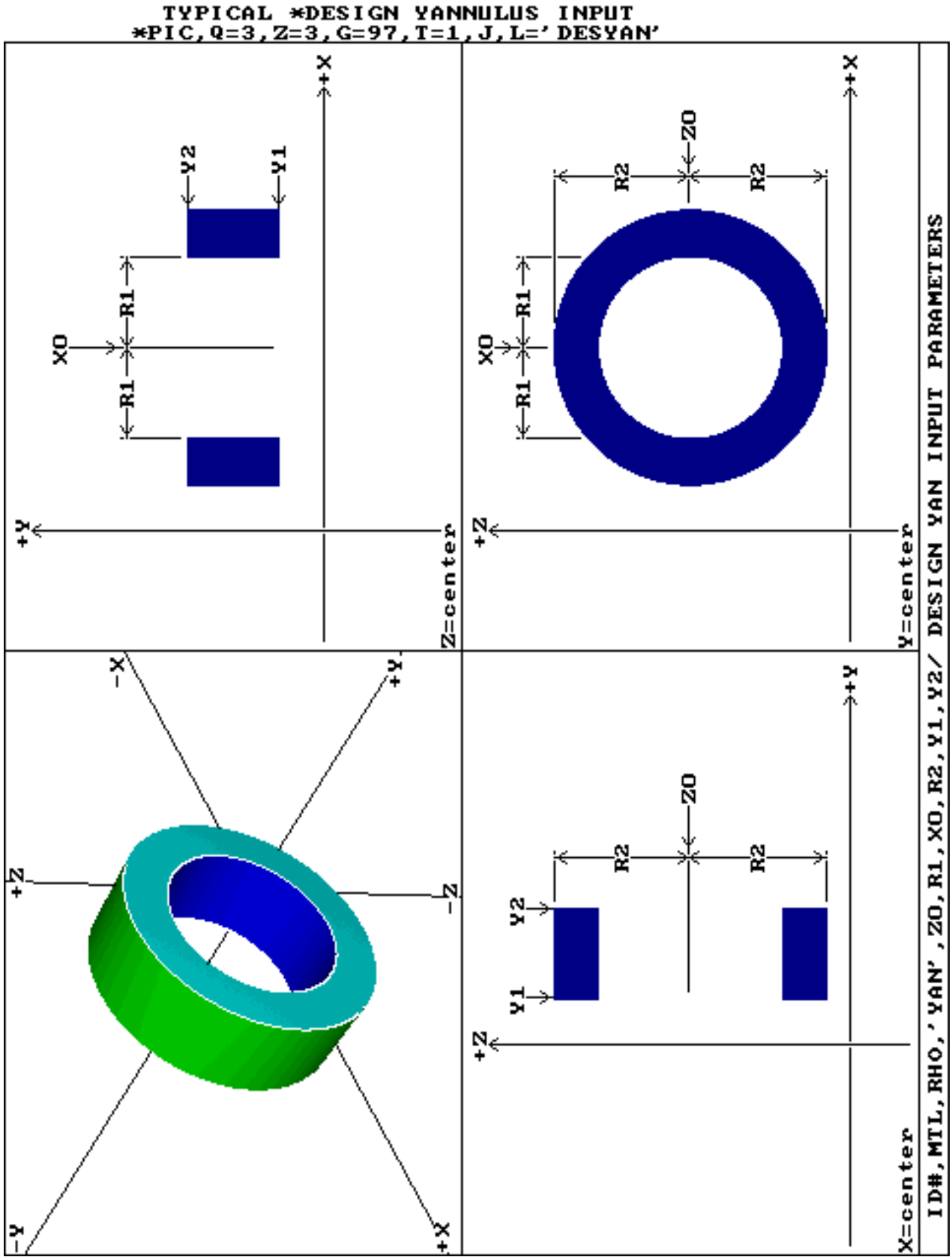


Figure 18: (DESZAN) ZANnulus Parameters

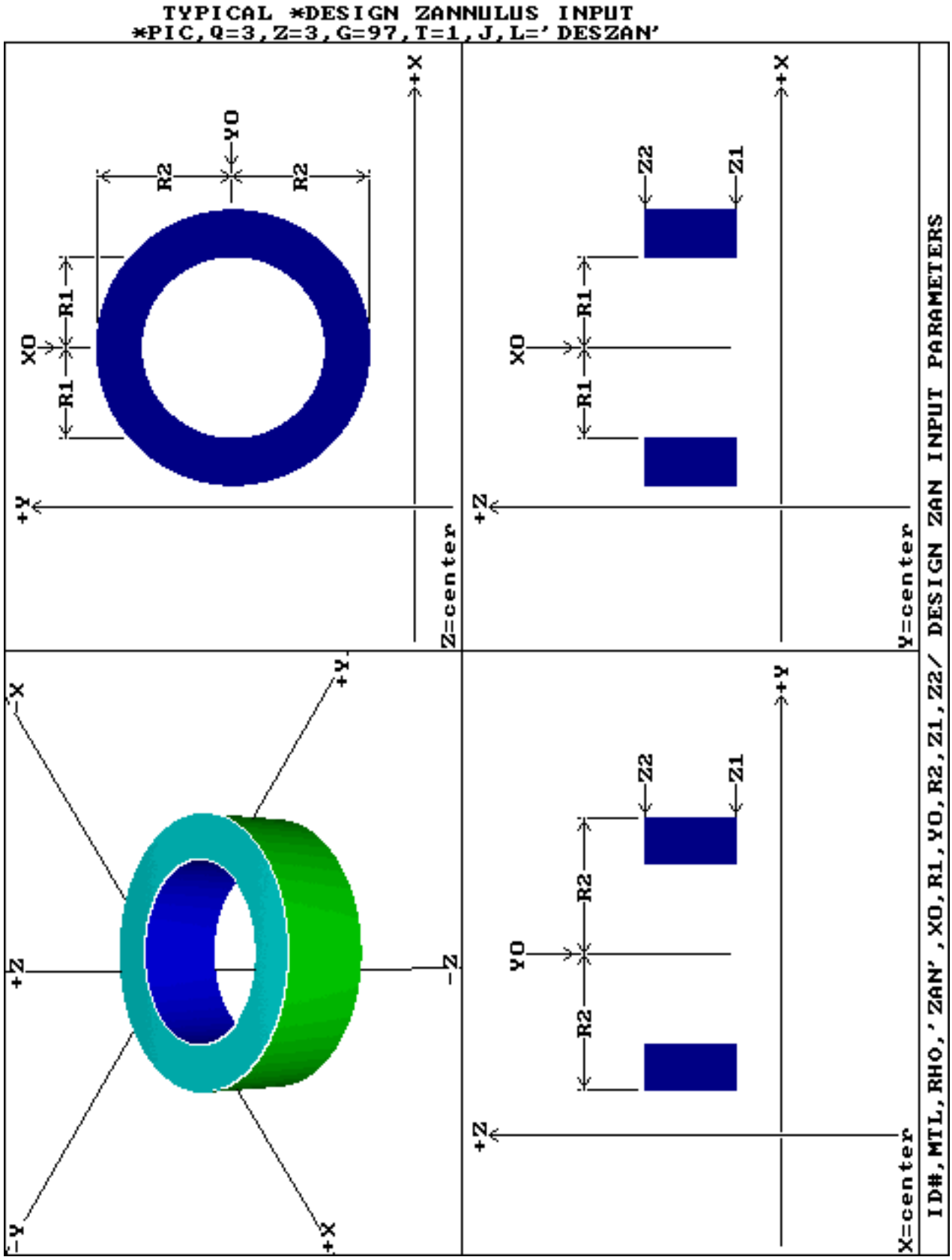


Figure 19: (DESXCO) XCOne Parameters

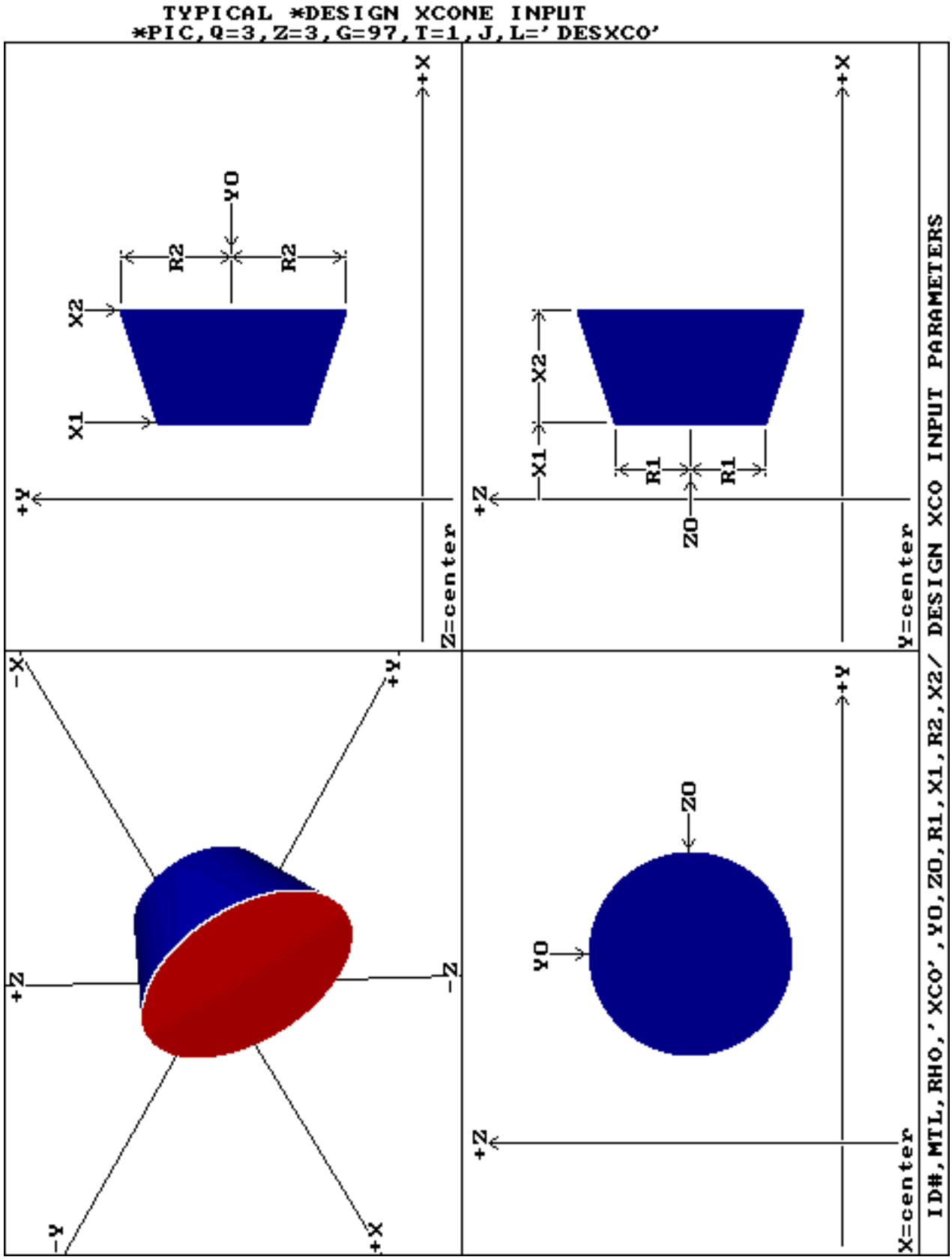


Figure 20: (DESYCO) YCOne Parameters

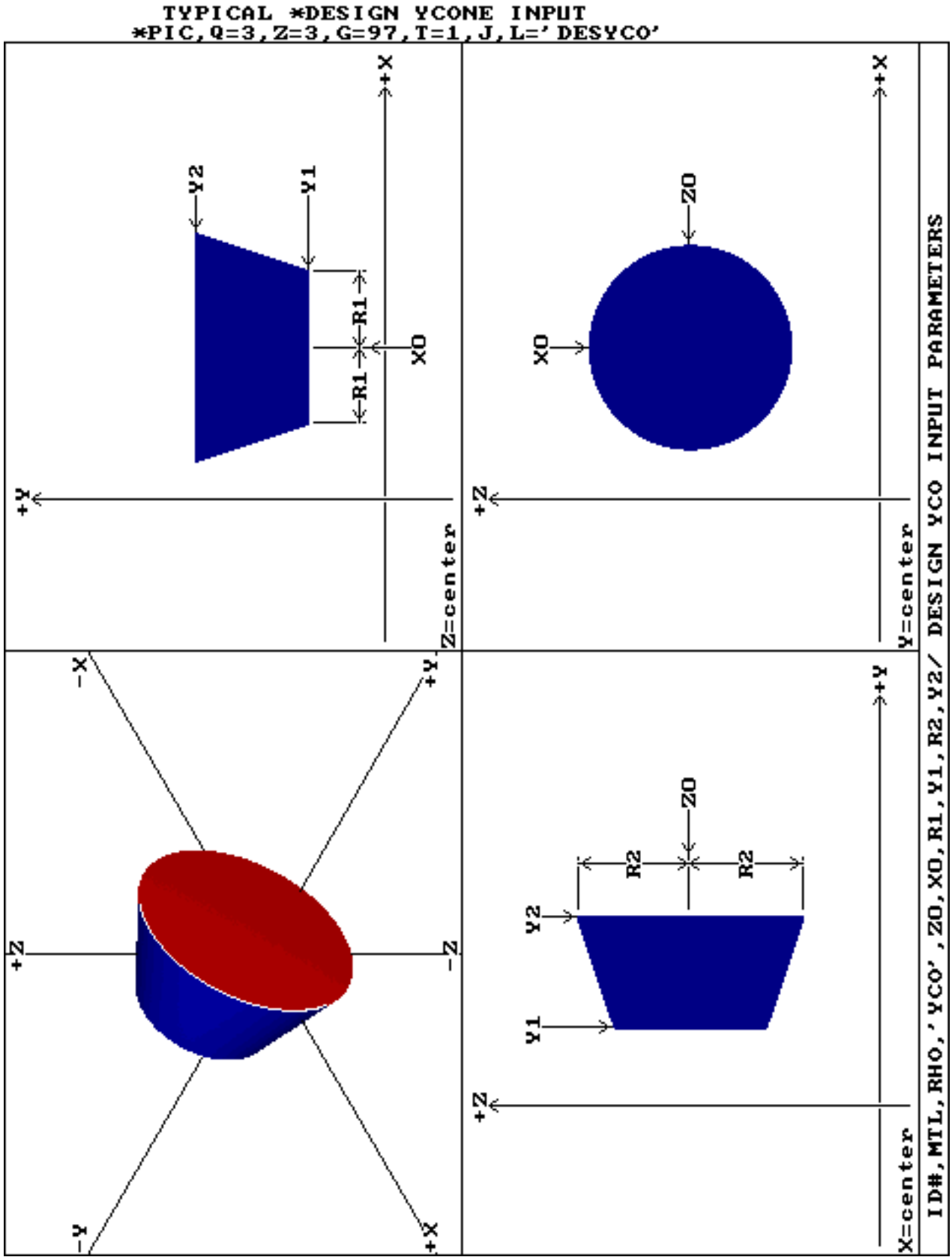


Figure 21: (DESZCO) ZCOne Parameters

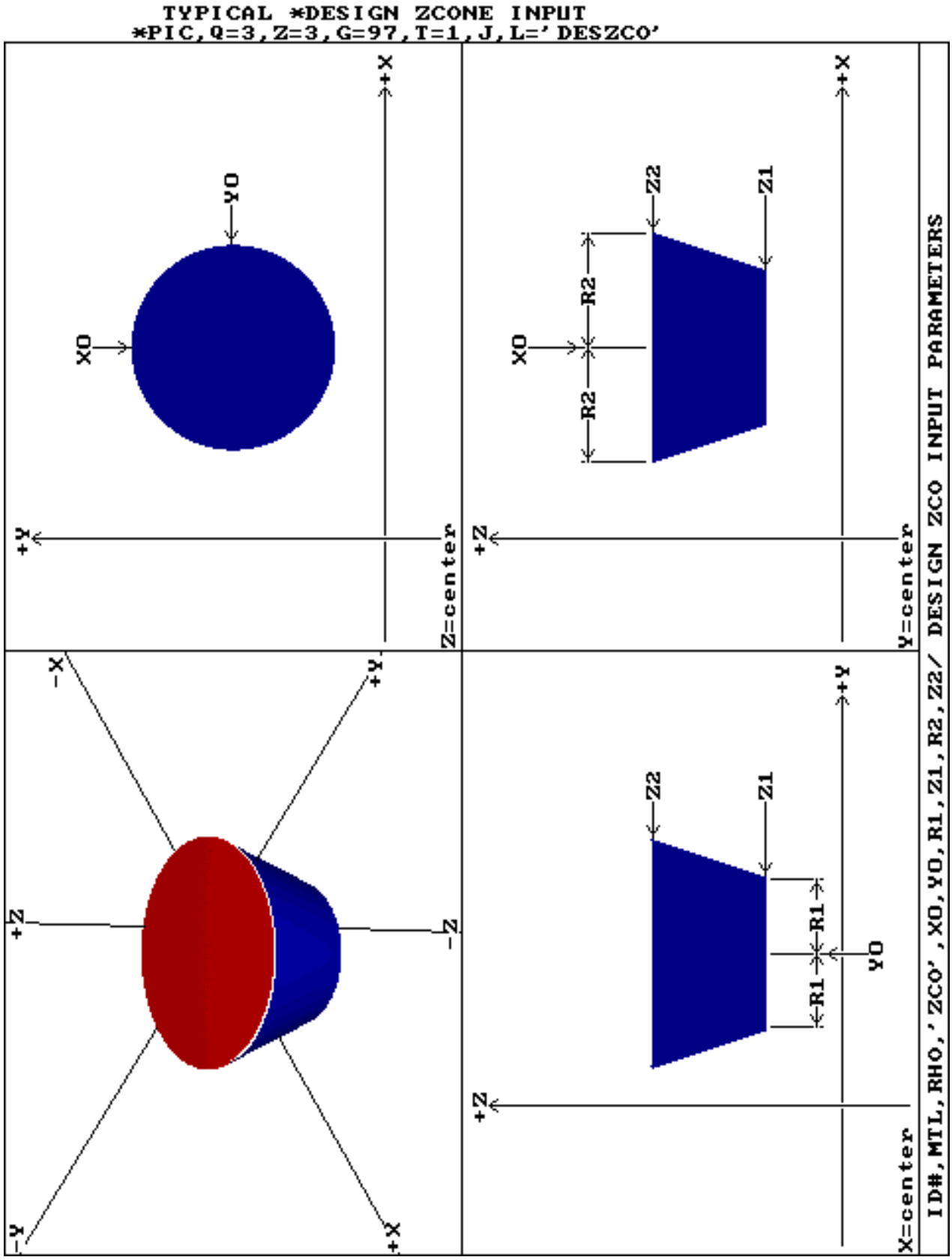


Figure 22: (DESTHE) THEta Box Parameters

TYPICAL *DESIGN THETA BOX INPUT
*PIC,Q=3,Z=3,G=97,T=2,J,L='DESTHE'

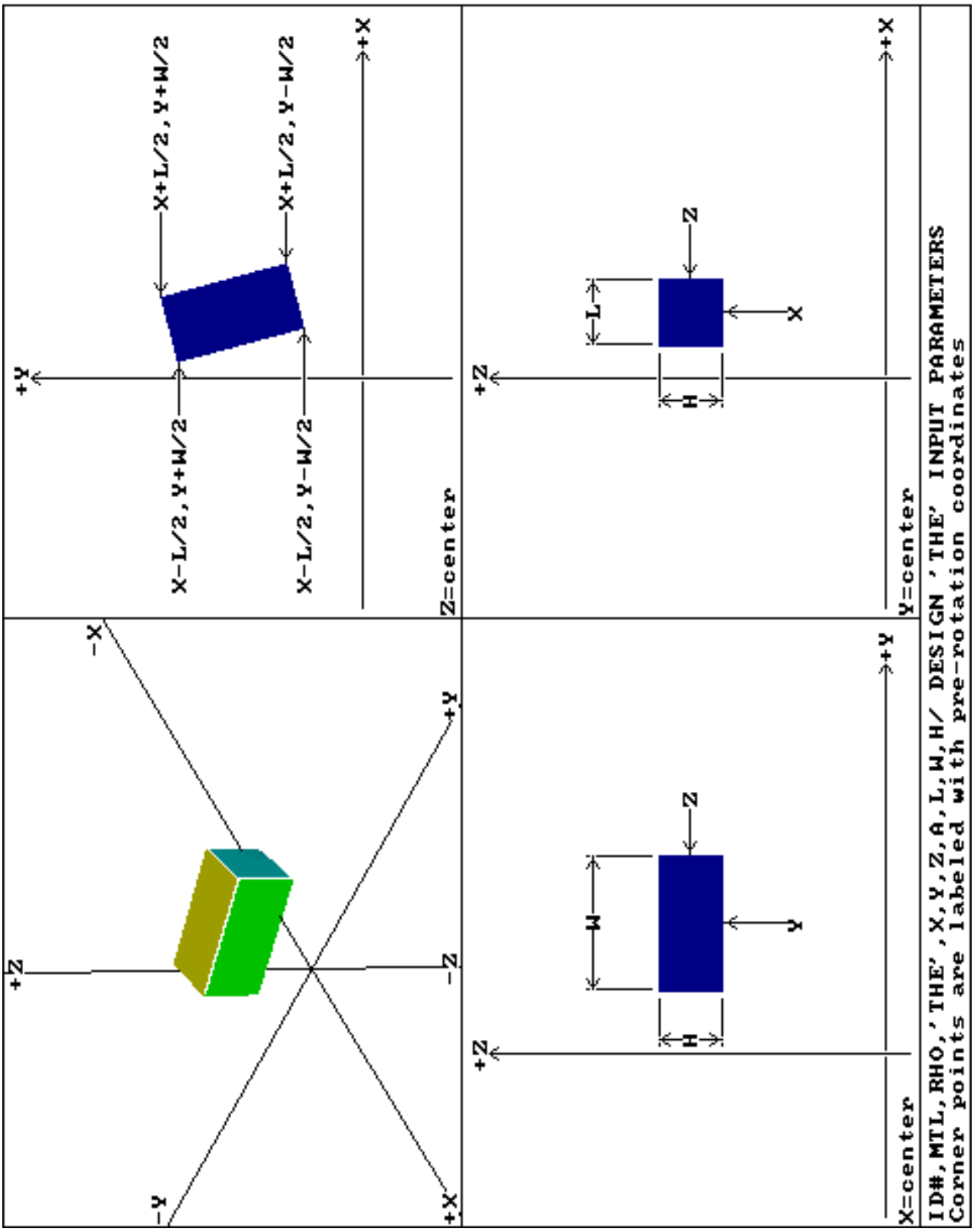


Figure 23: (DESPIE) PIE Segement Parameters

TYPICAL *DESIGN PIE SECTOR INPUT
*PIC,Q=3,Z=3,G=97,T=2,J,L='DESPIE'

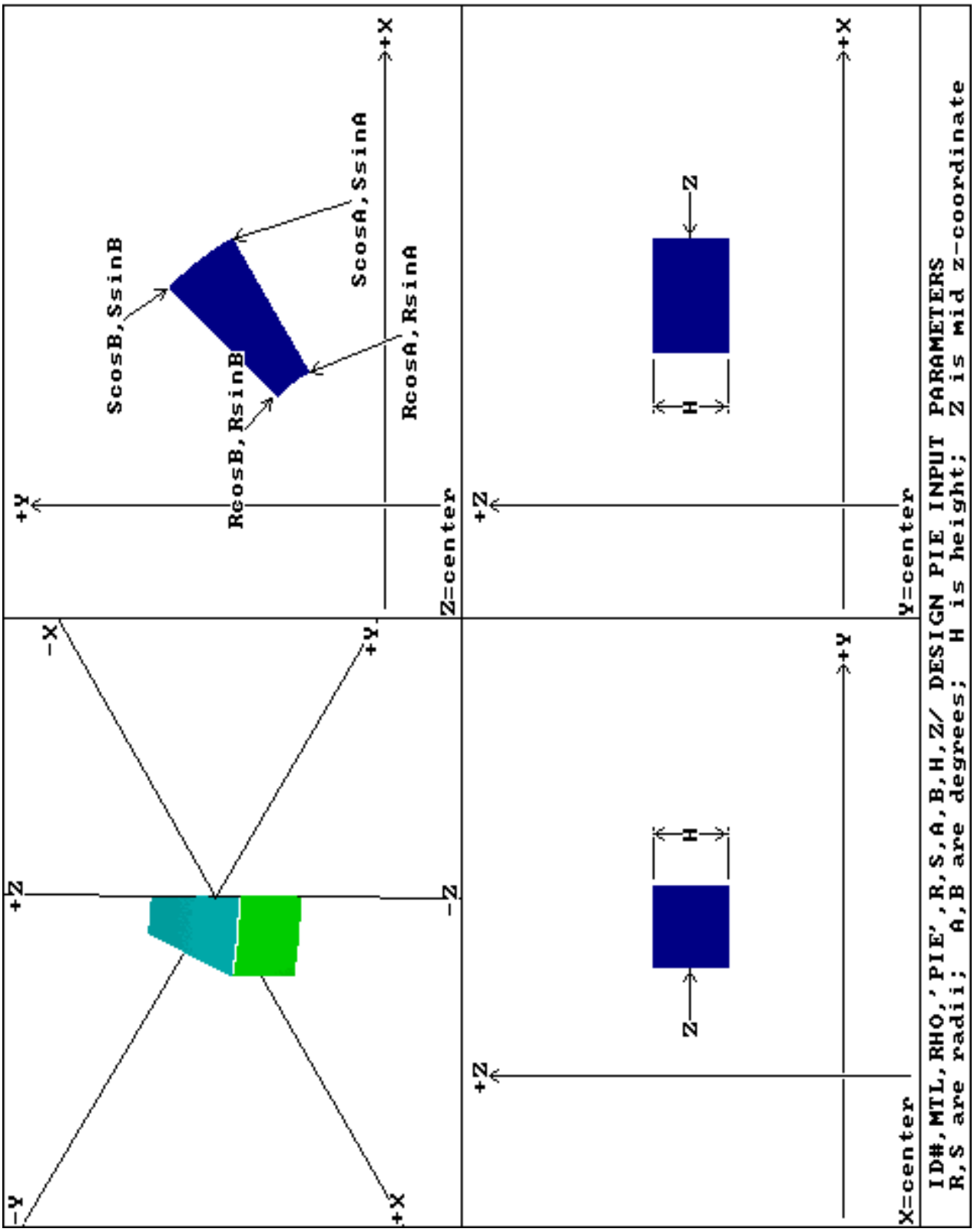


Figure 24: (DESMID) MID Point Box Parameters

TYPICAL *DESIGN MIDPOINT BOX INPUT
*PIC,Q=3,Z=3,G=97,T=1,J,L='DESMID'

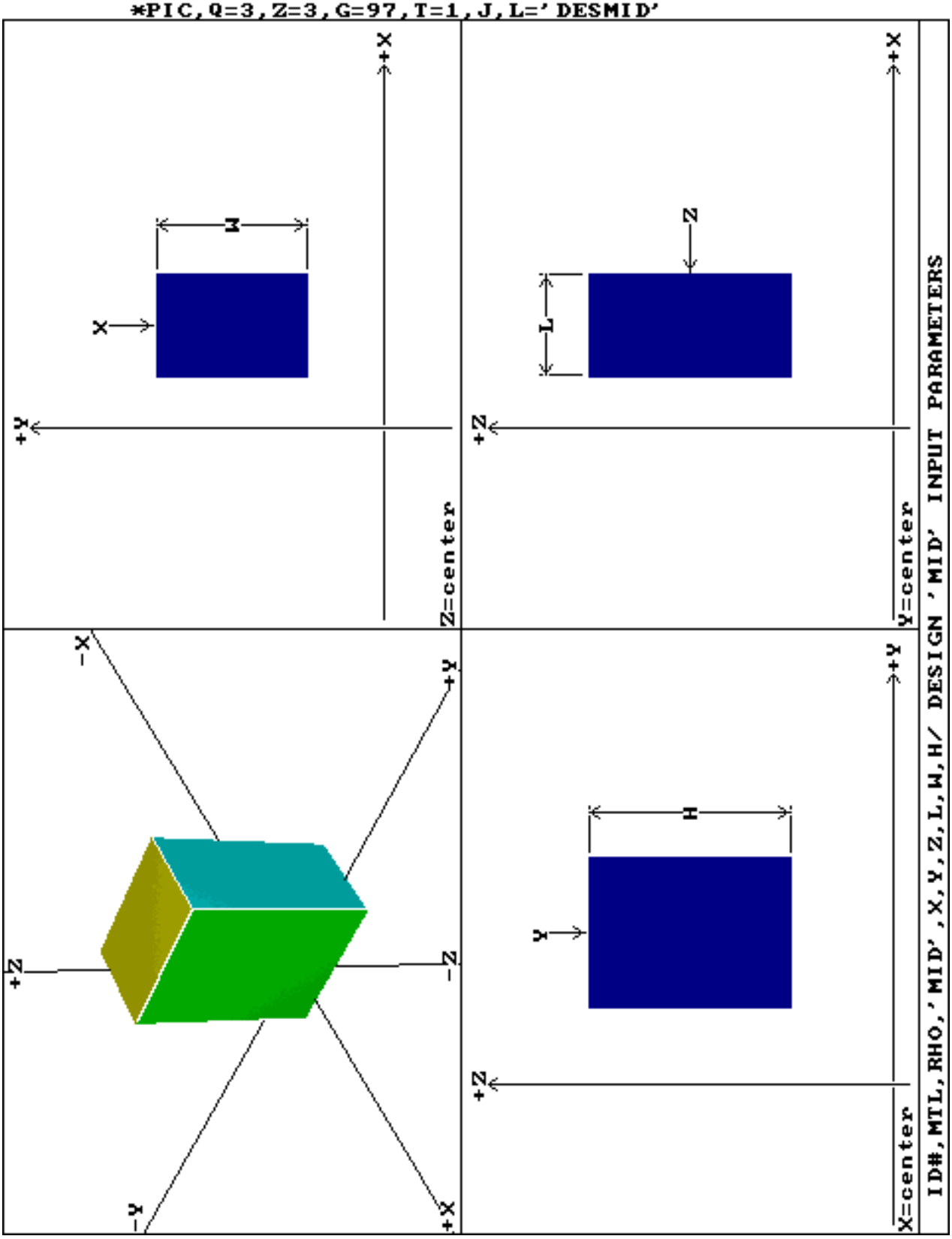


Figure 25: (DESROT) ROTated Box Parameters

```
TYPICAL *DESIGN ROTATED BOX INPUT
*PIC,Q=3,Z=3,G=97,T=3,J,L='DESROT'
```

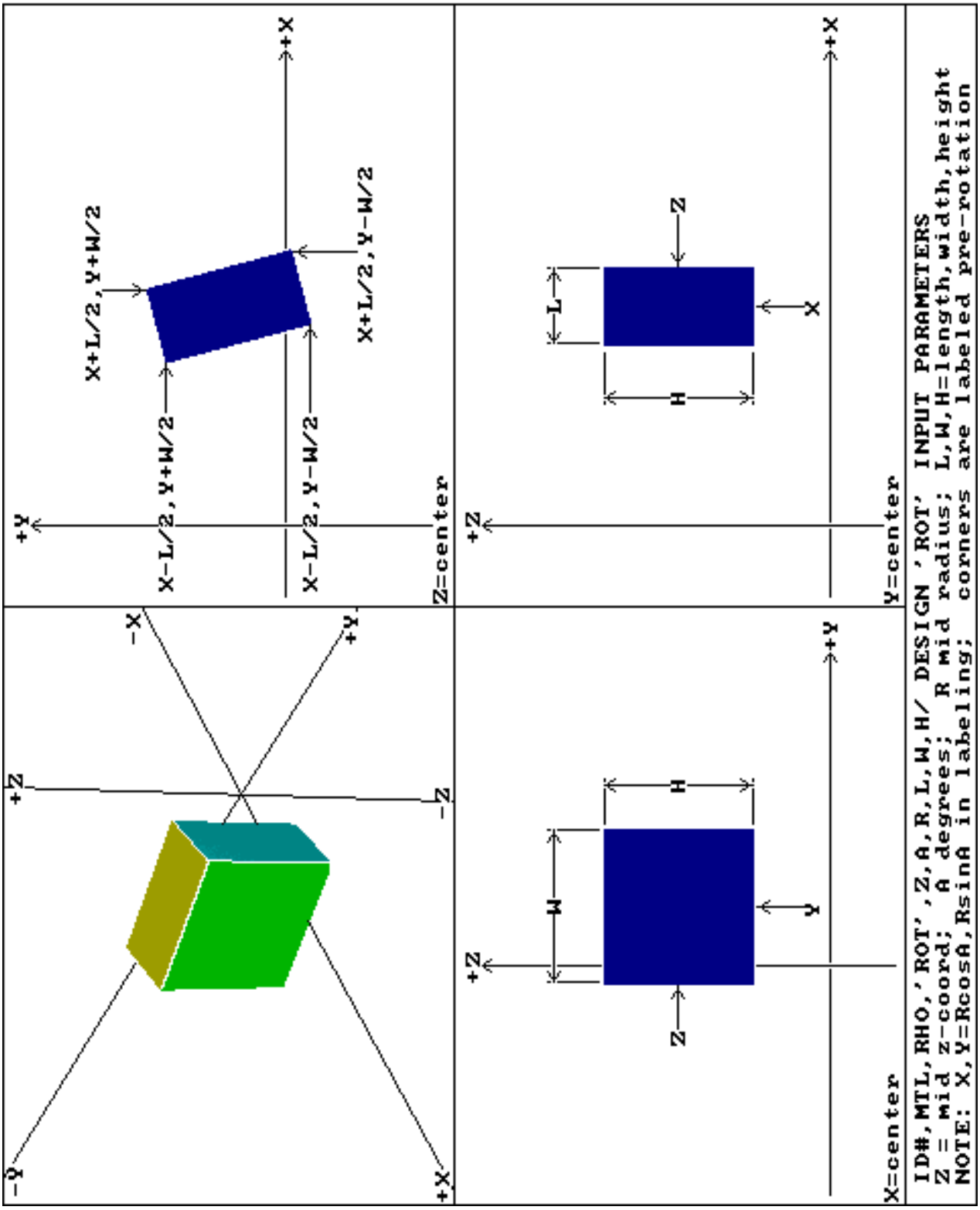


Figure 26: (DESCAK) CAKE Segment Parameters

TYPICAL *DESIGN CAKE SECTOR INPUT
*PIC,Q=3,Z=3,G=97,T=2,J,L='DESCAK'

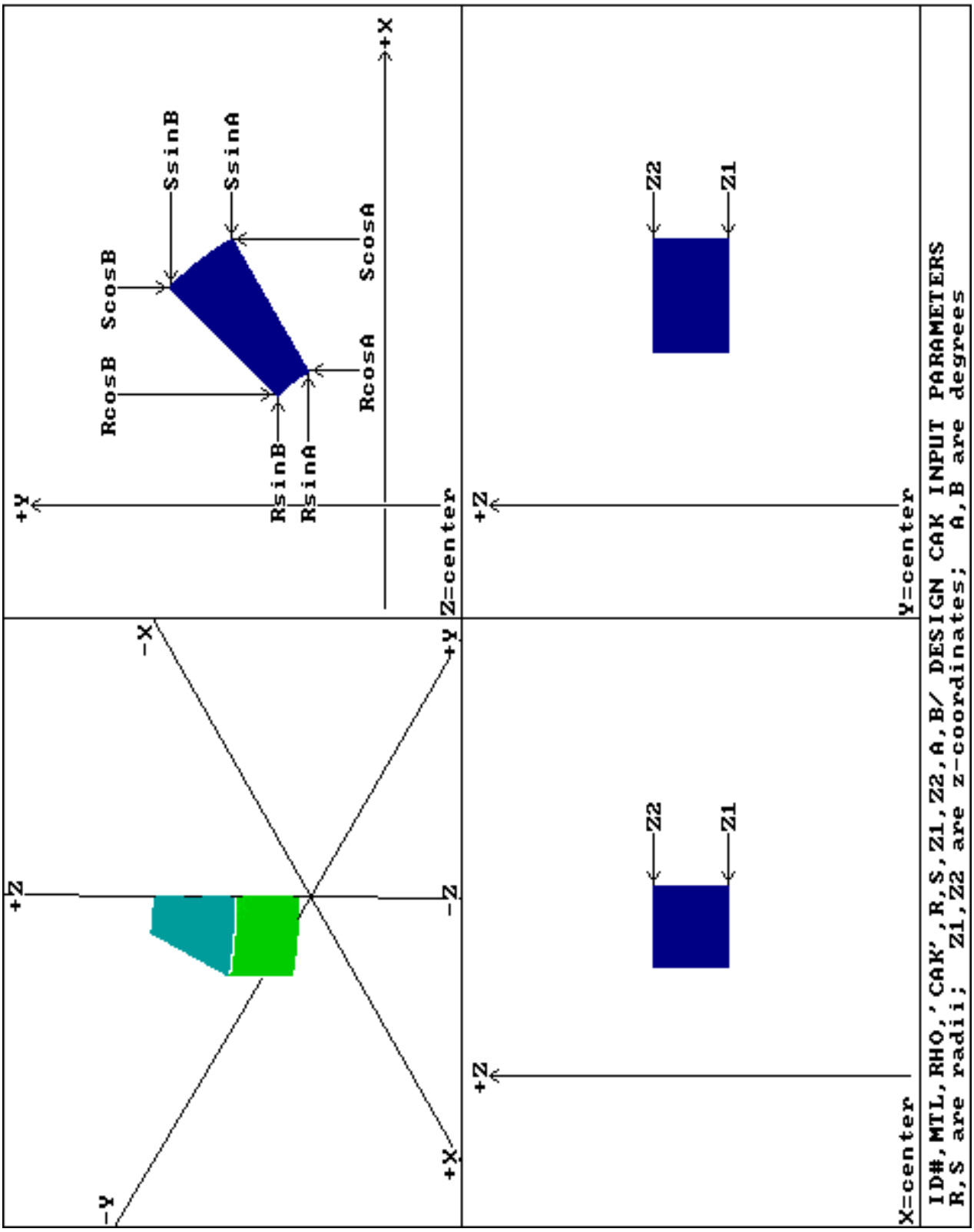


Figure 27: (DESHOL) HOLlow Box Parameters

```
TYPICAL *DESIGN HOLLOW BOX INPUT
*PIC,Q=3,Z=3,G=97,T=3,J,L='DESHOL'
```

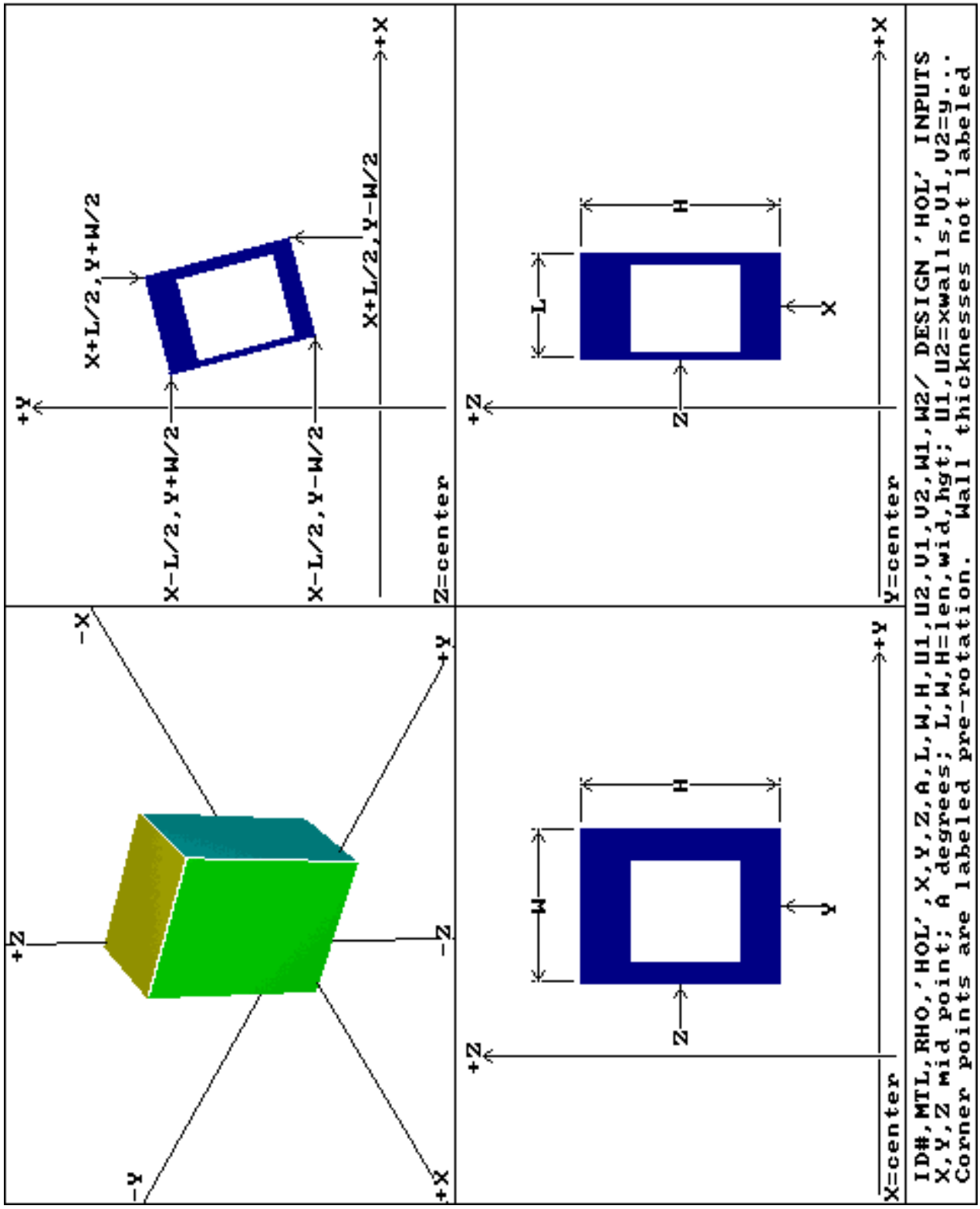


Figure 28: (DESCUT) Cutting Surface Logic

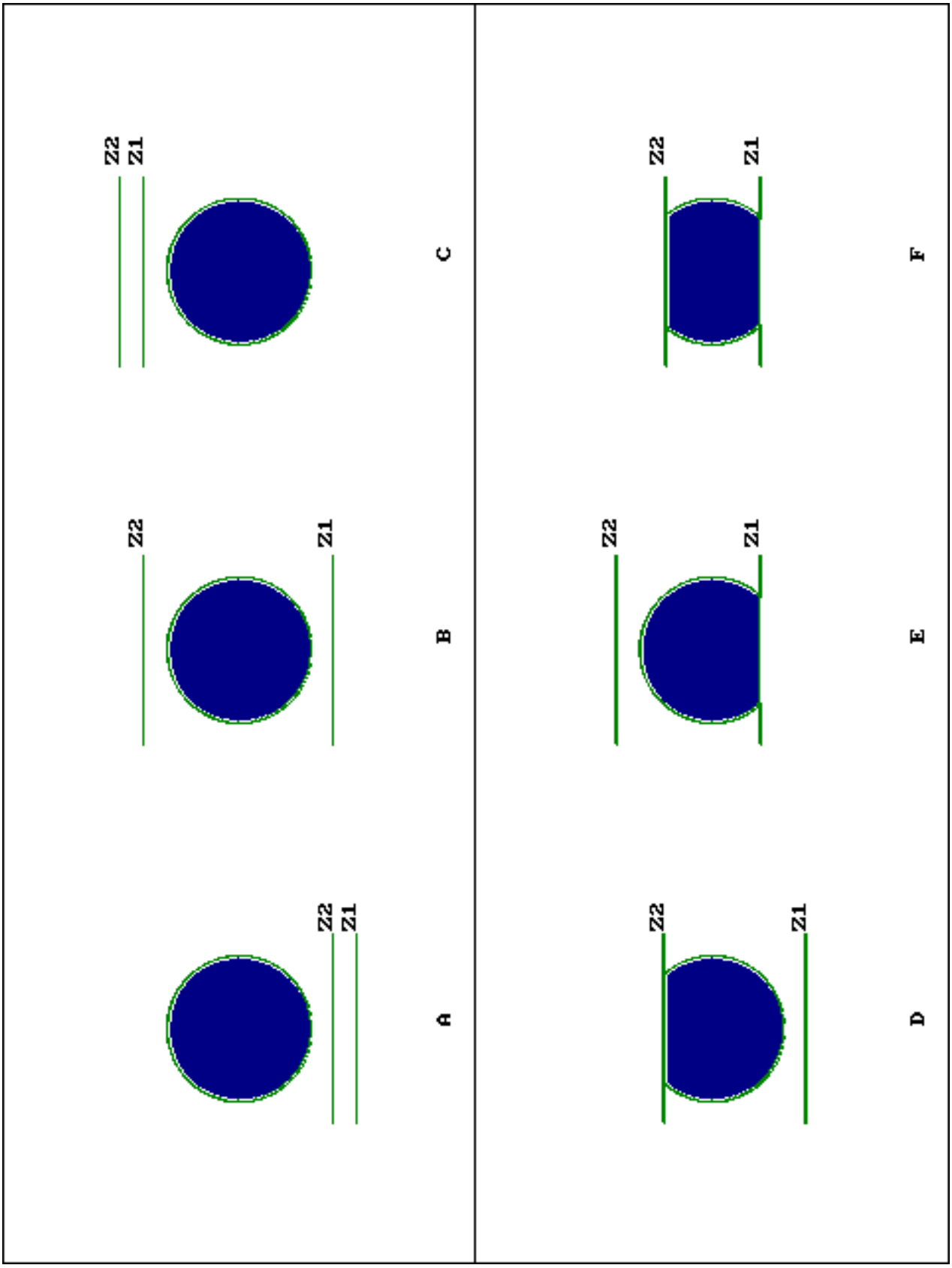
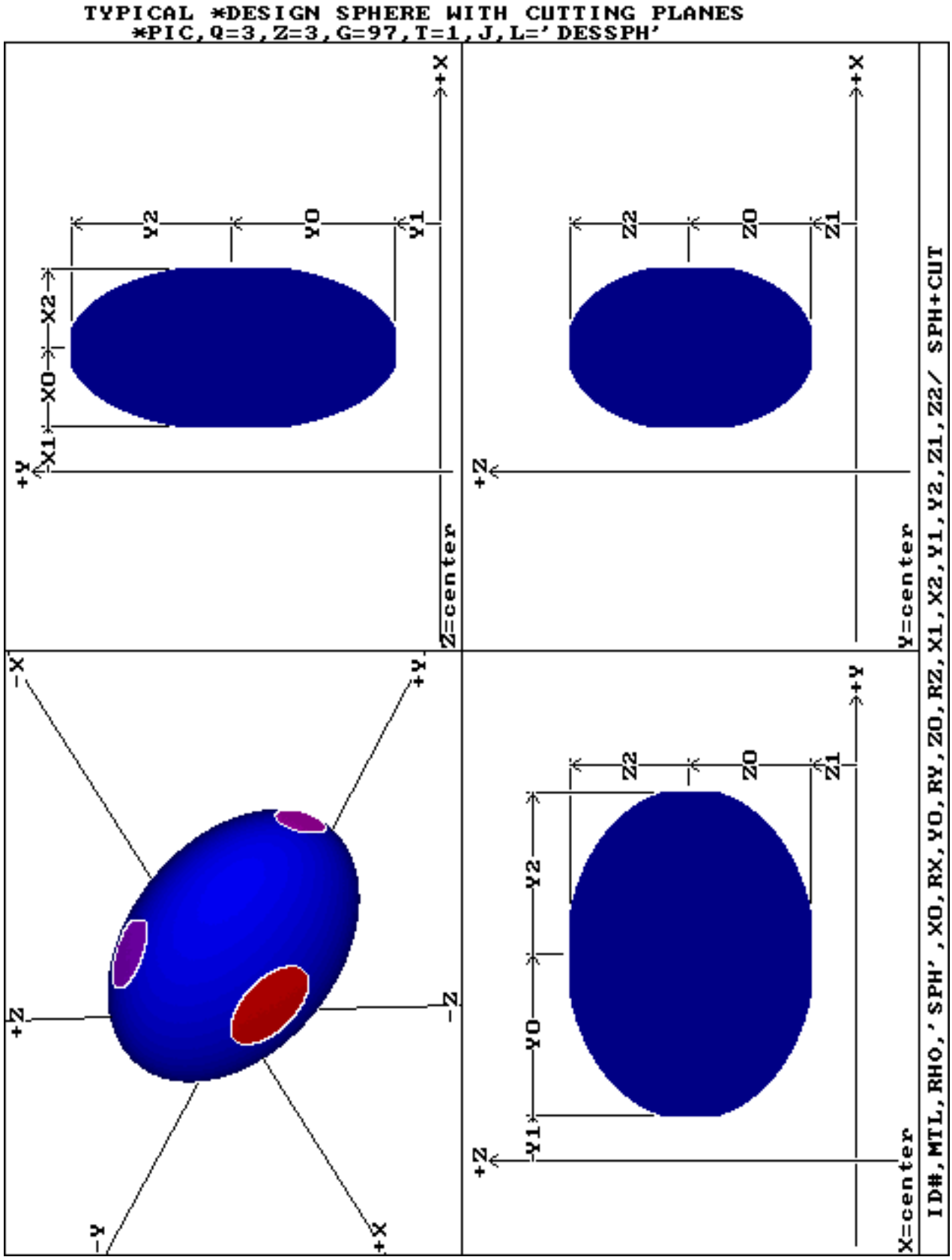


Figure 29: (DESCUS) Cutting Surface with Ellipsoid



DETECTOR

DETECTOR, description of point and volume detectors

****
The DETECTOR processor provides for the description of point detectors and distributed detectors.
****

****
Input Record Description:
****

==========
Header line
==========

Contains *DET in columns 1 through 4.

=======
Options
=======

A=O or absent, isotropic angular dependence

A=1, cosine angular dependence

A=2, tabulated angular dependence

B, angle bin input (2 azimuth, 2 polar), if B=1, azimuths, then polar

C, multichannel input

D, if present, omit distribution data (assumed flat); i.e., input detector variable end points but no relative strength.

E, dose capability of detector, same units as sigma run (auto adj)

G, group boundary input, groups/channels/angles

O=o, overlap option for R option regions (see *OVERLAP section).

P, periodic/reflective boundary condition inputs spatial/angular

S, if present, generate a body for all non-point detectors.

R, if present, generate a region corresponding to volume detectors.

T, if present, tabulated time dependence

V, voxel file, 'name'.mcn, value=material

****
Data Record Description
****

Repeat from here as needed.

==========
Basic Detector Information
==========

For isotropic point detectors, the input for each detector consists of

'NAME' X Y Z /

where NAME is truncated to 12 characters and X,Y,Z, are the detector position coordinates in centimeters.

Distributed detector inputs use the input

'NAME' X Y Z NSG NLK NAX MTL RHO/

followed by spatial distributions, angular distributions if A=2, and a time distribution if T is present in the options. For distributed detectors

X,Y,Z are a translation vecter if this is not a point detector.

NSG is 0,1,2, or 3 (POInt,XYZ,CYLinder,SPHere) indicating point, rectangular, cylindrical, or spherical geometry. NSG=0 indicates a point detector

NLK is 0 if this detector has unique dimensions

NLK is the index of a prior detector with the same dimensions if this detector has the same dimensions as detector NLK.

NAX is O or 3 if the user geometry is referenced to the z-axis

1 if the user geometry is referenced to the x-axis

2 if the user geometry is referenced to the y-axis

NAX can also have the values (XAX,YAX,ZAX) to indicate the axis.

Up to six distribution functions are used to describe distributed detectors (and SOURCES). These distributions are input immediately following the NAME line and consist of

$F(V_1)$, $F(V_2)$, and $F(V_3)$ for spatial distributions

$F(V_4)$ and $F(V_5)$ for angular distributions (input if A=2)

$F(V_6)$ for the time distribution (input if T option)

The spatial distribution variables depend upon the geometry and the user axis as follows

NSG = 1 (rectangular)	NAX=1	NAX=2	NAX=3
V1 = user x	code y	code z	code x
V2 = user y	code z	code x	code y
V3 = user z	code x	code y	code z

NSG= 2 (cylindrical)

V1 = user r:	code $r^2 = y^2 + z^2$	$z^2 + x^2$	$x^2 + y^2$
V2 = user azimuth:	measured from the user x axis (see NSG=1 for the defintion of the user x axis)		
V3 = user z	code x	code y	code z

NSG = 3 (spherical)

V1 = user r:	code r^2	$x^2 + y^2 + z^2$

V2 = user azimuth: measured from the user x axis (see NSG=1 for the defintion of the user x axis)

V3 = user polar cosine: measured from user -z axis (see NSG=1 for the definition of the user z axis)

The angular distributions are azimuth, $F(V_4)$, and polar cosine, $F(V_5)$. The azimuth and polar cosine are measured from the user (x,-z) axes, i.e., the code (y,-x) axes if NAX=1, from the code (Z,-Y) axes if NAX=2, and from the code (X,-Z) axes otherwise.

==========
Detector Coordinates (paired with next record)
==========

List the coordinate values from minimum to maximum.

==========
Detector Distribution (paired with above record)
==========

List the relative distribution at the coordinates on the previous record.

Each distribution, the three spatial, and the two angular and time distributions if required, are tabulated as:

,X/,F(X)/ where X denotes V_{-1} or V_{-2} or ...

i.e., two data vectors of the same length. Alternatively, each distribution can be tabulated as:

,/,X_1 $F(X_1)$ X_2 $F(X_2)$ ... /

and, if the relative distribution, F(X), is constant, which it is
-
for detectors and many source variables, the distribution can be input as

,X X X .../,/
  1 2 3

If the detector is a point, NSG=0, or has spatial distributions like another detector, NLK>0, spatial distributions are not input. If A<2 or absent, or the detector has distributions like another detector, NLK>0, angular distributions are not input.

If the T option was not present, or the detector has distributions like another detector, the time distribution is not input.

****
Output Figures
****

The following three figures indicate the modeling of volume detectors in the three volume detector geometries.

Figure 30 (DETXYZ) indicates the volume generated for a distributed rectangluar detector volume.

Figure 31 (DETCYL) indicates a volume generated for a distributed cylindrical volume.

Figure 32 (DETSPH) presents the volume generated for a distributed spherical volume.

Figure 30: (DETXYZ) Rectangular Detector Volume

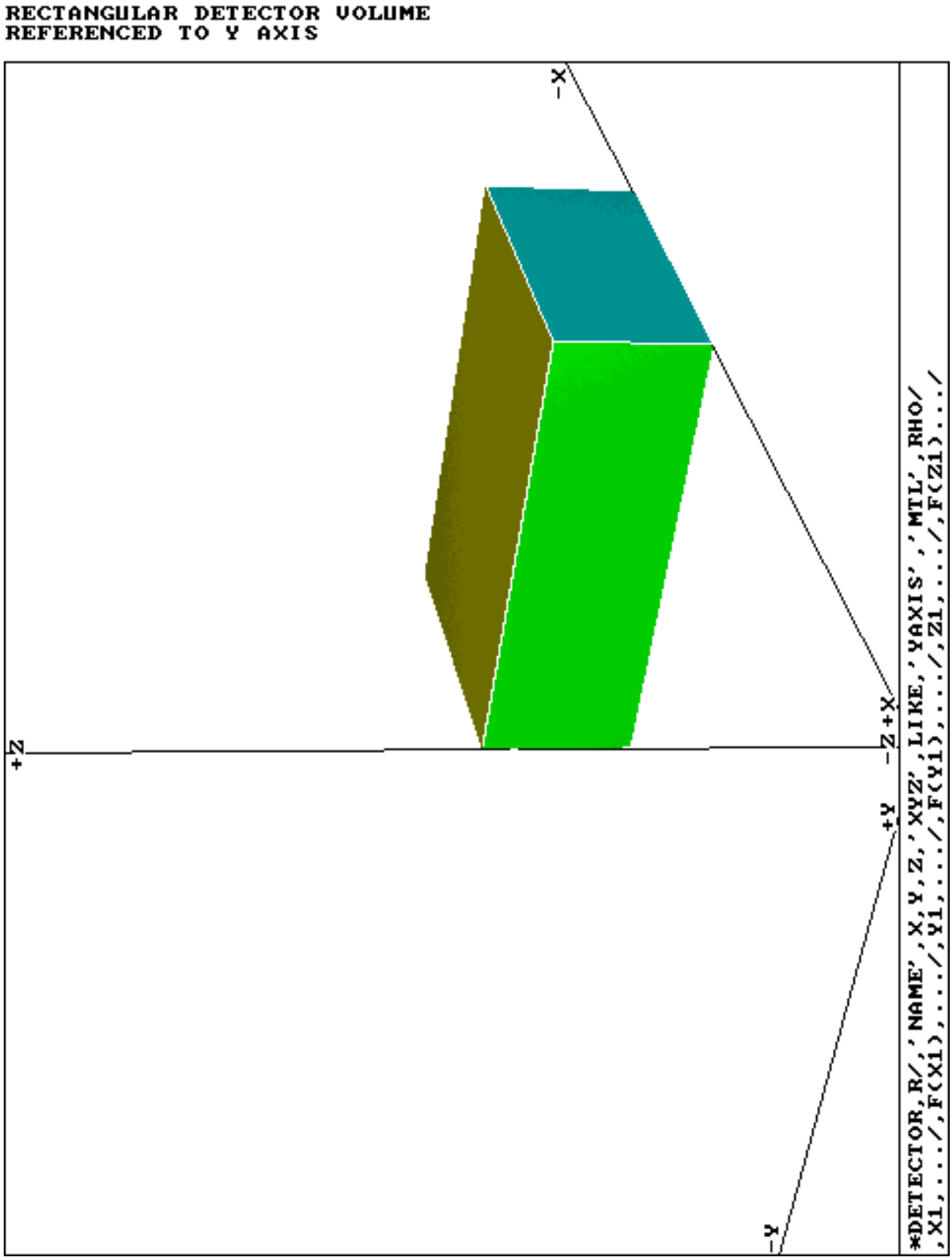


Figure 31: (DETCYL) Cylindrical Detector Volume

CYLINDRICAL DETECTOR VOLUME
REFERENCED TO Z AXIS

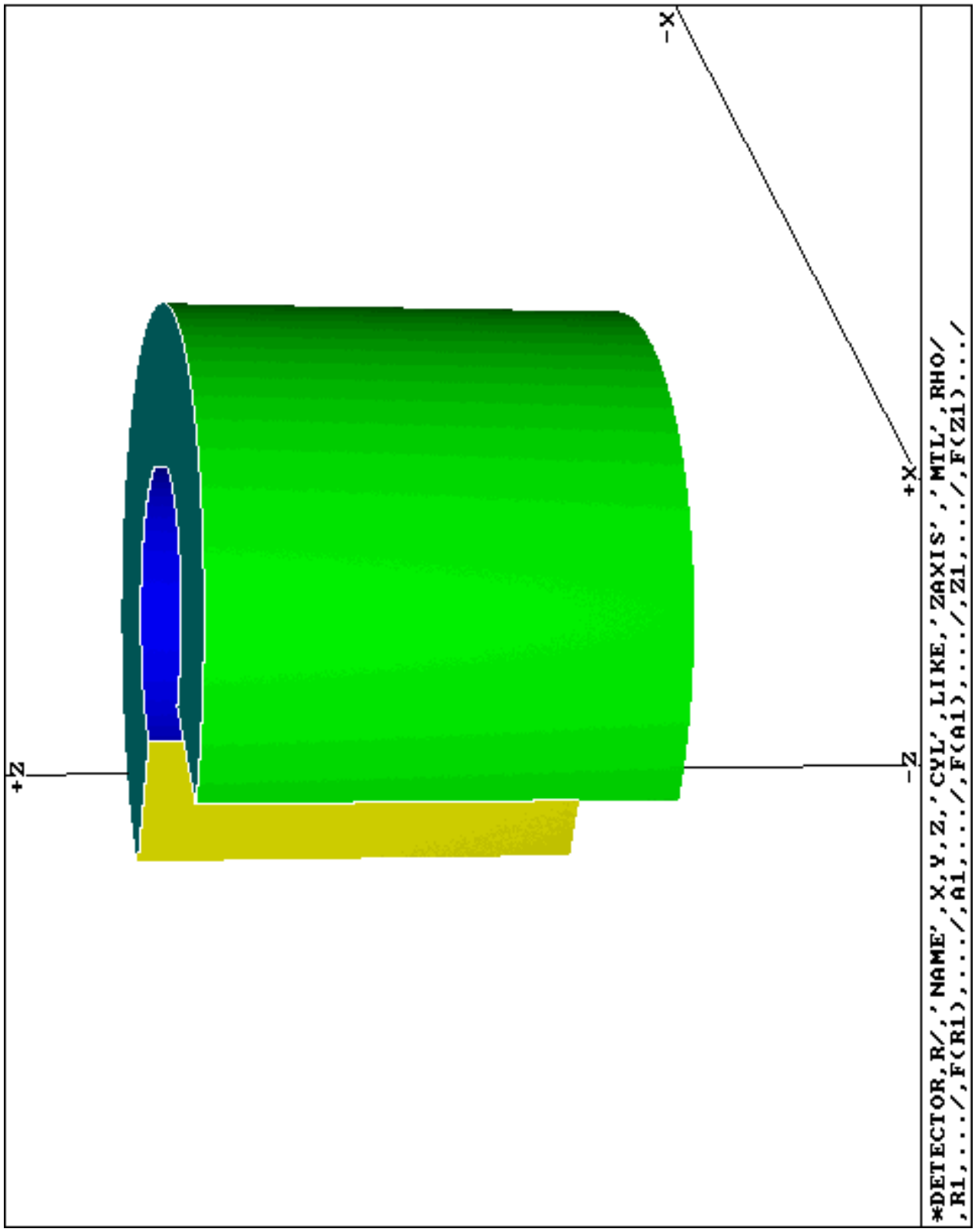
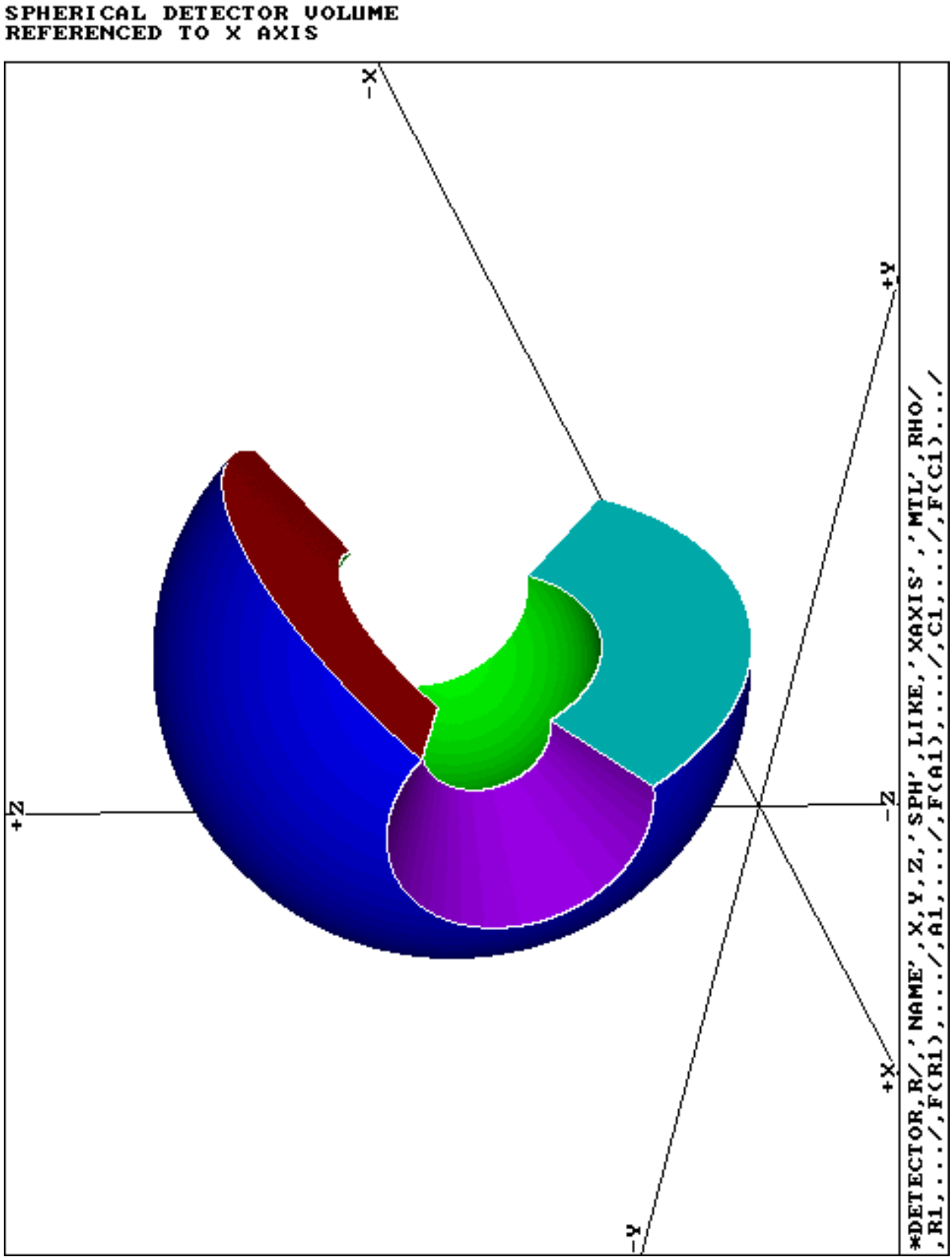


Figure 32: (DETSPH) Spherical Detector Volume



DOSE3D

DOSE3D gives new forward/adjoint Monte Carlo scoring

****
DOSE3D describes new options used to obtain 3D dose profiles using either forward or adjoint Monte Carlo.
****

****
Discussion
****

In progress.

DUMP

DUMP gives a formatted dump of common areas.

****
The DUMP processor obtains a formatted dump of common blocks and variable dimensioned arrays.
****

****
Input Data Record Description:
****

======
Header
======

Contains *DUM in columns 1 through 4.

=======
Options
=======

A, dump individual iloc addresses for corrupted areas

B, dump variable dimension arrays stored in blank common.

C, output TOC for all arrays

L, dump variables stored in labeled common blocks

T, dump temporary arrays stored in blank common.

J, dump scatter loaded arrays (input data prior to *EXECUTE)

****
Data Record Description:
****

There are no other data records.

DUPLICATE

DUPLICATE copies portions of previous geometry data.

****
This input provides for duplication of geometry subsets.
****

****
Input Data Description:
****

==========
Header line
==========

Contains *DUP in columns 1 through 4.

=======
Options
=======

O (integer,,0,3) overlap option, see OVERLAP discussion.

****
Data Record Description:
****

==========
Duplication Limits
==========

A single input record containing

MINR MAXR MINS MAXS MIND MAXD /

MINR, MAXR are the first through the last region to be duplicated. If both are zero, no duplication of regions is performed.

MINS,MAXS are the first through the last source to be duplicated. If both are zero, no duplication of sources is performed.

MIND, MAXD are the first through the last detector to be duplicated. If both are zero, no duplication of detectors is performed.

++++++++++
Discussion
++++++++++

The min and max limits for this processor are modified by the prior use of the *ADDRESS processor. Furthermore, this input must be preceeded by *ROTATE instructions to position the duplicated geometry data. Several examples are given on the following pages.

If the max limit exceeds the current code maximum, the max limit is set to the current maximum.

Suppose a device appears several times in a geometry, that it takes 7 regions to define the device, and that 3 detectors are located on the device. The following schematic demonstrates the use of duplication for the device.

any inputs including geometry prior to the first use of the device

*ADDRESS,RD/ set pointers for regions and detectors

geometry data for the device (assuming 7 regions)

detector data for the device (assuming 3 detectors)

*ROTATE/, data to position second device relative to first/

*DUPLICATE/,1,7,0,0,1,3/ copies 7 regions and 3 detectors

*ROTATE/, data to position third device relative to first/

*DUPLICATE/,1,7,0,0,1,3/ copies 7 regions and 3 detectors

Now suppose that it is more convenient to duplicate the second and third devices to obtain the fourth and fifth,i.e., these pairs have common orientation and separation.

*ROTATE/,data to position fourth device relative to second/

*DUPLICATE/,8,21,0,0,4,9/ copies 14 regions and 6 detectors

++++++++++++
Input Tables
++++++++++++

Table 40 (DUPONE) lists surface/region inputs used to model a fuel capsule in a radio-isotopic thermoelectric generator (RTG).

Table 41 (DUPTWO) lists the rotation/translation/reflection followed by duplications to build up 72 layers of 2x2 fuel capsules for the complete RTG.

Table 42 (DUPTHR) indicates the surfaces/regions then used to complete the description of the jacket and fins.

++++++++++++++
Output Figures
++++++++++++++

An XZ cross section of the complete model is shown in Figure 33 (DUPZXV).

A YZ cross section is shown in Figure 34 (DUPYZV).

The XY cross section shows the fins and is given in Figure 35 (DUPXYV).

A projected view of the complete RTG is shown in Figure 36 (DUPPRO).

That figure is repeated with a cutout to shown interior detail in Figure 37 (DUPCUT).

Table 40: (DUPONE) RTG Fuel Surfaces/Regions

```
*SURFACES,J/
,1,0,11,2.351,1.3692,0.,1.3692/
,2,0,11,2.351,1.4224,0.,1.4224/
,3,0,11,2.351,1.4795,0,1.4795/
,4,0,2,-.9352/
,5,0,2,-.84975/
,6,0,2,-.84075/
,7,0,2,-3.7033/
,8,0,2,-3.78875/
,9,0,2,-3.79775/
,10,0,2,-4.6385/
,11,0,2,4.6385/
,12,0,1,4.702/
,13,0,1,-4.702/
,14,0,3,-2.57325/
,15,0,3,2.57325/
*REGIONS,J,O=2/
,1,1,1,1,4,7,6*0,1,2.3,-1.0,0/
,2,0,0,2,5,8,6*0,0,.96,-2.3,0/
,3,0,2,3,6,9,6*0,1,.9,-2.3,0/
*SOURCE
'SINGLE' 2.351 -2.31925 0.0 2 0 2/
0 1.3692/,1 1/ RADIAL DISTRIBUTION
-3.1416 3.1416/,1 1/ AZIMUTHAL DISTRIBUTION
-1.38405 1.38405/,1 1/ AXIAL DISTRIBUTION
```

Table 41: (DUPTWO) RTG Rotate/Duplicate Fuel

```
*ROTATE,I=0/,-1 0 0 0 0 1 0/ REFLECT IN Y
*DUPLICATE,O=2/,1 999 1 999/ PRODUCE SECOND CAPSULE
*ROTATE,I=0/,-1 0 0 0 1 0 0/ REFLECT IN X
*DUPLICATE,O=2/,1 999 1 999/ PRODUCES THIRD AND FOURTH CAPSULES-FIRST LAYER
*ROTATE,I=0/,0 0 0 5.1465/
*DUPLICATE,O=2/,1 999 1 999/ SECOND LAYER
*ROTATE,I=0/,0 0 0 10.2930/
*DUPLICATE,O=2/,1 999 1 999/ THIRD AND FOURTH LAYERS
*ROTATE,I=0/,0 0 0 20.586/
*DUPLICATE,O=2/,1 999 1 999/ 5 THORUGH 8 LAYERS
*ROTATE,I=0/,0 0 0 41.172/
*DUPLICATE,O=2/,1 999 1 999/ 9 THROUGH 16 LAYERS
*ROTATE,I=0/,0 0 0 82.344/
*DUPLICATE,O=2/,1 24 1 8/ LAYERS 17 AND 18
C
C          NOW INPUTING MATRIX AROUND SOURCE MODULES
C
*ADDRESS,R/ SET REGION POINTER TO COUNT FROM ZERO
*ROTATE,I=0/ RESET TRANSLATION MATRIX TO DO NOTHING
*REGIONS,J,O=2/
,1,0,3,10,11,12,13,14,15,3*0,1,1,4.6,0/
*ROTATE,I=0/,0 0 0 5.1465/
*DUPLICATE,O=2/,1 999/
*ROTATE,I=0/,0 0 0 10.293/
*DUPLICATE,O=2/,1 999/
*ROTATE,I=0/,0 0 0 20.586/
*DUPLICATE,O=2/,1 999/
*ROTATE,I=0/,0 0 0 41.172/
*DUPLICATE,O=2/,1 999/
*ROTATE,I=0/,0 0 0 82.344/
*DUPLICATE,O=2/,1 2/
```

Table 42: (DUPTHR) RTG Jacket and Fins

```
C
C            NOW INPUTING JACKET AND FINS
C
*ADDRESS,RS/
*ROTATE,I=0/,0 0 0 -3.575/
*SURFACES,J/
,1,0,12,0,6.6496,0,6.6496/
,2,0,12,0,7.112,0,7.112/
,3,0,12,0,8.89,0,8.89/
,4,0,3,93.662/
,5,0,3,.975/
,6,0,3,0/
,7,0,3,94.937/
,8,0,1,0.0508/
,9,0,1,-.0508/
,10,0,6,.07184,0,0,.07184/
,11,0,6,-.07184,0,0,-.07184/
,12,0,2,.0508/
,13,0,2,-.0508/
,14,0,6,-.07184,0,0,.07184/
,15,0,6,0,-.07184,.07184,0/
,16,0,12,0,21.082,0,21.082/
,17,0,1,8.9/
,18,0,1,-8.9/
,19,0,2,8.9/
,20,0,2,-8.9/
,21,0,6,0,12.6,12.6,0/
,22,0,6,-12.6,0,0,-12.6/
,23,0,6,0,-12.6,12.6,0/
,24,0,6,-12.6,0,0,12.6/
*REGIONS,J,O=2/
,1,0,0,1,4,5,6*0,0,6.0,1.0,2/
,2,0,5,2,4,5,6*0,1,6.9,.1,2/
,3,0,4,3,4,5,6*0,1,8.5,.1,2/
,4,0,4,3,4,7,6*0,1,0,0,93.7/
,5,0,4,5,6,3,6*0,1,0,0,.4/
,6,0,4,4,5,16,17,12,13,3*0,1,10,0,10/
,7,0,4,4,5,16,21,14,15,3*0,1,7.07,7.07,10/
,8,0,4,4,5,16,19,8,9,3*0,1,0,10,10/
,9,0,4,4,5,16,24,10,11,3*0,1,-7.07,7.07,10/
,10,0,4,4,5,16,18,12,13,3*0,1,-10,0,10/
,11,0,4,4,5,16,22,14,15,3*0,1,-7.07,-7.07,10/
,12,0,4,4,5,16,20,8,9,3*0,1,0,-10,10/
,13,0,4,4,5,16,23,10,11,3*0,1,7.07,-7.07,10/
C
C              NOTE THAT TOP OF MODELED RTG IS AT 91.362 WITH FLAT END
C
```

Figure 33: (DUPZXV) RTG XZ Cross Section View

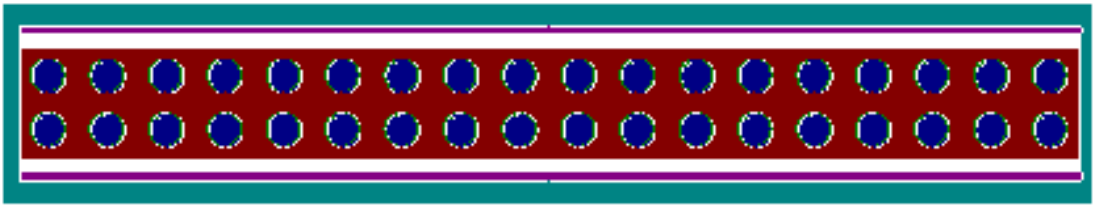


Figure 34: (DUPYZV) RTG YZ Cross Section View

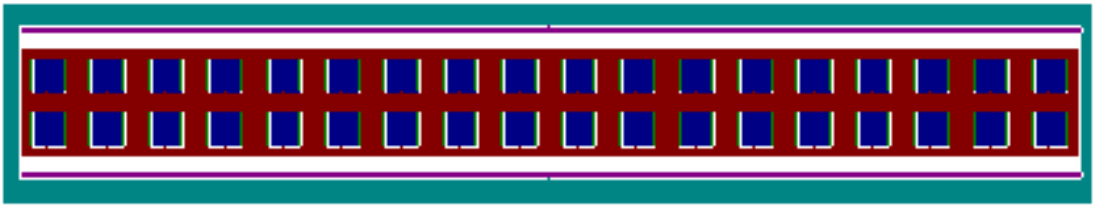


Figure 35: (DUPXYV) RTG XY Cross Section View

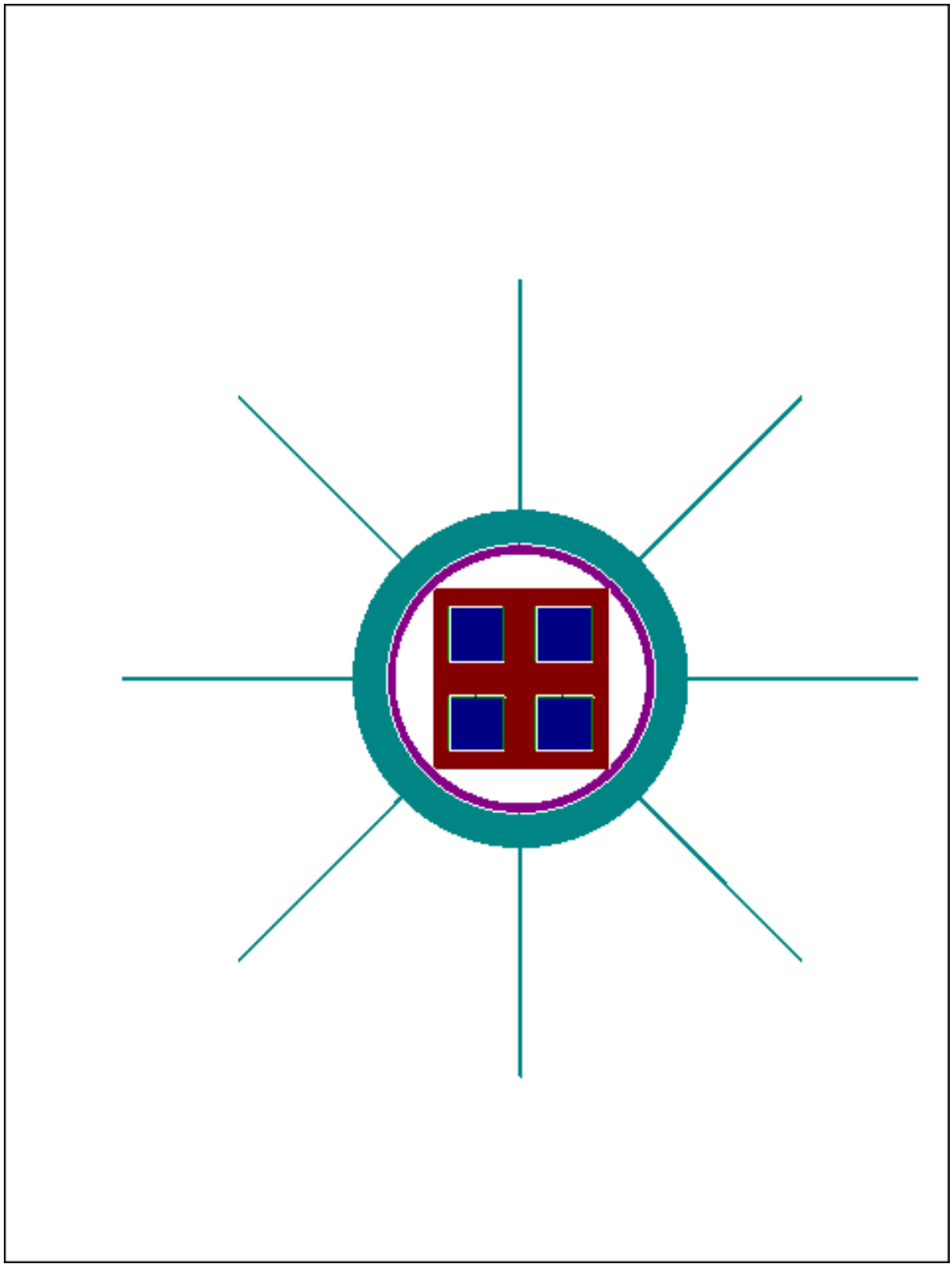
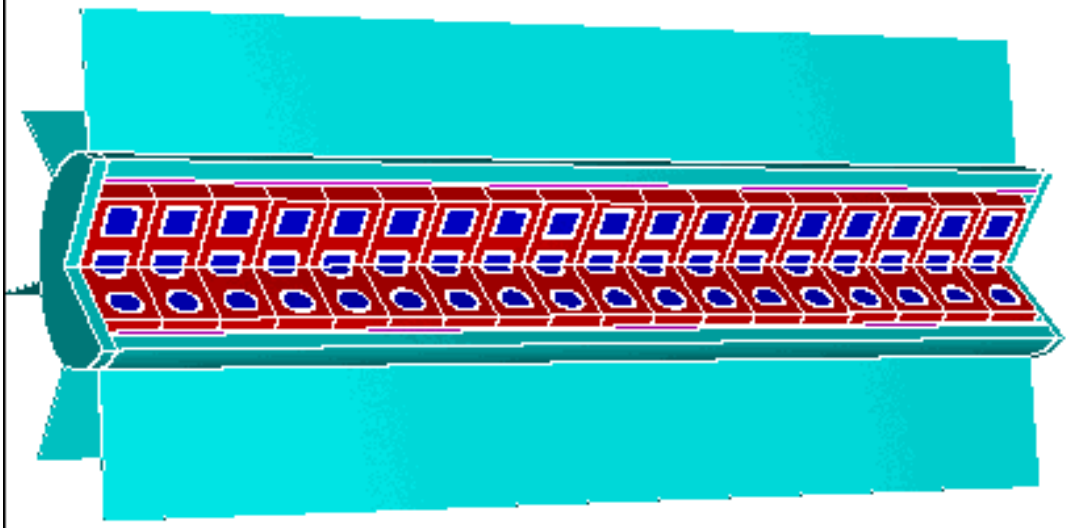


Figure 36: (DUPPRO) RTG Projected View

Figure 37: (DUPCUT) RTG Projected View/Cutout



END

END terminates data input in a processor.

****
The END processor terminates data scanning until the next header line. It functions as a temporary patch to data files so that extensive data lists not required for checkout runs are not used.
****

****
Input Data Description:
****

==========
Header line
==========

Contains *END in columns 1 through 4.

=======
Options
=======

No options apply.

****
Data Record Description:
****

There are no other data records.

ERROR

ERROR, resets the error flag

****
The ERROR processor tells the code to ignore inputs that caused errors. It is used during interactive (demand mode) runs.
****

****
Input Data Record Description:
****

==========
Header Line
==========

Contains *ERR in columns 1 through 4.

=======
Options
=======

E, input data to last 'no-error' input deleted. Does not apply after *EXEcute.

F (int,,0,2) error level increment to cause fatal on warning

A, delete last set of input regardless of errors. Does not apply after *EXEcute.

N, set error indicator to zero absolutely.

****
Data Record Description:
****

There are no data records for this processor.

****
Discussion
****

No options, last data input deleted only if it contained an error. Does not apply after * EXEcute.

ESABASE

ESABASE processes an ESABASE model

****
The ESABASE processor reads an ESABASE geometry and loads it in the NOVICE database. This input can be preceeded or followed by other geometry, material, spectrum, and detector inputs.
****

****
Input Data Record Description:
****

==========
Header line
==========

Contains *ESA in columns 1 through 4.

=======
Options
=======

A, indicates an input file in the MATRA SYSTEMA format (an expanded configuration file).

B, indicates an input file in the ESABASE format.

C, generate detector points in the corners of any BOX5, BOX6, BOXCG5, or BOXCG6 shapes (8 points per box).

D, generate a detector point at the center of any BOX5, BOX6, BOXCG5, or BOXCG6 shapes. (1 point per box)

E, generate detector points at mid edge of any BOX5, BOX6, BOXCG5, or BOXCG6 shapes (12 points per box).

F, generate detector points face centered for any BOX5, BOX6, BOXCG5, or BOXCG6 shapes (6 points per box).

H (real,,eps,inf) if box lims identical use =-eps, default 1 micron

K (material) to fill the interior of boxes

L (real,den,0,inf) density (g/cc) of box interior

M (material) default material for esabase/systema

O=o, o is the overlap option, i.e., O=3 allows overlaps in the geometry description. Where overlaps occur, the code uses that piece of the geometry that was described first in the input. This logic is used only where the objects physically interfere with each other. Where the objects are distinct, each is seen as described. See the OVERLAP section of the manual.

P=p, p is the spectrum scale factor for the trapped proton input spectrum. Default is 1.0.

R=r, r is the spectrum scale factor for the trapped electron input spectrum. Default is 1.0.

S=s, s is the spectrum scale factor for the solar flare proton input spectrum. Default is 1.0.

T=t, t is the thickness to be used for any shapes that do not have an input thickness or do not have a RADIATION associated thickness. Dimensions are the same as the geometry file input , e.g., MM. Default is 0.0 (if a thickness is not specified in the object description or in the RADIATION input, then the object is omitted from the geometry model unless T=t where t is non-zero).

****

Data Record Description:

****

File Name

Following the header line, with any options, is a single line containing the geometry input FILENAME (without extension) for the geometry being processed, e.g.

```
SATELLITE
```

Discussion

This processor can also be entered using the header lines

```
*DESIGN,A ...
```

or

```
*SYSTEMA ...
```

Note that the A option is required when using the *DESIGN header line. For the other two options, the A and B options are not required.

This interface processor can accept geometry data in two forms. The code first looks for a formatted SYSTEMA expanded configuration file with the name

```
FILENAME.SYS  (FILENAME.SYSEXP on UNIX systems)
```

If FILENAME.SYS exists, then SYSTEMA formats are assumed. Since the SYSTEMA file is already in an expanded form, it is processed in a single pass. A summary of the processing is written to the file SYSTEMA.GEO.

If FILENAME.SYS does not exist, then NOVICE looks for an ESABASE input file with the name:

```
FILENAME.BAS  (FILENAME.SYSBAS on UNIX systems)
```

If this file is found, then several steps are required before the geometry can be loaded:

(1) process COPY statements for objects,

(2) produce a configured geometry (this step is bypassed unless a FILENAME.FIG exists),

(3) process SHAPE/NAME and COPY structures,

(4) process NAME/ALIAS and NAME=ALIAS structures, and add explicit zeroes to three vectors (), (x), and (x,y).

After this processing, the ESABASE geometry is then loaded with summary output written to the file FILENAME.GEO. where FILENAME is the file name entered following the *ESA header/option line.

While loading the geometry for NOVICE, a file containing detector points (in NOVICE format) is created according to the C, D, E, and F options on the header line. This file is always named SYSTEMA.DET.

After loading the geometry, NOVICE then looks for a file containing spectra in the format used in an ESABASE analysis. This file is assumed to have the name

FILENAME.RAD (FILENAME.RADFOUTI on UNIX systems)

This file is processed to obtain spectra in the format required by NOVICE. Since the spectra may not be correctly normalized, e.g., the data may be average fluence per day, scale factors can be entered using the P, R, and S options on the header line. Output from spectrum processing is in a file always named SYSTEMA.SPE.

After processing spectra, NOVICE then looks for a file containing shield thickness and dose tabulations. This file is assumed to have the name

FILENAME.SHI (FILENAME.SHIEOUTG on UNIX systems)

This file is processed to obtain thickness/dose tabulations in the format required by NOVICE in ray-trace/sectoring calculations (*SIGMA). The output file produced for NOVICE is always named SYSTEMA.SIG.

Note that after processing the geometry (the *DESIGN header line), the SYSTEMA.SPE file is added to the input stream after the *SPECTRUM header line, the SYSTEMA.DET file is added to the input stream after the *DETECTOR header line, and the SYSTEMA.SIG file is added to the input stream as the final set of data in the *SIGMA portion of the input.

++++++++++++
Input Tables
++++++++++++

Sample input data for using an ESABASE model is shown in Table 43 (ESADAT).

+++++++++++++
Output Tables
+++++++++++++

Table 44 (ESASYS) shows part of the summary of geometry processing for a SYSTEMA expanded geometry input file.

Table 45 (ESAGEO) shows a partial summary from loading a basic ESABASE geometry.

Table 46 (ESASPE) shows a typical NOVICE spectrum input file created from ESABASE files.

Table 47 (ESADET) shows the detector point file created while processing the input geometry.

Finally, Table 48 (ESASIG) gives part of the dose attenuation data created from ESABASE files for NOVICE input.

++++++++++++++
Output Figures
++++++++++++++

Figure 38 (ESAPIC) shows a typical view of the model geometry used in the sample problem.

Table 43: (ESADAT) Sample NOVICE Input Data

```
*materials
c
c *** materials in 'satellite' sample problem
c
FIBRE 1.7  6 0 -1 12 0 -2/
ALUMINIU 2.7  13 0 1/
SOLPAN   2.3  14 0 1/
HONEYCOMB  1 6 0 -1 12 0 -4/
KAPTON   1.4 14 0 1/
ALUMINUM 2.7  13 0 1/
c
*design,a,o=3,d/ (c,d,e,f=8corner,1center,12edge,6face) detectors/box
satellit
c
c *** NOTE:  the line above is the file name (no extension)
c            for the geometry description (esabase or systema)
c
*spectrum
c
c *** get the spectrum information file created as part of the
c     processing of the esabase or systema files
c
&get SYSTEMA.SPE
c
*detector
c
c *** get the detector point data file created as part of the
c     processing of the esabase or systema files
c
&get SYSTEMA.DET
c
*exe
*sigma,h=3/
c
c *** typical user data for SIGMA ray tracing analysis
c
1 2 3 4 5 6 7 8 9 10 11 12/ center points in 12 boxes
.1 li3*100/ mass thickness boundaries (g/sqcm) pdf output (if any)
0 1i60*6.2832/ azimuthal intervals
,/ polar intervals, no input implies igloo solid angle bins
0 .1 .2 .3 .5 1/ parametric shield thicknesses
0/ no print plots of geometry cross section
c
c *** get the thickness/dose data file created as part of the
c     processing of the esabase or systema files
c
&get SYSTEMA.SIG
c
*end
*pic,g=257,q=2,l=test/
c
c *** generate a perspective view of the geometry
c
50 50 50 1000 1000 1000 500/ center point, view point, half height
*stop
```

Table 44: (ESASYS) SYSTEMA geometry summary

```
c NOVICE input data for GEO     , data from file:
c       satellit.EXP
 100001     4 data, SATELLITE$MM$$

 conversion to centimeters:     0.100000
 200001     0 data, <1>COMPLETE SERVICE MODULE$
 max level is   1, indices:     1
 200008     5 data, UNDEF    UNDEF$
 200005    37 data,
 x(1) =  0.00000*x(1) +  0.00000*x(2) +  1.00000*x(3) +   0.0000E+00
 x(2) =  0.00000*x(1) +  1.00000*x(2) +  0.00000*x(3) +   0.0000E+00
 x(3) = -1.00000*x(1) +  0.00000*x(2) +  0.00000*x(3) +   0.0000E+00
 composite rotation matrix
 x(1) =  0.00000*x(1) +  0.00000*x(2) +  1.00000*x(3) +   0.0000E+00
 x(2) =  0.00000*x(1) +  1.00000*x(2) +  0.00000*x(3) +   0.0000E+00
 x(3) = -1.00000*x(1) +  0.00000*x(2) +  0.00000*x(3) +   0.0000E+00
 200001     0 data, <1,1>SERVICE MODULE$
 max level is   2, indices:     1    1
 200008     5 data, UNDEF    UNDEF$
 200005    37 data,
 x(1) =  1.00000*x(1) +  0.00000*x(2) +  0.00000*x(3) +  -1.3800E+02
 x(2) =  0.00000*x(1) +  1.00000*x(2) +  0.00000*x(3) +   0.0000E+00
 x(3) =  0.00000*x(1) +  0.00000*x(2) +  1.00000*x(3) +   0.0000E+00
 composite rotation matrix
 x(1) =  0.00000*x(1) +  0.00000*x(2) +  1.00000*x(3) +   0.0000E+00
 x(2) =  0.00000*x(1) +  1.00000*x(2) +  0.00000*x(3) +   0.0000E+00
 x(3) = -1.00000*x(1) +  0.00000*x(2) +  0.00000*x(3) +  -1.3800E+02
 200001     0 data, <1,1,1>STRUCTURE SVM$
 max level is   3, indices:     1    1    1
 200008     5 data, UNDEF    UNDEF$
 200005    37 data,
 x(1) =  1.00000*x(1) +  0.00000*x(2) +  0.00000*x(3) +   0.0000E+00
 x(2) =  0.00000*x(1) +  1.00000*x(2) +  0.00000*x(3) +   0.0000E+00
 x(3) =  0.00000*x(1) +  0.00000*x(2) +  1.00000*x(3) +   0.0000E+00
 composite rotation matrix
 x(1) =  0.00000*x(1) +  0.00000*x(2) +  1.00000*x(3) +   0.0000E+00
 x(2) =  0.00000*x(1) +  1.00000*x(2) +  0.00000*x(3) +   0.0000E+00
 x(3) = -1.00000*x(1) +  0.00000*x(2) +  0.00000*x(3) +  -1.3800E+02
 200001     0 data, <1,1,1,1>SVM STRUCTURE -Z FACE$
 max level is   4, indices:     1    1    1    1
 200008     5 data, UNDEF    UNDEF$
 200005    37 data,
 x(1) =  1.00000*x(1) +  0.00000*x(2) +  0.00000*x(3) +   3.5550E+01
 x(2) =  0.00000*x(1) +  1.00000*x(2) +  0.00000*x(3) +   0.0000E+00
 x(3) =  0.00000*x(1) +  0.00000*x(2) +  1.00000*x(3) +   0.0000E+00
 composite rotation matrix
 x(1) =  0.00000*x(1) +  0.00000*x(2) +  1.00000*x(3) +   0.0000E+00
 x(2) =  0.00000*x(1) +  1.00000*x(2) +  0.00000*x(3) +   0.0000E+00
 x(3) = -1.00000*x(1) +  0.00000*x(2) +  0.00000*x(3) +  -1.0245E+02
 200012     2 data, FIBRE$
 material name   : FIBRE
 material density:    -1.000000
 body thickness  :   1.0000E-01
 200003     1 data, MLI$
 200011     5 data,
```

Table 45: (ESAGEO) ESABASE geometry summary

```
 linear dimensions are scaled by:   0.1000
<1> COMPLETE SERVICE MODULE
 0.000000E+00 0.000000E+00 1.000000E+00 0.000000E+00 1.000000E+00 0.000000E+00
-1.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
VOID          0.0000E+00  0.0000E+00  1.0000E-01
#no shapes
<1,1> SERVICE MODULE
 1.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 1.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 1.000000E+00-1.380000E+03 0.000000E+00 0.000000E+00
VOID          0.0000E+00  0.0000E+00  1.0000E-01
#no shapes
<1,1,1> STRUCTURE SVM
 1.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 1.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 1.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
VOID          0.0000E+00  0.0000E+00  1.0000E-01
#no shapes
<1,1,1,1> SVM STRUCTURE -Z FACE
 1.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 1.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 1.000000E+00 3.555000E+02 0.000000E+00 0.000000E+00
FIBRE        -1.0000E+00  1.0000E+00  1.0000E-01
#yes shapes
 0.000000E+00 0.000000E+00 1.000000E+00 0.000000E+00 1.000000E+00 0.000000E+00
-1.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00-1.024500E+02
TRAPEZE           63        12         1
  1  1  1  2  2  2  3  3  3  4  4  4
 0.000000E+00-1.395000E+03 1.000000E+03 0.000000E+00-6.800000E+02 1.595000E+03
 0.000000E+00 6.800000E+02 1.595000E+03 0.000000E+00 1.395000E+03 1.000000E+03
 1.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 1.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 1.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 1.000000E+00 0.000000E+00 1.000000E+00 0.000000E+00
-1.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00-1.024500E+02
RECTANGLE         61         9         2
  1  1  1  2  2  2  3  3  3
 0.000000E+00-1.395000E+03-1.000000E+03 0.000000E+00-1.395000E+03 1.000000E+03
 0.000000E+00 1.395000E+03-1.000000E+03
 1.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 1.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 1.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 1.000000E+00 0.000000E+00 1.000000E+00 0.000000E+00
-1.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00-1.024500E+02
TRAPEZE           63        12         3
  1  1  1  2  2  2  3  3  3  4  4  4
 0.000000E+00 1.395000E+03-1.000000E+03 0.000000E+00 6.800000E+02-1.595000E+03
 0.000000E+00-6.800000E+02-1.595000E+03 0.000000E+00-1.395000E+03-1.000000E+03
 1.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 1.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 1.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 1.000000E+00 0.000000E+00 1.000000E+00 0.000000E+00
-1.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00-1.024500E+02
<1,1,1,2> SVM STRUCTURE +Z FACE
 1.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 1.000000E+00 0.000000E+00
 0.000000E+00 0.000000E+00 1.000000E+00 1.380000E+03 0.000000E+00 0.000000E+00
FIBRE        -1.0000E+00  1.0000E+00  1.0000E-01
#yes shapes
 0.000000E+00 0.000000E+00 1.000000E+00 0.000000E+00 1.000000E+00 0.000000E+00
-1.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
TRAPEZE           63        12         4
```

Table 46: (ESASPE) Spectrum input for NOVICE

```
c NOVICE input data for SPE     , data from file:
c       satellit.RAD
'electron orb' electron     INP   1.0000E+00 SCALE/
,/  no energy record, therefore paired spectrum data
  4.0000E-02  4.6200E+07
  1.0000E-01  3.1700E+07
  2.0000E-01  1.5700E+07
  3.0000E-01  8.5100E+06
  4.0000E-01  5.0000E+06
  5.0000E-01  2.9400E+06
  6.0000E-01  2.0300E+06
  7.0000E-01  1.4000E+06
  8.0000E-01  9.7800E+05
  1.0000E+00  4.8700E+05
  1.2500E+00  2.4400E+05
  1.5000E+00  1.2200E+05
  1.7500E+00  7.0600E+04
  2.0000E+00  4.0800E+04
  2.2500E+00  2.0900E+04
  2.5000E+00  1.0700E+04
  2.7500E+00  6.3700E+03
  3.0000E+00  3.7800E+03
  3.2500E+00  2.4400E+03
  3.5000E+00  1.5800E+03
  3.7500E+00  8.4000E+02
  4.0000E+00  4.4800E+02
  4.2500E+00  2.2900E+02
  4.5000E+00  1.1700E+02
  4.7500E+00  2.2700E+01
  5.0000E+00  4.4200E+00 / end of paired spectrum data
'flare proton' proton       INP   1.0000E+00 SCALE/
,/  no energy record, therefore paired spectrum data
  1.0000E+01  5.0400E+10
  2.0000E+01  3.4600E+10
  3.0000E+01  2.3700E+10
  4.0000E+01  1.6300E+10
  5.0000E+01  1.1100E+10
  6.0000E+01  7.6400E+09
  7.0000E+01  5.2400E+09
  8.0000E+01  3.5900E+09
  9.0000E+01  2.4600E+09
  1.0000E+02  1.6900E+09
  1.1000E+02  1.1600E+09
  1.2000E+02  7.9400E+08
  1.3000E+02  5.4400E+08
  1.4000E+02  3.7300E+08
  1.5000E+02  2.5600E+08
  1.6000E+02  1.7500E+08
  1.7000E+02  1.2000E+08
  1.8000E+02  8.2500E+07
  1.9000E+02  5.6600E+07
  2.0000E+02  3.8800E+07 / end of paired spectrum data
*end/ end of spectrum inputs
```

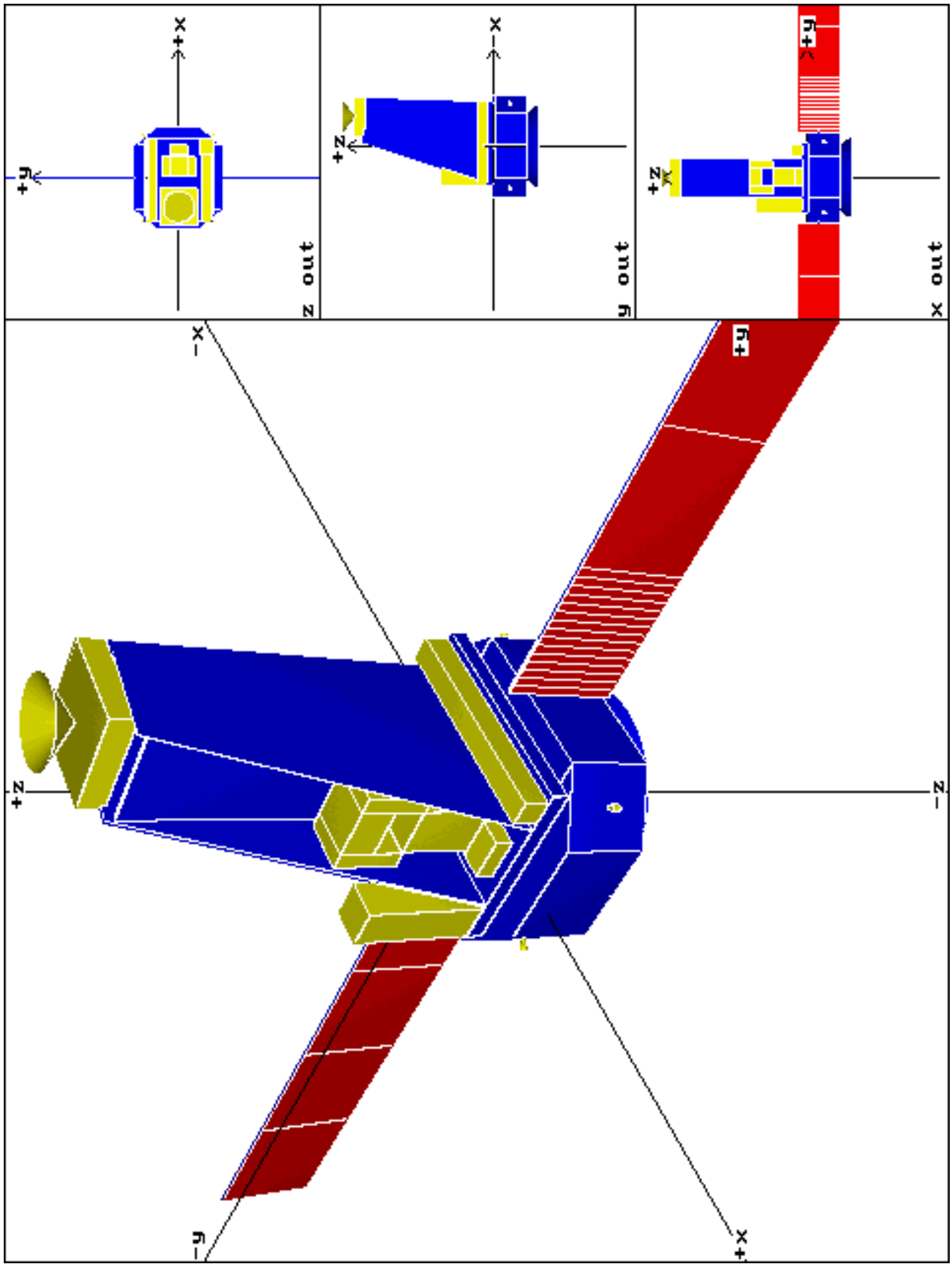
Table 47: (ESADET) Detector input for NOVICE

```
c NOVICE input data for DET     , data from file:
c       satellit.BAS
c <2,1,1> PLM PLATEAU
c detector pnt  1.0000E+01  1.1000E+02  1.3000E+02 before rotate/translate
' 1  0 0 0 14' -1.0000E+01  0.0000E+00  1.0000E+01 / <2,1,1>
c <2,2,1> DETECTOR IMAGE
c detector pnt  2.5000E+01  4.5000E+01  4.5000E+01 before rotate/translate
' 2  0 0 0 14' -9.5000E+01  0.0000E+00  4.5000E+01 / <2,2,1>
c <2,2,2> MASK IMAGE
c detector pnt  1.5000E+01  6.0000E+01  6.0000E+01 before rotate/translate
' 3  0 0 0 14' -9.5000E+01  0.0000E+00  4.2300E+02 / <2,2,2>
c <2,3,1> DETECTOR SPECTROMETER
c detector pnt  4.7000E+01  3.0000E+01  3.0000E+01 before rotate/translate
' 4  0 0 0 14'  3.3500E+01  0.0000E+00  6.7000E+01 / <2,3,1>
c <2,3,2> MASK / ANTI-MASK SPECTROMETER
c detector pnt  2.0000E+01  3.1000E+01  3.1000E+01 before rotate/translate
' 5  0 0 0 14'  3.3500E+01  0.0000E+00  1.7000E+02 / <2,3,2>
c <2,3,3,1> SPECTROMETER ARM FIRST PART
c detector pnt  3.8000E+01  1.0000E+01  3.1000E+01 before rotate/translate
' 6  0 0 0 14'  3.3500E+01  4.1000E+01  1.5200E+02 / <2,3,3,1>
c <2,3,3,2> SPECTROMETER ARM SECOND PART
c detector pnt  3.8000E+01  1.0000E+01  3.1000E+01 before rotate/translate
' 7  0 0 0 14'  3.3500E+01 -4.1000E+01  1.5200E+02 / <2,3,3,2>
c <2,4> XRM
c detector pnt  7.1500E+01  2.2500E+01  2.2500E+01 before rotate/translate
' 8  0 0 0 14'  9.6500E+01 -8.7500E+01  9.1600E+01 / <2,4>
c <2,5> OTC
c detector pnt  1.2500E+01  7.5000E+00  7.5000E+00 before rotate/translate
' 9  0 0 0 14' -7.7500E+01 -5.2400E+01  4.2540E+02 / <2,5>
c <2,6,1> +Y ELECTRONICS
c detector pnt  1.5000E+01  1.5000E+01  1.3000E+02 before rotate/translate
'10  0 0 0 14' -1.0000E+01  8.5000E+01  3.5000E+01 / <2,6,1>
c <2,6,2> -Y ELECTRONICS
c detector pnt  1.5000E+01  1.5000E+01  1.0500E+02 before rotate/translate
'11  0 0 0 14' -3.5000E+01 -8.5000E+01  3.5000E+01 / <2,6,2>
c <2,6,3> COOLERS
c detector pnt  1.0500E+01  2.6000E+01  1.6000E+01 before rotate/translate
'12  0 0 0 14'  8.9000E+01  0.0000E+00  3.0500E+01 / <2,6,3>
*end/ end of detector point inputs
```

Table 48: (ESASIG) Dose Tabulation for NOVICE

```
c NOVICE input data for SIG     , data from file:
c       satellit.SHI
'TOTAL DOSE  '  2.7000E-01  1.0000E+00 ALUMINUM     UNKNOWN      / tab header
  5.000E-02   1.000E-01   2.000E-01   3.000E-01   4.000E-01   5.000E-01
  6.000E-01   8.000E-01   1.000E+00   1.500E+00   2.000E+00   2.500E+00
  3.000E+00   4.000E+00   5.000E+00   6.000E+00   7.000E+00   8.000E+00
  9.000E+00   1.000E+01   1.200E+01   1.400E+01   1.600E+01   1.800E+01
  2.000E+01/
,/ no slab data input
 0.0/ no spherical shell data, use slab for electron
c     solid sphere data follows
  6.050E+07   3.827E+07   1.951E+07   1.166E+07   7.602E+06   5.277E+06
  3.849E+06   2.272E+06   1.448E+06   5.583E+05   2.573E+05   1.336E+05
  7.519E+04   2.696E+04   1.289E+04   8.082E+03   5.872E+03   4.721E+03
  3.992E+03   3.517E+03   2.874E+03   2.360E+03   1.972E+03   1.700E+03
  1.490E+03/
100*0/ calculate material effectiveness
'ELECTRONS   '  2.7000E-01  1.0000E+00 ALUMINUM     ELECTRON     / tab header
  5.000E-02   1.000E-01   2.000E-01   3.000E-01   4.000E-01   5.000E-01
  6.000E-01   8.000E-01   1.000E+00   1.500E+00   2.000E+00   2.500E+00
  3.000E+00   4.000E+00   5.000E+00   6.000E+00   7.000E+00   8.000E+00
  9.000E+00   1.000E+01/
,/ no slab data input
 1.5/ no spherical shell data, use slab for electron
c     solid sphere data follows
  6.046E+07   3.823E+07   1.948E+07   1.163E+07   7.576E+06   5.253E+06
  3.824E+06   2.249E+06   1.427E+06   5.420E+05   2.435E+05   1.219E+05
  6.487E+04   1.864E+04   5.938E+03   2.161E+03   7.604E+02   2.132E+02
  4.558E+01   4.098E+00/
100*0/ calculate material effectiveness
'BREMSSTRAHLU'  2.7000E-01  1.0000E+00 ALUMINUM     PHOTON       / tab header
  5.000E-02   1.000E-01   2.000E-01   3.000E-01   4.000E-01   5.000E-01
  6.000E-01   8.000E-01   1.000E+00   1.500E+00   2.000E+00   2.500E+00
  3.000E+00   4.000E+00   5.000E+00   6.000E+00   7.000E+00   8.000E+00
  9.000E+00   1.000E+01   1.200E+01   1.400E+01   1.600E+01   1.800E+01
  2.000E+01/
,/ no slab data input
 0.0/ no spherical shell data, use slab for electron
c     solid sphere data follows
  3.304E+04   2.567E+04   1.807E+04   1.369E+04   1.078E+04   8.818E+03
  7.453E+03   5.714E+03   4.644E+03   3.119E+03   2.319E+03   1.851E+03
  1.558E+03   1.212E+03   1.008E+03   8.691E+02   7.678E+02   6.912E+02
  6.317E+02   5.840E+02   5.122E+02   4.599E+02   4.190E+02   3.855E+02
  3.570E+02/
100*0/ calculate material effectiveness
'SOLAR PROTON'  2.7000E-01  1.0000E+00 ALUMINUM     PROTON       / tab header
  5.000E-02   1.000E-01   2.000E-01   3.000E-01   4.000E-01   5.000E-01
  6.000E-01   8.000E-01   1.000E+00   1.500E+00   2.000E+00   2.500E+00
  3.000E+00   4.000E+00   5.000E+00   6.000E+00   7.000E+00   8.000E+00
  9.000E+00   1.000E+01   1.200E+01   1.400E+01   1.600E+01   1.800E+01
  2.000E+01/
,/ no slab data input
 0.0/ no spherical shell data, use slab for electron
 ... some data omitted from the table
*end/ end of tabulated dose kernel inputs
```

Figure 38: (ESAPIC) Satellite Sample Picture



EUCLID

EUCLID converts EUCLID ascii file to NOVICE geometry.

****
This processor is used to convert EUCLID ascii files to a NOVICE geometry model.
****

****
Input Data Description
****

==========
Header Line
==========

Must contain *EUC in columns 1 through 4

==========
Options Field
==========

D='prefix'. All objects with a name starting with the characters denoted by prefix will have a detector point centered in the object.

F='filename'. Name of the file containing the EUCLID ascii information

O=o, overlap option. Sample output indicates an outside to inside modeling logic. Use O=-3 for this logic.

H (real,,eps,inf) if box lims identical use =-eps, default 1 micron

****
Description of Data Input Records
****

There is no other input. All input is obtained from the indicated file.

+++++++
Example
+++++++

```
*EUCLID,D='PUCE',F='EUCLID.GEO',O=-3/
```

++++++++++
Discussion
++++++++++

This processor can be used repetitively to describe the total model. It can also be intermixed with geometry loaded with other processors. At the present time, only the format for extruded prisms is known. Specifically, 3 to 8 points in a plane and an extrusion vector.

Material names and densities can be entered by editing the EUCLID file, adding lines of the form:

```
    * material  'material_name'            (or materiel)
    * density   'value'                    (or densite)
```

for example

```
    * materiel  aluminum
    * densite   2.7
```

The material name and density apply to all objects that follow until changed by additional input. The name 'void' is recognized as the absence of a material.

Alternatively, the material names and densities can be input using the *ARRAY processor. For this procedure, the numbers assigned by the code must be known (sequential by order of input starting from 1.) For example:

```
*array/,materials 1   0 5*2      3/
*array/,densities 2.7 0 5*2.33 7.9/
```

where the first object is aluminum (material 1, the outside of a box), the second a void (the box interior), the next five are silicon (material 2) parts, and the final object is a kovar (material 3) box cover.

++++++++++++
Input Tables
++++++++++++

Table 49 (EUCDAT) shows an abreviated form of the ascii input accepted by this processor.

Table 49: (EUCDAT) Example of EUCLID Data File

```
*EUCLID,O=-3   $ OUTSIDE TO INSIDE DEFINITION
        F='EUCLID.SSA' $ NAME OF GEOMETRY DATA FILE
        D='PUCE'       / AUTOMATIC DEFINITION OF DETECTORS
C                        FOR ELEMENT NAMES STARTING WITH PUCE

* ELEMENT RANGE : MX8FI-ANA  *
* FIGURE DE 8 ELEMENTS
* SOUS-ELEMENT NUMERIO 1
* ELEMENT NOMME : MX8_ANA
* PRISME
* ARETE DX -DY -DZ
* 0. 0. 6.7
* BASE DU PRISME
* ELEMENT OPAQUE COMPOSE DE
* BRISE DE 4 POINTS
* -15.75  15.75 0.
* -15.75 -15.75 0.
*  15.75 -15.75 0.
*  15.75  15.75 0.
* SOUSE-ELEMENT NUMERO 2
* ELEMENT NOMME : MX8I_ANA
* PRISME
* ARETE DX - DY - DZ
* 0. 0. 0.
* BASE DU PRISME
* ELEMENT OPAQUE COMPOSE DE
* BRISE DE 4 POINTS
* -14.95  14.95  1.6
* -14.95 -14.95  1.6
*  14.95 -14.95  1.6
*  14.95  14.95  1.6
* SOUSE-ELEMENT NUMERO 3
* ELEMENT NOMME : puce01_ANA
  .
  .
  .
* SOUS-ELEMENT NUMERO 8
* ELEMENT NOMME : COUVX8_ANA
* PRIMSE
* ARETE DX - DY - DZ
* 0. 0. 0.3
* BASE DU PRISME
* ELEMENT OPAQUE COMPOSE DE
* BRISE DE 4 POINTS
* -15.75  15.75  6.7
* -15.75 -15.75  6.7
*  15.75 -15.75  6.7
*  15.75  15.75  6.7
* FIN DU DECODAGE
***
*END
```

EXECUTE

EXECUTE sets default inputs, prepares cross sections.

****
The EXECUTE processor tells the code that the data base input is completed.
****

****
Input Data Record Description:
****

==========
Header line
==========

Contains *EXE in columns 1 through 4.

=======
Options
=======

X, generate cross section tables even if the data base input contains errors

N, do not generate cross sections even if the data base inputs are error free, e.g., *PICTURE and *SIGMA do not require cross section tables. N=1, generate photon xsects and not electron xsects.

L, library setup

M=m, multigroup library setup for DLCm. If M only, default is DLC31 library.

P, photon library setup

V=v, subdivide source groups into v subdivisions, default is V=10.

A, keep detailed photon cross sections. If multigroup cross section libraries are used, the A option implies no transport corrections. (Keeping detailed photon cross sections is always done, 90Oct09).

B, calculate bremsstrahlung production angular distribution using nist methods (default is classical, jackson ced, 15.10 summed

C=c, use incoherent with form factors in adjoint

E=e, 1/e is used for fractional energy loss. Default is 20. Use 40 or 50 for better accuracy on single energy and direction problems.

O=o, max Legendre order, O=0 (letter O = number zero) gives Gaussian approximation of electron angular straggling. The O option applies to both multigroup and electron data sets. Therefore, if defaults are not used both multigroup and electron particle types cannot be accomodated in a single problem setup.

R=r, overlap tolerance (cm), overlaps on a ray trace with less than this extent are ignored and do not require use of the overlap option to be ignored, default is 0.

W=w, fraction value of electron delta ray energy, default .03

D, debug option, print array allocations, etc..

G=g, maximum length of the ray trace array, if g>0, the alternate ray trace array is not allocated, if g<0 the alternate array is kept

Q=q, reset the max roots per surface to max(2,q), the default is Q=4.

F, place plot data for spectra, responses, and particle cross sections on the file PLOT.DAT.

J, explicit large angle scattering option for electrons and protons. This option will override the default Goutschmit-Saunderson formalism for angular deflections. The model should be more accurate than the default models. J=j, 1/j is expected fractional energy loss per particle step, default is j=20.

H=h, maximum fraction of dE/ds to knockon electrons/explicit modeling , default is 0.5.

I=i, minimum number of collisions in the multiple scattering energy-loss distribution. If less than this number, all are treated explicitly, default is i=5.

K=k, minimum number of collisions in the multiple scattering angular distribution. If less than this number, all are treated explicitly, default is k=5.

S=s, expected number of knockon productions per step, default is s=0.25. Use s=0.1 in adjoint calculations!

T=t, expected number of large angle deflections per step, default is t=1.00.

Y, bremsstrahlung threshold for low e straggling, default is min group

Z, correction for angular straggling z*(z+1) becomes z(z+doptz)

&e, scales electron step size by sqrt(z/13)

&g, prints cross reference tables of geometry boundary data

&n, print data note file

&s, read repair list for step surfaces

&x, scale x in surfaces

&y, scale y in surfaces

&z, scale z in surfaces

****
Data Record Description:
****

There are no data records for this processor.

****
Discussion
****

If this processor does not precede analysis processors, a nogo error flag is set. This logic permits the code to check the analysis processor inputs without doing lengthy calculations.

Data required in the data base but not supplied by the user are defaulted. Specifically:

No user materials, default three materials, 1 is aluminum at 2.7 gm/cc, 2 is silicon at 2.4 gm/cc , and 3 is water at 1.0 gm/cc

No user geometry, default a solid aluminum sphere of radius 0.5 cm centered at the origin

No user detectors, default a point detector at the origin

No user sources, default a point source at the origin (ignored for adjoint runs)

No user spectra, default a a geosynchronous electron spectrum (one year at 160 degrees west), and an anomalously large solar flare spectrum

No user responses, default deposition in every material

The *EXECUTE line produces a number of tables unless the *PRINT processor is used to eliminate these outputs.

++++++++++++
Output Tables
++++++++++++

The first table gives the composition and densities of the materials used in the problem description. The format of this table is shown in Table 50 (EXEMAT).

The next three tables summarize the geometry description. First quadric surface coefficients are listed as exemplified by Table 51 (EXESUR).

Next the body definitions are listed. These definitions include a list of the surfaces bounding the body and the coordinates of a point in the body as shown in Table 52 (EXEBOD).

The final geometry table contains region information including material composition and density, body index, and point-in-region coordinates as shown in Table 53 (EXEREG).

The next two tables also present geometry information. The first of these tables gives information on radiation sources as shown in Table 54 (EXESOU).

The second of these tables summarizes geometric information for detectors as indicated by Table 55 (EXEDET).

If the L-option was selected, summary information is then produced during the conversion of ASCII cross section files to binary files. A typical output for the LM-options is given in Table 56 (EXELIB).

After the source and detector description tables, particle spectrum tables are output with the format indicated in Table 57 (EXESPE).

The spectrum tables are followed by user supplied response functions with the format of Table 58 (EXERES).

The remainder of outputs give cross section information for particles defined in the users problems. Each of these cross section outputs are preceeded by a table giving information on the energy group structure, e.g., the information in Table 59 (EXEENE).

Typical cross information produced for neutrons and gamma rays is indicated in Table 60 (EXEMUL).

Summary cross sections produced for photons are indicated in Table 61 (EXEPHO).

Electron summary information includes range and stopping power as indicated in Table 62 (EXEELE).

Typical summary output cross sections for protons are indicated in Table 63 (EXEPRO).

Output for heavier ions is given in Table 64 (EXEHEV).

Table 50: (EXEMAT) Material Compositions

```
UNIT  12 OPENED JUMP.DAT

UNIT  12 CLOSED , STATUS = DEL

MATERIALS-----------------------------------------------------------------

MATERIAL  1,         PU02,   9.2970E+00 GRAMS/CC
   ELEMENT                 Z           A       GM/CC  ATMS/BN*CM  ELEC/BN*CM
 O , OXYGEN        8.0000E+00  1.5999E+01  1.0668E+00  4.0175E-02  3.2140E-01
 PU, PLUTONIUM     9.4000E+01  2.4200E+02  8.2302E+00  2.0490E-02  1.9261E+00
                                              TOTALS  6.0665E-02  2.2475E+00

MATERIAL  2,      IRIDIUM,   2.2420E+01 GRAMS/CC
   ELEMENT                 Z           A       GM/CC  ATMS/BN*CM  ELEC/BN*CM
 PT, PLATINUM      7.8000E+01  1.9509E+02  2.2420E+01  6.9240E-02  5.4007E+00

MATERIAL  3,       CARBON,   1.8000E+00 GRAMS/CC
   ELEMENT                 Z           A       GM/CC  ATMS/BN*CM  ELEC/BN*CM
 C , CARBON        6.0000E+00  1.2011E+01  1.8000E+00  9.0292E-02  5.4175E-01

MATERIAL  4,     ALUMINUM,   2.7000E+00 GRAMS/CC
   ELEMENT                 Z           A       GM/CC  ATMS/BN*CM  ELEC/BN*CM
 AL, ALUMINUM      1.3000E+01  2.6982E+01  2.7000E+00  6.0290E-02  7.8377E-01

MATERIAL  5,    CONVERTER,   1.6762E+00 GRAMS/CC
   ELEMENT                 Z           A       GM/CC  ATMS/BN*CM  ELEC/BN*CM
 BE, BERYLLIUM     4.0000E+00  9.0120E+00  1.2700E-01  8.4906E-03  3.3962E-02
 O , OXYGEN        8.0000E+00  1.5999E+01  1.3440E-01  5.0613E-03  4.0491E-02
 AL, ALUMINUM      1.3000E+01  2.6982E+01  3.4500E-02  7.7037E-04  1.0015E-02
 SI, SILICON       1.4000E+01  2.8086E+01  2.7670E-01  5.9358E-03  8.3101E-02
 FE, IRON          2.6000E+01  5.5847E+01  8.6700E-02  9.3535E-04  2.4319E-02
 CU, COPPER        2.9000E+01  6.3510E+01  5.1950E-01  4.9283E-03  1.4292E-01
 MO, MOLYBDENUM    4.2000E+01  9.5940E+01  4.9745E-01  3.1240E-03  1.3121E-01
                                              TOTALS  2.9246E-02  4.6602E-01
```

Table 51: (EXESUR) Quadric Surface Coefficients

SURFACES----------

INDEX	BODY	A0	A1*X A4*X*X A7*X*Y	A2*Y A5*Y*Y A8*Y*Z	A3*Z A6*Z*Z A9*Z*X
1	248	1.3338E+00	-1.7171E+00	0.0000E+00	0.0000E+00
		XX, YY, ZZ	3.6518E-01	0.0000E+00	3.6518E-01
2	249	1.2317E+00	-1.6528E+00	0.0000E+00	0.0000E+00
		XX, YY, ZZ	3.5152E-01	0.0000E+00	3.5152E-01
3	250	1.1282E+00	-1.5891E+00	0.0000E+00	0.0000E+00
		XX, YY, ZZ	3.3795E-01	0.0000E+00	3.3795E-01
4	251	9.3520E-01	0.0000E+00	1.0000E+00	
5	252	8.4975E-01	0.0000E+00	1.0000E+00	
6	253	8.4075E-01	0.0000E+00	1.0000E+00	
7	254	3.7033E+00	0.0000E+00	1.0000E+00	
8	255	3.7887E+00	0.0000E+00	1.0000E+00	
9	256	3.7977E+00	0.0000E+00	1.0000E+00	
10	257	4.6385E+00	0.0000E+00	1.0000E+00	
11	258	-4.6385E+00	0.0000E+00	1.0000E+00	
12	259	-4.7020E+00	1.0000E+00		
13	260	4.7020E+00	1.0000E+00		
14	261	2.5733E+00	0.0000E+00	0.0000E+00	1.0000E+00
15	262	-2.5733E+00	0.0000E+00	0.0000E+00	1.0000E+00
16	263	3.7033E+00	0.0000E+00	-1.0000E+00	
17	264	9.3520E-01	0.0000E+00	-1.0000E+00	
18	265	8.4975E-01	0.0000E+00	-1.0000E+00	
19	266	3.7887E+00	0.0000E+00	-1.0000E+00	
20	267	8.4075E-01	0.0000E+00	-1.0000E+00	
21	268	3.7977E+00	0.0000E+00	-1.0000E+00	
22	269	1.3338E+00	1.7171E+00	0.0000E+00	0.0000E+00
		XX, YY, ZZ	3.6518E-01	0.0000E+00	3.6518E-01
23	270	1.2317E+00	1.6528E+00	0.0000E+00	0.0000E+00
		XX, YY, ZZ	3.5152E-01	0.0000E+00	3.5152E-01
24	271	1.1282E+00	1.5891E+00	0.0000E+00	0.0000E+00
		XX, YY, ZZ	3.3795E-01	0.0000E+00	3.3795E-01
25	272	1.1006E+01	-1.7171E+00	0.0000E+00	-3.7588E+00
		XX, YY, ZZ	3.6518E-01	0.0000E+00	3.6518E-01
26	273	1.1006E+01	1.7171E+00	0.0000E+00	-3.7588E+00
		XX, YY, ZZ	3.6518E-01	0.0000E+00	3.6518E-01
27	274	1.0542E+01	-1.6528E+00	0.0000E+00	-3.6182E+00
		XX, YY, ZZ	3.5152E-01	0.0000E+00	3.5152E-01
28	275	1.0079E+01	-1.5891E+00	0.0000E+00	-3.4785E+00
		XX, YY, ZZ	3.3795E-01	0.0000E+00	3.3795E-01
29	276	1.0542E+01	1.6528E+00	0.0000E+00	-3.6182E+00
		XX, YY, ZZ	3.5152E-01	0.0000E+00	3.5152E-01
30	277	1.0079E+01	1.5891E+00	0.0000E+00	-3.4785E+00
		XX, YY, ZZ	3.3795E-01	0.0000E+00	3.3795E-01
31	278	4.0023E+01	-1.7171E+00	0.0000E+00	-7.5175E+00
		XX, YY, ZZ	3.6518E-01	0.0000E+00	3.6518E-01
32	279	4.0023E+01	1.7171E+00	0.0000E+00	-7.5175E+00
		XX, YY, ZZ	3.6518E-01	0.0000E+00	3.6518E-01

Table 52: (EXEBOD) Intersected Body List/Logic

BODIES----------
INDEX LEVEL, LIST: SURFACES IF LEVEL=0, BODIES IF LEVEL > 0

1	0,	1	4	-7
2	0,	2	5	-8
3	0,	3	6	-9
4	0,	1	-16	17
5	0,	2	18	-19
6	0,	3	20	-21
7	0,	4	-7	22
8	0,	-16	17	22
9	0,	5	-8	23
10	0,	6	-9	24
11	0,	18	-19	23
12	0,	20	-21	24
13	0,	4	-7	25
14	0,	-16	17	25
15	0,	4	-7	26
16	0,	-16	17	26
17	0,	5	-8	27
18	0,	6	-9	28
19	0,	18	-19	27
20	0,	20	-21	28
21	0,	5	-8	29
22	0,	6	-9	30
23	0,	18	-19	29
24	0,	20	-21	30
25	0,	4	-7	31
26	0,	-16	17	31
27	0,	4	-7	32
28	0,	-16	17	32
29	0,	4	-7	33
30	0,	-16	17	33
31	0,	4	-7	34
32	0,	-16	17	34
33	0,	5	-8	35
34	0,	6	-9	36
35	0,	18	-19	35
36	0,	20	-21	36
37	0,	5	-8	37
38	0,	6	-9	38
39	0,	18	-19	37
40	0,	20	-21	38
41	0,	5	-8	39
42	0,	6	-9	40
43	0,	18	-19	39
44	0,	20	-21	40
45	0,	5	-8	41
46	0,	6	-9	42
47	0,	18	-19	41
48	0,	20	-21	42

Table 53: (EXEREG) Material Region Definitions

ADDING SURFACES TO BODY LIST
CHECKING POINT IN REGION(S) FOR CONSISTENCY
MAKING UP CONTAINED_BY LIST
CHECKING MATERIAL INDICES AND DENSITY

REGIONS----------

INDEX	BODY	MTL	GMS/CC	X	Y	Z	IN	CONTAINED LIST
1	1	1	9.30E+00	2.30E+00	-1.00E+00	0.00E+00	2	
2	2	0	0.00E+00	9.60E-01	-2.30E+00	0.00E+00	3	1
3	3	2	2.24E+01	9.00E-01	-2.30E+00	0.00E+00	217	2
4	4	1	9.30E+00	2.30E+00	1.00E+00	0.00E+00	5	
5	5	0	0.00E+00	9.60E-01	2.30E+00	0.00E+00	6	4
6	6	2	2.24E+01	9.00E-01	2.30E+00	0.00E+00	217	5
7	7	1	9.30E+00	-2.30E+00	-1.00E+00	0.00E+00	8	
8	9	0	0.00E+00	-9.60E-01	-2.30E+00	0.00E+00	9	7
9	10	2	2.24E+01	-9.00E-01	-2.30E+00	0.00E+00	217	8
10	8	1	9.30E+00	-2.30E+00	1.00E+00	0.00E+00	11	
11	11	0	0.00E+00	-9.60E-01	2.30E+00	0.00E+00	12	10
12	12	2	2.24E+01	-9.00E-01	2.30E+00	0.00E+00	217	11
13	13	1	9.30E+00	2.30E+00	-1.00E+00	5.15E+00	14	
14	17	0	0.00E+00	9.60E-01	-2.30E+00	5.15E+00	15	13
15	18	2	2.24E+01	9.00E-01	-2.30E+00	5.15E+00	218	14
16	14	1	9.30E+00	2.30E+00	1.00E+00	5.15E+00	17	
17	19	0	0.00E+00	9.60E-01	2.30E+00	5.15E+00	18	16
18	20	2	2.24E+01	9.00E-01	2.30E+00	5.15E+00	218	17
19	15	1	9.30E+00	-2.30E+00	-1.00E+00	5.15E+00	20	
20	21	0	0.00E+00	-9.60E-01	-2.30E+00	5.15E+00	21	19
21	22	2	2.24E+01	-9.00E-01	-2.30E+00	5.15E+00	218	20
22	16	1	9.30E+00	-2.30E+00	1.00E+00	5.15E+00	23	
23	23	0	0.00E+00	-9.60E-01	2.30E+00	5.15E+00	24	22
24	24	2	2.24E+01	-9.00E-01	2.30E+00	5.15E+00	218	23
25	25	1	9.30E+00	2.30E+00	-1.00E+00	1.03E+01	26	
26	33	0	0.00E+00	9.60E-01	-2.30E+00	1.03E+01	27	25
27	34	2	2.24E+01	9.00E-01	-2.30E+00	1.03E+01	219	26
28	26	1	9.30E+00	2.30E+00	1.00E+00	1.03E+01	29	
29	35	0	0.00E+00	9.60E-01	2.30E+00	1.03E+01	30	28
30	36	2	2.24E+01	9.00E-01	2.30E+00	1.03E+01	219	29
31	27	1	9.30E+00	-2.30E+00	-1.00E+00	1.03E+01	32	
32	37	0	0.00E+00	-9.60E-01	-2.30E+00	1.03E+01	33	31
33	38	2	2.24E+01	-9.00E-01	-2.30E+00	1.03E+01	219	32
34	28	1	9.30E+00	-2.30E+00	1.00E+00	1.03E+01	35	
35	39	0	0.00E+00	-9.60E-01	2.30E+00	1.03E+01	36	34
36	40	2	2.24E+01	-9.00E-01	2.30E+00	1.03E+01	219	35
37	29	1	9.30E+00	2.30E+00	-1.00E+00	1.54E+01	38	
38	41	0	0.00E+00	9.60E-01	-2.30E+00	1.54E+01	39	37
39	42	2	2.24E+01	9.00E-01	-2.30E+00	1.54E+01	220	38
40	30	1	9.30E+00	2.30E+00	1.00E+00	1.54E+01	41	
41	43	0	0.00E+00	9.60E-01	2.30E+00	1.54E+01	42	40

Table 54: (EXESOU) Particle Source Definitions

```
SOURCES-----------------------------------------------------------------------

----------  SOURCE NUMBER   1,       SINGLE, GEOMETRY = CYLINDRICAL ----------
USER O:  2.35E+00 -2.32E+00  0.00E+00, CODE O:  2.35E+00 -2.32E+00  0.00E+00
USER+Z:   .000000   .000000  1.000000, CODE+Z:   .000000   .000000  1.000000

CODE VARIABLE 1, V1, IS USER R = SQRT(USER Z**2 + USER X**2)

INDEX         V1     F(V1)    F(<V1)    F(@V1)     STRAT     F MOD     W MOD
    1  0.000E+00 1.067E+00 0.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E+00
    2  1.369E+00 1.067E+00 1.000E+00

CODE VARIABLE 2, V2, IS USER AZIMUTH FROM USER Z-AXIS TOWARDS USER X-AXIS

INDEX         V2     F(V2)    F(<V2)    F(@V2)     STRAT     F MOD     W MOD
    1 -3.142E+00 1.592E-01 0.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E+00
    2  3.142E+00 1.592E-01 1.000E+00

CODE VARIABLE 3, V3, IS USER Y

INDEX         V3     F(V3)    F(<V3)    F(@V3)     STRAT     F MOD     W MOD
    1 -1.384E+00 3.613E-01 0.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E+00
    2  1.384E+00 3.613E-01 1.000E+00

CODE VARIABLE 4, V4, IS ANGULAR AZIMUTH FROM USER Z-AXIS TOWARDS USER X-AXIS

INDEX         V4     F(V4)    F(<V4)    F(@V4)     STRAT     F MOD     W MOD
    1 -3.142E+00 1.592E-01 0.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E+00
    2  3.142E+00 1.592E-01 1.000E+00

CODE VARIABLE 5, V5, IS ANGULAR POLAR ANGLE COSINE = +-1 ON USER +-Y AXIS

INDEX         V5     F(V5)    F(<V5)    F(@V5)     STRAT     F MOD     W MOD
    1 -1.000E+00 5.000E-01 0.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E+00
    2  1.000E+00 5.000E-01 1.000E+00

CODE VARIABLE 6, V6, IS TIME

INDEX         V6     F(V6)    F(<V6)    F(@V6)     STRAT     F MOD     W MOD
    1  0.000E+00 1.000E+00 0.000E+00

  SOURCE NUMBER   1 IS BODY     1 AND IS IN REGION(S)    1

----------  SOURCE NUMBER   2,       SINGLE, GEOMETRY = CYLINDRICAL ----------
USER O:  2.35E+00 -2.32E+00  0.00E+00, CODE O:  2.35E+00  2.32E+00  0.00E+00
USER+Z:   .000000   .000000  1.000000, CODE+Z:   .000000   .000000  1.000000
   SEE SOURCE   1 FOR DISTRIBUTION INFORMATION

  SOURCE NUMBER   2 IS BODY     4 AND IS IN REGION(S)    4

----------  SOURCE NUMBER   3,       SINGLE, GEOMETRY = CYLINDRICAL ----------
```

Table 55: (EXEDET) Particle Detector Definitions

```
DETECTORS-----------------------------------------------------------------------

----------DETECTOR NUMBER   1,      1 METER, GEOMETRY = POINT       ----------
USER O:  0.00E+00  0.00E+00  1.00E+02, CODE O:  0.00E+00  0.00E+00  1.96E+02
USER+Z:   .000000   .000000  1.000000, CODE+Z:   .000000   .000000  1.000000

DETECTOR NUMBER   1 IS BODY     0 AND IS IN REGION(S)  248

----------DETECTOR NUMBER   2,      2 METER, GEOMETRY = POINT       ----------
USER O:  0.00E+00  0.00E+00  2.00E+02, CODE O:  0.00E+00  0.00E+00  2.96E+02
USER+Z:   .000000   .000000  1.000000, CODE+Z:   .000000   .000000  1.000000

DETECTOR NUMBER   2 IS BODY     0 AND IS IN REGION(S)  248

----------DETECTOR NUMBER   3,      3 METER, GEOMETRY = POINT       ----------
USER O:  0.00E+00  0.00E+00  3.00E+02, CODE O:  0.00E+00  0.00E+00  3.96E+02
USER+Z:   .000000   .000000  1.000000, CODE+Z:   .000000   .000000  1.000000

DETECTOR NUMBER   3 IS BODY     0 AND IS IN REGION(S)  248

REGION  248 CONTAINS DETECTOR(S)   1   2   3
```

Table 56: (EXELIB) Multigroup Library Creation

```
DETECTOR NUMBER   1 IS BODY     0 AND IS IN REGION(S)    1

REGION    1 CONTAINS DETECTOR(S)   1

NON EXISTANT FILE: DLC31.DAT

UNIT  10 OPENED MLIBE.DAT

LIBRARY*************************************************************************
    1 OLD   1.960E+01  1.690E+01  1.490E+01  1.420E+01  1.380E+01  1.280E+01
    :
   55 OLD   7.000E-02  4.500E-02  3.000E-02  2.000E-02
    1 OLX   1.690E+01  1.490E+01  1.420E+01  1.380E+01  1.280E+01  1.220E+01
    7 OLX   1.110E+01  1.000E+01  9.050E+00  8.190E+00  7.410E+00  6.380E+00
    :
   55 OLX   4.500E-02  3.000E-02  2.000E-02  1.000E-02
    1 ELM   1.960E+01  1.690E+01  1.490E+01  1.420E+01  1.380E+01  1.280E+01
    7 ELM   1.220E+01  1.110E+01  1.000E+01  9.050E+00  8.190E+00  7.410E+00
    :
   55 ELM   7.000E-02  4.500E-02  3.000E-02  2.000E-02
    1 EXM   1.690E+01  1.490E+01  1.420E+01  1.380E+01  1.280E+01  1.220E+01
    7 EXM   1.110E+01  1.000E+01  9.050E+00  8.190E+00  7.410E+00  6.380E+00
    :
   55 EXM   4.500E-02  3.000E-02  2.000E-02  1.000E-02
    1 WGT   1.000E+00  1.000E+00  1.000E+00  1.000E+00  1.000E+00  1.000E+00
    1 GRP           1          2          3          4          5          6
    7 GRP           7          8          9         10         11         12
    :
   55 GRP          55         56         57         58
    1 MATRIX
    2 MATRIX
    3 MATRIX
    4 MATRIX
    5 MATRIX
    6 MATRIX
    7 MATRIX
    8 MATRIX
    9 MATRIX
   10 MATRIX
    :
  169 MATRIX

UNIT  10 CLOSED , STATUS = KEEP

UNIT  30 CLOSED , STATUS = KEEP

PARTICLES-----------------------------------------------------------------------
 THE       PHOTON DATA BASE CONTAINS   0 SPECTRA AND   2 USER RESPONSES
 THE     ELECTRON DATA BASE CONTAINS   1 SPECTRA AND   2 USER RESPONSES
```

Table 57: (EXESPE) Particle Spectra Tabulations

PARTICLES----------

THE NEUTRON DATA BASE CONTAINS 1 SPECTRA AND 2 USER RESPONSES
THE GAMMA DATA BASE CONTAINS 0 SPECTRA AND 2 USER RESPONSES

SPECTRA----------

NEUTRON, SPECTRUM 1, NEUTRON-RTG

GROUP	E-MAX	E-MIN	#/MEV	#/GRP	# SUM	E/MEV	E/GRP	E SUM
1	1.96E+01	1.69E+01	1.15E-06	3.12E-06	3.12E-06	2.05E-05	5.54E-05	5.54E-05
2	1.69E+01	1.49E+01	7.61E-06	1.52E-05	1.83E-05	1.19E-04	2.38E-04	2.93E-04
3	1.49E+01	1.42E+01	2.10E-05	1.47E-05	3.30E-05	3.04E-04	2.13E-04	5.06E-04
4	1.42E+01	1.38E+01	3.28E-05	1.31E-05	4.61E-05	4.59E-04	1.84E-04	6.90E-04
5	1.38E+01	1.28E+01	6.04E-05	6.04E-05	1.07E-04	7.99E-04	7.99E-04	1.49E-03
6	1.28E+01	1.22E+01	1.14E-04	6.86E-05	1.75E-04	1.43E-03	8.56E-04	2.34E-03
7	1.22E+01	1.11E+01	2.36E-04	2.59E-04	4.34E-04	2.73E-03	3.00E-03	5.35E-03
8	1.11E+01	1.00E+01	5.73E-04	6.31E-04	1.07E-03	6.00E-03	6.60E-03	1.19E-02
9	1.00E+01	9.05E+00	1.28E-03	1.22E-03	2.29E-03	1.22E-02	1.16E-02	2.35E-02
10	9.05E+00	8.19E+00	2.60E-03	2.23E-03	4.52E-03	2.23E-02	1.92E-02	4.27E-02
11	8.19E+00	7.41E+00	4.87E-03	3.80E-03	8.32E-03	3.78E-02	2.95E-02	7.21E-02
12	7.41E+00	6.38E+00	9.77E-03	1.01E-02	1.84E-02	6.67E-02	6.88E-02	1.41E-01
13	6.38E+00	4.97E+00	2.44E-02	3.44E-02	5.28E-02	1.36E-01	1.91E-01	3.32E-01
14	4.97E+00	4.72E+00	4.18E-02	1.05E-02	6.32E-02	2.02E-01	5.06E-02	3.83E-01
15	4.72E+00	4.07E+00	5.73E-02	3.72E-02	1.00E-01	2.50E-01	1.63E-01	5.45E-01
16	4.07E+00	3.01E+00	1.01E-01	1.07E-01	2.08E-01	3.52E-01	3.74E-01	9.19E-01
17	3.01E+00	2.39E+00	1.65E-01	1.03E-01	3.10E-01	4.44E-01	2.75E-01	1.19E+00
18	2.39E+00	2.31E+00	2.00E-01	1.60E-02	3.26E-01	4.70E-01	3.76E-02	1.23E+00
19	2.31E+00	1.83E+00	2.31E-01	1.11E-01	4.37E-01	4.76E-01	2.29E-01	1.46E+00
20	1.83E+00	1.11E+00	3.00E-01	2.16E-01	6.53E-01	4.37E-01	3.14E-01	1.77E+00
21	1.11E+00	5.50E-01	3.52E-01	1.97E-01	8.50E-01	2.91E-01	1.63E-01	1.94E+00
22	5.50E-01	1.58E-01	3.13E-01	1.23E-01	9.73E-01	1.14E-01	4.47E-02	1.98E+00
23	1.58E-01	1.11E-01	2.30E-01	1.08E-02	9.84E-01	3.10E-02	1.46E-03	1.98E+00
24	1.11E-01	5.25E-02	1.84E-01	1.08E-02	9.95E-01	1.54E-02	8.98E-04	1.98E+00
25	5.25E-02	2.48E-02	1.30E-01	3.61E-03	9.98E-01	5.14E-03	1.43E-04	1.98E+00
26	2.48E-02	2.19E-02	1.03E-01	2.99E-04	9.99E-01	2.41E-03	6.99E-06	1.98E+00
27	2.19E-02	1.03E-02	8.54E-02	9.91E-04	1.00E+00	1.41E-03	1.63E-05	1.98E+00
28	1.03E-02	3.35E-03	5.56E-02	3.86E-04	1.00E+00	3.96E-04	2.75E-06	1.98E+00
29	3.35E-03	1.23E-03	3.24E-02	6.86E-05	1.00E+00	7.69E-05	1.63E-07	1.98E+00
30	1.23E-03	5.83E-04	2.05E-02	1.33E-05	1.00E+00	1.90E-05	1.23E-08	1.98E+00
31	5.83E-04	1.01E-04	1.23E-02	5.93E-06	1.00E+00	4.59E-06	2.21E-09	1.98E+00
32	1.01E-04	2.90E-05	5.43E-03	3.91E-07	1.00E+00	3.72E-07	2.68E-11	1.98E+00
33	2.90E-05	1.07E-05	3.02E-03	5.52E-08	1.00E+00	6.21E-08	1.14E-12	1.98E+00
34	1.07E-05	3.06E-06	1.77E-03	1.35E-08	1.00E+00	1.28E-08	9.79E-14	1.98E+00

RESPONSES----------

NEUTRON, RESPONSE 1, NUMBER FLUX
NEUTRON, RESPONSE 2, ENERGY FLUX
GAMMA, RESPONSE 3, NUMBER FLUX
GAMMA, RESPONSE 4, ENERGY FLUX

Table 58: (EXERES) Particle Response Tabulations

RESPONSES----------

PROTON, RESPONSE 1, REM_H2O

INDEX	ENERGY	PER PARTICLE	PER UNIT ENERGY
1	1.0000E+04	3.4587E-08	3.4587E-12
2	7.9433E+03	3.4005E-08	4.2810E-12
3	6.3096E+03	3.3471E-08	5.3047E-12
4	5.0119E+03	3.3009E-08	6.5862E-12
5	3.9811E+03	3.2654E-08	8.2024E-12
6	3.1623E+03	3.2447E-08	1.0261E-11
7	2.5119E+03	3.2438E-08	1.2914E-11
8	1.9953E+03	3.2689E-08	1.6383E-11
9	1.5849E+03	3.3272E-08	2.0993E-11
10	1.2589E+03	3.4269E-08	2.7221E-11
11	1.0000E+03	3.5777E-08	3.5777E-11
12	7.9433E+02	3.7906E-08	4.7721E-11
13	6.3096E+02	4.0702E-08	6.4509E-11
14	5.0119E+02	4.4424E-08	8.8637E-11
15	3.9811E+02	4.9254E-08	1.2372E-10
16	3.1623E+02	5.5419E-08	1.7525E-10
17	2.5119E+02	6.3191E-08	2.5157E-10
18	1.9953E+02	7.2904E-08	3.6539E-10
19	1.5849E+02	8.4964E-08	5.3609E-10
20	1.2589E+02	9.9862E-08	7.9324E-10
21	1.0000E+02	1.1820E-07	1.1820E-09
22	7.9433E+01	1.4069E-07	1.7712E-09
23	6.3096E+01	1.6822E-07	2.6661E-09
24	5.0119E+01	2.0182E-07	4.0269E-09
25	3.9811E+01	2.4276E-07	6.0979E-09
26	3.1623E+01	2.9254E-07	9.2509E-09
27	2.5119E+01	3.5294E-07	1.4051E-08
28	1.9953E+01	4.2611E-07	2.1356E-08
:			
41	1.0000E+00	2.4278E-05	2.4278E-05
42	7.9433E-01	3.2418E-05	4.0812E-05
43	6.3096E-01	4.2774E-05	6.7792E-05
44	5.0119E-01	5.5579E-05	1.1090E-04
45	3.9811E-01	7.0817E-05	1.7789E-04
46	3.1623E-01	8.8042E-05	2.7841E-04
47	2.5119E-01	1.0619E-04	4.2276E-04
48	1.9953E-01	1.2346E-04	6.1879E-04
49	1.5849E-01	1.3733E-04	8.6649E-04
50	1.2589E-01	1.4477E-04	1.1499E-03
51	1.0000E-01	1.4277E-04	1.4277E-03

PROTON, RESPONSE 2, NUMBER FLUX

PROTON, RESPONSE 3, ENERGY FLUX

Table 59: (EXEENE) Particle E Group Parameters

UNIT 10 OPENED D:LPSDATMLIBE.DAT

MULTIGROUP----------

ENERGY CONSTANTS FOR A PARTICLE WITH REST ENERGY 9.3955E+02 MEV

GROUP	EMAX	EMIN	EDEL	EAVE	VEL
1	1.9600E+01	1.6900E+01	2.7000E+00	1.8250E+01	5.8284E+09
2	1.6900E+01	1.4900E+01	2.0000E+00	1.5900E+01	5.4503E+09
3	1.4900E+01	1.4200E+01	7.0000E-01	1.4550E+01	5.2193E+09
4	1.4200E+01	1.3800E+01	4.0000E-01	1.4000E+01	5.1219E+09
5	1.3800E+01	1.2800E+01	1.0000E+00	1.3300E+01	4.9949E+09
6	1.2800E+01	1.2200E+01	6.0000E-01	1.2500E+01	4.8454E+09
7	1.2200E+01	1.1100E+01	1.1000E+00	1.1650E+01	4.6809E+09
8	1.1100E+01	1.0000E+01	1.1000E+00	1.0550E+01	4.4583E+09
9	1.0000E+01	9.0500E+00	9.5000E-01	9.5250E+00	4.2396E+09
10	9.0500E+00	8.1900E+00	8.6000E-01	8.6200E+00	4.0361E+09
11	8.1900E+00	7.4100E+00	7.8000E-01	7.8000E+00	3.8418E+09
12	7.4100E+00	6.3800E+00	1.0300E+00	6.8950E+00	3.6146E+09
13	6.3800E+00	4.9700E+00	1.4100E+00	5.6750E+00	3.2825E+09
14	4.9700E+00	4.7200E+00	2.5000E-01	4.8450E+00	3.0349E+09
15	4.7200E+00	4.0700E+00	6.5000E-01	4.3950E+00	2.8916E+09
16	4.0700E+00	3.0100E+00	1.0600E+00	3.5400E+00	2.5969E+09
17	3.0100E+00	2.3900E+00	6.2000E-01	2.7000E+00	2.2695E+09
18	2.3900E+00	2.3100E+00	8.0000E-02	2.3500E+00	2.1179E+09
19	2.3100E+00	1.8300E+00	4.8000E-01	2.0700E+00	1.9881E+09
20	1.8300E+00	1.1100E+00	7.2000E-01	1.4700E+00	1.6762E+09
:					
34	1.0700E-05	3.0600E-06	7.6400E-06	6.8800E-06	3.6305E+06
35	3.0600E-06	1.1300E-06	1.9300E-06	2.0950E-06	2.0034E+06
36	1.1300E-06	4.1400E-07	7.1600E-07	7.7200E-07	1.2161E+06
37	4.1400E-07	1.0000E-12	4.1400E-07	2.0700E-07	6.2974E+05

ENERGY CONSTANTS FOR A PARTICLE WITH REST ENERGY 0.0000E+00 MEV

GROUP	EMAX	EMIN	EDEL	EAVE	VEL
1	1.4000E+01	1.0000E+01	4.0000E+00	1.2000E+01	3.0000E+10
2	1.0000E+01	8.0000E+00	2.0000E+00	9.0000E+00	3.0000E+10
3	8.0000E+00	7.0000E+00	1.0000E+00	7.5000E+00	3.0000E+10
4	7.0000E+00	6.0000E+00	1.0000E+00	6.5000E+00	3.0000E+10
5	6.0000E+00	5.0000E+00	1.0000E+00	5.5000E+00	3.0000E+10
:					
16	1.5000E-01	1.0000E-01	5.0000E-02	1.2500E-01	3.0000E+10
17	1.0000E-01	7.0000E-02	3.0000E-02	8.5000E-02	3.0000E+10
18	7.0000E-02	4.5000E-02	2.5000E-02	5.7500E-02	3.0000E+10
19	4.5000E-02	3.0000E-02	1.5000E-02	3.7500E-02	3.0000E+10
20	3.0000E-02	2.0000E-02	1.0000E-02	2.5000E-02	3.0000E+10
21	2.0000E-02	1.0000E-02	1.0000E-02	1.5000E-02	3.0000E+10

Table 60: (EXEMUL) Summary Xsects, Neutron/Gamma

```
USING       5 MULTIGROUP LIBRARY DATA FOR MATERIAL   5, 1000*Z+A=     4009.01
USING       8 MULTIGROUP LIBRARY DATA FOR MATERIAL   3, 1000*Z+A=     6012.01
USING      11 MULTIGROUP LIBRARY DATA FOR MATERIAL   1, 1000*Z+A=     8016.00
USING      11 MULTIGROUP LIBRARY DATA FOR MATERIAL   5, 1000*Z+A=     8016.00
USING      16 MULTIGROUP LIBRARY DATA FOR MATERIAL   4, 1000*Z+A=    13026.98
USING      16 MULTIGROUP LIBRARY DATA FOR MATERIAL   5, 1000*Z+A=    13026.98
USING      17 MULTIGROUP LIBRARY DATA FOR MATERIAL   5, 1000*Z+A=    14028.09
USING      24 MULTIGROUP LIBRARY DATA FOR MATERIAL   5, 1000*Z+A=    26055.85
USING      26 MULTIGROUP LIBRARY DATA FOR MATERIAL   5, 1000*Z+A=    29063.51
USING      27 MULTIGROUP LIBRARY DATA FOR MATERIAL   5, 1000*Z+A=    42095.94
USING      33 MULTIGROUP LIBRARY DATA FOR MATERIAL   2, 1000*Z+A=    78195.09
USING      37 MULTIGROUP LIBRARY DATA FOR MATERIAL   1, 1000*Z+A=    94242.00

     NEUTRON AND       GAMMA TRANSPORT IN         PU02

GROUP    E-MAX    E-MIN    TOTAL   MEV/CM    P0 IN    P1 IN  TRNSPRT   IN GRP
                                             P0 TOT   P1 TOT   LAMBDA      ETA
    1 1.96E+01 1.69E+01 1.92E-01 1.37E+00 1.06E-01 9.10E-01 9.62E-02 9.48E-03
                                          1.50E-01 6.55E-01 9.14E-02 2.59E-02
    2 1.69E+01 1.49E+01 1.91E-01 1.22E+00 9.82E-02 8.98E-01 1.03E-01 1.00E-02
                                          1.48E-01 6.13E-01 9.78E-02 2.56E-02
    3 1.49E+01 1.42E+01 1.93E-01 1.10E+00 9.30E-02 9.11E-01 1.09E-01 8.29E-03
                                          1.48E-01 6.15E-01 1.04E-01 1.99E-02
    4 1.42E+01 1.38E+01 1.91E-01 1.05E+00 8.37E-02 9.22E-01 1.14E-01 6.54E-03
                                          1.45E-01 6.08E-01 1.10E-01 1.48E-02
    5 1.38E+01 1.28E+01 1.89E-01 9.77E-01 9.30E-02 8.98E-01 1.06E-01 9.44E-03
                                          1.43E-01 6.11E-01 1.01E-01 2.34E-02
    6 1.28E+01 1.22E+01 1.87E-01 8.51E-01 9.13E-02 9.01E-01 1.04E-01 9.04E-03
                                          1.42E-01 6.14E-01 9.97E-02 2.27E-02
    7 1.22E+01 1.11E+01 1.91E-01 8.24E-01 9.58E-02 8.80E-01 1.07E-01 1.15E-02
                                          1.45E-01 5.75E-01 1.01E-01 2.86E-02
    8 1.11E+01 1.00E+01 1.78E-01 7.14E-01 8.90E-02 8.69E-01 1.00E-01 1.17E-02
                                          1.33E-01 5.66E-01 9.43E-02 3.09E-02
    9 1.00E+01 9.05E+00 1.74E-01 6.38E-01 8.66E-02 8.57E-01 9.97E-02 1.24E-02
                                          1.30E-01 5.56E-01 9.33E-02 3.32E-02
   10 9.05E+00 8.19E+00 1.78E-01 5.95E-01 8.53E-02 8.50E-01 1.05E-01 1.28E-02
                                          1.36E-01 5.12E-01 9.85E-02 3.24E-02
    :
   37 4.14E-07 1.00E-12 5.28E+00 1.07E-06 2.20E-01 3.25E-02 5.27E+00 2.13E-01
                                          2.20E-01 3.25E-02 5.16E+00 1.03E-02
   38 1.40E+01 1.00E+01 4.68E-01 4.84E+00 7.30E-03 9.95E-01 4.61E-01 3.36E-05
                                          8.25E-01 7.00E-02 4.61E-01 5.91E-04
   39 1.00E+01 8.00E+00 4.34E-01 3.20E+00 6.63E-03 9.96E-01 4.28E-01 2.72E-05
                                          7.30E-01 9.38E-02 4.28E-01 7.53E-05
   40 8.00E+00 7.00E+00 4.16E-01 2.46E+00 4.88E-03 9.97E-01 4.12E-01 1.46E-05
                                          6.73E-01 1.13E-01 4.12E-01 1.14E-03
    :
   58 2.00E-02 1.00E-02 7.38E+02 1.11E+01 1.38E+00 3.06E-02 7.38E+02 1.34E+00
                                          1.38E+00 3.06E-02 7.37E+02 4.25E-04
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Table 61: (EXEPHO) Summary Xsects, Photons

UNIT 9 OPENED D:LPSDATXLIBE.DAT
PHOTON----------

ENERGY CONSTANTS FOR A PARTICLE WITH REST ENERGY 0.0000E+00 MEV

GROUP	EMAX	EMIN	EDEL	EAVE	VEL
1	1.0000E+01	7.9433E+00	2.0567E+00	8.9716E+00	3.0000E+10
2	7.9433E+00	6.3096E+00	1.6337E+00	7.1264E+00	3.0000E+10
:					
30	1.2589E-02	1.0000E-02	2.5893E-03	1.1295E-02	3.0000E+10
31	1.0000E-02	7.9433E-03	2.0567E-03	8.9716E-03	3.0000E+10

PHOTON IN ALUMINUM

INDEX	MEV	TOTAL	MU SUB E	COMPTON	PHOTO	PAIR
1	1.0000E+01	6.2427E-02	4.9793E-01	3.9925E-02	2.2706E-06	2.2500E-02
2	7.9433E+00	6.5140E-02	3.9264E-01	4.7128E-02	2.9672E-06	1.8009E-02
3	6.3096E+00	6.9827E-02	3.1765E-01	5.5387E-02	3.8845E-06	1.4437E-02
4	5.0119E+00	7.6370E-02	2.6204E-01	6.4782E-02	5.0887E-06	1.1583E-02
5	3.9811E+00	8.3873E-02	2.1581E-01	7.5380E-02	6.8219E-06	8.4870E-03
6	3.1623E+00	9.2983E-02	1.7900E-01	8.7228E-02	9.1777E-06	5.7456E-03
7	2.5119E+00	1.0369E-01	1.4894E-01	1.0035E-01	1.2705E-05	3.3206E-03
8	1.9953E+00	1.1660E-01	1.2515E-01	1.1476E-01	1.7808E-05	1.8218E-03
9	1.5849E+00	1.3104E-01	1.0470E-01	1.3042E-01	2.6692E-05	5.9266E-04
10	1.2589E+00	1.4735E-01	8.7505E-02	1.4731E-01	4.0063E-05	7.6955E-06
11	1.0000E+00	1.6544E-01	7.2834E-02	1.6538E-01	6.0067E-05	
12	7.9433E-01	1.8470E-01	5.9858E-02	1.8459E-01	1.0975E-04	
13	6.3096E-01	2.0509E-01	4.8572E-02	2.0488E-01	2.0479E-04	
14	5.0119E-01	2.2658E-01	3.8932E-02	2.2620E-01	3.8767E-04	
15	3.9811E-01	2.4918E-01	3.0854E-02	2.4843E-01	7.4776E-04	
16	3.1623E-01	2.7288E-01	2.4227E-02	2.7142E-01	1.4662E-03	
17	2.5119E-01	2.9781E-01	1.8939E-02	2.9490E-01	2.9176E-03	
18	1.9953E-01	3.2435E-01	1.4895E-02	3.1852E-01	5.8318E-03	
19	1.5849E-01	3.5370E-01	1.2062E-02	3.4186E-01	1.1837E-02	
20	1.2589E-01	3.8869E-01	1.0480E-02	3.6445E-01	2.4246E-02	
21	1.0000E-01	4.3563E-01	1.0305E-02	3.8583E-01	4.9803E-02	
22	7.9433E-02	5.0872E-01	1.1943E-02	4.0562E-01	1.0310E-01	
23	6.3096E-02	6.3777E-01	1.6120E-02	4.2357E-01	2.1420E-01	
24	5.0119E-02	8.8518E-01	2.4117E-02	4.3951E-01	4.4567E-01	
25	3.9811E-02	1.3813E+00	3.8142E-02	4.5342E-01	9.2787E-01	
26	3.1623E-02	2.3939E+00	6.1786E-02	4.6537E-01	1.9285E+00	
27	2.5119E-02	4.4666E+00	1.0078E-01	4.7552E-01	3.9911E+00	
28	1.9953E-02	8.7327E+00	1.6493E-01	4.8396E-01	8.2487E+00	
29	1.5849E-02	1.7392E+01	2.6809E-01	4.9103E-01	1.6901E+01	
30	1.2589E-02	3.4785E+01	4.3181E-01	4.9680E-01	3.4289E+01	
31	1.0000E-02	6.9849E+01	6.9357E-01	5.0156E-01	6.9348E+01	
32	7.9433E-03	1.3868E+02	1.1016E+00	5.0536E-01	1.3818E+02	

PHOTON IN SILICON

INDEX	MEV	TOTAL	MU SUB E	COMPTON	PHOTO	PAIR
1	1.0000E+01	5.9129E-02	4.7467E-01	3.6853E-02	2.8685E-06	2.2273E-02
2	7.9433E+00	6.1351E-02	3.7214E-01	4.3503E-02	3.7570E-06	1.7845E-02
:						

Table 62: (EXEELE) Summary Xsects, Electrons

```
UNIT  15 OPENED D:LPSDATPRATHE.DAT

ELECTRON-----------------------------------------------------------------------
  233 ARRAYS,    23071 DATA WORDS

ENERGY CONSTANTS FOR A PARTICLE WITH REST ENERGY     5.1100E-01 MEV
GROUP        EMAX        EMIN        EDEL        EAVE         VEL
    1  1.0000E+01  7.9433E+00  2.0567E+00  8.9716E+00  2.9956E+10
    2  7.9433E+00  6.3096E+00  1.6337E+00  7.1264E+00  2.9933E+10
    :
   30  1.2589E-02  1.0000E-02  2.5893E-03  1.1295E-02  6.2052E+09
   31  1.0000E-02  7.9433E-03  2.0567E-03  8.9716E-03  5.5488E+09
FINISHED STOPPING POWERS FOR ATOMIC NUMBER      13.00
FINISHED BREMSSTRAHLUNG  FOR ATOMIC NUMBER      13.00
FINISHED STOPPING POWERS FOR ATOMIC NUMBER      14.00
FINISHED BREMSSTRAHLUNG  FOR ATOMIC NUMBER      14.00

    ELECTRON IN     ALUMINUM
INDEX      MEV DEDS-TOT DEDS-ADJ DEDS-BRE RANGE-CM A-SPREAD E-SPREAD KNOCK-ON
    1 1.00E+01 5.30E+00 4.44E+00 7.63E-01 2.13E+00 3.42E-01 2.00E-02 1.98E+00
    2 7.94E+00 5.04E+00 4.19E+00 5.83E-01 1.74E+00 5.13E-01 1.59E-02 2.49E+00
    3 6.31E+00 4.83E+00 3.98E+00 4.46E-01 1.41E+00 7.67E-01 1.27E-02 3.14E+00
    4 5.01E+00 4.64E+00 3.80E+00 3.41E-01 1.13E+00 1.14E+00 1.01E-02 3.96E+00
    5 3.98E+00 4.49E+00 3.64E+00 2.61E-01 9.06E-01 1.68E+00 8.05E-03 5.00E+00
    6 3.16E+00 4.35E+00 3.51E+00 1.99E-01 7.21E-01 2.46E+00 6.43E-03 6.32E+00
    7 2.51E+00 4.24E+00 3.40E+00 1.53E-01 5.69E-01 3.58E+00 5.16E-03 8.01E+00
    8 2.00E+00 4.15E+00 3.31E+00 1.11E-01 4.46E-01 5.17E+00 4.15E-03 1.02E+01
    9 1.58E+00 4.09E+00 3.24E+00 8.67E-02 3.47E-01 7.43E+00 3.36E-03 1.30E+01
   10 1.26E+00 4.06E+00 3.20E+00 6.83E-02 2.67E-01 1.06E+01 2.74E-03 1.68E+01
   11 1.00E+00 4.07E+00 3.19E+00 5.48E-02 2.03E-01 1.51E+01 2.25E-03 2.18E+01
   12 7.94E-01 4.11E+00 3.21E+00 4.49E-02 1.53E-01 2.13E+01 1.87E-03 2.86E+01
   13 6.31E-01 4.22E+00 3.27E+00 3.76E-02 1.14E-01 3.02E+01 1.57E-03 3.80E+01
   14 5.01E-01 4.38E+00 3.38E+00 3.22E-02 8.33E-02 4.28E+01 1.34E-03 5.11E+01
   15 3.98E-01 4.61E+00 3.54E+00 2.84E-02 6.03E-02 6.09E+01 1.16E-03 6.99E+01
   16 3.16E-01 4.94E+00 3.76E+00 2.56E-02 4.31E-02 8.70E+01 1.02E-03 9.71E+01
   17 2.51E-01 5.37E+00 4.06E+00 2.37E-02 3.05E-02 1.25E+02 9.13E-04 1.37E+02
   18 2.00E-01 5.93E+00 4.44E+00 2.22E-02 2.13E-02 1.81E+02 8.29E-04 1.96E+02
   19 1.58E-01 6.64E+00 4.93E+00 2.13E-02 1.48E-02 2.63E+02 7.63E-04 2.86E+02
   20 1.26E-01 7.53E+00 5.53E+00 2.06E-02 1.01E-02 3.85E+02 7.12E-04 4.21E+02
   21 1.00E-01 8.63E+00 6.26E+00 1.99E-02 6.91E-03 5.67E+02 6.72E-04 6.28E+02
   22 7.94E-02 9.98E+00 7.34E+00 1.96E-02 4.68E-03 8.39E+02 8.03E-04 7.43E+02
   23 6.31E-02 1.16E+01 8.66E+00 1.94E-02 3.16E-03 1.25E+03 9.68E-04 8.84E+02
   24 5.01E-02 1.36E+01 1.03E+01 1.92E-02 2.13E-03 1.85E+03 1.18E-03 1.06E+03
   25 3.98E-02 1.61E+01 1.23E+01 1.92E-02 1.43E-03 2.76E+03 1.44E-03 1.26E+03
   26 3.16E-02 1.90E+01 1.48E+01 1.92E-02 9.56E-04 4.12E+03 1.76E-03 1.52E+03
   27 2.51E-02 2.25E+01 1.78E+01 1.92E-02 6.40E-04 6.14E+03 2.17E-03 1.82E+03
   28 2.00E-02 2.67E+01 2.14E+01 1.88E-02 4.28E-04 9.14E+03 2.67E-03 2.17E+03
   29 1.58E-02 3.17E+01 2.59E+01 1.85E-02 2.87E-04 1.36E+04 3.30E-03 2.57E+03
   30 1.26E-02 3.77E+01 3.12E+01 1.83E-02 1.92E-04 2.00E+04 4.08E-03 3.02E+03
   31 1.00E-02 4.47E+01 3.78E+01 1.81E-02 1.29E-04 2.94E+04 5.05E-03 3.51E+03
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Table 63: (EXEPRO) Summary Xsects, Protons

HEAVY----------

ENERGY CONSTANTS FOR A PARTICLE WITH REST ENERGY 9.3116E+02 MEV

GROUP	EMAX	EMIN	EDEL	EAVE	VEL
1	1.0000E+03	7.9433E+02	2.0567E+02	8.9716E+02	2.5818E+10
2	7.9433E+02	6.3096E+02	1.6337E+02	7.1264E+02	2.4723E+10
:					
41	1.0000E-01	7.9433E-02	2.0567E-02	8.9716E-02	4.1642E+08

TRANSPORT DATA FOR PROTON IN ALUMINUM

INDEX	MEV/AMU	E-MEV	E/AMU*CM	E/A/RHO	MEV/CM	E*CM2/GM	R-CM	GM/SQCM
1	1.00E+03	1.00E+03	4.77E+00	1.77E+00	4.77E+00	1.77E+00	1.50E+02	4.05E+02
2	7.94E+02	7.94E+02	5.12E+00	1.90E+00	5.12E+00	1.90E+00	1.08E+02	2.92E+02
3	6.31E+02	6.31E+02	5.49E+00	2.03E+00	5.49E+00	2.03E+00	7.73E+01	2.09E+02
4	5.01E+02	5.01E+02	5.90E+00	2.18E+00	5.90E+00	2.18E+00	5.45E+01	1.47E+02
5	3.98E+02	3.98E+02	6.62E+00	2.45E+00	6.62E+00	2.45E+00	3.79E+01	1.02E+02
6	3.16E+02	3.16E+02	7.43E+00	2.75E+00	7.43E+00	2.75E+00	2.62E+01	7.07E+01
7	2.51E+02	2.51E+02	8.34E+00	3.09E+00	8.34E+00	3.09E+00	1.79E+01	4.84E+01
8	2.00E+02	2.00E+02	9.69E+00	3.59E+00	9.69E+00	3.59E+00	1.21E+01	3.28E+01
9	1.58E+02	1.58E+02	1.13E+01	4.17E+00	1.13E+01	4.17E+00	8.20E+00	2.21E+01
10	1.26E+02	1.26E+02	1.31E+01	4.84E+00	1.31E+01	4.84E+00	5.51E+00	1.49E+01
11	1.00E+02	1.00E+02	1.54E+01	5.71E+00	1.54E+01	5.71E+00	3.68E+00	9.92E+00
12	7.94E+01	7.94E+01	1.84E+01	6.80E+00	1.84E+01	6.80E+00	2.45E+00	6.61E+00
13	6.31E+01	6.31E+01	2.19E+01	8.10E+00	2.19E+01	8.10E+00	1.63E+00	4.40E+00
14	5.01E+01	5.01E+01	2.60E+01	9.64E+00	2.60E+01	9.64E+00	1.08E+00	2.92E+00
15	3.98E+01	3.98E+01	3.12E+01	1.15E+01	3.12E+01	1.15E+01	7.18E-01	1.94E+00
16	3.16E+01	3.16E+01	3.73E+01	1.38E+01	3.73E+01	1.38E+01	4.77E-01	1.29E+00
17	2.51E+01	2.51E+01	4.47E+01	1.66E+01	4.47E+01	1.66E+01	3.17E-01	8.55E-01
:								
42	7.94E-02	7.94E-02	1.18E+03	4.36E+02	1.18E+03	4.36E+02	6.38E-05	1.72E-04

STRAGGLING DATA FOR PROTON IN ALUMINUM

INDEX	MEV/AMU	DEDS/CM	E-SQ/CM	DEL/CM	LOW DEL	MAX DEL	USE DEL	ANGULAR
1	1.00E+03	4.09E+00	6.50E-02	9.63E-01	2.50E-01	3.37E+00	2.50E-01	3.36E-05
2	7.94E+02	4.41E+00	5.59E-02	1.30E+00	1.99E-01	2.48E+00	1.99E-01	4.83E-05
3	6.31E+02	4.73E+00	4.88E-02	1.80E+00	1.58E-01	1.85E+00	1.58E-01	6.98E-05
4	5.01E+02	5.06E+00	4.33E-02	2.51E+00	1.25E-01	1.39E+00	1.25E-01	1.01E-04
5	3.98E+02	5.69E+00	3.90E-02	3.57E+00	9.95E-02	1.06E+00	9.95E-02	1.48E-04
6	3.16E+02	6.38E+00	3.56E-02	5.15E+00	7.91E-02	8.11E-01	7.91E-02	2.18E-04
7	2.51E+02	7.14E+00	3.30E-02	7.53E+00	6.28E-02	6.25E-01	6.28E-02	3.23E-04
8	2.00E+02	8.28E+00	3.09E-02	1.12E+01	4.99E-02	4.84E-01	4.99E-02	4.83E-04
9	1.58E+02	9.59E+00	2.93E-02	1.67E+01	3.96E-02	3.77E-01	3.96E-02	7.24E-04
10	1.26E+02	1.11E+01	2.80E-02	2.53E+01	3.15E-02	2.95E-01	3.15E-02	1.09E-03
11	1.00E+02	1.30E+01	2.70E-02	3.86E+01	2.50E-02	2.31E-01	2.50E-02	1.66E-03
12	7.94E+01	1.54E+01	2.63E-02	5.93E+01	1.99E-02	1.82E-01	1.99E-02	2.52E-03
:								
41	1.00E-01	1.16E+03	2.04E-01	0.00E+00	7.50E-03	2.19E-04	2.19E-04	5.77E+02

Table 64: (EXEHEV) Summary Xsects, Heavy Ions

HEAVY----------

ENERGY CONSTANTS FOR A PARTICLE WITH REST ENERGY 9.3116E+02 MEV

GROUP	EMAX	EMIN	EDEL	EAVE	VEL
1	1.0000E+03	7.9433E+02	2.0567E+02	8.9716E+02	2.5818E+10
2	7.9433E+02	6.3096E+02	1.6337E+02	7.1264E+02	2.4723E+10
:					
41	1.0000E-01	7.9433E-02	2.0567E-02	8.9716E-02	4.1642E+08

TRANSPORT DATA FOR IRON IN SILICON

INDEX	MEV/AMU	E-MEV	E/AMU*CM	E/A/RHO	MEV/CM	E*CM2/GM	R-CM	GM/SQCM
1	1.00E+03	5.58E+04	5.28E+01	2.20E+01	2.95E+03	1.23E+03	1.37E+01	3.29E+01
2	7.94E+02	4.44E+04	5.58E+01	2.33E+01	3.12E+03	1.30E+03	9.91E+00	2.38E+01
3	6.31E+02	3.52E+04	5.98E+01	2.49E+01	3.34E+03	1.39E+03	7.08E+00	1.70E+01
4	5.01E+02	2.80E+04	6.51E+01	2.71E+01	3.63E+03	1.51E+03	5.00E+00	1.20E+01
5	3.98E+02	2.22E+04	7.19E+01	3.00E+01	4.02E+03	1.67E+03	3.49E+00	8.37E+00
6	3.16E+02	1.77E+04	8.07E+01	3.36E+01	4.51E+03	1.88E+03	2.41E+00	5.78E+00
7	2.51E+02	1.40E+04	9.18E+01	3.82E+01	5.13E+03	2.14E+03	1.65E+00	3.96E+00
8	2.00E+02	1.11E+04	1.06E+02	4.40E+01	5.90E+03	2.46E+03	1.12E+00	2.70E+00
:								
42	7.94E-02	4.44E+00	4.67E+02	1.95E+02	2.61E+04	1.09E+04	2.76E-04	6.63E-04

STRAGGLING DATA FOR IRON IN SILICON

INDEX	MEV/AMU	DEDS/CM	E-SQ/CM	DEL/CM	LOW DEL	MAX DEL	USE DEL	ANGULAR
1	1.00E+03	4.67E+01	2.18E-02	3.39E+02	4.19E-01	3.37E+00	4.19E-01	6.40E-05
2	7.94E+02	5.02E+01	2.36E-02	3.49E+02	4.19E-01	2.49E+00	4.19E-01	9.04E-05
3	6.31E+02	5.46E+01	2.59E-02	3.57E+02	4.19E-01	1.85E+00	4.19E-01	1.29E-04
4	5.01E+02	6.04E+01	2.90E-02	3.61E+02	4.19E-01	1.40E+00	4.19E-01	1.85E-04
5	3.98E+02	6.79E+01	3.28E-02	3.53E+02	4.19E-01	1.06E+00	4.19E-01	2.67E-04
6	3.16E+02	7.74E+01	3.78E-02	3.25E+02	4.19E-01	8.12E-01	4.19E-01	3.90E-04
7	2.51E+02	8.94E+01	4.41E-02	2.59E+02	4.19E-01	6.26E-01	4.19E-01	5.73E-04
8	2.00E+02	1.05E+02	5.20E-02	1.26E+02	4.19E-01	4.85E-01	4.19E-01	8.49E-04
9	1.58E+02	1.23E+02	5.59E-02	0.00E+00	4.19E-01	3.78E-01	3.78E-01	1.27E-03
10	1.26E+02	1.44E+02	5.26E-02	0.00E+00	4.19E-01	2.95E-01	2.95E-01	1.90E-03
11	1.00E+02	1.69E+02	5.01E-02	0.00E+00	4.19E-01	2.31E-01	2.31E-01	2.87E-03
12	7.94E+01	2.00E+02	4.81E-02	0.00E+00	4.19E-01	1.82E-01	1.82E-01	4.35E-03
13	6.31E+01	2.37E+02	4.65E-02	0.00E+00	4.19E-01	1.43E-01	1.43E-01	6.61E-03
14	5.01E+01	2.80E+02	4.53E-02	0.00E+00	4.19E-01	1.13E-01	1.13E-01	1.01E-02
15	3.98E+01	3.30E+02	4.44E-02	0.00E+00	4.19E-01	8.93E-02	8.93E-02	1.54E-02
16	3.16E+01	3.88E+02	4.36E-02	0.00E+00	4.19E-01	7.06E-02	7.06E-02	2.36E-02
17	2.51E+01	4.52E+02	4.31E-02	0.00E+00	4.19E-01	5.59E-02	5.59E-02	3.62E-02
18	2.00E+01	5.22E+02	4.26E-02	0.00E+00	4.19E-01	4.43E-02	4.43E-02	5.55E-02
19	1.58E+01	5.98E+02	4.22E-02	0.00E+00	4.19E-01	3.51E-02	3.51E-02	8.53E-02
20	1.26E+01	6.79E+02	4.19E-02	0.00E+00	4.19E-01	2.78E-02	2.78E-02	1.31E-01
21	1.00E+01	7.64E+02	4.17E-02	0.00E+00	4.19E-01	2.21E-02	2.21E-02	2.01E-01
22	7.94E+00	8.49E+02	4.15E-02	0.00E+00	4.19E-01	1.75E-02	1.75E-02	3.09E-01
23	6.31E+00	9.33E+02	4.14E-02	0.00E+00	4.19E-01	1.39E-02	1.39E-02	4.74E-01
:								

FASTER

FASTER, forward/adjoint multigroup Monte Carlo

****
The FASTER analysis processor controls a coupled forward/adjoint Monte Carlo calculation for neutrons and gamma rays.
****

****
Input Data Record Description:
****

==========
Header line
==========

Contains *FAS in columns 1 through 4.

=======
Options
=======

N=n, n is index of the neutron source spectrum, default is 1

G=g, g is the index of the gamma spectrum, default is 2

H=h, h is the number of histories per group , default is 16

K=k, k is maximum number of wall reflections (default is 1)

U, if present, uncollided flux is deleted from outputs

D=d, d is the detector index, default is 1

S=s, s is the source index, default is all source volumes forced selection loop.

A=a, maximum implicit albedo collisions

P=p, put summary output on unit p

B=b, relative importance of penetration/albedo

B=0, all penetration

B=1, all albedo

B=.5, default

R=r, random half space selection, with probability r isotropic and with probability 1-r force direction in source volume. Both selections are made from the adjoint particle position.

J, if present, select half space based on mfp in each half space even if one half space has zero (default is to use half space space model only if there are non-zero mean free paths in both half spaces). If J=j is input, and j greater than zero, the probability for half space 1 (detector) is the greater of the calculated probability or j. If J=j and j less than zero, then the probability for half space 1 (source) is the lesser of the calculated probability or 1+j.

W=w, if w is 1 or 3 dump old half space parameters. If w is 2 or 3, dump new half space parameters.

Y (,cos,-1,1) cone limited source on y axis

****
Data Record Description:
****

There are no data records for this processor.

++++++++++++
Output Tables
++++++++++++

While running, this processor produces summary output as shown in Table 65 (FASSUM). This information is most informative when running interactively on a personal computer to get a feel for how a problem is progressing.

At the completion of a run several output tables are produced. The first of these tables gives both the neutron and gamma ray fluxes versus energy as indicated in Table 66 (FASOLD).

The next several tables have the same flux information but include additional labeling and conversion of fluxes to responses. Specifically, Table 67 (FASNEU) indicates the outputs for neutron flux/response.

The Table 68 (FASGAM) indicates the outputs for gamma ray flux/response. Note that the gamma ray output includes separate tables for primary gammas and secondary gammas (produced by neutrons).

Table 65: (FASSUM) Summary Output

```
INPUT *HEADER,OPTIONS/
Line  25:*FASTER,B=0,K=5/

FASTER-------------------------------------------------------------------------
HIST/SCAT/KILL    1  286 56  0  0  1  0  0  0  0  0  0  0  0  0  1
HIST/SCAT/KILL    2  288 57  0  0  0  0  0  0  0  0  0  0  0  0  1
HIST/SCAT/KILL    3  288 57  0  0  0  0  0  0  0  0  0  0  0  0  1
HIST/SCAT/KILL    4  290 58  0  0  0  0  0  0  0  0  0  0  0  0  0
HIST/SCAT/KILL    5  290 58  0  0  0  0  0  0  0  0  0  0  0  0  0
HIST/SCAT/KILL    6  290 58  0  0  0  0  0  0  0  0  0  0  0  0  0
HIST/SCAT/KILL    7  287 57  0  0  0  0  0  0  0  0  0  0  0  0  1
HIST/SCAT/KILL    8  290 58  0  0  0  0  0  0  0  0  0  0  0  0  0
HIST/SCAT/KILL    9  290 58  0  0  0  0  0  0  0  0  0  0  0  0  0
HIST/SCAT/KILL   10  290 58  0  0  0  0  0  0  0  0  0  0  0  0  0
HIST/SCAT/KILL   11  290 58  0  0  0  0  0  0  0  0  0  0  0  0  0
HIST/SCAT/KILL   12  290 58  0  0  0  0  0  0  0  0  0  0  0  0  0
HIST/SCAT/KILL   13  290 58  0  0  0  0  0  0  0  0  0  0  0  0  0
HIST/SCAT/KILL   14  290 58  0  0  0  0  0  0  0  0  0  0  0  0  0
HIST/SCAT/KILL   15  290 58  0  0  0  0  0  0  0  0  0  0  0  0  0
HIST/SCAT/KILL   16  290 58  0  0  0  0  0  0  0  0  0  0  0  0  0
```

Table 66: (FASOLD) Old Format Flux Output

COSINE OF INCIDENT CURRENT 0 (0 IMPLIES INPUT ANGULAR DISTRIBUTION)

GROUP	E-MAX	E-MIN	FLUX/MEV		FLUX/GROUP		FLUX SUM	
1	1.9600E+01	1.6900E+01	2.30E-19	3	6.21E-19	3	6.21E-19	3
2	1.6900E+01	1.4900E+01	1.03E-18	2	2.05E-18	2	2.67E-18	1
3	1.4900E+01	1.4200E+01	2.23E-18	26	1.56E-18	26	4.23E-18	9
4	1.4200E+01	1.3800E+01	1.98E-18	15	7.91E-19	15	5.03E-18	8
5	1.3800E+01	1.2800E+01	6.89E-18	15	6.89E-18	15	1.19E-17	9
6	1.2800E+01	1.2200E+01	1.70E-17	37	1.02E-17	37	2.21E-17	17
7	1.2200E+01	1.1100E+01	6.36E-17	41	6.99E-17	41	9.21E-17	32
8	1.1100E+01	1.0000E+01	7.62E-17	2	8.38E-17	2	1.76E-16	16
9	1.0000E+01	9.0500E+00	4.77E-16	32	4.53E-16	32	6.29E-16	24
10	9.0500E+00	8.1900E+00	3.27E-15	78	2.82E-15	78	3.45E-15	63
11	8.1900E+00	7.4100E+00	7.17E-16	9	5.59E-16	9	4.01E-15	55
12	7.4100E+00	6.3800E+00	2.28E-15	4	2.35E-15	4	6.35E-15	34
13	6.3800E+00	4.9700E+00	5.66E-15	6	7.98E-15	6	1.43E-14	15
14	4.9700E+00	4.7200E+00	1.55E-14	5	3.87E-15	5	1.82E-14	12
15	4.7200E+00	4.0700E+00	5.05E-15	8	3.28E-15	8	2.15E-14	10
16	4.0700E+00	3.0100E+00	5.68E-15	21	6.02E-15	21	2.75E-14	9
17	3.0100E+00	2.3900E+00	2.51E-14	19	1.55E-14	19	4.31E-14	9
18	2.3900E+00	2.3100E+00	1.21E-13	68	9.71E-15	68	5.28E-14	14
19	2.3100E+00	1.8300E+00	3.69E-14	43	1.77E-14	43	7.05E-14	15
20	1.8300E+00	1.1100E+00	6.70E-15	8	4.82E-15	8	7.53E-14	14
21	1.1100E+00	5.5000E-01	2.24E-15	8	1.25E-15	8	7.65E-14	14
22	5.5000E-01	1.5800E-01	2.18E-16	7	8.53E-17	7	7.66E-14	14
23	1.5800E-01	1.1100E-01	3.15E-17	13	1.48E-18	13	7.66E-14	14
24	1.1100E-01	5.2500E-02	1.25E-17	4	7.31E-19	4	7.66E-14	14
25	5.2500E-02	2.4800E-02	4.66E-17	61	1.29E-18	61	7.66E-14	14
26	2.4800E-02	2.1900E-02	3.02E-17	21	8.77E-20	21	7.66E-14	14
27	2.1900E-02	1.0300E-02	1.04E-17	27	1.21E-19	27	7.66E-14	14
:								
37	4.1400E-07	1.0000E-12	1.17E-29	0	4.86E-36	0	7.66E-14	14
38	1.4000E+01	1.0000E+01	2.74E-18	72	1.09E-17	72	1.09E-17	72
39	1.0000E+01	8.0000E+00	1.72E-16	0	3.44E-16	0	3.55E-16	2
40	8.0000E+00	7.0000E+00	6.04E-16	1	6.04E-16	1	9.59E-16	1
41	7.0000E+00	6.0000E+00	1.46E-15	2	1.46E-15	2	2.42E-15	1
42	6.0000E+00	5.0000E+00	4.79E-15	18	4.79E-15	18	7.21E-15	12
43	5.0000E+00	4.0000E+00	7.49E-15	6	7.49E-15	6	1.47E-14	6
44	4.0000E+00	3.0000E+00	1.37E-14	0	1.37E-14	0	2.84E-14	3
45	3.0000E+00	2.5000E+00	1.71E-14	0	8.53E-15	0	3.69E-14	2
46	2.5000E+00	2.0000E+00	2.56E-14	8	1.28E-14	8	4.97E-14	3
47	2.0000E+00	1.5000E+00	2.80E-14	15	1.40E-14	15	6.37E-14	4
48	1.5000E+00	1.0000E+00	9.34E-14	69	4.67E-14	69	1.10E-13	29
49	1.0000E+00	7.0000E-01	1.12E-13	43	3.35E-14	43	1.44E-13	24
50	7.0000E-01	4.5000E-01	7.72E-14	41	1.93E-14	41	1.63E-13	22
51	4.5000E-01	3.0000E-01	6.36E-14	10	9.54E-15	10	1.73E-13	21
52	3.0000E-01	1.5000E-01	5.44E-14	21	8.15E-15	21	1.81E-13	20
53	1.5000E-01	1.0000E-01	4.07E-15	16	2.04E-16	16	1.81E-13	20
54	1.0000E-01	7.0000E-02	5.27E-14	81	1.58E-15	81	1.83E-13	20
55	7.0000E-02	4.5000E-02	2.71E-15	28	6.77E-17	28	1.83E-13	20
56	4.5000E-02	3.0000E-02	7.05E-16	39	1.06E-17	39	1.83E-13	20
57	3.0000E-02	2.0000E-02	1.03E-17	49	1.03E-19	49	1.83E-13	20
58	2.0000E-02	1.0000E-02	3.23E-22	0	3.23E-24	0	1.83E-13	20

Table 67: (FASNEU) Neutron Flux/Response Output

SOURCE 1, ORIGIN DETECTOR 1, 1 KM
NEUTRON FLUX, FISSION SPECTRUM OF NEUTRONS

GROUP	EMAX	EMIN	FLUX/MEV		FLUX/GRP		FLUX-SUM	
1	1.9600E+01	1.6900E+01	2.30E-19	25	6.21E-19	25	6.21E-19	25
2	1.6900E+01	1.4900E+01	1.03E-18	2	2.05E-18	2	2.67E-18	6
3	1.4900E+01	1.4200E+01	2.23E-18	27	1.56E-18	27	4.23E-18	10
4	1.4200E+01	1.3800E+01	1.98E-18	29	7.91E-19	29	5.03E-18	10
5	1.3800E+01	1.2800E+01	6.89E-18	16	6.89E-18	16	1.19E-17	10
6	1.2800E+01	1.2200E+01	1.70E-17	37	1.02E-17	37	2.21E-17	17
7	1.2200E+01	1.1100E+01	6.36E-17	42	6.99E-17	42	9.21E-17	32
8	1.1100E+01	1.0000E+01	7.62E-17	2	8.38E-17	2	1.76E-16	16
9	1.0000E+01	9.0500E+00	4.77E-16	33	4.53E-16	33	6.29E-16	24
10	9.0500E+00	8.1900E+00	3.27E-15	78	2.82E-15	78	3.45E-15	63
11	8.1900E+00	7.4100E+00	7.17E-16	10	5.59E-16	10	4.01E-15	55
12	7.4100E+00	6.3800E+00	2.28E-15	5	2.35E-15	5	6.35E-15	34
13	6.3800E+00	4.9700E+00	5.66E-15	7	7.98E-15	7	1.43E-14	15
14	4.9700E+00	4.7200E+00	1.55E-14	6	3.87E-15	6	1.82E-14	12
15	4.7200E+00	4.0700E+00	5.05E-15	9	3.28E-15	9	2.15E-14	10
16	4.0700E+00	3.0100E+00	5.68E-15	21	6.02E-15	21	2.75E-14	9
17	3.0100E+00	2.3900E+00	2.51E-14	19	1.55E-14	19	4.31E-14	9
18	2.3900E+00	2.3100E+00	1.21E-13	69	9.71E-15	69	5.28E-14	14
19	2.3100E+00	1.8300E+00	3.69E-14	43	1.77E-14	43	7.05E-14	15
20	1.8300E+00	1.1100E+00	6.70E-15	9	4.82E-15	9	7.53E-14	14
21	1.1100E+00	5.5000E-01	2.24E-15	8	1.25E-15	8	7.65E-14	14
22	5.5000E-01	1.5800E-01	2.18E-16	8	8.53E-17	8	7.66E-14	14
23	1.5800E-01	1.1100E-01	3.15E-17	14	1.48E-18	14	7.66E-14	14
24	1.1100E-01	5.2500E-02	1.25E-17	25	7.31E-19	25	7.66E-14	14
25	5.2500E-02	2.4800E-02	4.66E-17	62	1.29E-18	62	7.66E-14	14
26	2.4800E-02	2.1900E-02	3.02E-17	33	8.77E-20	33	7.66E-14	14
27	2.1900E-02	1.0300E-02	1.04E-17	37	1.21E-19	37	7.66E-14	14
28	1.0300E-02	3.3500E-03	9.37E-19	40	6.51E-21	40	7.66E-14	14
29	3.3500E-03	1.2300E-03	6.37E-20	39	1.35E-22	39	7.66E-14	14
30	1.2300E-03	5.8300E-04	4.28E-21	0	2.77E-24	0	7.66E-14	14
31	5.8300E-04	1.0100E-04	3.40E-22	0	1.64E-25	0	7.66E-14	14
32	1.0100E-04	2.9000E-05	1.89E-22	0	1.36E-26	0	7.66E-14	14
33	2.9000E-05	1.0700E-05	2.52E-23	0	4.60E-28	0	7.66E-14	14
34	1.0700E-05	3.0600E-06	6.51E-24	0	4.97E-29	0	7.66E-14	14
35	3.0600E-06	1.1300E-06	2.45E-25	0	4.73E-31	0	7.66E-14	14
36	1.1300E-06	4.1400E-07	9.46E-29	0	6.78E-35	0	7.66E-14	14
37	4.1400E-07	1.0000E-12	1.17E-29	0	4.86E-36	0	7.66E-14	14

AIR RAD RESPONSE	6.64E-23	0
WATER RAD RESPONSE	9.60E-25	0
NUMBER FLUX USER RESPONSE	7.66E-14	13
ENERGY FLUX USER RESPONSE	2.61E-13	10

Table 68: (FASGAM) Gamma Flux/Response Output

SOURCE 1, ORIGIN DETECTOR 1, 1 KM
GAMMA FLUX, FISSION SPECTRUM OF NEUTRONS

GROUP	EMAX	EMIN	FLUX/MEV	FLUX/GRP	FLUX-SUM
1	1.4000E+01	1.0000E+01	2.74E-18 72	1.09E-17 72	1.09E-17 72
2	1.0000E+01	8.0000E+00	2.50E-19 37	5.00E-19 37	1.14E-17 69
3	8.0000E+00	7.0000E+00	3.99E-17 24	3.99E-17 24	5.14E-17 24
4	7.0000E+00	6.0000E+00	1.17E-16 25	1.17E-16 25	1.69E-16 18
5	6.0000E+00	5.0000E+00	1.70E-15 52	1.70E-15 52	1.87E-15 47
6	5.0000E+00	4.0000E+00	6.73E-16 68	6.73E-16 68	2.54E-15 39
7	4.0000E+00	3.0000E+00	1.34E-16 20	1.34E-16 20	2.68E-15 37
8	3.0000E+00	2.5000E+00	1.57E-16 33	7.83E-17 33	2.75E-15 36
9	2.5000E+00	2.0000E+00	4.79E-15 45	2.39E-15 45	5.15E-15 28
10	2.0000E+00	1.5000E+00	6.65E-16 21	3.33E-16 21	5.48E-15 26
11	1.5000E+00	1.0000E+00	5.12E-16 94	2.56E-16 94	5.74E-15 26
12	1.0000E+00	7.0000E-01	1.02E-16 23	3.05E-17 23	5.77E-15 25
13	7.0000E-01	4.5000E-01	5.56E-16 65	1.39E-16 65	5.91E-15 25
14	4.5000E-01	3.0000E-01	2.94E-17 71	4.41E-18 71	5.91E-15 25
15	3.0000E-01	1.5000E-01	2.39E-17 71	3.59E-18 71	5.91E-15 25
16	1.5000E-01	1.0000E-01	6.22E-19 27	3.11E-20 27	5.91E-15 25
17	1.0000E-01	7.0000E-02	1.55E-17 95	4.64E-19 95	5.92E-15 25
18	7.0000E-02	4.5000E-02	5.14E-19 46	1.28E-20 46	5.92E-15 25
19	4.5000E-02	3.0000E-02	5.84E-20 72	8.76E-22 72	5.92E-15 25

AIR RAD RESPONSE 6.37E-24 0
WATER RAD RESPONSE 4.60E-23 0
NUMBER FLUX USER RESPONSE 5.92E-15 24
ENERGY FLUX USER RESPONSE 2.07E-14 27

SOURCE 1, ORIGIN DETECTOR 1, 1 KM
GAMMA FLUX, FISSION SPECTRUM OF GAMMAS

GROUP	EMAX	EMIN	FLUX/MEV	FLUX/GRP	FLUX-SUM
2	1.0000E+01	8.0000E+00	1.72E-16 0	3.43E-16 0	3.43E-16 0
3	8.0000E+00	7.0000E+00	5.64E-16 0	5.64E-16 0	9.08E-16 0
4	7.0000E+00	6.0000E+00	1.34E-15 0	1.34E-15 0	2.25E-15 0
5	6.0000E+00	5.0000E+00	3.09E-15 0	3.09E-15 0	5.34E-15 0
6	5.0000E+00	4.0000E+00	6.81E-15 1	6.81E-15 1	1.22E-14 0
7	4.0000E+00	3.0000E+00	1.36E-14 1	1.36E-14 1	2.57E-14 0
8	3.0000E+00	2.5000E+00	1.69E-14 0	8.45E-15 0	3.42E-14 0
9	2.5000E+00	2.0000E+00	2.08E-14 1	1.04E-14 1	4.46E-14 0
10	2.0000E+00	1.5000E+00	2.73E-14 15	1.37E-14 15	5.82E-14 3
11	1.5000E+00	1.0000E+00	9.29E-14 70	4.65E-14 70	1.05E-13 31
12	1.0000E+00	7.0000E-01	1.12E-13 44	3.35E-14 44	1.38E-13 25
13	7.0000E-01	4.5000E-01	7.66E-14 41	1.92E-14 41	1.57E-13 23
14	4.5000E-01	3.0000E-01	6.35E-14 10	9.53E-15 10	1.67E-13 22
15	3.0000E-01	1.5000E-01	5.43E-14 22	8.15E-15 22	1.75E-13 21
16	1.5000E-01	1.0000E-01	4.07E-15 16	2.04E-16 16	1.75E-13 21
17	1.0000E-01	7.0000E-02	5.24E-14 82	1.57E-15 82	1.77E-13 20
18	7.0000E-02	4.5000E-02	2.50E-15 29	6.26E-17 29	1.77E-13 20
19	4.5000E-02	3.0000E-02	6.54E-16 42	9.80E-18 42	1.77E-13 20
20	3.0000E-02	2.0000E-02	4.69E-18 71	4.69E-20 71	1.77E-13 20

AIR RAD RESPONSE 1.06E-22 35
WATER RAD RESPONSE 1.14E-21 31
NUMBER FLUX USER RESPONSE 1.77E-13 19
ENERGY FLUX USER RESPONSE 2.85E-13 15

FEDIFU

FEDIFU is an approximate electron transport procedure

****
FEDIFU is a processor that approximates electron transport using numerical integration procedures.
****

****
Discussion
****

In progress.

FILES

FILES lists files used by NOVICE

****
The FILES processor establishes the equivalence between logical units and file names.
****

****
Input Data Record Description:
****

======
Header
======

Contains *FIL in columns 1 through 4.

=======
Options
=======

L, list file status after data (if any)

O, open files as they are defined

C, close files as they are defined. Open is performed before close. If the file name is associated with unit 11 (formatted) of 12 (unformatted), the file is deleted when closed.

P or P=p, as paths are entered loop through all files with that path type. If open, close(if P=1 or P=2) and open with new name if just closed and P=2.

Q or Q=q, as file names are entered, determine new path if file name preceeded by *&%+- and if open, close (if Q=2 or Q=2) then open with new name if just closed and Q=2.

****
Data Record Description:
****

Repeat this line as needed.

=========
File Data
=========

LUN NAME /

LUN, logical designation of the file (1 through 50)

NAME, alphanumeric file name with path if required.

If the file name being replaced has a path and the new file name does not, the old path is attached to the new file name. If the new file name has a path, the path and name are both replaced.

****
Discussion
****

Standard file assignments are given in the config.nov file.

If a file is given the extension 'tmp', then that file is deleted if opened during the run. Ascii files that exist before a run starts are opened for extension unless they have the extension 'new'.

On the following files the .* is replaced by .extension

3 letter key for file format, status, and action:

first letter is format
   (f,u,b,d,s=for,unf,bin_stream,direct,sys)
   (o --> system file needing explict open)

second letter is status
   (o,n,u,s=old,new,unk,scratch)
   (don't use s, watcom s must be unnamed)

third letter is action (r,w,b)=(read,write,both)
   if action is read and file does not exist, action is

* before file name indicates a library file

```
- indicates use old path (from previous run) for this file
+ indicates use new path (for this run) for this file
& indicates use current user path, e.g. location of inputs
% indicates a temporary path
\ indicates a subdirectory after indicated path
. indicates path/subdirectory for CAD file

NOTE, files with extension .new are rewritten from the beginning
when opened.  Therefore do not close/reopen (which looses data if
crash or give a different extension.

Also, .tmp files are deleted when closed.
for   1 &novice.dat          batch input file
fuw   2 +output.new          output file
fuw   3 &put.dat             put file
for   4 &get.dat             get file
sur   5 stdin                interactive input
suw   6 stdout               interactive output
fnw   7 +punch.dat           'punch' output file
ouw   8 prn                  plot file
uor   9 *xlibedp.dat         photon xsect lib (lahey)
uor  10 *mlibe.dat           multigroup library
fnb  11 +scratch.tmp         formatted scratch
bnb  12 +jump.tmp            unformatted scratch
bnw  13 +save.new            save file before *exe
bnw  14 +start.new           save file after *exe
for  15 *prathe.dat          brem production lib
for  16 *lowpho.dat          photons, 100ev to 1kev
for  17 *dlcf23.dat          dlc file 23 bcd data
for  18 *dlcf27.dat          dlc file 27 bcd data
buw  19 +restrt19.new        restart.u19
buw  20 +restrt19.new        restart.u20
bor  21 -oldrun.dat          restart from prior run
fub  22 +fluxes.new          fluxes for *pulse
fuw  23 +afwldcf.new         afwl sector interface
fuw  24 +matrix.new          adjoint flux by sou group
fuw  25 +goplot.new          print plot summary output
fuw  26 +gcrsum.new          gcr summary outputs
for  27 &gcregs.*            gsfc gcr inputs
fuw  28 +sector.new          file created by sigma run
fuw  29 +efkout.*            summary dose outputs
fob  30 *bugle93             bugle93 data lib, ascii
fuw  31 +protel.new          proton pulse output
for  32* ascii.num           character generation data
for  33 -syntha.*            applicon synthavision
fnw  34 +magics.new          error file for syntha...
fuw  35 +mtlibe.new          material composition data
fuw  36 +sector.new          sector data file input
bnw  37 +test.tmp            picture output file
fnb  38 +text.tmp            picture text file
```

for	39	+desbox.tmp	path pointer name.dim
???	40	????????.???	used by lf90 graphics
for	41	*guide\nov.doc	path pointer name.doc
for	42	*camera\camsur.gsf	camera man model surfaces
for	43	*camera\camreg.gsf	cam man model regions
for	44	&cgafwl.*	afwl sector geometry data
for	45	*config.nov	configuration input file
for	46	*tables\prenov.tbl	path pointer name.tbl
fub	47	+plot.*	plot data file
fuw	48	+summary.new	novice summary output
for	49	&sigma.hac	sigma.hac sector input
for	50	&mcnpgeo.*	mcnp geometry interface
bnw	51	+picpcx.pcx	picture pcx output
fnw	52	+picpcl.pcl	picture pcl output
fub	53	+catia.lib	catia library
for	54	*options.lib	option check file
for	55	&mev2.dat	trw free field mevdp file
fnw	56	+mev2.new	novice free field mevdp
bor	57	-save.dat	old save file
bor	58	-start.dat	old start file
for	59	*mtlibe.dat	library material data
fuw	60	+keyboard.new	saved keyboard inputs
fnw	61	+runerror.new	error messages
for	62	+sigma.had	sigma.hac format output
for	63	&novice.run	interactive input
for	64	command.arg	commandline arguments
fnw	65	+sigmapar.new	shield sensitivity output
fuw	66	+sigmasoc.new	shield optimization data
fnw	67	+socode.new	shield optimization outs
for	68	-socode.dat	shield opt, old outputs
for	69	-sigmasoc.dat	output from old sigma run
fnw	70	+socgeom.new	shield geometry model
fnw	71	+sigmasum.new	sigma table output file
fnw	72	+dumpfile.new	dump output file
fuw	73	+debugger.new	debug output file
fob	74	*novajobs.dat	job start/stop summary
fnw	75	+trecorbt.new	orbit outputs for sofip
fnw	76	+sofipout.dat	sofip spectra outputs
fnw	77	+sigmaker.dat	sigma kernel outputs
fnw	78	+shieldos.out	shieldose outputs
uor	79	*xlibedp.dat	ppc xlibe unit
for	80	*shieldos.lib	shieldose ascii library
uor	81	*shieldos.bin	shieldose binary lib
for	82	*sofiplib.dat	sofip library
fnw	83	+fileused.new	x use summary
fnw	84	+sigmatoc.new	sigma tables toc
fnw	85	+brangout.new	brang summary outputs
fnw	86	+branglib.new	brang library outputs
fuw	87	+photonxs.new	fine structure xsects
fuw	88	+calender.dat	mtnext, calender data
for	89	*commons.doc	common block lengths

```
for  90 *library.dat         saved data sets for &lib
fuw  91 +library.new         saved data sets for &lib
fuw  92 +execute.new         *exe output tables
fuw  93 +sigmass.new         sigma spreadsheet output
fuw  94 +geometry.new        geometry sur/bod/reg outs
fuw  95 +nieltabs.new        niel response functions
fuw  96 +raymaps.new         ray map for plotting
for  97 &esabase.dat         esabase processing file
for  98 &esabase.sum         esabase processing file
for  99 &esabase.out         esabase processing file
fuw 100 +raypaths.new        ray map picture input
fuw 101 +raytable.new        summarized ray map
for 102 *menu\topics.lib     menu topics
for 103 *menu\powerbar.lib   powerbar topics
for 104 *menu\figures.lib    list of all figures
for 105 *menu\tables.lib     list of all tables
bor 106 *pictures\geopro.pcx path pointer name.pic
fuw 107 +mdat0000.new        menu prepared inputs
fuw 108 +mout0000.new        output from menu inputs
buw 109 +mpcx0000.new        menu output pcx files
for 110 *menu\demofile.lib   word charts for demo
for 111 *inputs\demodata.dat input files for demo
for 112 *outputs\demooutp.out output files for demo
for 113 *menu\subprogr.doc   subprogram names/functions
fuw 114 +adjflux.new         adjoint flux spectra
fuw 115 +adjdose.new         adjoint responses
fuw 116 +adjcurnt.new        adjoint current/charging
fuw 117 +crdetail.new        cosmic ray details
fuw 118 +sigmatab.new        attenuation kernels
fuw 119 +sigmalim.new        min, max, ave data
bub 120 +bmpfiles.new        bitmap output/input
bor 121 +iges.dat            iges input file
bub 122 +igestmp.new         iges binary file
bub 123 +igesuse.new         iges binary file
fuw 124 +igesout.new         iges ouput during input
fuw 125 +igesrun.new         iges output during run
for 126 *tablelab.lib        table info library
fuw 127 +tableinf.new        output table info
fuw 128 *license.new         decoded license
for 129 *license.dat         coded license
```

GCR

GCR calculates 1D and 3D galactic cosmic ray transport.

****
The GCR analysis processor generates galactic cosmic ray spectra and transports the particles through shield layers.
****

****
Input Data Record Description:
****

==========
Header line
==========

Contains *GCR in columns 1 through 4.

=======
Options
=======

Z=z, maximum atomic number to transport, default is 28

D=d, selects detailed printout, D=2 is most detailed D=1 obtains print of free space spectra.

F=f, index of the source distribution to use for the 3D angular integration (absence of F implies default isotropic).

N=n, test of spallation yield sensitivity, production of spallation products is limited to atomic numbers 1 thru n and 29-n thru 28, with equal probable production.

X, print cross section data

A, attenuate and generate spall source, if A=a, only atomic numbers 1 thru a produce spall source (A=1 gives proton reactions only and accounts for most of the spallation source).

S, replace calculated spectra with those from GSFC model. If S=s, and s greater than 0, use CREME96 models. If S=2, also write tables comparing CREME96 with old models.

E=e, subdivide each group into e subgroups for transport

H, calculate transport in slab geometry (all layers must be same material).

C, outputs let response by ion on gcrsum.dat file

H=h, h is the number of histories for ray-tracing in the 3D geometry model (h > 2).

I, if present, output gcr let by ion

M (mat) selects pulse height analysis and material (use *pulse)

G=g, g is the detector number for the 3D option.

T=t, t replaces 12. in temperature calculation

R=r, replaces excitation energy by r

B=b, power of energy in Poisson energy dependence

J=j, use *SPECTRUM spectrum number j

K, kernel attenuation data file output. K=0=no, K=1=yes, K=2=yes plus the usual summary output.

P, omit earth shadowing from geomagnetic/earth shielding factors.

Q, put all output to screen or NOVICE.SUM file

U (mat) niel response material, threshold is 10 ev

V, if present, do spoil kinematics in lab cordinate systems

Y, stop dump point if any 1 through 5

&A (rea,cen,eps,inf) delta radius for edge of ion track care

&B (rea,,eps,1) fractional range factor for ion track care

&C (rea,cen,eps,inf) core lenght for equilibrium of core

&D decay source from gcr spallation

&E plot flux vs energy, multiple thicknesses, 1 plot per ion

&F (rea,sec,eps,inf) flare duration for gcr beta/gamma sources

&G (alpha) if present, put gcr spectran on file 210=spectrum.new

&H (int) Xapsos/Gee gcr spectra,)=use creme, 1=use xapsos

&I (int) test target/projectile two-out model

&T (int,,0,3) (running,cm*g/cc,mm,mils) thickness value

W, weather indices as in CREME model

W absent or W=0, nominal values for particles indicated on the next two records.

W=1, nominal GCR envirnoment.

W=2, same with fully ionized anomolous component

W=3, solar min + worst case compositions

W=4, nominal values with singly ionized anomolous component

W=5, gcr+peak ordinaty flare

W=6, same as 5 with worst-case compositions

W=7, peak 10% worst-case flare, nominal compositions

W=8, peak 10% worst-case flare, worst-case compositions

W=9, Aug 4 1972 flare, nominal compositions

W=10, same, worst-case compositions

W=11, 56 and 72 flare envelope, nominal compositions

W=12, 56 and 72 flare envelope, worst case compositions

W=13, use storm condition rigidities on nominal models

Note: some of the weather models appear equivalent to the nominal models. There may be subtle differences. For instance when W=5 through W=12 are run, the geomagnetic shielding is decreased by delta rigidity = -rigidity * .54 *exp(-rigidity/2.9). This decrease is not in the default (W=0) models.

Obsolete options (now obtained with *PULSE)

I, output LET spectrum from each ion

L, calculate LET spectrum

****
Data Record Description:
****

==========
Minimum Z Values (paired input with next record)
==========

Minimum atomic number for GCR, OR integrated, OR peak, AL integrated, AL peak/

==========
Maximum Z Values (paired input with prior record)
==========

Maximum atomic number for GCR, OR integrated, OR peak, AL integrated, AL peak/

The spectra are added together for the indicated environments. This makes sense only for 1, 3, and 5 or 2 and 4.

The values on these two records are ignored for W=1 through 12.

=====
Orbit
=====

One record containing:

YEAR,INC,ANG1,ANG2,AMIN,AMAX,FWORST/ where

YEAR, the year in decimal form

INC, orbit inclination in degrees

ANG1, initial longitude in degrees

ANG2, initial latitude in degress

AMIN, minimum altitude, km

AMAX, maximum altitude, km

FWORST, parameter controlling interpolation of models between nominal and worst case, 0. gives nominal, 1. gives worst case, FWORST
i.e., estimate = nominal * (worst/nominal)

The year is used only for nominal GCR environments. For weather conditions W=1 through 12, FWORST is ignored here and set internally.

==========
Shield Materials (paired with next record)
==========

Shield materials by layer/ if 1D (omit for 3D)

==========
Shield Thicknesses (paired with previous record)
==========

Layer Thicknesses (cm) by layer/ if 1D (omit for 3D)

Omit the above two records if H=h with h greater than 2.

****
Discussion
****

LET spectra and pulse height distributions from galactic cosmic rays are obtained by processing the FLUXES.DAT file using the *PULSE processor with typical graphical outputs as indicated in the PULSE discussion.

++++++++++++
Output Tables
++++++++++++

The GCR processor produces a table of geomagnetic shielding data as shown in Table 69 (GCRGEO). This table indicates the energy for different A/Z factors, The proton column has an A/Z of 1 and the A/Z=2 column is used for all other ions.

If the D option is selected, output includes the spectrum of each ion in the format of Table 70 (GCRION).

If the D=1 option is selected the output also includes the stopping powers and ranges of all materials in the format of Table 71 (GCRLET).

With the D=1 option, the output also includes particle fluxes at each shield layer as indicated by Table 72 (GCRFLX).

Total particle fluxes and dose rates (rad and rem) are obtained at each shield layer and output with the format indicated in Table 73 (GCRREM).

These data are also saved in a file 74 (GCRSUM).DAT with the format indicated in Table GCROUT.

++++++++++++++
Output Figures
++++++++++++++

Dose by ion data saved on the PLOT.DAT file and plotted using the *PLOT processor is shown in Figure 39 (GCRCBI) as a running sum.

The data is repeated in Figure 40 (GCRDBI) as a dose by ion specie.

Figure 41 (GCRDVT) indicates a typical dose versus shield thickness.

Table 69: (GCRGEO) Geomagnetic Shielding Factors

RIGDTY, MV	TRANSMIT	MEV-PROTN	E/A,A/Z=2	E/A,A/Z=4	E/A,A/Z=8	GEOMAG
716.284	.000	243.659	64.367	17.065	4.295	.000
731.524	.004	253.014	67.039	17.792	4.480	.004
746.764	.006	262.490	69.760	18.534	4.668	.006
762.004	.007	272.084	72.529	19.290	4.860	.007
777.244	.008	281.794	75.346	20.061	5.056	.008
792.484	.008	291.617	78.210	20.847	5.255	.008
807.724	.010	301.550	81.122	21.647	5.459	.010
822.964	.013	311.590	84.080	22.462	5.666	.013
838.204	.016	321.736	87.084	23.292	5.877	.016
853.444	.018	331.984	90.134	24.136	6.092	.018
868.685	.023	342.332	93.229	24.994	6.311	.023
883.925	.030	352.777	96.370	25.867	6.534	.030
899.165	.035	363.318	99.554	26.754	6.760	.035
914.405	.040	373.951	102.783	27.655	6.990	.040
929.645	.043	384.675	106.056	28.571	7.224	.043
944.885	.047	395.487	109.371	29.501	7.462	.047
960.125	.058	406.386	112.730	30.445	7.704	.058
975.365	.066	417.369	116.131	31.403	7.949	.066
990.605	.072	428.434	119.573	32.375	8.198	.072
1005.845	.076	439.579	123.058	33.362	8.452	.076
1021.085	.083	450.802	126.583	34.362	8.708	.083
1036.325	.087	462.101	130.149	35.377	8.969	.087
1051.565	.091	473.475	133.756	36.405	9.233	.091
:						
2697.494	1.000	1922.635	685.056	218.583	59.180	1.000
2712.734	1.000	1937.046	691.130	220.822	59.830	1.000
2727.974	1.000	1951.465	697.215	223.069	60.484	1.000
2743.214	1.000	1965.892	703.312	225.325	61.140	1.000
2758.454	1.000	1980.328	709.419	227.589	61.800	1.000
2773.695	1.000	1994.772	715.536	229.861	62.464	1.000
2788.935	1.000	2009.224	721.664	232.140	63.130	1.000
2804.175	1.000	2023.684	727.803	234.428	63.800	1.000
2819.415	1.000	2038.151	733.951	236.724	64.473	1.000
2834.655	1.000	2052.627	740.110	239.028	65.149	1.000
2849.895	1.000	2067.110	746.279	241.339	65.828	1.000
2865.135	1.000	2081.600	752.457	243.659	66.510	1.000
2880.375	1.000	2096.098	758.645	245.986	67.196	1.000
2895.615	1.000	2110.603	764.843	248.321	67.884	1.000
2910.855	1.000	2125.115	771.051	250.663	68.576	1.000
2926.095	1.000	2139.634	777.268	253.014	69.271	1.000
2941.335	1.000	2154.160	783.494	255.371	69.970	1.000
2956.575	1.000	2168.694	789.730	257.737	70.671	1.000
2971.815	1.000	2183.233	795.974	260.109	71.375	1.000
2987.055	1.000	2197.780	802.228	262.490	72.083	1.000
3002.295	1.000	2212.332	808.491	264.877	72.793	1.000
3017.536	1.000	2226.892	814.762	267.272	73.507	1.000
3032.776	1.000	2241.458	821.042	269.674	74.224	1.000
3048.016	1.000	2256.030	827.331	272.084	74.944	1.000

Table 70: (GCRION) Individual Heavy Ion Spectra

GCR FOR Z= 2, YEAR 1991.0, F-WORST= .0000
INCLINATION= 29.00, MAX/MIN ALTITUDE= 10000.0 10000.0 KM

GROUP	EMAX	EMIN	UNSHLD NUM/MEV	UNSHLD NUM/GRP	UNSHLD NUM SUM	SHIELD NUM/MEV	SHIELD NUM/GRP	SHIELD NUM SUM
1	1.00E+04	7.94E+03	4.66E-02	3.84E+02	3.84E+02	4.48E-02	3.69E+02	3.69E+02
2	7.94E+03	6.31E+03	7.47E-02	4.89E+02	8.73E+02	7.18E-02	4.69E+02	8.38E+02
3	6.31E+03	5.01E+03	1.18E-01	6.13E+02	1.49E+03	1.13E-01	5.89E+02	1.43E+03
4	5.01E+03	3.98E+03	1.83E-01	7.55E+02	2.24E+03	1.76E-01	7.25E+02	2.15E+03
5	3.98E+03	3.16E+03	2.78E-01	9.11E+02	3.15E+03	2.67E-01	8.76E+02	3.03E+03
6	3.16E+03	2.51E+03	4.13E-01	1.08E+03	4.23E+03	3.97E-01	1.03E+03	4.06E+03
7	2.51E+03	2.00E+03	5.98E-01	1.24E+03	5.46E+03	5.74E-01	1.19E+03	5.25E+03
8	2.00E+03	1.58E+03	8.41E-01	1.38E+03	6.85E+03	8.08E-01	1.33E+03	6.58E+03
9	1.58E+03	1.26E+03	1.15E+00	1.50E+03	8.34E+03	1.10E+00	1.44E+03	8.01E+03
10	1.26E+03	1.00E+03	1.51E+00	1.56E+03	9.90E+03	1.45E+00	1.50E+03	9.51E+03
11	1.00E+03	7.94E+02	1.91E+00	1.57E+03	1.15E+04	1.83E+00	1.51E+03	1.10E+04
12	7.94E+02	6.31E+02	2.32E+00	1.52E+03	1.30E+04	2.23E+00	1.46E+03	1.25E+04
13	6.31E+02	5.01E+02	2.71E+00	1.41E+03	1.44E+04	2.17E+00	1.13E+03	1.36E+04
14	5.01E+02	3.98E+02	3.03E+00	1.25E+03	1.57E+04	1.58E+00	6.53E+02	1.43E+04
15	3.98E+02	3.16E+02	3.23E+00	1.06E+03	1.67E+04	1.11E+00	3.65E+02	1.46E+04
16	3.16E+02	2.51E+02	3.30E+00	8.58E+02	1.76E+04	7.55E-01	1.96E+02	1.48E+04
17	2.51E+02	2.00E+02	3.22E+00	6.65E+02	1.82E+04	4.91E-01	1.01E+02	1.49E+04
18	2.00E+02	1.58E+02	3.02E+00	4.95E+02	1.87E+04	3.55E-01	5.83E+01	1.50E+04
19	1.58E+02	1.26E+02	2.72E+00	3.55E+02	1.91E+04	2.46E-01	3.21E+01	1.50E+04
20	1.26E+02	1.00E+02	2.38E+00	2.47E+02	1.93E+04	1.08E-01	1.12E+01	1.50E+04
21	1.00E+02	7.94E+01	2.04E+00	1.68E+02	1.95E+04	3.07E-02	2.53E+00	1.50E+04
22	7.94E+01	6.31E+01	1.72E+00	1.12E+02	1.96E+04	6.98E-03	4.56E-01	1.50E+04
23	6.31E+01	5.01E+01	1.45E+00	7.51E+01	1.97E+04	0.00E+00	0.00E+00	1.50E+04
24	5.01E+01	3.98E+01	1.23E+00	5.07E+01	1.97E+04	0.00E+00	0.00E+00	1.50E+04
25	3.98E+01	3.16E+01	1.07E+00	3.50E+01	1.98E+04	0.00E+00	0.00E+00	1.50E+04
26	3.16E+01	2.51E+01	9.65E-01	2.51E+01	1.98E+04	0.00E+00	0.00E+00	1.50E+04
27	2.51E+01	2.00E+01	9.15E-01	1.89E+01	1.98E+04	0.00E+00	0.00E+00	1.50E+04
28	2.00E+01	1.58E+01	9.21E-01	1.51E+01	1.98E+04	0.00E+00	0.00E+00	1.50E+04
29	1.58E+01	1.26E+01	9.92E-01	1.29E+01	1.98E+04	0.00E+00	0.00E+00	1.50E+04
30	1.26E+01	1.00E+01	1.15E+00	1.19E+01	1.99E+04	0.00E+00	0.00E+00	1.50E+04
31	1.00E+01	7.94E+00	1.42E+00	1.17E+01	1.99E+04	0.00E+00	0.00E+00	1.50E+04
32	7.94E+00	6.31E+00	1.86E+00	1.22E+01	1.99E+04	0.00E+00	0.00E+00	1.50E+04
33	6.31E+00	5.01E+00	2.56E+00	1.33E+01	1.99E+04	0.00E+00	0.00E+00	1.50E+04
34	5.01E+00	3.98E+00	3.64E+00	1.50E+01	1.99E+04	0.00E+00	0.00E+00	1.50E+04
35	3.98E+00	3.16E+00	5.22E+00	1.71E+01	1.99E+04	0.00E+00	0.00E+00	1.50E+04
36	3.16E+00	2.51E+00	7.40E+00	1.93E+01	1.99E+04	0.00E+00	0.00E+00	1.50E+04
37	2.51E+00	2.00E+00	1.01E+01	2.09E+01	2.00E+04	0.00E+00	0.00E+00	1.50E+04
38	2.00E+00	1.58E+00	1.31E+01	2.15E+01	2.00E+04	0.00E+00	0.00E+00	1.50E+04
39	1.58E+00	1.26E+00	1.57E+01	2.05E+01	2.00E+04	0.00E+00	0.00E+00	1.50E+04
40	1.26E+00	1.00E+00	1.73E+01	1.80E+01	2.00E+04	0.00E+00	0.00E+00	1.50E+04

Table 71: (GCRLET) Material Stopping Powers

STOPPING POWERS IN ALUMINUM

I	E	1=Z	2=Z	3=Z	4=Z	5=Z	6=Z	7=Z
1	1.00E+04	1.79E+00	1.80E+00	2.37E+00	3.20E+00	4.20E+00	5.41E+00	6.31E+00
2	7.94E+03	1.75E+00	1.76E+00	2.32E+00	3.13E+00	4.11E+00	5.29E+00	6.17E+00
3	6.31E+03	1.71E+00	1.73E+00	2.27E+00	3.07E+00	4.02E+00	5.18E+00	6.04E+00
4	5.01E+03	1.68E+00	1.69E+00	2.22E+00	3.01E+00	3.94E+00	5.08E+00	5.93E+00
5	3.98E+03	1.65E+00	1.67E+00	2.18E+00	2.96E+00	3.87E+00	4.99E+00	5.83E+00
6	3.16E+03	1.63E+00	1.65E+00	2.15E+00	2.92E+00	3.82E+00	4.93E+00	5.76E+00
7	2.51E+03	1.62E+00	1.64E+00	2.13E+00	2.91E+00	3.79E+00	4.91E+00	5.73E+00
8	2.00E+03	1.63E+00	1.64E+00	2.12E+00	2.91E+00	3.78E+00	4.92E+00	5.74E+00
9	1.58E+03	1.65E+00	1.66E+00	2.13E+00	2.95E+00	3.82E+00	4.98E+00	5.81E+00
10	1.26E+03	1.69E+00	1.70E+00	2.17E+00	3.02E+00	3.89E+00	5.10E+00	5.95E+00
11	1.00E+03	1.75E+00	1.77E+00	2.23E+00	3.14E+00	4.03E+00	5.29E+00	6.18E+00
12	7.94E+02	1.85E+00	1.86E+00	2.33E+00	3.31E+00	4.22E+00	5.58E+00	6.51E+00
13	6.31E+02	1.98E+00	1.99E+00	2.47E+00	3.54E+00	4.50E+00	5.98E+00	6.98E+00
14	5.01E+02	2.16E+00	2.17E+00	2.66E+00	3.85E+00	4.87E+00	6.51E+00	7.60E+00
15	3.98E+02	2.38E+00	2.40E+00	2.92E+00	4.26E+00	5.36E+00	7.20E+00	8.40E+00
16	3.16E+02	2.68E+00	2.69E+00	3.24E+00	4.78E+00	5.98E+00	8.08E+00	9.43E+00
17	2.51E+02	3.04E+00	3.06E+00	3.66E+00	5.44E+00	6.78E+00	9.19E+00	1.07E+01
18	2.00E+02	3.50E+00	3.52E+00	4.18E+00	6.26E+00	7.77E+00	1.06E+01	1.23E+01
19	1.58E+02	4.07E+00	4.10E+00	4.83E+00	7.27E+00	9.00E+00	1.23E+01	1.43E+01
20	1.26E+02	4.77E+00	4.80E+00	5.63E+00	8.52E+00	1.05E+01	1.44E+01	1.68E+01
21	1.00E+02	5.63E+00	5.66E+00	6.62E+00	1.01E+01	1.24E+01	1.70E+01	1.98E+01
22	7.94E+01	6.67E+00	6.72E+00	7.82E+00	1.19E+01	1.47E+01	2.01E+01	2.35E+01
23	6.31E+01	7.95E+00	8.00E+00	9.30E+00	1.42E+01	1.74E+01	2.40E+01	2.80E+01
24	5.01E+01	9.50E+00	9.56E+00	1.11E+01	1.70E+01	2.08E+01	2.87E+01	3.35E+01
25	3.98E+01	1.14E+01	1.15E+01	1.33E+01	2.03E+01	2.49E+01	3.43E+01	4.01E+01
26	3.16E+01	1.36E+01	1.37E+01	1.59E+01	2.44E+01	2.99E+01	4.12E+01	4.81E+01
27	2.51E+01	1.64E+01	1.65E+01	1.91E+01	2.93E+01	3.59E+01	4.94E+01	5.77E+01
28	2.00E+01	1.97E+01	1.98E+01	2.29E+01	3.51E+01	4.30E+01	5.93E+01	6.92E+01
29	1.58E+01	2.36E+01	2.38E+01	2.75E+01	4.22E+01	5.17E+01	7.11E+01	8.29E+01
30	1.26E+01	2.83E+01	2.85E+01	3.30E+01	5.06E+01	6.19E+01	8.51E+01	9.90E+01
31	1.00E+01	3.39E+01	3.42E+01	3.96E+01	6.06E+01	7.41E+01	1.02E+02	1.18E+02
32	7.94E+00	4.06E+01	4.09E+01	4.74E+01	7.23E+01	8.84E+01	1.21E+02	1.40E+02
33	6.31E+00	4.85E+01	4.88E+01	5.67E+01	8.61E+01	1.05E+02	1.43E+02	1.64E+02
34	5.01E+00	5.78E+01	5.82E+01	6.76E+01	1.02E+02	1.24E+02	1.67E+02	1.91E+02
35	3.98E+00	6.87E+01	6.91E+01	8.05E+01	1.20E+02	1.46E+02	1.94E+02	2.20E+02
36	3.16E+00	8.14E+01	8.19E+01	9.56E+01	1.40E+02	1.69E+02	2.23E+02	2.52E+02
37	2.51E+00	9.61E+01	9.67E+01	1.13E+02	1.62E+02	1.95E+02	2.54E+02	2.84E+02
38	2.00E+00	1.13E+02	1.14E+02	1.33E+02	1.86E+02	2.22E+02	2.85E+02	3.17E+02
39	1.58E+00	1.32E+02	1.33E+02	1.57E+02	2.10E+02	2.49E+02	3.16E+02	3.49E+02
40	1.26E+00	1.54E+02	1.55E+02	1.83E+02	2.34E+02	2.76E+02	3.46E+02	3.78E+02
41	1.00E+00	1.78E+02	1.79E+02	2.12E+02	2.58E+02	3.02E+02	3.73E+02	4.04E+02
42	7.94E-01	2.04E+02	2.05E+02	2.41E+02	2.79E+02	3.25E+02	3.95E+02	4.25E+02
43	6.31E-01	2.30E+02	2.31E+02	2.63E+02	2.96E+02	3.44E+02	4.10E+02	4.37E+02
44	5.01E-01	2.57E+02	2.54E+02	2.78E+02	3.07E+02	3.55E+02	4.16E+02	4.40E+02
45	3.98E-01	2.82E+02	2.71E+02	2.82E+02	3.10E+02	3.58E+02	4.11E+02	4.31E+02
46	3.16E-01	3.01E+02	2.79E+02	2.76E+02	3.03E+02	3.50E+02	3.94E+02	4.09E+02
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Table 72: (GCRFLX) Ion Fluxes at Shield Layers

FLUXES THROUGH LAYER 1, THICKNESS IS 1.2500E-01 CM OF ALUMINUM

I	E	1=Z	2=Z	3=Z	4=Z	5=Z	6=Z	7=Z
1	1.00E+04	2.78E-01	1.79E-01	7.69E-04	4.10E-04	1.12E-03	5.45E-03	1.21E-03
2	7.94E+03	4.25E-01	2.87E-01	1.36E-03	7.28E-04	1.99E-03	8.74E-03	2.06E-03
3	6.31E+03	6.37E-01	4.54E-01	2.39E-03	1.27E-03	3.47E-03	1.38E-02	3.42E-03
4	5.01E+03	9.30E-01	7.03E-01	4.10E-03	2.18E-03	5.96E-03	2.14E-02	5.54E-03
5	3.98E+03	1.32E+00	1.07E+00	6.89E-03	3.68E-03	1.00E-02	3.25E-02	8.74E-03
6	3.16E+03	1.81E+00	1.59E+00	1.10E-02	5.86E-03	1.60E-02	4.83E-02	1.34E-02
7	2.51E+03	2.39E+00	2.30E+00	1.59E-02	8.50E-03	2.32E-02	6.99E-02	1.97E-02
8	2.00E+03	2.94E+00	3.23E+00	2.24E-02	1.20E-02	3.26E-02	9.83E-02	2.81E-02
9	1.58E+03	2.52E+00	4.41E+00	3.05E-02	1.63E-02	4.44E-02	1.34E-01	3.85E-02
10	1.26E+03	1.71E+00	5.80E+00	4.02E-02	2.14E-02	5.84E-02	1.76E-01	5.07E-02
11	1.00E+03	1.15E+00	7.34E+00	5.09E-02	2.71E-02	7.40E-02	2.23E-01	6.37E-02
12	7.94E+02	7.61E-01	8.94E+00	6.19E-02	3.30E-02	9.01E-02	2.72E-01	7.65E-02
13	6.31E+02	5.75E-01	8.69E+00	7.22E-02	3.83E-02	1.00E-01	2.64E-01	7.31E-02
14	5.01E+02	3.81E-01	6.33E+00	6.81E-02	3.41E-02	8.29E-02	1.92E-01	5.20E-02
15	3.98E+02	1.22E-01	4.45E+00	5.02E-02	2.37E-02	5.70E-02	1.35E-01	3.56E-02
16	3.16E+02	2.79E-02	3.02E+00	3.29E-02	1.62E-02	3.73E-02	9.16E-02	2.35E-02
17	2.51E+02	0.00E+00	1.96E+00	2.16E-02	1.05E-02	2.42E-02	5.95E-02	1.49E-02
18	2.00E+02	0.00E+00	1.42E+00	1.29E-02	6.60E-03	1.62E-02	4.30E-02	1.05E-02
19	1.58E+02	0.00E+00	9.83E-01	9.30E-03	4.72E-03	1.18E-02	2.97E-02	7.14E-03
20	1.26E+02	0.00E+00	4.30E-01	6.22E-03	3.04E-03	7.57E-03	1.30E-02	3.08E-03
21	1.00E+02	0.00E+00	1.22E-01	3.12E-03	1.23E-03	2.73E-03	3.67E-03	8.67E-04
22	7.94E+01	0.00E+00	2.77E-02	7.93E-04	3.04E-04	5.12E-04	8.25E-04	1.96E-04
23	6.31E+01	0.00E+00	0.00E+00	2.52E-04	8.46E-05			

I	E	8=Z	9=Z	10=Z	11=Z	12=Z	13=Z	14=Z
1	1.00E+04	5.09E-03	1.09E-04	8.30E-04	1.83E-04	1.19E-03	1.92E-04	9.17E-04
2	7.94E+03	8.16E-03	1.74E-04	1.33E-03	2.93E-04	1.86E-03	3.07E-04	1.43E-03
3	6.31E+03	1.29E-02	2.75E-04	2.10E-03	4.63E-04	2.88E-03	4.85E-04	2.21E-03
4	5.01E+03	2.00E-02	4.26E-04	3.26E-03	7.18E-04	4.38E-03	7.53E-04	3.37E-03
5	3.98E+03	3.04E-02	6.48E-04	4.95E-03	1.09E-03	6.57E-03	1.14E-03	5.05E-03
6	3.16E+03	4.51E-02	9.63E-04	7.35E-03	1.62E-03	9.65E-03	1.70E-03	7.43E-03
7	2.51E+03	6.53E-02	1.39E-03	1.06E-02	2.35E-03	1.39E-02	2.46E-03	1.07E-02
8	2.00E+03	9.18E-02	1.96E-03	1.50E-02	3.30E-03	1.95E-02	3.46E-03	1.50E-02
9	1.58E+03	1.25E-01	2.67E-03	2.04E-02	4.49E-03	2.65E-02	4.71E-03	2.04E-02
10	1.26E+03	1.65E-01	3.51E-03	2.68E-02	5.91E-03	3.49E-02	6.20E-03	2.68E-02
11	1.00E+03	2.09E-01	4.45E-03	3.40E-02	7.49E-03	4.42E-02	7.86E-03	3.40E-02
12	7.94E+02	2.54E-01	5.41E-03	4.14E-02	9.11E-03	5.38E-02	9.56E-03	4.14E-02
13	6.31E+02	2.47E-01	5.84E-03	4.12E-02	9.59E-03	5.36E-02	9.96E-03	4.07E-02
14	5.01E+02	1.80E-01	4.73E-03	3.02E-02	7.68E-03	4.08E-02	7.84E-03	3.02E-02
15	3.98E+02	1.26E-01	3.17E-03	2.10E-02	5.23E-03	2.79E-02	5.29E-03	2.10E-02
16	3.16E+02	8.56E-02	2.14E-03	1.43E-02	3.51E-03	1.86E-02	3.62E-03	1.39E-02
17	2.51E+02	5.55E-02	1.35E-03	9.04E-03	2.19E-03	1.19E-02	2.25E-03	9.02E-03
18	2.00E+02	4.01E-02	9.31E-04	6.72E-03	1.54E-03	8.72E-03	1.61E-03	6.50E-03
19	1.58E+02	2.77E-02	6.86E-04	4.51E-03	1.11E-03	6.11E-03	1.12E-03	4.48E-03
20	1.26E+02	1.21E-02	3.92E-04	1.96E-03	6.03E-04	2.54E-03	6.29E-04	1.94E-03

:

Table 73: (GCRREM) Physical/REM Dose Output

TOTAL GM/SQCM IS 1.013E+01, RAD/REM DOSE IN WATER

GM/SQCM	Z	RAD(Z)	REM(Z)	REM(Z)	RAD(<Z)	REM(<Z)	REM(<Z)
1.013E+01	1	3.18E-04	3.18E-04	3.18E-04	3.18E-04	3.18E-04	3.18E-04
1.013E+01	2	2.26E-03	2.29E-03	2.29E-03	2.58E-03	2.60E-03	2.61E-03
1.013E+01	3	3.70E-05	3.89E-05	3.90E-05	2.61E-03	2.64E-03	2.64E-03
1.013E+01	4	3.62E-05	4.56E-05	4.61E-05	2.65E-03	2.69E-03	2.69E-03
1.013E+01	5	1.48E-04	2.58E-04	2.61E-04	2.80E-03	2.95E-03	2.95E-03
1.013E+01	6	6.47E-04	1.51E-03	1.53E-03	3.45E-03	4.45E-03	4.49E-03
1.013E+01	7	2.44E-04	7.26E-04	7.46E-04	3.69E-03	5.18E-03	5.23E-03
1.013E+01	8	1.07E-03	3.88E-03	4.01E-03	4.76E-03	9.06E-03	9.24E-03
1.013E+01	9	2.99E-05	1.33E-04	1.38E-04	4.79E-03	9.20E-03	9.38E-03
1.013E+01	10	2.77E-04	1.49E-03	1.58E-03	5.07E-03	1.07E-02	1.10E-02
1.013E+01	11	7.52E-05	4.67E-04	4.99E-04	5.14E-03	1.11E-02	1.15E-02
1.013E+01	12	5.16E-04	3.65E-03	3.91E-03	5.66E-03	1.48E-02	1.54E-02
1.013E+01	13	1.09E-04	8.73E-04	9.44E-04	5.77E-03	1.57E-02	1.63E-02
1.013E+01	14	5.51E-04	4.99E-03	5.42E-03	6.32E-03	2.07E-02	2.17E-02
1.013E+01	15	3.22E-05	3.24E-04	3.64E-04	6.35E-03	2.10E-02	2.21E-02
1.013E+01	16	1.42E-04	1.56E-03	1.77E-03	6.49E-03	2.25E-02	2.39E-02
1.013E+01	17	1.44E-02	1.72E-01	1.94E-01	2.09E-02	1.95E-01	2.18E-01
1.013E+01	18	3.12E-02	4.08E-01	4.72E-01	5.21E-02	6.02E-01	6.90E-01
1.013E+01	19	2.34E-02	3.28E-01	3.76E-01	7.55E-02	9.30E-01	1.07E+00
1.013E+01	20	5.54E-02	8.17E-01	9.33E-01	1.31E-01	1.75E+00	2.00E+00
1.013E+01	21	1.33E-02	2.14E-01	2.58E-01	1.44E-01	1.96E+00	2.26E+00
1.013E+01	22	5.19E-02	8.82E-01	1.10E+00	1.96E-01	2.84E+00	3.35E+00
1.013E+01	23	2.75E-02	4.91E-01	6.56E-01	2.24E-01	3.33E+00	4.01E+00
1.013E+01	24	5.92E-02	1.10E+00	1.48E+00	2.83E-01	4.44E+00	5.49E+00
1.013E+01	25	4.61E-02	8.89E-01	1.24E+00	3.29E-01	5.32E+00	6.73E+00
1.013E+01	26	4.61E-01	9.13E+00	1.25E+01	7.90E-01	1.45E+01	1.93E+01
1.013E+01	27	1.66E-03	3.32E-02	4.86E-02	7.91E-01	1.45E+01	1.93E+01
1.013E+01	28	2.60E-02	5.19E-01	7.89E-01	8.17E-01	1.50E+01	2.01E+01
FLUX BY ION		9.50E+03	1.51E+04	1.09E+02	5.77E+01	1.54E+02	4.70E+02
FLUX BY ION		1.30E+02	4.40E+02	9.58E+00	7.12E+01	1.59E+01	9.18E+01
FLUX BY ION		1.64E+01	7.12E+01	3.60E+00	1.39E+01	1.27E+03	2.41E+03
FLUX BY ION		1.64E+03	3.57E+03	7.54E+02	2.65E+03	1.27E+03	2.52E+03
FLUX BY ION		1.81E+03	1.72E+04	5.71E+01	8.34E+02		

Table 74: (GCRSUM) GCRSUM.DAT Output Format

```
1.250E-01  1  1  4.69E-04  5.10E-04  5.10E-04  4.69E-04  5.10E-04  5.10E-04
1.250E-01  1  2  3.01E-03  3.73E-03  3.73E-03  3.48E-03  4.24E-03  4.24E-03
1.250E-01  1  3  4.34E-05  6.32E-05  6.38E-05  3.52E-03  4.30E-03  4.30E-03
1.250E-01  1  4  4.28E-05  7.76E-05  7.99E-05  3.56E-03  4.38E-03  4.38E-03
1.250E-01  1  5  1.77E-04  3.98E-04  4.16E-04  3.74E-03  4.78E-03  4.80E-03
1.250E-01  1  6  8.04E-04  2.36E-03  2.51E-03  4.54E-03  7.13E-03  7.31E-03
1.250E-01  1  7  2.91E-04  1.04E-03  1.13E-03  4.83E-03  8.17E-03  8.44E-03
1.250E-01  1  8  1.30E-03  5.50E-03  6.03E-03  6.14E-03  1.37E-02  1.45E-02
1.250E-01  1  9  3.52E-05  1.76E-04  1.96E-04  6.17E-03  1.39E-02  1.47E-02
1.250E-01  1 10  3.37E-04  1.99E-03  2.25E-03  6.51E-03  1.58E-02  1.69E-02
1.250E-01  1 11  8.88E-05  5.87E-04  6.71E-04  6.60E-03  1.64E-02  1.76E-02
1.250E-01  1 12  6.33E-04  4.74E-03  5.50E-03  7.23E-03  2.12E-02  2.31E-02
1.250E-01  1 13  1.30E-04  1.08E-03  1.26E-03  7.36E-03  2.22E-02  2.43E-02
1.250E-01  1 14  6.64E-04  6.14E-03  7.33E-03  8.02E-03  2.84E-02  3.17E-02
1.250E-01  1 15  3.79E-05  3.80E-04  4.61E-04  8.06E-03  2.88E-02  3.21E-02
1.250E-01  1 16  1.74E-04  1.91E-03  2.35E-03  8.24E-03  3.07E-02  3.45E-02
1.250E-01  1 17  1.60E-02  1.81E-01  2.38E-01  2.42E-02  2.12E-01  2.72E-01
1.250E-01  1 18  3.31E-02  4.03E-01  5.37E-01  5.73E-02  6.14E-01  8.09E-01
1.250E-01  1 19  2.56E-02  3.33E-01  4.48E-01  8.29E-02  9.48E-01  1.26E+00
1.250E-01  1 20  5.91E-02  7.96E-01  1.04E+00  1.42E-01  1.74E+00  2.30E+00
1.250E-01  1 21  1.45E-02  2.12E-01  2.92E-01  1.57E-01  1.96E+00  2.59E+00
1.250E-01  1 22  5.58E-02  8.59E-01  1.20E+00  2.12E-01  2.82E+00  3.80E+00
1.250E-01  1 23  2.90E-02  4.69E-01  6.67E-01  2.41E-01  3.28E+00  4.46E+00
1.250E-01  1 24  6.30E-02  1.07E+00  1.53E+00  3.04E-01  4.35E+00  6.00E+00
1.250E-01  1 25  4.88E-02  8.62E-01  1.26E+00  3.53E-01  5.21E+00  7.26E+00
1.250E-01  1 26  4.71E-01  8.55E+00  1.21E+01  8.24E-01  1.38E+01  1.94E+01
1.250E-01  1 27  1.73E-03  3.25E-02  4.69E-02  8.26E-01  1.38E+01  1.94E+01
1.250E-01  1 28  2.73E-02  5.30E-01  7.79E-01  8.53E-01  1.43E+01  2.02E+01
FLUX BY ION  1.46E+04  1.99E+04  1.33E+02  7.10E+01  1.94E+02  6.03E+02
FLUX BY ION  1.63E+02  5.63E+02  1.20E+01  9.17E+01  2.02E+01  1.20E+02
FLUX BY ION  2.12E+01  9.25E+01  4.63E+00  1.86E+01  1.57E+03  2.92E+03
FLUX BY ION  2.02E+03  4.37E+03  9.44E+02  3.30E+03  1.57E+03  3.14E+03
FLUX BY ION  2.25E+03  2.08E+04  7.08E+01  1.04E+03
1.250E-01  2  1  5.94E-04  7.11E-04  7.11E-04  5.94E-04  7.11E-04  7.11E-04
1.250E-01  2  2  3.84E-03  5.42E-03  5.51E-03  4.43E-03  6.14E-03  6.23E-03
1.250E-01  2  3  5.53E-05  9.33E-05  9.90E-05  4.49E-03  6.23E-03  6.32E-03
1.250E-01  2  4  5.46E-05  1.20E-04  1.31E-04  4.54E-03  6.35E-03  6.46E-03
1.250E-01  2  5  2.25E-04  6.26E-04  6.95E-04  4.77E-03  6.97E-03  7.15E-03
1.250E-01  2  6  1.02E-03  3.68E-03  4.17E-03  5.79E-03  1.07E-02  1.13E-02
  :
1.250E-01  2 24  7.99E-02  1.50E+00  2.46E+00  3.86E-01  6.26E+00  9.65E+00
1.250E-01  2 25  6.19E-02  1.20E+00  2.02E+00  4.48E-01  7.46E+00  1.17E+01
1.250E-01  2 26  5.96E-01  1.18E+01  1.92E+01  1.04E+00  1.93E+01  3.09E+01
1.250E-01  2 27  2.18E-03  4.36E-02  7.44E-02  1.05E+00  1.93E+01  3.10E+01
1.250E-01  2 28  3.45E-02  6.89E-01  1.23E+00  1.08E+00  2.00E+01  3.22E+01
FLUX BY ION  1.46E+04  1.99E+04  1.33E+02  7.10E+01  1.94E+02  6.03E+02
FLUX BY ION  1.63E+02  5.63E+02  1.20E+01  9.17E+01  2.02E+01  1.20E+02
FLUX BY ION  2.12E+01  9.25E+01  4.63E+00  1.86E+01  1.57E+03  2.92E+03
FLUX BY ION  2.02E+03  4.37E+03  9.44E+02  3.30E+03  1.57E+03  3.14E+03
FLUX BY ION  2.25E+03  2.08E+04  7.08E+01  1.04E+03
```

Figure 39: (GCRCBI) Cumulative Dose by GCR Ion

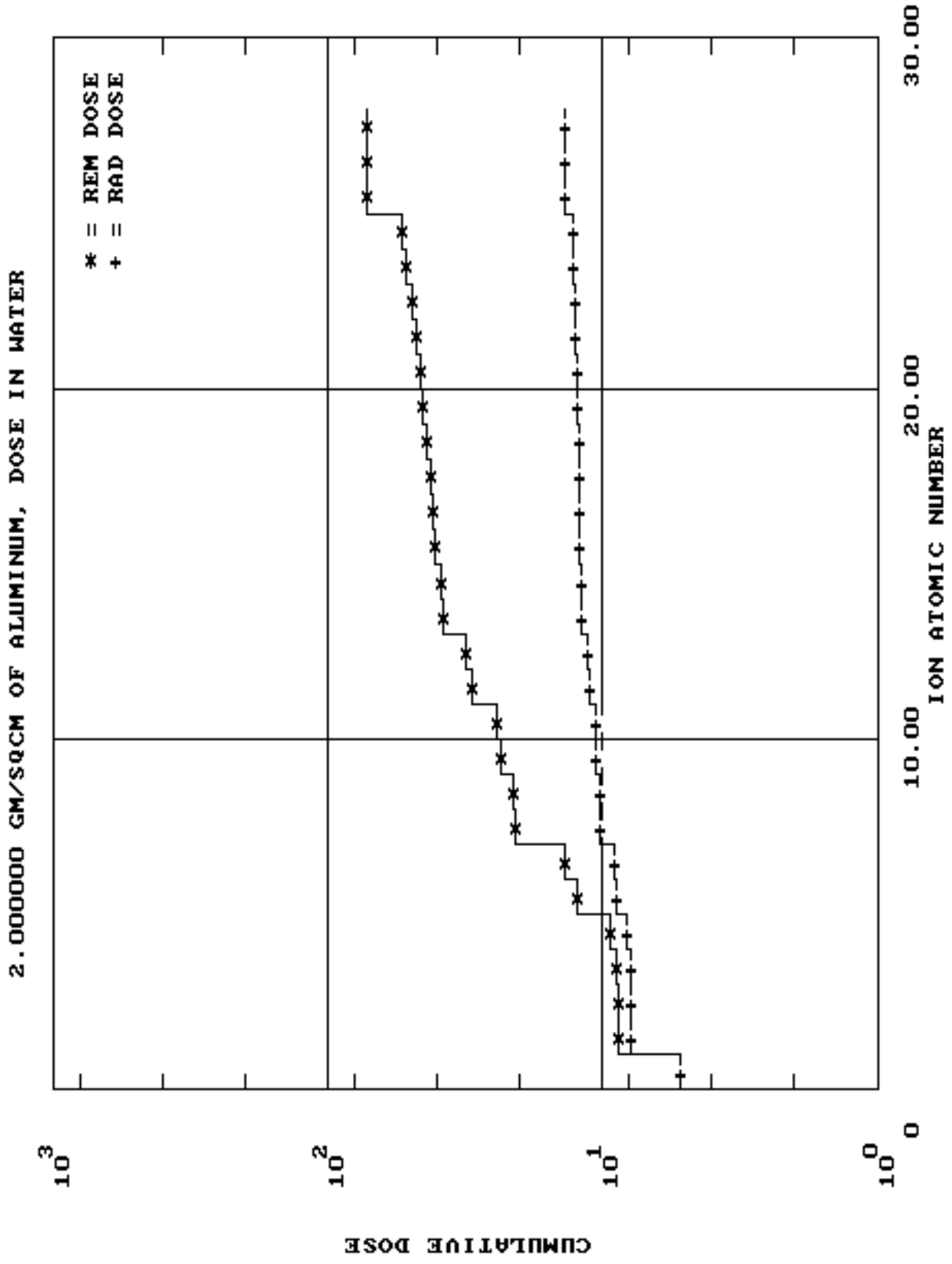


Figure 40: (GCRDBI) GCR Dose by Ion Specie

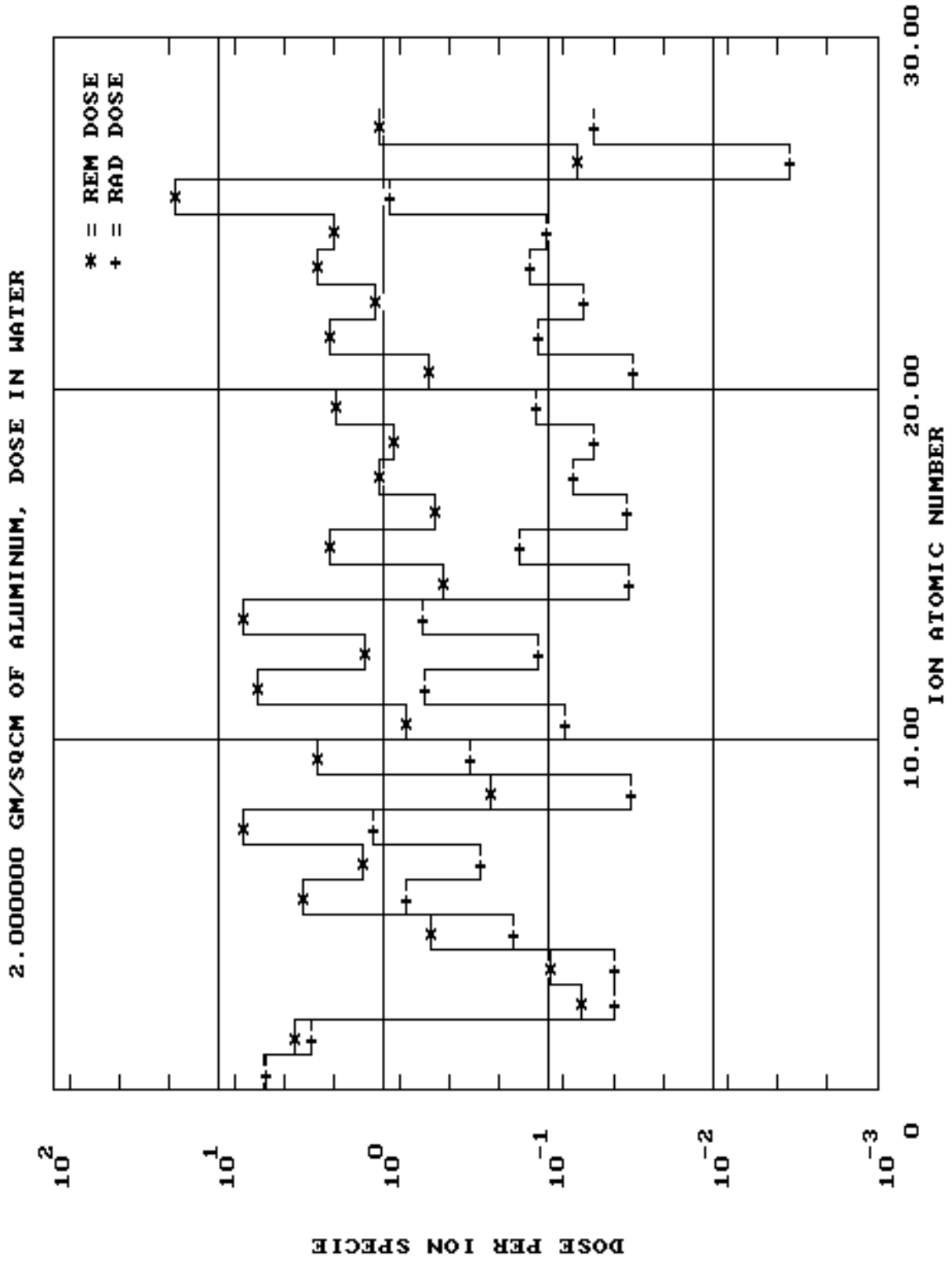
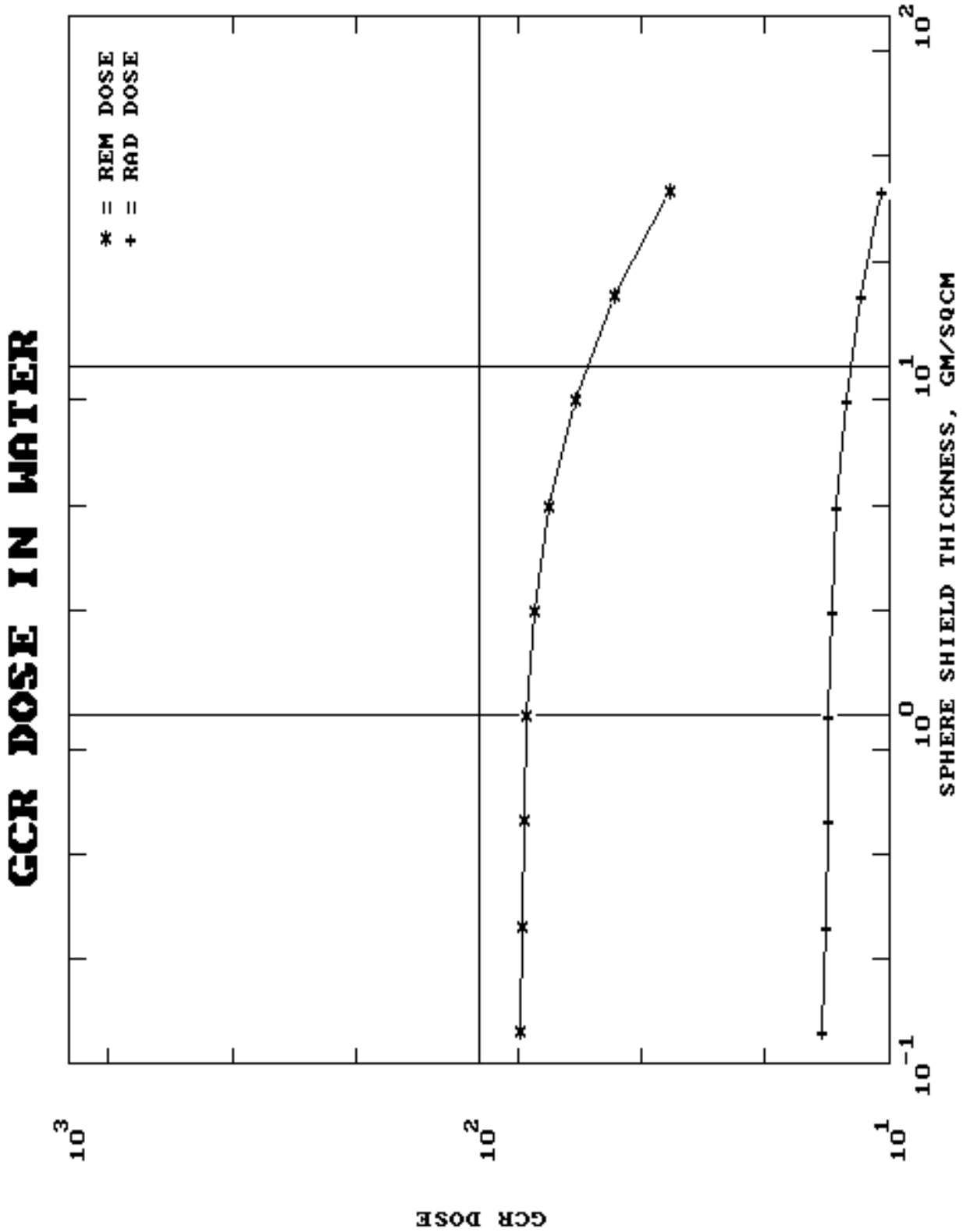


Figure 41: (GCRDVT) GCR Dose Versus Thickness



GEOMETRY

GEOMETRY discusses basic geometry modeling concepts.

****
Basic GEOMETRY concepts are discussed here: surface, body, region, combinatorial geometry, etc..
****

****
Discussion
****

The following terminology is clarified:

Surface, the usual analytic geometry definition

body, level 0, a volume enclosed by one or more surfaces

body, level >0, a volume defined by the intersection of other bodies

region, a body, any level , containing a single material of constant density , or void.

A surface is any expression of the form

$$U(x) = U(x,y,z) = U(x_1, x_2, x_3) = 0$$

Most surfaces are expressed in the quadric form

$$U(x) = a_0 + \mathrm{Sum}(i=1,3)\ (a_i x_i + a_{i+3} x_i^2 + a_{i+6} x_i x_j)$$

Where a_0 through a_9 are constants,

$x_1, x_2, x_3 = x,y,z$

and $j=i+1$ modulo 3

i.e., for i=1,2,3 the values of j are j=2,3,1

A point $\underline{x}$ is on the surface if $U(\underline{x})=0$.

A point $\underline{x}$ is "inside" the surface if $U(\underline{x})<0$.

A point $\underline{x}$ is "outside" the surface if $U(\underline{x})>0$.

All geometry descriptors except *SURFACE/*REGION generate surfaces automatically. The *SURFACE processor recognizes simple inputs for most surfaces of interest.

Let Vi denote the volume inside surface i. The volume outside the surface is the complement of Vi and is denoted by -Vi .

These terms are indicated in the upper part of Figure 42 (GEOINT).

The volumes, interior or exterior, defined by surfaces can be unioned and intersected in a general manner to make new volumes. The volumes defined by surfaces, or their unions and intersections, are called bodies.

The intersection of two bodies yields a body containing point common to both bodies, as indicated in the lower part of Figure 42 (GEOINT).

The union of two bodies yields a body containing points in either body or both, see the lower portion of Figure 43 (GEOUNI).

The logic for handling combinations of bodies is more complicated if both unions and intersections are allowed. The logic is simplified by using intersection combinations only. Unions are still obtained by noting that

V1 U V2 = -(-V1 Intersect -V2)

i.e., the union of two bodies is the complement of the intersection of the body complements

In the upper part of Figure 43 (GEOUNI), the complement of the picture on the right (an intersection of body complements) is the picture obtained for body unions.

Figure 42: (GEOINT) Body Intersections

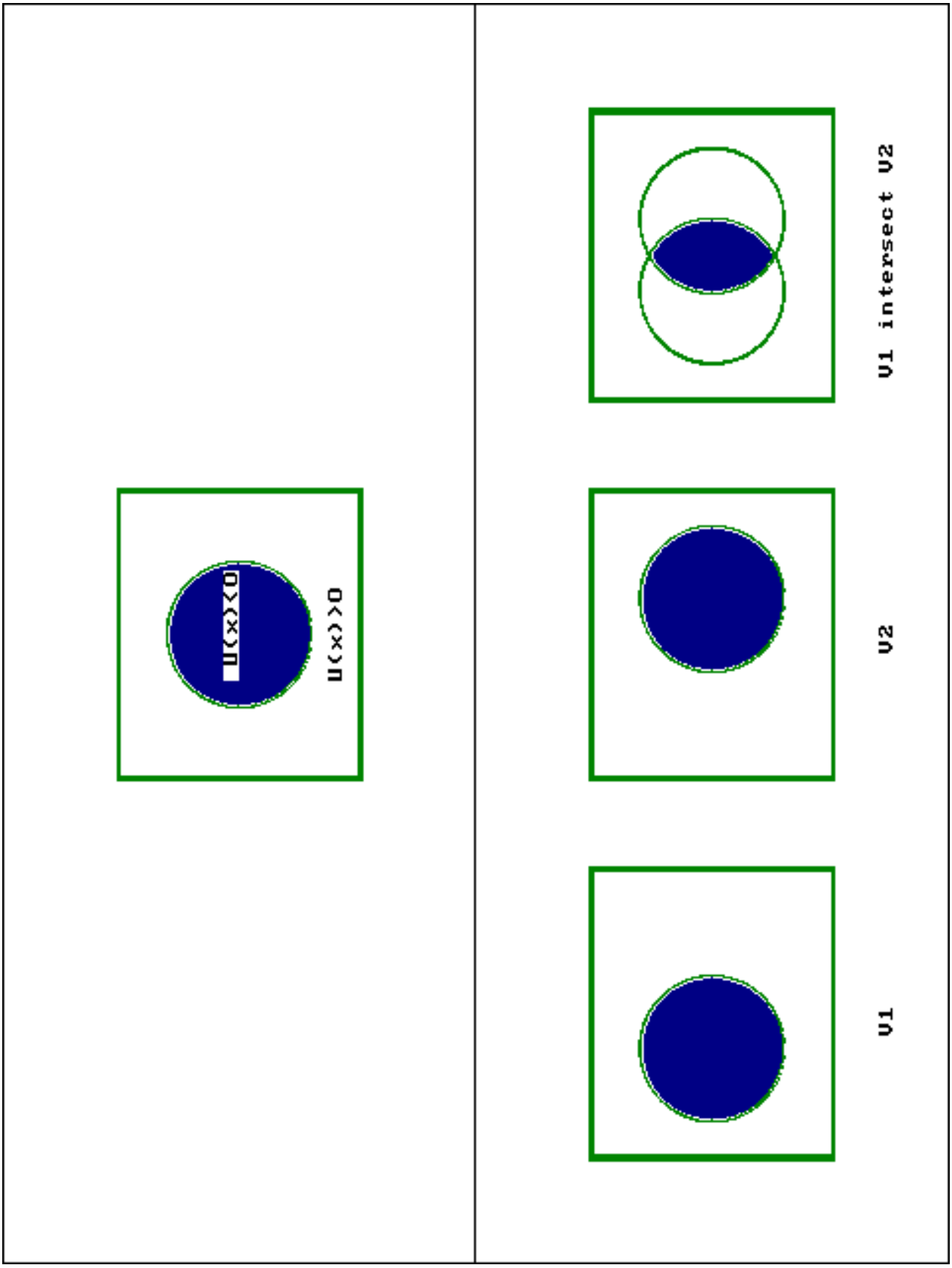
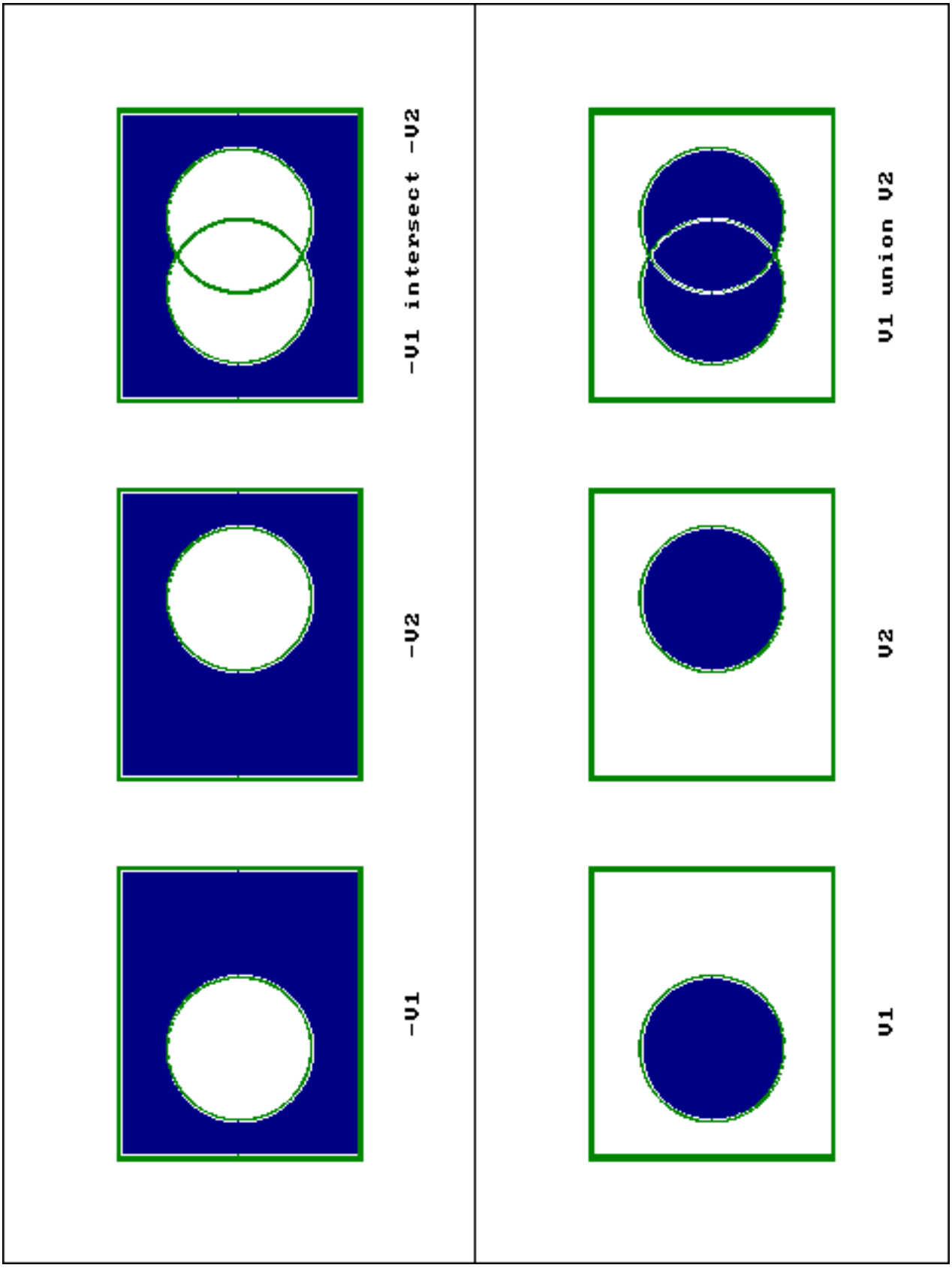


Figure 43: (GEOUNI) Body Unions



A region is a body of uniform material composition (or void). The body comprising the region is , in general, the intersection of other bodies (or their complements), and these other bodies are also intersections of lower level bodies (or their complements), etc., until the zeroth level bodies (surface interiors and exteriors) are encountered.

The logic for handling arbitrary levels of body intersections has been inplemented in the NOVICE code. Most of the geometry description options of the code barely use the general logic. A notable exception is the "combinatorial geometry" description discussed under *MAGIC. The combinaterial geometry inputs allow the union operation. This operation is implemented here as the complement of intersected complements.

The geometry description methods used in NOVICE can result in two or more regions bodies containing common points. This implies that the regions overlap, which can be viewed as either an error, or expected. The code logic allows the user to select which. Overlaps which do occur are resolved in favor of the region first defined.

Overlap logic is discussed further in the OVERLAP section.

The geometry logic does not require that all space be defined. Undefined space is assumed to be void. In fact, ray tracing is more efficient if voids are left undefined (solid bodies still have necessary portions deleted, but the deleted parts, if void , need not be made explicit regions).

The user can describe different subsets of the geometry with different local coordinates. When the subset data is submitted to the code, it is preceeded by rotate/translate instructions that tell the code how to move the subset to its actual position in the total geometry.

The rotate/translate instructions include translations, rotations in any plane about a fixed point, and reflection in an arbitrary plane. These capabilities are described in the *ROTATE section.

The final placement of subsets using rotate/translate is visualized more easily by assuming the code physically moves the subset as each rotate/translate instruction is encountered, i.e., after instruction one, the subset is where instruction one said to put it. Instruction two says given this position, now move the subset to the next position, etc..

The ability to load geometry several ways, makes it difficult to keep track of code assigned region numbers. This becomes evident when a subset of the geometry is being duplicated. The *DUPLICATE process is simplified by preceeding the subset being duplicated with *ADDRESS. Then the duplication reference to region n means region n since *ADDRESS.

Duplication does not make sense unless the duplicate has a different position. The different position is established by rotate/translate instructions prior to the duplicate instructions. It must be remembered that if the subset was rotated/translated during input, it resides in its final position. The *ROTATE sections contains an option for inverting the rotation/translation process as the first step in the process to be applied to the duplicates. The subset being duplicated is then effectively in the same state it was before loading.

++++++++++++
Output Tables
++++++++++++

During the input of the various geometry modeling processors, several lines of output are produced. These outputs include the indices and coefficients of new unique surfaces, the indices of duplicated surfaces (and the multiplier and precision of that duplication), the indices and surface/body lists of bodies definitions, and the indices and compositions of material regions. The format of these data are indicated in Table 75 (GEOINP).

++++++++++++++
Output Figures
++++++++++++++

Typical modeling performed by the program are indicated in several views of the Galileo spacecraft. Figure 44 (GEOZXV), gives a ZX cross section.

Figure 45 (GEOYZV) gives a YZ cross of the spacecraft.

Figure 46 (GEOXYV) gives a XY cross sections of this spacecraft.

A projected view of the spacecraft is shown in Figure 47 (GEOPRO).

The same view with a cutout is given in Figure 48 (GEOCUT).

A closer view with the same cutout is shown in Figure 49 (GEODUT). The geometry model used for these figures included use of the BAYS, DESIGN, SURFACE/REGION and ROTATE processors.

Table 75: (GEOINP) Outputs During Geometry Input

```
                 1         2         3         4         5         6         7
        12345678901234567890123456789012345678901234567890123456789012345678901234567890
INPUT *HEADER,OPTIONS/
Line  69:*DUPLICATE,O=2/,1 999 1 999/ PRODUCES 3rd & 4th CAPSULES-FIRST LAYER
        DATA INTERPRETATION STARTING AT COLUMN 16 OF LINE   69
             SURFACE  22  1.3338E+00  1.7171E+00  0.0000E+00  0.0000E+00
                          XX, YY, ZZ  3.6518E-01  0.0000E+00  3.6518E-01
             SURFACE   7 DUPLICATED, EPSILON, SCALE =   .00000000  1.00000000
             SURFACE   4 DUPLICATED, EPSILON, SCALE =   .00001000  1.00000000
     LEVEL  0 BODY      7,LIST=     4    -7    22
             SURFACE  22 DUPLICATED, EPSILON, SCALE =   .00000000  1.00000000
             SURFACE  16 DUPLICATED, EPSILON, SCALE =   .00000000  1.00000000
             SURFACE  17 DUPLICATED, EPSILON, SCALE =   .00000000  1.00000000
     LEVEL  0 BODY      8,LIST=   -16    17    22
             SURFACE  22 DUPLICATED, EPSILON, SCALE =   .00000000  1.00000000
             SURFACE   4 DUPLICATED, EPSILON, SCALE =   .00000000  1.00000000
             SURFACE   7 DUPLICATED, EPSILON, SCALE =   .00000000  1.00000000
             BODY      7, DUPLICATED
             REGION    7     7 2 0  1 -1.00E+00 -2.30E+00 -1.00E+00  0.00E+00
             SURFACE  23  1.2317E+00  1.6528E+00  0.0000E+00  0.0000E+00
                          XX, YY, ZZ  3.5152E-01  0.0000E+00  3.5152E-01
             SURFACE   5 DUPLICATED, EPSILON, SCALE =   .00000000  1.00000000
             SURFACE   8 DUPLICATED, EPSILON, SCALE =   .00000000  1.00000000
     LEVEL  0 BODY      9,LIST=     5    -8    23
             REGION    8     9 2 0  0  0.00E+00 -9.60E-01 -2.30E+00  0.00E+00
             SURFACE  24  1.1282E+00  1.5891E+00  0.0000E+00  0.0000E+00
                          XX, YY, ZZ  3.3795E-01  0.0000E+00  3.3795E-01
             SURFACE   6 DUPLICATED, EPSILON, SCALE =   .00000000  1.00000000
             SURFACE   9 DUPLICATED, EPSILON, SCALE =   .00000000  1.00000000
     LEVEL  0 BODY     10,LIST=     6    -9    24
             REGION    9    10 2 0  2 -1.00E+00 -9.00E-01 -2.30E+00  0.00E+00
             SURFACE  22 DUPLICATED, EPSILON, SCALE =   .00000000  1.00000000
             SURFACE  16 DUPLICATED, EPSILON, SCALE =   .00000000  1.00000000
             SURFACE  17 DUPLICATED, EPSILON, SCALE =   .00000000  1.00000000
             BODY      8, DUPLICATED
             REGION   10     8 2 0  1 -1.00E+00 -2.30E+00  1.00E+00  0.00E+00
             SURFACE  23 DUPLICATED, EPSILON, SCALE =   .00000000  1.00000000
             SURFACE  18 DUPLICATED, EPSILON, SCALE =   .00000000  1.00000000
             SURFACE  19 DUPLICATED, EPSILON, SCALE =   .00000000  1.00000000
     LEVEL  0 BODY     11,LIST=    18   -19    23
             REGION   11    11 2 0  0  0.00E+00 -9.60E-01  2.30E+00  0.00E+00
             SURFACE  24 DUPLICATED, EPSILON, SCALE =   .00000000  1.00000000
             SURFACE  20 DUPLICATED, EPSILON, SCALE =   .00000000  1.00000000
             SURFACE  21 DUPLICATED, EPSILON, SCALE =   .00000000  1.00000000
     LEVEL  0 BODY     12,LIST=    20   -21    24
             REGION   12    12 2 0  2 -1.00E+00 -9.00E-01  2.30E+00  0.00E+00
```

Figure 44: (GEOZXV) ZX Cross Section, Galileo

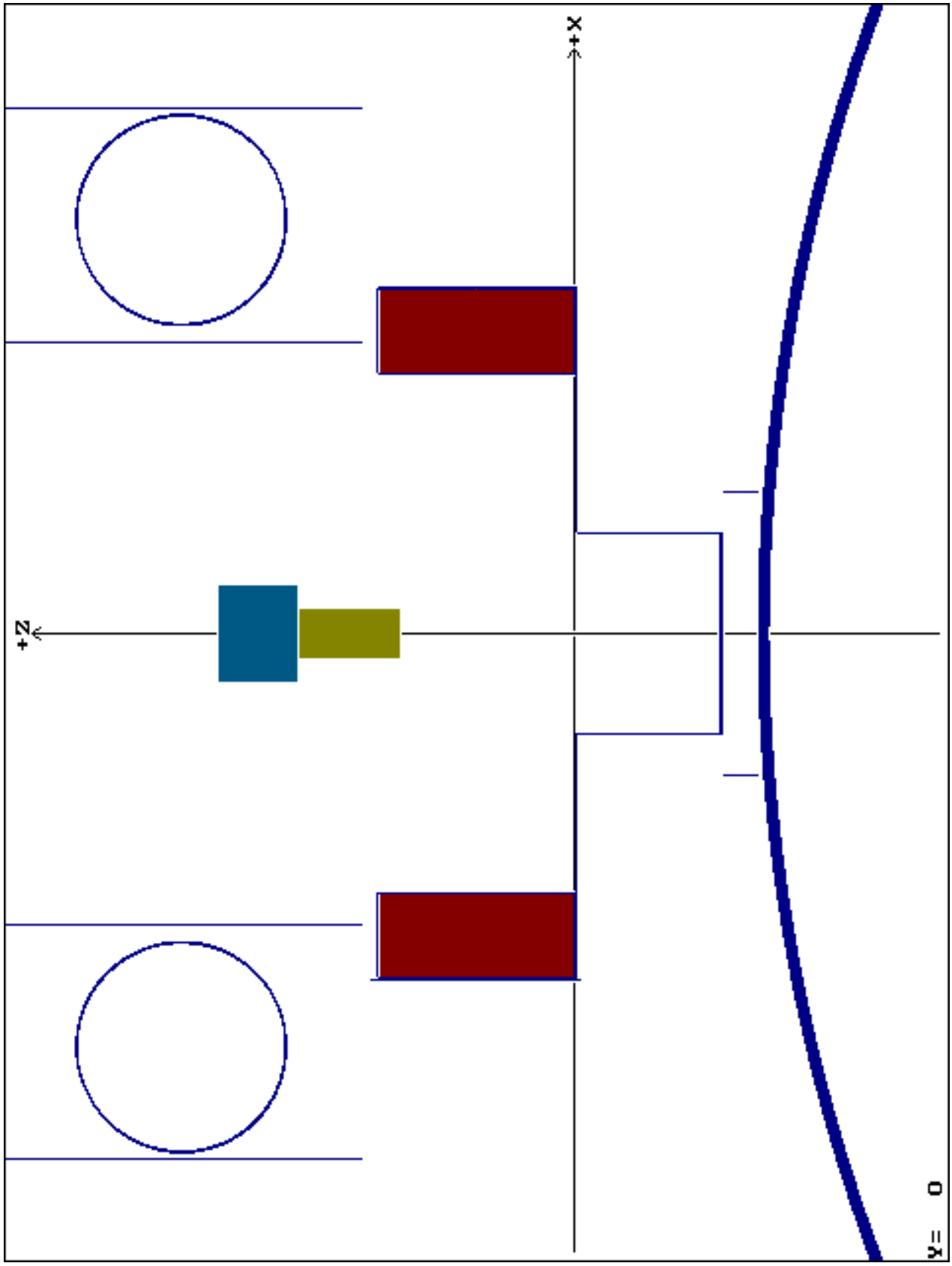


Figure 45: (GEOYZV) YZ Cross Section, Galileo

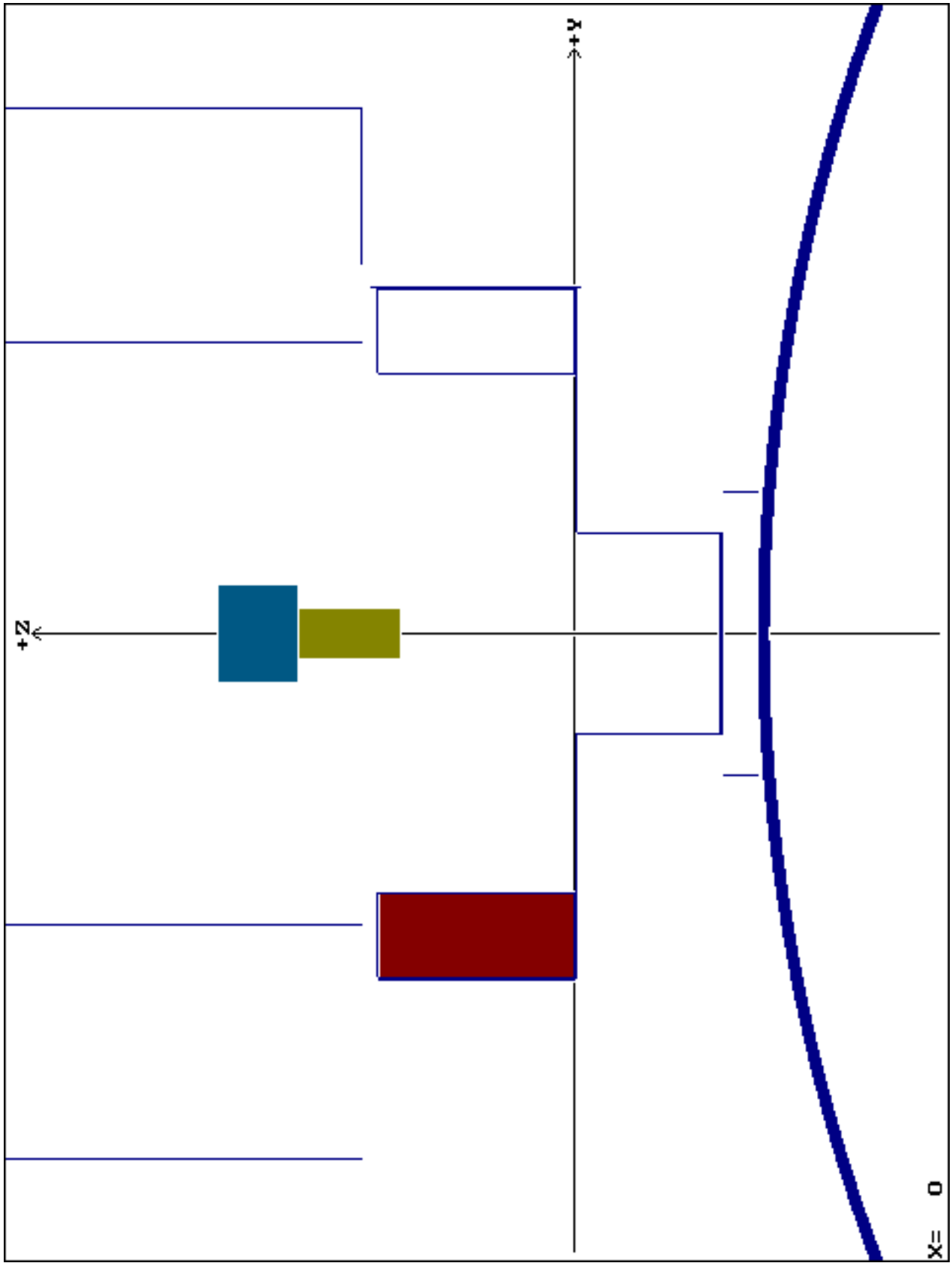


Figure 46: (GEOXYV) XY Cross Section, Galileo

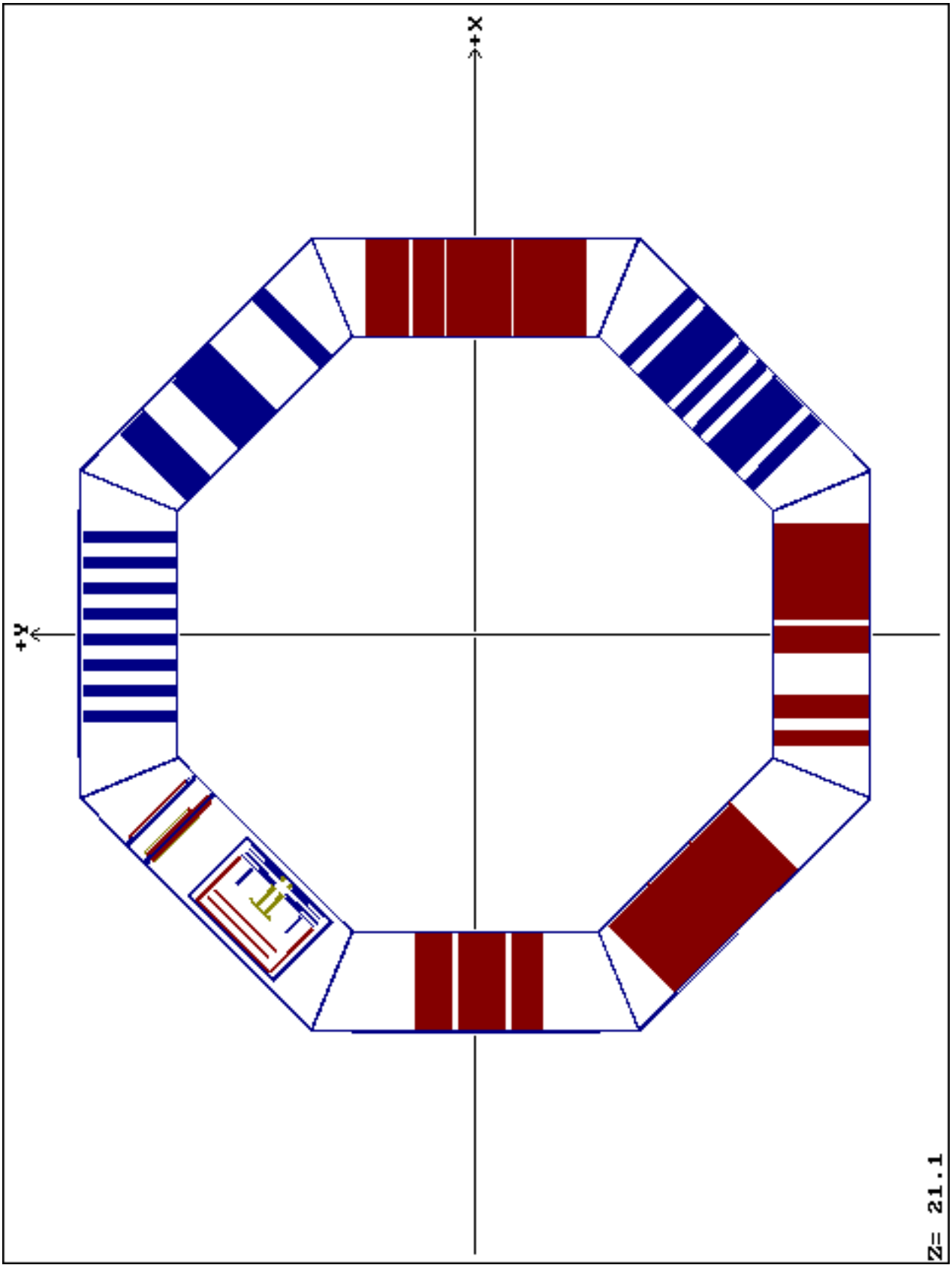


Figure 47: (GEOPRO) Projected View, Galileo

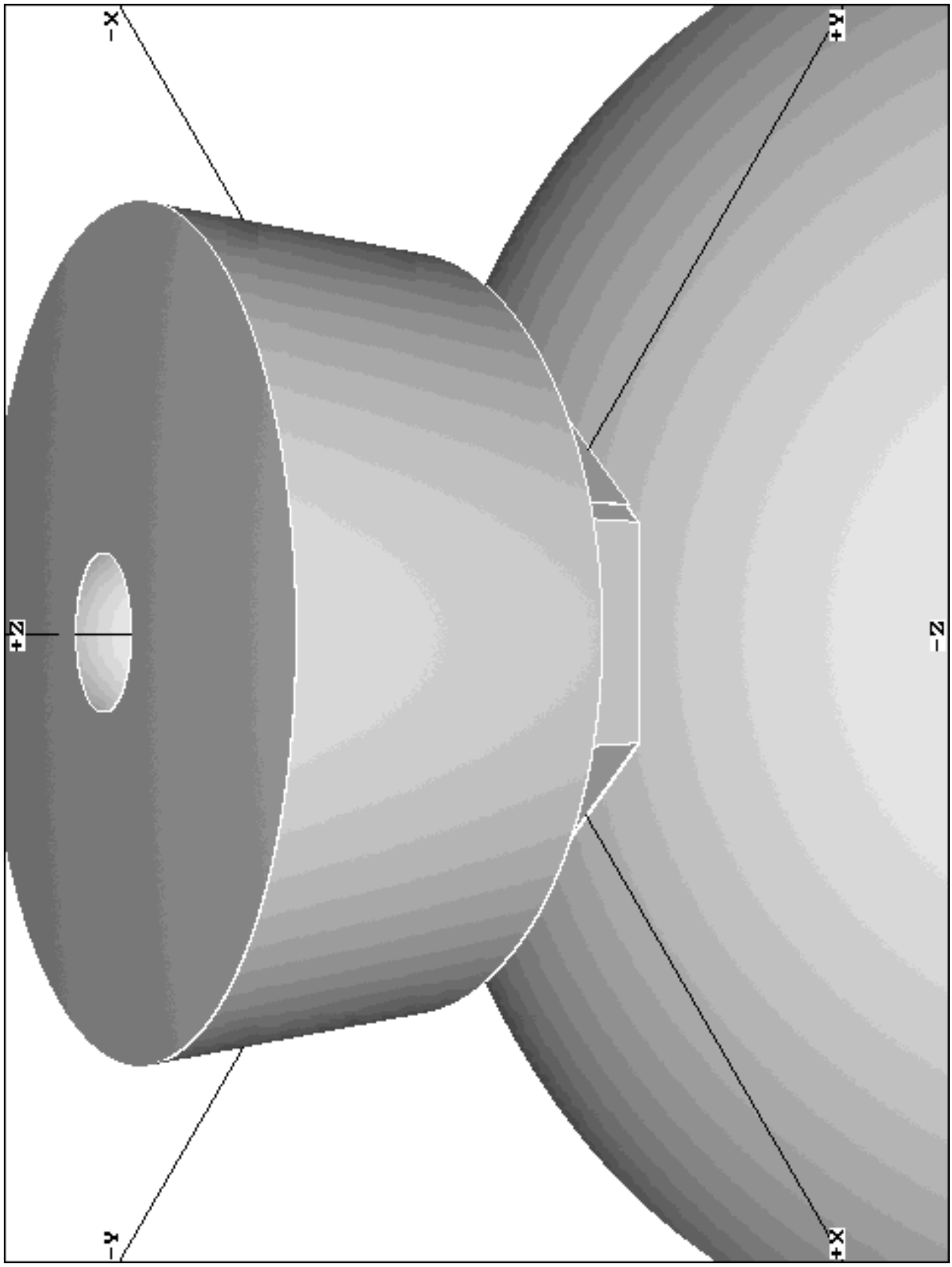


Figure 48: (GEOCUT) Projected Cutaway, Galileo

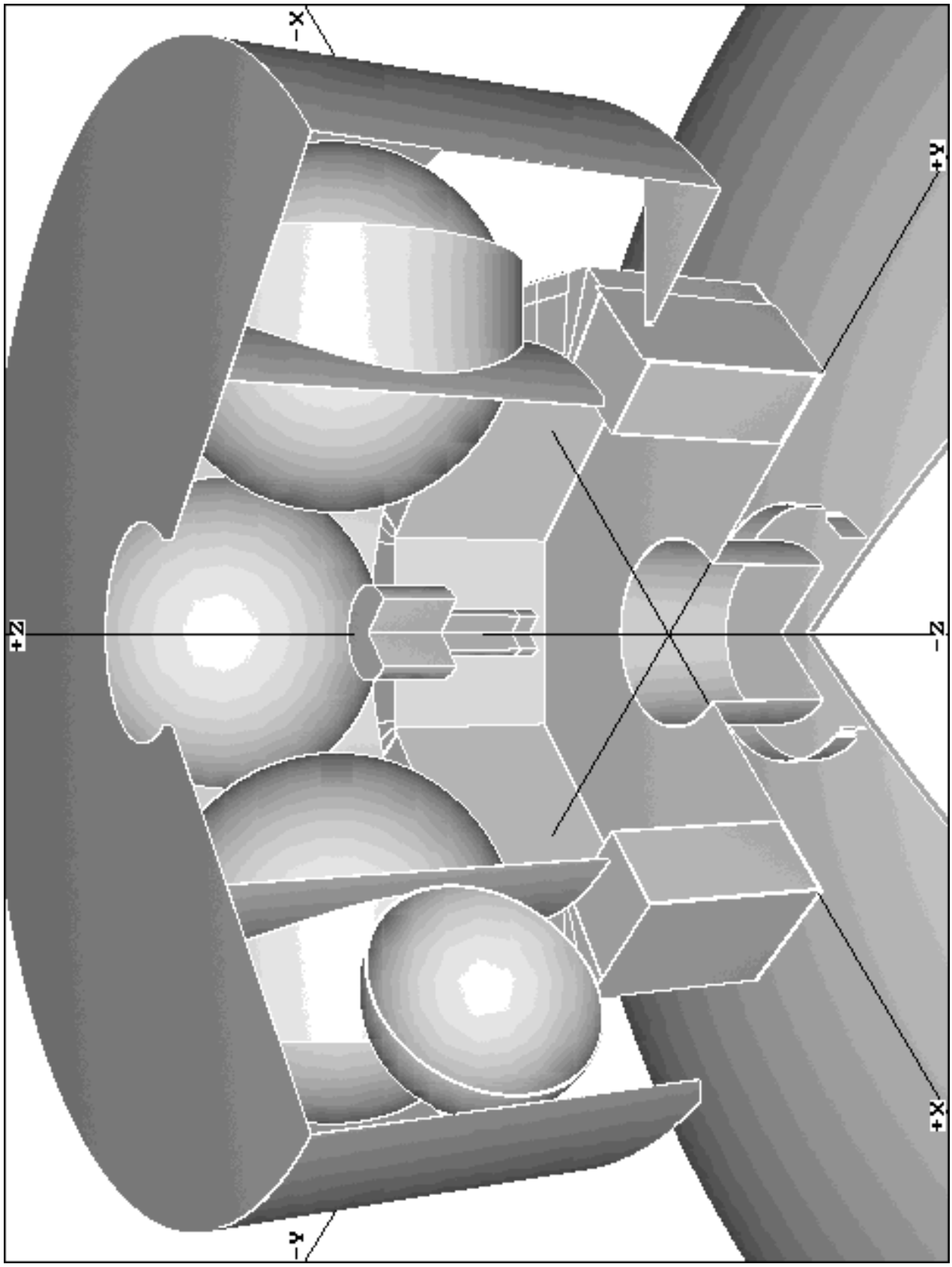
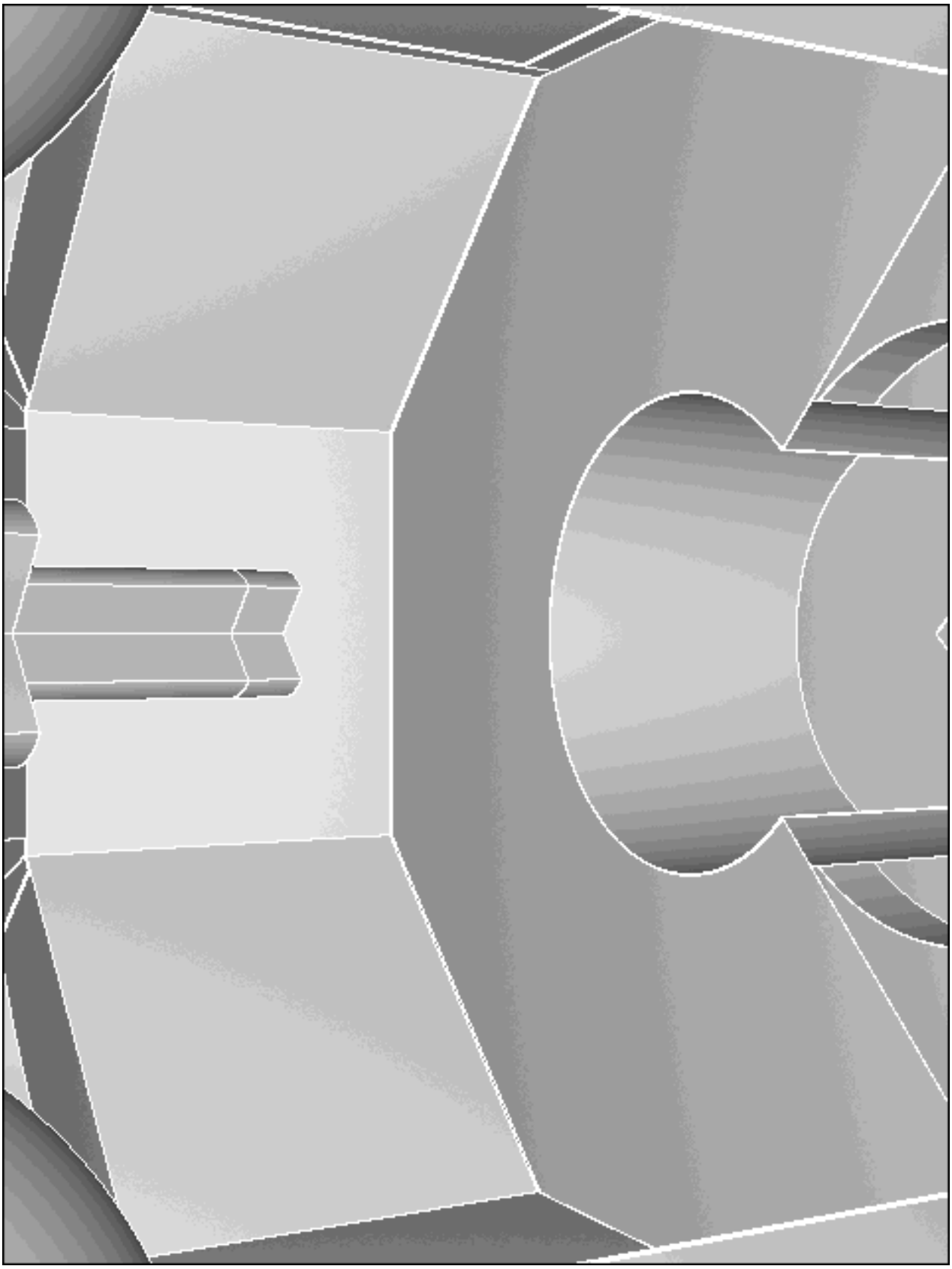


Figure 49: (GEODUT) Cutaway Closeup, Galileo



GET

GET inserts named files into the input stream.

****
The GET processor provides for retrieving input lines from various data files including files saved using the *PUT processor.
****

****
Input Data Record Description:
****

======
Header
======

Contains *GET in columns 1 through 4.

=======
Options
=======

No options apply.

****
Data Record Description:
****

=========
File Name
=========

This record contains the file name to be used for input. Input is taken from the named file until an end of file mark. Input then continues from the standard input file.

****
Discussion
****

The GET processor can now be accessed from within a NOVICE.RUN file (91FEB). Older code versions did not allow this capability.

The file being retrieved must start with a header line, i.e., this processor cannot be used to access other data files while within an input or analysis processor.

To retrieve data files while within a processor, use the command

&GET name

where '&GET ' are in columns 1 through 5 and 'name' is the name of the data file.

*GET and &GET files can contain *GET/&GET commands, up to 10 levels deep.

The command '&LIB name' will get partial data sets from the ascii file 'LIBRARY.DAT'. These data sets must start with a line of the form c ***name and the data set ends with the next line containing c *** in columns 1 through 6. 'name' indicates any string of ascii characters.

The same logic is used if the input line contains &lib in columns 1 through 4 with column 5 not blank. The columns 2 up to the first blank column are used as the name of the library file, e.g.

&library2.dat iskibidly

will open the ascii file 'LIBRARY2.DAT' and search that file for the line that starts with

```
    ***iskibidly
   c
```

NOTE, the name string is case sensitive (and the library file is also) on unix systems (on DOS systems, case does not matter).

In 1996 March, the user can also designate files with automatic path addition to the file names. For the &GET command, precede the file name by *+-&% for the (library, new, old, user, temp) paths. For the &LIB command, follow the & by *+-&% to indicate the path, e.g. &&LIB datasetname will look for a file named LIBRARY.NEW in the USER directory.

GRAPHICS

GRAPHICS discusses common graphics topics

****
The GRAPHICS section is a discussion of several graphics topics in NOVICE. In particular, the P option discussions have been removed from PICTURE and PLOT and put here.
****

****
Discussion
****

The P option in both *PLOT and *PICTURE can select to have NOVICE drive a HP printer directly. This is option is now considered obsolete since: (1) NOVICE saves graphics output in PCX format, and (2) most word processors can now input color PCX files, resize, etc., and then print. The old P options still work with some HP printers and are:

P, print picture

P=-1, print-screen output (only works on 320 by 200 black and white).

The first four options below (P=0 thru 3) were developed to simulate the "print screen" key when using monochrome graphics and resolutions such as 320x100, 640x200, and 640x400. When these resolutions are used on a screen with a 4x3 aspect they will preserve aspect on the hardcopy produced on a dot matrix printer, e.g., a printer that produces 72 dots per inch vertically and either 72, 90, or 120 dots per inch horizontally. The code looks at the screen resolution and sets the appropriate horizontal resolution. Options beyond P=3 assume an HP or compatible printer with equal dot spacing vertically and horizontally, e.g. 180 or 300 dots per inch. When applied to resolutions that do not have a 4x3 aspect (such as 320x200), the hardcopy is distorted. the pixel counts preserve the 4x3 aspect, e.g. 640x480 and 800x600.

P=0, dot matrix output, turned 90 degrees, trys two passes for more contrast, standard density. (didn't work, don't use)

P=1, dot matrix output, turned 90 degrees, single pass at standard density.

P=2, regular orientation (paper like screen). If pixels down screen is less than 401, trys two passes for contrast at standard density (didn't work, don't use). If pixels down is greater than 400, single pass at dual density.

P=3, regular orientation (paper like screen). If pixels down screen is less than 401, single pass at standard density. If pixels down screen is greater than 400, single pass at dual density.

In discussion below, landscape mode means that the long axis on paper is the same as on the screen. Portrait mode means output on the paper is rotated 90 degrees from how it appears on the screen.

P=4, HP PaintJet print, landscape mode, 180 dots per inch with 2x2 output dots per screen pixel. (This is the usual.)

P=5, HP PaintJet print, portrait mode, 180 dots per inch with 2x2 output dots per screen pixel

P=6, HP PaintJet print, landscape mode, 180 dots per inch with 4x4 output dots per screen pixel

P=7, HP PaintJet print, portrait mode, 180 dots per inch with 4x4 output dots per screen pixel

P=8, HP PaintJet print, landscape mode, 180 dots per inch with 1x1 output dot per screen pixel (shading uses different part of 4x4 pattern depending upon pixel indices)

P=9, HP PaintJet print, portrait mode, 180 dots per inch with 1x1 output dot per screen pixel (see note above)

The following options produce black and white output on the HP laserJet printer. They should also work on the DeskJet.

P=10, HP LaserJet print, landscape mode, 300 dots per inch with 2x2 output dots per screen pixel

P=11, HP LaserJet print, portrait mode, 300 dots per inch with 2x2 output dots per screen pixel

P=12, HP LaserJet print, landscape mode, 300 dots per inch with 4x4 output dots per screen pixel

P=13, HP LaserJet print, portrait mode, 300 dots per inch with 4x4 output dots per screen pixel

P=14, HP LaserJet print, landscape mode, 300 dots per inch with 1x1 output dots per screen pixel

P=15, HP LaserJet print, portrait mode, 300 dots per inch with 1x1 output dots per screen pixel

P=20, HP DeskJet 500 Color print, landscape mode, 300 dots per inch with 2x2 output dots per screen pixel

P=21, HP DeskJet 500 Color print, portrait mode, 300 dots per inch with 2x2 output dots per screen pixel

P=22, HP DeskJet 500 Color print, landscape mode, 300 dots per inch with 4x4 output dots per screen pixel

P=23, HP DeskJet 500 Color print, portrait mode, 300 dots per inch with 4x4 output dots per screen pixel

P=24, HP DeskJet 500 Color print, landscape mode, 300 dots per inch with 1x1 output dots per screen pixel

P=25, HP DeskJet 500 Color print, portrait mode, 300 dots per inch with 1x1 output dots per screen pixel

P=30, HP WhatEver B/W print, landscape mode, 600 dots per inch with 2x2 output dots per screen pixel

P=31, HP WhatEver B/W print, portrait mode, 600 dots per inch with 2x2 output dots per screen pixel

P=32, HP WhatEver B/W print, landscape mode, 600 dots per inch with 4x4 output dots per screen pixel

P=33, HP WhatEver B/W print, portrait mode, 600 dots per inch with 4x4 output dots per screen pixel

P=34, HP WhatEver B/W print, landscape mode, 600 dots per inch with 1x1 output dots per screen pixel

P=35, HP WhatEver B/W print, portrait mode, 600 dots per inch with 1x1 output dots per screen pixel

P=40, HP WhatEver Color print, landscape mode, 600 dots per inch with 2x2 output dots per screen pixel

P=41, HP WhatEver Color print, portrait mode, 600 dots per inch with 2x2 output dots per screen pixel

P=42, HP WhatEver Color print, landscape mode, 600 dots per inch with 4x4 output dots per screen pixel

P=43, HP WhatEver Color print, portrait mode, 600 dots per inch with 4x4 output dots per screen pixel

P=44, HP WhatEver Color print, landscape mode, 600 dots per inch with 1x1 output dots per screen pixel

P=45, HP WhatEver Color print, portrait mode, 600 dots per inch with 1x1 output dots per screen pixel

P=104 through 1xx, Transparency output where applicable (multipass).

P = 204 through 2xx, like 4 through xx, except graphics output is saved in a file 'name'.PCL where 'name' is the picture file name. To print, COPY 'name.PCL' LPT1, not PRINT 'name'.PCL.

P=304 through 3xx, like 4 through xx, except graphics output is saved in a file TMJnnn.PCX in PaintBrush format (nnn is a number starting at 001).

P=404 through 4xx, like 4 through xx, except both .PCL and PCX files are created.

HELP

HELP accesses documentation interactively.

****
The HELP processor can be invoked at anytime to display portions of the users guide including pictures but not tables.
****

****
Input Data Record Description:
****

======
Header
======

Inline data starting in column 1 that contains

?

?name

help

help,name

manual

manual,name

where help must be spelled out but manual can be abbreviated to man, and where name is the name of a section of the users guide (the first three letters without the .DOC extension) or the name of a picture file (without the .PIC extension).

Options
=======

No options apply

****
Data Record Description:
****

There are no data records for this processor.

IGES

IGES interfaces with IGES/STEP output files.

****
The IGES processor reads geometry data from a file prepared by a CAD (computer aided design) system. This interface was generated for NASA/GSFC.
****

****
Input Data Record Description:
****

==========
*header,options/
==========

This line must contain *IGE in columns 1 through 3.

=======
Options
=======

a, do not test for containing interval

b, debug output while generating pictures

c, do ray trace checks

d, real, centimeters, delta for multiple cross section views

e, real ,centimeters, elevation for cross section view (or min)

f, real, centimeters, elevation for cross section view, max

g, graphics mode

i, process original ascii file

k, use interval knot limits

l, alphanumeric, name of pcx save file

m, present or m=1, only across. m=2 only updown

p, save geometry data for pictures

q, picture type (1,2,3)=perpendicular to(x,y,z)

r, read binary file from original ascii file

s, min fraction of solver step (default is 0.1)

u, use gradiant changes in place of uvsolv changes

w, original ascii file is workstation/mac format(1 char/record end)

x, input frame for output picture

z, parameters not equal to boundary values

****
Data Record Description:
****

There are no data records for this processor.

****
Discussion
****

Output files from the SDRC IDEAS system contain the following record types:

102, Composite Curve Entity. The Parameter Data (PD) contains pointers to the Directory Entry (DE) of constituent entities. The constituent entities are probably actual curves. Parameters are N, DE(1)...DE(N).

116, Point Entity. The parameter data gives (x,y,z) and a pointer to the DE of a Subfigure Definition Entity (a 0 indicates none)

126, Rational B-Spline Curve Entity. Field 15 in the DE indicates the form of the curve (0,1,2,3,4,5) = (general B-spline, line, circular arc, elliptical arc, parabolic arc, hyperbolic arc). The parameter data consists of:

K, upper index of spline sum

M, degree of basis functions
PROP1, (0,1) = (nonplanar, planar)
PROP2, (0,1) = (open curve, closed curve)
PROP3, (0,1) = (rational, polynomial)
PROP4, (0,1) = (non periodic, periodic)

Let N=1+K-M and A=N+2*m
T(-M), first knot
...
T(N+M), last knot
W(0), first weight
...
W(K), last weight
X(0),
Y(0),
Z(0), x,y,z of first control point
...
X(K),
Y(K),
Z(K), x,y,z of last (K+1 th) control point
V(0), starting parameter value (minimum value of T)
V(1), ending parameter value (maximum value of T)
XNORM
YNORM
ZNORM, unit normal if planar (absent if not planar ???)

128, Rational B-Spline Surface Entity. Field 15 in the DE indicates the surface type (0,1,2,3,4,5,6,7,8,9) = (general, plane, right circular cylinder, cone, sphere, torus, surface of revolution, tabulated cylinder, ruled surface, general quadric).

The parameter data consists of:

K1, upper index of first sum
K2, upper index of second sum
M1, degree of first set of basis functions
M2, degree of second set of basis functions
PROP1, (0,1) = (not closed, closed) in first parametric direction
PROP2, (0,1) = (not closed, closed) in 2nd parametric direction
PROP3, (0,1) = (rational, polynomial)
PROP4, (0,1) = (nonperiodic, periodic) in first direction
PROP5, (0,1) = (nonperiodic, periodic) in 2nd direction

Let N1=1+K1-M1, N2=1+K2-M2, A=N1+2*M1, B=N2+2*m2, C=(1+K1)*(1+K2)
S(-M1),
...
S(N1+M1), first knot sequence
T(-M2),
...

T(N2+M2), second knot sequence
W(0,0), W(1,0), ..., W(K1,K2), weights
X(0,0), Y(0,0), Z(0,0), X(1,0), ...
X(K1,K2), Y(K1,K2), Z(K1,K2), control points
U(0), U(1), V(0), V(1), min/max parameters for two directions

142, Curve on a Parametric Surface Entity. An example is the intersection of two surfaces. The parameter data contains:

CRTN, how the curve was created (0,1,2,3) = (unspecified, projection of curve on surface, intersection of two surfaces, isoparametric curve - u or v parametric)
SPTR, point to the DE of the surface the curve lies on
BPTR, pointer to the DE of the entity defining the curve
CPTR, pointer to the mapping of the curve on the surface
PREF, preferred representation (0,1,2,3) = (unspecified, SoB, C, C and SoB)

144, Trimmed (Parametric) Surface Entity. S(u,v) is a regular parameterized surface whose rectangular domain D is points for which a<=u<=b and c<=v<=d. The mapping has a continuous normal vector in D, is one-to-one in D, and no singular points (linearly independent first partials).

Furthermore, there is exactly one outer boundary, and any number (including 0) inner boundaries. Inner boundaries are mutually disjoint and are inside the outer boundary.
The parametric data contains:

PTS, pointer to the DE of the surface entity being trimmed

N1, (0,1) = (n,y) the outer boundary is the boundary of D
N2, number of inner boundaries
PT(0), pointer to the DE of the outer boundary (or 0 if none)
PT(1), pointer to the DE of the first inner boundary
...
PT(N2), pointer to the DE of the last inner boundary

ISODOSE

ISODOSE generates isodose contour plots.

****
ISODOSE generates isodose contour plots using output dose tables from a SIGMA ray-trace sectoring calculation.
****

****
Input Record Description
****

==========
Header Line
==========

The header line must contain *ISO in columns 1 through 4. If any options are used, at least one must be on this line and the option field must be terminated by a slash.

==========
Options Field (abc)
==========

a, interpolate the log of the dose

b, do not put values on contour lines (no logic to avoid collisions)

c, greater than 0, output contour legend and add moptc to color numbers.

d, try new layout of board dose planes

****
Data Record Description
****

There is no other input after the header/options.

****
Discussion
****

The array of detector points is generated easily using the *DESIGN XYBoard, YZBoard, or ZXBoard option.

KERNEL

KERNEL does approximate neutron and gamma ray transport.

****
The KERNEL analysis processor calculates neutral particle transport, multigroup approximation, in 3D geometries using an approximate Greens function. This procedure is recommended prior to Monte Carlo runs on the same problem to obtain relative radiation levels and to exercise the problem setup.
****

****
Input Data Record Description:
****

==========
Header line
==========

Contains *KER in columns 1 through 4.

=======
Options
=======

A=a, first source volume in integration, default is 1.

B=b, last source volume in integration, default is max number defined.

C=c, first detector to be calculated, default is 1.

D=d, last detector to be calculated, default is max number.

E=e, e is the cosine of the maximum deflection angle for the Compton scattering transfer matrix (default is E=-1.0)

M, perform spectrum independent transfer matrix calculation. The transfer matrix is saved as data set MATRIX.DAT. The default is a separate calculation for each spectrum which is less costly in time when only a few spectra are used.

N, present for a neutron calculation, absent for photon calculation

U=u, temporary overide of the x coordinate of the detector

V=v, temporary overide of the y coordinate of the detector.

W=w, temporary overide of the z coordinate of the detector.

The u,v,and w options give user coordinates and are translated/rotated like the original user coordinates. This capability is used for a quick change of detector position without repeating the entire problem setup.

X=x, number of intervals in the first source variable integration.

Y=y, number of intervals in the second source variable integration.

Z=z, number of intervals in the third source variable integration.

&d debug output

The defaults for x,y,z are one interval in each.

F,P,R options are used for debugging code changes.

****
Data Record Description:
****

There are no data records for this processor.

++++++++++++
Output Tables
++++++++++++

The KERNEL processor produces several summary outputs while running to indicate its progress when operating on a personal computer. The format of this output is shown in Table 76 (KERSUM).

The results of the completed run include group fluxes and response functions in the format of Table 77 (KEROUT).

Table 76: (KERSUM) Intermediate Outputs

```
INPUT *HEADER,OPTIONS/
Line   1:*KERNEL,C=1,D=1/
CALCULATING PHOTON DOWN SCATTER MATRICES
STARTING CALCULATION FOR DETECTOR   1
USER AND GLOBAL DETECTOR POSITIONS
  0.0000E+00  0.0000E+00  5.0000E+01  0.0000E+00  0.0000E+00  1.4550E+02
SOURCE,GEOM,LIKE,AXIS,BODY,USER X
    1     1     1     2     1  2.3510E+00 -2.3193E+00  0.0000E+00
SOURCE 4.33E-03 1.28E-02 3.78E-02 1.14E-01 1.11E-01 4.87E+01 2.51E-01 3.28E-01
SOURCE 3.40E+00 9.98E-01 5.02E+00 1.08E+02 2.97E+01 4.27E+01 1.26E+01 3.51E+00
SOURCE 2.66E+00 1.16E+01 5.38E+00 1.51E-01 8.11E+01 5.50E+01 2.04E-01 8.96E-02
SOURCE 3.29E+03 1.15E+01 4.61E+01 2.39E+04 1.82E+00 7.85E-02 3.83E+04 1.17E+01
SOURCE 6.21E-01 9.84E+04 3.36E+01 1.76E+00 1.05E-02 3.37E+07 7.22E+01 2.13E-02
SOURCE 1.71E-02 4.40E-03 1.30E-02 3.84E-02 1.16E-01 1.13E-01 4.21E+01 2.55E-01
SOURCE 2.81E-01 2.51E+00 1.01E+00 4.74E+00 1.06E+02 2.67E+01 3.69E+01 1.09E+01
:
SOURCE 3.03E+07 6.30E+01 1.95E-02 1.57E-02
SOURCE 2.90E-03 8.69E-03 2.59E-02 7.97E-02 7.74E-02 3.26E+01 1.71E+00 8.53E-01
SOURCE 2.87E+00 1.43E+00 3.93E+00 6.08E+01 1.91E+01 1.42E+01 1.23E+01 6.47E+00
:
SOURCE 4.17E+04 3.21E+01 8.53E-04 9.22E-07
FLUX 2.19E-11 1.06E-10 4.24E-10 2.07E-09 1.60E-09 5.57E-08 3.87E-07 1.97E-07
FLUX 2.47E-07 2.87E-07 3.34E-07 3.59E-07 2.10E-07 9.55E-10 1.51E-07 9.89E-08
FLUX 3.53E-08 2.85E-08 1.18E-08 1.62E-08 3.64E-10 1.32E-08 4.41E-09 1.69E-09
FLUX 4.13E-11 8.35E-10 1.52E-10 2.55E-12 1.87E-11 1.07E-12 4.04E-15 9.43E-15
FLUX 1.33E-16 4.84E-18 3.03E-18 2.28E-21 5.12E-25 6.78E-28 5.20E-31 1.90E-35
FLUX 0.00E+00 2.23E-11 1.08E-10 4.31E-10 2.10E-09 1.63E-09 4.81E-08 3.35E-07
FLUX 1.71E-07 2.14E-07 2.49E-07 2.89E-07 3.10E-07 1.82E-07 8.26E-10 1.31E-07
:
FLUX 1.18E-27 9.05E-31 3.31E-35 0.00E+00
SOURCE,GEOM,LIKE,AXIS,BODY,USER X
    2     1     1     2     4  2.3510E+00 -2.3193E+00  0.0000E+00
FLUX 4.39E-11 2.13E-10 8.49E-10 4.14E-09 3.21E-09 1.11E-07 7.74E-07 3.94E-07
FLUX 4.93E-07 5.74E-07 6.67E-07 7.17E-07 4.20E-07 1.91E-09 3.03E-07 1.98E-07
FLUX 7.05E-08 5.69E-08 2.36E-08 3.25E-08 7.27E-10 2.64E-08 8.83E-09 3.39E-09
FLUX 8.27E-11 1.67E-09 3.04E-10 5.10E-12 3.74E-11 2.15E-12 8.09E-15 1.89E-14
FLUX 2.66E-16 9.69E-18 6.06E-18 4.57E-21 1.02E-24 1.36E-27 1.04E-30 3.80E-35
:
FLUX 1.58E-26 1.22E-29 4.45E-34 0.00E+00
SOURCE,GEOM,LIKE,AXIS,BODY,USER X
    8     1     1     2    16  2.3510E+00 -2.3193E+00  0.0000E+00
FLUX 3.73E-10 1.78E-09 6.99E-09 3.35E-08 2.60E-08 1.02E-06 6.43E-06 3.26E-06
FLUX 4.06E-06 4.71E-06 5.47E-06 5.87E-06 3.43E-06 1.56E-08 2.49E-06 1.62E-06
FLUX 5.75E-07 4.65E-07 1.93E-07 2.65E-07 5.94E-09 2.15E-07 7.19E-08 2.75E-08
:
FLUX 1.95E-26 1.51E-29 5.49E-34 0.00E+00
SOURCE,GEOM,LIKE,AXIS,BODY,USER X
    9     1     1     2    25  2.3510E+00 -2.3193E+00  0.0000E+00
SOURCE,GEOM,LIKE,AXIS,BODY,USER X
   10     1     1     2    26  2.3510E+00 -2.3193E+00  0.0000E+00
:
   71     1     1     2   199  2.3510E+00 -2.3193E+00  0.0000E+00
SOURCE,GEOM,LIKE,AXIS,BODY,USER X
   72     1     1     2   200  2.3510E+00 -2.3193E+00  0.0000E+00
```

Table 77: (KEROUT) Flux/Response Output Format

```
SOURCE SPECTRUM       5 YEAR
DETECTOR   1  0.0000E+00  0.0000E+00  1.4550E+02       50 TOP
            UPPER MEV   LOWER MEV    FLUX/MEV  GROUP FLUX    FLUX SUM
GROUP   1  7.0000E+00  6.0000E+00    7.99E-02    7.99E-02    7.99E-02
GROUP   2  6.0000E+00  5.0000E+00    2.42E-01    2.42E-01    3.22E-01
GROUP   3  5.0000E+00  4.0000E+00    7.24E-01    7.24E-01    1.05E+00
GROUP   4  4.0000E+00  3.0000E+00    2.25E+00    2.25E+00    3.29E+00
GROUP   5  3.0000E+00  2.6160E+00    5.51E+00    2.12E+00    5.41E+00
GROUP   6  2.6160E+00  2.6140E+00    4.07E+05    8.13E+02    8.18E+02
GROUP   7  2.6140E+00  2.0000E+00    2.03E+02    1.25E+02    9.43E+02
GROUP   8  2.0000E+00  1.7500E+00    2.21E+02    5.52E+01    9.98E+02
GROUP   9  1.7500E+00  1.5000E+00    4.18E+02    1.05E+02    1.10E+03
GROUP  10  1.5000E+00  1.2500E+00    3.06E+02    7.66E+01    1.18E+03
GROUP  11  1.2500E+00  1.0000E+00    5.37E+02    1.34E+02    1.31E+03
GROUP  12  1.0000E+00  7.5000E-01    5.10E+03    1.28E+03    2.59E+03
GROUP  13  7.5000E-01  5.8500E-01    3.08E+03    5.08E+02    3.10E+03
GROUP  14  5.8500E-01  5.8400E-01    2.07E+05    2.07E+02    3.30E+03
GROUP  15  5.8400E-01  5.0000E-01    4.14E+03    3.48E+02    3.65E+03
GROUP  16  5.0000E-01  4.0000E-01    2.57E+03    2.57E+02    3.91E+03
GROUP  17  4.0000E-01  3.5000E-01    2.21E+03    1.11E+02    4.02E+03
GROUP  18  3.5000E-01  3.0000E-01    2.33E+03    1.17E+02    4.14E+03
GROUP  19  3.0000E-01  2.7500E-01    2.00E+03    5.00E+01    4.19E+03
GROUP  20  2.7500E-01  2.3900E-01    1.66E+03    5.98E+01    4.25E+03
GROUP  21  2.3900E-01  2.3800E-01    3.94E+04    3.94E+01    4.29E+03
GROUP  22  2.3800E-01  2.0000E-01    2.41E+03    9.16E+01    4.38E+03
GROUP  23  2.0000E-01  1.7500E-01    1.54E+03    3.85E+01    4.42E+03
GROUP  24  1.7500E-01  1.5300E-01    9.42E+02    2.07E+01    4.44E+03
GROUP  25  1.5300E-01  1.5200E-01    1.32E+05    1.32E+02    4.57E+03
GROUP  26  1.5200E-01  1.2500E-01    2.62E+03    7.07E+01    4.64E+03
GROUP  27  1.2500E-01  1.0000E-01    9.77E+02    2.44E+01    4.66E+03
GROUP  28  1.0000E-01  9.9000E-02    2.19E+04    2.19E+01    4.69E+03
GROUP  29  9.9000E-02  8.0000E-02    8.01E+02    1.52E+01    4.70E+03
GROUP  30  8.0000E-02  6.1000E-02    1.11E+02    2.10E+00    4.70E+03
GROUP  31  6.1000E-02  5.9000E-02    1.47E+04    2.94E+01    4.73E+03
GROUP  32  5.9000E-02  5.0000E-02    1.41E+03    1.27E+01    4.75E+03
GROUP  33  5.0000E-02  4.4000E-02    3.26E+02    1.96E+00    4.75E+03
GROUP  34  4.4000E-02  4.3000E-02    9.74E+01    9.74E-02    4.75E+03
GROUP  35  4.3000E-02  3.0000E-02    1.38E+01    1.80E-01    4.75E+03
GROUP  36  3.0000E-02  2.0000E-02    8.88E-02    8.88E-04    4.75E+03
GROUP  37  2.0000E-02  1.8000E-02    4.06E-04    8.12E-07    4.75E+03
GROUP  38  1.8000E-02  1.6000E-02    1.14E-06    2.29E-09    4.75E+03
GROUP  39  1.6000E-02  1.0000E-02    6.23E-10    3.74E-12    4.75E+03
GROUP  40  1.0000E-02  5.0000E-03    1.20E-13    6.00E-16    4.75E+03
TOTAL RESPONSE FOR         PU02    6.71E-06
TOTAL RESPONSE FOR      IRIDIUM    5.31E-06
TOTAL RESPONSE FOR       CARBON    2.02E-06
TOTAL RESPONSE FOR     ALUMINUM    1.99E-06
TOTAL RESPONSE FOR    CONVERTER    2.24E-06
TOTAL RESPONSE FOR      SILICON    2.07E-06
TOTAL RESPONSE FOR     TUNGSTEN    4.84E-06
TOTAL RESPONSE FOR  NUMBER FLUX    4.75E+03
TOTAL RESPONSE FOR  ENERGY FLUX    5.03E+03
```

LABEL

LABEL enters title information for output files

****
The LABEL input processor enters a line used to label each printout page. Labeling can be done at any time.
****

****
Input Data Record Description:
****

==========
Header line
==========

Contains *LAB in columns 1 through 4.

=======
Options
=======

A=a (alpha) character subfields, labels sigma table outputs

B=b (alpha) character subfields, labels sigma table outputs

C=c (alpha) character subfields

D (alpha) character subfield first 6 characters label sigtab outputs

E (alpha) character subfields

F (alpha) character subfields

G (alpha) character subfields, labels gcr output flux spectra

H=h, used for name label on hardcopy outputs (PCX files)

I (alpha) character subfields

...

Z=z (alpha) character subfields

The values of the options are character strings with a maximum of 12 characters each.

****
Data Record Description:
****

==========
Input lines
==========

One record of alphanumeric data enclosed in quotes. Must be contained on a single line. Use a slash to terminate the record.

****
Discussion
****

All character strings entered with the option letters are written in the time and date stamp at the beginning of formatted output files.

The values entered for option letters A and B replace the word 'Table' in the SIGMATAB.NEW and SIGMASUM.NEW summary files, e.g., if A='Table A' and B='Table B' then the tables in these two files will have names such as Table A01 and Table B01. This is convenient for preparing a summary report with the tables as appendices (less editing).

The value entered for option D is also used to label the summary tables and replaces the word 'dose' The first six characters of this string are used. Typical values might be 'dose', 'upsets', 'pC/cm2', and 'pC/cc'.

LIBRARY

LIBRARY discusses NOVICE libraries.

****
The LIBRARY section discusseses several aspects of NOVICE data libraries.
****

****
Discussion
****

The &LIB data line:

The command '&LIB name' will get partial data sets from the ascii file 'LIBRARY.DAT'. These data sets must start with a line of the form c ***name and the data set ends with the next line containing c *** in columns 1 through 6. 'name' indicates any string of ascii characters.

The same logic is used if the input line contains &lib in columns 1 through 4 with column 5 not blank. The columns 2 up to the first blank column are used as the name of the library file, e.g.

```
&library2.dat iskibidly
```

will open the ascii file 'LIBRARY2.DAT' and search that file for the line that starts with

```
 ***iskibidly
c
```

NOTE, the name string is case sensitive (and the library file is also) on unix systems (on DOS systems, case does not matter).

In 1996 March, the user can also designate files with automatic path addition to the file names. For the &LIB command, follow the & by *+-&% to indicate the path, e.g. &&LIB datasetname will look for a file named LIBRARY.NEW in the USER directory.

MAGIC

MAGIC models geometry using combinatorial geometry logic.

****
The MAGIC processor provides a combinatorial geometry description. Two phases are involved: the first phase describes bodies, the second phase describes regions as body intersections and, optionally, unions of body intersections.
****

****
Input Data Record Description:
****

****
Header line
****

==========
Contains *MAG in columns 1 through 4.
==========

=======
Options
=======

O, see OVERLAP section for discussion of O option

G, put data on wireframe plot file

H (real,,eps,inf) if box lims identical use =-eps, default 1 micron

M (material) default material

T, special interface for TRW data. T or T=0, double lines on bodies only, T=1 for double lines on both bodies and regions. T=2, TRW data, long line format (no double lines)

F, fixed format data as prepared for MORSE etc.

B=b, add b to body indices called out on region lines. Applies to fixed format inputs only.

S, SYNTHAVISION interface file input (omit all other input below, special option developed for Jet Propulsion Lab). S=1, do not generate arcs for ASL/REV bodies.

****
Data Record Description:
****

==========
Body Descriptions
==========

The first set of lines describe bodies until terminated by an END line (not the *END line). The body lines are shown in the accompanying table and figures.

Body description data consists of

NAME N D in fixed format and
-

N NAME D / in free field format
-

where NAME is the body name, N is the body number, and D is a
-
data string giving the body location and dimensions.

In fixed field format (F option), the format is (2X,A3,I5,6E10.0) with continuation lines in (10X,6E10.0). In fixed format, the body number N is ignored, bodies are numbered in the order input. In free field format, the body number N is saved and must be the body number referred to on the region lines (the code sets up an internal alias table to keep track of its internal numbering of bodies)

Body names and data strings are listed in Table 78 (MAGDAT).

The coordinates and shapes of the bodies are shown in Figures 50 (MAGELL) through 58 (MAGARB).

==========
Region Descriptions
==========

The second set of lines describe regions until terminated by an END line (not the *END line).

The volume comprising a region is defined, for the simplest case, by listing the bodies that comprise the region. This list is combined by intersection logic. If the region is inside the body, the body is listed unsigned or with a plus sign. If the region is outside the body (inside the body complement), the body is listed with a minus sign.

In the more complicated case, a region is the union of intersected bodies, where each intersected body is defined by a list of the type described in the preceeding paragraph. In a sense, the union logic is superfluous since each intersected body being unioned into the region definition could be described as a separate region.

Fixed format region inputs (F option) have the format

(A10,9(A2,I5))

For explicit combinatorial geometry as input to MORSE or QAD the first 10 columns contain 2 integers (2I5); the region index and the number of 'next' regions when leaving the region. NOVICE logic does not need these numbers. However, each region must start on a new line and the region number must appear someplace before column 10 so start of a new region is recognized. Thereafter, pairs of A2 words and I5 integers are input. The A2 word is blank unless a new intersected body list is being started. Then the A2 word is OR. (If OR occurs anywhere, it must also start the very first list of the region). The I5 word is a signed body index. The region inputs are terminated by a line with END in column 3-5. Material compositions and densities must be entered using *ARRAY.

Free field region inputs consist of

I M RHO B /
-

where I is a number given to the region by the user, M is the composition (material) index, O if void, RHO is the region density, gm/cc, or density scale factor if flagged minus, and $\bar{B}$ is the list of intersected bodies comprising the region. The elements of the body list are unsigned or positive if the region is inside the body, and signed negative if the region is outside the body.

If the region is the union of multiple intersected bodies, each intersected body being unioned is defined by a record of the form

OR $\bar{B}$ /

The word OR appears explicitly on the line. $\bar{B}$ is another body list of the form already mentioned. The first record of the region, the one with composition data, does not contain OR.

When all regions have been described, region inputs are terminated by

END /

==========
Point in Region
==========

The final set of lines are optional and are input as one record per region with

,I X Y Z /

the region index and x,y,z, coordinates of any point in the region that is to be contained by a higher indexed region. The most complete error checking is done if this line is supplied for every region.

++++++++++++
Input Figures
++++++++++++

Inputs are shown in Figures 50 (MAGELL) through 58 (MAGARB).

+++++++++++++
Output Figures
+++++++++++++

Figure 59 (MAGSAT) is a perspective view of a satellite modeled completely with combinatorial geometry logic.

A cut away view of this model is shown in Figure 60 (MAGCUT).

Figure 61 (MAGDUT) is the same cut away view from a closer viewpoint.

Table 78: (MAGDAT) Magic Body Names and Data

```
ELL U V L  ellipsoid ellipsoid
    - -

SPH V,R sphere
    -

RPP X X Y Y Z Z  right parallelepiped
     1 2 1 2 1 2

RCC V H R right circular cylinder
    - -

TRC V H R R truncated right cone
    - -  1 2

BOX V L  W  H box
    - -  -  -

RAW or

WED V L  W  H wedge
    - -  -  -

REC V H A  B right elliptic cylinder
    - - -  -

ARB X  X  X  X  ...X  F F ...F
    - 1- 2- 3- 4   - 8 1 2    6
                     arbitrary polyhedron

END end of body inputs
```

All coordinates/dimensions are in centimeters. The variable F_i for the ARB body is a 4 digit number where the digits are the point indices comprising the ith face listed clockwise or counter-clockwise.

Figure 50: (MAGELL) Ellipsoidal Body

TYPICAL *MAGIC 'ELL' INPUT
*PIC,Q=3,Z=3,G=97,T=2,J,L='MAGELL'

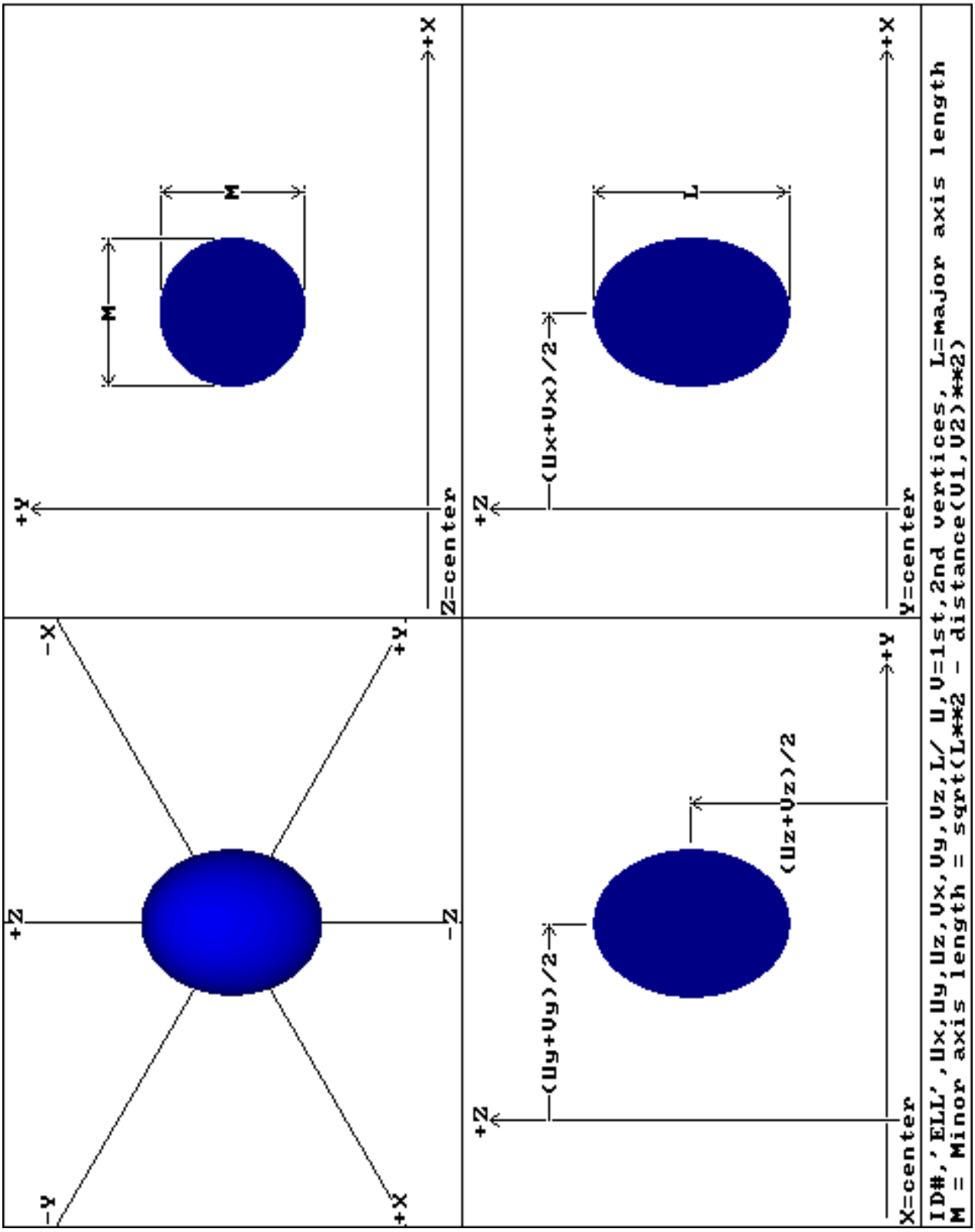


Figure 51: (MAGSPH) Spherical Body

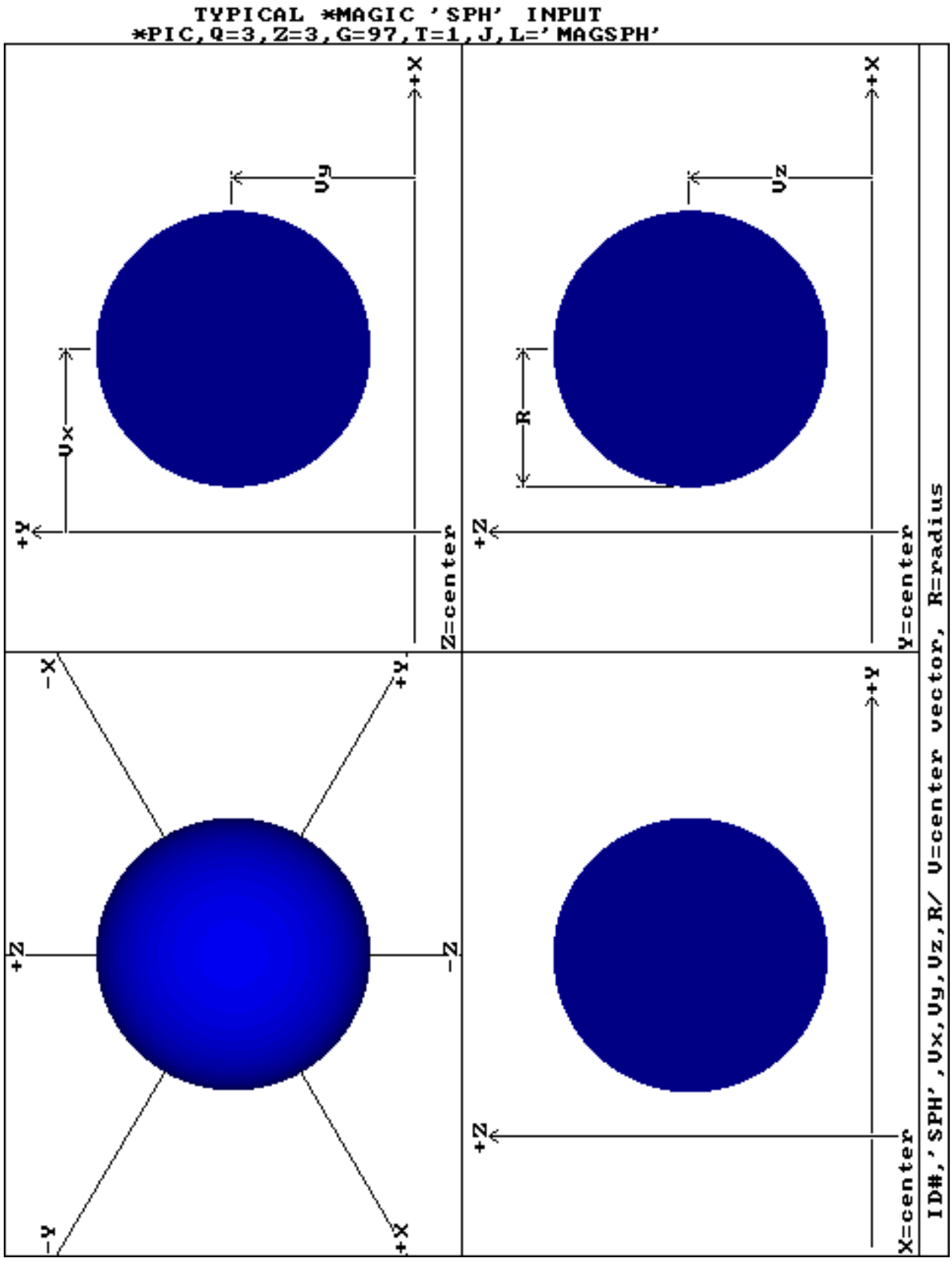


Figure 52: (MAGRPP) Rectangular Parallelapiped

TYPICAL *MAGIC 'RPP' INPUT
*PIC,Q=3,Z=3,G=97,T=1,J,L='MAGRPP'

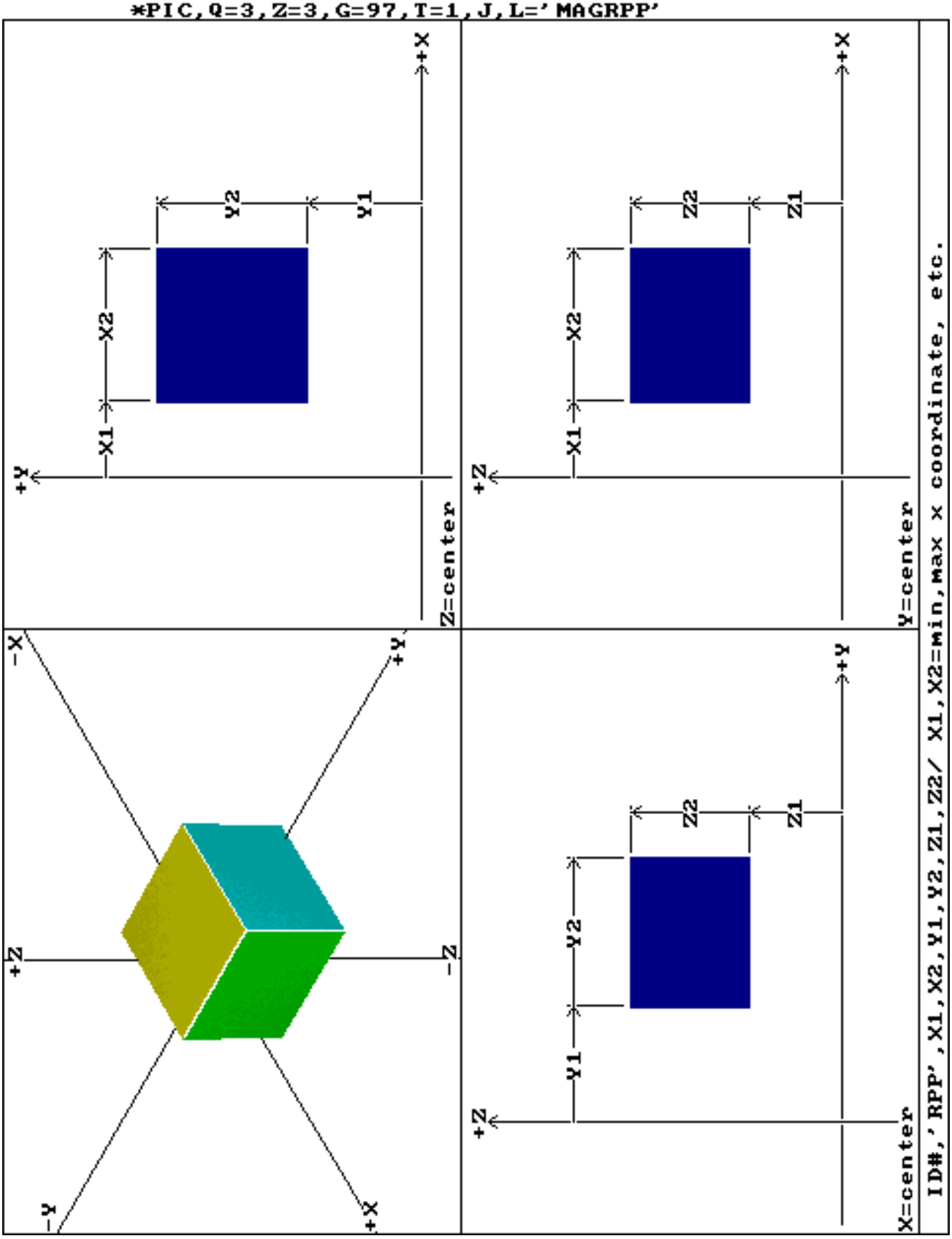


Figure 53: (MAGRCC) Right Circular Cylinder Body

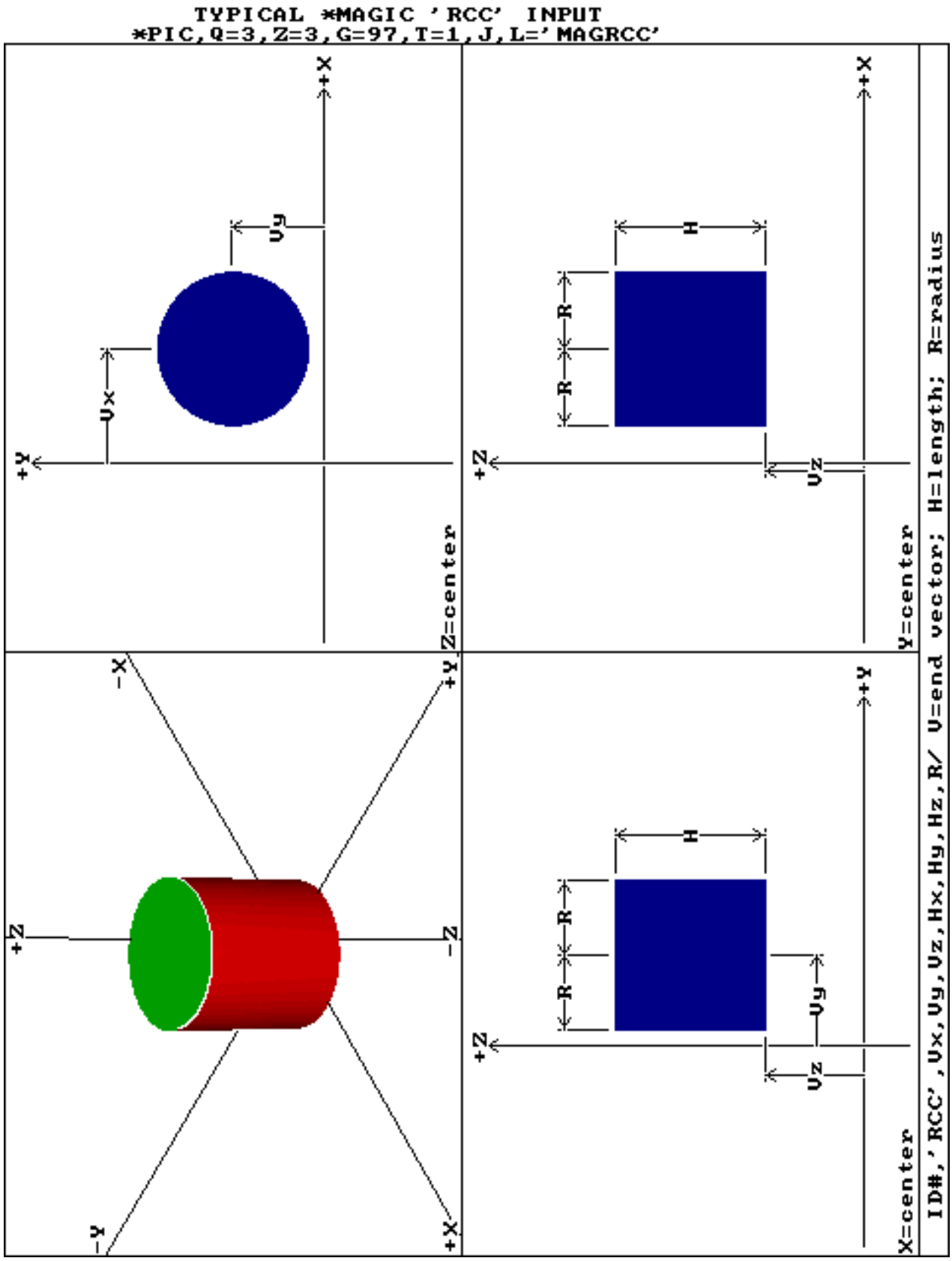
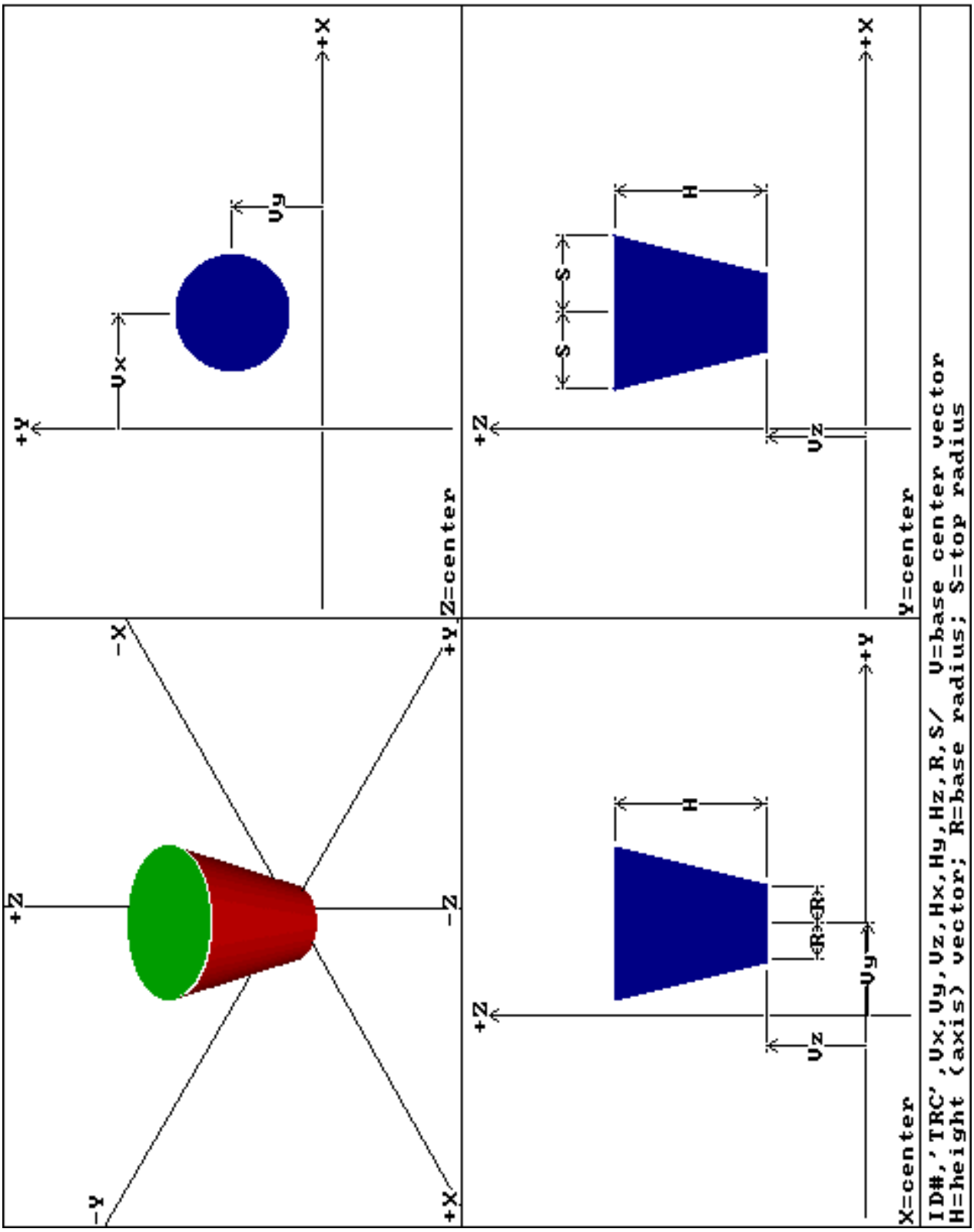


Figure 54: (MAGTRC) Truncated Cone Body

TYPICAL *MAGIC 'TRC' INPUT
*PIC,Q=3,Z=3,G=97,T=2,J,L='MAGTRC'



ID#,'TRC',Ux,Uy,Uz,Hx,Hy,Hz,R,S/ U=base center vector
H=height (axis) vector; R=base radius; S=top radius

Figure 55: (MAGBOX) Box Body

TYPICAL *MAGIC 'BOX' INPUT
*PIC,Q=3,Z=3,G=97,T=2,J,L='MAGBOX'

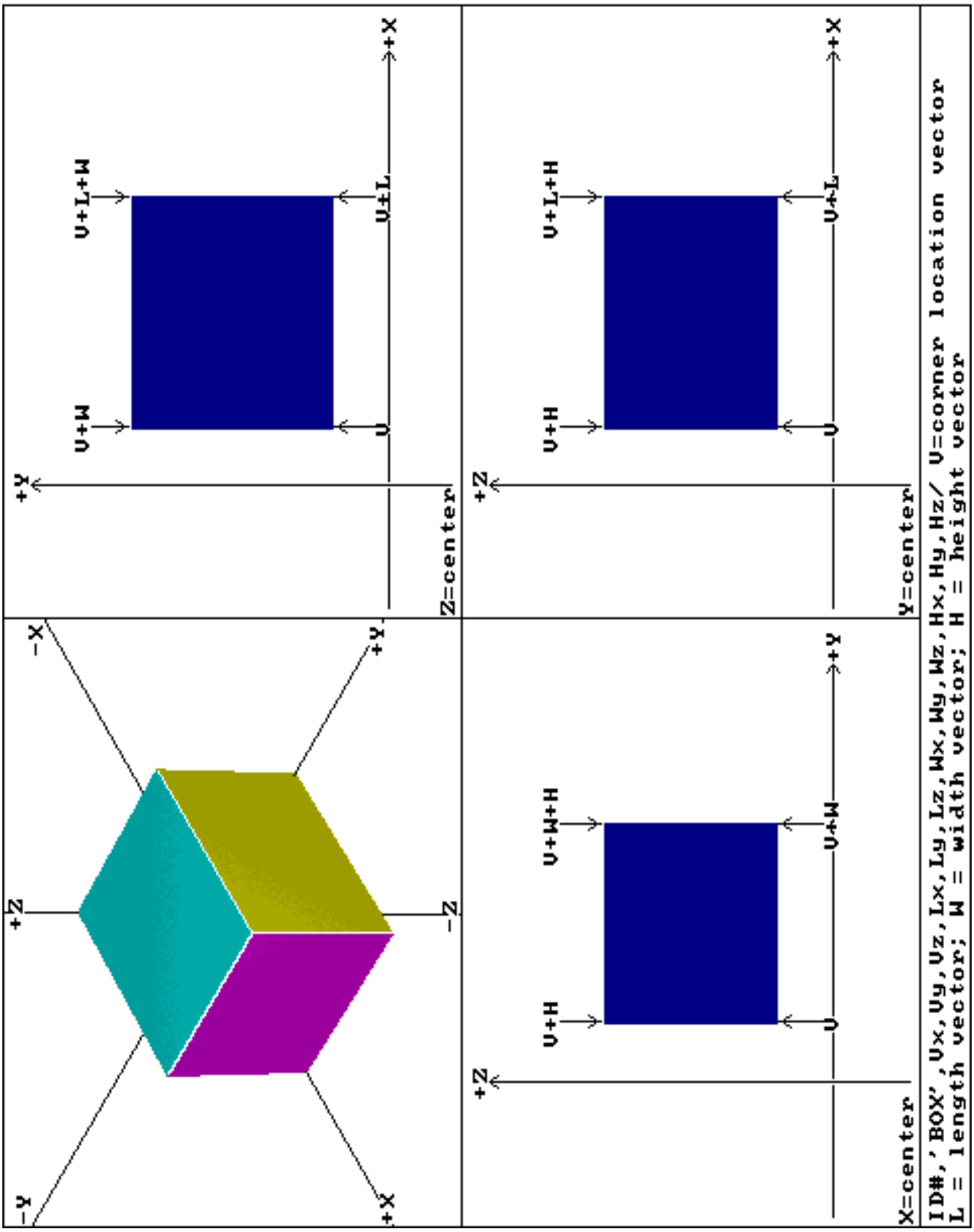


Figure 56: (MAGWED) Wedge Body

TYPICAL *MAGIC 'WED' INPUT
*PIC,Q=4,Z=3,G=97,T=2,J,L='MAGWED'

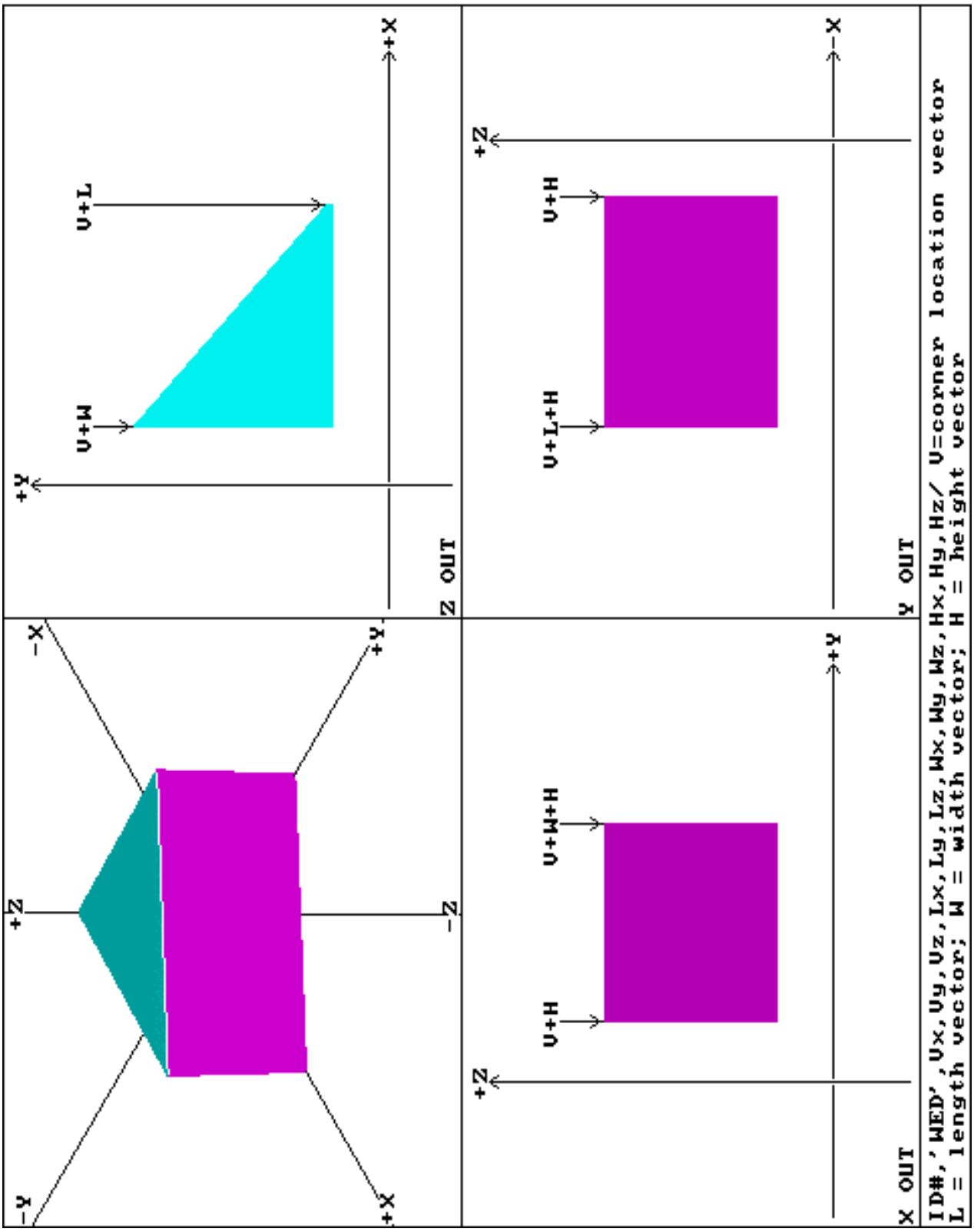


Figure 57: (MAGREC) Right Elliptic Cylinder Body

TYPICAL *MAGIC 'REC' INPUT
*PIC,Q=3,Z=3,G=97,T=2,J,L='MAGREC'

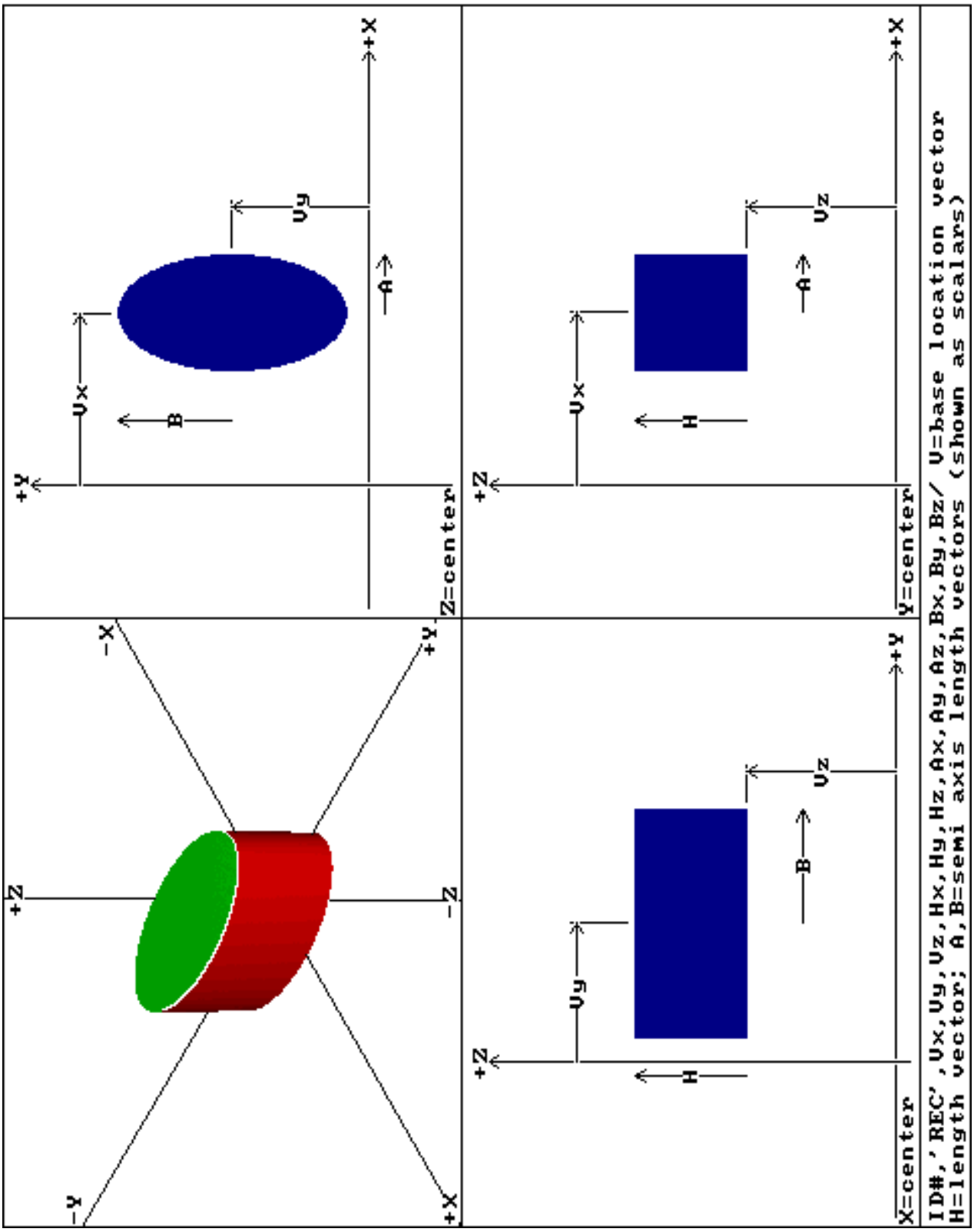


Figure 58: (MAGARB) Arbitrary Polyhedron Body

TYPICAL *MAGIC 'ARB' INPUT
*PIC,Q=4,Z=3,G=97,T=2,J,L='MAGARB'

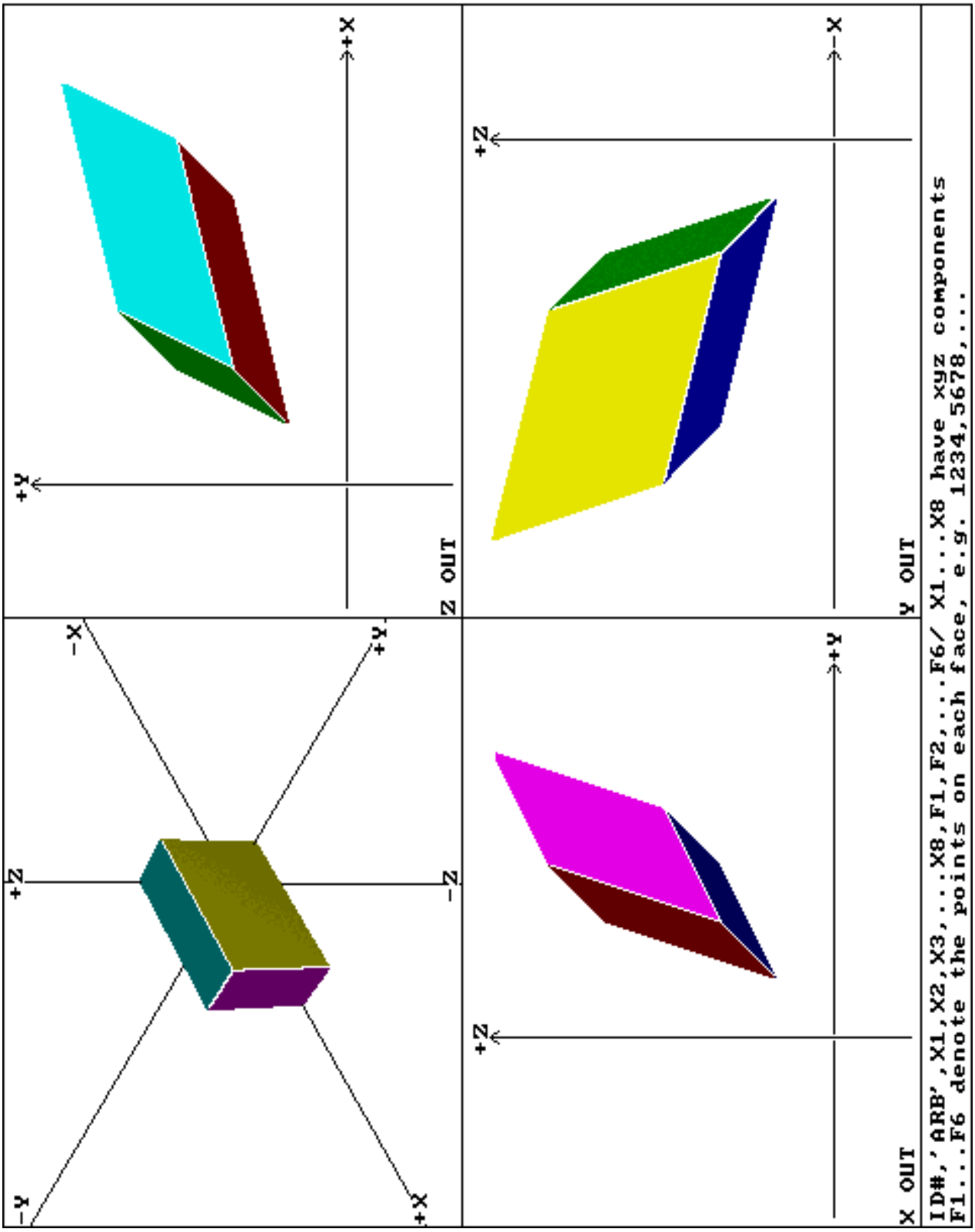


Figure 59: (MAGSAT) Satellite Model Perspective

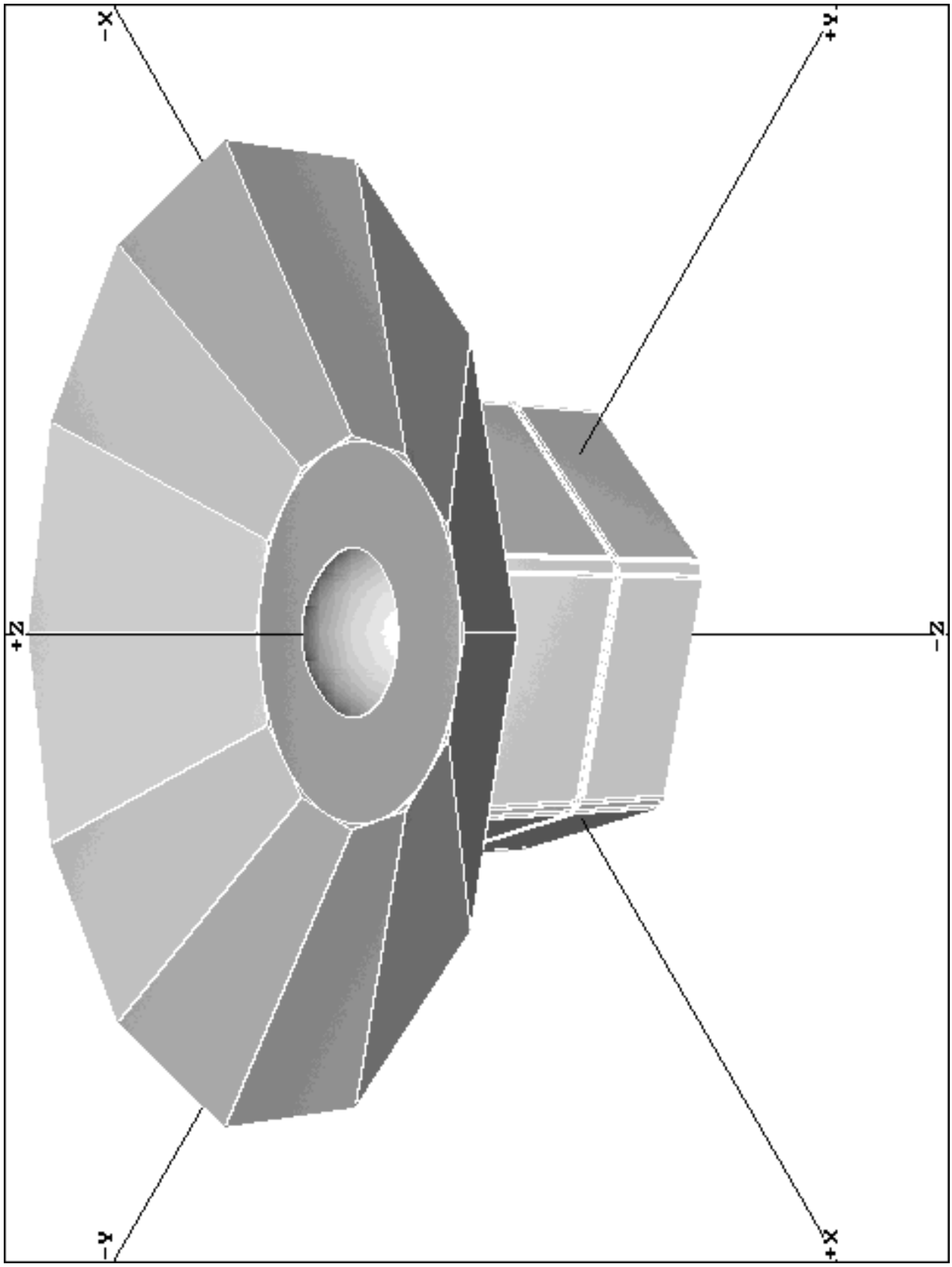


Figure 60: (MAGCUT) Cut Away with Perspective

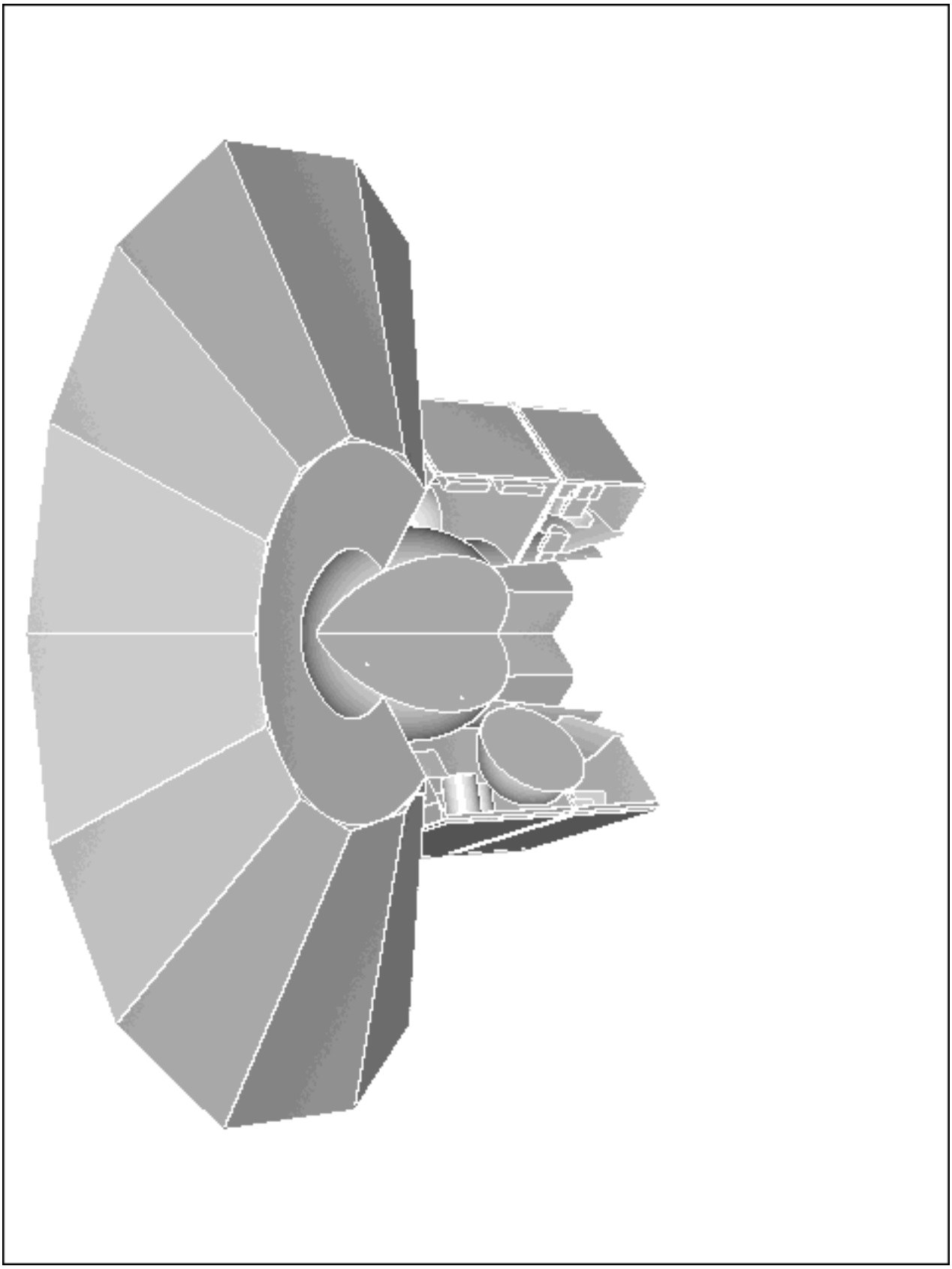
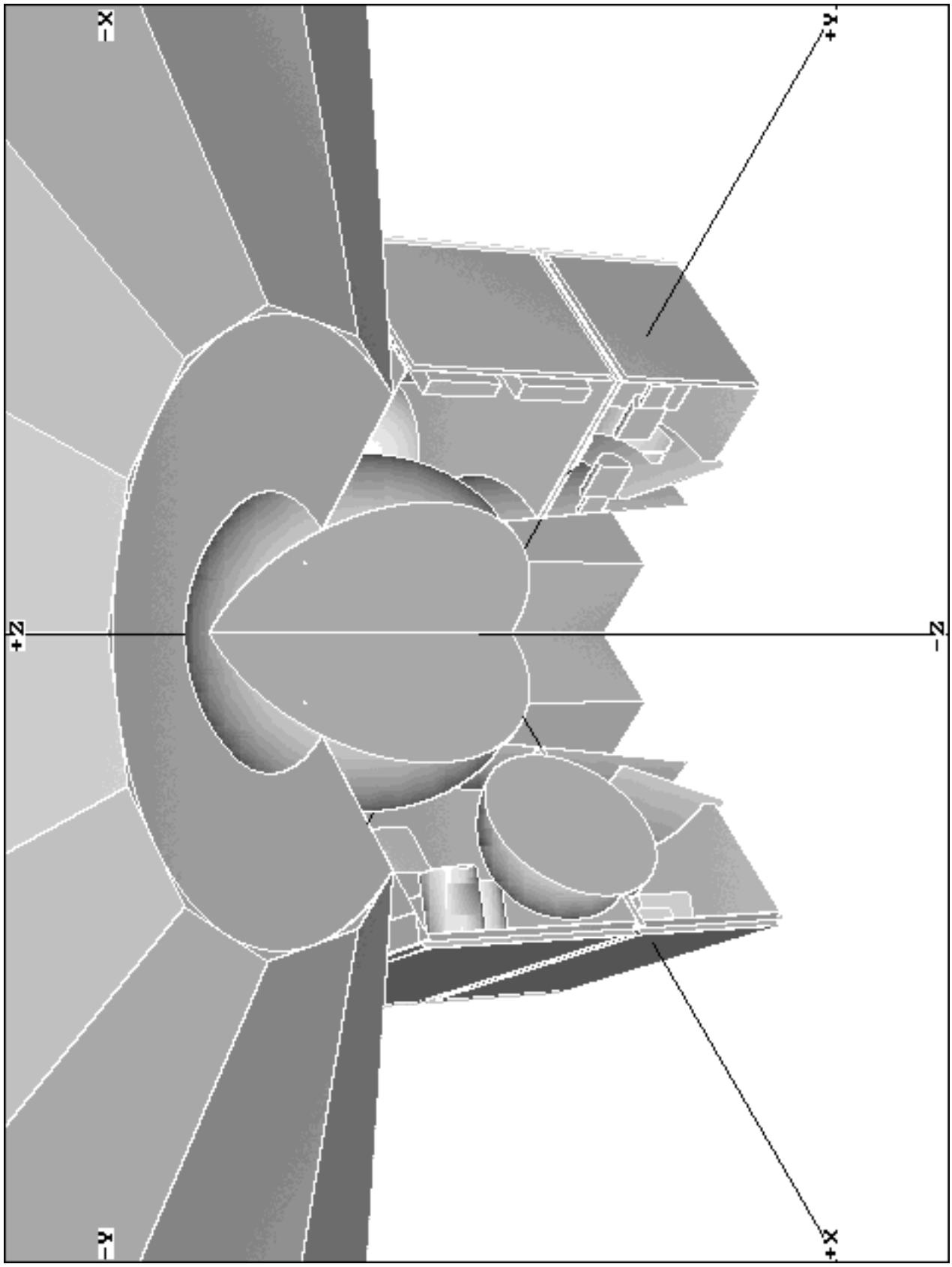


Figure 61: (MAGDUT) Cut Away Closeup



MATERIAL

MATERIAL enters composition data for materials.

****
The MATERIAL input processor is used to give material composition data and/or select materials from the library.
****

****
Input Data Record Description:
****

==========
Header line
==========

Contains *MAT in columns 1 through 4.

=======
Options
=======

H, all materials are honeycomb, and cell parameters are entered to calculate effective density for materials. The *MATerial section must be used twice if the problem contains regular materials and honeycomb materials.

S, no atomic weight field

****
Data Record Description:
****

Repeat as needed, the data

==========
Material Definition
==========

'NAME' RHO Z1 A1 F1 Z2 A2 F2 Z3 A3 F3 .../

NAME is the name of the material, truncated to 12 characters

RHO is the density of the material, grams/cc

Z1 A1 F1 are the atomic number, atomic weight, and fractional density of the first element in the material

Z2 A2 F2 are similar data for the second element , etc.

If the atomic weight is input as zero, it is set by the code. The fractional density is a mass fraction if positive. If flagged minus, the fractional density is an atom density. Either is relative since the sum of fractional densities is normalized to RHO.

The material composition data can be read from and or added to the file MTLIBE.DAT. If the material is already in the library, simply input the name and the density. If the material is not in the library, then input the chemical formula and the density, or the material name, chemical formula, and density.

==========
Honeycomb Parameters (H option)
==========

If the H option was selected, supply another record for each material (two records for each material in pairs). The second record contains parameters used to calculate the effective density:

T, the thickness of the face skin. Both faces are assumed to be the same thickness. If not, enter the average for both faces. The units for this parameter and those that follow must be the same and have no effect on the result.

H, the height of the honeycomb cell ignoring the faces.

W, the width of the honeycomb cell ignoring the wall.

A, the wall thickness in the W (width) direction.

L, the length of the honeycomb cell ignoring the wall. L=W is assumed if L is zero or not input (square cell).

B, the wall thickness in the L (length) direction. B=A is assumed if B is zero or not input (square cell+wall).

The density and composition entered in the composition record are assumed to apply to the faces and to the cell walls. The effective density is then calculated as:

rho(effective) = rho(face material)

* {1 - W*L*H/[(W+A)*(L+B)*(H+2T)]}

MCNP

MCNP interfaces geometry models with MCNP.

****
The MCNP processor serves two functions. If used before the *EXECUTE processor, it inputs MCNP geometry data. If used after the *EXECUTE processor, it outputs MCNP geometry data. The input function takes input from MCNPGEO.DAT. Output is to the file MCNPGEO.DAT on unit 50.
****

****
Input Data Record Description:
****

==========
Header Line
==========

Contains *MCN in columns 1 through 4.

=======
Options
=======

a, if present, do not output region containing all other regions and spherical shell surrounding everything.

b, if present, output rotation matrices.

c, if present, output particle spectra.

e, if present, output *f8 tally records. If E=e, then tally type e is generated.

h, histories, 1 000 000 default

m if present, output material composition data

p if present, particle type 1,2,3=n,p,e 2 default

r 0,1,2,3=none,min,max, both reflective boundaries in x

s 0,1,2,3=none,min,max, both reflective boundaries in y

t 0,1,2,3=none,min,max, both reflective boundaries in z

U=u, output regions by material order, universe/lattice, information and u=10000*nx+100*ny+nz where nx,ny,nz are subdivisions in x,y,z.

V=v, add v to region index to get universe index

W if present, particle weight, 1 default

X if present, initial x, 0 default

Y if present, initial y, 0 default

Z if present, initial z, 0 default

****
Data Record Description:
****

==========
Surface Parameters
==========

Surface parameters are:

I, the surface index sequentially numbered.

N, the surface shape name, see Table MCNSUR.

A, the surface data parameters as needed (no slash at end)

These data lines are terminated by a blank line.

==========
Region parameters
==========

I, the region (cell) index

M, the material index (0 for void)

R, the region density (omit if void), flag minus(-) if g/cc.

B, the list of surfaces bounding the region, flagged minus(-) if the region is inside (opposite to NOVICE) and positive(+) or unsigned if the region is outside the surface.

These data lines are terminated by a blank line

There are additional items to discuss including coordinate transformations.

See MCNP users guide to complete description.

Output from NOVICE to MCNP is working on June 07, 1991.

Output from NOVICE to MCNP is not working on February 23, 1997.

++++++++++++
Input Tables
++++++++++++

The Table MCNSUR gives the parameters required to describe surfaces.

Table 79: (MCNSUR) MCNP Surface Parameters

name	equation	input data
P	0 = Ax + By + Cz - D	A,B,C,D
PX	0 = x - D	D
PY	0 = y - D	D
PZ	0 = z - D	D
SO	0 = x**2 + y**2 + z**2 - R**2	R
S	0 = (x-X)**2 + (y-Y)**2 + (z-Z)**2 - R**2	X,Y,Z,R
SX	0 = (x-X)**2 + y**2 + z**2 - R**2	X,R
SY	0 = x**2 + (y-Y)**2 + z**2 - R**2	Y,R
SZ	0 = x**2 + y**2 + (z-Z)**2 - R**2	Z,R
CPX	0 = (y-Y)**2 + (z-Z)**2 - R**2	Y,Z,R
CPY	0 = (x-X)**2 + (z-Z)**2 - R**2	X,Z,R
CPZ	0 = (x-X)**2 + (y-Y)**2 - R**2	X,Y,R
CX	0 = y**2 + z**2 - R**2	R
CY	0 = x**2 + z**2 - R**2	R
CZ	0 = x**2 + y**2 - R**2	R
KPX	0 = (y-Y)**2 + (z-Z)**2 - T(x-X)**2	X,Y,Z,T,+-1
KPY	0 = (x-X)**2 + (z-Z)**2 - T(y-Y)**2	X,Y,Z,T,+-1
KPZ	0 = (x-X)**2 + (y-Y)**2 - T(z-Z)**2	X,Y,Z,T,+-1
KX	0 = y**2 + z**2 -T(x-X)**2	X,T,+-1
KY	0 = x**2 + z**2 -T(y-Y)**2	Y,T,+-1
KZ	0 = x**2 + y**2 -T(z-Z)**2	Z,T,+-1
SQ	0 = A(x-X)**2 + B(y-Y)**2 + C(z-Z)**2 +2D(x-X) + 2E(y-Y) + 2F(z-Z) + G	A,B,C,D,E,F,G
GQ	0 = Ax**2 + By**2 + Cz**2 + Dxy + Eyz + Fzx + Gx + Hy + Jz + K	A,B,C,D,...,K
TX	0 = -1 + ((x-X)/B)**2 +(sqrt((y-Y)**2+(z-Z)**2) - A)/C)**2	X,Y,Z,A,B,C
TY	0 = -1 + ((y-Y)/B)**2 +(sqrt((x-X)**2+(z-Z)**2) - A)/C)**2	X,Y,Z,A,B,C
TZ	0 = -1 + ((z-Z)/B)**2 +(sqrt((x-X)**2+(y-Y)**2) - A)/C)**2	X,Y,Z,A,B,C

X , one, two or three pairs of points for (x,r)

Y , pairs for (y,r), surface is rotated around y axis

Z , pairs for (z,r), surface is rotated around z axis

MENU

MENU accesses the full screen menu system.

****
The MENU processor provides access to various aspects of NOVICE, particularly documentation including tables and figures.
****

****
Input Data Record Description:
****

==========
Header Line
==========

Contains *MEN in columns 1 through 4.

=======
Options
=======

A, character writing option

B, tjmenu

D, debug mode

G, graphics mode (default 257)

P, power bar line

****
Data Record Description:
****

There are no data records for this processor.

****

Discussion

****

The various topics listed in the menu are opened when double clicked.

To exit, move the cursor to the upper left corner and double click

MEVDP

MEVDP accepts geometry models in MEVDP format.

****
The MEVDP processor reads a geometry model in the format provided to the MEVDP program. This part of the geometry can be preceeded or followed by geometry data prepared in other formats.
****

****
Input Data Record Description:
****

==========
Header line
==========

Contains *MEV in columns 1 through 4.

****
Options
****

G, if present generate wireplot file
H (real,,eps,inf) if box lims identical use =-eps, default 1 micron

L (alpha) name of trw free field input file, default is mev2.dat

O, see OVERLAP section for discussion of O option

S if present, boeing north american free field input

F, if present, geometry data is free field. If absent, geometry data is fixed format.

T, if present, geometry data is TRW free field.

****
Data Record Description:
****

==========
Shield Header (fixed format is I5,I2,1X,I2,2F10.0,2I5)
==========

Each shield is composed of one or more solid volumes and may also have one or more voids cutout of the solid volumes. The first line of a shield contains SN, ST, MTL, RAD, RHO, JMX, and NV where

SN is the serial number of the shield

ST is the shield type (0 through 13) odd numbers indicate a solid and even numbers denote a void.

MTL is the material number (1X in format skips over octant number)

RAD is the radius (cm) or half angle (radians) for certain volume types

RHO is the material density (g/cc)

JMX is the number of 3-coordinate points for ellipsoids, 4 if regular, 6 if truncated by two planes on semimajor axis, 5 if portion below one plane is deleted, and -5 if portion above one plane is deleted.

NV is the total number of volumes comprising the shield.

NOTE: each volume of the shield is preceeded by a line of this format. However, MTL, RHO, and NV are only taken from the first line. On multiple volume shields, only SN, ST, RAD, and JMX are applicable. (SN is not actually used).

==========
Shield Volume (fixed format is 6F10.0)
==========

Each of the shield volumes is described be several 3-coordinate points. The number of points depends upon the shield type.

ST=0 or 1, Hexahedron, coordinates of eight corners. Order of points must be the following. When viewing the front (choice of front is up to the user), input #1=lower-left, #2=lower-right, #3=upper-left, #4=upper-right. Then when viewing the opposite face (from the space containing the outward normal of that face) input #5=upper-left, #6=upper-right, #7=lower-left, #8=lower-right.

ST=2 or 3, Cylinder, coordinates of bottom center and top center. RAD is the cylinder radius.

ST=4 or 5, Sphere, coordinates of center and point on surface.

ST=6 or 7, Hemisphere, coordinates of center and polar point.

ST=8 or 9, Cone, coordinates of base center and apex, RAD is half angle

ST=10 or 11, Truncated cone, base center, apex, and truncation point, RAD is half angle

ST=12 or 13, Ellipsoid, surface points of semi-axes, center point, truncation point (if JMX=+-5 or 6), second truncation (JMX=6)

Fixed format data is terminated by a line with an asterisk in column 1 (e.g., *end) or a column with blanks in columns 1-5.

++++++++++
Discussion
++++++++++

When using the T option, the code first goes through a conversion; e.g., input from mev2.dat (unit 55) with output to mev2.new (unit 56). The output file is not automatically used. The user must add it to the data stream, e.g.,

```
*mevdp,f,t/ (f option now assumed for t option 96may08)
&get mev2.out
```

The following methods can be used to point to the mevdp input geometry file:

Copy the file to a local file named MEV2.DAT and use the the following novice input:

```
*mevdp,t/
&get mev2.new
```

Use the following input data:

```
*mevdp,tl='mevdp_datafile_name'/
&get mev2.new
```

Use the following input data (no local file named mev2.dat):

```
*mevdp,t/
&get 'mevdp_datafile_name'
&get mev2.new
```

Use the following input data:

```
*files
55 'D:\novice\userdata\mevdp_datafile_name'
*mevdp,t/
&get mev2.new
```

NIEL

NIEL calculates non ionizing energy loss responses.

****
The NIEL analysis processor calculates non-ionizing energy loss functions for electrons protons, and other heavy ions.
****

****
Input Data Record Description:
****

==========
Header line
==========

Contains *NIE in columns 1 through 4.

=======
Options
=======

J, if present, use J. Janni screening model (Atomic Data and Nuclear Data Tables, Vol 27, Num 2/3, March/May 1982).

M=m, only calculate for material m

N, if present, calculate NIEL responses in subsequent analyses.

P, if present input energy partition for one or more elements. For elements not entered, default is 10 eV.

R if present normalize output at energy point r=index (default e=10)

W if present dump elastic recoil table

Z=z, atomic number of the particle type.

****
Data Record Description:
****

==========
Atomic Numbers (P option, paired input,next record)
==========

Atomic numbers with input partition energies.

==========
Partition Energies (P option, paired input, previous record)
==========

Partition energies in MeV for elements above.

If the P option was selected supply two records (or ,/,pairs/) containing atomic numbers (integers) and partition energies (mev).

OPTIONS

OPTIONS sets additional options for processors.

****
The OPTIONS processor sets up additional options for the input section that immediately follows it.
****

If this processor preceeds the *ADJOIMT section, several options will be applied.

****
Input Data Record Description:
****

======
Header
======

Contains *OPT in columns 1 through 4.

=======
Options
=======

A, if absent, new default, use forward flux (slowing down spectrum) for importance sampling. Do not force the values to be monotonically increasing as in the old default.

A, if present or A=0, like A absent except increase importance above 1 MeV by multiplying by the energy.

A=1, use the group width as the importance (assumes a forward flat differential flux).

A=2, use forward flux for importance, force monotonic increasing (old default)

A=3, like A absent, but use all spectra in defining the source for the slowing down spectrum (default is to use the first two specta -- or the only spectrum if just one -- normalized to unity and then added).

B absent, uses new default analog for high energy delta creation. B present, uses analog but with group averaged upscatter cross sections. B=1, uses old models with importance weighted upscatter. B=2, uses old modelswith importance weighted upscatter, plus post weight set equal to pre weight (only correct mathematically if A=1 is also used and if all cross section terms are handled perfectly -- they aren't).

C, use old model for effect of large energy bremsstrahlung production on adjoint electron. Current model is analog using flat forward flux guess (independent of what is used for other modeling).

E, per cent error for automatic termination of run, see U and V options

E, (before *EXE) set electron step size based variation by material as sqrt(13/Z-ave).

F, do not attenuation photon flux sources creating electrons, e.g. if the sources correspond to bremsstrahlung flux at the designated position.

G, always ray trace on electron steps (more time consuming). Default model checks endpoints of the step and assumes all is copecetic if the endpoints are in the same region (this can be incorrect, e.g., when traversing a corner).

D, debug, print jump arrays, kills

P, plot particle trajectories while running

H, if H=h is input, only the first h histories (per group) are plotted.

I, if I=i and J=j are supplied, only particles with these group indices are plotted

J, see I above

K, if K=k and L=l are supplied, only particles with these flux group indices are plotted.

L, see K above

M, generate a unique restart file for each detector (and electron and photon for b=4)

N infinite array in x, beta/new scoring

O infinite array in y, beta/new scoring

Q if present, in new scoring reflect at x=0, y=0

R=r, plot size (updown) around the detector point (whatever units the last geometric data used, default centimeters).

S=s, interval between restart file generation

T=t, maximum total elapsed time

U=u, index of the spectrum for automatic termination using E option

V=v, index of the response for automatic termination using E option

W=w, index of the detector for automatic termination using E option (do not use, or use W=1, for adjoint, E option applies to each one as it is run)

X, if present, use restricted range for biasing production sites Present default is to use full range regardless of photon energy. Thus, a photon of 5 MeV can only be produced by an electron with energy greater than 5, and the depth of possible should subtract off the range at 5 MeV.

X=1, select the energy of the electron before selecting the collision point. With the electron energy known, the depth of possible creation is then limited at the top end by the actual electron energy rather than the max energy cutoff.

X=2, increase the relative importance of electron-photon versus photon-photon for low energies rather than use the present model which is 50-50.

Y=1, select electron creating photon analog

Y=2, select photon scattering to photon analog

Y=3, select both electron and photon analog

Z scales scattering ratio in adjoint photon

****
Data Record Description:
****

There are no other data records.

OVERLAP

The SIMPLE, BAYS, DESIGN, MAGIC, and REGION input processors all have the option letter O which has the same interpretation during overlap resolution. This appendix discusses overlaps and describes the effect of the O option.

Also used in geometry inputs is the P=p option which sets a tolerance used in determining if surfaces are unique or not. In single precision versions of the code, the tolerance is 1.E-5 and in double precision versions 1.E-7. The user can set a new tolerance using P=p, e.g. P=1-10 sets the tolerance to 1.E-10 in the double precision version (and zero in the single precision version). This option is set using the *option processor just before each geometry input processor where it is to be used.

Geometry descriptions can be simplified if the user chooses to allow overlaps. For instance, suppose one region is surrounded by another. If the surrounded region is described first, and the overlap is allowed, the description of the surrounding region need not delete the interior region. The resolution of overlaps will delete it automatically.

The overlap logic can be used to reduce ray tracing times for very large problems. Basically, the ray tracer never looks at interior regions wholly contained by other regions if (1) the ray does not intersect the surrounding region, and (2) the interior region bodies were not explicitly deleted from the surrounding region body (explicit deletion puts the region bodies on the same level, i.e., after deletion, the interior region body is now "outside" the surrounding region body).

Thus, major subsets of the geometry can be enclosed by regions that allow overlap. If the ray does not intersect the enclosing region, the regions will not be examined in the ray trace.

NOVICE contains several different resolutions of overlapping regions. In some cases overlaps simplify problem description and/or save ray tracing time. In other cases overlaps constitute errors. The user tells the code how overlaps are resolved through the O option. The code default, absence of the O option, is that overlaps constitute errors.

An overlap table is setup after all the regions are described. This table is setup using the O option in effect when each region was input in conjunction with the coordinates of a point in each region. The "point-in-region" coordinates are computed by the code for BAY, SIMPLE and DESIGN regions and user supplied for MAGIC and REGION inputs.

If the letter O was absent during the region input, the region has the following attributes

1) the region cannot overlap with any region having a smaller region index (any region already described)

2) the region can overlap regions (be contained in regions) with a larger region index (regions not yet described) only if those regions are input with the O option.

If the O option is present, or has the value 1, 0=1, the input regions have the following characteristics

1) the region can overlap with (contain) any region having a smaller region index. The region with the smaller index, if it overlaps (is contained in) this one , is assumed to be wholly contained in this one. Any portions of the lesser indexed region not contained in this one are ignored.

2) the region can overlap (be contained by) regions with a larger index if they are described with the O option.

The above logic is used to resolve overlaps that can be determined using the "point-in-region" coordinates. However there are many partial overlaps that cannot be resolved by this logic, e.g.,

If x_{-1} and x_{-2} denote the point-in-region coordinates, and neither point is in the other region, then the preliminary overlap logic will not see this overlap. However, ray tracing can encounter this overlap.

The option 0=2 allows this type of overlap. Basically, the 0=1 logic is applied plus, during ray tracing, the lesser indexed region is seen by the code. Both regions involved in this unresolved overlap must be input with 0=2, or an error is assumed.

Finally, the option 0=3 works like 0=2 except the region is not allowed to be contained by any higher indexed region. A region described with the O=3 option can have unresolved overlaps with all other regions. These overlaps are not resolved until ray tracing, and the overlaps are always resolved in favor of the lowest indexed region involved in the overlap.

The overlap table setup uses the following logic:

1) if the region does not have "point-in-region" coordinates it will not be tested for overlap with other regions. Other regions will be tested against it however.

2) If the region cannot overlap other regions (defined without the O option), the point-in-region coordinates are tested to see if they occupy any other region. If this regions coordinates are also inside a lesser indexed region, an error message is printed. If this regions coordinates are also inside a higher indexed region, the following resolution is made:

a) if the higher indexed region allows overlaps, being inside is okay. If this is the first higher indexed region that accepts the point-in region, the region being tested is said to be contained in this higher indexed region.

b) If the higher indexed region does not allow overlaps and a containing region has not been set as described in a), an error message is printed.

3) If the region can overlap (contain) other regions, no testing against lower indexed regions is made.

4) If the region allows unresolved overlaps (containing or contained by, O=3), then no tests are performed as in O=1 or O=2. Furthermore, during ray tracing, overlaps are always resolved in favor of the lowest indexed region of the overlap.

Many unsuspected partial overlaps can be found by exercising the ray trace, e.g., using PICTURE. The PICTURE analysis has an option that performs ray traces in the three orthogonal directions for every point-in-region. Partial overlaps not allowed by the overlap diagnostic messages if encountered by the ray traces.

The ray trace package in this code cannot get lost. The user controls the resolution of geometric conflicts/overlaps through the O option. It is assumed that most, if not all geometric modeling errors were resolved using PICTURE and/or short runs. Any residual error overlaps found during calculations will yield messages (up to a reasonable limit), will be resolved in favor of the lesser indexed region, but will not terminate the calculation.

Overlap Outputs

Overlaps not specifically permitted by the user produce output lines with the format shown in Table 80 (OVRLAP).

Graphic Examples

Figure 62 (OVELAP) illustrates how overlaps are resolved if the user does not allow overlaps. The code sees the lower indexed volume. Figure 63 (OVELAQ) illustrates the resolution of overlaps with the O=1 or O=2 options. (O=2 eliminates error messages for any overlaps not found during the initial overlap table setup). The O=3 option works like O=0 except no errors are assumed.

Table 80: (OVRLAP) Ray Trace Overlap Messages

```
INPUT *HEADER,OPTIONS/
Line   1:*PICTURE,O/

OVERLAPS FOR
X,U =   1.2000E+01  2.6000E+01  0.0000E+00  1.0000E+00  0.0000E+00  0.0000E+00
REG0 REG1  ENTRANCE        EXIT           REG2  ENTRANCE        EXIT
  21   14   16 1.4801E+01   16 1.7199E+01    4    6 1.4439E+01    6 1.7561E+01
OVERLAPS FOR
X,U =   1.2000E+01  2.6000E+01  0.0000E+00  0.0000E+00  1.0000E+00  0.0000E+00
REG0 REG1  ENTRANCE        EXIT           REG2  ENTRANCE        EXIT
  21   12   14-7.0000E+00   14-1.0000E+00    2    4-2.0000E+00    4 2.0000E+00
  21   17   19-2.2000E+01   19-1.8000E+01    7    9-1.9000E+01    9-1.3000E+01
OVERLAPS FOR
X,U =   2.0000E+01  2.5250E+01  0.0000E+00  1.0000E+00  0.0000E+00  0.0000E+00
REG0 REG1  ENTRANCE        EXIT           REG2  ENTRANCE        EXIT
  21   13   15-1.6583E+00   15 1.6583E+00    3    5-2.0000E+00    5 2.0000E+00
  21   14   16 5.7639E+00   16 1.0236E+01    4    6 6.0635E+00    6 9.9365E+00
  21   15   17 1.3273E+01   17 1.8727E+01    5    7 1.4439E+01    7 1.7561E+01
OVERLAPS FOR
X,U =   2.0000E+01  2.5250E+01  0.0000E+00  0.0000E+00  1.0000E+00  0.0000E+00
REG0 REG1  ENTRANCE        EXIT           REG2  ENTRANCE        EXIT
  21   13   15-5.5000E+00   15 4.9999E-01    3    5-2.0000E+00    5 2.0000E+00
  21   18   20-2.0500E+01   20-1.6500E+01    8   10-1.9000E+01   10-1.3000E+01
OVERLAPS FOR
X,U =   2.0000E+01  2.5250E+01  0.0000E+00  0.0000E+00  0.0000E+00  1.0000E+00
REG0 REG1  ENTRANCE        EXIT           REG2  ENTRANCE        EXIT
  21   13    2-1.0000E+00    3 1.0000E+00    3    2-1.0000E+00    3 1.0000E+00
OVERLAPS FOR
X,U =   2.8000E+01  2.4750E+01  0.0000E+00  1.0000E+00  0.0000E+00  0.0000E+00
REG0 REG1  ENTRANCE        EXIT           REG2  ENTRANCE        EXIT
  21   12   14-1.7199E+01   14-1.4801E+01    2    4-1.7561E+01    4-1.4439E+01
  21   13   15-1.0236E+01   15-5.7639E+00    3    5-9.9365E+00    5-6.0635E+00
  21   14   16-2.5981E+00   16 2.5981E+00    4    6-2.0000E+00    6 2.0000E+00
  21   15   17 5.0953E+00   17 1.0905E+01    5    7 6.1460E+00    7 9.8540E+00
OVERLAPS FOR
X,U =   2.8000E+01  2.4750E+01  0.0000E+00  0.0000E+00  1.0000E+00  0.0000E+00
REG0 REG1  ENTRANCE        EXIT           REG2  ENTRANCE        EXIT
  21   14   16-4.5000E+00   16 1.5000E+00    4    6-2.0000E+00    6 2.0000E+00
  21   19   21-1.9500E+01   21-1.5500E+01    9   11-1.9000E+01   11-1.3000E+01
OVERLAPS FOR
X,U =   2.8000E+01  2.4750E+01  0.0000E+00  0.0000E+00  0.0000E+00  1.0000E+00
REG0 REG1  ENTRANCE        EXIT           REG2  ENTRANCE        EXIT
  21   14    2-1.0000E+00    3 1.0000E+00    4    2-1.0000E+00    3 1.0000E+00
OVERLAPS FOR
X,U =   3.6000E+01  2.4000E+01  0.0000E+00  1.0000E+00  0.0000E+00  0.0000E+00
REG0 REG1  ENTRANCE        EXIT           REG2  ENTRANCE        EXIT
  21   13   15-1.8727E+01   15-1.3273E+01    3    5-1.7561E+01    5-1.4439E+01
  21   14   16-1.0905E+01   16-5.0953E+00    4    6-9.8540E+00    6-6.1460E+00
  21   15   17-3.0000E+00   17 3.0000E+00    5    7-2.0000E+00    7 2.0000E+00
OVERLAPS FOR
X,U =   3.6000E+01  2.4000E+01  0.0000E+00  0.0000E+00  1.0000E+00  0.0000E+00
REG0 REG1  ENTRANCE        EXIT           REG2  ENTRANCE        EXIT
  21   15   17-3.0000E+00   17 3.0000E+00    5    7-2.0000E+00    7 2.0000E+00
  21   20   22-1.8000E+01   22-1.4000E+01   10   12-1.9000E+01   12-1.3000E+01
```

Figure 62: (OVELAP) Overlap Logic, O=0 or O=3

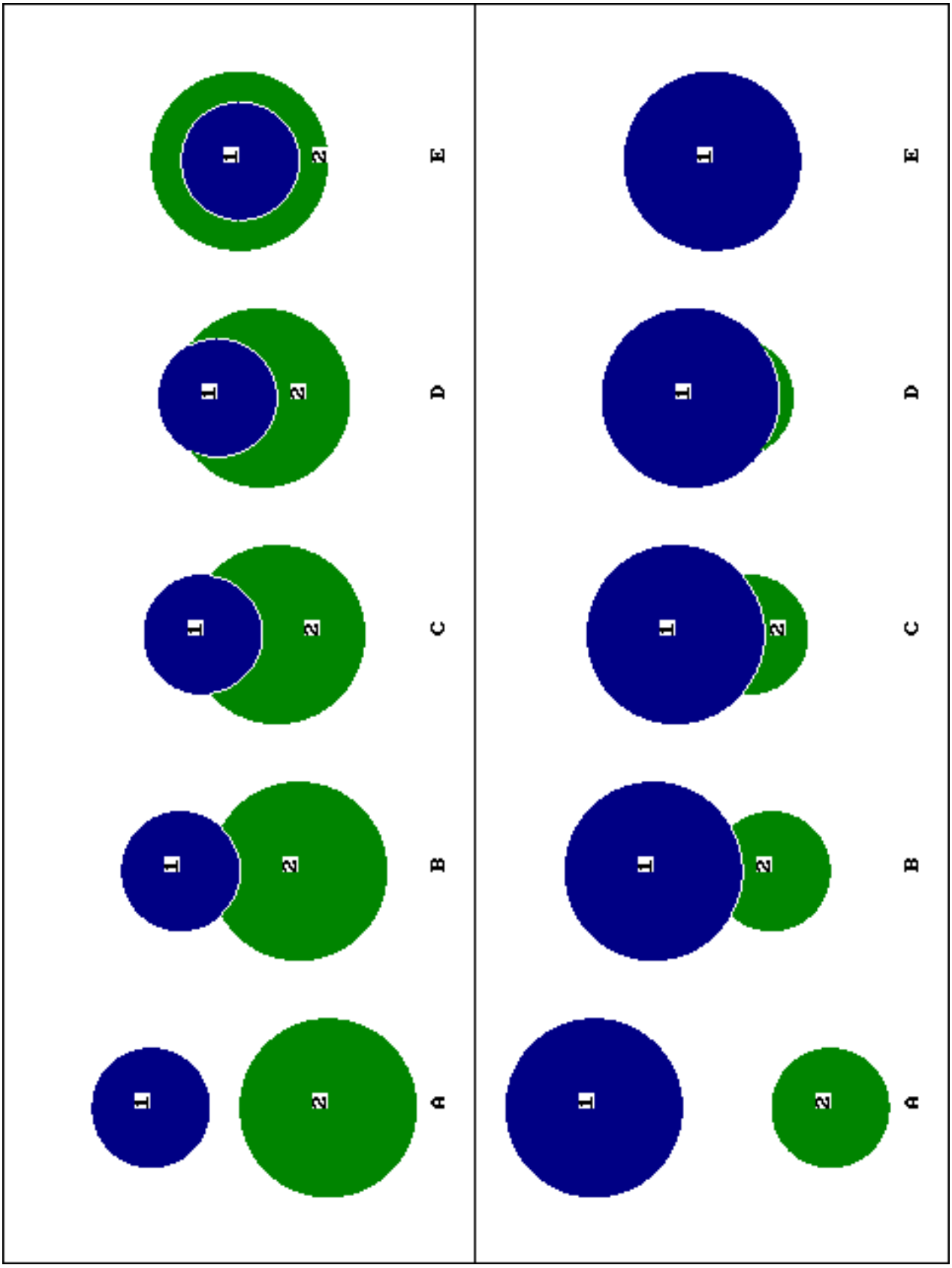
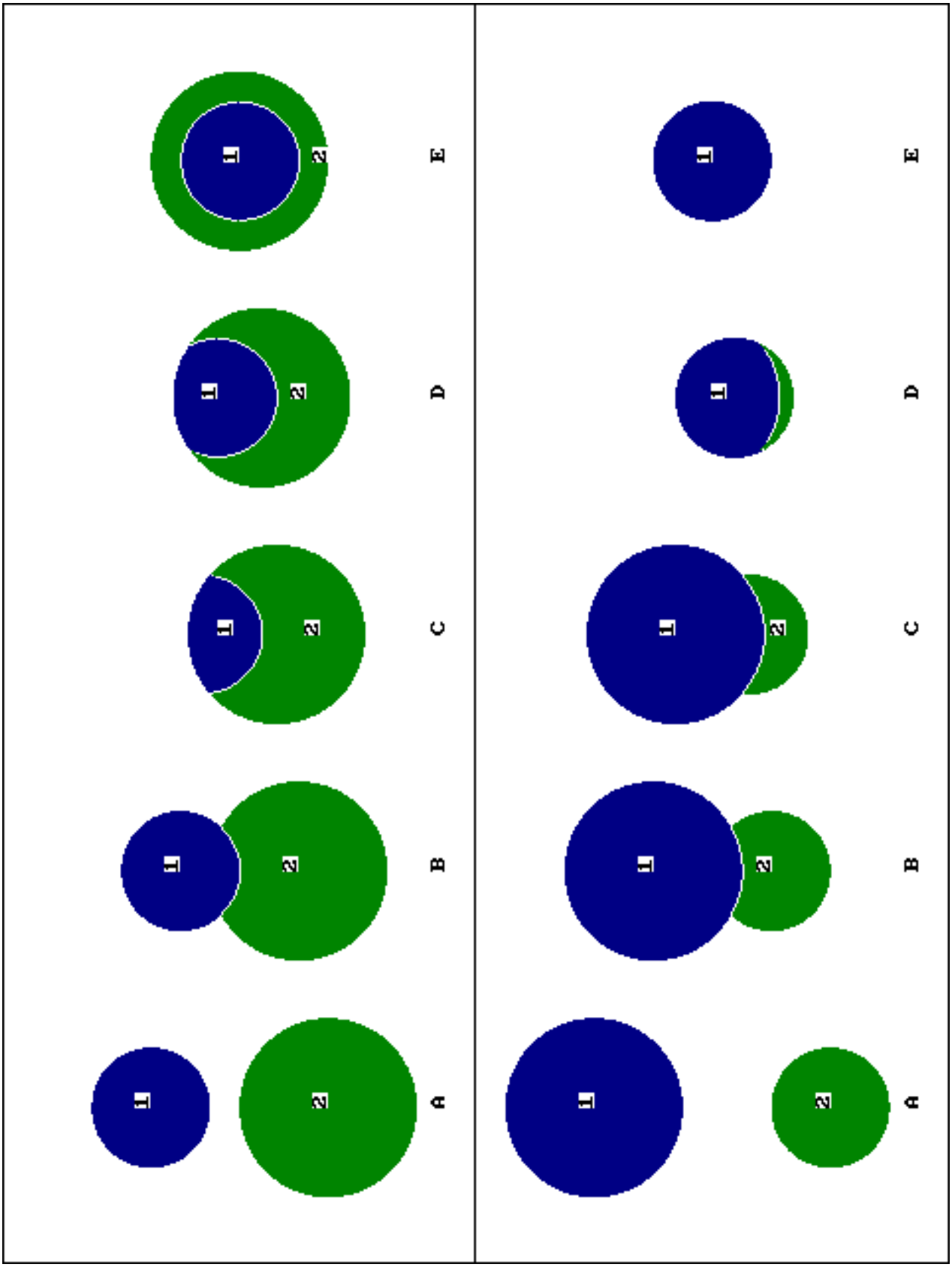


Figure 63: (OVELAQ) Overlap Logic, O=1 or O=2



PARTICLE

PARTICLE sets up energy groups.

****
The PARTICLE processor overrides the particle names and group structure.
****

****
Input Data Record Description:
****

==========
Header line
==========

Contains *PAR in columns 1 through 4.

=======
Options
=======

No options apply.

****
Data Record Description:
****

Repeat the following data as needed.

==========
Particle Identification
==========

'NAME' Z A/

The particle NAME is truncated to 12 characters. Z and A are the particle identifier as indicated in Table 1 of the introduction.

==========
Energy Group Structure
==========

energies from in ascending or descending order.

The energy group boundaries are MeV, or MeV/amu if A is greater than 1.

****
Discussion
****

For multiple heavy ion types, the lowest atomic number ion determines the group structure for spectra, responses, and cross sections.

PDFiles

PDFiles, documents techniques for preparing PDF files.

****
PDFiles, at present, is a collection of routines used to prepare a PDF version of the NOVICE User's Guide. PDF files have a universal format that can be read using the Adobe Acrobat Reader on a variety of systems (Intel Windows PCs, Macs, Unix work stations, etc.). The Acrobat Reader can also print the document, or subsets, using the print drivers resident on the host computer.
****

==========
Discussion
==========

The preparation of the NOVICE98.PDF file requires the following steps (98May28, may be automated later). The steps are:

Create the text file TESTFILE.PS using the old User's Guide software by running DISKPDF8.BAT in the C:\NOVICE\LIBRARY\RUNGUIDE directory;

Copy TESTFILE.PS TO C:\NOVICE\PSFILES\NOVICE.DOC, go to the C:\NOVICE\PSFILES directory and run PSGUIDE which creates a file NOVICE.TXT using NOVICE.DOC as input;

In Windows, use WordPerfect, open NOVICE.DOC, set the top, bottom, and right margins as small as possible, select Courier as the default font, under files print, select the AppleWriter printer, and under details, print to file C:\NOVICE\PSFILES\NOVICE.PS;

Back in C:\NOVICE\PSFILES, under DOS, run PSCRIBS; this reads NOVICE.PS and inserts tables and formatted bare postscript graphics in the NOVA98.PS file;

Back in Windows, under programs, select adobe, then distiller, and point distiller to the NOVA98.PS file, and give a name for the PDF file (don't use NOVICE98.PDF unless it has been deleted); and

In Windows, under programs, select adobe, then reader, and review the final PDF file. The PDF file is too big for one floppy but can be packed with PKZIP to get a file small enough for a single 1.44 floppy.

==========
Other Notes
==========

1) The old code for generating the User's Guide is used first. This code, RETEST, is located in the C:\NOVICE\LIBRARY\NEWGUIDE directory. It is run from the C:\NOVICE\LIBRARY\RUNGUIDE directory. There are several batch files in the RUNGUIDE directory, for example:

DISKALL6.BAT uses the input file DISKALL6.DAT and creates individual files for each of the User's Guide sections and places them in the C:\NOVICE\LIBRARY\GUIDE directory. The name of each of the sections is truncated at three letters, e.g., the DESIGN description is in the DES.DOC file.

DISKONE6.BAT uses the input file DISKONE6.DAT and creates a single User's Guide file called NOVICE.DOC.

DISKONE8.BAT uses the input file DISKONE8.DAT and sends the User's guide to the printer. This run is DOS mode and uses PCL commands to generate the graphics pages.

DISKPDF8.BAT uses the input file DISKPDF8.DAT and creates the first file used to create NOVICE98.PDF. The output file from this run is TESTFILE.PS. The file is not PostScript, but starts the process of creating a PostScript that is fed to Adobe Distiller to create the final PDF file.

PICTURE

PICTURE generates geometry pictures.

****
The PICTURE analysis processor generates printed cross sections of the geometry. It is used primarily as a debugging aid.
****

****
Input Data Record Description:
****

==========
Header line
==========

Contains *PIC in columns 1 through 4.

=======
Options
=======

O, if present, perform orthogonal ray traces from all point-in-regions prior to picture generation

The following definitions apply to the E or Q options.

E, a major option, if present, regenerate previous picture. If E=1, the old picture is in unformatted rather than binary format (generated before Aug 1991).

F do not compute cosine at each pixel (default is compute)

M use region index as color index (default is material index)

L, L='name', name is the name of the picture file without the .pic extension

Q, generate a screen picture

Q=-6, yz cross section, single view

Q=-5, zx cross section, single view

Q=-4, xy cross section, single view

Q=-3, perspective from infinity, front view (yz view)

Q=-2, perspective from infinity, side view (zx view)

Q=-1, perspective from infinity, top view (xy view)

Q=0 (or Q), perspective

Q=1, large perspective plus three small cross sections

Q=2, large perspective plus three small perspectives

Q=3, perspective and three cross sections, same size

Q=4, perspective and perspectives from top,side,front

Q=5, perspective and cross sections and three small perspectives

Q=6, perspective and top,side,front and three small cross sections

M=1 use region index as color index (default is material index)
M=2 use surface index for color index (modulo number of colors)

M, (no Q option, print plot) plot by material number instead of region number

J, name.dim file exists for dimensioning figure. Only works if the Q option selected includes a cross sectional view. However, text information can be added to the view, see Table 81 (PICDIM).

J=1, same as J plus use region rather than surface dimensions

K, do not generate off pixel between regions (default is to leave a blank space between different regions)

K=k, put color number k between regions. Does not apply if V option is used (white background) or if number of colors is not 256 or larger. Value of k must be from 1 through 15, where 15 is white on screen and black on hardcopy. Colors 1, 2, and 4 are blue, green, and red respectively.

I, Number of colors - 1, e.g. 255

G=graphics mode (if negative, in core)

C, cutter bodies are input

A, look ahead in initial search pattern

B, cosine power in shaded output (default is one)

F=1, interpolate for cosine at each pixel (default is compute)

F=f, (no Q option, print plot) selects graphics mode with characters rather than pixels.

F=6, (no Q option, print plot) puts output of cross section picture in graphics mode (even print plot using letters).

H, grey scale output

V, white background

D, transparency flags are being input. If D=d and d less than 0, then a special pealing logic is used. The first view shows everything visible from the outside. The next view sets everything seen in the first view as transparent before starting, and so on until nothing is seen.

P, graphics printing options, see GRAPHICS processor discussion

P, (no Q option, print plot) graphics print after plot (PrintScreen)

R, x resolution in initial search (default is 16) for projected views. If pixels have different surface/region, interval is halved and process repeated, etc., to single pixel level.

S, y resolution in initial search (default is 16)

W, write intermediate debug data to output file

X, number of x pixels (to reset automatic settings)

X=x, (no Q option, print plot) characters across, default is 79

Y, number of y pixels (to reset automatic settings)

Y=y, (no Q option, print plot) lines up/down, default is 48

Z put axes on any xy yz and/or zx views. if z=3 also put

T, number of lines at bottom (+ 2 heading lines at right on screen, 2 lines at top on paper-landscape mode)

X, number of x pixels (to reset automatic settings)

X=x, (no Q option, print plot) characters across, default is 79

Y, number of y pixels (to reset automatic settings)

Y=y, (no Q option, print plot) lines up/down, default is 48

Z put axes on any xy yz and/or zx views. if z=3 also put

T, number of lines at bottom (+ 2 heading lines at right on screen, 2 lines at top on paper-landscape mode)

T, (no Q option, print plot) put title on the graphics plot (requires line of input for each plot)

Z, put axes on any XY, YZ, and/or ZX views. If Z=3, also put axes on any perspective views.

N, generate picture restarts (every major line in projected views) on RESTRT19.DAT and RESTRT20.DAT. To use a restart, rename the last complete restart file as OLDRUN.DAT, delete name.PIC and name.TXT files and rerun. (Several production runs of projected views of large geometries at high resolution -1200x1600- have taken over 3 days on a 20Mhz 386 PC with a coprocessor, requiring more than 250,000 ray traces and 600,000 surface normals.)

&a if present, &b applies to centers of step regions, >=0 skip perspective

&b (alpha) automatically produce a plot at the center of enclosures/totes

&c always plot region midpoint on verticle rays for xsect views

&d if present, all transarent but step region

&e no perspective on multi-view

&f only plot if also a detector point label

&g apl plot legend

&h don't do local rotates with &b

&i put region indices on plots, may get crowded

&j global coordinates for plot labels

&k skip perp ray-trace in xsect pics

&l Q=7 option nw,ne,sw,se=1,2,3,4

&m make movie data for , multi views every 360/moptm degrees, with d

&n get step neighbors within dopgn

&o output octant data for box being run

&p subs for character font averaging

&q character font overaging, bypasses everything else

&r randomize projected ray trace for each pixel

&s (rea,cen,0,inf) sphere radius detector plot

&t ray trace test

&x (int,,0,inf) multiple slice views, Q=-6 yz

&y (int,,0,inf) multiple slice views, Q=-5 zx

&z (int,,0,inf) multiple slice views, Q=-4 xy

****
Data Record Description:
****

==========
Picture Frame (Q option)
==========

Input this line if Q option selected. Contains the center of the picture (x,y,z coordinates), the coordinates of the view point, the half height, and half width.

New option: an additional 6 words are read: xdelq, ydelq, zdelq, xmaxq, ymaxq, zmaxq. If present and any of the delq's is non zero, then a loop is made to shift the center point and repeat the picture. All delq's are applied at the same time to the center point and the picture is repeated until one of the center coordinates exceeds the maximum (obviously input should go from minimum center coordinates to maximum).

Note: this logic is applied as an outer loop around the Transparency Flag pealing option.

==========
Transparency Flags (Q,D options)
==========

Input this line if Q and D options selected. Provide a zero or one for each region, Zero if transparent, one if visible. The transparency flag is not checked unless the region is non-void.

For the D=d, d negative option, omit this record. All regions are initially set as opaque.

==========
Cutter Bodies (Q,C options)
==========

Input this line if Q and C options selected. Provide minimum and maximum dimensions of a rectangular box in the order x-min, x-max, y-min, y-max, z-min, zmax/. Up to ten bodies can be input. Terminate this input with a ,/ record.

==========
Title lines (Q,T options)
==========

Input this data if Q and T options selected. Supply t+2 lines (where T=t was used to select). The first two lines label the top of the figure. The last t lines label the side. If the J option was also input, these title lines are the first t+2 lines of the name.DIM file (where name is the name entered with the L='name' option).

Repeat as needed

==========
Print Plot Data (no Q option)
==========

2,K,L, DELXK MINXK MAXXK MINXI MAXXI MINXJ MAXXJ /

where K indicates the axis perpendicular to the plot, i.e.,

K=1, x is perpendicular and XI=y and XJ=z

K=2, y is perpendicular and XI=z and XJ=x

K=3, z is perpendicular and XI=x and XJ=y

XI is plotted across the printout page/screen and XJ is plotted down the page/screen. Plots are generated for MINXK, MINXK+DELXK,MINXK+2*DELXK, ..., until MAXXK is exceeded.

If L=0, surfaces encountered during ray traces are plotted. Ray tracing is across the page/screen so horizontal surfaces will not be seen.

If L=1, regions are plotted.

==========
Print Plot Title Line (T option)
==========

Single record of alphanumeric information.

****
NAME.DIM File Format (Q option)
****

Fairly complicated. If done now, a mouse would be used to point to labeling positions.

At present, reserved for internal use by E.M.P. Consultants. (I just don't feel like writing it up right now).

++++++++++++
Input Tables
++++++++++++

Several examples of NAME.DIM input are given in Table 81 (PICDIM).

+++++++++++++
Input Figures
+++++++++++++

Figures 64 (PICQV1) through 69 (PICQV6) show the layout obtained by using the Q=1 through Q=6 options.

++++++++++++++
Output Figures
++++++++++++++

Figure 70 (PICYZV) is a YZ cross section of a satellite obtained using the Q=-6 option.

Figure 71 (PICZXV) is z ZX cross section of a satellite using Q=-5.

Figure 72 (PICXYV) is a XY cross section of the same satellite obtained using the Q=-4 option.

Figure 73 (PICPRO) is a projected view of the satellite obtained using Q (or Q=0).

Figure 74 (PICCUT) was obtained using Q and the C (cutter) options.

****
Discussion
****

Tables and figures follow.

Table 81: (PICDIM) Dimension File (name.DIM)

```
C
COMMENT: DESBOX.DIM FILE, FIRST DIM FILE CREATED, TITLES AND XYZ LABELS
C
$            TYPICAL *DESIGN BOX INPUT$
$        *PIC,Q=3,Z=3,G=97,T=1,J,L='DESBOX'$
$  ID#,MTL,RHO,'BOX',X1,X2,Y1,Y2,Z1,Z2/ DESIGN BOX INPUT PARAMETERS$
$  END OF TITLES
XYCROSSSECTIONVIEW,SURFACE2,YMINPOINTER=Y1,YMAXPOINTER=Y2
XYCROSSSECTIONVIEW,SURFACE4,XMINPOINTER=X1,XMAXPOINTER=X2
 END OF XYCROSSSECTIONVIEW LABELING
XZCROSSSECTIONVIEW,SURFACE2,ZMINPOINTER=Z1,ZMAXPOINTER=Z2
XZCROSSSECTIONVIEW,SURFACE6,XMINPOINTER=X1,XMAXPOINTER=X2
 END OF XZCROSSSECTIONVIEW LABELING
YZCROSSSECTIONVIEW,SURFACE4,ZMINPOINTER=Z1,ZMAXPOINTER=Z2
YZCROSSSECTIONVIEW,SURFACE6,YMINPOINTER=Y1,YMAXPOINTER=Y2
 END OF YZCROSSSECTIONVIEW LABELING
C
COMMENT: DESPIE.DIM FILE, USES UV AND XY LOGIC
$          TYPICAL *DESIGN PIE SECTOR INPUT$
$        *PIC,Q=3,Z=3,G=97,T=2,J,L='DESPIE'$
$  ID#,MTL,RHO,'PIE',R,S,A,B,H,Z/ DESIGN PIE INPUT PARAMETERS$
$  R,S are radii;  A,B are degrees;  H is height;  Z is mid z-coordinate$
$  END OF TITLES
XYC1,UMAXVMIN='RcosA,RsinA'
XYC6,VMINUMIN='RcosB,RsinB'
XYC2,UMAXVMIN='ScosA,SsinA'
XYC2,UMINVMAX='ScosB,SsinB'
 END OF XYPROJECTEDVIEW LABELING
XZC2,ZMAXZ=H
XZC6,ZAVEP=Z
 END OF XZPROJECTEDVIEW LABELING
YZC5,ZMAXZ=H
YZC6,ZAVEP=Z
 END OF YZPROJECTEDVIEW LABELING
C
COMMENT: GEOINT.DIM FILE, W=WINDOW,L=LINE,$=TEXT
C
XYCWINDOWED PLOT COMMANDS
W      0     0   639   479
L      0   239   639   239    15
$    116   451     8     8     0     0
$V1$
$    310   451     8     8     0     0
$V2$
$    450   451     8     8     0     0
$V1 intersect V2$
$    296   119     8     8     0     0
$ U(x)<0$
$    296   172     8     8     0     0
$U(x)>0$
Comment:  XYP for xy projected, UVP for perspective view, etc..
```

Figure 64: (PICQV1) Layout of Q=1 Output

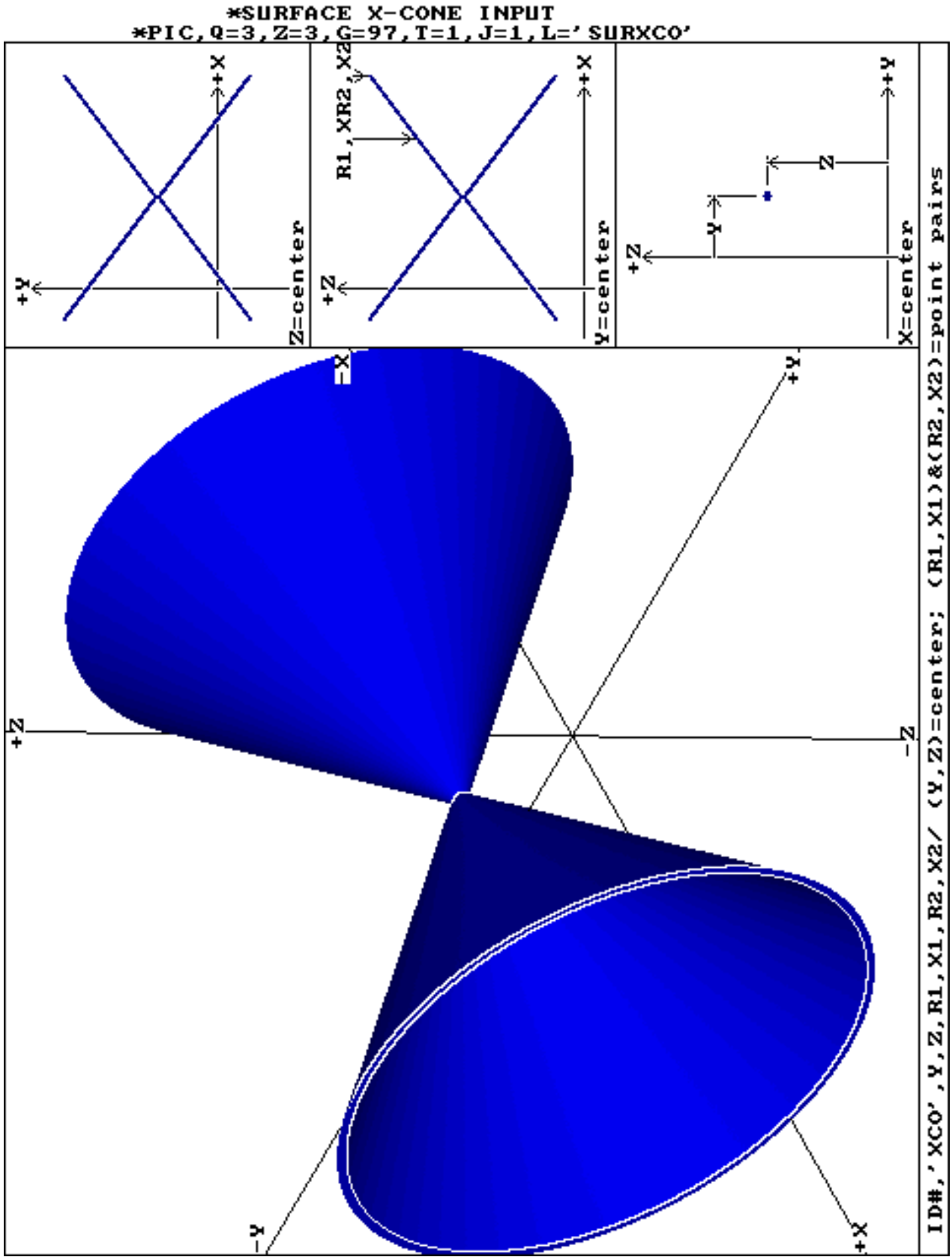


Figure 65: (PICQV2) Layout of Q=2 Output

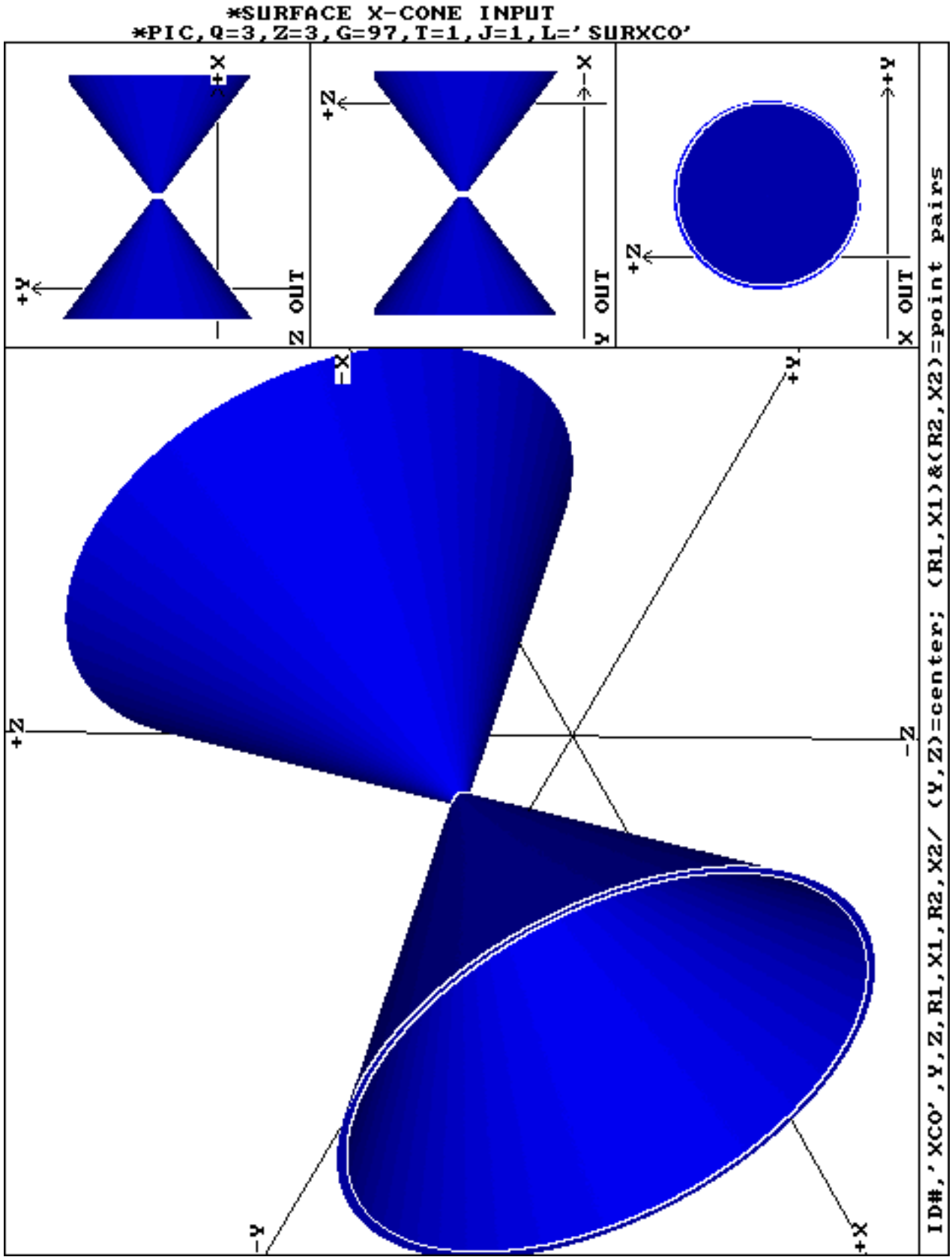


Figure 66: (PICQV3) Layout of Q=3 Output

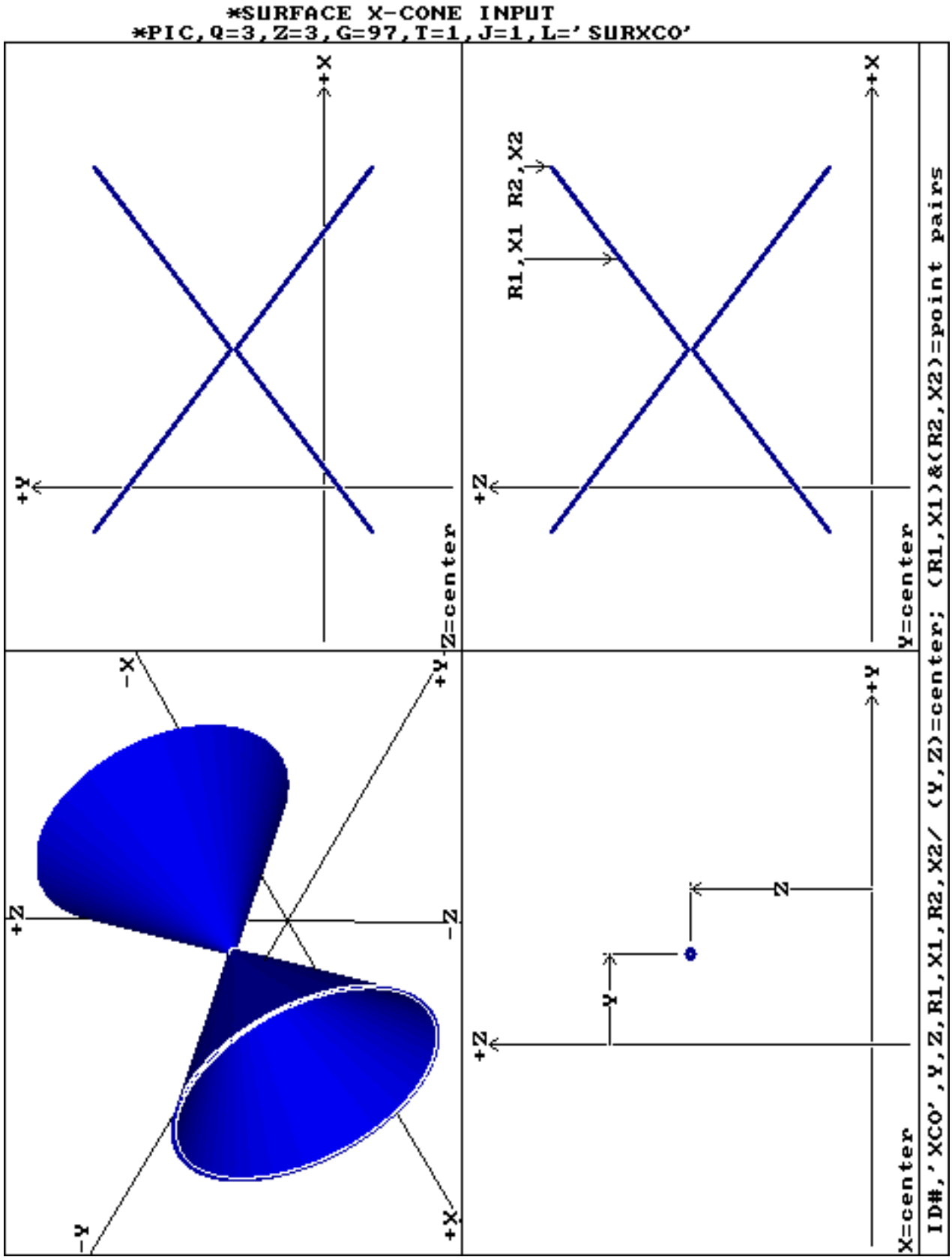


Figure 67: (PICQV4) Layout of Q=4 Output

*SURFACE X-CONE INPUT
*PIC,Q=3,Z=3,G=97,T=1,J=1,L='SURXCO'

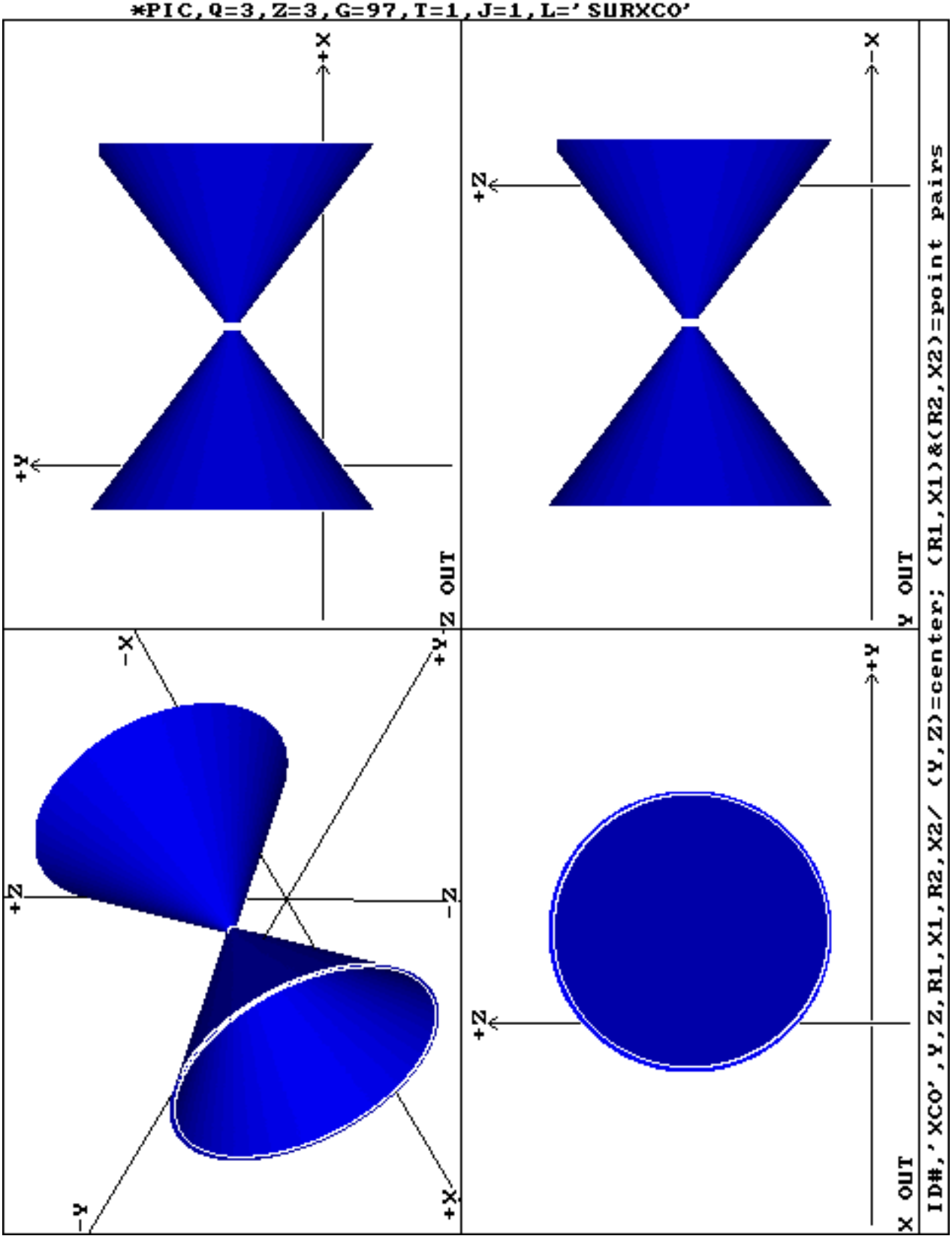


Figure 68: (PICQV5) Layout of Q=5 Output

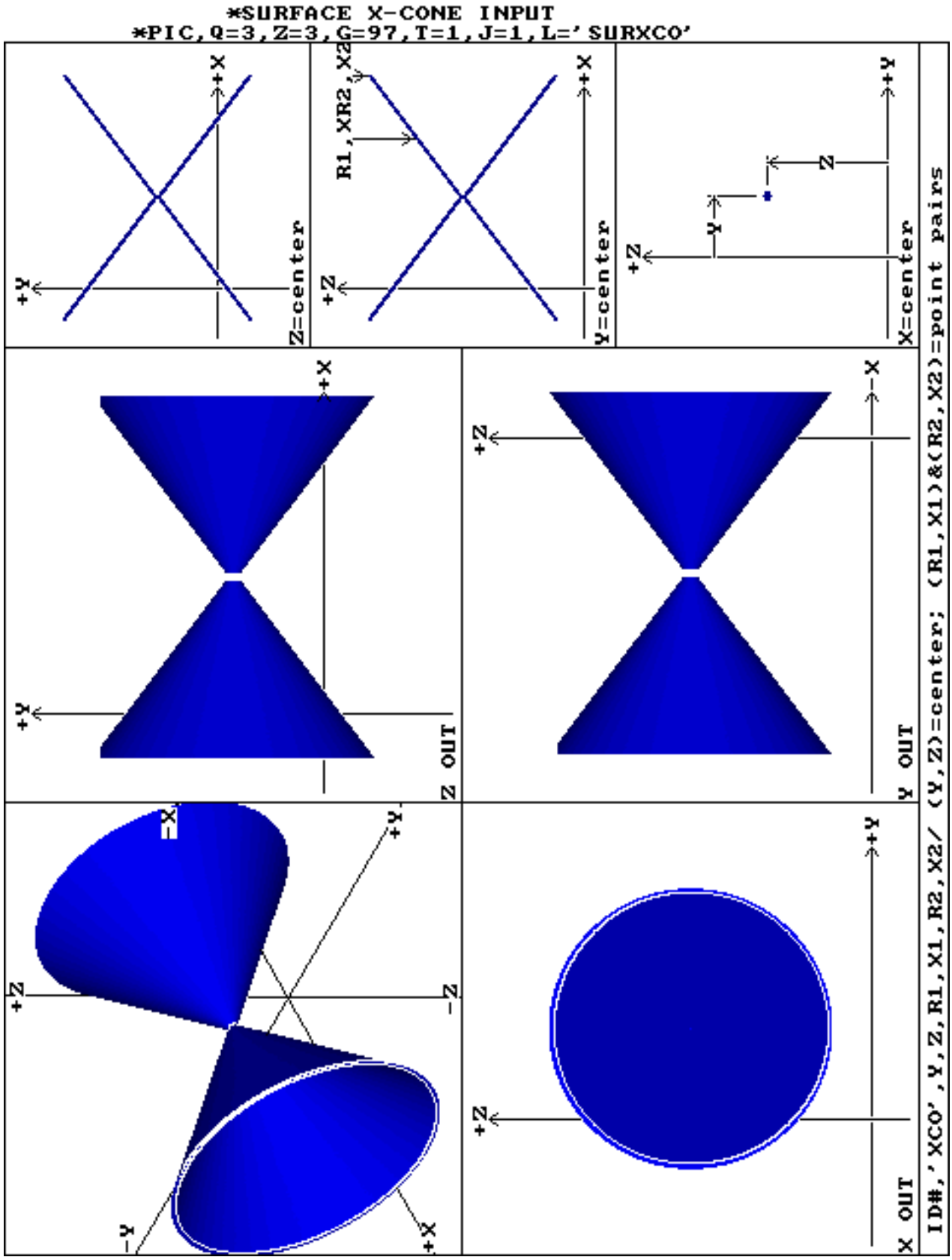


Figure 69: (PICQV6) Layout of Q=6 Output

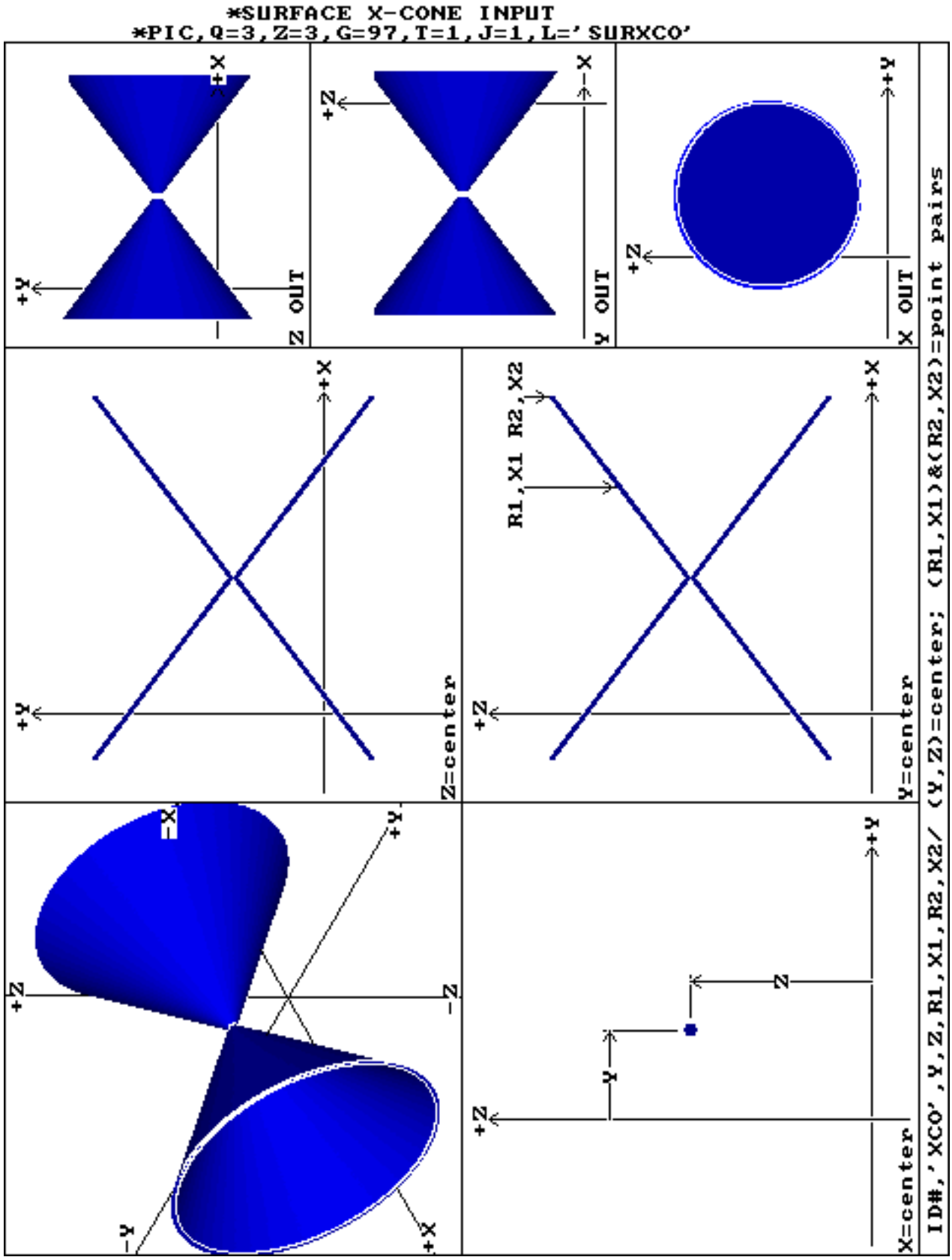


Figure 70: (PICYZV) YZ Cross Section, Q=-6

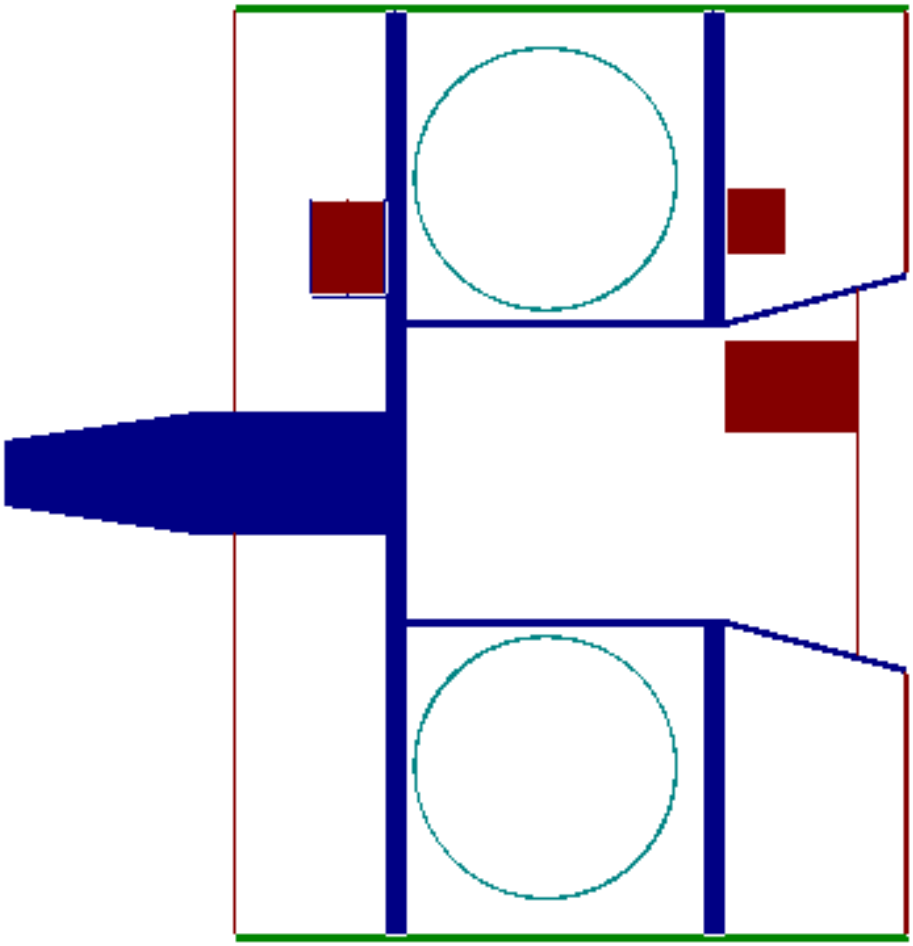


Figure 71: (PICZXV) ZX Cross Section, Q=-5

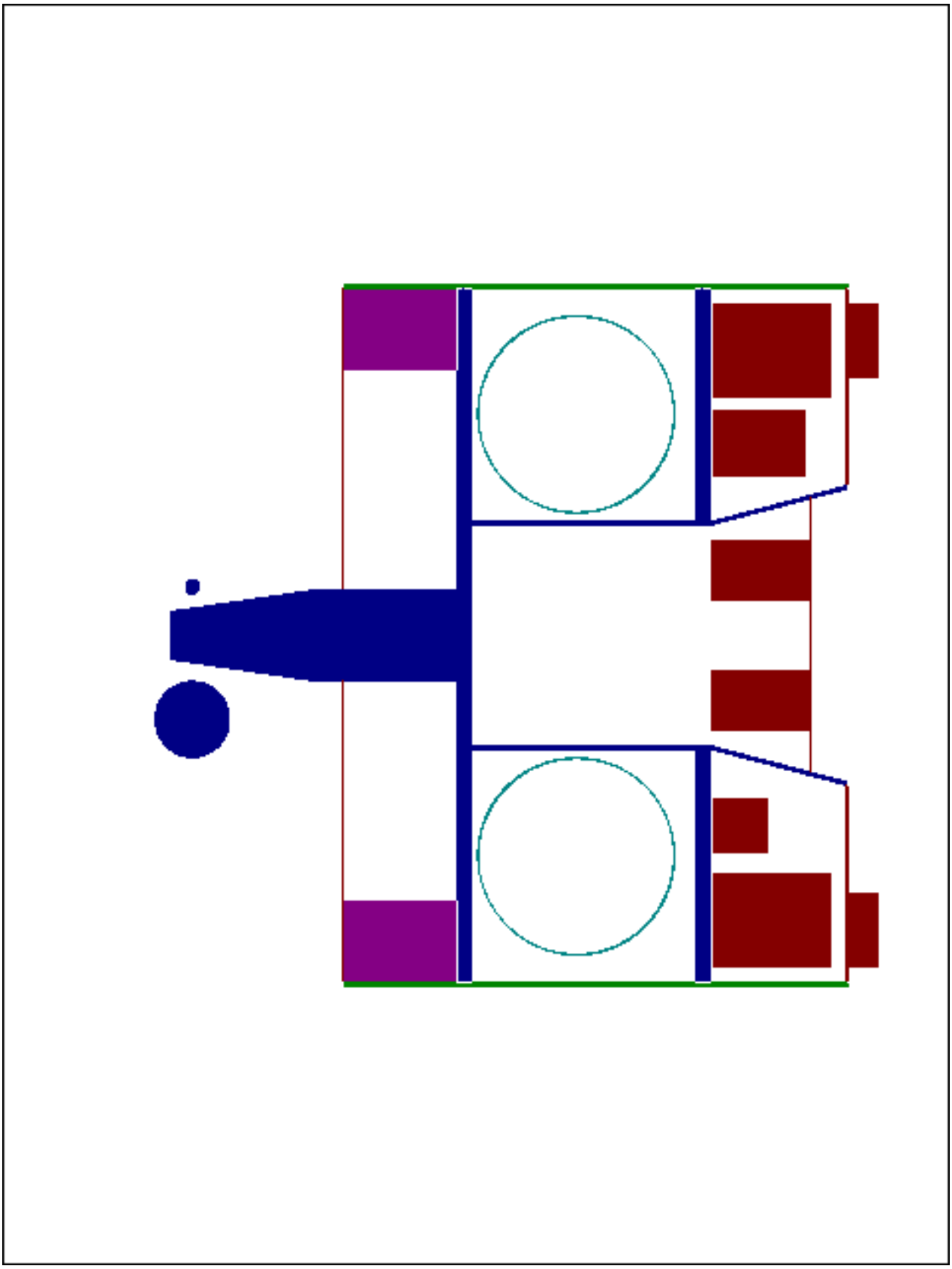


Figure 72: (PICXYV) XY Cross Section, Q=-4

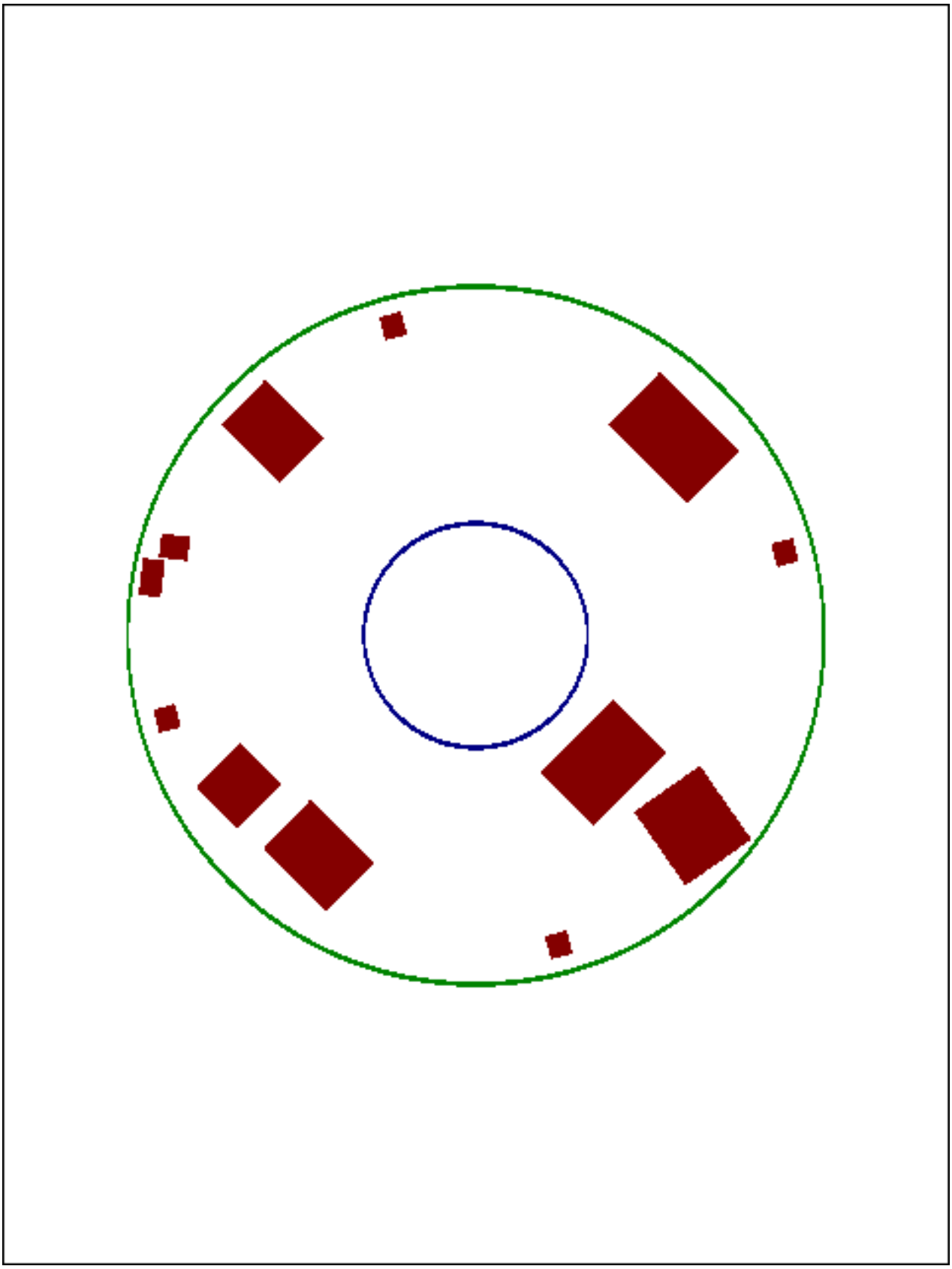


Figure 73: (PICPRO) Projected View, Q or Q=0

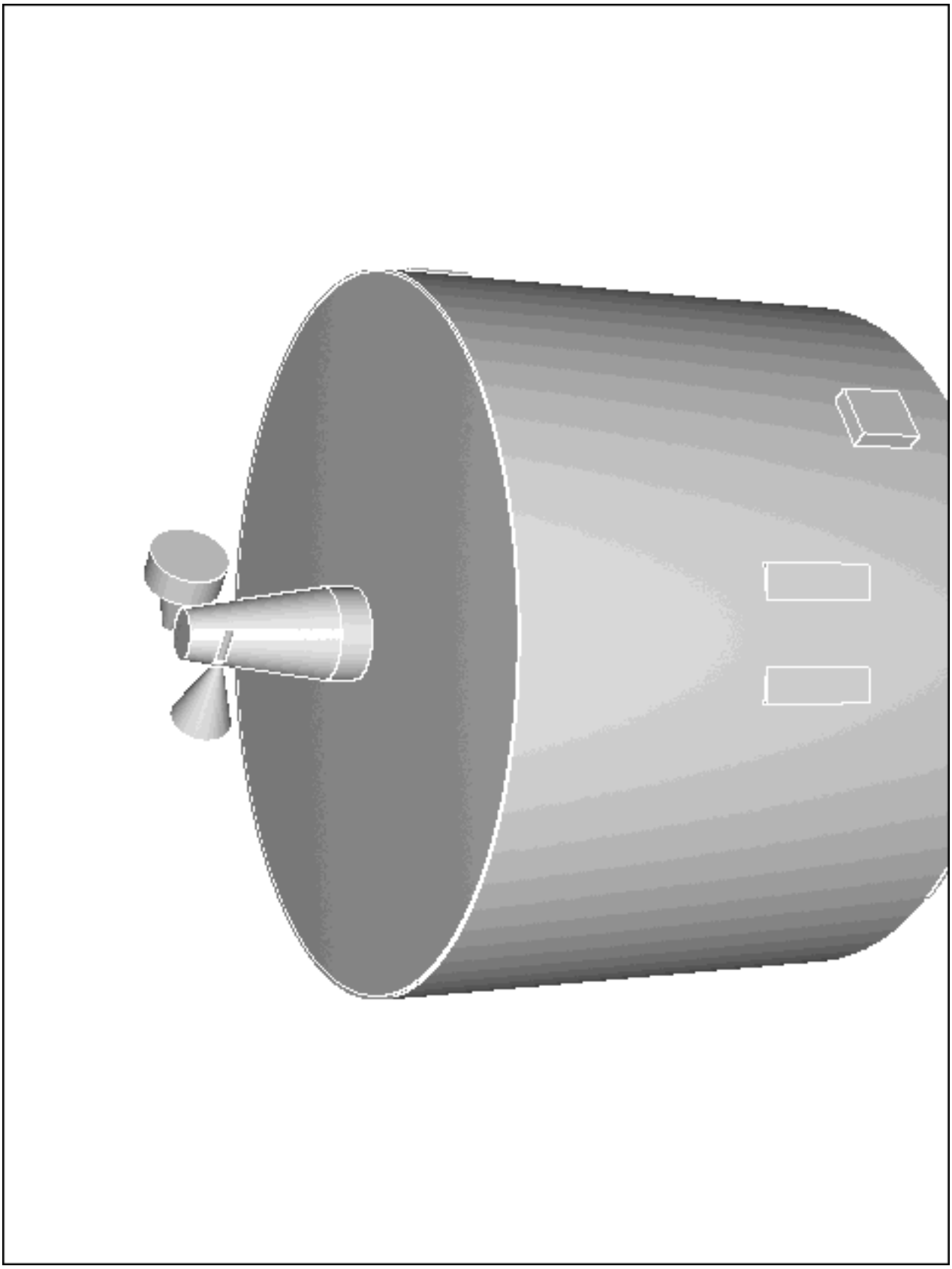
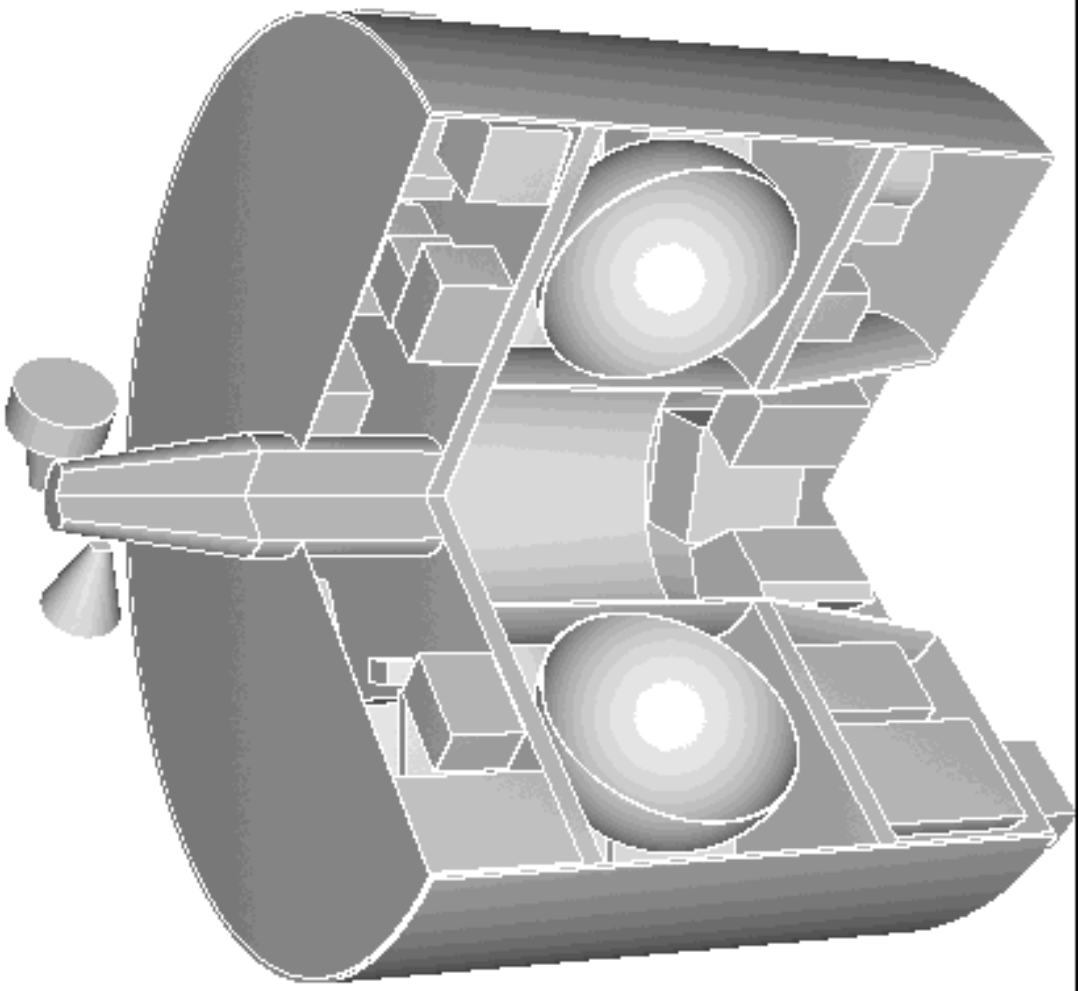


Figure 74: (PICCUT) Cutaway View, Q and C



PLOT

PLOT generates graphs of NOVICE output.

****
The PLOT processor produces plotted output from several NOVICE output files.
****

****
Input Data Record Description:
****

==========
Header Line
==========

Contains *PLO in columns 1 through 4.

=======
Options
=======

A, change plot type to this value

B, column input for plot data

D, set max height for 3d to doptd

E, value determines verticle line visibility

G=g, graphics display option, if negative generated in core. The default is G=257 (vesa 640x480).

H, nclear determines type of plot

R, generate plot in portrait mode (default is landscape)

K, put border around plot.

P, graphics print and file save options, see GRAPICS processor

N=n, n is the name of the plot type, e.g. TABULATED

N=SIGMa, plot sector mass thickness data (SECTOR.DAT files)

N=TABulated, plot data from tabulated data file N=TABulated is the default.

N=ELECtron, plot electron cross sections (obsolete, do not use)

N=HEAVy, plot heavy ion cross sections (obsolete, do not use)

N=PHOTon, plot photon cross sections (obsolete, do not use)

N=SPECtrum, plot particle spectrum (obsolete, do not use)

H=2, plot 3d data as histogram

H=3, for SECTOR.DAT plot, plot max thickness - sector thickness

S, full line subdivisions rather than tic marks

L=l, output picture file is saved as l.pic. The default is L=AAA.

M=m, input plot file name if N=TAB or N=SIG. The default is M=PLOT.DAT (tabulated) or M=SECTOR.DAT (SIGMA).

I, do not restrict log10 of plotted variables to 10 cycles.

I=i, restrict log10 cycles to i cycles.

V, reverse video

X=x, scale factor for the x variable

X=x, name of X array (obsolete, do not use)

Y=y, scale factor for the y variable, e.g., 3.17+7 to convert GCR output from /second to /year.

Y=y, name of Y array (obsolete, do not use)

Z=z, scale factor for the z variable

C, index of plot (obsolete, do not use)

T=t, title (obsolete, do not use)

U=u, curve label (obsolete, do not use)

W, dump debug (obsolete, do not use) is M=PLOT.DAT. (obsolete, do not use)

F=f, plot type (0,1,2) = (lin/lin, lin/log, log/log) (obsolete, do not use)

&a min x tic

&b max x tic

&c min y tic

&d max y tic

&t prepre columned output tables when plotting

****
Data Record Description:
****

==========
SIGMA Plot (N=SIGMA option)
==========

Supply name of sector data file

==========
Plot Parameters (N=SIGMA option)
==========

Then supply: number_azimuthal_points, number_polar_points, nclear, A, B, C, D, E/ The parameters A,B,C,D,E are discussed below.

If nclear is 0, hidden lines are plotted. If nclear is 1, hidden lines are not plotted. If nclear is 2, plotted as histogram. If nclear is 3, plotted as histogram of max thickness all sectors minus thickness of individual sectors.

==========
N=ELECTRON, HEAVY, PHOTON, or SPECTRUM Plot
==========

Supply: index_of_plot, A, B, C, D, E/ where if index is zero, all materials or spectra are plotted.

A, B, C, are components of the normal to the picture plane. D is the distance from the plot plane, and E determines whether verticle lines are shown with perspective or not. (I have to try this again to see how it works).

==========
N=TABulated Plot
==========

Supply the name of the data file. The file must be prepared according to the following formats. These same formats are used for tabulated plot files created by NOVICE.

rb= Control Data: NTBCD, NXBCD, NYBCD, NGT, NCURV, NLBCD, MAXPNT, NTXBCD, NZBCD NGTX, NGTY, NGTZ, NCLEAR/

==========
N=TAB, Perspective Components
==========

A, B, C, D, E/ same as above

==========
Plot Title
==========

single line

==========
N=TAB, X Title
==========

NTXBCD lines of labeling

==========
N=TAB, Y Title
==========

single line labeling

==========
N=TAB, Curve title
==========

NCURV lines of labeling

==========
N=TAB, X Scale Values (NTXBCD > 0)
==========

If NTXBCD > 1, (NTXBCD-1) factors to get x scale values

==========
N=TAB, X Values
==========

X values/

==========
N=TAB, Y Values
==========

Y values/

==========
N=TAB, Z Values (NZBCD > 0)
==========

Z values/ repeat NZBCD times

****
Discussion
****

The PLOT.DAT file can be edited to vary the type of plot and the plotted data. Each set of plot data is headed by a comment line. The next line contains the following control words:

NGT,NCURV,MAXPNT,NTXBCD where

NGT is the plot type (-1,0,1,2,3,4,5)=(lin/log histo, lin/lin, lin/log, log/log, log/log histo, log/log errors, log/log histo & errors). In addition, the following values are now recognized: 10-13, 20-23, 30-33. The 10 series are lin/lin, the 20 series are lin/log, and the 30 series are log/log. The second digit 0 indicates no error bars or histogram. The second digit 1 indicates histogram data. The second digit 2 indicates error bars, and the second digit 3 indicates both histogram and error bars.

NCURV is the number of curves.

MAXPNT is the maximum number of data points. (Not counting the endpoint of the last interval of a histrogram plot.)

NTXBCD is the number of x labels/scales on the plot bottom.

NGTSCA

++++++++++++++
Output Figures
++++++++++++++

The PLOT.DAT file will contain spectra, responses, and cross sections if the *EXECUTE processor includes the F option. Data plotted from such a plot file is indicated in the following figures: Figure 75 (PLONOE), a differential spectrum.

Figure 76 (PLONGE), an integral spectrum (both forms are placed on the plot file).

Figure 77 (PLORES), a response function.

Figure 78 (PLOPST), photon cross sections.

Figure 79 (PLOPDE), photon linear energy transfer (LET) values.

Figure 80 (PLOELR), electron range.

Figure 81 (PLOEDE), electron LET.

Figure 82 (PLONST), neutron total cross section.

Figure 83 (PLONSF), fast neutron total cross section.

Figure 84 (PLOGST), gamma ray total cross section.

Figure 85 (PLONDE), neutron LET.

Figure 86 (PLOGDE), gamma ray LET.

Figure 87 (PLOPRR), proton range.

Figure PLOPRl, proton LET.

Figure 89 (PLOIOR), ion range.

Figure 90 (PLOIOL), ion LET.

++++++++++++
Output Tables
++++++++++++

The format of the PLOT.DAT file is indicated in Table 82 (PLOTBL).

Figure 75: (PLONOE) Source Spectrum, Differential

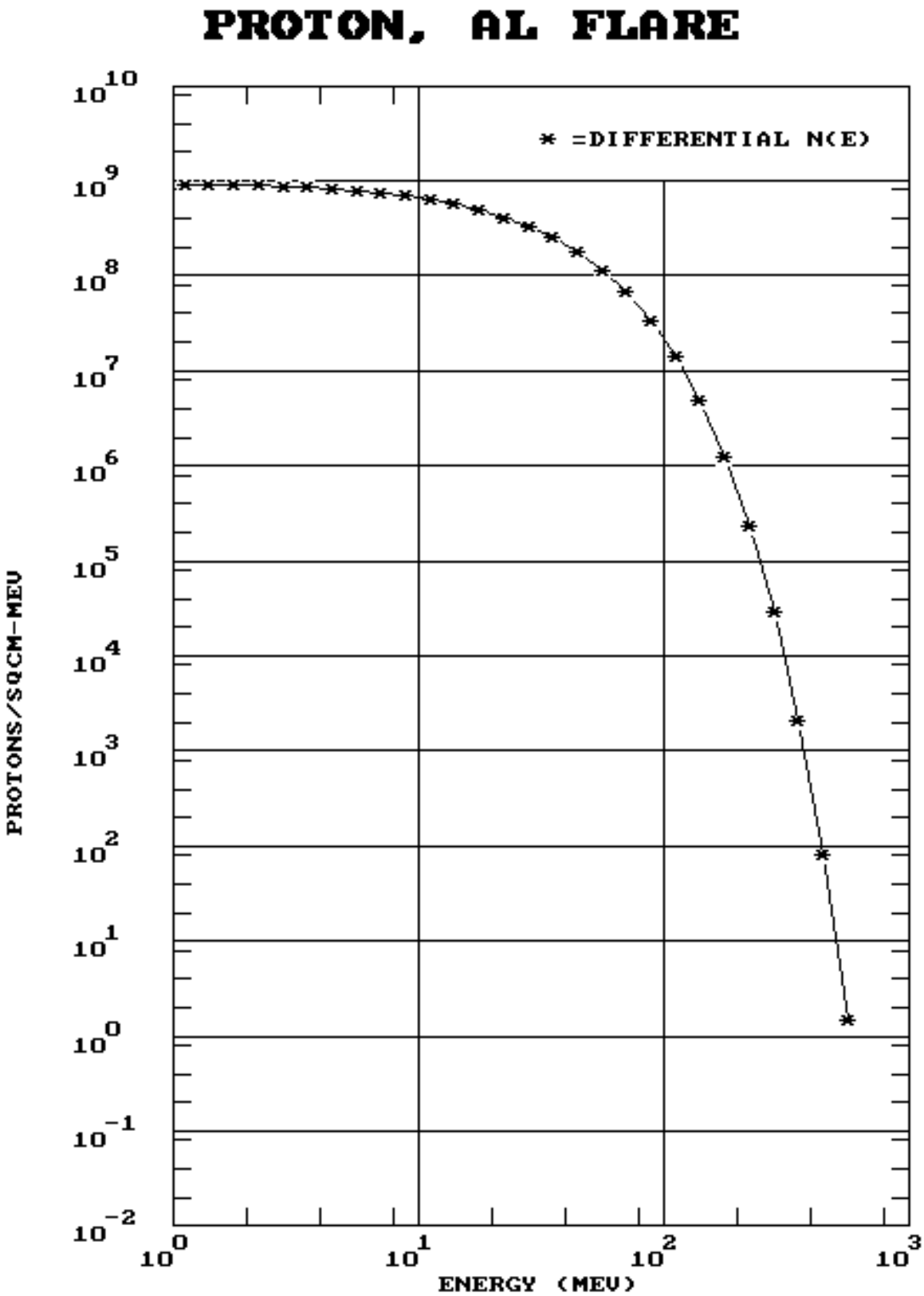


Figure 76: (PLONGE) Source Spectrum, Integral

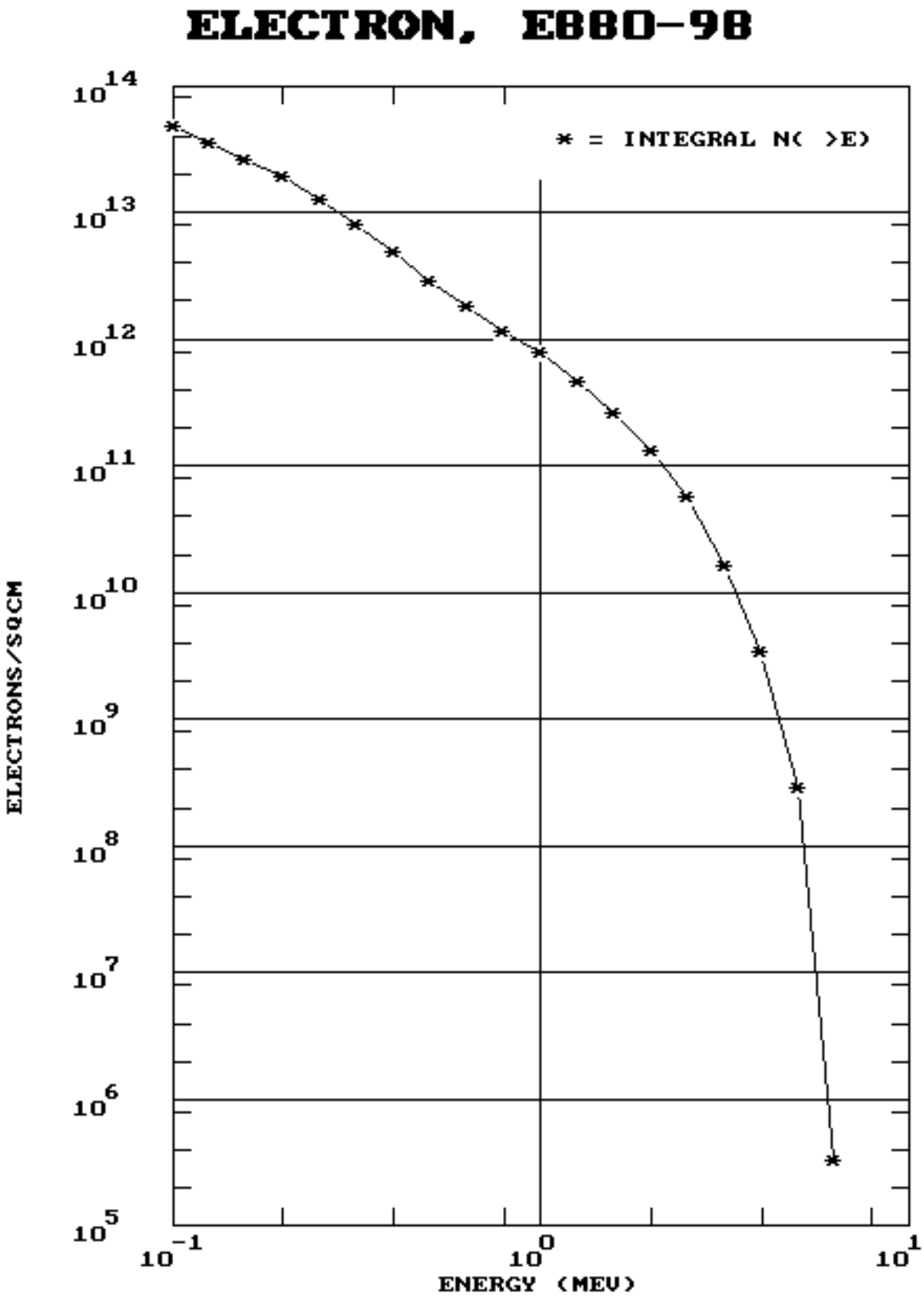


Figure 77: (PLORES) Response Function Data

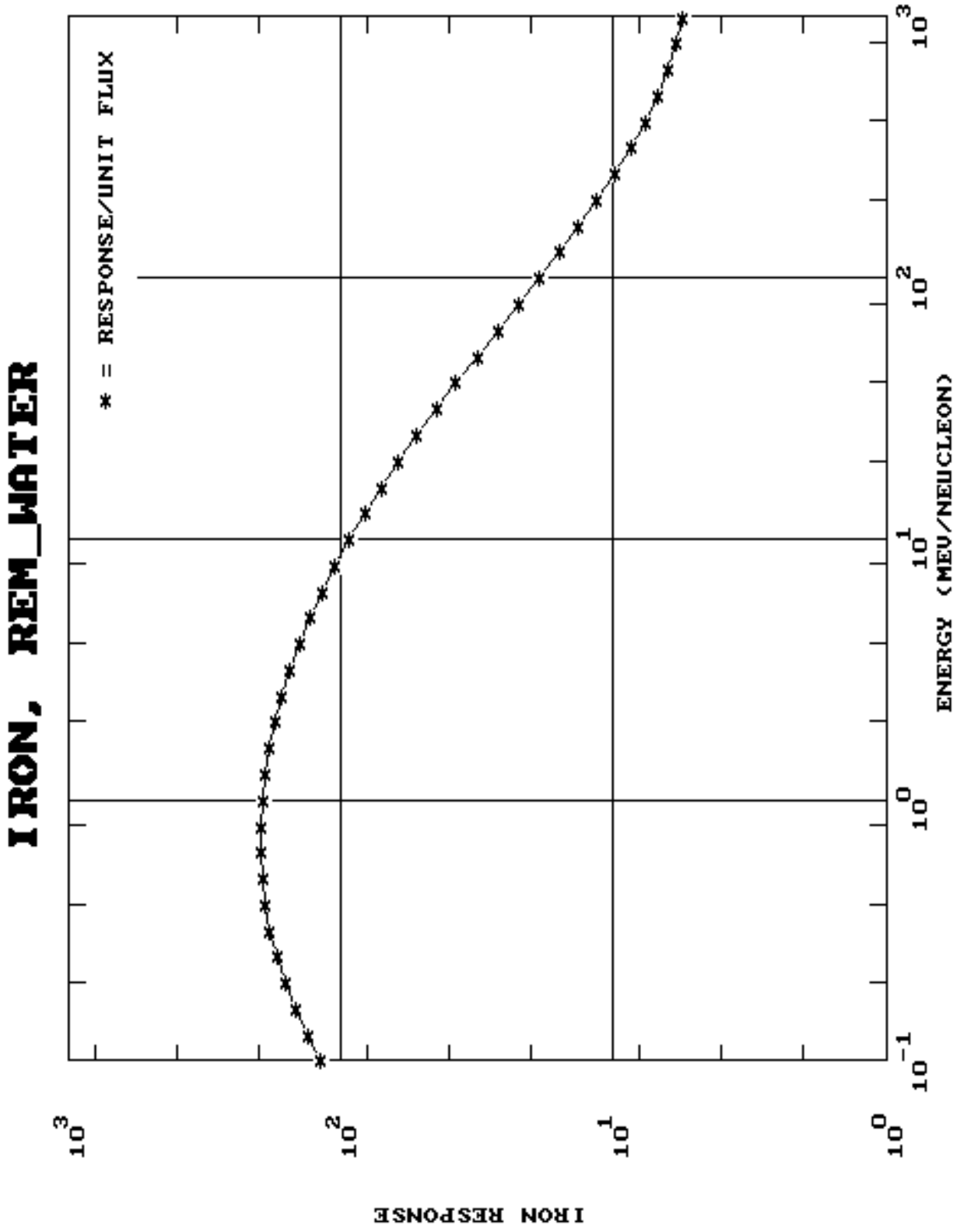


Figure 78: (PLOPST) Photon Cross Sections

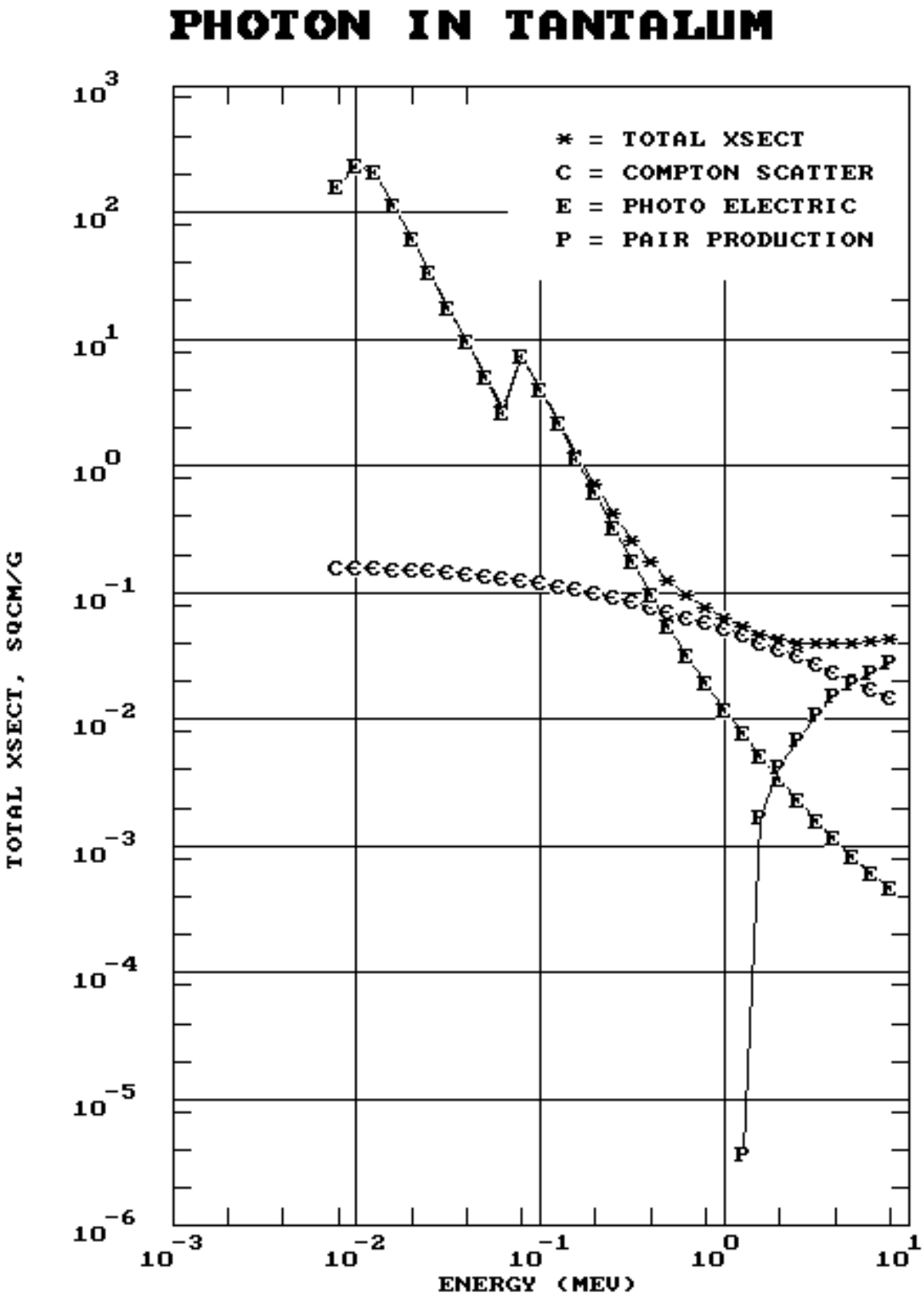


Figure 79: (PLOPDE) Photon Total LET

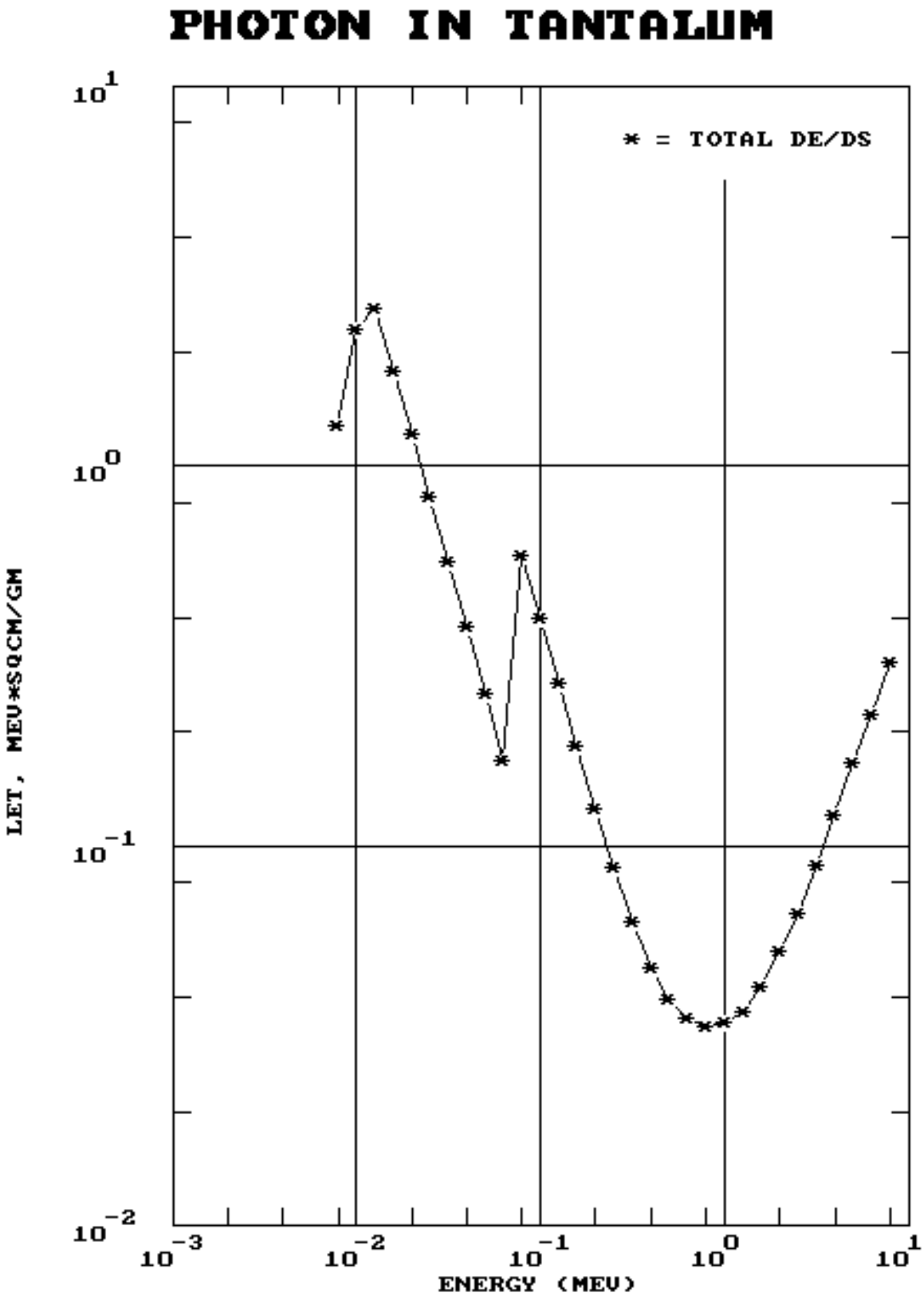


Figure 80: (PLOELR) Electron Range

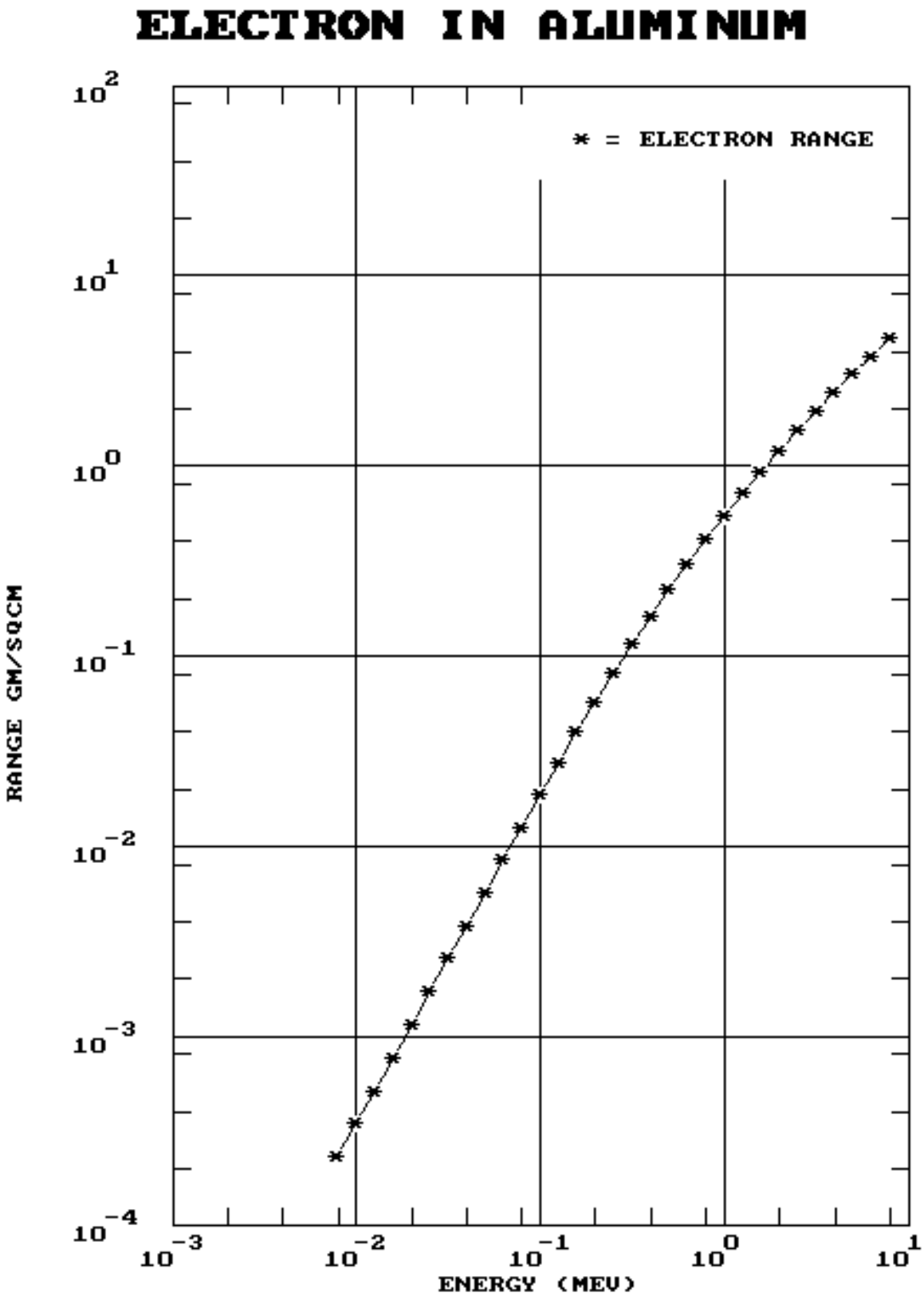


Figure 81: (PLOEDE) Electron Stopping Power

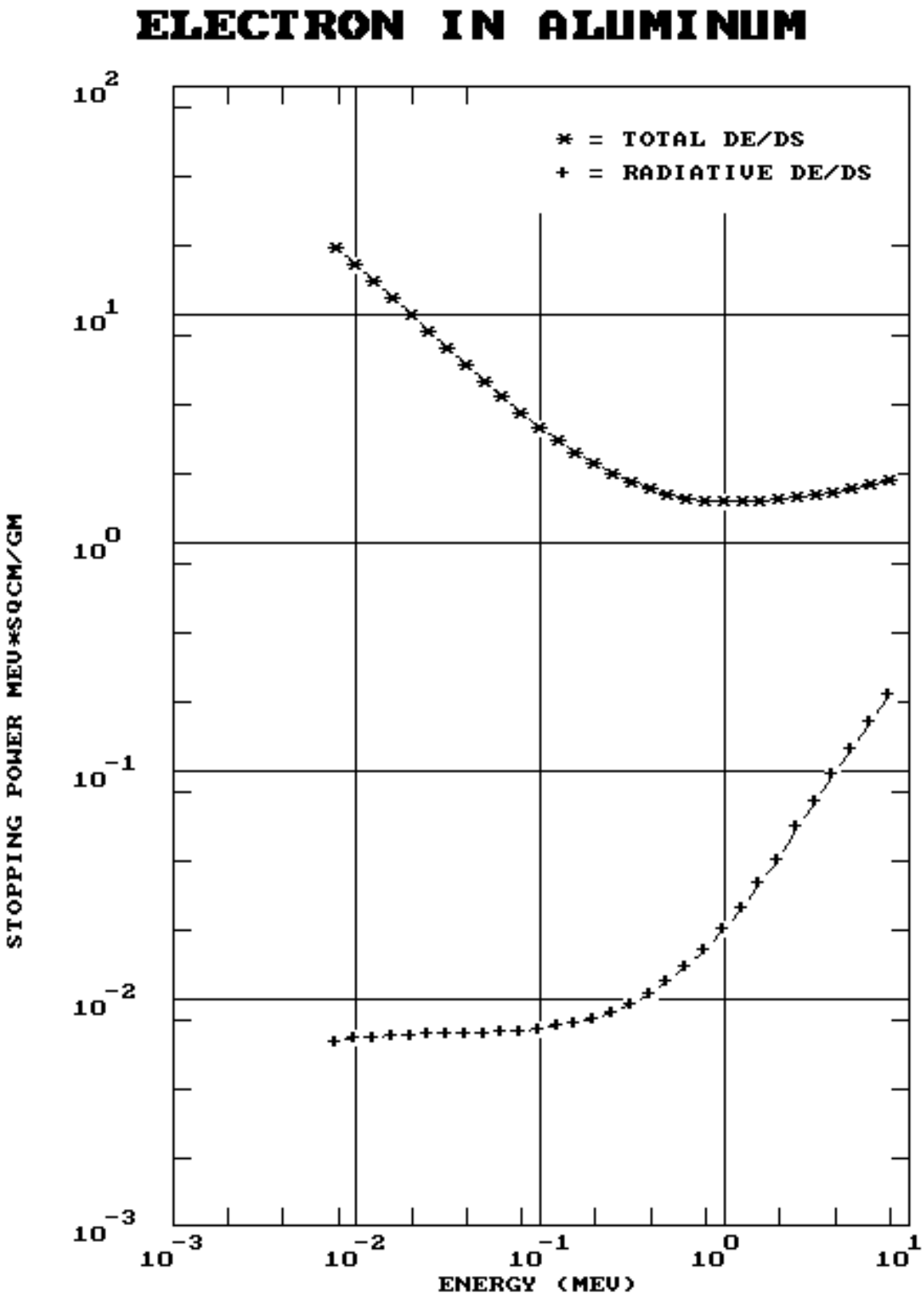


Figure 82: (PLONST) Neutron Total Cross Section

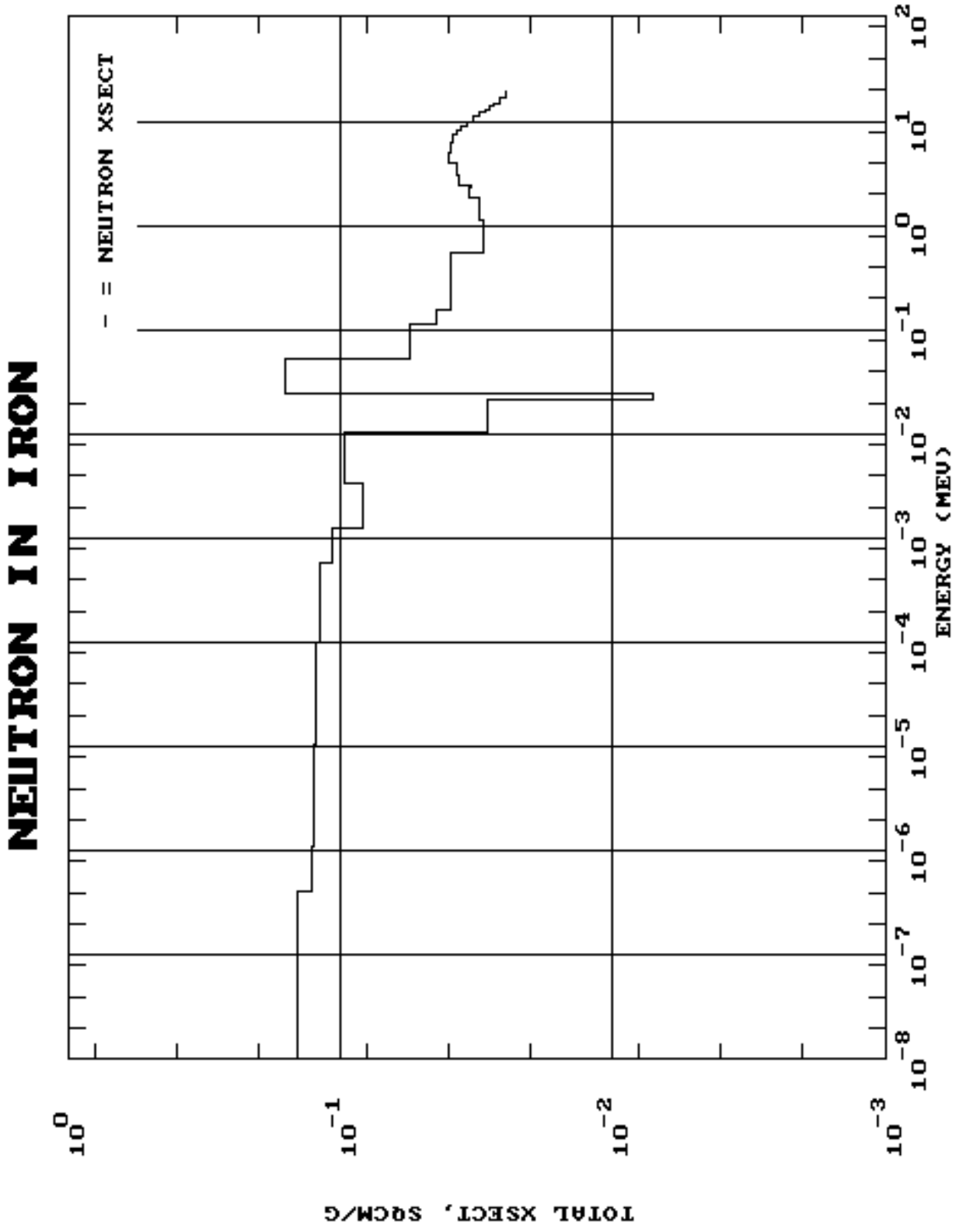


Figure 83: (PLONSF) Fast Neutron Cross Section

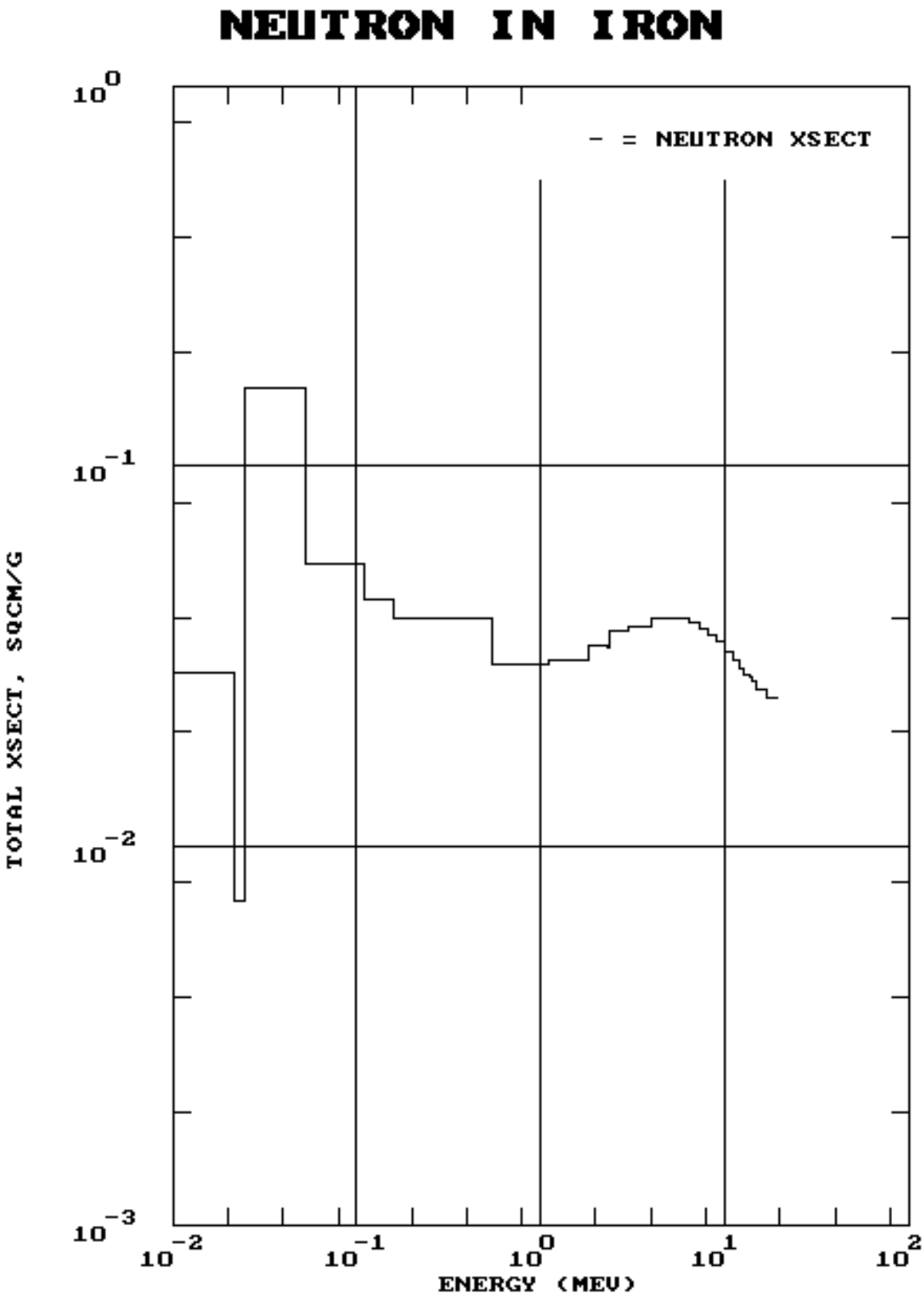


Figure 84: (PLOGST) Gamma Ray Cross Section

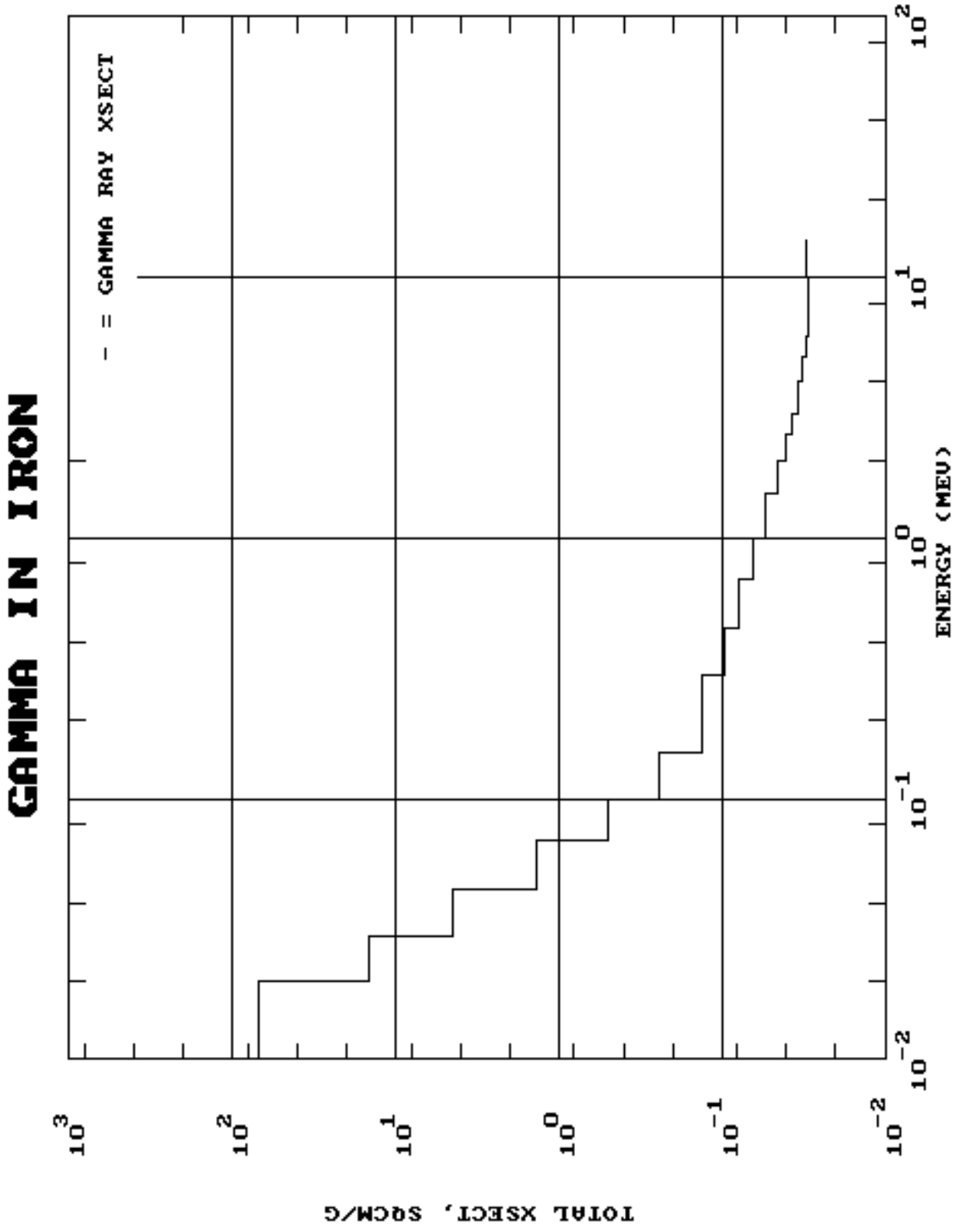


Figure 85: (PLONDE) Neutron Total Let

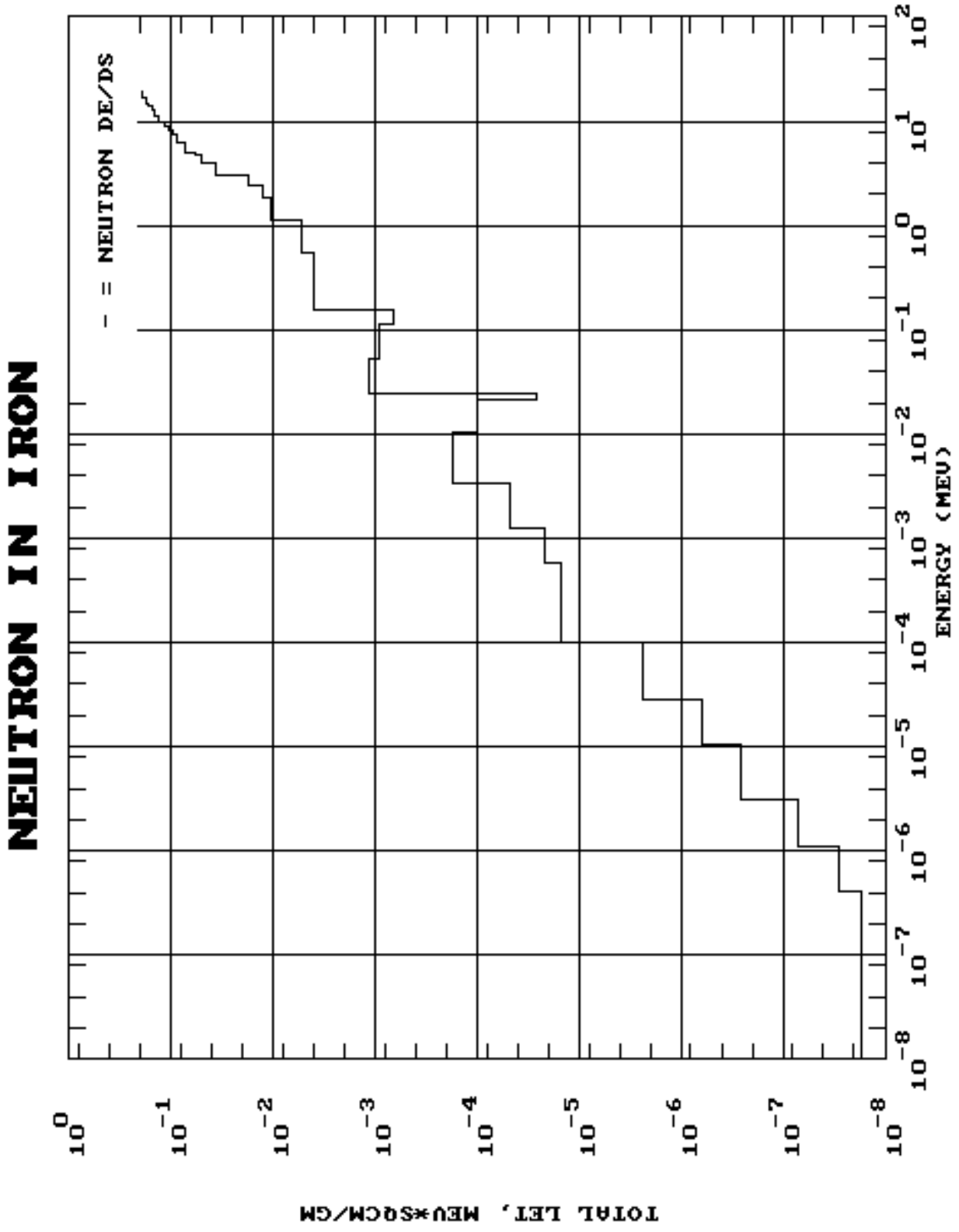


Figure 86: (PLOGDE) Gamma Ray Total LET

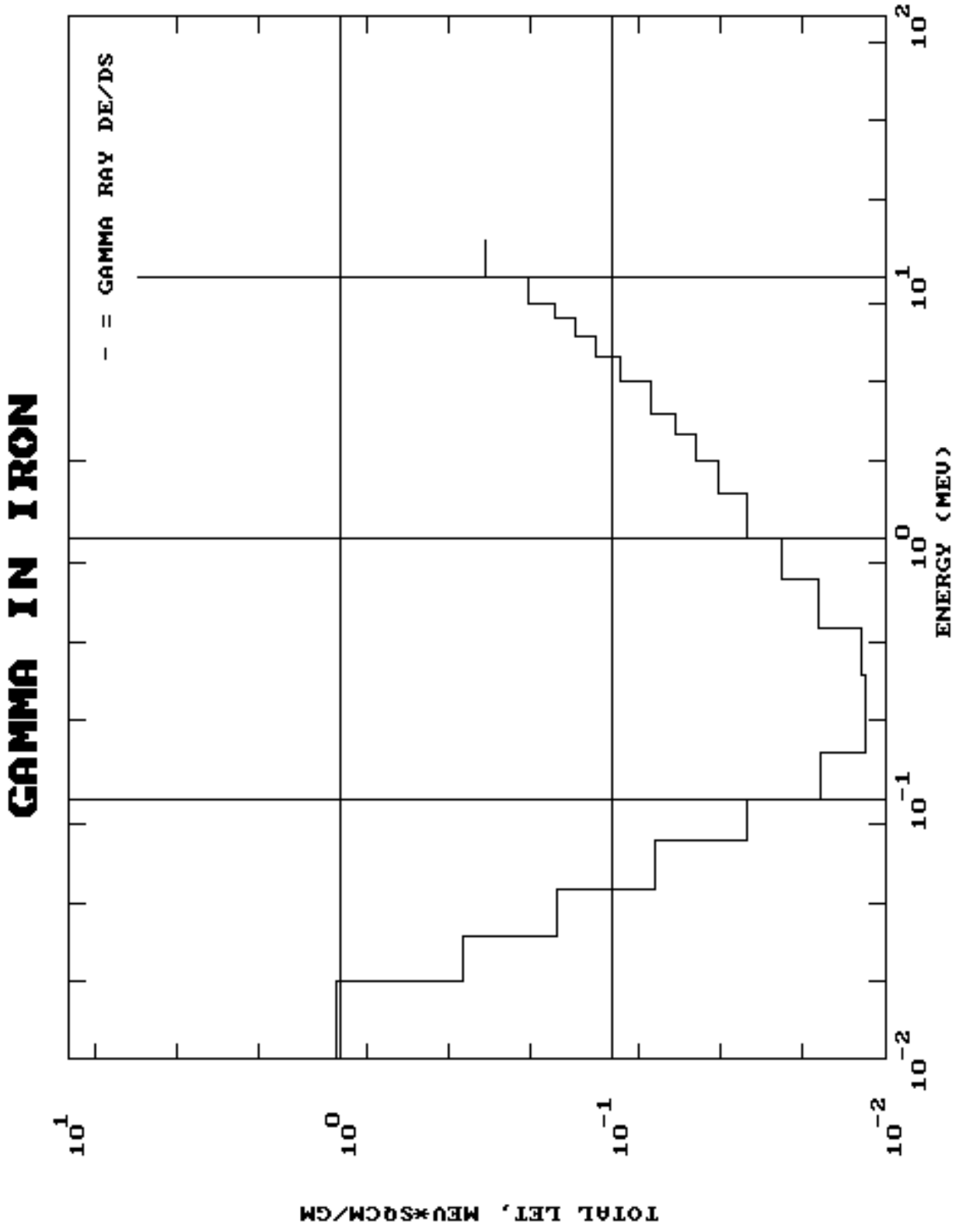


Figure 87: (PLOPRR) Proton Range

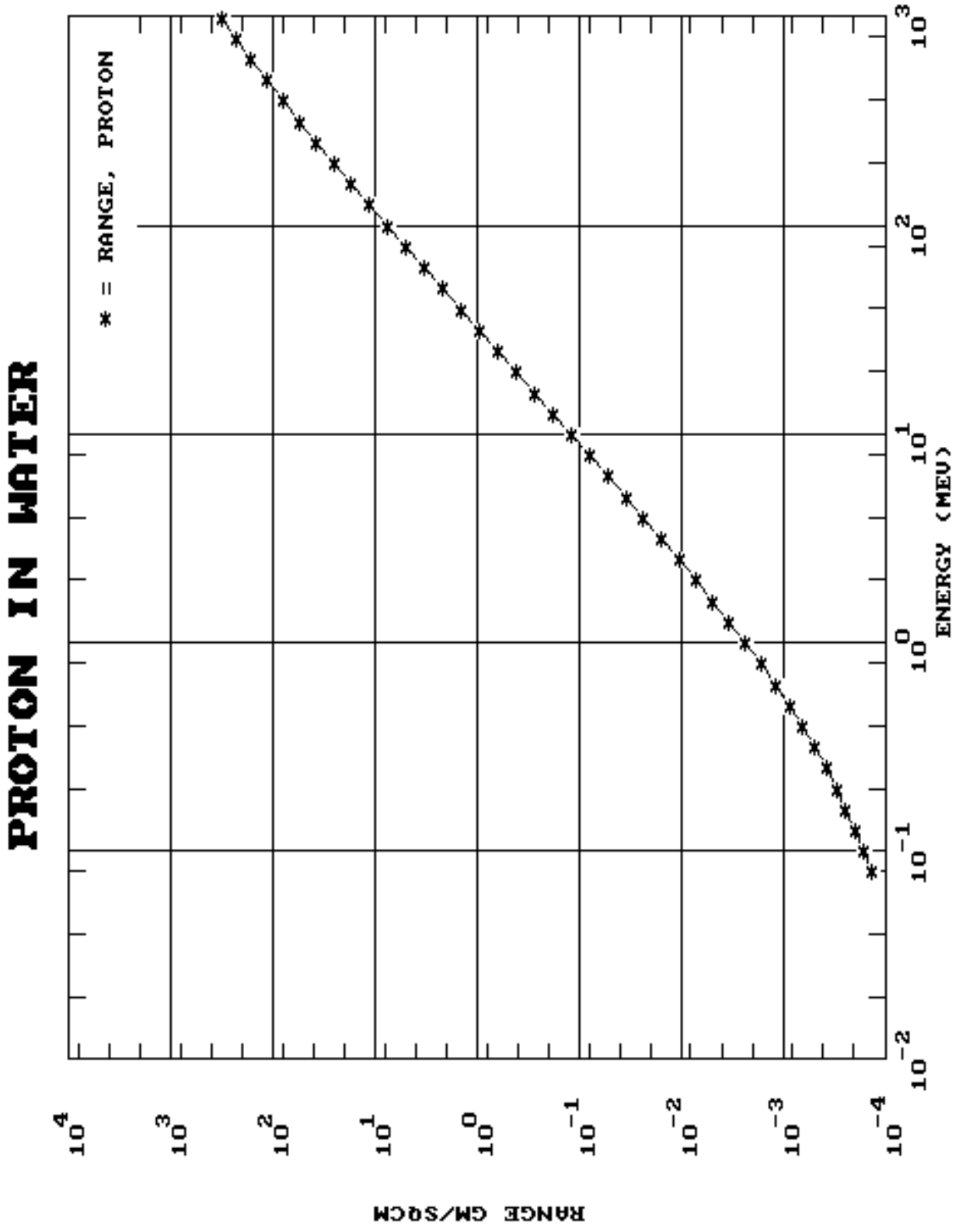


Figure 88: (PLOPRL) Proton Stopping Power

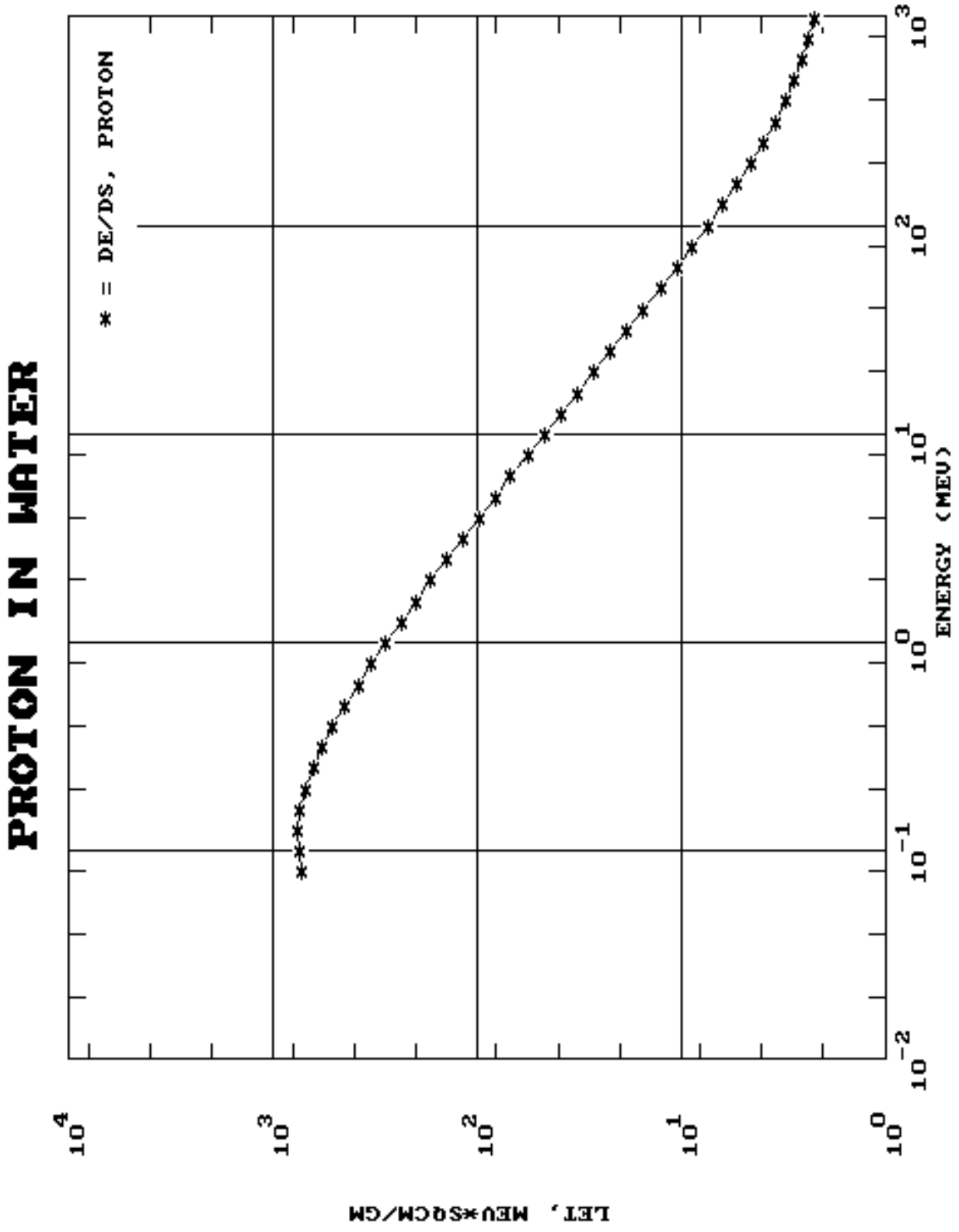


Figure 89: (PLOIOR) Ion Range

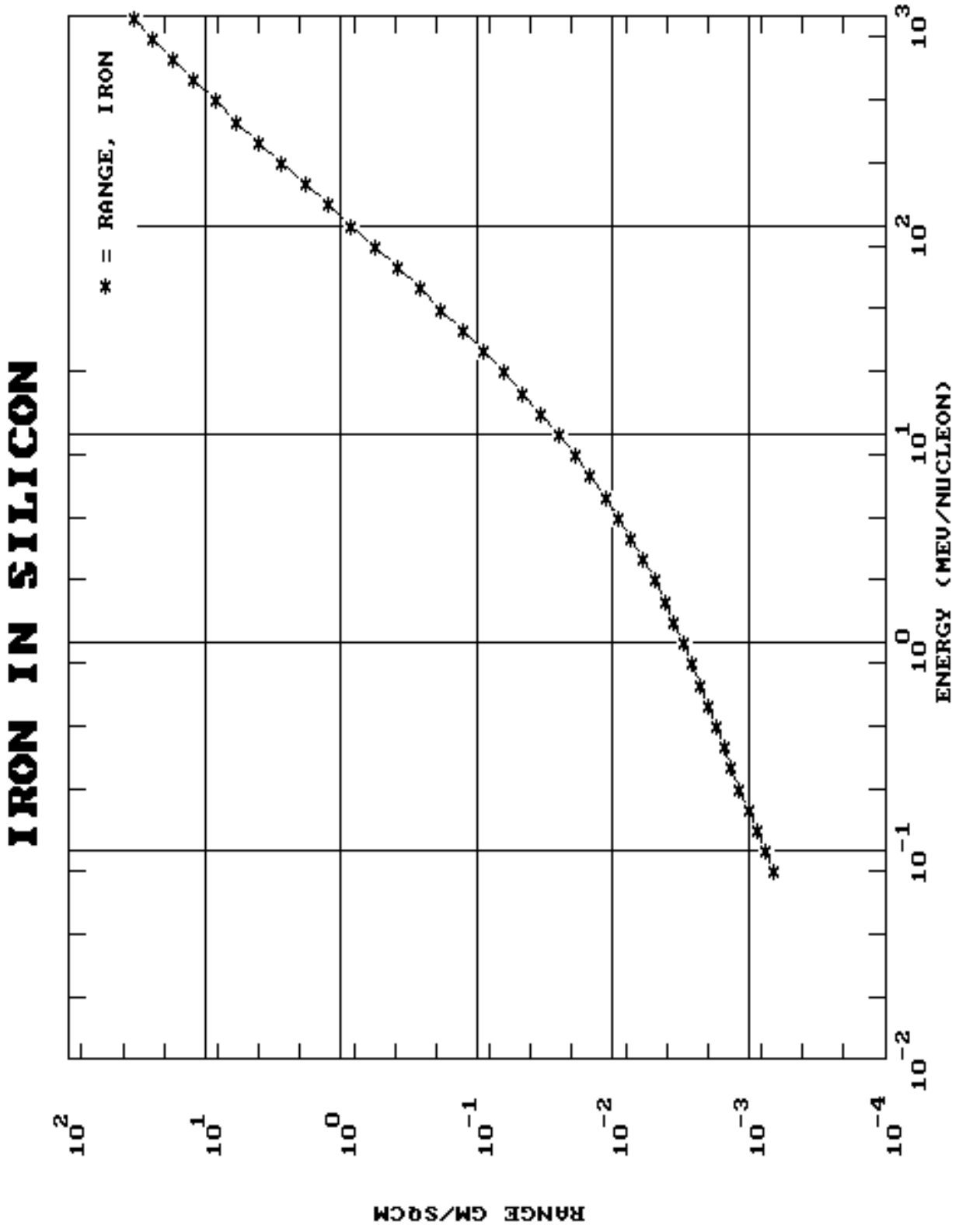


Figure 90: (PLOIOL) Ion Stopping Power

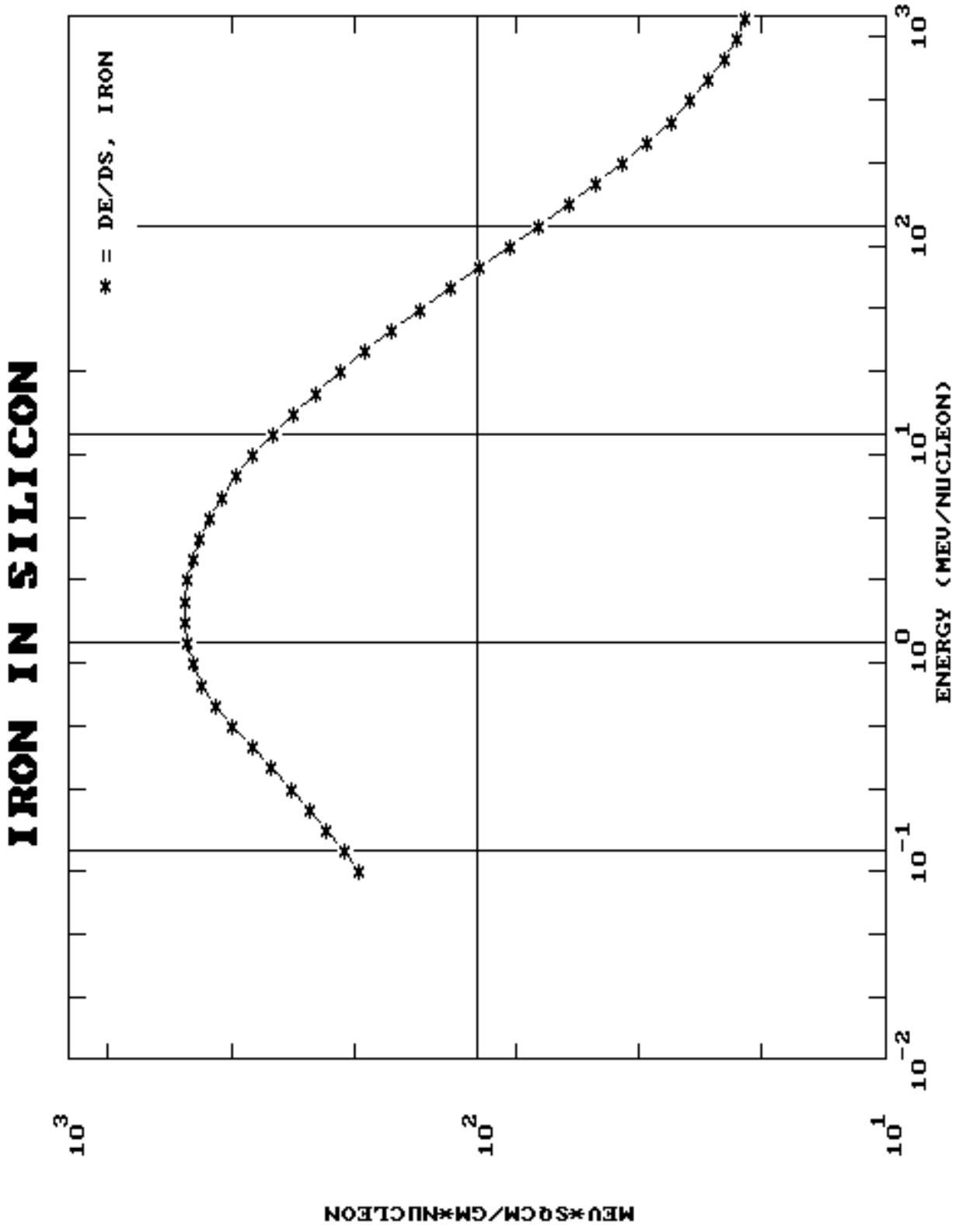


Table 82: (PLOTBL) Plot Data File Format

```
C*****PHOTON,DEBRIS_GAM,25X25X10
  2  1 40  1  0
PHOTON,DEBRIS_GAM,25X25X10
ENERGY (MEV/NUCLEON)
INTEGRAL FLUX/SQCM
* = N( >E), PHOTON
 7.94E+00 6.31E+00 5.01E+00 3.98E+00 3.16E+00 2.51E+00 2.00E+00 1.58E+00
 1.26E+00 1.00E+00 7.94E-01 6.31E-01 5.01E-01 3.98E-01 3.16E-01 2.51E-01
 2.00E-01 1.58E-01 1.26E-01 1.00E-01 7.94E-02 6.31E-02 5.01E-02 3.98E-02
 3.16E-02 2.51E-02 2.00E-02 1.58E-02 1.26E-02 1.00E-02 7.94E-03 6.31E-03
 5.01E-03 3.98E-03 3.16E-03 2.51E-03 2.00E-03 1.58E-03 1.26E-03 1.00E-03
 0.00E+00 1.50E-03 8.60E-03 2.36E-02 4.97E-02 8.99E-02 1.39E-01 1.98E-01
 2.67E-01 3.42E-01 4.24E-01 5.13E-01 6.13E-01 7.15E-01 8.08E-01 8.93E-01
 9.71E-01 9.97E-01 9.98E-01 9.99E-01 9.99E-01 9.99E-01 9.99E-01 9.99E-01
 9.99E-01 9.99E-01 9.99E-01 9.99E-01 9.99E-01 9.99E-01 9.99E-01 9.99E-01
 9.99E-01 9.99E-01 9.99E-01 9.99E-01 9.99E-01 9.99E-01 9.99E-01 9.99E-01
C*****PHOTON,DEBRIS_GAM,25X25X10
  3  1 40  1  0
PHOTON,DEBRIS_GAM,25X25X10
ENERGY (MEV/NUCLEON)
PARTICLES/SQCM-MEV/NUCLEON
* = N(E)PHOTON
 1.00E+01 7.94E+00 6.31E+00 5.01E+00 3.98E+00 3.16E+00 2.51E+00 2.00E+00
 1.58E+00 1.26E+00 1.00E+00 7.94E-01 6.31E-01 5.01E-01 3.98E-01 3.16E-01
 2.51E-01 2.00E-01 1.58E-01 1.26E-01 1.00E-01 7.94E-02 6.31E-02 5.01E-02
 3.98E-02 3.16E-02 2.51E-02 2.00E-02 1.58E-02 1.26E-02 1.00E-02 7.94E-03
 6.31E-03 5.01E-03 3.98E-03 3.16E-03 2.51E-03 2.00E-03 1.58E-03 1.26E-03
 1.00E-03
 0.00E+00 9.20E-04 5.47E-03 1.46E-02 3.18E-02 6.18E-02 9.48E-02 1.44E-01
 2.12E-01 2.90E-01 3.96E-01 5.48E-01 7.70E-01 9.83E-01 1.14E+00 1.31E+00
 1.52E+00 6.17E-01 5.27E-02 4.48E-03 2.89E-04 0.00E+00 0.00E+00 0.00E+00
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
C*****DEBRIS_GAM PULSE HEIGHT
  5  1 30  1  0
DEBRIS_GAM PULSE HEIGHT
 ENERGY LOSS BOUNDARY
 COUNTS PER UNIT ENERGY LOSS
* = DIFFERENTIAL COUNTS
 1.00E+00 7.94E-01 6.31E-01 5.01E-01 3.98E-01 3.16E-01 2.51E-01 2.00E-01
 1.58E-01 1.26E-01 1.00E-01 7.94E-02 6.31E-02 5.01E-02 3.98E-02 3.16E-02
 2.51E-02 2.00E-02 1.58E-02 1.26E-02 1.00E-02 7.94E-03 6.31E-03 5.01E-03
 3.98E-03 3.16E-03 2.51E-03 2.00E-03 1.58E-03 1.26E-03 1.00E-03
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 2.04E-09 2.18E-08 4.99E-08 7.13E-08 9.67E-08 7.09E-08 1.32E-07 1.55E-07
 2.87E-07 4.21E-07 3.23E-07 4.60E-07 4.69E-07 1.67E-07 4.22E-07 2.15E-07
 3.05E-07 3.04E-07 5.63E-07 5.16E-07 2.62E-07 1.06E-06
 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
 8.70E+01 4.20E+01 3.60E+01 2.10E+01 2.50E+01 1.60E+01 3.00E+01 2.10E+01
 1.40E+01 2.70E+01 1.80E+01 1.80E+01 1.80E+01 2.80E+01 4.20E+01 3.10E+01
 6.40E+01 3.90E+01 6.40E+01 4.10E+01 5.30E+01 3.50E+01
 :
 :
```

PRESET

PRESET discussions parameters in CONFIG.NOV

****
The PRESET appendix discusses the parameters defined in the CONFIG.NOV file.
****

****
Discussion
****

The NOVICE code looks for a file, CONFIG.NOV, in the home directory before running. This file, if present, contains parameters that supercede parameters built into the program. Specifically, the CONFIG.NOV file can be used to overide the file names listed in the FILES section. This feature is used, for example, when library files are kept in a separate directory.

This file can also contain parameters that override the builtin graphics mode, resolution, and color tables.

The format of the CONFIG.NOV file is as follows:

If a line has file in columns 1-4 (must be lower case), then columns 5-8 contain the file number (see FILES section), columns 9-12 contain file format, status, and read/write, and columns 13-40 contain the file name (must start in column 13). File names ending with the .* extension will be given the extension .DAT unless the user specifies a different extension using the e=extension option on the command line or by entering a different extension when prompted by the program.

Note that the file names for the help files (units 40 and 41) and the *PICTURE files (units 37,38, and 39) normally change during a run. Therefore, the names entered for these units are given special treatment by the code. When the file name to be attached to one of these units is defined, the path (if any) previously associated with the unit is also associated with the new file name. For example, if the CONFIG.NOV file has unit 41 with a file name of c:\novice\guide\des.doc then if the user issues a help command for DESIGN input, the file that will be attached is c:\novice\library\guide\DES.DOC.

Files can be given an extension of 'TMP'. If these files are opened during a run, they will be deleted at the end of the run.

Ascii files that already exist and that are opened for output are normally positioned for extension. These files will rewritten from the beginning (equivalent to deleting the old file) if they are given the extension 'NEW'.

If a line has mode in columns 1-4 (must be lower case), then columns 5-8 contain the mode passed by the BIOS call to the video board, columns 9-12 contain the number of pixel columns (e.g. 640), columns 13-16 contain the number of pixel rows (e.g. 480), and columns 17-20 contain the number of colors (e.g. 256).

Lines that start with COMPUTER define the hardware the software is running on. At this time (90 Dec 05), the only hardware sensitive setting is bytes per word which defaults to 4 and is set to 8 if the line COMPUTER CRAY is encountered in this CONFIG.NOV file.

Lines that start with SYSTEM define the operating system the software is running under. At present, no settings depend upon the system name.

Several controls are set in 'config.nov' using the keyword 'option'. The values for the options can be edited in 'config.nov' or entered in the data file using the ARRAY processor.

If changing values using ARRAY, the input should be:

```
    *array,a/ a option selects index,value pairs
    'name' i1,v(i1),i2,v(i2)..../
```

where name can be 3 letters or more of the words options, global, or control.

The values that can be changed are indicated in config.nov. That information needs to be stored here.

++++++++++++
Output Tables
++++++++++++

Part of the current config.nov file is listed in Table 83 (PRENOV).

Table 83: (PRENOV) NOVICE CONFIG.NOV File

```
c license information
company: experimental and mathematical physics consultants
...
c licensed modules
modules: adjoint ........3d charged particle adjoint monte carlo
...
c modules not requiring license
c module: xray    .............1d/3d xray attenuation, no scatter
...
c end of license information
c option for checking monotonicity of sigma tabulated dose data
c 0, no check, 1 check for exponent error, 2 exponent + monotonicity
option    21               2  (0,1,2) = (no,exp,exp+mono)

c option for limiting file types to formatted and unformatted
option    22               5  (0=all,2=f/u,3=f/u/s,4=f/u/s/d,5+t)
file for   1&novice.dat                     batch input file
 ile fnw   2+novice.out                     output file
file fuw   2+output.new                     output file
file fuw   3&put.dat                        put file
file for   4&get.dat                        get file
file sur   5stdin                           interactive input
file for 126*tablelab.lib                   table info library
file fuw 127+tableinf.new                   output table info
file fuw 128*license.new                    decoded license
file for 129*license.dat                    coded license

        bios col lin clr ext
mode   1   3  80  24   2                 standard text textc80
mode   2  19 320 200 256                 standard vga mres256color
mode   3  17 640 480   2
mode   4  18 640 480  16
mode   5   4 320 200   4                 cga mode 4   mres4color
mode   6   6 640 200   2                 cga mode 6   hresbw
mode   7 10216001200 256                 hp laserjet,p=10/11 2x2 dots

mode   8 256 640 400 256                 all vesa compatible cards
mode   9 257 640 480 256                 all vesa compatible cards
mode  10 258 800 600  16                 all vesa compatible cards
mode  11 259 800 600 256                 all vesa compatible cards
mode  12 2601024 768  16                 all vesa compatible cards
mode  13 2611024 768 256                 all vesa compatible cards
mode  14 26212801024  16                 all vesa compatible cards
mode  15 26312801024 256                 all vesa compatible cards
mode  20 274 640 480 256                 true color, 3 byte/pixel
 ode  275 through 277 800x600            all vesa compatible cards
 ode  278 through 280 1024x768           all vesa compatible cards
 ode  281 through 283 1280x1024          all vesa compatible cards
eof  marker for end of settings
```

PRINT

PRINT toggles printing off and on

****
The PRINT processor controls printing of input data and/or summary tables for the data base. It can be used repetitively.
****

****
Input Data Record Description:
****

==========
Header line
==========

Contains *PRI in columns 1 through 4.

=======
Options
=======

No options apply.

****
Data Record Description:
****

There are no other data records.

None

****
Discussion
****

The print control flag is a toggle. It is initially on. *PRINT turns it off. The next *PRINT turns it back on. Etc.

This control is ignored for results from an analysis processor.

PULSE

PULSE calculates single event effects using flux files.

****
The PULSE analysis processor calculates pulse height distributions in rectangular, cylindrical, or spherical volumes using numerical integration and chord length distributions. The pulse height analysis includes incident particles, the equilibrium distribution of secondaries in the material surrounding the sensitive volume, and secondaries produced in the sensitive volume.
****

****
Input Data Record Description:
****

==========
Header line
==========

Contains *PUL in columns 1 through 4.

=======
Options
=======

M, selects pulse height analysis, M=m defines the material surrounding the sensitive volume.

B, calculate latchup probability. Only applies to M option with rectangular sensitive volume. The chord lengths for this option are for adjoining faces of two adjacent bits separated by the third dimension of the bit volumes (the other two bit dimensions are the adjoining face dimensions). During the binning of deposited energies, the particle tracks must extend completely along the chord -- tracks that range out are not in the latch pulse heights. This modeling assumes, therefore, that the latch is caused by a particle track connecting two adjacent bits, and the threshold energy deposited data defines minimum ionization levels such that fields between bits can sustain a current. If B=b, b non zero then an additional data line is entered to define the connected volumes and tracks are generated using monte carlo methods to obtain chord length distributions.

D, output sigma kernels versus thickness (assumes calc versus thickness)

F (,cen,,) funnel lenght to add to chord lenght in pulsef

G, reserved, geometry

H, reserved, histories

N, if M option, don't count particles that range out (telescope)

L, selects the LET spectrum output, L=l defines the material used for the LETs (L= the index of the material used to establish the LET values).

J, output effective let spectra with different max slants

K, convert M option outputs to let spectra by dividing by projected area (surface area/4) and deposited energy by mean chord length in mg. If K=k is input, the area is multiplied by k and the mean chord is divided by k. For rectangular volumes, the face area/2 and thickness are used for direct comparision with let spectra (l option) outputs. and actual thickness for rpp volume.

E, use range energy on electrons

I, output LET spectra by isotope (when processing GCR outputs)

Y, print source and slowing down spectra for secondary electrons

W=w, if present, include spallation production if atomic number of the individual heavy ion is w. (Does not apply to GCR.) Only applies to M option (not L option)

T, debug option

C, calculate lineal energy loss distributions using LET table calculated for L option, for sphere of 1 micron radius (default).

C=c, compute lineal energy transfer (biological effects) for sphere of radius c (default is c of 1 micron).

P=p, particle type (P=-1 for gcr, else usual name)

Q, reserved, charging

R, add any angular fluxes

X, use let*path for energy loss (LET spectrum approximation)

Z, maximum atomic number for incident ion causing

A=a, discrete direction for L option let spectra in rectangular volumes (if A option is absent, directions are isotropic)

U=u, thickness (cm) for L option let spectra in rectangular volumes (if U options is absent, default is 1 micron).

V=v, ratio of width to thickness for L option let spectra in rectangular volumes (if V option is absent, v=2 is assumed).

S, if present, exclude side incidence in l option rpp calculations.

&P, plot latch/burnout tracks when doing b=1 calculation

&H, hit file output

&S, general scale factor for flux file

&T, overrite thick on fluxes.new, same units (cm*g/cc)

****
Data Record Description:
****

Supply the following input records only if the M option was selected:

==========
Chord Table Integer Data
==========

,NCHRD NPOLAR NTHETA MPHD GPHD MAXEXP/

==========
Chord Table Decimal Data
==========

,PMIN PMAX TMIN TMAX L1 L2 L3 L4/

==========
Pulse Height Channel Boundaries
==========

,energy boundaries of pulse height channels, MeV or MeV/amu /

where

NCHRD, points in the chord length table, e.g., 100

NPOLAR, intervals in polar integration used to set up chord length table, e.g., 10. (more intervals should be used if the detector is relatively long in one or two dimensions)

NTHETA, intervals in azimuthal integration used to set up chord length table e.g., 10

MPHD, material index of the pulse height detector

GPHD, geometry of the pulse height detector, 0=rectangular, 1=cylindrical, 2=spherical or ellipsoidal.

If GPHD is less than zero, the sensitive volume is region -GPHD.

MAXEXP, if entered and non zero, indicates the use of experimental data to compute device upset rates.

PMIN PMAX, polar cosine integration limits, use 0,1 for isotropic and c-d,c+d for mono polar cosine c (where d is a small number).

TMIN TMAX, radians, limits on the azimuthal integration, use a,PI/2 for isotropic incidence, use a-d, a+d, for mono azimuth =a (where d is a small number)

L1 L2 L3 are the detector dimensions

x,y,z dimensions if rectangular (L4 not used)

radius, height,(L3 and L4 not used) if cylindrical

radius (L2, L3, and L4 not used) if spherical.

outer radius and inner radius if L1 and L2 not zero (spherical shell)

ellipsoid dimensions if L1, L2, and L3 are all non zero. This chords for this geometry are determined by a numerical integration that agrees (to four places) with the analytic distributions for the limiting case of a sphere.

If GPHD is negative, (L2,L3,L4) are the coordinates of the center of a sphere and L1 is the radius where the sphere contains the region -GPHD and is as small as possible. Chord lengths are calculated by ray tracing and may require a large amount of time. The mesh points used for each fixed direction in the averaging process is sqrt(NCHRD) in radius and azimuth.

==========
Experimental Data
==========

If MAXEXP is greater than zero, the following data are entered

bits, dead_layer_thickness, dead_layer_material, active_layer_thickness, active_layer_material, substrate_thickness, substrate_material/

NOTE: the active layer thickness is used, in conjunction with the LET of the particle in the active layer, to determine the upset (or other single event effect) threshold in MeV. The bit model entered above is not used in generating this critical energy deposit (equivalently, charge deposit).

If the substrate thickness and material are non zero, follow this record by a record containing:

Operating_voltage, doping_level_per_cc,
device_thickness_for_field/

The experimental data is then entered with multiple records of:

upsets, current, seconds, angle, ion_Z, ion_A, ion_E/

These experimental data are terminated with a null record ,/

If the dead layer thickness and material are input as 0, no correction is made for the dead layer. If the substrate thickness and material are input as 0, no correction is made for funneling and the voltage, doping, and field thickness are not input as noted above.

Finally, if cross section data have already been corrected for non normal incidence and reduced to cm^2/bit, input pairs of data for each experimental point in the form x1 L1/ where x1 is in cm^2 and L1 is in MeV*cm^2/gram. This input can also use or omit the funnel correction as indicated by the presence or absence of a substrate material.

The cross section data should be entered in the order of increasing LET (and presumably cross section). It is likely that the code will fail if this order is not followed.

NOTE: The dimension of the bit determined from the cross section data is scaled so that the experimental lateral dimension matches the lateral dimension of the chord length geometry model for the maximum bit cross section data point. For rectangular, L3 is held constant and L1 and L2 are scaled. For cylindrical, L2 is held constant and L1 is scaled. For spherical (or spherical shell) L1 (or L1 and L2) is scaled. For elliptical, L3 is held constant and L1 and L2 are scaled. (For elliptical, L3 is forced to be the minimum dimension of the 3 input dimensions. This is not the case for the rectangular geometry.) For explicit geometry, L1 is scaled (the radius of the containing sphere). Thus the lateral dimension is scaled. However, the distance along each ray is determined by the actual geometry.

==========
Latch/Burnout Explicit Geometries
==========

If B=b, b non zero is entered, then the chord length distributions for the connected volumes in latch/burnout are defined by the following data:

NH, number of histories used to connect the volumes.

SEP, a three vector defining the displacement between the volumes.

G1, the geometry of the first volume (0,1,2)=(xyz,cyl,sph).

D1, a three vector of volume 1 dimensions.

G2, the geometry of the second volume.

D2, a three vector of volume 2 dimensions.

++++++++++++
Output Tables
++++++++++++

Table 84 (PULFLX) shows the format of the FLUXES.DAT file. This file contains group fluxes from prior transport calculations and is used for all PULSE calculations. *PULSE should use the same problem setup as the transport calculation or else use the SAVE/START file from that calculation.

Table 85 (PULOUT) indicates the initial output from PULSE. At the bottom of this table are tabulations of chord length distributions.

Table 86 (PULLET) indicates the format of the LET spectrum obtained from using the L option.

Table 87 (PULPHD) shows the format of pulse heights obtained with the M option.

Table 88 (PULGOP) contains a GOPLOT.DAT file also obtained when the M option is invoked.

+++++++++++++
Output Figures
+++++++++++++

Plots of data saved on the PLOT.DAT file include both pulse height distributions and LET spectra. Outputs after processing a FLUXES.DAT file from a GCR calculation are: Figure 91 (PULGIP), an integral pulse height spectrum.

Figure 92 (PULGDP), a differential pulse height spectrum.

Figure 93 (PULGIL), an integral LET spectrum.

Figure 94 (PULGDL), a differential LET spectrum.

Plots obtained from the PLOT.DAT file after using PULSE on an electron/photon FLUXES.Dat file include: Figure 95 (PULCLD).

Chord length distributions for the sensitive volume.

Figure 96 (PULSEP), secondary electron phd.

Figure 97 (PULDEP), pulse height from secondary electrons in the detector.

Figure 98 (PULTEP), pulse height from all photon produced electrons.

Figure 99 (PULEDL), secondary electron differental LET spectrum.

Figure PLOPET, primary electron pulse height distribution.

Figure 101 (PULEIL), primary electron integral LET spectrum.

Table 84: (PULFLX) FLUXES.DAT Interface File

```
C IDPAR IDSPE IDSOU IDDET IDTHI IDMTL IDGEO
C NEMAX LEUNI LFUNI LGUNI  IELE  IFLX  MODF  IERR  MODE
   3    1    0    1    0    0    0   31    1    1    2   8948  21464 1   2641 1
C       THICK       SCALE
5.000E+29 1.000E+00
1.000E+01 7.943E+00 6.310E+00 5.012E+00 3.981E+00 3.162E+00 2.512E+00 1.995E+00
1.585E+00 1.259E+00 1.000E+00 7.943E-01 6.310E-01 5.012E-01 3.981E-01 3.162E-01
2.512E-01 1.995E-01 1.585E-01 1.259E-01 1.000E-01 7.943E-02 6.310E-02 5.012E-02
3.981E-02 3.162E-02 2.512E-02 1.995E-02 1.585E-02 1.259E-02 1.000E-02 7.943E-03
2.416E-08 4.901E-07 6.203E-06 1.884E-05 5.443E-05 1.944E-04 2.056E-04 4.126E-04
5.623E-04 1.211E-03 1.061E-03 1.304E-03 1.549E-03 1.877E-03 2.396E-03 1.984E-03
2.760E-03 3.793E-03 3.994E-03 5.703E-03 5.832E-03 6.658E-03 2.781E-03 2.901E-03
1.611E-03 1.051E-03 1.793E-04 1.142E-05 3.029E-05 9.094E-10 6.510E-17
5.435E-01 2.673E-01 2.422E-01 2.441E-01 2.625E-01 1.604E-01 1.840E-01 1.594E-01
1.418E-01 7.776E-02 1.581E-01 1.675E-01 1.581E-01 1.979E-01 1.?
C IDPAR IDSPE IDSOU IDDET IDTHI IDMTL IDGEO
C NEMAX LEUNI LFUNI LGUNI  IELE  IFLX  MODF  IERR  MODE
   3    1    0    1    0    0    0   31    1    1    2   8965  17953 1   2641 1
C       THICK       SCALE
4.066E+00 1.000E+00
1.000E+01 7.943E+00 6.310E+00 5.012E+00 3.981E+00 3.162E+00 2.512E+00 1.995E+00
1.585E+00 1.259E+00 1.000E+00 7.943E-01 6.310E-01 5.012E-01 3.981E-01 3.162E-01
2.512E-01 1.995E-01 1.585E-01 1.259E-01 1.000E-01 7.943E-02 6.310E-02 5.012E-02
3.981E-02 3.162E-02 2.512E-02 1.995E-02 1.585E-02 1.259E-02 1.000E-02 7.943E-03
1.820E-08 6.330E-07 5.320E-06 2.258E-05 7.727E-05 1.598E-04 2.715E-04 5.250E-04
5.971E-04 8.926E-04 1.117E-03 1.227E-03 1.648E-03 1.901E-03 2.128E-03 2.837E-03
2.485E-03 3.250E-03 3.321E-03 4.616E-03 4.459E-03 4.727E-03 3.762E-03 3.045E-03
1.820E-03 6.214E-04 8.274E-05 1.506E-05 1.460E-07 2.972E-09 2.424E-14
3.532E-01 2.611E-01 1.821E-01 1.497E-01 1.212E-01 9.891E-02 9.396E-02 8.696E-02
9.485E-02 1.020E-01 9.819E-02 1.022E-01 1.118E-01 1.114E-01 1.065E-01 1.167E-01
1.455E-01 1.259E-01 1.603E-01 1.495E-01 1.760E-01 2.669E-01 1.518E-01 1.804E-01
1.786E-01 2.269E-01 3.427E-01 8.086E-01 5.918E-01 9.166E-01 9.921E-01
C IDPAR IDSPE IDSOU IDDET IDTHI IDMTL IDGEO
C NEMAX LEUNI LFUNI LGUNI  IELE  IFLX  MODF  IERR  MODE
   4    1    0    1    0    0    0   31    1    1    2   8965  17953 1   2641 1
C       THICK       SCALE
4.156E+00 1.000E+00
1.000E+01 7.943E+00 6.310E+00 5.012E+00 3.981E+00 3.162E+00 2.512E+00 1.995E+00
1.585E+00 1.259E+00 1.000E+00 7.943E-01 6.310E-01 5.012E-01 3.981E-01 3.162E-01
2.512E-01 1.995E-01 1.585E-01 1.259E-01 1.000E-01 7.943E-02 6.310E-02 5.012E-02
3.981E-02 3.162E-02 2.512E-02 1.995E-02 1.585E-02 1.259E-02 1.000E-02 7.943E-03
0.000E+00 0.000E+00 1.088E-06 7.633E-06 3.209E-05 8.529E-05 1.274E-04 1.646E-04
2.700E-04 2.887E-04 3.095E-04 2.145E-04 1.685E-04 1.571E-04 8.464E-05 8.737E-05
4.707E-05 4.303E-05 4.445E-05 1.746E-05 1.648E-05 9.287E-06 1.149E-05 4.188E-06
4.771E-06 3.443E-06 1.351E-06 1.581E-06 7.8
```

Table 85: (PULOUT) Pulse Height Output File

```
INPUT *HEADER,OPTIONS/
Line  21:*PULSE,L=2,M=2/
1                                                                    PAGE  27

PHDNEW-----------------------------------------------------------------------
         -28 PARTICLE TYPE
           1 SPECTRUM INDEX
           0 SOURCE INDEX
           0 DETECTOR INDEX
           1 THICKNESS INDEX
           1 MATERIAL INDEX
           1 GEOMETRY INDEX
  1.2500E-01 THICKNESS, GM/SQCM
  1.0000E+00 SCALE FACTOR
          50 ENERGY GROUPS
           0 ENERGY UNITS
           1 FLUX UNITS
           0 ERROR UNITS
           0 ENERGY ADDRESS
           0 FLUX ADDRESS
           0 ERROR ADDRESS

UNIT  25 OPENED GOPLOT.DAT
INPUT CHORD TABLE LENGTH,COS AND THE INTERVALS,MTL,GE
Line  22:100 10 10 2 0/
INPUT COSINE LIMITS, AZIMUTHAL LIMITS, DIMENSIONS
Line  23:0 1 0 1.57 .0010 .0020 .0004/
INPUT ENERGY CHANNEL BOUNDARIES
Line  24:.001 LI40*10/
              ARRAY ORDER CHANGED TO DECREASING
              *INFO*INFO*INFO*INFO*INFO*INFO*INFO*INFO*INFO*INFO*INFO*

INDEX    CHORD, S   AREA.LT.S    VOL.LT.S  LATCH.LT.S
    1  4.0000E-05  5.7905E-08  6.2953E-11  0.0000E+00
    2  4.1666E-05  6.0300E-08  6.5524E-11  0.0000E+00
    3  4.3401E-05  6.2793E-08  6.8199E-11  0.0000E+00
    4  4.5208E-05  6.5388E-08  7.0980E-11  0.0000E+00
    5  4.7091E-05  6.8090E-08  7.3872E-11  0.0000E+00
    6  4.9052E-05  7.0903E-08  7.6879E-11  0.0000E+00
    7  5.1095E-05  7.3830E-08  8.0005E-11  0.0000E+00
    8  5.3223E-05  7.6878E-08  8.3255E-11  0.0000E+00
    9  5.5439E-05  8.0050E-08  8.6634E-11  0.0000E+00
    :
   98  2.0936E-03  1.6020E-06  7.9994E-10  5.7795E-07
   99  2.1807E-03  1.6027E-06  8.0000E-10  5.7795E-07
  100  2.2716E-03  1.6028E-06  8.0000E-10  5.7795E-07
```

Table 86: (PULLET) Pulse LET Spectrum Output

LET SPECTRUM FOR ALL ELEMENTS IN MATERIAL, GM/CC= SILICON 2.330E+00

LINEAR ENERGY TRANSFER (LET) SPECTRUM
, AVERAGED OVER FINITE THICKNESS, RIGHT COLUMN IS 3 MICRON, ISOTROPIC FLUX

INDEX	MEV/CM	.00000 CM	.00010 CM	.00030 CM	.00100 CM	.00300 CM	
1	1.00E+05	0.00E+00	7.36E-02	0.00E+00	0.00E+00	0.00E+00	1.43E+03
2	7.94E+04	0.00E+00	2.20E-01	0.00E+00	0.00E+00	0.00E+00	2.26E+03
3	6.31E+04	7.83E+02	7.84E+02	7.83E+02	7.83E+02	7.75E+02	3.59E+03
4	5.01E+04	3.44E+03	3.44E+03	3.44E+03	3.44E+03	3.44E+03	5.46E+03
5	3.98E+04	7.31E+03	7.31E+03	7.31E+03	7.31E+03	7.31E+03	7.65E+03
6	3.16E+04	1.19E+04	1.19E+04	1.19E+04	1.19E+04	1.19E+04	9.98E+03
7	2.51E+04	1.71E+04	1.71E+04	1.71E+04	1.71E+04	1.71E+04	1.23E+04
8	2.00E+04	2.24E+04	2.24E+04	2.24E+04	2.24E+04	2.24E+04	1.45E+04
9	1.58E+04	2.72E+04	2.72E+04	2.72E+04	2.72E+04	2.72E+04	1.65E+04
10	1.26E+04	3.17E+04	3.17E+04	3.17E+04	3.17E+04	3.17E+04	1.81E+04
11	1.00E+04	3.53E+04	3.53E+04	3.53E+04	3.53E+04	3.53E+04	1.95E+04
12	7.94E+03	3.85E+04	3.85E+04	3.85E+04	3.85E+04	3.85E+04	2.05E+04
13	6.31E+03	4.10E+04	4.10E+04	4.10E+04	4.10E+04	4.10E+04	2.13E+04
14	5.01E+03	4.24E+04	4.24E+04	4.24E+04	4.24E+04	4.24E+04	2.17E+04
15	3.98E+03	4.34E+04	4.34E+04	4.34E+04	4.34E+04	4.34E+04	2.20E+04
16	3.16E+03	4.40E+04	4.40E+04	4.40E+04	4.40E+04	4.40E+04	2.22E+04
17	2.51E+03	4.44E+04	4.44E+04	4.44E+04	4.44E+04	4.44E+04	2.23E+04
18	2.00E+03	4.46E+04	4.46E+04	4.46E+04	4.46E+04	4.46E+04	2.24E+04
19	1.58E+03	4.47E+04	4.47E+04	4.47E+04	4.47E+04	4.47E+04	2.25E+04
20	1.26E+03	4.48E+04	4.48E+04	4.48E+04	4.48E+04	4.48E+04	2.26E+04
21	1.00E+03	4.50E+04	4.50E+04	4.50E+04	4.50E+04	4.50E+04	2.27E+04
22	7.94E+02	4.52E+04	4.52E+04	4.52E+04	4.52E+04	4.52E+04	2.28E+04
23	6.31E+02	4.53E+04	4.53E+04	4.53E+04	4.53E+04	4.53E+04	2.29E+04
24	5.01E+02	4.55E+04	4.55E+04	4.55E+04	4.55E+04	4.55E+04	2.30E+04
25	3.98E+02	4.57E+04	4.57E+04	4.57E+04	4.57E+04	4.57E+04	2.31E+04
26	3.16E+02	4.59E+04	4.59E+04	4.59E+04	4.59E+04	4.59E+04	2.32E+04
27	2.51E+02	4.60E+04	4.60E+04	4.60E+04	4.60E+04	4.60E+04	2.34E+04
28	2.00E+02	4.63E+04	4.63E+04	4.63E+04	4.63E+04	4.63E+04	2.37E+04
29	1.58E+02	4.65E+04	4.65E+04	4.65E+04	4.65E+04	4.65E+04	2.40E+04
30	1.26E+02	4.69E+04	4.69E+04	4.69E+04	4.69E+04	4.69E+04	2.44E+04
31	1.00E+02	4.75E+04	4.75E+04	4.75E+04	4.75E+04	4.75E+04	2.49E+04
32	7.94E+01	4.83E+04	4.83E+04	4.83E+04	4.83E+04	4.83E+04	2.56E+04
33	6.31E+01	4.95E+04	4.95E+04	4.95E+04	4.95E+04	4.95E+04	2.65E+04
34	5.01E+01	5.11E+04	5.11E+04	5.11E+04	5.11E+04	5.11E+04	2.75E+04
35	3.98E+01	5.30E+04	5.30E+04	5.30E+04	5.30E+04	5.30E+04	2.86E+04
36	3.16E+01	5.55E+04	5.55E+04	5.55E+04	5.55E+04	5.55E+04	2.99E+04
37	2.51E+01	5.80E+04	5.80E+04	5.80E+04	5.80E+04	5.80E+04	3.11E+04
38	2.00E+01	6.13E+04	6.13E+04	6.13E+04	6.13E+04	6.13E+04	3.23E+04
39	1.58E+01	6.51E+04	6.51E+04	6.51E+04	6.51E+04	6.51E+04	3.33E+04
40	1.26E+01	6.61E+04	6.61E+04	6.61E+04	6.61E+04	6.61E+04	3.38E+04
41	1.00E+01	6.62E+04	6.62E+04	6.62E+04	6.62E+04	6.62E+04	3.42E+04
42	7.94E+00	6.64E+04	6.64E+04	6.64E+04	6.64E+04	6.64E+04	3.48E+04
43	6.31E+00	6.68E+04	6.68E+04	6.68E+04	6.68E+04	6.68E+04	3.58E+04
44	5.01E+00	6.78E+04	6.78E+04	6.78E+04	6.78E+04	6.78E+04	3.72E+04
:							
51	1.00E+00	8.06E+04	8.06E+04	8.06E+04	8.06E+04	8.06E+04	4.03E+04

Table 87: (PULPHD) Pulse Height Print File

```
        -28 PARTICLE TYPE
          1 SPECTRUM INDEX
          0 SOURCE INDEX
          0 DETECTOR INDEX
          1 THICKNESS INDEX
          1 MATERIAL INDEX
          1 GEOMETRY INDEX
  1.2500E-01 THICKNESS, GM/SQCM
  1.0000E+00 SCALE FACTOR
         50 ENERGY GROUPS
          0 ENERGY UNITS
          1 FLUX UNITS
          0 ERROR UNITS
          0 ENERGY ADDRESS
      11125 FLUX ADDRESS
      12525 ERROR ADDRESS

     CHANNEL  COUNTS/  COUNTS/   SUMMED     - = COUNTS PER UNIT ENERGY
  I   ENERGY   ENERGY  CHANNEL   COUNTS     * = COUNTS SUMMED
  1 7.94E+00 0.00E+00 0.00E+00 0.00E+00 .*
  2 6.31E+00 0.00E+00 0.00E+00 0.00E+00 .*
  3 5.01E+00 0.00E+00 0.00E+00 0.00E+00 .*
  4 3.98E+00 0.00E+00 0.00E+00 0.00E+00 .*
  5 3.16E+00 0.00E+00 0.00E+00 0.00E+00 .*
  6 2.51E+00 1.14E-06 7.40E-07 7.40E-07 .*
  7 2.00E+00 5.53E-05 2.86E-05 2.93E-05 .*
  8 1.58E+00 2.02E-04 8.29E-05 1.12E-04 .*
  9 1.26E+00 7.37E-04 2.40E-04 3.52E-04 .*
 10 1.00E+00 2.34E-03 6.07E-04 9.59E-04 .*
 11 7.94E-01 5.27E-03 1.08E-03 2.04E-03 .*
 12 6.31E-01 1.19E-02 1.94E-03 3.98E-03 .-*
 13 5.01E-01 2.36E-02 3.07E-03 7.05E-03 .- *
 14 3.98E-01 4.42E-02 4.55E-03 1.16E-02 .-  *
 15 3.16E-01 6.86E-02 5.62E-03 1.72E-02 .-   *
 16 2.51E-01 9.70E-02 6.31E-03 2.35E-02 .-     *
 17 2.00E-01 1.28E-01 6.63E-03 3.02E-02 .-       *
 18 1.58E-01 1.57E-01 6.44E-03 3.66E-02 .-         *
 19 1.26E-01 1.93E-01 6.28E-03 4.29E-02 .-           *
 20 1.00E-01 2.11E-01 5.46E-03 4.83E-02 .-             *
  :
 31 7.94E-03 1.14E+00 2.35E-03 7.77E-02 .-                      *
 32 6.31E-03 1.97E+00 3.22E-03 8.09E-02 . -                      *
 33 5.01E-03 2.68E+00 3.48E-03 8.44E-02 .  -                      *
 34 3.98E-03 4.61E+00 4.75E-03 8.91E-02 .   -                      *
 35 3.16E-03 7.17E+00 5.87E-03 9.50E-02 .     -                      *
 36 2.51E-03 8.54E+00 5.55E-03 1.01E-01 .       -                      *
 37 2.00E-03 1.16E+01 5.98E-03 1.07E-01 .         -                      *
 38 1.58E-03 1.98E+01 8.12E-03 1.15E-01 .                 -                  *
 39 1.26E-03 9.20E+00 3.00E-03 1.18E-01 .       -                              *
 40 1.00E-03 4.44E+01 1.15E-02 1.29E-01 .                                                *
*************************************************************
  0.0000E+00 UPSETS/BIT BASED ON WEIGHTED EXPERIMENTAL DATA
*************************************************************
```

Table 88: (PULGOP) PHD GOPLOT.DAT Output File

```
1.000E+01 7.943E+00 6.310E+00 5.012E+00 3.981E+00 3.162E+00 2.512E+00 1.995E+00
1.585E+00 1.259E+00 1.000E+00 7.943E-01 6.310E-01 5.012E-01 3.981E-01 3.162E-01
2.512E-01 1.995E-01 1.585E-01 1.259E-01 1.000E-01 7.943E-02 6.310E-02 5.012E-02
3.981E-02 3.162E-02 2.512E-02 1.995E-02 1.585E-02 1.259E-02 1.000E-02 7.943E-03
6.310E-03 5.012E-03 3.981E-03 3.162E-03 2.512E-03 1.995E-03 1.585E-03 1.259E-03
1.000E-03
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 7.404E-07 2.858E-05 8.286E-05
2.401E-04 6.069E-04 1.083E-03 1.941E-03 3.066E-03 4.554E-03 5.616E-03 6.306E-03
6.631E-03 6.443E-03 6.276E-03 5.462E-03 5.015E-03 4.146E-03 3.462E-03 2.781E-03
2.135E-03 1.805E-03 1.771E-03 1.760E-03 1.935E-03 2.167E-03 2.351E-03 3.221E-03
3.482E-03 4.747E-03 5.870E-03 5.553E-03 5.980E-03 8.124E-03 2.998E-03 1.150E-02
1.000E+01 7.943E+00 6.310E+00 5.012E+00 3.981E+00 3.162E+00 2.512E+00 1.995E+00
1.585E+00 1.259E+00 1.000E+00 7.943E-01 6.310E-01 5.012E-01 3.981E-01 3.162E-01
2.512E-01 1.995E-01 1.585E-01 1.259E-01 1.000E-01 7.943E-02 6.310E-02 5.012E-02
3.981E-02 3.162E-02 2.512E-02 1.995E-02 1.585E-02 1.259E-02 1.000E-02 7.943E-03
6.310E-03 5.012E-03 3.981E-03 3.162E-03 2.512E-03 1.995E-03 1.585E-03 1.259E-03
1.000E-03
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 5.543E-07 2.157E-05 6.257E-05
1.821E-04 4.620E-04 8.254E-04 1.497E-03 2.378E-03 3.550E-03 4.473E-03 5.153E-03
5.489E-03 5.605E-03 5.689E-03 5.038E-03 4.706E-03 3.894E-03 3.250E-03 2.616E-03
2.010E-03 1.710E-03 1.668E-03 1.650E-03 1.827E-03 2.048E-03 2.247E-03 3.145E-03
3.432E-03 4.721E-03 5.847E-03 5.524E-03 5.956E-03 8.108E-03 2.989E-03 1.146E-02
```

Figure 91: (PULGIP) GCR Integral Pulse Heights

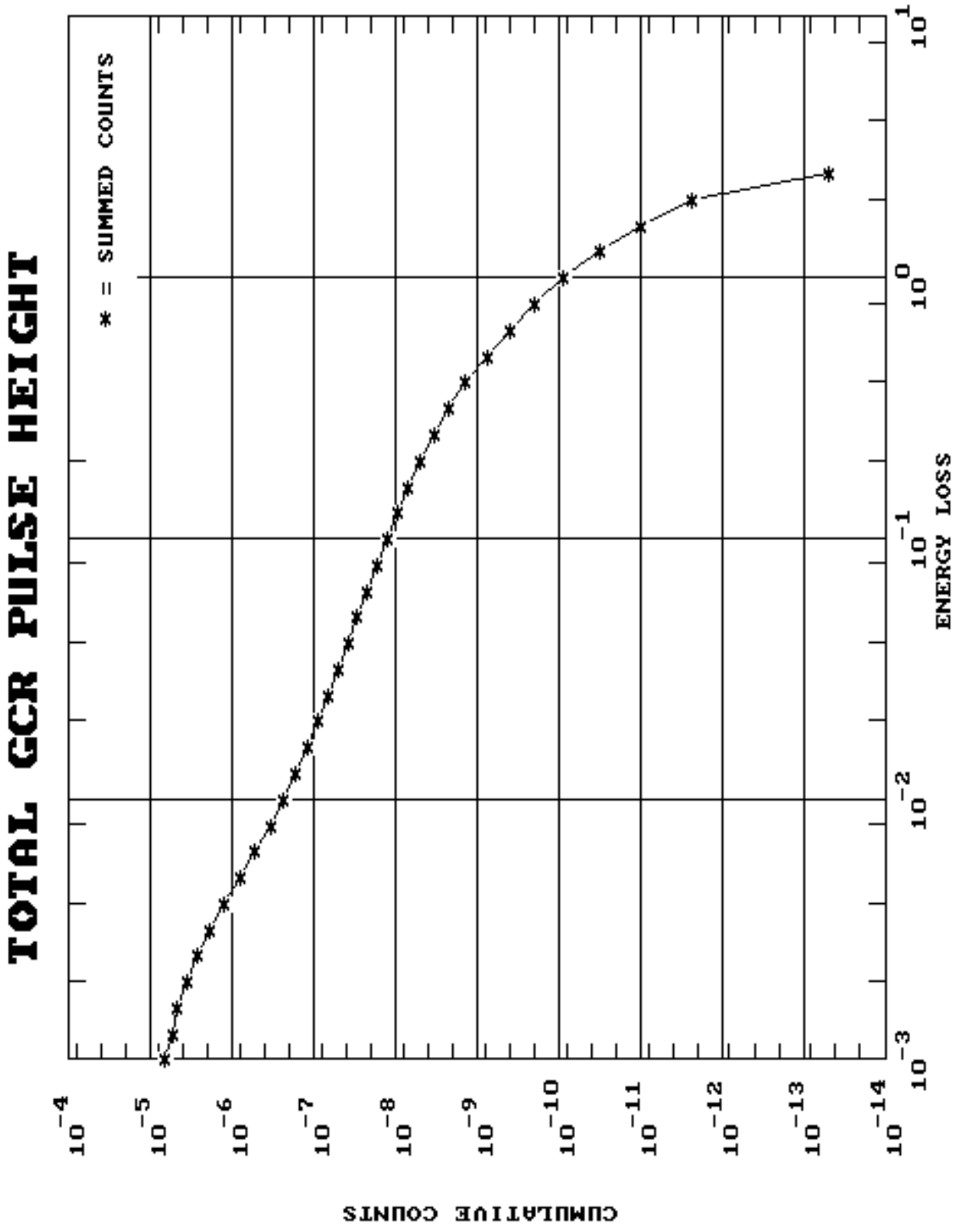


Figure 92: (PULGDP) GCR Differential Pulse Height

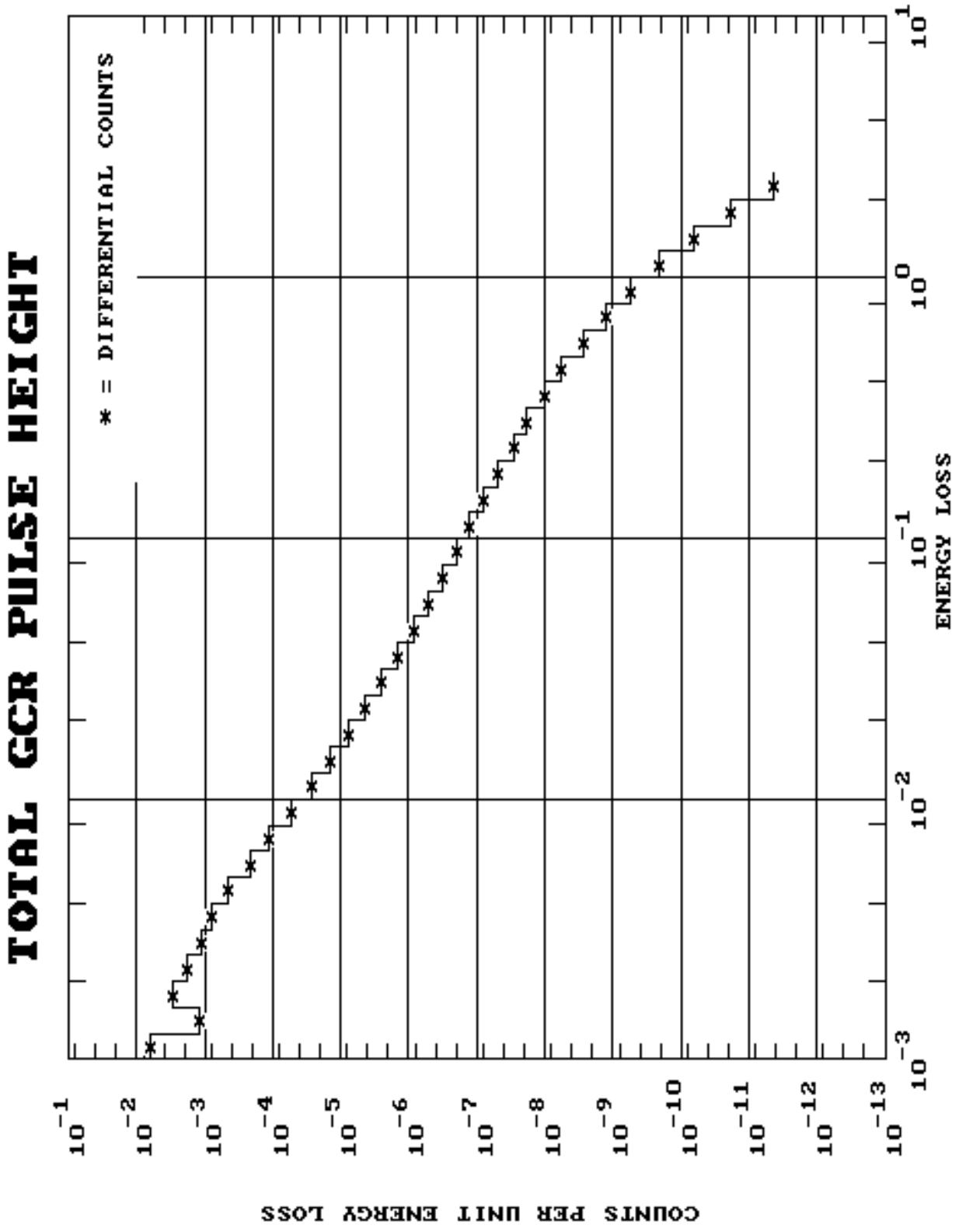


Figure 93: (PULGIL) GCR Integral LET Spectrum

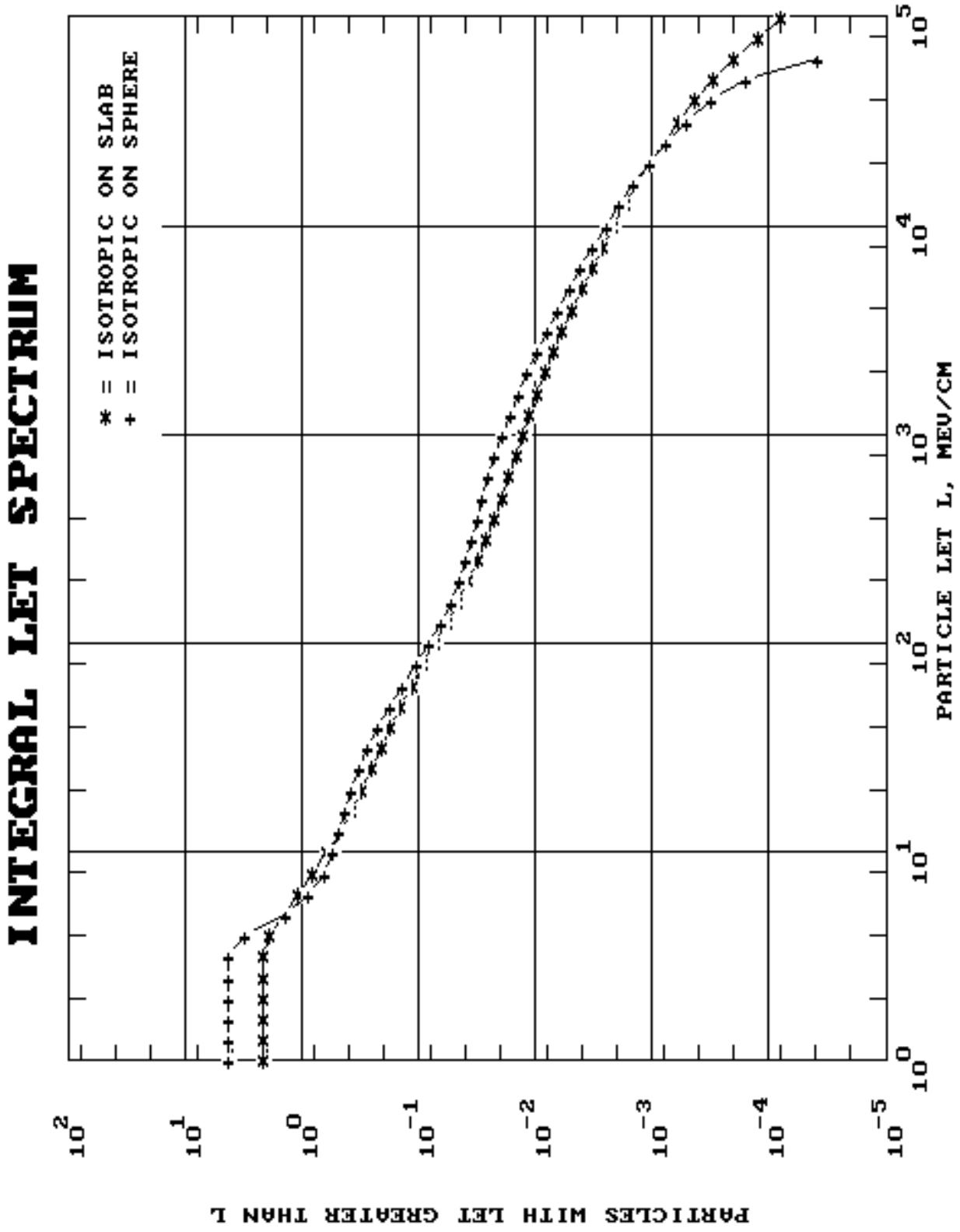


Figure 94: (PULGDL) GCR Differential LET Spectrum

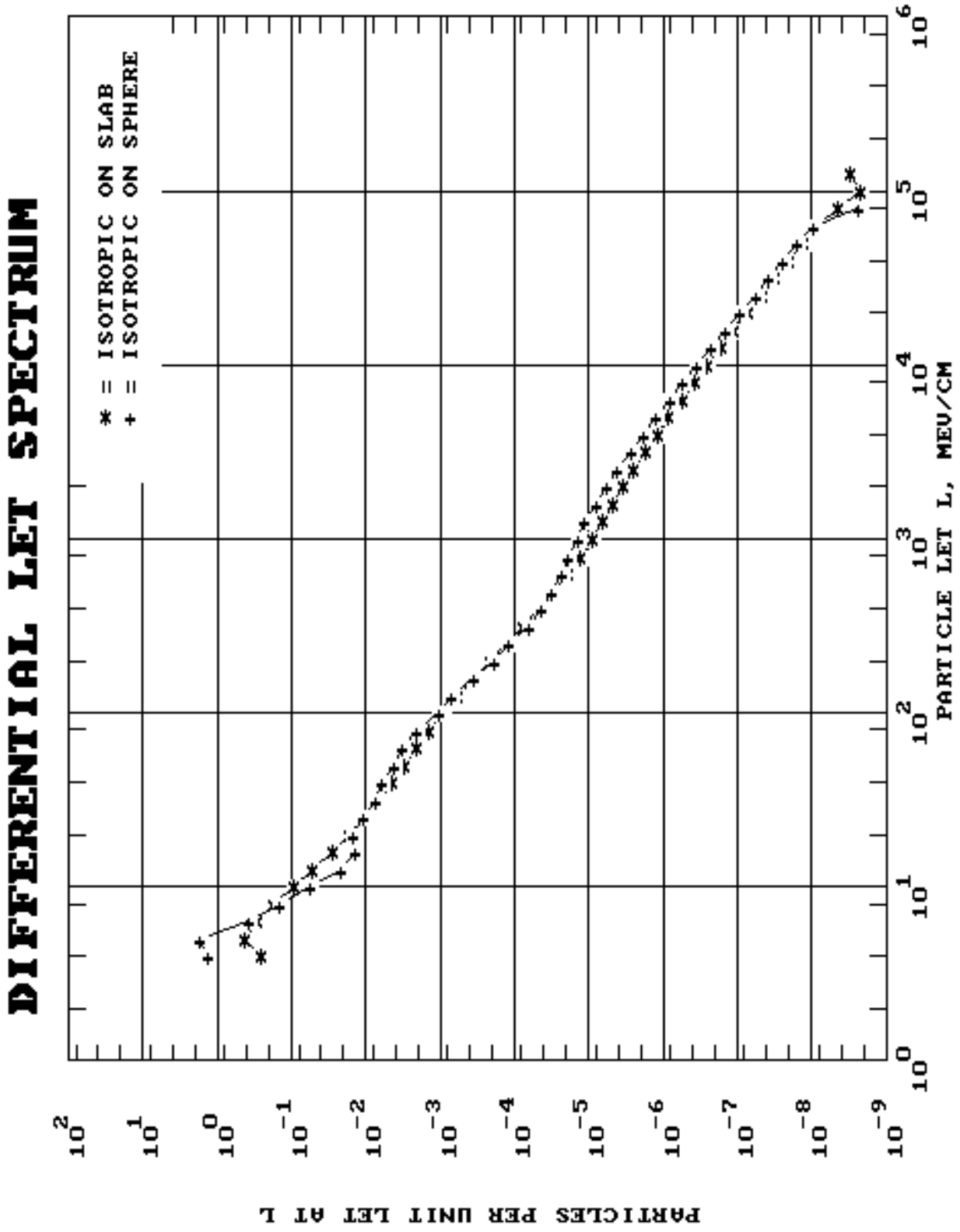


Figure 95: (PULCLD) Chord Length Distributions

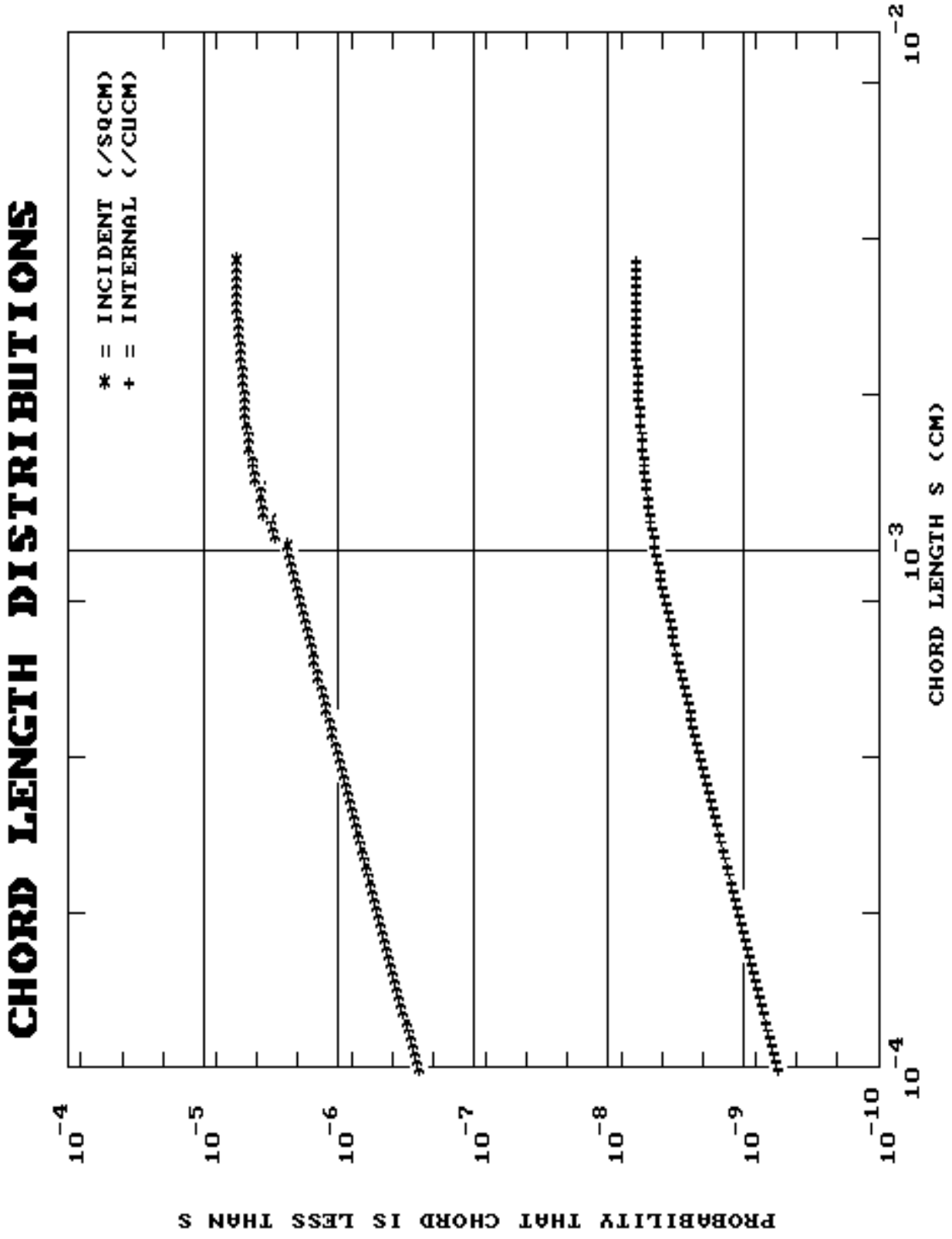


Figure 96: (PULSEP) Secondary Electron Pulse Hgt

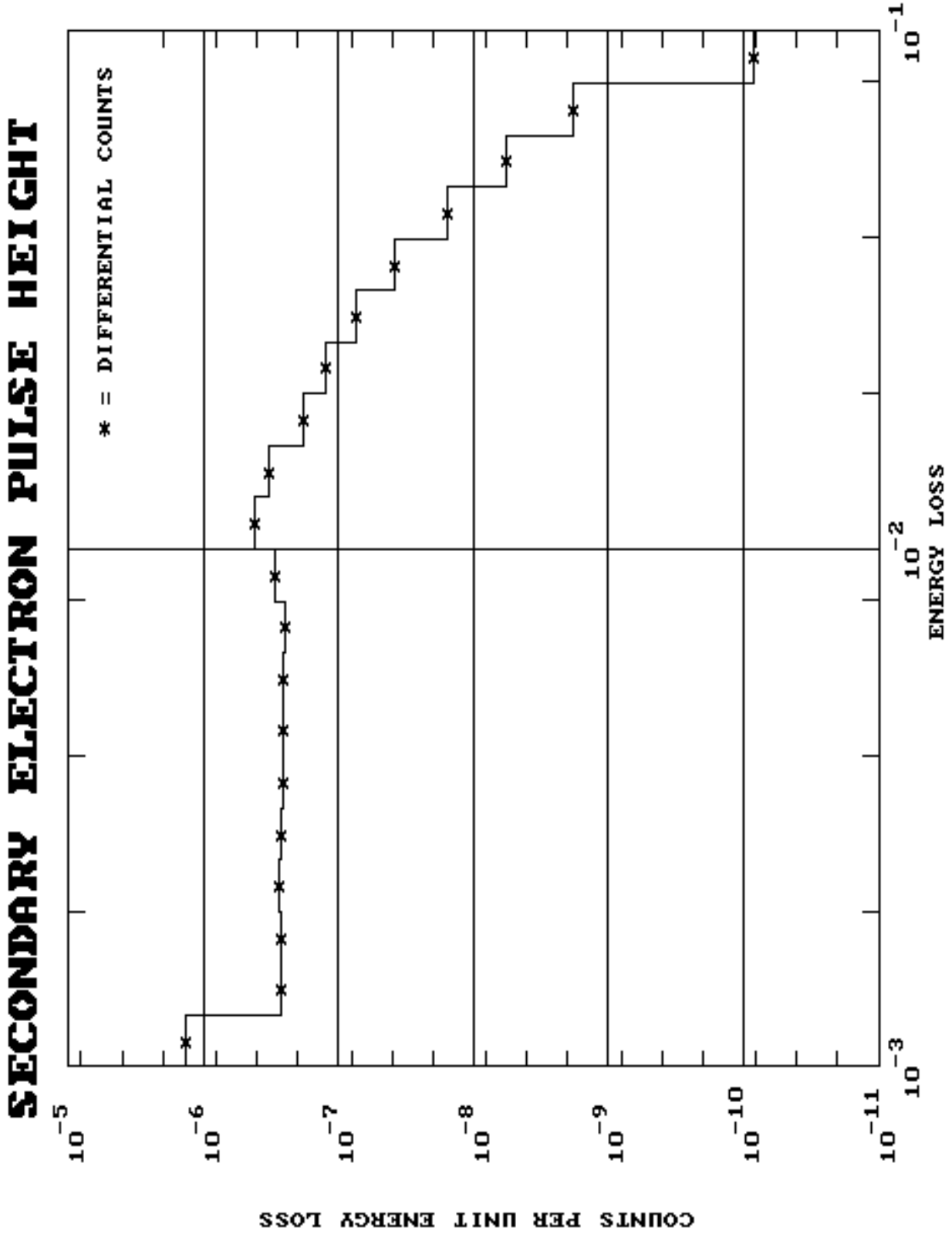


Figure 97: (PULDEP) Detector Electron Pulse Hgt

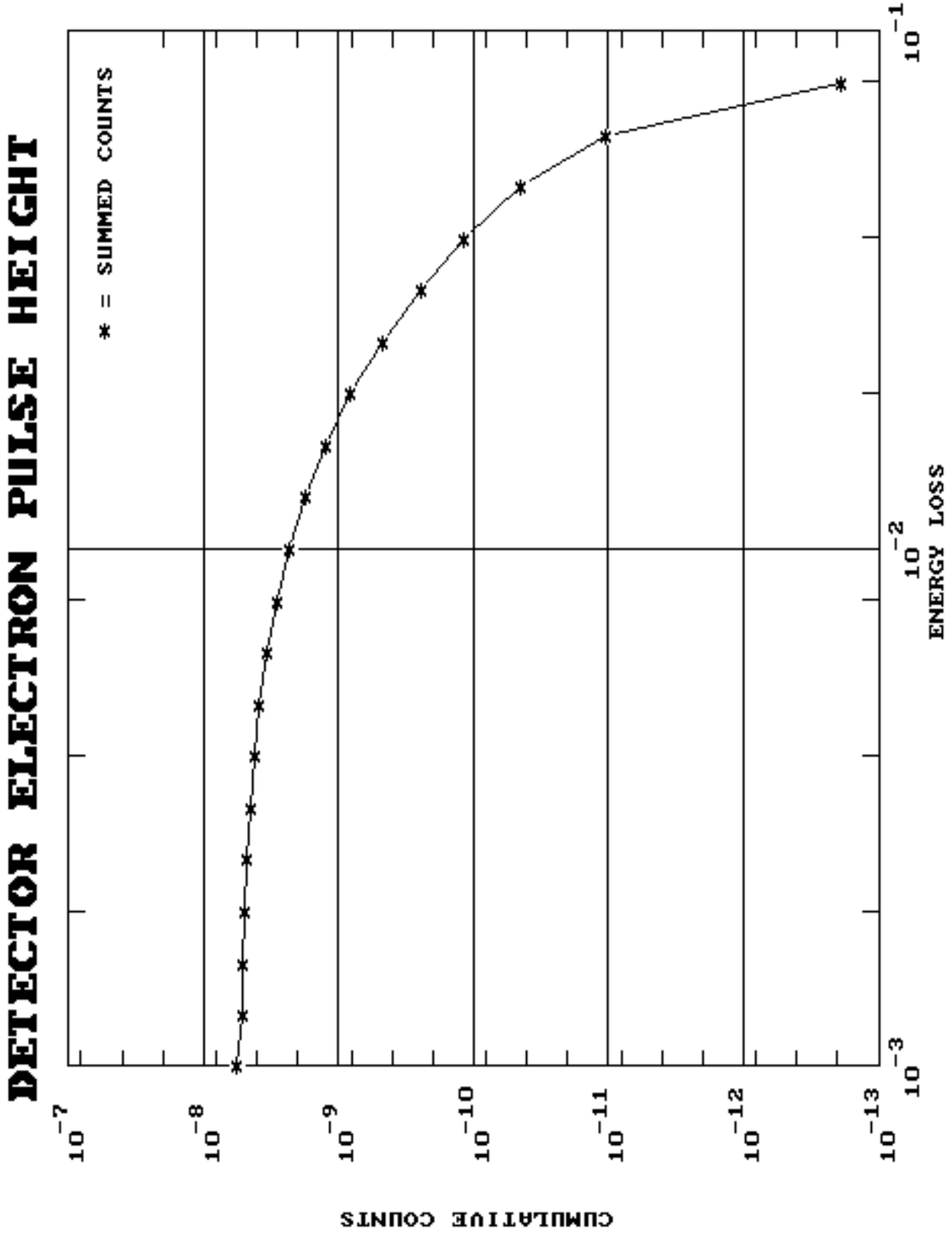


Figure 98: (PULTEP) Total Electron Pulse Height

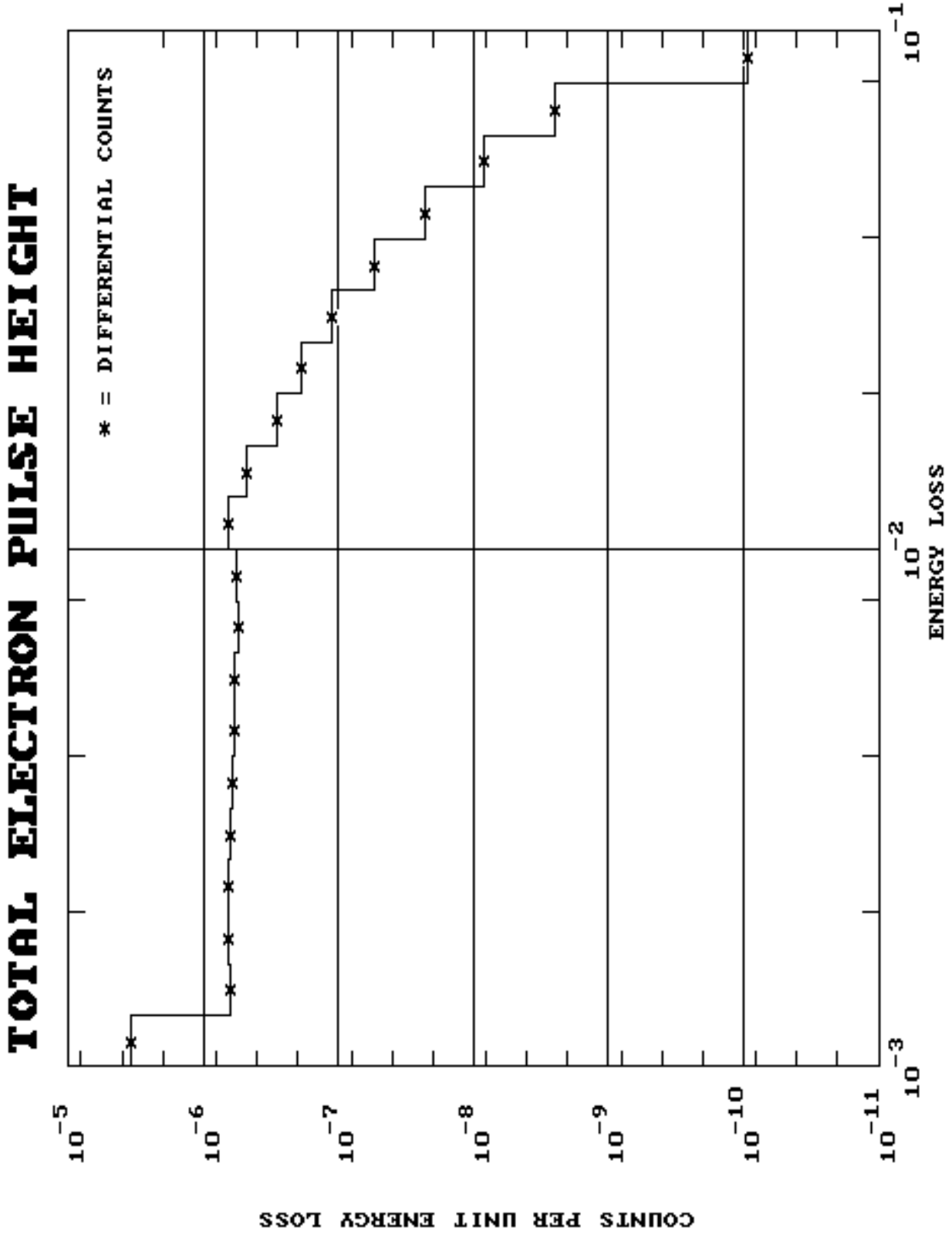


Figure 99: (PULEDL) Electron LET Spectrum

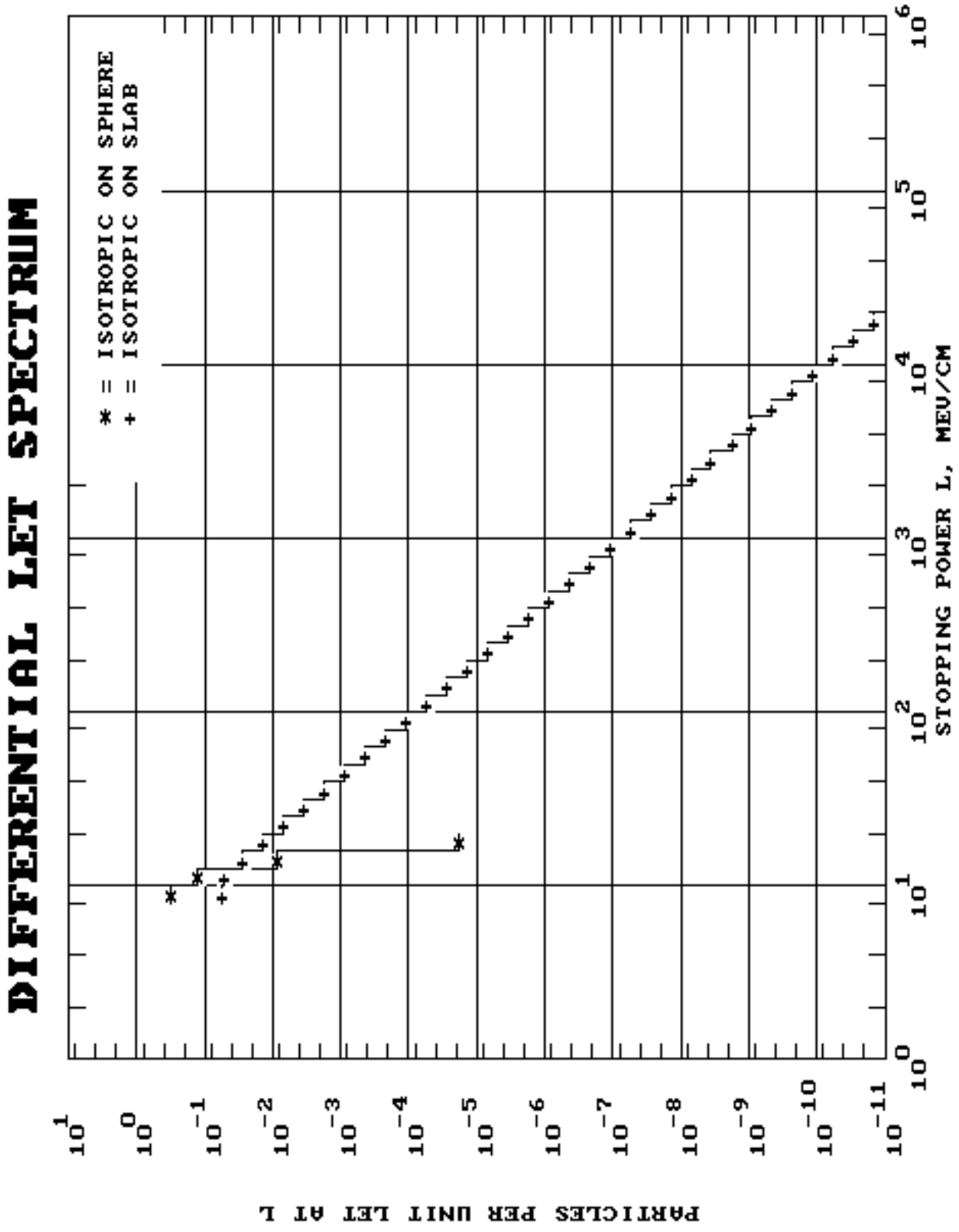


Figure 100: (PULPEP) Primary Electron Pulse Height

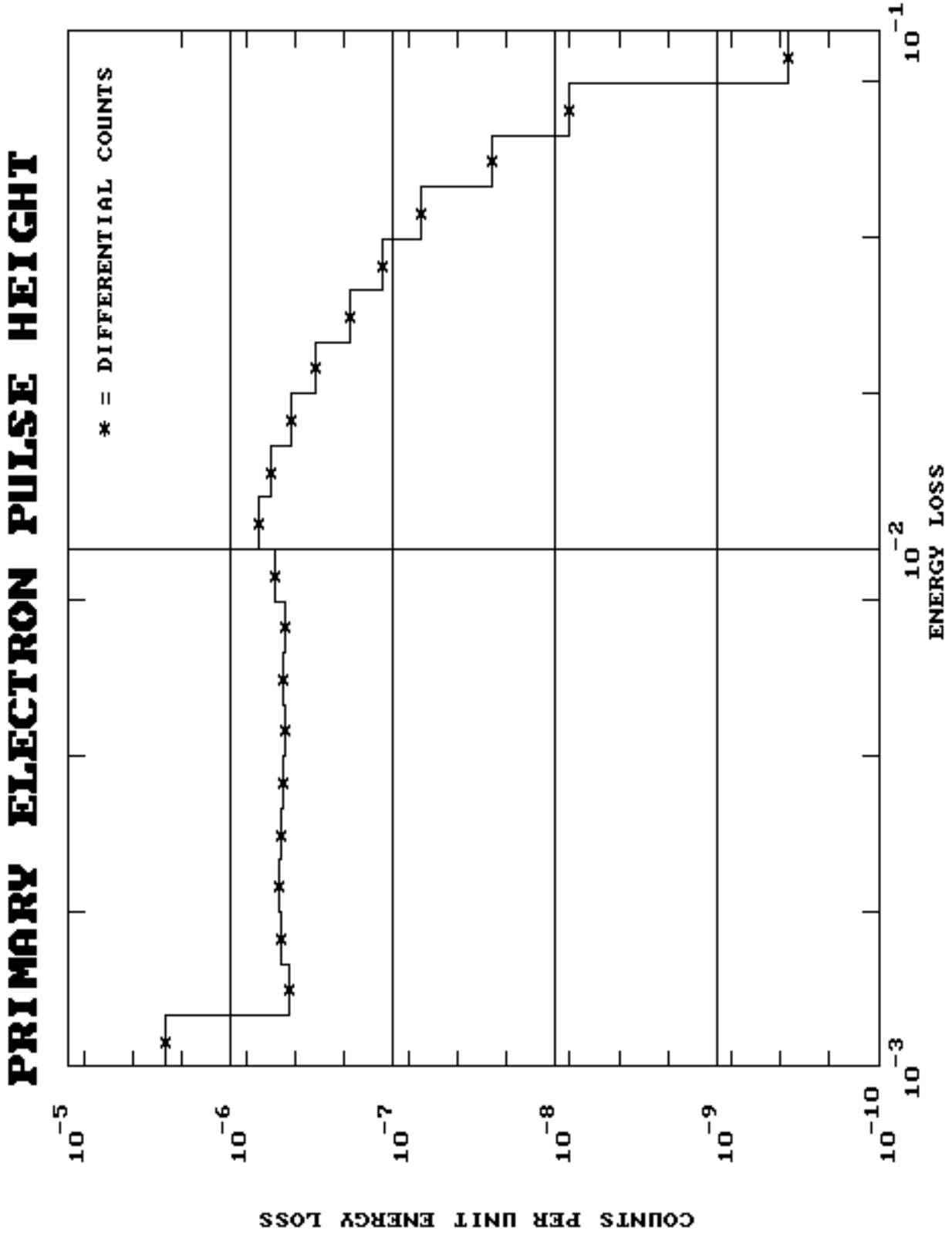
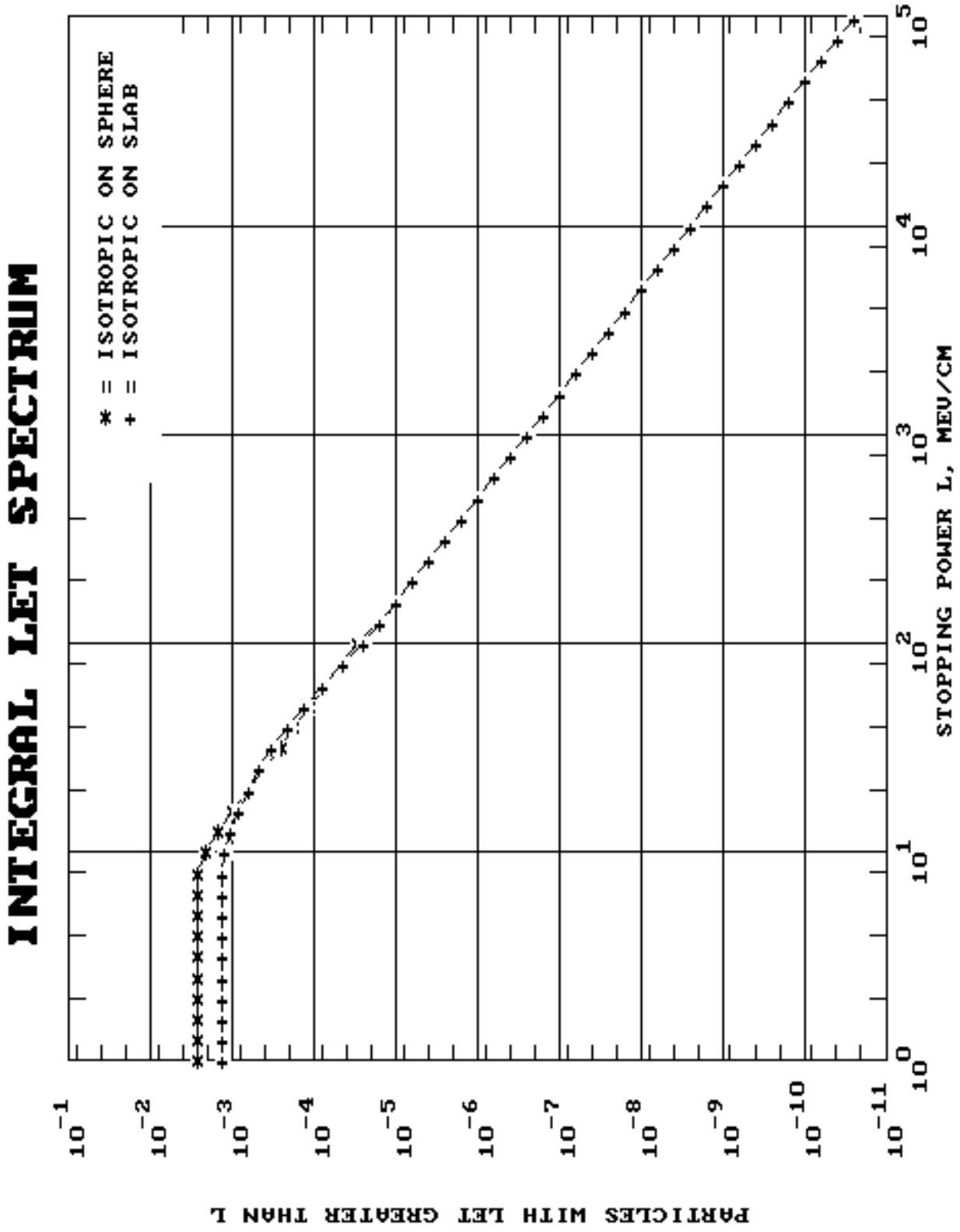


Figure 101: (PULEIL) Beta Integral LET Spectrum



PUT

PUT saves data lines for later retrieval (GET).

****
The PUT processor provides for saving input lines for reuse by invoking the *GET processor.
****

****
Input Data Record Description:
****

======
Header
======

Contains *PUT in columns 1 through 4.

=======
Options
=======

No options apply.

****
Data Record Description:
****

==========
Name of Saved File
==========

The first record contains the name of the saved file.

==========
Terminator Record
==========

The second record contains a line used to terminate the input records belonging to the save file, i.e., the last record must match the second record exactly (blank records aren't allowed).

==========
Data Records
==========

Repeat data records as needed. Input terminates when a record matching the 'Terminator Record' line is encountered.

QAD

QAD, a point-kernel neutron-gamma ray calculation

****
QAD uses point-kernel methods to calculate gamma-ray and neutron fluxes in a 3-D geometry model. This version uses the NOVICE geometry model.
****

****
Input Data Record Description:
****

======
Header
======

Must contain *QAD in columns 1 through 4.

=======
Options
=======

A, if present, average attenuation * buildup over the pencil length.

B=b (alphanumeric) buildup material, e.g., water. Allowed values are: beryllium, boron, carbon, nitrogen, oxygen, sodium, magnesium, aluminum, silicon, phosphorus, sulpher, argon, potassium, calcium, iron, copper, molybdenum, lead, uranium, water, air, and concrete. Only the first four letters are required.

C=c (alphanumeric) buildup quantity, i.e., absorption or exposure. Only the first three letters are required.

D, if present, debug output on ray trace data.

E=e (material name) material for energy absorption dose.

F, if present, debug option for flux data.

G, if present, exponential interpolation on dose for isodose output.

H, if present, no labels on isodose contours (labels may overlap).

I=i, if i non zero, colors i, i+1, ... are used for contour lines.

J=j, generate source file for ACCEPT and/or MCNP; (0,1,2) = (ACCEPT, MCNP, BOTH), e.g., if J only (j=0) then ACCEPT only.

K, que element processing order (pkm 5.2)

L=l (alphanumeric) name of curie loading file (default=loadings.txt) If not supplied or loadings.txt not present, then old QAD run.

M, if present, output dose for each tote and receiver combination.

N=n, n is the number of equal subdivisions along the length of a source pencil; default is 1. (Note, an analytic correction for 1/r^2 is always applied to the longest dimension of every source interval.) If n is positive, source points are at the midpoints of the subdivisions. If n is negative, source points are positioned at random within the subdivisions.

P=p, if present, plot while running; if p non zero only every pth receiver to source ray is plotted.

Q, forced run of old qad

R, if present only, input list of fixed detector points.

V, number of views and type

W, controls frequency and saving of pcx files

R=r, only run receiver point r, written in the form ix*10000+iy*100+iz where ix,iy,iz are the receiver indices in x,y,z, e.g. for x,y,z position 2,5,7 input R=20507.

S=s (spectrum) name of the photon source spectrum (default = 1)

T, if present, input order of processing list.

U, if present, input processing queue and tote types.

X=x, color number for source outline in plots.

Y=y, color number for tote outline in plots.

Z=z, color number for rays in plots.

&d, general debug option.

&h, angular bias single scatter

&p, put all pencils in curies. new file for use in geometry pictures

****
Data Record Description:
****

==========
Curie Decimal Data
==========

WRACK, width of a rack.

HRACK, height of a rack.

WPLAQ, width of a plaque.

HPLAQ, height of a plaque.

PSEP, pencil separation.

PLEN, active length of a pencil.

XSOU, x translation to position source relative to totes.

The source data is generated in the x plane starting at 0 for y and increasing along the conveyor direction; starting at 0 for z and decreasing (downward).

YSOU, y translation of the source.

ZSOU, z translation of the source.

If each rack has a different translation, supply a 3-vector translation for each rack. Follow the last translation by a forward slash.

When more than one translation vector is supplied, the translation input for each rack is supplied as though the translation applies to the entire rack array. For example, suppose an origin centered rack array requires a translation input of 0,-90,40 and contains two racks, the one with minimum y-coordinate raised 3 inches and the one with maximum y-coordinate dropped 3 inches. Then the input for the translations would be: 0,-90,43 ,0,-90,37.

==========
Curie Integer Data
==========

MAXPV, number of pencil positions per plaque for verticle orientation.

MAXPH, number of pencil positions per plaque if horizontal.

MAXRV, number of racks in the verticle direction (downward, y)

MAXRH, number of racks in the horizontal direction (horizontal, z)

LISTVH(i,j), rack numbers for source layout (corresponding to loadings file) numbers are listed here with verticle varying most rapidly. The list is followed by a forward slash.

==========
Detector and Tote Integers
==========

Omit this and next 2 records (Integers, Decimals, and Offsets) if totes entered as 'tote' not 'box' in *DESIGN input.

MAXDX, number of detectors in the x direction, perpendicular to source plane.

MAXDY, number of detectors in the y direction (along conveyor).

MAXDZ, number of detectors in the z direction (floor to ceiling).

MAXTX, number of totes in the x direction (on one side of source).

MAXTY, number of totes in the y direction.

MAXTZ, number of totes in the z direction. Follow by forward slash.

==========
Detector and Tote Decimals
==========

Omit if 'tote' not 'box' geometry data.

TOTEX, dimension of tote in the x direction.

DOFFX, distance of detector from tote wall in x direction.

TOTEY, dimension of tote in the y direction.

DOFFY, distance of detector from tote wall in y direction.

TOTEZ, dimension of tote in the z direction.

DOFFZ, distance of detector from tote wall in z direction.

XMIN, first x center for totes.

XMAX, last x center for totes (= XMIN if only one row).

YMIN, first y center for totes.

YMAX, last y center for totes. Offsets by row are on the next record.

ZMIN, first z center for totes.

ZMAX, last z center for totes. Follow by forward slash.

==========
Tote Offsets Parallel to Conveyor
==========

Omit if 'tote' not 'box' geometry data.

Supply y offsets in the following order:

Offsets for rows parallel to the conveyor for all x values going from closest to the source plane outward; the first set is for the lowest z position.

Supply y offsets for the x values on the other side of the source plane, from source outward, again for the lowest z position.

Supply data in the same order for the next z level.

Repeat as needed if there are additional z levels.

Follow the last entry by a forward slash.

==========
Processing Order Data
==========

If T option, enter code tote slot index for processing order.

Positive integers if order only, negative integers if region indices.

==========
Fixed Detector List
==========

If R option present and not R=r form, input list of detector points supplied during the geometry modeling.

==========
Processing Queue
==========

If U option, enter list of tote types to be processed in the same order they enter the system. Note, if the queue length exceeds the number of tote slots, then multiple runs are made. Tote types called out must be numbered consecutively from 1.

==========
Tote Type Data
==========

If U option, enter one record for each tote type mentioned in the previous record. The record contains:

name, density, detector_type detector_data/

where name is the index or name of a material described during geometry input;

density is the average tote density (g/cc) if positive or a scale factor for the reference density if flagged minus;

detector_type is none, mesh, or list; and

detector_data is absent if type is none;

is up to 9 triplets of (x,y,z) coordinates relative to the tote center if type is list; and

is dx, nx, dy, ny, dz, nz if type is mesh, where dx, dy, and dz are offsets from the edges of the tote and nx, ny, and nz are the number of points in the x, y, and z directions (if nx=1, the mesh is centered in x, etc.).

****
Ignore all the following information if no Q option.
****

==========
Direct Novice Interface (original notes, some not implemented).
==========

Q option, all old format direct input except for geometry. Also, the old format source distributions and receiver points are not used if a curie loading file is present.

All other options should be ignored.

D option, ray trace debug (prints all)

Title comes from *Label input

V Option, novice *Source index; else direct input

C Option, cosine source distribution, if used with V option, applied directly to novice source data (novice distribution ignored). Else, tabulated distribution has no distribution input.

Compositions from *Materials data.

G Option is source geometry flag (only used if not V option

N Option selects neutrons and N=n is moments set (default=1)

A Option is ASO normalization

If not V option, input:

X points/, distribution if not C/, Y points/, p(y) if not C/, Z ...

S Option, source spectrum option for gammas (default is first photon)

S with no value, user specified here

If the Q option is present, then the following input formats apply. Note that if a curie strength loadings file is present, then the source distributions are ignored and receiver points are taken from the CURIE.NEW file.

The following is a quick summary of standard QAD input (Q option and no loadings file).

```
================
Title line (a72)
================

=================
Integers 8(i5,i4)
=================
```

LSO r, x, or rho intervals

MSO z, z, or polar intervals

NSO azimuth, y, or azimthal intervals

MAT number of unique elements (if 0 data from previous case used)

NCOMP, number of compositions

NREG, geometry flag, if 0 same as previous case

NRGY, number of gamma groups

NBOUND, not used

NSOPT, source geometry (0,1,2)=(cyl,xyz,sph)

NZSO, most probable source region

ISRC, source type, if 0 same as last case, 1=cosine, 2=tabulatted

INEUT, 0=none, 1,2,3=index of moments set

NGPF, first source point for ray output

NGPL, last source point for ray output

NGPI, increment for ray output

NGINT, number of additional gamma calculations

==========
decimals 8e9.4
==========

ASO, source strength

XISO(1,1)

XISO(2,1)

XISO(1,2)

XISO(2,2)

XISO(1,3)

XISO(2,3) S=ASO * cos(XISO(1,1)*(P-XISO(2,1))) * cos(P-2) *
cos(P-3)

==========
decimal 8e9.4
==========

RSO, subdivisions in first coodinate

==========
decimal 8e9.4
==========

ZSO, subdivisions in second

```
=============
decimal 8e9.4
=============

PHISO, subdivisions in third

Omit next three lines if ISRC=2

=============
decimal 8e9.4
=============

FL, weighting for RSO points

=============
decimal 8e9.4
=============

FM, weighting for ZSO points

=============
decimal 8e9.4
=============

FN, weighting for PHISO points

=============
Geometry data
=============

now a single line (comment) to indicate where data used to be

================
Integer 8(i5,i4)
================

NBLD (1-8)=(h2o-d,Al-d,Fe-d,Pb-d,h2o-ea,ConC-d,Fe-ea,Pb-ea)

NBLD>=10, then geometric progression and supply next line

MATZ1, atomic number of first element

...

MATZn, atomic number of last element (n=MAT on first line)
```

```
========================================
Text (2a4) if NBLD >=10 on previous line
========================================

MATGP, buildup material, values

BERY,BORO,CARB,NITR,OXYG,SODI,MAGN,ALUM,SILI,PHOS,SULP,ARGO

 POTA,CALC,IRON,COPP,MOLY,LEAD,URAN,WATE,AIR ,CONC

IGGP, exposure type, values

' ABS',' EXP'

=====================================================
decimal, 8E9.4, start new line for each composition
=====================================================

COMP11, element1 in composition 1

COMP21, element2 in composition 1

...

COMP(MAT,NCOMP), elementMAT in composition NCOMP

==============
decimal, 8e9.4
==============

EBAR, mean gamma energy by group

==============
decimal, 8e9.4
==============

GAMEN, gamma source energy spectrum, make consistent with ASO
```

==========
decimal, 8e9.4
==========

CONF, gamma flux to dose conversion, fluxes in MeV/cm^2

==========
decimal, 8e9.4
==========

FEABSG, gamm to heaging conversion

==========
character a12
==========

WIDTHT, title for total range, e.g. 0.1-10.0

character, 6a12

WIDTHG, similar title for each group

==========
character, 3a24
==========

UNITG, units of gamma flux (2 a12 fields, over/under)

UNITD, units of gamma dose

UNITH, units of gamma heating

==========
decimal, 8e9.4, only if NGINT>0, NGINT is number of sets
==========

WTG1, conversion for first group

...

WTGg, conversion for last group g

```
==============================================================
character, 3a24, titles for NGINT sets above, otherwise omit
==============================================================

UNITGI, 2 a12 fields to label first conversion set

...

=====================
Mixed, 3e9.4,2(i5,i4)
=====================

RRC

ZRC

PHIRC, first three are detector coorinates

NRCOPT, detector coordinate geometry (0,1,2)=(cyl,xyz,sph)

NGPF, ray print min

NGPL, ray print max

NGPI, ray print mod

if NRCOPT=-1, end of problem, start from beginning (title)
```

RADECS

RADECS prepares comparison tables, SIGMA/ADJOINT

****
RADECS prepares comparison tables for SIGMA and ADJONT calculations to simplify the evaulation of the different analysis methods.
****

****
Discussion
****

In progress.

REFERENCE

REFERENCE prepares annotated SIGMA output tables.

****
REFERENCE reads data files documenting part/packaging and combines these data with calculated radiation levels from SIGMA.
****

****
Discussion
****

In progress.

REGION

REGION models regions by listing surfaces.

****
The REGION processor is used to described regions by listing bounding surfaces. The bounding surfaces can be any surfaces generated by other geometry input procedures or surfaces entered using SURFACE
****

****
Input Data Record Description:
****

==========
Header line
==========

Contains *REG in columns 1 through 4.

=======
Options
=======

A, signed body list, no point in region usage

F, fixed format data from previous novice run

O, overlap option, see OVERLAP appendix

J, compatibility with formats used in older code versions

****
Data Record Description:
****

Repeat as needed

==========
Region Data each region and contains
==========

I M RHO X Y Z L/
-

where

I is the region index

M is the material index

RHO is the region density, gm/cc, or a density scale factor if flagged minus

X,Y,Z, cm, are the coordinates of any point in the region

L is a list of the surfaces bounding the region. If a surface -
index is entered unsigned, the surface is one entered using SURFACE input and the surface index is that assigned by the user and may differ from that assigned by the code. If a surface index is entered flagged minus, the index is that assigned by the code to the surface however generated.

****
Discussion
****

The figures presented here were generated using the Computerized Anatomical Man (CAM) Model developed by McDonnell Douglas for NASA. The CAM model is described using Surface/Region inputs and contains more than 2000 non-void regions.

++++++++++++++
Output Figures
++++++++++++++

Figure 102 (REGZXV) is a ZX cross section through this model.

Figure 103 (REGYZV) shows a YZ cross section through the model.

Figure 104 (REGXYV) shows a XY cross section of the CAM model.

A projected view of the model is shown in Figure 105 (REGPRO).

A projection with cutout is given in Figure 106 (REGCUT).

A closeup of the head and shoulders are show in Figure 107 (REGHEA).

Figure 102: (REGZXV) ZX View of Camera Man Model

Figure 103: (REGYZV) YZ View of Camera Man Model

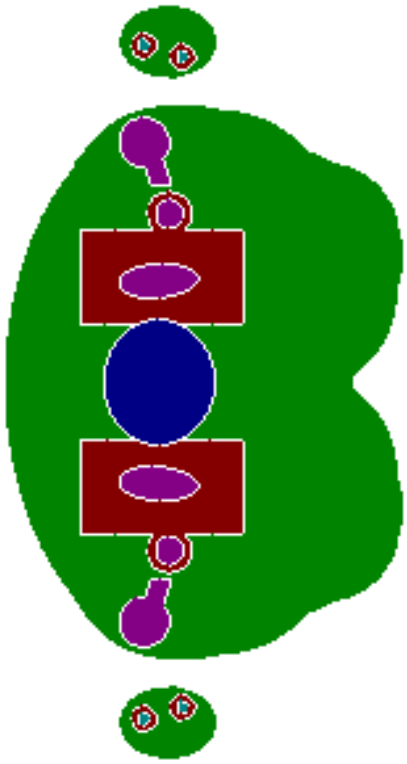


Figure 104: (REGXYV) XY View of Camera Man Model

Figure 105: (REGPRO) Projected View of Man Model

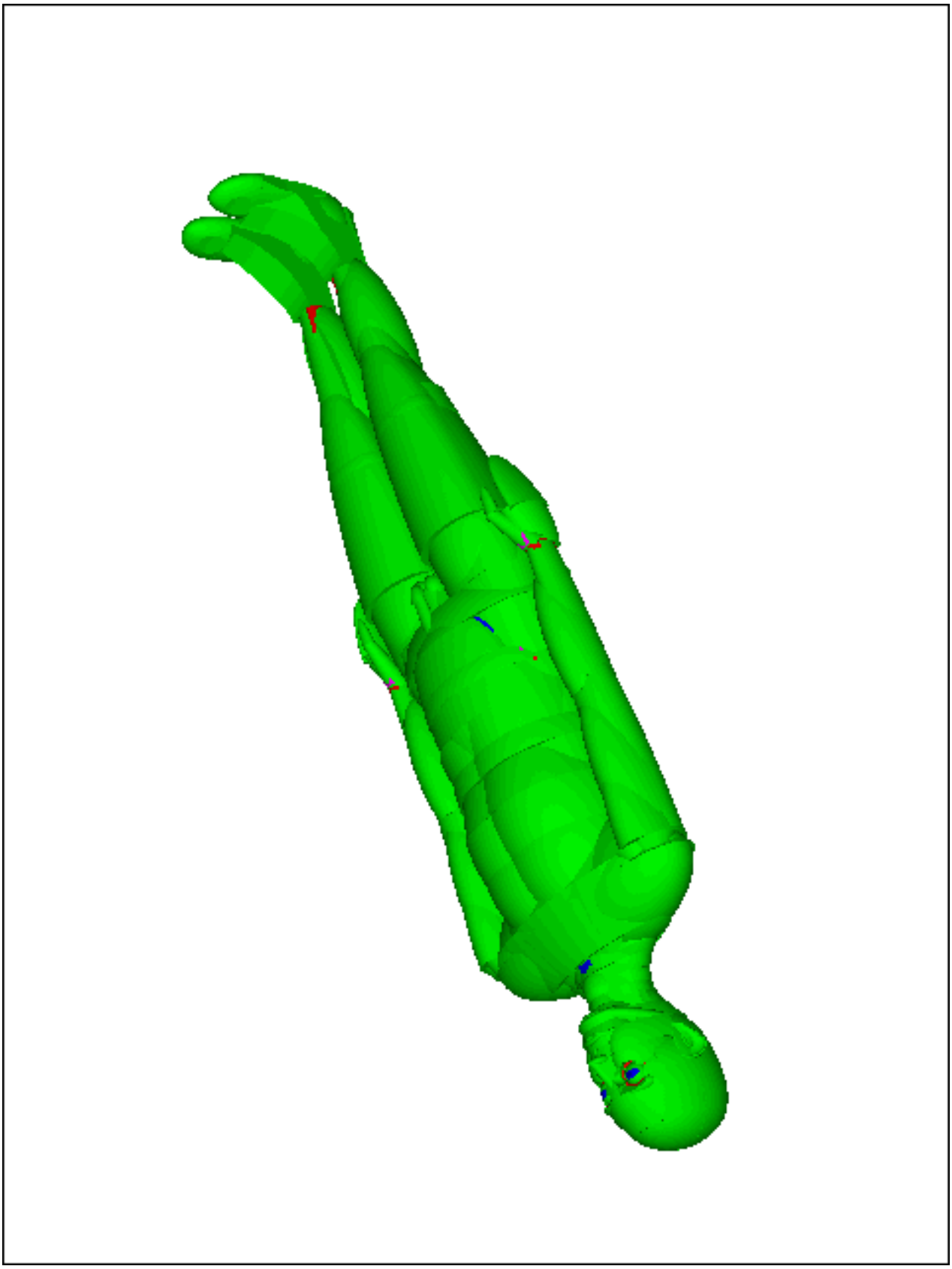


Figure 106: (REGCUT) Cutaway View of Man Model

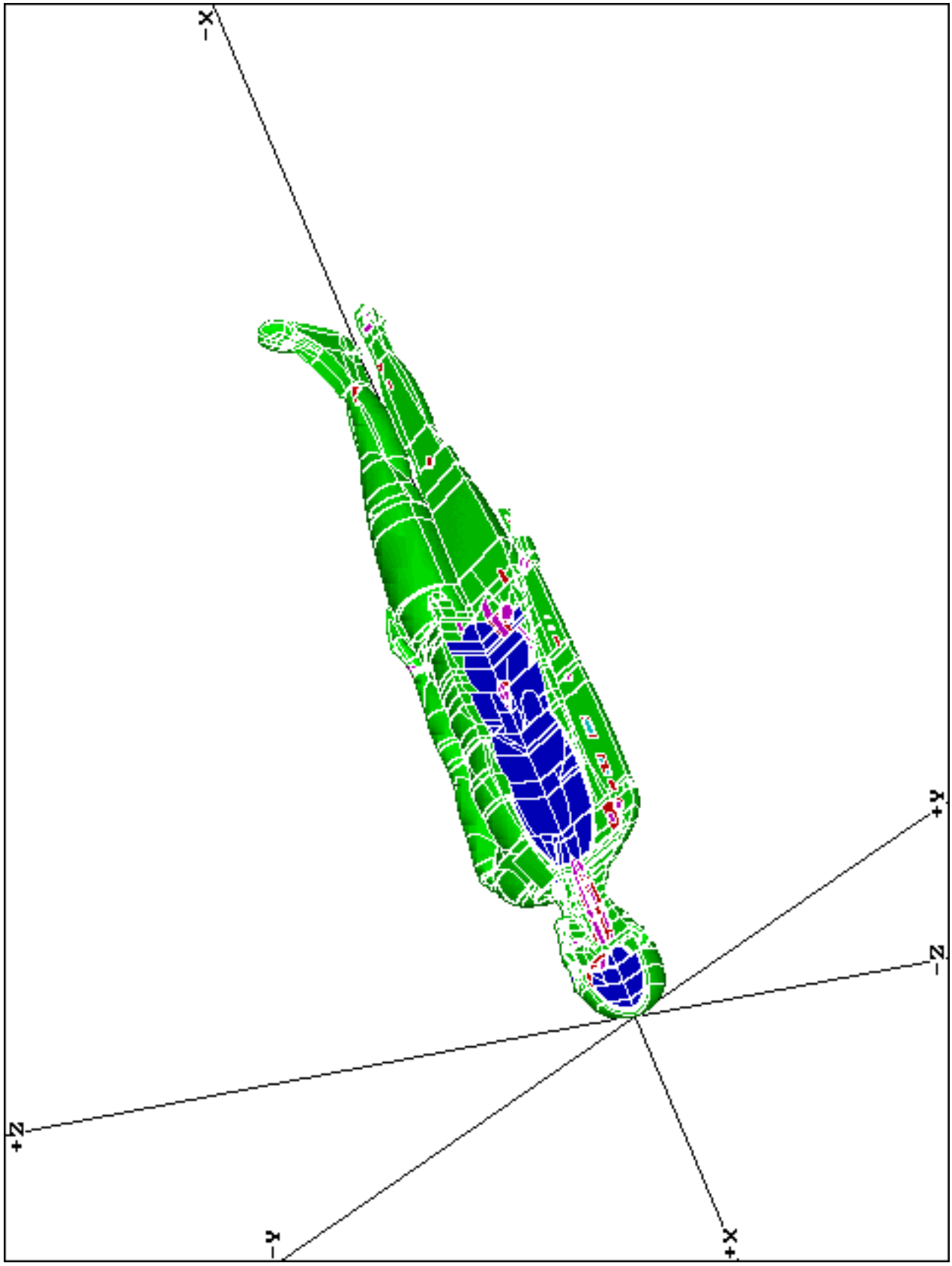
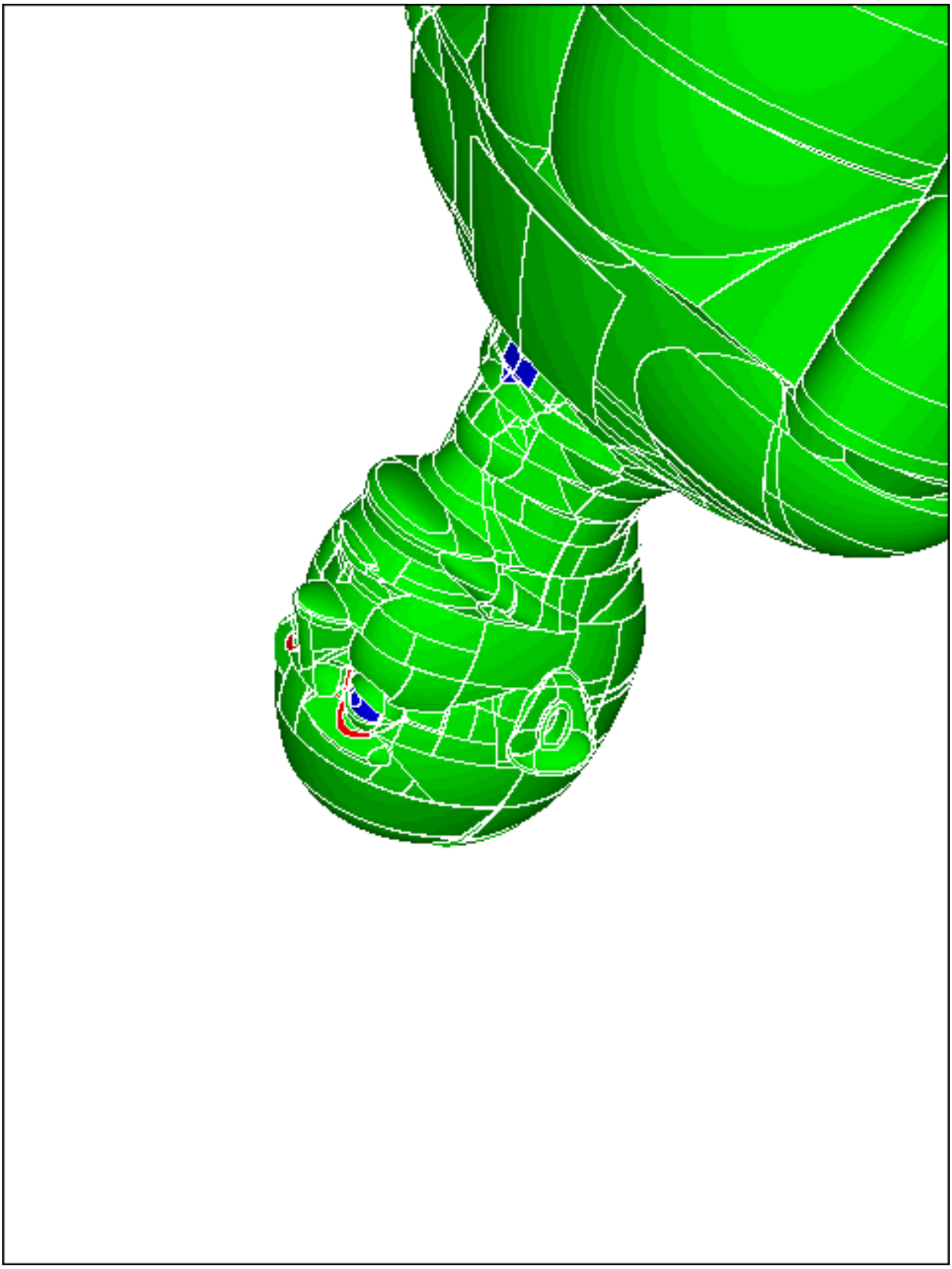


Figure 107: (REGHEA) Closeup of Man Model Head



REPAIR

*REPAIR, options/ invoke REPAIR processor

=======
Options
=======

n (transformation) name of base transformation for the step file

r repair regions

s repair surfaces

c repair data from external file

&get CAD.DES

RESPONSE

RESPONSE describes user supplied response functions.

****
This input processor provides user tabulation of response functions.
****

****
Input Data Record Description:
****

==========
Header line
==========

Contains *RES in columns 1 through 4.

=======
Options
=======

None.

****
Data Record Description:
****

Repeat as needed, the following data:

==========
Response Parameters
==========

'NAME' Z A ISP R /

The NAME is truncated to 12 characters, Z and A are the particle identifier as given in Table 1, ISP less than 0 indicates a builtin response, and R is a multiplicative scale factor.

Tabulation Energies (ISP=0 or TAB, paired with next)

Energies in MeV or Mev/amu.

Tabulated Response (ISP=0 or Tab, paired with previous)

Response at tabulation energies.

When ISP is O (or TAB), the two records

$,E_-/,F_-/$ or $,/,E_1\ F_1\ E_2\ F_2\ .../$ are supplied. If the response is tabulated with the E_- and F_- data vectors, power law interpolation is used to get values at the boundaries of the particle energy groups.

The builtin responses are

ISP=-1(EDAmage), 3 MeV equivalent damage for electrons as used by JPL

ISP=-2(ERAd) electrons as used by JPL

ISP=-3(PDAmage), 20 MeV equivalent damage for protons as used by JPL

ISP=-4(PRAd), rad(silicon) for protons as used by JPL

ISP=-5(DLC), data from file. Expanded data on the 'name' line is 'name' Z A ISP R NOT MT LREC MINX MAXX MODX/ where NOT is not used(input a zero), MT is the logical designation of a formatted file, LREC is the first record to read from that file, MINX is the first piece of data from that file, MAXX is the last datum, and MODX is the skip factor. This process will read information from DLC multigroup library files. (Not in 1997, thats an old one where a tape was hung on a specific logical unit. Need to change that to a file name. Actually it may work if the file name is entered using *FILE for unit MT.)

ISP=-6(REM), material responses other than rad. The expanded 'name' line input is 'name' Z A ISP R MTL LET/ where R is the scale factor (a factor of 1.602E-8/density for rads is built in) MTL is the material index, and LET=0 gives a rem response (quality factor between 1 and 20) while LET=1 gives a rem response with the quality factor extrapolated above 20. This following option only applies to charged particles.

ISP=-7 (LET), material response as a function of LET (linear energy transfer). The expanded 'name' line input is

'name' Z A ISP R MTL ID XA/

where Z and A identify the particle (or the particle name can be input), ISP is either -7 or the acronym 'LET', R is a multiplier for the response, MTL is the index or name of the material whose LET determines the response, ID is either 0 or 1 and determines if the tabulated response is used directly(0) or corrected(1) for isotropic incidence on a planar geometry where response is related to deposited energy rather than LET, and XA is the minimum ratio of thickness to slant path length if the isotropic incidence conversion is being applied.

ISP=-8 (KNO), material response is density of electron knock-on atoms. The expanded 'name' line input is:

'name' electron ISP S MTL/

where the response only applies to electrons, ISP is the word KNOck of the number -8, S is a scale factor, and M is the material name or index (all materials are equivalent since the process applies to orbital electrons only). Using 1 1 for S and M means the density of knockons is obtained for material 1. The density for other materials can then be scaled by multiplying by the electron density of that material divided by the electron density of material 1. The electron densities are listed in the material composition tables right after the *EXE line.

ISP=-8 (BEN) or ISP=-9 (B2P), Bendel model for proton upsets, either one parameter (BEN) or two parameter (B2P). The expanded 'name' data line is:

```
'name' proton   ISP  S MTL  EMIN EMAX APARM BPARM .../
```

for an energy response or, for a LET response

```
'name' proton   ISP  S MTL  ID   XA  APARM  BPARM .../
```

where ISP is -8, -9, BEN, or B2P; S is a multiplier, material is is a numeric zero or the word VOID if the response is for energy, or a material name or index if a response for LET, EMIN and EMAX are energy limits for an energy response; if a LET response, then ID and XA select usual or effective LET and XA is the minimum ratio of thickness to slant thickness; APARM is the first parameter, BPARM the second ...

Additional options, original equation is (E is energy or LET):

$$(24/a)^{14}\ 1.e\text{-}12 *\{1-\exp[-.18*\mathrm{sqrt}(\mathrm{sqrt}(18/a)*(E-a))]\}^{4}$$

Rewrite as

$$(b/a)^{L}\ c *\{1-\exp[-d*\mathrm{sqrt}(\mathrm{sqrt}(e/a)*(E-a))]\}^{M}$$

then data are (a=aparm, b=bparm):

a, b, M, L, c, d, and e, where L and M can be decimal values.

ISP=-10 (WEI), Weibel distribution. The expanded 'name' data line for an energy response is:

```
'name' proton   ISP S MTL EMIN EMAX WA WB WC WD/
```

and for a LET response:

'name' proton ISP S MTL ID XA WA WB WC WD/ where the response is evaluated as

WB * [1. - exp{-((E - WA)/WC) }] and E is an energy if MTL is a numeric 0 or the word void, or a LET if MTL is the name or index of a material.

ROTATE

ROTATE calculates coordinate transformation matrices.

****
The ROTATE processor moves geometry to its desired position in the total mockup. The commands precede the geometry data they apply to.
****

****
Input Data Record Description:
****

==========
Header line
==========

Contains *ROT in columns 1 through 4.

=======
Options
=======

D, if present, dump old,mod,new matrices

G, if present, some combination of global transforms embedded

I, if absent, the input modifies the current rotate/translate matrix

I, present or I=0, the matrix is initialized to do nothing prior to inputs

I=i, initialize the matrix to the ith saved matrix
--

I=-i, initialize the matrix to the inverse of the ith saved
--
matrix

L, if present, transformation is given in local coordinate system.

N, (alpha) name of geometric transformation

U, (alpha) name of -x axis (default -x)

V, (alpha)

W, (alpha)

X, (aplha) name for +x axis (defaut +x axis)

Y, (aplha) name for +y axis (defaut +y axis)

Z, (aplha) name for +z axis (defaut +z axis)

L=1, same as L except final rotate is saved in temporary storage which has room for 20 levels of local rotate.

L=-1, decrement the number of local rotates in temporary storage and reload the rotation matrix for the decremented layer.

****
Data Record Description:
****

Repeat the follow line as needed.

==========
Operation Input
==========

Input the data records in the same way the geometry is to be moved.

To translate, input:

,0 x y z / x,y,z are added to subsequent geometry inputs

To rotate x to y by Theta degrees (negative angles are okay) around x,y,z the input is:

,1 x y z Theta /

To rotate y to z by Theta, around x,y,z the input is:

,2 x y z Theta /

To rotate z to x by Theta, around xyz supply:

,3 x y z Theta /

To reflect coordinates in the plane through x y z with normal along x-u,y-v,z-w, input:

,-1 x y z u v w /

The final matrix is saved if it is unique and EXECUTE has not been input.

The options above can also be invoked with the words

TRAnslate, XYRotate, YZRotate, ZXRotate, and REFlect.

After invoking the *ROTATE processor, a short table is written to indicate the current rotation/translation in effect. This table indicates the internal coordinates for the users origin and x, y, and z-axes. The table also gives user coordinates for the code internal origin, x, y, and z-axes.

The options L=+1 and L=-1 allow the user to store rotation data with objects. The data can then be retrieved as:

```
    &get local_part
```

where local_part is a data set of the form

```
    *Rotate,L=1/ define a local transformation

     ... data defining transformation

    *Design,O=3/

     ... data defining geometry

    *Rotate,L=-1/ decrement local rotate

     ... no data following *Rotate,L=-1/
```

In addition, the input sections between *Rot,L=1 and *Rot,L=-1 can include retrieval or definition of other data bracked by another set of *Rot,L=1 and *Rot,L=-1, etc., up to 20 levels.

The numbers following L= must be non zero and are not used otherwise. The L=1 (or L=+1) indicates the beginning of another level of local transformation, while the L=-1 indicates the end of that level.

++++++++++++
Output Tables
++++++++++++

The output from the rotate commands is given in Table 89 (ROTINP).

Table 90 (ROTPRT) is the beginning of a sample problem that illustrates the use of the *ROT,L=1 and *ROT,L=-1 options.

This table describes a single object.

Table 91 (ROTLIN) is a data set with multiple references to Table 90 (ROTPRT).

Table 92 (ROTSID) is a data set with multiple references to Table 91 (ROTLIN).

Table 93 (ROTBRD) is a data set with multiple references to Table 92 (ROTSID).

Table 94 (ROTBOX) is a data set with multiple references to Table 93 (ROTBRD).

Table 95 (ROTSHO) is a data set that references Table 94 (ROTBOX).

++++++++++++++
Output Figures
++++++++++++++

Figure 108 (ROTPIC) shows the box, board, and part geometry generated using the above data sets.

The following figures demonstate the effect of the movement operations. For all five figures, three bodies were first defined; a cylinder on the x-axis, a cone on the y-axis, and a box on the z-axis. A single *ROTATE operation was then defined followed by a dupliction of the three bodies.

Figure 109 (ROTTRA) gives the effect of a translation.

Figure 110 (ROTXYZ) is a XY rotation around Z.

Figure 111 (ROTYZX) is a YZ rotation around X.

Figure 112 (ROTZXY) is a ZX rotation around Y.

Figure 113 (ROTREF) shows a reflection in a plane along (1,1,1).

Figure 108: (ROTPIC) Sample Problem Picture

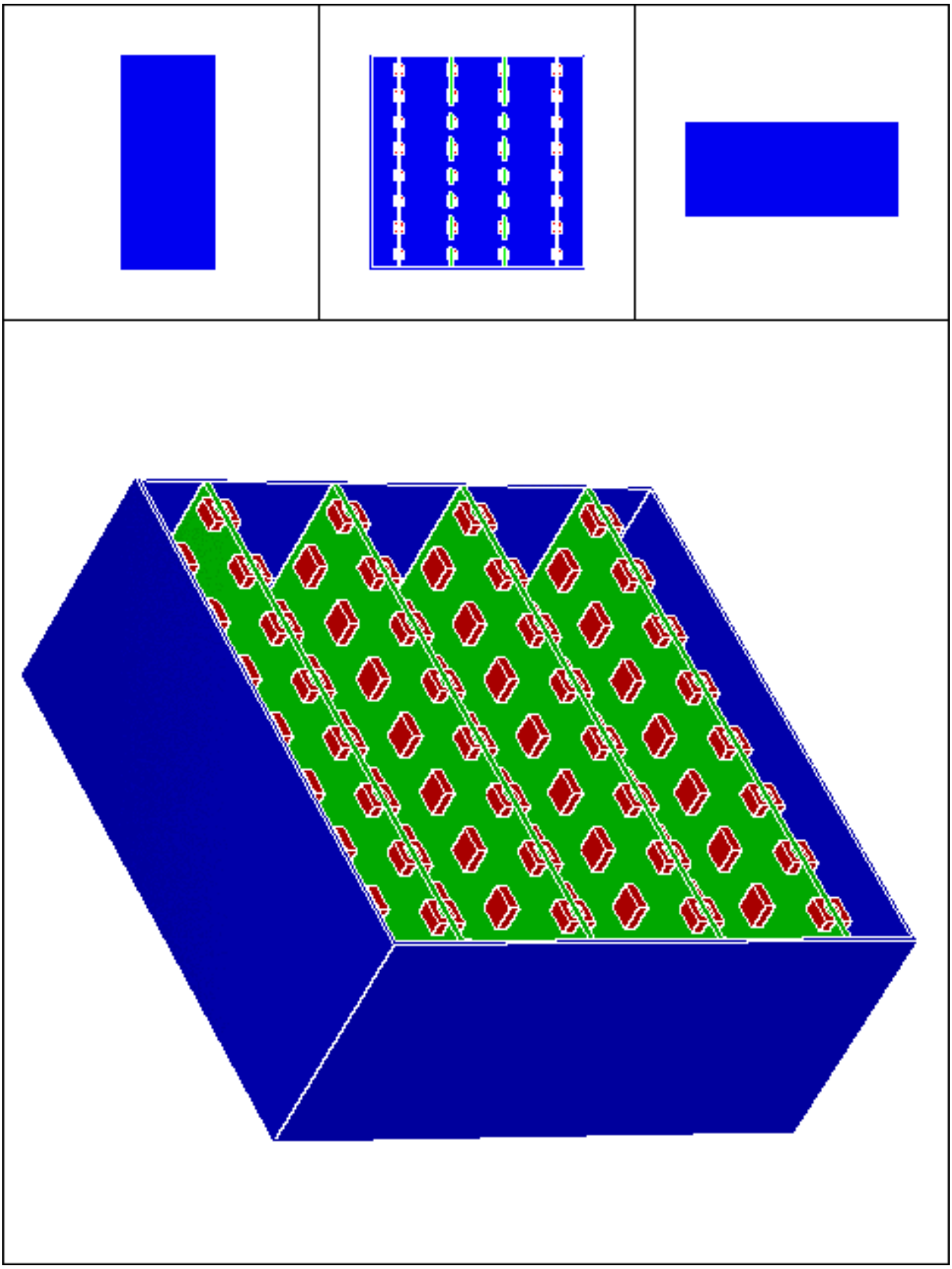


Figure 109: (ROTTRA) Translate Operation

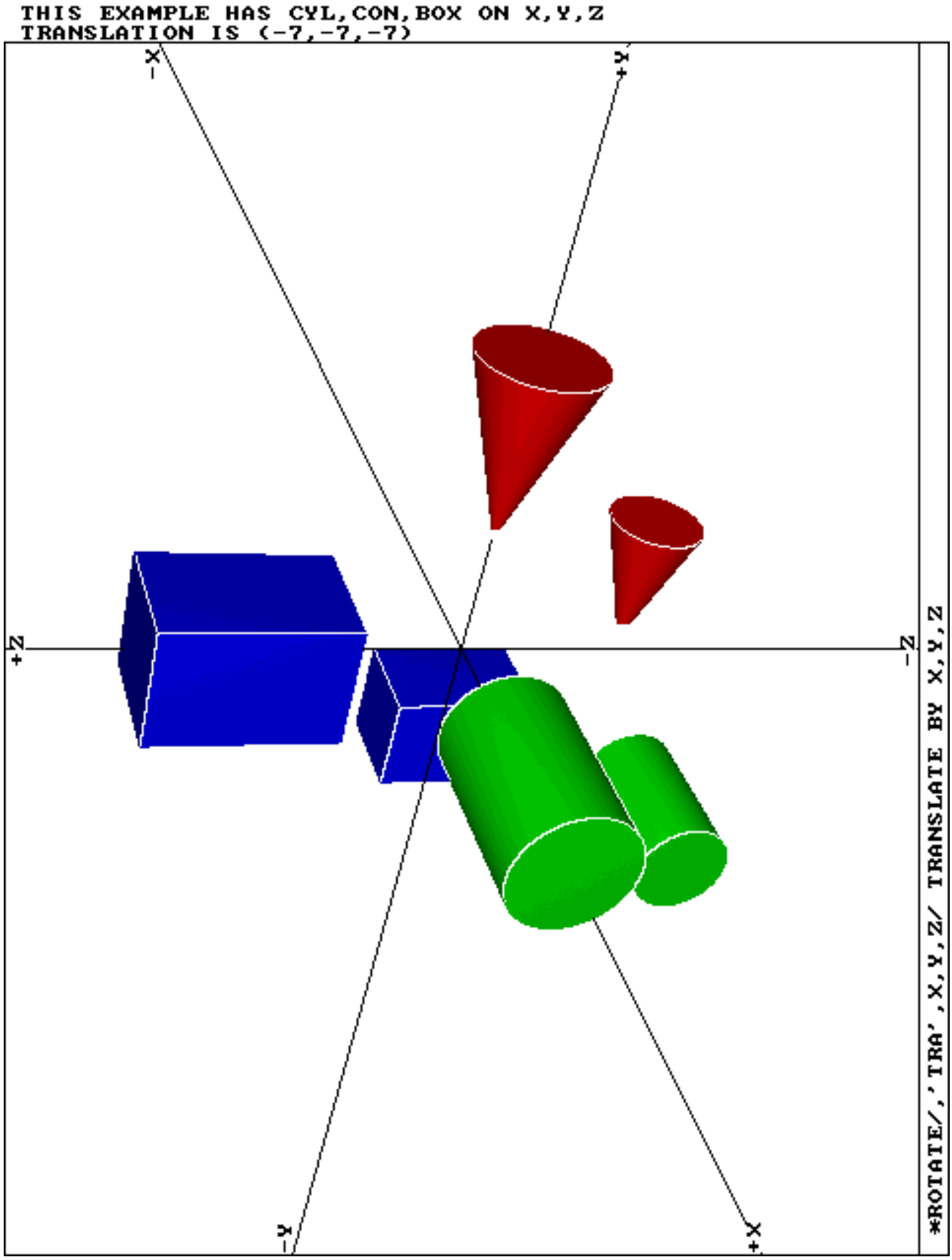


Figure 110: (ROTXYZ) X to Y Rotate Around Z Axis

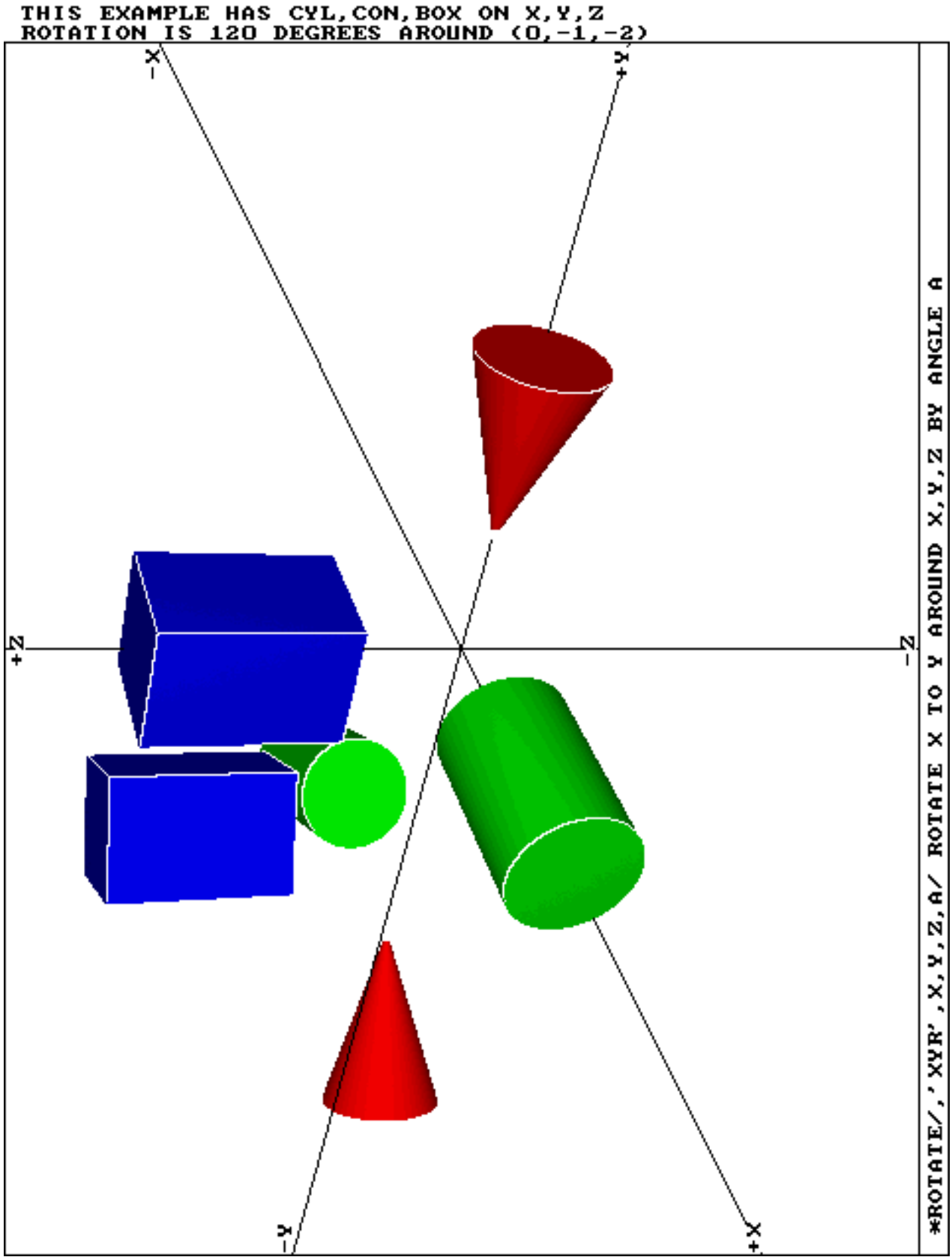


Figure 111: (ROTYZX) Y to Z Rotate Around X Axis

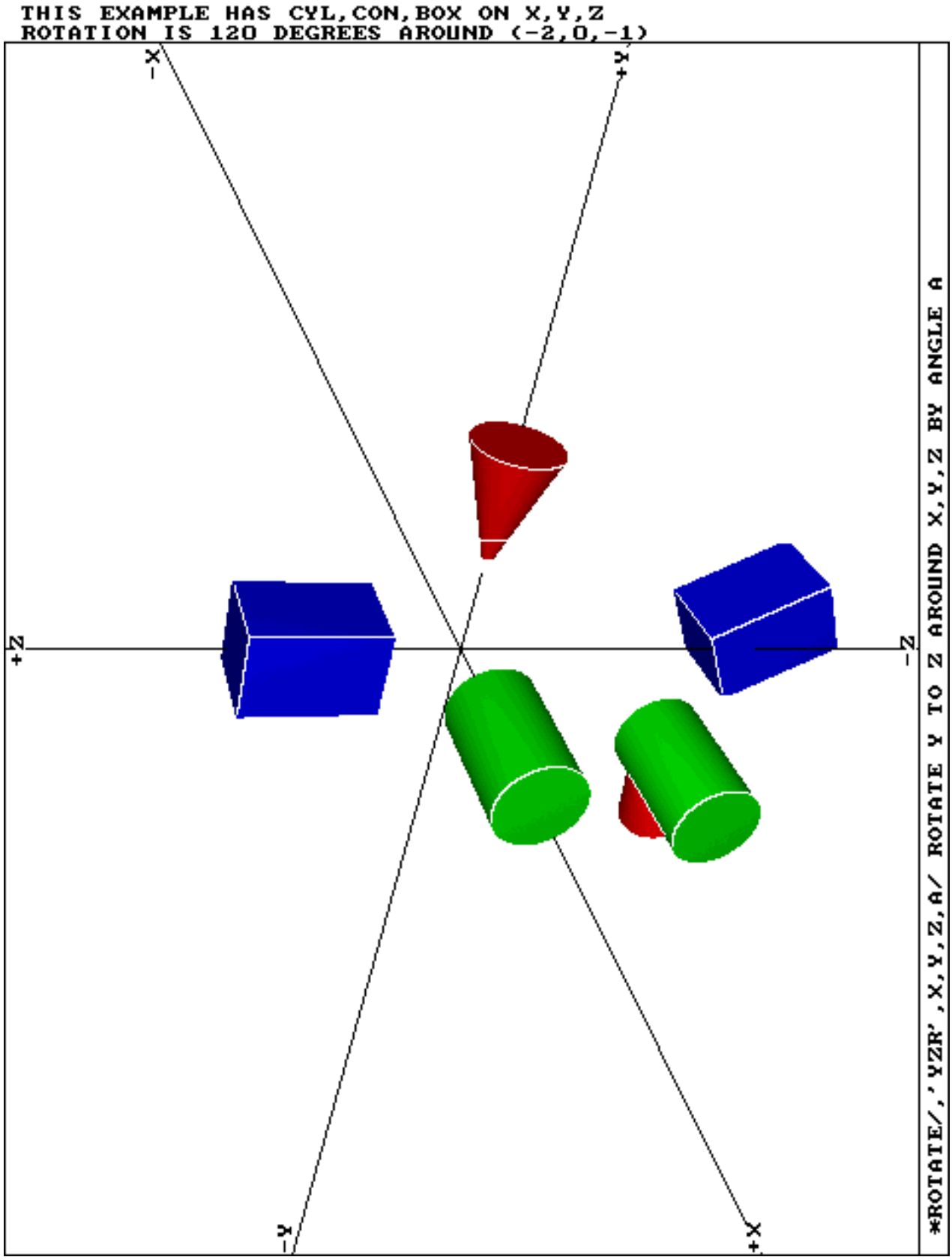


Figure 112: (ROTZXY) Z to X Rotate Around Y Axis

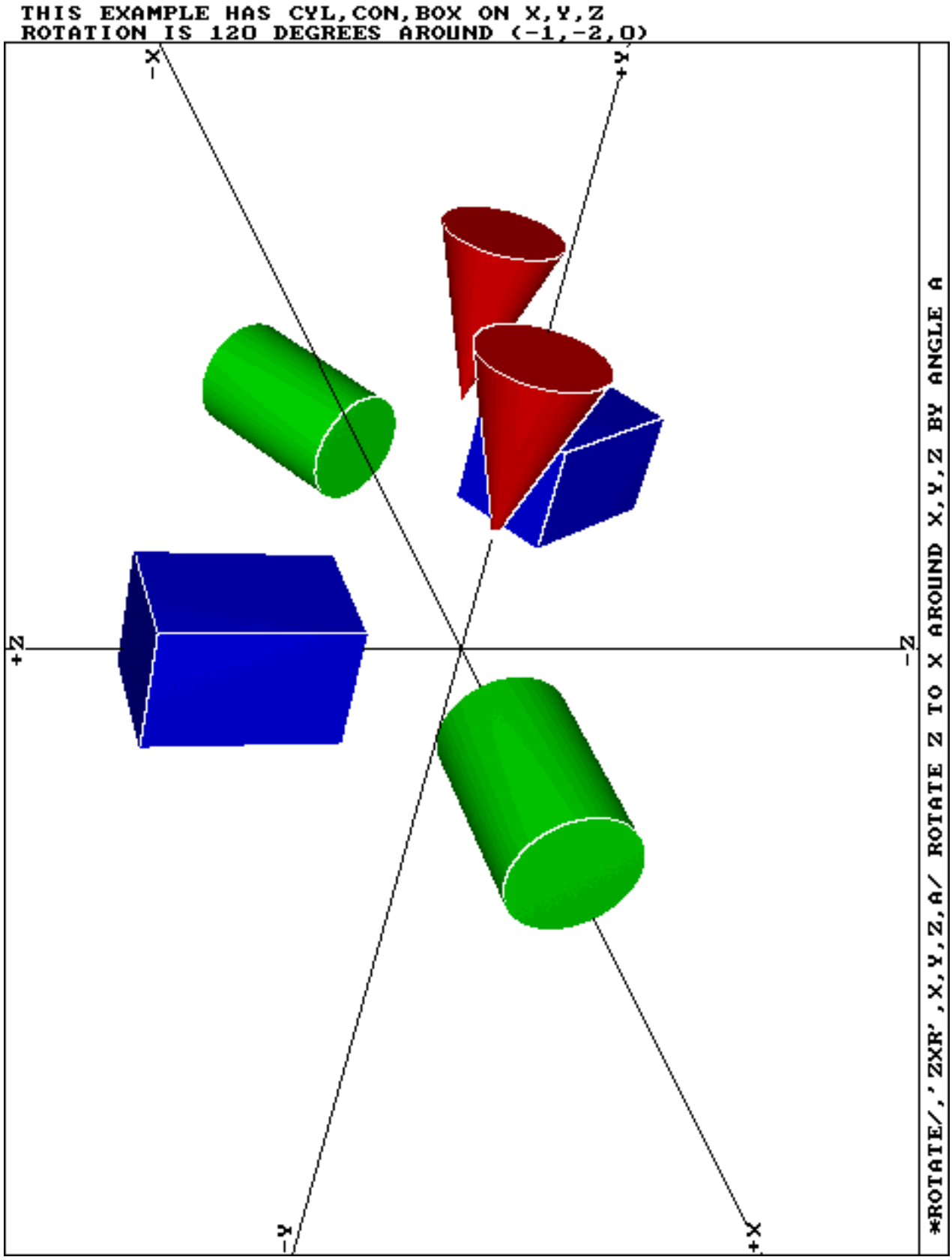


Figure 113: (ROTREF) Reflection in Plane

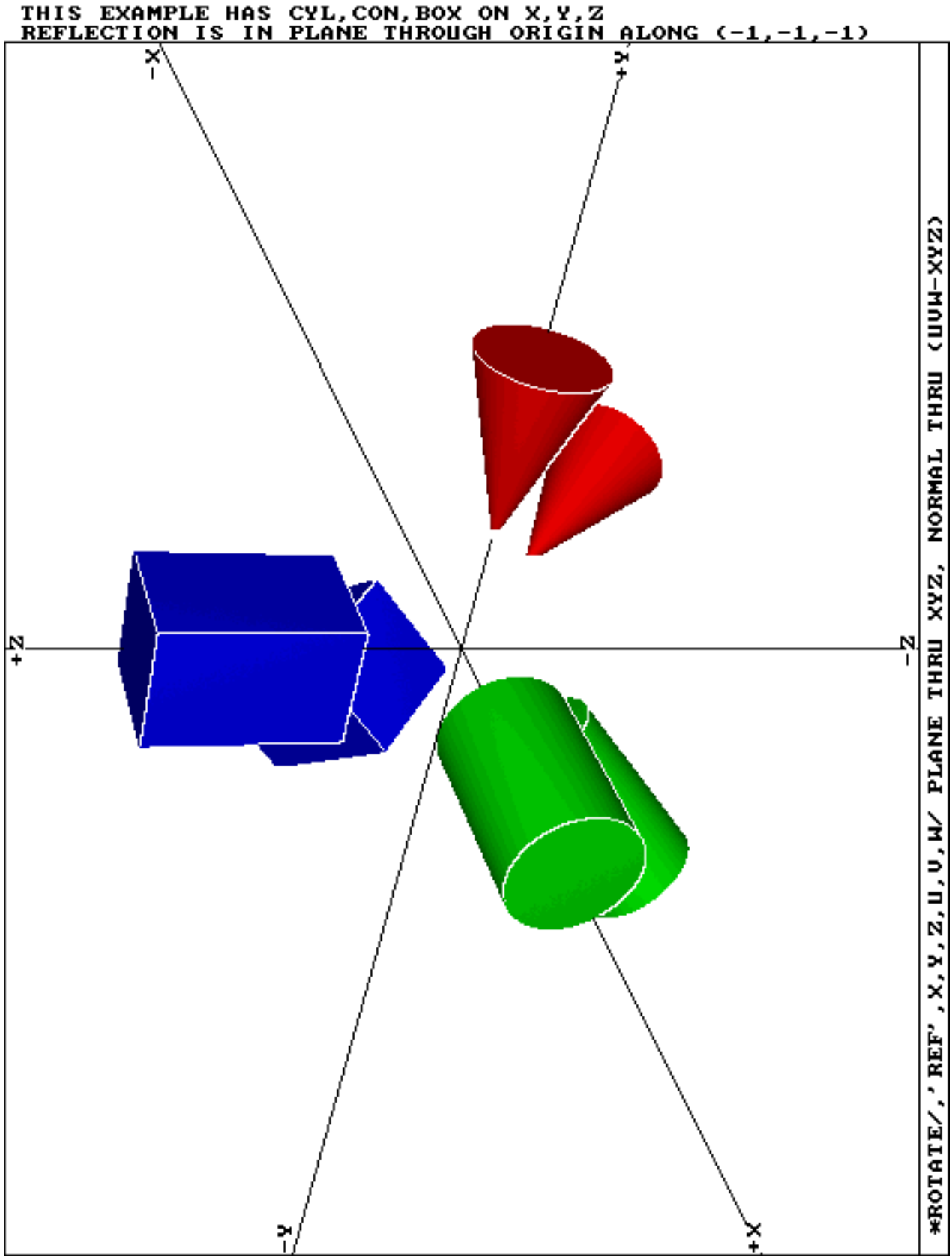


Table 89: (ROTINP) Rotate Output Table

```
--------------------------------------------------------------------------------
                  1         2         3         4         5         6         7
         12345678901234567890123456789012345678901234567890123456789012345678901234567890
INPUT *HEADER,OPTIONS/
Line  66:*ROTATE,I=0/,-1 0 0 0 0 1 0/ REFLECT IN Y
INPUT TYPE,X,Y,Z, ETC
         DATA INTERPRETATION STARTING AT COLUMN 13 OF LINE   66
Line  67:*END
              *END OR HEADER LINE TERMINATED INPUT
              *INFO*INFO*INFO*INFO*INFO*INFO*INFO*INFO*INFO*INFO*INFO*

            CODE EQUIVALENT OF USER DATA          USER EQUIVALENT OF CODE DATA
      U O:  0.00E+00  0.00E+00  0.00E+00    C O:  0.00E+00  0.00E+00  0.00E+00
      U+X:  1.000000   .000000   .000000    C+X:  1.000000   .000000   .000000
      U+Y:   .000000 -1.000000   .000000    C+Y:   .000000 -1.000000   .000000
      U+Z:   .000000   .000000  1.000000    C+Z:   .000000   .000000  1.000000
                  1 = INDEX OF SAVED COORDINATE TRANSFORMATION
--------------------------------------------------------------------------------
  15=SUR   3=BOD   3=REG   5=MAT   1=SOU   0=DET   0=PAR   1=SPE   0=RES  0=ERR
--------------------------------------------------------------------------------
```

Table 90: (ROTPRT) PART Data Set

Table 91: (ROTLIN) LINE Data Set

```
*rot,l=1/  line get part 1
translate .5 0 0/
&get part
*rot,l=-1/ line end part 1
*rot,l=1/  line get part 2
translate 1.5 0 0/
&get part
*rot,l=-1/ line end part 2
*rot,l=1/  line get part 3
translate 2.5 0 0/
&get part
*rot,l=-1/ line end part 3
*rot,l=1/  line get part 4
translate 3.5 0 0/
&get part
*rot,l=-1/ line end part 4
*rot,l=1/  line get part 5
translate 4.5 0 0/
&get part
*rot,l=-1/ line end part 5
*rot,l=1/  line get part 6
translate 5.5 0 0/
&get part
*rot,l=-1/ line end part 6
*rot,l=1/  line get part 7
translate 6.5 0 0/
&get part
*rot,l=-1/ line end part 7
*rot,l=1/  line get part 8
translate 7.5 0 0/
&get part
*rot,l=-1/ line end part 8
```

Table 92: (ROTSID) SIDE Data Set

Table 93: (ROTBRD) BOARD Data Set

```
*rot,l=1/  board get side 1
translate 0 0 .05/
&get side
*rot,l=-1/ board end side 1
*rot,l=1/  board get side 2
yzrotate 0 0 0 180/
translate 0 0  .05/
&get side
*rot,l=-1/ board end side 2
*design,o=3/
1 silicon 2.33 box 0 8 -2 2 -.05 .05/
```

Table 94: (ROTBOX) BOX Data Set

Table 95: (ROTSHO) Sample Problem Data

```
*materials
aluminum 2.7 13 0 1/
silicon  2.3 14 0 1/
kovar    7.95 26 0 1/ approximated by iron
&get box
c
c the BOX data set first defines four boards
c and then defines a box containing the boards
c
c a BOARD is defined by describing two sides of parts
c and then the board between the two sides of parts is defined
c
c a SIDE of a board is defined by four lines of components
c
c each LINE of components is defined by eight parts
c
c the PART consists of an interior void and a kovar cover.
c
*exe
*pic,g=257,q=2,l=test,c,r=4,s=4/
4 0 0 100 100 100 6/
-100 100 1.5 100 -100 100/,/ cutoff +y side through middle of line
*stop
```

SAVE

SAVE saves input data in binary format before *EXE.

****
The SAVE processor has the code save a restart file containing input data and data base arrays. The restart file is used by a subsequent run when the *START line is seen.
****

****
Input Data Record Description:
****

======
Header
======

Contains *SAV in columns 1 through 4.

=======
Options
=======

No options apply.

****
Data Record Description:
****

There are no other data records.

SCORING

SCORING scores forward on DETECTOR, adjoint on SOURCE

****
This section discusses new scoring capabilities added to BETA and ADJOINT. The scoring uses mesh data entered with the SOURCE and DETECTOR processors
****

****
Discussion
****

In progress.

SECTOR

SECTOR interfaces with the AFWL SECTOR code.

****
The SECTOR processor describes the conversion of SECTOR input to NOVICE input.
****

****
Discussion
****

In progress.

SELTZER

SELTZER discusses access to SHIELDOSE.

****
The SELTZER processor accesses SHIELDOSE and SHIELDOSE2 from within NOVICE.
****

****
Input Data Description
****

==========
Header Line
==========

Must contain *SEL in columns 1 through 4.

=======
Options
=======

D, if present, run DOSCON after SHIELDOSE 2

E, (spectrum,,,) name of trapped electron spectrum

F, (spectrum,,,) name of solar flare spectrum

N, (alpha) name of input data file

P, (spectrum,,,) name of trapped protom spectrum

R, if present, dose function (default=3=silicon)

S, (alpha) name of the sigma output file

T, if present, input thicknesses (1,2,3=mils,g/sqcm,mm)

V, if present and V=2 the SHIELDOSE-2 is run. The default is to run the original version.

****
Data Record Descriptions
****

==========
Inner Shell Radii
==========

r1 r2 ... rn/

Supply this line if V=2 and the D option is present.

++++++++++++
Input Tables
++++++++++++

Table 96 (SELTZE) is an example of an input file for either the original or revised versions of SHIELDOSE. This particular file was generated by a SOFIP calculation. Note the expanded information on the first line. Also note the expanded information just after the title line. This expanded line controls the used of either differential or integral spectra and the restriction of spectrum extrapolation. (needs additional writeup.)

Table 96: (SELTZE) Sample SHIELDOSE Input Data

```
    3    11     2     0     0     0     2
   24     1
    5.00000    10.00000    20.00000    30.00000    40.00000    50.00000
   60.00000    80.00000   100.00000   150.00000   200.00000   250.00000
  300.00000   400.00000   500.00000   600.00000   750.00000  1000.00000
 1500.00000  2000.00000  2500.00000  3000.00000  4000.00000  5000.00000
    2.000  1000.000     2.000  1000.000   301     0.100     7.000   101
solar max  orbit,inclination(deg),perigee(km),apogee(km)  0 35786 35786
   20    16    26  1.0000E+00  3.1558E+07     0     0     0     0     0     0
 1.0000E+01  2.0000E+01  3.0000E+01  4.0000E+01  5.0000E+01  6.0000E+01
 7.0000E+01  8.0000E+01  9.0000E+01  1.0000E+02  1.1000E+02  1.2000E+02
 1.3000E+02  1.4000E+02  1.5000E+02  1.6000E+02  1.7000E+02  1.8000E+02
 1.9000E+02  2.0000E+02
 6.3409E+08  4.3478E+08  2.9811E+08  2.0441E+08  1.4016E+08  9.6101E+07
 6.5894E+07  4.5181E+07  3.0979E+07  2.1242E+07  1.4565E+07  9.9866E+06
 6.8475E+06  4.6952E+06  3.2193E+06  2.2074E+06  1.5135E+06  1.0378E+06
 7.1158E+05  4.8791E+05
 1.0000E-02  3.0000E-02  5.0000E-02  7.0000E-02  1.0000E-01  2.0000E-01
 3.0000E-01  4.0000E-01  5.0000E-01  6.0000E-01  7.0000E-01  8.0000E-01
 9.0000E-01  1.0000E+00  1.2500E+00  1.5000E+00
 4.5191E+08  3.3546E+08  2.4916E+08  1.8482E+08  1.1594E+08  2.4835E+07
 7.1686E+06  2.6253E+06  1.0370E+06  4.1324E+05  1.6345E+05  6.4385E+04
 2.5322E+04  9.9581E+03  9.6578E+02  9.3663E+01
 1.0000E-01  2.0000E-01  3.0000E-01  4.0000E-01  5.0000E-01  6.0000E-01
 7.0000E-01  8.0000E-01  9.0000E-01  1.0000E+00  1.2500E+00  1.5000E+00
 1.7500E+00  2.0000E+00  2.2500E+00  2.5000E+00  2.7500E+00  3.0000E+00
 3.2500E+00  3.5000E+00  3.7500E+00  4.0000E+00  4.2500E+00  4.5000E+00
 4.7500E+00  5.0000E+00
 2.1861E+08  1.0309E+08  5.0506E+07  2.5797E+07  1.3662E+07  7.8952E+06
 5.0790E+06  3.4554E+06  2.3450E+06  1.5573E+06  6.6311E+05  3.0988E+05
 1.6500E+05  9.5316E+04  5.1732E+04  2.5971E+04  1.3303E+04  7.3374E+03
 4.6206E+03  3.1828E+03  2.0078E+03  1.1558E+03  7.4432E+02  4.2289E+02
 1.3436E+02  2.9089E+01
```

SHIELD

SHIELD calculates transport by numerical integration.

****
The SHIELD analysis processor calculates electron, bremsstrahlung, or heavy charged particle transport in multilayer 1D shields. The spectrum exiting the last layer can optionally be used in a pulse height analysis.
****

****
Input Data Record Description:
****

==========
Header line
==========

Contains *SHI in columns 1 through 4.

=======
Options
=======

A=a, a is the cosine of the incident angle, if A is absent the incident particles have an angular dependence given by C

C=c, c is the power of the cosine dependence of the incident particle flux, C=O or absent gives isotropic flux.

E=e, e is the discrete energy incident (overides spectra list input later). Absence implies spectra in list.

F, if present, print detailed output

M, if present, calculate pulse height data at last layer (M=1, at all layers)

P, if present, punch response kernels for SIGMA

T, if present, shield thicknesses are running sum

W=w, normalization weight for discrete energy, angle options. default is 1.

X, apply approximate albedo correction for back scattered electrons

Z=z, atomic number of heavy charged particle. Absence implies electrons.

Z=-1 for photon to electron calculation

R, use slab fluxes in pulse height analysis

****
Data Record Description:
****

==========
Cosine boundaries of angular mesh
==========

```
,c c ... / e.g. ,0 1I9*.9 .95 .98 1 /
  1 2
```

==========
Materials for Layers (Paired input with next)
==========

A material index or name for each layer.

==========
Layer Thicknesses (Paired input with above)
==========
thickness for each layer.

The paired input can be supplied as:

```
,MTL/,T/ or ,/,MTL T MTL T ... / T in cm
   -  -           1 1   2 2       i
```

==========
Layer Subdivisions
==========

Input a number for each shield layer , e.g., 50 per cm.

```
,MAX MAX ... /
    1   2
```

==========
Source Spectra List
==========

```
,S S ... /
  1 2
```

If the M option was present, also supply the lines

==========
Single Event Integer Parameters (M option)
==========

```
,NCHRD NPOLAR NTHETA MPHD GPHD /
```

==========
Single Event Real Parameters (M option)
==========

```
,PMIN PMAX TMIN TMAX L1 L2 L3 /
```

==========
Energy Loss Channels (M option)
==========

,energy boundaries of pulse height channels, MeV or MeV/amu /

where

NCHRD, points in the chord length table, e.g., 100

NPOLAR, intervals in polar integration used to set up chord length table, e.g., 10. (more intervals should be used if the detector is relatively long in one or two dimensions)

NTHETA, intervals in azimuthal integration used to set up chord length table e.g., 10

MPHD, material index of the pulse height detector

GPHD, geometry of the pulse height detector, 0=rectangular, 1=cylindrical, 2=spherical.

PMIX PMAX, polar cosine integration limits, use, 0,1 for isotropic and c-d c+d for mono polar cosine c.

TMIN TMAX, radians, limits on the azimuthal integration, use 0 PI/2 for isotropic incidence, use 0-d, 0+d, for mono azimuth =0 (d is a small number)

L1 L2 L3 are the detector dimensions

x,y,z, dimensions if rectangular

radius, height,(L3 not used) if cylindrical

radius (L2 and L3 not used) if spherical

Note: SHIELD assumes the z axis is perpendicular to the material layers. In the pulse height analysis, polar cosines are measured from the -z axis and azimuth is measured around the z axis. The cylindrical detector axial dimension is along the z axis.

++++++++++++
Output Tables
++++++++++++

Table 97 (SHIINP) indicates outputs generated during the setup of a *SHIELD problem.

At the first layer, SHIELD list response functions as shown in Table 98 (SHIRES).

Table 99 (SHIFLX) indicates the format for group flux and cumulative response outputs.

The angular flux output format is indicated in Table 100 (SHIANG).

Shield summarizes response versus thickness at the end of the calculation with the format shown in Table 101 (SHISUM).

The summary data can also be saved in a file (PUNCH.DAT) with the format shown in Table 102 (SHIPUN).

Table 97: (SHIINP) Shield Input Stream

```
INPUT *HEADER,OPTIONS/
Line  11:*SHIELD,Z=1,FPT/

SHIELD-------------------------------------------------------------
INPUT COSINE BOUNDARIES OF ANGULAR INTERVALS
Line  12:0 .1 .2 .3 .4 .5 .6 .7 .8 .9 .95 .99 1/
INPUT MATERIAL AND THICKNESS PAIRS FOR SHIELD LAYERS
Line  13:8*1/,.25 .5 1 2 5 10 15 20/
INPUT SHIELD SUBDIVISIONS FOR TRANSPORT
Line  14:10/

UNIT   7 OPENED PUNCH.DAT
INPUT LIST OF SOURCE SPECTRA
Line  15:1/ SPECTRA

ENTER SPINER

ENTER SHIPOM

PLOT BUFFER SET

ANGULAR DATA SET
ENTER SHIELT
MTL,NSUBT,DELZ           1          10  2.5000E-01
FINISHED ELECTRON SETUP
FINISHED SECONDARY SOURCE SETUP
START SUB LAYER   1
START SUB LAYER   2
START SUB LAYER   3
START SUB LAYER   4
START SUB LAYER   5
START SUB LAYER   6
START SUB LAYER   7
START SUB LAYER   8
START SUB LAYER   9
START SUB LAYER  10
ENTER SHIELT
MTL,NSUBT,DELZ           1          10  2.5000E-01
FINISHED ELECTRON SETUP
FINISHED SECONDARY SOURCE SETUP
START SUB LAYER   1
:
```

Table 98: (SHIRES) Shield Response Listing

0.0000E+00 GM/SQCM, LAYER 0, AL FLARE, PROTON

LEVEL	ENERGY-MEV	ALUMINUM	SILICON	NUMBER FLUX	ENERGY FLUX
1	5.0119E+02	3.4977E-08	3.5990E-08	1.0000E+00	5.0119E+02
2	3.9811E+02	3.9260E-08	4.0372E-08	1.0000E+00	3.9811E+02
3	3.1623E+02	4.4088E-08	4.5309E-08	1.0000E+00	3.1623E+02
4	2.5119E+02	4.9509E-08	5.0849E-08	1.0000E+00	2.5119E+02
5	1.9953E+02	5.7485E-08	5.9022E-08	1.0000E+00	1.9953E+02
6	1.5849E+02	6.6794E-08	6.8557E-08	1.0000E+00	1.5849E+02
7	1.2589E+02	7.7609E-08	7.9633E-08	1.0000E+00	1.2589E+02
8	1.0000E+02	9.1524E-08	9.3865E-08	1.0000E+00	1.0000E+02
9	7.9433E+01	1.0895E-07	1.1169E-07	1.0000E+00	7.9433E+01
10	6.3096E+01	1.2969E-07	1.3290E-07	1.0000E+00	6.3096E+01
11	5.0119E+01	1.5439E-07	1.5813E-07	1.0000E+00	5.0119E+01
12	3.9811E+01	1.8493E-07	1.8929E-07	1.0000E+00	3.9811E+01
13	3.1623E+01	2.2154E-07	2.2661E-07	1.0000E+00	3.1623E+01
14	2.5119E+01	2.6539E-07	2.7129E-07	1.0000E+00	2.5119E+01
15	1.9953E+01	3.1790E-07	3.2470E-07	1.0000E+00	1.9953E+01
16	1.5849E+01	3.8080E-07	3.8863E-07	1.0000E+00	1.5849E+01
17	1.2589E+01	4.5615E-07	4.6515E-07	1.0000E+00	1.2589E+01
18	1.0000E+01	5.4502E-07	5.5527E-07	1.0000E+00	1.0000E+01
19	7.9433E+00	6.4845E-07	6.6000E-07	1.0000E+00	7.9433E+00
20	6.3096E+00	7.7150E-07	7.8449E-07	1.0000E+00	6.3096E+00
21	5.0119E+00	9.1790E-07	9.3246E-07	1.0000E+00	5.0119E+00
22	3.9811E+00	1.0835E-06	1.0988E-06	1.0000E+00	3.9811E+00
23	3.1623E+00	1.2789E-06	1.2947E-06	1.0000E+00	3.1623E+00
24	2.5119E+00	1.5095E-06	1.5255E-06	1.0000E+00	2.5119E+00
25	1.9953E+00	1.7589E-06	1.7767E-06	1.0000E+00	1.9953E+00
26	1.5849E+00	2.0490E-06	2.0688E-06	1.0000E+00	1.5849E+00
27	1.2589E+00	2.3869E-06	2.4088E-06	1.0000E+00	1.2589E+00
28	1.0000E+00	2.7469E-06	2.7557E-06	1.0000E+00	1.0000E+00
29	7.9433E-01	3.1183E-06	3.1352E-06	1.0000E+00	7.9433E-01
30	6.3096E-01	3.5400E-06	3.5669E-06	1.0000E+00	6.3096E-01
31	5.0119E-01	4.0187E-06	4.0580E-06	1.0000E+00	5.0119E-01
32	3.9811E-01	4.4121E-06	4.5427E-06	1.0000E+00	3.9811E-01
33	3.1623E-01	4.8423E-06	5.0843E-06	1.0000E+00	3.1623E-01
34	2.5119E-01	5.3145E-06	5.6905E-06	1.0000E+00	2.5119E-01
35	1.9953E-01	5.7064E-06	6.2169E-06	1.0000E+00	1.9953E-01
36	1.5849E-01	6.1243E-06	6.7884E-06	1.0000E+00	1.5849E-01
37	1.2589E-01	6.5728E-06	7.4125E-06	1.0000E+00	1.2589E-01
38	1.0000E-01	6.9000E-06	7.8917E-06	1.0000E+00	1.0000E-01
39	7.9433E-02	6.9904E-06	8.0845E-06	1.0000E+00	7.9433E-02

Table 99: (SHIFLX) Shield Flux Output

SLAB AND SPHERE SCALAR FLUXES

GROUP	E-UPR	AVE-E	FLUX	CURRENT	SPHERE	I-FLUX	I-CURRNT	I-SPHERE
1	5.01E+02	4.22E+02	1.65E-07	8.53E-08	3.41E-07	1.65E-07	8.53E-08	3.41E-07
2	3.98E+02	3.39E+02	3.42E-06	1.77E-06	7.07E-06	3.59E-06	1.85E-06	7.41E-06
3	3.16E+02	2.72E+02	3.70E-05	1.91E-05	7.65E-05	4.06E-05	2.10E-05	8.39E-05
4	2.51E+02	2.17E+02	2.39E-04	1.24E-04	4.95E-04	2.80E-04	1.45E-04	5.78E-04
5	2.00E+02	1.74E+02	1.02E-03	5.27E-04	2.11E-03	1.30E-03	6.72E-04	2.69E-03
6	1.58E+02	1.39E+02	3.12E-03	1.61E-03	6.44E-03	4.42E-03	2.28E-03	9.12E-03
7	1.26E+02	1.11E+02	7.26E-03	3.75E-03	1.50E-02	1.17E-02	6.03E-03	2.41E-02
8	1.00E+02	8.84E+01	1.36E-02	7.03E-03	2.81E-02	2.53E-02	1.31E-02	5.22E-02
9	7.94E+01	7.04E+01	2.14E-02	1.11E-02	4.43E-02	4.67E-02	2.41E-02	9.65E-02
10	6.31E+01	5.61E+01	2.94E-02	1.52E-02	6.07E-02	7.61E-02	3.93E-02	1.57E-01
11	5.01E+01	4.46E+01	3.61E-02	1.86E-02	7.45E-02	1.12E-01	5.79E-02	2.32E-01
12	3.98E+01	3.55E+01	4.05E-02	2.09E-02	8.37E-02	1.53E-01	7.89E-02	3.15E-01
:								
27	1.26E+00	1.13E+00	4.70E-03	2.43E-03	9.71E-03	4.84E-01	2.50E-01	1.00E+00

UNIT 22 OPENED FLUXES.DAT

CUMULATIVE RESPONSES

LEVEL	ENERGY-MEV	ALUMINUM	SILICON	NUMBER FLUX	ENERGY FLUX
1	3.9811E+02	1.3053E-14	1.3424E-14	3.4109E-07	1.4394E-04
2	3.1623E+02	3.1525E-13	3.2404E-13	7.4107E-06	2.5403E-03
3	2.5119E+02	3.9721E-12	4.0805E-12	8.3907E-05	2.3319E-02
4	1.9953E+02	3.1033E-11	3.1867E-11	5.7849E-04	1.3088E-01
5	1.5849E+02	1.6457E-10	1.6895E-10	2.6884E-03	4.9783E-01
6	1.2589E+02	6.3624E-10	6.5297E-10	9.1247E-03	1.3921E+00
7	1.0000E+02	1.9206E-09	1.9704E-09	2.4115E-02	3.0541E+00
8	7.9433E+01	4.7693E-09	4.8912E-09	5.2221E-02	5.5387E+00
9	6.3096E+01	1.0101E-08	1.0356E-08	9.6514E-02	8.6582E+00
10	5.0119E+01	1.8789E-08	1.9256E-08	1.5725E-01	1.2064E+01
11	3.9811E+01	3.1507E-08	3.2277E-08	2.3178E-01	1.5391E+01
12	3.1623E+01	4.8593E-08	4.9759E-08	3.1546E-01	1.8362E+01
13	2.5119E+01	6.9986E-08	7.1634E-08	4.0301E-01	2.0834E+01
14	1.9953E+01	9.5308E-08	9.7507E-08	4.8958E-01	2.2778E+01
15	1.5849E+01	1.2397E-07	1.2677E-07	5.7143E-01	2.4238E+01
16	1.2589E+01	1.5528E-07	1.5870E-07	6.4610E-01	2.5298E+01
:					
38	7.9433E-02	5.0202E-07	5.1018E-07	9.9999E-01	2.7553E+01
TOTALS					
SLAB FLUX RESPONSE		2.4305E-07	2.4700E-07	4.8414E-01	1.3340E+01
SLAB CURRENT RESPONSE		1.2551E-07	1.2755E-07	2.5000E-01	6.8884E+00
SPHERE FLUX RESPONSE		5.0202E-07	5.1018E-07	9.9999E-01	2.7553E+01
RATIO OF SPHERE/2*SLAB		1.0328E+00	1.0328E+00	1.0328E+00	1.0328E+00

Table 100: (SHIANG) Shield Angular Flux Output

GROUP	6.67E-02	1.56E-01	2.53E-01	3.52E-01	4.52E-01	5.52E-01	6.51E-01
1	8.53E-10	2.56E-09	4.26E-09	5.97E-09	7.67E-09	9.38E-09	1.11E-08
2	1.77E-08	5.30E-08	8.84E-08	1.24E-07	1.59E-07	1.94E-07	2.30E-07
3	1.91E-07	5.74E-07	9.56E-07	1.34E-06	1.72E-06	2.10E-06	2.49E-06
4	1.24E-06	3.71E-06	6.18E-06	8.66E-06	1.11E-05	1.36E-05	1.61E-05
5	5.27E-06	1.58E-05	2.64E-05	3.69E-05	4.75E-05	5.80E-05	6.86E-05
6	1.61E-05	4.83E-05	8.05E-05	1.13E-04	1.45E-04	1.77E-04	2.09E-04
7	3.75E-05	1.12E-04	1.87E-04	2.62E-04	3.37E-04	4.12E-04	4.87E-04
8	7.03E-05	2.11E-04	3.51E-04	4.92E-04	6.32E-04	7.73E-04	9.13E-04
9	1.11E-04	3.32E-04	5.54E-04	7.75E-04	9.97E-04	1.22E-03	1.44E-03
10	1.52E-04	4.56E-04	7.59E-04	1.06E-03	1.37E-03	1.67E-03	1.97E-03
11	1.86E-04	5.59E-04	9.32E-04	1.30E-03	1.68E-03	2.05E-03	2.42E-03
12	2.09E-04	6.28E-04	1.05E-03	1.46E-03	1.88E-03	2.30E-03	2.72E-03
13	2.19E-04	6.57E-04	1.09E-03	1.53E-03	1.97E-03	2.41E-03	2.85E-03
14	2.16E-04	6.49E-04	1.08E-03	1.52E-03	1.95E-03	2.38E-03	2.81E-03
15	2.05E-04	6.14E-04	1.02E-03	1.43E-03	1.84E-03	2.25E-03	2.66E-03
16	1.87E-04	5.60E-04	9.33E-04	1.31E-03	1.68E-03	2.05E-03	2.43E-03
17	1.66E-04	4.97E-04	8.28E-04	1.16E-03	1.49E-03	1.82E-03	2.15E-03
18	1.44E-04	4.31E-04	7.18E-04	1.00E-03	1.29E-03	1.58E-03	1.87E-03
19	1.22E-04	3.67E-04	6.11E-04	8.55E-04	1.10E-03	1.34E-03	1.59E-03
20	1.03E-04	3.08E-04	5.13E-04	7.18E-04	9.23E-04	1.13E-03	1.33E-03
21	8.51E-05	2.55E-04	4.26E-04	5.96E-04	7.66E-04	9.37E-04	1.11E-03
22	7.00E-05	2.10E-04	3.50E-04	4.90E-04	6.30E-04	7.70E-04	9.10E-04
23	5.72E-05	1.72E-04	2.86E-04	4.00E-04	5.15E-04	6.29E-04	7.43E-04
24	4.64E-05	1.39E-04	2.32E-04	3.25E-04	4.18E-04	5.11E-04	6.04E-04
25	3.75E-05	1.13E-04	1.88E-04	2.63E-04	3.38E-04	4.13E-04	4.88E-04
26	3.02E-05	9.07E-05	1.51E-04	2.12E-04	2.72E-04	3.33E-04	3.93E-04
27	2.43E-05	7.28E-05	1.21E-04	1.70E-04	2.19E-04	2.67E-04	3.16E-04

ANGULAR FLUXES

GROUP	7.51E-01	8.51E-01	9.25E-01	9.70E-01	9.95E-01
1	1.28E-08	1.45E-08	7.89E-09	6.62E-09	1.70E-09
2	2.65E-07	3.00E-07	1.63E-07	1.37E-07	3.52E-08
3	2.87E-06	3.25E-06	1.77E-06	1.48E-06	3.81E-07
4	1.85E-05	2.10E-05	1.14E-05	9.60E-06	2.46E-06
5	7.91E-05	8.97E-05	4.88E-05	4.09E-05	1.05E-05
6	2.41E-04	2.74E-04	1.49E-04	1.25E-04	3.20E-05
7	5.62E-04	6.37E-04	3.47E-04	2.91E-04	7.46E-05
8	1.05E-03	1.19E-03	6.50E-04	5.45E-04	1.40E-04
9	1.66E-03	1.88E-03	1.02E-03	8.59E-04	2.20E-04
10	2.28E-03	2.58E-03	1.40E-03	1.18E-03	3.02E-04
11	2.79E-03	3.17E-03	1.72E-03	1.45E-03	3.71E-04
12	3.14E-03	3.56E-03	1.94E-03	1.62E-03	4.16E-04
13	3.28E-03	3.72E-03	2.02E-03	1.70E-03	4.36E-04
14	3.25E-03	3.68E-03	2.00E-03	1.68E-03	4.31E-04
15	3.07E-03	3.48E-03	1.89E-03	1.59E-03	4.07E-04
16	2.80E-03	3.17E-03	1.73E-03	1.45E-03	3.72E-04
:					
27	3.64E-04	4.13E-04	2.25E-04	1.88E-04	4.83E-05

Table 101: (SHISUM) Shield Summary Output Table

ALUMINUM COBALT60 ELECTRON

LAYER	GM/SQCM	SHELL	RATIO	SLAB	SLAB/2
1	0.00E+00	0.00E+00	1.00E+00	0.00E+00	0.00E+00
2	2.70E+00	0.00E+00	1.00E+00	0.00E+00	0.00E+00

COPPER COBALT60 ELECTRON

LAYER	GM/SQCM	SHELL	RATIO	SLAB	SLAB/2
1	0.00E+00	0.00E+00	1.00E+00	0.00E+00	0.00E+00
2	2.70E+00	0.00E+00	1.00E+00	0.00E+00	0.00E+00

INSB COBALT60 ELECTRON

LAYER	GM/SQCM	SHELL	RATIO	SLAB	SLAB/2
1	0.00E+00	0.00E+00	1.00E+00	0.00E+00	0.00E+00
2	2.70E+00	0.00E+00	1.00E+00	0.00E+00	0.00E+00

NUMBER FLUX COBALT60 ELECTRON

LAYER	GM/SQCM	SHELL	RATIO	SLAB	SLAB/2
1	0.00E+00	0.00E+00	1.00E+00	0.00E+00	0.00E+00
2	2.70E+00	0.00E+00	1.00E+00	0.00E+00	0.00E+00

ENERGY FLUX COBALT60 ELECTRON

LAYER	GM/SQCM	SHELL	RATIO	SLAB	SLAB/2
1	0.00E+00	0.00E+00	1.00E+00	0.00E+00	0.00E+00
2	2.70E+00	0.00E+00	1.00E+00	0.00E+00	0.00E+00

ALUMINUM COBALT60 PHOTON

LAYER	GM/SQCM	SHELL	RATIO	SLAB	SLAB/2
1	0.00E+00	5.15E-10	1.12E+00	4.59E-10	2.30E-10
2	2.70E+00	4.76E-10	1.25E+00	3.81E-10	1.90E-10

COPPER COBALT60 PHOTON

LAYER	GM/SQCM	SHELL	RATIO	SLAB	SLAB/2
1	0.00E+00	4.95E-10	1.12E+00	4.42E-10	2.21E-10
2	2.70E+00	4.60E-10	1.24E+00	3.71E-10	1.85E-10

INSB COBALT60 PHOTON

LAYER	GM/SQCM	SHELL	RATIO	SLAB	SLAB/2
1	0.00E+00	5.02E-10	1.12E+00	4.48E-10	2.24E-10
2	2.70E+00	4.78E-10	1.20E+00	3.97E-10	1.98E-10

NUMBER FLUX COBALT60 PHOTON

LAYER	GM/SQCM	SHELL	RATIO	SLAB	SLAB/2
1	0.00E+00	1.00E+00	1.12E+00	8.92E-01	4.46E-01
2	2.70E+00	9.62E-01	1.20E+00	8.03E-01	4.01E-01

ENERGY FLUX COBALT60 PHOTON

LAYER	GM/SQCM	SHELL	RATIO	SLAB	SLAB/2
1	0.00E+00	1.25E+00	1.12E+00	1.11E+00	5.57E-01
2	2.70E+00	1.15E+00	1.26E+00	9.17E-01	4.59E-01

Table 102: (SHIPUN) Shield "Punch" File

```
C     ALUMINUM     AL FLARE       PROTON
 0.00E+00 6.75E-01 1.35E+00 2.70E+00 5.40E+00 1.35E+01 2.70E+01 4.05E+01
 5.40E+01
 5.02E-07 1.34E-07 6.75E-08 3.31E-08 1.30E-08 1.10E-09 1.34E-10 2.15E-11
 3.70E-12
 1.03E+00 1.81E+00 1.96E+00 2.58E+00 3.31E+00 3.43E+00 6.03E+00 7.09E+00
 7.81E+00
C      SILICON     AL FLARE       PROTON
 0.00E+00 6.75E-01 1.35E+00 2.70E+00 5.40E+00 1.35E+01 2.70E+01 4.05E+01
 5.40E+01
 5.10E-07 1.37E-07 6.90E-08 3.39E-08 1.33E-08 1.13E-09 1.38E-10 2.20E-11
 3.79E-12
 1.03E+00 1.81E+00 1.96E+00 2.58E+00 3.31E+00 3.43E+00 6.03E+00 7.10E+00
 7.82E+00
C  NUMBER FLUX     AL FLARE       PROTON
 0.00E+00 6.75E-01 1.35E+00 2.70E+00 5.40E+00 1.35E+01 2.70E+01 4.05E+01
 5.40E+01
 1.00E+00 4.41E-01 2.78E-01 1.45E-01 6.56E-02 8.06E-03 9.95E-04 1.61E-04
 2.99E-05
 1.03E+00 1.68E+00 1.92E+00 2.29E+00 3.15E+00 3.76E+00 6.25E+00 7.40E+00
 8.54E+00
C  ENERGY FLUX     AL FLARE       PROTON
 0.00E+00 6.75E-01 1.35E+00 2.70E+00 5.40E+00 1.35E+01 2.70E+01 4.05E+01
 5.40E+01
 2.76E+01 1.74E+01 1.28E+01 7.76E+00 3.73E+00 6.42E-01 8.04E-02 1.36E-02
 2.68E-03
 1.03E+00 1.54E+00 1.80E+00 2.14E+00 2.78E+00 3.85E+00 5.81E+00 6.96E+00
 8.47E+00
```

SHOW

SHOW produces a plot of orbit and environment data.

```
*************************************************************
This processor produces a plot of orbit and environment data
using the SOFIPORB.NEW file created from the last run.
*************************************************************
```

```
************************
Input Data Description:
************************
```

```
===========
Header line
===========
```

Contains *SHO in columns 1 through 4.

```
=======
Options
=======
```

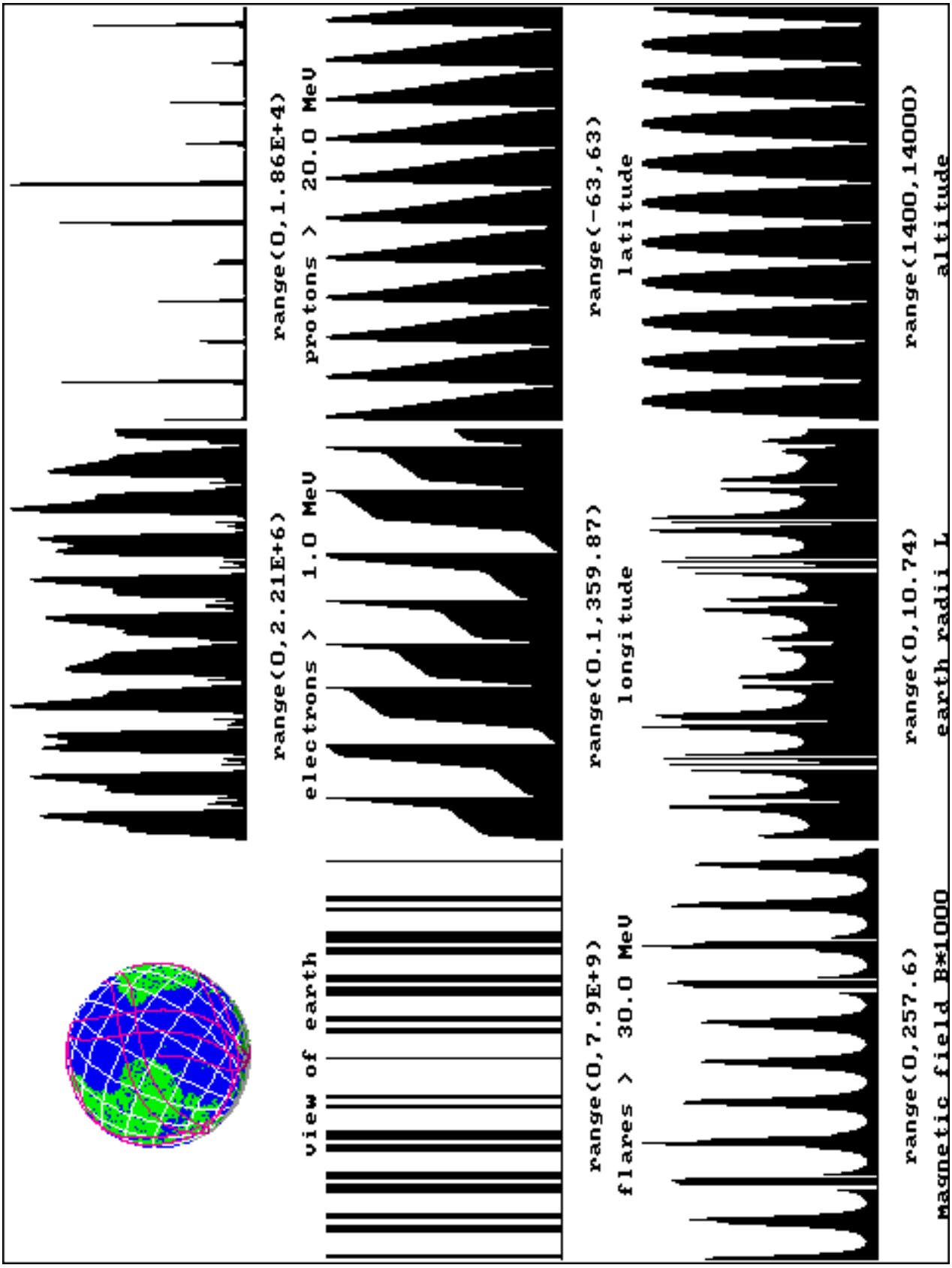
G, G=g, only show every gth earth view

H, if present, show orbit trace history on earth view. If H=h, then color number h is used for the trace.

```
*************************
Data Record Description:
*************************
```

There is no other data.

Figure 114: (SHOVUE) Last frame of orbit data.



SIGMA

SIGMA does ray-trace sectoring analysis.

****
SIGMA is a 3D ray tracing/sectoring analysis that uses
interpolations of 1D attenuation kernels.
****

****
Input Data Record Description:
****

==========
Header line
==========

Contains *SIG in columns 1 through 4.

=======
Options
=======

A, output shield sensitivity data on unit 65 (SIGMAPAR.DAT)

C, calculate shield optimization data for post processing by the *SOCODE processor. C=c, then transformation matrix 'c' is used for absolute location of box and part shields. Additional inputs for this option are described below. Outputs are placed on unit 66 (SIGMASOC.DAT).

D, if present, print mass distribution data

E, put attenuation kernel data on summary file SIGMASUM.DAT

F, create SIGMASUM.DAT file (input just before kernel defs)

G, when using C option to generate side sensitivies for F option, do not save shield sensitivies on SIGMASOC.DAT file

I=i, number of inner surfaces around detector points for breakdown of mass distribution data, default is 6

T=t, number of inner and outer surfaces for mass distribution data, default is inner + 1

M=m, index of the shield material for parametric shielding. The default is m=1

N, if present, the parametric shielding for the slant path models is determined using the cosine at the outside of the system geometry rather than at the first non void surface going outward from the detector point.

N=1, same as above and average cosine is used for min path

N=-1, same as above but usual cosine for min path (outside first non void)

R, if present, sample detector point at random over the volume of the detector. Sampling performed for each ray trace.

Q, generate mass thickness table, SECTOR.DAT If Q or Q=0, the mass thickness table is slant path. If Q=2, the mass thickness table is minimum path. If Q=1, both the slant and min path tables (in that order) are written to the SECTOR.DAT file.

The data on the SECTOR.DAT file is written with azimuth varying most rapidly and with polar angle cosine going from its maximum to its minimum.

P, print two dimensional maps of slant path thickness, minimum path thickness, first non-void region of sectors, and last non void region of sectors.

P=1, the sector thicknesses are printed in decimal format rather than in integer format scale factors.

The order of tables for the P and Q options is: azimuth varying most rapidly, e.g. across page, and polar angle increasing most slowly (polar angle cosine is decreasing).

J, old format kernel tabulations

K, old (JPL) interpolation between slab and spherical shell.

H or H=h, Monte Carlo option. This option forces repetitive integrations over solid angle with the rays located at random within the sectors. Statistics are computed using complete integrations over solid angle as individual samples. H=2 is sufficient to estimate the precision of the sectoring, i.e., if enough sectors are being used.

B=b, use bremsstrahlung dose source scaling only if thickness of of outside layer exceeds b g/sqcm. Scaling is on production only and is applied only if particle type and material are identified with the attenuation data. No correction is made for thickness of the last layer (assumed infinitely thick).

S or S=0, use old SIGMA.HAC file to define solid angle intervals and the base thickness associated with each.

S=1, create a SIGMA.HAC file

S=2, use an old SIGMA.HAC file on unit 49, and create a new SIGMA.HAD file on unit 62 in the same run.

This option allows the user to create (or otherwise acquire) mass thicknesses around a typical box location in a space platform. Then, when doing box level analysis, only the box model plus this file are required for the analysis.

U, this option allows the user to input the obsolete print/plot data line.

V, if (absent, present), for the curvature model use the (min,slant) value for the inner cavity radius.

W, if (absent, present), for the curvature model add the parametric shield thicknesses to the (inner, outer) mass thicknesses.

X, if (absent, present), for the curvature model use the (min, slant) thicknesses for the inner shield geometry.

Y=y if (Y absent or Y=1, Y=2, Y=3) thickness outputs in new tables are in g/sqcm, mm, or mils.

L, if present, do all attenuation with relative attenuation factors of unity (regardless of kernel inputs). L=1, do all attenuation with relative effectiveness factors regardless of kernel input. L=2, do all kernels twice, once with relative effectiveness using physics, and again with density scaling only.

O, if present, generate a formatted file containing a line for each solid angle element containing the azimuth and polar angles, fractional solid angle, slant thickness in equivalent aluminum (no relative effectiveness factors), and first five dose kernels.

Z=z, use the azimuthal and polar distributions for source number z to weight the relative dose by direction.

&a, no rotate of detectors for box plot outputs, use local coordinates

&c, LastCarRegion, output tables of distance in CAD and explicit

&d, debug output flag

&e, weight across

&f, weight updown

&g, weight x

&h, weight y

&i, weight z

&j, weight u

&k, weight v

&l, weight w

&o, output detector point surround information

&r, do not initialize ray plot screen on multiple detector points

****
Data Record Description:
****

==========
Detector Points
==========

,list of detector points /

The input 0/ selects all detectors.

==========
Mass Distribution Boundaries
==========

,list mass distribution table boundaries in gm/cm^2 /

==========
Azimuthal Integration Mesh
==========

,list azimuthal integration boundaries, radians /

e.g. ,0 1I60*6.2832 / 60 AZIMUTHAL INTERVALS

==========
Polar Cosine Mesh
==========

,list polar cosine integration boundaries /

e.g. ,-1 1I30*1 / 30 POLAR COSINE INTERVALS

If the angular limits are input as 0,1In*6.2832/,/ and no polar intervals are input, a solid angle 'igloo' is used for the integration. The number of azimuthal intervals, N, is ensured to be a multiple of four. The number of polar intervals is set to N/2. For each octant, the igloo is constructed by having N/4 equal azimuthal intervals at the equator. At the next higher (or lower) latitude, the number of azimthal intervals is decreased by 1, and so on, so that at the last polar interval (at the poles) there is only one azimuthal interval per octant. With this construction, the polar boundaries are roughly equal in angle (if polar cosine boundaries are input equally spaced, the incremental polar angle at the pole is much larger than at the equator).

Parametric Shielding Thicknesses

,list parametric shield thicknesses, gm/cm^2 / The first thickness should be zero (set by the code if not zero). These thicknesses are used in an estimate of the effect of adding shield material around the detector points.

If the C option was selected, the following data are required to define the shield locations and other parameters. The parametric shield thicknesses on the preceding line are used in generating dose versus thickness for for the potential shields.

Shield Material and Dimensions (C option)

Each line contains the shield material index (or name) and the min and max dimensions of the rectangular shield (min x, max x, min y, max y, min z, max z). The line is terminated with a slash. The first shield must be a box surrounding all the detector points. The second and remaining shields can be either fixed or relocatable (relative to individual detector points). After all shields are entered, a null record terminates the input, i.e., input ,/ or ,0/ (logically, a no material or dimension shield). The box level shield is given an identifying index of 0. The remaining shields are identified by the indices 1, 2, ... based on order of input.

Detector Shields (C option)

Follow the shield definitions with a single record containing part level shield indices for each detector point in this SIGMA calculation. There should be one entry for each of the detectors listed on the first data line following the *SIGMA header/option line. The entry for a detector is 0 if the point does not have a part level shield. The entry for a detector is the part shield index (based on order of input) if the detector has a relocatable part shield (the part shield is automatically translated to the detector point location). The entry for a detector is negative if the part shield is already located absolutely (the same shield may enclose more than one part). Note that the only relocations of shields are the global transformation (C=c on the option line) and translation to individual detector points. Orientation effects may require input of the part shield two or more times, e.g., once for shielding parts on the front of a board and again for shielding parts on the back of the same board, so that constraints in the *SOCODE calculation can prohibit the addition of shielding beneath the part, etc..

Sensitivity Complexity (C option)

The final record of input for shield optimization contains two parameters:

MCROSS, the maximum number of shield surface crossings to be included in the dose versus thickness tables (the code keeps separate information on dose components seeing more than MCROSS shield surfaces, on dose components that do not see any shield surfaces, and on unique dose components that see from one through MCROSS shield surfaces.)

IGNORE, an option to ignore part shields of other detectors when calculating a specific detector. IGNORE=0, ignore relocatable shields of other detectors when doing a specific detector. IGNORE=1, ignore both relocatable and absolute shields around other detectors (unless the absolute shield contains the current detector). IGNORE=2, include both relocatable and absolute shield effects for the current detector (subject to the MCROSS limitation).

==========
Summary Table Setup (F option)
==========

A record containing pairs of integers giving the kernel index and the model index (1 through 4 = shell/slant, min path shell, solid/slant, and curvature). No entries are required. If entered several additional tables are added to SIGMASUM.DAT:

Thicknesses (average, min, max, effective).

Side sentivity for enclosing box (if C option)

Side sentivity around detector (if C option)

Added shield sensitivity

==========
User Summary Tables (F option)
==========

Then multiple records are used to define additional output tables (the input is terminated by a null record ,/ which can be the first record, i.e., user tables are not required).

Output table title line (enclosed in quotes, 64 characters max) followed by (no slash, single record) quads of data defining column outputs in the table with the following definitions for each quad: first index = output column (1 through 10) second value = kernel index based on order of input (1 through max) third value = model index (1 through 4 = shell/slant, min path shell, solid/slant, and curvature) fourth value = scale factor (positive or negative).

Note that multiple quads can refer to the same output column The output is then summed and given the subtitle Total.

==========
Print Plot (U option)
==========

If the 'U' option was selected then input: ,p/ p is picture size in cm, if p is zero, no azimuthal pictures are obtained. This input used to be required. Old data files with this data line will cause a warning message. If 'igloo' sectoring is selected, the print plot is not generated.

Repeat data for each attenuation starting here.

==========
Tabulated Attenuation Header
==========

'NAME' FT FK {material particle} / material and particle optional

The tabulation thicknesses are multiplied by FT to give them units of grams/cm^2. The kernel data is multiplied by FK. The NAME is truncated to 12 characters.

Allowed materials are the names of materials in the problem setup or the indices of these materials. Only the first three letters of the particle or material names are required.

Allowed particles are NEUTRON, GAMMARAY, PHOTON, ELECTRON, POSITRON, PROTON, ION/GCR, or UNKNOWN (or an index from 1 through 8).

==========
Tabulation Thicknesses
==========

,tabulation thicknesses /

==========
Slab Response (no J option)
==========

,slab kernel at tabulation thicknesses/

==========
Shell Geometry Response
==========

, shell kernel at tabulation thicknesses/

==========
Solid Sphere Response (no J option)
==========

,solid sphere kernel at tabulation thicknesses/

==========
Ratio of Shell to Slab (J option)
==========

,ratio of the shell to slab kernel at the tab thicknesses /

==========
Material Effectiveness
==========

,ratio effectiveness of materials for this kernel /

The relative effectiveness of materials is usually based on 1D calculations for the materials involved. For instance, assume a 1D calculation shows that tungsten attenuates faster than aluminum on a gm/cm^2 basis: 1.5 gm/sqcm Al gives the same attentuation as 1 gm/sqcm W. Then W has a relative effectiveness of 1.5. If the kernel data being input was for Al, and if materials 1 and 2 are W and Al respectively, the material effectiveness inputs would be

,1.5 1/

and if the input kernel data were for W, the inputs would be

,1 .667/

If the optional particle and material are input on the first line of kernel tabulation data, then the code calculates values for the material effectiveness data if that data was input as all zeroes.

The relative effectiveness is calculated using the ratios of linear energy transfer (LET) cross sections. For electrons/positrons, this procedure uses the geometric mean of the LET and the transport cross section. The energy group used in this procedure is min(10,(1+NG)/2) The calculation of material effectiveness requires that cross section data be present in core, i.e., the problem setup includes the spectra used to generate the kernels, and the *EXECUTE line does not have the N option.

****
Discussion
****

The SIGMA.HAC and SIGMA.HAD files have the following format

A comment line describing the file

NUMTHE,NUMPHI on second line (12I6 format) giving the number of azimuthal and polar intervals.

NUMTHE*NUMPHI (8E9.2 format) lines containing:

TMIN,TMAX,PMIN,PMAX,DOME,SLANT,SMIN where TMIN and TMAX are the min and max azimuthal angles of the sector (radians), PMIN and PMAX are the min and max polar angle COSINES of the sector, DOME is the solid angle of the sector (TMAX-TMIN)*(PMAX-PMIN), SLANT is the slant thickness of the solid angle interval in g/sqcm of equivalent aluminum, and SMIN is the minimum thickness of the solid angle interval in g/sqcm of equivalent aluminum. SMIN is set equal to SLANT if it is zero.

If slab kernel input is ,list/ and solid sphere input is ,/ then the solid sphere data is calculated.

If slab and solid sphere inputs are both ,/ and the shell input is ,list/ then the solid sphere data is equated to the shell data and the slab data is calculated.

If slab input is ,/ and solid sphere data is ,list/ then the slab data is computed.

If shell input is ,f/ (f non zero) then the shell data is set to f * slab data except for first point which is set to slab data, which is typical for electrons.

If shell input is ,/ then the shell input is set to solid sphere.

++++++++++++
Output Tables
++++++++++++

Table 103 (SIGINP) indicates a typical input stream for SIGMA.

After input, SIGMA prepares tables of the tabulated attenuation data in the format of Table 104 (SIGKER).

While running, SIGMA prints a line in the summary file for each azimuthal interval (the outer loop of the integration over solid angle) as shown in Table 105 (SIGRUN).

The results of the sectoring calculation are output as shown in Table 106 (SIGOUT).

If requested by the D option, output also includes inner and outer sectors of the spacecraft and the response through the sectors, Table 107 (SIGINR) (inner sectors).

Table 108 (SIGOTR) gives the outer sector format.

SIGMA can also prepare summaries of minimum and slant path thickness as shown in Table 109 (SIGTHK). This information can also be presented in a decimal format (P=1 option).

Optional tables also include the first non-void region at the outside of the geometry and just around the detector points, e.g. Table 110 (SIGHIT).

After running all detector points, SIGMA prints a summary as shown in Table 111 (SIGSUM).

The summary information is also saved in the file EFKOUT.DAT as shown in Table 112 (SIGEFK).

Finally, the solid angle thickness information saved in file SECTOR.DAT has the format shown in Table 113 (SIGSEC).

++++++++++++++
Output Figures
++++++++++++++

A plot obtained from the SECTOR.DAT file using the PLOT processor is shown in Figure 115 (SIGTHI).

Table 103: (SIGINP) SIGMA Input Stream

```
INPUT *HEADER,OPTIONS/
Line   1:*SIGMA,H,M='ALUMINUM'/
OPTION, INLORD,OPTORD,VALUE 13  1  2 ALUMINUM

SIGMA-----------------------------------------------------------------------------
ALUMINU      STRING RECOGNIZED AS MATERIAL   4
INPUT LIST OF DETECTOR POINTS
Line   2:1 2 3 4 5 6 7 8 9 10 11 12 13/
INPUT MASS THICKNESS BOUNDARIES IN GM/SQCM
Line   3:.1 LI10*100/
INPUT BOUNDARIES OF AZIMUTHAL INTEGRATION MESH, RADIAN
Line   4:0 1I20*6.2832/
INPUT COSINE BOUNDARIES FOR POLAR INTEGRATION MESH
Line   5:,/
INPUT PARAMETRIC SHIELD THICKNESSES, GM/SQCM
Line   6:0 .1 .2 .3 .4 .5/
INPUT PICTURE SIZE, 0.0 GIVES NO PICTURES
Line   7:,/ NO PICTURE

UNIT  12 OPENED JUMP.DAT
INPUT KERNEL TITLE,T AND K SCALE/,T/,SLAB/,SHELL/,SOLID/
Line   8:'ALFLARE' 1 1 ALUMINUM PROTON/
DATUM  3 IS INLINE STRING  1 ALUMINUM
DATUM  4 IS INLINE STRING  2 PROTON
ALUMINUM     STRING RECOGNIZED AS MATERIAL   4
PRO  KEYWORD IS LISTED ITEM NUMBER  6 PROT
Line   9:.1 .2 .3 .5 .7 1 1.5 2 3 4 5 10 20/ g/sqcm
Line  10:5690 4150 3300 2370 1830 1340 880 618 355 222 147 30.8 3.33/ slab
Line  11:8040 6340 5330 4150 3420 2650 1900 1420 901 624 439 111 16.5/ shell
Line  12:8040 6340 5330 4150 3420 2650 1900 1420 901 624 439 111 16.5/ sphere
Line  13:100*0/ relative attenuation effectivesness by material
:
Line  38:'TOTAL' 1 1 ALUMINUM UNKNOWN/
DATUM  3 IS INLINE STRING  1 ALUMINUM
DATUM  4 IS INLINE STRING  2 UNKNOWN
ALUMINUM     STRING RECOGNIZED AS MATERIAL   4
UNK  KEYWORD IS LISTED ITEM NUMBER  8 UNKN
Line  39:.1 .2 .3 .5 .7 1 1.5 2 3 4 5 10 20/
Line  40:122900 40740 22220 10203 6173 3974 2883 2439 1948 1604 1359 822 376/
Line  41:151992 52532 29896 14469 9058 5763 4105 3492 3344 2733 2280 1647 909/
Line  42:303043 92858 51409 25119 14754 8202 4605 3581 3347 2733 2280 1647 909/
Line  43:100*0/
              END OF INPUT ON UNIT  5
              *WARN*WARN*WARN*WARN*WARN*WARN*WARN*WARN*WARN*WARN*WARN*
Line  44:*STOP/
              *END OR HEADER LINE TERMINATED INPUT
              *INFO*INFO*INFO*INFO*INFO*INFO*INFO*INFO*INFO*INFO*INFO*
```

Table 104: (SIGKER) Kernel Output Table

ATTENUATION DATA FOR P880-98

GM/SQCM	SLAB	SHELL	SOLID
1.00E-01	1.01E+04	1.70E+04	1.70E+04
2.00E-01	6.64E+03	1.01E+04	1.01E+04
3.00E-01	5.34E+03	8.02E+03	8.02E+03
5.00E-01	4.21E+03	6.23E+03	6.23E+03
7.00E-01	3.60E+03	5.31E+03	5.31E+03
1.00E+00	3.08E+03	4.44E+03	4.44E+03
1.50E+00	2.65E+03	3.73E+03	3.73E+03
2.00E+00	2.32E+03	3.28E+03	3.28E+03
3.00E+00	1.88E+03	3.17E+03	3.17E+03
4.00E+00	1.56E+03	2.62E+03	2.62E+03
5.00E+00	1.33E+03	2.21E+03	2.21E+03
1.00E+01	8.09E+02	1.62E+03	1.62E+03
2.00E+01	3.70E+02	9.01E+02	9.01E+02

RELATIVE MATERIAL EFFECTIVENESS FACTORS ARE:
9.97E-01 1.06E+00 1.22E+00 1.00E+00 9.68E-01 1.50E+00

ATTENUATION DATA FOR E880-98

GM/SQCM	SLAB	SHELL	SOLID
1.00E-01	1.12E+05	1.34E+05	2.85E+05
2.00E-01	3.35E+04	4.16E+04	8.19E+04
3.00E-01	1.64E+04	2.12E+04	4.27E+04
5.00E-01	5.63E+03	7.66E+03	1.83E+04
7.00E-01	2.30E+03	3.24E+03	8.93E+03
1.00E+00	6.94E+02	9.64E+02	3.40E+03
1.50E+00	8.78E+01	1.23E+02	6.21E+02
2.00E+00	1.08E+01	1.42E+01	1.00E+02
3.00E+00	4.42E-02	5.92E-02	9.02E-01
4.00E+00	4.18E-06	5.00E-06	1.28E-05

RELATIVE MATERIAL EFFECTIVENESS FACTORS ARE:
1.02E+00 1.03E+00 9.77E-01 1.00E+00 1.15E+00 1.28E+00

ATTENUATION DATA FOR BREM880-98

GM/SQCM	SLAB	SHELL	SOLID
1.00E-01	1.91E+02	1.62E+02	2.13E+02
2.00E-01	1.03E+02	1.02E+02	1.28E+02
3.00E-01	7.35E+01	7.55E+01	8.92E+01
5.00E-01	4.84E+01	4.94E+01	5.85E+01
7.00E-01	3.58E+01	3.80E+01	4.42E+01
1.00E+00	2.69E+01	2.91E+01	3.19E+01
1.50E+00	2.14E+01	2.16E+01	2.38E+01
2.00E+00	1.83E+01	1.76E+01	2.10E+01
3.00E+00	1.21E+01	1.45E+01	1.56E+01
4.00E+00	1.01E+01	1.31E+01	1.30E+01
5.00E+00	7.39E+00	1.02E+01	9.97E+00
1.00E+01	7.00E+00	6.81E+00	7.06E+00

Table 105: (SIGRUN) Integration Status Output

```
RELATIVE MATERIAL EFFECTIVENESS FACTORS ARE:
 1.00E+00 1.00E+00 1.00E+00 1.00E+00 1.00E+00 1.00E+00

ATTENUATION DATA FOR        TOTAL
    GM/SQCM        SLAB       SHELL       SOLID
   1.00E-01    1.23E+05    1.52E+05    3.03E+05
   2.00E-01    4.07E+04    5.25E+04    9.29E+04
   3.00E-01    2.22E+04    2.99E+04    5.14E+04
   5.00E-01    1.02E+04    1.45E+04    2.51E+04
   7.00E-01    6.17E+03    9.06E+03    1.48E+04
   1.00E+00    3.97E+03    5.76E+03    8.20E+03
   1.50E+00    2.88E+03    4.11E+03    4.61E+03
   2.00E+00    2.44E+03    3.49E+03    3.58E+03
   3.00E+00    1.95E+03    3.34E+03    3.35E+03
   4.00E+00    1.60E+03    2.73E+03    2.73E+03
   5.00E+00    1.36E+03    2.28E+03    2.28E+03
   1.00E+01    8.22E+02    1.65E+03    1.65E+03
   2.00E+01    3.76E+02    9.09E+02    9.09E+02

UNIT  12 CLOSED , STATUS = DEL

********************       55959 DATA LOCATIONS USED********************
SIGMA DETECTOR NUMBER AND AZIMUTHAL SWEEP ARE    1    1
SIGMA DETECTOR NUMBER AND AZIMUTHAL SWEEP ARE    1    2
SIGMA DETECTOR NUMBER AND AZIMUTHAL SWEEP ARE    1    3
SIGMA DETECTOR NUMBER AND AZIMUTHAL SWEEP ARE    1    4
SIGMA DETECTOR NUMBER AND AZIMUTHAL SWEEP ARE    1    5
SIGMA DETECTOR NUMBER AND AZIMUTHAL SWEEP ARE    1    6
SIGMA DETECTOR NUMBER AND AZIMUTHAL SWEEP ARE    1    7
:
SIGMA DETECTOR NUMBER AND AZIMUTHAL SWEEP ARE   13   20
-------------------------------------------------------------------------------
 203=SUR  87=BOD  87=REG   6=MAT   1=SOU  13=DET   3=PAR   4=SPE   6=RES  0=ERR
-------------------------------------------------------------------------------
                  1         2         3         4         5         6         7
         12345678901234567890123456789012345678901234567890123456789012345678901
INPUT *HEADER,OPTIONS/
Line  44:*STOP/
```

Table 106: (SIGOUT) SIGMA Output Table

```
-----------------------------------------------------------------------------
    NUMBER 1, DETECTOR    1, PARTICLE: PROTON  ,      ALFLARE, KERNEL    1
USER XYZ=-3.27E+01 1.05E+02 4.06E+01, CODE XYZ=-3.43E+01 1.06E+02 4.06E+01

 MASS PATH    SHELL SPHERE    SHELL SPHERE    SOLID SPHERE    SHELL SPHERE
GRAMS/SQCM      SLANT PATH     NORMAL PATH      SLANT PATH      +CURVATURE
 INTRINSIC     2.75E+02  2     2.72E+02  4     2.75E+02  2     2.75E+02  2
+    .1000     2.58E+02  2     2.61E+02  4     2.58E+02  2     2.61E+02  4
+    .2000     2.46E+02  2     2.51E+02  4     2.46E+02  2     2.51E+02  4
+    .3000     2.34E+02  2     2.42E+02  4     2.34E+02  2     2.42E+02  4
+    .4000     2.24E+02  2     2.33E+02  4     2.24E+02  2     2.33E+02  4
+    .5000     2.14E+02  2     2.24E+02  4     2.14E+02  2     2.24E+02  4

-----------------------------------------------------------------------------
    NUMBER 1, DETECTOR    1, PARTICLE: PROTON  ,     ATTEN AL, KERNEL    2
USER XYZ=-3.27E+01 1.05E+02 4.06E+01, CODE XYZ=-3.43E+01 1.06E+02 4.06E+01

 MASS PATH    SHELL SPHERE    SHELL SPHERE    SOLID SPHERE    SHELL SPHERE
GRAMS/SQCM      SLANT PATH     NORMAL PATH      SLANT PATH      +CURVATURE
 INTRINSIC     4.48E+01  2     4.34E+01  4     4.48E+01  2     4.48E+01  2
+    .1000     4.20E+01  2     4.16E+01  4     4.20E+01  2     4.20E+01  2
+    .2000     3.98E+01  2     3.99E+01  4     3.98E+01  2     3.99E+01  4
+    .3000     3.78E+01  2     3.83E+01  4     3.78E+01  2     3.83E+01  4
+    .4000     3.60E+01  2     3.66E+01  4     3.60E+01  2     3.66E+01  4
+    .5000     3.43E+01  2     3.51E+01  4     3.43E+01  2     3.51E+01  4

-----------------------------------------------------------------------------
    NUMBER 1, DETECTOR    1, PARTICLE: PROTON  ,      P880-98, KERNEL    3
USER XYZ=-3.27E+01 1.05E+02 4.06E+01, CODE XYZ=-3.43E+01 1.06E+02 4.06E+01

 MASS PATH    SHELL SPHERE    SHELL SPHERE    SOLID SPHERE    SHELL SPHERE
GRAMS/SQCM      SLANT PATH     NORMAL PATH      SLANT PATH      +CURVATURE
 INTRINSIC     1.78E+03  1     1.61E+03  2     1.78E+03  1     1.78E+03  1
+    .1000     1.74E+03  1     1.59E+03  2     1.74E+03  1     1.74E+03  1
+    .2000     1.70E+03  1     1.57E+03  2     1.70E+03  1     1.70E+03  1
+    .3000     1.67E+03  1     1.55E+03  2     1.67E+03  1     1.67E+03  1
+    .4000     1.65E+03  1     1.52E+03  2     1.65E+03  1     1.65E+03  1
+    .5000     1.62E+03  1     1.50E+03  2     1.62E+03  1     1.62E+03  1

-----------------------------------------------------------------------------
    NUMBER 1, DETECTOR    1, PARTICLE: ELECTRON,      E880-98, KERNEL    4
USER XYZ=-3.27E+01 1.05E+02 4.06E+01, CODE XYZ=-3.43E+01 1.06E+02 4.06E+01

 MASS PATH    SHELL SPHERE    SHELL SPHERE    SOLID SPHERE    SHELL SPHERE
GRAMS/SQCM      SLANT PATH     NORMAL PATH      SLANT PATH      +CURVATURE
 INTRINSIC     2.87E-04  8     2.37E-02  2     2.63E-03  9     2.37E-02  2
+    .1000     1.04E-04  8     1.35E-02  2     7.84E-04  8     1.35E-02  2
+    .2000     3.80E-05  7     7.49E-03  2     2.36E-04  7     7.49E-03  2
+    .3000     1.39E-05  6     3.90E-03  2     7.14E-05  6     3.90E-03  2
+    .4000     5.13E-06  5     2.05E-03  3     2.18E-05  5     2.05E-03  3
+    .5000     1.90E-06  5     9.33E-04  4     6.68E-06  4     9.33E-04  4
   :
   :
```

Table 107: (SIGINR) Inner Region/Sector Output

SECTOR	INNER SURFACE	SUMMED OVER OUTER SURFACES	SOLID ANGLE FRACTION
1	25		3.94E-02

GM/SQCM	INTRVL	SUMMED	INTRVL	SUMMED	INTRVL	SUMMED	INTRVL	SUMMED
12.59	0.00E+00	0.00E+00	1.11E-03	1.11E-03	0.00E+00	0.00E+00	1.11E-03	1.11E-03
17.78	1.00E-02	1.00E-02	3.00E-02	3.11E-02	1.00E-02	1.00E-02	3.00E-02	3.11E-02
25.12	2.56E-02	3.56E-02	8.33E-03	3.94E-02	2.56E-02	3.56E-02	8.33E-03	3.94E-02
35.48	3.33E-03	3.89E-02	0.00E+00	3.94E-02	3.33E-03	3.89E-02	0.00E+00	3.94E-02
50.12	5.56E-04	3.94E-02	0.00E+00	3.94E-02	5.56E-04	3.94E-02	0.00E+00	3.94E-02

AVE FOR	GM/SQCM	DOSE	GM/SQCM	DOSE	GM/SQCM	DOSE	GM/SQCM	DOSE
SECTOR	1.89E+01	6.48E-04	1.58E+01	7.66E-04	1.89E+01	6.48E-04	1.51E+01	3.09E-04

PARAMETRIC SHIELDING

GM/SQCM	DOSE	DOSE	DOSE	DOSE
.00	6.48E-04	7.66E-04	6.48E-04	3.09E-04
.10	6.34E-04	7.52E-04	6.34E-04	3.03E-04
.20	6.21E-04	7.37E-04	6.21E-04	2.96E-04
.30	6.09E-04	7.24E-04	6.09E-04	2.89E-04
.40	5.96E-04	7.10E-04	5.96E-04	2.83E-04
.50	5.84E-04	6.97E-04	5.84E-04	2.77E-04

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SECTOR	INNER SURFACE	SUMMED OVER OUTER SURFACES	SOLID ANGLE FRACTION
6	63 + ANY OTHER INNER SURFACES		2.86E-01

GM/SQCM	INTRVL	SUMMED	INTRVL	SUMMED	INTRVL	SUMMED	INTRVL	SUMMED
.40	1.78E-02	1.78E-02	8.39E-02	8.39E-02	1.78E-02	1.78E-02	8.39E-02	8.39E-02
.56	5.72E-02	7.50E-02	3.33E-02	1.17E-01	5.72E-02	7.50E-02	3.33E-02	1.17E-01
.79	3.44E-02	1.09E-01	2.22E-03	1.19E-01	3.44E-02	1.09E-01	2.22E-03	1.19E-01
1.12	7.22E-03	1.17E-01	2.78E-03	1.22E-01	7.22E-03	1.17E-01	2.78E-03	1.22E-01
1.58	1.67E-03	1.18E-01	4.44E-03	1.27E-01	1.67E-03	1.18E-01	4.44E-03	1.27E-01
2.24	5.56E-03	1.24E-01	3.00E-02	1.57E-01	5.56E-03	1.24E-01	3.00E-02	1.57E-01
3.16	9.44E-03	1.33E-01	2.94E-02	1.86E-01	9.44E-03	1.33E-01	2.94E-02	1.86E-01
4.47	2.50E-02	1.58E-01	1.83E-02	2.04E-01	2.50E-02	1.58E-01	1.83E-02	2.04E-01
:								
35.48	5.56E-04	2.86E-01	0.00E+00	2.86E-01	5.56E-04	2.86E-01	0.00E+00	2.86E-01

AVE FOR	GM/SQCM	DOSE	GM/SQCM	DOSE	GM/SQCM	DOSE	GM/SQCM	DOSE
SECTOR	1.00E+00	5.00E-01	8.00E-01	4.47E-01	1.00E+00	5.00E-01	6.94E-01	3.70E-01

PARAMETRIC SHIELDING

GM/SQCM	DOSE	DOSE	DOSE	DOSE
.00	5.00E-01	4.47E-01	5.00E-01	3.70E-01
.10	4.42E-01	3.92E-01	4.42E-01	3.20E-01
.20	3.95E-01	3.52E-01	3.95E-01	2.84E-01
.30	3.57E-01	3.18E-01	3.57E-01	2.53E-01
.40	3.24E-01	2.88E-01	3.24E-01	2.27E-01
.50	2.97E-01	2.64E-01	2.97E-01	2.06E-01

TOT ALL	GM/SQCM	DOSE	GM/SQCM	DOSE	GM/SQCM	DOSE	GM/SQCM	DOSE
SECTORS	8.60E-01	1.84E+00	5.81E-01	1.75E+00	8.60E-01	1.84E+00	5.55E-01	1.46E+00

Table 108: (SIGOTR) Outer Region Table

---------- solar flare, DETECTOR 3, epic-d----------

SECTOR	INNER SURFACE	OUTER REGION	OUTER SURFACE	SOLID ANGLE FRACTION
1	63	116	372	1.89E-02

GM/SQCM	INTRVL	SUMMED	INTRVL	SUMMED	INTRVL	SUMMED	INTRVL	SUMMED
.56	0.00E+00	0.00E+00	1.11E-03	1.11E-03	0.00E+00	0.00E+00	1.11E-03	1.11E-03
1.58	1.11E-03	1.11E-03	0.00E+00	1.11E-03	1.11E-03	1.11E-03	0.00E+00	1.11E-03
2.24	0.00E+00	1.11E-03	8.89E-03	1.00E-02	0.00E+00	1.11E-03	8.89E-03	1.00E-02
3.16	1.11E-03	2.22E-03	1.67E-03	1.17E-02	1.11E-03	2.22E-03	1.67E-03	1.17E-02
4.47	4.44E-03	6.67E-03	1.11E-03	1.28E-02	4.44E-03	6.67E-03	1.11E-03	1.28E-02
6.31	2.78E-03	9.44E-03	1.11E-03	1.39E-02	2.78E-03	9.44E-03	1.11E-03	1.39E-02
8.91	1.67E-03	1.11E-02	0.00E+00	1.39E-02	1.67E-03	1.11E-02	0.00E+00	1.39E-02
12.59	1.11E-03	1.22E-02	2.78E-03	1.67E-02	1.11E-03	1.22E-02	2.78E-03	1.67E-02
17.78	6.11E-03	1.83E-02	2.22E-03	1.89E-02	6.11E-03	1.83E-02	2.22E-03	1.89E-02

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SECTOR	INNER SURFACE	OUTER REGION	OUTER SURFACE	SOLID ANGLE FRACTION
23	61	115	389	1.67E-03

GM/SQCM	INTRVL	SUMMED	INTRVL	SUMMED	INTRVL	SUMMED	INTRVL	SUMMED
1.12	0.00E+00	0.00E+00	1.11E-03	1.11E-03	0.00E+00	0.00E+00	1.11E-03	1.11E-03
2.24	0.00E+00	0.00E+00	5.56E-04	1.67E-03	0.00E+00	0.00E+00	5.56E-04	1.67E-03
8.91	5.56E-04	5.56E-04	0.00E+00	1.67E-03	5.56E-04	5.56E-04	0.00E+00	1.67E-03
17.78	5.56E-04	1.11E-03	0.00E+00	1.67E-03	5.56E-04	1.11E-03	0.00E+00	1.67E-03
25.12	5.56E-04	1.67E-03	0.00E+00	1.67E-03	5.56E-04	1.67E-03	0.00E+00	1.67E-03

AVE FOR	GM/SQCM	DOSE	GM/SQCM	DOSE	GM/SQCM	DOSE	GM/SQCM	DOSE
SECTOR	9.84E+00	1.29E-04	1.02E+00	3.81E-03	9.84E+00	1.29E-04	1.01E+00	2.06E-03

SECTOR	INNER SURFACE	OUTER REGION	OUTER SURFACE	SOLID ANGLE FRACTION
24	*****ALL OTHER INNER/OUTER COMBINATIONS NOT LISTED*****			1.51E-01

GM/SQCM	INTRVL	SUMMED	INTRVL	SUMMED	INTRVL	SUMMED	INTRVL	SUMMED
.28	0.00E+00	0.00E+00	1.11E-03	1.11E-03	0.00E+00	0.00E+00	1.11E-03	1.11E-03
.40	0.00E+00	0.00E+00	1.67E-02	1.78E-02	0.00E+00	0.00E+00	1.67E-02	1.78E-02
.56	3.89E-03	3.89E-03	0.00E+00	1.78E-02	3.89E-03	3.89E-03	0.00E+00	1.78E-02
.79	7.22E-03	1.11E-02	0.00E+00	1.78E-02	7.22E-03	1.11E-02	0.00E+00	1.78E-02
1.12	6.67E-03	1.78E-02	0.00E+00	1.78E-02	6.67E-03	1.78E-02	0.00E+00	1.78E-02
1.58	0.00E+00	1.78E-02	5.56E-04	1.83E-02	0.00E+00	1.78E-02	5.56E-04	1.83E-02
2.24	5.56E-04	1.83E-02	2.22E-03	2.06E-02	5.56E-04	1.83E-02	2.22E-03	2.06E-02
3.16	1.11E-03	1.94E-02	1.11E-03	2.17E-02	1.11E-03	1.94E-02	1.11E-03	2.17E-02
4.47	1.67E-03	2.11E-02	0.00E+00	2.17E-02	1.67E-03	2.11E-02	0.00E+00	2.17E-02
6.31	1.11E-03	2.22E-02	3.89E-03	2.56E-02	1.11E-03	2.22E-02	3.89E-03	2.56E-02
8.91	2.22E-03	2.44E-02	0.00E+00	2.56E-02	2.22E-03	2.44E-02	0.00E+00	2.56E-02
12.59	1.67E-03	2.61E-02	1.00E-02	3.56E-02	1.67E-03	2.61E-02	1.00E-02	3.56E-02
17.78	4.50E-02	7.11E-02	8.56E-02	1.21E-01	4.50E-02	7.11E-02	8.56E-02	1.21E-01
25.12	5.28E-02	1.24E-01	2.44E-02	1.46E-01	5.28E-02	1.24E-01	2.44E-02	1.46E-01
35.48	2.06E-02	1.44E-01	5.00E-03	1.51E-01	2.06E-02	1.44E-01	5.00E-03	1.51E-01
50.12	6.11E-03	1.51E-01	0.00E+00	1.51E-01	6.11E-03	1.51E-01	0.00E+00	1.51E-01

AVE FOR	GM/SQCM	DOSE	GM/SQCM	DOSE	GM/SQCM	DOSE	GM/SQCM	DOSE
SECTOR	1.50E+00	6.29E-02	9.39E-01	6.65E-02	1.50E+00	6.29E-02	7.25E-01	5.61E-02

Table 109: (SIGTHK) Thickness Mapping

LOGARITHM MAP OF SLANT PATH THICKNESS, 3.5006E-01=1, 10*=11, 100*=21, ETC..
POLAR DOWN PAGE, AZIMUTHAL ACROSS, INTERVALS 1 THROUGH 18 OUT OF 60

1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2
4	4	4	4	4	4	3	3	3	2	2	2	2	2	2	2	2	2
4	4	4	4	4	4	3	3	3	2	2	2	2	2	2	2	2	2
5	5	5	5	4	4	3	3	3	3	2	2	2	2	2	2	1	1
6	6	6	5	5	4	4	3	3	3	3	1	1	1	1	1	1	1
7	7	8	6	5	4	4	2	2	2	1	1	1	1	1	1	1	11
8	11	12	12	10	9	4	2	2	2	1	1	1	1	1	1	1	13
15	16	16	14	13	11	5	2	2	2	1	1	1	1	1	1	1	13
16	16	16	15	14	14	12	7	11	16	17	17	15	1	1	1	1	13
16	16	16	15	14	14	14	8	11	16	17	17	15	1	1	1	1	13
16	16	16	15	14	14	14	8	11	16	17	17	15	1	1	1	1	13
15	15	15	15	14	14	14	8	11	16	17	17	15	1	1	1	1	13
16	17	16	15	14	12	9	3	12	16	17	17	15	1	1	1	1	13
16	16	14	13	11	14	11	14	12	14	15	16	14	2	2	1	1	13
16	16	13	12	10	11	4	14	3	2	10	12	1	3	3	3	2	13
16	14	12	12	11	8	4	4	3	3	2	2	2	13	6	3	3	13
16	15	16	15	14	13	13	16	3	3	3	3	3	12	4	3	3	12
18	17	16	13	12	12	11	12	13	3	3	3	3	3	3	3	3	10
18	16	15	12	10	10	10	11	11	12	16	3	3	3	3	3	4	10
17	17	17	11	10	10	10	10	10	11	12	15	3	3	3	3	10	13
17	15	13	11	10	10	15	12	10	10	11	12	17	3	3	3	11	14
16	15	11	11	10	10	15	15	12	10	11	11	13	4	4	4	11	12
17	13	12	11	11	10	16	15	10	10	12	12	13	14	5	5	5	5
20	18	17	17	16	15	12	12	12	13	16	16	16	17	6	6	11	15

POLAR DOWN PAGE, AZIMUTHAL ACROSS, INTERVALS 19 THROUGH 36 OUT OF 60

1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
2	2	2	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2
2	2	2	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2
2	2	2	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2
2	2	3	4	4	4	3	2	2	2	2	2	2	2	2	2	2	2
8	7	3	4	4	4	3	3	2	2	2	2	2	2	2	2	2	3
11	11	10	10	9	5	4	4	2	1	1	1	3	3	3	3	3	3
13	13	13	13	12	12	10	4	2	1	1	1	1	1	1	1	3	11
14	14	15	15	15	15	14	13	4	1	1	1	1	1	1	7	10	13
14	14	15	15	16	16	16	15	13	5	1	9	7	1	9	12	13	16
14	14	15	15	16	16	16	15	13	5	12	15	17	17	17	17	17	17
14	14	15	15	16	16	16	15	13	5	12	15	17	17	17	17	17	17

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Table 110: (SIGHIT) First Non-Void Region Map

MAP OF FIRST NON VOID OUTER REGION
POLAR DOWN PAGE, AZIMUTHAL ACROSS, INTERVALS 1 THROUGH 18 OUT OF 60

114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114
114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114
114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114
114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114
114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114
114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114
114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114
114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114
114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114
114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	117	117	117
114	114	114	114	114	114	114	114	114	114	117	117	117	117	117	117	117	117
114	114	114	114	114	114	114	117	117	117	117	117	117	117	117	117	117	117
114	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117
117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117
117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117
117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117
117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117
117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117
117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117
117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117
117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117
117	75	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117
117	75	117	75	117	117	117	117	117	117	117	117	117	117	117	117	117	117
117	75	117	75	117	117	117	117	117	117	117	117	117	117	117	117	117	117
117	117	117	75	117	117	117	117	117	117	117	117	117	117	117	117	117	117
117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117
116	116	117	117	117	117	117	104	104	117	117	117	117	117	117	117	117	117
116	116	116	116	116	117	117	117	104	117	117	117	117	117	117	117	117	117
116	116	116	116	116	116	113	113	116	116	117	117	117	117	117	117	117	117
116	116	116	116	116	116	116	116	116	116	111	111	111	116	116	116	116	116

POLAR DOWN PAGE, AZIMUTHAL ACROSS, INTERVALS 19 THROUGH 36 OUT OF 60

114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114
114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114
114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114
114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114
114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114
114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114
114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114
114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114
114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114	114
117	117	117	117	117	117	117	114	114	114	114	114	114	114	114	114	114	114
117	117	117	117	117	117	117	117	117	117	117	117	114	114	114	114	114	114
117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	114	114
117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117	117
117	117	117	117	117	4	12	117	117	117	117	117	117	117	117	117	117	117
117	117	117	117	117	4	12	117	117	117	117	117	117	117	117	117	117	117
117	117	117	117	117	4	12	117	117	117	117	117	117	117	117	117	117	117

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Table 111: (SIGSUM) Summary Output Table

SUMMARY OF solar flare

POINT	X	Y	Z				
GM/SQCM	DOSE	GM/SQCM	DOSE	GM/SQCM	DOSE	GM/SQCM	DOSE
3	-3.29E+01	5.20E+01	1.45E+02				
8.60E-01	1.84E+00	5.81E-01	1.75E+00	8.60E-01	1.84E+00	5.55E-01	1.84E+00

UNIT 29 OPENED EFKOUT.DAT

SUMMARY OF electron

POINT	X	Y	Z				
GM/SQCM	DOSE	GM/SQCM	DOSE	GM/SQCM	DOSE	GM/SQCM	DOSE
3	-3.29E+01	5.20E+01	1.45E+02				
4.49E-01	2.49E+00	3.67E-01	5.45E+00	4.59E-01	7.90E+00	3.67E-01	7.90E+00

SUMMARY OF bremss

POINT	X	Y	Z				
GM/SQCM	DOSE	GM/SQCM	DOSE	GM/SQCM	DOSE	GM/SQCM	DOSE
3	-3.29E+01	5.20E+01	1.45E+02				
1.50E+00	2.82E-02	9.38E-01	3.02E-02	1.56E+00	3.39E-02	9.48E-01	3.39E-02

SUMMARY OF geotail

POINT	X	Y	Z				
GM/SQCM	DOSE	GM/SQCM	DOSE	GM/SQCM	DOSE	GM/SQCM	DOSE
3	-3.29E+01	5.20E+01	1.45E+02				
5.16E-01	8.61E+00	3.94E-01	9.02E+00	5.16E-01	8.61E+00	4.06E-01	9.02E+00

Table 112: (SIGEFK) EFKOUT.DAT File Summary

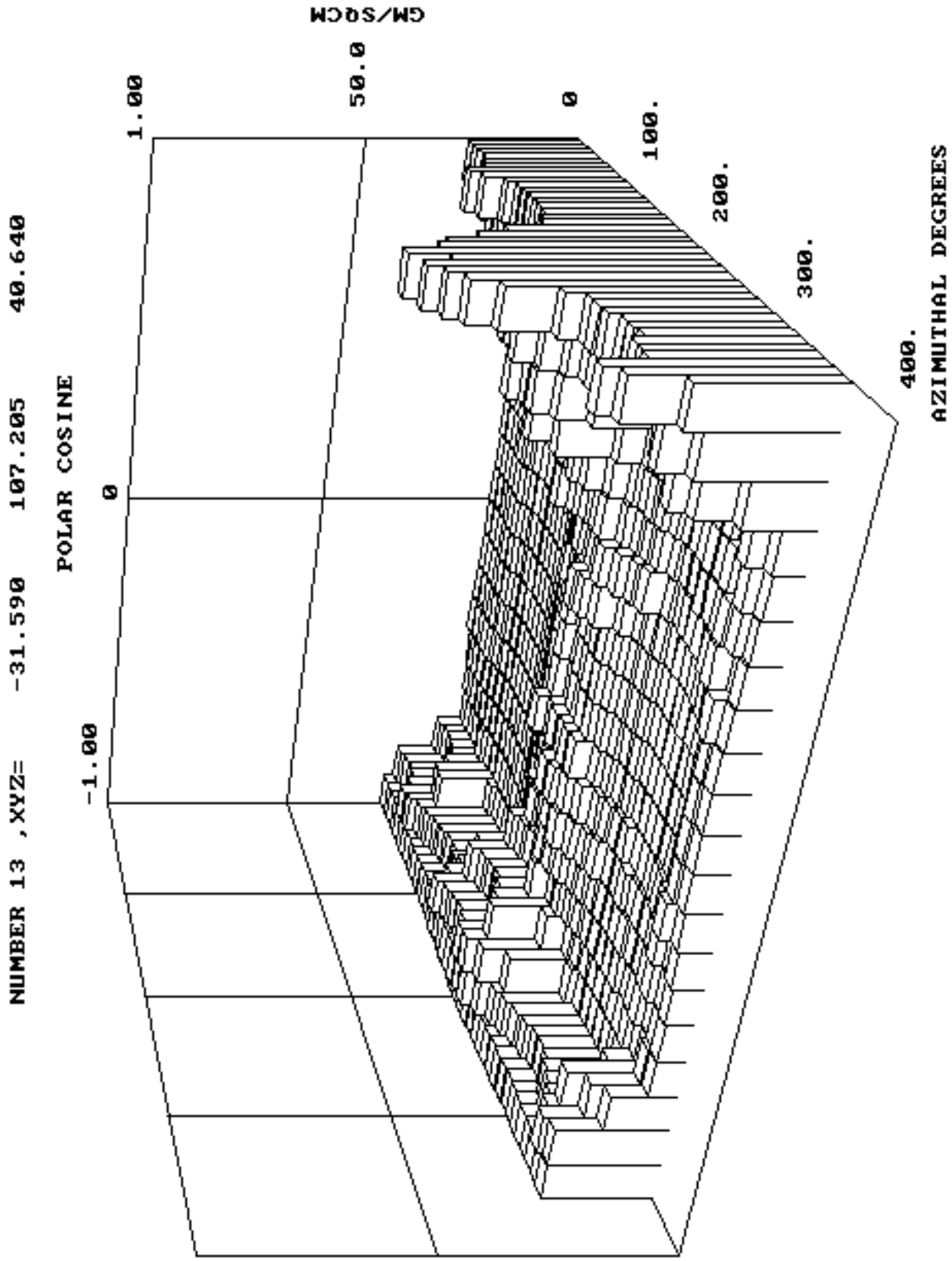
```
C     ATTEN AL USING APPROXIMATION SPHERICAL SHELL/SLANT PATH
 4.48E+01 1.69E+02 2.30E+02 2.26E+02 2.73E+02 1.87E+02 3.27E+01 9.11E+01
 1.04E+02 9.98E+01 1.27E+02 8.99E+01 3.19E+01
C     ATTEN AL USING APPROXIMATION SPHERICAL SHELL/MINIMUM PATH
 4.34E+01 1.57E+02 2.20E+02 1.87E+02 2.55E+02 1.83E+02 3.88E+01 8.08E+01
 1.08E+02 1.15E+02 1.24E+02 9.15E+01 2.92E+01
C     ATTEN AL USING APPROXIMATION SOLID SPHERE/SLANT PATH
 4.48E+01 1.69E+02 2.30E+02 2.26E+02 2.73E+02 1.87E+02 3.27E+01 9.11E+01
 1.04E+02 9.98E+01 1.27E+02 8.99E+01 3.19E+01
C     ATTEN AL USING APPROXIMATION SPHERICAL SHELL/CURVATURE
 4.48E+01 1.69E+02 2.30E+02 2.26E+02 2.73E+02 1.87E+02 3.88E+01 9.11E+01
 1.08E+02 1.15E+02 1.27E+02 9.15E+01 3.19E+01
C      P880-98 USING APPROXIMATION SPHERICAL SHELL/SLANT PATH
 1.78E+03 2.97E+03 3.53E+03 3.50E+03 3.91E+03 3.08E+03 1.66E+03 2.21E+03
 2.28E+03 2.27E+03 2.54E+03 2.21E+03 1.63E+03
C      P880-98 USING APPROXIMATION SPHERICAL SHELL/MINIMUM PATH
 1.61E+03 2.81E+03 3.37E+03 2.93E+03 3.75E+03 2.97E+03 1.52E+03 2.01E+03
 2.20E+03 2.32E+03 2.44E+03 2.14E+03 1.45E+03
C      P880-98 USING APPROXIMATION SOLID SPHERE/SLANT PATH
 1.78E+03 2.97E+03 3.53E+03 3.50E+03 3.91E+03 3.08E+03 1.66E+03 2.21E+03
 2.28E+03 2.27E+03 2.54E+03 2.21E+03 1.63E+03
C      P880-98 USING APPROXIMATION SPHERICAL SHELL/CURVATURE
 1.78E+03 2.97E+03 3.53E+03 3.50E+03 3.91E+03 3.08E+03 1.66E+03 2.21E+03
 2.28E+03 2.32E+03 2.54E+03 2.21E+03 1.63E+03
C      E880-98 USING APPROXIMATION SPHERICAL SHELL/SLANT PATH
 2.87E-04 2.39E+03 4.43E+03 4.18E+03 4.35E+03 1.92E+03 4.56E-08 4.91E+01
 8.93E+01 5.50E+01 7.59E+01 1.03E+01 3.30E-10
C      E880-98 USING APPROXIMATION SPHERICAL SHELL/MINIMUM PATH
 2.37E-02 4.56E+03 8.38E+03 6.52E+03 7.16E+03 2.88E+03 1.02E+00 1.25E+02
 3.76E+02 3.06E+02 1.83E+02 6.10E+01 4.32E-09
C      E880-98 USING APPROXIMATION SOLID SPHERE/SLANT PATH
 2.63E-03 5.21E+03 9.64E+03 9.12E+03 9.68E+03 4.41E+03 9.74E-08 2.05E+02
 3.64E+02 2.37E+02 3.31E+02 5.69E+01 2.20E-10
C      E880-98 USING APPROXIMATION SPHERICAL SHELL/CURVATURE
 2.37E-02 5.21E+03 9.64E+03 9.12E+03 9.68E+03 4.41E+03 1.02E+00 2.05E+02
 3.76E+02 3.06E+02 3.31E+02 6.10E+01 4.32E-09
C   BREM880-98 USING APPROXIMATION SPHERICAL SHELL/SLANT PATH
 7.72E+00 1.90E+01 2.56E+01 2.50E+01 2.83E+01 1.95E+01 7.05E+00 1.08E+01
 1.17E+01 1.13E+01 1.33E+01 1.05E+01 6.87E+00
C   BREM880-98 USING APPROXIMATION SPHERICAL SHELL/MINIMUM PATH
 8.71E+00 2.64E+01 3.70E+01 3.27E+01 3.66E+01 2.34E+01 8.26E+00 1.35E+01
 1.53E+01 1.49E+01 1.62E+01 1.27E+01 7.34E+00
C   BREM880-98 USING APPROXIMATION SOLID SPHERE/SLANT PATH
 7.93E+00 2.16E+01 2.97E+01 2.89E+01 3.28E+01 2.19E+01 7.18E+00 1.18E+01
 1.28E+01 1.23E+01 1.46E+01 1.14E+01 7.01E+00
C   BREM880-98 USING APPROXIMATION SPHERICAL SHELL/CURVATURE
 8.71E+00 2.64E+01 3.70E+01 3.27E+01 3.66E+01 2.34E+01 8.26E+00 1.35E+01
 1.53E+01 1.49E+01 1.62E+01 1.27E+01 7.34E+00
```

Table 113: (SIGSEC) SECTOR.DAT File

C epic-d ,XYZ= -32.900 52.000 144.900
1800

.364	.364	.364	.364	.364	.364	.364	.364	.364	.364
.364	.364	.364	.364	.364	.364	.364	.364	.364	.364
.364	.364	.364	.364	.364	.364	.364	.364	.364	.364
.364	.364	.364	.364	.364	.364	.364	.364	.364	.364
.364	.364	.364	.364	.364	.364	.364	.364	.364	.364
.364	.364	.364	.364	.364	.364	.364	.364	.364	.364
.391	.391	.391	.391	.391	.391	.391	.391	.391	.391
.391	.391	.391	.391	.391	.391	.391	.391	.391	.391
.391	.391	.391	.391	.391	.391	.391	.391	.391	.391
.391	.391	.391	.391	.391	.391	.391	.391	.391	.391
.391	.391	.391	.391	.391	.391	.391	.391	.391	.391
.391	.391	.391	.391	.391	.391	.391	.391	.391	.391
.422	.422	.422	.422	.422	.422	.422	.422	.422	.422
.422	.422	.422	.422	.422	.422	.422	.422	.422	.422
.422	.422	.422	.422	.422	.422	.422	.422	.422	.422
.422	.422	.422	.422	.422	.422	.422	.422	.422	.422
.422	.422	.422	.422	2.633	3.571	3.466	2.471	.472	.422
.422	.422	.422	.422	.422	.422	.422	.422	.422	.422
.459	.459	.459	.459	.459	.459	.459	.459	.459	.459
.459	.459	.459	.459	.459	.459	.459	.459	.459	.459
.459	.459	.459	.459	.459	.459	.459	.459	.459	.459
.459	.459	.459	.459	.459	.459	.459	.459	.459	.459
.459	.459	.459	.459	2.059	8.479	8.400	3.370	.459	.474
.478	.471	.459	.459	7.244	.459	.459	.459	.459	.459
.502	.502	.502	.502	.502	.502	.502	.502	.502	.502
.502	.502	.502	.499	.495	.495	.499	.502	.502	.502
.502	.502	.502	.502	.502	.502	.502	.502	.499	.495
.495	.499	.502	.502	.502	.502	.502	.502	.502	.502
.502	.502	.502	.502	.502	4.596	.502	.502	.502	.529
.534	.525	8.689	.502	.502	.502	.502	.502	.502	.502
.555	.555	.555	.555	.555	.555	.555	.555	.555	.545
.520	.502	.490	.482	.478	.478	.482	.490	.502	.520
.545	.555	.555	.555	.545	.520	.502	.490	.482	.478
.478	.482	.490	.502	.520	.545	.555	.555	.555	.555
.555	.555	.555	.555	.555	.555	.555	.555	.555	.585
6.265	9.147	.555	.555	.555	.555	.555	.555	.555	.555
.620	.620	.620	.620	.620	.620	.620	.607	.566	.535
.512	.495	.483	.476	.472	.472	.476	.483	.495	.512
.535	.566	.607	.566	.535	.512	.495	.483	.476	.472
.472	.476	.483	.495	.512	.535	.566	.607	.620	.620
.620	.620	.620	.620	.620	.620	.620	.620	.631	.652
.656	.649	.620	.620	.620	.620	.620	.620	.620	.620
.703	.703	.703	.703	.703	.703	.659	.604	.564	.535
.513	.497	.486	.479	.475	.475	.479	.486	.497	.513
.535	.575	.684	.575	.535	.513	.497	.486	.479	.475
.475	.479	.486	.497	.513	.535	.564	.604	.659	.703
.703	.703	.703	.703	.703	.703	.703	.703	.720	.735
.738	.733	.708	.703	.703	.703	.703	.703	.703	.703

Figure 115: (SIGTHI) Sector Mass Thicknesses



SIMPLE

SIMPLE describes simple geometry meshes.

****
The SIMPLE input processor accepts data to describe meshes in rectangular, cylindrical, or spherical geometries.
****

****
Input Data Record Description:
****

==========
Header line
==========

Contains *SIM in columns 1 through 4.

=======
Options
=======

O, overlap resolution, see OVERLAP appendix

****
Data Record Description:
****

Repeat the following as needed

==========
Simple Geometry Header
==========

NGT MTL RHO XT YT ZT /

where

NGT indicates the geometry, NGT=0 for rectangular,

NGT=1 for cylindrical with axial dimension along x

NGT=2 for cylindrical with axial dimension along y

NGT=3 for cylindrical with axial dimension along z

NGT=4 for spherical

The values for NGT can also be supplied as

XYZ, XCYlinder, YCYlinder, ZCYlinder, or SPHere.

MTL, material composition index, O for void

RHO, density in grams/cc, or density scale factor if flagged minus

XT,YT,ZT translation vector to local origin

==========
Mesh Boundaries
==========

If rectangular geometry, supply 3 records of boundaries

,x boundaries/,y boundaries/,z boundaries/ all in cm

If cylindrical geometry mesh, supply 2 records of boundaries

,radial boundaries/, axial boundaries/ both in cm

If spherical geometry, supply one record of boundaries

,radial boundaries/ in cm

++++++++++++++
Output Figures
++++++++++++++

Figure 116 (SIMXYZ) shows an example of a rectangular mesh.

Figure 117 (SIMXCY) is a cylindrical mesh parallel to the x axis.

Figure 118 (SIMYCY) is a cylindrical mesh parallel to the y axis

Figure 119 (SIMZCY) illustrates a cylindrical mesh with axis parallel to the z-axis.

An example of a spherical mesh is shown in Figure 120 (SIMSPH).

Figure 116: (SIMXYZ) Rectangular Mesh

```
TYPICAL *SIMPLE XYZ MESH INPUT
*PIC,Q=3,Z=3,G=97,T=3,M=1,J,L='SIMXYZ'
```

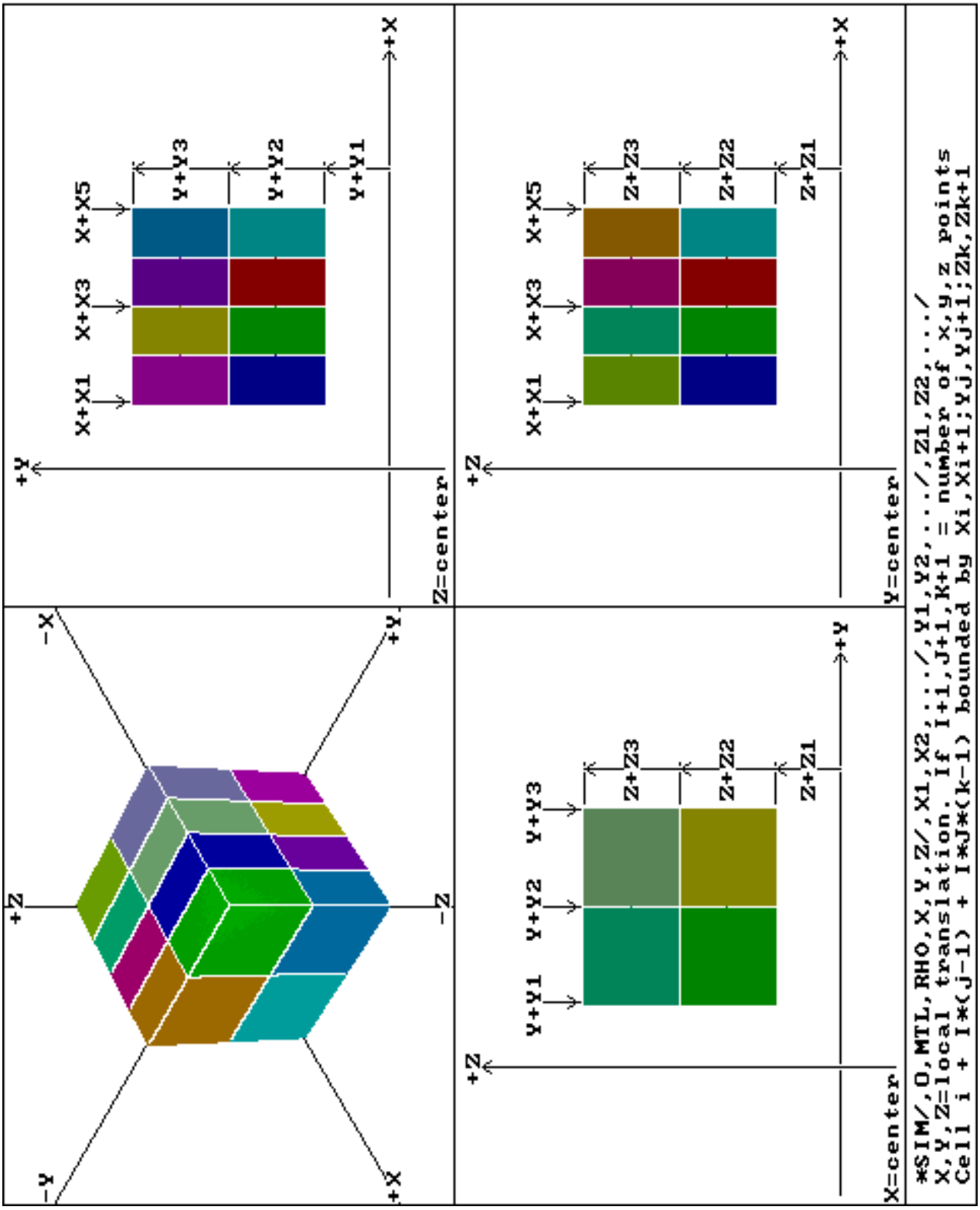


Figure 117: (SIMXCY) Cylinders Parallel to X-axis

```
TYPICAL *SIMPLE X-CYLINDER MESH INPUT
*PIC,Q=3,Z=3,G=97,T=3,M=1,J,L='SIMXCY'
```

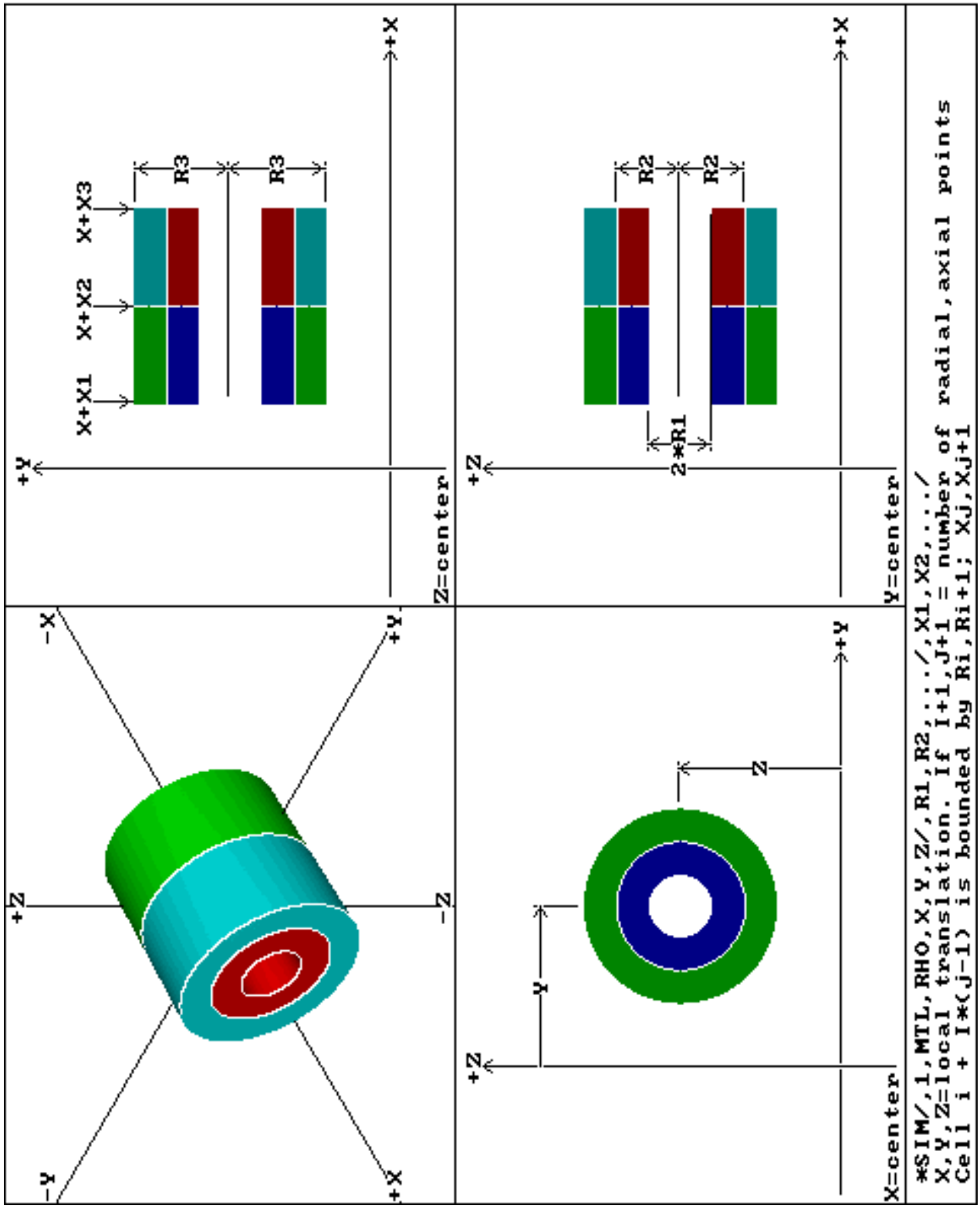


Figure 118: (SIMYCY) Cylinders Parallel to Y-axis

```
TYPICAL *SIMPLE Y-CYLINDER MESH INPUT
*PIC,Q=3,Z=3,G=97,T=3,M=1,J,L='SIMYCY'
```

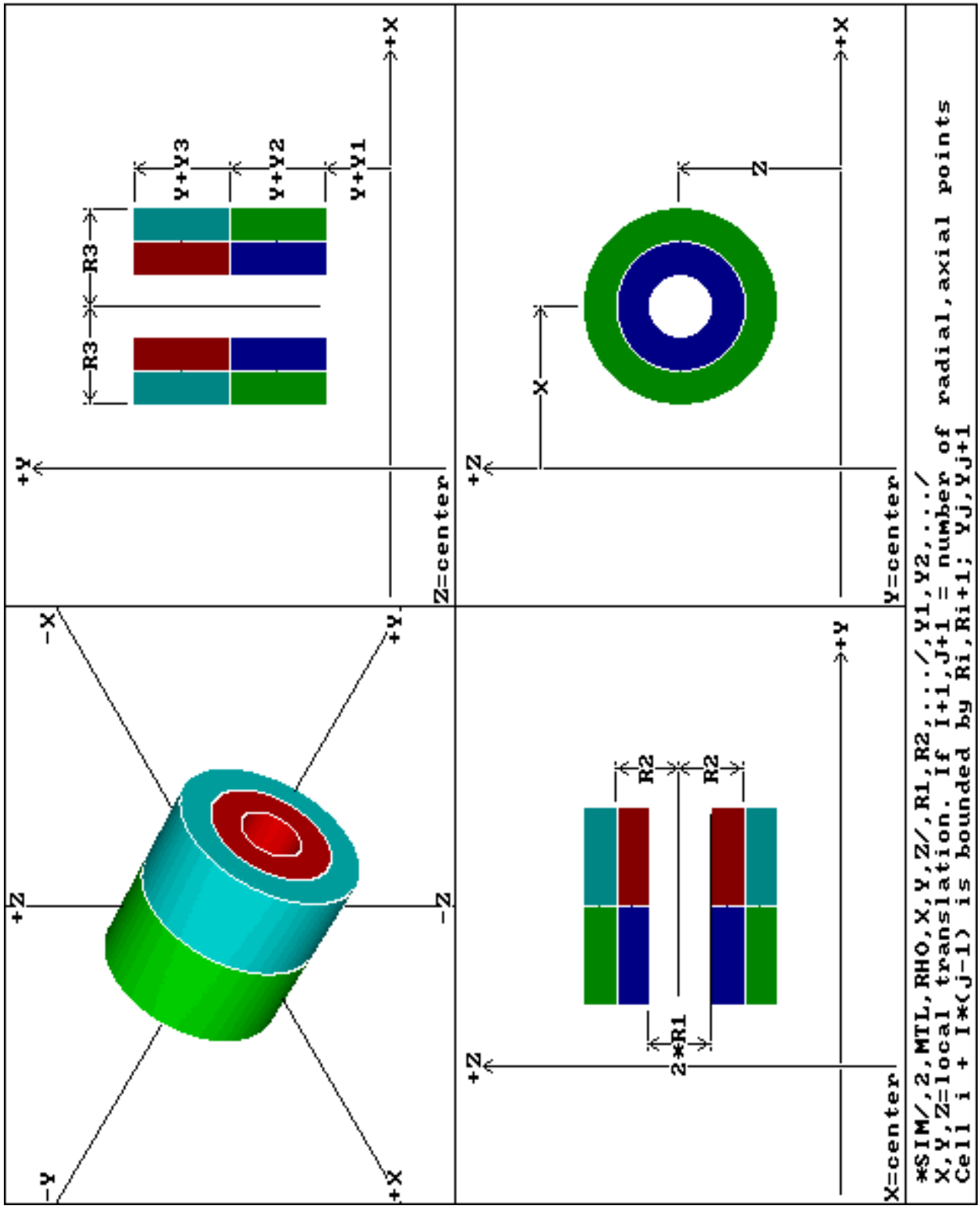


Figure 119: (SIMZCY) Cylinders Parallel to Z-axis

```
TYPICAL *SIMPLE Z-CYLINDER MESH INPUT
*PIC,Q=3,Z=3,G=97,T=3,M=1,J,L='SIMZCY'
```

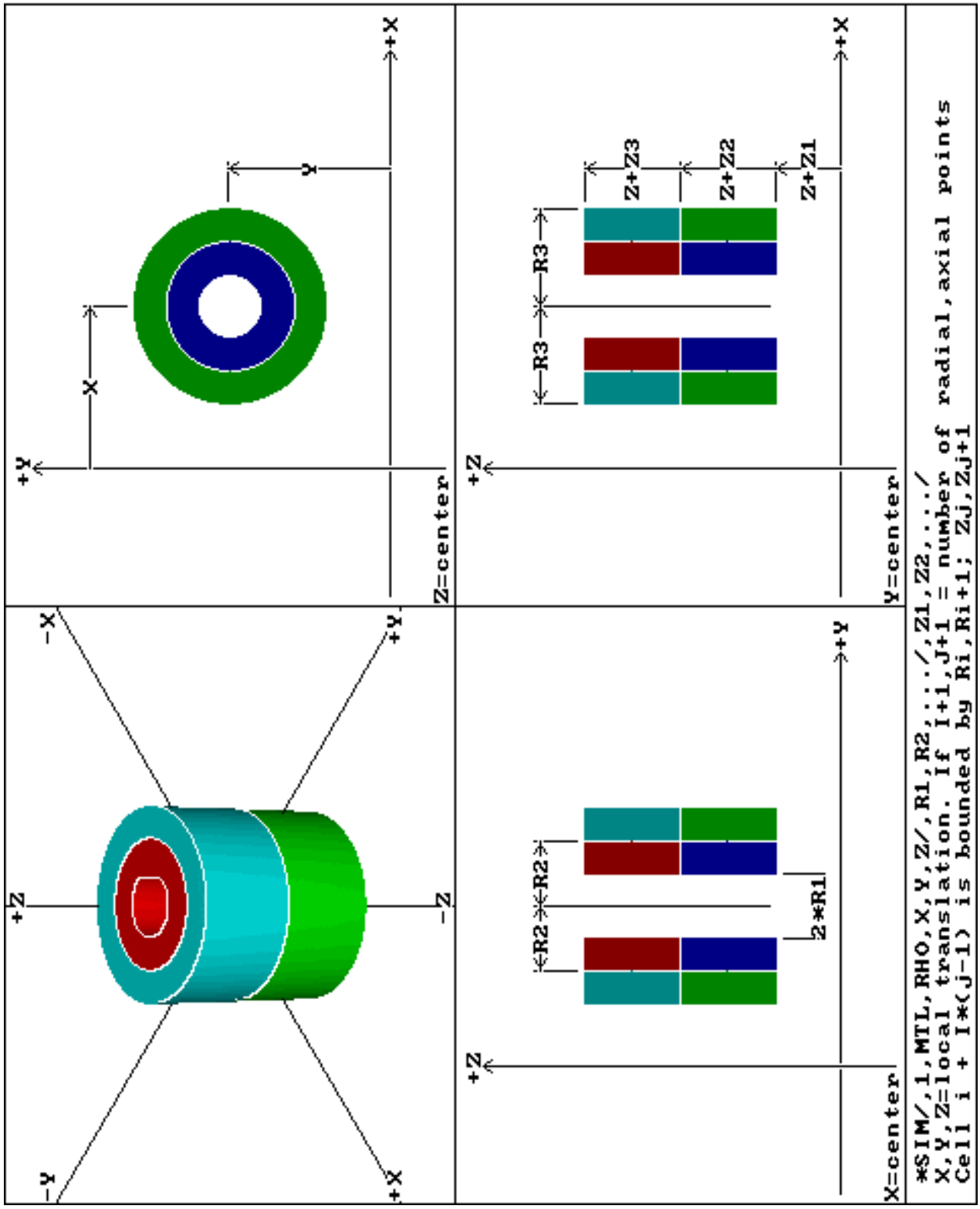
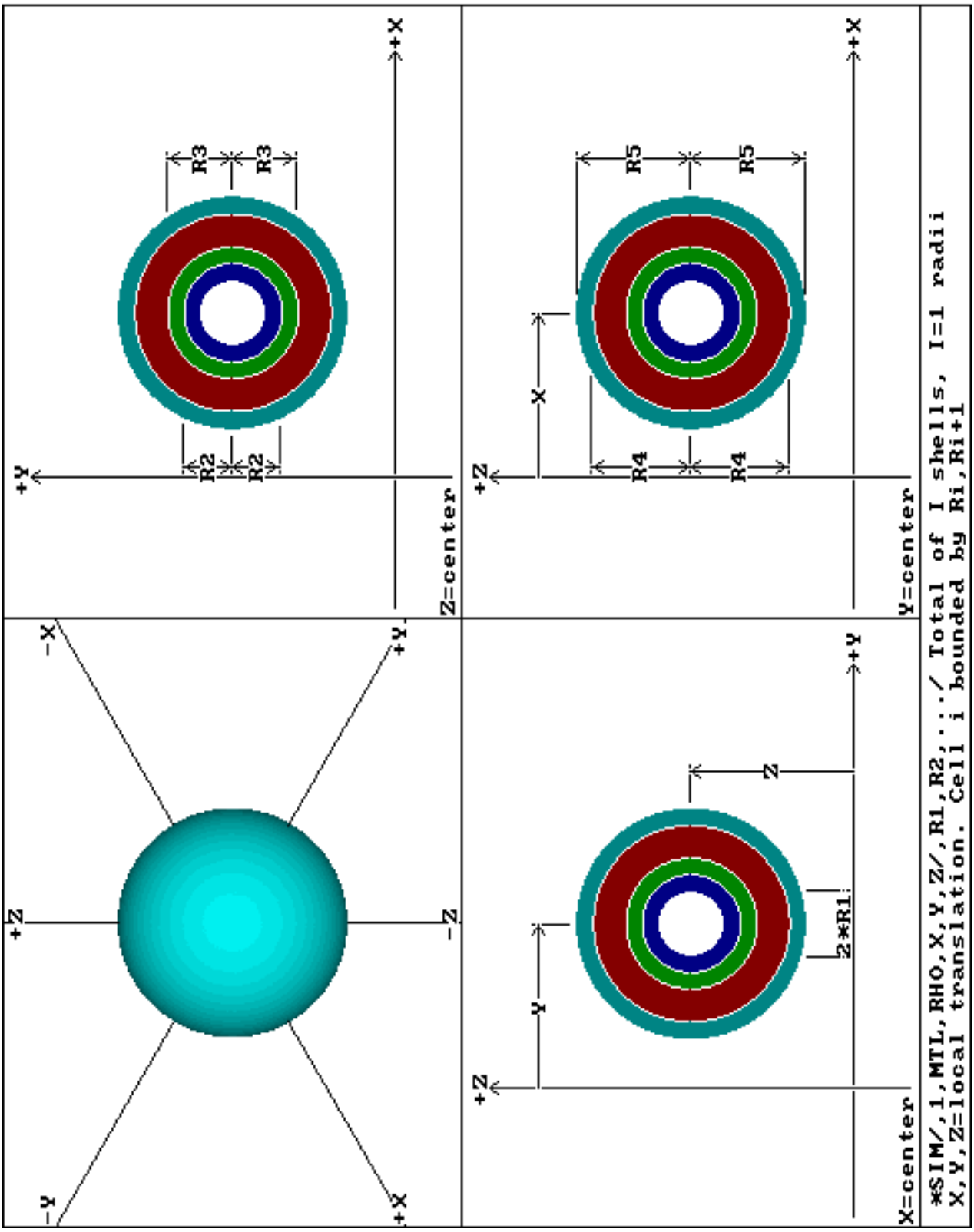


Figure 120: (SIMSPH) Spherical Mesh

```
TYPICAL *SIMPLE SPHERICAL SHELL INPUT
*PIC,Q=3,Z=3,G=97,T=2,M=1,J,L='SIMSPH'
```



SKIP

SKIP is used to ignore parts of an input file.

****
The *SKIP command is used to simplify skipping unused data in an input file, e.g., *picture commands after checkout is completed.
****

++++++++++
Discussion
++++++++++

The four characters *ski must be the first non-blank characters on a line and must start before column 72 (shifted to the right helps find them for use in a future calculation). All lines, including any &GET commands, are ignored until the sequence *ENDSKI is seen as the first seven non blank characters on a subsequent line. Either upper or lower case can be entered. The skipped lines are listed in the output file. The word jump can be used in place of skip.

SOCODE

SOCODE calculates a minimum weight shield configuration.

****
SOCODE is a post processor for SIGMA output (C option) that calculates a weight optimized shield distribution around multiple electronic parts.
****

****
Input Data Record Description:
****

==========
Header line
==========

Contains *SOC in columns 1 through 4.

Options

A, allow different thickness increments for each shield surface
A=a, do not change thickness increment until 'a' thickness peals follow 'a' increments of the same shield.

B=b, dose functional (0,1) = (all, positive--above constraint)

C, use derivatives rather than finite variations for building shields.

E, convergence criterion, e.g., .01 is within one percent of dose criterion.

F, dose functional forcing function is $(D/D0 - 1)^F$, use F=2

I, dose versus thickness interpolation (1,2) = (lin/log,log/log)

J, multiple crossing effects (1,2) = (add thicknesses,calculate equivalent thickness to give same dose on subsequent shield)

M, maximum number of iterations, e.g., 99999

N, subtraction frequency, e.g., 3, every Nth iteration decrementa shield thickness by 1/2 of the current positive shield thickness increment.

P, intermediate print frequency (to unit 67, SOCODE.DAT)

S, allow peal if dose increasess with thickness (vot typical)

T, initial thickness increment, e.g., .01 cm.

Comment: If an old SOCODE.DAT file exists, initial values for the shield thicknesses are read from this file.

****
Data Record Description:
****

==========
Dose Functions
==========

Dose Functions, One record for each containing:

Multiplier for the dose function, e.g., how many times this the detector/shield combination appears in the configuration.

Dose Constraints

Dose function constraint are quads of data containing:

Detector index, Dose Kernel Index, Attenuation Model Index, Dose multiplier.

This input is terminated by a blank record, i.e., ,/

==========
Shield Repetition Factors
==========

Shield repetition factors are a single record indicating how frequently each shield appears in the total configuration, e.g., 1. for the first shield (a box containing the detectors and part shields), and other multiples as required for absolute and relocatable part shields.

==========
Initial Shield Thickness (paired with next record)
==========

Initial shield thicknesses/

==========
Maximum Shield Thickness (paired with above record)
==========

Maximum shield thicknesses/

The two records for each shield contain initial and maximum thickness for each side in order -x, +x, -y, +y, -z, and +z/

==========
Shield Geometry Constraints
==========

Shield geometry constraints/

The constraints on equality of shield thicknesses, two integers for each side of the shield in the order -x, +x, ..., +z where the first integer is the index of a lower numbered shield and the second integer is the side of the lower numbered shield (1=-x, 2=+x, ..., 6=+z). If the two integers are zero, the surface has its own unique thickness. If non zero, the thickness is forced to be the same as the thickness of the indicated shield and side.

****
Discussion
****

The shield is built by adding incremental thickness to shield surfaces (accounting for area increases due to the other wall thicknesses) based on finding the maximum change in the dose constraint for the minimum change in weight. When weight is subtracted, it is subtracted from the wall giving the minimum increase in dose for the maximum change in weight.

SOFIP

SOFIP calculates trapped electron and proton spectra.

****
The SOFIP processor uses SOFIP and TRECO in NOVICE for calculating orbits with B/L coordinartes and for generating trapped electron and proton spectra for those orbits.
****

****
Input Data Description
****

==========
Header Line
==========

This line must contain *SOF in columns 1 through 4.

=======
Options
=======

A, (rea,sec,eps,inf) orbit step size, default ??

B, (alpha) basic name for spectra save (auto load?)

C=c, confidence interval (percent) for SOLPRO model.

E, (rea,mev,eps,inf) electron energy for sofiporb file

F, (rea,mev,eps,inf) flare energy for sofiporb file

G, (int) selects shorbt review of sofiporb.dat file

H, show orbit track on earth view

L, (int,,1,360) parametric delta longitude

M=m, mission length in months (to scale trapped and for flare statistics)

P, (rea,mev,eps,inf) proton energy for sofiporb file

R, do not rewind the spectrum file, 76=sofipout.new

S, (int,,1,64,4) skip earth view frames

T=t, units on thicknesses in shieldose output file, (1,2,3) = (mils,g/cm2,mm), default is mils.

****
Data Record Description
****

==========
Orbit Parameters
==========

apo,per,lat,lon,inc,dur,mdl,yr1,...yr10/

where:

apo is the orbit apogee (min altitude) in kilometers

per is the orbit perigee (max altitude) in kilometers

lat is the initial orbit latitude (degrees)

lon is the initial orbit longtitude (degrees)

inc is the orbit inclination (degrees)

dur is the orbit duration (hours)

mdl is the b field model (1 through 7)

yr1 ... yr10 are up to 10 years to evaluate b/l values.

==========
Particle Models
==========

year, cutoff/

year determines if solar min or solar max models apply

cutoff, if non zero truncates the orbit file reading.

SHIELDOSE Thicknesses

,t1 t2 ... tn/

where the thicknesses are used to prepare a SHIELDOSE input file. Units of thickness are specified using the T option.

Input Tables

Table 114 (SOFIPD) gives an example of input data for a run of TRECO (orbit generation) and SOFIP. Table 115 (SOFSEL) is input for a TRECO/SOFIP run followed by runs of the original and revised versions of SHIELDOSE

Table 114: (SOFIPD) Example of SOFIP Input Data

```
*sofip
35786.                          apogee
35786.                          perigee
0.                              latitude
200.                            longitude
0                               inclination
48.                             duration
5                               b model
1960.                           first year
1965.                           second year
-1.                             terminate year input
2000.                           year for solar min/max
48.                             length of orbit
1.                              yes omit calc
0.                              shieldose use default
*dump,bltj/
```

Table 115: (SOFSEL) SOFIP/SHIELDOSE Input Data

```
*sofip,m=180            $     mission length in months, 15 years
       c=95             $     95 percent confidence interval
       t=2              /     thicknesses in cm*g/cc
c treco input (orbit and b/l coordinates)
35786.                  $     apogee
35786.                  $     perigee
0.                      $     latitude
200.                    $     longitude
0                       $     inclination
48.                     $     duration
5                       $     b model
1960.                   $     first year
1965.                   /     second year

c sofip input
2000.                   $     year for solar min/max determination
48.                     /     length of orbit, full orbit if not input

.01 li40*100            /     shieldose thicknesses, no input=default

*seltzer,v=1            /     run original shieldose version

*seltzer,v=2,d/         /     run second shieldose version and doscon

c doscon input data
.1                      $     first inner radius
1.                      $     second inner radius
10.                     $     third inner radius
100.                    /     fourth inner radius
*stop
```

SOLAR

SOLAR calculates probabilistic flare environment

****
The SOLAR processor calculates parameters for a probabilistic
flare model (solar particle events).
****

****
Input Data Description
****

==========
Header Line
==========

Must contain *SOL in columns 1 through 4.

=======
Options
=======

A=a, minimum year for flare occurence.

B=b, maximum year for flare occurence.

C=c, minimum flux level for the flare.

D=d, maximum flux level for the flare.

E=e, multiplier for exp(log mean flux) for two section log normal.

F=f, number of intervals for multi section log normal using
flares ranked by size.

G, if present multiply log normal moments by n/(n-1), ...,
n/(n-3).

H, if present, calculate integral fluxes for different missions
and confidence levels.

I, if present, time filter is less than min and greater than max

J, (int,,1,99) add this number of flares to the population

K, (real,,eps,inf) added flare size is k * population max

L, if present, used add flare for h option calculations

M, (real,,eps,inf) get frequency for m year periods

N, if present, compute statistics for all timer intervals of M option

O, if present, use max flares per year as frequency

****
Description of Input Data Recordls
****

==========
Mission Lengths (H option)
==========

years1 years2 ... yearsn /

where years1, etc., are the missiion durations in years.

Omit this record if no H option.

==========
Confidence Levels (H option)
==========

fraction1 fraction2 ... fractionm/

where fraction1, etc., are the confidence levels expressed as fractions.

Omit this record if no H option.

==========
Fluence by Confidence Level
==========

mev, fluence, sigma, freq1, years1, ..., freqn, yearsn/

where

mev is the energy in mev,

fluence is exp(log mean fluence) for the integral fluence at the energy mev,

sigma is the square root of the variance of the log normal distribution,

freq1, is the flare frequencey (per year) for mission 1,

years1, is the length in years of mission 1,

...

freqn, is the flare frequency (per year) for the last mission, and

yearsn, is the length in years of the last mission.

This record can be repeated as needed (or omitted altogether).

****
Discussion
****

The SOLAR processor performs two functions. The first function is the calculation of parameters (variance and log mean flux) for two flare libraries. One library is pre cycle 22 and has limited threshold data at 10, 30 and 100 (or is it 60) mev. The second library is a complete set of flares from cycle 22 with energy points running from 1 through 300 mev.

The second function calculates fluence levels for different confidence levels. Input is the variance and the geometric mean flux (exp(log mean flux)) plus the mean flare occurence per year and the length of the mission in years. These inputs can be obtained from the first function (requires multiple runs) or from an external analysis. The H option does an automatic calculation for all energies.

++++++++++++
Input Example
++++++++++++

Table 116 (SOLARD) is an example of input data for a SOLAR run.

Table 116: (SOLARD) Example of SOLAR Input Data

```
*solar,  a=1000   $ no flares before this year
         b=2000   $ no flares after  this year
         c=1-20   $ no flares with fluence lower than this
         d=1+20   $ no flares with fluence greater than this
         e=.1     $ for small/large passes use .1 times mean log
         f=2      $ divide data into two sets based on rank
         h        / generate integral spectra for all 23 energies
c         g        / put n/(n-1) ... factors in statistics

2 5 10 15 20/ mission durations
.8 .9 .95 .99/ confidence fractions

*stop

c repeat the following line as needed for multiple cases
  10          $ energy threshold (used to pickup average fluence)
2.46 4.62+7   $ variance and flux level
5.38   2      $ 2 year missio
5.38   5      $ 5 year mission
5.38   10     $ 10 years
5.38   15     / 15 years

  30
1.98 1.14+7   $
6.34   2      $
6.34   5      $
6.34   10     $
6.34   15     /

 100
2.52 2.71+6   $
1.33   2      $
1.33   5      $
1.33   10     $
1.33   15     $
 6  2   6 5   6 10   6 15/    lie to it about frequency only

10 2.67   2.44+7   9.42 2  9.42 5  9.42 10  9.42 15/
30 2.51   4.12+6   9.42 2  9.42 5  9.42 10  9.42 15/
100 2.05  4.42+5   9.42 2  9.42 5  9.42 10  9.42 15/

*dump,bltj/
*stop
```

SOURCE

SOURCE describes the spatial/angular source distribution.

```
*****************************************************************
The SOURCE input processor accepts descriptions of point sources
or/and distributed line, surface, and volume sources in
rectangular, cylindrical, and spherical geometries.
*****************************************************************
```

Header line

Contains *SOU in columns 1 through 4.

Options

A, present, or A=O, sources are isotropic

A=1, sources have cosine angular distribution

A=2, sources have tabulated angular distribution

B, angle bin input (2 azimuth, 2 polar)

C, multichannel input

D, if present, omit relative distribution (assumed flat); i.e., input the points put not the relative strength.

G, group boundary input

H, (real,,eps,inf) if box lims identical use=-eps, default 1 micron

O=o, overlap option, see *OVERLAP section.

S, if present, generate a body for all non-point sources

P, periodic/reflective boundary condition inputs spatial/angular

T, if present, a tabulated time distribution is input

R, if present, generate a region for any volume sources

V, voxel file, 'name'.mcn, value = material

****
Data Record Description
****

Repeat from here as needed.

==========
Source Parameter Data
==========

For point isotropic sources, the input is

'NAME' X Y Z /

where the name is truncated to 12 characters and X,Y,Z are the location of the source.

For distributed sources, the first line is (NSG=O for point angular)

'NAME' X Y Z NSG NLK NAX MTL RHO /

where NAME is truncated to 12 characters, (X,Y,Z) are a local translation vector,

NSG=1, 2, or 3 for rectangular, cylindrical, or spherical geometry

NSG can also be specified as POInt, XYZ, CYLinder, or SPHere.

NLK=0 if this source has unique distributions

NLK=n if this source has distributions like source n

NAX=0 or 3, the geometry is referenced to the z axis

=1, the geometry is referenced to the x axis

=2, the geometry is referenced to the y axis

NAX can also be specified as XAXis, YAXis, or ZAXis.

MTL, RHO give the composition and density for the region generated with the R option.

Distributions are omitted if NLK is greater than zero.

The inputs for SOURCE and DETECTOR are identical except for the header line.

Spatial/Angular Distributions (non point)

Up to six distribution functions are used to describe distributed SOUrces (and DETectors). These distributions are input immediately following the NAME line and consist of

$F(V_1)$, $F(V_2)$, and $F(V_3)$ for spatial distributions

$F(V_4)$ and $F(V_5)$ for angular distributions (input if A=2)

$F(V_6)$ for the time distribution (input if T option)

The spatial distribution variables depend upon the geometry and the user axis as follows

NSG = 1 (rectangular)	NAX=1	NAX=2	NAX=3
V1 = user x	code y	code z	code x
V2 = user y	code z	code x	code y
V3 = user z	code x	code y	code z

NSG= 2 (cylindrical)

V1 = user r: code $r^2 = y^2 + z^2$ $z^2 + x^2$ $x^2 + y^2$

V2 = user azimuth: measured from the user x axis (see NSG=1 for the defintion of the user x axis)

V3 = user z code x code y code z

NSG = 3 (spherical)

V1 = user r: code r^2 $x^2 + y^2 + z^2$

V2 = user azimuth: measured from the user x axis (see NSG=1 for the defintion of the user x axis)

V3 = user polar cosine: measured from user -z axis (see NSG=1 for the definition of the user z axis)

The angular distributions are azimuth, $F(V_4)$, and polar cosine, $F(V_5)$. The azimuth and polar cosine are measured from the user (x,-z) axes, i.e., the code (y,-x) axes if NAX=1, from the code (Z,-Y) axes if NAX=2, and from the code (X,-Z) axes otherwise.

Each distribution, the three sptial, and the two angular and time distributions if required, are tabulated as:

,X/,F(X)/ where X denotes V_{-1} or V_{-2} or ...

i.e., two data vectors of the same length. Alternatively, each distribution can be tabulated as:

,/,X_1 $F(X_1)$ X_2 $F(X_2)$ ... /

and, if the relative distribution, F(X), is constant, which it is
-
for many source variables, the distribution can be input as

```
,X X X .../,/
  1 2 3
```

If the source is a point, NSG=0, or has spatial distributions like another source, NLK>0, spatial distributions are not input. If A<2 or absent, or the source has distributions like another source, NLK>0, angular distributions are not input.

If the T option was not present, or the source has distributions like another source, the time distribution is not input.

++++++++++++++
Output Figures
++++++++++++++

Example of a volume source in XYZ geometry is shown in Figure 121 (SOUXYZ).

Figure 122 (SOUCYL) is an example of a cylindrical volume source.

A spherical volume source example is show in Figure 123 (SOUSPH).

Figure 121: (SOUXYZ) Rectangular Source Volume

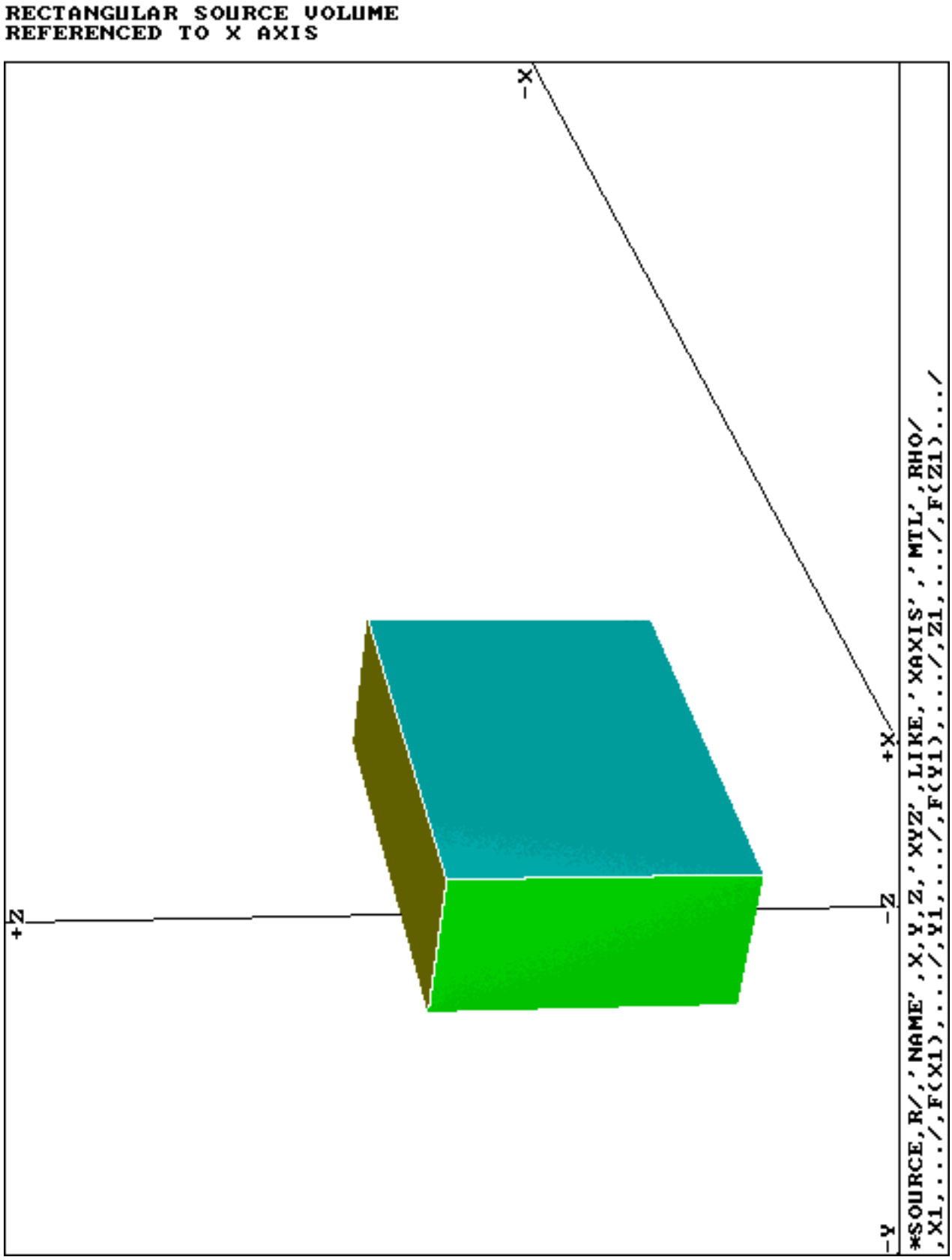


Figure 122: (SOUCYL) Cylindrical Source Volume

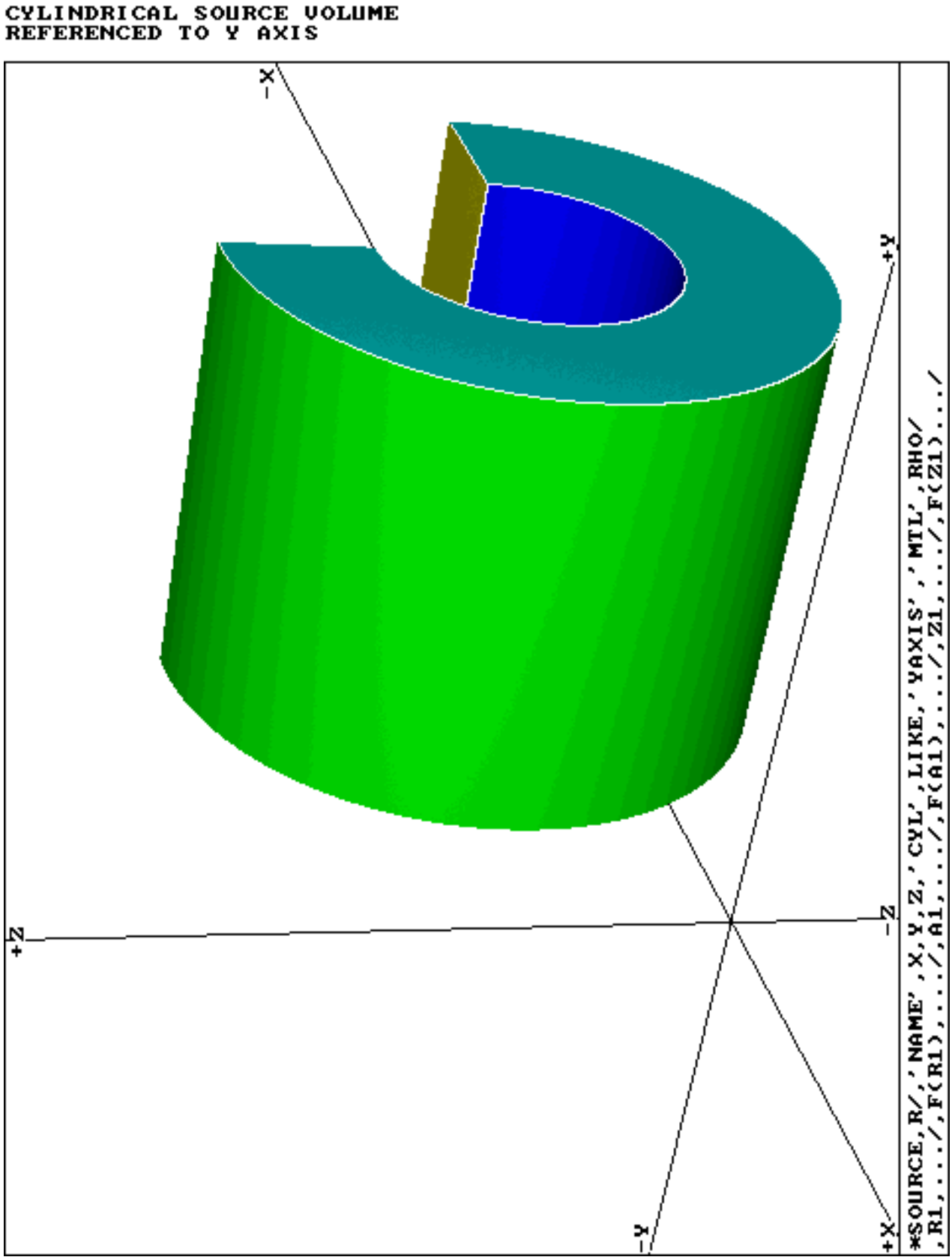
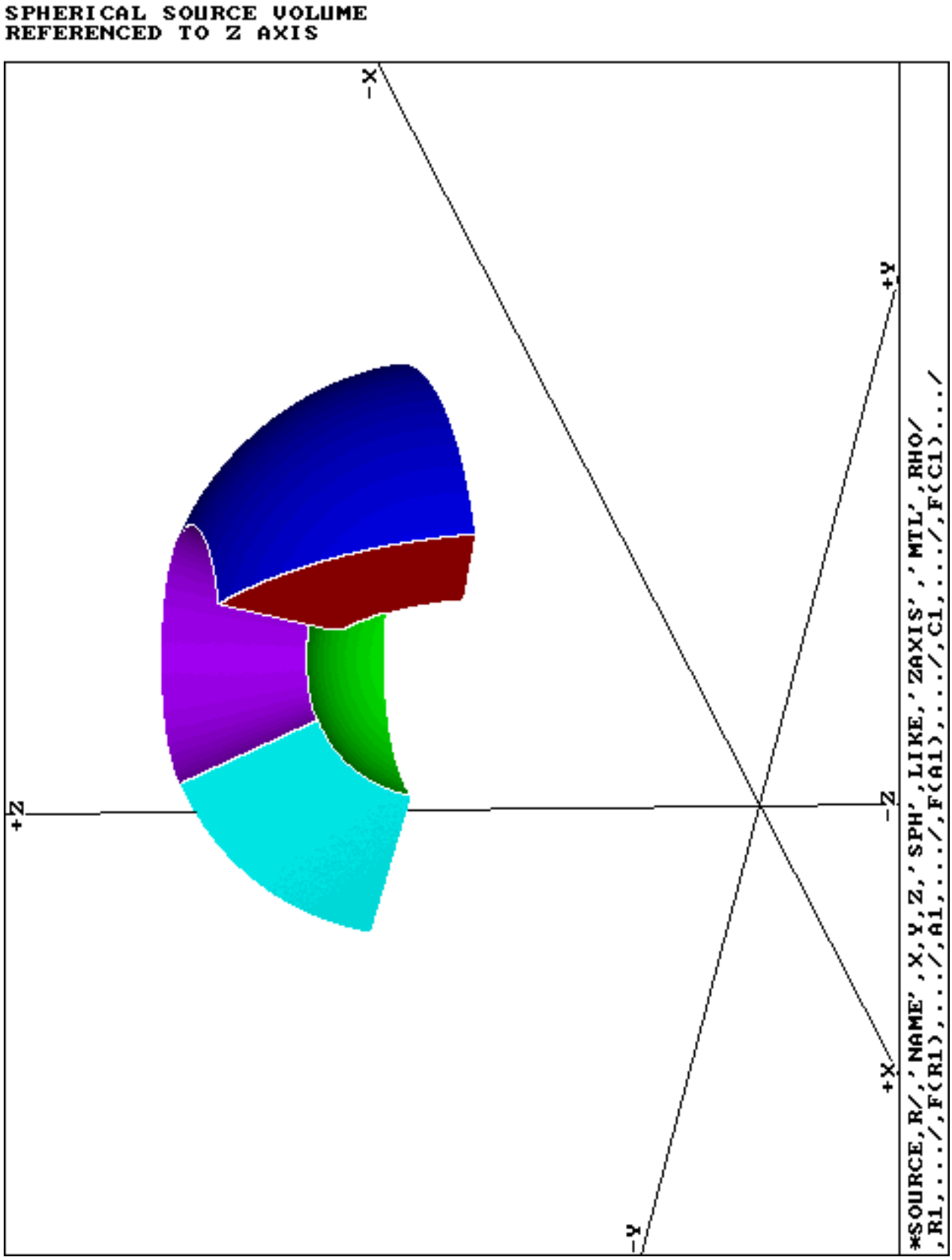


Figure 123: (SOUSPH) Spherical Source Volume



SPARES

SPARES sets up storage for post *EXE geometry data

****
The SPARES processor will setup storage for geometry so that geometry can be loaded after the *EXE processor.
****

****
Discussion
****

In progress.

SPECTRUM

SPECTRUM describes the particle spectra.

****
The SPECTRUM input processor accepts data describing the energy distribution of particle source spectra.
****

****
Input Data Record Description:
****

==========
Header line
==========

Contains *SPE in columns 1 through 4.

=======
Options
=======

A, (alpha) use esp spectrum output

B, (alpha) geomag shielding file for esp spectrum

C, (alpha) output file from processing esp and geomag

E, if present, NORM options 1,4,6, and 8 are in gram calories instead of MeV, i.e., the input S is multiplied by 2.6114E13 MeV per gram calorie if NORM=1,4,6, or 8 and the 'E' option is present.

R, if present, subtract spectrum from 1.0(or r=value), ITS flip?

****
Input Data Records:
****

Repeat from here as needed

==========
Spectrum Header Parameters
==========
The first line contains

'NAME' Z A ISP S NORM EMIN EMAX ALPH BETA ENORM/

where NAME is truncated to 12 characters

Z,A identify the particle type, see Table 1 of the introduction

ISP, >= 0, a tabulated spectrum, see tabulated spectra table

<0, an anlytic spectrum form, see analytic spectra table

S, spectrum normalization constant

NORM, how to use S, see spectrum normalization table

EMIN,EMAX minimum and maximum energies for analytic spectra

EMIN,EMAX are extrapolation limits for ISP=8 through 14 if non.

ALPHA,BETA parameters for analytic spectra

ENORM, another normalization constant for more exotic NORMs

This line can be slash terminated at any point where the remaining parameters do not apply, e.g., for a tabulated spectrum and NORM < 2
-

,'NAME' Z A ISP S NORM/

New options added (98Jun03) for correction of heavy ion spectra for geomagnetic shielding (protons or heavier ions). After the ALPHA and BETA parameters (supply zeroes if needed to space over EMIN, EMAX, ALPHA, and BETA), then input H1, H2, A1, A2, A3, Q/ where H1 is perigee, H2 is apogee, A1 is inclination, A2 is initial longitude, A3 initial latitude?, and Q is 0 for earth shadowing, 1 for no shadowing, and 2 for no shadowing and correction (original CREME) for reduced geomagnetic shielding due to "stormy" conditions.

==========
Tabulation Energies (if ISP implies TAB, paired input)
==========

Tabulation energies/

==========
Tabulated Spectrum (paired with above input)
==========

Tabulated spectrum/
Thus the first record contains tabulation energies, MeV or MeV/amu. The second contains the corresponding differential, group integrated, or integral spectrum.

++++++++++++
Input Tables
++++++++++++

The data strings required for tabulated spectra are given in Table 117 (SPETAB).

The analytic spectra forms use the ALPHA and BETA parameters and the formulas shown in Table 118 (SPEANA).

The normalization options are indicated in Table 119 (SPENOR).

Table 117: (SPETAB) Tabulated Spectra Options

```
ISP            Data Vectors

0 ,E/ ,n(E)/                    (DNL)differential number spectrum
   -   ----

1 ,E/,En(E)/                    (DEL)differential energy spectrum
   -  -----

2 ,E  /,n  /                    (GNL)number in group spectrum
   - g  - g

3 ,E  / ,E  n  /                (GEL)energy in group spectrum
   - g   - g- g

4 ,E/,n(>E) /                   (INL)integral number spectrum
   -

5 ,E/,I(>E) /                  (IEL)integral energy spectrum
   -

6 ,E/,P/          (PNL)discrete energy/probability spectrum
   -  -

7 ,E/,EP /  (PEL)discrete energy and energy weighted probability
   -  --
spectrum
```

Interpolation on the above is linear when needed. On the following, power law interpolation is used.

8, like 0, differential number spectrum (DNP)

9, like 4, integral number spectrum (INP)

10, like 1, differential energy spectrum (DEP)

11, like 5, integral energy spectrum (IEP)

12, like 8, except exponential interpolation (DNE)

13, like 9, except exponential interpolation (INE)

20, add spectra option (ADD), first record is spectra indices and second record is scale factors.

Table 118: (SPEANA) Analytic Spectra

ISP Spectrum

-1 fission neutron (FISsion)

$$n(E)=\exp(-E/.965).\sinh[\ \mathrm{sqrt}(\ 2.29E\ )\ ]$$

-2 black body (BLAck)

$$n(E)=E^{2}/(\exp(E/\mathrm{alpha})\ -\ 1)$$

-3 fission gamma (GAMma)

$$n(E)=\exp(-E/\mathrm{alpha})$$

-4 gaussian (GAUssian)

$$n(E)=\exp(-((E-\mathrm{alpha})^{2}/\mathrm{beta})\ )$$

-5 gaussian (FULl_width) (input BETA (beta')is full width at half max)

$$\mathrm{beta}\ =\ \mathrm{beta'}\ /\ 2\ \mathrm{sqrt}(\ \ln(2)\ )$$

-6 beta decay (BETa), ALPHA is max energy

$$n(E)\ =\ (E\ +\ mc^{2}\ )\ (\mathrm{alpha}^{2}\ -\ E)\ \ \mathrm{sqrt}(\ E^{2}\ (E\ +\ 2mc\ )\ )$$

-7 beta decay with corrections (CORrections)

not implemented

-8 poisson (POIsson)

$$n(E)=E^{\mathrm{alpha}}\ \ \exp(-E/\mathrm{beta})$$

-9 self rectified

not implemented

Table 119: (SPENOR) Normalization Options

NORM	Interpretation of S
0 (NUMber)	total particles
1 (ENErgy)	total energy, MeV
2 (SCAle)	multiplicative constant
3 (NOG)	S=n(ENORM) particles/MeV at energy ENORM
4 (EOE)	S=ENORM * n(ENORM), MeV/MeV at energy ENORM.
5 (NOG)	$S=n_{ENORM}$ (particles in group ENORM)
6 (EOG)	$S=E_{ENORM} * n_{ENORM}$ (energy in group ENORM, MeV)
7 (NGT)	$S=\int_{ENORM}^{Emax} n(E)\,dE$; integral spectrum > ENORM
8 (EGT)	$S=\int_{ENORM}^{Emax} En(E)\,dE$; integral energy > ENORM, MeV.

For NORM > 2, linear interpolation is used to find the normalization factor.

START

START reads input data (binary).

****
This processor has the code read an old restart file. The old restart was named SAVE.NEW before *EXE or START.NEW after *EXE. It must be renamed START.DAT before the run that uses this processor.
****

****
Input Data Record Description:
****

======
Header
======

Contains *STA in columns 1 through 4.

=======
Options
=======

V, version number to start with (start.dat if not specified)

****
Data Record Description:
****

There are no other data records.

STEP

*STEP,options/invoke STEP procesor

=======
Options
=======

a already loaded objects, tree changes only

b last letter of n option is a version, drop for CAD file

d create system.det file with detectors center and corner

g create system.geo file with boxed limits and alxxxx material names

m (alpha) name of modfile, .MOD extension assumed

n (alpha) name of STEP interface file, .STP extension assumed

p create system.pic file with picture centers and 4 plots and system

r ste default density

t (material) default material

u tnew file, use 1st unit name for none,tree,geom,both=0,1,2,3

v tnew file, use 2nd unit name for none,tree,geom,both=0,1,2,3

w (alpha) name of mods in cad file, e.g. 'spp-...' 2008feb01

x (real,cen,-inf,inf) add to x translate

y (real,cen,-inf,inf) add to y translate

z (real,cen,-inf,inf) add to z translate

STOP

STOP terminates an interactive run.

****
The STOP processor terminates scanning of data lines.
****

****
Input Data Record Description:
****

==========
Header line
==========

Contains *STO in columns 1 through 4.

=======
Options
=======

N, if present, do not write start.new file

****
Data Record Description:
****

There are no other data records.

SUMMARY

SUMMARY, an extended NOVICE introduction.

****
The SUMMARY section of the NOVICE users guide contains additional information about the input and analysis processors plus a short discussion about near term (1997-98) modifications.
****

****
Discussion
****

NOVICE Introduction and Summary

=======
Forward
=======

The NOVICE code system calculates radiation effects in three dimensional models of space systems. NOVICE can also be used for other radiation transport and shielding analyses not related to space activities. This summary documents the current version. The status of modifications in progress is given in Appendix A.

The algorithms contained in NOVICE have been proven in more than two decades of applications. In fact, some algorithms were developed in their original form in the early 1960's. While the program was originally run only on mainframes, the current computer choice is usually a personal computer (PC) or workstation (WS). Fortran compilers/linkers on a either a PC or WS generate a NOVICE executable that includes full use of extended memory and/or virtual memory.

On a PC, NOVICE is usually run under DOS or in a DOS box under Windows. A Windows95 executable has been tested successfully but requires modifications for full compatibility, e.g., testing for user interactions with the graphics window. Graphics operations have been ported to X-Windows on both Sun and DEC (VMS, assisted by J.M. Colson at Thomson CSF) workstations.

The NOVICE code retains many characteristics of older mainframe programs. A problem description (input data file) is usually prepared with a text editor. Alternatively, data lines can be supplied directly from the keyboard if NOVICE is run in an interactive mode. Many parts of the NOVICE input stream can be driven effectively by a menu system. Some parts of this menu system are already in the current executable. However, the menu system is not complete, so this summary will assume data preparation using a text editor.

Most of the NOVICE input gives a general description of the analysis model. NOVICE input includes problem specific information about:

1) The geometry model, i.e., the dimensions, shape, and material identification for regions that constitute the system under analysis. For simple geometry models, these data are supplied directly in-line. For some complex models, the geometry description is extracted from supporting data files, either the output from a CAD (computer aided design) system, or an input file prepared for some other analysis program.

2) The spatial distribution of the radiation sources, i.e., the geometry of the source and the relative distribution (source strength) in spatial and angular coordinates. For some analyses, the source distribution is implicit, e.g., the free space radiation incident on a space system is assumed isotropic unless modified by an input distribution.

3) The energy distribution (spectrum) of the radiation source, e.g., the electron and proton integral spectra for a space mission orbit or trajectory;

4) The spatial distribution of the radiation detectors, e.g., points situated at the centers of critical electronics parts. More generally, volume detectors can be entered so that computed radiation levels represent averages over a critical volume.

5) The energy distribution of the detector response to radiation. Many responses are built into NOVICE, specifically energy deposition (dose) and volumetric charge deposition in all materials. In fact materials can be included in the problem for the sole purpose of obtaining dose and charging, i.e., modeling of a small volume of silicon is NOT necessary to obtain silicon dose.

6) The composition of the materials that are used in either the geometry model and/or the radiation response data. Usually, the chemical compositions can be obtained from a library (in ascii format which the user can edit to add new materials).

The data described above constitute a 'data base' on which several analyses can be performed. The data base must be completely described prior to using any of the analysis procedures. When data is not supplied for one of the data base categories, default information is supplied (described later.)

The user controls the order of input and analysis processing by using 'header lines' in the input data stream. Each header line contains an asterisk in column 1 followed by the name of the input data or the analysis processor e.g., *materials. Only the first three letters are required. The header line may also contain an 'options field' consisting of letters and/or letters followed by values, e.g., abc=3 selects options a, b, and c where c has the value 3.

The user's guide is organized alphabetically, as appendices, by the keywords that are used on the header lines. In some cases, however, the keywords correspond to a general topic, and not a specific 'header line'. For example, the DATA keyword is followed by a discussion of data formats that applies to all of the processors, either input or analysis.

The remainder of this introduction is a general guide to the purpose/function of the data base processors and analysis processors described in the users guide. The discussion will start with the analysis processors. This will be followed by a discussion of the data base processors used to prepare a model for analysis. Logically, the analysis processors come after the data base input processors. However, the data base input processors are more easily understood if their function can be related to the various analyses.

In general, a specific processor can be used repetitively in the data stream. Each time an analysis processor is used, a new analysis is performed, e.g., *adjoint/ will run only electrons while *adjoint,z=1/ will run only protons. For the data base processors, each time the processor is used, it simply defines more data of that type. In particular, various geometry input processors can be used in a problem to describe the complete model. For example, part of the geometry model may come from a CAD model file of the spacecraft structure while another part of the model may be a user prepared file describing an electronics box with explicit part packaging.

All of the analysis processors use one or more parts of the data base described above. To simplify the discussion of data base use, a key letter is used to denote the six data categories in the data base, namely:

- d, Detector spatial and angular extent,
- f, Fixed source spatial and angular distribution,
- g, three dimension Geometry model,
- m, Material compositions
- r, energy dependent Response, and
- s, source Spectrum,

==========
Analysis Processors
==========

Table 1 is a listing of the analysis processors in the NOVICE code system. The name of each processor is followed by one or more letters in parentheses indicating the parts of the data base that are used. When used, the default data rather than explicit user input may suffice. A very short description is then given for the type of analysis the processor performs. A more complete description is given below.

ADJOINT(dfgmrs): performs 3D adjoint transport of electrons, bremsstrahlung, protons, and other heavy ions. Outputs include dose, charging, current, and any user supplied response functions. A major option provides for calculation of pulse height spectra, with coincidence/anti-coincidence logic. These data can be used for upset/latchup predictions in arbitrary sensitive volume geometries.

ADJOINT,K(mrs): performs 1D adjoint transport of electrons, bremsstrahlung, protons, and other heavy ions. Particle tracks are generated for an infinite medium of any material. Analytic methods are then used to overlay each track on simple shield geometries for a number of shield thicknesses. The 1D shield geometries are semi-infinite slabs (no backing), semi-infinite slabs with backing equal to thickness, semi-infinite slabs with infinite backing, center of solid spheres, and center of spherical shells. Calculated outputs are the same as for the 3D analysis. Thickness/response, e.g., dose, tabulation tables are output in the format required by the SIGMA processor.

SIGMA(dfgms): performs 3D ray-trace solid angle sectoring calculations of radiation levels. The user specifies the azimuthal and polar integrations, both limits and number of intervals, that define the solid angle sectors. For each sector, ray-tracing is used to obtain the mass thickness. The mass thickness is then used to estimate the radiation level by interpolating a tabulated thickness/level table. The user can specify any number of tables of any quantity, e.g., dose, upsets, charging, etc.. The SIGMA processor includes scaling for the different attenuation properties of materials (both density and physics). In addition, SIGMA calculates the reduction in levels for added mass around the detectors. This sensitivity information can be saved for use the SOCODE processor. SIGMA outputs four estimates of radiation levels using different assumptions on the attenuation/thickness relation: spherical shell, minimum path spherical shell/slab, solid sphere, and cavity enhancement. These four outputs usually bracket an explicit Monte Carlo calculation and their differences serve as a reminder that ray-trace/sectoring is an approximation no matter how detailed the geometry model or how many sectors where used in the analysis.

SOCODE(m): uses SIGMA shield thickness sensitivity outputs and descriptions of part and box level shields to calculate minimum weight shields. The user specifies the candidate shield materials and the constraints on radiation level. The geometry of the part and box level shields can be rectangular, cylindrical, or spherical and is supplied to SIGMA before the sensitivity analysis is performed. Note: the shields are not modeled explicitly in the geometry model.

GCR(mr): only material definitions are required for 1D analysis. In the 1D analysis, either a multi layer spherical shield is considered (with different layer materials) or a multi layer slab shield (with the same material for all layers. If a 3D analysis is performed, the user must also supply the geometry model and detector descriptions (dgmr). This processor uses the CREME models for the GCR environment (with both geomagnetic shielding and earth shadowing), including various weather conditions. Basic outputs include physical and biological dose. Fluxes are saved on a file for post processing into pulse heights and single event effects. Dose and other response outputs are saved in the format required by the SIGMA analysis processor.

PULSE(m): uses output flux files and chord length tables (calculated for rectangular, cylindrical, spherical, and general geometry sensitive volumes) to calculate pulse heights, latchup, and burnout. PULSE also calculates LET spectra and can use experimentally measured data for accurate assessment of upset rates. Upsets and related quantities are output in the thickness/response tabulation format required by the SIGMA processor.

PICTURE(g): generates cross sections and perspective views of a 3D geometry model. Multiple cutouts can be used to reveal the interior of the model. The graphical output includes both single views and combinations of perspectives from an arbitrary point, from infinity along the three axes, and cross sections on three planes through a point. This output is saved in PCX format files which can be viewed and printed from a word processor such as WordPerfect or Word.

BETA(dfgmrs): calculates electron, bremsstrahlung, or heavy ion transport using forward Monte Carlo methods. This processor performs both dose and pulse height analysis including coincidence and anti-coincidence logic. The heavy ion transport can model the effects of angular and energy-loss straggling. BETA has provisions for multiple cases of mono-energetic and mono-directional sources.

FASTER(dfgmrs): calculates neutron and gamma ray transport using a multigroup cross section library and a combination of forward and adjoint Monte Carlo methods. FASTER includes a semi-analytic model for simulating the albedo (reflection) from infinitely thick regions.

KERNEL(dfgmrs): uses point kernel methods (based on multigroup cross sections) to calculate neutron and gamma ray transport in 3D geometry models. Build-up is modeled by a straight-ahead transport, with down-scatter, Greens function.

XRAY(mrs): calculates 1D transport of photons neglecting scattering. An option allows for 3D transport with a user specified source distribution for the incident x-rays (dfgmrs). X-ray analysis can use mixed spectra defined with SPECTRUM.

SHIELD(mrs): calculates 1D transport of electrons, bremsstrahlung, and protons in 1D slab and spherical shell geometries.

EXECUTE(dfgmrs): collects all of the user supplied data, checks the input geometry description, supplies defaults for missing data, generates tables of physics data used in the transport calculations, and prints summary tables of the input data base. This processor is automatically invoked if not supplied before using one of the other analysis procedures. If this processor is supplied, the user can also specify several options that control the preparation of macroscopic physics data, e.g., the length of condensed history steps used in charged particle transport.

Particles

As indicated in the analysis processor descriptions, NOVICE can perform transport calculations for many different particles. For most analyses, the user does not have to worry about details of the particle physics, i.e., the cross section data libraries. The detailed physics data is automatically prepared, as required, for the particles indicated when defining spectra and responses. The particles and data libraries included in NOVICE are summarized in Table 2.

Neutrons and gamma rays (primary and secondary) are transported using coupled multigroup cross sections. The energy group structure is fixed during the preparation of the multigroup library. The library is obtained as distributed data from the Radiation Shielding Information Center (RSIC). The last library implemented in NOVICE is BUGLE93. NOVICE automatically selects microscopic cross sections from this library using material compositions. If an element is missing from the library, NOVICE issues a warning message and uses data for an element in the library which is closest in atomic number and atomic weight. Therefore it is imperative that the user review messages generated during the preparation of macroscopic cross sections (after the *execute input section).

Photons, electrons, and positrons use a combination of calculated cross sections and data libraries prepared by the National Institute of Standards and Technology (NIST). The data libraries include the photon cross sections and bremsstrahlung production cross sections used in the Integrated Tiger Series codes. Calculated data are: stopping powers, energy loss straggling parameters, and angular straggling distributions. Positrons are treated like electrons, i.e., there are no corrections for the difference in electron and positron transport.

Protons, alphas, and other heavy ions are transported using a calculated data base. Stopping power calculations use the same formalism as Ziegler in the TRIM codes. Energy loss straggling and angular straggling are developed from formalisms that parallel the methods in Janni's proton range tables. When used, the total attenuation coefficient uses the approximations in CREME except for protons in aluminum, where the data of Seltzer in SHIELDOSE2 is used. In general, heavy ions are named by their chemical name. The exceptions are hydrogen and helium where the names proton and alpha are also recognized.

A particle name from the above list is required when the user provides an input spectrum or response function. The input data processors that determine cross sections, by designating the particle type or by providing material compositions, are listed in Table 3. A more detailed discussion follows.

SPECTRUM: processes input that gives the energy distribution of primary particles. Data includes a spectrum name (for labeling output tables), the particle type (e.g., electrons), the form of the input spectrum (both tabular and analytic expressions can be used), normalization parameters, minimum and maximum energies for truncation or extrapolation, and one or two parameters used for analytic spectra shapes.

Tabulated spectra include discrete energies, tabulated differential, and tabulated integral. The tabulated spectra can be interpolated linearly, linear-log, or log-log. Normalization options include scaling, total number, and total energy. Analytic spectra that can be selected include fission neutron, exponential (an approximation used for both fission gammas and for solar flare protons), Gaussian, block body, and beta ray decay.

RESPONSE: user specified response functions have many parallels to spectrum input. Basic information includes a title for labeling output, particle type, the form of the input response (both tabular and built-in data can be used), normalization parameters, minimum and maximum energies for truncation and extrapolation, and parameters for the built-in responses. Built-in responses --aside from energy deposition (dose) and charging which are always obtained without user input except for the selection of materials-- include electron and proton dose in silicon (legislated data from the Voyager and Galileo projects), and electron and proton damage in silicon (also legislated). Provision is also made for using the volumetric knock-on production rate as a response. The user can also select quality factor weighting and lineal energy transfer responses used in assessment of biological response.

The tabulated user input can include responses as a function of particle energy or particle LET (linear energy transfer). The LET responses are applied to all heavy ions and provide a simplified estimate of single particle effects without modeling sensitive volumes. For protons, the user can also supply one and two parameter BENDEL responses.

PARTICLE: this input processor allows the user to select the energy grid used during particle transport calculations. The default is log spaced with ten points per decade of energy (or energy/amu for heavy ions).

MATERIAL: used to select and/or specify the composition of materials. When first implemented, this was the only method for supplying compositions. Over the years, a material library was added as was the ability to call out materials during geometry definition. As a result, it is now best to supply these data as the first part of the input stream (if needed). Why? Because these inputs are absolute, a material is defined even if already defined from the region call-out/material library logic.
A warning on duplicate material names was just added to NOVICE.

Geometry Modeling

Table 4 lists the input processors used for geometry modeling. This category includes both detector and source modeling in addition to the material geometry modeling. In fact, distributed sources and detectors often map one-to-one onto a portion of the geometry model. Therefore, provision is made for automatically defining the region corresponding to these volumes.

DETECTOR: input data includes the detector name (for labeling output), the position (if a point) or translation vector (if not a point), the geometry (point, rectangular, cylindrical, or spherical), the local axis for polar angle measurements, the identification of a prior detector definition which is identical except for the translation vector, and the material and density if a region is to be automatically defined.

For point detectors, only the name and position are input. For distributed detectors, the spatial extent/distribution in the three spatial coordinates are also required. Each of the coordinates can be discrete or have finite extent allowing the modeling of a variety of line, surface, and volume detectors. If an angular distribution option is selected, the user can also specify detector sensitivity as a function of azimuthal angle and polar angle cosine. Here also, the extent/distribution can be discrete or finite thereby modeling a variety of mono-directional, cone, or solid angle sector angular sensitivities.

SOURCE: input data for the spatial and angular distributions of sources parallels that of detectors in all aspects. A final note; when a source or detector is like a previous source or detector, then the definition of spatial extent/distribution (and angular extent/distribution if selected) is omitted. The spatial/angular data for that previous detector/source is used.

GEOMETRY: this section of the user's guide is a general discussion of the geometry modeling used in **NOVICE**. While **NOVICE** accepts simple input for many objects, these data are all converted to surface/region logic internally. The user can also describe subsets of the model using the same logic. With this logic, surfaces are the usual analytic geometry planes, cones, spheres, etc., or general quadric surfaces with special provision for toroidal and **NURBS** (non uniform rational B-spline) surfaces.

A surface divides all space into two parts (which may be disjoint), the part inside the surface and the part outside the surface. A volume (region, cell, ...) is defined by intersecting surfaces and/or surface complements. More complex shapes are defined by intersecting the bodies defined by intersecting surfaces, and so on. Unions are obtained by taking the complements of intersected complements. **NOVICE** only requires the description of non-void space (but voids can be defined).

Using the above logic, rays and particle tracks never get 'lost' in **NOVICE**. During the ray trace, overlaps may be detected (the user can specify an overlap tolerance) and annotated in the output. The user can then correct the overlaps or tell **NOVICE** to use the geometry as is with a consistent resolution of the overlaps (the volume defined first takes precedence -- see also **OVERLAP** below). Note: the usual way of correcting overlaps is to go back to the individual geometry modelers. A global fix was just added to **NOVICE** to make all overlaps allowed without changing individual geometry modelers. This fix is controlled by user input in the **CONTROL** processor.

OVERLAP: this appendix describes several options available for using the OVERLAP logic in NOVICE. In the most simple case, all geometry is specified as allowing overlaps. Then overlaps are never considered to be errors. When two regions overlap, the code automatically selects the first one described in user input where the overlap occurs. If the overlap is not complete, the other object is seen where the first object does not cover it. This logic can simplify the description of many problems, i.e., the usual operation of deleting volumes from volumes is not required. For example, an electronics box could be described in the following steps: first define parts (from inside out if they have multi volume covers), then define boards, then define a void corresponding to the inside of the box, and finally describe the box as a solid. The overlap logic will automatically delete volumes already defined, e.g., the solid box is seen as the box walls since the interior void was already defined. Similarly, the interior void has boards and parts automatically deleted from its volume since they were already defined.

The second use of the overlap option is to group portions of the geometry. This logic can substantially reduce the time required for ray tracing. Consider a model that has two or more electronics boxes with substantial internal details. When doing analysis on one box, the other box is only important if a particle or ray enters the box. By enclosing each box and its contents in a 'container' volume, the interior of the container volume is examined as required during the analysis. If this logic is not used, the code must look at each object inside the box to determine if the ray or particle enters that object.

DESIGN: this input processor uses a single input line to define simple shapes in a model. The line contains the region number (user name), the material index (or name), the density, the shape, and the coordinates or dimensions for that shape. Allowed shapes include box, cylinder (elliptical), annulus, cone, sphere (ellipsoidal), and a number of others. The cylindrical and conical shapes can be parallel to any axis. Provision is made for intersecting the non-box shapes with a RPP (rectangular parallelapiped), defined on the same data line, to truncate the volume along any of the three axes. In addition, a multi-line input can be provided to cut-out other regular shaped volumes from the volume being defined (the OVERLAP option may provide the same result).

SIMPLE: this input processor is used to describe regular meshes in rectangular, cylindrical, or spherical coordinates.

ROTATE: this input processor defines a coordinate transformation resulting from single or multiple rotations, translations, and reflections in any combination and order. The data can be given in either the global reference frame or the local reference frame. The local reference frame is preferred since it permits the automatic fetching (see GET command later) of other geometry subsets which may, in turn, have their own ROTATE commands.

The ROTATE command precedes the data to which it applies and is used until modified by subsequent input. Provision is made for dropping down one level in the transformation chain when the transformations are defined in the local reference frame.

MAGIC: a two step geometry modeler based on combinatorial geometry logic. First regular body shapes are defined; rpp, cylinder, cone, sphere, etc.. These shapes include body definitions defined in the APPLICON/SYNTHAVISION modeler; toruses and extrusions and rotations of piecewise curves. The volumes are then defined by intersections and unions of the bodies. This is the basic logic used in the MORSE, QAD-CG, and ITS-ACCEPT codes and is derived from the original package developed by MAGI for the SAM code and continued, it seems, in the BRLCAD program.

MEVDP: this input processor accepts geometry data prepared for the MEVDP code (developed by ROCKWELL for AFWL by S. Hamilton-Anderson, et.al.) including extensions made by McAlpine at Hughes and TRW. (MEVDP is a ray-trace/sectoring code developed in the late 1960's.)

MCNP: this processor accepts a geometry model prepared using the LANL surface/cell logic (including like/but logic, excluding repeated structure/universe logic). If it follows the *EXECUTE line the NOVICE geometry is output to a file in MCNP format. See the SURFACE and REGION processors below for the basic modeling logic. (MCNP is a forward Monte Carlo neutron and gamma ray code that uses point value cross section libraries.)

SECTOR: this processor accepts a geometry model prepared for the AFWL nee Philips Laboratory SECTOR code. The modeling is similar to MEVDP, i.e., solid volumes with cutouts, both with simple regular shapes, with a more general procedure for coordinate transformations and for saving and retrieving geometry subsets. The transport modeling is more rigorous (the work of G. Radke) and includes a spherical shell approximation for electrons. This processor also recognizes SECTOR input for spectra, material compositions, and detectors. Currently a stand-alone code.

Table 5 lists input processors used in more complex geometry modeling.

BAYS: an input processor for a spacecraft bus as engineered by JPL for the Voyager and Galileo projects.

CATIA, a general geometry input procedure that accepts surface, body, and region descriptions (DESIGN, MAGIC, and MCNP primitives) with embedded coordinate transformation data and general intersection/union logic. The original purpose was to generalize an interface between NOVICE and the CATIA CAD system, developed by O. Chirol for Alcatel Espace.

ADDRESS: an input processor, used to import a geometry model prepared for another code into a geometry model currently defined in NOVICE. Provides index modifiers for surfaces, regions, detectors, sources, and materials to avoid conflicts where explicit user indices are required.

DUPLICATE: an alternative method for defining repetitive structures in a geometry. Basically, a coordinate transformation is defined using *ROTATE. Then the code is told to duplicate previous inputs for regions, detectors, and sources. The processor can be used repetitively. An example is the description of an RTG (radioisotope thermoelectric generator) where one fuel capsule is defined, then duplicated with a reflection to get one side of a layer, the side is then duplicated with a different reflection to get both sides of the layer, and finally layers are duplicated with translations to obtain the final multi layer assembly.

SURFACE: an input processor that accepts quadric surface descriptions with simple inputs for planes, cones, elliptical cylinders and ellipsoids. This processor includes an interface with the CAM (Computerized Anatomical Man) model of the 50 percentile astronaut, developed by MDAC (Yucker and Billings) for NASA/HSC.

REGION: an input processor that defines regions by listing the surfaces that bound the region. The inside/outside sense of the surface can be supplied explicitly by the user or alternatively, can be determined by NOVICE using supplied coordinates for any point in the region.

ESABASE: an input processor that accepts a geometry model prepared from an ESABASE (developed for the European Space Agency by MATRA) file. The processor automatically generates detector points inside any box shaped regions and also processes information files on spectra and thickness/dose tabulations.

SYSTEMA: an input processor for the MATRA in-house extension of ESABASE.

ARRAYS: an input processor that provides a simple interface for changing the materials and/or densities of regions without modifying the original input. Used for parametric 'what if' analysis. Can be used after the *EXECUTE line.

==========
System Features
==========

Table 6 lists input processors used for general system level functions.

COMMAND: describes information that can be entered on the command line. The command line information can also be read from a file filename' using *=filename on the command line. (On an IBM mainframe NOVICE looks for command line information in SYSIN.) The argument I=filename specifies the input file. A batch run starts if the specified file exists or if the I=filename argument is not present and a file novice.dat exists. An interactive run starts if the specified file does not exist or if I=filename is not present and novice.dat does not exist. I=* also starts an interactive run and I= starts from the menu. R=filename can be used to specify a file to be loaded prior to going interactive. Other command line input includes: alternate names for the config.nov, output, summary, old save, new save, old start, and new start files. A name can also be entered as n=jobname, then input is taken from jobname.dat, output goes to jobname.out, summary output to jobname.sum, etc.. The command line will also accept a time limit, t=seconds (default one year) and directory paths to: library files, old output files, new output files, user files, and temporary files.

DATA: discusses input preparation including interpolation options and in-line data conversion, e.g., rd60 converts 60 degrees to radians, '0 1i10*5' generates 11 points evenly spaced on [0,5], and '.001 li40*10' generates 41 points log spaced on [.001,10.].

DUMP: provides for formatted dumps of problem data including labeled commons, permanent arrays in blank common, temporary arrays in blank common, and scatter loaded data from the data base inputs prior to the *EXECUTE line. Used for remote debugging of user problems.

END: signifies the end of an input section. Useful for skipping over input that is not wanted for a specific analysis; the data that follows the *END line is ignored until the next *header line.

ERROR: resets the error counter, effectively ignoring *NOGO errors. An option provides for ignoring interactive input causing the error.

FILES: lists files and names. Provides for renaming files during the run and for inputting alternate directory paths.

GET: instructs the program to start reading input from a specified file until an end-of-file is encountered. GET commands can be embedded to ten levels with a simple change to increase that number. Note: this level should be added to the PRESET section.

GRAPHICS: a discussion of graphics modes supported on the PC. The discussion also describes the P option in the PICTURE and PLOT processors (used for printing graphics directly from NOVICE.)

LABEL: provides labels/titles for output files.

LIBRARY: an input processor similar to GET except that only part of the library file is used. The idea is to avoid the proliferation of many small data files. These small files are gathered into a single library file with named separators. Only the data following the name separator is extracted up to the next named separator. For example, &lib geo160w gets data from the
***geo160w.
'library.dat' file starting at the line c

MENU: accesses the current menu system. This menu system currently gives online access to the user's guide (text, tables, and figures), supporting documentation including scanned charts on physics, and text files describing related topics including PC versions of codes made available through RSIC (ITS3, CEPXS/ONELD, CHARGE, MCNP4, ONEDANT/TWODANT, TORT/DORT, MORSE-EMP, etc.)

OPTIONS: an alternate input of options to an analysis processor that already uses all 26 option letters. Currently limited to the *ADJOINT processor and used to set: time limits by detector point; separate restart files for each detector, and plotting of histories during the analysis.

PRESET: describes control functions contained in the 'config.nov' library file and how they can be changed in the input stream. These disparate controls include: graphics printer driver (now considered obsolete with PCX capabilities); background color on the graphics screen (black or white); maximum video resolution and print-plot buffer size; error checking on SIGMA dose/thickness tabulations; ray-map thickness and dose file/plot generation (on, off, PCX output, etc.) for the ADJOINT, SIGMA, GCR-3D, and XRAY-3D analysis processors; particle/ray trajectory plotting during analysis for SIGMA, GCR-3D, and XRAY-3D (input controlled for ADJOINT), and language selection (English, French) for date and time outputs.

PRINT: toggles the printing of large output tables on and off.

PUT: saves data for multiple GET operations thereafter.

SAVE: saves all input data prior the *EXECUTE command in binary format.

START: read a previous START file (data base inputs after EXECUTE processing). The start file is now named 'start.new'. If renamed to 'start.dat' before the next run, NOVICE will automatically read this file for the data base definition. If not renamed, NOVICE will generate a new 'start.new' file.

UNITS: provides input for converting all input data of a specific type, e.g., *units/,centimeters 0.1/ will convert all linear dimensions (in mm) to centimeters.

HELP: an old access to the users guide in interactive mode. Also recognizes man(ual) and ?.

STOP: signifies the end of NOVICE input in interactive mode. The end-of-file suffices in batch mode.

CRASH: clears core between independent runs started from a single input stream.

PLOT: most of the analysis processors prepare formatted output on the 'plot.dat' file, e.g., particle spectra, response versus thickness, etc.. These data can be plotted using *PLOT. If the PLOT input includes a file label (name) option, the plot files are also saved in PCX format. An option in the *EXECUTE processor provides for putting spectra, response, and cross section data on the 'plot.dat' file.

Default Input Data

NOVICE defaults data required in the data base that was not supplied by the user. These data are given in Table 7. The default materials are aluminum, silicon, and water. The default spectra are geosynchronous electrons (worst case 160 degrees west, Stassinopoulos) and an anomalously large solar flare. The default source and detector are both a point at the origin and the default geometry is a solid sphere of aluminum centered at the origin with a radius of 0.5 cm. Thus a new user can run the following problems with no other input:

```
*adjoint,h=256,b=4/,1/ elec/brem .5 cm al sphere
*adjoint,h=64,z=1/,1/ AL flare   .5 cm al sphere
*adjoint,kh=256,b=4/,1/,.01 li30*10/ elec&brem vs thickness
*adjoint,kh=64,z=1/,1/,.01 li30*10/ AL flare vs thickness
```

and plot the output spectra and dose vs thickness

```
*plot
```

and do a perspective view of the geometry

```
*picture,q/,0 0 0   10 10 10   1/
```

Table 1: NOVICE Analysis Processors

In the following list, terms such as (dfgmrs) indicate the parts of the data base that are used:

d=detectors	f=fixed source	g=3D geometry
m=materials	r=responses	s=spectra

EXECUTE(dfgmrs), signifies the end of user data base inputs. Default values are supplied for required data that were not input. Cross section tables are generated. Data base summary tables are then printed. EXECUTE must precede any of the other analysis procedure, defaulted if it doesn't.

PICTURE(g), checks for geometric overlaps and generates printed geometry pictures.

ADJOINT,K(mrs), generates 1D attenuation kernels for electrons, bremsstrahlung, and heavy charged particles using semi-analytic Monte Carlo

ADJOINT(dfgmrs), calculates electron, bremsstrahlung, and heavy charged particle transport in 3D geometries using adjoint Monte Carlo

SIGMA(dfgms), approximate 3D space radiation analysis using tabulated 1D attenuation kernels and ray tracing/sectoring.

GCR(mrs), calculates 1D galactic cosmic ray transport or 3D transport (dgmr).

SHIELD(mrs), calculates electron, bremsstrahlung, and heavy charged particle transport in multi-layer 1D geometries by numerical integration.

PULSE(m), calculates pulse height spectra (soft error rates) for rectangular, cylindrical, or spherical sensitive volumes using numerical integration and chord length distributions.

FASTER(dfgmrs), 3D neutral particle transport using multigroup cross sections and forward/adjoint Monte Carlo.

BETA(dfgmrs), 3D charged particle transport using analog Monte Carlo

KERNEL(dfgmrs), 3D neutral particle transport using point kernel and approximate Greens function method.

XRAY(mrs), 1D or 3D (dfgmrs) photon attenuation (no scattering), only suitable for low energy spectra.

SOCODE(m), calculates weight optimized shielding.

Table 2: NOVICE Particles and Cross Sections

Z,A: Code Identifier	Particle Name	Energy Range	Cross Sections
0,1	neutron	(1) thermal to 18 MeV	(2) BUGLE93
0,-1	gamma ray	(1) .01 MeV to 14 MeV	(2) BUGLE93
0,0	photon	(3) 100 eV to 100 GeV	(2) NIST
-1,0	electron	(4) 100 eV to 100 GeV	calculated and NIST
1,0	positron	(4) 100 eV to 100 GeV	calculated and NIST
1,1	proton	(4) 10 keV to 100 GeV	calculated
Z> 1,A> 1	heavy ions, alphas, cosmic rays	(4) 10 keV/amu to 100 GeV/amu	calculated

(1) coupled neutron-gamma library with fixed group structure

(2) libraries as distributed by the Radiation Shielding Information Center, Oak Ridge National Laboratory.

(3) extrapolation is used for energies outside this range

(4) no explicit limits on energy range

Table 3: NOVICE Input Processors Affecting Cross Sections

SPECTRA, describe the input of particle spectra. Both analytic functions and tabular data are accepted

RESPONSE, describes the input of user tabulated response functions. Energy deposition response (rads) is obtained automatically for every material in the problem

MATERIAL, provides information on material compositions, i.e., partial densities of constituent elements.

PARTICLES, gives the user some latitude in selecting energy groups

Table 4: NOVICE Geometry Modeling Processors

DETECTOR, input of detector points. Also volume, surface, or line detectors in rectangular, cylindrical, or spherical coordinates

SOURCE, input of point, line, surface or volume sources in rectangular, cylindrical, or spherical coordinates.

GEOMETRY, a discussion of the 3D modeling logic used by the code

OVERLAP, discusses overlap options available for simplifying some mockups

DESIGN, description of 3D material geometry composed of boxes, cylinders, annuli, cones, spheres, and other simple shapes

SIMPLE, allows simple inputs to describe material meshes in rectangular, cylindrical, or spherical coordinates

ROTATE, describes specific inputs for translation, rotation, and reflection of geometric inputs. These data apply to source and detector geometries as well as material geometry.

MAGIC, allows combinatorial description of 3D geometry, i.e.,body descriptions and regions composed of body intersections and unions

MEVDP, geometry inputs in the format of the 'Modified Elemental Volume Dose Program'

MCNP, geometry inputs or outputs in LANL MCNP format

SECTOR, geometry inputs in AFWL SECTOR code format.

Table 5: NOVICE Geometry Modeling Processors, Advanced

BAYS, inputs specific to mockup of spacecraft bays as engineered by JPL for deep space probes

ADDRESS, used to set internal pointers prior to input of a geometry subset, so the subset can be duplicated without knowing code assigned numbering.

CATIA, a general modeler using DESIGN, MAGIC, and MCNP primitives with embedded rotate/translate commands.

DUPLICATE, describes capabilities for duplicating prior subsets of sources, detectors, and material geometry.

SURFACE, input of quadric surfaces with recognition of simple forms such as planes, cones, cylinders, and spheres.

REGION, input of material regions by listing boundary surfaces

ESABASE, geometry inputs in ESABASE format

SYSTEMA, geometry inputs in SYSTEMA format

ARRAYS, provides a mechanism for changing material designation of regions without changing geometry descriptor lines.

Table 6: NOVICE General Processors

COMMAND, discusses command line parameters
DATA, describes the header line logic, options field, free field inputs, and data entry options.
DUMP, provides formatted dump of the input data base for debugging purposes.
END, terminates data scanning until the next header line
ERROR, for interactive processing, instructs code to ignore inputs that caused errors.
FILES, allows the user to change the default names of input and output files
GET, allows the user to insert files into the input data stream.
GRAPHICS, discusses graphics modes, file formats, printing
LABEL, provision for entering a problem title
LIBRARY, discusses preparation and use of the 'library.dat' file
MENU, discusses use of the current MENU system
OPTIONS, describes options beyond the usual A through Z
PRINT, provision for omitting extensive lists of input and lists of data base tables.
PUT, provides for saving portions of the input stream for later recall e.g., using GET.
SAVE, saves the data base for subsequent reuse.
START, starts a problem from a previous SAVE file.
UNITS, provides for non standard input units such as inches instead of centimeters.
HELP, displays portions of the users guide on the screen during interactive runs.
STOP, terminates all data scanning
CRASH, clears program memory between independent runs.
PRESET, discusses CONFIG.NOV file for presetting file names and graphics modes.
PLOT, displays data and calculated figures on screen with optional hardcopy output.

Table 7: Default Input Data

```
*MATERIALS

   ALUMINUM   2.7   13  0  1/

   SILICON    2.33  14  0  1/

   WATER      1.0   1  0  -2   8 0 -1/

*SPECTRUM

  'GEO160W' ELECTRON INP 365.25 SCALE  .04  5.5/ Stassinopolous

  5.5      5.       4.       3.       2.       1.5      1.
  .9       .8       .7       .6       .5       .4       .3
  .2       .1       .07      .04     / tabulation energies

  3.14e+4  3.14e+5  3.45e+7  2.79e+8  3.03e+9  9.30e+9  3.77e+10
  5.32e+10 7.51e+10 1.08e+11 1.59e+11 2.34e+11 4.01e+11 6.87e+11
  1.28e+12 2.61e+12 3.17e+12 3.85e+12/ integral, per day

  'AL FLARE' PROTON EXP 2.45E+10 NUMBER  .1 1.E+5 26.5/

*DESIGN

   1 ALUMINUM   2.7    SPHERE    0 .5   0 .5   0 .5/

*SOURCE

  'POINT 0,0,0'  0  0  0/  IGNORED IF DOING ADJOINT CALCS

*DETECTOR

  'POINT 0,0,0'  0  0  0/
```

Appendix A: NOVICE Modifications Currently Under Development

DOCUMENTATION: bring up to date; reorganize with usual inputs for each processor described first; add discussion of input and output files to each processor; add details about output tables to each processor (also add these details to NOVICE output files, the programming is completed except for supporting calls and preparation of the text files containing the descriptions); add example inputs for every input line in the users guide; add a quick reference guide (for experienced users); interface with the Microsoft Help system (requires graphics outputs in bitmap format, the conversion of PCX to bitmap is completed, will add bitmaps to NOVICE as alternate input/output graphics format).

MENU system: the current MENU system includes an editor and the ability to run partial problems with viewing of the output and error message files; the editor needs stabilization; a faster scroll procedure is needed for text files, particularly users guide sections, the Microsoft Help interface may suffice; the current system allows copying example data from the users guide examples, needs the examples for copying; need to implement full screen menu input for all input and analysis processors. Add wire-frame plotting (a stand-alone code) for geometry menus.

FILE handling: need to archive all output files to prevent automatic reuse (rewriting) on subsequent runs. A stand-alone code now used for backups will be added to NOVICE for this task. The archived files will be ZIPed with a name indicating date and time and stored in a subdirectory ZIPOUTS. A stand-alone code is now used to convert ascii files for use on PC, WS, and PPC; add to NOVICE.

DOSE profiles: a stand alone processor now extracts 2D and 3D energy deposition data from MCNP, ITS3, and NOVICE/BETA output files and converts all outputs to a common format for comparison and plotting. This processor will be added to NOVICE.

GRAPHICS: make NOVICE aware of user interaction with the graphics window under Win95; complete Power PC implementation of graphics (calls to open window, define color palette, and write pixel); extend shading of perspectives from 16 shades to 256 shades using 3 byte and 16M color capabilities on PC.

REPORT dose reference: a stand-alone processor now extracts dose outputs from SIGMA and combines min/max/average values by detector point name with reference documentation on the part (part name, type, architecture, supplier, etc.); add to NOVICE.

SOFIP/TRECO trapped environment: now used as a stand-alone processor. Coding completed, except for I/O files, to read old block data maps of AE8 and AP8 (and older maps) as a library and output spectra in format expected by SHIELDOSE and NOVICE; add to NOVICE.

SHIELDOSE and SHIELDOSE2: add to NOVICE; SHIELDOSE includes options for input of integral spectra and output of thickness dose tabulations for SIGMA. Coding is completed except for re-definition of I/O file units.

GCR: incorporate the revised NRL models for the free-space environment, etc., in NOVICE.

SOLAR particle events: add a stand-alone code that uses flare data through cycle 22 and generates the probabilistic spectrum by convolution (numerical integration by Yucker, rather than the Monte Carlo integration used by Feynman, et.al.).

SCORING: additional inputs added to SOURCE and DETECTOR processors (option letter controlled) to define energy, energy-loss, and angular bins for forward Monte Carlo scoring on detectors and adjoint Monte Carlo scoring on sources.

DEPOSITION profiles: using new SCORING capabilities to obtain 2D and 3D dose profiles in BETA, including repeated structure logic with middle, edge, and corner outputs to investigate beam leakage effects in finite geometries. Currently in operation, needs better output formatting.

ADJOINT photon electron: using new SCORING capabilities to obtain deposition from mono-directional and mono-energetic photon sources. Currently in operation, needs better output formatting.

ADJOINT mono-directional/mono-energetic: currently done using spectra with narrow groups and sources with small angular aperture. Revised modeling is already in place to use energy loss straggling and angular straggling distributions to map onto discrete energies and directions. Use with new SCORING to obtain parametric data.

ADJOINT GCR: interface GCR environment to ADJOINT processor for M option coincidence/anti-coincidence pulse height analysis.

GEOMETRY/CAD interfaces:

SECTOR: this interface is currently a stand alone code. It reads input files for the AFWL SECTOR code and prepares a corresponding input file for NOVICE. Processing includes geometry, material compositions, spectra, and detectors. Need to rework I/O, etc., and add to NOVICE.

IGES/STEP with NURBS surfaces: the original IGES interface was for solids modeling using combinatorial logic. The NURBS interface is complete to the extent of reading an SDRC IDEAS CAD output IGES file and ray-tracing the NURBS surfaces (an iterative process to obtain intersections). This interface file is missing information on which surfaces bound a volume. An examination of the STEP interface file is currently underway to, hopefully, complete the interface to NOVICE.

EUCLID: develop an interface with an ascii output file. The interface for rectangular shapes is under discussion and will require about one day for implementation and checkout.

PROENGINEER: discussions only; examination of ascii files shows conventional solid modeling including coordinate transformation information; a straight-forward implementation is expected.

COMPUTERVISION: under discussion only.

SPARES: set aside storage space for geometric data entered after the *EXECUTE line. This provides a way of describing part and box level shields without modifying the origin system model. The purpose to allow input of the shield models calculated by SOCODE (now saved in DESIGN format on a file) for an explicit analysis using the SIGMA or ADJOINT processors.

SURFACE

SURFACE accepts input for simple/quadric surfaces.

****
The SURFACE input processor provides a direct input of quadric surfaces, either expanded, or in simpler forms.
****

****
Input Data Record Description:
****

==========
Header line
==========

Contains *SUR in columns 1 through 4.

=======
Options
=======

A, process input file containing the CGCODE output of SECTOR geometry conversion. A=1, process an input file containing the CAMERA Man Model developed by Billings and Yucker at McDAC.

A=-1, process input file with GE format of CGCODE output including detector points.

C, read camera body replacement strings

D, read camera undefined region data

F, fixed format data from a previous novice run

J, if present, old formats are used (not described here)

O option, see OVERLAP section. Applies to regions entered using the A option above.

R, step material density, default to -1, default material density

S, step interface option, gt 0 means keep in local coordinates

T, (material) step material, default to aluminum

U, data for A option on unit44 instead of input file (unit05).
U=u, data for A option is on unit u instead of 44 or 05.

V, omit voids when loading cam model (safe).

M, in CAMERA model, set all material indices to 1. Without M option, material indices are set to the abbreviated indices 0 through 7 to denote void, organ, muscle, bone, marrow/fat, skeleton, tissue, and water respectively. See examples in *REGION section.

M=1, in CAM model keep separate indices for lung, organ, and intestine, i.e., indices 0 through 9 denote void, lung, organ, intestine, muscle, bone, marrow/fat, skeleton, tissue, and water. Hopefully, will give better cross section views when using color.

M=2, in CAM model, keep separate indices for all organs, old 13 becomes 10, old 23 becomes 11, old33 becomes 12, ..., old 113 becomes 20 (old 10m+3 becomes m+9)

****
Data Record Description:
****

Repeat from here as needed

==========
Surface Parameters
==========

The line format is

I n C/
-

where

I is the surface index assigned by the user, must be unique.

n indicates the surface input type

C is a data string giving constants that define the surface.
-

++++++++++++
Input Tables
++++++++++++

The values of n and C are given in Table 120 (SURDAT).
-

++++++++++++++
Input Figures
++++++++++++++

Surface shapes are shown schematically in Figures 124 (SURXPL) through 139 (SURZZP).

****
Discussion
****

The material compositions used in the CAM model are given below. Note that the M option determines whether all of these compositions are required or if additional compositions should be supplied.

Material Compositions (from Table 4, RSIC CCC-240) in NOVICE *MATERIALS format.

```
'Lung'         0.257   1 0 .0980  6 0 .1450  7 0 .0380
                       8 0 .7070 11 0 .0015 12 0 .0002
                      15 0 .0030 16 0 .0018 19 0 .0026
                      20 0 .0009 17 0 .0020/

'Organ'        1.058   1 0 .0980  6 0 .1450  7 0 .0380
                       8 0 .7070 11 0 .0015 12 0 .0002
                      15 0 .0030 16 0 .0018 19 0 .0026
                      15 0 .0030 16 0 .0018 19 0 .0026 /

'Intestine'    0.451   1 0 .0980  6 0 .1450  7 0 .0380
                       8 0 .7070 11 0 .0015 12 0 .0002
                      15 0 .0030 16 0 .0018 19 0 .0026
                      20 0 .0009 17 0 .0020/
```

Note that Lung, Organ, and Intestine have the same relative compositions, and vary only in the their densities.

```
'Muscle'       1.060   1 0 .1020  6 0 .1230  7 0 .0350
                       8 0 .7290 11 0 .0008 12 0 .0002
                      15 0 .0020 16 0 .0050 19 0 .0030 /

'Bone'         1.750   1 0 .0640  6 0 .2780  7 0 .0270
                       8 0 .4100            12 0 .0020
                      15 0 .0700 16 0 .0020
                      20 0 .1470 /

'Marrow(fat)'  0.918   1 0 .1220  6 0 .7610
                       8 0 .1170 /

'Skeleton'     1.499   1 0 .0820  6 0 .4230  7 0 .0190
                       8 0 .3220            12 0 .0010
                      15 0 .0490 16 0 .0010
                      20 0 .1030 /

'Tissue'       1.000   1 0 .1000  6 0 .1800  7 0 .0300
                       8 0 .6500 11 0 .0015 12 0 .0005
                      15 0 .0100 16 0 .0025 19 0 .0020
                      20 0 .0015 17 0 .0015 /

'Water'        1.000   1 0 .1190
                       8 0 .8881 /
```

NOVICE assigns material indices to the regions of the CAM model based on the values of the M option. Densities are always set to the values on the region lines. The user is responsible for loading material compositions that agree with the selected M option.

If the M is absent, materials 0 through 7 are assigned to void, organ, muscle, bone, marrow(fat), skeleton, tissue, and water respectively (lung, organ, and intestine are all set to organ).

If M is present without a value, all material indices are set to material 1 (one).

If M=1 is present, materials 0 through 9 are assigned to void, lung, organ, intestine, muscle, bone, marrow(fat), skeleton, tissue, and water.

If M=2 is present, materials 0 through 9 are assigned as with M=1. Materials 10, 11, .. 17 are assigned to CAM materials 13,23,33,43,53,63,73, and 83 for the spinal column, eye, thyroid, heart, stomach, liver/gall bladder, spleen, and kidneys.

Thus, the correspondence between CAM materials and those of NOVICE is:

CAM #	Material Name	M Option absent	present	M=1	M=2
1	Void	0	0	0	0
2	Void (internal)	0	0	0	0
21	Void (disconnect)	0	0	0	0
2	Lung	1	1	1	1
4	Intestine	1	1	3	3
5	Muscle	2	1	4	4
6	Bone	3	1	5	5
7	Red Marrow(Torso)	4	1	6	6
17	Yellow Marrow(Limbs)	4	1	6	6
8	Skeleton(Torso)	5	1	7	7
18	Skeleton(Limbs)	5	1	7	7
9	Tissue	6	1	8	8
3	Brain	1	1	2	2
13	Spinal Cord	1	1	2	10
23	Eye	1	1	2	11
33	Thyroid	1	1	2	12
43	Heart	1	1	2	13
53	Stomach	1	1	2	14
63	Liver/Gall Bladder	1	1	2	15
73	Spleen	1	1	2	16
83	Kidneys	1	1	2	17

The logic of the CAM model input process is:

The surfaces are read from a file named 'CAMERA.SUR'. The first line of this file is a comment line, the second line has two integers (2I5 format) giving the number of surfaces and regions respectively in the CAM model. Lines thereafter describe the surfaces.

The first line of a surface contains: I,N,A0,A1,A2,A3 in (I4,I2,3X,4E15.0) format. I is the surface index, N is the last non zero coefficient of the surface equation (in expanded quadric form A0 + A1*x + A2*y +A3*z + A4*x*x A5*y*y + A6*z*z + A7*x*y + A8*y*z + A9*z*x), and A0 through A3 are the first four constants in the surface equation. If the value of N exceeds 3, the remaining surface coefficients (A4, A5, ..., A-N) are read in a (9X,4E15.0) format.

After all surfaces are input, region descriptions are taken from the file 'CAMERA.REG'. The first line of this file is a comment line.

Each region is described by an initial line containing: I,M,R,X,Y,Z,N1,N2,N3,N4,N5,N6 in (I5,I4,4E9.0,3X,6I4) format. where I is the region index, M is the material index, R is the density of the material in the region, X,Y,Z are the cartesian coordinates of a point inside the region, and N1 through N6 are the indices of the first six surfaces bounding the region. If the region has more than six bounding surfaces, the N6 has the value -1, and boundaries N6 through possibly N23 are read in a second line which has the format (18I4).

Table 120: (SURDAT) Quadric Surface Data

Type	Constant List	
0 EXP	a a a a a ... a / 0 1 2 3 4 j	expanded quadric
1 XPL	a /	x=a plane
2 YPL	a /	y=a plane
3 ZPL	a /	z=a plane
4 YZP	y z y z / 0 0 1 1	plane parallel x axis
5 ZXP	z x z x / 0 0 1 1	plane parallel y axis
6 XYP	x y x y / 0 0 1 1	plane parallel z axis
7 XCO	y z r x r x / 0 0 1 1 2 2	x cone
8 YCO	z x r y r y / 0 0 1 1 2 2	y cone
9 ZCO	x y r z r z / 0 0 1 1 2 2	z cone
10 XCY	y a z b / 0 0	x cylinder
11 YCY	z a x b / 0 0	y cylinder
12 ZCY	x a y b / 0 0	z cylinder
13 SPH	x a y b z c / 0 0 0	ellipsoid
19 XXP	a b /	x-a= +- b
20 YYP	a b /	y-a= +- b
21 ZZP	a b /	z-a= +- b
22 XYZ	x1 y1 z1 x2 y2 z2 x3 y3 z3 /	3 point plane

Figure 124: (SURXPL) Plane Perpendicular to X-axis

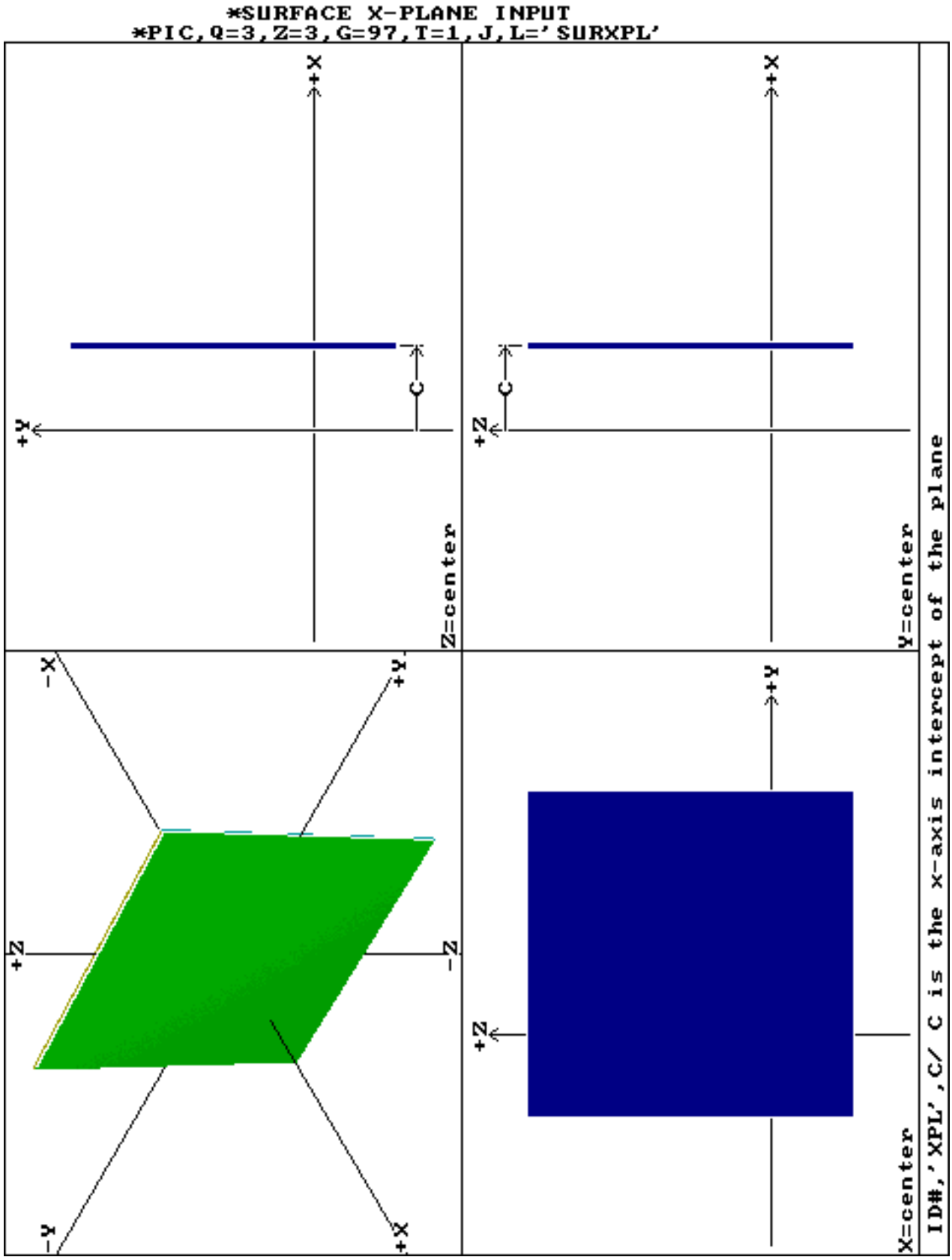


Figure 125: (SURYPL) Plane Perpendicular to Y-axis

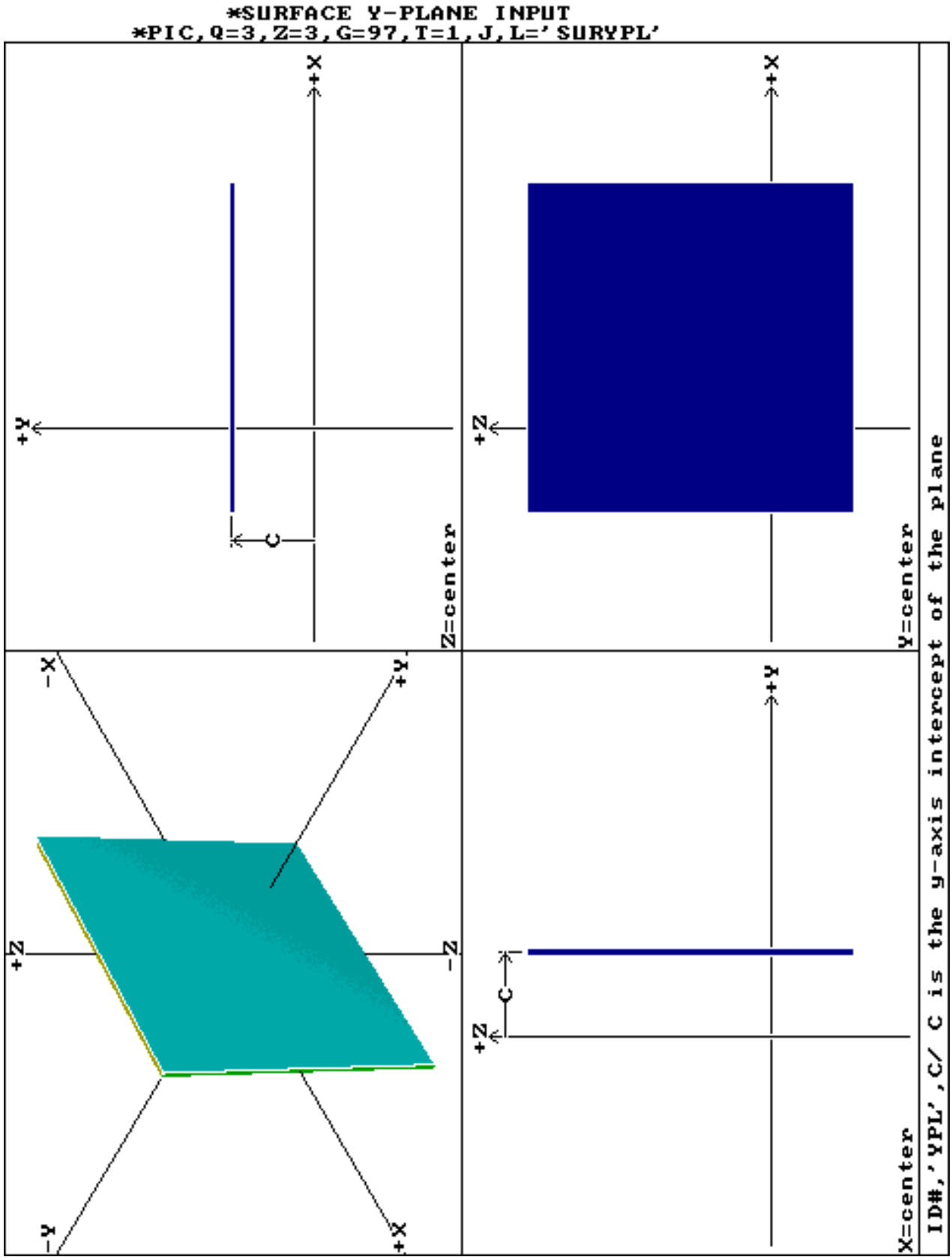


Figure 126: (SURZPL) Plane Perpendicular to Z-axis

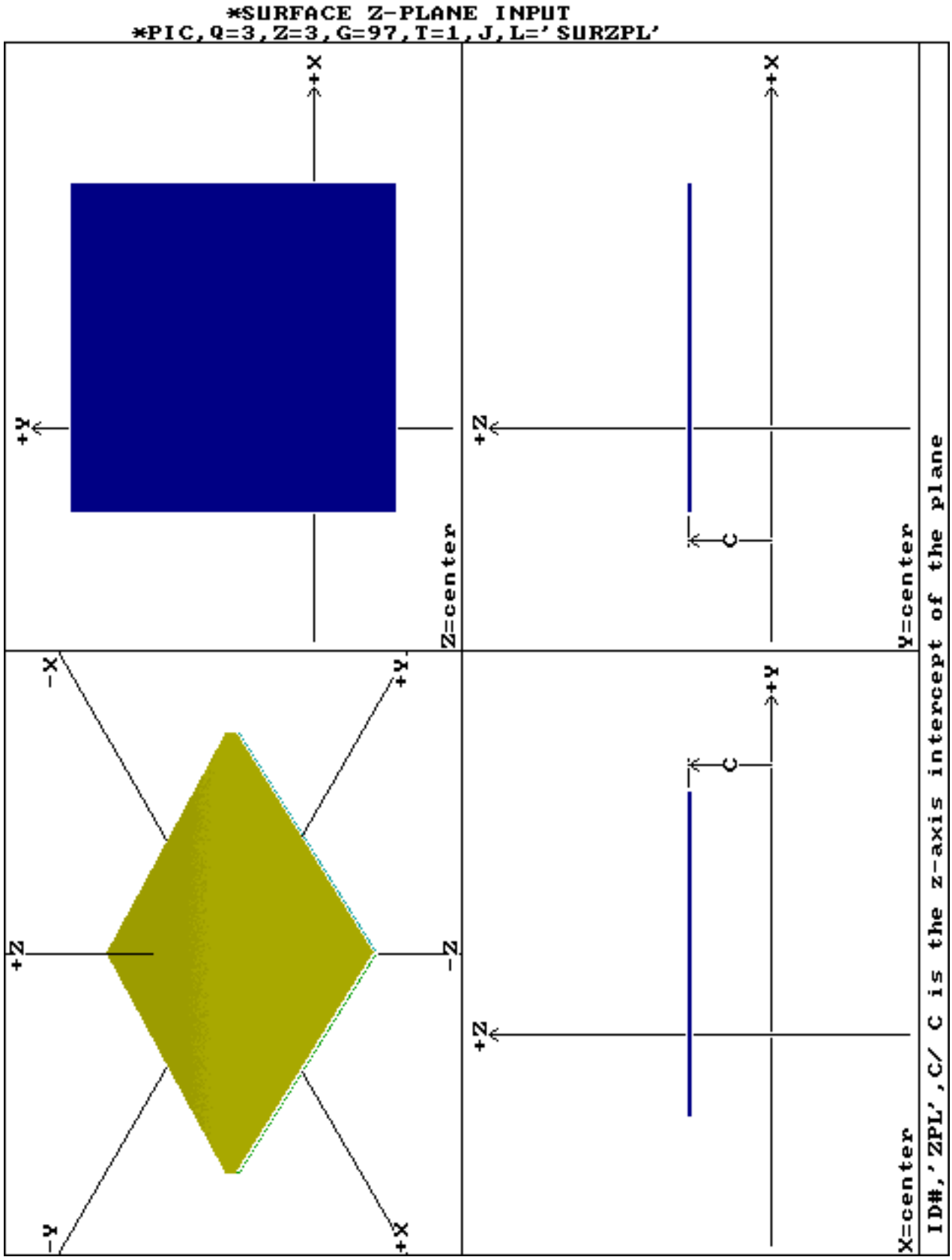


Figure 127: (SURXYP) Plane Parallel to Z-axis

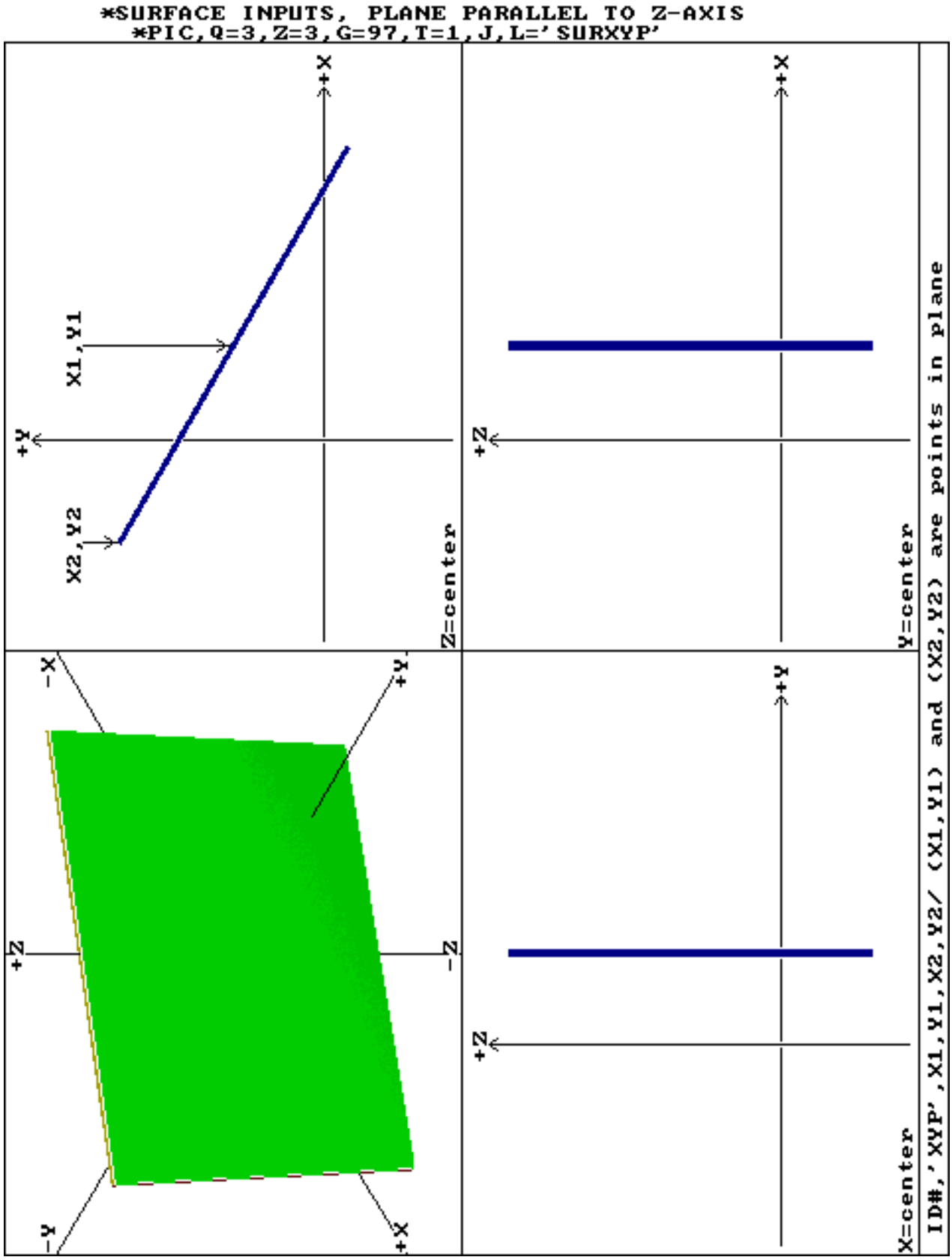


Figure 128: (SURYZP) Plane Parallel to X-axis

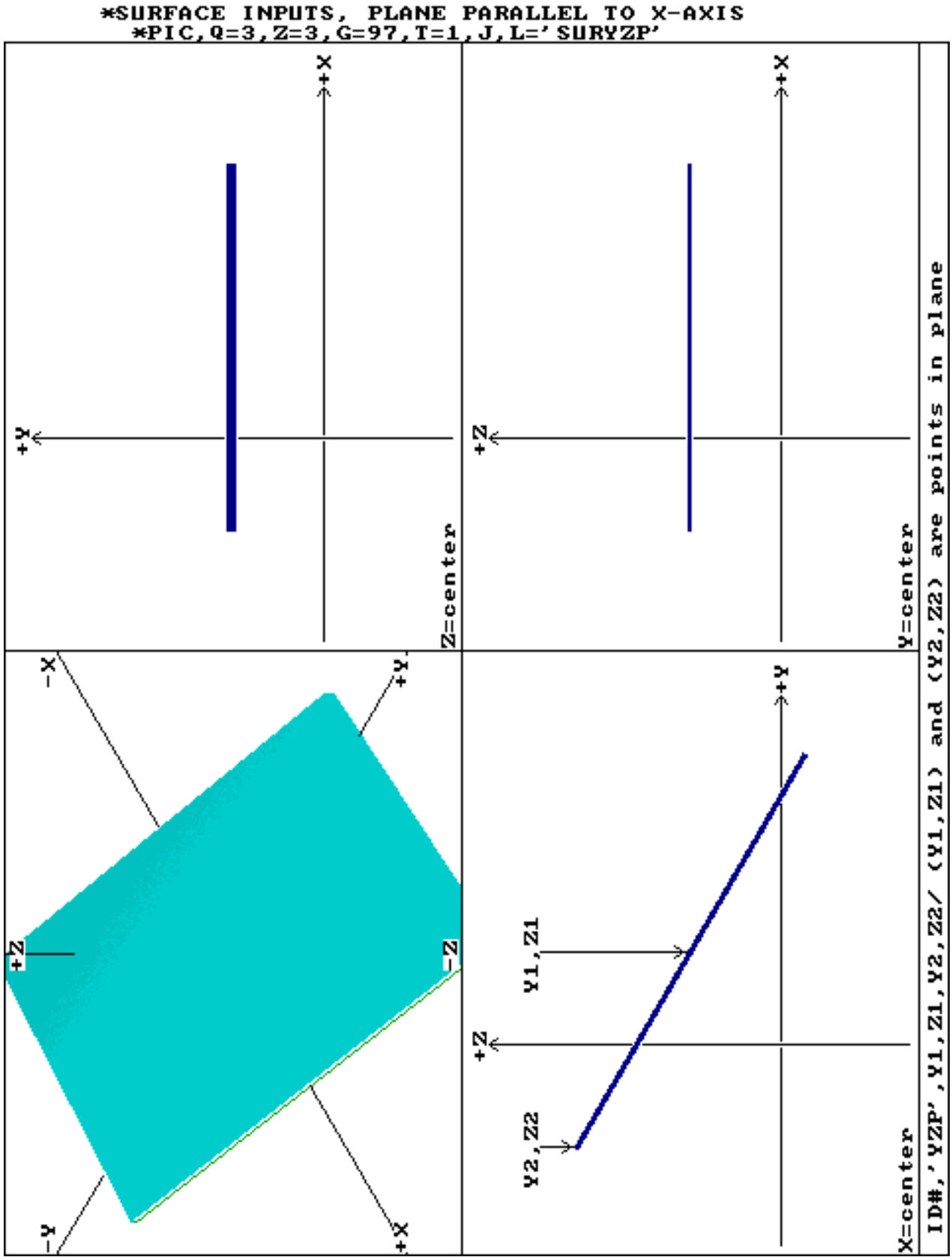


Figure 129: (SURZXP) Plane Parallel to Y-axis

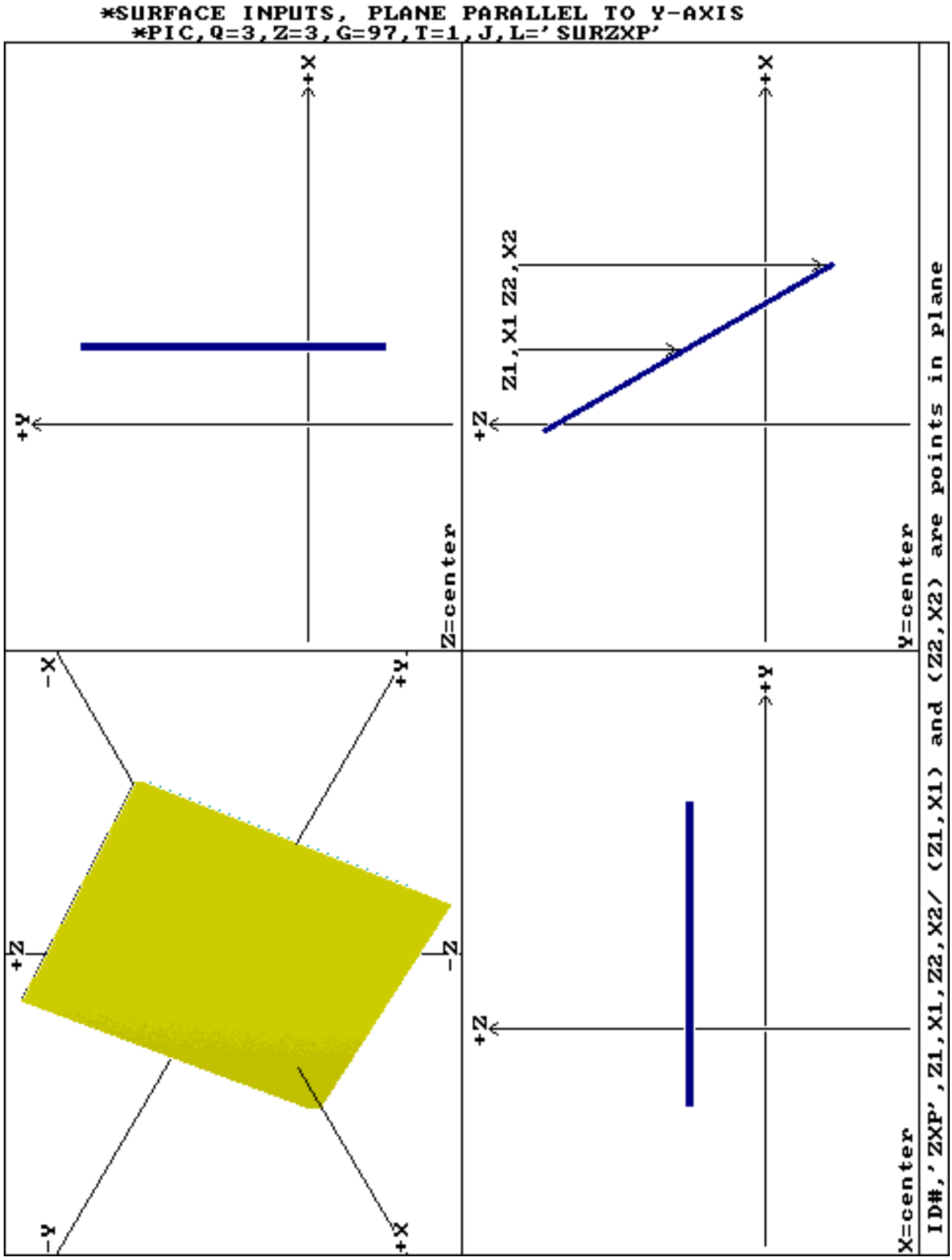


Figure 130: (SURXCO) Cone Parallel to X-axis

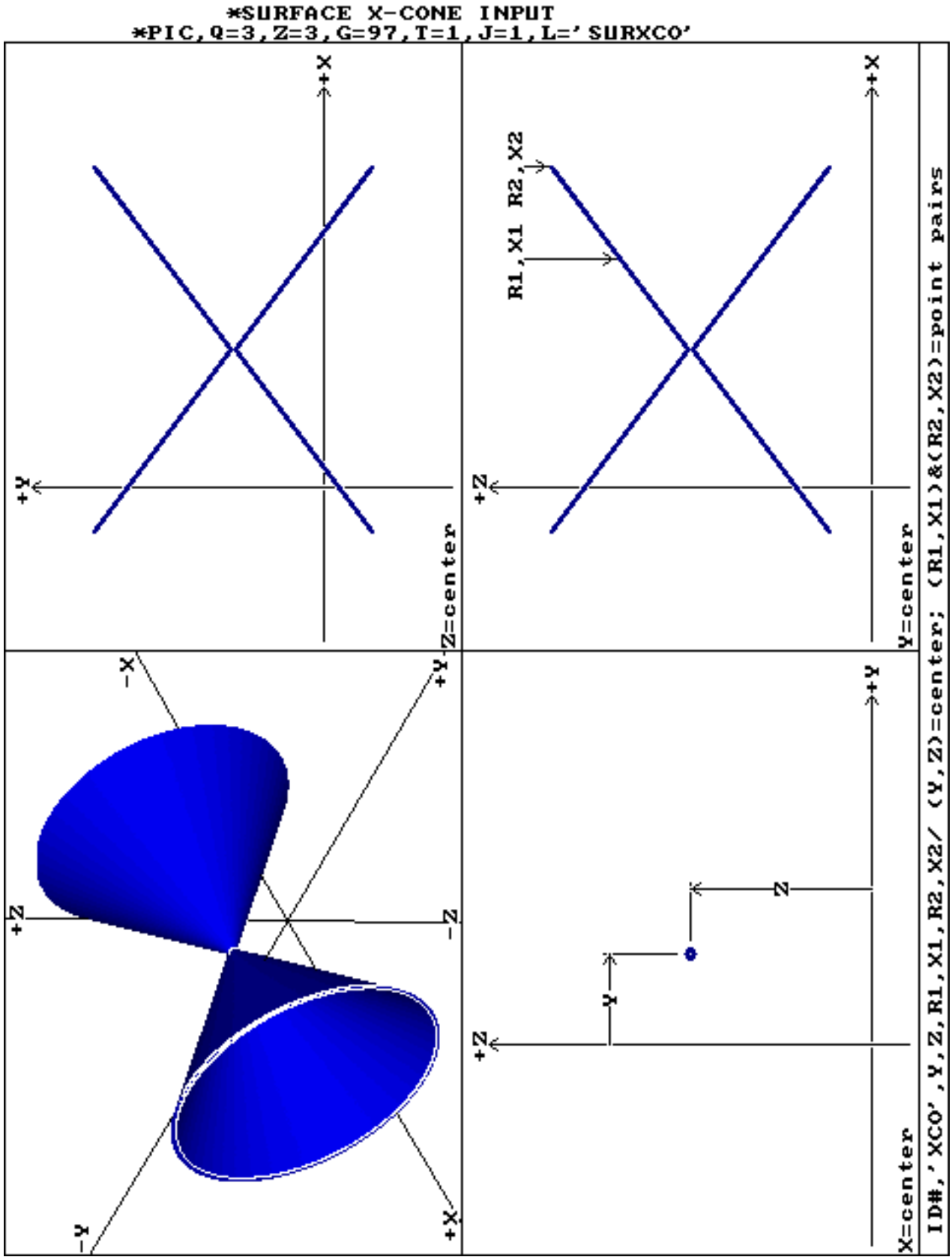


Figure 131: (SURYCO) Cone Parallel to Y-axis

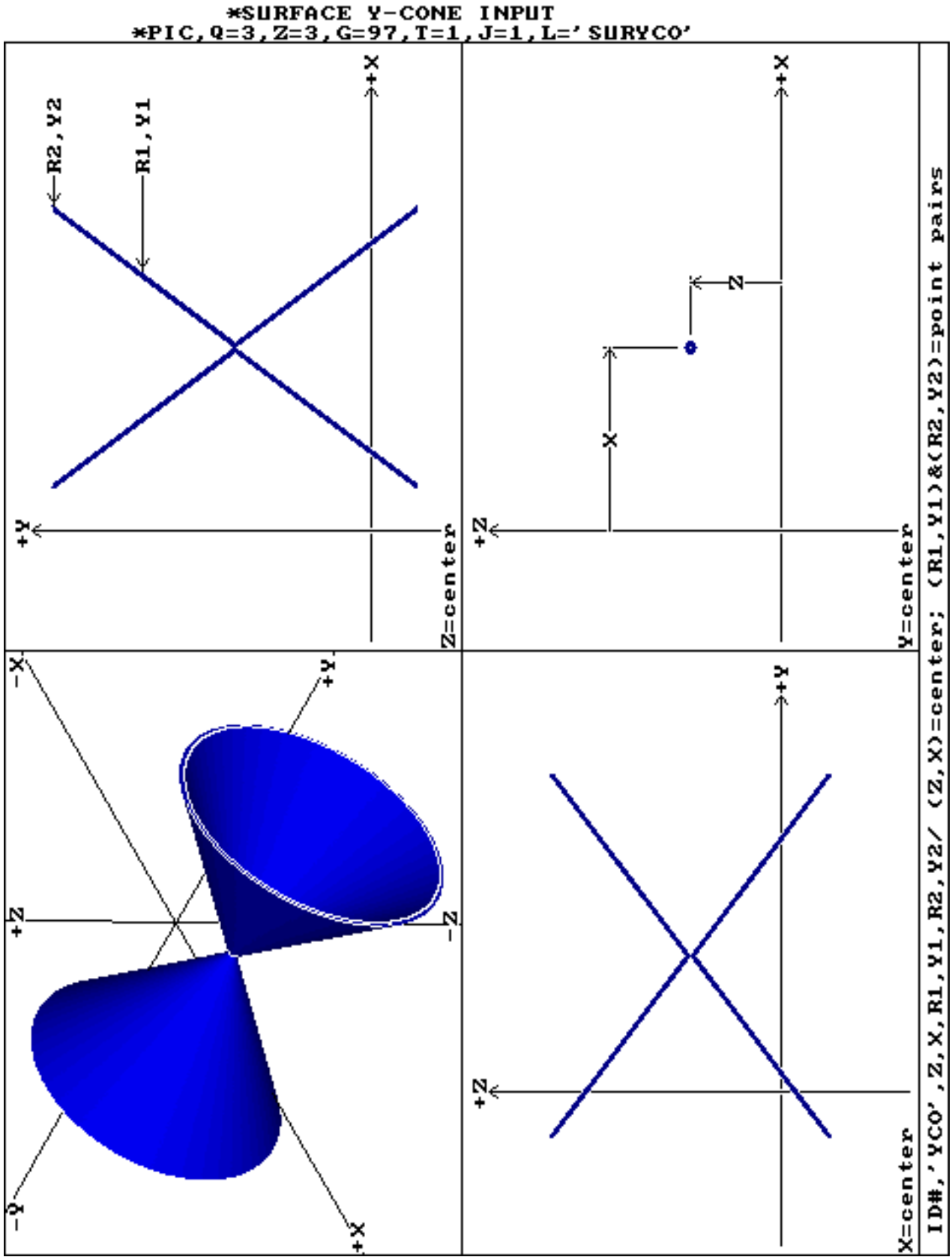


Figure 132: (SURZCO) Cone Parallel to Z-axis

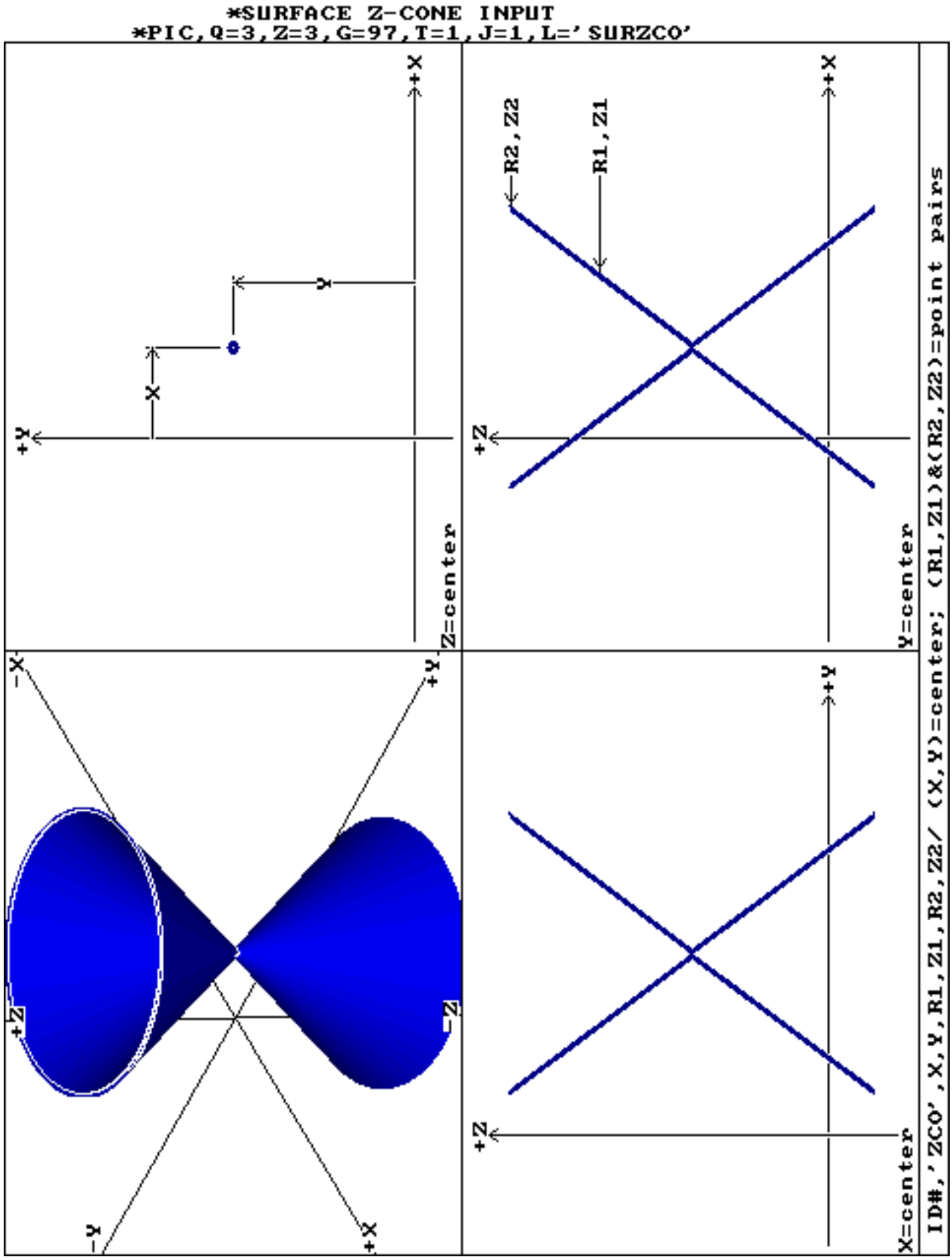


Figure 133: (SURXCY) Cylinder Parallel to X-axis

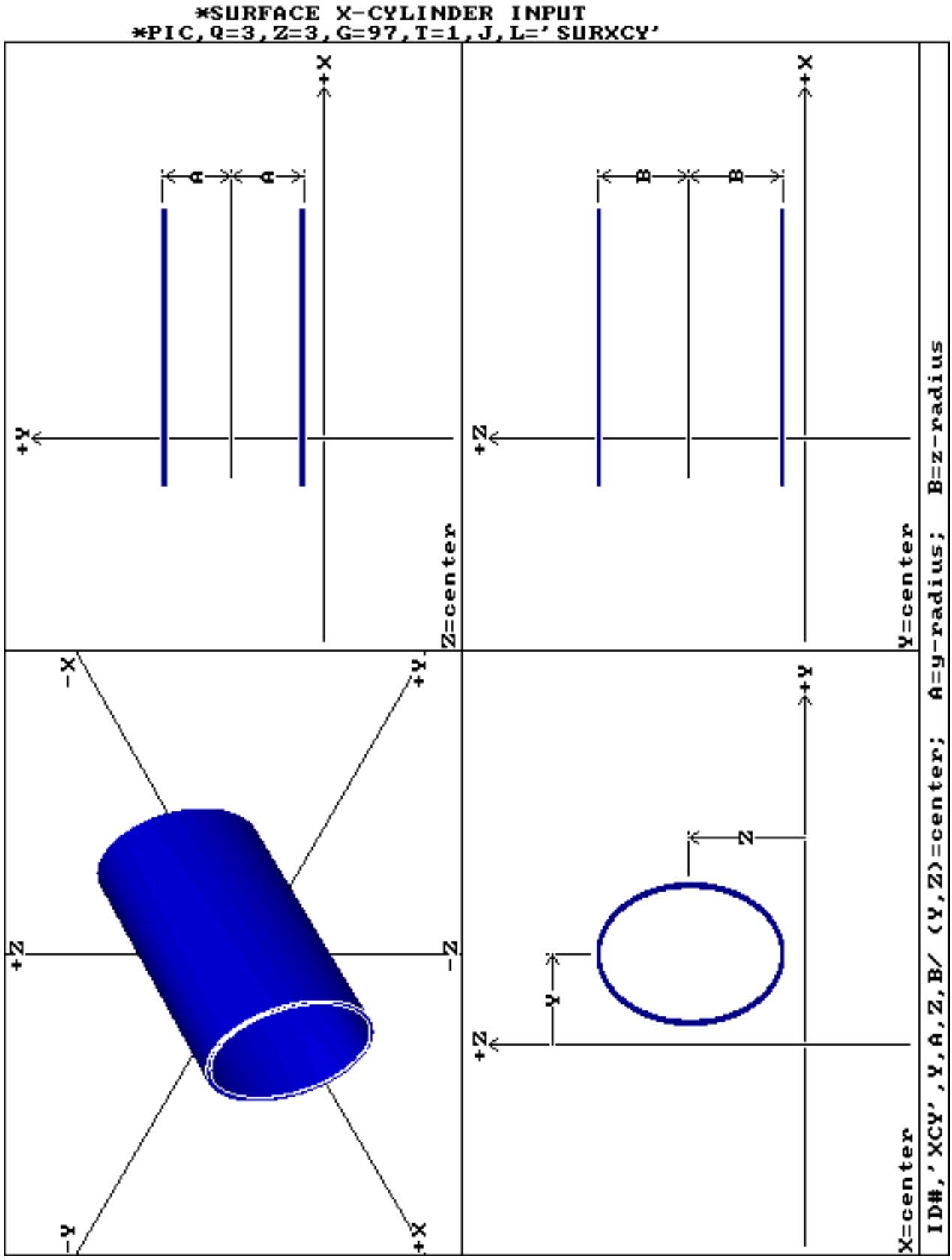


Figure 134: (SURYCY) Cylinder Parallel to Y-axis

```
*SURFACE Y-CYLINDER INPUT
*PIC,Q=3,Z=3,G=97,T=1,J,L='SURYCY'
```

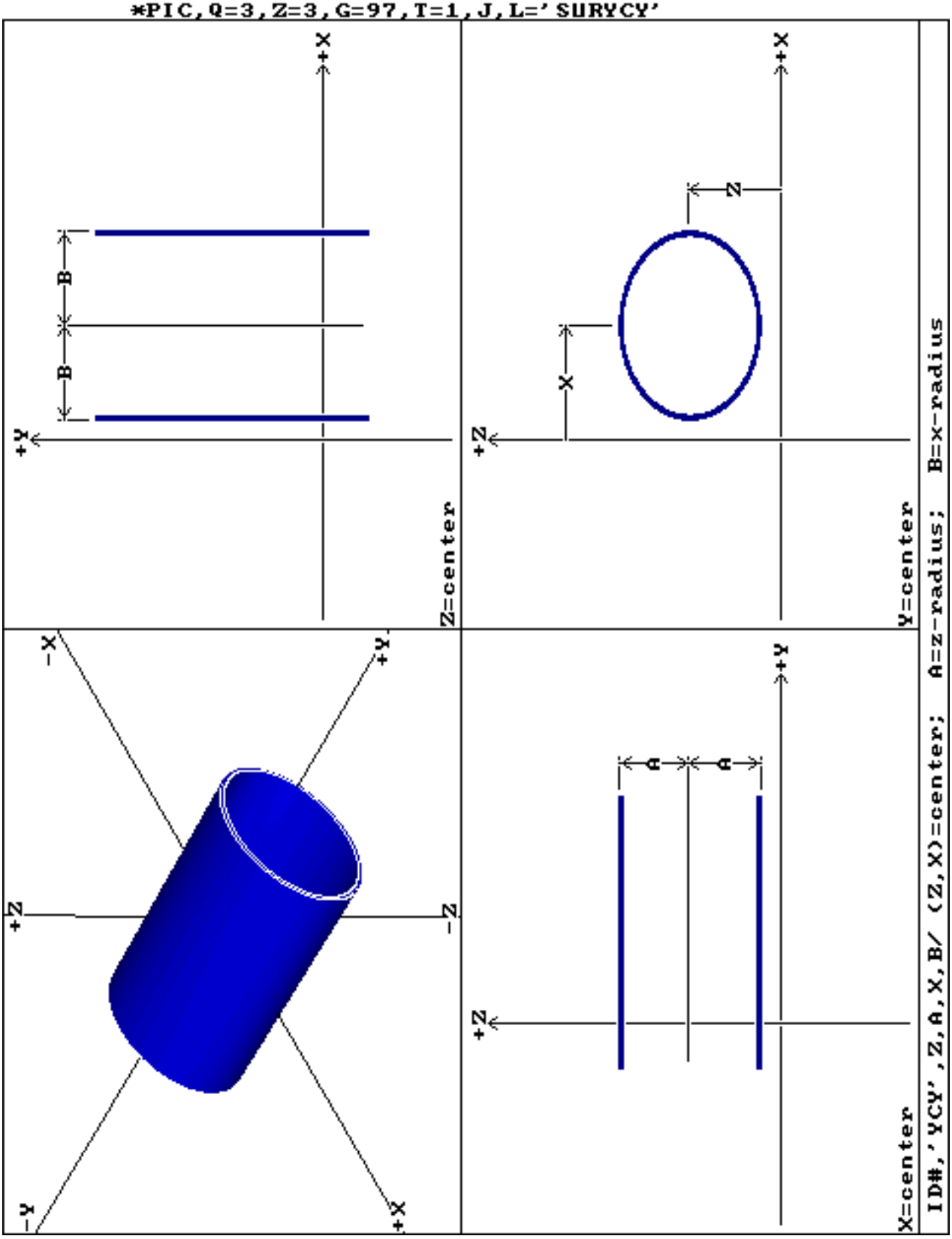


Figure 135: (SURZCY) Cylinder Parallel to Z-axis

*SURFACE Z-CYLINDER INPUT
*PIC,Q=3,Z=3,G=97,T=1,J,L='SURZCY'

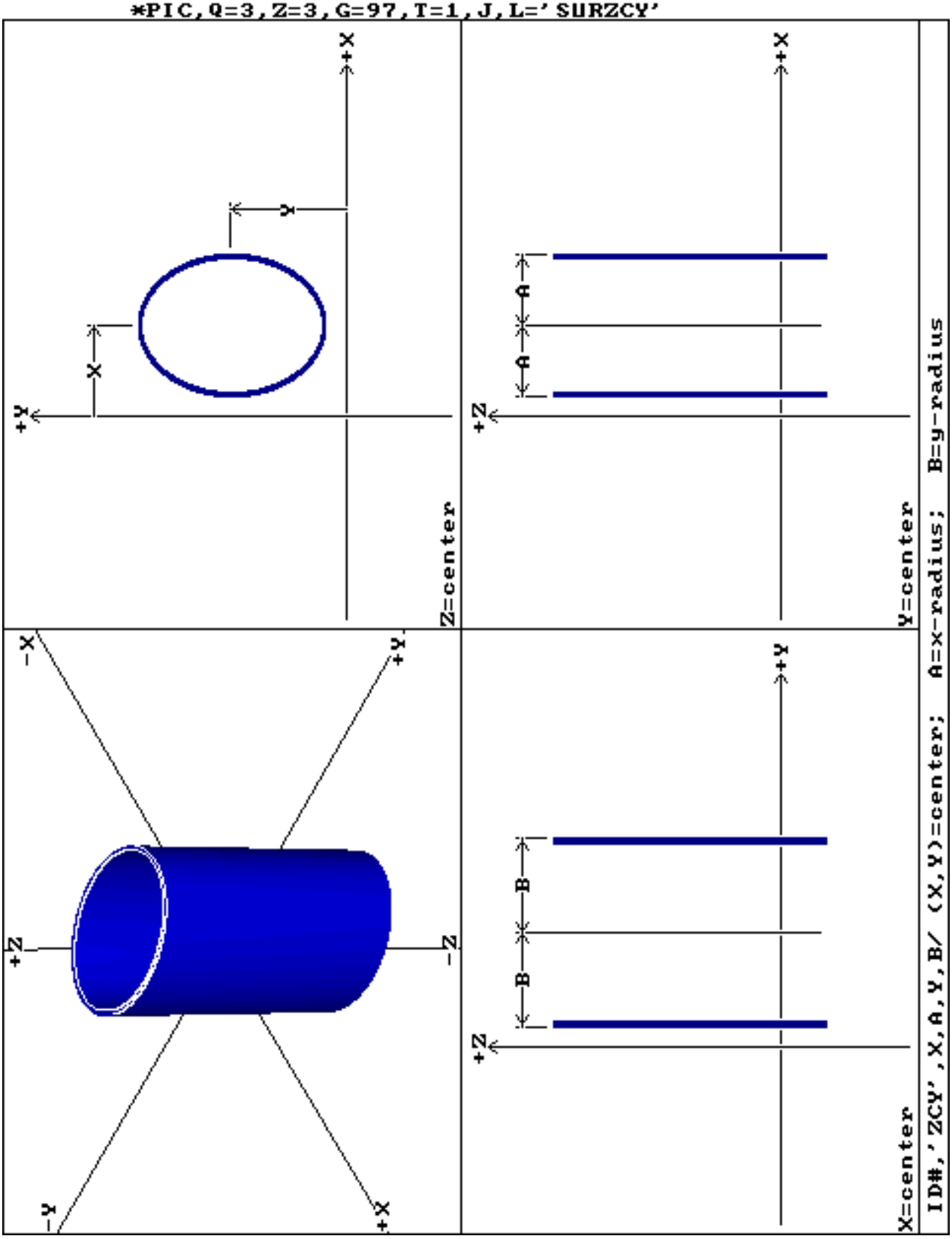
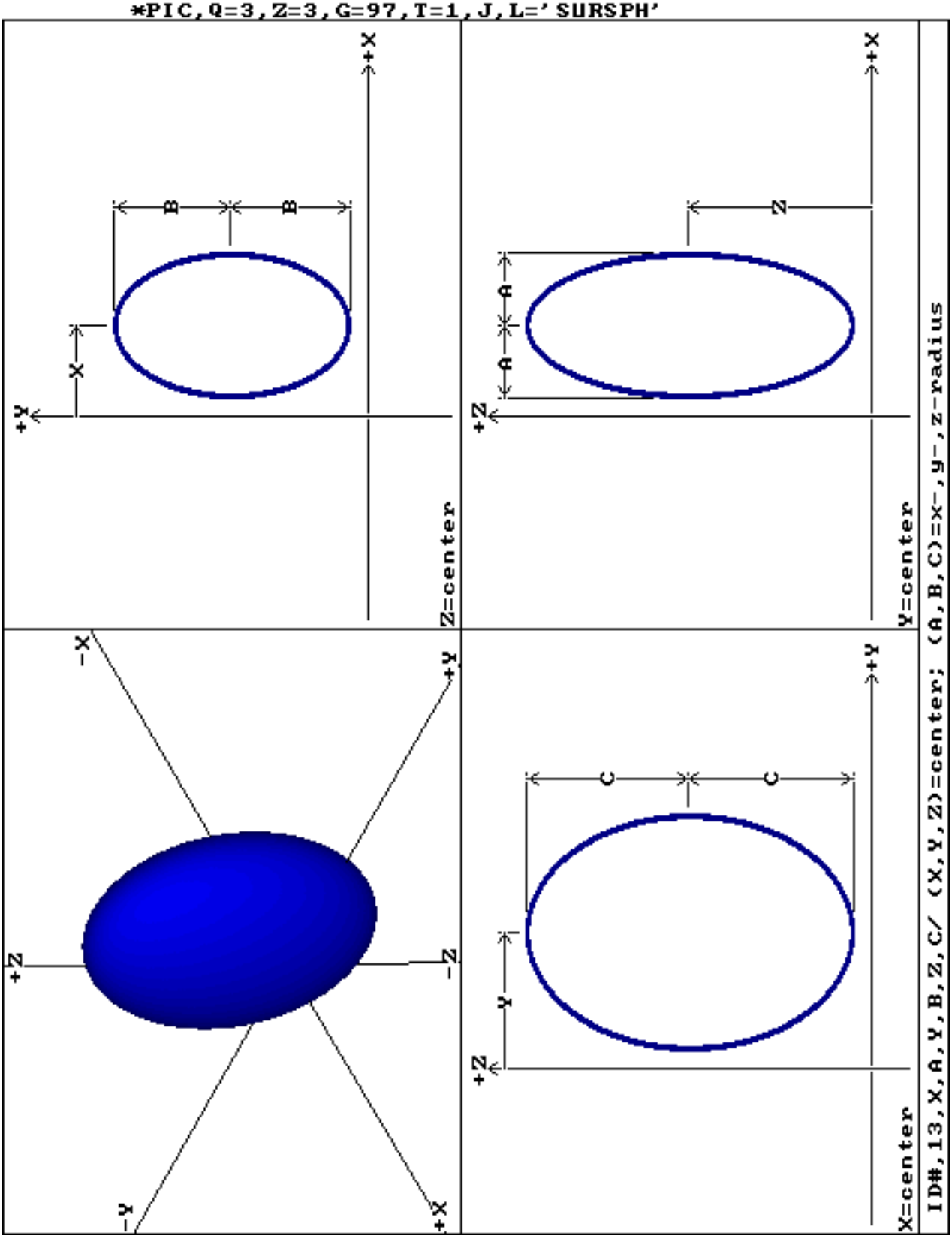


Figure 136: (SURSPH) Spherical/Ellipsoidal Surface

```
*SURFACE SPHERE INPUT
*PIC,Q=3,Z=3,G=97,T=1,J,L='SURSPH'
```




```
ID#,13,X,A,Y,B,Z,C/ (X,Y,Z)=center; (A,B,C)=x-,y-,z-radius
```

Figure 137: (SURXXP) Two Planes Perpendicular to X

```
*SURFACE INPUT, TWO SHEET X-PLANE
*PIC,Q=3,Z=3,G=97,T=1,J,L='SURXXL'
```

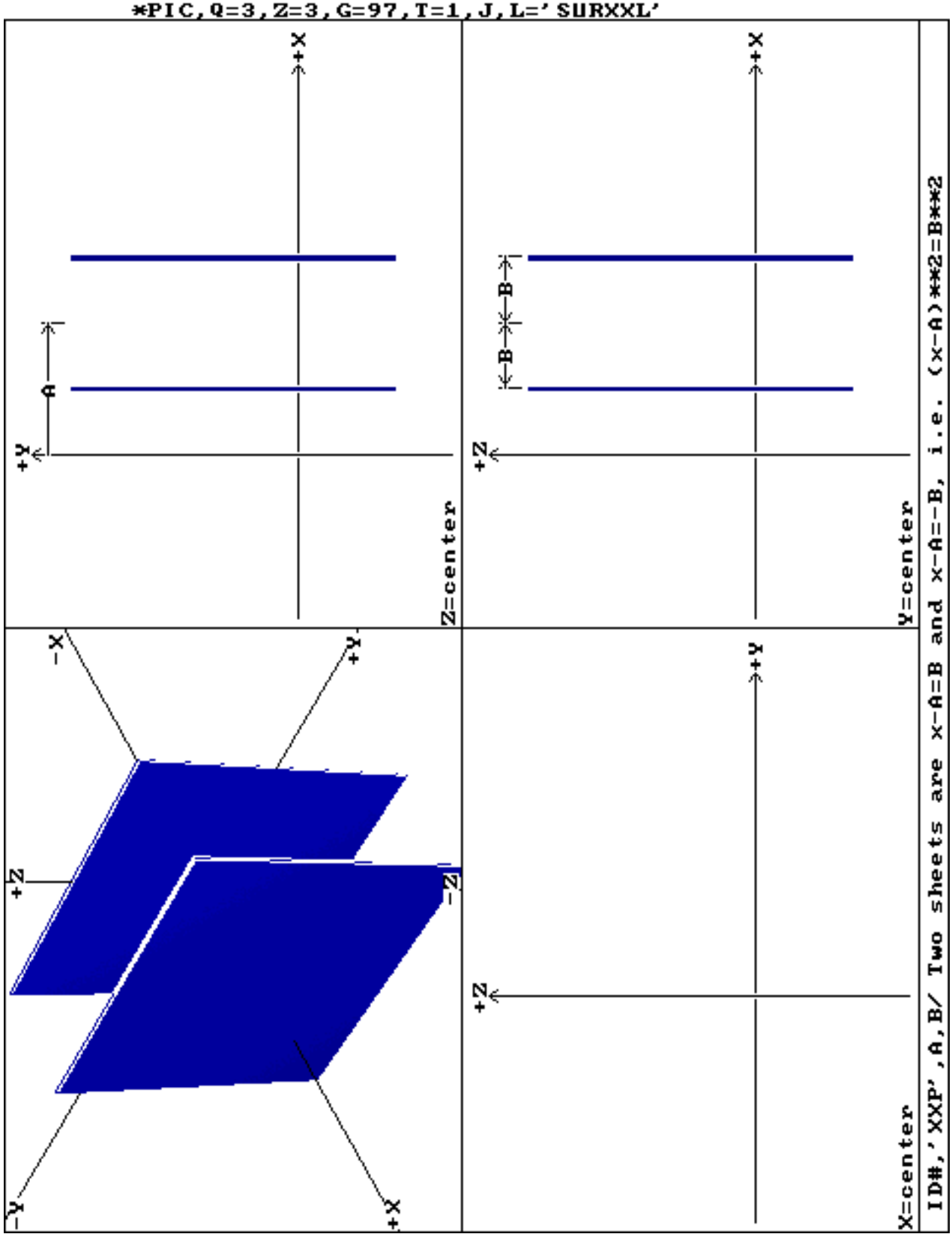


Figure 138: (SURYYP) Two Planes Perpendicular to Y

```
*SURFACE INPUT, TWO SHEET Y-PLANE
*PIC,Q=3,Z=3,G=97,T=1,J,L='SURYYL'
```

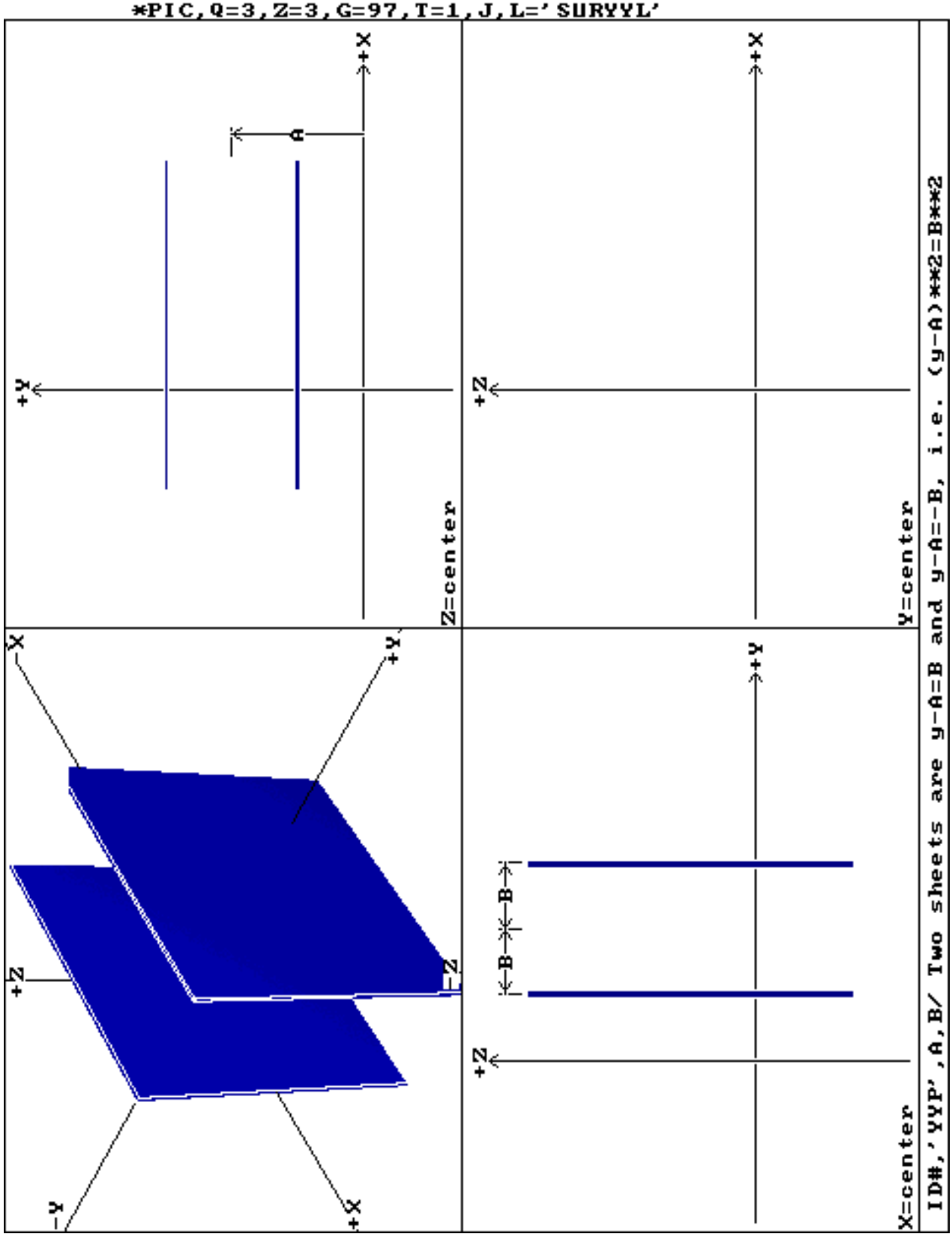
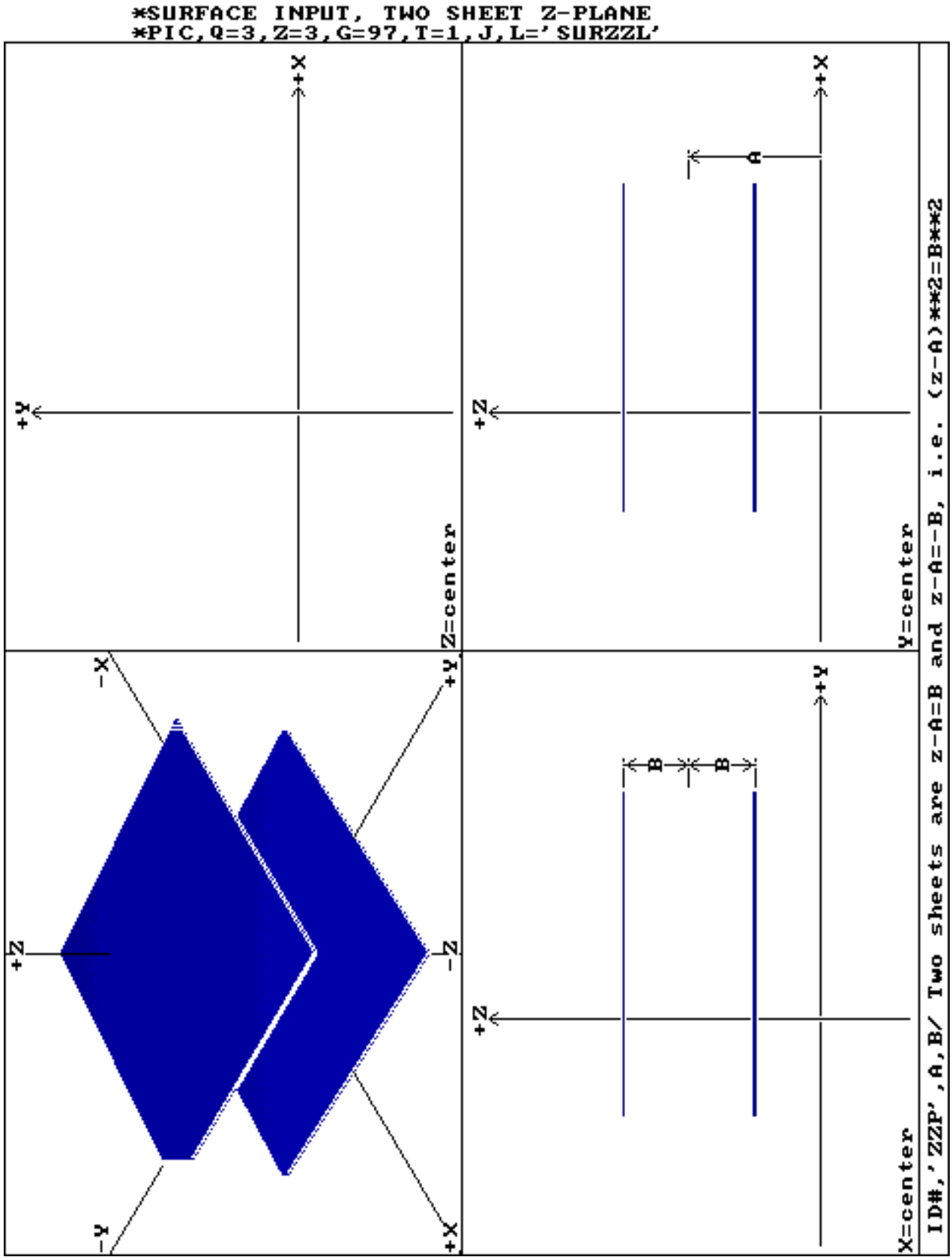


Figure 139: (SURZZP) Two Planes Perpendicular to Z



SYSTEMA

SYSTEMA processes an SYSTEMA model

****
The SYSTEMA processor reads an SYSTEMA geometry and loads it in the NOVICE database. This input can be preceeded or followed by other geometry, material, spectrum, and detector inputs.
****

****
Input Data Record Description:
****

==========
Header line
==========

Contains *SYS in columns 1 through 4.

=======
Options
=======

A, indicates an input file in the MATRA SYSTEMA format (an expanded configuration file).

B, indicates an input file in the SYSTEMA format.

C, generate detector points in the corners of any BOX5, BOX6, BOXCG5, or BOXCG6 shapes (8 points per box).

D, generate a detector point at the center of any BOX5, BOX6, BOXCG5, or BOXCG6 shapes. (1 point per box)

E, generate detector points at mid edge of any BOX5, BOX6, BOXCG5, or BOXCG6 shapes (12 points per box).

F, generate detector points face centered for any BOX5, BOX6, BOXCG5, or BOXCG6 shapes (6 points per box).

H, (real,,eps,inf) if box lims indentical use =-eps, default 1 micron

K, (material) to fill the interior of boxes

L, (real,,eps,inf) density (g/cc) of box interior

M, (material) default material for esabase/systema

O=o, o is the overlap option, i.e., O=3 allows overlaps in the geometry description. Where overlaps occur, the code uses that piece of the geometry that was described first in the input. This logic is used only where the objects physically interfere with each other. Where the objects are distinct, each is seen as described. See the OVERLAP section of the manual.

P=p, p is the spectrum scale factor for the trapped proton input spectrum. Default is 1.0.

R=r, r is the spectrum scale factor for the trapped electron input spectrum. Default is 1.0.

S=s, s is the spectrum scale factor for the solar flare proton input spectrum. Default is 1.0.

T=t, t is the thickness to be used for any shapes that do not have an input thickness or do not have a RADIATION associated thickness. Dimensions are the same as the geometry file input , e.g., MM. Default is 0.0 (if a thickness is not specified in the object description or in the RADIATION input, then the object is omitted from the geometry model unless T=t where t is non-zero).

****

Data Record Description:

****

File Name

Following the header line, with any options, is a single line containing the geometry input FILENAME (without extension) for the geometry being processed, e.g.

```
SATELLITE
```

Discussion

This processor can also be entered using the header lines

```
*DESIGN,A ...
```

or

```
*SYSTEMA ...
```

Note that the A option is required when using the *DESIGN header line. For the other two options, the A and B options are not required.

This interface processor can accept geometry data in two forms. The code first looks for a formatted SYSTEMA expanded configuration file with the name

FILENAME.SYS (FILENAME.SYSEXP on UNIX systems)

If FILENAME.SYS exists, then SYSTEMA formats are assumed. Since the SYSTEMA file is already in an expanded form, it is processed in a single pass. A summary of the processing is written to the file SYSTEMA.GEO.

If FILENAME.SYS does not exist, then NOVICE looks for an SYSTEMA input file with the name:

FILENAME.BAS (FILENAME.SYSBAS on UNIX systems)

If this file is found, then several steps are required before the geometry can be loaded:

(1) process COPY statements for objects,

(2) produce a configured geometry (this step is bypassed unless a FILENAME.FIG exists),

(3) process SHAPE/NAME and COPY structures,

(4) process NAME/ALIAS and NAME=ALIAS structures, and add explicit zeroes to three vectors (), (x), and (x,y).

After this processing, the SYSTEMA geometry is then loaded with summary output written to the file FILENAME.GEO. where FILENAME is the file name entered following the *SYS header/option line.

While loading the geometry for NOVICE, a file containing detector points (in NOVICE format) is created according to the C, D, E, and F options on the header line. This file is always named SYSTEMA.DET.

After loading the geometry, NOVICE then looks for a file containing spectra in the format used in an SYSTEMA analysis. This file is assumed to have the name

FILENAME.RAD (FILENAME.RADFOUTI on UNIX systems)

This file is processed to obtain spectra in the format required by NOVICE. Since the spectra may not be correctly normalized, e.g., the data may be average fluence per day, scale factors can be entered using the P, R, and S options on the header line. Output from spectrum processing is in a file always named SYSTEMA.SPE.

After processing spectra, NOVICE then looks for a file containing shield thickness and dose tabulations. This file is assumed to have the name

FILENAME.SHI (FILENAME.SHIEOUTG on UNIX systems)

This file is processed to obtain thickness/dose tabulations in the format required by NOVICE in ray-trace/sectoring calculations (*SIGMA). The output file produced for NOVICE is always named SYSTEMA.SIG.

Note that after processing the geometry (the *DESIGN header line), the SYSTEMA.SPE file is added to the input stream after the *SPECTRUM header line, the SYSTEMA.DET file is added to the input stream after the *DETECTOR header line, and the SYSTEMA.SIG file is added to the input stream as the final set of data in the *SIGMA portion of the input.

The SYSTEMA interface is very similar to the ESABASE interface. See the ESABASE processor for examples.

TRACER

TRACER sets parameters for subprogram entrance/exit.

****
The TRACER processor describes input for getting detailed tracing of all routines called by NOVICE. The output and time requirements can be very large. Used primarily for debugging when the source of a catastrophic error can not be found.
****

****
Input Data Record Description:
****

======
Header
======

Contains *TRA in columns 1 through 4.

=======
Options
=======

E, output on exit also

F, output full on each call

G, dump even in graphics mode

****
Data Record Description:
****

There are no other data records.

UNITS

UNITS sets conversion factors for input data.

****
The UNITS input processor defines conversion factors for user data supplied with non standard units
****

****
Input Data Record Description:
****

==========
Header line
==========

Contains *UNI in columns 1 through 4.

=======
Options
=======

No options apply.

****
Data Record Description:
****

==========
Name and Factor Pairs
==========

A single record consisting of pairs of names and factors

```
,NAME F NAME F ... /
     1 1    2 2
```

where NAME is truncated to 3 characters. Allowed names are

MEV, F converts energy input to MeV or Mev/amu

CEN, F converts linear dimensions to centimeters

DEN, F converts densities to grams/cc. Note that if materials are entered by name on geometry definition input lines, the density is defined as the default density of the material and will then be scaled by F. Therefore, set this factor to unity when using material names rather than indices.

RAD, F converts angle inputs to radians

DEG, F converts angle inputs to degrees

SEC, F converts time inputs to seconds

GRA, F converts weight inputs to grams

COS, if F is 1, polar angle cosines are being input

COS, if F is -1, polar angles are being input in radians

COS, if F is negative, -F*input gives polar angle in radians,

The polar angle cosine is computed before storing the datum

VERSION

VERSION outputs information on the executable.

****
The *VERSION command creates several output lines indicating when the executable was created and the compiler options used.
****

==========
Header Line
==========

Must contain *VER in the first four non-blank columns.

++++++++++
Discussion
++++++++++

There are no options or other input for this processor.

XRAY

XRAY calculates xray transport with no scattering.

****
The XRAY processor calculates photon transport using attenuation only.
****

****
Input Data Record Description:
****

======
Header
======

Contains *XRA in columns 1 through 4.

=======
Options
=======

A=a, incident angle in degrees, default is 0 degrees.

C=c, renormalize all photon spectra to c calories per sqcm.

D, dump 3D ray trace information

E, put calories/gram rather than rad on plot output file.

F, output energy dependent fluences.

G=g, g is the detector point index for 3D calculations, default is detector point 1.

H=h, h is the number of histories (greater than 1) for a 3D calculation. If absent, a 1D calculation is assumed.

****
Data Record Description:
****

==========
Layer Materials (no H option, paired input)
==========

Material for each layer/

==========
Layer Thickness (no H option, paired with above record)
==========

Thicknesses of layers/

Omit these data if the H>1 option was selected. Two record logical pair input. The first record contains material indices (or names) and the second record contains material thicknesses in centimeters. A zero thickness is allowed for the first material layer.

****
Output Tables
****

Table 121 (XRAY1D) gives sample output for a 1D analysis (no H option).

Table 122 (XRAY2D) gives sample output for response versus thickness from the 1D analysis.

Table 123 (XRAY3D) gives sample output for a 3D analysis (H=h, h greater than 1).

Table 121: (XRAY1D) Sample 1D Output

```
-------------------------------XRAY ATTENUATION-------------------------------

XRAY DATA, LAYER  2, MATERIAL  1, CM=  1.0000E-04, TOTAL G/SQCM=  2.7000E-04

FLUXES FOR SPECTRUM       photon

GROUP       E-MIN       E-MAX  NUMBER/MEV  NUMBER/GRP  NUMBER-SUM  ENERGY-SUM
    6   2.512E-02   3.162E-02   8.259E+00   5.371E-02   5.371E-02   1.524E-03
    7   1.995E-02   2.512E-02   1.757E+05   9.075E+02   9.075E+02   2.045E+01
    8   1.585E-02   1.995E-02   4.587E+08   1.882E+06   1.883E+06   3.371E+04
    9   1.259E-02   1.585E-02   2.292E+11   7.470E+08   7.489E+08   1.066E+07
   10   1.000E-02   1.259E-02   3.075E+13   7.962E+10   8.037E+10   9.099E+08
   11   7.943E-03   1.000E-02   1.442E+15   2.966E+12   3.046E+12   2.752E+10
   12   6.310E-03   7.943E-03   2.902E+16   4.741E+13   5.045E+13   3.654E+11
   13   5.012E-03   6.310E-03   2.940E+17   3.815E+14   4.320E+14   2.525E+12
   14   3.981E-03   5.012E-03   1.699E+18   1.751E+15   2.183E+15   1.040E+13
   15   3.162E-03   3.981E-03   6.164E+18   5.047E+15   7.231E+15   2.843E+13
   16   2.512E-03   3.162E-03   1.505E+19   9.790E+15   1.702E+16   5.620E+13
   17   1.995E-03   2.512E-03   2.586E+19   1.336E+16   3.038E+16   8.631E+13
   18   1.585E-03   1.995E-03   3.140E+19   1.288E+16   4.327E+16   1.094E+14
   19   1.259E-03   1.585E-03   2.645E+19   8.620E+15   5.189E+16   1.216E+14
   20   1.000E-03   1.259E-03   7.985E+19   2.067E+16   7.256E+16   1.450E+14
   21   7.943E-04   1.000E-03   7.463E+19   1.535E+16   8.791E+16   1.588E+14
   22   6.310E-04   7.943E-04   5.793E+19   9.465E+15   9.737E+16   1.655E+14
   23   5.012E-04   6.310E-04   3.500E+19   4.542E+15   1.019E+17   1.681E+14
   24   3.981E-04   5.012E-04   1.458E+19   1.503E+15   1.034E+17   1.687E+14
   25   3.162E-04   3.981E-04   3.377E+18   2.765E+14   1.037E+17   1.688E+14
   26   2.512E-04   3.162E-04   3.275E+17   2.130E+13   1.037E+17   1.689E+14
   27   1.995E-04   2.512E-04   9.064E+15   4.683E+11   1.037E+17   1.689E+14
   28   1.585E-04   1.995E-04   3.182E+13   1.306E+09   1.037E+17   1.689E+14
   29   1.259E-04   1.585E-04   1.734E+10   5.652E+05   1.037E+17   1.689E+14
   30   1.000E-04   1.259E-04   2.114E+06   5.473E+01   1.037E+17   1.689E+14
                                                     CALORIES PER SQCM   6.466E+00

NUMBER/ENERGY BALANCE FOR SPECTRUM       photon
               INTO SLAB    OUT OF SLAB   STOP IN SLAB   STOPPED/GRAM
 PHOTONS        1.90E+17       1.04E+17       8.63E+16       3.20E+20
     MEV        2.61E+14       1.69E+14       9.23E+13       3.42E+17
CALORIES        1.00E+01       6.47E+00       3.53E+00       1.31E+04

SPECTRUM WEIGHTED RESPONSES
SPECTRUM  1       photon, RESPONSE  1     ALUMINUM  4.40E+09, AVE=  6.32E+09
                                     CALORIES/GRAM  1.05E+04, AVE=  1.51E+04
SPECTRUM  1       photon, RESPONSE  2      SILICON  4.25E+09, AVE=  5.95E+09
                                     CALORIES/GRAM  1.02E+04, AVE=  1.42E+04
SPECTRUM  1       photon, RESPONSE  3  NUMBER FLUX  1.04E+17, AVE=  1.37E+17
SPECTRUM  1       photon, RESPONSE  4  ENERGY FLUX  1.69E+14, AVE=  2.09E+14
```

Table 122: (XRAY2D) Sample 2D Output

RESPONSE 3 NUMBER FLUX VS THICKNESS FOR SPECTRUM 5 photon10

LAYER	MATERIAL	DELTA CM	TOT G/SQCM	RESPONSE
1	1	0.00E+00	0.00E+00	9.65E+15
2	1	1.00E-04	2.70E-04	9.55E+15
3	1	1.00E-03	2.97E-03	9.15E+15
4	1	1.00E-02	3.00E-02	7.94E+15
5	1	1.00E-01	3.00E-01	5.12E+15
6	1	1.00E+00	3.00E+00	1.24E+15

RESPONSE 4 ENERGY FLUX VS THICKNESS FOR SPECTRUM 5 photon10

LAYER	MATERIAL	DELTA CM	TOT G/SQCM	RESPONSE
1	1	0.00E+00	0.00E+00	2.61E+14
2	1	1.00E-04	2.70E-04	2.61E+14
3	1	1.00E-03	2.97E-03	2.58E+14
4	1	1.00E-02	3.00E-02	2.45E+14
5	1	1.00E-01	3.00E-01	1.90E+14
6	1	1.00E+00	3.00E+00	6.17E+13

Table 123: (XRAY3D) Sample 3D Output

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-------------------------------XRAY ATTENUATION-------------------------------

DETECTOR  1    XYZ=0,0,0, AVERAGE G/SQCM  2.7000E+00

FLUXES FOR SPECTRUM     photon10

GROUP       E-MIN       E-MAX  NUMBER/MEV  NUMBER/GRP  NUMBER-SUM  ENERGY-SUM
    1   7.943E-02   1.000E-01 3.00E+14  0 6.16E+12  0 6.16E+12  0 5.53E+11  0
    2   6.310E-02   7.943E-02 1.06E+15  0 1.73E+13  0 2.34E+13  0 1.78E+12  0
    3   5.012E-02   6.310E-02 2.47E+15  0 3.20E+13  0 5.54E+13  0 3.59E+12  0
    4   3.981E-02   5.012E-02 3.86E+15  0 3.98E+13  0 9.52E+13  0 5.38E+12  0
    5   3.162E-02   3.981E-02 3.77E+15  0 3.09E+13  0 1.26E+14  0 6.48E+12  0
    6   2.512E-02   3.162E-02 1.85E+15  0 1.20E+13  0 1.38E+14  0 6.83E+12  0
    7   1.995E-02   2.512E-02 2.77E+14  0 1.43E+12  0 1.40E+14  0 6.86E+12  0
    8   1.585E-02   1.995E-02 4.19E+12  0 1.72E+10  0 1.40E+14  0 6.86E+12  0
    9   1.259E-02   1.585E-02 7.27E+08  0 2.37E+06  0 1.40E+14  0 6.86E+12  0
   10   1.000E-02   1.259E-02 1.93E+01  0 4.98E-02  0 1.40E+14  0 6.86E+12  0
   11   7.943E-03   1.000E-02 1.04E-14  0 2.13E-17  0 1.40E+14  0 6.86E+12  0
                                                  CALORIES PER SQCM 2.63E-01  0
SPECTRUM  5     photon10, RESPONSE  1     ALUMINUM  2.9114E+04  0
                                     CALORIES/GRAM  6.9593E-02  0
SPECTRUM  5     photon10, RESPONSE  2      SILICON  3.7557E+04  0
                                     CALORIES/GRAM  8.9775E-02  0
SPECTRUM  5     photon10, RESPONSE  3  NUMBER FLUX  1.3953E+14  0
SPECTRUM  5     photon10, RESPONSE  4  ENERGY FLUX  6.8585E+12  0
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