

**INSTALLATION AND OPERATION OF PARTICLE TRANSPORT
SIMULATION PROGRAMS TO MODEL THE DETECTION AND
MEASUREMENT OF SPACE RADIATION BY SPACE-BORNE
SENSORS**

Stanley Woolf

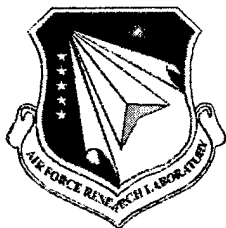
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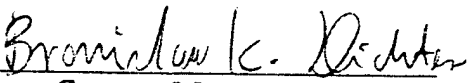
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14. ABSTRACT This is a report of technical progress made during 1 Aug 00 to 31 Jul 01 in the areas of: (1) research and evaluation of particle transport simulation programs for modeling the detection and measurement of space radiation by space-borne sensors; (2) construction of realistic flight sensor computer models; (3) performance of particle transport calculation; (4) analysis of transport simulation results, including single particle tracking; (5) addition of new capabilities such as single particle tracking and specialized source geometry to an existing particle transport simulation program; (6) space-borne dosimeter simulation studies; (7) three-dimensional visualization of ITS-ACCEPT and MCNPX were applied to the modeling of the geometry files. The computer programs ITS-ACCEPT and MCNPX were applied to the modeling of the CEASE and HEP sensors. Shown in this report are listings of input files with geometry/materials drawings for the various simulation programs, annotated computer code listings showing program modifications and partial listings of computer code outputs for individual particle tracking and coincidence event identifications.					
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1. Introduction

The effort to be described in this report was performed as partial fulfillment of two primary objectives: (1) perform computer simulations of charged particle transport, energy and charge deposition in satellite-borne instrumentation used in research efforts of the Air Force Research Laboratory/ Space Weather Center of Excellence (AFRL/VSBXR) to detect and characterize (by type, energy, intensity, *etc.*) particles associated with ionizing radiation in space; (2) transfer this simulation capability to AFRL/VSBXR and provide advice to Air Force researchers on its use; and (3) create and install additional capabilities in existing Monte Carlo transport programs to: (a) simulate a number of source geometries encountered in the VSXBR research program; and (b) permit "observation" of individual electron track histories.

During this reporting period we worked with the Monte Carlo simulation programs listed below at ARCON and provided assistance and guidance for their use at AFRL. The Monte Carlo transport simulations programs that were used at both ARCON and AFRL in this effort are:

- "ITS 3.0 – Integrated TIGER Series of Coupled Electron/Photon Monte Carlo Code System" [1] - ACCEPT – General three-dimensional transport code
- "MCNPX, Version 2.1.5 – Monte Carlo transport code for neutrons, photons, electrons, mesons, protons, deuterons, tritons, ³He, alpha" [2]

In addition to the two codes listed above, we also acquired a three dimensional geometry and visualization program, Sabrina[3], that while written primarily for use with the MCNP code series, can also be used for reading and writing geometry files for ITS/ACCEPT.

In the following sections, we briefly discuss the computer programs listed above, some of their interrelationships, and provide descriptions and examples of our application of these codes to the modeling of particle transport and trajectory tracking in the CEASE[4] and HEP[5] instruments.

2. Electron Transport Modeling

2.1 Electron Energy Deposition Calculations in Silicon Wafers

Transport calculations for 4 MeV and 6 MeV electrons incident on rectangular silicon dosimeter wafers (0.05cm × 0.9cm × 0.9cm). Twelve source geometry configurations were assumed for each source energy. Duplicate simulation runs were made with both ITS-ACCEPT[1] and MCNPX[2]. The result of performing these calculations accomplished two objectives: 1) provide a set of input files for both simulation programs that could be modified, if desired, and used by AFRL personnel for performing these and similar simulations; and 2) compare the relative advantages and disadvantages of the ACCEPT and MCNPX codes for electron transport. The input files were also set up to produce electron pulse-height spectra. We provided interpretation of the pulse-height spectra results for both codes, the presentations of which are formatted differently, and showed for all practical purposes, the equivalence of their answers.

For all source configurations and both source energies, the Monte Carlo runs were made using 200,000 case histories. The source geometries consisted of: normally incident electron

beams (or point sources); point isotropic sources; disk sources-normal incidence; disk sources-isotropic incidence. All sources were located on the wafer surfaces, either on the $0.9\text{cm} \times 0.9\text{cm}$ surface (Fig. 1a) or on the $0.05\text{cm} \times 0.9\text{cm}$ surface (Fig. 1b). The input and output files for all 24 Monte Carlo runs were provided to AFRL. Default values for the electron low energy cut-off were used with both ACCEPT ($0.05E_{\text{source}}$) and MCNPX (1.0 keV). Since the default value for the MCNPX cut-off energy was set much lower than the ACCEPT value, the run times for MCNPX (~ 1 hr) far exceeded those for ACCEPT (~ 0.5 min) by two orders of magnitude. When the same electron cut-off energy was used in MCNPX, the run time was found to be a factor of 1.5 greater than that required for ACCEPT. With the current version of ACCEPT, the lowest electron cut-off energy allowed by the code is 24.5 keV. When the program was run with this cut-off, the run time for 200000 histories increased to 1.17 minutes with no significant change in the results. To achieve the low energy cut-off value of 1 keV, it would have been necessary to use ACCEPTP and XGENP, the P-code versions of ACCEPT and XGEN, containing low-energy electron physics. ACCEPT energy deposition results are shown in Figs. 2-6 for 6 MeV sources. Fig. 2 displays the total energy deposited in the silicon wafer shown in Fig. 1a for the eight source configurations described and labeled in Table 1.

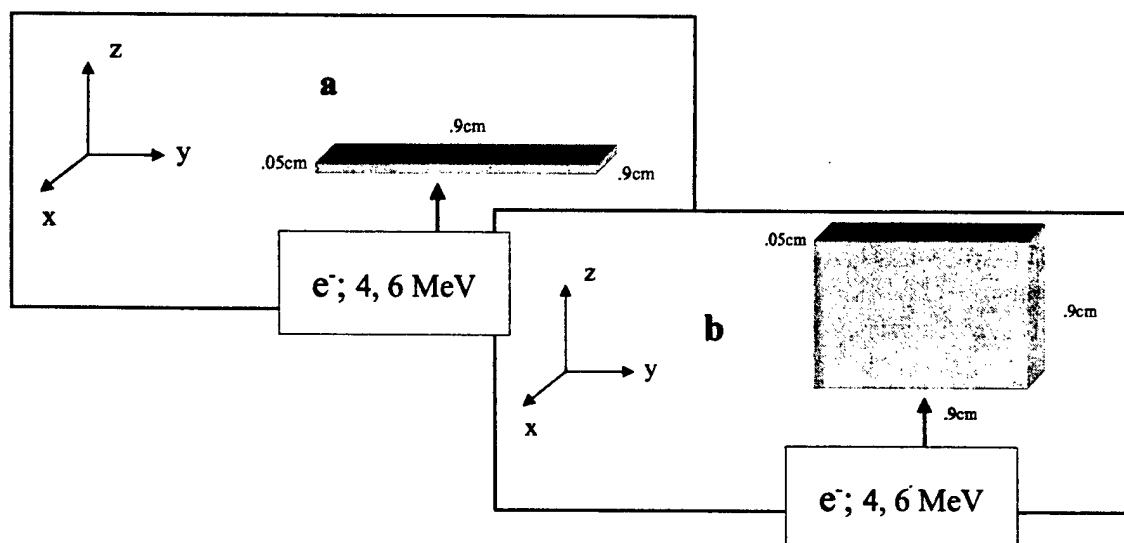


Figure 1. Electron sources incident on silicon dosimeter wafer

Table 1.
Source Configurations for Transport Simulation of 4.0 and 6.0 MeV Electrons in Silicon

Electron Source Configuration	Source Geometry
(1) Single Beam, Normal Incidence at (.45,.45,0.)	
(2) Disk Source, Rad. = 0.1cm, Normal Incidence centered at (.45,.45,0.)	
(3) Disk Source, Radius = 0.2cm, Normal Incidence centered at (.45,.45,0.)	
(4) Disk Source, Radius = 0.449cm, Normal Incidence centered at (.45,.45,0.)	
(5) Point Isotropic, 45° cone centered at (.45,.45,0.)	
(6) Disk Source, Rad. = 0.1cm, Isotropic 45° cones centered at (.45,.45,0.)	
(7) Disk Source, Rad. = 0.2cm, Isotropic 45° cones centered at (.45,.45,0.)	
(8) Disk Source, Rad. = 0.449cm, Isotropic 45° cones centered at (.45,.45,0.)	

The choice of 200000 histories resulted in poor statistics for the point sources, except in the immediate vicinity of the source point. The statistics were much improved, however, everywhere in the silicon wafer (~1%-5% estimated standard error) with the use of spatially

uniform disk sources. The number of histories (200000) was chosen as an expedient to ensure input file correctness. The run files corresponding to the source configurations shown in Table 1 were turned over to AFRL for production runs.

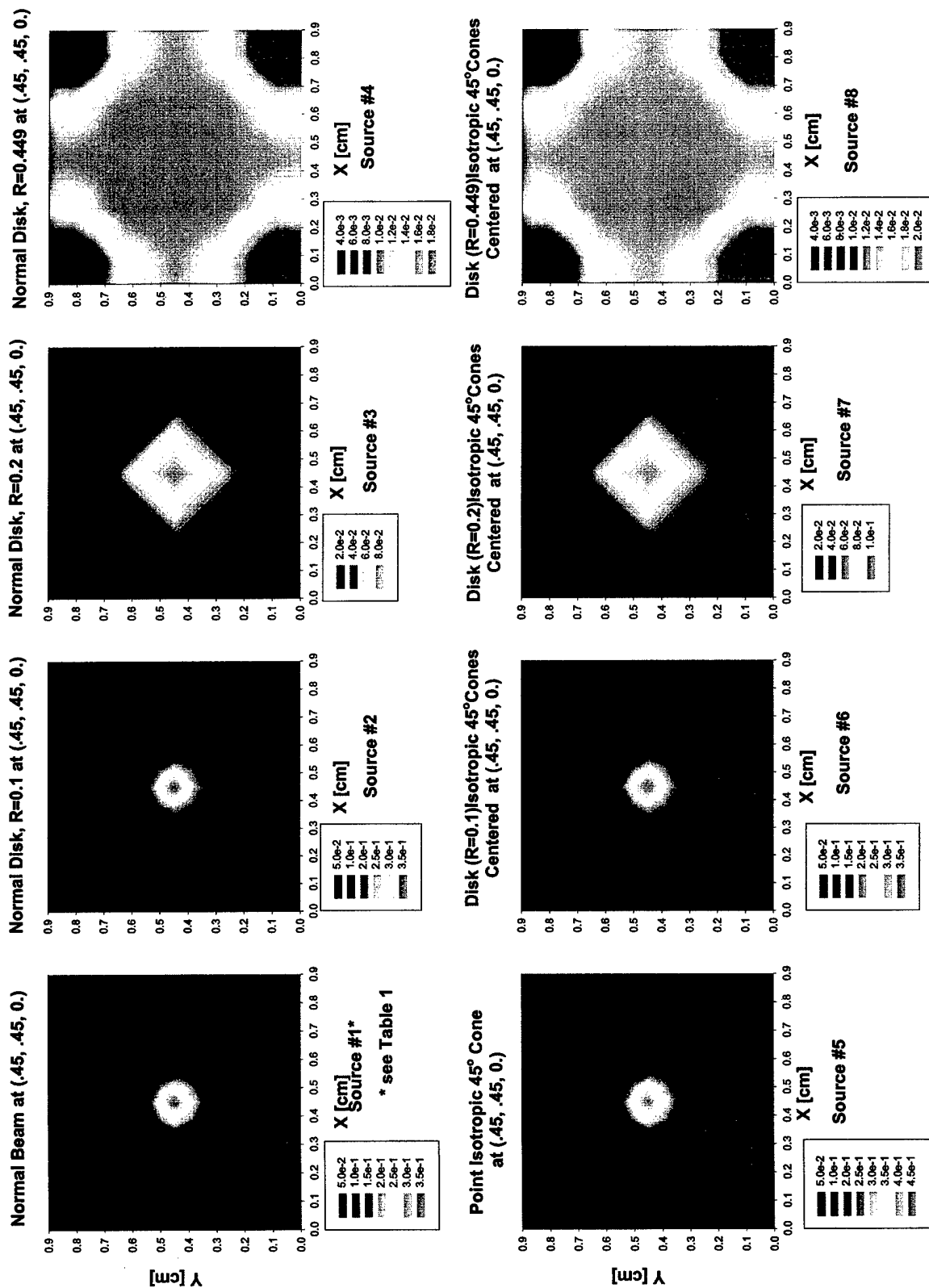


Figure 2. Total energy deposition [MeV] in Si wafer (0.05x0.9x0.9 cm³, see Figure 1a) for 8 source geometries; electron source energy = 6 MeV

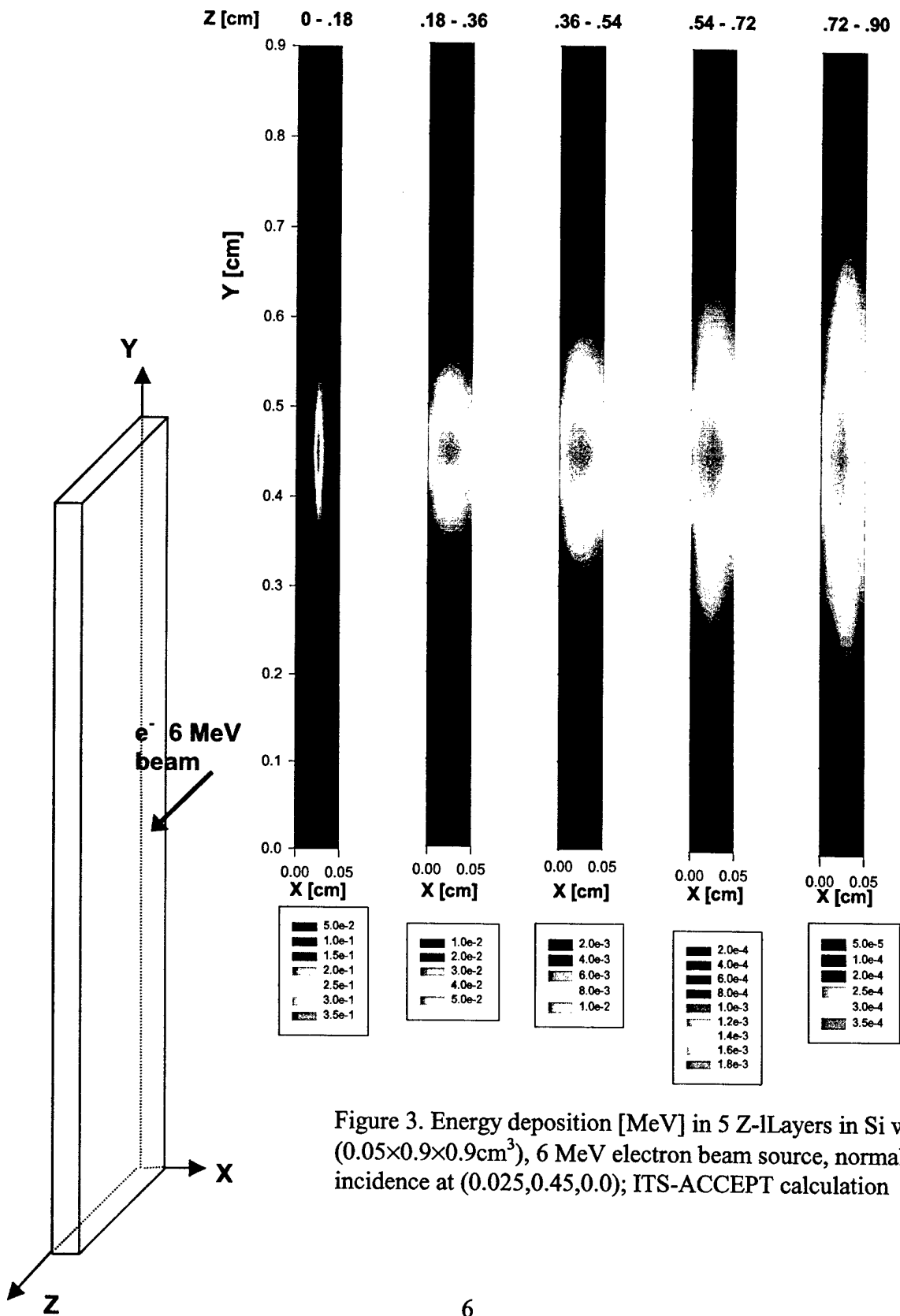
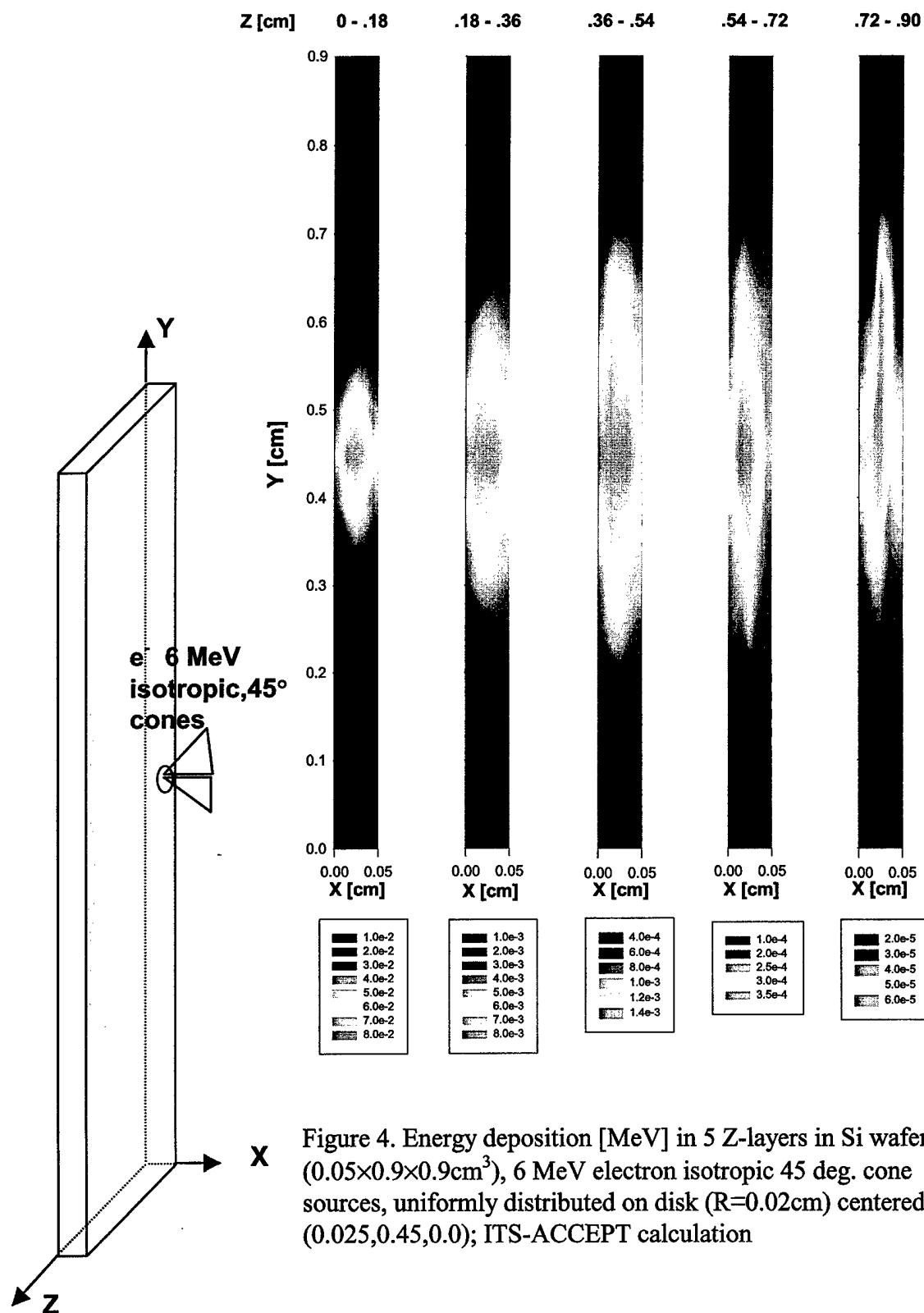


Figure 3. Energy deposition [MeV] in 5 Z-layers in Si wafer (0.05x0.9x0.9cm³), 6 MeV electron beam source, normal incidence at (0.025,0.45,0.0); ITS-ACCEPT calculation



2.2 ITS-ACCEPT Electron/Photon Transport Simulations for the HEP Instrument

A new ACCEPT geometry input file for the in-flight version of the HEP instrument was created from a complete set of manufacturing drawings supplied by Amptek, Inc. [5]. This geometry description exactly mimics the geometry description written during the first year of this effort for MCNPX [6]. The ACCEPT geometry description, which contains the same degree of detail as the manufacturing drawings, permits us to: (1) take advantage of the speed and efficiency of the ACCEPT code for performing coupled electron-photon transport calculations in complicated structures; and (2) use the ACCEPT code to confirm the validity of the MCNPX geometry description by comparing electron transport results obtained with the two programs. Unlike ACCEPT, MCNPX can be used to perform transport calculations for protons, neutrons, mesons, and other particle species. It is therefore important to have the ACCEPT version of the HEP geometry to use as an independent verification of the MCNPX geometry description.

Figure 5 shows a cut-away view of the HEP sensor. This illustration was drawn using SABRINA [3] an interactive, three-dimensional geometry visualization and modeling program

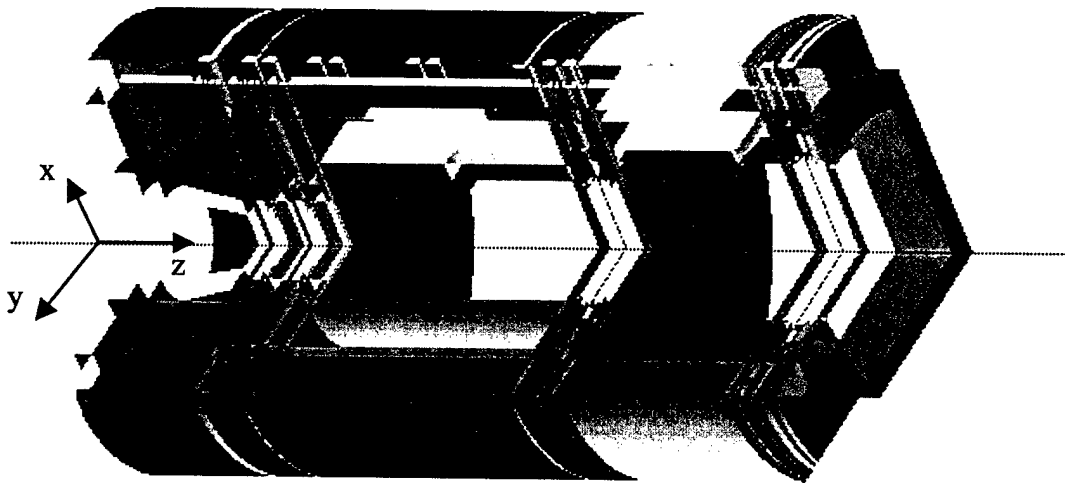


Figure 5. Sabrina [3] rendering of ITS-ACCEPT [1] geometry model of HEP [5] Flight Sensor

that can be used to construct and visualize geometry models for both MCNPX and ACCEPT. Additional useful features of the SABRINA program are: automatic conversion of ACCEPT models to the MCNPX format and particle track ray-tracing.

The ACCEPT input file corresponding to the HEP flight sensor depicted in Figure 5 is listed in Appendix 1. Several ACCEPT runs were made to test the robustness of the geometry file. The purpose was to uncover "holes" (errors) in the geometry specification that are not immediately obvious from the pictures generated with SABRINA. An efficient way to determine which, if any, cells are improperly defined in the input file is to run a large number of case histories for several source configurations and energies. The diagnostic messages that appear in the ACCEPT output when a particle has "lost its way" are of limited value. Because geometry file flaws are usually manifested by abrupt program halts when ten particles have been lost, we have found that the most effective method for constructing highly detailed geometry files is to build up the model in gradual stages of complexity. Test runs of ACCEPT were made using this gradual approach until the model illustrated in Figure 5 passed all tests for robustness. The run file consisting of 318 geometric bodies defining 505 material cells is listed in Appendix 4. This file was used to simulate a 25 MeV electron disk source normally incident on the front face ($z = 0$ plane) of the instrument.

2.3 ITS-ACCEPT Program Enhancements

The ITS-ACCEPT Monte Carlo program modifications that were made fall into two categories: the addition of new source options; and the addition of code that permits the user to view the energy deposition contributions of individual electron tracks. The primary motivation for the source option enhancement was supplied by the fact that the standard disk source option in ACCEPT does not allow for the specification of electron source beam slant angles without slanting the source plane. Source electrons emanating from a plane with off-normal angles of incidence could not originate at equidistant points from the target. The demonstration of this is given in a set of electron transport runs that were made for the aluminum-void-silicon slab geometry shown in Figure 6. Runs were made for six source disk slant angles ($\theta = 0, 15, 30, 45, 60, 75^\circ$). The electron source energy in all cases was 3.5 MeV. Because of the manner in which the standard disk source option in ACCEPT is implemented, it was necessary to adjust the position of the disk center for each θ value in order to ensure that the source disk not intersect with the target medium. An ACCEPT input data file corresponding to the illustration of Figure 6 with $\theta = 45^\circ$ is shown in Figure 7. For the case shown, the radius R of the disk source was set at 1.0 cm. For the 45° slant source it was necessary to place the coordinates of the disk center at $X_s = 2.5, Y_s = 2.5, Z_s = -0.7071067$ to avoid having source electrons originate inside the target medium. While the ACCEPT code does not permit this source condition, it could be modified to allow sources originating in the interior of a scattering medium.

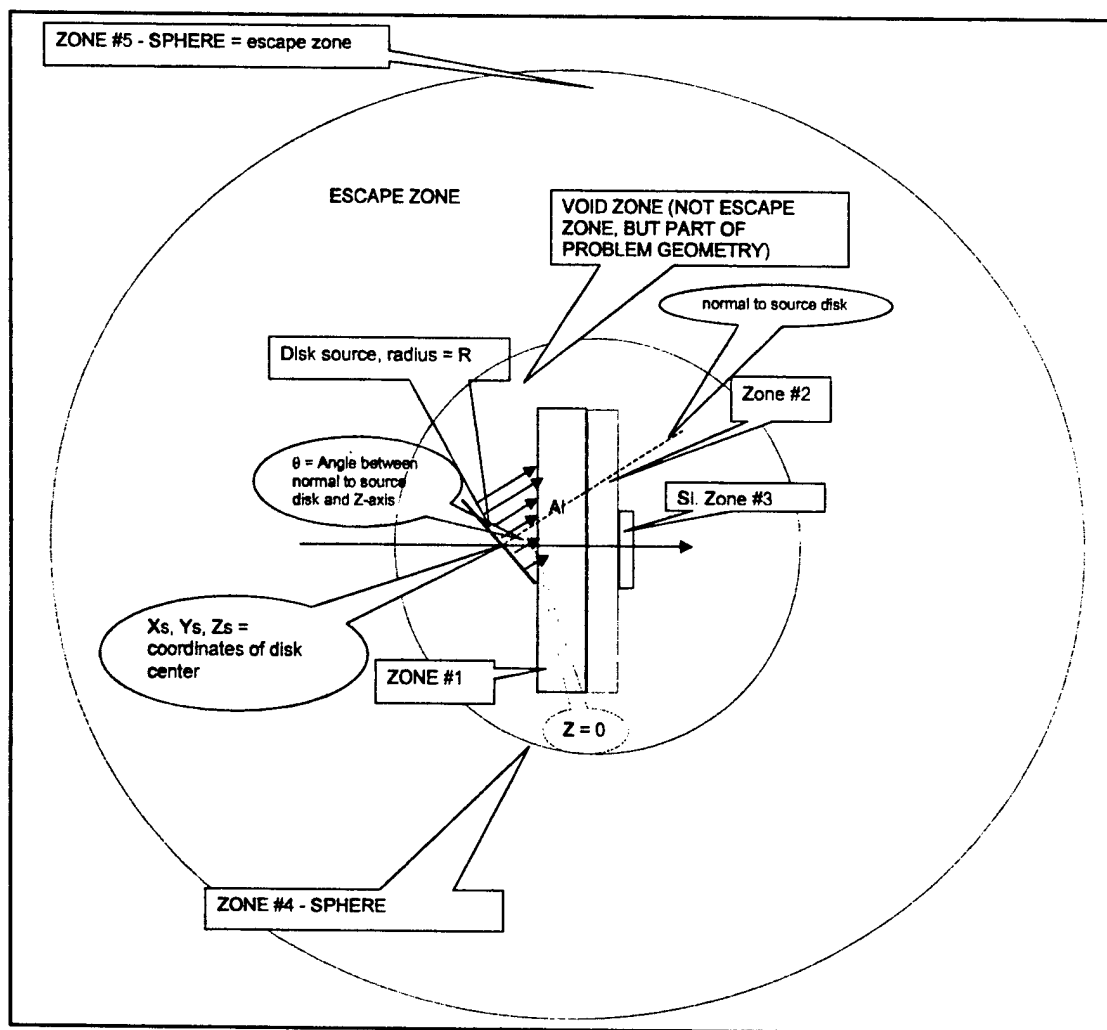


Figure 6. Aluminum / void / silicon ACCEPT problem geometry (not drawn to scale) with slant disk source as described in the input data file shown in Figure 7.

2.3.1 Disk and Rectangle Source Options

A capability was added to the ACCEPT program to allow the use of disk and rectangular spatially uniform distributed sources (electrons or photons) with provision for changing the slant angle of the source beam direction without slanting the source plane itself. These new options are now implemented in the code by the addition of:

(1) a line such as

```
"RECTANGLE-SOURCE 2.05 2.95 2.05 2.95 0.0 0.0"
```

to the ACCEPT input file for the rectangle source case. The 6 numbers (required) are the bounding coordinates of the source rectangle (X_{MIN} , X_{MAX} , Y_{MIN} , Y_{MAX} , Z_{MIN} , Z_{MAX}); and (2)

```
"CIRCLE-SOURCE 2.5 2.5 0.0 3.5 2.5 0.0"
```

to the ACCEPT input file for the disk source case. The 6 (required) numbers are the X , Y , Z coordinates of the disk center and a point on the disk circumference. The program computes the

source disk radius and checks internal consistency by comparing this value with the value entered on the "RADIUS" input line. In both the rectangle and circle source cases, if an error in the input data violates the conditions for geometric validity, informative diagnostics messages are printed in the ACCEPT output file, and the run is aborted. One restriction in the use of these options is that the orientation of the source planes cannot be arbitrarily chosen. Their orientation must be perpendicular to any one of the three Cartesian coordinate axes. Since the choice of orientation of the source beam is allowed to be arbitrary, this restriction, which greatly simplified the re-programming of ACCEPT, does not result in sacrifice of utility.

Test runs were made for both the rectangle and disk source cases. The disk source results were validated by matching the old disk source results for normal incidence.

```

TITLE
  3.5 MEV ON AL/VOID/SI, SLANT DISK SOURCE (THETA=45deg) ZS=-.7071
***** GEOMETRY *****
GEOMETRY
*1
  RPP    0.000  5.000  0.000  5.000  0.000  0.635
*2
  RPP    0.000  5.000  0.000  5.000  0.635  0.792
*3
  RPP    2.050  2.950  2.050  2.950  0.792  0.842
*4
  SPH    2.500  2.500  0.421  4.243
*5
  SPH    2.5    2.5    0.421  10.0
  END
*ZONES
  Z01 +1
  Z02 +2
  Z03 +3
  Z04 +4 -1 -2 -3
  * ESCAPE ZONE IS A VOID SPHERE OF RADIUS  10 CM ENCLOSING THE SLAB
  Z05 +5 -1 -2 -3 -4
  END
*MATERIAL
  1
  0
  2
  0
  0
***** SOURCE *****
ELECTRONS
ENERGY  3.5
POSITION  2.5 2.5 -0.7071067
RADIUS  1.0
DIRECTION 45.0  0.0

```

Figure 7. ACCEPT Input data file for 3.5 MeV 45° slant disk source incident on aluminum / void / silicon configuration shown in Figure 6.

2.3.2 Individual Electron Track Option

The second modification to ACCEPT permits the user to view the energy deposition contributions of individual case histories (electron tracks) in as many as 10 problem geometry cells. To implement this option, a line of the following form

"INDIVIDUAL-HISTS 92 145 93 146"

is added to the ACCEPT input file. The four numbers shown in the above example are the cell numbers corresponding to the electrically active parts (92, 145) of the CEASE front and back silicon detectors, respectively, and their corresponding electrically inactive parts (93, 146). A supplementary output file (EDSHOW.TXT) is produced by this version of ACCEPT and consists of: (a) tables (5 columns), for each cell, of (1) the case history number, energy deposition contributions [MeV] by the (2) primary electron, (3) knock-on electrons, (4) bremsstrahlung produced secondary electrons [see Figure 8], and (5) total energy deposition; and (b) a summary table showing the total energy deposition, for each history, in each cell (for example, 4 columns corresponding to cells 92, 145, 93, 146)[see Figure 9]. This last summary table allows for quick recognition of coincidence events occurring in the front and back detectors.

ENERGY DEPOSITION IN CELL NO. 92				
Hist. no.	Primary	Knock-on	Secondary	Total
1	.44027E-01	.00000E+00	.00000E+00	.44027E-01
2	.52327E-01	.00000E+00	.00000E+00	.52327E-01
3	.77735E-01	.00000E+00	.00000E+00	.77735E-01
4	.11630E+00	.00000E+00	.00000E+00	.11630E+00
5	.53479E-01	.00000E+00	.00000E+00	.53479E-01
6	.61459E-01	.00000E+00	.00000E+00	.61459E-01
7	.10316E+00	.00000E+00	.00000E+00	.10316E+00
8	.53607E-01	.00000E+00	.00000E+00	.53607E-01
9	.49054E-01	.00000E+00	.00000E+00	.49054E-01
.				
.				
.				
.				
.				
96	.44499E-01	.00000E+00	.00000E+00	.44499E-01
97	.76406E-01	.00000E+00	.00000E+00	.76406E-01
98	.71468E-01	.00000E+00	.00000E+00	.71468E-01
99	.88710E-01	.00000E+00	.00000E+00	.88710E-01
100	.56262E-01	.00000E+00	.00000E+00	.56262E-01
ENERGY DEPOSITION IN CELL NO. 145				
Hist. no.	Primary	Knock-on	Secondary	Total
1	.45224E+00	.00000E+00	.00000E+00	.45224E+00
2	.00000E+00	.00000E+00	.00000E+00	.00000E+00
3	.00000E+00	.00000E+00	.00000E+00	.00000E+00
4	.38100E+00	.00000E+00	.00000E+00	.38100E+00
.				
.				
.				
.				
.				
94	.00000E+00	.00000E+00	.00000E+00	.00000E+00
95	.00000E+00	.00000E+00	.00000E+00	.00000E+00
96	.35406E+00	.00000E+00	.00000E+00	.35406E+00
97	.00000E+00	.00000E+00	.00000E+00	.00000E+00
98	.18983E+00	.00000E+00	.00000E+00	.18983E+00
99	.40809E+00	.00000E+00	.00000E+00	.40809E+00
100	.00000E+00	.00000E+00	.00000E+00	.00000E+00

Figure 8. Portion of EDSHOW.TXT file produced by ACCEPT when the "INDIVIDUAL-HISTS" option is exercised. The table itemizes contributions to energy deposition attributable to primary, knock-on and secondary electrons for every case history.

TOTAL ENERGY DEPOSITION IN CELLS				
	92	145	93	146
Hist.no.				
1	.44027E-01	.45224E+00	.00000E+00	.00000E+00
2	.52327E-01	.00000E+00	.00000E+00	.00000E+00
3	.77735E-01	.00000E+00	.00000E+00	.00000E+00
4	.11630E+00	.38100E+00	.00000E+00	.00000E+00
5	.53479E-01	.44387E+00	.00000E+00	.00000E+00
6	.61459E-01	.00000E+00	.00000E+00	.00000E+00
7	.10316E+00	.00000E+00	.00000E+00	.00000E+00
8	.53607E-01	.16434E+00	.00000E+00	.00000E+00
9	.49054E-01	.44833E+00	.00000E+00	.00000E+00
			.	
			.	
			.	
			.	
97	.76406E-01	.00000E+00	.00000E+00	.00000E+00
98	.71468E-01	.18983E+00	.00000E+00	.00000E+00
99	.88710E-01	.40809E+00	.00000E+00	.00000E+00
100	.56262E-01	.00000E+00	.00000E+00	.00000E+00

Figure 9. Portion of EDSHOW.TXT file produced by ACCEPT when the "INDIVIDUAL-HISTS" option is exercised. This table lists total energy deposition in all requested cells for every case history.

Program listings of the ACCEPT subroutines that were modified to incorporate the "RECTANGLE-SOURCE", "CIRCLE-SOURCE" and "INDIVIDUAL-HISTS" options are given in Appendix 2.

3. Proton Transport Modeling

3.1 Energy Deposition Calculations - CEASE Telescope

Energy deposition plots (see Figure 10) for electrons and protons were supplied by AFRL [6]. The curves shown in Figure 10 represent calculations for the front (DFT - thickness = 0.015 cm) and back (DBT - thickness = 0.05cm) silicon wafer detectors in the CEASE telescope. This provided an opportunity to test the validity of our CEASE model and the physical realism of MCNPX proton transport calculations. The CEASE model [7] written earlier for MCNPX was used in eight Monte Carlo runs corresponding to proton source energies, 4, 4.5, 5, 7.5, 9.5, 15, 30, 100 MeV with normally incident protons (disk sources covering the telescope aperture). The MCNPX simulation results, $Edep_{DBT}$ vs. $Edep_{DFT}$ for the proton sources, are plotted in Figure 11. They appear to closely track the proton energy deposition curves of Figure 10.

Computed Energy Depositions in CEASE Telescope

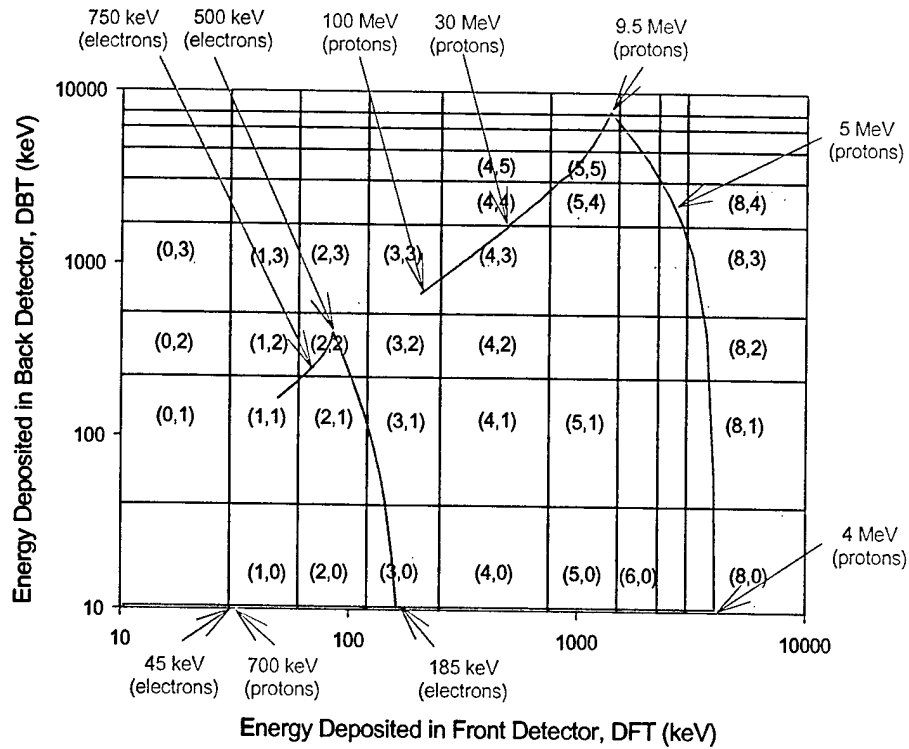


Figure 10. Computed energy depositions due to protons and electrons in DBT vs. DFT for the CEASE telescope[4,6]

Proton Energy Deposition MCNPX simulations

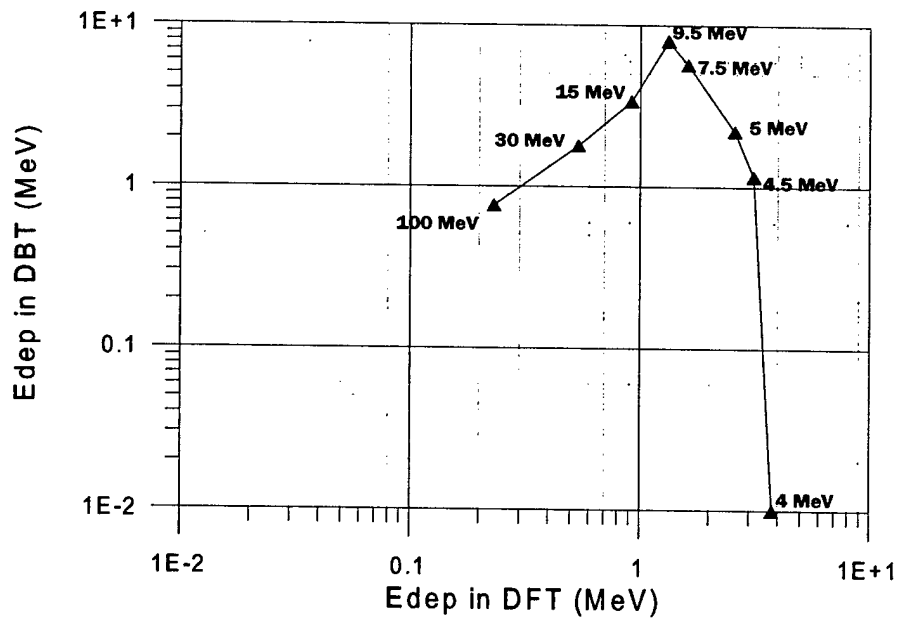


Figure 11. Energy depositions due to protons in DBT vs. DFT for the CEASE telescope as computed with the MCNPX simulation program.

3.2 Coincidence Event Identification - CEASE

A short FORTRAN program, count.F, was written to analyze the track file ("ptrac") produced by MCNPX in order to identify coincidence events in the DFT and DBT detectors. This program lists the energy deposition from protons in each detector for each proton track history and enables the investigator to recognize and evaluate coincidence events. The program is also configured to record the energy deposition in any cell of the CEASE simulation geometry. An annotated sample output file displaying the accounting results for 10000 proton histories (100 MeV proton source in CEASE aperture, normal incidence) is shown in Figure 12. The cell numbers containing the coincidence events listed at the end of the output identify tracks of interest that can be re-examined. The program listing of count.F is given in Appendix 3.

MCNPX - CEASE cell #	Total energy deposition	# of protons in cell	energy deposition due to protons	# of electrons in cell	energy deposition due to electrons	# of neutrons in cell	Energy deposition due to neutrons	# of photons in cell	Energy deposition due to photons
1	0.00000E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
2	0.00000E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
3	0.00000E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
.									
24	0.47660E-02	13	0.47660E-02	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
25	0.14176E+00	125	0.14176E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
26	0.31609E+00	246	0.31603E+00	0	0.00000E+00	0	0.00000E+00	1	0.58880E-04
27	0.46626E+00	357	0.46478E+00	0	0.00000E+00	0	0.00000E+00	1	0.14821E-02
28	0.60600E+00	467	0.60600E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
29	0.73127E+00	549	0.73111E+00	0	0.00000E+00	0	0.00000E+00	1	0.16188E-03
30	0.83742E+00	631	0.83742E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
31	0.96039E+00	704	0.95784E+00	0	0.00000E+00	0	0.00000E+00	2	0.25468E-02
32	0.10499E+01	760	0.10499E+01	0	0.00000E+00	0	0.00000E+00	1	0.45840E-04
33	0.11213E+01	807	0.11213E+01	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
34	0.12038E+01	874	0.12038E+01	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
35	0.12848E+01	906	0.12848E+01	0	0.00000E+00	0	0.00000E+00	1	0.21850E-04
36	0.13170E+01	931	0.13170E+01	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
37	0.15761E-01	290	0.15761E-01	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
38	0.94740E+00	333	0.94740E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
39	0.12217E-01	705	0.12217E-01	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
40	0.28122E+01	700	0.28122E+01	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
41	0.00000E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
42	0.00000E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
43	0.17045E+00	229	0.17045E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
44	0.00000E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
45	0.00000E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
46	0.64099E+00	605	0.64099E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
47	0.00000E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
48	0.26440E-02	0	0.00000E+00	0	0.00000E+00	1	0.13955E-05	3	0.26426E-02
49	0.00000E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
50	0.26963E+01	198	0.26587E+01	0	0.00000E+00	6	0.63279E-02	31	0.31316E-01
51	0.75840E+00	228	0.75837E+00	0	0.00000E+00	1	0.12650E-04	1	0.11150E-04
.									
61	0.94892E+00	667	0.94866E+00	0	0.00000E+00	0	0.00000E+00	2	0.26012E-03
62	0.20318E+00	684	0.20318E+01	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
63	0.00000E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00

Figure 12. Output file from count.F interpreting particle track, coincidence event and energy deposition data from MCNPX-ptrac file for protons, electrons, neutrons and photons.

68	0.00000E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
69	0.15190E+00	523	0.15190E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
70	0.18603E+00	209	0.18603E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
71	0.00000E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
72	0.34538E+00	142	0.34538E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
73	0.00000E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
74	0.14732E+01	581	0.14732E+01	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
75	0.26610E+01	671	0.26585E+01	0	0.00000E+00	0	0.00000E+00	1	0.25213E-02
76	0.22022E+01	606	0.22017E+01	0	0.00000E+00	0	0.00000E+00	1	0.45914E-03
77	0.00000E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
78	0.79859E+00	657	0.79859E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
79	0.00000E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
80	0.00000E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00

128	0.12088E+01	238	0.12080E+01	0	0.00000E+00	1	0.45992E-05	1	0.80680E-03
129	0.10351E+01	209	0.10351E+01	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
130	0.88508E+00	180	0.88487E+00	0	0.00000E+00	1	0.11277E-04	3	0.20188E-03
131	0.88338E+00	164	0.88333E+00	0	0.00000E+00	1	0.37793E-04	1	0.87200E-05

146	0.45599E-02	1	0.45599E-02	0	0.00000E+00	0	0.00000E+00	0	0.00000E+00
-----	-------------	---	-------------	---	-------------	---	-------------	---	-------------

no. of escaped particles = 114 140 0 0 0 0 0 0 145 0

escaped energy = 0.59827E+01

total energy deposited = 0.93343E+02

from protons = 0.90556E+02

from photons = 0.69015E-01

from neutrons = 0.24006E-01

from electrons = 0.00000E+00

from inelastic collisions = 0.26944E+01

number of proton coincidence events = 272

number of neutron coincidence events = 4

number of photon coincidence events = 2

history numbers for proton coincidence events

2	3	4	5	7	14	16	23	27	30	35	40	42	45	48
51	54	61	64	69	72	73	79	83	86	88	89	93	94	95
99	103	106	111	114	115	117	121	125	129	134	137	138	147	156
161	169	172	176	177	181	183	185	188	192	200	201	205	212	217
219	220	221	222	226	230	232	235	236	240	245	247	255	259	264
269	271	276	281	282	285	290	295	296	302	306	310	314	316	320
325	326	328	334	338	341	342	347	348	354	357	358	369	373	374
375	376	384	388	396	398	400	402	407	408	409	412	418	421	422
426	427	430	433	436	437	440	446	455	460	467	468	472	475	480
483	485	489	491	496	498	500	503	505	509	511	512	521	523	524
533	537	541	542	551	557	558	565	569	571	576	578	582	585	586
589	591	592	596	601	602	605	614	618	619	629	632	635	642	645
656	659	662	663	664	669	670	672	676	679	681	684	687	690	693
697	701	705	707	709	712	717	721	722	729	734	746	753	759	762
767	768	776	779	786	788	793	796	799	801	804	807	809	813	816
819	824	828	833	841	843	845	847	850	853	854	859	863	865	867
869	871	874	876	885	886	888	889	892	901	904	906	913	916	921
925	931	934	936	937	939	943	946	961	963	964	970	973	979	980
983	997													

Figure 12 (cont.). Output file from count.F interpreting particle track, coincidence event and energy deposition data from MCNPX-ptnac file for protons, electrons, neutrons and photons.

3.3 Beam Source Subroutine for MCNPX

A specialized source subroutine that allows the user to run beam sources at arbitrary positions and arbitrary orientations was written for use with MCNPX. MCNPX makes allowance for user-supplied source routines in addition to those supplied in the program. This is accomplished by omission of the source descriptor records in the MCNPX input data file. When this is done, the program searches for the user-supplied "SUBROUTINE SOURCE". In our version the user enters, as input to screen prompts, the source position (x, y, z), source direction cosines (u, v, w), source particle type (ipt), source particle energy (MeV), geometry surface number on which or cell number in which the source origination point is located. The program listing for source.F is given in Appendix 4.

4. Dome Dosimeter Study

Electron and proton transport calculations were made for the CEASE DD1 and DD2 dosimeters [4] and PASP Dome D2 and D3 dosimeters [8,9] using the ITS/ACCEPT and MCNPX simulation programs. The purpose of these calculations was to provide a means for determining the effects of differences in shield geometry on dose measurements in the same radiation environment. The data sets obtained with the CEASE and PASP dosimeters, normalized to take into account differences in shielding geometry, would then be used to study the solar cycle dependence of the electron dose from the outer radiation belt.

The schematic shown in Figure 13 for the CEASE DD1 and DD2 dosimeter assemblies was provided by AFRL[10]. The dosimeter assembly consists of a flat rectangular silicon diode resting on an aluminum oxide substrate, which in turn is mounted on an aluminum base. The dosimeter is capped with an aluminum plate.

4.1 CEASE Dosimeter Models - ACCEPT and MCNPX

Models for the original CEASE DD1 and DD2 geometries were obtained directly using the "CIRCLE-SOURCE" option as described in Section 2.3.1, above. Isotropic electron sources were assumed uniformly distributed on the disc surface as shown in Figure 14. We then wrote and installed a new source option, "DOME SOURCE", for ITS/ACCEPT in which the isotropic, inward-directed electron source is assumed to be uniformly distributed on the surface of a thin void hemispherical shell with the same radius as the disc shield plates. This source is depicted in the ACCEPT geometry schematic of Figure 15. The ACCEPT input file corresponding to the geometries shown in Figures 14 and 15 is listed in Appendix 5 for the CEASE DD1 dosimeter. Both the "CIRCLE-SOURCE" and "DOME SOURCE" input data (see annotations) are shown in the same file listing to conserve space.

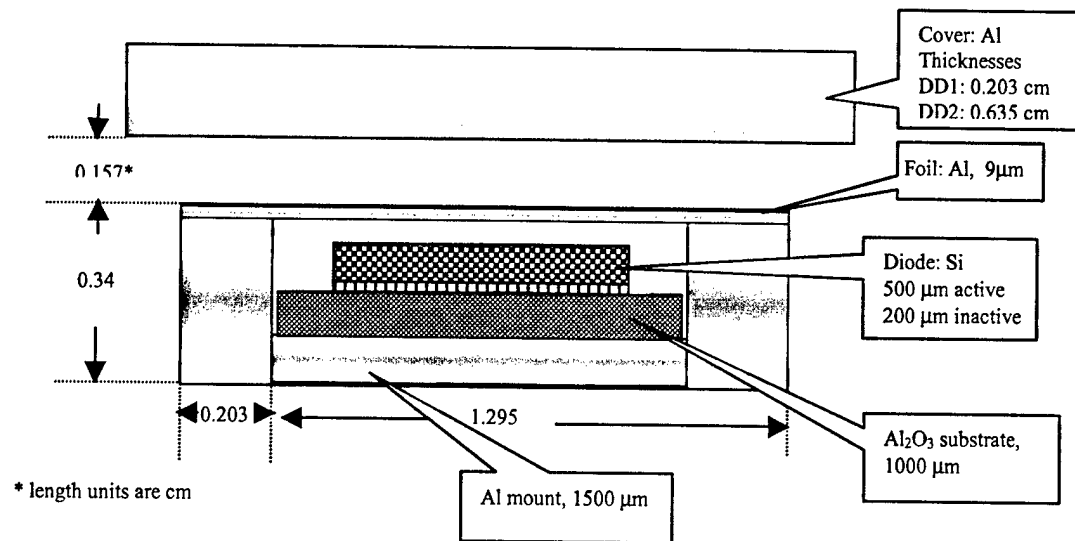


Figure 13. CEASE DD1 and DD2 dosimeter assemblies [10].

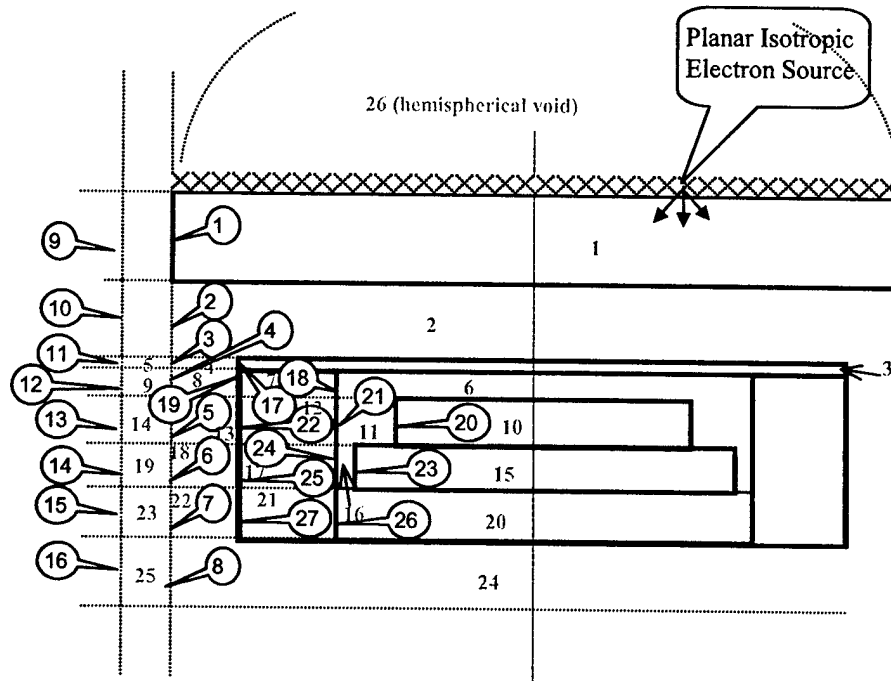


Figure 14. CEASE DD1 and DD2 dosimeter geometry schematic for ACCEPT showing plane isotropic electron source; = geometry zones; nn = material cells.

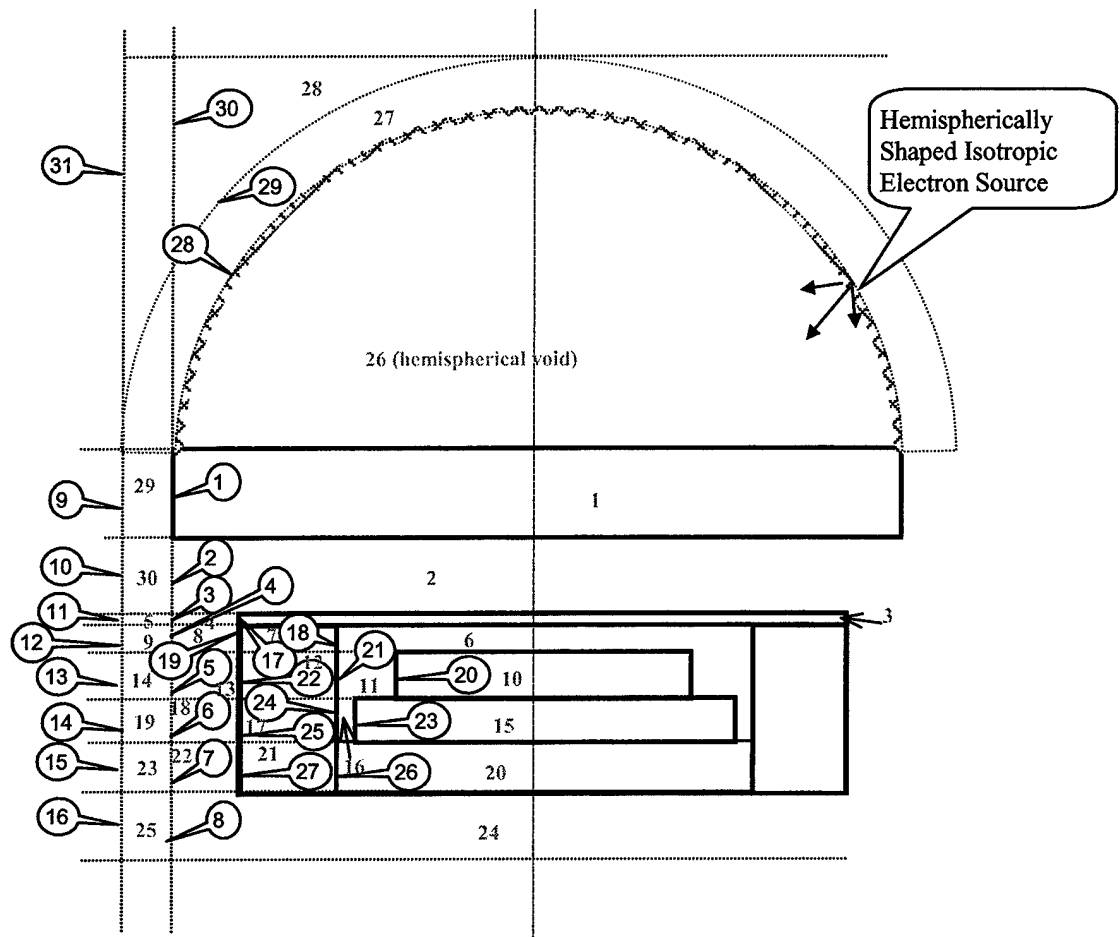


Figure 15. CEASE DD1 and DD2 dosimeter geometry schematic for ACCEPT showing hemispherically shaped isotropic electron source;  = geometry zones; nn = material cells.

The equivalent simulation scenarios were executed using MCNPX. Figure 16 is a surface and cell schematic for the DD1, DD2 MCNPX model corresponding to that shown for ACCEPT in Figure 15. The corresponding MCNPX input file for DD2 is given in Appendix 6. For the case of the flat plate source, the MCNPX-supplied source provided a cosine-isotropic source option that could be implemented using the run input data file. It was necessary to write a source subroutine for MCNPX that allowed isotropy in angle rather than cosine. It was also necessary to write new source subroutines for the hemispherical shell sources. These code modifications provided, along with appropriate geometry factor adjustments, a tool for the AFRL researchers to compare simulated dosimeter responses with different source geometry assumptions.

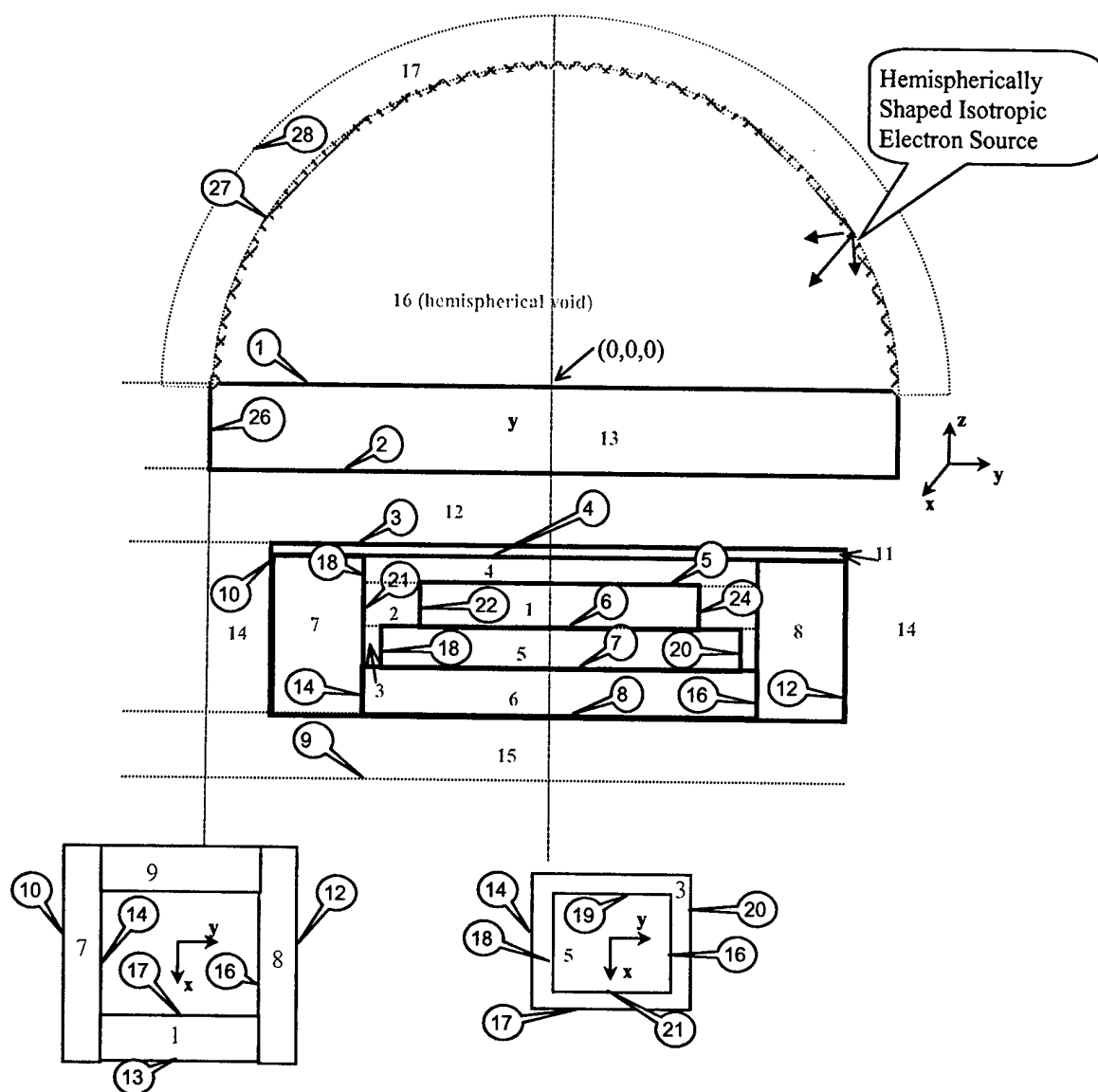


Figure 16. CEASE DD1 and DD2 dosimeter geometry schematic for MCNPX showing hemispherically shaped isotropic electron source;  = surfaces; nn = material cells.

4.2 PASP Dosimeter Models - ACCEPT and MCNPX

The PASP dome dosimeters were modeled using the "HEMISPHERICAL DOME SOURCE" option in ITS/ACCEPT and new source routines for MCNPX. The ACCEPT geometry schematics and source configuration for the PASP Dome 2 and Dome 3 dosimeters are shown in Figures 17a and 17b, respectively. The corresponding geometry schematics for MCNPX are shown in Figures 18a and 18b. The computer code listings for the "DOME SOURCE" option in ACCEPT and the specialized source subroutines for MCNPX are given in Appendices 7 and 8, respectively.

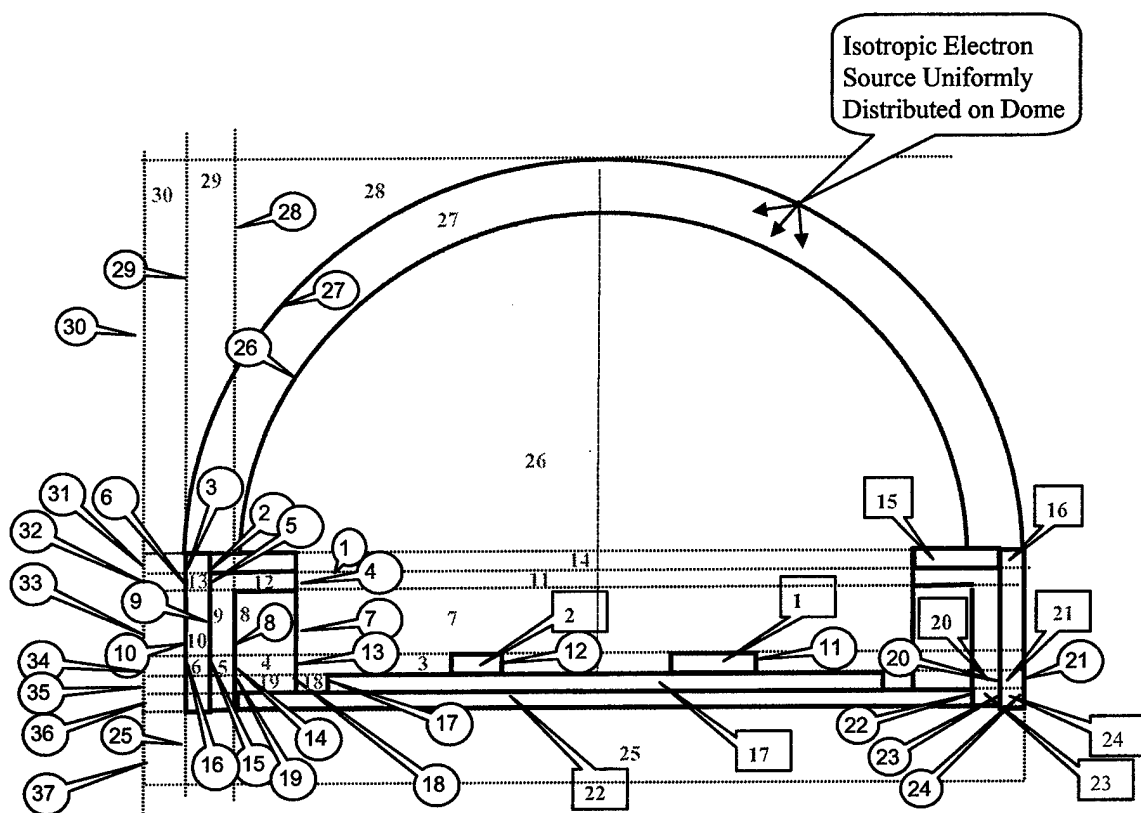


Figure 17a. "PASP Dome 2" dosimeter[8,9] geometry Schematic for ACCEPT showing isotropic electron source incident on surface of Al dome, = geometry zones; nn = material cells.

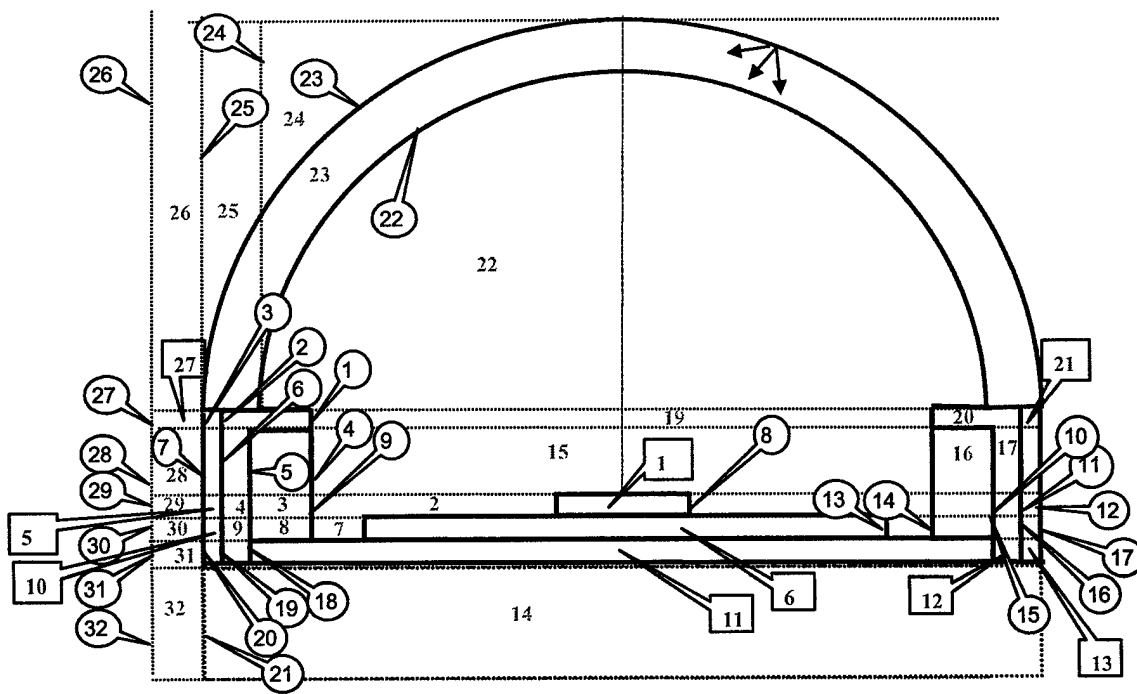


Figure 17b. "PASP Dome 3" dosimeter[8,9] geometry schematic for ACCEPT showing isotropic electron source incident on surface of Al dome; = geometry zones; nn = material cells.

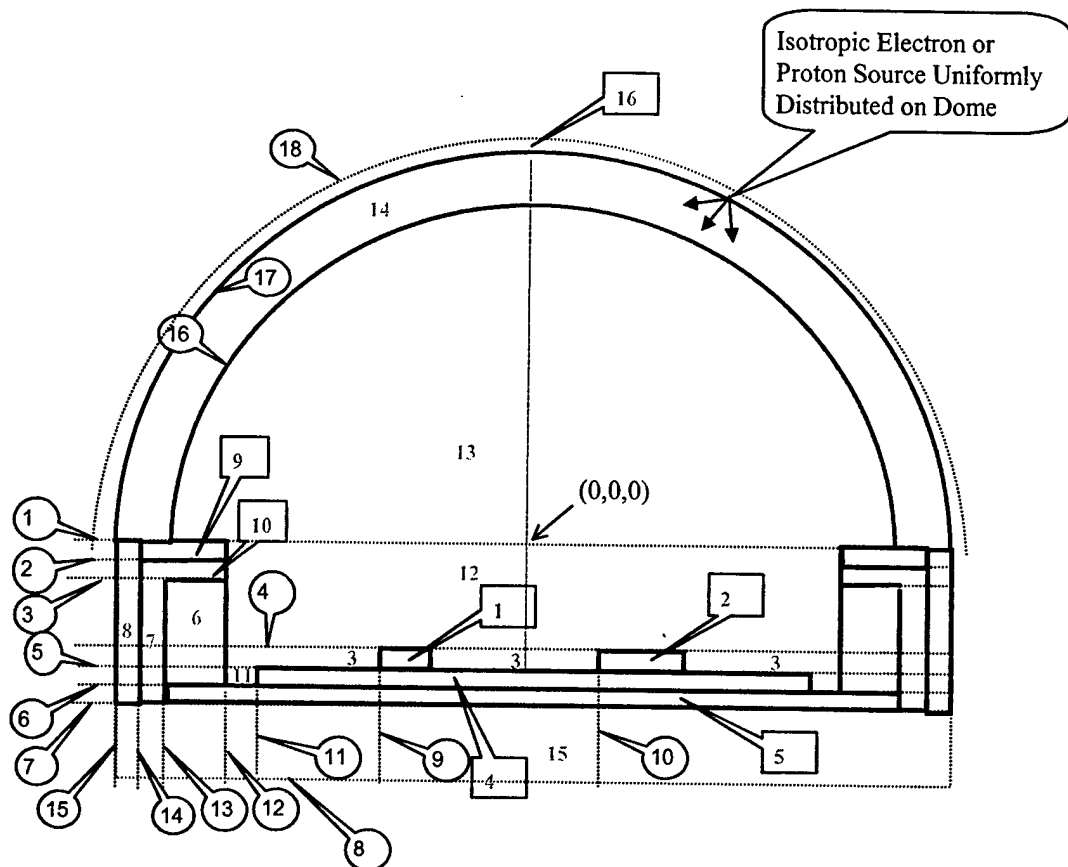


Figure 18a. "PASP Dome 2" dosimeter geometry schematic for MCNPX showing isotropic electron or proton source incident on surface of Al dome;  = surfaces; nn = material cells.

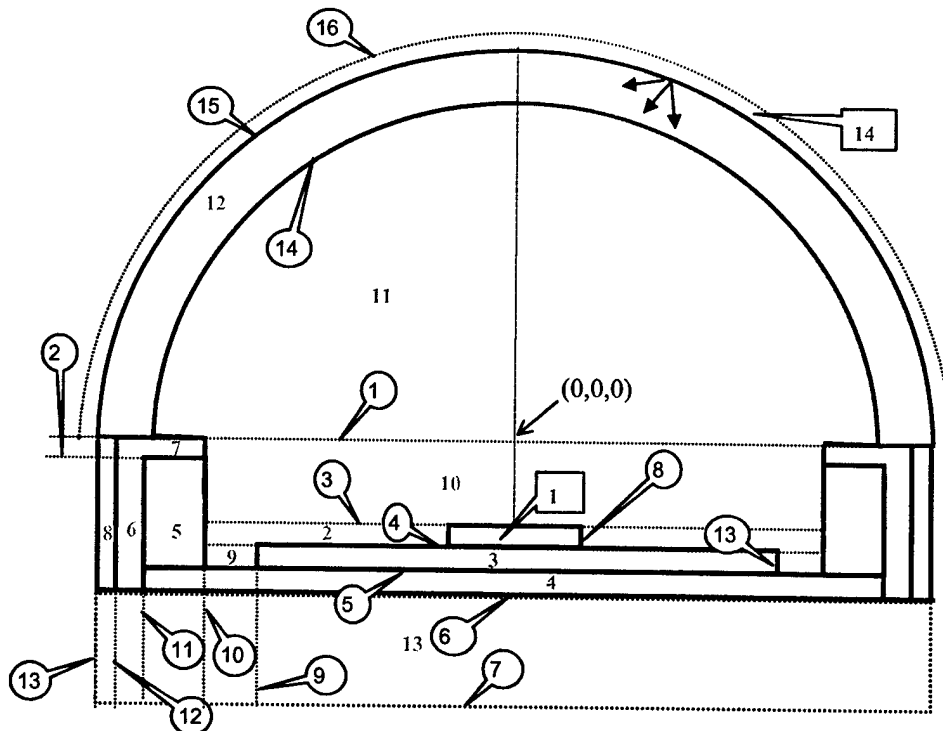


Figure 18b. "PASP Dome 3" dosimeter geometry schematic for MCNPX showing isotropic electron or proton source incident on surface of Al dome;  = surfaces; nn = material cells.

In all cases, trial runs were made with small numbers of histories (10000) to check on equivalence of the results obtained with both codes. While the modified version of ITS/ACCEPT was sufficient to accomplish the immediate goals of modeling electron transport, the addition of MCNPX provided: (1) a check on the ITS/ACCEPT results; and (2) a capability for modeling proton transport with the same problem geometries. Electron transport simulations were run at AFRL using the CEASE and PASP dosimeter models described above for several power law electron energy spectra characteristic of the outer belt electron environment. Results are reported in [11].

5. Summary

During the period covered by this report, the technical activity and progress achieved consisted primarily of: (1) modeling of electron transport and calculation of electron energy deposition in silicon dosimeter wafers; (2) construction of a highly detailed ITS-ACCEPT computer model for the HEP sensor, in-flight model; (3) design and installation of enhancements such as expanded source geometry repertoire, single history tracking, and coincidence event recognition capability, to the ITS-ACCEPT transport program; (4) construction of geometry and electron and proton source models for CEASE and PASP dosimeter studies; (5) acquisition and implementation of a three-dimensional geometry construction and visualization program that is compatible with both the ITS and MCNP code series; (6) providing assistance, advice, input data files and computer code enhancements to AFRL for implementation by AFRL research personnel.

We anticipate continuing this and related research efforts by providing simulation calculations and results, computer code enhancements and new geometry models, and by performing in an advisory capacity to the sponsor.

References

1. *ITS - Integrated TIGER Series of Coupled Electron /Photon Monte Carlo Code System*, J. A. Halbleib *et al.* ORNL RSICC Computer Code Package CCC-467.
2. *MCNPX™ , Version 2.1.5 User's Manual*, L. S. Waters, Ed., Los Alamos Radiation Transport Group(X-6), November 14,1999.
3. *Sabrina 4.15 for Windows*, Copyright 2001, White Rock Science, P.O. Box 4729, White Rock, NM, 87544
4. B. Dichter, *et al.*, Compact Environmental Anomaly Sensor (CEASE): A Novel Spacecraft Instrument for *In Situ* Measurements of Environmental Conditions, *IEEE Trans. Nucl. Sci.* **45(6)**, 2758, Dec. 1998.
5. R. Redus, HEP Flight Model, June 30, 1998, Amptek, Inc., Bedford, MA.
6. D. Brautigam, AFRL/VSBXR, private communication, October 4, 2000.
7. S. Woolf, Installation and Operation of Particle Transport Simulation Programs to Model the Detection and Measurement of Space Radiation by Space-borne Sensors, Air Force Research Laboratory Report AFRL-VS-TR-2001-1605, December 29, 2000.
8. M. S. Gussenhoven, *et al.*, Low altitude orbit edge of the inner radiation belt: Dose models from the APEX satellite, *IEEE Trans. Nucl. Sci.* **42(6)**, 2035, December1995.
9. M. S. Gussenhoven, *et al.*, Low altitude orbit dose as a function of inclination, magnetic activity and solar cycle, *IEEE Trans. Nucl. Sci.* **44(6)**, 2161, December1997.
10. D. Brautigam, AFRL/VSBXR, private communication, May 15, 2001.
11. D. Brautigam *et al.*, Solar cycle variation of outer belt electron dose at low earth orbit, to appear in *IEEE Trans. Nucl. Sci.* **48(6)**, Dec. 2001.

APPENDIX 1

Annotated ITS-ACCEPT Input Data File for the HEP In-Flight Instrument

25 MEV ELECTRON DISK SOURCE - HEP FLIGHT MODEL, FRONT ENTRY, NORMAL INCIDENCE
 ***** GEOMETRY *****

GEOMETRY

*BODIES

*1

TRC	0.0	0.0	0.0	0.0	0.00000	0.25400	0.6096	0.562396
-----	-----	-----	-----	-----	---------	---------	--------	----------

*2

RCC	0.0	0.0	0.0	0.0	0.00000	0.25400	0.80010	
-----	-----	-----	-----	-----	---------	---------	---------	--

*3

RCC	0.0	0.0	0.0	0.0	0.00000	0.25400	1.58877	
-----	-----	-----	-----	-----	---------	---------	---------	--

*4

RCC	0.0	0.0	0.0	0.0	0.00000	0.25400	2.0955	
-----	-----	-----	-----	-----	---------	---------	--------	--

*5

TRC	0.0	0.0	0.25400	0.0	0.00000	0.25400	0.562396	0.5151928
-----	-----	-----	---------	-----	---------	---------	----------	-----------

*6

RCC	0.0	0.0	0.25400	0.0	0.00000	0.25400	0.80010	
-----	-----	-----	---------	-----	---------	---------	---------	--

*7

RCC	0.0	0.0	0.25400	0.0	0.00000	0.25400	2.0955	
-----	-----	-----	---------	-----	---------	---------	--------	--

*8

TRC	0.0	0.0	0.50800	0.0	0.00000	0.9271	0.5151928	0.3429
-----	-----	-----	---------	-----	---------	--------	-----------	--------

*9

RCC	0.0	0.0	0.50800	0.0	0.00000	0.9271	0.80010	
-----	-----	-----	---------	-----	---------	--------	---------	--

*10

RCC	0.0	0.0	0.50800	0.0	0.0	0.9271	1.58877	
-----	-----	-----	---------	-----	-----	--------	---------	--

*11

RCC	0.0	0.0	0.50800	0.0	0.00000	0.9271	2.0955	
-----	-----	-----	---------	-----	---------	--------	--------	--

*12

RCC	0.0	0.0	1.43510	0.0	0.00000	0.11690	1.58877	
-----	-----	-----	---------	-----	---------	---------	---------	--

*13

RCC	0.0	0.0	1.43510	0.0	0.00000	0.11690	2.0955	
-----	-----	-----	---------	-----	---------	---------	--------	--

*14

RCC	0.0	0.0	1.55200	0.0	0.00000	0.05070	1.58877	
-----	-----	-----	---------	-----	---------	---------	---------	--

*15

RCC	0.0	0.0	1.55200	0.0	0.00000	0.05070	2.0955	
-----	-----	-----	---------	-----	---------	---------	--------	--

*16

RCC	0.0	0.0	1.60270	0.0	0.00000	0.01274	0.47625	
-----	-----	-----	---------	-----	---------	---------	---------	--

*17

RCC	0.0	0.0	1.60270	0.0	0.00000	0.01274	1.43510	
-----	-----	-----	---------	-----	---------	---------	---------	--

*18

RCC	0.0	0.0	1.60270	0.0	0.00000	0.01274	1.58877	
-----	-----	-----	---------	-----	---------	---------	---------	--

*19

RCC	0.0	0.0	1.60270	0.0	0.00000	0.01274	2.0955	
-----	-----	-----	---------	-----	---------	---------	--------	--

*20

TRC	0.0	0.0	1.61544	0.0	0.0	0.08128	0.5	0.38000
-----	-----	-----	---------	-----	-----	---------	-----	---------

*21

RCC	0.0	0.0	1.61544	0.0	0.0	0.08128	0.50000	
-----	-----	-----	---------	-----	-----	---------	---------	--

*22

RCC	0.0	0.0	1.61544	0.0	0.0	0.08128	0.69850	
-----	-----	-----	---------	-----	-----	---------	---------	--

*23

RCC	0.0	0.0	1.61544	0.0	0.0	0.08128	1.43510	
-----	-----	-----	---------	-----	-----	---------	---------	--

*24

RCC	0.0	0.0	1.61544	0.0	0.0	0.08128	1.58877	
-----	-----	-----	---------	-----	-----	---------	---------	--

*25

RCC	0.0	0.0	1.61544	0.0	0.0	0.08128	2.0955	
-----	-----	-----	---------	-----	-----	---------	--------	--

*26

TRC	0.0	0.0	1.69672	0.0	0.0	0.06668	0.38000	0.28209
-----	-----	-----	---------	-----	-----	---------	---------	---------

*27

RCC	0.0	0.0	1.69672	0.0	0.00000	0.06668	0.5	
-----	-----	-----	---------	-----	---------	---------	-----	--

*28

RCC	0.0	0.0	1.69672	0.0	0.00000	0.06668	0.6350	
-----	-----	-----	---------	-----	---------	---------	--------	--

*29

RCC	0.0	0.0	1.69672	0.0	0.00000	0.06668	0.6985	
-----	-----	-----	---------	-----	---------	---------	--------	--

*30

RCC	0.0	0.0	1.69672	0.0	0.00000	0.06668	1.43510	
-----	-----	-----	---------	-----	---------	---------	---------	--

*31

RCC	0.0	0.0	1.69672	0.0	0.00000	0.06668	1.58877	
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*32							
RCC	0.0	0.0	1.69672	0.0	0.00000	0.06668	2.0955
*33							
RCC	0.0	0.0	1.76340	0.0	0.00000	0.02600	0.28209
*34							
RCC	0.0	0.0	1.76340	0.0	0.00000	0.02600	0.30000
*35							
RCC	0.0	0.0	1.76340	0.0	0.00000	0.02600	0.50000
*36							
RCC	0.0	0.0	1.76340	0.0	0.00000	0.02600	0.63500
*37							
RCC	0.0	0.0	1.76340	0.0	0.00000	0.02600	0.69850
*38							
RCC	0.0	0.0	1.76340	0.0	0.00000	0.02600	1.43510
*39							
RCC	0.0	0.0	1.76340	0.0	0.00000	0.02600	1.58877
*40							
RCC	0.0	0.0	1.76340	0.0	0.00000	0.02600	2.09550
*41							
RCC	0.0	0.0	1.78940	0.0	0.00000	0.00801	0.28209
*42							
RCC	0.0	0.0	1.78940	0.0	0.00000	0.00801	0.48200
*43							
RCC	0.0	0.0	1.78940	0.0	0.00000	0.00801	0.50000
*44							
RCC	0.0	0.0	1.78940	0.0	0.00000	0.00801	0.63500
*45							
RCC	0.0	0.0	1.78940	0.0	0.00000	0.00801	0.69850
*46							
RCC	0.0	0.0	1.78940	0.0	0.00000	0.00801	1.43510
*47							
RCC	0.0	0.0	1.78940	0.0	0.00000	0.00801	1.58877
*48							
RCC	0.0	0.0	1.78940	0.0	0.00000	0.00801	2.09550
*49							
RCC	0.0	0.0	1.79741	0.0	0.0	0.03400	0.48200
*50							
RCC	0.0	0.0	1.79741	0.0	0.0	0.03400	0.50000
*51							
RCC	0.0	0.0	1.79741	0.0	0.0	0.03400	0.69850
*52							
RCC	0.0	0.0	1.79741	0.0	0.0	0.03400	1.43510
*53							
RCC	0.0	0.0	1.79741	0.0	0.0	0.03400	1.58877
*54							
RCC	0.0	0.0	1.79741	0.0	0.0	0.03400	2.09550
*55							
RCC	0.0	0.0	1.83141	0.0	0.0	0.00801	0.48200
*56							
RCC	0.0	0.0	1.83141	0.0	0.0	0.00801	0.50000
*57							
RCC	0.0	0.0	1.83141	0.0	0.0	0.00801	0.69850
*58							
RCC	0.0	0.0	1.83141	0.0	0.0	0.00801	1.43510
*59							
RCC	0.0	0.0	1.83141	0.0	0.0	0.00801	1.58877
*60							
RCC	0.0	0.0	1.83141	0.0	0.0	0.00801	2.09550
*61							
RCC	0.0	0.0	1.83942	0.0	0.0	0.14432	0.50000
*62							
RCC	0.0	0.0	1.83942	0.0	0.0	0.14432	0.69850
*63							
RCC	0.0	0.0	1.83942	0.0	0.0	0.14432	1.43510
*64							
RCC	0.0	0.0	1.83942	0.0	0.0	0.14432	1.58877
*65							
RCC	0.0	0.0	1.83942	0.0	0.0	0.14432	2.09550
*66							
RCC	0.0	0.0	1.98374	0.0	0.0	0.01270	0.47625
*67							

RCC	0.0	0.0	1.98374	0.0	0.0	0.01270	1.43510	
*68								
RCC	0.0	0.0	1.98374	0.0	0.0	0.01270	1.58877	
*69								
RCC	0.0	0.0	1.98374	0.0	0.0	0.01270	2.09550	
*70								
RCC	0.0	0.0	1.99644	0.0	0.0	0.03810	1.58877	
*71								
RCC	0.0	0.0	1.99644	0.0	0.0	0.03810	2.09550	
*72								
RCC	.0	.0	2.03454	.0	.0	.0507000	1.5887700	
*73								
RCC	.0	.0	2.03454	.0	.0	.0507000	2.0955000	
*74								
RCC	.0	.0	2.08524	.0	.0	.0127400	.4762500	
*75								
RCC	.0	.0	2.08524	.0	.0	.0127400	1.4351000	
*76								
RCC	.0	.0	2.08524	.0	.0	.0127400	1.5887700	
*77								
RCC	.0	.0	2.08524	.0	.0	.0127400	2.0955000	
*78								
TRC	.0	.0	2.09798	.0	.0	.0812800	.5000000	.3800000
*79								
RCC	.0	.0	2.09798	.0	.0	.0812800	.5000000	
*80								
RCC	.0	.0	2.09798	.0	.0	.0812800	.6985000	
*81								
RCC	.0	.0	2.09798	.0	.0	.0812800	1.4351000	
*82								
RCC	.0	.0	2.09798	.0	.0	.0812800	1.5887700	
*83								
RCC	.0	.0	2.09798	.0	.0	.0812800	2.0955000	
*84								
TRC	.0	.0	2.17926	.0	.0	.0666800	.3800000	.2820900
*85								
RCC	.0	.0	2.17926	.0	.0	.0666800	.5000000	
*86								
RCC	.0	.0	2.17926	.0	.0	.0666800	.6350000	
*87								
RCC	.0	.0	2.17926	.0	.0	.0666800	.6985000	
*88								
RCC	.0	.0	2.17926	.0	.0	.0666800	1.4351000	
*89								
RCC	.0	.0	2.17926	.0	.0	.0666800	1.5887700	
*90								
RCC	.0	.0	2.17926	.0	.0	.0666800	2.0955000	
*91								
RCC	.0	.0	2.24594	.0	.0	.0260000	.2820900	
*92								
RCC	.0	.0	2.24594	.0	.0	.0260000	.3000000	
*93								
RCC	.0	.0	2.24594	.0	.0	.0260000	.5000000	
*94								
RCC	.0	.0	2.24594	.0	.0	.0260000	.6350000	
*95								
RCC	.0	.0	2.24594	.0	.0	.0260000	.6985000	
*96								
RCC	.0	.0	2.24594	.0	.0	.0260000	1.4351000	
*97								
RCC	.0	.0	2.24594	.0	.0	.0260000	1.5887700	
*98								
RCC	.0	.0	2.24594	.0	.0	.0260000	2.0955000	
*99								
RCC	.0	.0	2.27194	.0	.0	.0080100	.2820900	
*100								
RCC	.0	.0	2.27194	.0	.0	.0080100	.4820000	
*101								
RCC	.0	.0	2.27194	.0	.0	.0080100	.5000000	
*102								
RCC	.0	.0	2.27194	.0	.0	.0080100	.6350000	

*103							
RCC	.0	.0	2.27194	.0	.0	.0080100	.6985000
*104							
RCC	.0	.0	2.27194	.0	.0	.0080100	1.4351000
*105							
RCC	.0	.0	2.27194	.0	.0	.0080100	1.5887700
*106							
RCC	.0	.0	2.27194	.0	.0	.0080100	2.0955000
*107							
RCC	.0	.0	2.27995	.0	.0	.0340000	.4820000
*108							
RCC	.0	.0	2.27995	.0	.0	.0340000	.5000000
*109							
RCC	.0	.0	2.27995	.0	.0	.0340000	.6985000
*110							
RCC	.0	.0	2.27995	.0	.0	.0340000	1.4351000
*111							
RCC	.0	.0	2.27995	.0	.0	.0340000	1.5887700
*112							
RCC	.0	.0	2.27995	.0	.0	.0340000	2.0955000
*113							
RCC	.0	.0	2.31395	.0	.0	.0080100	.4820000
*114							
RCC	.0	.0	2.31395	.0	.0	.0080100	.5000000
*115							
RCC	.0	.0	2.31395	.0	.0	.0080100	.6985000
*116							
RCC	.0	.0	2.31395	.0	.0	.0080100	1.4351000
*117							
RCC	.0	.0	2.31395	.0	.0	.0080100	1.5887700
*118							
RCC	.0	.0	2.31395	.0	.0	.0080100	2.0955000
*119							
RCC	.0	.0	2.32196	.0	.0	.1443200	.5000000
*120							
RCC	.0	.0	2.32196	.0	.0	.1443200	.6985000
*121							
RCC	.0	.0	2.32196	.0	.0	.1443200	1.4351000
*122							
RCC	.0	.0	2.32196	.0	.0	.1443200	1.5887700
*123							
RCC	.0	.0	2.32196	.0	.0	.1443200	2.0955000
*124							
RCC	.0	.0	2.46628	.0	.0	.0127000	.4762500
*125							
RCC	.0	.0	2.46628	.0	.0	.0127000	1.4351000
*126							
RCC	.0	.0	2.46628	.0	.0	.0127000	1.5887700
*127							
RCC	.0	.0	2.46628	.0	.0	.0127000	2.0955000
*128							
RCC	.0	.0	2.47898	.0	.0	.0507600	1.5887700
*129							
RCC	.0	.0	2.47898	.0	.0	.0507600	2.0955000
*130							
RCC	.0	.0	2.52974	.0	.0	.0508400	0.75057
*131							
RCC	.0	.0	2.52974	.0	.0	.0508400	0.94615
*132							
RCC	.0	.0	2.52974	.0	.0	.0508400	1.45415
*133							
RCC	.0	.0	2.52974	.0	.0	.0508400	1.58877
*134							
RCC	.0	.0	2.52974	.0	.0	.0508400	2.0955
*135							
RCC	.0	.0	2.58058	.0	.0	3.0	0.75057
*136							
RCC	.0	.0	2.58058	.0	.0	3.0	0.94615
*137							
RCC	.0	.0	2.58058	.0	.0	3.0	1.45415
*138							

RCC	.0	.0	2.58058	.0	.0	3.0	1.58877
*139							
RCC	.0	.0	2.58058	.0	.0	3.0	2.0955
*140							
RCC	.0	.0	5.58058	.0	.0	0.05060	0.75057
*141							
RCC	.0	.0	5.58058	.0	.0	0.05060	0.94615
*142							
RCC	.0	.0	5.58058	.0	.0	0.05060	1.45415
*143							
RCC	.0	.0	5.58058	.0	.0	0.05060	1.58877
*144							
RCC	.0	.0	5.58058	.0	.0	0.05060	2.0955
*145							
RCC	.0	.0	5.63118	.0	.0	0.05080	1.58877
*146							
RCC	.0	.0	5.63118	.0	.0	0.05080	2.0955
*147							
RCC	.0	.0	5.68198	.0	.0	0.01270	1.4351
*148							
RCC	.0	.0	5.68198	.0	.0	0.01270	1.58877
*149							
RCC	.0	.0	5.68198	.0	.0	0.01270	2.0955
*150							
TRC	.0	.0	5.69468	.0	.0	0.02742	0.71664 0.690
*151							
RCC	.0	.0	5.69468	.0	.0	0.02742	1.1050
*152							
RCC	.0	.0	5.69468	.0	.0	0.02742	1.4351
*153							
RCC	.0	.0	5.69468	.0	.0	0.02742	1.58877
*154							
RCC	.0	.0	5.69468	.0	.0	0.02742	2.0955
*155							
RCC	.0	.0	5.72210	.0	.0	0.02740	0.690
*156							
RCC	.0	.0	5.72210	.0	.0	0.02740	1.1050
*157							
RCC	.0	.0	5.72210	.0	.0	0.02740	1.4351
*158							
RCC	.0	.0	5.72210	.0	.0	0.02740	1.58877
*159							
RCC	.0	.0	5.72210	.0	.0	0.02740	2.0955
*160							
RCC	.0	.0	5.74950	.0	.0	0.081830	0.74334
*161							
RCC	.0	.0	5.74950	.0	.0	0.081830	0.82335
*162							
RCC	.0	.0	5.74950	.0	.0	0.081830	1.1050
*163							
RCC	.0	.0	5.74950	.0	.0	0.081830	1.4351
*164							
RCC	.0	.0	5.74950	.0	.0	0.081830	1.58877
*165							
RCC	.0	.0	5.74950	.0	.0	0.081830	2.0955
*166							
RCC	.0	.0	5.83133	.0	.0	0.070610	0.82335
*167							
RCC	.0	.0	5.83133	.0	.0	0.070610	1.0
*168							
RCC	.0	.0	5.83133	.0	.0	0.070610	1.1050
*169							
RCC	.0	.0	5.83133	.0	.0	0.070610	1.4351
*170							
RCC	.0	.0	5.83133	.0	.0	0.070610	1.58877
*171							
RCC	.0	.0	5.83133	.0	.0	0.070610	2.0955
*172							
RCC	.0	.0	5.90194	.0	.0	0.017560	0.74334
*173							
RCC	.0	.0	5.90194	.0	.0	0.017560	0.82335

*174							
RCC	.0	.0	5.90194	.0	.0	0.017560	1.0
*175							
RCC	.0	.0	5.90194	.0	.0	0.017560	1.1050
*176							
RCC	.0	.0	5.90194	.0	.0	0.017560	1.4351
*177							
RCC	.0	.0	5.90194	.0	.0	0.017560	1.58877
*178							
RCC	.0	.0	5.90194	.0	.0	0.017560	2.0955
*179							
RCC	.0	.0	5.91950	.0	.0	0.061620	0.74334
*180							
RCC	.0	.0	5.91950	.0	.0	0.061620	0.82335
*181							
RCC	.0	.0	5.91950	.0	.0	0.061620	1.0
*182							
RCC	.0	.0	5.91950	.0	.0	0.061620	1.1050
*183							
RCC	.0	.0	5.91950	.0	.0	0.061620	1.4351
*184							
RCC	.0	.0	5.91950	.0	.0	0.061620	1.58877
*185							
RCC	.0	.0	5.91950	.0	.0	0.061620	2.0955
*186							
RCC	.0	.0	5.98112	.0	.0	0.048870	0.690
*187							
RCC	.0	.0	5.98112	.0	.0	0.048870	1.0
*188							
RCC	.0	.0	5.98112	.0	.0	0.048870	1.1050
*189							
RCC	.0	.0	5.98112	.0	.0	0.048870	1.4351
*190							
RCC	.0	.0	5.98112	.0	.0	0.048870	1.58877
*191							
RCC	.0	.0	5.98112	.0	.0	0.048870	2.0955
*192							
TRC	.0	.0	6.02999	.0	.0	0.08865	0.69 .74334
*193							
RCC	.0	.0	6.02999	.0	.0	0.088650	1.0
*194							
RCC	.0	.0	6.02999	.0	.0	0.088650	1.1050
*195							
RCC	.0	.0	6.02999	.0	.0	0.088650	1.4351
*196							
RCC	.0	.0	6.02999	.0	.0	0.088650	1.58877
*197							
RCC	.0	.0	6.02999	.0	.0	0.088650	2.0955
*198							
RCC	.0	.0	6.11864	.0	.0	0.01270	1.4351
*199							
RCC	.0	.0	6.11864	.0	.0	0.01270	1.58877
*200							
RCC	.0	.0	6.11864	.0	.0	0.01270	2.0955
*201							
RCC	.0	.0	6.13134	.0	.0	0.05088	1.58877
*202							
RCC	.0	.0	6.13134	.0	.0	0.05088	2.0955
*203							
RCC	.0	.0	6.18222	.0	.0	0.05072	1.0
*204							
RCC	.0	.0	6.18222	.0	.0	0.05072	1.58877
*205							
RCC	.0	.0	6.18222	.0	.0	0.05072	2.0955
*206							
RCC	.0	.0	6.23294	.0	.0	2.0	1.0
*207							
RCC	.0	.0	6.23294	.0	.0	2.0	1.58877
*208							
RCC	.0	.0	6.23294	.0	.0	2.0	2.0955
*209							

RCC	.0	.0	8.23294	.0	.0	0.05080	1.0
*210							
RCC	.0	.0	8.23294	.0	.0	0.05080	1.58877
*211							
RCC	.0	.0	8.23294	.0	.0	0.05080	2.0955
*212							
RCC	.0	.0	8.28374	.0	.0	0.05080	1.58877
*213							
RCC	.0	.0	8.28374	.0	.0	0.05080	2.0955
*214							
RCC	.0	.0	8.33454	.0	.0	0.01270	1.4351
*215							
RCC	.0	.0	8.33454	.0	.0	0.01270	1.58877
*216							
RCC	.0	.0	8.33454	.0	.0	0.01270	2.0955
*217							
TRC	.0	.0	8.34724	.0	.0	0.02743	1.0 0.975
*218							
RCC	.0	.0	8.34724	.0	.0	0.02743	1.4351
*219							
RCC	.0	.0	8.34724	.0	.0	0.02743	1.58877
*220							
RCC	.0	.0	8.34724	.0	.0	0.02743	2.0955
*221							
RCC	.0	.0	8.37467	.0	.0	0.02743	0.975
*222							
RCC	.0	.0	8.37467	.0	.0	0.02743	1.4351
*223							
RCC	.0	.0	8.37467	.0	.0	0.02743	1.58877
*224							
RCC	.0	.0	8.37467	.0	.0	0.02743	2.0955
*225							
RCC	.0	.0	8.40210	.0	.0	0.08179	1.02834
*226							
RCC	.0	.0	8.40210	.0	.0	0.08179	1.10835
*227							
RCC	.0	.0	8.40210	.0	.0	0.08179	1.4351
*228							
RCC	.0	.0	8.40210	.0	.0	0.08179	1.58877
*229							
RCC	.0	.0	8.40210	.0	.0	0.08179	2.0955
*230							
RCC	.0	.0	8.48389	.0	.0	0.07061	1.10835
*231							
RCC	.0	.0	8.48389	.0	.0	0.07061	1.32319
*232							
RCC	.0	.0	8.48389	.0	.0	0.07061	1.4351
*233							
RCC	.0	.0	8.48389	.0	.0	0.07061	1.58877
*234							
RCC	.0	.0	8.48389	.0	.0	0.07061	2.0955
*235							
RCC	.0	.0	8.55450	.0	.0	0.01753	1.02834
*236							
RCC	.0	.0	8.55450	.0	.0	0.01753	1.10835
*237							
RCC	.0	.0	8.55450	.0	.0	0.01753	1.32319
*238							
RCC	.0	.0	8.55450	.0	.0	0.01753	1.4351
*239							
RCC	.0	.0	8.55450	.0	.0	0.01753	1.58877
*240							
RCC	.0	.0	8.55450	.0	.0	0.01753	2.0955
*241							
RCC	.0	.0	8.57203	.0	.0	0.05309	1.02834
*242							
RCC	.0	.0	8.57203	.0	.0	0.05309	1.10835
*243							
RCC	.0	.0	8.57203	.0	.0	0.05309	1.32319
*244							
RCC	.0	.0	8.57203	.0	.0	0.05309	1.4351

*245							
RCC	.0	.0	8.57203	.0	.0	0.05309	1.58877
*246							
RCC	.0	.0	8.57203	.0	.0	0.05309	2.0955
*247							
RCC	.0	.0	8.62512	.0	.0	0.03987	0.975
*248							
RCC	.0	.0	8.62512	.0	.0	0.03987	1.32319
*249							
RCC	.0	.0	8.62512	.0	.0	0.03987	1.4351
*250							
RCC	.0	.0	8.62512	.0	.0	0.03987	1.58877
*251							
RCC	.0	.0	8.62512	.0	.0	0.03987	2.0955
*252							
TRC	.0	.0	8.66499	.0	.0	0.08865	0.975 1.02834
*253							
RCC	.0	.0	8.66499	.0	.0	0.08865	1.32319
*254							
RCC	.0	.0	8.66499	.0	.0	0.08865	1.4351
*255							
RCC	.0	.0	8.66499	.0	.0	0.08865	1.58877
*256							
RCC	.0	.0	8.66499	.0	.0	0.08865	2.0955
*257							
RCC	.0	.0	8.75364	.0	.0	0.01270	1.4351
*258							
RCC	.0	.0	8.75364	.0	.0	0.01270	1.58877
*259							
RCC	.0	.0	8.75364	.0	.0	0.01270	2.0955
*260							
RCC	.0	.0	8.76634	.0	.0	0.05080	1.58877
*261							
RCC	.0	.0	8.76634	.0	.0	0.05080	2.0955
*262							
RCC	.0	.0	8.81414	.0	.0	0.06604	0.9525
*263							
RCC	.0	.0	8.81414	.0	.0	0.06604	1.58877
*264							
RCC	.0	.0	8.81414	.0	.0	0.06604	2.0955
*265							
RCC	.0	.0	8.88018	.0	.0	0.33180	1.270
*266							
RCC	.0	.0	8.88018	.0	.0	0.33180	1.58877
*267							
RCC	.0	.0	8.88018	.0	.0	0.33180	2.0955
*268							
RCC	.0	.0	9.21198	.0	.0	0.69402	2.0955
*269							
RPP	0.4788	0.6574		-0.5780189	0.5780189	2.61874	4.0665
*270							
RPP	0.4788	0.75057		-0.5780189	0.5780189	2.58058	4.1064
*271							
RPP	0.75057	0.94615		-0.5780189	0.5780189	2.58058	4.1064
*272							
RPP	1.18237	1.36097		-.635	.635	3.380564	4.82854
*273							
RPP	1.18237	1.45415		-.635	.635	3.342464	4.86664
*274							
RPP	1.45415	1.58877		-.635	.635	3.342464	4.86664
*275							
RPP	0.94615	1.0		-.635	.635	6.25348	7.70128
*276							
RPP	0.94615	1.0		-.635	.635	6.23294	6.25348
*277							
RPP	0.94615	1.0		-.635	.635	7.70128	7.73938
*278							
RPP	1.0	1.12475		-.635	.635	6.25348	7.70128
*279							
RPP	1.0	1.12475		-.635	.635	6.23294	6.25348
*280							

RPP	1.0	1.12475	-.635	.635		6.25348	7.73938	
*281								
RPP	1.12475	1.456353	-.635	.635		6.23294	7.73938	
*282								
RPP	1.456353	1.58877	-.635	.635		6.23294	7.73938	
*283								
RPP	1.584653	1.58877	-.1143	.1143		0.5080	8.88018	
*28								
RPP	1.58877	1.8415	-.1143	.1143		0.5080	8.88018	
*285								
RCC	.0	.0	10.16	.0	.0	0.3175	2.921	
*286								
RPP	-2.794	4.064	-3.9624	3.9624		10.16	10.4775	
*287								
RPP	-2.921	-2.667	-1.191365	1.191365		10.16	10.4775	
*288								
RPP	-2.159	4.064	-3.9624	3.9624		9.906	10.16	
*289								
RPP	-2.159	4.064	-3.9624	3.9624		0.0	0.254	
*290								
RPP	4.064	4.318	-3.9624	3.9624		0.0	10.16	
*291								
RPP	-2.794	-2.159	-3.9624	3.9624		0.0	10.16	
*292								
RPP	-2.159	4.064	-3.7084	3.9624		0.254	9.906	
*293								
RPP	-2.159	4.064	-3.9624	-3.7084		0.254	9.906	
*294								
RPP	-2.159	4.064	-3.7084	3.70840		0.254	9.906	
*295								
RCC	0.	0.	9.906	0.		0.	0.254	2.0955
*296								
RPP	4.318	5.318	-3.9624	3.9624		0.0	10.4775	
*297								
RPP	-3.794	-2.794	-3.9624	3.9624	0.0	10.4775		
*298								
RPP	-3.794	5.318	-3.9624	3.9624	-1.0	0.0		
*299								
RPP	-3.794	5.318	-3.9624	3.9624	10.4775	11.4775		
*300								
RPP	-3.794	5.318	-4.9624	-3.9624	-1.0	11.4775		
*301								
RPP	-3.794	5.318	3.9624	4.9624	-1.0	11.4775		
*302								
RPP	-1.524	-0.016	3.7084	3.9624	1.508125	8.611575		
*303								
RPP	-1.5748	-0.9398	-3.9624	-3.7084	3.889375	6.270625		
*304								
RCC	1.8415		0.0	1.6764		0.260	0.0	0.08
*305								
RCC	1.8415		0.0	1.6764		0.260	0.0	0.08
*306								
RCC	1.8415		0.0	2.21488		0.260	0.0	0.08
*307								
RCC	1.8415		0.0	2.46888		0.260	0.0	0.08
*308								
RCC	1.8415		0.0	3.01752		0.260	0.0	0.08
*309								
RCC	1.8415		0.0	3.27152		0.260	0.0	0.08
*310								
RCC	1.8415		0.0	4.21986		0.260	0.0	0.08
*311								
RCC	1.8415		0.0	4.46786		0.260	0.0	0.08
*312								
RCC	1.8415		0.0	5.88010		0.260	0.0	0.08
*313								
RCC	1.8415		0.0	6.13410		0.260	0.0	0.08
*314								
RCC	1.8415		0.0	7.01294		0.260	0.0	0.08
*315								
RCC	1.8415		0.0	7.26694		0.260	0.0	0.08

```

*316
  RCC 1.8415      0.0      8.54456      0.260 0. 0. 0.08
*317
  RCC 1.8415      0.0      8.79956      0.260 0. 0. 0.08
*318
  SPH 0.0          0.0      5.0          15.0
  END

```

*////////////////////////////////////

*ZONES

*collimator aperture

Z01 +1

*Tungsten P17

Z02 +2 -1

*Tungsten P17

Z03 +3 -1 -2

*Void

Z04 +4 -1 -2 -3

* collimator aperture

Z05 +5

*Tungsten P17

Z06 +6 -5

*Copper P16

Z07 +7 -6 -5

* collimator aperture

Z08 +8

*Tungsten P17

Z09 +9 -8

*Copper P16

Z10 +10 -8 -9 -283

*Copper case cylinder

Z11 +11 -10 -9 -8 -283 -284

*Copper P16

Z12 +12 -283

*Copper case cylinder

Z13 +13 -12 -283 -284

*Plastic Kel-F P4

Z14 +14 -283

*Copper case cylinder

Z15 +15 -14 -283 -284

*

*D1 Assembly starts here

*

*Void P9

Z16 +16

*Phosphor Bronze P9

Z17 +17 -16

*Plastic Kel-F P4

Z18 +18 -17 -16 -283

*Copper case cylinder

Z19 +19 -18 -17 -16 -283 -284

*Void

Z20 +20

*PCB Ring mount

Z21 +21 -20

Z22 +22 -21 -20

*Plastic Kel-F P8

Z23 +23 -22 -21 -20

*Plastic Kel-F P4

Z24 +24 -23 -22 -21 -20 -283

*Copper case cylinder

Z25 +25 -24 -23 -22 -21 -20 -283 -284

*void

Z26 +26

*PCB Ring mount

Z27 +27 -26

Z28 +28 -27 -26

Z29 +29 -28 -27 -26

*

*

*Plastic Kel-F P8

*Two-column format used on this
and the following five pages to
conserve space. Actual file
format is single-column.*

Z30 +30 -29 -28 -27 -26

*Plastic Kel-F P4

Z31 +31 -30 -29 -28 -27 -26 -283

*Copper case cylinder

Z32 +32 -31 -30 -29 -28 -27 -26 -283 -284

*void

Z33 +33

*Rubber wafer mount

Z34 +34 -33

*void

Z35 +35 -34 -33

*PCB Ring mount

Z36 +36 -35 -34 -33

Z37 +37 -36 -35 -34 -33

*Plastic Kel-F P8

Z38 +38 -37 -36 -35 -34 -33

*

*Plastic Kel-F P4

Z39 +39 -38 -37 -36 -35 -34 -33 -283

*Copper case cylinder

Z40 +40 -39 -38 -37 -36 -35 -34 -33 -283 -

284

*Aluminum coating on Si wafer

Z41 +41

*Oxide ring

Z42 +42 -41

```

*void
  Z43 +43 -42 -41
*PCB Ring mount
  Z44 +44 -43 -42 -41
  Z45 +45 -44 -43 -42 -41
*Plastic Kel-F P8
  Z46 +46 -45 -44 -43 -42 -41
*Plastic Kel-F P4
  Z47 +47 -46 -45 -44 -43 -42 -41 -283
*Copper case cylinder
  Z48 +48 -47 -46 -45 -44 -43 -42 -41 -283 -284
* Silicon wafer
  Z49 +49
* void
  Z50 +50 -49
*PCB Ring mount
  Z51 +51 -50 -49
*Plastic Kel-F P8
  Z52 +52 -51 -50 -49
*Plastic Kel-F P4
  Z53 +53 -52 -51 -50 -49 -283
*Copper case cylinder
  Z54 +54 -53 -52 -51 -50 -49 -283 -284
*Aluminum coating on Si wafer
  Z55 +55
*void
  Z56 +56 -55
*PCB Ring mount
  Z57 +57 -56 -55
*Plastic Kel-F P8
  Z58 +58 -57 -56 -55
*Plastic Kel-F P4
  Z59 +59 -58 -57 -56 -55 -283
*Copper case cylinder
  Z60 +60 -59 -58 -57 -56 -55 -283 -284
*void
  Z61 +61
*PCB Ring mount
  Z62 +62 -61
*Plastic Kel-F P8
  Z63 +63 -62 -61
*Plastic Kel-F P4
  Z64 +64 -63 -62 -61 -283
*Copper case cylinder
  Z65 +65 -64 -63 -62 -61 -283 -284
*void
  Z66 +66
*
*End of D1 Assembly
*
*Phosphor Bronze P9
  Z67 +67 -66
*Plastic Kel-F P4
  Z68 +68 -67 -66 -283
*Copper case cylinder
  Z69 +69 -68 -67 -66 -283 -284
* Plastic Kel-F P6
  Z70 +70 -283
*Copper case cylinder
  Z71 +71 -70 -283 -284
*
*Start of D2 Assembly
*
*Plastic Kel-F P4
  Z72 +72 -283
*Copper case cylinder
  Z73 +73 -72 -283 -284
*Void P9
  Z74 +74
*Phosphor Bronze P9
  Z75 +75 -74

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*Plastic Kel-F P4
  Z76 +76 -75 -74 -283
*Copper case cylinder
  Z77 +77 -76 -75 -74 -283 -284
*Void
  Z78 +78
*PCB Ring mount
  Z79 +79 -78
  Z80 +80 -79 -78
*Plastic Kel-F P8
  Z81 +81 -80 -79 -78
*Plastic Kel-F P4
  Z82 +82 -81 -80 -79 -78 -283
*Copper case cylinder
  Z83 +83 -82 -81 -80 -79 -78 -283 -284
*void
  Z84 +84
*PCB Ring mount
  Z85 +85 -84
  Z86 +86 -85 -84
  Z87 +87 -86 -85 -84
*Plastic Kel-F P8
  Z88 +88 -87 -86 -85 -84
*Plastic Kel-F P4
  Z89 +89 -88 -87 -86 -85 -84 -283
*Copper case cylinder
  Z90 +90 -89 -88 -87 -86 -85 -84 -
  283 -284
*void
  Z91 +91
*Rubber wafer mount
  Z92 +92 -91
*void
  Z93 +93 -92 -91
*PCB Ring mount
  Z94 +94 -93 -92 -91
  Z95 +95 -94 -93 -92 -91
*Plastic Kel-F P8
  Z96 +96 -95 -94 -93 -92 -91
*Plastic Kel-F P4
  Z97 +97 -96 -95 -94 -93 -92 -91 -283
*Copper case cylinder
  Z98 +98 -97 -96 -95 -94 -93 -92 -91
  -283 -284
*Aluminum coating on Si wafer
  Z99 +99
*Oxide ring
  Z100 +100 -99
*void
  Z101 +101 -100 -99
*PCB Ring mount
  Z102 +102 -101 -100 -99
  Z103 +103 -102 -101 -100 -99
*Plastic Kel-F P8
  Z104 +104 -103 -102 -101 -100 -99
*Plastic Kel-F P4
  Z105 +105 -104 -103 -102 -101 -100 -99 -
  283
*Copper case cylinder
  Z106 +106 -105 -104 -103 -102 -101 -100 -
  99 -283 -284
* Silicon wafer
  Z107 +107
* void
  Z108 +108 -107
*PCB Ring mount
  Z109 +109 -108 -107
*Plastic Kel-F P8
  Z110 +110 -109 -108 -107
*Plastic Kel-F P4
  Z111 +111 -110 -109 -108 -107 -283

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*Copper case cylinder
Z112 +112 -111 -110 -109 -108 -107 -283 -
284
*Aluminum coating on Si wafer
Z113 +113
*void
Z114 +114 -113
*PCB Ring mount
Z115 +115 -114 -113
*Plastic Kel-F P8
Z116 +116 -115 -114 -113
*Plastic Kel-F P4
Z117 +117 -116 -115 -114 -113 -283
*Copper case cylinder
Z118 +118 -117 -116 -115 -114 -113 -283 -284
*void
Z119 +119
*PCB Ring mount
Z120 +120 -119
*Plastic Kel-F P8
Z121 +121 -120 -119
*Plastic Kel-F P4
Z122 +122 -121 -120 -119 -283
*Copper case cylinder
Z123 +123 -122 -121 -120 -119 -283 -284
*void
Z124 +124
*Phosphor Bronze P9
Z125 +125 -124
*
*   end of D2 assembly
*
*   start of S1, S3 assembly
*
*Plastic Kel-F P4
Z126 +126 -125 -124 -283
*Copper case cylinder
Z127 +127 -126 -125 -124 -283 -284
*   Plastic Kel-F P6
Z128 +128 -283
*Copper case cylinder
Z129 +129 -128 -283 -284
*   Plastic Kel-F P5
Z130 +130
*Spectralon P13, P14
Z131 +131 -130
*   Plastic Kel-F P5
Z132 +132 -131 -130
*Spectralon P13, P14
Z133 +133 -132 -131 -130 -283
*Copper case cylinder
Z134 +134 -133 -132 -131 -130 -283 -284
* GSO S1 (will add pin diode later)
Z135 +135 -269 -270
*Spectralon P13, P14
Z136 +136 -135 -269 -270 -271
*Plastic Scintillator S3 with pin diode hole
Z137 +137 -136 -135 -272 -273 -274
*Spectralon P13, P14 with pin diode hole
Z138 +138 -137 -136 -135 -272 -273 -274 -283
*Copper case cylinder
Z139 +139 -138 -137 -136 -135 -283 -284
*   Plastic Kel-F P5
Z140 +140
*Spectralon P13, P14
Z141 +141 -140
*   Plastic Kel-F P5
Z142 +142 -141 -140
*Spectralon P13, P14
Z143 +143 -142 -141 -140 -283
*Copper case cylinder
Z144 +144 -143 -142 -141 -140 -283 -284
*   Plastic Kel-F P5
Z145 +145 -283
*Copper case cylinder
Z146 +146 -145 -283 -284
*
*End of S3, S1 Assembly
*
*Start D3 Assembly
*
* Phosphor Bronze P9B
Z147 +147
*Plastic Kel-F P5
Z148 +148 -147 -283
*Copper case cylinder
Z149 +149 -148 -147 -283 -284
*Void
Z150 +150
*PCB annulus
Z151 +151 -150
*Plastic Kel-F P7
Z152 +152 -151 -150
*Plastic Kel-F P5,P6
Z153 +153 -152 -151 -150 -283
*Copper case cylinder
Z154 +154 -153 -152 -151 -150 -283 -284
*Void
Z155 +155
*PCB annulus
Z156 +156 -155
*Plastic Kel-F P7
Z157 +157 -156 -155
*Plastic Kel-F P5,P6
Z158 +158 -157 -156 -155 -283
*Copper case cylinder
Z159 +159 -158 -157 -156 -155 -283 -284
*Void
Z160 +160
*Rubber mounting spacer
Z161 +161 -160
*PMMA
Z162 +162 -161 -160
*Plastic Kel-F P7
Z163 +163 -162 -161 -160
*Plastic Kel-F P5,P6
Z164 +164 -163 -162 -161 -160 -283
*Copper case cylinder
Z165 +165 -164 -163 -162 -161 -160 -283 -
284
*Si wafer - electrically active part
Z166 +166
*Si wafer - electrically inactive part
Z167 +167 -166
*PMMA
Z168 +168 -167 -166
*Plastic Kel-F P7
Z169 +169 -168 -167 -166
*Plastic Kel-F P5,P6
Z170 +170 -169 -168 -167 -166 -283
*Copper case cylinder
Z171 +171 -170 -169 -168 -167 -166 -283 -
284
*Void
Z172 +172
*Rubber mounting spacer
Z173 +173 -172
*Void
Z174 +174 -173 -172
*PMMA
Z175 +175 -174 -173 -172

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*Plastic Kel-F P7
  Z176 +176 -175 -174 -173 -172
*Plastic Kel-F P5,P6
  Z177 +177 -176 -175 -174 -173 -172 -283
*Copper case cylinder
  Z178 +178 -177 -176 -175 -174 -173 -172 -283
-284
*Void
  Z179 +179
*Rubber mounting spacer
  Z180 +180 -179
*PMMA
  Z181 +181 -180 -179
*PMMA
  Z182 +182 -181 -180 -179
*Plastic Kel-F P7
  Z183 +183 -182 -181 -180 -179
*Plastic Kel-F P5,P6
  Z184 +184 -183 -182 -181 -180 -179 -283
*Copper case cylinder
  Z185 +185 -184 -183 -182 -181 -180 -179 -283
-284
*Void
  Z186 +186
*PCB annulus
  Z187 +187 -186
*PMMA
  Z188 +188 -187 -186
*Plastic Kel-F P7
  Z189 +189 -188 -187 -186
*Plastic Kel-F P5,P6
  Z190 +190 -189 -188 -187 -186 -283
*Copper case cylinder
  Z191 +191 -190 -189 -188 -187 -186 -283 -284
*Void
  Z192 +192
*PCB annulus
  Z193 +193 -192
*PMMA
  Z194 +194 -193 -192
*Plastic Kel-F P7
  Z195 +195 -194 -193 -192
*Plastic Kel-F P5,P6
  Z196 +196 -195 -194 -193 -192 -283
*Copper case cylinder
  Z197 +197 -196 -195 -194 -193 -192 -283 -284
*Phosphor bronze P9B
  Z198 +198
*Plastic Kel-F P5,P6
  Z199 +199 -198 -283
*Copper case cylinder
  Z200 +200 -199 -198 -283 -284
*Plastic Kel-F P6
  Z201 +201 -283
*Copper case cylinder
  Z202 +202 -201 -283 -284
*
*End D3 Assembly
*
*Begin S2 Assembly
*
*Plastic Kel-F P4
  Z203 +203
*Spectralon P12
  Z204 +204 -203 -283
*Copper case cylinder
  Z205 +205 -204 -203 -283 -284
*GSO S2
  Z206 +206 -275 -276 -277
*Spectralon P12

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  Z207 +207 -206 -275 -276 -277 -278 -279 -
280 -281 -282 -283
*Copper case cylinder
  Z208 +208 -207 -206 -283 -284
*Plastic Kel-F P6
  Z209 +209
*Spectralon P12
  Z210 +210 -209 -283
*Copper case cylinder
  Z211 +211 -210 -209 -283 -284
*
*end S2 assembly
*begin D4 assembly
*
*Plastic Kel-F P6
  Z212 +212 -283
*Copper case cylinder
  Z213 +213 -212 -283
*Phosphor bronze P9B
  Z214 +214
*Plastic Kel-F P6
  Z215 +215 -214 -283
*Copper case cylinder
  Z216 +216 -215 -214 -283 -284
*Void
  Z217 +217
*PCB annulus
  Z218 +218 -217
*Plastic Kel-F P6
  Z219 +219 -218 -217 -283
*Copper case cylinder
  Z220 +220 -219 -218 -217 -283 -284
*Void
  Z221 +221
*PCB annulus
  Z222 +222 -221
*Plastic Kel-F P6
  Z223 +223 -222 -221 -283
*Copper case cylinder
  Z224 +224 -223 -222 -221 -283 -284
*Void
  Z225 +225
*Rubber mounting spacer
  Z226 +226 -225
*PMMA
  Z227 +227 -226 -225
*Plastic Kel-F P6
  Z228 +228 -227 -226 -225 -283
*Copper case cylinder
  Z229 +229 -228 -227 -226 -225 -283 -284
*Si wafer - electrically active part
  Z230 +230
*Si wafer - electrically inactive part
  Z231 +231 -230
*PMMA
  Z232 +232 -231 -230
*Plastic Kel-F P6
  Z233 +233 -232 -231 -230 -283
*Copper case cylinder
  Z234 +234 -233 -232 -231 -230 -283 -284
*Void
  Z235 +235
*Rubber mounting spacer
  Z236 +236 -235
*Void
  Z237 +237 -236 -235
*PMMA
  Z238 +238 -237 -236 -235
*Plastic Kel-F P6
  Z239 +239 -238 -237 -236 -235 -283
*Copper case cylinder

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Z240 +240 -239 -238 -237 -236 -235 -283 -
 284
 *Void
 Z241 +241
 *Rubber mounting spacer
 Z242 +242 -241
 *PCB annulus
 Z243 +243 -242 -241
 *PMMA
 Z244 +244 -243 -242 -241
 *Plastic Kel-F P6
 Z245 +245 -244 -243 -242 -241 -283
 *Copper case cylinder
 Z246 +246 -245 -244 -243 -242 -241 -283 -
 284
 *Void
 Z247 +247
 *PCB annulus
 Z248 +248 -247
 *PMMA
 Z249 +249 -248 -247
 *Plastic Kel-F P6
 Z250 +250 -249 -248 -247 -283
 *Copper case cylinder
 Z251 +251 -250 -249 -248 -247 -283 -284
 *Void
 Z252 +252
 *PCB annulus
 Z253 +253 -252
 *PMMA
 Z254 +254 -253 -252
 *Plastic Kel-F P6
 Z255 +255 -254 -253 -252 -283
 *Copper case cylinder
 Z256 +256 -255 -254 -253 -252 -283 -284
 *Phosphor bronze P9B
 Z257 +257
 *PMMA
 Z258 +258 -257 -283
 *Copper case cylinder
 Z259 +259 -258 -257 -283 -284
 *Plastic Kel-F P4
 Z260 +260 -283
 *
 *end D4 assembly
 *Copper case cylinder
 Z261 +261 -260 -283 -284
 *Void
 Z262 +262
 *Aluminum p18
 Z263 +263 -262 -283
 *Copper case cylinder
 Z264 +264 -263 -262 -283 -284
 *Copper base
 Z265 +265
 *Aluminum p18
 Z266 +266 -265
 *Copper case cylinder
 Z267 +267 -266 -265
 *Copper base
 Z268 +268 OR +295
 *Pin Diode Mounted on S1 flat
 Z269 +135 +269
 Z270 +136 +269
 *void flat slot for pin diode
 * carved out of S1
 Z271 +135 +270 -269
 *carved out of Spectralon
 Z272 +136 +270 -269
 *carved out of Spectralon
 Z273 +136 +271

*Pin diode mounted on S3 flat
 Z274 +137 +272
 Z275 +138 +272
 *void flat slot for pin diode
 * carved out of S3
 Z276 +273 +137 -272
 *carved out of Spectralon
 Z277 +273 +138 -272
 *carved out of Spectralon
 Z278 +274 +138
 *Void in front of pin diode on S2
 Z279 +206 +276
 *Pin diode on S2
 Z280 +206 +275
 *Void behind pin diode on S2
 Z281 +206 +277
 *Void in front of pin diode on S2
 Z282 +207 +276
 *Pin diode on S2
 Z283 +207 +275
 *Void behind pin diode on S2
 Z284 +207 +277
 *Void in front of pin diode on S2
 Z285 +207 +279
 *Pin diode on S2
 Z286 +207 +278
 *Void behind pin diode on S2
 Z287 +207 +280
 *Void above Pin diode on S2 cut out from
 Spectralon
 Z288 +207 +281
 Z289 +207 +282
 *Long void slot in copper case to accommodate
 pin diode connections
 Z290 +283 +11
 Z291 +283 +13
 Z292 +283 +15
 Z293 +283 +19
 Z294 +283 +25
 Z295 +283 +32
 Z296 +283 +40
 Z297 +283 +48
 Z298 +283 +54
 Z299 +283 +60
 Z300 +283 +65
 Z301 +283 +69
 Z302 +283 +71
 Z303 +283 +73
 Z304 +283 +77
 Z305 +283 +83
 Z306 +283 +90
 Z307 +283 +98
 Z308 +283 +106
 Z309 +283 +112
 Z310 +283 +118
 Z311 +283 +123
 Z312 +283 +127
 Z313 +283 +129
 Z314 +283 +134
 Z315 +283 +139
 Z316 +283 +144
 Z317 +283 +146
 Z318 +283 +149
 Z319 +283 +154
 Z320 +283 +159
 Z321 +283 +165
 Z322 +283 +171
 Z323 +283 +178
 Z324 +283 +185
 Z325 +283 +191
 Z326 +283 +197

Z327 +283 +200
 Z328 +283 +202
 Z329 +283 +205
 Z330 +283 +208
 Z331 +283 +211
 Z332 +283 +213
 Z333 +283 +216
 Z334 +283 +220
 Z335 +283 +224
 Z336 +283 +229
 Z337 +283 +234
 Z338 +283 +240
 Z339 +283 +246
 Z340 +283 +251
 Z341 +283 +256
 Z342 +283 +259
 Z343 +283 +261
 Z344 +283 +264
 Z345 +284 +11
 Z346 +284 +13
 Z347 +284 +15
 Z348 +284 +19
 Z349 +284 +25
 Z350 +284 +32
 Z351 +284 +40
 Z352 +284 +48
 Z353 +284 +54
 Z354 +284 +60
 Z355 +284 +65
 Z356 +284 +69
 Z357 +284 +71
 Z358 +284 +73
 Z359 +284 +77
 Z360 +284 +83
 Z361 +284 +90
 Z362 +284 +98
 Z363 +284 +106
 Z364 +284 +112
 Z365 +284 +118
 Z366 +284 +123
 Z367 +284 +127
 Z368 +284 +129
 Z369 +284 +134
 Z370 +284 +139
 Z371 +284 +144
 Z372 +284 +146
 Z373 +284 +149
 Z374 +284 +154
 Z375 +284 +159
 Z376 +284 +165
 Z377 +284 +171
 Z378 +284 +178
 Z379 +284 +185
 Z380 +284 +191
 Z381 +284 +197
 Z382 +284 +200
 Z383 +284 +202
 Z384 +284 +205
 Z385 +284 +208
 Z386 +284 +211
 Z387 +284 +213
 Z388 +284 +216
 Z389 +284 +220
 Z390 +284 +224
 Z391 +284 +229
 Z392 +284 +234
 Z393 +284 +240
 Z394 +284 +246
 Z395 +284 +251
 Z396 +284 +256
 Z397 +284 +259
 Z398 +284 +261
 Z399 +284 +264

*Overlap of slot with material zones

Z400 +12 +283
 Z401 +14 +283
 Z402 +18 +283
 Z403 +24 +283
 Z404 +31 +283
 Z405 +39 +283
 Z406 +47 +283
 Z407 +53 +283
 Z408 +59 +283
 Z409 +64 +283
 Z410 +68 +283
 Z411 +70 +283
 Z412 +72 +283
 Z413 +76 +283
 Z414 +82 +283
 Z415 +89 +283
 Z416 +97 +283
 Z417 +105 +283
 Z418 +111 +283
 Z419 +117 +283
 Z420 +122 +283
 Z421 +126 +283
 Z422 +128 +283
 Z423 +133 +283
 Z424 +138 +283
 Z425 +143 +283
 Z426 +145 +283
 Z427 +148 +283
 Z428 +153 +283
 Z429 +158 +283
 Z430 +164 +283
 Z431 +170 +283
 Z432 +177 +283
 Z433 +184 +283
 Z434 +190 +283
 Z435 +196 +283
 Z436 +199 +283
 Z437 +201 +283
 Z438 +204 +283
 Z439 +207 +283
 Z440 +210 +283
 Z441 +212 +283
 Z442 +215 +283
 Z443 +219 +283
 Z444 +223 +283
 Z445 +228 +283
 Z446 +233 +283
 Z447 +239 +283
 Z448 +245 +283
 Z449 +250 +283
 Z450 +255 +283
 Z451 +258 +283
 Z452 +260 +283
 Z453 +263 +283
 Z454 +10 +283

*Stainless Bulkhead

Z455 +285

*VOID REGION SURROUNDING bulkhead

Z456 +286 OR +287 -285

*Aluminum case back plate perp. to z

Z457 +288 -295

*Aluminum case front plate perp. to z

Z458 +289 -4

*Aluminum case top plate perp. to x

Z459 +290

*Aluminum case bottom plate perp. to x

Z460 +291

*Aluminum case upper side plate perp. to y

Z461 +292 -302

*Aluminum case lower side plate perp. to y

Z462 +293 -303

*Void cavity inside Al case

Z463 +294 -7 -11 -13 -14 -15
-19 -25 -32 -40 -48 -54
-60 -65 -69 -71 -73 -77 -83 -90 -97 -98
-106 -112 -118 -123 -127 -128 -129 -134 -139 -144 -145
-146 -149 -154 -159 -165
-171 -178 -185
-191 -192 -193 -194 -195
-196 -197 -198 -199 -200 -201 -202 -203 -204 -205
-206 -207 -208 -209 -210 -211 -212 -213 -214 -215
-216 -217 -218 -219 -220 -221 -222 -223 -224 -225
-226 -227 -228 -229 -230 -231 -232 -233 -234 -235
-236 -237 -238 -239 -240 -241 -242 -243 -244 -245
-246 -247 -248 -249 -250 -251 -252 -253 -254 -255
-256 -257 -258 -259 -260 -261 -262 -263 -264 -265
-266 -267 -268

*Void region (rectangular) surrounding case

Z464 +296
Z465 +297
Z466 +298
Z467 +299
Z468 +300
Z469 +301

*Large connector hole in upper y plate

Z470 +302

*Small connector hole in lower y plate

Z471 +303

*Pinhole #1

Z472 +304 +15
Z473 +304 +19
Z474 +304 +25
Z475 +304 +32

*Pinhole #2

Z476 +305 +65
Z477 +305 +69

*Pinhole #3

Z478 +306 +83
Z479 +306 +90
Z480 +306 +98
Z481 +306 +106
Z482 +306 +112

*Pinhole #4

Z483 +307 +123
Z484 +307 +127

*Pinhole #5

Z485 +308 +139

*Pinhole #6

Z486 +309 +139

*Pinhole #7

Z487 +310 +139

*Pinhole #8

Z488 +311 +139

*Pinhole #9

Z489 +312 +165
Z490 +312 +171
Z491 +312 +178
Z492 +312 +185

*Pinhole #10

Z493 +313 +197
Z494 +313 +200
Z495 +313 +202
Z496 +313 +205

*Pinhole #11

Z497 +314 +208

*Pinhole #12

Z498 +315 +208

*Pinhole #13

Z499 +316 +229
Z500 +316 +234

Z501 +316 +240

Z502 +316 +246

*Pinhole #14

Z503 +317 +256

Z504 +317 +261

Z505 +317 +264

*Escape Sphere

Z506 +318

-296 -297 -298 -299 -300 -301

END

*Eight-column format on the following
two pages used to conserve space.
Actual file format is single column.*

*MATERI	0	* 71	9	*142	13	*213	2
AL	* 36	9	*107	13	*178	9	*249
* 1	2	* 72	8	*143	9	*214	7
0	* 37	13	*108	12	*179	1	*250
* 2	2	* 73	0	*144	0	*215	13
3	* 38	9	*109	9	*180	13	*251
* 3	13	* 74	2	*145	6	*216	9
3	* 39	0	*110	13	*181	9	*252
* 4	13	* 75	13	*146	7	*217	0
0	* 40	1	*111	9	*182	0	*253
* 5	9	* 76	13	*147	7	*218	2
0	* 41	13	*112	1	*183	2	*254
* 6	2	* 77	9	*148	13	*219	7
3	* 42	9	*113	13	*184	13	*255
* 7	11	* 78	2	*149	13	*220	13
9	* 43	0	*114	9	*185	9	*256
* 8	0	* 79	0	*150	9	*221	9
0	* 44	2	*115	0	*186	0	*257
* 9	2	* 80	2	*151	0	*222	1
3	* 45	2	*116	2	*187	2	*258
* 10	2	* 81	13	*152	2	*223	7
9	* 46	13	*117	13	*188	13	*259
* 11	13	* 82	13	*153	7	*224	9
9	* 47	13	*118	13	*189	9	*260
* 12	13	* 83	9	*154	13	*225	13
9	* 48	9	*119	9	*190	0	*261
* 13	9	* 84	0	*155	13	*226	9
9	* 49	0	*120	0	*191	6	*262
* 14	8	* 85	2	*156	9	*227	0
13	* 50	2	*121	2	*192	7	*263
* 15	0	* 86	13	*157	0	*228	2
9	* 51	2	*122	13	*193	13	*264
* 16	2	* 87	13	*158	2	*229	9
0	* 52	2	*123	13	*194	9	*265
* 17	13	* 88	9	*159	7	*230	9
1	* 53	13	*124	9	*195	8	*266
* 18	13	* 89	0	*160	13	*231	2
13	* 54	13	*125	0	*196	8	*267
* 19	9	* 90	1	*161	13	*232	9
9	* 55	9	*126	6	*197	7	*268
* 20	2	* 91	13	*162	9	*233	9
0	* 56	0	*127	7	*198	13	*269
* 21	0	* 92	9	*163	1	*234	8
2	* 57	6	*128	13	*199	9	*270
* 22	2	* 93	13	*164	13	*235	8
2	* 58	0	*129	13	*200	0	*271
* 23	13	* 94	9	*165	9	*236	0
13	* 59	2	*130	9	*201	6	*272
* 24	13	* 95	13	*166	13	*237	0
13	* 60	2	*131	8	*202	0	*273
* 25	9	* 96	12	*167	9	*238	0
9	* 61	13	*132	8	*203	7	*274
* 26	0	* 97	13	*168	13	*239	8
0	* 62	13	*133	7	*204	13	*275
* 27	2	* 98	12	*169	12	*240	8
2	* 63	9	*134	13	*205	9	*276
* 28	13	* 99	9	*170	9	*241	0
2	* 64	2	*135	13	*206	0	*277
* 29	13	*100	4	*171	10	*242	0
2	* 65	11	*136	9	*207	6	*278
* 30	9	*101	12	*172	12	*243	0
13	* 66	0	*137	0	*208	2	*279
* 31	0	*102	10	*173	9	*244	0
13	* 67	2	*138	6	*209	7	*280
* 32	1	*103	12	*174	13	*245	8
9	* 68	2	*139	0	*210	13	*281
* 33	13	*104	9	*175	12	*246	0
0	* 69	13	*140	7	*211	9	*282
* 34	9	*105	13	*176	9	*247	0
6	* 70	13	*141	13	*212	0	*283
* 35	13	*106	12	*177	13	*248	8

*284	0	*355	0	*426	2	*497
0	*320	0	*391	13	*462	0
*285	0	*356	0	*427	2	*498
0	*321	0	*392	13	*463	0
*286	0	*357	0	*428	0	*499
8	*322	0	*393	13	*464	0
*287	0	*358	0	*429	0	*500
0	*323	0	*394	13	*465	0
*288	0	*359	0	*430	0	*501
0	*324	0	*395	13	*466	0
*289	0	*360	0	*431	0	*502
0	*325	0	*396	13	*467	0
*290	0	*361	0	*432	0	*503
0	*326	0	*397	13	*468	0
*291	0	*362	0	*433	0	*504
0	*327	0	*398	13	*469	0
*292	0	*363	0	*434	0	*505
0	*328	0	*399	12	*470	0
*293	0	*364	0	*435	0	*506
0	*329	0	*400	12	*471	0
*294	0	*365	9	*436	0	
0	*330	0	*401	12	*472	
*295	0	*366	13	*437	0	
0	*331	0	*402	13	*473	
*296	0	*367	13	*438	0	
0	*332	0	*403	12	*474	
*297	0	*368	13	*439	0	
0	*333	0	*404	12	*475	
*298	0	*369	13	*440	0	
0	*334	0	*405	12	*476	
*299	0	*370	13	*441	0	
0	*335	0	*406	13	*477	
*300	0	*371	13	*442	0	
0	*336	0	*407	13	*478	
*301	0	*372	13	*443	0	
0	*337	0	*408	13	*479	
*302	0	*373	13	*444	0	
0	*338	0	*409	13	*480	
*303	0	*374	13	*445	0	
0	*339	0	*410	13	*481	
*304	0	*375	13	*446	0	
0	*340	0	*411	13	*482	
*305	0	*376	13	*447	0	
0	*341	0	*412	13	*483	
*306	0	*377	13	*448	0	
0	*342	0	*413	13	*484	
*307	0	*378	13	*449	0	
0	*343	0	*414	13	*485	
*308	0	*379	13	*450	0	
0	*344	0	*415	13	*486	
*309	0	*380	13	*451	0	
0	*345	0	*416	7	*487	
*310	0	*381	13	*452	0	
0	*346	0	*417	13	*488	
*311	0	*382	13	*453	0	
0	*347	0	*418	2	*489	
*312	0	*383	13	*454	0	
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*313	0	*384	13	*455	0	
0	*349	0	*420	5	*491	
*314	0	*385	13	*456	0	
0	*350	0	*421	0	*492	
*315	0	*386	13	*457	0	
0	*351	0	*422	2	*493	
*316	0	*387	13	*458	0	
0	*352	0	*423	2	*494	
*317	0	*388	12	*459	0	
0	*353	0	*424	2	*495	
*318	0	*389	12	*460	0	
0	*354	0	*425	2	*496	
*319	0	*390	12	*461	0	

```
*****  
***** SOURCE *****  
ELECTRONS  
ENERGY 25.0  
POSITION 0.0 0.0 -0.5  
    RADIUS 2.1  
    DIRECTION 0.0  
***** OPTIONS *****  
HISTORIES 100000
```


APPENDIX 2

Annotated ITS-ACCEPT Program Listings Incorporating Disk and Rectangle Source Geometry and Individual History Tracking Options

```

SUBROUTINE INPUT                                INPUT    00007
C *****INPUT                                INPUT    00009
C                                     INPUT    00010
C                                     INPUT    00011
C PROGRAM INPUT IS CALLED BY                   INPUT    00012
C                                     ITS          INPUT    00013
C PROGRAM INPUT CALLS                         INPUT    00014
C   INTRINSIC FUNCTIONS                       INPUT    00015
C                                     REAL      (TIGER & CYLTRAN)
C                                     SQR, ABS   (ACCEPT)
C                                     INPUT    00016
C   EXTERNAL FUNCTIONS                       INPUT    00017
C                                     ALIST, ELIST, START, PREP, KOP,
C                                     REQALL, GEOMIN, SCRINF, OPOPTS
C                                     INPUT    00018
C                                     KEYMAP, OPREAD
C                                     INPUT    00019
C                                     JOGEN      (ACCEPT)
C                                     INPUT    00020
C                                     INPUT    00021
C                                     INPUT    00022
C ORIGINATION DATE      12 DEC 67.             INPUT    00023
C LAST MODIFIED         17 MAY 91              INPUT    00024
C                                     INPUT    00025
C                                     INPUT    00026
C FUNCTION
C   THIS PROGRAM IS USED TO READ AND PROCESS USER-SUPPLIED
C   CARD INPUT
C                                     INPUT    00027
C                                     INPUT    00028
C                                     INPUT    00029
C *****INPUT                                INPUT    00030
C *** COMMON BLOCKS CNSTNT, PARAMS, OUT, CALC, XPED, STTS, SCALE, PLTITLINPUT 00031
C   PAREM, GOMLOC (ACCEPT)                     INPUT    00032
C   FLUOR          (PCODES)                     INPUT    00033
C   PLOT           (PLOTS)                      INPUT    00034
C$ LIST(S=0)                                    INPUT    00035
C DIR$ NOLIST                                   INPUT    00036
C IMPLICIT DOUBLE PRECISION (A-H,O-Z)           CNSTNT   00081

```

No changes in CNSTNT common block - listing, omitted for brevity, is identical to that given in Reference 1.

```

SAVE                                            CNSTNT   00082
C                                     PARAMS    00002
C -----PARAMS                                PARAMS    00003
C                                     PARAMS    00004
C ... I/O UNIT DECLARATIONS AND ARRAY BUFFERS  PARAMS    00005
C   PARAMETER (IIN = 5, IOUT = 6, ITP10 = 10, ITP11 = 11, ITP12 = 12, PARAMS 00006
C   $ ITP14 = 14, MAXKEY = 36)
C                                     PARAMS    00008
C   PARAMETER ( INMT=15,      INEM=8,      INMAX=64,  NSURV=2775, PARAMS    00009
C   $ IMTOP=INMAX+1,  IKTOP=89,  IMMAX=33,  INPANG=21, PARAMS    00010
C   $ INRANG=34,  INTANG=INMAX/4+1, INEEL=13,  INPEL=21, PARAMS    00011
C   $ INEPS=9,      INGAS=1000,  INLAN=5000,  INPPS=21,  PARAMS    00012
C   $ INLAMB=1591,   JAHSUB=51,  IJSPEC=51,  JATPR=698,  PARAMS    00013
C   $ JATAN=799,  INTAB=30,  IMTAX=64)
C                                     STAN      00001
C TMJ: END OF MODIFICATION                  STAN      00002
C                                     PARAMS    00015
C   PARAMETER ( IMTOP1 = IMTOP,  INMAX1 = INMAX+1,  INMTP1 = INMT+1, PARAMS    00016
C   $ INEEL1 = INEEL,  INGAS1 = INGAS+1,  INLAN1 = INLAN+1, PARAMS    00017
C   $ INEPS1 = INEPS,  NSURV1 = NSURV+1,          PARAMS    00018
C   $ INRNG1 = INRANG,  INTNG1 = INTANG )          PARAMS    00019
C                                     PARAMS    00020
C   PARAMETER ( KPTMAX=5000,          INSTAT=30,          PARAMS    00021
C   $ NCHANG=INPANG*INRANG*INTANG,  NJAHI=NCHANG*INMT,    PARAMS    00022
C   $ NBDIS = IKTOP*IMTOP,          NJAHI2=NBDIS*INMT,    PARAMS    00023
C   $ NGG = INMAX*IMMAX,          NJAHI3=NGG*INMT,        PARAMS    00024
C   $ NJAHI4 = NSURV*INMT,          NJAHI5=JATPR*INMT )   PARAMS    00025

```

**Code
modification**

C		PARAMS	00026
C	... ARRAY DIMENSIONS FOR ZONING AND ESCAPE DISTRIBUTIONS	PARAMS	00027
	PARAMETER (IKMAX = 18, IJMAX = 50,	PARAMS	00028
	\$ IKPMAX = 18, IJPMAX = 50,	PARAMS	00029
	\$ INIZON = 901, INSZON = 900)	PARAMS	00030
C		PARAMS	00031
	PARAMETER (IKMX1 = IKMAX+1, IKPMX1 = IKPMAX+1,	PARAMS	00032
	\$ IJMX1 = IJMAX+1, IJPMX1 = IJPMAX+1,	PARAMS	00033
	\$ IMMAX1 = IMMAX+1)	PARAMS	00034
C		PARAMS	00035
C	... ARRAY DIMENSIONS FOR PULSE-HEIGHT AND FLUX DISTRIBUTIONS	PARAMS	00036
	PARAMETER (IJSMAX = 160, IJFMAX = 10,	PARAMS	00037
	\$ IJSMX1 = IJSMAX+1, IJFMX1 = IJFMAX+1,	PARAMS	00038
	\$ IJFMXP = 10, IJFMP1 = IJFMXP+1,	PARAMS	00039
	\$ IKFMAX = 6, IKFMP1 = 6,	PARAMS	00040
	\$ IKFMX1 = IKFMAX+1, IKFMP1 = IKFMP1+1,	PARAMS	00041
	\$ INLF = 10, INLFP = 10)	PARAMS	00042
C		PARAMS	00043
C	... COMMON AZIMUTHAL PARAMETERS TO FACILITATE COMMON CODING	PARAMS	00044
	PARAMETER (IKMAZ = 1, IKPMAZ = 1)	PARAMS	00045
	PARAMETER (IKFMAZ = 1, IKFMZP = 1)	PARAMS	00046
C		PARAMS	00048
C	... PARAMETERS SPECIFIC TO ACCEPT AND CYLTRAN	PARAMS	00049
C	-----	PARAMS	00050
	PARAMETER (IKMZ1 = IKMAZ+1, IKPMZ1 = IKPMAZ+1,	PARAMS	00051
	\$ IKFMZ1 = IKFMAZ+1, IKFPZ1 = IKFMZP+1,	PARAMS	00052
	\$ INPNTS = 500,	PARAMS	00053
	\$ NANGS = 360)	PARAMS	00054
C	-----	PARAMS	00055
C		PARAMS	00077
C	... ACCEPT SPECIFIC PARAMETERS	PARAMS	00078
C	-----	PARAMS	00079
	PARAMETER (NESC = 1, NESC1 = NESC,	PARAMS	00080
	\$ INUMR = 900, NAZ = 5, ITMA= 18000, IFPD = 6000,	PARAMS	00081
	\$ IJTY = 500, IARB = 5, NIEWS = 5, NCZONE = 60,	PARAMS	00082
	\$ INVALID = 10, INOFND = 10)	PARAMS	00083
C	... PARAMETERS FOR AUTOMATIC SUBZONING	PARAMS	00084
	PARAMETER (ILSUBZ=4)	PARAMS	00085
C	-----	PARAMS	00086
	PARAMETER (NLAST = 50)	PARAMS	00089
	PARAMETER (INUMK = 3, INGP = INMT)	PARAMS	00103
	LOGICAL RRRKILL, FLMTL	OUT	00002

No changes in OUT common block - listing, omitted for brevity, is identical to that given in Reference 1.

C	COMMON /OUT/	OUT	00003
C		PLTITL	00002
	CHARACTER*80 TITLE	PLTITL	00003
	COMMON /PLTITL/ TITLE	PLTITL	00004
C		PLTITL	00005
C		CALC	00002
	COMMON /CALC/	CALC	00003

No changes in CALC common block - listing, omitted for brevity, is identical to that given in Reference 1.

C		CALC	00139
C		XPED	00002
	COMMON /XPED/	XPED	00003
	1 DETOUR(INMT), RHO(INMT), MT, MTP, MTP0	XPED	00010
C		XPED	00012
	LOGICAL DMPFLG, FLMC	STTS	00002
	DOUBLE PRECISION IRSAV	STTS	00010
	COMMON /STTS/ IB, NB, NSORS, IBT, BOLD, BATCH, KPUTMX, DMPFLG	STTS	00017
	\$, IHIST, IRSAV, KPUT, FLMC	STTS	00018
C		STTS	00019
C		SUBZ	00002
	COMMON /SUBZ/ NSUBZ(INIZON), ZFAC(ILSUBZ)	SUBZ	00003
	1 , NX(ILSUBZ), XH(ILSUBZ), XFAC(ILSUBZ),	SUBZ	00005
	2 NY(ILSUBZ), YH(ILSUBZ), YFAC(ILSUBZ),	SUBZ	00006
	3 NZ(ILSUBZ), ZH(ILSUBZ)	SUBZ	00007
	\$, EPS1X(ILSUBZ), EPS1Y(ILSUBZ), EPS1Z(ILSUBZ),	SUBZ	00009

	\$ EPS2X(ILSUBZ), EPS2Y(ILSUBZ), EPS2Z(ILSUBZ)	SUBZ	00010
C	CHARACTER*3 OTYPE(10), OBODY	PAREM	00002
	LOGICAL FLDBG, FLDBG1	PAREM	00003
	COMMON /PAREM/	PAREM	00004
	\$ XB(3), WT(3), RIN, ROUT, PINF, DIST, IR,	PAREM	00008
	\$ FLDBG, IRPRIM, ICALL, LSURF, NBO, LRI, LRO,	PAREM	00009
	\$ KLOOP, LOOP, ITYPE, FLDBG1	PAREM	00013
	COMMON /PAREMO/ OTYPE	PAREM	00014
C		PAREM	00015
C		PAREM	00016
	COMMON /GOMLOC/	GOMLOC	00002
	\$ LDATA, LTMA, LFPD, NUMR, NUMB, LDATP1, LTMAM1,	GOMLOC	00003
	\$ NVALD, NOFND	GOMLOC	00004
C		GOMLOC	00005
C		GOMLOC	00006
	COMMON /PLOT/ NPLOTS, PHIPLT(NVIEWS), THEPLT(NVIEWS),	PLOT	00002
	\$ XMNPLT(NVIEWS), XMXPLT(NVIEWS), YMNPLT(NVIEWS), YMXPLT(NVIEWS),	PLOT	00003
	\$ XMN, XMX, YMN, YMX, KPLT	PLOT	00004
C\$	LIST(S=1)	PLOT	00005
CDIR\$	LIST	INPUT	00051
	COMMON /SCALE/ BNUM, XNUM	INPUT	00052
	COMMON /EXTSORC/ IRECTS, IDISKS, XLOWS, XHIGHS, YLOWS, YHIGHS, ZLOWS,	SCALE	00002
	\$ ZHIGHS, XCENT, YCENT, ZCENT, XCIR, YCIR, ZCIR, KPERPYZ, KPREPXZ, KPERPKY		
C		SCALE	00003
C		INPUT	00057
	COMMON /HITS/EDPR(10), EDNK(10), EDSC(10), EDTL(10), LHCL(10), NINDV		
	CHARACTER*80 KARD	INPUT	00058
	COMMON / IOPACK / KARD	INPUT	00059
	LOGICAL EOFLAG, FLKEY(MAXKEY), FLDUP, FLNEW	INPUT	00060
C		INPUT	00061
	WRITE(IOUT, ' (''1*****'') /	INPUT	00062
	\$ ' ' * BEGIN READING INPUT ' ' /	INPUT	00063
	\$ ' ' *****'') ')	INPUT	00064
	IF (IRUN .NE. 1) THEN	INPUT	00065
C		INPUT	00066
C		INPUT	00067
C	* CONVERT UNITS FROM CM BACK TO GM/CM**2 FOR MULTIPLE PROBLEMS *	INPUT	00068
C		INPUT	00069
C		INPUT	00070
	DO 50 L=1, NMT	INPUT	00071
	RHOL = RHO(L)	INPUT	00073
	DO 10 N=1, NMAX1	INPUT	00074
	RANGE(N, L) = RANGE(N, L) * RHOL	INPUT	00075
	DRG(N, L) = DRG(N, L) * RHOL	INPUT	00076
	PXRAY(N, L) = PXRAY(N, L) / RHOL	INPUT	00077
	PBREM(N, L) = PBREM(N, L) / RHOL	INPUT	00078
10	CONTINUE	INPUT	00079
	DO 20 N=1, NMAX	INPUT	00080
	DRGS(N, L) = DRGS(N, L) * RHOL	INPUT	00081
	COSAV(N, L) = COSAV(N, L) / RHOL	INPUT	00082
20	CONTINUE	INPUT	00083
	DO 30 J=1, NGMAX	INPUT	00084
	AT(J, L) = AT(J, L) / RHOL	INPUT	00085
30	CONTINUE	INPUT	00086
50	CONTINUE	INPUT	00087
	END IF	INPUT	00088
C	*****	INPUT	00133
C	* SET DEFAULT INPUT PARAMETERS *	INPUT	00134
C	*****	INPUT	00135
	FLSTRG = .TRUE.	INPUT	00136
	FLNOK = .TRUE.	INPUT	00137
	FLNEL = .FALSE.	INPUT	00138
	FLBAD = .TRUE.	INPUT	00139
	FLGSEC = .TRUE.	INPUT	00140
	FLNXEV = .FALSE.	INPUT	00141
	FLBSC = .FALSE.	INPUT	00142
	FLCOH = .TRUE.	INPUT	00143
	FLSKN = .TRUE.	INPUT	00144
	FLDBG = .FALSE.	INPUT	00146

New code

New code

```

FLDBG = .FALSE.
RLAN = C5EM1
BNUM = CZERO
XNUM = CZERO
DLIM = CZERO
NPRTCL = 1

```

```

INPUT 00147
INPUT 00149
INPUT 00150
INPUT 00151
INPUT 00152
INPUT 00153

```

```

C
IRECTS = 0
IDISKS = 0
KPERPYZ = 0
KPERPXZ = 0
KPERPGY = 0
C
NINDV=0
DO 599 J=1,10
599 LHCL(J)=0
C

```

New code

```

TITLE = ' '
NPRT = 12
IECHO = 0
NB = 10
IMAX = 1000
IBT = 0
MBSC = 1
BOLD = CZERO
IMXOLD = 0
INRAN = CZERO
BASE = CTWO
XNCYC = CEIGHT
TMFAC = BASE**(-1.0/XNCYC)
DMPFLG = .FALSE.

```

```

INPUT 00154
INPUT 00155
INPUT 00156
INPUT 00157
INPUT 00158
INPUT 00159
INPUT 00160
INPUT 00161
INPUT 00162
INPUT 00163
INPUT 00168
INPUT 00170
INPUT 00171
INPUT 00172
INPUT 00173
INPUT 00174
INPUT 00175
INPUT 00176
INPUT 00177
INPUT 00182
INPUT 00184
INPUT 00185
INPUT 00186
INPUT 00188
INPUT 00193
INPUT 00194
INPUT 00195
INPUT 00196
INPUT 00197
INPUT 00198
INPUT 00199
INPUT 00200
INPUT 00201
INPUT 00202
INPUT 00203
INPUT 00204
INPUT 00205
INPUT 00210
INPUT 00213
INPUT 00214
INPUT 00215
INPUT 00216
INPUT 00218
INPUT 00219
INPUT 00220
INPUT 00221
INPUT 00222
INPUT 00223
INPUT 00224
INPUT 00225
INPUT 00226
INPUT 00228
INPUT 00230
INPUT 00231
INPUT 00232

```

```

C
C ... INITIALIZE LOGICALS FOR IDENTIFYING MATERIALS (NON-P CODES) OR
C ELEMENTS (P CODES) THAT ARE PRESENT IN A GIVEN PROBLEM - USED
C FOR IDENTIFYING RELEVANT LINE RADIATION.
NGP = NMT
DO 60 J=1,NGP
60 FLMTCL(J) = .FALSE.
C
NPLOTS = 0
C
C ... SOURCE VARIABLES
C
FLESRC = .TRUE.
JSPEC = 0
FLSPEC = .FALSE.
TIN = CONE
TPCUT = C1EM2
TCUT = CZERO
TSAVE = CZERO
ICTH = 1
CTSR = CZERO
CTHIN = C90
ZSR = CZERO
XSR = CZERO
YSR = CZERO
CPSR = CZERO
SORCIN = CZERO
C
C ... ELECTRON ESCAPE VARIABLES
C
JMAX = 10
FLESC = .FALSE.
ITMK = 1
IAMK = 1
KMAX = 18
KMAZ = 1
IAMKZ = 1
C
C ... PHOTON ESCAPE VARIABLES
C

```

JPMAX = 10	INPUT	00233
FLESCP = .FALSE.	INPUT	00234
IPMK = 1	INPUT	00235
IBMK = 1	INPUT	00236
KPMAX = 18	INPUT	00237
KPMAZ = 1	INPUT	00238
IBMKZ = 1	INPUT	00240
C -----	INPUT	00242
C ... ELECTRON FLUX VARIABLES	INPUT	00243
C -----	INPUT	00244
FLFLUX = .FALSE.	INPUT	00245
JFMAX = 10	INPUT	00246
KFMAX = 6	INPUT	00247
KFMAZ = 1	INPUT	00248
IFAMKZ = 1	INPUT	00250
IFMK = 1	INPUT	00252
IFAMK = 1	INPUT	00253
C -----	INPUT	00254
C ... PHOTON FLUX VARIABLES	INPUT	00255
C -----	INPUT	00256
FLFLXP = .FALSE.	INPUT	00257
JFMAXP = 10	INPUT	00258
KFMAXP = 6	INPUT	00259
KFMAZP = 1	INPUT	00260
IFBMKZ = 1	INPUT	00262
IFMKP = 1	INPUT	00264
IFBMK = 1	INPUT	00265
C -----	INPUT	00266
C ... PULSE HEIGHT DISTRIBUTION VARIABLES	INPUT	00267
C -----	INPUT	00268
FLPHD = .FALSE.	INPUT	00269
JSMAX = 12	INPUT	00270
IPHMK = 1	INPUT	00271
C -----	INPUT	00272
C *****	INPUT	00273
C * BEGIN READING INPUT *	INPUT	00274
C * ZERO-LEVEL KEYWORDS IN ALPHABETICAL ORDER *	INPUT	00275
C *****	INPUT	00276
C	INPUT	00280
C ... SET ERROR TRAP FLAG TO ZERO	INPUT	00281
IERTRP = 0	INPUT	00282
NUMCRD = 0	INPUT	00283
FLNEWD = .FALSE.	INPUT	00284
FLDUP = .FALSE.	INPUT	00285
DO 65 IKEY=1,MAXKEY	INPUT	00286
65 FLKEY(IKEY) = .FALSE.	INPUT	00287
C	INPUT	00288
C ... READ THE NEXT CARD IN THE INPUT FILE	INPUT	00289
C	INPUT	00290
C	INPUT	00291
70 CALL OPREAD(1,IECHO,EFLAG)	INPUT	00292
C -----	INPUT	00293
C	INPUT	00294
C ... NOTE, COMMENT CARDS DENOTED BY * IN COLUMN 1, SKIPPED INTERNALLY	INPUT	00295
C	INPUT	00296
IF (.NOT. EFLAG) THEN	INPUT	00297
NUMCRD = NUMCRD + 1	INPUT	00298
C	INPUT	00299
80 IF (KOP('BATCHES') .GE. 1) THEN	INPUT	00300
C -----	INPUT	00301
C ... BATCHES	INPUT	00302
C -----	INPUT	00303
C Check if primary keyword has been used	INPUT	00304
C	INPUT	00305
IKEY = 1	INPUT	00306
C	INPUT	00307
IF (FLKEY(IKEY)) CALL KEYMAP(IKEY,FLDUP)	INPUT	00308
C -----	INPUT	00309
FLKEY(IKEY) = .TRUE.	INPUT	00310
C	INPUT	00311
NB = PARM(1)	INPUT	00312

C	ELSE IF (KOP('CUTOFFS') .GE. 0) THEN	INPUT	00313
C	-----	INPUT	00314
C ...	CUTOFFS	INPUT	00315
C	-----	INPUT	00316
C	IKEY = 2	INPUT	00317
C		INPUT	00318
C	IF (FLKEY(IKEY)) CALL KEYMAP(IKEY,FLDUP)	INPUT	00319
C	-----	INPUT	00320
C	FLKEY(IKEY) = .TRUE.	INPUT	00321
C		INPUT	00322
C	KARG = KOP('CUTOFFS')	INPUT	00323
C	IF (KARG .GE. 1) THEN	INPUT	00324
C	TCUT = PARM(1)	INPUT	00325
C	END IF	INPUT	00326
C	IF (KARG .GE. 2) THEN	INPUT	00327
C	TPCUT = PARM(2)	INPUT	00328
C	END IF	INPUT	00329
C		INPUT	00330
C	ELSE IF (KOP('DETAIL-IONIZE') .GE. 0) THEN	INPUT	00331
C		INPUT	00332
C ...	DETAIL-IONIZATION	INPUT	00333
C	-----	INPUT	00334
C	IKEY = 33	INPUT	00335
C		INPUT	00336
C	IF (FLKEY(IKEY)) CALL KEYMAP(IKEY,FLDUP)	INPUT	00337
C	-----	INPUT	00338
C	FLKEY(IKEY) = .TRUE.	INPUT	00339
C		INPUT	00340
C	NPRTCL = 2	INPUT	00341
C		INPUT	00342
C		INPUT	00343

```

C
C      ELSE IF (KOP('RECTANGLE-SOURCE') .GE. 0) THEN
C
C          RECTANGULAR PLANE SOURCE
C          -----
C
C          IKEY = 34
C
C
C          IF (FLKEY(IKEY)) CALL KEYMAP(IKEY,FLDUP)
C          -----
C          FLKEY(IKEY) = .TRUE.
C
C
C          KARG = KOP('RECTANGLE-SOURCE')
C          IF (KARG.LT.6) THEN
C              WRITE(IOUT,68)
C
68      FORMAT(1X,'>>>>')
C              WRITE(IOUT,51)
C              WRITE(IOUT,68)
C
C          ELSE
C              CALL ABORTX('INPUT')
C              ELSE
C              IRECTS = 1
C              XLOWS = PARM(1)
C              XHIGHS = PARM(2)
C              YLOWS = PARM(3)
C              YHIGHS = PARM(4)
C              ZLOWS = PARM(5)
C              ZHIGHS = PARM(6)
C          END IF

```

New code

```

C      ELSE IF (KOP('CIRCLE-SOURCE').GE.0) THEN
C
C      CIRCLE PLANE SOURCE
C
C      -----
C
C      IKEY = 35
C
C
C      IF (FLKEY(IKEY)) CALL KEYMAP(IKEY,FLDUP)
C      -----
C      FLKEY(IKEY) = .TRUE.
C
C
C      KARG = KOP('CIRCLE-SOURCE')
C      IF (KARG.LT.6) THEN
C          WRITE(IOUT,68)
C
C          WRITE(IOUT,52)
C
C          WRITE(IOUT,68)
C
52  FORMAT(1X,' USER MUST ENTER 6 NUMBERS - COORDINATES OF CIRCLE CENT
SER (XO,YO,ZO),AND COORDINATES A POINT ON CIRCUMFERENCE'/1X,' (XC,YC
$,ZC) TO DEFINE POSITION AND ORIENTATION OF SOURCE CIRCLE')
C
C      CALL ABORTX('INPUT')
C      ELSE
C          IDISKS = 1
C          XCENT = PARM(1)
C          YCENT = PARM(2)
C          ZCENT = PARM(3)
C          XCIR = PARM(4)
C          YCIR = PARM(5)
C          ZCIR = PARM(6)
C          CALL OPREAD(1,IECHO,EFLAG)
C          IF (KOP('RADIUS').GE.1) THEN
C              SORCIN = PARM(1)
C          ELSE
C              GO TO 80
C          END IF
C
C
C      END IF
C
C      ELSE IF (KOP('INDIVIDUAL-HISTS').GE.0) THEN
C
C      RECORD SINGLE HISTORY ENERGY DEPOSITIONS
C      -----
C
C      IKEY = 36
C
C      IF (FLKEY(IKEY)) CALL KEYMAP(IKEY,FLDUP)
C
C      FLKEY(IKEY) = .TRUE.
C
C      KARG = KOP('INDIVIDUAL-HISTS')
C      IF (KARG.LT.1.OR. KARG.GT.10) THEN
C          WRITE(IOUT,68)
C          WRITE(IOUT,688)
C          WRITE(IOUT,68)
688  FORMAT(1X,'USER MUST ENTER NO FEWER THAN 1 AND NO MORE THAN 10 CEL
$ L NUMBERS IN WHICH THE ENERGY DEPOSITION'/1X,'FOR INDIVIDUAL ELECT
$ RON HISTORIES ARE TO BE RECORDED.')
C

```

New code

```

        CALL ABORTX('INPUT')
      ELSE
        DO 689 KRRG=1,KARG
689      LHCL(KRRG)=PARM(KRRG)
        NINDV=KARG
        WRITE(IOUT,587)
        WRITE(IOUT,588) (LHCL(KRRG),KRRG=1,NINDV)
588      FORMAT(1X,'ENERGY DEPOSITION FOR INDIVIDUAL HISTORIES WILL BE RECO
$RDED ON FILE "EDSHOW.TXT" FOR CELL NOS. '/5X,10I5)
        WRITE(IOUT,587)
587      FORMAT(/1X,'*****
$*****'
$/1X,'*****
$*****')
      END IF

```

New code

C

C

C

C ...

C

C

C

C

C

```

      ELSE IF (KOP('DIRECTION') .GE. 0) THEN

```

```

        DIRECTION
        -----

```

```

        IKEY = 3

```

```

        IF (FLKEY(IKEY)) CALL KEYMAP(IKEY,FLDUP)
        -----

```

```

        FLKEY(IKEY) = .TRUE.

```

```

INPUT  00344
INPUT  00345
INPUT  00346
INPUT  00347
INPUT  00348
INPUT  00349
INPUT  00350
INPUT  00351
INPUT  00352
INPUT  00353

```

Remaining portion of subroutine INPUT (omitted here for brevity) is identical to original ACCEPT [1] code

•
•
•
•
•
•
•
•
•
•

END

INPUT 01841

	SUBROUTINE HIST	HIST	00007
C	*****	HIST	00009
C		HIST	00010
C	SUBROUTINE HIST IS CALLED BY	HIST	00011
C	ITS	HIST	00012
C	SUBROUTINE HIST CALLS	HIST	00013
C	INTRINSIC FUNCTIONS	HIST	00014
C	SQRT, RANF	HIST	00015
C	REAL (CYLTRAN)	HIST	00016
C	EXTERNAL FUNCTIONS	HIST	00017
C	CLASS, ECROS, EHIST, TIMER, PHIST	HIST	00018
C	RANINT, RANSAV	HIST	00019
C	ZONE (CYLTRAN)	HIST	00020
C	FOLD, ZONEA (ACCEPT)	HIST	00021
C	PLTDAT (M-CODES)	HIST	00022
C		HIST	00023
C	ORIGINATION DATE 16 JAN 68.	HIST	00024
C	LAST MODIFIED 30 MAY 91	HIST	00025
C		HIST	00026
C	FUNCTION	HIST	00027
C	THIS PROGRAM SAMPLES PHASE SPACE PARAMETERS FOR	HIST	00028
C	SOURCE PARTICLES. SUBSEQUENTLY CALLS EITHER EHIST OR	HIST	00029
C	PHIST. RETRIEVES "BANKED" ELECTRONS AND CALLS EHIST.	HIST	00030
C	TALLIES PULSE HEIGHT DISTRIBUTION.	HIST	00031
C		HIST	00032
C	*****	HIST	00033
C	*** COMMON BLOCKS CNSTNT, PARAMS, OUT, CALC, XPED, STOR, STTS,	HIST	00034
C	(PAREM)-ACCEPT	HIST	00035
C\$	LIST(S=0)	HIST	00036
CDIR\$	NOLIST	HIST	00037
	IMPLICIT DOUBLE PRECISION (A-H,O-Z)	CNSTNT	00081

No changes in CNSTNT common block - listing, omitted for brevity, is identical to that given in Reference 1.

	PARAMETER (CCOHLN=57.031547D0, CCOHMX=80.654788D0)	CNSTNT	00140
C		PARAMS	00002
C	-----	PARAMS	00003
C		PARAMS	00004
C	... I/O UNIT DECLARATIONS AND ARRAY BUFFERS	PARAMS	00005
	PARAMETER (IIN = 5, IOUT = 6, ITP10 = 10, ITP11 = 11, ITP12 = 12,	PARAMS	00006

PARAMS common block identical to that shown in subroutine INPUT

```
COMMON /EXTSorc/ IRECTS, IDISKS, XLOWS, XHIGHS, YLOWS, YHIGHS, ZLOWS,
$ ZHIGHS, XCENr, YCENr, ZCENr, XCIR, YCIR, ZCIR, KPERPYZ, KPREPXZ, KPERPX
LOGICAL RRKILL, FLMTel
COMMON /OUT/
```

OUT	00002
OUT	00003

**New
Code**

No changes in OUT common block - listing, omitted for brevity, is identical to that given in Reference 1.

C		CALC	00002
	COMMON /CALC/	CALC	00003

No changes in CALC common block - listing, omitted for brevity, is identical to that given in Reference 1.

C		XPED	00002
	COMMON /XPED/	XPED	00003
	1 DETOUR(INMT), RHO(INMT), MT, MTP, MTP0	XPED	00010
C		XPED	00012
	LOGICAL DMPFLG, FLMC	STTS	00002
	DOUBLE PRECISION IRSaV	STTS	00010
	COMMON /STTS/ IB, NB, NSORS, IBT, BOLD, BATCH, KPUTMX, DMPFLG	STTS	00017
	\$, IHIST, IRSaV, KPUT, FLMC	STTS	00018
C		STTS	00019
C		PAREM	00002
	CHARACTER*3 OTYPE(10), OBODY	PAREM	00003
	LOGICAL FLDBG, FLDBGL	PAREM	00004
	COMMON /PAREM/	PAREM	00008
	\$ XB(3), WT(3), RIN, ROUT, PINF, DIST, IR,	PAREM	00009

```

$ FLDBG, IRPRIM, ICALL, LSURF, NBO, LRI, LRO,
$ KLOOP, LOOP, ITYPE, FLDBG,
COMMON /PAREMO/ OTYPE
C
COMMON /HITS/EDPR(10),EDNK(10),EDSC(10),EDTL(10),LHCL(10),NINDV
C$ LIST(S=1)
CDIR$ LIST
COMMON /STOR/
1 CTHS(NLAST), TS(NLAST), WS(NLAST), ZS(NLAST), IPRS(NLAST),
2 LBS(NLAST), NTS(NLAST)
$ ,XS(NLAST), YS(NLAST), STHS(NLAST),
3 CPHS(NLAST), SPHS(NLAST)
4 ,LBSC(NLAST)
C
EXTERNAL RAN
C
CIMAX = IMAX
IF (FLSPEC) THEN
TAV = CZERO
ELSE
TAV = CIMAX*TIN
END IF
C
CALL RANINT(IRA)
C
IF (IB .EQ. 1) INRAN = IRA
DO 130 I = 1, IMAX
DO 1301 JJJ=1,10
EDPR(JJJ)=0.
EDNK(JJJ)=0.
EDSC(JJJ)=0.
1301 EDTL(JJJ)=0.
IHIST = I
MODTMJ = MIN(100,IMAX)
IF(I.EQ.MODTMJ*(I/MODTMJ)) THEN
CALL TOTTIM(XTMJ)
WRITE(*, '(/' ' HISTORY' ',I8,', ' ELAPSED MINUTES' ',F10.2)')
11,XTMJ/60.
ENDIF
W = CONE
CWCF = W
LAST = 0
C
CALL RANSAV(IRSAV)
C
C
C
C ... SOURCE ENERGY
C
IF (FLSPEC) THEN
RA = RAN(IRAN)
DO 14 JHIST = 2,JSPEC
IF ( RA. GT. SPECIN(JHIST) ) GO TO 16
14 CONTINUE
16 T = ESP(JHIST-1) + ( RA -SPECIN(JHIST-1) )*( ESP(JHIST)
$ - ESP(JHIST-1) )/( SPECIN(JHIST) - SPECIN(JHIST-1) )
TAV = TAV + T
IF ( (FLESRC .AND. (T .GT. TCUT) ) .OR.
$ (.NOT. FLESRC .AND. (T .GT. TPCUT)) ) THEN
GO TO 20
ELSE
NTREJ = NTREJ + 1
TREJ = TREJ + W*T
GO TO 1299
END IF
END IF
T = TIN
20 NT = NTFST
C
CALL CLASS (T,NT)
C

```

New
Code

New
Code

```

PAREM 00013
PAREM 00014
PAREM 00015
PAREM 00016
HIST 00047
HIST 00048
STOR 00002
STOR 00003
STOR 00004
STOR 00006
STOR 00007
STOR 00009
HIST 00050
RANNUM 00003
HIST 00089
HIST 00090
HIST 00091
HIST 00092
HIST 00093
HIST 00094
HIST 00095
HIST 00096
HIST 00097
HIST 00098
HIST 00101
HIST 00103
HIST 00104
LAHEY 00017
LAHEY 00018
LAHEY 00019
LAHEY 00020
LAHEY 00021
LAHEY 00022
HIST 00105
HIST 00106
HIST 00107
HIST 00108
HIST 00109
HIST 00110
HIST 00111
HIST 00112
HIST 00113
HIST 00114
HIST 00115
HIST 00116
HIST 00117
HIST 00118
HIST 00119
HIST 00120
HIST 00121
HIST 00122
HIST 00123
HIST 00124
HIST 00125
HIST 00126
HIST 00127
HIST 00128
HIST 00129
HIST 00130
HIST 00131
HIST 00132
HIST 00133
HIST 00134
HIST 00135
HIST 00136

```

C		HIST	00137
C	... SOURCE DIRECTION	HIST	00138
C	-----	HIST	00139
	IF (ICTH .EQ. 2) THEN	HIST	00140
	RA = RAN(IRAN)	HIST	00141
	COM = CTHIN+ RA*(CONE-CTHIN)	HIST	00142
	ELSE IF (ICTH .EQ. 3) THEN	HIST	00143
	RA = RAN(IRAN)	HIST	00144
	COM = SQRT(CTHIN+RA*(CONE-CTHIN))	HIST	00145
	ELSE IF (ICTH .EQ. 1) THEN	HIST	00146
	CTH(1) = CTSR	HIST	00147
	STH(1) = STSR	HIST	00149
	CPH(1) = CPSR	HIST	00150
	SPH(1) = SPSR	HIST	00151
	GO TO 69	HIST	00153
	END IF	HIST	00154
C		HIST	00155
	IF (CTSR .EQ. CONE) THEN	HIST	00156
	CTH(1) = COM	HIST	00157
	STH(1) = SQRT(CONE-COM*COM)	HIST	00159
	RA = RAN(IRAN)	HIST	00160
	JAZ = RA*C360	HIST	00161
	CPH(1) = CCH(JAZ+1)	HIST	00162
	SPH(1) = SCH(JAZ+1)	HIST	00163
	ELSE	HIST	00165
C		HIST	00172
	CALL FOLD(CTSR,STSR,CPSR,SPSR,COM,CTH(1),STH(1),CPH(1),SPH(1))	HIST	00173
C	-----	HIST	00174
	END IF	HIST	00176
C		HIST	00177
C	... SOURCE POSITION	HIST	00178
C	-----	HIST	00179
69	IF (SORCIN .NE. CZERO) THEN	HIST	00198
	RA = RAN(IRAN)	HIST	00199
	R = SQRT(RA)*SORCIN	HIST	00200
	RA = RAN(IRAN)	HIST	00201
	JAZ = RA*C360	HIST	00202
	SCHR = SCH(JAZ+1)*R	HIST	00203
	CCHR = CCH(JAZ+1)*R	HIST	00204
	IF (IDISKS .EQ. 0) THEN		
	X = XSR + CCHR*W1X+SCHR*W2X		
	Y = YSR+CCHR*W1Y+SCHR*W2Y		
	Z = ZSR+CCHR*W1Z+SCHR*W2Z		
	ELSE		
	IF (KPERPXY.EQ.1) THEN		
	X = XCENT + CCHR		
	Y = YCENT + SCHR		
	Z = ZCENT		
	END IF		
	IF (KPERPXZ.EQ.1) THEN		
	X = XCENT + CCHR		
	Y = YCENT		
	Z = ZCENT + SCHR		
	END IF		
	IF (KPERPYZ.EQ.1) THEN		
	X = XCENT		
	Y = YCENT + CCHR		
	Z = ZCENT + SCHR		
	END IF		
	END IF		
	ELSE		
	IF (IRECTS .EQ. 0) THEN	HIST	00208
	X = XSR	HIST	00209
	Y = YSR	HIST	00210
	Z = ZSR	HIST	00211

New
Code

ELSE

RRAA1 = RAN(IRAN)
RRAA2 = RAN(IRAN)

IF (KPERPXY .EQ. 1) THEN
X = XLOWS + RRAA1*(XHIGHS-XLOWS)
Y = YLOWS + RRAA2*(YHIGHS-YLOWS)
Z = ZLOWS

END IF

IF (KPERPXZ .EQ. 1) THEN
X = XLOWS + RRAA1*(XHIGHS-XLOWS)
Y = YLOWS

Z = ZLOWS + RRAA2*(ZHIGHS-ZLOWS)
END IF

IF (KPERPYZ .EQ.1) THEN

X = XLOWS

Y = YLOWS + RRAA1*(YHIGHS-YLOWS)
Z = ZLOWS + RRAA2*(ZHIGHS-ZLOWS)
END IF

END IF

END IF

C

XB(1) = X
XB(2) = Y
XB(3) = Z
WT(1) = STH(1)*CPH(1)
WT(2) = STH(1)*SPH(1)
WT(3) = CTH(1)

C

CALL ZONEA

C

LB = IR
LBCZ = IRPRIM
IPR = 1

C

C

C ... CALL TRACKING ROUTINES

C

70 IF (FLESRC .OR. (IPR .NE. 1)) THEN

C

C ...

PARTICLE TO BE TRACKED IS AN ELECTRON

C

IF (MT .NE. MAT(LB)) THEN
MT = MAT(LB)
END IF

C

CALL EHIST

C

ELSE

C

C ...

PARTICLE TO BE TRACKED IS A PHOTON

C

LPCZ = LBCZ

C

CALL PHIST(X,Y,Z,LB,CTH(1),STH(1),CPH(1),SPH(1),T,W,1)

C

END IF

C

New
Code

HIST 00212
HIST 00213
HIST 00220
HIST 00221
HIST 00222
HIST 00223
HIST 00224
HIST 00225
HIST 00226
HIST 00227
HIST 00228
HIST 00229
HIST 00230
HIST 00232
HIST 00233
HIST 00234
HIST 00235
HIST 00236
HIST 00237
HIST 00238
HIST 00239
HIST 00240
HIST 00241
HIST 00242
HIST 00248
HIST 00249
HIST 00250
HIST 00251
HIST 00252
HIST 00253
HIST 00254
HIST 00255
HIST 00262
HIST 00265
HIST 00266
HIST 00267
HIST 00269
HIST 00270

C		HIST	00271
C	... REMOVE SECONDARY ELECTRONS FROM STORAGE FOR TRANSPORT	HIST	00272
C	-----	HIST	00273
	IF (LAST .NE. 0) THEN	HIST	00274
	LB = LBS(LAST)	HIST	00275
	Z = ZS(LAST)	HIST	00276
	T = TS(LAST)	HIST	00277
	NT = NTS(LAST)	HIST	00278
	CTH(1) = CTHS(LAST)	HIST	00279
	W = WS(LAST)	HIST	00280
	IPR = IPRS(LAST)	HIST	00281
C		HIST	00283
	X = XS(LAST)	HIST	00284
	Y = YS(LAST)	HIST	00285
	STH(1) = STHS(LAST)	HIST	00286
	CPH(1) = CPHS(LAST)	HIST	00287
	SPH(1) = SPHS(LAST)	HIST	00288
C		HIST	00289
	LBCZ = LBCS(LAST)	HIST	00291
	KLOOP = KLOOP+1	HIST	00292
	LAST = LAST-1	HIST	00294
	GO TO 70	HIST	00295
	END IF	HIST	00296
C		HIST	00297
	IF (.NOT. FLPHD) GO TO 1299	HIST	00298
C		HIST	00299
C		HIST	00300
C	... SCORE PULSE-HEIGHT DISTRIBUTION	HIST	00301
C	-----	HIST	00302
	EABST = CZERO	HIST	00303
	DO 100 LS=LPHDB,LPHDE	HIST	00304
	EABST = EABST+PHDD(LS)	HIST	00305
100	PHDD(LS) = CZERO	HIST	00306
	DO 110 JS=1,JSMAX	HIST	00307
	IF(SMARK(JS) .LE. EABST) GO TO 120	HIST	00308
110	CONTINUE	HIST	00309
	NPHD = NPHD+1	HIST	00310
	GO TO 1299	HIST	00311
120	ABE(JS) = ABE(JS)+CWCF	HIST	00312
1299	IF(NINDV.EQ.0)GO TO 130		
	DO 1298 NIND=1,NINDV		
	EDTL(NIND)=EDPR(NIND)+EDNK(NIND)+EDSC(NIND)		
1298	CONTINUE		
	WRITE(44)(EDPR(NIND),EDNK(NIND),EDSC(NIND),EDTL(NIND),NIND		
	\$ =1,NINDV)		
	130 CONTINUE		
C		HIST	00313
	CALL RANSAV(IRC)	HIST	00314
C	-----	HIST	00315
	RETURN	HIST	00316
	END	HIST	00317
		HIST	00318

**New
Code**

IF (FLESRC) THEN	SRCINF	00041
WRITE(IOUT,(''0SOURCE ELECTRONS''))	SRCINF	00042
ELSE	SRCINF	00043
WRITE(IOUT,(''0SOURCE PHOTONS''))	SRCINF	00044
END IF	SRCINF	00045
C	SRCINF	00046
WRITE(IOUT,(''0THE MAXIMUM SOURCE ENERGY IS'',T38,F12.5,	SRCINF	00047
\$ ' ' MEV'')) TIN	SRCINF	00048
WRITE(IOUT,(''0THE GLOBAL ELECTRON CUTOFF ENERGY IS'',T38,F12.5,	SRCINF	00049
\$ ' ' MEV'')) TCUT	SRCINF	00050
WRITE(IOUT,(''0THE PHOTON CUTOFF ENERGY IS'',T38,F12.5,	SRCINF	00051
\$ ' ' MEV'')) TPCUT	SRCINF	00052
IF (TSAVE .GT. TCUT) WRITE(IOUT,(''0THE GLOBAL ELECTRON TRAP'',	SRCINF	00053
\$ ' ' PING ENERGY IS'',T38,F12.5,' ' MEV'')) TSAVE	SRCINF	00054
C	SRCINF	00055
IF (FLSPEC) THEN	SRCINF	00056
WRITE(IOUT,(''0SOURCE SPECTRUM''))	SRCINF	00057
WRITE(IOUT,('12I6')) JSPEC	SRCINF	00058
WRITE(IOUT,(''0NORMALIZED CUMULATIVE SPECTRUM''))	SRCINF	00059
WRITE(IOUT,('6F12.5')) (SPECIN(J),J=1,JSPEC)	SRCINF	00060
IF ((SPECIN(1) .NE. CONE) .OR. (SPECIN(JSPEC) .NE. CZERO)) THEN	SRCINF	00061
WRITE(IOUT,*) ' INPUT CUMULATIVE SOURCE SPECTRUM MUST BE',	SRCINF	00062
\$ ' MONOTONICALLY DECREASING FROM 1.0 TO 0.0'	SRCINF	00063
C	SRCINF	00064
CALL ABORTX('SRCINF')	SRCINF	00065
C	SRCINF	00066
END IF	SRCINF	00067
WRITE(IOUT,(''0SPECTRAL ENERGIES (MEV''))	SRCINF	00068
WRITE(IOUT,('6F12.5')) (ESP(J),J=1,JSPEC)	SRCINF	00069
C	SRCINF	00070
END IF	SRCINF	00071
C		
IF (IRECTS.EQ.0 .AND. IDISKS.EQ.0) THEN		
C	SRCINF	00072
WRITE(IOUT,(''0COORDINATES OF THE POINT SOURCE OR OF THE'',	SRCINF	00083
\$ ' ' CENTER OF THE BEAM (DISK) SOURCE ARE'/'	SRCINF	00084
\$ ' ' X = ',E12.5,' ' CM',10X,' ' Y = ',E12.5,	SRCINF	00085
\$ ' ' CM',10X,' ' Z = ',E12.5,' ' CM''))	SRCINF	00086
\$ XSR, YSR, ZSR	SRCINF	00087
WRITE(IOUT,(''0THE RADIUS OF THE BEAM (DISK) SOURCE IS = ',	SRCINF	00088
\$ '1PE12.4,' ' CM'')) SORCIN	SRCINF	00089
C	SRCINF	00095
END IF		
C		
WRITE(IOUT,(''0REFERENCE DIRECTION FOR ANGULAR DISTRIBUTION'',	SRCINF	00090
\$ ' ' IS DEFINED BY'/' THETA = ',G11.4,	SRCINF	00091
\$ ' ' DEGREES',10X,' ' PHI = ',G11.4,' ' DEGREES''))	SRCINF	00092
\$ CTSR, CPSR	SRCINF	00093
TEMPA = CTSR/C180PI	SRCINF	00096
CTSR = COS(TEMPA)	SRCINF	00097
STSR = SIN(TEMPA)	SRCINF	00099
TEMPA = CPSR/C180PI	SRCINF	00100
CPSR = COS(TEMPA)	SRCINF	00101
SPSR = SIN(TEMPA)	SRCINF	00102

New
Code

New
Code

```

C
IF (IRECTS.EQ.1) THEN
  WRITE(IOUT,55) XLOWS,XHIGHS,YLOWS,YHIGHS,ZLOWS,ZHIGHS
55  FORMAT(/1X,'RECTANGULAR PLATE SOURCE',/5X,'BOUNDING COORDINATES A
$RE - '/10X,'XLOW = ',E12.5,' ' XHIGH = ',E12.5/10X,'YLOW = ',E12.5
$, ' YHIGH = ',E12.5/10X,'ZLOW = ',E12.5,' ' ZHIGH = ',E12.5)
  IF (ABS(XHIGHS-XLOWS) .LE. CT1EM7) KPERPYZ=1
  IF (ABS(YHIGHS-YLOWS) .LE. CT1EM7) KPERPXZ=1
  IF (ABS(ZHIGHS-ZLOWS) .LE. CT1EM7) KPERPKY=1
  KPRPSUM=KPERPYZ+KPERPXZ+KPERPKY
  IF (KPRPSUM.EQ.0 .OR. KPRPSUM.EQ.3) THEN
    WRITE(IOUT,54)
54  FORMAT(/1X,'PROBLEM IN DEFINITION OF SOURCE PLANE ORIENTATION')
    CALL ABORTX('SRCINF')
  END IF
END IF

```

New
Code

```

C
IF (IDISKS.EQ.1) THEN
  WRITE (IOUT,56) XCENT, YCENT, ZCENT, XCIR, YCIR, ZCIR
56  FORMAT (//1X, 'CIRCULAR DISK SOURCE' /5X, 'COORDINATES OF CENTER ARE' /
$10X, 'XCENTER = ', E12.5, ' YCENTER = ', E12.5, ' ZCENTER = ', E12.5
$/5X, 'COORDINATES OF POINT ON CIRCUMFERENCE ARE' /10X, 'XCIR = ',
$E12.5, ' YCIR = ', E12.5, ' ZCIR = ', E12.5)
  IF (ABS (XCENT-XCIR) .LE. CT1EM7) KPERPYZ=1
  IF (ABS (YCENT-YCIR) .LE. CT1EM7) KPERPXZ=1
  IF (ABS (ZCENT-ZCIR) .LE. CT1EM7) KPERPXY=1
  KPRPSUM=KPERPYZ+KPERPXZ+KPERPXY
  IF (KPRPSUM.EQ.0 .OR. KPRPSUM.EQ.3) THEN
    WRITE (IOUT,54)
    CALL ABORTX ('SRCINF')
    END IF
C
    IF (SORCIN.EQ.CZERO) THEN
      WRITE (IOUT,57)
      CALL ABORTX ('SRCINF')
      END IF
C
      RSSQ=SQRT ((XCENT-XCIR)**2+(YCENT-YCIR)**2+(ZCENT-ZCIR)**2)
      IF (ABS (RSSQ-SORCIN) .GT. CT1EM7) THEN
        WRITE (IOUT,58)
        CALL ABORTX ('SRCINF')
        ELSE
          SORCIN=RSSQ
          WRITE (IOUT,59) SORCIN
59  FORMAT (//1X, 'RADIUS OF THE DISK SOURCE IS ', E12.5)
          END IF
57  FORMAT (///1X, 'SOURCE DISK RADIUS NOT SPECIFIED')
58  FORMAT (///1X, 'SOURCE DISK RADIUS INCONSISTENT WITH SPECIFICATION O
$F POINTS ON CIRCUMFERENCE AND AT CENTER OF SOURCE DISK')
      END IF

```

New
Code

```

C
C
C This code block checks to see if the sine of the input polar
C angle direction is less than zero. If it is, it allows this
C condition within an acceptable tolerance and changes the sine
C of the angle to zero; else it aborts.
C
IF (STSR .LT. CZERO) THEN
  IF (STSR .GT. -C1EM6) THEN
    WRITE (IOUT, ' (//, ' >>> SRCINF: WARNING! SINE OF SOURCE',
$    ' INPUT POLAR ANGLE DIRECTION IS CHANGED TO ZERO.'))
    STSR = CZERO
    CTSR = SIGN (CONE, CTSR)
  ELSE
    WRITE (IOUT, ' (//, ' >>> THE INPUT POLAR ANGLE WITH THE',
$    ' DIRECTION KEYWORD MUST BE BETWEEN ZERO AND 180',
$    ' DEGREES.'))
C
    CALL ABORTX ('SRCINF')
C
    END IF
  END IF

```

```

SRCINF 00103
SRCINF 00104
SRCINF 00105
SRCINF 00106
SRCINF 00107
SRCINF 00108
SRCINF 00109
SRCINF 00110
SRCINF 00111
SRCINF 00112
SRCINF 00113
SRCINF 00114
SRCINF 00115
SRCINF 00116
SRCINF 00117
SRCINF 00118
SRCINF 00119
SRCINF 00120
SRCINF 00121
SRCINF 00122
SRCINF 00123

```

C		SRCINF	00124
C	IF (IRECTS.EQ.0 .AND. IDISKS.EQ.0) THEN		
	WSRX = STSR*CPSR	SRCINF	00125
	WSRY = STSR*SPSR	SRCINF	00126
	WSRZ = CTSR	SRCINF	00127
C	-----	SRCINF	00128
C ...	USUALLY W1(V) = R(V) X OMEGA(V)	SRCINF	00129
C	-----	SRCINF	00130
	W1X = YSR*WSRZ - ZSR*WSRY	SRCINF	00131
	W1Y = ZSR*WSRX - XSR*WSRZ	SRCINF	00132
	W1Z = XSR*WSRY - YSR*WSRX	SRCINF	00133
	XNRM = W1X*W1X + W1Y*W1Y + W1Z*W1Z	SRCINF	00134
C	-----	SRCINF	00135
C ...	UNLESS R(V) X OMEGA(V) = 0	SRCINF	00136
C	-----	SRCINF	00137
	IF (XNRM.EQ. CZERO) THEN	SRCINF	00138
C	-----	SRCINF	00139
C ...	IF I(V) * OMEGA(V) = 0, W1(V) = I(V)	SRCINF	00140
C	-----	SRCINF	00141
	IF (WSRX.EQ. CZERO) THEN	SRCINF	00142
	W1X = CONE	SRCINF	00143
	W1Y = CZERO	SRCINF	00144
	W1Z = CZERO	SRCINF	00145
C	-----	SRCINF	00146
C ...	IF J(V) * OMEGA(V) = 0, W1(V) = J(V)	SRCINF	00147
C	-----	SRCINF	00148
	ELSE IF (WSRY.EQ. CZERO) THEN	SRCINF	00149
	W1X = CZERO	SRCINF	00150
	W1Y = CONE	SRCINF	00151
	W1Z = CZERO	SRCINF	00152
C	-----	SRCINF	00153
C ...	IF K(V) * OMEGA(V) = 0, W1(V) = K(V)	SRCINF	00154
C	-----	SRCINF	00155
	ELSE IF (WSRZ.EQ. CZERO) THEN	SRCINF	00156
	W1X = CZERO	SRCINF	00157
	W1Y = CZERO	SRCINF	00158
	W1Z = CONE	SRCINF	00159
C	-----	SRCINF	00160
C ...	OTHERWISE, W1(V) = +OR- K(V) X OMEGA(V)	SRCINF	00161
C	-----	SRCINF	00162
	ELSE	SRCINF	00163
	W1Z = CZERO	SRCINF	00164
	W1X = CONE/SQRT(CONE + (WSRX/WSRY)**2)	SRCINF	00165
	W1Y = -W1X*WSRX/WSRY	SRCINF	00166
	END IF	SRCINF	00167
	ELSE	SRCINF	00168
	XNRM = SQRT(XNRM)	SRCINF	00169
	W1X = W1X/XNRM	SRCINF	00170
	W1Y = W1Y/XNRM	SRCINF	00171
	W1Z = W1Z/XNRM	SRCINF	00172
	END IF	SRCINF	00173
C	-----	SRCINF	00174
	W2X = WSRY*W1Z - WSRZ*W1Y	SRCINF	00175
	W2Y = WSRZ*W1X - WSRX*W1Z	SRCINF	00176
	W2Z = WSRX*W1Y - WSRY*W1X	SRCINF	00177
	XSR = XSR + CT1EM7*WSRX	SRCINF	00178
	YSR = YSR + CT1EM7*WSRY	SRCINF	00179
	ZSR = ZSR + CT1EM7*WSRZ	SRCINF	00180
	IF (SORCIN.EQ. CZERO) THEN	SRCINF	00181
	XSR = XSR+CT1EM7*W1X	SRCINF	00182
	YSR = YSR+CT1EM7*W1Y	SRCINF	00183
	ZSR = ZSR+CT1EM7*W1Z	SRCINF	00184
	END IF	SRCINF	00185
C	-----		
	END IF		
C	-----		
	IF (ICTH.EQ. 1) THEN	SRCINF	00187
	WRITE(IOUT,('MONODIRECTIONAL SOURCE IN REFERENCE',	SRCINF	00188
	\$ ' ' DIRECTION'))	SRCINF	00189
	ELSE IF (ICTH.EQ. 2) THEN	SRCINF	00190
	WRITE(IOUT,('ISOTROPIC SOURCE TRUNCATED AT ',G11.4,	SRCINF	00191
	\$ ' ' DEGREES WITH RESPECT TO REFERENCE DIRECTION')) CTHIN	SRCINF	00192
	CTHIN = COS(CTHIN/C180PI)	SRCINF	00193
	ELSE	SRCINF	00194
	WRITE(IOUT,('COSINE-LAW SOURCE TRUNCATED AT ',G11.4,	SRCINF	00195
	\$ ' ' DEGREES WITH RESPECT TO REFERENCE DIRECTION')) CTHIN	SRCINF	00196
	CTHIN = COS(CTHIN/C180PI)**2	SRCINF	00197
	END IF	SRCINF	00198
C	-----	SRCINF	00199
	IF (NB.LE. 0) NB = 10	SRCINF	00200
	IF (IMAX.LT. NB) IMAX = NB	SRCINF	00201
	IMAX = IMAX/NB	SRCINF	00202
C	-----	SRCINF	00203
		SRCINF	00204

New
Code

New
Code

C	IF ((IBT .NE. 0) .AND. (IMAX .NE. IMXOLD)) THEN	SRCINF	00205
C	...	SRCINF	00206
C	BATCH SIZES INCONSISTENT ON RESTART - TERMINATE RUN	SRCINF	00207
	WRITE(IOUT,(''0*** FATAL ERROR ON ATTEMPTED RESTART ****'/	SRCINF	00208
\$	'' NEW BATCH SIZE = '',I10, '' DOESNT EQUAL OLD BATCH SIZE = ''	SRCINF	00209
\$	I10/'' BATCH SIZES MUST MATCH TO CORRECTLY ACCUMULATE'',	SRCINF	00210
\$	'' STATISTICS'')') IMAX, IMXOLD	SRCINF	00211
C	~~CALL ABORTX('SRCINF')~~	SRCINF	00212
C	-----	SRCINF	00213
C	END IF	SRCINF	00214
C		SRCINF	00215
C	NB = NB + IBT	SRCINF	00216
	WRITE(IOUT,(''0THE STANDARD ERROR ESTIMATES ARE BASED ON '',I5,	SRCINF	00217
\$	'' BATCHES OF '',I7, '' HISTORIES EACH'')') NB,IMAX	SRCINF	00218
C		SRCINF	00219
C	RETURN	SRCINF	00220
C		SRCINF	00221
C	END	SRCINF	00222
		SRCINF	00223
		SRCINF	00224
		SRCINF	00225

C	SUBROUTINE KEYMAP (INDX, FLDUP)	KEYMAP	00003
C	*****	KEYMAP	00004
C		KEYMAP	00005
C	SUBROUTINE KEYMAP IS CALLED BY	KEYMAP	00006
C	INPUT	KEYMAP	00007
C	SUBROUTINE KEYMAP CALLS	KEYMAP	00008
C	INTRINSIC FUNCTIONS	KEYMAP	00009
C		KEYMAP	00010
C	EXTERNAL FUNCTIONS	KEYMAP	00011
C		KEYMAP	00012
C		KEYMAP	00013
C	ORIGINATION DATE 15 AUG 90	KEYMAP	00014
C	LAST MODIFIED 11 MARCH 91	KEYMAP	00015
C		KEYMAP	00016
C	FUNCTION	KEYMAP	00017
C	This subroutine contains the INPUT Primary Keyword mapping.	KEYMAP	00018
C	It takes the "indx" of the keyword list array as input and	KEYMAP	00019
C	returns the status of the duplicate keyword flag, "fldup".	KEYMAP	00020
C		KEYMAP	00021
C	INPUT PARAMETERS	KEYMAP	00022
C	INDX - Index of the keyword list array	KEYMAP	00023
C		KEYMAP	00024
C	OUTPUT PARAMETERS	KEYMAP	00025
C	FLDUP - Status of the duplicate keyword flag	KEYMAP	00026
C		KEYMAP	00027
C	*****	KEYMAP	00028
C	*** COMMON BLOCKS CNSTNT, PARAMS	KEYMAP	00029
C\$	LIST(S=0)	KEYMAP	00030
C	CDIR\$ NOLIST	KEYMAP	00031
	IMPLICIT DOUBLE PRECISION (A-H,O-Z)	CNSTNT	00081

No changes in CNSTNT common block - listing, omitted for brevity, is identical to that given in Reference 1.

	CNSTNT	00082
C	PARAMS	00002
C	-----	PARAMS
C		PARAMS
	PARAMS	00004

PARAMS common block identical to that shown in subroutine INPUT

C\$	LIST(S=1)	KEYMAP	00034
C	CDIR\$ LIST	KEYMAP	00035
C		KEYMAP	00036
	CHARACTER*17 OKEYLS (MAXKEY)	KEYMAP	00037
	LOGICAL FLDUP	KEYMAP	00038
C		KEYMAP	00039
	DATA OKEYLS / 'BATCHES', 'CUTOFFS',	KEYMAP	00040
	\$ 'DIRECTION', 'DUMP', 'ECHO',	KEYMAP	00041
	\$ 'ELECTRONS', 'ELECTRON-ESCAPE', 'ELECTRON-FLUX',	KEYMAP	00042
	\$ 'ENERGY', 'GEOMETRY', 'HISTORIES', 'NEW-DATA-SET',	KEYMAP	00043
	\$ 'NEXT-EVENT-ESCAPE', 'NO-KNOCKONS', 'NO-STRAGGLING',	KEYMAP	00044
	\$ 'PHOTONS', 'PHOTON-ESCAPE', 'PHOTON-FLUX', 'PLOTS',	KEYMAP	00045
	\$ 'POSITION', 'PRINT-ALL', 'PULSE-HEIGHT',	KEYMAP	00046
	\$ 'RANDOM-NUMBER', 'RESTART', 'SCALE-BREMS',	KEYMAP	00047
	\$ 'SCALE-IMPACT', 'SIMPLE-BREMS', 'SPECTRUM', 'TITLE',	KEYMAP	00048
	\$ 'TRAP-ELECTRONS', 'NO-COHERENT', 'NO-INCOH-BINDING',	KEYMAP	00049
C	\$ 'DETAIL-IONIZE' /	KEYMAP	00050
	\$ 'DETAIL-IONIZE', 'RECTANGLE-SOURCE', 'CIRCLE-SOURCE',		
	\$ 'INDIVIDUAL-HISTS' /		
C		KEYMAP	00051
C	Print that the keyword pointed to by INDX is a duplicate entry	KEYMAP	00052
C		KEYMAP	00053
	WRITE(IOUT, '(' >>>> KEYMAP: DUPLICATE INPUT KEYWORD: ', (A))')	KEYMAP	00054
	\$ OKEYLS (INDX)	KEYMAP	00055
	IF (.NOT. FLDUP) FLDUP = .TRUE.	KEYMAP	00056
C		KEYMAP	00057
	RETURN	KEYMAP	00058
	END	KEYMAP	00059

**New
Code**

APPENDIX 3

count.F Program Listing

```

parameter (maxhis = 10000)
parameter (mxclls = 2)
dimension edep(200),nelec(200),nprot(200),nneut(200),nphot(200)
1,edelec(200),edprot(200),edphot(200),edneut(200),iesc(10),

2numcoin(3),koinc(3,mxclls),kcell(mxclls)
dimension nhcoin(maxhis,3),npart(3)
data npart/9,1,2/
data kcell/67,88/
data eps/1.e-8/
data ntime,nw8win,nclimp,nwcut,nh,iesc,numcoin/18*0/
data eesc,elostot/0.0,0.0/
data edeptot,eprtot,ephtot,edntot,edeltot/5*0./
data edep,edprot,edphot,edelec,edneut/1000*0./
data nelec,nprot,nneut,nphot/800*0/
open(1,file='trkbin',status='unknown',form='UNFORMATTED')
open(7,file='countups',status='unknown')
print 77
read(5,*)nmax
77 format(1x,'Enter number of histories')
111 format(1x,'problem in track file')
c start a history
do 18 i=1,3
do 18 k=1,mxclls
18 koinc(i,k)=0
20 nh=nh+1
lflag=0
elost=0.0
if(nh.gt.nmax)go to 2000
read(1,end=2000)nhstry,nstart
read(1)nevent,nsurf,i1,ipt,ncell,mat,xs,ys,zs,us,vs,ws,es,wt,time
do 25 nc=1,mxclls
do 25 i=1,3
np=npart(i)
25 if(ipt.eq.np .and. ncell.eq.kcell(nc)) koinc(i,nc)=koinc(i,nc)+1
ec=es
iptold=ipt
ncold=ncell
oldtim=time
c read event records
1000 read(1)nevent,nsurf,i1,ipt,ncell,mat,x,y,z,u,v,w,e,wt,time
do 26 nc=1,mxclls
do 26 i=1,3
np=npart(i)
26 if(ipt.eq.np .and. ncell.eq.kcell(nc)) koinc(i,nc)=koinc(i,nc)+1
if(i1.eq.0.and.lflag.gt.0)elost=elost-e*wt
nter=0
de=ec-e
dt=time-oldtim
if(nevent.eq.9000)then
nter=nsurf

```

```

      nbrnch=i1
      if (nter.eq.1)then
        iesc(ipt)=iesc(ipt)+1
        eesc=eesc+e*wt/nmax

      go to 20
end if
      if (nter.gt.2)then
        if (nter.eq.3)ntime=ntime+1
        if (nter.eq.4)nw8win=nw8win+1
        if (nter.eq.5)nclimp=nclimp+1
        if (nter.eq.6)nwcut=nwcut+1
      end if
end if
      if (nevent.ge.2000. and. nevent.lt.3000)then
        nter=nsurf
        if (nter.gt.12.and.nter.lt.15)then
          lflag=lflag+1
          elost=elost+e
        end if
        if (nter.eq.1)then
          iesc(ipt)=iesc(ipt)+1
          eesc=eesc+e*wt/nmax
          go to 19
        end if
      end if
      if (nter.eq.2)de=ec-e
      if (ipt.eq.iptold .and. dt.ge.eps.and.de.ge.eps)then
c      energy deposition by charged particle CSDA or neutral particle
c      inelastic collision
        edep(ncold)=edep(ncold)+de*wt
c      electron
        if (ipt.eq.3)then
          nelec(ncold)=nelec(ncold)+1
          edelec(ncold)=edelec(ncold)+de*wt
        end if
c      proton
        if (ipt.eq.9)then
          nprot(ncold)=nprot(ncold)+1
          edprot(ncold)=edprot(ncold)+de*wt
        end if
c      neutron
        if (ipt.eq.1)then
          nneut(ncold)=nneut(ncold)+1
          edneut(ncold)=edneut(ncold)+de*wt
        end if
c      photon
        if (ipt.eq.2)then
          nphot(ncold)=nphot(ncold)+1
          edphot(ncold)=edphot(ncold)+de*wt
        end if
      end if
19 iptold=ipt
   ec=e
   oldtim=time
   ncold=ncell
   if (nevent.eq.9000)then

```

```

        elostot=elostot+elost
        do 220 k=1,3
        do 219 nc=1,mxcalls
219      if(koinc(k,nc).eq.0)go to 220
          numcoin(k)=numcoin(k)+1
          ll=numcoin(k)
          nhcoin(ll,k)=nh
220      continue
        do 221 k=1,3
        do 221 nc=1,mxcalls
221      koinc(k,nc)=0
          go to 20
        end if
      go to 1000
2000 continue
      elostot=elostot/nmax
      do 2100 m=1,200
      edep(m)=edep(m)/nmax
      edprot(m)=edprot(m)/nmax
      edphot(m)=edphot(m)/nmax
      edneut(m)=edneut(m)/nmax
      edelec(m)=edelec(m)/nmax
      edeptot=edeptot+edep(m)
      eprtot=eprtot+edprot(m)
      ephtot=ephtot+edphot(m)
      edntot=edntot+edneut(m)
      edeltot=edeltot+edelec(m)
2100 write(7,112)m,edep(m),nprot(m),edprot(m),nelec(m),edelec(m),
      lnneut(m),edneut(m),nphot(m),edphot(m)
          edeptot=edeptot+elostot
          write(7,119)(iesc(i),i=1,10),eesc
          write(7,114)edeptot,eprtot,ephtot,edntot,edeltot,elostot,
      $numcoin(1),numcoin(2),numcoin(3)
          do 300 k=1,3
          maxk=numcoin(k)
          if(k.eq.1)write(7,302)
          if(k.eq.2)write(7,303)
          if(k.eq.3)write(7,304)
          write(7,301)(nhcoin(m,k),m=1,maxk)
300      continue
301      format(15i8)
302      format(/1x,'history numbers for proton coincidence events')
303      format(/1x,'history numbers for neutron coincidence events')
304      format(/1x,'history numbers for photon coincidence events')
114      format(1x,'total energy deposited = ',e12.5/10x,'from protons = ',
      xe12.5,/10x,'from photons = ',e12.5/10x,'from neutrons = ',e12.5/
      x10x,'from electrons = ',e12.5/10x,'from inelastic collisions='
      $,e12.5/10x,'number of proton coincidence events = ',i5
      $/10x,'number of neutron coincidence events = ',i5
      $/10x,'number of photon coincidence events = ',i5)
119      format(1x,'no. of escaped particles = ',10i6,/1x,
      $' escaped energy = ',e12.5)
112      format(1x,i5,e12.5,4(i15,e12.5))
      stop
      end

```


APPENDIX 4

source.F Program Listing for MCNPX Beam Source Allowing for User-supplied Location, Direction, Energy, Particle Specie

```

c_deck so source
1-
subroutine source
2
c user supplied source subroutine
#include "cm.h"
c
  data issty/0/
  if(issty.eq.0)then
    wgt=1.0
    tme=0.0
    write(jtty,1)
    read(itty,*)xxx,yyy,zzz
    write(jtty,2)
    read(itty,*)uuu,vvv,www
    aa=sqrt(uuu**2+vvv**2+www**2)
    uuu=uuu/aa
    vvv=vvv/aa
    www=www/aa
    write(jtty,7)
    read(itty,*)ipt
    write(jtty,3)
    read(itty,*)erg
    write(jtty,4)
    read(itty,*)jsu
    write(jtty,5)
    read(itty,*)icl
    write(47)wgt,tme,xxx,yyy,zzz,uuu,vvv,www,erg,ipt,jsu,icl
    print 6,xxx,yyy,zzz,uuu,vvv,www,icl,jsu,ipt,erg,wgt,tme
    write(iuo,8)
    write(iuo,6)xxx,yyy,zzz,uuu,vvv,www,icl,jsu,ipt,erg,wgt,tme
    write(iuo,9)
    issty=1
  else
    rewind 47
    read(47)wgt,tme,xxx,yyy,zzz,uuu,vvv,www,erg,ipt,jsu,icl
    do 50 ispr=1,3
      spare(ispr)=0.0
    end if
    1 format(1x,'Enter the source point (x,y,z)')
    2 format(1x,'Enter the source beam direction cosines (u,v,w)')
    3 format(1x,'Enter the source energy (MeV)')
    4 format(1x,'If this is a surface source, enter surface number'/
    $1x, 'if not, enter 0')
    5 format(1x,'Enter the cell number containing the source point')
    6 format(1x,'Enter particle type (ipt)')
    7 format(1x,'User-supplied source'/1x,'xxx = ',e12.5,' yyy = ',e12.5
    $,' zzz = ',e12.5/1x,'uuu = ',e12.5,' vvv = ',e12.5,' www = ',e12.5
    $/1x,'icl = ',i5,' jsu = ',i5,' ipt = ',i5/1x,'erg = ',e12.5,
    $' wgt = ',e12.5,' time = ',e12.5)
    8 format(/////1x,'*****',
    $1x, '*****',
    $1x, '*****')
    9 format(/1x,'*****',
    $1x, '*****',
    $1x, '*****')
    return
  end
end
13

```


APPENDIX 5 **ITS-ACCEPT Input File for the CEASE-DD1 Dosimeter**

```

10 MEV DOME SOURCE FLAT DOSIMETER TEST -DD1
***** GEOMETRY *****
GEOMETRY
*1
RCC 0.0 0.0 -0.2032 0.0 0.00000 0.2032 1.75514
*2
RCC 0.0 0.0 -0.36068 0.0 .00000 0.15748 1.75514
*3
RCC 0.0 0.0 -0.36158 0.0 .00000 0.00090 1.75514
*4
RCC 0.0 0.0 -0.38158 0.0 .00000 0.02000 1.75514
*5
RCC 0.0 0.0 -0.45158 0.0 .00000 0.07000 1.75514
*6
RCC 0.0 0.0 -0.55158 0.0 .00000 0.10000 1.75514
*7
RCC 0.0 0.0 -0.70400 0.0 .00000 0.15242 1.75514
*8
RCC 0.0 0.0 -1.20400 0.0 .00000 0.50000 1.75514
*9
RCC 0.0 0.0 -0.2032 0.0 0.00000 0.2032 1.76
*10
RCC 0.0 0.0 -0.36068 0.0 .00000 0.15748 1.76
*11
RCC 0.0 0.0 -0.36158 0.0 .00000 0.00090 1.76
*12
RCC 0.0 0.0 -0.38158 0.0 .00000 0.02000 1.76
*13
RCC 0.0 0.0 -0.45158 0.0 .00000 0.07000 1.76
*14
RCC 0.0 0.0 -0.55158 0.0 .00000 0.10000 1.76
*15
RCC 0.0 0.0 -0.70400 0.0 .00000 0.15242 1.76
*16
RCC 0.0 0.0 -1.20400 0.0 .00000 0.50000 1.76
*17
RPP -0.85 0.85 -0.85 0.85 -0.36158 -.36068
*18
RPP -0.6477 0.6477 -0.6477 0.6477 -0.38158 -0.36158
*19
RPP -0.85 0.85 -0.85 0.85 -0.38158 -.36158
*20
RPP -0.45 0.45 -0.45 0.45 -0.45158 -0.38158
*21
RPP -0.6477 0.6477 -0.6477 0.6477 -0.45158 -0.38158
*22
RPP -0.85 0.85 -0.85 0.85 -0.45158 -0.38158
*23
RPP -0.6342 0.6342 -0.6342 0.6342 -0.55158 -0.45158
*24
RPP -0.6477 0.6477 -0.6477 0.6477 -0.55158 -0.45158
*25
RPP -0.85 0.85 -0.85 0.85 -0.55158 -0.45158
*26
RPP -0.6477 0.6477 -0.6477 0.6477 -0.70400 -0.55158
*27
RPP -0.85 0.85 -0.85 0.85 -0.70400 -0.55158
*28
SPH 0.0 0.0 0.0 1.75514
*29
SPH 0.0 0.0 0.0 1.76
*30
RCC 0.0 0.0 0.0 0.0 0.00000 1.76 1.75514
*31
RCC 0.0 0.0 0.0 0.0 0.00000 1.76 1.76
*32
SPH 0.0 0.0 0.0 5.0
*33
SPH 0.0 0.0 0.0 10.0

```

END

*VOID

Z01 +1
Z02 +2
Z03 +17
Z04 +3 -17
Z05 +11 -3 -17
Z06 +18
Z07 +19 -18
Z08 +4 -19 -18
Z09 +12 -4 -19 -18
Z10 +20
Z11 +21 -20
Z12 +22 -21 -20
Z13 +5 -22 -21 -20
Z14 +13 -5 -22 -21 -20
Z15 +23
Z16 +24 -23
Z17 +25 -24 -23
Z18 +6 -25 -24 -23
Z19 +14 -6 -25 -24 -23
Z20 +26
Z21 +27 -26
Z22 +7 -27 -26
Z23 +15 -7 -27 -26
Z24 +8
Z25 +16 -8
Z26 +28 +30
Z27 +29 +31 -28
Z28 +30 -29
Z29 +9 -1
Z30 +10 -2
Z31 +31 -1 -2 -3 -4 -5 -6 -7 -8 -9 -10 -11 -12 -13 -14
-15 -16 -17 -18 -19 -20 -21 -22 -23 -24 -25 -26 -26
-28 -29 -30
Z32 +32 -31

END

*MATERIAL

1	1
0	0
1	0
0	1
0	1
0	0
1	0
0	0
0	0
2	0
0	0
1	0
0	0
0	0
3	0
0	0

***** SOURCE *****

ELECTRONS

SPECTRUM 11

1.0000	.9553	.9062	.8559	.8046	.7508	.6932	.6312
.5627	.4573	0.0					
10.0000	9.2000	9.1000	9.0000	8.9000	8.6000	8.3000	8.0000
7.5000	5.0000	0.0					

***** OPTIONS *****

PULSE-HEIGHT 10 10

NBINE 102

DOME-SOURCE 0. 0. 0.0 1.755

***** OPTIONS *****

HISTORIES 10000

This is the hemispherical dome source option as depicted in Figure 15. For the flat disc source option depicted in Figure 14, this line must be replaced with

CIRCLE-SOURCE 0. 0. -0.01 1.755 0. -0.01
RADIUS 1.755
DIRECTION 180.0
ISOTROPIC

APPENDIX 6

MCNPX Input File for the CEASE-DD2 Dosimeter

CEASE DD2 dosimeter MCNPX, electrons, isotropic source on hemispherical void

```
C      Cells
C      Silicon Dosimeter DD2
1      2 -2.33 23 -25 22 -24 6 -5
C      Voids surrounding DD2
2      0 15 -17 14 -16 6 -5 #1
3      0 15 -17 14 -16 7 -6 #5
4      0 15 -17 14 -16 6 5 -4
c      Aluminum Oxide substrate
5      3 -3.97 19 -21 18 -20 7 -6
c      Aluminum base
6      1 -2.7 15 -17 14 -16 8 -7
c      Aluminum sides
7      1 -2.7 11 -13 10 -14 8 -4
8      1 -2.7 11 -13 16 -12 8 -4
9      1 -2.7 11 -15 14 -16 8 -4
10     1 -2.7 17 -13 14 -16 8 -4
c      Al foil
11     1 -2.7 11 -13 10 -12 4 -3
c      void cylinder above foil
12     0 -26 3 -2
c      Al cover plate
13     1 -2.7 2 -1 -26
c      Void cylinder around box
14     0 8 -3 -26 #1 #2 #3 #4 #5 #6 #7 #8 #9 #10 #11
c      Void cylinder below box
15     0 9 -8 -26
c      Void hemispherical region above plate
16     0 1 -27
c      Hemispherical void region enclosing upper half(dome)
17     0 27 -28 1
c      Spherical void region enclosing everything
18     0 -29 #1 #2 #3 #4 #5 #6 #7 #8 #9 #10 #11 #12 #13 #14 #15 #16
        #17
c      exterior void escape region
19     0 #18

c      Surfaces
1      pz 0.0
2      pz -0.635
3      pz -0.79248
4      pz -0.79338
5      pz -0.81338
6      pz -0.88338
7      pz -0.98338
8      pz -1.1358
9      pz -1.6358
10     py -0.85
11     px -0.85
12     py 0.85
13     px 0.85
14     py -0.6477
15     px -0.6477
16     py 0.6477
17     px 0.6477
18     py -0.6342
19     px -0.6342
20     py 0.6342
```

```

21      px    0.6342
22      py   -0.45
23      px   -0.45
24      py    0.45
25      px    0.45
26      cz   1.79578
27      so   1.79578
28      so    1.8
29      so    3.0
c
c      Transport electrons and photons
mode    e p
c      Source is defined by subroutine "sourcedd2.F" (which must be renamed
c            to "source.F")
c      no. of histories
nps     10000
c
c      electron cutoff energy = 0.5 MeV
cut:e    1.e+10  0.5
c      photon cutoff energy = 10 keV
cut:p    1.e+10  0.01
c
c      materials
c
c      aluminum
M1      13027 -1.0
C      Silicon
M2      14000 -1.0
C      Aluminum Oxide
M3      13027 -0.529251  8016 -0.470749
C      Kel-F (chlorotrifluoroethylene C2ClF3)
M4      6000 -0.20625  17000 -0.30440  9019 -0.48935
c
c      maximum electron energy(MeV) needed for cross sections
phys:e  12.
c      maximum photon energy(MeV) needed for cross sections
phys:p  12.
c      tallies
c      energy deposition (MeV) tally
*F18:e   1  5 13
c      pulse height tally
F48:e    1  5 13
E48      0 1.e-5 .1 97I 9.9 9.99999 10.
c      cell importances for electrons
imp:e    1 17R 0
c      cell importances for photons
imp:p    1 17R 0

```

APPENDIX 7

ITS-ACCEPT Subroutine Modifications for Dome Source Option - Code Listings -

SUBROUTINE INPUT	INPUT	00007
C *****	INPUT	00009
C	INPUT	00010
C PROGRAM INPUT IS CALLED BY	INPUT	00011
C ITS	INPUT	00012
C PROGRAM INPUT CALLS	INPUT	00013
C INTRINSIC FUNCTIONS	INPUT	00014
C REAL (TIGER & CYLTRAN)	INPUT	00015
C SQRT, ABS (ACCEPT)	INPUT	00016
C EXTERNAL FUNCTIONS	INPUT	00017
C ALIST, ELIST, START, PREP, KOP,	INPUT	00018
C REQALL, GEOMIN, SCRINF, OPOPTS	INPUT	00019
C KEYMAP, OPREAD	INPUT	00020
C JOGEN (ACCEPT)	INPUT	00021
C	INPUT	00022
C ORIGINATION DATE 12 DEC 67.	INPUT	00023
C LAST MODIFIED 17 MAY 91	INPUT	00024
C	INPUT	00025
C FUNCTION	INPUT	00026
C THIS PROGRAM IS USED TO READ AND PROCESS USER-SUPPLIED	INPUT	00027
C CARD INPUT	INPUT	00028
C	INPUT	00029
C *****	INPUT	00030
C *** COMMON BLOCKS CNSTNT, PARAMS, OUT, CALC, XPED, STTS, SCALE, PLTTITLE	INPUT	00031
C PAREM, GOMLOC (ACCEPT)	INPUT	00032
C FLUOR (PCODES)	INPUT	00033
C PLOT (PLOTS)	INPUT	00034
C\$ LIST(S=0)	INPUT	00035

•
•
•

Code listing omitted here is identical to that given in Appendix 2

•
•
•

C\$ LIST(S=1)	INPUT	00051
CDIR\$ LIST	INPUT	00052
COMMON /SCALE/ BNUM, XNUM	SCALE	00002
COMMON /EXTSARC/ IRECTS, IDISKS, XLOWS, XHIGHS, YLOWS, YHIGHS, ZLOWS,		
\$ ZHIGHS, XCENT, YCENT, ZCENT, XCIR, YCIR, ZCIR, KPERPYZ, KPREPXZ, KPERPXV		
\$ IDOME, RDOME		
C	SCALE	00003
C	INPUT	00057
COMMON /HITS/EDPR(10), EDNK(10), EDSC(10), EDTL(10), LHCL(10), NINDV		

New
Code

•
•

Code listing omitted here is identical to that given in Appendix 2

```

      NPRTCL = 1
C
      IRECTS = 0
      IDISKS = 0
      KPERPYZ = 0
      KPERPXZ = 0
      KPERPXY = 0
      IDOME = 0
C
      NINDV=0
      DO 599 J=1,10
599  LHCL(J)=0
C
      TITLE = ' '
      NPRT = 12
      IECHO = 0
      NB = 10
      IMAX = 1000
      IBT = 0
      MBSC = 1
      BOLD = CZERO
      IMXOLD = 0
      INRAN = CZERO
      BASE = CTWO
      XNCYC = CEIGHT
      TMFAC = BASE**(-1.0/XNCYC)
      DMPFLG = .FALSE.
C
C ... INITIALIZE LOGICALS FOR IDENTIFYING MATERIALS (NON-P CODES) OR
C ... ELEMENTS (P CODES) THAT ARE PRESENT IN A GIVEN PROBLEM - USED
C ... FOR IDENTIFYING RELEVANT LINE RADIATION.
      NGP = NMT
      DO 60 J=1,NGP
60  FLMTCL(J) = .FALSE.
C
      NPLOTS = 0
C
C -----
C ... SOURCE VARIABLES
C -----
      FLESRC = .TRUE.
      JSPEC = 0
      FLSPEC = .FALSE.
      TIN = CONE
      TPCUT = C1EM2
      TCUT = CZERO
      TSAVE = CZERO
      ICTH = 1
      CTSR = CZERO
      CTHIN = C90
      ZSR = CZERO
      XSR = CZERO
      YSR = CZERO
      CPSR = CZERO
      SORCIN = CZERO
C
C -----
C ... ELECTRON ESCAPE VARIABLES
C -----

```

INPUT 00153

New
Code

INPUT 00154
 INPUT 00155
 INPUT 00156
 INPUT 00157
 INPUT 00158
 INPUT 00159
 INPUT 00160
 INPUT 00161
 INPUT 00162
 INPUT 00163
 INPUT 00168
 INPUT 00170
 INPUT 00171
 INPUT 00172
 INPUT 00173
 INPUT 00174
 INPUT 00175
 INPUT 00176
 INPUT 00177
 INPUT 00182
 INPUT 00184
 INPUT 00185
 INPUT 00186
 INPUT 00188
 INPUT 00193
 INPUT 00194
 INPUT 00195
 INPUT 00196
 INPUT 00197
 INPUT 00198
 INPUT 00199
 INPUT 00200
 INPUT 00201
 INPUT 00202
 INPUT 00203
 INPUT 00204
 INPUT 00205
 INPUT 00210
 INPUT 00213
 INPUT 00214
 INPUT 00215
 INPUT 00216
 INPUT 00218
 INPUT 00219
 INPUT 00220

JMAX = 10	INPUT	00221
FLESC = .FALSE.	INPUT	00222
ITMK = 1	INPUT	00223
IAMK = 1	INPUT	00224
KMAX = 18	INPUT	00225
KMAZ = 1	INPUT	00226
IAMKZ = 1	INPUT	00228
C -----	INPUT	00230
C ... PHOTON ESCAPE VARIABLES	INPUT	00231
C -----	INPUT	00232
JPMAX = 10	INPUT	00233
FLESCP = .FALSE.	INPUT	00234
IPMK = 1	INPUT	00235
IBMK = 1	INPUT	00236
KPMAX = 18	INPUT	00237
KPMAZ = 1	INPUT	00238
IBMKZ = 1	INPUT	00240
C -----	INPUT	00242
C ... ELECTRON FLUX VARIABLES	INPUT	00243
C -----	INPUT	00244
FLFLUX = .FALSE.	INPUT	00245
JFMAX = 10	INPUT	00246
KFMAX = 6	INPUT	00247
KFMAZ = 1	INPUT	00248
IFAMKZ = 1	INPUT	00250
IFMK = 1	INPUT	00252
IFAMK = 1	INPUT	00253
C -----	INPUT	00254
C ... PHOTON FLUX VARIABLES	INPUT	00255
C -----	INPUT	00256
FLFLXP = .FALSE.	INPUT	00257
JFMAXP = 10	INPUT	00258
KFMAXP = 6	INPUT	00259
KFMAZP = 1	INPUT	00260
IFBMKZ = 1	INPUT	00262
IFMKP = 1	INPUT	00264
IFBMK = 1	INPUT	00265
C -----	INPUT	00266
C ... PULSE HEIGHT DISTRIBUTION VARIABLES	INPUT	00267
C -----	INPUT	00268
FLPHD = .FALSE.	INPUT	00269
JSMAX = 12	INPUT	00270
IPHMK = 1	INPUT	00271
C -----	INPUT	00272
C *****	INPUT	00273
C * BEGIN READING INPUT *	INPUT	00274
C * ZERO-LEVEL KEYWORDS IN ALPHABETICAL ORDER *	INPUT	00275
C *****	INPUT	00276
C -----	INPUT	00280
C ... SET ERROR TRAP FLAG TO ZERO	INPUT	00281
IERTRP = 0	INPUT	00282
NUMCRD = 0	INPUT	00283
FLNEWD = .FALSE.	INPUT	00284
FLDUP = .FALSE.	INPUT	00285
DO 65 IKEY=1,MAXKEY	INPUT	00286
65 FLKEY(IKEY) = .FALSE.	INPUT	00287
C -----	INPUT	00288
C ... READ THE NEXT CARD IN THE INPUT FILE	INPUT	00289
C -----	INPUT	00290
C 70 CALL OPREAD(1,IECHO,EFLAG)	INPUT	00291
C -----	INPUT	00292
C ... NOTE, COMMENT CARDS DENOTED BY * IN COLUMN 1, SKIPPED INTERNALLY	INPUT	00293
C -----	INPUT	00294
IF (.NOT. EFLAG) THEN	INPUT	00295
NUMCRD = NUMCRD + 1	INPUT	00296
C -----	INPUT	00297
80 IF (KOP('BATCHES') .GE. 1) THEN	INPUT	00298
C -----	INPUT	00299
C ... BATCHES	INPUT	00300
	INPUT	00301
	INPUT	00302

C	-----	INPUT	00303
C	Check if primary keyword has been used	INPUT	00304
C	IKEY = 1	INPUT	00305
C	IF (FLKEY(IKEY)) CALL KEYMAP(IKEY,FLDUP)	INPUT	00306
C	-----	INPUT	00307
C	FLKEY(IKEY) = .TRUE.	INPUT	00308
C		INPUT	00309
C	NB = PARM(1)	INPUT	00310
C		INPUT	00311
C	ELSE IF (KOP('CUTOFFS') .GE. 0) THEN	INPUT	00312
C	-----	INPUT	00313
C ...	CUTOFFS	INPUT	00314
C	-----	INPUT	00315
C	IKEY = 2	INPUT	00316
C		INPUT	00317
C	IF (FLKEY(IKEY)) CALL KEYMAP(IKEY,FLDUP)	INPUT	00318
C	-----	INPUT	00319
C	FLKEY(IKEY) = .TRUE.	INPUT	00320
C		INPUT	00321
C	KARG = KOP('CUTOFFS')	INPUT	00322
C	IF (KARG .GE. 1) THEN	INPUT	00323
C	TCUT = PARM(1)	INPUT	00324
C	END IF	INPUT	00325
C	IF (KARG .GE. 2) THEN	INPUT	00326
C	TPCUT = PARM(2)	INPUT	00327
C	END IF	INPUT	00328
C		INPUT	00329
C	ELSE IF (KOP('DETAIL-IONIZE') .GE. 0) THEN	INPUT	00330
C		INPUT	00331
C ...	DETAIL-IONIZATION	INPUT	00332
C	-----	INPUT	00333
C	IKEY = 33	INPUT	00334
C		INPUT	00335
C	IF (FLKEY(IKEY)) CALL KEYMAP(IKEY,FLDUP)	INPUT	00336
C	-----	INPUT	00337
C	FLKEY(IKEY) = .TRUE.	INPUT	00338
C		INPUT	00339
C	NPRCTL = 2	INPUT	00340
C		INPUT	00341
C		INPUT	00342
C		INPUT	00343
C	ELSE IF (KOP('RECTANGLE-SOURCE') .GE.0) THEN		
C	-----		
C	RECTANGULAR PLANE SOURCE		
C	-----		
C	IKEY = 34		
C			
C	IF (FLKEY(IKEY)) CALL KEYMAP(IKEY,FLDUP)		
C	-----		
C	FLKEY(IKEY) = .TRUE.		
C			
	KARG = KOP('RECTANGLE-SOURCE')		
	IF (KARG.LT.6) THEN		
	WRITE(IOUT,68)		
68	FORMAT(1X,'>>>>')		
	WRITE(IOUT,51)		
	WRITE(IOUT,68)		
51	FORMAT(1X,' USER MUST ENTER 6 NUMBERS (XLOW,XHIGH,YLOW,YHIGH,ZLOW,		
	\$ZHIGH) TO DEFINE SOURCE LOWER AND UPPER COORDINATE LIMITS OF SOURC		
	\$E RECTANGLE')		
	CALL ABORTX('INPUT')		
	ELSE		
	IRECTS = 1		

```

XLOWS = PARM(1)
XHIGHS = PARM(2)
YLOWS = PARM(3)
YHIGHS = PARM(4)
ZLOWS = PARM(5)
ZHIGHS = PARM(6)
END IF

C
ELSE IF (KOP('CIRCLE-SOURCE').GE.0) THEN
C
C      CIRCLE PLANE SOURCE
C
C      -----
C
C      IKEY = 35
C
C
C      IF (FLKEY(IKEY)) CALL KEYMAP(IKEY,FLDUP)
C      -----
C      FLKEY(IKEY) = .TRUE.
C
C
C      KARG = KOP('CIRCLE-SOURCE')
IF (KARG.LT.6) THEN
      WRITE(IOUT,68)
      WRITE(IOUT,52)
      WRITE(IOUT,68)
52  FORMAT(1X,' USER MUST ENTER 6 NUMBERS - COORDINATES OF CIRCLE CENT
SER (XO,YO,ZO),AND COORDINATES A POINT ON CIRCUMFERENCE'/1X,'(XC,YC
$,ZC) TO DEFINE POSITION AND ORIENTATION OF SOURCE CIRCLE')
C
      CALL ABORTX('INPUT')
ELSE
      IDISKS = 1
      XCENT = PARM(1)
      YCENT = PARM(2)
      ZCENT = PARM(3)
      XCIR = PARM(4)
      YCIR = PARM(5)
      ZCIR = PARM(6)
      CALL OPREAD(1,IECHO,EFLAG)
      IF (KOP('RADIUS').GE.1) THEN
      SORCIN = PARM(1)
      ELSE
      GO TO 80
      END IF
C
C
C      END IF
C
C
ELSE IF (KOP('INDIVIDUAL-HISTS').GE.0) THEN
C
C      RECORD SINGLE HISTORY ENERGY DEPOSITIONS
C      -----
C
C      IKEY = 36
C
C
C      IF (FLKEY(IKEY)) CALL KEYMAP(IKEY,FLDUP)
C
C      FLKEY(IKEY) = .TRUE.
C
C
C      KARG = KOP('INDIVIDUAL-HISTS')
      IF (KARG.LT.1.OR. KARG.GT.10) THEN

```

```

        WRITE(IOUT,68)
        WRITE(IOUT,688)
        WRITE(IOUT,68)
688  FORMAT(1X,'USER MUST ENTER NO FEWER THAN 1 AND NO MORE THAN 10 CEL
      $L NUMBERS IN WHICH THE ENERGY DEPOSITION'/1X,'FOR INDIVIDUAL ELECT
      $RON HISTORIES ARE TO BE RECORDED.')
```

C

```

        CALL ABORTX('INPUT')
      ELSE
        DO 689 KRRG=1,KARG
689  LHCL(KRRG)=PARM(KRRG)
        NINDV=KARG
        WRITE(IOUT,587)
        WRITE(IOUT,588) (LHCL(KRRG),KRRG=1,NINDV)
588  FORMAT(1X,'ENERGY DEPOSITION FOR INDIVIDUAL HISTORIES WILL BE RECO
      $RDED ON FILE "EDSHOW.TXT" FOR CELL NOS.'/5X,10I5)
        WRITE(IOUT,587)
587  FORMAT(/1X,'*****
      $*****
      $/1X,'*****
      $*****')
```

C

```

      END IF
```

C

```

      ELSE IF (KOP('DOME-SOURCE').GE.0) THEN
C
C      _____
C
C      HEMISPHERICAL DOME SOURCE
C
C      -----
C
C      IKEY = 37
C
C
C      IF (FLKEY(IKEY)) CALL KEYMAP(IKEY,FLDUP)
C      -----
C      FLKEY(IKEY) = .TRUE.
C
C
C      KARG = KOP('DOME-SOURCE')
      IF (KARG.LT.4) THEN
        WRITE(IOUT,68)
        WRITE(IOUT,53)
        WRITE(IOUT,68)
53  FORMAT(1X,' USER MUST ENTER 4 NUMBERS - COORDINATES OF SPHERE CENT
      $ER (XO,YO,ZO),AND SPHERE RADIUS'/1X,'(RDOME)')
```

C

```

        CALL ABORTX('INPUT')
      ELSE
        IDOME = 1
        XCENT = PARM(1)
        YCENT = PARM(2)
        ZCENT = PARM(3)
        RDOME = PARM(4)
C
C
C      END IF
C
```

**New
Code**

C

```

      ELSE IF (KOP('DIRECTION').GE. 0) THEN
C
C      _____
C ...  DIRECTION
```

```

INPUT  00344
INPUT  00345
INPUT  00346
```

C	-----	INPUT	00347
	IKEY = 3	INPUT	00348
C		INPUT	00349
	IF (FLKEY(IKEY)) CALL KEYMAP(IKEY,FLDUP)	INPUT	00350
C	-----	INPUT	00351
	FLKEY(IKEY) = .TRUE.	INPUT	00352
C		INPUT	00353

•
•
•

**Remaining portion of subroutine INPUT (omitted here for brevity) is
identical to original ACCEPT [1] code**

•
•
•

END

INPUT 01841

C	SUBROUTINE KEYMAP (INDX, FLDUP)	KEYMAP	00003
C	*****	KEYMAP	00004
C		KEYMAP	00005
C	SUBROUTINE KEYMAP IS CALLED BY	KEYMAP	00006
C	INPUT	KEYMAP	00007
C	SUBROUTINE KEYMAP CALLS	KEYMAP	00008
C	INTRINSIC FUNCTIONS	KEYMAP	00009
C		KEYMAP	00010
C	EXTERNAL FUNCTIONS	KEYMAP	00011
C		KEYMAP	00012
C		KEYMAP	00013
C	ORIGINATION DATE 15 AUG 90	KEYMAP	00014
C	LAST MODIFIED 11 MARCH 91	KEYMAP	00015
C		KEYMAP	00016
C	FUNCTION	KEYMAP	00017
C	This subroutine contains the INPUT Primary Keyword mapping.	KEYMAP	00018
C	It takes the "indx" of the keyword list array as input and	KEYMAP	00019
C	returns the status of the duplicate keyword flag, "fldup".	KEYMAP	00020
C		KEYMAP	00021
C	INPUT PARAMETERS	KEYMAP	00022
C	INDX - Index of the keyword list array	KEYMAP	00023
C		KEYMAP	00024
C	OUTPUT PARAMETERS	KEYMAP	00025
C	FLDUP - Status of the duplicate keyword flag	KEYMAP	00026
C		KEYMAP	00027
C	*****	KEYMAP	00028
C	*** COMMON BLOCKS CNSTNT, PARAMS	KEYMAP	00029
C\$	LIST(S=0)	KEYMAP	00030
C	CDIR\$ NOLIST	KEYMAP	00031

No changes in CNSTNT common block - listing, omitted for brevity, is identical to that given in Reference 1.

C		PARAMS	00002
C	-----	PARAMS	00003

PARAMS common block identical to that shown in subroutine INPUT listed in Appendix 2.

C\$	LIST(S=1)	KEYMAP	00034
C	CDIR\$ LIST	KEYMAP	00035
C		KEYMAP	00036
C	CHARACTER*17 OKEYLS (MAXKEY)	KEYMAP	00037
C	LOGICAL FLDUP	KEYMAP	00038
C		KEYMAP	00039
C	DATA OKEYLS / 'BATCHES', 'CUTOFFS',	KEYMAP	00040
\$	'DIRECTION', 'DUMP', 'ECHO',	KEYMAP	00041
\$	'ELECTRONS', 'ELECTRON-ESCAPE', 'ELECTRON-FLUX',	KEYMAP	00042
\$	'ENERGY', 'GEOMETRY', 'HISTORIES', 'NEW-DATA-SET',	KEYMAP	00043
\$	'NEXT-EVENT-ESCAPE', 'NO-KNOCKONS', 'NO-STRAGGLING',	KEYMAP	00044
\$	'PHOTONS', 'PHOTON-ESCAPE', 'PHOTON-FLUX', 'PLOTS',	KEYMAP	00045
\$	'POSITION', 'PRINT-ALL', 'PULSE-HEIGHT',	KEYMAP	00046
\$	'RANDOM-NUMBER', 'RESTART', 'SCALE-BREMS',	KEYMAP	00047
\$	'SCALE-IMPACT', 'SIMPLE-BREMS', 'SPECTRUM', 'TITLE',	KEYMAP	00048
\$	'TRAP-ELECTRONS', 'NO-COHERENT', 'NO-INCOH-BINDING',	KEYMAP	00049
C	\$ 'DETAIL-IONIZE' /	KEYMAP	00050
\$	'DETAIL-IONIZE', 'RECTANGLE-SOURCE', 'CIRCLE-SOURCE'		
\$	'INDIVIDUAL-HISTS', 'DOME-SOURCE' /		
C		KEYMAP	00051
C	Print that the keyword pointed to by INDX is a duplicate entry	KEYMAP	00052
C		KEYMAP	00053
C	WRITE(IOUT, '(' >>>> KEYMAP: DUPLICATE INPUT KEYWORD: ', (A))')	KEYMAP	00054
\$	OKEYLS (INDX)	KEYMAP	00055
C	IF (.NOT. FLDUP) FLDUP = .TRUE.	KEYMAP	00056
C		KEYMAP	00057
C	RETURN	KEYMAP	00058
C	END	KEYMAP	00059

New
code


```

C      END IF
C      WRITE(IOUT,(''0THE MAXIMUM SOURCE ENERGY IS'',T38,F12.5,
$      ' ' MEV''')) TIN
C      WRITE(IOUT,(''0THE GLOBAL ELECTRON CUTOFF ENERGY IS'',T38,F12.5,
$      ' ' MEV''')) TCUT
C      WRITE(IOUT,(''0THE PHOTON CUTOFF ENERGY IS'',T38,F12.5,
$      ' ' MEV''')) TPCUT
C      IF (TSAVE .GT. TCUT) WRITE(IOUT,(''0THE GLOBAL ELECTRON TRAP'',
$      ' ' PING ENERGY IS'',T38,F12.5,' ' MEV''')) TSAVE
C      IF (FLSPEC) THEN
C        WRITE(IOUT,(''0SOURCE SPECTRUM'''))
C        WRITE(IOUT,('12I6')) JSPEC
C        WRITE(IOUT,(''0NORMALIZED CUMULATIVE SPECTRUM'''))
C        WRITE(IOUT,('6F12.5')) (SPECIN(J),J=1,JSPEC)
C        IF ((SPECIN(1) .NE. CONE) .OR. (SPECIN(JSPEC) .NE. CZERO)) THEN
C          WRITE(IOUT,*) ' INPUT CUMULATIVE SOURCE SPECTRUM MUST BE',
$          ' MONOTONICALLY DECREASING FROM 1.0 TO 0.0'
C          CALL ABORTX('SRCINF')
C          -----
C          END IF
C          WRITE(IOUT,(''0SPECTRAL ENERGIES (MEV)'''))
C          WRITE(IOUT,('6F12.5')) (ESP(J),J=1,JSPEC)
C        END IF
C      IF (IRECTS.EQ.0 .AND. IDISKS.EQ.0 .AND. IDOME.EQ.0) THEN
C        WRITE(IOUT,(''0COORDINATES OF THE POINT SOURCE OR OF THE'',
$        ' ' CENTER OF THE BEAM (DISK) SOURCE ARE''/
$        ' ' X = ',E12.5,' ' CM'',10X,' ' Y = ',E12.5,
$        ' ' CM'',10X,' ' Z = ',E12.5,' ' CM'''))
$        XSR, YSR, ZSR
C        WRITE(IOUT,(''0THE RADIUS OF THE BEAM (DISK) SOURCE IS = ',
$        ' 1PE12.4,' ' CM''')) SORCIN
C      END IF
C      IF (IDOME.EQ.0) THEN
C        WRITE(IOUT,(''0REFERENCE DIRECTION FOR ANGULAR DISTRIBUTION'',
$        ' ' IS DEFINED BY''/' ' THETA = ',G11.4,
$        ' ' DEGREES'',10X,' ' PHI = ',G11.4,' ' DEGREES'''))
$        CTSR, CPSR
C        TEMPA = CTSR/C180PI
C        CTSR = COS(TEMPA)
C        STSR = SIN(TEMPA)
C        TEMPA = CPSR/C180PI
C        CPSR = COS(TEMPA)
C        SPSR = SIN(TEMPA)
C      END IF
C      IF (IRECTS.EQ.1) THEN
C        WRITE(IOUT,55) XLOWS,XHIGHS,YLOWS,YHIGHS,ZLOWS,ZHIGHS
55      FORMAT(/1X,'RECTANGULAR PLATE SOURCE',/5X,'BOUNDING COORDINATES A
$RE - '/10X,'XLOW = ',E12.5,' ' XHIGH = ',E12.5/10X,'YLOW = ',E12.5
$, ' YHIGH = ',E12.5/10X,'ZLOW = ',E12.5,' ' ZHIGH = ',E12.5)
C        IF (ABS(XHIGHS-XLOWS) .LE. CT1EM7) KPERPYZ=1
C        IF (ABS(YHIGHS-YLOWS) .LE. CT1EM7) KPERPXZ=1
C        IF (ABS(ZHIGHS-ZLOWS) .LE. CT1EM7) KPERPXY=1
C        KPRPSUM=KPERPYZ+KPERPXZ+KPERPXY
C        IF (KPRPSUM.EQ.0 .OR. KPRPSUM.EQ.3) THEN
C          WRITE(IOUT,54)
54      FORMAT(/1X,'PROBLEM IN DEFINITION OF SOURCE PLANE ORIENTATION')
C          CALL ABORTX('SRCINF')
C          END IF
C        END IF
C      IF (IDISKS.EQ.1) THEN

```

```

SRCINF 00045
SRCINF 00046
SRCINF 00047
SRCINF 00048
SRCINF 00049
SRCINF 00050
SRCINF 00051
SRCINF 00052
SRCINF 00053
SRCINF 00054
SRCINF 00055
SRCINF 00056
SRCINF 00057
SRCINF 00058
SRCINF 00059
SRCINF 00060
SRCINF 00061
SRCINF 00062
SRCINF 00063
SRCINF 00064
SRCINF 00065
SRCINF 00066
SRCINF 00067
SRCINF 00068
SRCINF 00069
SRCINF 00070
SRCINF 00071

```

New
code

New
code

New
code

```

WRITE(IOUT,56)XCENT,YCENT,ZCENT,XCIR,YCIR,ZCIR
56  FORMAT(/1X,'CIRCULAR DISK SOURCE'/5X,'COORDINATES OF CENTER ARE'/
$10X,'XCENTER = ',E12.5,' YCENTER = ',E12.5,' ZCENTER = ',E12.5
$/5X,'COORDINATES OF POINT ON CIRCUMFERENCE ARE'/10X,'XCIR = ',
$E12.5,' YCIR = ',E12.5,' ZCIR = ',E12.5)
IF (ABS(XCENT-XCIR).LE.CT1EM7)KPERPYZ=1
IF (ABS(YCENT-YCIR).LE.CT1EM7)KPERPXZ=1
IF (ABS(ZCENT-ZCIR).LE.CT1EM7)KPERPXY=1
KPRPSUM=KPERPYZ+KPERPXZ+KPERPXY
IF (KPRPSUM.EQ.0 .OR. KPRPSUM.EQ.3) THEN
WRITE(IOUT,54)
CALL ABORTX('SRCINF')
END IF

```

C

```

IF (SORCIN.EQ.CZERO) THEN

WRITE(IOUT,57)

CALL ABORTX('SRCINF')

END IF

```

C

```

RSSQQ=SQRT((XCENT-XCIR)**2+(YCENT-YCIR)**2+(ZCENT-ZCIR)**2)
IF (ABS(RSSQQ-SORCIN).GT.CT1EM7) THEN

WRITE(IOUT,58)

CALL ABORTX('SRCINF')

ELSE

SORCIN=RSSQQ
WRITE(IOUT,59)SORCIN
59  FORMAT(/1X,'RADIUS OF THE DISK SOURCE IS ',E12.5)

END IF

57  FORMAT(///1X,'SOURCE DISK RADIUS NOT SPECIFIED')
58  FORMAT(///1X,'SOURCE DISK RADIUS INCONSISTENT WITH SPECIFICATION O
$F POINTS ON CIRCUMFERENCE AND AT CENTER OF SOURCE DISK')

```

END IF

C

```

IF (IDOME.EQ.1) THEN
WRITE(IOUT,61)XCENT,YCENT,ZCENT,RDOME
61  FORMAT(/1X,'HEMISPHERICAL DOME SOURCE'/5X,'COORDINATES OF SPHERE
$CENTER ARE'/
$10X,'XCENTER = ',E12.5,' YCENTER = ',E12.5,' ZCENTER = ',E12.5
$/5X,'DOME RADIUS = ',E12.5)
END IF

```

**New
code**

C

C

This code block checks to see if the sine of the input polar angle direction is less than zero. If it is, it allows this condition within an acceptable tolerance and changes the sine of the angle to zero; else it aborts.

SRCINF	00103
SRCINF	00104
SRCINF	00105
SRCINF	00106
SRCINF	00107
SRCINF	00108
SRCINF	00109
SRCINF	00110
SRCINF	00111
SRCINF	00112
SRCINF	00113
SRCINF	00114
SRCINF	00115
SRCINF	00116

```

IF (STSR.LT.CZERO) THEN
IF (STSR.GT.-C1EM6) THEN
WRITE(IOUT,'(//',' >>>> SRCINF: WARNING! SINE OF SOURCE'',
$  '' INPUT POLAR ANGLE DIRECTION IS CHANGED TO ZERO.'')' SRCINF
STSR = CZERO
CTSR = SIGN(CONE,CTSR)
ELSE
WRITE(IOUT,'(//',' >>>> THE INPUT POLAR ANGLE WITH THE'',

```

```

$          ' ' DIRECTION KEYWORD MUST BE BETWEEN ZERO AND 180 ' ', SRCINF 00117
$          ' ' DEGREES. ' ' ) SRCINF 00118
C          CALL ABORTX('SRCINF') SRCINF 00119
C          ----- SRCINF 00120
C          END IF SRCINF 00121
C          END IF SRCINF 00122
C          SRCINF 00123
C          SRCINF 00124
C
IF(IRECTS.EQ.0 .AND. IDISKS.EQ.0 .AND. IDOME.EQ.0) THEN
WSRX = STSR*CPSR SRCINF 00125
WSRY = STSR*SPSR SRCINF 00126
WSRZ = CTSR SRCINF 00127
C          ----- SRCINF 00128
C ... USUALLY W1(V) = R(V) X OMEGA(V) SRCINF 00129
C          ----- SRCINF 00130
C          W1X = YSR*WSRZ - ZSR*WSRY SRCINF 00131
C          W1Y = ZSR*WSRX - XSR*WSRZ SRCINF 00132
C          W1Z = XSR*WSRY - YSR*WSRX SRCINF 00133
C          XNRM = W1X*W1X + W1Y*W1Y + W1Z*W1Z SRCINF 00134
C          ----- SRCINF 00135
C ... UNLESS R(V) X OMEGA(V) = 0 SRCINF 00136
C          ----- SRCINF 00137
C          IF (XNRM .EQ. CZERO) THEN SRCINF 00138
C          ----- SRCINF 00139
C ... IF I(V) * OMEGA(V) = 0, W1(V) = I(V) SRCINF 00140
C          ----- SRCINF 00141
C          IF (WSRX .EQ. CZERO) THEN SRCINF 00142
C          W1X = CONE SRCINF 00143
C          W1Y = CZERO SRCINF 00144
C          W1Z = CZERO SRCINF 00145
C          ----- SRCINF 00146
C ... IF J(V) * OMEGA(V) = 0, W1(V) = J(V) SRCINF 00147
C          ----- SRCINF 00148
C          ELSE IF (WSRY .EQ. CZERO) THEN SRCINF 00149
C          W1X = CZERO SRCINF 00150
C          W1Y = CONE SRCINF 00151
C          W1Z = CZERO SRCINF 00152
C          ----- SRCINF 00153
C ... IF K(V) * OMEGA(V) = 0, W1(V) = K(V) SRCINF 00154
C          ----- SRCINF 00155
C          ELSE IF (WSRZ .EQ. CZERO) THEN SRCINF 00156
C          W1X = CZERO SRCINF 00157
C          W1Y = CZERO SRCINF 00158
C          W1Z = CONE SRCINF 00159
C          ----- SRCINF 00160
C ... OTHERWISE, W1(V) = +OR- K(V) X OMEGA(V) SRCINF 00161
C          ----- SRCINF 00162
C          ELSE SRCINF 00163
C          W1Z = CZERO SRCINF 00164
C          W1X = CONE/SQRT(CONE + (WSRX/WSRY)**2) SRCINF 00165
C          W1Y = -W1X*WSRX/WSRY SRCINF 00166
C          END IF SRCINF 00167
C          ELSE SRCINF 00168
C          XNRM = SQRT(XNRM) SRCINF 00169
C          W1X = W1X/XNRM SRCINF 00170
C          W1Y = W1Y/XNRM SRCINF 00171
C          W1Z = W1Z/XNRM SRCINF 00172
C          END IF SRCINF 00173
C          SRCINF 00174
C          W2X = WSRY*W1Z - WSRZ*W1Y SRCINF 00175
C          W2Y = WSRZ*W1X - WSRX*W1Z SRCINF 00176
C          W2Z = WSRX*W1Y - WSRY*W1X SRCINF 00177
C          XSR = XSR + CT1EM7*WSRX SRCINF 00178
C          YSR = YSR + CT1EM7*WSRY SRCINF 00179
C          ZSR = ZSR + CT1EM7*WSRZ SRCINF 00180
C          IF (SORCIN .EQ. CZERO) THEN SRCINF 00181
C          XSR = XSR+CT1EM7*W1X SRCINF 00182
C          YSR = YSR+CT1EM7*W1Y SRCINF 00183
C          ZSR = ZSR+CT1EM7*W1Z SRCINF 00184
C          END IF SRCINF 00185
C          END IF
C
IF(IDOME.EQ.0) THEN
IF (ICTH .EQ. 1) THEN
WRITE(IOUT,(' 'OMONODIRECTIONAL SOURCE IN REFERENCE ' ',
$          ' ' DIRECTION ' '))
ELSE IF (ICTH .EQ. 2) THEN
WRITE(IOUT,(' 'OISOTROPIC SOURCE TRUNCATED AT ' ',G11.4,
$          ' ' DEGREES WITH RESPECT TO REFERENCE DIRECTION ' ')) CTHIN
CTHIN = COS(CTHIN/C180PI)

```

New
code

New
code

	ELSE	SRCINF	00195
	WRITE(IOUT,(''0COSINE-LAW SOURCE TRUNCATED AT '',G11.4,	SRCINF	00196
	\$ '' DEGREES WITH RESPECT TO REFERENCE DIRECTION'')) CTHIN	SRCINF	00197
	CTHIN = COS(CTHIN/C180PI)**2	SRCINF	00198
	END IF	SRCINF	00199
	END IF		
C	IF (NB .LE. 0) NB = 10	SRCINF	00200
	IF (IMAX .LT. NB) IMAX = NB	SRCINF	00201
	IMAX = IMAX/NB	SRCINF	00202
		SRCINF	00203
C	IF ((IBT .NE. 0) .AND. (IMAX .NE. IMXOLD)) THEN	SRCINF	00204
C	...	SRCINF	00205
C	BATCH SIZES INCONSISTENT ON RESTART - TERMINATE RUN	SRCINF	00206
C	WRITE(IOUT,(''0*** FATAL ERROR ON ATTEMPTED RESTART ***'/	SRCINF	00207
	\$ '' NEW BATCH SIZE = '',I10,' ' DOESNT EQUAL OLD BATCH SIZE = ''	SRCINF	00208
	\$ I10/' ' BATCH SIZES MUST MATCH TO CORRECTLY ACCUMULATE'',	SRCINF	00209
	\$ '' STATISTICS'')'') IMAX, IMXOLD	SRCINF	00210
C	CALL ABORTX('SRCINF')	SRCINF	00211
C	-----	SRCINF	00212
C	END IF	SRCINF	00213
		SRCINF	00214
C	NB = NB + IBT	SRCINF	00215
	WRITE(IOUT,(''0THE STANDARD ERROR ESTIMATES ARE BASED ON '',I5,	SRCINF	00216
	\$ '' BATCHES OF '',I7,' ' HISTORIES EACH'')) NB,IMAX	SRCINF	00217
C	RETURN	SRCINF	00218
C		SRCINF	00219
C	END	SRCINF	00220
		SRCINF	00221
		SRCINF	00222
		SRCINF	00223
		SRCINF	00224
		SRCINF	00225

New
code

C	SUBROUTINE HIST	HIST	00007
C	*****	HIST	00009
C		HIST	00010
C	SUBROUTINE HIST IS CALLED BY	HIST	00011
C	ITS	HIST	00012
C	SUBROUTINE HIST CALLS	HIST	00013
C	INTRINSIC FUNCTIONS	HIST	00014
C	SQRT, RANF	HIST	00015
C	REAL (CYLTRAN)	HIST	00016
C	EXTERNAL FUNCTIONS	HIST	00017
C	CLASS, ECROS, EHIST, TIMER, PHIST	HIST	00018
C	RANINT, RANSAV	HIST	00019
C	ZONE (CYLTRAN)	HIST	00020
C	FOLD, ZONEA (ACCEPT)	HIST	00021
C	PLTDAT (M-CODES)	HIST	00022
C		HIST	00023
C	ORIGINATION DATE 16 JAN 68.	HIST	00024
C	LAST MODIFIED 30 MAY 91	HIST	00025
C		HIST	00026
C	FUNCTION	HIST	00027
C	THIS PROGRAM SAMPLES PHASE SPACE PARAMETERS FOR	HIST	00028
C	SOURCE PARTICLES. SUBSEQUENTLY CALLS EITHER EHIST OR	HIST	00029
C	PHIST. RETRIEVES "BANKED" ELECTRONS AND CALLS EHIST.	HIST	00030
C	TALLIES PULSE HEIGHT DISTRIBUTION.	HIST	00031
C		HIST	00032
C	*****	HIST	00033
C	*** COMMON BLOCKS CNSTNT, PARAMS, OUT, CALC, XPED, STOR, STTS,	HIST	00034
C	(PAREM) -ACCEPT	HIST	00035
C	CS LIST(S=0)	HIST	00036
C	CDIR\$ NOLIST	HIST	00037

No changes in CNSTNT common block - listing, omitted for brevity, is identical to that given in Reference 1.

C		PARAMS	00002
C	-----	PARAMS	00003

PARAMS common block identical to that shown in subroutine INPUT listed in Appendix 2.

COMMON /EXTSORC/ IRECTS, IDISKS, XLOWS, XHIGHS, YLOWS, YHIGHS, ZLOWS,		
\$ ZHIGHS, XCENT, YCENT, ZCENT, XCIR, YCIR, ZCIR, KPERPYZ, KPREPXZ, KPERDYZ,		
\$ IDOME, RDOME		
LOGICAL RRKILL, FLMTL	OUT	00002
COMMON /OUT/	OUT	00003
1 FLMTL (INGP)	OUT	00004

**New
code**

No changes in OUT common block - listing, omitted for brevity, is identical to that given in Reference 1.

C		CALC	00002
C	COMMON /CALC/	CALC	00003
C	1 ACON (INMT), ASTEP (INMAX, INMT), AT (NSURV, INMT),	CALC	00004

No changes in CALC common block - listing, , omitted for brevity, is identical to that given in Reference 1.

C		CALC	00139
C		XPED	00002
C	COMMON /XPED/	XPED	00003
C	1 DETOUR (INMT), RHO (INMT), MT, MTP, MTP0	XPED	00010
C		XPED	00012
C	LOGICAL DMPFLG, FLMC	STTS	00002
C	DOUBLE PRECISION IRSV	STTS	00010
C	COMMON /STTS/ IB, NB, NSORS, IET, BOLD, BATCH, KPUTMX, DMPFLG	STTS	00017
C	\$, IHIST, IRSV, KPUT, FLMC	STTS	00018
C		STTS	00019
C		PAREM	00002
C	CHARACTER*3 OTYPE(10), OBODY	PAREM	00003
C	LOGICAL FLDBG, FLDBGL	PAREM	00004
C	COMMON /PAREM/	PAREM	00008
C	\$ XB(3), WT(3), RIN, ROUT, PINF, DIST, IR,	PAREM	00009
C	\$ FLDBG, IRPRIM, ICALL, LSURF, NBO, LRI, LRO,	PAREM	00013
C	\$ KLOOP, LOOP, ITYPE, FLDBGL	PAREM	00014

C	COMMON /PAREMO/ OTYPE	PAREM	00015
C		PAREM	00016
	COMMON /HITS/EDPR(10),EDNK(10),EDSC(10),EDTL(10),LHCL(10),NINDV		
C\$	LIST(S=1)	HIST	00047
C DIR\$	LIST	HIST	00048
	COMMON /STOR/	STOR	00002
	1 CTHS(NLAST), TS(NLAST), WS(NLAST), ZS(NLAST), IPRS(NLAST),	STOR	00003
	2 LBS(NLAST), NTS(NLAST)	STOR	00004
	\$,XS(NLAST), YS(NLAST), STHS(NLAST),	STOR	00006
	3 CPHS(NLAST), SPHS(NLAST)	STOR	00007
	4 ,LBCS(NLAST)	STOR	00009
C		HIST	00050
	EXTERNAL RAN	RANNUM	00003
C		HIST	00089
	CIMAX = IMAX	HIST	00090
	IF (FLSPEC) THEN	HIST	00091
	TAV = CZERO	HIST	00092
	ELSE	HIST	00093
	TAV = CIMAX*TIN	HIST	00094
	END IF	HIST	00095
C		HIST	00096
	CALL RANINT(IRA)	HIST	00097
C		HIST	00098
	IF (IB .EQ. 1) INRAN = IRA	HIST	00101
	DO 130 I = 1, IMAX	HIST	00103
	DO 1301 JJJ=1,10		
	EDPR(JJJ)=0.		
	EDNK(JJJ)=0.		
	EDSC(JJJ)=0.		
1301	EDTL(JJJ)=0.		
	IHIST = I	HIST	00104
	MODTMJ = MIN(100,IMAX)	LAHEY	00017
	IF (I.EQ.MODTMJ*(I/MODTMJ)) THEN	LAHEY	00018
	CALL TOTTIM(XTMJ)	LAHEY	00019
	WRITE(*, '(/' ' HISTORY' ',I8,' ', ELAPSED MINUTES' ',F10.2)')	LAHEY	00020
	1I,XTMJ/60.	LAHEY	00021
	ENDIF	LAHEY	00022
	W = CONE	HIST	00105
	CWCF = W	HIST	00106
	LAST = 0	HIST	00107
C		HIST	00108
	CALL RANSAV(IRSAV)	HIST	00109
C		HIST	00110
C		HIST	00111
C		HIST	00112
C	... SOURCE ENERGY	HIST	00113
C		HIST	00114
	IF (FLSPEC) THEN	HIST	00115
	RA = RAN(IRAN)	HIST	00116
	DO 14 JHIST = 2,JSPEC	HIST	00117
	IF (RA. GT. SPECIN(JHIST)) GO TO 16	HIST	00118
14	CONTINUE	HIST	00119
16	T = ESP(JHIST-1) + (RA -SPECIN(JHIST-1))*(ESP(JHIST)	HIST	00120
\$	- ESP(JHIST-1))/(SPECIN(JHIST) - SPECIN(JHIST-1))	HIST	00121
	TAV = TAV + T	HIST	00122
	IF ((FLESRC .AND. (T .GT. TCUT)) .OR.	HIST	00123
\$	(.NOT. FLESRC .AND. (T .GT. TPCUT)) THEN	HIST	00124
	GO TO 20	HIST	00125
	ELSE	HIST	00126
	NTREJ = NTREJ + 1	HIST	00127
	TREJ = TREJ + W*T	HIST	00128
	GO TO 1299	HIST	00129
	END IF	HIST	00130
	END IF	HIST	00131
	T = TIN	HIST	00132
20	NT = NTFST	HIST	00133
C		HIST	00134
	CALL CLASS (T,NT)	HIST	00135
C		HIST	00136
	IF (IDOME.EQ.0) THEN		
C		HIST	00137

New
code

C ... SOURCE DIRECTION	HIST	00138
C -----	HIST	00139
IF (ICTH .EQ. 2) THEN	HIST	00140
RA = RAN(IRAN)	HIST	00141
COM = CTHIN+ RA*(CONE-CTHIN)	HIST	00142
ELSE IF (ICTH .EQ. 3) THEN	HIST	00143
RA = RAN(IRAN)	HIST	00144
COM = SQRT(CTHIN+RA*(CONE-CTHIN))	HIST	00145
ELSE IF (ICTH .EQ. 1) THEN	HIST	00146
CTH(1) = CTSR	HIST	00147
STH(1) = STSR	HIST	00149
CPH(1) = CPSR	HIST	00150
SPH(1) = SPSR	HIST	00151
GO TO 69	HIST	00153
END IF	HIST	00154
C	HIST	00155
IF (CTSR .EQ. CONE) THEN	HIST	00156
CTH(1) = COM	HIST	00157
STH(1) = SQRT(CONE-COM*COM)	HIST	00159
RA = RAN(IRAN)	HIST	00160
JAZ = RA*C360	HIST	00161
CPH(1) = CCH(JAZ+1)	HIST	00162
SPH(1) = SCH(JAZ+1)	HIST	00163
ELSE	HIST	00165
C	HIST	00172
CALL FOLD(CTSR,STSR,CPSR,SPSR,COM,CTH(1),STH(1),CPH(1),SPH(1))	HIST	00173
C -----	HIST	00174
END IF	HIST	00176
C	HIST	00177
C ... SOURCE POSITION	HIST	00178
C -----	HIST	00179
69 IF (SORCIN .NE. CZERO) THEN	HIST	00198
RA = RAN(IRAN)	HIST	00199
R = SQRT(RA)*SORCIN	HIST	00200
RA = RAN(IRAN)	HIST	00201
JAZ = RA*C360	HIST	00202
SCHR = SCH(JAZ+1)*R	HIST	00203
CCHR = CCH(JAZ+1)*R	HIST	00204
IF (IDISKS .EQ. 0) THEN		
X = XSR + CCHR*W1X+SCHR*W2X		
Y = YSR+CCHR*W1Y+SCHR*W2Y		
Z = ZSR+CCHR*W1Z+SCHR*W2Z		
ELSE		
IF (KPERPXY.EQ.1) THEN		
X = XCENT + CCHR		
Y = YCENT + SCHR		
Z = ZCENT		
END IF		
IF (KPERPXZ.EQ.1) THEN		
X = XCENT + CCHR		
Y = YCENT		
Z = ZCENT + SCHR		
END IF		
IF (KPERPYZ.EQ.1) THEN		
X = XCENT		
Y = YCENT + CCHR		
Z = ZCENT + SCHR		
END IF		
END IF		
ELSE		
IF (IRECTS .EQ. 0 .AND. IDOME.EQ.0) THEN	HIST	00208
X = XSR	HIST	00209
Y = YSR	HIST	00210
Z = ZSR	HIST	00211

New
code

New
code

```

ELSE
  IF (IRECTS.NE.0) THEN

    RRAA1 = RAN (IRAN)
    RRAA2 = RAN (IRAN)

    IF (KPERPXY .EQ. 1) THEN
      X = XLOWS + RRAA1*(XHIGHS-XLOWS)
      Y = YLOWS + RRAA2*(YHIGHS-YLOWS)
      Z = ZLOWS
    END IF

    IF (KPERPXZ. EQ. 1) THEN
      X = XLOWS + RRAA1*(XHIGHS-XLOWS)
      Y = YLOWS
      Z = ZLOWS + RRAA2*(ZHIGHS-ZLOWS)
    END IF

    IF (KPERPYZ .EQ.1) THEN
      X = XLOWS
      Y = YLOWS + RRAA1*(YHIGHS-YLOWS)
      Z = ZLOWS + RRAA2*(ZHIGHS-ZLOWS)
    END IF
  END IF
  IF (IDOME.NE.0) THEN
    STHDM=RAN (IRAN)

```

106

```

    CTHDM=SQRT (1.-STHDM*STHDM)
    PPHDM=C2PI*RAN (IRAN)
    CPPHDM=COS (PPHDM)
    SPPHDM=SIN (PPHDM)
    ALDM=STHDM*CPPHDM
    BTDM=STHDM*SPPHDM
    X=RDOME*ALDM
    Y=RDOME*BTDM
    Z=RDOME*CTHDM
    PHSDM=C2PI*RAN (IRAN)
    CTHSDM=2.*RAN (IRAN) -1.
    STHSDM=SQRT (1.-CTHSDM*CTHSDM)
    SPHSDM=SIN (PHSDM)
    CPHSDM=COS (PHSDM)
    UUUD=STHSDM*CPHSDM
    VVVD=STHSDM*SPHSDM
    WWWD=CTHSDM
    AAAD=SQRT (UUUD**2+VVVD**2+WWWD**2)
    UUUD=UUUD/AAAD
    VVVD=VVVD/AAAD
    WWWD=WWWD/AAAD
    PRODD=ALDM*UUUD+BTDM*VVVD+CTHDM*WWWD
    IF (PRODD.GT.0.0) GO TO 106
    STH(1)=STHSDM
    CTH(1)=CTHSDM
    SPH(1)=SPHSDM
    CPH(1)=CPHSDM
  END IF
END IF

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New
code

```

C      END IF
      XB(1) = X
      XB(2) = Y
      XB(3) = Z
      WT(1) = STH(1)*CPH(1)
      WT(2) = STH(1)*SPH(1)
      WT(3) = CTH(1)
C
C      CALL ZONEA
C      -----
      LB = IR

```

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HIST      00212
HIST      00213
HIST      00220
HIST      00221
HIST      00222
HIST      00223
HIST      00224
HIST      00225
HIST      00226
HIST      00227
HIST      00228
HIST      00229

```

LBCZ = IRPRIM	HIST	00230
IPR = 1	HIST	00232
C	HIST	00233
C	HIST	00234
C ... CALL TRACKING ROUTINES	HIST	00235
C	HIST	00236
70 IF (FLESRC .OR. (IPR .NE. 1)) THEN	HIST	00237
C	HIST	00238
C ... PARTICLE TO BE TRACKED IS AN ELECTRON	HIST	00239
C	HIST	00240
IF (MT .NE. MAT(LB)) THEN	HIST	00241
MT = MAT(LB)	HIST	00242
END IF	HIST	00248
C	HIST	00249
CALL EHIST	HIST	00250
C	HIST	00251
ELSE	HIST	00252
C	HIST	00253
C ... PARTICLE TO BE TRACKED IS A PHOTON	HIST	00254
C	HIST	00255
LPCZ = LBCZ	HIST	00262
C	HIST	00265
CALL PHIST(X,Y,Z,LB,CTH(1),STH(1),CPH(1),SPH(1),T,W,1)	HIST	00266
C	HIST	00267
END IF	HIST	00269
C	HIST	00270
C	HIST	00271
C ... REMOVE SECONDARY ELECTRONS FROM STORAGE FOR TRANSPORT	HIST	00272
C	HIST	00273
IF (LAST .NE. 0) THEN	HIST	00274
LB = LBS(LAST)	HIST	00275
Z = ZS(LAST)	HIST	00276
T = TS(LAST)	HIST	00277
NT = NTS(LAST)	HIST	00278
CTH(1) = CTHS(LAST)	HIST	00279
W = WS(LAST)	HIST	00280
IPR = IPRS(LAST)	HIST	00281
C	HIST	00283
X = XS(LAST)	HIST	00284
Y = YS(LAST)	HIST	00285
STH(1) = STHS(LAST)	HIST	00286
CPH(1) = CPHS(LAST)	HIST	00287
SPH(1) = SPHS(LAST)	HIST	00288
C	HIST	00289
LBCZ = LBCS(LAST)	HIST	00291
KLOOP = KLOOP+1	HIST	00292
LAST = LAST-1	HIST	00294
GO TO 70	HIST	00295
END IF	HIST	00296
C	HIST	00297
IF (.NOT. FLPHD) GO TO 1299	HIST	00298
C	HIST	00299
C	HIST	00300
C ... SCORE PULSE-HEIGHT DISTRIBUTION	HIST	00301
C	HIST	00302
EABST = CZERO	HIST	00303
DO 100 LS=LPHDB,LPHDE	HIST	00304
EABST = EABST+PHDD(LS)	HIST	00305
100 PHDD(LS) = CZERO	HIST	00306
DO 110 JS=1,JSMAX	HIST	00307
IF(SMARK(JS) .LE. EABST) GO TO 120	HIST	00308
110 CONTINUE	HIST	00309
NPHD = NPHD+1	HIST	00310
GO TO 1299	HIST	00311
120 ABE(JS) = ABE(JS)+CWC	HIST	00312
1299 IF(NINDV.EQ.0)GO TO 130		
DO 1298 NIND=1,NINDV		
EDTL(NIND)=EDPR(NIND)+EDNK(NIND)+EDSC(NIND)		
1298 CONTINUE		
WRITE(44) (EDPR(NIND),EDNK(NIND),EDSC(NIND),EDTL(NIND),NIND		
\$ =1,NINDV)		
130 CONTINUE	HIST	00313
C	HIST	00314
CALL RANSAV(IRC)	HIST	00315
C	HIST	00316
RETURN	HIST	00317
END	HIST	00318

APPENDIX 8