APPENDIX D

The UCNtransport Code and UCNA Geometries

UCNtransport is a general purpose Monte Carlo UCN transport code which was written to allow the relatively straightforward creation and modification of non-trivial geometries. It provides for propagation through bulk media and static longitudinal magnetic fields which may be reasonably approximated by constant gradients, and while its current implementation propagates UCN by solving for the intersection of ballistic trajectories with the geometry, it is designed to straightforwardly accept a drop-in integrator for use in regions possessing complicated magnetic fields, complex interactions with bulk matter, or which require spin transport. In this appendix, a basic user's manual is provided which introduces the main features of UCNtransport, a function/variable list is provided, and examples of geometry files for the crossed polarizer analyzer and UCNA geometries are given. Note also that there is a version of UCNtransport which is compiled with a small number of ROOT libraries so that the output events file is written to a TTree rather than a text file as an aid for analysis.

D.1 Basics of Using UCNtransport

UCNtransport uses two text files to specify a geometry: a *regions* file which specifies the physical properties of elements (or *regions*) of the geometry (e.g. a guide section with uniform properties or a foil) and a *connections* file which specifies the topology of the geometry (i.e. how the various regions are interconnected). A region can be a cylinder or box (although additional shapes are relatively easy to implement) with a specified *basepoint* at one end and a *cut-plane* associated with that basepoint which specifies the angle at which the base end of each region is cut so that it joins properly with the adjoining region. (The far end of a region automatically conforms to the cut-plane of the region connected to it.) Cut-planes define the longitudinal boundaries of any region and become especially important in the case of differently oriented regions as shown in Fig. D.1.

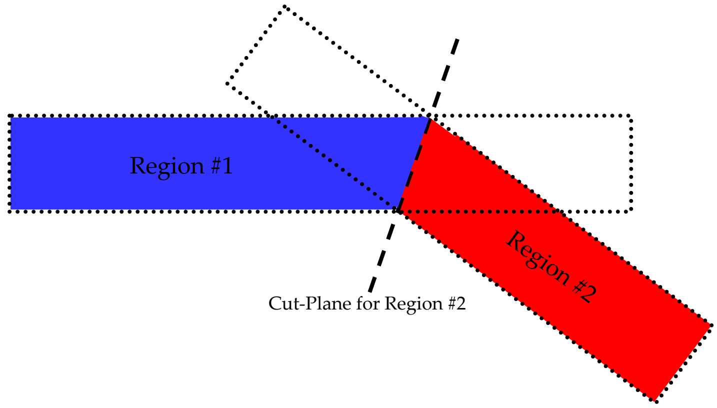

Figure D.1: The manner in which two regions with different orientations are joined using a cut-plane.

D.1.1 Options/Format for the 'regions' File:

The basic structure of a regions file was presented in Chap. 4. What follows is a more complete description of the various entries. Note that the UCNtransport global coordinate system is oriented so that $+z \implies$ the horizontal main beam direction ("downstream") and $+y \implies$ the (upward) vertical direction. Also note that the regions file must be terminated with a line containing only '/'. It is also important that no empty lines be placed between entries.

Reg#: This is simply the unique number for the particular region defined. The first region should be called 0. Regions that connect end-to-end using the '*' basepoint signal (see below) must always have sequential region numbers.

RType: The type of region being defined:

$1 \rightarrow$ Box
$2 \rightarrow$ Cylinder

Note that while two connected cylinder-regions may have differing orientations, two connected box-regions as well as a connection between a box- and cylinder-region should NOT have different orientations. (An ERROR message will be output to the console, but the geometry will still be run.) Also, there is currently no error-trapping for attempting to connect same-type regions with different sizes and the same orientation. The program automatically handles box-cylinder and cylinder-box connections by assuming a lip whose material properties are associated with the region on whose cut-plane the lip exists, but for same-type connections with different sizes special handling code 5 (see connections file format below) must be utilized for the cut-plane separating the regions.

BP(x,y,z): The global coordinate of the center of the region's cut-plane. (A region's cut-plane is always defined at its upstream side.) An entry of '*' should be used for regions which are connected to the (downstream) end (i.e. opposite side from cut-plane) of the previous region. When defining a geometry that includes T's, define a set of regions that form a contiguous path from region zero to an end region using * entries, then explicitly specify a new basepoint and define another contiguous path using * entries. Continue until all contiguous sections are defined. Then, to indicate the interconnections (besides using a correct 'connections' file) do the following (see the geometries at the end of this appendix for examples):

1) For each set of contiguous regions which ENDS in the side of another region, replace the '*' for the last region's basepoint with a '<'. This indicates that that region terminates in the side of some other part of the geometry.

2) For a set of contiguous regions which BEGINS in the side of some region, place a '>' in front (no space) of the entered basepoint. This indicates that the basepoint is the beginning of a new set of contiguous regions which starts in the side of some other part of the geometry.

Notes:
(1) The program uses a box-region's y-dim to calculate the basepoint offset when a box-region is T'ed into a cylinder region, which should be kept in mind when defining the orientation of box regions in such circumstances!

(2) Region 0 should always be given a base point.

(3) Coordinates are in meters.

Dim: For a box this should be 'xlength,ylength,zlength'. For a cylinder this should be 'diameter,length', where 'length' is the distance from the center of the region's cut-plane. All distances should be in meters.

Orient: This specifies the three angles which define the orientation of a region. The format is 'ψ, θ, ϕ' where the rotations are as follows:

1) Rotation around global y-axis through ψ. (The global y-axis points up.)
2) Rotation through θ around the direction of the global x-axis rotated as in 1).
3) Rotation through ϕ around the direction of the global z-axis rotated as in 1).

The angles should be in DEGREES. Note that the rotations are carried out in the order specified. Physically, ψ allows you to change the orientation of a region in a plane parallel to the floor. θ allows the beam direction to be aimed up towards the ceiling or down towards the floor. ψ then allows for rotations of the resulting geometry about the horizontal beam axis (i.e. +z-direction after the ψ rotation but before the θ rotation). Note that the signs of the angles are via the RHR so that, for example, a positive θ will aim the +z-axis towards the floor. Also note that if a region with a non-zero ϕ orientation is connected to a straight section (i.e. a region with θ equal to zero), the straight section should be given the ϕ orientation of the previous region. (Subsequent straight sections may then have ϕ equal to zero.)

Grad B: This specifies (constant) magnetic field gradients in a region of non-zero LONGITUDINAL (only) magnetic field. The format is '$\mathrm{d}B/\mathrm{d}x, \mathrm{d}B/\mathrm{d}y, \mathrm{d}B/\mathrm{d}z$', where the directions (x, y, z) are such that they would coincide with the global coordinate system if the region orientation were $\psi = 0, \theta = 0, \phi = 0$ (i.e. the magnetic field gradients are to be defined relative to the region with z representing the longitudinal direction). Units should be T/m. Note that gravity is automatically included in the -y (global) direction.

Spec: The specularity for the inner surface of the region.

Loss: Value of the loss-per-bounce probability for the inner surface of the region or, depending on loss model (see below), the imaginary component of the Fermi potential.

Depol: Value of the depolarization probability for the inner surface of the region.

WPot: Value of the Fermi potential for the surface of the region (i.e. the walls), which should be in neV.

BPot: Value of the Fermi potential for any bulk medium in the region, which should be in neV. Note that for scattering off the surface of a bulk medium, the wall values (i.e. spec, SM, LM, losspb, DM, surf/scat, depol) for that region are used.

Surf/Scat: Allows the specification of a surface parameter (e.g. a coating thickness, roughness parameter, or correlation length) OR the input of a mean free path (in meters) for the case of scattering in a bulk medium.

Absorb: The probability of absorption due to interaction with a medium is calculated as $1 - e^{-aT}$ where T is the time of a time step along the particle's trajectory in the medium and a, which is specified by this entry, is an attenuation parameter related to the usual macroscopic cross section

$$\text{absorption cross section} \times \text{speed} \times \text{particle number density of medium.}$$

Since for UCN $\sigma_\mathrm{a} \propto 1/v$, $a = n\sigma_0 v_0$ where n is the number density and σ_0 is the neutron absorption cross section at a reference speed v_0.

Det: Indicates a region which corresponds to a detector:

0 $\rightarrow$ Not a detector region
$\rightarrow$ The region corresponds to detector number

Any particle absorbed in a region designated as a detector region will cause a count to be added to the timing histogram for that detector. At the end of a simulation a text file will be written out containing the timing histogram for all defined detectors.

PM: Indicates which propagation mode to use for bulk media:

- 0 $\rightarrow$ Medium has a Fermi potential as specified in BPot.
- 1 $\rightarrow$ Absorbing Medium... used for absorption in detectors and deuterium.
- 2 $\rightarrow$ Propagation through a foil... uses transmission formula which includes incoherent sum of reflections from inner surfaces, Eq. (2.18). NB: For thin foils the Fermi potential for the foil is the potential specified in BPot, of course, but it is assumed that there is vacuum on either side of the foil.
- 3 $\rightarrow$ Bulk Medium which scatters particles... scattering is assumed elastic and isotropic with a mean free path defined in 'Surf/Scat'.
- 4 $\rightarrow$ Bulk Medium with scattering and absorption.
- 5 $\rightarrow$ Trajectory tracking for the region is turned on so that each particle's dynamical information is recorded at a fixed interval set in the header (rather than only when it intersects with the geometry). It is generally advisable to enable trajectory tracking for a small number of regions only since otherwise the events file can become very large.

SM: Indicates which scattering model to use in the region:

- 0 $\rightarrow$ Specified probability of specular bounce, diffuse surface reflection ($\cos\theta \sin\theta \, d\theta$) for non-specular bounce.
- 1 $\rightarrow$ Probability of a non-specular bounce is (1-spec) weighted by the cos of the angle between the incident velocity and local normal. Outgoing distribution after a non-specular bounce is $\cos^2\theta \sin\theta \, d\theta$ for the polar angle and random for the azimuthal angle.
- 2 $\rightarrow$ User defined.

LM: Indicates which model to use in determining whether a particle is lost during a wall collision:

- 0 $\rightarrow$ Specified probability of wall loss, no energy dependence.
- 1 $\rightarrow$ Energy dependent loss-per-bounce (see Eq. (2.12)).
- 2 $\rightarrow$ Energy and angle dependent wall loss using an imaginary wall potential and the Morozov formula from [37], which is just Eq. (2.9). The value of the imaginary potential is obtained from the loss-per-bounce entry.

DM: Indicates which model to use in determining whether a particle is depolarized during a wall collision:

0 → Specified probability of depolarization.
1 → User defined.

D.1.2 Format for the 'connections' File:

In each line of the connections file the first entry is a region number and subsequent entries are the region numbers to which it is connected. The connection list must be entered in such a way that the FIRST connection indicated for a region is the connection through the current region's cut-plane. Region 0 (the starting region) is an exception since there is no region connected to it through its cut-plane and the first entry in region 0's connection list should be 0. (Note that a special-handling instruction must always be given indicating how region 0's cut-plane should be treated.) Place a '/' in the first empty connection column. For each region, specify ALL connections. If a cut-plane requires special handling (e.g. part of it needs to be a reflective surface or there is a spin-flip resonance there), put a comma immediately (no spaces) after the cut-plane's region number in the first column of the connections file followed by a (no spaces) special handling instruction identifier number. For example:

```
2,#  1  3  /
```

would indicate that the cut-plane ASSOCIATED WITH REGION 2 (and which sits between region 2 and region 1) needs to be handled specially. For three guides connected end-to-end, for example, the connections file would be:

```
0,1  0  1  /
 1   0  2  /
 2   1  /
```

Pre-programmed special handling codes are:

1 → Cut-plane is 100% absorptive
2 → Special-handling instruction which allows the input of a value which will be associated with the cut-plane. For example, '5 4,2(38) 6' would associate the value 38 with region 5's cut-plane. Note the different location of the special handling instruction for this particular code.
3 → Cut-plane represents a spin-flip resonance. Spin-flip efficiencies are defined in the handling routine.
4 → Cut-plane is a monitoring detector (i.e. it doesn't absorb the particle) which records angular distributions.
5 → Cut-plane separates two dissimilar-sized same-type guides where there is a lip. The lip is taken to have the same material properties as the cut-plane's region.

D.1.3 Batch Mode:

Batch mode is turned on with a flag in the header and allows any number of batches to be run with each batch containing any number of simulation runs. A specified set of geometry files is read in at the beginning of each batch mode so that geometry changes may be implemented at the batch level. Each simulation run in a batch allows one physics parameter to be changed. Note that the changed parameter is returned to the original value before the next simulation is run. The physics parameter to be changed is specified by one of the following (case-sensitive) codes:

gradBx, gradBy, gradBz, spec, loss, depol, wpot, bpot, scat, abs, PM, SM, LM, DM

In batch mode an additional output file is created for each batch which contains the integrated counts in each real detector for each simulation in the batch. The format for a batch file is as follows:

```
Number of BATCHES to run:
2

--------------------------------------------------
Number of simulations this batch:
1

Geometry files this batch (regions connex):
regionsck connexck

Integrated counts filename for this batch:
counts1.sim

start region  |  end region  |  events filename  |  detectors filename  |  parameter name  |  parameter value
     2              4          events1_1.sim       detectors1_1.sim         spec              0.5
---------------------------------------------------
Number of simulations this batch:
2

Geometry files this batch (regions connex):
regionsck connexck

Integrated counts filename for this batch:
counts2.sim

start region  |  end region  |  events filename  |  detectors filename  |  parameter name  |  parameter value
     3              4          events2_1.sim       detectors2_1.sim         spec              0.8
     1              1          events2_2.sim       detectors2_2.sim         spec              1.0
----------------------------------------------------
```

where the ’————–’ lines must be present to separate batches, but the number of ’-”s is not important, the ’integrated counts filename’, ’events filename’, and ’detectors filename’ can be anything you wish, and ’parameter name’ should be one of the code names above. The ’start region’ and ’end region’ designations indicate the range of regions for which the parameter change is implemented.

D.2 UCNtransport Functions and Variables

Variables:

regions Holds the geometry information for each region.

0 $\rightarrow$ surface type

1 $\rightarrow$ Dim x or Diameter
2 $\rightarrow$ Dim y or Length
3 $\rightarrow$ Dim z
4 $\rightarrow$ θ orientation of the region in RADIANS
5 $\rightarrow$ ϕ orientation in RADIANS
6 $\rightarrow$ ψ orientation in RADIANS

basepoints Holds each region's basepoint.

0 $\rightarrow$ bpx
1 $\rightarrow$ bpy
2 $\rightarrow$ bpz

cplanes Holds the orientation and special-handling information for each cut-plane. A cut-plane with $\theta = 0$ and $\phi = 0$ is defined to be perpendicular to the z-axis.

0 $\rightarrow$ θ orientation of cut-plane [RADIANS]
1 $\rightarrow$ ϕ orientation [RADIANS]
2 $\rightarrow$ special handling code
3 $\rightarrow$ special-handling code 2 value
4 $\rightarrow$ internal special handling code
5 $\rightarrow$ T Cut-plane offset
6 $\rightarrow$ region-shift Flag
7 $\rightarrow$ ψ orientation [RADIANS]

Where the region-shift flags are:

0 $\rightarrow$ Region has not been changed
-1 $\rightarrow$ Region has been shrunk
1 $\rightarrow$ Region has been expanded

and the internal special handling codes are:

0 $\rightarrow$ No internal special handling
1 $\rightarrow$ Cylinder region - Box region connection
2 $\rightarrow$ The region is T'ed into (i.e. a region connects into its side)
3 $\rightarrow$ The region T's into another region, BEGINNING in the side of a contiguous section
4 $\rightarrow$ The region T's into another region, ENDING in the side of a contiguous section

rparams Holds the physics parameters for each region.

0 $\rightarrow$ $\mathrm{d}B/\mathrm{d}x$

1 → dB/dy
2 → dB/dz
3 → Spec
4 → Losspb
5 → Depol
6 → Wall Potential
7 → Bulk Potential
8 → Surf/Scatt
9 → Absorption
10 → Det
11 → Prop Mode
12 → Scatt Model
13 → Loss Model
14 → Depol Model
15 → open slot for future

connex Holds the region connection information. For each region (first slot), the array holds up to six regions that are connected to it. A '-1' is placed in the first empty slot.

***struct* particle** This structure holds all the dynamical information about a particular particle:

double t → time
double x → global x coordinate
double y → global y coordinate
double z → global z coordinate
double v_x → x-component of velocity (relative to global coordinate system)
double v_y → y-component of velocity (relative to global coordinate system)
double v_z → z-component of velocity (relative to global coordinate system)
double spin[3] → Three components of a UNIT VECTOR pointing in the direction of the particle's spin (relative to global coordinate system).
int region → Region number in which particle currently resides
int xcode → This variable is set to -1 if the current intersection of the particle is with the current region. It is set to -2 if the particle has no current intersection (i.e. it is being propagated through a complex magnetic field). If the current intersection is with a cut-plane then this is set to the region number associated with the cut-plane.
int num → Particle number

Functions:

simexec Executes the main simulation logic. It allows file names for the three output files (*events*, *detectors*, and *bounces*) to be specified. The events file contains an entry for each event (see the 'event' function below) which gives the particle's dynamical information along with other event-specific information. The detectors file gives timing histograms

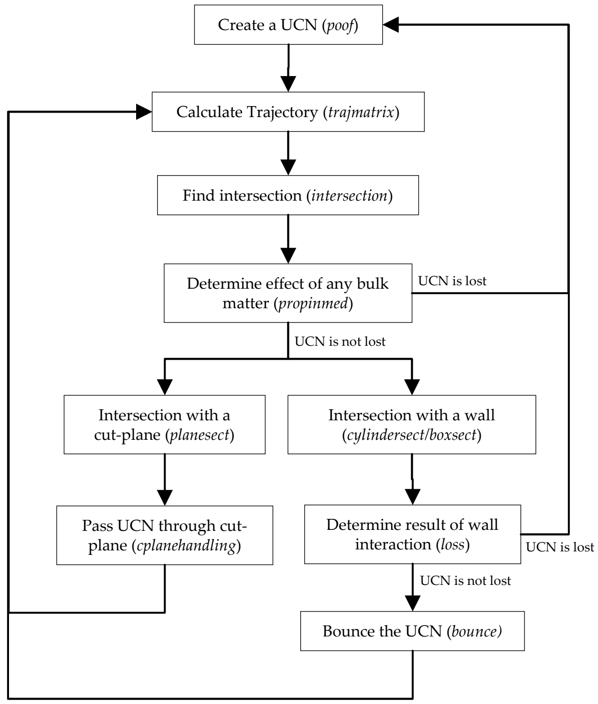

Figure D.2: Flowchart of the main simulation logic for UCNtransport.

for each defined detector region, and the bounces file is used to output summary information about bounces when bounce event reporting has been turned off to reduce the size of the events file. See Fig. D.2 for a flow chart of the main simulation logic.

geomread Fills the corresponding arrays from the regions and connections files, where the names of those files are specified in the function arguments.

geomprint Writes the above array values into a text file called 'geomout' for diagnostic purposes.

rota Rotates a vector in the following order:

1. Rotate by ψ around global y-axis
2. Rotate by θ around x-axis that would result by rotating global x-axis via 1
3. Rotate by ϕ around z-axis that would result by rotating global z-axis via 1

This carries out an ACTIVE rotation. This is also the INVERSE of the associated passive rotation.

rotp Rotates the global coordinate system in the following order:

1. Rotate by ψ around global y-axis
2. Rotate by θ around the x-axis resulting from 1
3. Rotate by ϕ around z-axis which resulted after step 1 (and before step 2)

This carries out a PASSIVE rotation. This is also the INVERSE of the associated active rotation.

solve2 Finds the smallest non-zero real root of

$$at^2 + bt + c = 0.$$

solve4 Finds the smallest non-zero real root of

$$at^4 + bt^3 + ct^2 + dt + e = 0.$$

It uses the procedure in [3], which requires solution of an associated cubic equation.

newton Applies Newton's Method to a root of a polynomial of the form

$$t^4 + a_3 t^3 + a_2 t^2 + a_1 t + a_0 = 0.$$

This function is used to polish roots obtained from 'solve4' as well as to search for roots if 'solve4' fails.

solve3 Finds the real roots of a complex cubic polynomial of the form

$$ax^3 + bx^2 + cx + d = 0.$$

ccuberoot Calculates the complex cube root of a complex number, which is needed in the evaluation of 'solve3'.

grn Returns a random number in $[0, 1]$.

timezero Checks to see if a double-precision number is consistent with zero (i.e. within a certain range of zero) and if so sets the value exactly equal to zero. This function is used when a zero result is expected but roundoff error might have left a small residual value. (For example, any intersection time that is too small could be the result of roundoff error allowing the solvers to find the current intersection as a very small non-zero time solution.) The zero boundary set in 'timezero' typically corresponds to distances of less than an angstrom for particles with UCN-type speeds.

mathzero This function is exactly like 'timezero' except that the zero boundary is defined differently. This function is used for testing math parameters for zero consistency (e.g. for sign determination in 'solve4') rather than to eliminate solutions with times that are too small.

poof Creates a particle. The first two arguments are the following pieces of information:

Argument #1 → Region number in which to start the particle. NB: No error trapping for an undefined region.

Argument #2 → Particle will be created in a plane parallel to the region's cut-plane a distance into the region from the cut-plane given by this argument. Distance is in meters. NB: No error trapping for offsets longer than the region.

A third argument allows one to select from different speed distributions:

0 → A $v^2 \mathrm{d}v$ distribution of speeds with cutoff defined in header.

1 → A distribution (defined in the function) which needs to be evaluated via the Monte Carlo method.

A fourth argument allows one to select from different angular distributions:

0 → A $\cos\theta \sin\theta \, \mathrm{d}\theta$ distribution (appropriate for isotropic illumination of a plane) directed into 2π into the region.

1 → An isotropic distribution ($\sin\theta \, \mathrm{d}\theta \mathrm{d}\phi$) directed into 4π.

Note that for 4π starting distributions one must always specify some non-zero initial offset.

propagate Finds the smallest-time intersection of the particle's trajectory with the geometry (using 'intersection') and then updates the particle's dynamical variables, checks that the particle is still in the geometry, and writes trajectory events if tracking is turned ON (all via 'move').

move Updates the particle's position, velocity, and time. One of the function arguments specifies a checking code so that 'move' knows which geometry checks to perform:

0 → Ensure that particle has not left a region.

1 → Ensure that particle has not left a region AND check for a valid cut-plane intersection.

intersection Take the particle's current dynamical information and find the earliest-time intersection with any accessible region or cut-plane (using 'planesect', 'cylindersect', and 'boxsect'). It returns the elapsed time between the current location and the intersection.

trajmatrix Calculates the trajectory matrix

$$\begin{matrix} c_2^x & c_1^x & c_0^x \\ c_2^y & c_1^y & c_0^y \\ c_2^z & c_1^z & c_0^z \end{matrix}$$

for a particle, which encodes the particle's vector position equation $\boldsymbol{r} = \boldsymbol{c_2} t^2 + \boldsymbol{c_1} t + \boldsymbol{c_0}$ relative to the global coordinate system.

planesect Finds the intersection of a trajectory with accessible cut-planes. The function returns the elapsed time from starting point to intersection.

cplanehandling Takes care of handling cut-plane intersections. It passes, bounces, etc. the particle in accordance with the handling code.

boxsect Finds the intersection of a trajectory with accessible box regions. The function returns the elapsed time from starting point to intersection.

cylindersect Finds the intersection of a trajectory with accessible cylinder regions. The function returns the elapsed time from starting point to intersection.

bounce Performs a bounce based on the models and values specified for the region number. The function returns -1 on error, 1 for wall penetration, 2 for physical wall loss, and 0 otherwise. The third argument which is passed is a flag indicating whether calculated normals should be reversed. (This needs to be done when the intersection with a cut-plane is from outside the cut-plane's region.) The flag values are:

1 $\rightarrow$ Calculated normal is an INWARD NORMAL
-1 $\rightarrow$ Calculated normal is an OUTWARD NORMAL

nsbounce Calculates the results of a non-specular bounce based on the selected scattering model and sets the post-bounce particle velocity.

bouncetype Determines if a bounce is specular or non-specular.

loss Determines if a particle is lost during a wall collision.

depol Determines if a particle is depolarized during a collision and alters the spin as appropriate.

propinmed Handles propagation of a particle through a medium. Function arguments are the time to the next intersection point and the particle's trajectory matrix.

normal Calculates the (inward) normal vector to a point on a surface. For a cut-plane this normal will always be given into the region associated with the cut-plane.

gsys2bsys Transforms the components of a vector relative to the global coordinate system into a system with the $+x$-dir along the inward normal at the current point of intersection, the $+z$-dir in the longitudinal direction, and the $+y$-dir consistent with a right-handed coordinate system.

bsys2gsys Function that is the inverse of 'gsys2bsys'. Note that the definition of the axes perpendicular to the normal may change from intersection point to intersection point, so

’gsys2bsys’ and ’bsys2gsys’ can only be used as inverses when applied at the same point in the geometry.

tjunc Determines whether the intersection with a region that is T’ed into happens at the location of the T-junction.

cplaneshift Shifts the basepoint and/or length of a T-ing region depending on which side of the cut-plane the particle is currently moving. The first argument should be +1 to expand the T-ing region into the connecting region and -1 to shrink the T-ing region so that it no longer penetrates the connecting region.

recdet Writes the detector histograms to a data file.

paramadjust Adjusts a physics parameter to a new value. The arguments are as follows:

(action, parameter name, start region, end region, new parameter value)

where ’start region’ and ’end region’ define the range of regions for which the parameter should change, and the ’action’ string is "set" or "reset" where "set" indicates to load the passed value and "reset" indicates that the original value should be loaded.

event Writes an event into the events file. An event is one of the following:

-10 → Error in transporting a particle through a change in Fermi potential
-9 → Error in determining the result of a non-specular bounce
-8 → Error in determining polarization state after an interaction
-7 → Error in determining bounce type
-6 → Error in determining wall loss
-5 → Attempt to call ’bounce’ with no velocity component into a wall
-4 → Error in determining whether an intersection occurred at a T-junction
-3 → Particle escaped the geometry
-2 → Error in calculating particle propagation inside a bulk medium
-1 → Error in calculating an intersection
0 → Record a trajectory point
1 → Intersection with a region
2 → Intersection with a cut-plane
3 → Leaving a specular bounce
4 → Leaving a non-specular bounce
5 → Leaving a specular bounce where particle was depolarized
6 → Leaving a non-specular bounce where particle was depolarized
7 → Loss of particle upon wall interaction other than due to penetration
8 → Absorption of particle in a region
9 → Absorption of particle in a detector region (or detection by a cut-plane)

10 $\rightarrow$ AFP spin flip
11 $\rightarrow$ Beta-decay of a neutron
12 $\rightarrow$ Entering a bounce or checking for reflection off an increase in Fermi potential
13 $\rightarrow$ Particle lost due to penetration into wall or penetrates a bulk medium
14 $\rightarrow$ Creation of a new particle
15 $\rightarrow$ Particle gets an energy shift due to an interaction with a bulk medium
16 $\rightarrow$ Intersection with a T-junction
17 $\rightarrow$ Particle scattered inside a bulk medium
18 $\rightarrow$ Particle trapped in switcher as it changed state (UCNA geometry only)
19 $\rightarrow$ Missed AFP spin flip

Each event includes all of the particle's dynamical information, the event code indicated above, and other values specific to the particular event (e.g. the particle's direction relative to a cut-plane detector's local coordinate system).

D.3 Basic Crossed Polarizer Analyzer Geometry Files

D.3.1 Regions File

```
Reg# RType BP(x,y,z)                Dim[m]             Orient         Grad B [T/m]     Spec  Loss   Depol  WPot[neV] BPot[neV] Surf/Scat Absorb[1/s] Det PM SM LM DM
0    2     0.0,0.0,0.0              0.20,0.0254        0.0,-90.0,0.0  0.0,0.0,0.0      0.960 1.0e-5 1.0e-4 335.      335.      0.0       1.0e7       0   1  0  0  0
1    2     *                        0.20,0.0762        0.0,-90.0,0.0  0.0,0.0,0.0      0.200 1.0e-5 1.0e-4 335.      108.      0.08      40.0        0   4  0  0  0
2    2     *                        0.20,0.0762        0.0,-90.0,0.0  0.0,0.0,0.0      0.200 1.0e-5 1.0e-4 335.      0.0       0.0       0.0         0   0  0  0  0
3    2     *                        0.20,0.1905        0.0,-90.0,0.0  0.0,0.0,0.0      0.500 1.0e-5 1.0e-4 335.      0.0       0.0       0.0         0   0  0  0  0
4    2     *                        0.20,0.003175      0.0,-90.0,0.0  0.0,0.0,0.0      0.500 1.0e-5 1.0e-4 335.      0.0       0.0       0.0         0   0  0  0  0
5    2     *                        0.20,1.3843        0.0,-90.0,0.0  0.0,0.0,0.0      0.960 1.0e-5 1.0e-4 335.      0.0       0.0       0.0         0   0  0  0  0
6    2     *                        0.20,0.0127        0.0,-90.0,0.0  0.0,0.0,0.0      0.500 1.0e-5 1.0e-4 335.      335.      0.0       1.0e7       0   1  0  0  0
7    2     >0.0,1.21539,0.10        0.1016,2.5e-4      0.0,0.0,0.0    0.0,0.0,0.0      0.800 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
8    2     *                        0.1016,0.1016      0.0,0.0,0.0    0.0,0.0,0.0      0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
9    2     *                        0.1016,1.0         -45.0,0.0,0.0  0.0,0.0,0.0      0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
10   2     *                        0.1016,2.5e-4      -45.0,0.0,0.0  0.0,0.0,0.0      0.800 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
11   2     *                        0.1016,1.0         -45.0,0.0,0.0  0.0,0.0,0.0      0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
12   2     *                        0.1016,2.5e-4      -45.0,0.0,0.0  0.0,0.0,0.0      0.800 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
13   2     *                        0.1016,0.1016      -45.0,0.0,0.0  0.0,0.0,0.0      0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
14   2     *                        0.1016,0.1016      0.0,0.0,0.0    0.0,0.0,0.0      0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
15   2     *                        0.1016,2.5e-4      0.0,0.0,0.0    0.0,0.0,0.0      0.800 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
16   2     *                        0.1016,1.0         0.0,0.0,0.0    0.0,0.0,0.0      0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
17   2     *                        0.1016,2.5e-4      0.0,0.0,0.0    0.0,0.0,0.0      0.800 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
18   2     *                        0.1016,1.0         0.0,0.0,0.0    0.0,0.0,0.0      0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
19   2     *                        0.1016,2.5e-4      0.0,0.0,0.0    0.0,0.0,0.0      0.800 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
20   2     *                        0.1016,0.103188    0.0,0.0,0.0    0.0,0.0,0.0      0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
21   2     *                        0.1016,0.0127      0.0,0.0,0.0    0.0,0.0,0.0      0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
22   2     *                        0.1016,0.103188    0.0,0.0,0.0    0.0,0.0,0.0      0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
23   2     *                        0.1016,2.5e-4      0.0,0.0,0.0    0.0,0.0,0.0      0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
24   2     *                        0.1016,0.08255     0.0,0.0,0.0    0.0,0.0,0.0      0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
25   2     *                        0.1016,0.0127      0.0,0.0,0.0    0.0,0.0,0.0      0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
26   2     *                        0.1016,0.08255     0.0,0.0,0.0    0.0,0.0,0.0      0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
27   2     *                        0.1016,2.5e-4      0.0,0.0,0.0    0.0,0.0,0.0      0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
28   2     *                        0.1016,0.103188    0.0,0.0,0.0    0.0,0.0,0.0      0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
29   2     *                        0.1016,0.0127      0.0,0.0,0.0    0.0,0.0,0.0      0.500 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
30   2     *                        0.0762,0.103188    0.0,0.0,0.0    0.0,0.0,0.0      0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
31   2     *                        0.0762,2.5e-4      0.0,0.0,0.0    0.0,0.0,0.0      0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
32   2     *                        0.0762,0.598361    0.0,0.0,0.0    0.0,0.0,0.0      0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
33   2     *                        0.0762,2.5e-4      0.0,0.0,0.0    0.0,0.0,0.0      0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
34   2     *                        0.0762,1.27e-4     0.0,0.0,0.0    0.0,0.0,0.0      0.960 1.0e-5 1.0e-4 180.      70.       0.0       1000.       0   2  0  0  0
35   2     *                        0.0762,2.5e-4      0.0,0.0,0.0    0.0,0.0,0.0      0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
36   2     *                        0.0762,1.0414      0.0,0.0,0.0    0.0,0.0,0.0      0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
37   2     *                        0.0762,0.0254      0.0,0.0,0.0    0.0,0.0,0.0      0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
38   2     *                        0.0762,0.042558   -4.0,0.0,0.0   0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
39   2     *                        0.0762,0.042558   -8.0,0.0,0.0   0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
40   2     *                        0.0762,0.042558   -12.0,0.0,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
41   2     *                        0.0762,0.042558   -16.0,0.0,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
42   2     *                        0.0762,0.042558   -20.,0.0,0.0   0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
43   2     *                        0.0762,0.042558   -24.,0.0,0.0   0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
44   2     *                        0.0762,0.042558   -28.0,0.0,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
45   2     *                        0.0762,0.042558   -32.0,0.0,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
46   2     *                        0.0762,0.042558   -36.0,0.0,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
47   2     *                        0.0762,0.042558   -40.0,0.0,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
48   2     *                        0.0762,0.042558   -44.0,0.0,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
49   2     *                        0.0762,0.042558   -48.0,0.0,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
50   2     *                        0.0762,0.042558   -52.0,0.0,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
51   2     *                        0.0762,0.042558   -56.0,0.0,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
52   2     *                        0.0762,0.042558   -60.0,0.0,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
53   2     *                        0.0762,0.002      -60.0,0.0,0.0  0.0,0.0,0.0       0.960 1.0    1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
54   2     *                        0.0762,0.02       -60.0,0.0,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
55   2     *                        0.0762,0.001      -60.0,0.0,0.0  0.0,0.0,0.0       0.960 1.0    1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
56   2     *                        0.0762,0.342138   -60.0,0.0,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
57   2     *                        0.0762,0.001      -60.0,0.0,0.0  0.0,0.0,0.0       0.960 1.0    1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
58   2     *                        0.0700,0.00127    -60.0,0.0,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 168.      0.0       0.0       0.0         0   0  0  0  0
59   2     *                        0.0700,0.084667   -60.0,0.0,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
60   2     *                        0.0700,0.004      -60.0,0.0,0.0  0.0,0.0,0.0       0.960 1.0    1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
61   2     *                        0.0700,0.084667   -60.0,0.0,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
62   2     *                        0.0700,0.004      -60.0,0.0,0.0  0.0,0.0,0.0       0.960 1.0    1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
63   2     *                        0.0700,0.084667   -60.0,0.0,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
64   2     *                        0.0700,0.00254    -60.0,0.0,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 168.      0.0       0.0       0.0         0   0  0  0  0
65   2     *                        0.0700,0.368681   -60.0,0.0,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
66   2     *                        0.0700,0.250444   -60.0,0.0,0.0  0.0,0.0,3.2261    0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
67   2     *                        0.0700,0.09454    -60.0,0.0,0.0  0.0,0.0,3.2261    0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
68   2     *                        0.0700,0.19       -60.0,0.0,0.0  0.0,0.0,23.334    0.960 4.0e-4 2.0e-6 299.      0.0       0.0       0.0         0   0  0  0  0
69   2     *                        0.0700,0.05       -60.0,0.0,0.0  0.0,0.0,23.334    0.960 4.0e-4 2.0e-6 299.      0.0       0.0       0.0         0   0  0  0  0
70   2     *                        0.0700,0.03       -60.0,0.0,0.0  0.0,0.0,11.6667   0.960 4.0e-4 2.0e-6 299.      0.0       0.0       0.0         0   0  0  0  0
71   2     *                        0.0700,0.02       -60.0,0.0,0.0  0.0,0.0,-4.67     0.960 4.0e-4 2.0e-6 299.      0.0       0.0       0.0         0   0  0  0  0
72   2     *                        0.0700,0.05       -60.0,0.0,0.0  0.0,0.0,-16.8     0.960 4.0e-4 2.0e-6 299.      0.0       0.0       0.0         0   0  0  0  0
73   2     *                        0.0700,0.15       -60.0,0.0,0.0  0.0,0.0,-22.5     0.960 4.0e-4 2.0e-6 299.      0.0       0.0       0.0         0   0  0  0  0
74   2     *                        0.0700,0.18       -60.0,0.0,0.0  0.0,0.0,-7.2      0.960 4.0e-4 2.0e-6 299.      0.0       0.0       0.0         0   0  0  0  0
75   2     *                        0.0700,0.15       -60.0,0.0,0.0  0.0,0.0,-2.5      0.960 4.0e-4 2.0e-6 299.      0.0       0.0       0.0         0   0  0  0  0
76   2     *                        0.0700,0.035      -60.0,0.0,0.0  0.0,0.0,-0.5463   0.960 4.0e-4 2.0e-6 299.      0.0       0.0       0.0         0   0  0  0  0
77   2     *                        0.0700,0.035      -60.0,0.0,0.0  0.0,0.0,-0.5463   0.960 4.0e-4 2.0e-6 299.      0.0       0.0       0.0         0   0  0  0  0
78   2     *                        0.0700,0.00254    -60.0,0.0,0.0  0.0,0.0,-0.10     0.960 4.0e-4 2.0e-6 299.      0.0       0.0       0.0         0   0  0  0  0
79   2     *                        0.0700,0.28873    -60.0,0.0,0.0  0.0,0.0,-0.10     0.960 4.0e-4 2.0e-6 299.      0.0       0.0       0.0         0   0  0  0  0
80   2     *                        0.0700,0.28873    -60.0,0.0,0.0  0.0,0.0,-0.10     0.960 4.0e-4 2.0e-6 299.      0.0       0.0       0.0         0   0  0  0  0
81   2     *                        0.0700,0.156667   -60.0,0.0,0.0  0.0,0.0,-0.75     0.960 4.0e-4 2.0e-6 299.      0.0       0.0       0.0         0   0  0  0  0
82   2     *                        0.0700,0.156667   -60.0,0.0,0.0  0.0,0.0,-4.0      0.960 4.0e-4 2.0e-6 299.      0.0       0.0       0.0         0   0  0  0  0
83   2     *                        0.0700,0.156667   -60.0,0.0,0.0  0.0,0.0,-1.1      0.960 4.0e-4 2.0e-6 299.      0.0       0.0       0.0         0   0  0  0  0
84   2     *                        0.0700,0.250444   -60.0,0.0,0.0  0.0,0.0,0.0       0.960 4.0e-4 2.0e-6 299.      0.0       0.0       0.0         0   0  0  0  0
85   2     *                        0.0700,1.27e-4    -60.0,0.0,0.0  0.0,0.0,0.0       0.960 4.0e-4 2.0e-6 299.      0.0       0.0       0.0         0   0  0  0  0
86   2     *                        0.0700,0.0254     -60.0,0.0,0.0  0.0,0.0,0.0       0.960 4.0e-4 2.0e-6 299.      0.0       0.0       0.0         0   0  0  0  0
87   2     *                        0.0700,0.132645   -60.0,0.0,0.0  0.0,0.0,4.0       0.960 4.0e-4 2.0e-6 299.      0.0       0.0       0.0         0   0  0  0  0
88   2     *                        0.0700,0.212645   -60.0,0.0,0.0  0.0,0.0,24.0      0.960 4.0e-4 2.0e-6 299.      0.0       0.0       0.0         0   0  0  0  0
89   2     *                        0.0700,0.052645   -60.0,0.0,0.0  0.0,0.0,5.6       0.960 4.0e-4 2.0e-6 299.      0.0       0.0       0.0         0   0  0  0  0
90   2     *                        0.0700,0.155636   -60.0,0.0,0.0  0.0,0.0,0.0       0.960 4.0e-4 2.0e-6 299.      0.0       0.0       0.0         0   0  0  0  0
91   2     *                        0.0700,1.27e-5    -60.0,0.0,0.0  0.0,0.0,0.0       0.960 4.0e-4 2.0e-6 299.      168.      0.0       1000        0   2  0  0  0
92   2     *                        0.0590,0.011000   -60.0,0.0,0.0  0.0,0.0,0.0       0.000 1.0    2.0e-6 123.      0.0       0.0       0.0         0   0  0  0  0
93   2     *                        0.0700,0.119094   -60.0,0.0,0.0  0.0,0.0,0.0       0.960 4.0e-4 2.0e-6 299.      0.0       0.0       0.0         0   0  0  0  0
94   2     *                        0.0700,0.086784   -60.0,0.0,0.0  0.0,0.0,-3.0      0.960 4.0e-4 2.0e-6 299.      0.0       0.0       0.0         0   0  0  0  0
95   2     *                        0.0700,0.173567   -60.0,0.0,0.0  0.0,0.0,-28.0     0.960 4.0e-4 2.0e-6 299.      0.0       0.0       0.0         0   0  0  0  0
96   2     *                        0.0700,0.173567   -60.0,0.0,0.0  0.0,0.0,-5.0      0.960 4.0e-4 2.0e-6 299.      0.0       0.0       0.0         0   0  0  0  0
97   2     *                        0.0700,2.5e-4     -60.0,0.0,0.0  0.0,0.0,-5.0      0.960 4.0e-4 2.0e-6 299.      0.0       0.0       0.0         0   0  0  0  0
98   2     *                        0.0762,2.5e-4     -60.0,0.0,0.0  0.0,0.0,-5.0      0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
99   2     *                        0.0762,0.0757     -60.0,0.0,0.0  0.0,0.0,-0.122    0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
100  2     *                        0.0762,0.03721    -60.0,10.,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
101  2     *                        0.0762,0.03721    -60.0,20.,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
102  2     *                        0.0762,0.03721    -60.0,30.,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
103  2     *                        0.0762,0.03721    -60.0,40.,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
104  2     *                        0.0762,0.03721    -60.0,50.,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
105  2     *                        0.0762,0.03721    -60.0,60.,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
106  2     *                        0.0762,0.03721    -60.0,70.,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
107  2     *                        0.0762,0.03721    -60.0,80.,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
108  2     *                        0.0762,1.0        -60.0,90.,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
109  2     *                        0.0762,1.0e-4     -60.0,90.,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      70.       0.0       1000        0   2  0  0  0
110  2     *                        0.0762,0.1016     -60.0,90.,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       1.0e7       1   1  0  0  0
111  2     *                        0.0762,1.0e-4     -60.0,90.,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      70.       0.0       1000        0   2  0  0  0
112  2 >-1.486409,1.16459,4.09884 0.00635,0.0508     0.0,90.0,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
113  2     *                        0.1016,7.938e-4    0.0,90.0,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
114  2     *                        0.1016,1.0         0.0,90.0,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       0.0         0   0  0  0  0
115  2     *                        0.1016,1.0e-4      0.0,90.0,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      70.       0.0       1000        0   2  0  0  0
116  2     *                        0.1016,0.1016      0.0,90.0,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      0.0       0.0       1.0e7       2   1  0  0  0
117  2     *                        0.1016,1.0e-4      0.0,90.0,0.0  0.0,0.0,0.0       0.960 1.0e-5 1.0e-4 180.      70.       0.0       1000        0   2  0  0  0
/
```

D.3.2 Connections File

```
connex: The first region should be region 0, and a special-handling code must be used to specify how to treat its cut-plane.
-----------------------------------------------------------------------------------------------------------------------------
Region#     Connects through its own cut-plane to:     AND also to:     AND also to:     AND also to:     AND also to:     AND also to:
0,1         0                                               1                /
1           0                                               2                /
2           1                                               3                /
3           2                                               4                /
4           3                                               5                /
5           4                                               6                7                 /
6           5                                               /
7           5                                               8                /
8           7                                               9                /
9           8                                               10               /
10          9                                               11               /
11          10                                              12               /
12          11                                              13               /
13          12                                              14               /
14          13                                              15               /
15          14                                              16               /
16          15                                              17               /
17          16                                              18               /
18          17                                              19               /
19          18                                              20               /
20          19                                              21               /
21          20                                              22               /
22          21                                              23               /
23          22                                              24               /
24          23                                              25               /
25          24                                              26               112               /
26          25                                              27               /
27          26                                              28               /
28          27                                              29               /
29          28                                              30               /
30,5        29                                              31               /
31          30                                              32               /
32          31                                              33               /
33          32                                              34               /
34          33                                              35               /
35          34                                              36               /
36          35                                              37               /
37          36                                              38               /
38          37                                              39               /
39          38                                              40               /
40          39                                              41               /
41          40                                              42               /
42          41                                              43               /
43          42                                              44               /
44          43                                              45               /
45          44                                              46               /
46          45                                              47               /
47          46                                              48               /
48          47                                              49               /
49          48                                              50               /
50          49                                              51               /
51          50                                              52               /
52          51                                              53               /
53          52                                              54               /
54          53                                              55               /
55          54                                              56               /
56          55                                              57               /
57          56                                              58               /
58,5        57                                              59               /
59          58                                              60               /
60          59                                              61               /
61          60                                              62               /
62          61                                              63               /
63          62                                              64               /
64          63                                              65               /
65          64                                              66               /
66          65                                              67               /
67          66                                              68               /
68          67                                              69               /
69          68                                              70               /
70          69                                              71               /
71          70                                              72               /
72          71                                              73               /
73          72                                              74               /
74          73                                              75               /
75          74                                              76               /
76          75                                              77               /
77          76                                              78               /
78          77                                              79               /
79          78                                              80               /
80,3        79                                              81               /
81          80                                              82               /
82          81                                              83               /
83          82                                              84               /
84          83                                              85               /
85          84                                              86               /
86          85                                              87               /
87          86                                              88               /
88          87                                              89               /
89          88                                              90               /
90          89                                              91               /
91          90                                              92               /
92,5        91                                              93               /
93,5        92                                              94               /
94          93                                              95               /
95          94                                              96               /
96          95                                              97               /
97          96                                              98               /
98,5        97                                              99               /
99          98                                              100              /
100         99                                              101              /
101         100                                             102              /
102         101                                             103              /
103         102                                             104              /
104         103                                             105              /
105         104                                             106              /
106         105                                             107              /
107         106                                             108              /
108         107                                             109              /
109         108                                             110              /
110         109                                             111              /
111         110                                             /
112         25                                              113              /
113,5       112                                             114              /
114         113                                             115              /
115         114                                             116              /
116         115                                             117              /
117         116                                             /
```

D.4 Basic UCNA Geometry Files

D.4.1 Regions File

```
Reg# RType BP(x,y,z)                  Dim[m]                  Orient           Grad B [T/m]    Spec   Loss    Depol   WPot[neV] BPot[neV] Surf/Scat Absorb[1/s] Det PM SM LM DM
0    2     0.0,0.0,0.0                0.20,0.0254             0.0,-90.0,0.0    0.0,0.0,0.0     0.993  1.0e-5  0.0     335.      335.      0.0       1.0e7       0   1  0  1  0
1    2     *                          0.20,0.0762             0.0,-90.0,0.0    0.0,0.0,0.0     0.200  1.0e-5  0.0     335.      108.      0.08      40.0        0   4  0  1  0
2    2     *                          0.20,0.0762             0.0,-90.0,0.0    0.0,0.0,0.0     0.200  1.0e-5  0.0     335.      0.0       0.0       0.0         0   0  0  1  0
3    2     *                          0.20,0.1905             0.0,-90.0,0.0    0.0,0.0,0.0     0.500  1.0e-5  0.0     335.      0.0       0.0       0.0         0   0  0  1  0
4    2     *                          0.20,0.003175           0.0,-90.0,0.0    0.0,0.0,0.0     0.500  1.0e-5  0.0     335.      0.0       0.0       0.0         0   0  0  1  0
5    2     *                          0.20,1.3843             0.0,-90.0,0.0    0.0,0.0,0.0     0.993  1.0e-5  0.0     335.      0.0       0.0       0.0         0   0  0  1  0
6    2     *                          0.20,0.0127             0.0,-90.0,0.0    0.0,0.0,0.0     0.500  1.0e-5  0.0     335.      335.      0.0       1.0e7       0   1  0  1  0
7    2     >0.0,1.21539,0.10          0.1016,2.5e-4           0.0,0.0,0.0      0.0,0.0,0.0     0.500  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
8    2     *                          0.1016,0.1016           0.0,0.0,0.0      0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
9    2     *                          0.1016,1.0              -45.0,0.0,0.0    0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
10   2     *                          0.1016,2.5e-4           -45.0,0.0,0.0    0.0,0.0,0.0     0.500  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
11   2     *                          0.1016,1.0              -45.0,0.0,0.0    0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
12   2     *                          0.1016,2.5e-4           -45.0,0.0,0.0    0.0,0.0,0.0     0.500  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
13   2     *                          0.1016,0.1016           -45.0,0.0,0.0    0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
14   2     *                          0.1016,0.1016           0.0,0.0,0.0      0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
15   2     *                          0.1016,2.5e-4           0.0,0.0,0.0      0.0,0.0,0.0     0.500  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
16   2     *                          0.1016,1.0              0.0,0.0,0.0      0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
17   2     *                          0.1016,2.5e-4           0.0,0.0,0.0      0.0,0.0,0.0     0.500  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
18   2     *                          0.1016,1.0              0.0,0.0,0.0      0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
19   2     *                          0.1016,2.5e-4           0.0,0.0,0.0      0.0,0.0,0.0     0.500  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
20   2     *                          0.1016,0.103188         0.0,0.0,0.0      0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
21   2     *                          0.1016,0.0127           0.0,0.0,0.0      0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
22   2     *                          0.1016,0.103188         0.0,0.0,0.0      0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
23   2     *                          0.1016,2.5e-4           0.0,0.0,0.0      0.0,0.0,0.0     0.800  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
24   2     *                          0.1016,0.08255          0.0,0.0,0.0      0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
25   2     *                          0.1016,0.0127           0.0,0.0,0.0      0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
26   2     *                          0.1016,0.08255          0.0,0.0,0.0      0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
27   2     *                          0.1016,2.5e-4           0.0,0.0,0.0      0.0,0.0,0.0     0.800  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
28   2     *                          0.1016,0.103188         0.0,0.0,0.0      0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
29   2     *                          0.1016,0.0127           0.0,0.0,0.0      0.0,0.0,0.0     0.010  0.5     0.0     180.      0.0       0.0       0.0         0   0  0  1  0
30   2     *                          0.0762,0.103188         0.0,0.0,0.0      0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
31   2     *                          0.0762,2.5e-4           0.0,0.0,0.0      0.0,0.0,0.0     0.500  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
32   2     *                          0.0762,0.064961         0.0,0.0,0.0      0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
33   2     *                          0.0762,0.5334           0.0,0.0,0.0      0.,0.,11.243    0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
34   2     *                          0.0762,2.5e-4           0.0,0.0,0.0      0.,0.,11.243    0.500  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
35   2     *                          0.0762,1.27e-4          0.0,0.0,0.0      0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      70.       0.0       1000.       0   2  0  1  0
36   2     *                          0.0762,2.5e-4           0.0,0.0,0.0      0.,0.,-11.243   0.500  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
37   2     *                          0.0762,0.5334           0.0,0.0,0.0      0.,0.,-11.243   0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
38   2     *                          0.0762,0.508            0.0,0.0,0.0      0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
39   2     *                          0.0762,2.5e-4           0.0,0.0,0.0      0.0,0.0,0.0     0.500   0.5    0.0     180.      0.0       0.0       0.0         0   0  0  1  0
40   2     *                          0.0762,0.0254           0.0,0.0,0.0      0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
41   2     *                          0.0762,0.042558         -4.0,0.0,0.0     0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
42   2     *                          0.0762,0.042558         -8.0,0.0,0.0  0.0,0.0,0.0      0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
43   2     *                          0.0762,0.042558         -12.0,0.0,0.0    0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
44   2     *                          0.0762,0.042558         -16.0,0.0,0.0    0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
45   2     *                          0.0762,0.042558         -20.0,0.0,0.0    0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
46   2     *                          0.0762,0.042558         -24.0,0.0,0.0    0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
47   2     *                          0.0762,0.042558         -28.0,0.0,0.0    0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
48   2     *                          0.0762,0.042558         -32.0,0.0,0.0    0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
49   2     *                          0.0762,0.042558         -36.0,0.0,0.0    0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
50   2     *                          0.0762,0.042558         -40.0,0.0,0.0    0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
51   2     *                          0.0762,0.042558         -44.0,0.0,0.0    0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
52   2     *                          0.0762,0.042558         -48.0,0.0,0.0    0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
53   2     *                          0.0762,0.042558         -52.0,0.0,0.0    0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
54   2     *                          0.0762,0.042558         -56.0,0.0,0.0    0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
55   2     *                          0.0762,0.042558         -60.0,0.0,0.0    0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
56   2     *                          0.0762,0.002            -60.0,0.0,0.0    0.0,0.0,0.0     0.500   0.8    0.0     180.      0.0       0.0       0.0         0   0  0  1  0
57   2     *                          0.0762,0.02             -60.0,0.0,0.0    0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
58   2     *                          0.0762,0.001            -60.0,0.0,0.0    0.0,0.0,0.0     0.500   0.8    0.0     180.      0.0       0.0       0.0         0   0  0  1  0
59   2     *                          0.0762,0.342138         -60.0,0.0,0.0    0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
60   2     *                          0.0762,0.001            -60.0,0.0,0.0    0.0,0.0,0.0     0.500   0.8    0.0     180.      0.0       0.0       0.0         0   0  0  1  0
61   2     *                          0.0700,0.00127          -60.0,0.0,0.0    0.0,0.0,0.0     0.01   0.990   0.0     180.      0.0       0.0       0.0         0   0  0  1  0
62   2     *                          0.0700,0.084667         -60.0,0.0,0.0    0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
63   2     *                          0.0700,0.004            -60.0,0.0,0.0    0.0,0.0,0.0     0.01   0.990   0.0     180.      0.0       0.0       0.0         0   0  0  1  0
64   2     *                          0.0700,0.084667         -60.0,0.0,0.0    0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
65   2     *                          0.0700,0.004            -60.0,0.0,0.0    0.0,0.0,0.0     0.01   0.990   0.0     180.      0.0       0.0       0.0         0   0  0  1  0
66   2     *                          0.0700,0.084667         -60.0,0.0,0.0    0.0,0.0,0.0     0.993  1.0e-5  0.0     180.      0.0       0.0       0.0         0   0  0  1  0
67   2     *                          0.0700,0.00254          -60.0,0.0,0.0    0.0,0.0,0.0     0.01   0.990   0.0     168.      0.0       0.0       0.0         0   0  0  1  0
68   2     *                          0.0700,0.368681         -60.0,0.0,0.0    0.0,0.0,0.0     0.960  4.0e-4  0.0     168.      0.0       0.0       0.0         0   0  0  1  0
69   2     *                          0.0700,0.250444         -60.0,0.0,0.0    0.,0.,3.2261    0.960  4.0e-4  0.0     168.      0.0       0.0       0.0         0   0  0  1  0
70   2     *                          0.0700,0.09454          -60.0,0.0,0.0    0.,0.,3.2261    0.960  4.0e-4  0.0     168.      0.0       0.0       0.0         0   0  0  1  0
71   2     *                          0.0700,0.19             -60.0,0.0,0.0    0.,0.,23.334    0.960  4.0e-4  0.0     168.      0.0       0.0       0.0         0   0  0  1  0
72   2     *                          0.0700,0.05             -60.0,0.0,0.0    0.,0.,23.334    0.960  4.0e-4  0.0     168.      0.0       0.0       0.0         0   0  0  1  0
73   2     *                          0.0700,0.03             -60.0,0.0,0.0    0.,0.,11.6667   0.960  4.0e-4  0.0     168.      0.0       0.0       0.0         0   0  0  1  0
74   2     *                          0.0700,0.02             -60.0,0.0,0.0    0.,0.,-4.67     0.960  4.0e-4  0.0     168.      0.0       0.0       0.0         0   0  0  1  0
75   2     *                          0.0700,0.05             -60.0,0.0,0.0    0.,0.,-16.8     0.960  4.0e-4  0.0     168.      0.0       0.0       0.0         0   0  0  1  0
76   2     *                          0.0700,0.15             -60.0,0.0,0.0    0.,0.,-22.5     0.960  4.0e-4  0.0     168.      0.0       0.0       0.0         0   0  0  1  0
77   2     *                          0.0700,0.18             -60.0,0.0,0.0    0.,0.,-7.2      0.960  4.0e-4  0.0     200.      0.0       0.0       0.0         0   0  0  1  0
78   2     *                          0.0700,0.15             -60.0,0.0,0.0    0.,0.,-2.5      0.960  4.0e-4  0.0     200.      0.0       0.0       0.0         0   0  0  1  0
79   2     *                          0.0700,0.035            -60.0,0.0,0.0    0.,0.,-0.5463   0.960  4.0e-4  0.0     200.      0.0       0.0       0.0         0   0  0  1  0
80   2     *                          0.0700,0.035            -60.0,0.0,0.0    0.,0.,-0.5463   0.960  4.0e-4  0.0     200.      0.0       0.0       0.0         0   0  0  1  0
81   2     *                          0.0700,0.00254          -60.0,0.0,0.0    0.,0.,-0.10     0.960  4.0e-4  0.0     200.      0.0       0.0       0.0         0   0  0  1  0
82   2     *                          0.0700,0.28873          -60.0,0.0,0.0    0.,0.,-0.10     0.960  4.0e-4  0.0     200.      0.0       0.0       0.0         0   0  0  1  0
83   2     *                          0.0700,0.28873          -60.0,0.0,0.0    0.,0.,-0.10     0.960  4.0e-4  0.0     200.      0.0       0.0       0.0         0   0  0  1  0
84   2     *                          0.0700,0.47             -60.0,0.0,0.0    0.0,0.0,0.0     0.960  4.0e-4  0.0     168.      0.0       0.0       0.0         0   0  0  1  0
85   2     *                          0.0700,0.250444         -60.0,0.0,0.0    0.0,0.0,0.0     0.960  4.0e-4  0.0     168.      0.0       0.0       0.0         0   0  0  1  0
86   2     *                          0.0700,7.938e-4         -60.0,0.0,0.0    0.,0.,-0.75397  0.500   0.8    0.0     168.      0.0       0.0       0.0         0   0  0  1  0
87   2     *                          0.0700,0.86995          -60.0,0.0,0.0    0.,0.,-0.75397  0.960  4.0e-4  0.0     168.      0.0       0.0       0.0         0   0  0  1  0
88   2     *                          0.0700,7.938e-4         -60.0,0.0,0.0    0.,0.,-0.75397  0.500   0.8    0.0     168.      0.0       0.0       0.0         0   0  0  1  0
89   2     *                          0.0700,0.13335          -60.0,0.0,0.0    0.,0.,-0.75397  0.960  4.0e-4  0.0     168.      0.0       0.0       0.0         0   0  0  1  0
90   2     *                          0.0700,7.938e-4         -60.0,0.0,0.0    0.,0.,-0.75397  0.500   0.8    0.0     168.      0.0       0.0       0.0         0   0  0  1  0
91   2     *                          0.0700,0.093345         -60.0,0.0,0.0    0.,0.,-0.75397  0.960  4.0e-4  0.0     168.      0.0       0.0       0.0         0   0  0  1  0
92   2     *                          0.0700,0.18415          -60.0,0.0,0.0    0.,0.,-0.75397  0.960  4.0e-4  0.0     168.      0.0       0.0       0.0         0   0  0  1  0
93   1     *                      0.0273,0.0573,0.0015875     -60.0,0.0,0.0    0.,0.,1.616     0.960  4.0e-4  0.0     168.      0.0       0.0       0.0         0   0  0  1  0
94   1     <                          0.0273,0.0573,0.7112    -60.0,0.0,0.0    0.,0.,1.616     0.960  4.0e-4  0.0     168.      0.0       0.0       0.0         0   0  0  1  0
95   2 -7.405942,1.215390,8.085805  0.124638,0.003175         30.0,0.0,0.0     0.0,0.0,0.0     0.90   4.0e-4  0.0     252.      252.      0.0       1.0e7       0   1  0  1  0
96   2     *                          0.124638,3.0            30.0,0.0,0.0     0.0,0.0,0.0     0.960  4.0e-4  0.0     168.      0.0       0.0       0.0         0   0  0  1  0
97   2     *                          0.124638,0.003175       30.0,0.0,0.0     0.0,0.0,0.0     0.90   4.0e-4  0.0     252.      252.      0.0       1.0e7       0   1  0  1  0
98   2 >-1.486409,1.16459,4.098835  0.00635,0.0508            0.0,90.0,0.0     0.0,0.0,0.0     0.950  1.0e-5  1.0e-4  180.      0.0       0.0       0.0         0   0  0  1  0
99   2     *                          0.1016,7.938e-4         0.0,90.0,0.0     0.0,0.0,0.0     0.950  1.0e-5  1.0e-4  180.      0.0       0.0       0.0         0   0  0  1  0
100  2     *                          0.1016,1.0              0.0,90.0,0.0     0.0,0.0,0.0     0.950  1.0e-5  1.0e-4  180.      0.0       0.0       0.0         0   0  0  1  0
101  2     *                          0.1016,1.0e-4           0.0,90.0,0.0     0.0,0.0,0.0     0.950  1.0e-5  1.0e-4  180.      70.       0.0       1000        0   2  0  1  0
102  2     *                          0.1016,0.1016           0.0,90.0,0.0     0.0,0.0,0.0     0.950  1.0e-5  1.0e-4  180.      0.0       0.0       1.0e7       1   1  0  1  0
103  2 >-4.763383,1.18039,8.295841   0.00635,0.005            0.0,90.0,0.0     0.0,0.0,0.0     0.950  1.0e-5  1.0e-4  168.      0.0       0.0       0.0         0   0  0  1  0
104  2     *                          0.0508,0.085598         0.0,90.0,0.0     0.0,0.0,0.0     0.950  1.0e-5  1.0e-4  70.       0.0       0.0       0.0         0   0  0  1  0
105  2     *                          0.0508,4.0e-5           0.0,90.0,0.0     0.0,0.0,0.0     0.950  1.0e-5  1.0e-4  335.      0.0       0.0       0.0         0   0  0  1  0
106  2     *                          0.0762,2.5e-4           0.0,90.0,0.0     0.0,0.0,0.0     0.950  1.0e-5  1.0e-4  70.       0.0       0.0       0.0         0   0  0  1  0
107  2     *                          0.0762,1.0              0.0,90.0,0.0     0.0,0.0,0.0     0.950  1.0e-5  1.0e-4  180.      0.0       0.0       0.0         0   0  0  1  0
108  2     *                          0.0762,1.0e-4           0.0,90.0,0.0     0.0,0.0,0.0     0.950  1.0e-5  1.0e-4  180.      70.       0.0       1000        0   2  0  1  0
109  2     *                          0.0762,0.1016           0.0,90.0,0.0     0.0,0.0,0.0     0.950  1.0e-5  1.0e-4  180.      0.0       0.0       1.0e7       2   1  0  1  0
110  2 >-6.654354,1.15307,9.387593   0.0047625,0.005          0.0,90.0,0.0     0.0,0.0,0.0     0.900  1.0e-5  1.0e-4  168.      0.0       0.0       0.0         0   0  0  1  0
111  2     *                          0.0762,2.5e-4           0.0,90.0,0.0     0.0,0.0,0.0     0.900  1.0e-5  1.0e-4  180.      0.0       0.0       0.0         0   0  0  1  0
112  2     *                          0.0762,1.0              0.0,90.0,0.0     0.0,0.0,0.0     0.900  1.0e-5  1.0e-4  180.      0.0       0.0       0.0         0   0  0  1  0
113  2     *                          0.0762,1.0e-4           0.0,90.0,0.0     0.0,0.0,0.0     0.900  1.0e-5  1.0e-4  180.      70.       0.0       1000        0   2  0  1  0
114  2     *                          0.0762,0.1016           0.0,90.0,0.0     0.0,0.0,0.0     0.900  1.0e-5  1.0e-4  180.      0.0       0.0       1.0e7       3   1  0  1  0
115  2 -2.277809,1.215390,6.860794 0.0700,0.0254              120.,0.0,0.0     0.0,0.0,0.0     0.993  1.0e-5  1.0e-4  180.      0.0       0.0       0.0         0   0  0  1  0
116  2     *                          0.0700,0.0508           120.,45.,0.0     0.0,0.0,0.0     0.993  1.0e-5  1.0e-4  180.      0.0       0.0       0.0         0   0  0  1  0
117  2     *                          0.0700,0.004            120.,45.,0.0     0.0,0.0,0.0     0.01   0.990   1.0e-4  180.      0.0       0.0       0.0         0   0  0  1  0
118  2     *                          0.0700,0.084667         120.,45.,0.0     0.0,0.0,0.0     0.993  1.0e-5  1.0e-4  180.      0.0       0.0       0.0         0   0  0  1  0
119  2     *                          0.0700,0.002            120.,45.,0.0     0.0,0.0,0.0     0.01   0.990   1.0e-4  180.      0.0       0.0       0.0         0   0  0  1  0
120  2     *                          0.0762,0.0762           120.,45.,0.0     0.0,0.0,0.0     0.993  1.0e-5  1.0e-4  180.      0.0       0.0       0.0         0   0  0  1  0
121  2     *                          0.0762,0.0762           120.,75.,0.0     0.0,0.0,0.0     0.993  1.0e-5  1.0e-4  180.      0.0       0.0       0.0         0   0  0  1  0
122  2     *                          0.0762,0.002            120.,75.,0.0     0.0,0.0,0.0     0.50    0.8    1.0e-4  180.      0.0       0.0       0.0         0   0  0  1  0
123  2     *                          0.0762,0.470154         120.,75.,0.0     0.0,0.0,0.0     0.993  1.0e-5  1.0e-4  180.      0.0       0.0       0.0         0   0  0  1  0
124  2     *                          0.0762,1.0e-4           120.,75.,0.0     0.0,0.0,0.0     0.950  1.0e-5  1.0e-4  180.      70.       0.0       1000        0   2  0  1  0
125  2     *                          0.0762,0.1016           120.,75.,0.0     0.0,0.0,0.0     0.950  1.0e-5  1.0e-4  180.      0.0       0.0       1.0e7       4   1  0  1  0
126  1 -2.204485,1.215390,6.818460 0.215,0.215,0.215          -60.0,0.0,0.0    0.0,0.0,0.0     0.010  0.7     1.0e-4  180.      0.0       0.0       0.0         0   0  0  1  0
127  1     *                          0.215,0.215,0.215       -60.0,0.0,0.0    0.0,0.0,0.0     0.010  0.7     1.0e-4  180.      180.      0.0       1.0e7       0   1  0  1  0
/
```

D.4.2 Connections File

connex: The first region should be region 0, and a special-handling code must be used to specify how to treat its cut-plane.

Region#	Connects through its own cut-plane to:	AND also to:	AND also to:	AND also to:	AND also to:	AND also to:
0,1	0	1	/			
1	0	2	/			
2	1	3	/			
3	2	4	/			
4	3	5	/			
5	4	6	7	/		
6	5	/				
7	5	8	/			
8	7	9	/			
9	8	10	/			
10	9	11	/			
11	10	12	/			
12	11	13	/			
13	12	14	/			
14	13	15	/			
15	14	16	/			
16	15	17	/			
17	16	18	/			
18	17	19	/			
19	18	20	/			
20	19	21	/			
21	20	22	/			
22	21	23	/			
23	22	24	/			
24	23	25	/			
25	24	26	98	/		
26	25	27	/			
27	26	28	/			
28	27	29	/			
29	28	30	/			
30,5	29	31	/			
31	30	32	/			
32	31	33	/			
33	32	34	/			
34	33	35	/			
35	34	36	/			
36	35	37	/			
37	36	38	/			
38	37	39	/			
39	38	40	/			
40	39	41	/			
41	40	42	/			
42	41	43	/			
43	42	44	/			
44	43	45	/			
45	44	46	/			
46	45	47	/			
47	46	48	/			
48	47	49	/			
49	48	50	/			
50	49	51	/			
51	50	52	/			
52	51	53	/			
53	52	54	/			
54	53	55	/			
55	54	56	/			
56	55	57	/			
57	56	58	/			
58	57	59	/			
59	58	60	/			
60	59	61	/			
61,5	60	62	/			
62	61	63	/			
63	62	64	/			
64	63	65	/			
65	64	66	/			
66	65	67	/			
67	66	68	/			
68	67	69	/			
69	68	70	/			
70	69	71	/			
71	70	72	/			
72	71	73	/			
73	72	74	/			
74	73	75	/			
75	74	76	/			
76	75	77	/			
77	76	78	/			
78	77	79	/			
79	78	80	/			
80	79	81	/			
81	80	82	/			
82	81	83	/			
83,3	82	84	/			
84	83	85	/			
85	84	86	103	/		
86	85	87	/			
87	86	88	/			
88	87	89	/			
89	88	90	/			
90	89	91	/			
91	90	92	/			
92	91	93	/			
93	92	94	/			
94	93	96	/			
95,1	95	96	/			
96	95	97	94	110	/	
97	96	/				
98	25	99	/			
99,5	98	100	/			
100	99	101	/			
101	100	102	/			
102	101	/				
103	85	104	/			
104,5	103	105	/			
105	104	106	/			
106,5	105	107	/			
107	106	108	/			
108	107	109	/			
109	108	/				
110	96	111	/			
111,5	110	112	/			
112	111	113	/			
113	112	114	/			
114	113	/				
115	115	116	/			
116	115	117	/			
117	116	118	/			
118	117	119	/			
119	118	120	/			
120,5	119	121	/			
121	120	122	/			
122	121	123	/			
123	122	124	/			
124	123	125	/			
125	125	/				
126	126	127	/			
127	126	/				
/						