SNAKE Manual

(January 14, 2005)

SNAKE traces trajectories through a series of boxes called "free boxes" each of which has its own "relative coordinate system". In each box the nature of the magnet field is described. There are many options for how to describe the magnetic field in each box. Those options and the interrelationship of the various boxes are described in the "Directive File". Each free box must overlap with the preceding one. Within the free boxes the users specifies a series of "endplanes". SNAKE integrates trajectories from endplane to endplane and stores trajectory information at each endplane. Each endplane must be after, in terms of the progression of the trajectory, the one before it. This includes endplanes in two successive boxes.

Directive File:

File in which your spectrometer or beamline is set up. (See /home/lerose/magnets/SNAKE/MAPS/septum/Leftseptum_dir.dat for a sample directive file.)

- Starts with a one line entry of three real numbers (usually 10., 40., 10.). These are the integration minimum step size, maximum step size, and step size increment.
- Next line selects spin raytracing and synchrotron radiation options. For normal tracing of charged particles through magnetic fields just put false, false
- Next line is a list of particle properties (1., 1.7588e11,1.,.000511 for electrons. See comments in sample directive files for units)
- Box name (40 characters)
- Box label (8 characters)
- Label of reference free box (8 characters), may be "absolute" or the label of any previously defined free box.
- Origin of the free box relative coordinate system (x,y,z) in the reference free box relative coordinate system.
- Rotation angles in degrees (θz, θx, θy) of the coordinate system of the free box relative to the reference free box.
- Minimum x, y, z values of the free box relative coordinate system (along with the next line defines the size of the free box)
- Maximum x, y, z values of the free box relative coordinate system
- METHOD, specifies the type of integration used in this box
  - METHOD = 1 no field (straight lines)
  - METHOD = 2 matrix (only partially implemented)
  - METHOD = 3 Runge-Khuta (raytracing)
- ITYPE specifies the type of field or matrix (see next line for more)
- INDFI further specification of the field or matrix
  - For METHOD=1, ITYPE=INDFI=anything (integer of course)
  - For METHOD=2,
    - ITYPE=1 1st order matrix
      - INDFI=1 1000mm drift
      - INDFI=2 500mm drift (not implemented)

- ITYPE=2 2nd order matrix (not implemented)
  - For METHOD=3
    - ITYPE=1 constant field along
      - INDFI=1 field along x
      - INDFI=2 field along y
      - INDFI=3 field along z
    - ITYPE=2 analytic field
      - INDFI=1 Dipole with n and β
      - INDFI=3 Quadrupole (very simple)
      - INDFI=4 Dipole entrance fringe field
      - INDFI=5 Dipole exit fringe field
      - INDFI=6 Uniform Dipole
      - INDFI=7 Multipole entrance fringe field
      - INDFI=8 Uniform multipole
      - INDFI=9 Multipole exit fringe field
      - INDFI=10 Multipole-Multipole overlapping fringe fields
      - INDFI=11 Multipole-dipole overlapping fringe fields
      - INDFI=12 dipole-dipole overlapping fringe fields
      - INDFI=13 Dipole multipole overlapping fringe fields
      - INDFI=14 ?
      - INDFI=16 P. Vernin test?
      - INDFI=17 CLAM by P. Vernin?
      - INDFI=18 RAYTRACE style Dipole
      - INDFI=19 Helmholtz coil
      - INDFI=20 Solenoid
    - ITYPE=3 field map
      - INDFI=1 1-dimensional y-distribution
      - INDFI=2 2-dimensional xy-distribution
      - INDFI=3 2-dimensional xy distribution with variable y-increment
      - INDFI=5 3-D field map
      - INDFI=6 another type of 3-D field map?
      - INDFI=7 two 3-D field maps
- Field map or dipole input filename. "NONE" if appropriate
  - If INDFI=7 give two lines. 1st map-file and its multiplicative factor on the first and 2nd map-file and its multiplicative factor on the second
- "r" (I think this is for rectangular free box. Pascal has implemented other options too. I always use "r")
- Field multiplication factor (overall scale factor to increase or decrease the magnetic field)
- Number of additional data. Determined by options selected above and followed by that number of lines of addition single numbers. See below for details.
- Method of determining endplanes (either LOOP or LIST generally LIST is better)

- LOOP: next line is (Min., Max, step) of the y value of the endplane in the box's relative coordinate system.
- LIST is followed by a list of endplanes each described by 10-element line of input as follows
  - "x", "y", or "z" to define which relative coordinate axis along which the endplanes are defined. Generally use "y" here.
  - Location along the selected axis where the endplane crosses
  - Angle in degrees that the endplane makes with the axis
  - None (see Pascal if you want to use anything else)
  - 6 numbers describing a collimating aperture (elliptical and trapezoidal are possible). All zeroes means no collimator. See below for an explanation of the parameters.
  - Repeat 10-element line for the desired number of endplanes
  - "EOL" for end of list
- Next line is the "Box Name" for the next free box followed by descriptors described above for the next free box or "END*" indicating the end of the directive file.

**Additional Data** (the ones you need for HRS)
- INDFI=7, 8, or 9: Number of additional data = 6
  1. Quadrupole field at R in Tesla
  2. Sextupole field
  3. Octupole field
  4. Decapole field
  5. Dodecapole field
  6. R (reference radius in mm.)
- INDFI=10: Number additional data = 13
  1. Quadrupole field at R in Tesla for 1st quad
  2. Sextupole field
  3. Octupole field
  4. Decapole field
  5. Dodecapole field
  6. R (reference radius in mm.)
  7. Quadrupole field at R in Tesla for 2nd quad
  8. Sextupole field
  9. Octupole field
  10. Decapole field
  11. Dodecapole field
  12. R (reference radius in mm.)
  13. Distance between the magnets in mm.
- INDFI=14: Number of additional data =10
  1. Not used (formerly B field)
  2. angle in degrees between dipole and quadrupole axes
  3. Not used (formerly dipole gap)
  4. Quadrupole field at R in Tesla
  5. Sextupole field
  6. Octupole field

7. Decapole field
8. Dodecapole field
9. R (reference radius in mm.)
10. Distance between magnets (mm)
- INDFI=19 (Helmholtz coil) Number of additional data =2
    1. coil radii and separation (meters)
    2. current in coils (2 single loops)
- INDFI=20 (Solenoid) Number of additional data =3
    1. coil radius (meters)
    2. length of solenoid (meters)
    3. current (in each of 1000 loops) (amps)

Collimators

The six numbers read in to describe the collimators are read into a 6 dimensional array called colli. The meanings of the six numbers are as follow:

(mm)	Trapezoid (see figure below)	Ellipse
colli(1)	xmin	xmax (semi-major axis length (x))
colli(2)	xmax	zmax (semi-minor axis length (z))
colli(3)	zmax1	h (x offset from zero)
colli(4)	zmax2	k (z offset from zero)
colli(5)	zmin1	0. (zeroes here indicate choice of an elliptical collimator)
colli(6)	zmin2	0.

Trapezoidal Collimator Parameters
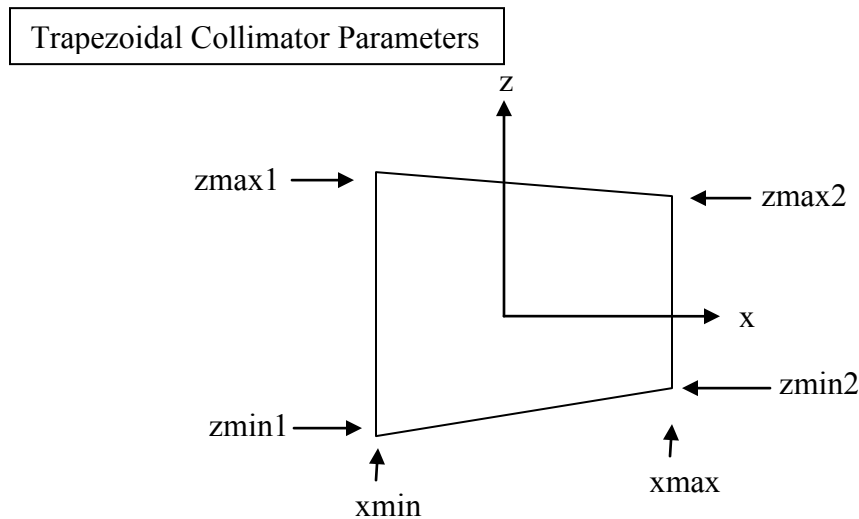
Trajectory Files

Trajectories can be entered into SNAKE in two ways.
1. From the terminal: In this case you elect the option and are asked for a series of inputs to specify the trajectories you want. Options include: Loops (a systematic series of trajectories), Individual (the user specifies all parameters for each

trajectory), and Random (the user specifies the maximum and minimum values of all parameters and a random set of trajectories is generated within those limits)

2. From disk: In this case the user is asked for a filename from which the trajectory parameters are read. The options are the same as above and the format of the files are the same as if you were typing the inputs in the terminal input option. In the same directory as the sample directive file the files Rtest_traj.dat, ran_traj.dat, and t_traj.dat are examples of input files for the Individual, Random, and Loop options respectively. Note that in the example ran_traj.dat file the 3rd line is blank. This space is for the seed used by the random number generator (a large odd number). When it is left blank the random number generator uses the seed produced in its last call which is stored in the file sn-rand.dat.