Exercise Tal1:

BACKGROUND: It's possible we might be interested in more than just keff. We might want to know something about flux or current for different components of our simulation. To get this data we must use what are known as tallies or detectors in mcnp and serpent respectively.

GOAL: Learn how to set up a few basic tallies/detectors using geometries we are familiar with. Measure the neutron surface current, surface flux, and flux of the Godiva sphere created in g1.

INSTRUCTIONS:

Copy your completed g1decks to tal1.

In mcnp:

Add tallies F1, F2, and F4

Specify their appropriate particle type.

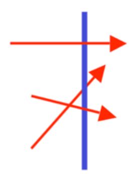
Specify their appropriate surface/cell.

Run the input deck

Search for "1tal" in the output file and record the results

F1 - Current across surface

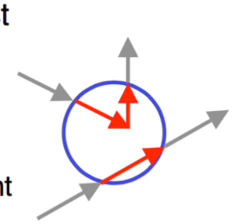
$$J = \frac{1}{W} \sum_{\substack{\text{all flights} \\ \text{crossing surface}}} wgt$$



W = total source weight

F4 - Flux in a cell

$$\phi = \frac{1}{V \cdot W} \sum_{\substack{\text{all flights} \\ \text{in cell}}} \text{wgt} \bullet \text{dist}$$

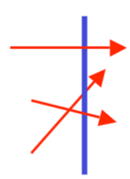


V = cell volume

W = total source weight

F2 - Flux on surface

$$\phi = \frac{1}{A \cdot W} \sum_{\substack{\text{all flights} \\ \text{crossing surface}}} \frac{\text{wgt}}{|\mu|}$$



A = surface area

W = total source weight

$\mu = \Omega \bullet$ [surface normal]

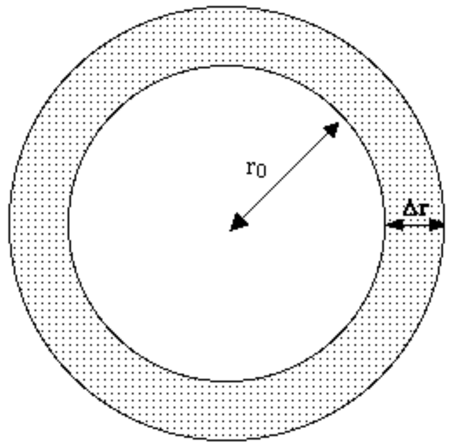
In serpent:

There are detectors in serpent capable of measuring surface current and flux, "ds" and "dc".

Add these detectors to your input deck.

There is no direct way to measure surface flux in serpent, so we will have to be creative.

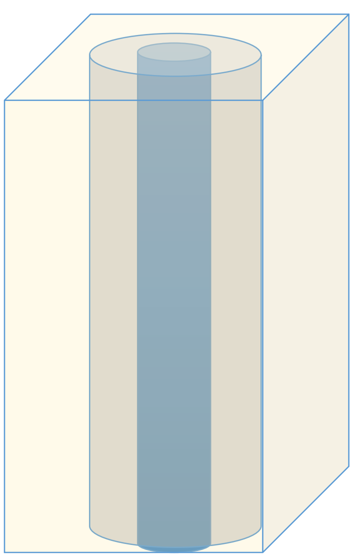
Add a new spherical surface to the serpent deck which is slightly larger than the current sphere.
Add a new cell between the 2 surfaces and fill it with void.
Add a detector to measure flux in this shell region.
Run the input deck and locate the file containing the detector outputs



EXERCISES:
a) Did the outputs from the tallies match with that of the detectors? If not trouble shoot by looking up the units.

b) Play with the shell thickness in serpent. What is the optimal thickness given 10,000 source points? Speculate on why you need this thickness.

Exercise Tal2-4:



BACKGROUND: You may be interested in isolating particular contributors to flux and current such as finding flux from fission only or finding the flux given a specific energy range. Serpent and mcnp have many capabilities for refining tallies/detectors. The geometry for Tal2-4 is a basic fuel rod consisting of fuel surrounded by cladding, surrounded by water inside a box.

GOAL: Learn a few of the more nuanced features available for tallies/detectors. Using the simple fuel rod geometry provided, find the fission flux in the fuel, find the flux in the coolant in the energy range 0 to 6.25e-7 MeV, and find the positive surface current in the cladding.

INSTRUCTIONS:

<u>In mcnp:</u>

Make a fission detector:

- Make a flux detector using “f14”
- Specify the reaction using “fm14”

Make the coolant flux detector

- Make a flux detector using “f4”
- Specify the energy bin using “e4”

Make the positive current detector

- Mcnp does something interesting were it breaks down macrobody surfaces into simpler surfaces.
- Use the surface 2.1 for just the siding of the cylinder
- Make a current detector using “f1”
- Specify the directions of interest using “c1”

<u>In serpent:</u>

Make a fission detector:

- Specify the material using “dm”
- Specify the reaction type using “dr”
- Specify volume

Make the coolant flux detector

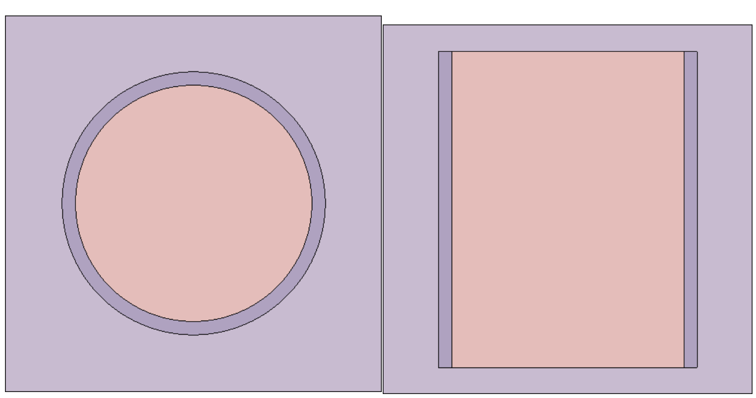
- Add an energy description using “ene”
- Make a cell detector
- Specify “de” to be the energy description you set

Make the positive current detector

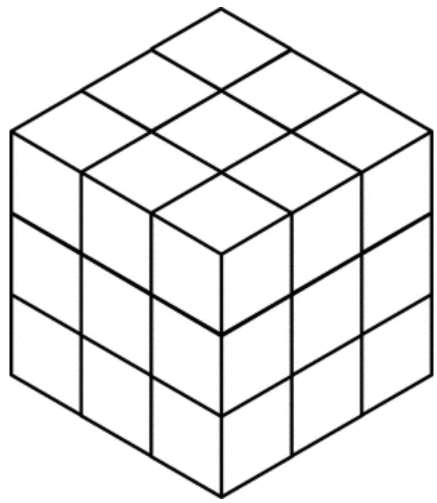
- Make a current detector on cladding
- Specify directionality 1

EXERCISES:

a) Was there a significant difference between using the partial surface in mcnp as opposed to the complete surface in serpent for the current detector? Why or why not?



Exercise Tal5:



BACKGROUND: Meshes are tallies/detectos set up as grids over a simulation. Meshes can be useful for looking at flux distribution in a simulation.

GOAL: Learn how to make a mesh tally/detector by applying a 10x10x1 grid over the godiva sphere created previously.

INSTRUCTIONS:

Copy g1 to tal5

<u>In mcnp:</u>
Add an fmesh4 command
Specify "geom=xyz" to make an xyz grid
Place the "origin" at -9 -9 -9 (this is really one corner)
Extend the mesh grid to 9 9 9 in each direction
Make the grid 10 in the x direction, 10 in the y direction, and 1 in the z direction

<u>In serpent:</u>
Add a detector with "dx" from -9 to 9 in 10 intervals,
"dy" from -9 to 9 in 10 intervals,
and "dz from -9 to 9 in 1 interval.
Remember to watch your units and specify the volume for the flux

EXERCISES:
a) Compare the outputs from the two programs. Are they within error?

b) Estimate the number of particles being tracked in each grid increment. Is this a reasonable number to produce accurate results?

c) Vary the number of grid increments and compare the results again to get a feel for how particle number and increment number must relate.