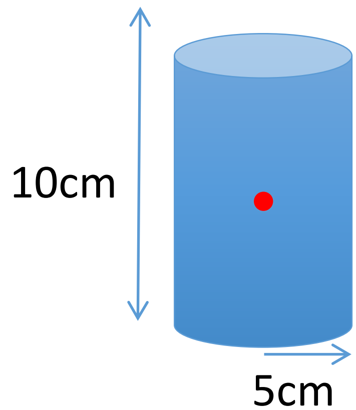
Exercise Source1:

BACKGROUND: Previously we have set initial neutron source points in our mcnp and serpent simulations. These sources were used for the initial cycle of neutrons in the inactive cycles. In the cycles which followed the neutrons source points were chosen by sampling the locations where fission occurred at the end of the first cycle It is however possible to set a custom source for all of the runs. This is useful for modeling simulation in the presence of a neutron source. MCNP is capable of modeling more than just neutrons.



Source1 is an input deck of a cylinder of H_2O with some dissolved nitrogen and carbon. A neutron source is placed in the center of the cylinder. Because this is not a neutron multiplying system, we do not run the simulation with a view to measuring k_{eff}. Instead the cell flux will be found for the cylinder.

GOAL: Learn how to use a simple point source by placing a source of 0.14MeV neutrons in the center of a cylinder.

INSTRUCTIONS:

<u>In mcnp:</u>
Use "sdef" to specify energy "eng=" and position "pos"
Set "mode" to n for neutron transport
Set "nps" to 1000, this is the activity of the source

<u>In serpent:</u>
Set "nps" to 1000
Place a point source "sp" at (0,0,5) with energy "se" 0.14MeV using "src"

EXERCISES:

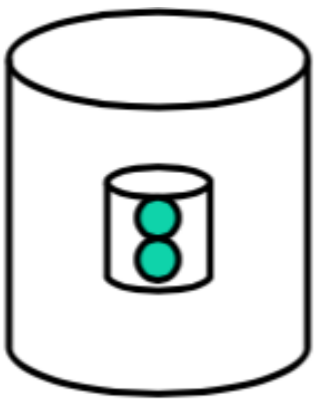
a) Run both input decks and compare the tally/detector results for the cell flux. Do the results match within error?

b) Re-run the serpent input deck using the –tracks command to visualize the neutron source. Does the source look like what you would expect?

Exercise Source3:

BACKGROUND: Because we rarely see true point sources in nature, it can be far more useful to model volumetric sources.

Source3 is a volumetric source of neutrons coming out of the bottom sphere in the geometry shown. This is a lead cylindrical shield containing 2 polyethylene spheres. The source is confined from -1 to 1 cm in the x,y,z directions, is located inside cell 40, and has two distinct energy peaks at 1.173 and 1.332 MeV of equal probability.



GOAL: Practice making a volumetric source and use the plotting features available in serpent to visualize the source.

INSTRUCTIONS:

Open the source3 deck provided

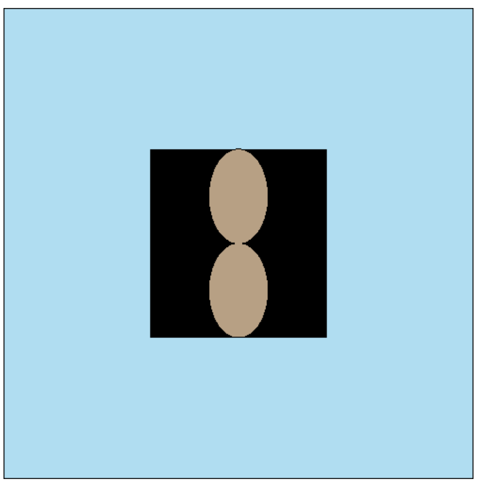
> <u>In mcnp:</u>
> Set “nps” to 1000
> Use SDEF to specify the energy “eng=”, the cell “cell=”, and the X,Y,Z distributions.
> For the distributions set X = D10, Y = D20, Z = D30, and energy = D40
> Use SI to specify the range in position and energy for each of the distributions. These will look like “SI10”, “SI20”…
> Similar to SI, use SP to specify the probability of finding the particle within that range.
> Set the position probability to 0 outside the range and 1 inside the range.
> Set the energy probability to be equal for each energy.

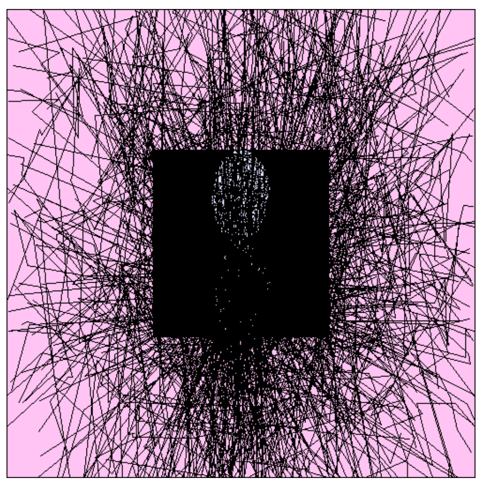
In serpent:
Set “nps” to 1000
Use src to specify energy “sb”, cell “sc”, and distribution in the X,Y,Z directions “sx”/“sy”/“sz”.

EXERCISES:

a) Run both input decks and compare the tally/detector results for the cell flux. Do the results match within error? Many of these exercises will be close but not quite within error. Speculate as to why.

b) Re-run the serpent input deck using the –tracks command to visualize the neutron source. Does the source look like what you would expect?





Exercise Source4:

BACKGROUND: It can also be useful to model more than one source in the same simulation. In MCNP this can be done using distributions while in serpent multiple source commands are required.

Source4 uses the same geometry as source3, a lead cylindrical shield filled with 2 polyethylene spheres. It contains two point sources, one in the center of each sphere. The top source having energy 1.88 MeV and the bottom source having 0.14 MeV.

GOAL: Learn to place multiple sources in the same simulation.

INSTRUCTIONS:

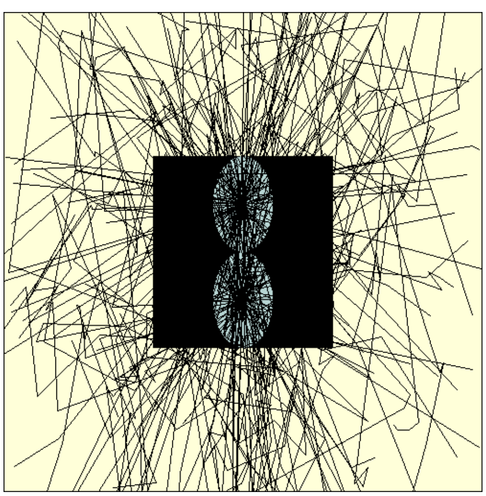
Copy source3 to source4.

<u>In mcnp:</u>
In the sdef command set the source position to 0 in the x and z directions.
Set the y position to a distribution, such as D20.
Set energy to be a function of y using "=FY", and set it to be a distribution using "=D45" in the same equality.
Set distribution 20 to be two discrete values, 0 and 2, and make those values of equal probability
Using the command "ds45" set the distribution function to 0.14 MeV corresponding to y=0 and 1.88 MeV corresponding to y=2

<u>In serpent:</u>
Specify 2 sources by using two "src" commands.
For each command specify the point source using "sp"
Specify the energy for each point using the command "se"

EXERCISES:
a) Run both input decks and compare the tally/detector results for the cell flux. Do the results match within error? Many of these exercises will be close but not quite within error. Speculate as to why.

b) Re-run the serpent input deck using the –tracks command to visualize the neutron source. Does the source look like what you would expect?



Exercise Source5:

BACKGROUND: Another useful type of source is the surface source. These can be useful for modeling beam sources with known energy and/or angular distributions, such as neutron beamlines in a TRIGA reactor.

Source5 has the same geometry as source3. The sources are surface sources located on the 2 spherical surfaces. These are spherical sources however disks are also commonly used for beam studies. The bottom source has energy 0.14 MeV and the top source has 1.88 MeV.

GOAL: Learn to create surface sources using the geometry given in source3.

INSTRUCTIONS:

Copy source4 to source5. Delete the previous source descriptions.

<u>In mcnp:</u>
Use the "sdef" command to specify radius, position, and energy.
Energy should be a function of position "fpos"
Describe the center positions of both sphere using the "si" and "sp" commands
Describe depences of energy on position using the "ds" command
Use "si" and "sp" to describe the radius
For the radius "sp" use "-21 2". This tells mcnp that the probability is proportional to R^2

<u>In serpent:</u>
Create 4 independent sources using "src", you will need 4 to specify both inwards and outwards direction for the 2 sources.
Use the "ss" command to specify surface source, as before neg numbers are inward and pos numbers are outward.
Use the "se" command to specify energy.

EXERCISES:
a) Run both input decks and compare the tally/detector results for the cell flux. Do the results match within error? Many of these exercises will be close but not quite within error. Speculate as to why.

b) Re-run the serpent input deck using the –tracks command to visualize the neutron source. Does the source look like what you would expect?