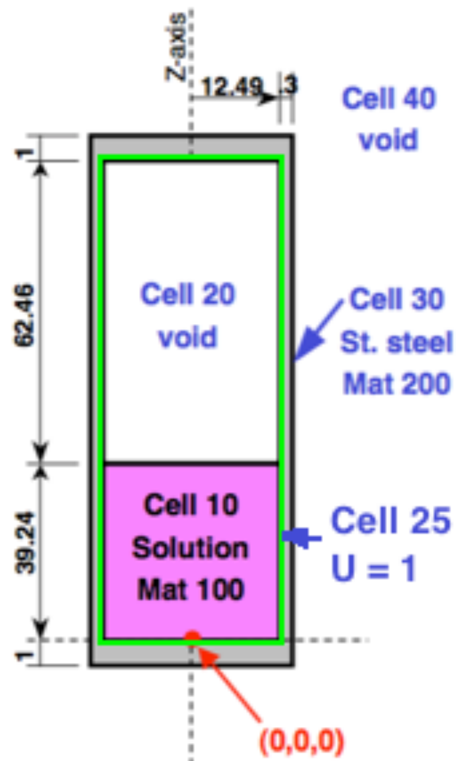
Exercise 1: Puc2

BACKGROUND: Both mcnp and serpent use the concept of universes. Universes are like different sketches that you can cut and paste from to create your final design. Both mcnp and serpent use the command “fill” to cut a section of one universe and fit it into a surface in another universe. In the previous exercise set we created an input deck for puc1, a steal container filled partially with fissile material in solution. It was noted that there are many ways to create the same geometry using mcnp/serpent. Here is another way of creating this geometry.

GOAL: Recreate the same geometry as puc1 using 2 universes. One of our universes (universe 1) will be an infinite sea of fissile material in solution underneath an infinite sky of void. The base universe, or universe which is run, will then contain the metal container surrounded by void. Inside the container will be cell 25 which will be filled with universe 1. This should produce identical geometry to puc1 and so should produce identical keff values. You should leave this exercise with a basic understanding of what a universe is and how to move between universes.



INSTRUCTIONS:

Open the puc2 folders provided. Theses folders are completed puc1 folders just to get everyone started at the same place.

You should be able to edit the cells cards to make puc2.

In mcnp you do not need to specify your base level universe (the universe which the simulation will actually run).

In serpent you must specify your base level universe as universe 0 and all other universes must be fully defined in order for the simulation to run.

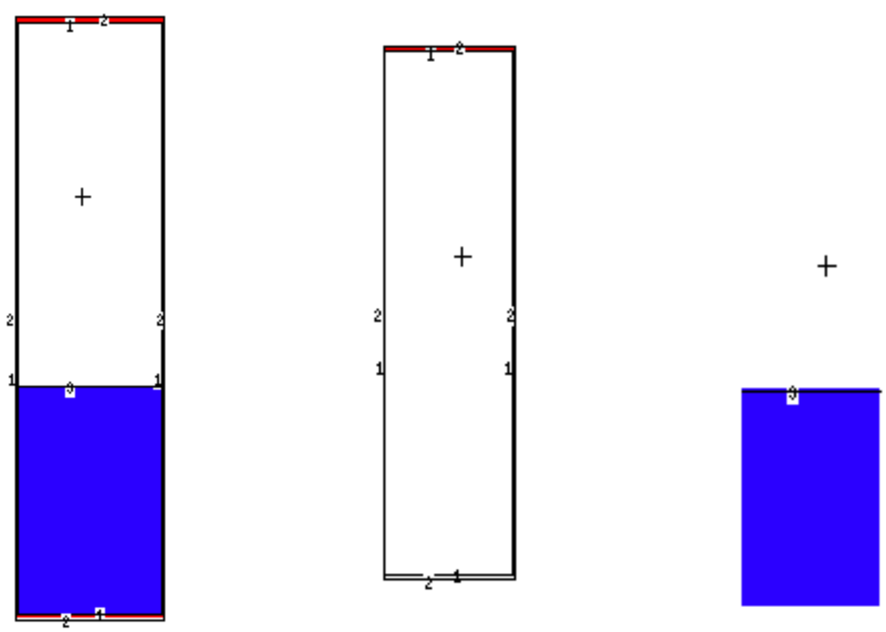
For more help, read the instructions in all caps in the input deck.

EXERCISE:

a) Run both of the completed input decks. Do the resulting keff values match within error? Record keff. How does keff for puc2 compare to keff for puc1?

b) Rerun the mcnp file using the plot command. Adjust the “Level” on the plot window and press “Redraw.” What are these levels?

Level - Level 0 Level 1



Exercise 2: Puc4

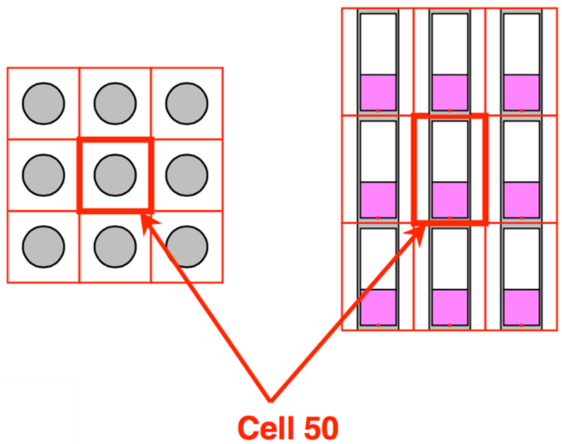
BACKGROUND: Mcnp and serpent also have the concept of a lattice. Lattices are repeated geometries created by defining a universe and then repeating that universe with a consistent spacing.

In mcnp, defining a universe to be in a lattice will create an infinite number of the geometries. To reduce the mcnp lattice to a finite size you must use the fill command to crop part of the lattice into another universe.

In serpent lattices are finite in size. To model an infinite lattice in serpent you can change the boundary conditions of a geometry to be reflective.

Puc4 is intended to model an infinite number of the containers from exercise puc1. These containers are infinite in both the horizontal and vertical directions.

GOAL: Create an infinite lattice which repeats the solution container from puc1 in the x, y, and z directions.



INSTRUCTIONS:

Go back to the puc1 exercise again, provided in the Puc4 folder.

Create a fourth surface which is a rectangular prism (-17.79:17.79) in the x & y directions, and (-1:102.7) in the z direction.

Put your container full of solution into this box and call it cell 50.

<u>In mcnp</u>
Create an infinite lattice by using the lattice command on cell 50.

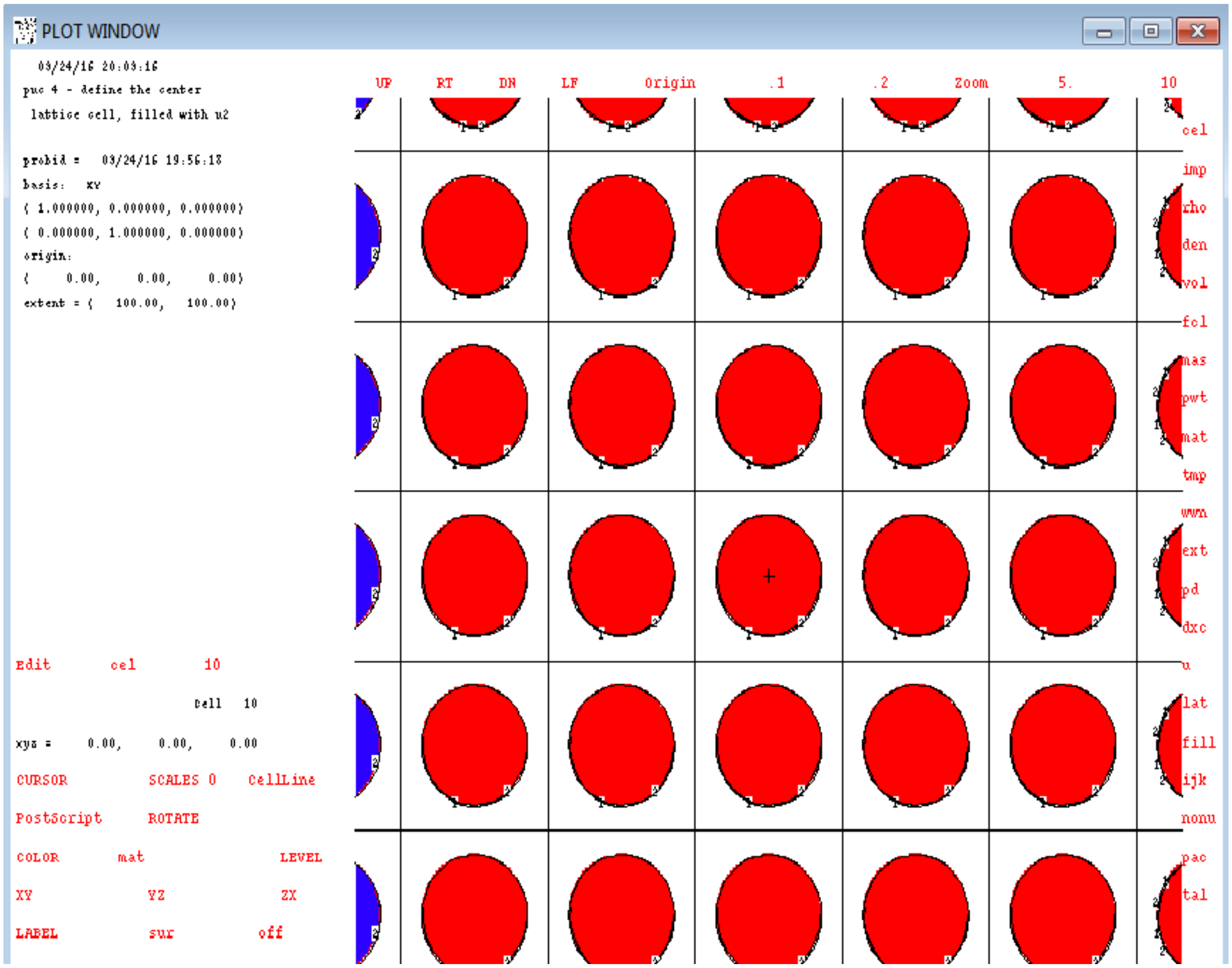
<u>In serpent</u>
Create a model of an infinite lattice by applying reflective boundary conditions to the geometry.

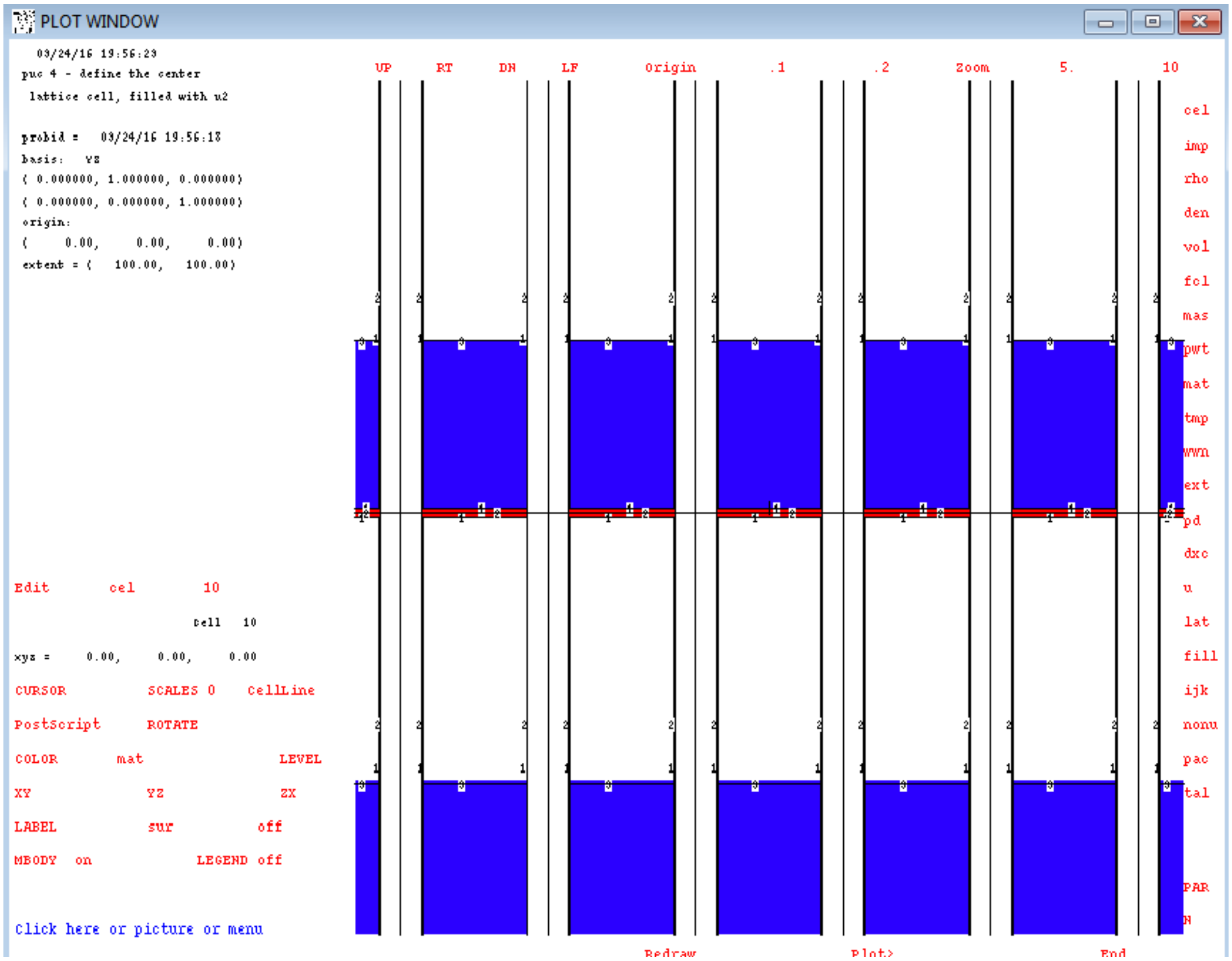
EXERCISE:

a) Run both of the completed input decks. Do the resulting keff values match within error? Record keff. How does keff for puc4 compare to keff for puc1? How does the run time compare?

b) consider the use of an initial source. How might this source affect the results? Does it make sense to use a source or should it be taken out?

c) Rerun the mcnp deck and plot the results.





Exercise 3: Puc5

BACKGROUND: Most reactors do not contain fuel elements stacked vertically, however it can be useful to approximate a reactor as infinite in the x and y direction.

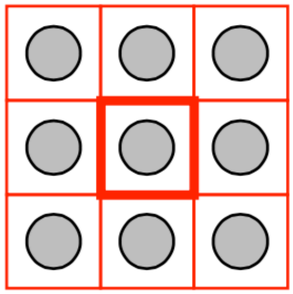
Puc5 represents an infinite number of containers in the horizontal directions but is singular in the vertical direction.

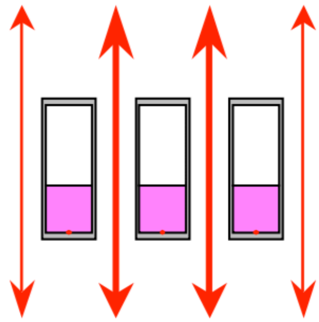
GOAL: Make a lattice which is only infinite in the x and y direction, and is one layer high in the z direction.

INSTRUCTIONS:

Copy your folders from puc4 to puc5.

<u>In mcnp</u>
Make the rectangular prism infinite in the z direction. This is done by making the prism from z=0 to z=0. If the box is infinite, it cannot repeat.



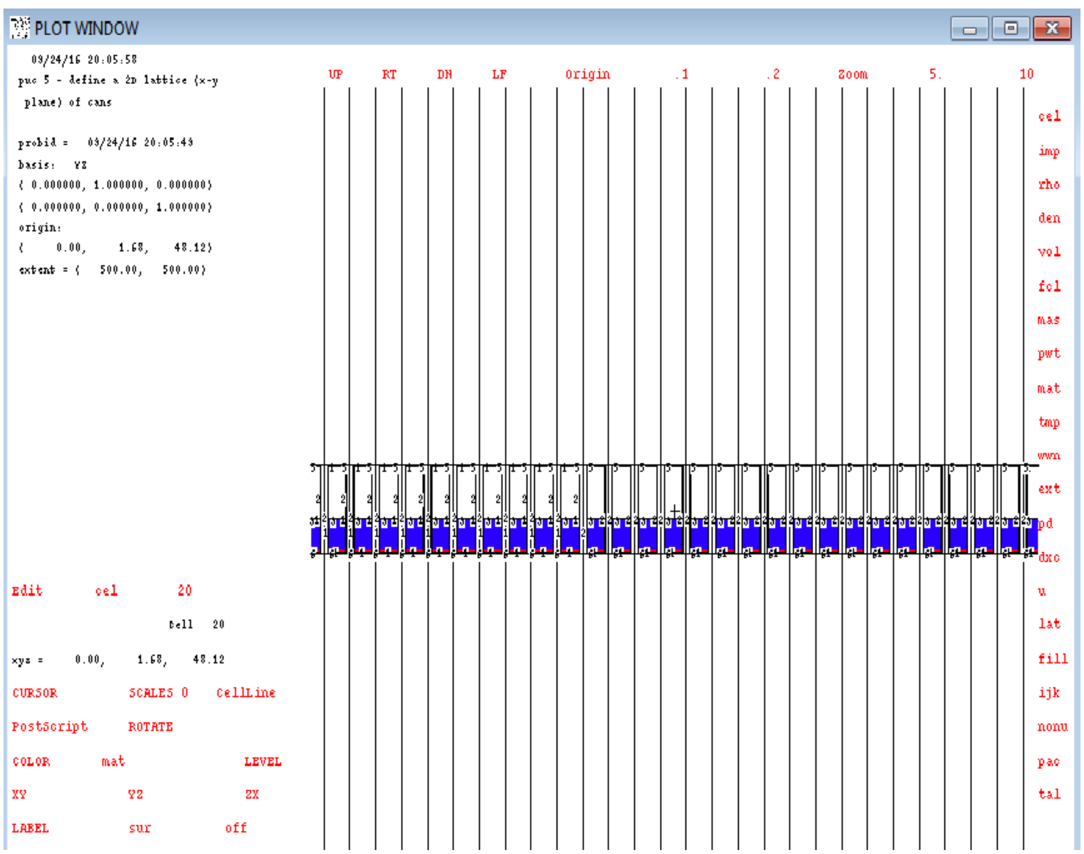


In serpent
Specify reflective boundary conditions in the x and y direction and vacuum boundary conditions in the z direction.

EXERCISE:

a) Run both of the completed input decks. Do the resulting keff values match within error? Record keff. How does keff for puc5 compare to keff for puc4?

b) Rerun the mcnp deck and plot the results.



Exercise 4: Puc6

BACKGROUND: Real reactors are finite. It is useful to be able to create finite reactors using repeated universes.

Puc6 consists of 6 containers placed in 2 rows of 3 without any vertical stacking.

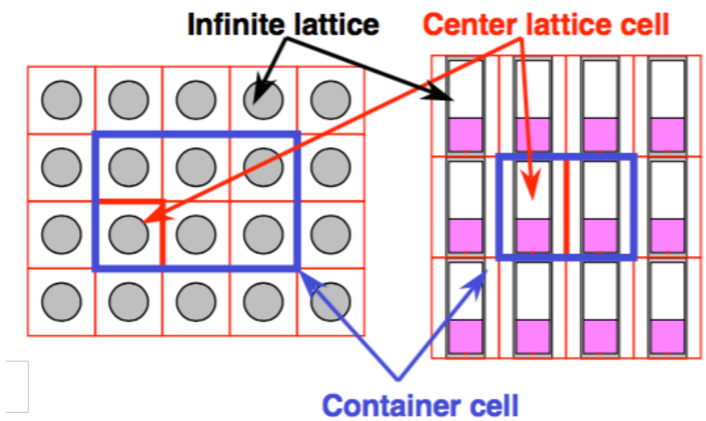
GOAL: Make a lattice which is a finite 2x3x1 lattice. This exercise will give you practice using the fill command in mcnp and will give you new experience using the lat command in serpent.

INSTRUCTIONS:

Copy puc4 to puc6 or puc1 to puc6.

Make surface 5 a rectangular prism capable of containing a 2x3x1 lattice.

<u>In mcnp</u>
Define a lattice in one universe
Crop the 2x3x1 from one universe into the base universe using the fill command.
Check your initial source and make sure it makes sense



<u>In serpent</u>
Make sure boundary conditions are vacuum.
Use the lattice command to make a 2x3x1 lattice of universe 1.
Lat type 1 should make a simple square lattice.
The lattice in serpent is just a special kind of universe. Call it universe 2 ("lat 2").
Fill the base universe with universe 2 inside of surface 5.
Add some plots and meshes to view your work.
Check your initial source and make sure it makes sense

HINTS:

Make sure all universes are defined in all space.

In serpent you will specify the center point of your lattice, make sure this lines up with the dimensions of surface 5.

EXERCISE:

a) Run both of the completed input decks. Do the resulting keff values match within error? Record keff.

b) Rerun the mcnp deck and plot the results. Compare these to the serpent plots.