Estimate the Radiation for Hall-B Polarized Target Design Using FLUKA

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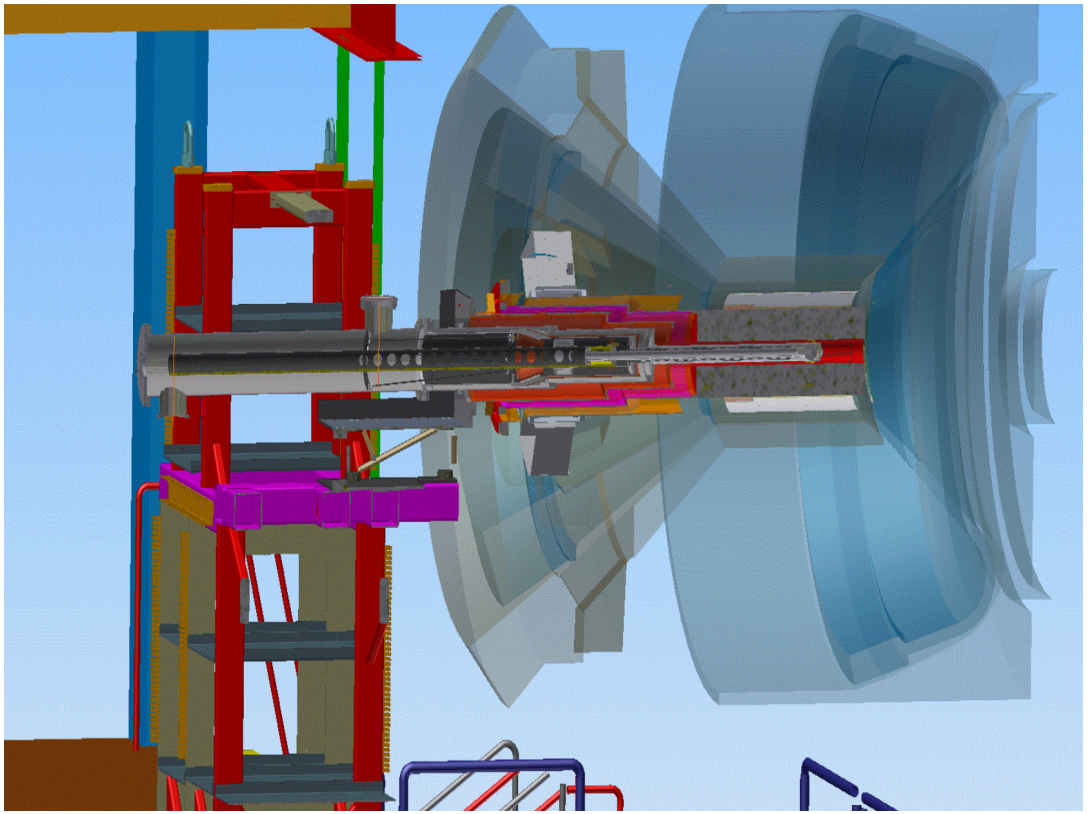
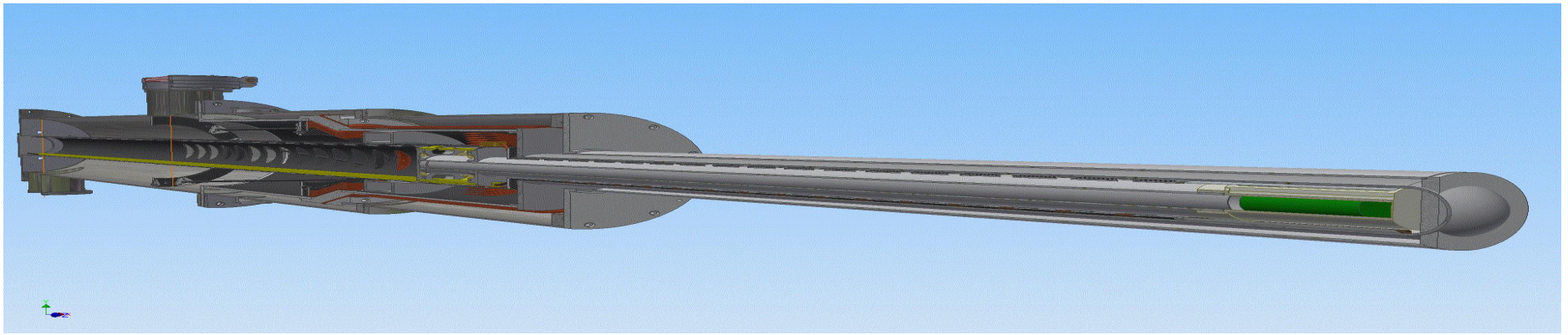
Hall-B Double-Cell Polarized Target





Project Description

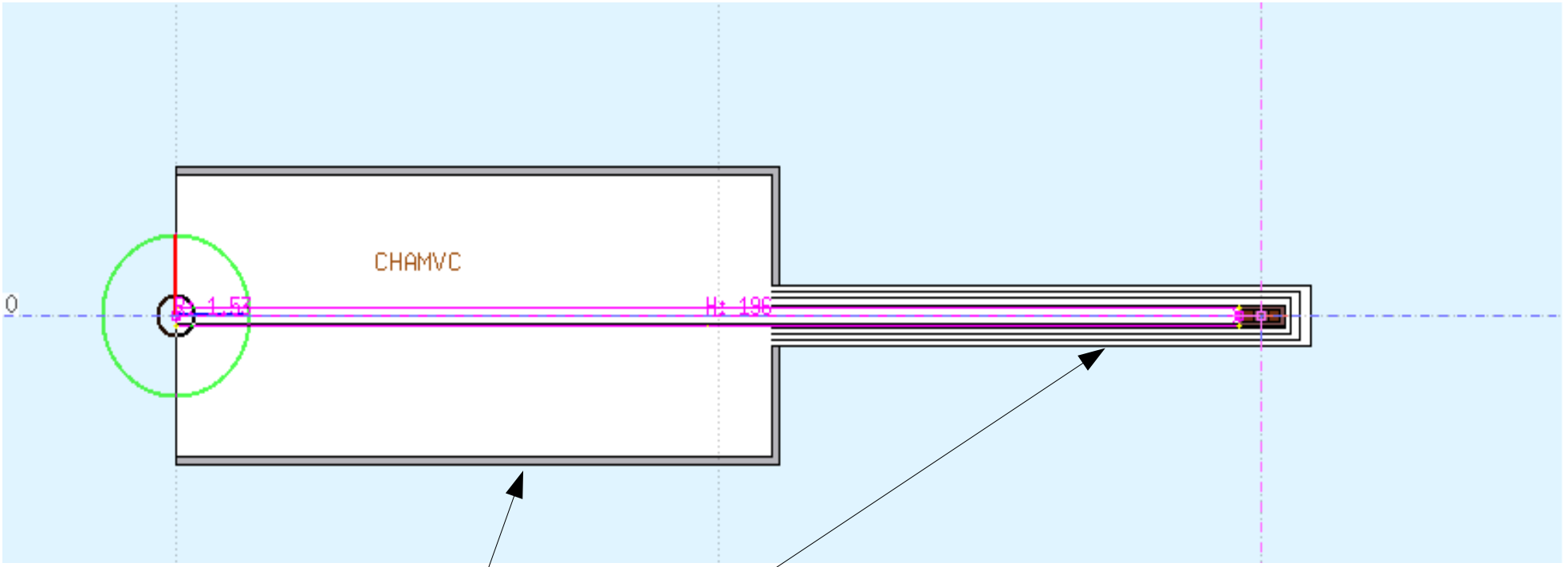
Hall-B double-cell polarized target:

1. Beam:
   90 days 11 GeV beam at 10nA current. Circle raster with 1.9cm diameter

2. Materials that the electron beam will see(from James):

   -Entrance window to helium bath: 0.015''(0.0381cm) Aluminum
   -Helium bath (0.5cm-1mil)
   -entrance window of cell 1: 0.001''(0.00254cm) Aluminum
   -target material (60% NH3, 40% liquid Helium, 2cm in length)
   -exit window of cell 1: 0.001''(0.00254cm) Aluminum
   -Helium bath (3cm-2mil)
   -entrance window of cell 2: 0.001''(0.00254cm) Aluminum
   -target material (60% NH3, 40% liquid Helium, 2cm in length)
   -exit window of cell 2: 0.001''(0.00254cm) Aluminum
   -Helium bath(0.5cm-1mil)
   -exit window of bath: 0.001''(0.00254cm) Aluminum
   -heat shield: 0.001''(0.00254cm) Aluminum
   -exit window from target: 0.015''(0.0381cm) Aluminum

Geometry in FLUKA



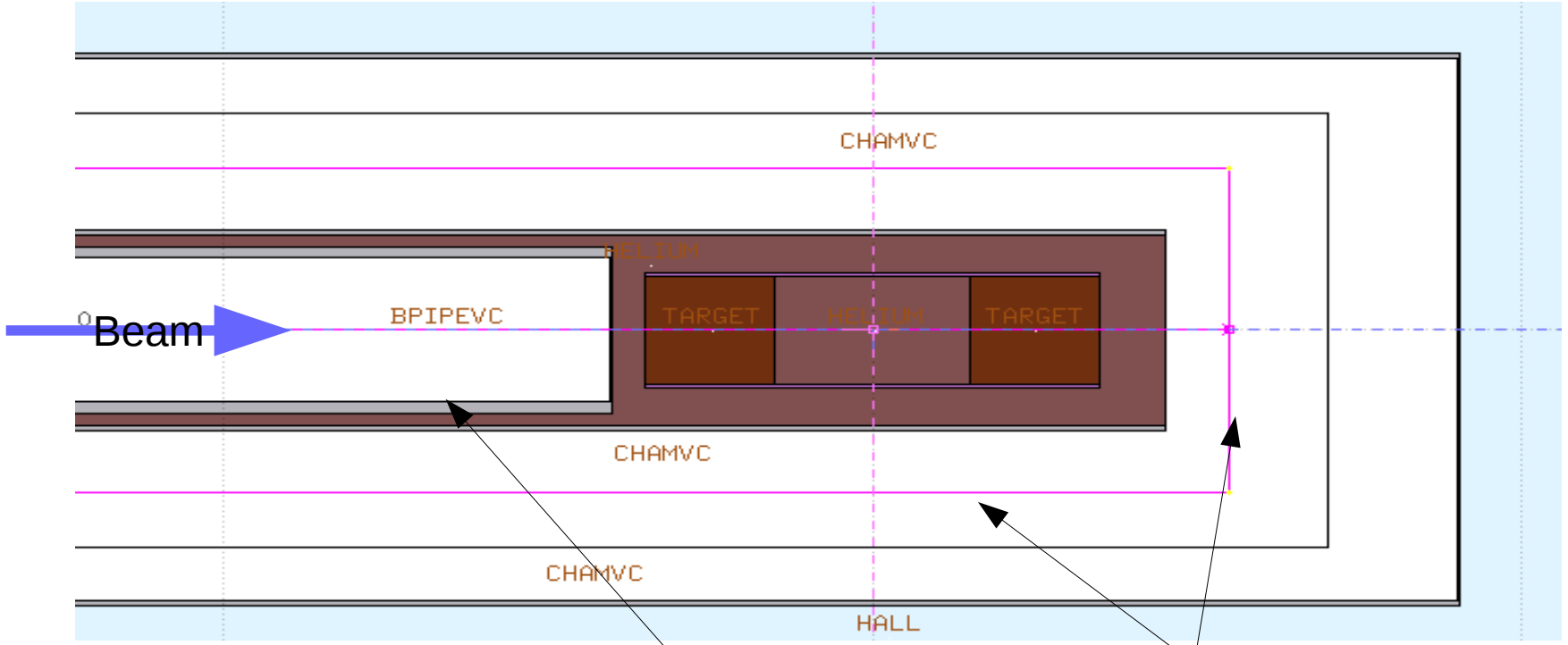
Values might need to know:

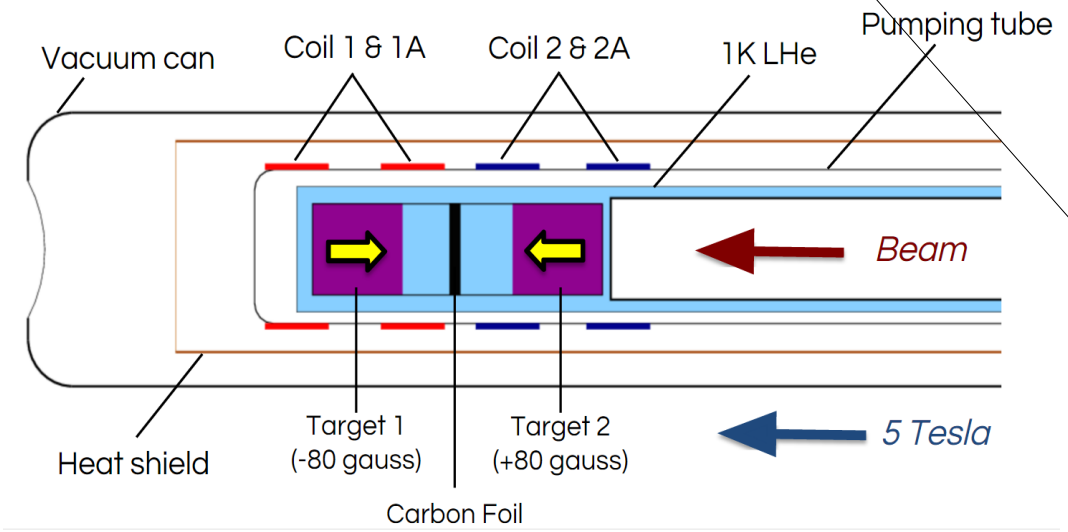
1. Thickness of the pipe connected to the nose, I am using 0.5” now.

2. Thickness of the nose itself; I am using 0.04” now.

I did not add 5T target field. Since the radiation mainly come from neutron or photon, This field will not affect the radiation result.

Geometry in FLUKA (Zoom in)

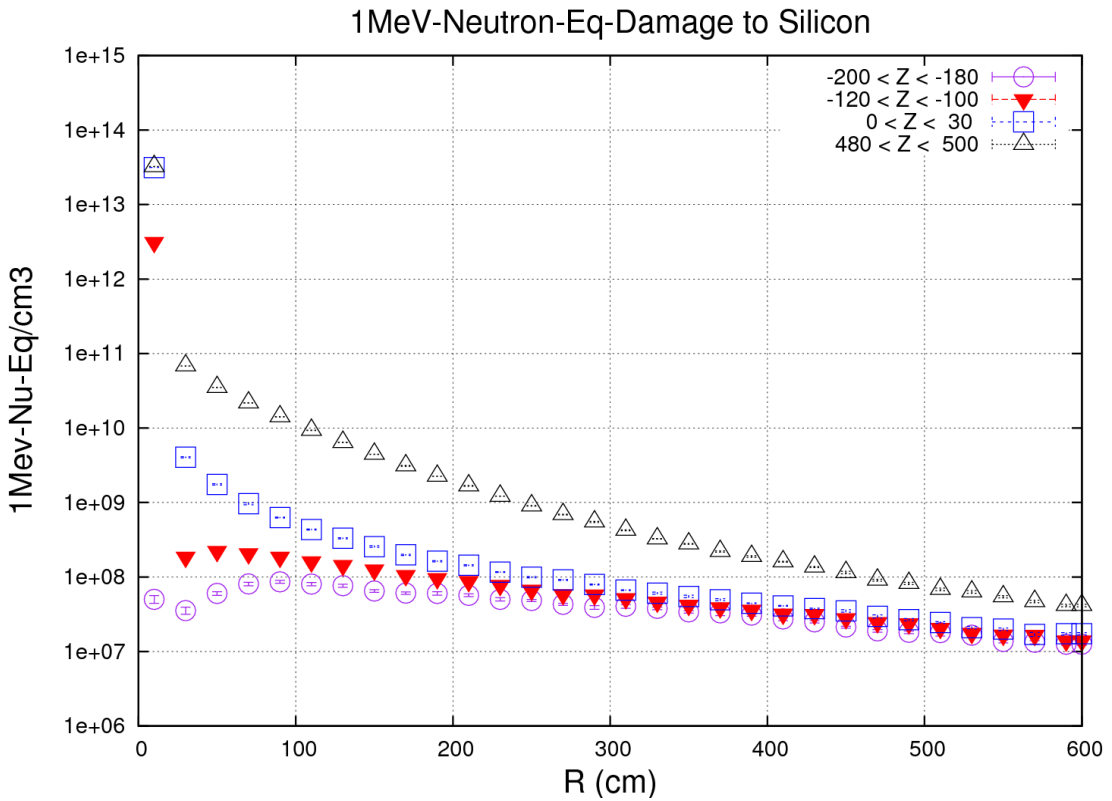




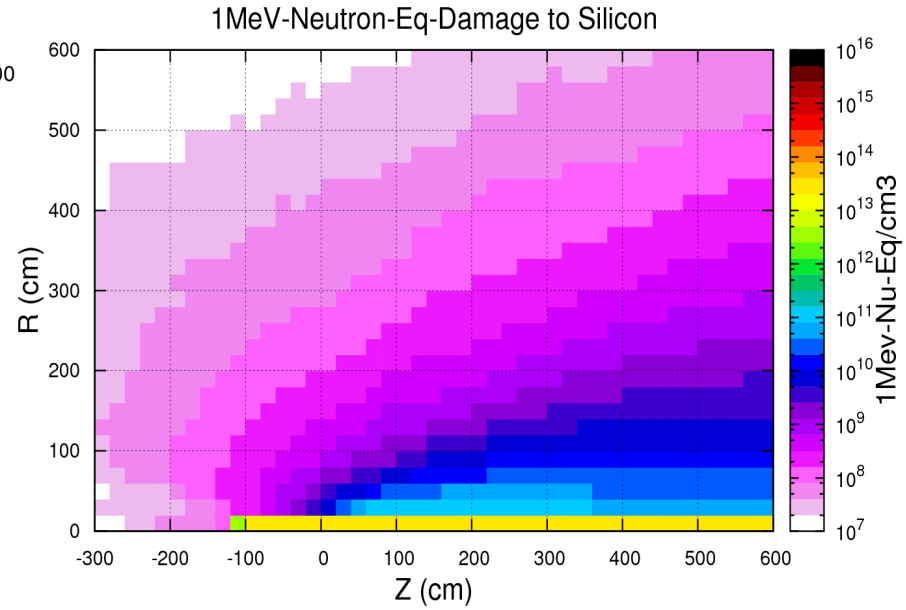
Values might need to know:

1. Thickness of the side of the pumping tube and its bottom. I am using 0.001" now.
2. Thickness and diameter of the beam pipe, I am now using 0.2cm.

Accumulated Damage

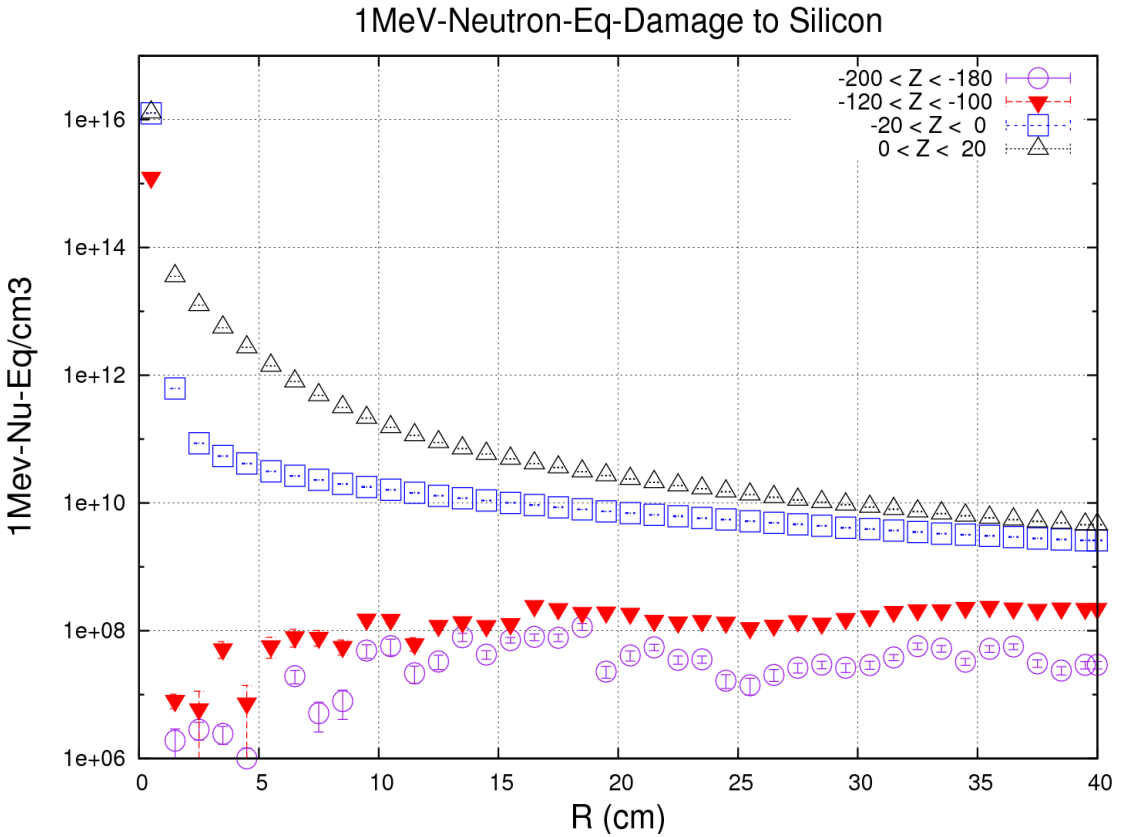


90 days, 11 GeV beam with 10nA current
20cm each bin.



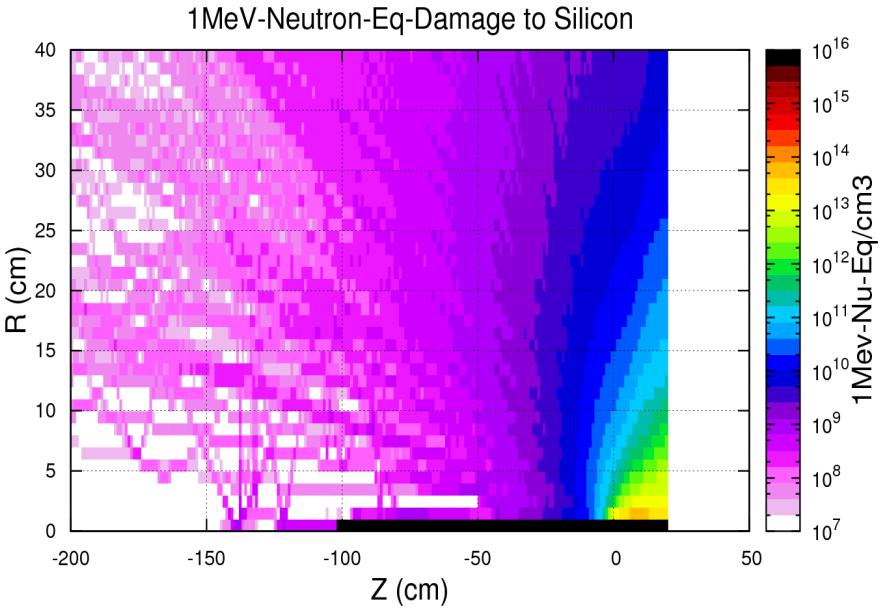
Conclusion:
It is safe to place detector at any location with R>20 cm.
Need to change bin size in order to study for area with R<20cm.

Accumulated Damage (Zoom in)

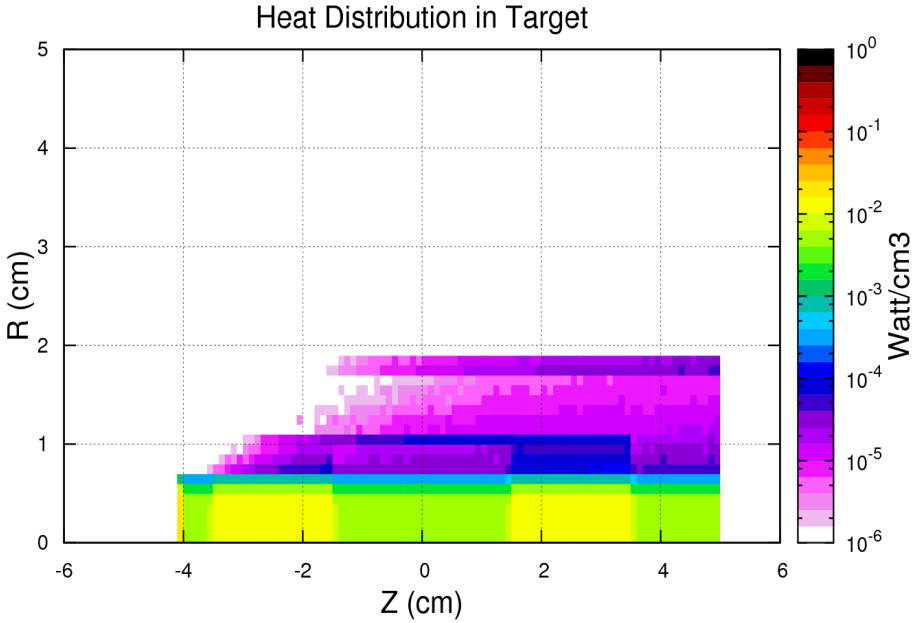


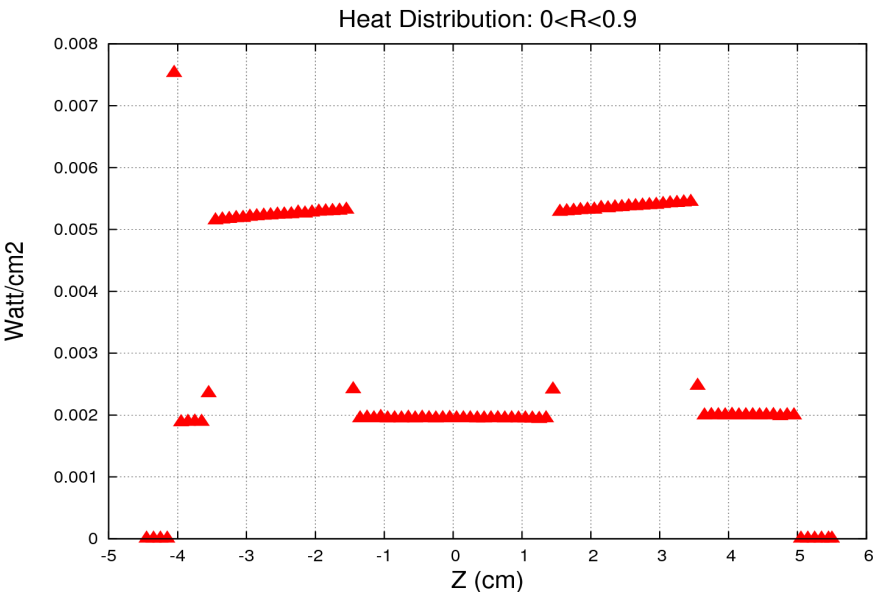
90 days, 11 GeV beam with 10nA current
1cm each bin.

Conclusion:
It is safe to place detector at any location with R>5 cm. Of course it should not block the outgoing particle from reaching CLAS12 detectors.



Heat Load in Target

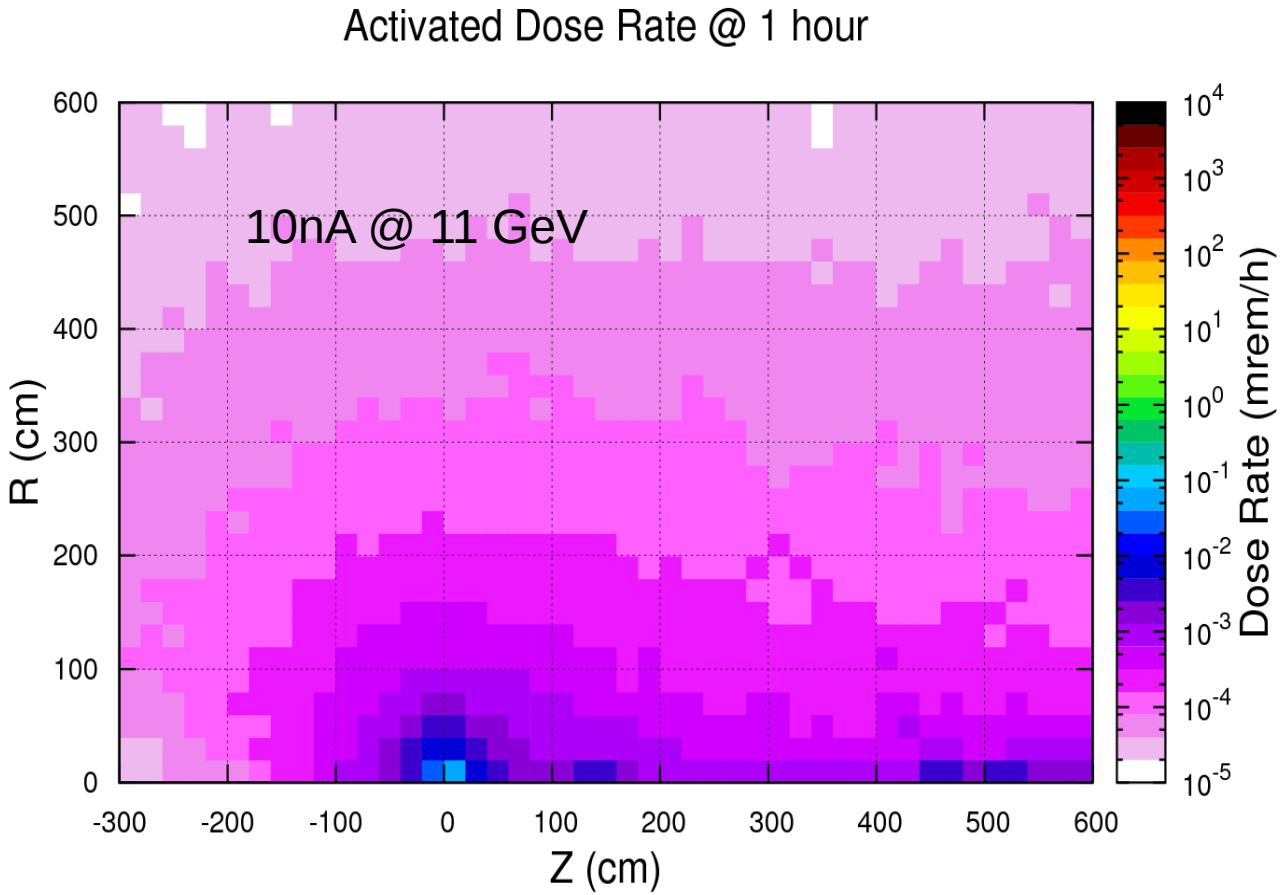




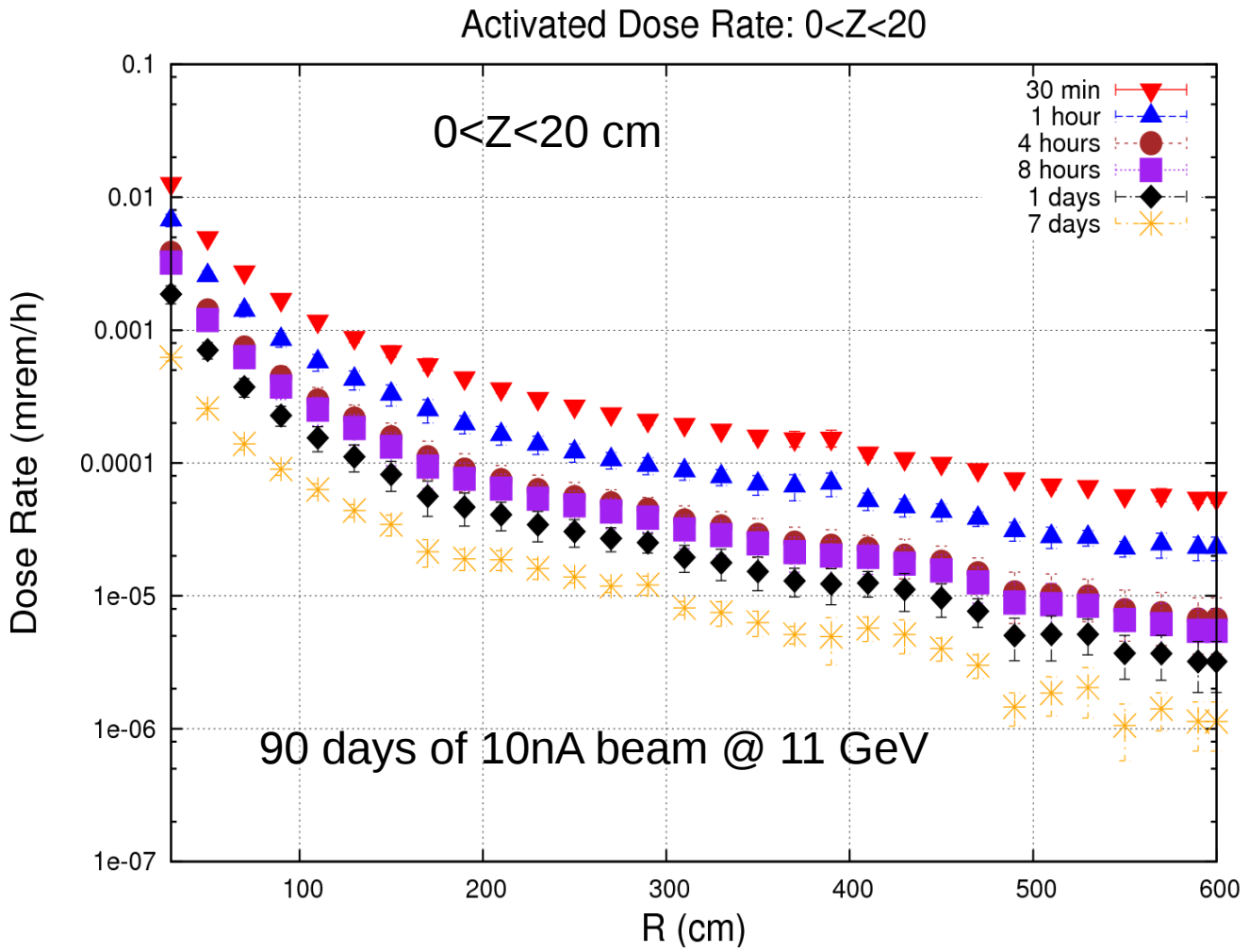
10nA beam @ 11 GeV

Conclusion:
The heat power in target is ~0.0055 w/cm^2.
For 1.9 diameter raster size, the total heat loan in each target cell is ~0.0312 watt.

Activation Map @ 1 hour (2D)



Dose Rate from Activation



Conclusion:
Negligible everywhere. No need to worry about activation.

Summary

1) FLUKA simulation has been performed Hall-B double-cell polarized target assuming 11 GeV beam with 10nA beam current for 90days. I did not use 5T target field since it will not affect the radiation result in this project.

2) The accumulated 1MeV neutron equivalent damage to silicon for area with Z<20cm and R>5cm is below 10^13. It will be safe to place detectors or electronics in this area.

3) Heat load in target is about 5.5 mili-watt per cm^2, or about 31.2 mili-watt for each target cell.

4) Dose rate from activation is negligible everywhere.