Dosimetry and neutron fluxes for ePIC – hadron beam+gas

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Preliminaries (PYTHIA)

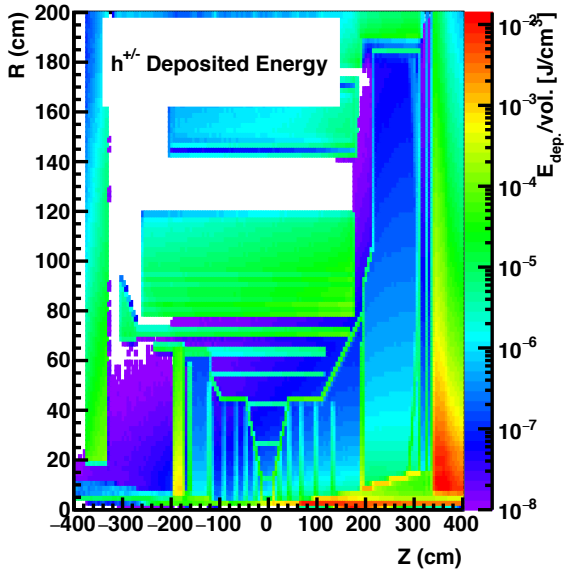
- Using PYTHIA6 minBias sample from the Yellow Report (in eic-smear format).
  - e+p 18x275 GeV beam energy configuration.
  - $Q^2 < 1.0\ GeV^2$ (other samples are available and can be processed).
  - ~200M events used in GEANT simulation.
  - GEANT simulation performed using “starsim” (GEANT3) with Yuri’s settings
    - Studies now done for both “arches” and ”bryceCanyon” – the latter shown here.
    - Using GCALOR for hadronic transport, very low threshold for neutrons.
  - Doses reported for gamma, electrons, and charged hadrons.
  - All results shown for ~1 run (6 months of active running) with top luminosity (amounting to 500kHz minBias rate).
    - Note: I am using the 500kHz with the “wrong” beam energy (500 kHz is for 10x275GeV).
  - The Wiki is updated, and more updates will follow.

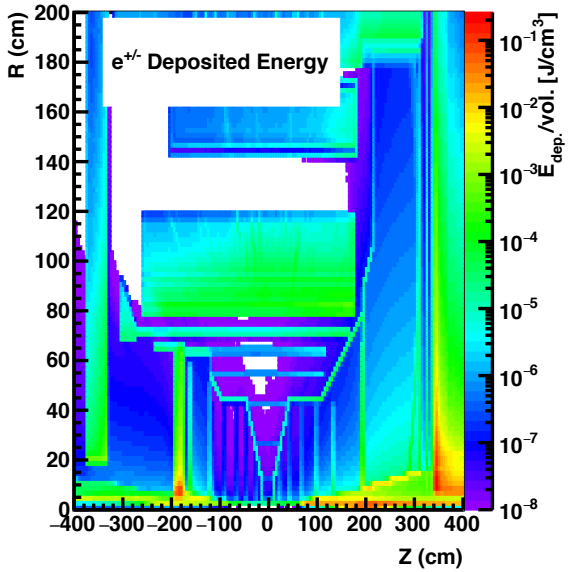
Hadron beam+gas (275 GeV proton beam)

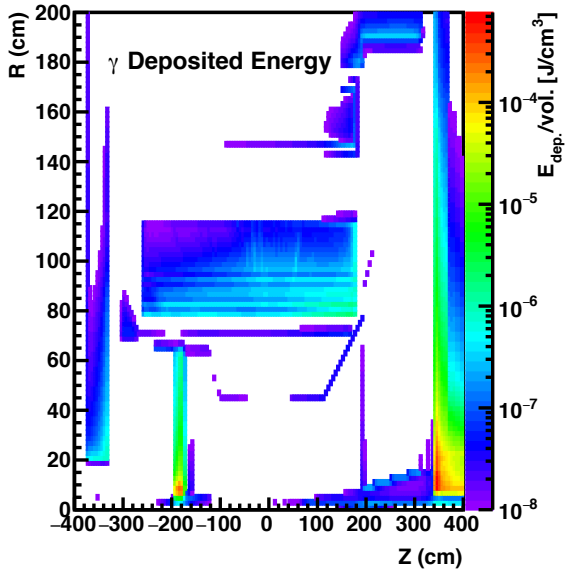
- Hadron beam+gas events primarily fixed target p+H2 collisions.
  - Using Pythia p+p events for production of particles, then scaling the cross section by a factor of 2.
- Rate (22.5 kHz) extracted from table on Wiki.
- Assumes ”best” case vacuum (important point).

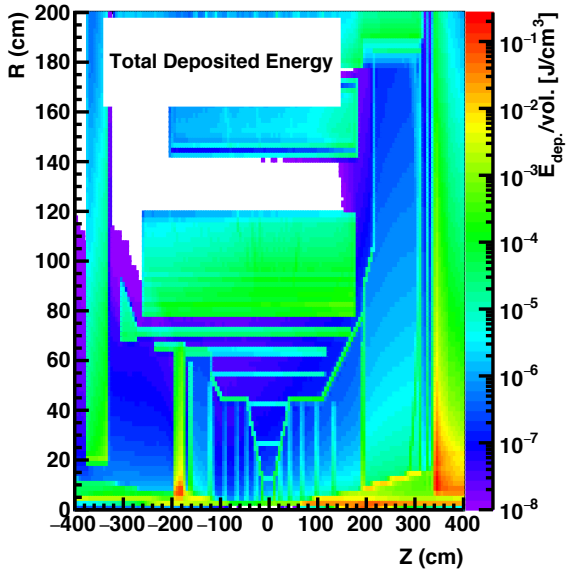
PYTHIA e+p

Energy deposition (central detector)



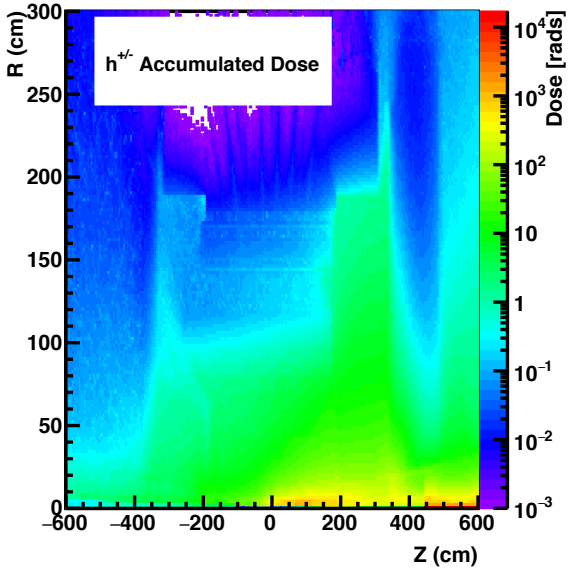


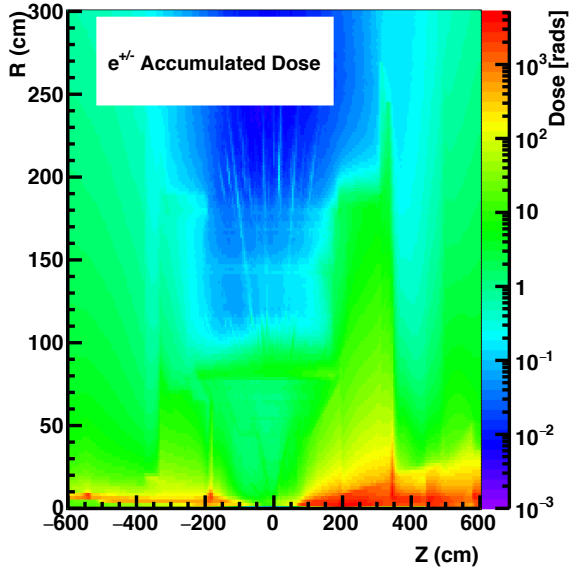


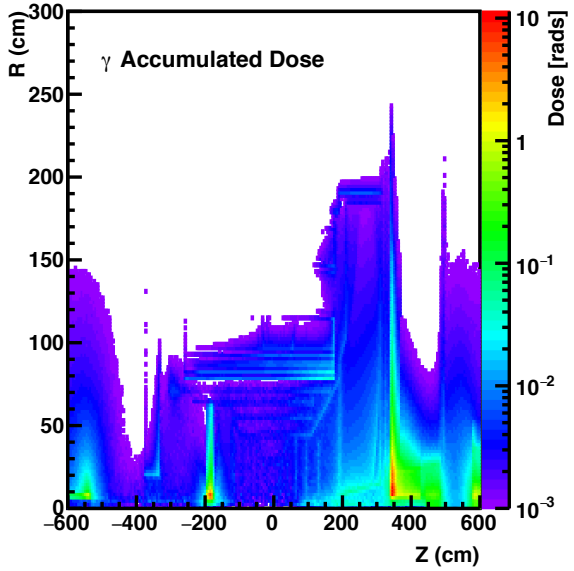


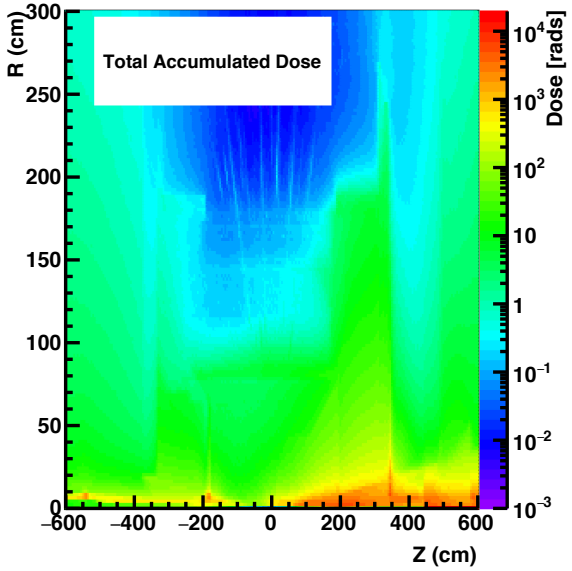
- Energy deposit from electrons and hadrons most significant.
- Hot spots:
  - hadron endcap near the beamline.
  - beamline components on the hadron-going and electron-going side.
  - Electron endcap near beampipe.

Accumulated Dose ($h^{+/-}$, $e^{+/-}$, γ) (central detector)



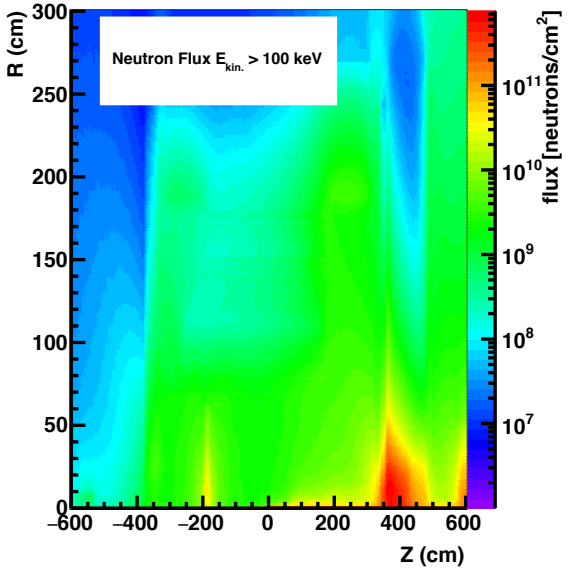


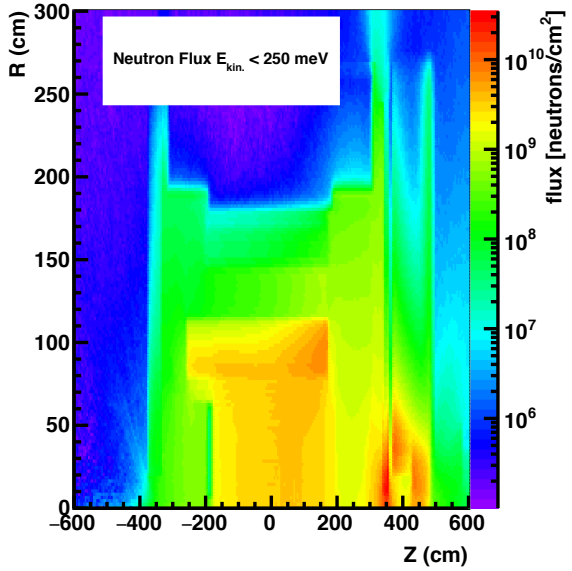


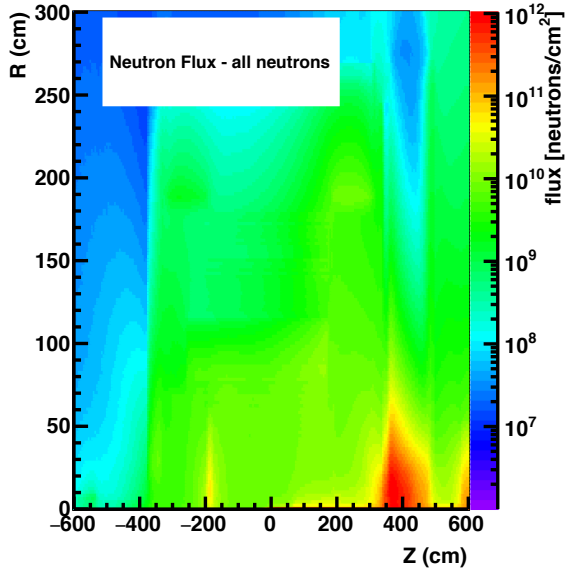


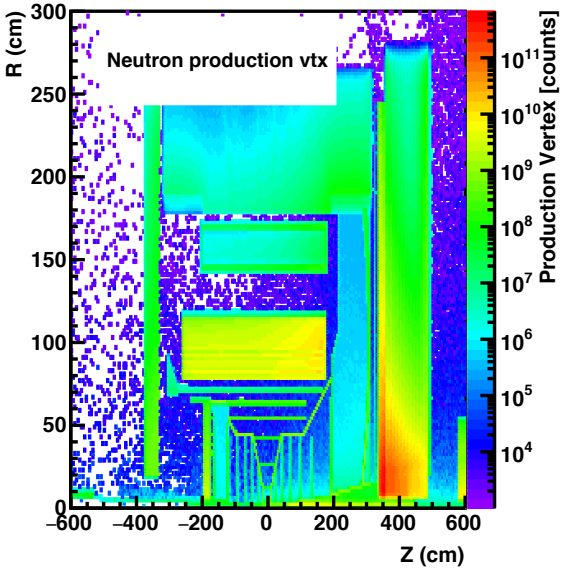
- Rates in most regions of ePIC < 10 krad for one run.
- Problem spots are near the beamline.
- Doses are overall quite manageable

Neutron Fluxes (central detector)



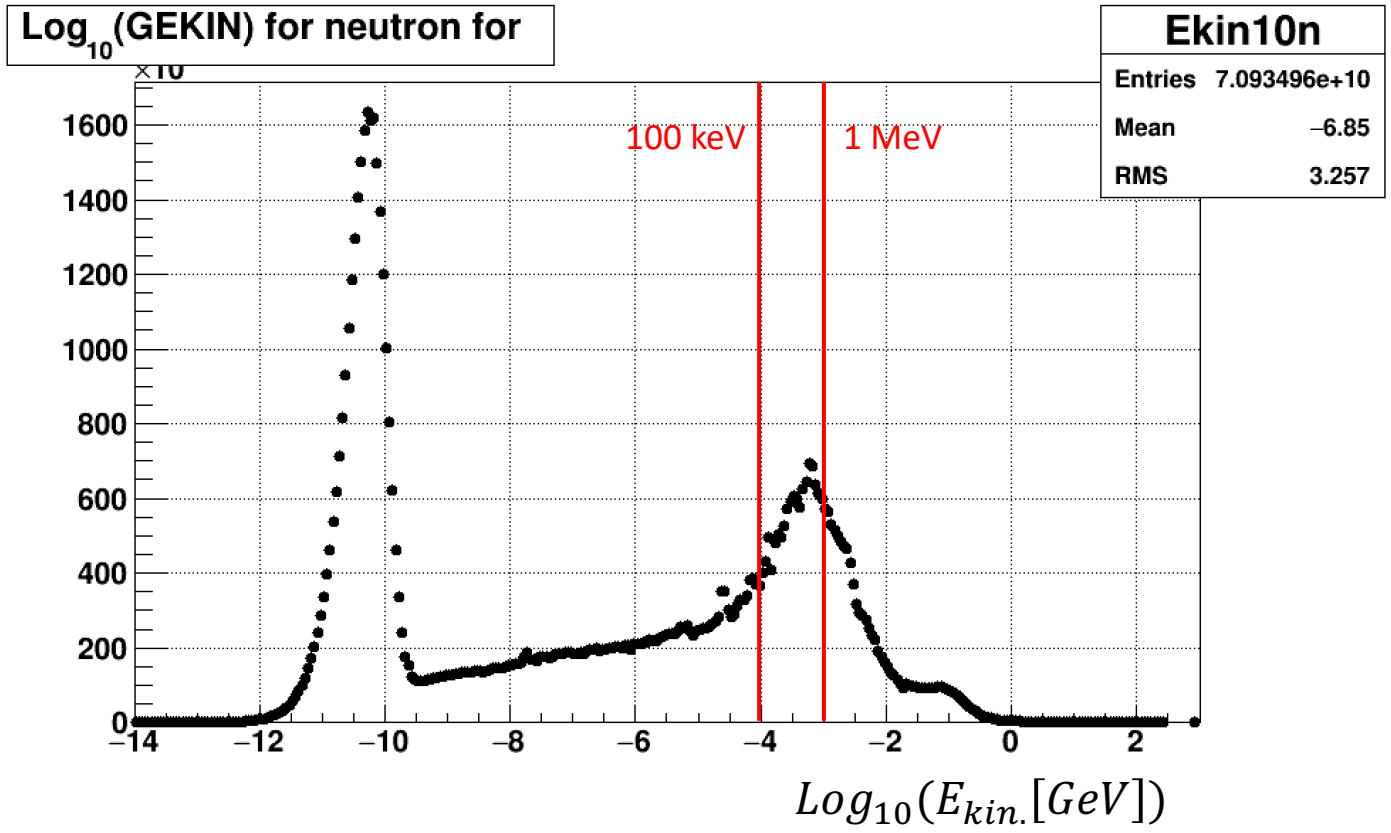


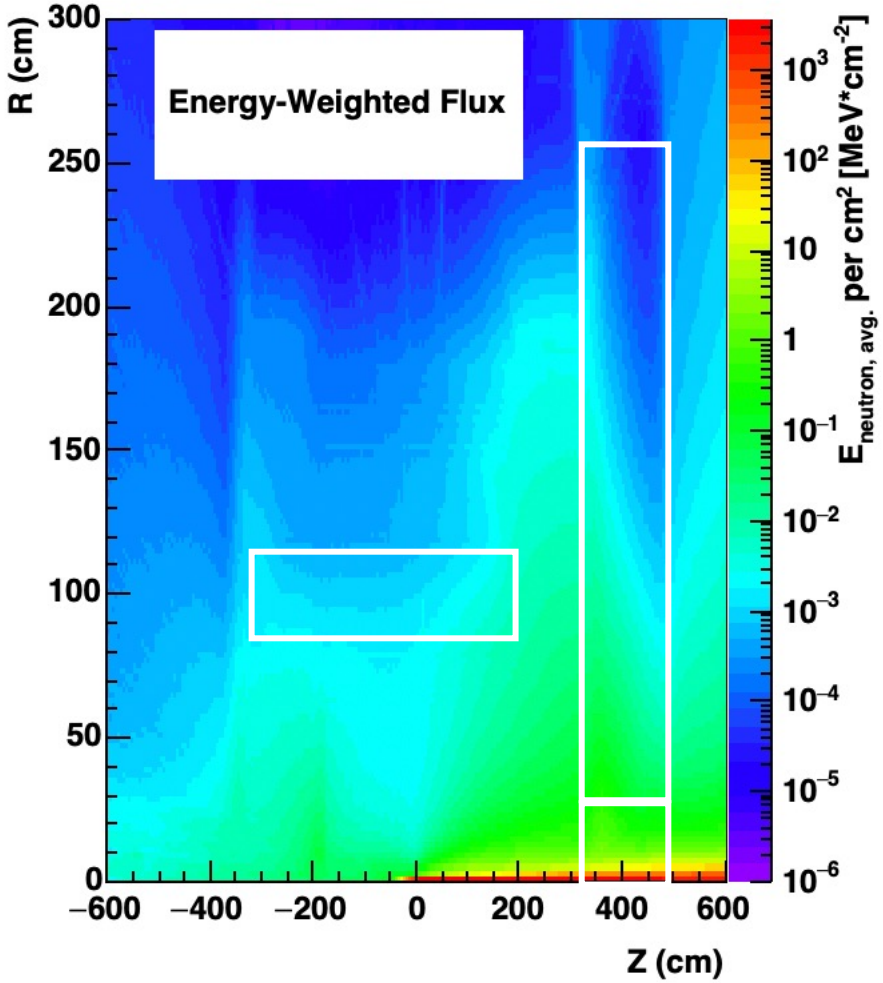




- Thermal neutrons mostly absorbed in the endcap and barrel*.
  - *Major difference between SciGlass and Imaging system.
- Fast neutrons mostly in endcap and in the B0pf magnet + detector area.
- Most neutrons produced within the endcap, close to the beampipe, and in the imaging EMCAL.

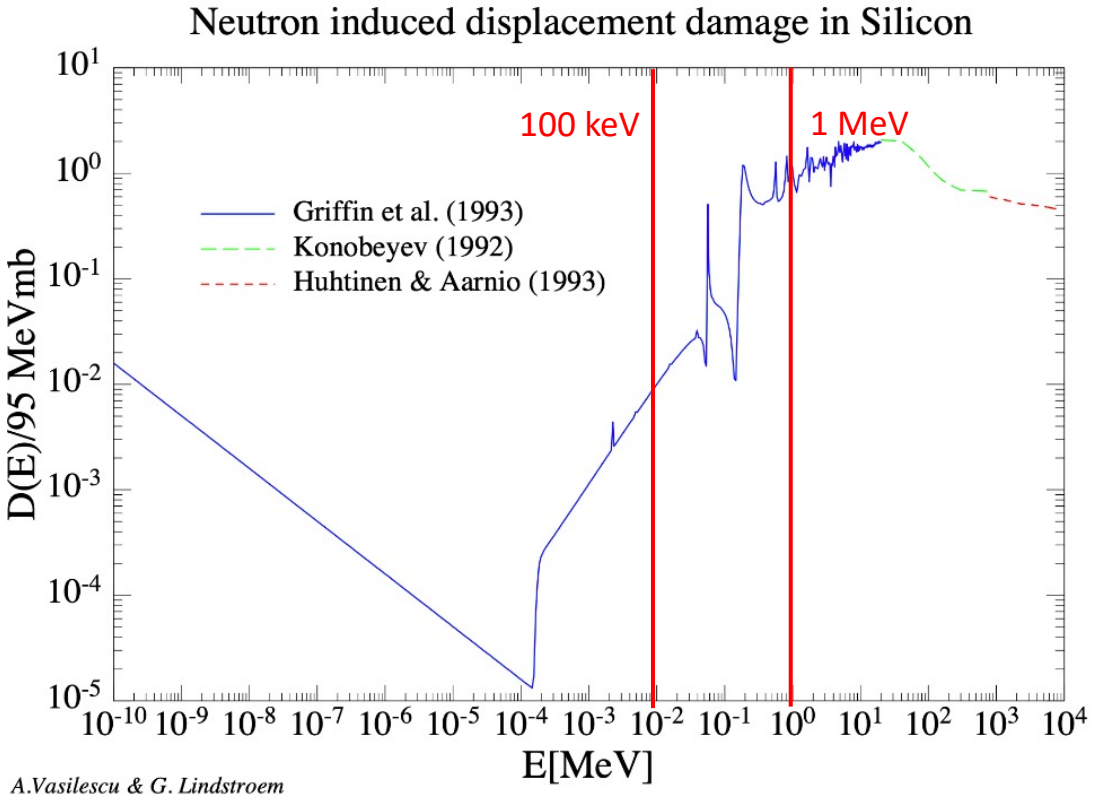
Neutron Energy Spectrum

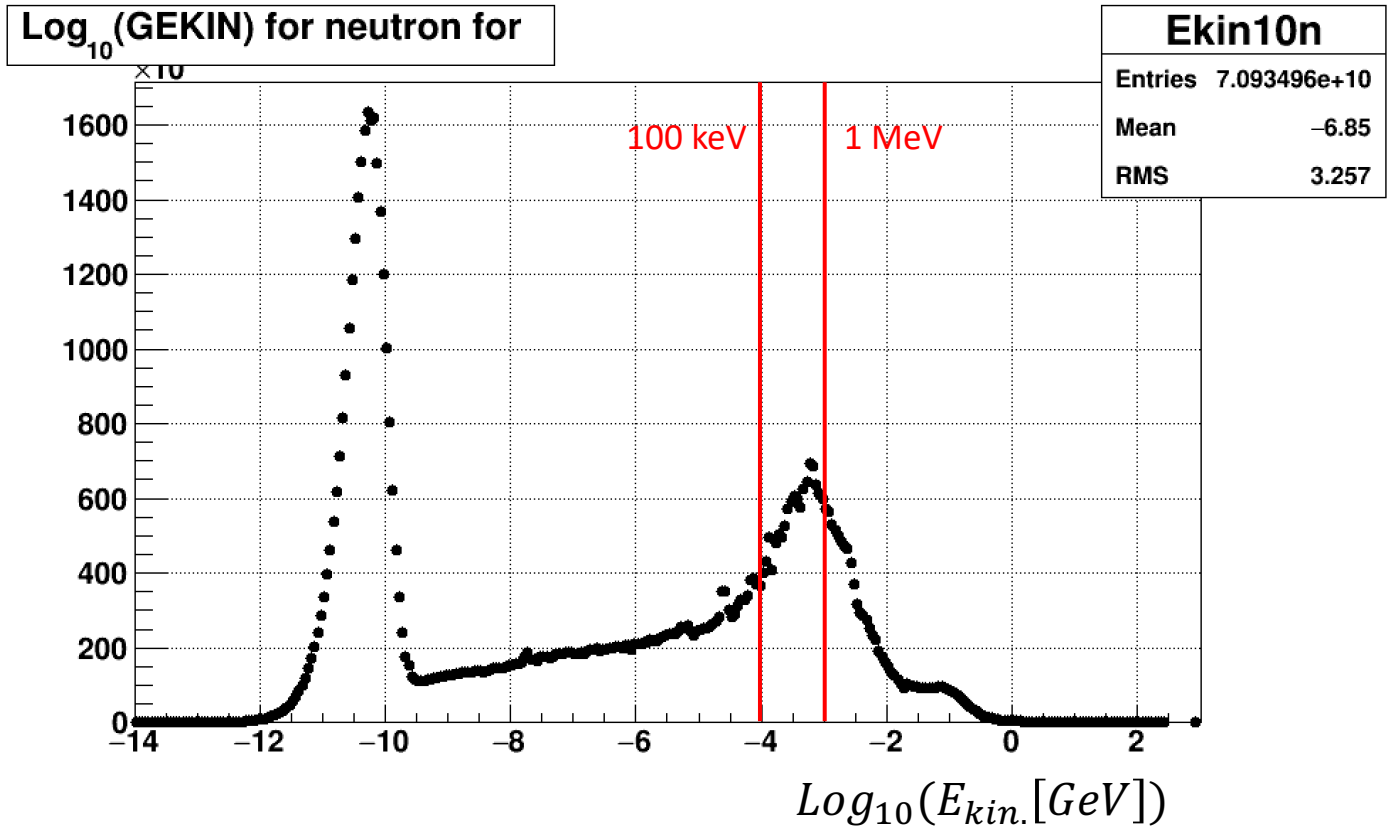




Average energy of neutrons per cm^2 for 6 month run period.

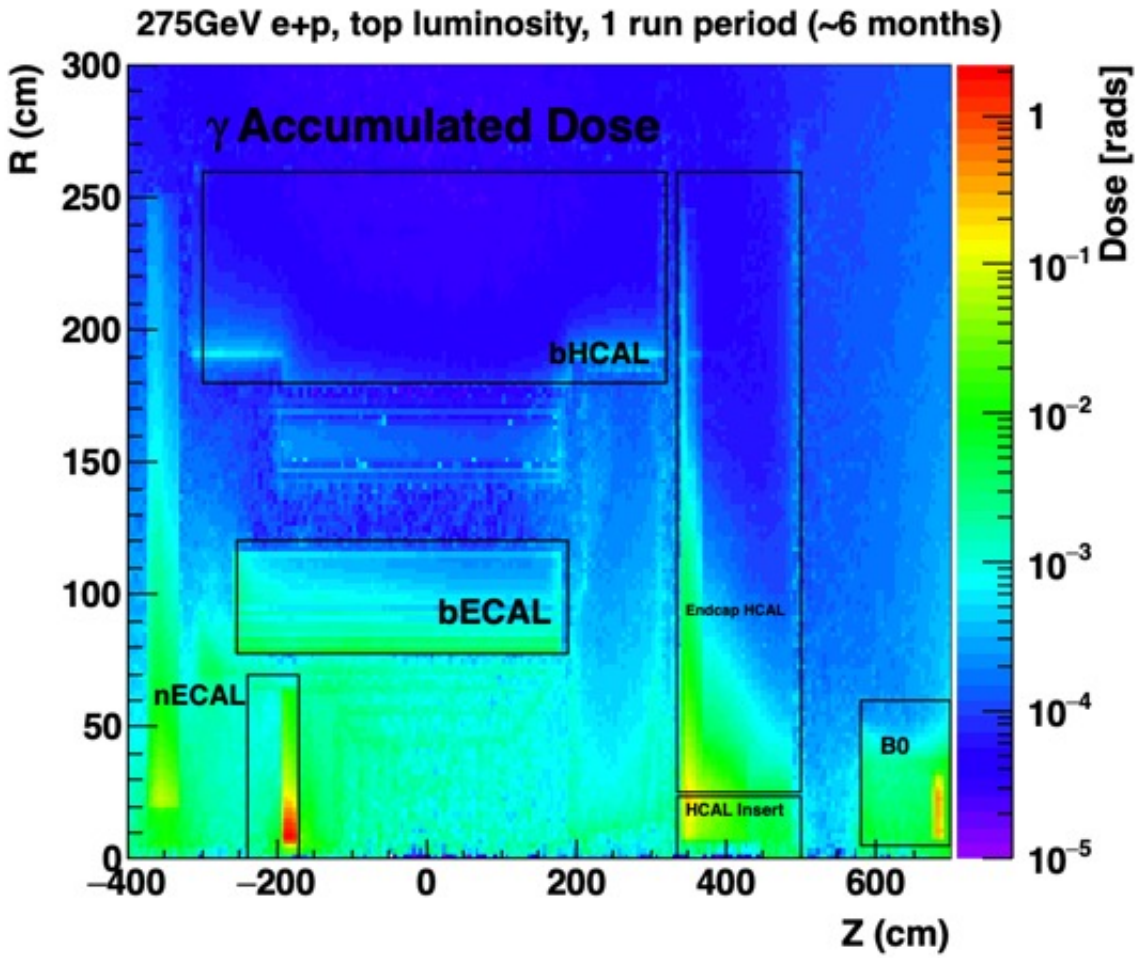
Neutron Damage

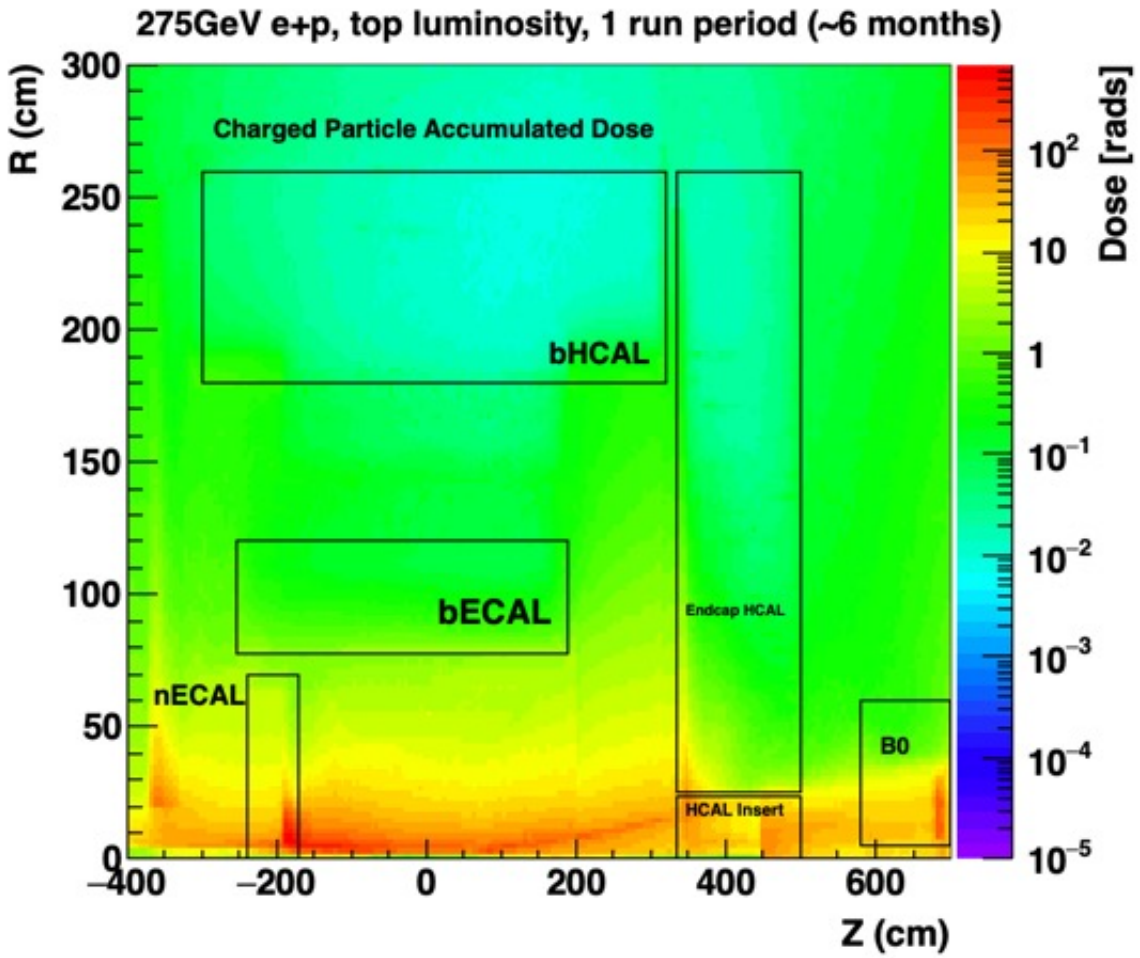




Hadron beam+gas

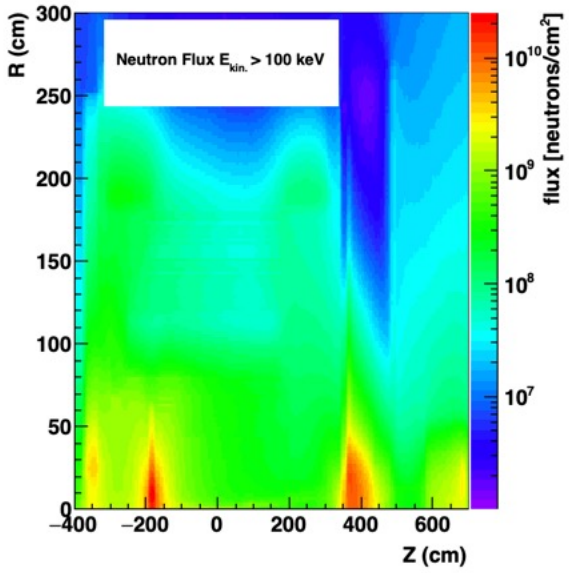
Accumulated Dose ($h^{+/-}$, $e^{+/-}$, γ) (central detector)

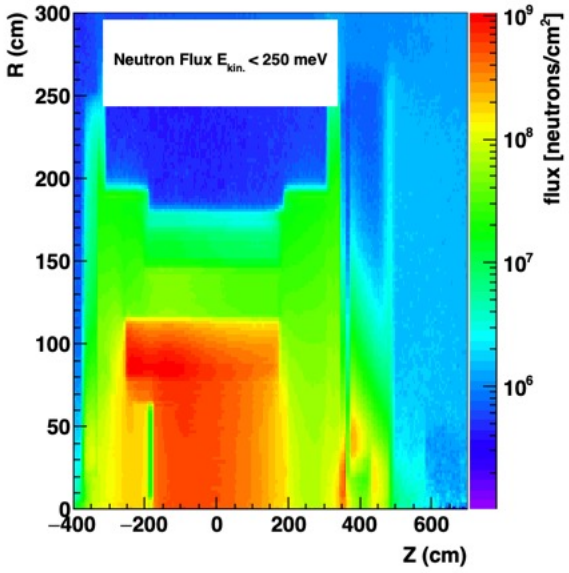


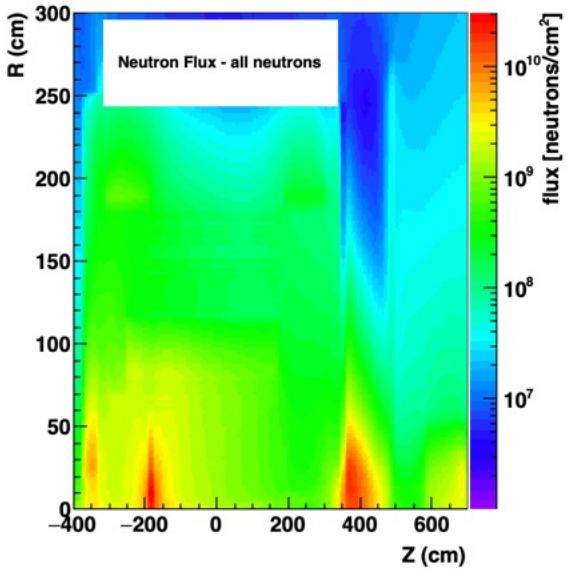


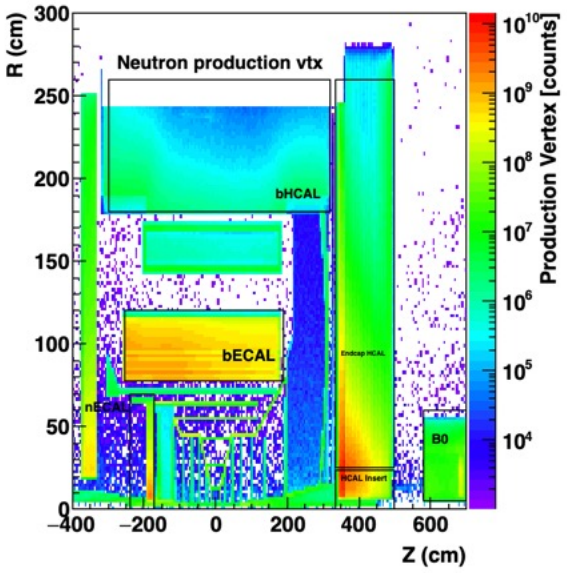
- A few hot spots, but does ~ 1-2 orders of magnitude less than for DIS min-bias for the same energy.

Neutron Fluences (central detector)



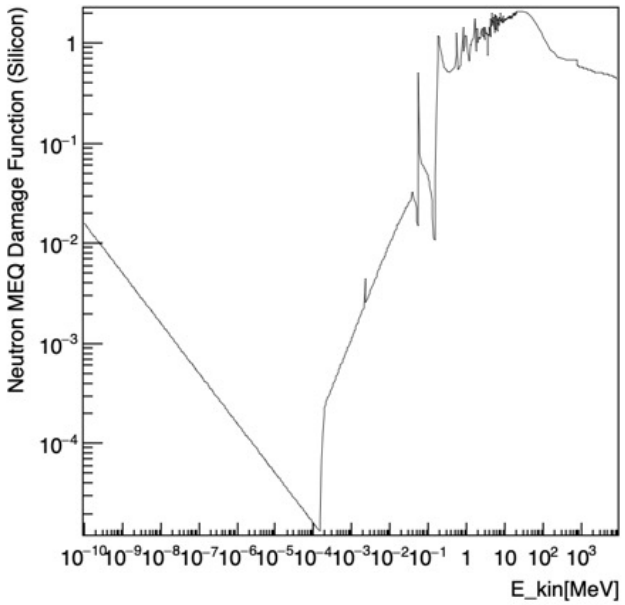


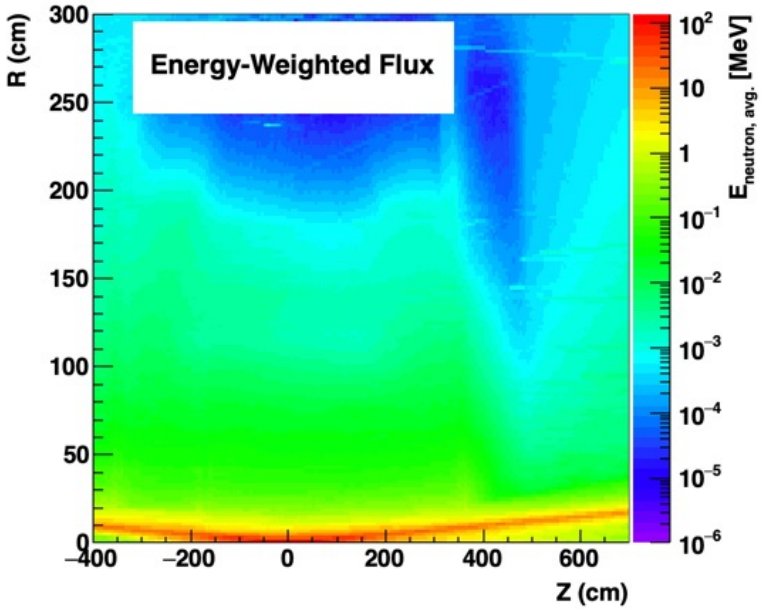


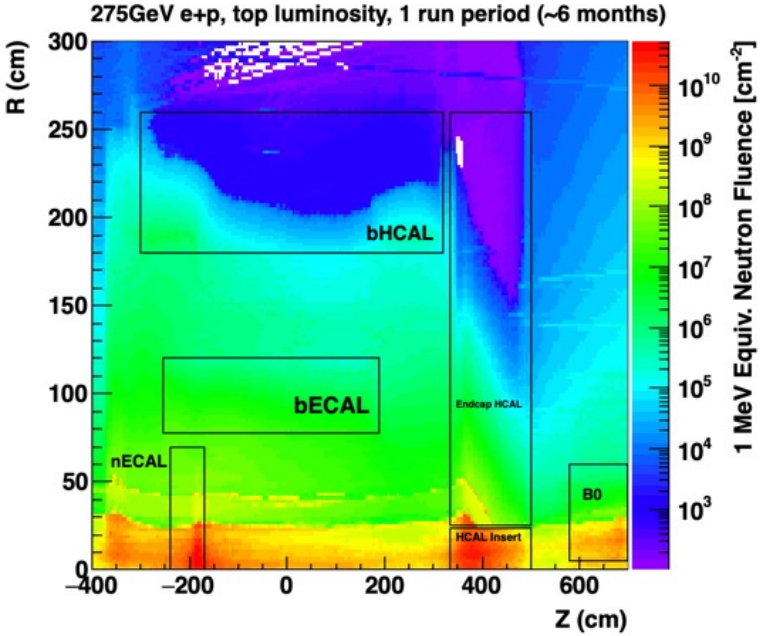


- Similar to accumulated doses, ~ 2 orders magnitude less.

1 MeV neutron equivalent fluence







- Less overall fluence, but very different distribution (much more fluence in the backwards endcap than in DIS min-bias).

Conclusions (so far)

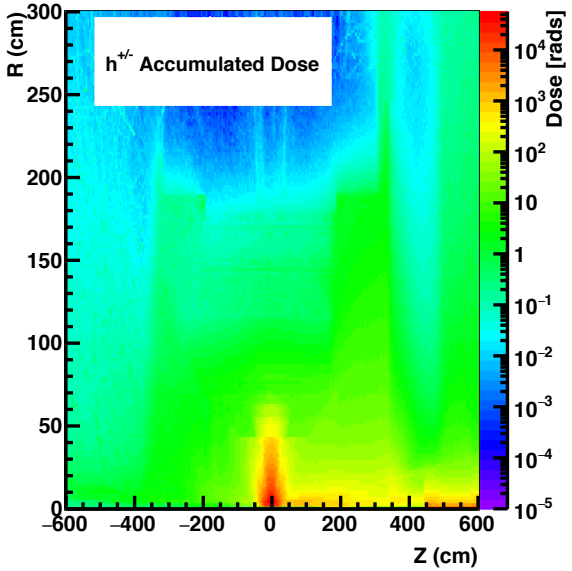
- Beam+gas rates with “best” vacuum tolerable, but if the rate increase significantly, we will quickly approach a similar fluence as for min-bias collisions.

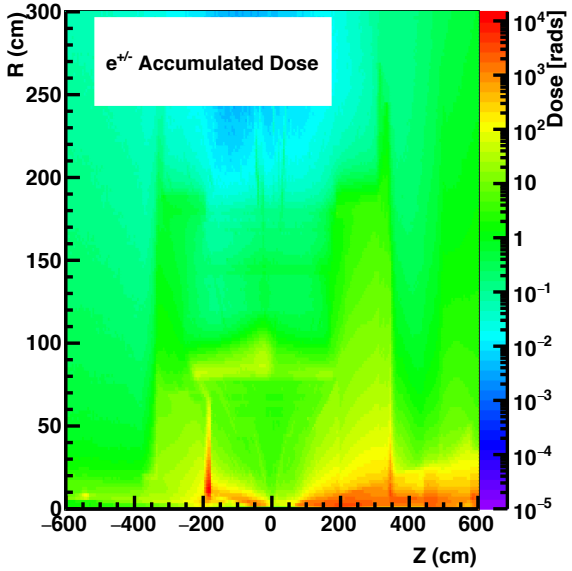
Preliminaries (BeAGLE)

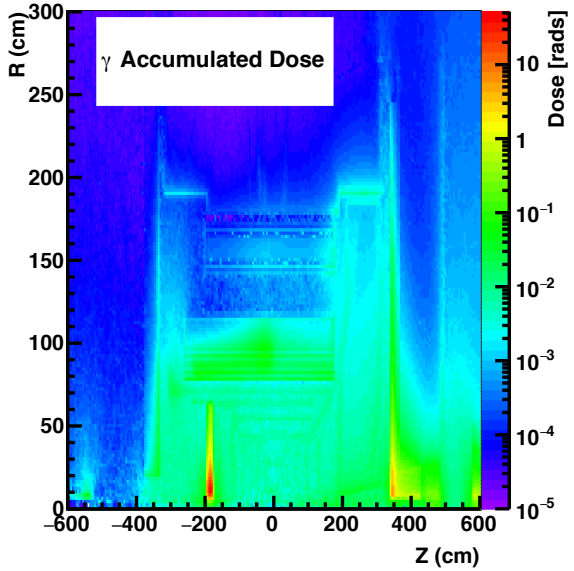
- Using BeAGLE minBias sample from the Yellow Report (in eic-smear format).
  - e+Au 18x110 GeV beam energy configuration.
  - Everything else is the same as above, and I assume 100 kHz rate for now.

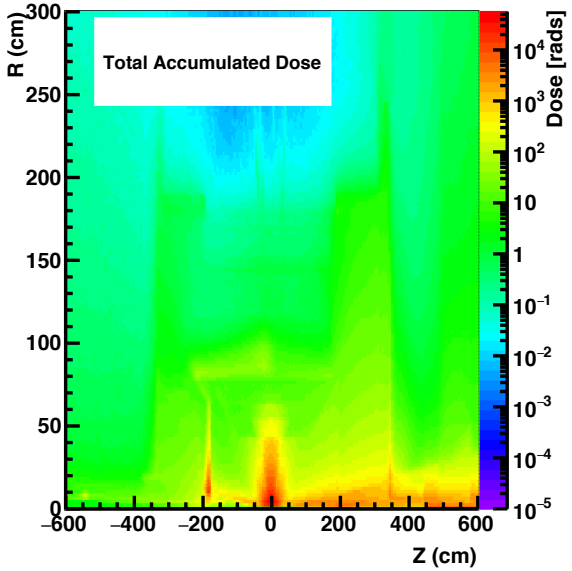
BEAGLE e+Au

Accumulated Dose ($h^{+/-}$, $e^{+/-}$, γ) (central detector)



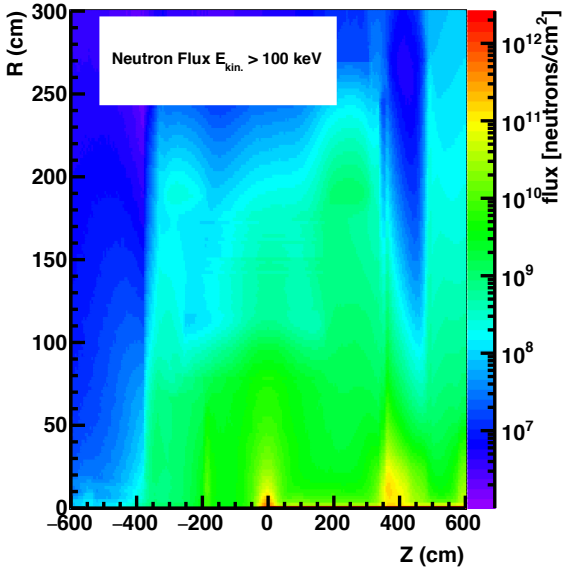


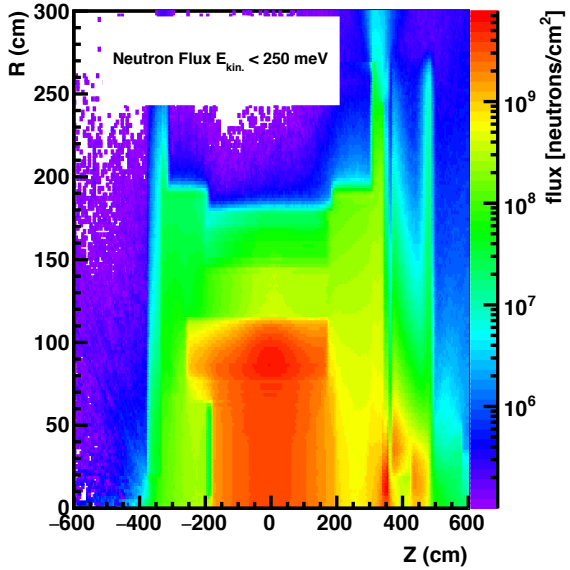


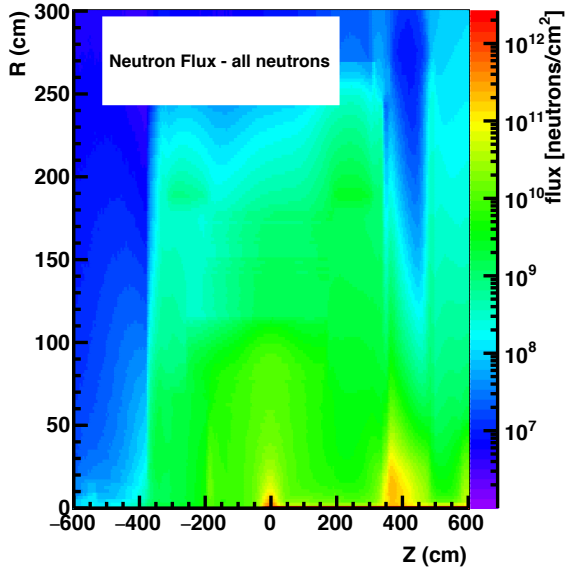


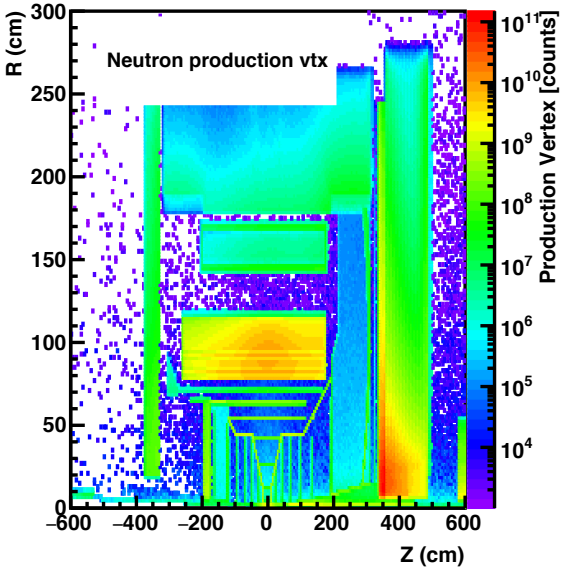
- Rates in most regions of ePIC < 1 krad for one run for most regions (except hot spots).
- Problem spots are near the beamline, and at mid-rapidity near the beamline.
- Hot spots (near beamline) can have doses of 10 krad, and maybe begin approaching 100krad.

Neutron Fluxes (central detector)



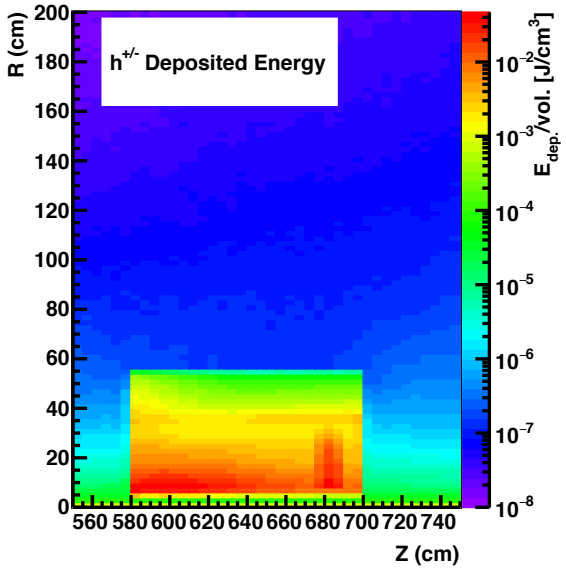


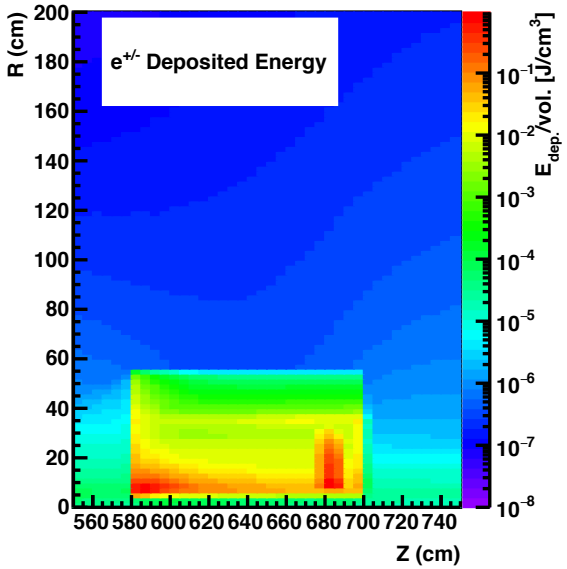


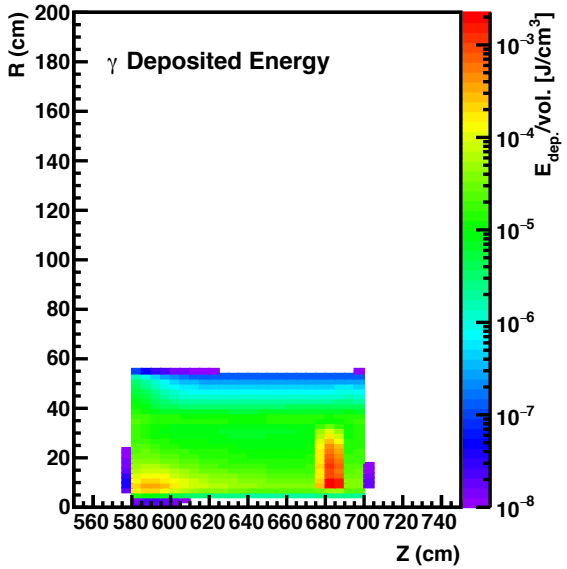


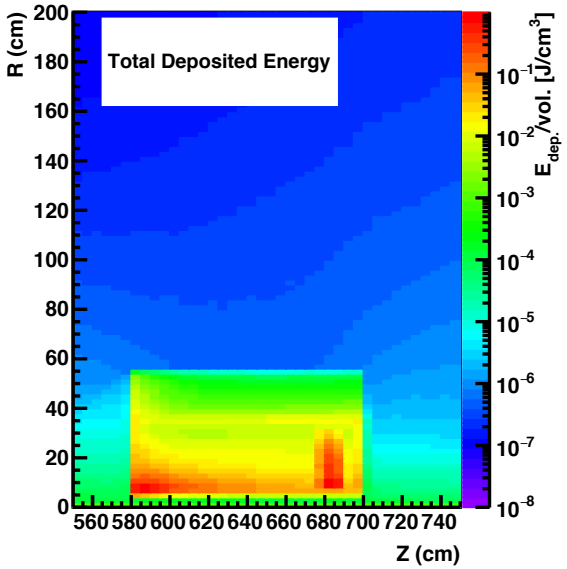
- Larger thermal neutron flux at mid-rapidity.
- Hot spots near beamline, as before.

Energy deposition (B0)



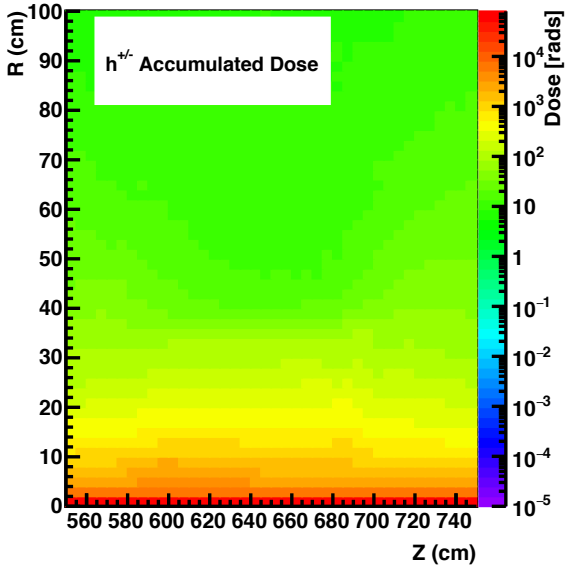


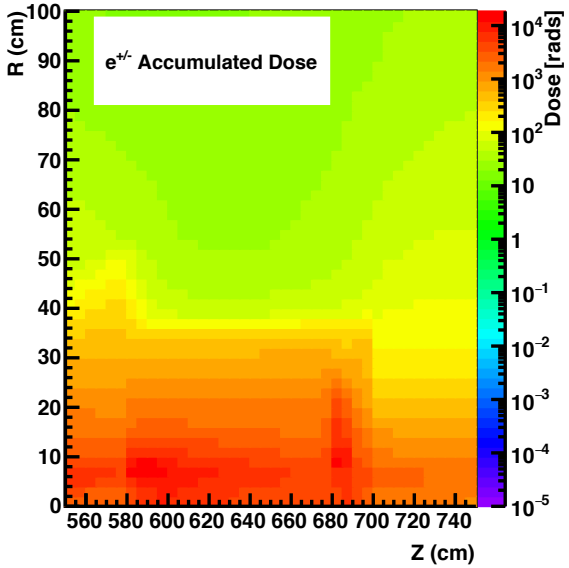


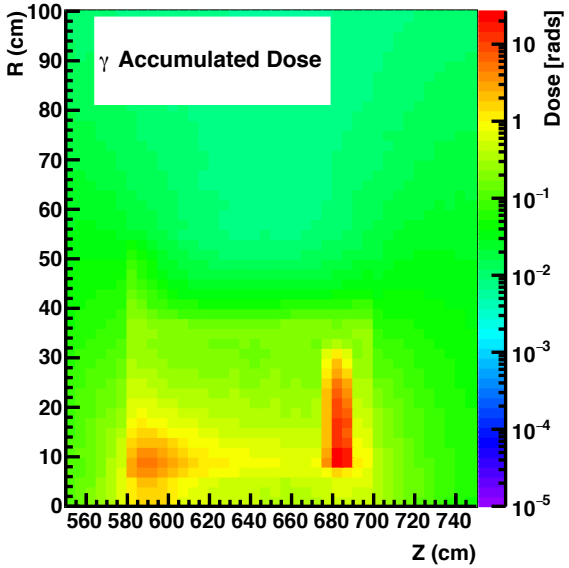


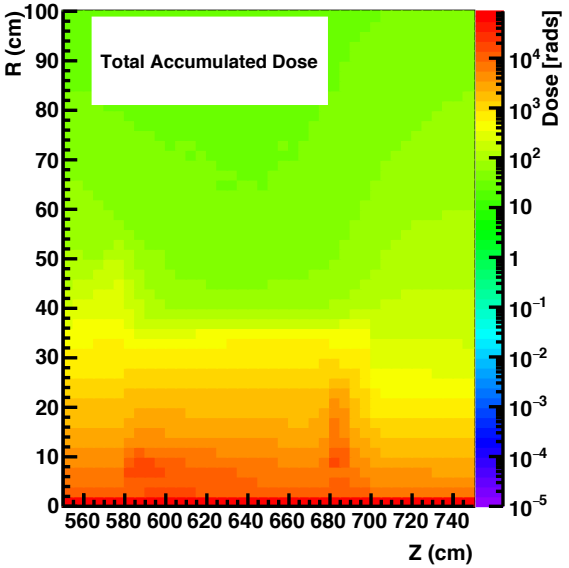
- High energy deposition from electrons in early tracking layers and of course in the EMCAL.
- Occupancies in the silicon need to be studied.

Accumulated Dose ($h^{+/-}$, $e^{+/-}$, γ) (B0)



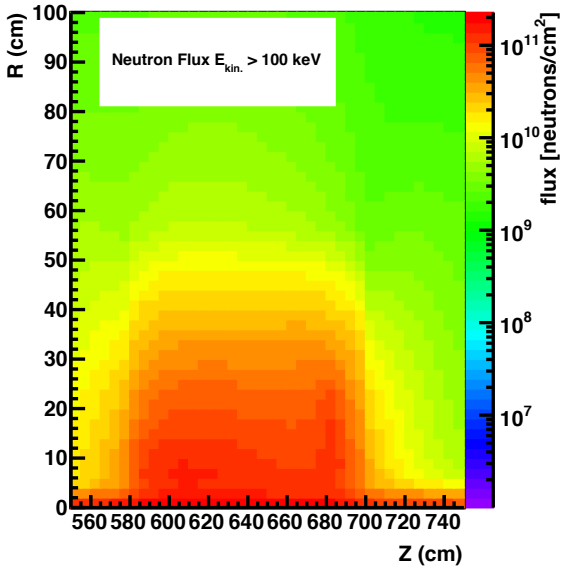


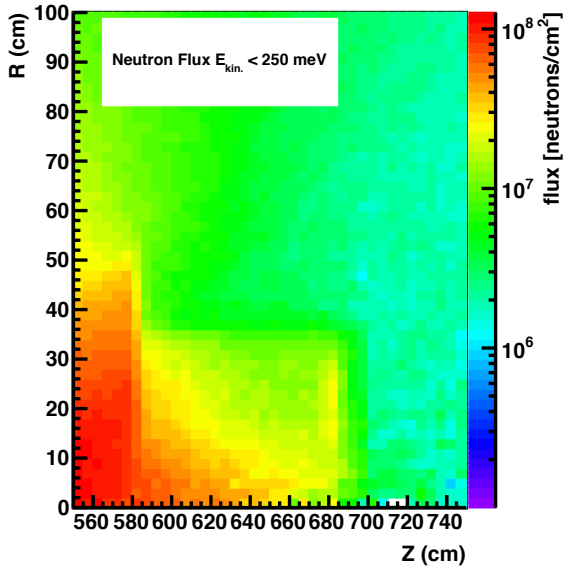


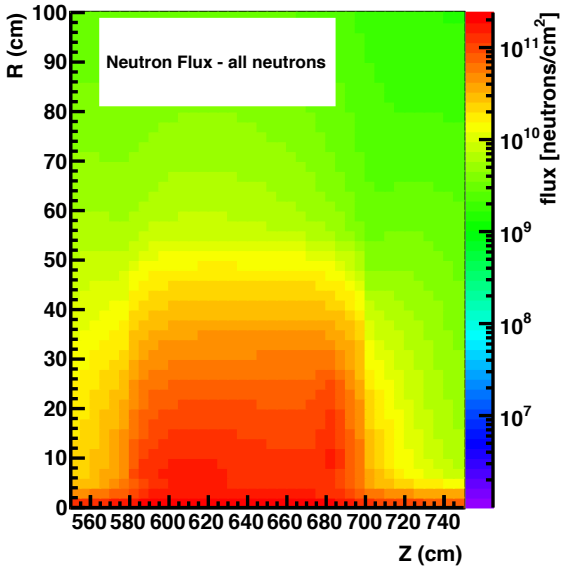


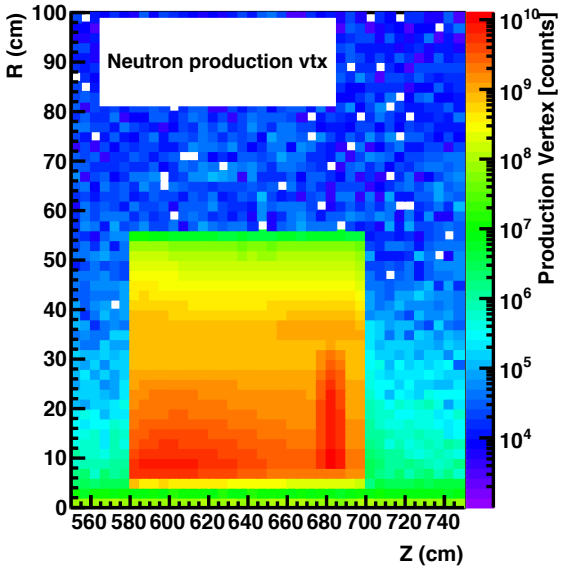
- Fairly substantial doses, but manageable (< 100 krad total), around 10krad of dose across the entire B0 system from electrons.

Neutron Fluxes (B0)









- Neutron fluxes maximum ~ 10^{11} cm^{-2}, overall.