A reminder on expected neutron flux and radiation dose estimates with BeAST

Alexander Kiselev

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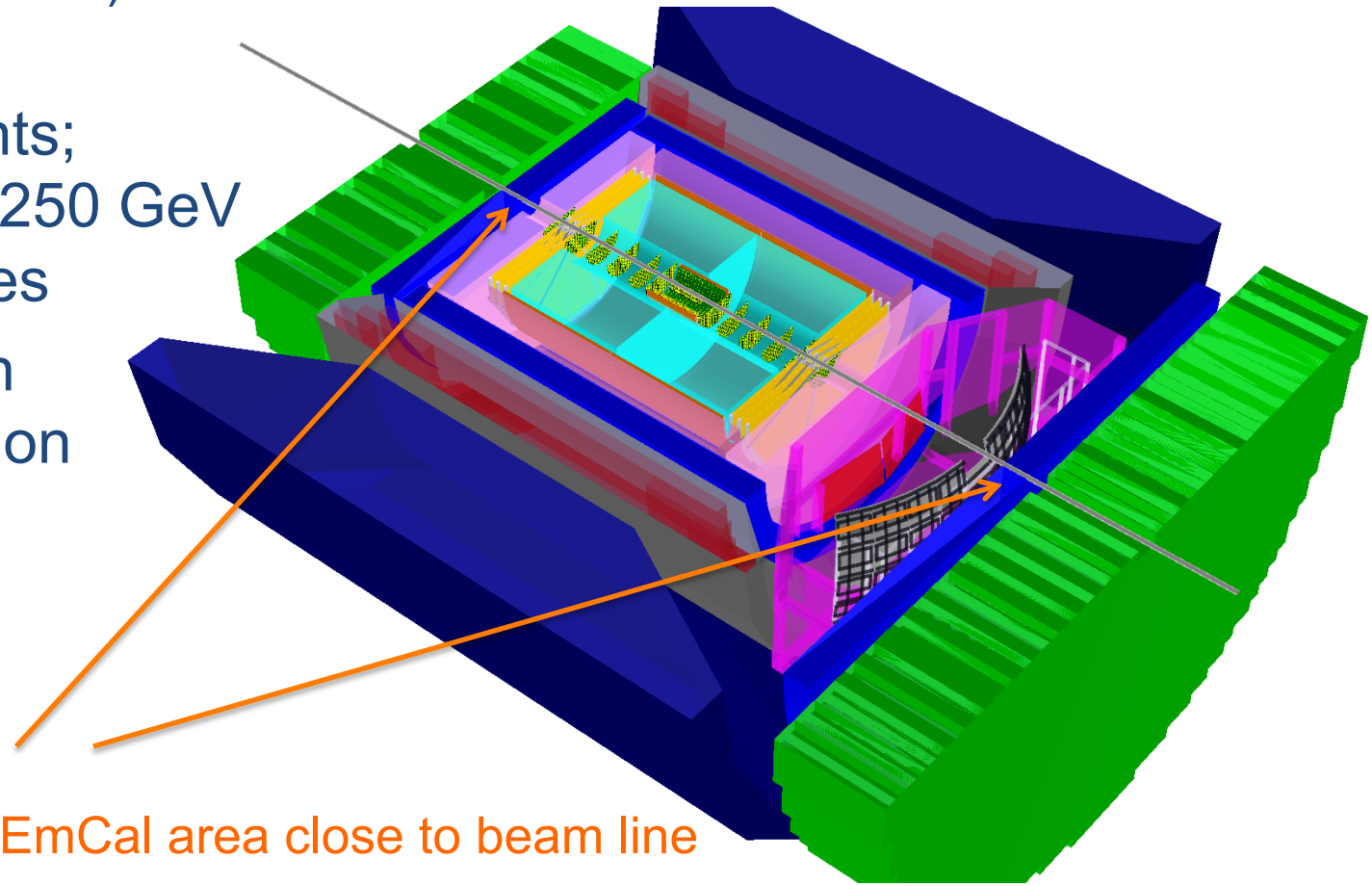
EicRoot & BeAST

- BeAST geometry embedded into the STAR experimental hall

(the latter is not shown)

- 100k ep events; PYTHIA, 20x250 GeV beam energies
- GEANT3 with HADR=5 option



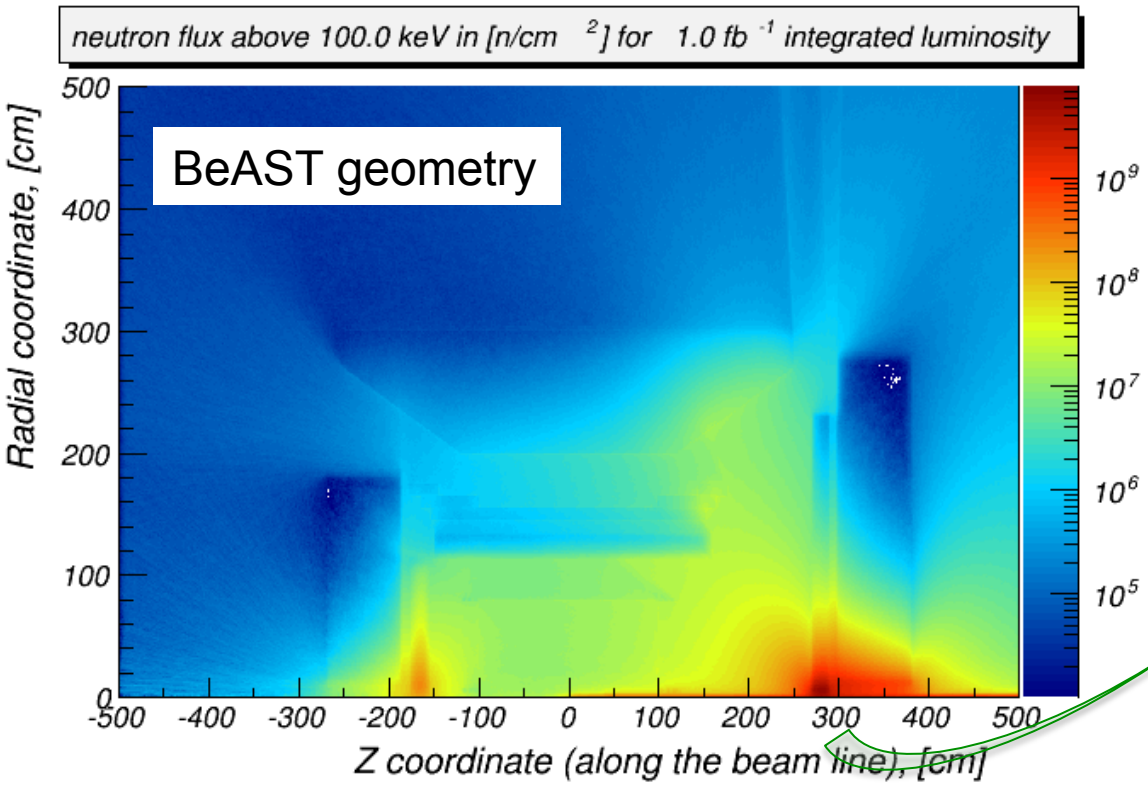
-> focus on endcap EmCal area close to beam line

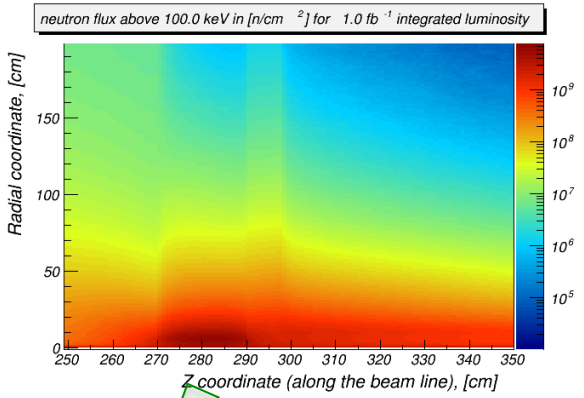
-> the main objective was to get some idea about the radiation dose for the crystal EmCal in the electron-going direction and the neutron fluence for the forward EmCal/HCal in the forward direction

Neutron fluence

The quantity: Fluence = "a sum of neutron path lengths"/"cell volume" for N events

-> basically use Y.Fisyak's approach





-> forward EmCal: up to ~$5*10^9$ n/cm^2 per fb^{-1} (*inside the towers*); perhaps ~5 less at the SiPM location;

NB: "standard" EIC run at ~10^{33} cm^{-2}s^{-1} luminosity is 10 fb^{-1}

- Assume azimuthally-symmetric setup -> so build {R,Z} map

- Close to beam line: ~10^{34} cm^{-2}s^{-1} over ~10 years would exceed ~10^{11} n/cm^2

Neutron flux & radiation dose

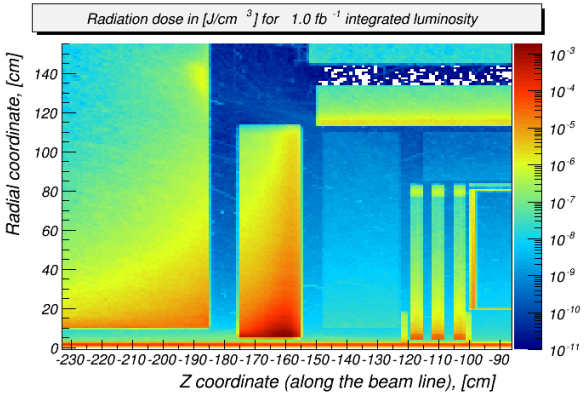
So far the only modeling source of information used to question SiPM readout (integrated flux is too high) and to help justify PWO as inner crystal EmCal (integrated dose is pretty low)

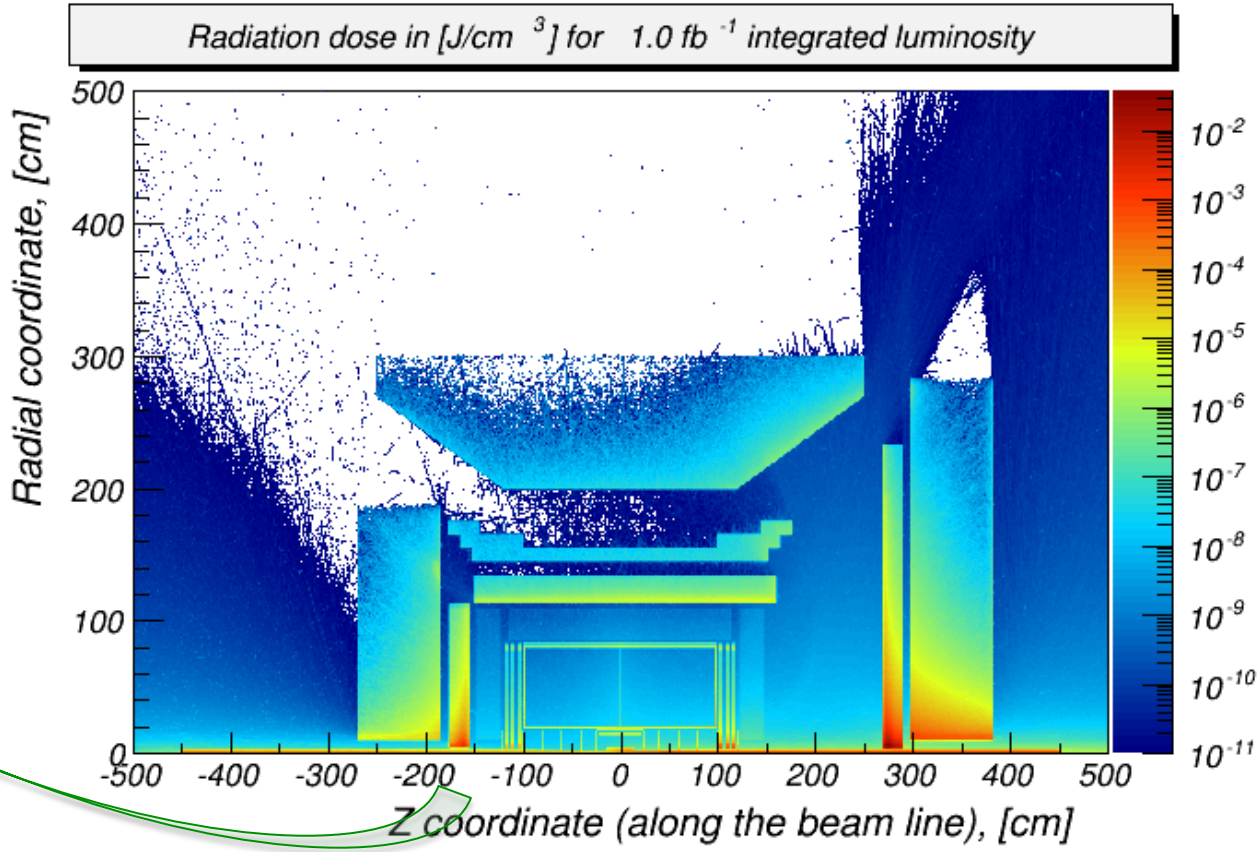
Small print:

- These are the rates **from primary interaction only:**
  - No synchrotron radiation
  - No beam-gas scattering
- Neither machine elements were incorporated in that simulation nor the experimental hall material
- It is a particular detector geometry (BeAST)
- GEANT3 used; comparison against GEANT4 has never been done
- Thermal neutrons are not accounted
- Strictly speaking, integrated neutron flux is high only close to the beam pipe

Radiation dose

The (primary) quantity: E_{sum} = "a sum of dE/dx"/"cell volume" for N events





-> crystal EmCal: up to ~$2*10^{-3}$ J/cm^3 per fb^{-1} (close to beam line)

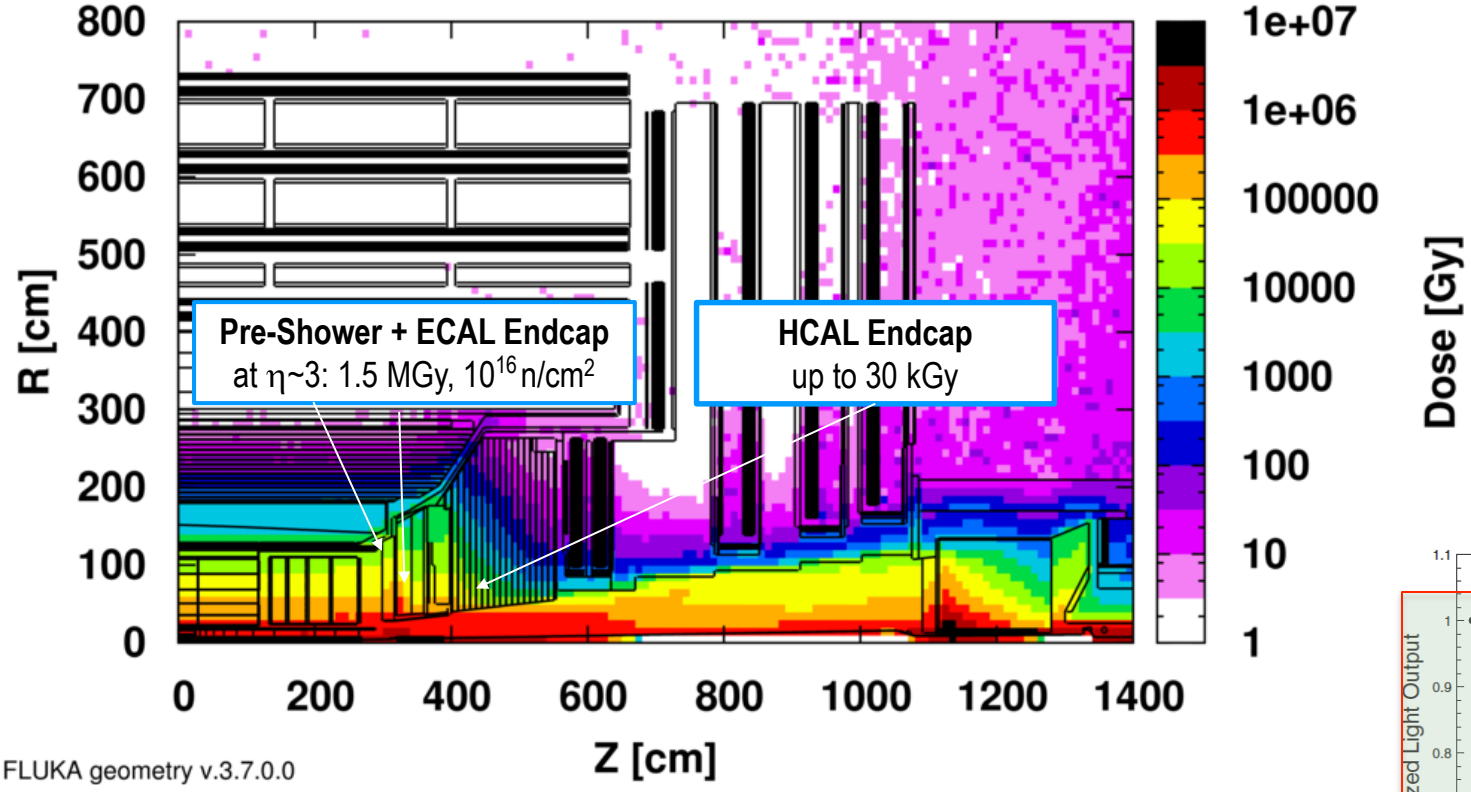
1 rad = 0.01 Gy & [Gy] = [J/kg] & PWO density ~8g/cm^3 -> ~250 rad/year

(at "nominal" luminosity ~10^{33} cm^{-2} s^{-1})

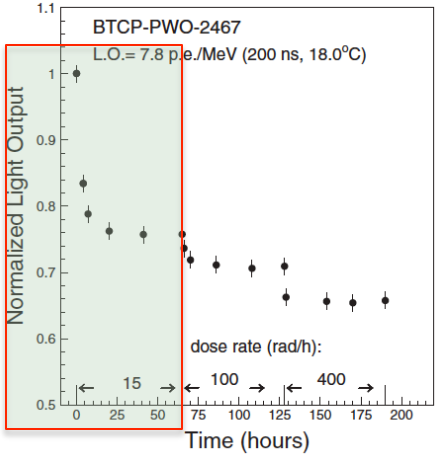
-> looks OK?

Extreme comparison (CMS)

3000 fb-1 Absolute Dose map in [Gy] simulated with MARS and FLUKA



clearly our numbers are orders of magnitude smaller



-> however integrated flux of ~10^{11} n/cm^2 is already harmful for SiPMs

-> and PWO crystals show reduction in light output at relatively small doses