Radiation damage simulations for endcap upgrades

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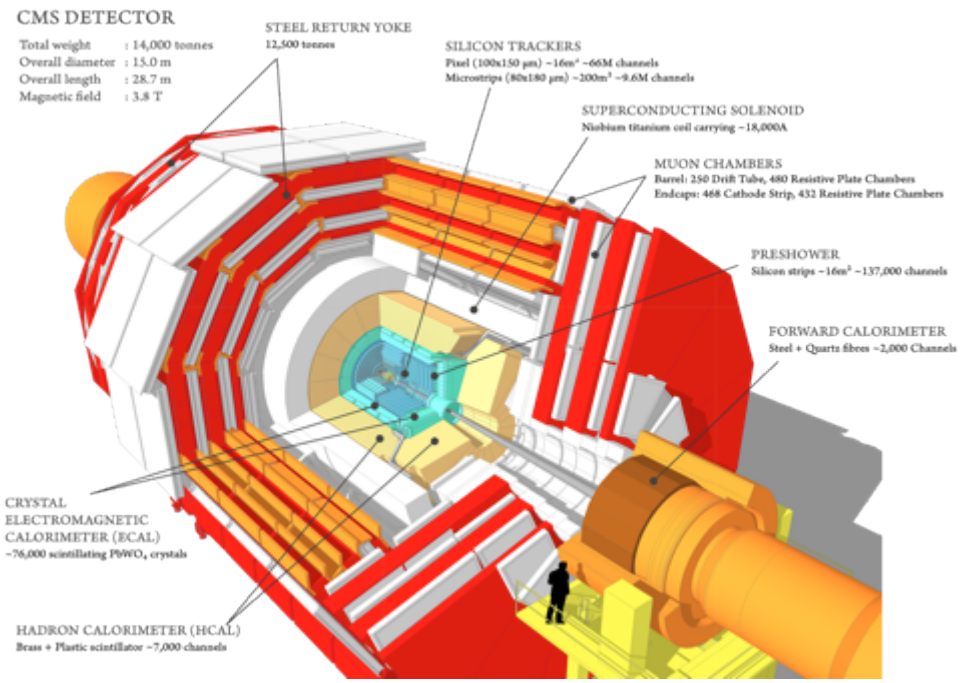
CMS

- Particle detector with 4 main layers:
  - muon detector
  - electromagnetic calorimeter (ECAL)
  - tracking system
  - "hermetic" hadron calorimenter (HCAL)

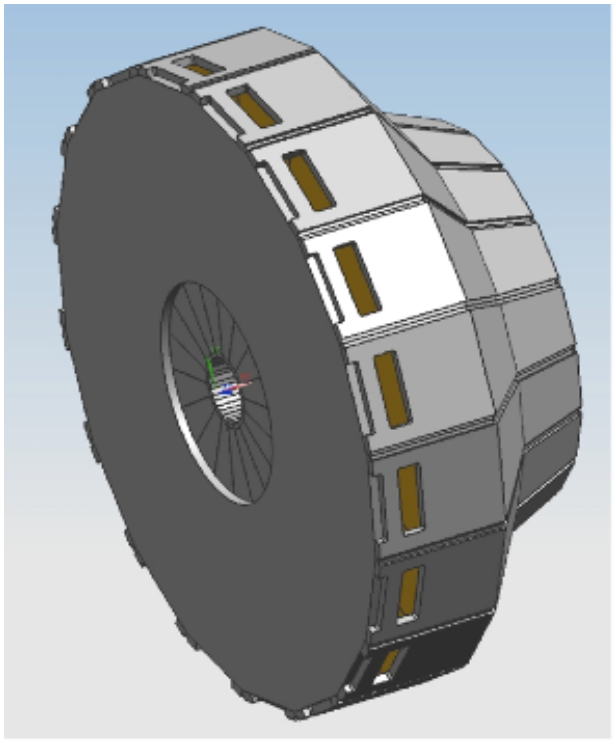


CMS public site: Lucas Taylor, 2011

http://cms.web.cern.ch/news/cms-detector-design

Texas Tech Experimental HEP Group

- Improving the sensitivity of the CMS detector to jet physics
- Upgrades for the CMS calorimeter endcaps



Endcap replacement image: S. Kunori, Texas Tech University, 31-Jan-2014

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Background

- Understanding calorimeters
  - Scintillating fibers (glowing)
  - Cerenkov radiation (optical fibers)
- Radiation damage
  - Fibers dimming over time
  - Replace calorimeters by 2020 (optimization)
- 100 simulations- 3 files
  - Analyze data, find discrepancies
  - Bronze, tungsten
  - Optimize factor and radius

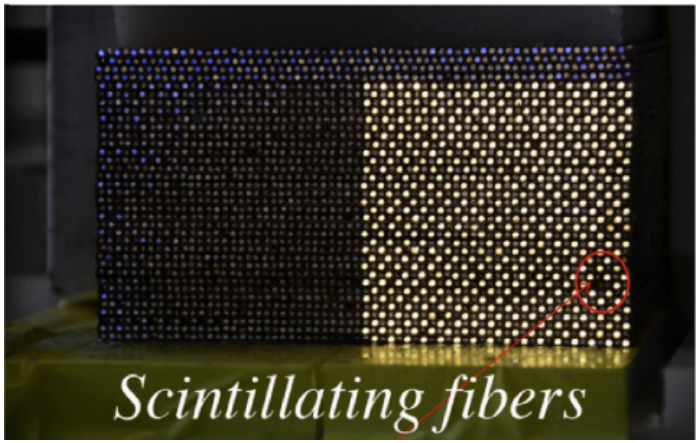
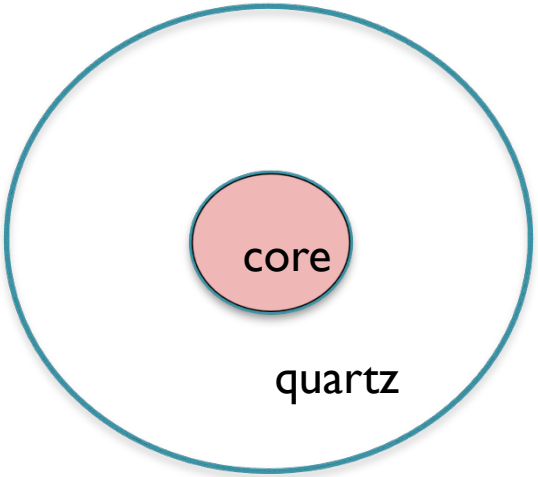
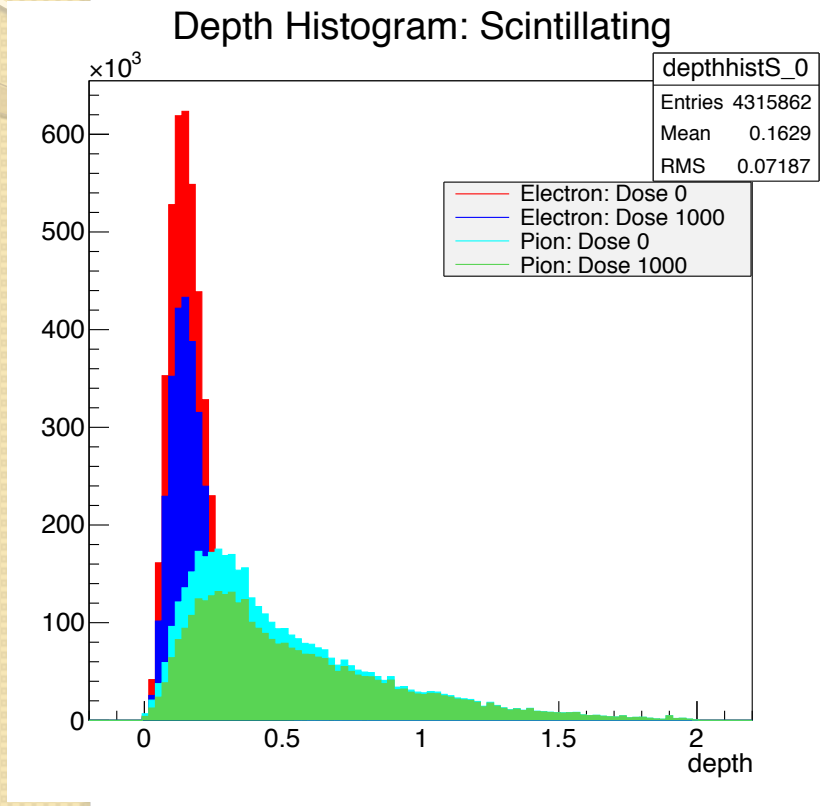


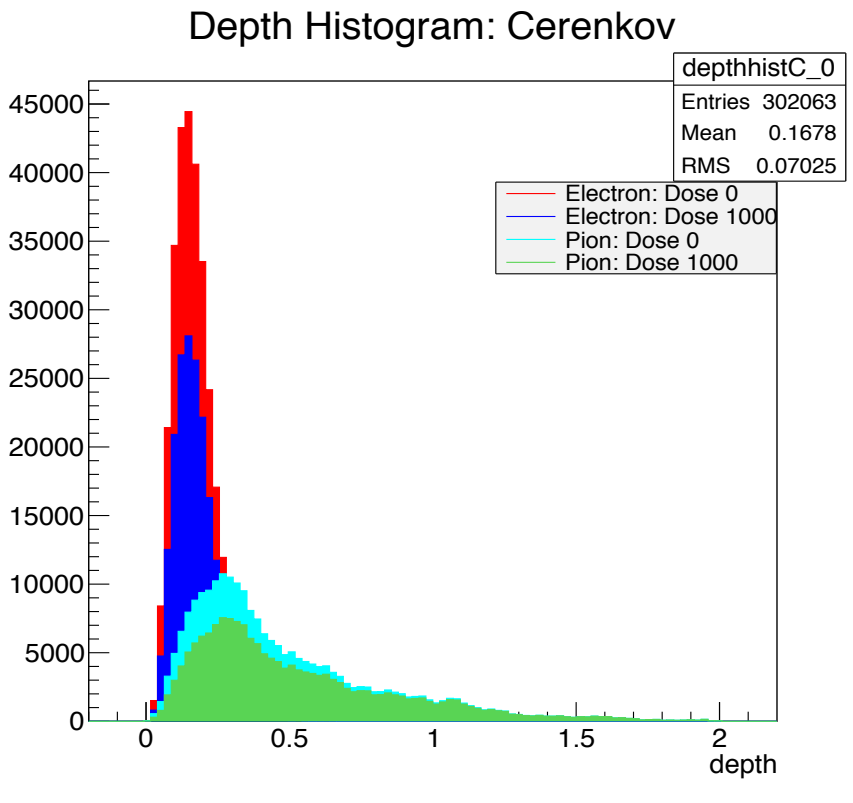
Photo of fibers lit from behind: S. Kunori, Texas Tech University: 31-Jan-2014



Scincillating fiber, with a core of undertermined material and radius

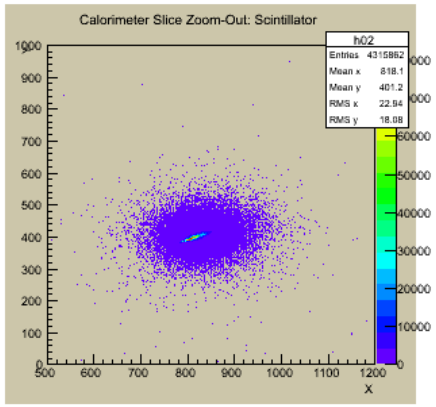
Longitudinal movement

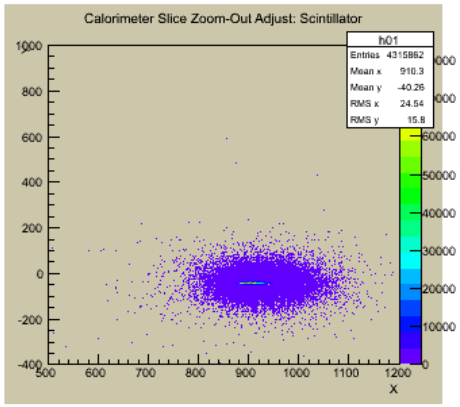


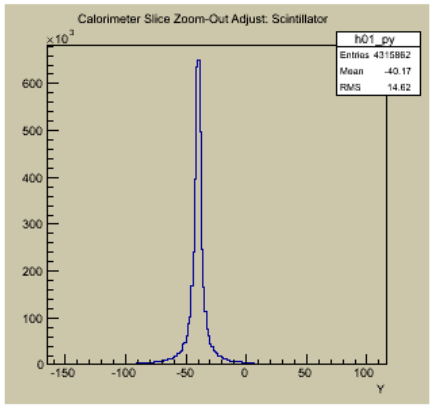


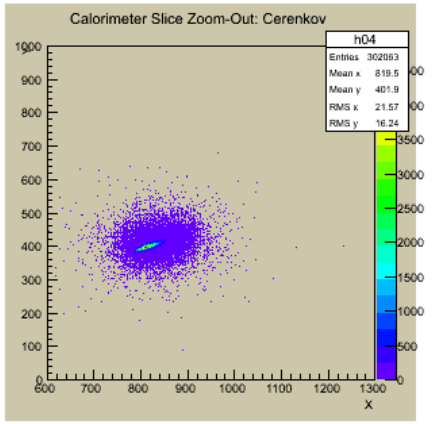
This shows how radiation damage affects the longitudinal movement of electrons and pions.

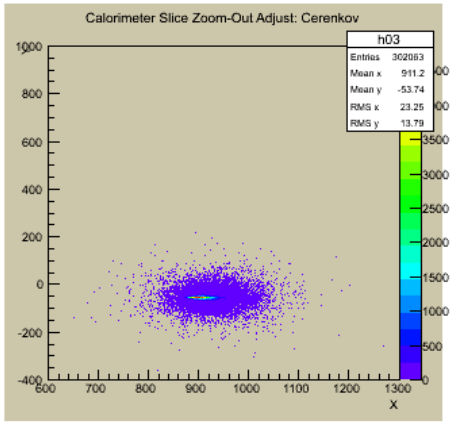
Transverse particle movement

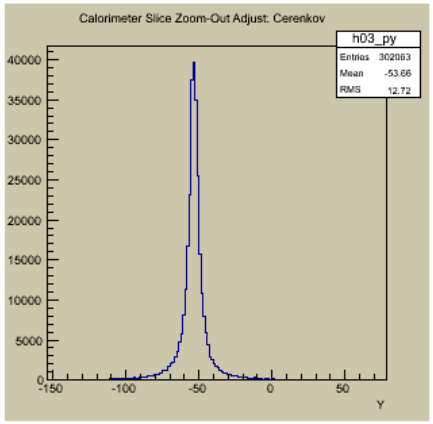












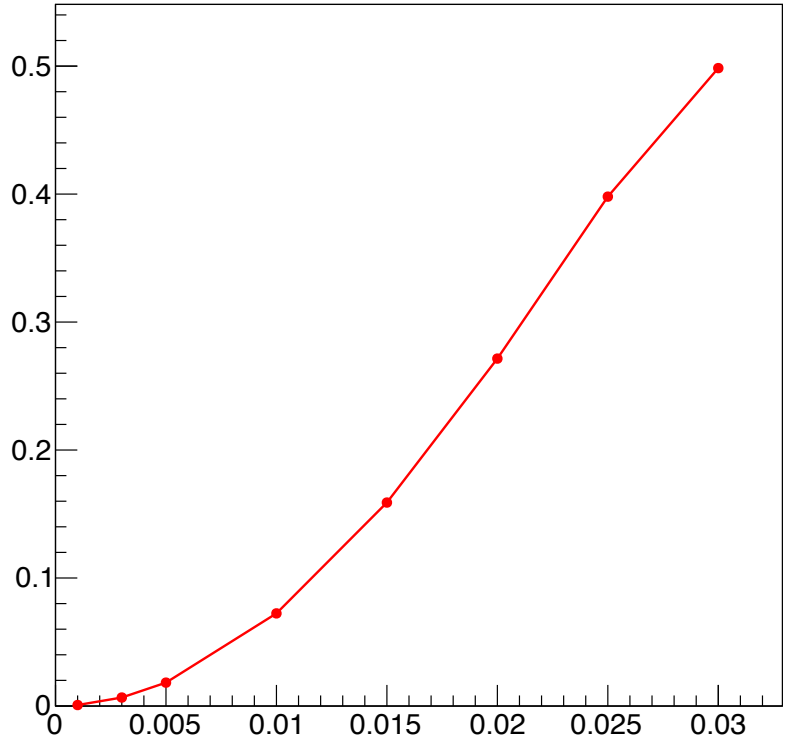
Find angle of xy slice, then turn all points and project on the new y-axis. Find the diameter which 95% of data lie between to find 1D moliere radius. The radii make sense for tungsten and brass material, showing correct calculations.

Brass moliere radii calculations are shown above

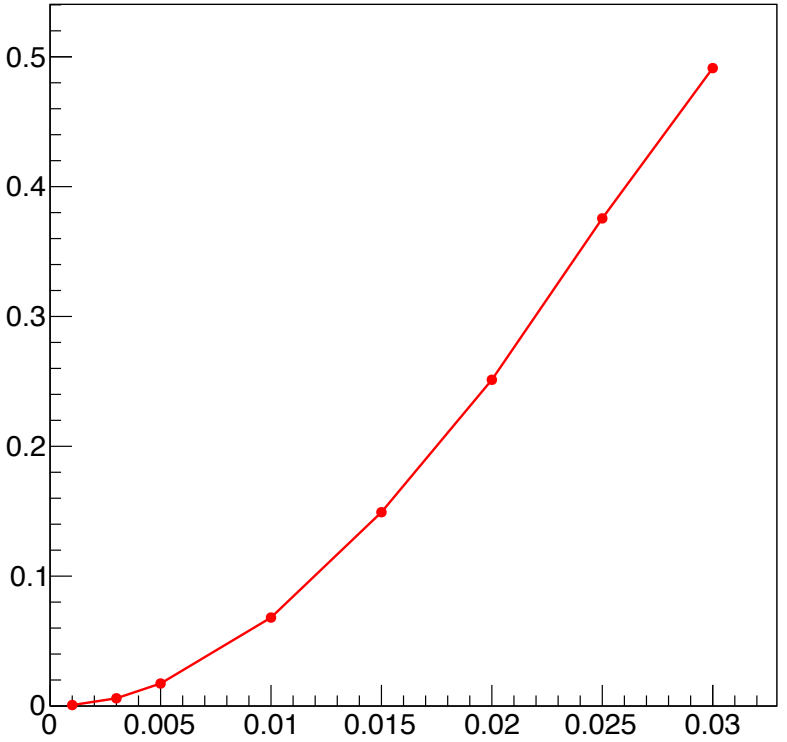
	Scincillating	**Cerenkov**
Tungsten	18 mm	14.4 mm
Brass	30.8 mm	25.9 mm

Ratio within radius comparisons

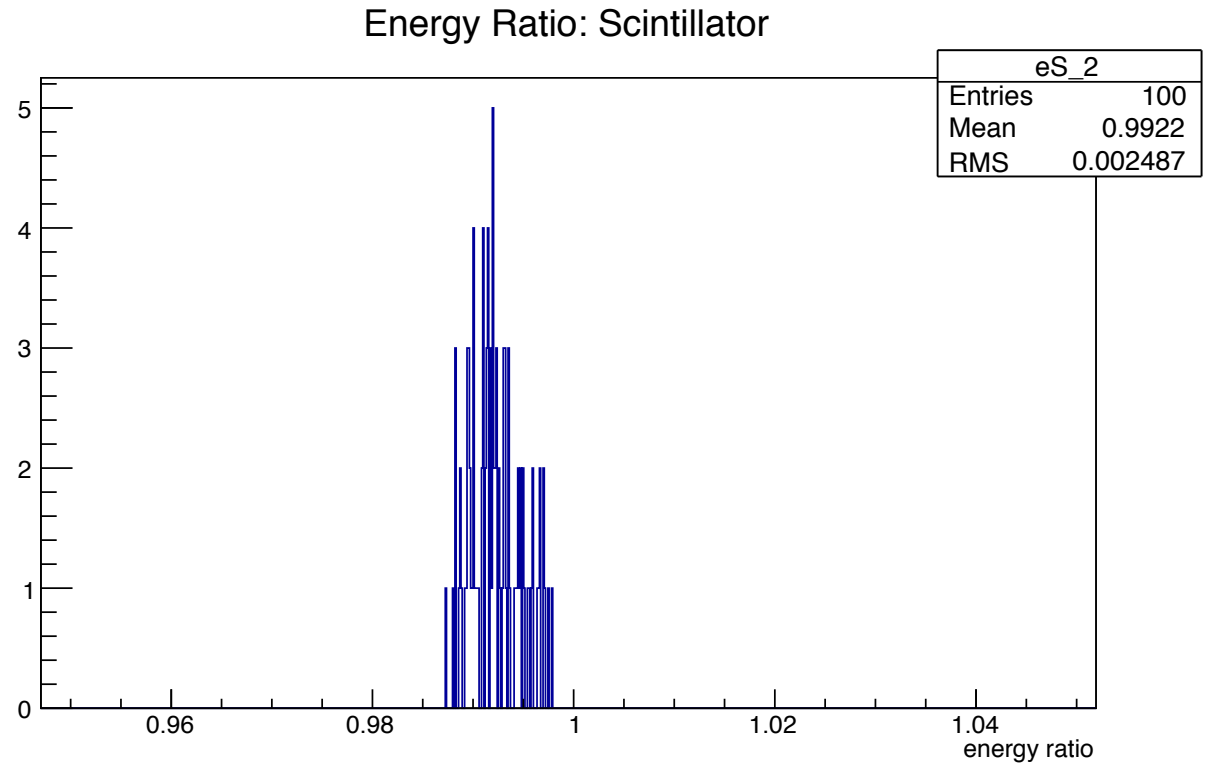
Simulation



Ideal (Monte Carlo)



Finding energy changes with radiation dose



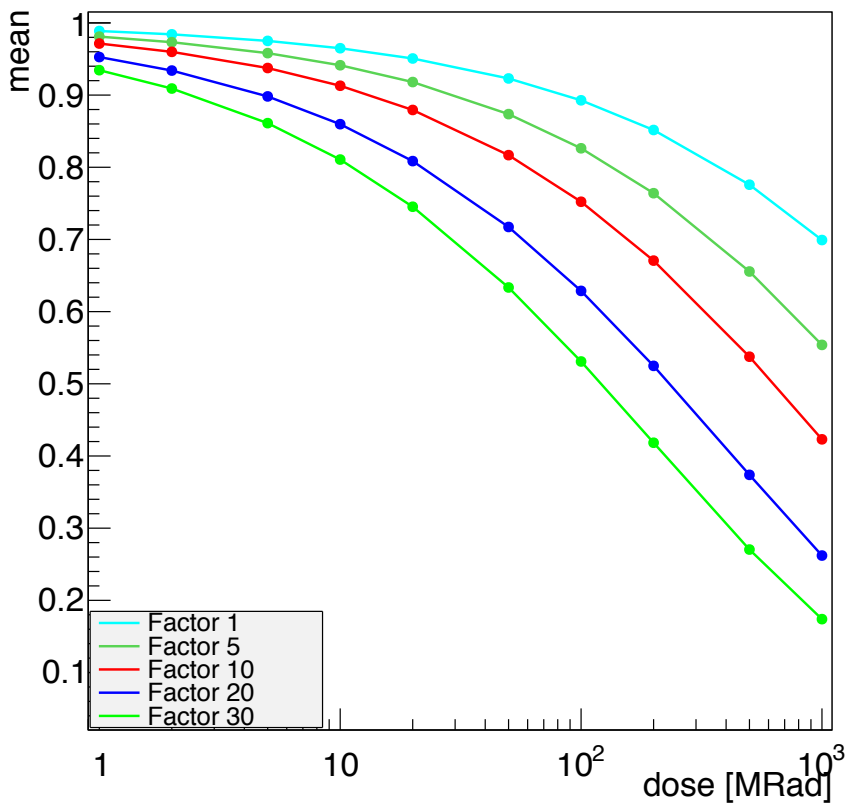
Example Energy Ratio for dose of 2 MRads

11 energy plots formed, each with a different value for dose- ranging from 1 to 1000 MRads, divided over energy with 0 dose.

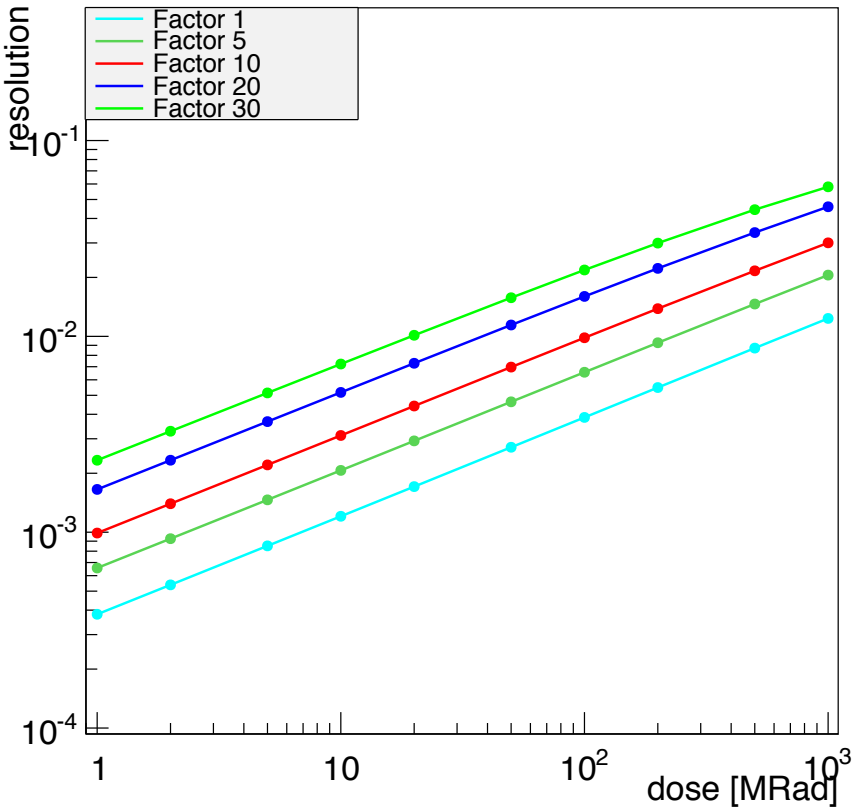
To see how energy changes as dose increases, we plot the mean and resolution of each plot, then experiment with changing factor.

Electron scincillating fibers: factor overlay

Mean

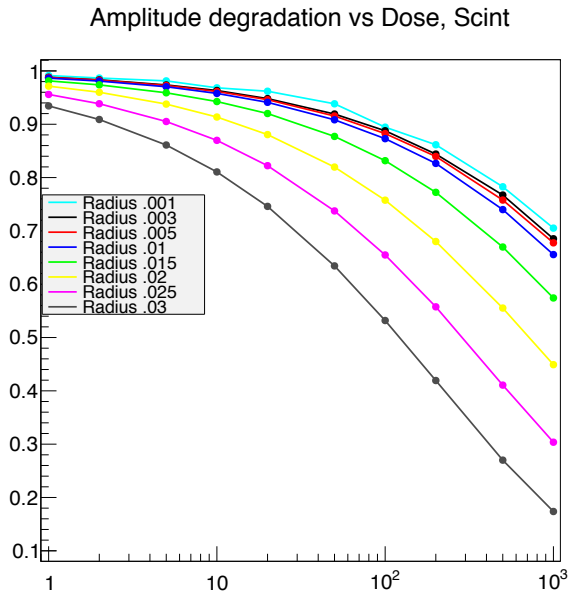


Resolution

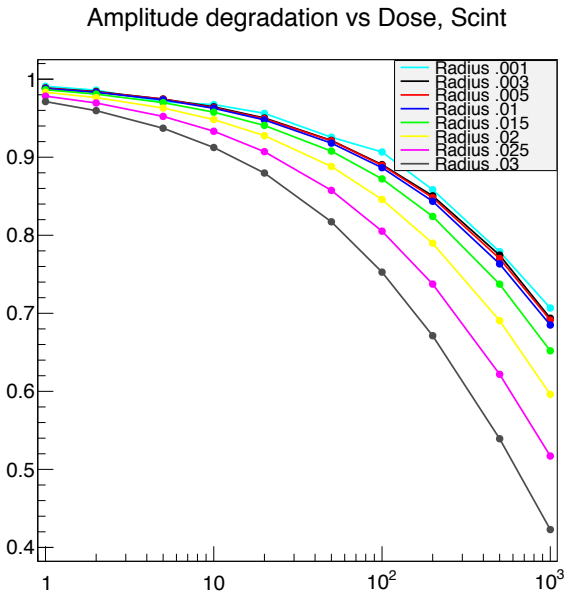


Amplitude for different radii

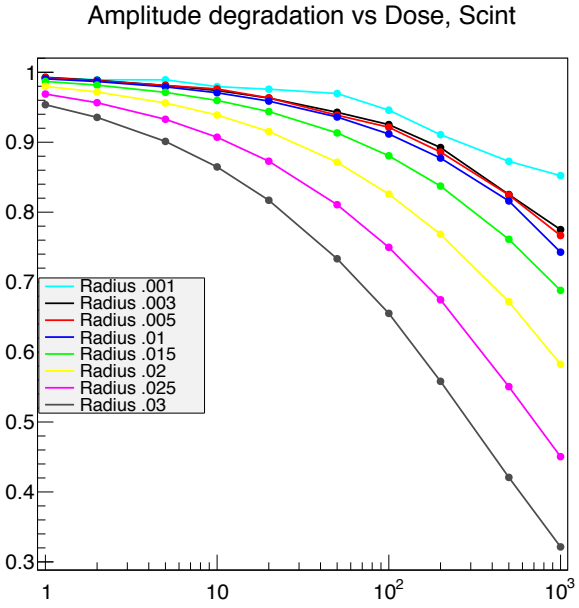
Electrons: Factor 30



Electrons: Factor 10

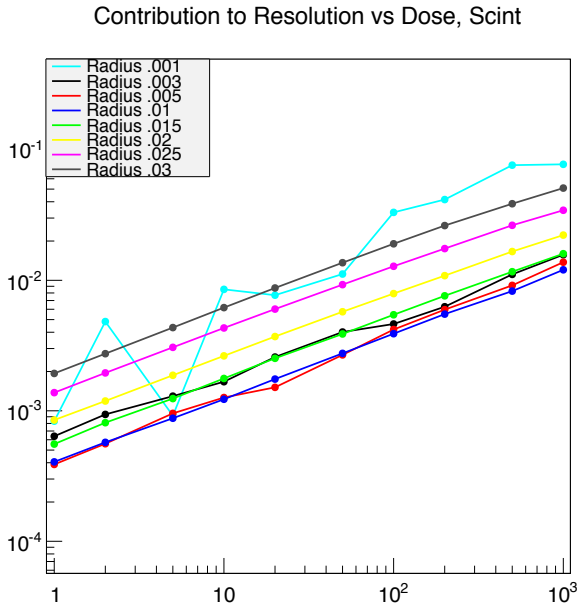


Pions: Factor 30

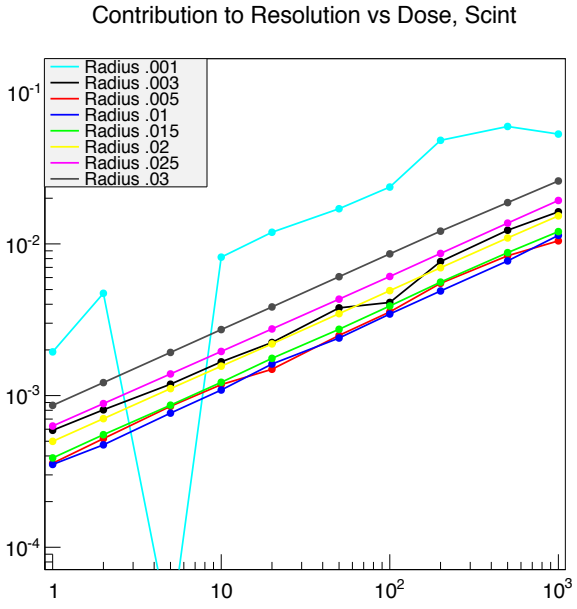


Resolution for different radii

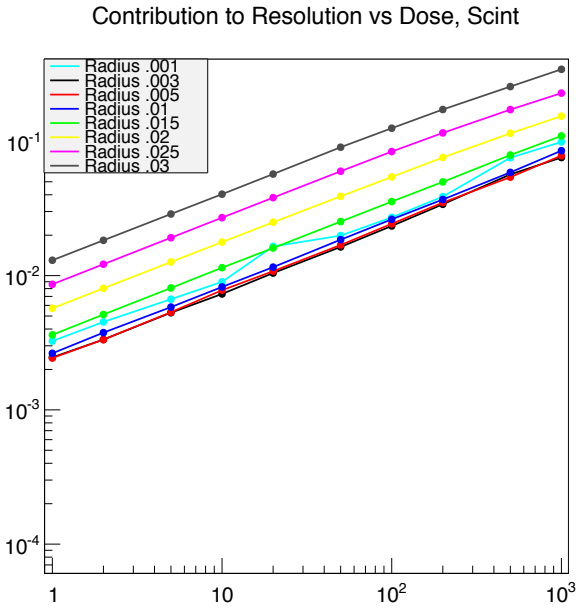
Electrons: Factor 30



Electrons: Factor 10



Pions: Factor 30



- Thanks to Dr. Alexander Ledovskoy for all his guidance and help, to University of Michigan for this opportunity, and to the Texas Tech group for letting me join their group!

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Travels!!