Study of the Performance of LumiCal in Combination with a Tracking Detector

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Outline

- Introduction and motivation for the study
- Geometry implementation in LuCaS
- Hit properties generated by electrons
- LumiCal with and without tracking detector
- Summary and plans

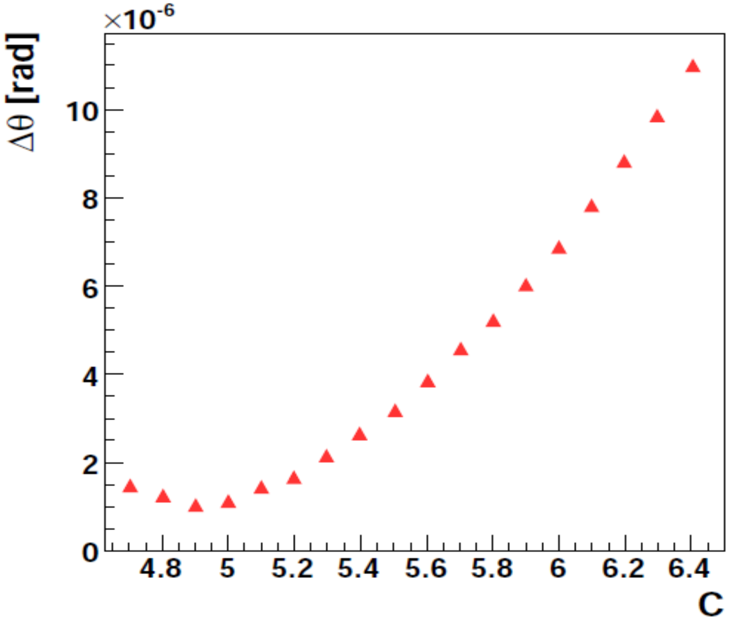
LumiCal Clustering Algorithm

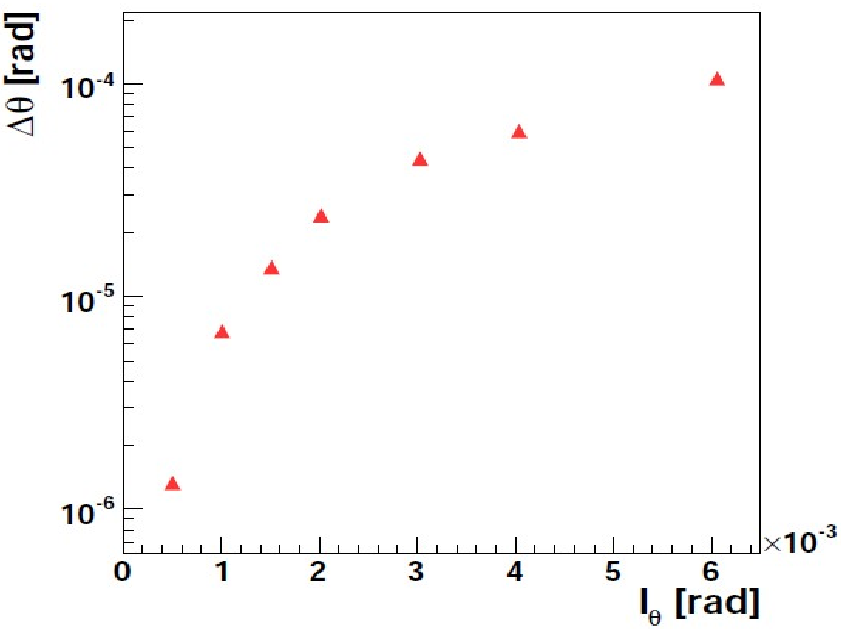
- Polar and azimuthal angles measured based on reconstruction in LumiCal;
- Studied earlier by Iftach Sadeh at TAU;
- Clustering Algorithm:
  - Selection of shower peak layer (z direction) and perform the 2D clustering within the layer;
  - Composing 3D clusters and finally assigning all hits to these clusters;
  - Correcting the parameters of the cluster based on their energy density distribution.
- It was shown that the reconstruction algorithm gives a bias in polar angle measurement, while the precise θ is crucial for luminosity measurement.

Polar Angle Bias

Polar angle reconstruction in LumiCal:

$$< \theta >= \frac{\sum_i \theta_i \cdot \mathcal{W}_i}{\sum_i \mathcal{W}_i}. \qquad \mathcal{W}_i = \max\{\ 0\ ,\ \mathcal{C} + \ln\frac{E_i}{E_{tot}}\},$$





Polar angle bias depending on weight constant and angular cell size at optimal (weight constant)

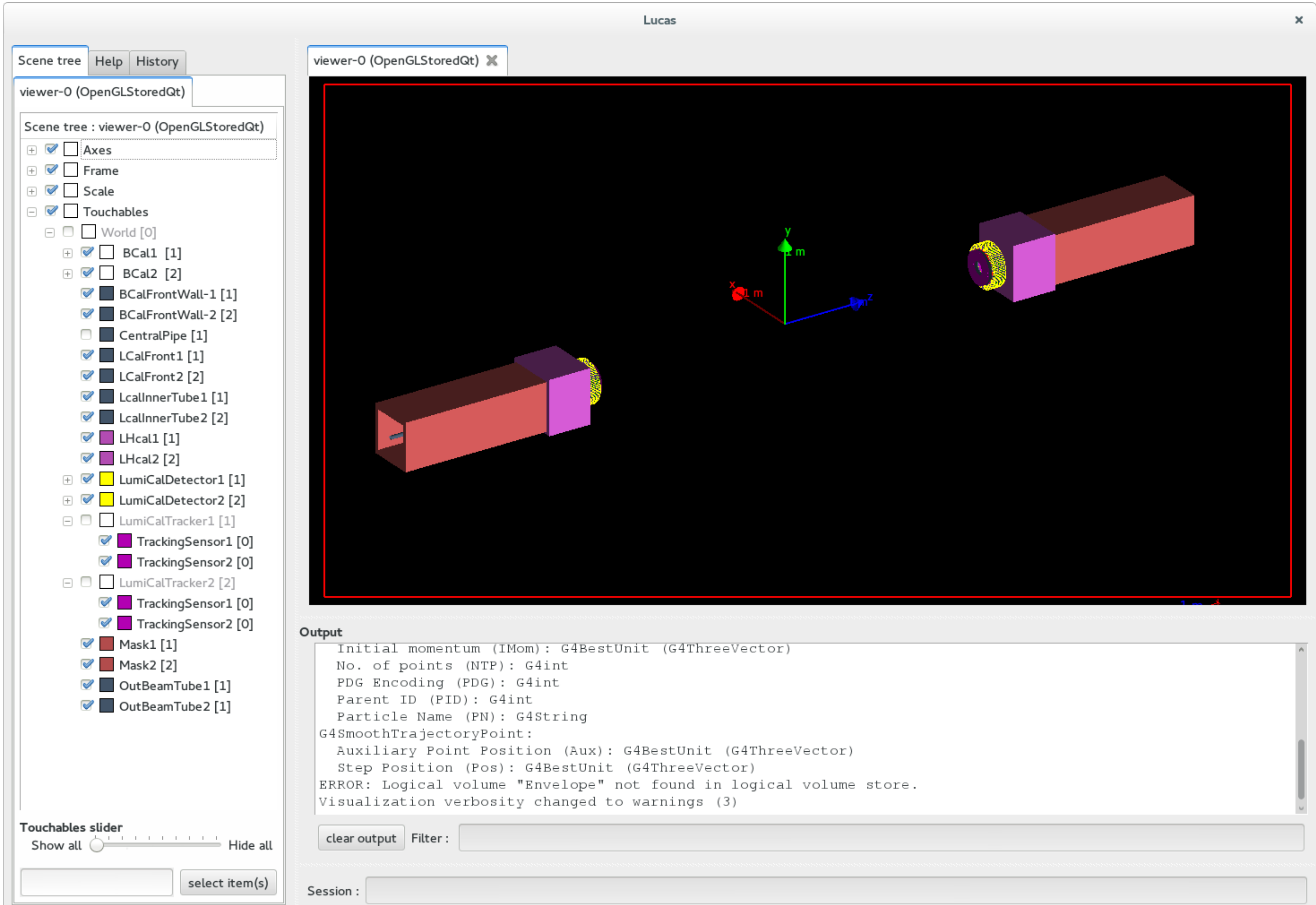
Tracking Detector

- Improve polar angle measurement accuracy;
- Provide information for better LumiCal sensors alignment;
- Provide more information to enable e/γ identification, important for various physics study.

A possible candidate could be Mimosa sensor

- Mimosa – MOS Active Pixel, developed in Strasbourg.
- Mimosa-26 is used in STAR inner tracker at RHIC, possibly also for ALICE ITS upgrade;
- We are developing the facilities for Mimosa test at TAU;
- Important to evaluate the radiation dose and radiation hardness of the Mimosa sensor;

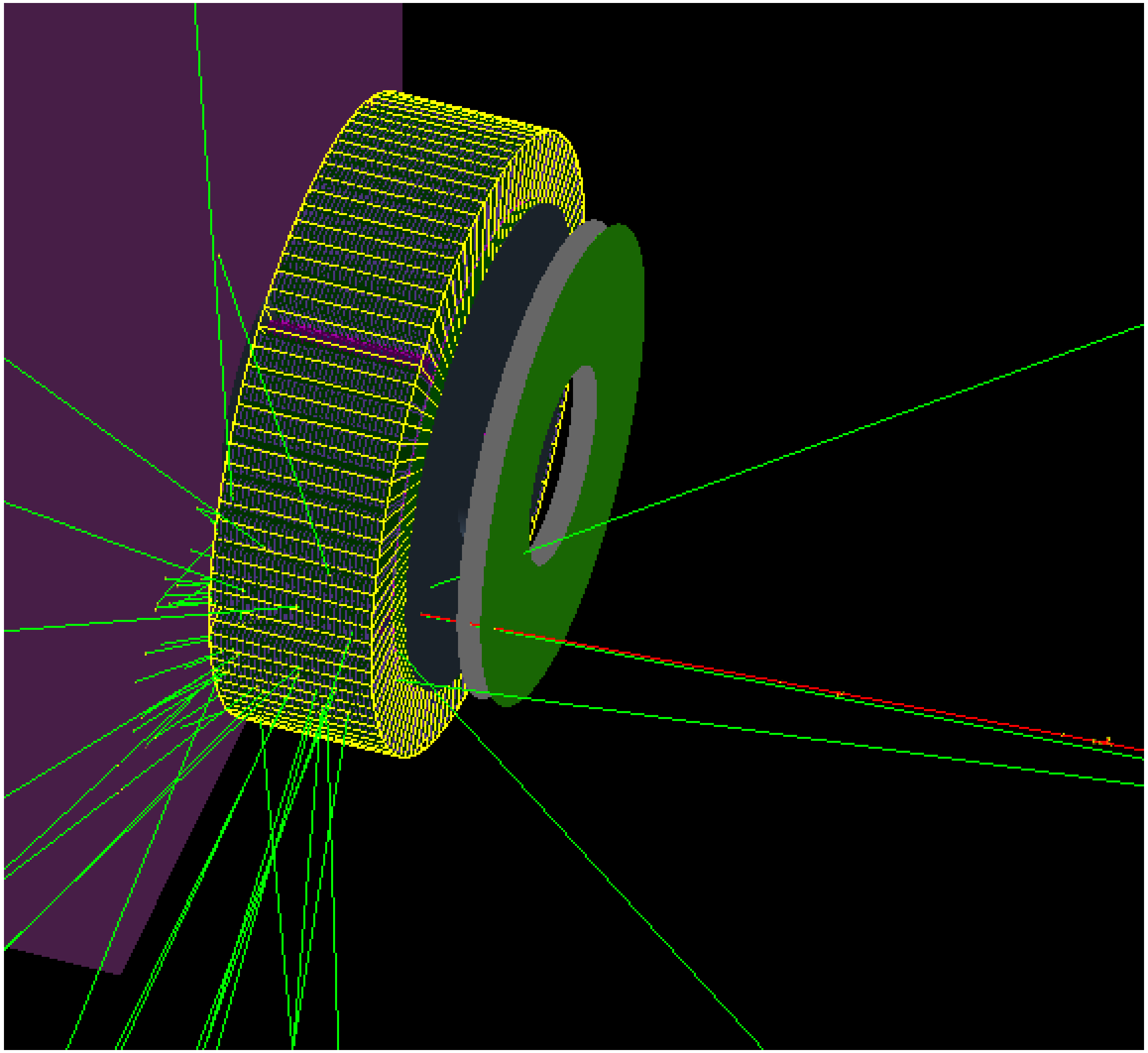
Tracking Detector in LuCaS



Tracker effect on LumiCal

- Two layers of 50 μm silicon, 50 mm away from the LumiCal with 20 mm between them

- Multiple scattering on big angles in tracking detector;
- Secondary particles production;

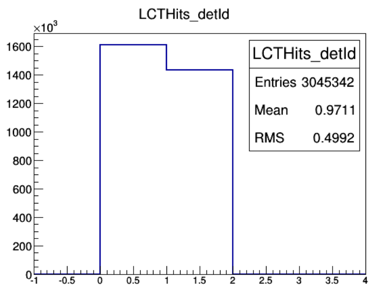


Simulation

- 250 GeV electrons;
- Uniformly distributed over azimuthal angle 2π;
- Uniformly distributed over polar angle in the range 41 - 69 mrad;
- Different tracking detector were used:
  - 50 μm thickness;
  - 300 μm thickness;

Hits Occupancy for Tracking Sensors

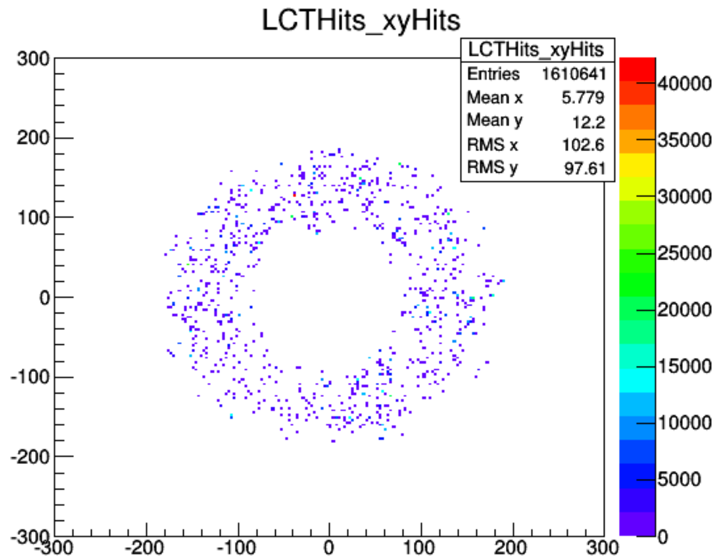
Close/Far

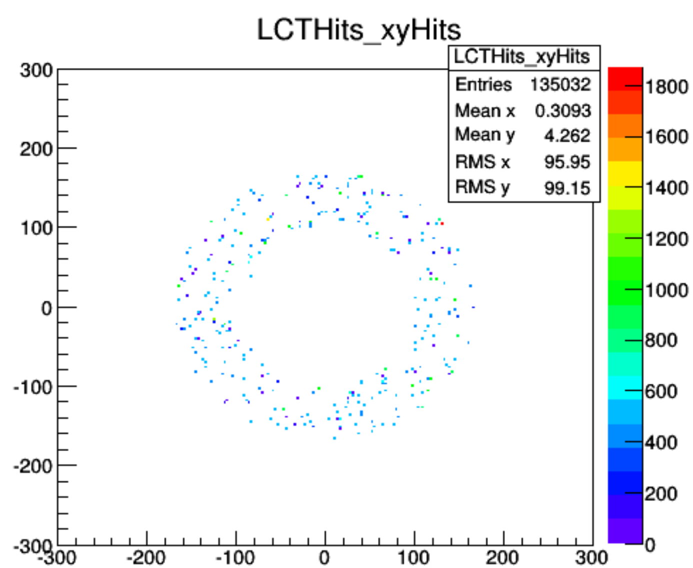


All tracks

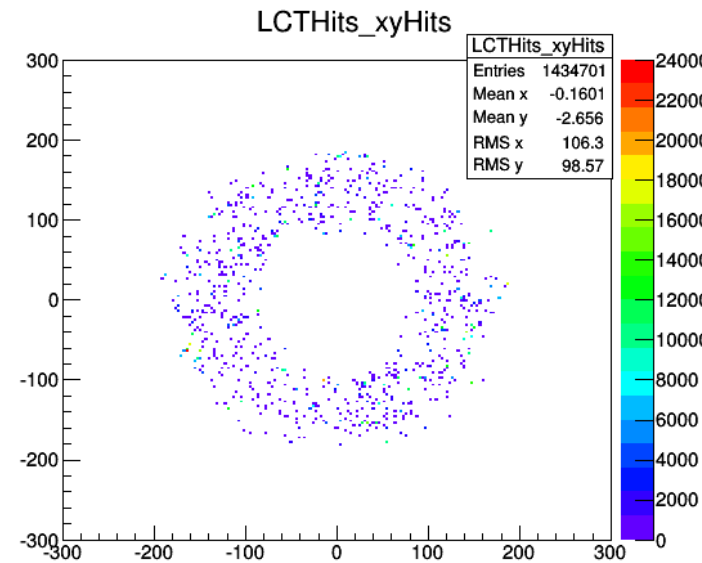
Only primary tracks

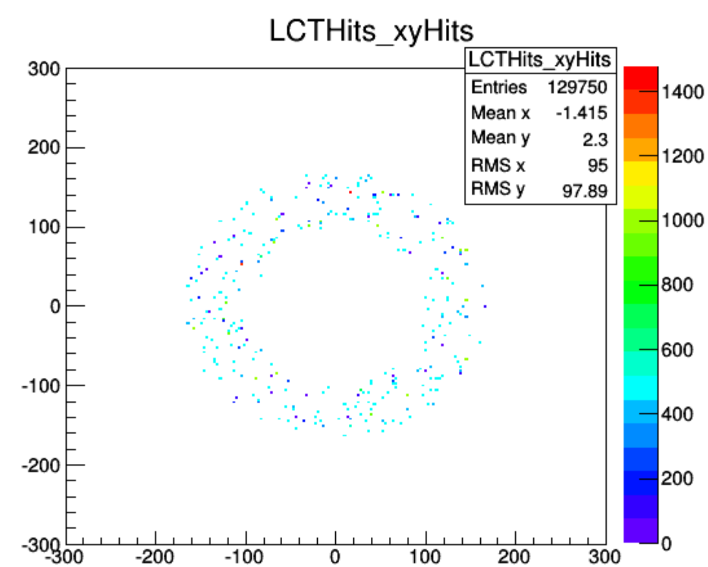
Sensor close to LumiCal





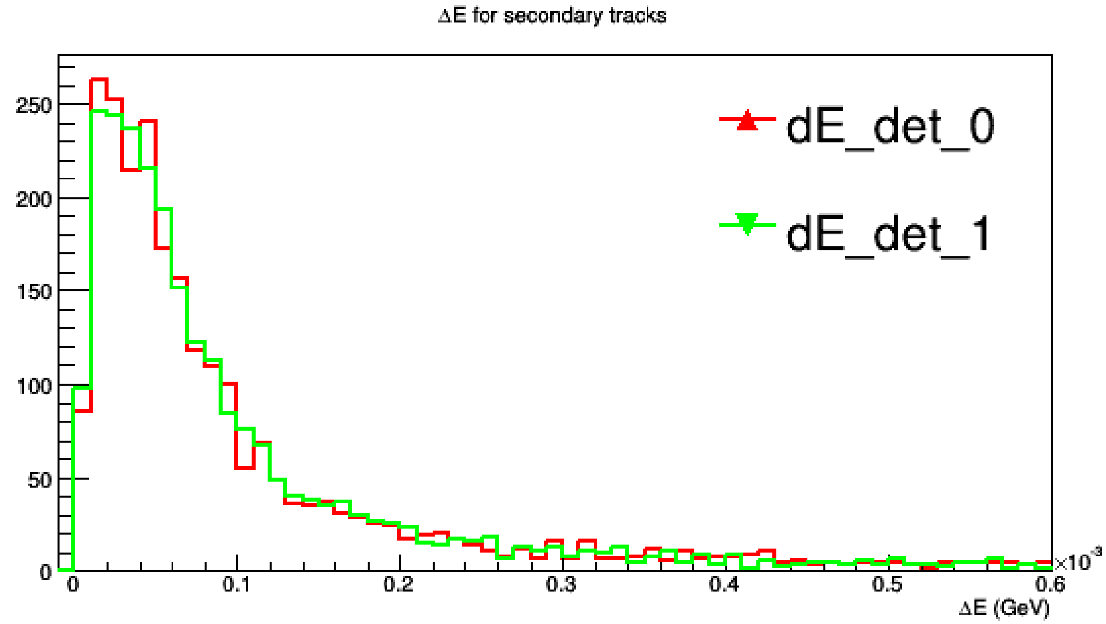
Sensor far from Lumical

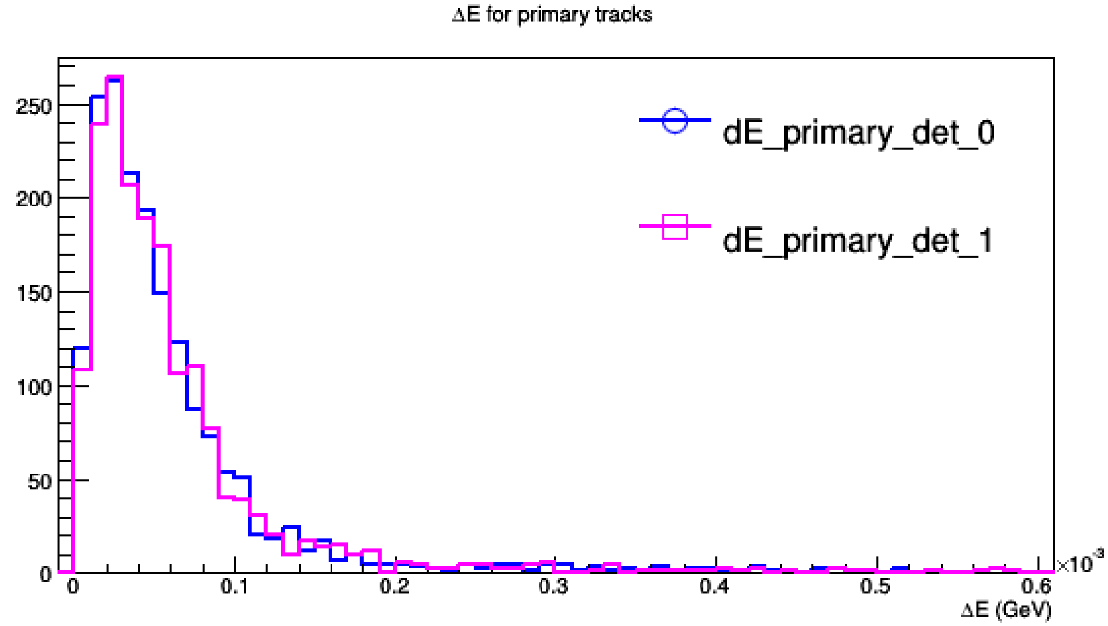




Hit Energy Distribution

- 2000 primary electrons;
- 300 μm silicon tracking detectors.
- Secondary tracks produce wider distributions.
- Can not be used for discrimination between primary and secondary.

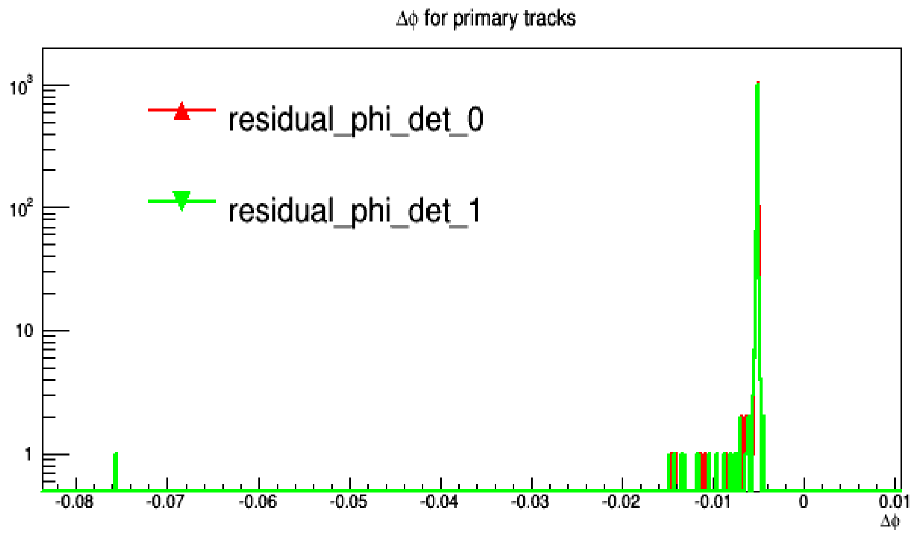


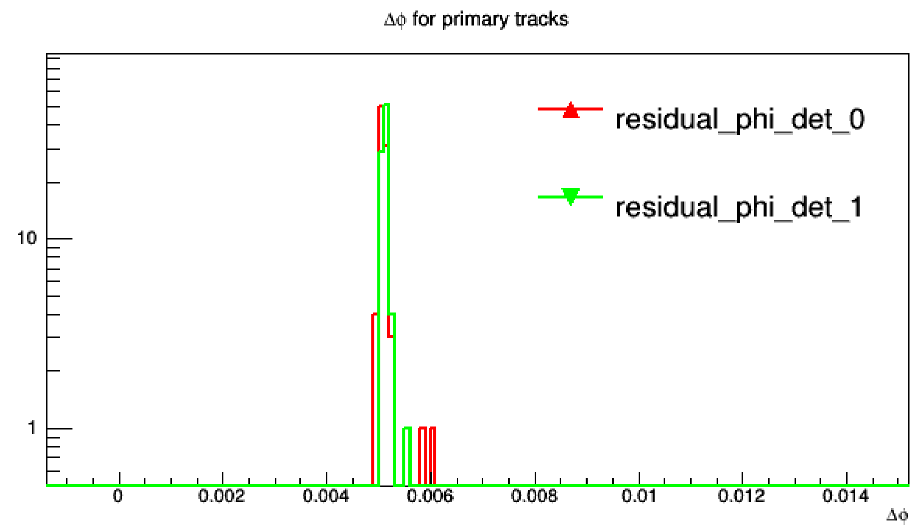


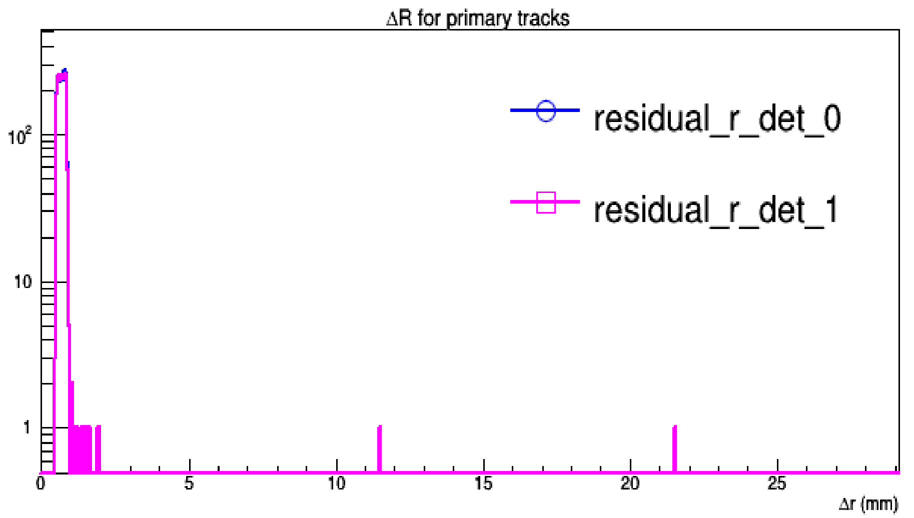
R, φ residuals between hits and primary tracks propagation

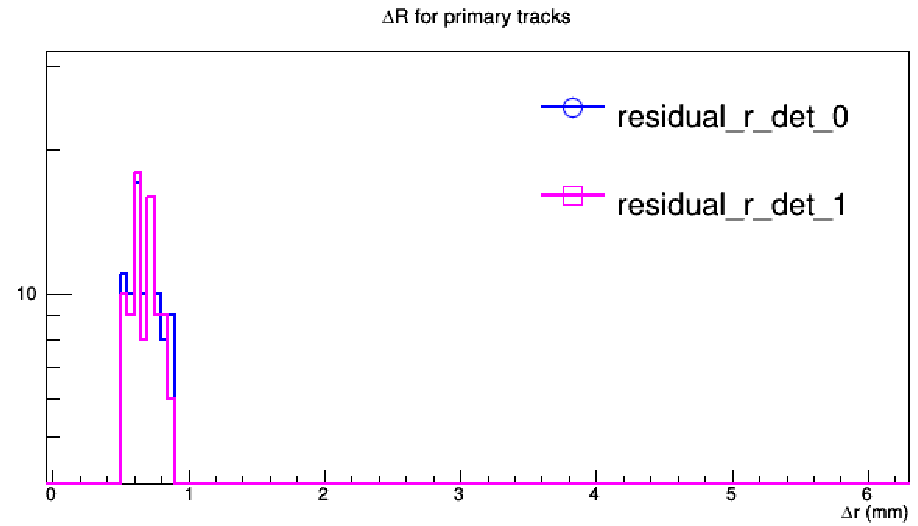
Electrons

Positrons



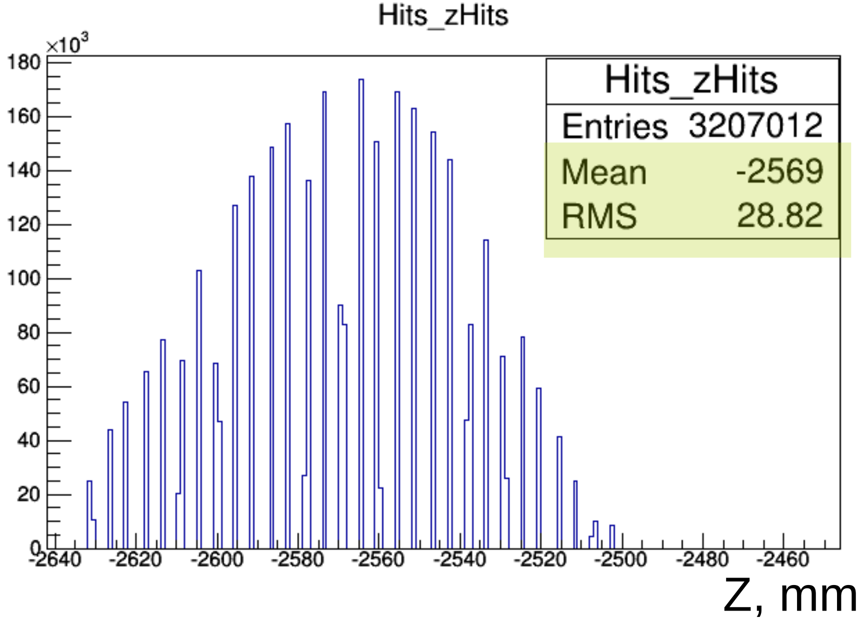




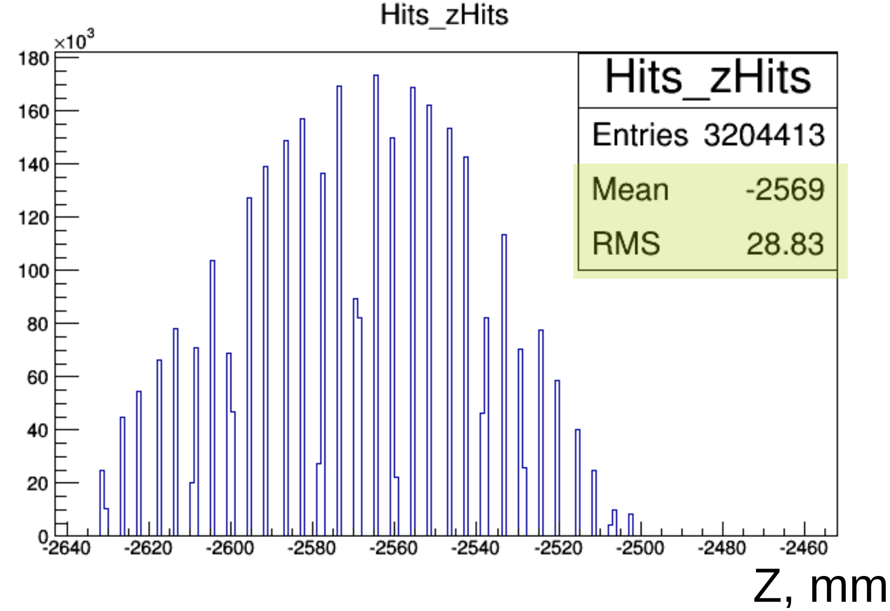


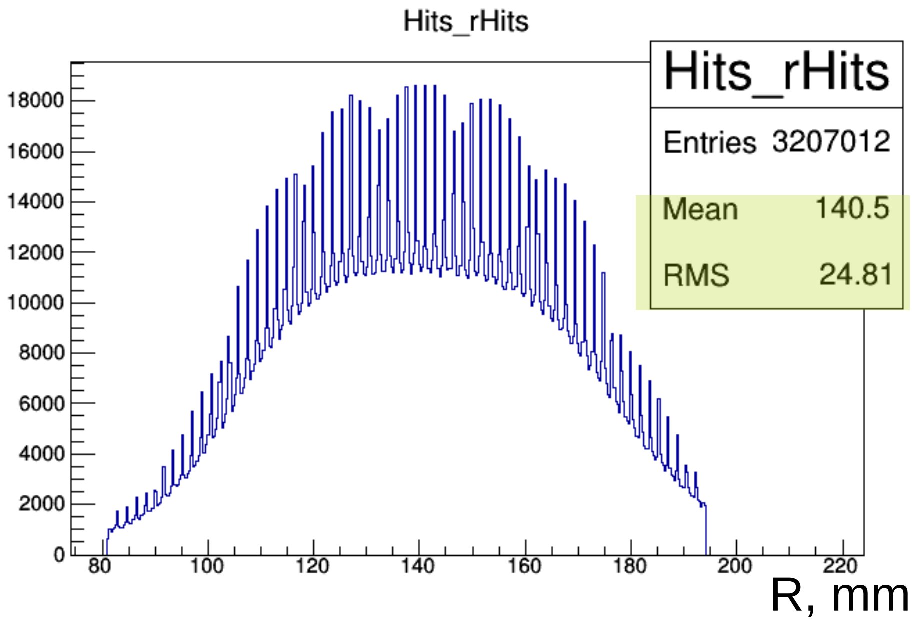
LumiCal w/, w/o Tracking Detector

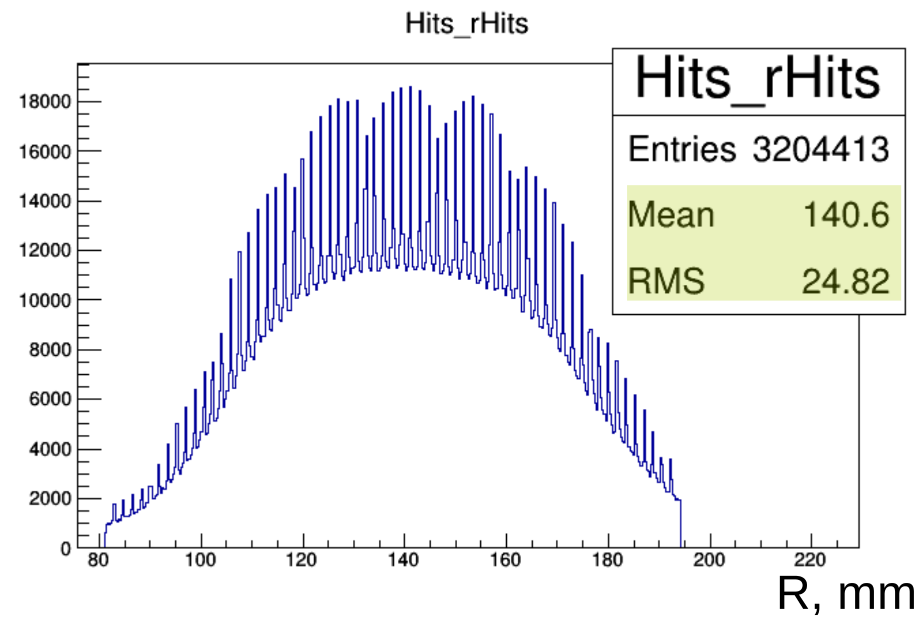
With tracking detector



W/o tracking detector







Summary and Plans

- There is significant occupancy of tracking detector caused by the scattered particles from LumiCal.
- There does not seem to be a strong influence of tracking detector on LumiCal performance, though the effect of multiple scattering on luminosity measurement must be evaluated.
- Electrons and positrons displacement in proximity of LumiCal is around 0.5-1 mm, which can be resolved by modern tracking detector and give the possibility to distinguish e/γ.
- Study different configurations of tracking detector.
- Check the performance with track reconstruction using official ILD framework.