

# LumiCal Performance with the Tracking Detector

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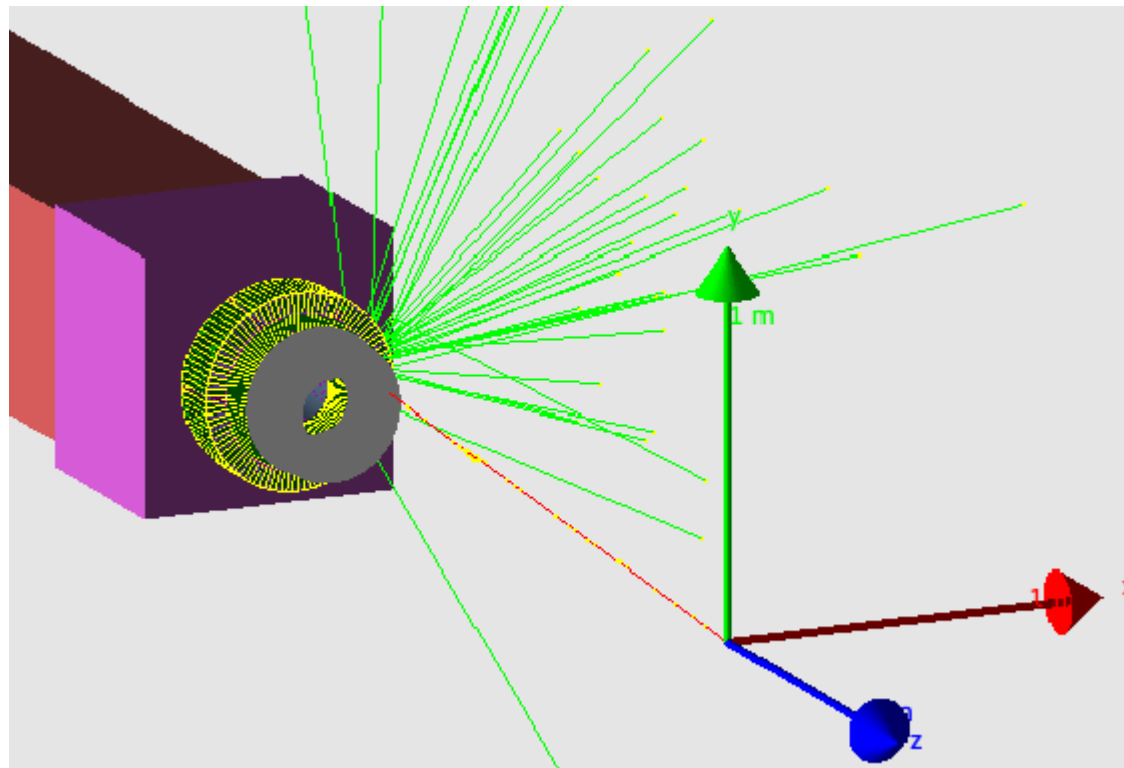
FCAL Workshop  
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# Outline

- Introduction and motivation for the study
- Simulation with LuCaS
- Reconstruction with LumiCal clustering software
- Electrons and photons identification
- Summary and plans

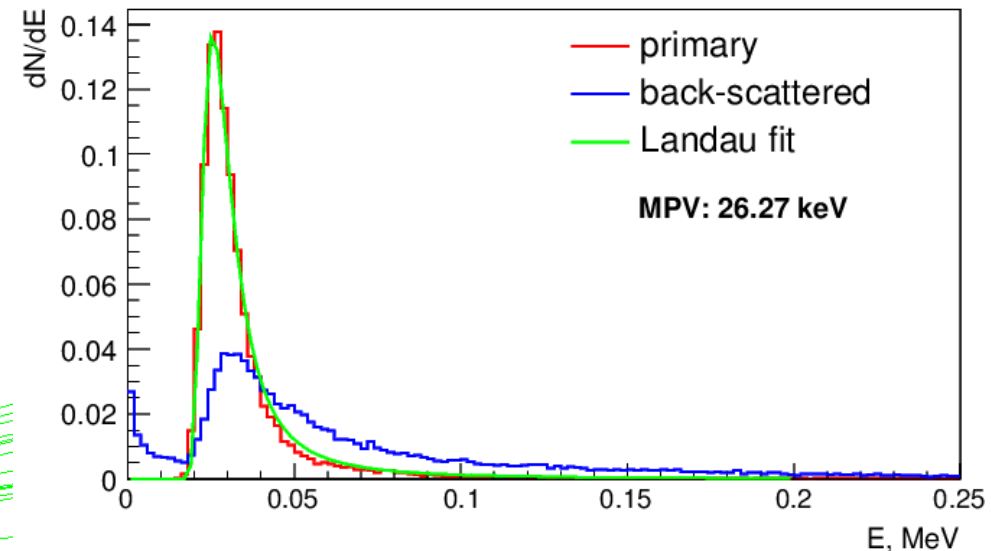
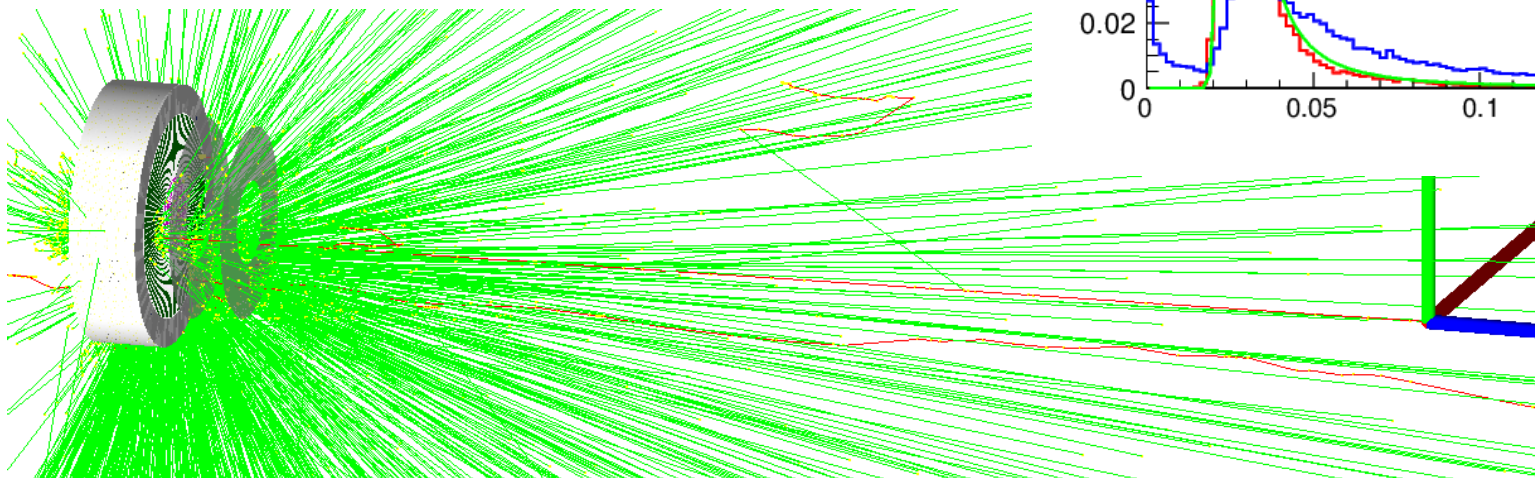
# Tracking Detector in Front of LumiCal

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



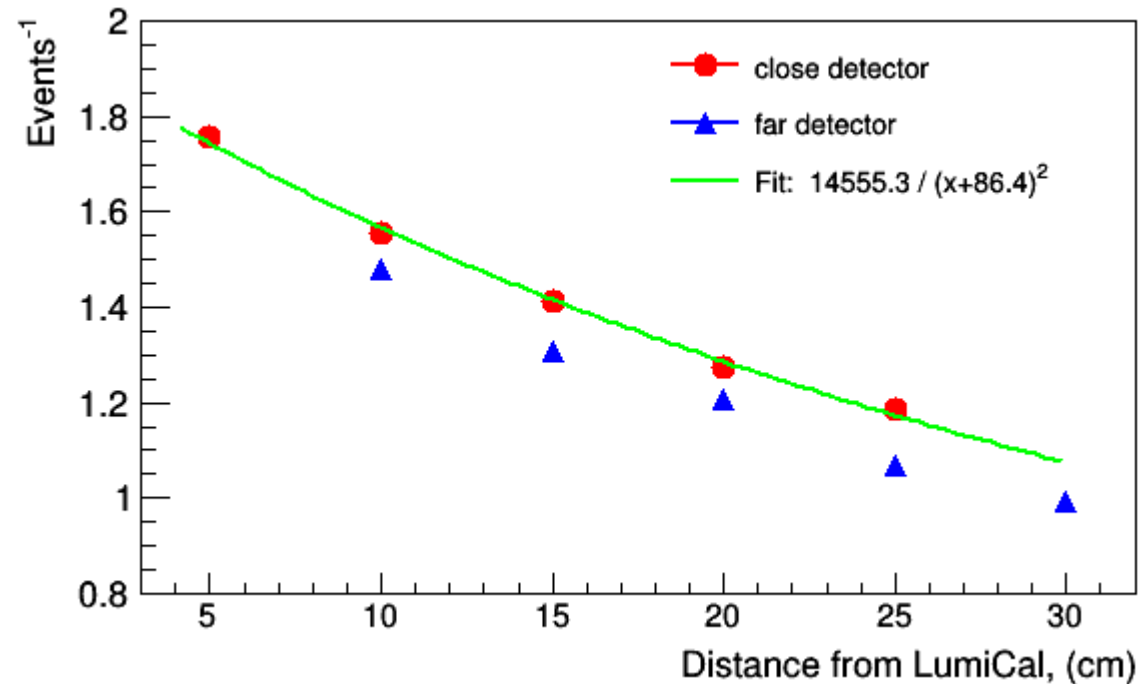
# Simulation

- Modified versions of LuCaS (Geant4 application) was used;
- LCIO output for LumiCal and root for tracking detector were implemented;
- Range cut: 20  $\mu\text{m}$  (5  $\mu\text{m}$  also was tested);
- Minimum step: 5  $\mu\text{m}$ ;
- Physics list: QGSP\_BERT;
- Two layers of Si 100  $\mu\text{m}$  thick;
- No mechanical constraints;



# Occupancy of Planes of Tracking Detector

- Average occupancy per event from back-scattered particles normalized on the number of primary ones is less than 2 at a distance of 5 cm from LumiCal.
- It decreases down to  $\sim 1$  at 30 cm.
- The second layer has 5% - 10% less occupancy for the same distance from LumiCal.



N_primary	Close Detector		Far Detector		Far/Close
	Position (cm)	N_RecPoints	Position (cm)	N_RecPoints	
5000	5	8781	10	7407	0.95
5000	10	7767	15	6545	0.92
5000	15	7071	20	6025	0.95
5000	20	6373	25	5351	0.90
5000	25	5938	30	4969	

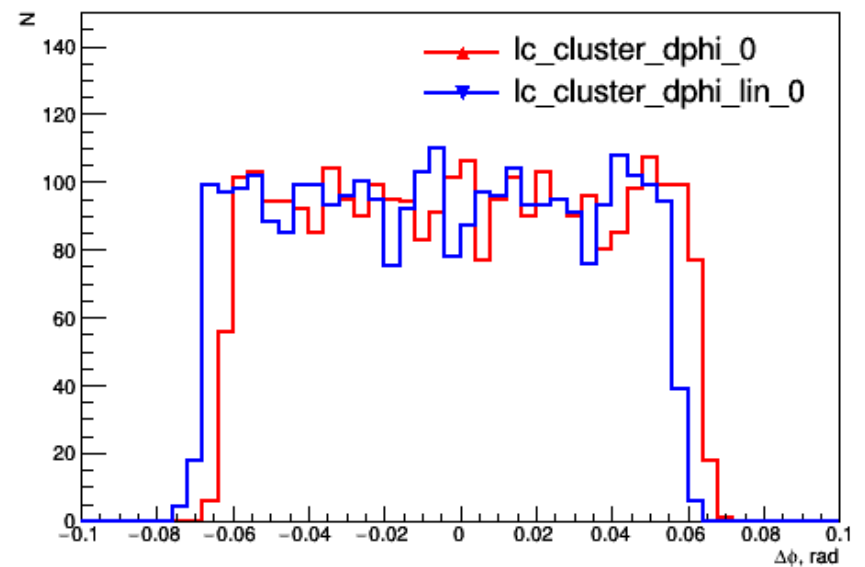
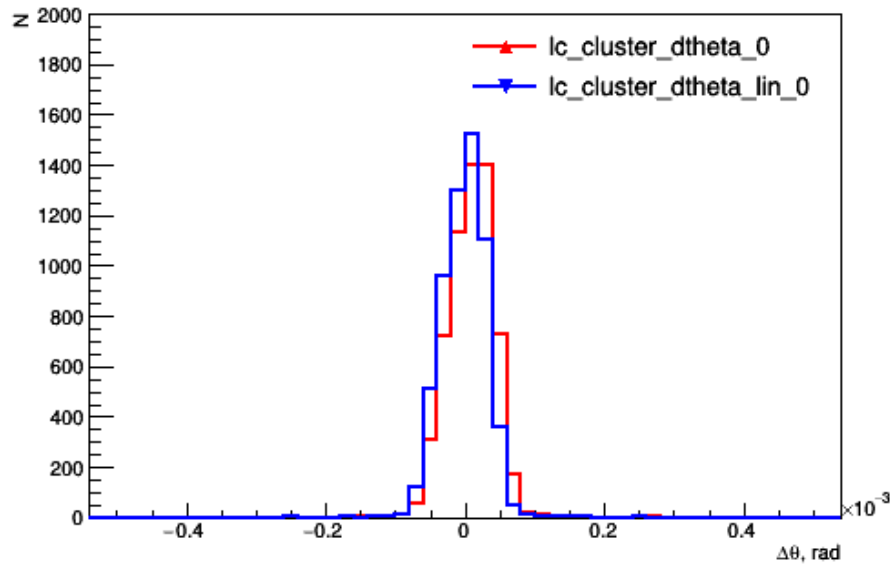
# Simulation and Reconstruction Strategy

- Reconstruct track using:
  - LumiCal cluster: energy, position;
  - Primary vertex position;
- Check track matching to the clusters in the tracking detector planes;
- Use position, residuals,  $dE$  for  $e$ ,  $\gamma$  identification.
- This approach requires track reconstruction. They exist, but need to be optimized for longitudinal geometry.

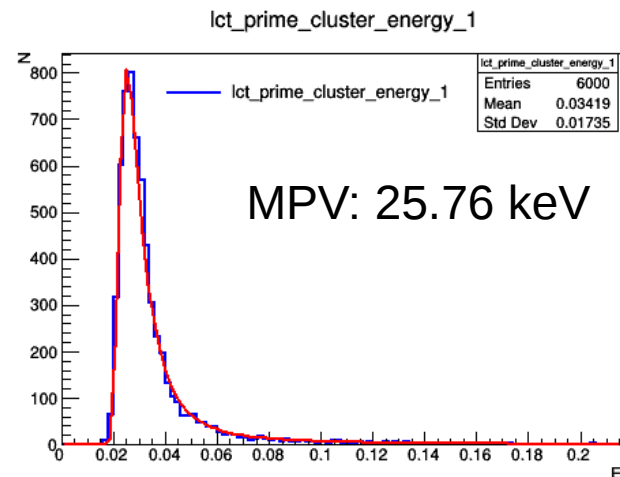
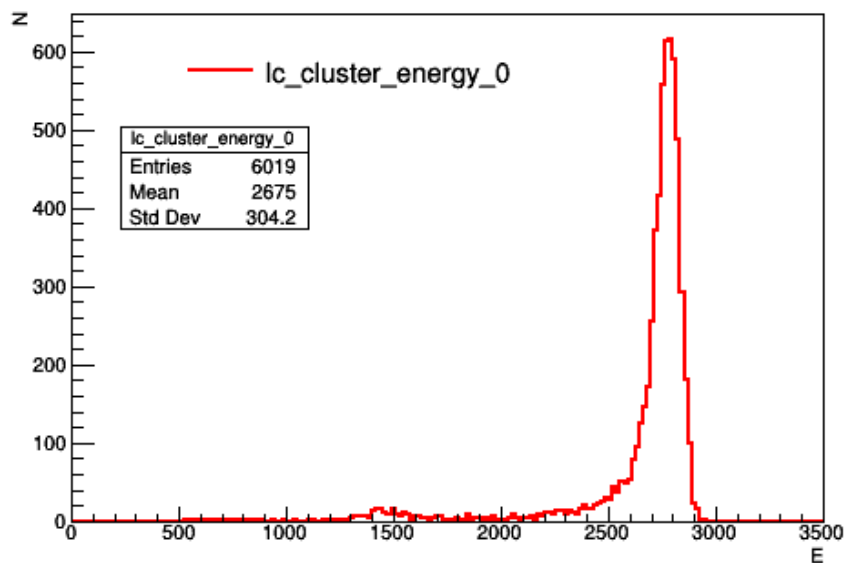
## Simpler intermediate approach to evaluate the performance supposing perfect tracking:

- Build the trajectory (helix / line) primary MC particle based on its momentum, charge and primary vertex position:
  - Check matching to the LumiCal cluster,
  - Check matching to the clusters in the tracking detector planes,
  - Apply criteria for particle identification and check the performance.

# Electron in LumiCal

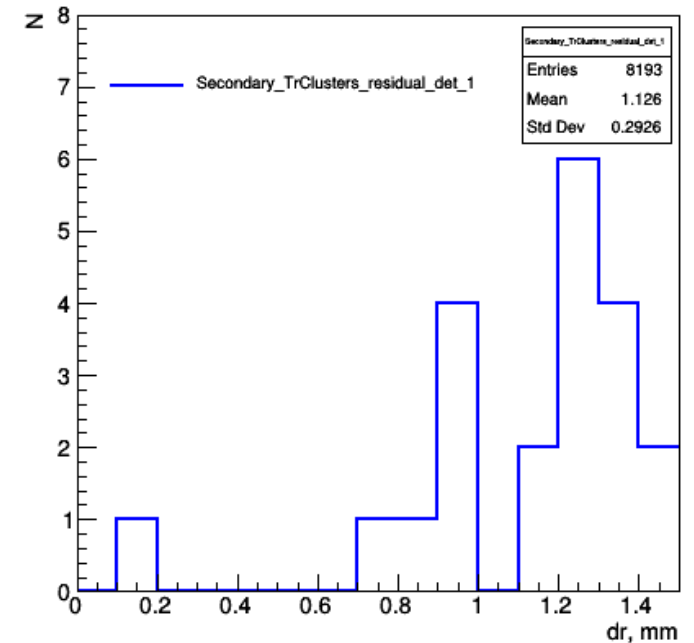
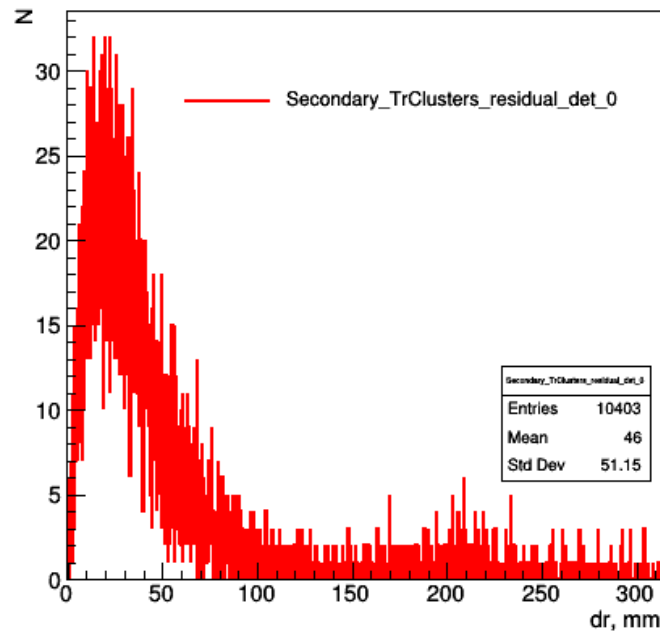


Angle residuals between reconstructed  $\theta$ ,  $\phi$  after the simulation and calculated from helix and linear trajectory using initial particle momentum.

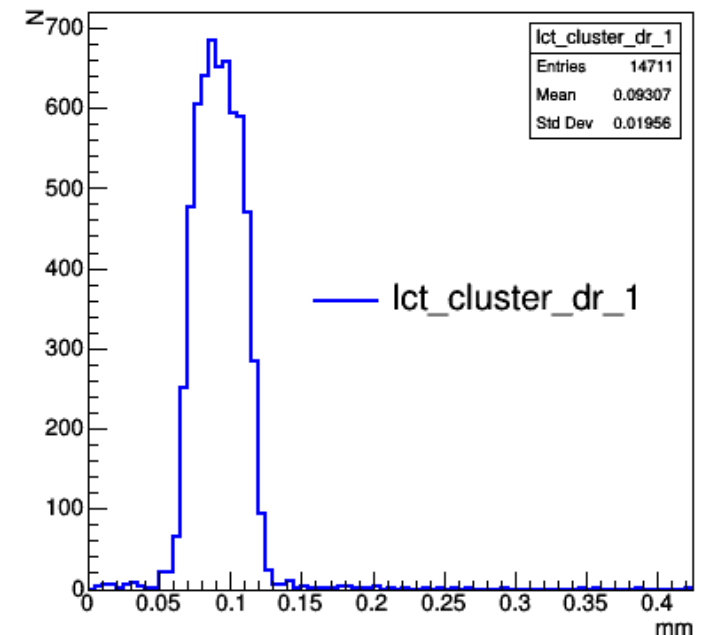
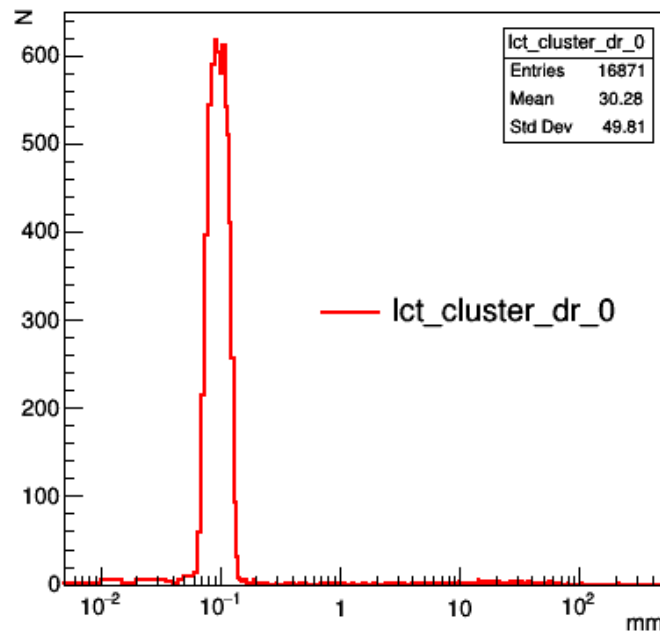


# Electron in Tracking Detector

- Difference between clusters from primary electron and secondary tracks. Based on the information from Geant4.
- Zoomed in around the area close to 0.

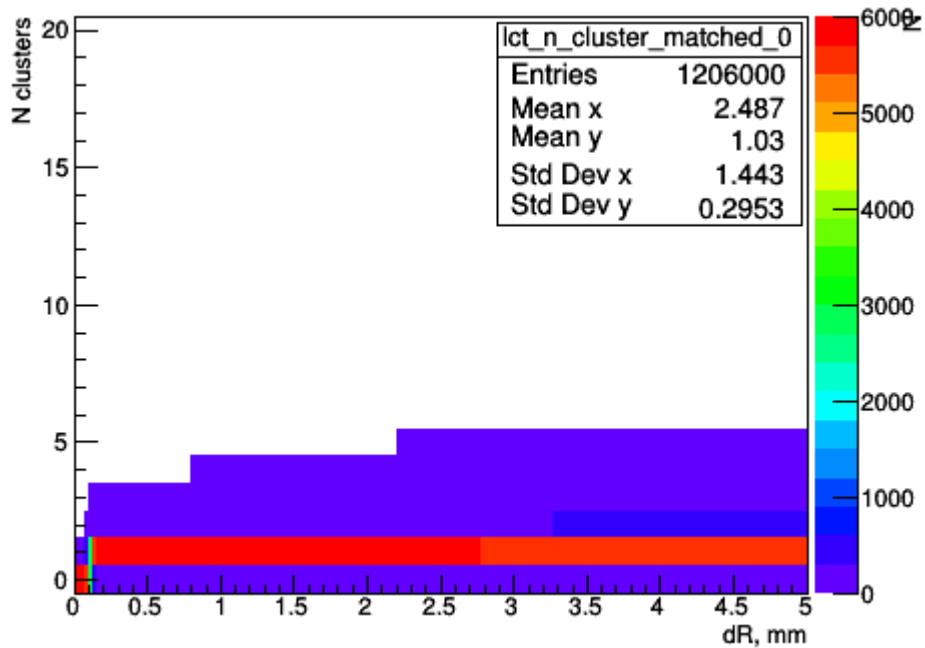


- Residual between clusters in the tracker layer and helix.
- Zoomed in around the area close to 0.

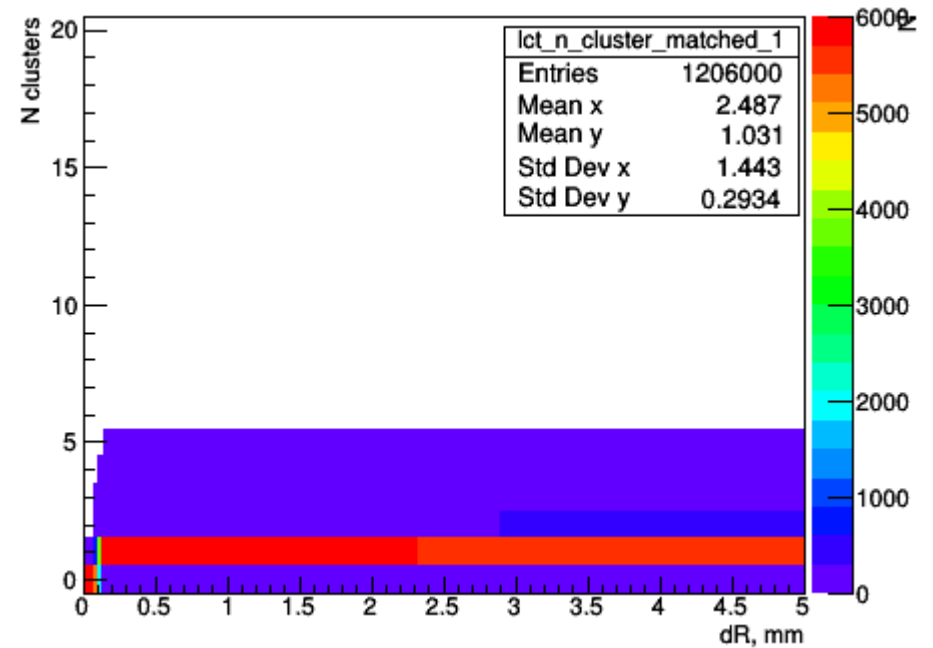
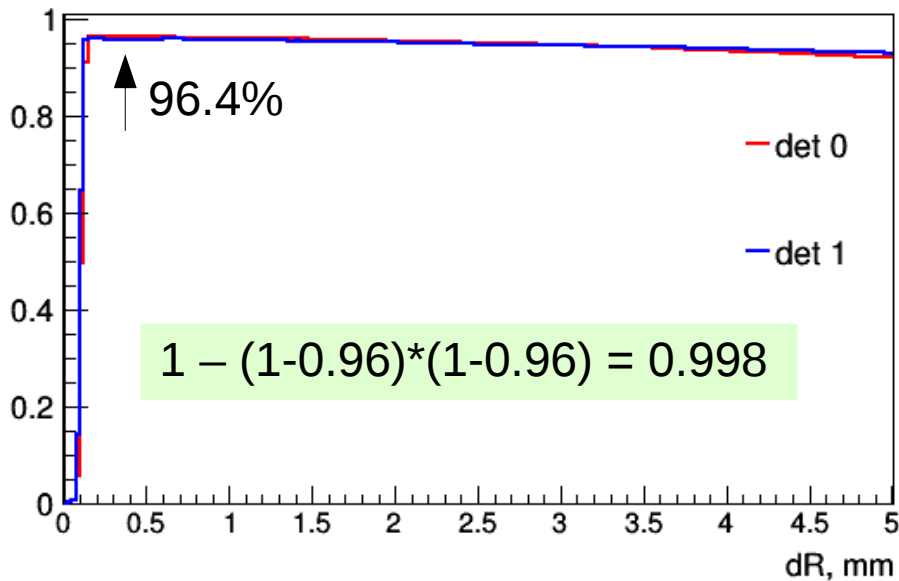




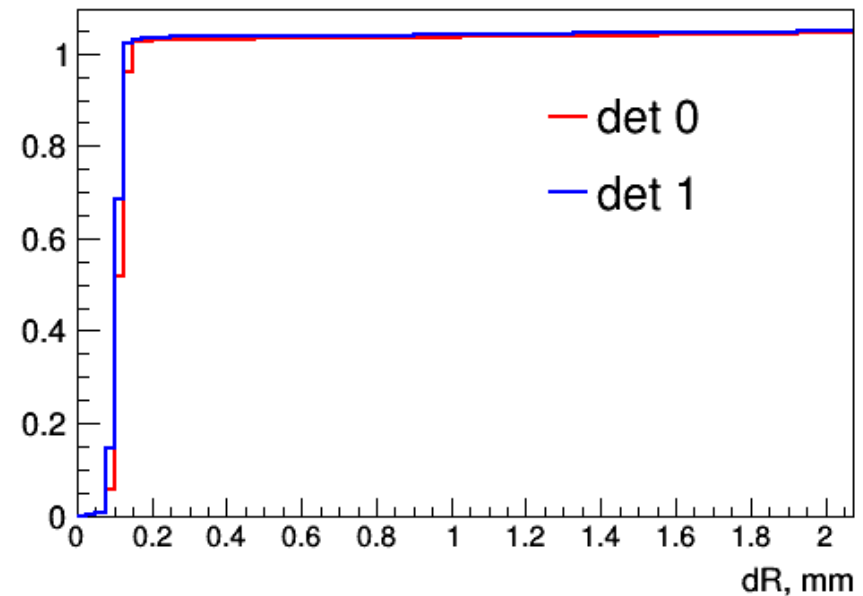
# Electron in Tracking Detector



Electron identification efficiency

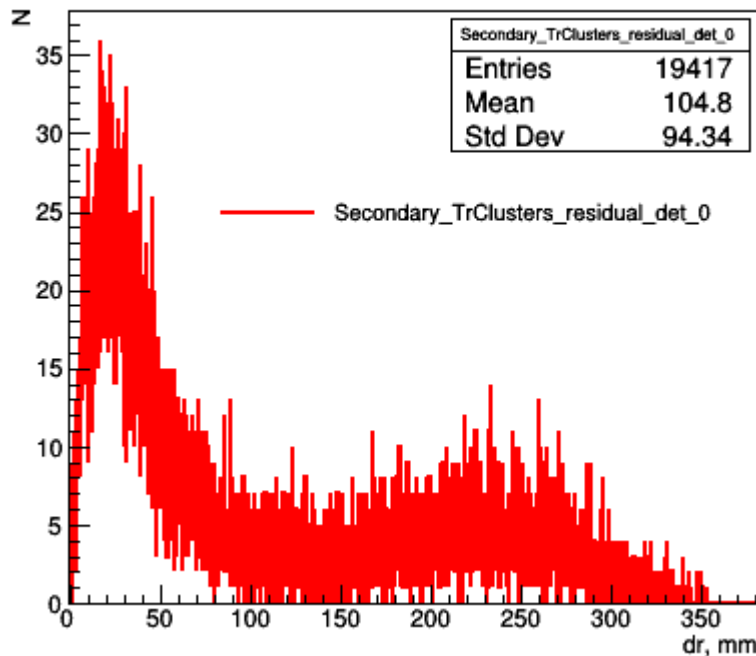


Number of clusters in helix vicinity

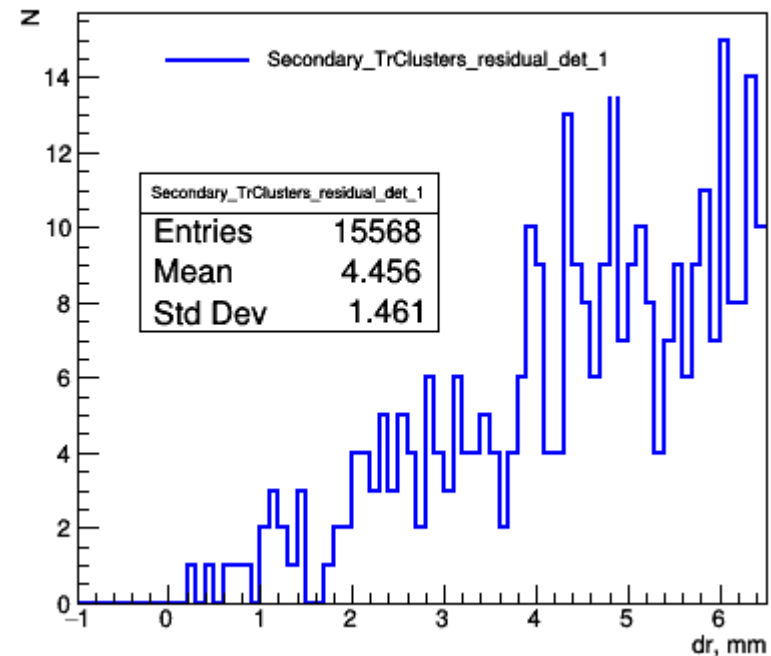


# $e^- \gamma$ Event in the Tracking Deatector

Secondary\_TrClusters\_residual\_det\_0



Secondary\_TrClusters\_residual\_det\_1



Electron:

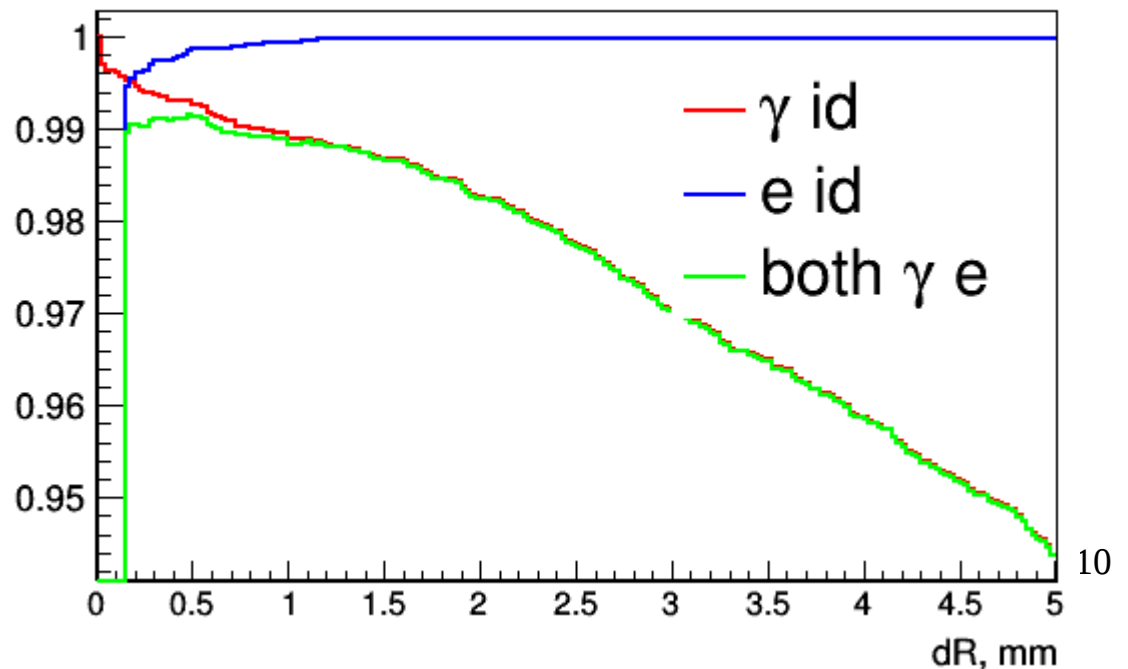
- At least one cluster in each tracking detector plane assigned to the helix

Photon:

- No cluster in each tracking detector plane assigned to the line

Event:

- Electron && Photon



# Summary and Plans

- Reconstruction in LumiCal does not show visible influence of tracking detector on LumiCal performance.
- Electron and photon identification efficiency with two 100  $\mu\text{m}$  silicon sensitive planes in front of LumiCal estimated to be 99.8% and  $\sim 99\%$  (99.3% combined) in simplified approach when the trajectories are built as helix and line using initial momentum. 250 GeV  $e, \gamma$  with uniformly distributed and not correlated momenta.
- Implement (or adapt existing) realistic tracking algorithm.
- Consider the simulation with full detector geometry for more realistic background from secondary particles.
- Study  $e, \gamma$  identification capability using generated Bhabha events, possible backgrounds and physics event of interest.
- Think about possible mechanical design of the tracking detector and the sensor construction.