

LumiCal Performance with a Tracking Detector

Oleksandr Borysov
Tel Aviv University

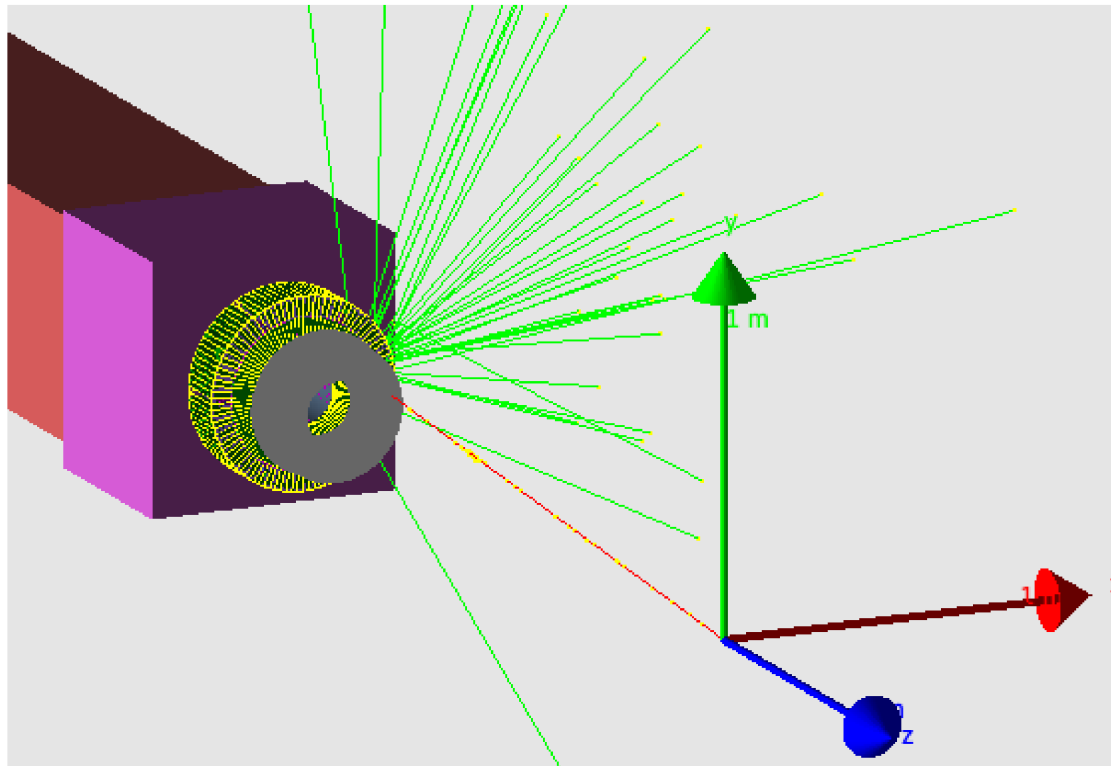
FCAL Meeting, CERN
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Outline

- Introduction and motivation for the study
- Simulation with LuCaS
- Reconstruction with LumiCal clustering software
- LumiCal with and without tracking detector
- Summary and plans

Tracking Detector

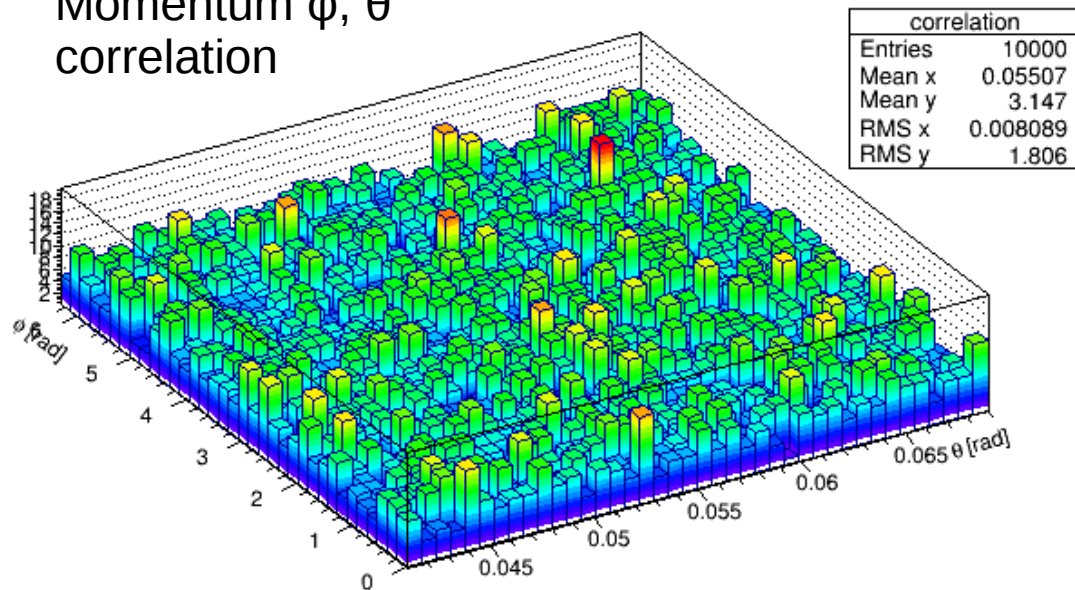
- Improve polar angle measurement accuracy;
- LumiCal alignment;
- Provide more information to enable e/ γ identification, important for various physics study.



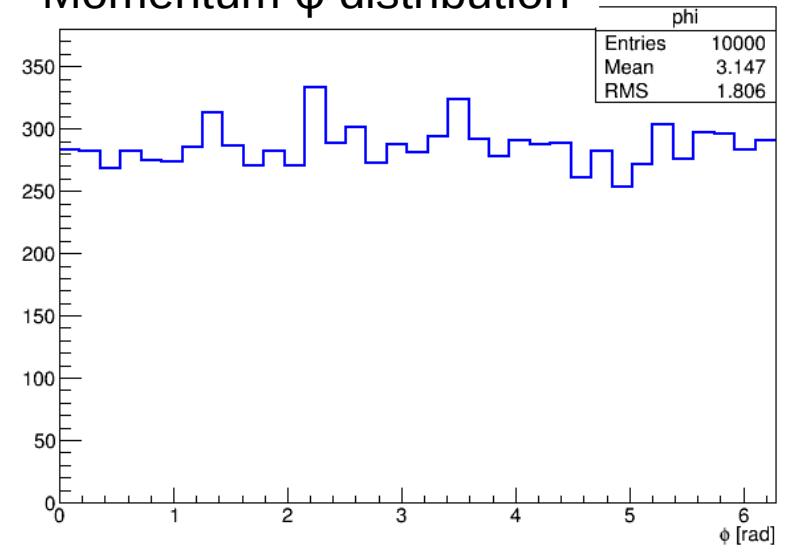
Generated Events

- Subset of 2000-5000 events out of 10000 were used for simulation
- Each event contains one e^- , 250 GeV;
- Uniformly distributed on momentum φ (0, 2π), θ (41, 69 mrad).

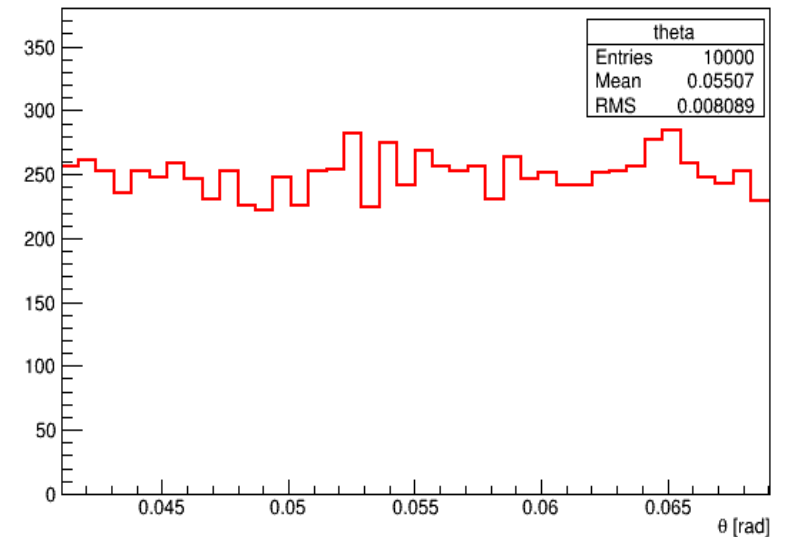
Momentum φ , θ
correlation



Momentum φ distribution

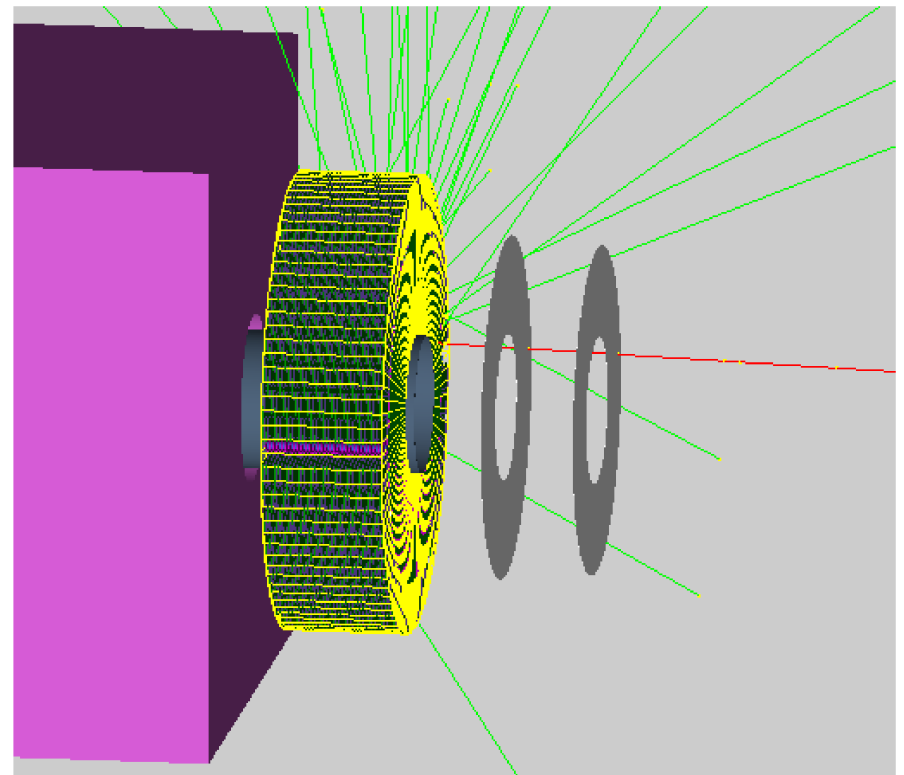


Momentum θ distribution

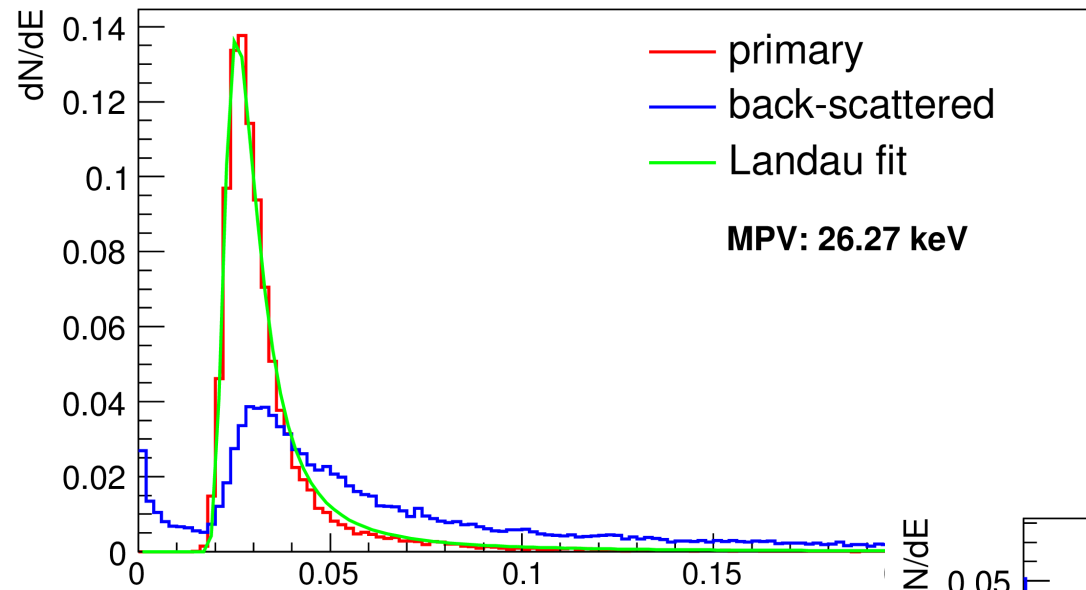


Simulation

- Modified versions of LuCaS (Geant4 application) was used;
- Range cut: 20 μm (5 μm also was tested);
- Minimum step: 5 μm ;
- Physics list: QGSP_BERT;
- Two layers of Si 100 μm and 300 μm thick;
- Different distance to LumiCal;
- No mechanical constraints;

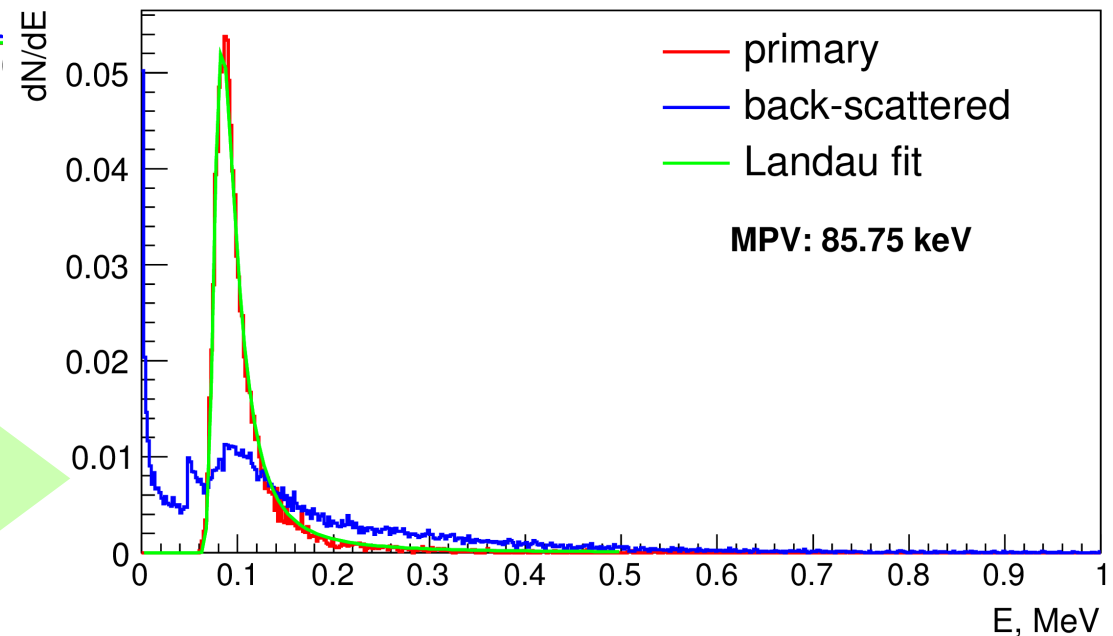


Energy Deposition in Tracking Detector



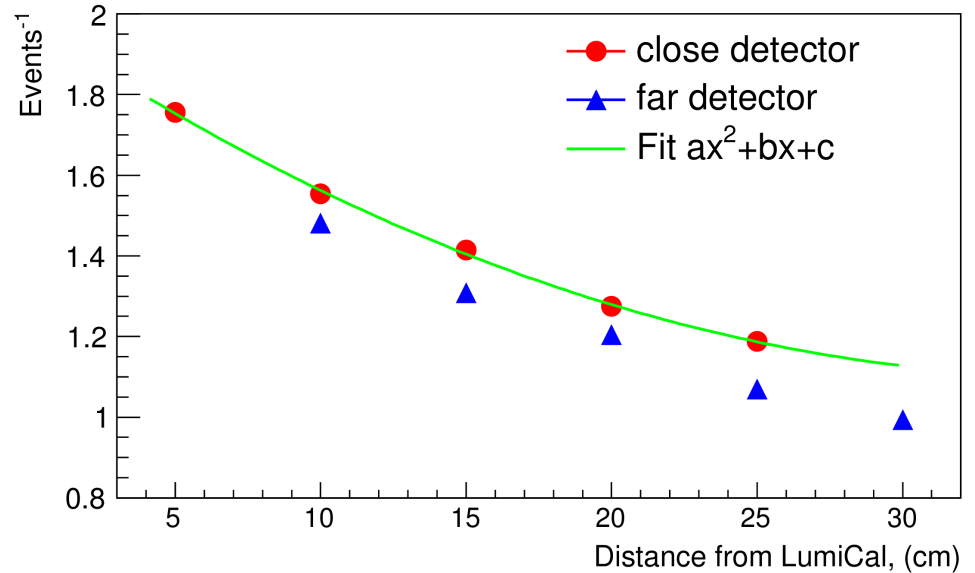
Si, 100 μm

Si, 300 μm



Occupancy of Tracking Detectors

- 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 ~ 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	

Momentum Change

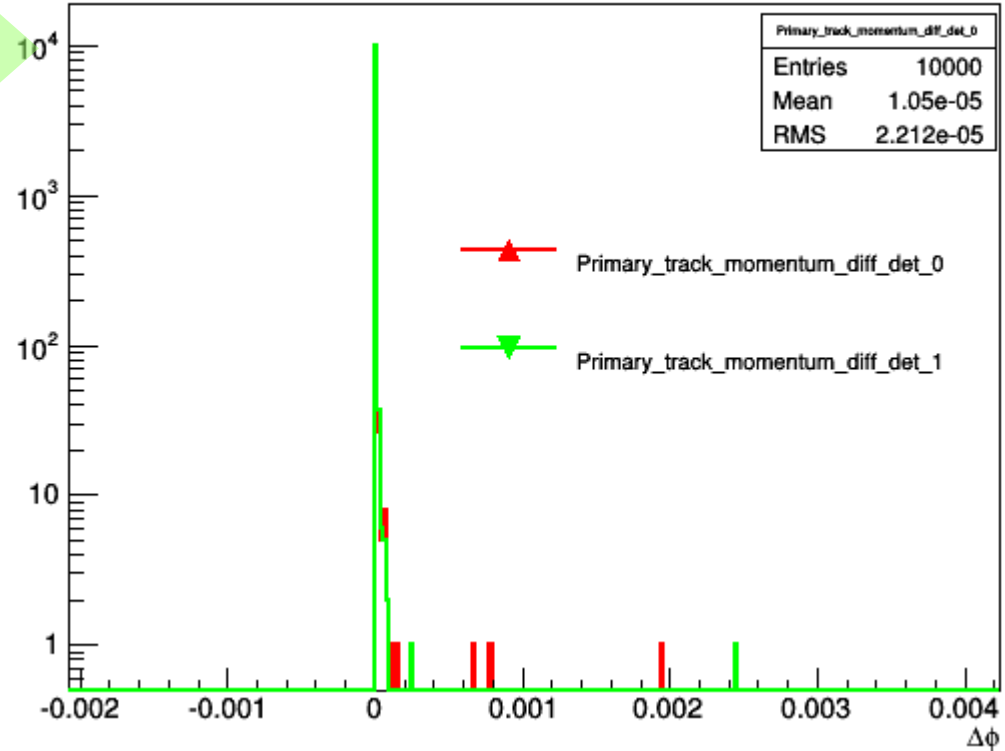
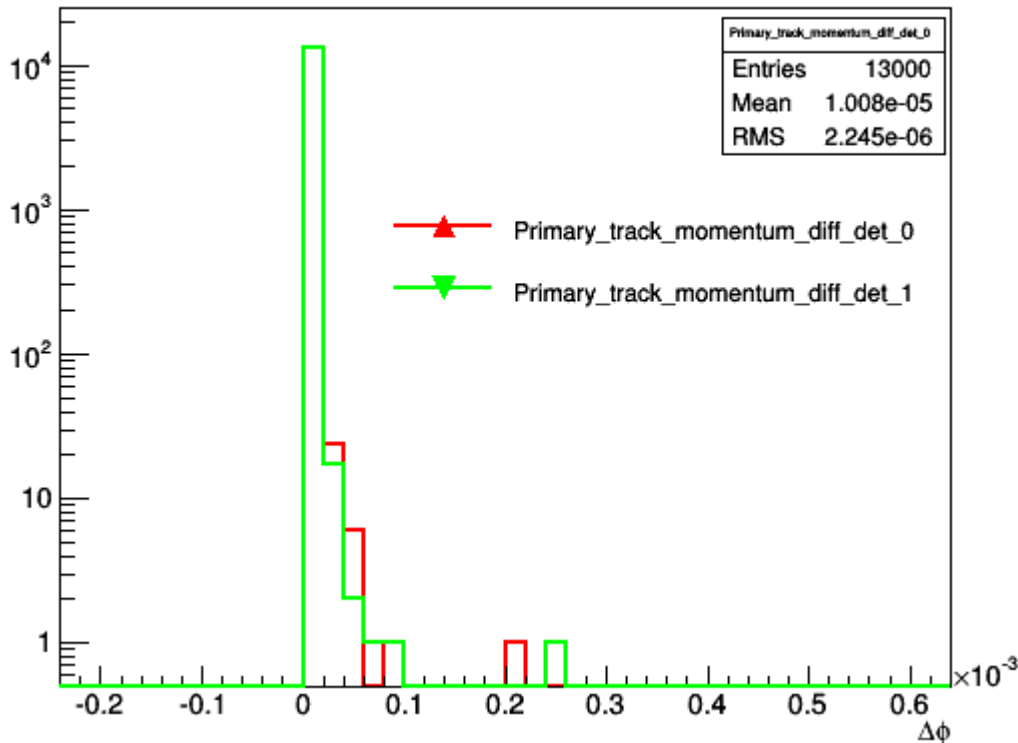
Momentum change of primary track

Si 300 μm

$\Delta\phi$ for 100 μm Si is much less;

Si 100 μm

Momentum change of primary track



- Viewed from IP the maximum angles correspond to
- $\sim 3 \mu\text{rad}$, for 100 μm Si at 30 cm;
- $\sim 30 \mu\text{rad}$, for 300 μm Si at 30 cm;
- Lumical pad size from IP: 0.8 mrad.

Reconstruction in LumiCal

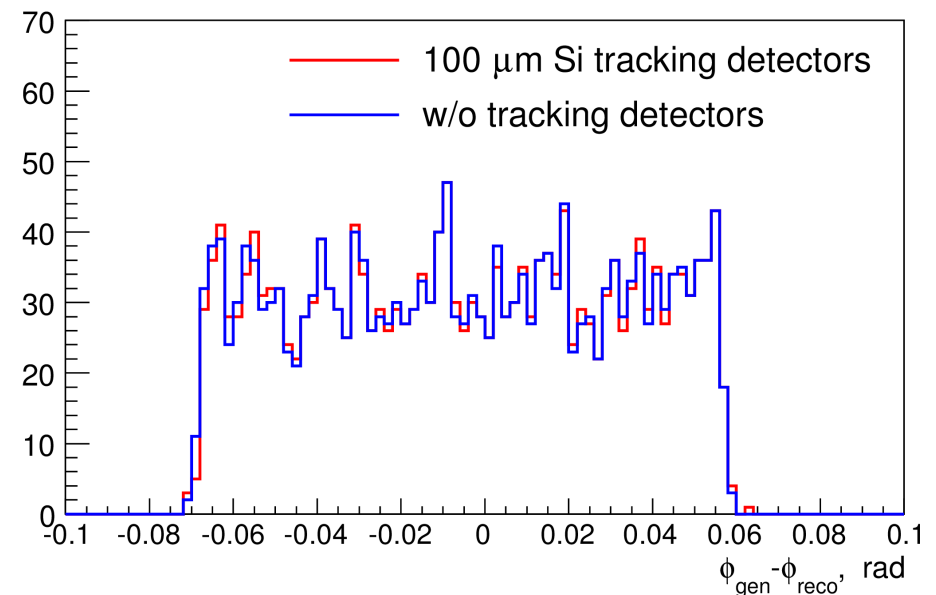
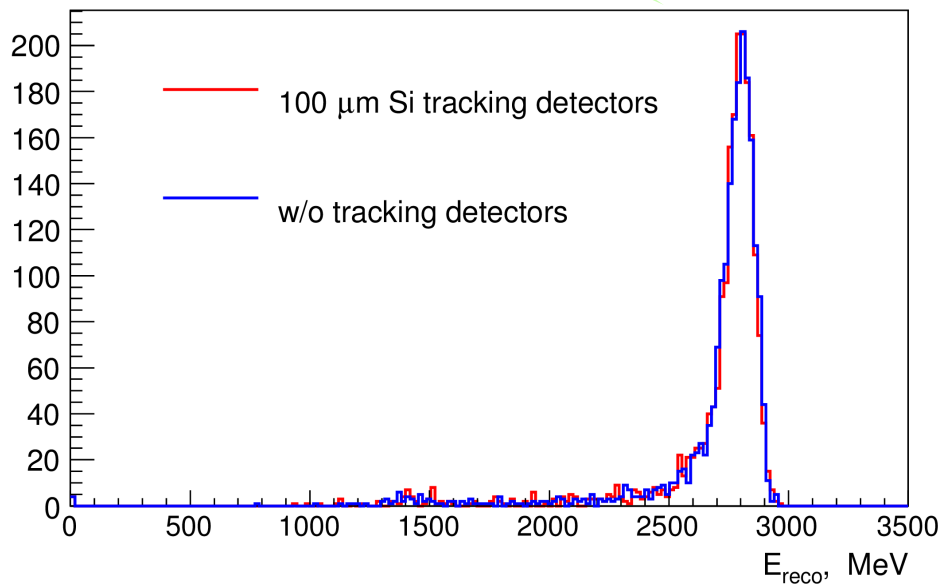
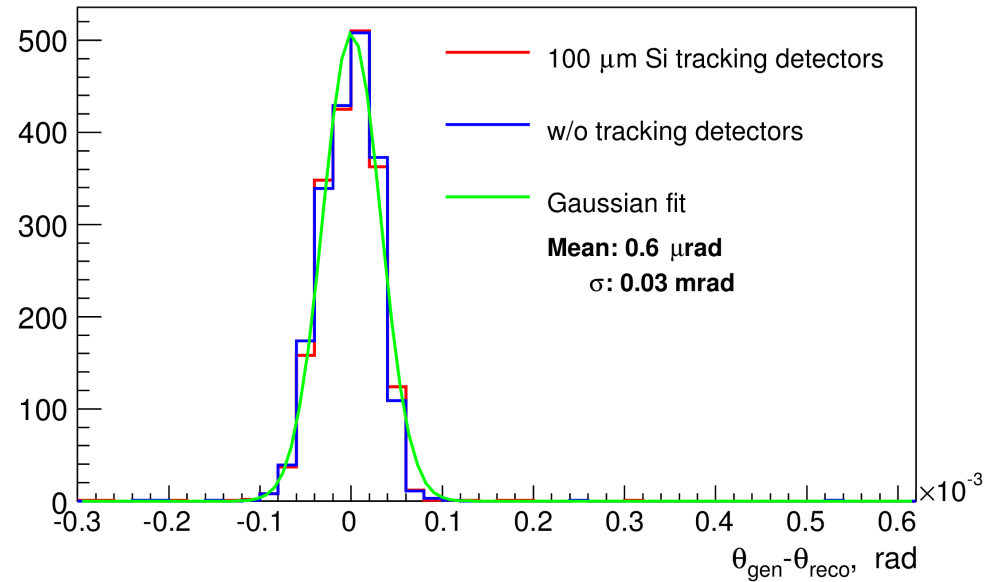
2 cases:

- without tracking detector (air);
- with 2 layer of 100 μm thick Si.

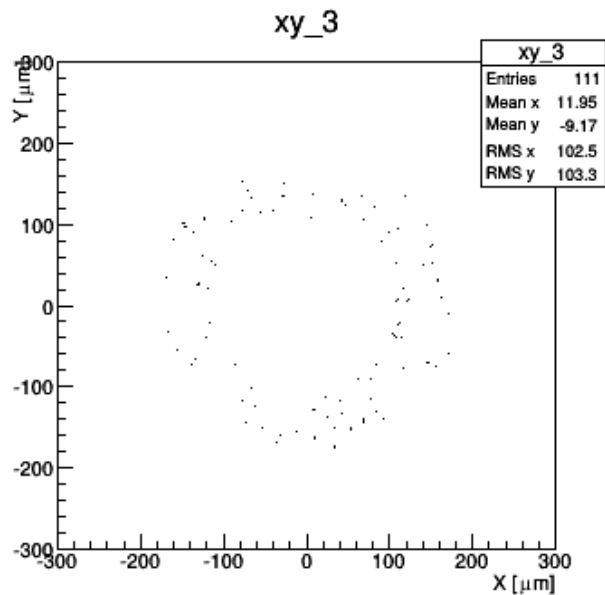
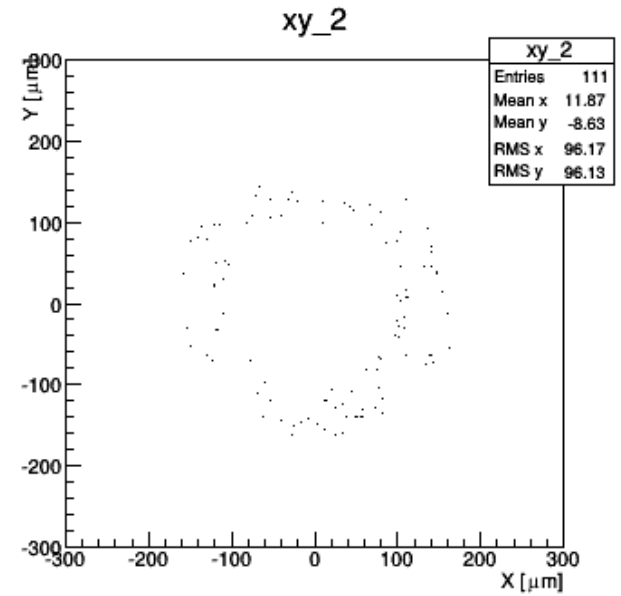
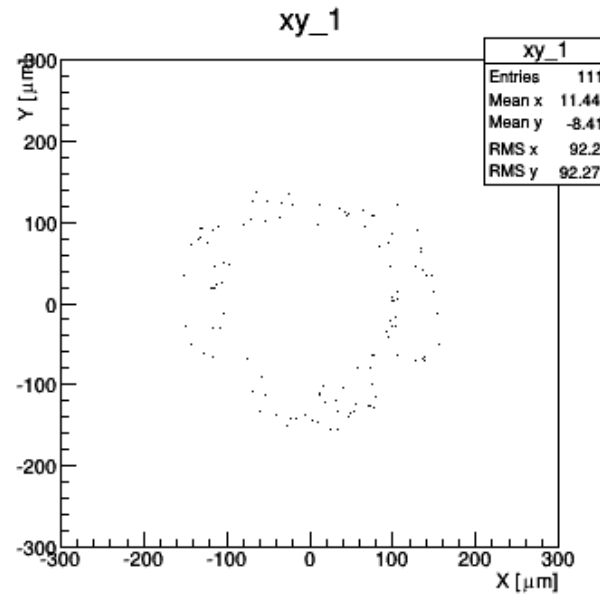
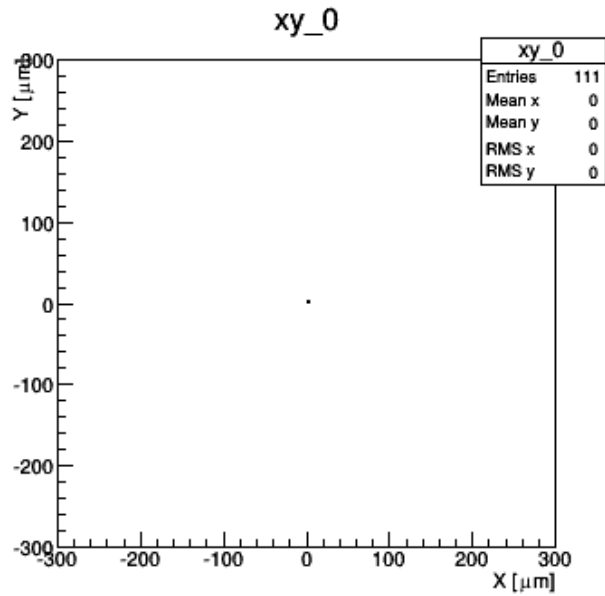
$\theta_{\text{gen}} - \theta_{\text{reco}}$;

$\phi_{\text{gen}} - \phi_{\text{reco}}$;

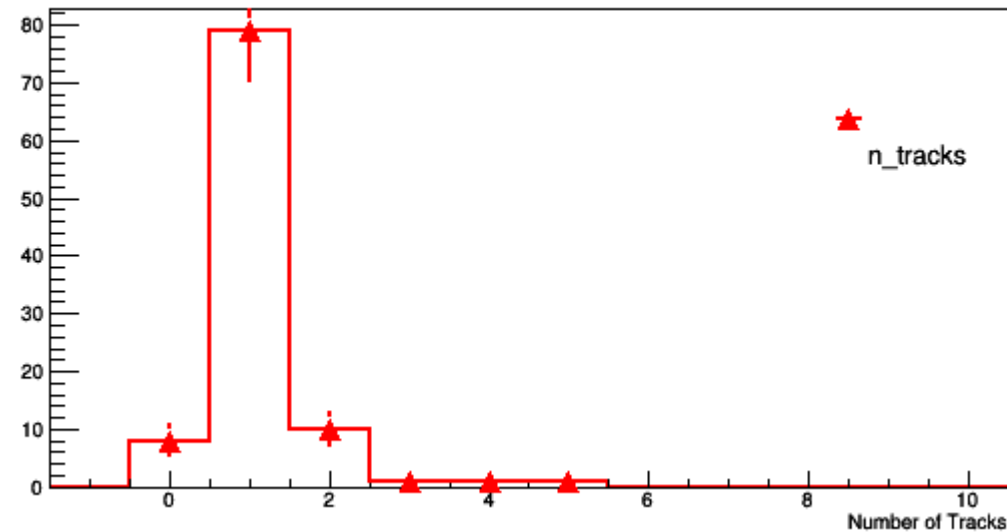
E_{reco} ;



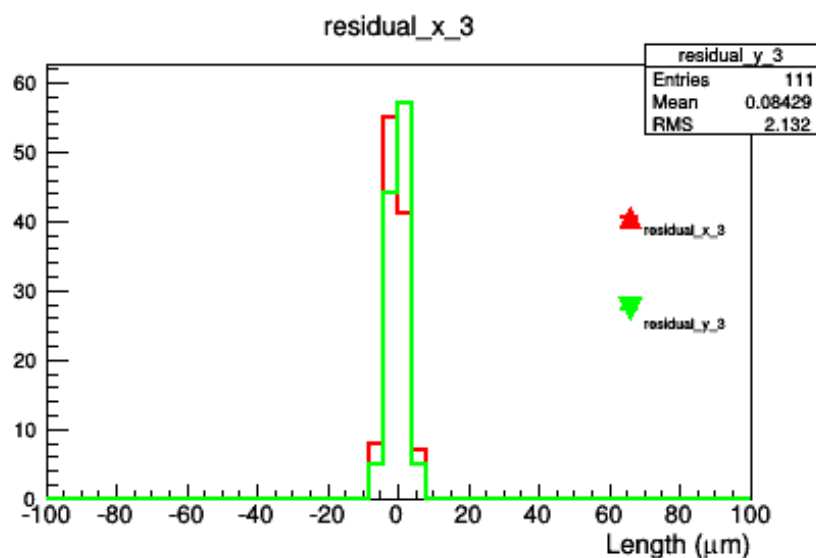
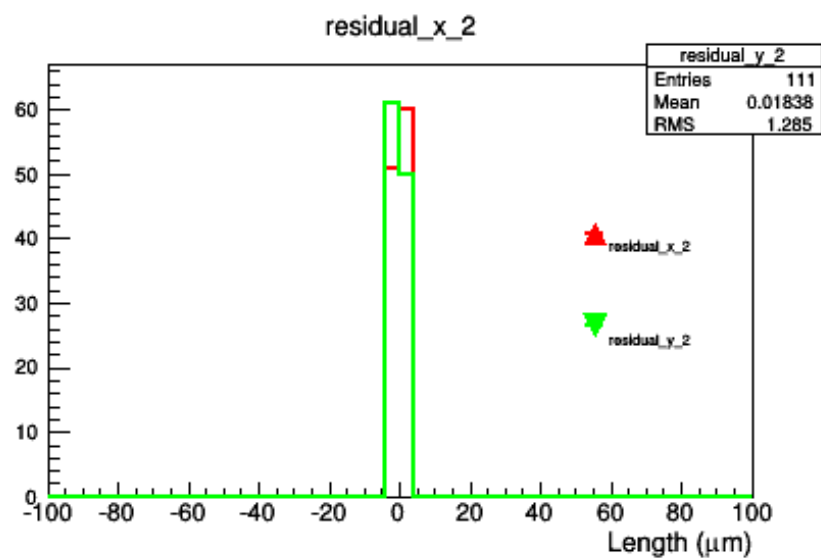
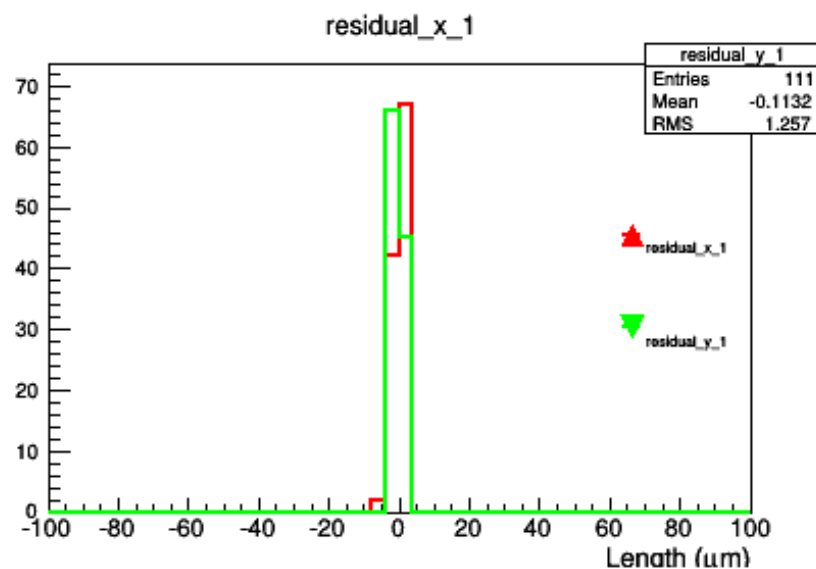
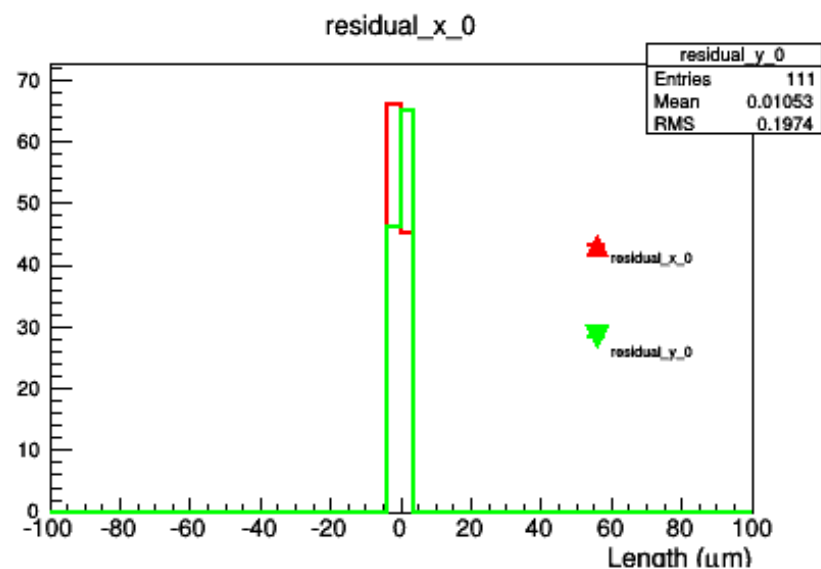
Treck Reconstruction



Number of tracks per event distribution



Residuals



Summary and Plans

- The average occupancy of tracking detectors caused by the scattered particles from LumiCal varies from 2 to 1 depending on the distance to LumiCal. At a distance of 30 cm it is about 1 for each primary particle.
- Reconstruction in LumiCal does not show visible influence of tracking detector on LumiCal performance.
- Include tracking detector in φ , θ reconstruction.

Backup

LuCaS with qt UI

The screenshot displays the LuCaS Qt UI interface. On the left is the 'Scene tree' panel, which lists the components of the detector simulation. The main window shows a 3D visualization of the detector components, including the beam pipe, calorimeters, and tracking sensors, with a coordinate system and distance markers (1 m).

Scene tree : viewer-0 (OpenGLStoredQt)

- Axes
- Frame
- Scale
- Touchables
 - World [0]
 - BCal1 [1]
 - BCal2 [2]
 - BCalFrontWall-1 [1]
 - BCalFrontWall-2 [2]
 - CentralPipe [1]
 - LCalFront1 [1]
 - LCalFront2 [2]
 - LcalInnerTube1 [1]
 - LcalInnerTube2 [2]
 - LHcal1 [1]
 - LHcal2 [2]
 - LumiCalDetector1 [1]
 - LumiCalDetector2 [2]
 - LumiCalTracker1 [0]
 - TrackingSensor1 [0]
 - TrackingSensor2 [1]
 - LumiCalTracker2 [1]
 - TrackingSensor1 [0]
 - TrackingSensor2 [1]
 - Mask1 [1]
 - Mask2 [2]
 - OutBeamTube1 [1]
 - OutBeamTube2 [1]

Output

```
Initial momentum magnitude (IMag): G4BestUnit (G4double)
Initial momentum (IMom): G4BestUnit (G4ThreeVector)
No. of points (NTP): G4int
PDG Encoding (PDG): G4int
Parent ID (PID): G4int
Particle Name (PN): G4String
G4TrajectoryPoint:
Position (Pos): G4BestUnit (G4ThreeVector)
WARNING: Trajectory storing has been requested. This action may be
reversed with "/tracking/storeTrajectory 0".
```

clear output Filter:

Session: