Impact Parameter Resolution Studies with Realistic Pattern Recognition Algorithm

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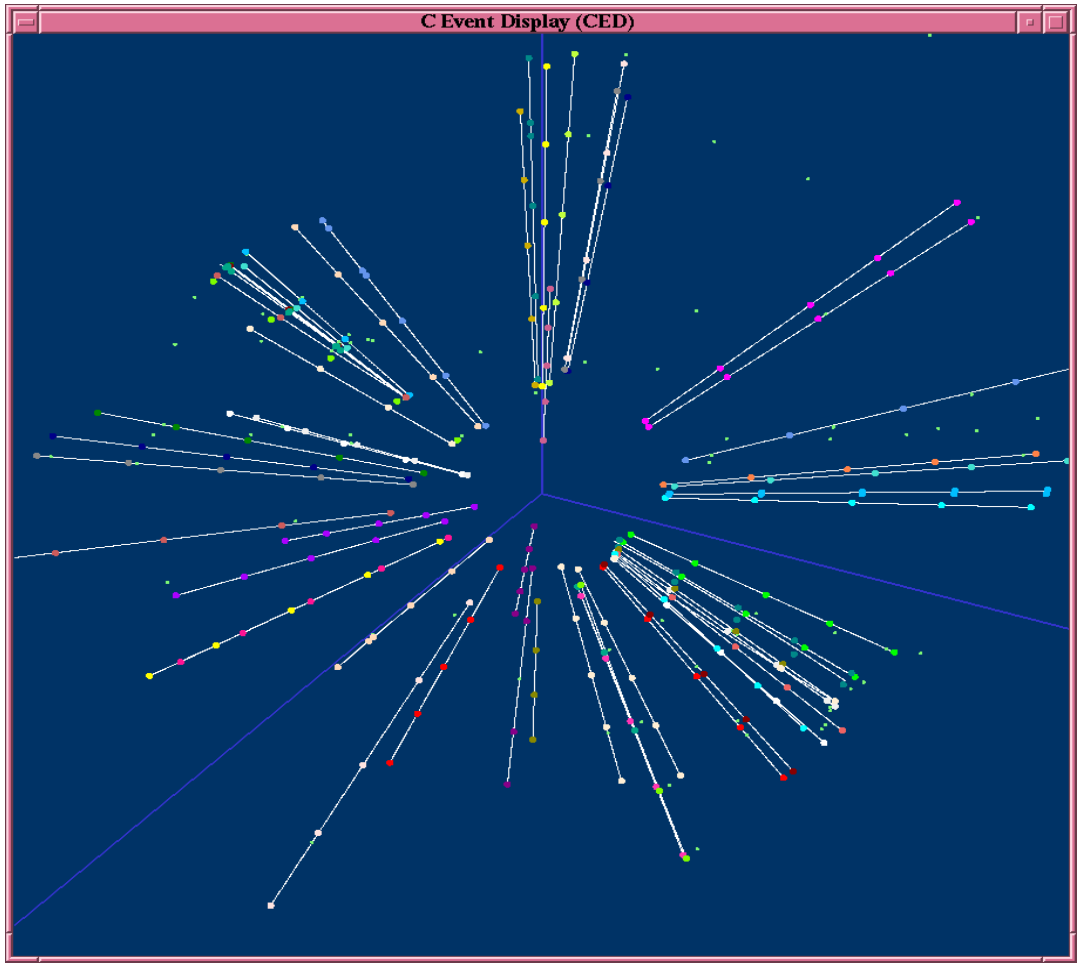
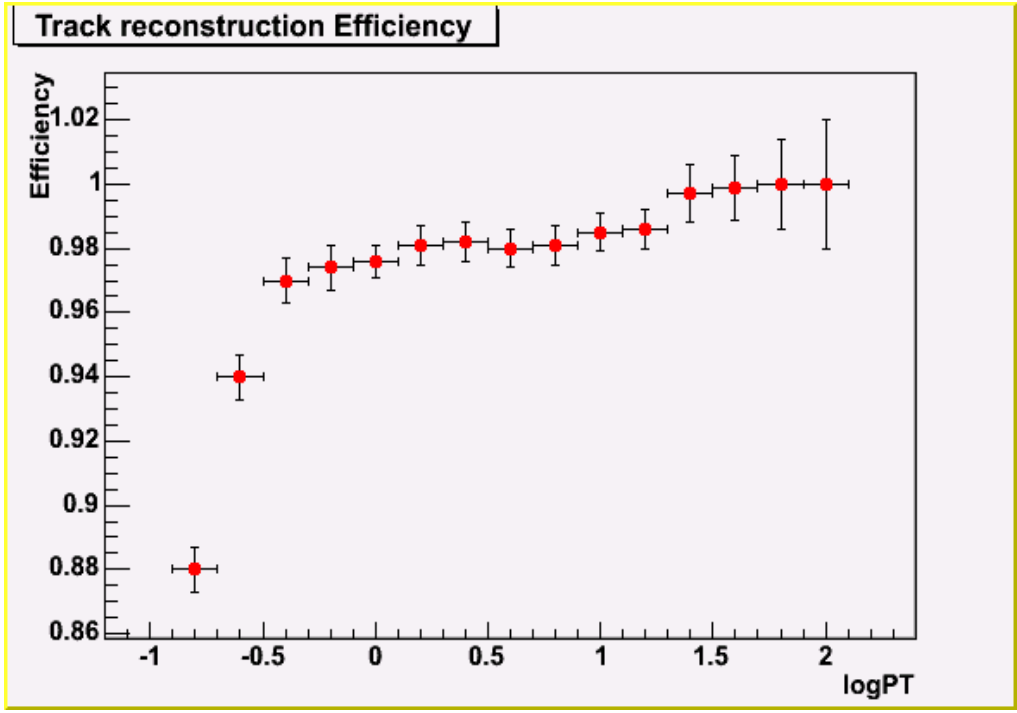
Pattern Recognition Algorithm





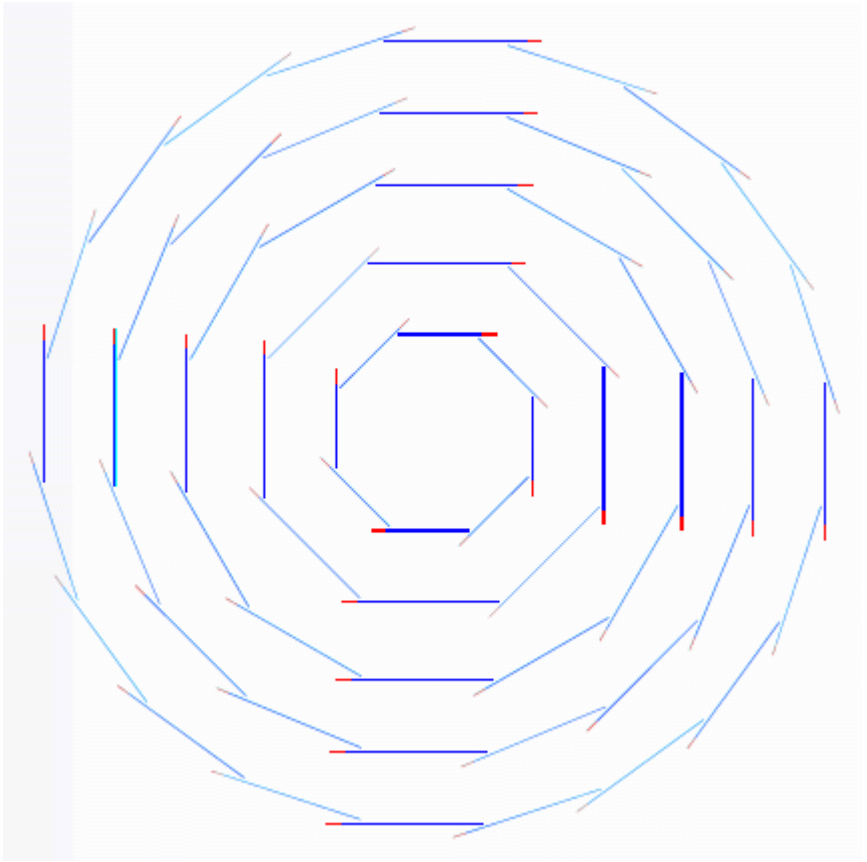
Fake rate : ~ 0.6 fake tracks/event;
with cut on curvature (p_T > 50 MeV)
0.15 fake tracks/event

Goal of present study : estimate precision of reconstructed track parameters (impact parameter) with realistic pattern recognition in the conditions of high local track density

Analysis Strategy

- Generate samples of single particles with predefined energy and polar angle :
  - Muon, E = 0.2, 0.5, 1, 2, 5, 10 GeV; ctanΘ = 0,1,2
- Each single particle event is overlaid with hit pattern produced by one ttbar->6jet event
- Vertex hits digitization procedure
- Pattern recognition
- Analysis of reference tracks => estimation of IP resolution as a function of particle energy and Θ
- Detector simulation is done with Mokka

Vertex Detector Geometry

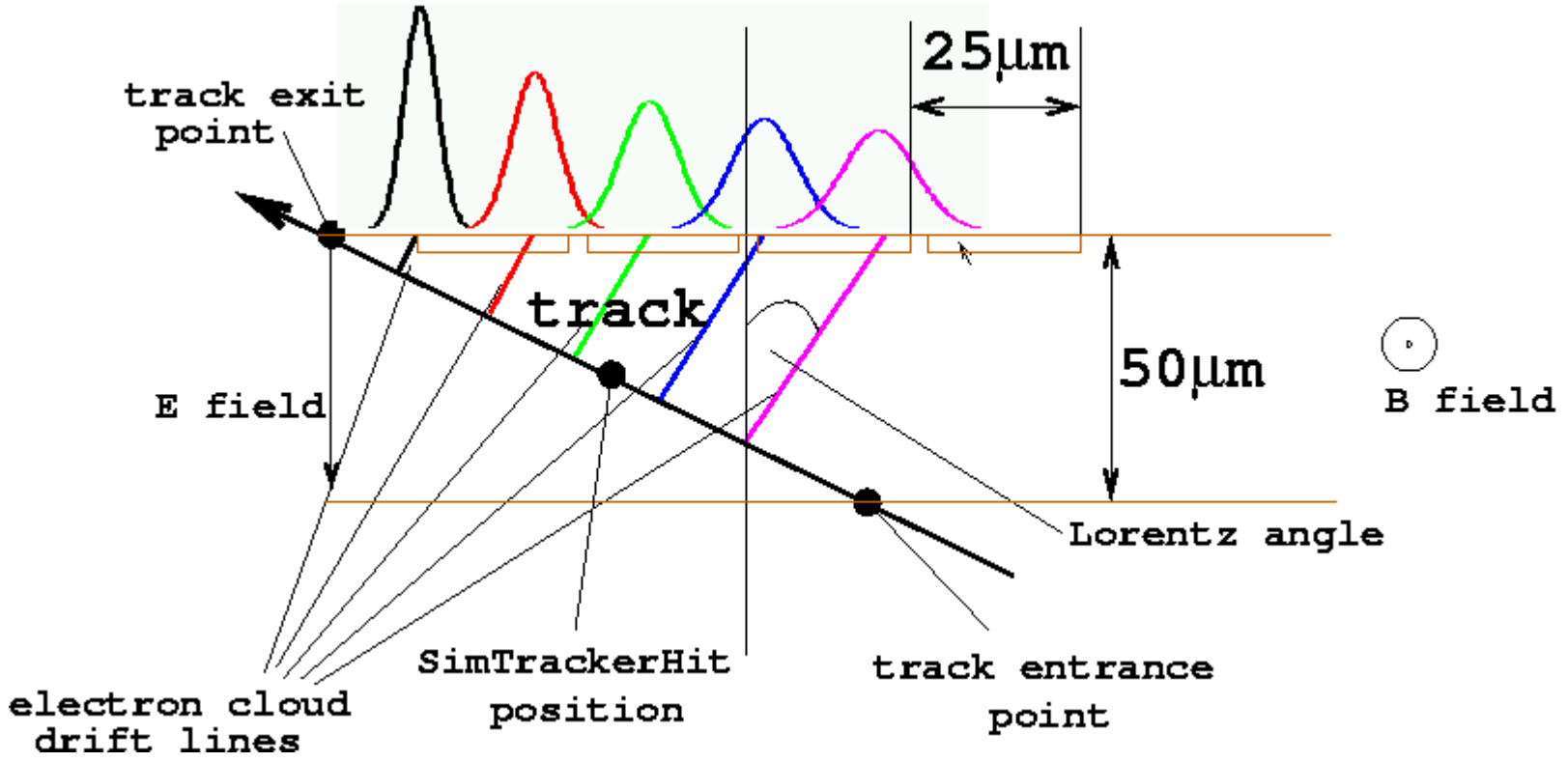


Si layer thickness = 50 μm
Pixel size = 25x25 μm

	Radius (cm)	Ladders	Length (cm)
1	1.5	8	10.0
2	2.6	8	2×12.5
3	3.8	12	2×12.5
4	4.9	16	2×12.5
5	6.0	20	2×12.5

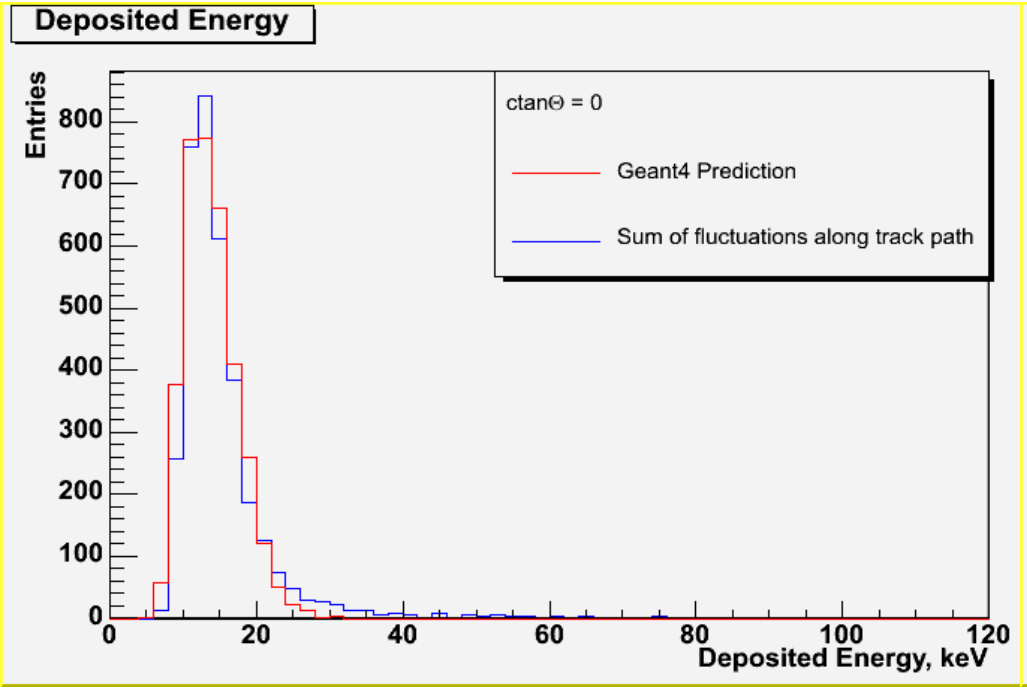
Material up to first layer : beam pipe (500 μm beryllium)

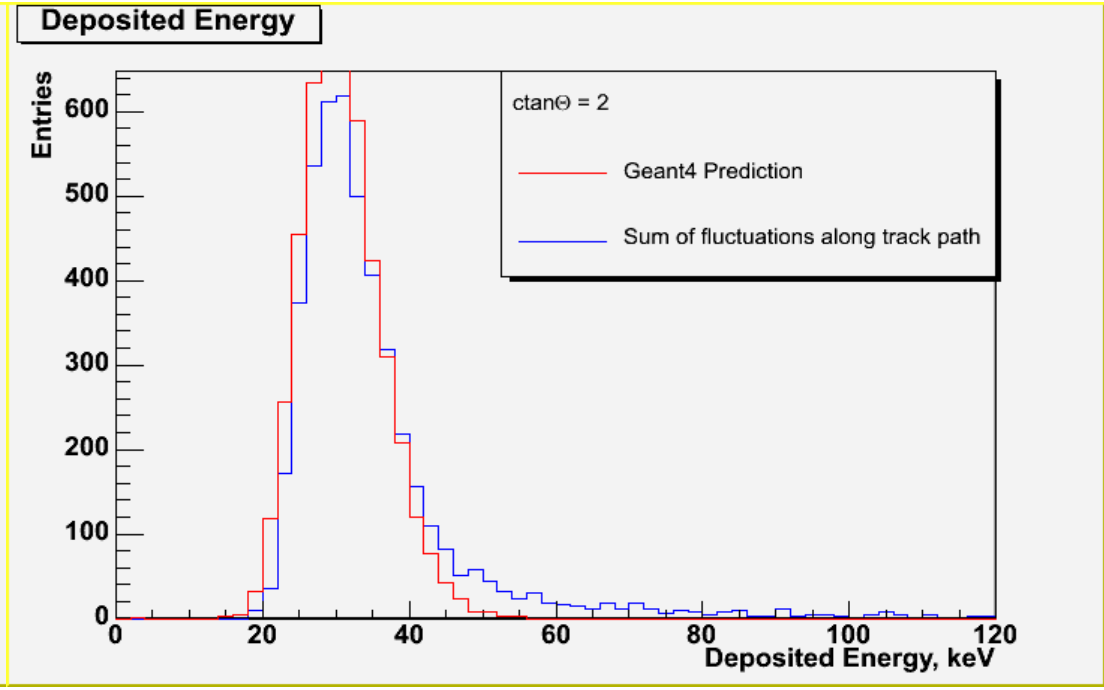
Digitization Procedure



- Lorentz angle = 33° at 4T magnetic field
- Diffusion = 2 um for 50 um thick layer
- Electron-hole pairs yield = 270 e / keV
- Noise = 100 e (gaussian); 225 e for comparison
- Threshold = 2σ -> 200 e

Control plots (deposited energy)

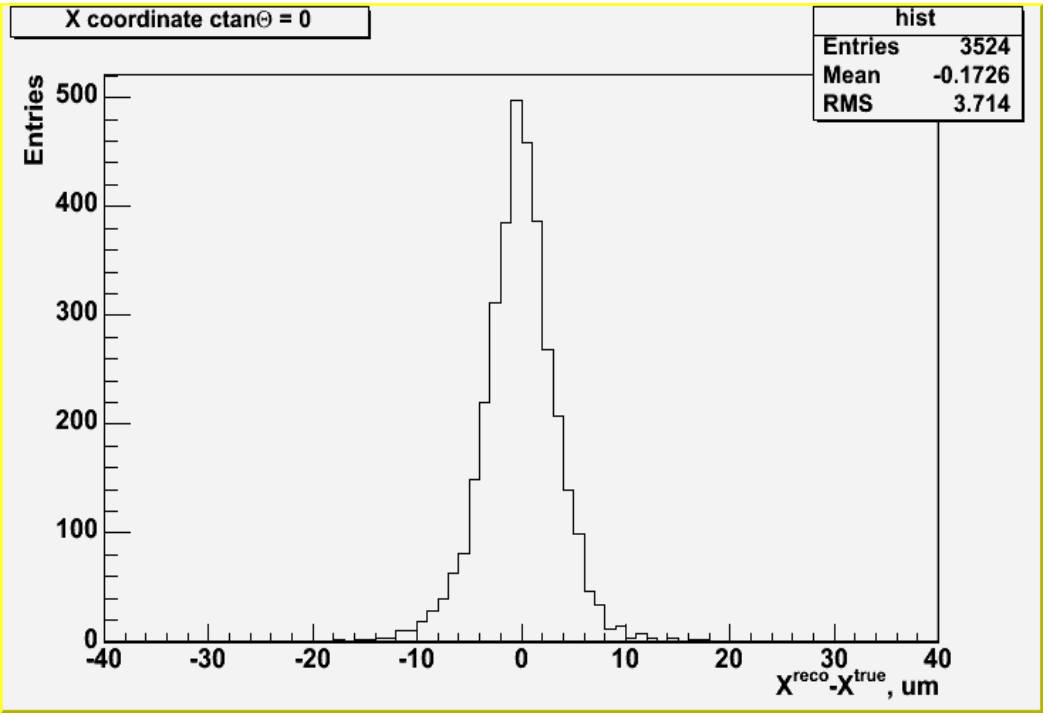


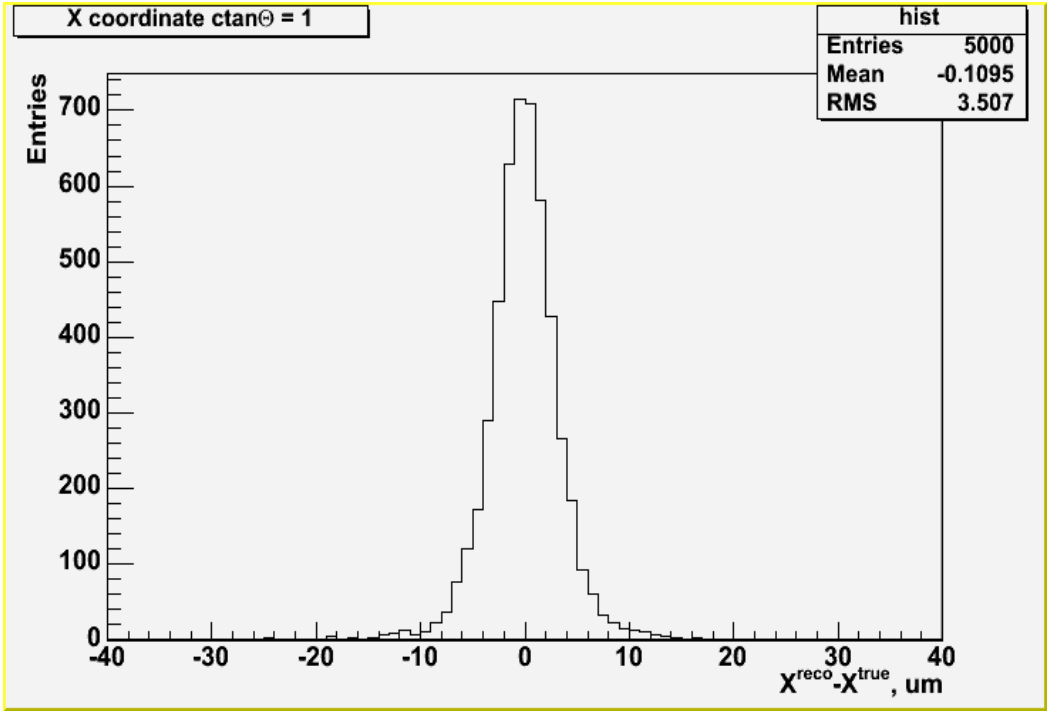


Slightly larger Landau tail in the implemented digitization procedure compared to Geant4 prediction

R-Phi Resolution

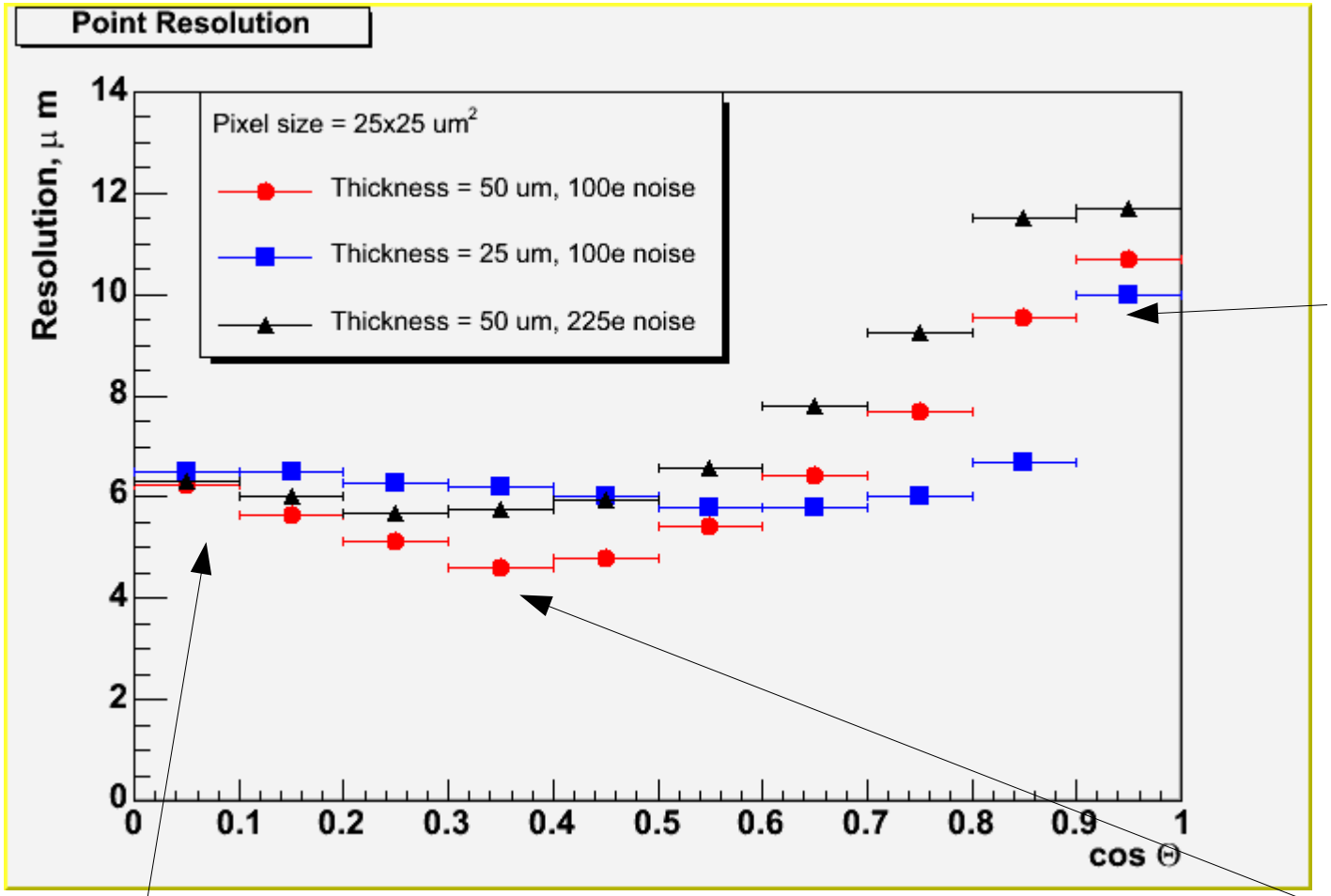
Hit coordinate is reconstructed using simple centre-of-gravity technique





R-Phi resolution slightly improves at smaller incident angles at smaller polar angles. Explanation : longer track length within active layer -> larger deposited charge -> smaller fluctuations.

Z-Resolution

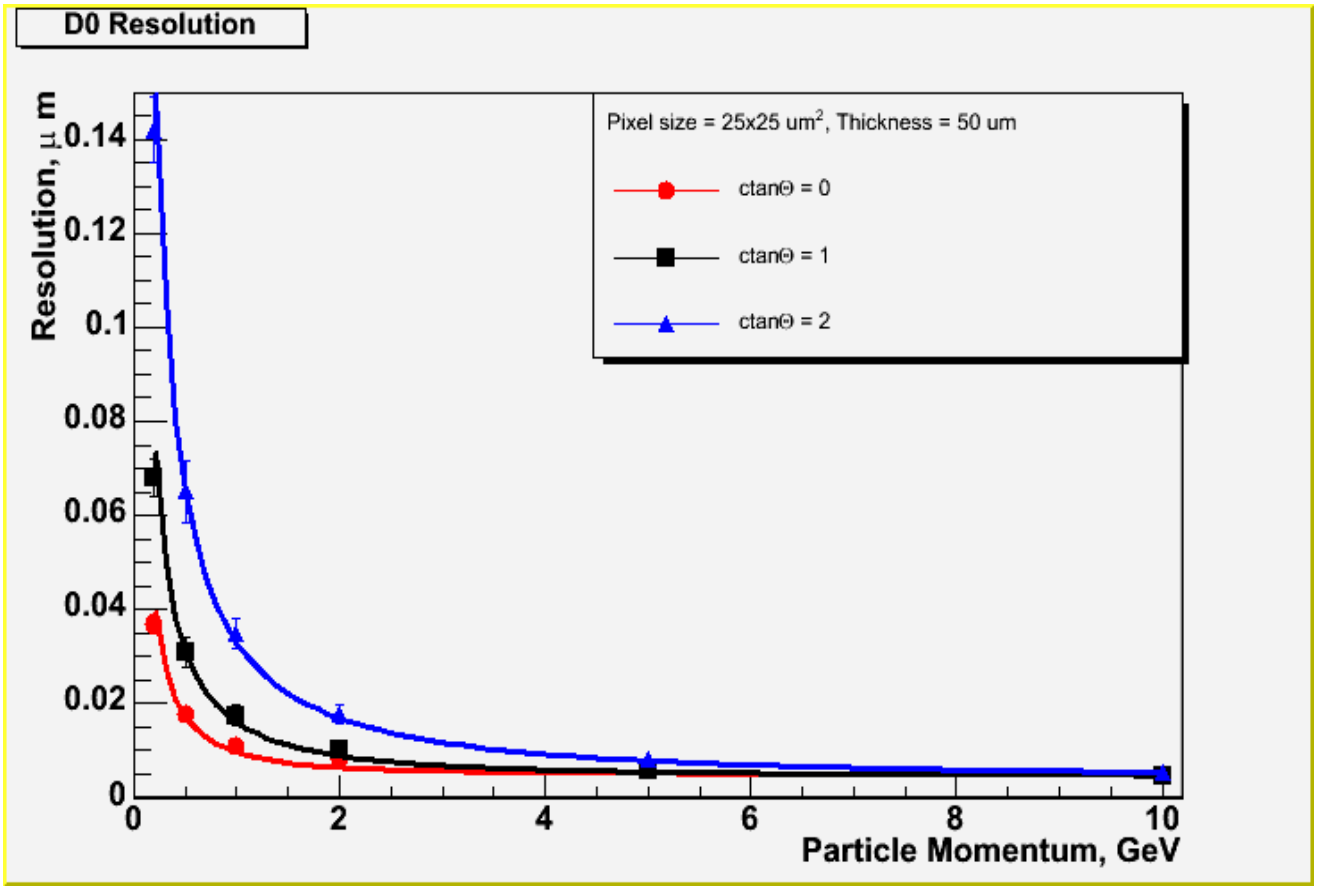


At shallow angles cluster size gets extremely large -> simple centre-of-gravity approach yeilds poor resolution due to inter-pixel charge fluctuations

In many cases at normal incidence only one row is fired : resolution is limited by pixel size

When track is inclined more than one row is fired -> resolution gets better

Impact Parameter Resolution (D0 Track Parameter)

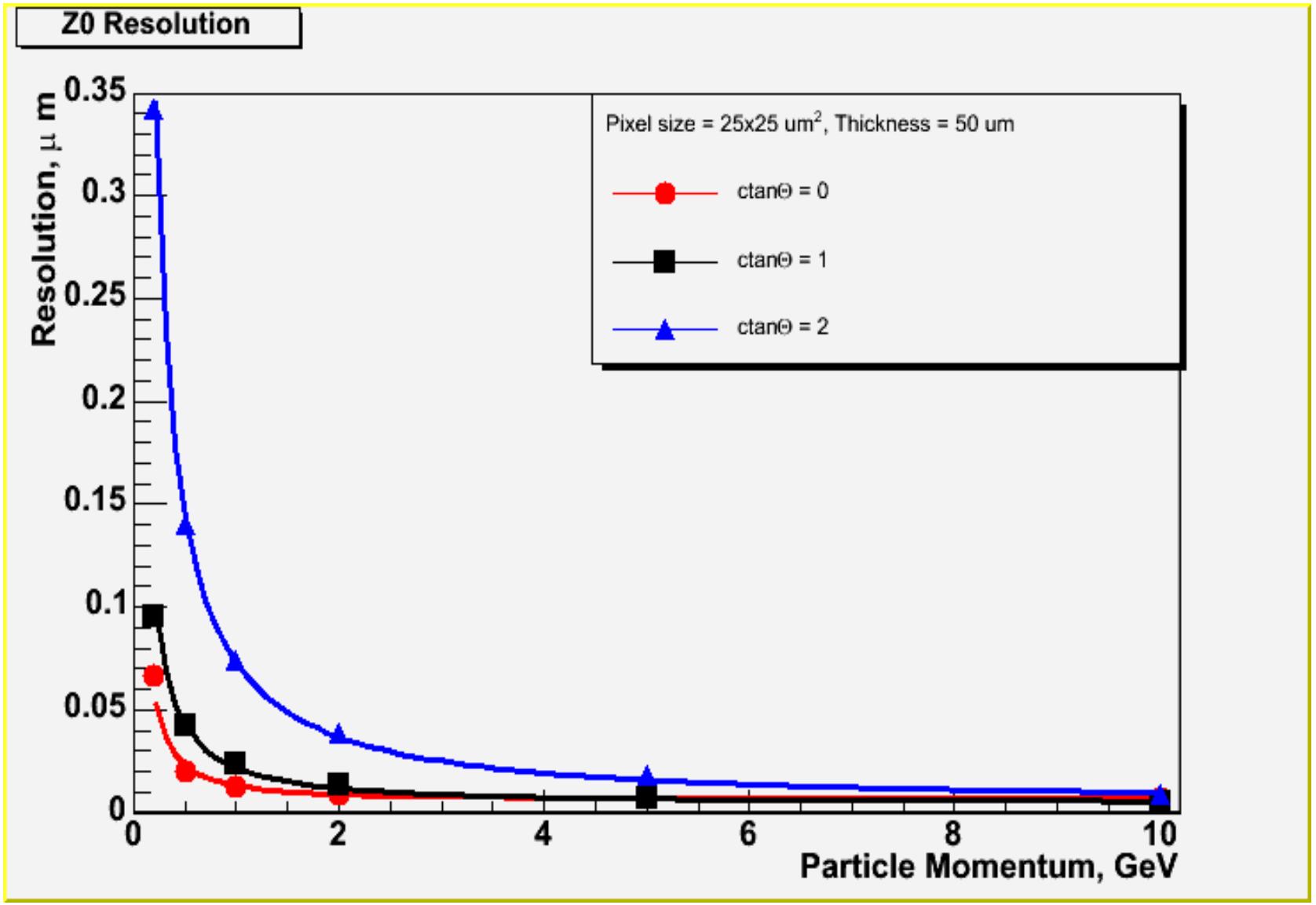


$$\sigma_{d0} = \sqrt{a^2 + b^2/p^2 \sin^3\Theta}$$

a = 4.6 um ; b = 8.5 um GeV for existing patrec

a = 4.4 um ; b = 8.1 um GeV for ideal patrec

Impact Parameter Resolution (Z0 Track Parameter)



Summary & Outlook

- Standalone pattern recognition for the vertex detector has been implemented and released within MarlinReco package
- Pattern recognition algorithm is close in quality to an ideal pattern recognition (only 5% deterioration of impact parameter resolution)
- Plans before Bangalore :
  - Validation of digitization procedure with testbeam data
  - Study of alternative methods for hit position reconstruction
  - Study of alternative configurations of vertex detector (introduction of endcap layers, variation of cell size along z coordinate)