

# Reconstruction of Long-lived Particles in IDEA tracker at FCC-ee

Masters Thesis Status and Prospects

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# Current status (New setup)

.... What changed in the new setup.

- ❑ New digitizer for the Drift Chamber
- ❑ The new pre-trained model for Track finding algorithm

## DCH Digitizer

- ❑ Get simHit and turn them into realistic detector signals (digiHits).
  - ❑ Adds detector effects: spatial smearing, timing, dead time, and readout windows.
  - ❑ DigiHits are then passed to the track finder algorithm

# Current status (New setup)

New digitizer: DCHdigi\_v02

## ...Working principle

- ❑ Group SimHits per cell → merge into **time trains** within deadtime → 1 DigiHit/train
- ❑ Smears hit position (along wire, radial distance).
- ❑ Computes **arrival time = SimHit time + drift time + signal travel** – reduce timing bias
- ❑ Applies readout window - too early/late hit discarded – suppresses out-of-time background and late pulses.
- ❑ Adds dN/dx cluster counts via a Delphes parametrization.

# Current status (New setup)

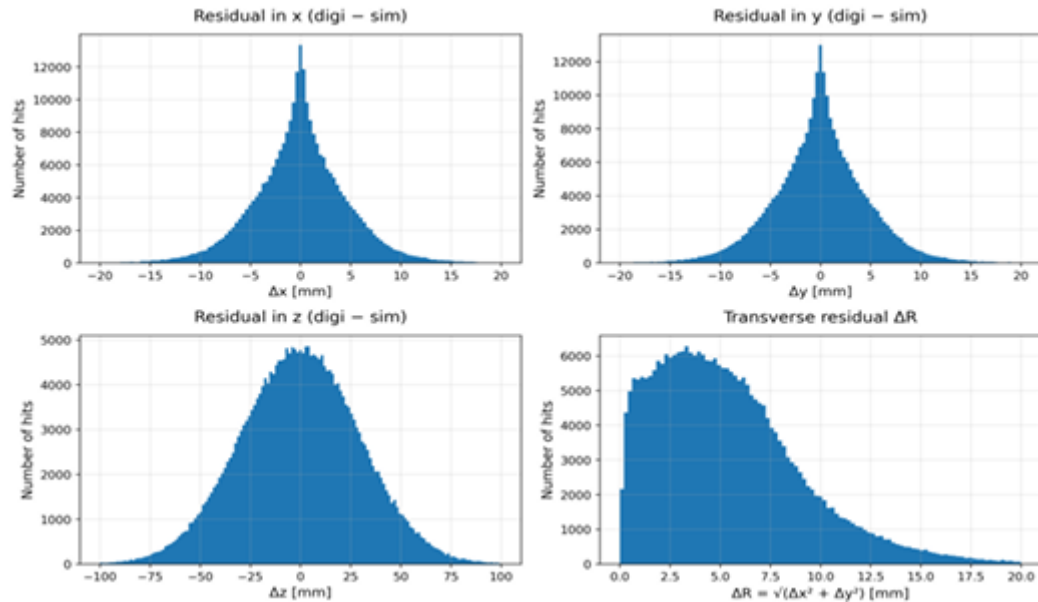
...Some Key differences between the Old and the New digitizer

Aspect	DCHdigi_v01(Old)	DCHdigi_v02(New)
Hit creation	One DigiHit per SimHit	One DigiHit per time train
Spatial resolution	zRes = 30.0 mm xyRes = 0.1 mm	zRes = 1.0 mm xyRes = 0.1 mm
Timing	DigiHit time = SimHit time	Drift + signal travel + window
Dead time	None	400ns per cell
Readout window	None	Start = 1.0ns Duration cuts =450.0ns

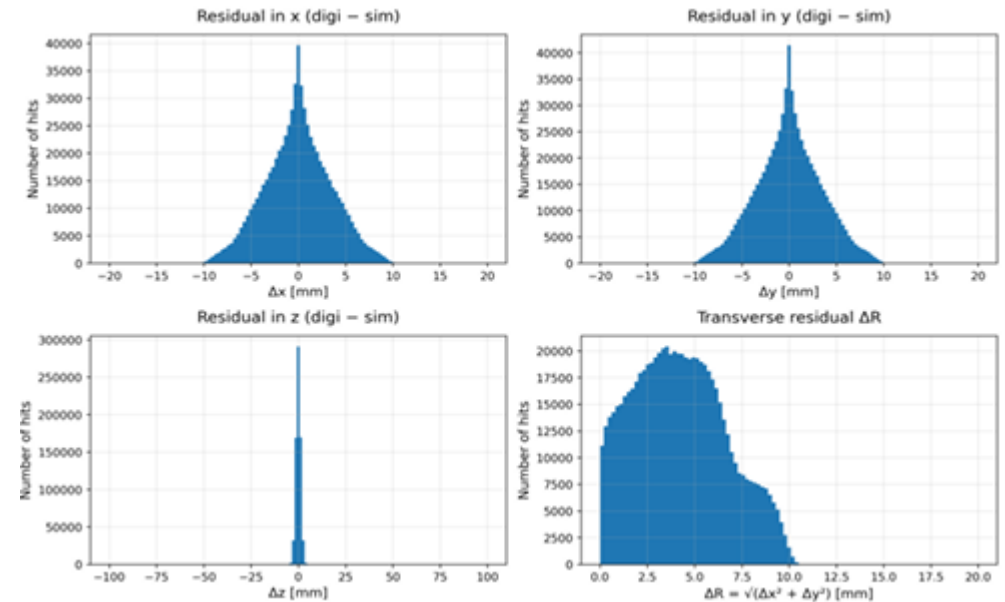
# Old vs New digitizer – Performance

- ❑ 5000 events of Muon particle gun
- ❑ Momentum range: 0.5 to 5GeV

## Residual Plots



Old digitizer



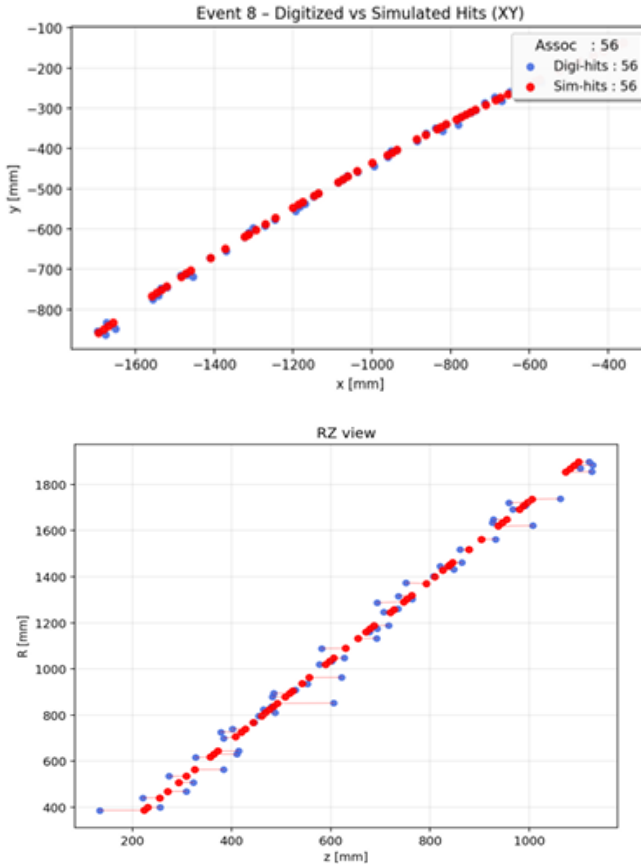
New digitizer

- ✓ New digitizer changes residual widths/bias due to timing + merging.

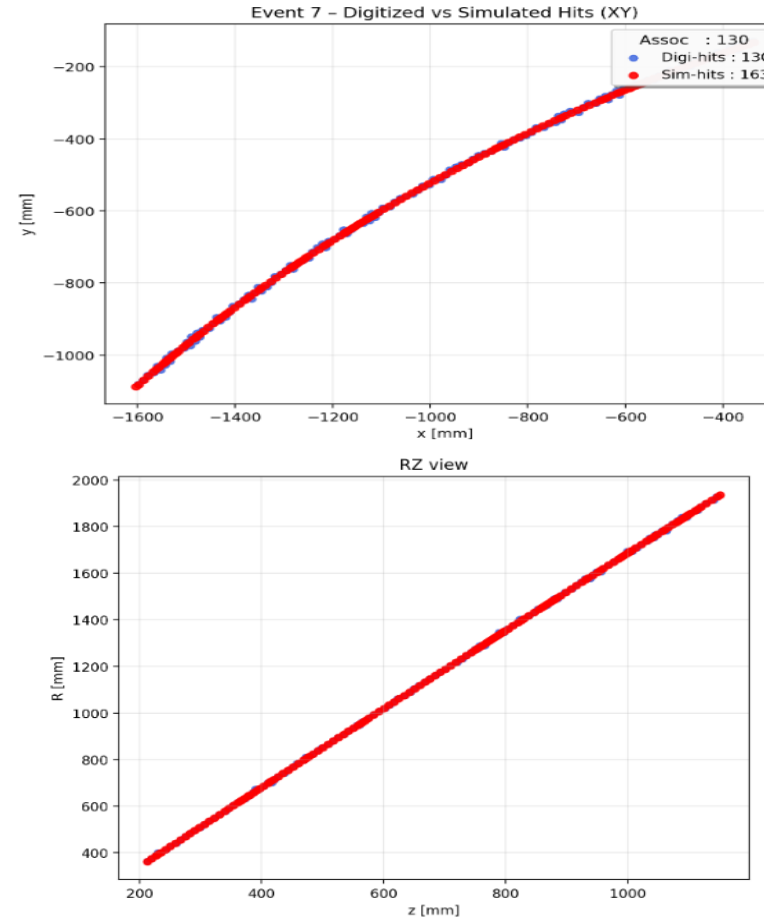
# Old vs New digitizer – Performance

...Event displays

## Old digitizer



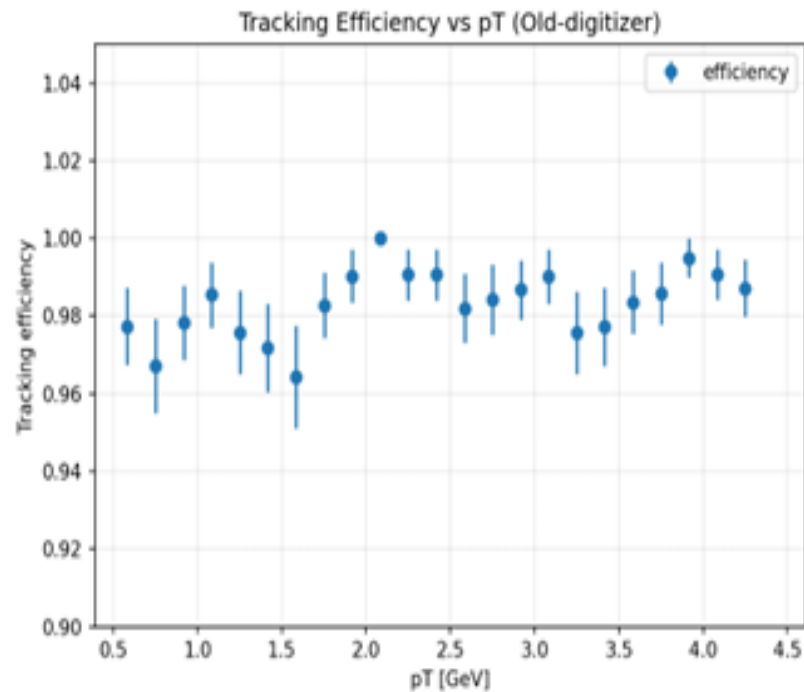
## New digitizer



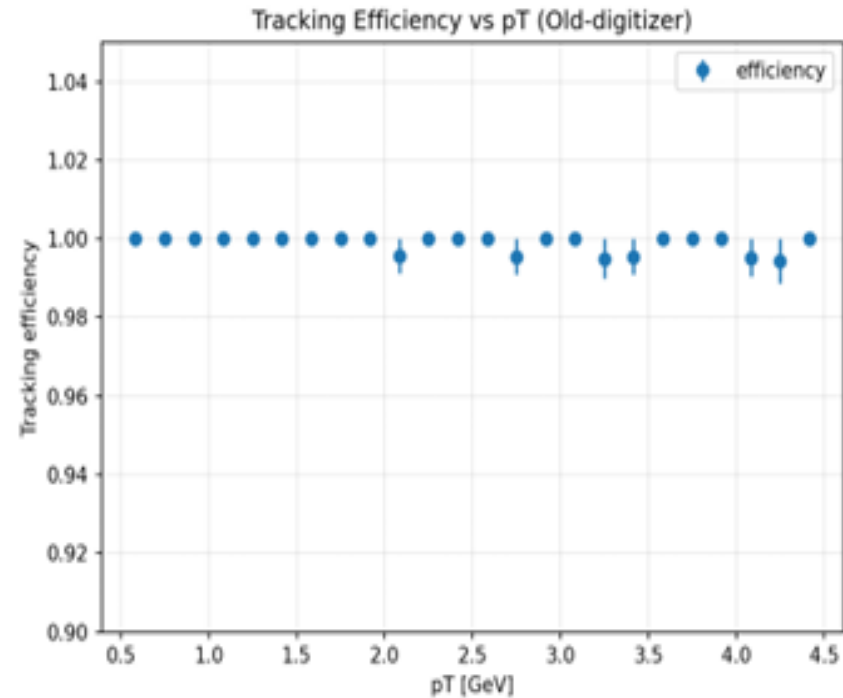
✓ Hit patterns change due to time-train merging and readout window.

# Old vs New digitizer – Performance

...Tracking efficiency



Old digitizer



New digitizer

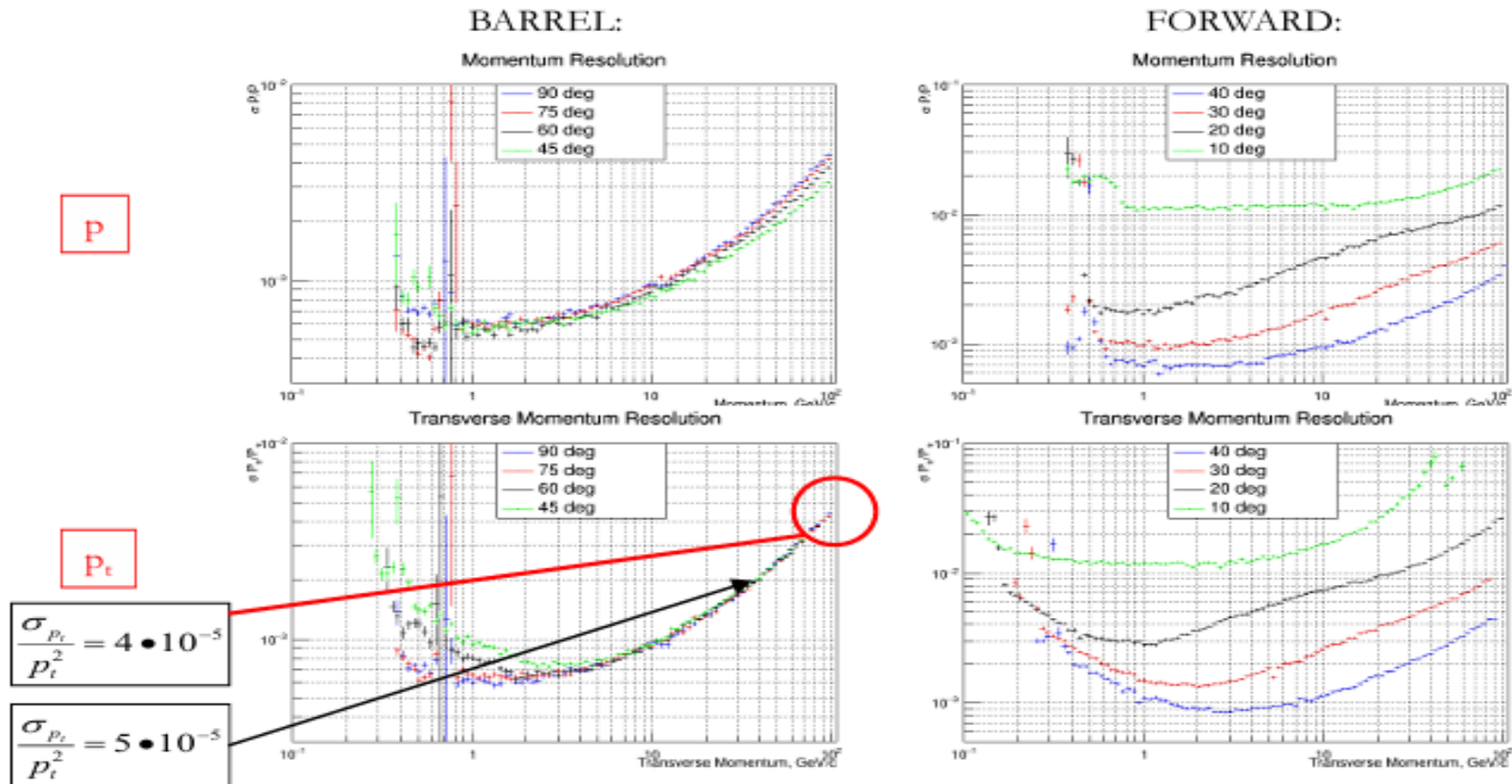


# Summary

- ❑ Digitization is now **electronics-like: time-train merging (deadtime), timing model, smearing, and readout-window cuts.**
- ❑ TO-DO:
  - Run **FullSim→Reco pion-gun: 10k events**, angles **20° / 60° / 90°**, momenta **0.2 / 0.5 / 1 / 5 / 10 GeV**
  - Reproduce reference plots
    - $\sigma(p)/p$  vs  $p$ ,  $\sigma(p_T)/p_T$  vs  $p_T$  (barrel/forward)
    - $\sigma(R-\phi \text{ IP})$  and  $\sigma(Z)$  resolution vs  $p$
    - $\sigma(\theta)$  and  $\sigma(\phi)$  resolution vs  $p$

# BACKUP

## IDEA – layout v1 – Expected tracking performance



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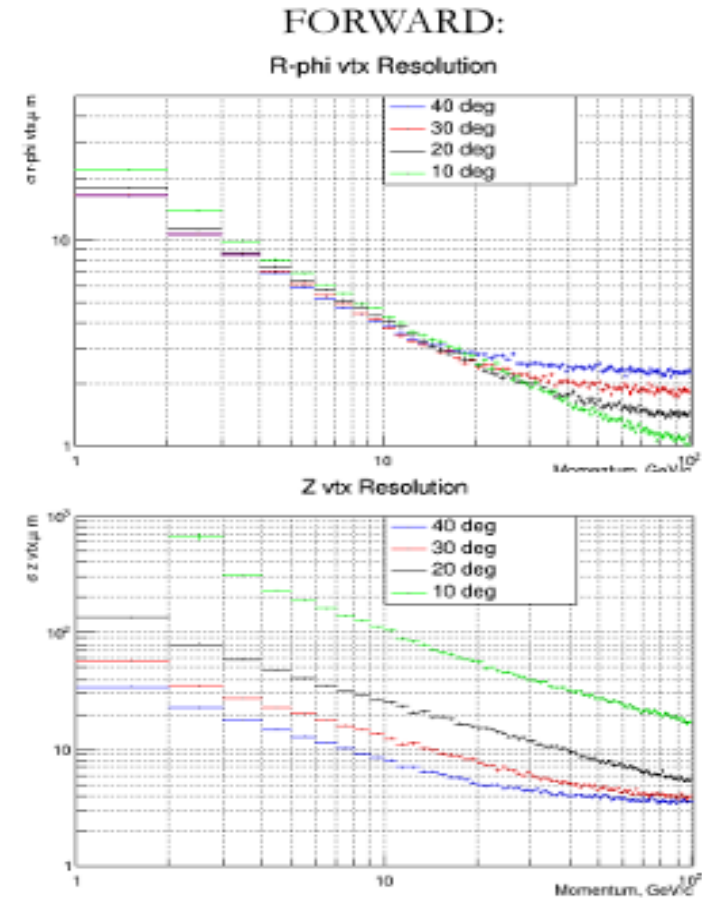
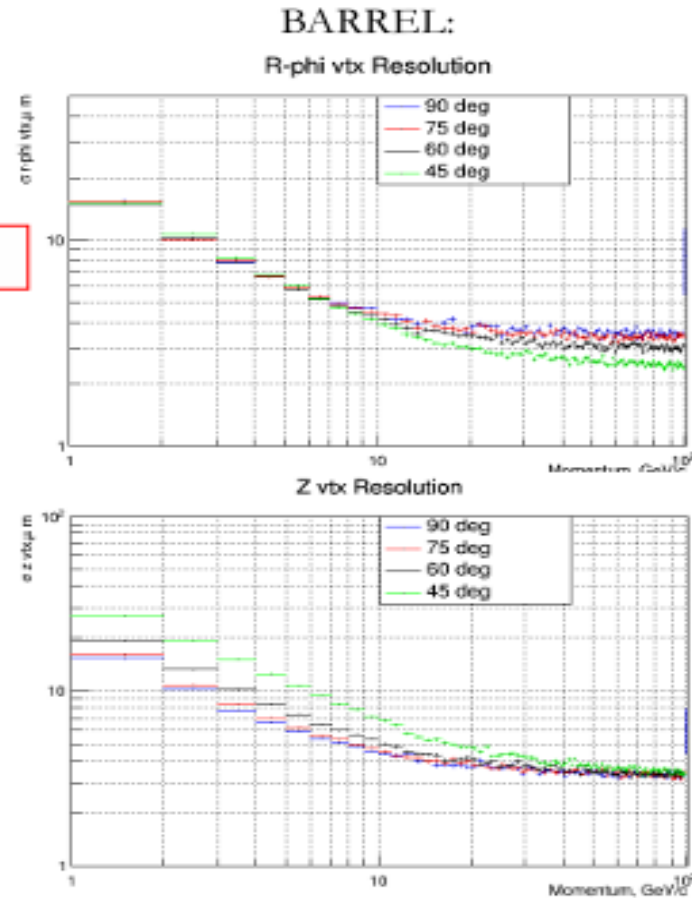
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## IDEA – layout v1 – Expected tracking performance

impact parameter

Z



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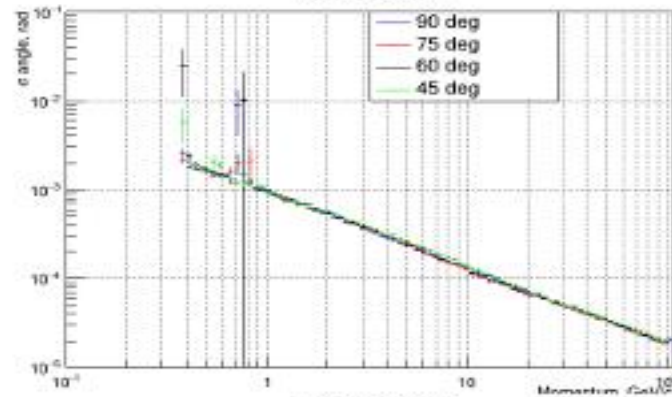


## IDEA – layout v1 – Expected tracking performance

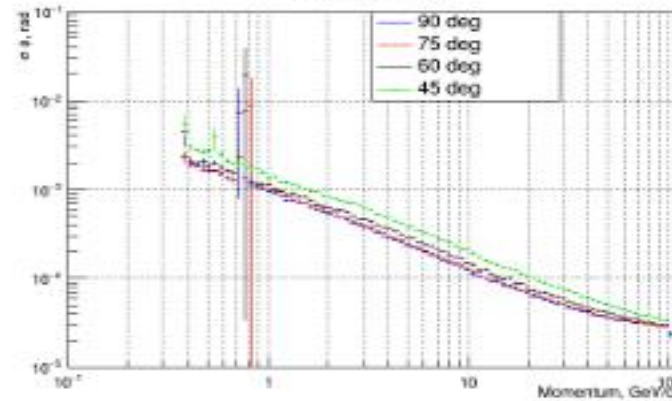
theta

BARREL:

Theta resolution



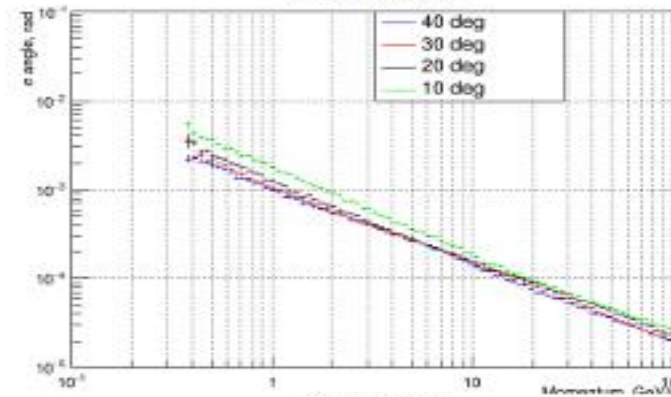
Phi Resolution



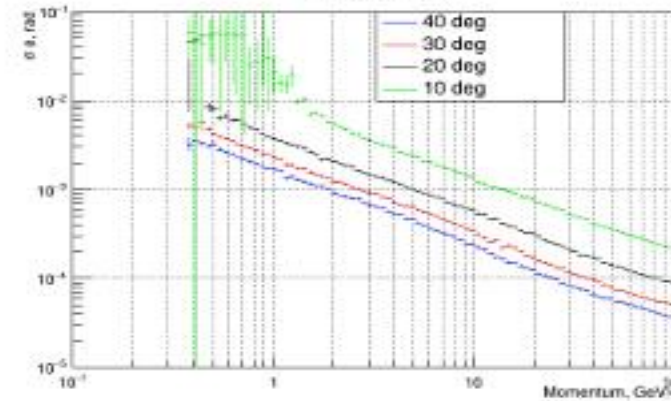
phi

FORWARD:

Theta resolution



Phi Resolution



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