

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

Masters Thesis Status and Prospects

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Content

- 1. Current status(New setup)**

- 2. New digitizer**

- 3. Old vs New – performance**

- 4. Summary/To-do-list**

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)

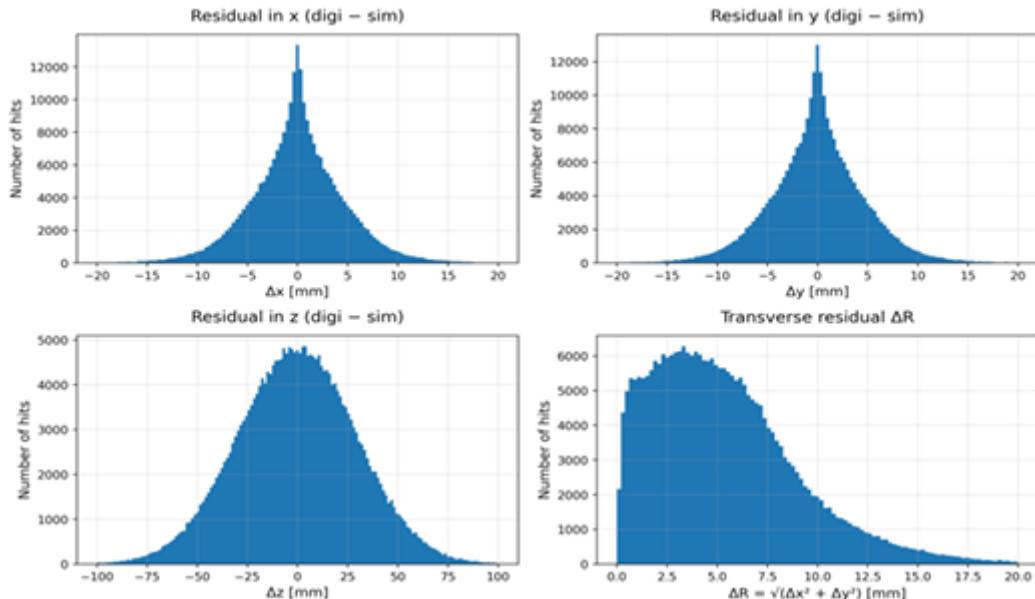
...Some Key differences between the Old and the New digitizer

Aspect	DCHdigi_v01(Old)	DCHdigi_v02(New)
Hit creation	One DigiHit per SimHit	One DigiHit per time train
Spatial resolution	$z\text{Res} = 30.0 \text{ mm}$ $xy\text{Res} = 0.1 \text{ mm}$	$z\text{Res} = 1.0 \text{ mm}$ $xy\text{Res} = 0.1 \text{ mm}$
Timing	$\text{DigiHit time} = \text{SimHit time}$	Drift + signal travel + window
Dead time	None	400ns per cell
Readout window	None	Start = 1.0ns Duration cuts = 450.0ns

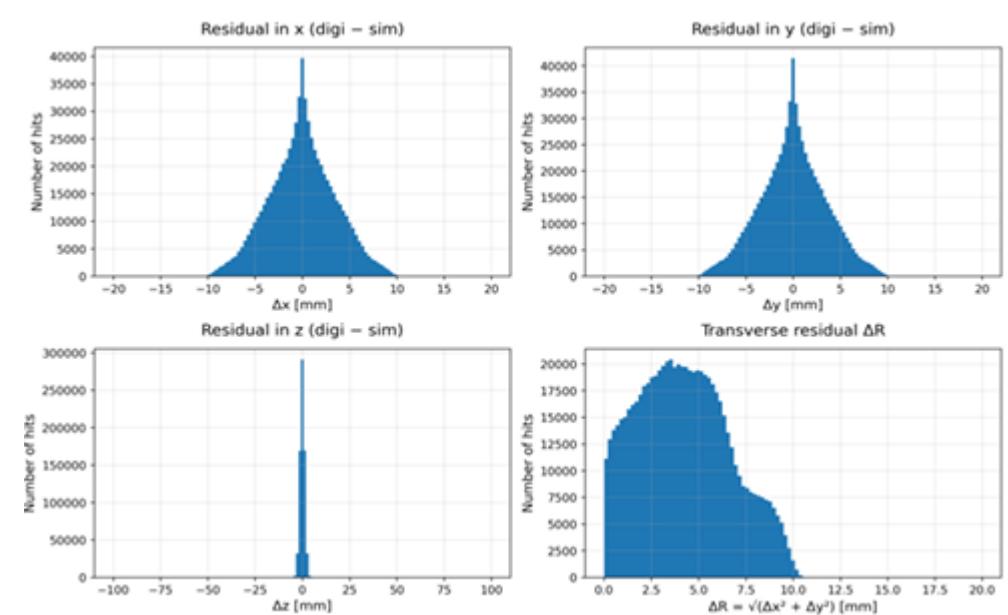
Old vs New digitizer – Performance

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

Residual Plots



Old digitizer



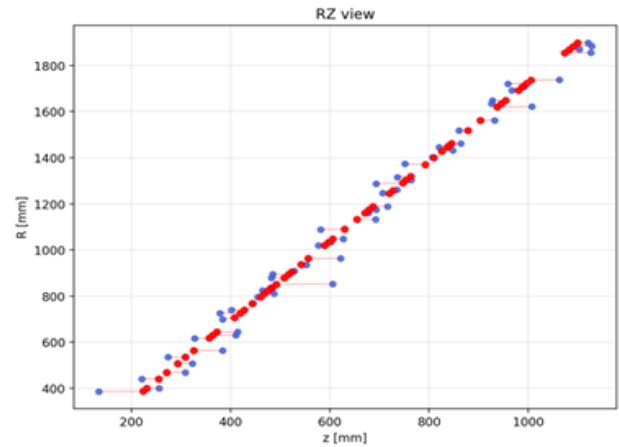
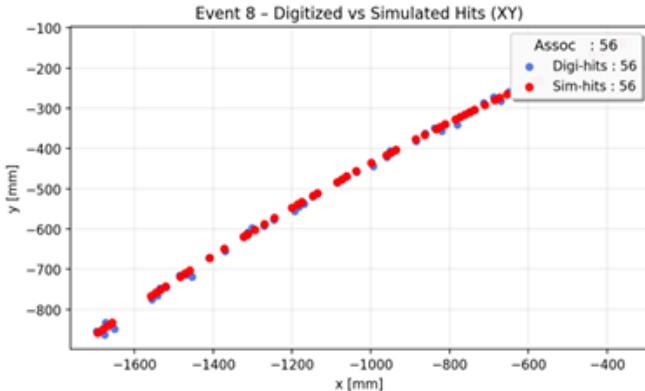
New digitizer

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

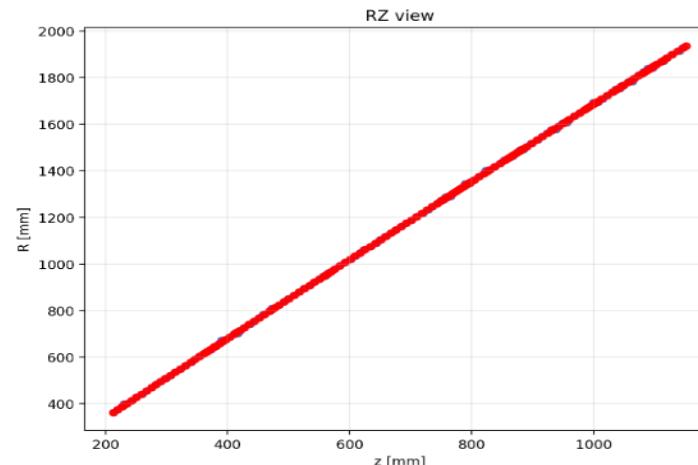
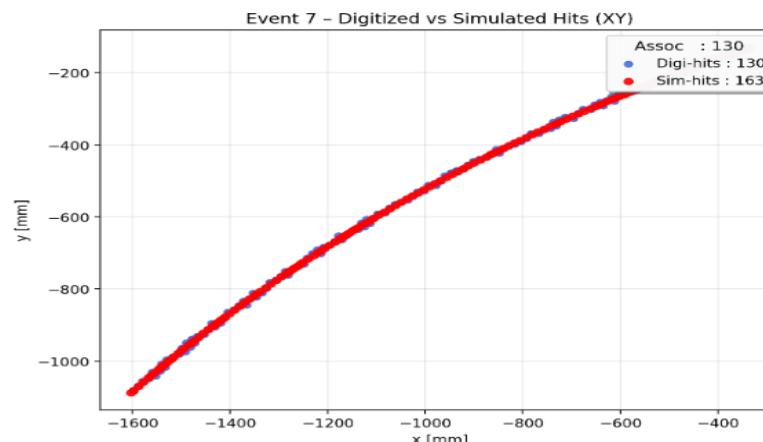
Old vs New digitizer – Performance

...Event displays

Old digitizer



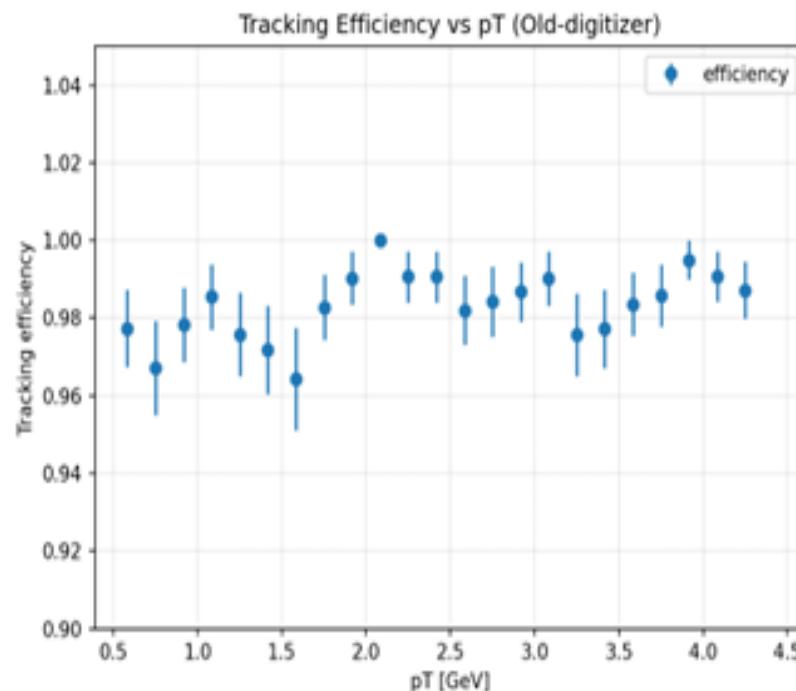
New digitizer



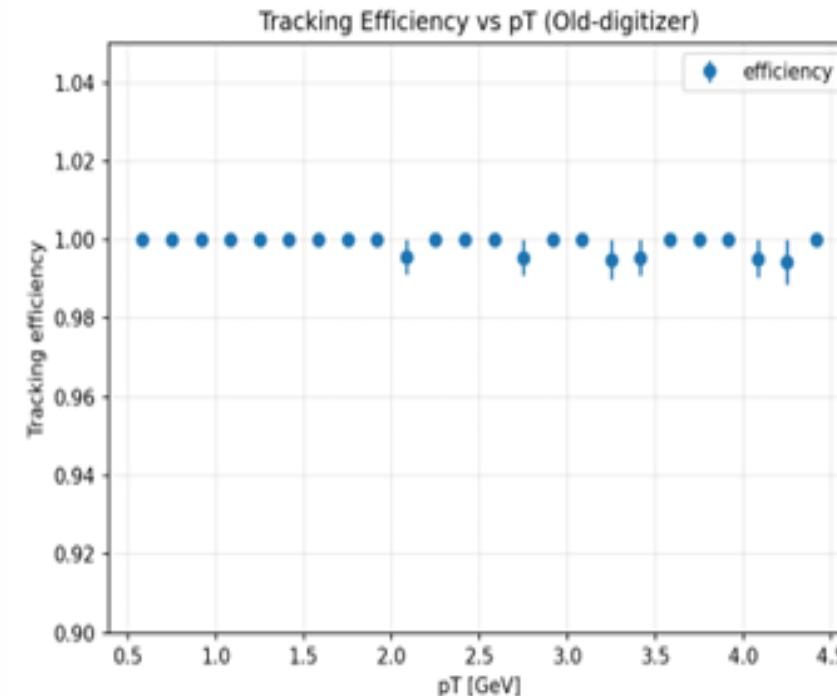
- ✓ Hit patterns change due to time-train merging and readout window.

Old vs New digitizer – Performance

...Tracking efficiency



Old digitizer



New digitizer

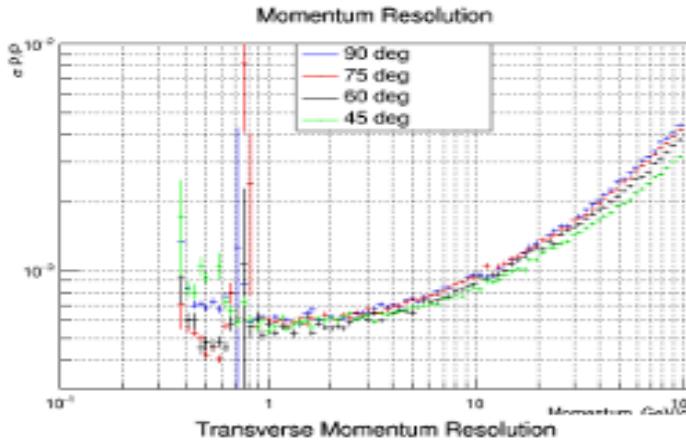
Summary

- 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 , $\sigma(pT)/pT$ vs pT (barrel/forward)
 - $\sigma(R-\phi)$ and $\sigma(Z)$ resolution vs p
 - $\sigma(\theta)$ and $\sigma(\phi)$ resolution vs p

BACKUP

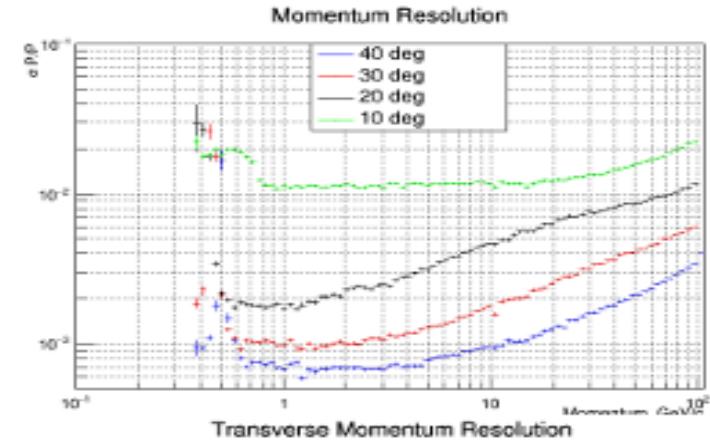
IDEA – layout v1 – Expected tracking performance

BARREL:



P

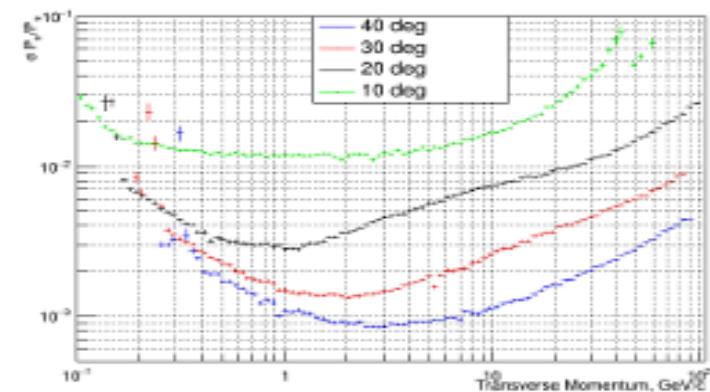
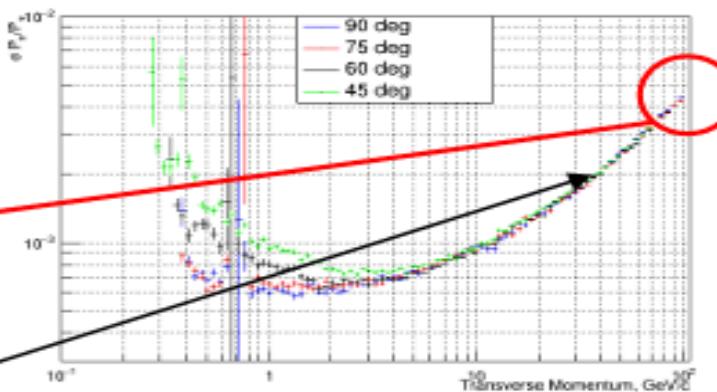
FORWARD:



P_t

$$\frac{\sigma_{P_t}}{P_t^2} = 4 \cdot 10^{-5}$$

$$\frac{\sigma_{P_t}}{P_t^2} = 5 \cdot 10^{-5}$$



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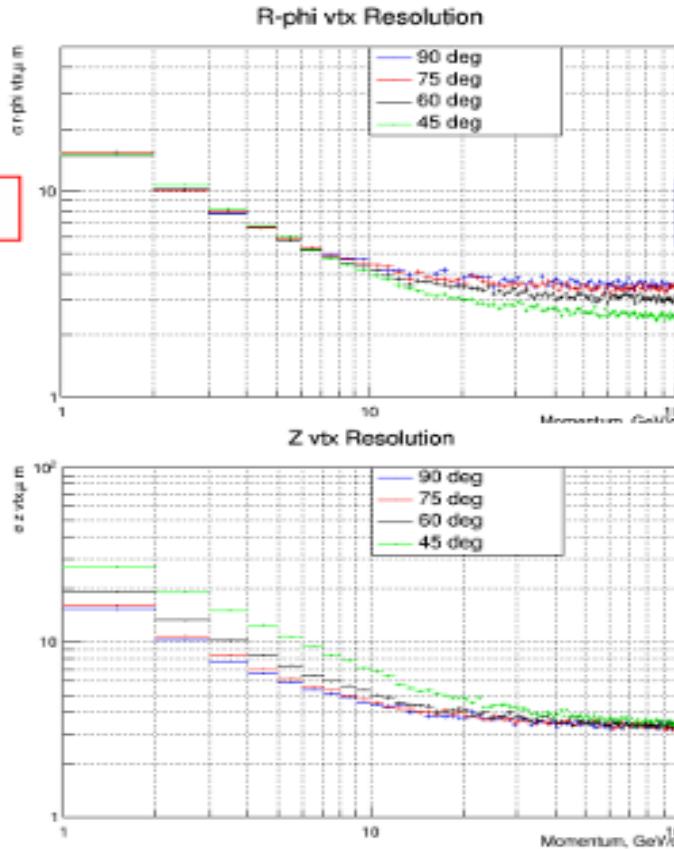


Obedience Munkombwe – Reconstruction of LLPs with IDEA tracker at FCC-ee

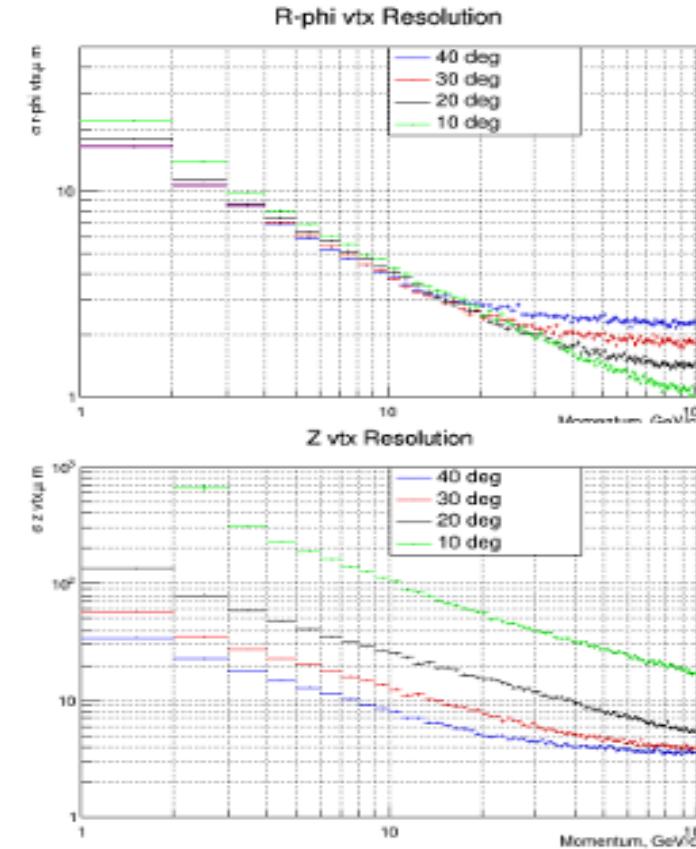
BACKUP

IDEA – layout v1 – Expected tracking performance

BARREL:



FORWARD:

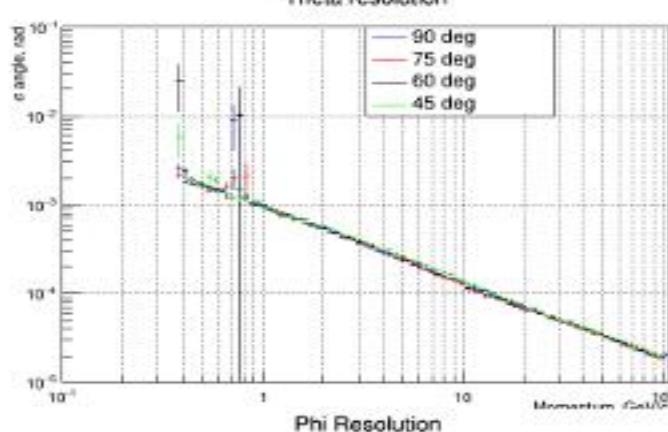


BACKUP

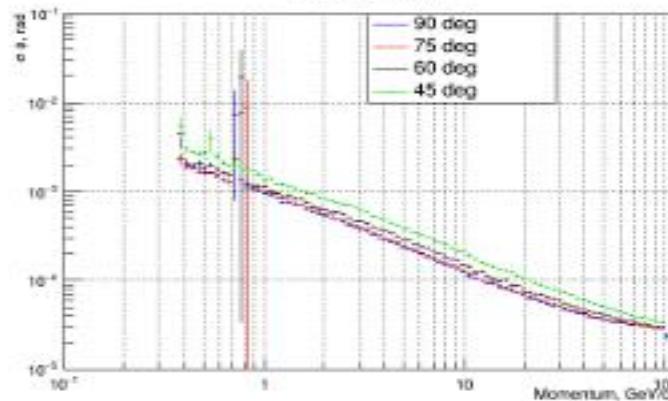
IDEA – layout v1 – Expected tracking performance

BARREL:

theta

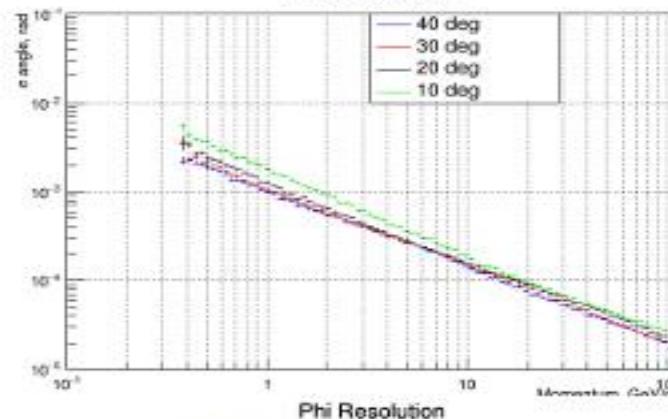


phi

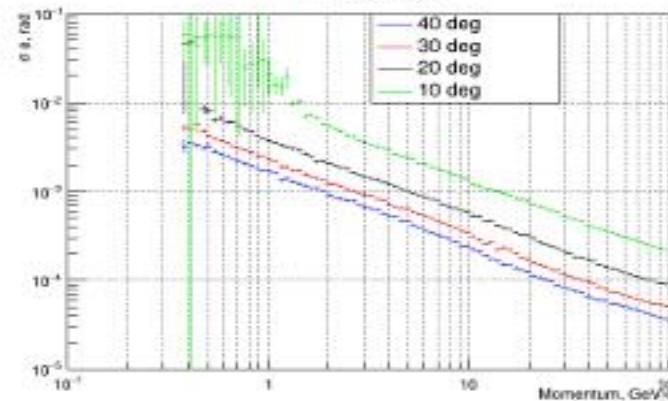


FORWARD:

Theta resolution



Phi resolution



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