μRWELL-BOT Simulation Update

Matt Posik
Temple University

Outline

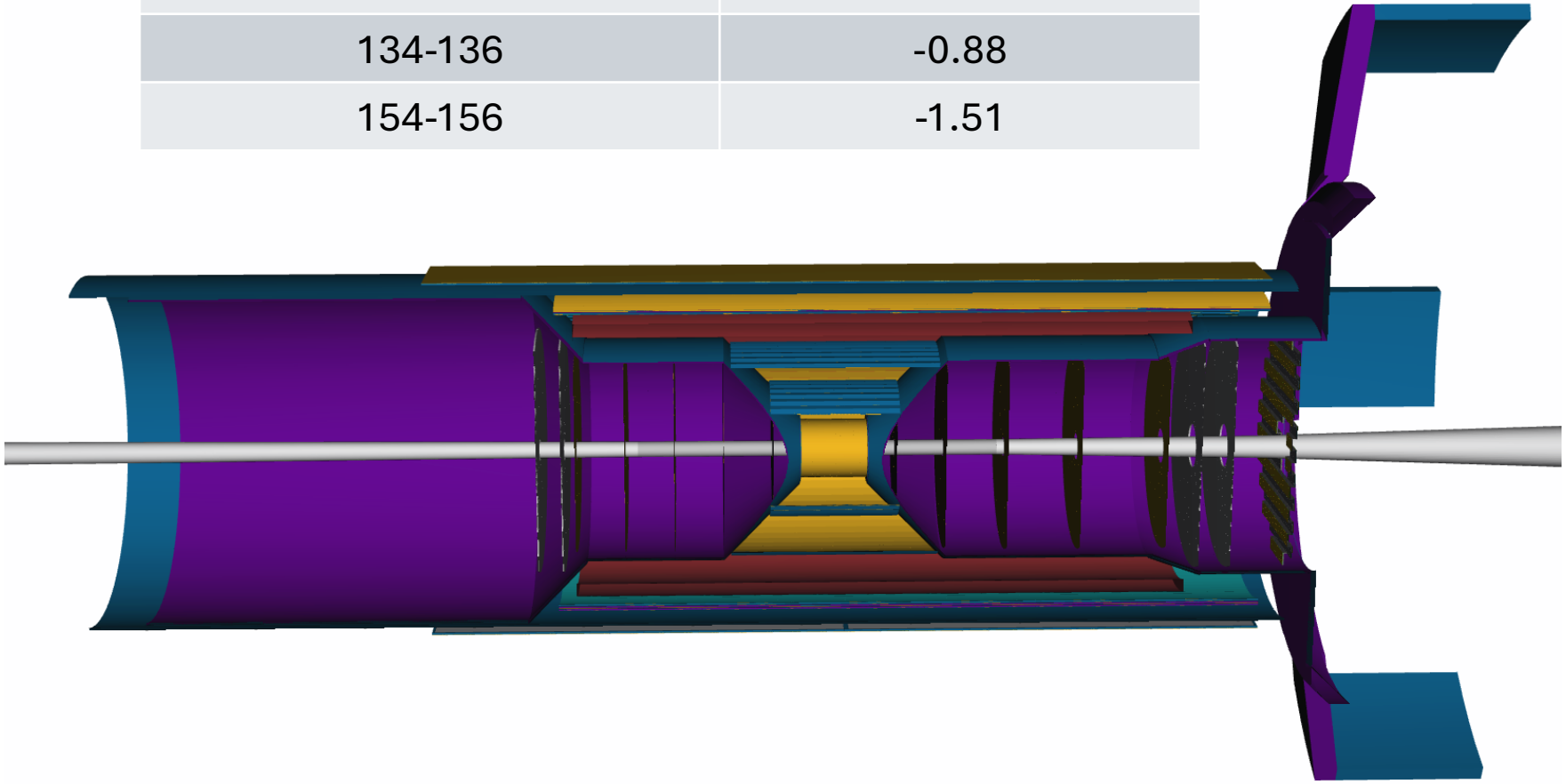
- ❑ Simulation details
- ❑ Extracting angular resolutions are extracted
- ❑ μRWELL-BOT spatial resolution impact on angular resolution
  - Drift gap dependance
  - Fast Simulation Comparisons
  - ACTS Track States
  - Fast Tracklets
- ❑ Next Steps

Simulation Details

- ❑ ePIC: 24.06.0
- ❑ EICrecon: v1.14.0
- ❑ Single particle π^-
- ❑ Discrete momentum
  - ➢ 1, 2, 4, 6, 8, 10 GeV
- ❑ $0^o \leq \phi \leq 360^o$
- ❑ $\Delta\theta = 2^o$

θ bins and corresponding η settings

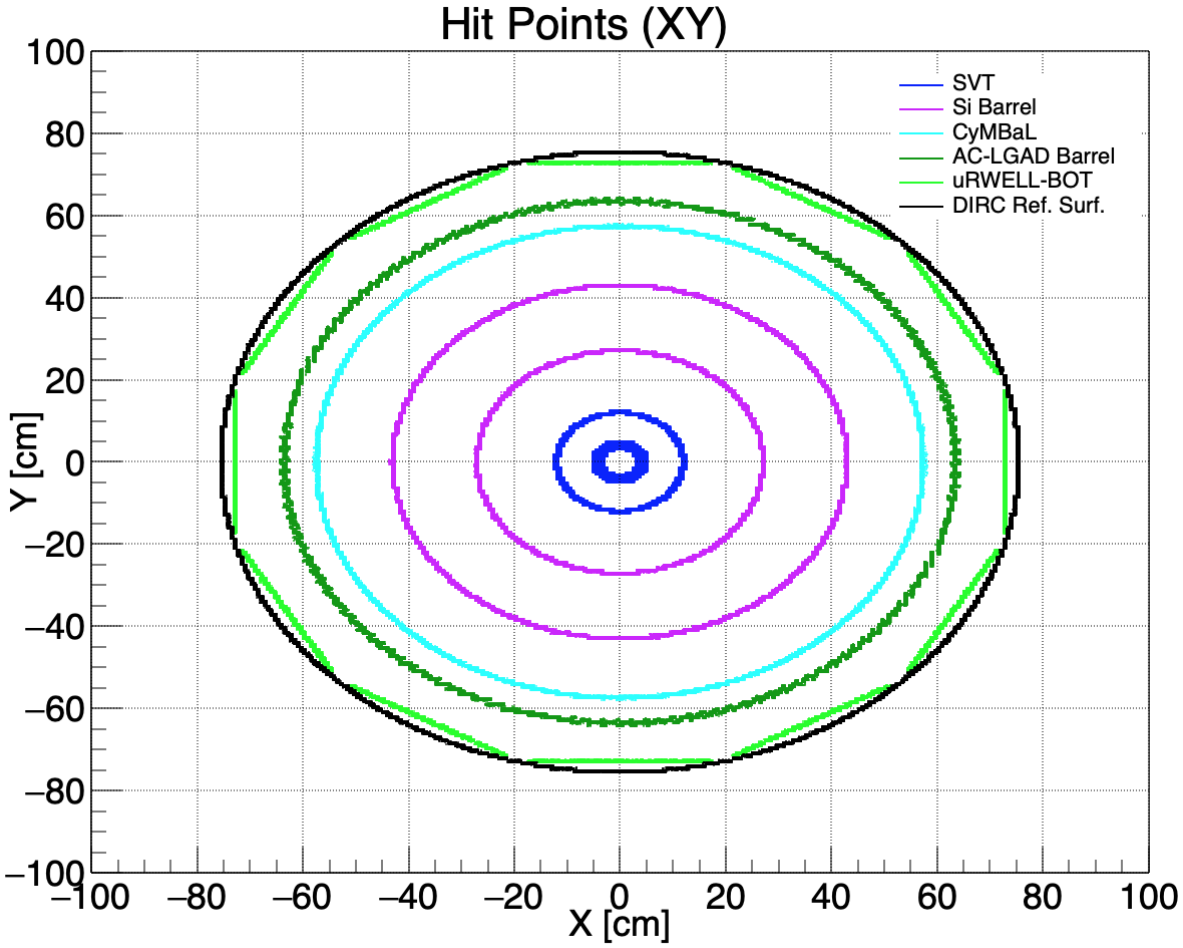
θ [deg]	$< \eta >$
92-94	-0.05
117-119	-0.51
134-136	-0.88
154-156	-1.51

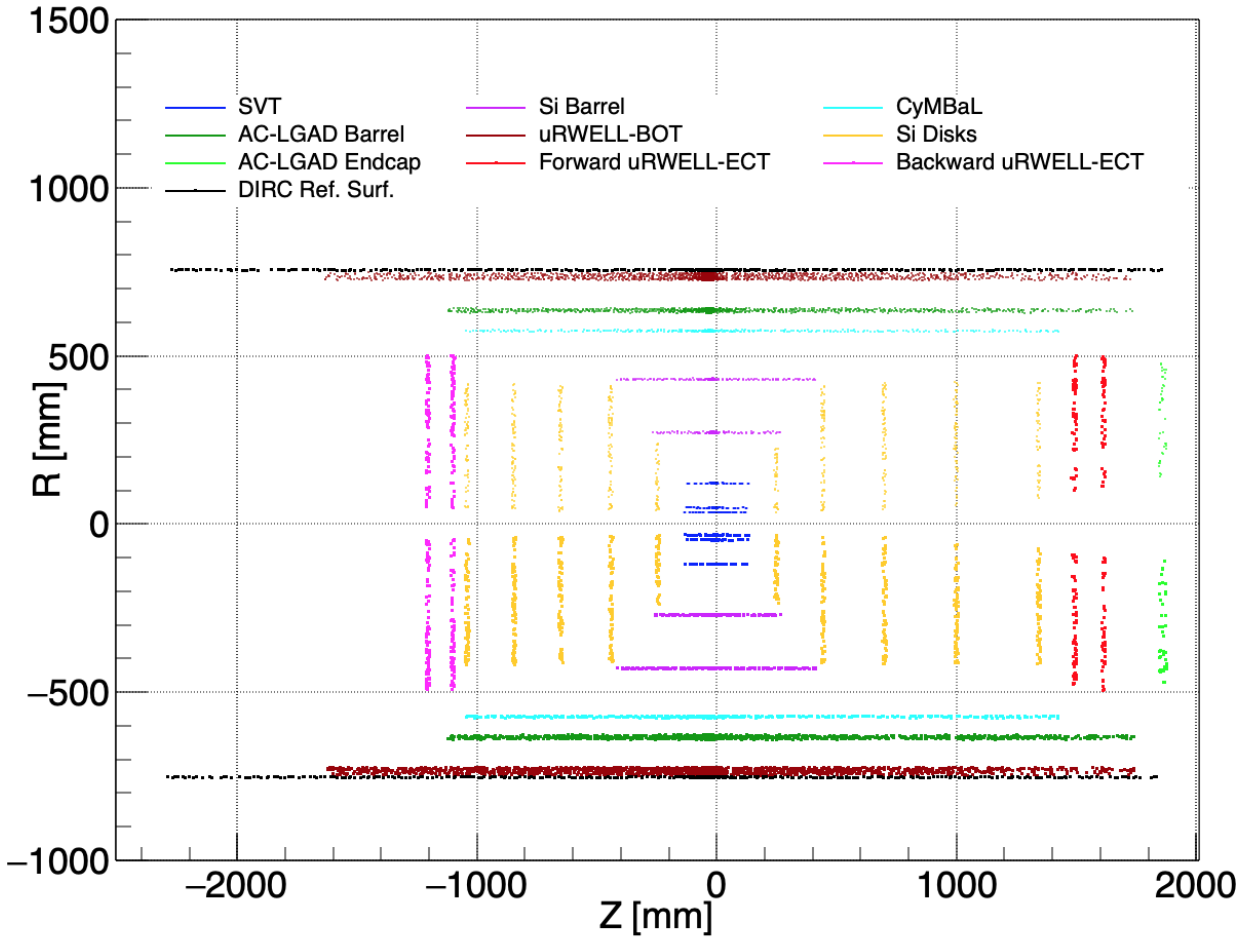


Extracting Angular Resolutions

- Define low mass DIRC reference surface (~R = 76cm) in DD4HEP to record truth hit information

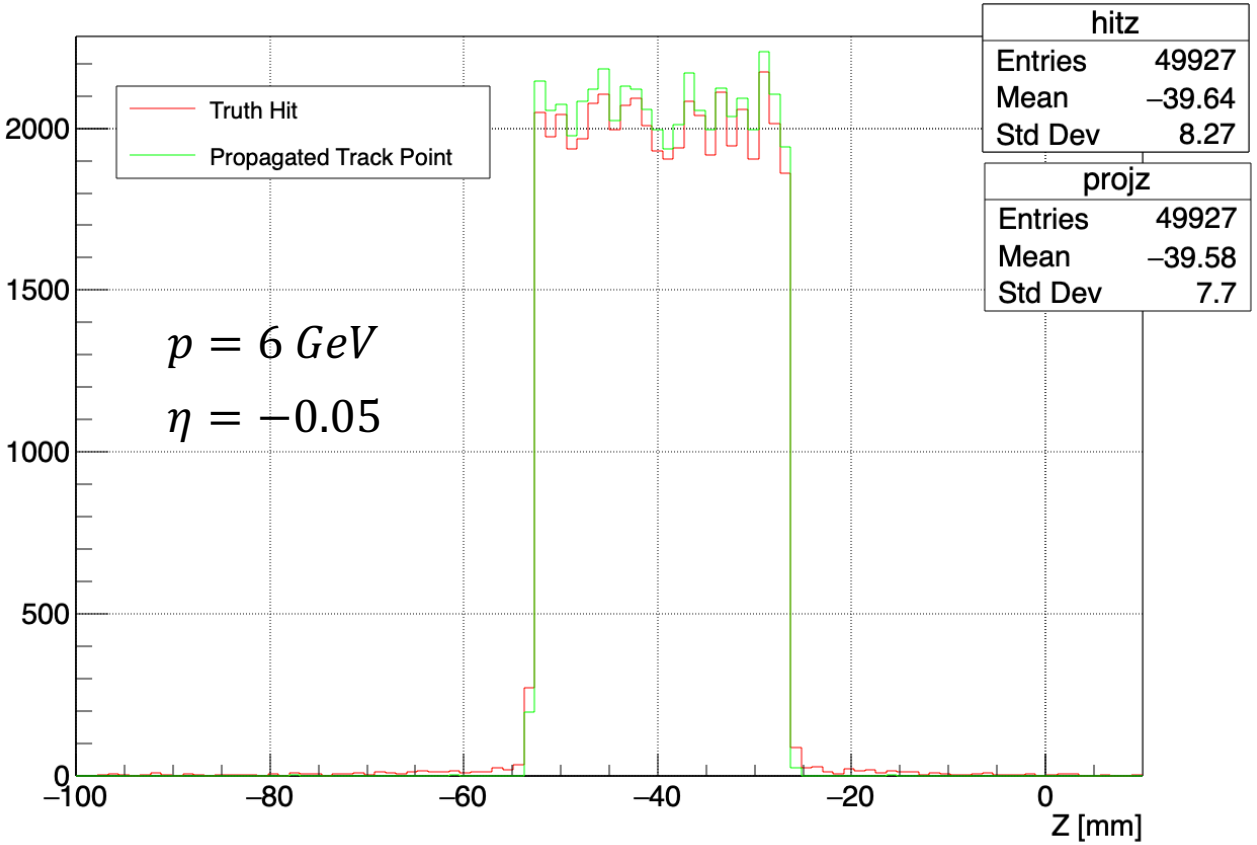
ePIC 24.06.0

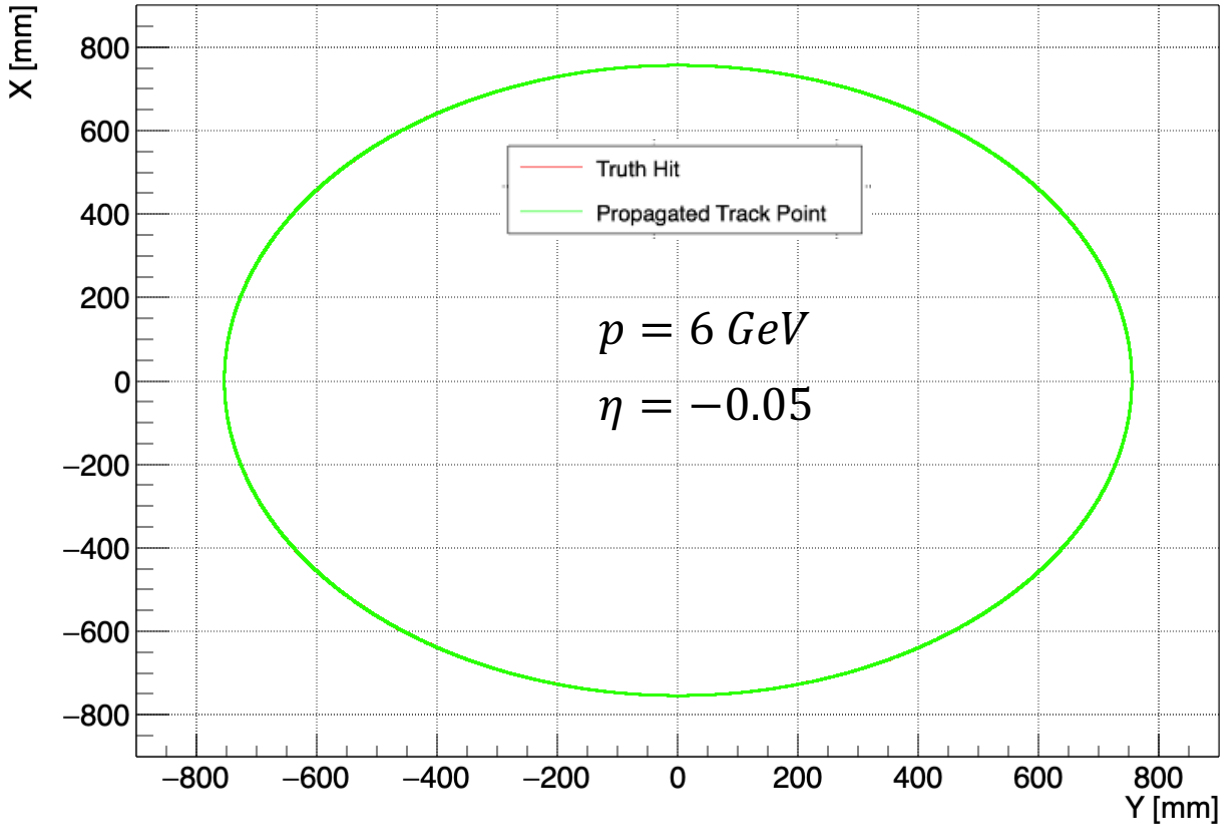




Extracting Angular Resolutions

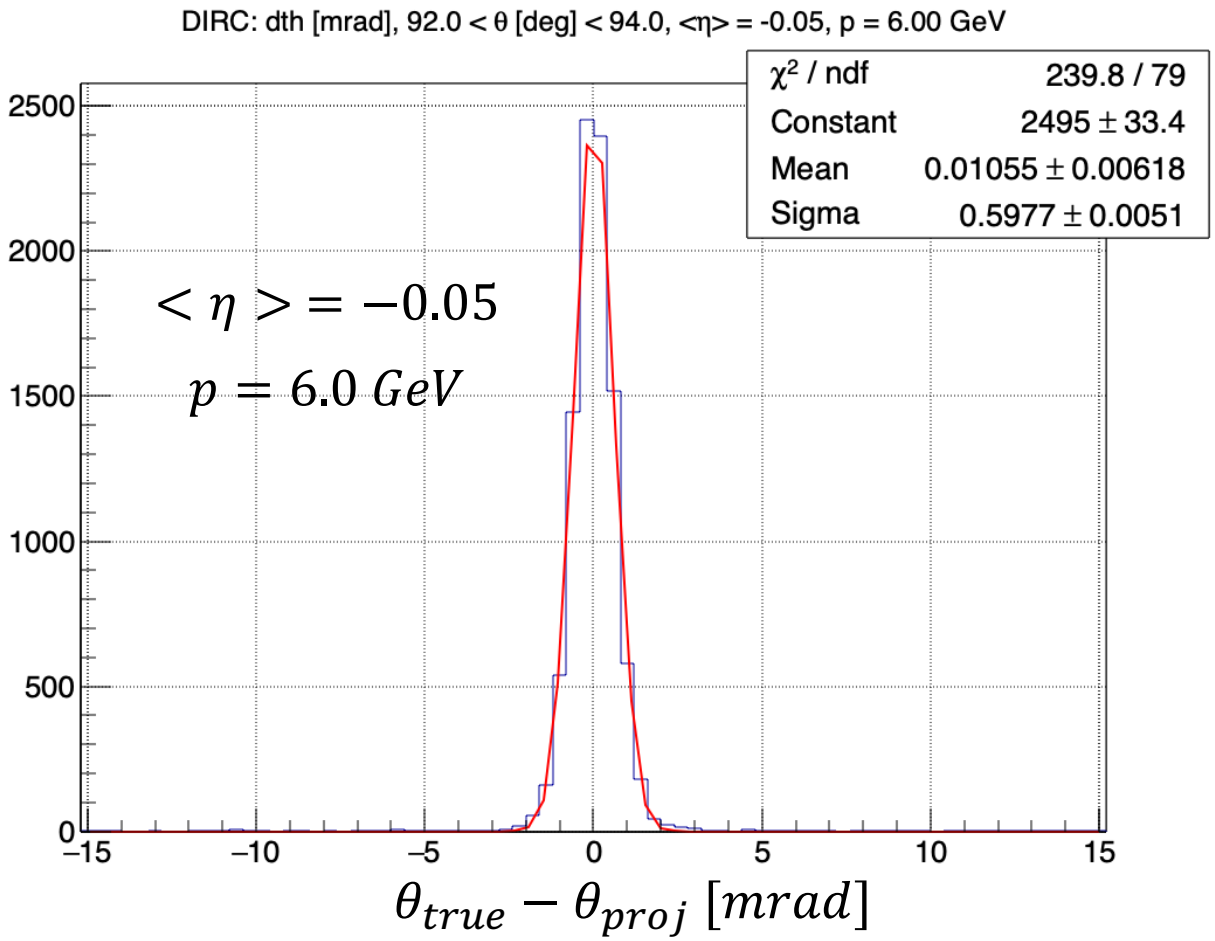
- ❑ Define low mass DIRC reference surface in DD4HEP to record truth hit information
- ❑ Define ACTS surface that matches D44HEP DIRC reference surface to propagate tracks to





Extracting Angular Resolutions

- Take difference of truth hit and propagated track point
  - Resolution is given by Gaussian sigma
    - $\sigma_\theta = 0.6\, mrad$



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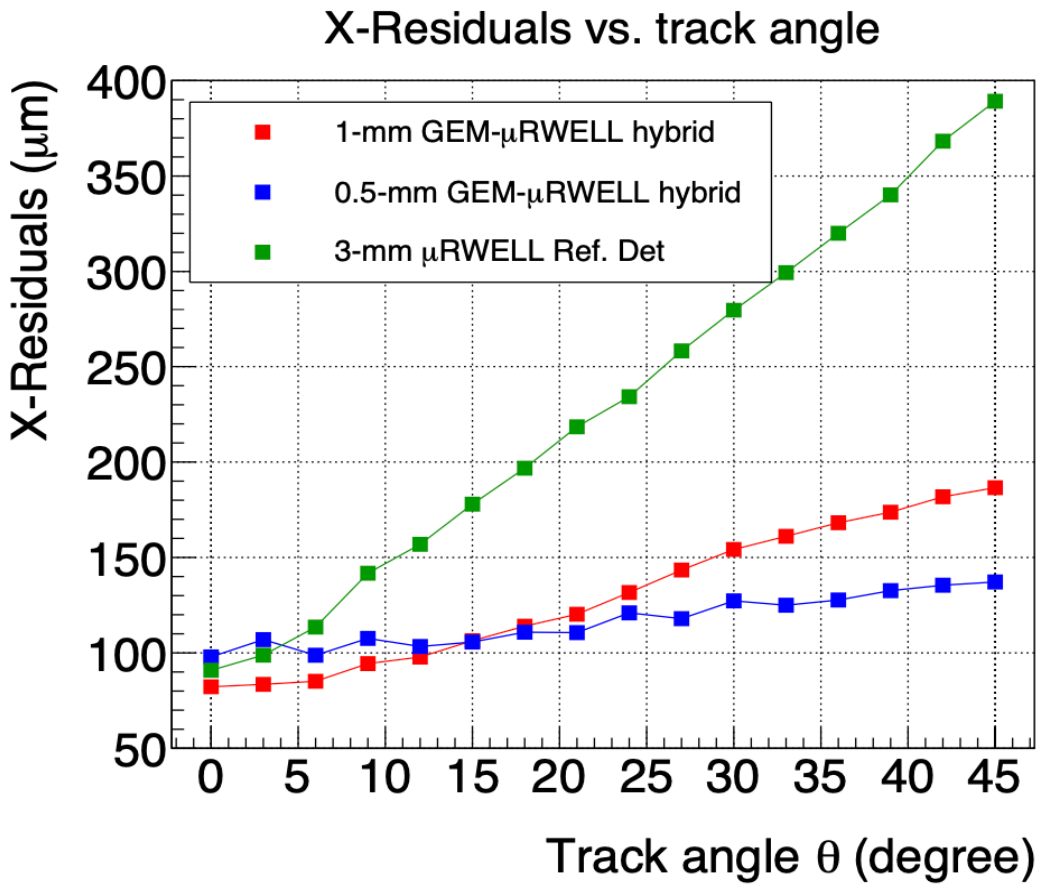
μRWELL Drift Gap Dependence

- MPGD resolution depends on track angle and size of the drift gap
  - Use test beam results to set resolution based on simulation η and drift gap sizes

eRD108 Test Beam Results



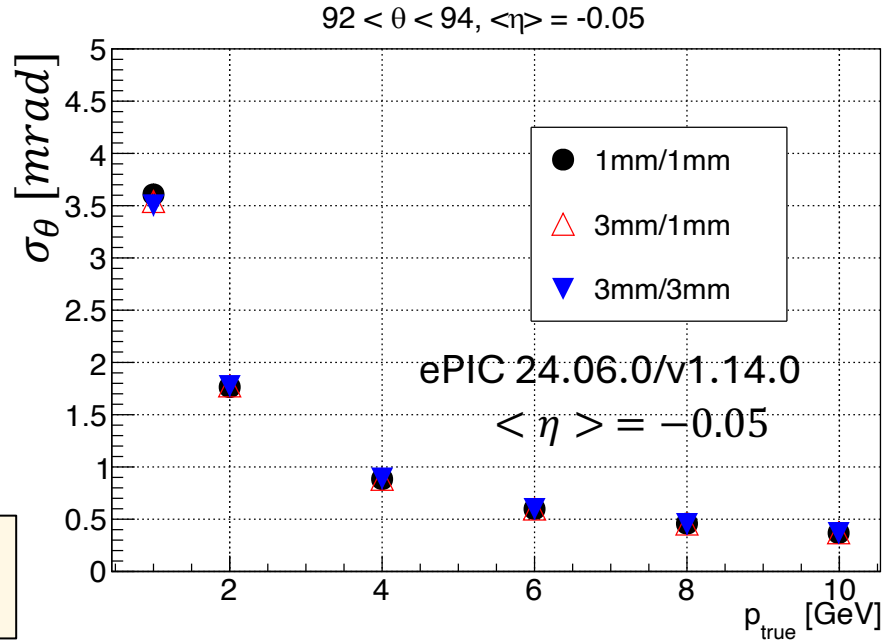
MPGD resolutions used in simulation

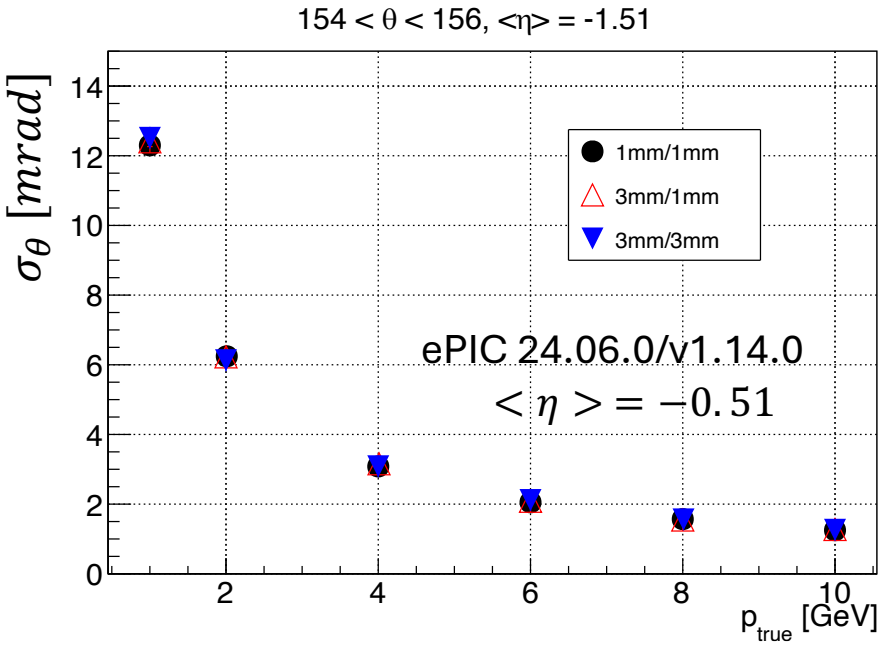
θ – 90° [deg]	$< \eta >$	1mm Resolution [μm]	3mm Resolution [μm]
2-4	-0.05	80	90
27-29	-0.51	150	250
44-46	-0.88	190	390
64-66	-1.51	240	520

μRWELL Drift Gap Dependence

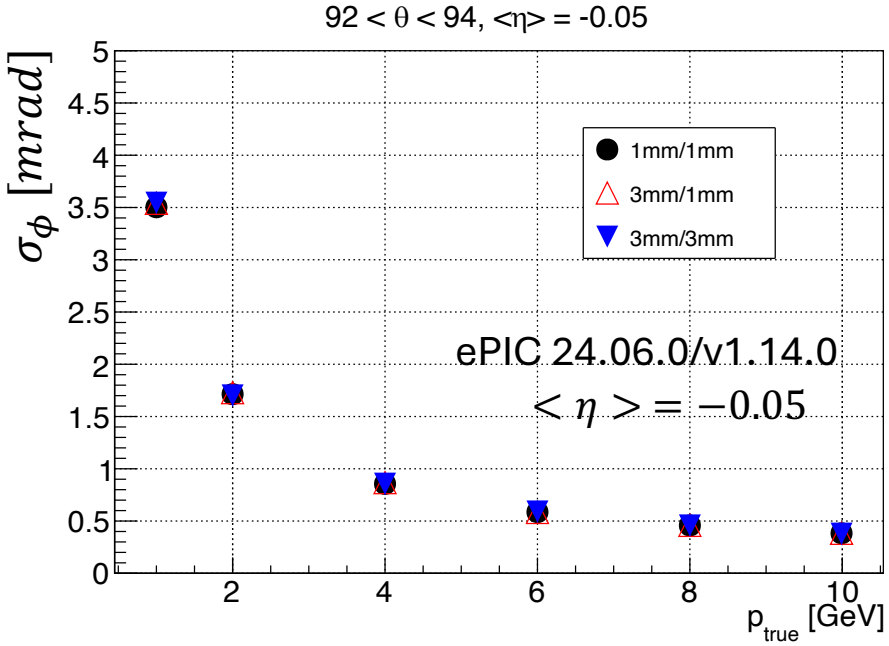
σ_θ

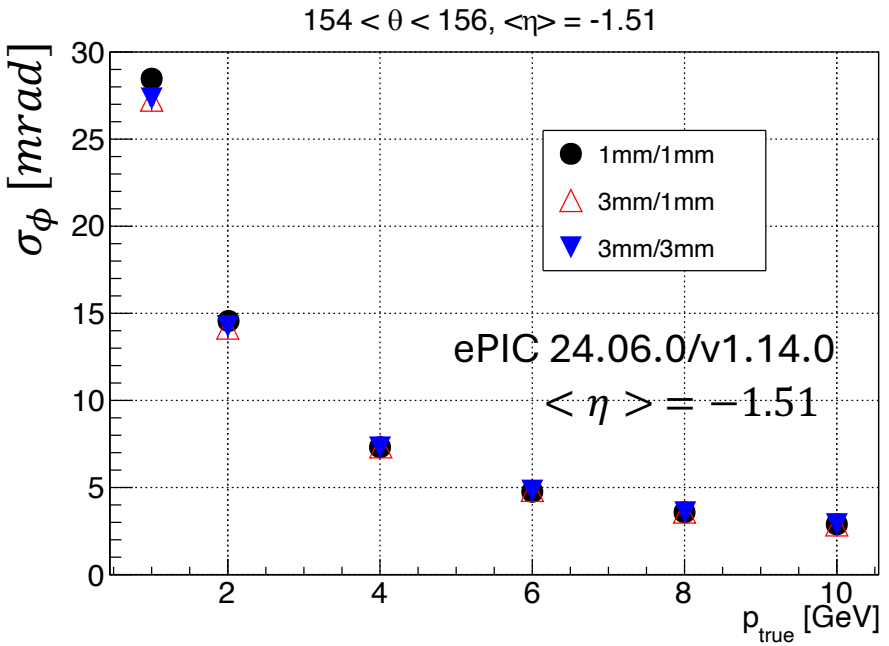
Legend is drift gap size for
CyMBaL / μRWELL-BOT





σ_ϕ





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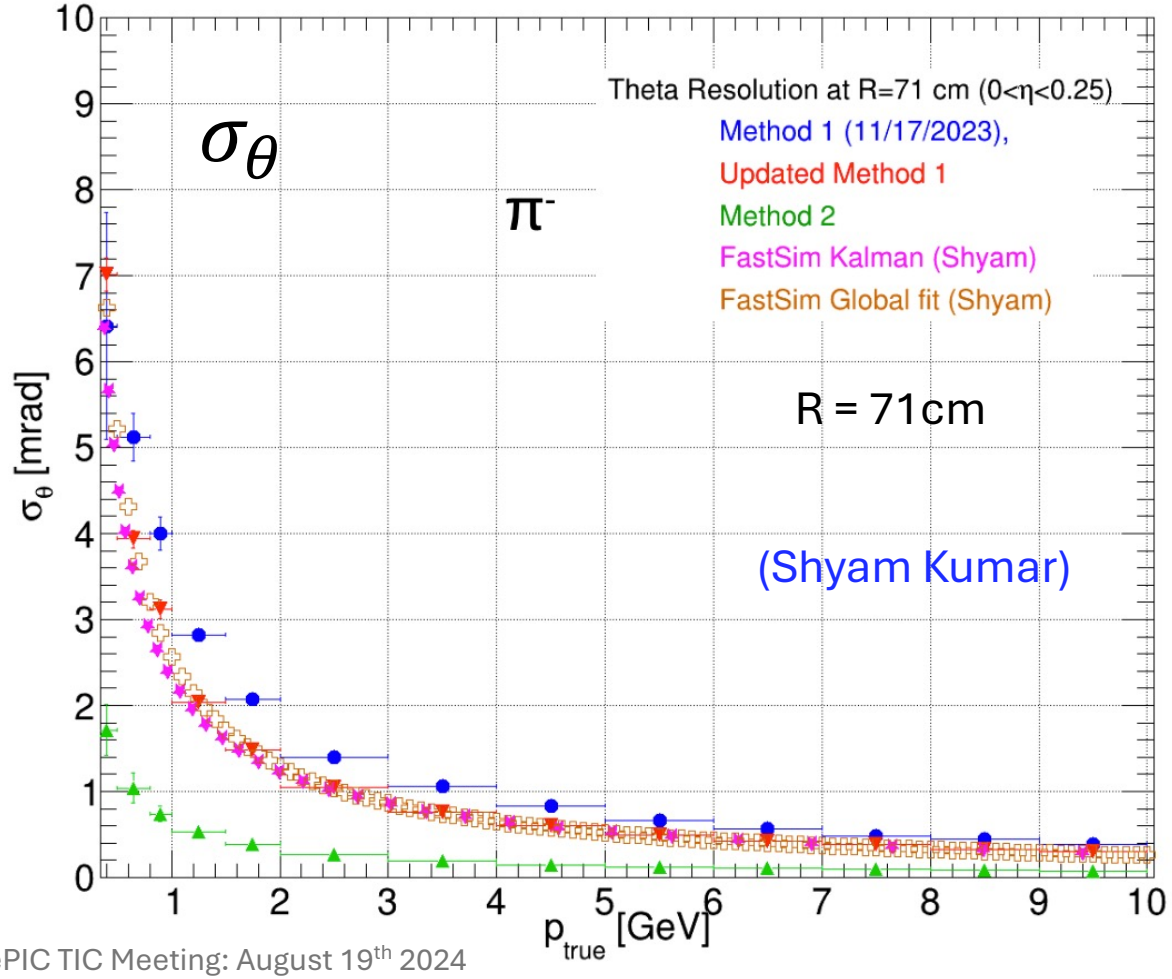
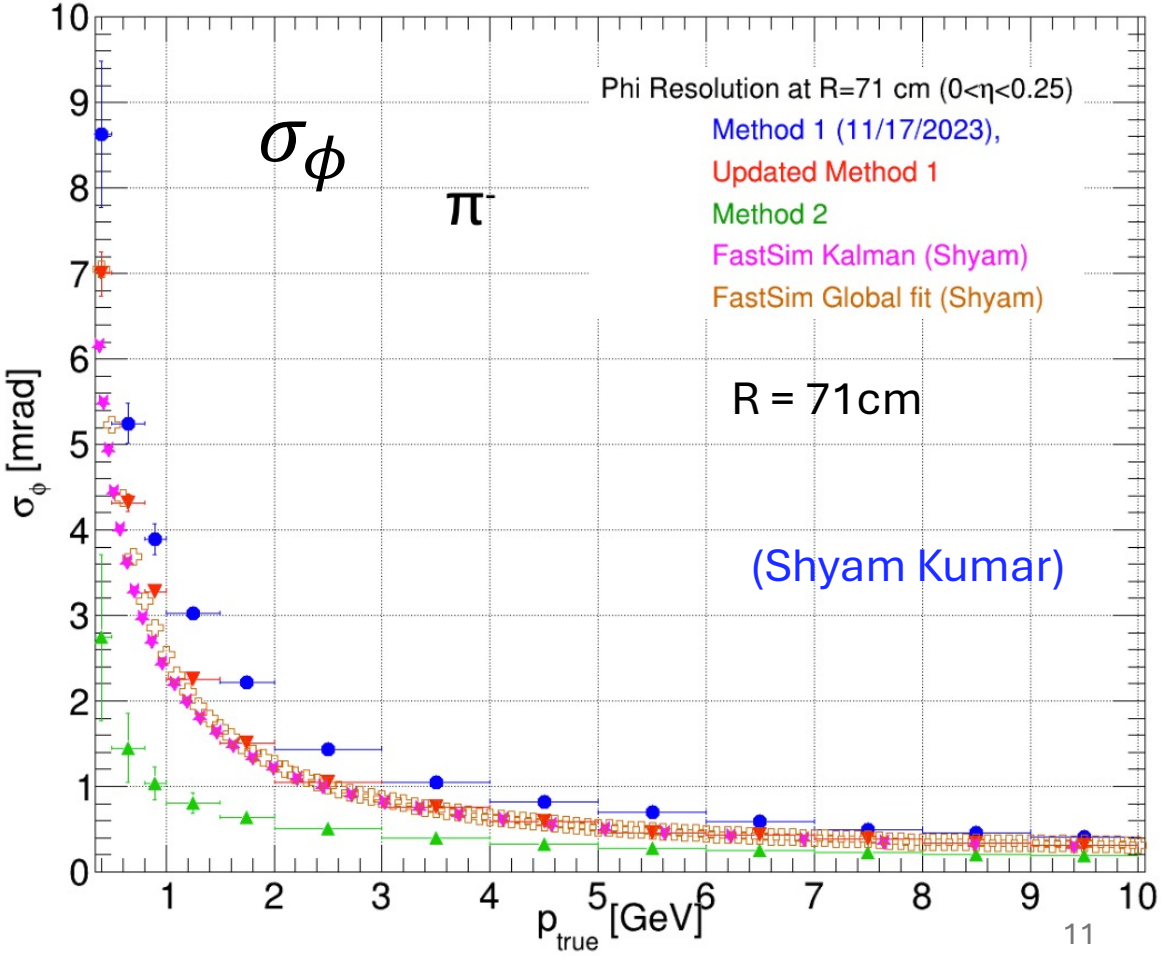
Fast Simulation Comparison

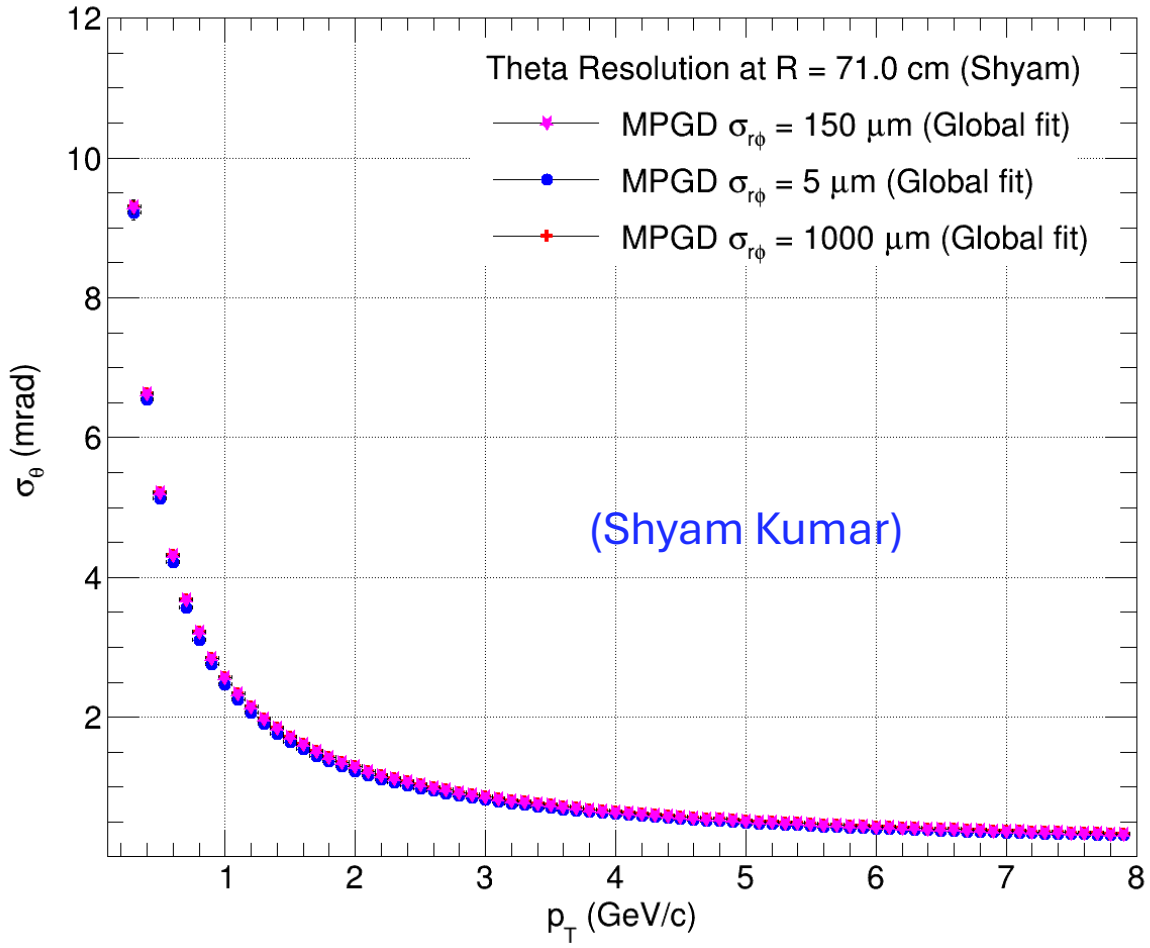
- Good agreement seen between ePIC full sim and fast sim
  - These Results are before DIRC move to R = ~76cm
  - Fast sim results produced by Shyam Kumar MPGD Simulation Meeting

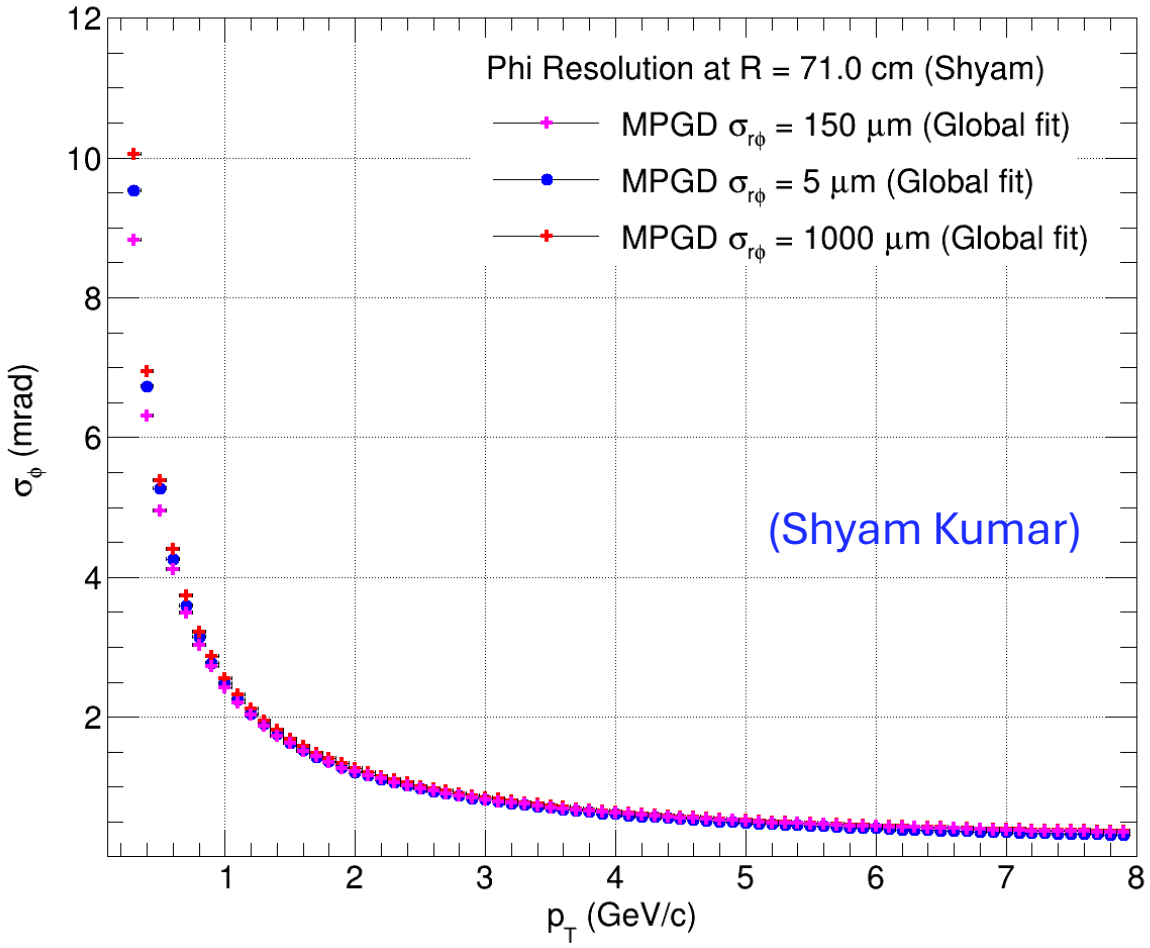




Fast Simulation Comparison

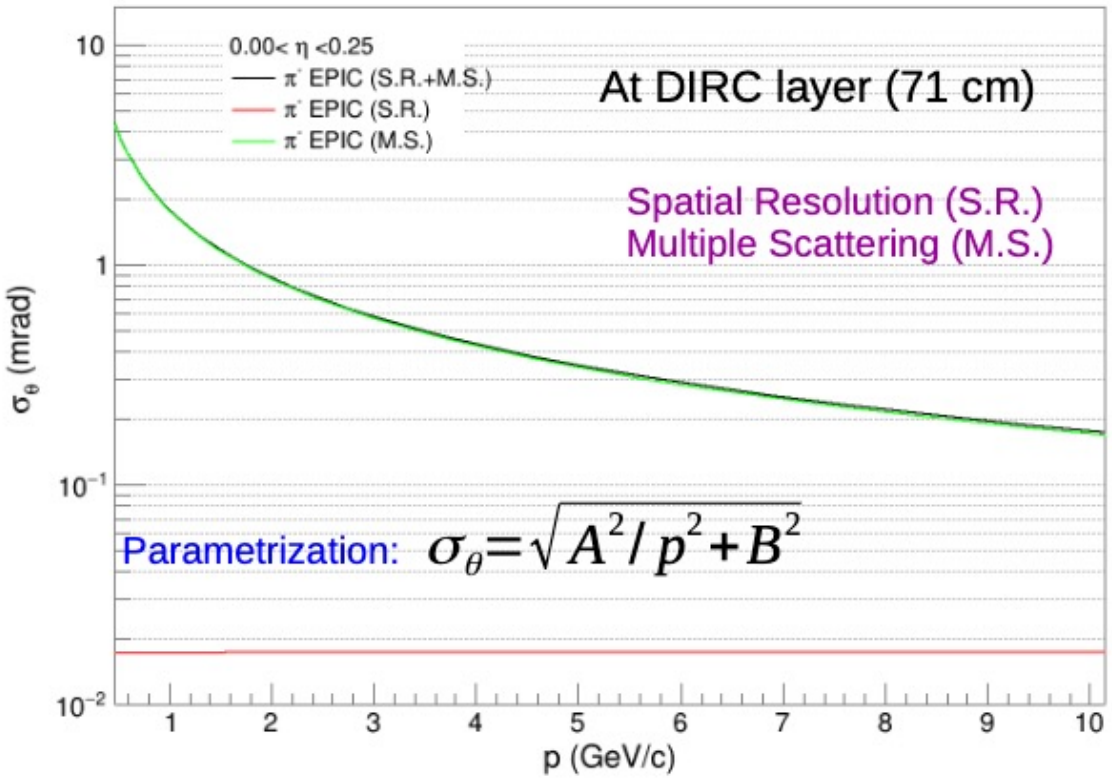
- Same dependance on spatial resolution as seen in fast simulations

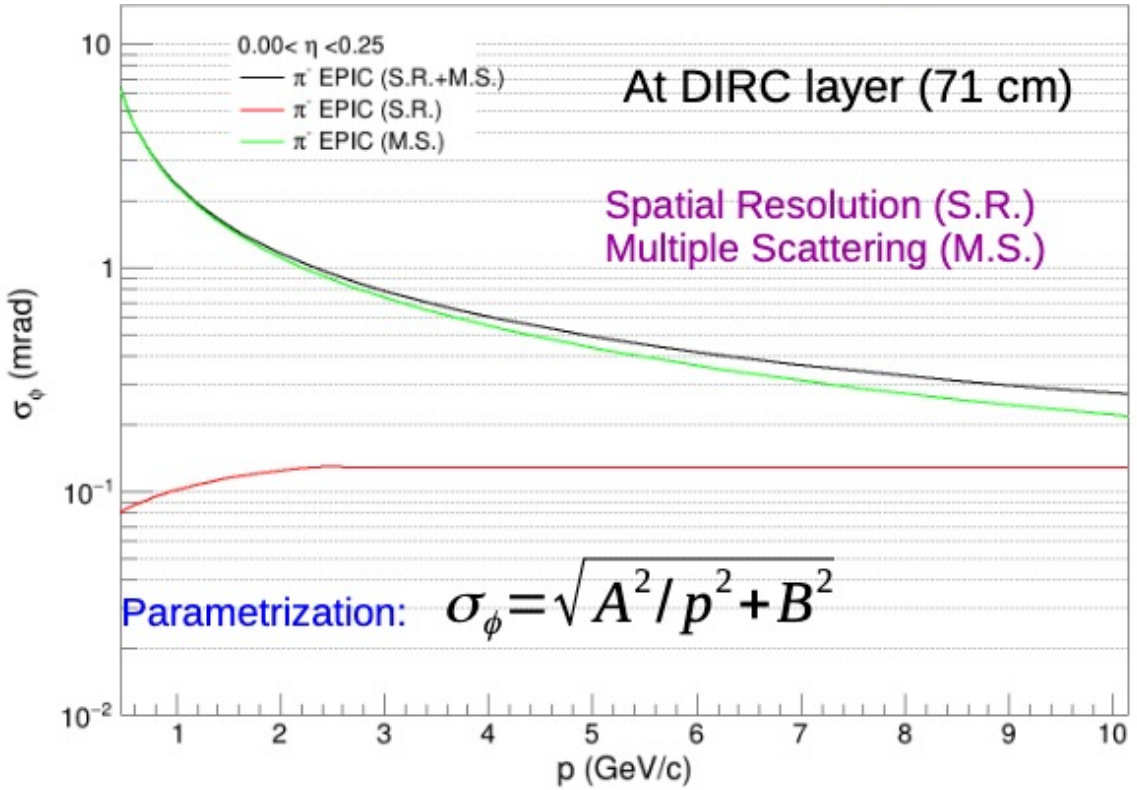




Multiple Scattering Contribution

- Contributions to angular resolutions from fast simulation
- Angular resolutions dominated by MS
  - MS more dominant in polar angle resolution





Shyam Kumar [MPGD Simulation Meeting]

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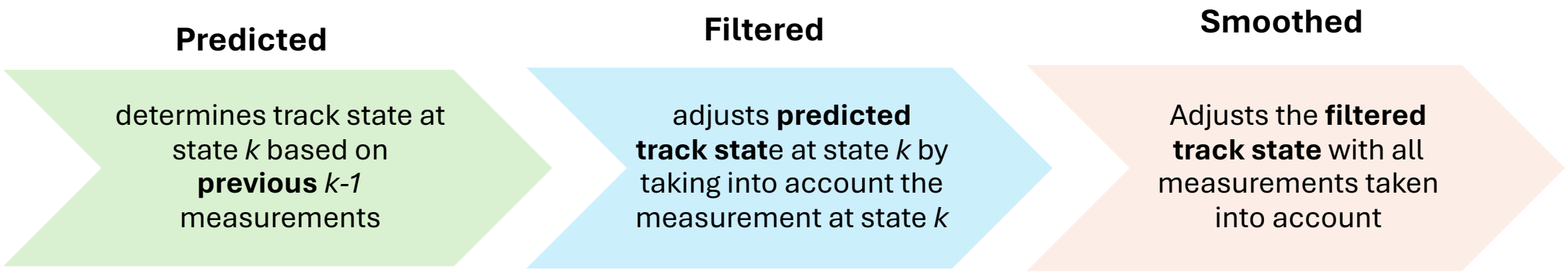
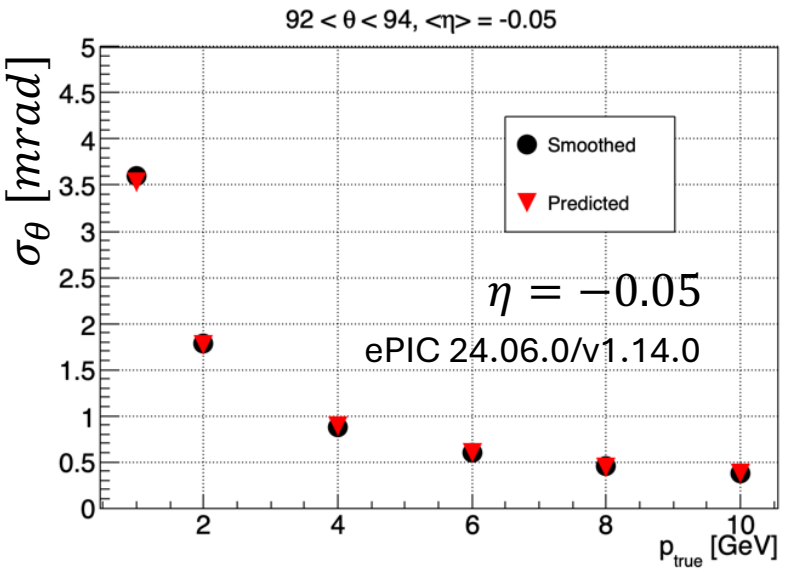
ACTS Track States

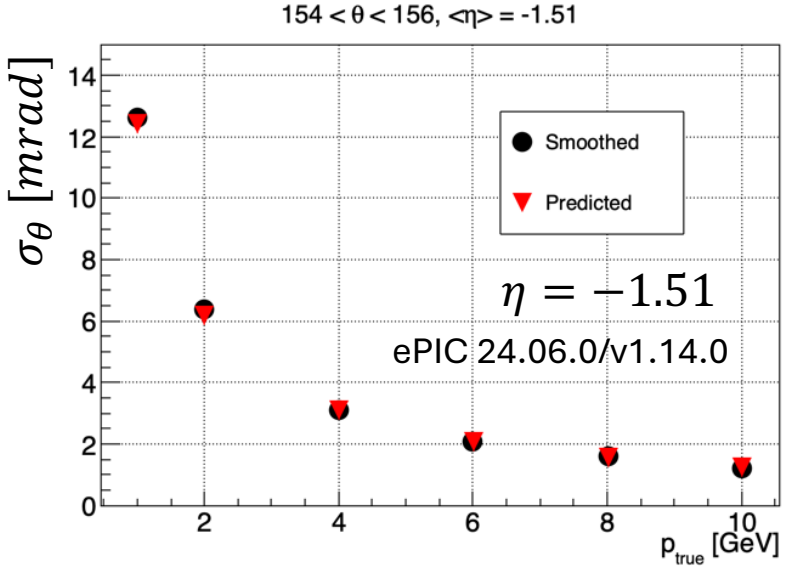
- 3 ACTS track states
  - EICrecon currently saves predicted track states as default
  - Beatrice showed track residual improvement using the smoothed track state
    - Tracking WG Meeting

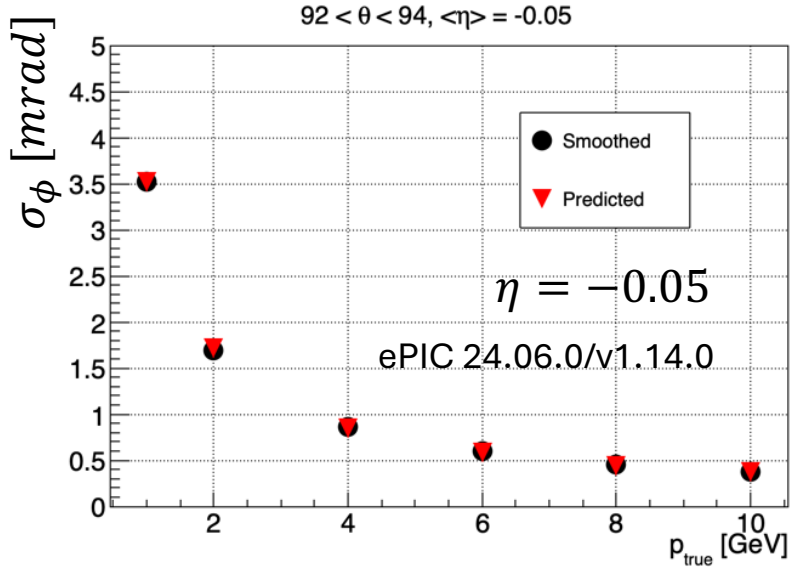


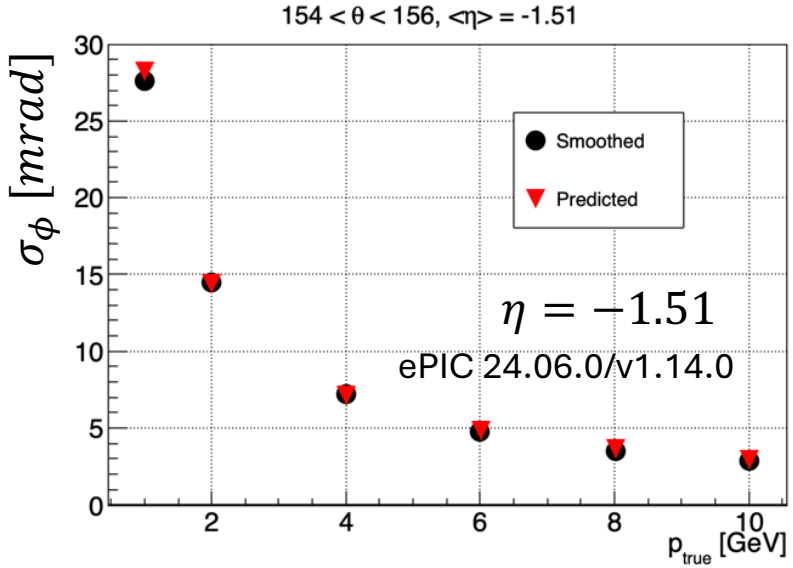
ACTS Track States Comparison

- Different track states yield comparable angular resolutions









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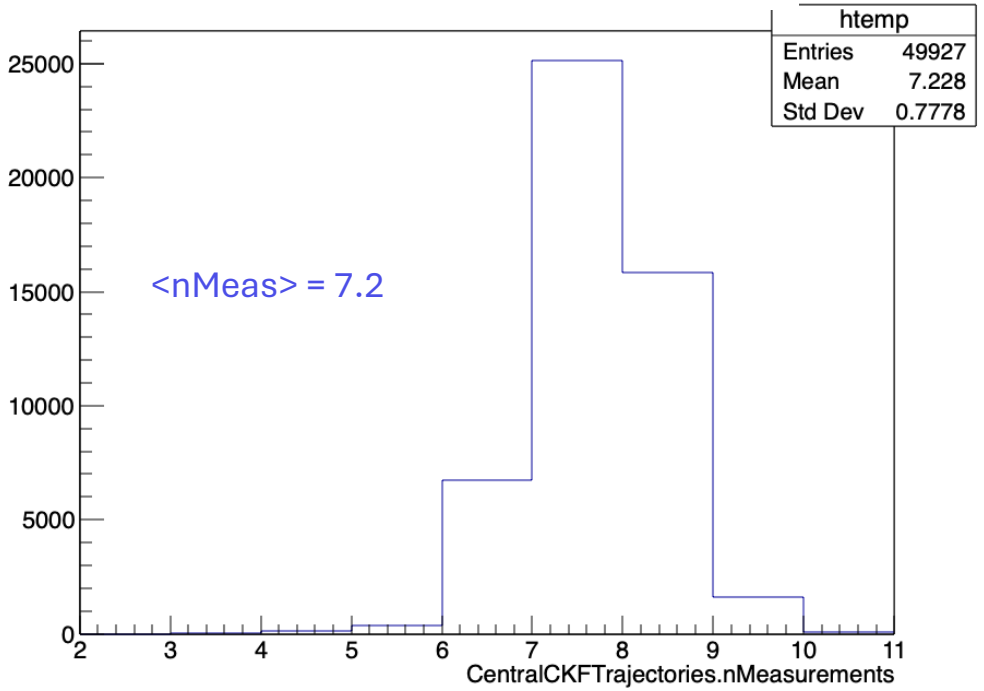
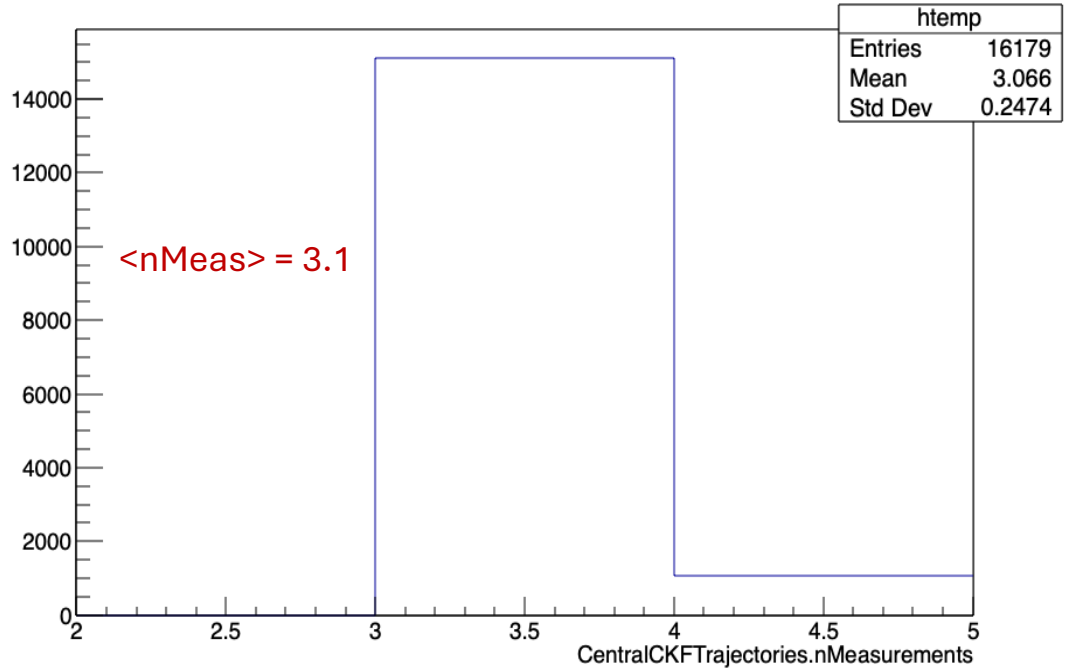
Fast Tracks

- Use only hits from MPGDs and AC-LGADs in track reconstruction
  - Three *fast* layers → ~3 measurements / track
  - Note this study used fixed MPGD resolutions (no track angle dependance)

Full Track Reconstruction



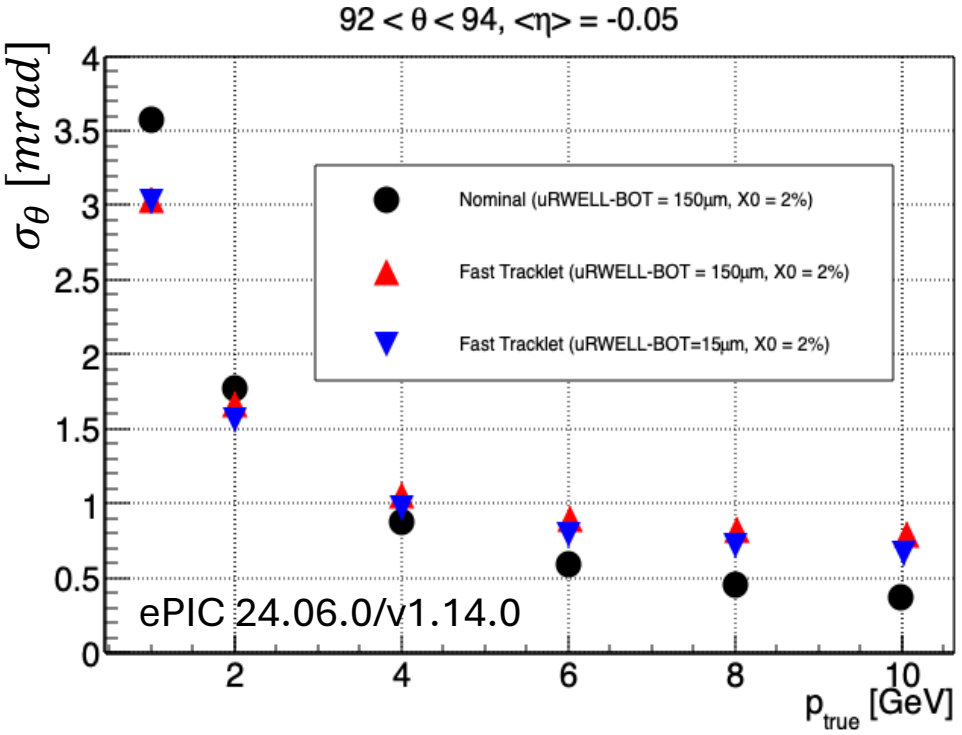
Fast Tracklet Reconstruction



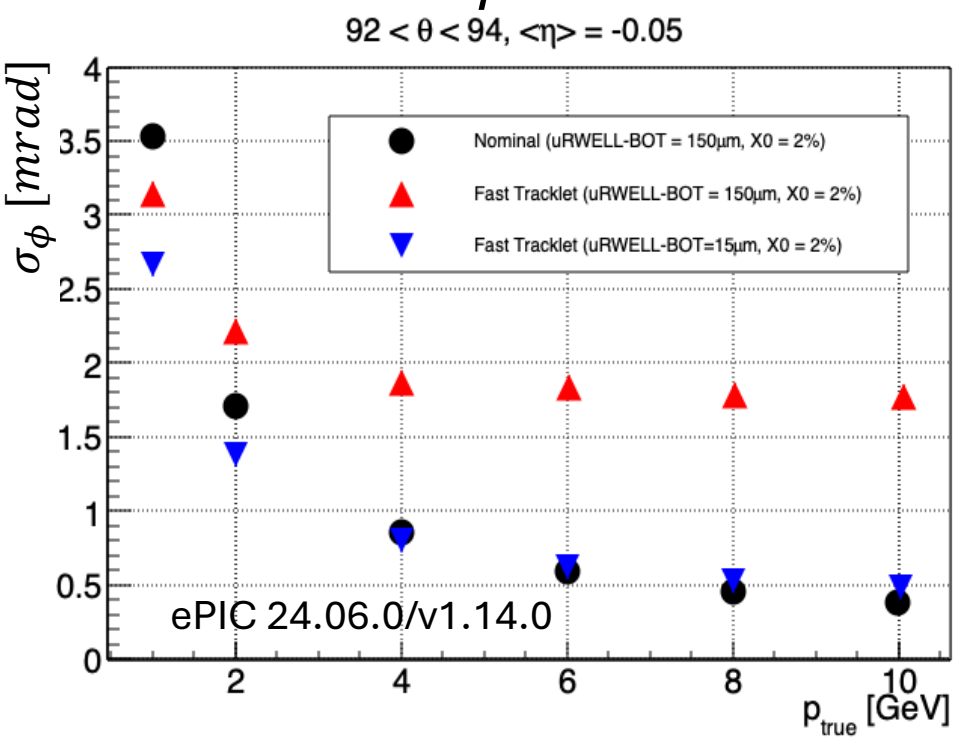
Fast Tracks: Angular Resolution Comparison

- Fast tracklet results show
  - Sensitivity to detector resolution, mostly in ϕ
  - Improvement at low p

σ_θ



σ_ϕ



Summary and Next Steps

❑ Summary

- Current track reconstruction seems to be dominated by multiple scattering that can not be overcome from improving detector resolution
- Fast tracklet results show sensitivity to detector resolution and improvement at lower momentum

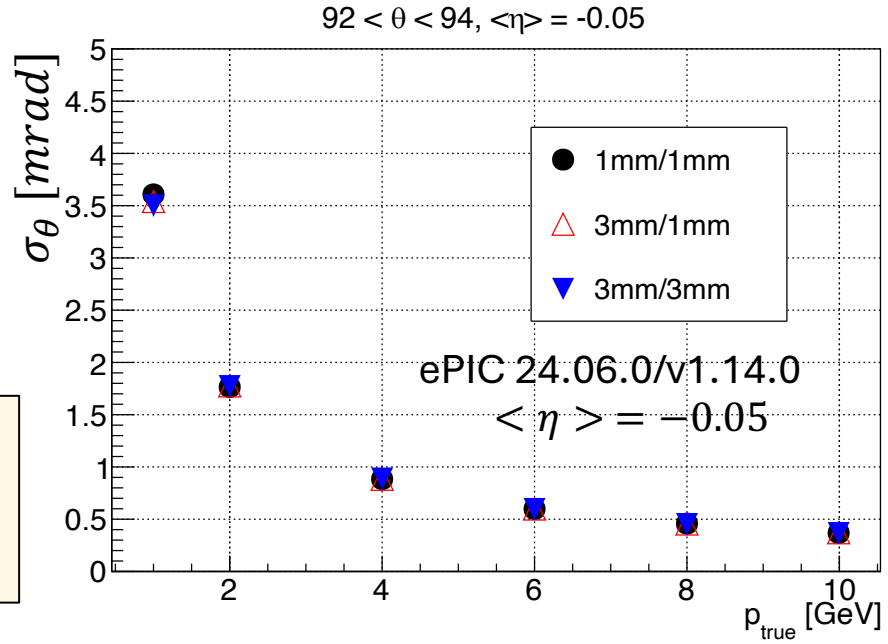
❑ Next Steps (beyond just μRWELL simulations)

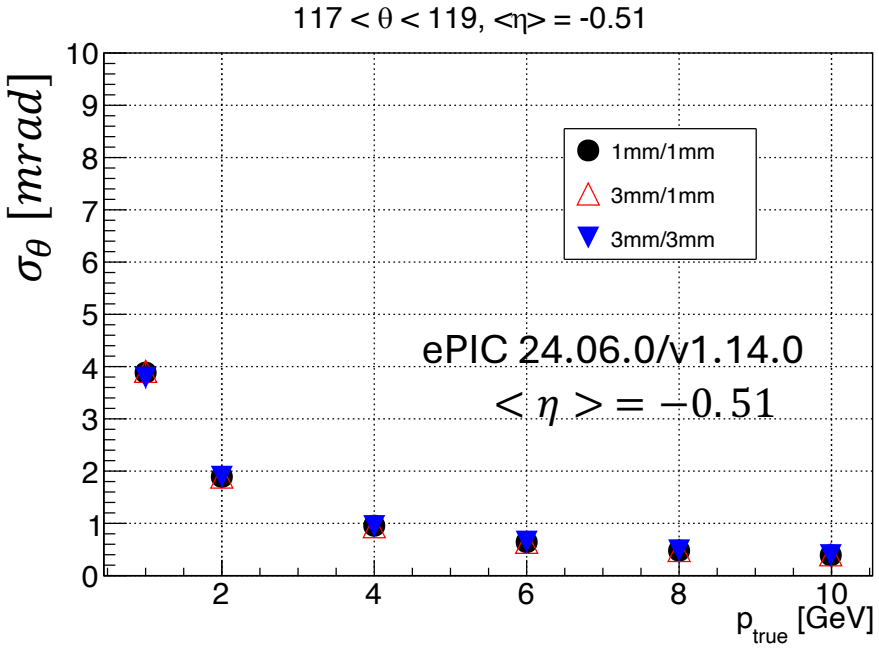
- Study impact of BIC tracking layer on angular resolutions
  - ➢ Integrating BIC hits into ACTS in progress: (PR#710, Wouter)
- Try to improve angular estimates at large radii by reversing the track finding direction in EICrecon
- Assess tracking performance with more refined set of DIRC requirements, e.g. needed tracking resolutions vs. momentum and eta

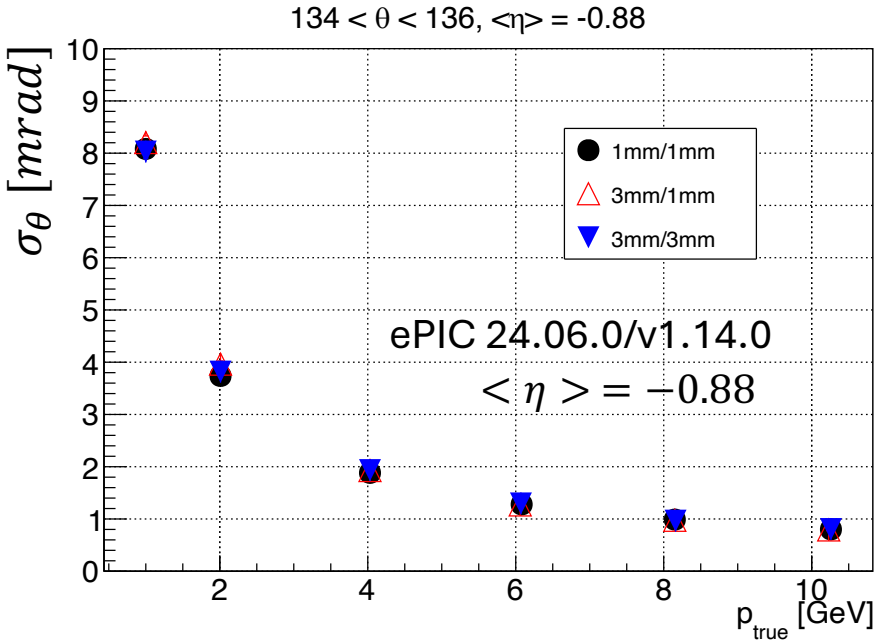
Backup

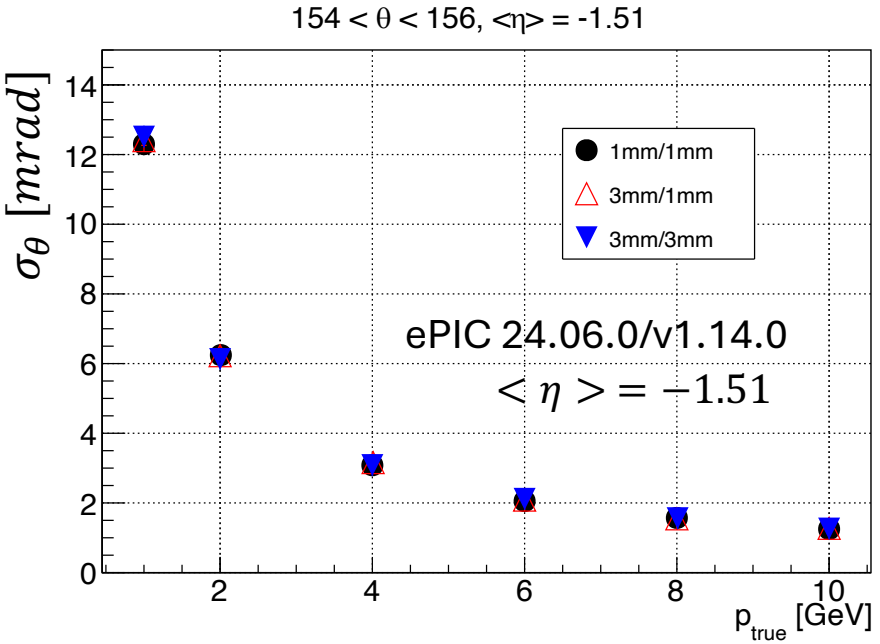
μRWELL Drift Gap Dependence: σ_θ

Legend is drift gap size for **CyMBaL / μRWELL-BOT**









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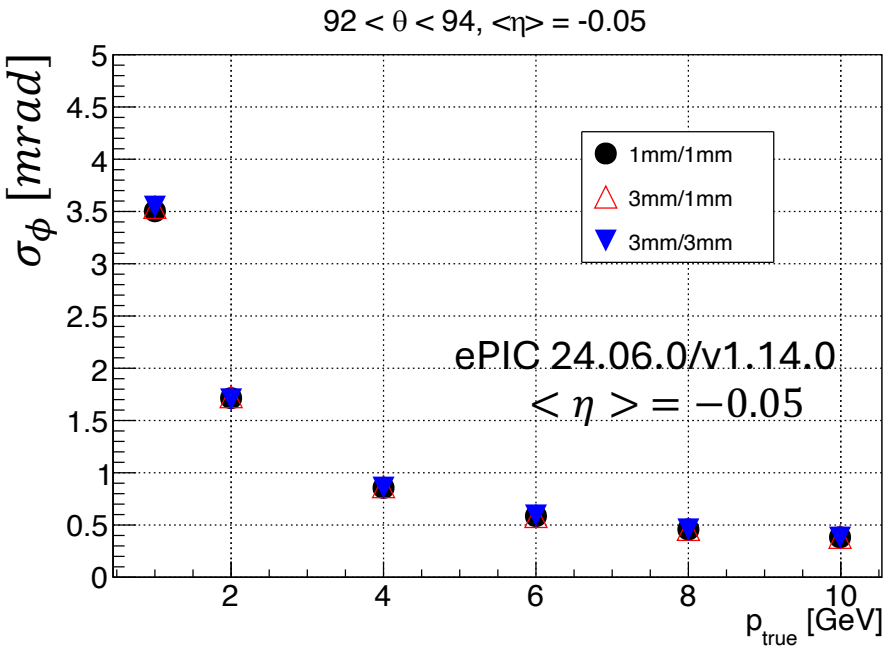
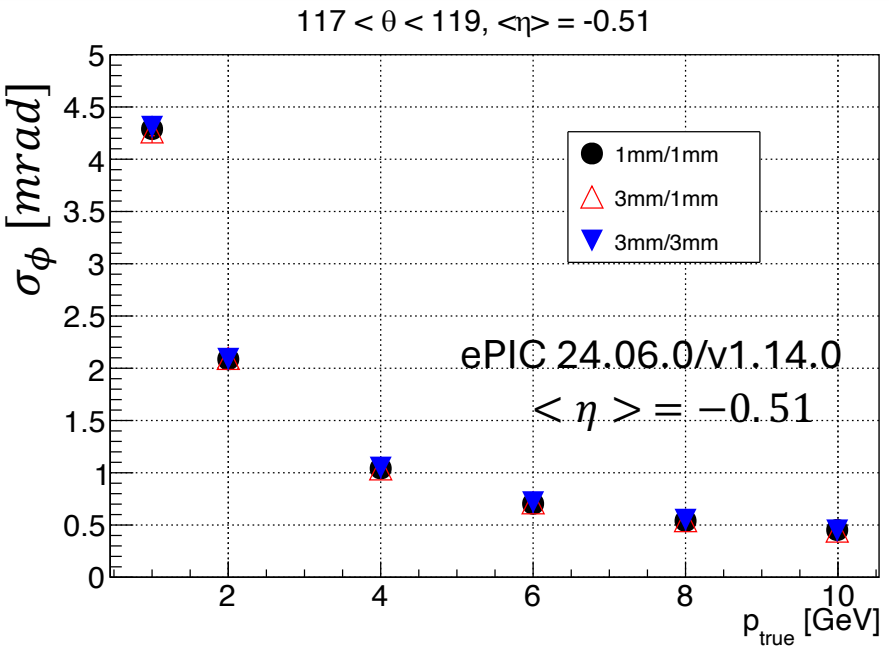
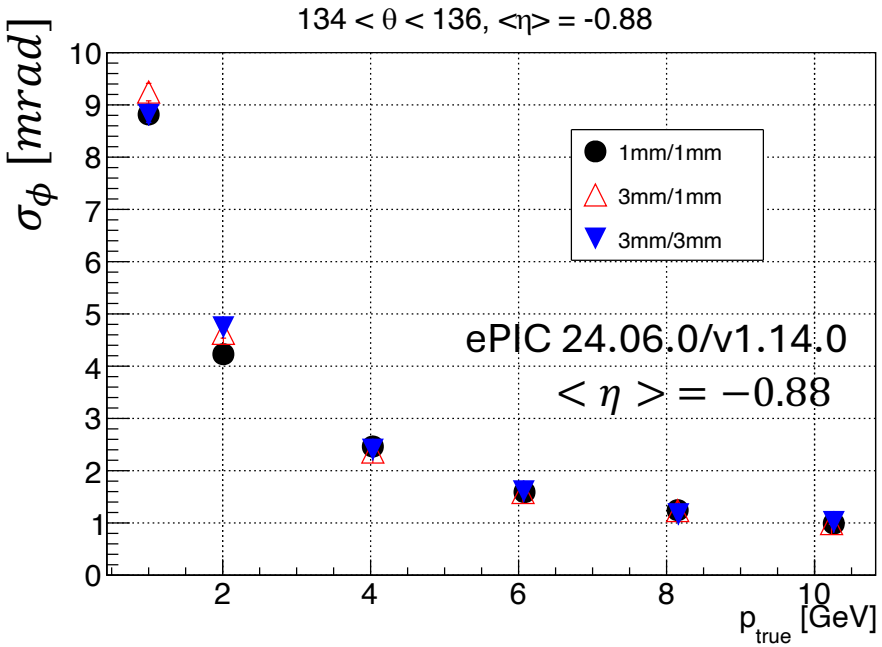
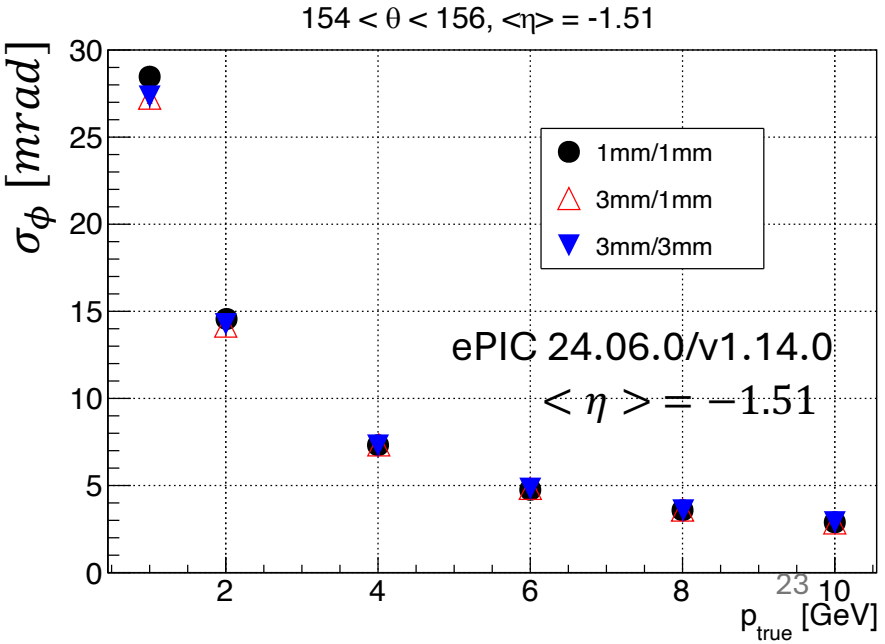
Legend is drift gap size for **CyMBaL / μRWELL-BOT**



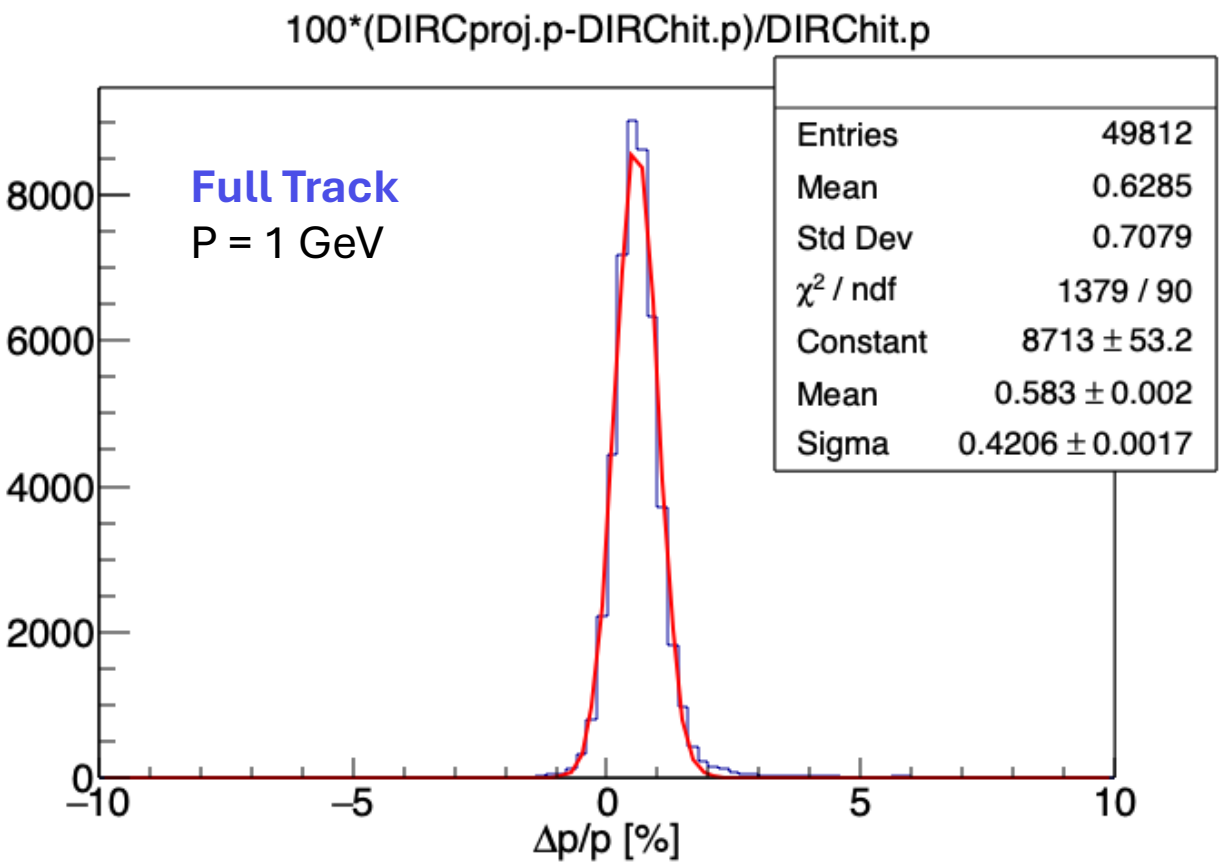


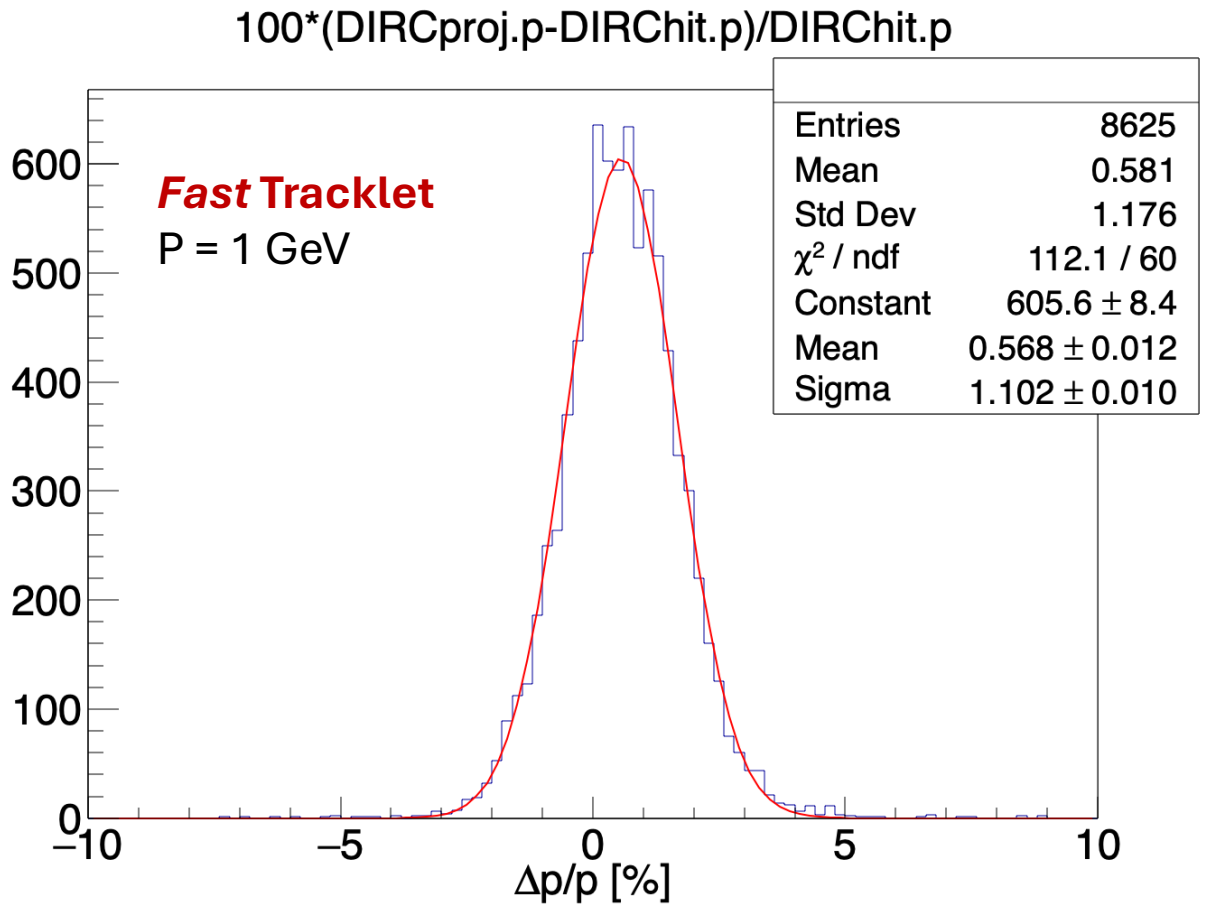




Evaluating Performance with *Fast* Tracklets

- Full track gives better momentum resolution at hpDIRC compared to *fast* tracklets





Evaluating Performance with *Fast* Tracklets

- Clear μRWELL-BOT spatial resolution impact seen in momentum resolution at hpDIRC seen in ***fast* tracklets**