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Tracking performance with 5um and 10um beampipe gold coating

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ePIC Tracking WG meeting

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Overview

Question:

do we need to increase the beampipe gold coating from 5um to 10um to better shield synchrotron radiation background?

Potential impacts on tracking performance:

- 10um gives worse **tracking** and vertexing resolution
- at 10x275 (highest rate beam config), 10um reduces SR rate by at least a factor of 3
 - reduce SVT readout data rate (see [my talk](#) at the Jan 2026 collaboration meeting)
 - **better tracking efficiency and purity**

Goal:

make decision and propagate the change to next simulation campaign to support physics analysis.

DIS+background study

- **Feb 2026 campaign files (10x275):**

- **Two beampipe settings:**

- `/volatile/eic/EPIC/RECO/26.02.0/epic_craterlake/Bkg_Exact1S_2us/GoldCt/5um(10um)`
`/DIS/NC/10x275/minQ2=1`

- **What it actually means:**

- **SR source files:** recorded particles on the **outer surface of beampipe**, i.e. after going through the 5um(10um) gold coating
- **all other background and signal particles:** are generated at the vertex, and propagated through the beampipe:
 - DD4hep beampipe defined [here](#), **5um Au coating** covers $z = -74.8\text{cm}$ to 64.8cm

⇒ **5um (10um) background file** = SR source with **5um (10um)** coating

+all other particles go through **5um Au coating** in simulation

(this inconsistency can be resolved if we use 10um Au in dd4hep + 10um Au of SR source, see my next talk)

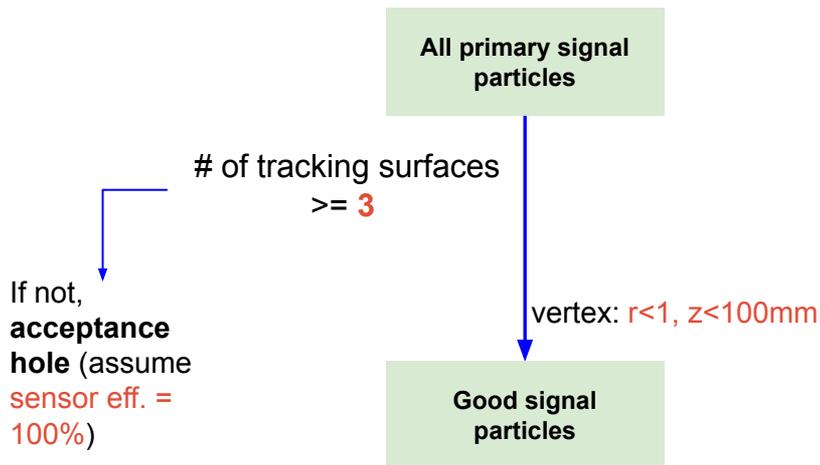
DIS+background study

- **Tracking Study:**

- from [previous study](#) with 18x275: 5um coating shows good performance with 4 hits per track cut
- this study:
 - 10x275 (known to have highest rate):
 - 38 events / file, 100 files processed per setting.
 - check **efficiency** and **purity** for 2x2=4 combinations:
 - 5um v.s. 10um Au coating
 - 4 v.s. 5 nMeasurement cut per track

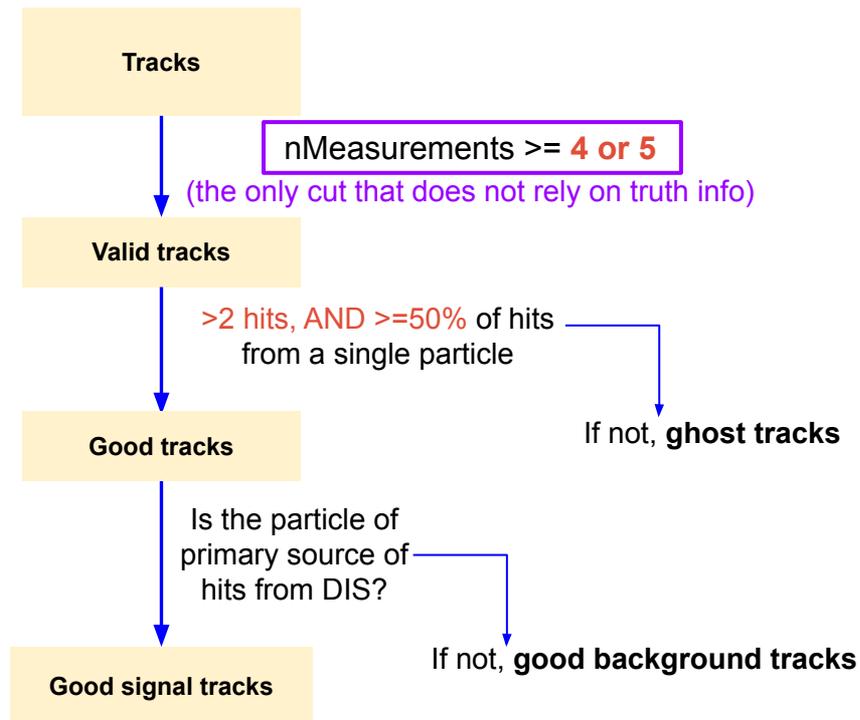
Hit-based Tracking Study Workflow (03.2026)

- Truth info from MC



❖ **Example:** if a particle leaves 3 hits, but track requires 5, then it's counted against efficiency.

- Reconstructed tracks



Tracking efficiency:

good signal particle with a good signal track / good signal particles

Tracking Purity:

good signal tracks / valid tracks

Purity of Track Hits:

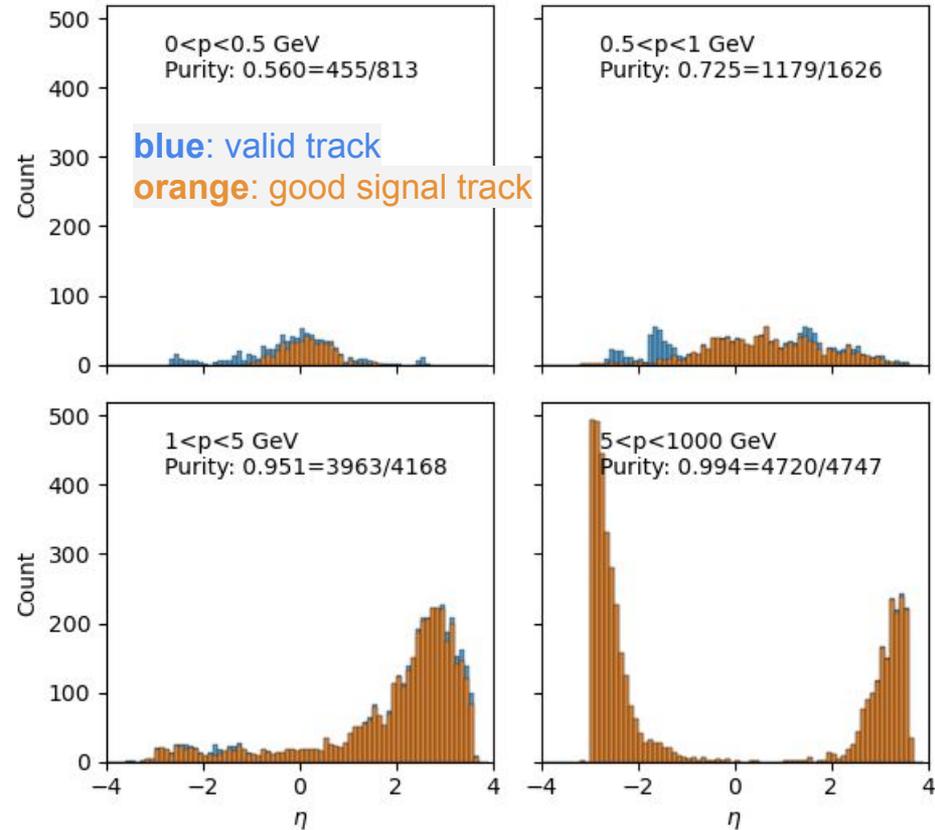
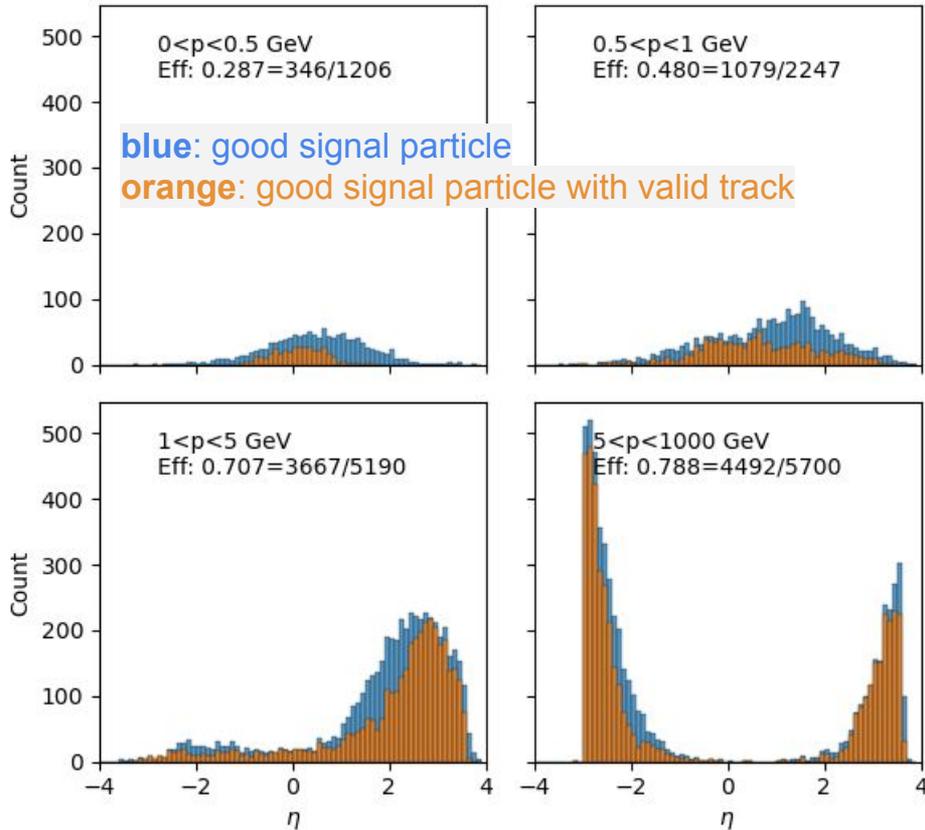
In a given valid track, the fraction of hits from the particle of primary source

Efficiency and Purity:

10x275, 5 μ m gold coating, at least 5 hits per track: low efficiency, high purity

Efficiency (5 hits) | 10x275, 5 μ m | total=0.668 (9584/14343)

Purity (5 hits) | 10x275, 5 μ m | total=0.909 (10317/11354)

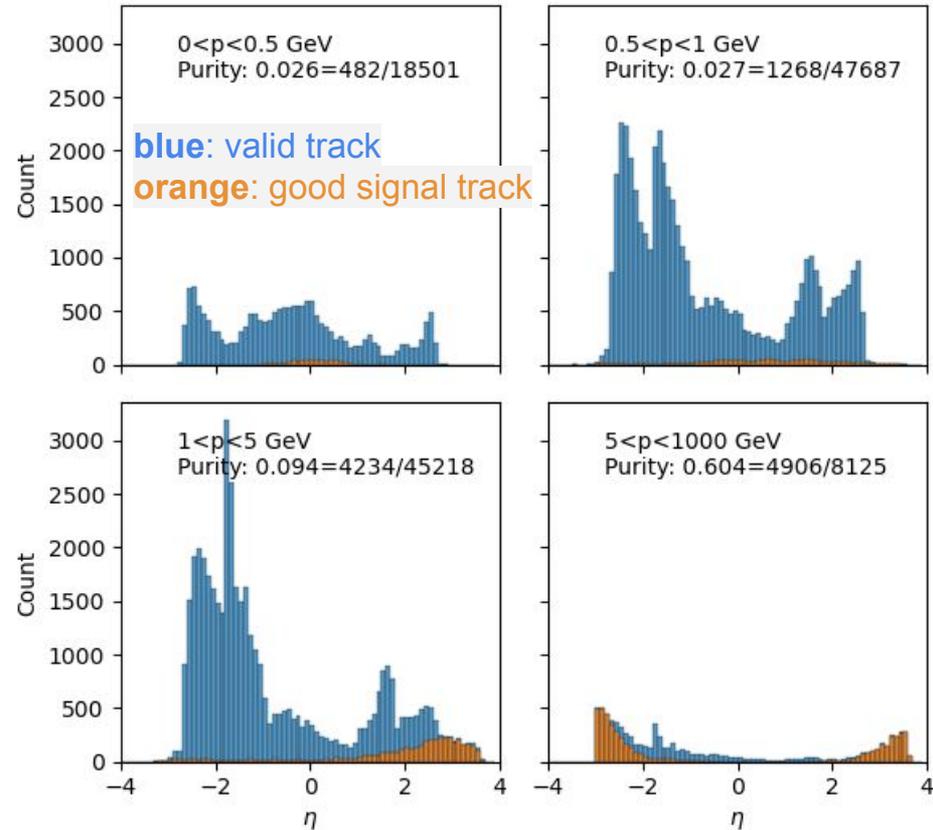
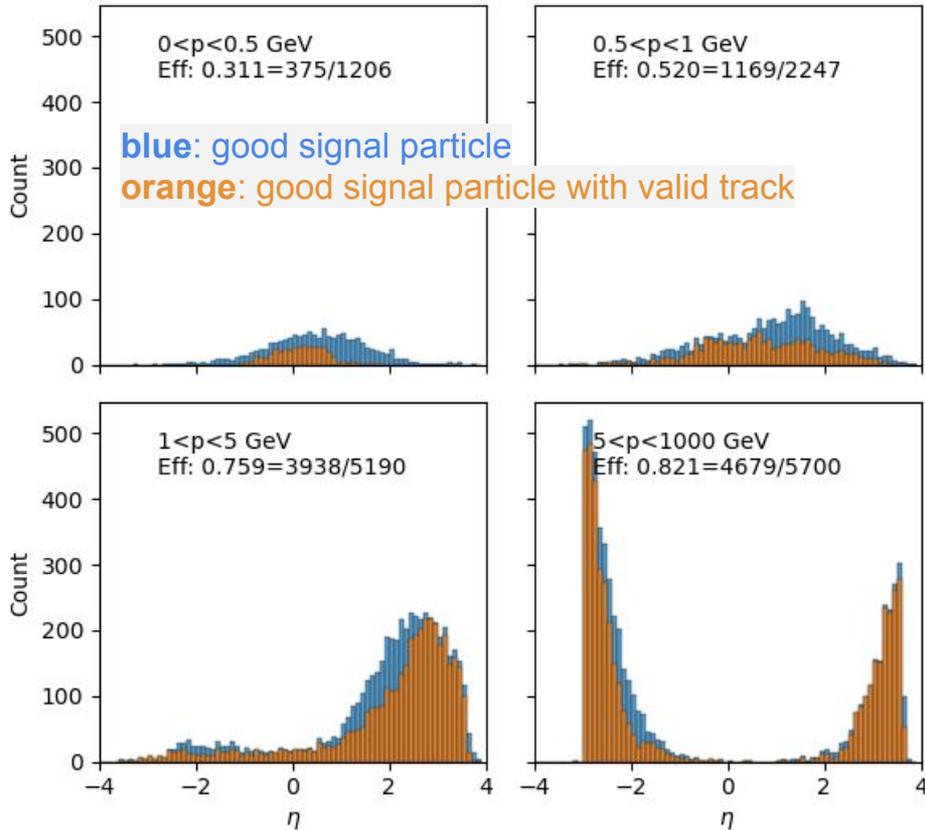


Efficiency and Purity:

10x275, 5 μ m gold coating, at least 4 hits per track: low efficiency, very low purity

Efficiency (4 hits) | 10x275, 5 μ m | total=0.708 (10161/14343)

Purity (4 hits) | 10x275, 5 μ m | total=0.091 (10890/119531)

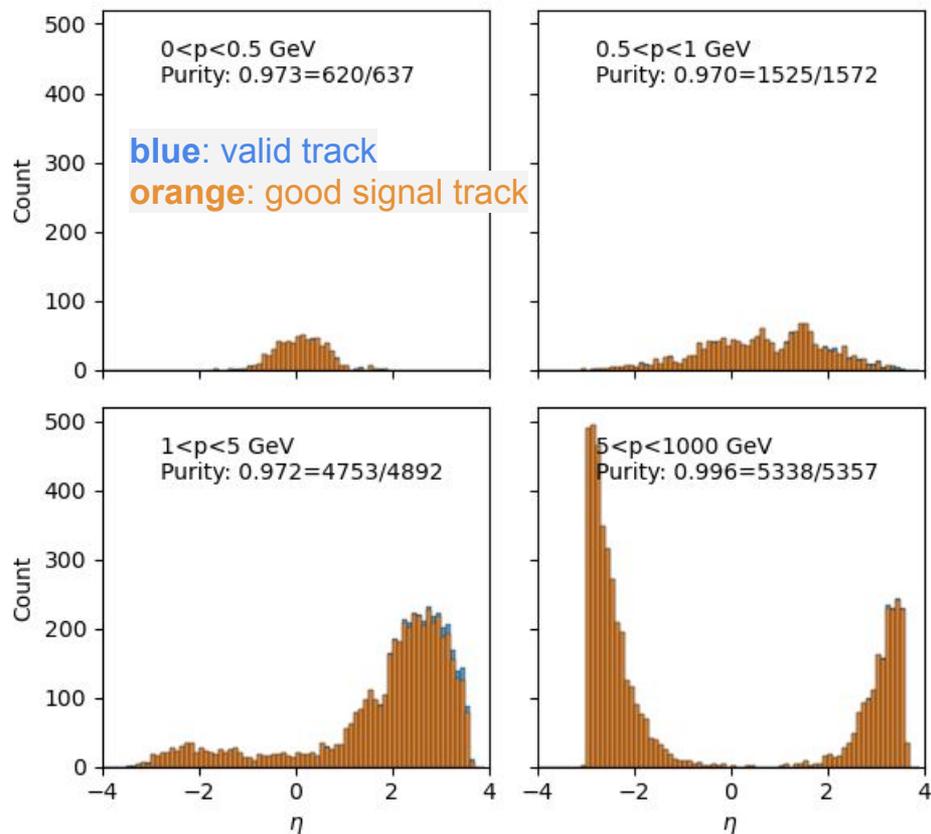
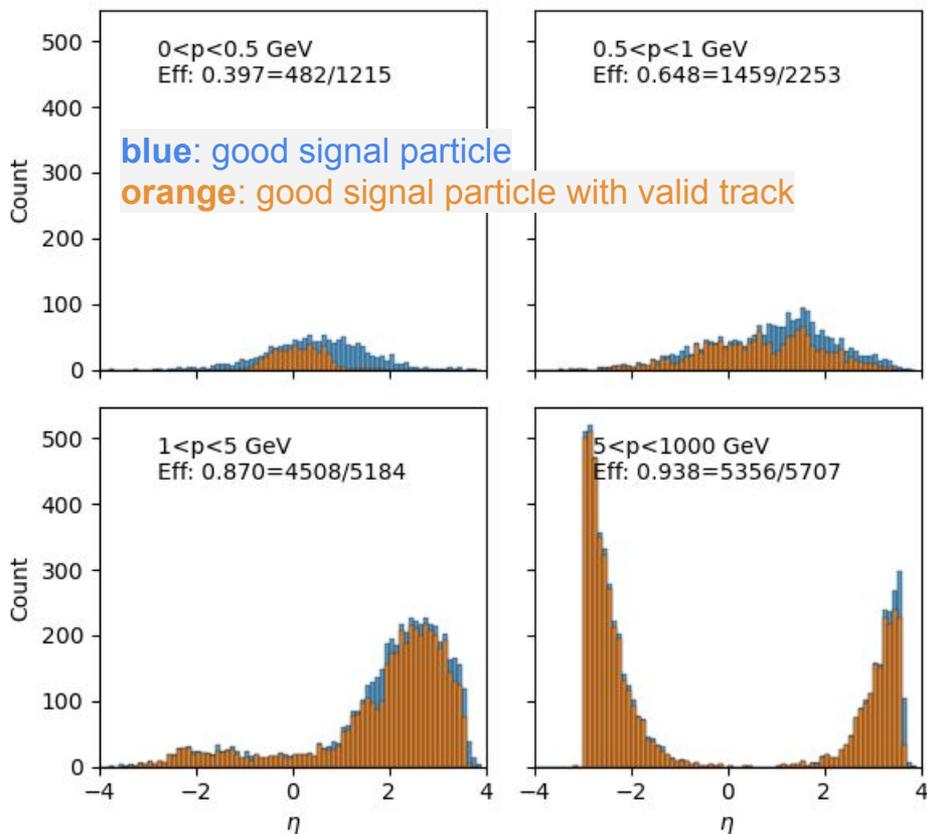


Efficiency and Purity:

10x275, 10 μ m gold coating, at least 5 hits per track: OK efficiency, high purity

Efficiency (5 hits) | 10x275, 10 μ m | total=0.822 (11805/14359)

Purity (5 hits) | 10x275, 10 μ m | total=0.982 (12236/12458)

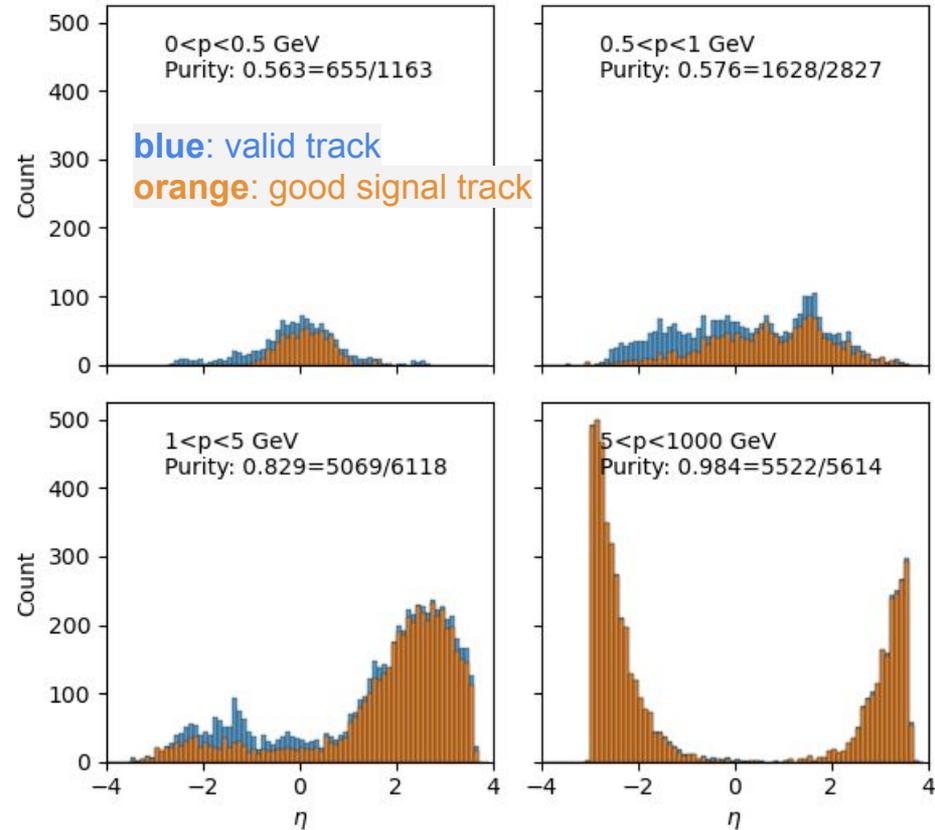
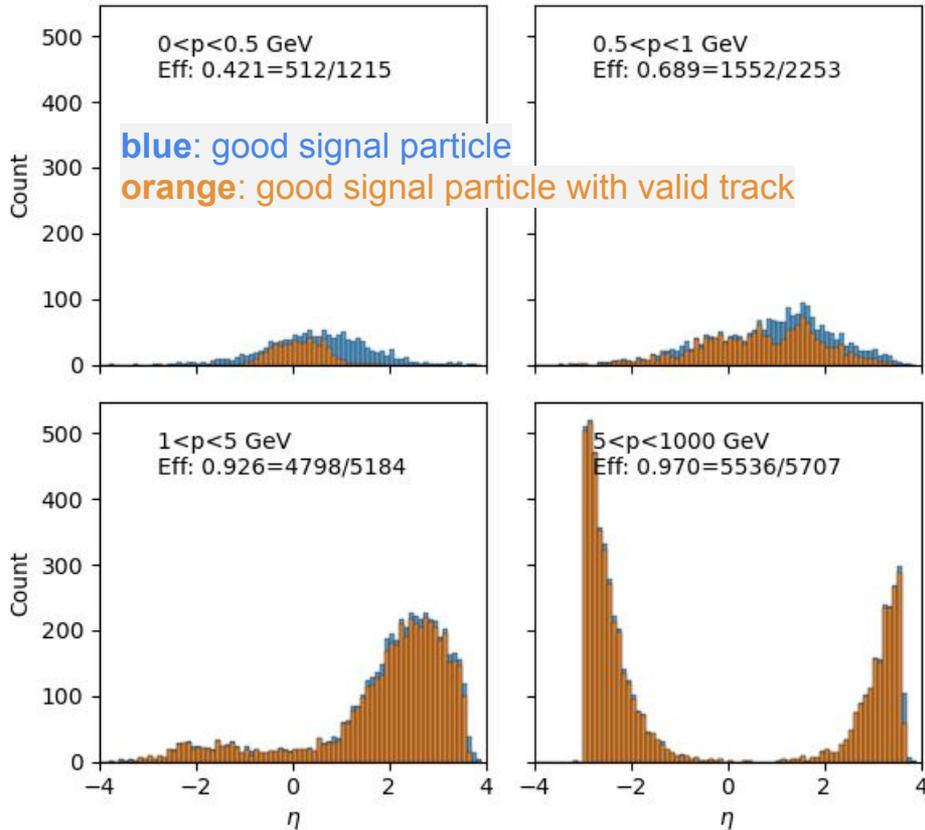


Efficiency and Purity:

10x275, 10 μ m gold coating, at least 4 hits per track: OK efficiency, OK purity

Efficiency (4 hits) | 10x275, 10 μ m | total=0.863 (12398/14359)

Purity (4 hits) | 10x275, 10 μ m | total=0.819 (12874/15722)



Single pi+ study

Goal:

compare the tracking resolutions with 5 vs 10um Au coating

Set up:

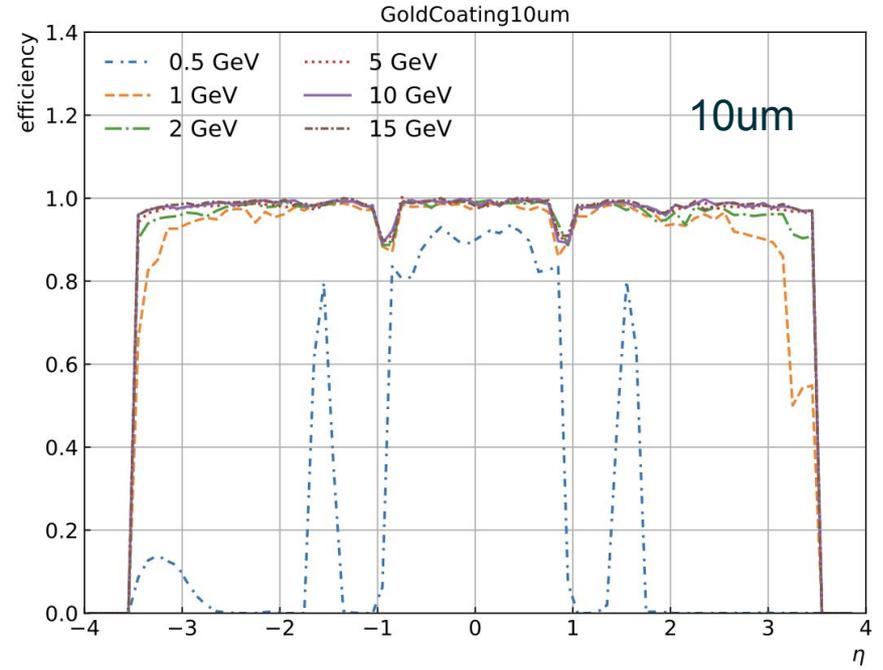
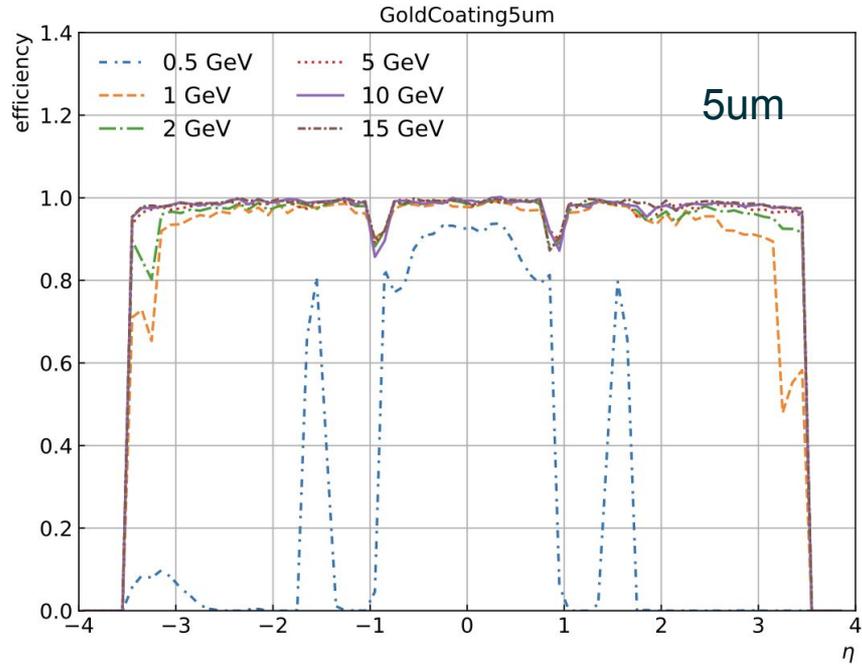
- **eic-shell:** 26.02-stable
- **epic:** commit on Feb 24, 2026

Simulations:

- 7 eta bins, fixed momentum, **uniform in phi and eta**, 10k events / setting
- Beampipe Au coating:
 - default: 5um
 - modified: 10um → updated xml + updated material map
- analysis scripts (efficiency, pull/resolution, chi2, residuals...) available on [github](#)

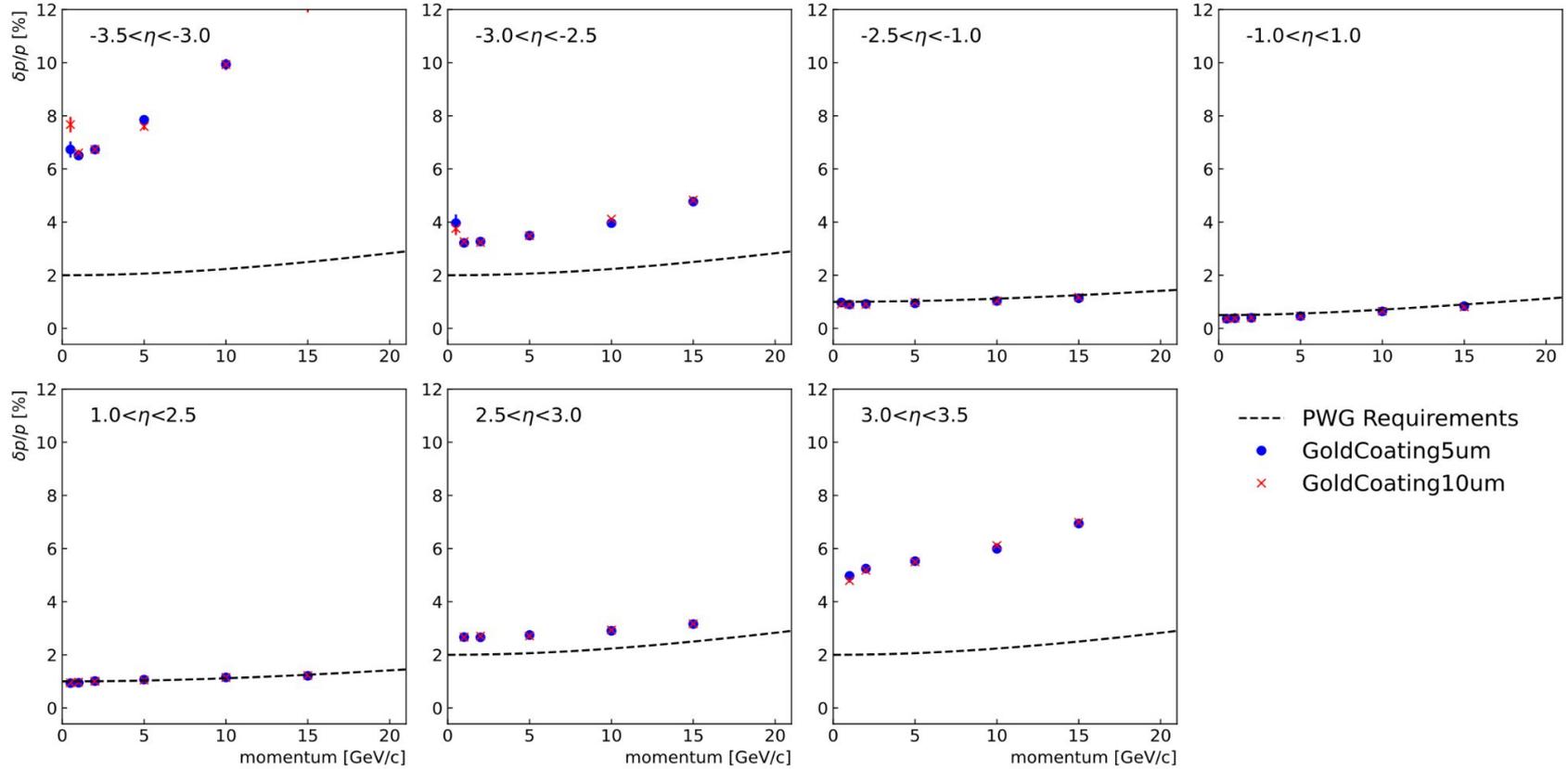
Results

Impact on **Efficiency**: negligible



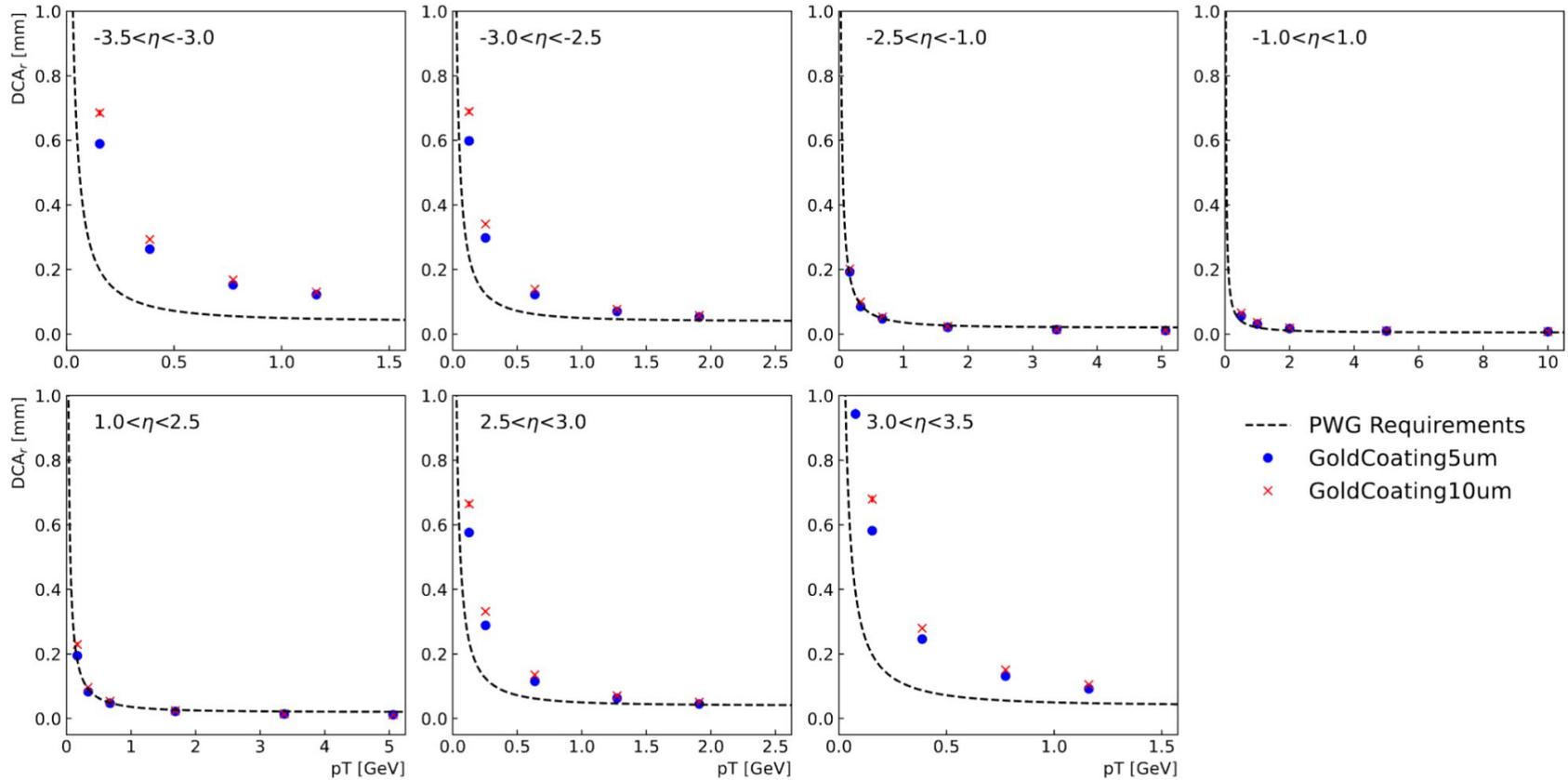
Results

Impact on $d\rho/p$: negligible



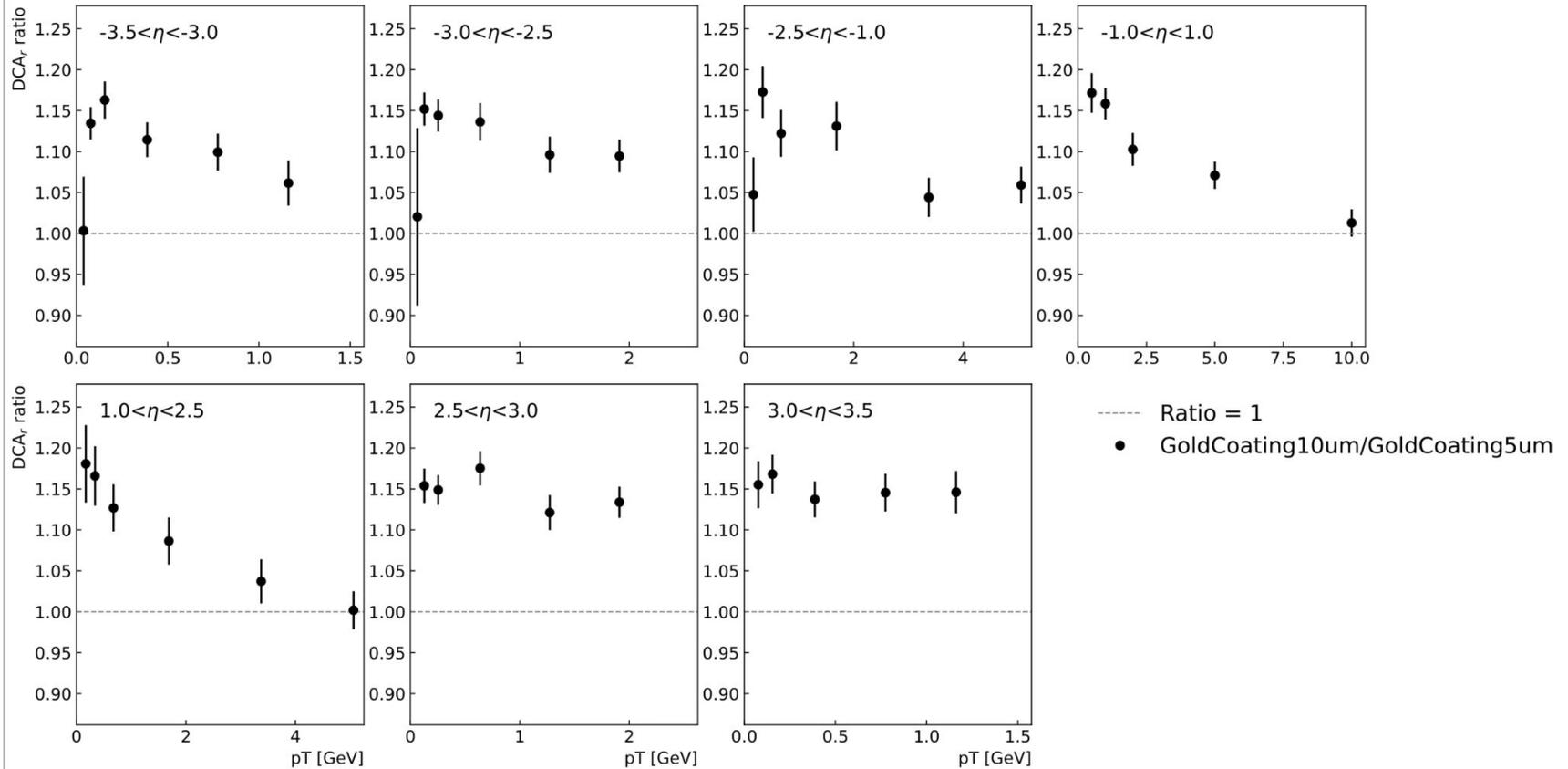
Results

Impact on **DCA_r**: didn't make a qualitative difference wrt requirements



Results

Impact on **DCA_r** (shown in ratio): 0-20%



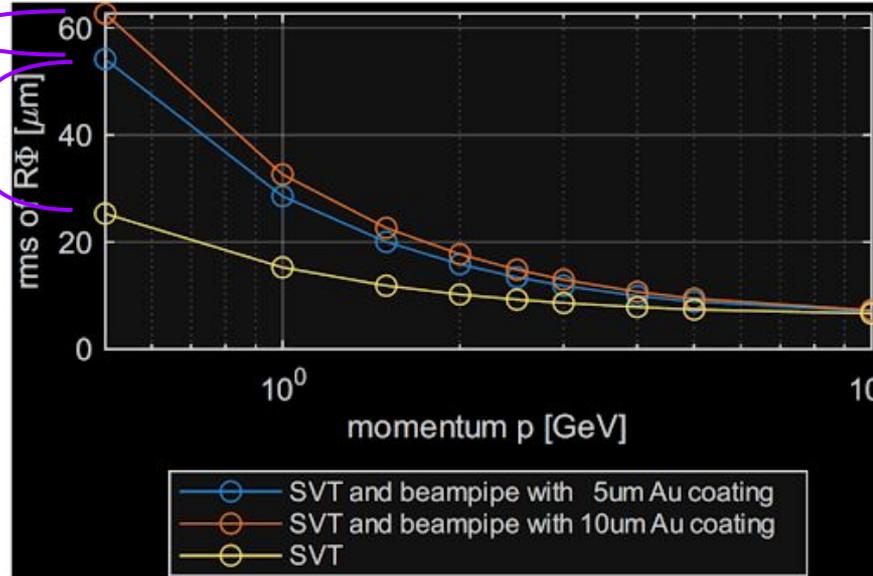
Results

Impact on **DCAr**: consistency check

fast simulation from Ernst at eta=0

effect of the Au coating
change: 5 → 10μm

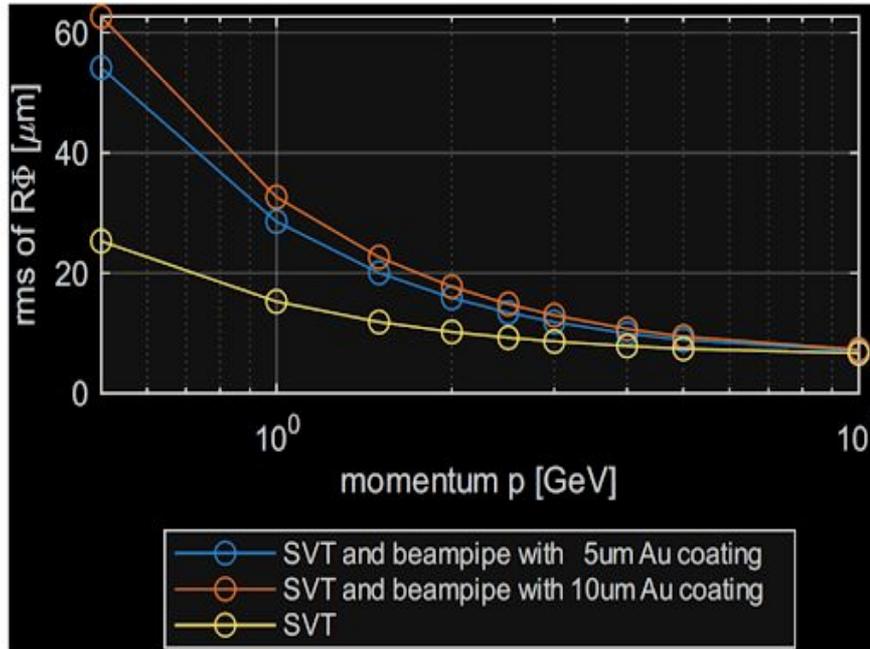
effect of the entire
beampipe



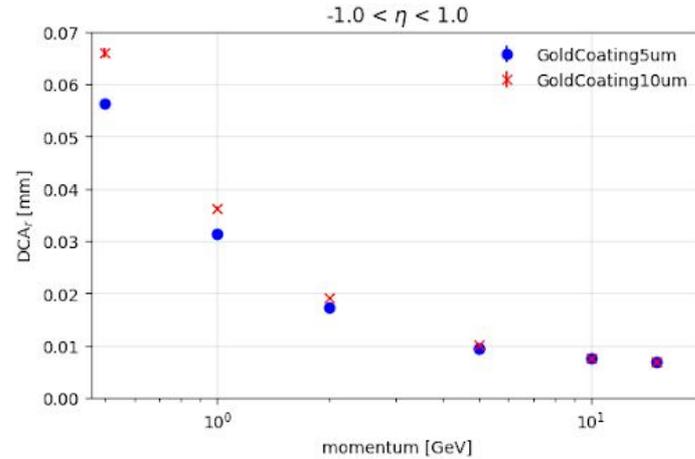
Results

Impact on **DCAr**: consistency check

- fast simulation from Ernst at eta=0

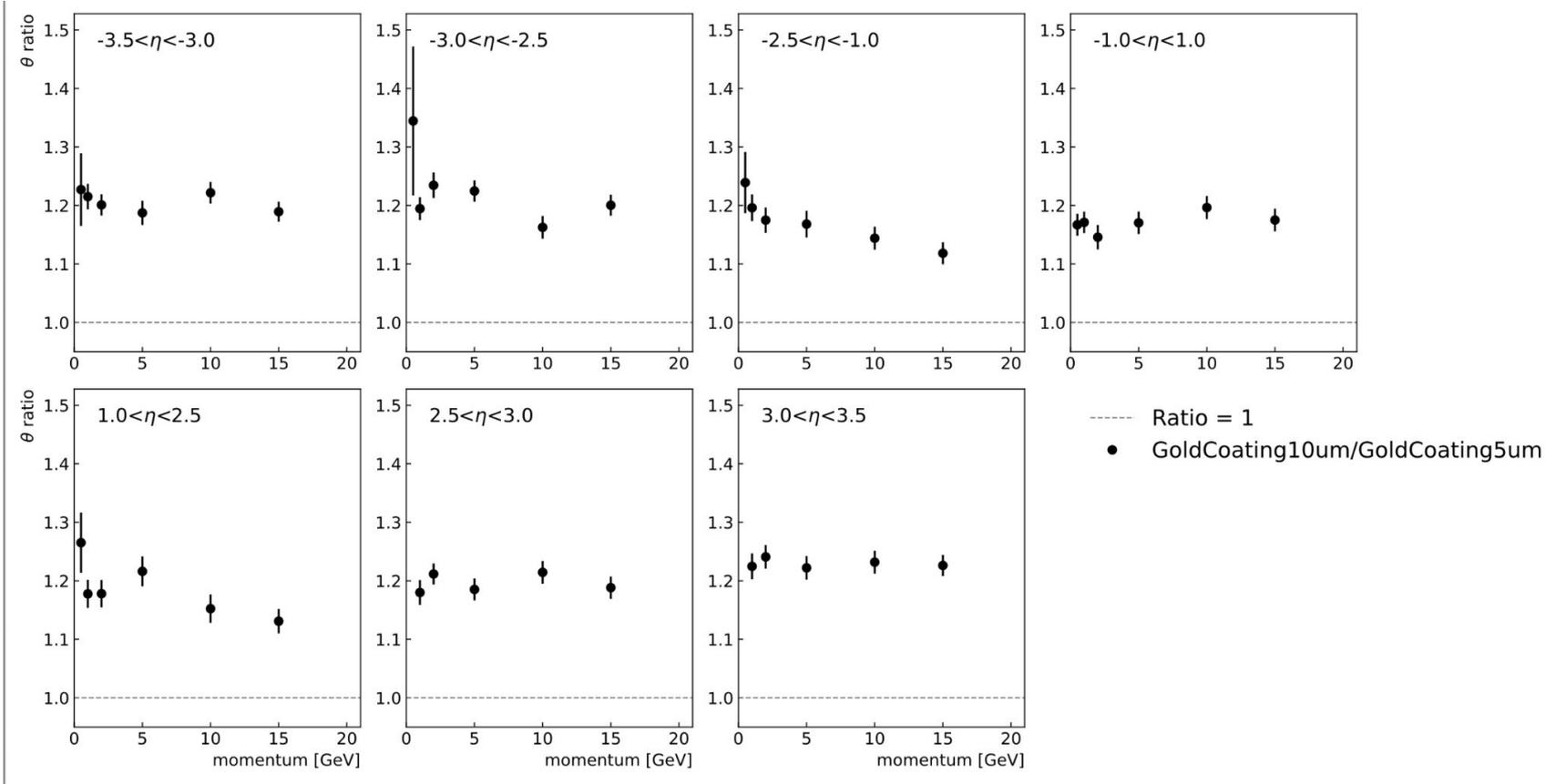


- this work ($-1 < \eta < 1$)



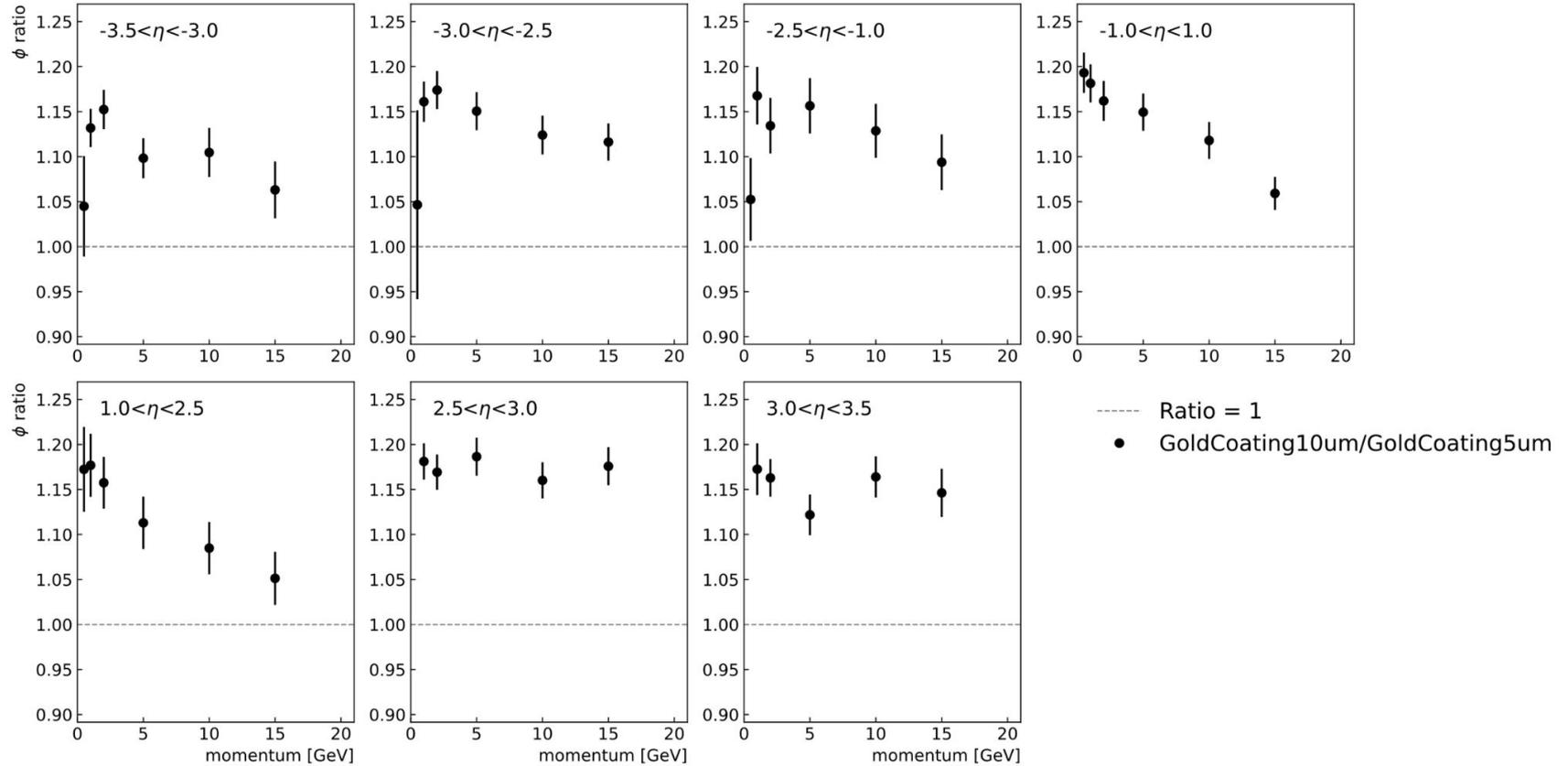
Results

Impact on **theta** (shown in ratio): ~20%



Results

Impact on ϕ (shown in ratio): 5-20%



Summary

5um → 10um gold coating:

- Single particle resolution study:
 - efficiency, dp/p unchanged
 - up to 20% increases in theta, phi, DCAR
- DIS study:
 - vertex resolution: see Barak's talk next

⇒ no obvious show stopper
- DIS+background study:
 - purity and efficiency: big improvement with 4 or 5 hit cut
 - SVT hit rate: factor of 4 reduction

Shall we make 10um official in simulation?