Funding support:

SVT: configuration scenarios and impact evaluations

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for the SVT subsystem collaboration

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General Status and Updates
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UK colleagues have been part of the SVT from the very beginning, and were planning its largest in-kind contribution.

In simplified terms, the UK contribution would have delivered the SVT outer barrel — **L3 and L4**.

Paul Newman described the status of UK in-kind funding: the UK can no longer provide the originally planned contribution on the timescale the project requires.

For planning purposes, the SVT can no longer count on the UK for L3 and L4. Some UK groups expect to stay involved in the SVT through other funding, but this is unlikely to involve detector construction.

The UK funding decisions were not made on scientific merit.

In a funding constrained environment, any response must consider cost. A scenario under study is therefore to **descope or defer L4**, using the material and supply savings **to preserve L3**.   Descoping or deferring one or more disks in the hadron direction may also be necessary to close the gap.

The UK impact is wide-ranging — design and engineering effort, sensor and module expertise, accumulated experience, institutional capacity, and in-kind funds.

The SVT is also growing. Discussions with prospective collaborators are progressing well; the interest is real, significant, and focused on the disks.

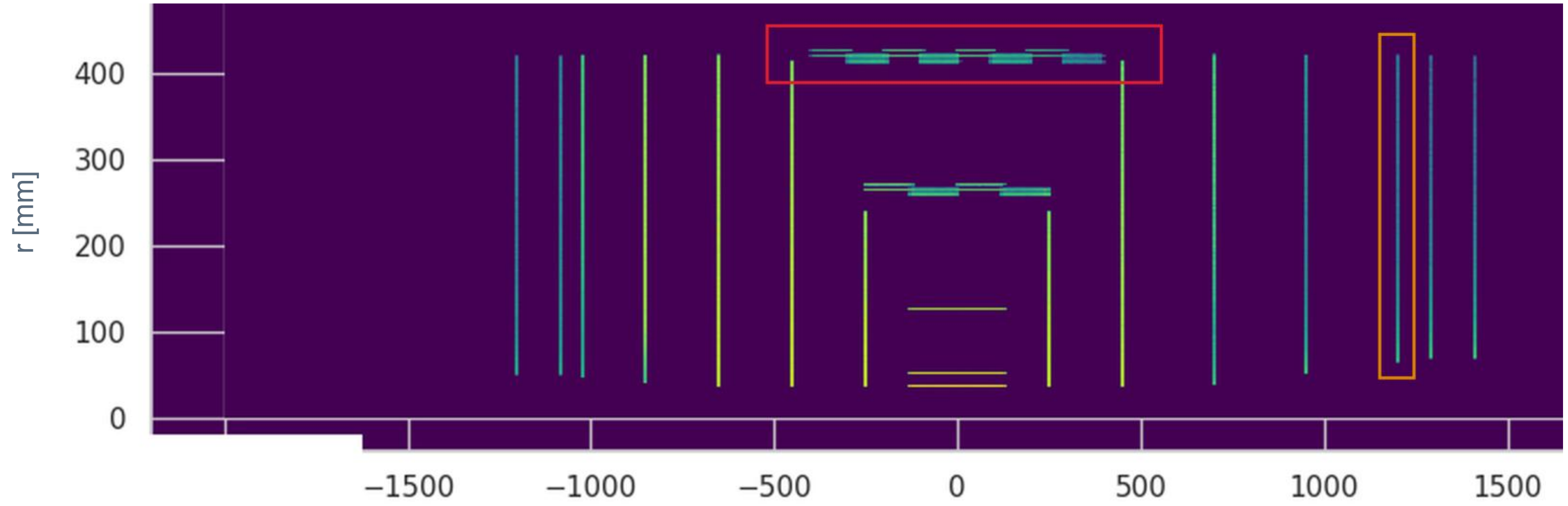
Reorganization of the effort within the SVT is being worked out to cover the effort needed for L3.

Descope or defer: Installing later will require rolling out the detector; the SVT installation sequence is being re-examined so that a later installation of L4 and HD4 need not mean full disassembly and reassembly, and the risks that carries.

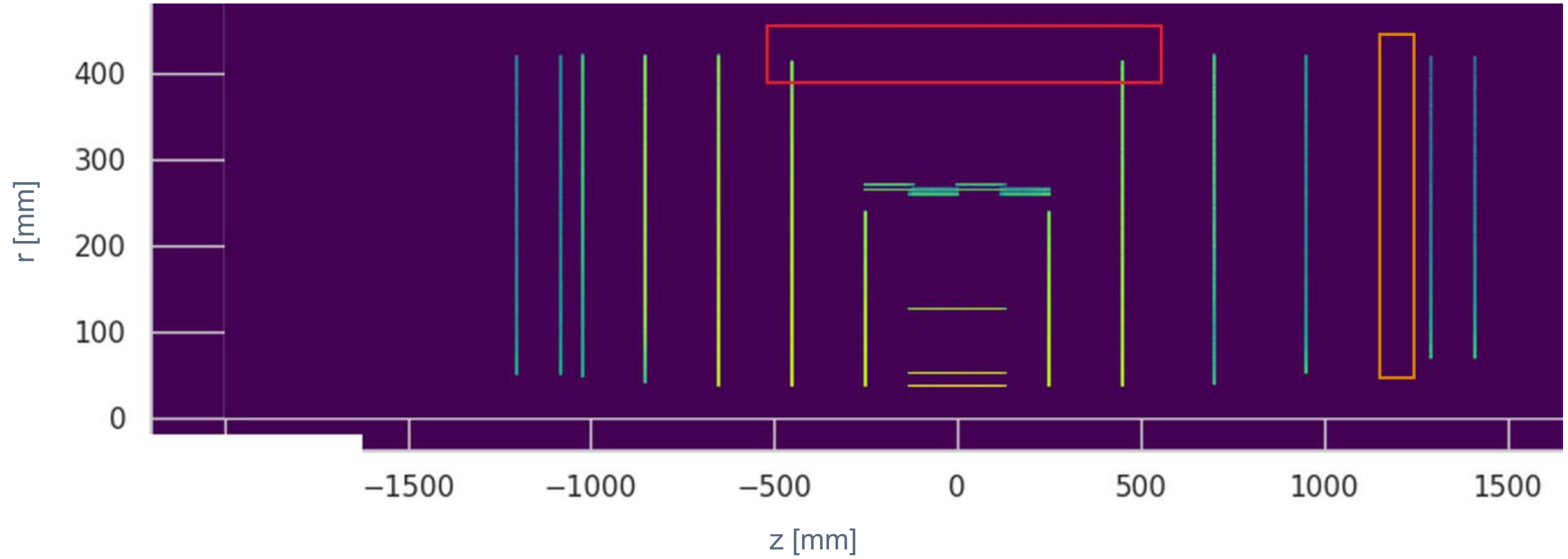
The remainder of this talk asks whether the scenarios make sense from a tracking-performance standpoint. HD4 is the disk case that has been worked through; unlike L4 it is an illustration rather than an optimized choice.

Simulated hit-maps and acceptances

epic (baseline)



no_L4_HD4 (defer or descope)



L4 outermost SVT barrel

r ≈ 42 cm, |z| ≲ 45 cm

→ |η| ≲ 0.9

HD4 hadron-side disk 4

z ≈ +120 cm, r ≈ 6–42 cm

→ 1.8 ≲ η ≲ 3.7

The acceptances do not overlap,

|η| < 1 → impact from L4 only

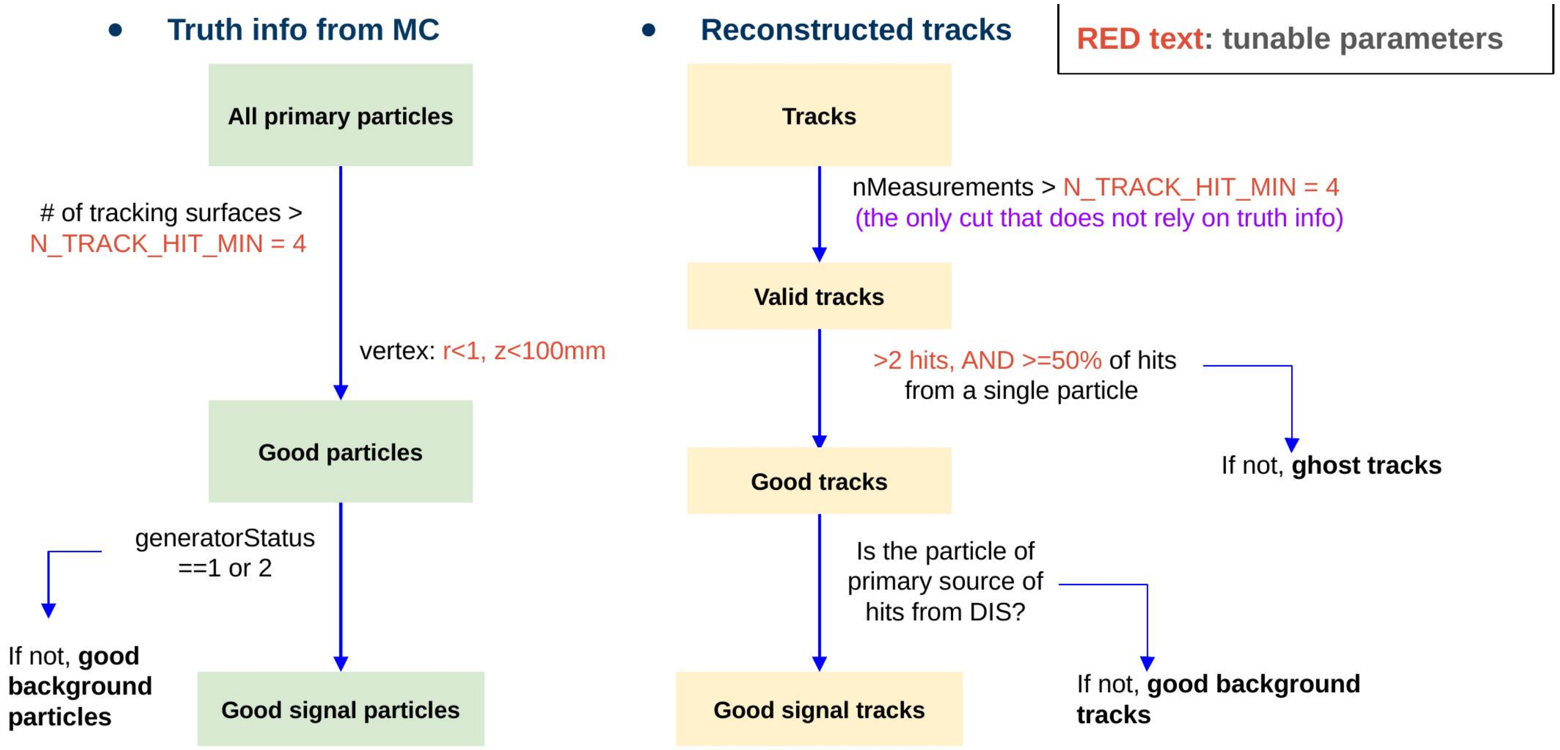
outside |η| < 1 → impact from HD4 only

single simulation, separate decisions.

Staves and disks were removed, whereas services were kept in these simulations. Tracking was not re-tuned for the reduced geometry. The reconstruction is the one optimised for the full detector.

SVT region of the central-tracker hit map, 10×275 forced DIS + background. Simulations by Shujie Li, using NERSC.

Simulated efficiency and purity defined



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 is conditional.

“Good particles” require more than four tracking surfaces — **in the geometry being tested**. A particle that falls below four surfaces leaves the denominator rather than counting as a loss.

So two effects are in play:

- **acceptance** — the particle is no longer findable at all, and leaves the denominator
- **reconstruction** — still findable, but found less often

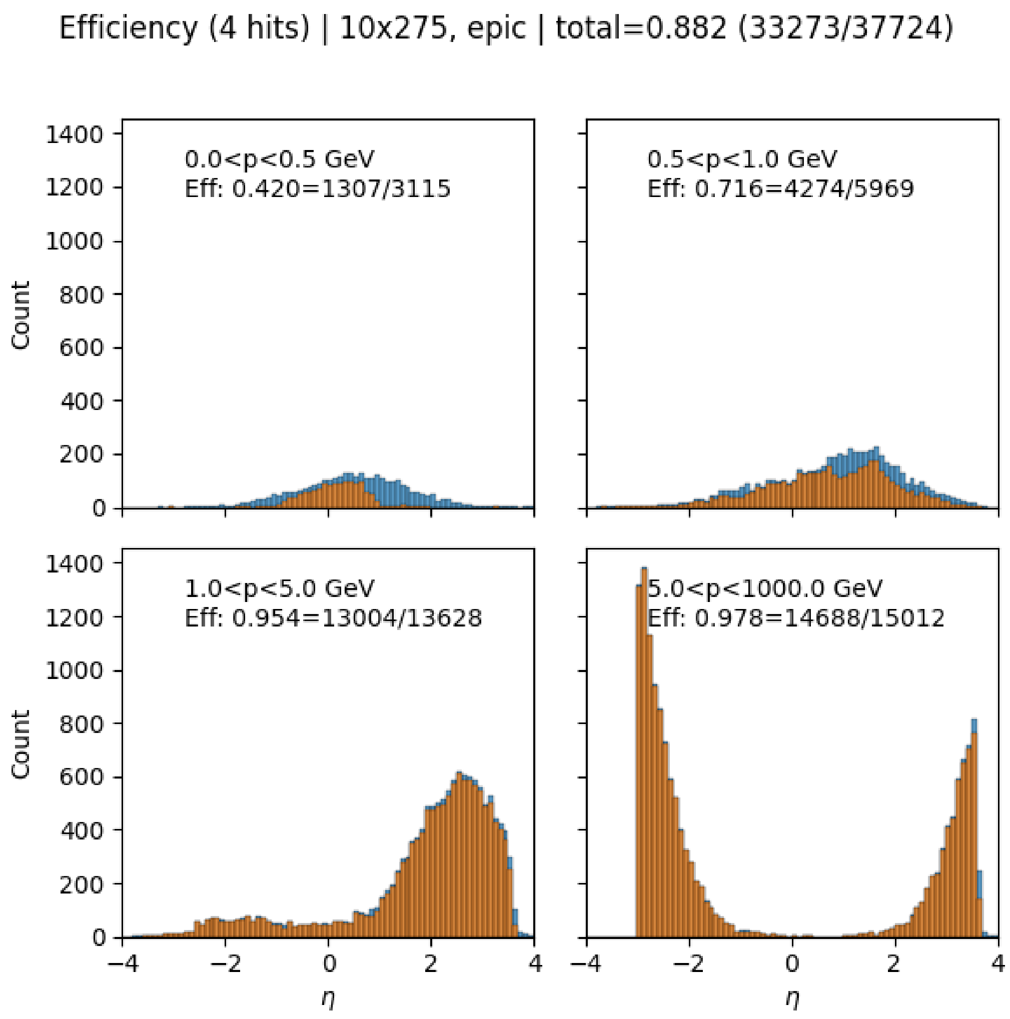
Efficiency reports only the second.

Counting tracks reports both, and is how the loss is quantified on slide 9.

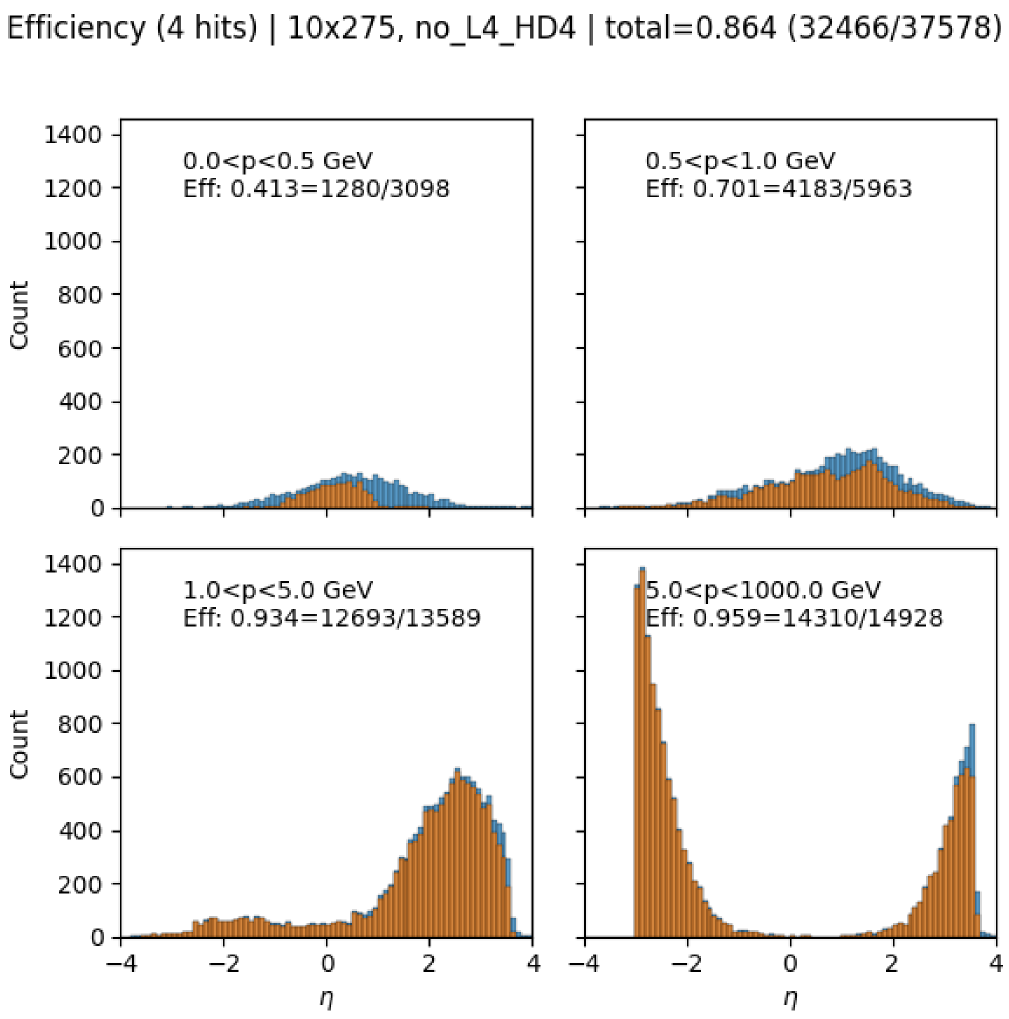
Truth-side and reconstruction-side chains, with the definitions of efficiency and purity used throughout.

Simulated track-finding efficiency

epic



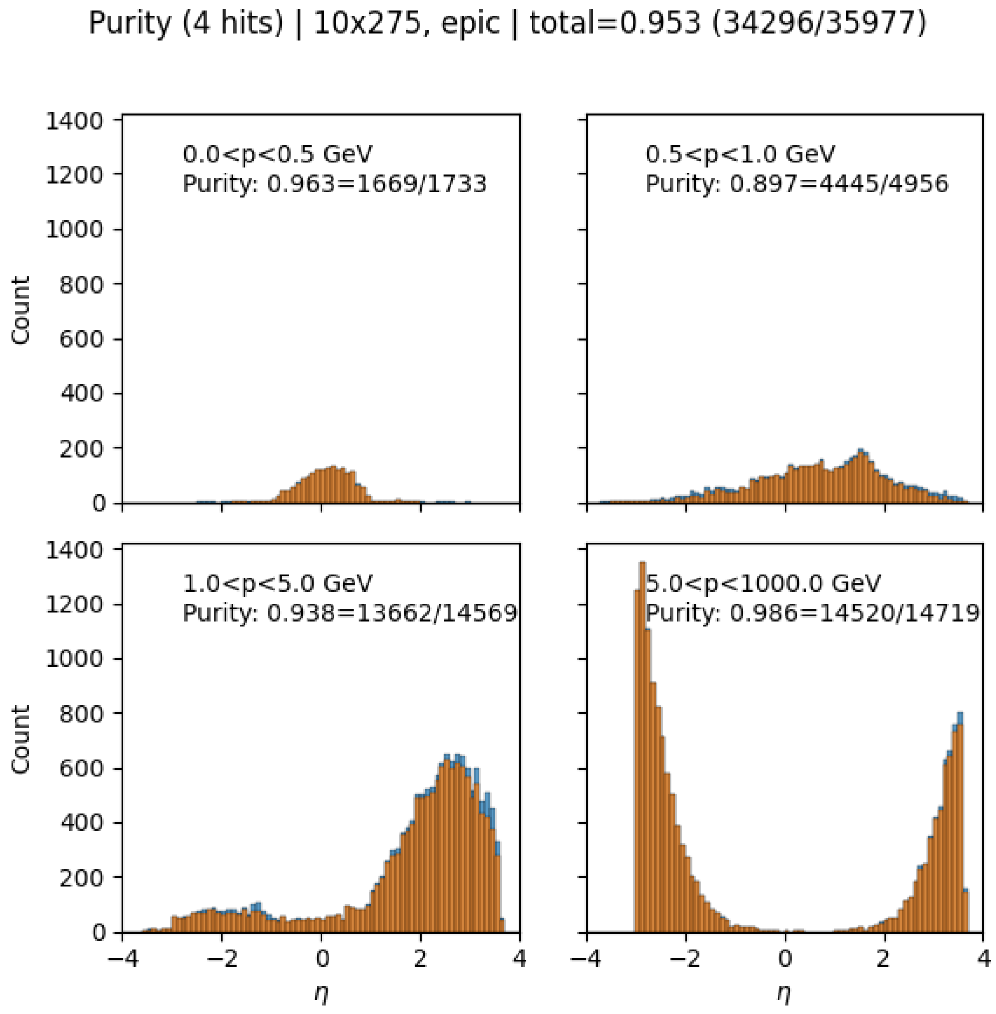
no_L4_HD4



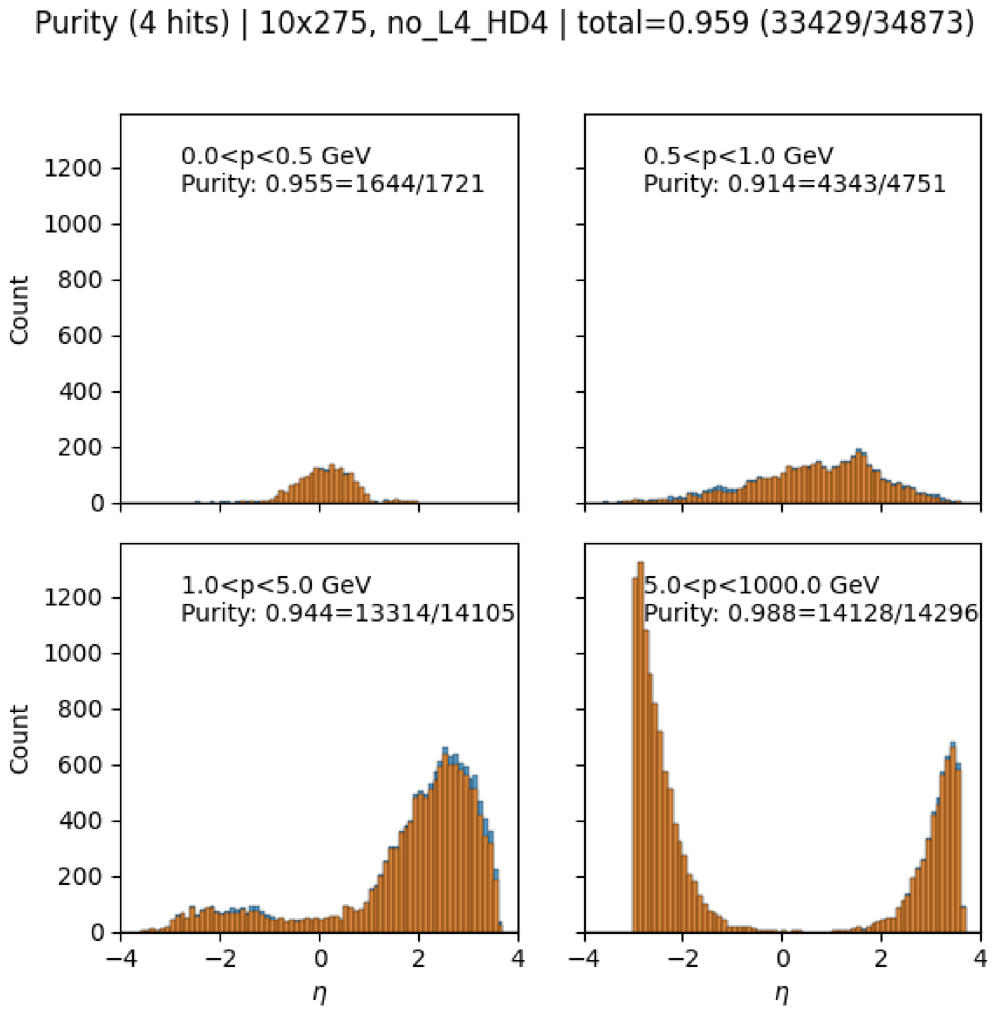
Full simulation, 10×275 forced DIS + background, no noise. Blue = good signal particles; orange = those with a good signal track.

Simulated purity of reconstructed tracks

epic

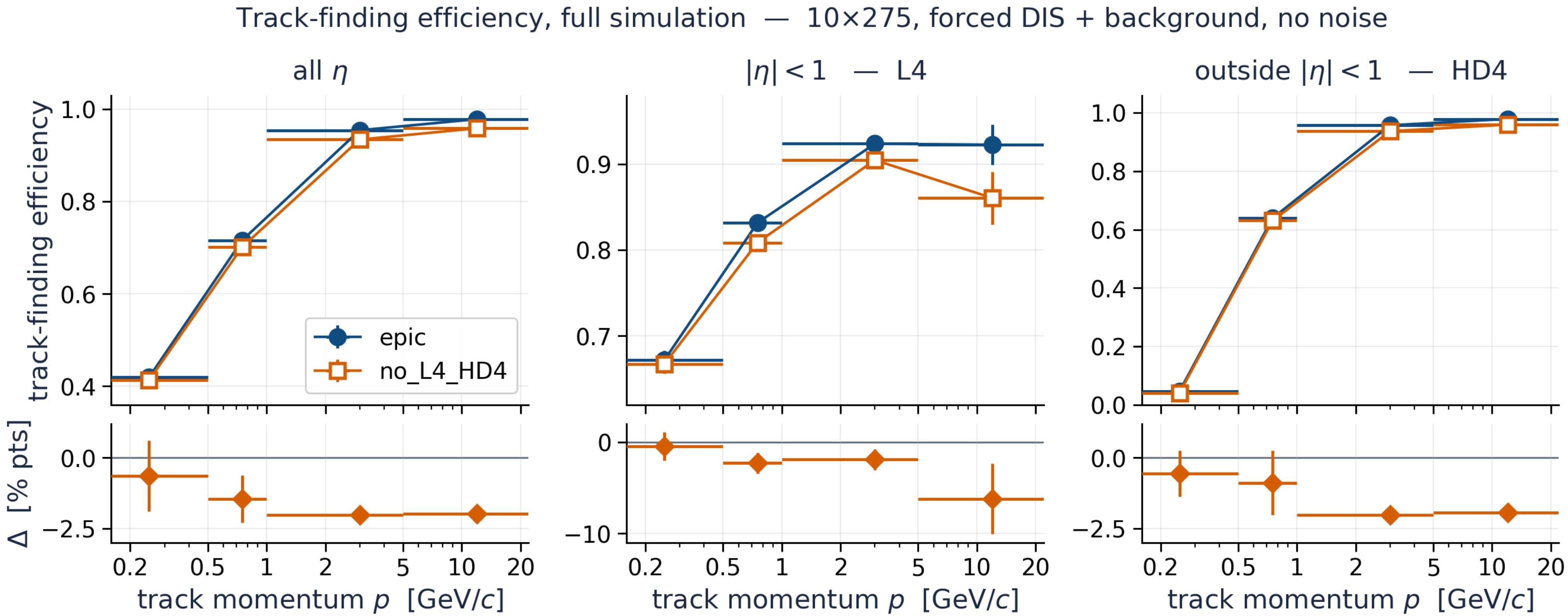


no_L4_HD4



Same samples. Blue = all valid tracks; orange = good signal tracks. Purity = good signal tracks / valid tracks.

Simulated efficiency summary — by region, so both components are visible

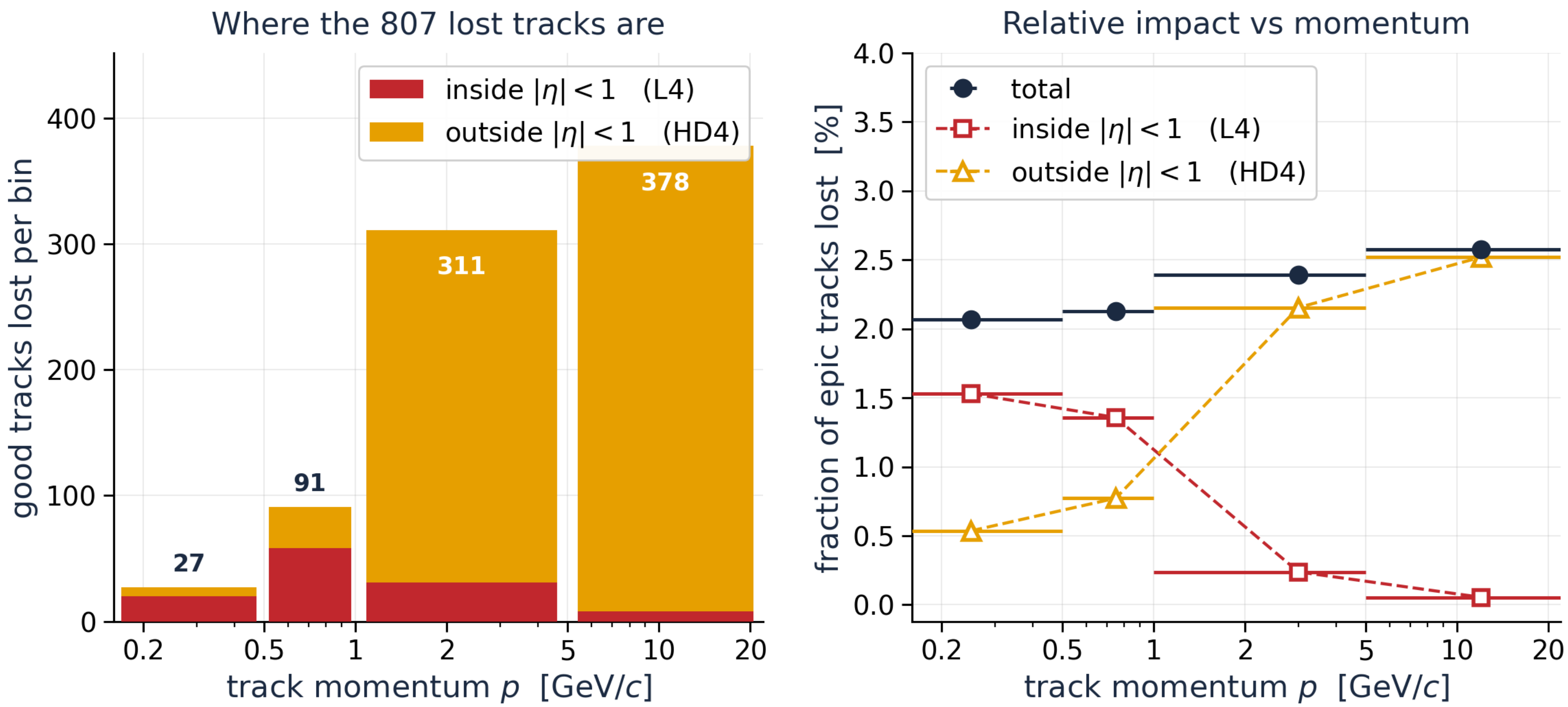


Horizontal bars = bin extent; markers at the bin centre. Lowest bin reaches $p = 0$, highest is unbounded (drawn at 12 GeV/c). Δ = no_L4_HD4 − epic; errors binomial.

Same full simulation. Left: all η. Centre: |η| < 1, the L4 acceptance. Right: outside |η| < 1, which contains HD4.

Simulated track losses – acceptance

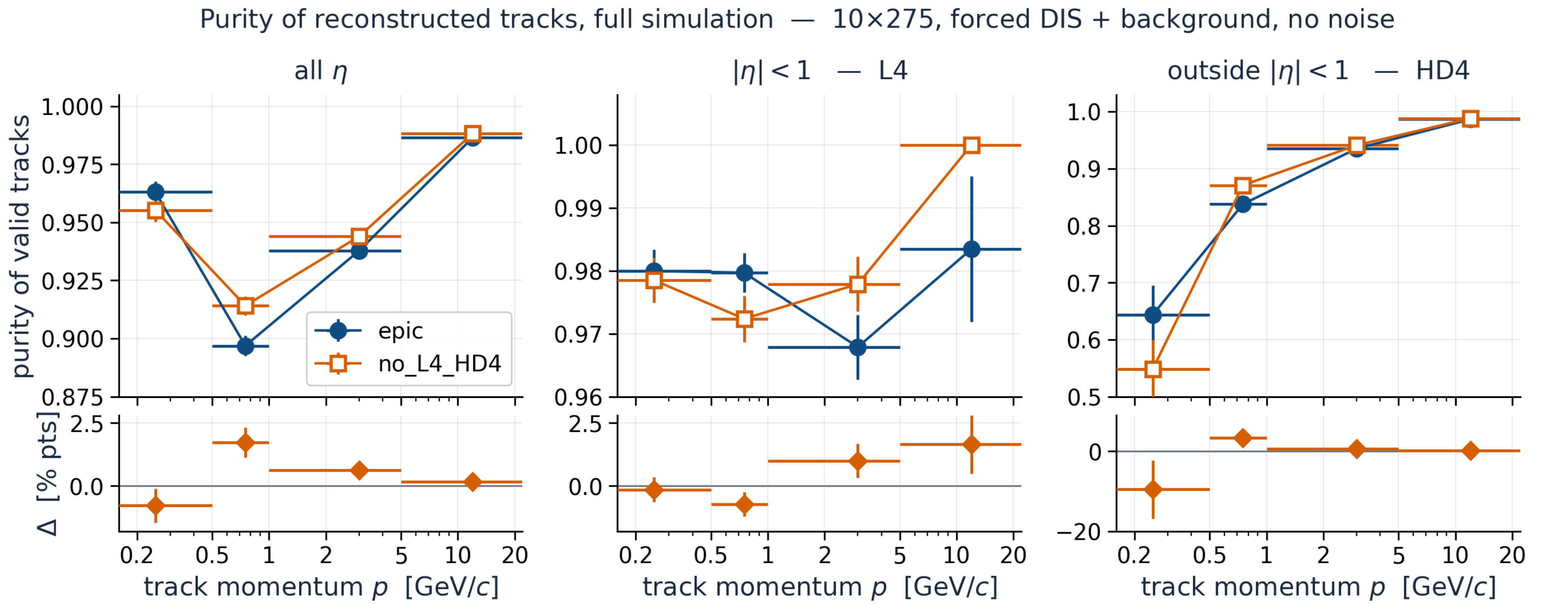
Decomposition of the efficiency loss by acceptance — full simulation, no noise



L4 covers $|\eta| \lesssim 0.9$ and HD4 $1.8 \lesssim \eta \lesssim 3.7$, so the two η slices separate them. 690 of the 807 lost tracks (85%) lie outside $|\eta| < 1$.

Same full simulation. Loss split by the two disjoint acceptances of slide 4. Counts include both acceptance and reconstruction effects.

Simulated purity of reconstructed tracks — by region

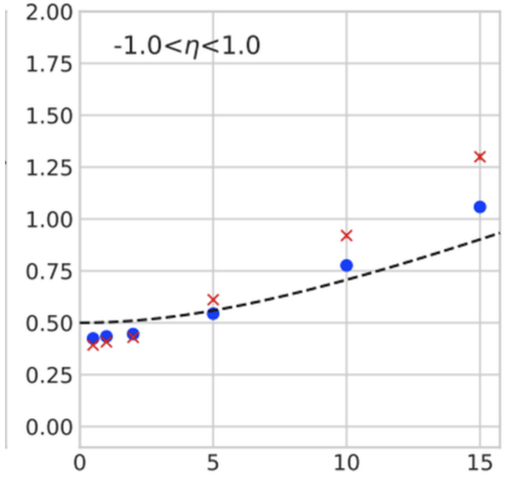


Horizontal bars = bin extent; markers at the bin centre. Lowest bin reaches $p = 0$, highest is unbounded (drawn at 12 GeV/c). Δ = no_L4_HD4 − epic; errors binomial.

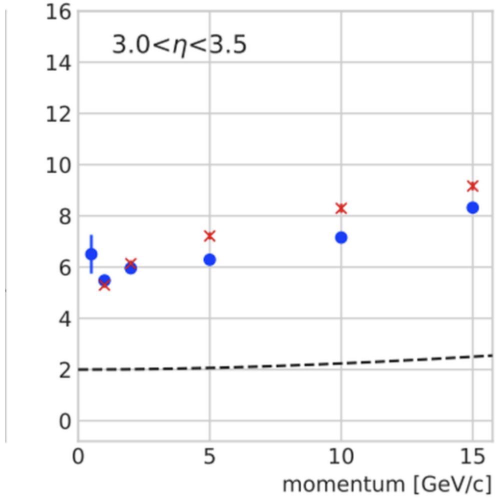
Purity is unchanged within the sensitivity of this study. Pure tracks are still found with the deferred or descoped SVT configurations in current simulations including backgrounds.

Same full simulation, no sensor noise. Same three regions and the same construction as slide 8.

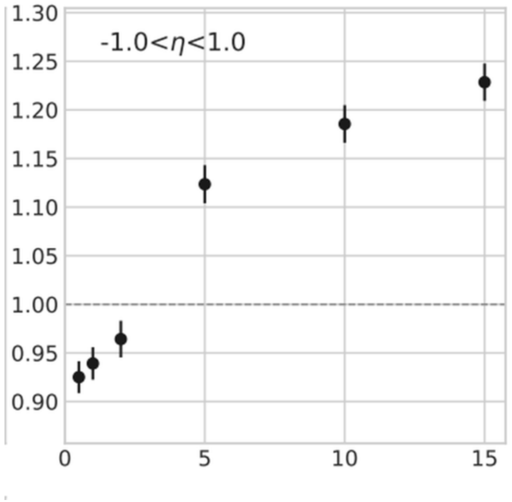
Momentum resolution



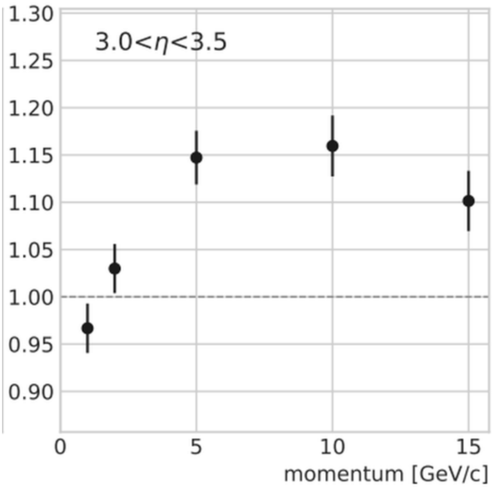
δp/p [%], |η| < 1



δp/p [%], 3.0 < η < 3.5



δp/p ratio, |η| < 1



δp/p ratio, 3.0 < η < 3.5

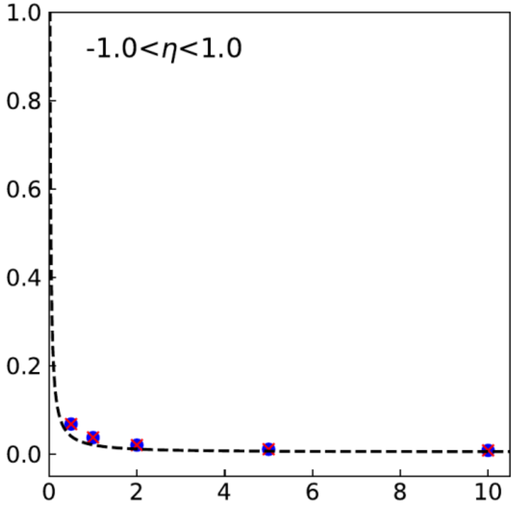
L4: δp/p rises with momentum centrally, reaching ≈ +23% at 15 GeV/c; below 2 GeV/c it improves by 4–8%, where one less layer of material helps. Both geometries meet the requirement to ≈ 5 GeV/c; at 15 GeV/c the reduced geometry sits ≈ 20% above the line.

HD4: δp/p +10 to +21% above 5 GeV/c forward. In that region **the baseline itself misses the requirement irrespective of HD4 descoping/deferment**.

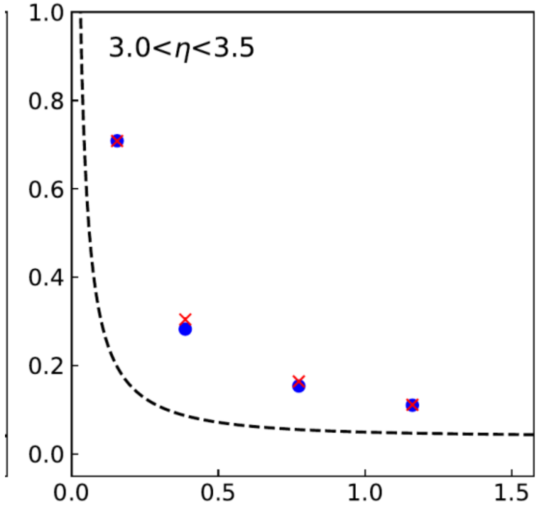
Angular resolution at the vertex is unaffected: the θ and φ ratios are flat within the ±3–5% scatter seen in η regions where nothing was removed (backup, slides 15–16).

Single π^+, no background, no noise.   Left: absolute, against the PWG requirement (dashed).   Right: ratio no_L4_HD4 / epic.

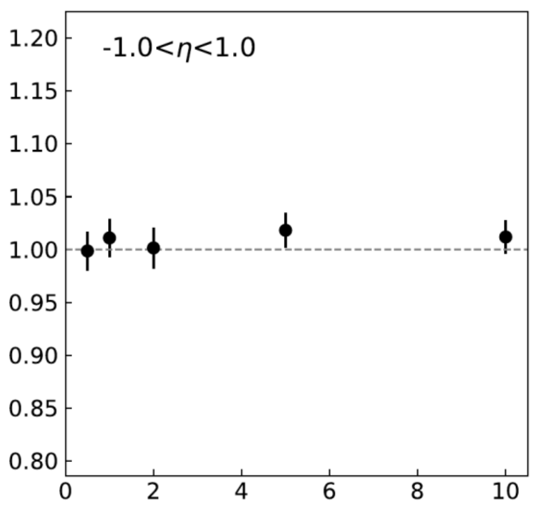
Impact-parameter resolution



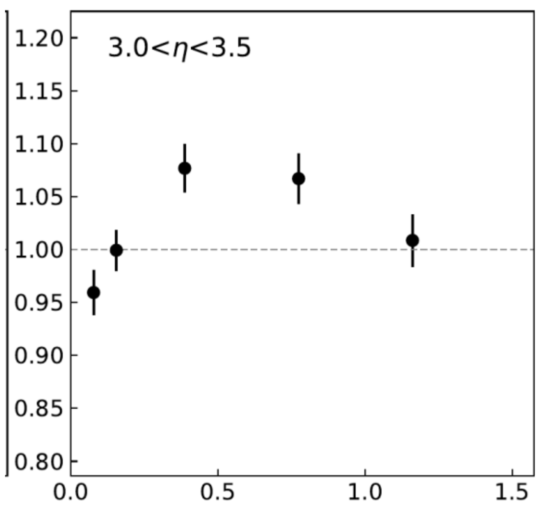
DCA$_r$ [mm], |η| < 1



DCA$_r$ [mm], 3.0 < η < 3.5



DCA$_r$ ratio, |η| < 1



DCA$_r$ ratio, 3.0 < η < 3.5

L4: DCA$_r$ is flat to ≤ 2% at every p_t, over the full range from 0.1 to 10 GeV/c. Impact-parameter resolution is set by the innermost layers and the first lever arm, not by the outermost barrel.

HD4: a 3–8% degradation forward, somewhat beyond the ±5% scatter seen in η regions where nothing was removed. Both geometries sit above the requirement curve there, as they do in the baseline.

Note: this is single-track impact parameter, not vertexing.

Single π^+, no background, no noise. Left: absolute, against the PWG requirement (dashed). Right: ratio no_L4_HD4 / epic. Same construction as slide 11.

Summary

The simulation studies find no show-stopper within what they address:

L4 $|\eta| \lesssim 0.9$

- Momentum resolution degraded — up to ≈ +23% at 15 GeV/c
- Modest acceptance loss concentrated at low momenta
- Purity unchanged
- Impact-parameter resolution, DCA_r, preserved
- Angular resolution at the vertex unchanged

HD4 $1.8 \lesssim \eta \lesssim 3.7$

- Momentum resolution degraded by +10 to +21% above 5 GeV/c
- Sizable acceptance loss concentrated at high η and high p
- Purity unchanged
- Impact-parameter resolution, DCA_r, preserved to within ~8%
- Angular resolution at the vertex unchanged to within ~10%

The simulations do not address: track projection into the outer PID subsystems; an end-to-end assessment of any physics measurement; optimized reconfiguration of the hadron disk array; re-tuning of the reconstruction for the alternate geometry.

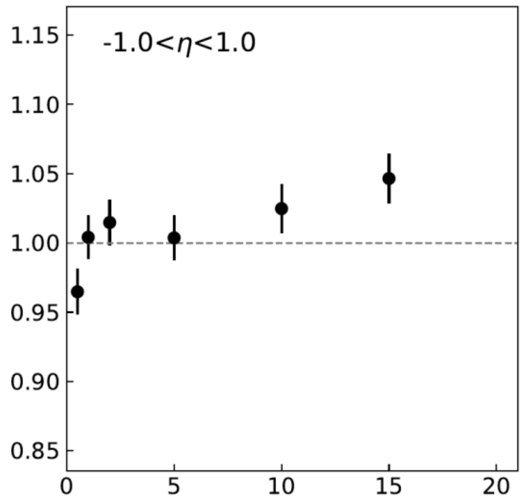
Reorganization of effort within the SVT to preserve L3 appears possible, and discussions with prospective collaborators are progressing well.

Taking either or both of these scenarios further will require a concerted effort across the SVT DSC, the tracking working group and the physics working groups.
These results are intended to be a starting point for discussion, not a conclusion.

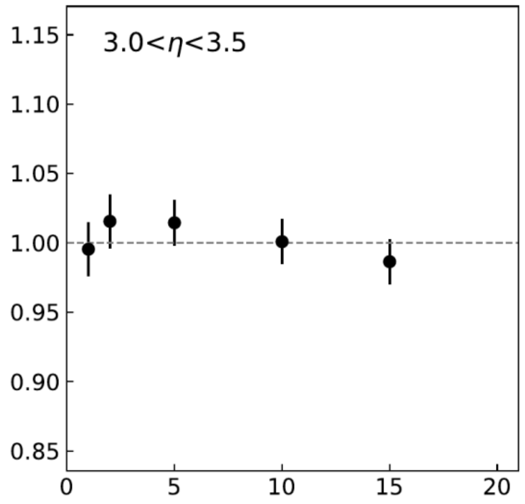
Backup

Backup — angular resolution at the vertex, ratios

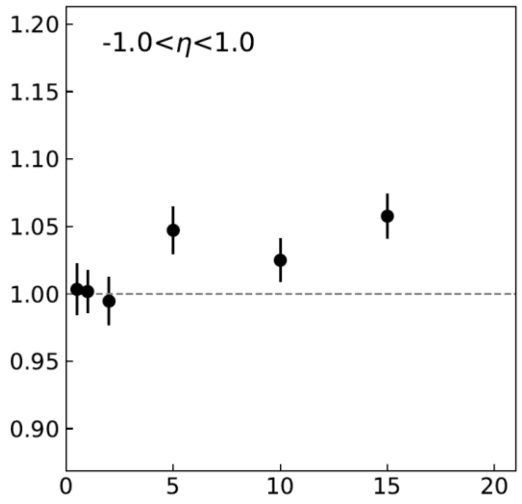
Ratio no_L4_HD4 / epic, single π^+, no background, no noise.   Dashed line = no change.   Source: S. Li, “L4 and HD4 Impact Study”, 08/2026.



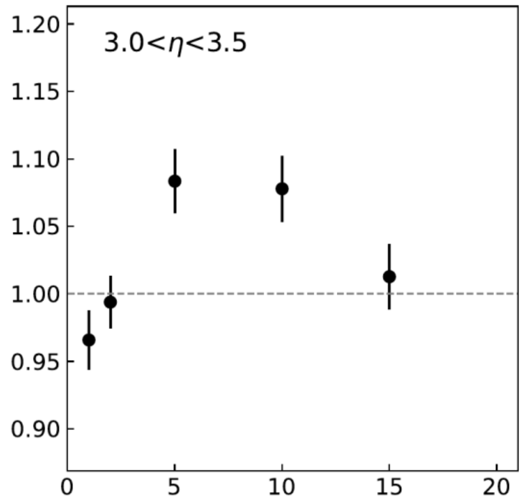
θ ratio, |η| < 1



θ ratio, 3.0 < η < 3.5



φ ratio, |η| < 1

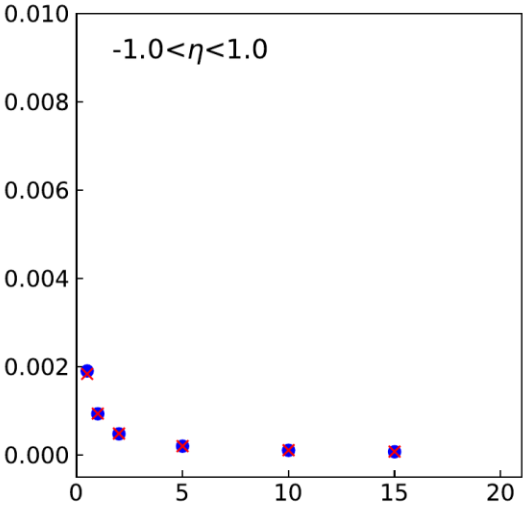


φ ratio, 3.0 < η < 3.5

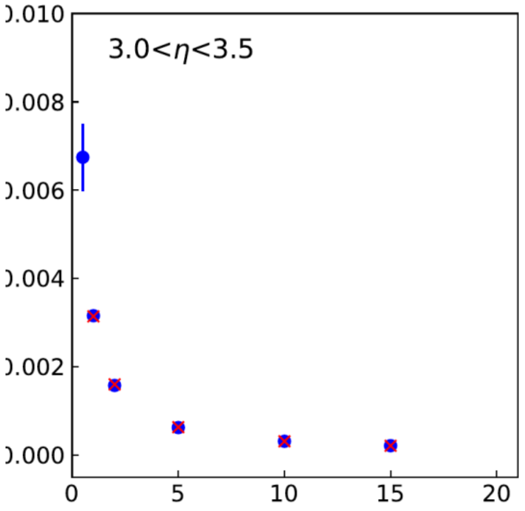
Angular resolution at the vertex is unaffected. The θ and φ ratios scatter within the same band seen in the η regions where neither component was removed — within about 5% centrally and about 10% forward. **This is the resolution at the point of closest approach;** track projection and matching into the outer PID subsystems is a separate question, and is not evaluated here.

Backup — angular resolution at the vertex, absolute

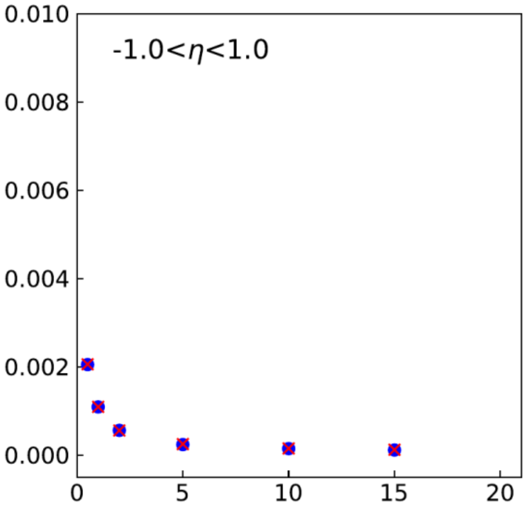
Single π^+, no background, no noise.   Blue = epic, red = no_L4_HD4.   Same η regions as the previous slide.   Source: S. Li, “L4 and HD4 Impact Study”, 08/2026.



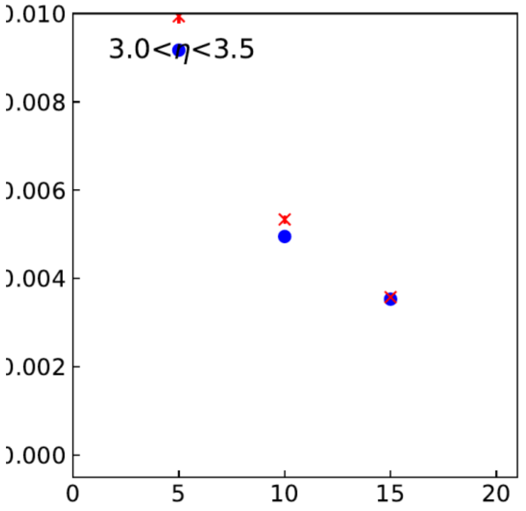
θ [rad], |η| < 1



θ [rad], 3.0 < η < 3.5



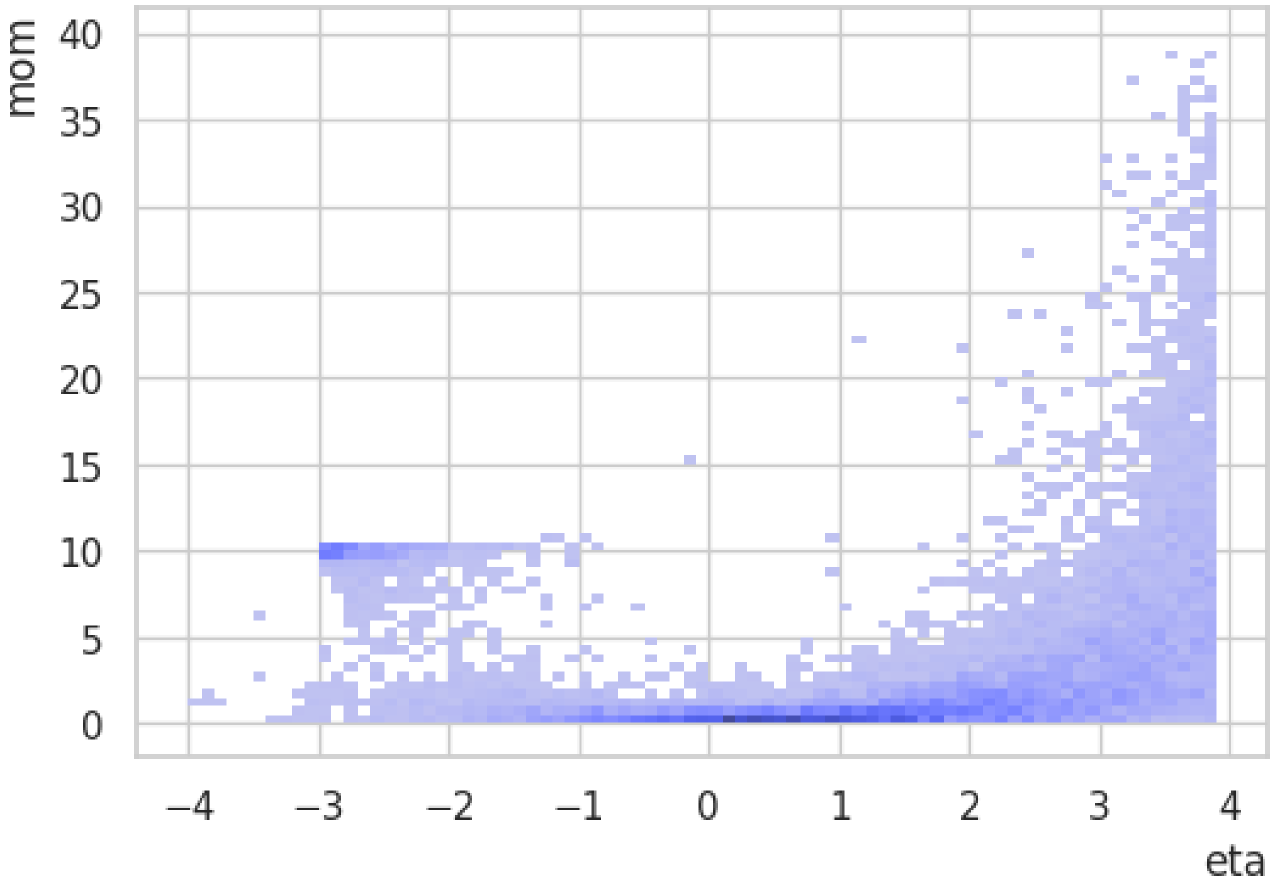
φ [rad], |η| < 1



φ [rad], 3.0 < η < 3.5

The two configurations lie on top of one another over most of the momentum range. Both θ and φ resolutions fall steeply with momentum and are indistinguishable between the geometries above a few GeV/c; the visible differences are confined to the lowest momentum points, where the multiple-scattering term dominates.

Backup — (signal) particle distribution



DIS distribution from Pythia 8, neutral current DIS, with 10 GeV electrons and 275 GeV protons; i.e. $Q^2 > 1$ GeV^2, inclusive

Efficiency, purity, and acceptance figures in the main slides include all beam backgrounds, not detector noise,

Momentum and DCA resolutions are single pions, mainly for reasons of statistics,

Initial studies including also noise and resolutions from the full sample have been done; they are best discussed in tracking working group.