Brookhaven National Laboratory

U.S. DEPARTMENT OF ENERGY

Fast Tracking Simulations using LDT

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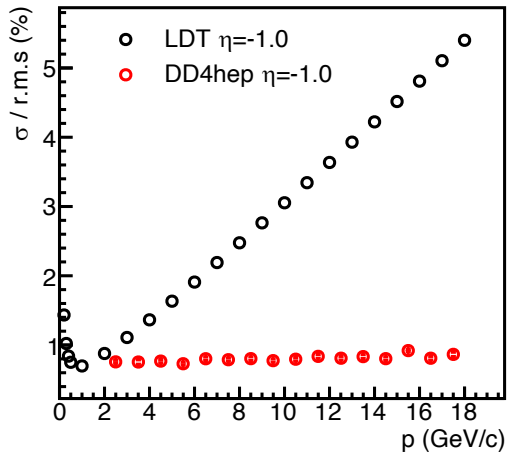
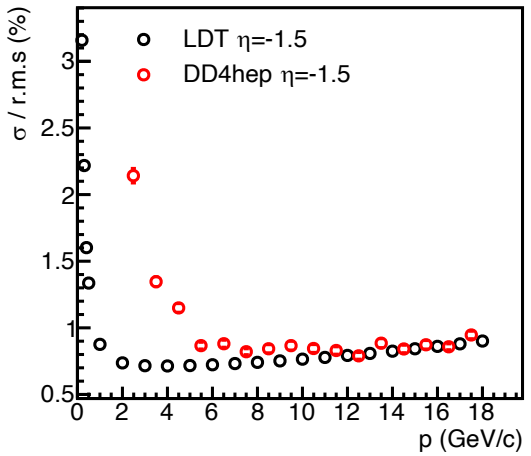
03-04-2024

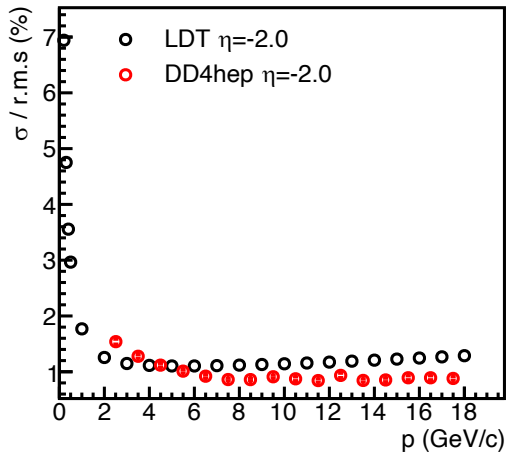
@BrookhavenLab

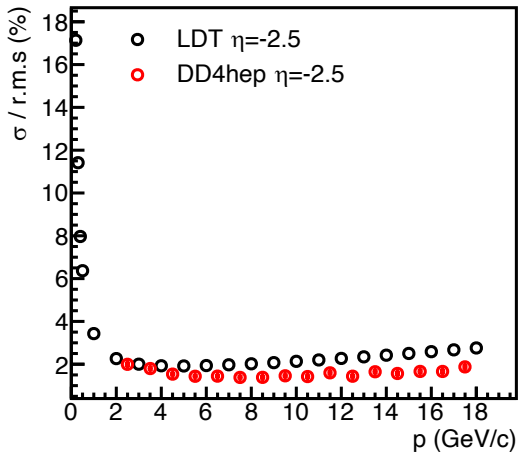
Last Update

02-26-2024





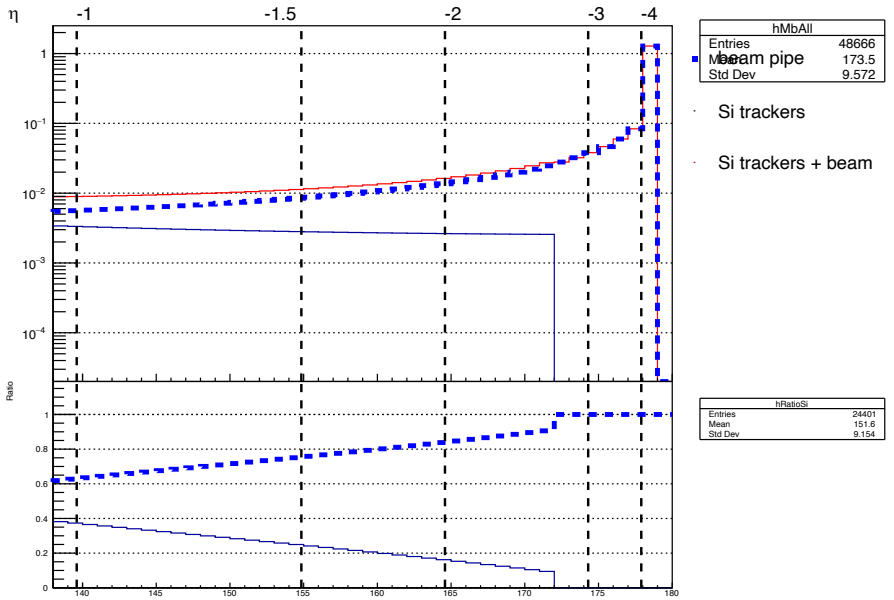




Particularly big discrepancy

Update in Detector Setup

- DD4hep: removed ToF and MPGD in the barrel
- LDT: corrected pixel resolutions
- LDT: corrected z position of two disks
- LDT: find tuned material thickness (radiation length) $x = X/X_0$

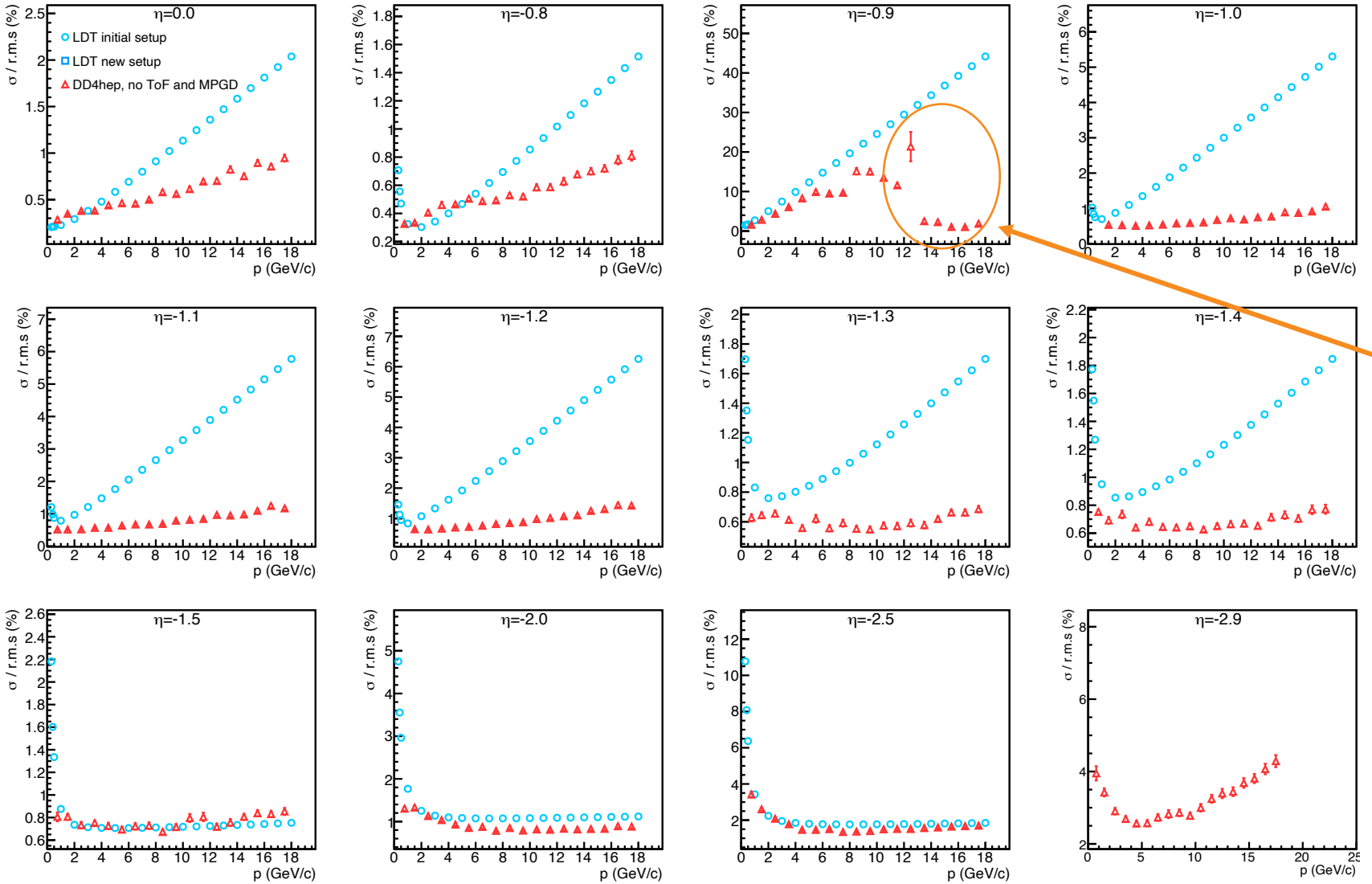


Isolate a component (e.g. aluminum+CF layer of 1 disk) and then run a material budget scan

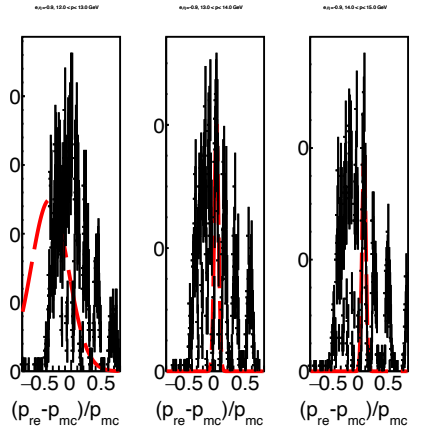
$$x' = \frac{x}{\sin\theta}$$

$$x = x' \sin(2\tan^{-1} e^{\eta})$$

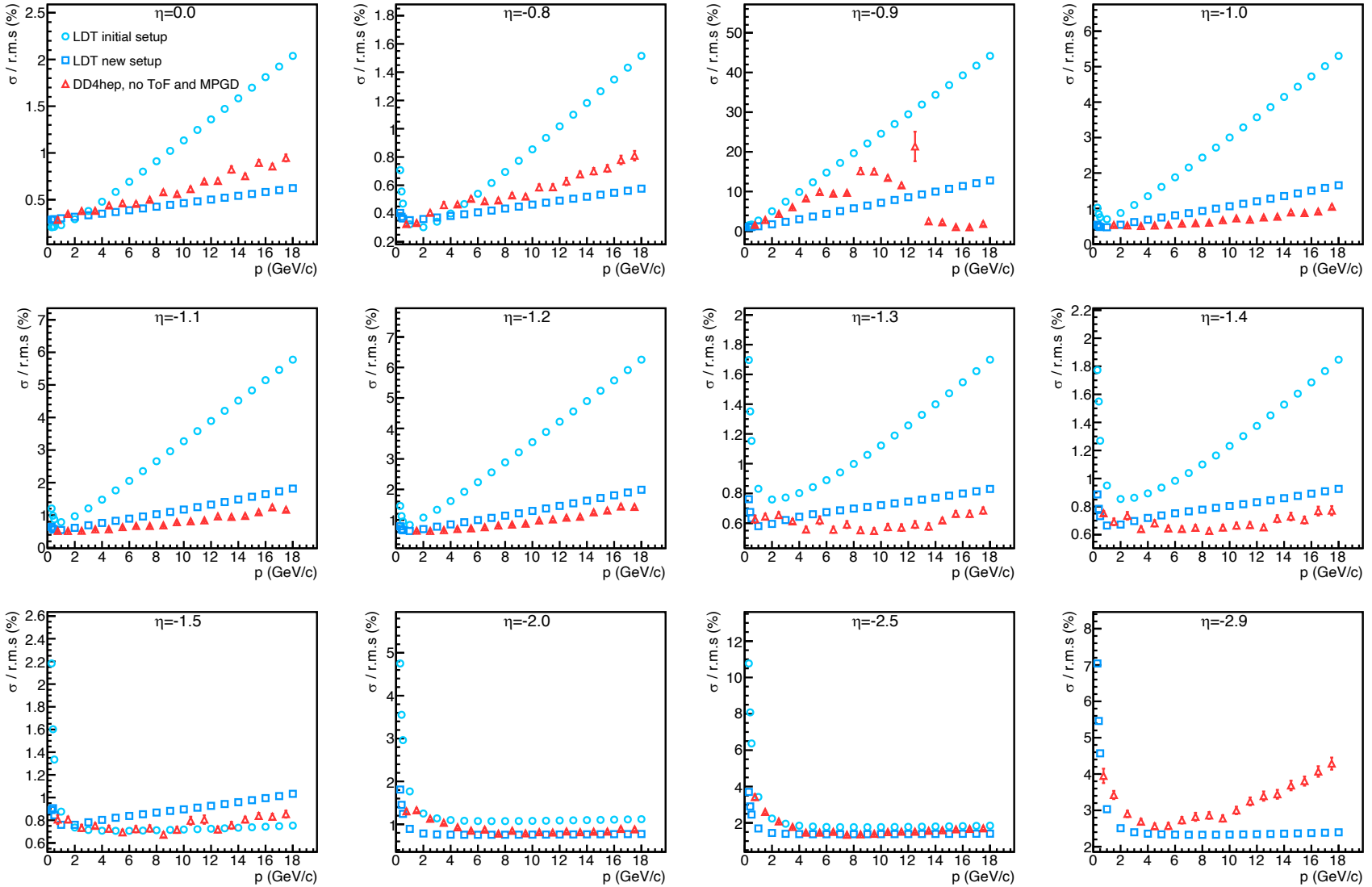
Momentum Resolution with the Modified DD4hep Setup



Removed barrel ToF and MPGD in DD4hep detector setup



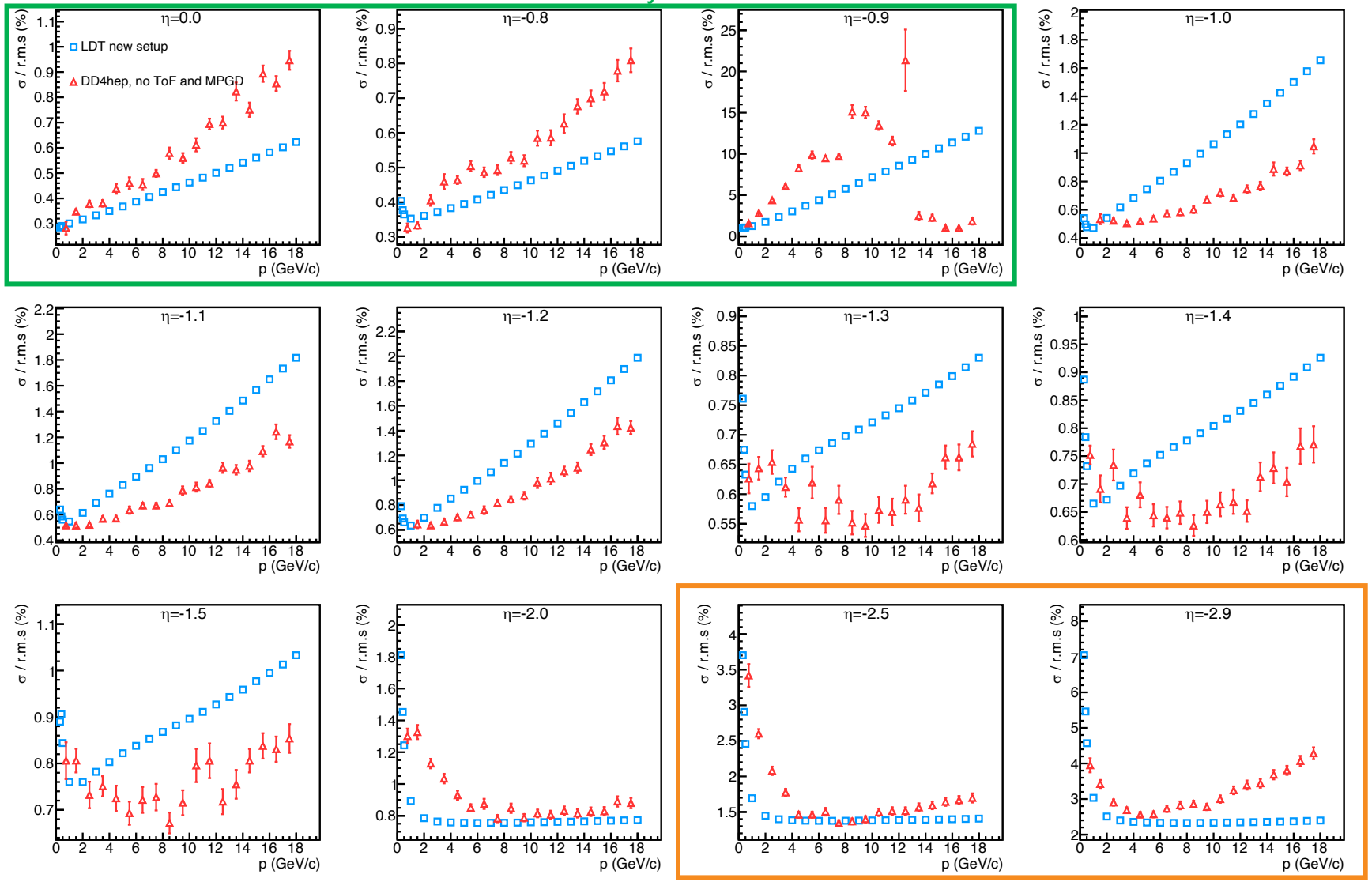
Momentum Resolution with the New LDT Setup



- Added aluminum foil in the outer barrel tracker layers to match DD4hep setup
- Fine tuned the thicknesses of the beam pipe and barrel tracker
- z and rφ resolutions changed from 20um to $20/\sqrt{12} = 5.77$um

Momentum Resolution with the New LDT Setup

Barrel hits only

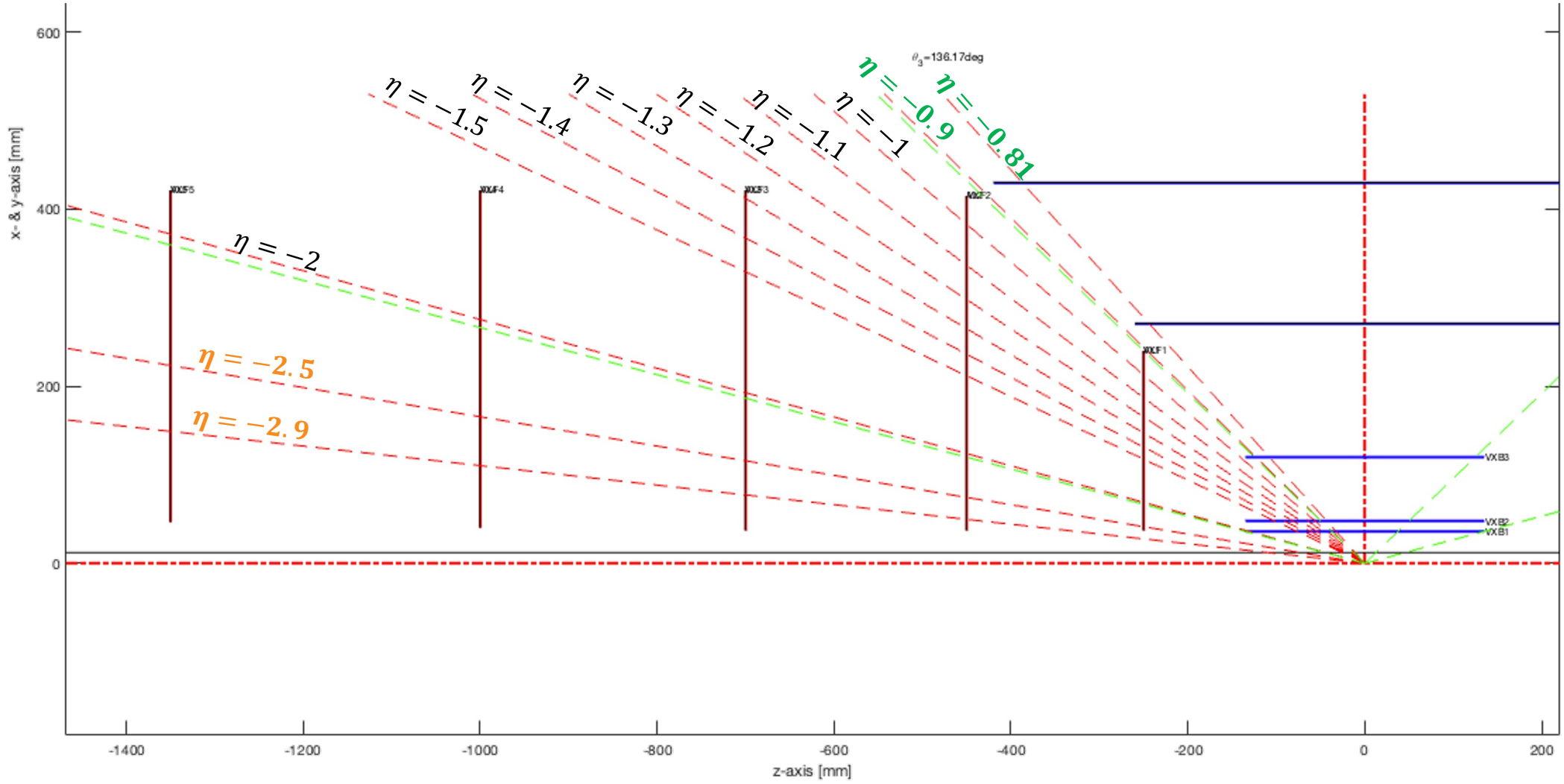


Backward disk hits only

- $\eta = 0, -0.8, -0.9$ and $\eta = -2.5, -2.9$
  Discrepancy from spatial resolution?
  Spatial resolution in LDT is possibly too fine

- $\eta = -2.5, -2.9$ bins worry me the most

Tracking Detector Layout in LDT



Summary

Updated detector setups in LDT and DD4hep

- The discrepancy between LDT and DD4hep reduces
- There are still questions concerning the discrepancy

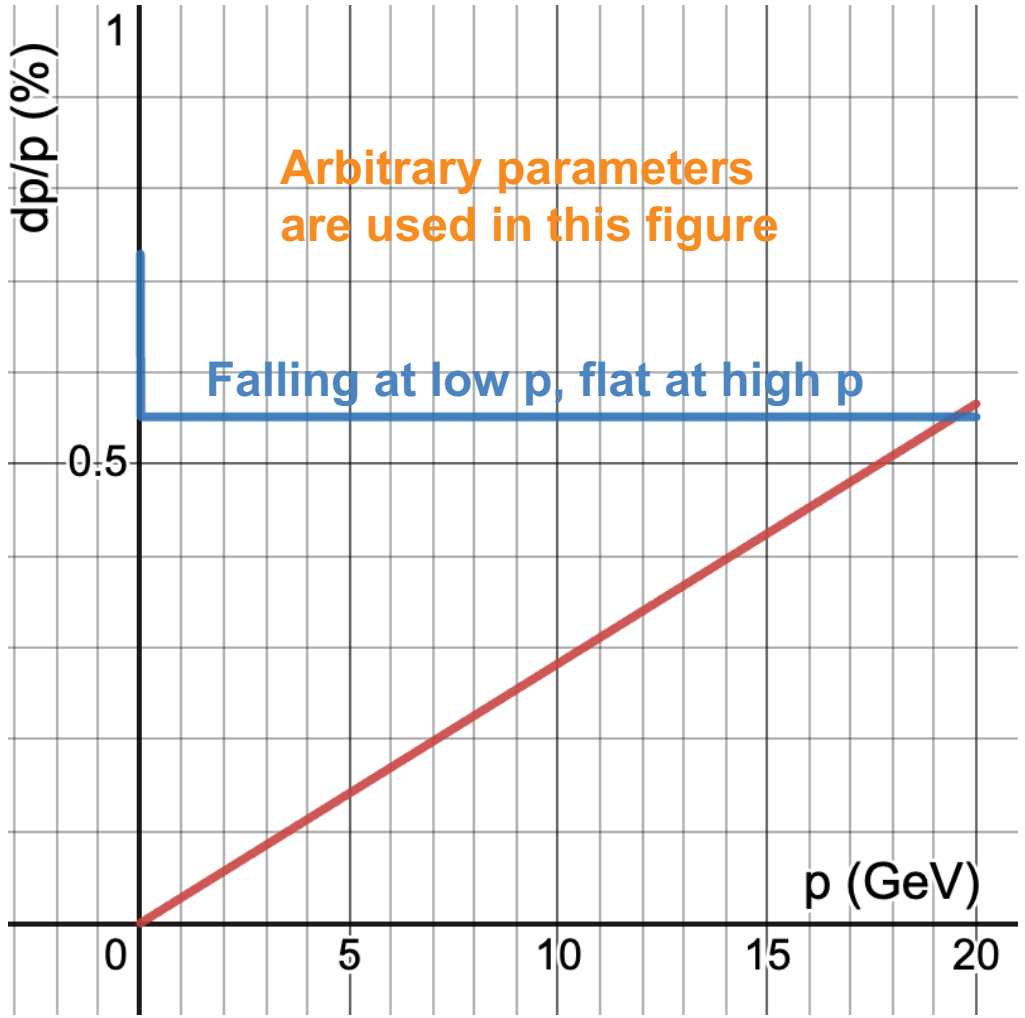
- LDT: Check with Ernst's LDT results
- LDT: Run standalone disks/barrel simulations
- DD4hep: Working on the material map of ACTS

Back Up

Analytical Calculation of Momentum Resolution

** For an equal distance, spatial resolution, multiple scattering tracker **

https://www.desmos.com/calculator/trrpytarr4



Error from detector design

$$\frac{\Delta p}{p}_{res} = \frac{12 \cdot \sigma_{pix} \cdot p}{0.3BL^2}\sqrt{\frac{5}{N+5}}$$

Error from multiple scattering

$$\frac{\Delta p}{p}_{ms} = \frac{0.0136}{0.3BL \cdot \frac{p}{\sqrt{m^2+p^2}}}\sqrt{X_0/X}$$

$$\approx \frac{0.0136}{0.3BL}\sqrt{X_0/X} \qquad \text{for } p \gg m$$

$$\frac{\Delta p}{p}_{tot} = \sqrt{\left(\frac{\Delta p}{p}_{res}\right)^2 + \left(\frac{\Delta p}{p}_{ms}\right)^2}$$

https://arxiv.org/abs/1805.12014