Brookhaven National Laboratory

U.S. DEPARTMENT OF ENERGY

ePIC Performance on Coherent J/ψ Diffractive Pattern

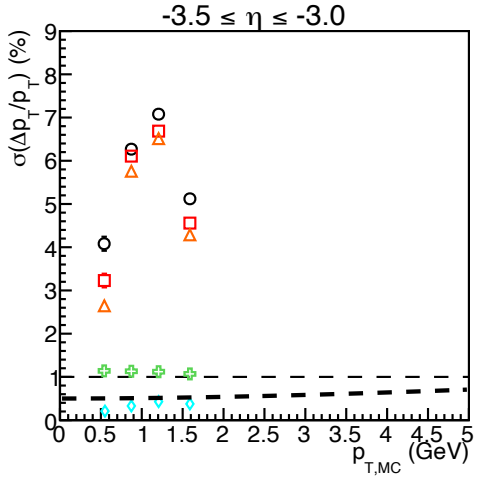
Cheuk-Ping Wong

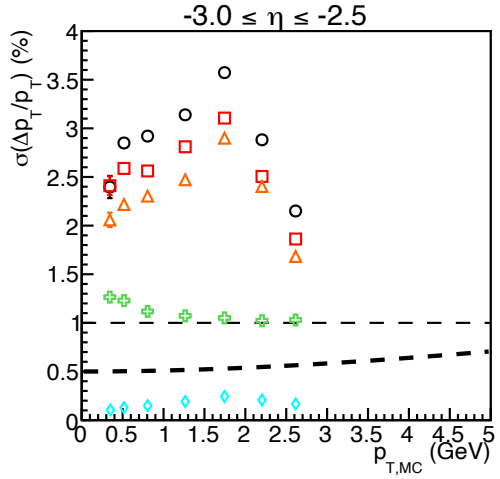
12-18-2023

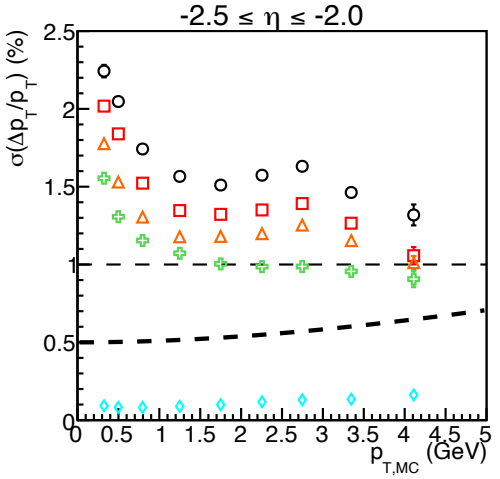
@BrookhavenLab

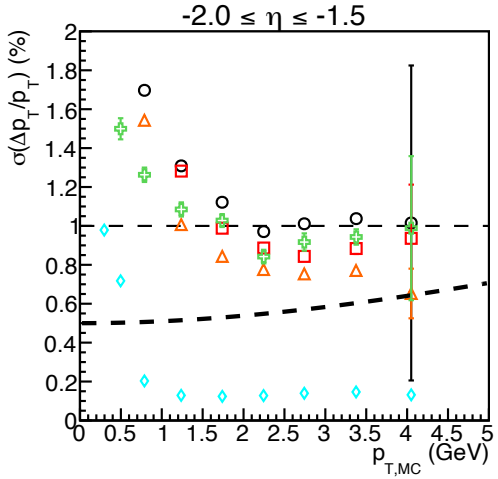
Last Update

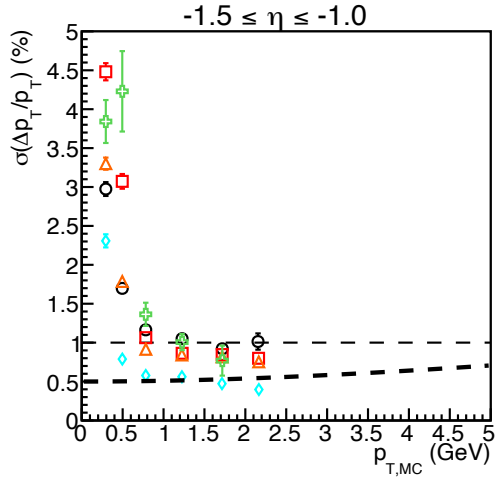
The 600cm air is a lot of material budget

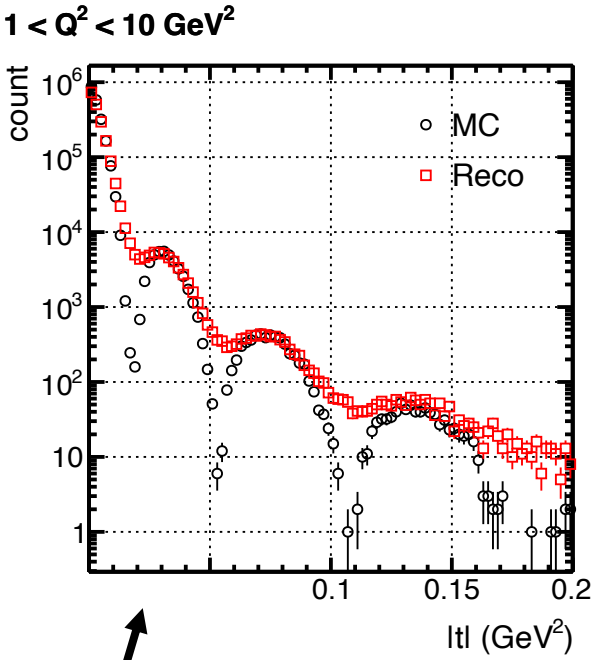










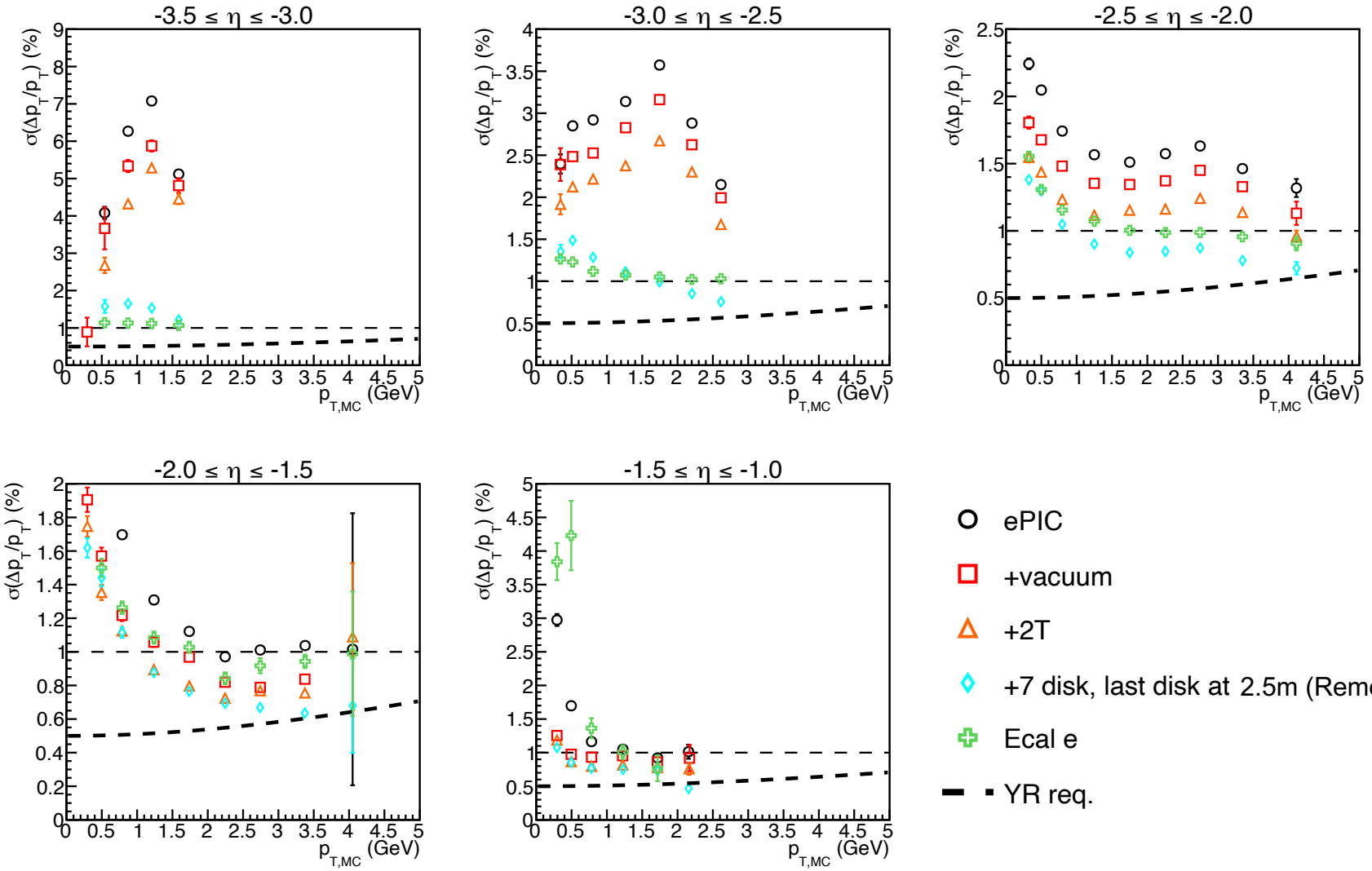


- ePIC
- ePIC, 2T
- ePIC in vacuum, 2T
- no sup.,8 Si,t_{Si}=5um,pix=10um,B=2T,z_{max}=600cm, no BP,vacuum
- Ecal e
- YR req.

Detector Setup (Backward Tracking)

- Magnetic field of 1.7T
- World volume: air
- 5 silicon disks
  - Silicon thickness of 40um
  - Support/service using aluminum (t=150um) and carbon fiber (t=120um)
  - Grid size: 20um x 20um
- MPGD
  - Grid size: 150x150um
  - z=110cm

Transverse Momentum Resolution (Backward e-)

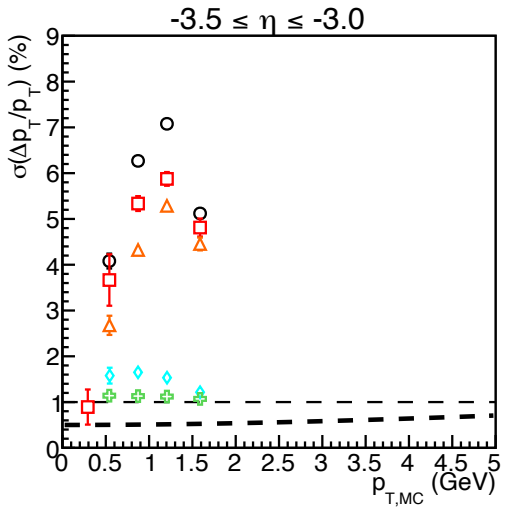


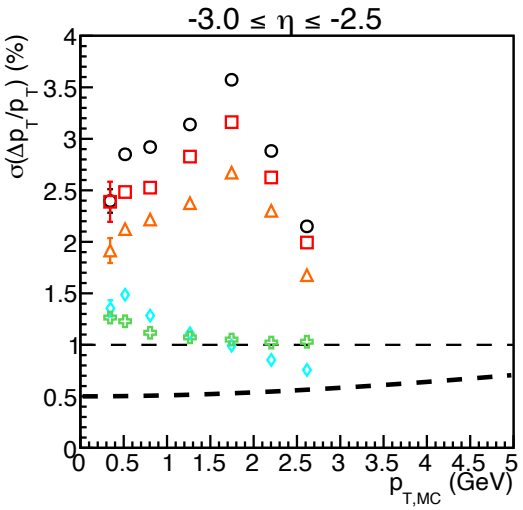
- Multiple scattering remains as the dominate factor in momentum resolution

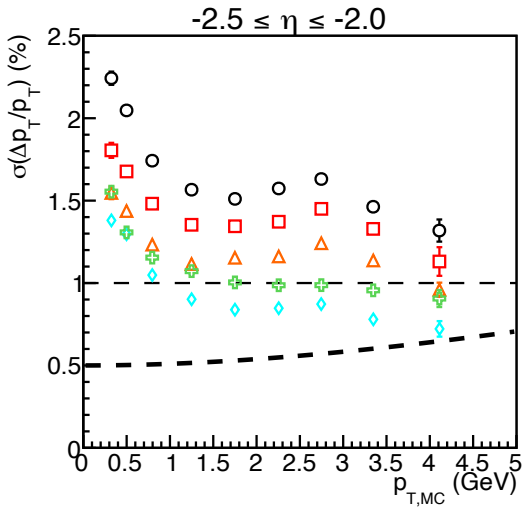
$$\frac{\Delta p_T}{p_T}_{ms} = \frac{0.0136}{0.3BL \cdot \frac{p}{\sqrt{m^2+p^2}}} \sqrt{X_0/X}$$

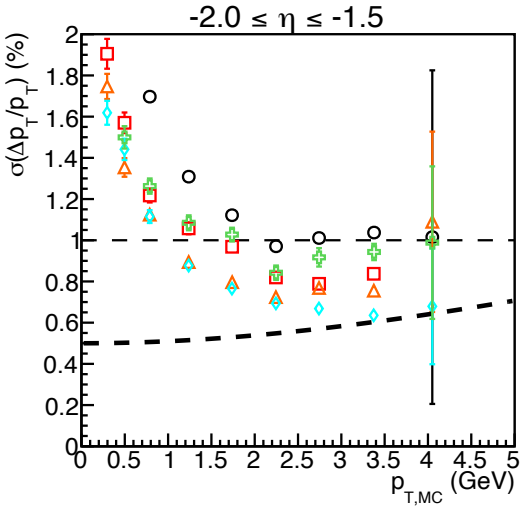
- Need to improve the resolution by a factor of 3
  - Stronger B field
  - Longer expansion volume
  - Reduce detector material budget
  - Reduce beam pipe material

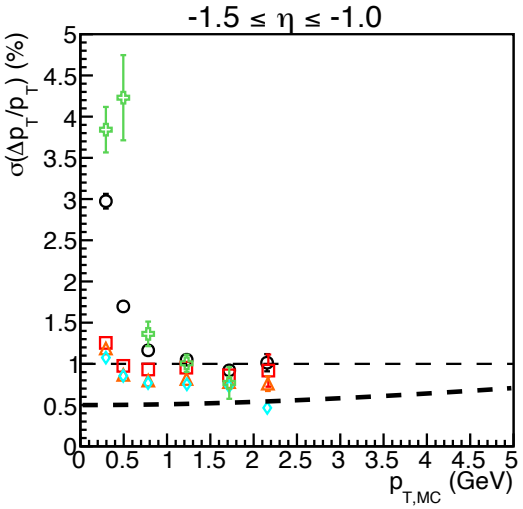
Transverse Momentum Resolution (Backward e-)



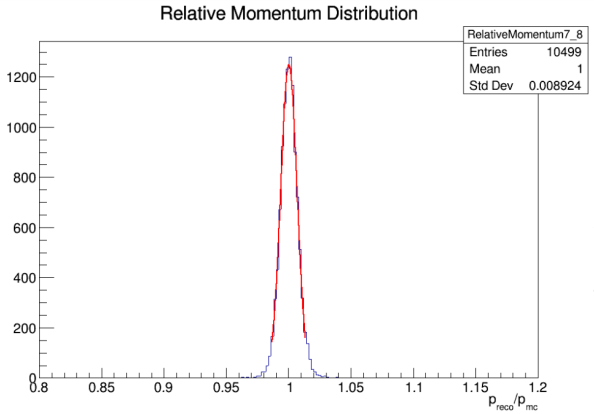








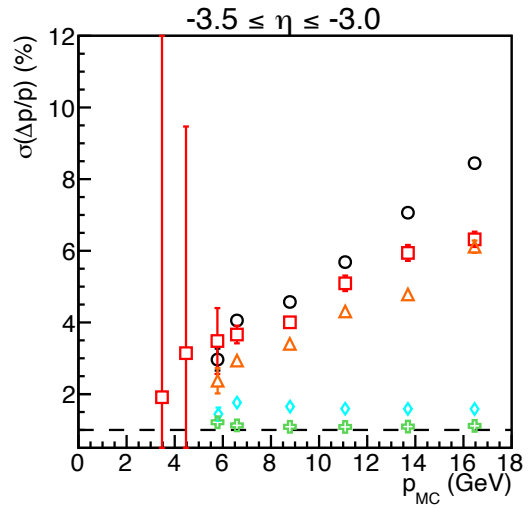
Still trying to figure out the weird shape of the transverse momentum resolution

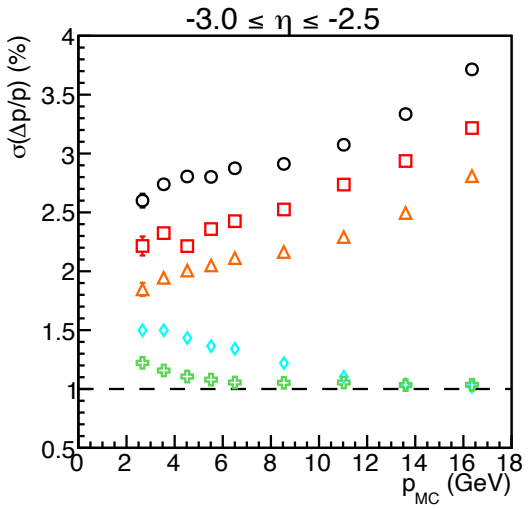


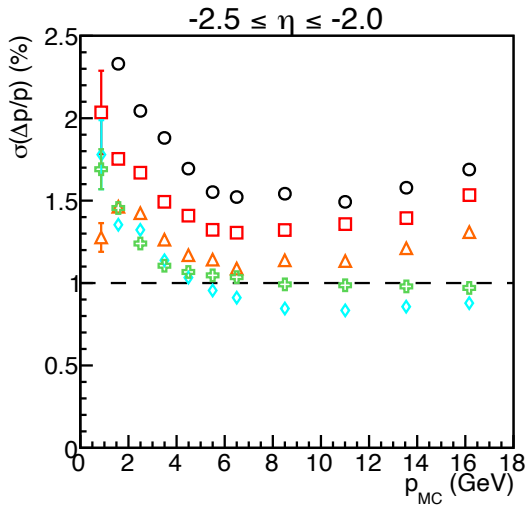
https://indico.bnl.gov/event/20126/contributions/78819/attachments/48723/82854/CraterlakeValidationPlots_2023_07_20.pdf

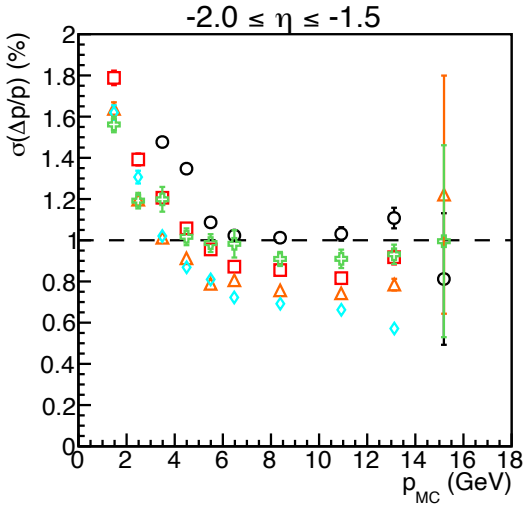
- Reconstructed events binned in η and p, fitted in 2σ range around peak and resolution extracted

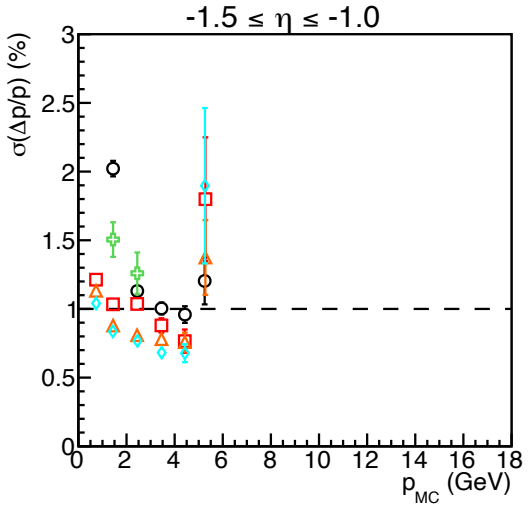
Momentum Resolutions (Backward e-)











- ePIC
- +vacuum
- +2T
- +7 disk, last disk at 2.5m (Removed pfRICH & bk MPGD)
- Ecal e

Summary

Even with vacuum as world volume, magnetic field 2T and an expansion volume of ~2.5m, we still need to reduce the material budget by a factor of 3.

Backup

Simulation Setup

Sartre

- eAu at 18x110 GeV
- $Q^2 \geq 1$ GeV^2
- Coherent events only
- Forced $J/\psi \rightarrow l^+ l^-$
- No background

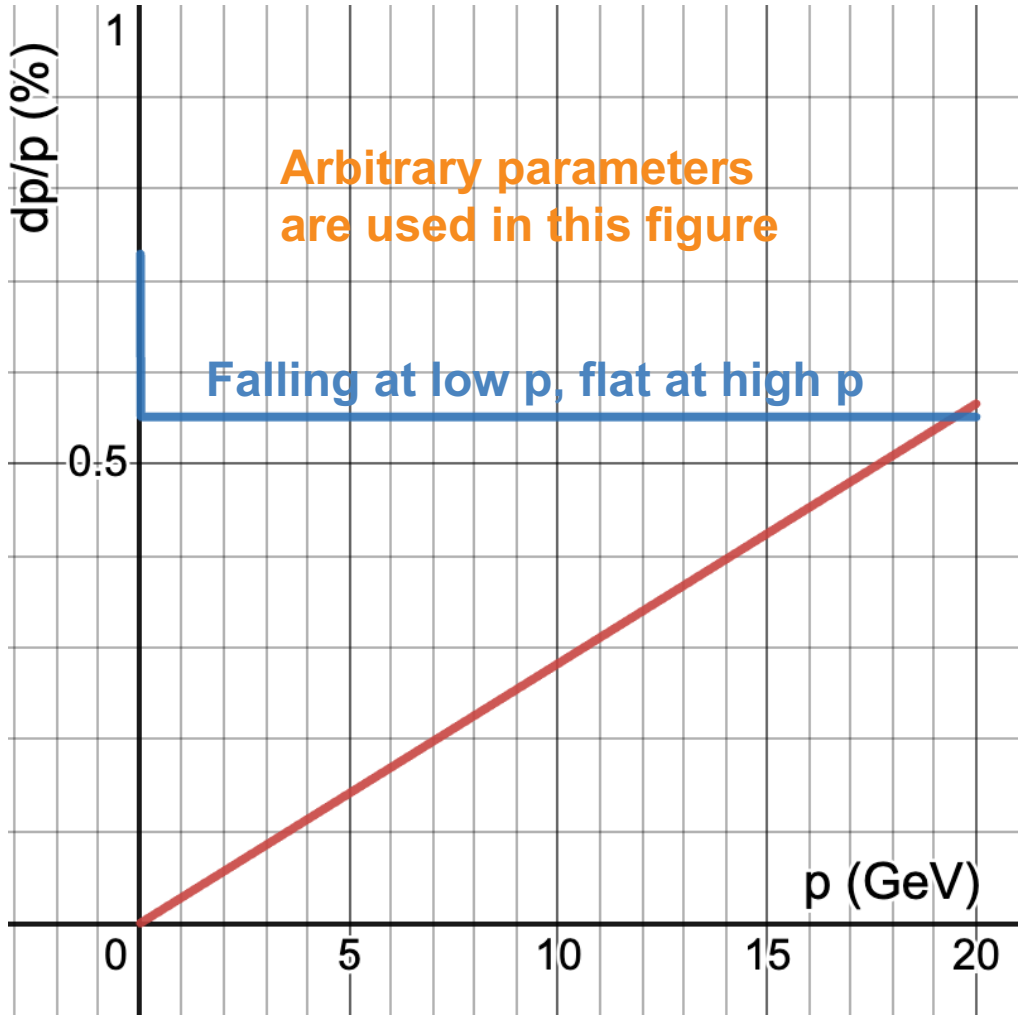
Detector

- epic-2023.10.0
- epic_craterlake_18x110_Au.xml

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

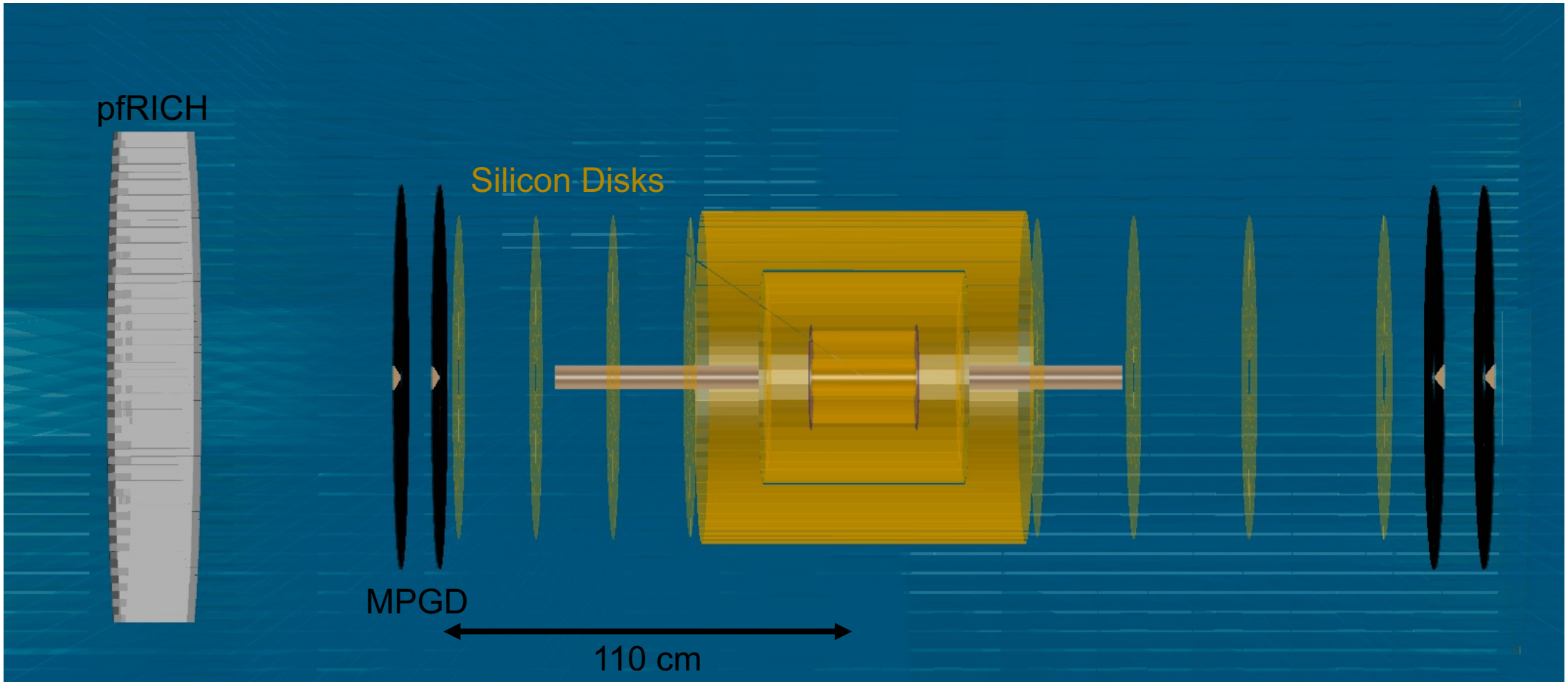
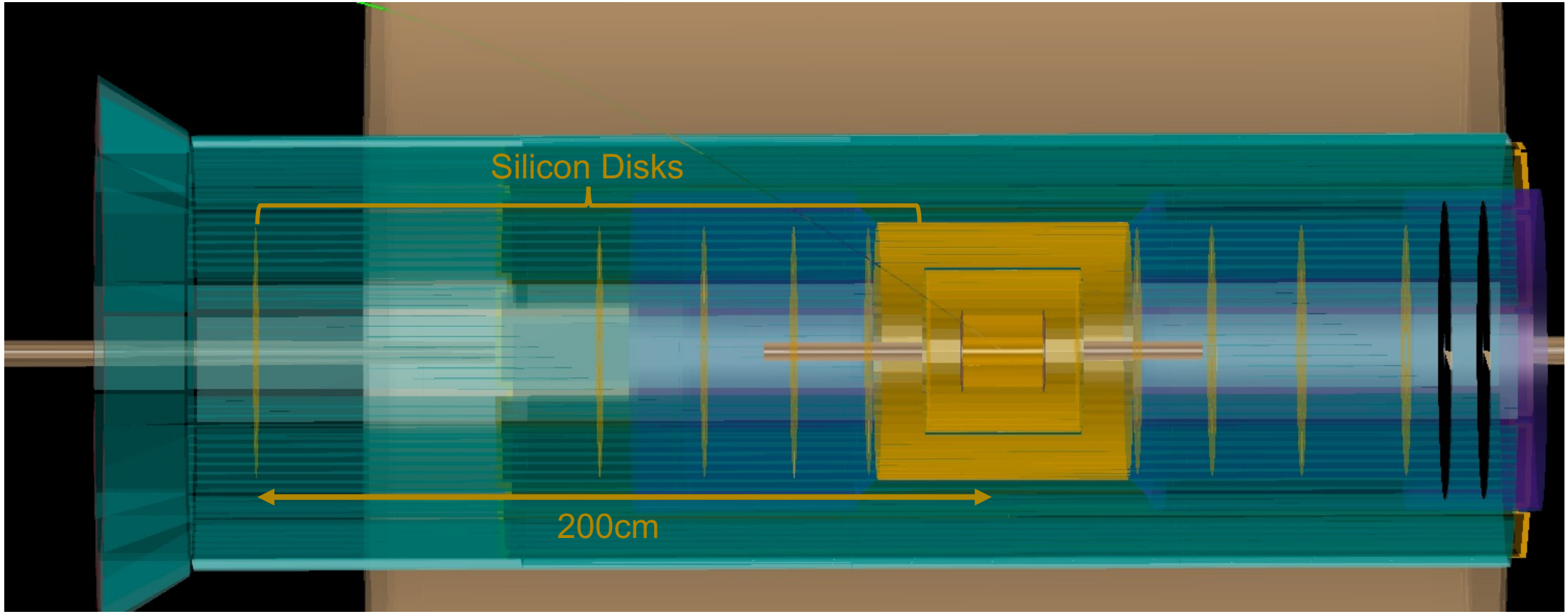
$$\frac{\Delta p}{p}_{ms} = \frac{0.0136}{0.3BL \cdot \frac{p}{\sqrt{m^2+p^2}}}\sqrt{X_0/X}$$

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

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

https://arxiv.org/abs/1805.12014

Event Display: Default Tracking System



Event Display: Backward All Silicon Disks