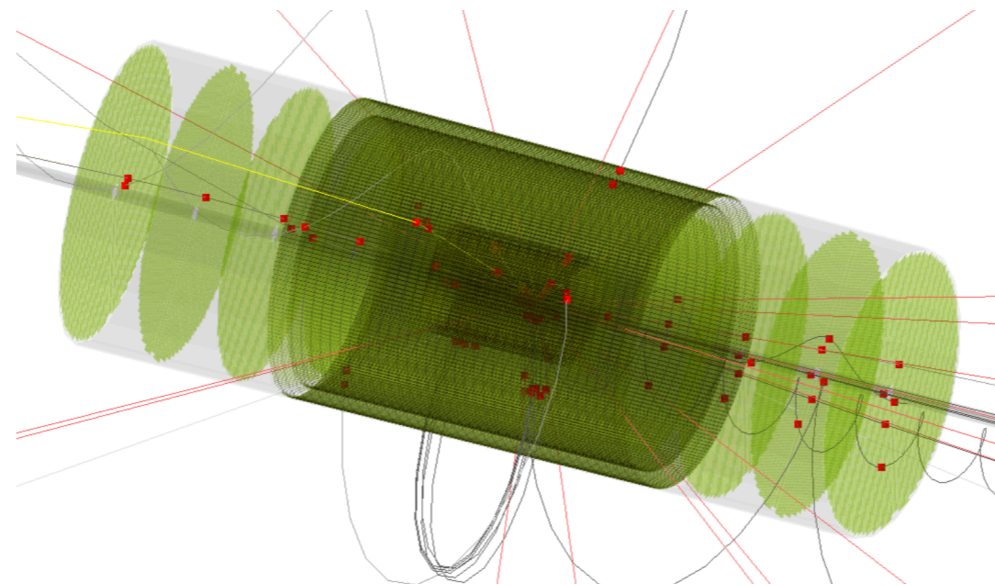# Jet-resolution studies in an All-Silicon tracker prototype for the EIC

Rey Cruz-Torres
07/20/2020
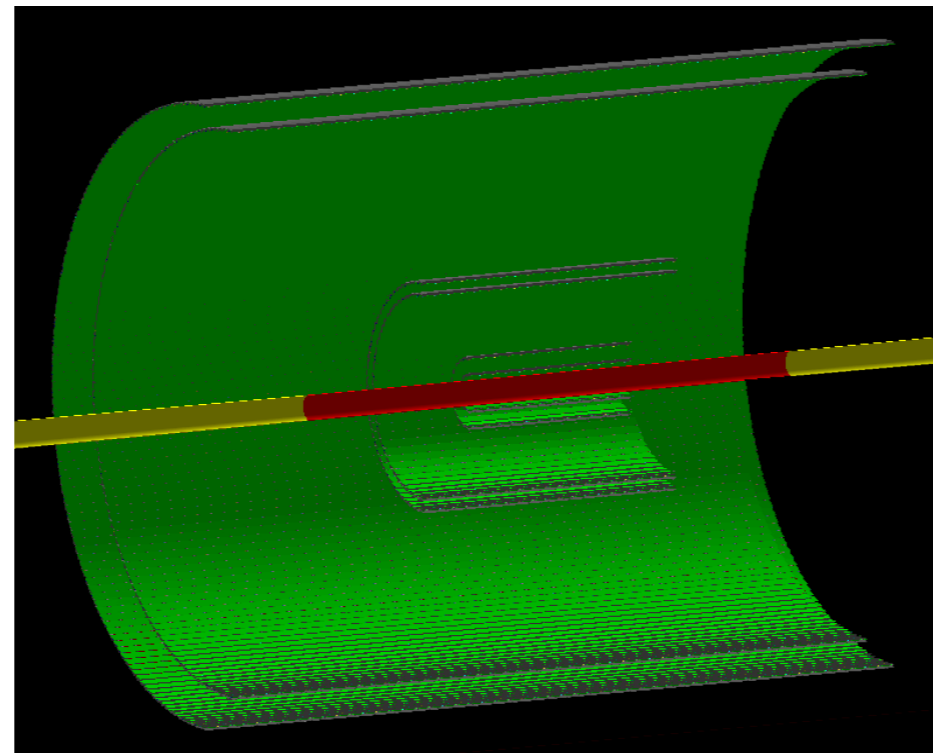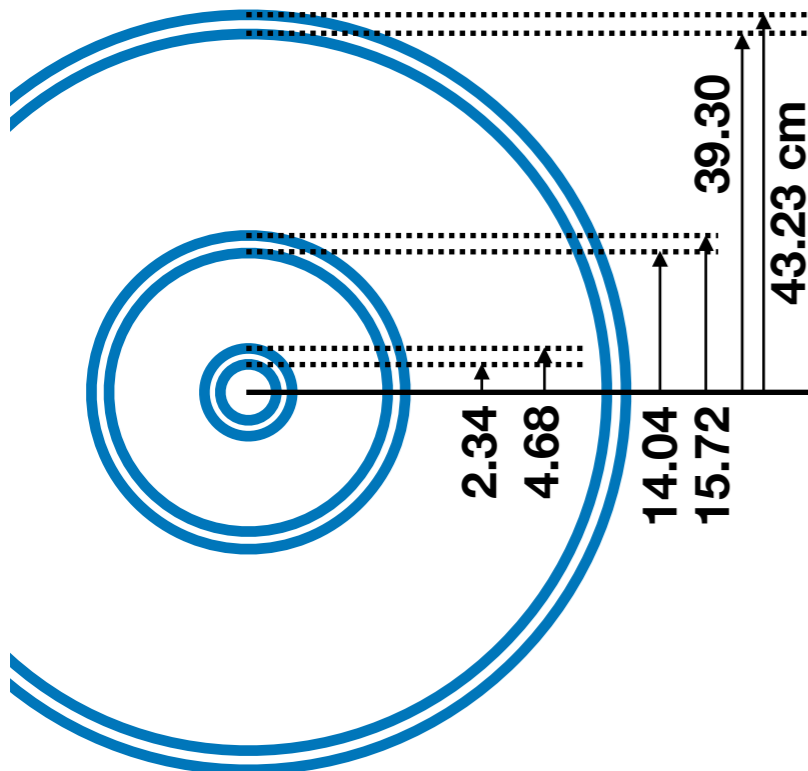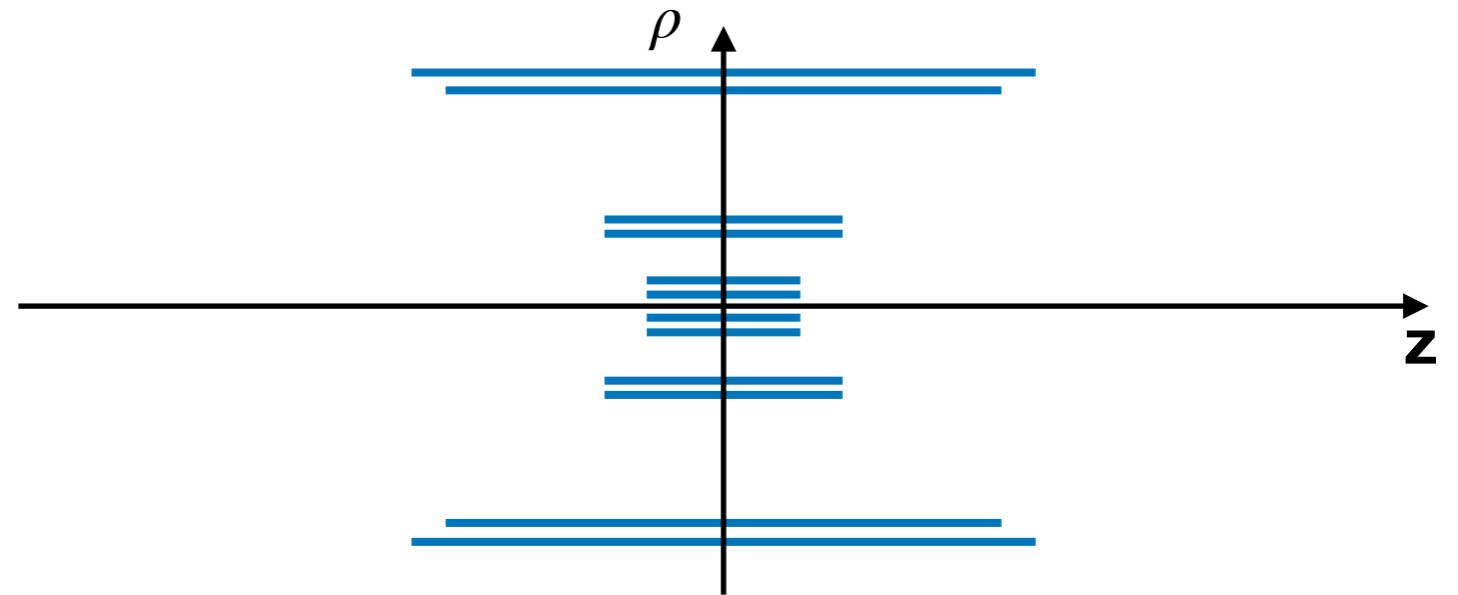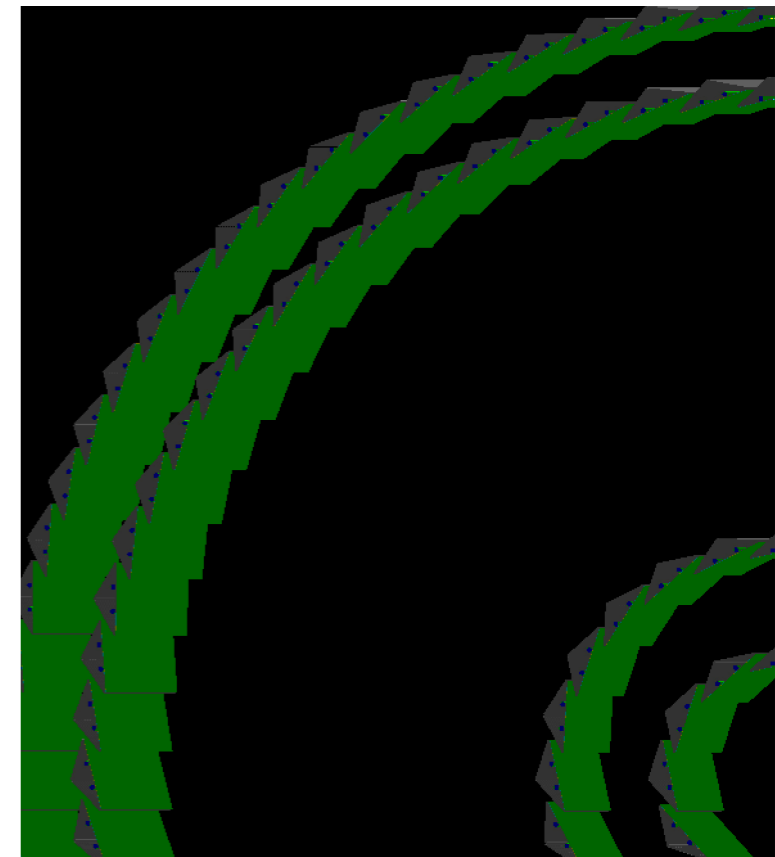
Outline

- All-Silicon tracker concept

- Single-particle detector performance

- (Charged) jet detector performance

Detector Geometry

- Geometry by E. Sichtermann and Y. Lai in EICroot

- Exported as TGeo file

- Imported into Fun4All with help from C. Pinkenburg and J. Huang

- Pixel size 20×20 μm

Barrel

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ρ

18.5

36.26

43.23

43.23

43.23 cm

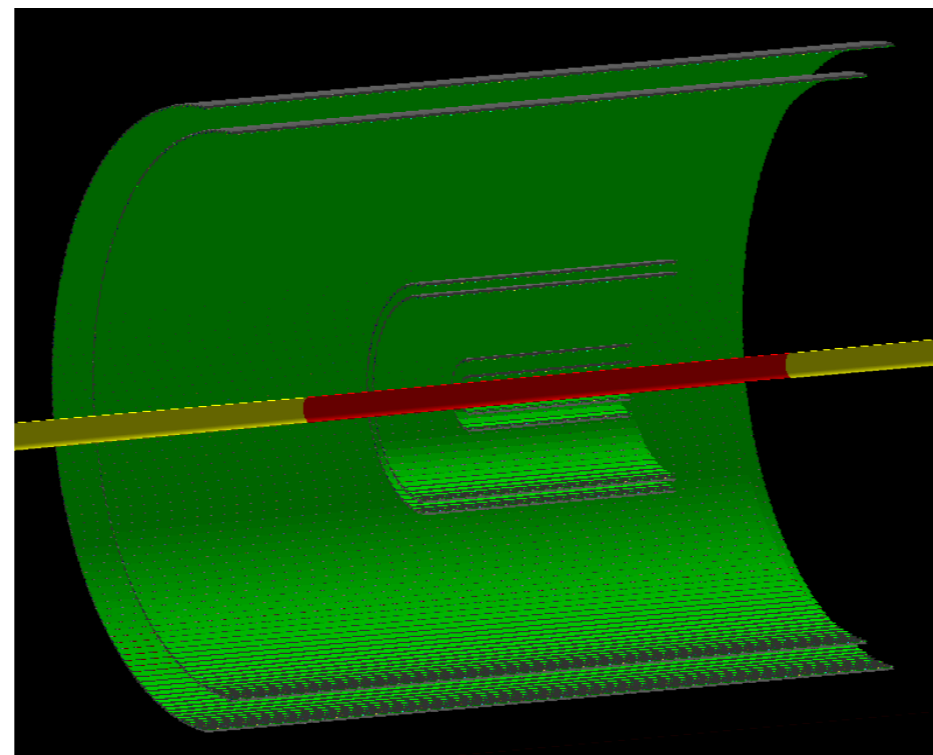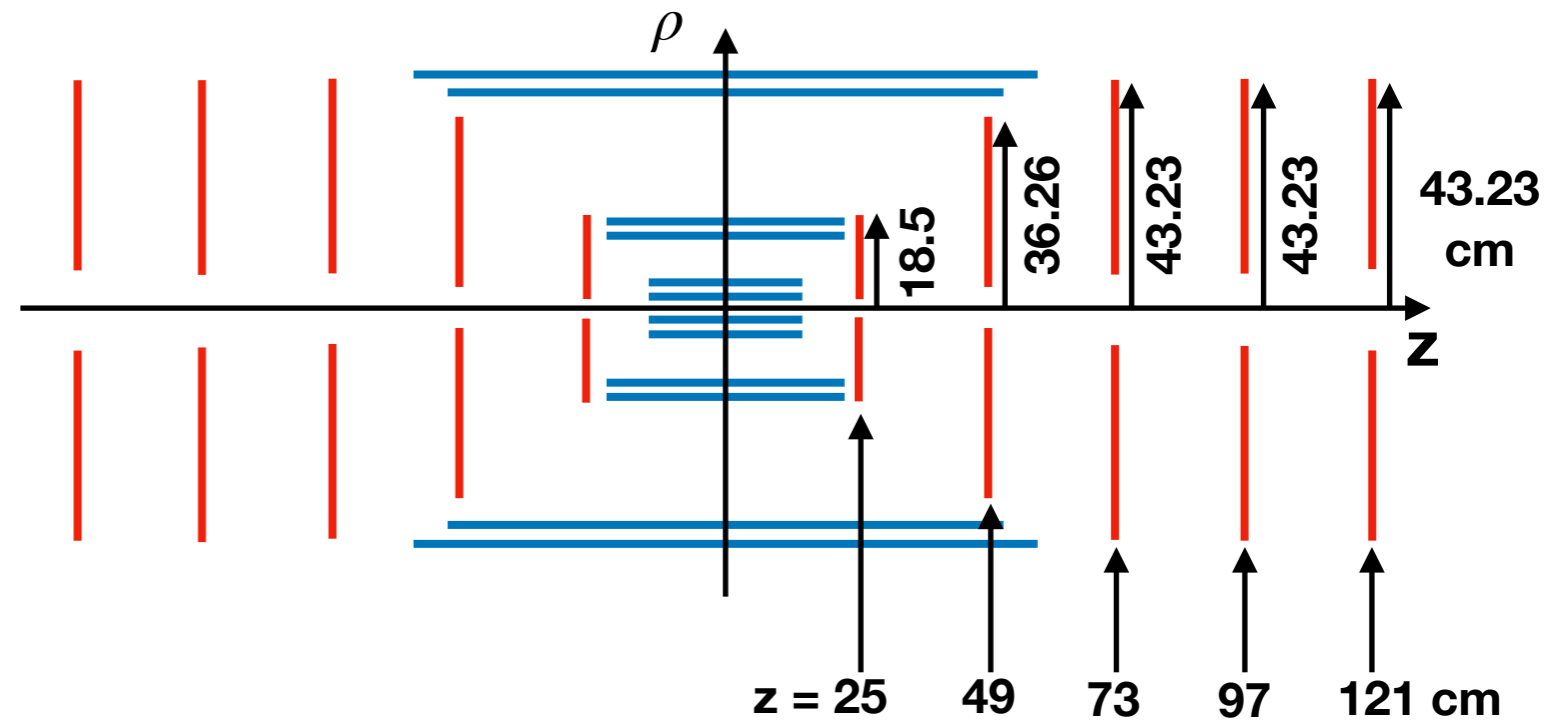z = 25   49   73   97   121 cm

Barrel

5F+5B Disks

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ρ

18.5   36.26   43.23   43.23   **43.23 cm**

z

z = 25   49   73   97   121 cm

Al Support Structure   **Barrel**   **5F+5B Disks**

5

Detector Geometry

- Geometry by E. Sichtermann and Y. Lai in EICroot

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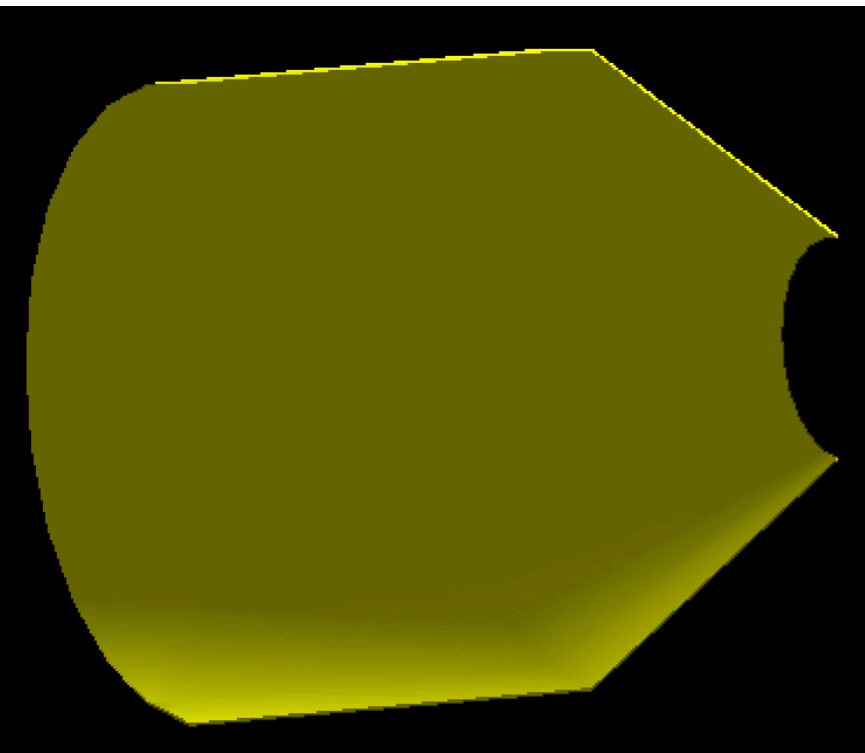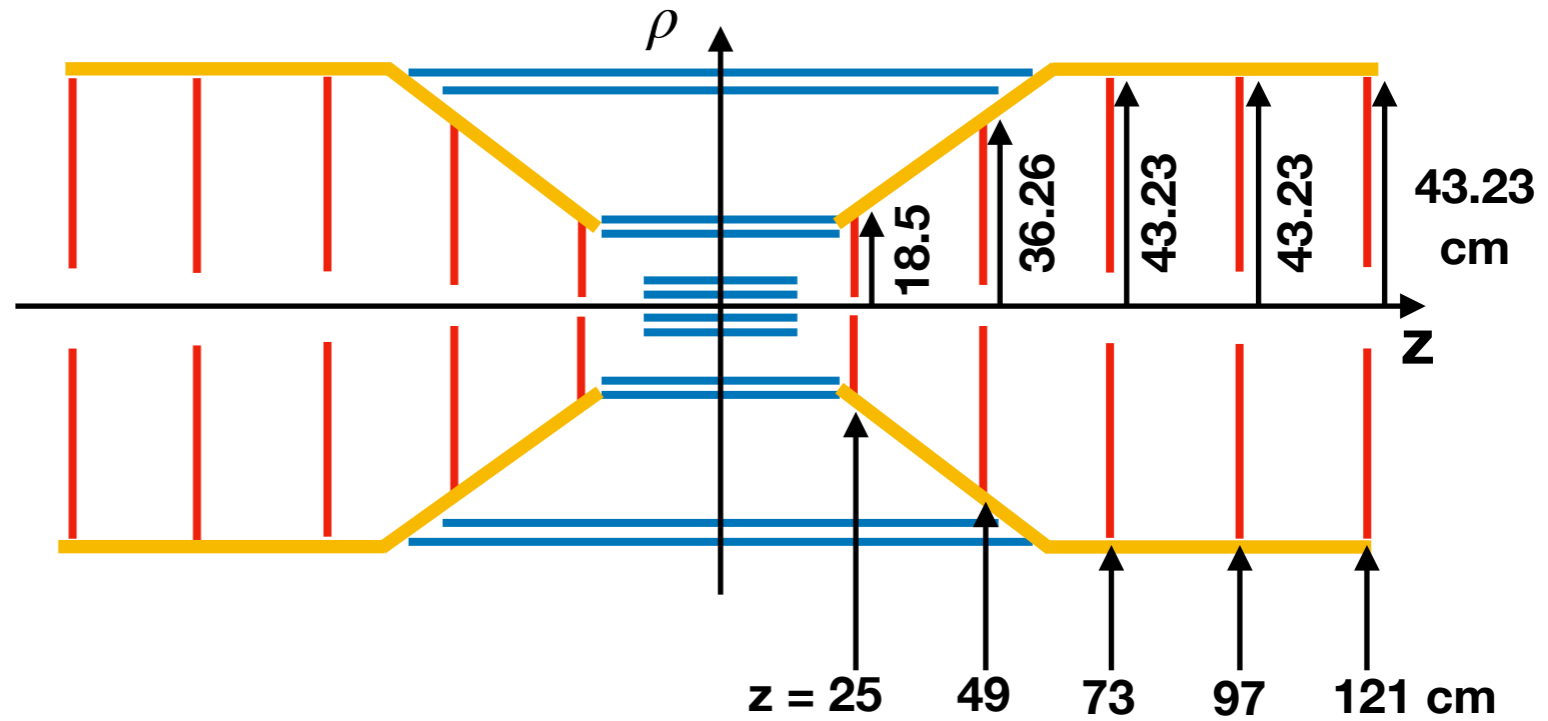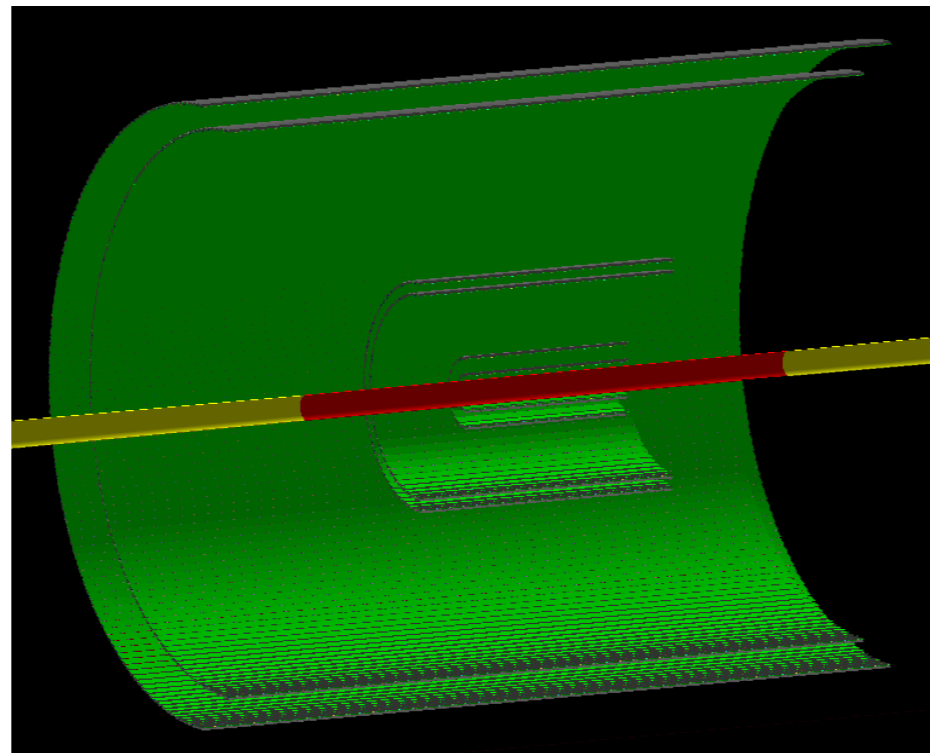
- Pixel size 20×20 μm

Single-Particle Resolutions
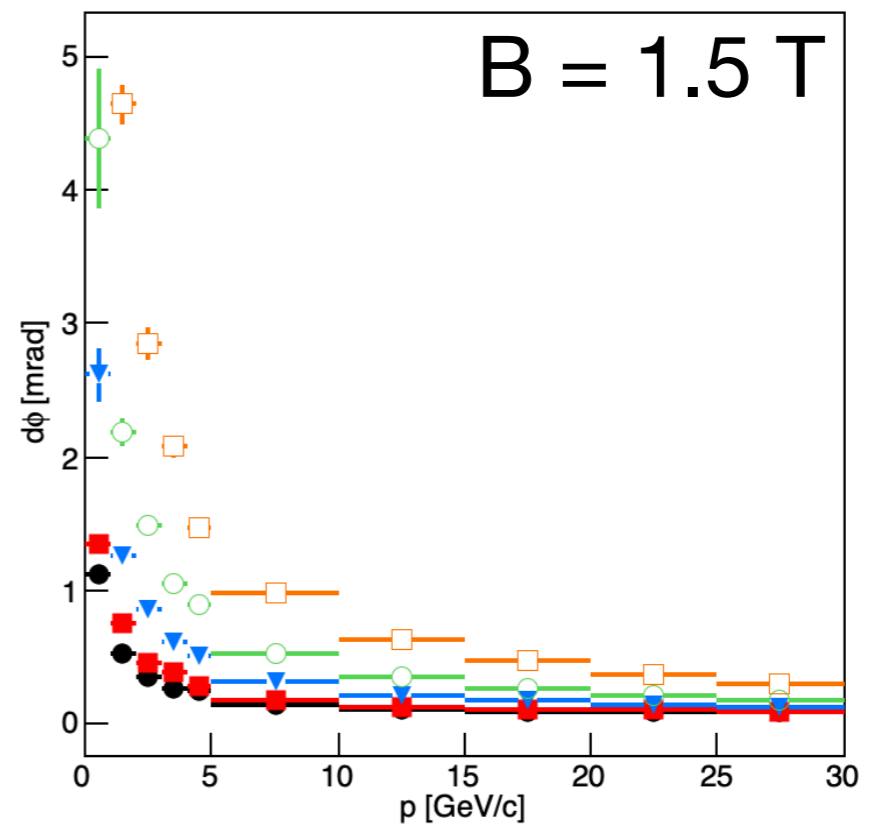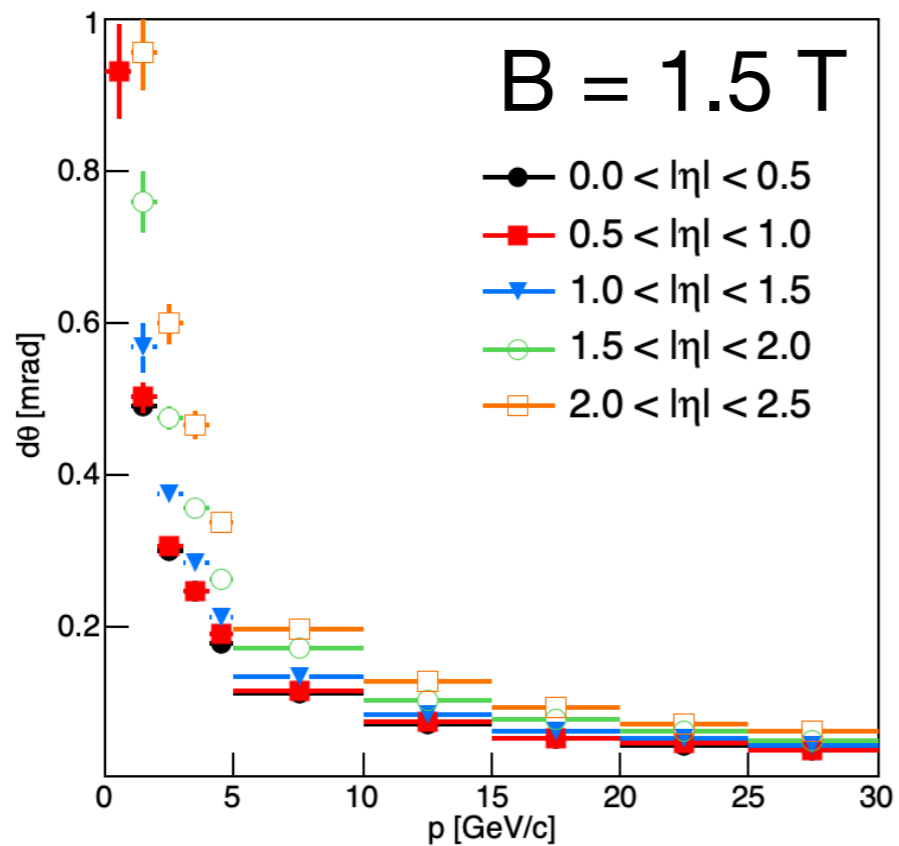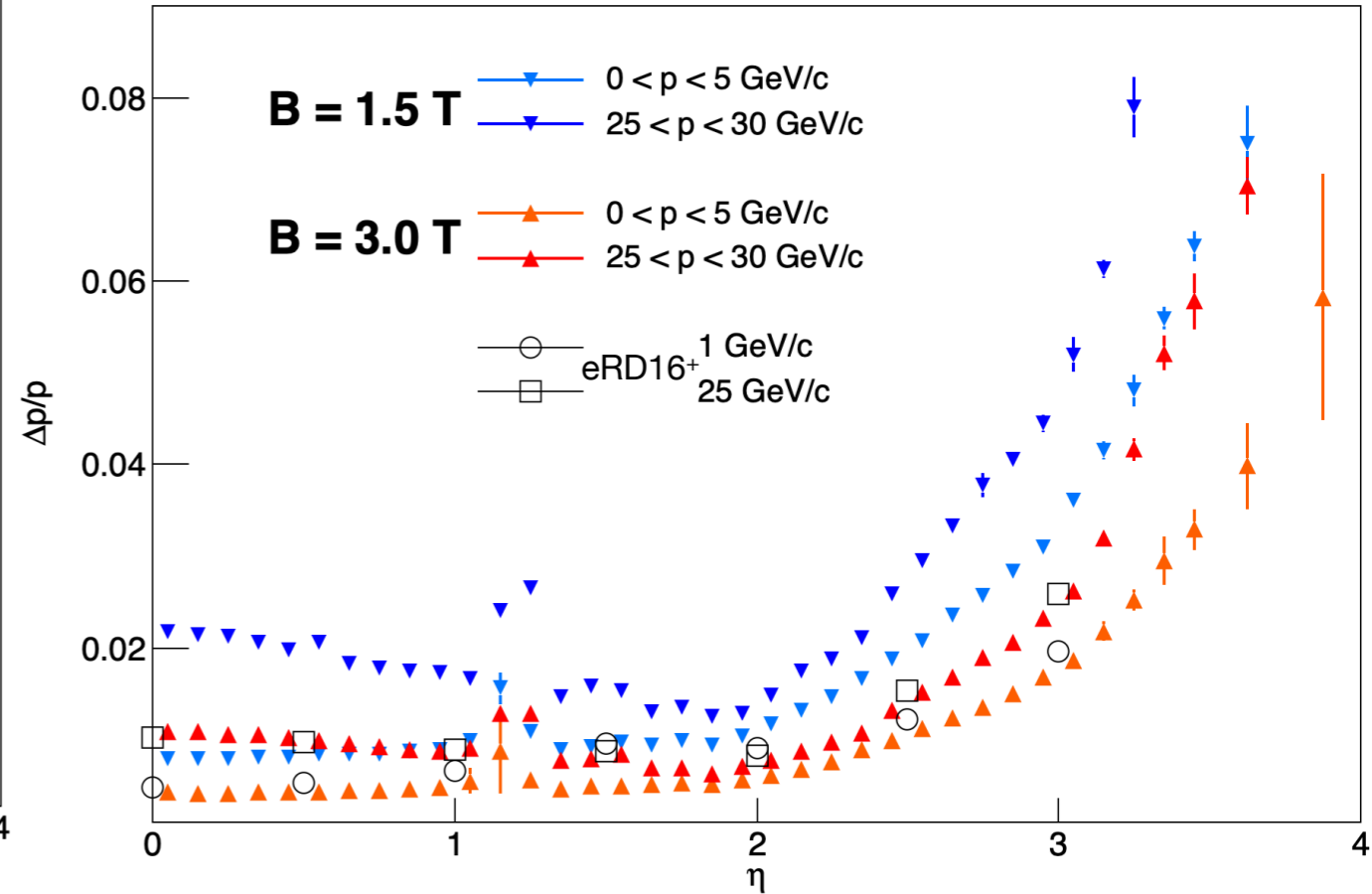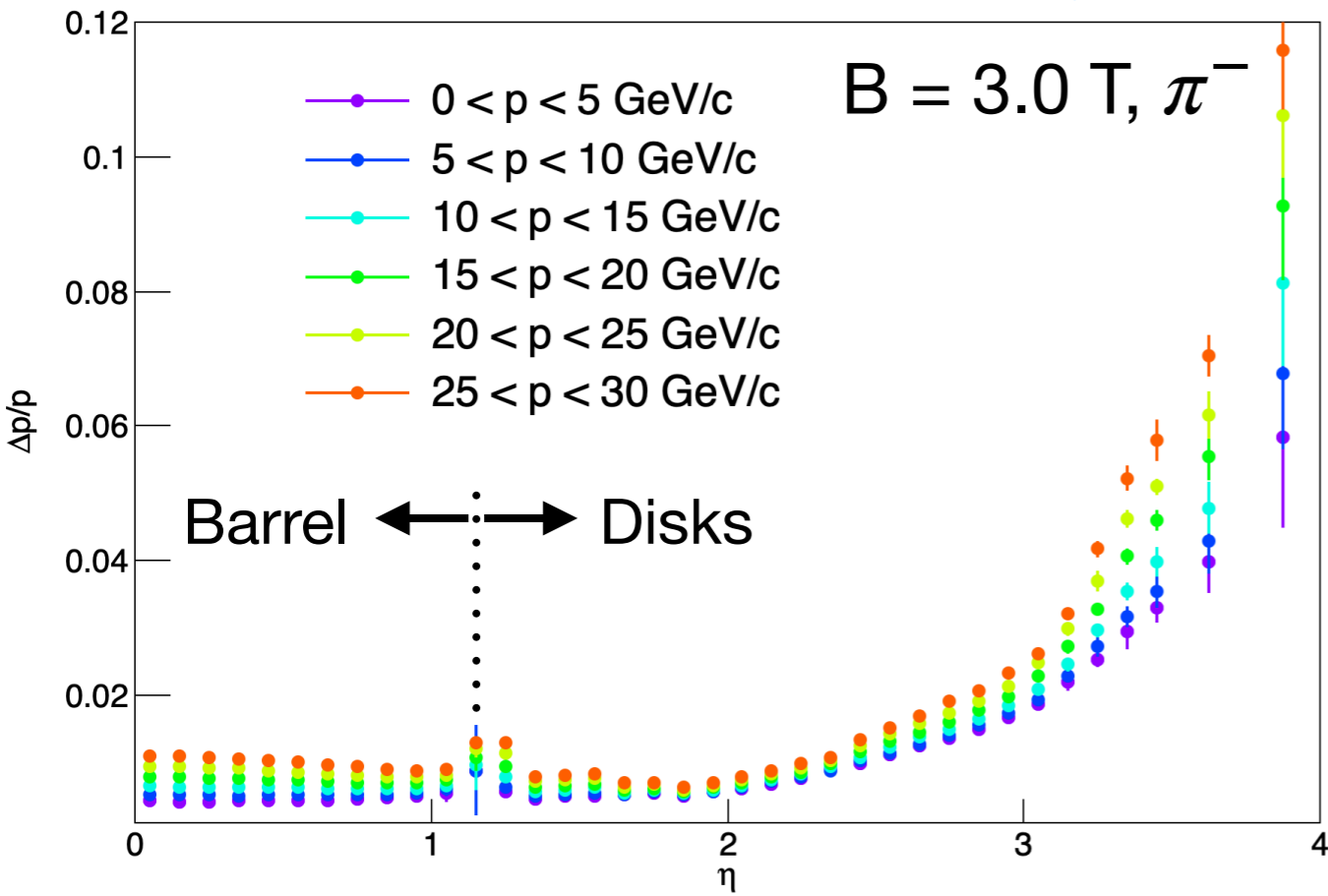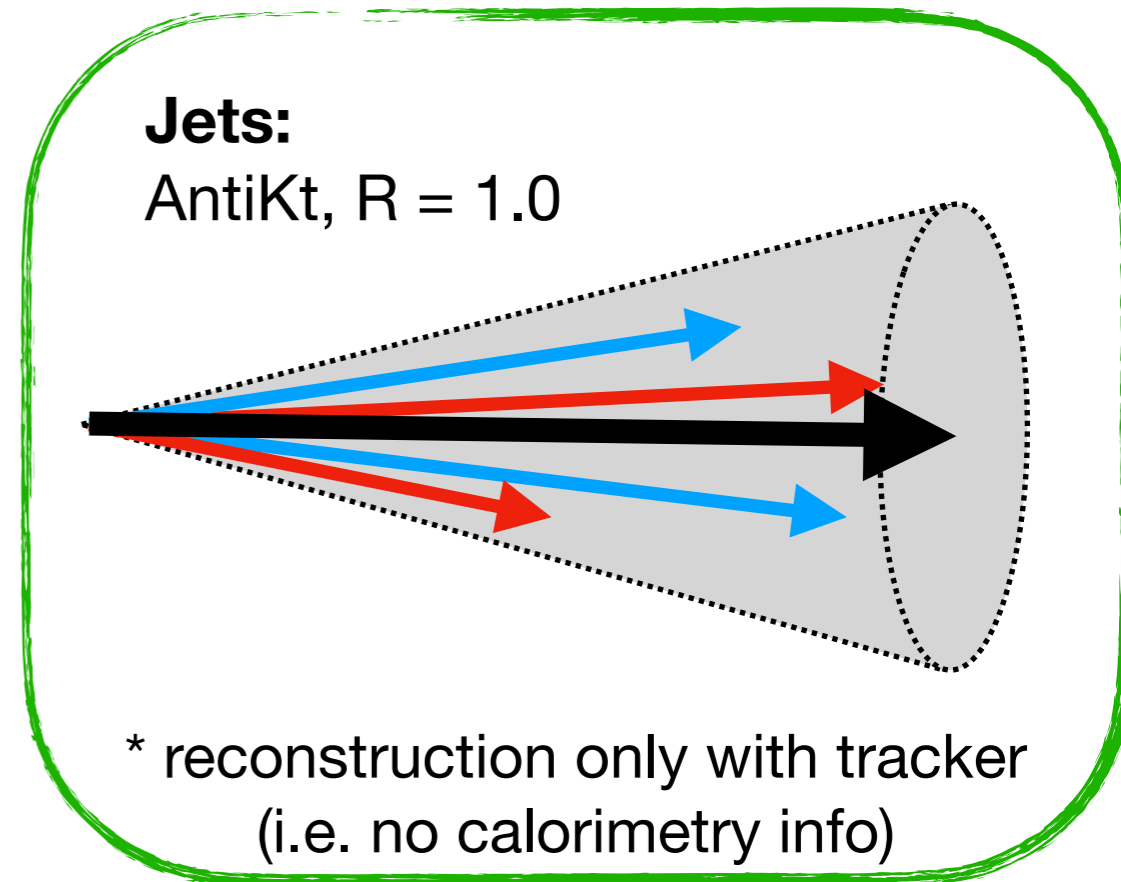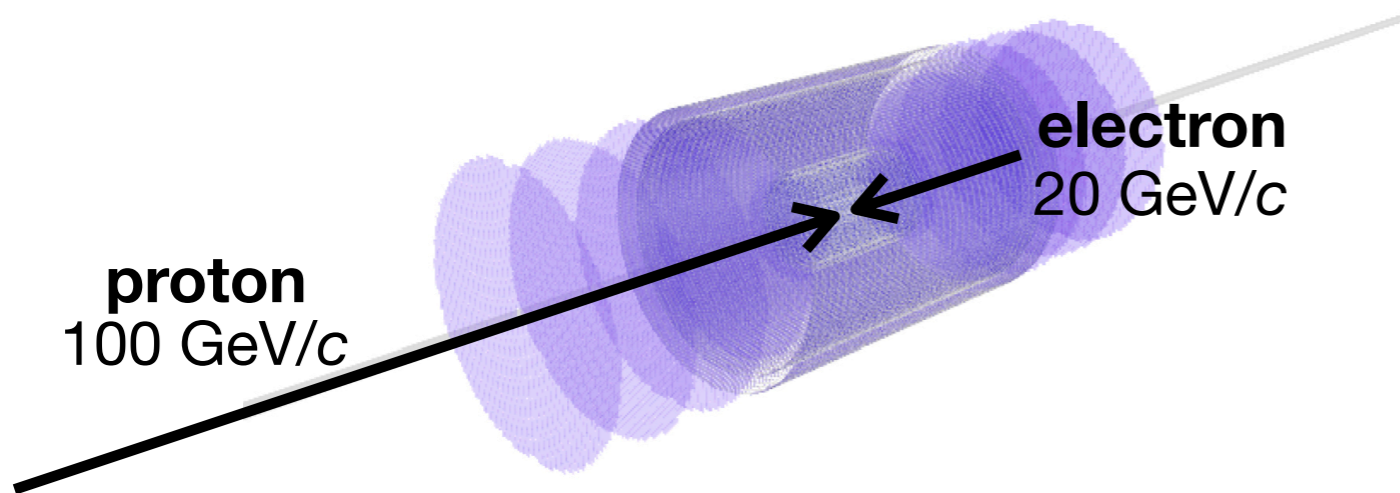
Pythia 8 and jet configuration*

- Back-to-back beams with different energies:
  - Beams:frameType=2
  - details here.

proton
100 GeV/c

electron
20 GeV/c

Jets:
AntiKt, R = 1.0

* reconstruction only with tracker
(i.e. no calorimetry info)

- Scattering $\mathrm{ff}' \to \mathrm{ff}'$ via $\gamma*/Z^0$ t-channel exchange (full interference between the $\gamma*$ and $\gamma*Z^0$):
  - WeakBosonExchange:ff2ff(t:gmZ) = on
  - details here.

- All Hard QCD processes on:
  - HardQCD:all = on
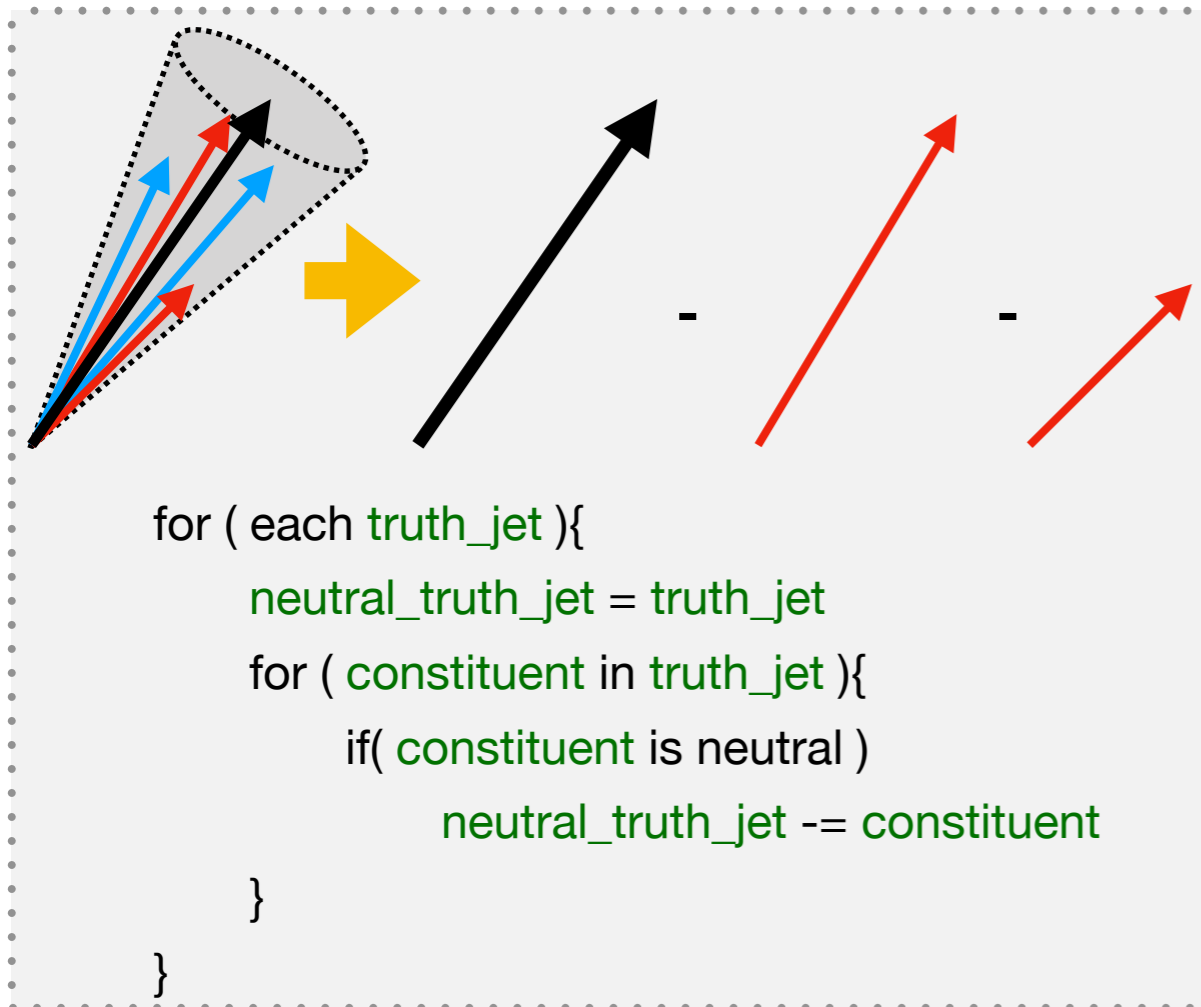 - details here.

$$Q^2 > 16 \; (\mathrm{GeV}/c^2)^2$$

Neutral-constituent contribution

We are using at the moment only tracker (i.e. the detector cannot "see" neutrals)
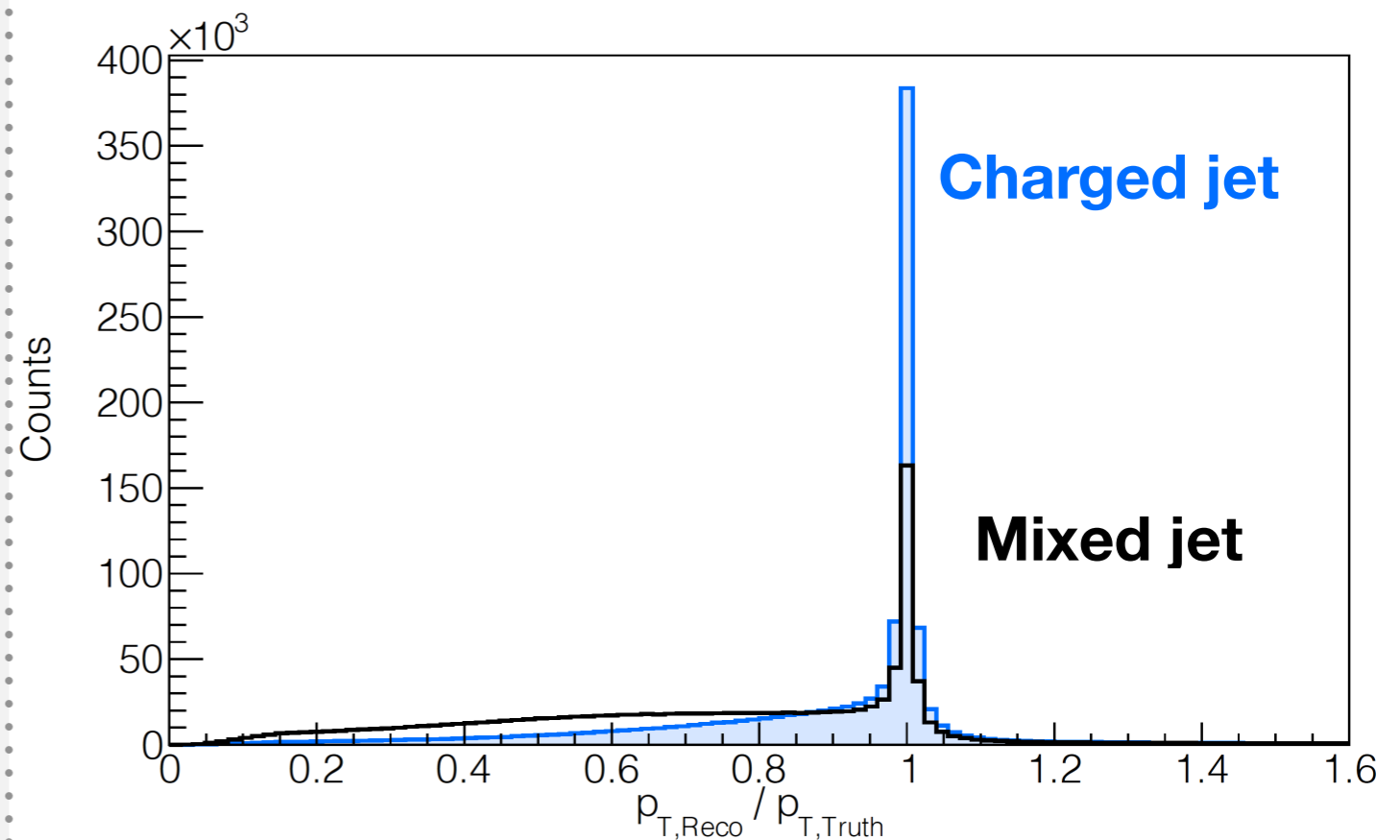
$$p^{jet,\,\mu}_{\text{truth}} = p^{jet,\,\mu}_{\text{charged}} + p^{jet,\,\mu}_{\text{neutral}}$$

Sum of charged constituent 4-momenta

Sum of neutral constituent 4-momenta

```
for ( each truth_jet ){
    neutral_truth_jet = truth_jet
    for ( constituent in truth_jet ){
        if( constituent is neutral )
            neutral_truth_jet -= constituent
    }
}
```

>1 constituent, mixed jet

Charged jet

Mixed jet

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Jet momentum resolution
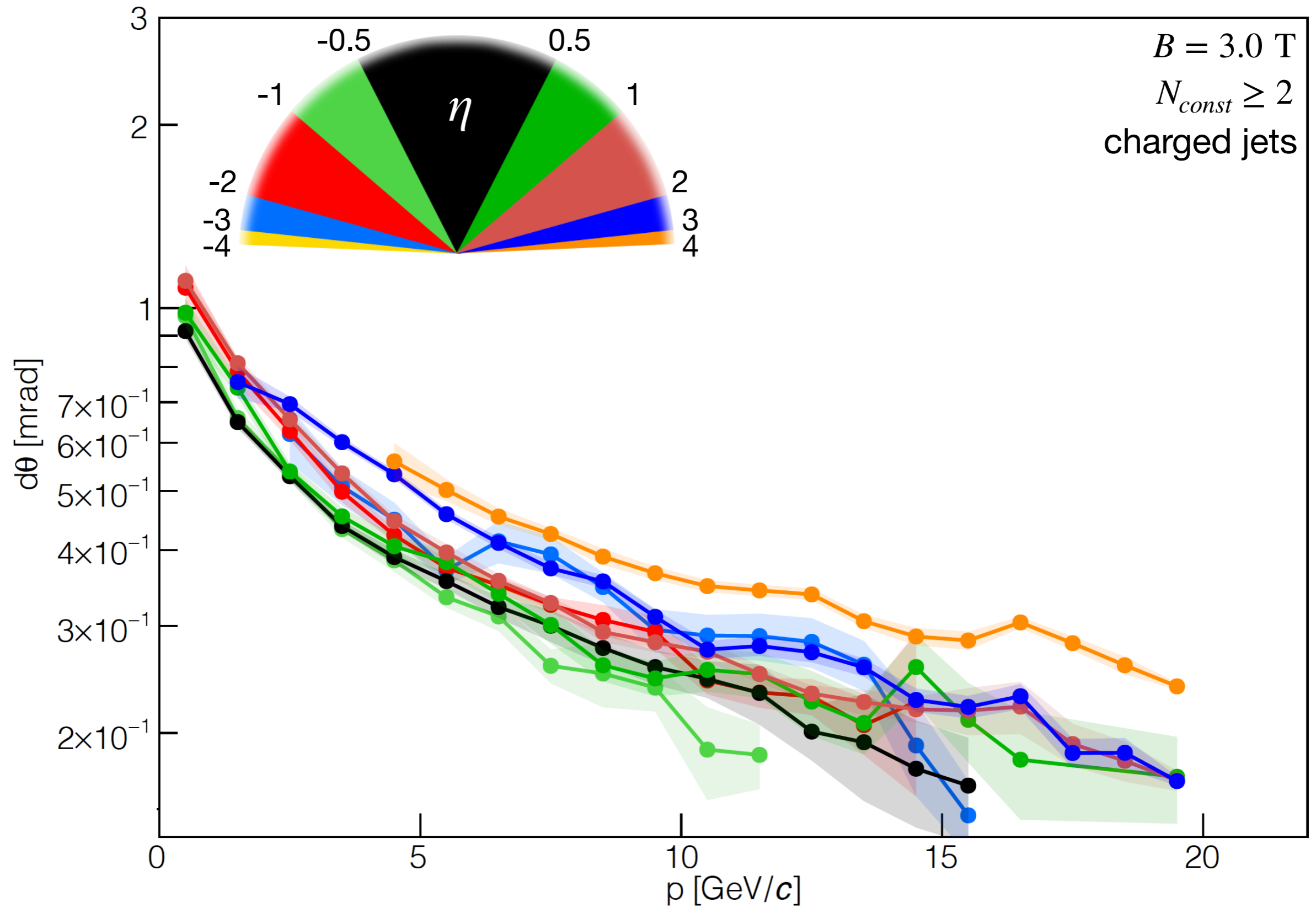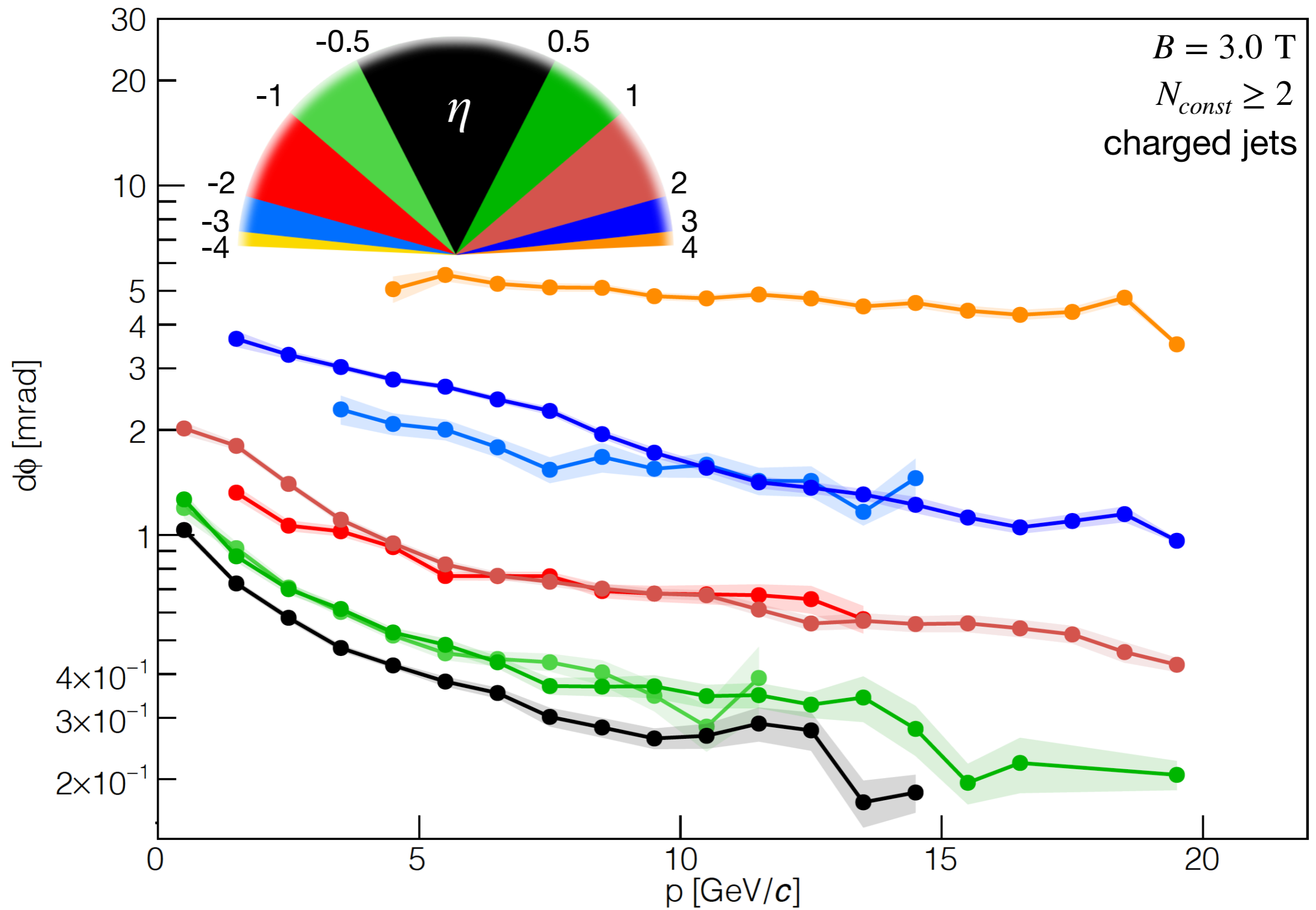
Jet theta resolution

Jet phi resolution

Summary and Conclusions

- Studied All-Silicon tracker prototype for the EIC

- Single particles:

    - **momentum** resolution: **~1%** for $|\eta| \lesssim 2.5$ (B = 3T)

    - $d\theta < 0.2$ **mrad**, $d\phi < 1$ **mrad** for $|\eta| \lesssim 2.5, p > 5$ GeV

- Tracker satisfies requirements outlined in <u>EIC detector handbook</u>

- Studied **jet** resolutions (for jets with $p < 20$ GeV/c):

    - **momentum** resolutions **< 0.7%** (for $|\eta| < 3$)

    - **theta** resolutions **< 1 mrad**

    - **phi** resolution **0.2 - 6 mrad**

Backup Slides

Pythia config file

```
Beams:idA = 2212   ! first beam, p = 2212, pbar = -2212
Beams:idB = 11     ! second beam, e = 11, ebar = -11
Beams:eA = 100     ! proton beam 100 GeV/c
Beams:eB = 20      ! electron beam 20 GeV/c
Beams:frameType=2  ! beams are back-to-back, but with different energies

! Settings related to output in init(), next() and stat()
Init:showChangedSettings = on
Main:timesAllowErrors=900000
Next:numberShowInfo = 1            ! print event information n times

! PDF
PDF:lepton=off
TimeShower:QEDshowerByL=off

! Process
WeakBosonExchange:ff2ff(t:gmZ)=on
HardQCD:all = on

! PhaseSpace
PhaseSpace:Q2Min=16
SpaceShower:pTmaxMatch=2

! Seed
Random:setSeed = on
Random:seed = 0
```