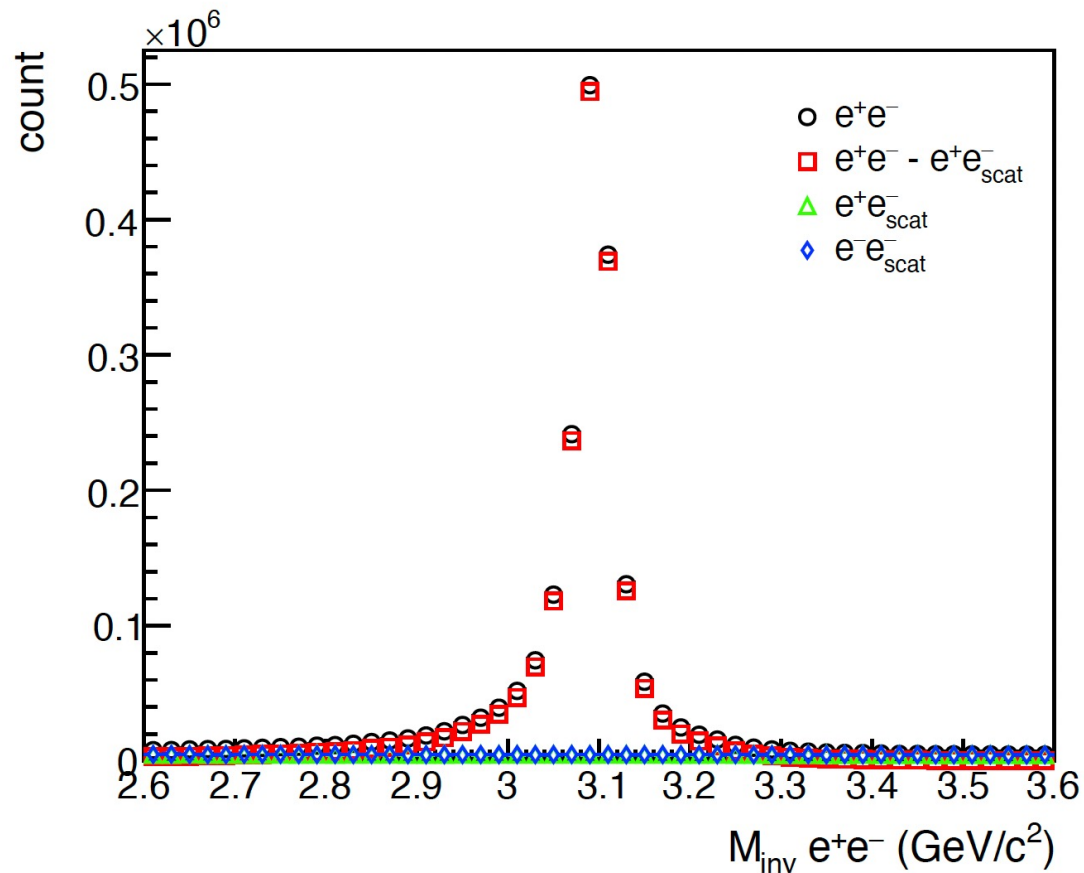


TPC Simulations in EicRoot

Cheuk-Ping Wong

01-27-2025

Last Update: Scattered Electron in J/ψ reconstruction

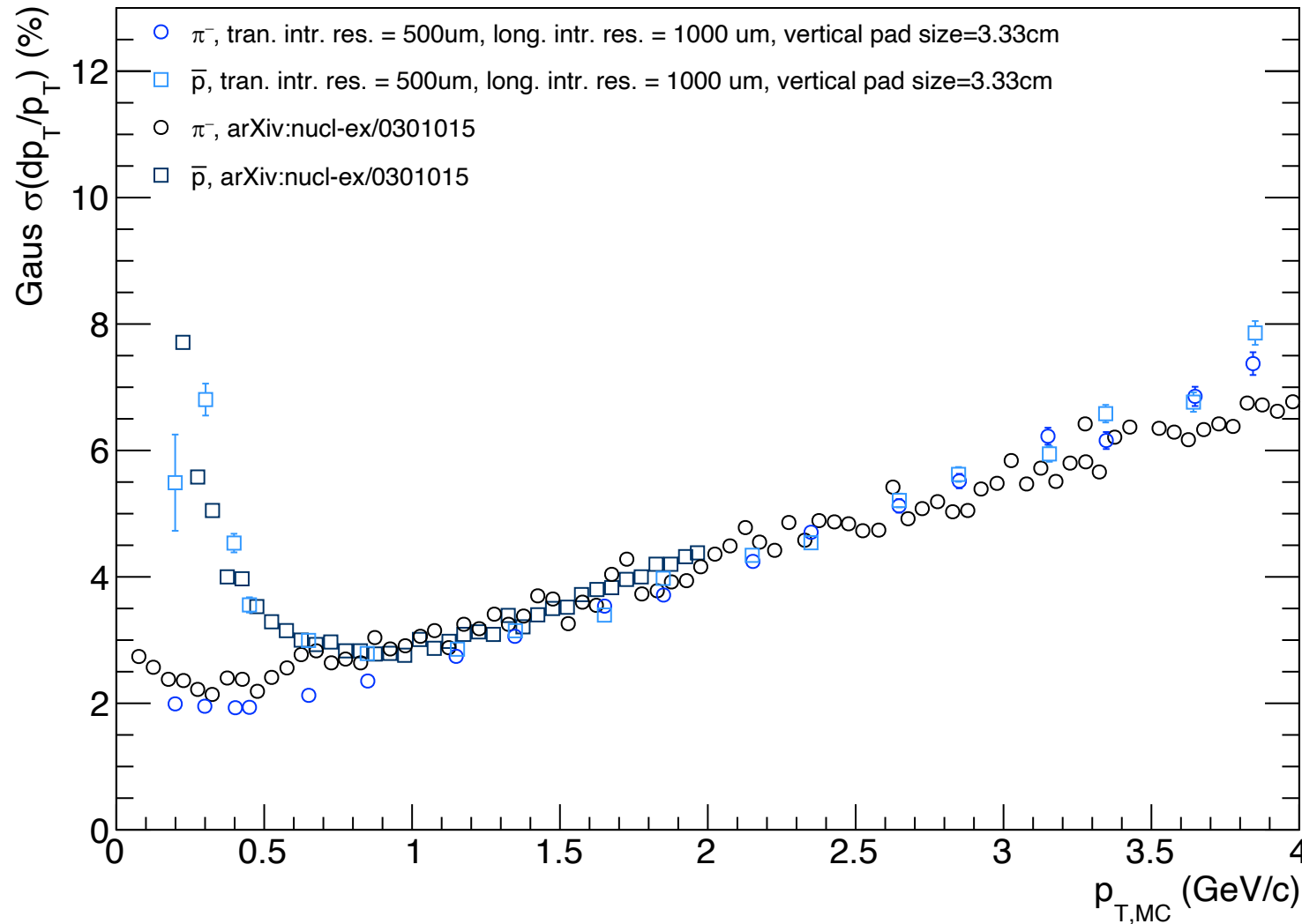


Like-sign pair subtraction in exclusive J/ψ reconstruction

What is the S/B ratio?

- $S/B > 13$ without $\eta_{J/\psi}$ selection
- $S/B \gg 100$ with $|\eta_{J/\psi}| < 1.5$ requirements

Reproduced STAR TPC Performance in EicRoot



Simplify digitization parameters in EicRoot

Transverse dispersion 1 um/ $\sqrt{cm}$

Longitudinal dispersion 1 um/ $\sqrt{cm}$

Transverse intrinsic resolution 500 um

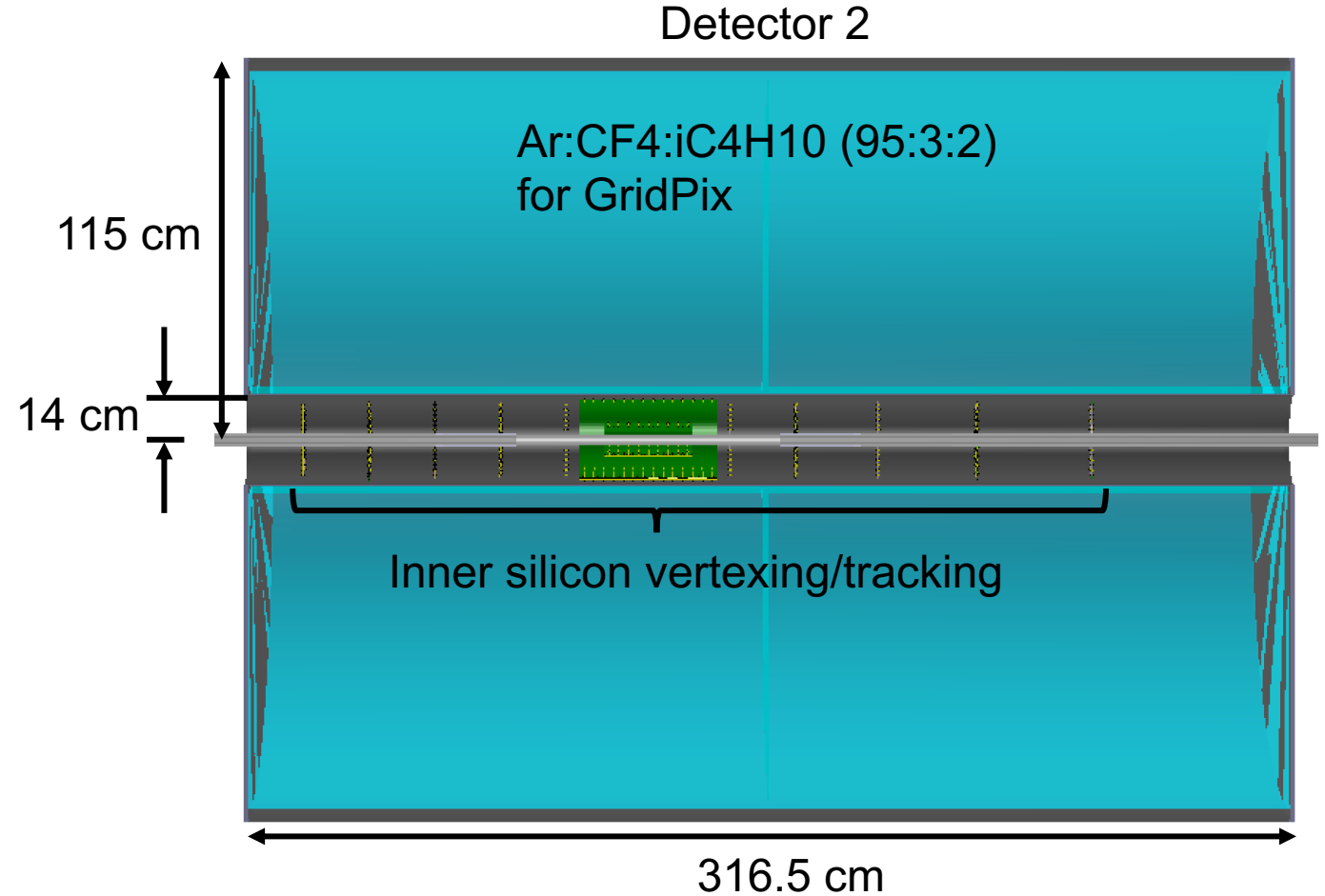
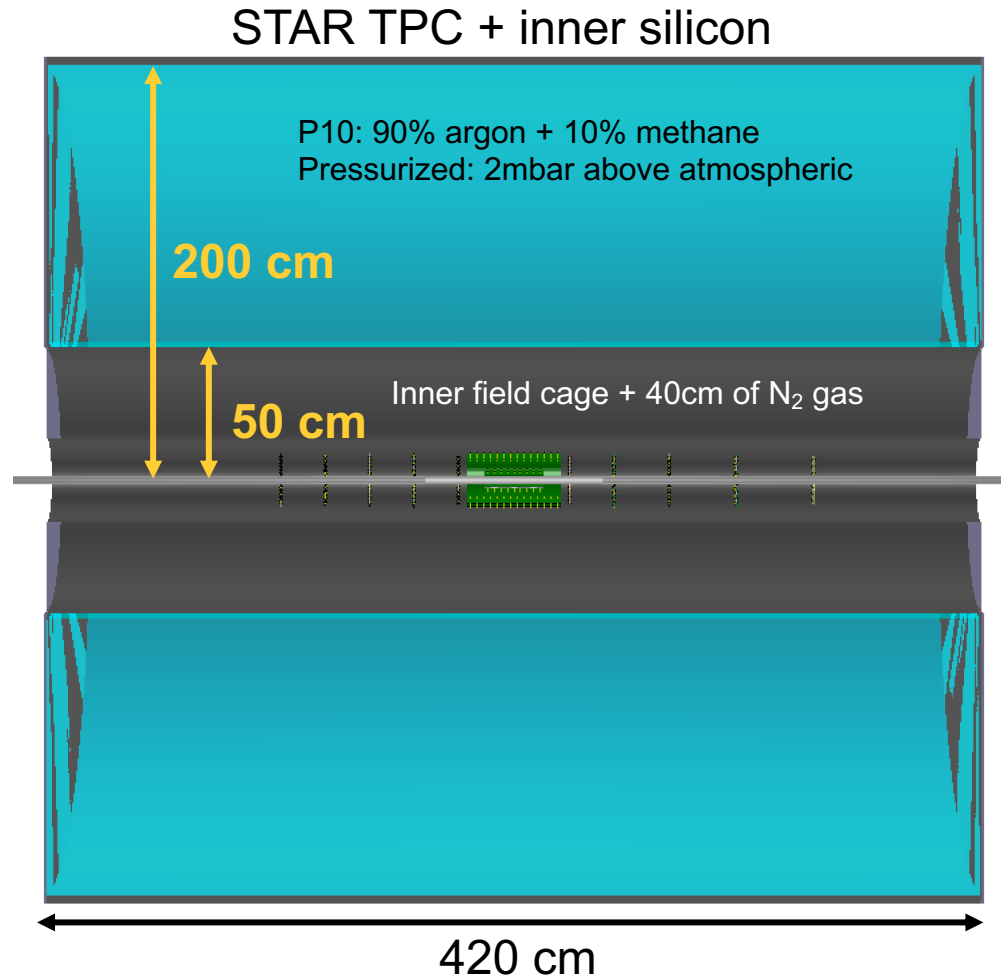
Longitudinal intrinsic resolution 1000 um

Radial intrinsic resolution 0 um

Vertical Pad Size 3.33 cm

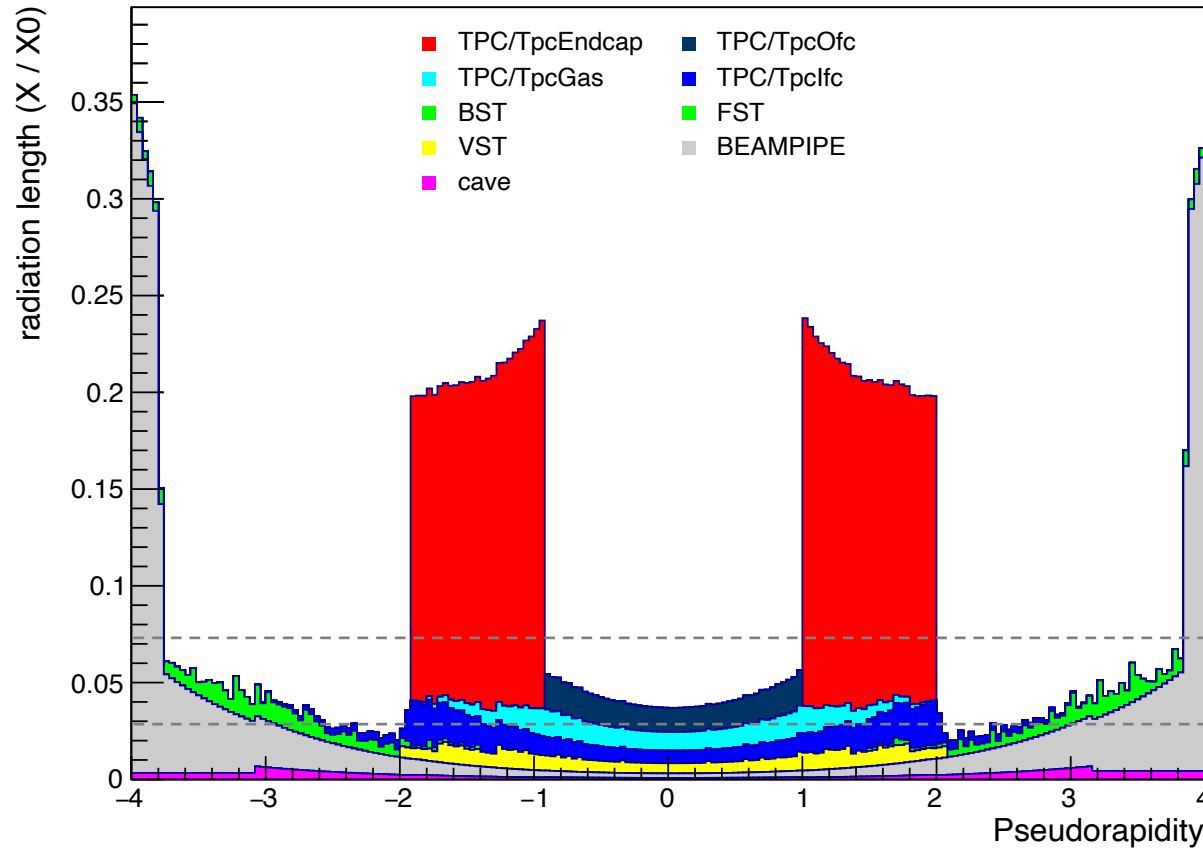
❖ Dispersion cannot be zero in EICRoot

Detector Setup

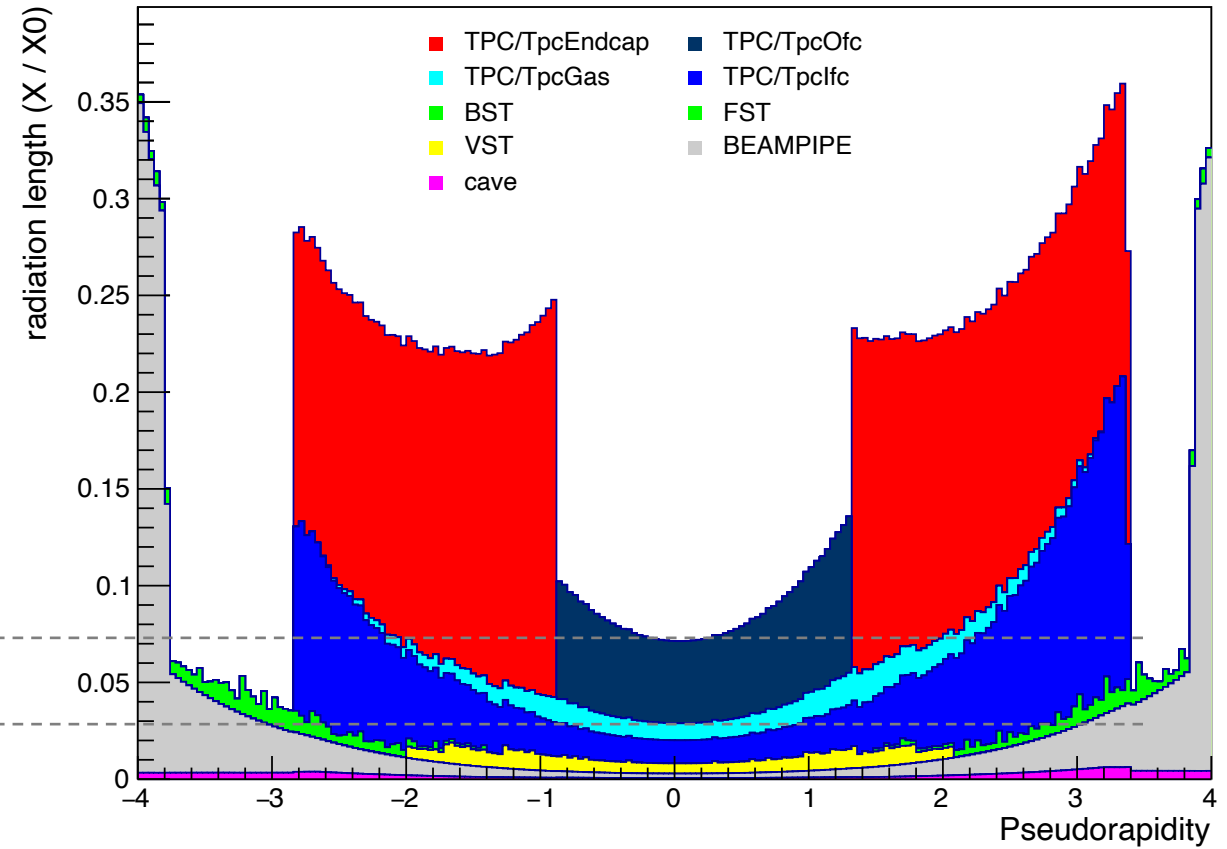


Material Budgets

STAR TPC + inner silicon



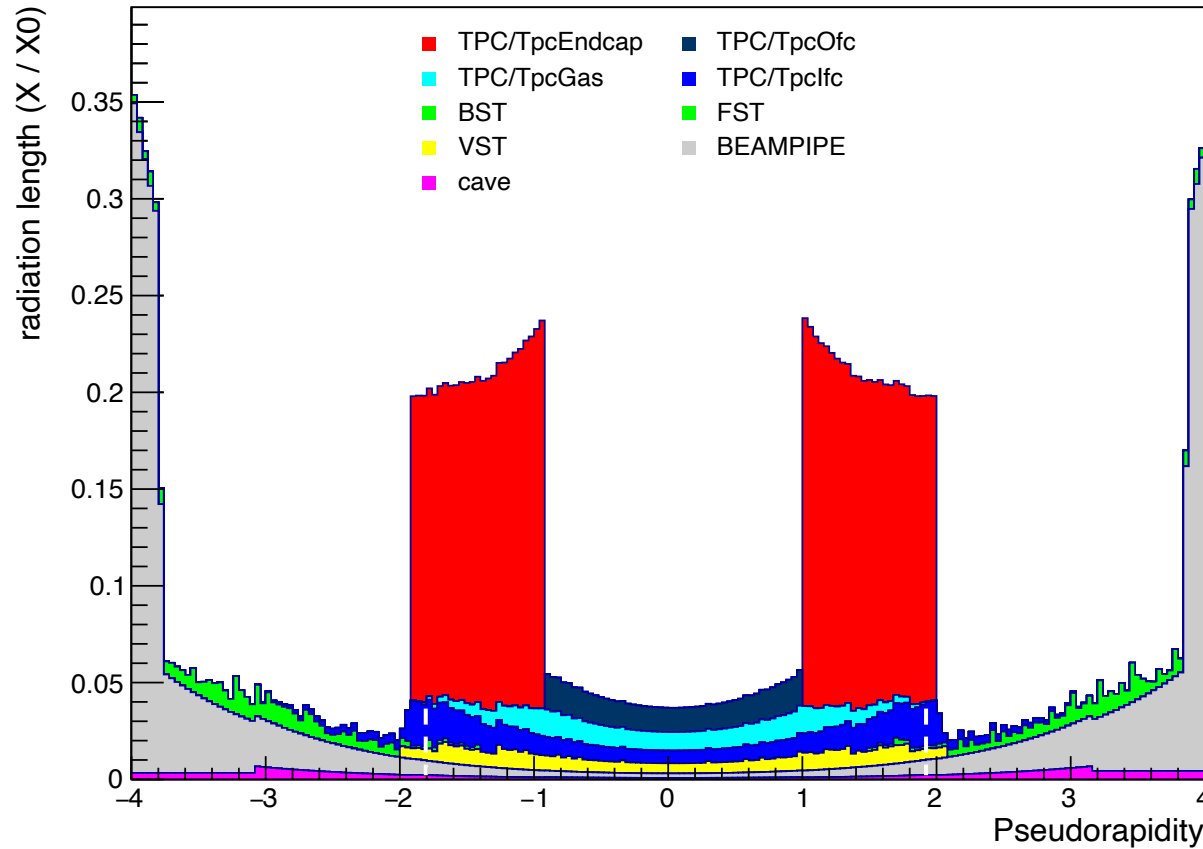
DET2 TPC + inner silicon



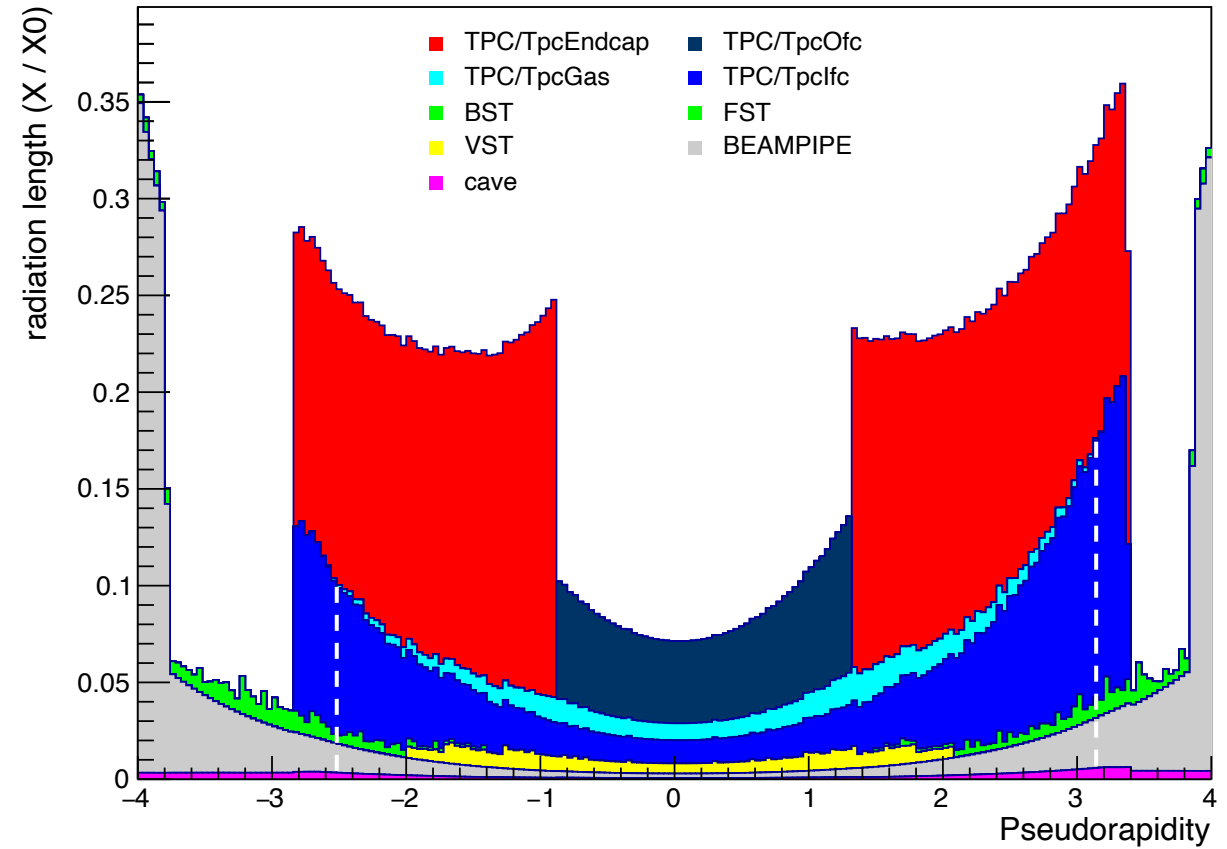
- DET2 TPC setup has thicker material budget than the STAR TPC

Material Budgets

STAR TPC + inner silicon



DET2 TPC + inner silicon



- DET2 TPC has a wider pseudorapidity coverage than the STAR TPC, because of the smaller inner radius

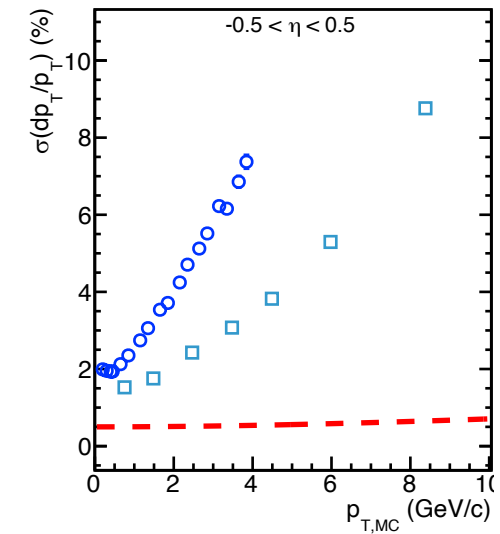
Digitization Parameters

GridPix parameters

	STAR TPC	DET2 TPC 1	DET2 TPC 2	DET2 TPC 3
transverse dispersion	$1 \mu\text{m}/\sqrt{\text{cm}}$	$1 \mu\text{m}/\sqrt{\text{cm}}$	$1 \mu\text{m}/\sqrt{\text{cm}}$	$1 \mu\text{m}/\sqrt{\text{cm}}$
longitudinal dispersion	$1 \mu\text{m}/\sqrt{\text{cm}}$	$1 \mu\text{m}/\sqrt{\text{cm}}$	$1 \mu\text{m}/\sqrt{\text{cm}}$	$1 \mu\text{m}/\sqrt{\text{cm}}$
transverse intrinsic resolution	500 μm	500 μm	$55/\sqrt{12} \mu\text{m}$	$55/\sqrt{12} \mu\text{m}$
longitudinal intrinsic resolution	1000 μm	1000 μm	$55/\sqrt{12} \mu\text{m}$	$55/\sqrt{12} \mu\text{m}$
radial intrinsic resolution	0 μm	0 μm	0 μm	0 μm
vertical pad size	3.33 cm	3.33 cm	3.33 cm	1 cm

- vertical pad size cannot be too small. Otherwise, reconstruction fails.
- GridPix: all the pads are squared ($55 \times 55 \mu\text{m}^2$) and fill 70% of active area $\rightarrow$ vertical pad size $\sim 0.00657 \text{ cm}$
- I tried vertical pad size = 0.1 mm. It got too many bad tracks (>50%) at $\eta \sim 0$

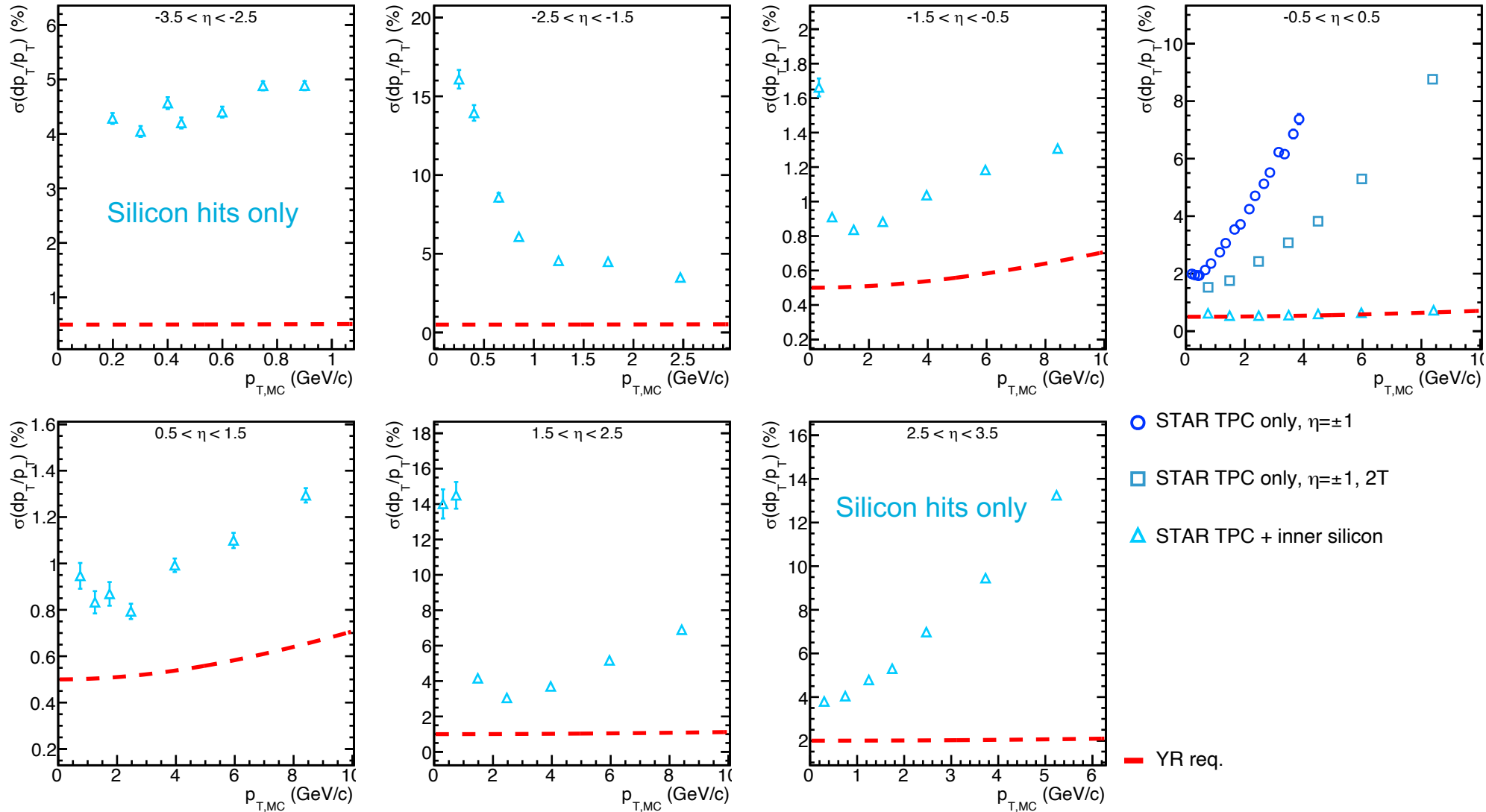
p_T Resolutions



○ STAR TPC only, $\eta = \pm 1$

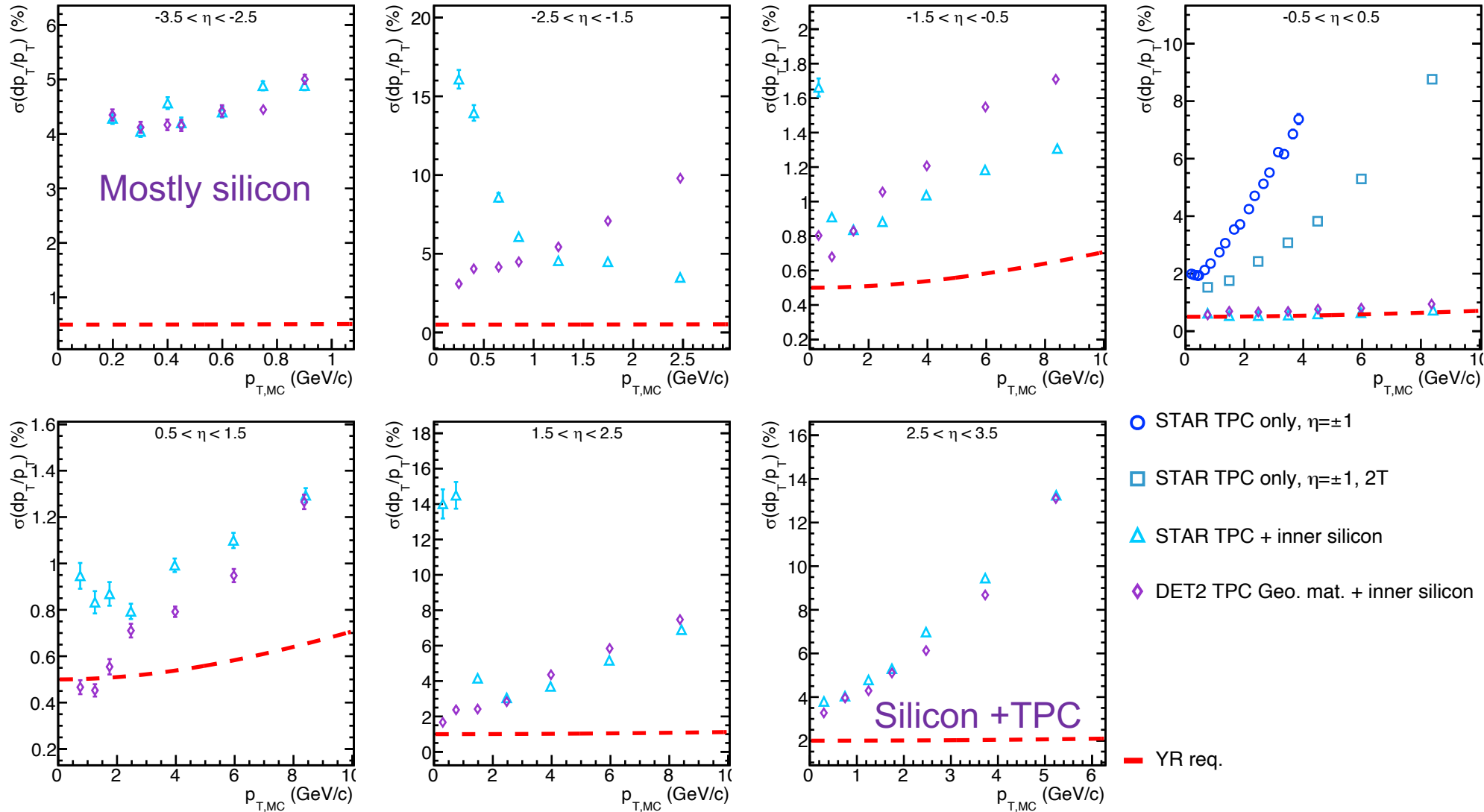
□ STAR TPC only, $\eta = \pm 1, 2T$

p_T Resolutions

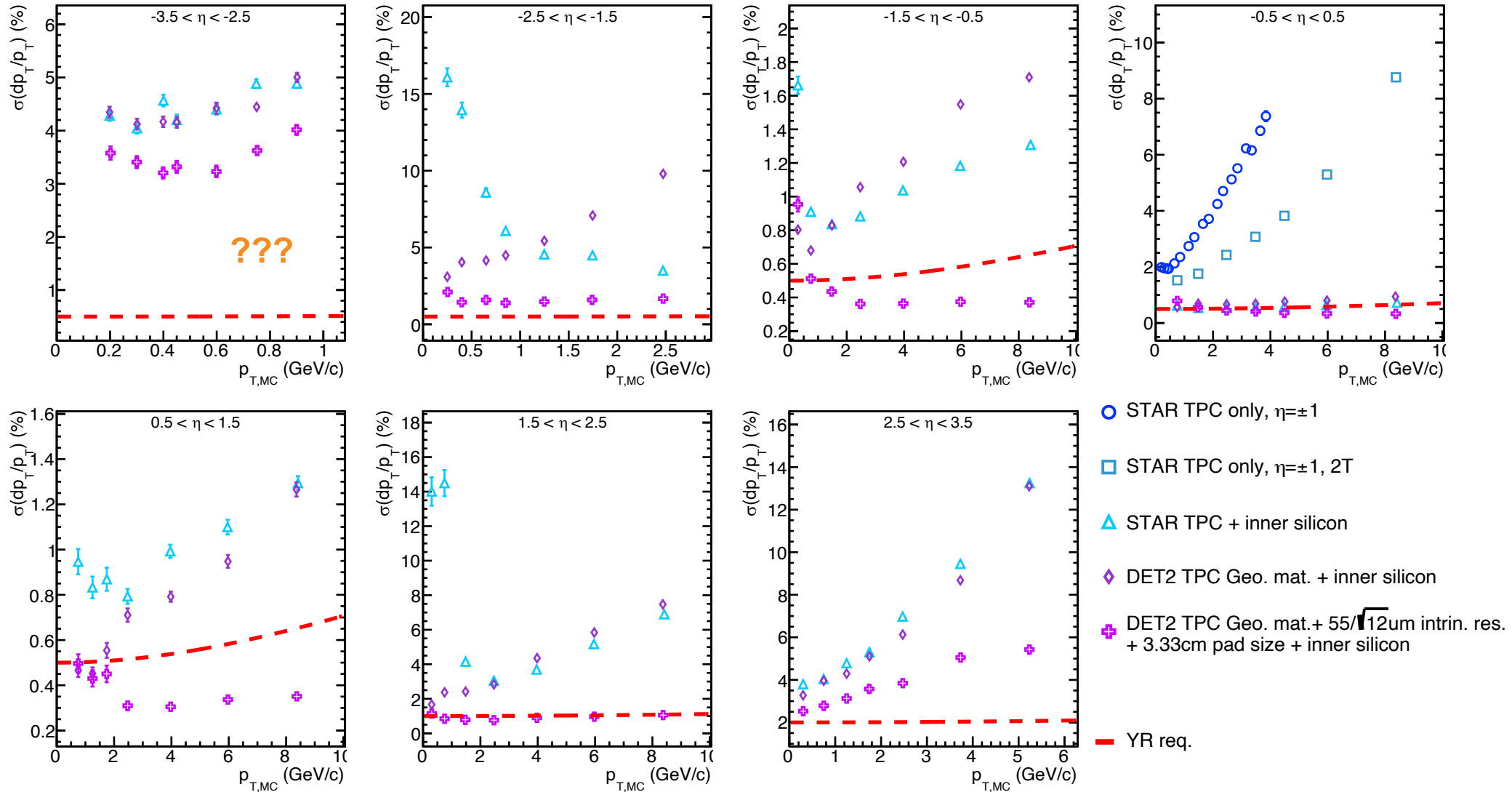


p_T Resolutions

- DET2 TPC has higher mat. budget
- But wider pseudorapidity coverage

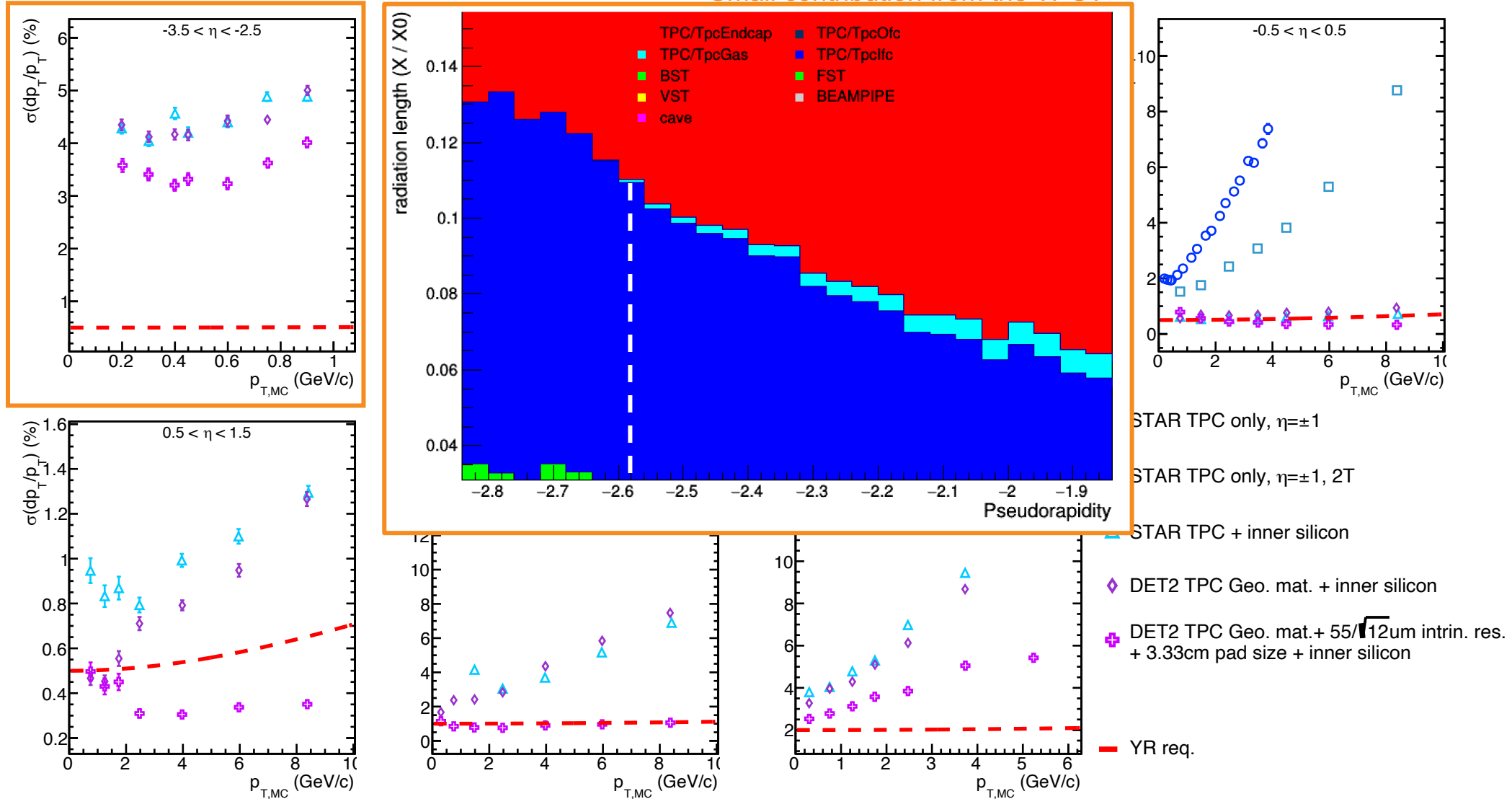


p_T Resolutions



p_T Resolutions

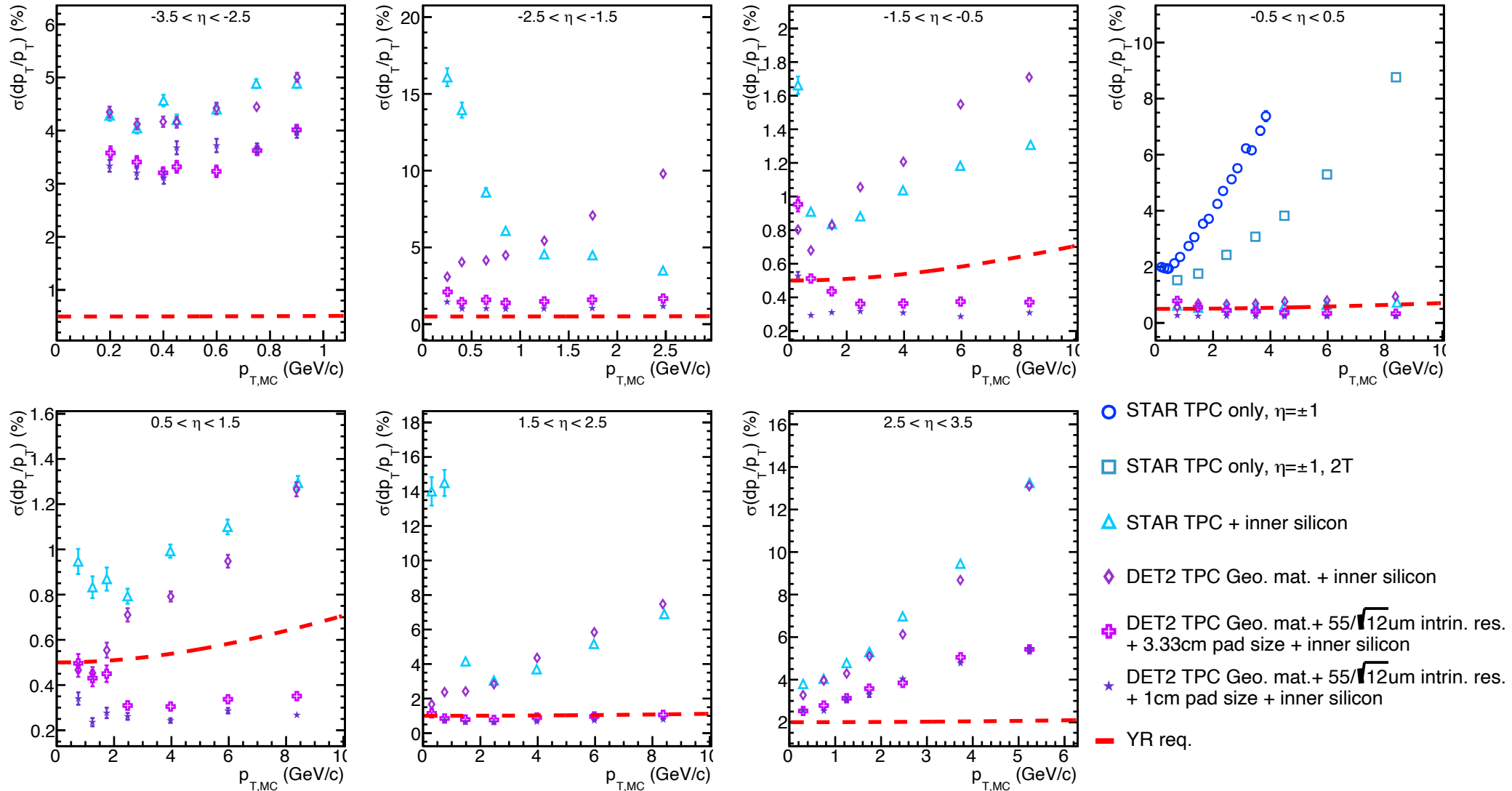
Small contribution from the TPC?



p_T Resolutions

• Satisfy YR requirements in $-1.5 < \eta < 2.5$

• For $|\eta| > 2.5$, we need to play around the silicon setup, and lower TPC inner field cage



Summary

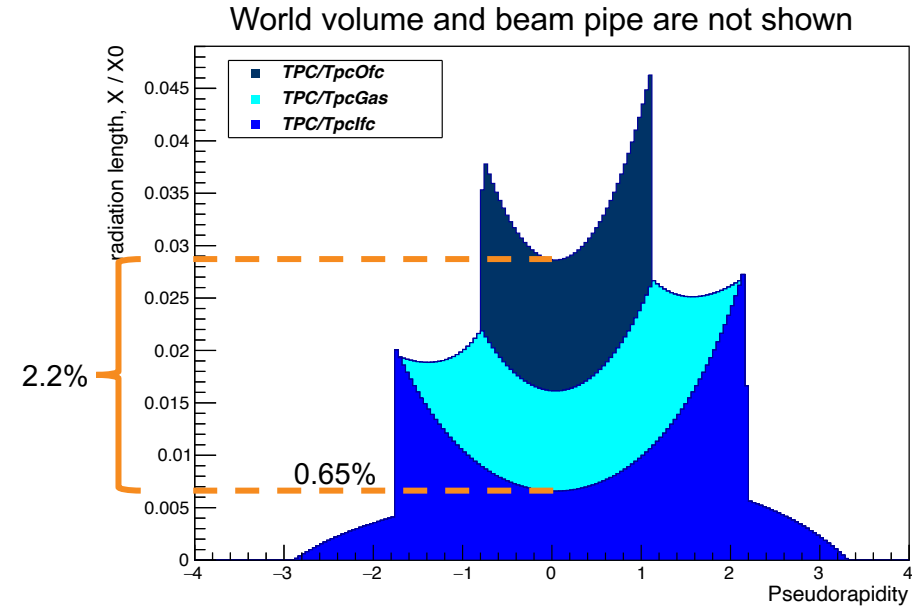
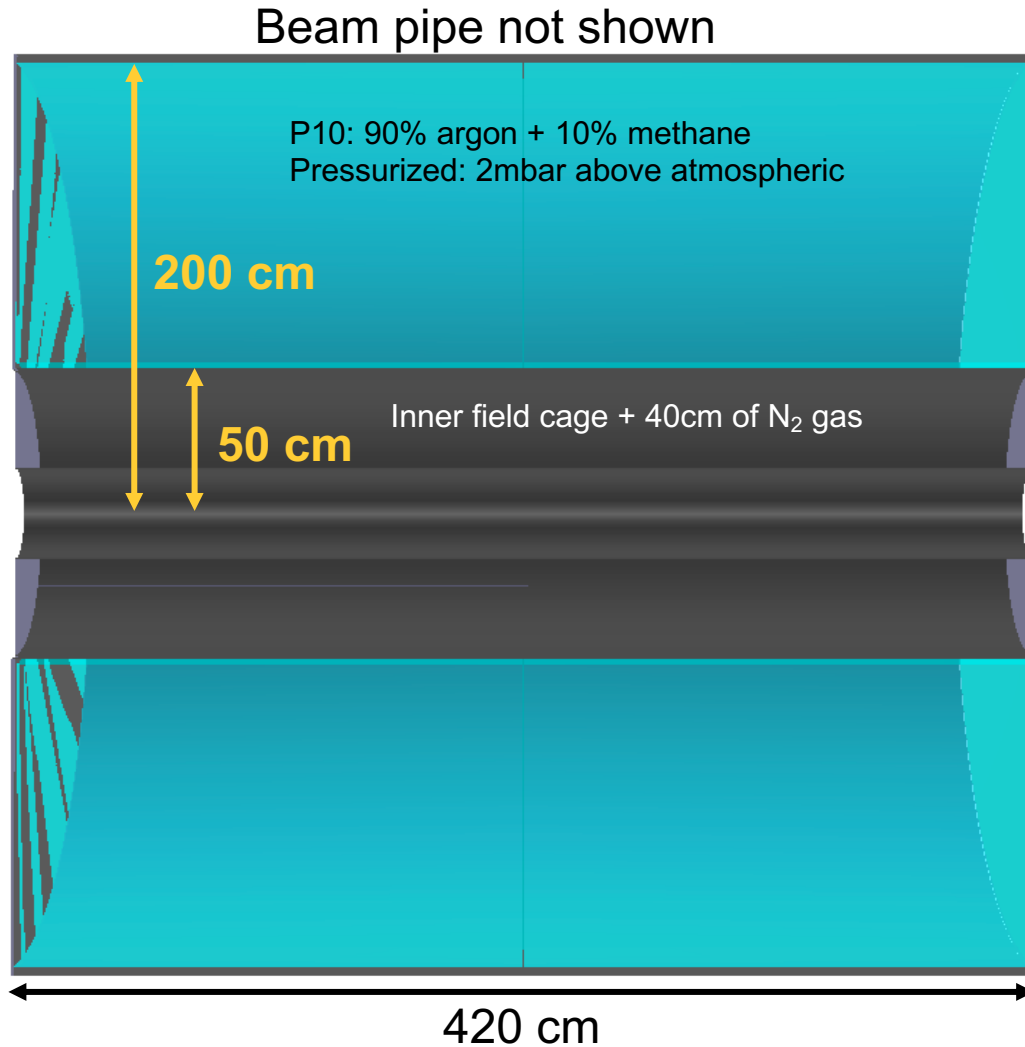
- Reproduced STAR TPC performance in EicRoot!
- Testing detector 2 tracking design: Gridpix TPC + inner silicon
 - Satisfy Yellow Report requirements at $-1.5 < \eta < 2.5$
 - At $\eta < -1.5$ or $\eta > 2.5$, we need to reduce TPC inner field cage materials and play around the inner silicon tracker layout

To-do List

- TPC simulations
 - TPC materials
 - Inner silicon layouts
 - Synchrotron radiation background effects on track reconstruction
 - FLUKA/GARFIELD → electron absorption in TPC and effect on the electric field
 - Add soft electrons in single track events? Ask Andrii?
- Angular resolutions for PID
- Simulation notes
 - The original note has been separated to two notes
 - One for tracking, and one for muon ID
 - Finish the draft of the tracking note. Let me go through the grammars with ChatGPT

Back Up

STAR TPC in EicRoot



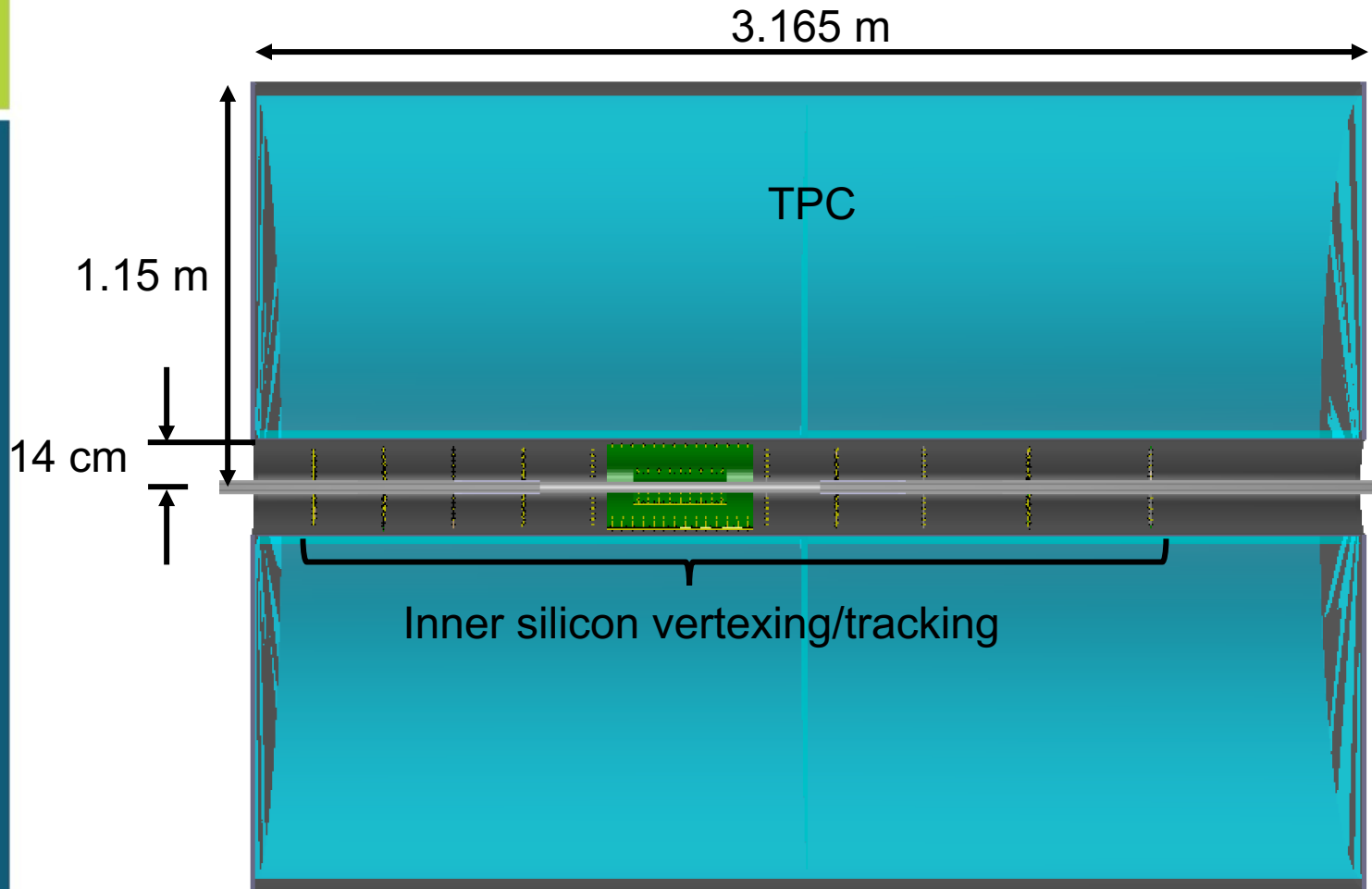
Inner field cage ($X/X_0=0.65\%$)

- N₂ 40 cm
- Al 0.004 cm
- Kapton 0.015 cm
- Nomex 1.27 cm
- Epoxy 0.08 cm

Outer field cage ($X/X_0=2.43\%$ including P10)

- Cu 0.013 cm
- Kapton 0.015 cm
- Nomex 0.953 cm
- Epoxy 0.05 cm

Detector Setup



TPC

- Gas: Ar:CF₄:iC₄H₁₀ (95:3:2)
- Field cage
 - carbon fiber
inner cage t=2.62mm
outer cage t=9.28mm
 - Kapton t=150um
 - Aluminum t =50um
- Central membrane: Kapton t=100um
- Endcaps:
 - aluminum t=13.4mm

Magnetic field

Constant 2T, solenoid