

TPC Simulations in EicRoot

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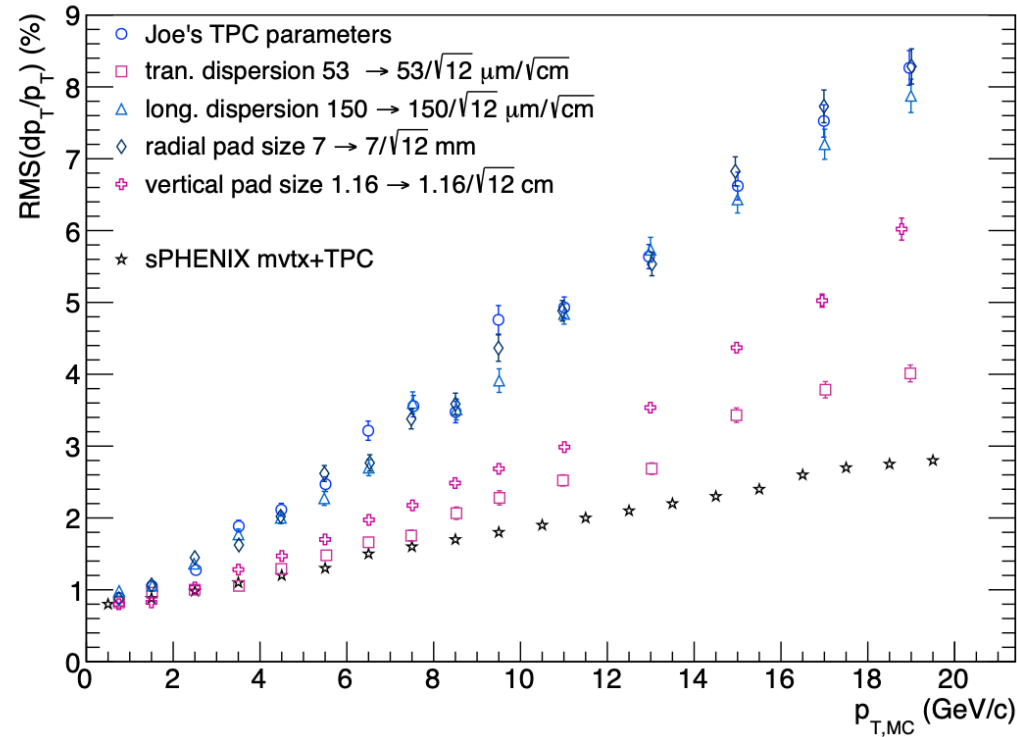
12-02-2024

Last Update

sPHENIX Tracking in EicRoot

11-08-2024

Testing Different TPC Digitization Parameters



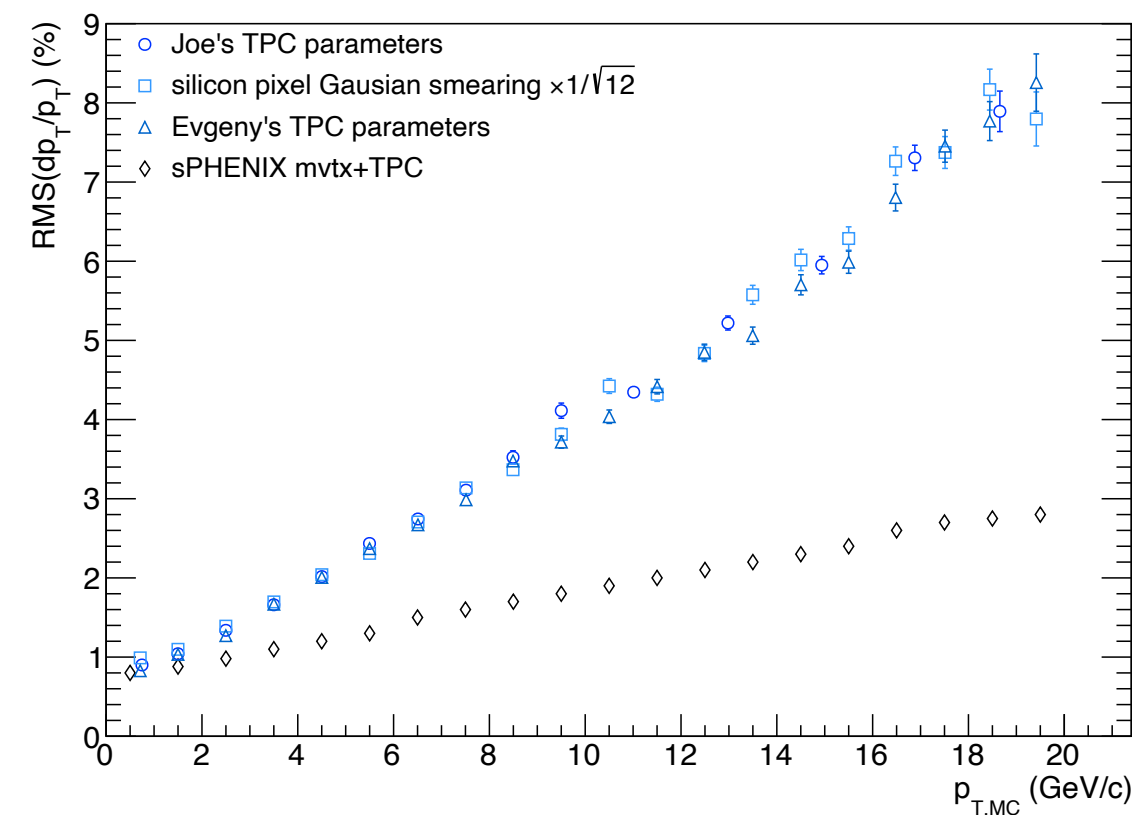
- p_T resolution is **sensitive** to the transverse dispersion and GEM vertical pad size

- p_T resolution is **insensitive** to the longitudinal dispersion and the radial pad size

To-do List

- Double check the digitization parameters of the MVTX
- Check material budgets
- Alexander will check the TPC code for better understanding of the TPC digitization parameters
- Check with Joe of the dispersion parameters
I sent an email to Joe before Thanksgiving, but I haven't heard back from him
- Simulate STAR TPC instead

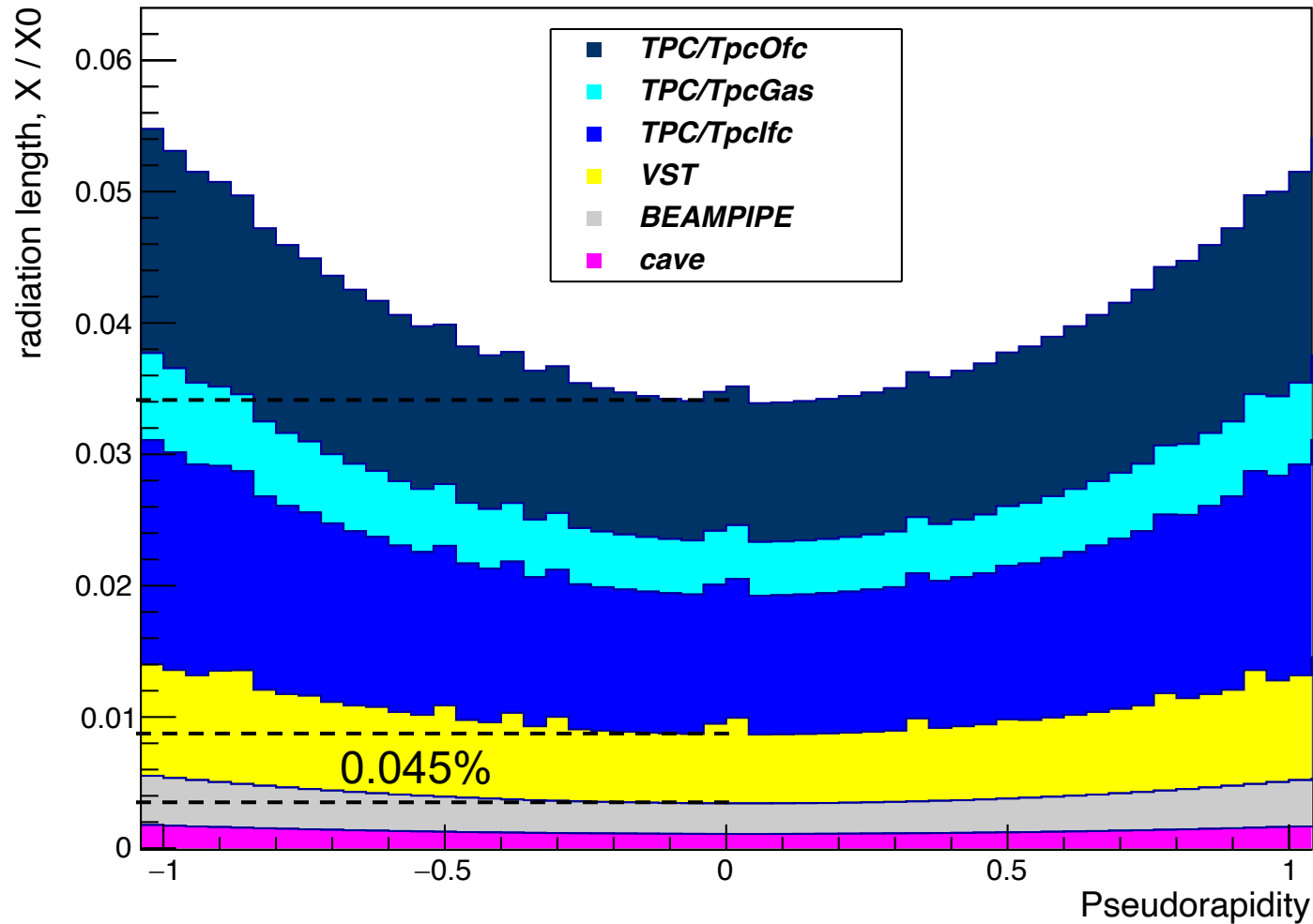
sPHENIX Tracking in EicRoot



	Joe's number	Evgeny's number
transverse dispersion	53 $\mu\text{m}/\sqrt{\text{cm}}$	53 $\mu\text{m}/\sqrt{\text{cm}}$
longitudinal dispersion	150 $\mu\text{m}/\sqrt{\text{cm}}$	150 $\mu\text{m}/\sqrt{\text{cm}}$
transverse intrinsic resolution	150 μm	70 μm https://arxiv.org/pdf/2101.12134
longitudinal intrinsic resolution	500 μm	1 μm
radial intrinsic resolution	7mm	0.5mm
GEM vertical pad size	0.96cm	0.96cm

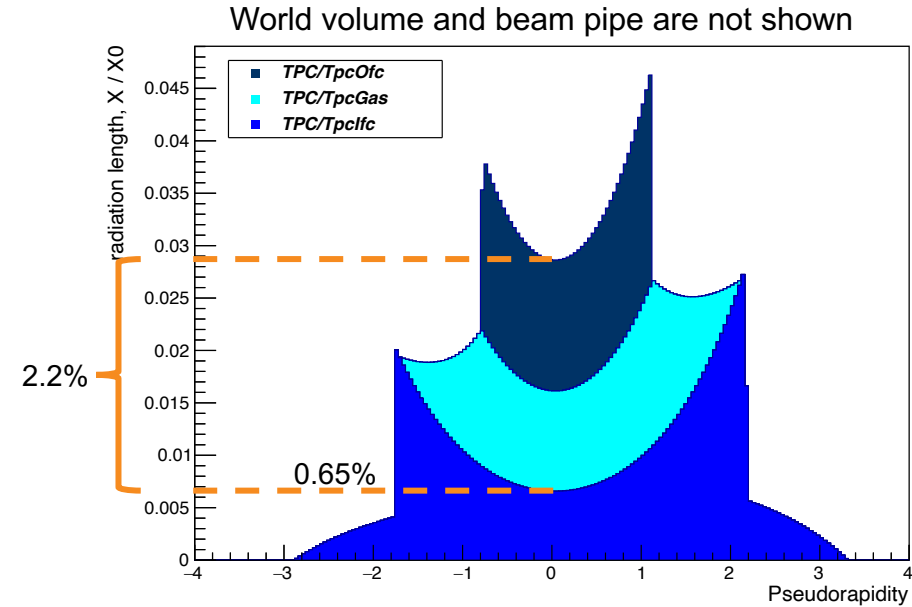
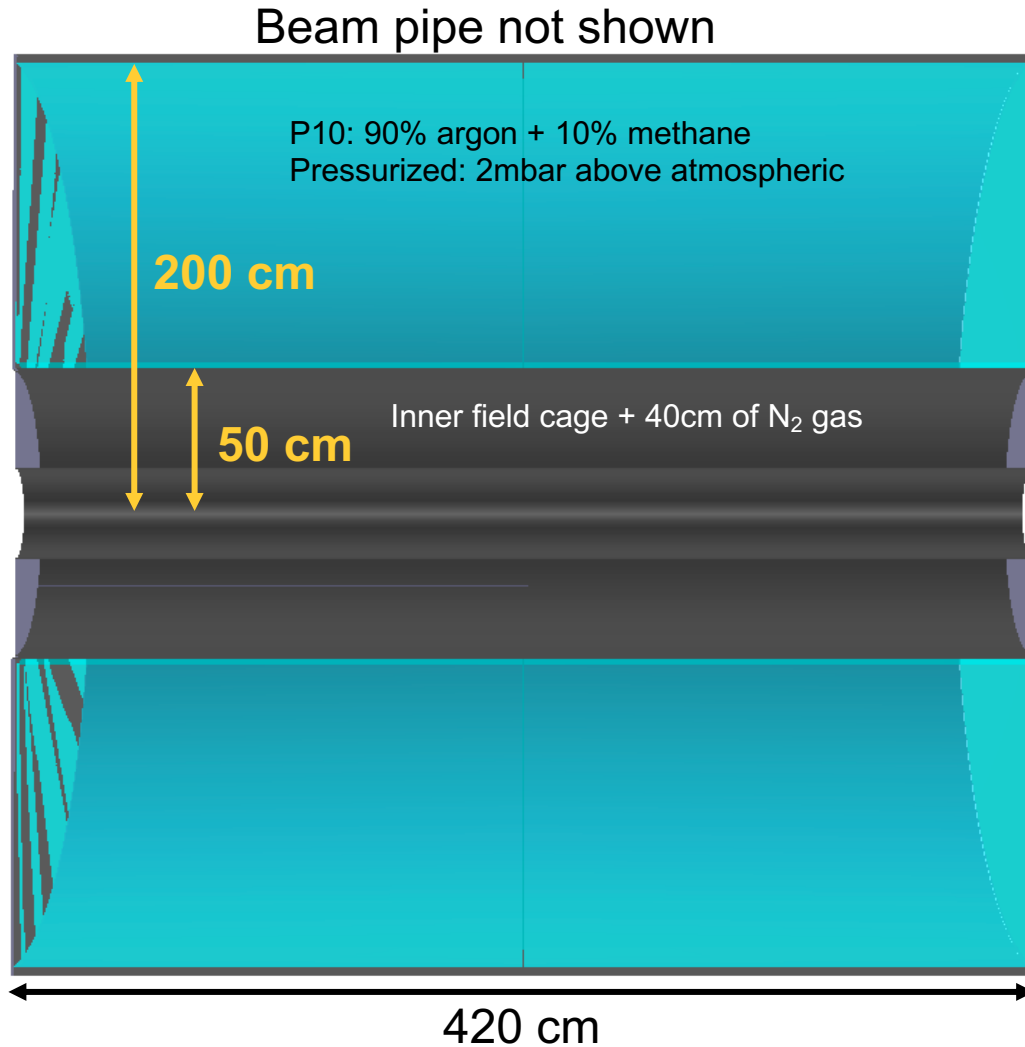
Transverse and longitudinal intrinsic resolutions does not have a significant impact on p_T resolutions

Material Budget for the sPHENIX Tracking Setup



- MVTX material budget is higher than stated in reference (0.03%), BUT INTT is not implemented in the setup
- TPC material budget ~2.5%

STAR TPC in EicRoot



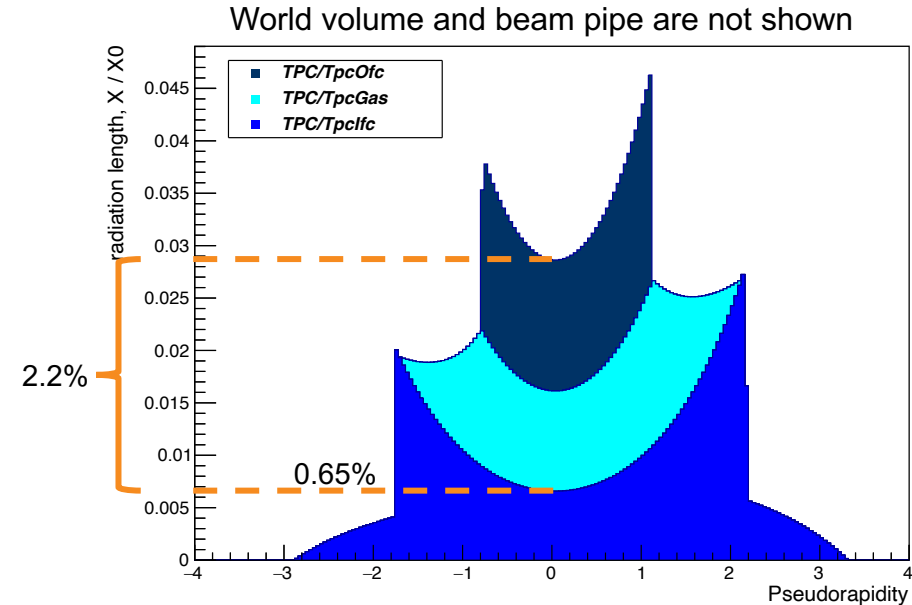
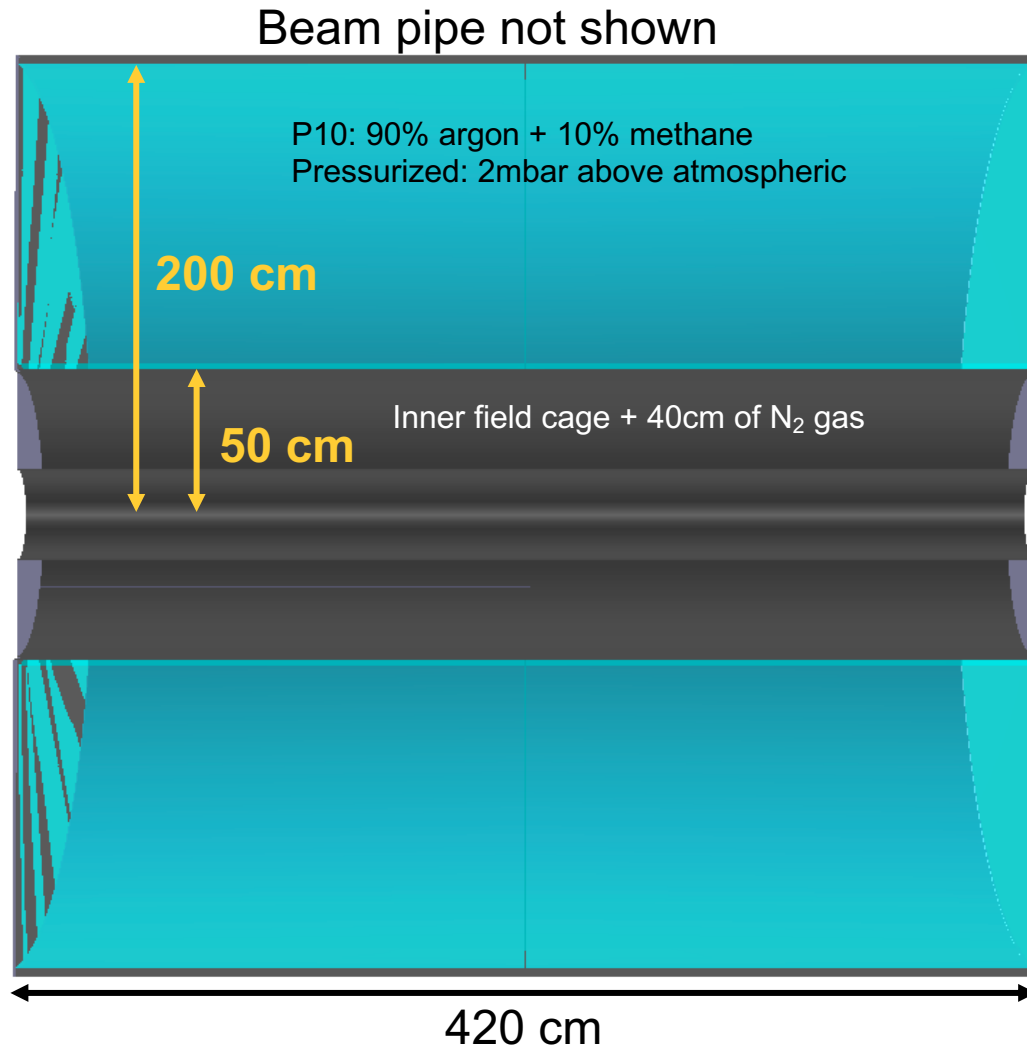
Inner field cage
($X/X_0=0.65\%$)

- 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

STAR TPC in EicRoot



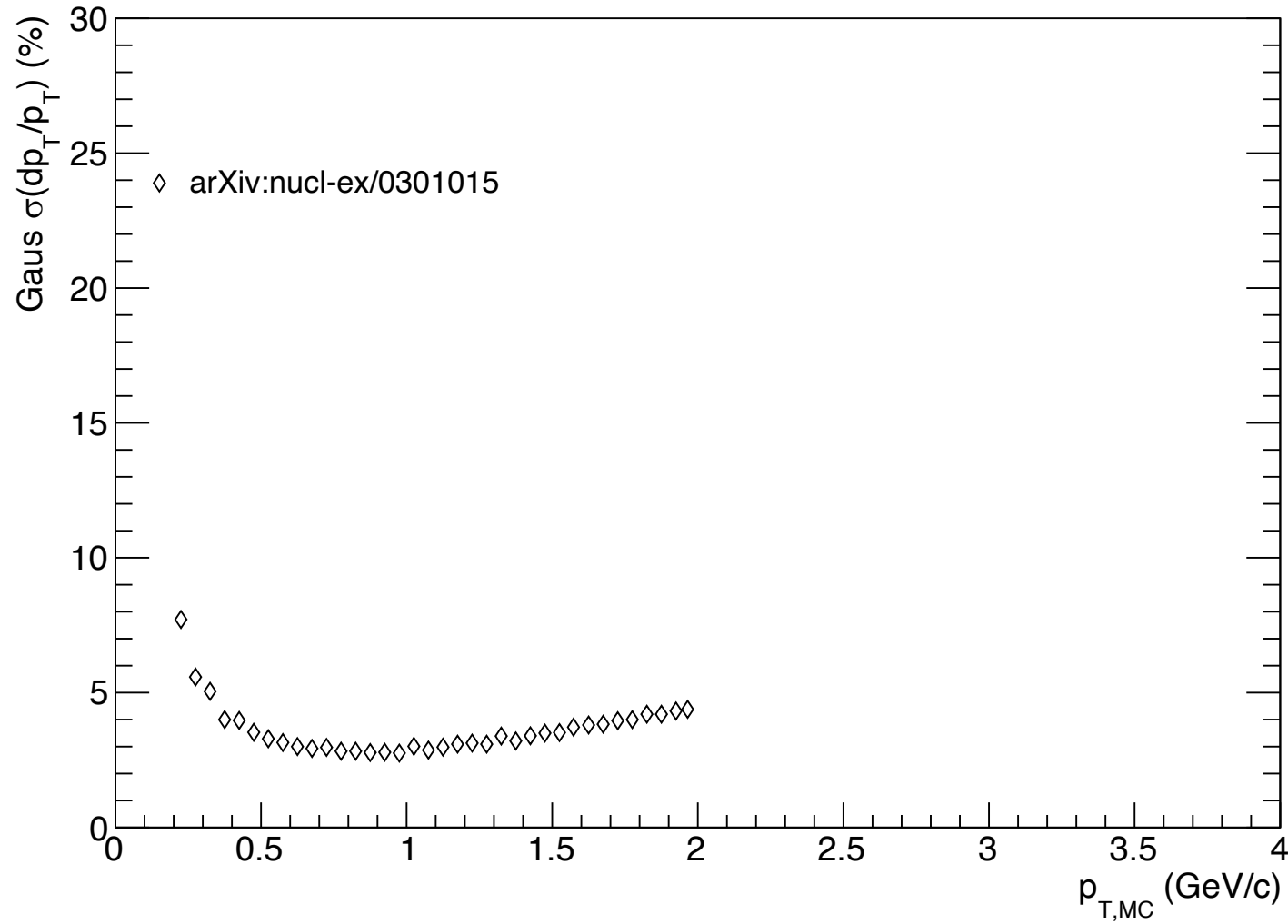
- Drift velocity 5.45 cm/us
- Transverse diffusion 230 $\mu\text{m}/\sqrt{\text{cm}}$
- Longitudinal diffusion 360 $\mu\text{m}/\sqrt{\text{cm}}$
- Inner pad row=13, outer pad row=32
→ avg vertical pad size = $(200-50)/(13+32)=3.33$ cm

TPC Digitization Parameters

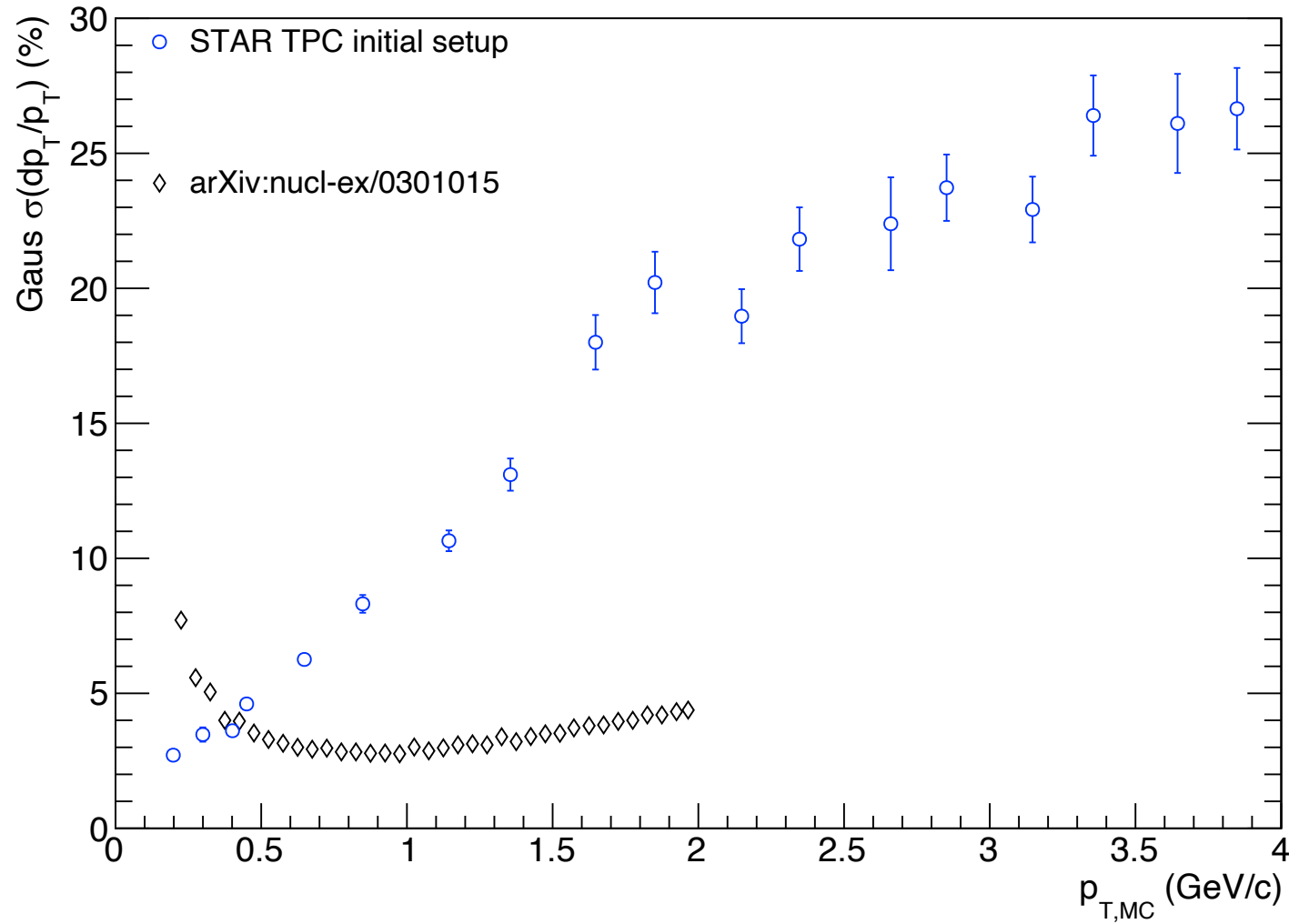
	arXiv:nucl-ex/0301015	What I put in
transverse dispersion	$230 \mu\text{m}/\sqrt{\text{cm}}$	$230 \mu\text{m}/\sqrt{\text{cm}}$
longitudinal dispersion	$360 \mu\text{m}/\sqrt{\text{cm}}$	$360 \mu\text{m}/\sqrt{\text{cm}}$
transverse intrinsic resolution	??	200 μm
longitudinal intrinsic resolution	??	500 μm
radial intrinsic resolution	??	0 μm
GEM vertical pad size	Inner pad row =13 Outer pad row=32	$(200-50)\text{cm}/(13+32)\text{row}=3.33\text{cm}$

- Emailed Gene, and then Gene forward my questions to Jim Thomas at Berkely.
- Jim said on last Wednesday that he need a few days to extract the parameters for me

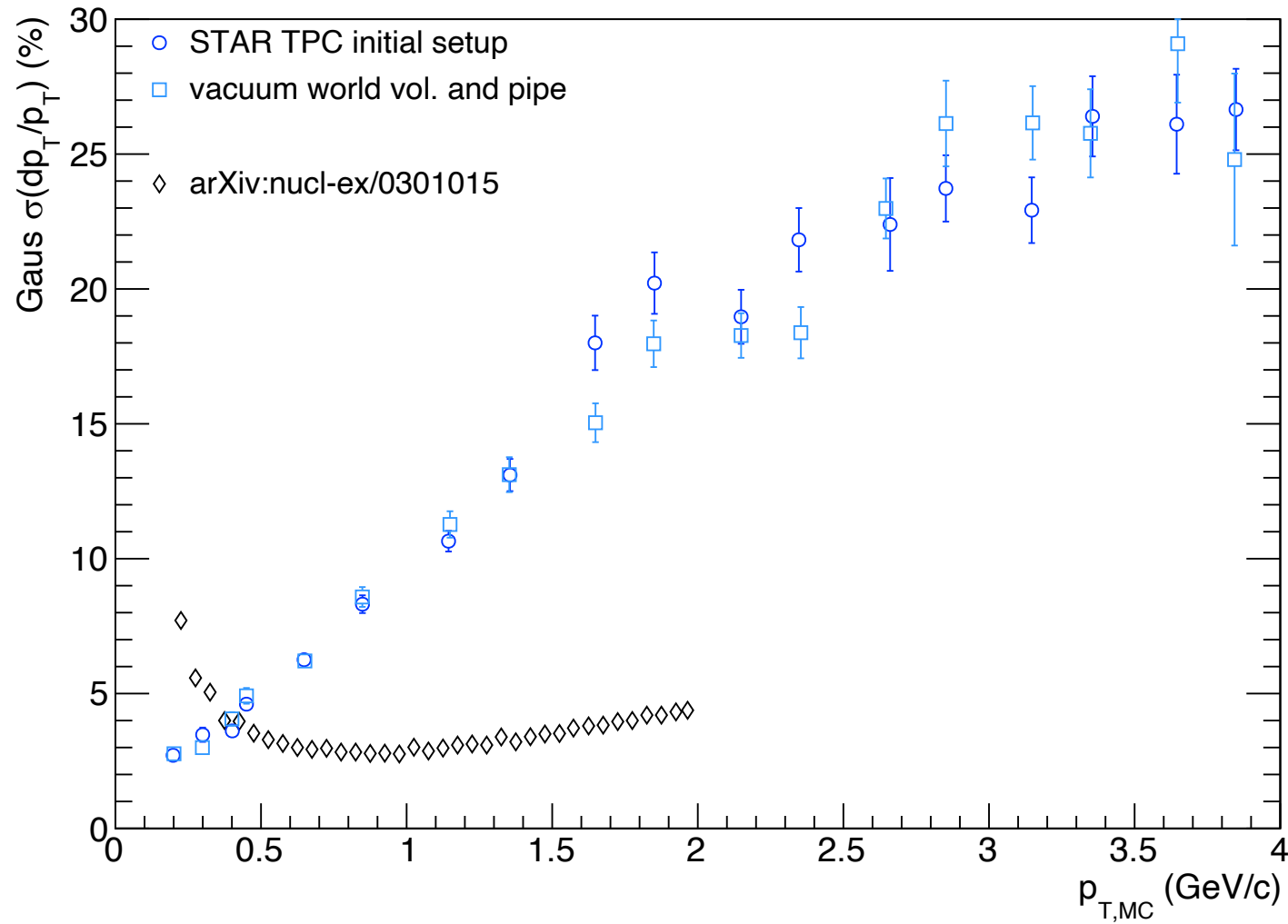
STAR TPC p_T Resolutions



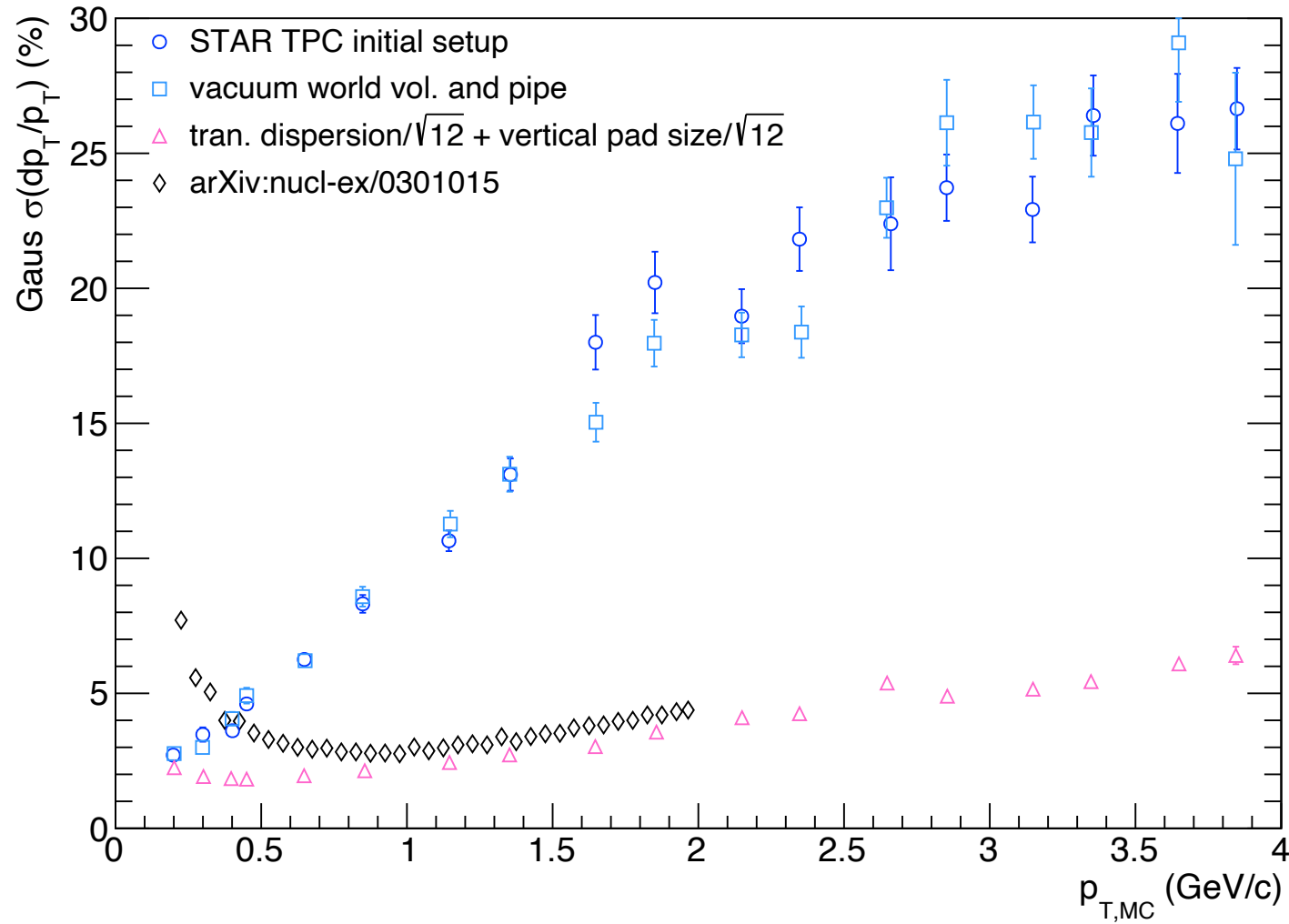
STAR TPC in EicRoot



STAR TPC in EicRoot



STAR TPC in EicRoot



Summary

- Transverse and longitudinal intrinsic resolutions does not have a significant impact on p_T resolutions
- Material implementation seems reasonable
- Implemented STAR TPC in EIC
 - Same issue as the sPHENIX tracking setup

To-do List

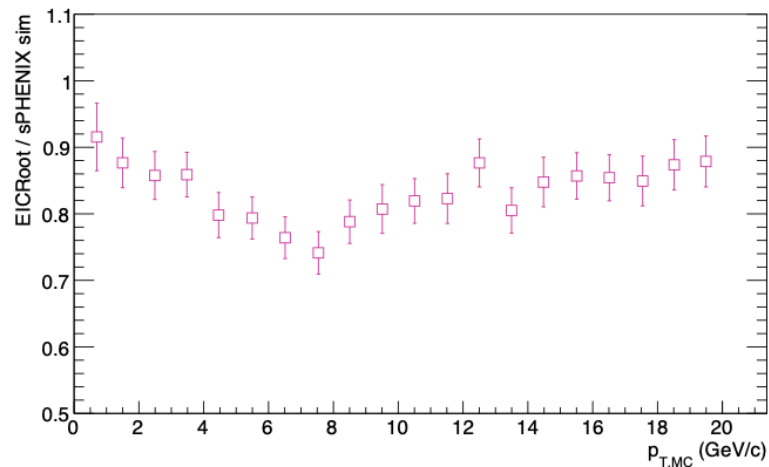
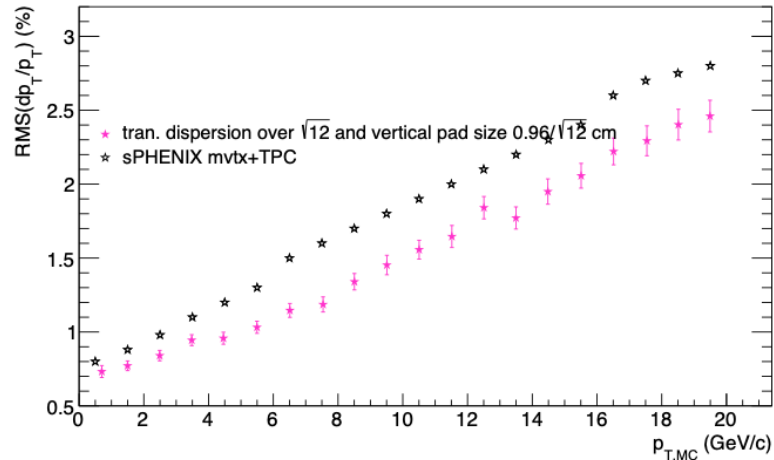
- I talked to Evgeny about setting up GridPix TPC in EicRoot
- I am running simulation with this new setup

Backup

sPHENIX Tracking in EicRoot

11-08-2024

Combined All the Changes



Black markers: Fun4all + ACTS

Pink markers: EICRoot

- Reduce the TPC size from $20 < r < 78$ cm to $30 < r < 78$ cm
- Reduce the transverse dispersion from $53 \mu\text{m}/\sqrt{\text{cm}}$ to $53/\sqrt{12} \mu\text{m}/\sqrt{\text{cm}}$
- Reduce GEM vertical pad size from $(78\text{cm}-20\text{cm})/50 \text{ hits} = 1.16 \text{ cm}$ to $(78\text{cm}-30\text{cm})/50 \text{ hits}/\sqrt{12} = 0.96/\sqrt{12} \text{ cm}$
- Now the p_T resolution from EICRoot is better than the sPHENIX simulation by ~20%-ish
- The discrepancy may also be stemmed from lacking realistic materials, like the INTT between the MVTX and the TPC, or supporting/cooling structure