

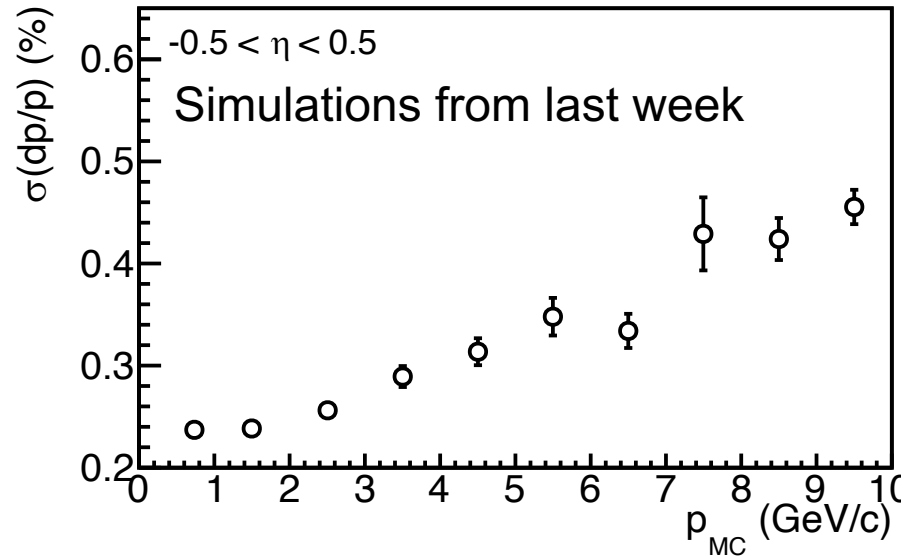
Tracking Simulation in EICRoot

Cheuk-Ping Wong

11-04-2024

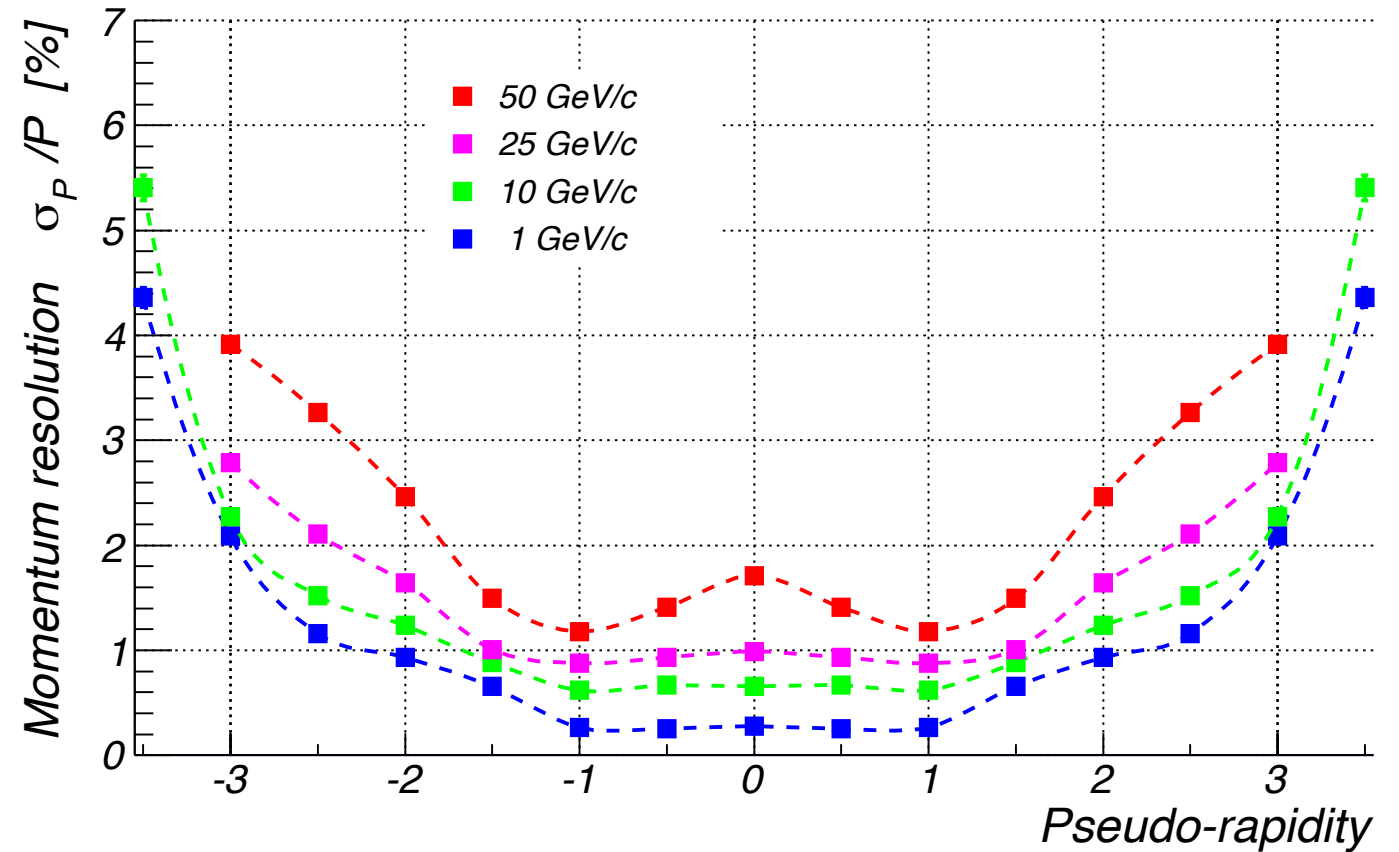
Cross-Checking with Alexander's Simulation

My TPC is ~50cm bigger in radius



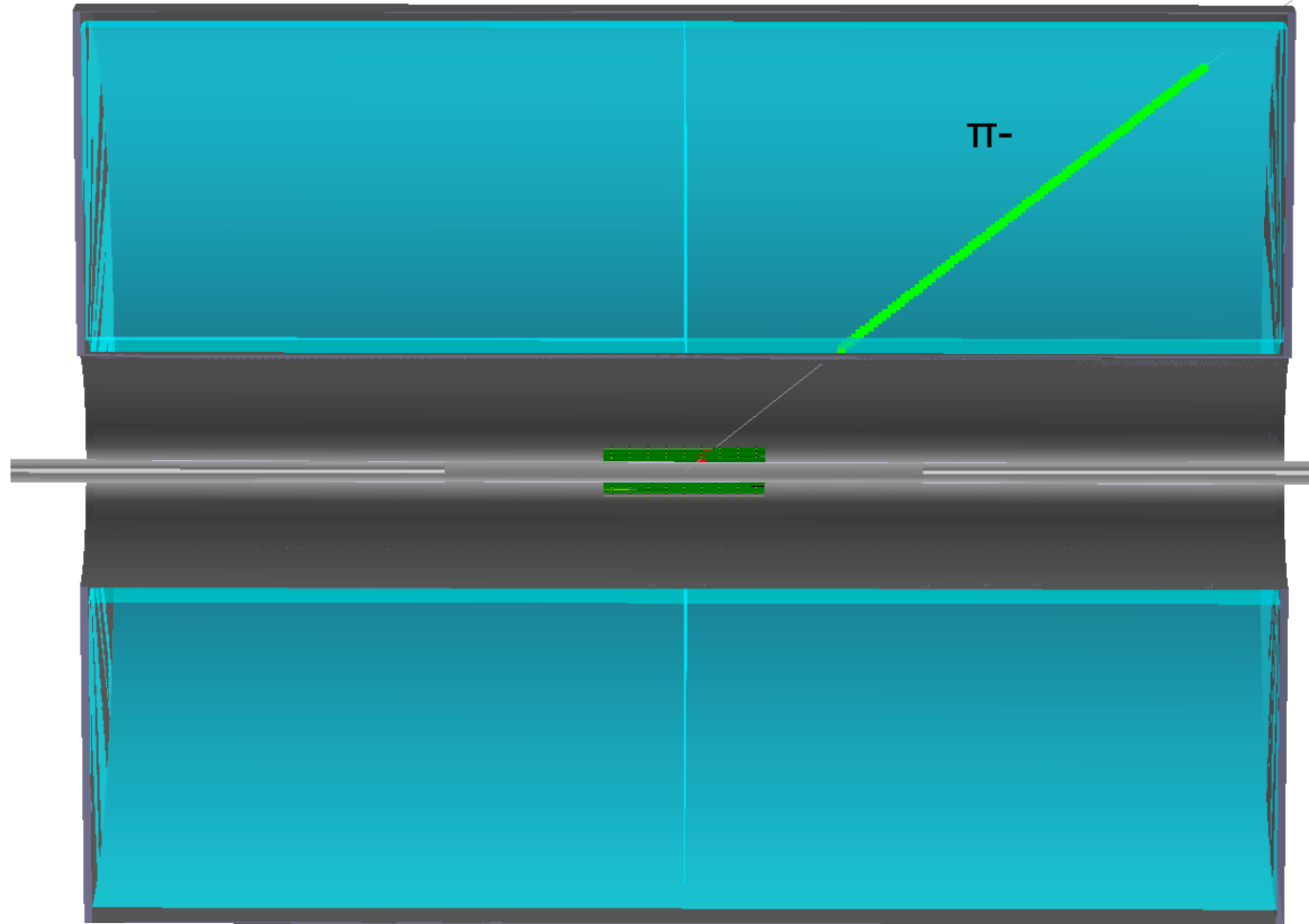
They are in the same ballpark

Alexander Kiselev, DIS 2016



sPHENIX Tracking System in EICRoot

Constant 1.4T solenoid field

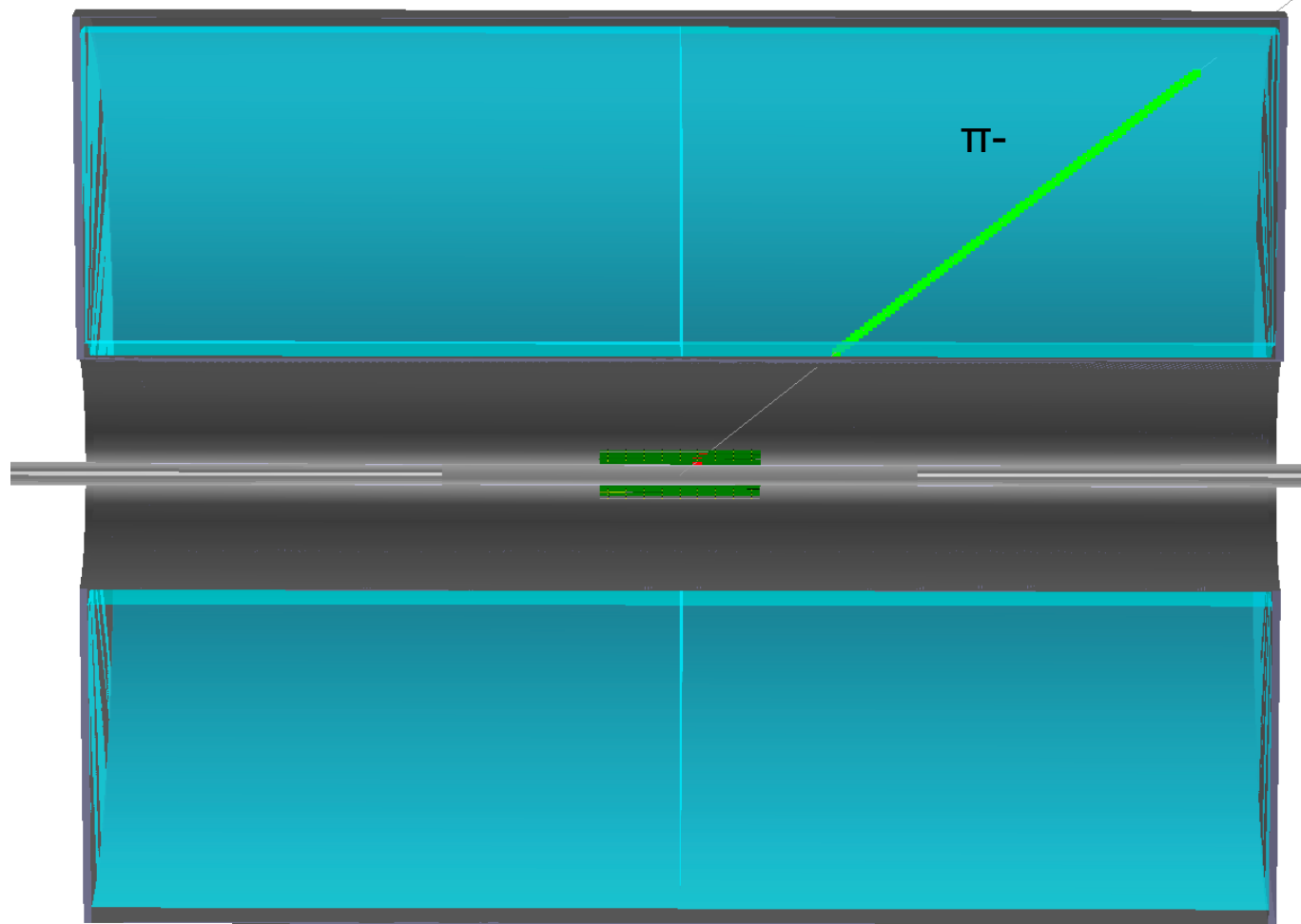


MVTX

- 3 layers: $r_1=24.61\text{mm}$, $r_2=31.98\text{mm}$, $r_3=39.93\text{mm}$
- Pixel size: $27 \times 27 \mu\text{m}^2$
- $X/X_0=0.3\%$

sPHENIX Tracking System in EICRoot

Constant 1.4T solenoid field



TPC

- $r_{in}=20\text{cm}$, $r_{out}=78\text{cm}$
- $L=200\text{cm}$
- Ar:CF₄:iC₄H₁₀ = 75:20:5
- Inner/outer field cage
Carbon fiber $t=0.0254\text{ cm x2}$
Kapton $0.2286+0.0051\text{ cm}$ (insulating & circuit card)
Copper 0.0017 cm x2
Epoxy
- Digitization parameters (from Joe Osborn)
 - 1.transverse dispersion : $53\text{ }\mu\text{m}/\sqrt{\text{cm}}$
 - 2.longitudinal dispersion : $150\text{ }\mu\text{m}/\sqrt{\text{cm}}$
 - 3.transverse intrinsic resolution : $150\text{ }\mu\text{m}$
 - 4.longitudinal intrinsic resolution : $500\text{ }\mu\text{m}$
 - 5.radial intrinsic resolution : 7mm (mid)
 - 6.GEM vertical pad size : 1.16cm
 $(r_{out}-r_{in})/50\text{hits}$

Magnetic Field Map

Solenoid

T

```
      0.0 100. 2
      0.0 100. 2
    -400.0 400. 2
0.00 0.000 1.400
0.00 0.000 1.400
0.00 0.000 1.400
0.00 0.000 1.400
0.00 0.000 1.400
0.00 0.000 1.400
0.00 0.000 1.400
0.00 0.000 1.400
0.00 0.000 1.400
```

Xmin Xmax nBin

Ymin Ymax nBin

Zmin Zmax nBin

Bx By Bz

.

.

.

Ar:CF4:iC4H10 Definition

//sPHENIX tpc Ar:CF4:iC4H10 75:20:5

sPHENIXtpcGas -4 39.948 12.011 18.998 1.008 18. 6. 9. 1. 2.252e-3 201 107 210 13

4 elements

Atomic mass

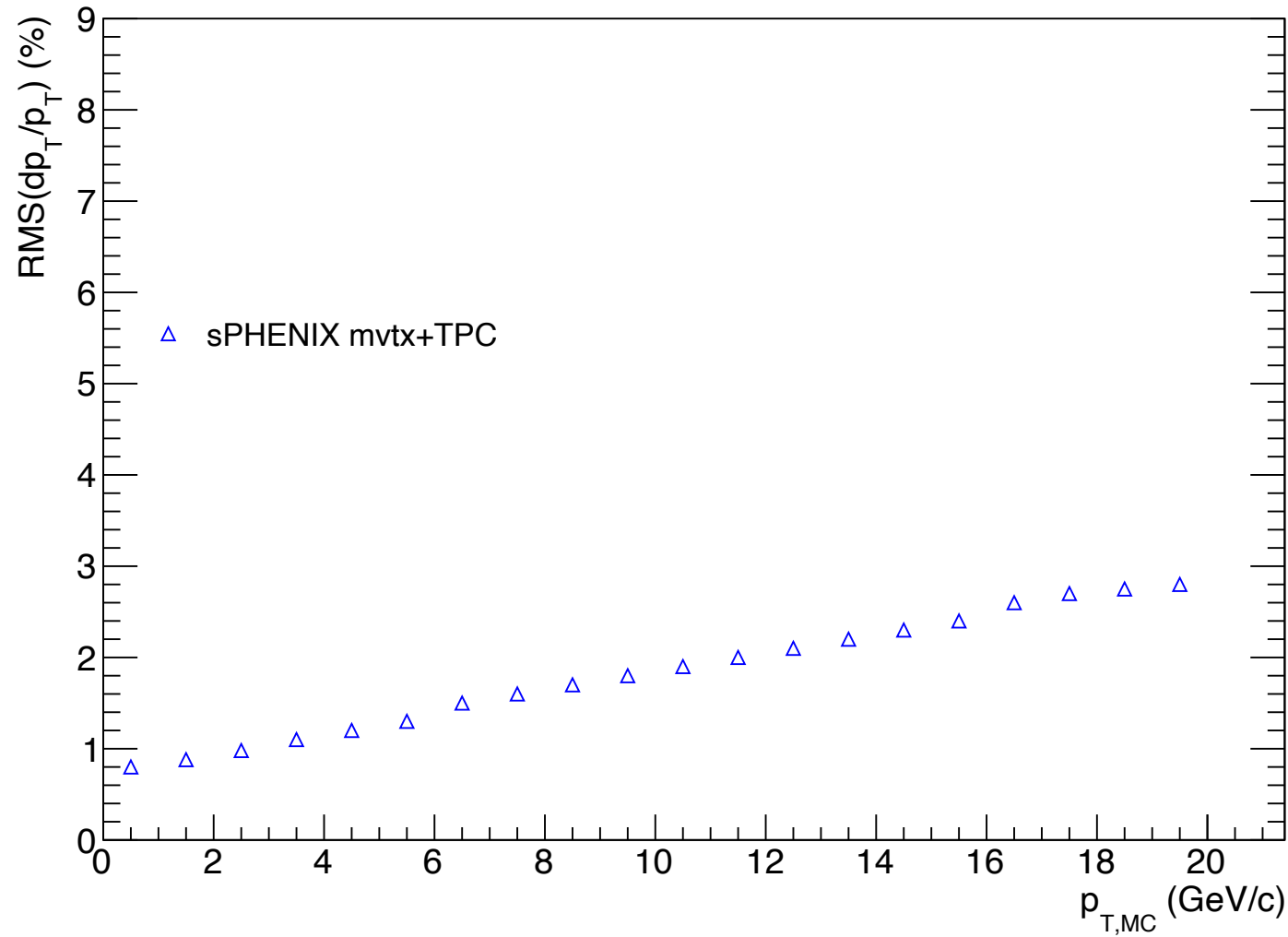
Atomic number

Density (g/cm³)

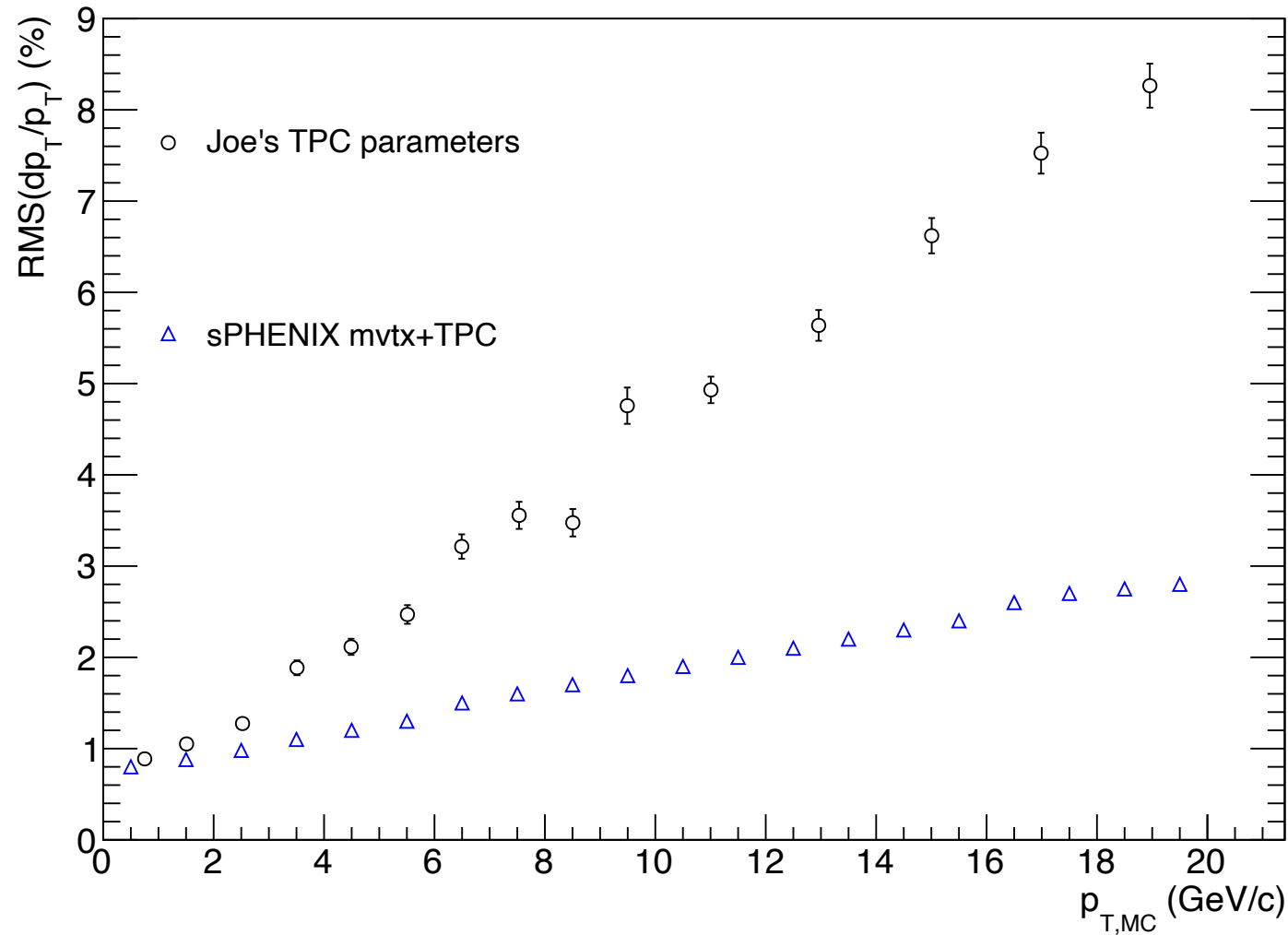
Number of atoms (ratio)
See calculation in the backup slides

sPHENIX p_T Resolution

<https://arxiv.org/pdf/2103.06703>



sPHENIX p_T Resolution from EICRoot



- 3.5 times worse??
- $\sqrt{12}$ (~ 3.46) effects?

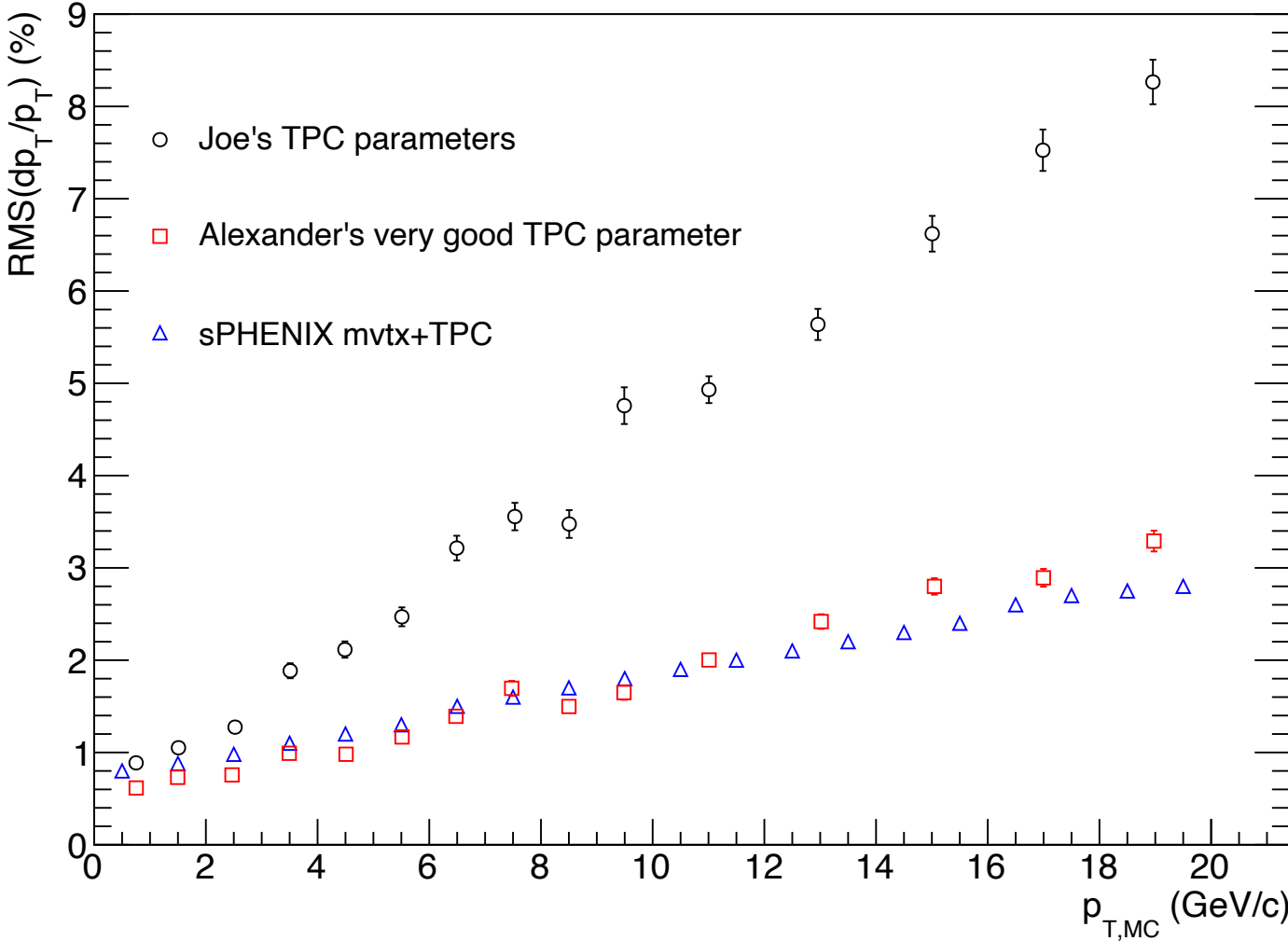
TPC Digitization Parameters

	Joe's number	What I put in
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	$150 \mu\text{m}$	$150 \mu\text{m}$
longitudinal intrinsic resolution	$500 \mu\text{m}$	$500 \mu\text{m}$
radial intrinsic resolution	5-10mm	7mm
GEM vertical pad size	??	$(78\text{cm}-20\text{cm})/50\text{hits}=1.16\text{cm}$

TPC Digitization Parameters

	Joe's number	What I put in	Alexander's very good TPC
transverse dispersion	53 $\mu\text{m}/\sqrt{\text{cm}}$	53 $\mu\text{m}/\sqrt{\text{cm}}$	15 $\mu\text{m}/\sqrt{\text{cm}}$
longitudinal dispersion	150 $\mu\text{m}/\sqrt{\text{cm}}$	150 $\mu\text{m}/\sqrt{\text{cm}}$	1 $\mu\text{m}/\sqrt{\text{cm}}$
transverse intrinsic resolution	150 μm	150 μm	200 μm
longitudinal intrinsic resolution	500 μm	500 μm	500 μm
radial intrinsic resolution	5-10mm	7mm	0mm
GEM vertical pad size	??	(78cm-20cm)/50hits=1.16cm	0.5 cm

sPHENIX p_T Resolution from EICRoot



	What I put in	Alexander's very good TPC
transverse dispersion	53 $\mu\text{m}/\sqrt{\text{cm}}$	15 $\mu\text{m}/\sqrt{\text{cm}}$
longitudinal dispersion	150 $\mu\text{m}/\sqrt{\text{cm}}$	1 $\mu\text{m}/\sqrt{\text{cm}}$
transverse intrinsic resolution	150 μm	200 μm
longitudinal intrinsic resolution	500 μm	500 μm
radial intrinsic resolution	7mm	0mm
GEM vertical pad size	1.16cm	0.5 cm

Summary

- Implemented sPHENIX tracking system in EICRoot
- The p_T resolution is off
→ Need to investigate the TPC digitization parameters
- We will be gone next week and the week after
 - I cannot bring Alexander's laptop with me to work on EICRoot simulations
 - I will work on the tracking simulation notes and STAR analysis

Backup

Subtitle

Number of Atoms Calculations from Chatgpt

To calculate the number of argon (Ar), carbon (C), fluorine (F), and hydrogen (H) atoms in a 1L gas mixture with 75% Ar, 20% CF₄, and 5% iC₄H₁₀, we can follow these steps:

Step 1: Calculate total moles in 1L at standard temperature and pressure (STP)

At STP, 1 mole of an ideal gas occupies 22.4 liters. Therefore, for 1 liter:

$$\text{Total moles} = \frac{1 \text{ L}}{22.4 \text{ L/mol}} \approx 0.04464 \text{ moles}$$

Step 2: Determine moles for each gas

- Argon (75%):

$$\text{Moles of Ar} = 0.75 \times 0.04464 \approx 0.03348 \text{ moles}$$

- Carbon Tetrafluoride (CF₄, 20%):

$$\text{Moles of CF}_4 = 0.20 \times 0.04464 \approx 0.00893 \text{ moles}$$

- Isobutane (iC₄H₁₀, 5%):

$$\text{Moles of iC}_4\text{H}_{10} = 0.05 \times 0.04464 \approx 0.00223 \text{ moles}$$

Number of Atoms Calculations from Chatgpt

Step 3: Calculate the number of atoms for each component

- **Argon (Ar):** Each mole of Ar contains 1 mole of Ar atoms.

$$\text{Atoms of Ar} = 0.03348 \text{ moles} \times 6.022 \times 10^{23} \approx 2.01 \times 10^{22} \text{ atoms}$$

- **Carbon Tetrafluoride (CF₄):** Each mole of CF₄ contains 1 mole of C atoms and 4 moles of F atoms.

$$\text{Atoms of C from CF}_4 = 0.00893 \text{ moles} \times 6.022 \times 10^{23} \approx 5.37 \times 10^{21} \text{ atoms}$$

$$\text{Atoms of F from CF}_4 = 4 \times 0.00893 \text{ moles} \times 6.022 \times 10^{23} \approx 2.14 \times 10^{22} \text{ atoms}$$

- **Isobutane (iC₄H₁₀):** Each mole of iC₄H₁₀ contains 4 moles of C atoms and 10 moles of H atoms.

$$\text{Atoms of C from iC}_4\text{H}_{10} = 4 \times 0.00223 \text{ moles} \times 6.022 \times 10^{23} \approx 5.35 \times 10^{21} \text{ atoms}$$

$$\text{Atoms of H from iC}_4\text{H}_{10} = 10 \times 0.00223 \text{ moles} \times 6.022 \times 10^{23} \approx 1.34 \times 10^{22} \text{ atoms}$$

Number of Atoms Calculations from Chatgpt

Step 4: Sum up the total number of each type of atom

- Total C atoms:

$$\text{Total C} = 5.37 \times 10^{21} + 5.35 \times 10^{21} \approx 1.07 \times 10^{22} \text{ atoms}$$

- Total F atoms:

$$\text{Total F} = 2.14 \times 10^{22} \text{ atoms}$$

- Total H atoms:

$$\text{Total H} = 1.34 \times 10^{22} \text{ atoms}$$

Final Summary of Atoms in 1L of Gas Mixture

- Argon (Ar): $\approx 2.01 \times 10^{22}$ atoms
- Carbon (C): $\approx 1.07 \times 10^{22}$ atoms
- Fluorine (F): $\approx 2.14 \times 10^{22}$ atoms
- Hydrogen (H): $\approx 1.34 \times 10^{22}$ atoms