On the way to understanding detector requirements for polarimetry

E Shulga

Motivation

EIC will operate at higher frequencies and with higher backgrounds, thus it is important to check detector capabilities and workout improvements to provide accurate measurements

Hadron Polarimetry at EIC

- **HJET polarimeter exists**
  - Move from IR-12 to IR-4 after RHIC shutdown (06/2025)
  - Update/refurbish some components
  - Upgrade silicon detectors and readout
    - Timing resolution
    - Background rejection
  - Add target gas analyzer
    - Dominant systematic uncertainty at RHIC
    - Enables collimator use to reduce background

$\frac{\sigma_P}{P} \approx 3\%$ per 4 hours

Open questions:

- Are the target chambers (impedance) suitable for EIC bunch frequencies? (ok)
- Will the fiber targets survive in the more extreme EIC hadron beam environment?
- How can we measure absolute beam polarization of light ion beams?

- **Two p-C polarimeters exist**
  - Move double target chamber to IR 4
  - Move single target chamber to IR 6
  - Similar detectors and readout as HJET

$\frac{\sigma_P}{P} < 1\%$ per scan

From: "Polarimetry at EIC" on July 25, 2023

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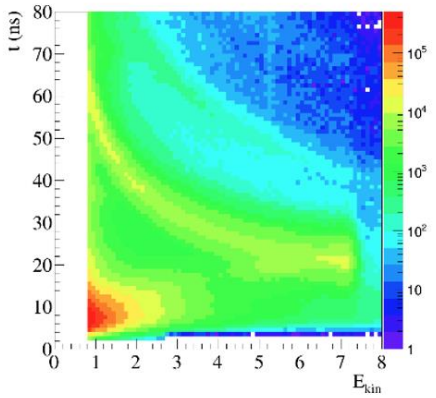
Expected differences

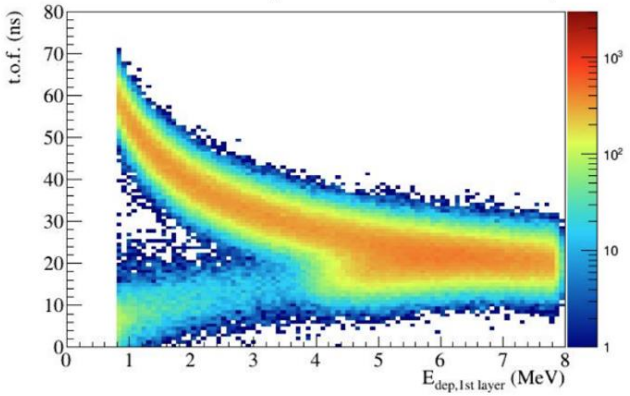
Main objectives: Increase time & energy resolution, Suppress backgrounds (with veto detector following the main)

From RHIC to EIC

RHIC Data



Simulation (PYTHIA+GEANT4)



Bunch length

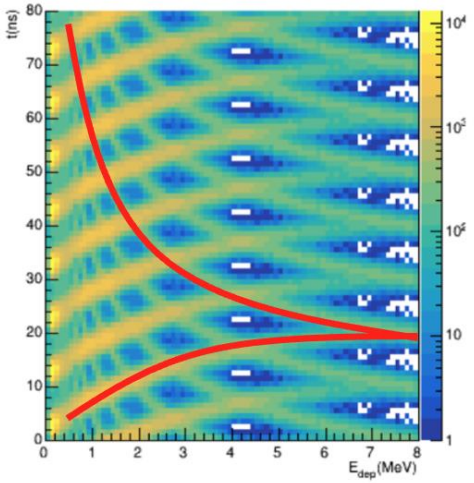
Detector resolution

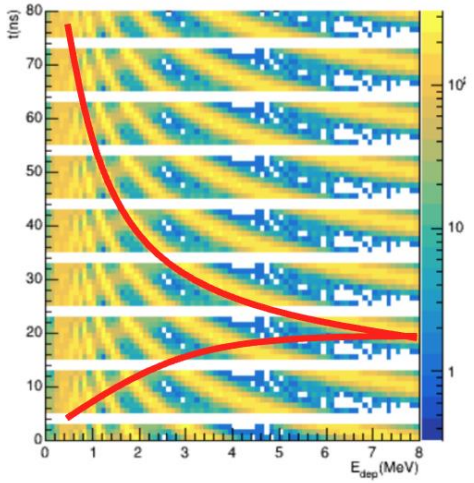
120 bunches → 1320 bunches

Bunch spacing 106 ns → 9.6 ns

Bunch length 3.5 ns → 0.2 ns

- Signal from recoil protons and punch-through particles overlap from different bunches
- Veto punch-through with second detector layer
  - see W. Schmidke's presentation





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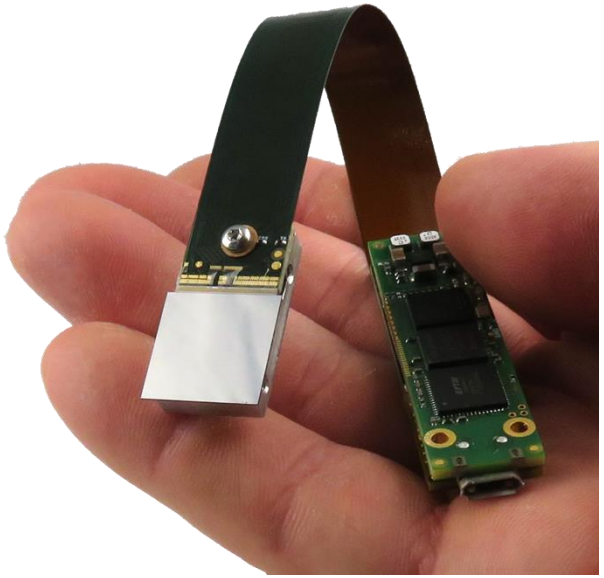
From: "Polarimetry at EIC" on July 25, 2023

First thoughts on technology

The MiniPIX TPX3 Flex is a miniaturized and low-power radiation camera with particle tracking and imaging detector Timepix3 (256 x 256 square pixels with a pitch of 55 μm). The device's chip is equipped with a sensor according to customer preference (standardly 300 μm thick silicon).
https://advacam.com/camera/minipix-tpx3-flex/ $16,496



+:

Well established technology
Readout and DAQ provided
There are also collaborators from UK bringing similar detectors to EIC

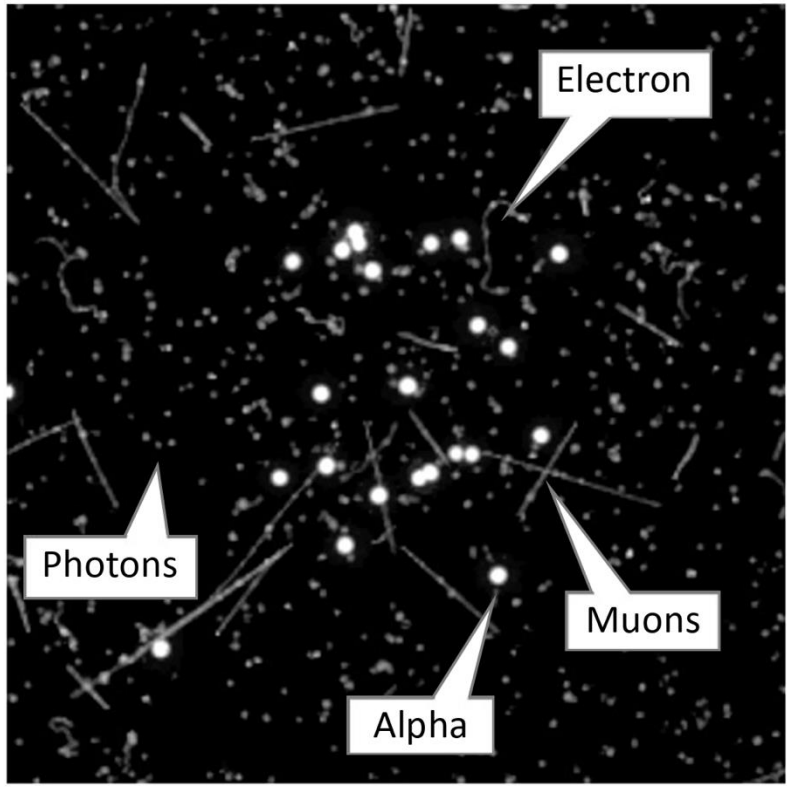
-:

Small size for HJET
Not clear if 55 μm pitch is needed, starting various simulations (toy-MC, Geat4)

First thoughts on technology

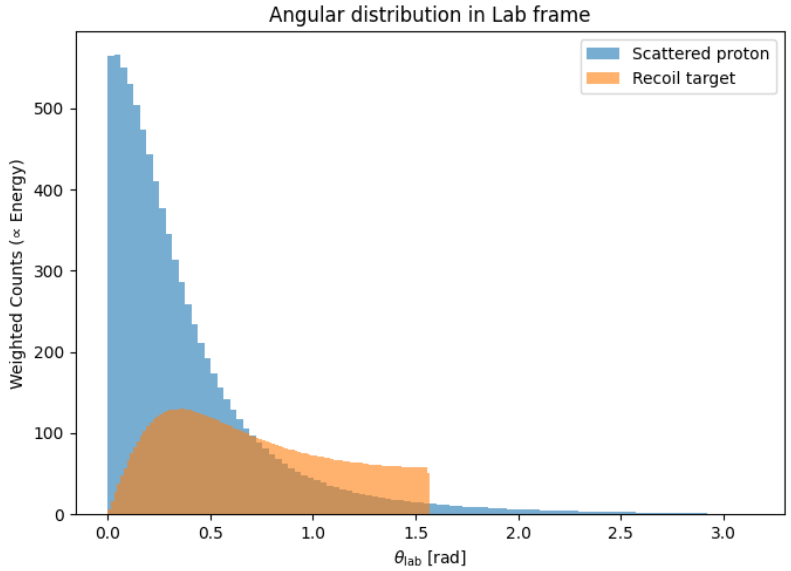
Main Features

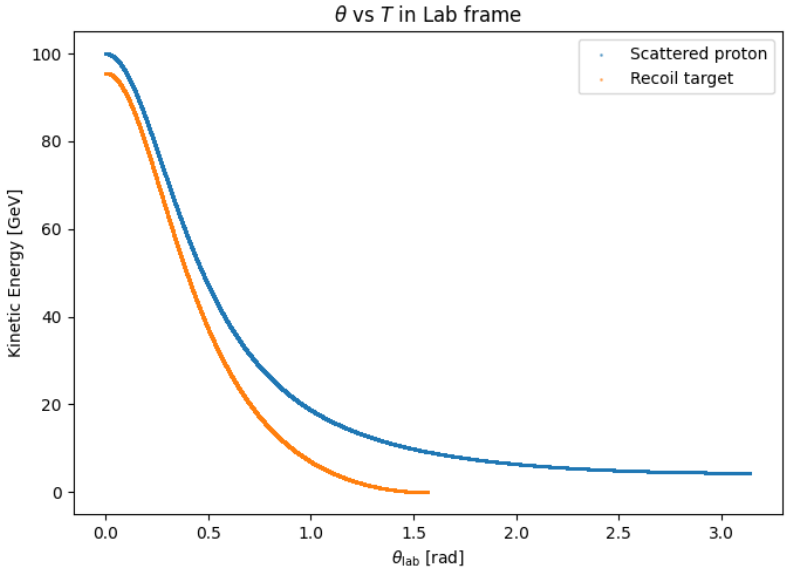
- Readout chip type Timepix3
- Pixel size[2] ..... 55 x 55 µm
- Sensor resolution ..... 256 x 256 pixels
- Time resolution ..... 1,6 ns
- Dynamic range in one frame[3] 1022
- Sensor material ..... 100, 300, 500 µm Si, 1000 µm CdTe
- Dark current ..... none
- Interface ..... USB 2.0 (High-Speed)
- Maximum readout speed ..... 2,35 million pixels / s
- Dimensions ..... see p. 8-11
- Weight ..... 22 g (CdTe sensor, no cover)

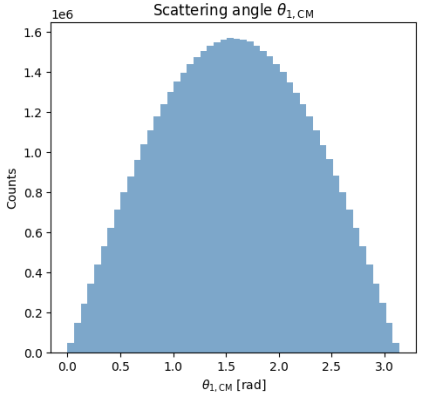


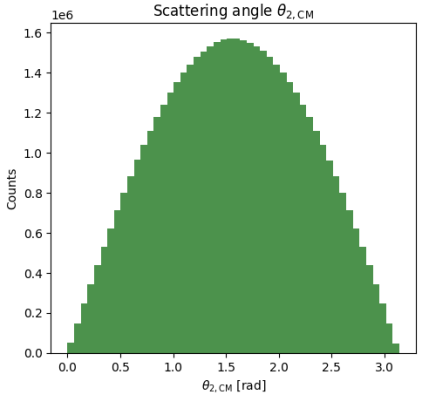
https://advacam.com/content/uploads/2024/08/MiniPIX-TPX3-Flex-Datasheet-2024-07-23-1.pdf

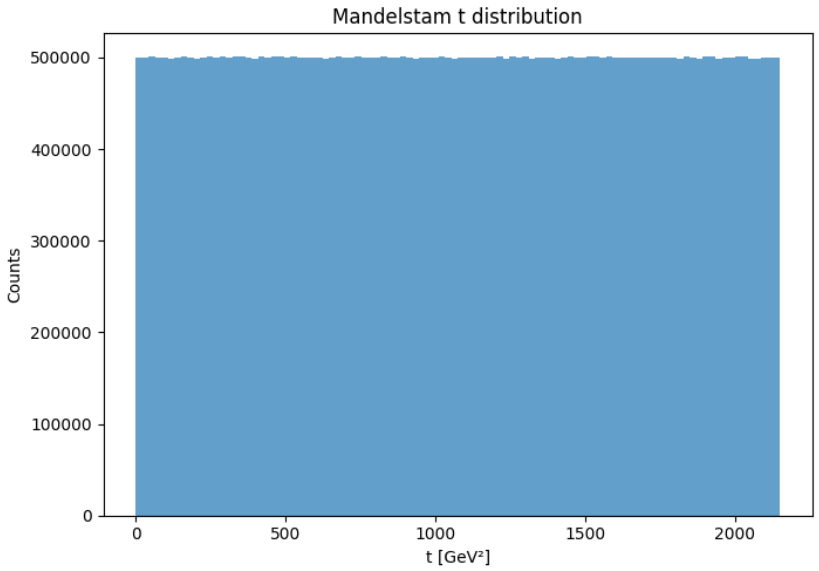
Toy MC for pp 100 GeV (first steps)

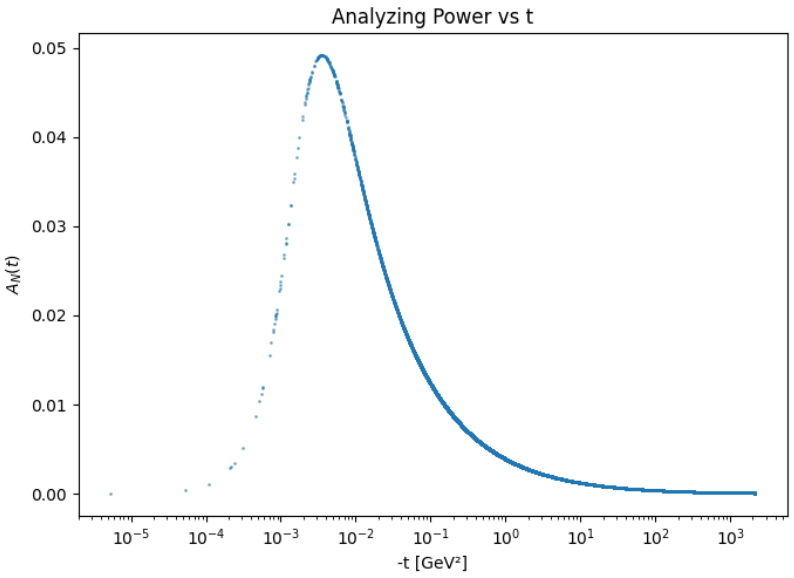


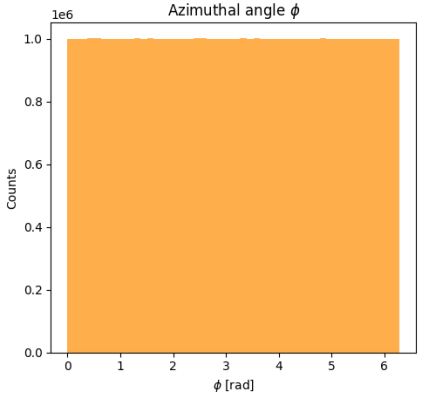






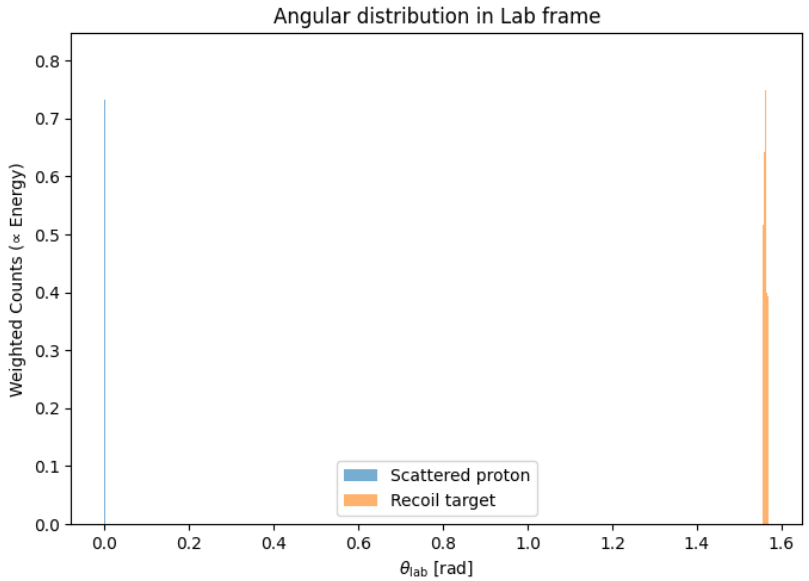


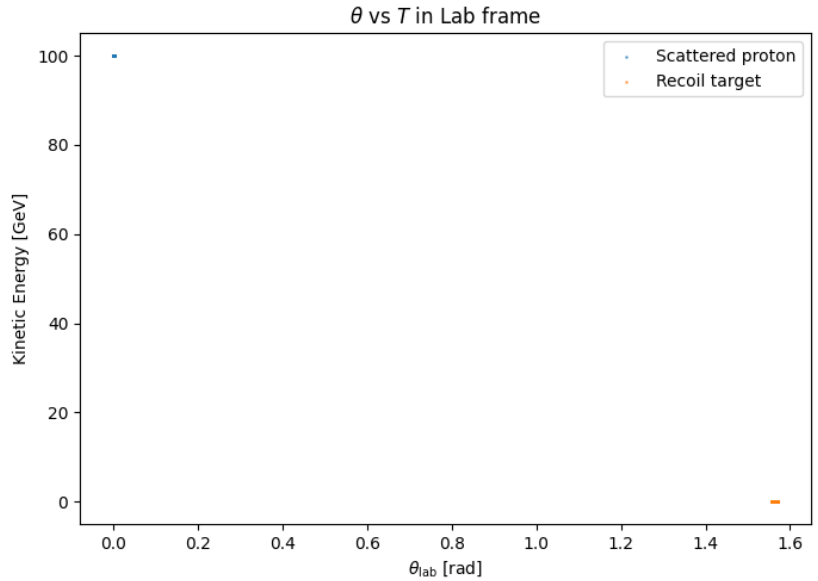


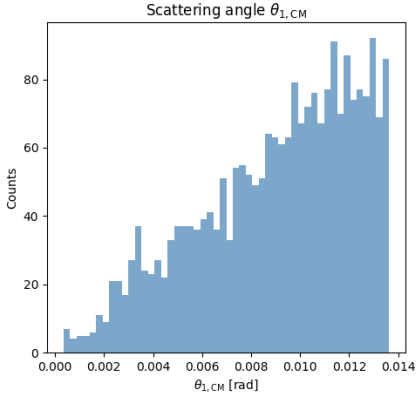


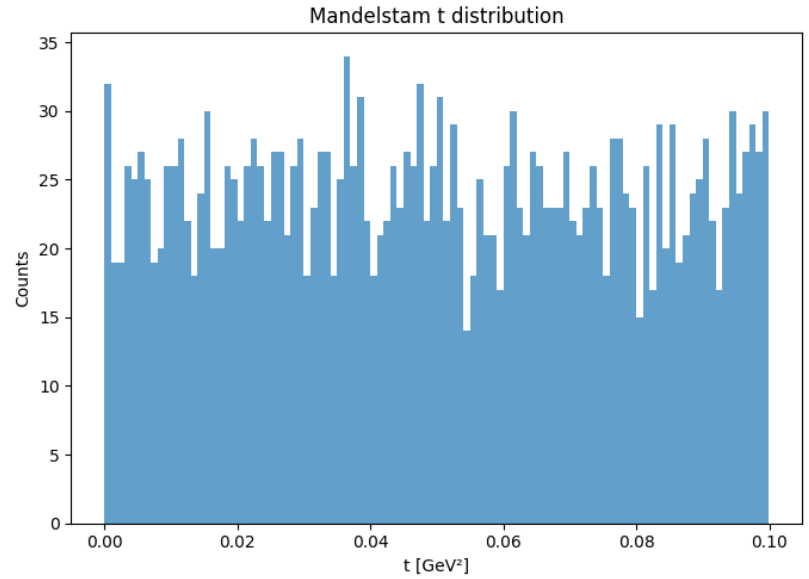
$A_N(t)$ is from: I Alekseev et al "Polarized proton collider at RHIC" 2003 Nucl. Instrum. Methods A 499 392-414

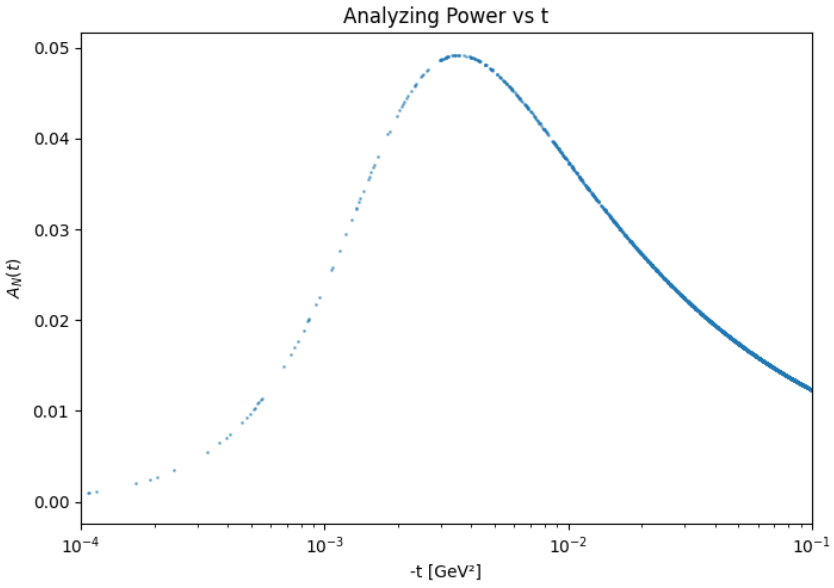
Toy MC for pp 100 GeV CNI region –t<0.1 GeV(first steps)

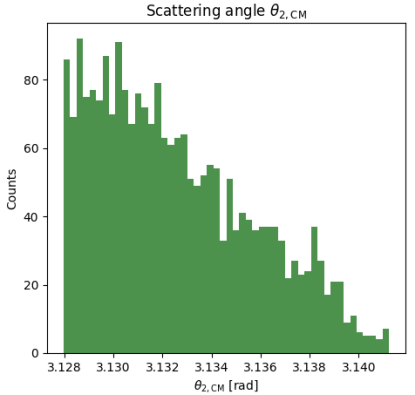


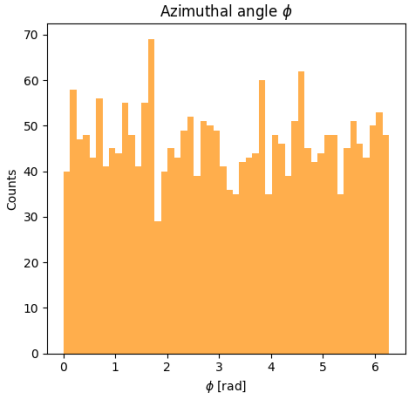












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Conclusion & Plans

Slowly learning/understanding the systems and requirements

Next steps:

- Understand the measurement procedure
- Estimate background contribution -> compare to RHIC data -> predict for EIC
- Develop detector system suitable for the high intensity measurement at EIC and background subtracktion