TOF Simulations in ePIC

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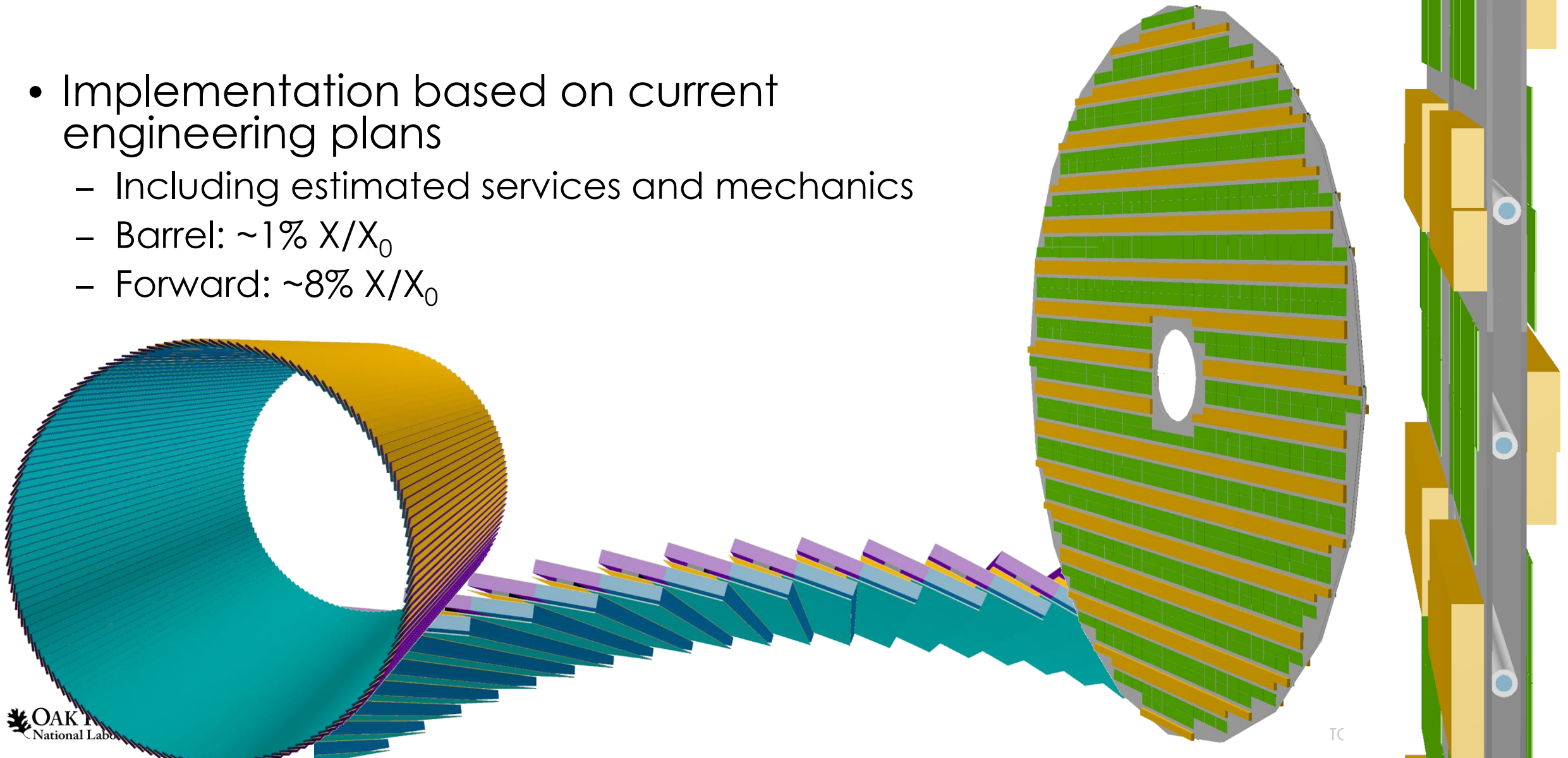
For the EIC TOF Group

ORNL is managed by UT-Battelle LLC for the US Department of Energy

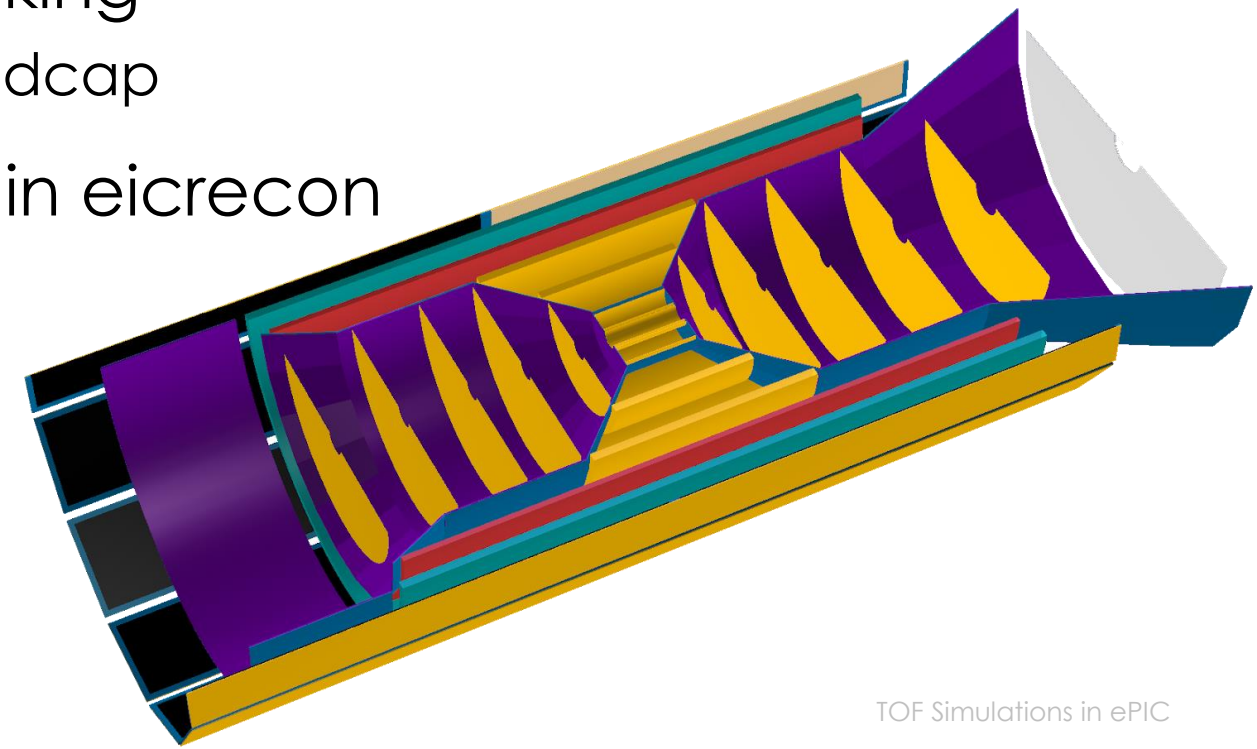
TOF Geometry in ePIC Software Framework

- Implementation based on current engineering plans
  - Including estimated services and mechanics
  - Barrel: ~1% X/X_0
  - Forward: ~8% X/X_0



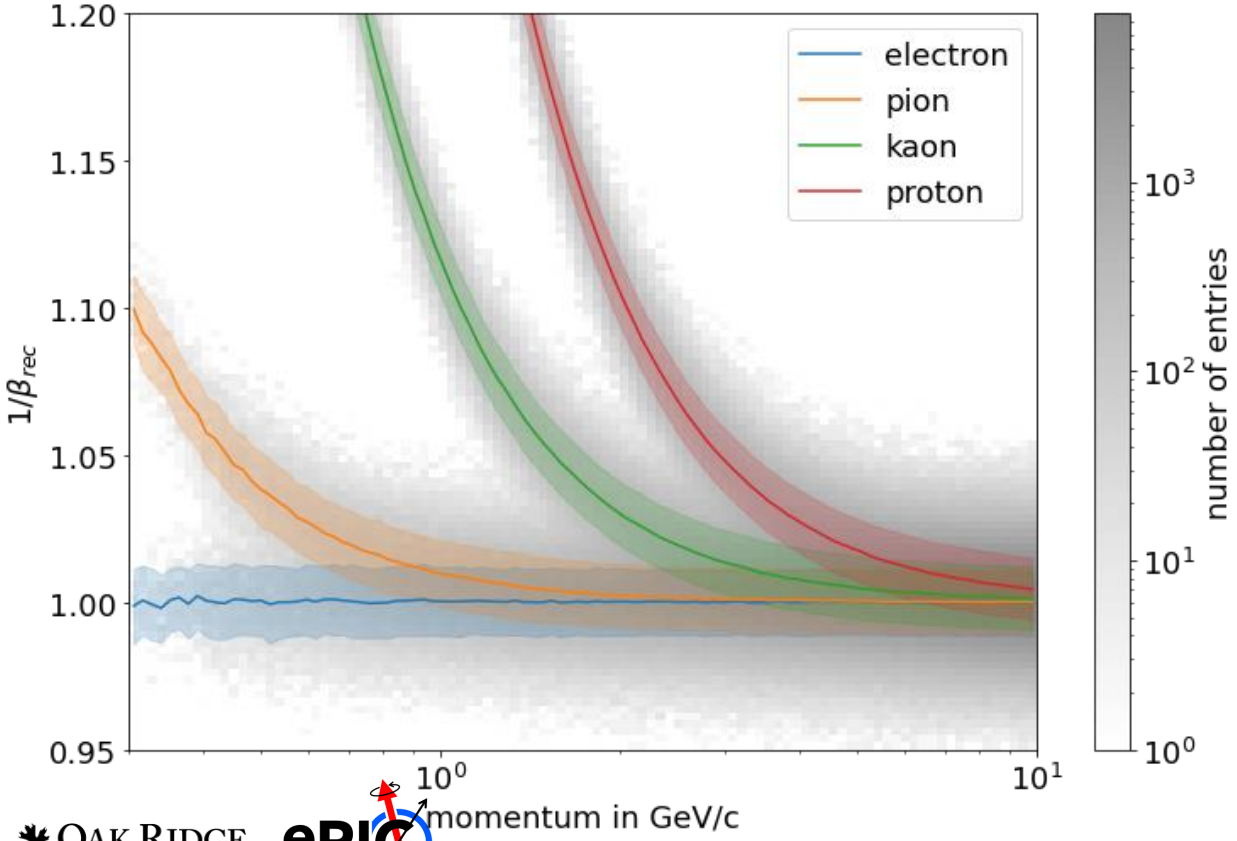
TOF Geometry in ePIC Software Framework

- Detector geometry fully implemented in DD4hep
  - Included in arches and brycecanyon models
- TOF layers integrated in ACTS tracking
  - Some issues with detailed forward endcap
- Digitization infrastructure in place in eicrecon
  - Single MIP time resolution
    25ps sensor (⊕ 20ps t_0 offline for now)
  - Position resolution:
    Endcap: 30 micron
    Barrel: 30 microns x 1/sqrt(12) cm

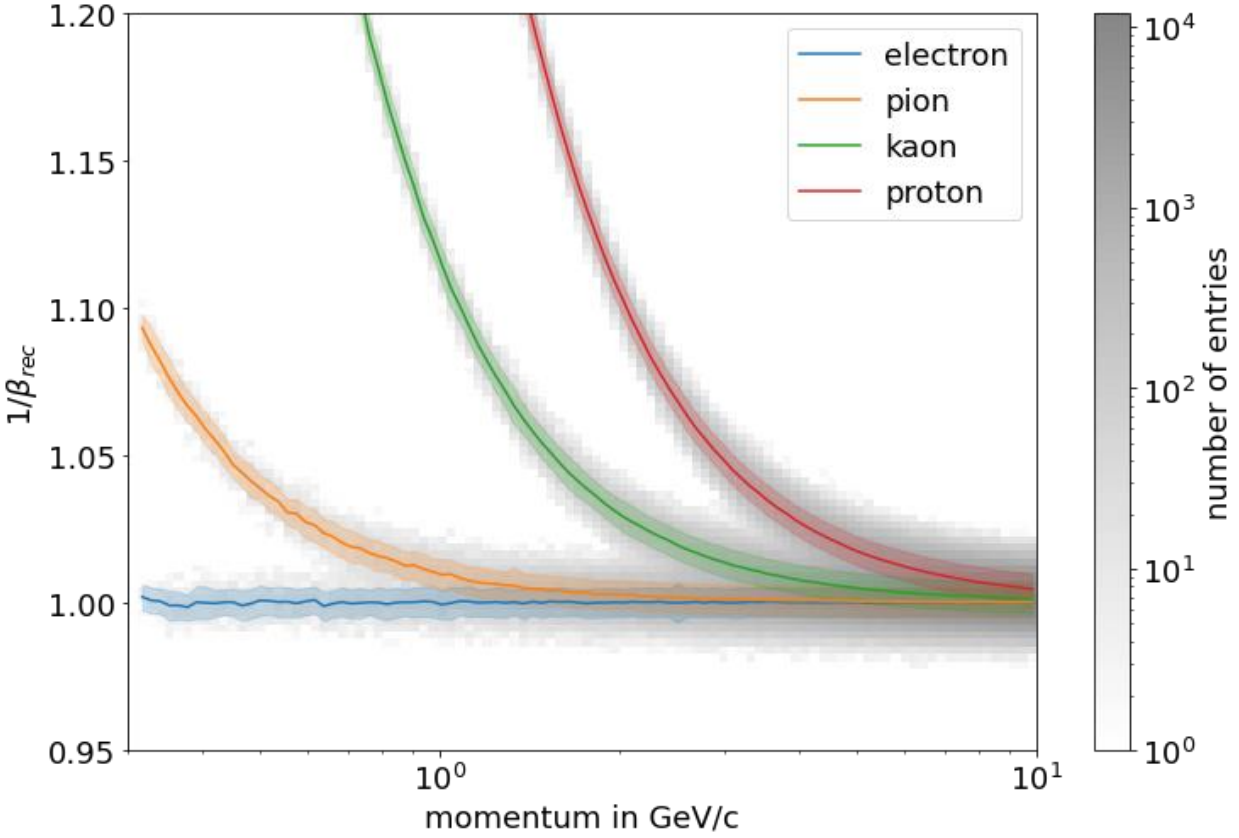


TOF PID Performance – Single Particle Gun

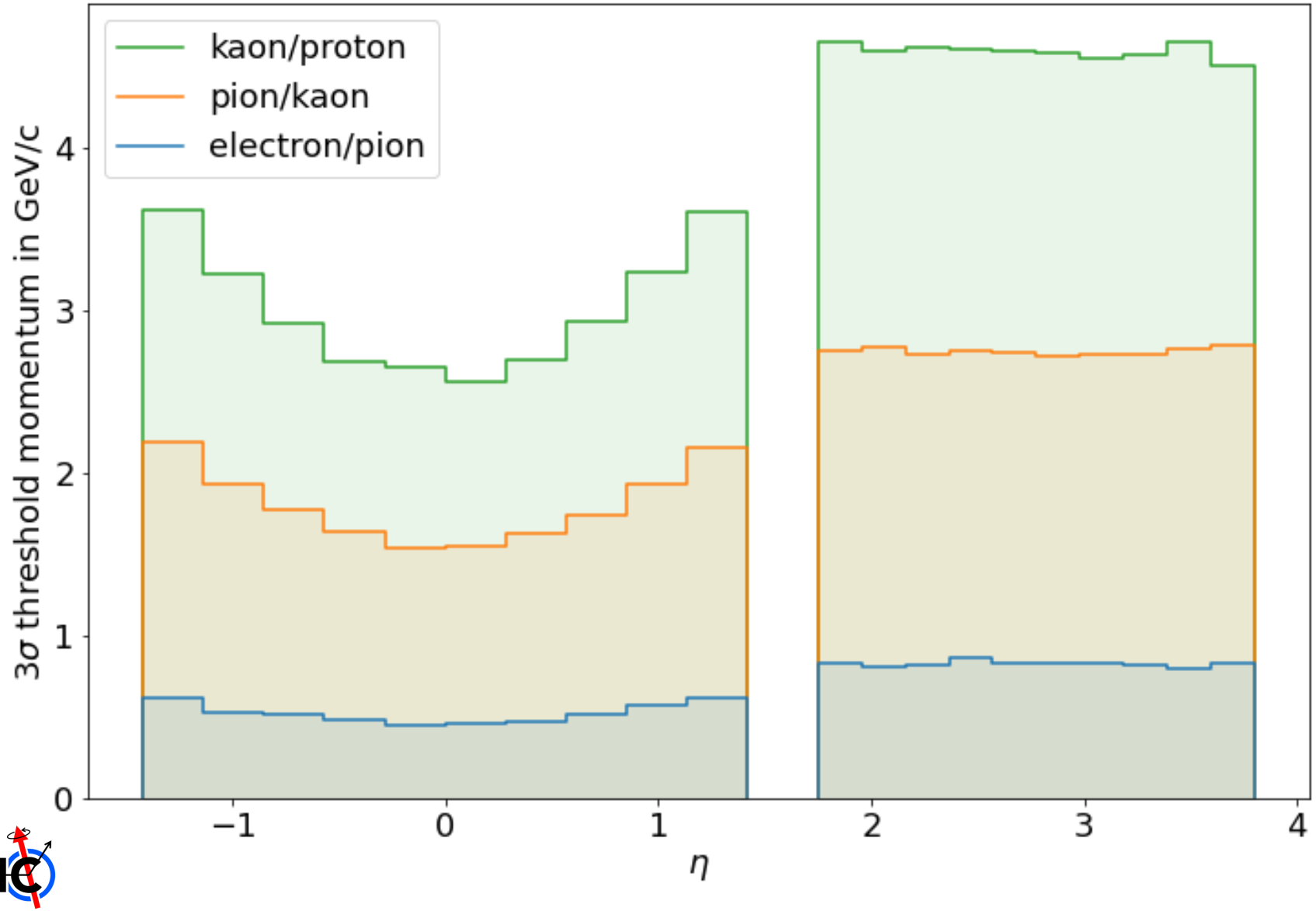
- Barrel Region
  - e/pi up to 0.5 GeV/c
  - pi/K up to 1.9 GeV/c
  - K/p up to 3.1 GeV/c



- Endcap Region
  - e/pi up to 0.8 GeV/c
  - pi/K up to 2.7 GeV/c
  - K/p up to 4.6 GeV/c

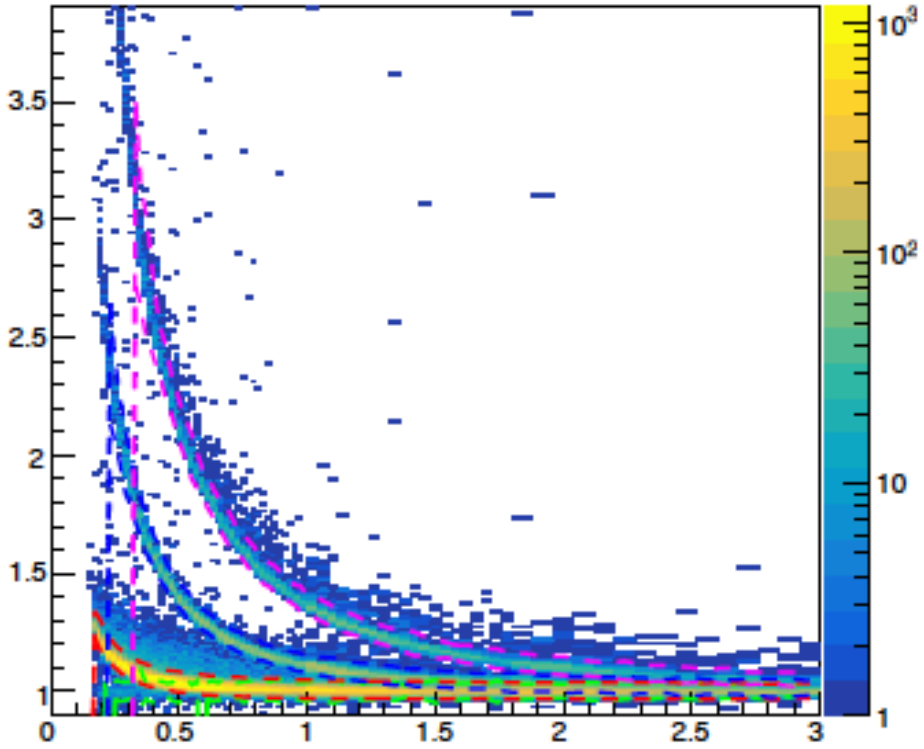


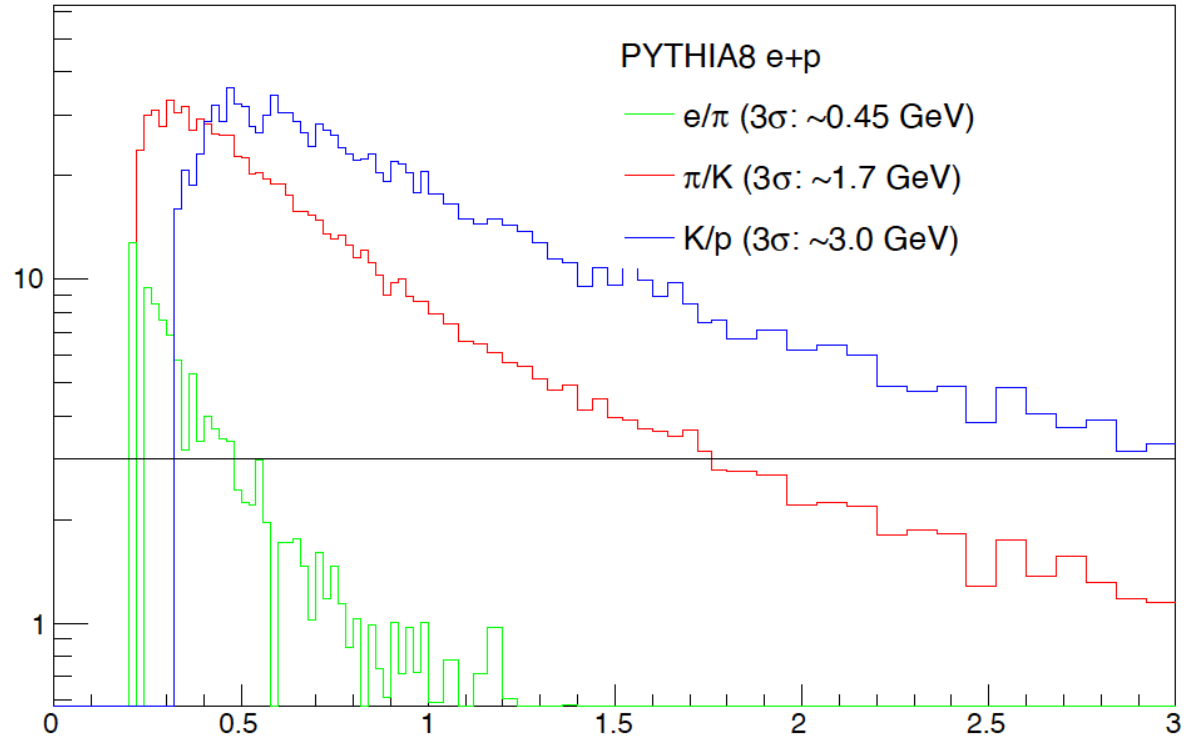
TOF PID Performance – Single Particle Gun



TOF PID Performance – Pythia DIS Events

- Compatible with single particle results
  - Barrel only due to issues in endcap reconstruction





Next Steps and Open Questions

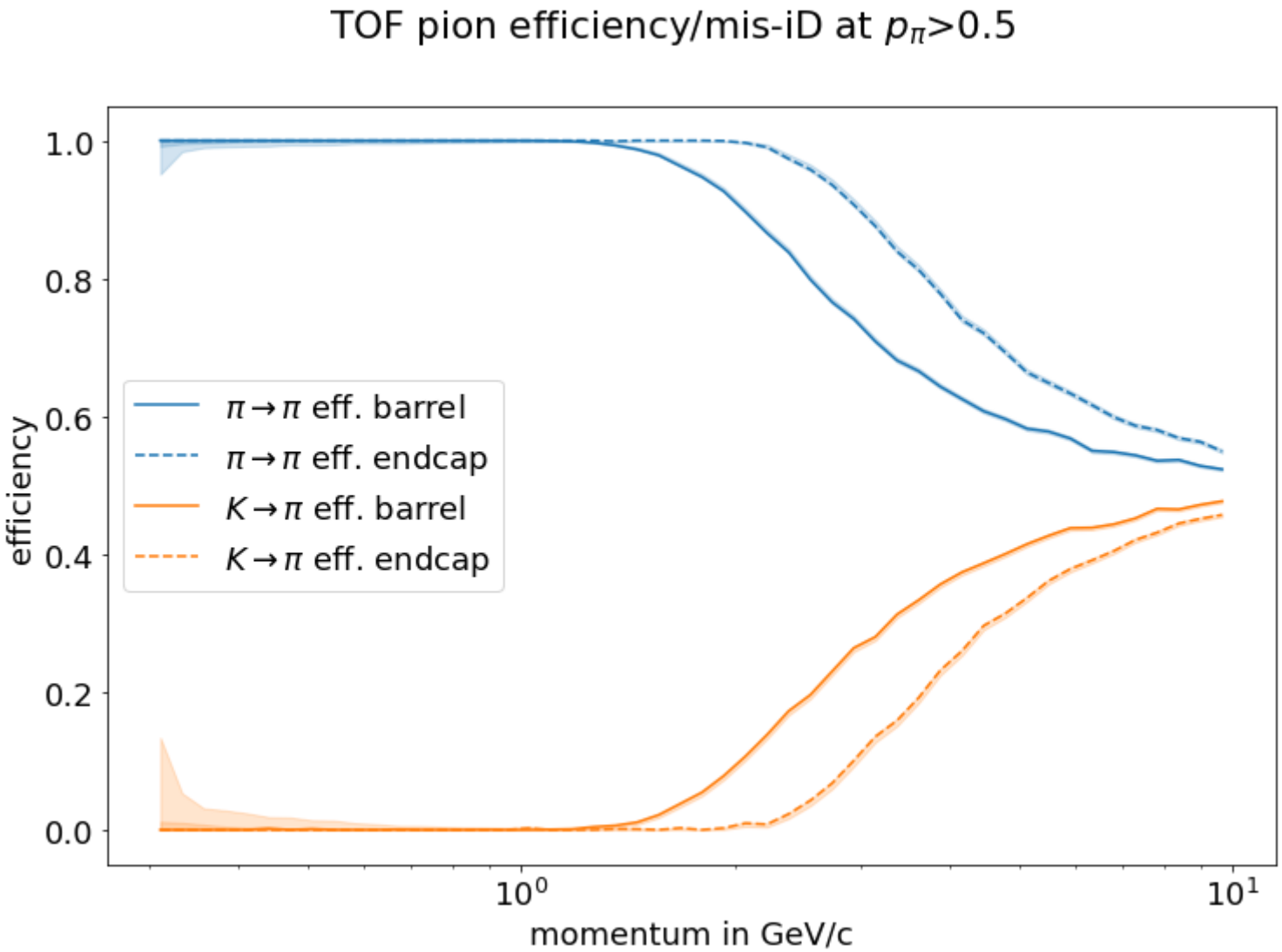
- Some reconstruction porting remaining:
  - TOF reconstruction as dedicated JANA2 factory with user output
  - Event t_0-estimation + combination with x-t method

- Validate time resolution requirements for PID performance
  - Full DIS events and combined PID of TOF+dRICH/TOF+hpDIRC
- Validate tracking performance and required granularity
  - Start by implementing dark noise numbers
  - Requires realistic tracking + backgrounds
  - Tracking efficiency, angular resolutions for Cherenkov detectors
  - TOF material impact on other detectors

Backup

TOF PID Performance – Efficiencies + mis-IDs

- Full



On PID Likelihoods

- Combining PID information from different detectors is straightforward with a likelihood approach
  - Ultimately each PID detector will provide a likelihood value for each particle hypothesis for each track (?)
- Has this been discussed before?
  - Are LLs available from e.g. Cherenkov detectors in EICrecon?
  - How should TOF make their LLs available?
  - Are there plans how to handle priors for individual analyses?

$$Pid(K,\pi) = \frac{L(K)P(K)}{L(K)P(K) + L(\pi)P(\pi)}$$

$$Pid(K) = \frac{L(K)P(K)}{\sum_{i=e,\mu,\pi,K,p,d} L(i)P(i)}$$