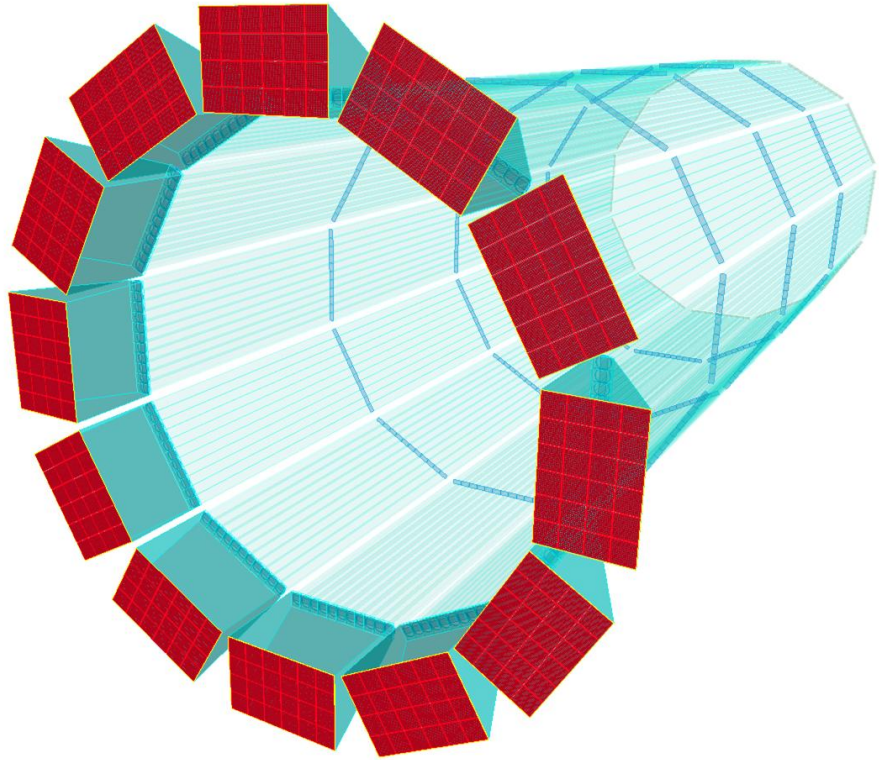
Simulations for ePIC hpDIRC Detector



Shubham Dutta

Stony Brook University

January 23rd, 2026

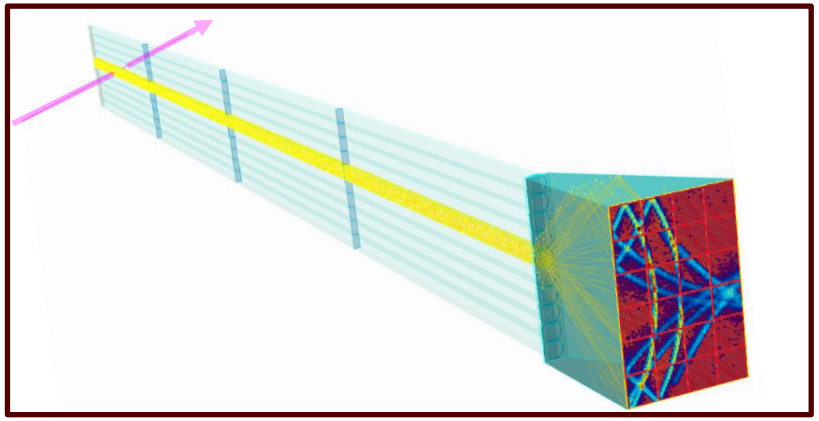
ePIC Collaboration Meeting

CUA GSI Jefferson Lab Old Dominion Stony Brook University University of South Carolina Wayne State University William & Mary University of Glasgow

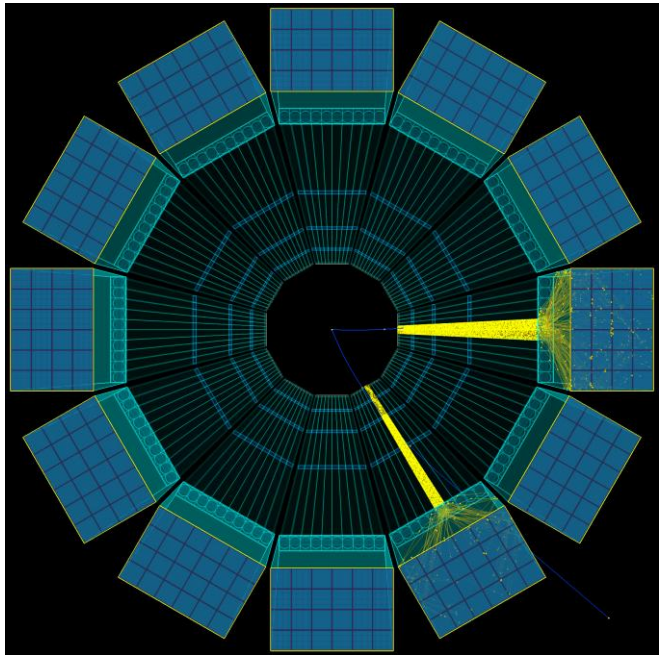
hpDIRC Near-term Software Goals

- Standalone:
  - Optimization of hpDIRC based on geometry changes
  - Misalignment mitigation
  - Sensor performance (PDE, arrangement)
  - Simulation of CRT and Lens characterization
  - Development of xpDIRC (studies potentially relevant for ePIC)

Single particle gun events to map hpDIRC performance



Stand-alone hpDIRC simulation



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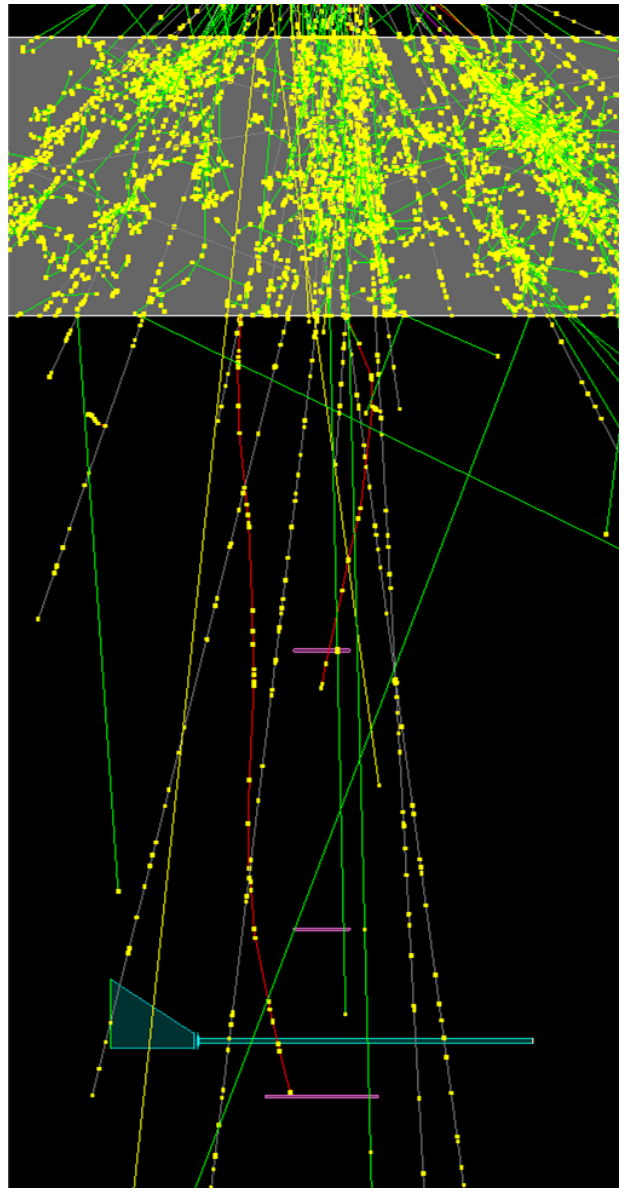
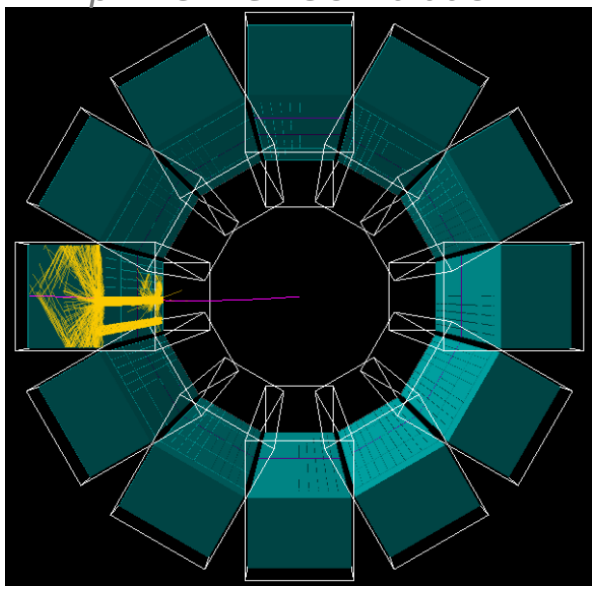
Geant4 simulation of CRT setup



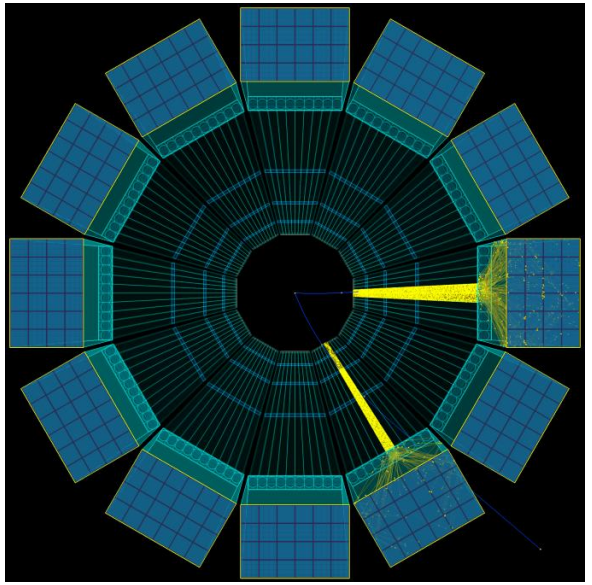
hpDIRC Near-term Software Goals

- Standalone:
  - Optimization of hpDIRC based on geometry changes
  - Misalignment mitigation
  - Sensor performance (PDE, arrangement)
  - Simulation of CRT and Lens characterization
  - Development of xpDIRC (studies potentially relevant for ePIC)
- ePIC stack (focus of further slides):
  - Finish implementation of geometric and time-imaging reconstruction in eicrecon
  - Debug any potential discrepancies in performance between eicrecon and standalone
  - Repeat PID performance with backgrounds (multiple hits/bar) with full stack & all detectors

hpDIRC in ePIC simulation



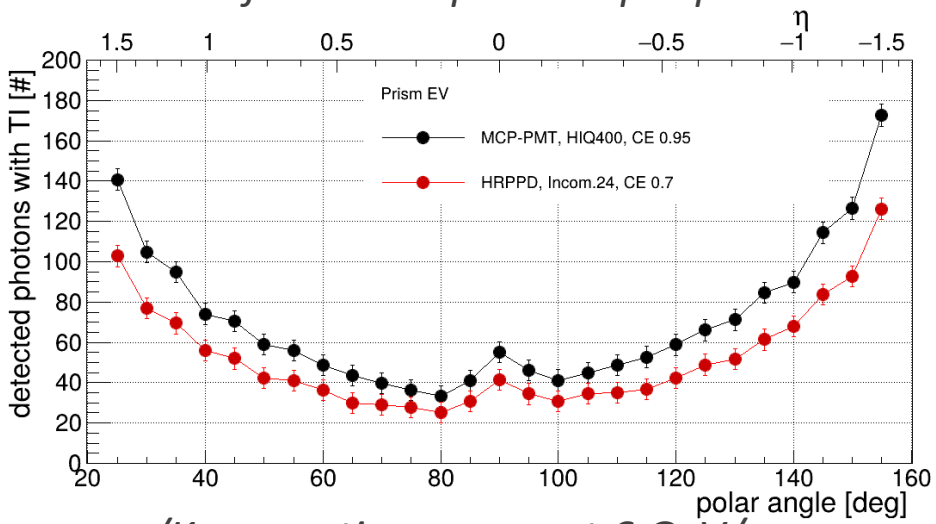
Stand-alone hpDIRC simulation



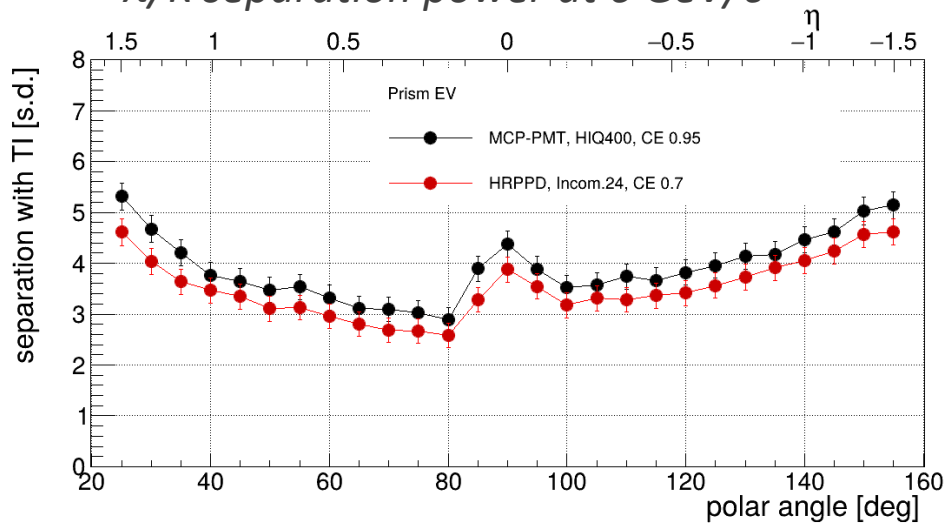
hpDIRC Performance Studies For TDR

- Performance evaluation may come from ePIC stack (time-permitting)
- Sensor choice (Greg's talk on Wednesday)
  - Measured most up-to-date sensor characteristic (e.g. PDE) impact on hpDIRC performance
- Tracking resolution
  - We still hope that 0.5 mrad is reached, eager to test new resolution maps

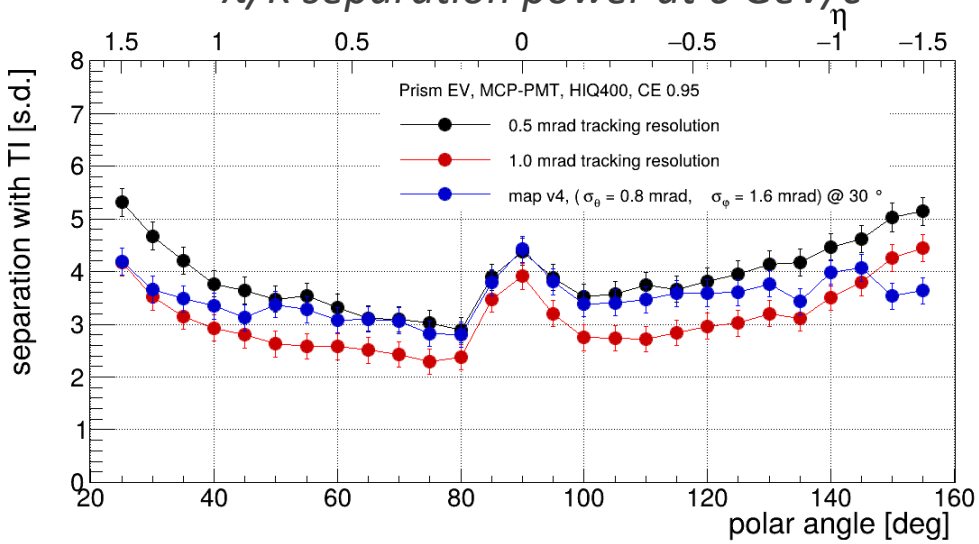
Number of detected photons per particle



π/K separation power at 6 GeV/c

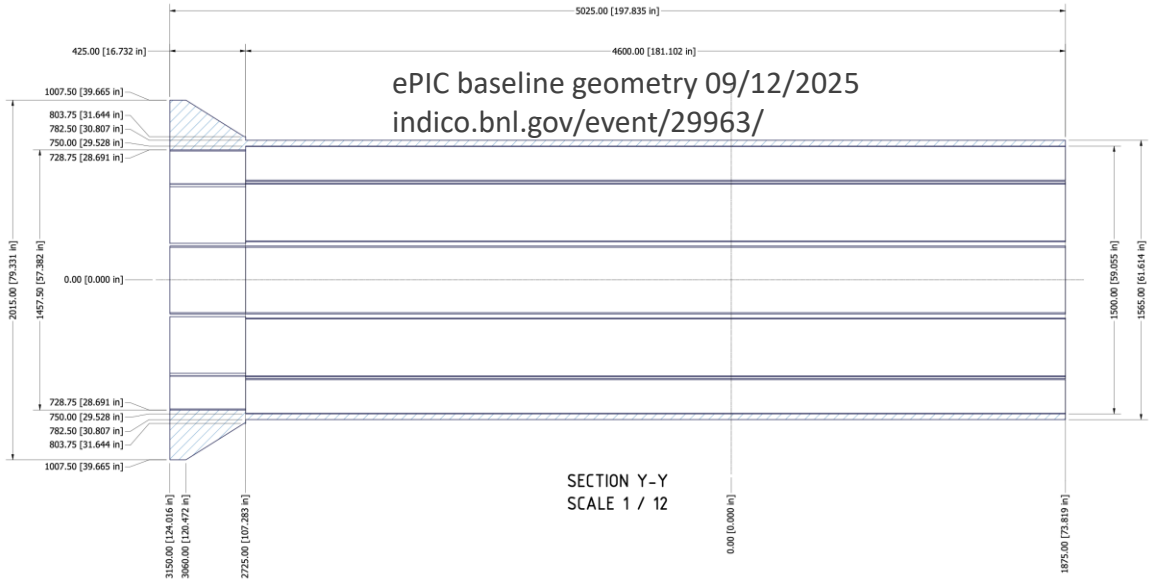


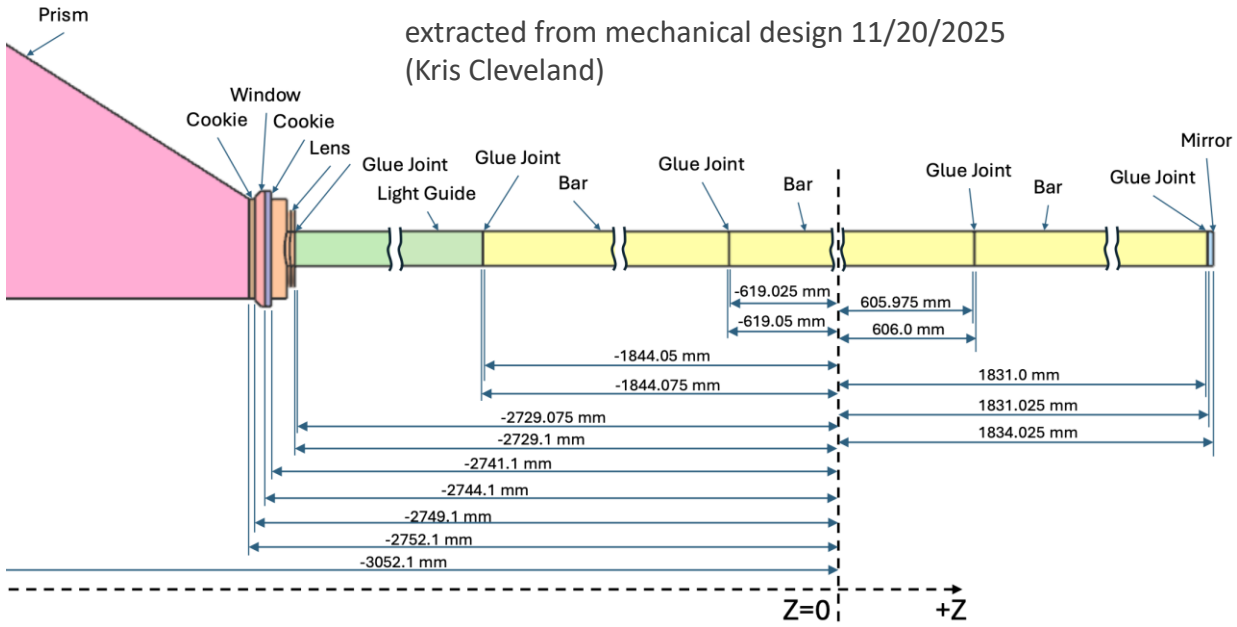
π/K separation power at 6 GeV/c



hpDIRC Ongoing Software Tasks

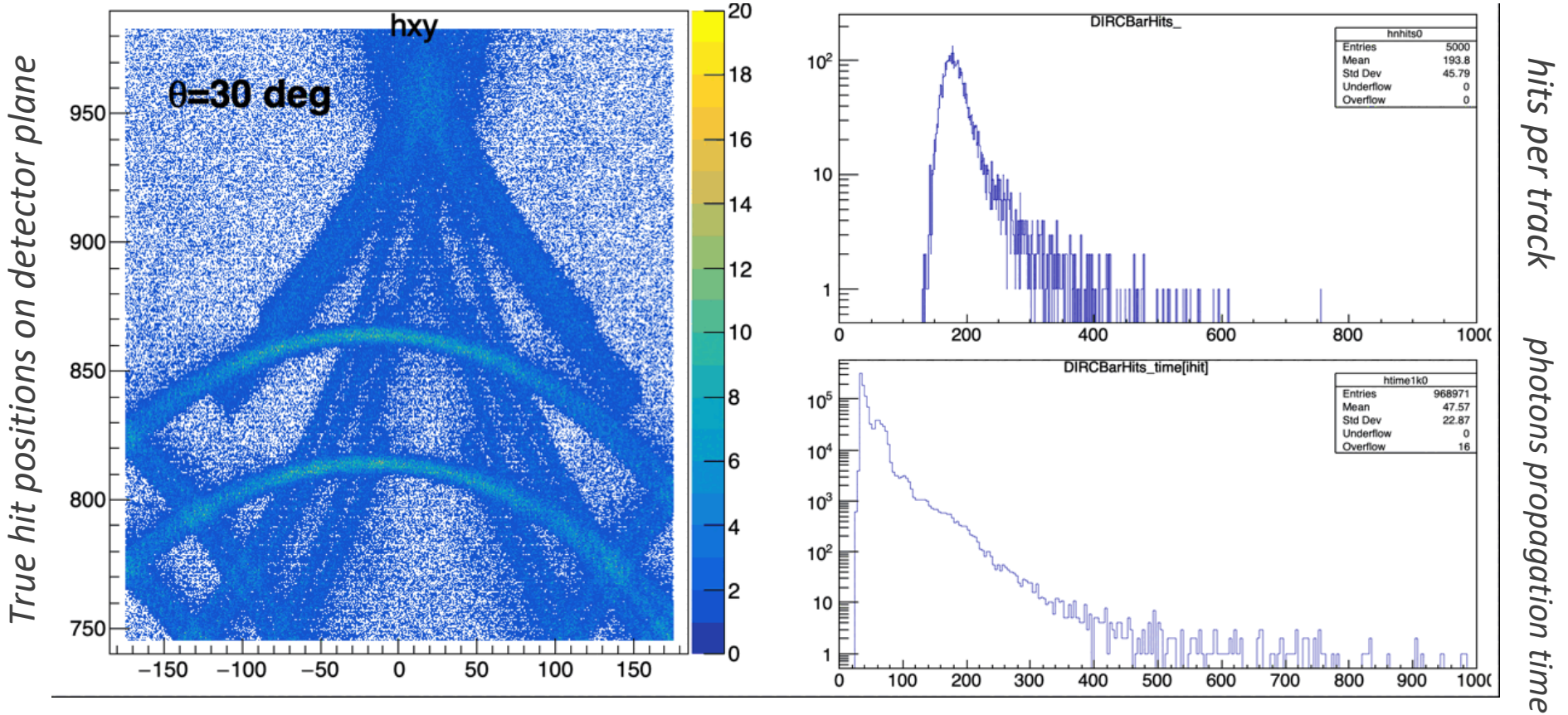
- Done:
  - Rationalizing dimensions/positioning between npsim/eicrecon design and dirc.xml
  - Rebuilding simulation/analysis framework in npsim/eicrecon (to the functional level)





HPDIRC ONGOING SOFTWARE TASKS

- Currently
  - First look at optical photons on the sensor plane obtained using npsim (from ePIC stack). The plots look reasonable.

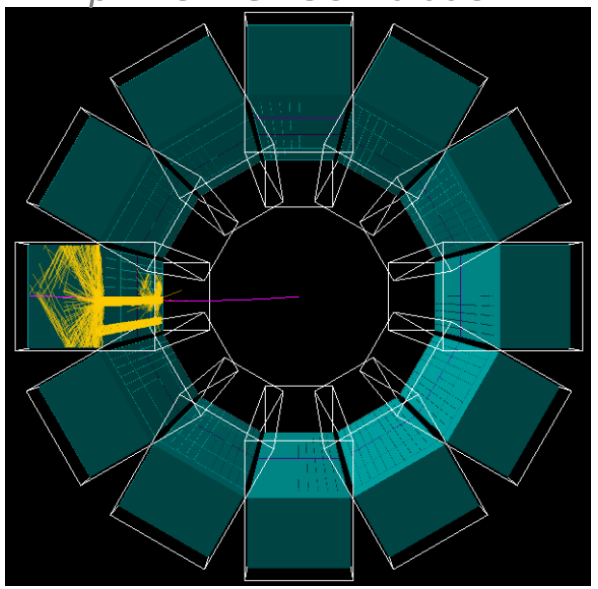


Goal: Comparing performance between eicrecon and the standalone framework

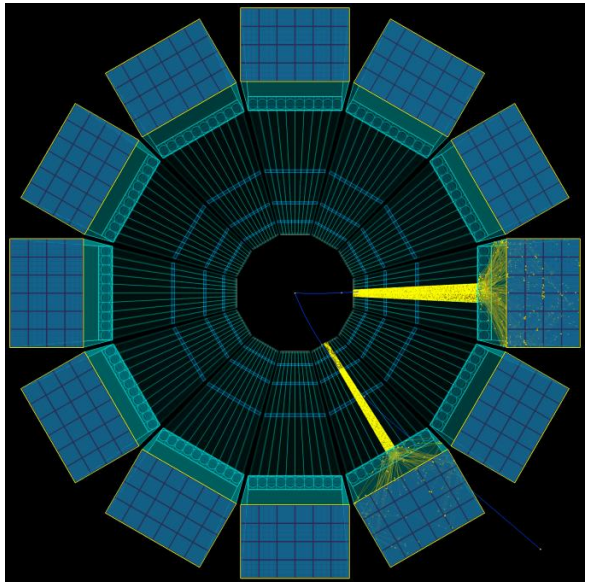
hpDIRC Ongoing Software Tasks

- Currently
  - Comparing performance between eicrecon and the standalone framework
  - Digitization based on either the standalone or dRICH approach (DIRCRawHit / RawTrackerHit → cell ID → position → PMT ID & pixel ID → DIRC tree)
  - Reimplementation of geometric and time-imaging PID reconstruction within eicrecon
- Near term
  - Repeat multiple-hits-per-bar studies using the full ePIC geometry
  - Quantify performance with Pythia using the latest ePIC geometry, including realistic sensor background rates
- Far term
  - Implementation of alternative ML-based reconstruction method

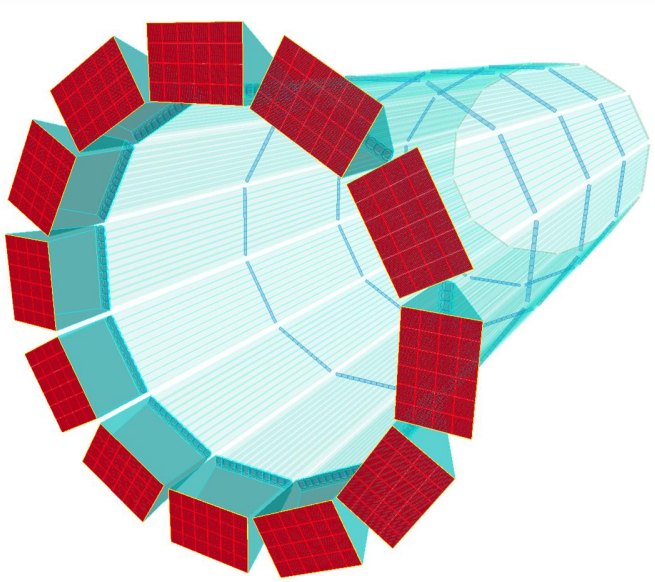
hpDIRC in ePIC simulation

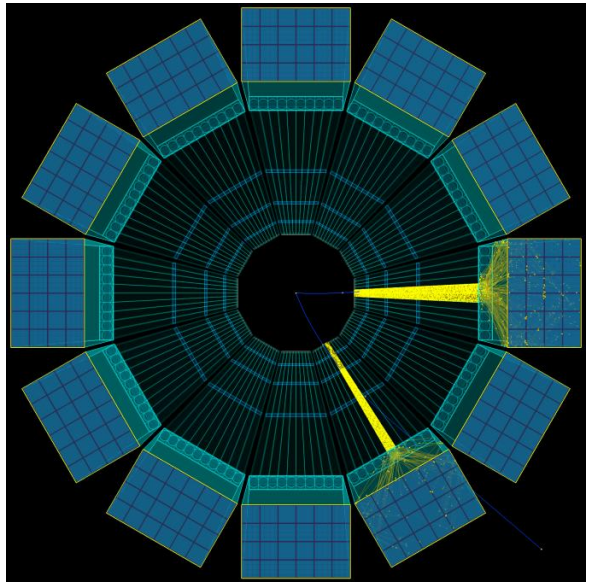


Stand-alone hpDIRC simulation



Thank you!





Questions?