Tracking Projections/ Resolution at hpDIRC

Matt Posik
and
Chandradoy Chatterjee

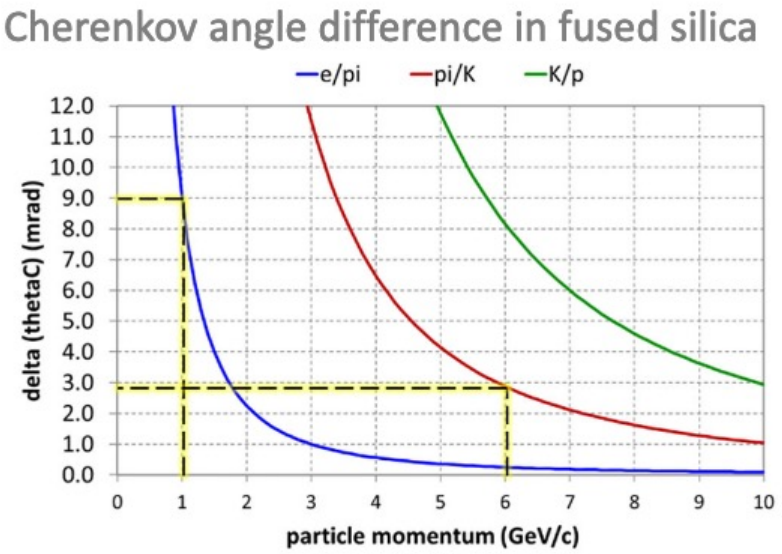
Workshop Motivation

- PID performance
  - PID performance is dependent on the angular resolution of tracks that enter the PID detectors.
  - hpDIRC performance ability to meet ePIC detector physics requirements is most sensitive to the tracking performance.

Cherenkov Angle Resolution

hpDIRC PID Goals

- π/K separation up to at least 6 GeV → $\Delta\theta \approx 3$ mrad
  - 3 s.d. requires σ_c(particle) ≤ 1 mrad @ 6 GeV
- e/π separation up to 1-1.2 GeV → $\Delta\theta \approx 6-9$ mrad
  - 3 s.d. requires σ_c(particle) ≤ 3 mrad @ 1 GeV



Cherenkov Angular Resolution

- $\sigma_c(\text{particle}) \approx \sqrt{\left(\frac{\sigma_c(\text{photon})}{\sqrt{N_\gamma}}\right)^2 + \sigma^2_{\text{correlated}}}$, $\sigma_{\text{correlated}} = \sqrt{\sigma^2_{tracking} + \sigma^2_{\text{ms}}}$
- ePIC hpDIRC
  - $\sigma_{\theta c}(particle) = 3-5\ mrad,$
  - $N_\gamma = 30-170$

Angular resolution from tracking system

Multiple scattering inside DIRC bar

Slide info from Aug. 19 2024 TIC Meeting (Jochen Schwiening)

Sensitivity of Tracking Resolution on Performance

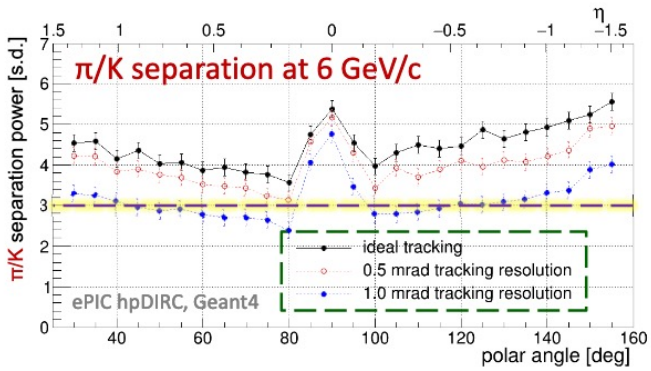
- Slide from Aug. 19 2024 TIC Meeting (Jochen Schwiening)

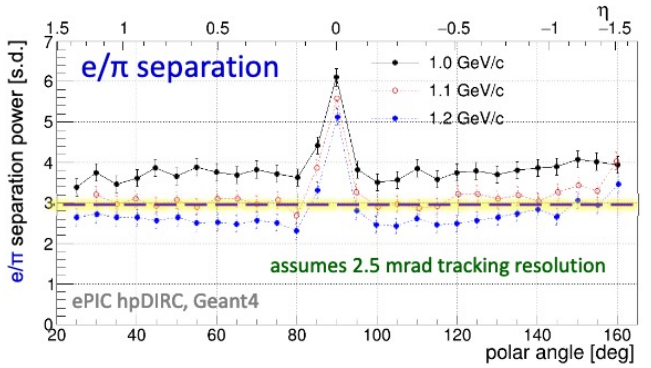
During YR/DPAP times, tracking experts suggested expected
tracking angular precision values of 0.5 mrad at 6 GeV/c
and 2.5 mrad at 1.2 GeV/c

Implemented these resolutions in hpDIRC standalone simulation

π/K separation at 6 GeV/c reaches 3 s.d. goal
for 0.5 mrad tracking resolution

e/π separation with 3 s.d. in reach at 1.1 GeV/c
for 2.5 mrad tracking resolution
(Caveat: non-Gaussian tails from multiple scattering,
3 s.d. value for core of log-likelihood difference distribution)





Caveat for all shown results: standalone Geant4, particle gun, no magnetic field, track hits center of bar, no backgrounds, 100 ps photon timing

Workshop Motivation

- PID performance
  - PID performance is dependent on the angular resolution of tracks that enter the PID detectors.
  - hpDIRC performance ability to meet ePIC detector physics requirements is most sensitive to the tracking performance.
- Guide ePIC detector design
  - Final placement of imaging layers in Barrel Imaging Calorimeter will be determined based on its impact on the angular resolution of tracks entering hpDIRC.
- Workshop Goals
  - Develop a work plan to
    - Converge on a common approach for estimating angular resolutions
    - Layout tasks needed to optimize angular resolutions

Workshop Agenda