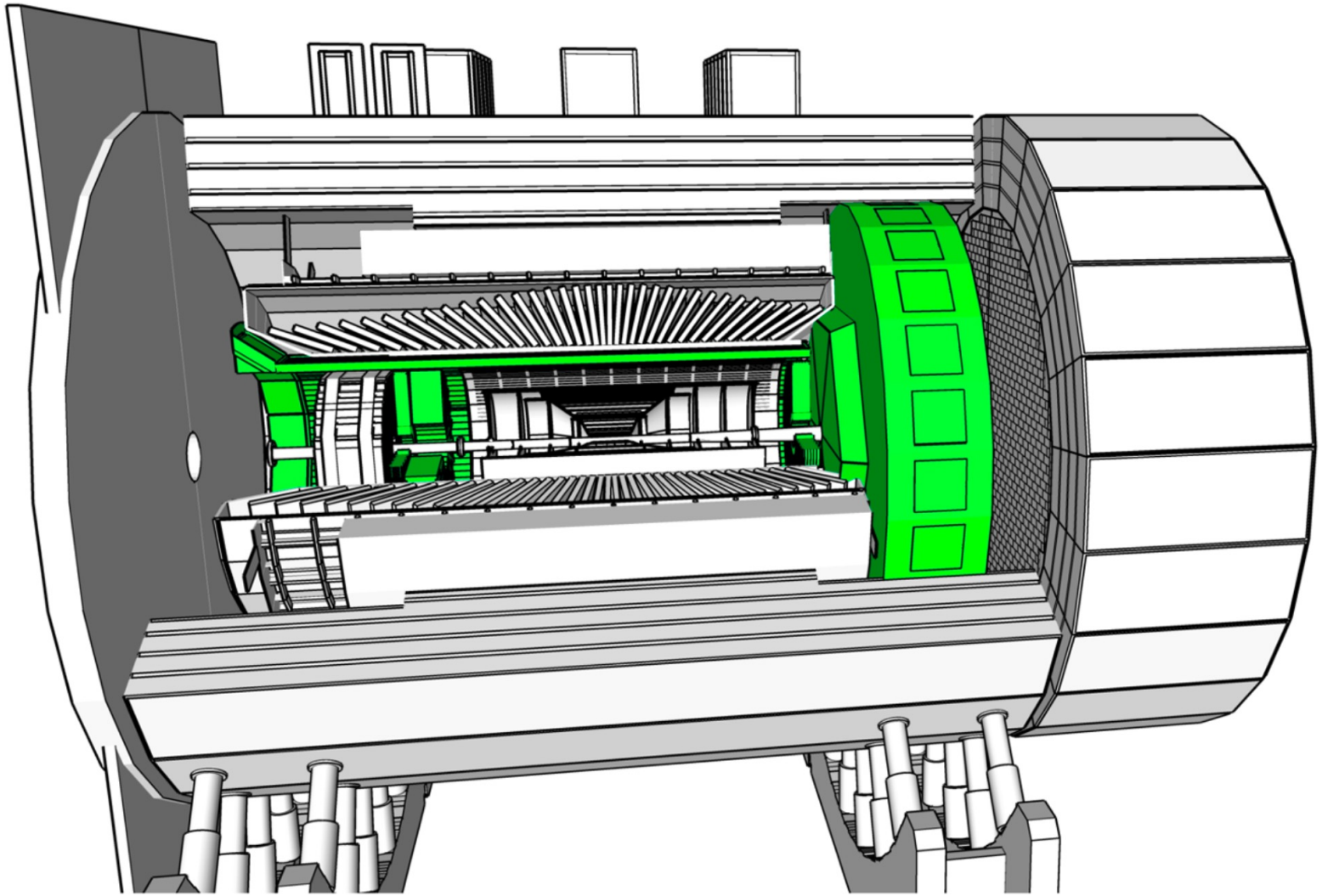
Backward Cherenkov based PID for EIC Detector 1



Cherenkov PID

Greg Kalicy (CUA)

Roberto Preghenella (INFN)

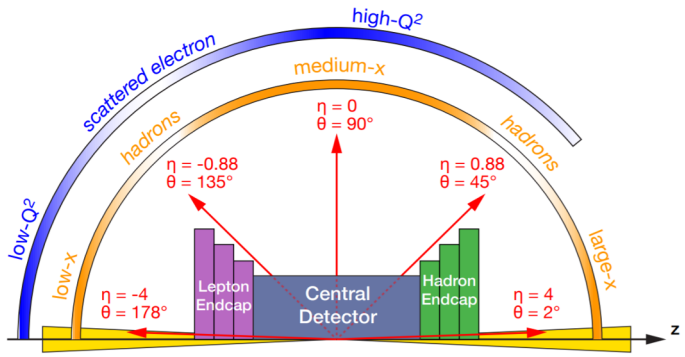
Tom Hemmick (Stony Brook University)

Xiaochun He (Georgia State University)

June 13th 2022

Cherenkov based PID for EIC Detector 1 meetings

- **INDICO space: https://indico.bnl.gov/category/412/**



- **May 20: 4th meeting,** Murad presented mRICH
  - Slides: https://indico.bnl.gov/event/15835/contributions/63332/attachments/41064/68724/mRICH_Review_5.20.2022.pdf
  - Recording: https://cua.zoom.us/rec/share/TR4DVUuG0yMwHzAcTuwqTCzSIbLz6s2Ku0pJRGTv_lJbvyd-h30kJb4u6V95YhQx._NISDylLuY5vosB1
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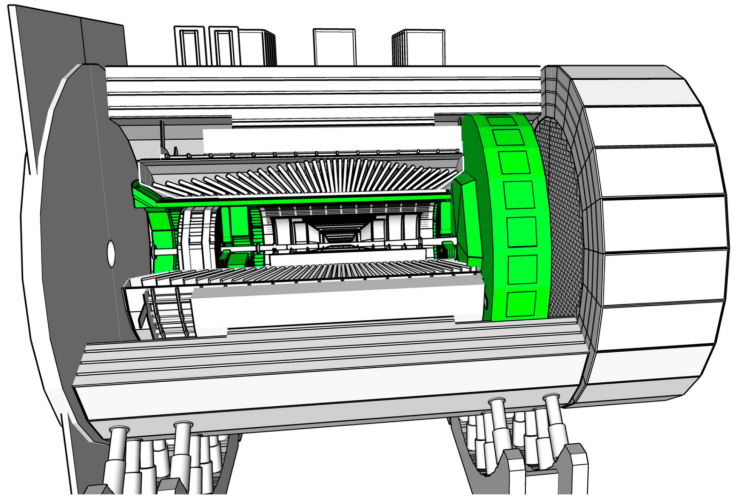
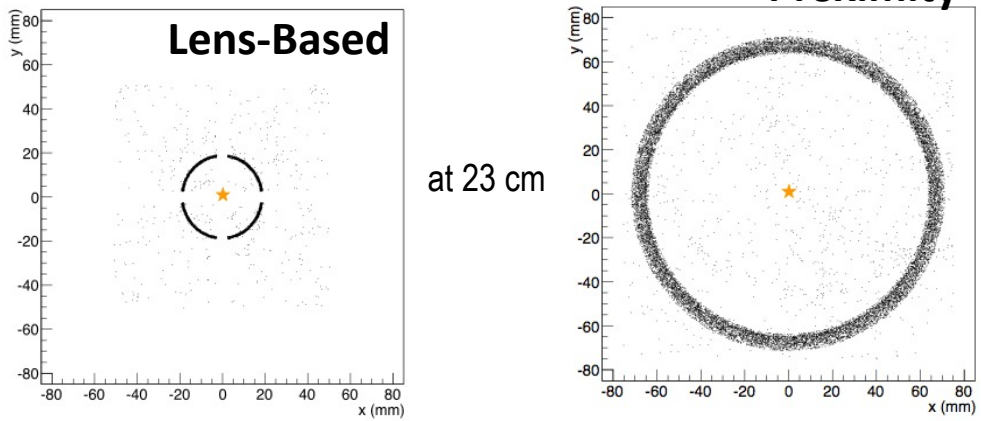


- **May 27: 5th meeting,** Alexander presented pfRICH
  - Slides: https://indico.bnl.gov/event/15835/contributions/63524/attachments/41063/68723/ayk-2022-05-20-pfrich-cherenkov-pid-wg-meeting-pfrich.pdf
  - Recording: https://cua.zoom.us/rec/share/yu4v3kp4eMnNuUvfFR50Y6l61hbW4llg8WqIS6xvZrHZxDQrP0zDhj0KNomAomc5.GBK15uN-ABnnyjsA
    Passcode: CbVK2+0p

Modular RICH Detector (mRICH)

3-9 GeV/c
-3.0 < η < -1.5

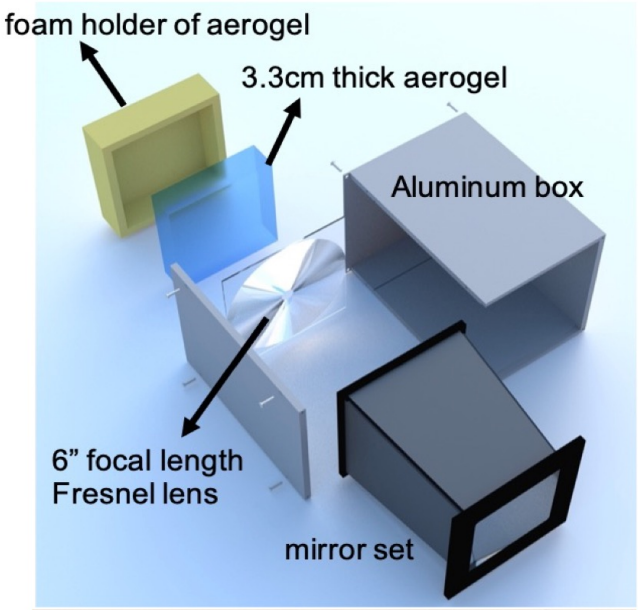
Overview:

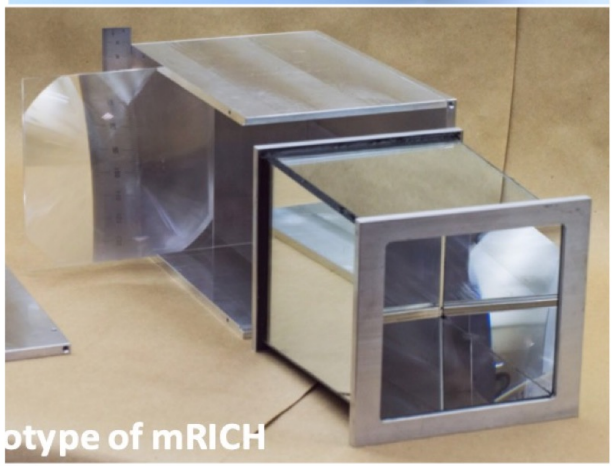
- Modular and compact RICH detector (~15x15x25 cm)
- Radiator: Aerogel, 11x11x3 cm and n=1.03
- Focusing: Fresnel lens with 6” focal length
- 

- π/K separation up to 10 GeV/c and e/π separation up to 2 GeV/c.
- Sensors: Currently **assuming SiPMs but LAPPDs would be good alternative**

Systematic effects

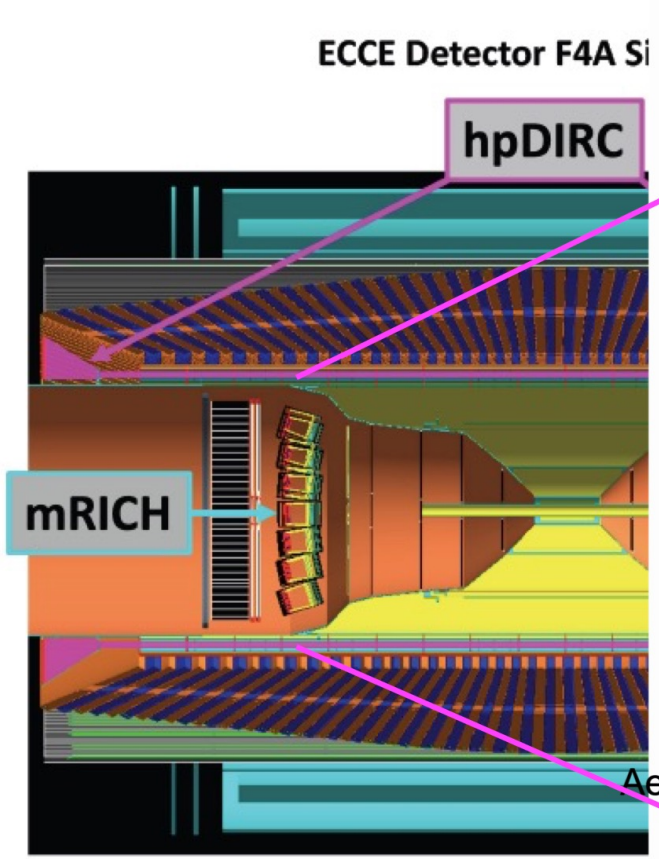
- Emission point error: minimized at the lens focal plane
- Chromatic dispersion error: reduced by UV filtering (acrylic).

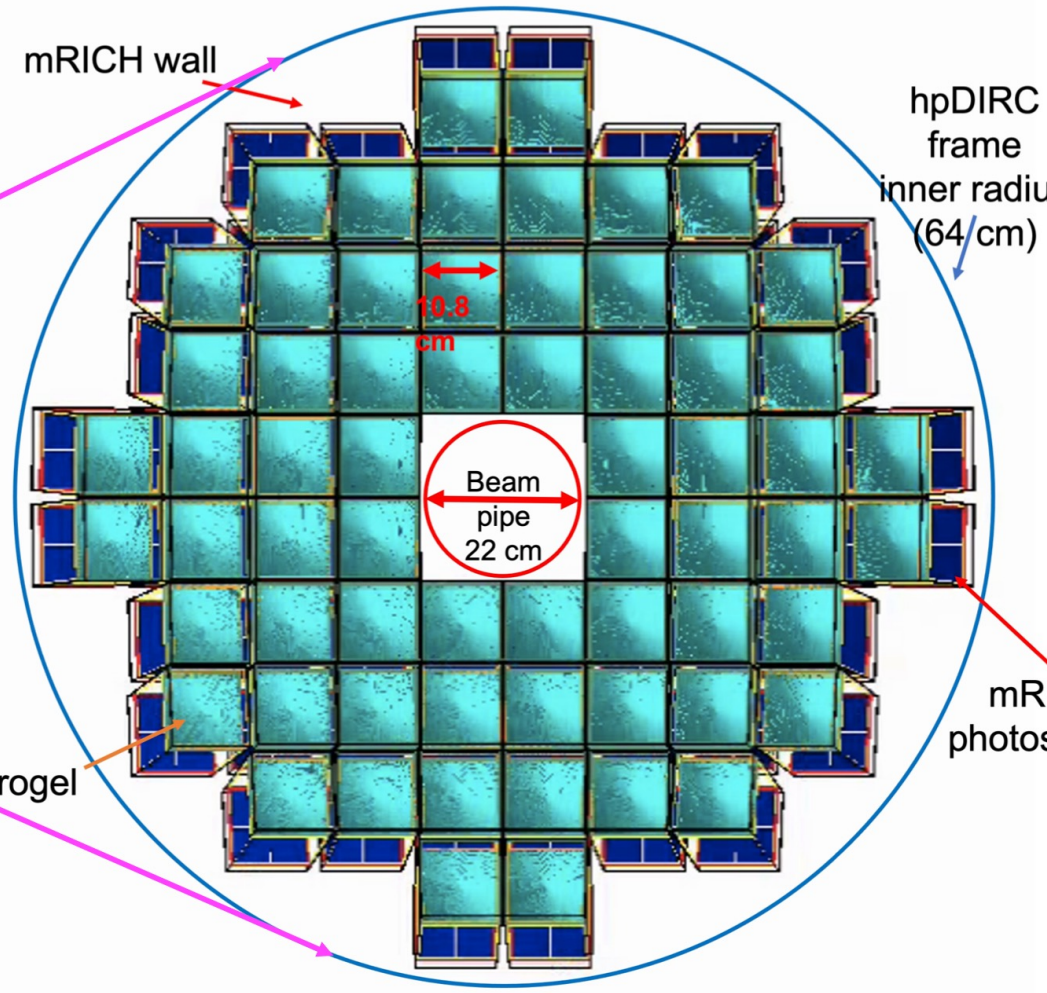


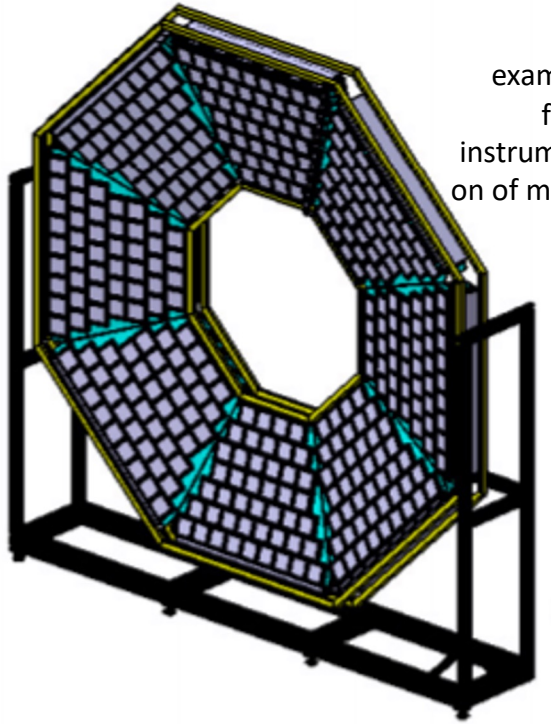


Modular RICH Detector (mRICH)

3-9 GeV/c
$-3.0 < \eta < -1.5$







example of flexible instrumentation of modular array

Modular RICH Detector (mRICH)

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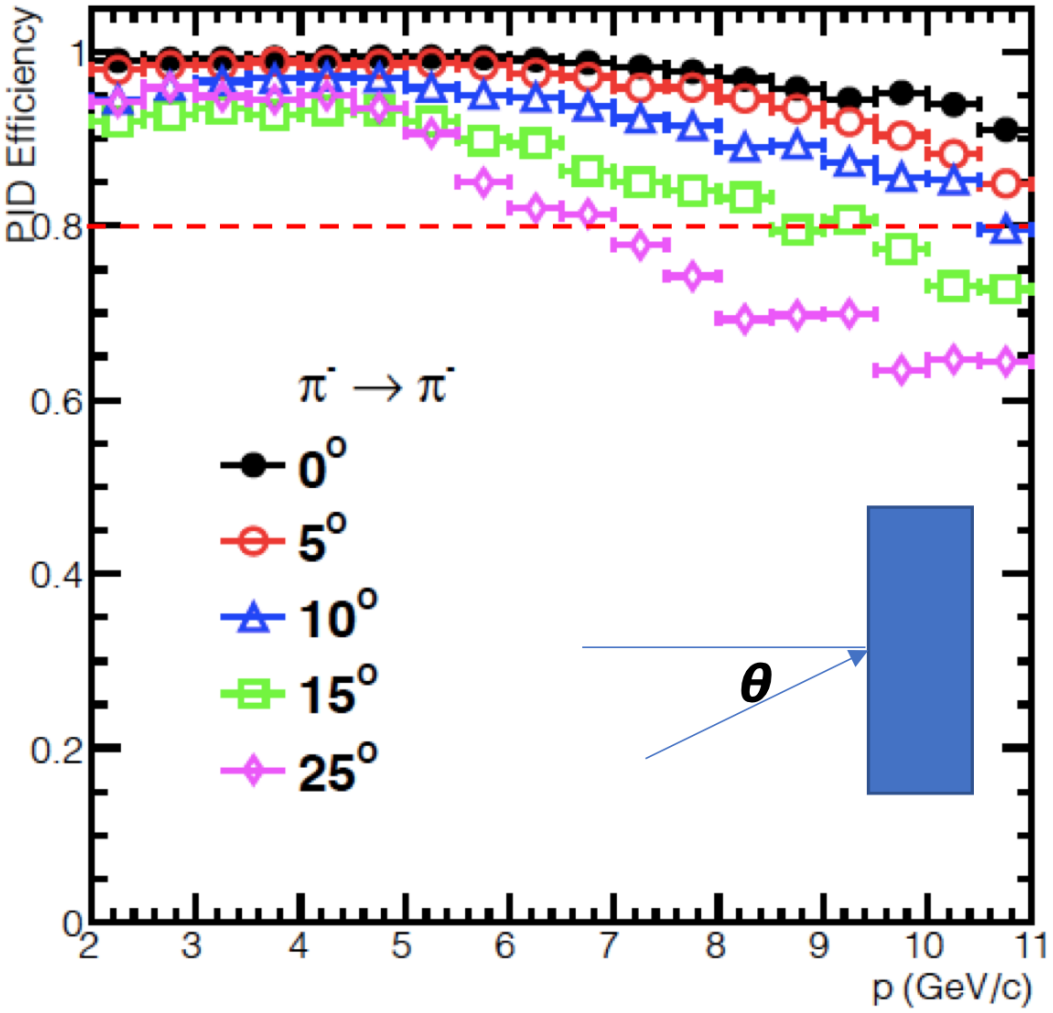
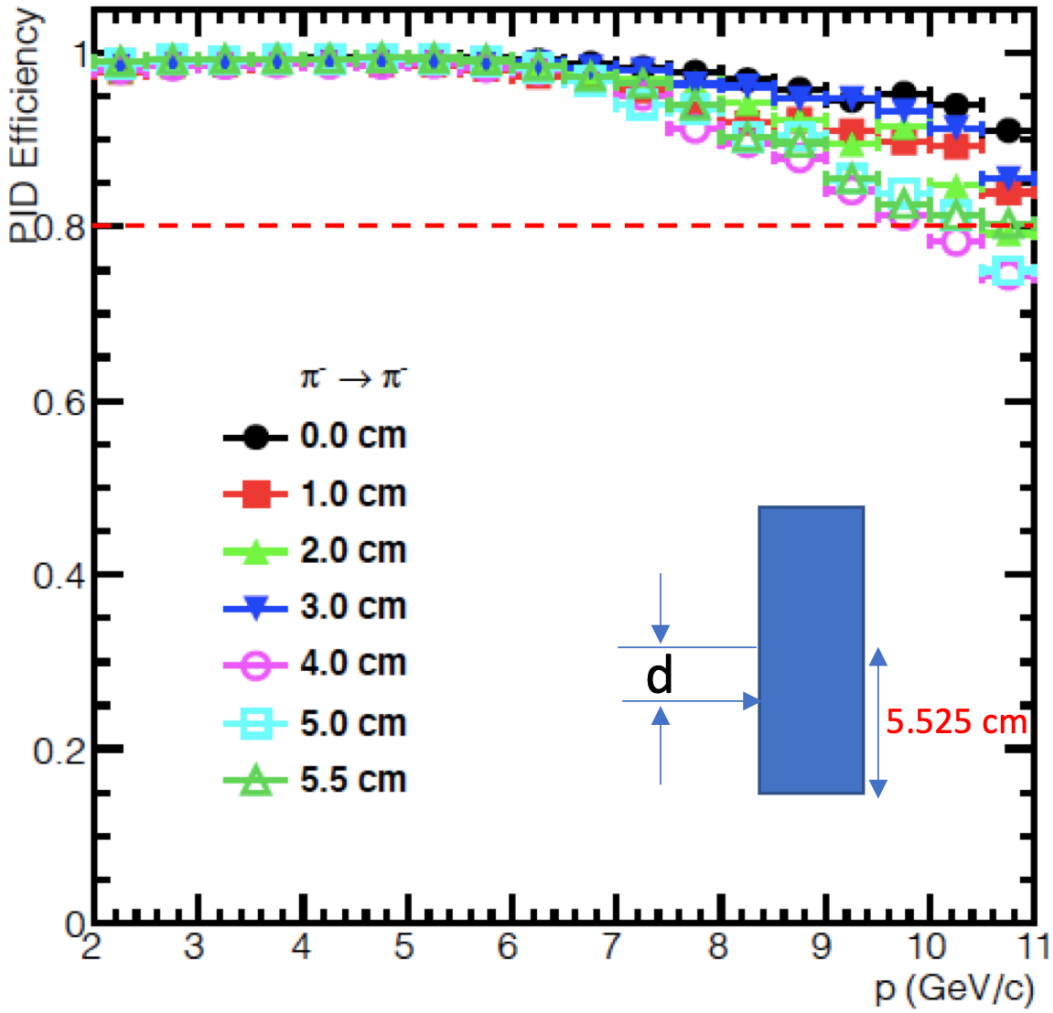




~3σ

- Efficiency drops beyond 15°

Modular RICH Detector (mRICH)

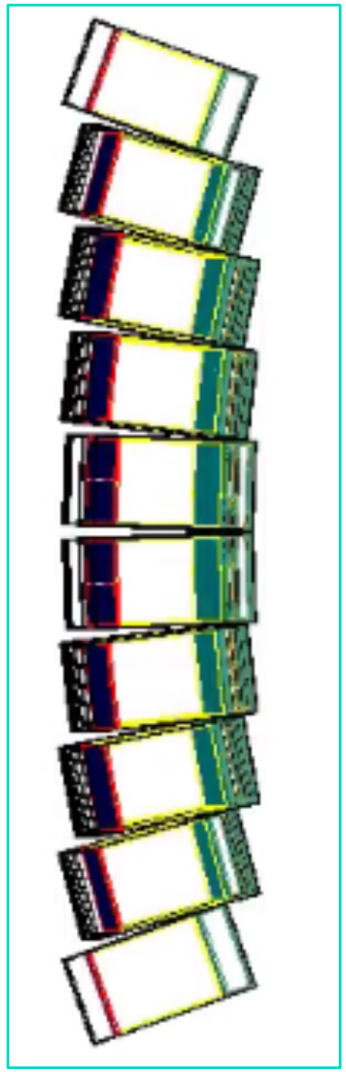
3-9 GeV/c
$-3.0 < \eta < -1.5$

- Mature design (dedicated work as part of EIC R&D since 2015 with solutions to challenges evaluated by committee)

- Progress since proposal submission:

  - Lowering material budget: Investigating use of a thinner 500μm and shorter (~1”) mirrors.
  - Shifting the projection point by 10 cm in z and 1-2 cm in xy off the 0,0,0 IR. (avoiding scenario where a particle goes through the long edge of the mirror with no impact on performance)
  - Investigating usage of thicker Aerogel to increase photon yield without worrying about the emission point systematic due lens focusing
  - Preparing detailed simulation studies with physics based events

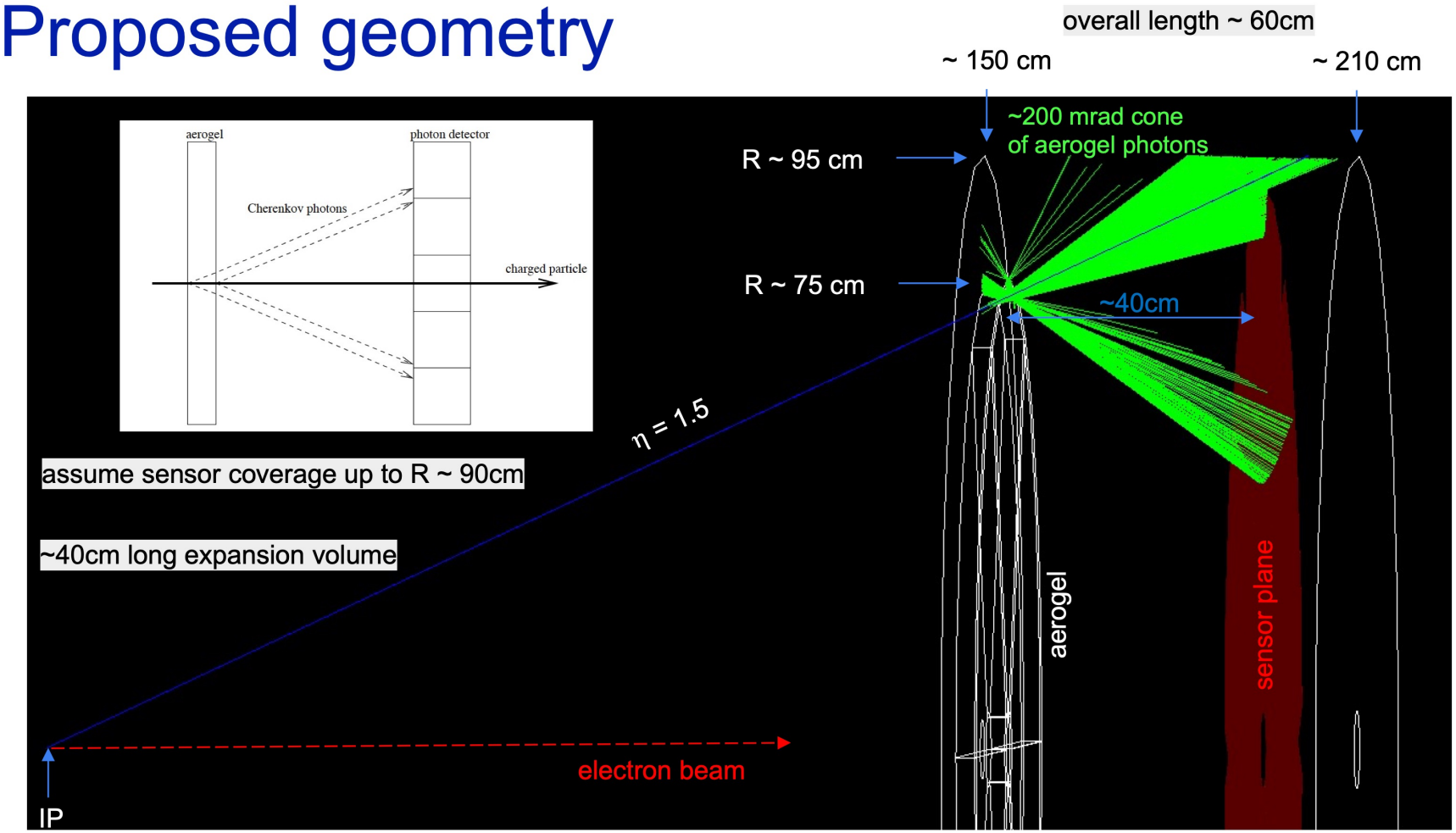
- Key ongoing task is SPR determination from test beam data



Proximity focusing RICH Detector (pfRICH)

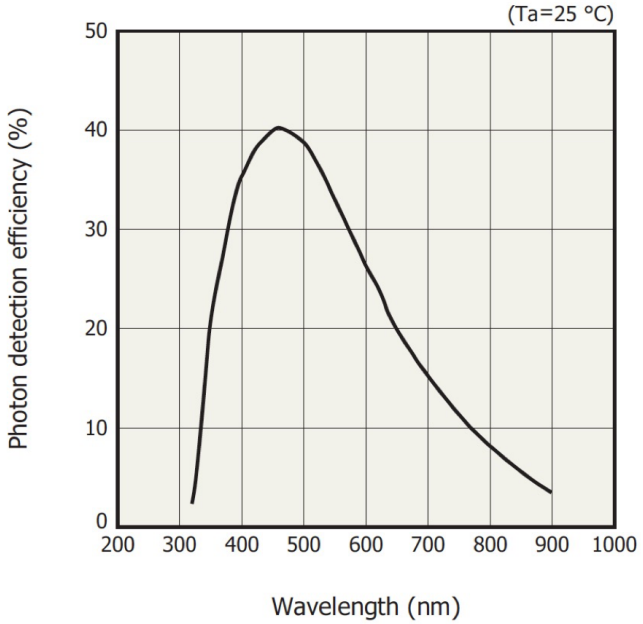
- A proximity-focusing aerogel RICH (pfRICH) with 40 cm proximity gap.
- Alternative proposed in ATHENA, deviates from the mRICH technology used in the Yellow Report.

Proposed geometry



Technical details

- Geometry: proximity focusing, no mirrors
  - Aerogel: parameterizations based on CLAS12 data
    - 3cm thick @ density 110mg/cm^3 (tuned to match <n> ~ 1.02)
    - Rayleigh scattering
    - Absorption length
  - Acrylic layer: 3mm thick, “cutoff” set @ 350nm
  - ~40cm long (air) expansion volume
  - SiPMs (S13361-3050AE-08 8x8 panels)
    - 3.4 mm pitch
    - QE as given by Hamamatsu
    - 85% geometric fill factor & 70% “safety factor” on top of it
- Custom GEANT4 / ROOT software



Proximity focusing RICH Detector (pfRICH)

- Main advantage: no need of lenses and mirrors.
- Full length around 60cm. Work on integration needed.
- Needs more detailed simulations for full evaluation:
  - Currently one block of aerogel instead of proper segmentation + support frame
  - Proper sensor plan. (The number of sensors is the driving costs)
  - Figuring out discrepancy between simulated and measured photon yield
- What are the associated acceptance and efficiency within the reference detector constraints?
- Need to identify manpower to do dedicated studies and work on construction