Modular aerogel RICH (mRICH)

Goal:

- Compact PID device with momentum coverage up to 10 GeV/c for pi/K and e/pi up to 2 GeV/c.
- First aerogel RICH with lens-based focusing (for performance and cost)

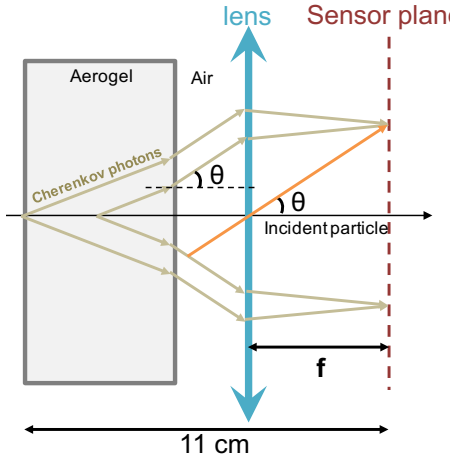
FY 19:

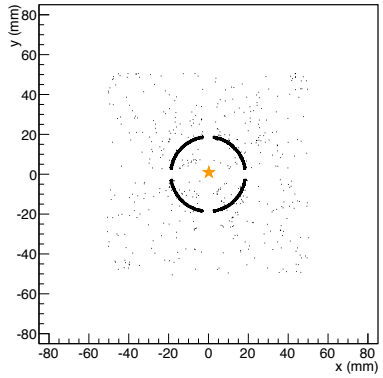
- Analyze the 2nd mRICH test beam data taken from June 25 to July 6, 2018.
- Publish the new results from this test and make plan for the 3rd beam test if it is necessary.
- Use the mRICH to develop an integrated readout electronics solution.
- Search for radiation hard materials for Fresnel lens.
- Optical characterization of Fresnel lens and aerogel.

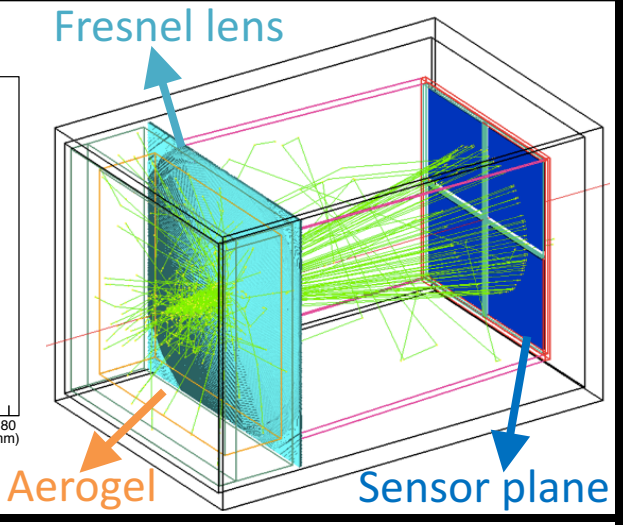
mRICH – lens-based focusing aerogel detector design

Smaller, but thinner ring improves PID performance and reduces length

Lens-Based mRICH Design

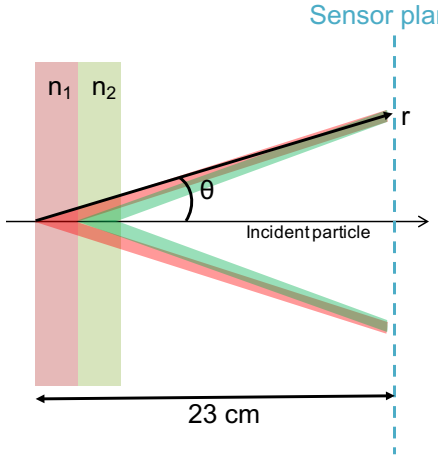


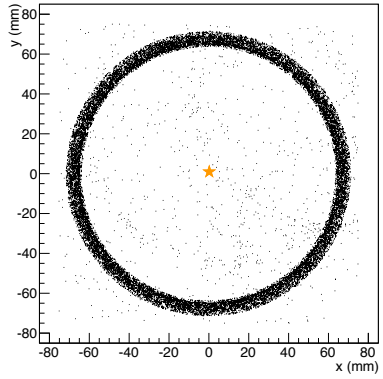




9 GeV/c pion beam launched at the center of xy plane in simulation

Two-Layer Proximity Focusing Design (BELLE-2 ARICH)





- EIC mRICH designed for K/pi ID up to 10 GeV/c
- BELLE-2 ARICH aims to separate pion and kaon up to 4 GeV/c

mRICH – lens-based focusing aerogel detector design

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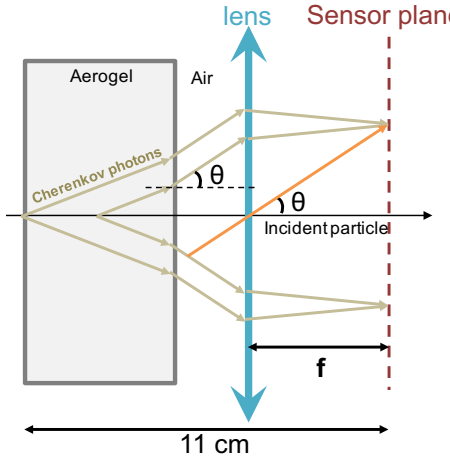
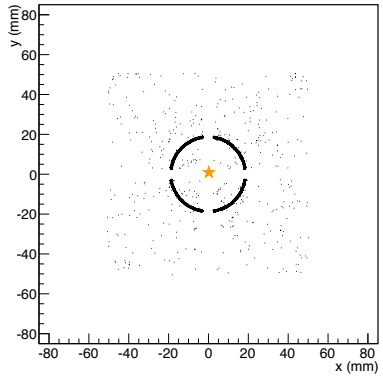
Lens-Based mRICH Design

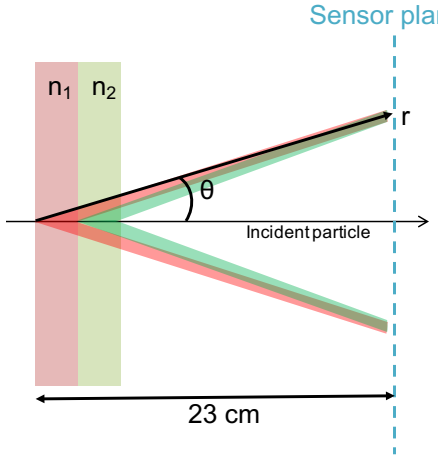


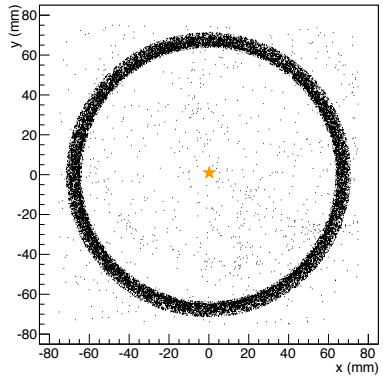


- 9 GeV/c pion beam launched at the center of xy plane in simulation
- **Smaller and thinner** ring image

9 GeV/c pion beam launched at the center of xy plane in simulation

Two-Layer Proximity Focusing Design (BELLE-2 ARICH)



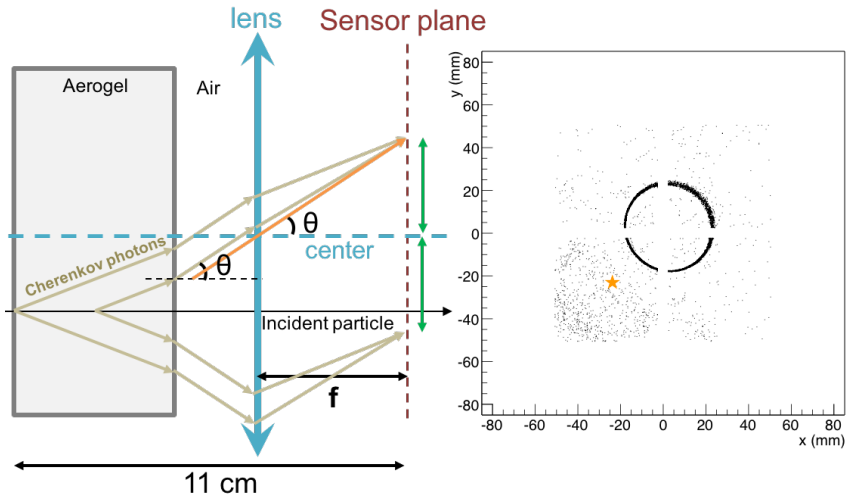


- EIC mRICH designed for K/pi ID up to 10 GeV/c
- BELLE-2 ARICH aims to separate pion and kaon up to 4 GeV/c

mRICH – lens-based focusing shifts image to center

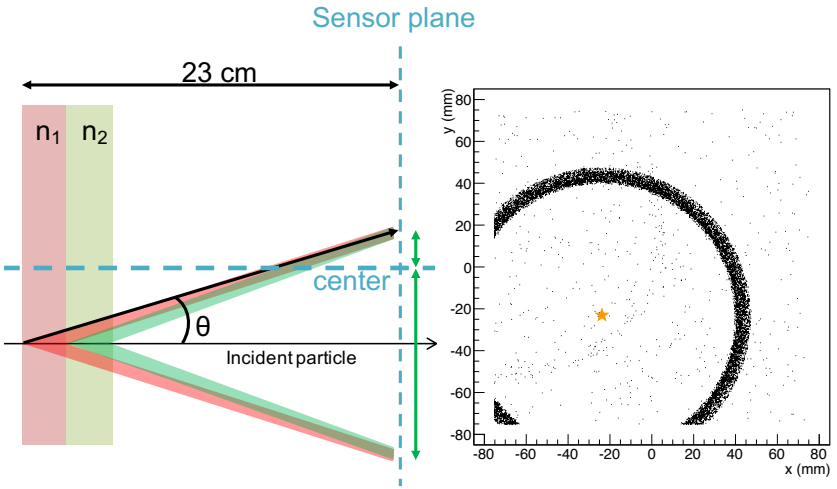
Ring centering of lens-based optics reduces sensor area (main cost driver)

Lens-Based mRICH Design



- 9 GeV/c pion beam incident at third quadrant (star) in simulation
- Ring image is **center** on the middle of the sensor plane

Two-Layer Proximity Focusing Design (BELLE-2 ARICH)

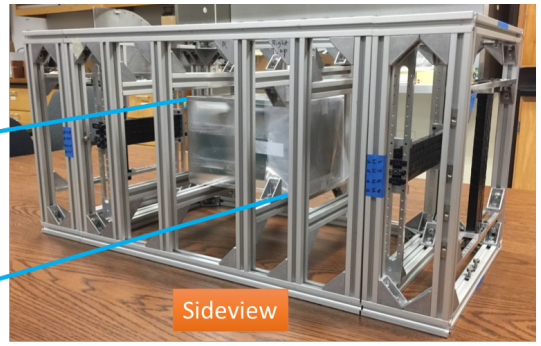


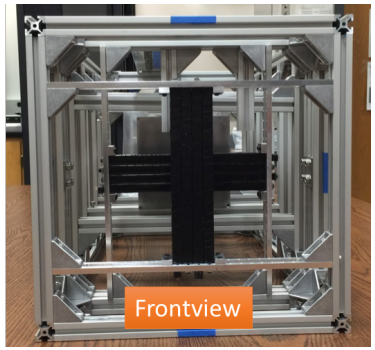
- 9 GeV/c pion beam incident at third quadrant (star) in simulation
- Ring is centered at point of incidence

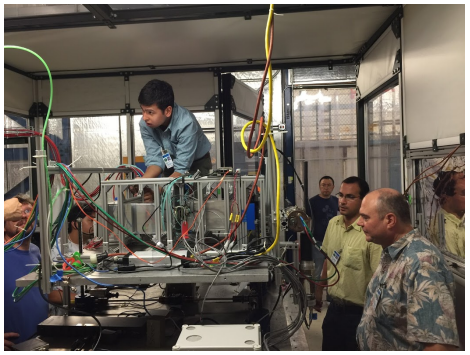
mRICH – FY18 progress (part one)

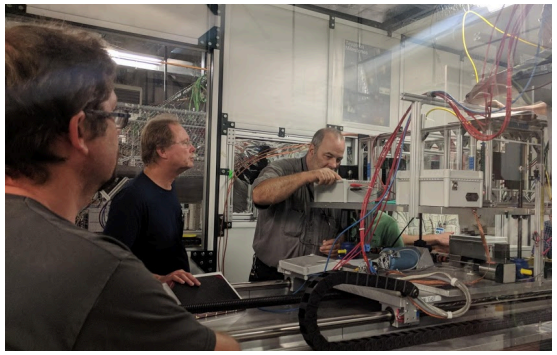
Another very successful mRICH prototype beam test at Fermilab (6/25 to 7/6/2018)

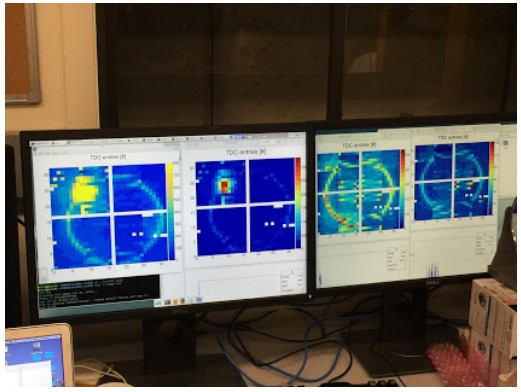
Two completed mRICH prototypes

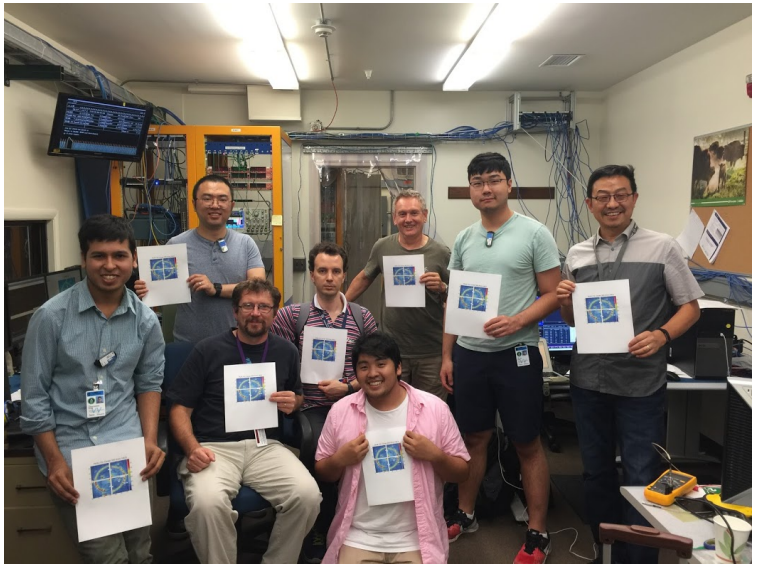








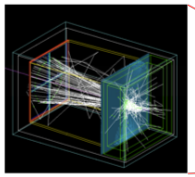




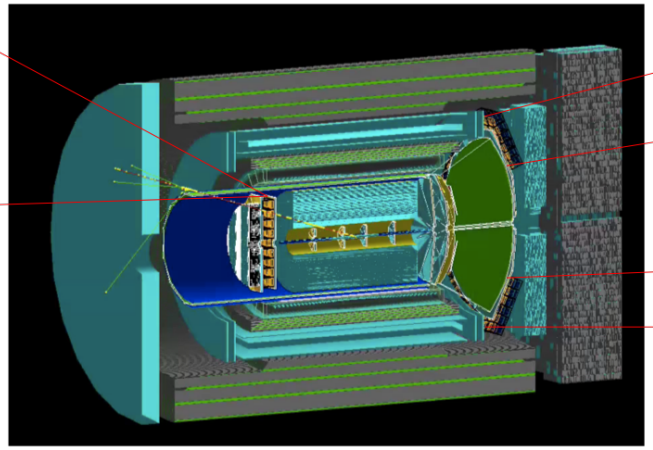
Group photo (missing two members) – the first confirmed ring image

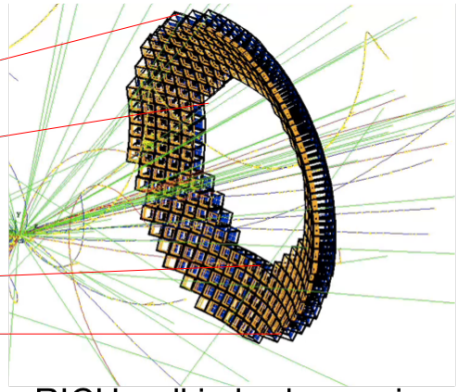
mRICH – FY18 progress (part two)

mRICH array implementation in Forward sPHENIX and JLab EIC detector concept in Geant4 simulation studies. Developed mRICH-based PID algorithms using a loglikelihood method.

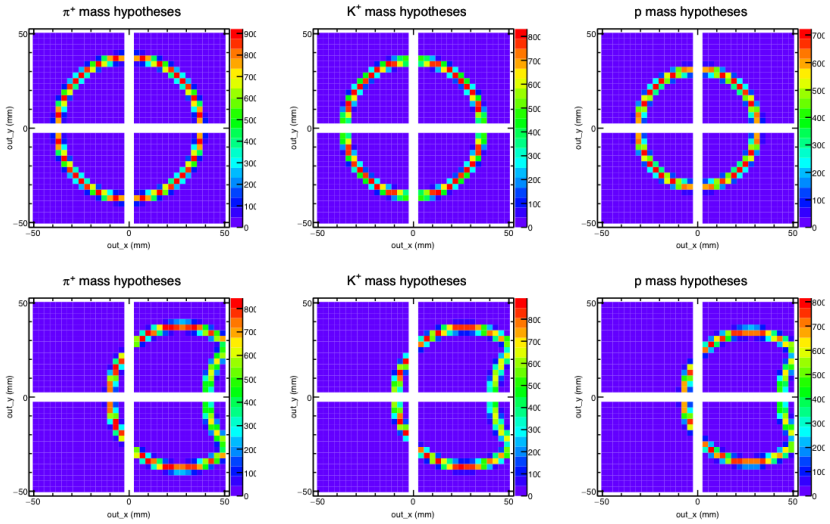


mRICH wall
e/π separation





mRICH wall in hadron-going direction for hadron PID



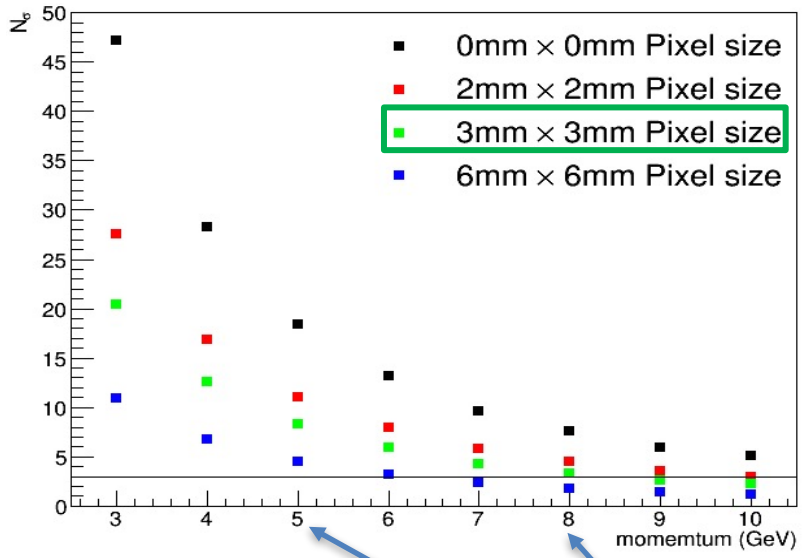
Examples of ring image patterns generated from Geant4 simulation for 5 GeV/c pi, K and proton, which are used in the loglikelihood PID method.

Upper row: incident at center at 0^0 angle

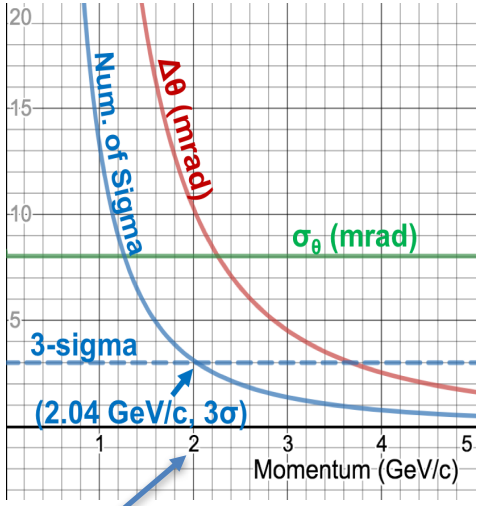
Lower row: incident at center at 10^0 angle

mRICH – FY19 activity (part one)

- Data analysis of the 2nd mRICH beam test and publish the new results – **verify the PID performance at 2, 5 and 8 GeV/c**



- Projected K/pi separation of mRICH 2nd prototype detector (**Green dots**)
- 2nd prototype detector can achieve 3-sigma K/pi separation up to 8 GeV/c

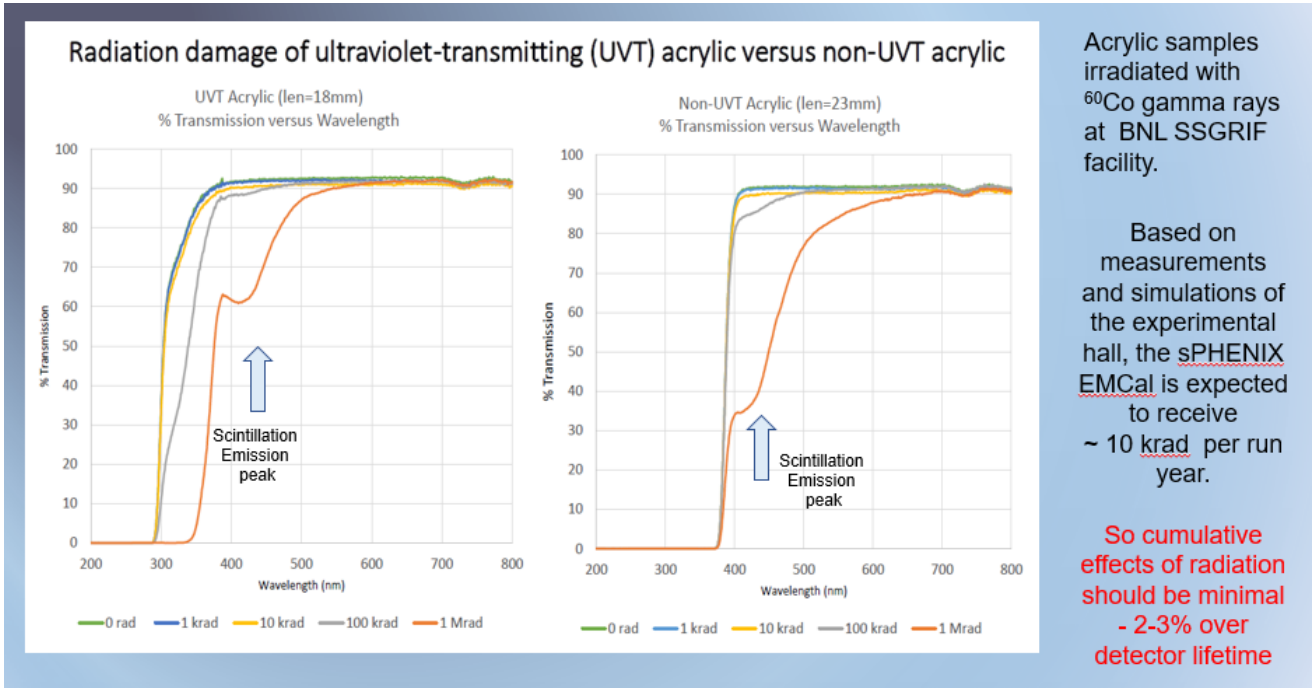


- Projected e/pi separation of mRICH 2nd prototype detector (**blue solid line**)
- 2nd prototype detector can achieve 3-sigma e/pi separation up to 2 GeV/c

Data sets taken during the second mRICH beam test at Fermilab in 2018

mRICH – FY19 activity (part two)

- Study of the radiation hardness of Fresnel lens (i.e., address the committee concern!)



Presented by Sean Stoll at IEEE NSS 2017

- Simulation study of mRICH performance in the Forward sPHENIX experiment at BNL (ongoing effort).
- Simulation study of mRICH performance in the electron endcap in JLEIC (ongoing effort).
- Work with dRICH group to develop a plan for a join dRICH/mRICH beam test.

BACKUP SLIDES

mRICH – FY17 progress

1st mRICH prototype results have been published in NIM A871, 13-19 (2017)

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journal homepage: www.elsevier.com/locate/nima

Modular focusing ring imaging Cherenkov detector for electron–ion collider experiments☆

C.P. Wong[g,*], M. Alfred[i], L. Allison[o], M. Awadi[i], B. Azmoun[c], F. Barbosa[m], L. Barion[j,r],

2nd mRICH prototype beam test is under preparation (PID validation test)

Two completed mRICH prototypes