# Discussion of Upcoming PID Review(s)

# Upcoming review / meeting schedule

- ❑ Incremental Design and Safety review of EIC Cherenkov PID Detectors: April 1-2
- ❑ EIC Detector R&D Day(s): April 16-17
- ❑ EIC Detector Advisory Committee (DAC) meeting: June 11-13

# First in the queue: EIC Project review

- Review dates: April 1 & 2
  - Day 1: General detector and installation
  - Day 2: Photosensors
- Review will cover all Cherenkov-based PID detectors
- Previous review: July 5 – 6 2023
- Go over report from previous review to assess where progress has been made and where we may need to invest more effort

# Charge

The scope of this review includes all aspects of particle identification detectors based on Cherenkov light detection in the central EIC detector, which includes the barrel, the forward endcap, and **the backward endcap** regions. This includes three detector systems. In particular, **a proximity-focusing RICH in the backward region**, a high-performance DIRC detector in the barrel region, and a dual RICH  detector in the forward region. The review may include:

- ❑ Design and fabrication choices and their cost-effectiveness
- ❑ Construction schedule
- ❑ Considerations for safety and quality assurance
- ❑ Levels of redundancy
- ❑ Front-end electronics and interface to the data acquisition system
- ❑ Commissioning and calibration procedures
- ❑ Considerations for materials and labor
- ❑ Operational reliability and longevity
- ❑ Any other considerations that may influence the construction, maintenance and operation of these particle identification detectors.

# Points to Address

1. Are the technical performance requirements appropriately defined and complete for this stage of the project?
   -> AK (cut'n'paste from July'23)
2. Are the plans for achieving detector performance and construction sufficiently developed and documented for the present phase of the project?
   -> Alex (?)
3. Are the current designs and plans for detector and electronics readout likely to achieve the performance requirements with a low risk of cost increases, schedule delays, and technical problems?
   -> Simulation team; Jeff (?)
4. Are the fabrication and assembly plans for the various particle identification detector systems consistent with the overall project and detector schedule?
   -> Alex, Sushrut, Charles, ..?
5. Are the plans for detector integration in the EIC detector appropriately developed for the present phase of the project?
   -> Alex, Daniel (?)
6. Have ES&H and QA considerations been adequately incorporated into the designs at their present stage?
   -> Alex (?), AK (QA)
7. Have the recommendations from previous reviews been adequately addressed?

# Recommendations from Previous Review

1. Capture the bi-directional interface between tracking and PID detectors: e.g., translation between position and angular resolution requirements for PID detectors

   -> Matt, provided simulation input is available

2. Perform a thermal simulation of the dRICH SiPM array considering different operating temperatures and impact on the quartz window and gas radiator

3. Create detailed QA plans, including the fraction of devices to be tested

   - Comment: Our QA plans / procedures are in much better shape – summarize QA tests on initial HRPPD batch and outline steps to QA production runs

     -> AK, Prakhar (HRPPD evaluation, B-field & aging studies, rad. hardness), Kong (mirrors), Matt (aerogel)

# Comments from Previous Review (Tech Performance)

- Many studies have been carried out with standalone simulation and reconstruction. However, additional support should be provided for integrating the latest designs and realistic PID performance into the full ePIC simulation.
  - Comment: Need to show some progress toward integrating pfRICH into DD4Hep / EICrecon – highlight coordination with dRICH team
  - Comment: Need to clean up inconsistencies between CAD and simulation model(s)
  - Workforce: Alexander, Chandra, Alex, Brian, [Bill, Youqi]

- Recent progress has been made in ePIC's cross-cutting PID WG to understand tracking requirements for PID detectors. Requirements documents should capture the bi-directional interface between tracking and PID detectors: e.g., translation between extrapolated track impact point and angle resolution requirements for PID detectors. It could be evaluated where the PID subdetectors can contribute to improving the tracking performance and how in the reconstruction algorithms this could be integrated.
  - Comment: More critical for hpDIRC

# Comments from Previous Review (Det Performance)

- Following the discussion, the integrated anode charge for the HRPPD over the experiment lifetime is understood to be only a few C/cm2 in a worst-case estimate at $10^7$ gain. Operating at a lower gain can increase the lifetime but should be balanced with reduced PDE. It would be good to have the integrated charge numbers available from the simulation, also for different quartz HRPPD window thicknesses.
  - Comment: Should have this pretty well in hand – summarize studies from Andrew et al.

- A charged particle timestamp with a resolution of ~20 ps is required. It was stated that an SPTR of ~50 ps is required to achieve this track resolution, based on the minimum of 6 photons per track and the requirement of ~100% geometric efficiency. However, it was also presented that the mean number of photoelectrons lies around 12 (in the aerogel) and >80 (in the entrance window). It, therefore, appears that for the majority of tracks, the requirement on SPTR could be relaxed. It would be good to see the results from simulation on how the overall pfRICH and ePIC performance behaves as a function of this SPTR.
  - Comment: Recent bench tests show HRPPDs well exceed 50 ps SPTR – need to demonstrate this with ASIC backplane; Brian

- It would be good to evaluate the effect of the different photon angles of incidence on the quartz window across the detector plane on the number of detected photons and Cherenkov-angle resolution.
  - Comment: Not sure if this was directed at us – should be in the standalone simulation

# Comments from Previous Review (Readout)

- The reviewers acknowledge that the EICROC will not be available before the design is finalized; thus, evaluation of the HRPPD performance will take place with the existing HGCROC under the assumption that similar performance will be achieved with the EICROC.
  - Comment: Discuss plans to test HRPPD + backplane at the SBU CRTS with hpDIRC; AK

# Comments from Previous Review (Fabrication/Assembly)

- In the worst-case scenario that HRPPDs cannot meet performance specifications or production schedule, a backup solution of MCP-PMTs is being considered and should be evaluated in parallel to the HRPPDs.
  - Comment: Yes – side-by-side comparison at Glasgow(?) -> Rachel

# Comments from Previous Review (Integration)

- It was mentioned that the 3.375 mm (or potentially smaller) pitch at the HRPPD backplane is dominated by requirements of the hpDIRC using the same photodetector, and the pfRICH could operate at larger pixel areas. It should be investigated whether a small change in layout would allow multiple pixels to be grouped into a single readout channel, in order to reduce the overall channel count and cost.
  - Comment: Don't know this status