Brookhaven National Laboratory

Jefferson Lab

U.S. DEPARTMENT OF ENERGY

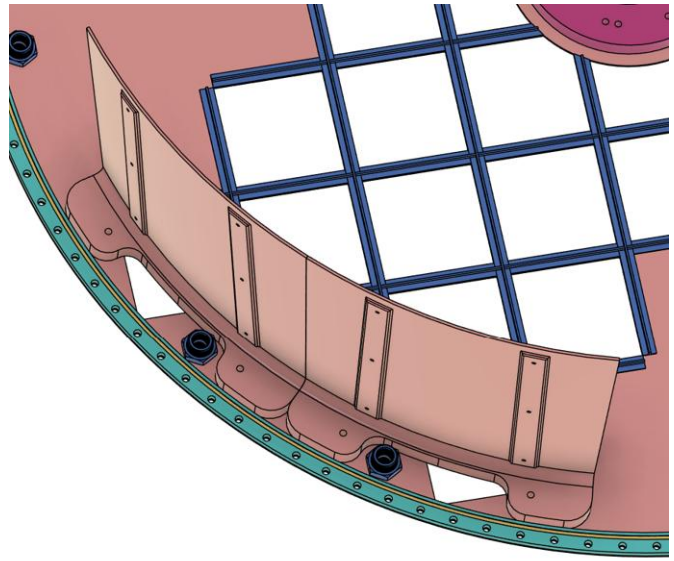
hpDIRC/pfRICH

Triple I Engineering Meeting Update

Alex Eslinger

Electron-Ion Collider

Engineering Status Overview



pfRICH

- Major full-scale mockup interface verification completed
- Sensor plane released for machining
- Mirror deformation work moving toward a reusable 3-post test platform

hpDIRC

- SLAC/BABAR knowledge-transfer and hardware recovery trip planned
- Sensor/prism-box integration discussions progressing
- GST deformation data received; next step is translating GST motion into bar-box/glue-joint loading

HRPPD

- Cooling/electronics packaging discussion advancing
- Mechanical cooling concept revised around installation constraints
- Several thermal and electronics architecture inputs still open

pfRICH: Full-Scale Mockup Progress

Vessel / Sensor Plane

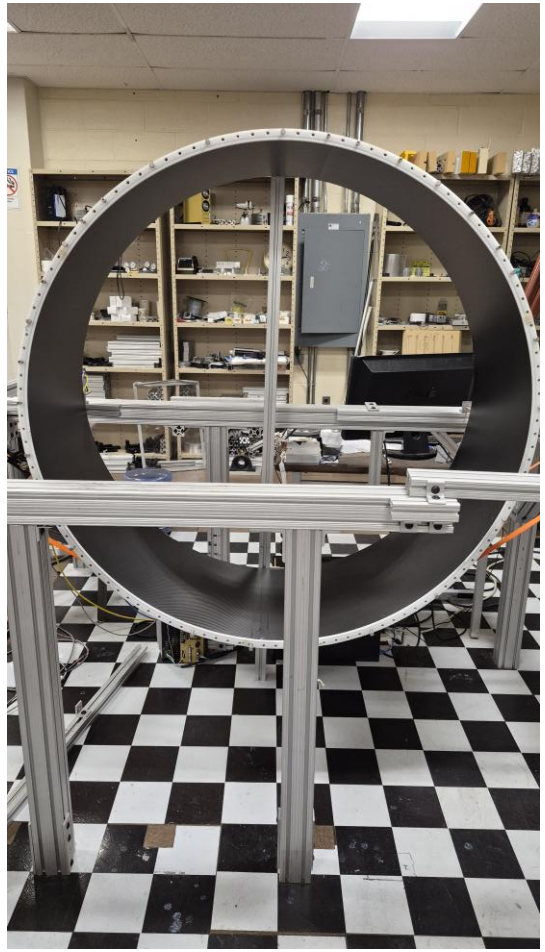
- Created a mockup ring to verify the vessel bolt-hole pattern
- Successfully tested on **both sides of the vessel**
- This was the final critical interface check before proceeding with the sensor plane
- **Sensor plane released for machining**, subject to machine availability

Supporting Work

- Small tapping fixture planned and underway
- Purpose: clean up / restore vessel threaded holes as needed

Near-Term

- Complete sensor-plane fabrication
- Begin next phase of full-scale mockup assembly



Main message:
Major fabrication milestone — the next large mockup component is cleared to proceed.

pfRICH: Mirror Deformation Investigation

Observed behavior

- Continued investigation of deformation in the co-bonded mirror substrates
- Thermal test made the CTE-mismatch effect clearly visible
- Hot water produced significant mirror springback / curvature change
- Mirror returned toward its original geometry after cooling

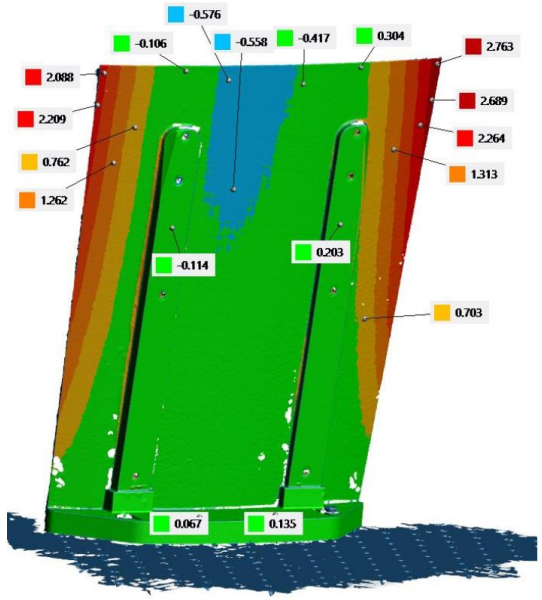
Why it matters

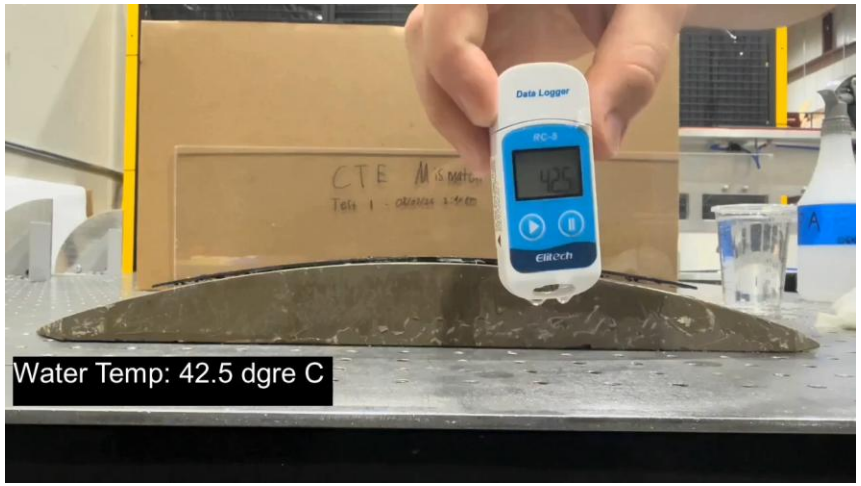
- Confirms that substrate/fixture interaction can significantly influence mirror shape
- Relevant to the ongoing concept of using Lexan in a more mechanically unconstrained mirror fixture (“picture frame”)

Engineering question

- How much of the final mirror shape is driven by:
  - molding/manufacturing deformation
  - CTE mismatch
  - and mounting constraint

“Picture Frame” Mirror Concept (SBU)





pfRICH: 3-Post Mirror Test Bed

Purpose

- Fabricate an adjustable **3-post mirror test fixture**
- Use a representative mirror to investigate mechanical correction strategies

Test Variables

- Post/support locations
- Constraint conditions
- Local adjustment / preload
- Potential compensation for molding-induced deformation

Advantage

- Allows rapid iteration of multiple mechanical solutions
- Avoids fabricating a separate modified mirror for every concept

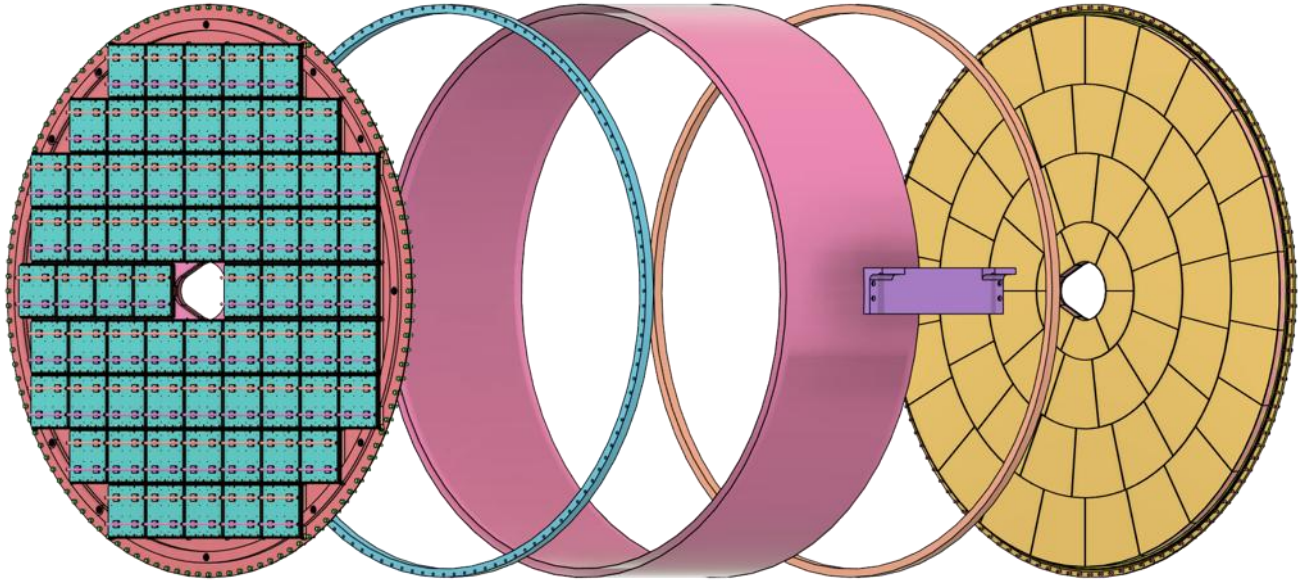
Goal

Develop a practical support strategy that controls mirror geometry without over-constraining the substrate

pfRICH: Upcoming CAD Revision

Inputs being incorporated

- Updated HRPPD model
- HRPPD thermal/cooling envelope
- New GST mounting rail produced 8/3/26



Resulting changes

- Expansion-volume geometry
- Sensor/service clearances
- Cooling envelope
- Mechanical interfaces to the GST rail

Near-term

- Incorporate updated hardware models once available
- Roll the related interface changes into a single substantial CAD revision

hpDIRC: SLAC / BABAR Recovery

Trip planned for Wednesday (8/19 – 8/22)

Knowledge Transfer

- Meet with Matt, who led BABAR assembly/disassembly activities
- Capture practical assembly, handling, and disassembly experience

Material Recovery

- Spare fused-silica bars
- Existing fixtures
- Tooling
- Other useful BABAR hardware/material where available

Additional Opportunity

- Use recovered material to investigate proposed QA approaches

Main objective

Recover both **hardware and first-hand experience** before they are lost

hpDIRC: Sensor & Prism-Box Integration

PANDA Collaboration

- Reviewed sensor mounting and design criteria with PANDA engineer
- Discussed how their experience translates to hpDIRC prism-box integration

Current Work

- Define sensor mounting constraints
- Identify mechanical interface requirements
- Continue developing QA / installation concepts

Cooling

- Mechanical cooling design is currently paused at the HRPPD/electronics interface
- Final geometry depends on electrical and thermal inputs discussed separately in the HRPPD update

Engineering Workbook

- Continued organizing/creating the hpDIRC engineering workbook
- JLab AI added as a beta interface for retrieving and navigating engineering information

hpDIRC: GST Deflection Analysis — Next Steps

GST data received

- Loaded and unloaded FEA datasets available
- Global displacement results and supporting scripts/images received

Analysis plan

- Extract GST deformation at the proposed hpDIRC mounting locations
- Reduce the global results into:
  - Relative displacement between supports
  - Local rotations / slope
  - Detector-relevant Z deformation along the mounting interface
- Compare candidate mounting schemes using those boundary conditions
- Determine how much GST deformation is transmitted into the bar-box structure
- If needed, apply the extracted GST displacement field to a **targeted hybrid bar-box FEA**

Near-term output

- Usable detector-level boundary conditions
- Mounting-scheme comparison
- Decision on whether additional bar-box FEA is required

HRPPD: Thermal Requirements / EE Interface

Productive EE discussion last week

Inputs still required

- Nominal component power
- Maximum / worst-case component power
- Total board thermal load
- Allowable operating-temperature range for major components

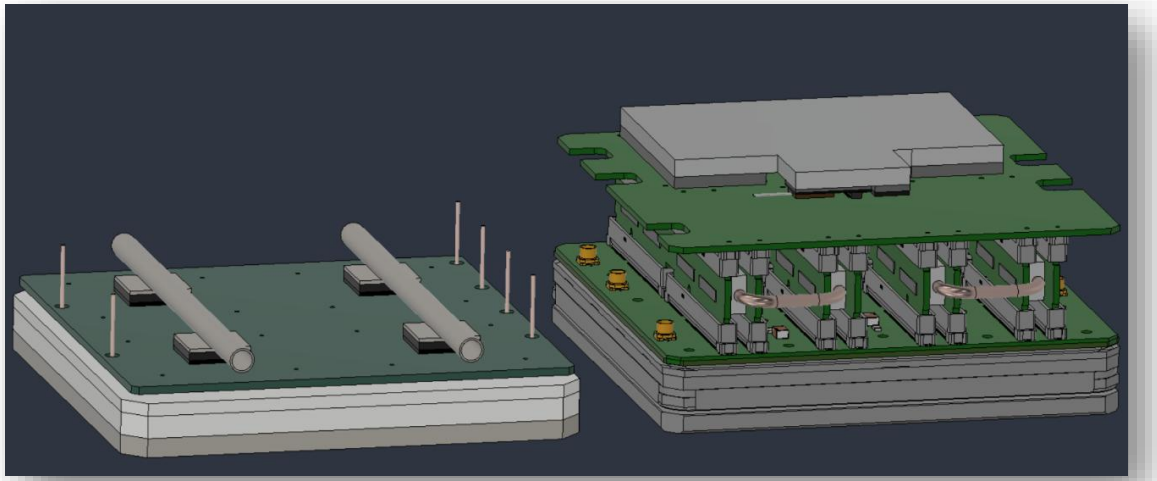
Temperature monitoring

- Boards are expected to include ambient-temperature sensors
- Readout/monitoring implementation is not yet fully defined

Mechanical impact

These values are required to validate:

- coolant flow assumptions
- block sizing
- interface temperature
- and overall cooling capacity



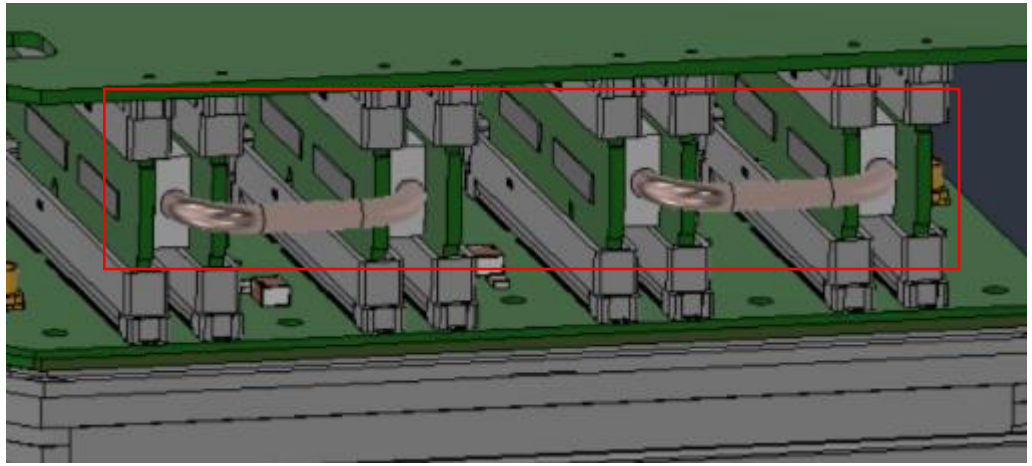
HRPPD: Cooling Block Concept

Previous concept

- Cooling tube sandwiched between mechanical components

Problem

- Difficult to install with the intended **single continuous tube run**



Revised concept

- U-shaped cooling block
- Tube sits inside the channel

Benefits

- More practical tube installation
- Better compatibility with a continuous cooling loop
- Simplifies the mechanical assembly concept

Near-term

- Finish block geometry once board power and temperature requirements are confirmed

HRPPD: Electronics Packaging Architecture

Current layout

- Boards arranged vertically / “RAM-card” style
- Bridge card/Readout board across the top

Alternative under consideration

- Boards stacked parallel
- Cooling plate positioned between boards

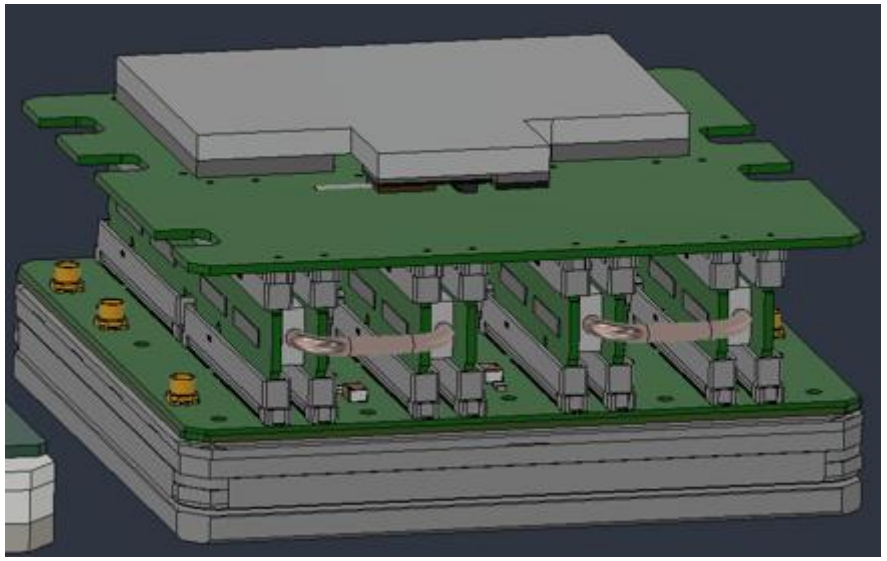
Recent progress

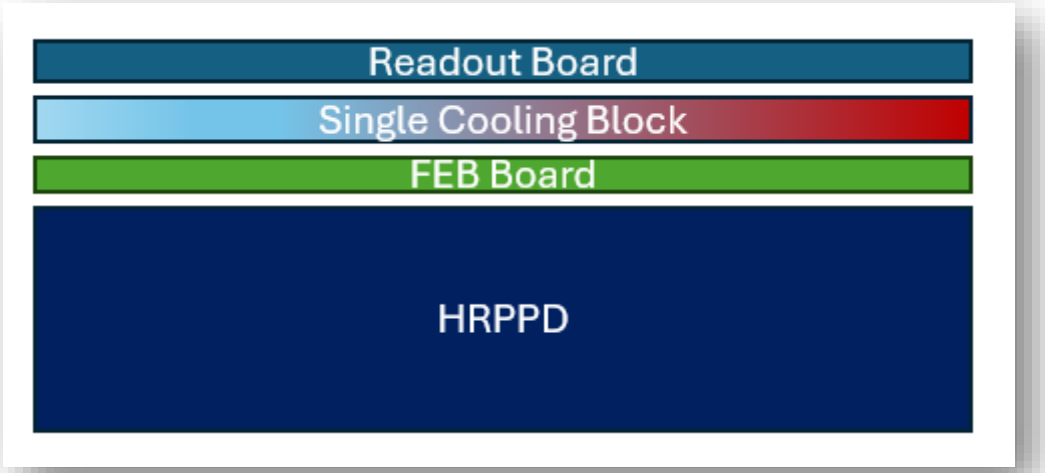
- Identified additional bridge-card placement constraints
- Identified several potentially missing interface/details in the present definition

Why this matters

The board architecture determines:

- cooling-block geometry
- tube routing
- service access
- detector envelope
- and final CAD packaging





HRPPD: Cross-Detector Impact

pfRICH:

- Sensor backplane size
- Expansion-volume geometry
- Cooling/service envelope
- Upcoming CAD revision

hpDIRC:

- Cooling-block geometry
- Sensor/prism-box packaging
- Tube routing and service access

Current dependency:
HRPPD electronics architecture + thermal requirements -> Cooling configuration -> Final detector packaging

Near-term:

- Close electrical/thermal inputs
- Resolve board orientation
- Resume detailed cooling CAD for both detector applications

Questions?