Brookhaven National Laboratory

Jefferson Lab

U.S. DEPARTMENT OF ENERGY

pfRICH

Triple I Engineering Meeting Update

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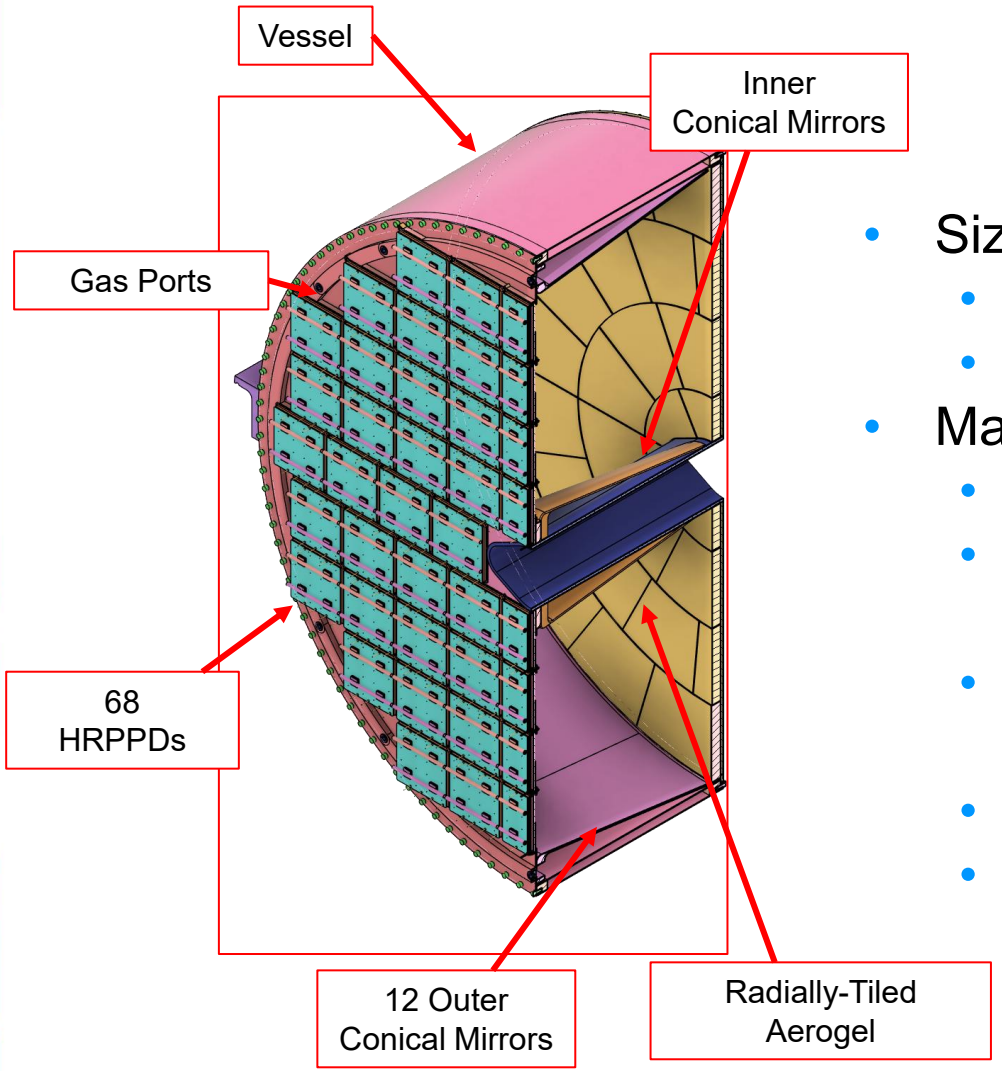
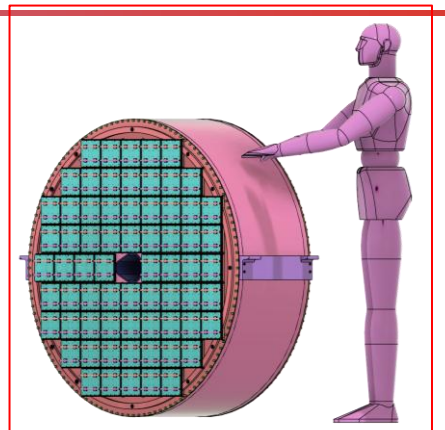
Electron-Ion Collider

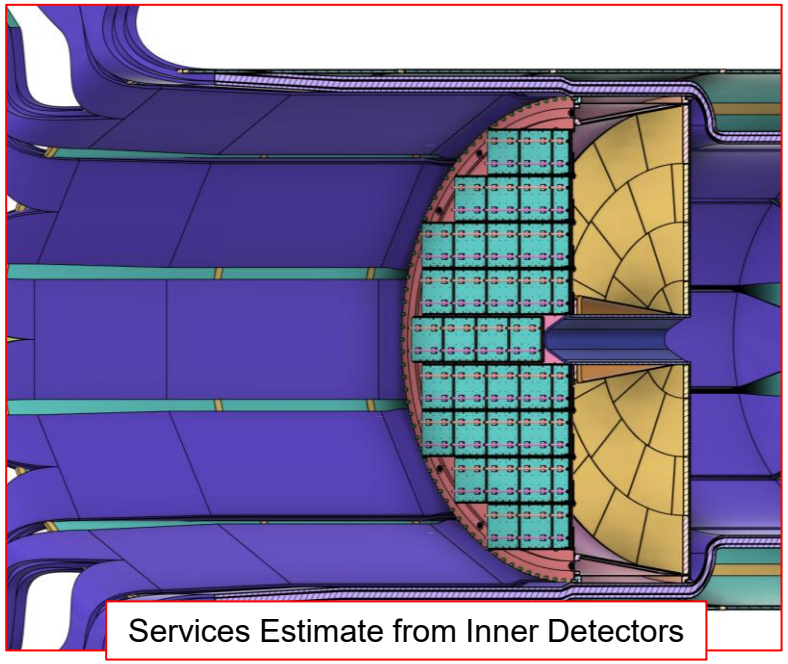
pfRICH: Overview



- Size and scale:
  - Outer Diameter: 130cm
  - Weight: ~200kg
- Major components:
  - Vessel
  - Sensor Plane with 68 HRPPDs
  - Aerogel Plane with radially-tiled aerogel
  - Inner Conical Mirrors
  - Outer Conical Mirrors



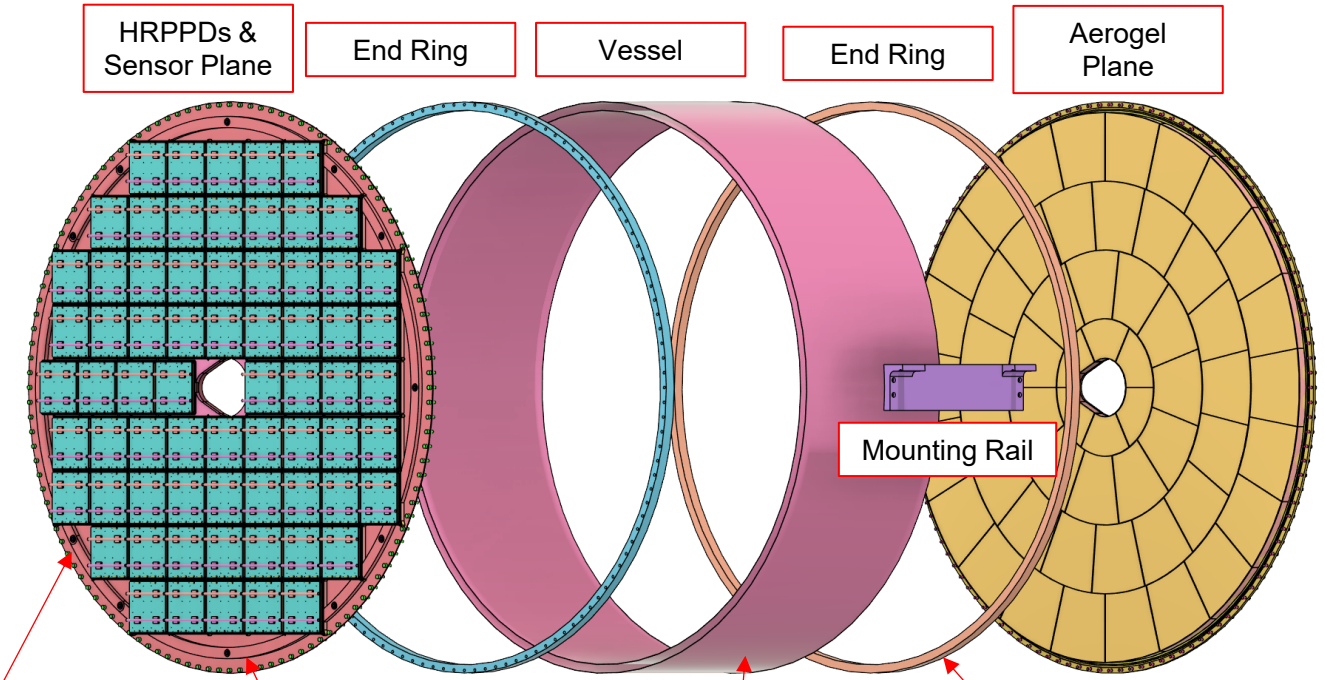
Size and Scale

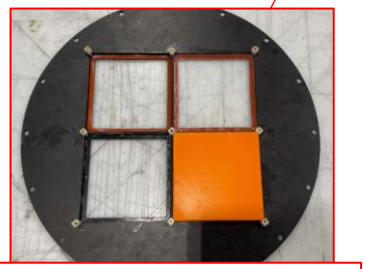


Services Estimate from Inner Detectors

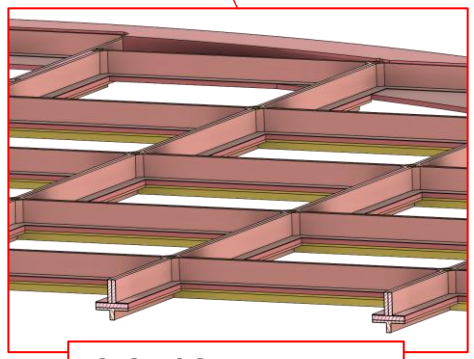
pfRICH: Components (External)

- Prototyping has been ongoing for the various components to verify manufacturing techniques and validate the design
- Stony Brook University (SBU) and Purdue University have been working to create a full-scale prototype (and small-scale test prototypes)
- One of the design changes that came from this prototyping was the layering of the sensor plane (shown in the C-S view)





Prototyping the Sensor Plane (Purdue)



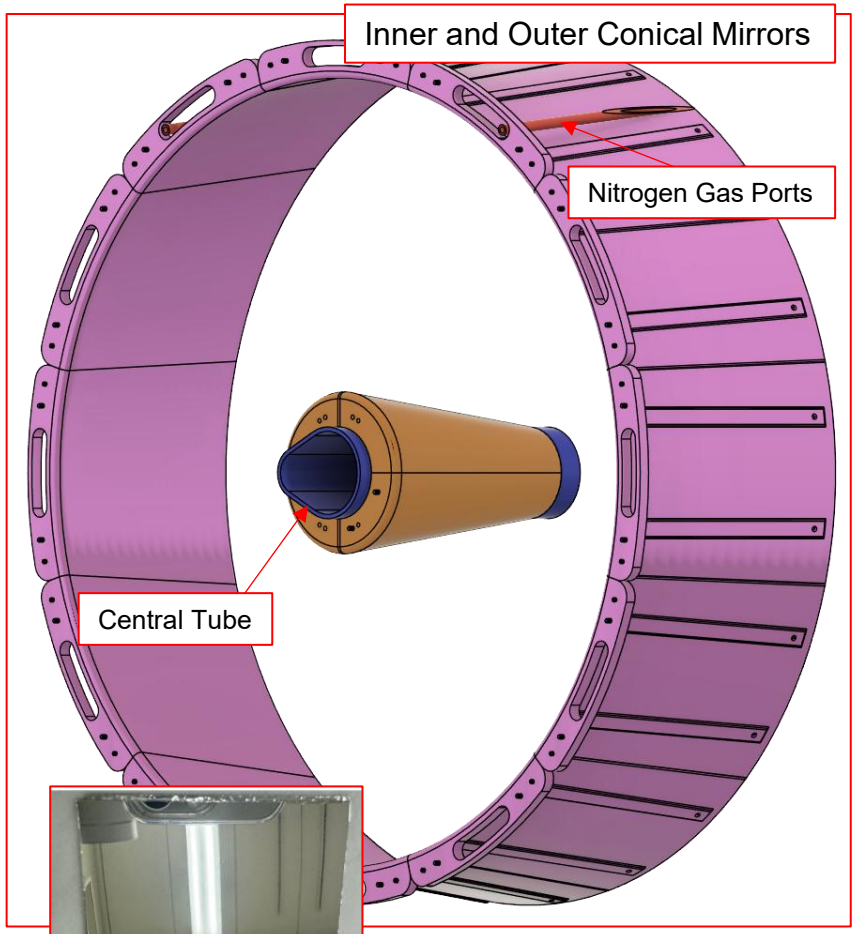
C-S of Sensor Plane

Prototyping the Vessel (SBU)

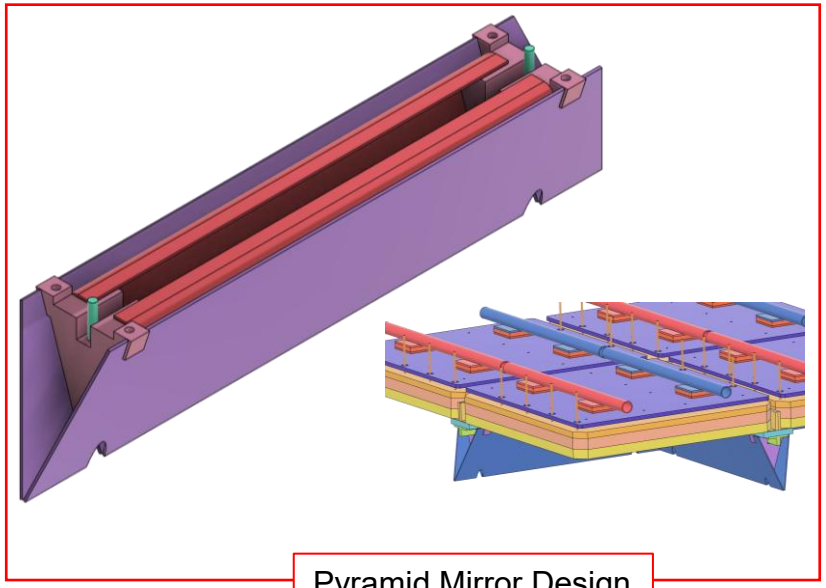
Prototyping the End Rings (Purdue)

pfRICH: Components (Internal)

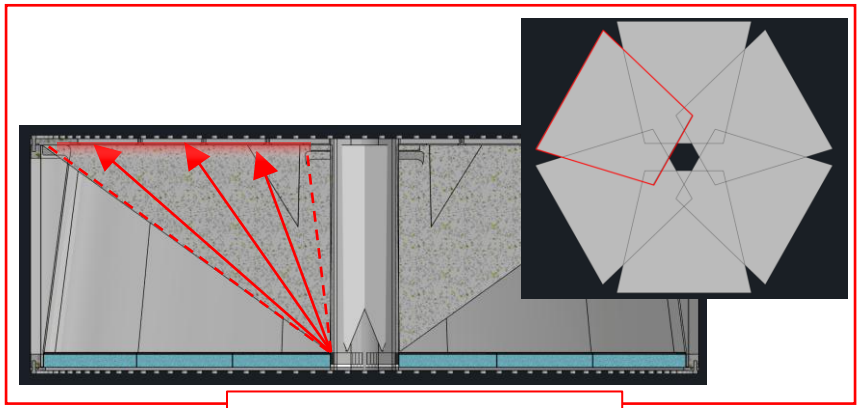
- **Internal components consist of:**
  - Conical Mirrors (Inner/Outer)
  - The central support tube
  - “Pyramid” Mirrors
  - Nitrogen gas hardware
  - Laser Monitoring System
- Inner and outer mirrors have been undergoing full scale prototyping
- Pyramid mirror design being considered for an engineering sample to confirm the design



Mirror Coating (SBU/Purdue)



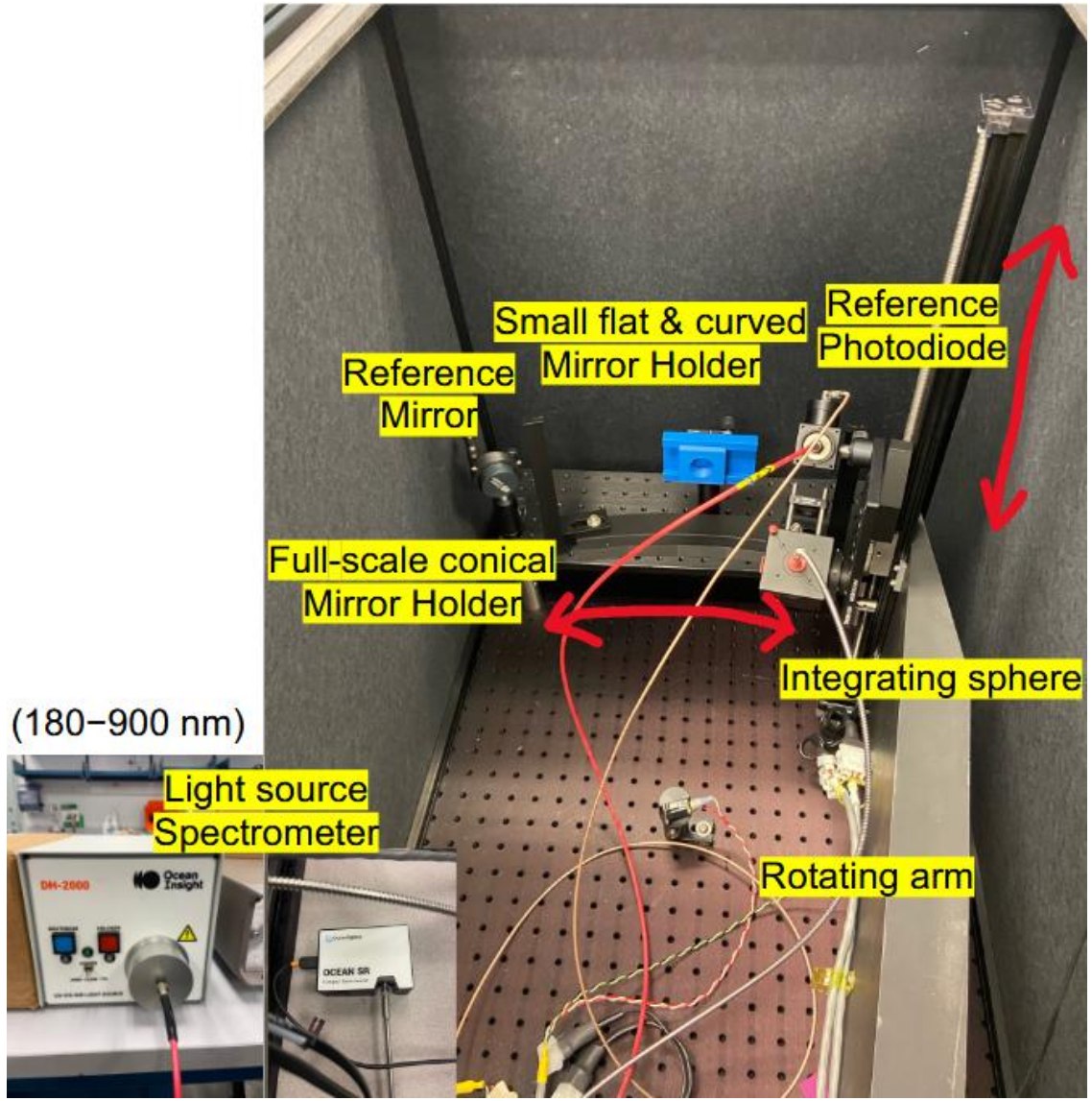
Pyramid Mirror Design



Laser Monitoring System

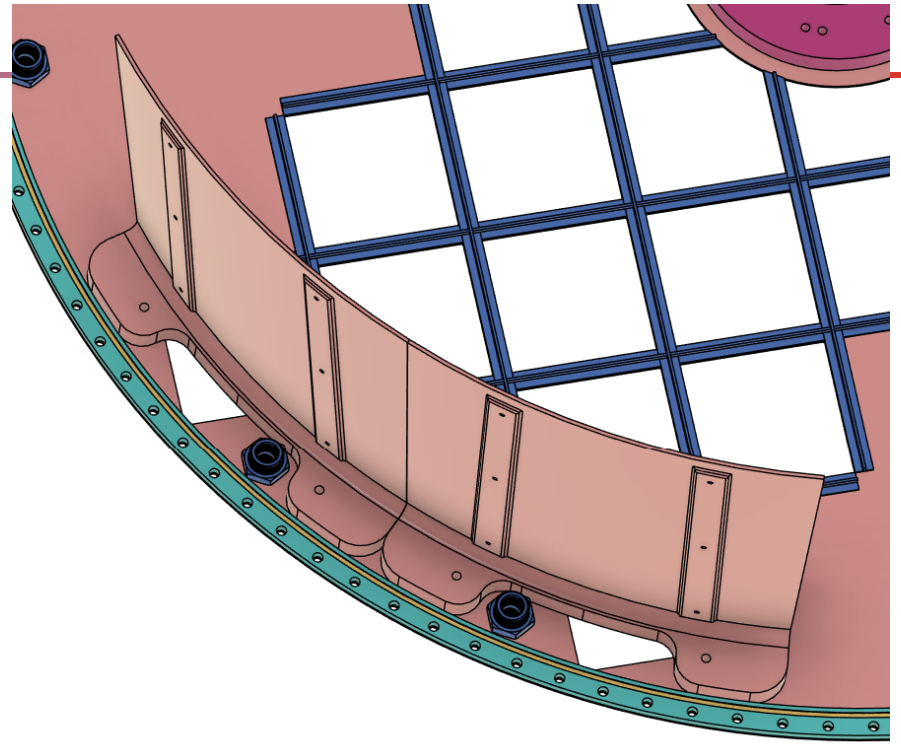
Large Mirror Test Stand

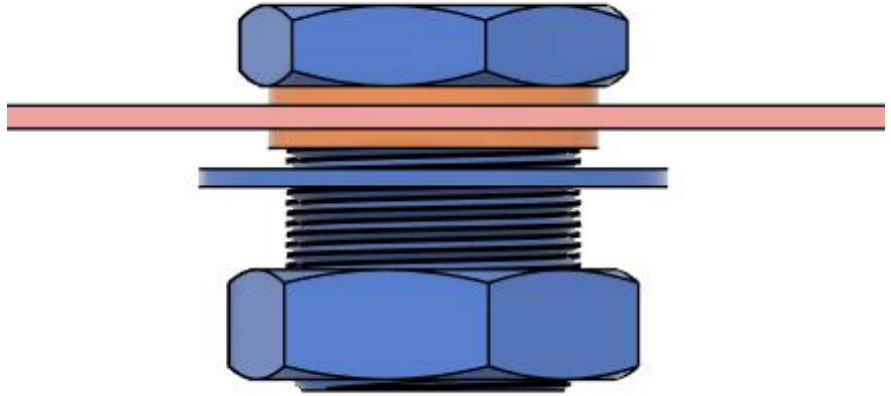
- At SBU, efforts have been made on the mirror QA test stand to make it more modular
- This mirror stand can now fit:
  - Small flat samples
  - Small curved samples
  - Full-sized articles
  - Reference Mirror
- This allows comparative measurements without any need for equipment swapping
- We also get the ability to measure various incident angles.



Sensor Plane Manufacturing

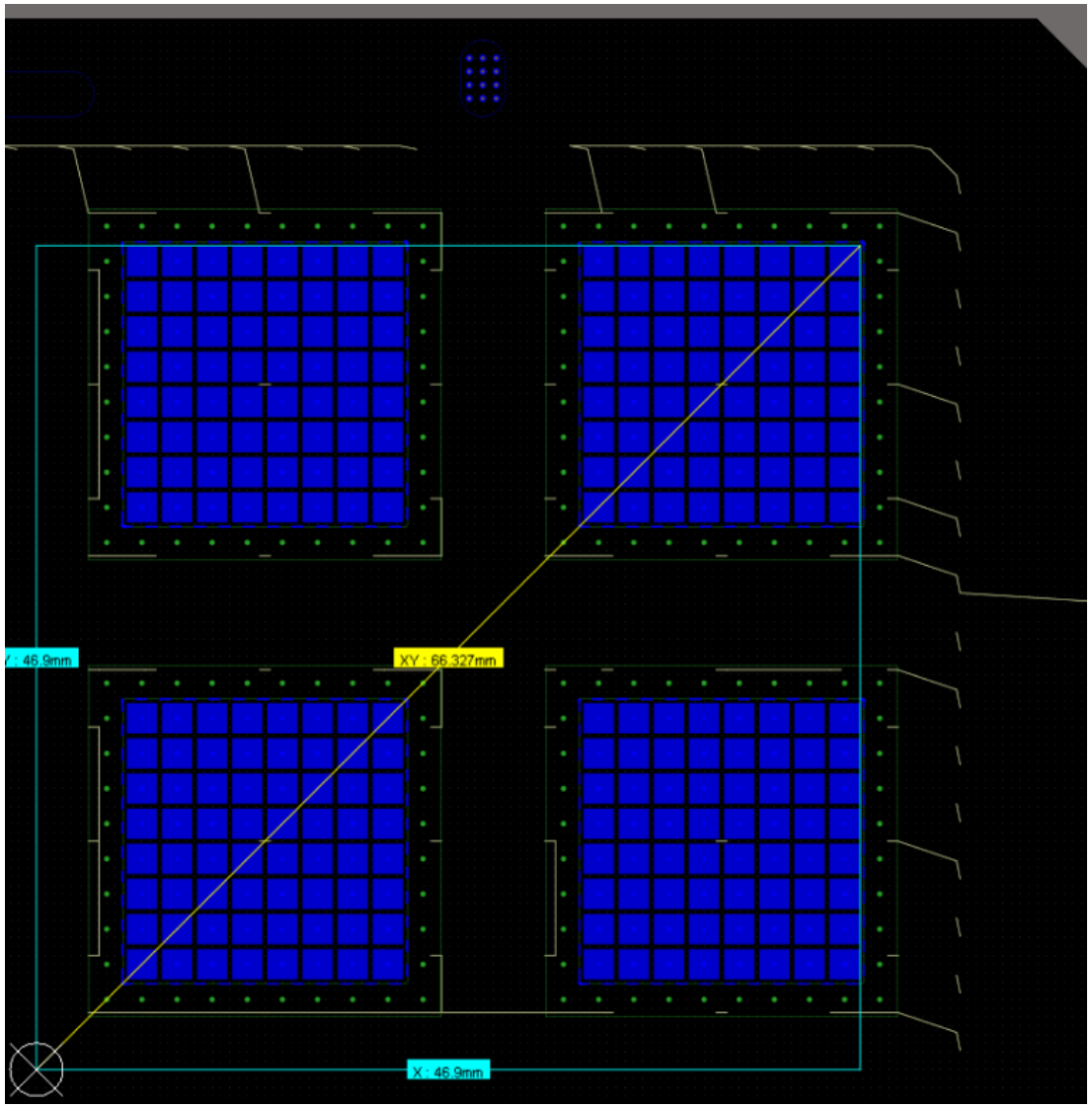
- There was a design change to go from a large (1/2”) sensor plane to a stack-up of parts that was much simpler to manufacture.
- The downstream effects of this design change have been the current effort with Purdue.
- Examples of things that have been affected:
  - Bulkhead gas fittings and placements
  - O-Ring design modification
  - Placement and mounting of the inner mirror spacer
  - Sealing methodology elsewhere
- We have also been working towards finalizing a machining order for the sensor plane; this is almost complete





HRPPD Progress (Background)

- HRPPDs are going through final design iterations before being sent for production
- Tolerance stacking and overall tolerances available are still being discussed
- Decisions have been made regarding:
  - Interposer sizing
  - Vacuum pad sizing
  - HV design
  - Pogo Pins
- This design appears to be nearing completion



Plans Towards FDR

- Utilizing the remaining components needed for prototype production, we can identify and refine the existing design
- Prototype the aerogel and pyramid mirror concepts (PED Request)
  - The pyramid mirrors have been integrated into the sensor plane design and manufacturability has been discussed with Purdue
  - The aerogel concept has been designed – in concept – but needs to be integrated into the latest design iterations
- Services routing needs to be finalized with a focus on installation and entry/exit points and patch panel placement **(highly dependent on the final HRPPD and ASIC design)**
- Depending on the ASIC configuration:
  - Cooling is still in a “draft” form awaiting final electronics layout for HRPPDs
  - There may be a need to sink the sensors into the expansion volume depending on the electronics layout (concept design already considered)
- Laser Monitoring subsystem needs to be finalized (In progress)
- Installation support is being co-developed with the GST/PST conversations
  - No word yet from Purdue regarding the rails
  - PDR-level design still current (as of now)

Background Issues (TBD)

- We're still considering vessel grounding/shielding to protect sensors from noise and to aid in light-tightening the vessel
- Still a lingering concern about the beampipe bakeout effects on pfRICH componentry
  - Destructive testing of a small carbon fiber mirror sample has shown that it can withstand significant heat
  - The HRPPD has an indium seal which is only good for ~70C

Services Estimates

- Current estimate for power for the whole detector remains unchanged at less than ~500w
- 68 HRPPD sensors in total:
  - 340 HV Lines (5 HV Lines per HRPPD)
  - 68/136 LV Lines (1 or 2 LV Lines per HRPPD)
  - 340 Fibers (5 total fibers per HRPPD)
  - ~2mm diameter per fiber

- Laser Monitoring System: ~12 fiber lines
- Vessel Gas (N2): 4 lines (2 inlet & 2 outlet)
  - Designed to attach to either ¼" NPT or 3/8" NPT fittings (bulkhead)
- Cooling: Liquid lines 15C, ¼" OD at HRPPD, design still dependent on ASICs

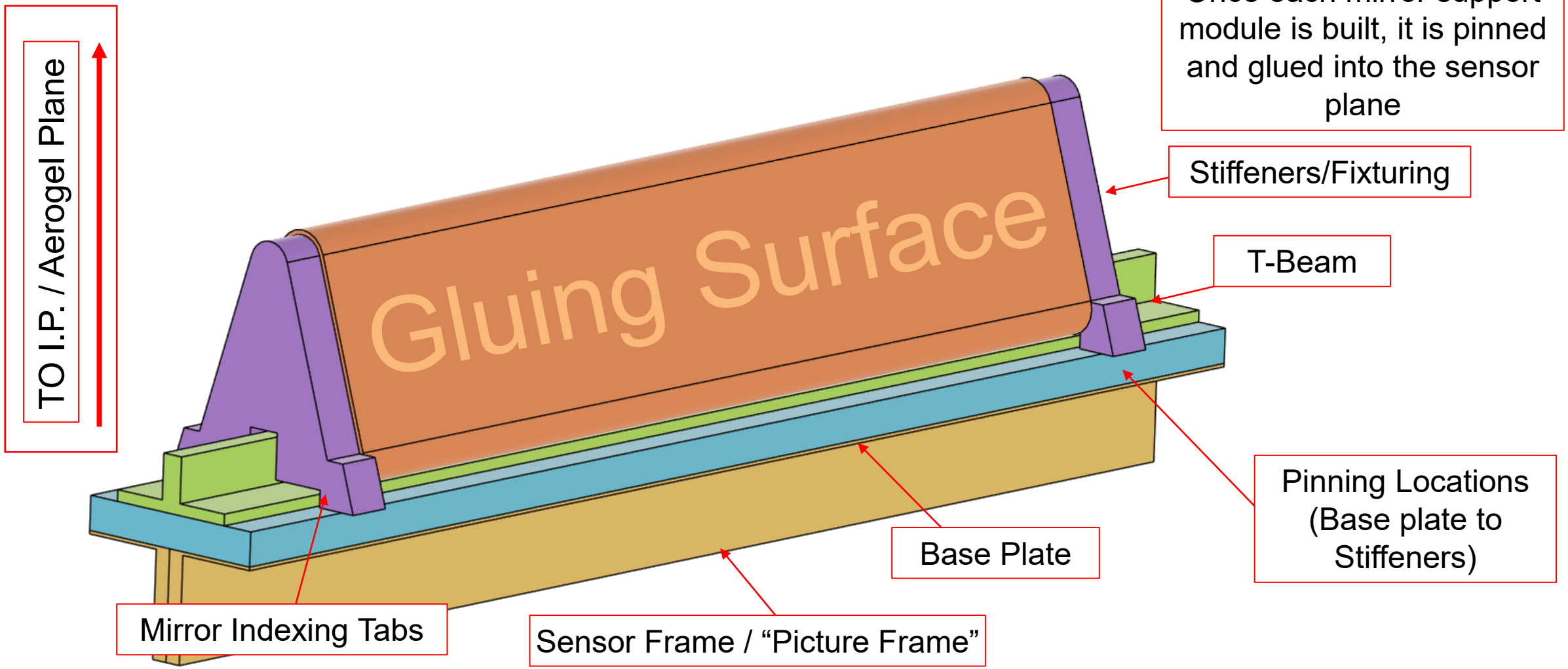
Figure 4.1: (Left) Schematic of the on-detector cooling assembly. (Right) Expected thermal gradiant across various sensor stack components.

Question & Comments

Backup

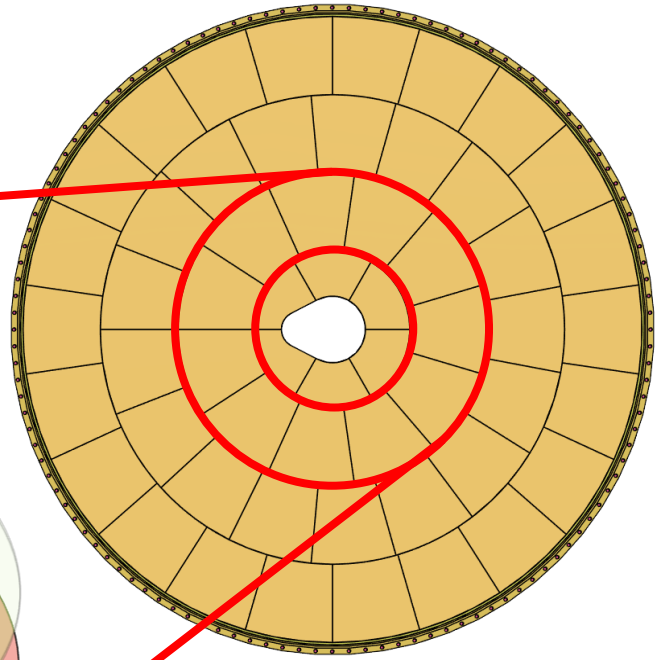
pfRICH: “Pyramid Mirrors”

Implementation:
Once each mirror support module is built, it is pinned and glued into the sensor plane

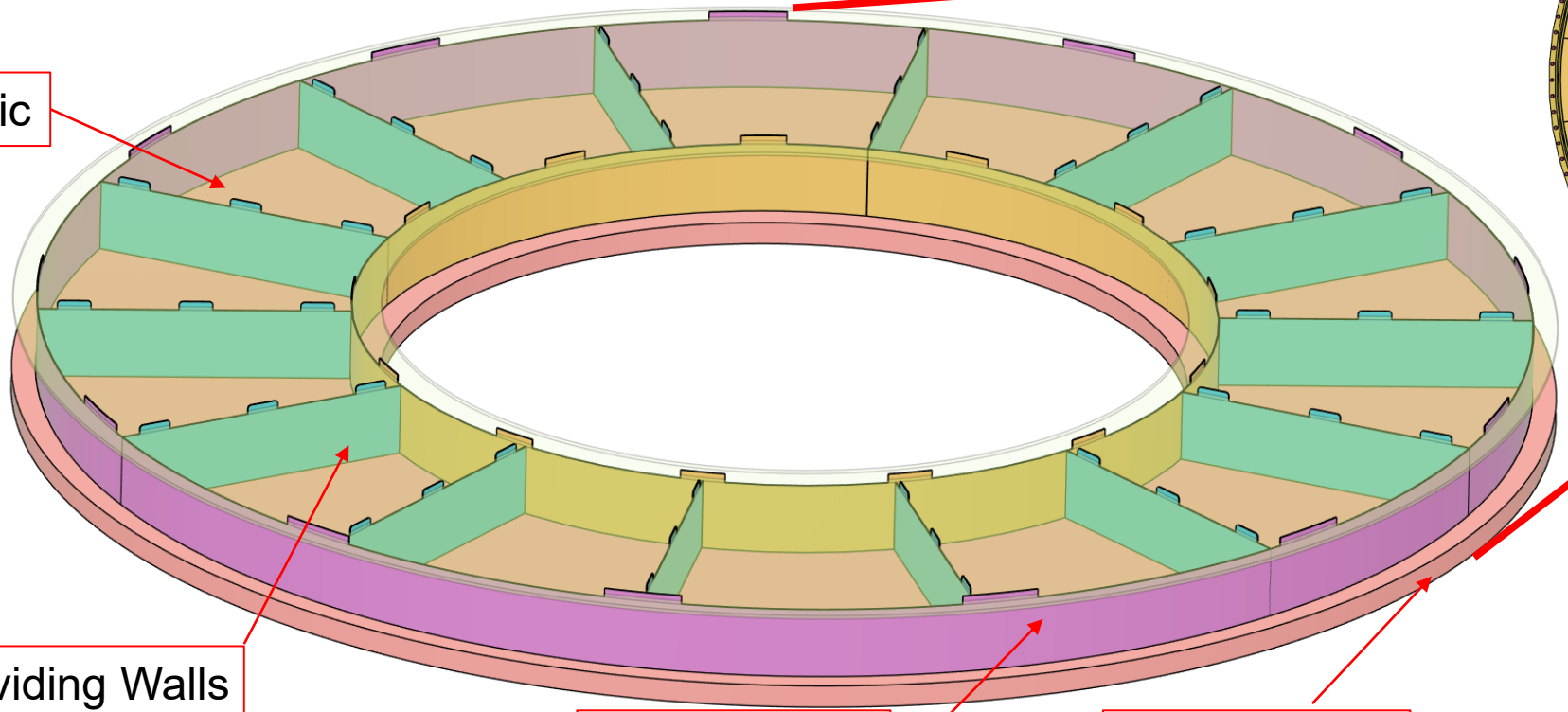


pfRICH: Aerogel Plane

Just a middle ring is shown



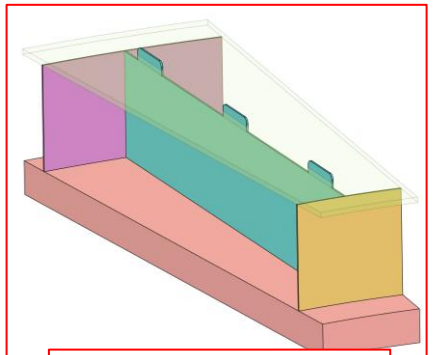
Acrylic



Dividing Walls (Separators)

Dividing Walls (Rings)

Aerogel Plane (Foam Core)



Tab and slot