Mechanical Integration of HRPPDs into pfRICH

Alex Eslinger (JLab)

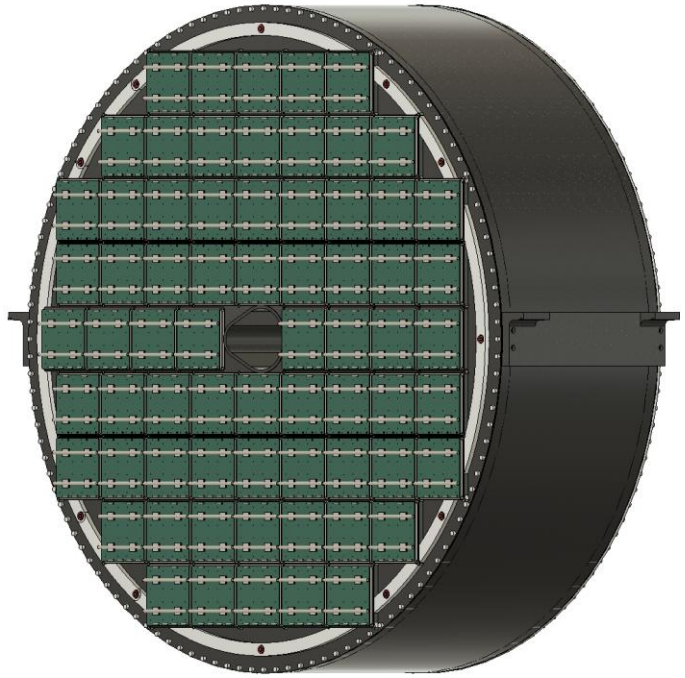
12-16-2025

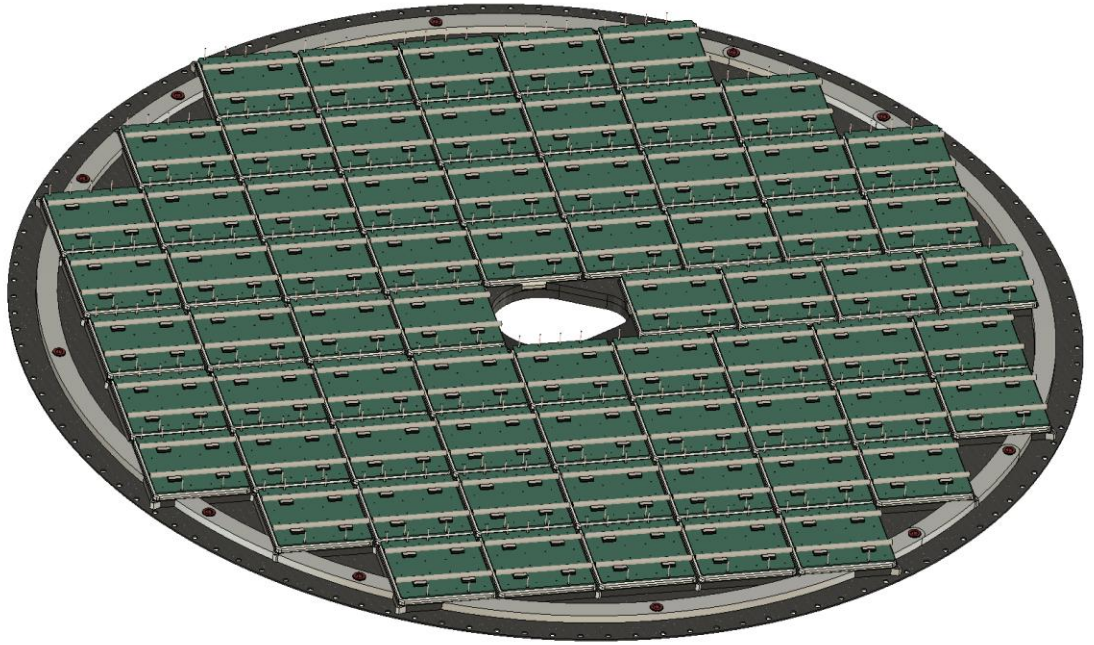
Goals

- Understand how the pfRICH is planning to mount the HRPPDs
- Show some of our recent prototyping efforts and outcomes
- Understand some challenges that arise from the mechanical design standpoint
- Describe a better mounting scheme

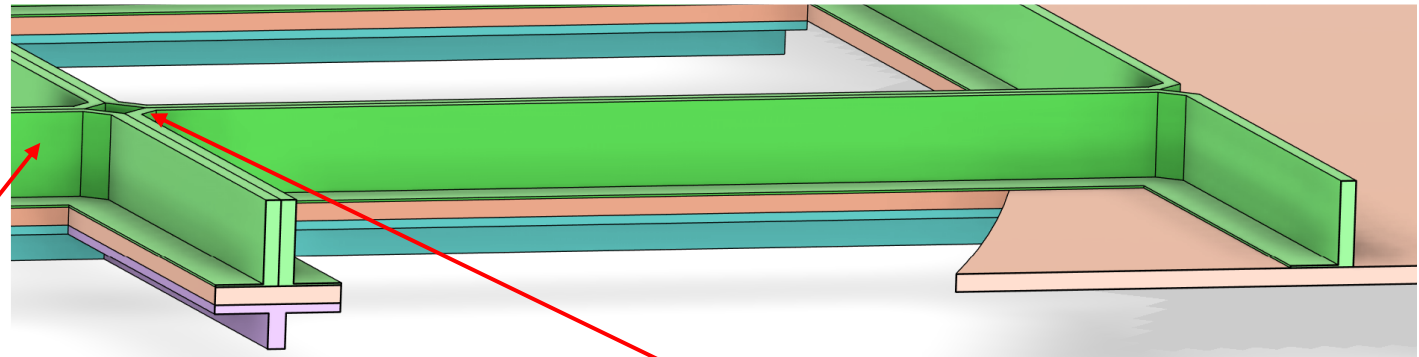
Conceptual Overview

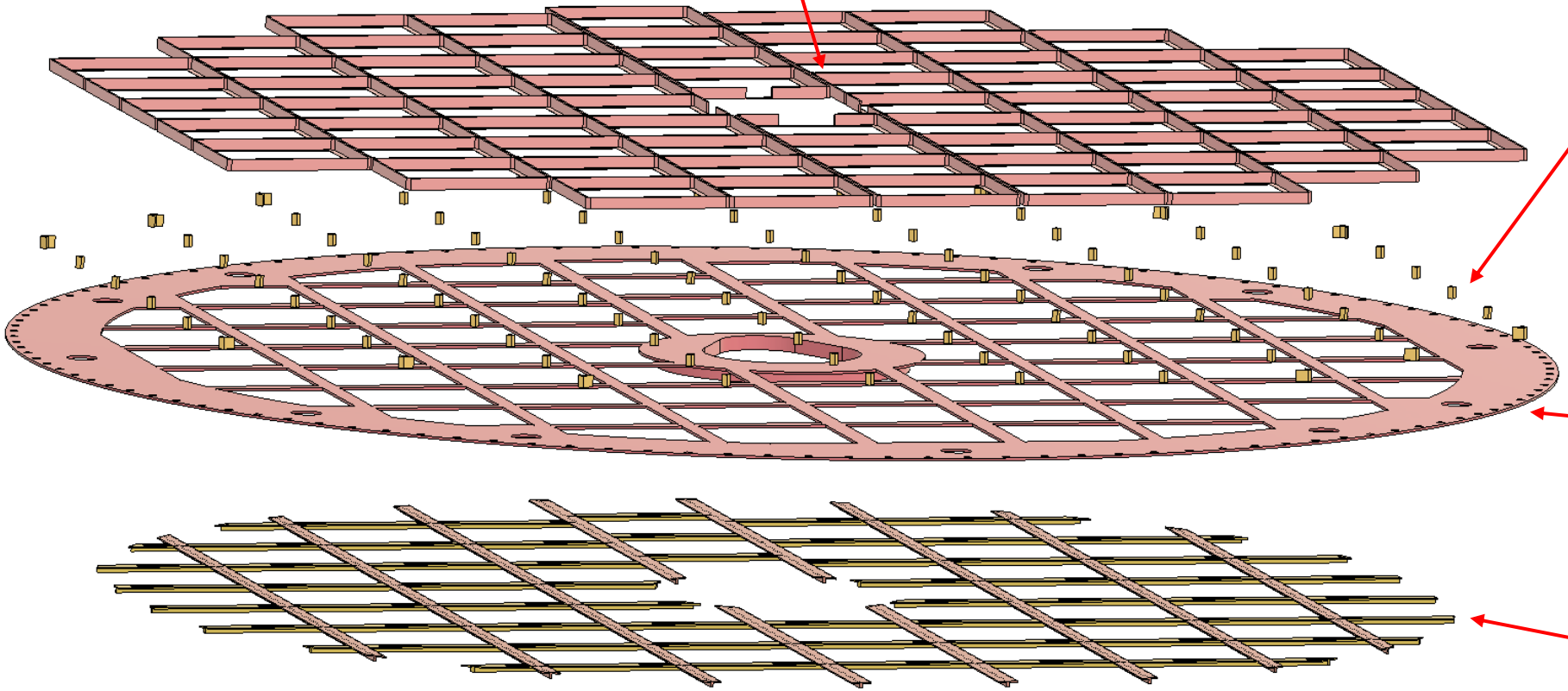
- The pfRICH uses 68 HRRPD sensors on the backplane
- These are mounted and sealed into the “sensor plane” which is made up of a multi-layer arrangement
- The HRPPDs are placed from the outside into pockets we call “picture frames”
- At *most* corners, we have inserts that use small hardware to press the HRPPDs into a face seal.





Exploded view





"Picture Frames"

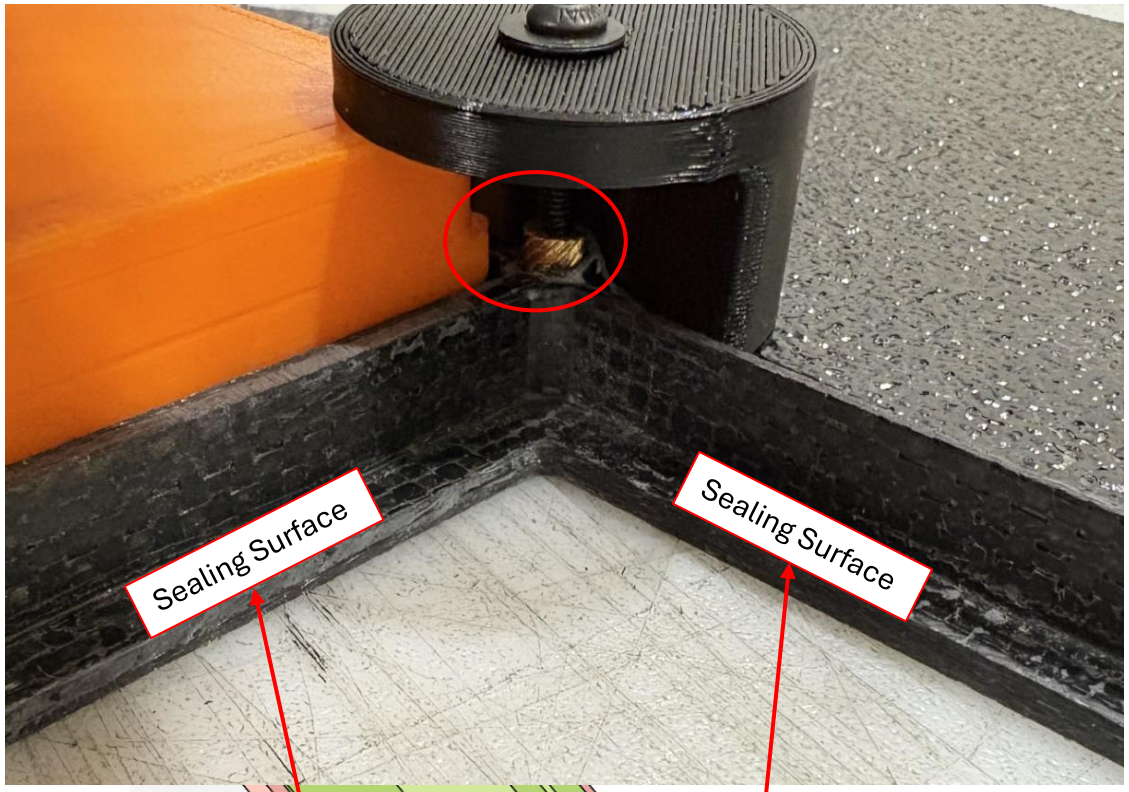
Threaded Insert Locations

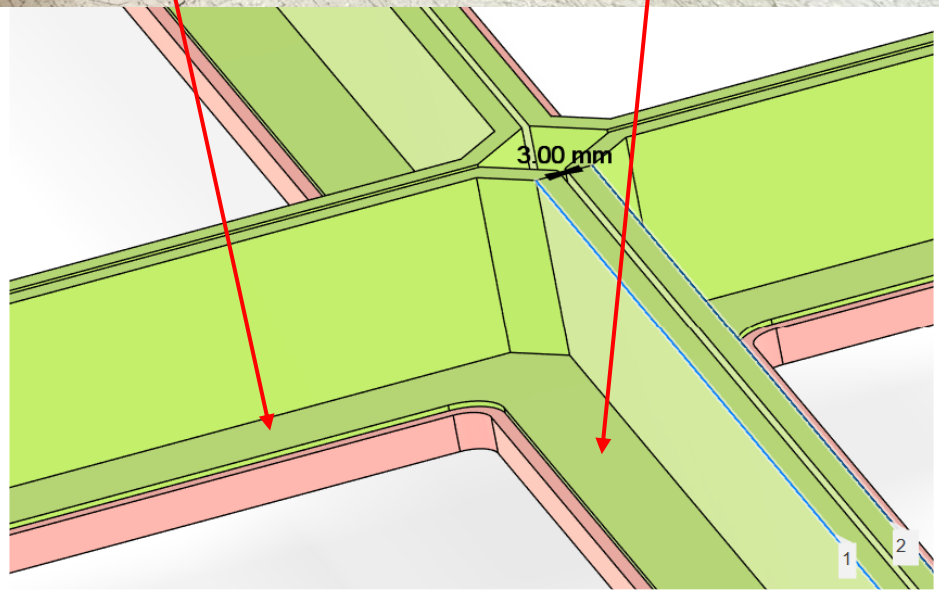
Sensor Plane Base

"T-Beams" / Stiffeners

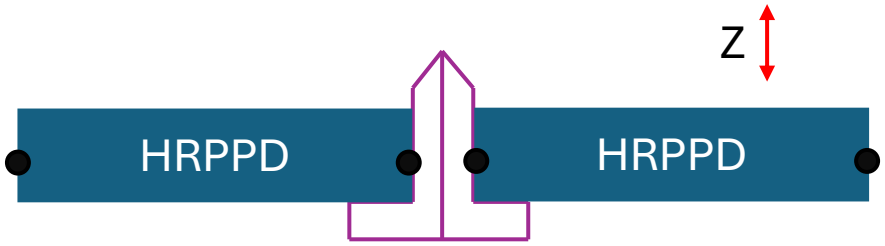
Challenges

- HRPPD Spacing for the final design is ~3mm between each sensor, which drives detector acceptance, number of sensors, and mechanical interface.
  - More than 3mm, we'd lose the ability to use 68 sensors, less than 3mm means we wouldn't have the mechanical space to tile them.
- The horizontal surface – in the current design – is the location of a face seal. Face seals need consistent pressure against them to work, but we only have the locations at the HRPPD chamfered corners for hold-down screws
- This chamfer also drives the size of the inserts we can utilize

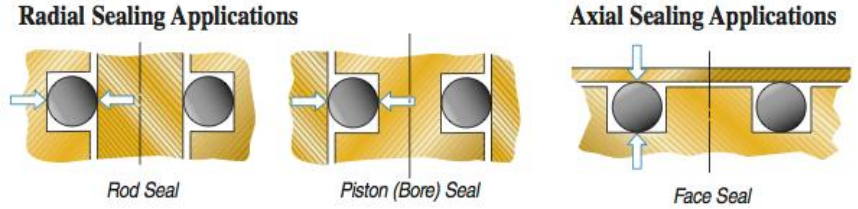




A Better Mounting Scheme

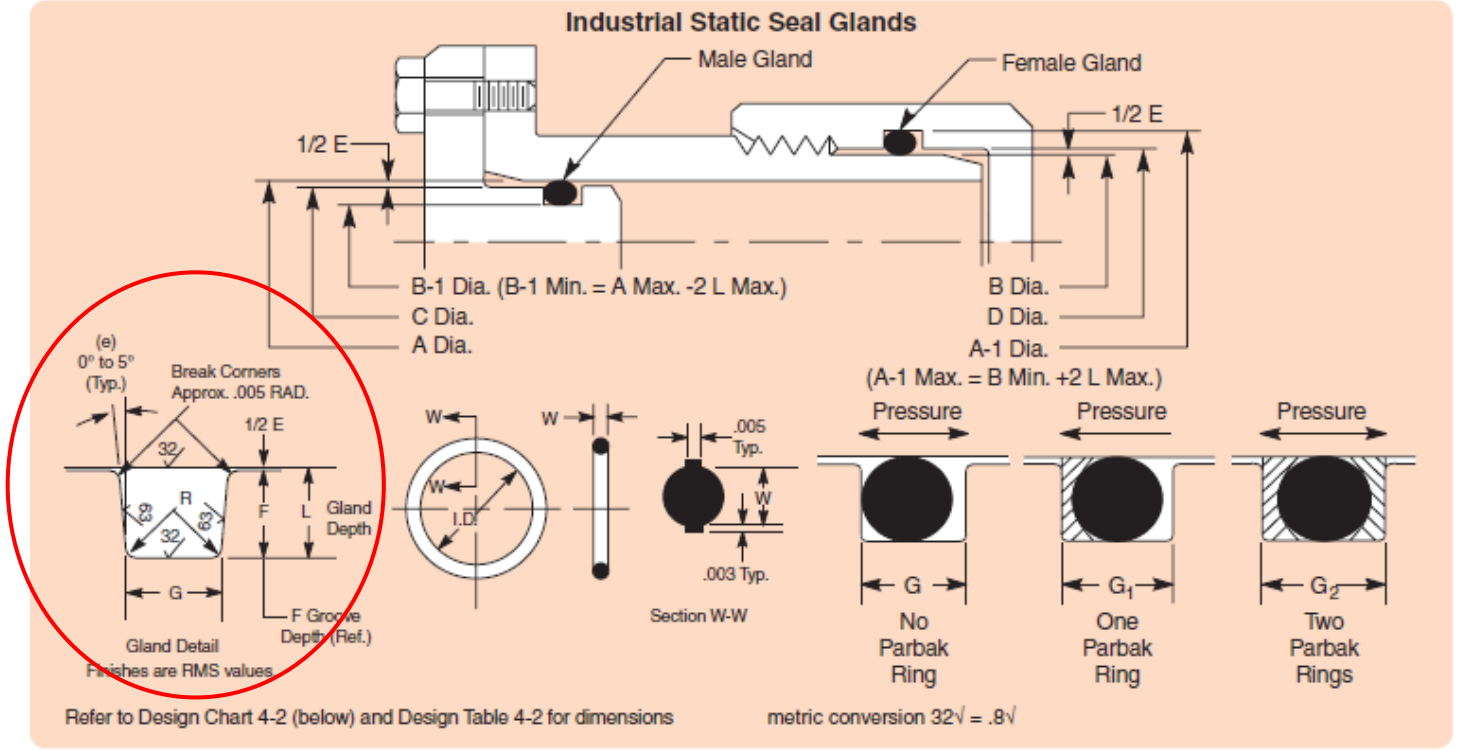


- In an ideal mounting scheme, we would have a radial O-ring around the perimeter of the HRPPD.
  - For reference, the groove would be ~2.5mm in Z and ~1.3mm deep to accommodate a 1/16” O-ring
- The interface to the sensor plane would be wedge-shaped and provide tension on the O-ring as it is pressed in.
- The hold down bolts would not be doing the sealing, they would just be to keep the sensor from coming out.
- This would require a rounded (filleted) edge on the HRPPD to have an O-ring (a chamfer would damage or cause the O-ring to leak)



Reference Sizing for Groove

- A 1/16” O-ring needs a gland depth (L) of .050 - .052” (1.27-1.32mm) and width (G) of 0.093-0.098” (2.36 – 2.49mm)
- A 3/32” O-ring needs a gland depth (L) of .081-.083” (2.05-2.11mm) and a width (G) of 0.140-0.145” (3.56-3.683mm)
- Can we hit any of these dimensions/roughness values in the ceramic?



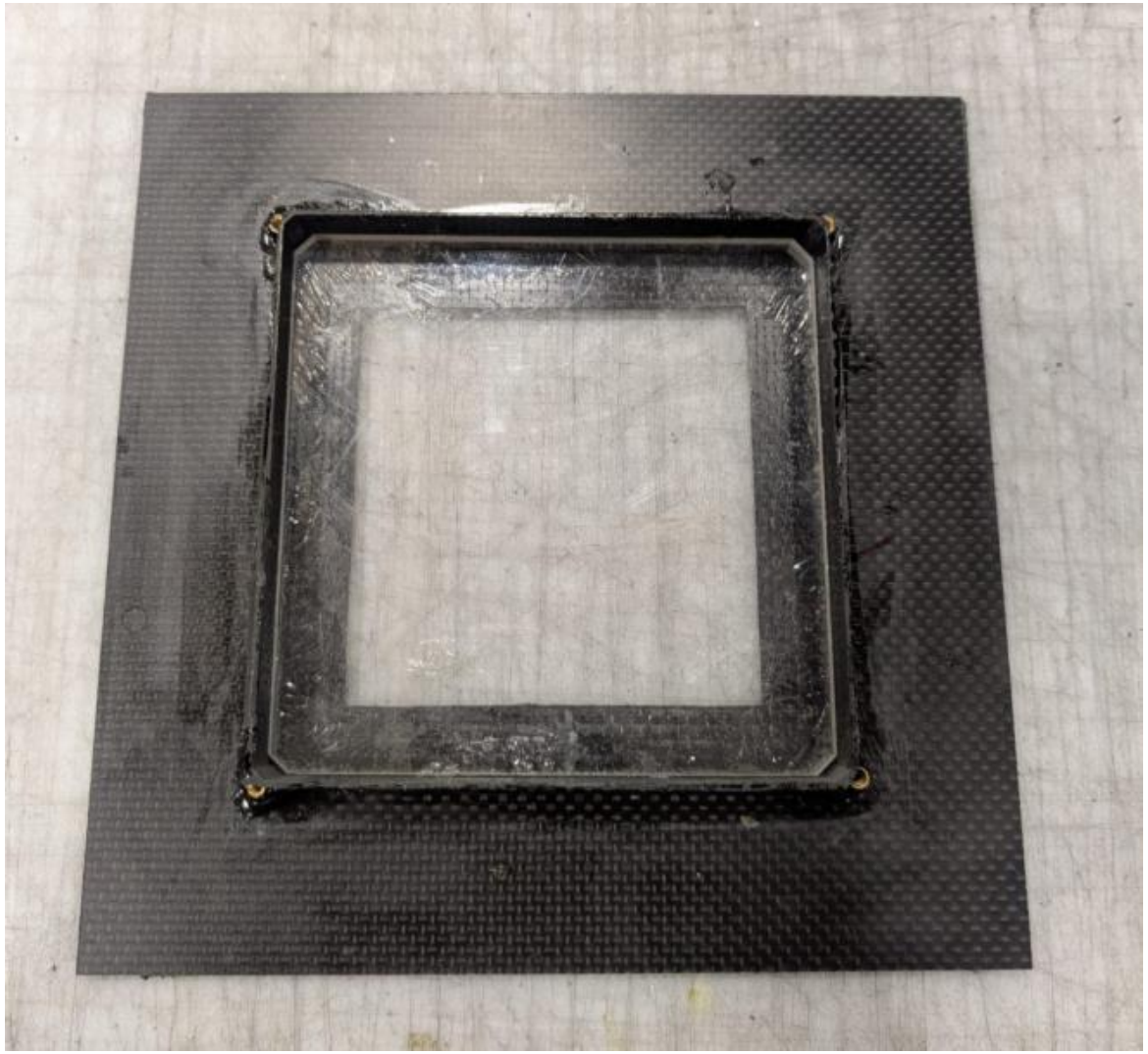
Industrial O-Ring Static Seal Glands

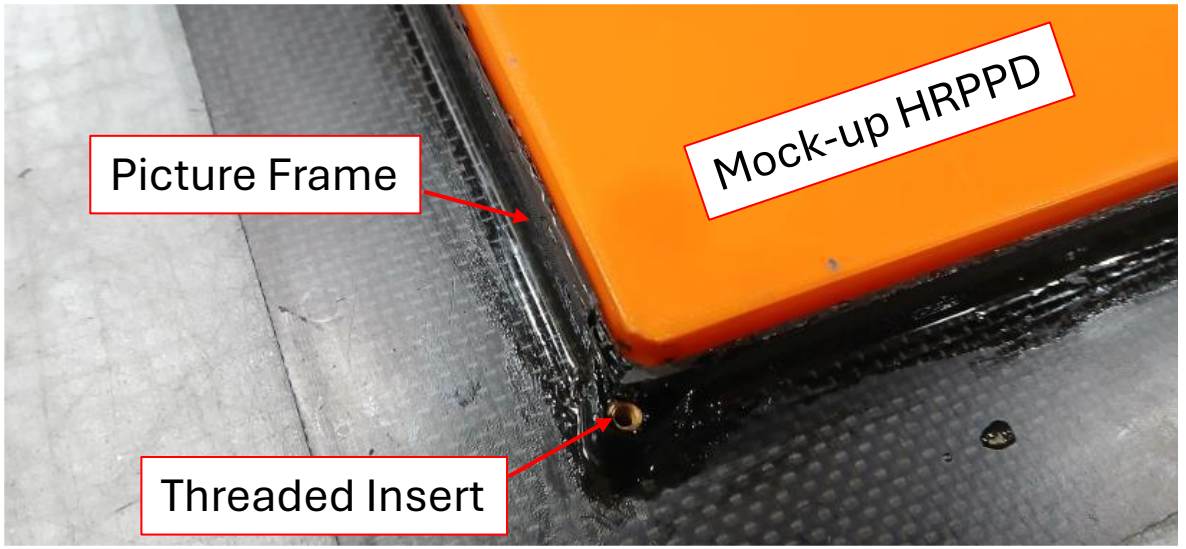
O-Ring 2-Size AS568B-	W Cross-Section Nominal	W Cross-Section Actual	L Gland Depth	Squeeze Actual	Squeeze %	E(a) Diametral Clearance	G - Groove Width: No Parbak Ring (G)	G - Groove Width: One Parbak Ring (G_1)	G - Groove Width: Two Parbak Ring (G_2)	R Groove Radius	Max. Eccentricity (b)
004 through 050	1/16	.070 ±.003 (1.78 mm)	.050 to .052	.015 to .023	22 to 32	.002 to .005	.093 to .098	.138 to .143	.205 to .210	.005 to .015	.002
102 through 178	3/32	.103 ±.003 (2.62 mm)	.081 to .083	.017 to .025	17 to 24	.002 to .005	.140 to .145	.171 to .176	.238 to .243	.005 to .015	.002
201 through 284	1/8	.139 ±.004 (3.53 mm)	.111 to .113	.022 to .032	16 to 23	.003 to .006	.187 to .192	.208 to .213	.275 to .280	.010 to .025	.003
309 through 395	3/16	.210 ±.005 (5.33 mm)	.170 to .173	.032 to .045	15 to 21	.003 to .006	.281 to .286	.311 to .316	.410 to .415	.020 to .035	.004
425 through 475	1/4	.275 ±.006 (6.99 mm)	.226 to .229	.040 to .055	15 to 20	.004 to .007	.375 to .380	.408 to .413	.538 to .543	.020 to .035	.005

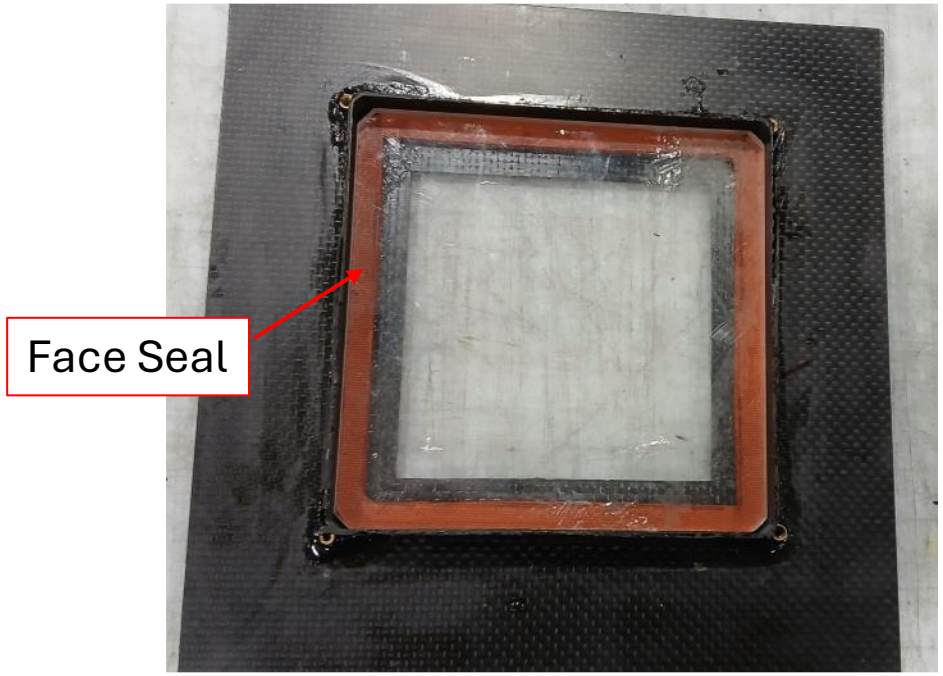
(a) Clearance (extrusion gap) must be held to a minimum consistent with design requirements for temperature range variation.
(b) Total indicator reading between groove and adjacent bearing surface.
(c) Reduce maximum diametral clearance 50% when using silicone or fluorosilicone O-rings.
(d) For ease of assembly, when Parbaks are used, gland depth may be increased up to 5%.

Design Chart 4-2: For Industrial O-Ring Static Seal Glands

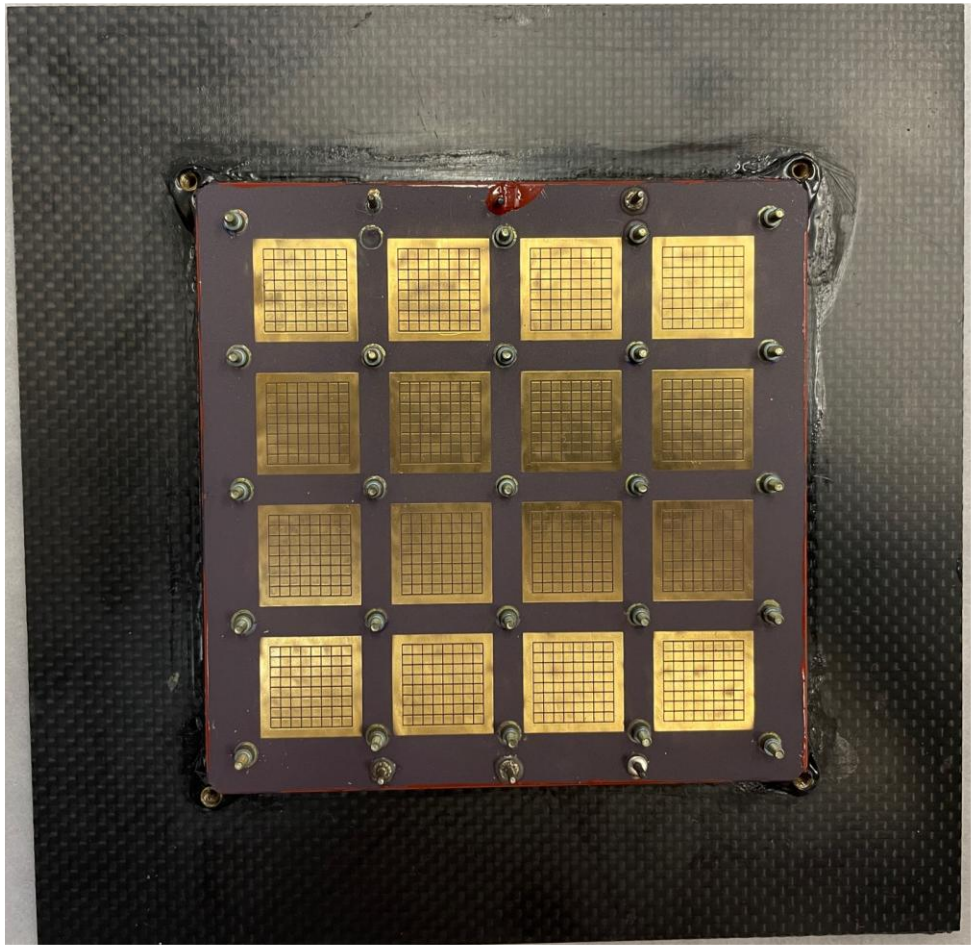
Prototyping efforts

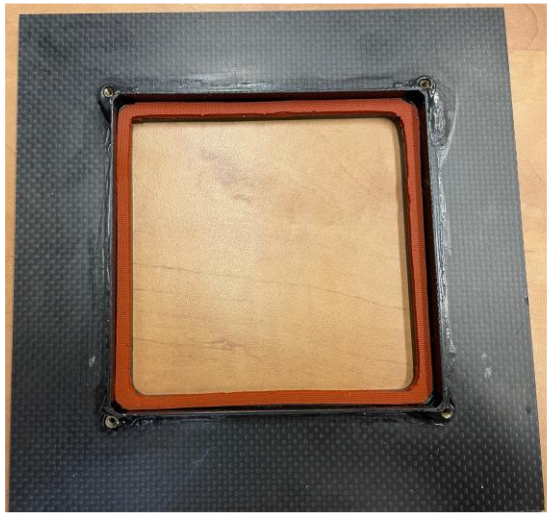


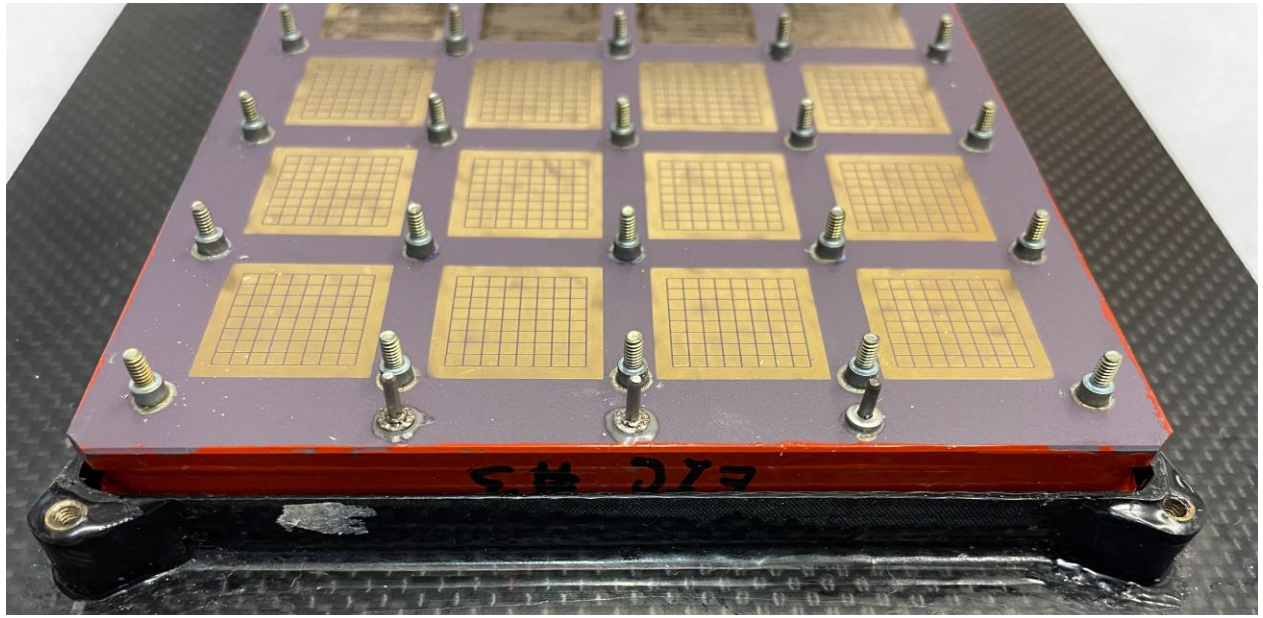




Prototyping efforts (Test Fit)



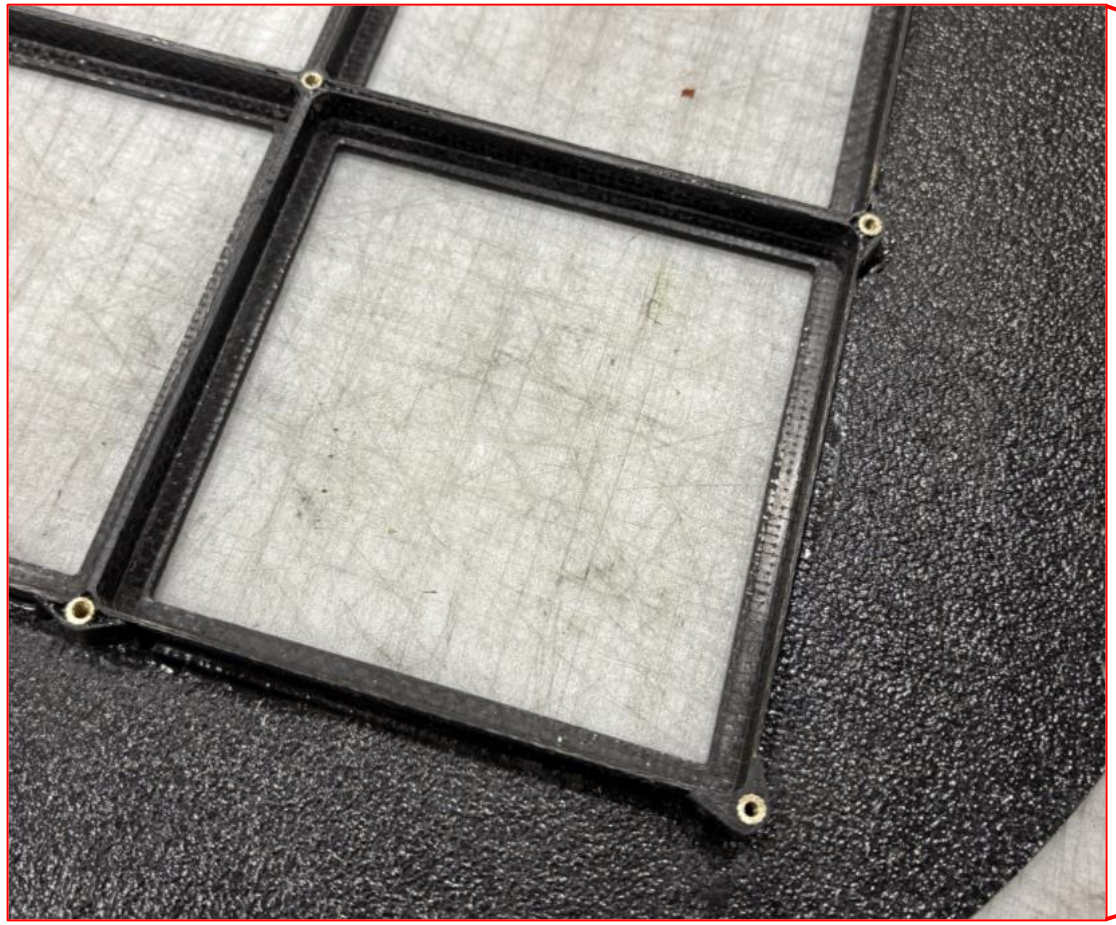


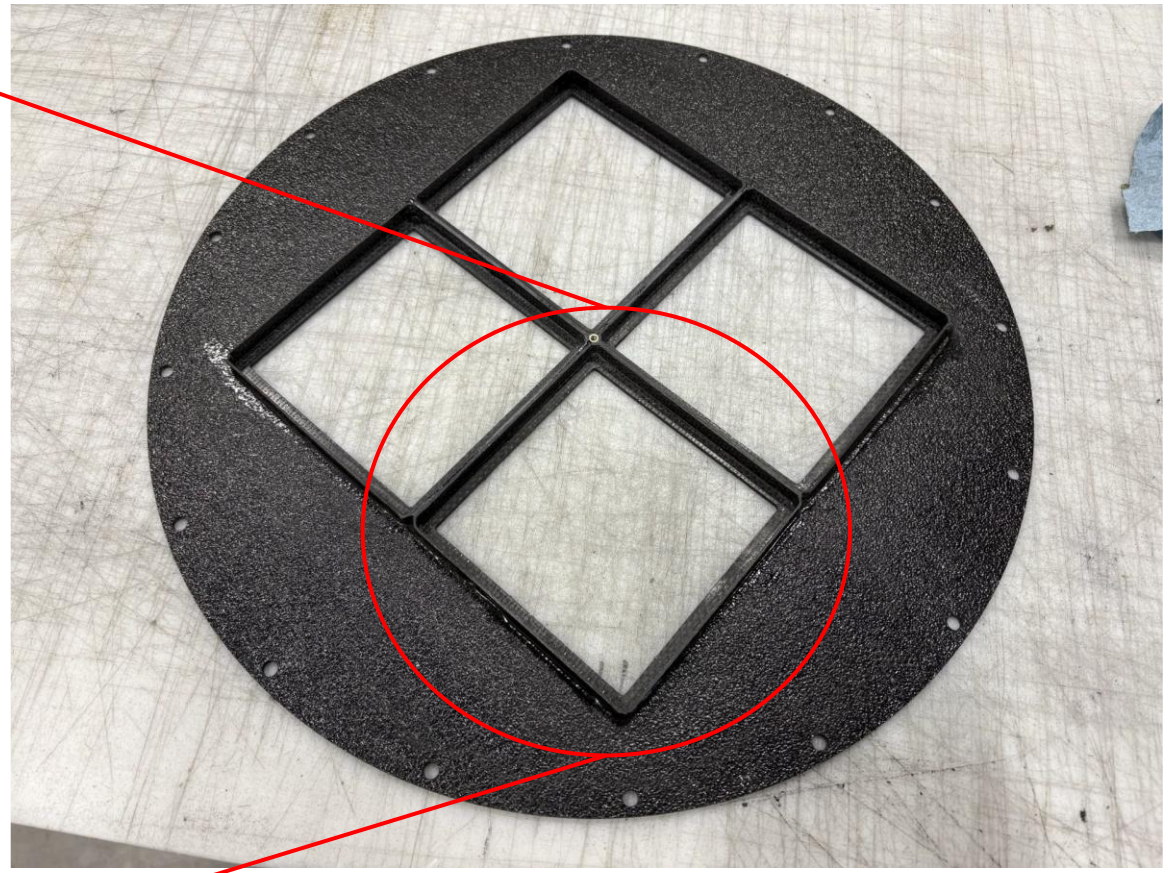


- Tried to place two different HRPPDs into this picture frame
  - One worked fine, another one a bit tight -> need to improve HRPPD assembly alignment*

*Notes from Alexander's test fit

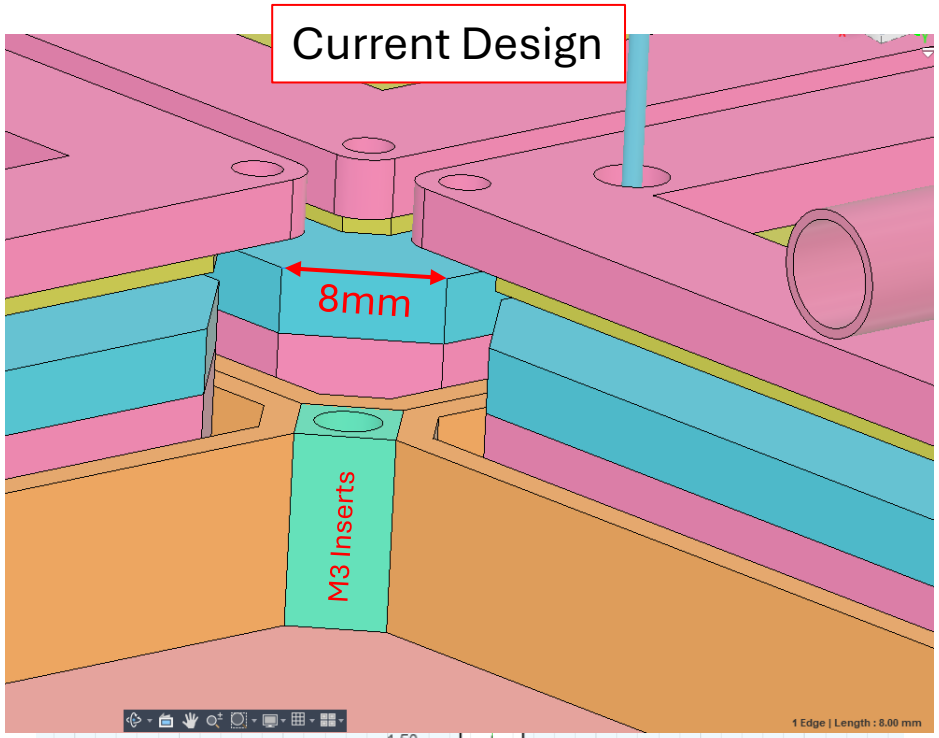
Prototyping efforts (Cont’d)

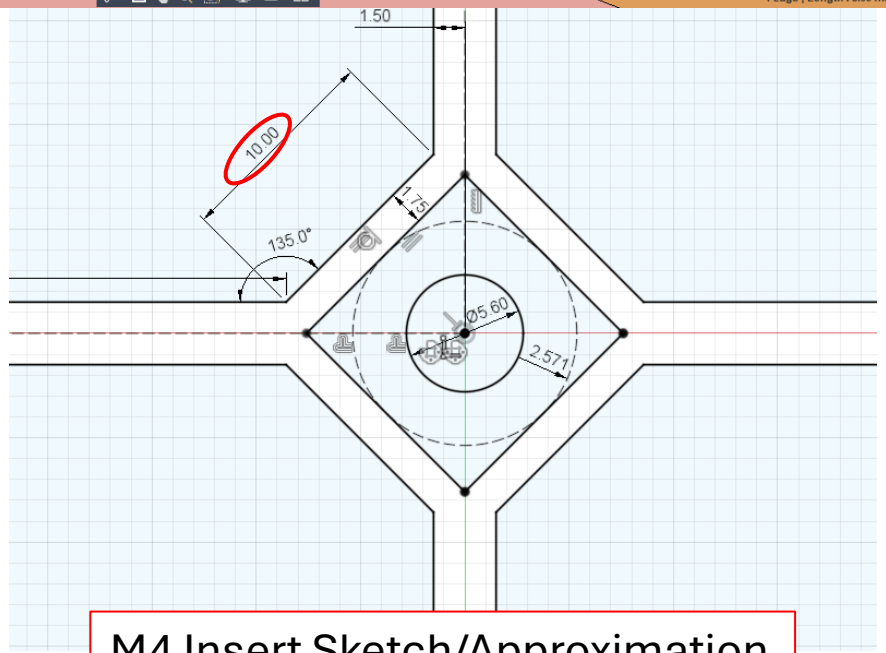




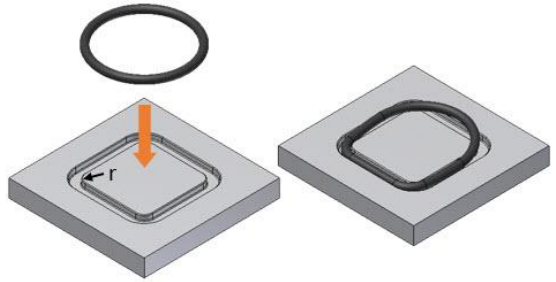
Chamfers

- Current chamfer (as shown in CAD) gives us an 8mm length.
- This drives the largest size of hardware we can use for the hold-down
- From the mechanical standpoint, a larger chamfer is better to allow larger inserts/hardware
- An M4 insert would need roughly a 10mm (45deg) chamfer





Fillets

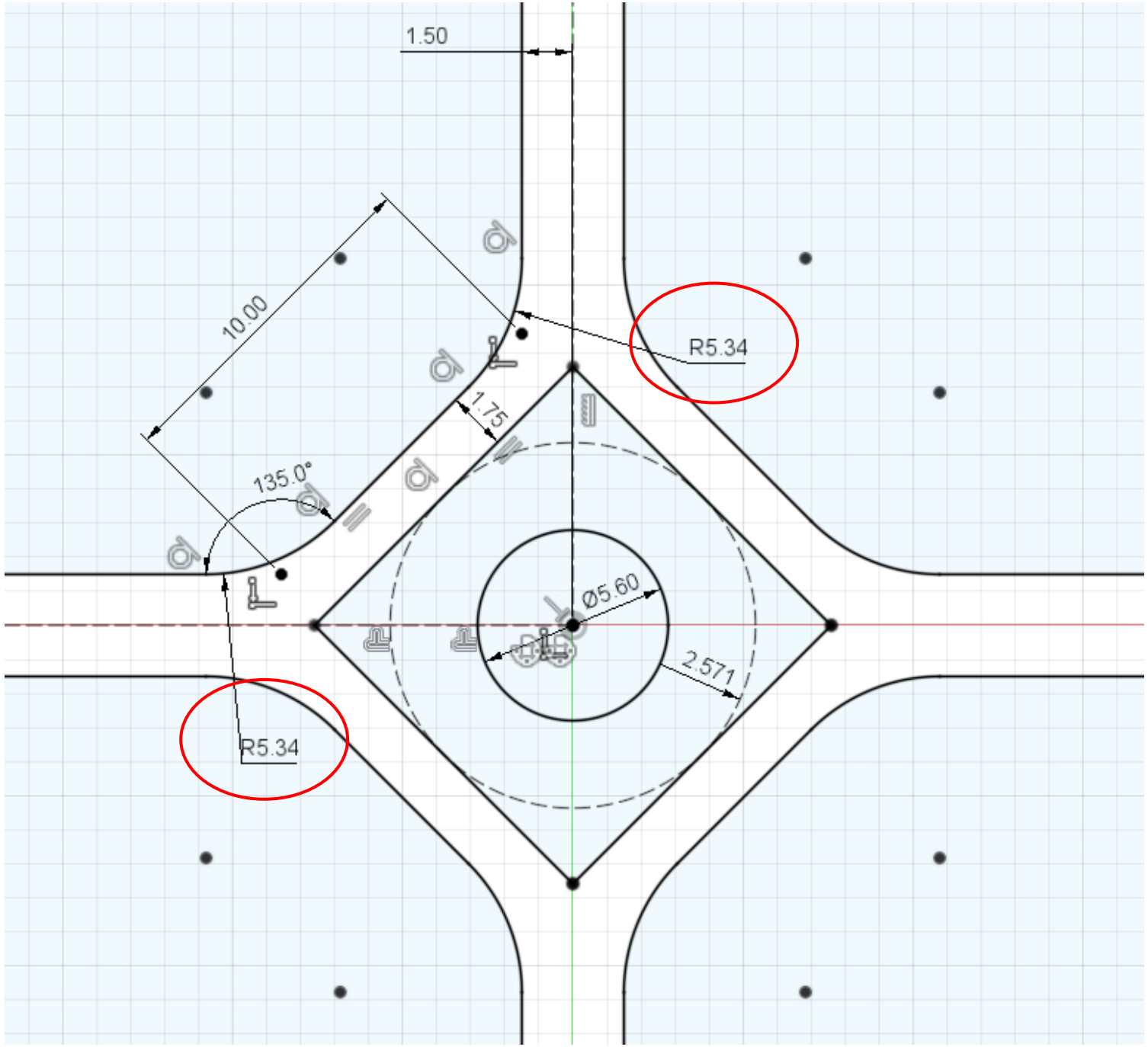


- Although I understand Kyocera cannot add fillets/rounds in the corners, I wanted to include information for reference
- For a standard O-ring, we would want the inside radius to be ideally 3 – 6 times the O-ring c-s diameter
  - E.g. 1/16” (1.78mm) O-ring needs an inside radius of 3/16” (5.34mm) at an absolute minimum
- Custom O-Seals can be molded to fit the exact grooves and a smaller radii can be used; however, we still need to consider the space for the inserts

Ref: https://www.gallagherseals.com/blog/using-o-ring-non-circular-grooves

Fillet Sketch

- Here’s a rough sketch for the addition of fillets along the corners which makes many assumptions:
  - 1/16” O-Ring
  - 3x O-ring radius minimum
  - Upsized M4 inserts
  - 10mm chamfer
- None of these assumptions are final, this is just a visual representation of the previous slide
- This is not a proposed design option



Summary

- Although there are challenges to the current design iteration (face seal and space limitations), they are mostly non-critical.
- The pfRICH is filled with nitrogen during operation and small leaks are not show-stoppers.
- However, there is a critical need for the chamfer or fillet in the corners of the HRPPDs because they allow for the mechanical holding of each sensor.
- From the pfRICH mechanical standpoint, there are not as many constraints in Z (height of the sensor stackup) as there are on the overall footprint.