PURDUE UNIVERSITY

Composites Manufacturing & Simulation Center

pfRICH Sensor Plate Prototype

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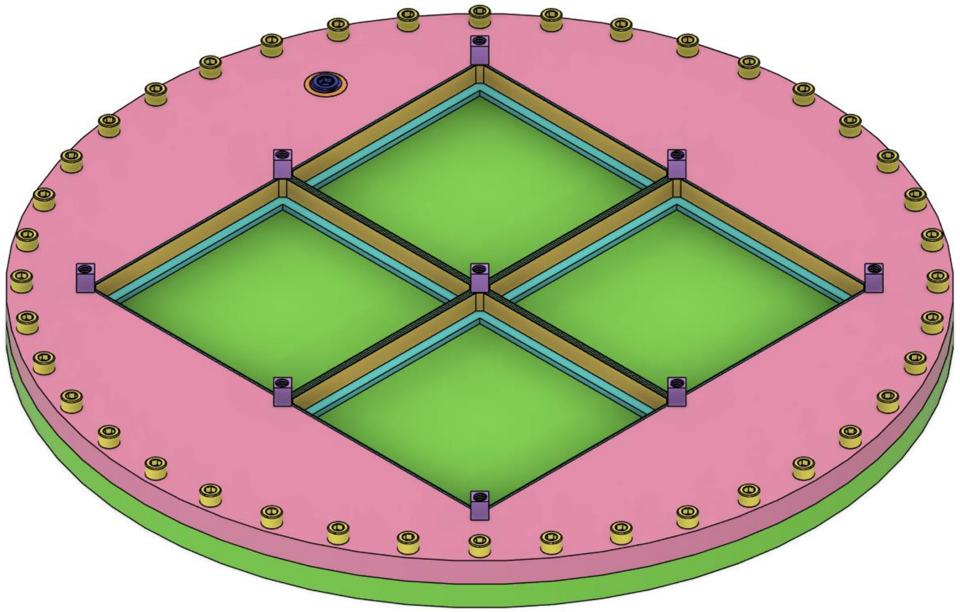
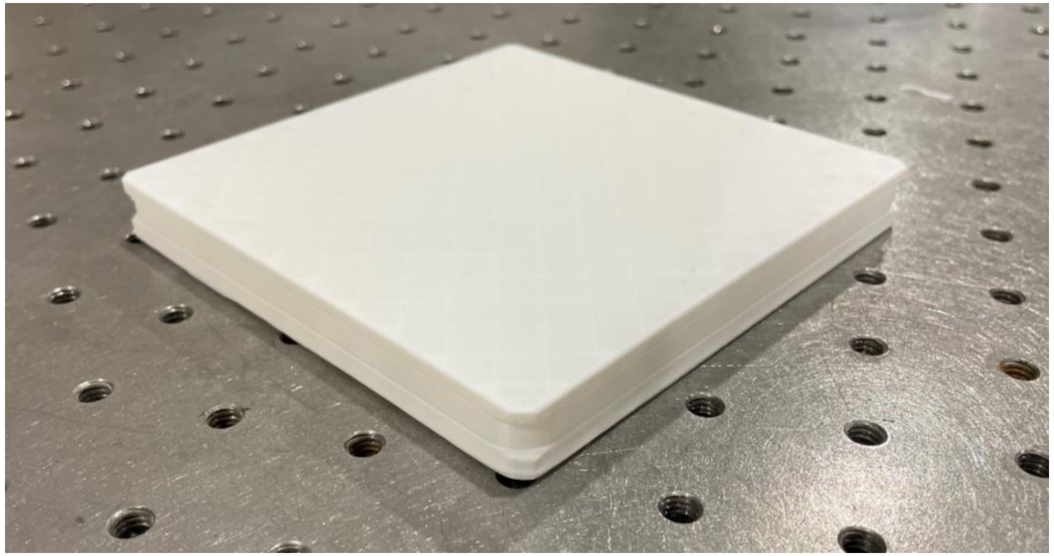
Prototype Design

- 4 sensor grid
- Carbon fiber sensor plate prototype constructed using same procedures as final
- Sealed to test backing plate
- 3D Printed sensor blanks used to test sealing against carbon fiber





Sensor plate production

- Carbon fiber “picture frame” units made to fit sensor geometry as precisely as possible
- Glued to continuous carbon fiber beams between frames
- Assembly of frames glued to solid CFRP plate

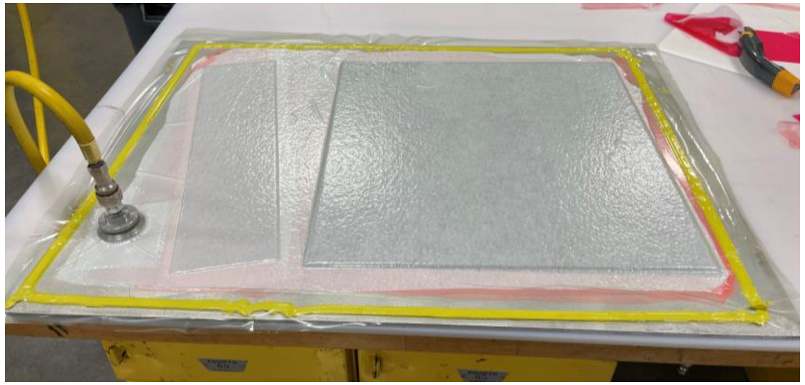
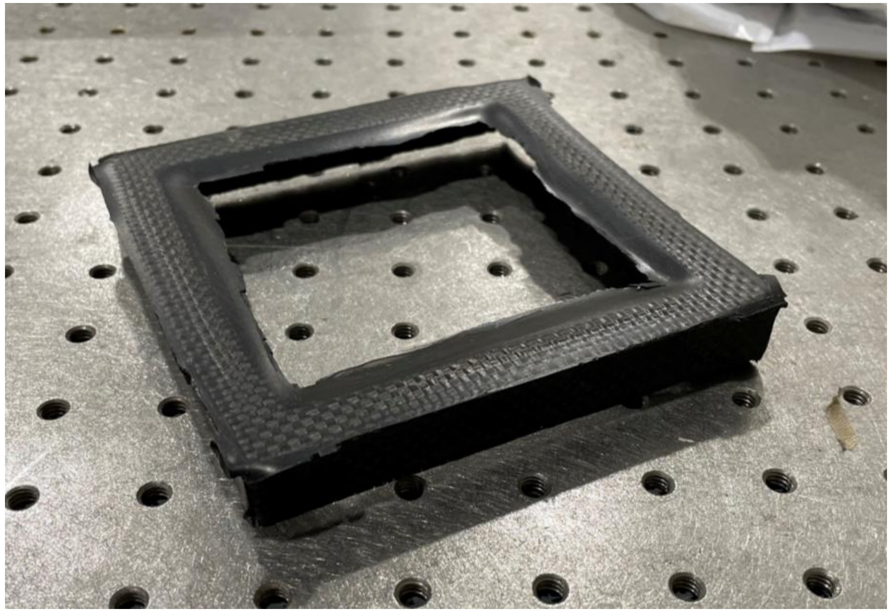
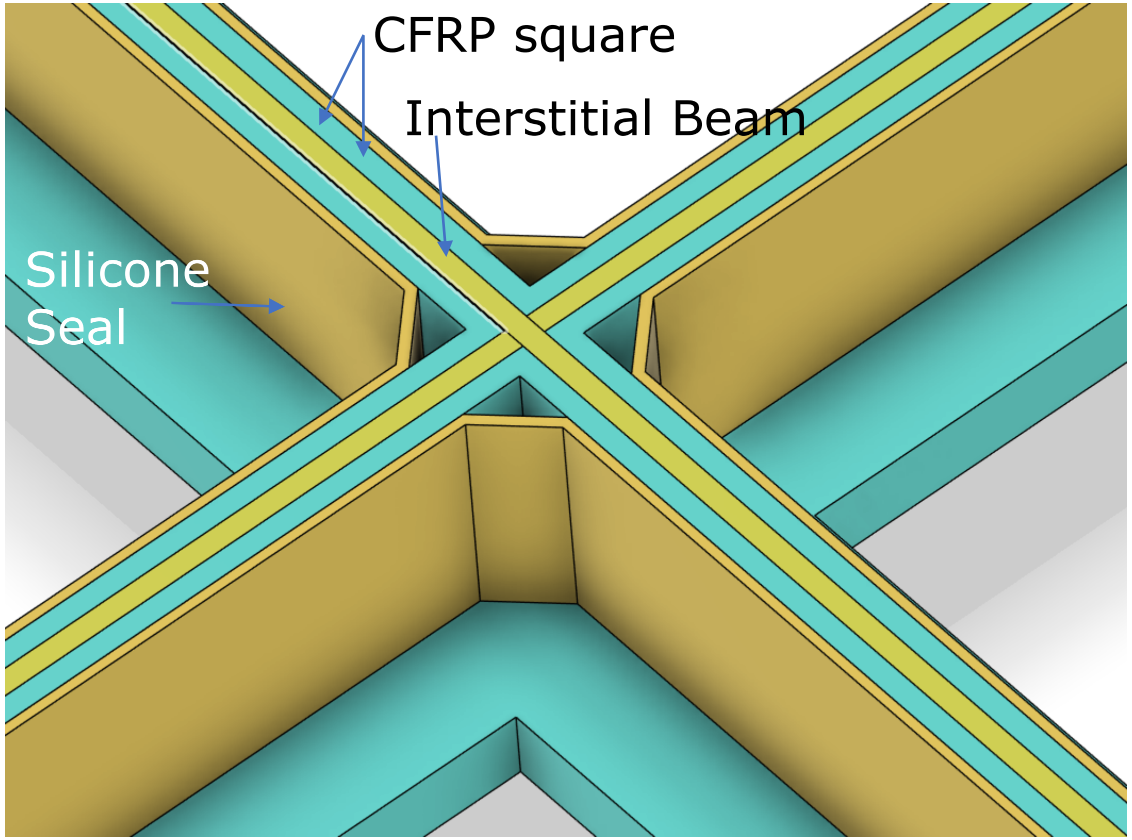
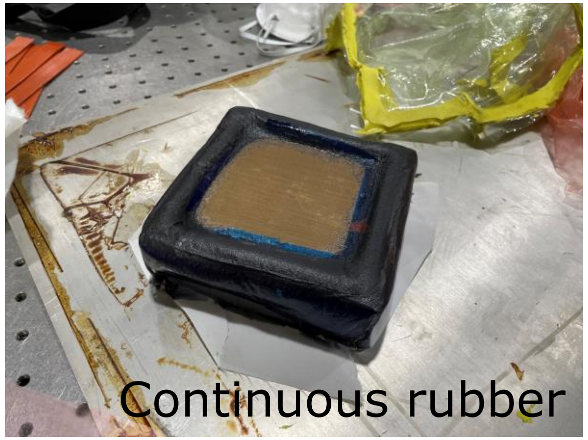


Plate layups for outer plate and interstitial beams

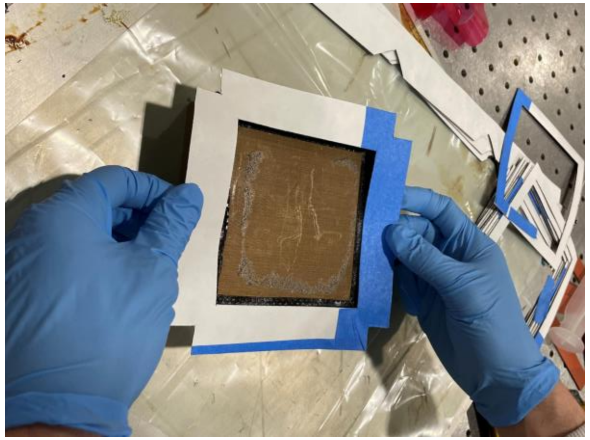


Untrimmed individual carbon unit

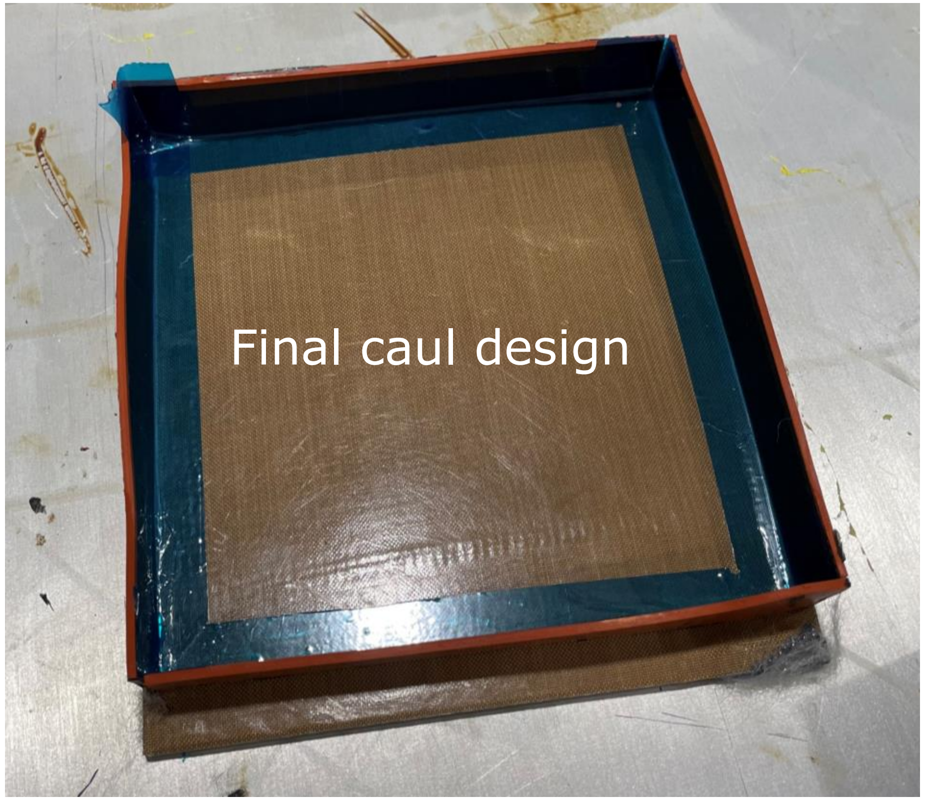




Continuous rubber

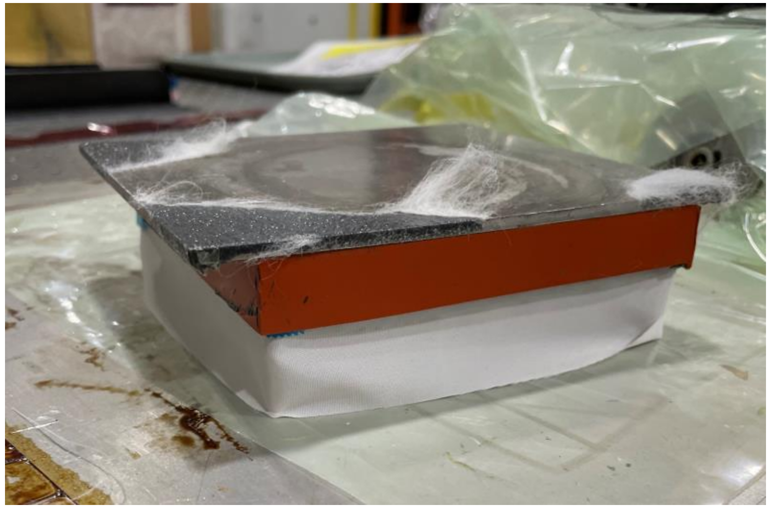


- Tried multiple top caul designs to achieve desired geometry and surface finish
- Continuous rubber caul was difficult to demold and top was not flat
- Final design is aluminum top plate over silicone dam with silicone over sides
- Silicone taped to aluminum to prevent resin buildup in the corners



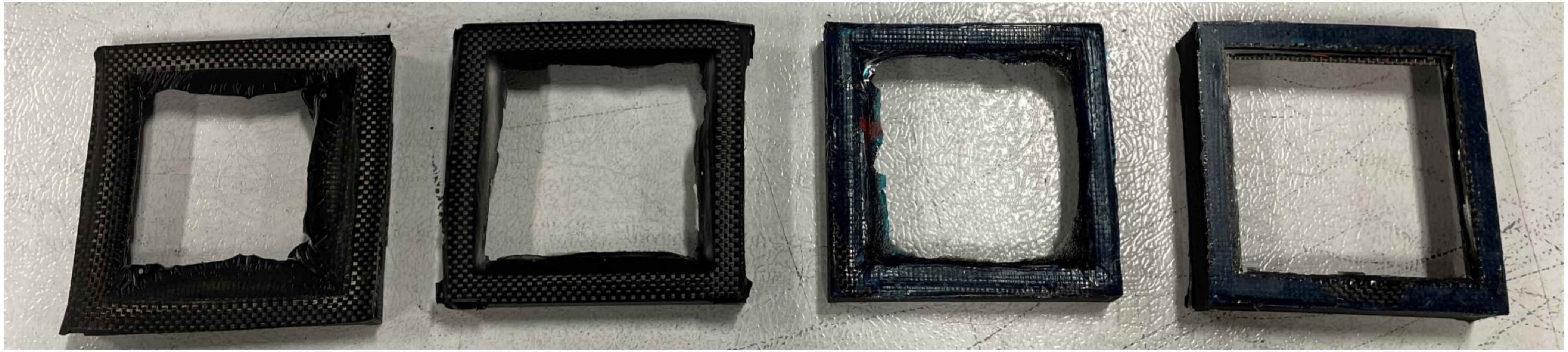
Final caul design

Inner Silicone Dam



Silicone over peel ply

Caul comparison

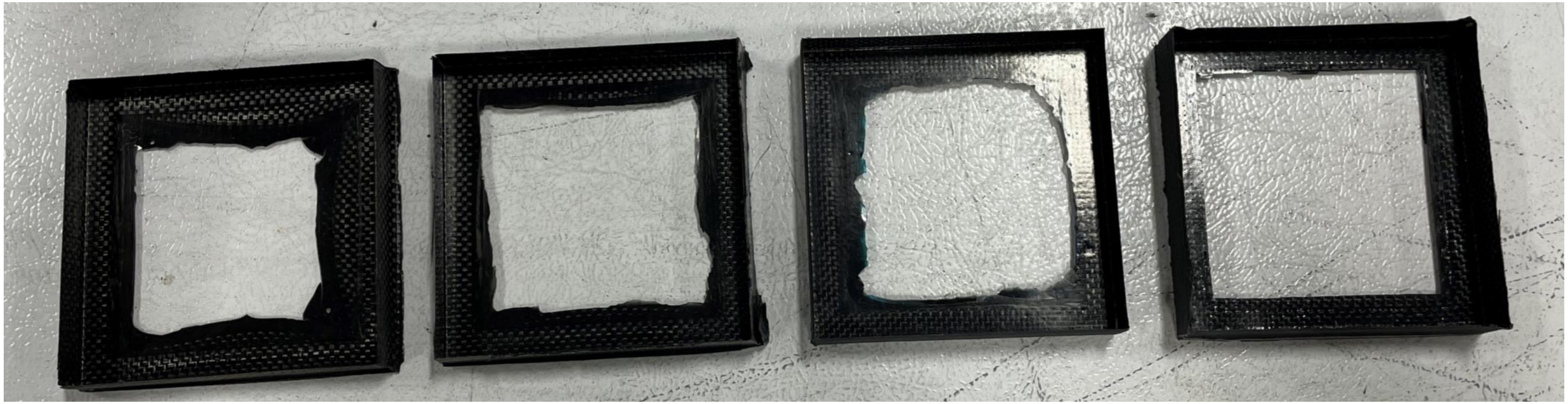


Aluminum top, silicone sides, no tape or dam

Silicone all over, Aluminum on top

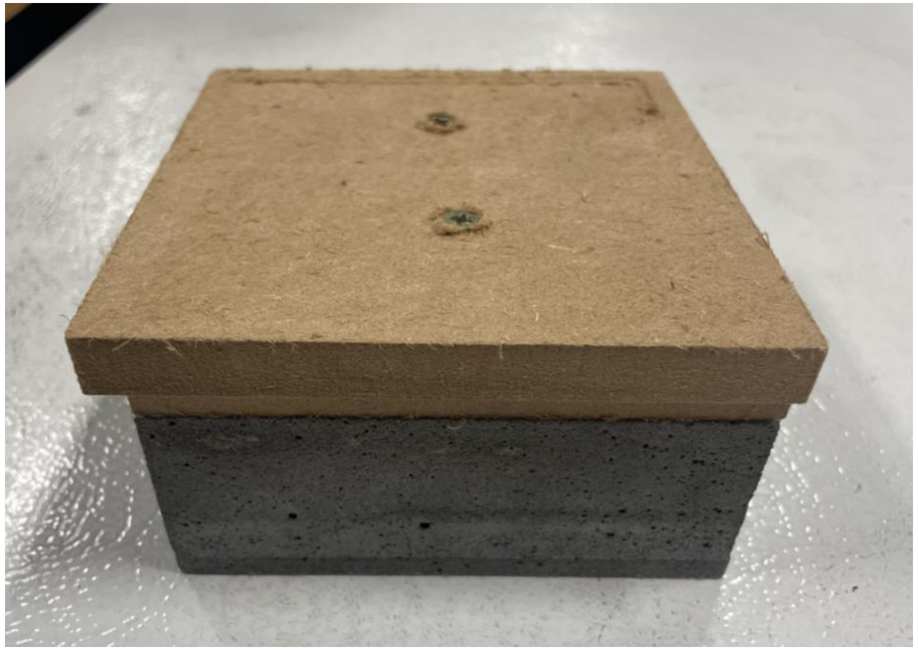
Continuous rubber caul

Aluminum top, silicone sides, with dam and tape

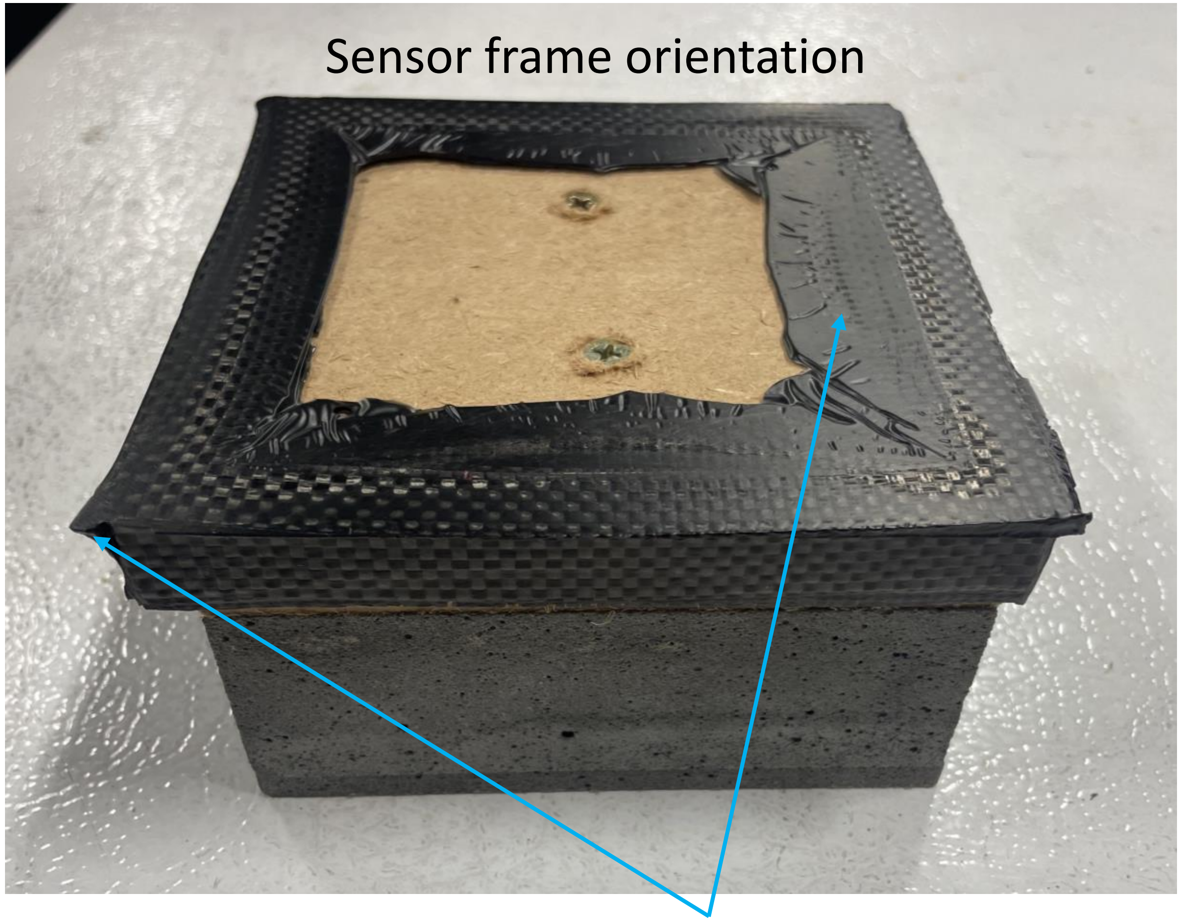


Sensor Frame Trimming

- After layup and curing, sensor plates need to be trimmed to shape on CNC router



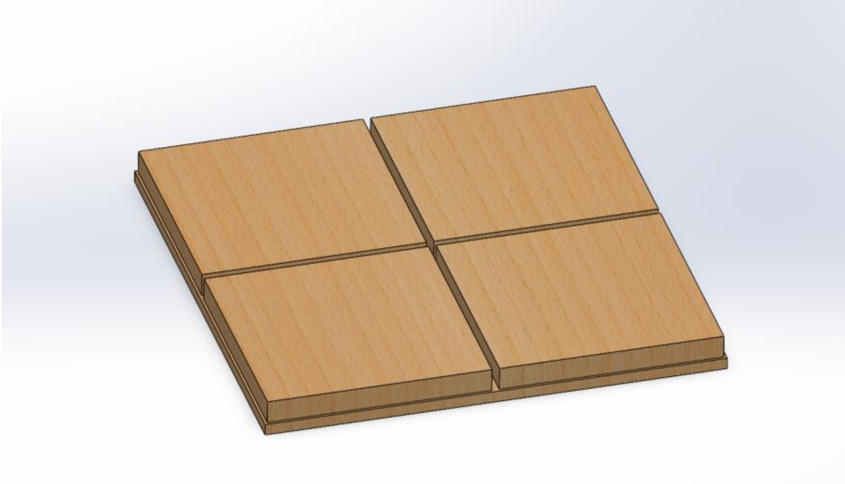
Trim tool (MDF on tooling board)



Faces to be trimmed and sanded

Sensor Frame Bonding

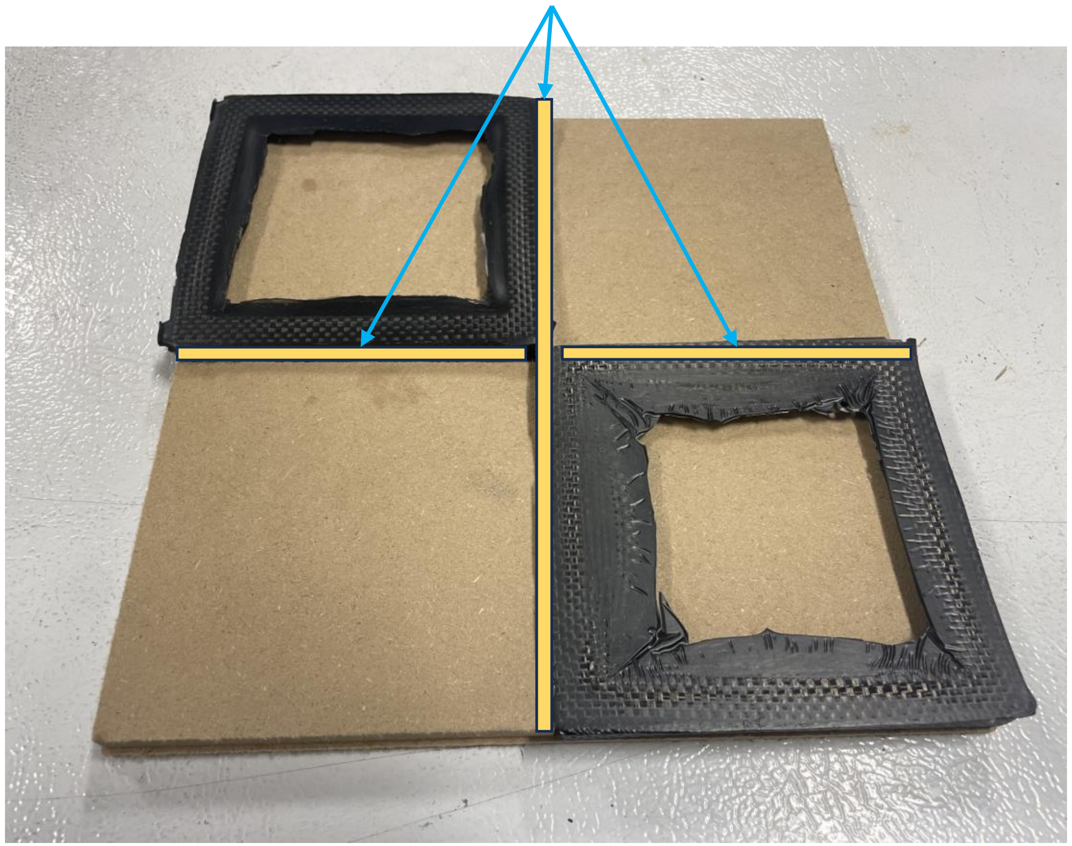
- Sensor frames to be bonded together using square bonding jig
- Interstitial beams give thickness between sensor plate walls



Square bonding jig (MDF)

Interstitial beam plate (to be cut on waterjet)

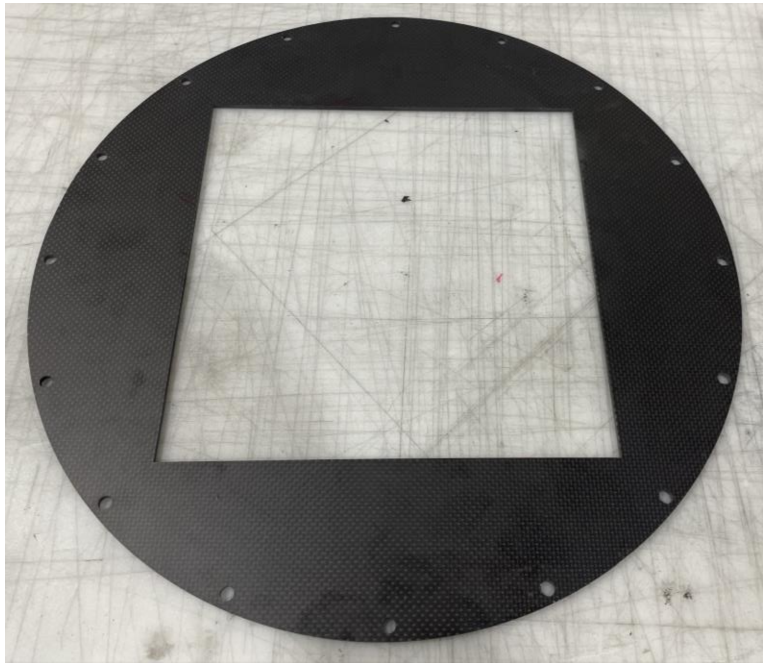
Interstitial beams



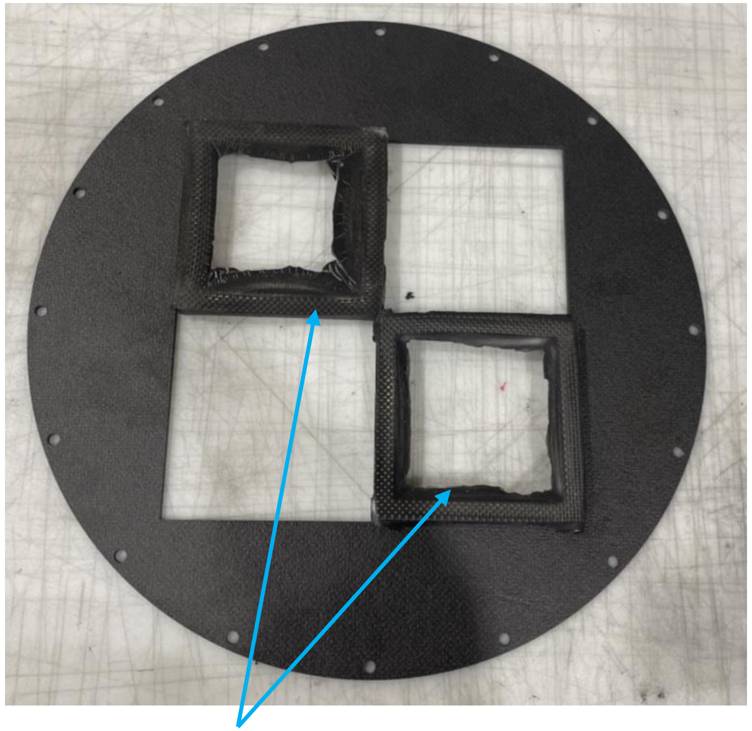
Example bonding layout with two sensor frames

Sensor Plate Support Disk

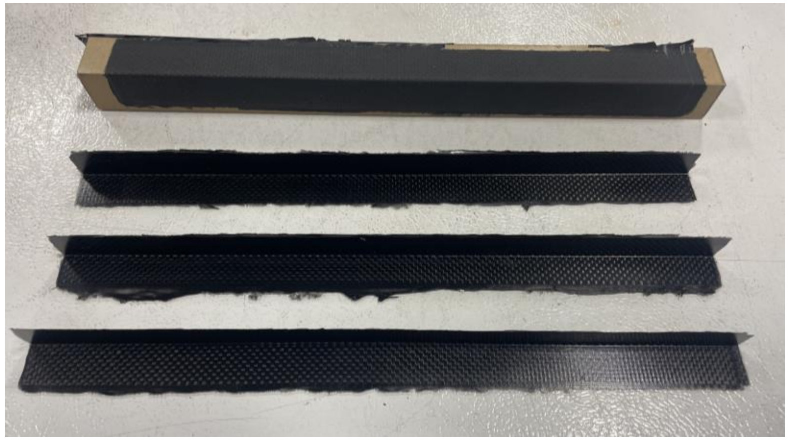
- Support disk cut on waterjet, interstitial beam still to be cut
- After four sensor frames are bonded together, entire assembly will be bonded to support disk with L-brackets



CFRP Support disk



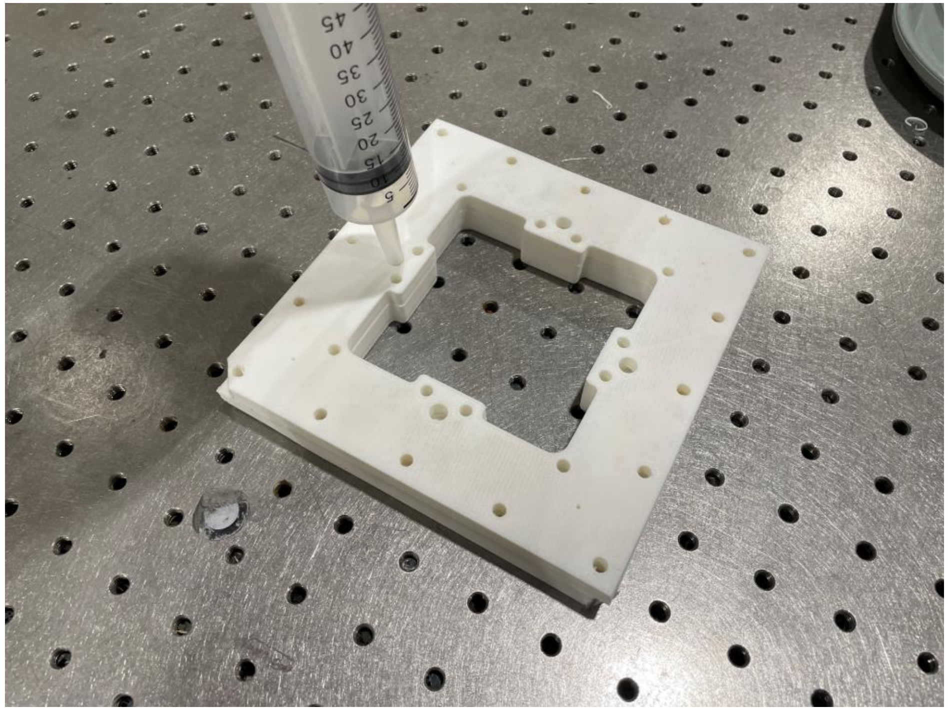
Sensor frames (x4)

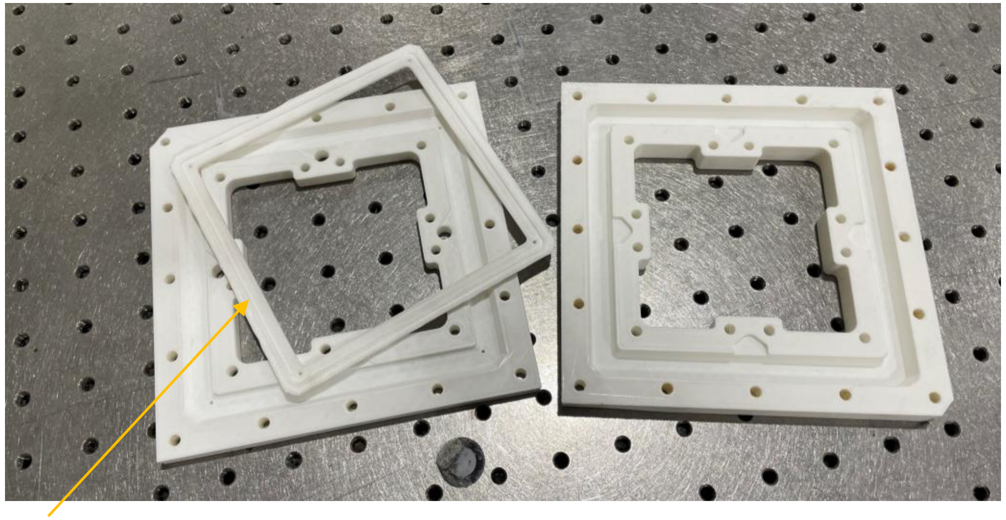


L-bracket layups

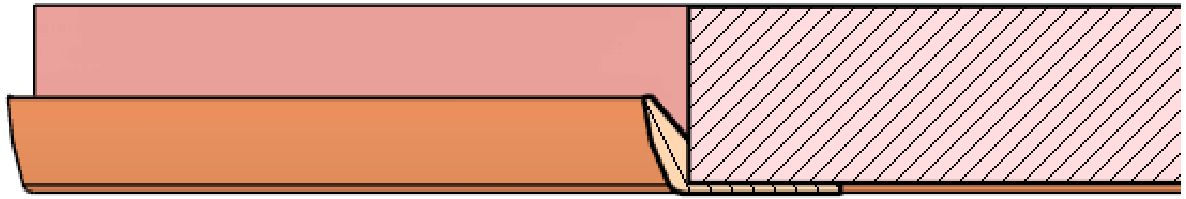
HRPPD silicone seal

- Seal cast from platinum cure silicone in a 3D printed "injection" mold
- Stays on by wrapping over bottom
- Seals between the sides of HRPPD and picture frame
- May be replaced by radial O-ring in final design



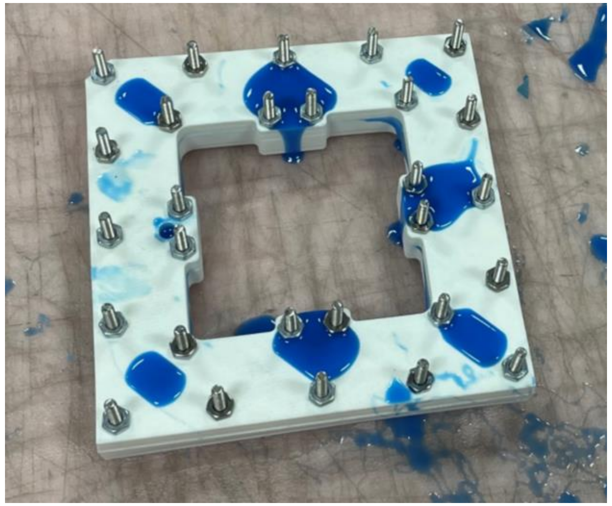


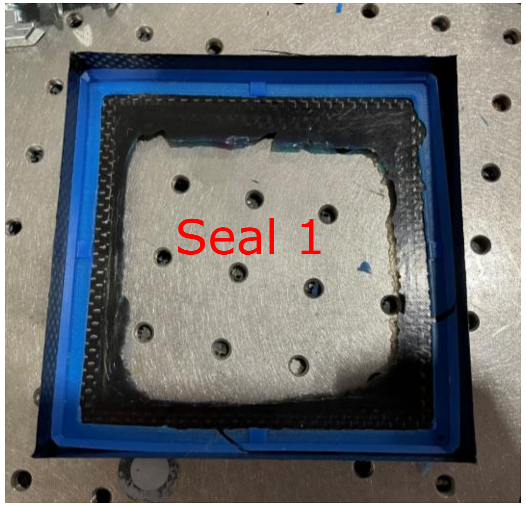
Inserts in mold make for faster design iteration



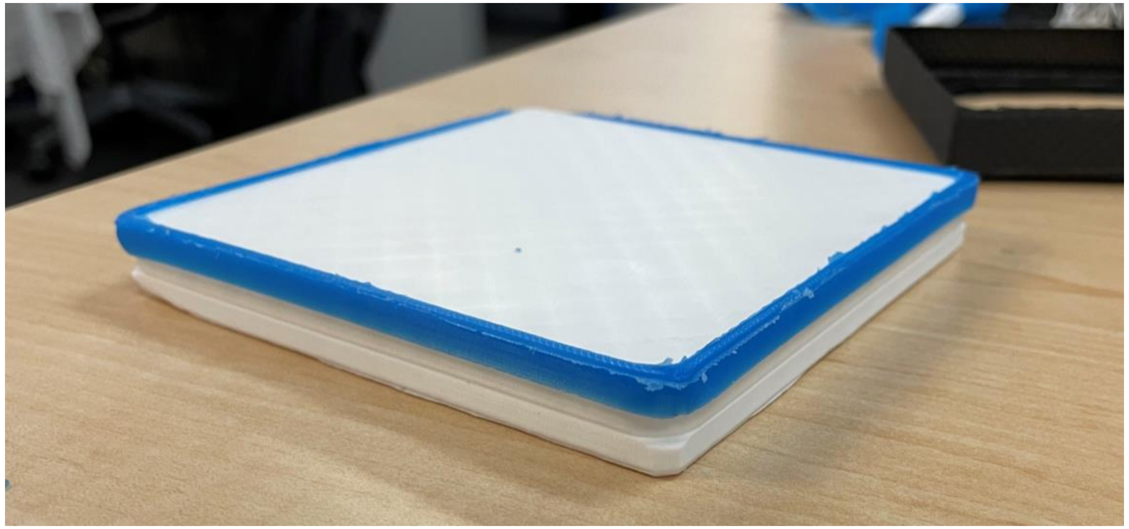
Seal 1 design

Seal Results

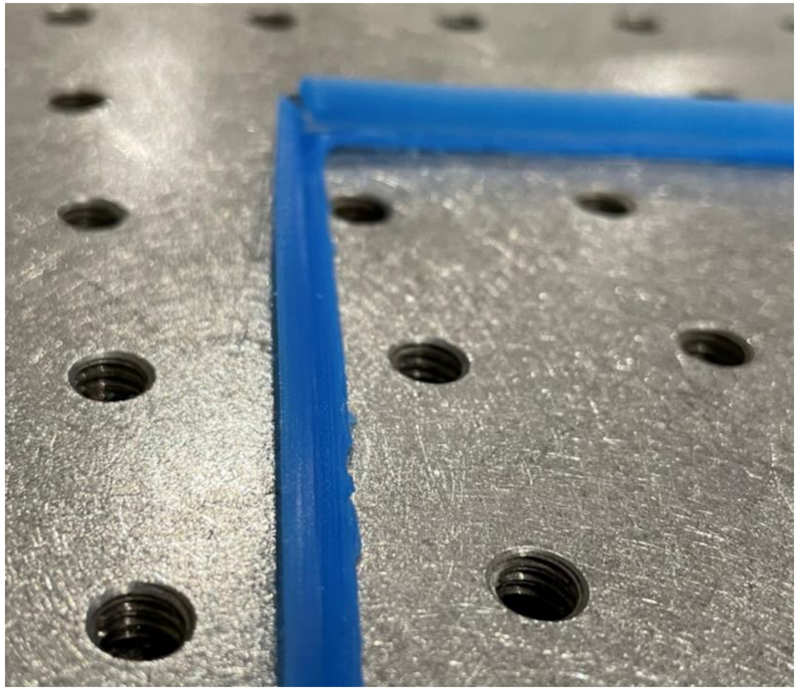




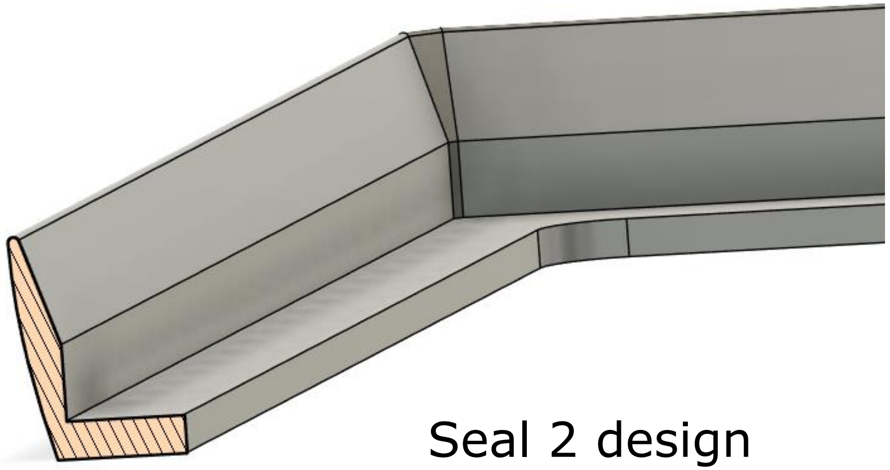
- First seal design tore during demold
- Thinned walls in second design to improve fit
- Thickened bottom and degassed before molding to prevent tearing
- Fit into picture frame is extremely tight with <1 mm wall thickness



Seal next steps



- Silicone didn’t tear through insertion cycles
- Fit is tight and inconsistent around the sensor
- Third design with thinner walls and tighter fit around sensor is in progress
- May be necessary to increase sealing space or find a different way to seal if thinner walls not possible

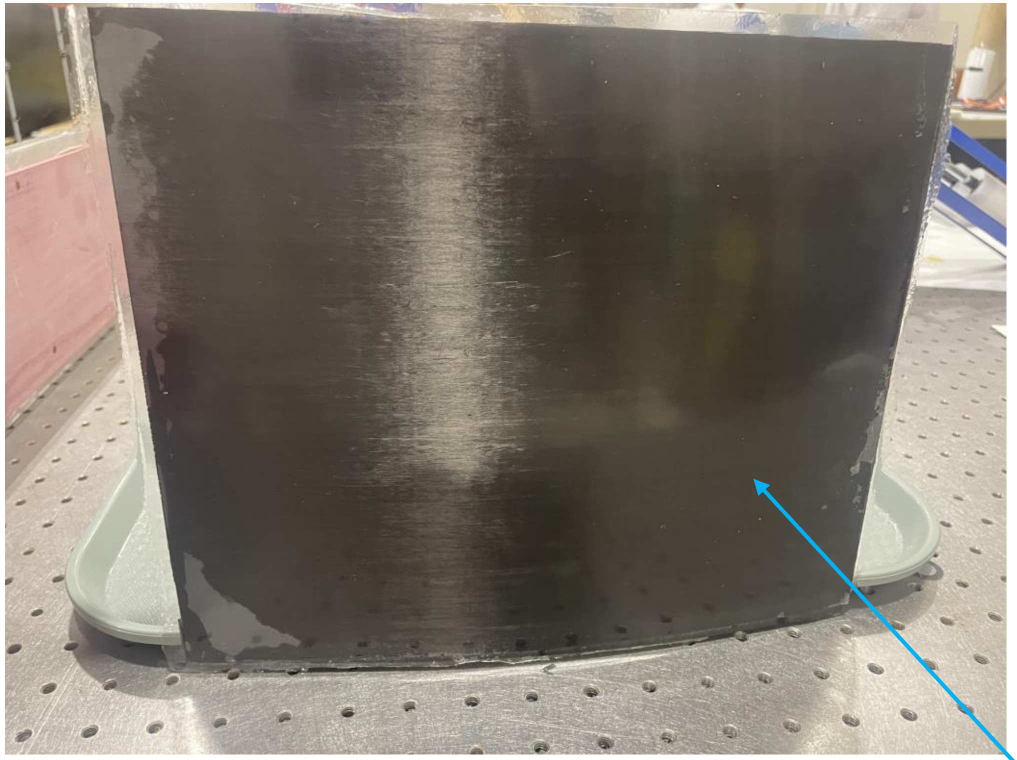


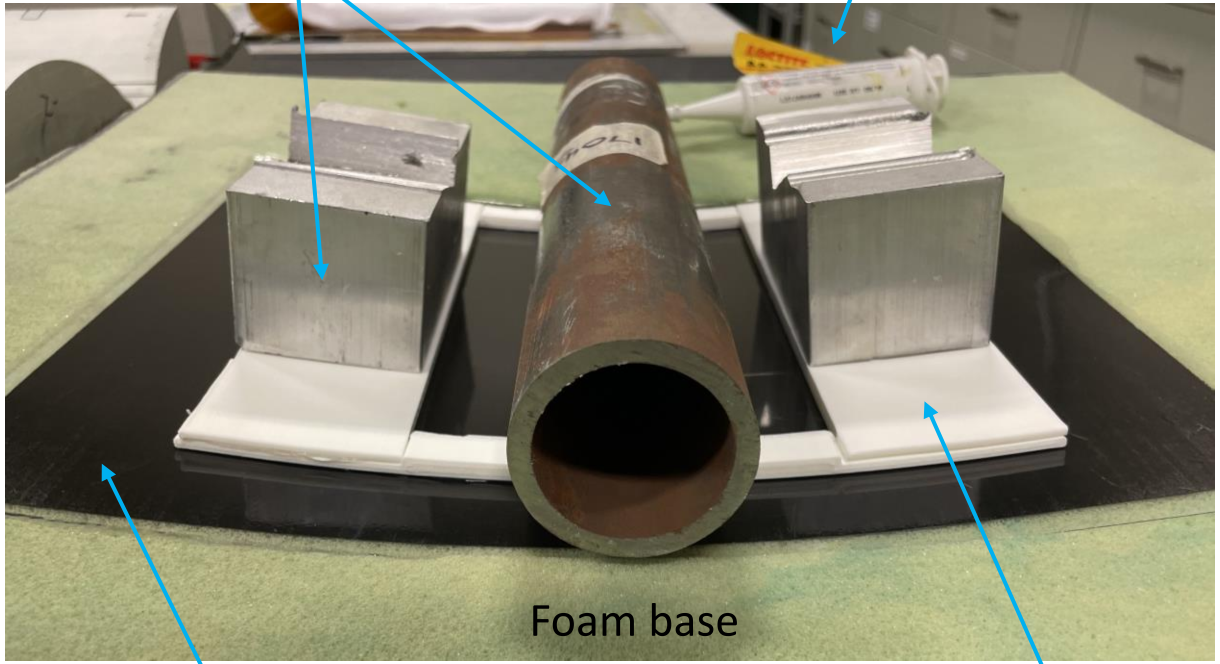
Seal 2 design

Trouble with seal fitting all the way around

pfRICH Mirror Substrate Test

- Mirror substrate test plate needed to create an ideal surface for depositing a mirror-like coating
- Test plate is comprised of CFRP plate co-bonded to Lexan sheet
- Curved shape created by bonding test plate to 3D printed curvature jig





Weights

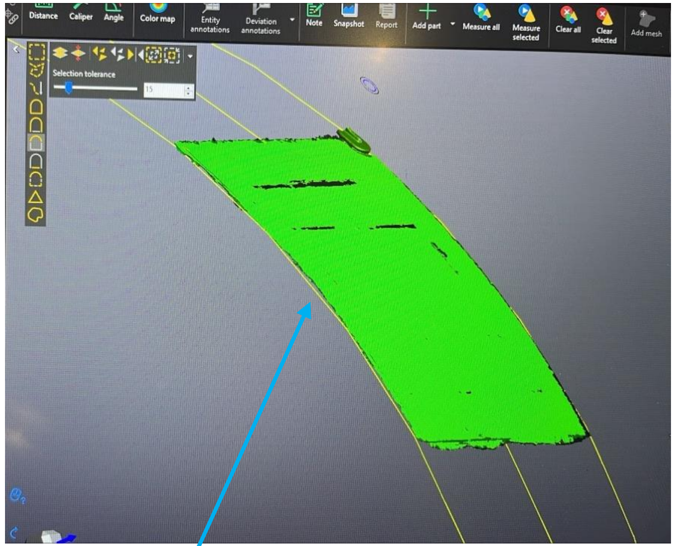
Loctite AA 332 adhesive

CFRP plate co-bonded to Lexan (protective film still on front face)

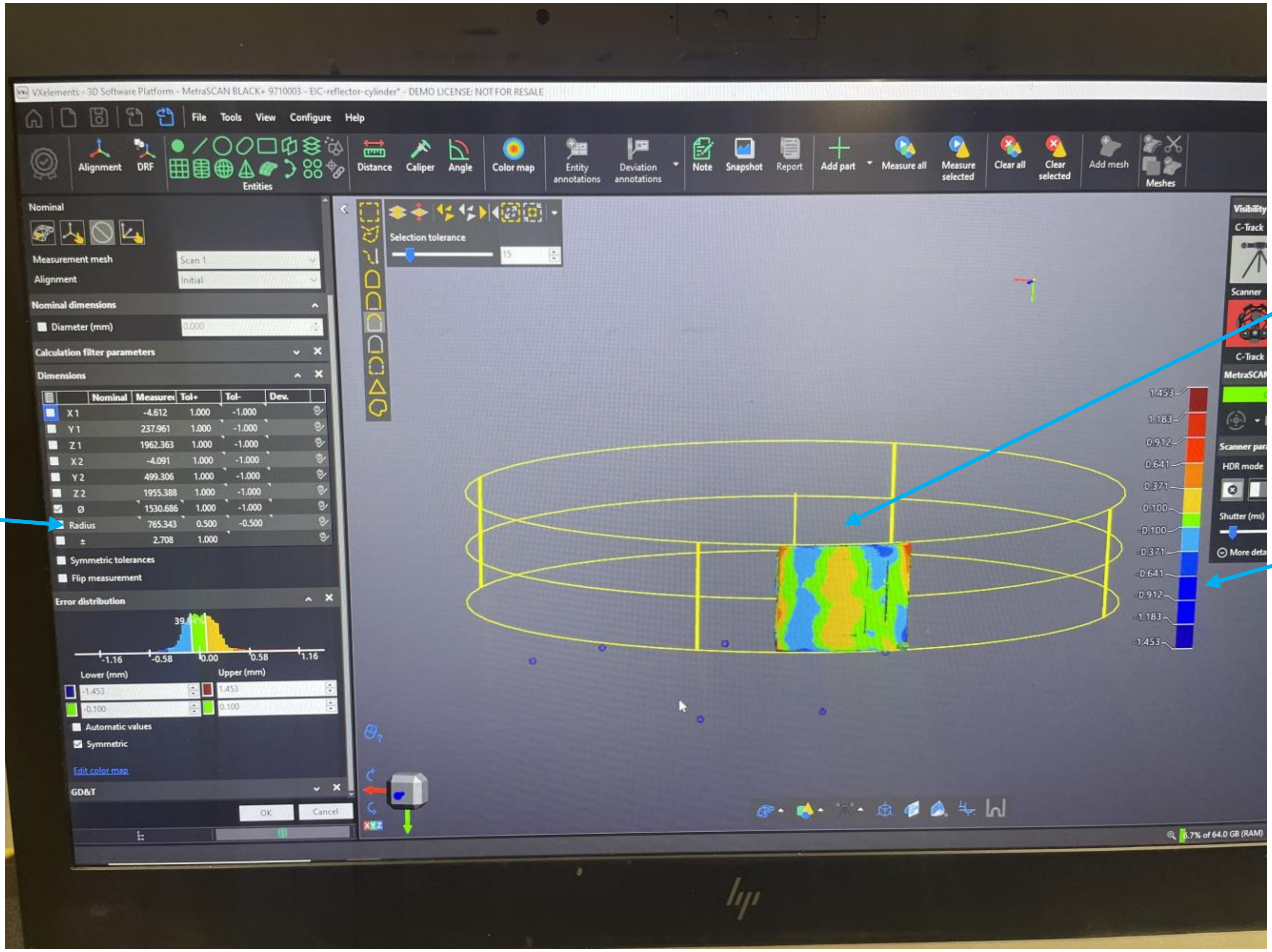
3D printed curvature

Mirror Substrate Test Metrology

- Mirror test plate curvature validated using MetraSCAN 3D laser scanner
- Outer curved surface of test plate fitted to a model cylinder to compare surface height deviations



Laser-scanned outer surface



Model cylinder radius = 765.343 mm

- Surface height deviation shows outer surface of our test plate is between +/- 371 micron from the model cylinder

Backup Slides

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pfRICH Mirror Substrate Bonding Pictures

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MetraSCAN Analysis