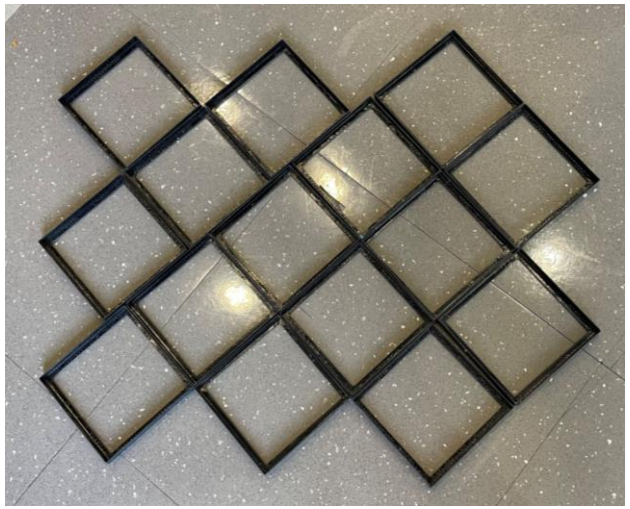
PURDUE UNIVERSITY

CMSC Composites Manufacturing & Simulation Center

pfRICH Sensor Plate Prototype



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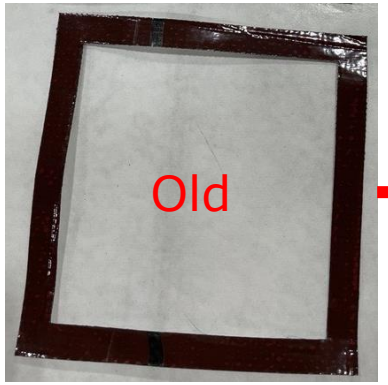
1 August 2024

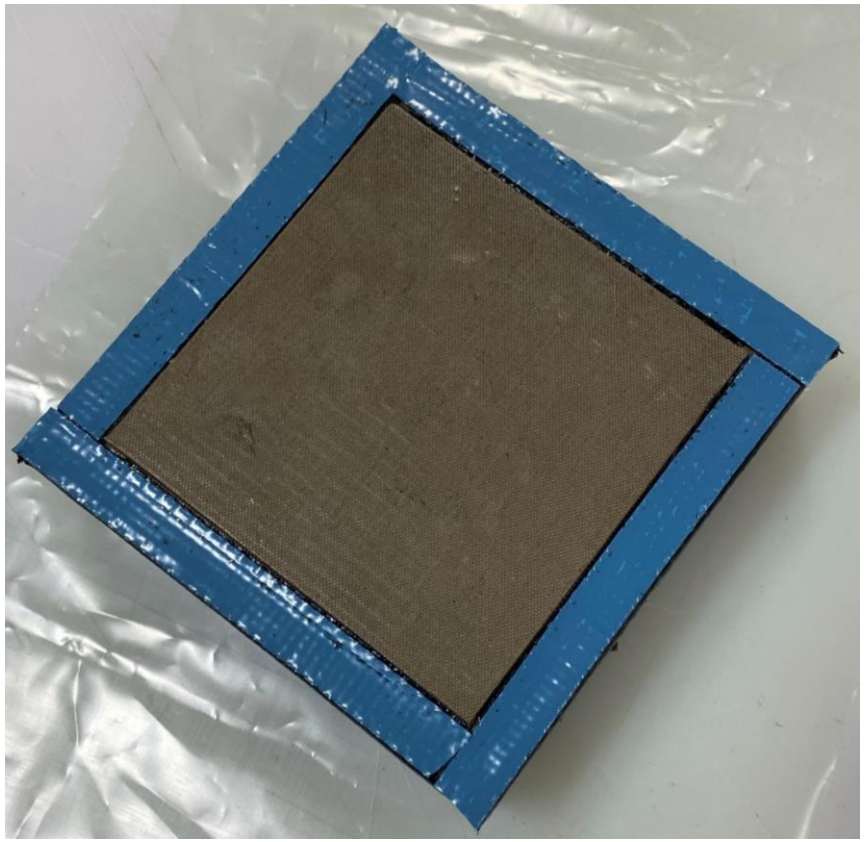
Sensor frame prototype progress

- 15 sensor frames are made plus 5 extra
- All frames are machined and sanded
- L-brackets for bonding to outer plate are made
- Still need to lay up plate for outer frame and interstitial beams
- More metrology to be done on sensor frames

New Picture Frame Layup Procedure

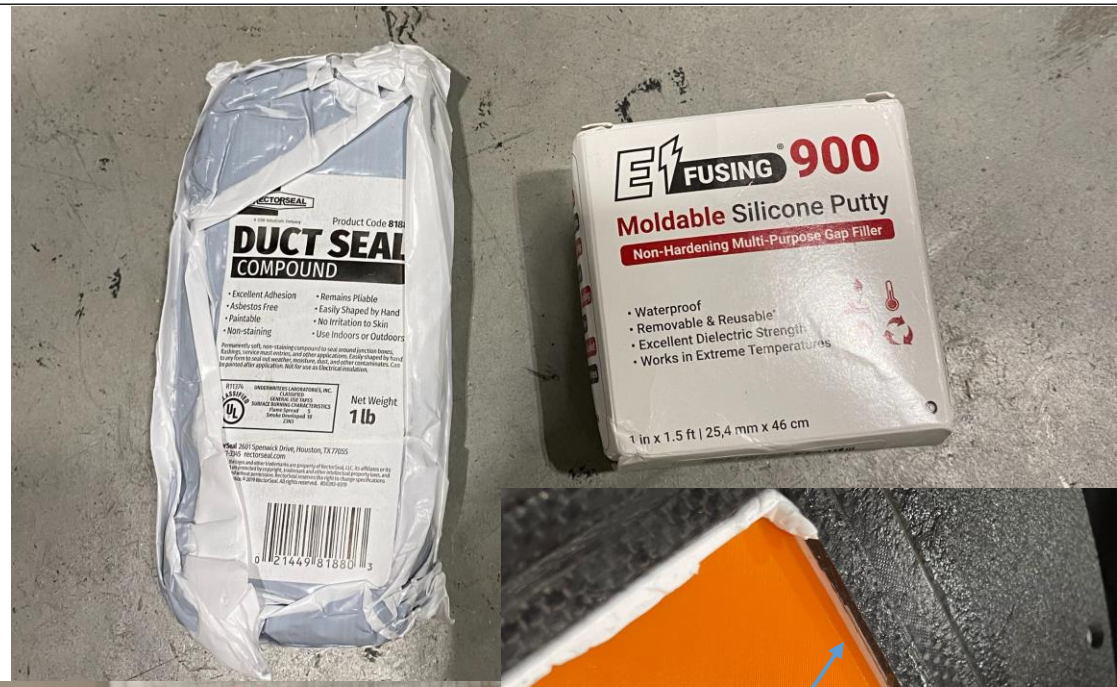
- Replaced the hollow box plies with 4 strips which cover the perimeter
- Reduces waste compared to original plies
- Strips were laid across the top of the picture frame mold and cut to length.
- Seams were alternated to prevent weak spots
- Resulted in a small visible seam in the final product



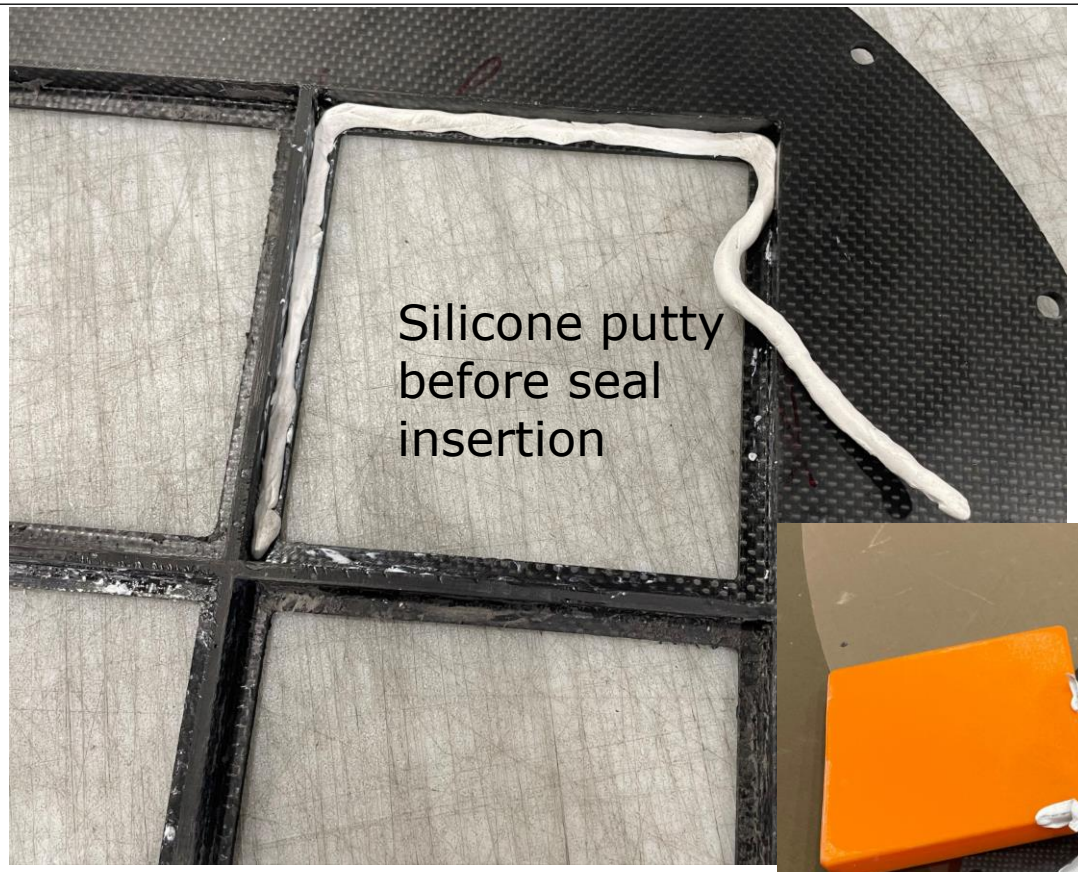


Sealing

- Two different sealing putties were tested
- Duct Seal worked but left residue on the sensor blanks and frames
- Silicone putty left little residue and easily scraped off
- Putty sealed to almost perfect vacuum and stayed sealed after pump removed
- Silicone putty is easy to apply and works better than any solid seal tested
- Effects of radiation and time on the silicone's sealing capacity remain to be tested



Sealing

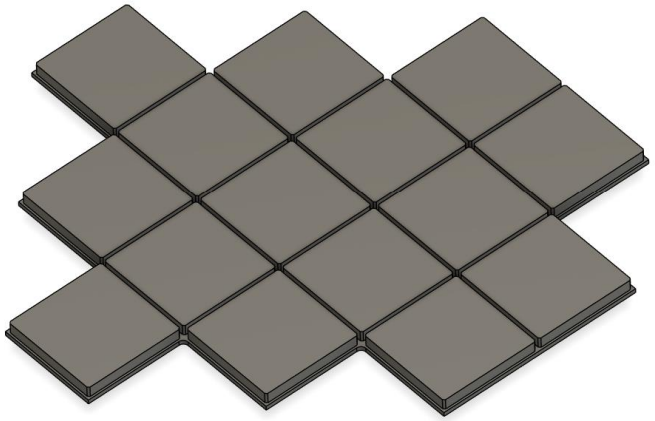

Silicone putty
before seal
insertion

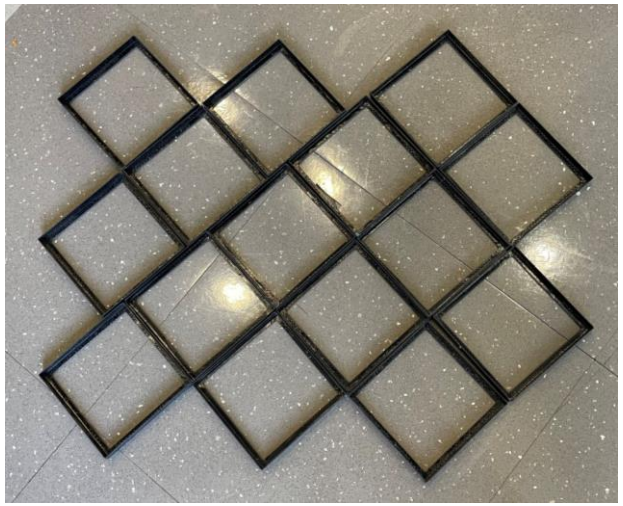

Residue from
silicone putty


Residue from
Duct Seal

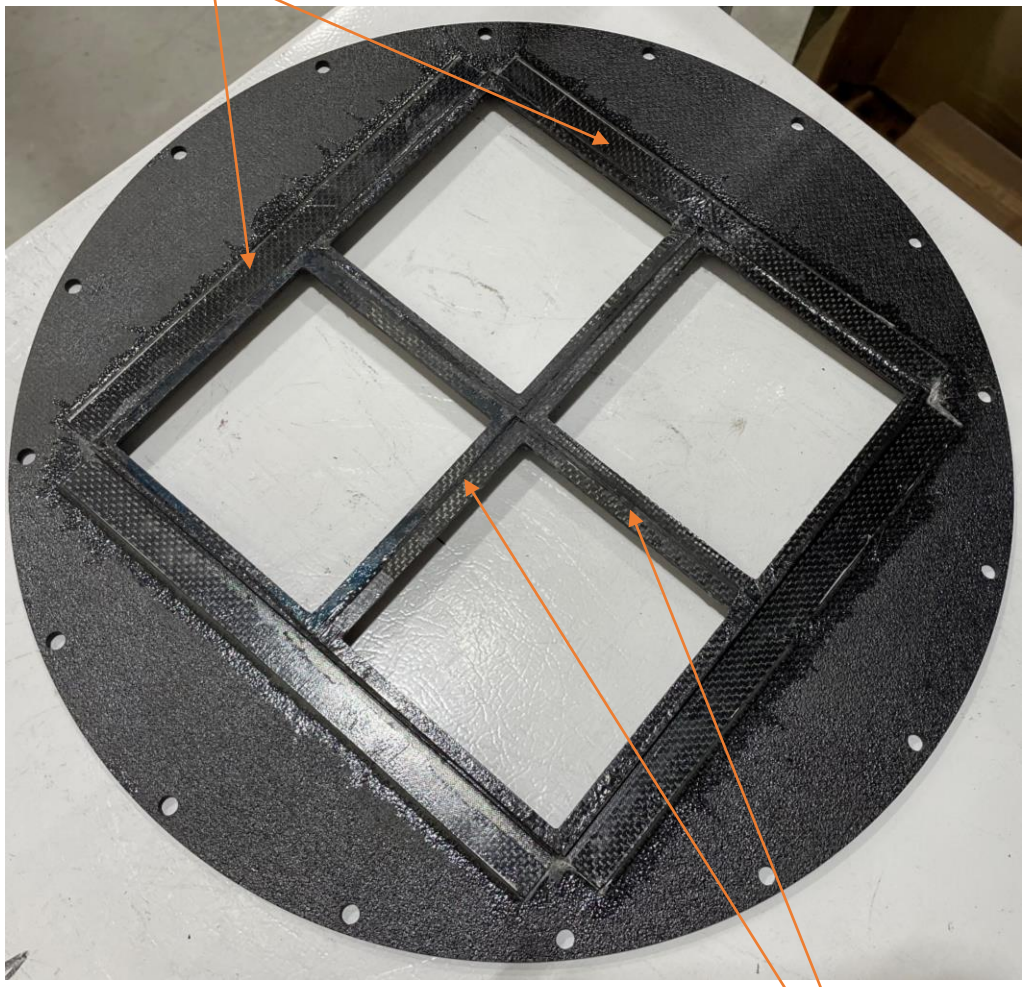
Bonding

- Frames will be bonded in groups of five to ensure enough adhesive working time
- Bonding jig is scaled up version of previous with more clearance
- Frames and interstitial beams will be bonded in jig first
- Frame assembly will then be bonded to outer plate with L-brackets





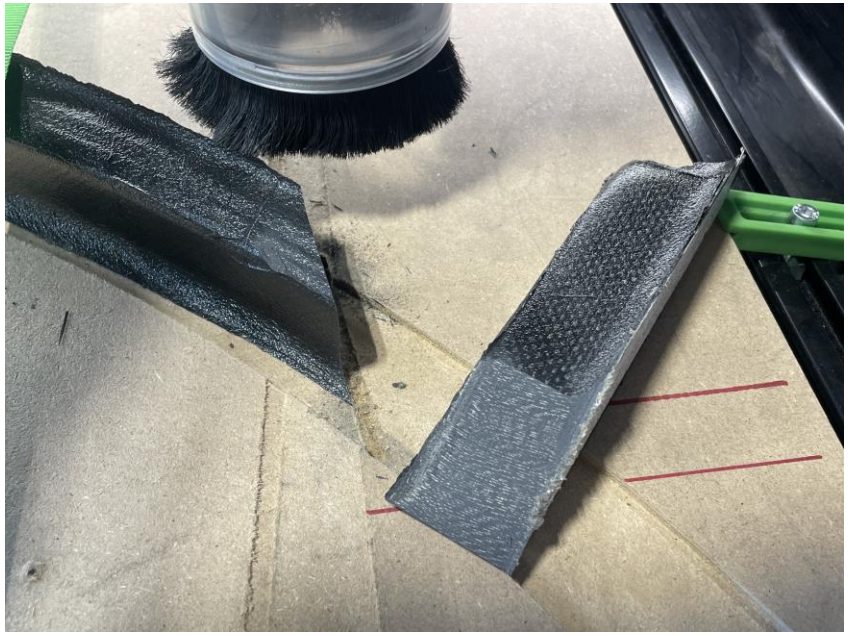
L-Brackets



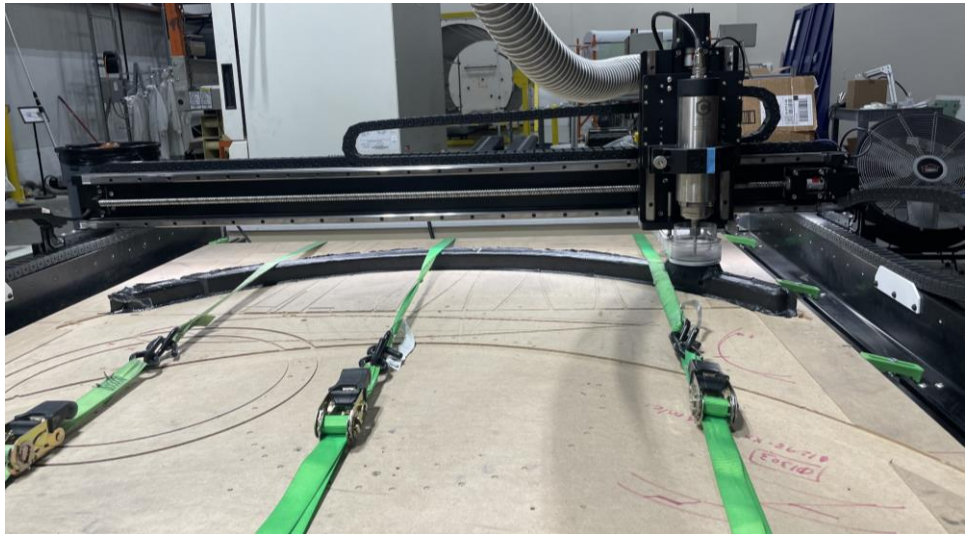
Interstitial Beams

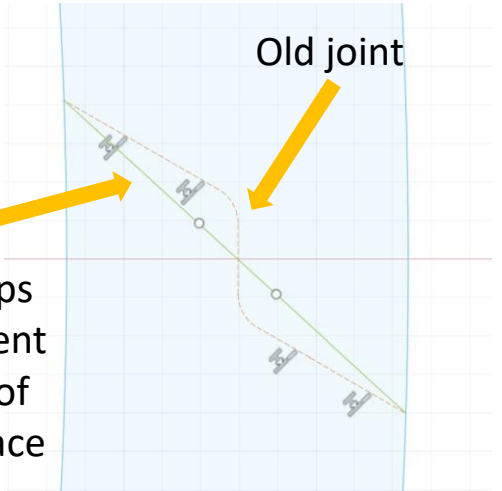
pfRICH End Ring Machining Process

Started with 4 cured end ring layups (nominal outer diameter = 1303 mm)

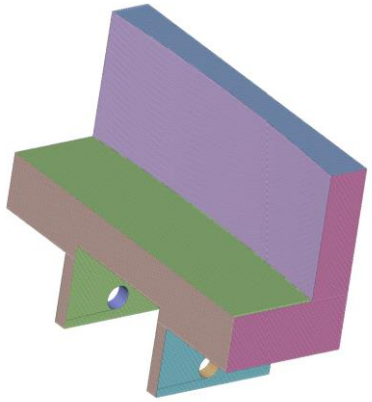


Machined scarf joint on both sides, accounting for 0.05 mm adhesive bond line thickness

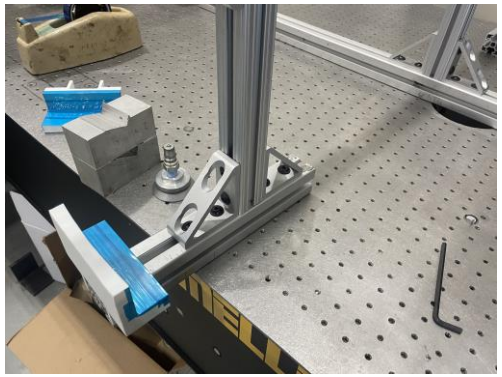




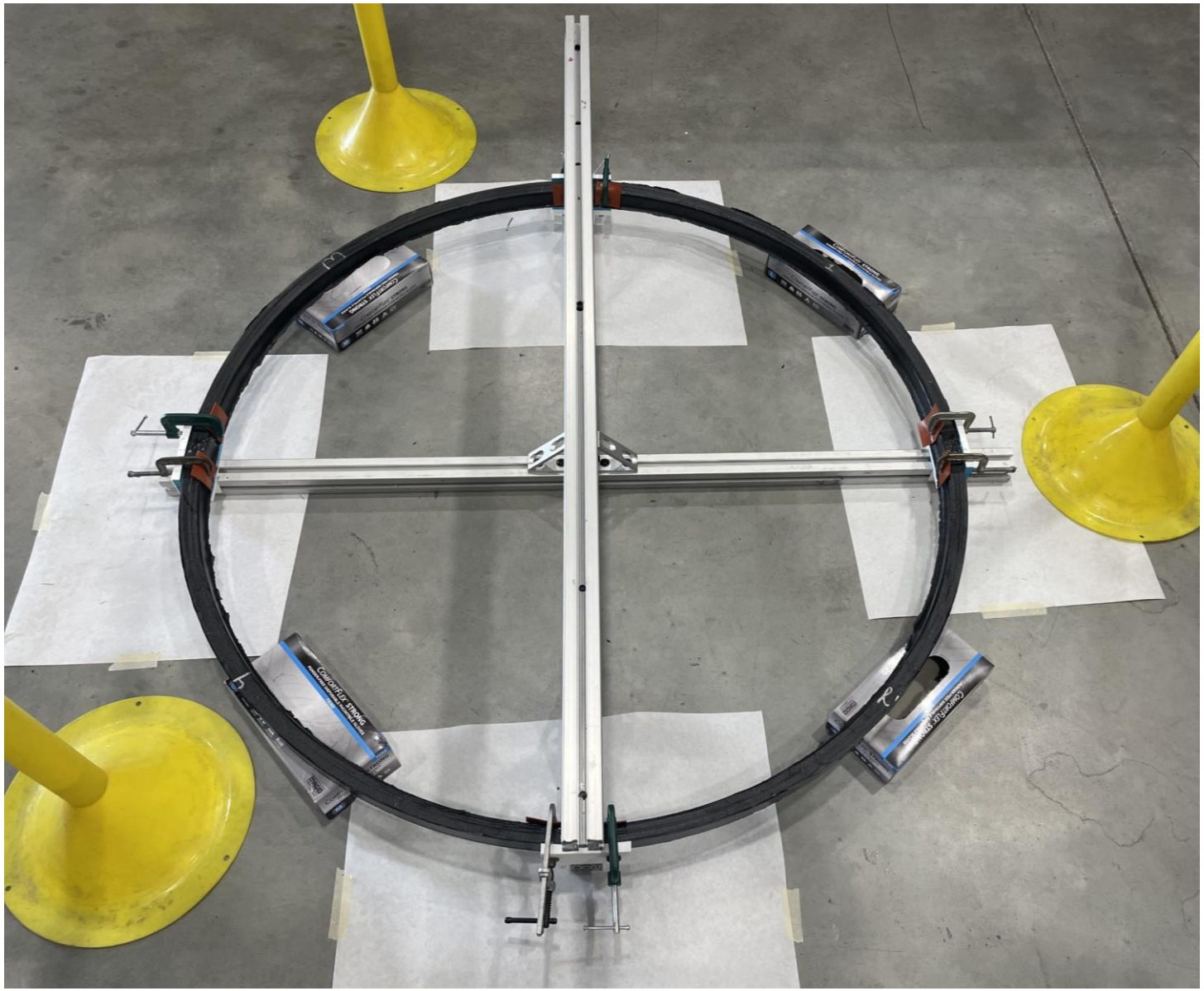
End Ring Bonding Process



New 3D printed bracket to fit outer curvature



Bracket assembled onto same aluminum extrusion jig as previous end ring bonding

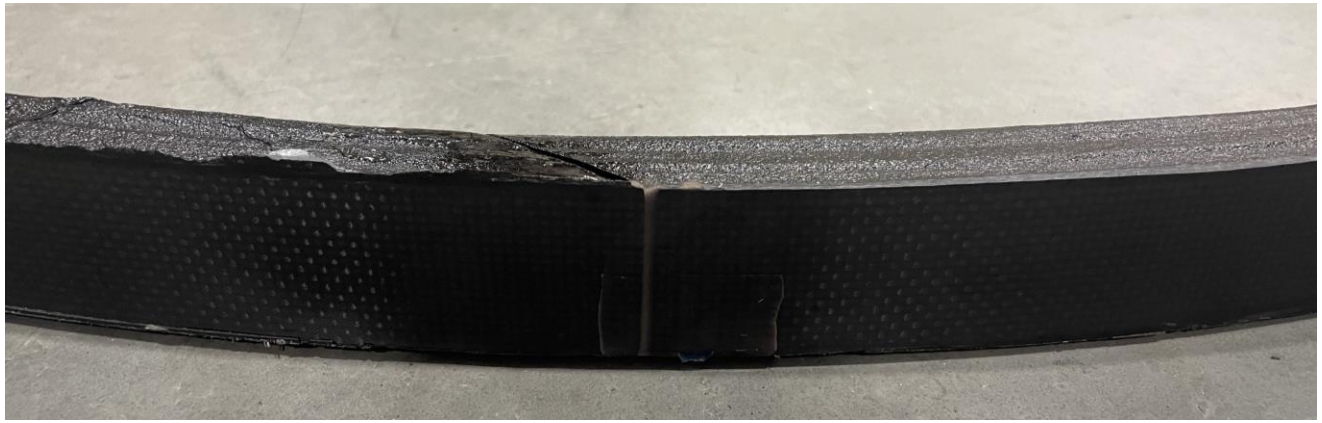


Fully-assembled bonding jig

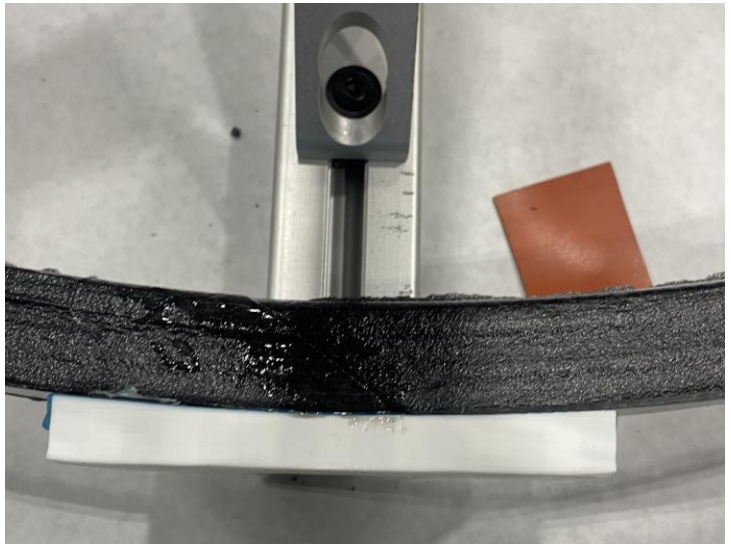
Clamps + silicon pads hold end ring to bracket

Bonded scarf joints with Araldite 2011 mixed with microballoons (to ensure 0.05 mm bond line)

Post-bonding Inspection



Bond lines appear larger than 0.05 mm, could be due to bonding jig innacuracies

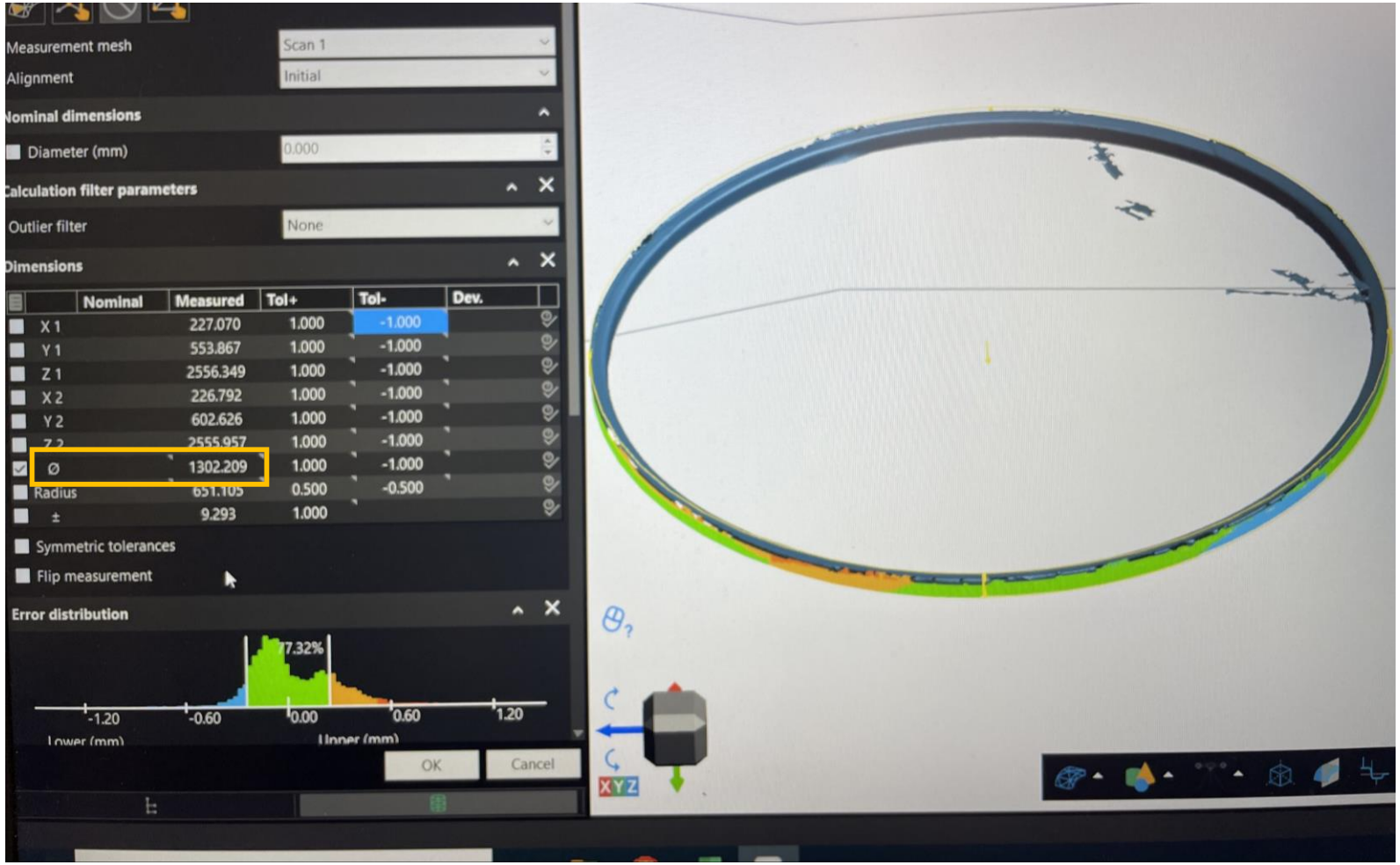


Bonded joints show some adhesive sag on top face (area to machine still has full adhesive coverage)

Metrology

Assembled end ring (~0.05 mm bond line)

Laser scanning setup (using Creaform MetraSCAN)

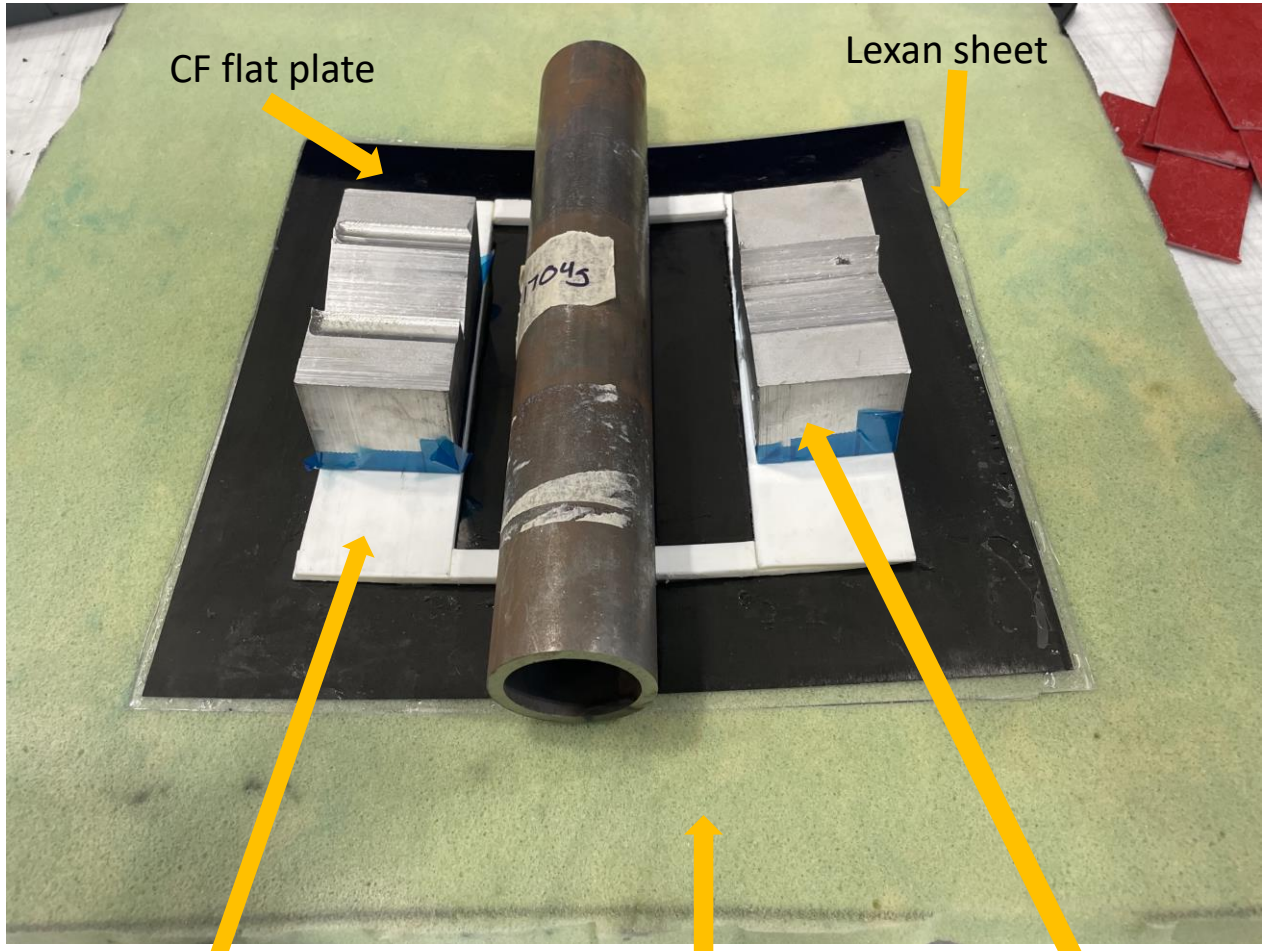


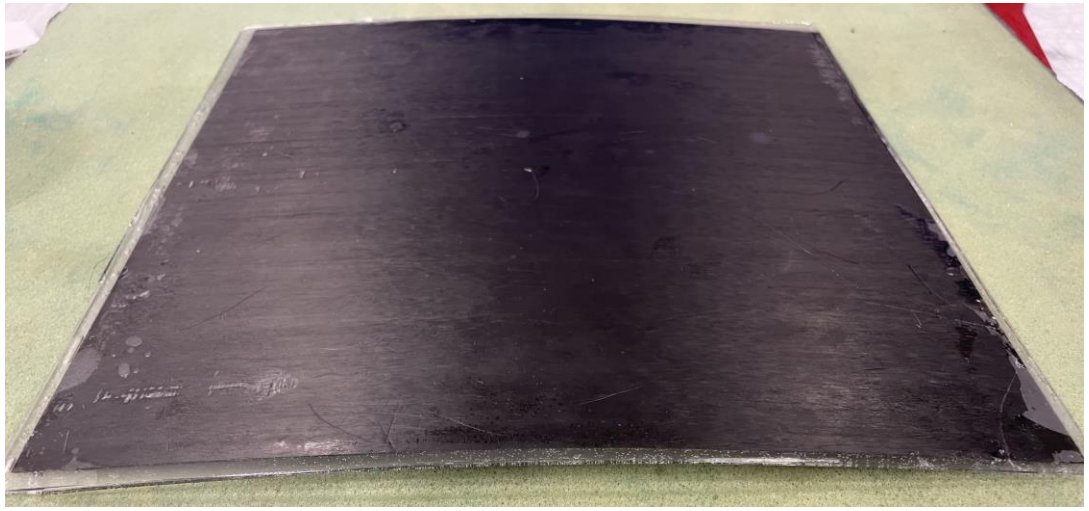
Best-fit cylinder has diameter of 1302.209 mm (0.791 mm difference compared to nominal)

Outer surface deviations fall within +/- 0.5 mm (surface is machined anyway)

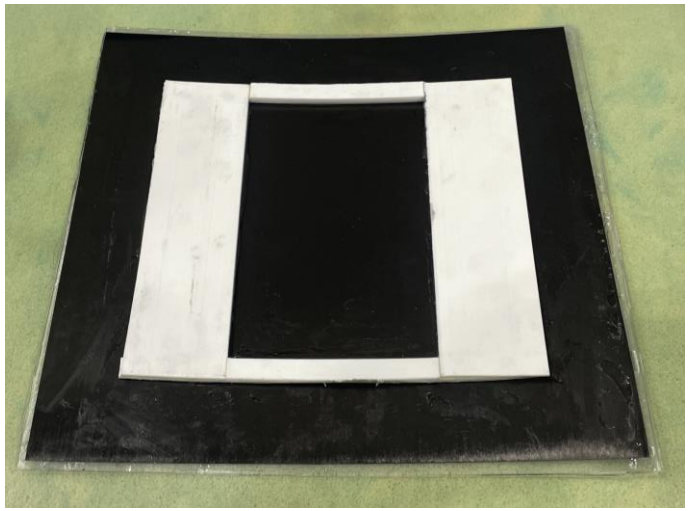
pfRICH Mirror Substrate Bonding

Bonded 3D printed curvature fixture to Lexan-CFRP mirror substrate test with Araldite 2011





Post-bonding curvature



Lexan surface

Mirror Substrate Bonding Metrology

Outlier filter: None

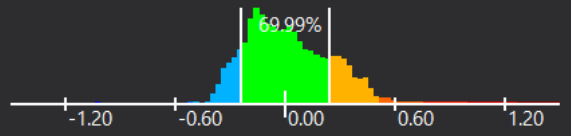
Dimensions

	Nominal	Measure	Tol+	Tol-	Dev.
X 1		99.187	1.000	-1.000	
Y 1		227.040	1.000	-1.000	
Z 1		4211.817	1.000	-1.000	
X 2		105.712	1.000	-1.000	
Y 2		533.398	1.000	-1.000	
Z 2		4227.763	1.000	-1.000	
Ø		2736.415	1.000	-1.000	
Radius		1368.207	0.500	-0.500	
±		2.902	1.000		

Symmetric tolerances

Flip measurement

Error distribution



Lower (mm) | Upper (mm)

-1.500 | 1.500

-0.250 | 0.250

Automatic values

Symmetric

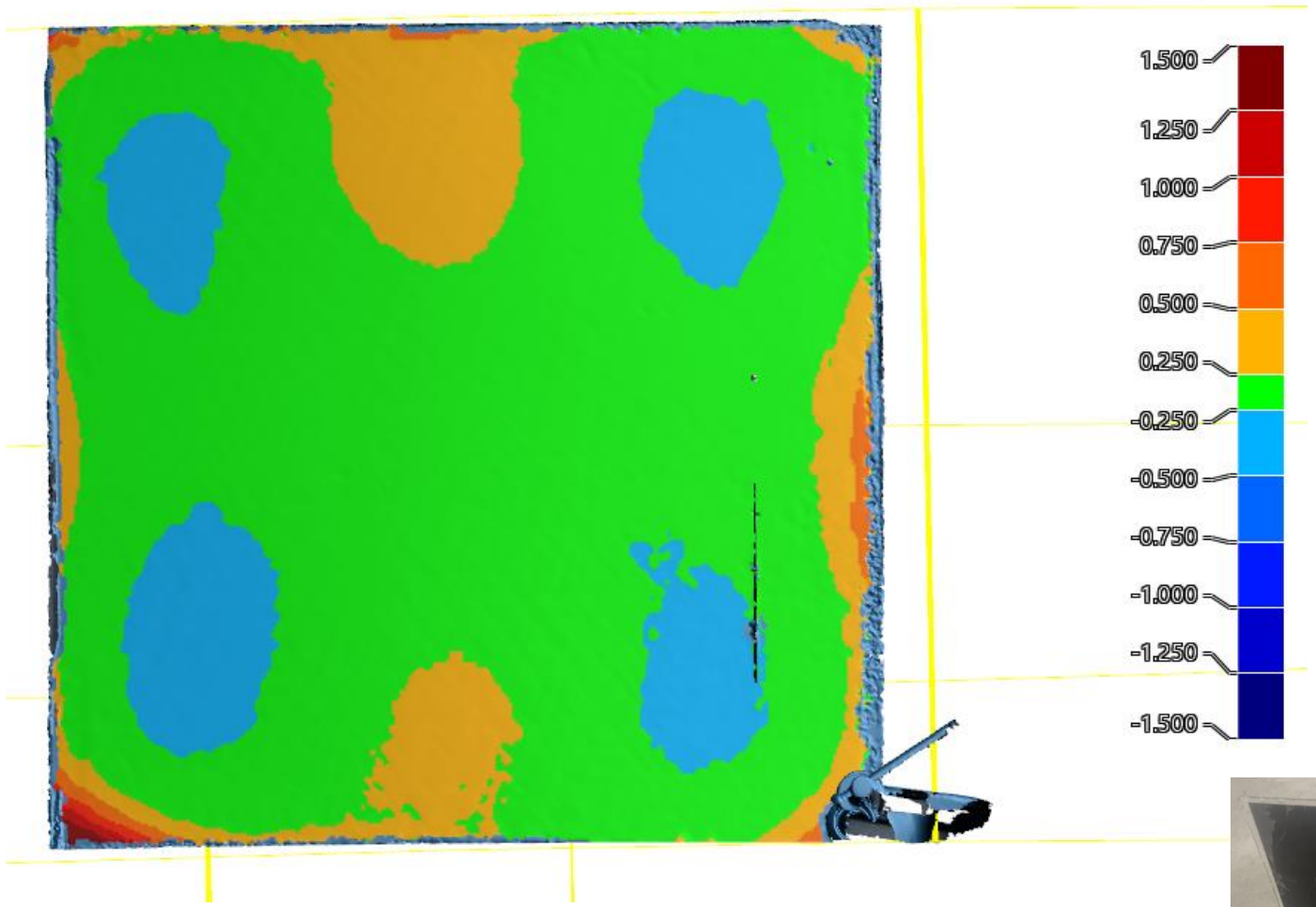
Edit color map

GD&T

Callout	Measured	Out of tol.
1.000	1.800	0.800

Radius: 1368 mm

Cylindricity: 1.8



Surface error distribution falls within +/- 0.5 mm (keep in mind protective plastic covering is still on Lexan sheet, potentially causing surface variations)

Laser scanning setup:

Mirror Substrates

Multiple curved as well as flat mirror substrates and co-bonded lexan substrates have been sent to SBU on August 7th