Disk status report

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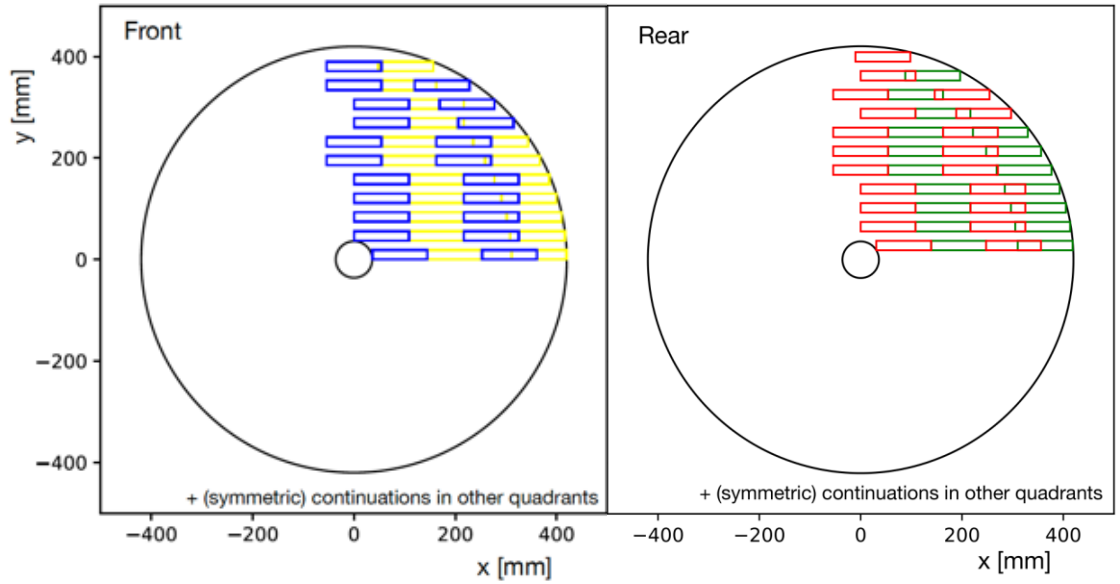
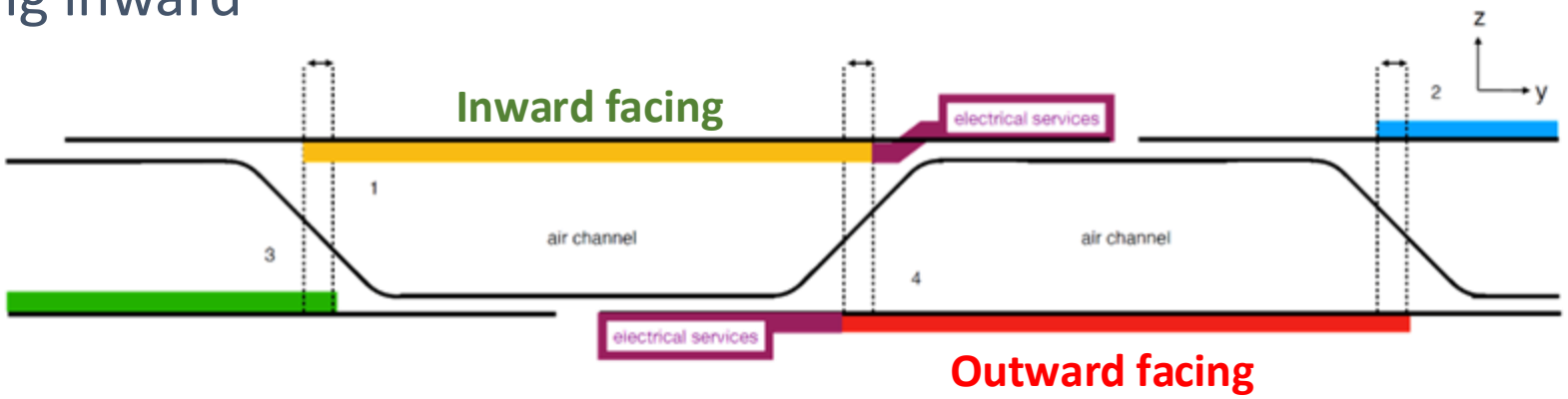
SVT workfest

July 11, 2025

Corrugated disk design

- Face sheet constructed out of modules
- Two module types:
  - **Outward facing** (sensor facing outward from corrugation)
  - **Inward facing** (sensor facing inward to corrugation)

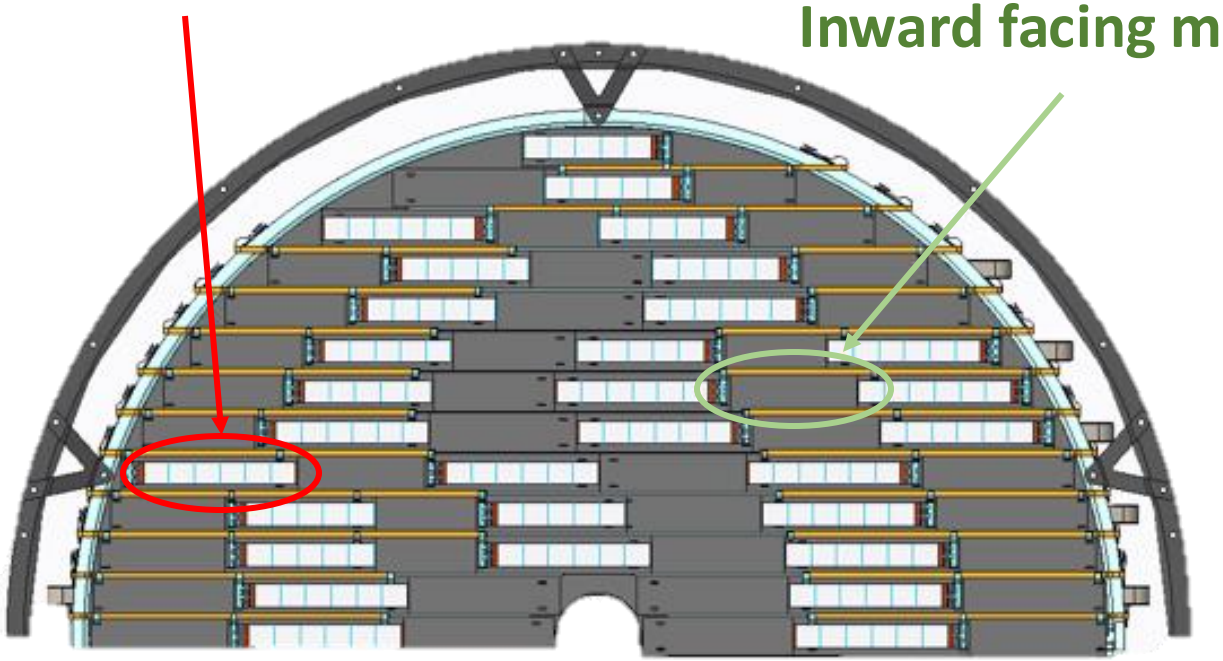




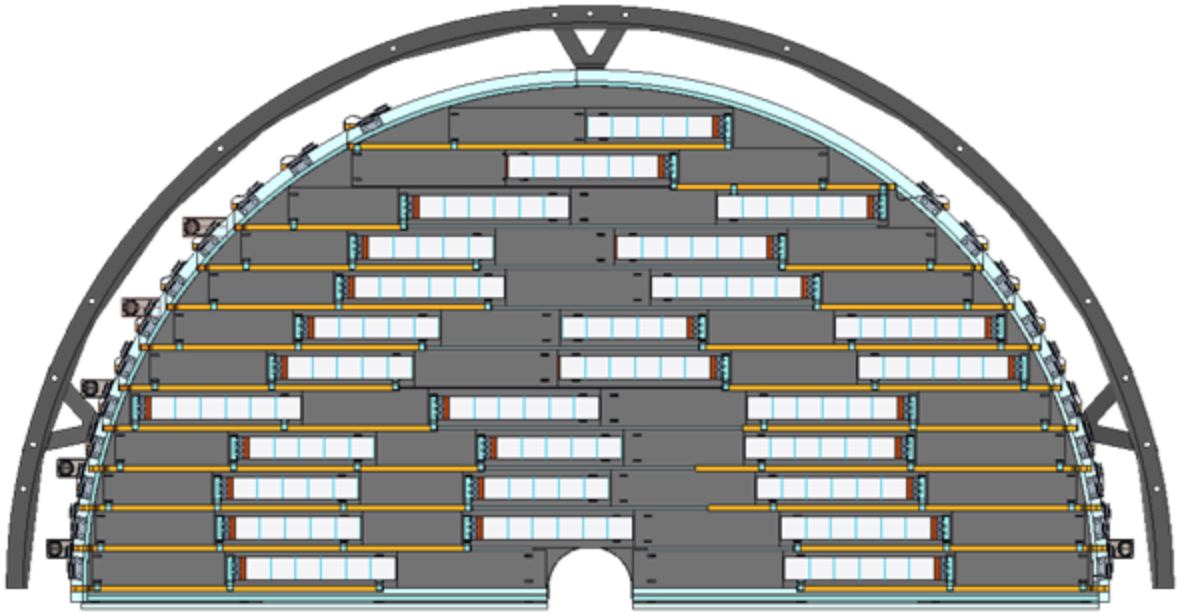
Sensor layout: first iteration

Outward facing module

Inward facing module



”Front” face of disk (facing in to IP)



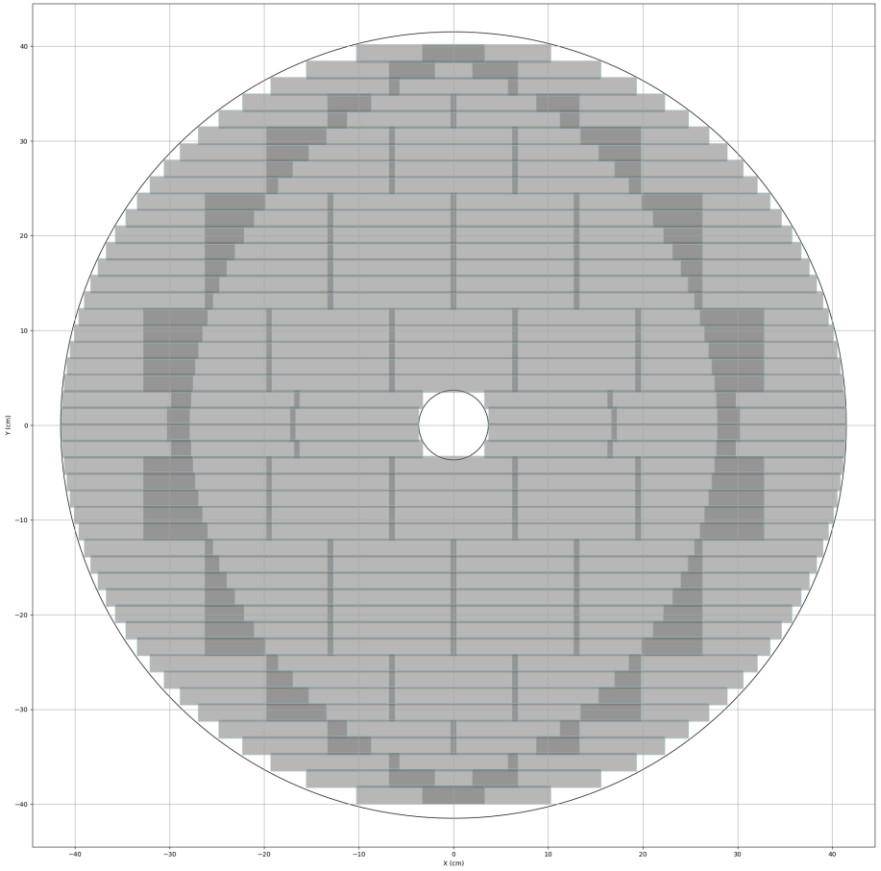
”Back” face of disk (facing away from IP)

****This is one example: Layout is being finalized**

Credit: Jim Curtis

Sensor layout: updates

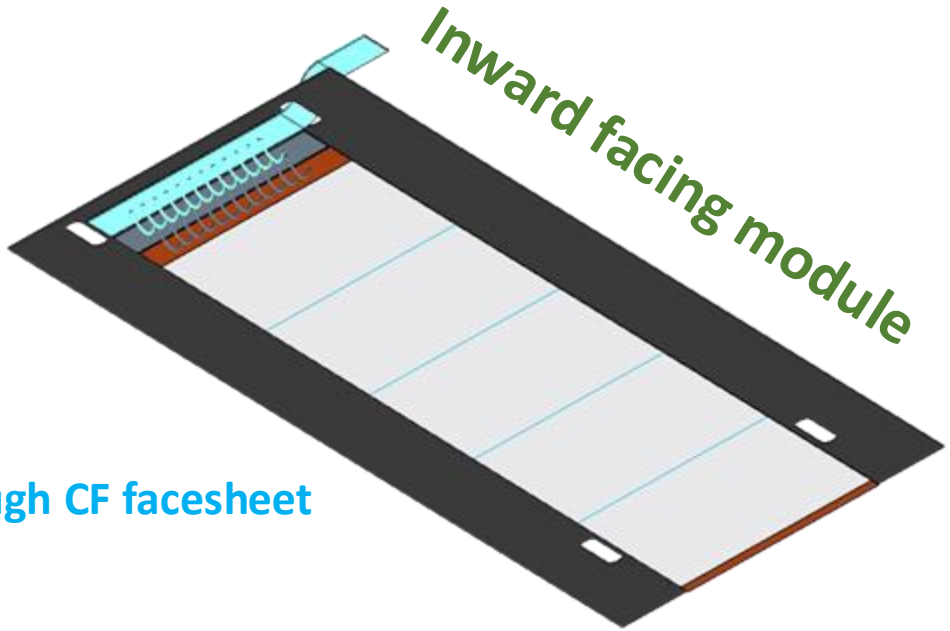
- ***Either*** 5 or 6 RSU EIC-LAS per disk (not both)
- **Consistent** overlap of EIC-LAS in **center** of the disk (starting at R_{in} to outer portion)
- **Larger** overlap of EIC-LAS at **outer** radii (covering remaining radii to R_{out})
- Keeps larger material budget to outer radii & provides simplification to the main FPC)
- **In progress:** determining final pitch(es), height, & angle of the corrugation



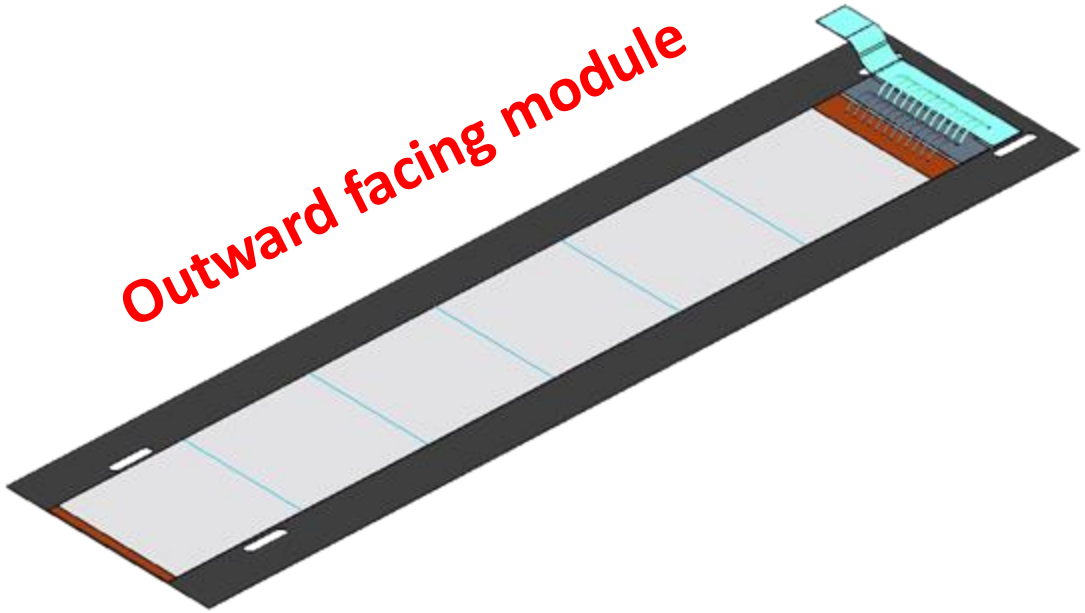
Modules

2300+ modules needed for disk assembly

- One sensor glued to a carbon fiber sheet & bonded to an Ancillary ASIC (AncASIC) and Flexible Printed Circuit (FPC)
- **To do:** Incorporate AncASIC size & placement



FPC through CF facesheet

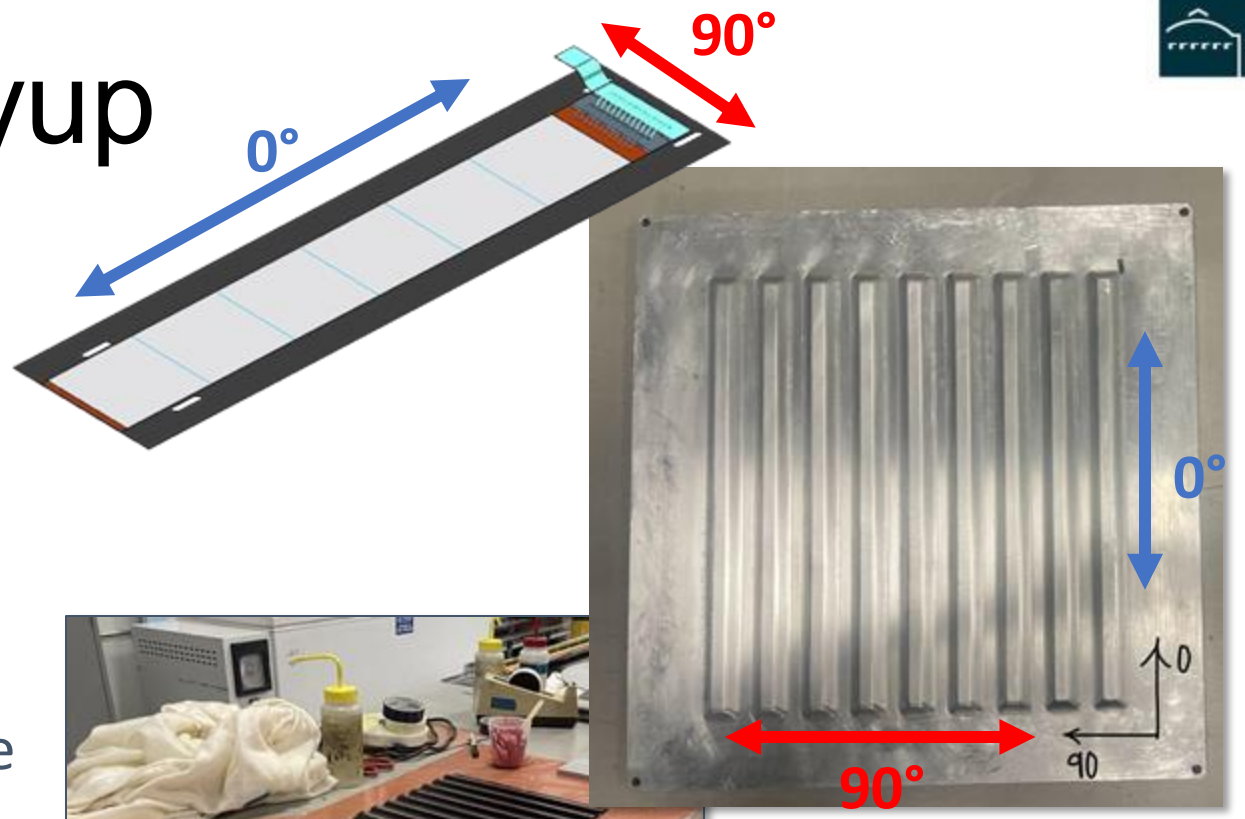


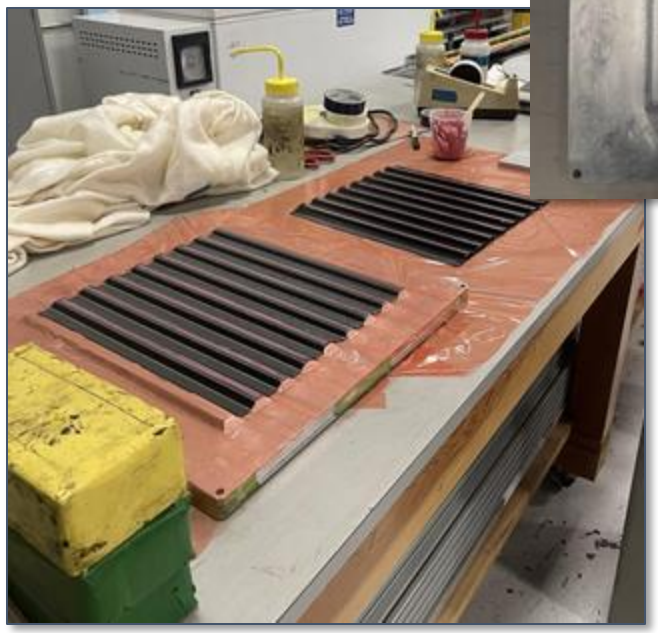
Credit: Jim Curtis

*design prior to information about AncASIC size & placement

Carbon composite & layup

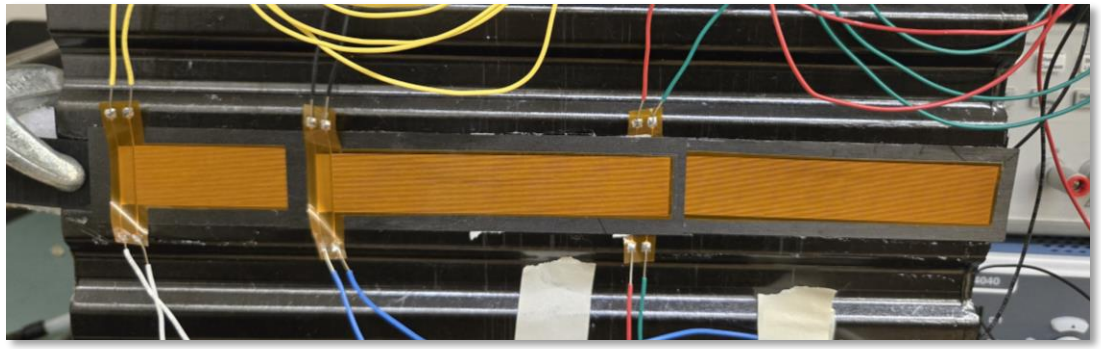
- **K13C2U** Carbon Fiber pre-preg
- **0°: along the corrugation**
- **90°: against the corrugation**
- Two different configurations
  - **Flat sheet: 0/90/0** → thermal advantage
  - **Corrugation: 90/0/90** → mechanical advantage for corrugation





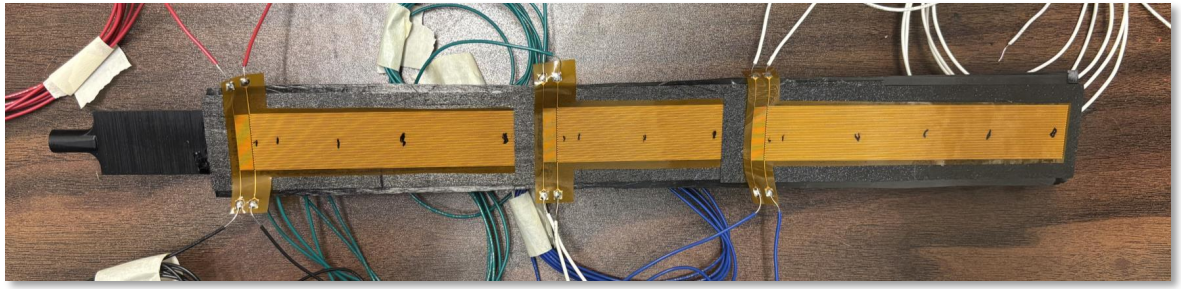
Credit: Skye Heiles

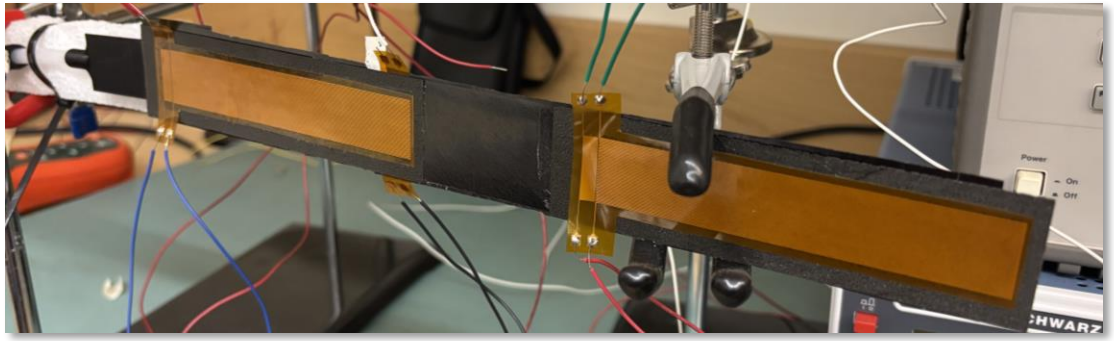
Completed thermal test pieces



Large corrugated piece with one channel used
All heaters outward facing
3rd LEC hidden

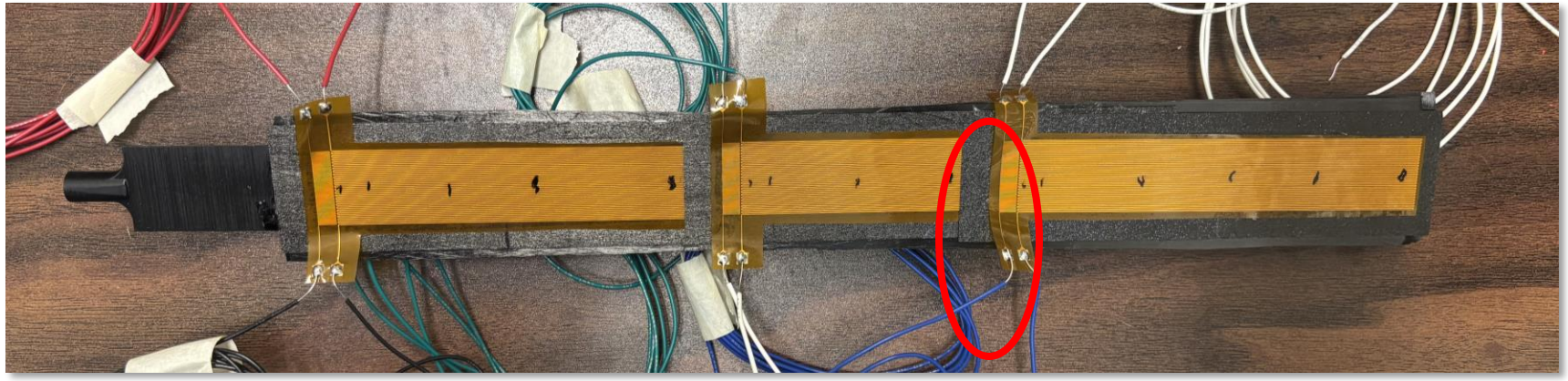
Single corrugation channel #1 & #2
All heaters facing outward
All LEC visible





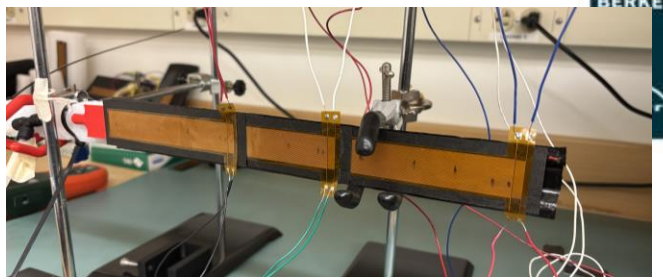
Single corrugation channel #3
One heater inward facing
2nd heater hidden

Heater adhesion



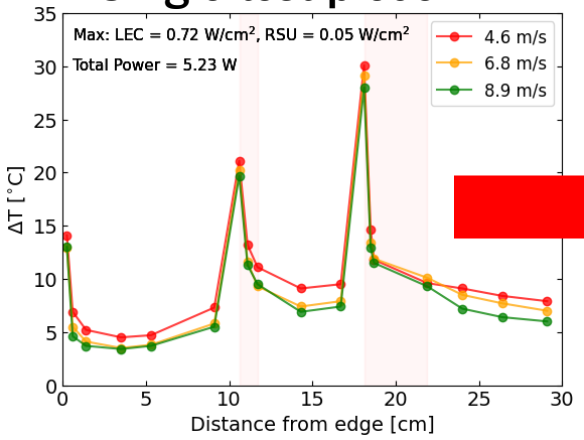
- Post inspection of some heaters shows delamination and larger than normal bonding material between layers.
- Without good adhesion, there is an air gap under the heater and the benefit of the CF conduction and the forced convection is lost.
- **Solution: Tighter control over adhesion procedure. Bonding under entire heater, not just copper traces**

Results & comparison

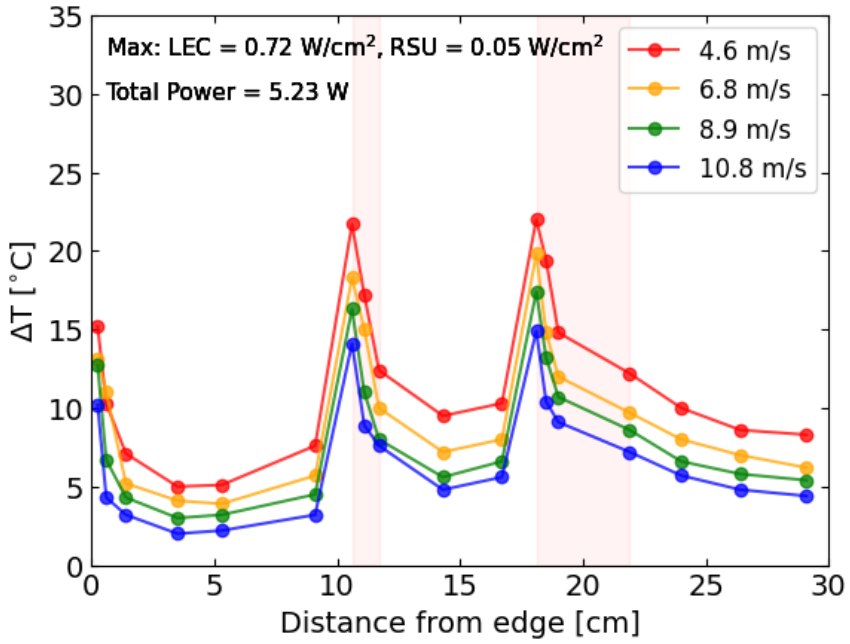


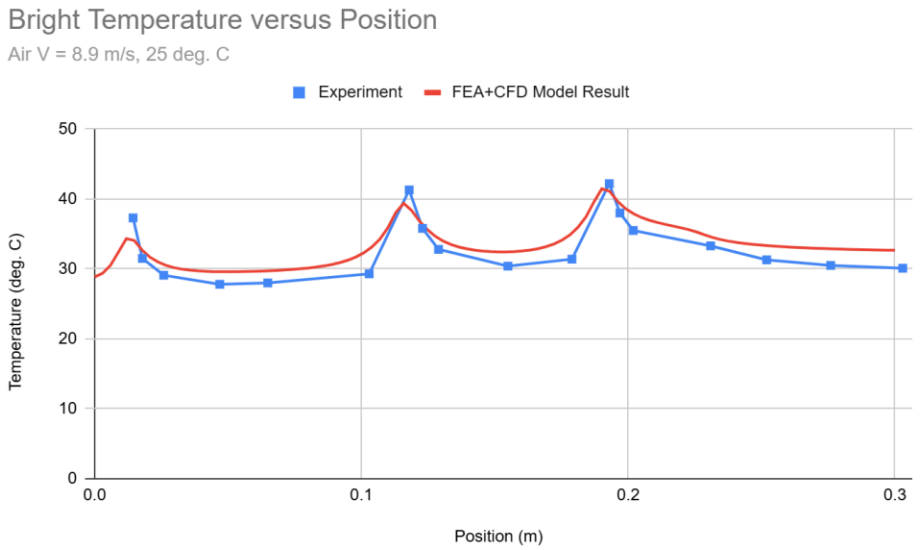
- Tighter control of bond thickness & adhesion under entire heater
- Measuring T directly (not Max function on IR camera)
- Better agreement between LEC 2 & 3 and with model

Single test piece #1



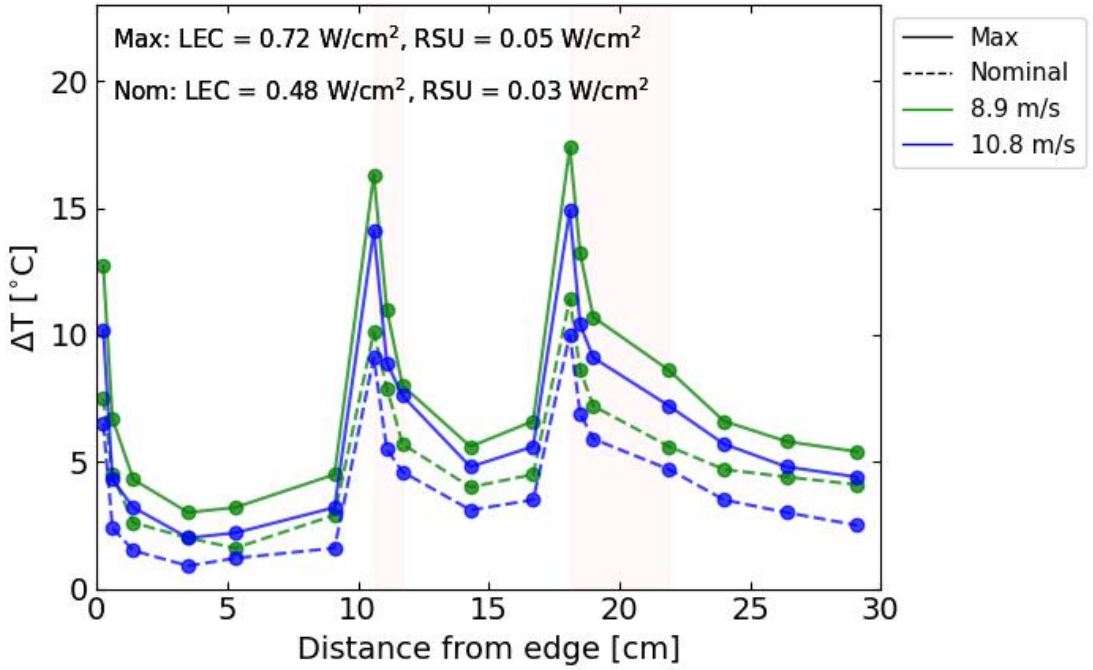
Single test piece #2

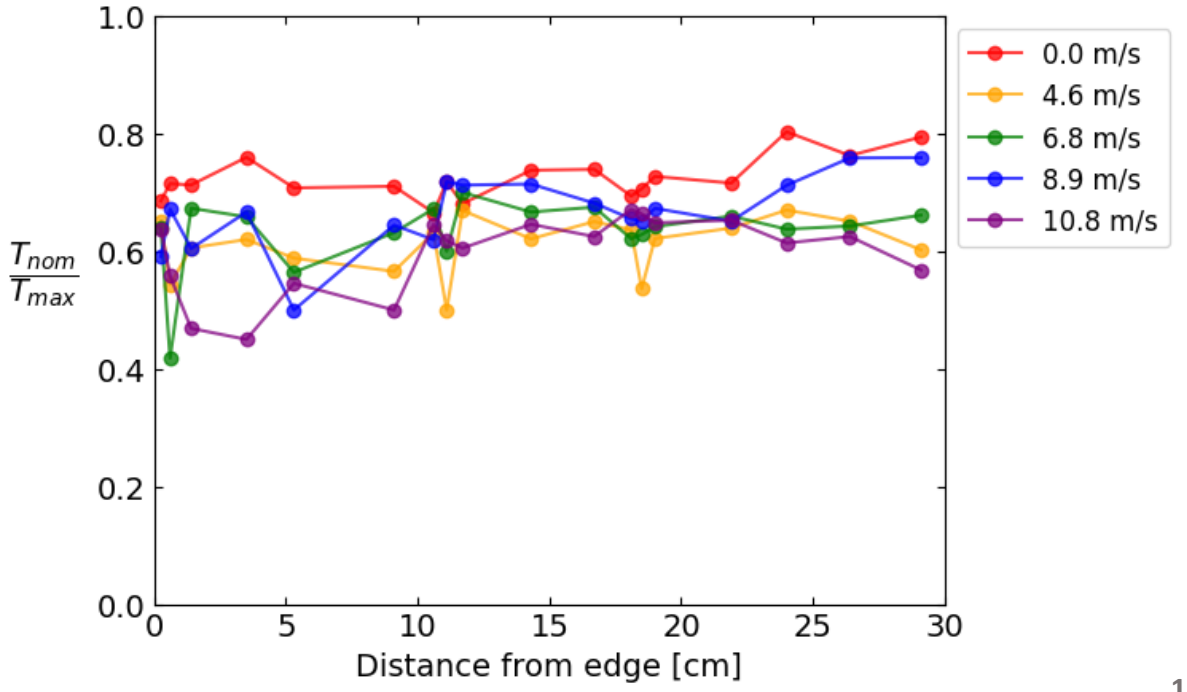




Day 1 discussion: Max & Nom power

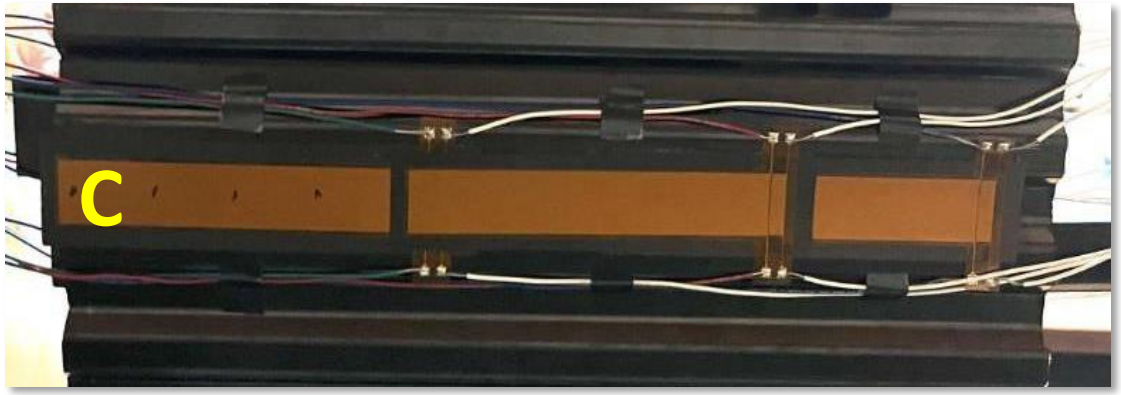
- From max to nominal power is a 40% reduction
- Nick showed a maximum RSU temp of ~35°C → would drop to ~21°C
  - Could flow higher temperature air & reduce temperature gradient across RSU

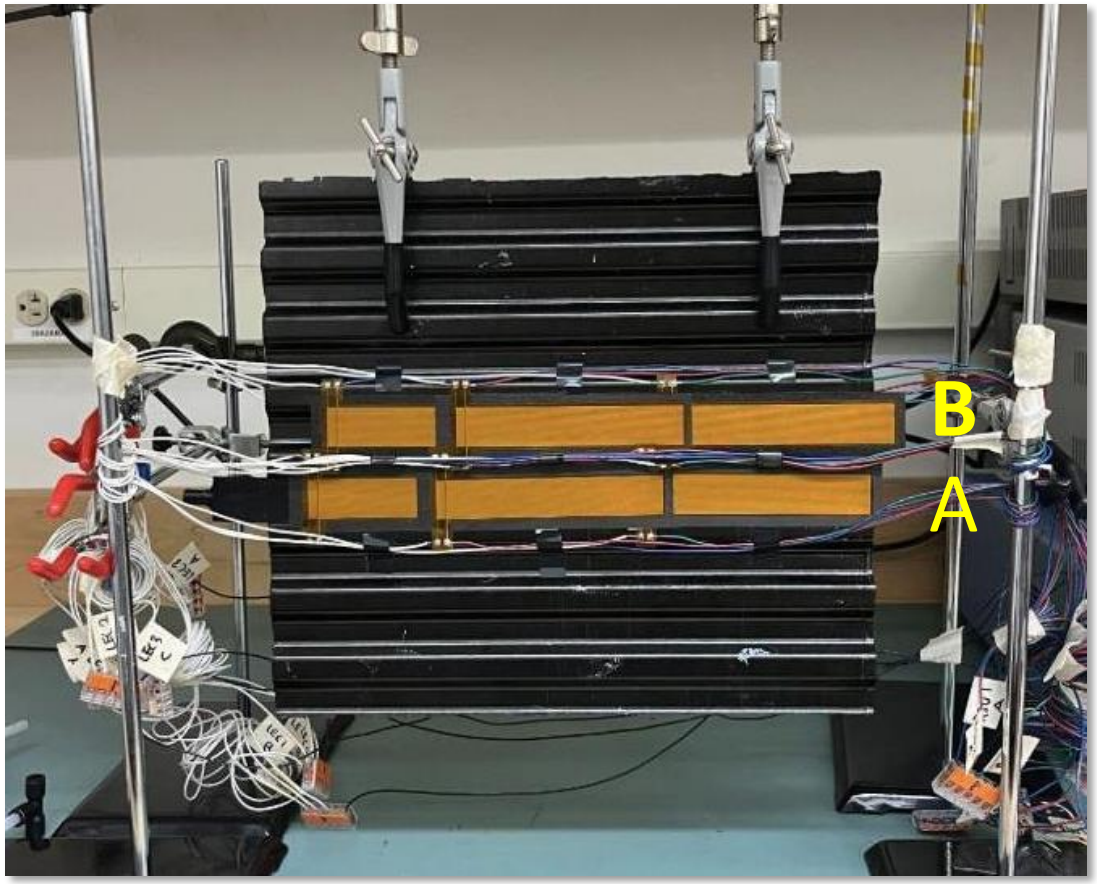




New thermal test piece

- Test proximity to neighbors
- 2 populated rows on the front
- 1 populated row on the back

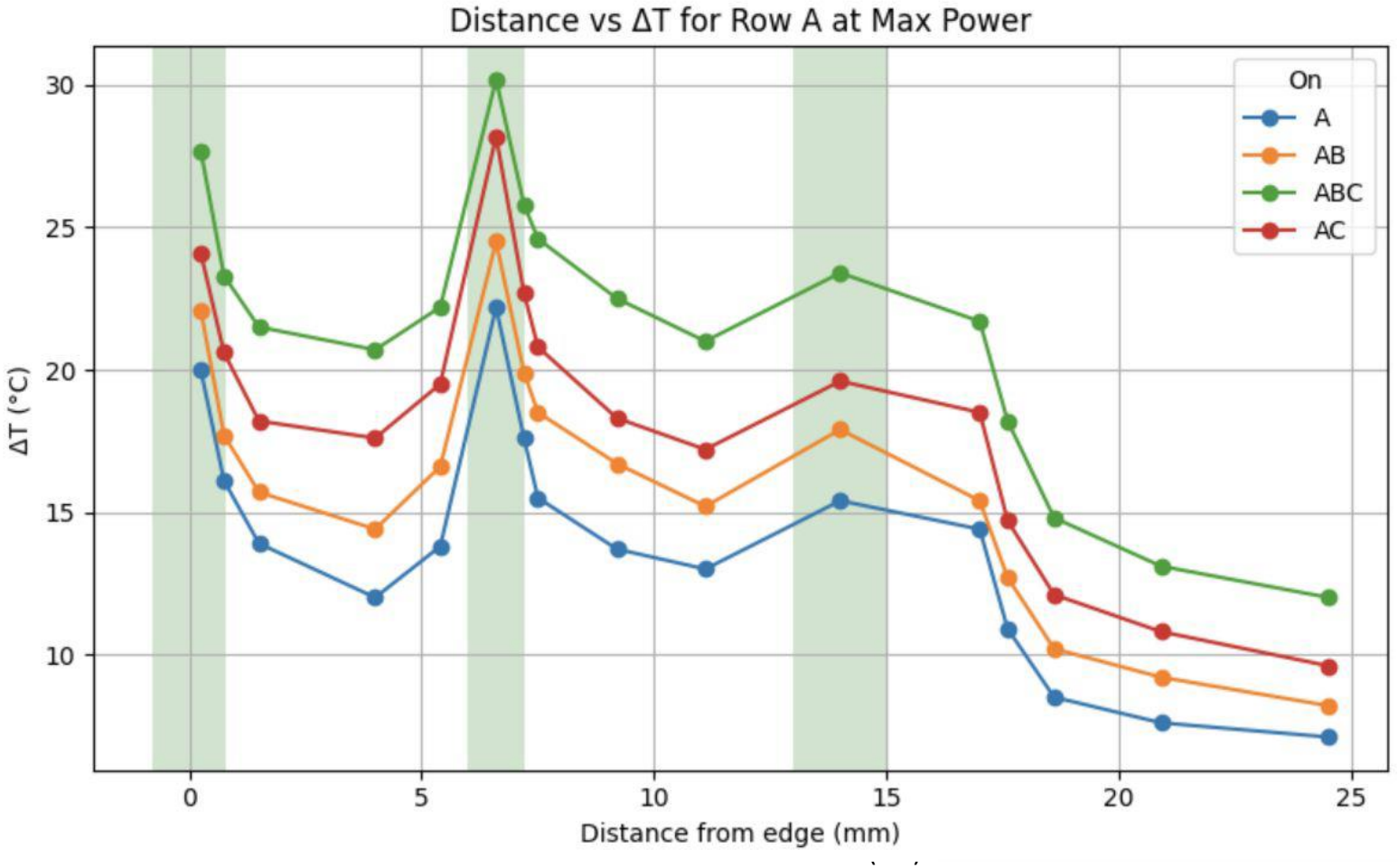




Credit: Katie Gray

Neighboring effects on row A

Under investigation

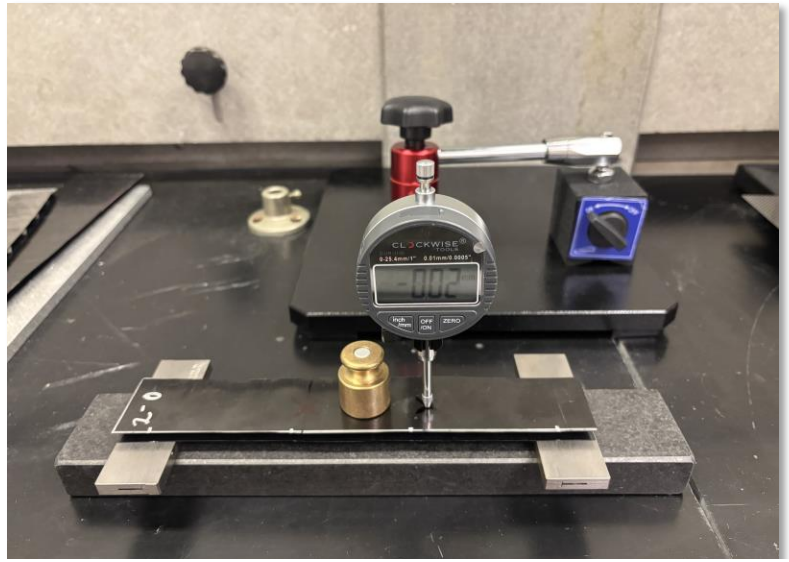


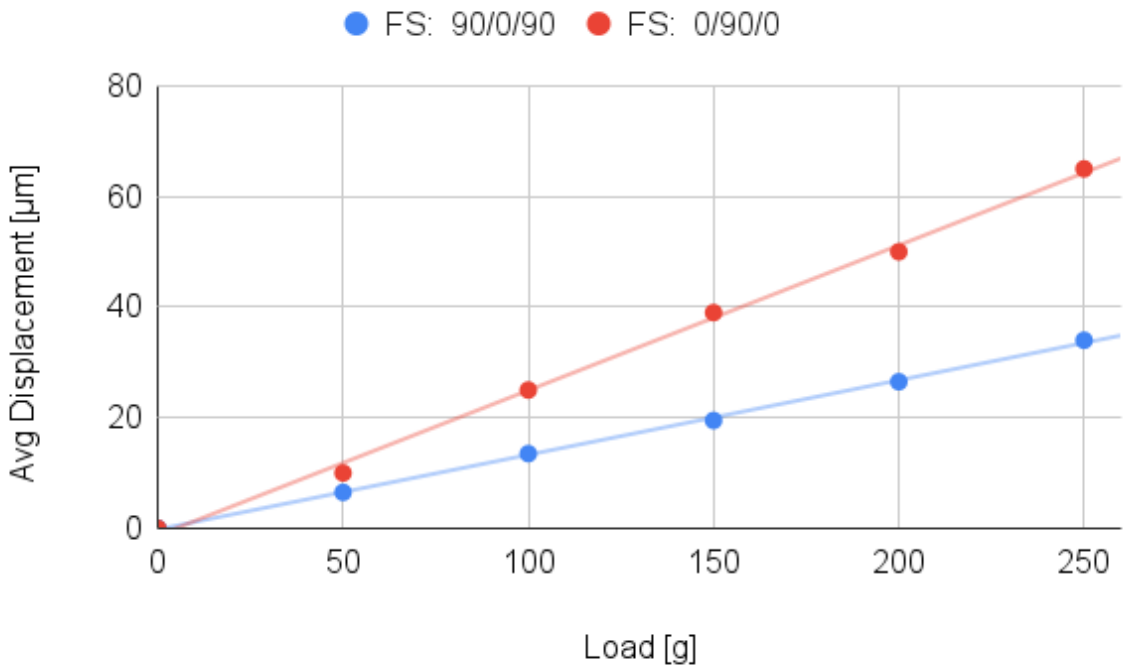
- No forced convection ($v_{air} = 0$)
- 3rd LEC hidden behind 2nd heater
- 4 configurations
  - **Just A powered**
  - **A & B powered**
  - **A & C powered**
  - **A, B, & C powered**
- Row behind (C) has the largest effect

Credit: Katie Gray

3-point bend tests

- 3-point bend tests performed, shown here along the corrugation
  - One corrugation width, approx. length of small disk radius. Load on the hump of corrugation
- 0/90/0 FS (in current design) has a larger displacement than 90/0/90
- **To do:** compare with FEA model



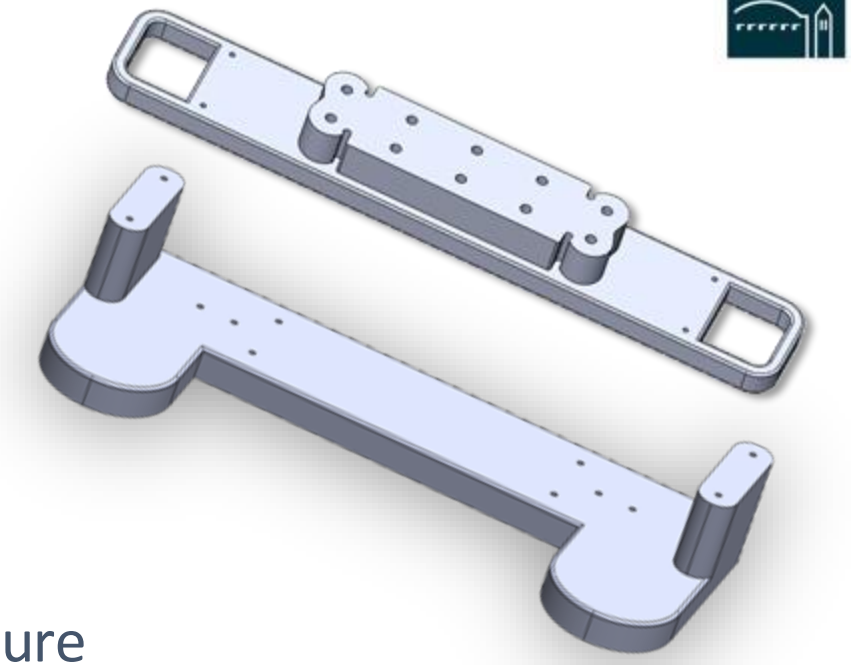


Material measurements

Piece	Exp. Density [g/cm^2]	Meas. Density [g/cm^2]	% Difference (exp. to meas.)	Meas. % X/X_0
Corrugation	0.023	0.024	+4.3	0.06
Flat sheet	0.023	0.026	+13	0.06
Panel (fs + glue + corr + glue + fs)	0.072	0.078	+8	0.18

- Flat sheet not bleeding as much/enough resin? **To be checked**
- If we consider silicon at 0.09% X/X_0 (with overlaps), FPC at 0.03% X/X_0 (averaged over pitch) → total X/X_0 is **≥0.3% X/X_0**
  - Need to save ≥0.05%: Likely place is cut outs in the flat sheets → need to be tested for mechanical strength and effect on the thermal performance

Module tooling



- First iteration complete & 3D printed
- Vacuum grabber may need some changes
  - Enclosed cavity which is hard/expensive to manufacture
- Quote in hand for other two pieces
  - Carbon fiber holder & alignment
  - Silicon pre-alignment base
- **To do:** manufacture alignment pieces, verify/change vacuum grabber

Next steps/plans (not exhaustive)

- Nearest neighbor model
  - Can we develop something that can represent the disk?
  - Test with forced convection
- Complete & test first set of tooling for module assembly
  - Dummy sensors for mechanical prototypes
    - Study gluing procedure, glue choice (Araldite & 3M double sided tape to start), QC for proper adhesion, handling, alignment with tooling only or use CMM, etc.
  - Thermomechanical dummies for thermal studies
    - Study thermal properties with silicon now included, cut outs in the FS
- Material reduction and thermal isolation with cut-outs in the FS
  - Slot near the LEC/RSU border → how does that affect the LEC cooling? Could help the temperature gradient of the RSUs
- CAD: Update sensor layout, AncASIC size & placement, RDO to FIB
- Incorporate air manifold into disk rim