

Disks: Modules

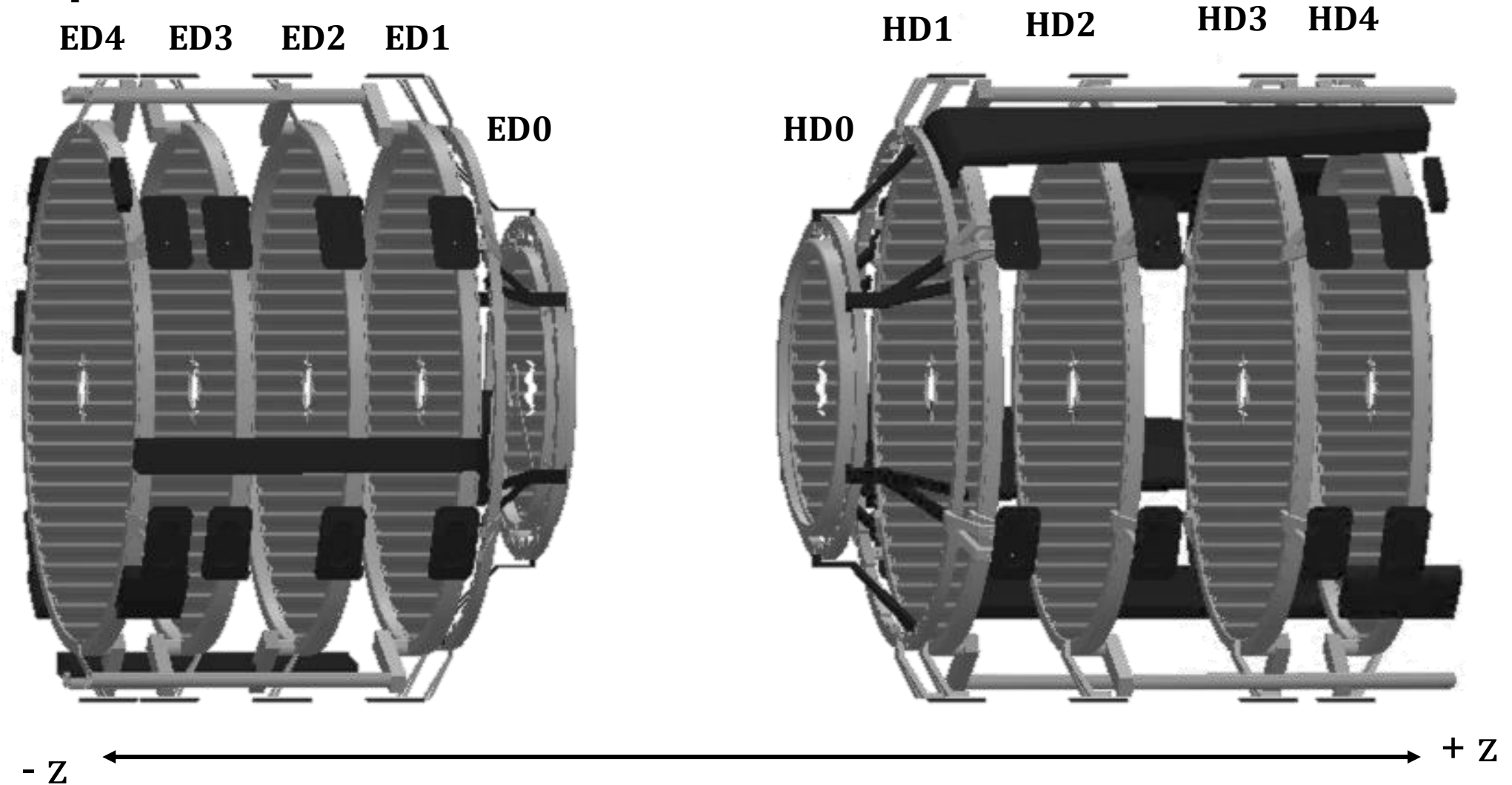
Nikki Apadula for the LBNL group

Previous relevant talks:

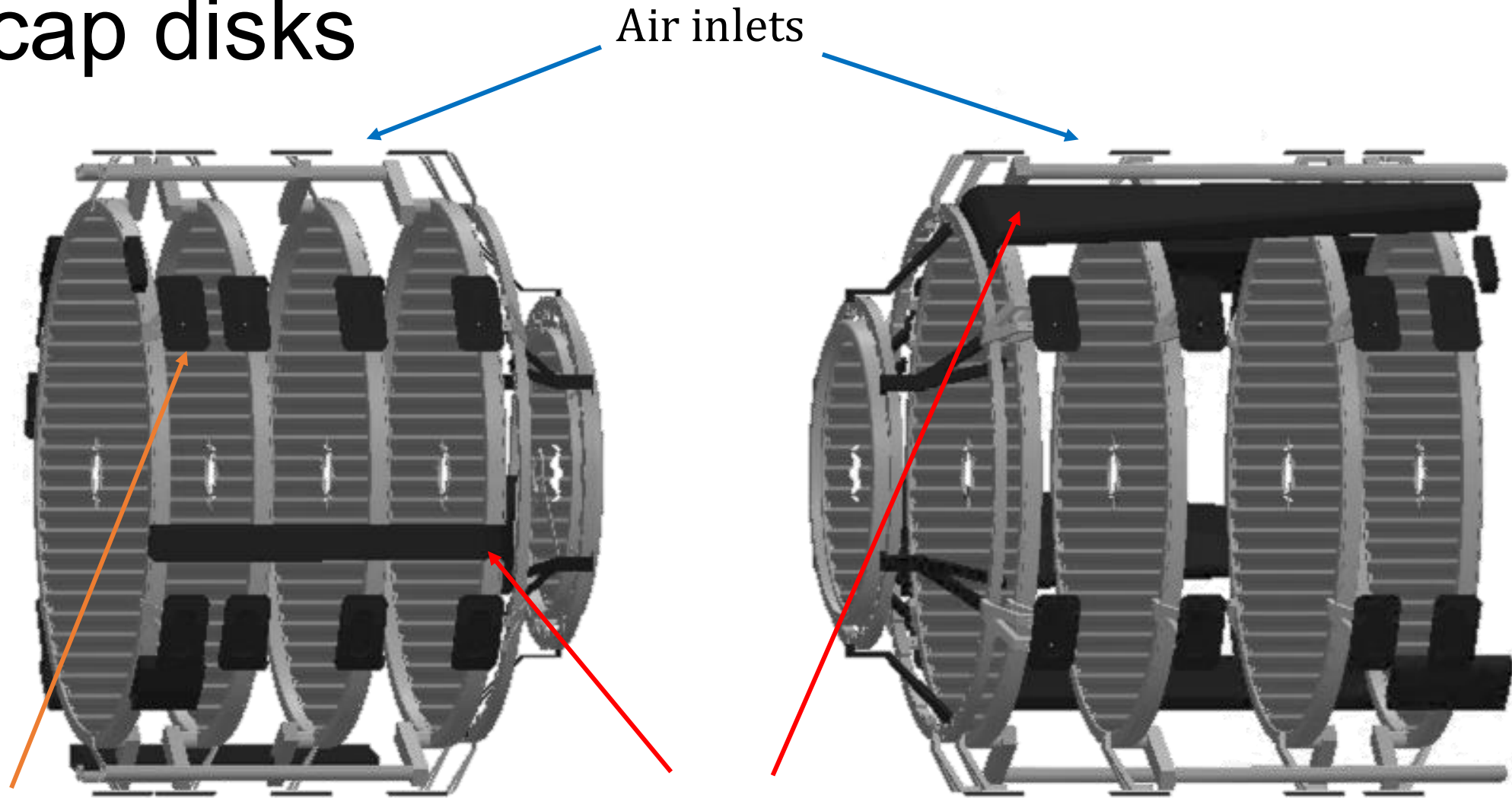
[Oxford Dec Workfest](#)

[SVT DSC Meeting - May '26](#)

Endcap disks



Endcap disks

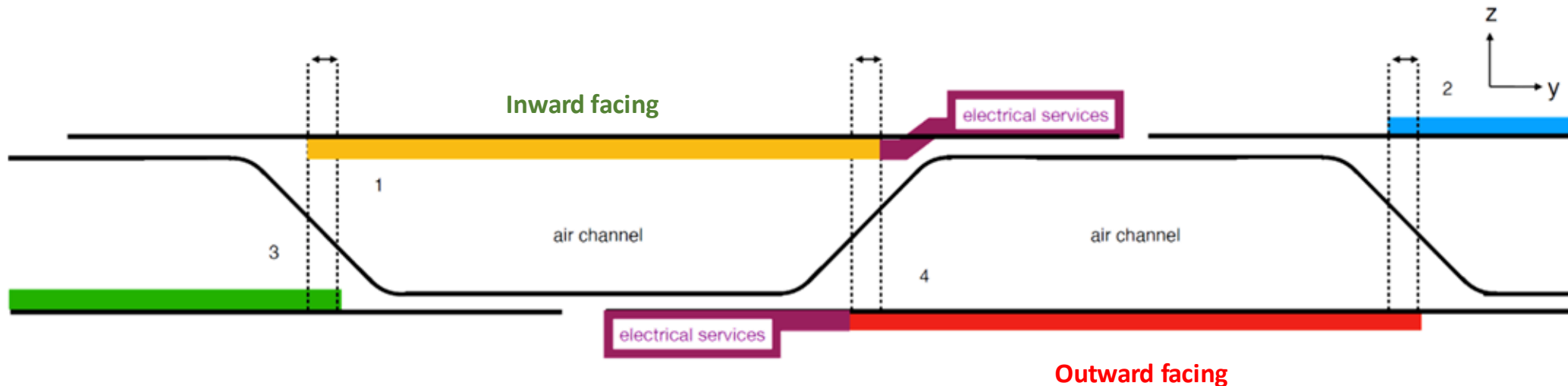
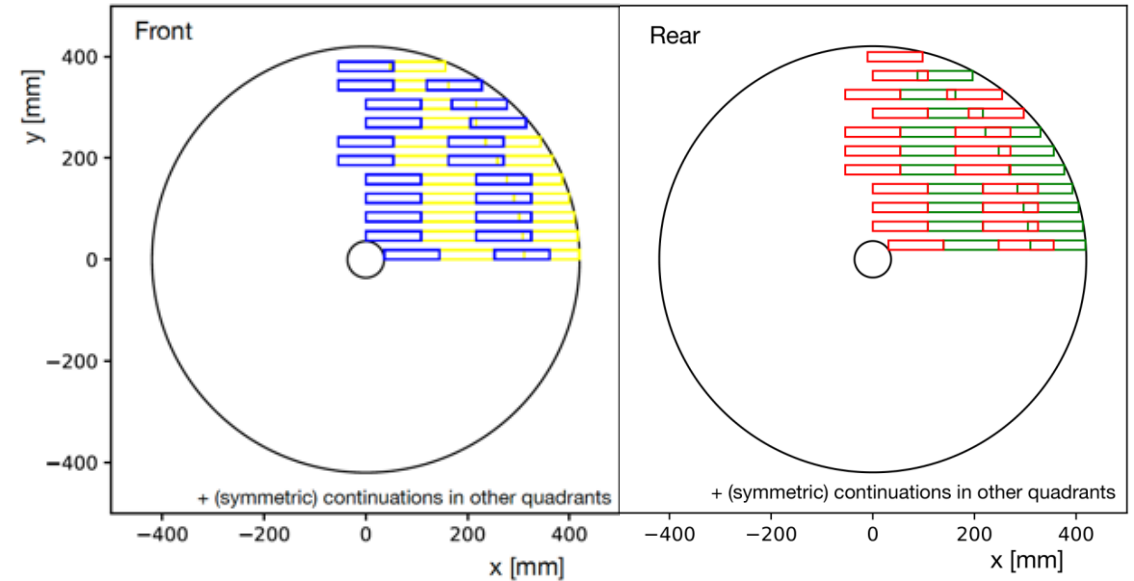


Air exhaust ducts

Connections to PST

Module layout

Just a reminder: modules will be placed on front and back of disk and alternate between inward and outward facing



Disk Modules



FPC design not final – just a representation

Module design

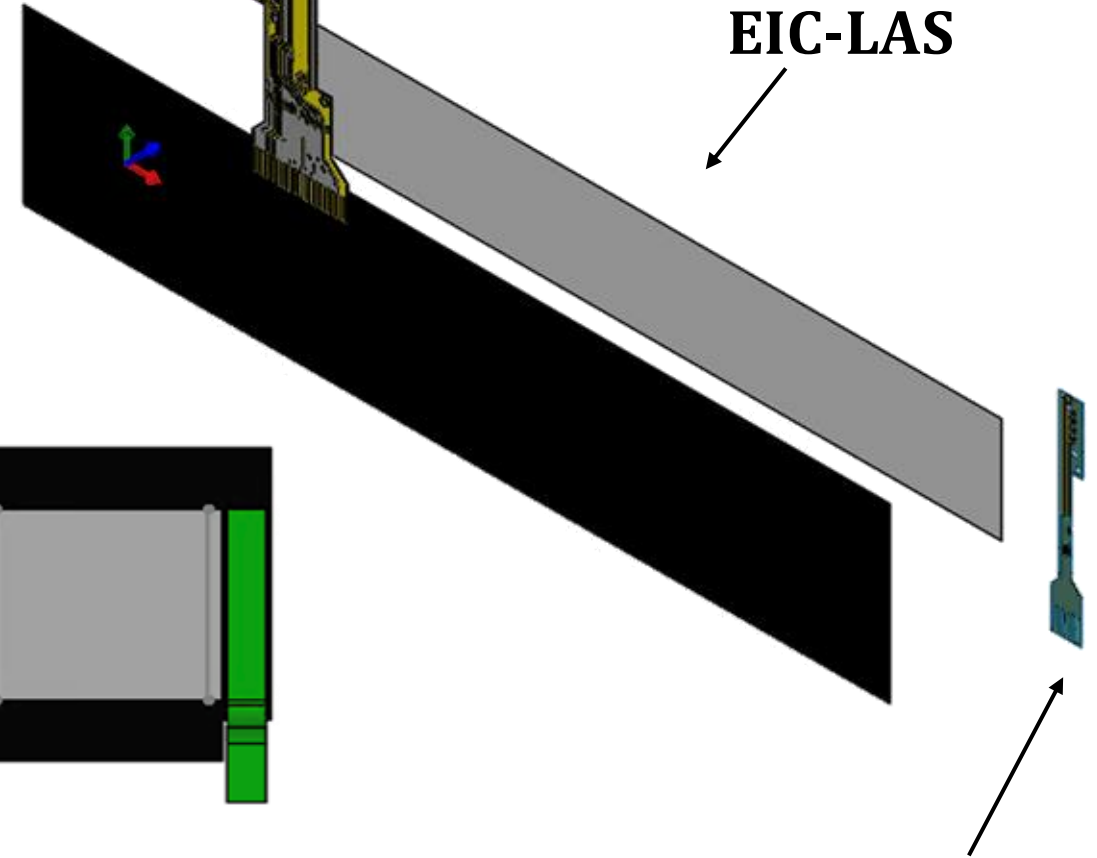
Carbon fiber flat sheet (CF FS)

- Cut outs to allow for inward facing bridge FPCs to come out

LEC Bridge FPC

EIC-LAS

AncASIC

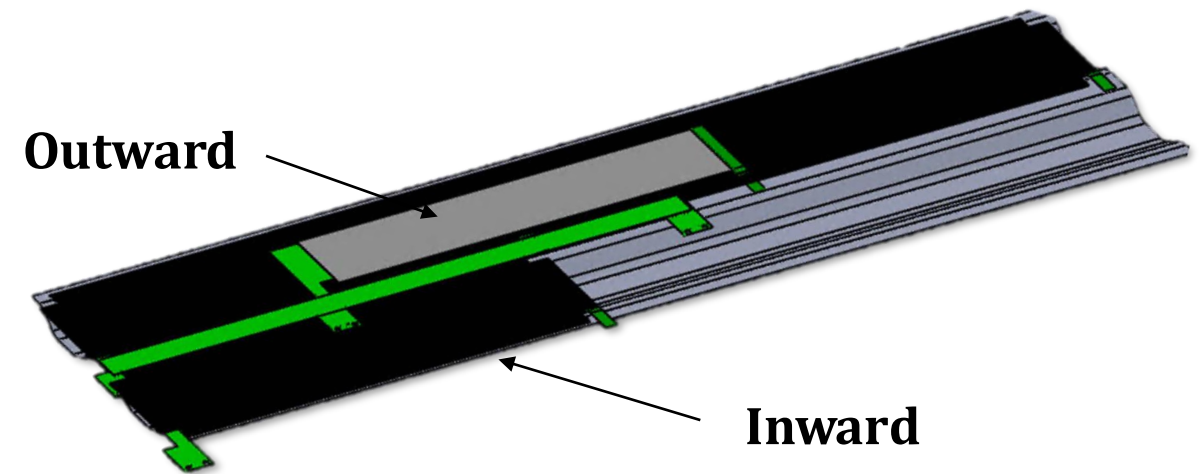
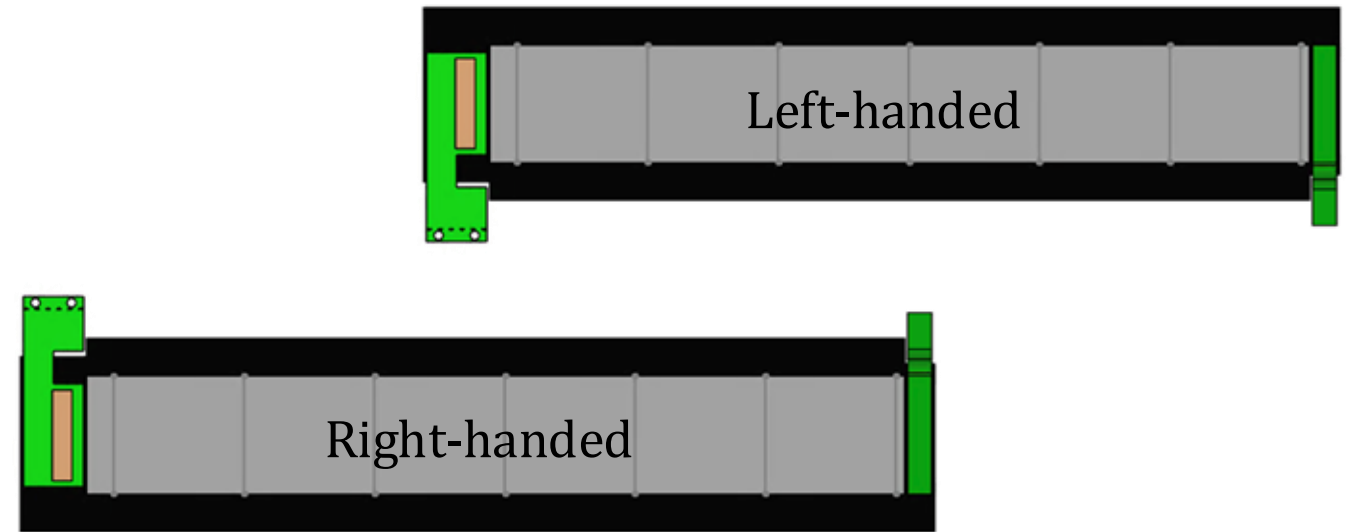


FPCs are a general representation – updated version in development & coming soon
Holes are for alignment and will be cut off

REC Bridge FPC

Module types

- Variations
 - 5 or 6 RSUs
 - **Inward** or **Outward** facing
 - **Left** or **Right** handed
 - Direction of bridge FPCs
 - **Narrow** or **wide**
 - Width of CF FS
- 4 different bridge FPCs
 - IN/Right
 - IN/Left
 - OUT/Right
 - OUT/Left



Adhesive choice options

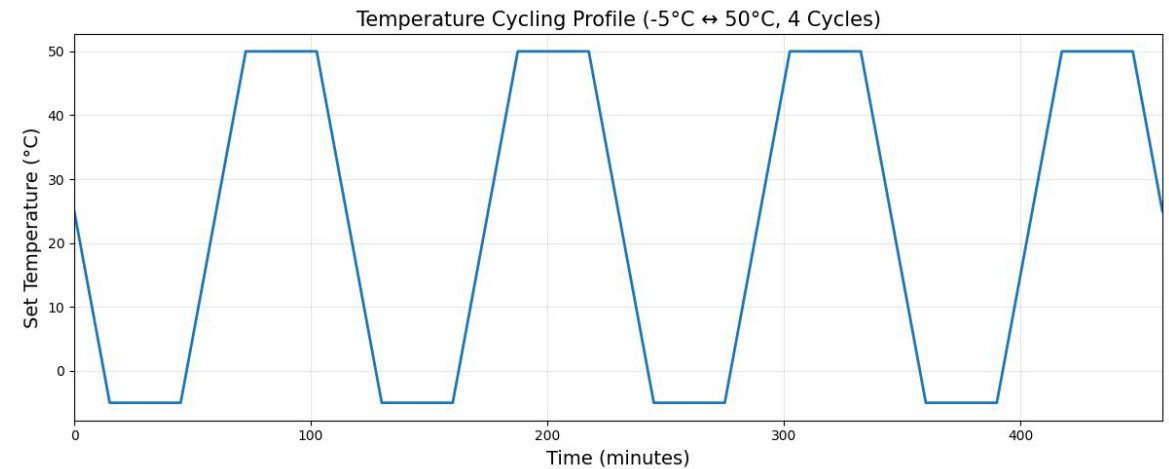
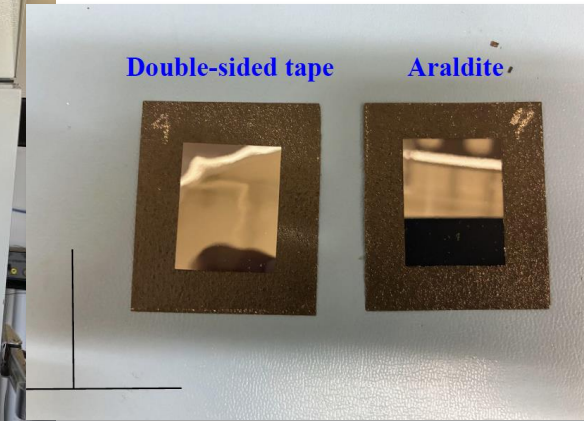
- To be used to adhere EIC-LAS & FPCs to CF FS
- Two candidates
 - 3M 467MP (used for STAR HFT PXL)
 - 60 μm thick, pressure sensitive, acrylic adhesive
 - Araldite 2011 (ALICE ITS2/3)
 - 2-part Epoxy
- Chosen for direct heritage
 - many relevant properties already validated (i.e. radiation tolerance)
- What is new → higher operating temperature



Environmental testing

- Thermal cycle
 - -5°C to 50°C (± 10 from normal operating limits)
- Extended thermal cycle
 - Cold air scenario, -30°C to 50°C
- High temperature long hold
 - 50°C for 4 days
- Over temperature
 - Up to 100°C , 1 hr at each temp
- Under temperature
 - Down to -40°C

No discernible slipping, warping, or cracking found for any sample



Comparison between Araldite & 3M 467MP

Criterion	Edge	Key point
Warpage / CTE mismatch	Tape	Full-scale test piece showed no slippage or warpage; predicted 10-20% of epoxy deflection
Thermal cycling & extreme temperature	Tie	No significant shift for either, including -40/90 °C ramps and a 4-day 50 °C soak
Radiation hardness	Epoxy	200-400 Mrad vs. 1-10 Mrad, but both exceed the 1 Mrad requirement
Material budget	Tape	0.015% X/X_0 vs. 0.019-0.024%
Assembly time & tooling	Tape	Wire-bond-ready in ~2-3 hr vs. ~13-19 hr
Process risk	Mixed	Epoxy has a long but process-intensive window; tape risks are discrete and mitigated
Reworkability	Epoxy	~20 min work time vs. none for tape
Wire-bond surface quality	Mixed	Tape bounces. Epoxy can over or underrun the edge
Electrical isolation, thermal conductivity	Tie	Comparable

Decision: Move forward with 3M 467MP as the leading choice

Assembly

Module assembly

- Time estimate assumptions
 - AncASIC glued & wire bonded to LEC bridge FPC **after** attachment to module
 - All components inspected before assembly
 - Flat sheet (FS) cut and prepared
- EIC-LAS, LEC/REC bridge FPCs glued one at a time
 - Once piece of 3M used for the entire length

Module assembly (One module)

**>2200 modules
needed for disks**

- Pre-alignment
 - CF FS, adhesive, LEC bridge FPC, REC bridge FPC, EIC-LAS
- Adhesive preparation, application, & vacuum adhesion (~2 hrs)
- Alignment of EIC-LAS, LEC bridge FPC, REC bridge FPC
- Vacuum adhesion (~20 min)
- Visual inspection
- Wire bonding: Alignment, bonding, visual inspection
- Testing
 - Quick test (powering, communication)
 - Overnight test? Longer?

Total time: ~1 day

5/day/site → 1 year to complete modules

Module tooling

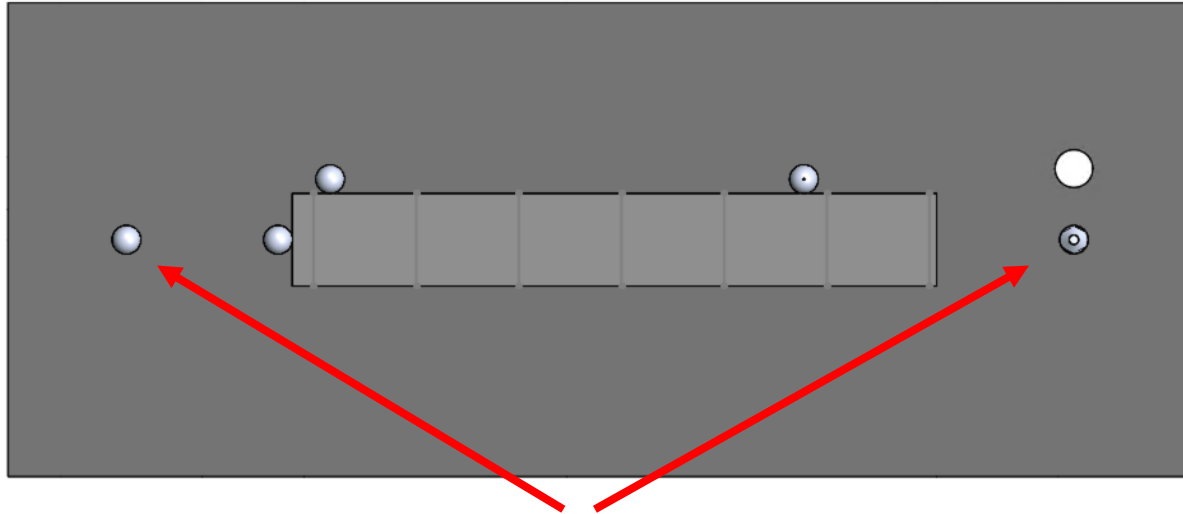
- LEC & REC bridge FPC pre-alignment jig & vacuum pick up tools
- EIC-LAS pre-alignment jig & vacuum pick up tool
- Adhesive alignment tool
- Module assembly jig (also acts as FS pre-alignment)
- Module wire-bonding/carrier/testing board (maybe separate)
- Storage base
- Cooling plate for testing?

Everything is a WIP – so please take with a grain of salt!

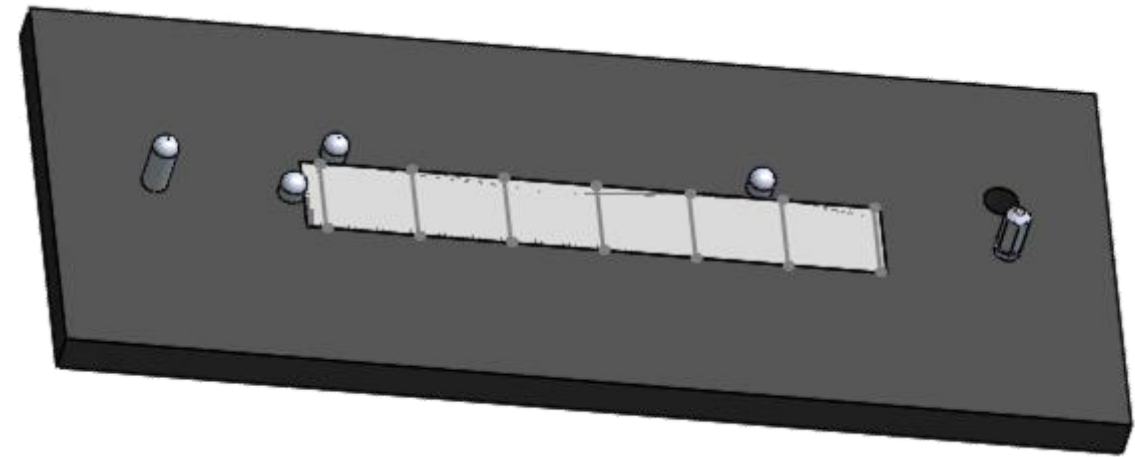
(some) Open questions:

- how many sets of tooling to make?
- how many carrier boards? → how many modules do we want to stockpile before disk assembly?
- do we need a longevity test? How long? Will affect # of carrier boards

Sensor pre-alignment

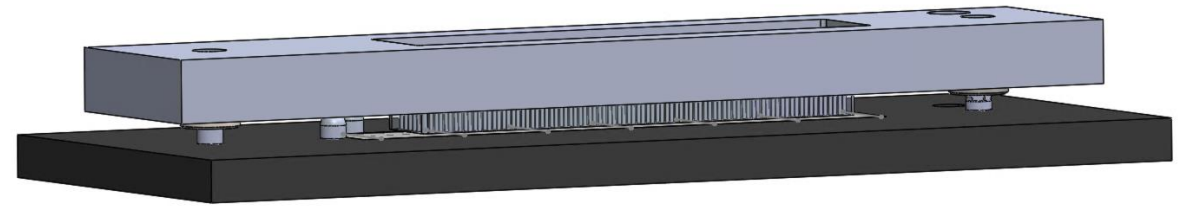
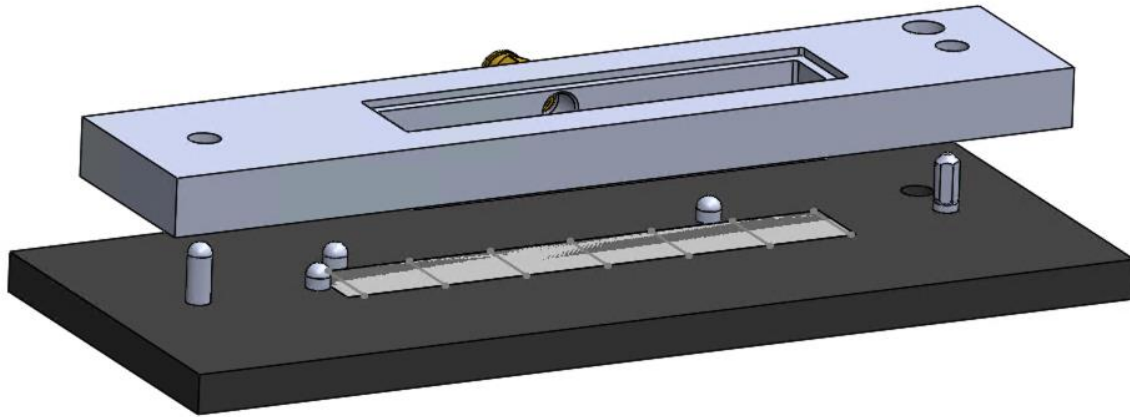
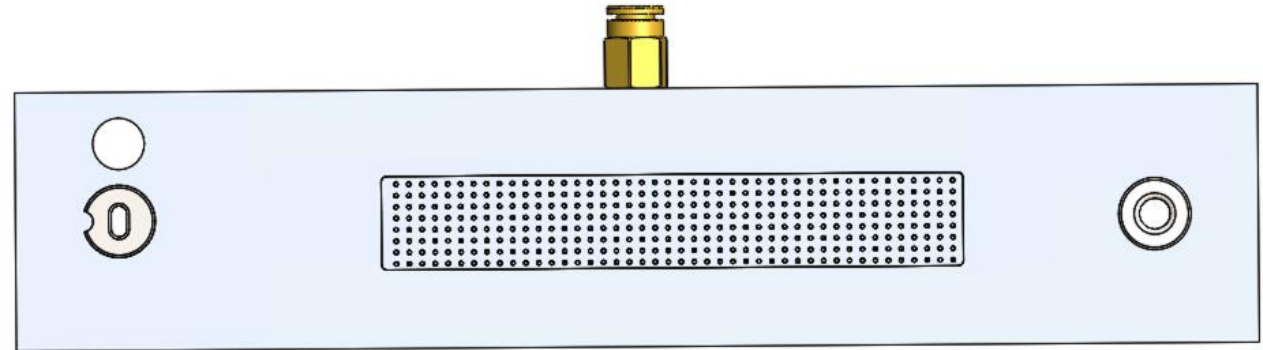


- **3 pins** for sensor alignment
- **2 pins** (round & diamond) for alignment to vacuum pick-up tool
- 1 pin (larger) for orientation



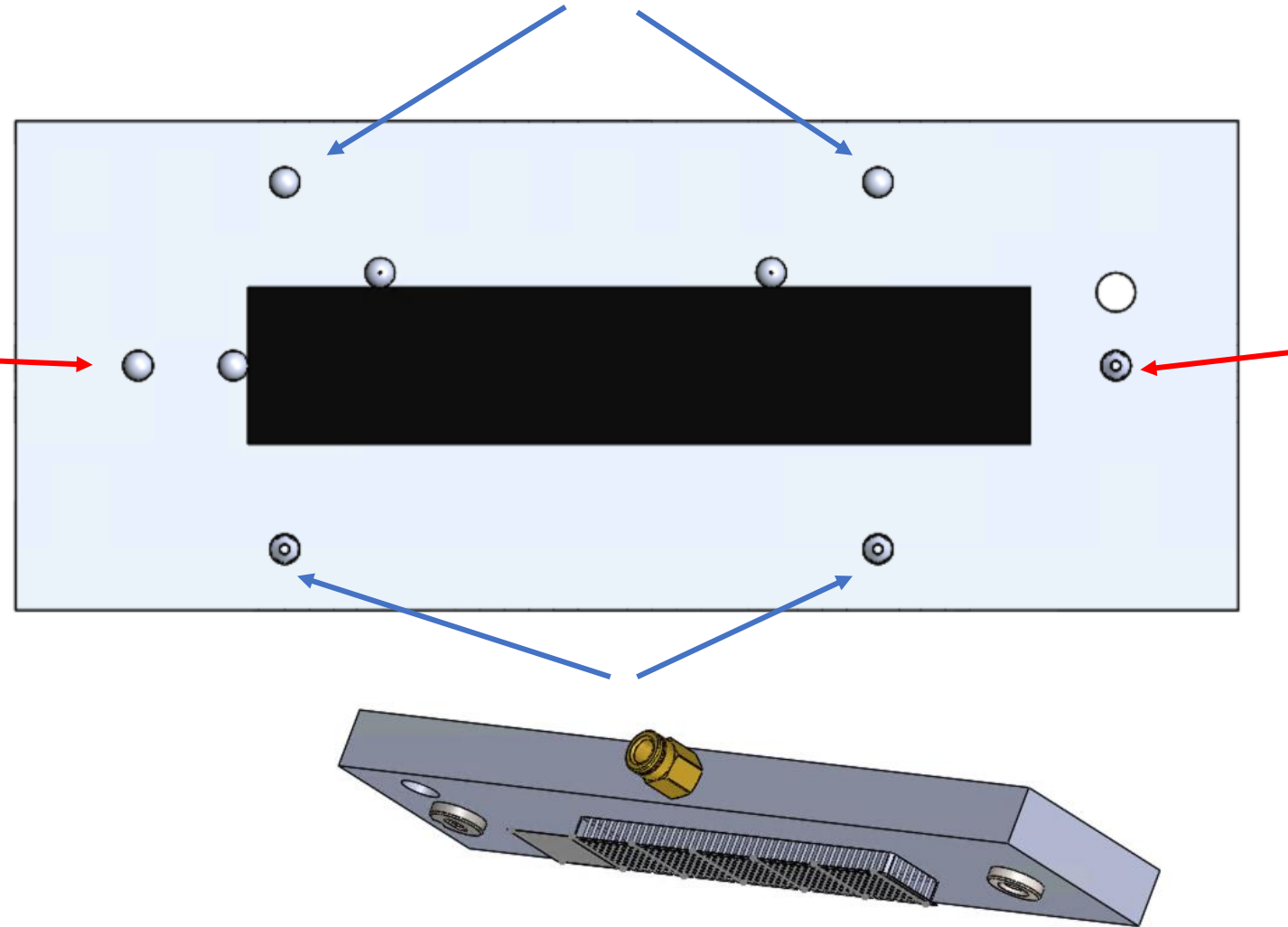
Vacuum pickup

- Keys to the two pins on the pre-alignment & module bases
- Used for 5 & 6 RSUs

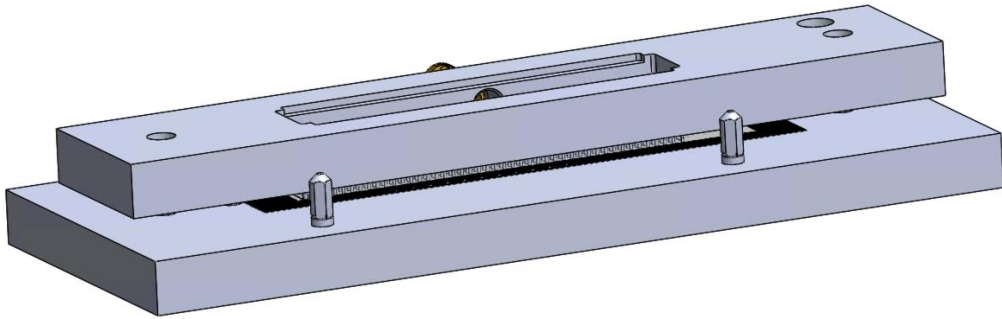


Module alignment & adhesion

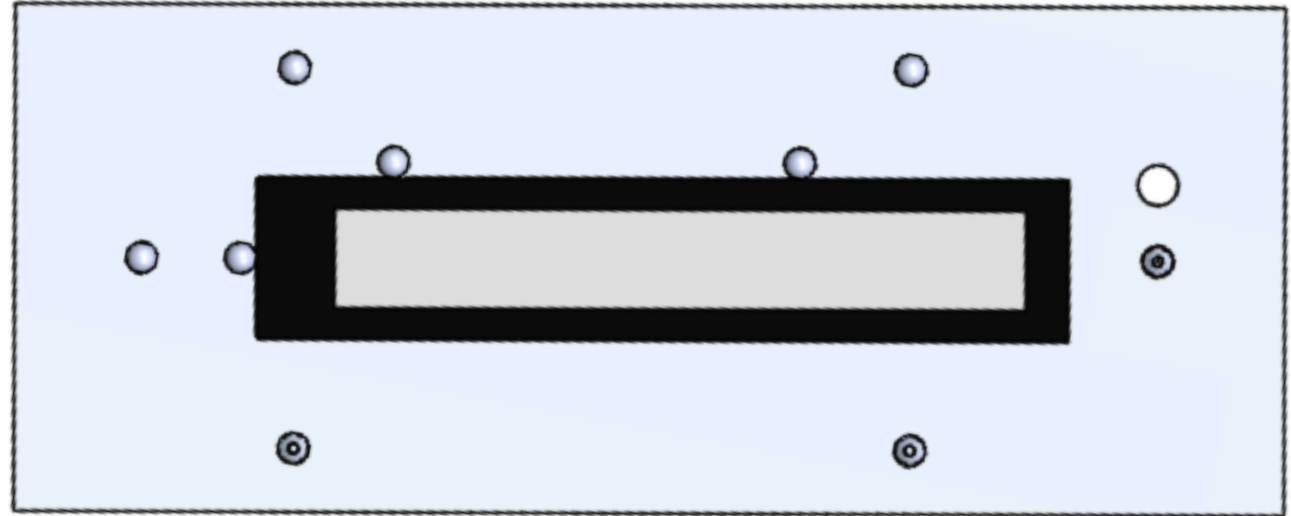
- 3 pin alignment for CF FS
- Held down by vacuum
- Same **2 pin alignment** as sensor pre-alignment base
- Sensor vacuum pick-up places EIC-LAS onto CF FS
- Aligned to LEC edge, so 5 or 6 RSU is the same
- **Pins** for LEC & REC FPC alignment



Module alignment & adhesion



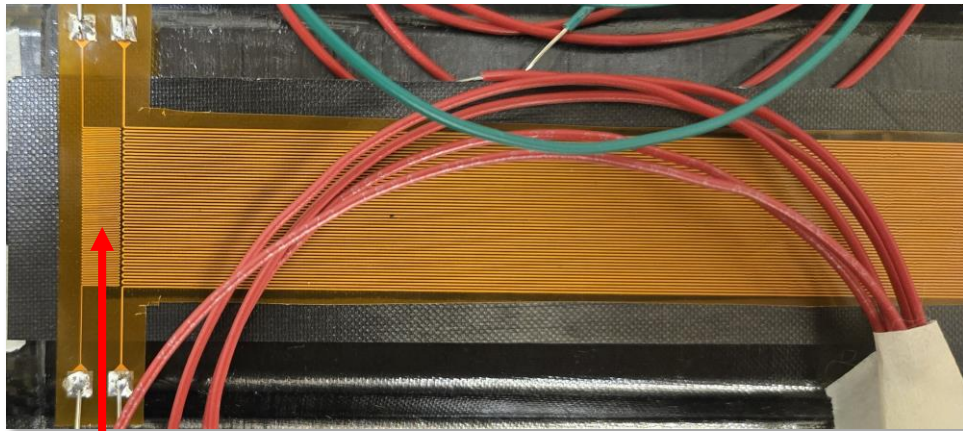
- Expect tape to already be on CF FS, then sensor placed
- FPCs placed after sensor



Module test pieces

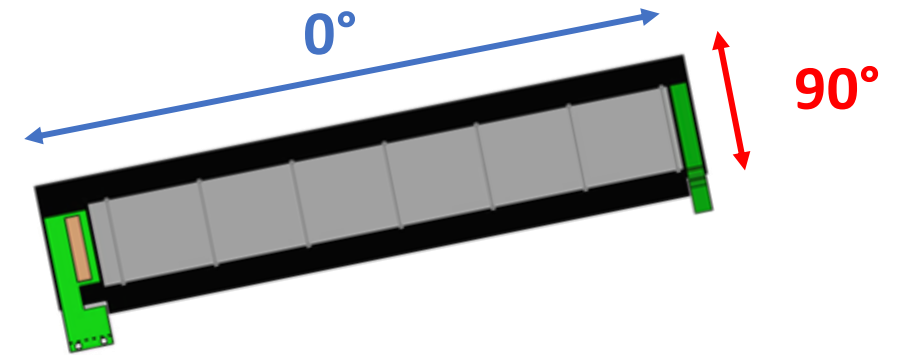
Previous module thermal test pieces

Heaters: 2 power regions



LEC
 0.24 W/cm^2

RSU region
5 or 6 RSU size
 0.05 W/cm^2



LEC

RSUs



Each region powered separately
Capable of a range of power densities

Dummy modules for a partial disk test piece

- Two types: **Mechanical & Thermomechanical**
- **Mechanical**
 - CF flat sheet: 2 widths to test gluing coverage on corrugation
 - Dummy silicon: 6-RSU sized
 - Dummy FPCs: flat flex cable cut to approximate size
 - **Realistic breakage/handling risk**
- **Thermomechanical**
 - CF flat sheet: 2 widths
 - Silicon embedded in Kapton with copper traces to mimic EIC-LAS power
 - Resistive heater to mimic AncASIC power
 - **For measuring thermal performance**

Partial disk test piece in Elaine's talk

Dummy modules for partial disk test piece



FPC mockups → flex cables

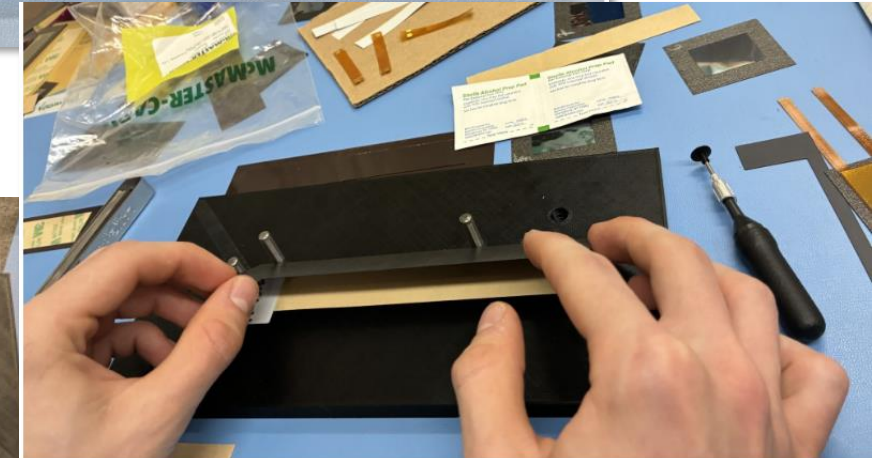
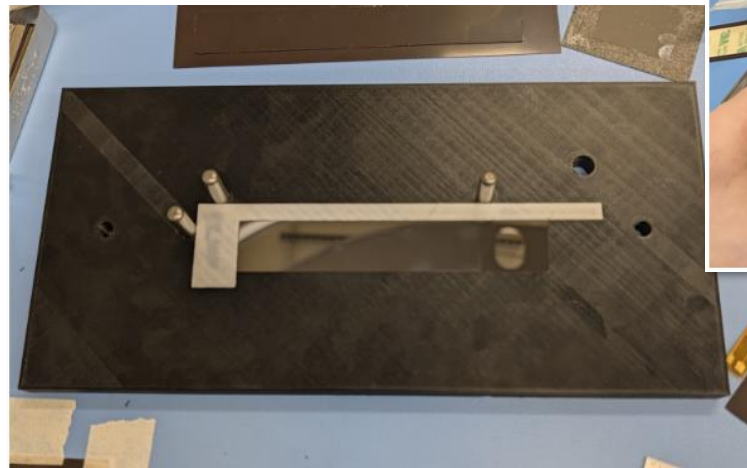
Thermomechanical EIC-LAS dummy



AncASIC thermal mockup

Assembly of dummy modules

- "Real" tooling not in hand
- 3D printed tool with pins
- Small, swappable alignment pieces to align tape & dummy sensors
- Module precision not necessary for partial disk
 - Testing handling, thermal performance, vibration, etc.



Outlook

- Tooling design ongoing
 - 3D printing some pieces to test the process
- Verifying the carbon fiber cutting & precision
- Some initial wire bonding tests complete
 - Pull tests before and after thermal cycling and air flow upcoming
- Partial disk test piece (coming in Elaine's talk)
 - Assembly of dummy modules
 - Will inform some of the handling of the modules
- Targeting a module created with “real” tooling by end of year

