AC-LGAD ToF : halfSTAVE prototype updates and heat transfer analysis for miniSTAVE and fullSTAVE

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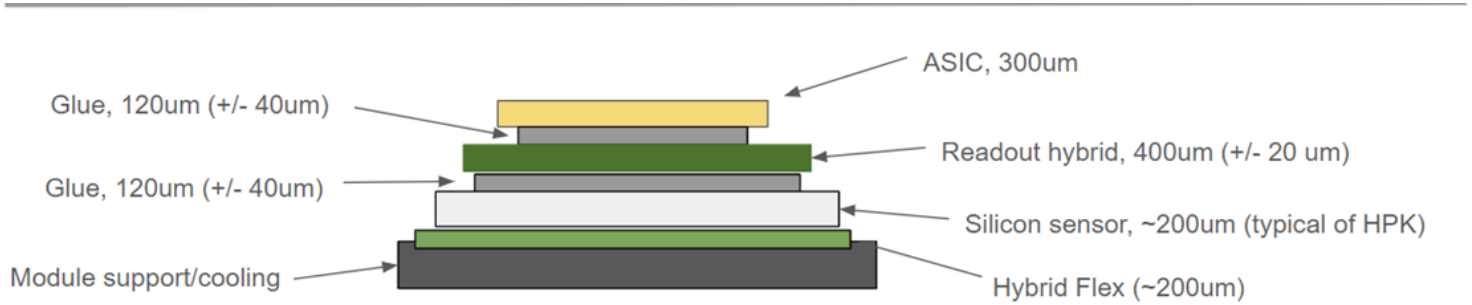
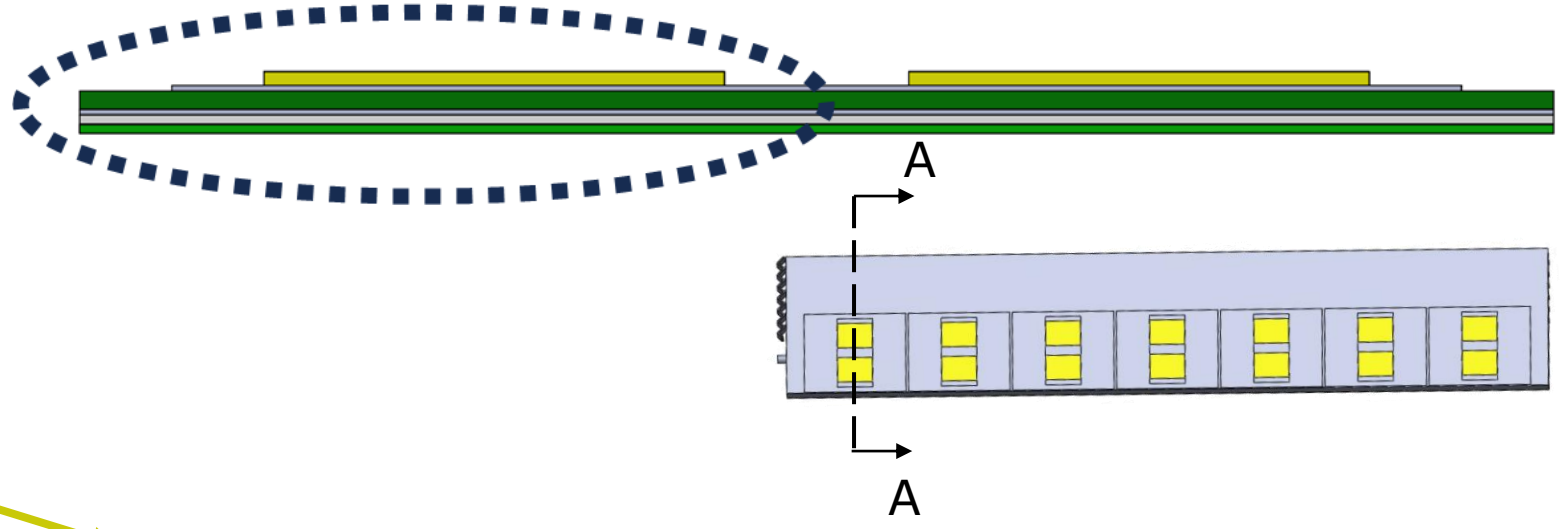
Sushrut Karmarkar, Andreas Jung

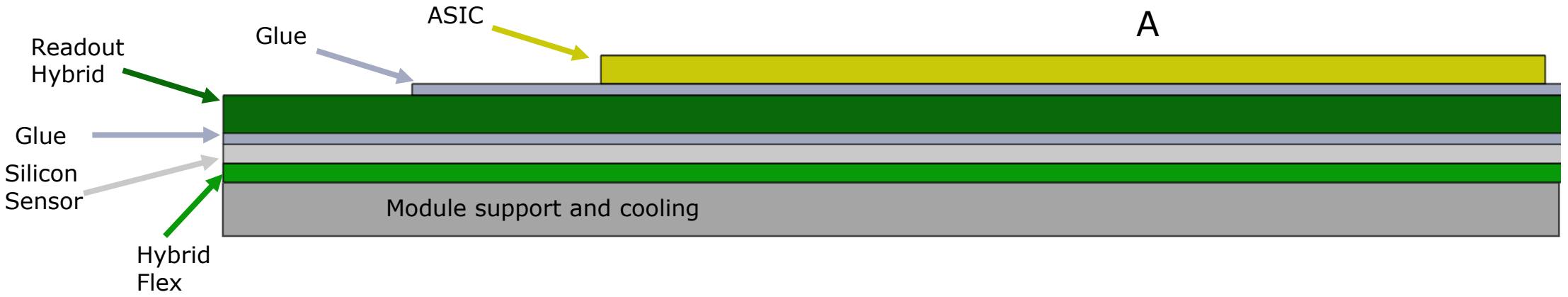
UG students – Yuvraj Chauhan, Pau Simpson, Sam Langley-Hawthorne, Xuli You, Alexandre Chevalier

Sensor cross-section set up – Ansys HT

Part Name	Thermal Conductivity (W/mK)	Thickness (µm)
ROC and ASIC (PCB/Kapton properties)	0.97	400 and 300
Silicon Module	148	200
Carbon Face Sheet	Kxx - 180 Kyy - 150 Kzz - 1.36	200
Carbon Foam	25	6420
Loctite Epoxy (Glue)	1.28	120
Stainless Steel Pipe	16	716







Water cooling at +18°C – miniSTAVE and fullSTAVE

Heat transfer coefficient estimated to be (h) 1000 W/m²K decaying down to 360 W/m²K (at outlet) --

- Need better pressure inlet and pressure outlet understanding for refining the simulations further
- Heat transfer coefficients in a pipe for water at room temp and pipe diameter of 5 mm used for the current estimation of h.
- Please can Yi/NCKU help with this – cross check my numbers ?

$$h = \frac{k \cdot Nu_L}{L}$$

$$Nusselt\ number\ (Nu_L) = \frac{\left(\frac{f}{8}\right)(Re - 1000)Pr}{1 + 12.7\left(\frac{f}{8}\right)^{0.5}((Pr)^{\frac{2}{3}} - 1)}$$

For laminar flow in a pipe at room temp we found out the Prandtl (Pr) and Reynolds (Re) numbers using (Gnielinski,1976) and first Petukhov eq. (1970) :

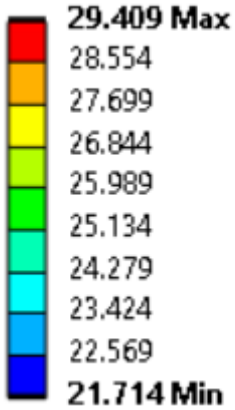
$$f = (0.790 \ln Re - 1.64)\text{^}(-2)$$

For flow conditions Re ~ 250,000

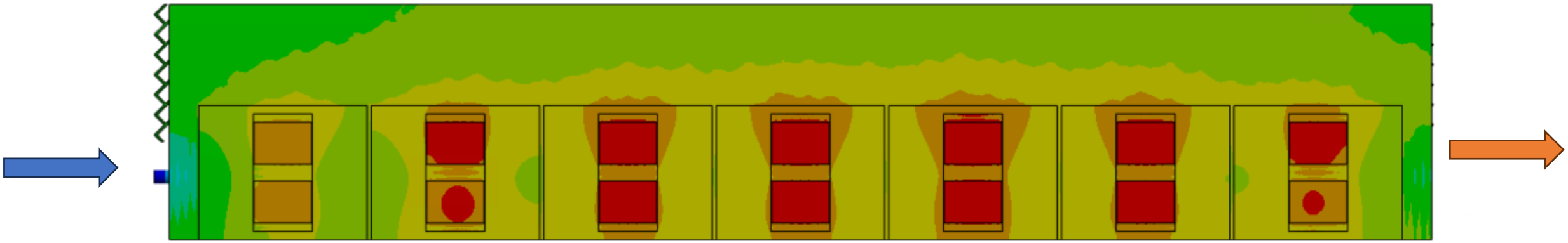
L = length (function of x); k = conductive heat transfer coefficient (W/mK)

Water cooling at +18°C – miniSTAVE

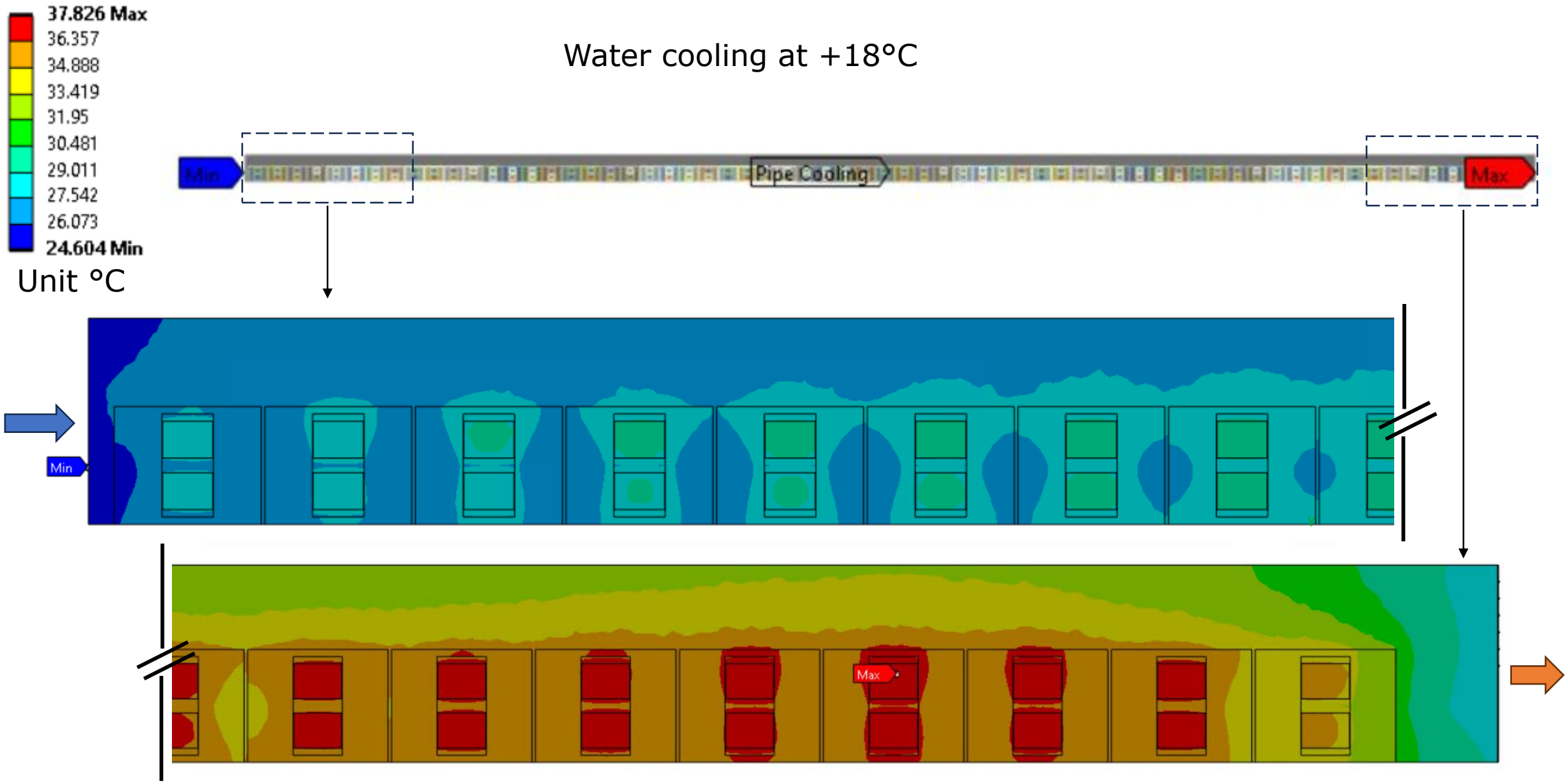
Unit °C



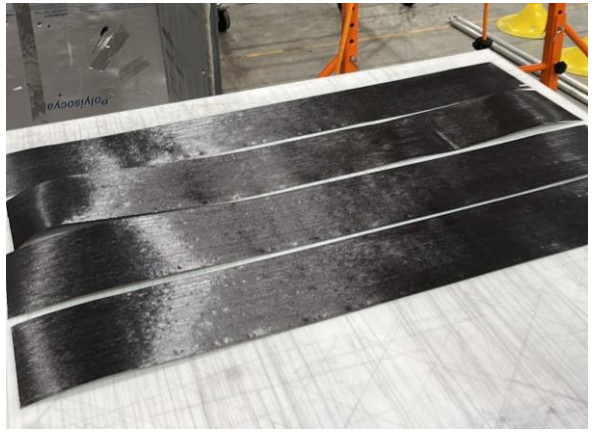
Convective heat loss from edge of the stave affects the temperature profile for the last sensor

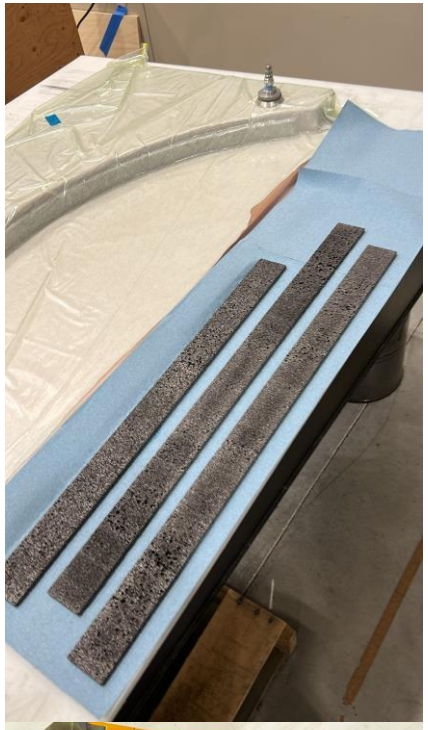


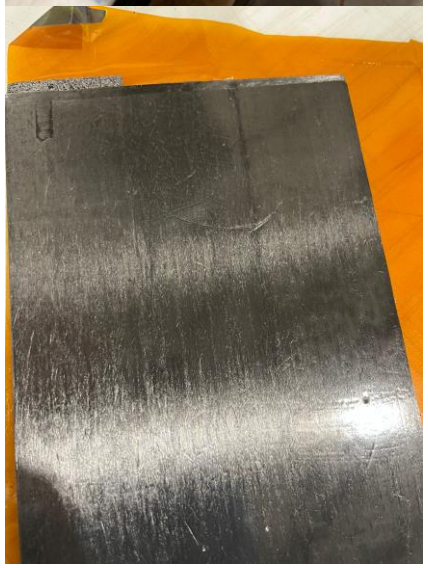
Full length stave simulations for HT – 2.7 m stave



halfSTAVE (~1m) prototyping efforts – co-cure



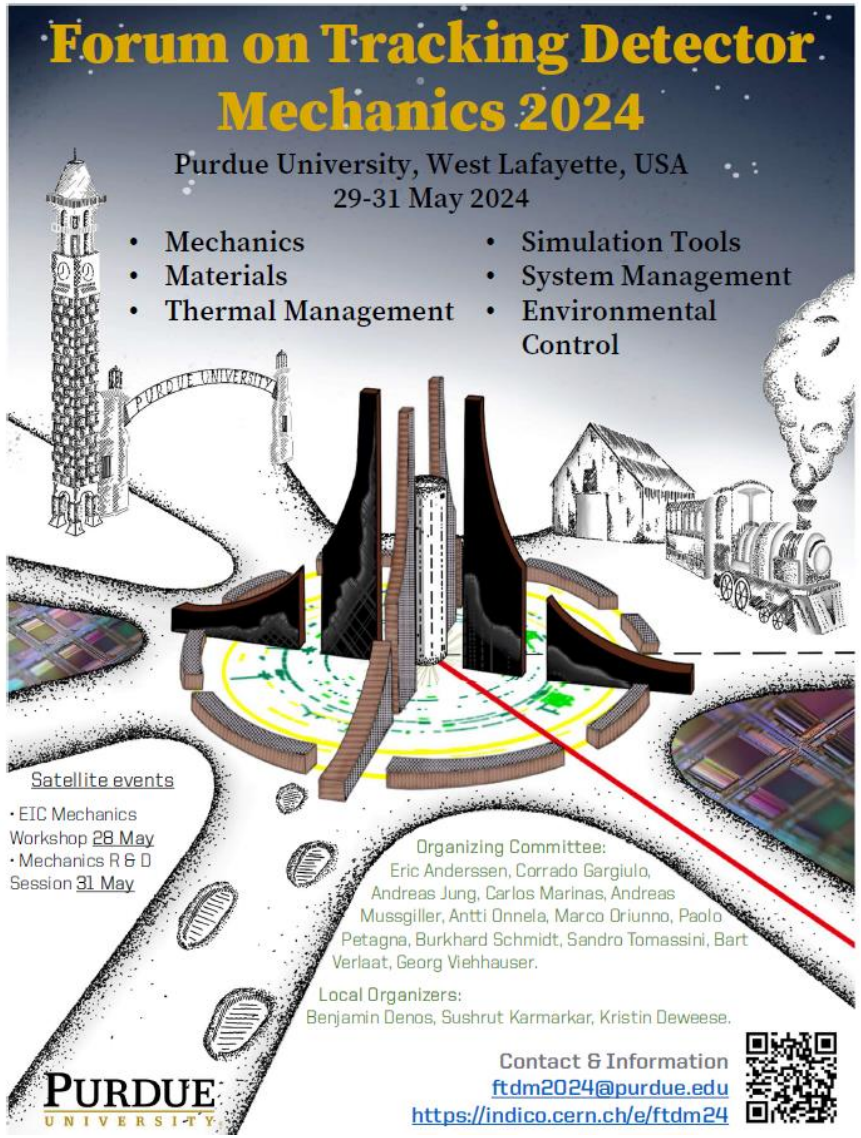




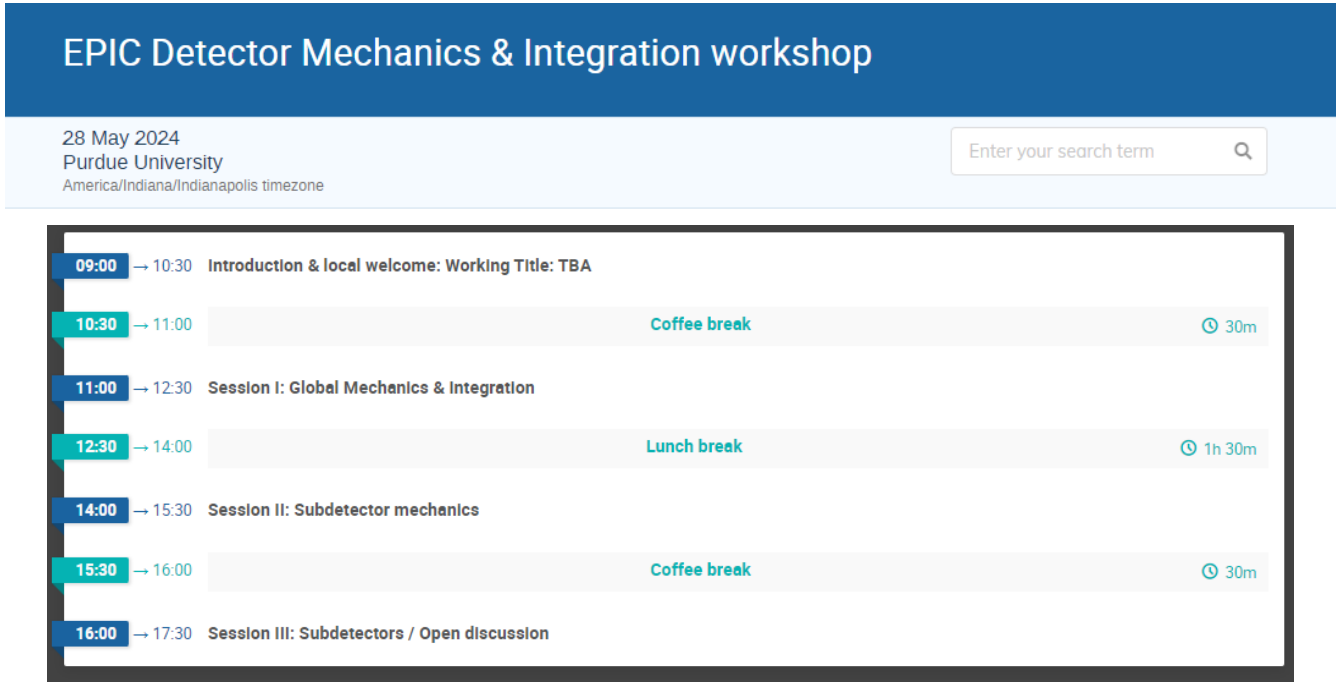
Next steps →

1. Bond the honeycomb
2. Router CNC the height of the honeycomb + carbon foam
3. Groove for cooling pipe
4. Trim structure into half
5. Bond pieces to make a ~1m halfSTAVE

Please consider submitting talk/poster for the conference & visiting our labs at Purdue University!



- Satellite event -- https://indico.cern.ch/event/1371986/



Forum on Tracking Detector Mechanics link – https://indico.cern.ch/event/1336746/