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

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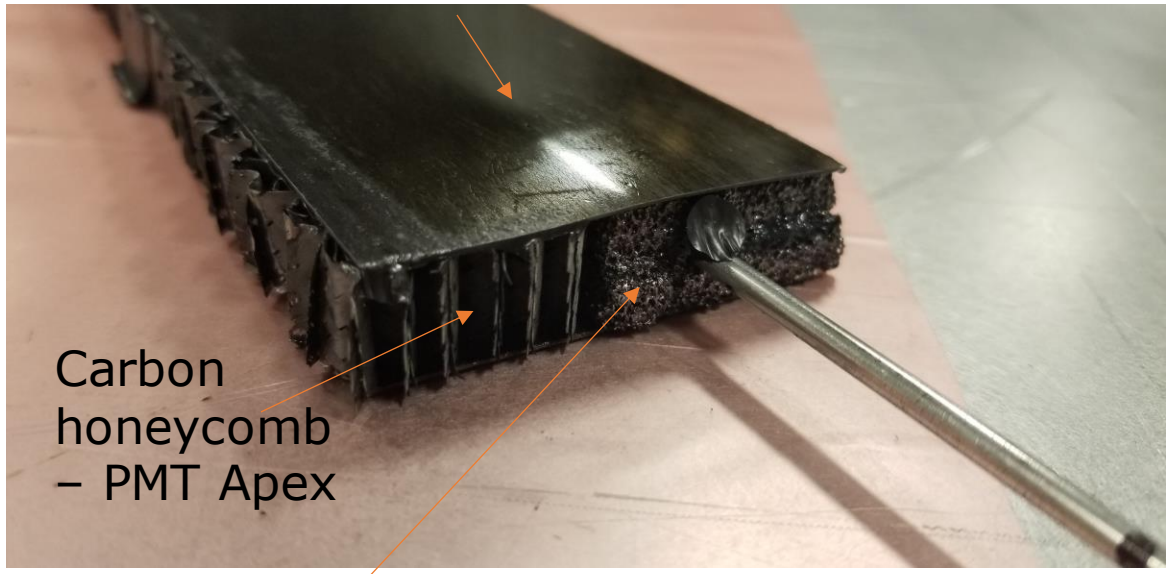
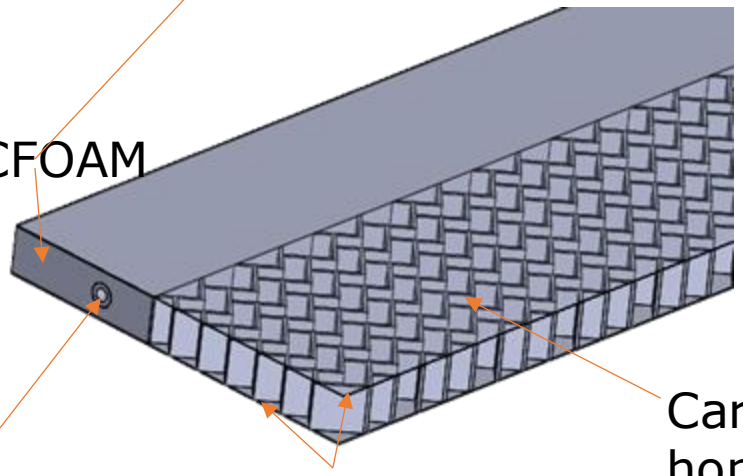
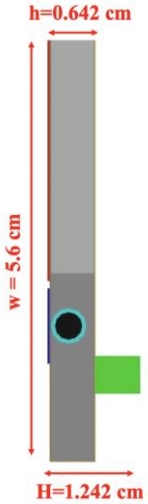
# miniSTAVE manufacturing #1 & #2

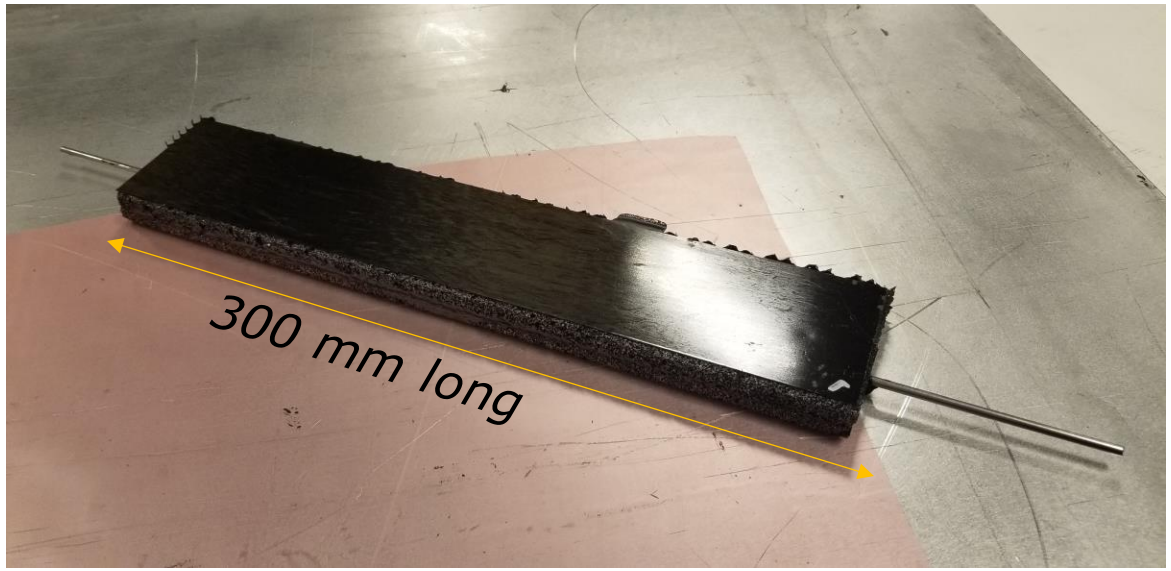
Top and bottom CFRP – EX1515 – K13D2U



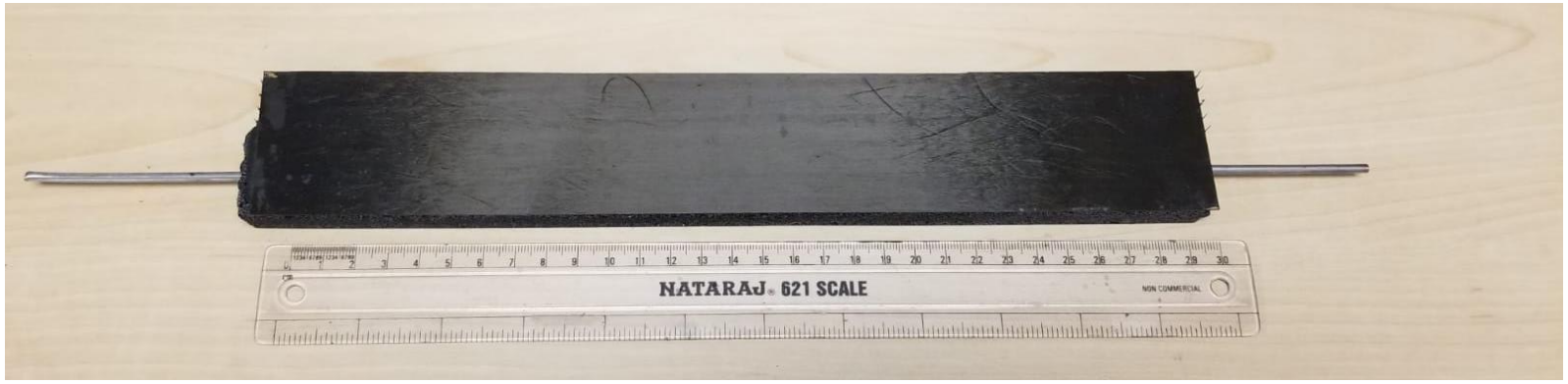



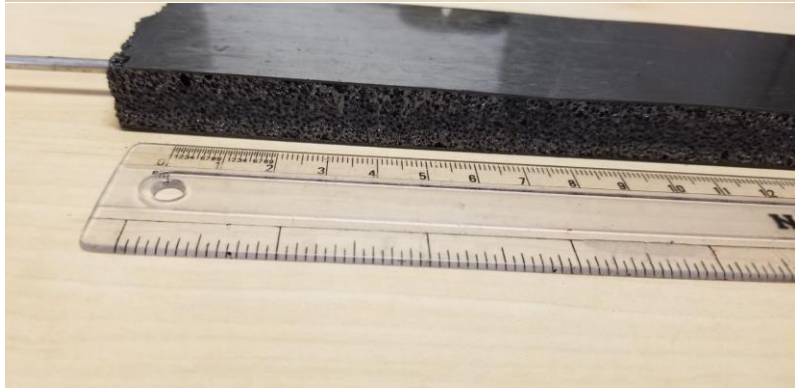

Part Dimensions here – also sharing a CAD model for the same

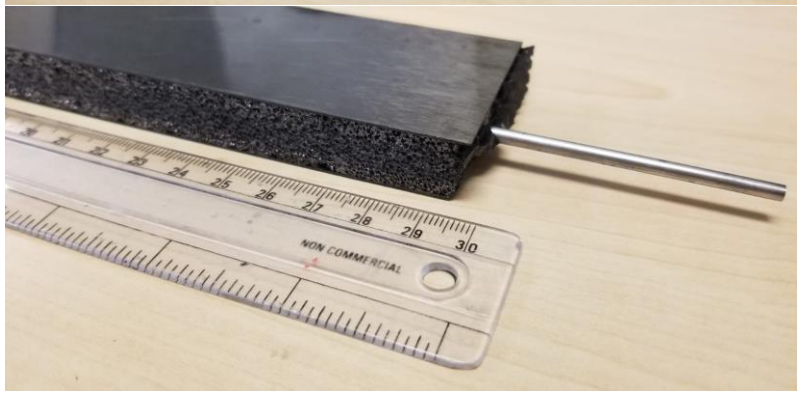


# miniSTAVE manufacturing #1 & #2





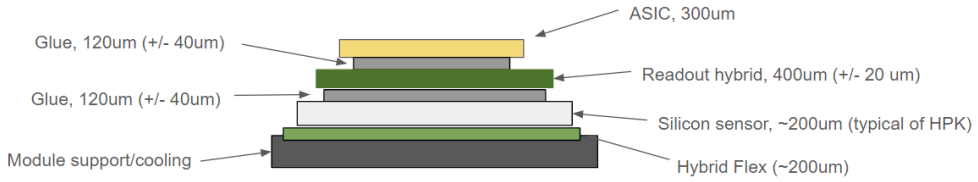




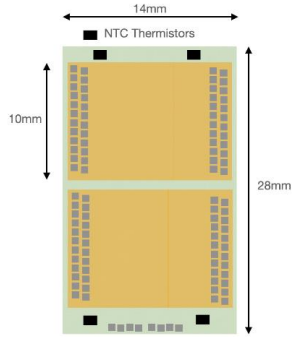

- First prototype helped finalize the foam cutting, honeycomb trimming and bonding procedures
- miniSTAVE #1 sent to (Prof. Yi Yang) NCKU/Taiwan (received on 26th March 2024) for cooling tests –
- Second version of prototyping underway for halfSTAVE (~ 1 m) in length
- Co-curing explored for facesheet and carbon foam to reduce thermal interfaces for better sensor cooling performance

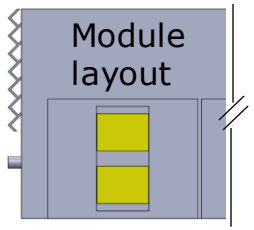
# Preliminary heat transfer analysis for miniSTAVE

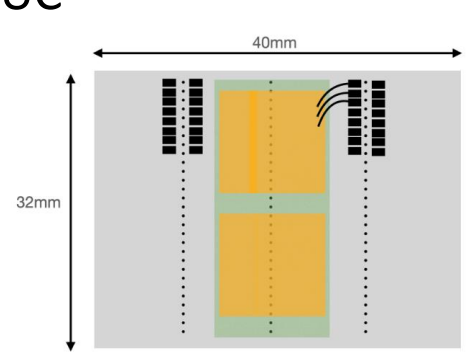
- In collaboration with Matthew Gignac (UC Santa Cruz)

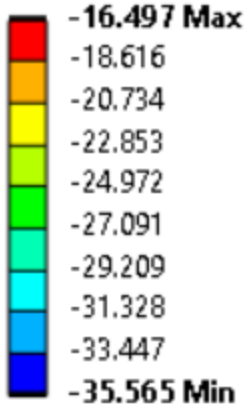

| Part Name | Thermal Conductivity (W/mK) | Thickness (µm) |
|---|---|---|
| ROC and ASIC (PCB/Kapton properties) | 0.97 | 400 and 300 |
| Silicon Module | 148 | 200 |
| Carbon Face Sheet | Kxx - 180<br>Kyy - 150<br>Kzz - 1.36 | 200 |
| Carbon Foam | 25 | 6420 |
| Loctite Epoxy | 1.28 | 120 |
| Stainless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



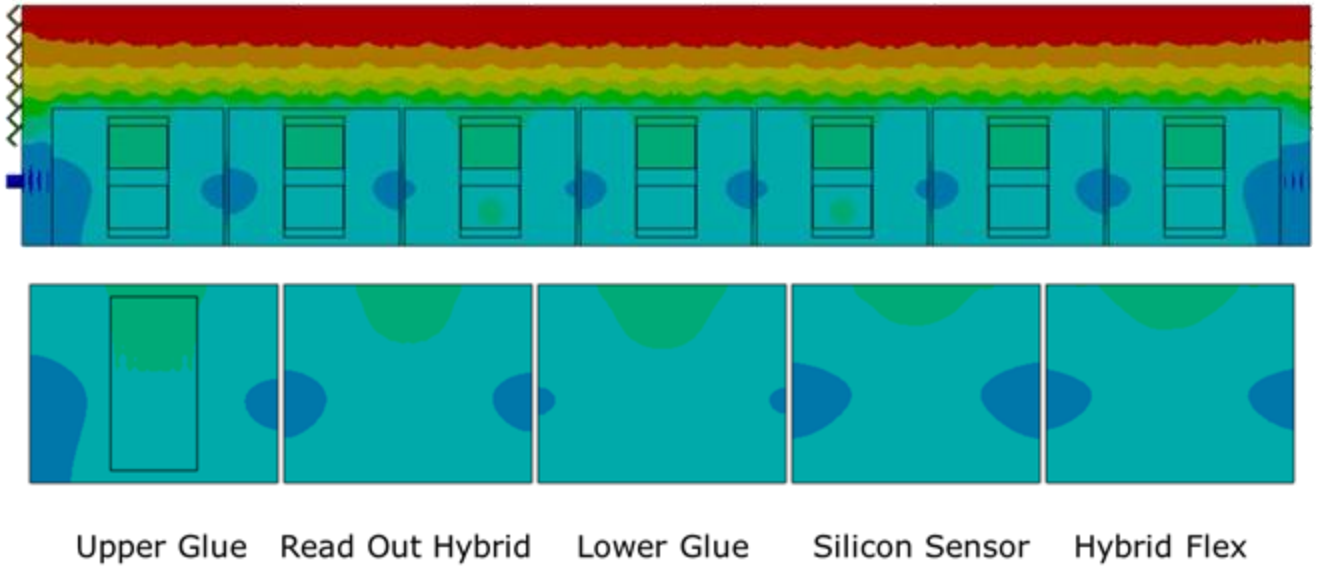



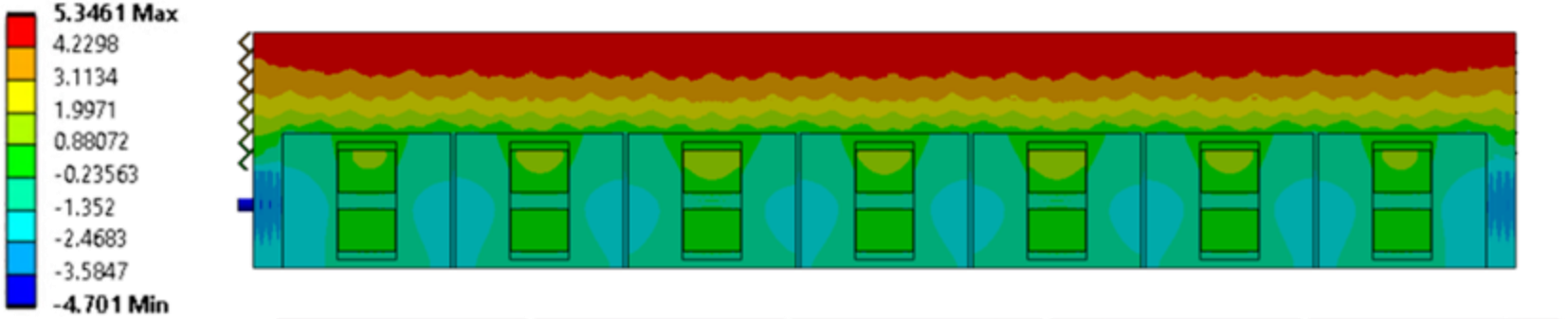

Unit °C




CO2 cooling – same conditions as CMS/CERN

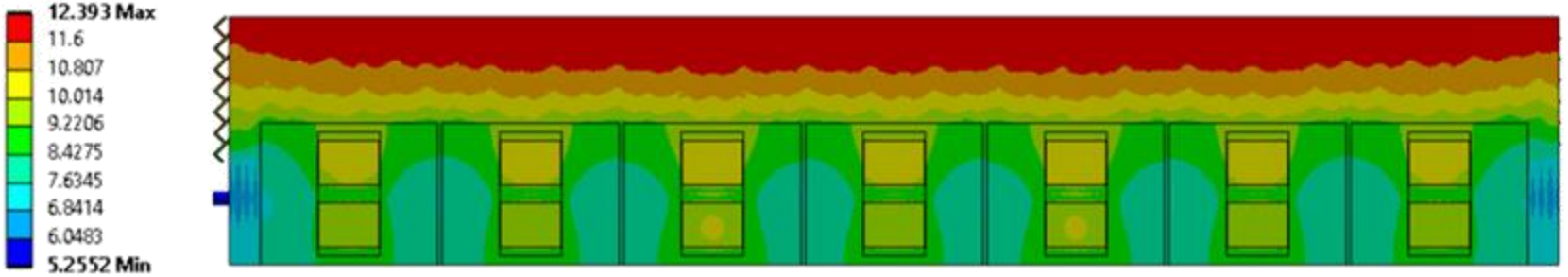


# miniSTAVE glycol cooling (-5°C) and water cooling (+5°C)




Unit °C

Upper Glue Read Out Hybrid Lower Glue Silicon Sensor Hybrid Flex




Unit °C

Upper Glue Read Out Hybrid Lower Glue Silicon Sensor Hybrid Flex

- Similar analysis for glycol cooling and water cooling as working fluid through the cooling pipe
- Fine – tuning this analysis with heat transfer coefficient in the pipe as a function of pressure and temperature and (in case of CO2 vapor quality) – on-going

# Notes from meeting discussion and next steps

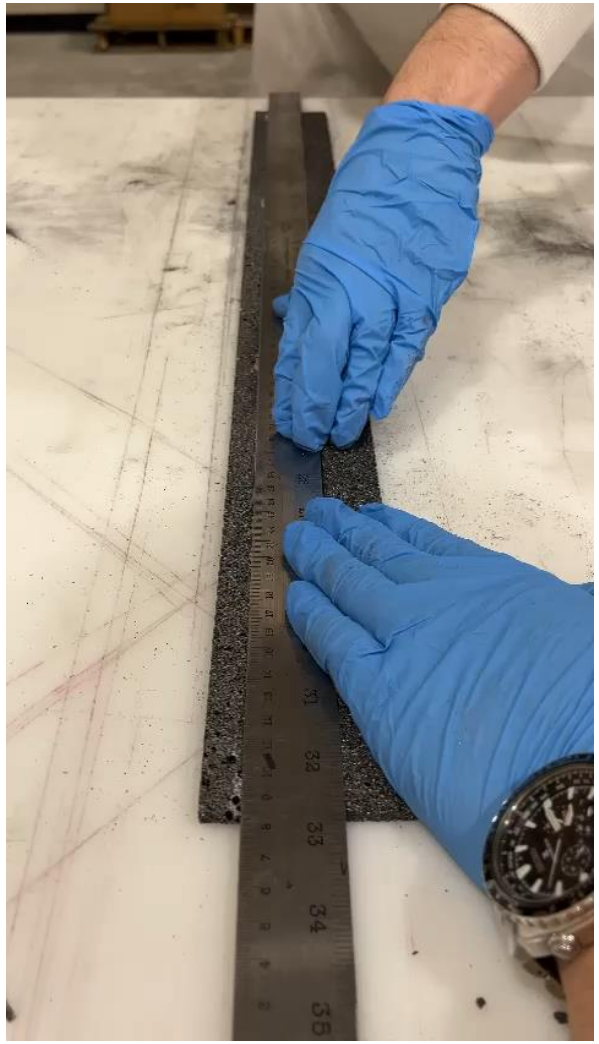
- Next steps (Purdue specific) –
  1. Prototyping halfSTAVE (~1m)
  2. Exploring co-cure options to reduce material budget and thermal interface layer – measure and document the weight of all the components used for material budget analysis
  3. Heat transfer analysis – fine tuning (with Matthew Gignac's input) for 18°C water cooled system
  4. Extend heat transfer analysis to estimate what will be the warpage in the mechanical structure due to temperature gradients

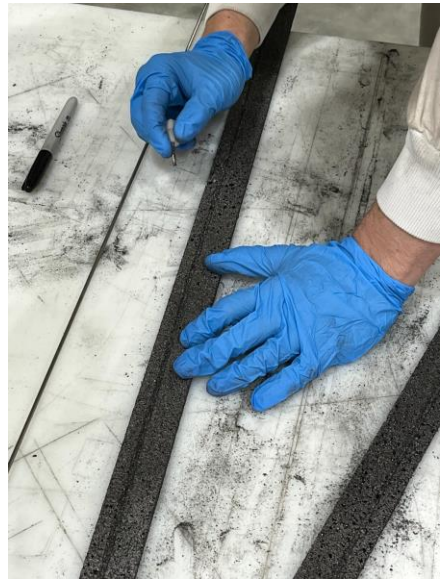
- Comments for external inputs –
  1. Can Yi Yang/NCKU measure flatness of the stave with mock heaters for heat load and water cooling set up in the environment chamber there?
  2. The honeycomb region on the top of the stave was reserved for the flex and wires and data cables. Do we really need that space or can we trim the width of the stave?
  3. What is the heat load output from the flex cables, data and power cables that we need to cool on the stave?
  4. Comment from Zhenyu – use realistic PCB and hybrid flex thermal conductivity values and re-run the current heat transfer set up.

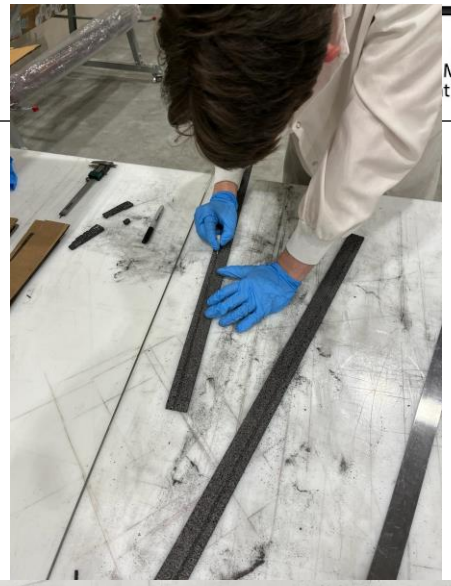
# Back Up Slides

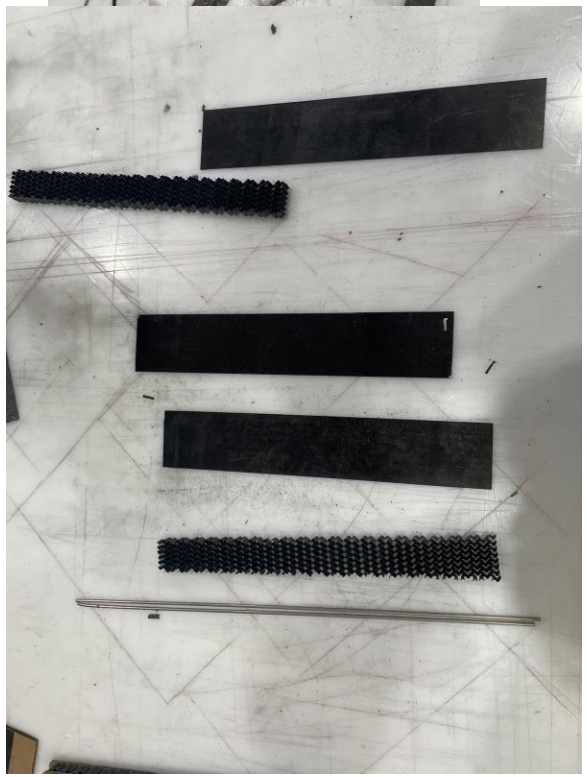
More pictures of the manufacturing process

# Manufacturing process







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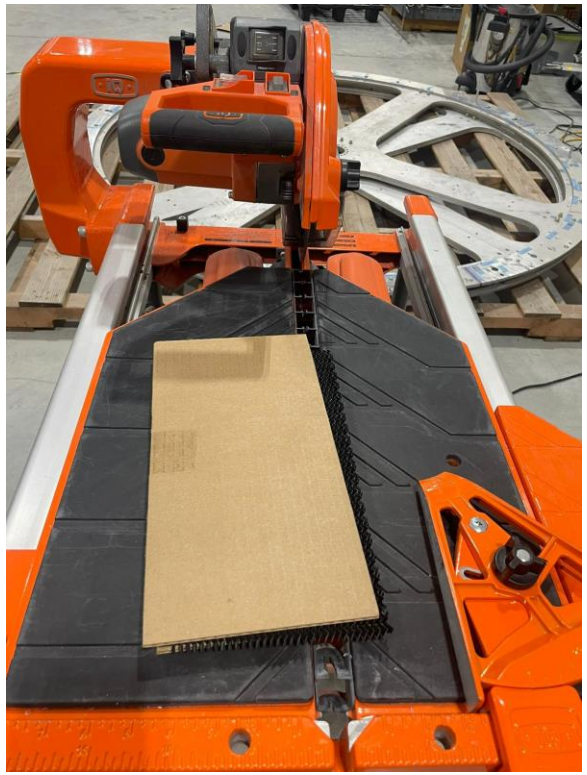
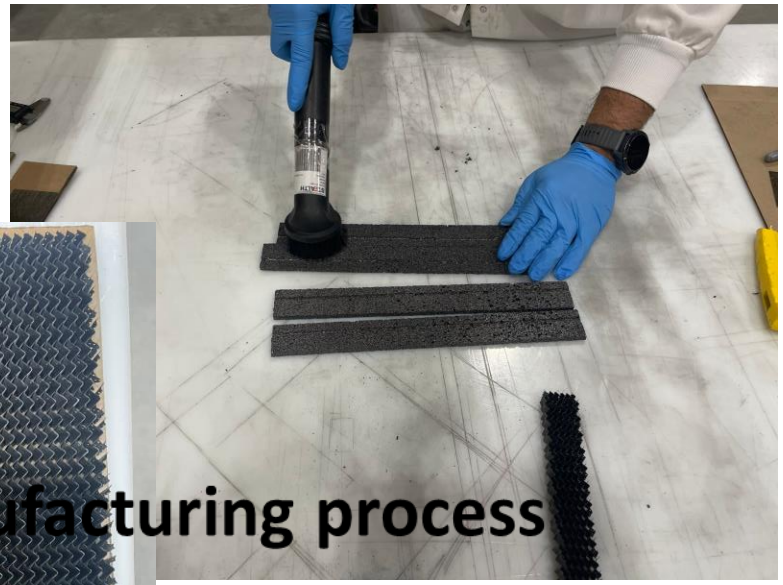
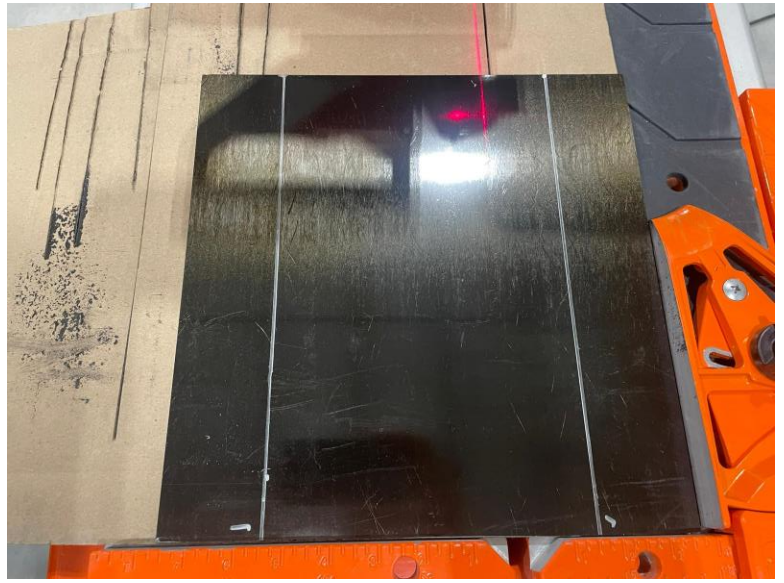




Manufacturing process



AI TECHNOLOGY PRIMA-BOND EG7655 EPOXY PASTE ADHESIVE

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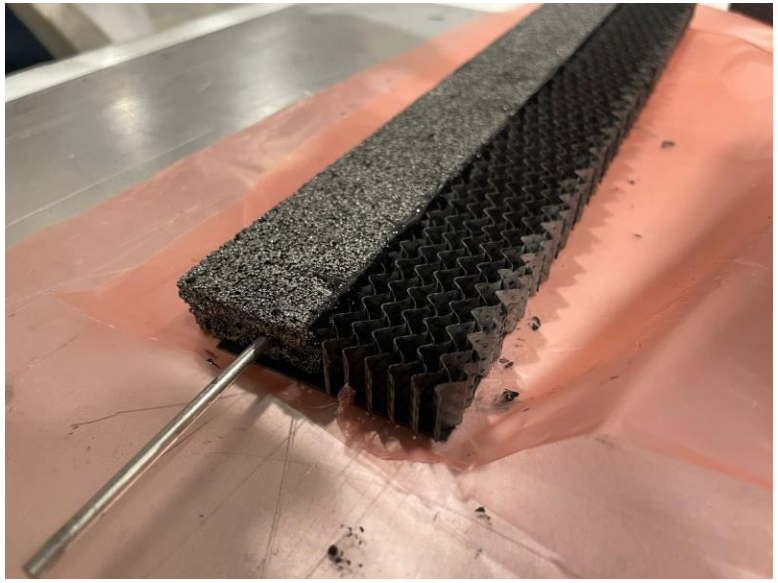


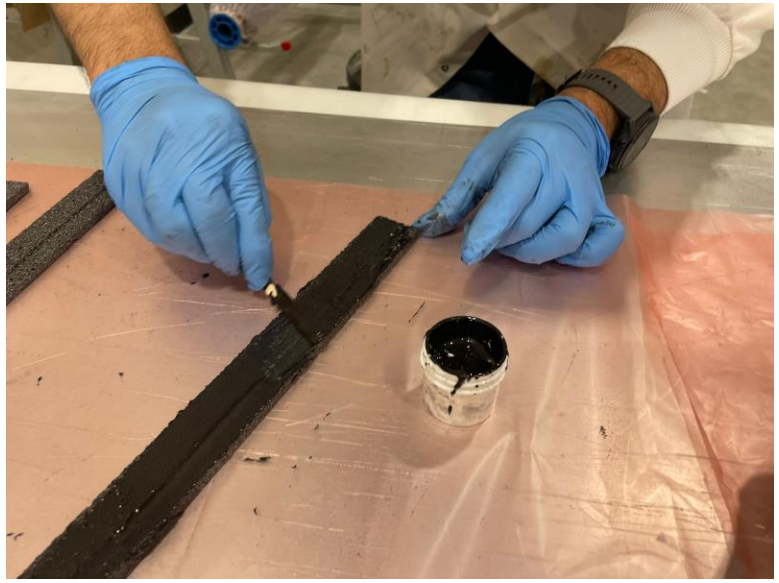

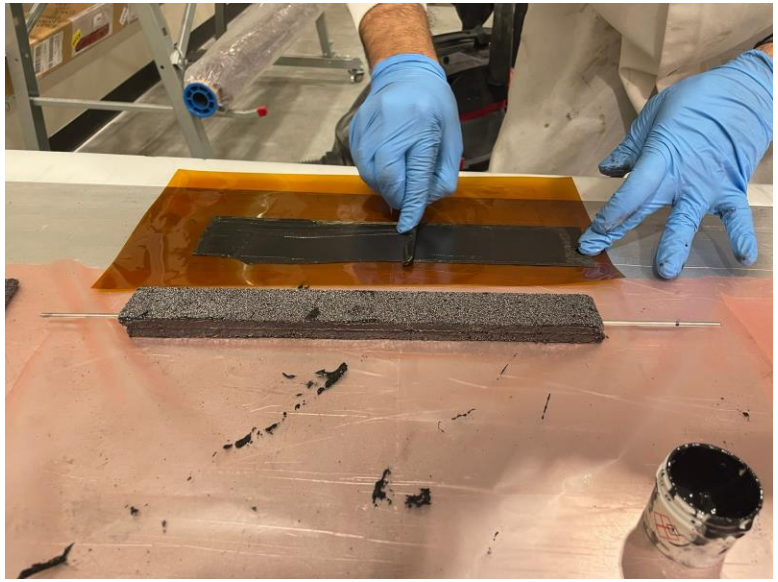

# Results






First stave received at Taiwan/NCKU on Monday 26th March 2024