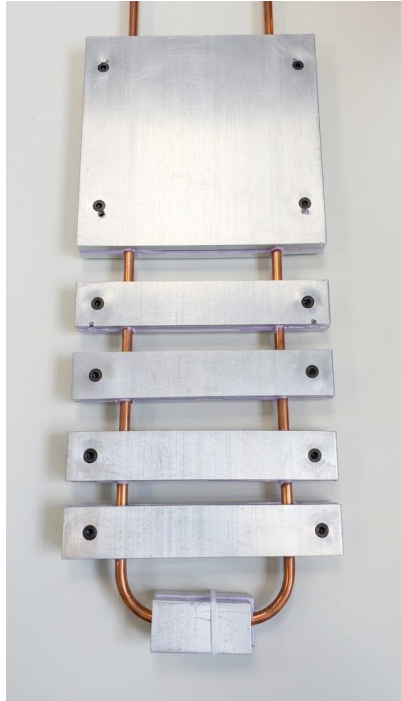


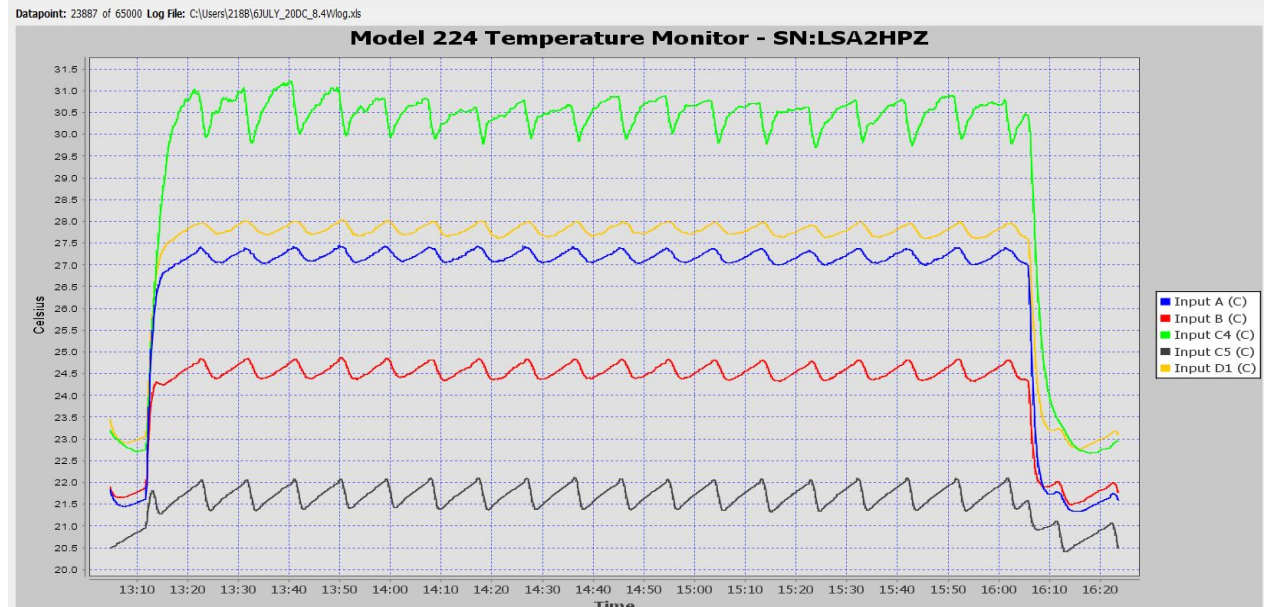
ESB Engineering Test Article (Update-II)

Shefali, Dr. Wouter Deconinck
University of Manitoba

Recap from previous update (Test Article 1)

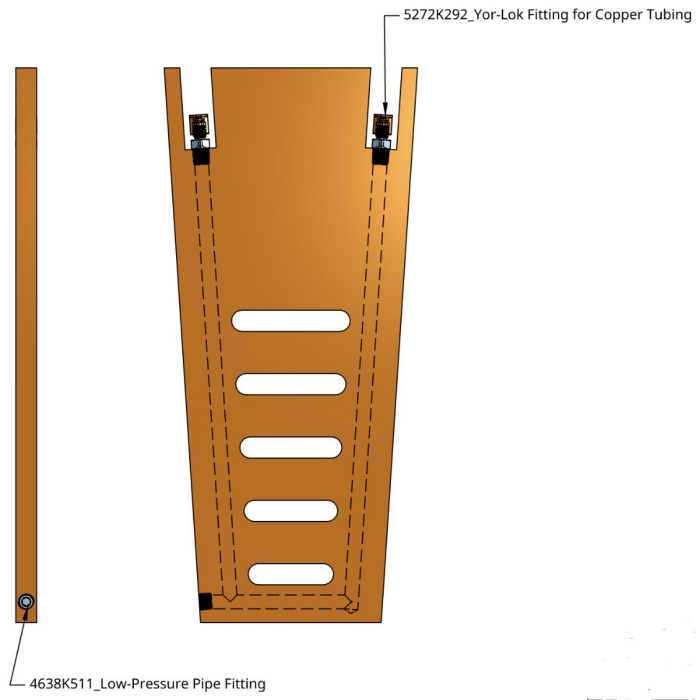


Cu pipe sandwiched between Cold Plates with Thermal Pads

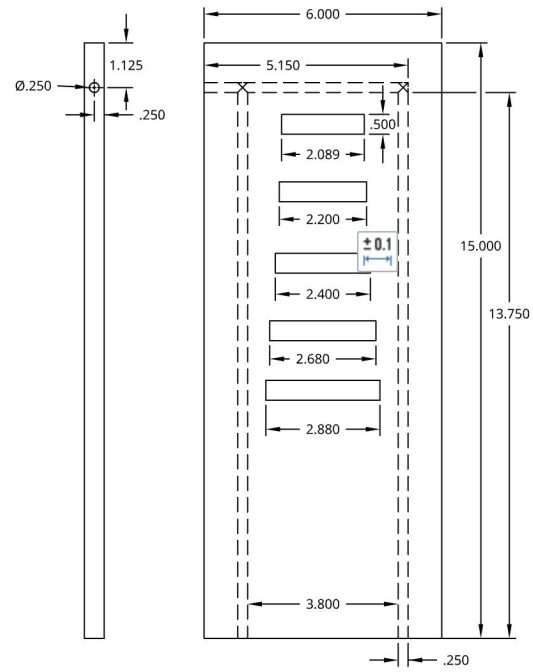


Test Results at 20°C, Power deposited = 8.4W

Engineering Test Article (Design #2)



CAD Render



CAD Drawing

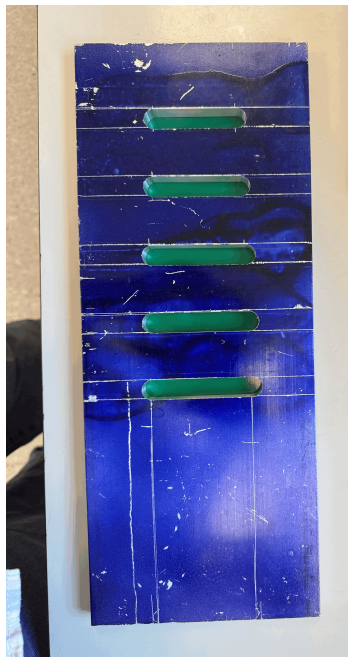
Testing Assembly #2



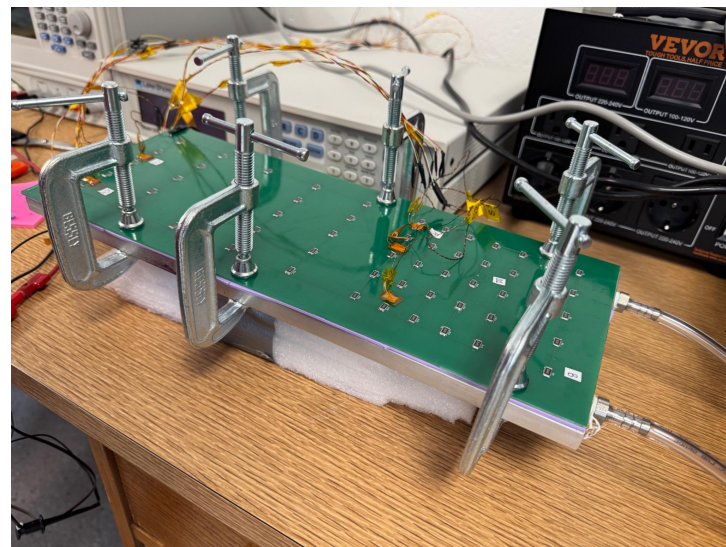
Inlet and outlet vertical channels for the internal cooling loop



Lateral cross-drilled passage interconnecting vertical fluid lines

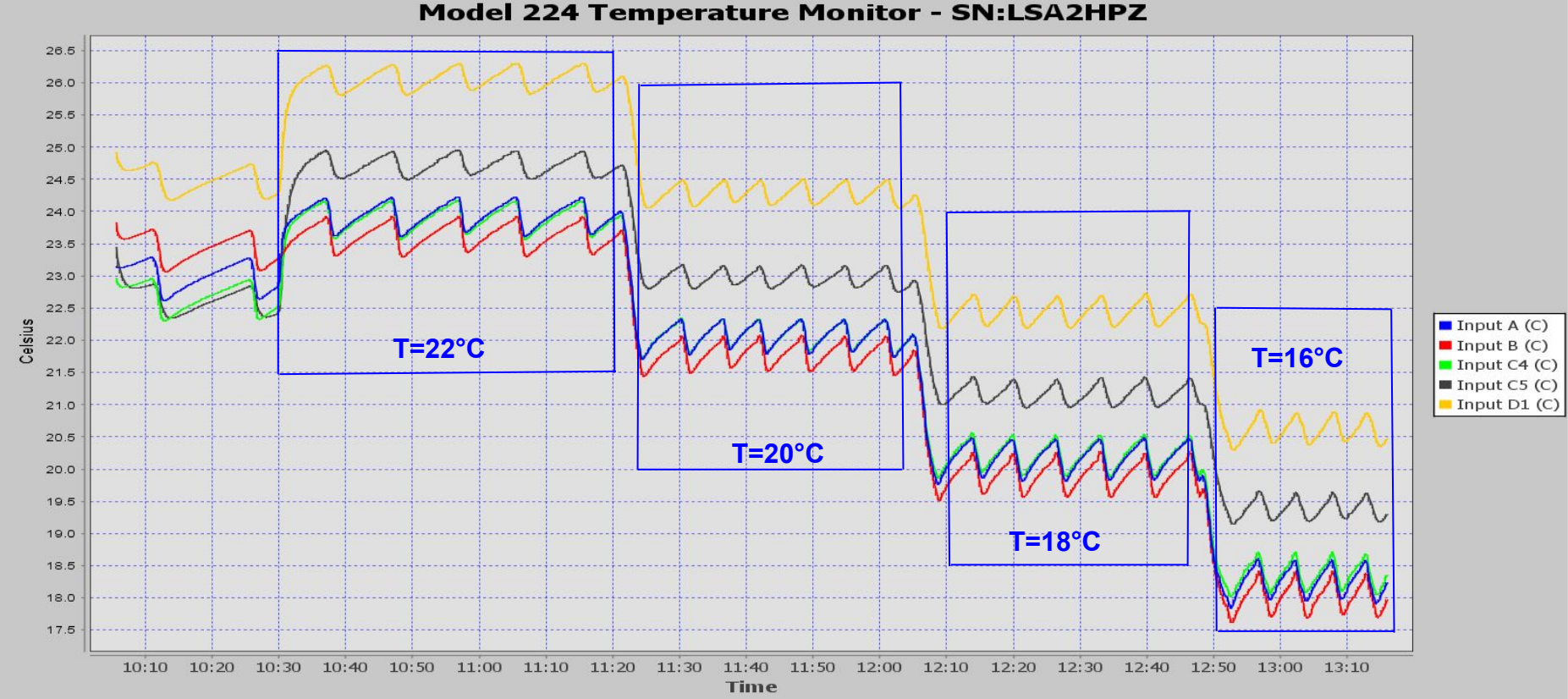


Alignment/clearance slots for Chip tray



Benchtop thermal test setup

Temperature Profiles across varied coolant temperature for test assembly 2



Calculating temp. difference across metal contacts

Thermal epoxy/TIM adds thermal resistance to the interface, while its impact on heat transfer strongly depends on the bond thickness.
If thickness of epoxy (t) = 0.0002m

Thermal resistance for epoxy $R = t/(k.A)$

Area = $\pi r l$

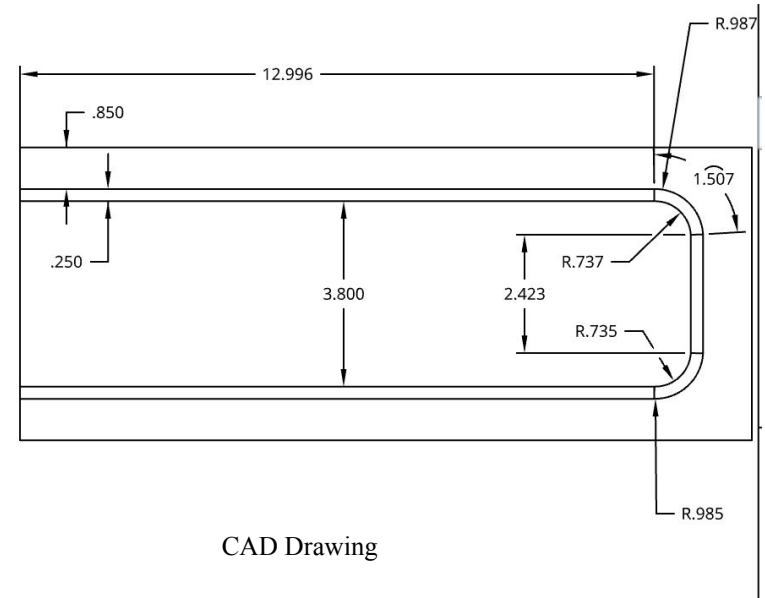
$r = 0.003175$

$l = 12.99 + 12.99 + 2.423 + 2(1.507) = 31.4 \text{ in} = 0.79\text{m}$

$A = 0.007876 \text{ m}^2$

$R = 0.01814 \text{ K/W}$

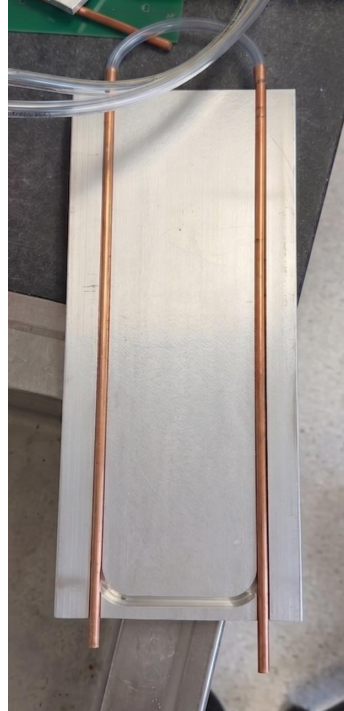
Temperature drop across the joint $\Delta T = Q.R = 0.15$



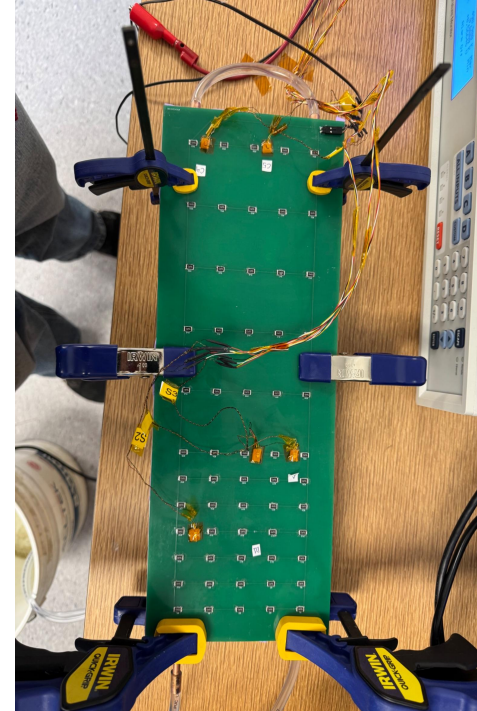
Engineering Test Article 3



CNC-machined channel profile for copper pipe press-fit integration.



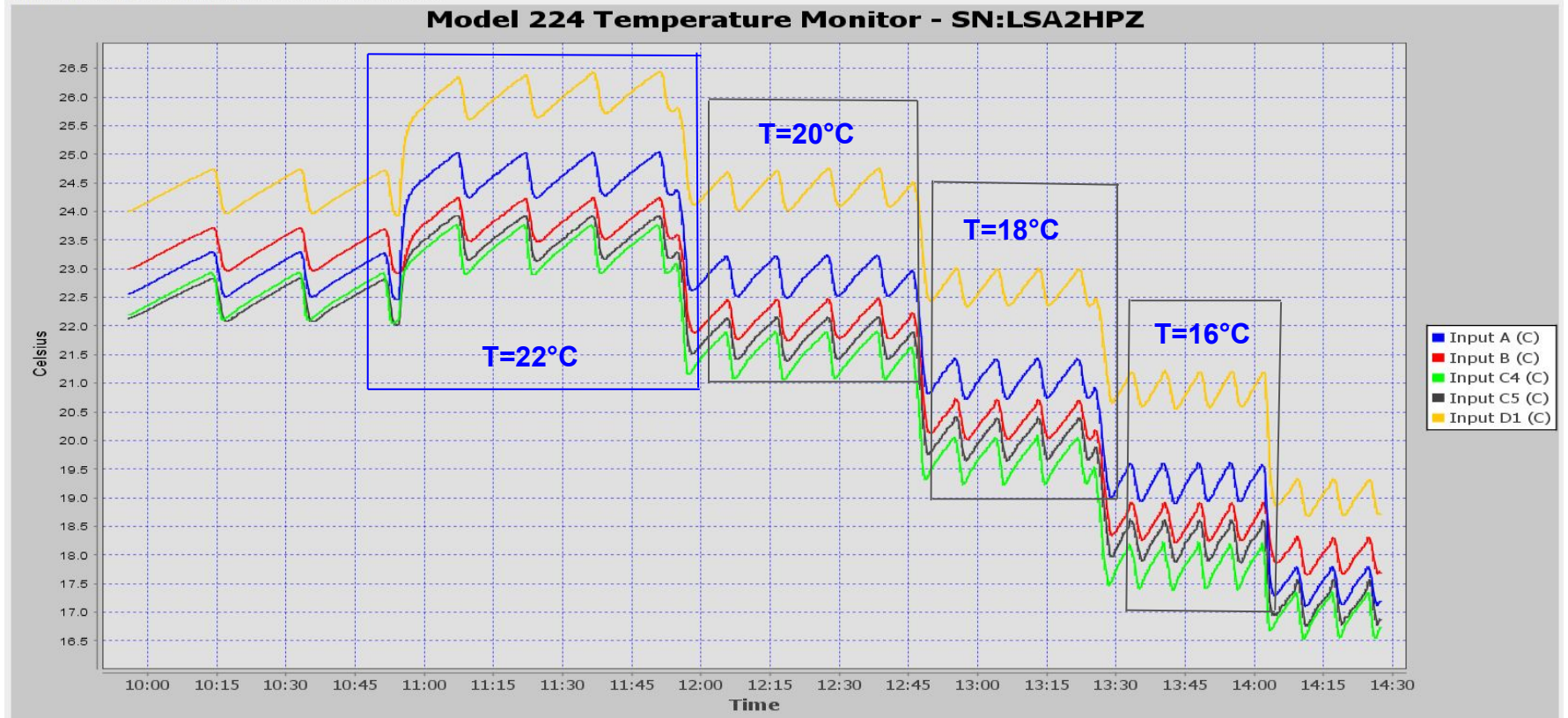
Copper cooling loop fitted into base plate groove.



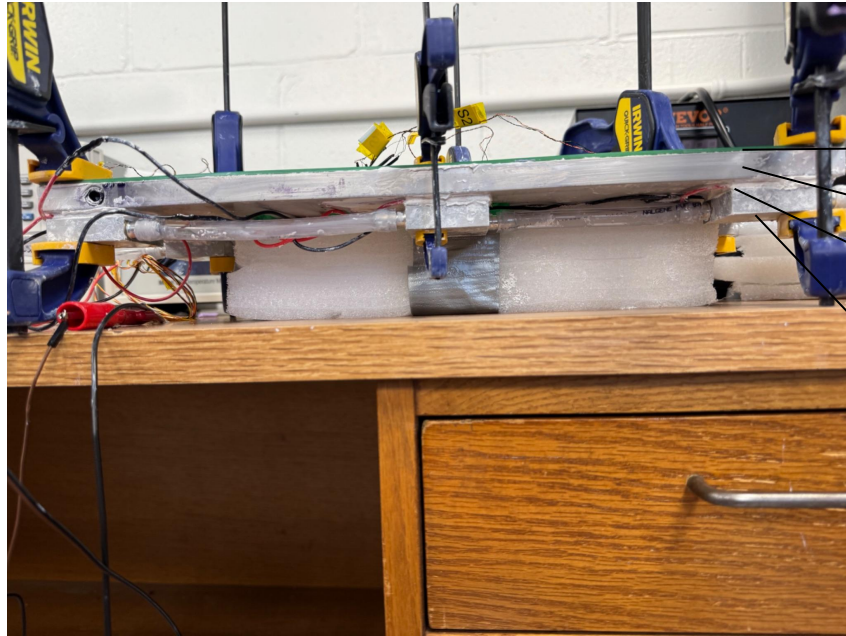
Benchtop thermal test assembly

Temperature Profiles across varied coolant temperature for test assembly 3

Datapoint: 32610 of 65000 Log File: C:\Users\2188\1SEPT_M3_test2_log.xls

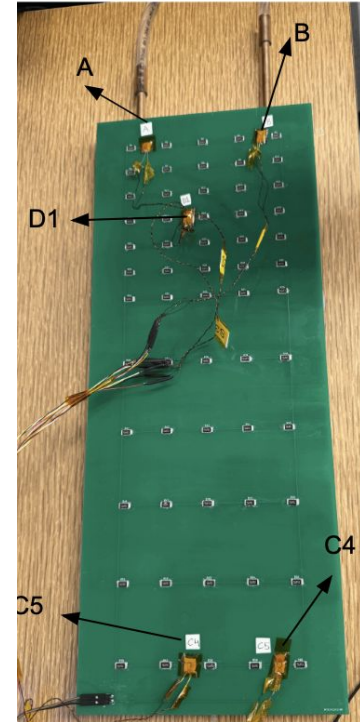


Engineering Test Article 4 following Dual-Cooling strategy



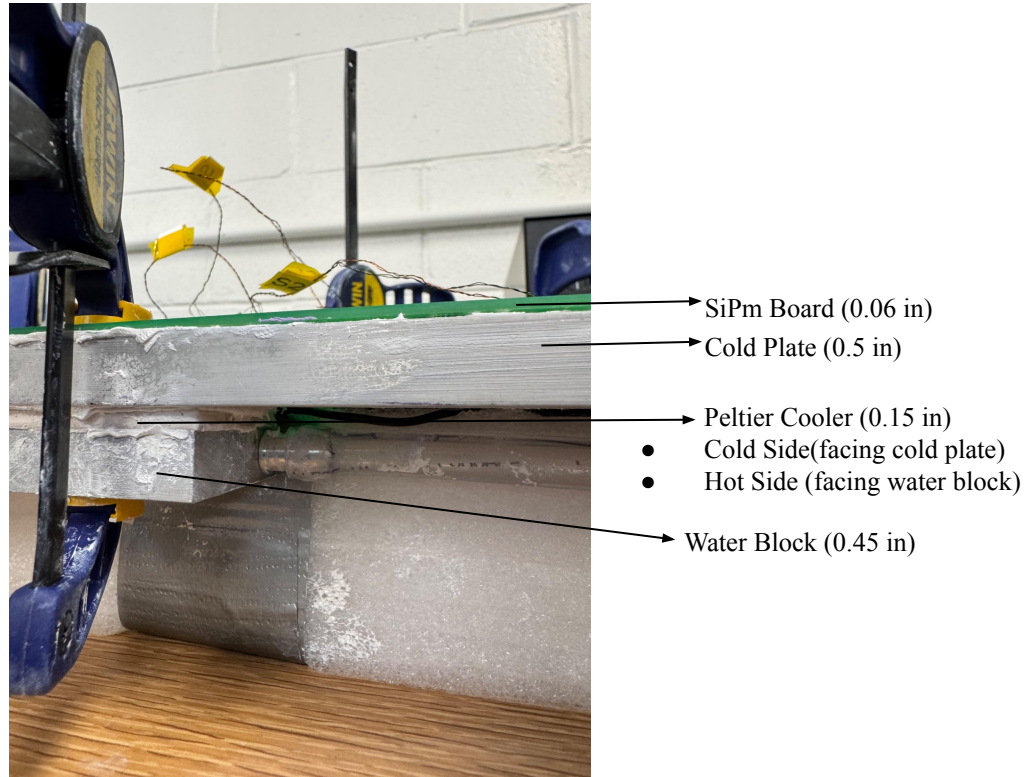
- PCB
- Cold Plate
- Peltier Cooler
 - Cold Side(facing cold plate)
 - Hot Side (facing water block)
- Water Block

Layered dual-cooling stack interfaces

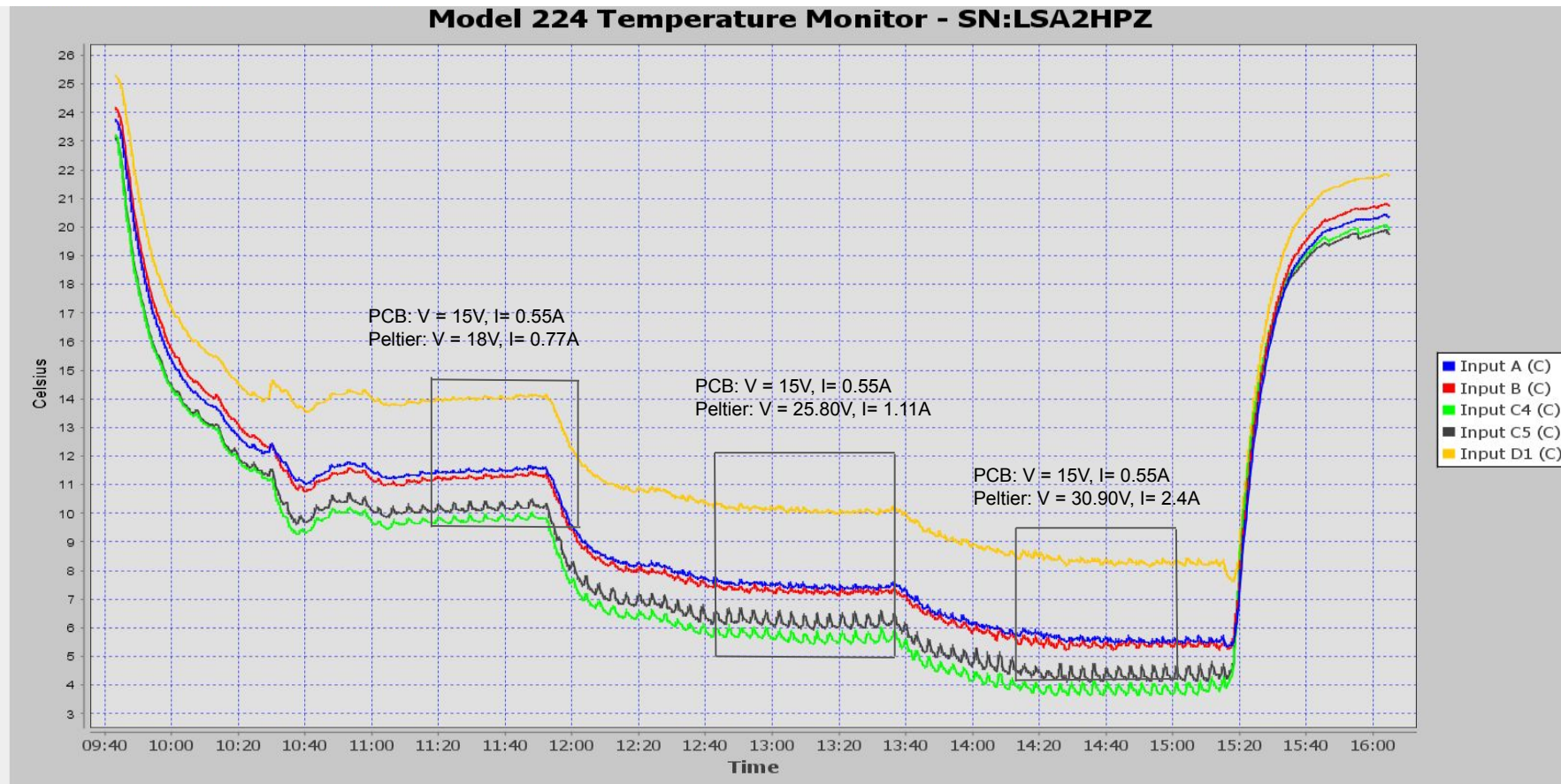


Sensor layout on top PCB surface

Thickness detail of the Dual-Cooling Assembly



Temperature Profiles across varied TEC Input Power at 20 °C coolant temperature for test assembly 4



Summary and next steps

Sensor	Model 1 (20°C)	Model 2 (T=20°C)	Model 3 (T=20°C)	Model 4 (TEC: 30.9V, 2.4A)
Input A	27.3	22.0	22.8	5.5
Input B	24.7	21.7	22.1	5.5
Input C4	30.5	22	21.5	3.9
Input C5	21.7	23	21.8	4.1
Input D1	27.9	24.3	24.3	8.2

- **Test Article 1:** Due to non-planar geometry it showed poor thermal conduction resulted in higher SiPM temperatures.
- **Test Article 2:** Improved heat transfer provided more effective cooling of the SiPM board.
- **Test Article 3:** The press-fit copper pipe in an aluminum base plate matched the thermal performance of Article 2 while mitigating galvanic corrosion risks associated with direct water contact on aluminum.
- **Test Article 4:** The dual-cooling strategy delivered better thermal performance among all, achieving SiPM temperatures below 8°C using a 20°C supply and eliminating the need for a dedicated ESB chiller.

Thankyou!