Cooling

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LBNL EIC Meeting

2/4/25

Sensor Power Regions

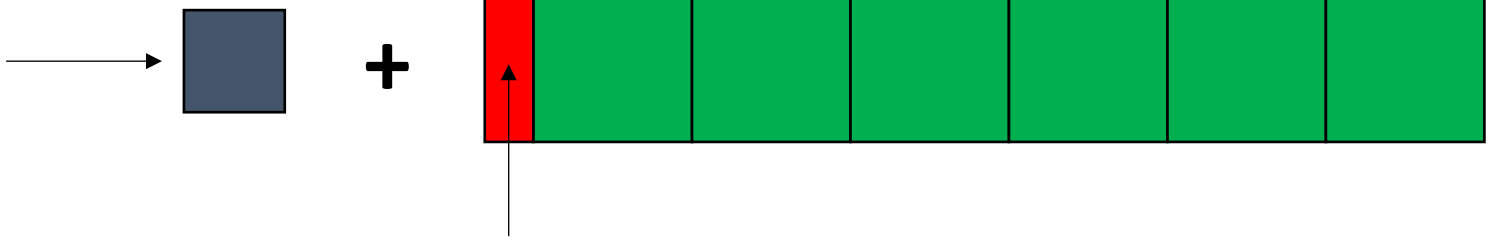
*Snapshot → new numbers shown today

Information from Iain and Georg's presentations at previous SVT meetings*

EIC-LAS

5-6 RSUs
Max: 0.05 W/cm2
Min: 0.03 W/cm2

AncASIC:
Max: 45% of LAS
Min: 35% of LAS



LEC
Max: 0.72 W/cm2
Min: 0.48 W/cm2

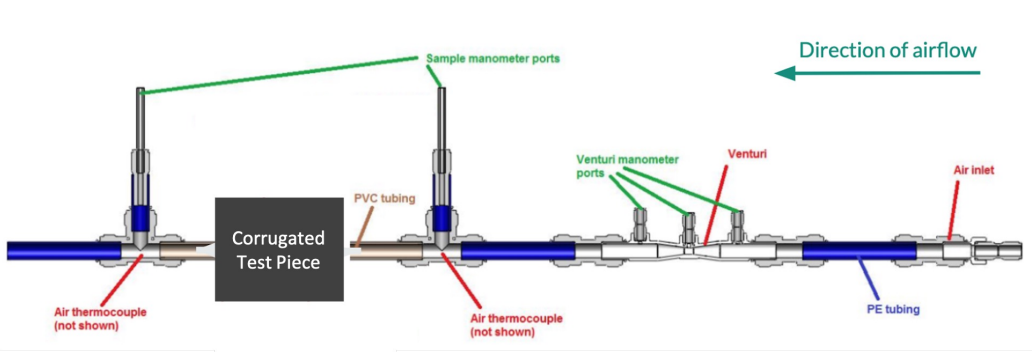
Total power (6 RSUs)
Max: 1.89 W
Min: 1.21 W

MOSAIX: same power densities as EIC-LAS

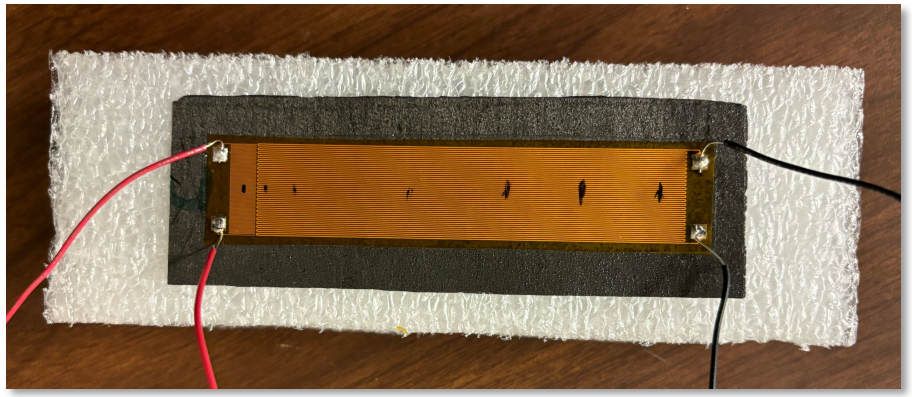
Thermal needs

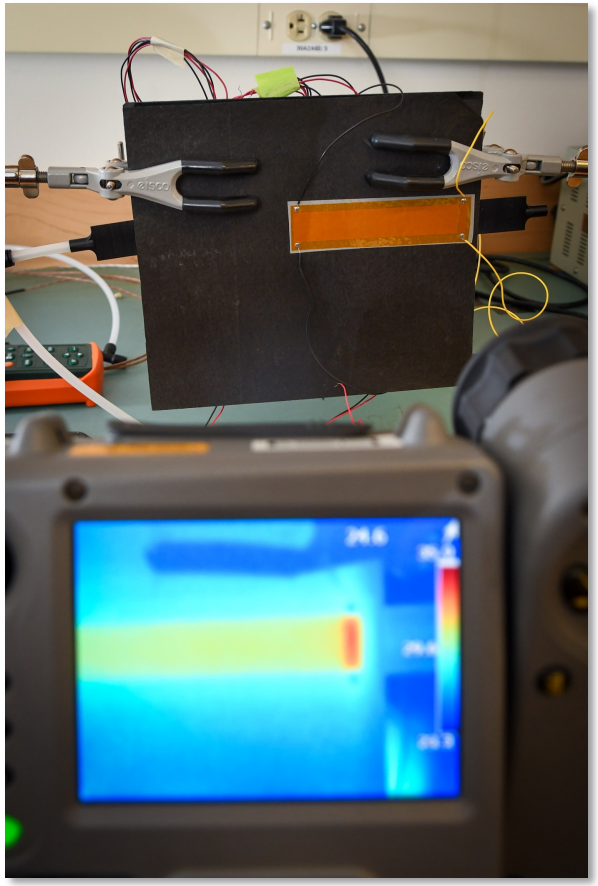
- End goal is operation of sensor at/near ***room temperature*** (25 – 30°C)
- $\Delta T = T_{Heater} - T_{Inlet\ Air}$
- **"Reasonable"** ΔT is one that achieves room temperature operation with sensible air inlet temperature
  - Aiming for $\Delta T < 20°C$ (which would require 5-10 °C air)
- **"Reasonable"** also has to take total air volume into account
  - E.g. if we can achieve room temperature with 30 m/s air, this is not reasonable

Discs: previous results

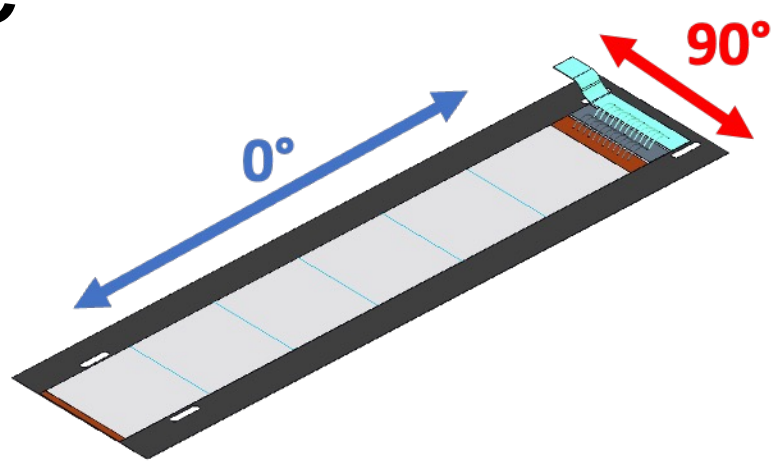


- Cooling through corrugated carbon veil (first prototype)
- Thermal studies using PGS (graphite) & unidirectional carbon fiber (K13C2U)

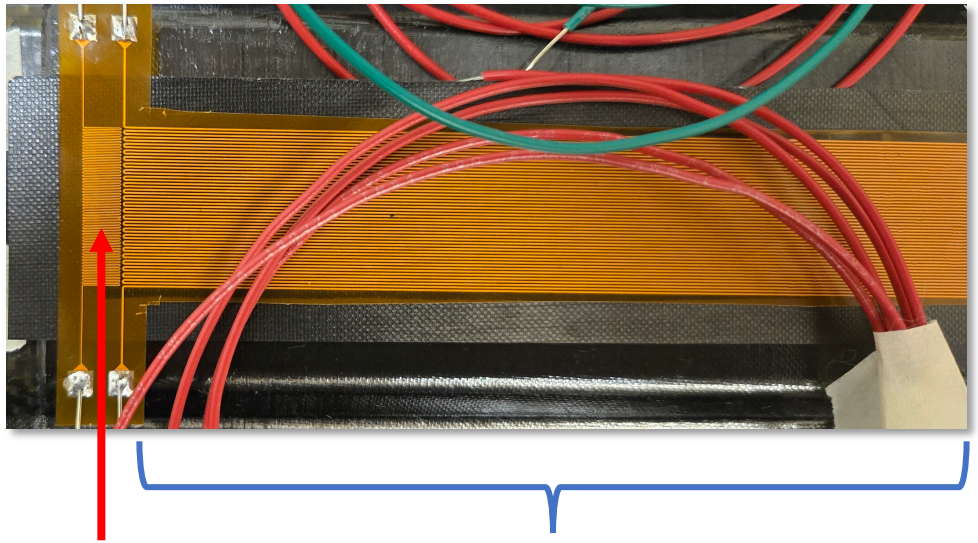


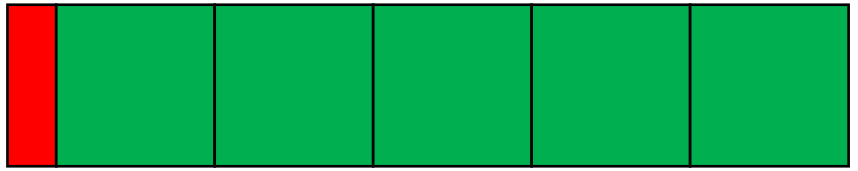


Modules: thermal performance



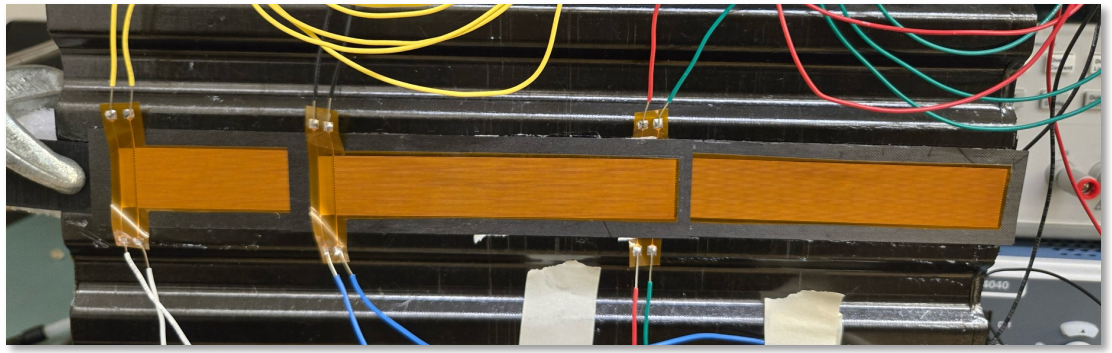
Heaters: 2 power regions





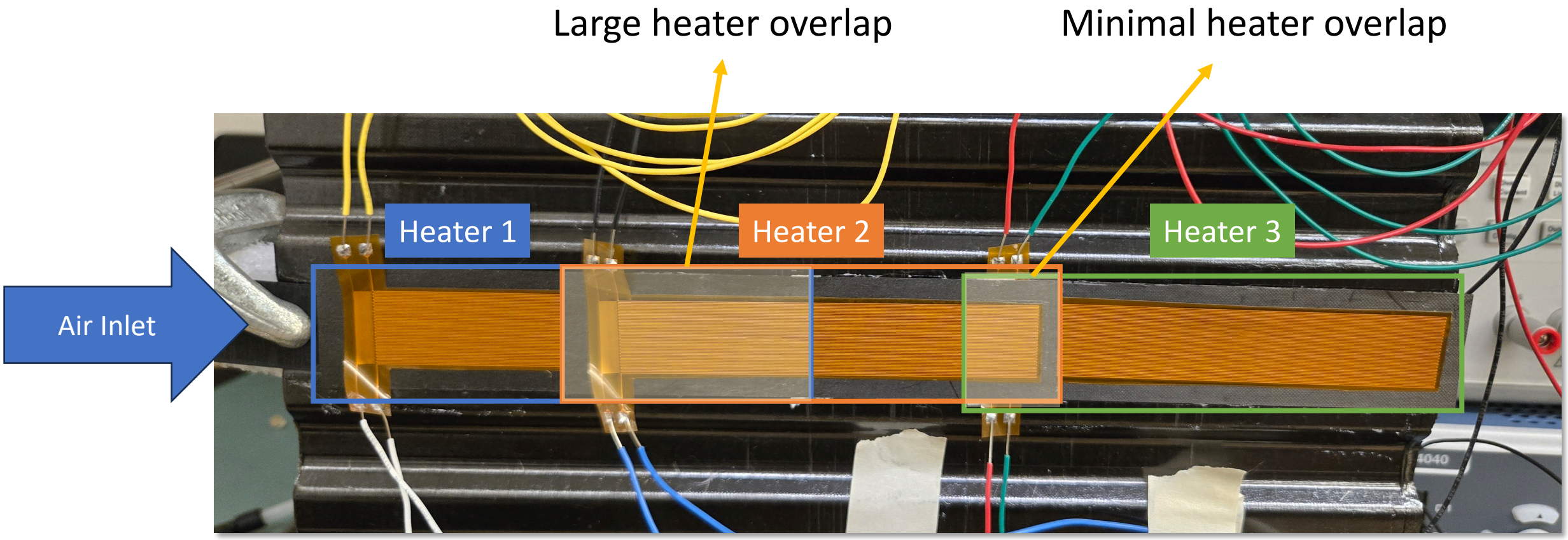
Each power region powered separately
Capable of a range of power densities

Thermal prototype

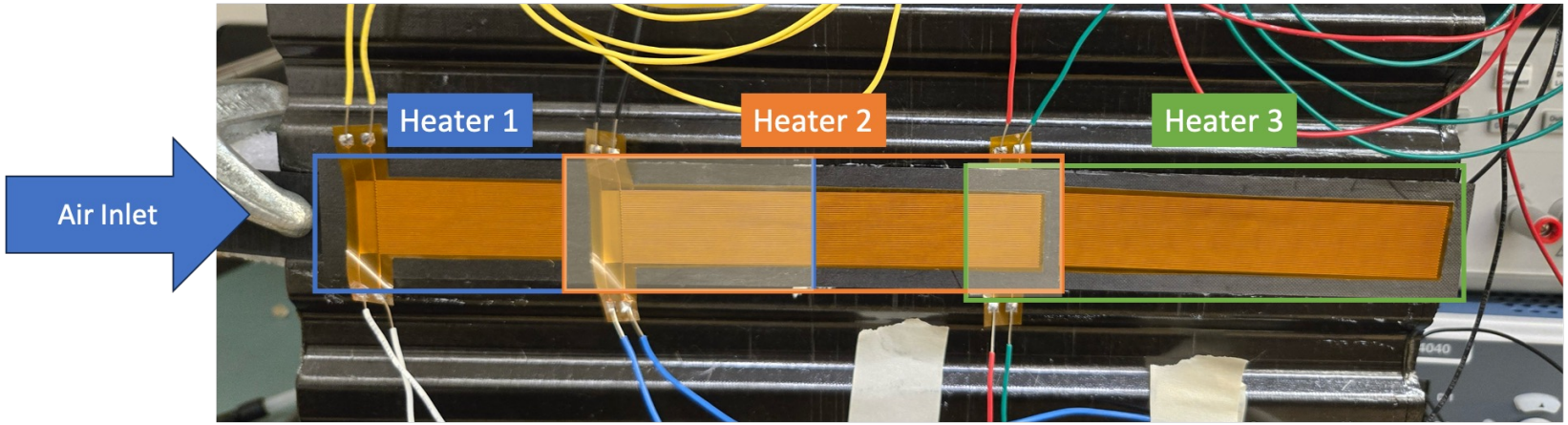


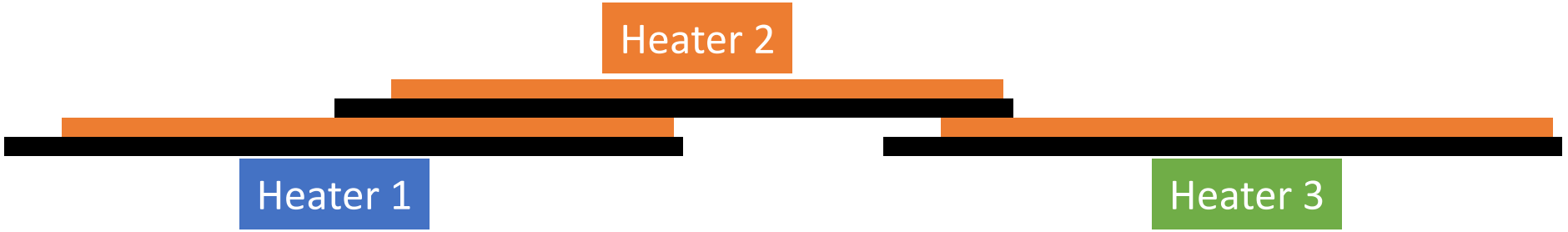
- Three heaters placed on one corrugated channel
- Two overlap regions
  - Large (~1/2 the heater length)
  - Minimal (~LEC length)
- Configuration: outward facing only
- Tested at two different powers, MAX and MIN (based on numbers shown in previous slide)
- Held in same orientation as planned in ePIC

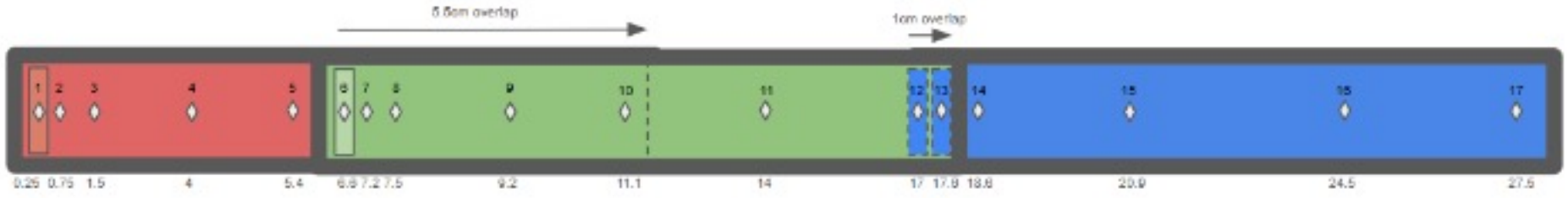
Test setup


Large heater overlap
Minimal heater overlap
Air Inlet
Heater 1
Heater 2
Heater 3

From the side

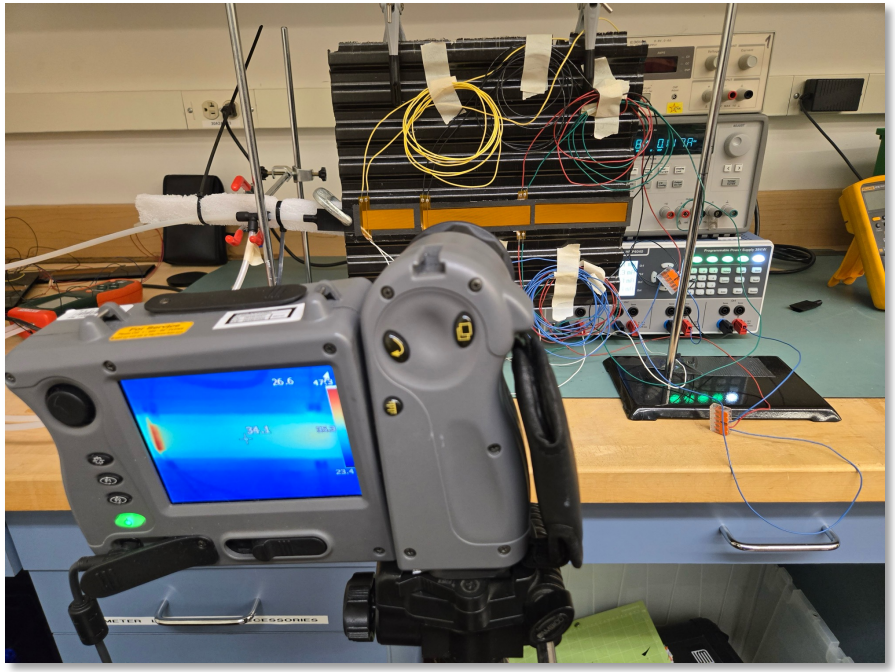




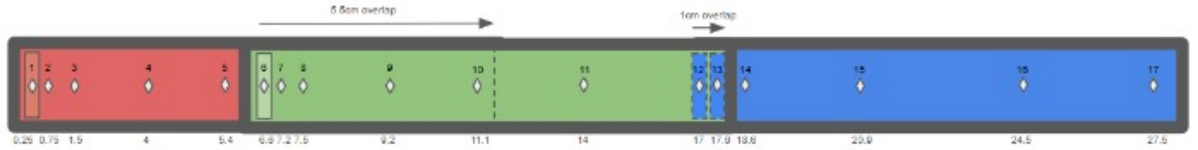


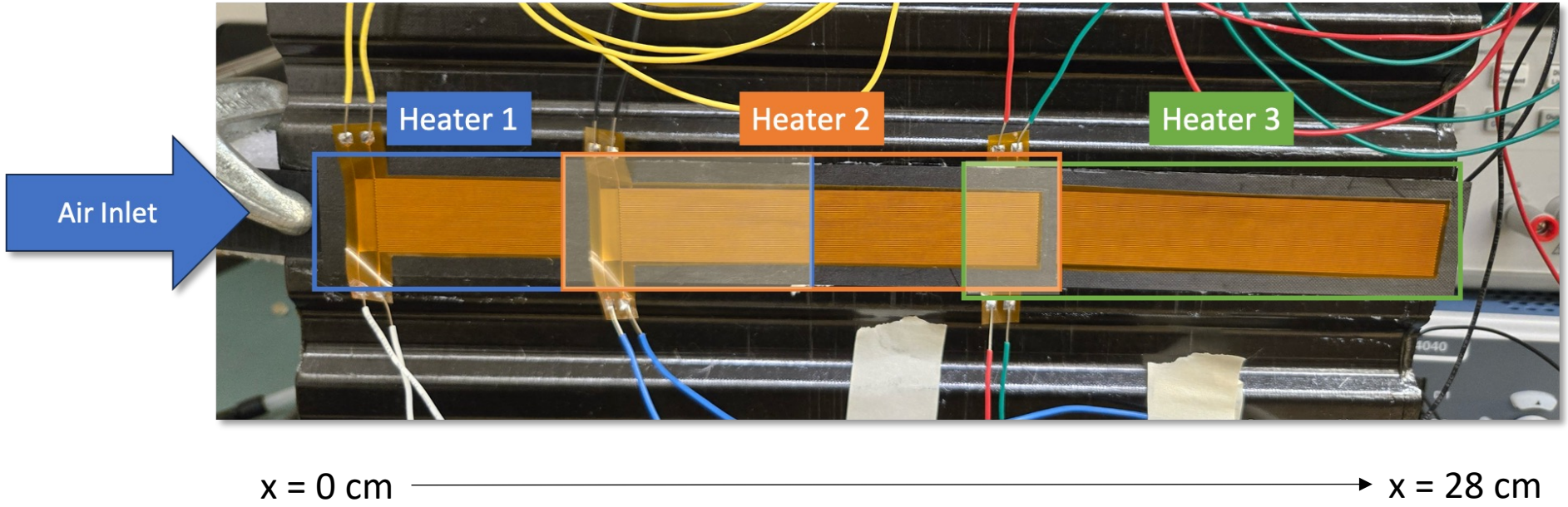
Test setup & caveats

- Using thermal camera → ~0.5°C fluctuations
- $\Delta T = T_{BrightTemp} - T_{DarkTemp}$
  - Dark temp taken with air flowing, but no power
  - Bright temp taken with air flowing and power on
- Cannot measure ΔT of sections we cannot see, i.e. hidden behind overlap
- Potential air leaks for large air velocity
  - Modules glued to each other ***ONLY*** via the carbon fiber → will not be the case for inward & outward alternation



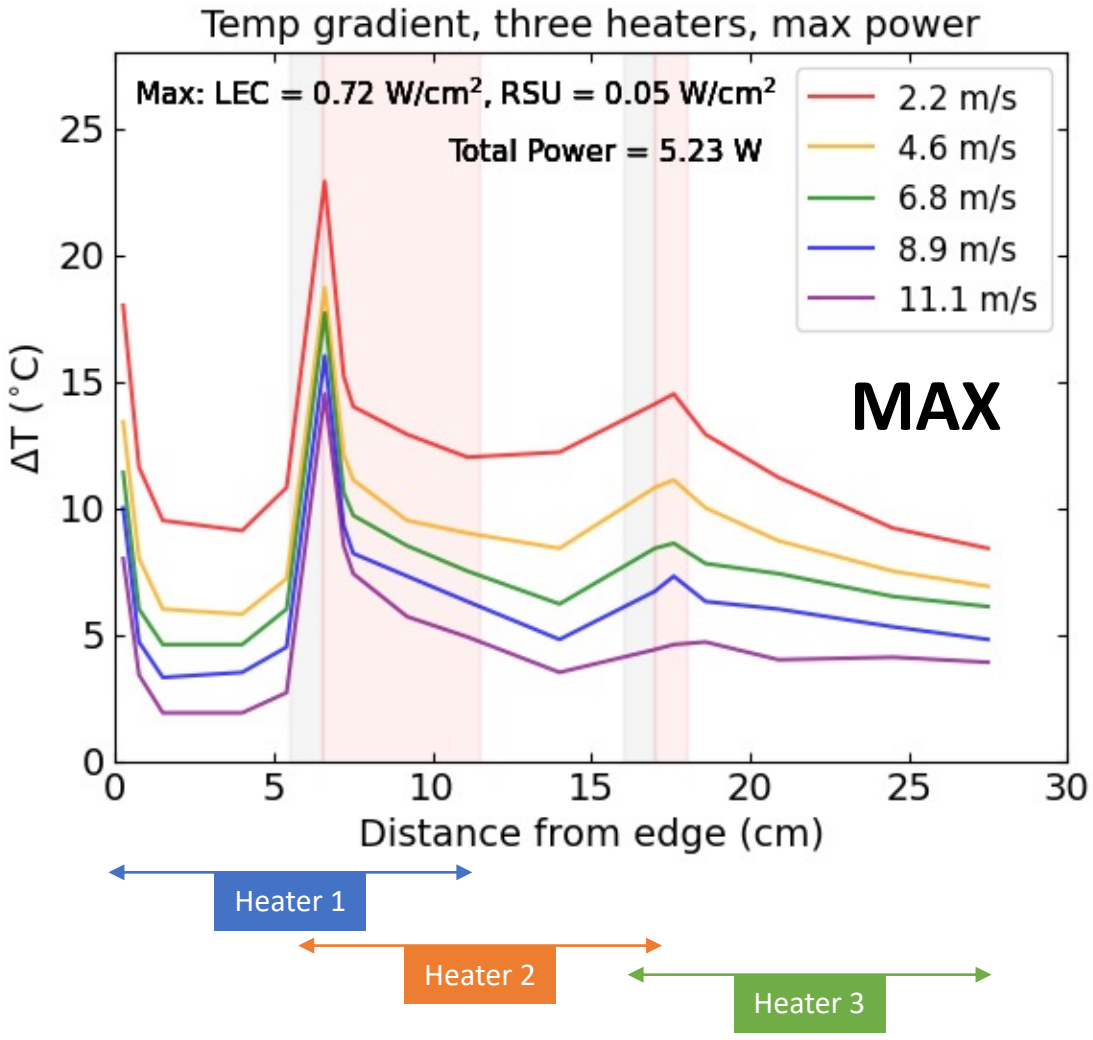
Measurements

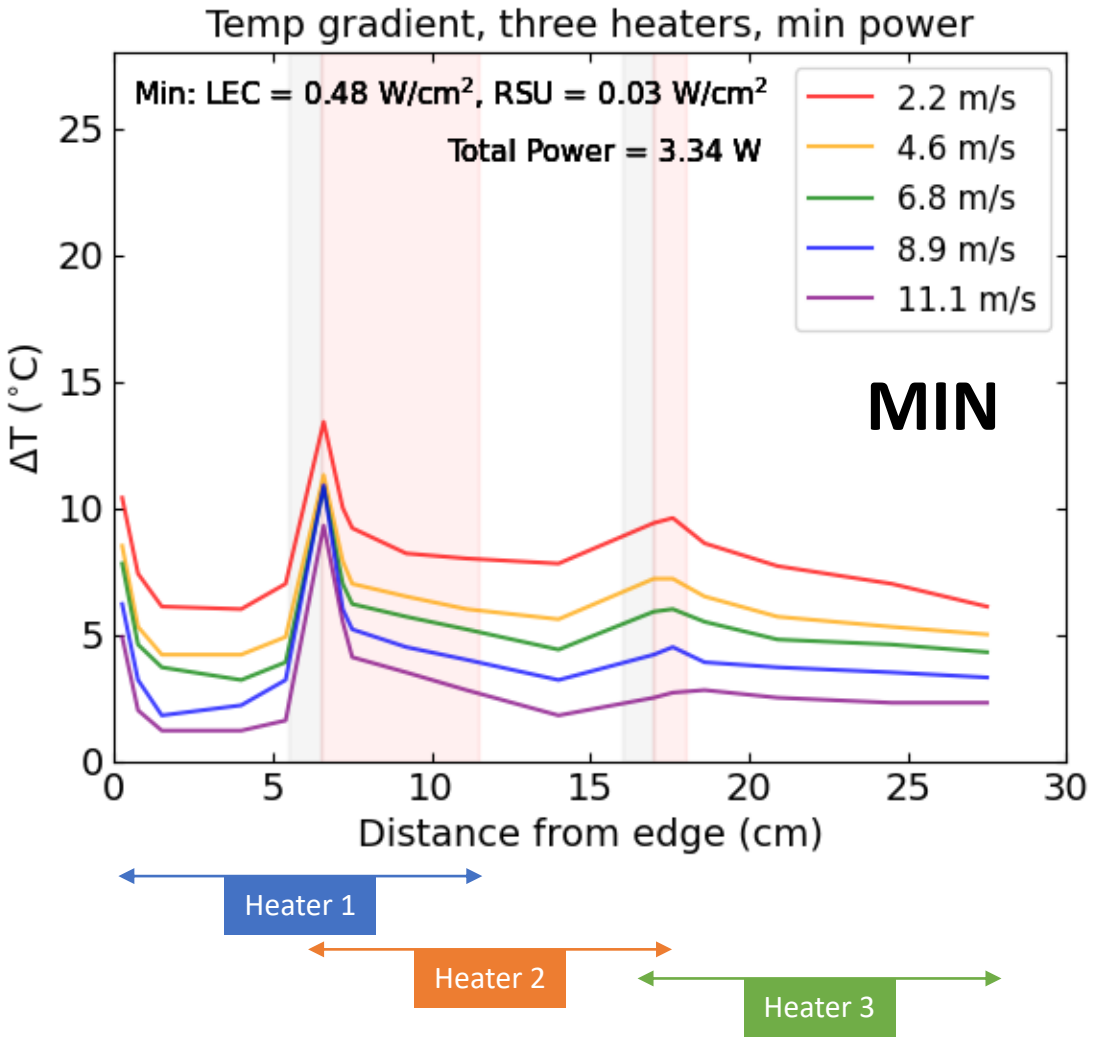




- Bright Temp measured at 17 different x values along corrugation (0 – 28 cm)
  - One point taken at each LEC position
- Data taken at 4-5 different air velocity values
- Taken at MAX and MIN powers
- Data taken with all three heaters on and then each heater powered individually

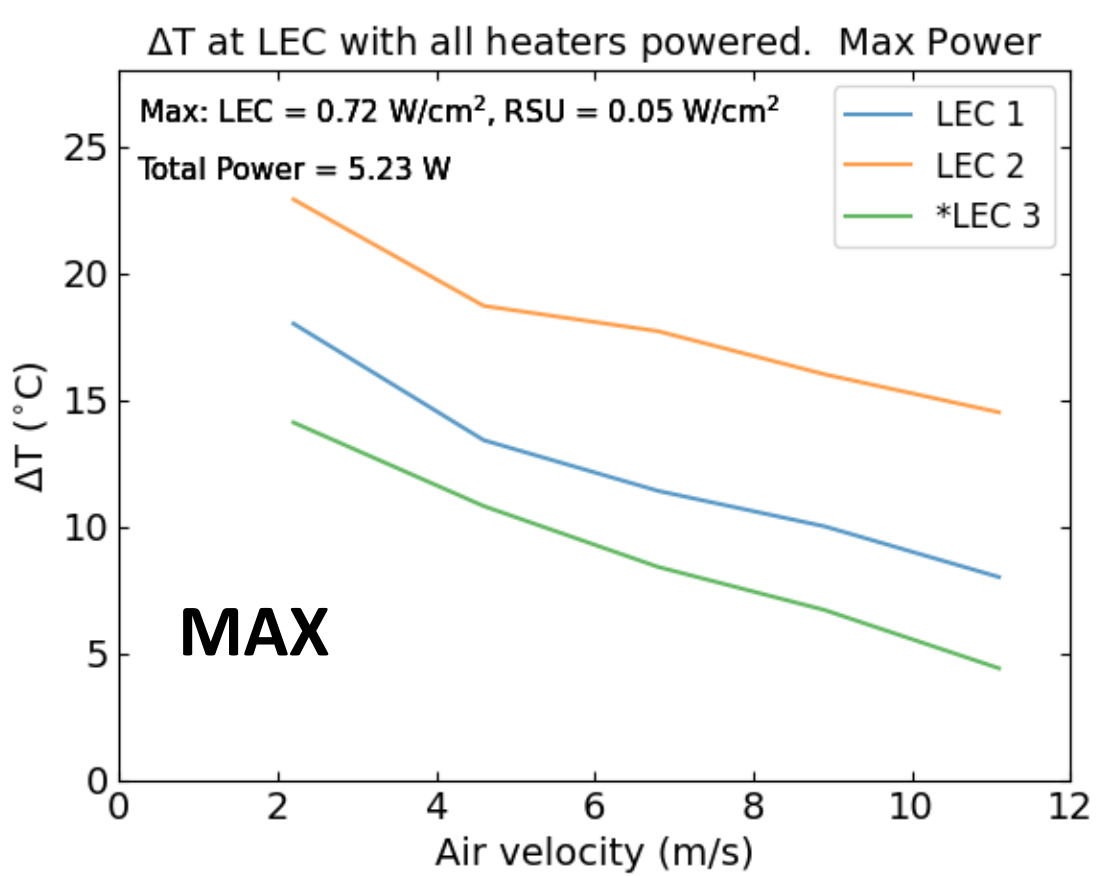
All heaters powered

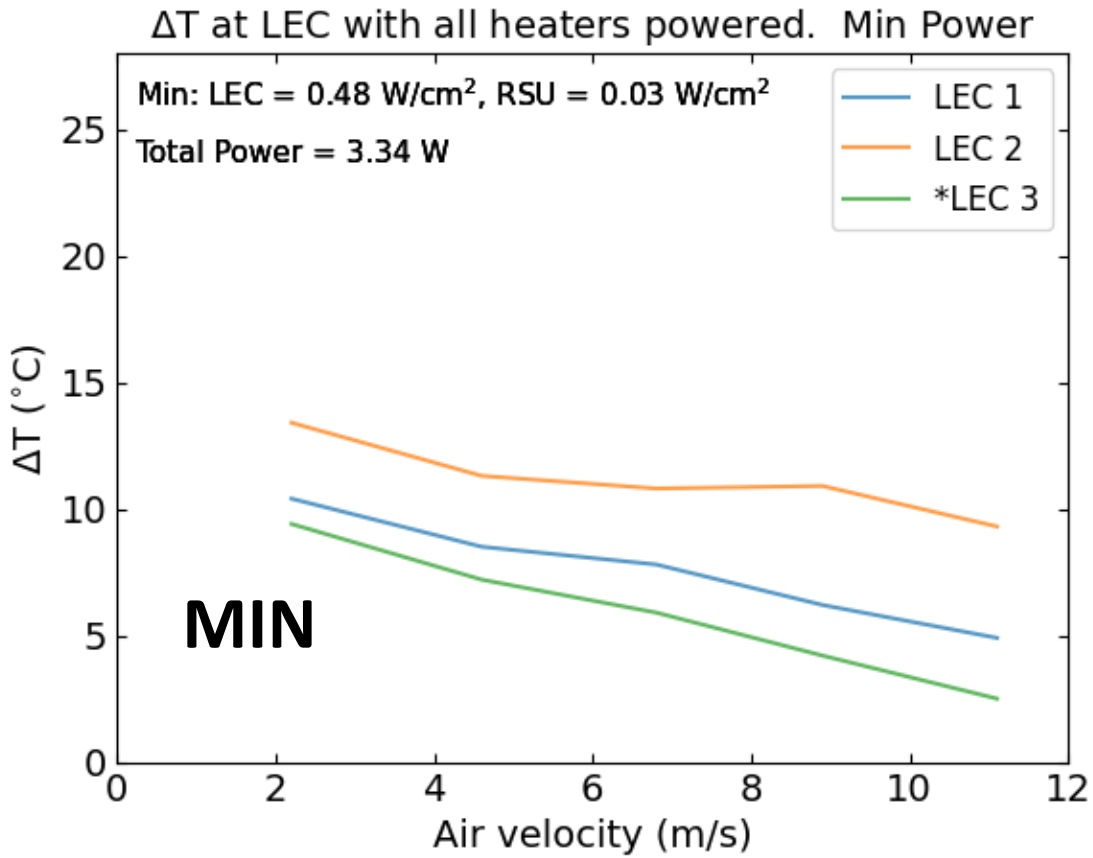




Isolated LEC

*LEC 3 → cannot be directly measured and is therefore a measurement of the RSU with the LEC on behind it



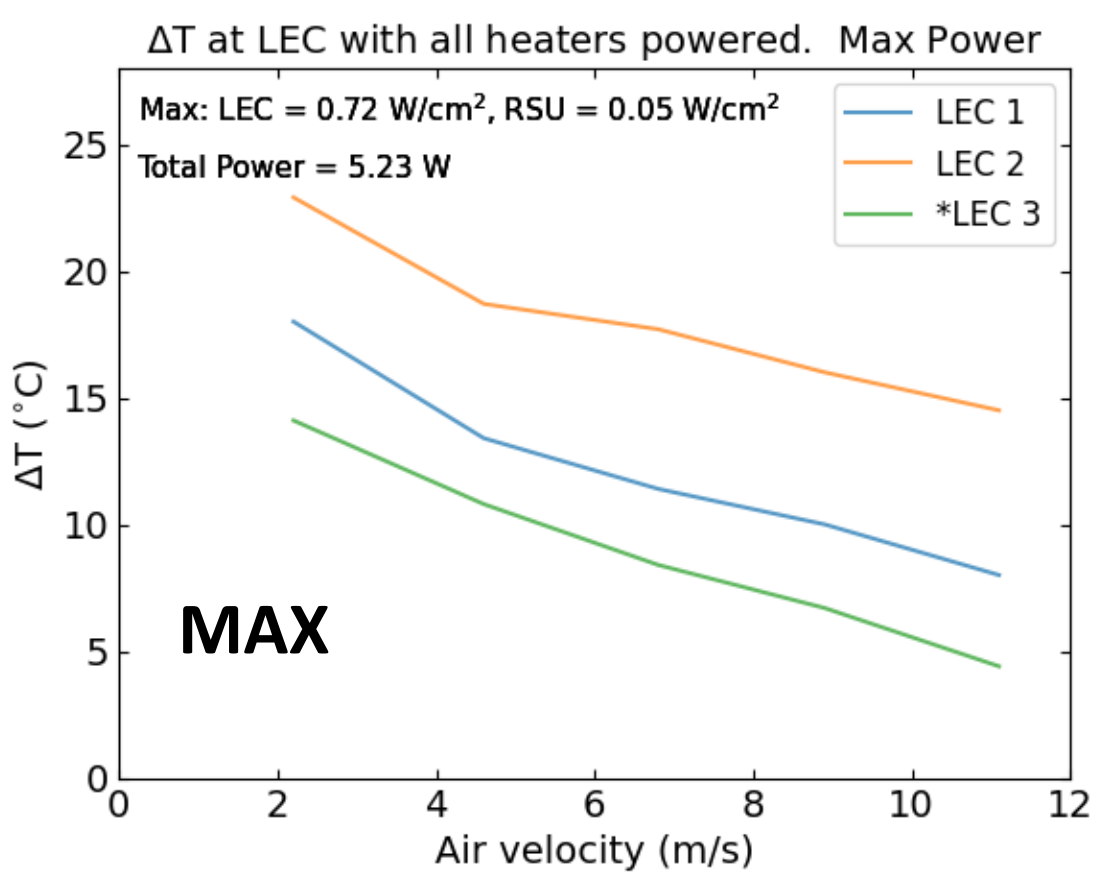


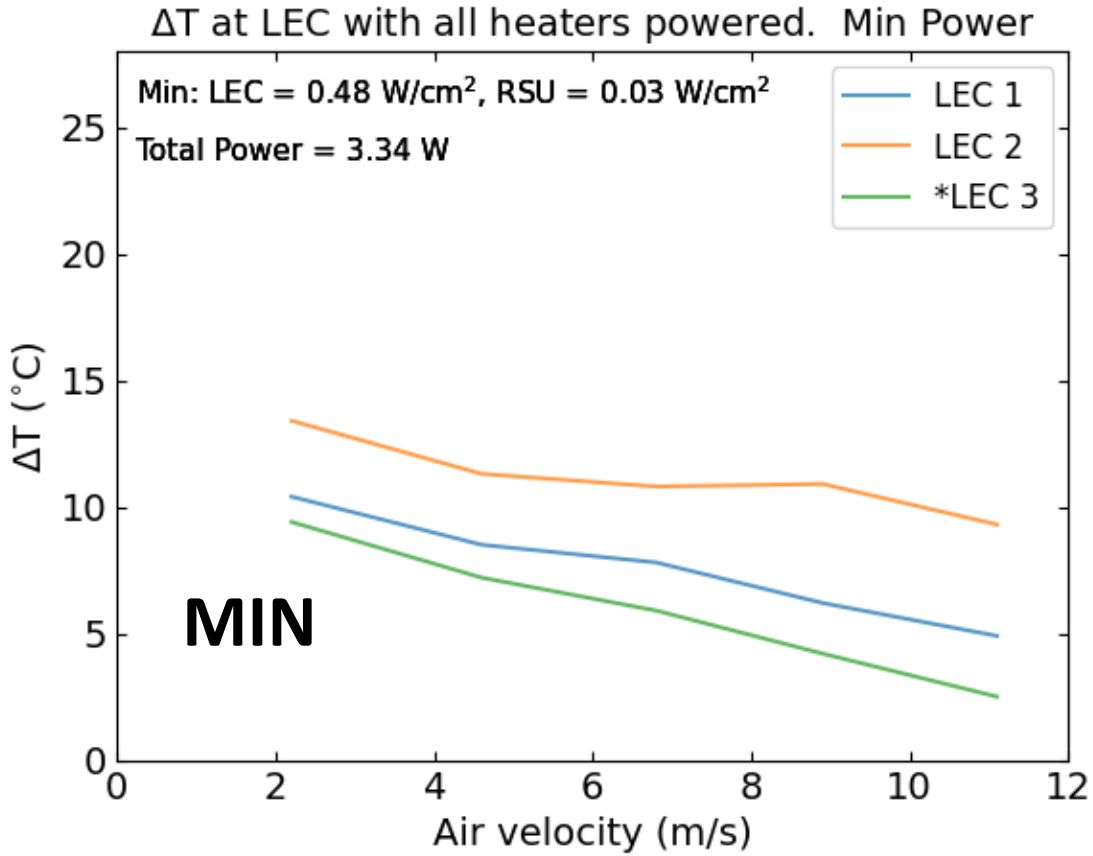
LEC 2 highest → expected since overlaps RSU

Expect *actual* LEC 3 to be similar to LEC 2

Isolated LEC

*LEC 3 → cannot be directly measured and is therefore a measurement of the RSU with the LEC on behind it

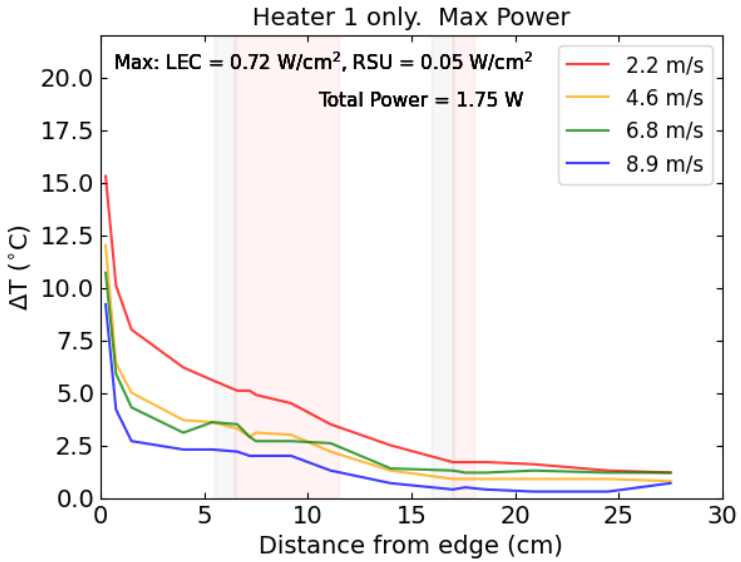


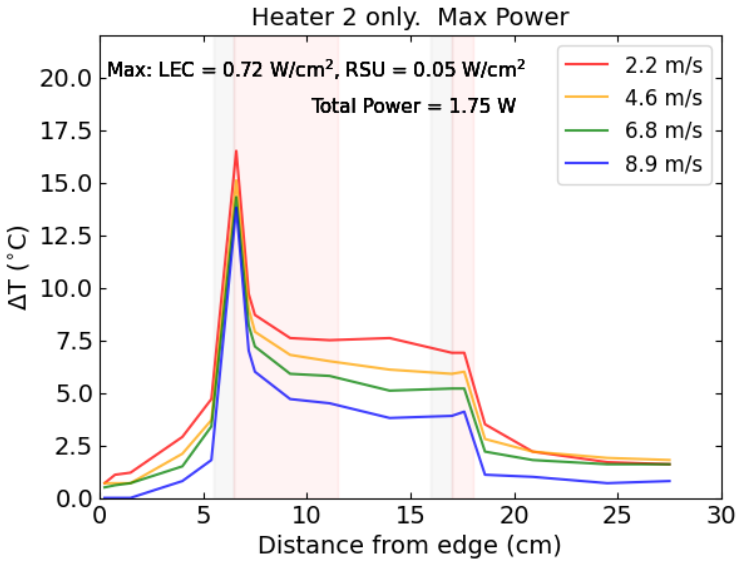


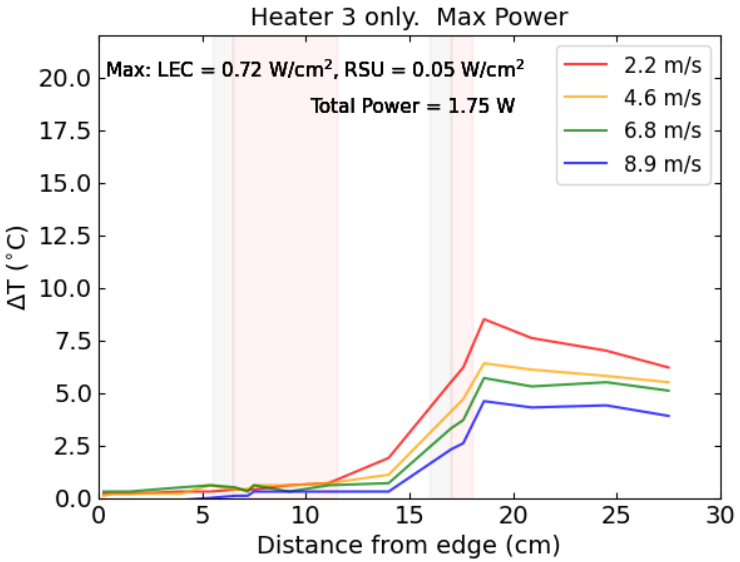
MAX: $\Delta T < 20°C$ for air > 8 m/s

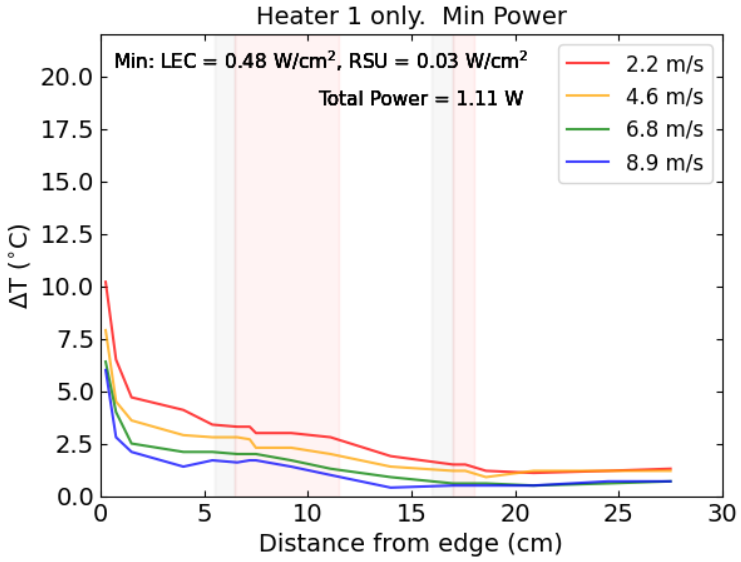
MIN: $\Delta T < 15°C$ for all air speeds

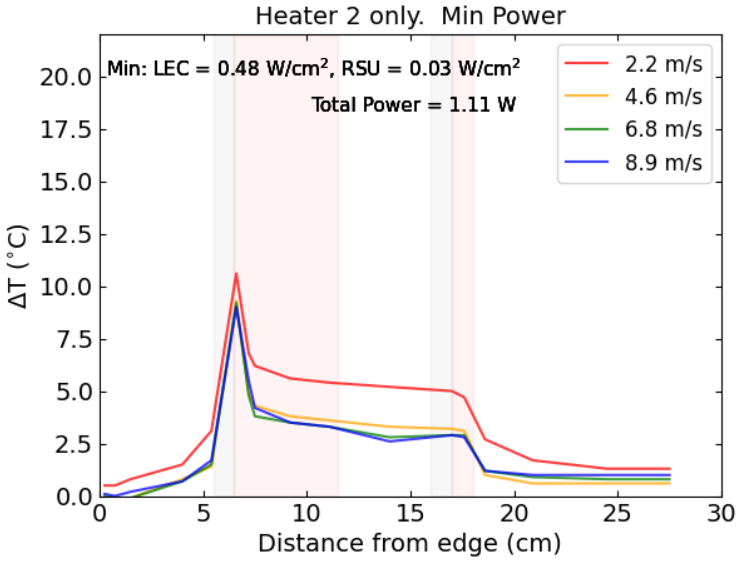
Powering individual heaters

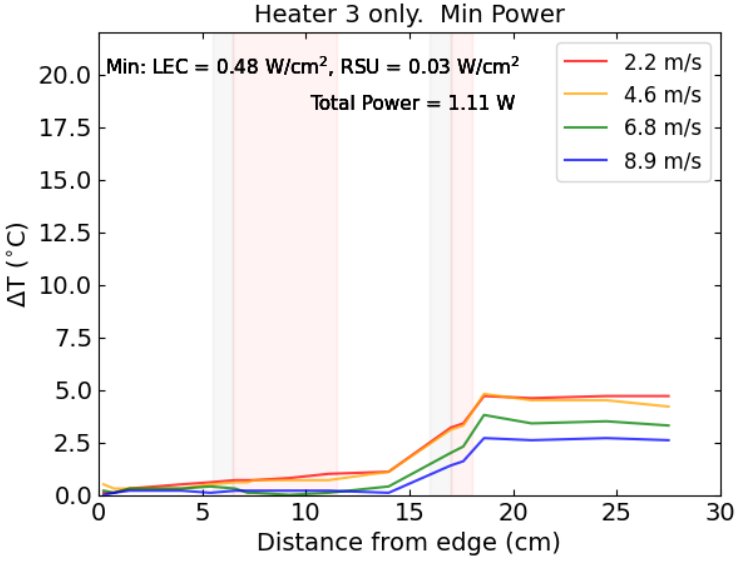




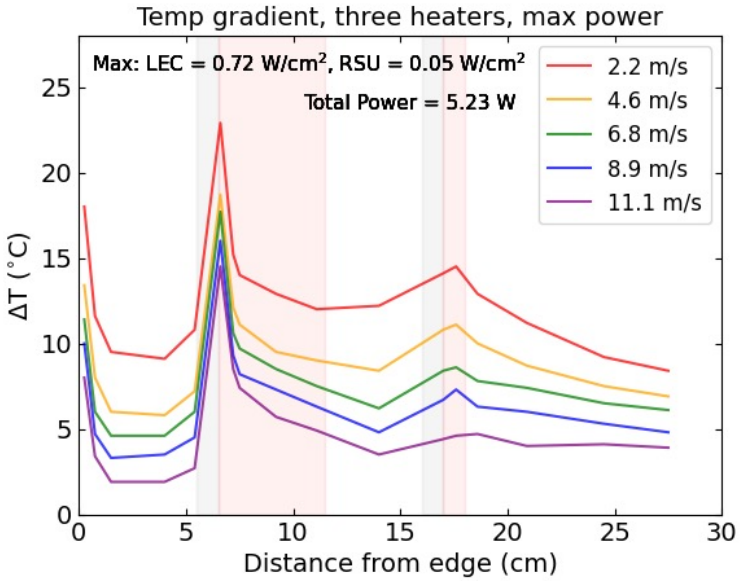








Comparing all powered to single



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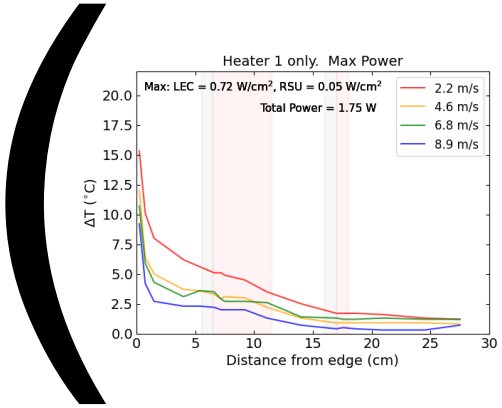

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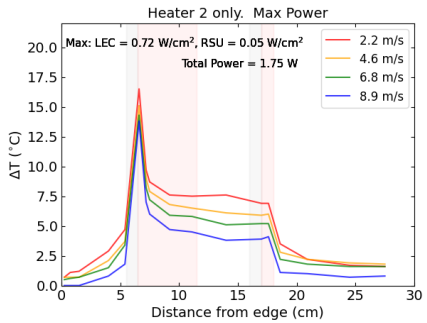

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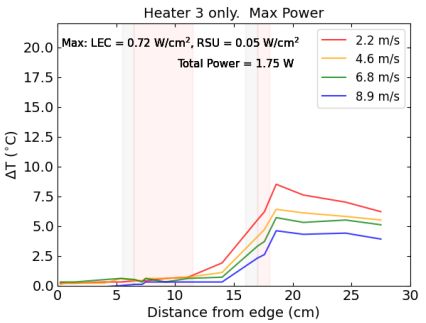
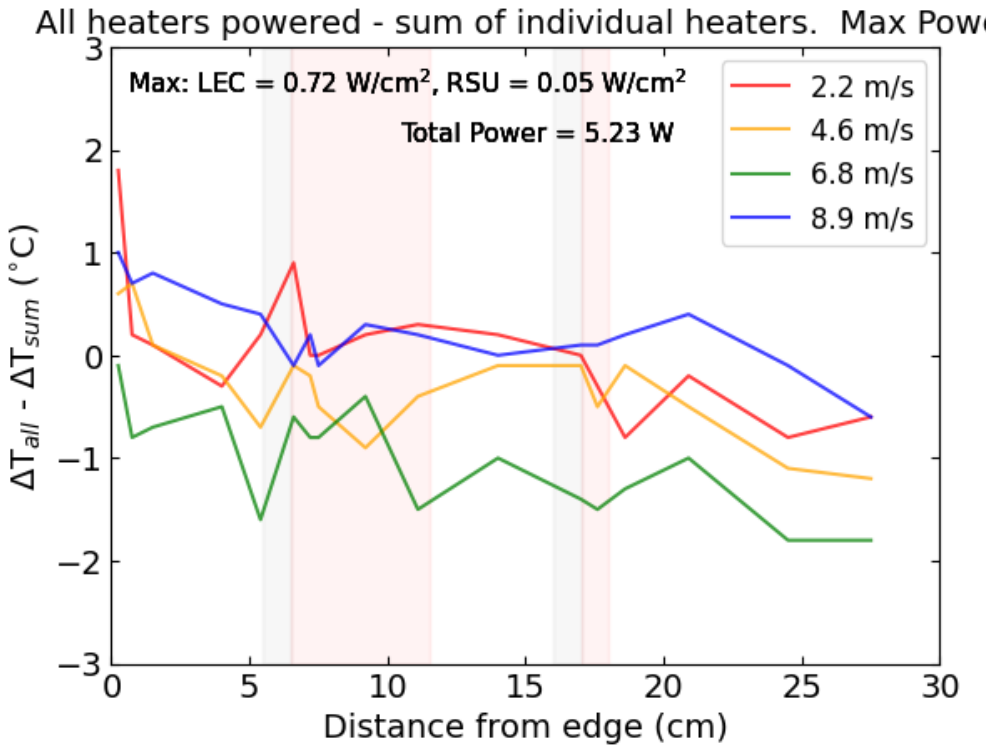
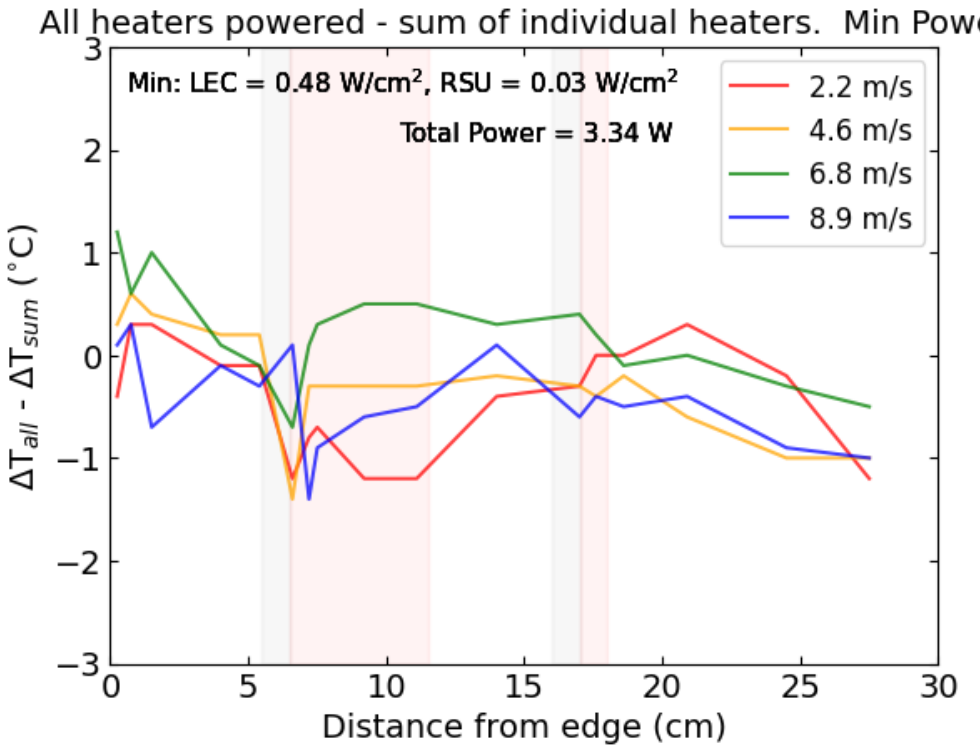


ΔT_{all}: all 3 powered

ΔT_{sum}: $\Delta T_1 + \Delta T_2 + \Delta T_3$

Comparing all powered to single

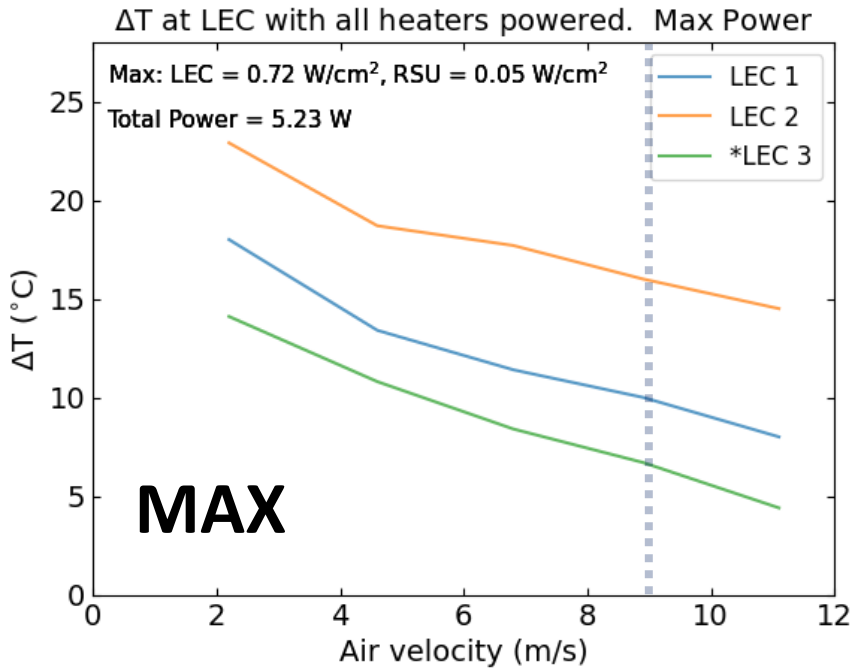


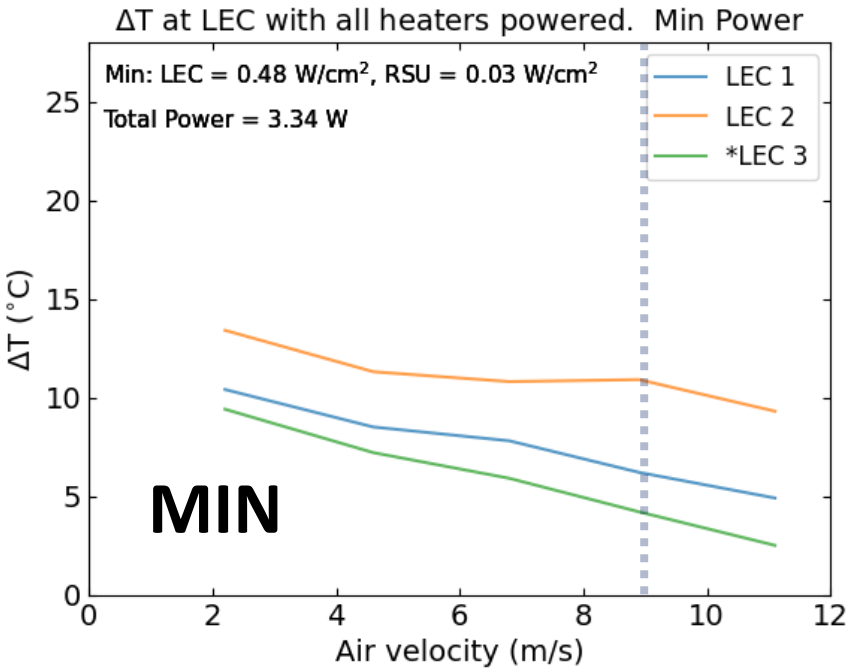


ΔT all powered – ΔT sum of individual results

Varies around 0 → confidence that we can predict ΔT if power changes

Summary





- At 9 m/s:
  - RSU ΔT < 10°C for MAX and < 5°C for MIN
  - LEC ΔT < 20°C for MAX and < 15°C for MIN
- ΔT dependent on overlap and proximity to air flow/edge of disc
- At 9 m/s through 2 corrugated channels, discs would need ~400 cfm