

Mini stave FEA update

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Mini stave thermal measurement at +15C (03.26)

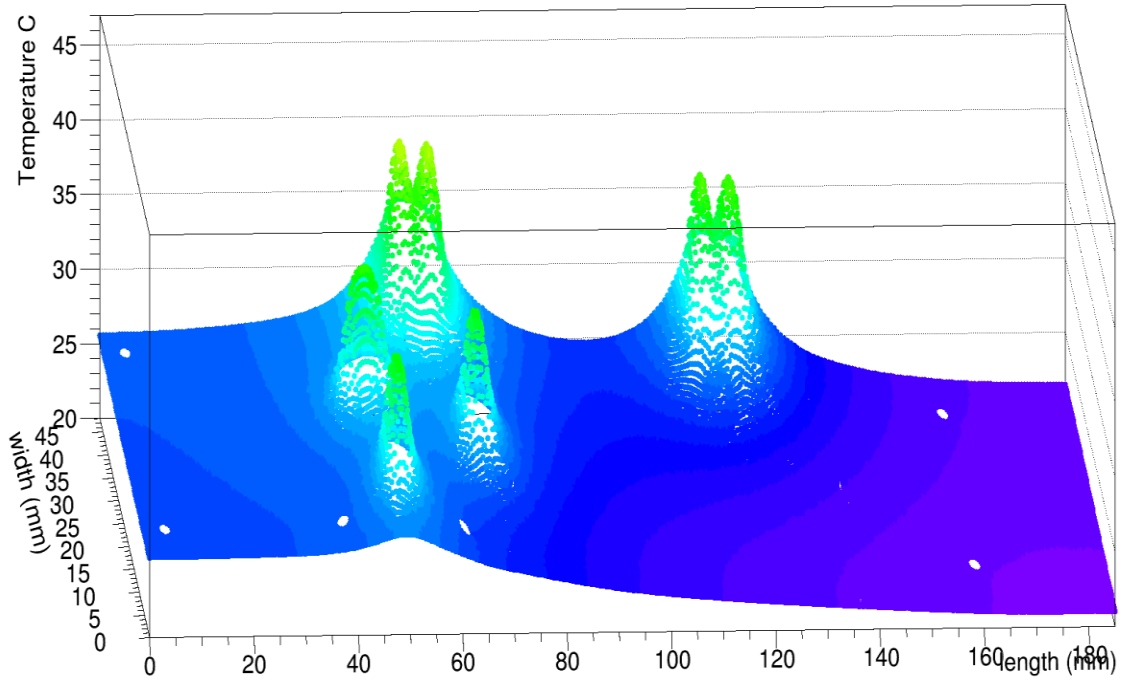
- Take measurement using small angle IR camera lens, pixel length~0.6 mm
- Chiller set Temperature +15C, Bypass inlet 16.7 C, outlet 17.1C, FEA pipe T 16.9C, Box air T 21.5C
- Powered resistors: only LHSM; R4//R5 , R6//R7 each resistor ~ 0.445W; R3~0.446W; R1&R2~0.447W
- Total PCB power: ~3.12W
- Data taken without air flow
- Data obtained at 20,40,60 mins after bypass in/out T is stable
- Average flow rate: ~0.97L/min

Mini stave FEA model (03.26)

- Pipe temperature :16.9 C
- Ambient contact coefficient : $8E-6$ W/mm²K ; pipe surface contact coefficient: $7E-3$ W/mm²K
- PCB conductivity: x & y direction: $2.5E-2$, z direction: $5E-4$ W/mm²K

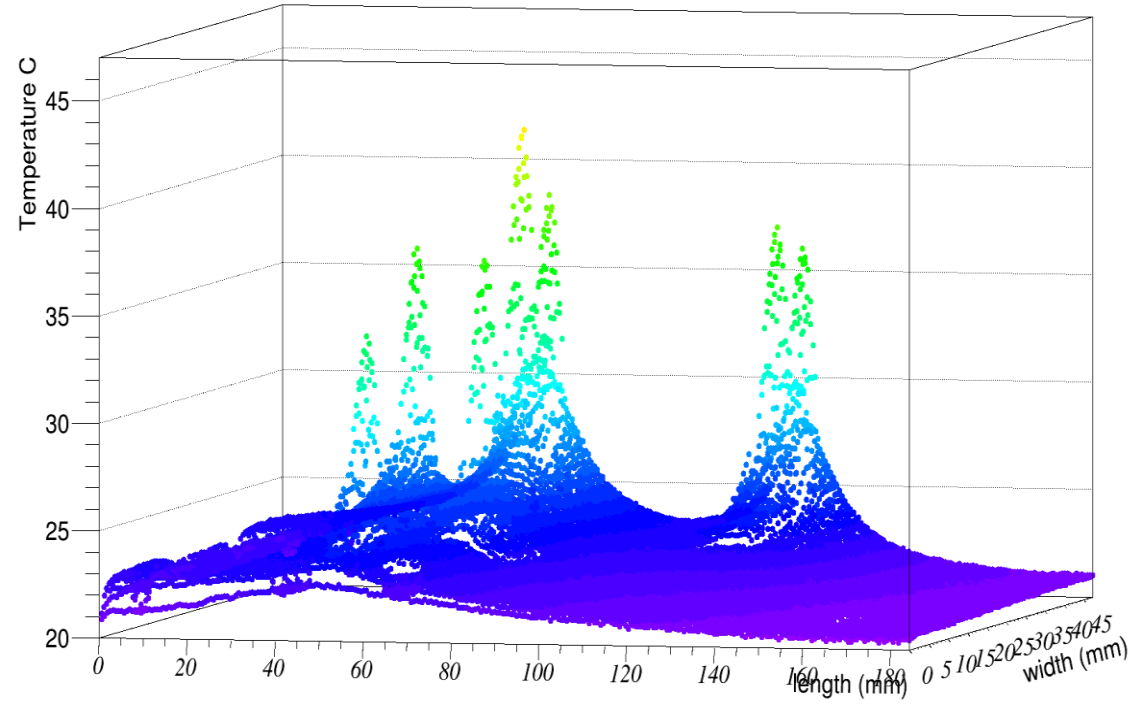
PCB surface temperature comparison at Chiller set T +15C

Simulated PCB surface Temperature



Ambient contact area: PCB & main stave region

PCB measured surface Temperature

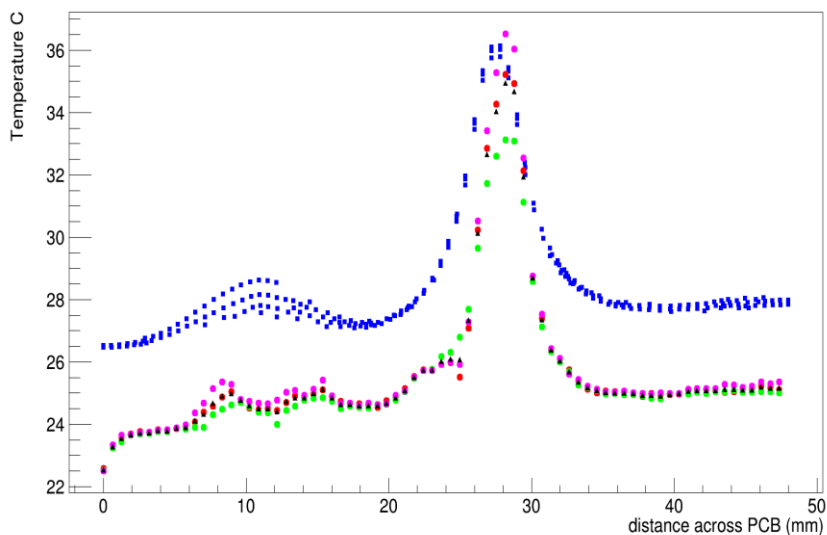


Data taken at 60mins

Temperature across PCB at Chiller set T +15C

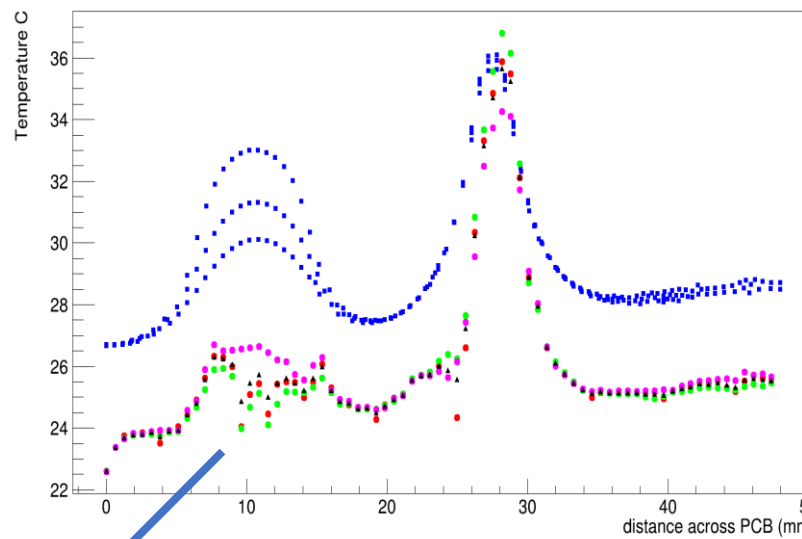
- Curve color: red x ; green x-1; purple x+1; black T average of three curves. x is pixel index along PCB length
- FEA simulation: blue curve

Temperature across PCB



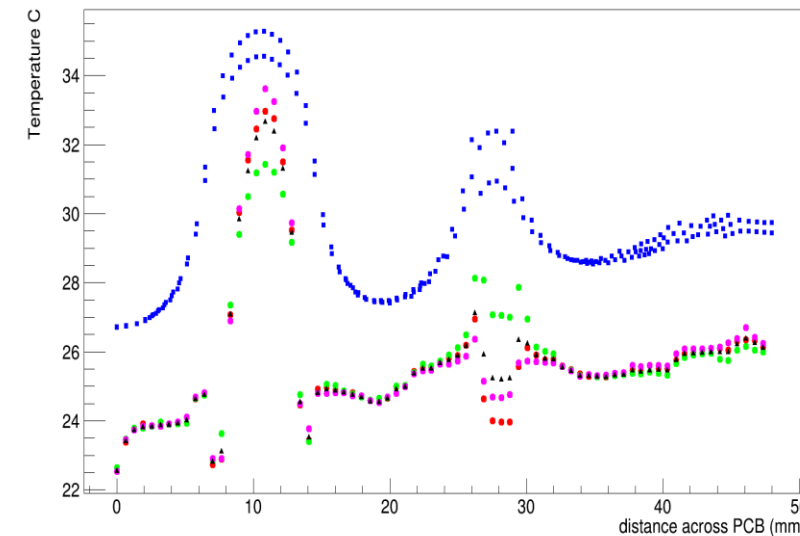
passes R3, x=223

Temperature across PCB

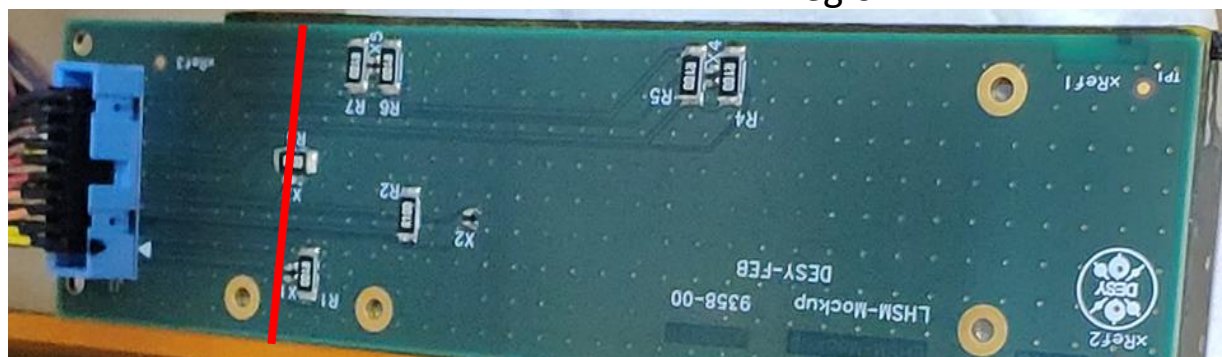


Thermometer region passes R3, x=226

Temperature across PCB



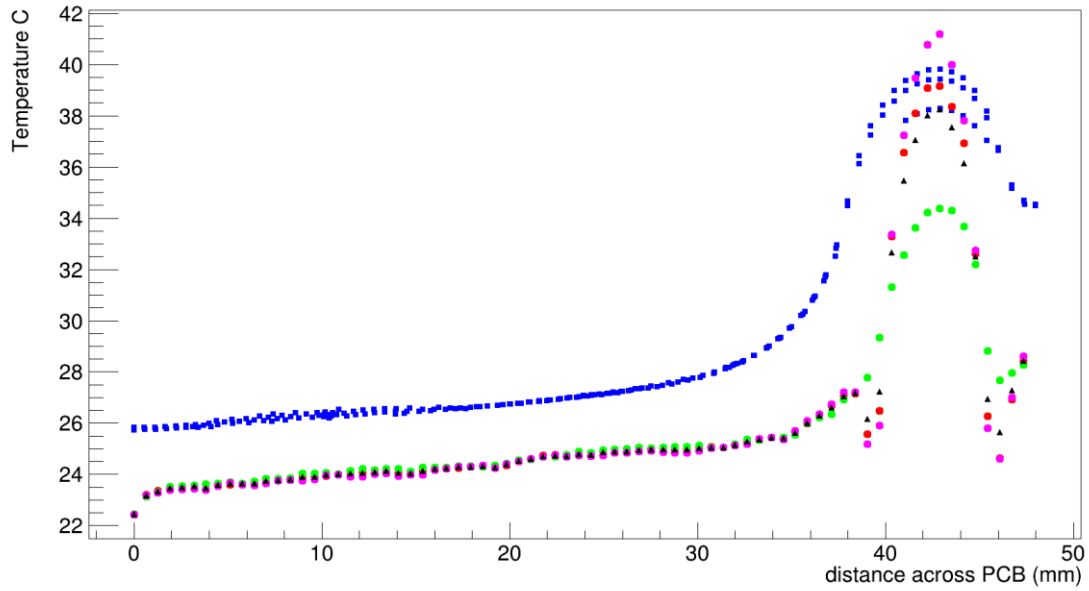
passes R1, R3 soldering point ;x=230



X

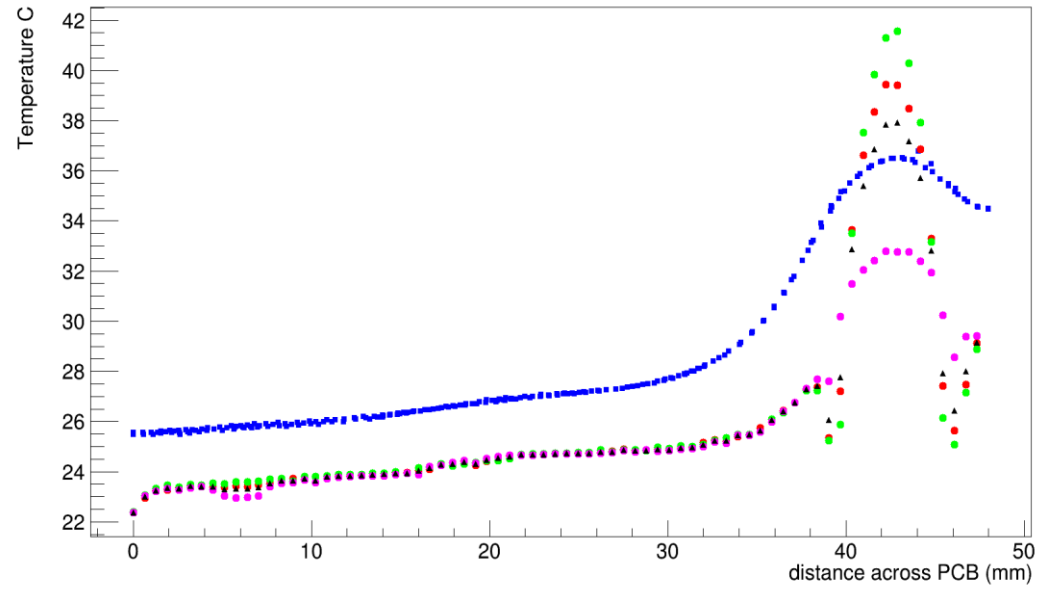
Temperature across PCB at Chiller set T +15C

Temperature across PCB



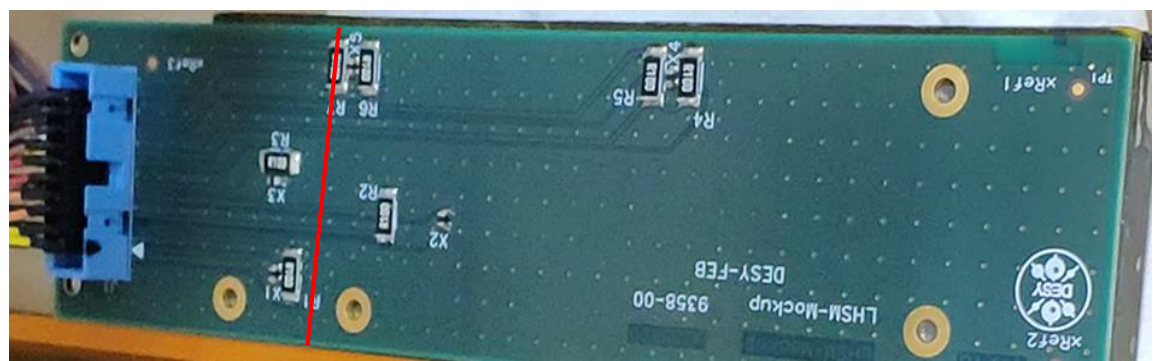
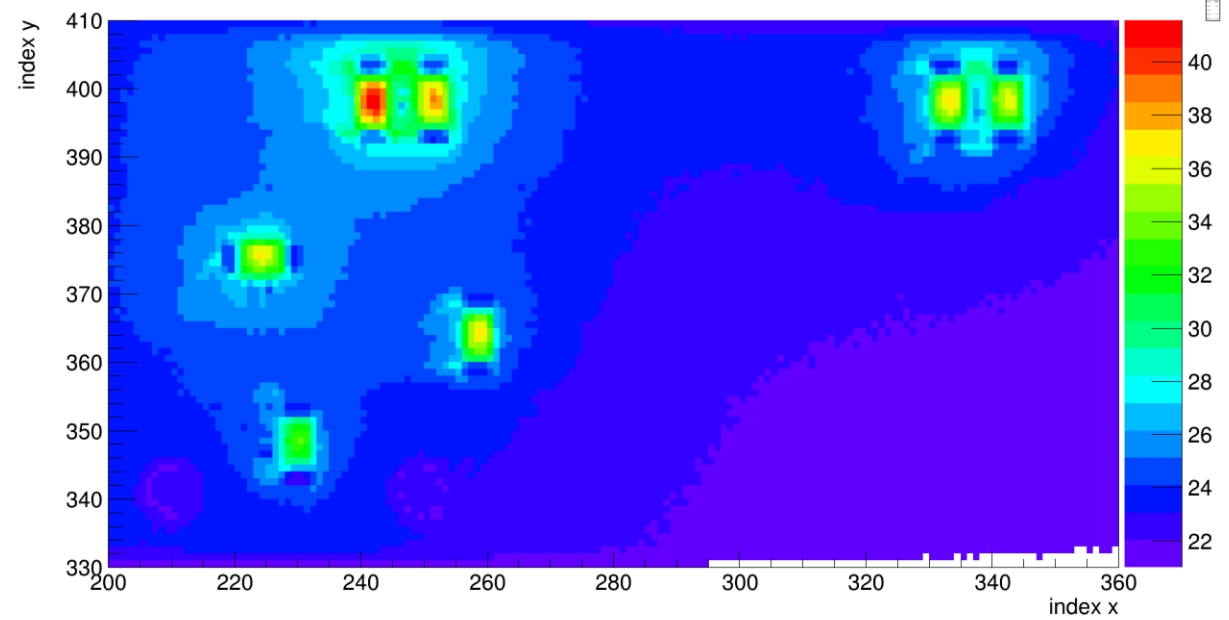
passes R7, x=241

Temperature across PCB



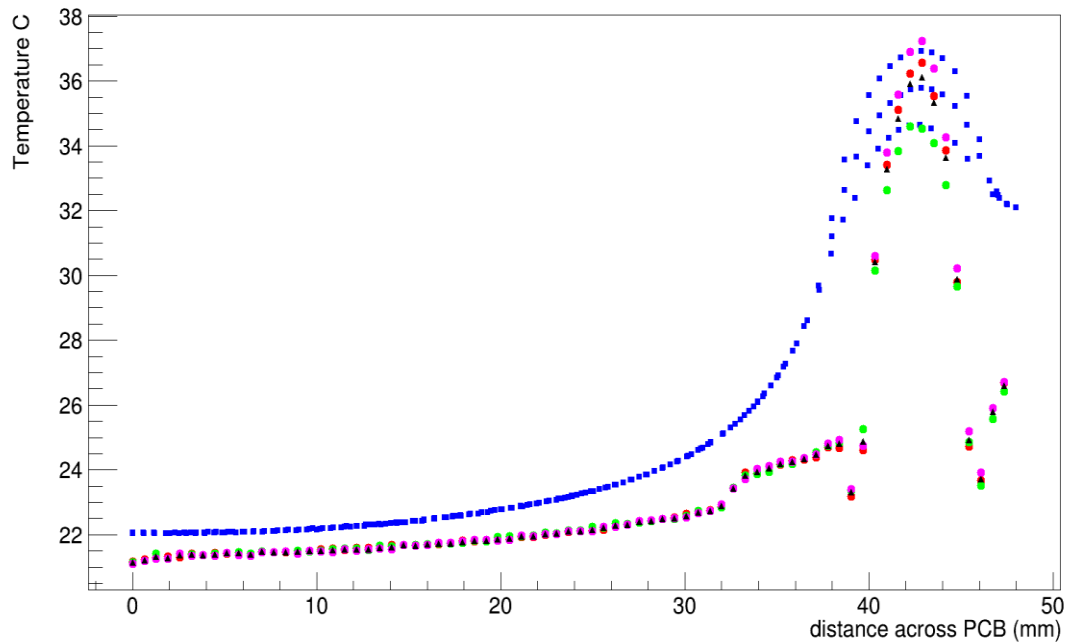
passes R7, x=244

Measured ministave surface Temperature

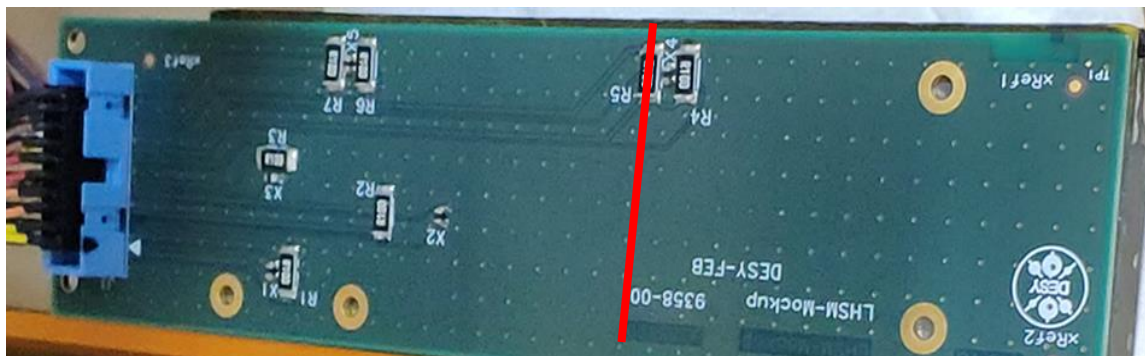


Temperature across PCB at Chiller set T +15C

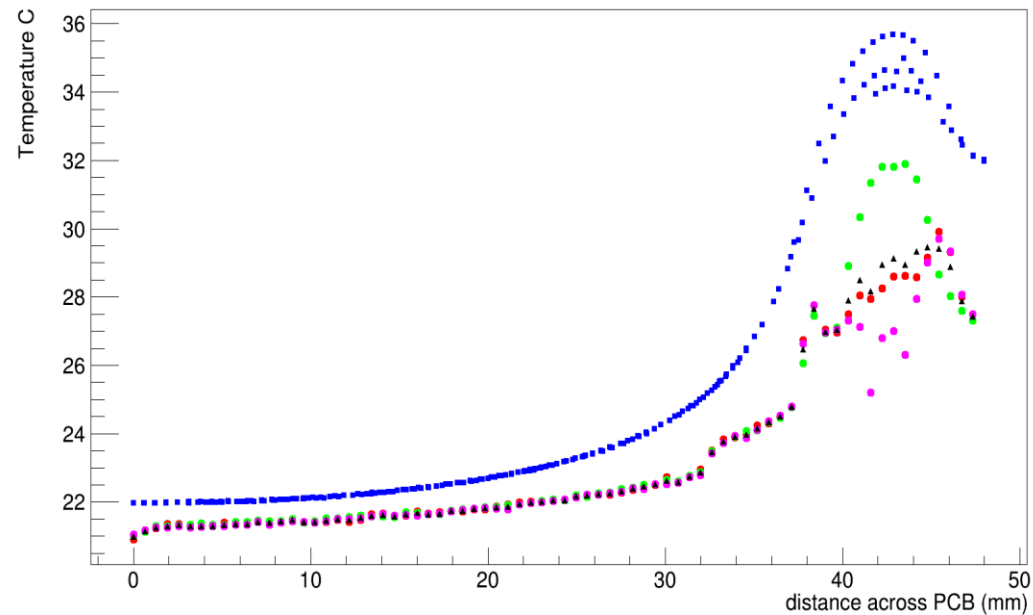
Temperature across PCB



passes R5, x=333

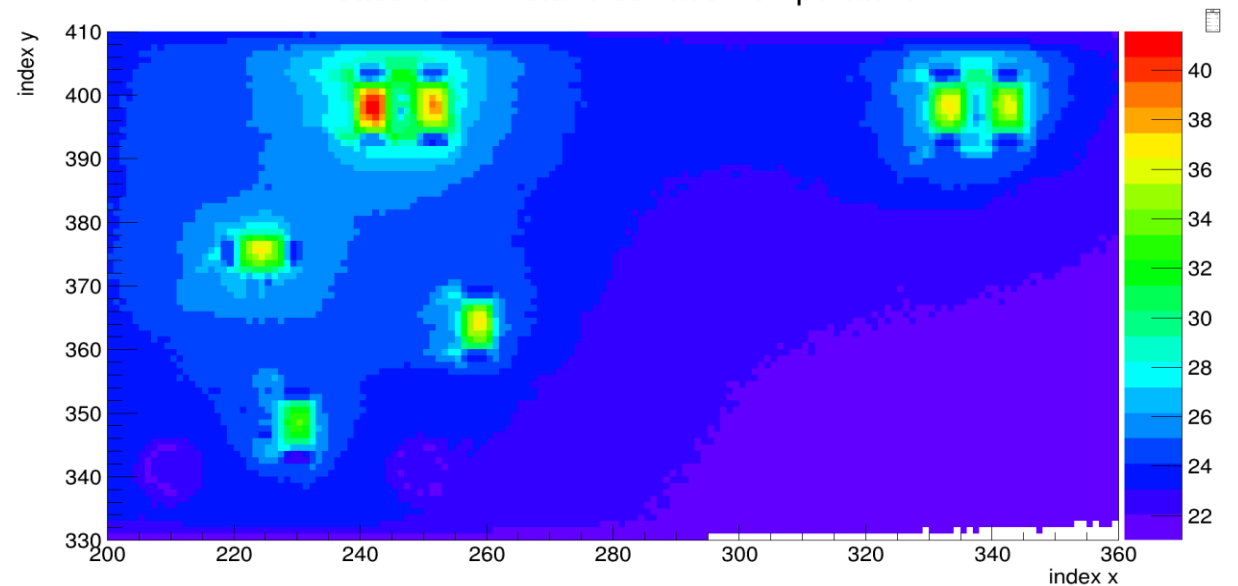


Temperature across PCB



between R5 & R4 (thermometer region), x=337

Measured ministave surface Temperature

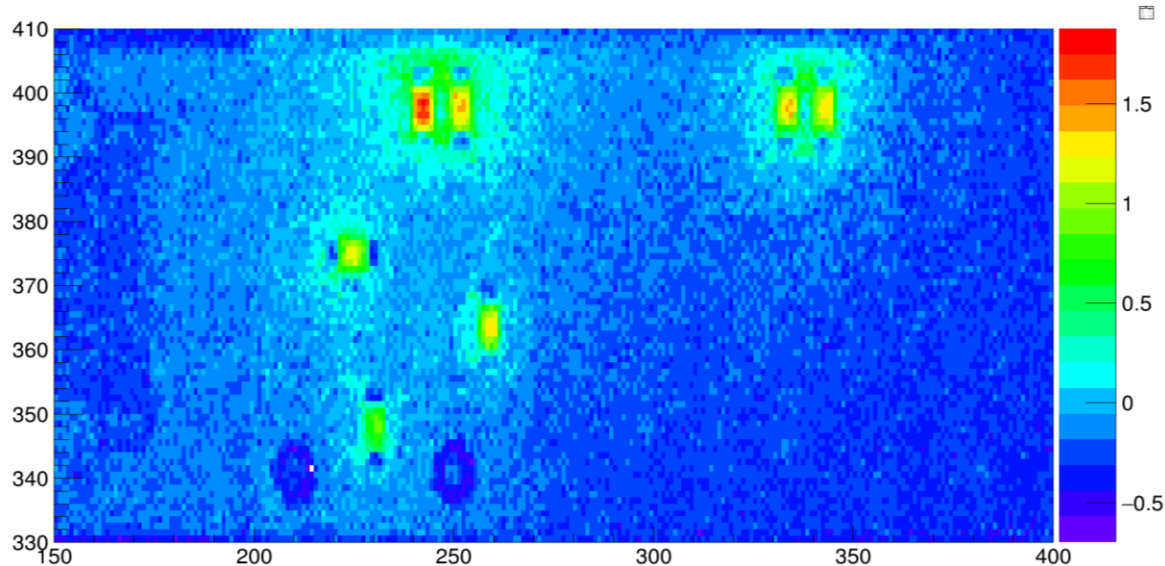


Measured temperature difference at different recording time

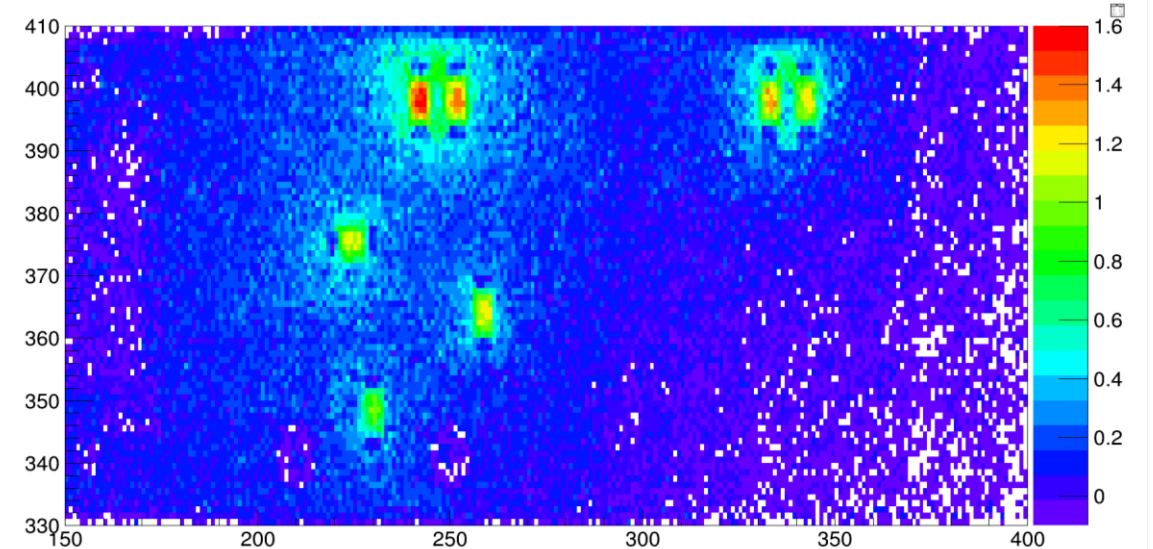
Time after equilibrium (mins)	T inlet(C)	T outlet(C)	T box air (C)	Humidity %
0	17.0	17.6		
10	16.5	17.0		
20	16.5	17.0	21.45	1.6
40	16.7	17.1	21.85	2.1
60	16.7	17.1	21.9	2.6
63(all resistor power off)	16.7	17.1	21.9	2.6
100	16.7	17.1	21.95	3.4

Measured Inlet/outlet temperature doesn't change after resistor power off

For hfe 7100, heat need for 0.1C raise:
 $C \cdot m \cdot \Delta T = 1510 \cdot 1180 \cdot 0.97 / 1000 / 60 \cdot 0.1$
 $\sim 2.88W$
 Total resistor power: 3.12W
 Ambient absorbs resistor heat

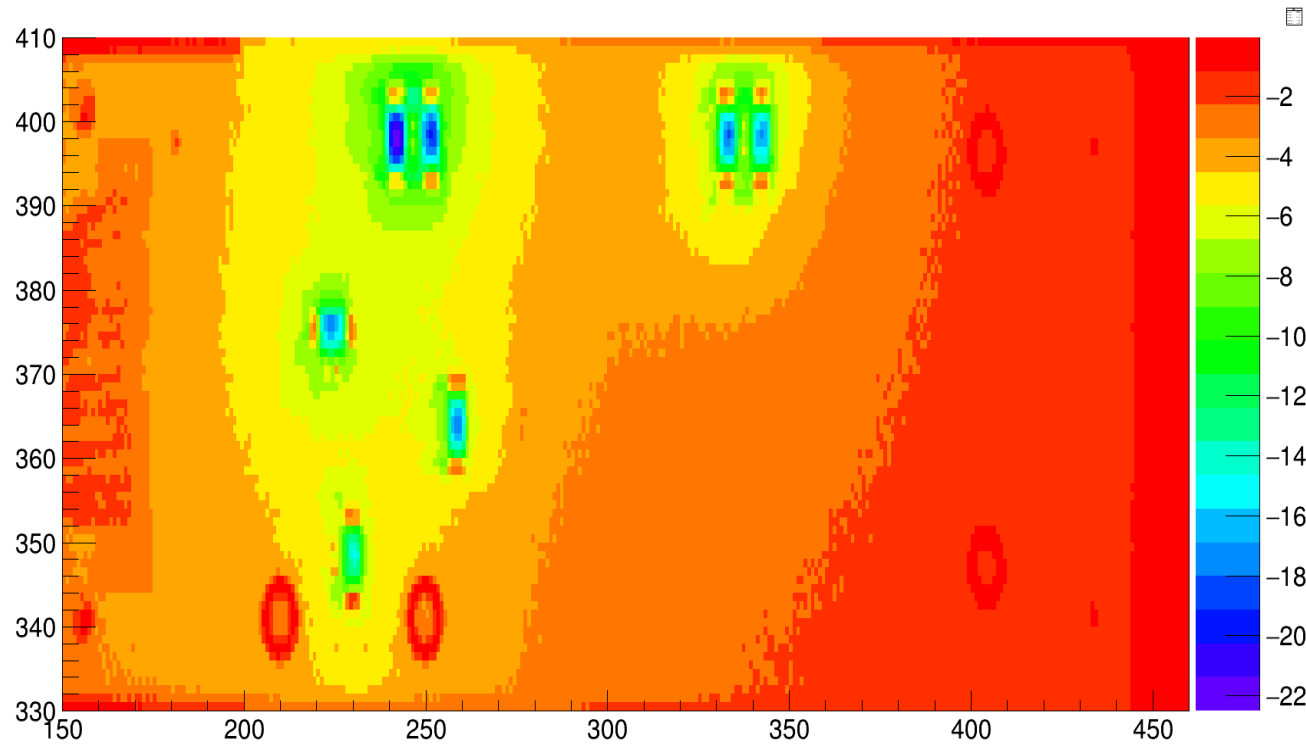


PCB T difference: record time 20 - 40 mins



PCB T difference: record time 40 - 60 mins

Measured temperature difference: resistor power on/off



PCB T difference: record time 100 - 60 mins
T difference between resistor power on/off

Resistor power on:
Average PCB T: ~23.0C
Average main stave T: ~18.4
Resistor power off:
Average PCB T: ~19.1
Average main stave T: ~18.5
Box air T: ~21.9

Assume in/out T difference after resistor power off is 0.3C
Total power obtained: $1510 * 1180 * 0.97 / 1000 / 60 * 0.3 \sim 8.64W$

Assume all the power is obtained through ambient contact:

Estimate ambient contact coefficient:
 $8.64 / ((21.9 - 19.1) * 48 * 185 + (21.9 - 18.5) * 115 * 297)$
 $\sim 6E-5 W/mm^2K$

Current FEA Model: $8E-6 W/mm^2K$