

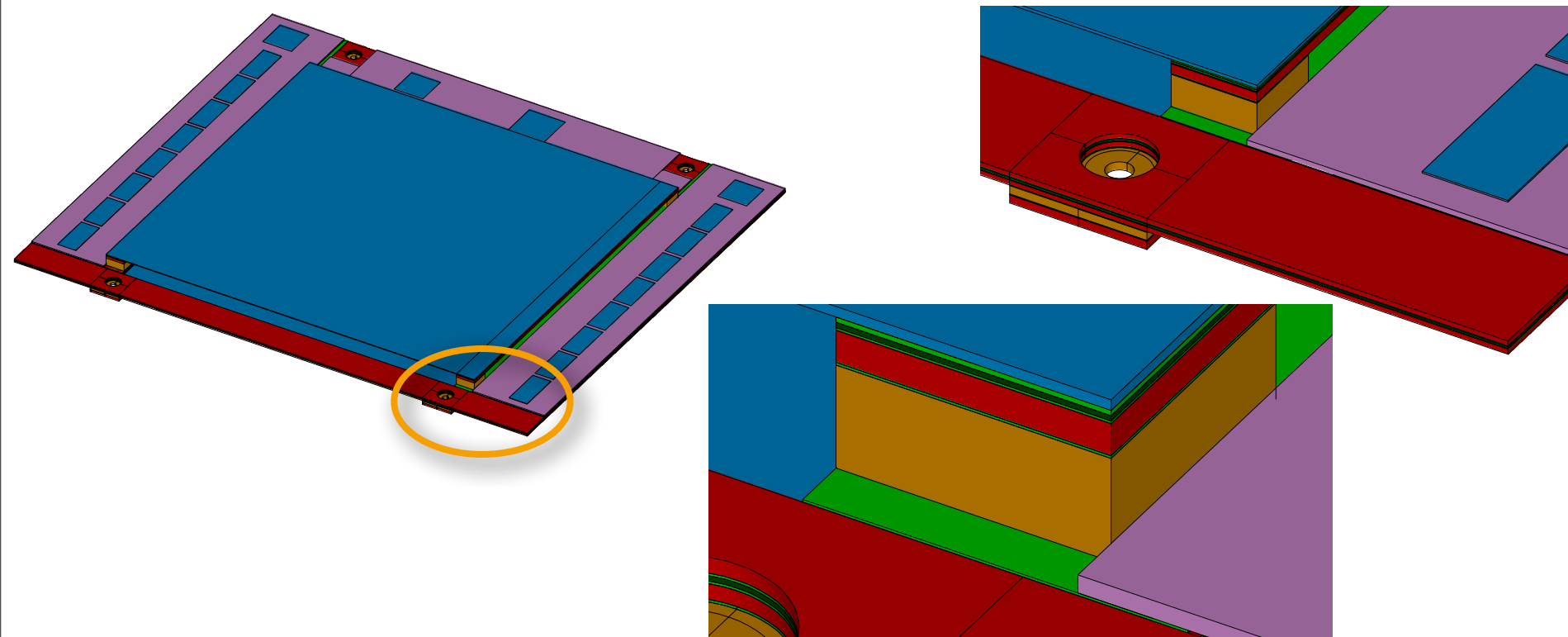
Finite Element Analysis of 2S Module



Andreas Mussgiller

Tracker Upgrade Weekly Meeting
24/01/2012

FE Design of the 2S Module - 4mm Spacing



- > Design updated to match ,official' CERN design
- > Support is a sandwich of CFRP/PGS/CFRP
- > Hybrid is 20mm wide
- > Service board is 15mm wide

- > Side support is 8mm wide
- > Al-heatspreader is 8mm x 8mm
- > CTE mismatch between CFRP and Al is compensated
- > 4mm spacing via CFRP bridge and Al pillars



Thermal Loads

> Sensors

- Area: $A = 10 \text{ cm} \times 9.2 \text{ cm} = 92 \text{ cm}^2$
- Volume: $V = 92 \text{ cm}^2 \times 0.02 \text{ cm} = 1.84 \text{ cm}^3$
- Damage constant: $\alpha = 4.0 \cdot 10^{-17} \text{ A/cm}$
- Fluence: $\Phi = 5.5 \cdot 10^{14} \text{ 1/cm}^2$
- Leakage current at +20°C: $I = 5.5 \cdot 10^{14} \text{ 1/cm}^2 \times 1.84 \text{ cm}^3 \times 4.0 \cdot 10^{17} \text{ A/cm} = 35.4 \text{ mA}$
- Leakage current at -20°C: $I \propto (kT)^2 \exp\left(-\frac{1.21 \text{ eV}}{kT}\right) \Rightarrow I = 0.60 \text{ mA}$
- Bias voltage: $U = 600 \text{ V}$
- Power: $P = 0.60 \text{ mA} \times 600 \text{ V} = 360 \text{ mW}$ (per sensor)

> CBCs: $2 \times 8 \times 254 \times 0.3 \text{ mW} = 1220 \text{ mW}$

> Concentrators: $2 \times 200 \text{ mW} = 400 \text{ mW}$

> LP-GBT: 500 mW

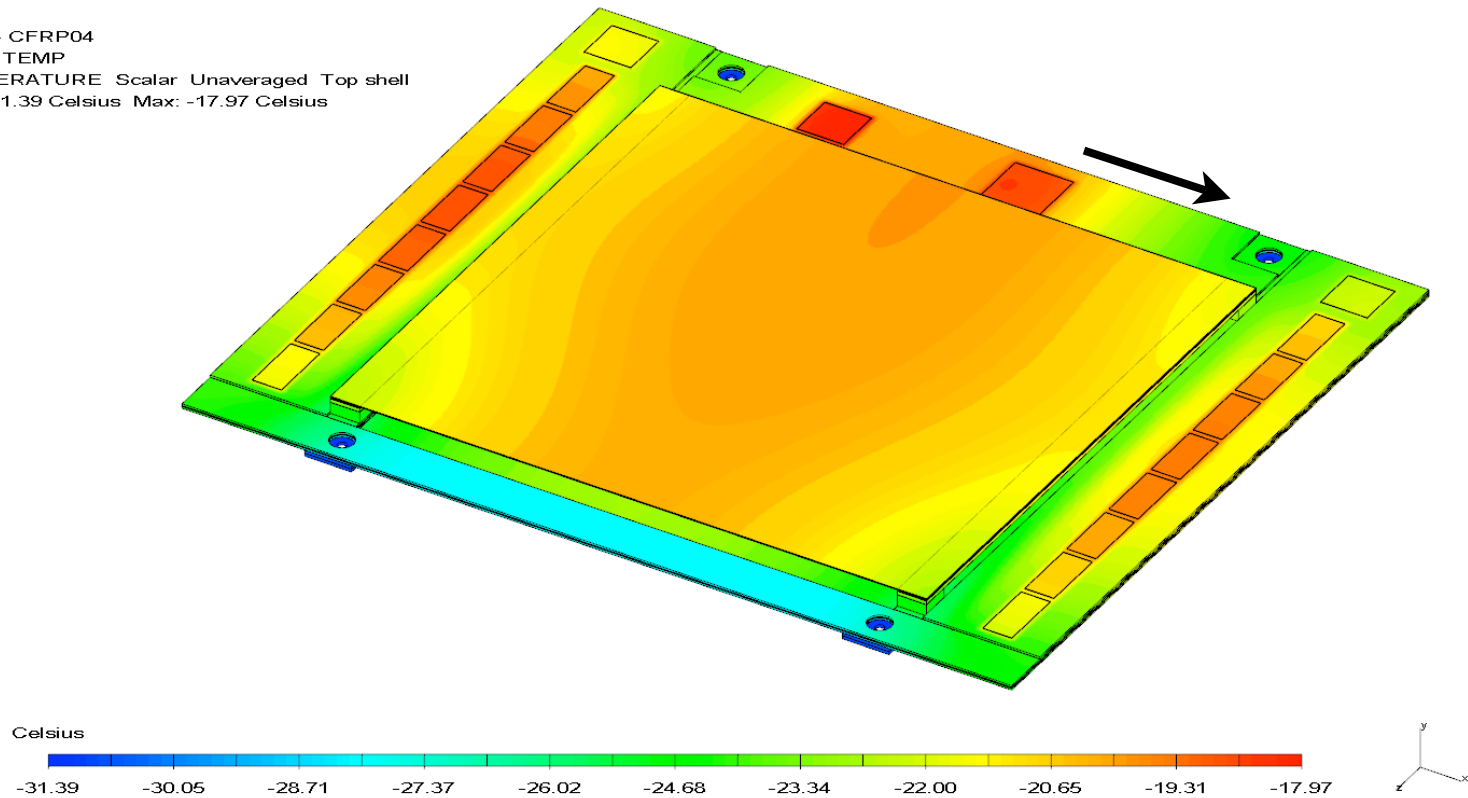
> DC/DC: 600 mW

> Total power: $2 \cdot 360 \text{ mW} + 1220 \text{ mW} + 400 \text{ mW} + 500 \text{ mW} + 600 \text{ mW} = 3.44 \text{ W}$



Thermal FEA Results - Full Module

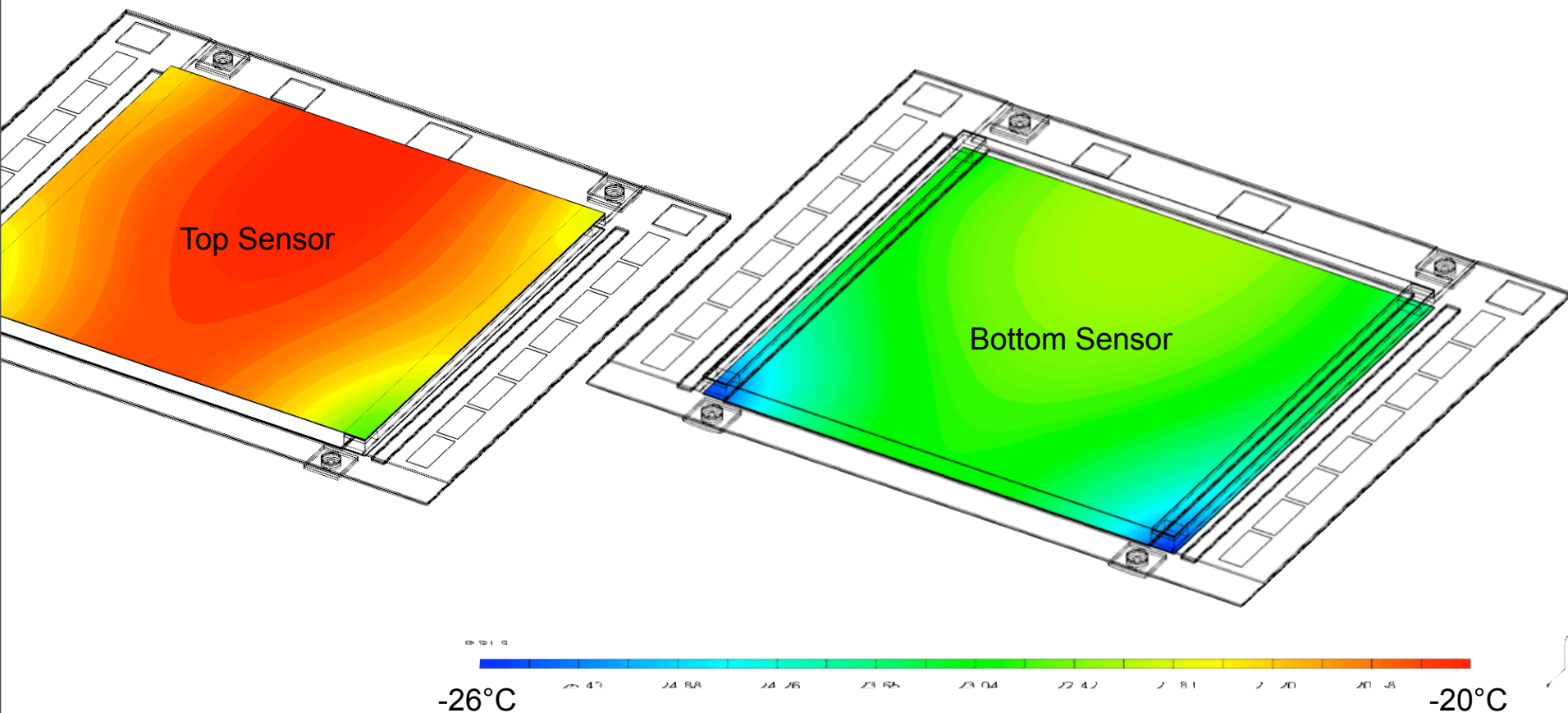
Fem1 - CFRP04
NODE TEMP
TEMPERATURE Scalar Unaveraged Top shell
Min: -31.39 Celsius Max: -17.97 Celsius



- > Asymetry on service board cause CBCs on left hybrid to have higher temperature
- > Can the GBT be moved closer to the heatspreader?

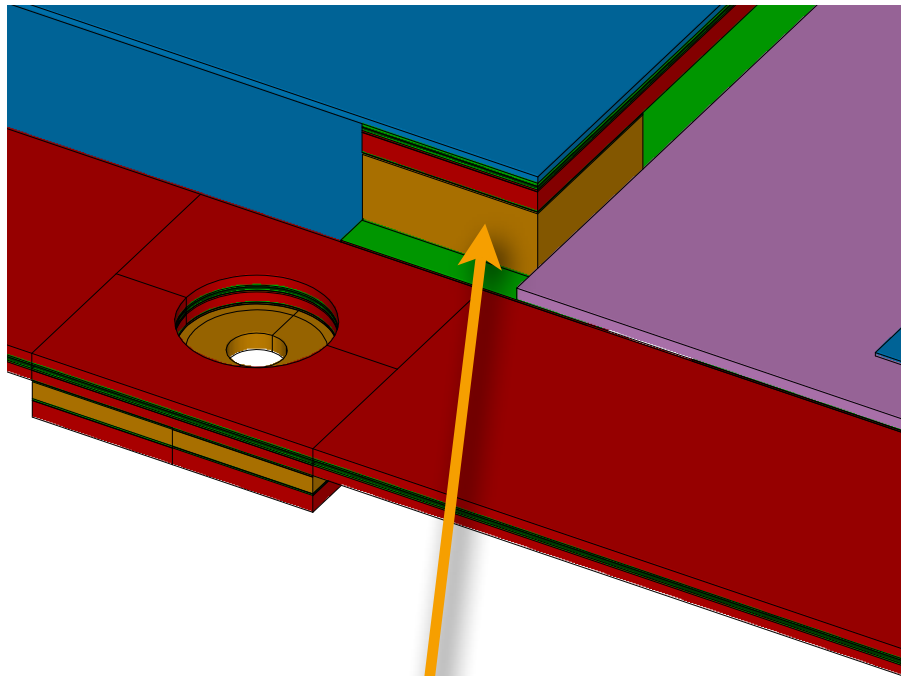


Thermal FEA Results - Sensors

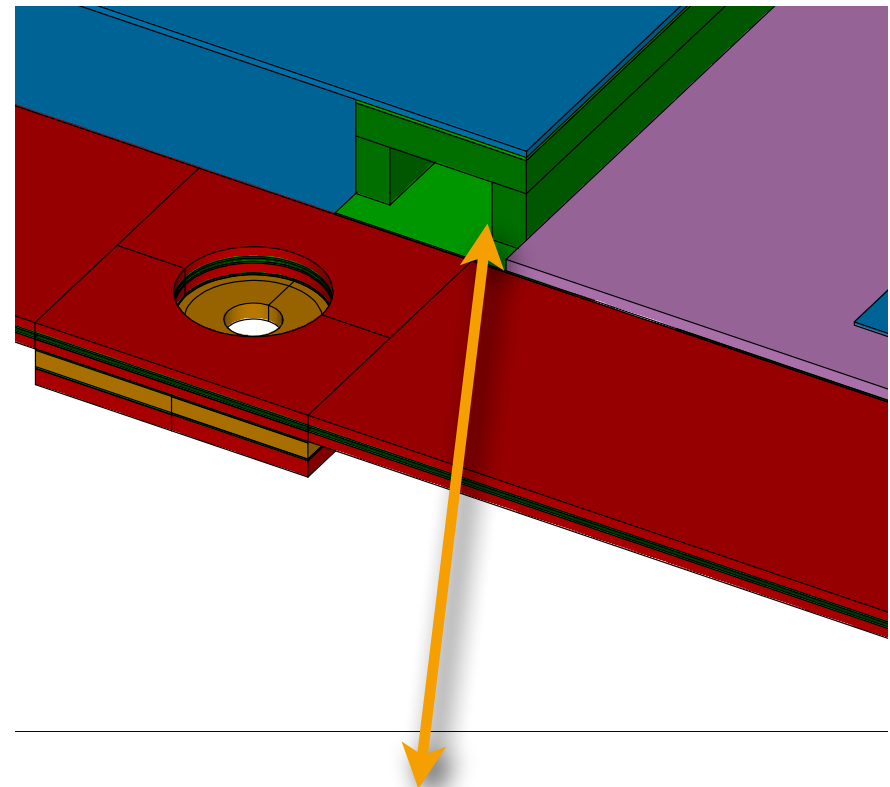


- > Same color scale in both pictures
- > Top sensor is about 3°C warmer than bottom sensor
- > 5mm x 5mm Al-Pillar are a bottleneck for the heat transfer

Material Budget

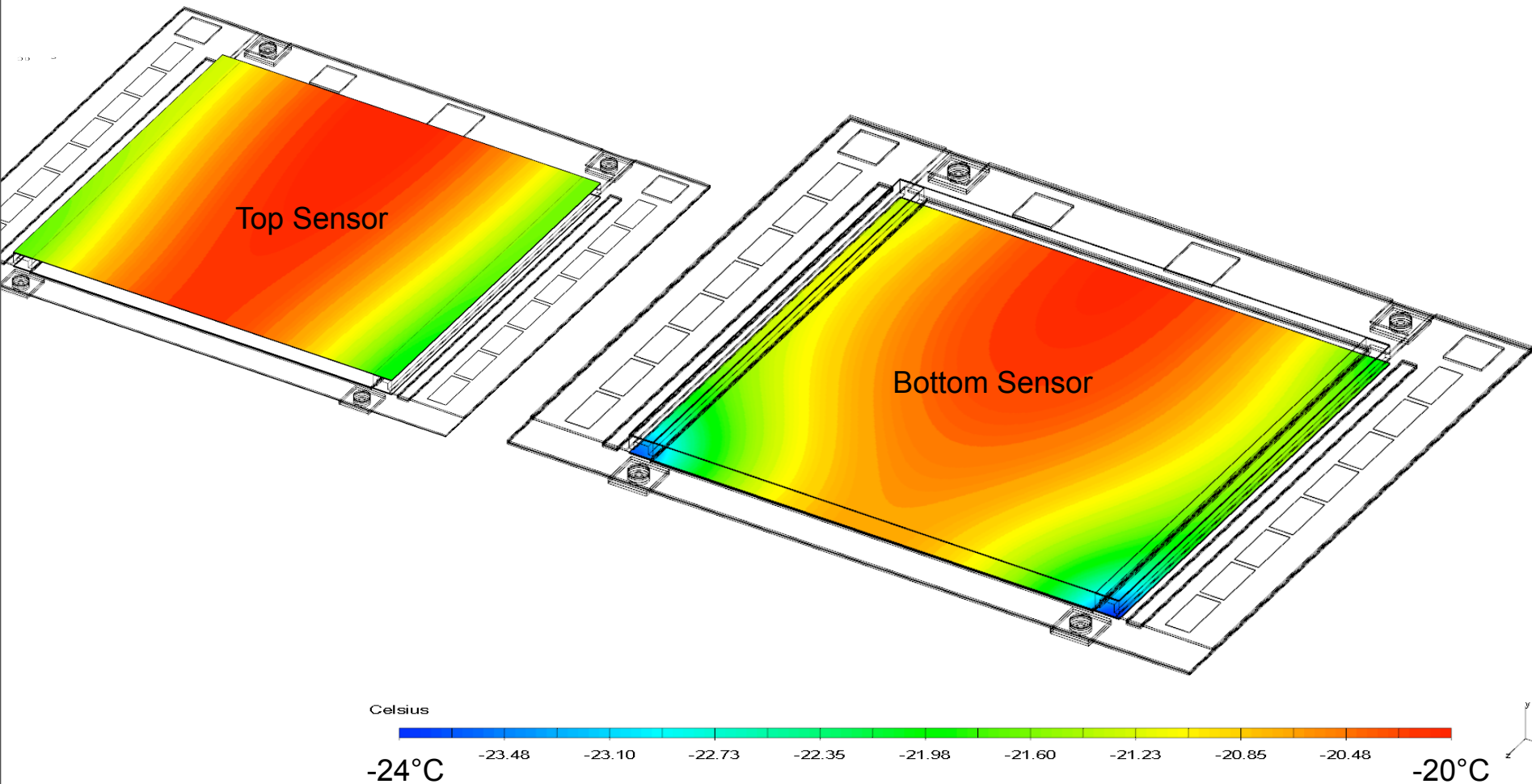


Name	Material	Mass [g]
Bridge x2	CFRP 03	1.010
Pillar x4	ALUMINIUM	0.528
PGS x2	PGS 0.100	0.080
Glue	EPOXY	0.060
		1.678



Name	Material	Mass [g]
Spacer x2	PYROID HT	3.596
		3.596

Thermal FEA Results - Sensors



- > Same color scale in both pictures
- > 2g more in module weight results in 2°C smaller temperature gradient