FE Analysis of Trigger Modules

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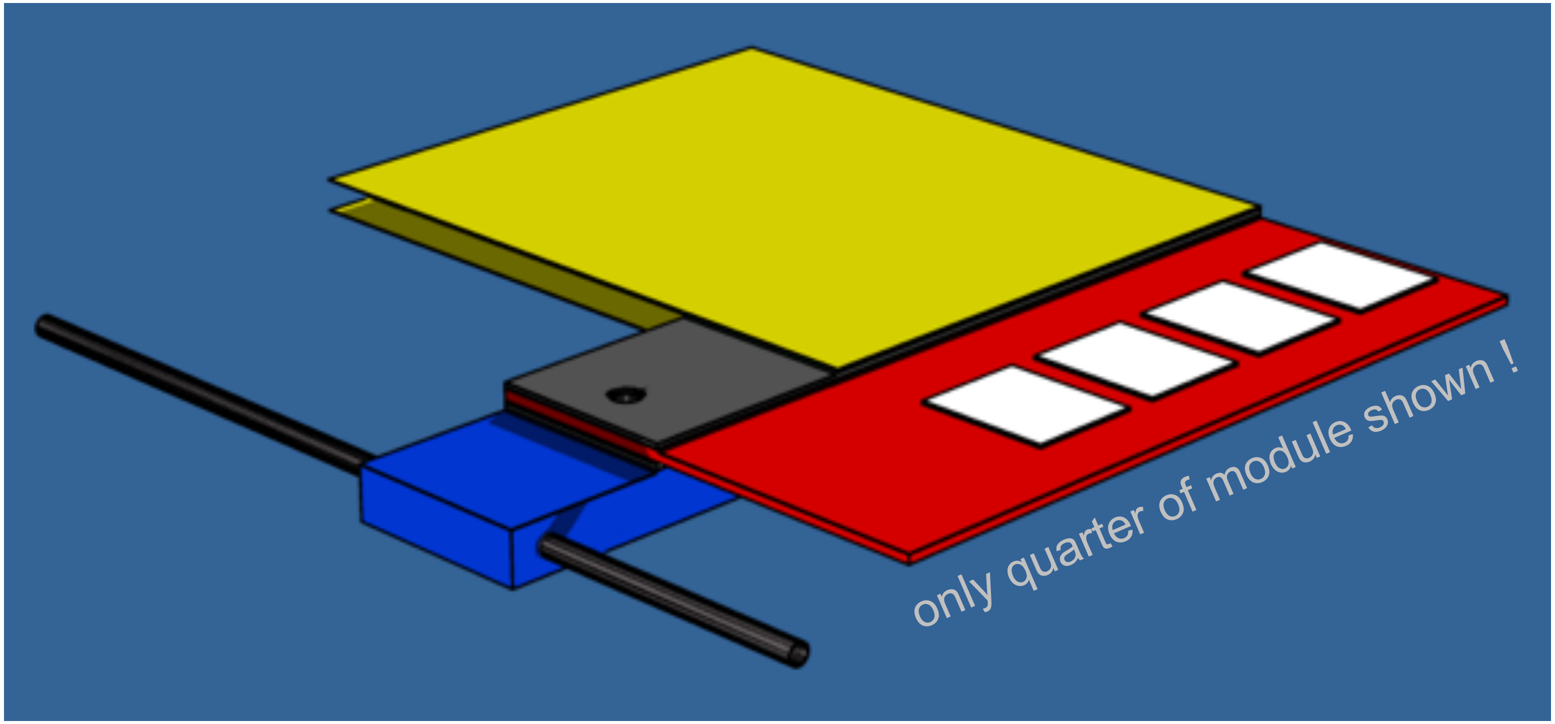
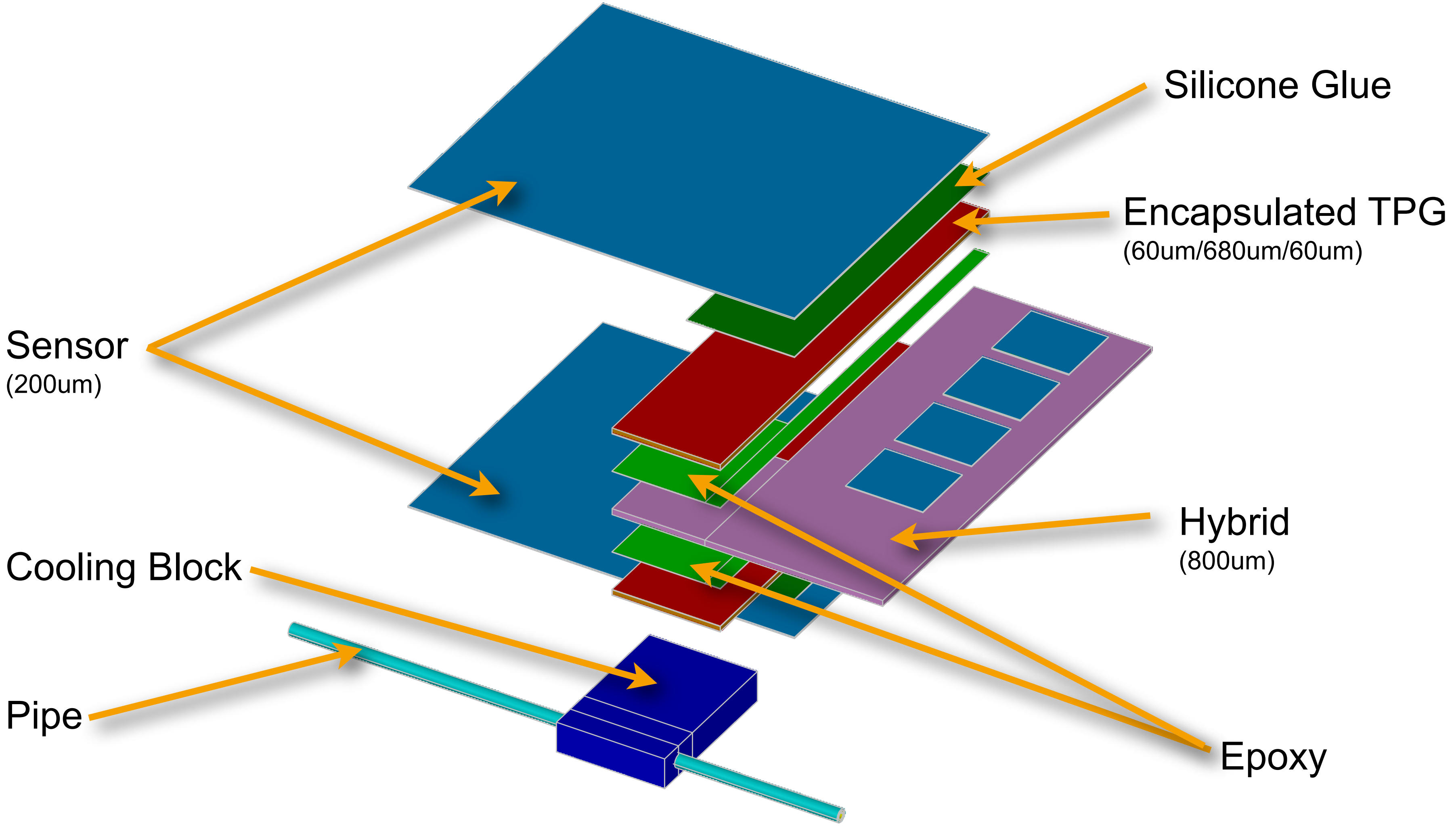
Tracker Upgrade Weekly Meeting
05/04/2011

Trigger Module



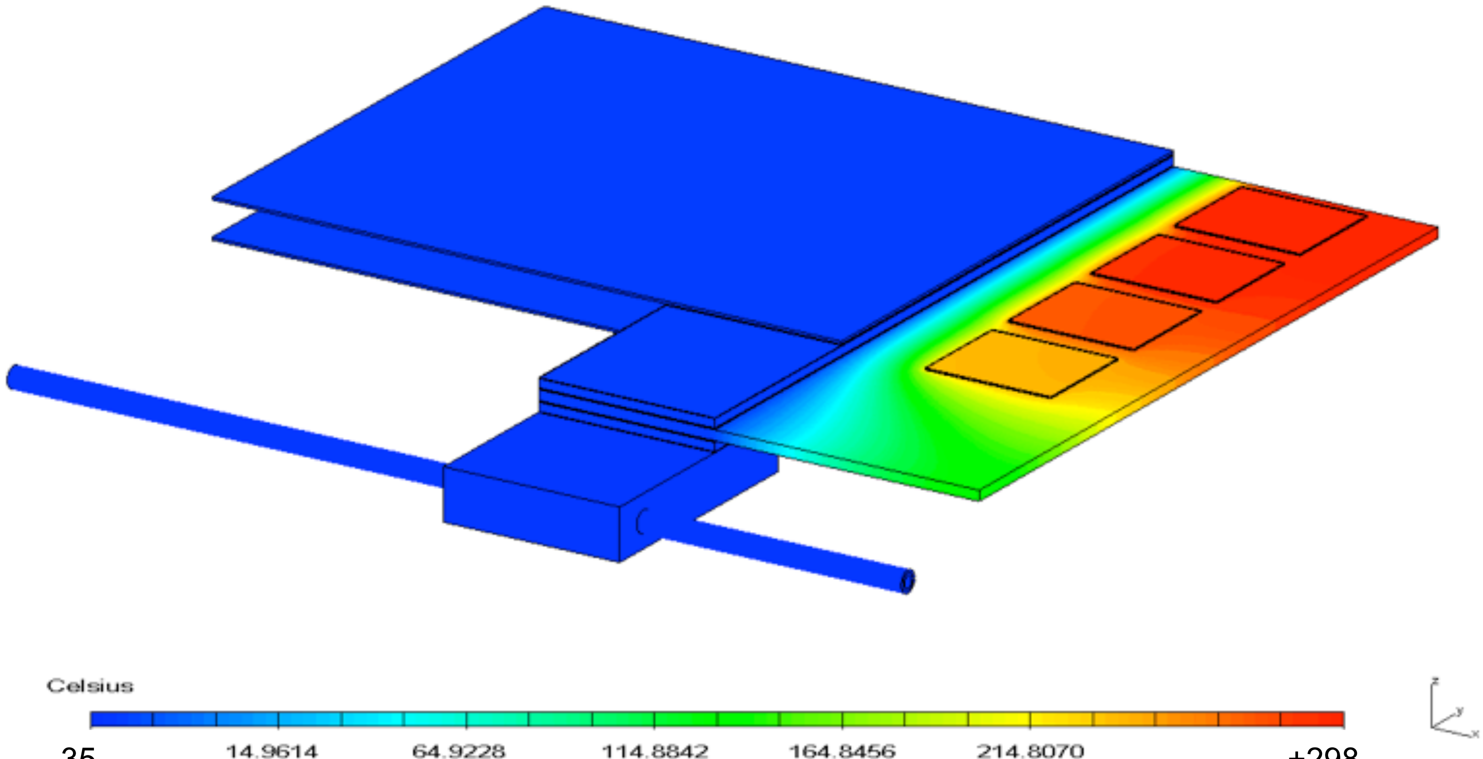
- 5 cm strips
- hybrids to both sides of the sensor
- Each hybrid handles signals from both sensors
- 16 chips in total

Trigger Module - Basic Design

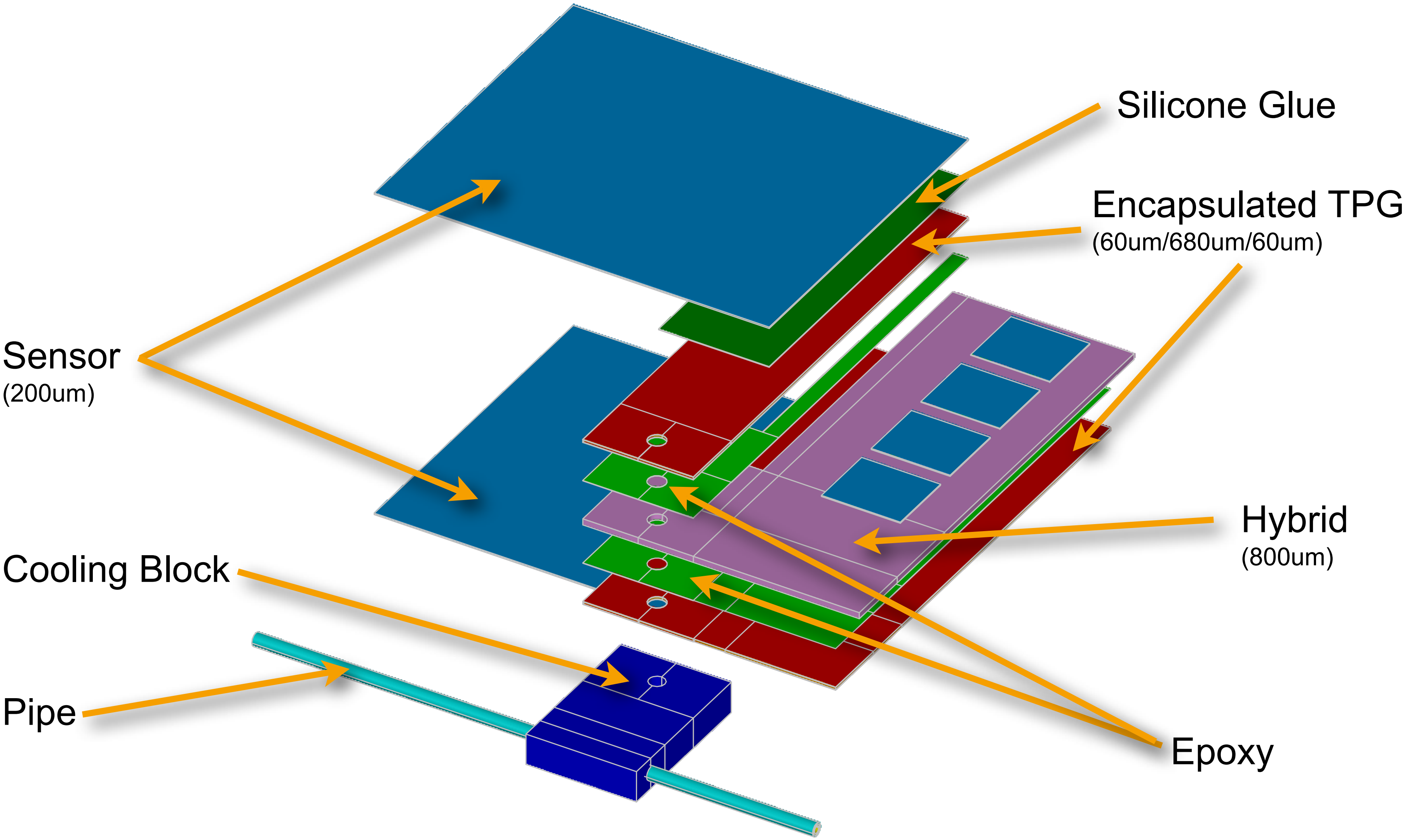


Thermal FE Analysis of Basic Design

- 100mW consumed by sensor (25mW in FE model)
- 2W consumed by chips (500mW in FE model)
- Hybrid made of Endicott Corel-Z with $\lambda = 0.3\ \mathrm{W/m \cdot K}$
- No dedicated heat management for chips

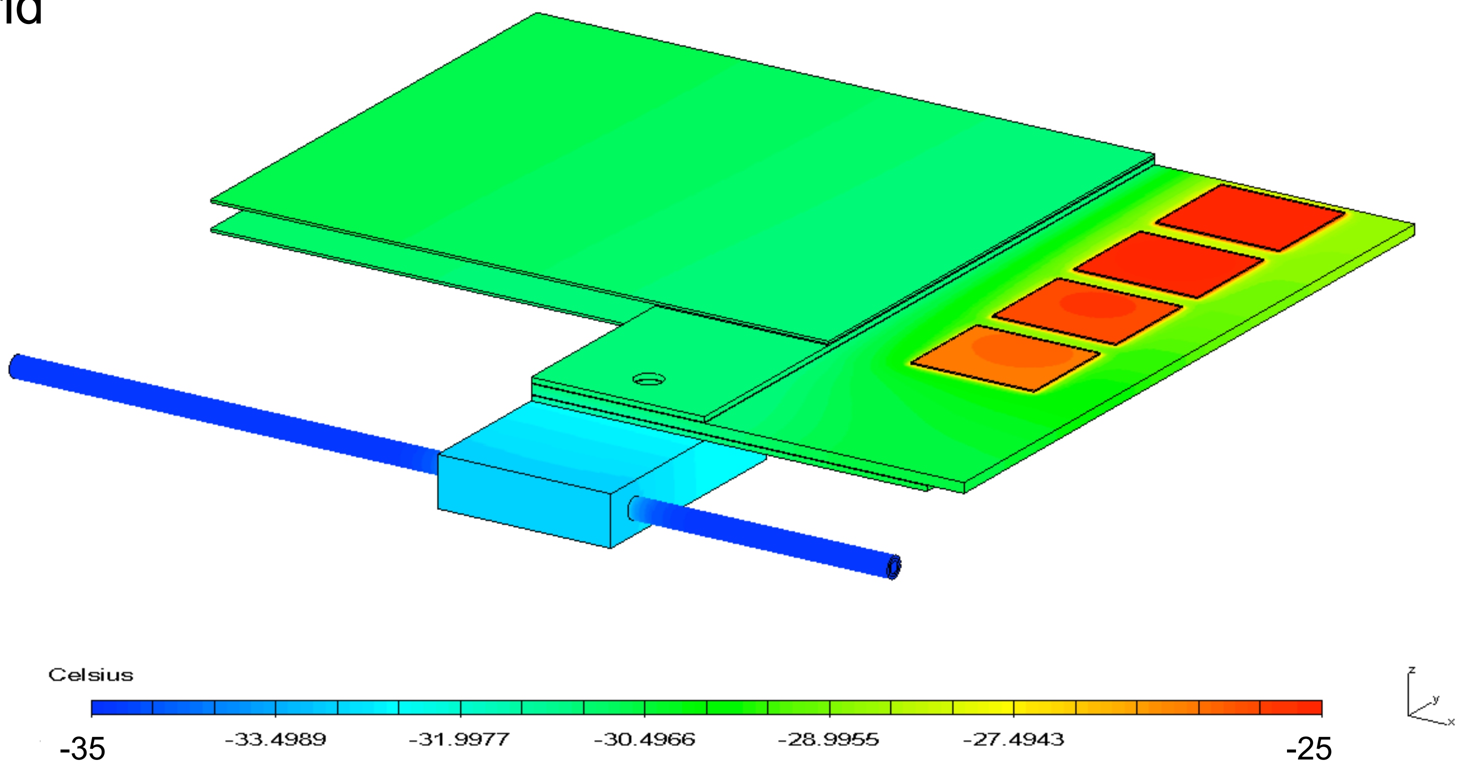


Trigger Module - TPG Heat Spreader Design

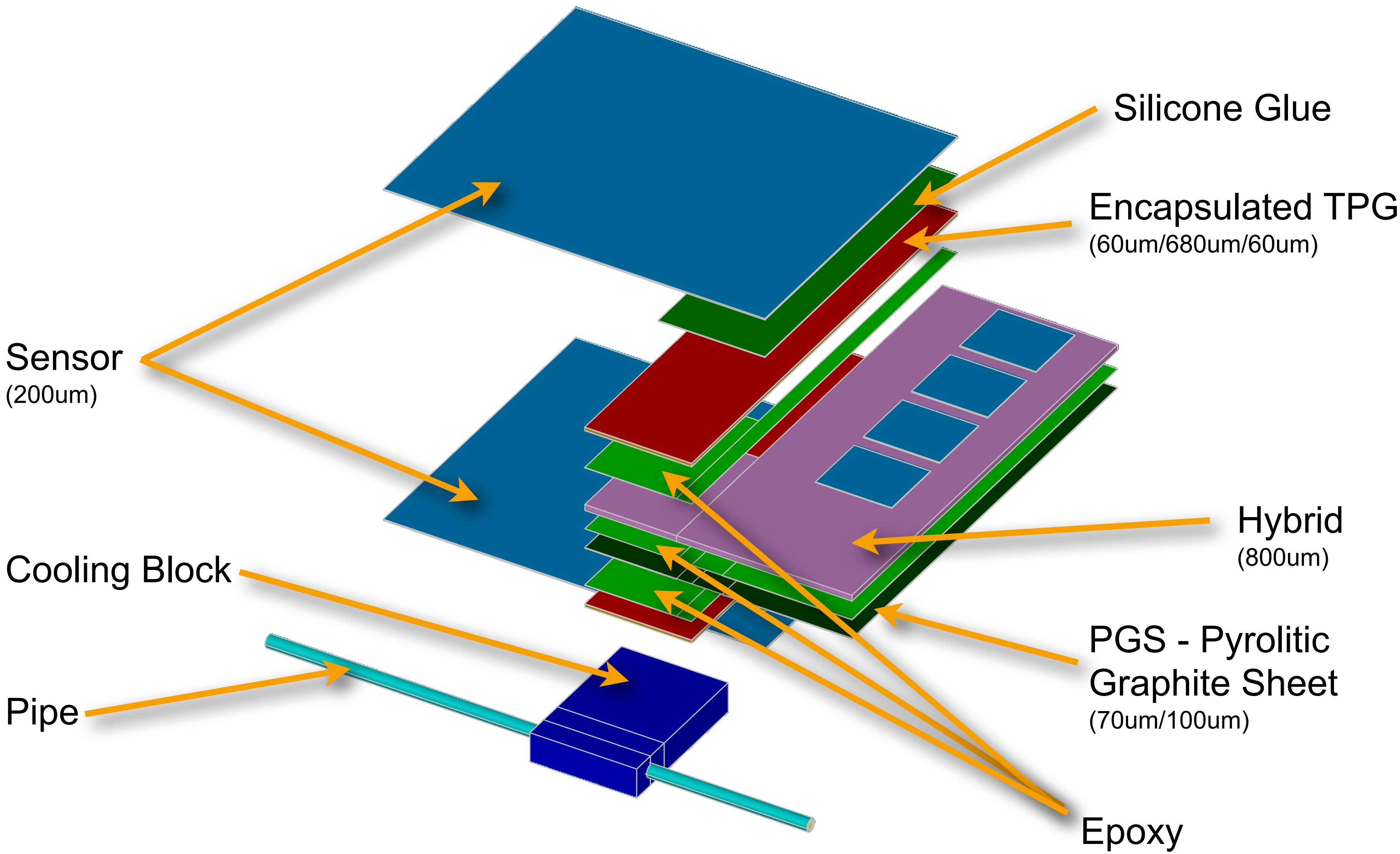


Thermal FE Analysis of TPG Heat Spreader Design

- 100mW consumed by sensor / 2W consumed by chips
- Hybrid made of Endicott Corel-Z with $\lambda = 0.3\ \mathrm{W/m \cdot K}$
- Bottom eTPG strip serves as heat spreader
- Bottom eTPG strip has gap to allow bonding from bottom sensor to hybrid



Trigger Module - PGS Heat Spreader Design

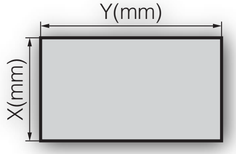


PGS - Pyrolitic Graphite Sheet

> From Panasonic specs:

■ Dimensions in mm (not to scale)
Dimension of representative

Part No.	Dimension X (Short)✻	Dimension Y (Long)✻	Thickness (mm)
EYGS1823 10, 07	180±5 mm	230±5 mm	0.10±0.03, 0.07±0.015
EYGS1218 10, 07, 03	115±5 mm	180±5 mm	0.10±0.03, 0.07±0.015, 0.025±0.010
EYGS0912 10, 07, 03	90±5 mm	115±5 mm	0.10±0.03, 0.07±0.015, 0.025±0.010



✻Please contact us for other dimensions other than those above.

■ Characteristics

Characteristics		Specification	Specification	Specification
Thickness		0.10 ± 0.03 mm	0.07 ± 0.015 mm	0.025 ± 0.010 mm
Density		0.85 g/cm^3	1.21 g/cm^3	1.90 g/cm^3
Thermal conductivity	a-b plane	700 W/(m·K)	1000 W/(m·K)	1600 W/(m·K)
Electrical conductivity		10000 S/cm	10000 S/cm	20000 S/cm
Extensional strength		19.6 MPa	22.0 MPa	30.0 MPa
Expansion coefficient	a-b plane	9.3×10^{-7} 1/K	9.3×10^{-7} 1/K	9.3×10^{-7} 1/K
	c axis	3.2×10^{-5} 1/K	3.2×10^{-5} 1/K	3.2×10^{-5} 1/K
Heat resistance		400 °C		
Bending(angle 180,R5)		10000 cycles		

✻Values are for reference, not guaranteed.

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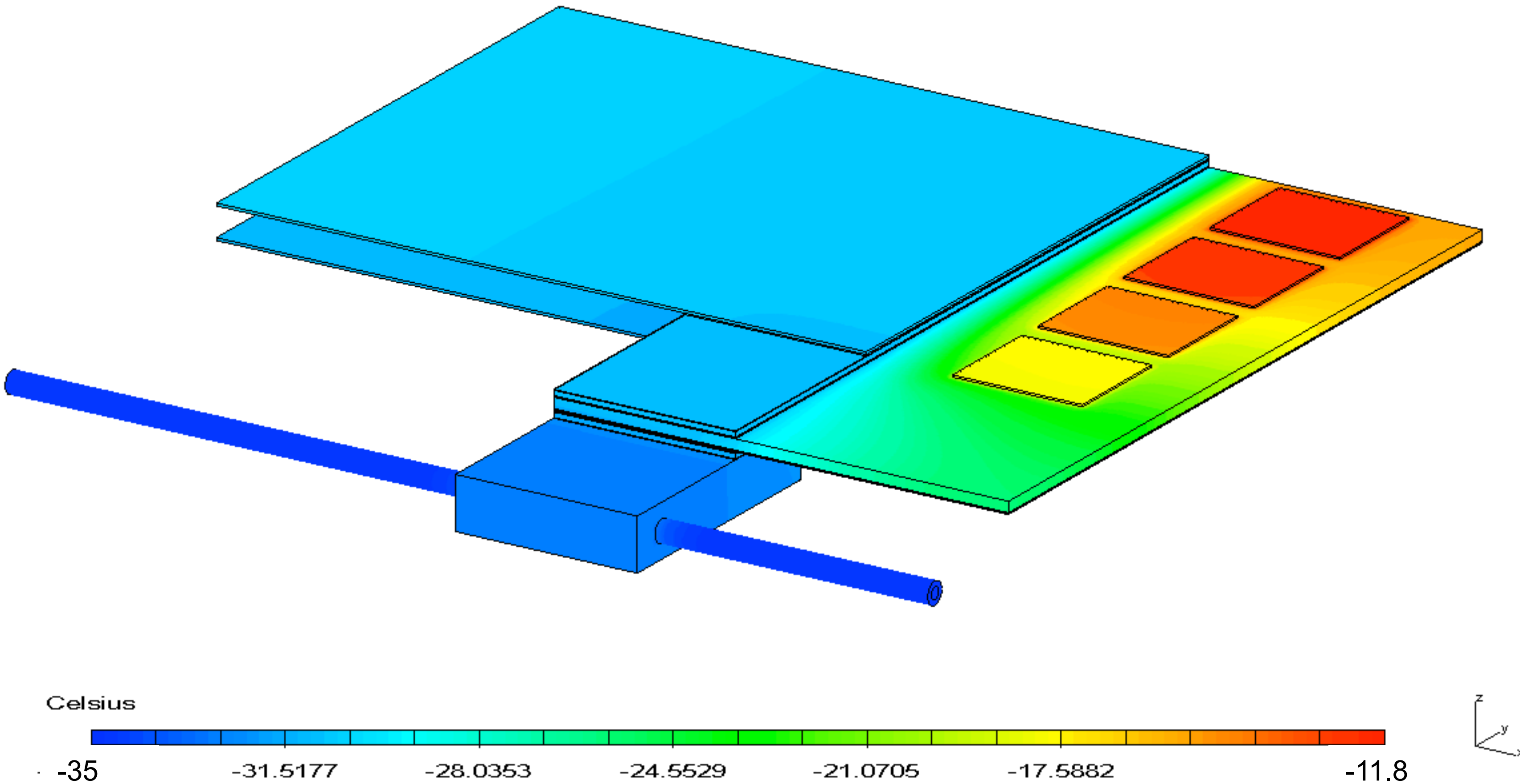
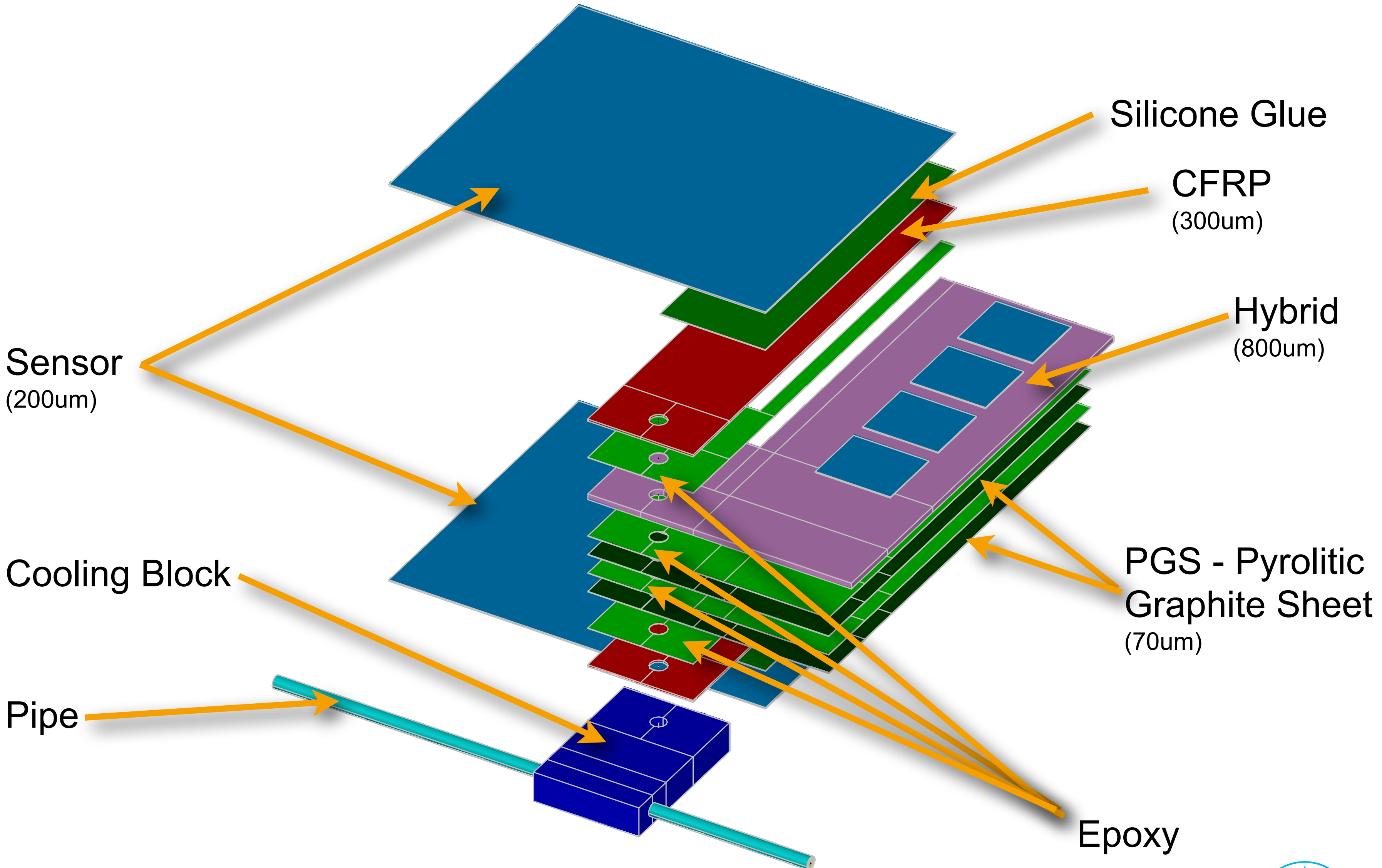
Thermal FE Analysis of PGS Heat Spreader Design

- Tmax for 70um and 100um PGS thickness very similar
- Thicker PGS layer needed for better thermal performance

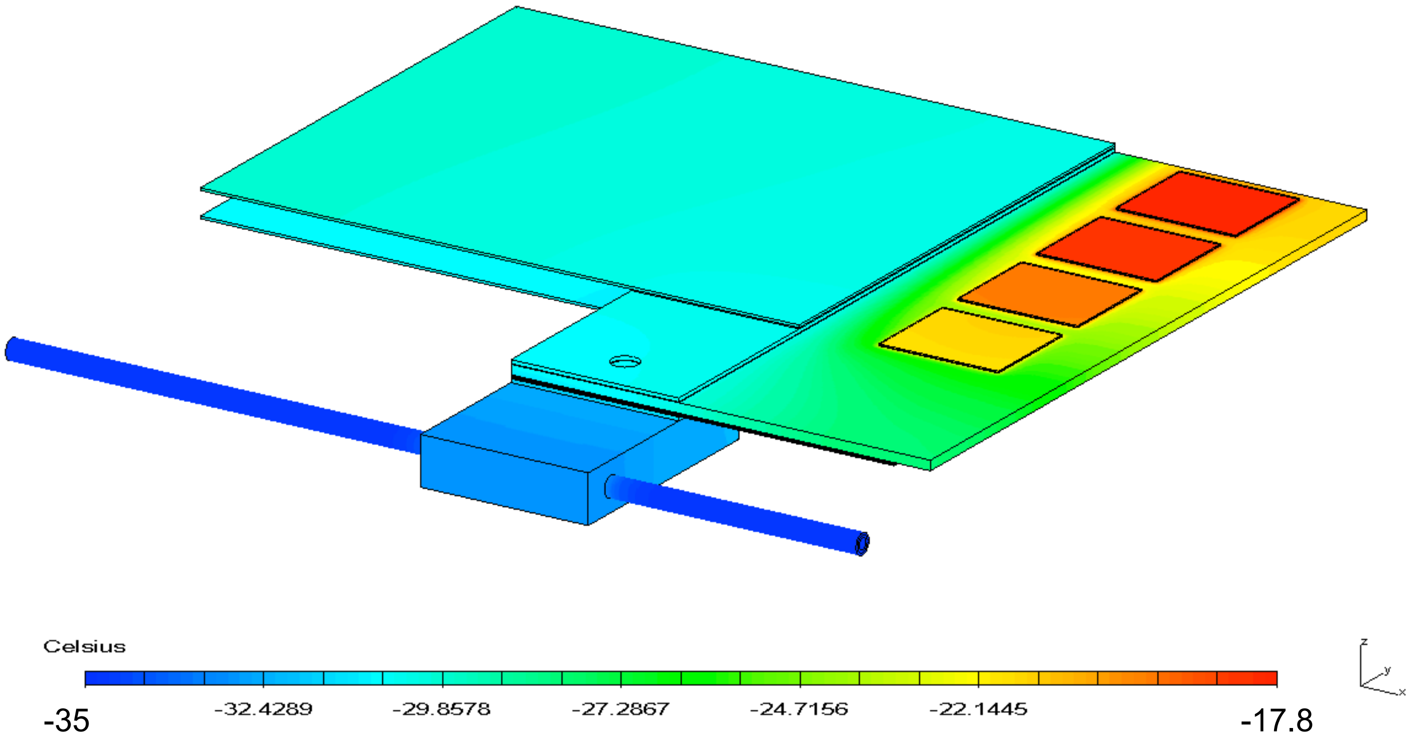


Trigger Module - Double PGS Heat Spreader Design



Thermal FE Analysis of Double PGS Heat Spreader Design

- Heat flux through support strip does not require use of TPG
- Calculation performed for CFRP support strip with UD and +45°/-45°/0/-45°/+45° structure
- Tmax for UD and +45°/-45°/0/-45°/+45° strips similar
  - Heat flux mostly through PGS

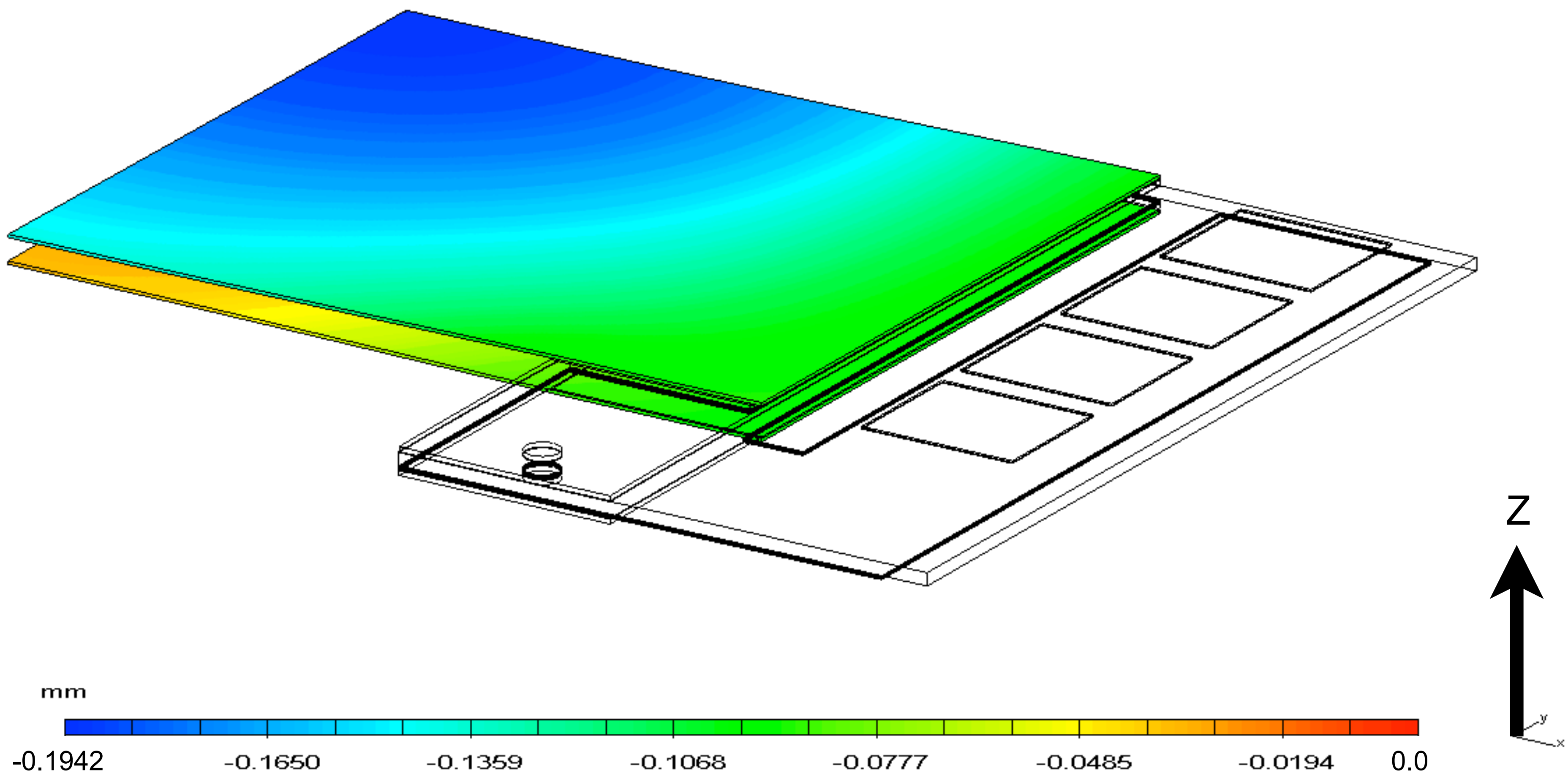


Thermal FE Analysis - Summary

- Basic design seems best wrt. deformation due to symmetry
- However...
  - Heat management for chips must be provided
  - Additional heat spreader layers break symmetry
- PGS could be an alternative to TPG
  - commercially available
  - available in 25um/70um/100um
  - we would need it a bit thicker
  - have to check if this could be made available

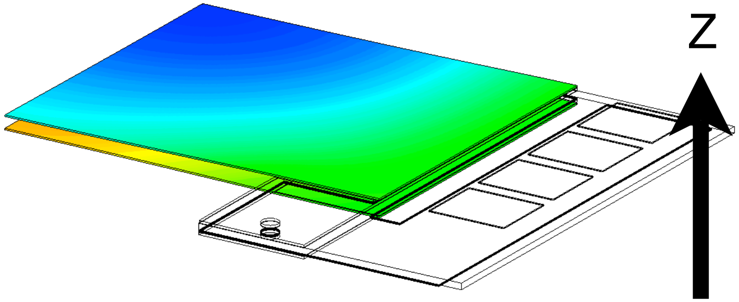
Mechanical FE Analysis

> Z Displacement of nodes on sensors for double PGS layer Design



Mechanical FE Analysis - Results

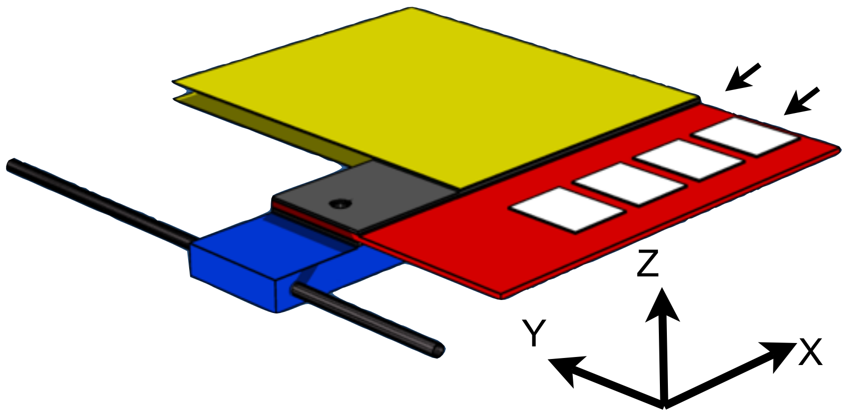
Design	Max Z displacement of sensors
TPG Heat Spreader	-148um
PGS Heat Spreader (70um)	-146um
PGS Heat Spreader (100um)	-144um
Double PGS Heat Spreader (UD)	-194um
Double PGS Heat Spreader (+45°/-45°/0/-45°/+45°)	-81um

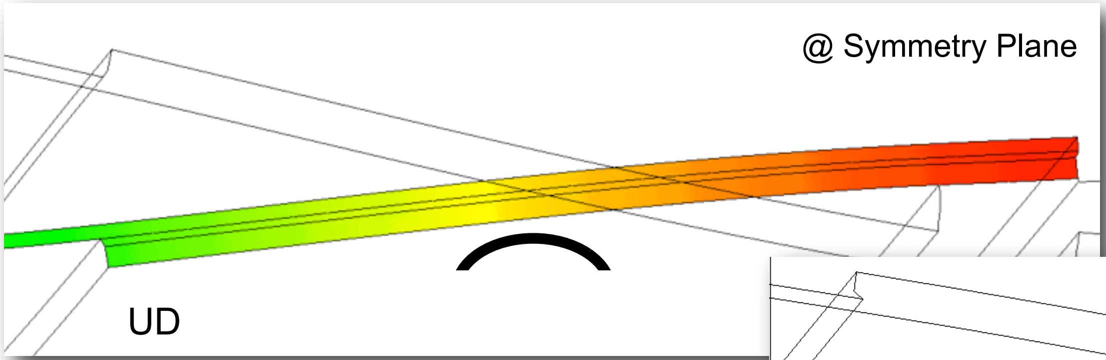


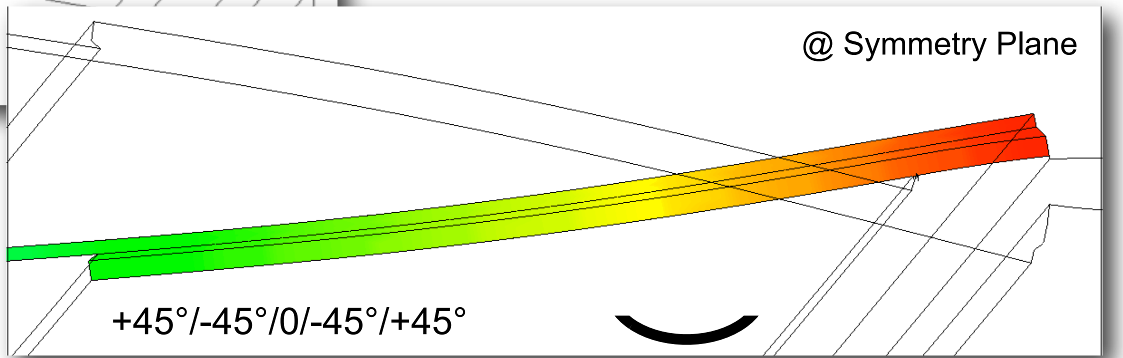
- Symmetry does not prevent deformation of sensors
  - It only prevents bending of hybrid
- Deformation of sensor caused by different CTEs of support strip, sensor and hybrid

Analysis of Bending of Sensors

	CTE		
	X [1e-6/m]	Y [1e-6/m]	Z [1e-6/m]
UD	-1,00	6,45	6,45
+45°/-45°/0/-45°/+45°	-1,06	-0,62	6,45
Silicon	2,00	2,00	2,00
Endicott Corel-Z	3,00	3,00	3,00

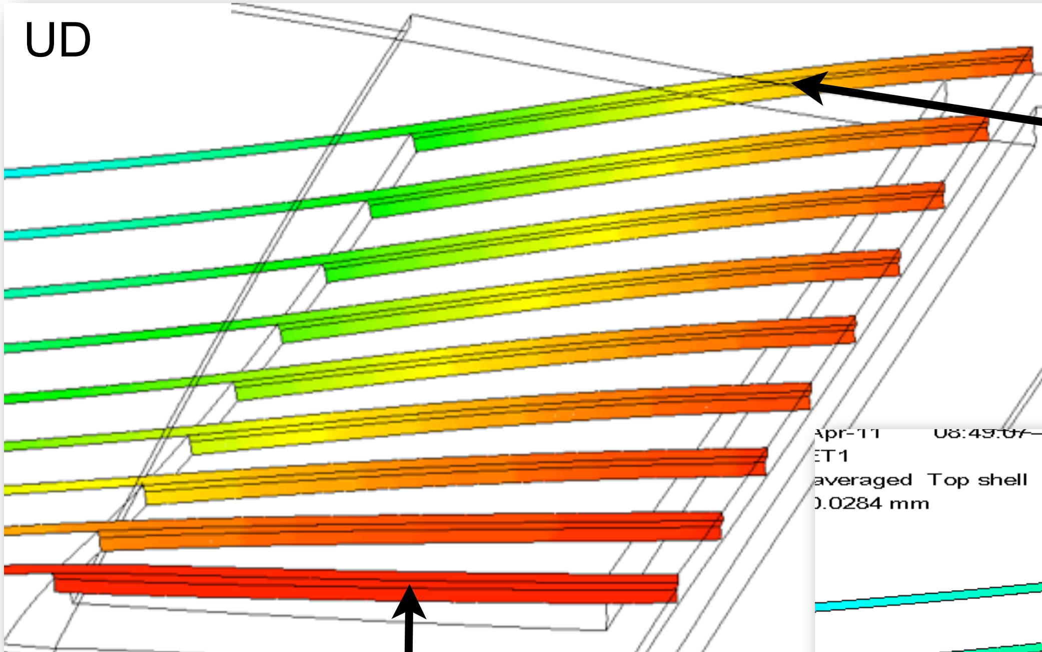






Bending due to sensor vs. support CTE difference

Analysis of Bending of Sensors

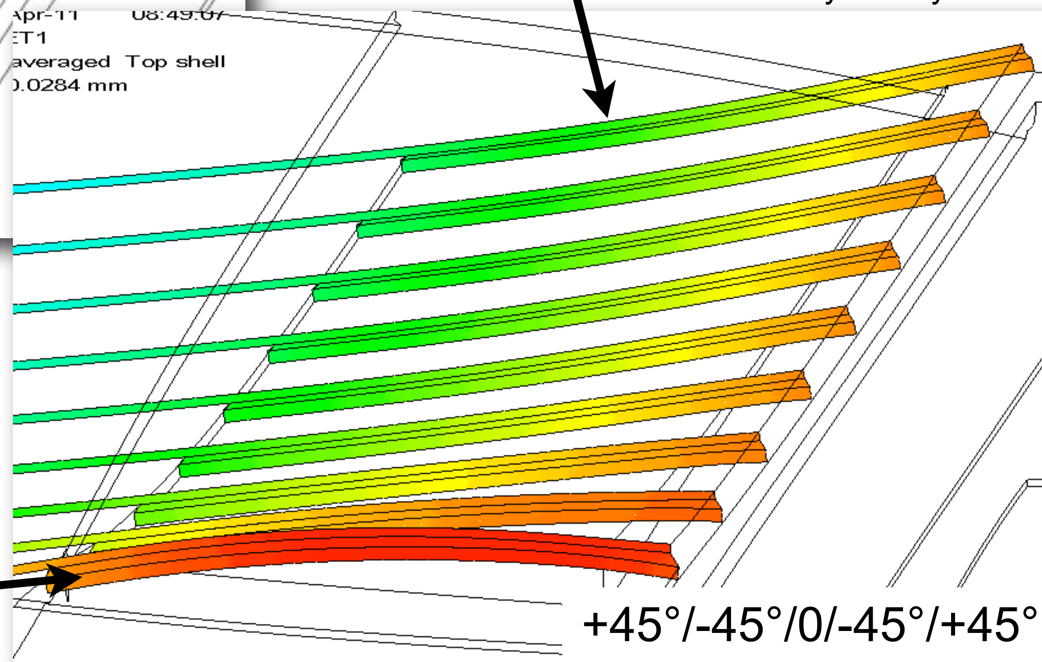


Cooling Block

Bending due to sensor vs. support CTE difference

Bending limited due to CTE symmetry

Symmetry Plane



Bending due to hybrid vs. support CTE difference

Summary