PS Module prototype

- *Module prototype discussion*
- *Bits and pieces...*

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Module prototype

- Ordered Al-CF (Metgraf 4-230) with dimensions: 12"x5.25"x0.5"
  - Estimated arrival 09/05
  - Cut with "wire EDM"
  - Start with pure Al test structures

- Carbon Fiber sheets: K13C
  - 4 layers a 60 μm → 240 μm
  - First drawings of the individual by Greg (from today)
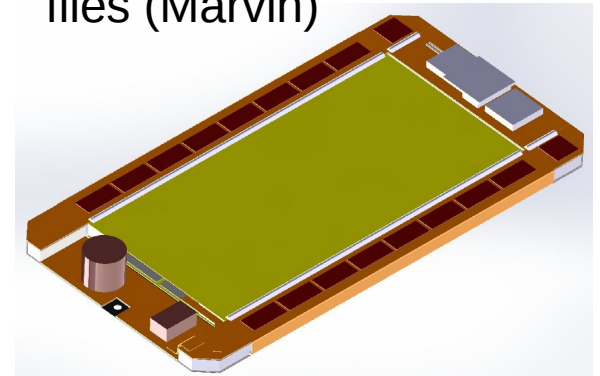
- Sensors ready, need to be bump-bonded with RO chips

	Al MetGraf 4-230
Matrix Alloy	Al
TC (W/mK)	
In Plane (x-y)	220-230
Thickness (z)	120
Cp (J/g-K)	0.852
CTE (Avg. 20°C to 150°C ppm/C)	
In Plane (x-y)	4
Thickness (z)	24
Tensile Strength (ksi)	
In Plane (x-y)	15
Thickness (z)	
Compressive Strength (ksi)	29.4
Yield Strength (ksi In Comp)	15.9
Young's Modulus (msi)	14.3
Flexure Strength (ksi)	27
Electrical Resistivity (μ·ohm·cm)	
Hardness (Rockwell E)	
Density (g/cc)	2.40
Plating	Ni, Au, Ag
Machinability	Excellent
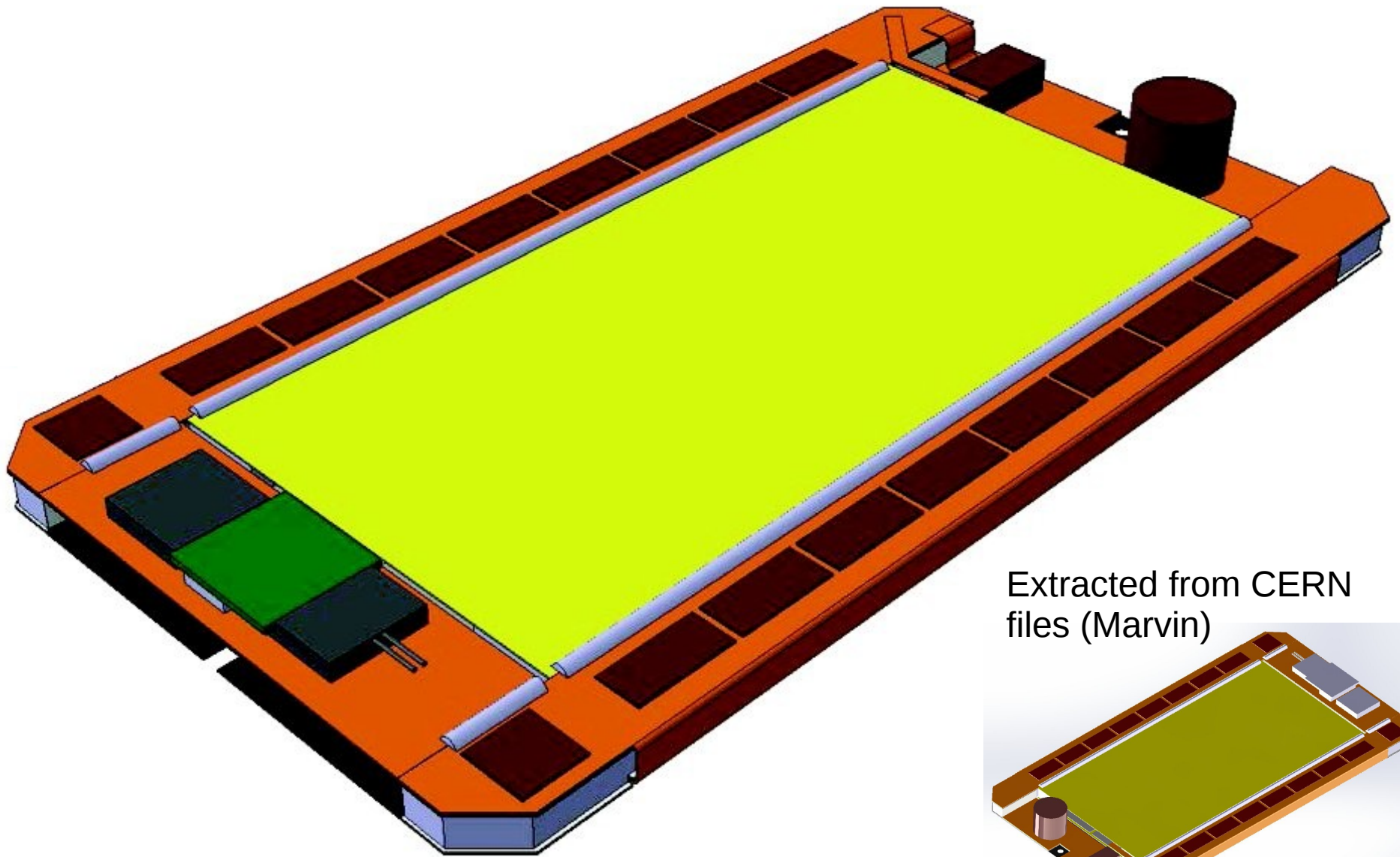
Extracted from CERN files (Marvin)
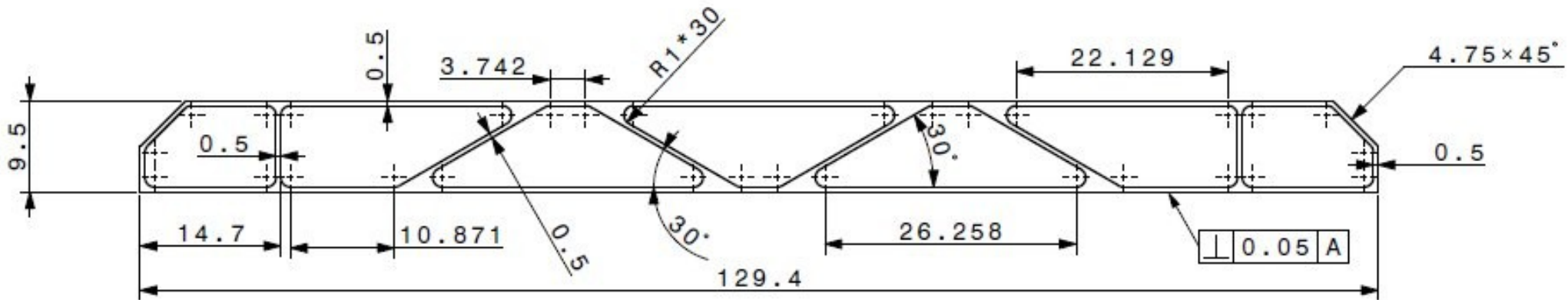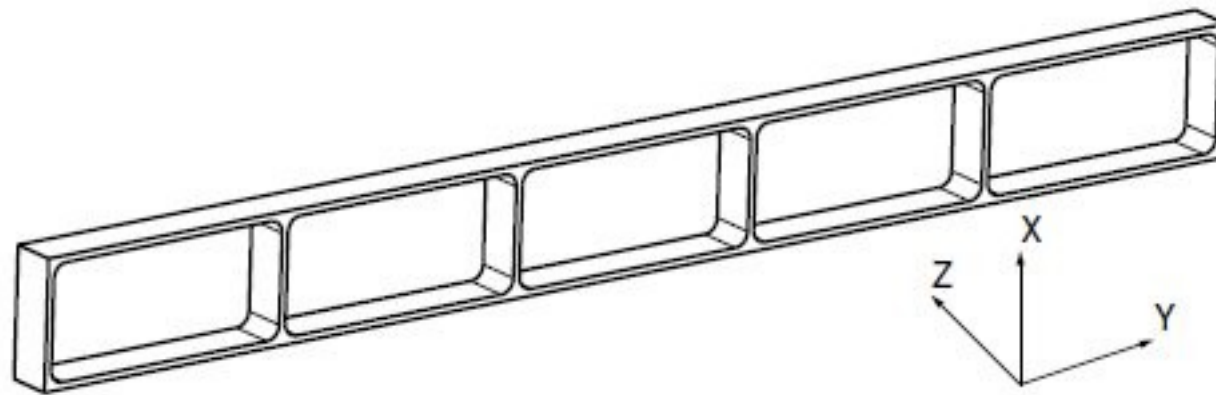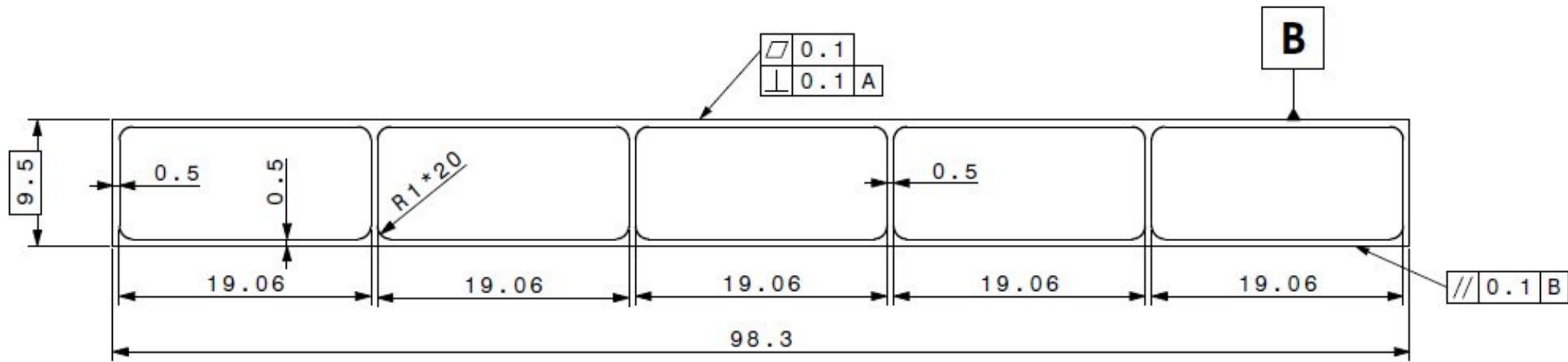
- Complex assembly
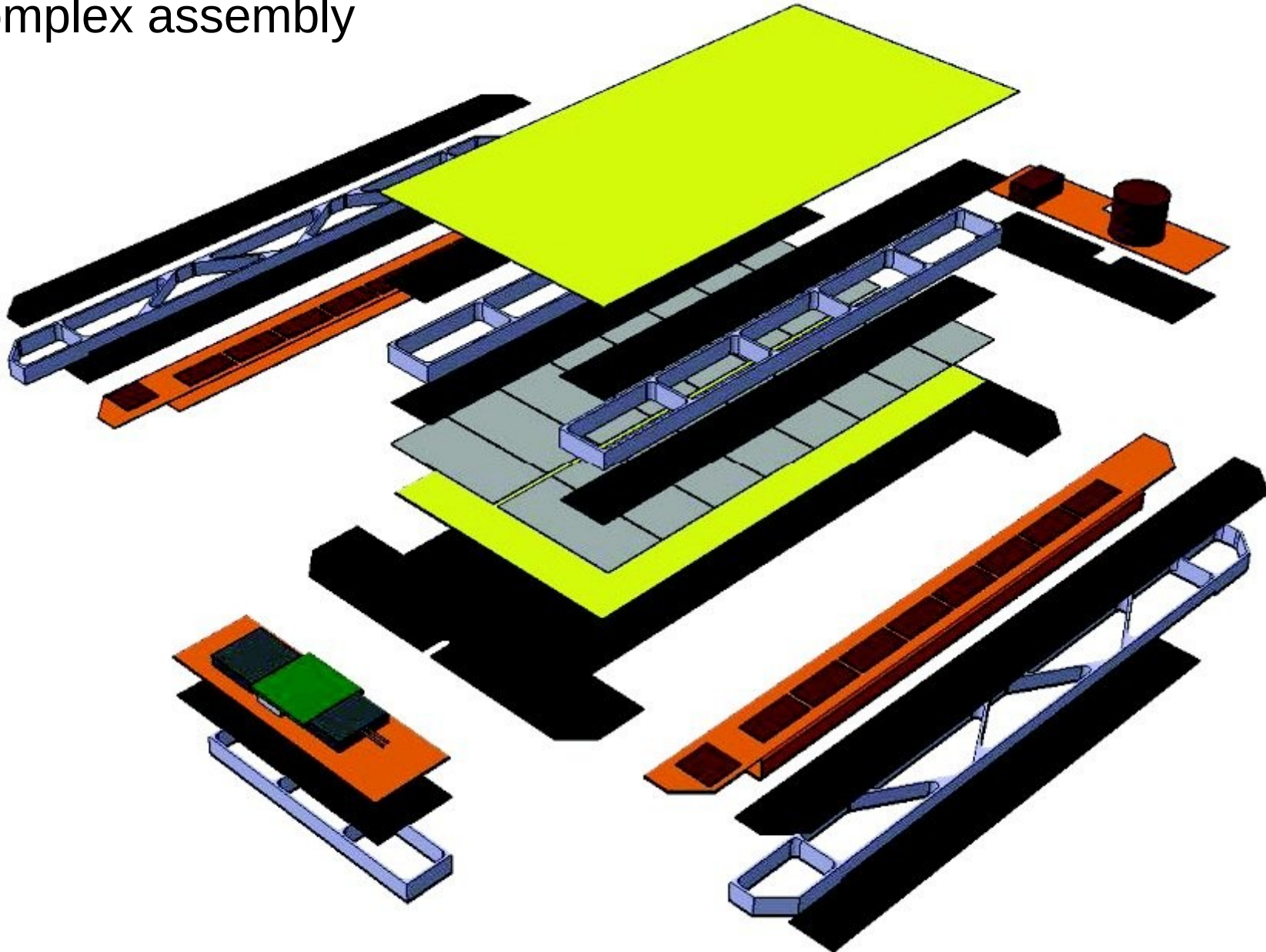
Module prototype / CERN

- Individual pieces of Al-CF might be easier to machine, but thermal conductivity worse and not as stiff
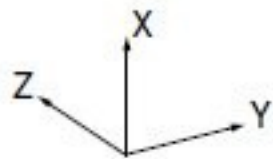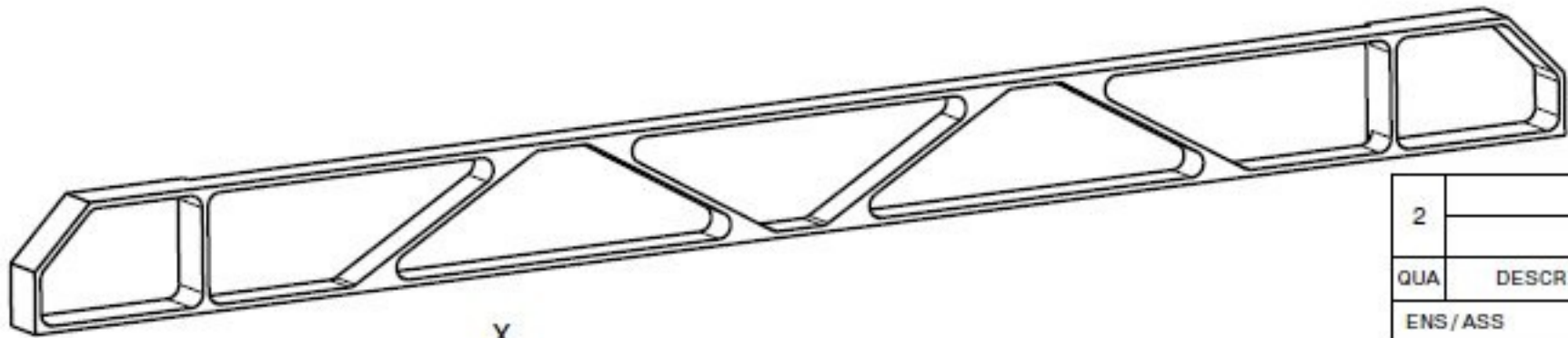
Fiber orientation in the Y-Z plane

Fiber orientation in the Y-Z plane

Module prototype / CERN
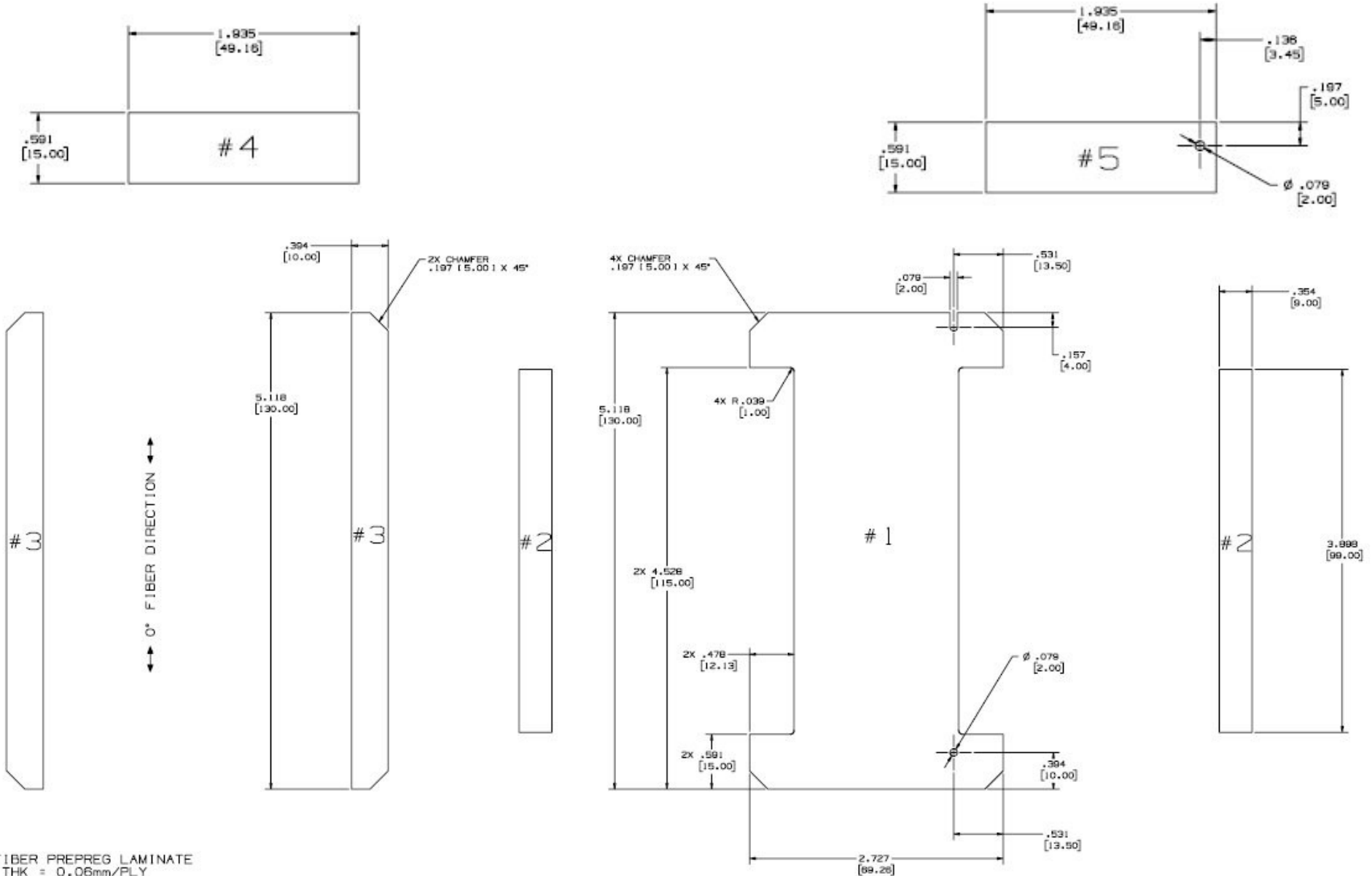

Fiber Orientation in the Y-Z plane

- PS4 parts made from Carbon Fiber – Sketch by Greg (from today)

Module prototype

- Build a full module prototype based on "CERN" design files
    - Using Al-CF, carbon fiber and sensors + bump-bonded RO chips (with internal heating)
- Add additional heating for the DC-DC converters and other Heat generators on other side of module
- Somewhat different in terms of thickness:
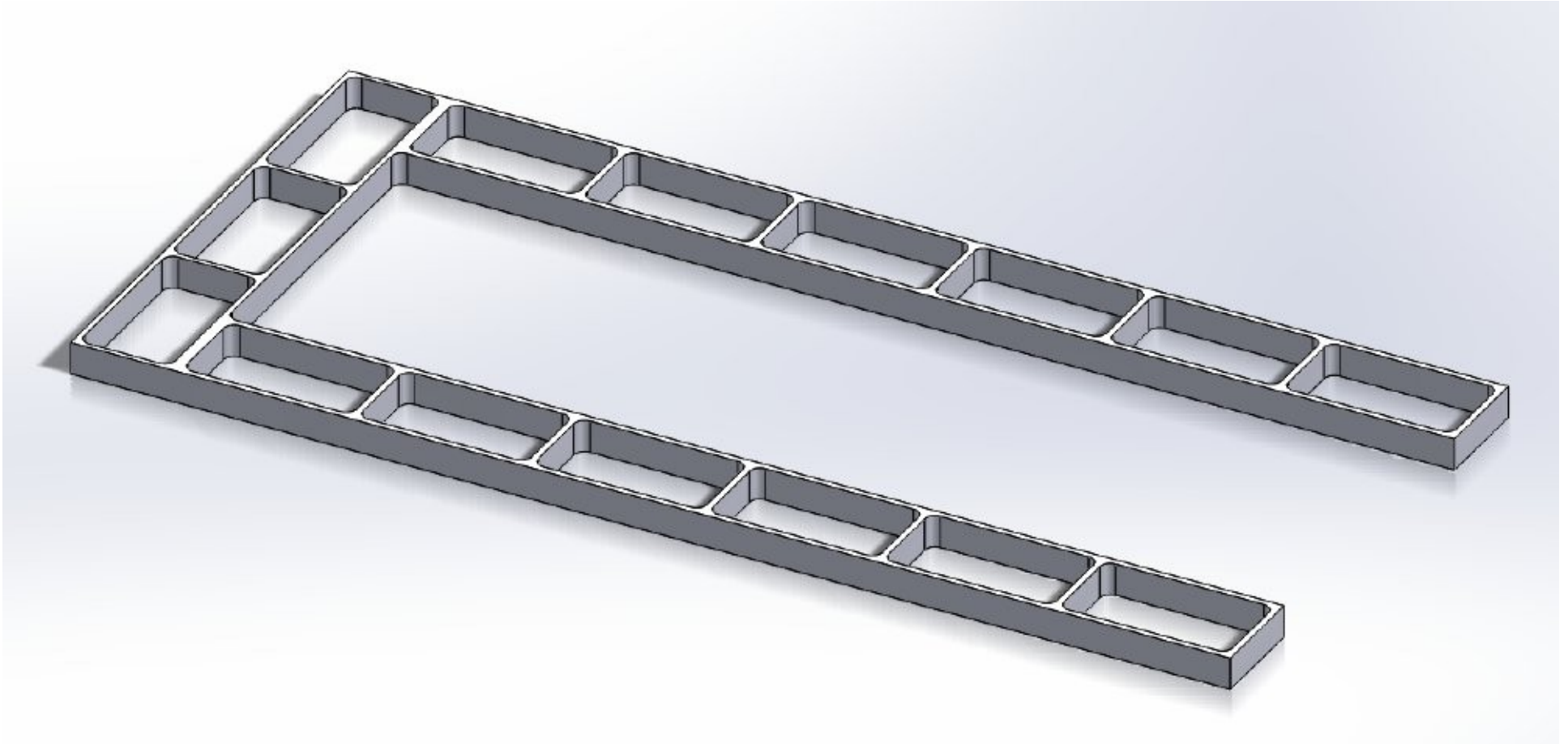   - $300\mu m + 600\mu m$(chips)

- Study thermal aspects of the module prototype → reference

- <u>Optimize module, some ideas:</u>
    - one Al-CF structure instead of many pieces
    - Avoid gaps, better thermal connectivity
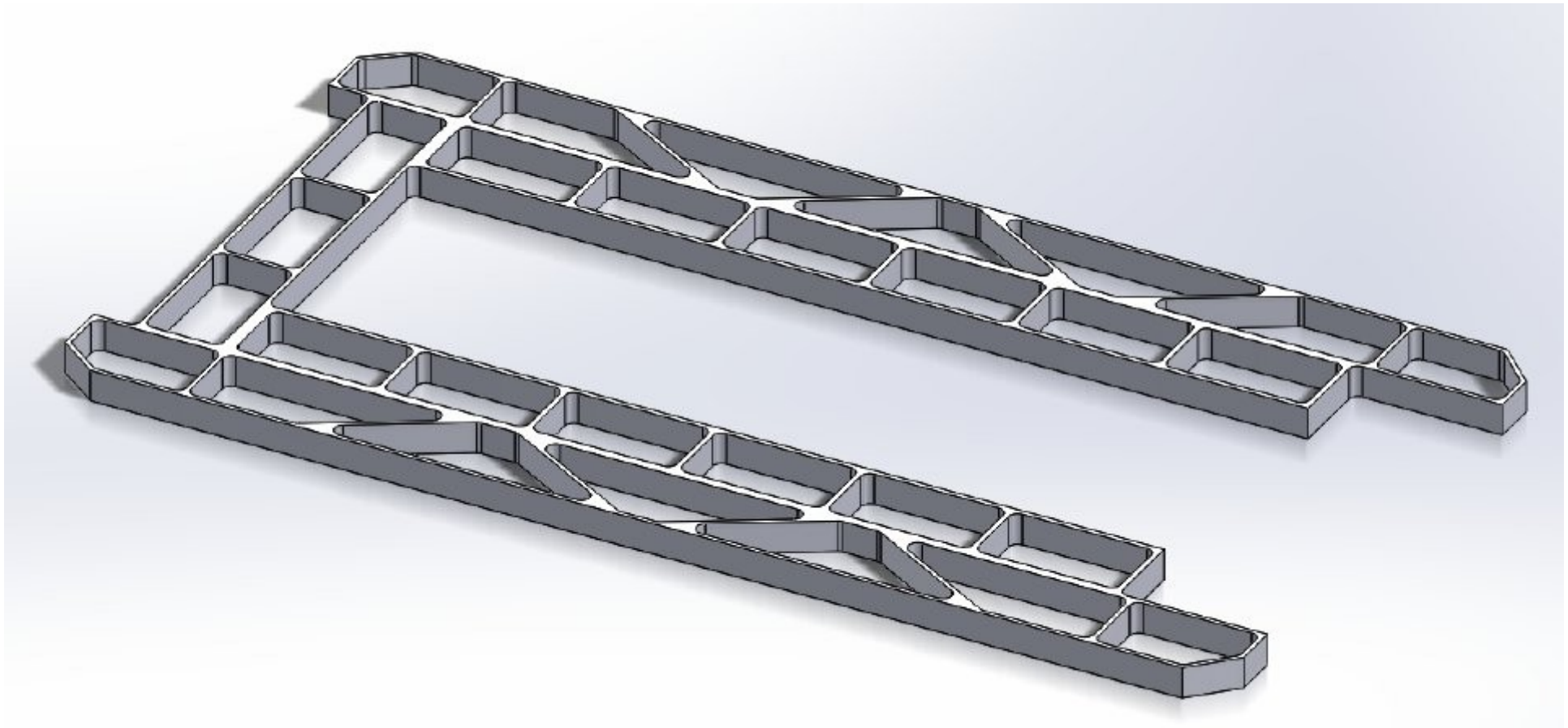   - Carbon foam instead of Al-CF

- Al-CF design (one structure) by Marvin

Module prototype / FNAL

- Al-CF design (one structure) by Marvin
- Better thermal conductivity, stiffer – test thermal properties of this alternative design as well

Rod support structure

Rod support structure:

- Start from ATLAS IBL and "match" it to CMS dimensions/needs
- Carbon Fiber base plate with carbon foam around cooling pipe and honey comb for most of the bulk

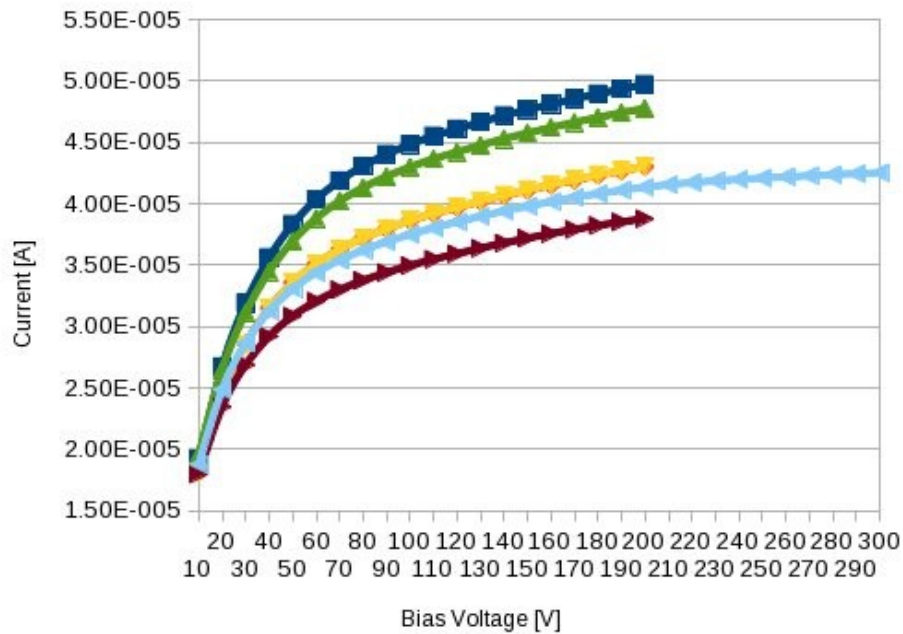# *Backup*

Adhesive tests

- Has putting the phase change adhesive on silicon an effect on its properties ?
  - Check via taking IC curves at room temp for reference
  - Put Laird TCPM 583 on one, check again at room temp
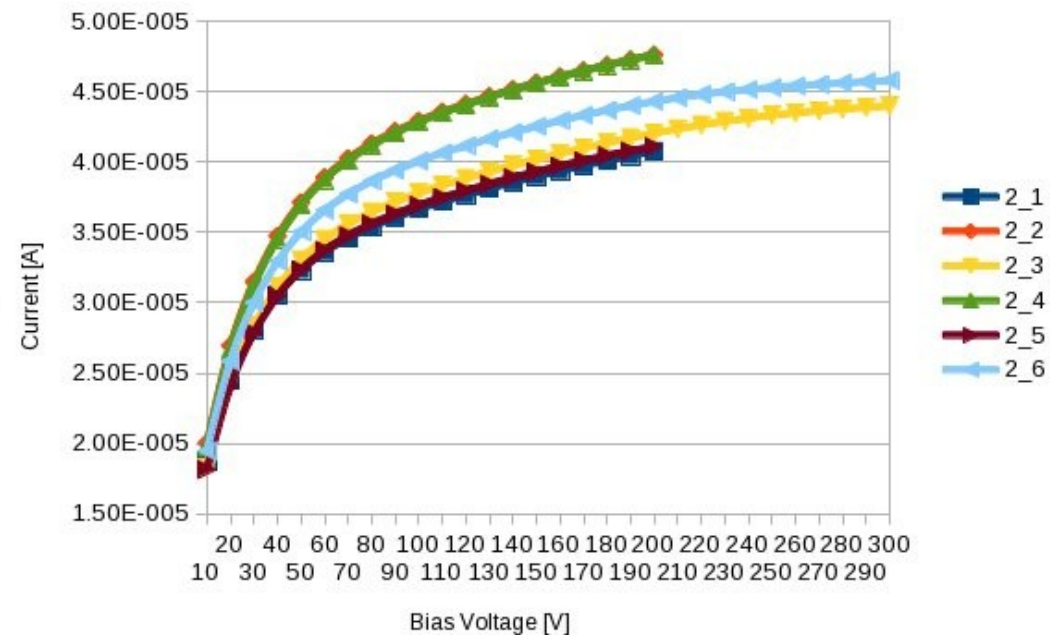 - Heat over night to 80 deg C and take IV curve again

Adhesive tests

•Check via taking IC curves at room temp for reference
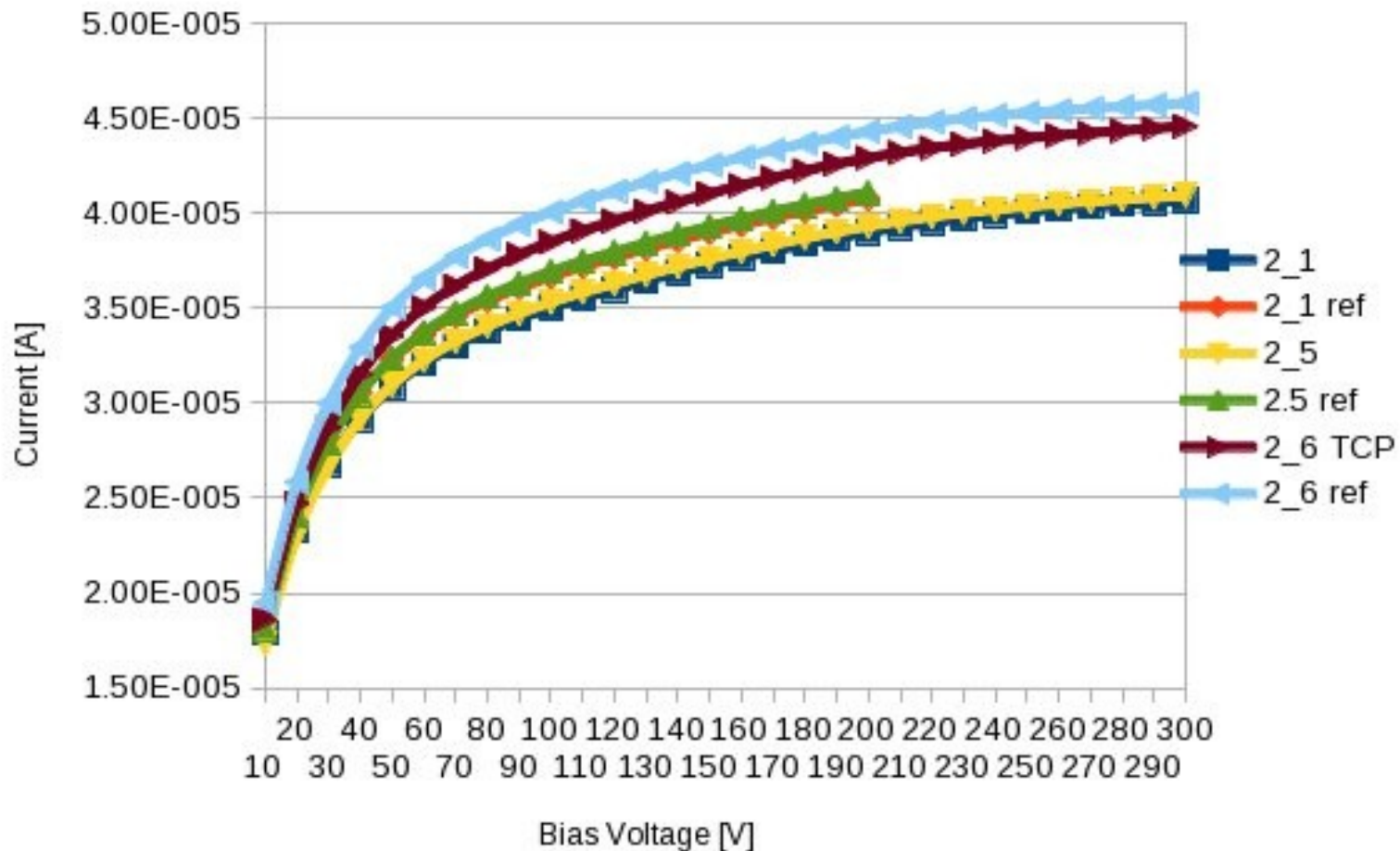

IV curves - non heated

IV curves non heated

Adhesive tests

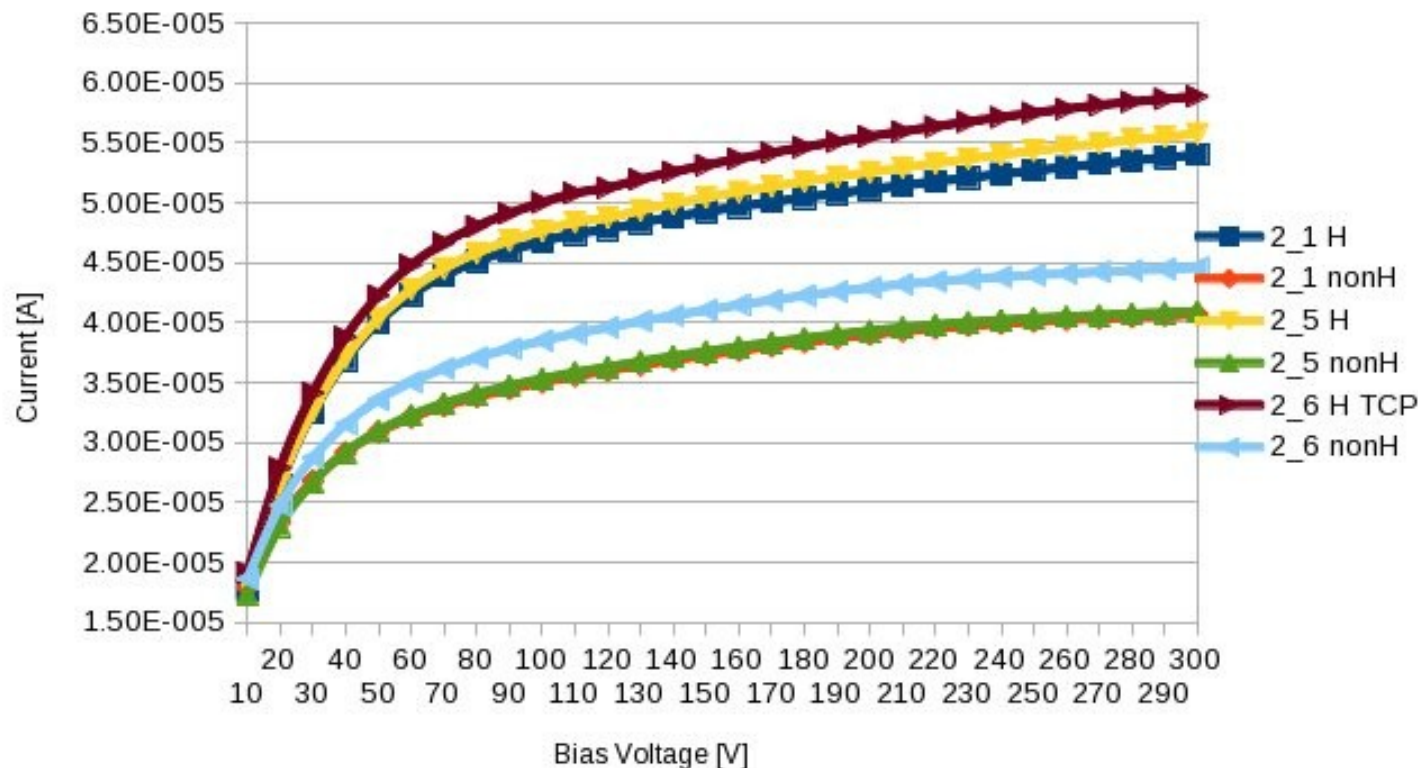- Put Laird TCPM 583 on one, check again at room temp

IV curves - non heated

Adhesive tests

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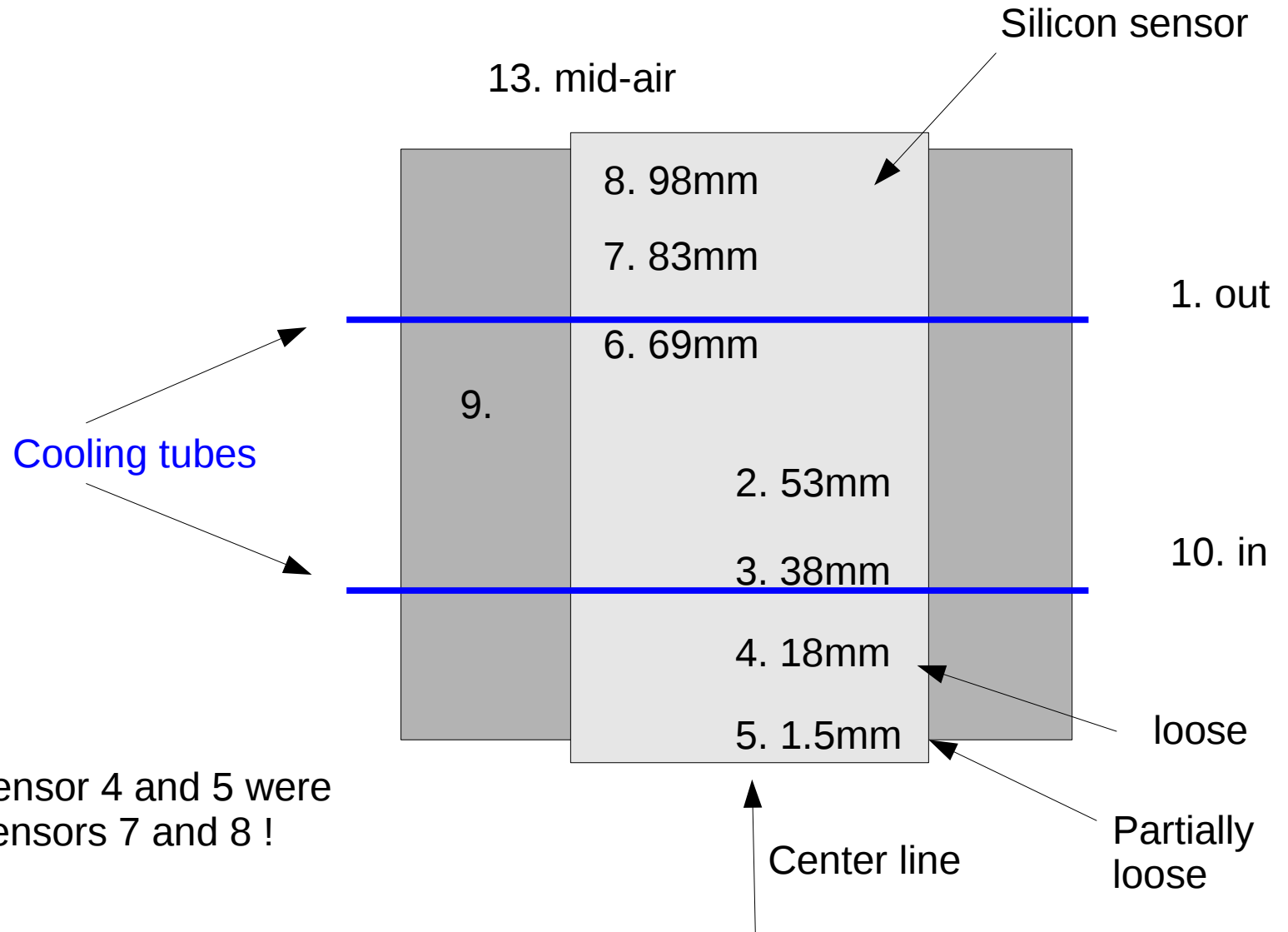
IV curves heated

- Heating has an effect, TCPM not ? --> can repeat tests with other silicon as well
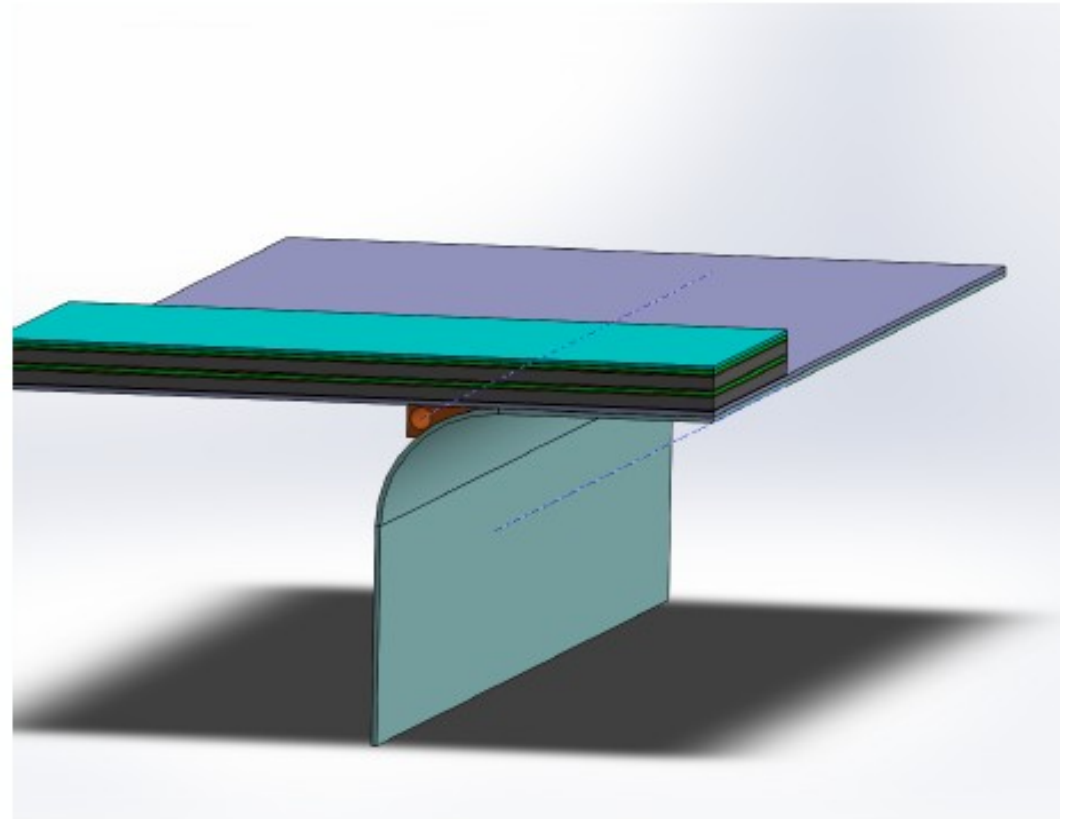
CMS detector upgrade

- Silicon in controlled environment, boxed & sealed

Silicon sensor

13. mid-air

8. 98mm

7. 83mm

1. out

6. 69mm

9.

Cooling tubes

2. 53mm

3. 38mm

10. in

4. 18mm

5. 1.5mm

loose

--> For new data sensor 4 and 5 were moved to across sensors 7 and 8 !

Center line

Partially loose

Thermal model

- Same model for 2D and 3D analysis

- Material properties and geometry stored in an Excel file

  - 2D and 3D use different files

- Application program is used to create the model

  - 2D and 3D have different programs

- Models are compared to "quarter sensor", use 1/4 of nominal heat load: 1.25 W
- Heat load divided by number of surface nodes, result is assigned as heating power to each surface node
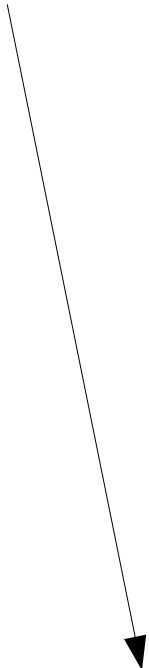
Cooling tubes

Cooling temp
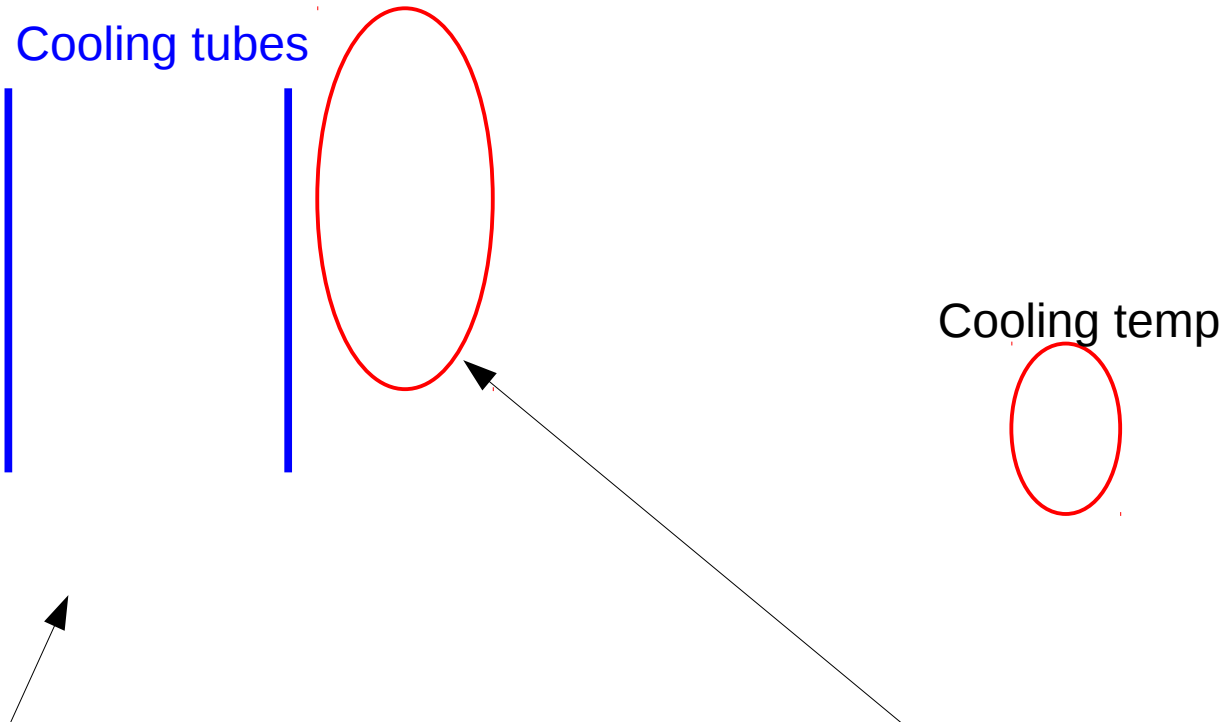
Temperature sensors:
"c 38": center line 38mm from edge
"q 69": quarter line 69mm from edge, etc
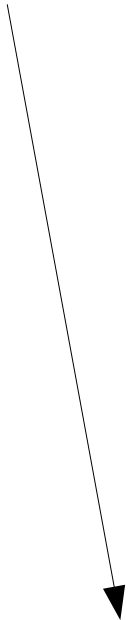"(across)" refers to sensors on bottom side

More pronounced "edge" in new
data compared to old but sensors
were not changed at these locations

- Differences with respect to averaged Tube in/out (-20C)
- "Sim ΔT" taken from model described earlier
- Similar but larger difference in the data from end to mid
- Old and new data are different at edges ("q98")

- Differences with respect to averaged Tube in/out (-20C) as a function of heating power
- "Sim ΔT" taken from model described earlier
- Three sets: "98 – 98mm (across)", "83 – 83mm (across)" and mid-edge "98 – 53mm"
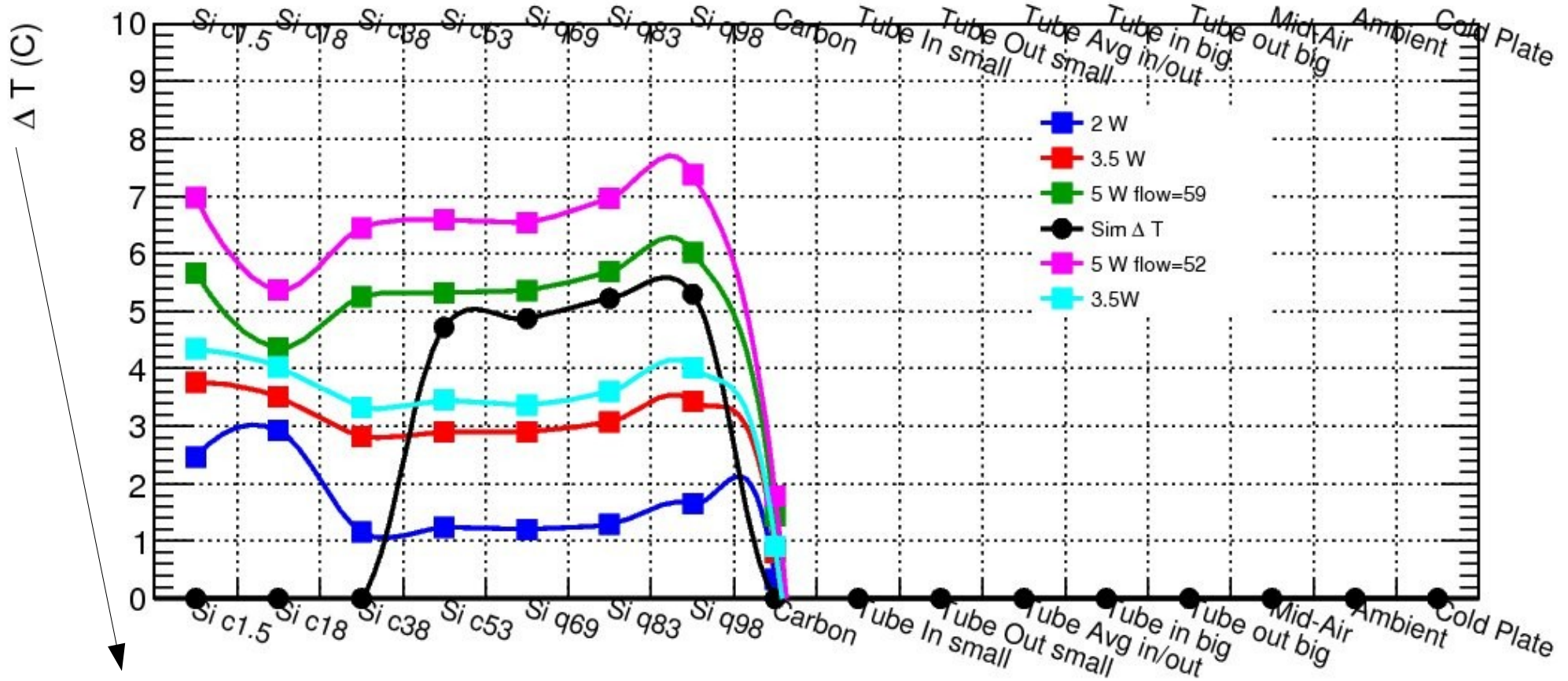- More pronounced "edge" in data compared to sim (green)
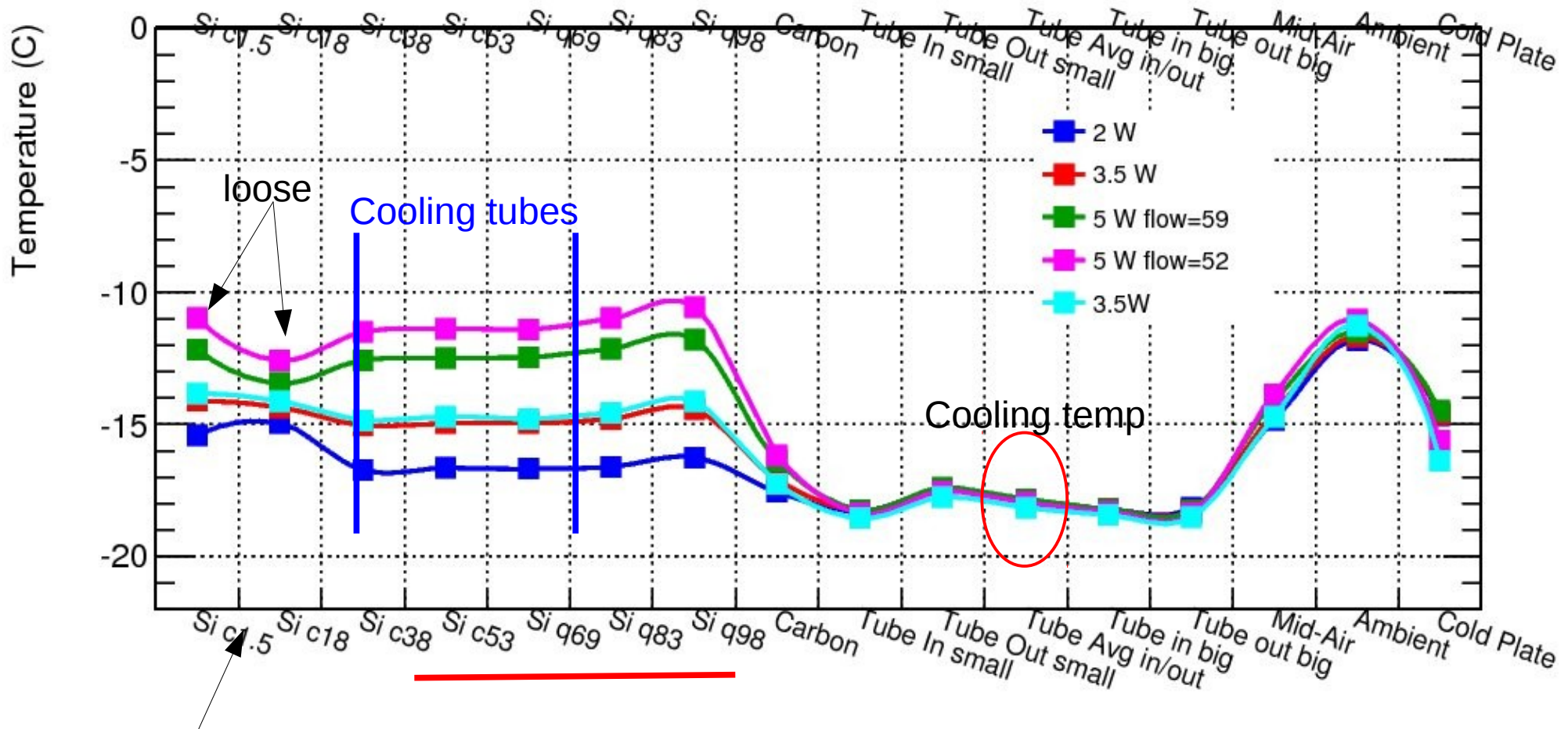
Temperature sensors:
"c 1.5": center line 1.5mm from edge
"c 18": center line 18mm from edge, etc

"q 1.5": quarter line 69mm from edge, etc

CMS detector upgrade

CMS detector upgrade

Red is all foam (1mm)

blue is 1 mm CF

green is 0.36 CF

Temperature at silicon midline