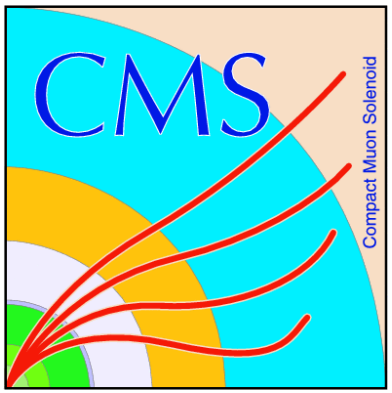


Status report from FNAL

- Module prototype building

G.Derylo, S.Gruenendahl,
M.Johnson, R.Lipton

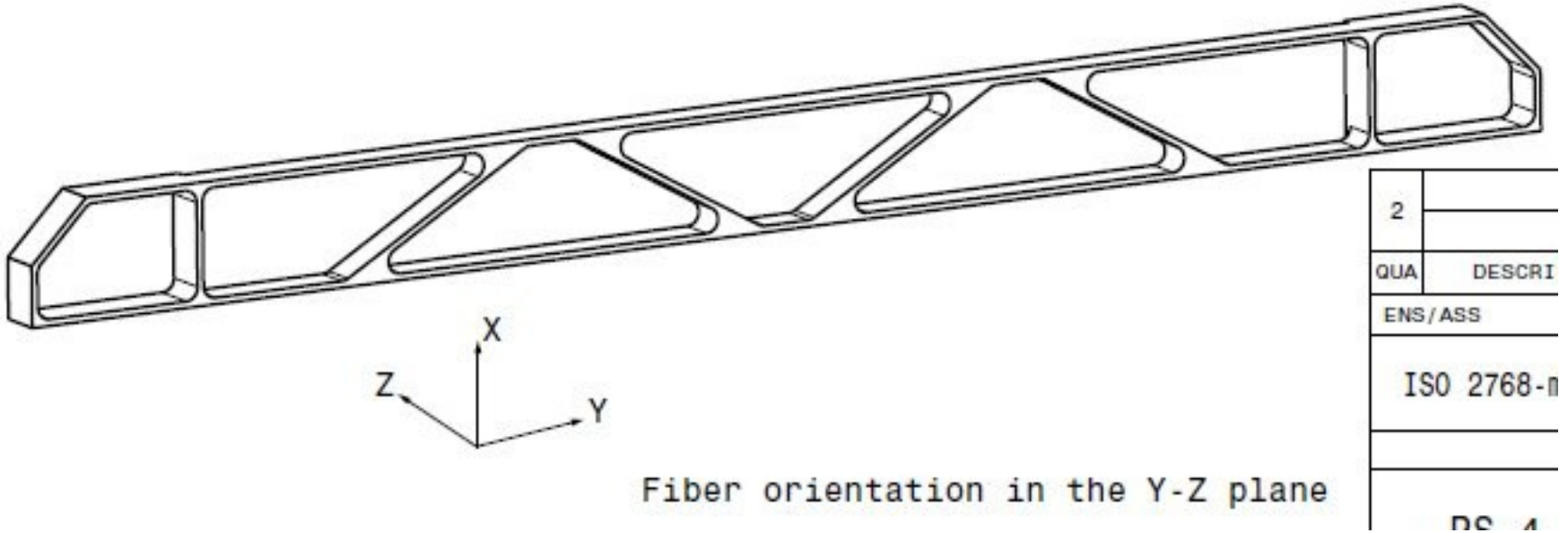
Module prototype

- Ordered Al-CF (Metgraf 4-230) with dimensions: 12”x5.25”x0.5”
  - 2 blocks at hand
  - Cut with “wire EDM”
  - Start with pure Al test Structures, expected end of this week...
- Carbon Fiber sheets: K13C
  - 4 layers a 60 μm → 240 μm
  - Drawings of individual parts
- 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

Module prototype

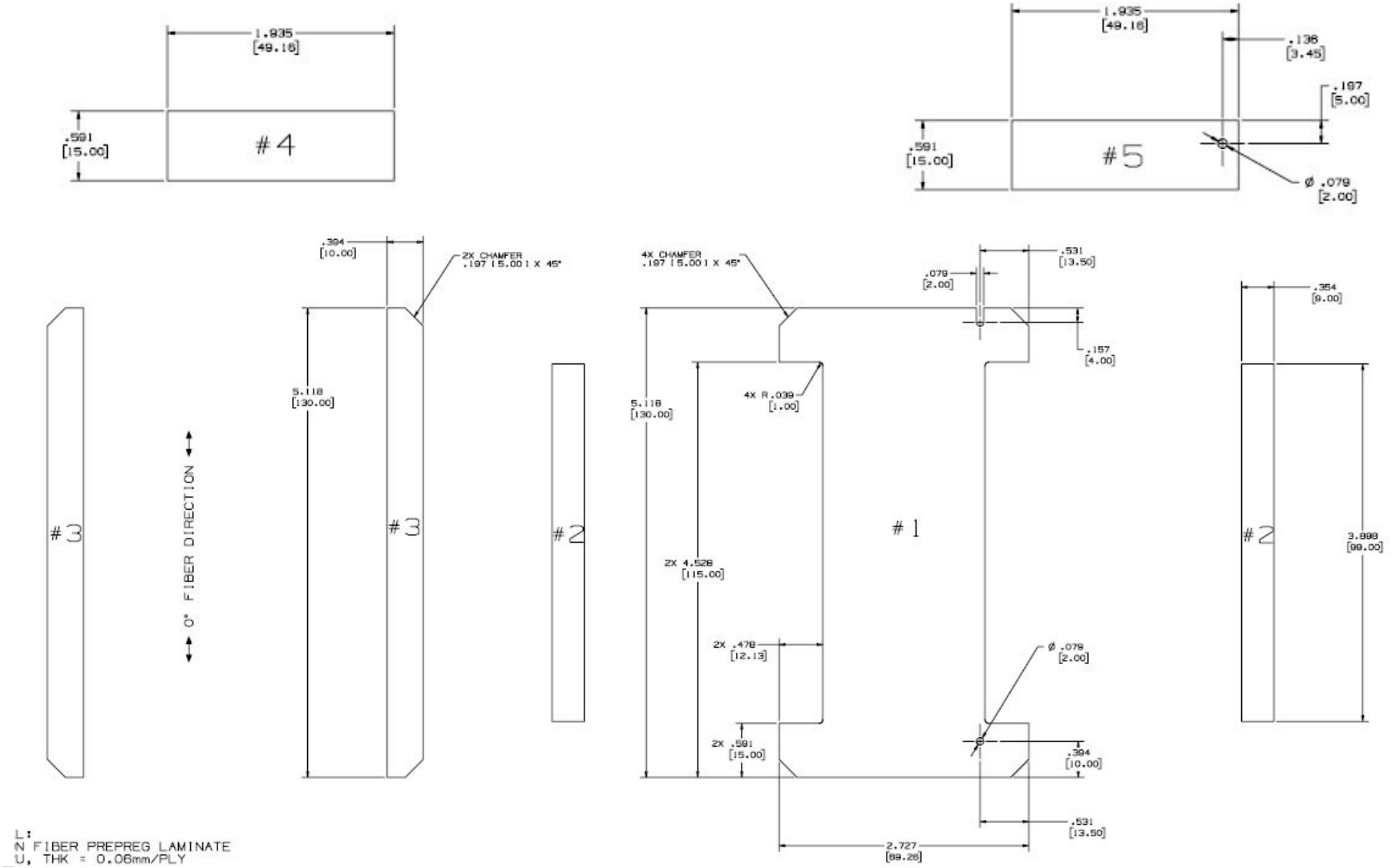
- Drawings from CERN have fiber orientation in y-z plane



- Comparable CTE to silicon → fiber orientation in x-y ?
- Plan to machine blocks in x-y orientation
  (fibers are randomly oriented in x-y)
- From yesterdays CERN meeting:
  --> Interest in test of y-z direction as well

Module prototype

- PS4 parts made from Carbon Fiber



Module prototype

- 4 layers of K13C in 0/90/90/0 orientation
- Fiber direction in “0” is parallel to long-side of parts
- Total thickness expected and verified to be 240 µm
- Seems that in latest CERN design this got increased from 200 to 500 µm
- Concerned about stability but not tested
- Flatness (?)
- Greg: not an issue, and at these values takes shape of underlying material

Module prototype

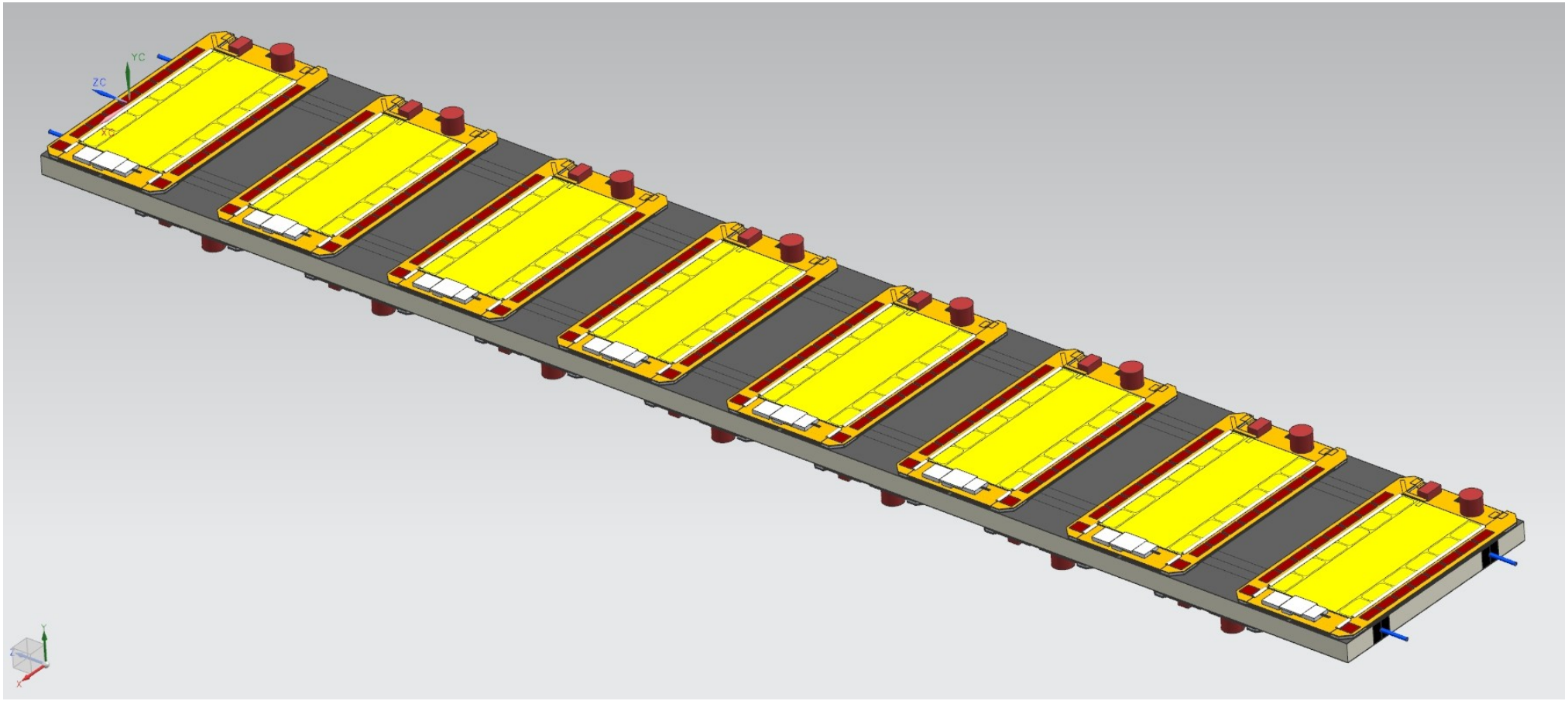
- Build a full module prototype based on CERN design files
  Using Al-CF, carbon fiber and sensors + bump-bonded RO chips (with internal heating)
  - Also get silicon wafers to get started...in contact with PCA

- Add additional heating for the DC-DC converters and other
  Heat generators on other side of module
- Somewhat different in terms of thickness: 300µm + 600µm(chips)

- Study thermal aspects of the module prototype → reference

- <u>Optimize module, some ideas:</u>
  - Avoid gaps, better thermal connectivity
  - Carbon foam instead of Al-CF
  - Optical hybrid to base plate level
  - Not yet decided how to simulate thermal cond. of wire bonds

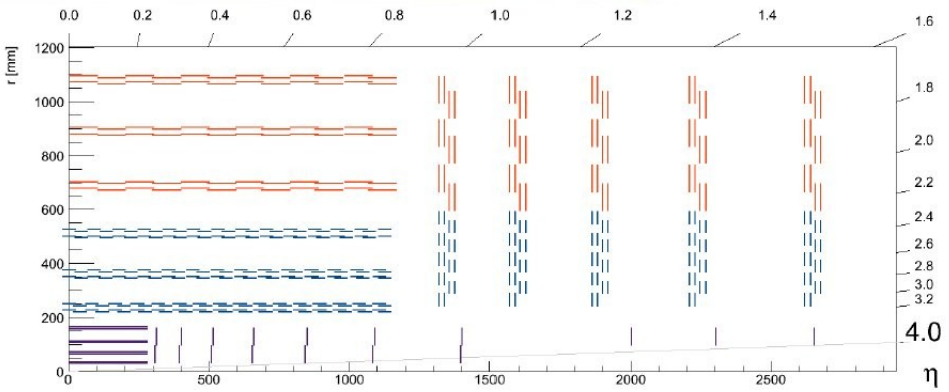
Rod support structure

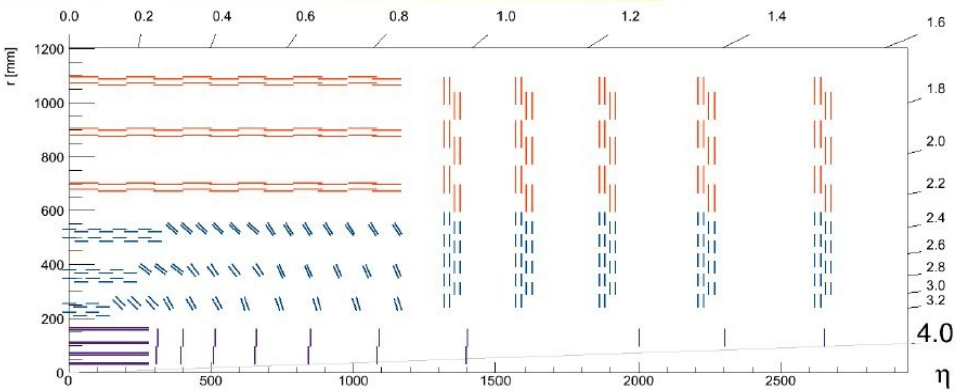


Rod support structure

- In contact with Ultracor to get honey comb material
- “UCF - 126 - 3/8 – 2.0” is now “UCF-304-3/8-2.0”

  same contraction, only a different fabric weaver
- Depending on chosen design straight section is about 800mm or 2300mm → get longer sheets of honey comb (?)



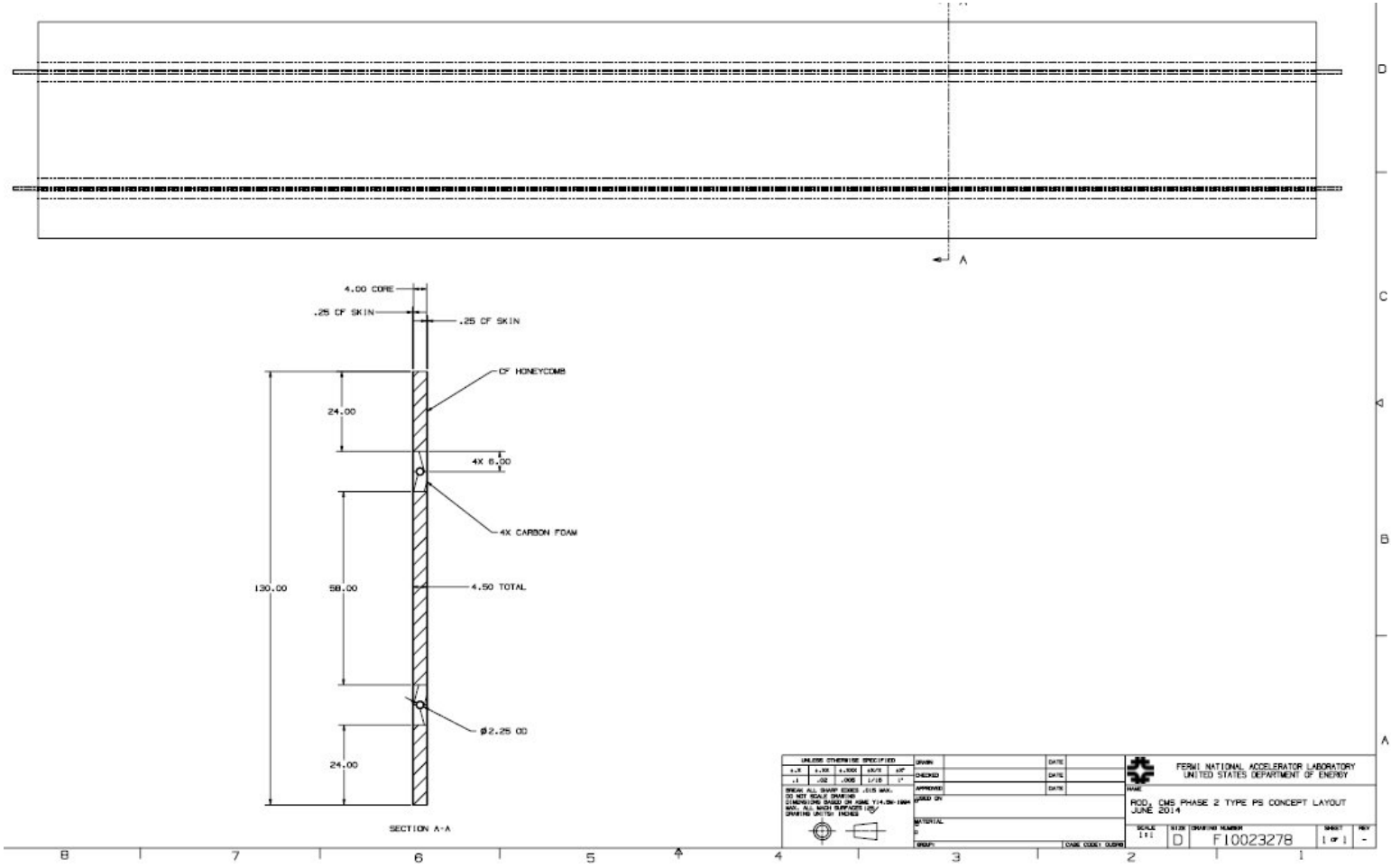


- Ordered more carbon foam

  “Allcomp”

Rod support structure

- Start with dimensions: 1200mm x 180(130)mm x 4mm



- Quotes for 40”x7”x5mm in “304” or “126” but than its 6.35mm

Summary

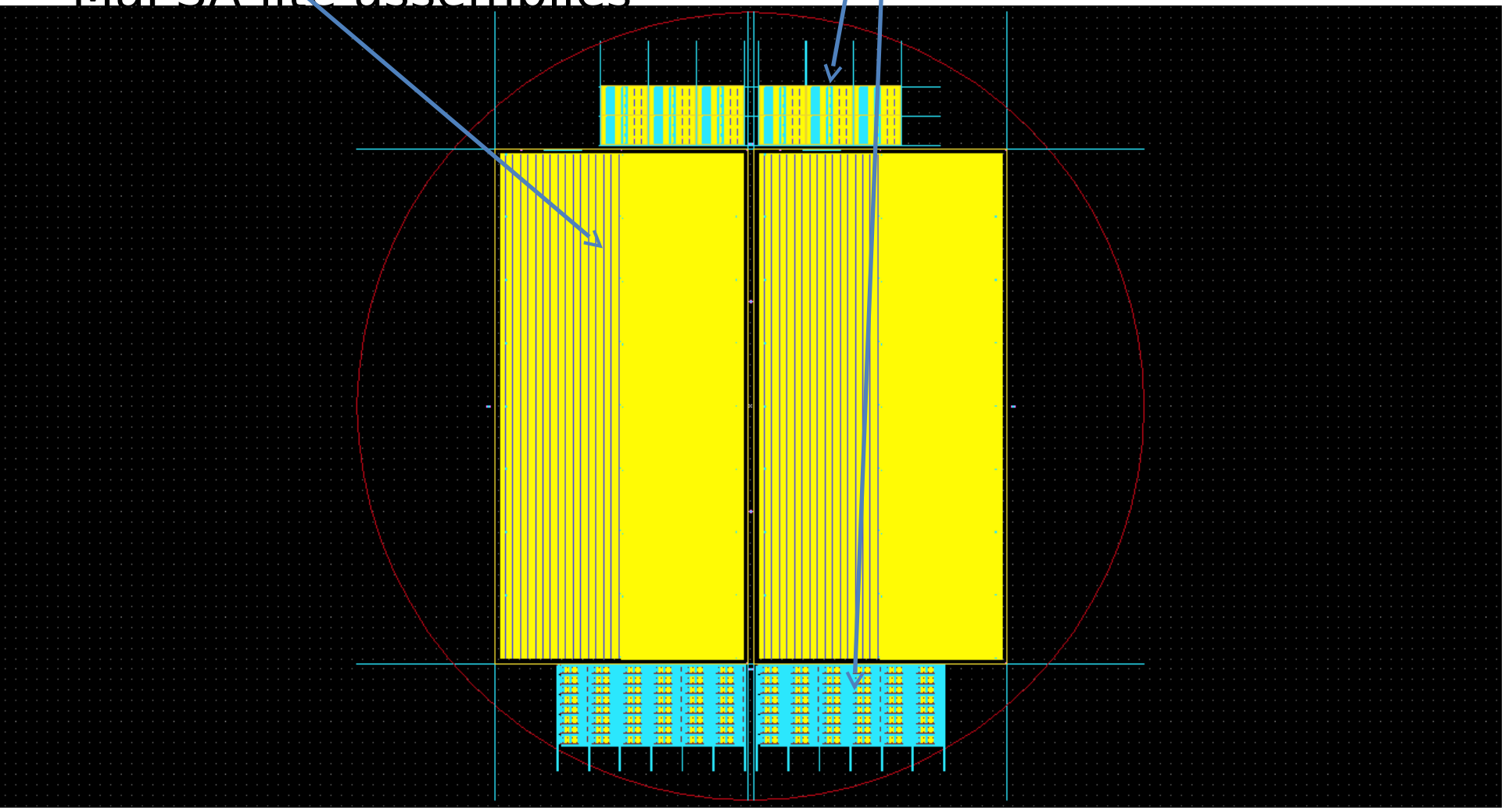
- Enough material to built several mock-up prototypes
- Proceed to built mock-up prototype according to existing design → test thermal stability
- Mock-up prototype: Al-CF + CF + carbon foam
- Combine with silicon dummy sensors w/o internal heating and w internal heating
- In parallel study thermal optimizations and built test structures

Backup

Dummy modules

Slide taken from R.Lipton

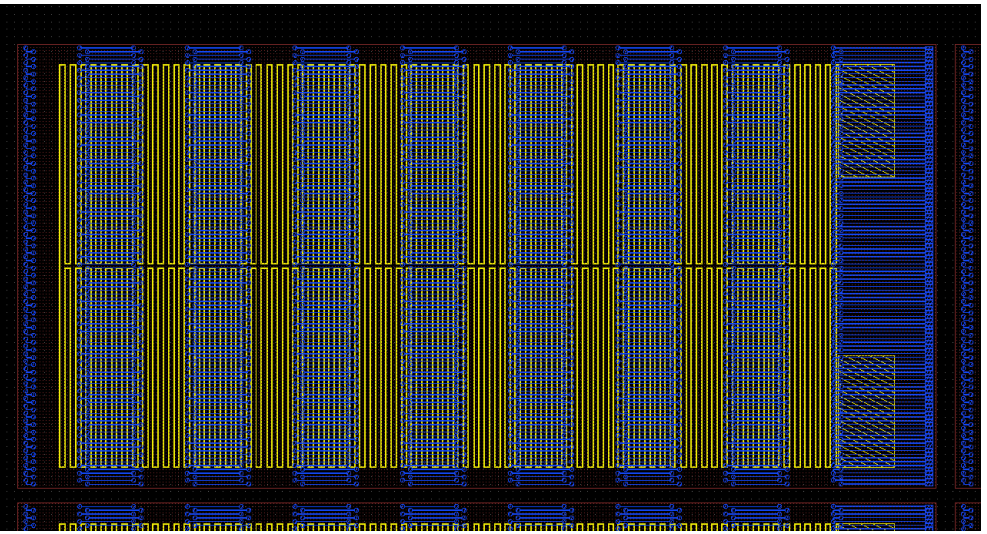
- We have fabricated 6 dummy sensor wafers on 6” silicon, each with 2 dummy PS sensors and 12 MaPSA-lite assemblies

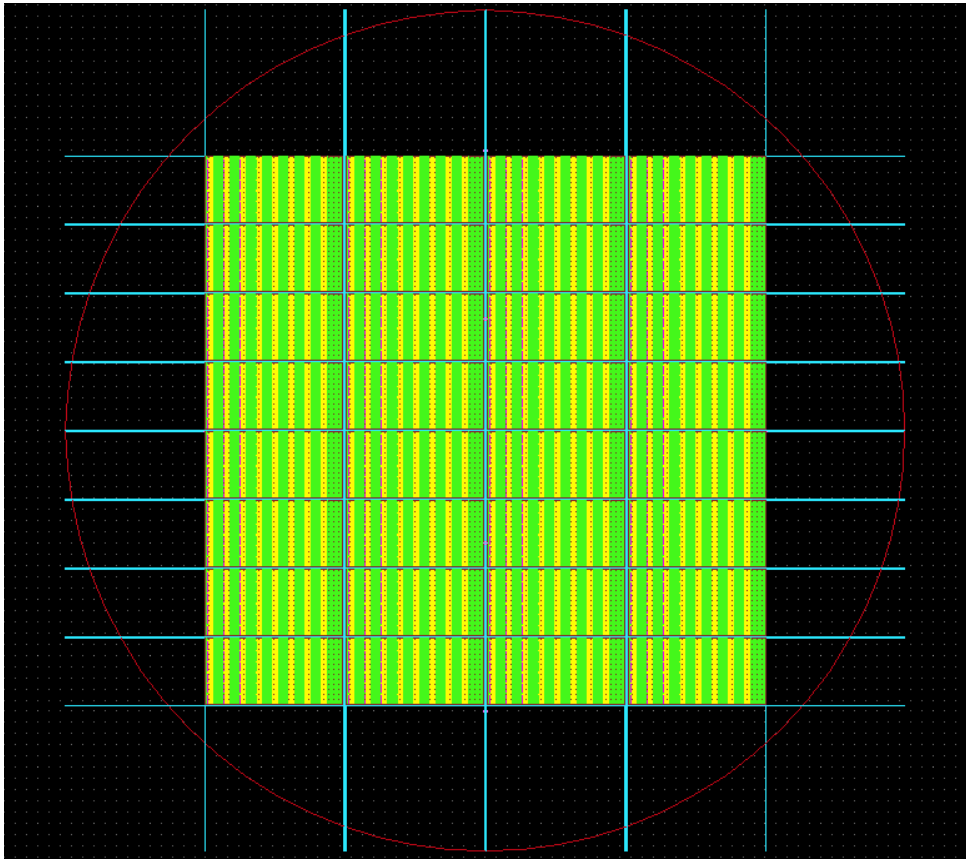


Readout chips (ROICs)

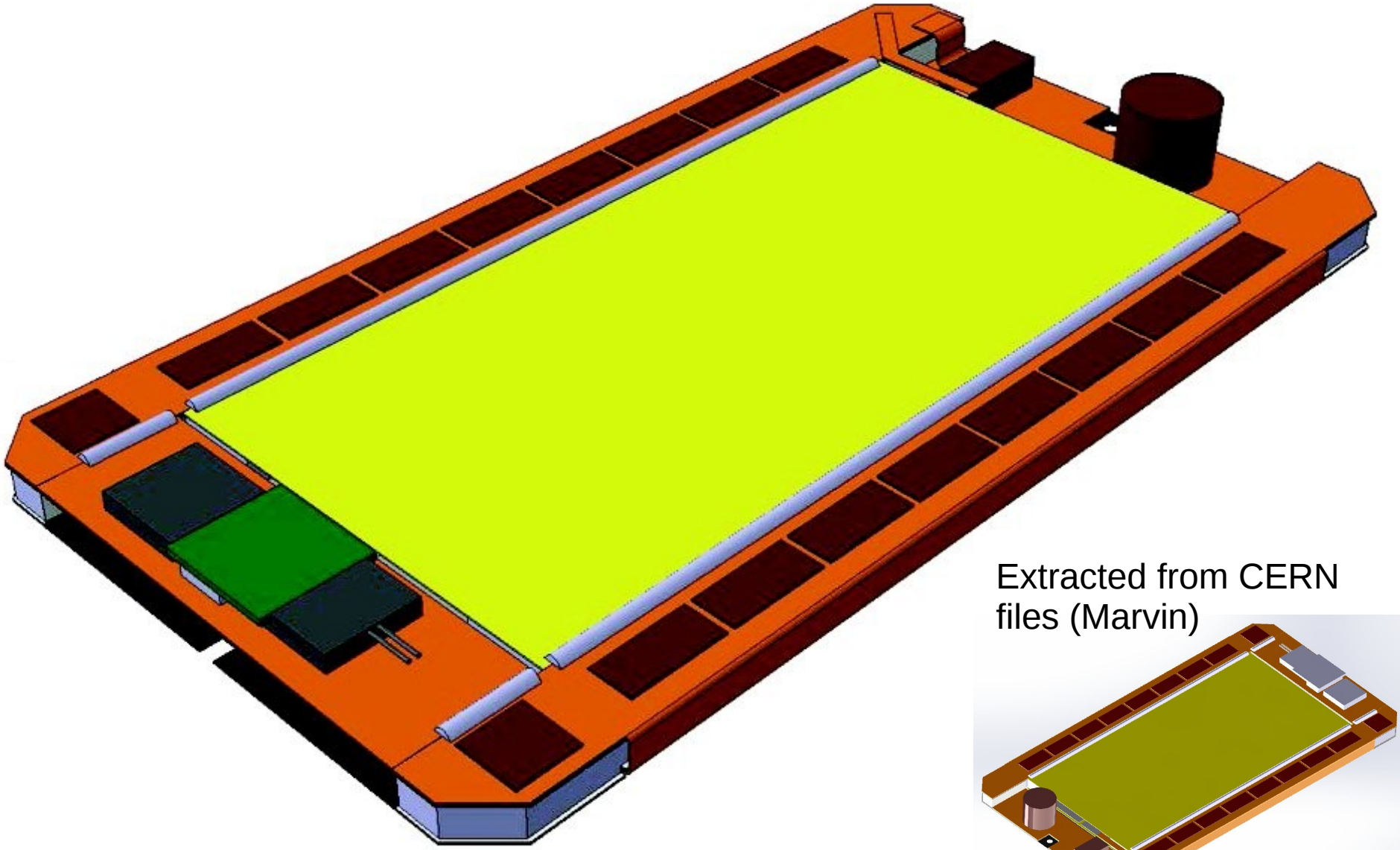
Slide taken from R.Lipton

- We are also fabricating dummy ROICs with heaters. Some of these are in process at UCDavis on 4” silicon, we also are producing some on 6” at Cornell. These are awaiting delivery of double side polished wafers. Fabrication should take a week.
- These can be assembled into thermal test modules.





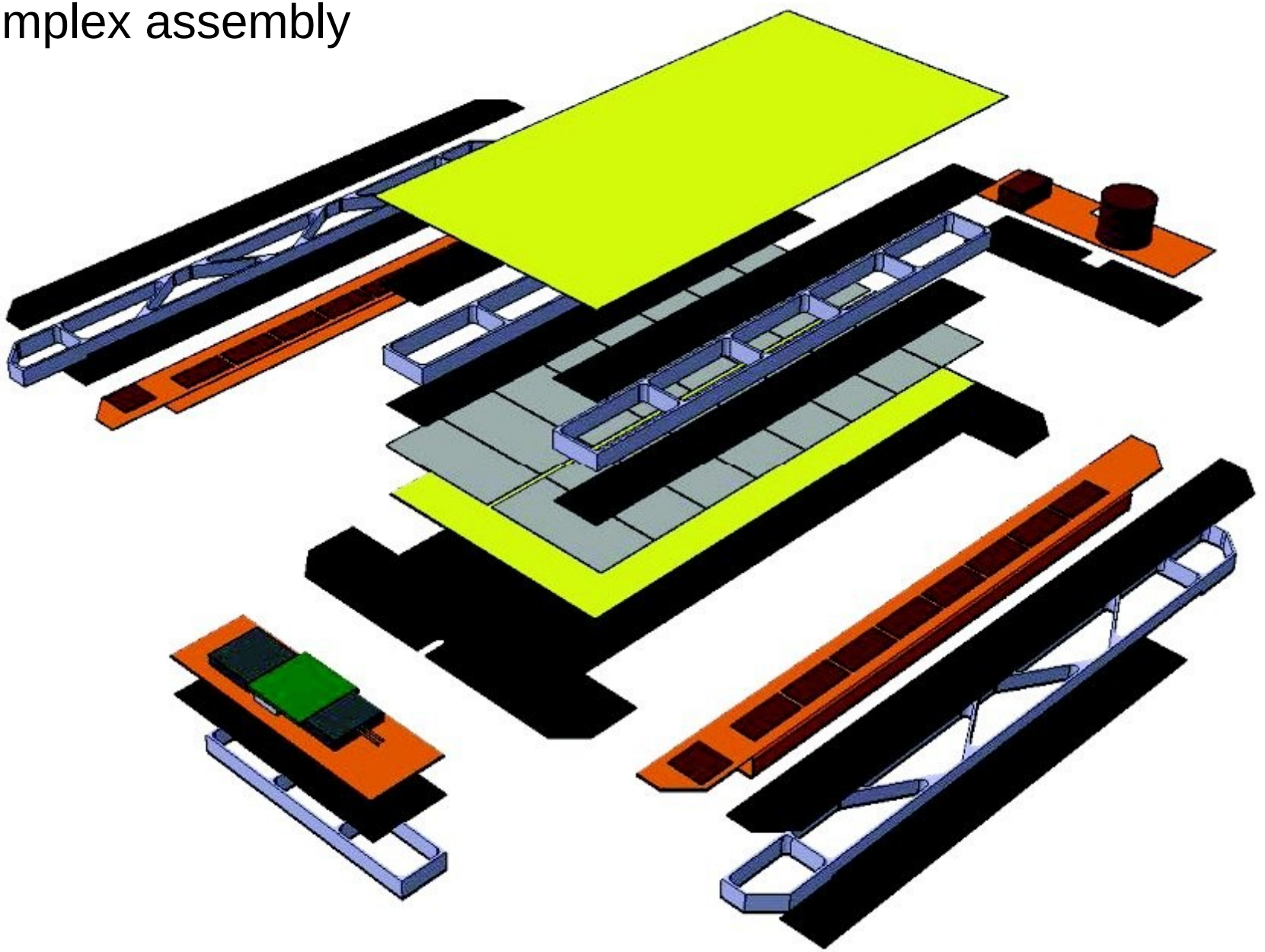
Module prototype / CERN



Extracted from CERN files (Marvin)

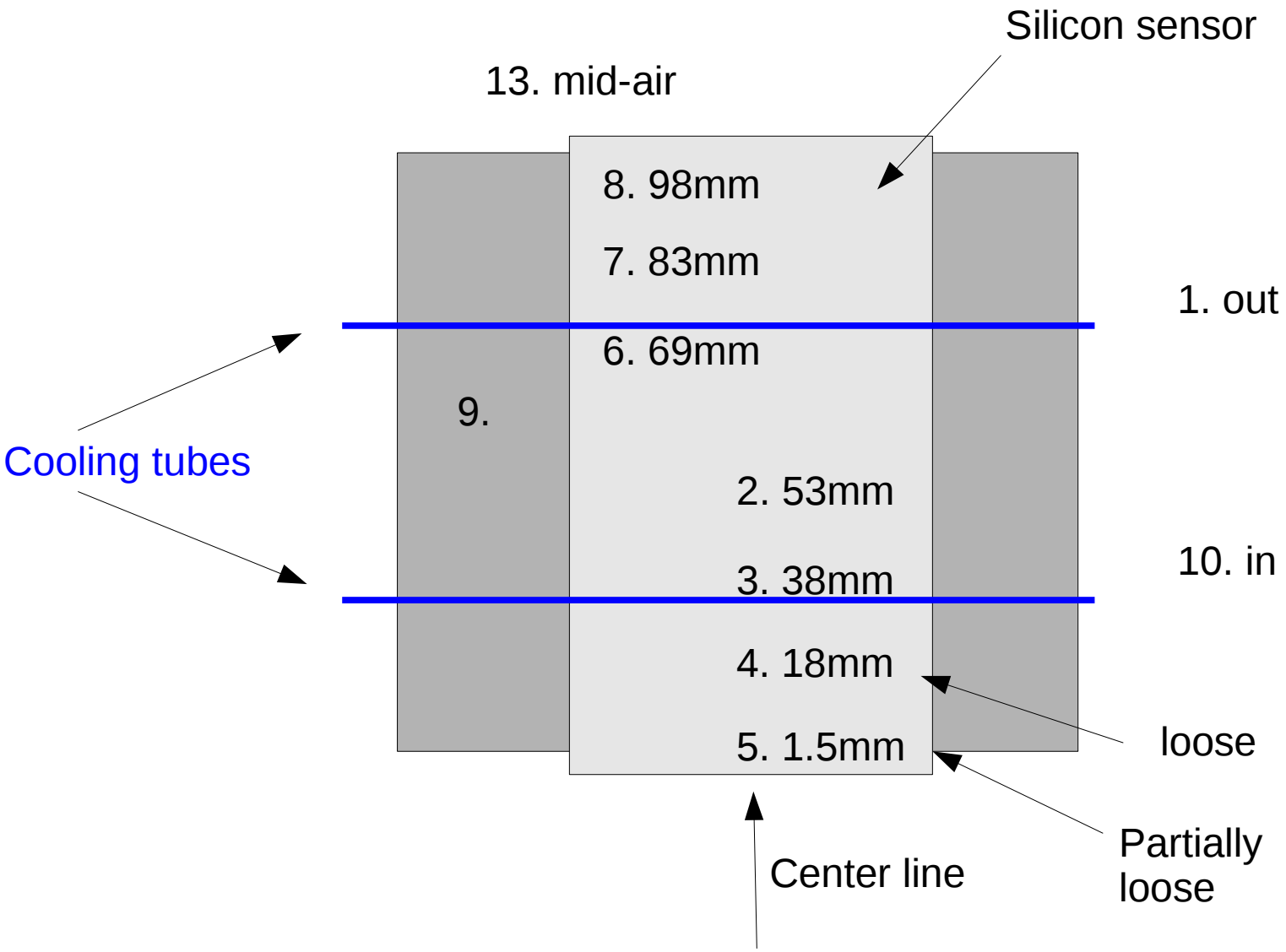
Module prototype / CERN

- Complex assembly

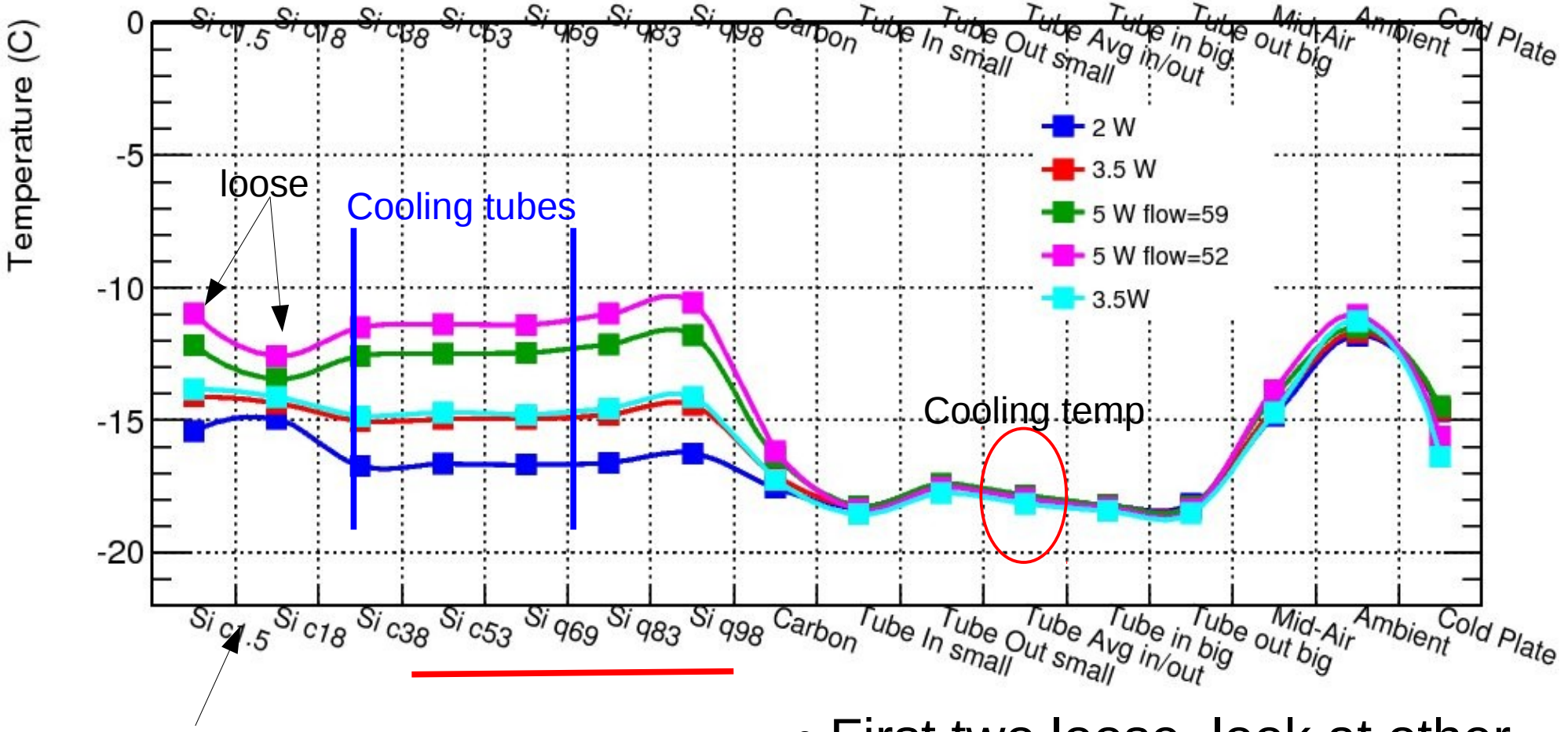


CMS detector upgrade

- Silicon in controlled environment, boxed & sealed



CMS detector upgrade



Temperature sensors:
"c 1.5": center line 1.5mm from edge
"c 18": center line 18mm from edge, etc

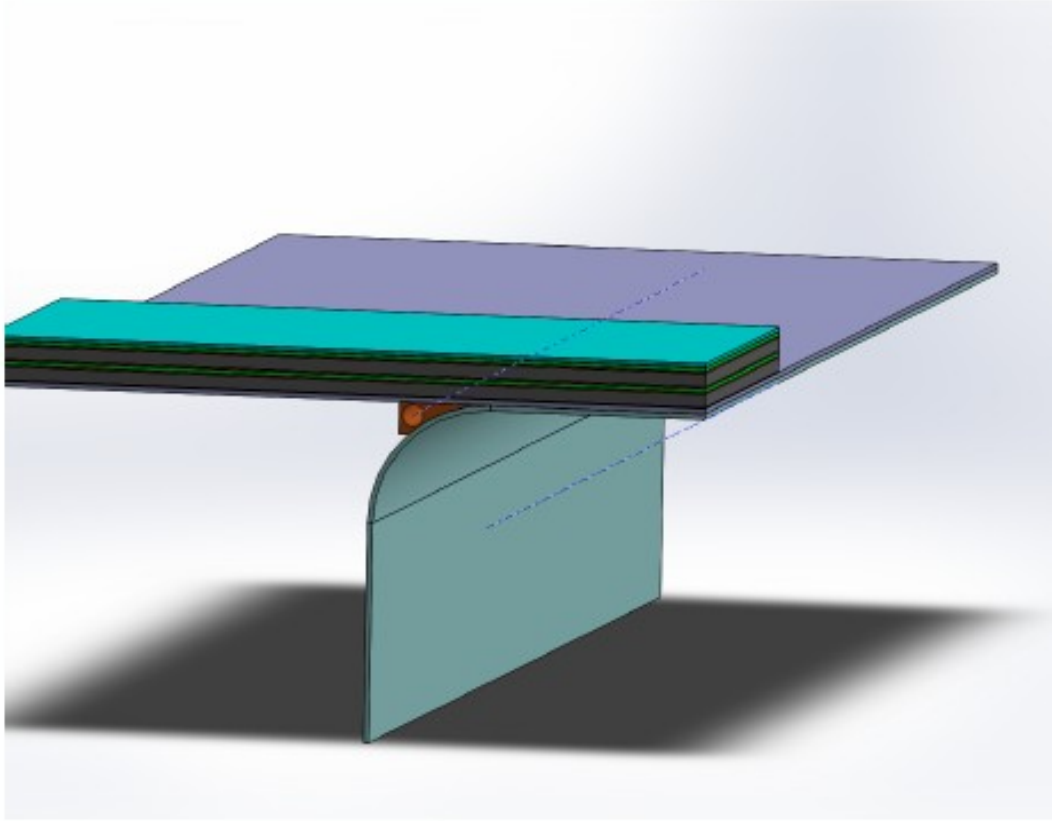
"q 1.5": quarter line 69mm from edge, etc

- First two loose, look at other half of sensors – (to the right)

Thermal model

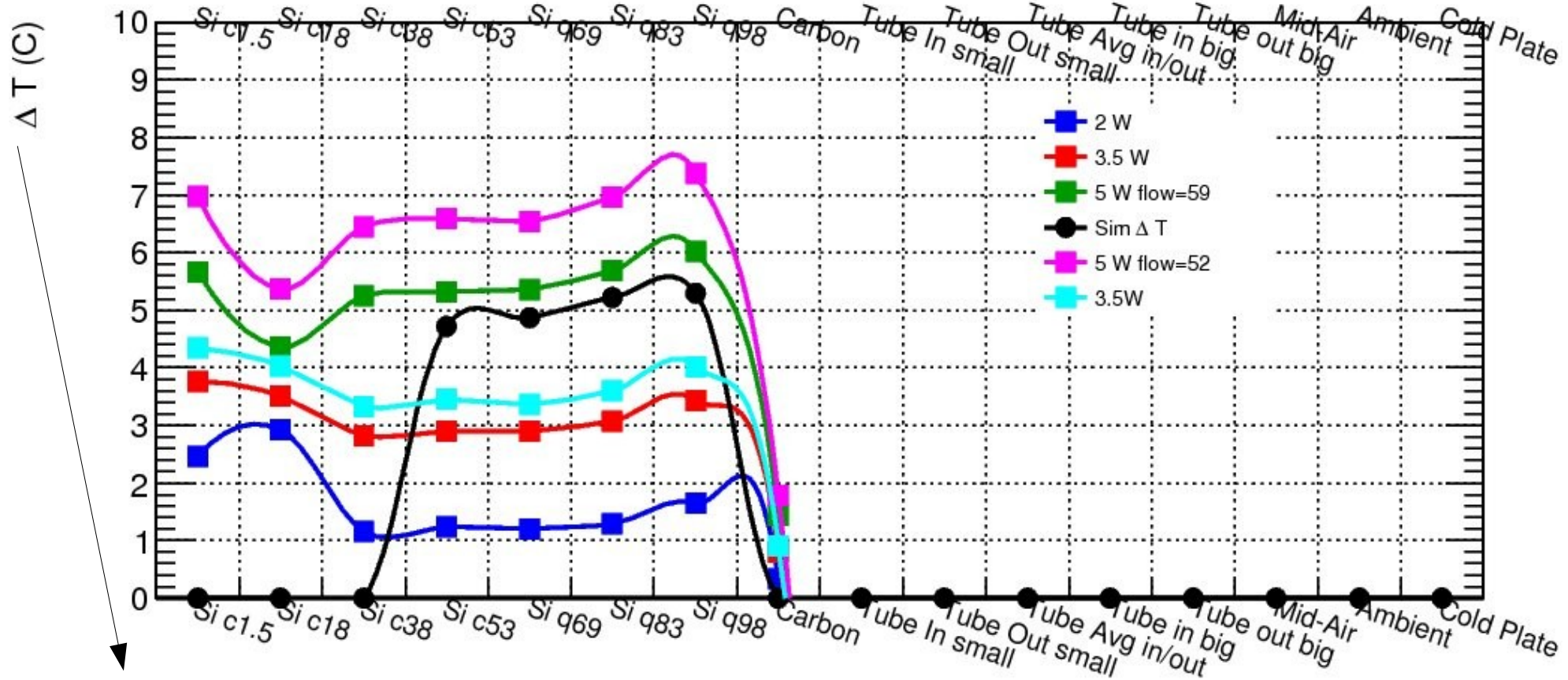
Slide taken from M.Johnson

- 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

CMS detector upgrade



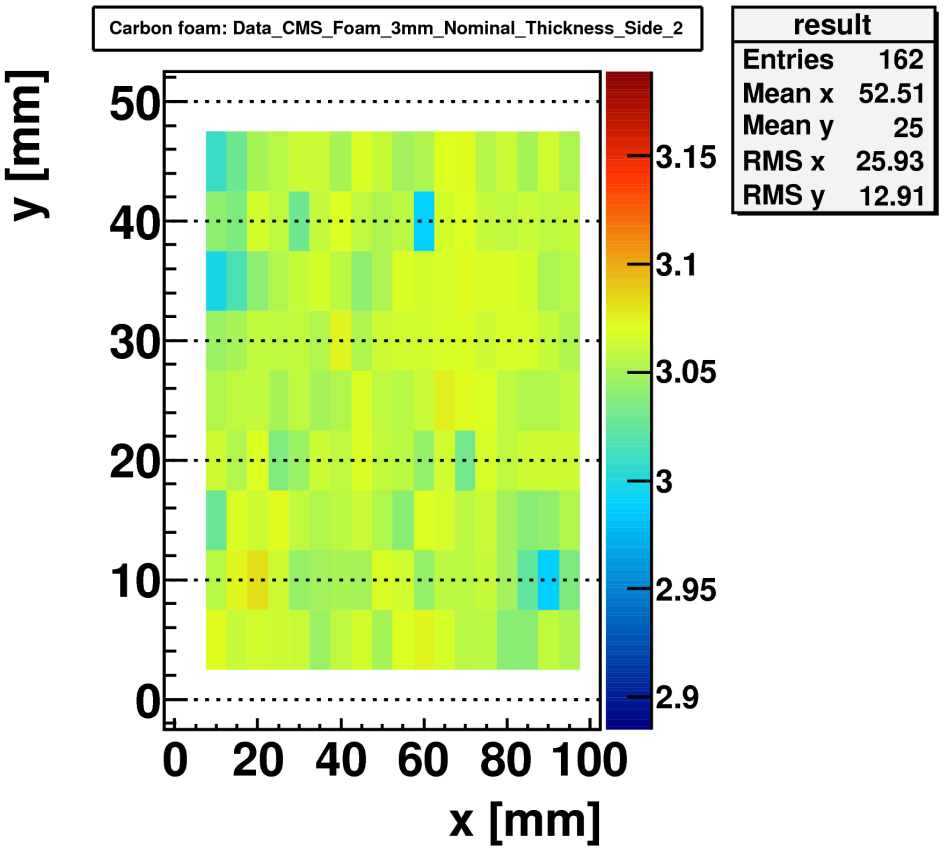
- Differences with respect to averaged Tube in/out (-18C)
- "Sim ΔT" taken from model described earlier
- Similar but larger difference in the data from end to mid
- <u>Check setup & take new data</u>
  - also measure at bottom/under modules

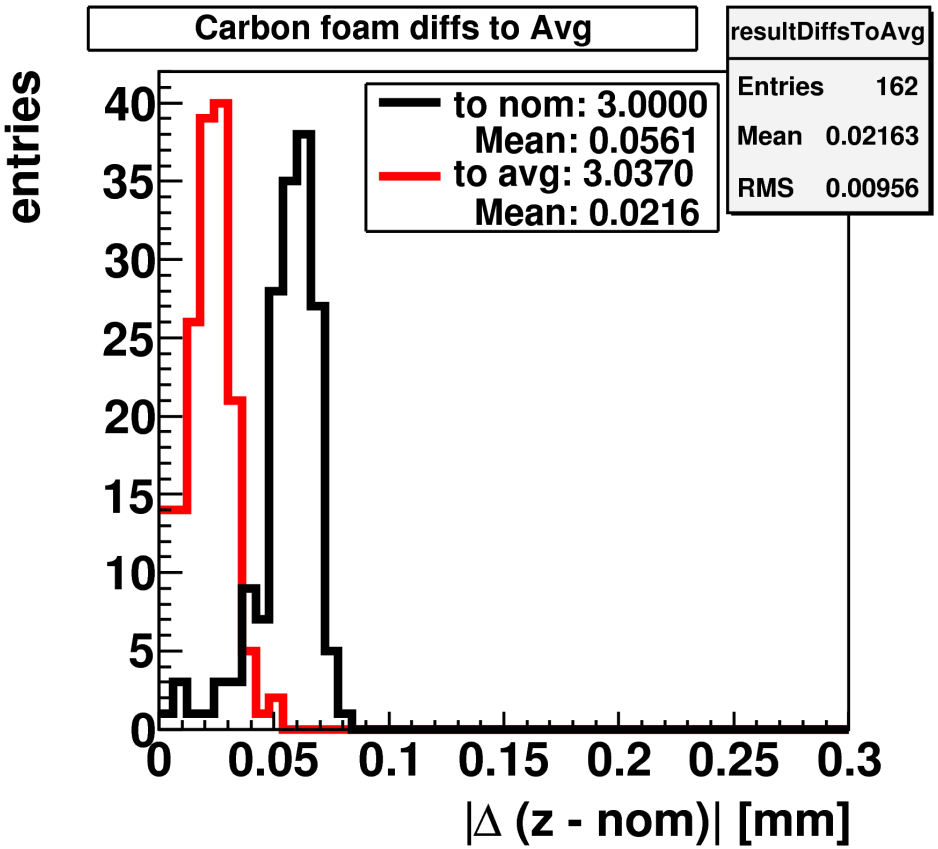
CMS detector upgrade

- Measurements every 5mm in x,y – first grid point: [10,5] mm
- 162 measurements per foam (2 runs)
- Contact probe (4mm diameter)
- These were labeled 0.40 and 0.60 [units 'mills']
- All results in mm, all clamped down on all sides (just gravity), by vacuum did not work, too porous

- Newly cut (“flysaw”): 1.5, 2 and 3mm
- Both sides measured, 1 run per side

CMS detector upgrade





<u>3mm (2mm) more flat than the 1.5mm:</u>

- too thin (especially 0.4 and 0.6mills) does not work reliably with the technique
- Could also be a bump on the reference table
- 2 and 3mm is probably good enough

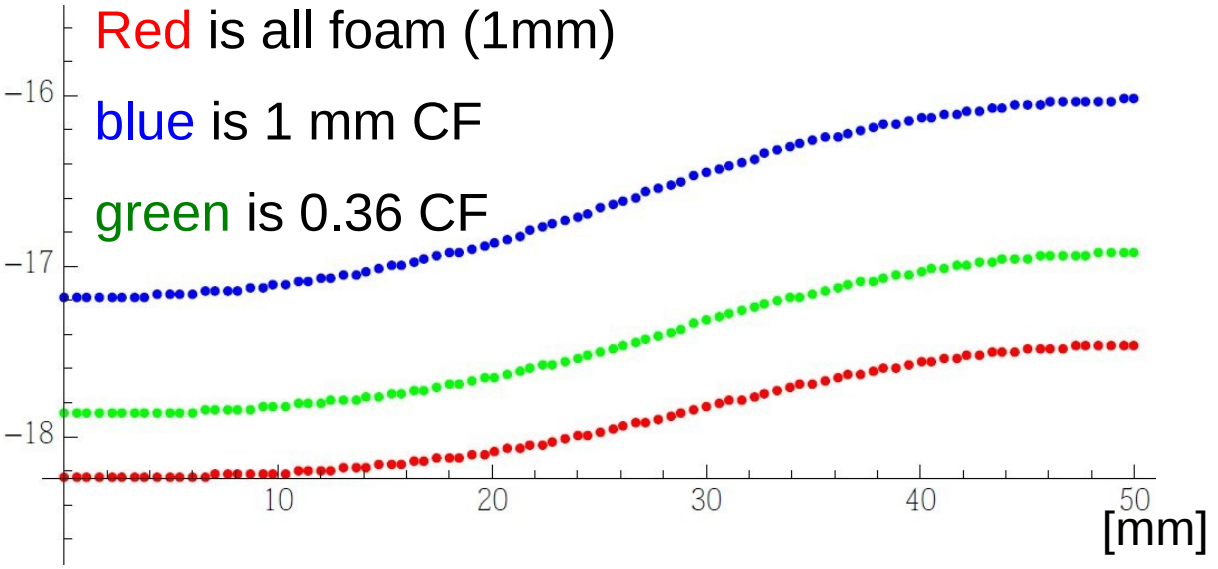
0.6 mills
--> 1.5mm

Glue tests

S.Gruenendahl

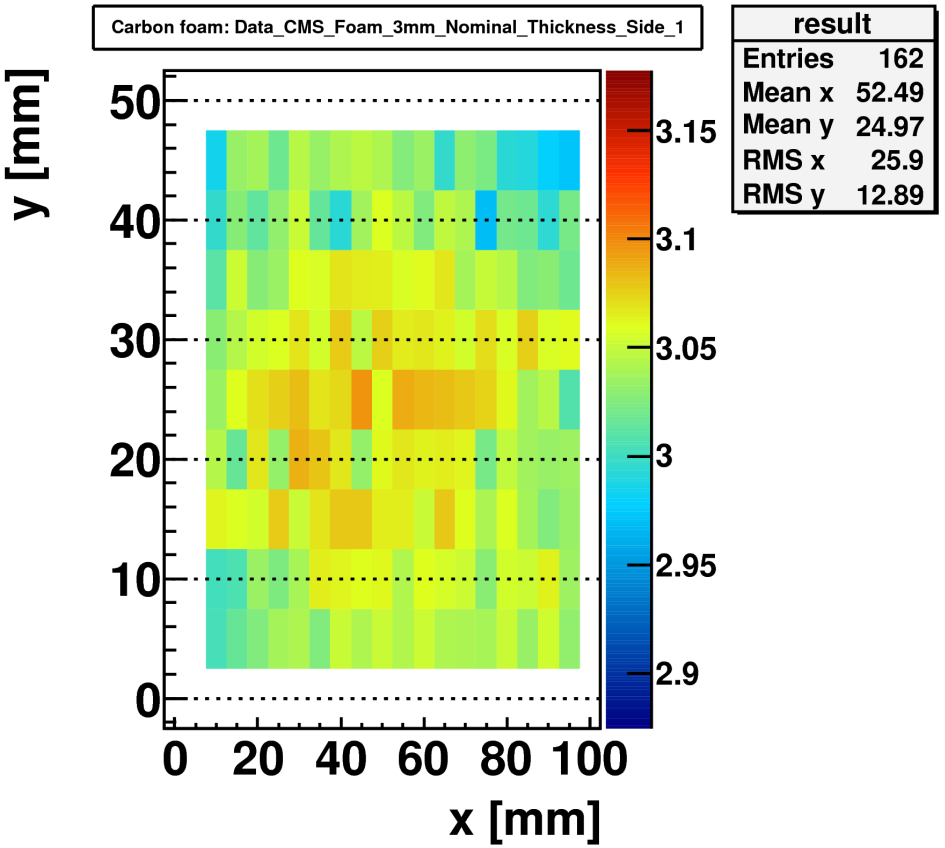
- Glue tests with sheets of Carbon Fiber (5 layers)
- Pull tests with 2.5 and 5MGray (300/fb or 3000/fb)

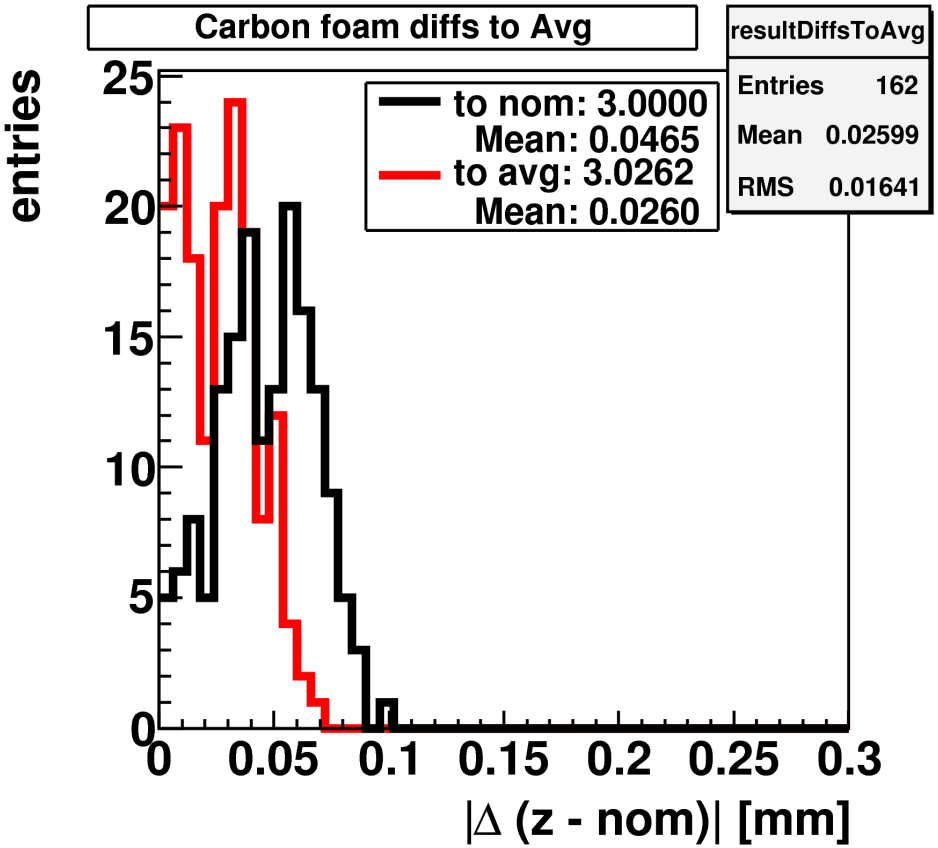
CMS detector upgrade



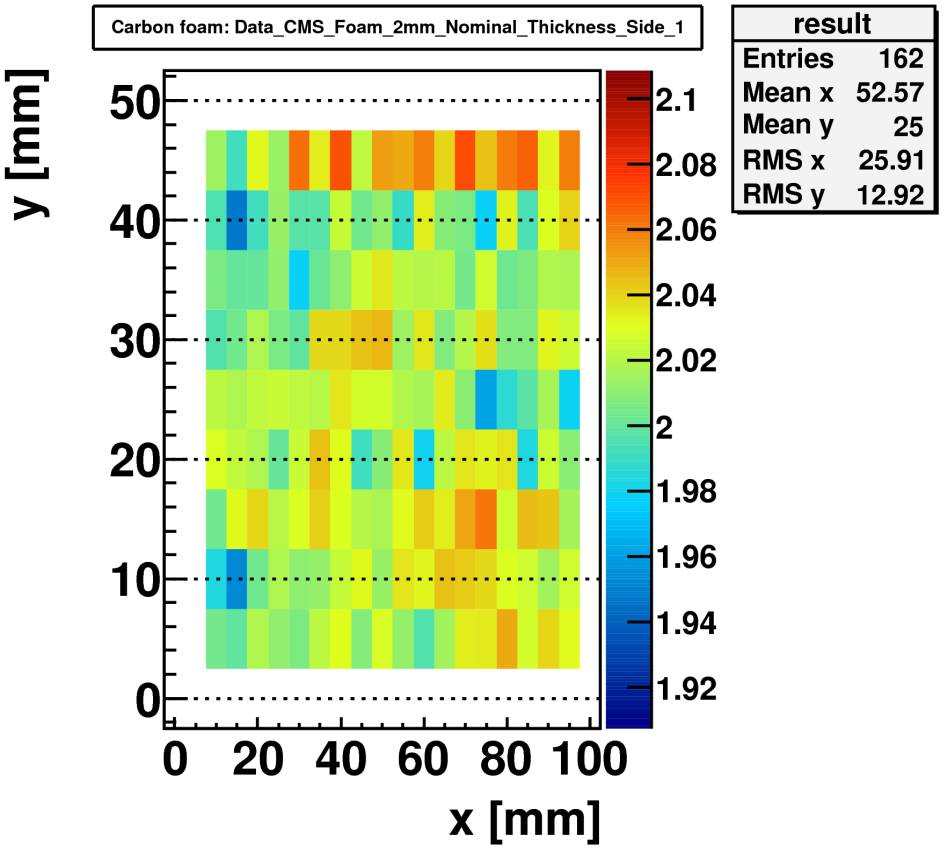
Temperature at silicon midline

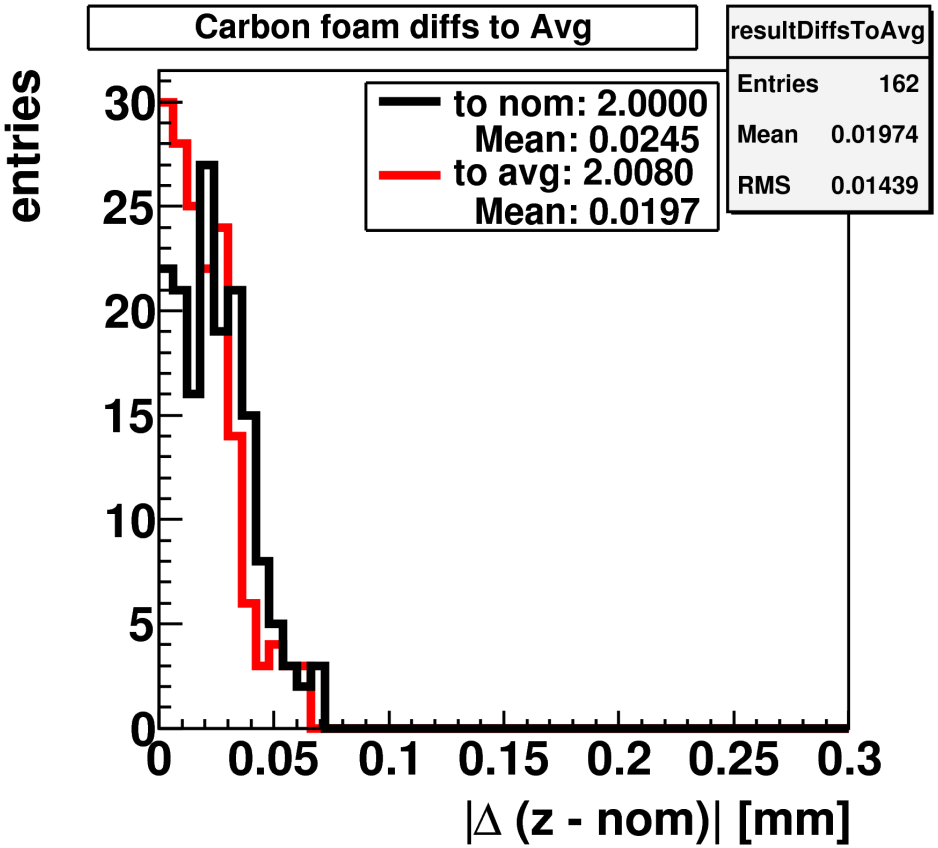
CMS detector upgrade





CMS detector upgrade





2mm more flat than the 1.5mm:

- too thin does not work reliably with the technique
- Bump on the reference table ? asked for a “zero” measurement