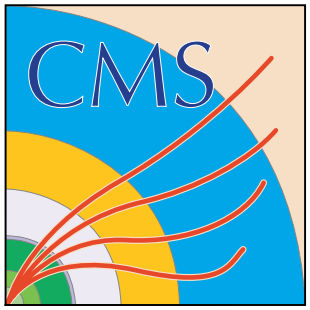
Module Design Status Report



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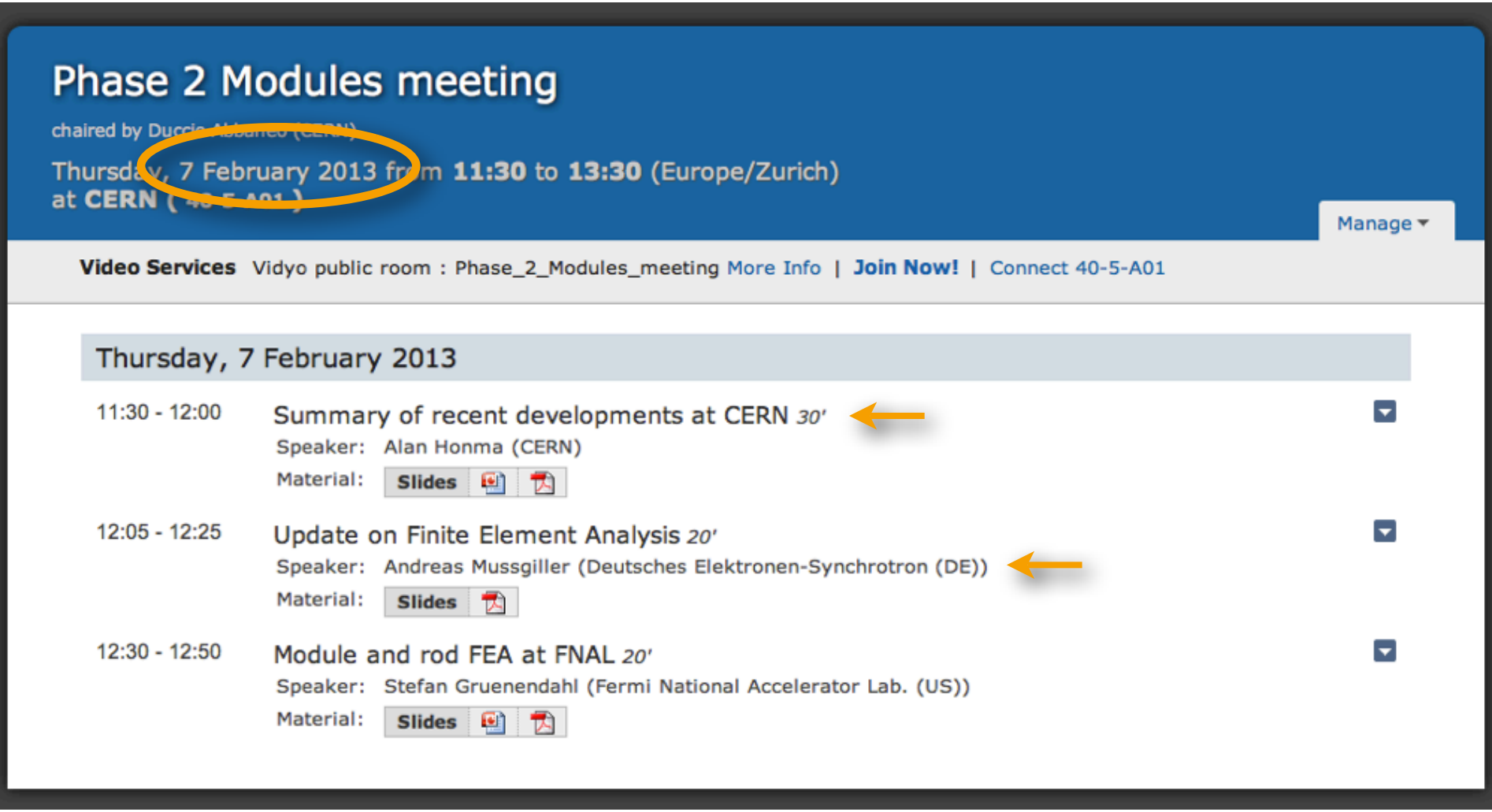
A. Mussgiller, A. Onnela

Upgrade Phase II Plenary
08/02/2013

HELMHOLTZ
ASSOCIATION

DESY

Introduction



Phase 2 Modules meeting

chaired by Duccio Abbaneo (CERN)

Thursday, 7 February 2013 from **11:30** to **13:30** (Europe/Zurich)
at **CERN** (40-5-A01)

Manage

Video Services Vidyo public room : Phase_2_Modules_meeting More Info | **Join Now!** | Connect 40-5-A01

Thursday, 7 February 2013

11:30 - 12:00 **Summary of recent developments at CERN** *30'*
Speaker: Alan Honma (CERN)
Material: **Slides**

12:05 - 12:25 **Update on Finite Element Analysis** *20'*
Speaker: Andreas Mussgiller (Deutsches Elektronen-Synchrotron (DE))
Material: **Slides**

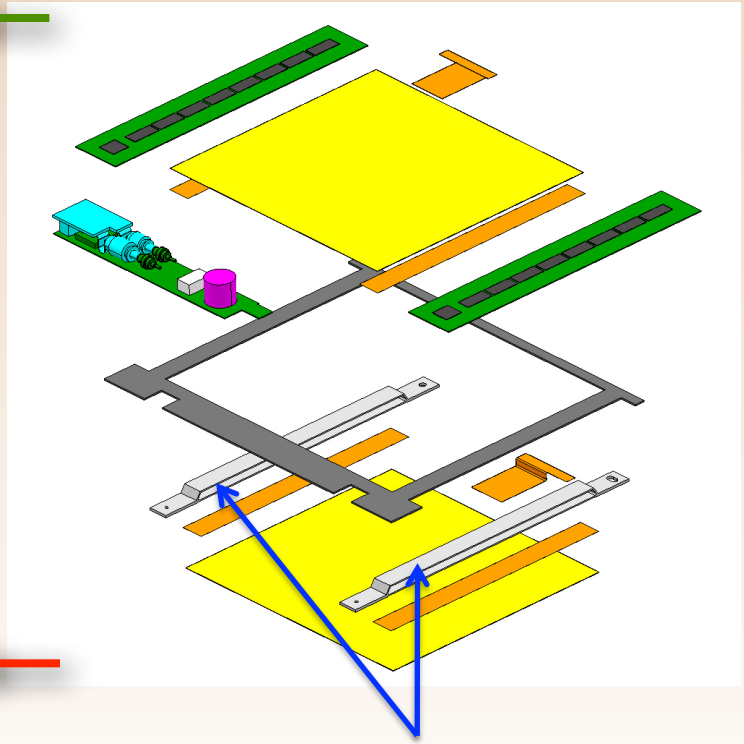
12:30 - 12:50 **Module and rod FEA at FNAL** *20'*
Speaker: Stefan Gruenendahl (Fermi National Accelerator Lab. (US))
Material: **Slides**

What is our "current" baseline?

Our current baseline now uses the unibody Al-CF composite bridge made by NovaPack. Why?

1. Nearly the same thermal performance
2. Nearly the same material budget
3. But much easier to assemble

"Current design"



These bridge pieces are different from the "previous" baseline.

In fact I could not see how to assemble the previous baseline without huge manpower costs:

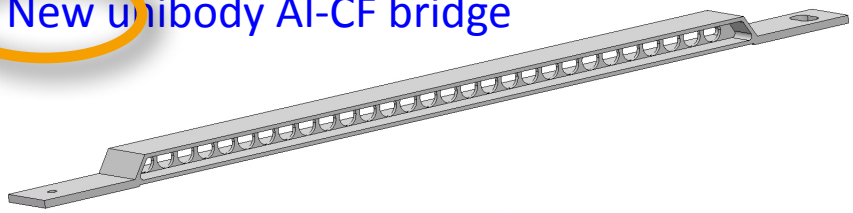
- Too many small pieces
- Many glue joints
- Not sufficiently rigid unless a very hard glue is used.

Alan Honma

Al-CF composite material for unibody bridge

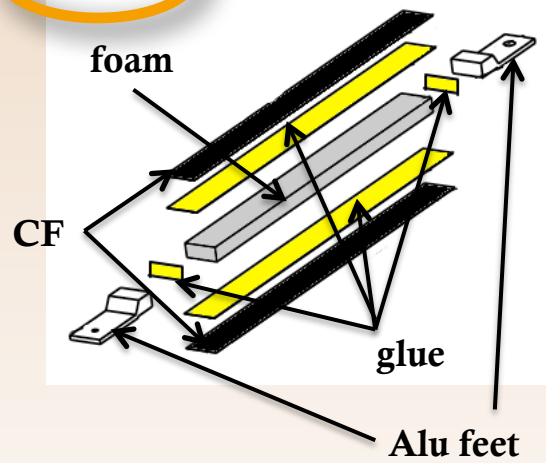
- Al-CF is an aluminium - carbon fibre composite (CF embedded) ←
- Good CTE match to Si (4ppm/°K) and still good thermal conductivity ←
- Much easier to assemble
- Base material not very expensive
- Easily machinable but expensive, (➔investigate 2nd source)
- Awaiting 1st low-CTE pieces (have 7ppm/°K samples)
- Parylene coating to avoid carbon dust?
- Thick parylene ➔ replaces kapton?
- Alodine+Ni+Au for conductive contacts?

New unibody Al-CF bridge



Exact shape and fibre orientation still under investigation

Old CF-foam bridge



Preserves excellent CTE match with the sensors but: CTE mismatch problem with rigid hybrid remains an issue.

Alan Honma

Some characteristics of Al-CF composite

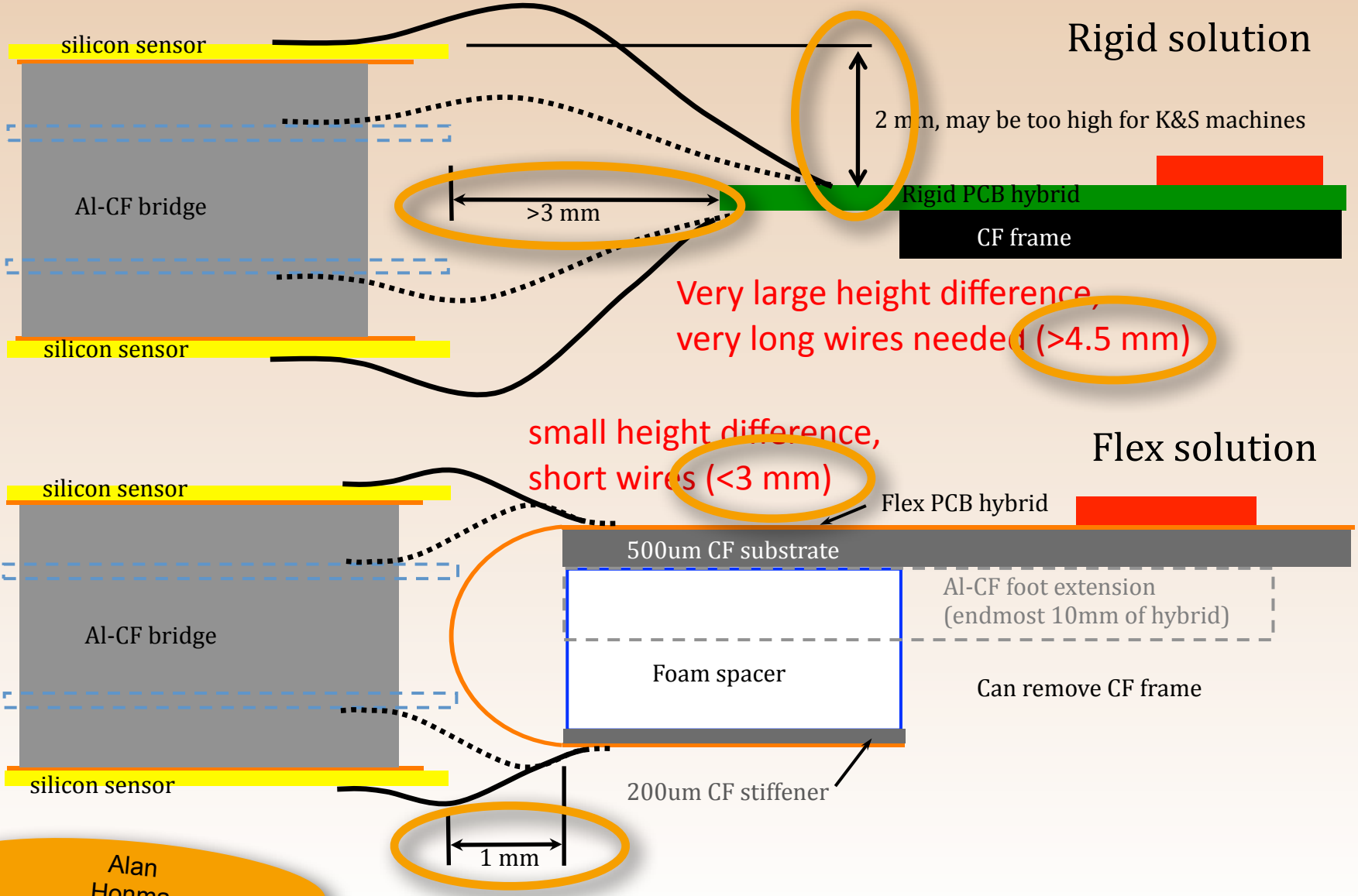
Al-CF composite from NovaPack (FR)

Properties	V2-7	V2-4
Thermal conductivity (W/m.K) / (X-Y)	200	230
Thermal conductivity (W/m.K) / (Z)	125	120
CTE 25 - 150°C (ppm/°C) / (X-Y)	7	4
CTE 25 - 150°C (ppm/°C) / (Z)	24	24
Young's modulus (GPa)	90	98
Electrical resistivity (µohm.cm)	6.9	?

Alan Honma

Need to diverge in module design: rigid vs flex hybrid

Connectivity between sensors and hybrid for rigid vs flex:

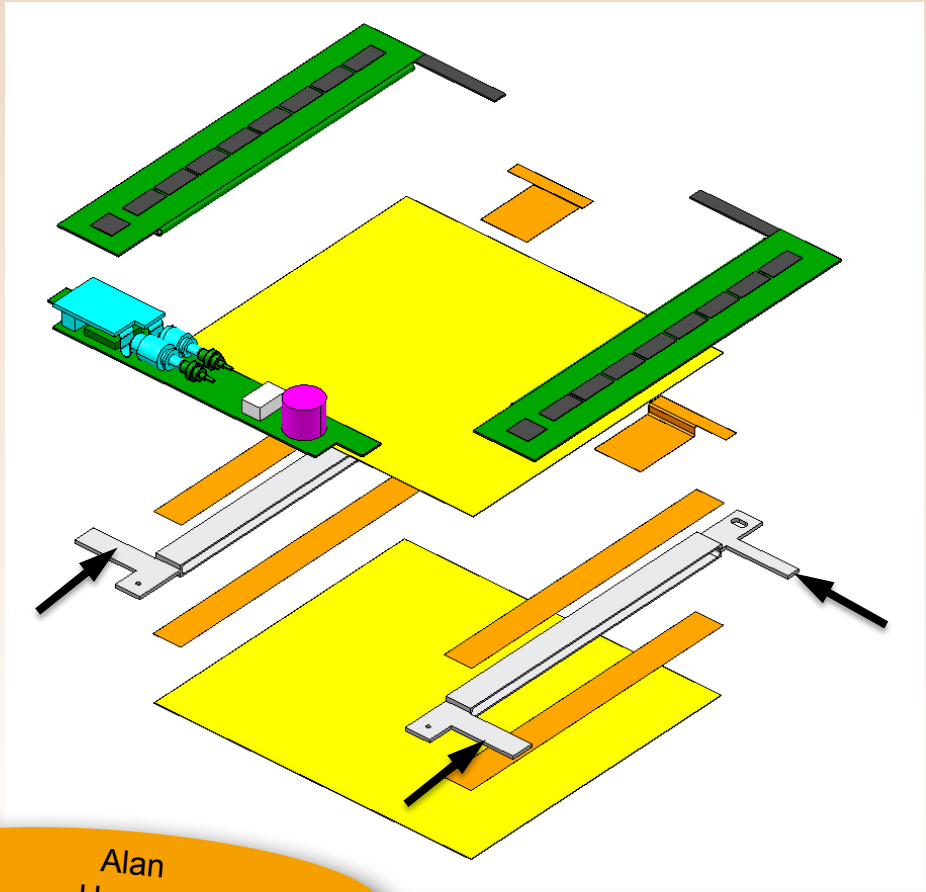


Revising module design for flex hybrids

Possible changes to flex hybrid module under investigation:

Remove the CF frame. As the flex needs a stiff substrate anyway, have it be CF and use it as the structural support for the hybrids. This would include the service hybrid.

Add support tabs to the bridges to provide mechanical and thermal connections between hybrids and attachment structure.



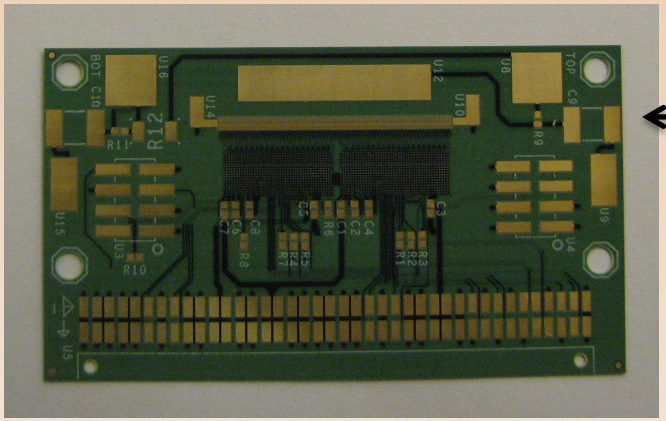
It is not clear if the flex hybrids will be sufficiently stiff to prevent possible damage to wire bonds from vibrational movement. Even more of an issue for rigid case.

Many questions to answer about lamination of flex on CF and making the wrap-around part of hybrid. Need to make prototypes!

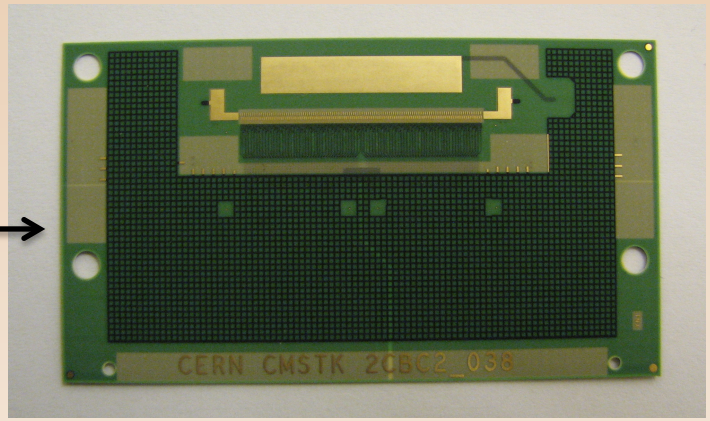
Alan Honma

2xCBC2 "Rigid" Hybrid Substrate

Received 2xCBC2 hybrid substrates (no components) just before winter holidays.



Top and Bottom views



Although of very low material budget (only 250um thick), they are also not at all rigid.

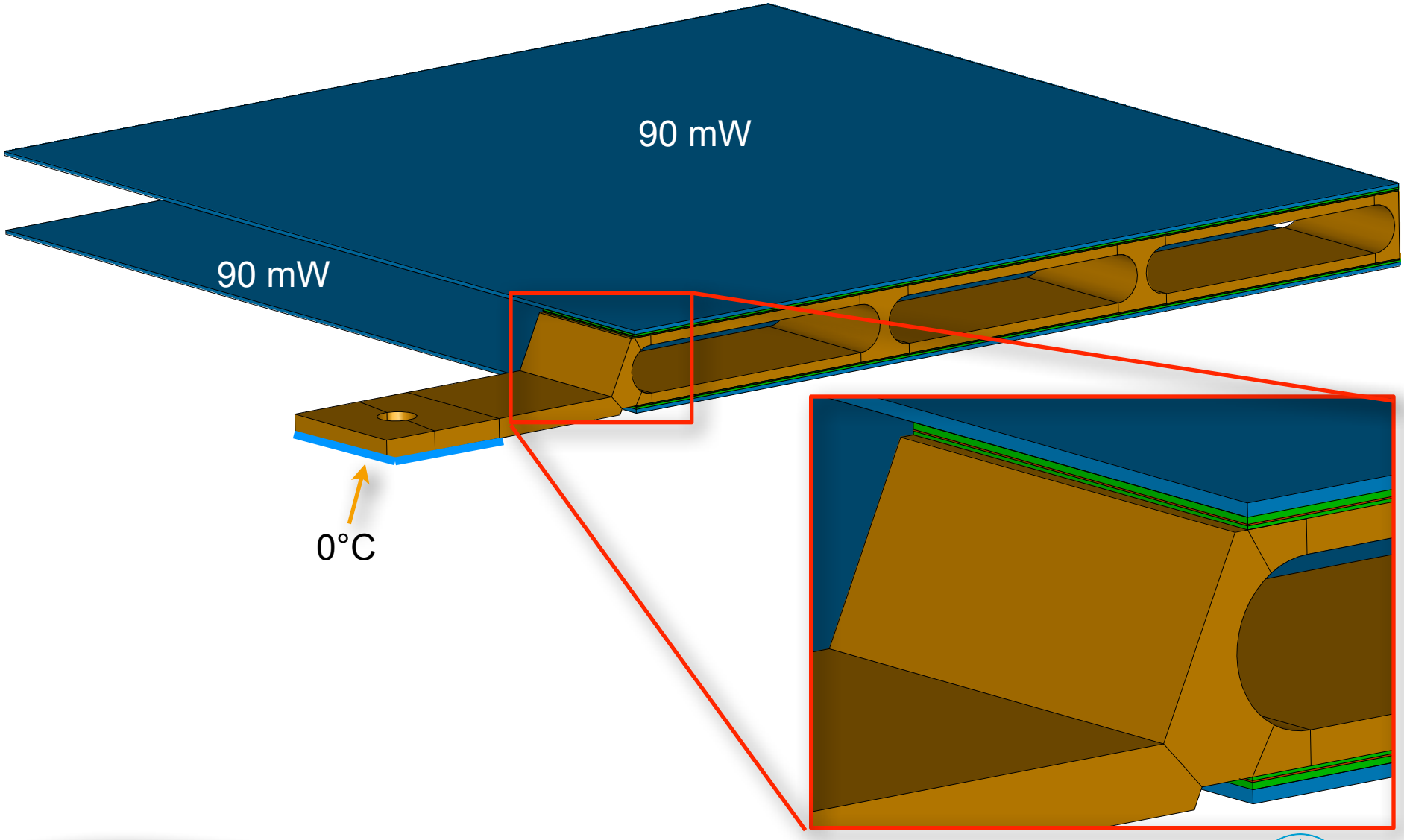
Large amplitude of flexing during bonding was observed unless supported directly under the bonding area.

Although we thought we were getting a 365um thick substrate, this seems not to be the case. This implies that the hybrid must be on a stiff flat surface for any wire bonding or gluing operations.

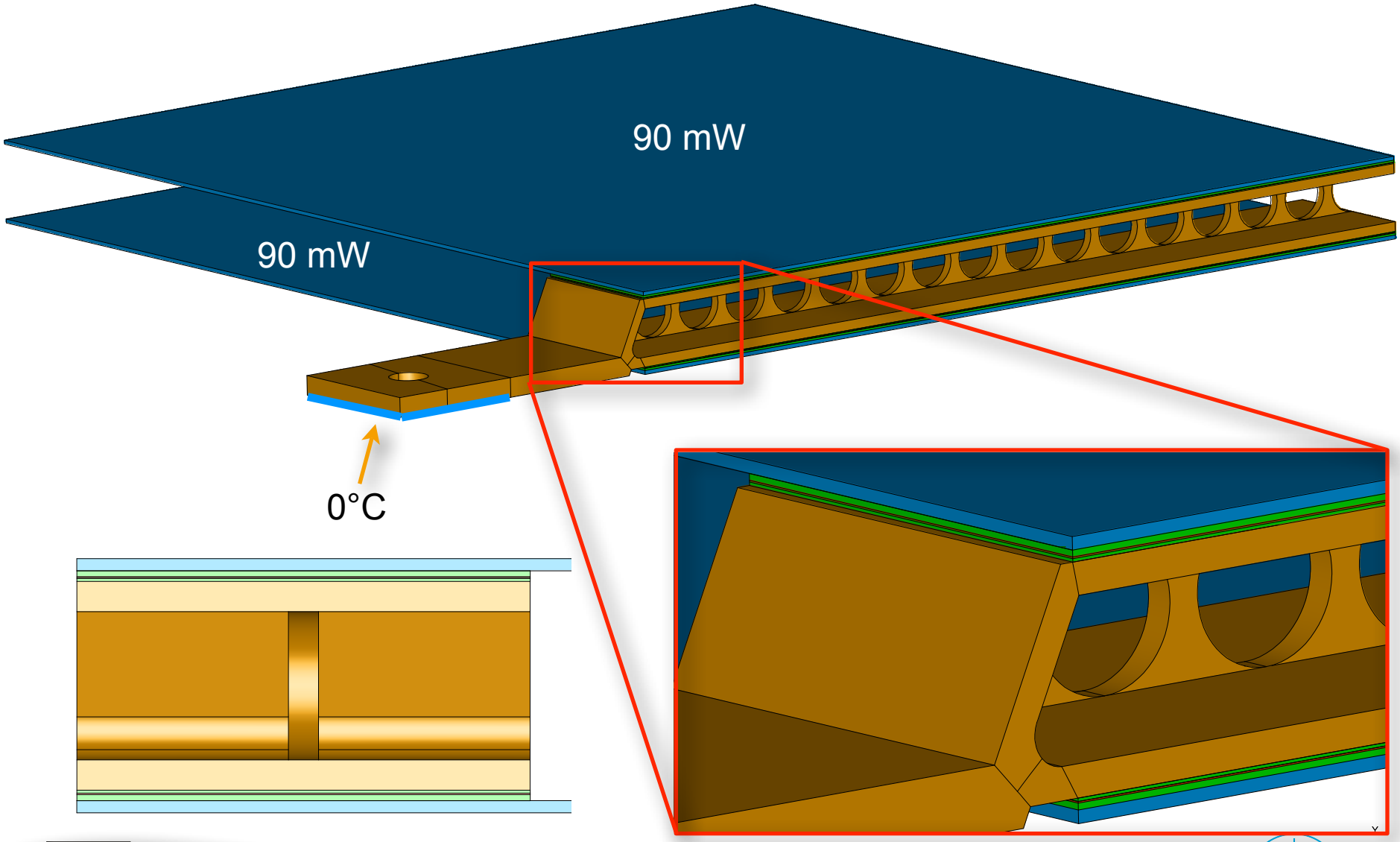
The 8xCBC2 hybrid designs have been modified to stagger the top and bottom bond areas in order to allow for proper support during bonding. Not clear if [illegible] and it does not solve problem should we need to do repairs.

Alan Honma

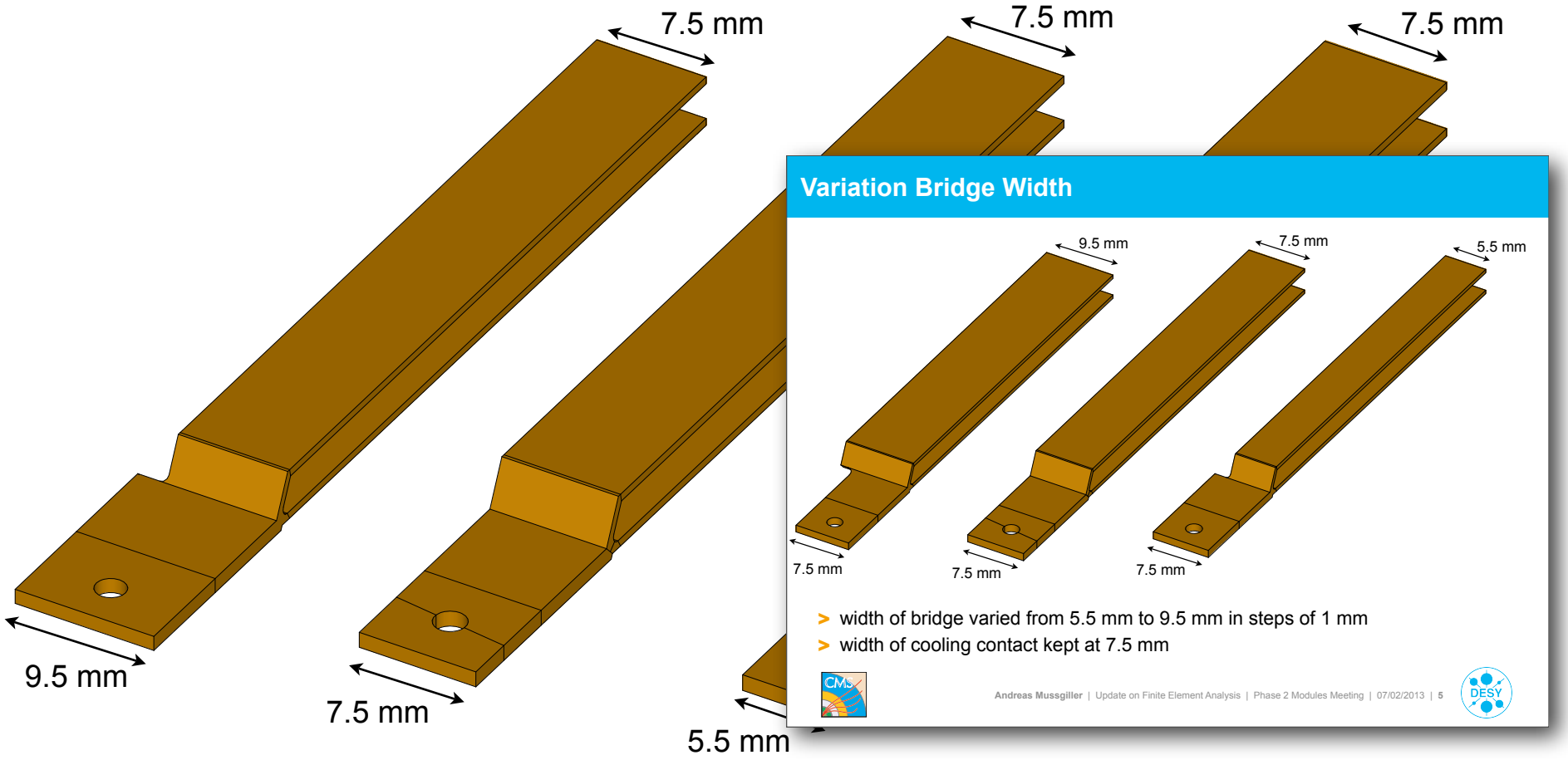
Unibody Longhole Support Bridge



Unibody IBeam Support Bridge



Variation of Cooling Contact Width



Variation Bridge Width

- width of bridge varied from 5.5 mm to 9.5 mm in steps of 1 mm
- width of cooling contact kept at 7.5 mm

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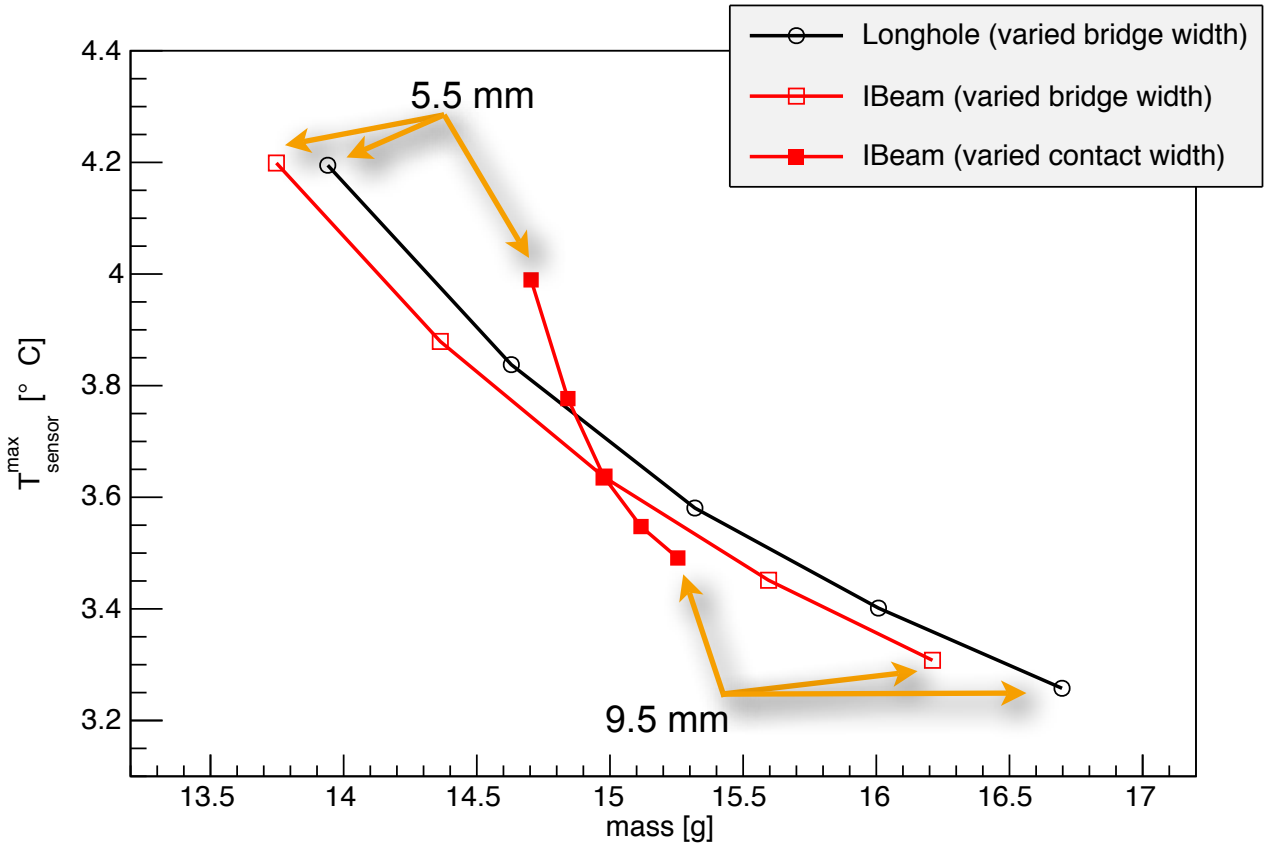
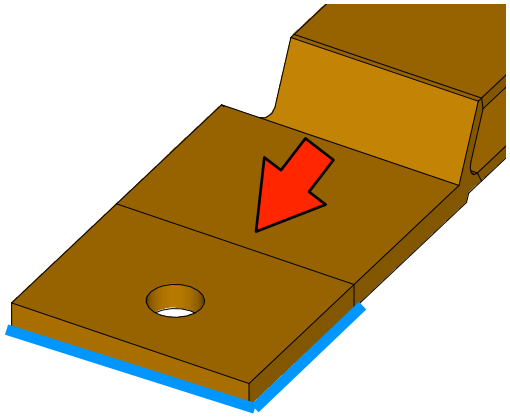
- width of cooling contact varied from 5.5 mm to 9.5 mm in steps of 1 mm
  - only studied for IBeam support bridge

Andreas Mussgiller

Maximum Sensor Temperature





- IBeam ☐ is slightly lighter than Longhole ○ version (~ 0.25 g)
- effect of varied cooling contact width ■ is due to
  - cross-section for heat transport ➡
  - contact surface area ▬

Summary and Outlook

- much progress on R&D of 2S (4mm) module design. Moving toward unibody Al-CF bridge for either rigid or flex solution, allows for much easier assembly.
- still need to find coating to prevent CF dust escaping and a good conductive coating: parylene and alodine?
- flex hybrid studies in progress, module changes needed to best incorporate it. Will give the best CTE match and ease of wire bonding, but a number of fab issues to be resolved.
- we must not forget the 1.8mm sensor gap modules! These have different problems that may need different solutions
- we do not benefit from a wider support bridge
  - 2 mm wider bridge: ~0.2°C lower temperature for 1.25 g increase in total mass
- wider cooling contact reduces maximum sensor temperature
  - ~0.15°C for 0.3 g increase in total weight (~2% of baseline)
- wider cooling contact and narrow bridge could be the way to go