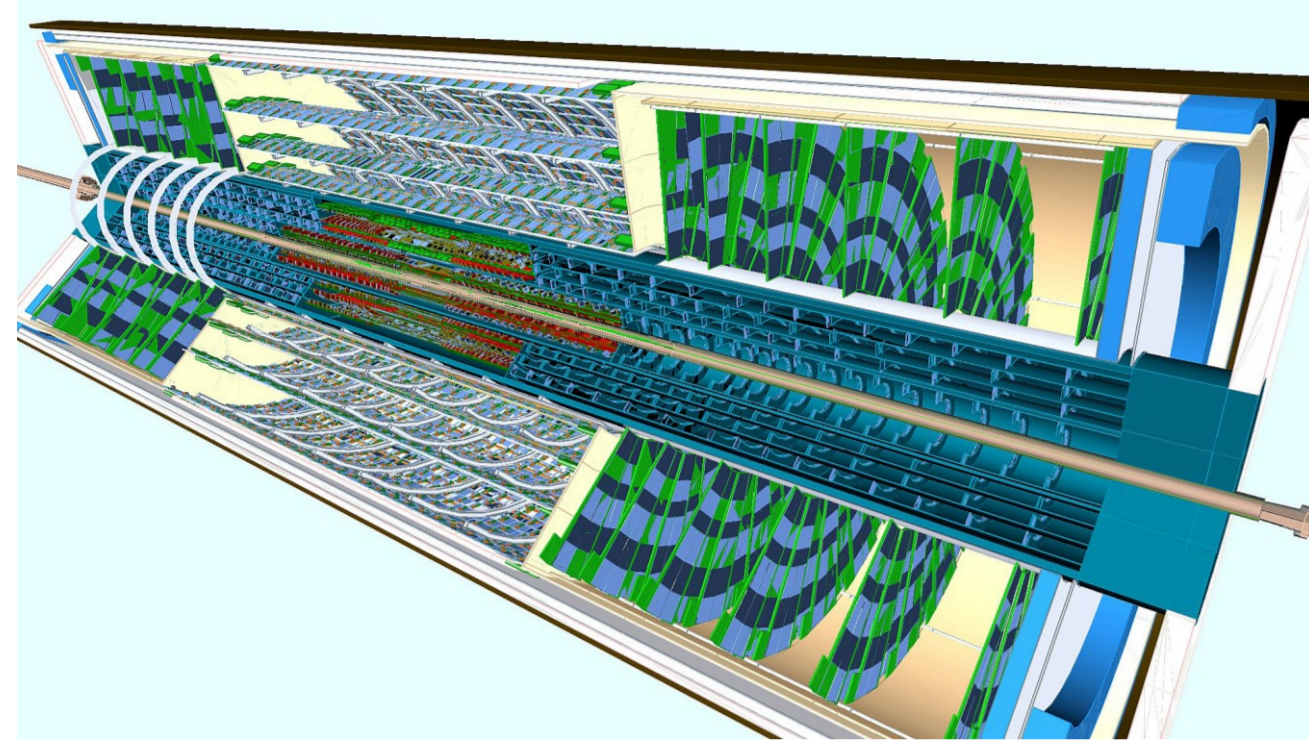




ATLAS-ITK - Inner Tracker detector

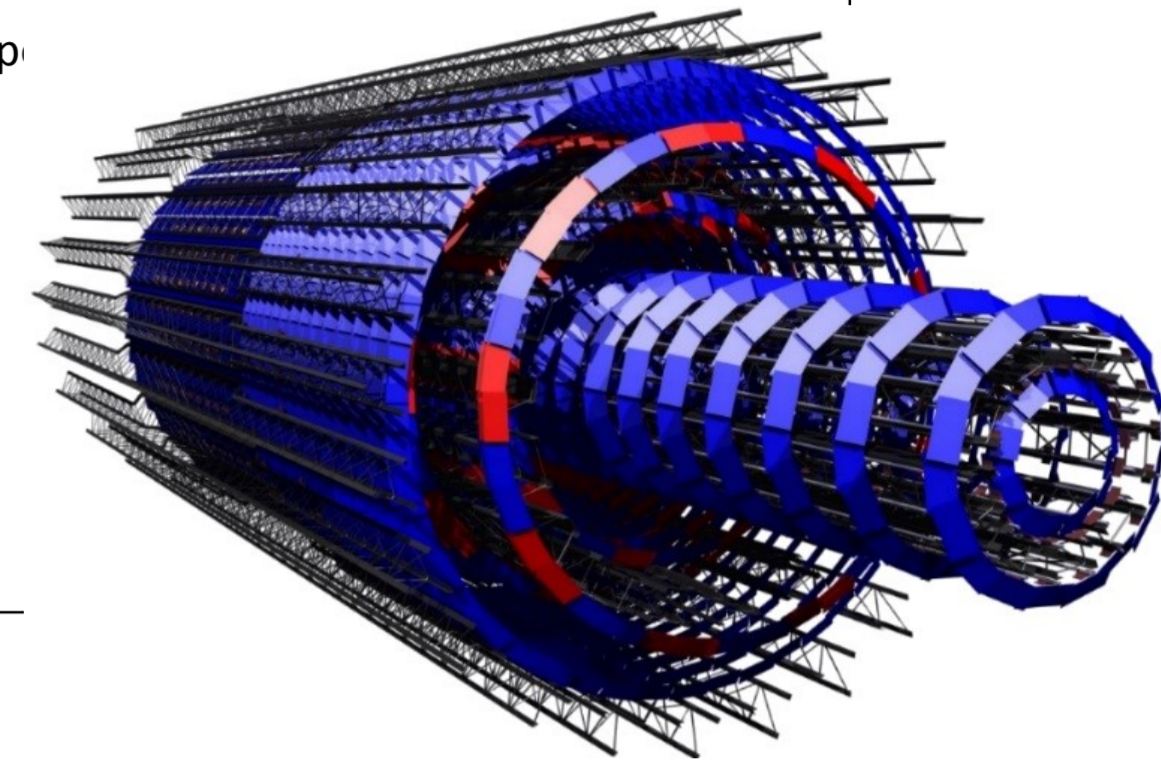
Developments / 3 external layers – 100% silicon

LHC High Luminosity 2026 - 2037



The ATLAS Phase-II Inner Tracker (ITK): towards a new, radiation-hard ATLAS tracking detector for the **high luminosity LHC (2026)**

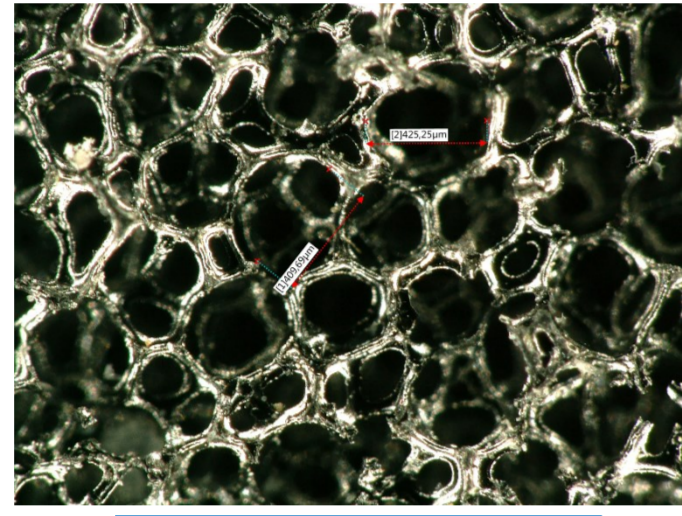
- > The Barrel region of the pixel detector will consist of 5 layers, 2 inner layers inserted in a carbon fiber-based called IST, and 3 outer layers localised between the IST and the PST (Pixel Support)
- > Depending of the layout, these 3 outer layers will be supported by 2 separate structures ; L2 and L3 will be simultaneously supported by CFRP Truss Longeron
- > Each module is glued on a graphite interface, directly glued on the local support structures called **staves** ; 1 staff will support 32 inclined modules and 14 modules on "plain"
- > CFRP Truss Longeron (L2/L3) will support 4 staves, 1.6m long
- > Stave cores are **carbon fiber-based** shells supporting high density **carbon foam** with embedded cooling pipes, data transmission lines and power distribution
- > The LPSC/ SERM activities in the project are within the Integration-Local Support Working Group.
 - ✓ Thermal and mechanical prototypes of staves
 - ✓ Cooling developments
 - ✓ Intermediate flanges / outer layers support
 - ✓ Integration



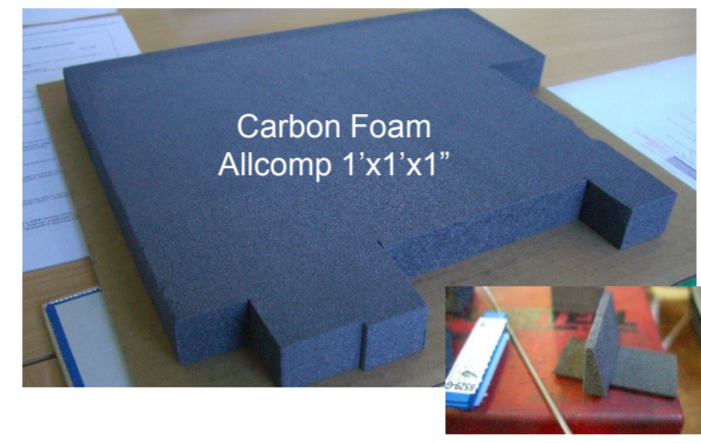
Materials

Carbon Foam

Graphite



Allicomp: open cells, rather good uniformity / size of cells
- Easy to machine
- Several densities



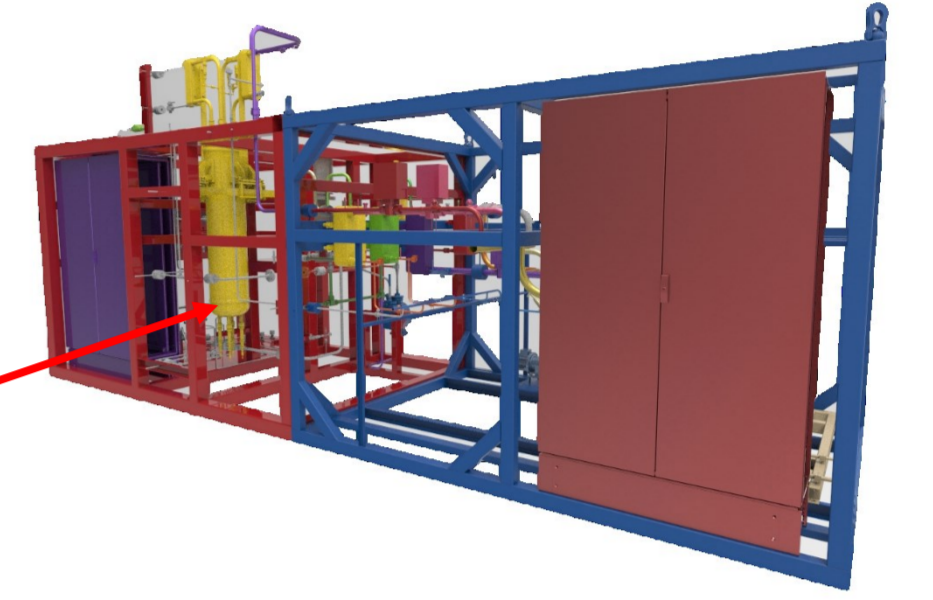
Products & supplier Data Base

Thermal tests and developments

Accumulator for Baby DEMO
+
On surface CO2 storage (D. Bondoux)



LPSC Accumulator



Carbon plates / Prepregs

3 different UD prepreg fibers tested

- ✓ T700 35 gr/m² 3 plies
- ✓ CN60-60S Ep.0,23 - 3 plies - [-90,0,90]
- ✓ HR40 300 gr -> 100 g (<4/10e)

Pitch XN900 110 gr/m² [35gr, XN900, 35gr] *Tested soon*

180gr/m² pitch 640

300gr/m² Gurit Nanocharged

K13D2U EX1515 45 gsm

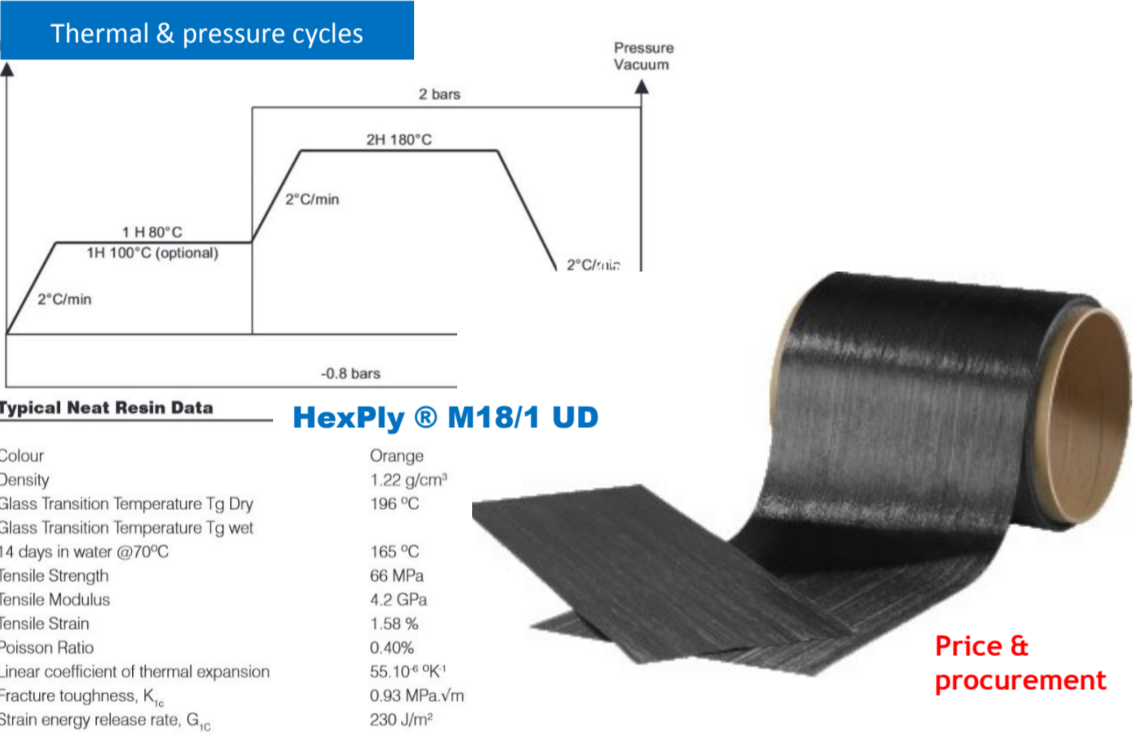
K13D2U RS3

Cloth UD-XB3515/34%/100/IM - Fiber Intermediate Module

Hexcel - HexPly M18/32%/116/M55J/300 - High module

Cloth UD-XB3515/44%/35/T700 - HR-230-35

Granoc E9026A-05S high-conductivity fiber



Mechanical & thermal prototypes

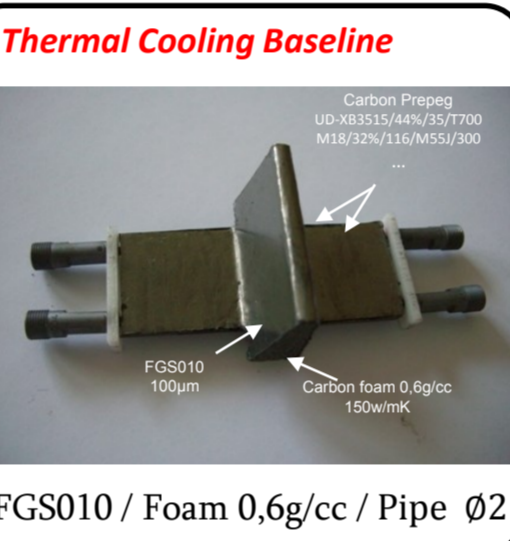
PROTOTYPES of Alpine staves

From tooling & prototypes towards a full stave with optimal design

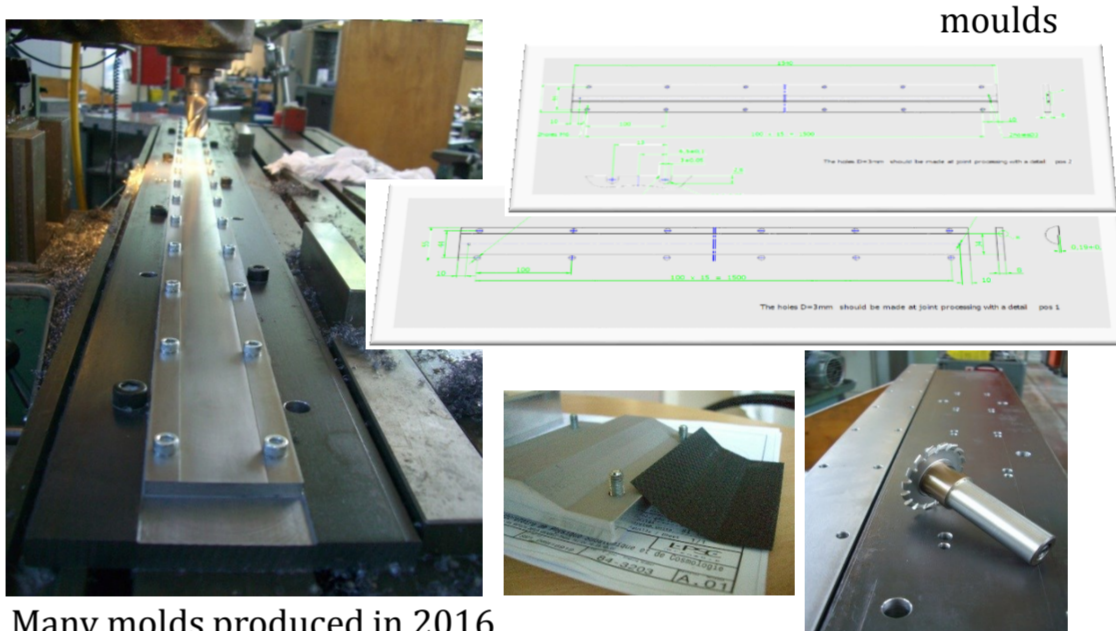
Assembly & Curing – Last prototypes 2016

Carbon foam : 0,6 g/cc
1 Ti Pipe 2,3 mm
FGS 010

Alpine 1 pipe



Manufacturing



Bench CO2

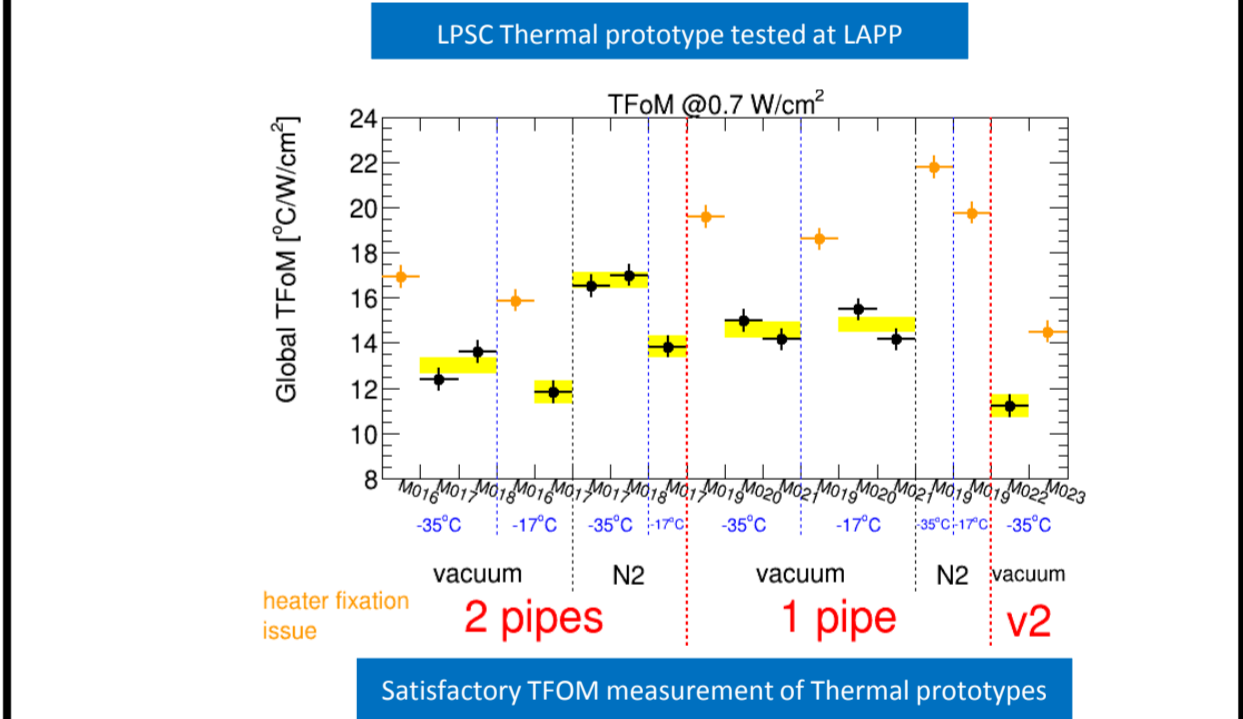
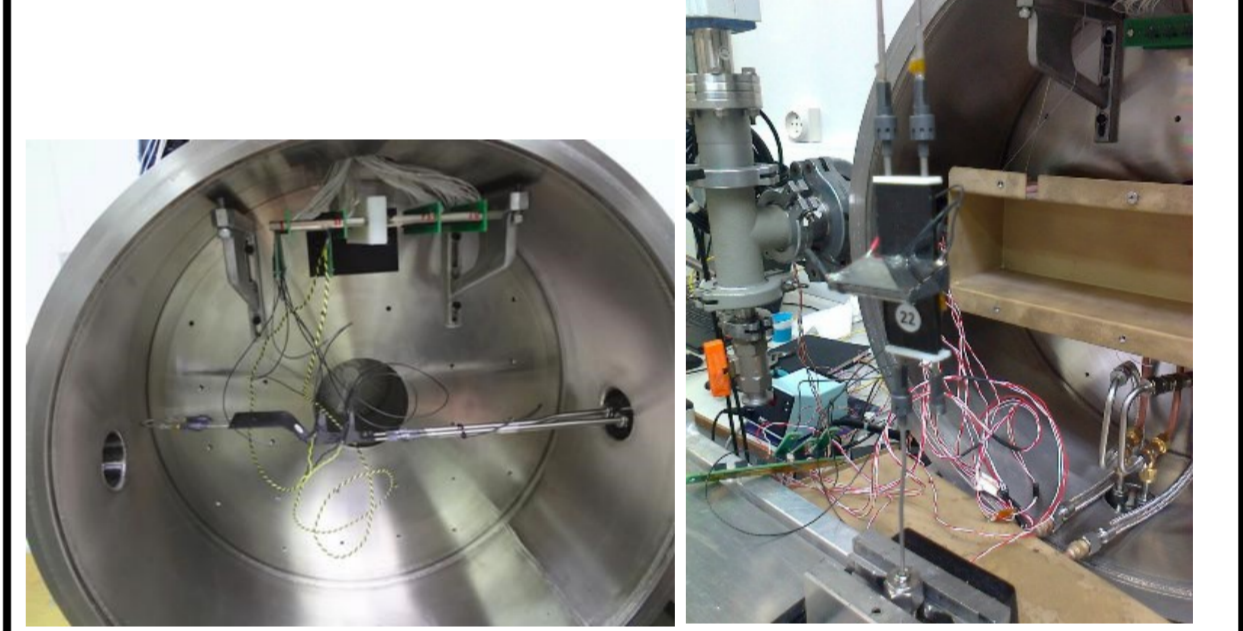
Thermal Tests & qualification of prototypes

Foreseen mid-2018 for tests on thermal prototypes



Thermal measurements

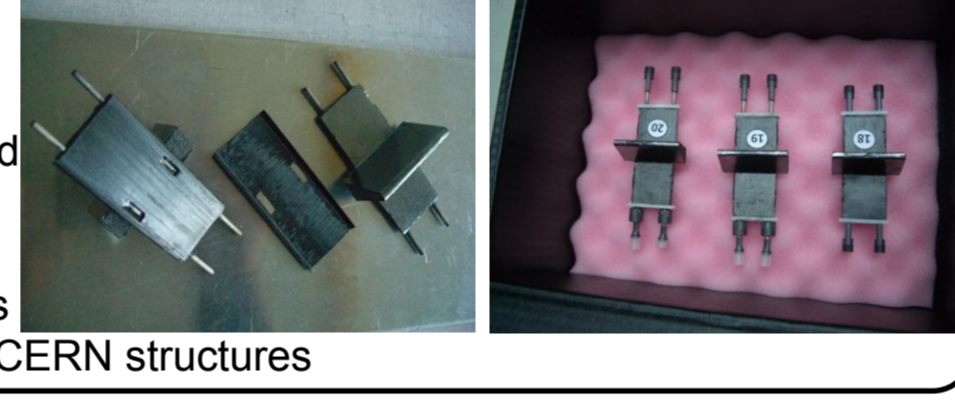
Now trying to measure thermal performance of Abyss prototypes with two mountains and 1 flat module or of baseline prototypes



Fabrication of prototypes / Thermal validation

Machining technics

- Gluing
- 2 Ti cooling pipes Ø2 or 2,3mm embedded
- Prepreg: optimization/price /radiation-hard
- Optimization of thermal layers:
 - > Graphite foil IPG or FGS 010/030
 - > Carbon foam : 0,6 g/cc or 0,2 for staves
 - > Mountains / all prepreg : to be adapted / CERN structures



From tooling & prototypes towards full staves

Moulds and Jigs

Characterisation of composites (>3 K_G)

Assembly & Curing

Fabrication of prototypes

From 1st Alpine Design

SLIM Foam

Production process / control

Loading 2021-2023

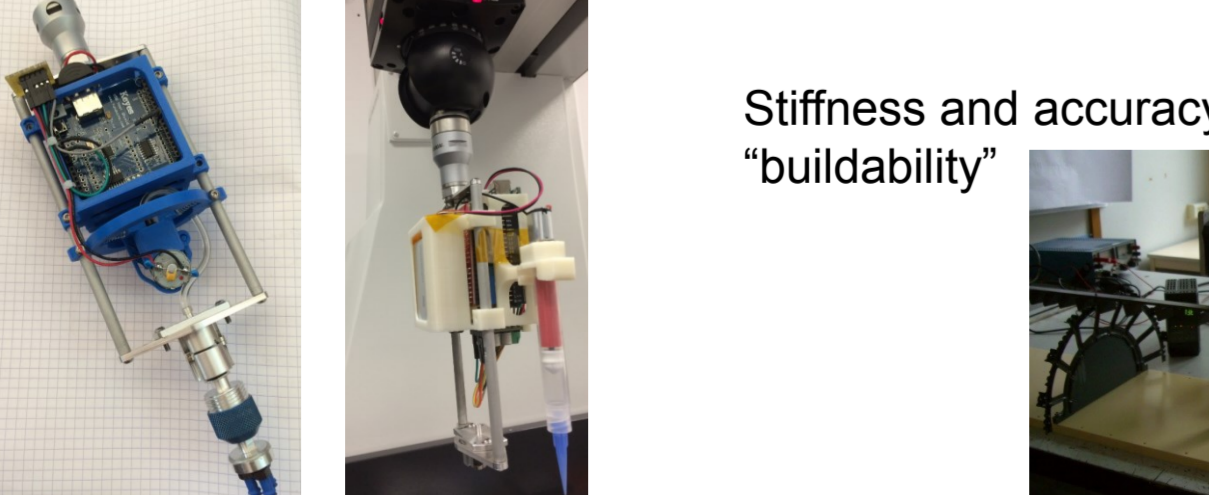
• Loading, bonding
And control with a 2m MMT
in duplication with Genève, CPPM, Wuppertal)



Module loading Status-survey facility

- Full equipped MMT which allow support and modules survey with contact probe and camera probe system
- Module loading- pickup tool, Glue deposition tool and process

Pick up and glue deposition tool / Few improvements required



Stiffness and accuracy control for the "buildability"

Laser Bench (dynamic + sag)

Module loading / Adaptations

Glue automatic dispenser and module handling system will be fabricated/adapted based on developments done at the CPPM (co-development with LPSC-SDI / A. Richard)

Prototypes...

ABYSS

2 mountains + lowland (transition area)

Several issues

- > Monolithic foam to be preferred
- > Machining of complex shapes with foam
- > Molds
- > Ti pipes to bend

Optimization of thermal layers:

- > Thermal flux from detector to CO₂ cooling pipes
- > Graphite foil IPG or FGS : very ≠ for assembly
- > Carbon foam design and assembly

Foam 0,6 g/cc + 0,2 Graphite FGS010 / IPG Shell -> molds

R&D on Alternative Thermal Solutions

- ◆ Curly pipe with foam (0.2 g/cm³)
 - several layers of glue + TPG to allow modularity
 - expected TFOM:
 - 13 °C/W/cm² for quads
 - 16 °C/W/cm² for M2
 - small prototypes in production
- ◆ Size-1 Alpine stave with demonstrator module size and position - for thermal tests

Full contact with the pipe loop

K9 Foam machined interface for Curly pipe

Curly pipe Design / CERN

Inclined Ring prototype for M4 support

Mechanical prototype for the Demonstrator Program - 2017

From tooling & prototypes towards a full stave with optimal design

Full Stave

LPSC | Inclined stave thermal prototype 1,6m long
Fabrication on going / October 2017 – related to step 3 & 5

1. Short integration prototype
2. Short thermal prototype
3. Long thermal prototype
4. Thermo-mechanical prototype

Identify potential source of deformation

Thermal cells

longeron

Thermal fluxes