ITK – Alpine Pixel Installation & Integration

1. *Alpine Thermal prototypes Fabrication*
2. *Kinematic of the Alpine Pixel*
3. *Mechanical support structures*
4. *Installation tools*

ITK General Meeting @ CERN – Feb 26

LPSC: Denis GRONDIN, Christian FOUREL, Lucie VIVARGENT
In collaboration with LAPP team

I - Alpine Thermal prototypes Fabrication

Outline

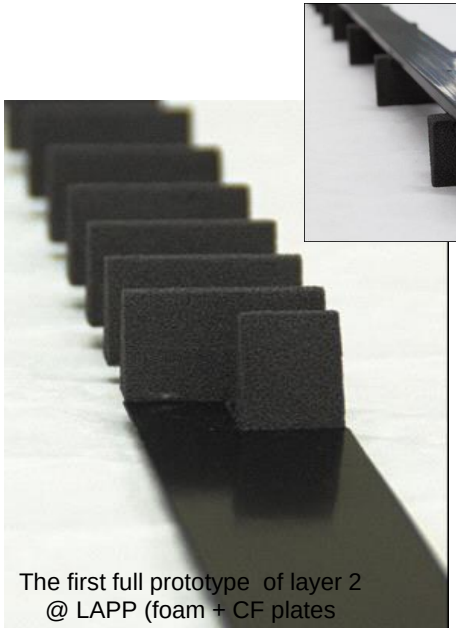
- Concept 1
- Properties of CF Material, foam and glues
- 5 Stave Designs /
  Carbon foam Stave with Titanium pipes & Graphite foil

"Simulation and measurements of the thermal/mechanical properties of Alpine Pixel"
See the talk of P. Delebecque: https://indico.cern.ch/event/361445/session/14/contribution/26

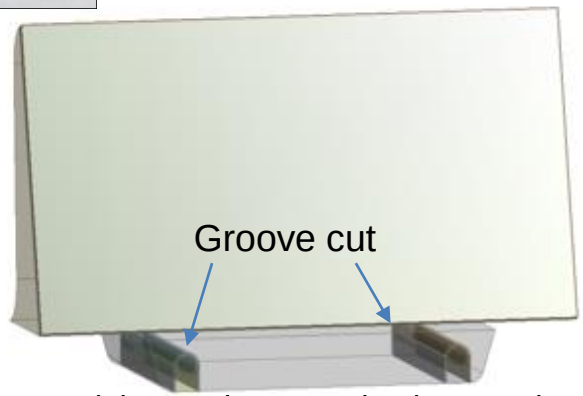
I.1 – Alpine thermal prototypes – Fabrication

~ IBL Like Thermal Prototypes

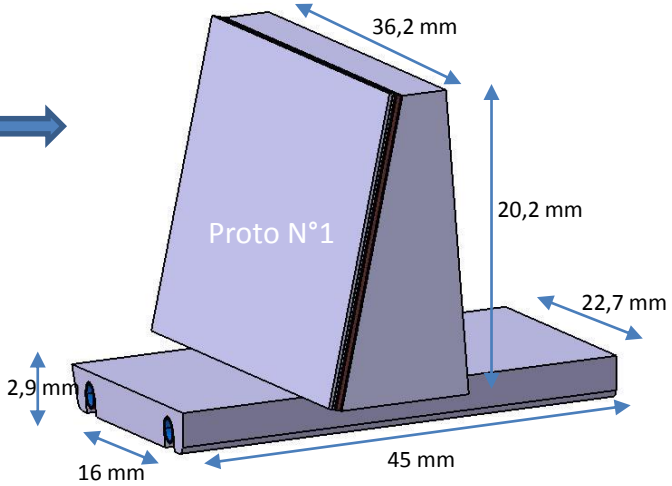
- To verify the thermal behavior of the end-cap structure and the machining technique
- The same foam as IBL but not the same shape
- 2 Ti cooling tubes are embedded
- Optimization of thermal layers: real performances of “sandwiches” to be tested
  - ➢ Thermal flux from detector to CO^2 cooling pipes
  - ➢ Graphite foil TPG or FGS003 or PGS performances
  - ➢ Carbon foam design and assembly



The first full prototype of layer 2 @ LAPP (foam + CF plates



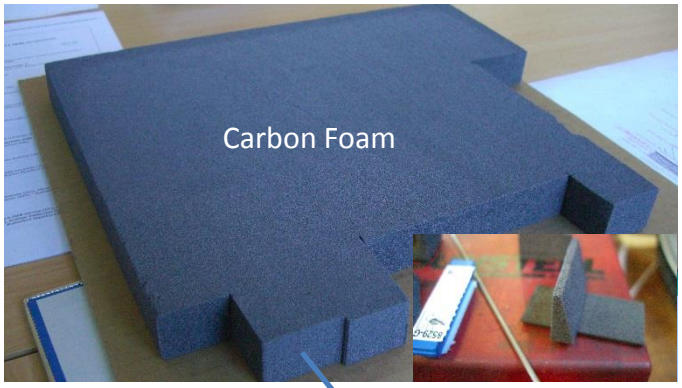
Minimum glue, easy implementation

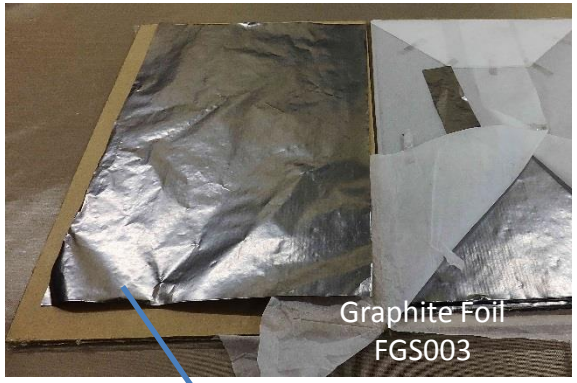


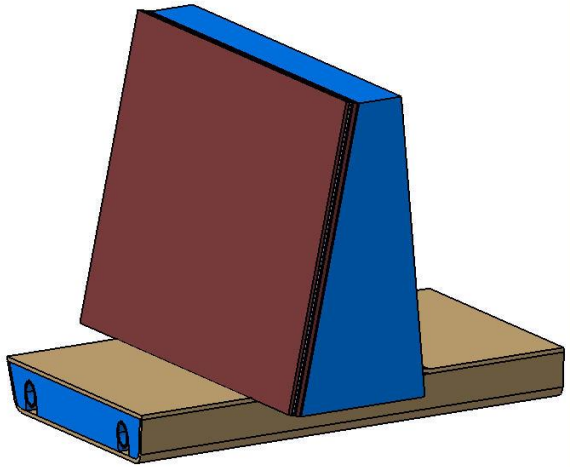
Thermal Cooling Baseline Prototype

I.2 – Alpine thermal prototypes – Concept 1

- Mountain and foam body: 1 body
- Graphite T. conductor: TPG or FGS003 or PGS
- 2 Ti pipes embedded with thermal glue

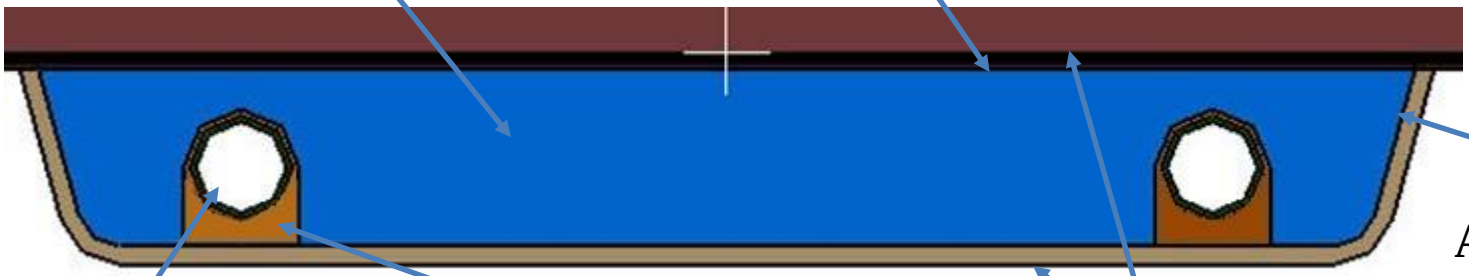






Thickness = 3,2 mm

Thickness = 30 µm



Glue
Araldite 2011
Epoxy bi-components

Ti Pipe
Φ = 2 mm;
Wall Thickness = 100µm

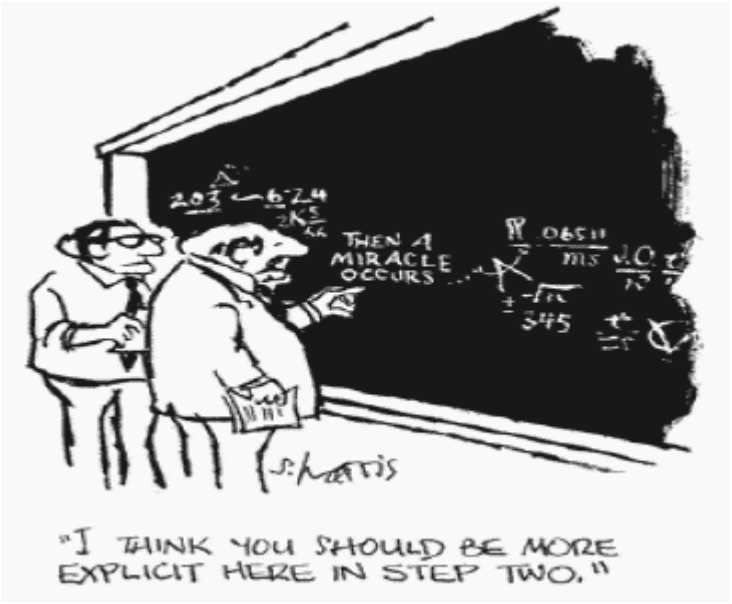
Glue Wall Th=0,1mm
Stycast or with
nanotube additives

Composite (ex.K13C-RS3)
Thickness = 0,3 mm

I.3 – Alpine thermal prototypes – Fabrication

Baseline model – geometry and materials

Material	TC [W/mK]	Thickness [mm]
Carbon K foam	40	-
Titanium tube 1,8 mm	16,5	0,10
Stycast glue 2850FT+Catalyst9	1,1	0,10
Graphite Foil (TPG)	1500/1500/10	0,30
Graphite Foil (Thermasol-FGS003)	1500/1500/15	0,030
Graphite Foil (PGS) t.b.d.	1500/1500/15	0,025



Gluing of components

Description	Catalyst 24	Catalyst 9
Viscosity(Pa*s)	0.03-0.04	0.08-0.105
Density(g/cm3)	1-1.05	0.95-1.05

Stycast 2850 FT +catalyst N°9

- Quite high viscosity
- Less Easily penetrate into foam / N°24
  - ➢ Optimum viscosity to find out

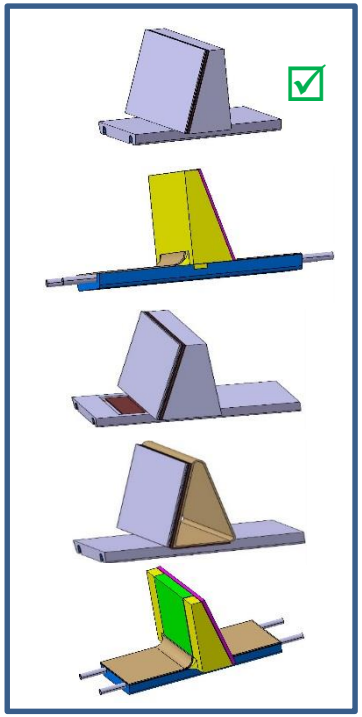
I.4 – Alpine thermal prototypes – Fabrication

Main goals

- Production of “baseline mountain” prototypes to measure the performances
- Enhance fabrication and assembly (foam, graphite, composite, Ti pipes, Glue)
- Crosscheck with simulations
- Get the real thermal conductivity numbers for the best materials

Prototyping - measurements

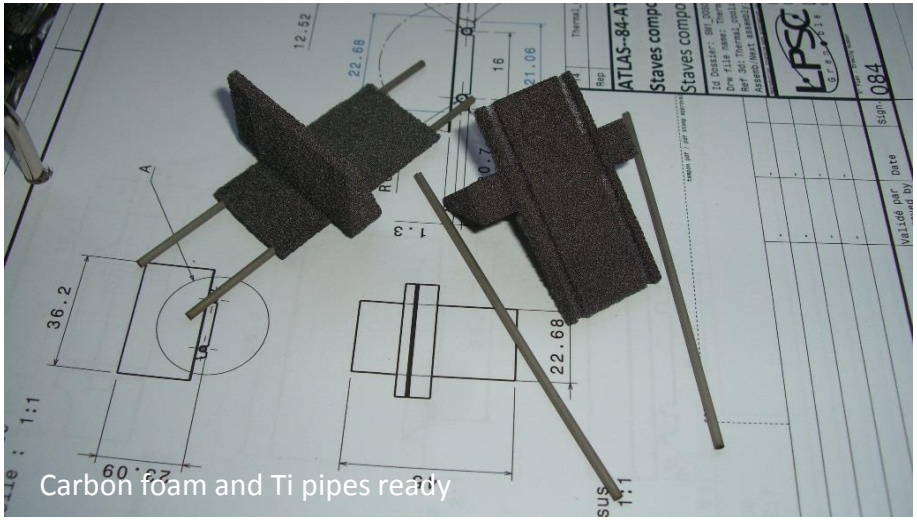
- Produce the first two baseline mountain prototypes : TPG / FGS003 Done
- Mould for prototypes’ backplate : Done
- Assembly mould for prototypes + backplate + faceplate : Done
- Produce prototypes N°2: Foam in 2 parts + FGS003 : t.b.d.
- Produce prototypes N°3: Foam + TPG ahead: t.b.d.
- Produce prototypes N°4: Full TPG – Mountain Carbon sheet: t.b.d.
- Produce prototypes N°5: Foam in 2 parts + Full FGS003 : t.b.d.
- **Interface debonding**



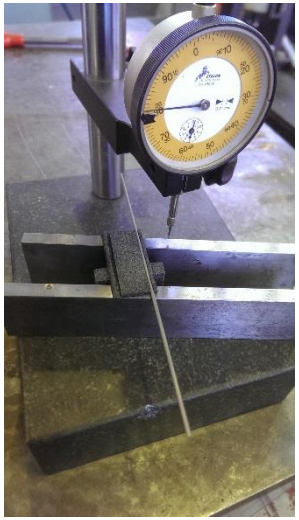
I.5 – Alpine thermal prototypes – Fabrication


EDM Machining


Lathe machining for pipe footprint

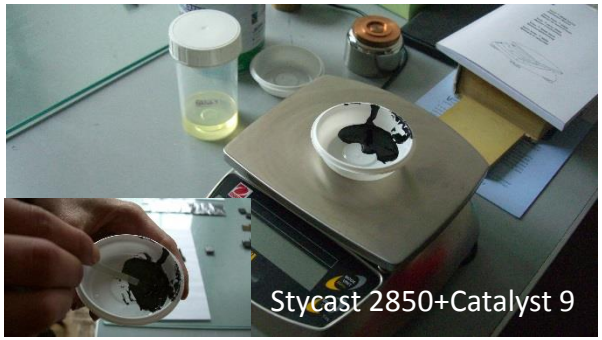


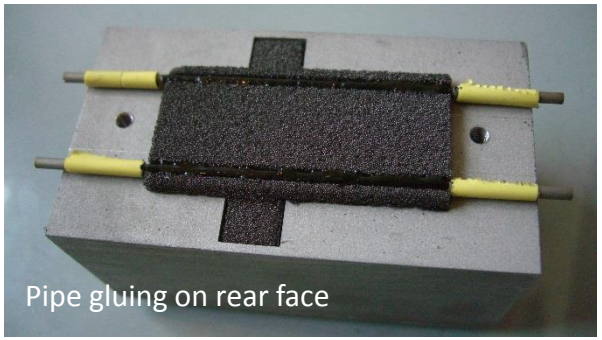
Carbon foam and Ti pipes ready

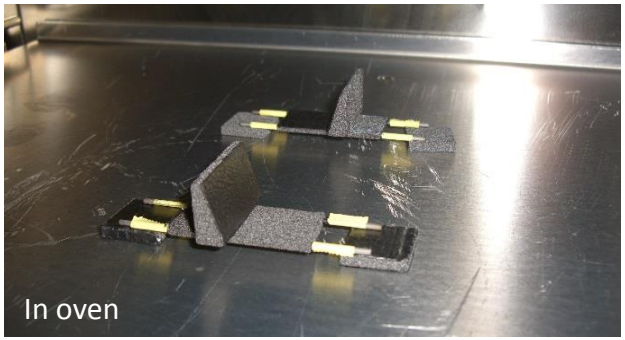


Step 1: Fabrication

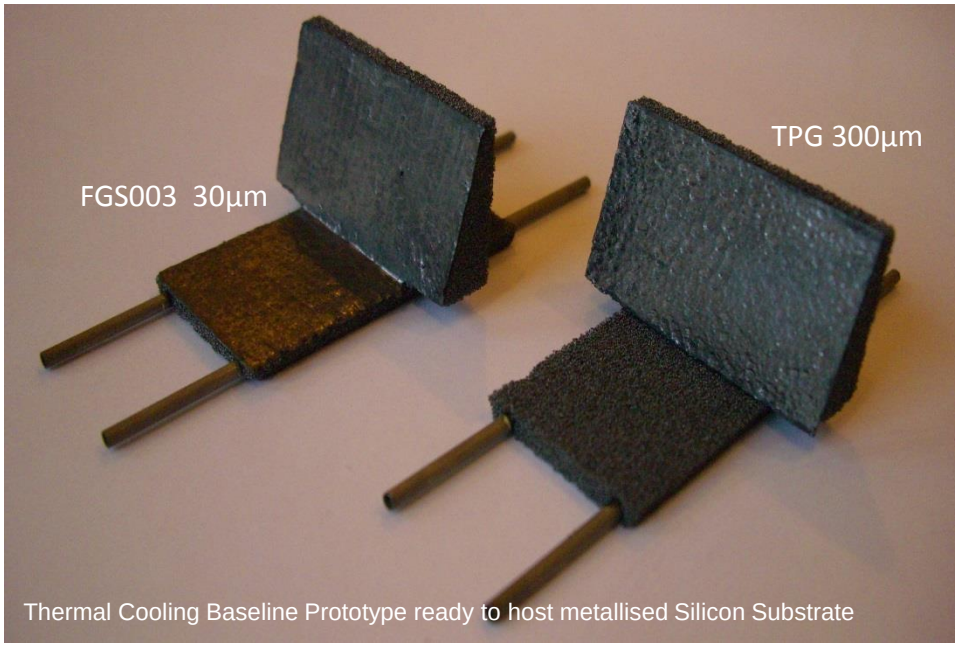
I.6 – Alpine thermal prototypes – Fabrication


Stycast 2850+Catalyst 9


Pipe gluing on rear face


In oven


Curing 65°C-2h



Thermal Cooling Baseline Prototype ready to host metallised Silicon Substrate

Step 2: Curing

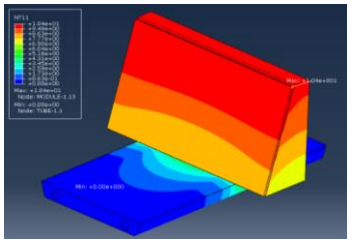
SUMMARY

Mechanics and Thermal management

- Prototype machining ok
- Efforts on going for long assembly technics

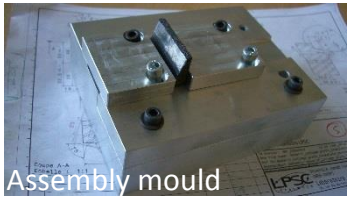
Next step @ LAPP *(see P;Delebecque talk)*

- Connection to open CO^2 loop
- Gluing of metallised Silicon Substrate (LPSC) used as heater to simulate power generated by sensor
- Simulation results have to be now compared with thermal measurements
- Graphite foil TPG to be compared / FGS003 and PGS performances

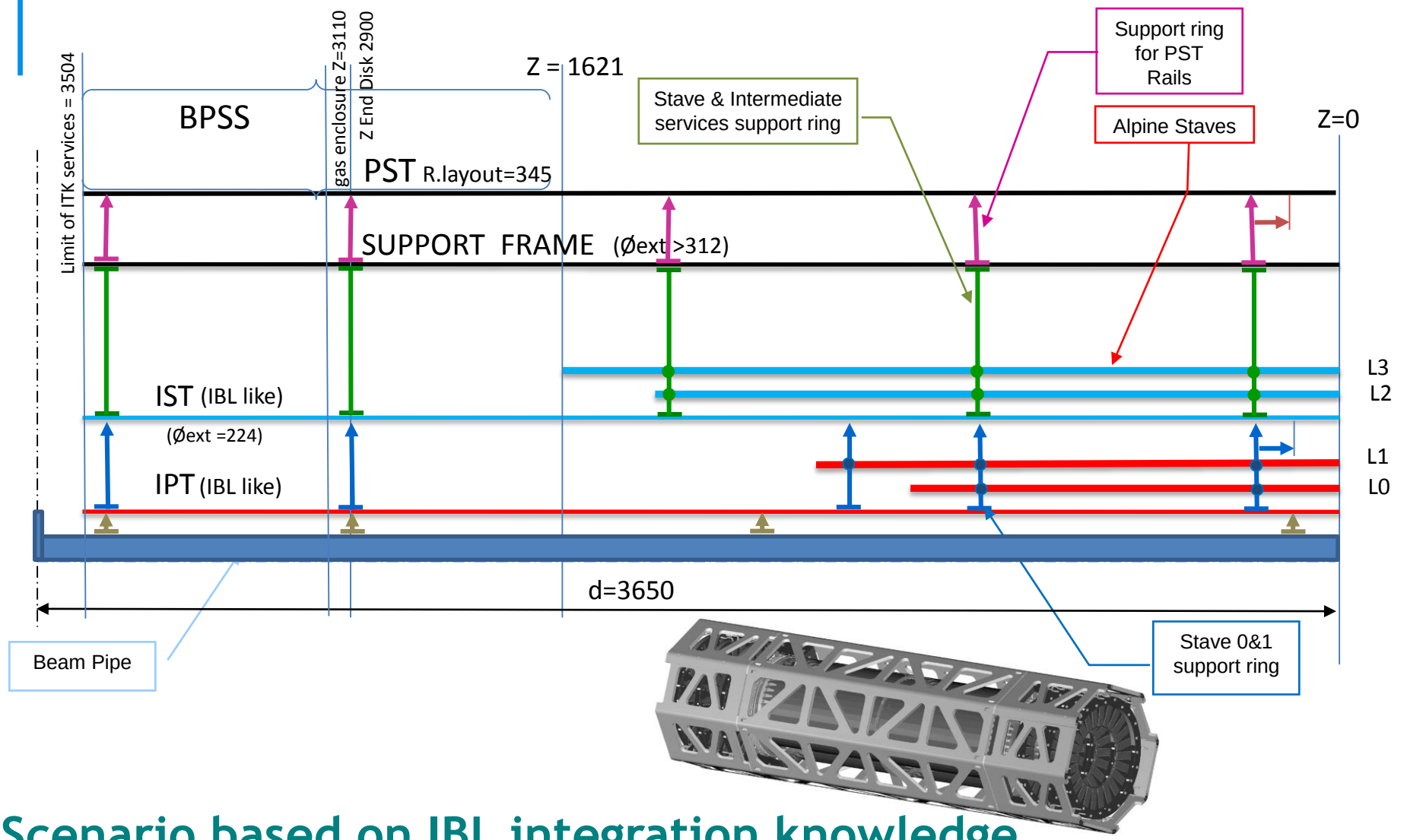


Next step @ LPSC

- Material and interfaces qualification
- Produce prototypes n°2 to 5 / Backplate curing
- Prototypes + Backplate + Faceplate assembly & Co-curing
- Carbone K13C2U & D2U + EX-1515 & RS-3, woven fabrics CC202-ET445…
- Improvements to be done on glues: viscosity and deposit



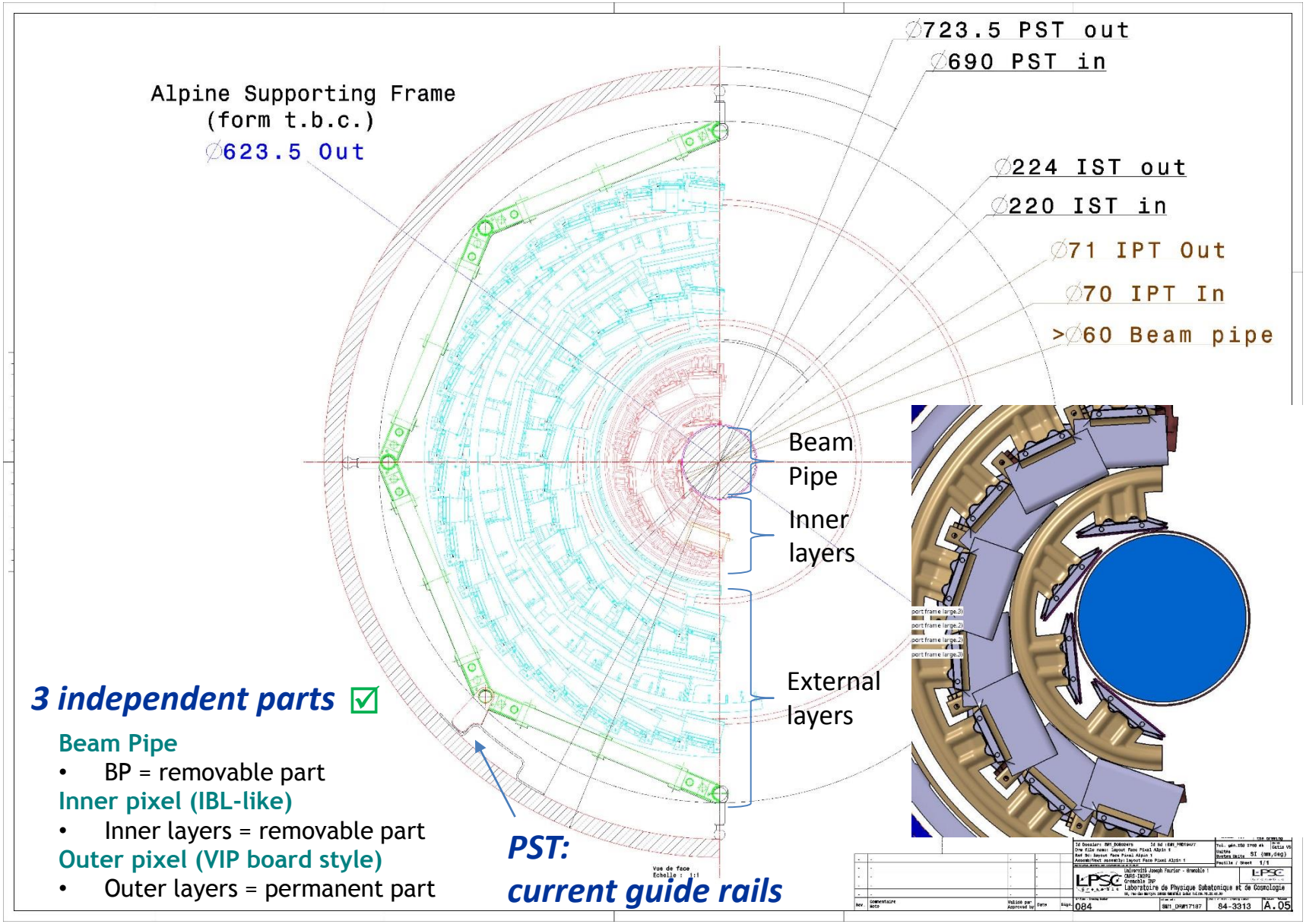
II – Integration design for alpine layout |η|=2.5



Scenario based on IBL integration knowledge

Fully meets ITK requirements (5.1/5.2/5.3: Beam Pipe/Inner layers/full Pixel removable)

II –Alpine Pixel – Supporting Frames



3 independent parts ☑

Beam Pipe

- BP = removable part

Inner pixel (IBL-like)

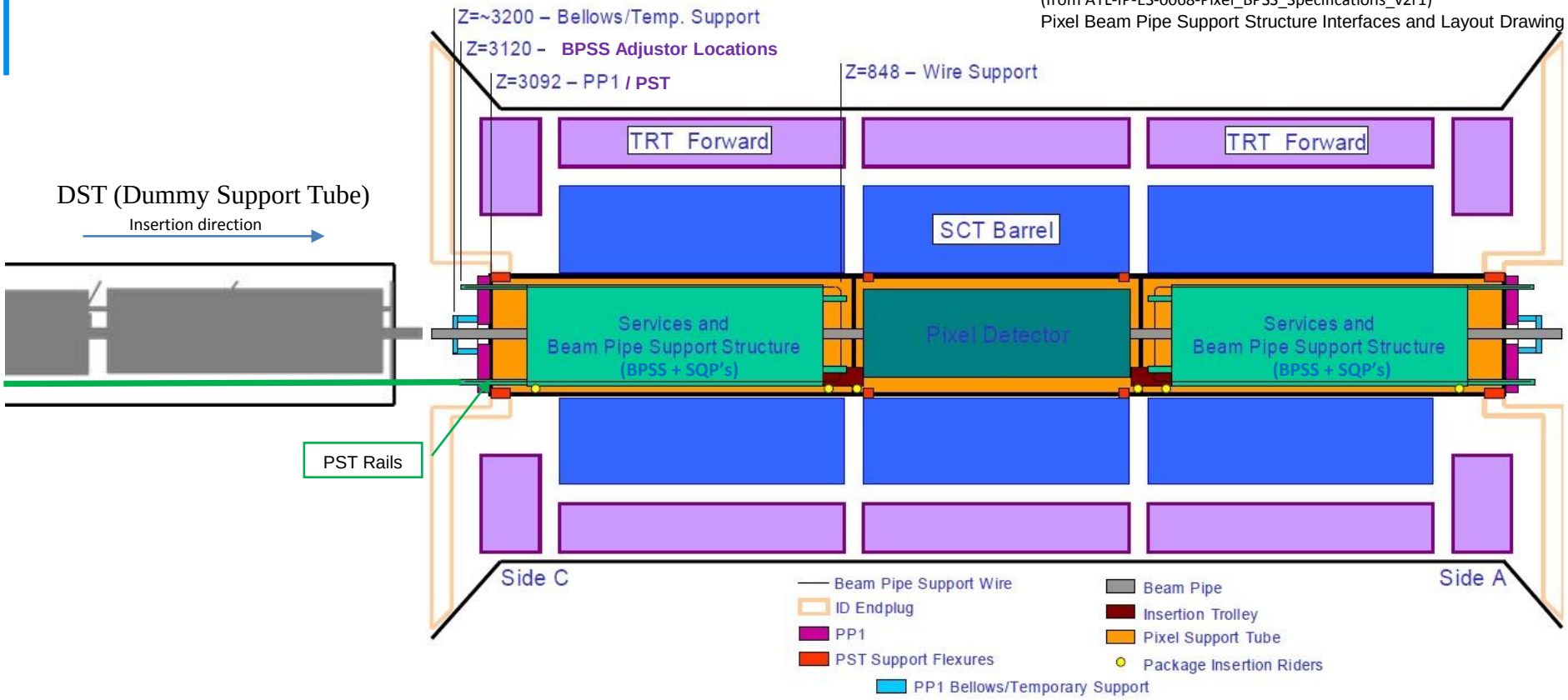
- Inner layers = removable part

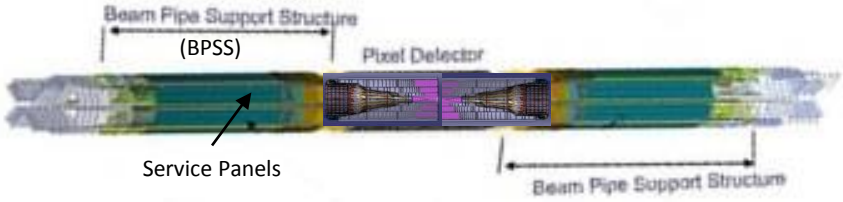
Outer pixel (VIP board style)

- Outer layers = permanent part

II – Insertion scenario : current / Alpine Pixel

(from ATL-IP-ES-0068-Pixel_BPSS_Specifications_v2r1)
Pixel Beam Pipe Support Structure Interfaces and Layout Drawing





*Integrated **Pixel package** with Beam pipe, Barrel with Disks and BPSS with Service panels on both sides.*

The pixel package

- about 7m long package assembled on surface
- lowered into the pit for insertion into detector
- like a "three wagons train"
- Detector (central part) is floating between the two external wagons
- rides on carbon rails bonded inside the PST (Pixel Support Tube)

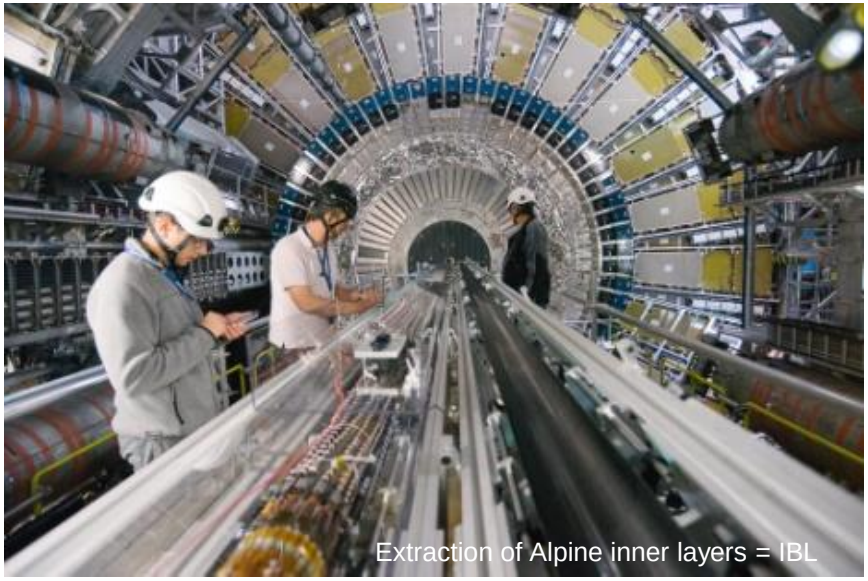
NEW
- Compatible with SLIM integration (5th Strip layer from UniGe)
- With **IPT** & **IST** integrated for fast extraction of BP &/or 2 inner layers

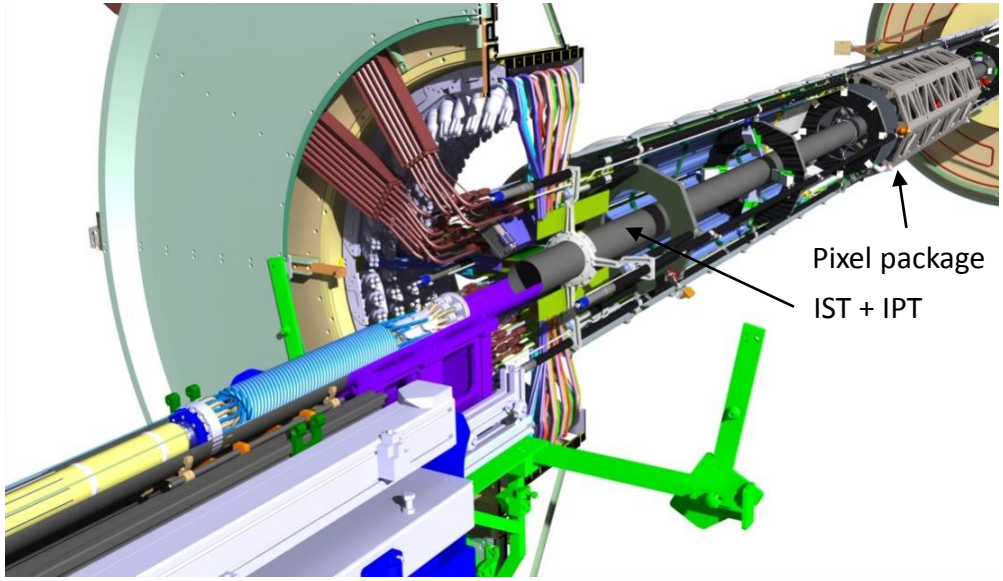
II – Insertion scenario : current / Alpine Pixel

What changes:

- **Diameter** of the Pixel package (*bigger*)
- **IPT** & **IST** tubes going through the whole package (rigidity of the package)
- ALARA constraint: **level of automation** needed (like IBL or more ?)

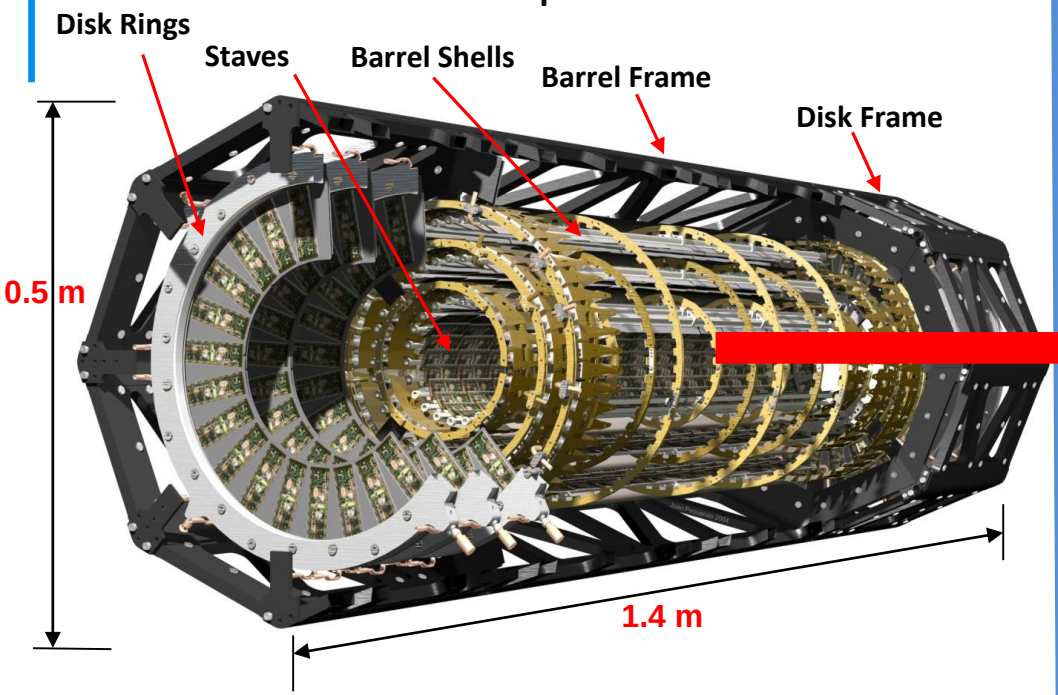
IBL like extraction of Beam Pipe and/or Inner layers



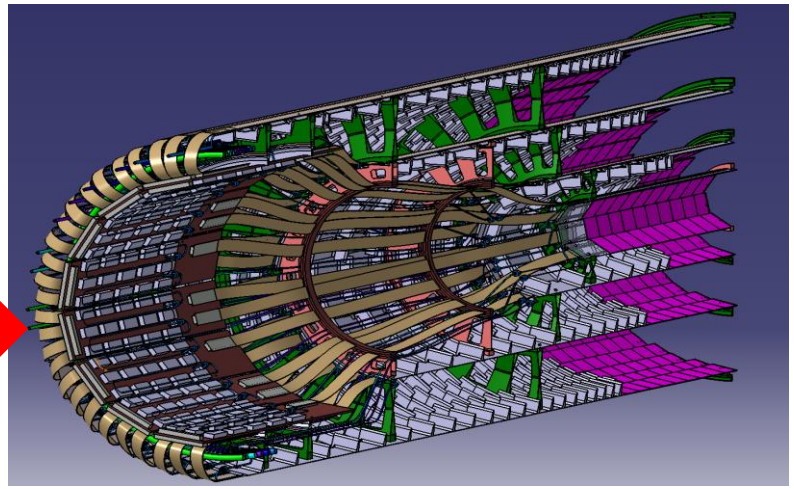


III – Mechanical support structures of Alpine Pixel Detector

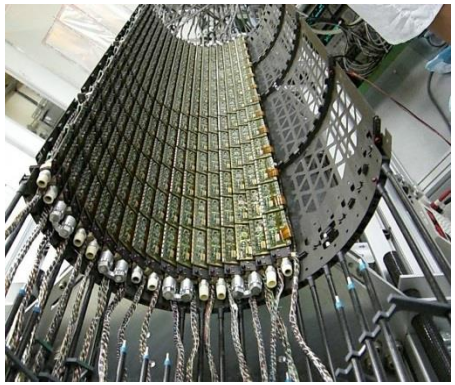
Current pixel detector



Alpine pixel detector

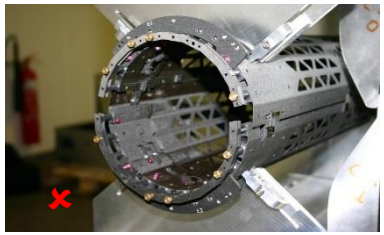


carbon composite structure + aluminum pieces supporting current barrel & end cap detectors ☑



Current stave integration halfshell

Alpine layer won‘t have shells ✘



- No carbon composite layer shells
- Only IST & IPT thin carbon interfaces and supporting flanges for layers *(material minimization)*

IV – INSTALLATION TOOLS

- **Structures to insert/remove the ITK Pixel**

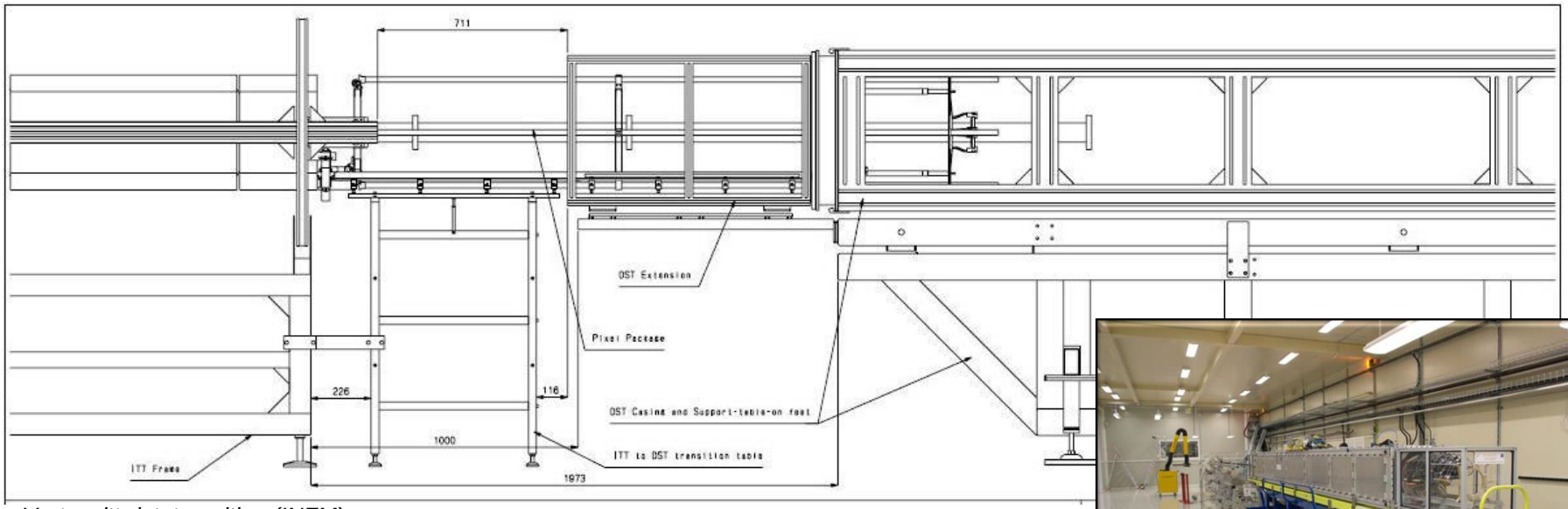
ITEM	STATUS	re-usable ?	Purpose
DST		**NO**	Reconsidered after current Pixel extraction
DST Cradle (with extensions)		**(NO)**	Or modified
Integration Structure		**(NO)**	Or modified
Transportation structure		**(NO)**	Or modified
DST Adapting Structure Support Structure in the Pit		**(NO)**	Only the connection (modified) to detector
ID rotation/adjusting stage		**YES**	Or larger one designed for IBL
Interface structure on detector		**YES**	
Spreader Bar		**YES**	

Due to the increasing diameter, many tools to reajust

IV.1 – INTEGRATION TOOLS: ON SURFACE

For ITK: current Pixel approach

New design from existing equipments to be adapted:
Translation – rotation - adaptation / different ∅ / accuracy/positioning+Interfaces/movement

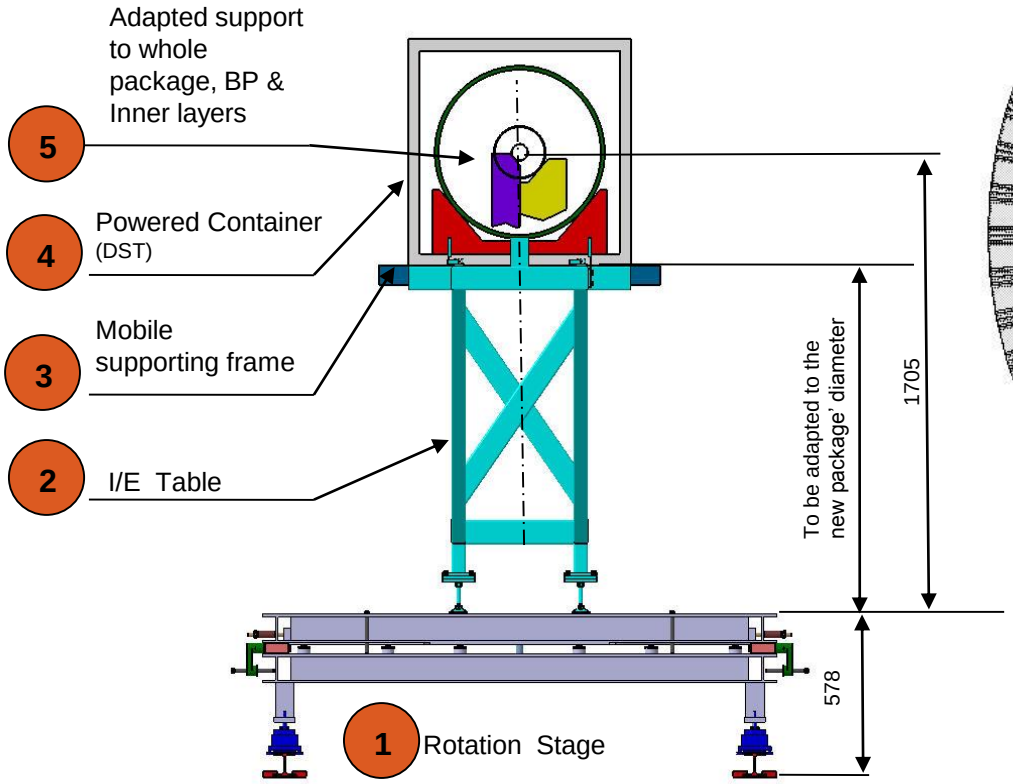


Vertex: itt-dst_transition (INFM)

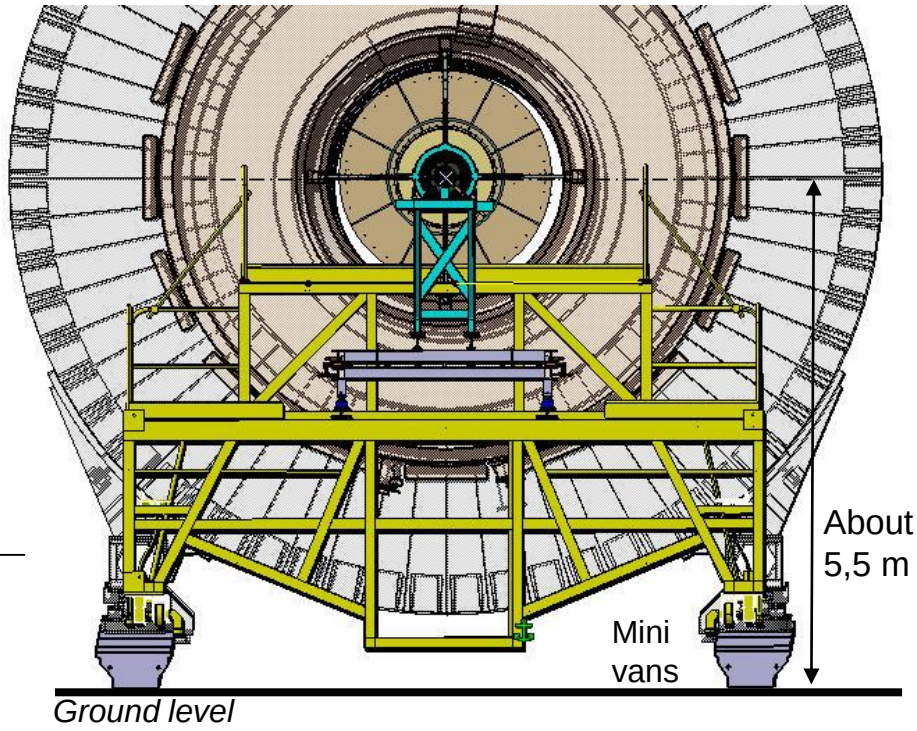
Stand for Integration to be readjusted - due to the increasing diameter

IV.2 –GLOBAL POSITIONNING

- Same tools for the global insertion and further extraction of BP or inner layers



Dimensions and positioning



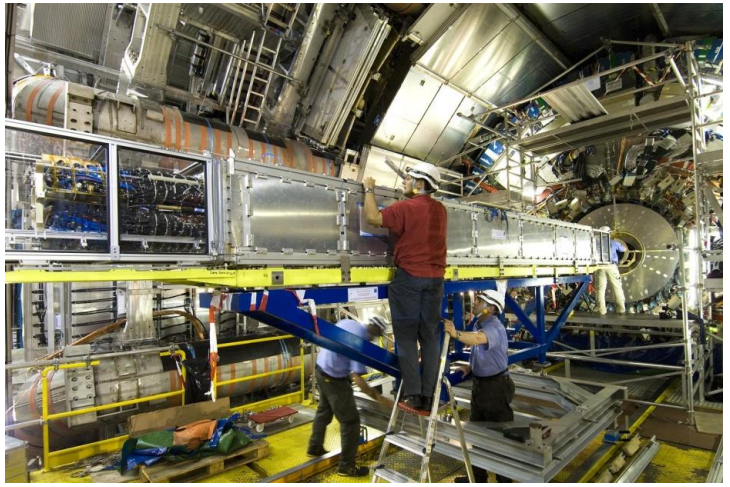
Assembly in situ @CERN (UX15 Cavern)

Adaptation of width and powered container (DST) adjusted

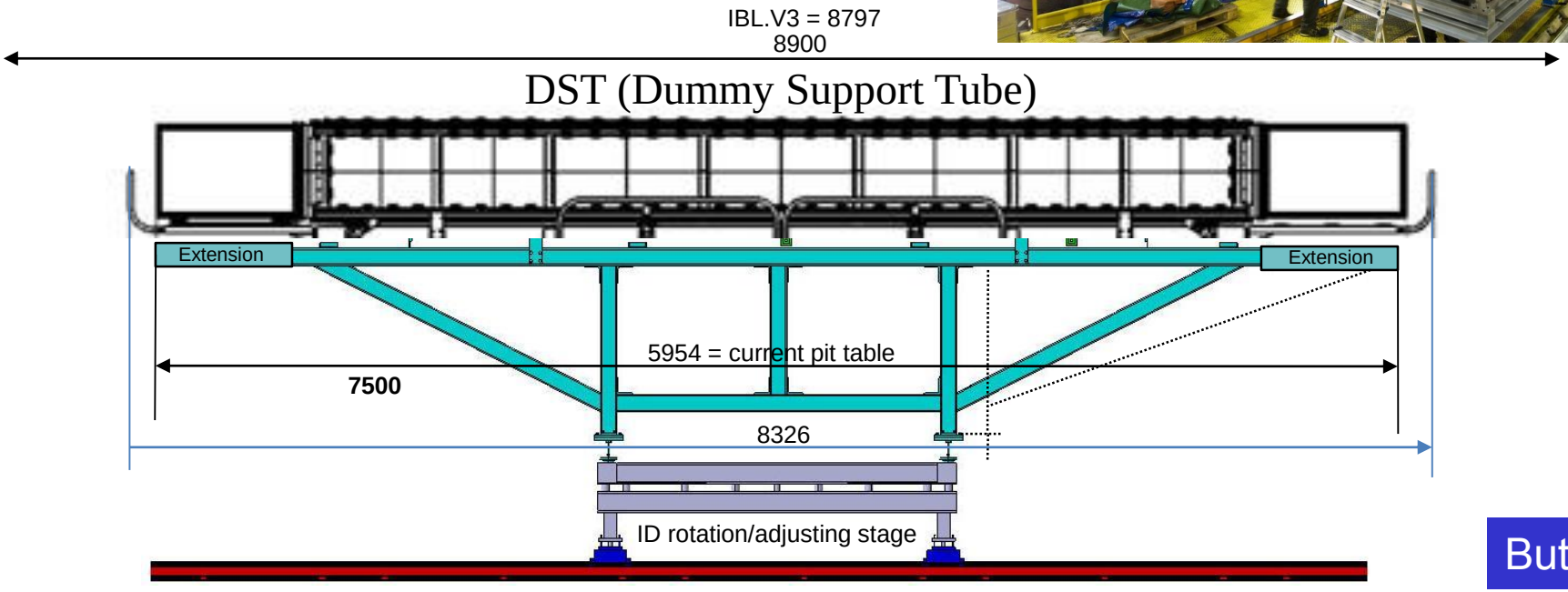
IV.3 – Transport & Handling tools

- **ITK requirements 6.5 :**
  envelope of the ITk in its installation cradle is 2.4m wide, 3.2m high and 7.5m long

INTO THE PIT



Width to be adapted but current design length ok

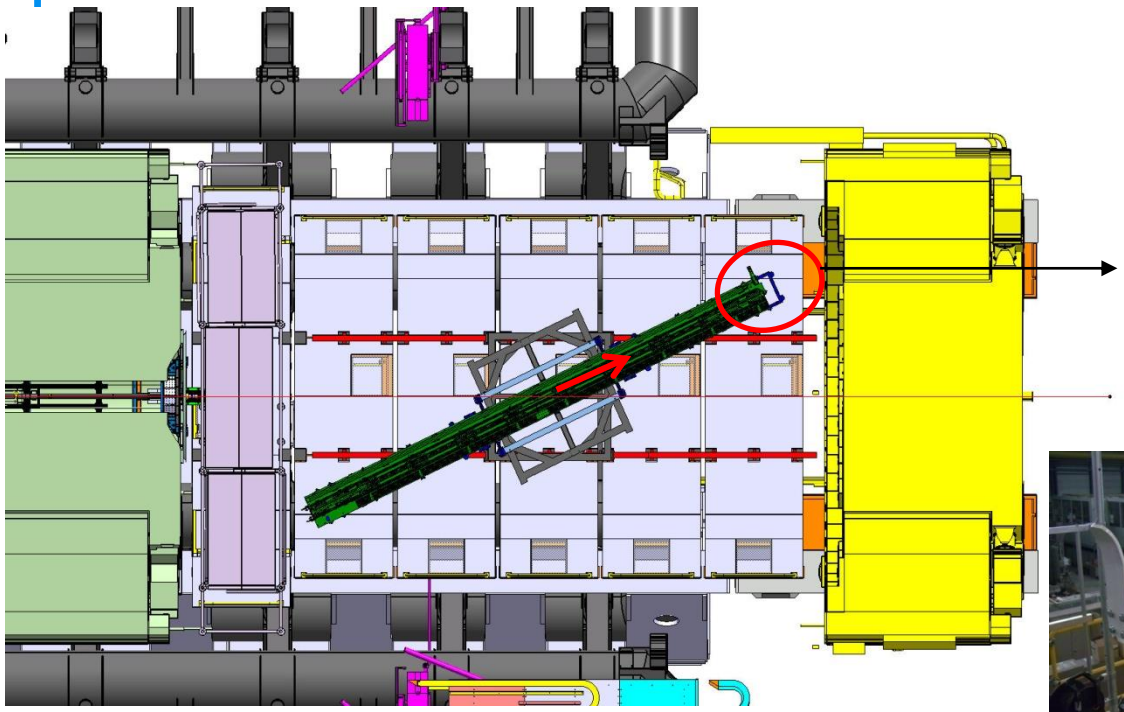


But…

DST lowered into the pit in a cradle to its final position near PST.

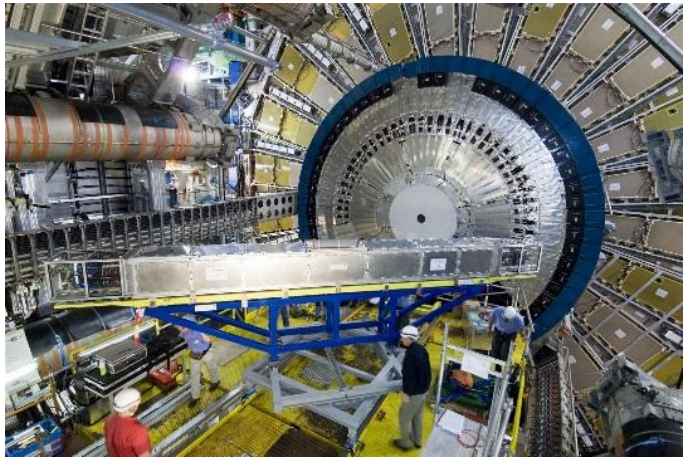
IV.4 – Interference ITK package / ECC Chains

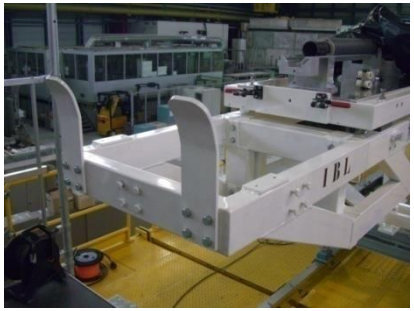
To avoid the conflict with the flexible chain, the sliding package can be moved in X direction > 250mm



Alignment and attachment of the DST to the PST
Simulation of the rotation and translation

- **From 7,5 m…**





Pit Table extension:
Removed during lowering
put back in place after rotatio

- **…To 9 m**

…Scenario based on IBL integration knowledge can allow a 9m long package ! (with specific system)

☑

IV.5 – CAD files necessary for tools evolution

- **Faster Development and reusable tools**