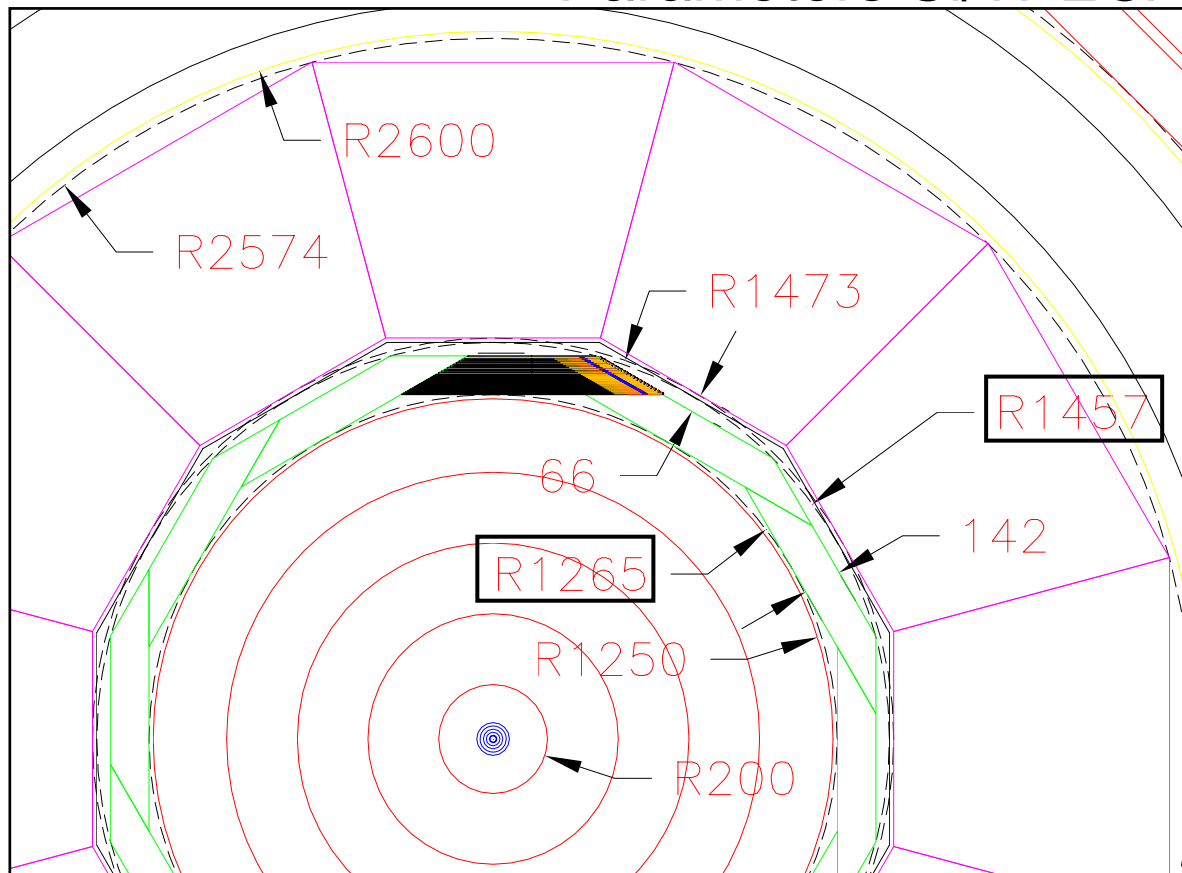


Parameters Si/W ECAL barrel



Physics requirement

Radial envelope: 1265 mm to 1473 mm

12 wedges over 2π

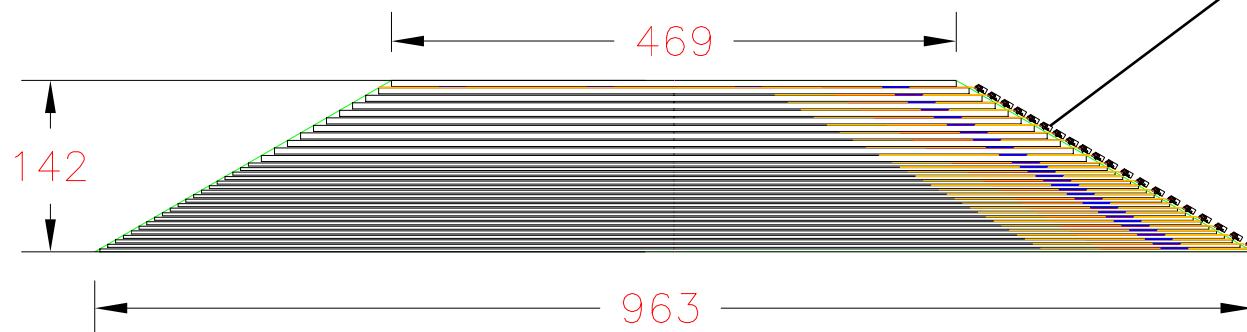
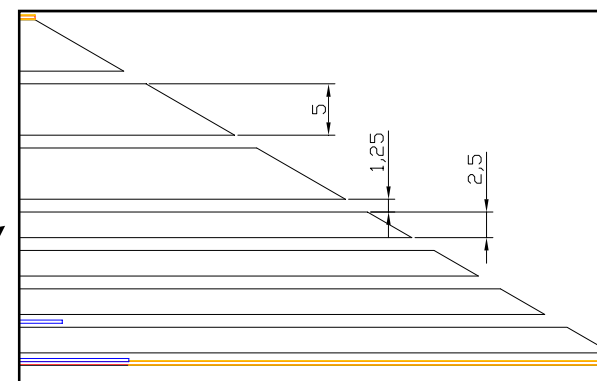
20 tungsten layers of 2.5 mm

10 tungsten layers of 5 mm

Instrumented gap 1.25 mm. i.e. shortest Moliere radius

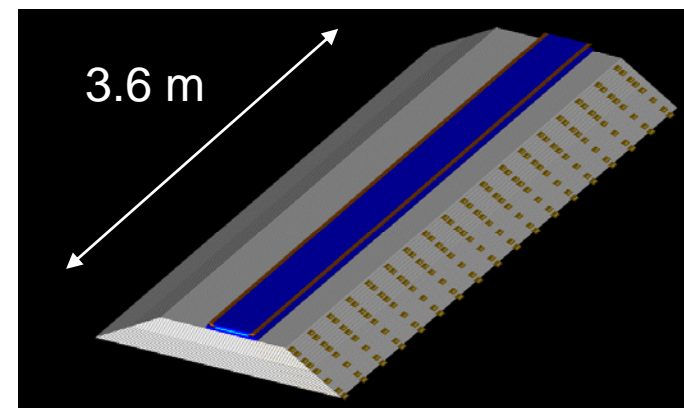
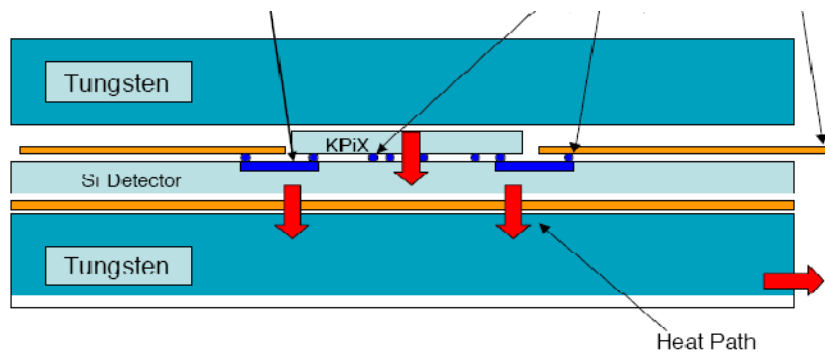
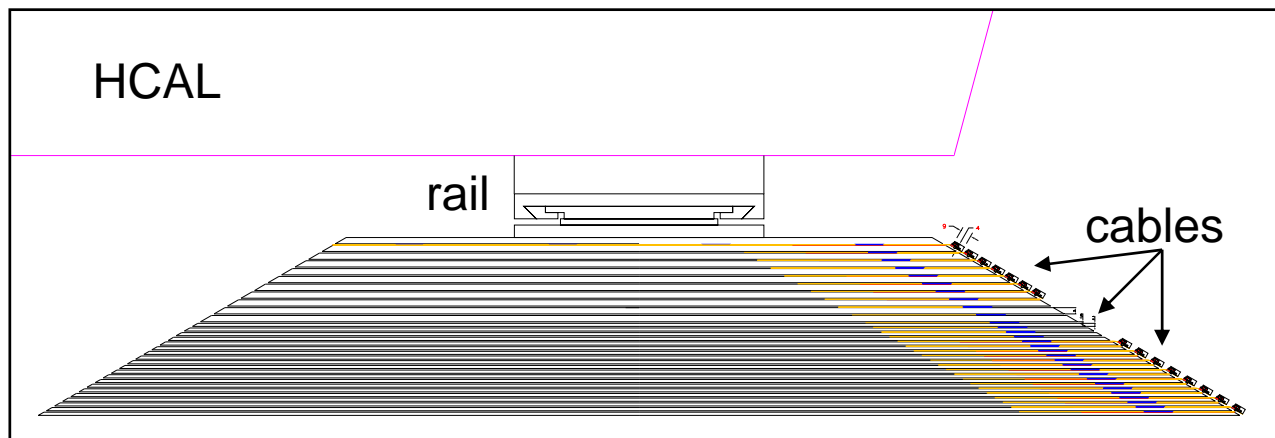
Z length: 3600 mm

Wedge mass 4900 Kg



Wedge Module design

- One single stack of 30 tungsten rolled plates, 3.6 m length-1m width interspaced of 1,25 mm with stainless steel dowel pins
- Self supporting design
- Electrical connections exit only on one side (laterally)
- Fixation and installation with rails on the HCAL barrel module



Tungsten

- It depends on the available size of the tungsten rolled plates
- Ideally we aim to one single module of the full width and full length (3.6m)
- Final size of the plates depends also on the material purity (ideally pure tungsten 99%)
- Preliminary contacts with tungsten plate producer are encouraging :
 1. High W purity means higher costs and reduced dimensions
 2. W amount required for SiD has impact on the turnover of the company, i.e. good lever arm for price discussion and R&D and...thin plates are more expensive than thick ones !?!
- In case large plates are not available, can we make a design with a plates assembly ?
- Relaxing the W purity, i.e. 97%, brings to thicker plates/wedge for the same X_0
- All this consideration does not affect yet the stringent requirements of 1,25 mm gap between W plates

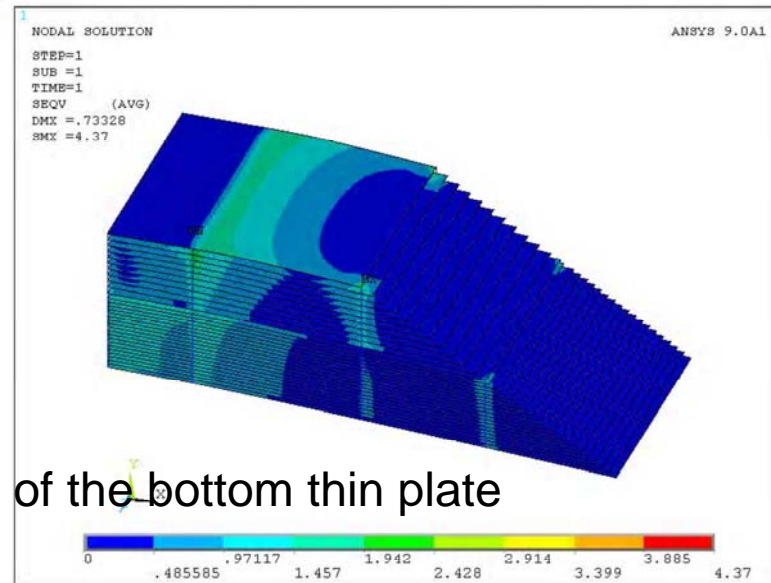
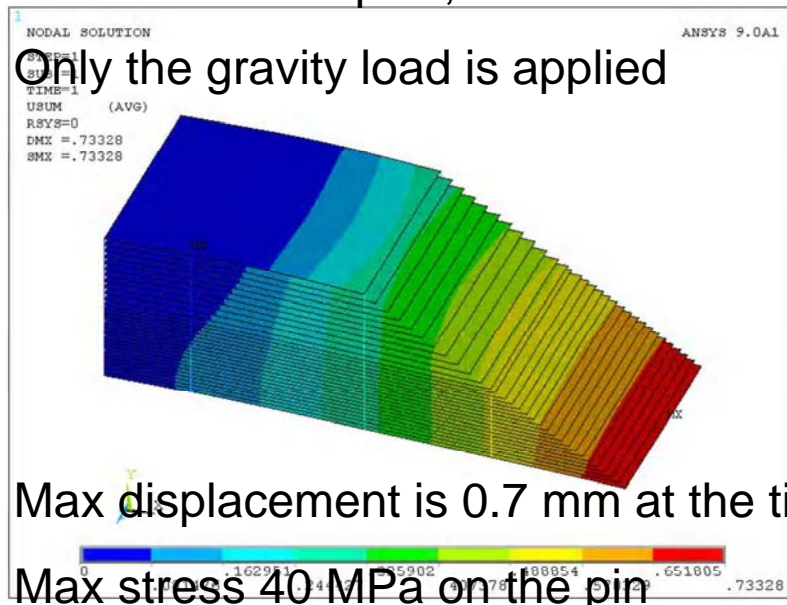
Stress & Deformation

Symmetry consideration allow to consider half width model

The rails system acts “backbone” of the wedge module, i.e. one need only to model a limited Z length (212 mm is the space occupied by two sensors)

Diameter of the pins, 2 mm

Only the gravity load is applied



Conclusion at first glance : contained deformation, high safety factor, easy-to-explain global behavior

Backbone effects of the rail confirmed

Considerations

The FEA analysis confirm that viability of the stacked-plates-with-pins concept

The model has been developed for the 3.6 meter wedge module

In the very likely case of smaller W plates, the model still holds on

How can we assembly large plates from smaller ones :

Brazing : high temperature process at 800°C, not an issue for W
 possibility to achieve good planarity developing some tooling
 ex. planarity < 50 microns over 150 micron ssteel foil, LHC vacuum tight
 large brazing furnaces under vacuum are required

Gluing : Room temperature process, large range of epoxy resin available
 Shear stress contained (see FEA)
 possibility to achieve good planarity developing some tooling
 no needs of special furnace, i.e. no limitation in size

Other : Electron-Beam or TIG welding

Small gap issues

The gap between W plates must be kept the smallest, 1.25 mm, (make SiD ECAL unique !)

Such parameter does not affect the mechanical design of the wedge concept

But it become dominant for the silicon sensor assembly and interconnections

Few considerations:

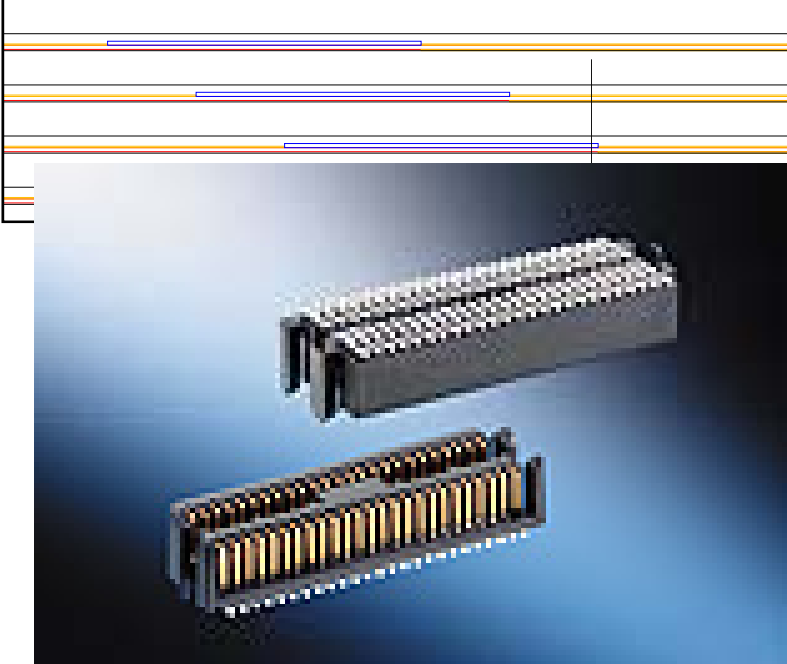
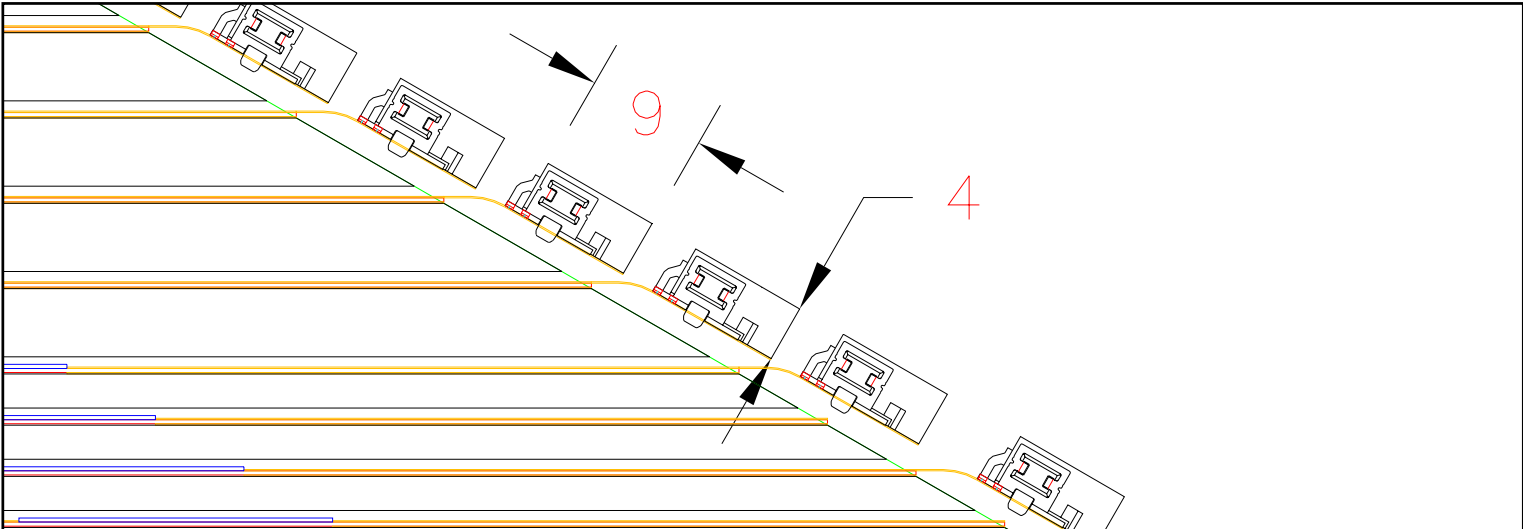
sensor + KPIX + Kapton circuit = 750 microns,

i.e. 500 micron left btw plates

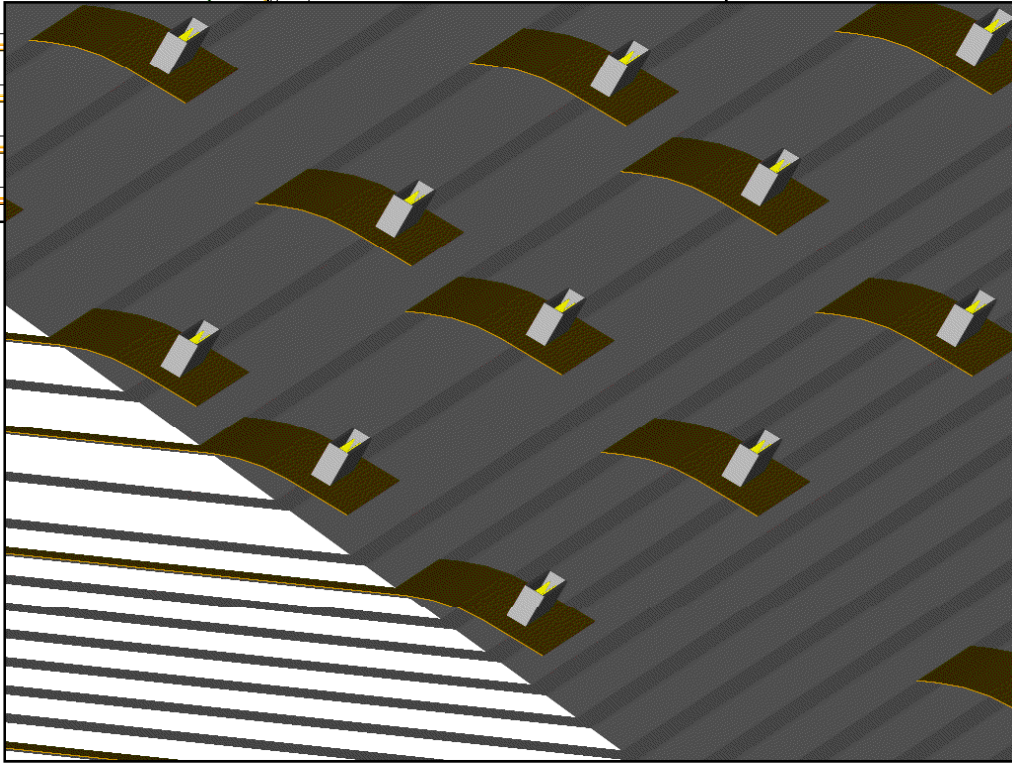
Wire bonding very difficult, typical height of a bond curl 2 mm

Grounding, short circuits, cooling

Cabling



ERNI microstac 0.8 pitch, 50 pins



Cooling

Electronic operated in pulsed mode -> 20mW per chip

Total heat load per wedge module 115 Watt

Active cooling required (each sub detector must remove the heat produced)

Sol.1

Pipes routed laterally of the wedge

Very complicate interface with the signal interconnection routing

Sol.2

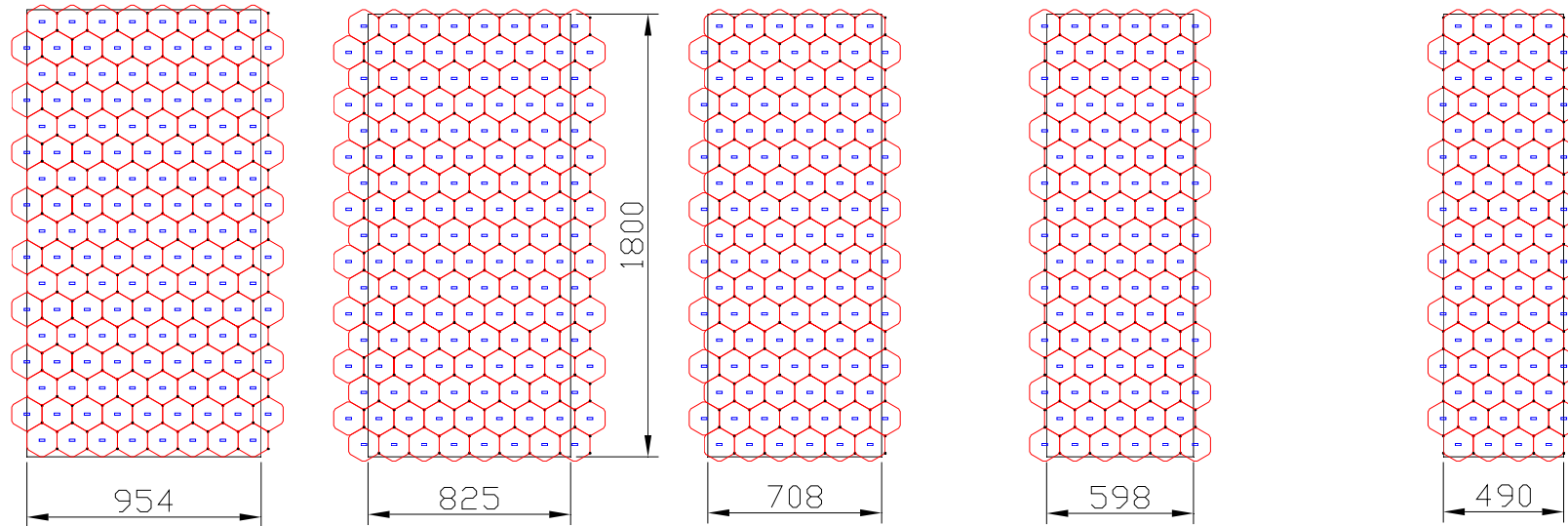
Cold plates on the top and on the bottom of the wedge

Possibility to rely on the thermal conductivity of tungsten and pins (very poor in both cases)

One should increase the cross section of the pins and make them in Aluminum

FEA model in preparation. Better understand the thermal requirements

Sensor integration



It is not possible to cover all the W plates dimension with the same silicon sensor size.

Increased number of masks for the edges

Hexagon geometry is an ideal tiling pattern, but doesn't make life easier
: pins, overlap, cables

SiD Integration

Mechanical interfaces :

Fixation of rails on HCAL

Clearance ECAL-HCAL defined by the space required for the cables. It is presently 66 mm, I guess we can reduce it but not before extensive discussions on the cables interconnections (is it an optimization parameter for the PFA ?)

Clearance ECAL-TRACKER: I would not touch ECAL with the tracker (both for supports and installation). A basic installation tooling may allow for tracker installation and maintenance independent of ECAL. Tracker services on ECAL should be such to allow the maintainability of the Si/W wedge modules.

Mechanical interfaces between the barrel and the forward part: cracks for the routing of the services for the detector inside the coil. Tracker supports vs. Ecal and Hcal interfaces (I assume the tracker supported by HCAL)

Other interfaces:

Definition of thermal volumes for HCAL-ECAL-TRACKER: one or three independents ?

Wide range of detector technologies adopted in the inner coil volume: Silicon strips, Silicon pixel column, GEM-RPC-MICROMEGA-Scint. -> all may required an optimized environmental set point

Thermal stability reqs. in operation and in maintenance

Bulkheads and thermal transition between adjacent regions

Dews points inside the coil

Inertion with N₂ ?

Future plans

Develop more details of the wedge module concept for the Lol

Further investigation on the W plates market

Be prepared to go further inside in the W plates joints technology

Understand the technology limit of the electrical interconnections

Trade off the cooling solutions, thermal and environmental requirements

Integrated design of cabling and cooling : solid model at the beginning then, ideally, a mock up

Sort out the mechanical and environmental interfaces for the inner coil detectors

More resources available from January 2008 on long term basis at LAPP
Annecy :

1 FTE staff Mechanical Engineer + mechanical workshop facility

Possibility to contribute also to the design of GEM and Micromegas for Hcal