

# ILD integration studies :

## Gaps Barrel-endcaps

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**LLR, Ecole polytechnique, Palaiseau**

*Contributions from :*

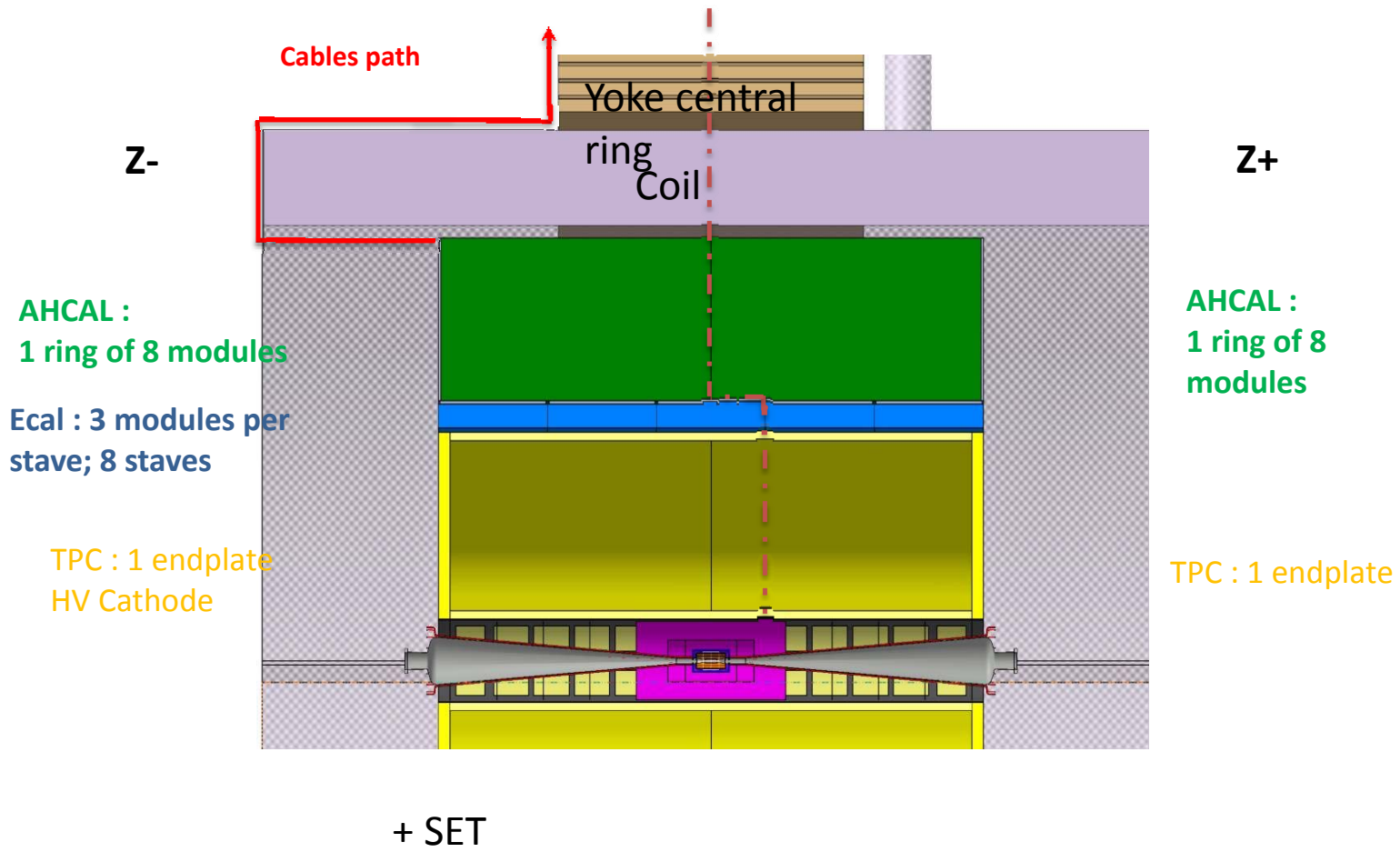
ECAL : J.Giraud, D.Gronin, D.Jaussaud

LPSC, Grenoble

DHCAL : J.C.Ianigro,

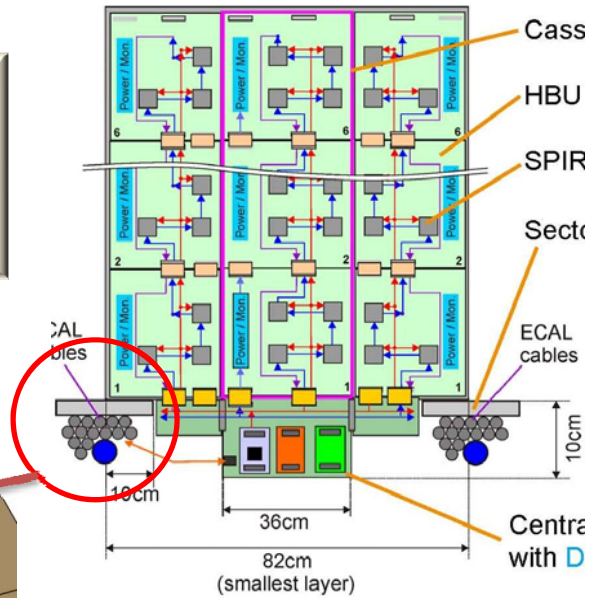
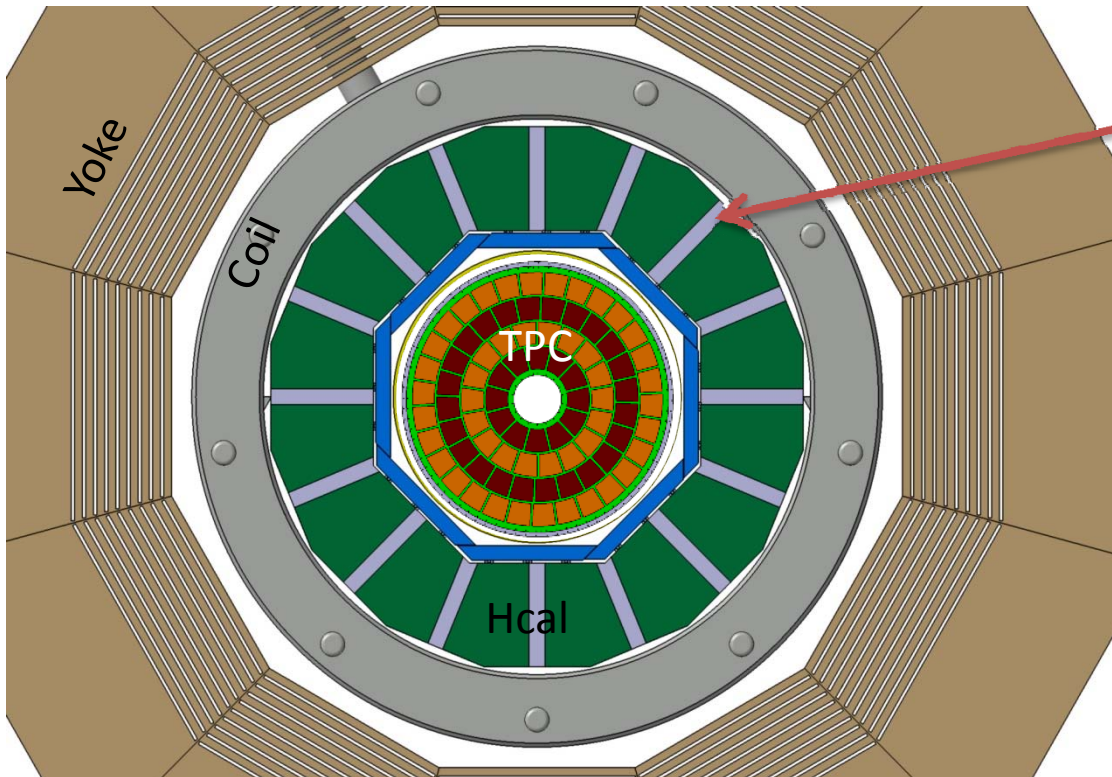
IPNL

TPC : R.Settles, T.Matsuda



**For each side :**

16 way-out zones for barrel cables  
 ( Hcal/Ecal/TPC)  
 20 cm large each; gap 10 cm; thickness support 1.5 cm  
**170 cm<sup>2</sup>**



*AHCAL : Electronic representation of 1 layer ; From K.Gadow*

On Hcal modules faces :

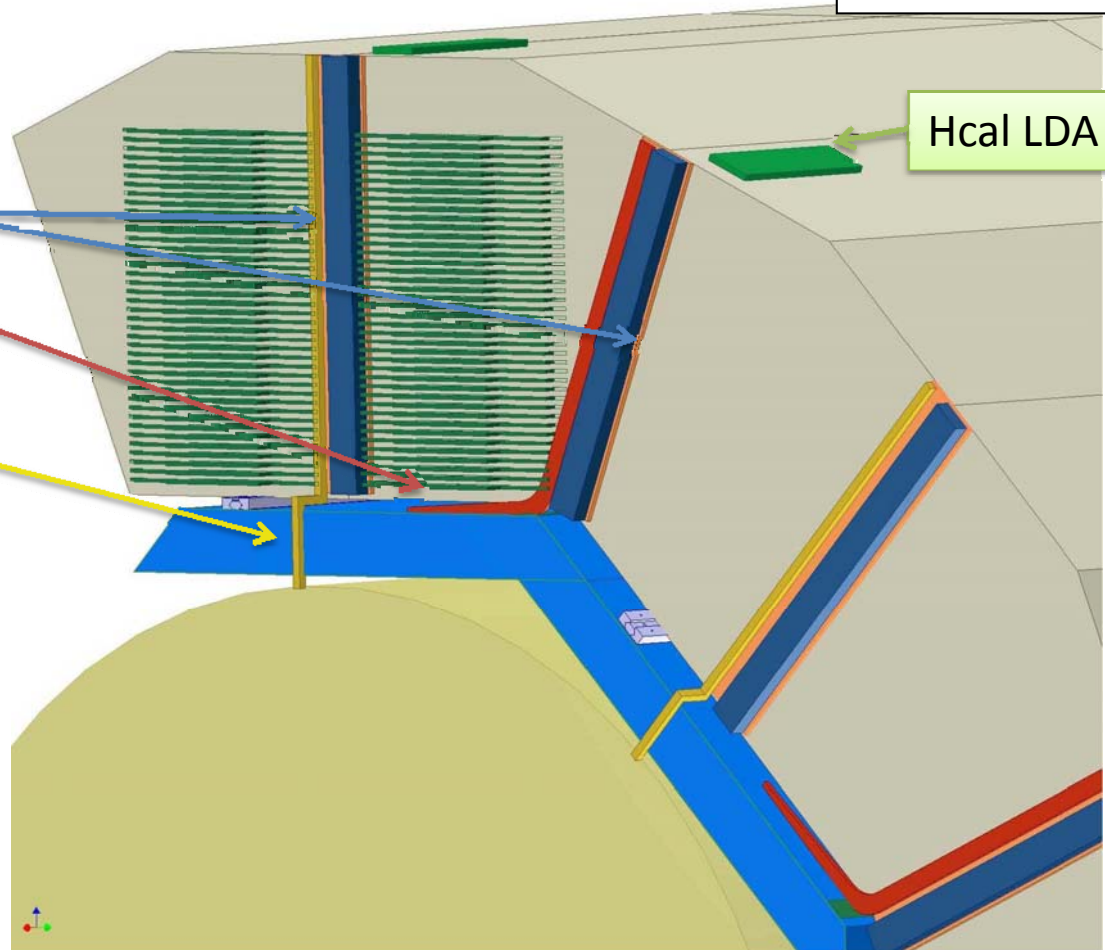
Red : Ecal cables  
Blue : Hcal cables  
yellow : TPC

Hcal= 50cm<sup>2</sup> 16 way-out

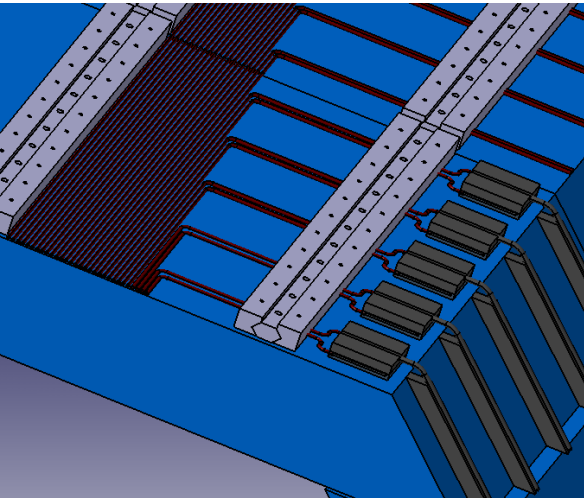
Ecal = 30 cm<sup>2</sup> ; 8 way-out

TPC= 10 cm<sup>2</sup> ; 8 way-out

Hcal LDA



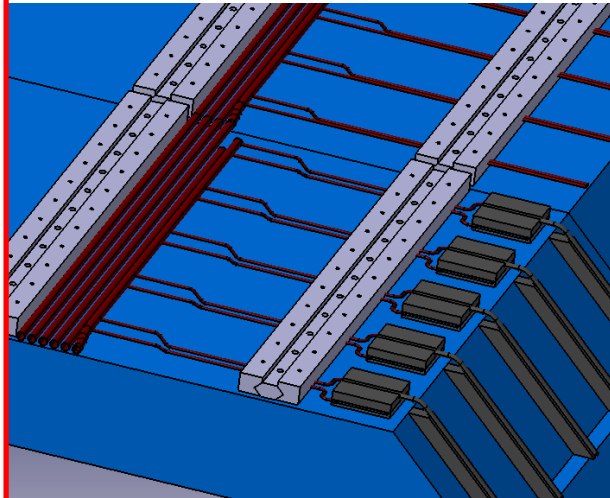
COOLING ECAL Barrel, 3 possibilities, leak less system with heat pipes .  
(J.Giraud & al, LPSC)



(1)  
Small Cu pipes  
distributing each  
columns

400 tubes full barrel

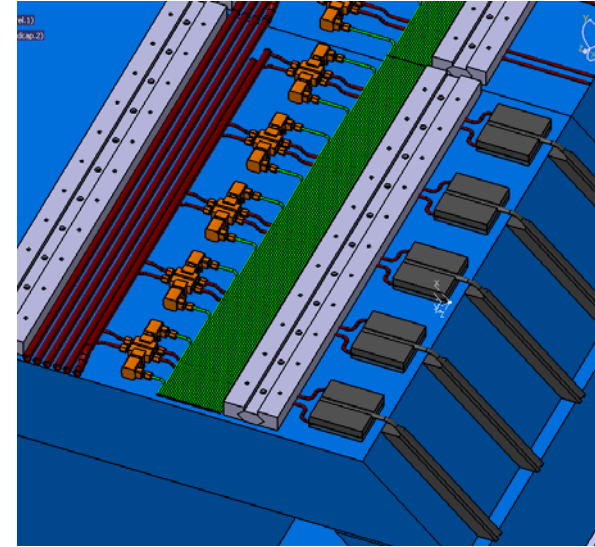
15 W max



(2)  
2 bigger pipes per  
modules

80 tubes full barrel

150 W

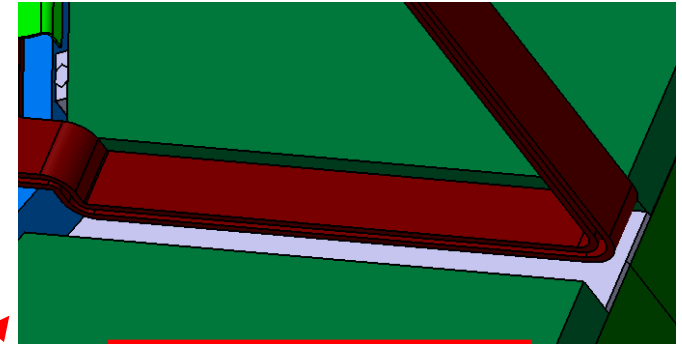
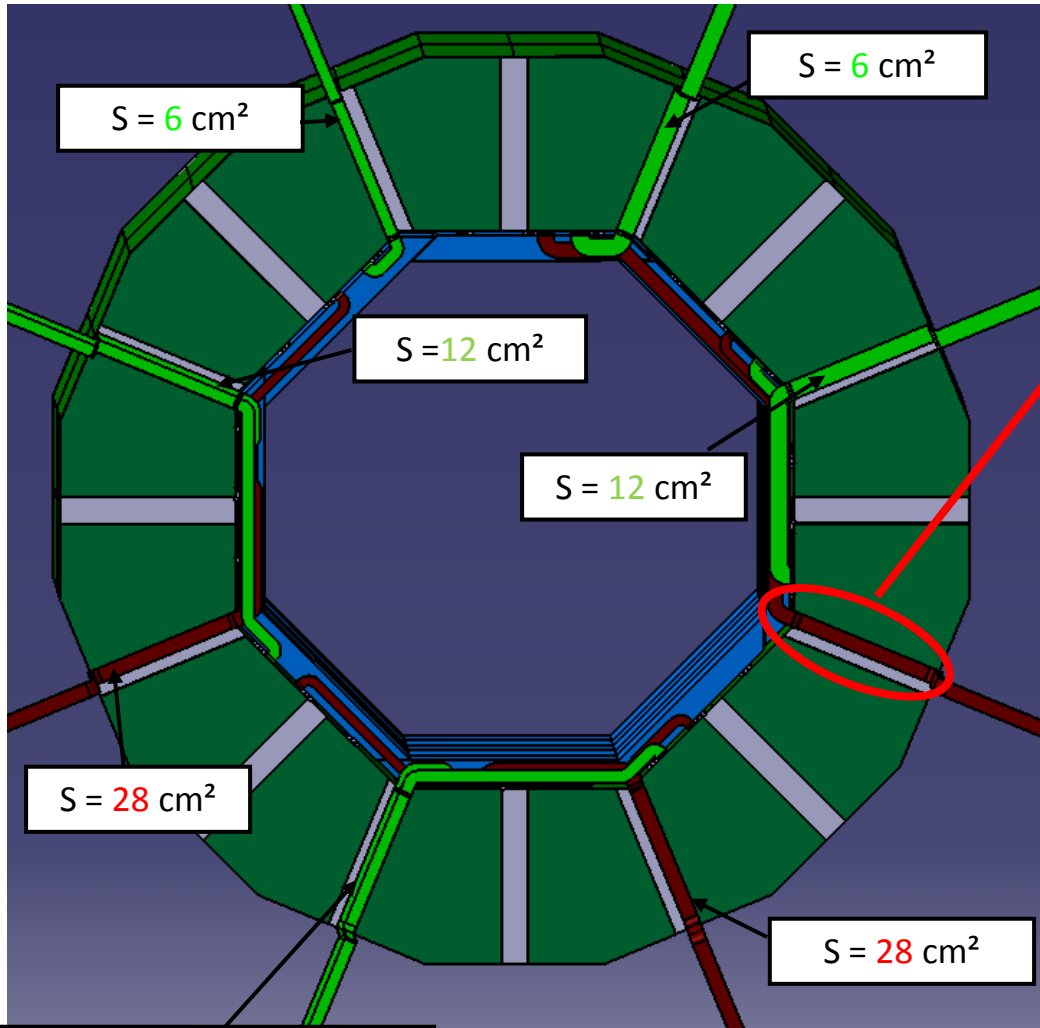


(3)  
Same as (2) + pneumatic  
valves

80 (water) + 400 (air)

150 W

Green : air path  
Red : water pipes



$S_{max} = 42 \text{ cm}^2$

3 overlapped lines of 6 pipes  
 $\varnothing 15 \text{ mm}$

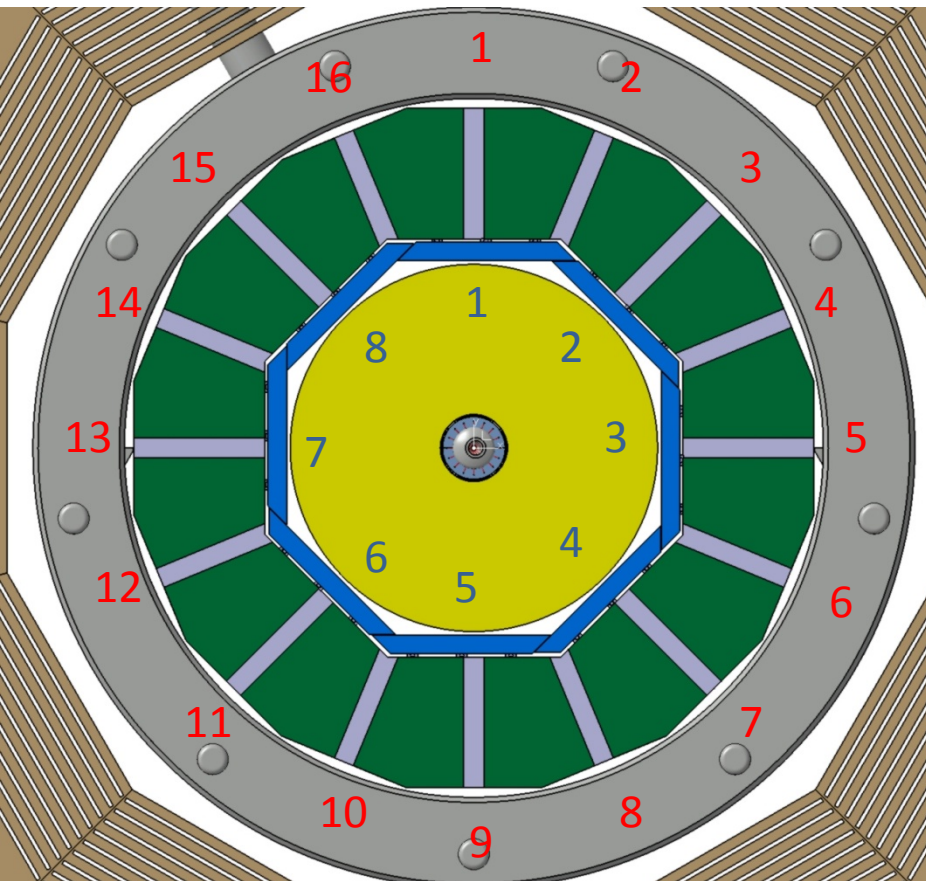
COOLING ECAL Barrel  
(*J.Giraud & al, LPSC*)

Services section vs way-out

Missing : TPC cooling

Liquid supply line = 5 mm ID; 7 OD

Vapor return = 8 mm ID; 10 OD



Way in	Cables			cooling		Total cm <sup>2</sup>
	Hcal	TPC	Ecal	Water	Air	
1	50	10				60
2	50		30		6	86
3	50	10				60
4	50		30		12	92
5	50	10				60
6	50		30	42		122
7	50	10				60
8	50		30	28		108
9	50	10				60
10	50		30	14	12	106
11	50	10				60
12	50		30	28		108
13	50	10				60
14	50		30		12	92
15	50	10				60
16	50		30		12	92

(170 cm<sup>2</sup> available per path)

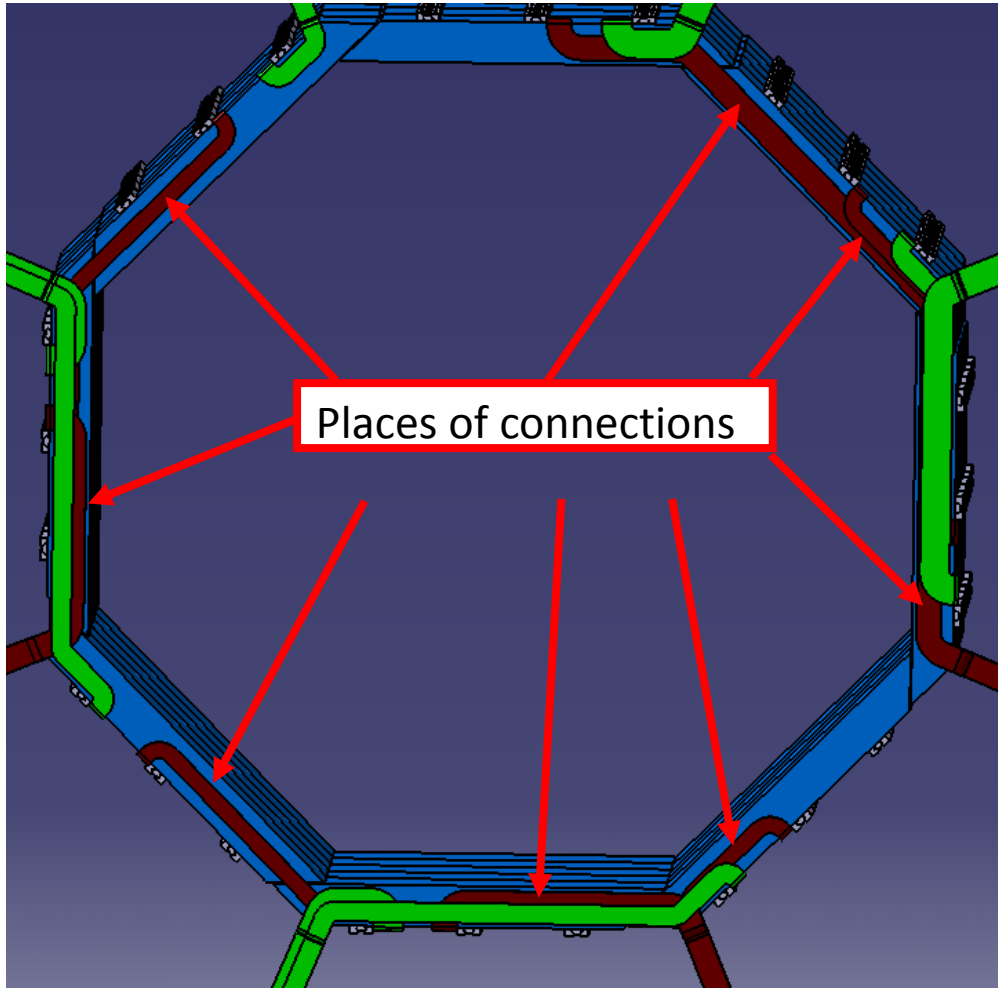
**Worse case : path (6), 122 cm<sup>2</sup>**

**Means 6.1 cm thick full**

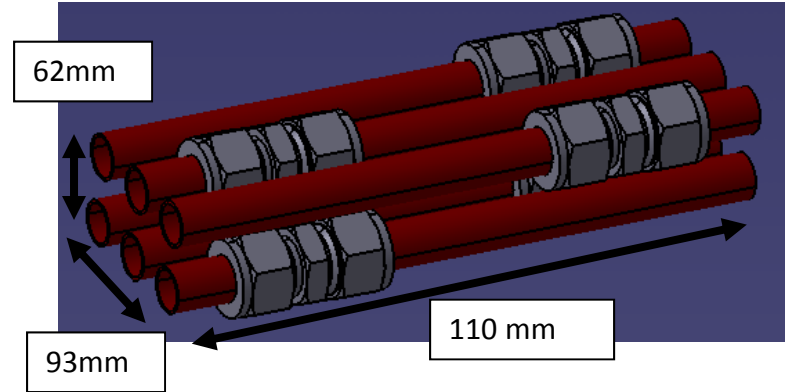
**Foreseen gap of 10 cm is enough**

**Ahcal electronic boards ?**

Another limitation to the minimal size of the gaps is the patch panels



3 modules :  $S = 58 \text{ cm}^2$



+ overlap with cables and air pipes.



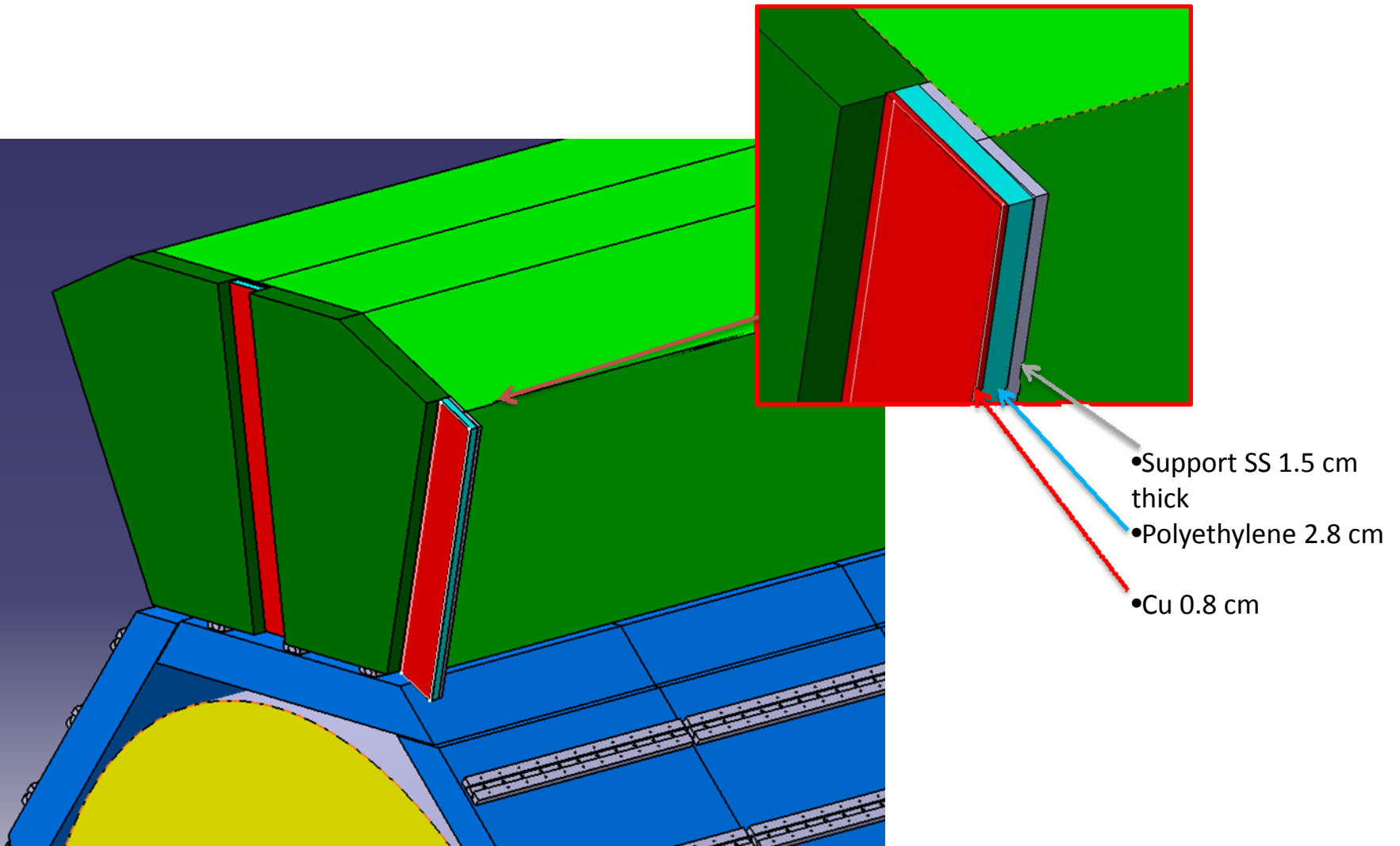
# Barrel services : dead materials

Copper  
X0=1,43 cm

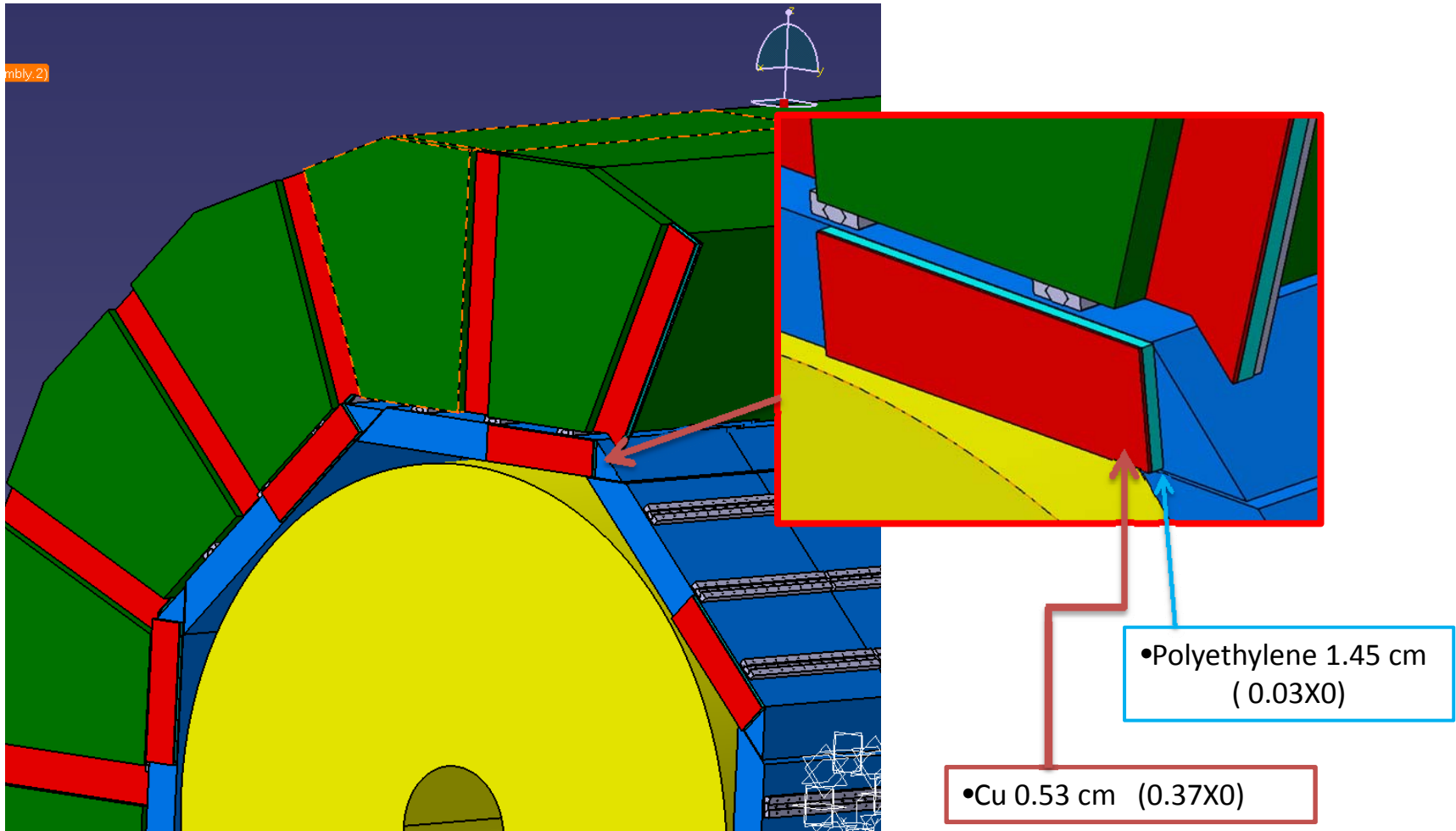
Polyéthylène  
X0= 47 cm

Way in	Cables			cooling		path width =20 cm				Cables			cooling		path width =20 cm		
	Hcal	TPC	Ecal	Water	Air	Total cm <sup>2</sup>	thickne ss	X0		Hcal	TPC	Ecal	Water	Air	Total cm <sup>2</sup>	thickne ss	X0
1	10	3				13	0,65	45,45%		40	7	0			47	2,35	5,00%
2	10		7			17	0,85	59,44%		40	0	23		3	66	3,3	7,02%
3	10	3				13	0,65	45,45%		40	7	0			47	2,35	5,00%
4	10		7			17	0,85	59,44%		40	0	23		6	69	3,45	7,34%
5	10	3				13	0,65	45,45%		40	7	0			47	2,35	5,00%
6	10		7	7,9		24,9	1,245	87,06%		40	0	23			63	3,15	6,70%
7	10	3				13	0,65	45,45%		40	7	0			47	2,35	5,00%
8	10		7	5,2		22,2	1,11	77,62%		40	0	23			63	3,15	6,70%
9	10	3				13	0,65	45,45%		40	7	0			47	2,35	5,00%
10	10		7	2,6		19,6	0,98	68,53%		40	0	23		6	69	3,45	7,34%
11	10	3				13	0,65	45,45%		40	7	0			47	2,35	5,00%
12	10		7	5,2		22,2	1,11	77,62%		40	0	23			63	3,15	6,70%
13	10	3				13	0,65	45,45%		40	7	0			47	2,35	5,00%
14	10		7			17	0,85	59,44%		40	0	23		6	69	3,45	7,34%
15	10	3				13	0,65	45,45%		40	7	0			47	2,35	5,00%
16	10		7			17	0,85	59,44%		40	0	23		6	69	3,45	7,34%
				average		16,31	0,82	57,01%					average		56,69	2,83	6,03%

To keep a symetry for simulation , is it possible to consider an average repartition in each of the 16 ways alongside the HCAL face? (From Inner radius of Ecal to outer radius Hcal)

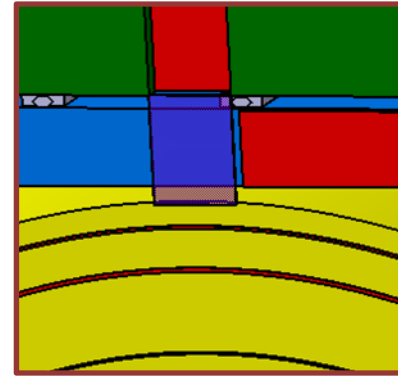
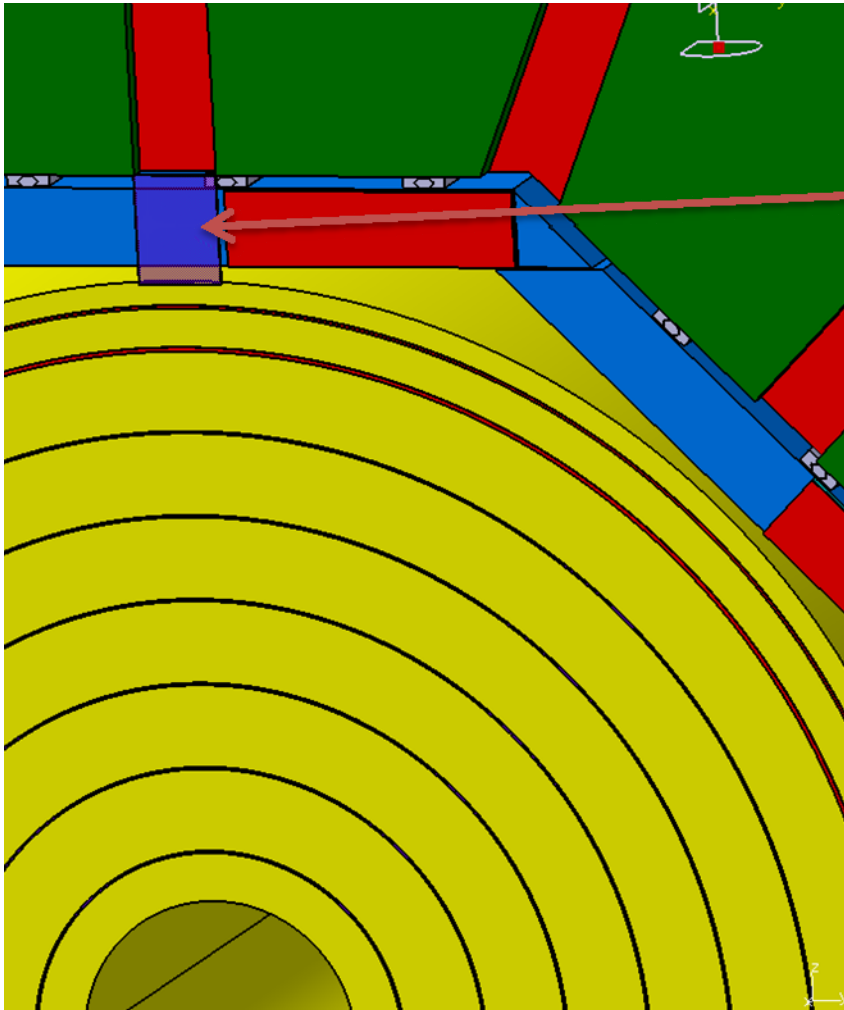


For simulation, same for Ecal?  
Coverage of half of the surface of each supermodule edge  
Here, only 8 ways-in for ECAL



Reminder : this is for Z- face : in Z+ numbers are minorized By 2/3 for ECAL

TPC for simulation : average on 8 way-out

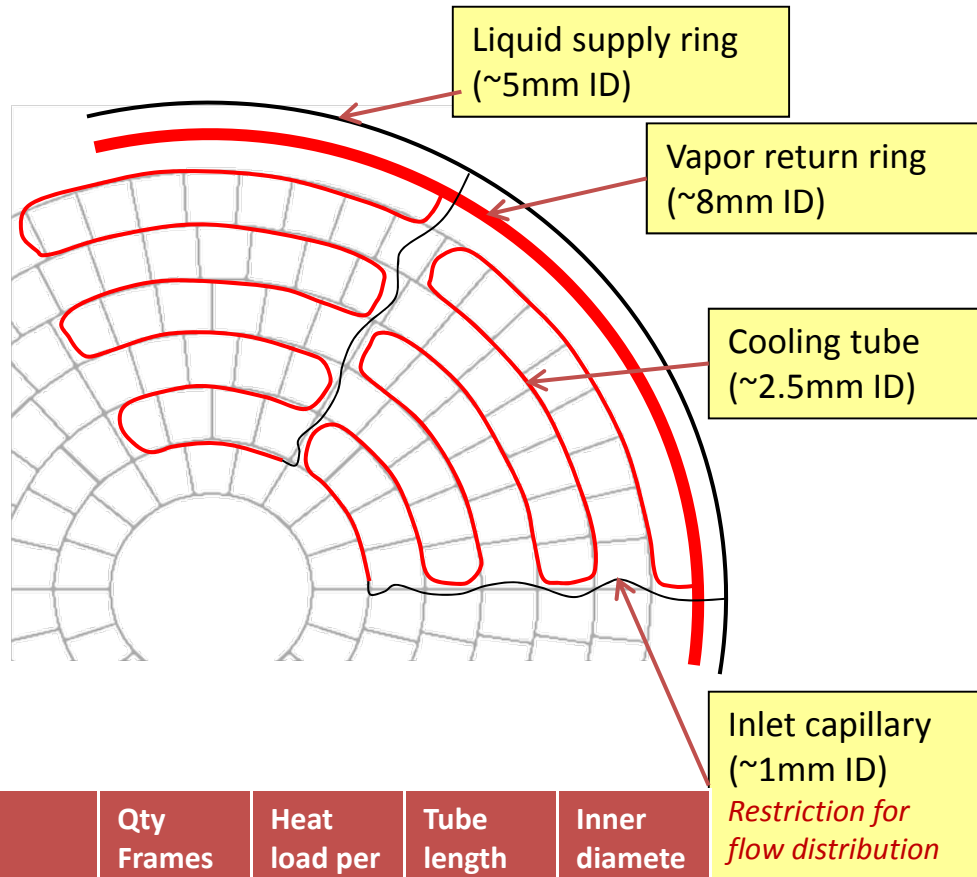


Equivalent thick. per 8 ways-out :

- Cu : 1.5 mm X 200 mm
- PE : 3.5 mm X 200 mm

# CO<sub>2</sub> cooling of an endplate with Timepix readout

Bart Verlaat, Nikhef, LCTPC collaboration meeting, September 2009

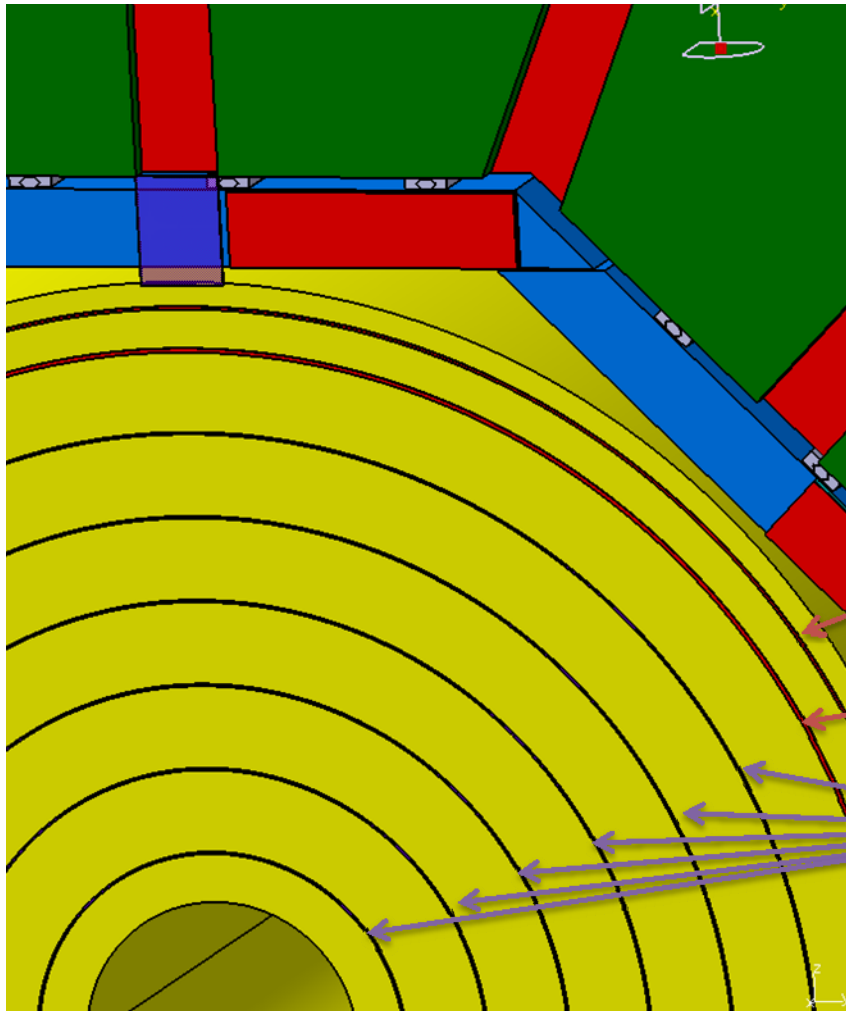


May be represented in simulation by rings of equivalent thickness in copper ?

	width of ring ( mm )	thickness of Cu ( mm )	X0%
Liquid supply	7	2,7	18,88%
vapor return	10	2,8	19,58%
Cooling tube	4	1,9	13,29%

Or by a average on all the surface of the endplates?  
0.62% X0

	Qty Frames / loop	Heat load per loop (W)	Tube length (m)	Inner diameter r (mm)
1 loop	200	1000	48m	6.2
2 loops	100	500	24m	4.3
4 loops	50	250	12m	3
6 loops	34	171	8m	2.2



rings of equivalent thickness in copper ?

Liquid supply ring  $7 \times 2.7 \text{ mm}^2$

Vapor return ring  $10 \times 2.8 \text{ mm}^2$

6 Cooling tubes  $4 \times 1.9 \text{ mm}^2$

## X<sub>0</sub> Thicknesses (slide from mtg103)

Sum of these plus S-Altros  
~ 5 % X<sub>0</sub>

Dan estimated at last meeting  
the space-frame thickness  
~ 8 % X<sub>0</sub> for the LP size. We  
don't know yet how this  
translates to the LCTPC size.

Cooling (my guess, needs  
confirmation)  
~ 2% X<sub>0</sub>

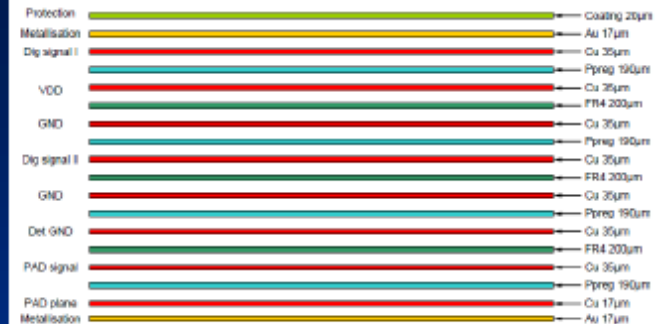
On PCB Board

Cable layout --- work in  
progress --- but it looks like the  
above X<sub>0</sub> may be doubled.

Don Settles MPI-Munich  
LCTPC integration model

06/05/2010

## LAYER STACKUP



Antoine JUNIQUE

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### Comparison of candidate models

	mass kg	material %X <sub>0</sub>	deflection microns	stress Mpa (yield:
241)				
LP1	18.87	16.9	33	1.5
Lightened (all aluminum)	8.93	8.0	68	3.2
Lightened (Al-C hybrid) C 1.3	7.35	7.2	< 168*	< 4.8*
Space-Frame	8.38	7.5	23	4.2

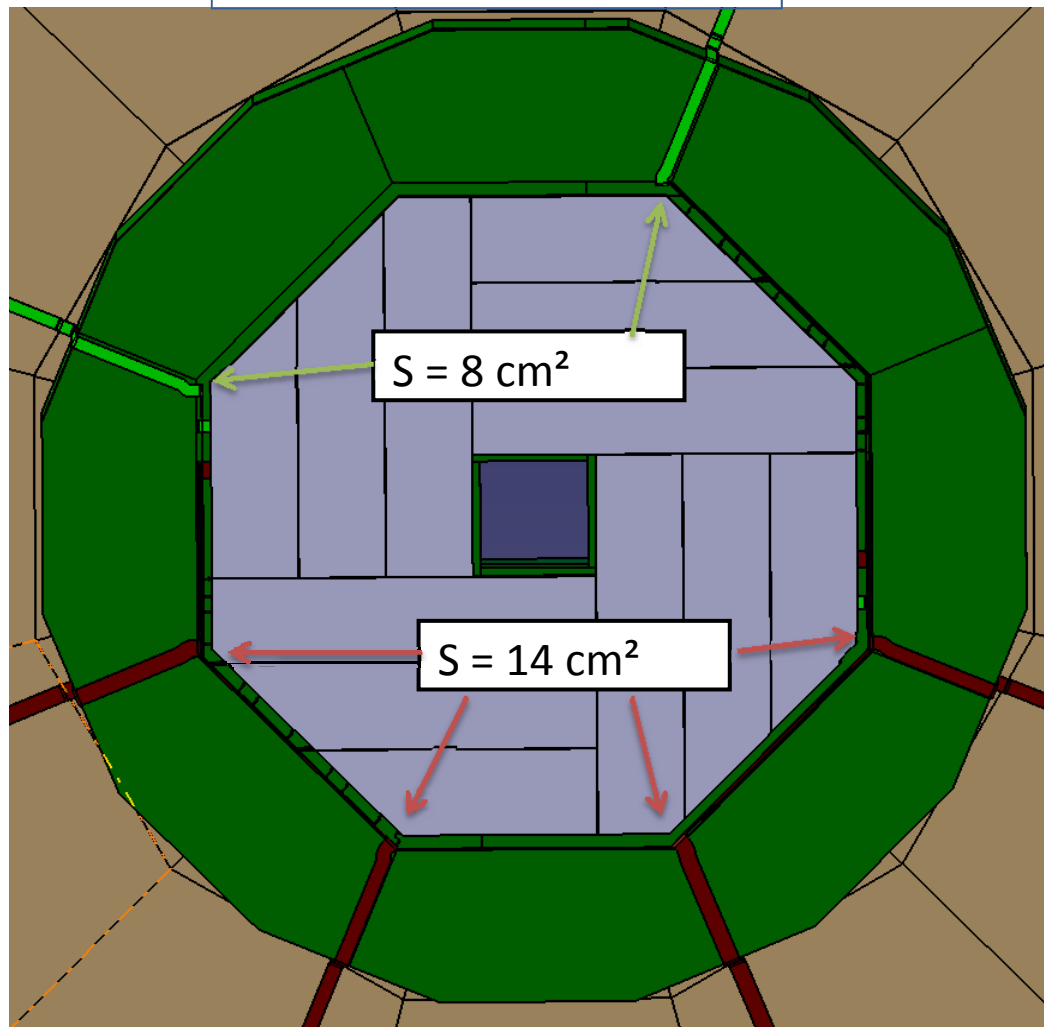
Material: space-frame has slightly more material than the Al-C hybrid.

Deflection: space frame is more rigid than LP1,  
~3x more rigid than the lightened (all Aluminum),  
and > 3x more rigid than the Al-C hybrid.

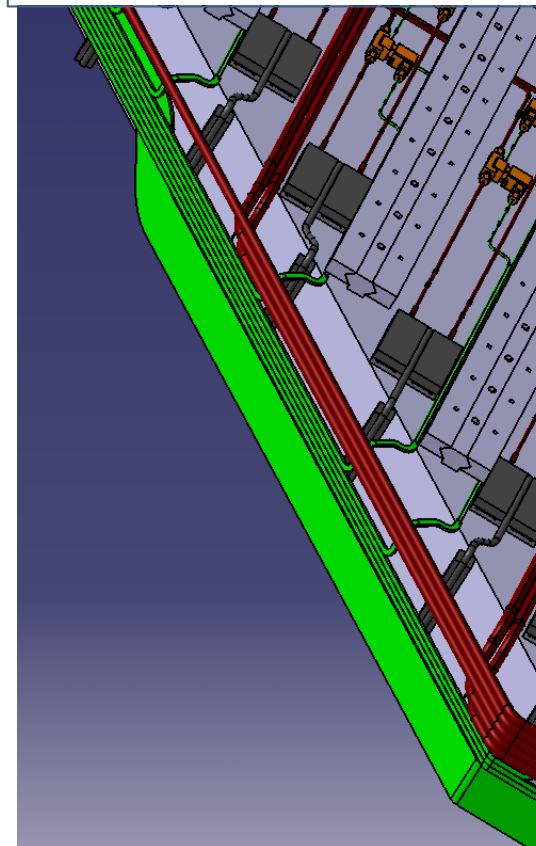
Work in progress in LCTPC

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front view :  
gap endcap/barrel



Back view :  
gap Ecal/Hcal endcap



**Warning** : on those drawings , the ways-out are just opposite to those of Barrel .  
***Have to be reconsidered***



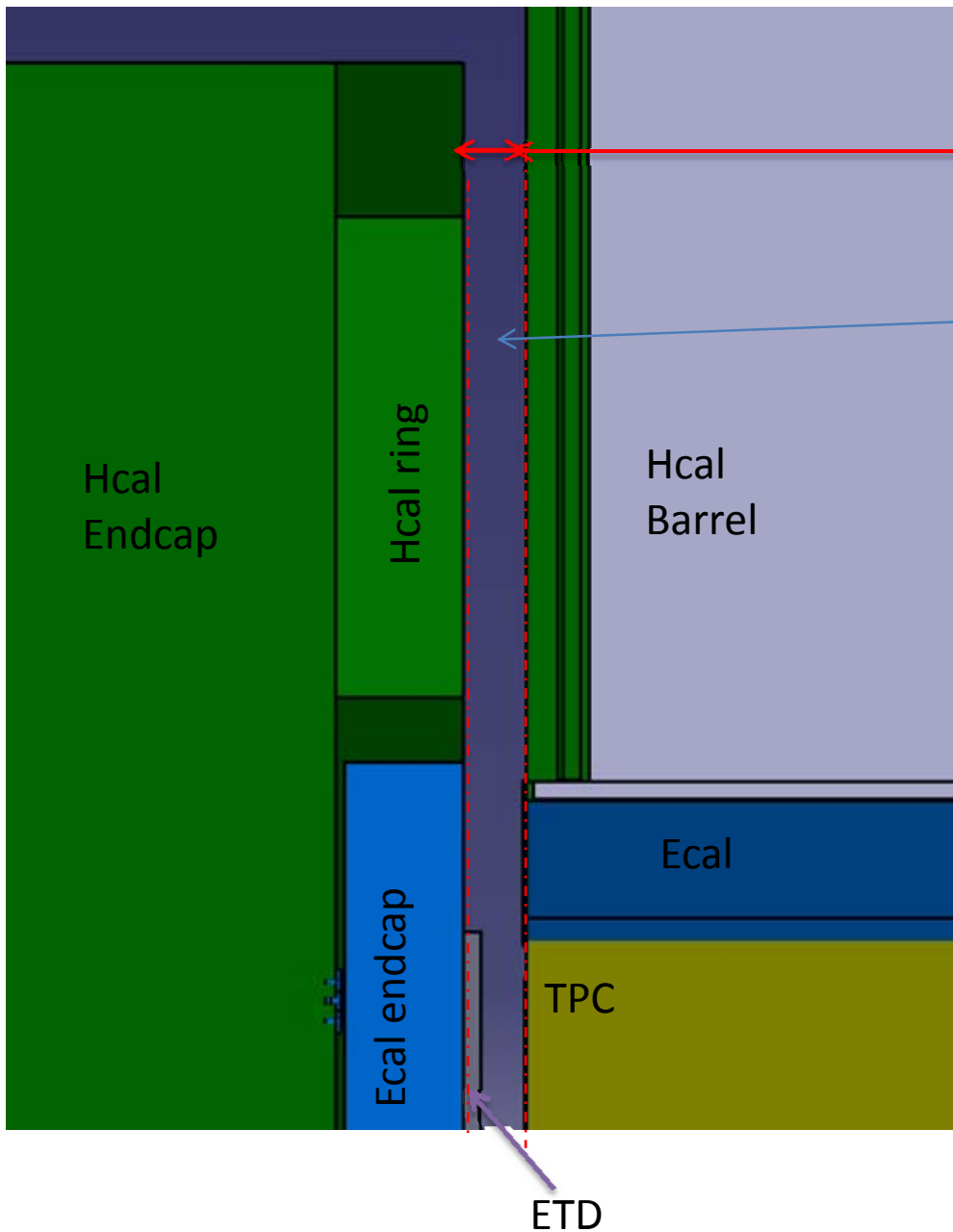
*Cables and services from the endcaps in the gap  
Barrel/endcaps:*

**Ecal :**

- Cooling = 56 cm<sup>2</sup> ( minimal thickness 1.5 cm)
- Air = 16 cm<sup>2</sup>
- Cables (?)= 15Mch  $\approx$  53 cm<sup>2</sup>

**ETD :** not yet considered.

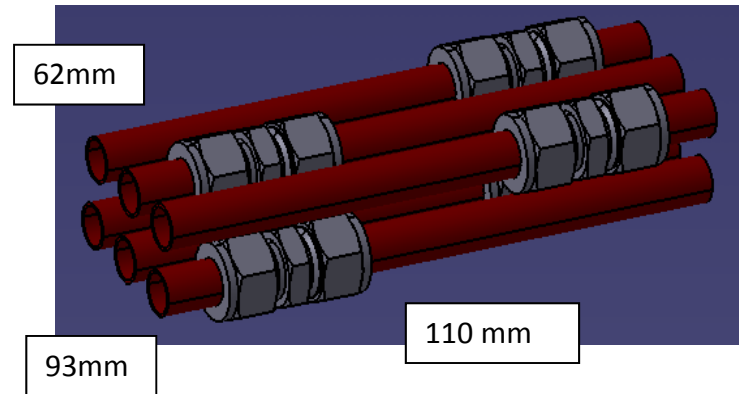
To be distributed on all the circumference except in front of the 16 ways reserved to barrel : 810 cm; seems far enough !



Gap of 10 cm

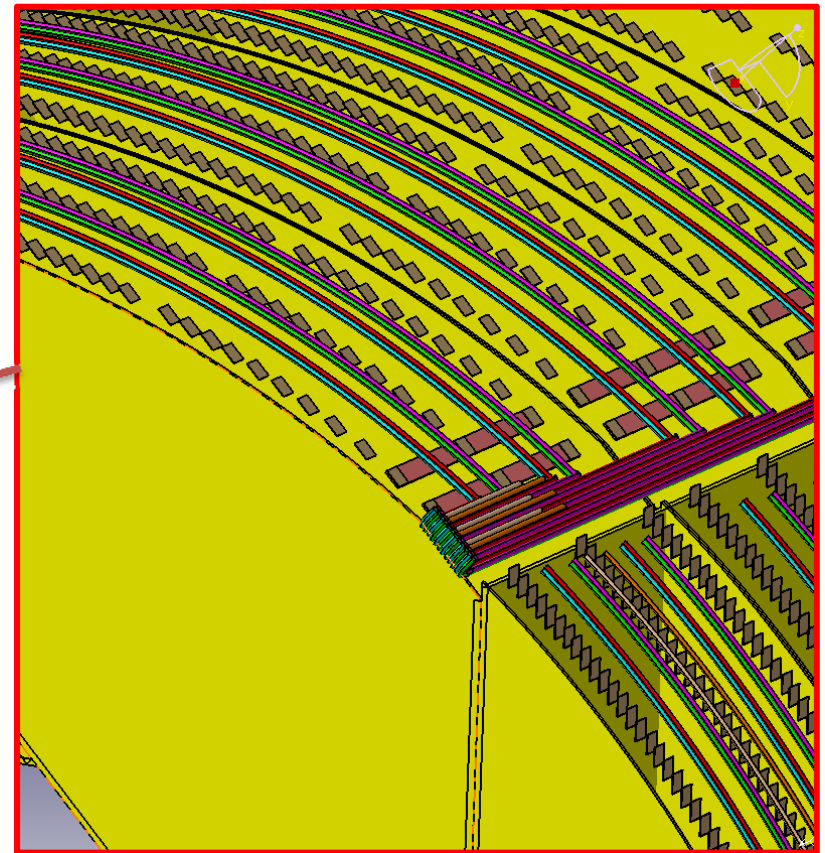
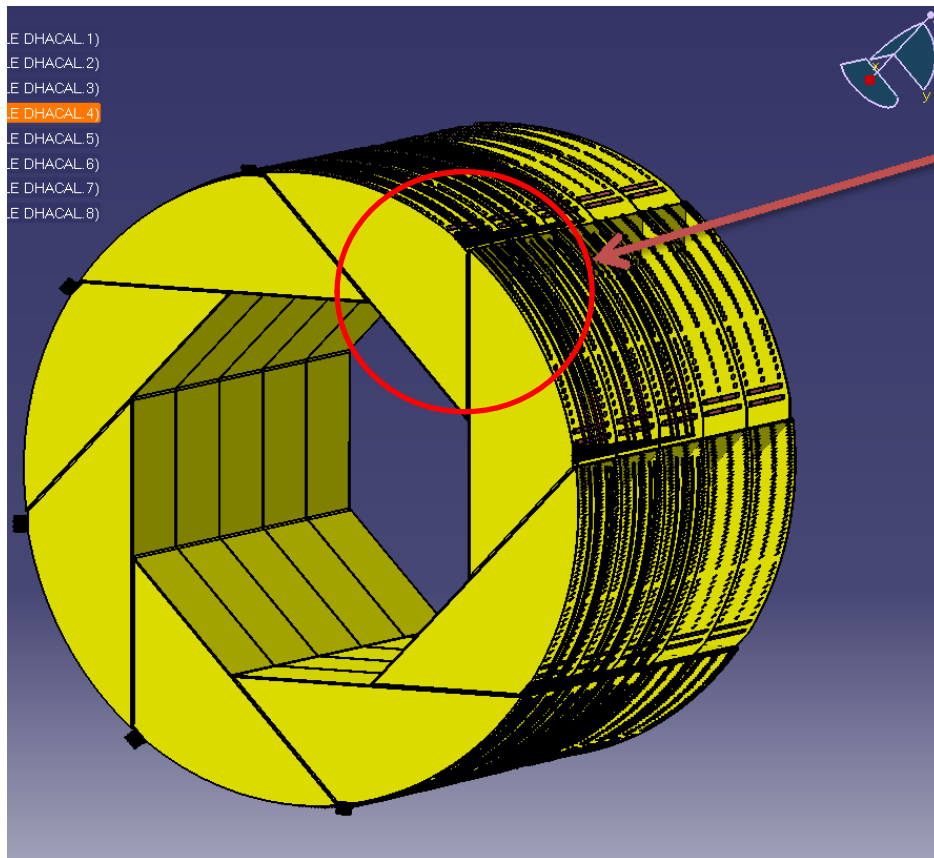
Electronic board of AHCAL : x cm

Way N°6: 72cm<sup>2</sup> for Ecal .  
Overlaps have to be checked as  
room for connections .



ETD structure : 4 cm thick.

From J.C.Ianigro, IPNL



Services and cables in the gap between Hcal & coil cryostat

• **Gap Barrel/Endcap :**

- ✓ No services : save 50 cm<sup>2</sup> X16 ( Cables AHCAL)
  
- ✓ The other services ECAL&TPC may be distributed other 360 °
  - ⇒ Possible reduction of the gap thickness  
(but still limited by patchpanels Ecal)
  
- ✓ Thickness of the structural wall of the outer modules ( 15 mm of stainless steel ? (i.e. 0.85 X0 )

• **Gap DHCal/ Coil cryostat :** actually is 35 mm

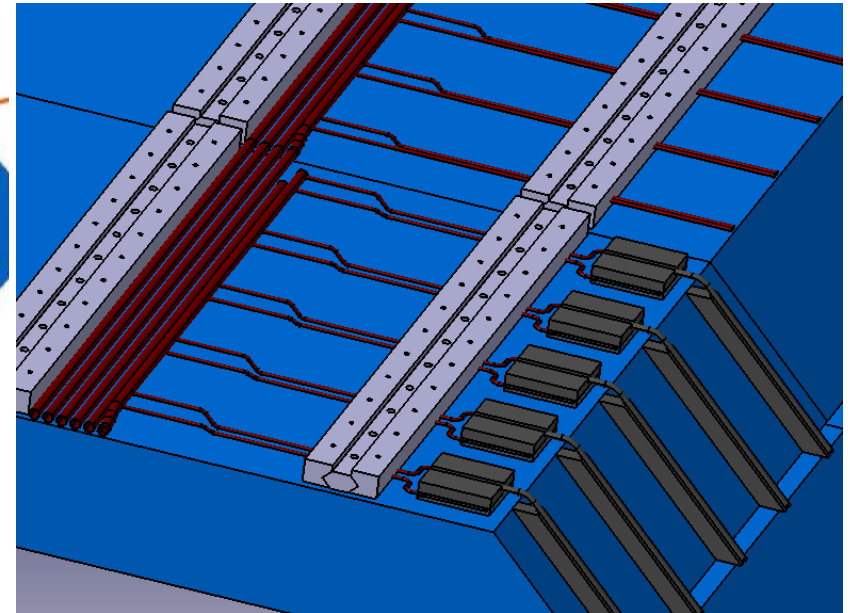
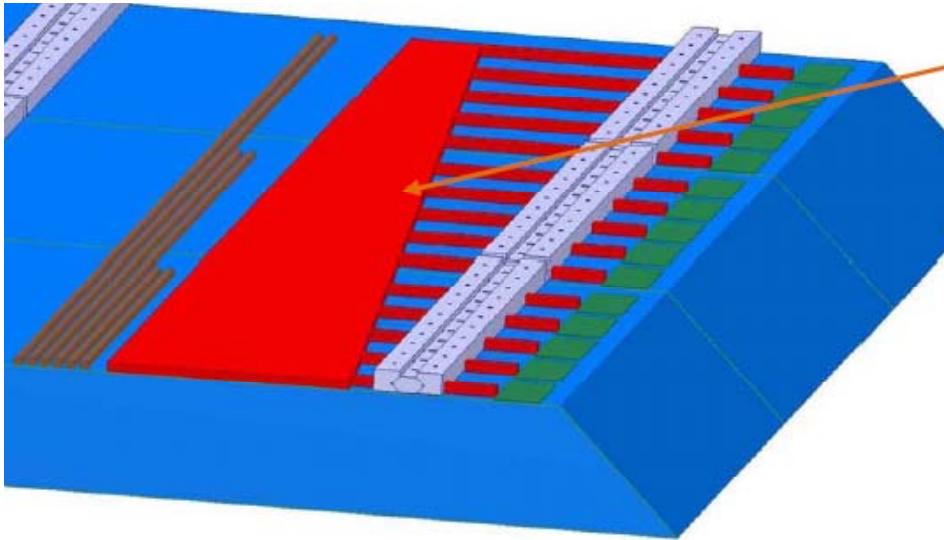
- ⇒ Certainly not enough for electronic Boards, services/cables  
Need to be checked

## For October's meeting :

✓ Update the CAD drawings with more detailed placeholders

✓ Ecal :

- Choice of the Ecal cooling solution ?
- Average material for simulation in the gap Ecal/Hcal Barrels



Cabling 30cm<sup>2</sup>+Elec.  
Boards

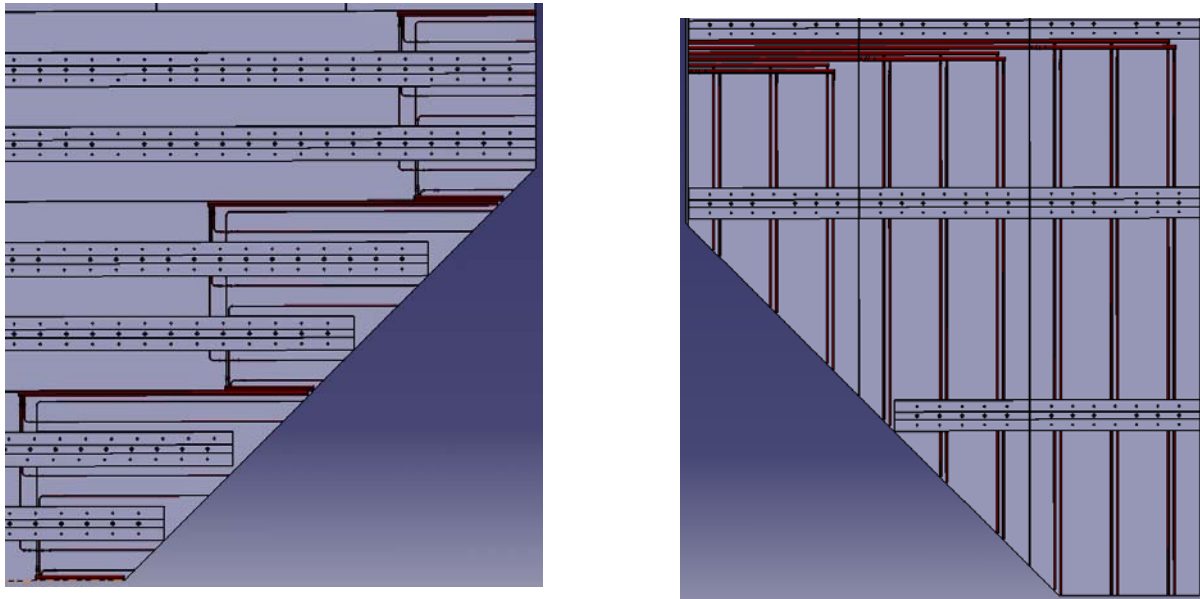


Cooling: pipes 14 cm<sup>2</sup> and heat  
exchanger

Rails

## For October's meeting :

- ✓ Update the CAD drawings with more detailed placeholders
- ✓ Ecal :
  - Choice of the Ecal cooling solution ?
  - Average material for simulation in the gap Ecal/Hcal Barrels
  - Material in the gap Ecal/Hcal endcap



Back view of Endcap solution 2 : 30 mm missing in the gap

## For October's meeting :

- ✓ Update the CAD drawings with more detailed placeholders
- ✓ Ecal :
  - Choice of the Ecal cooling solution ?
  - Average material for simulation in the gap Ecal/Hcal Barrels
  - Material in the gap Ecal/Hcal endcap
- ✓ AHcal :
  - Front end board dimensions and its X0%?
- ✓ DHcal:
  - Second CAD model
  - Work on gap Barrel/Coil cryostat
- ✓ Inner region :
  - beginning the same work if enough inputs

*(see M.Jore's talk )*