TPC Parameters for ILD Integration and the DBD

Status 20 May 2010

Integration: hardware model iteration # 3

--Iteration # 1 at wpmtg103 on 20100422 was only looking at the effect of the electronics (cables and pipes), using Antoine's ROB as a basis (263mm x 282mm containing 16 x 16 S-Altros).

--Iteration # 2 wpmtg104 on 20100506:

--a) The 'TPC envelope' required by the MDI group must be included in the thinking.

--b) Email exchange with Dan; we concluded that it is better if the basic unit is smaller in size and number of channels.

--Interation #3; the 'final' proposal.

« MDI parameters»

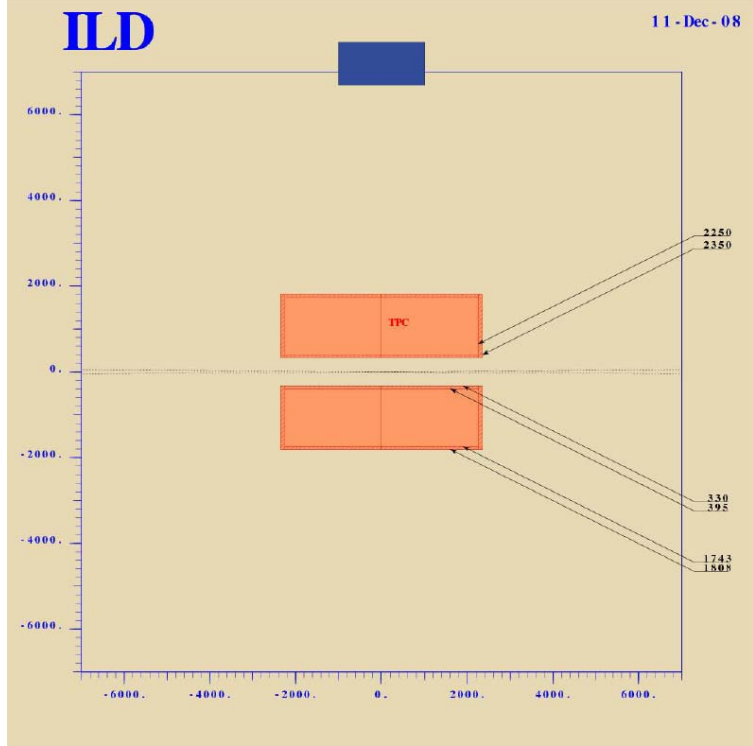
Point a), reminder ➔

here is the 'TPC envelope' as set up by the MDI-integration group for the LOI

TPC envelope
R_o = 1808 mm
R_i = 330 mm
L/2 = 2350 mm

TPC sensitive volume/area
R_o = 1743 mm
R_i = 395 mm
L/2 = 2250 mm
Volume = 40.7 cubic meters
Area/endcap= 9054145mm^2

Space for the inner FC = 65mm
Space for the outer FC = 65mm
Space for the endcap = 100mm
('Space' is provisional and to be filled by us, of course)



DETECTOR OPTIMISATION

Slightly varying versions before the LOI

Model Name		GLD	GLD′	GLD4LDC	LDC4GLD	LDC′	LDC	ILD
Simulation								Mokka
B field (T)		3.0	3.5	4.0	3.0	3.5	4.0	3.5
Beampipe r_{min}		15.5	14.0	13.0	15.5	14.0	13.0	14.5
Vertex Geometry				cylindrical		ladders		ladders
				3 double layers		5		3 double layers
	R_{min}	17.5	16.0	15.0	16.5	15.0	14.0	16.0
Barrel	Layers			4 cylinders			2 cylinders	
SIT	Radii			90, 160, 230, 300		161.4, 270.1		160, 300
TPC	R_{min}	437	435	371		371		395
drift	R_{max}	1978	1740	1520	1931	1733	1511	1739
region	z_{max}	2600	2350	2160	2498	2248	2186	2247.5
TPC pad rows		256	217	196	260	227	190	224
ECAL	R_{min}	2100	1850	1600	2020	1825	1610	1847.4
barrel	Layers			33		20(thin)+9(thick)		20+9
	Total X_0			28.4		22.9		23.6
ECAL endcap z_{min}		2800	2250	2100	2700	2300	2550	2450
HCAL	Layers	46	42	37		48		48
barrel	R_{max}	3617	3260	2857	3554	3359	3144	3330
λ_I (ECAL+HCAL)		6.79	6.29	5.67		6.86		6.86

TABLE 2.1-1
Geometrical parameters of the baseline detector models used for the optimisation studies (GLD, GLDPrime, GLD4LDC, LDC4GLD, LDCPrime and LDC). Also shown are the corresponding parameters for the ILD baseline detector. Unless otherwise specified, values are shown in units of mm.

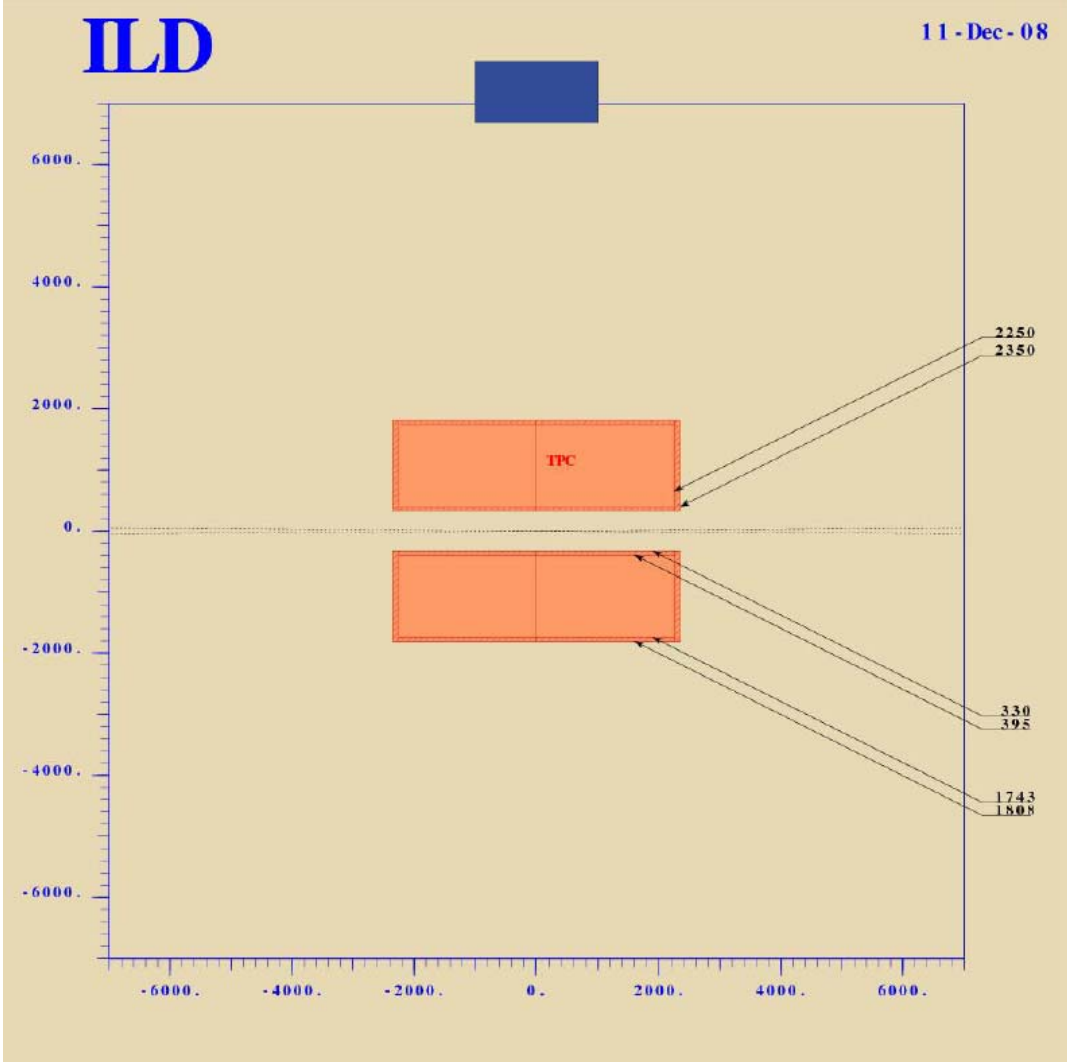
« MDI parameters»

Conclusion point a):

TPC sensitive area
R_o = 1743 mm
R_i = 395 mm

Area/endcap to be instrumented with MPGDs = 9054145mm^2

= 1998848 4mmx1mmpads/endcap



« MDI parameters»

Point b):

Readjust the sizes from interation #1 based on the TPC envelope for Catherine Clerc.

Reminder: we propose to define one "generic" TPC (not two) for MPGD (i.e., neither µgas- nor gem-specific).

	[TPC interface parameters]	Ref	ILD-000-xxxx
		Issue	
		Date	20/01/2010
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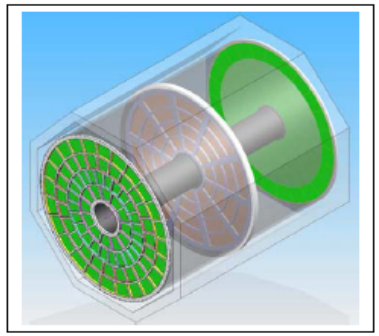


1. *Technological description*

Each endplate ≈ 10 m²
Pads :
- ✓ µmégas 7*3mm² i.e. 0.55Mch/endplate
- ✓ Gems : 1*5mm² i.e. 2.3 Mch/endplate

2. *Overall dimensions*

400 KG/endplate, ≈ 2t full TPC

3. *Support*

3 tie rods from each endplate face to HCal barrel

4. *Services*

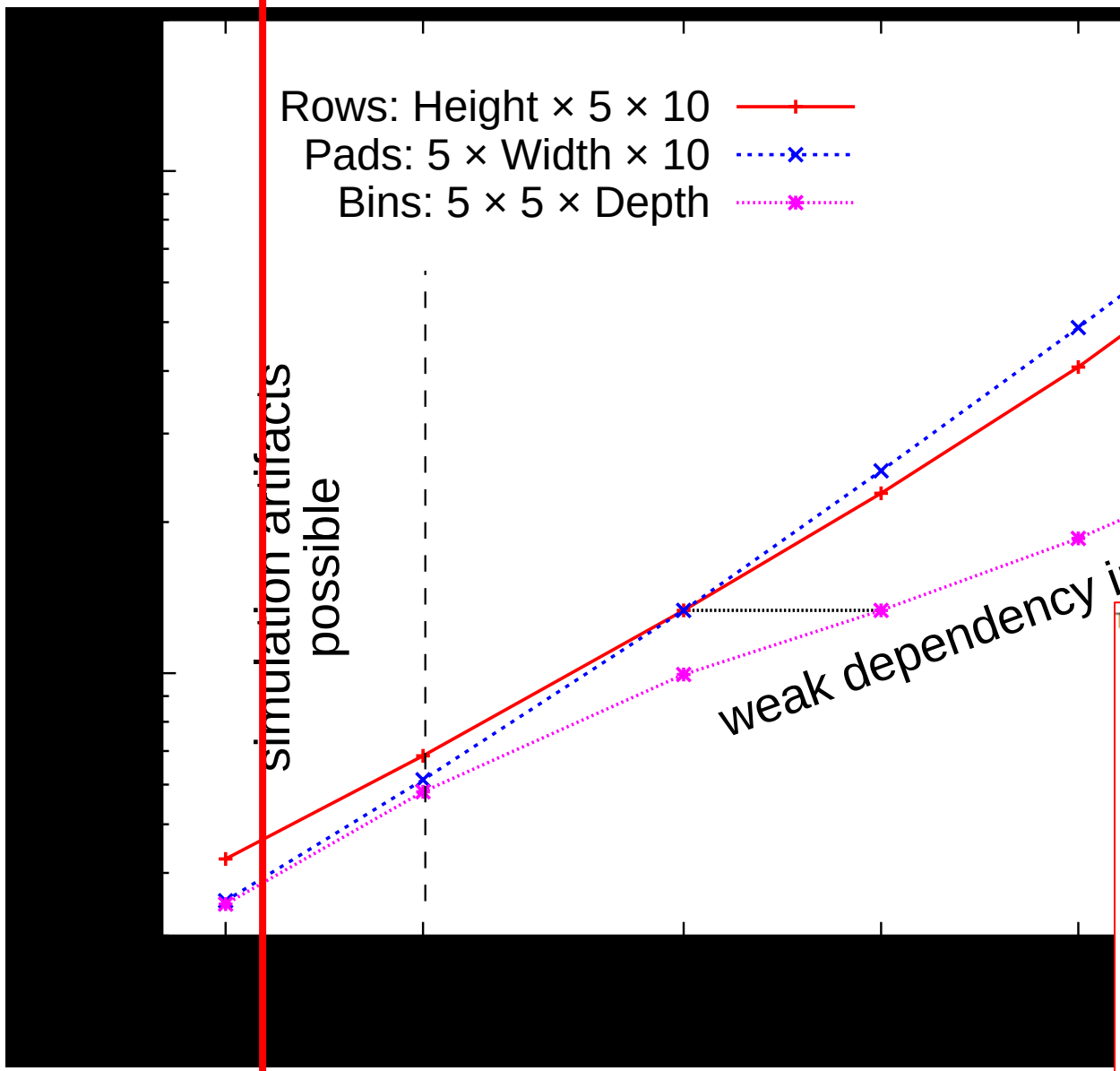
Cabling (µmégas)
- 80 modules each side.
- For each module (6800 channels) :
- 1 HV cable
- 1 double optical fibre
- 1 low-voltage 32A cable

Each side : 80 HV+80 Double Fibres+80 LV(32A) = 240 cables

Cooling :

160 W to remove (becomes negligeable is power pulsing can be fully implemented.)
But to be checked
With power pulsing 0.5mW per channel

Adrian's simulation: bottom line ⇒ want small pads



Width=1.27mm, Height=5mm, Occupancy=0.02% for γ's, e's, n's and 100BX: 0.02%Occ ≈ 0.02fC/cm^3 vol.chg!

THE ILD SUB-DETECTOR SYSTEMS from the LOI

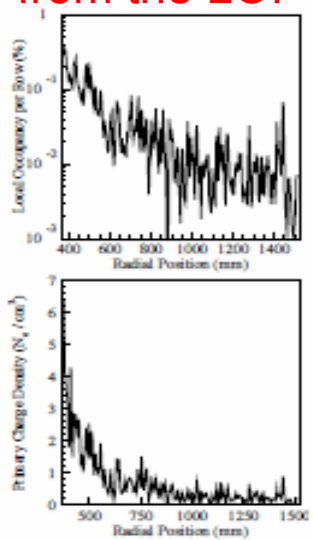
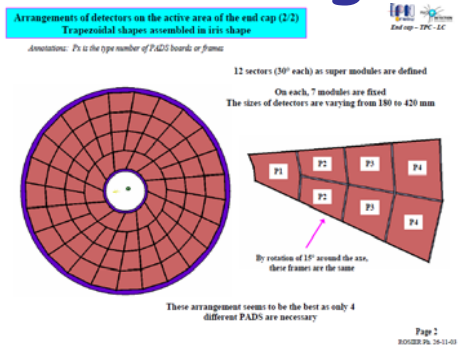
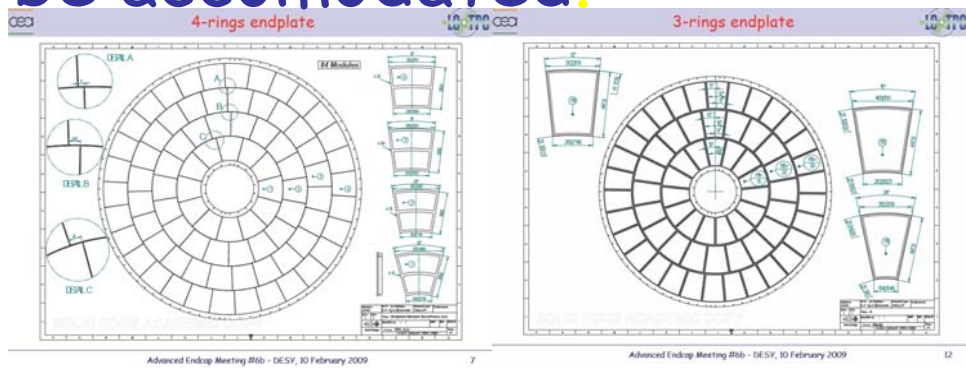


FIGURE 4.3-4. Occupancy for xyz = 1 × 5 × 5

"Generic" again means don't worry about sector/module shapes here. Suggestions will be made as to subdivide our readout units so that whatever shapes we decide on might be accomodated.

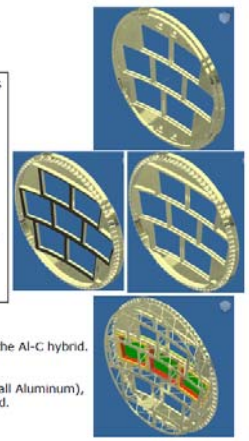




Also the shapes we decide on will depend on the outcome of Dan's studies

Comparison of candidate models

	mass kg	material $\%X_0$	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)	Al 7.35 C 1.29	7.2	< 168* (* values for the aluminum only)	< 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.

Electronics: both micromegas and gem have agreed to use S-Altro

Since the word 'module' has been used for different things, a 3rd notation is proposed here (sorry) to again increase the confusion:

Smodule	16 S-Altro	1024 pads
ROBn	N x Smodule	N x 1024 pads
ROB1	Smodule	1024 pads
ROB2	2 x Smodule	2048 pads
ROB4	4 x Smodule	4096 pads
ROB8	8 x Smodule	≈ LP 'module'
ROB16	16 x Smodule	Antoine's ROB

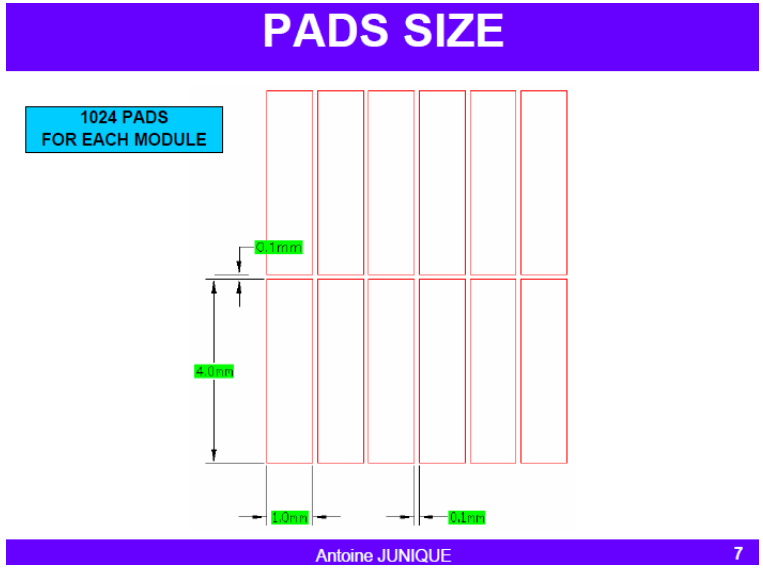
Smodule – smallest unit

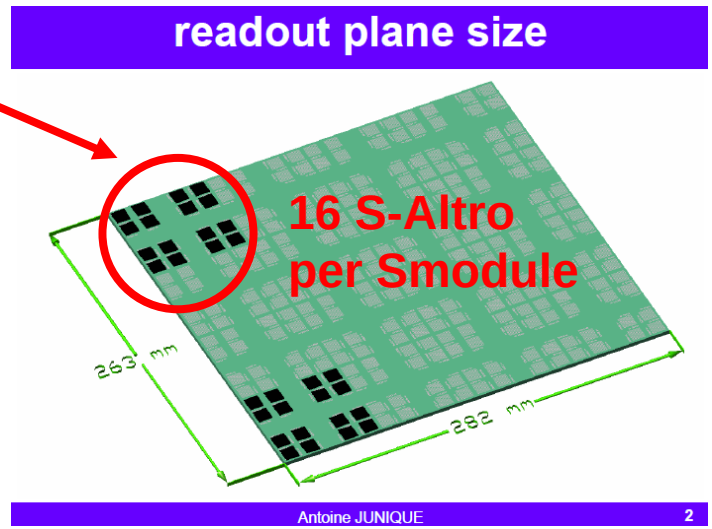
--pad pitch: 4.1 x 1.1mm^2

--16 S-Altro/Smodule

--1024 pads/Smodule

⇒ 4635.4 mm^2/Smodule

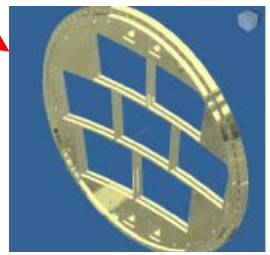




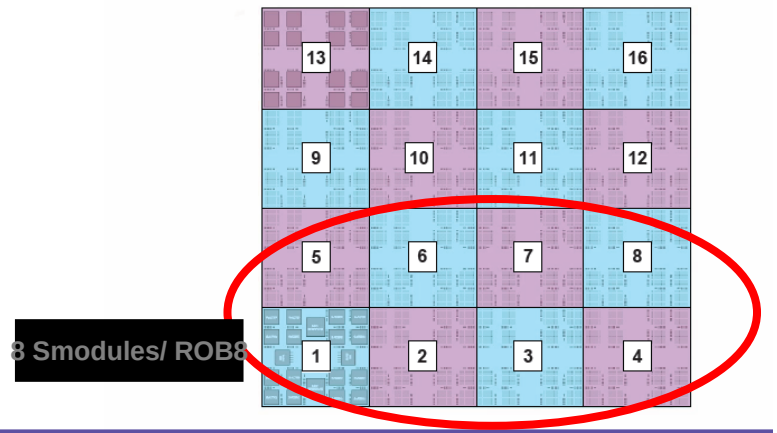
--ROB8 size:

½ 263 x 282mm^2 ≈

Dan's LP1 "ROB" size



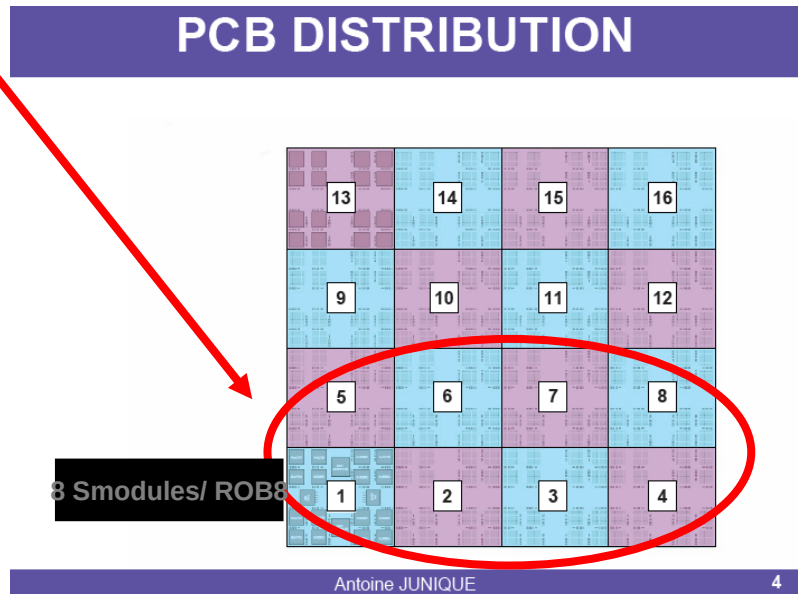
PCB DISTRIBUTION



Sizes

--8 Smodule per ROB8
= 8192 pads/ROB8
⇒ 37083.0 mm^2/ROB8

-- As just said, this is about the size of Dan's LP "module" and we decided at the last WP#104 meeting to use this size (since we are gainig experience with it now) as a basis for the present lctpc design.



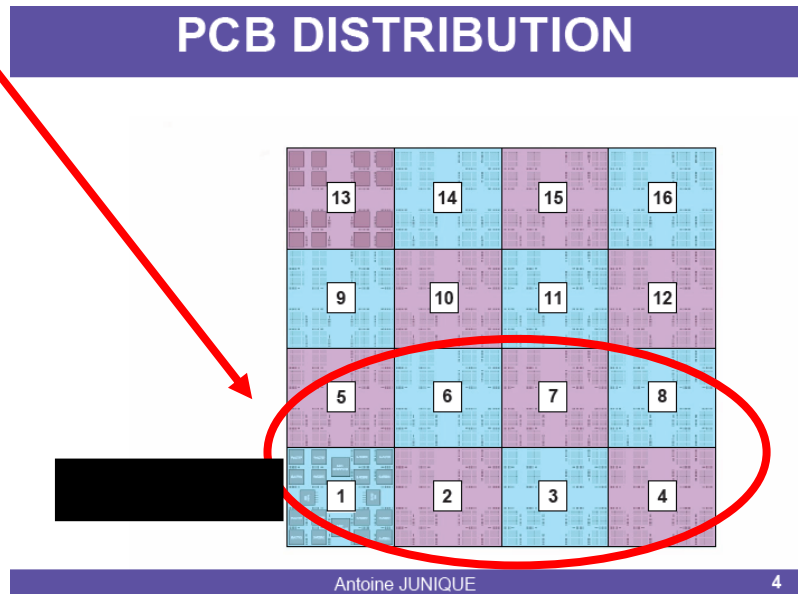
8 Smodule per ROB-8

Exercise to design the endcap using ROB8…

--8 Smodule per ROB8
= 8192 pads/ROB8
⇒ 37083 mm^2/ROB8

--R_endcap ~ 395mm to 17143mm
⇒ 9054145 mm^2/endcap

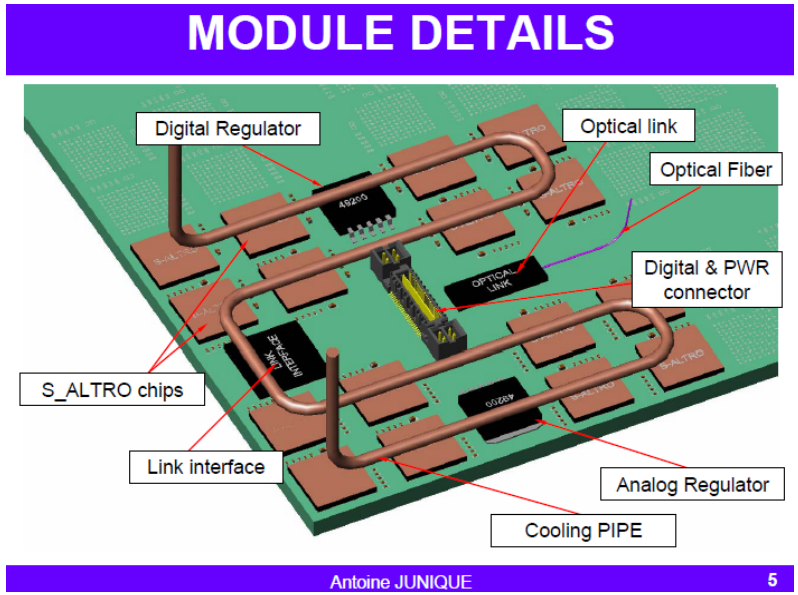
⇒ 244 ROB8/endcap



8 Smodule per ROB8

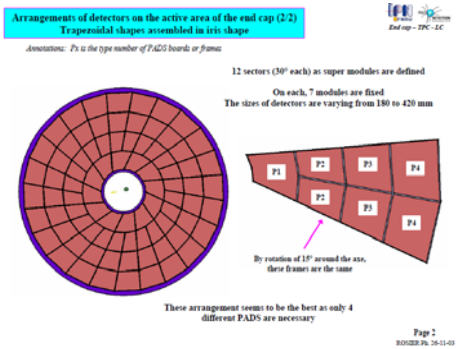
Channels

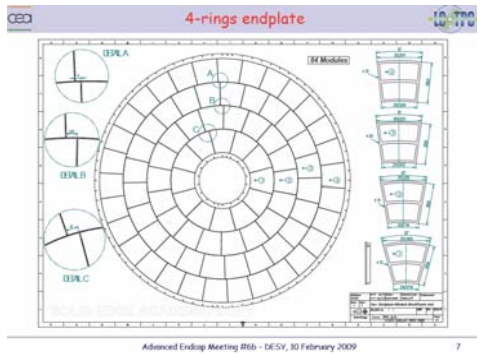
--64 pads/S-Altro
--16 S-Altro/Smodule
-- 8 Smodules/ROB8
⇒
--1024 pads/Smodule
--8192 pads/ROB8
--244 ROB8/endcap
--1998848 pads/endcap

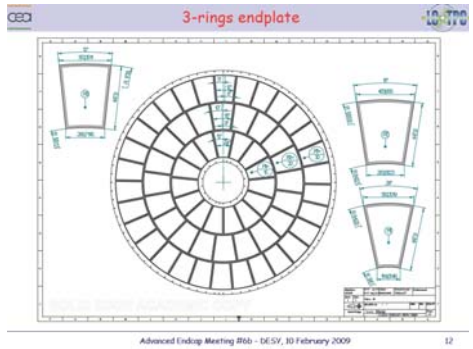


Of course, different ROBn can be used across the endcap, depending on the shapes of the different ROBs, but our starting point should be ROB8…

This is a job for the experts…







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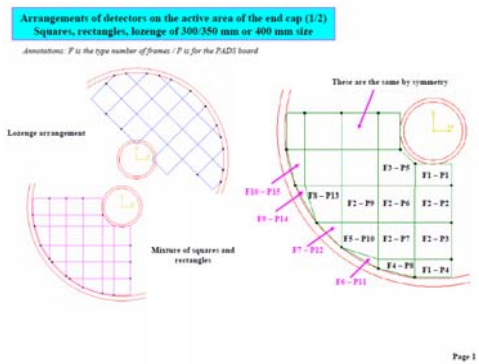

LCTPC milestones

2006-2012	Continue LCTPC R&D via small-prototypes and LP tests
2012	DBD
2013	Decide on all parameters
2014	Final design of the LCTPC
2018	Four years construction
2019-20	Commission/Install TPC in the ILC Detector