TPC Parameters for ILD Integration and the DBD
Status 6 May 2010

Rocky mountains symbolizing "we've got a rocky road ahead before we get to the linear collider"…

Integration: hardware model iteration # 2

--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). There are two ways to improve, ergo this new iteration:

--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: a proposal follows.

« MDI parameters»

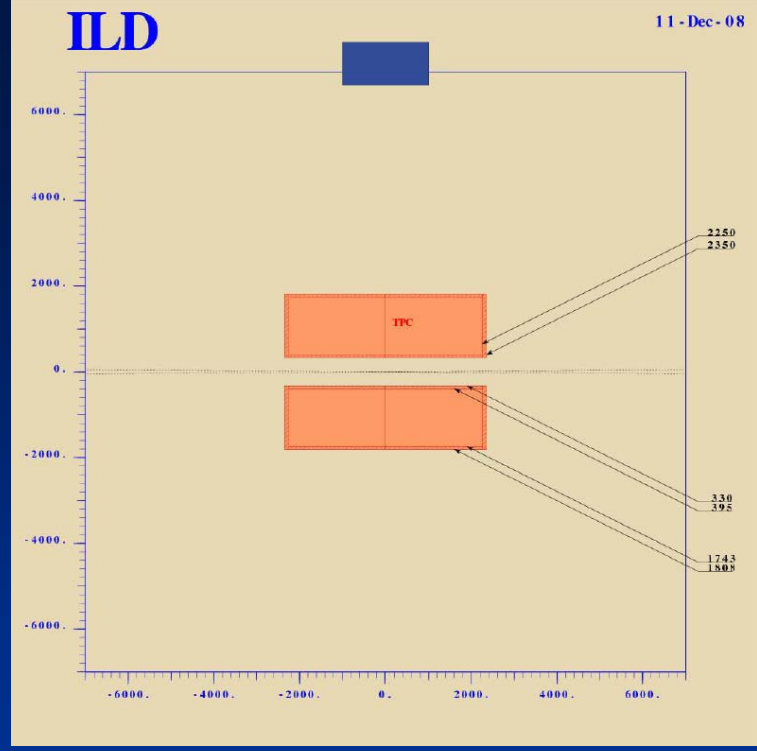
Starting with point a), ➔

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
Si Tracking								Sokka
B field (T)		3.0	3.5	4.0	3.0	3.5	4.0	3.5
Beampipe r_{min}		15.0	14.0	13.0	15.5	14.0	13.0	14.5
Vertex Geometry				cylindrical		ladders		ladders
	R_{min}	17.5	16.0	15.0	16.5	15.0	14.0	16.0
Barrel SET	Layers			4 cylinders			2 cylinders	2 cylinders
	Radii			90, 160, 230, 300			161.4, 270.1	160, 300
TPC drift region	R_{min}	437	435	371		371		395
	R_{max}	1978	1740	1520	1931	1733	1511	1739
	z_{max}	2600	2350	2160	2498	2248	2186	2247.5
TPC pad rows		256	217	196	260	227	190	224
ECAL barrel	R_{min}	2100	1850	1600	2020	1825	1610	1847
	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 barrel	Layers	46	42	37		48		48
	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.

Ron Settles MPI-Munich
LCTPC integration model

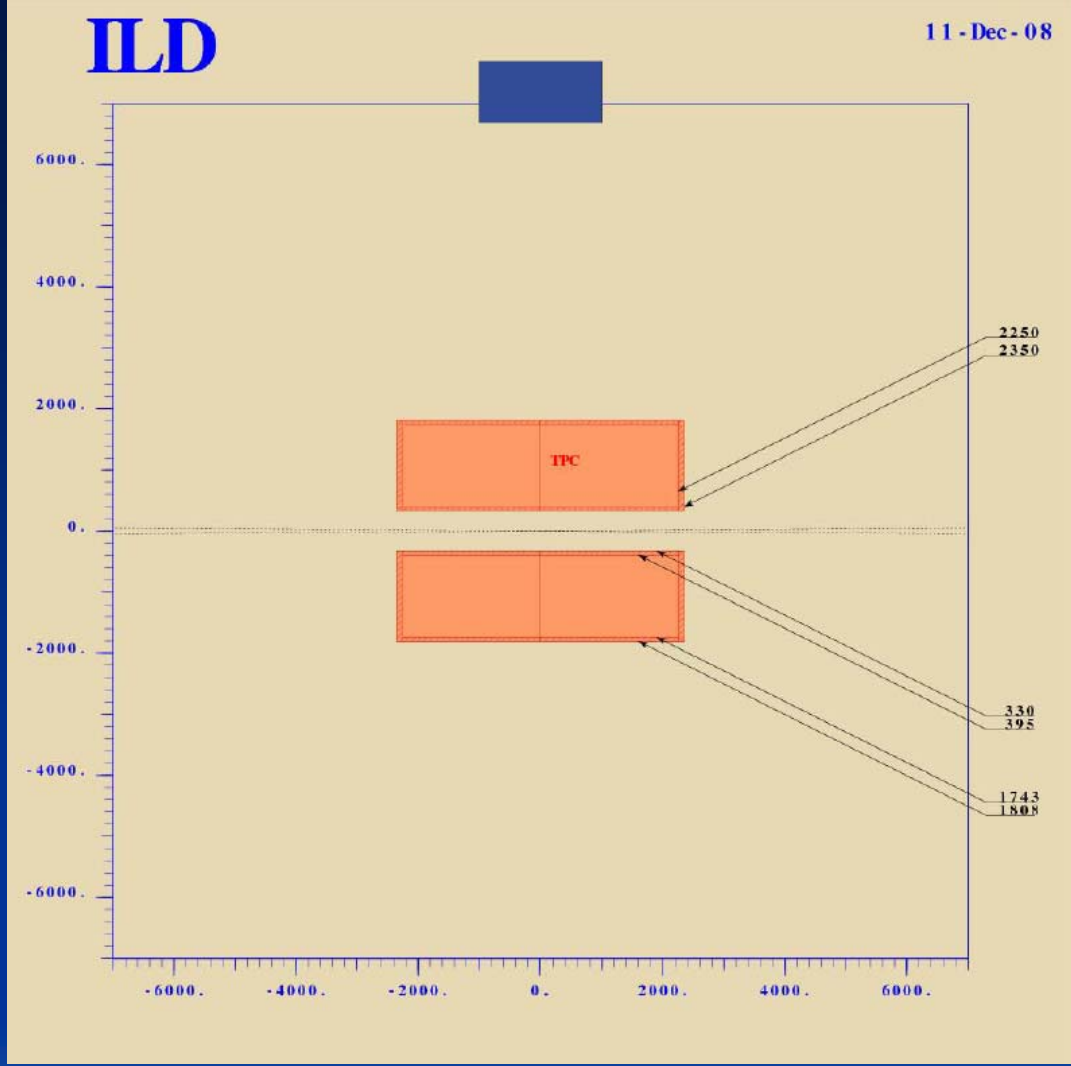
« MDI parameters»

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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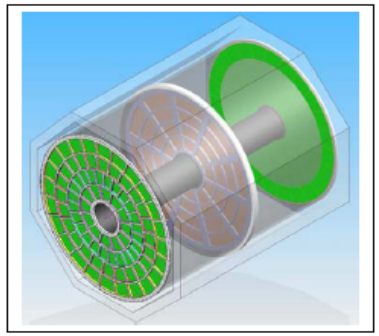
1. *Technological description*

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*

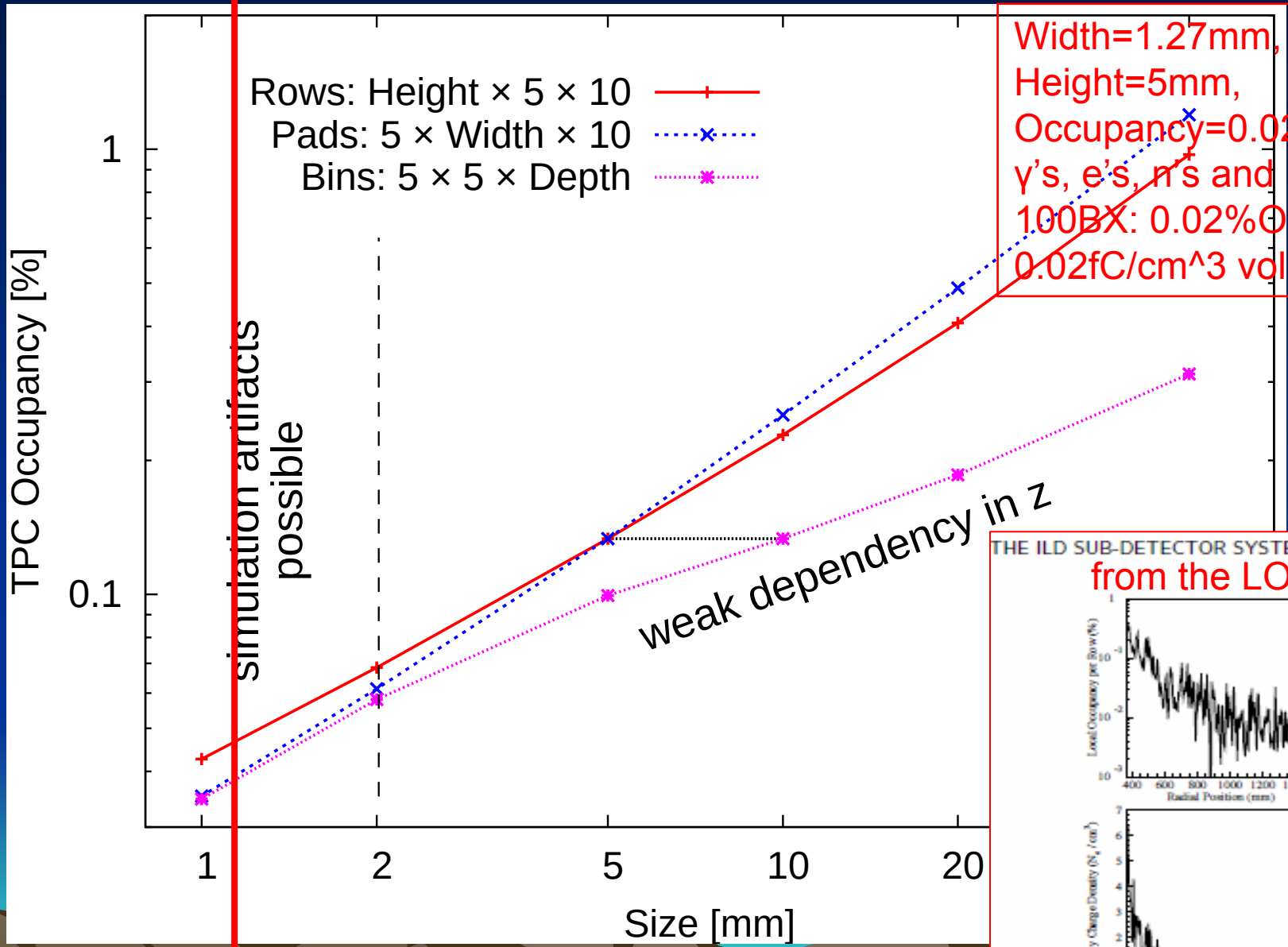
Cabling (µmégas)
- 80 modules each side.
- For each module (6800 channels) :
- 1 HV cable
- 1 double optical fibre
- 1 low-voltage 32A cable

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

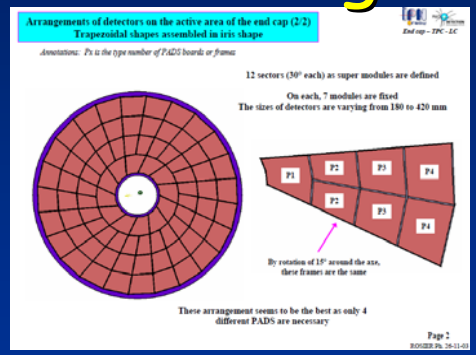


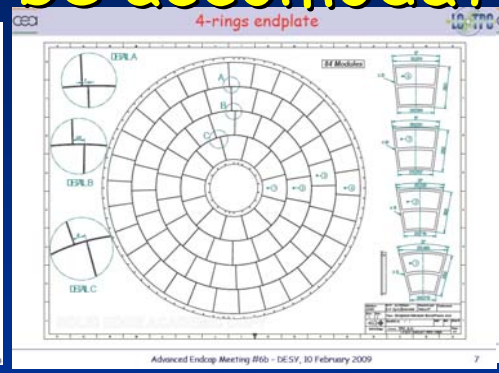
Width=1.27mm, Height=5mm, Occupancy=0.02% for γ's, e's, n's and 100BX: 0.02%Occ ≈ 0.02fC/cm^3 vol.chg!

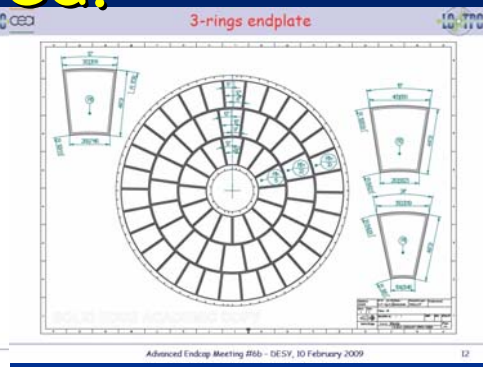
THE ILD SUB-DETECTOR SYSTEMS from the LOI

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

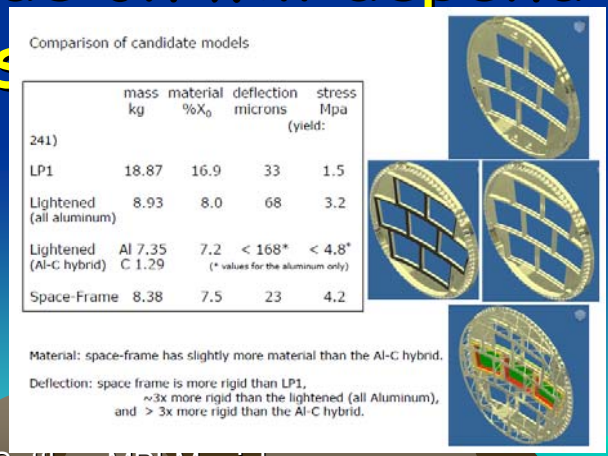
"Generic" again means don't worry about sector/module shapes here. Suggestions will be made as to subdivide our readout units so that whatever shapes we decide on might be accomodated.







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



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

Since the word 'module' has been used for different things, try new notation to reduce (or increase?) the confusion:

Smodule	16 S-Altro	1024 pads
ROB-n	2^n Smodule	2^n x 1024 pads
ROB-0	Smodule	
ROB-1	2 x Smodule	2048 pads
ROB-2	4 x Smodule	4096 pads
ROB-3	8 x Smodule	≈ LP 'module'
ROB-4	16 x Smodule	Antoine's ROB

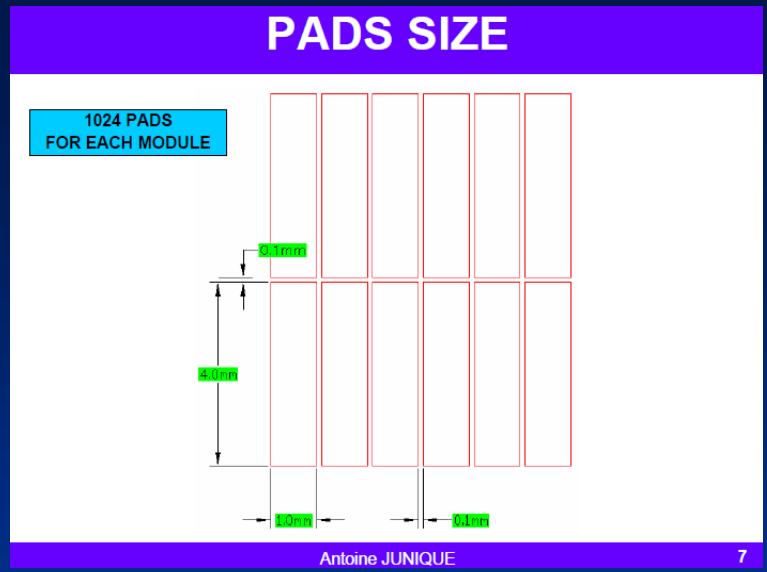
Smodule – smallest unit

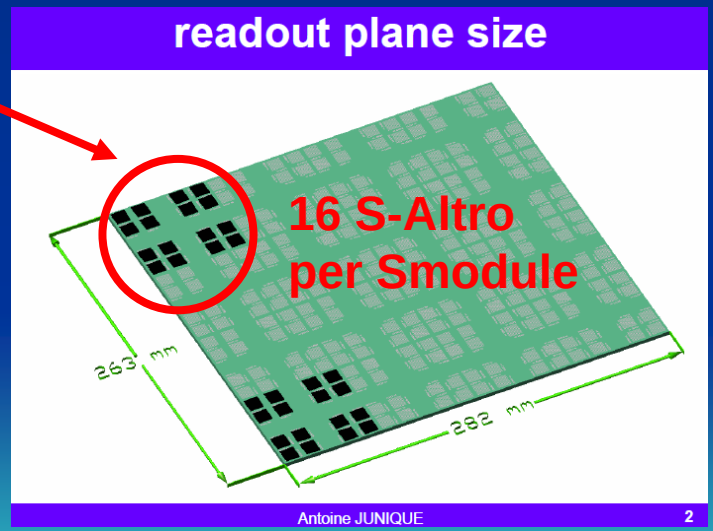
--pad pitch: 4.1 x 1.1mm^2

--16 S-Altro/Smodule

--1024 pads/Smodule

⇒ 4635.4 mm^2/Smodule



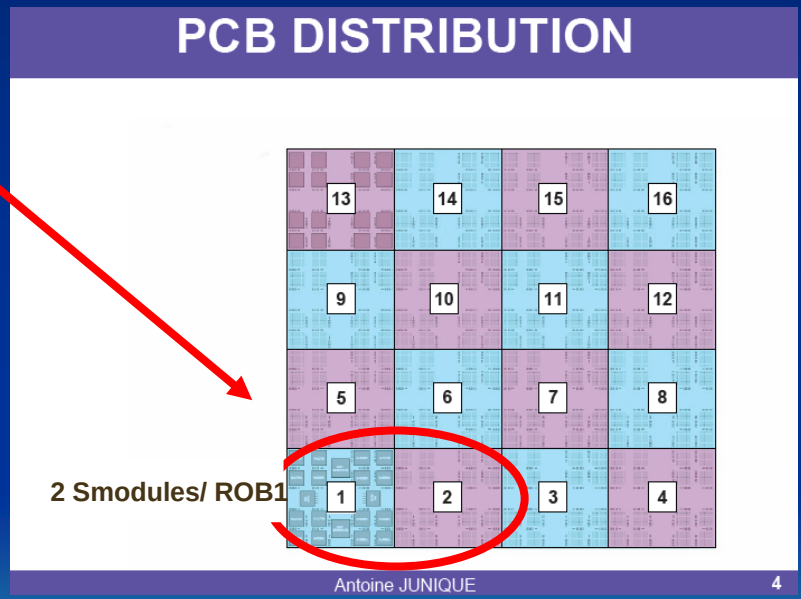


Sizes

--2 Smodule per ROB-1

= 2048 pads/ROB-1

⇒ 9270.8 mm^2/ROB-1



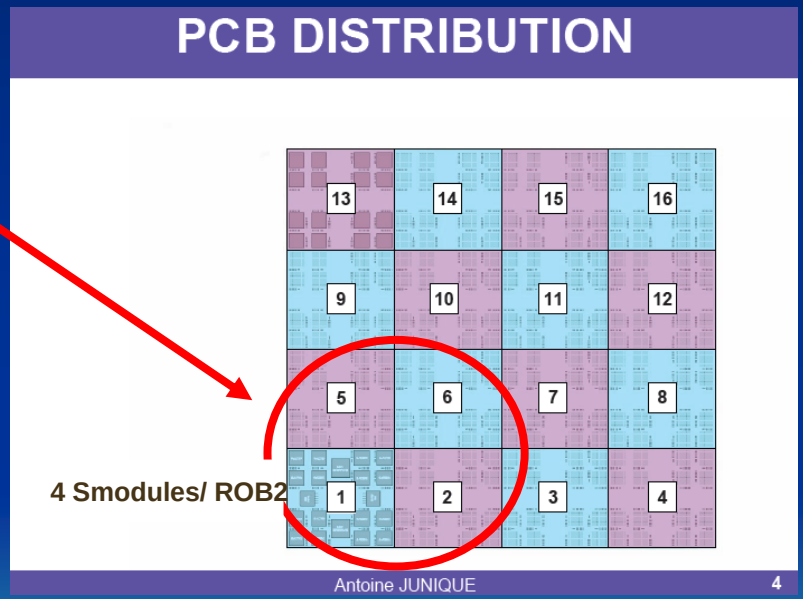
2 Smodule per ROB-1

Sizes

--4 Smodule per ROB-2

= 4096 pads/ROB-2

⇒ 18451.5 mm^2/ROB-2



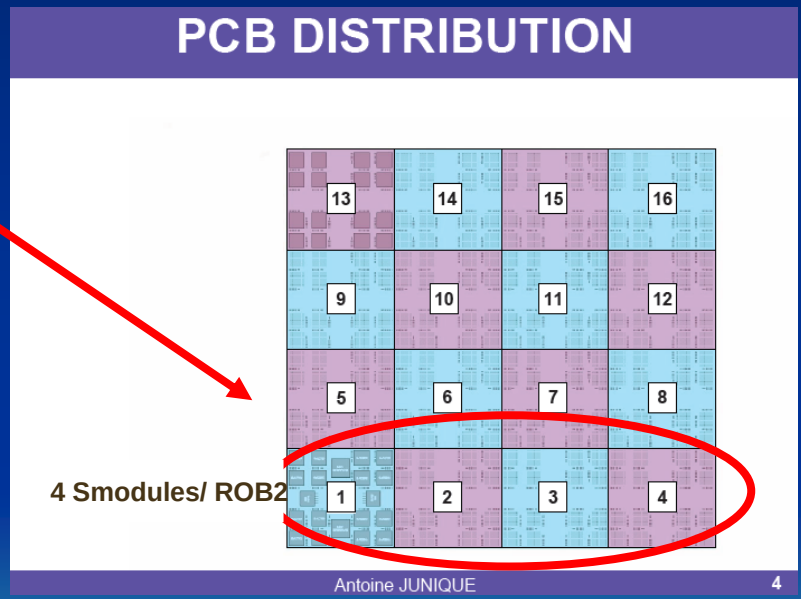
4 Smodule per ROB-2

OR

--4 Smodule per ROB-2

= 4096 pads/ROB-2

⇒ 18451.5 mm^2/ROB-2



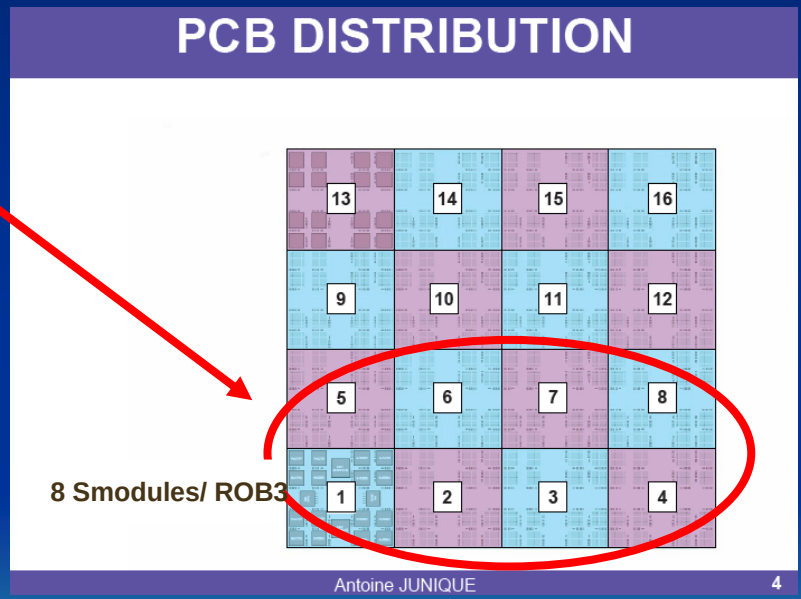
4 Smodule per ROB-2

Sizes

--8 Smodule per ROB-3

= 8192 pads/ROB-3

⇒ 37083.0 mm^2/ROB-3



8 Smodule per ROB-3

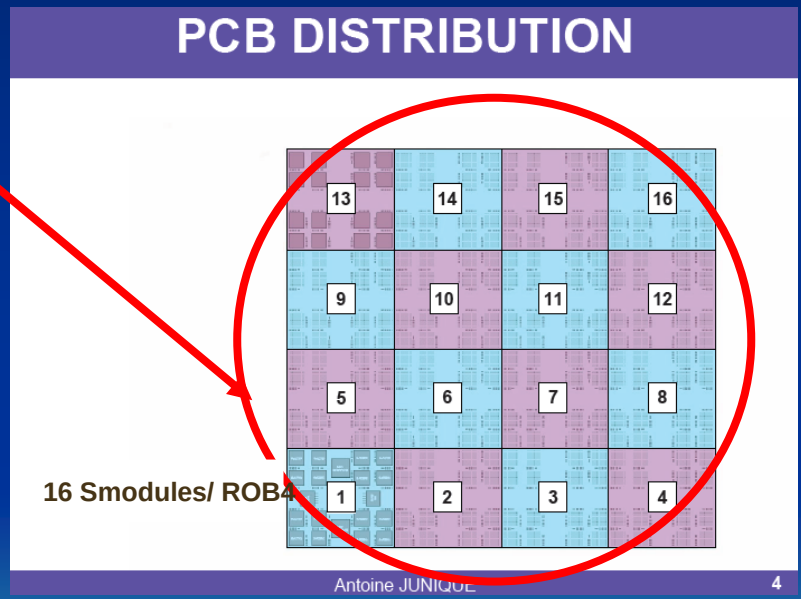
Sizes

--16 Smodule per ROB-4

= 16384 pads/ROB-4

⇒ 74166.0 mm^2/ROB-4

= Antoine's 'ROB'



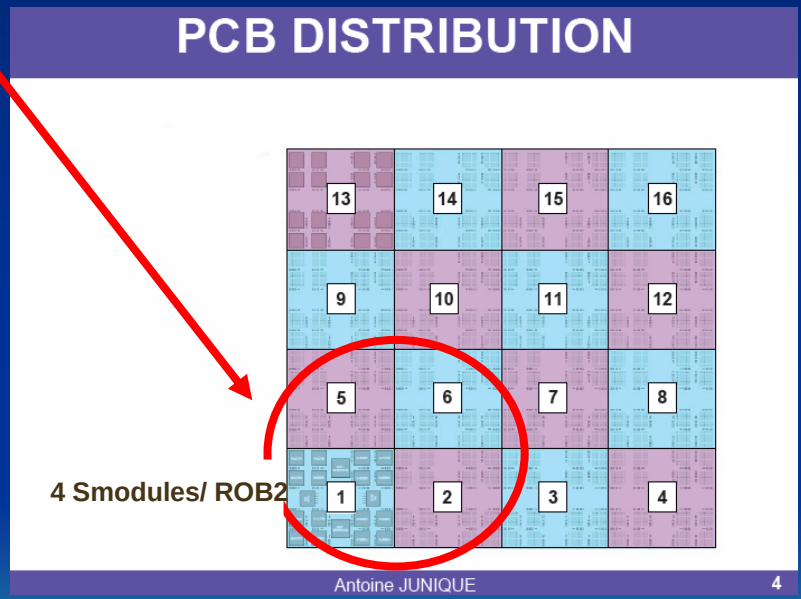
16 Smodule per ROB-4

Example: subdivide the endcap using ROB-2…

--2 Smodule per ROB-2
= 4096 pads/ROB-2
⇒ 18542 mm^2/ROB-2

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

⇒ 488 ROB-2/endcap

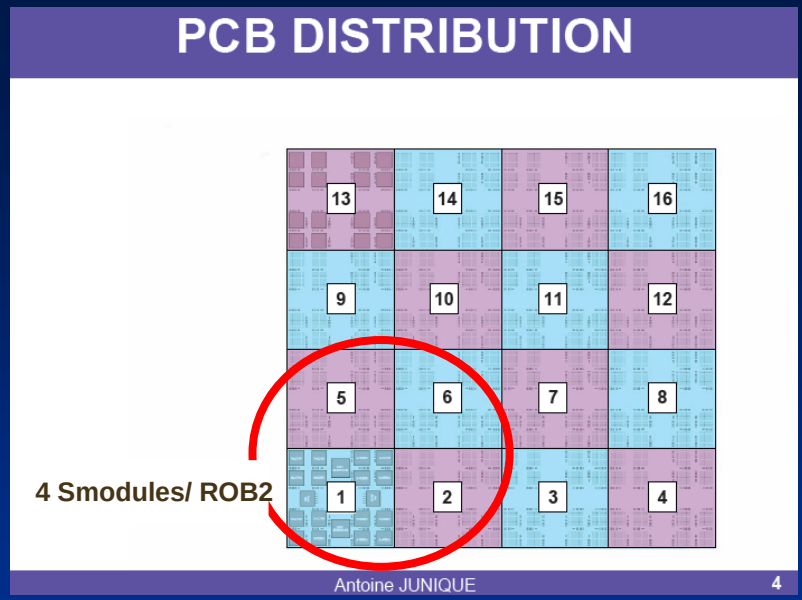


4 Smodule per ROB2

--ROB-2 size:

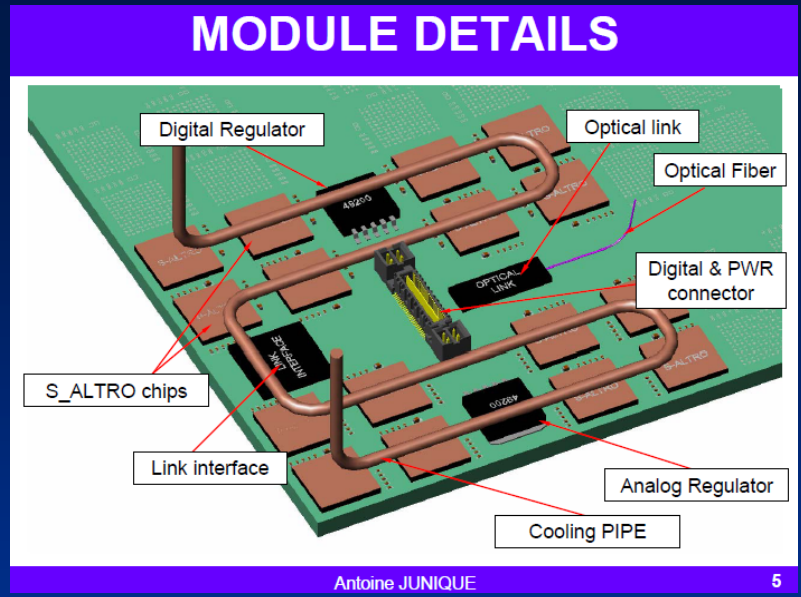
½ 263 x ½ 282mm^2 ≈

½ x Dan's LP1 "ROB"



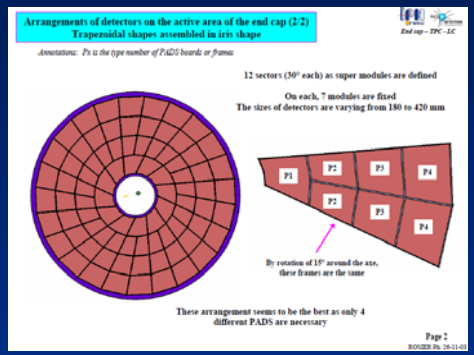
Channels

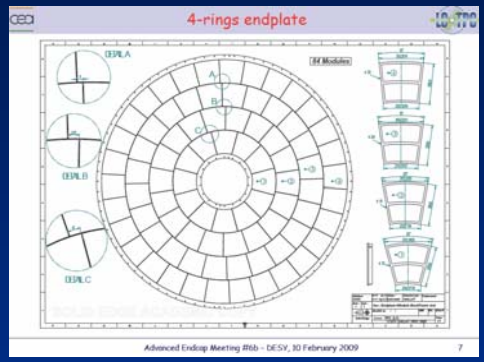
--64 pads/S-Altro
--16 S-Altro/Smodule
-- 4 Smodules/ROB-2
⇒
--1024 pads/Smodule
--4096 pads/ROB-2
--488 ROB-2/endcap
--1998848 pads/endcap

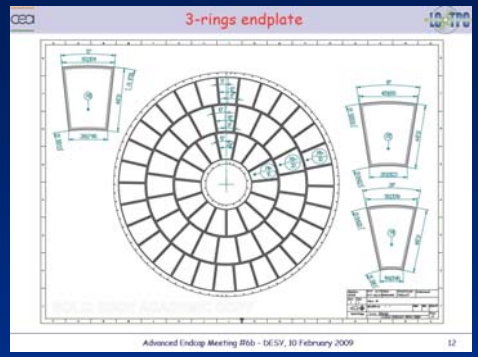


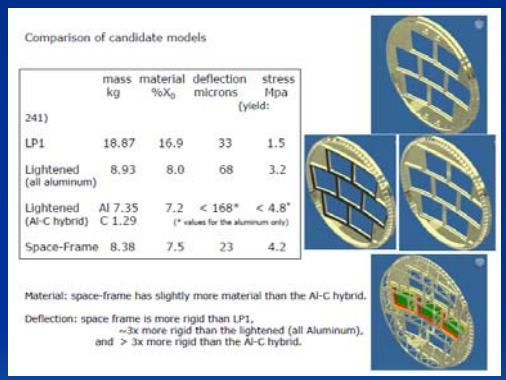
This is just an example. Different ROB-n can be used across the endcap, depending on the shapes of the different ROBs

This is a job for the experts…





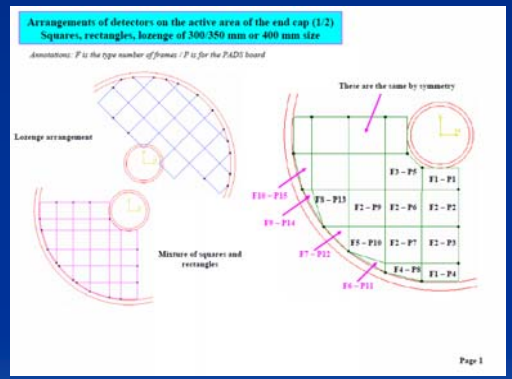



Comparison of candidate models

	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

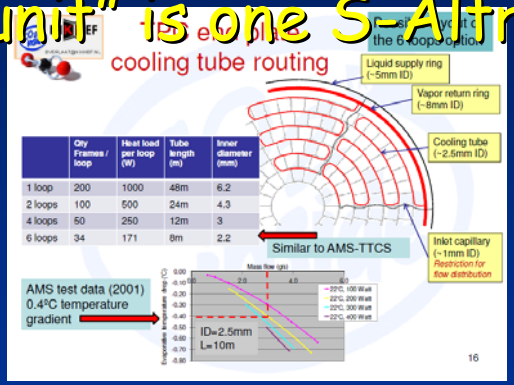
Material: space-frame has slightly more material than the Al-C hybrid.

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.

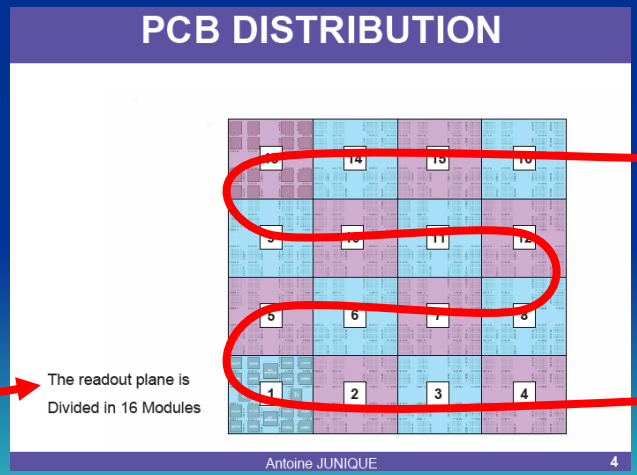


Cooling (slide from mtg103)

Also, these two strategies are different: Bart cools a timepix chip. This corresponds roughly to one ROB in a pad TPC (a "cooling unit") = 11 W at 40MSPS, where Antoine's "cooling unit" is one S-Altro = 0.05 W at 40 MSPS.



At Aleph, our "cooling unit" was ~ 1 W, roughly equivalent for this lctpc case 1 Smodule
= 16 S-Altros
= 0.7 W at 40 MSPS or
= 0.4 W at 10 MSPS. Should Bart use this?



Cables (slide from mgt103)

-- Cable for fieldcage: one 70 kV cable, φ ~ 15 mm (Catherine's estimate is o.k.)
-- Cables for MPGD, gating, clock, readout optical fibre, etc : ~ 10/ROB (depends on layout) ⇒ material small.
-- Power cables ⇒ material large. This is important because the material is large and is very sensitive to the cable layout scheme, and we have not had enough time to work this out. We must try to do this within the next few weeks.

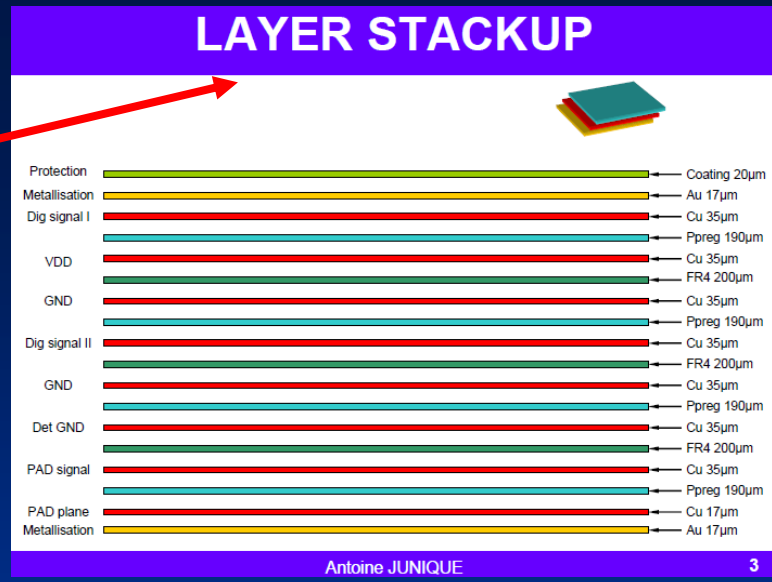
X_0 Thicknesses (slide from mtg103

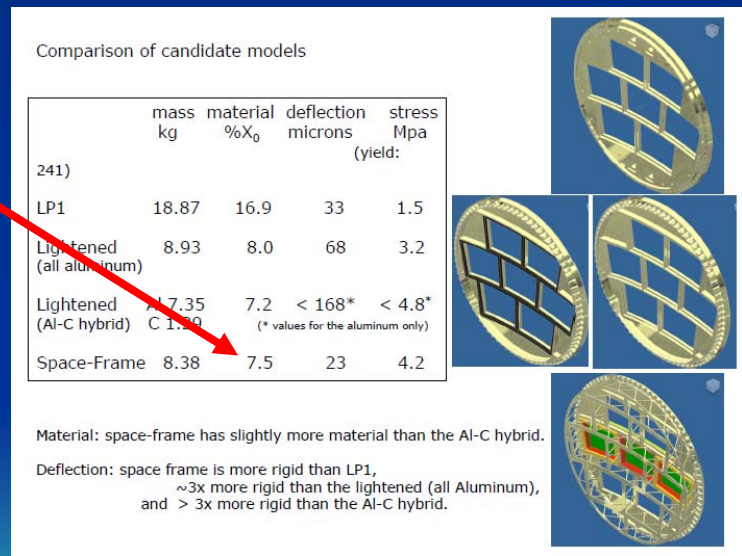
Sum of these plus S-Altros
~ 5 % X_0

Dan estimated at last meeting the space-frame thickness
~ 8 % X_0 for the LP size. We don't know yet how this translates to the LCTPC size.

Cooling (my guess, needs confirmation)
~ 2% X_0

Cable layout --- work in progress --- but it looks like the above X_0 may be doubled.





LCTPC milestones

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