

ILD-ECAL readiness

Vincent Boudry

École polytechnique, Palaiseau



***Journée Collisionneur Linéaire
LPSC, Grenoble
3 Dec. 2014***

Are you ready ?

YES! (by default)

...

Are you ready ?

YES!

Wait! for what ?

Oh! You mean “Now” ?

Landscape around the ILD-ECAL

Physics

⇒ Optimisation

Model

⇒ Everything not yet fixed

Construction: Calorimeters among the first to be build

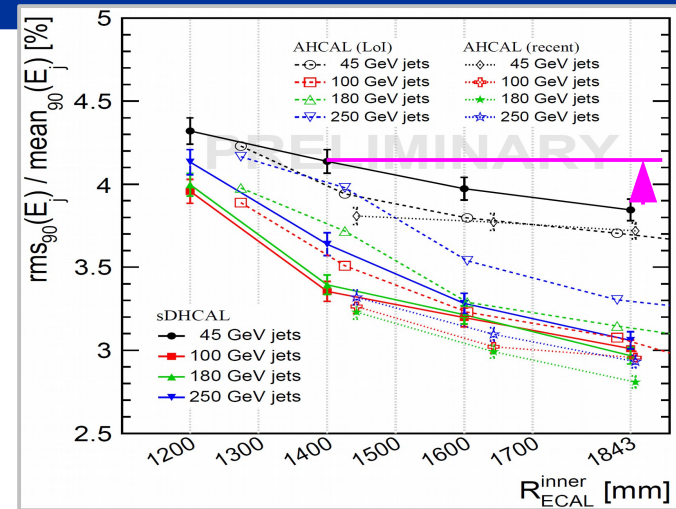
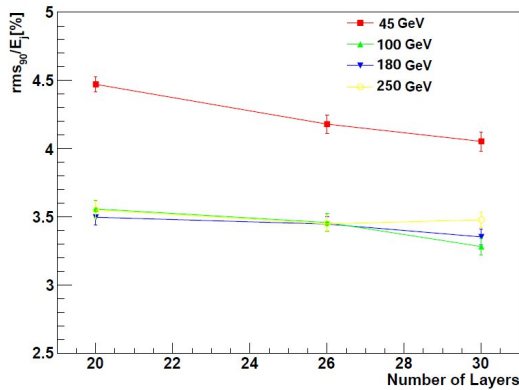
Physics optimisation

No magic spot

JER vs R_{INNER} (\leftrightarrow RTPC, @ fixed R/L ratio).

SiW ECAL: $5 \times 5 \text{ mm}^2$,
 AHCAL: $3 \times 3 \text{ cm}^2$, sDHCAL: $1 \times 1 \text{ cm}^2$

JER vs nb of Layers



\Rightarrow Define 1 or 2 well defined reference models to estimate readiness

\Rightarrow For what energy ?

See talks by Hieu and Henri

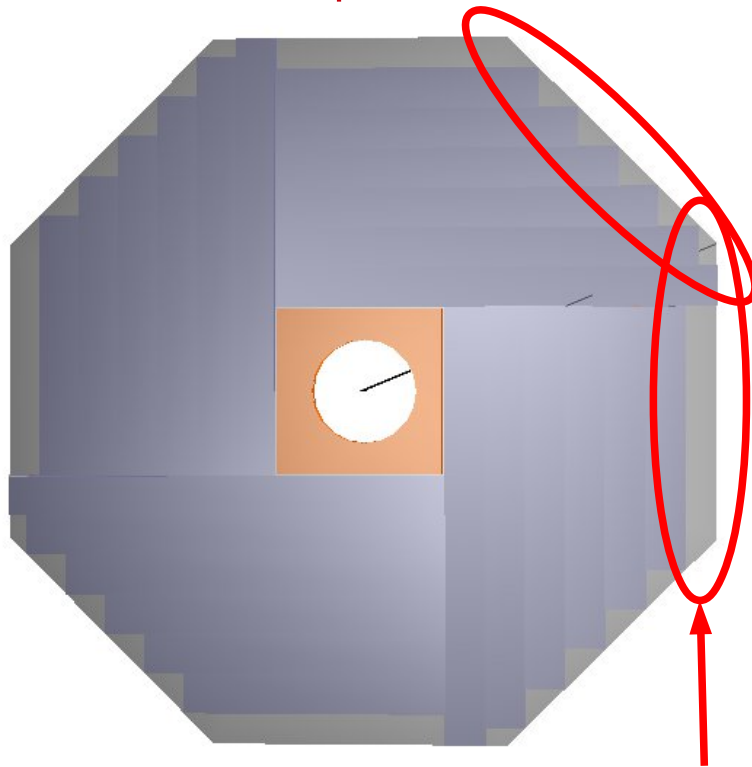


Model Limits

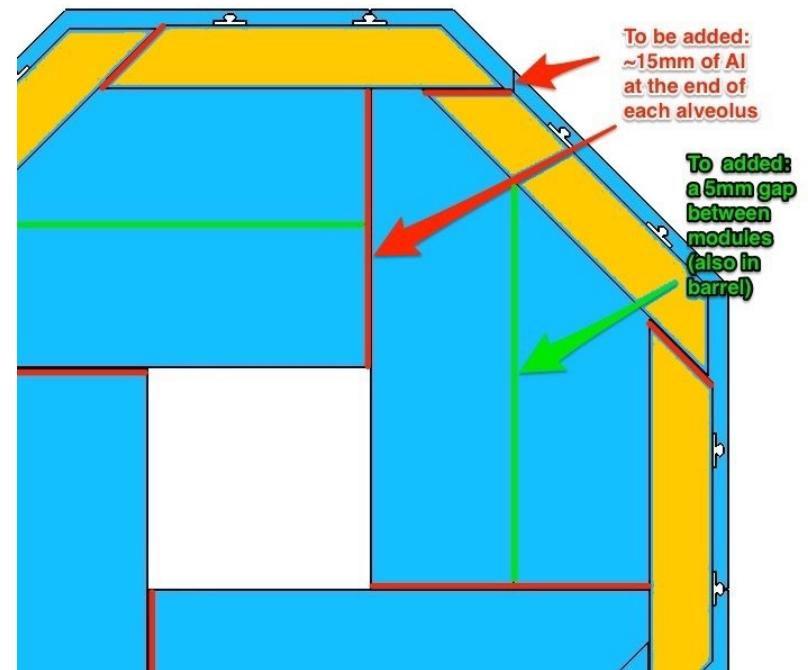
Simulation readiness

Work on-going (LLR: Henri, Dan Yu, Emilia Becheva, VB; Tokyo: Daniel)

Improvement of endcaps in simulation



Cause of $\cos\theta=0.7$ glitches

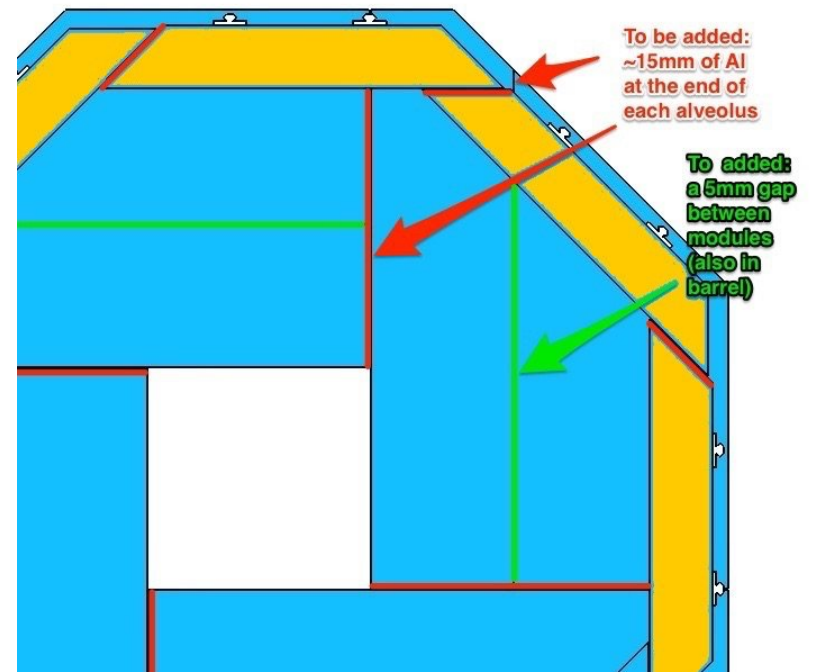
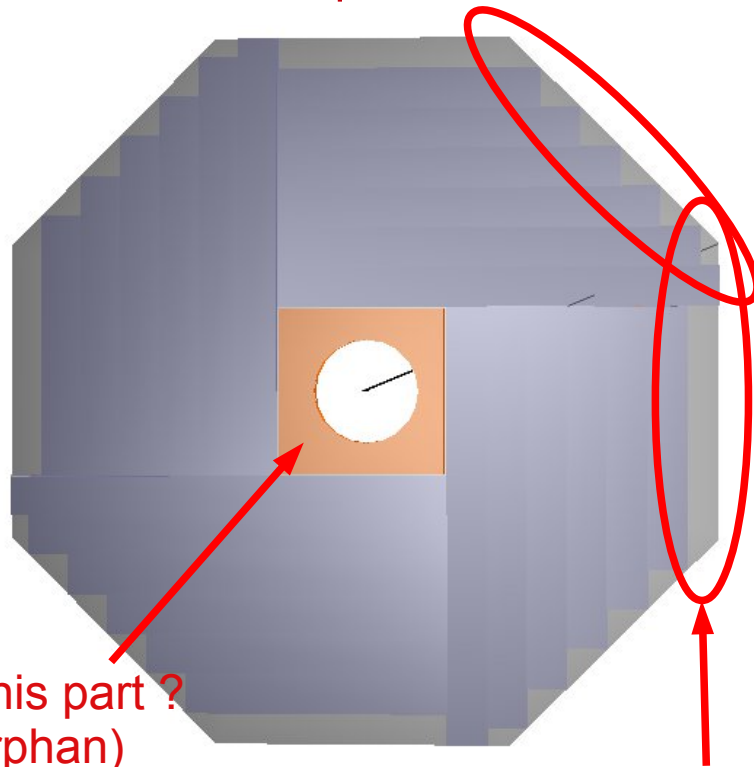


In close link with a mechanical model: base for the TDR.

Simulation readiness

Work on-going (LLR: Henri, Dan Yu, Emilia Becheva, VB; Tokyo: Daniel)

Improvement of endcaps in simulation



Cause of $\cos\theta=0.7$ glitches

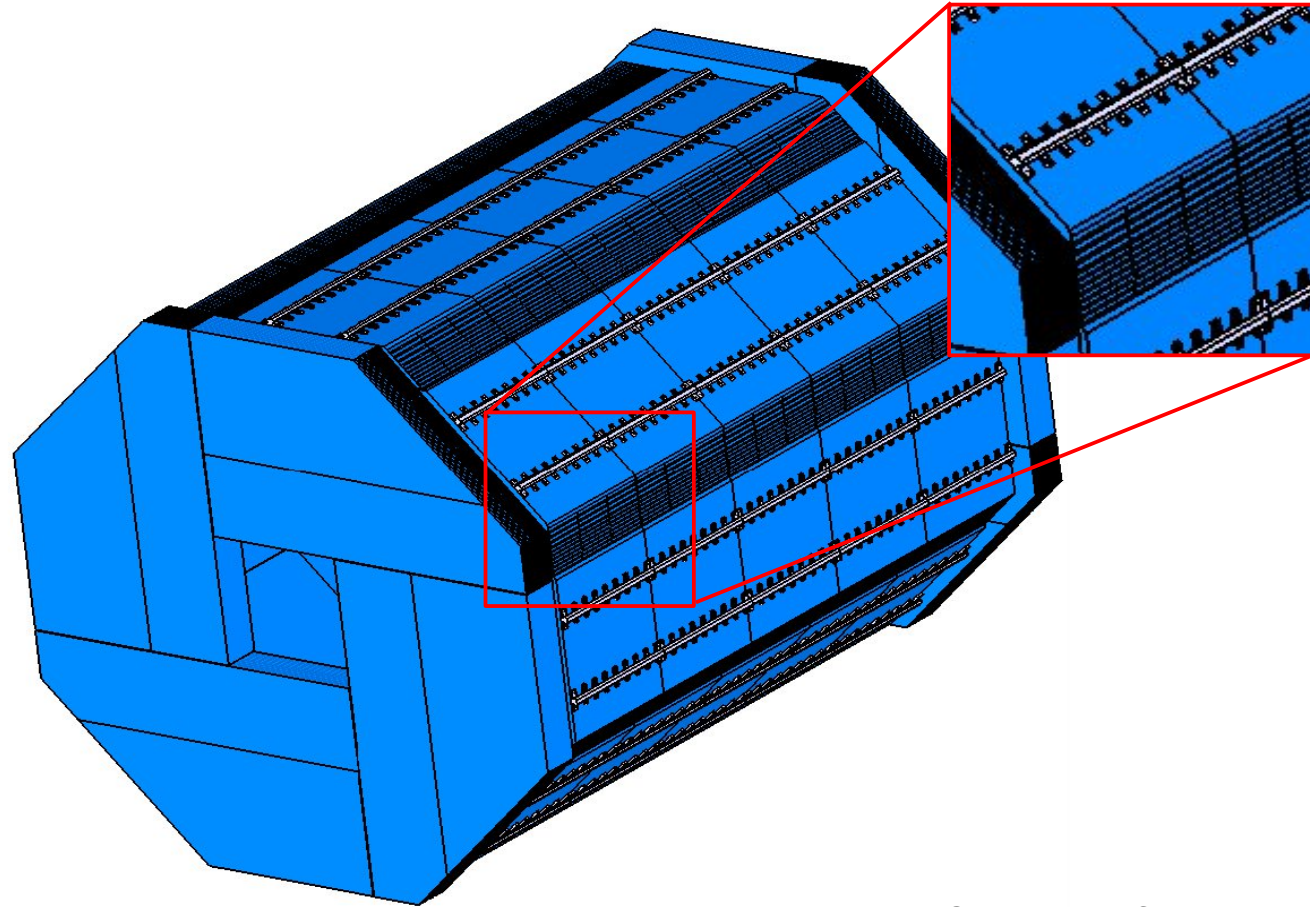
In close link with a mechanical model: base for the TDR.

Mechanical model

Large (DBD) → Small option

Paramètres

Matériau	=Tungstène
largeur-alveole	=253,6mm
ame	=1mm
nombrecolonne	=3
epaisseurW1	=2,8mm
epaisseurW2	=2,8mm
epaisseurW3	=5,6mm
rayonalveole	=0,3mm
jaumontagealv	=0,5mm
couchebasse	=2mm
couchehaute	=14,8mm
epaistoileexterieure	=2mm
jeumodule	=5mm
rayoninterneECAL	=1400mm
jeuintermodule	=5mm
epaisseur_wafer	=0,7mm
epaisseur_colle	=0,1mm
epaisseur_PCB	=1,2mm
epaisseur_BGA	=1,7mm
epaisseur_shielding	=0,5mm
epaisseur_1K	=0,15mm
epaisseur_3K	=0,25mm
epaisseur_kapton	=0,05mm
epaisseur_structil	=0,2mm



Courtesy of M. Anduze

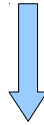
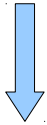
Redefine realistic parameters in term of base units (Wafer size: larger for cost optim.)
+ mechanical tolerance (See presentation of Denis)

— Mechanical studies to be redone (stability, vibration, thermal, ...)

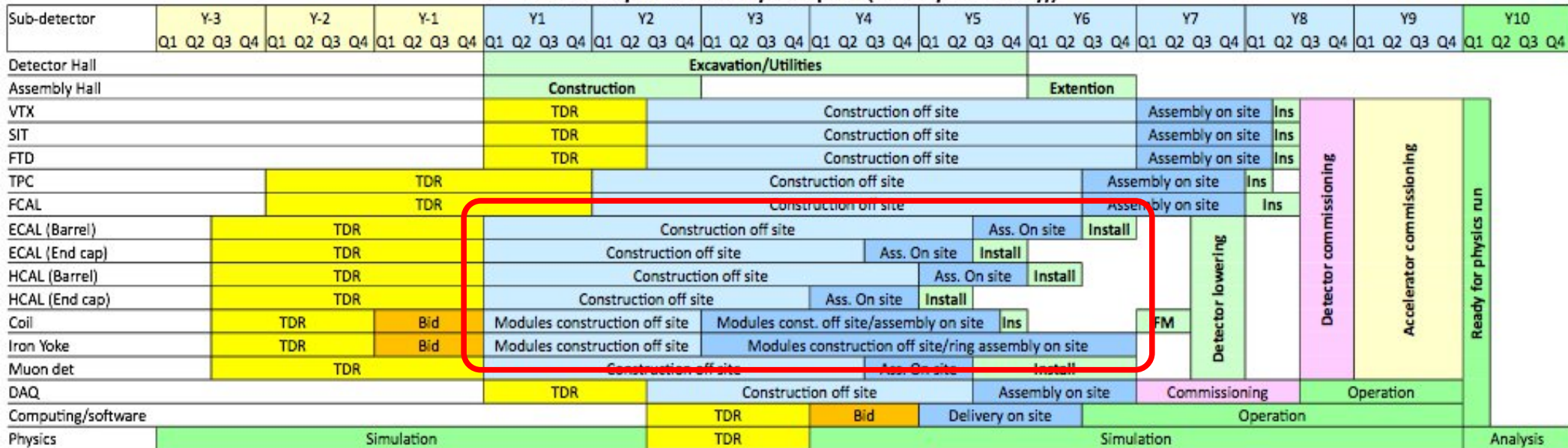
Planning

Now ?

Ground breaking (2017 ? 2018?)



ILD assembly timeline for Hybrid option (CMS style assembly)



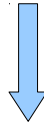
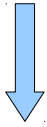
Ins: Install
FM: Field mapping

Almost there !!! Green Light in march 2016 , ground breaking in 2017 ? 18 ?

Planning

Now ?

Ground breaking (2017 ? 2018?)



ILD assembly timeline for Hybrid option (CMS style assembly)

Sub-detector	Y-3				Y-2				Y-1				Y1				Y2				Y3				Y4				Y5				Y6				Y7				Y8				Y9				Y10			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Detector Hall	Excavation/Utilities																																																			
ILD assembly timeline for Hybrid option (CMS style assembly)																																																				
Sub-detector	Y-3				Y-2				Y-1				Y1				Y2				Y3				Y4				Y5				Y6																			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4				
ECAL (Barrel)					TDR				Construction off site																Ass. On site				Install																							
ECAL (End cap)					TDR				Construction off site												Ass. On site				Install																											
HCAL (Barrel)					TDR				Construction off site												Ass. On site				Install																											
HCAL (End cap)					TDR				Construction off site								Ass. On site				Install																															
Coil					TDR				Bid				Modules construction off site								Modules const. off site/assembly on site								Ins																							
Iron Yoke					TDR				Bid				Modules construction off site								Modules construction off site/ring assembly on site																															
Muon det					TDR				Construction off site												Ass. On site				Install																											

Almost there !!! Green Light in march 2016 , ground breaking in 2017 ? 18 ?

Mass production

	Steps/Needs	Quantities	Unit	Tools	Place
2.1	Barrel	1			
2.1.1	Module structure construction	40			
	Tungsten plates (thickness tolerance +/- 40 µm) Thickness : 1.05 – 2.1 – 4.2 mm	61	ton		Industry Several suppliers
	Dimensional inspection of W plates	19000	plates	3D measurement system	HOME/Industry
2.1.1.2	Monolayer alveolar structure	440			
2.1.1.3	Module alveolar structure	40			
2.1.1.4	H-shaped slab structure	1320			
2.1.2	Active Sensor Unit fabrication (ASU)	13200			
	Processed wafers 9x9 cm²	52800			Industry several suppliers
	ASIC	211200			Industry
	PCB electrically tested	13200			Industry
	Wafer test set-up	3			Industry
	Asic test set-up	3			Industry
	PCB test set-up	3			
	Gluing and position robot	3			
	ASU test set-up	15			
2.1.4	Module/slave integration	8			
2.1.5	Barrel integration	1			
2.2	End caps				
2.2.1	Module structure construction	24			
2.2.1.1	General procurements				
	Tungsten plates (thickness tolerance +/- 40 µm) Thickness : 1.05 – 2.1 – 4.2 mm	28	ton		Industry/Several suppliers
	Dimensional inspections of W plates	12000	plates	3D measurement system	HOME/Industry
2.2.1.2	Monolayer alveolar structure (360 units - 3 shapes)				
2.2.1.3	Module alveolar structure (24 units - 3 shapes)				
2.2.1.4	H-shaped structure	440			
2.2.2	Active Sensor Unit fabrication (5280 units)				
	Processed wafers 9x9 cm²	21120			Industry several suppliers
	ASIC	84480			Industry
	PCB electrically tested	5280			Industry
2.3	Cooling sta				

Large production for some items

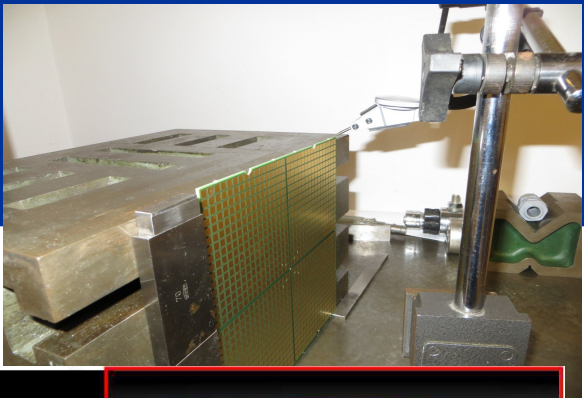
- *Wafers, PCB's, ASIC's*
- *ASU's, SLAB's, Barrel Modules*

Challenging production for others

- *Endcaps modules*

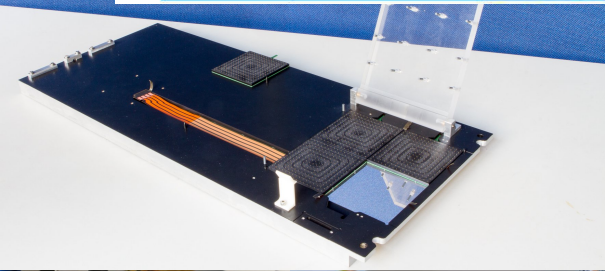
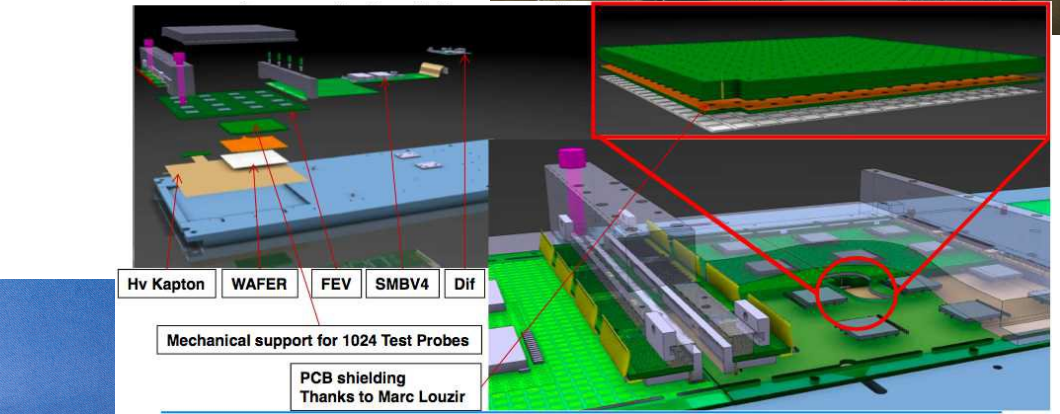
Preliminary list of item, cost, schedule “ready”

Test & assembly benches



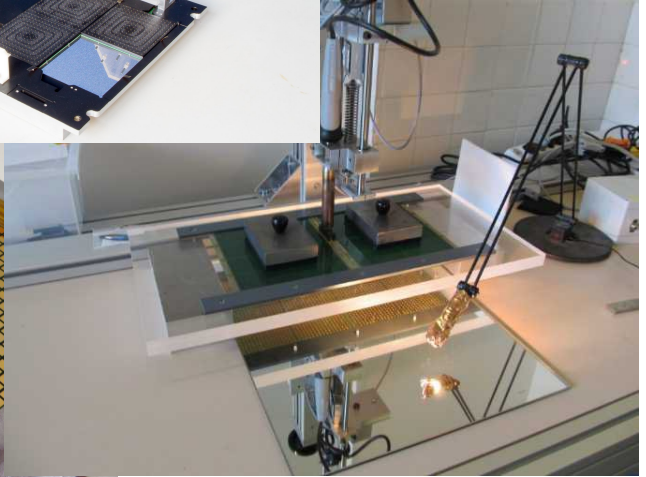
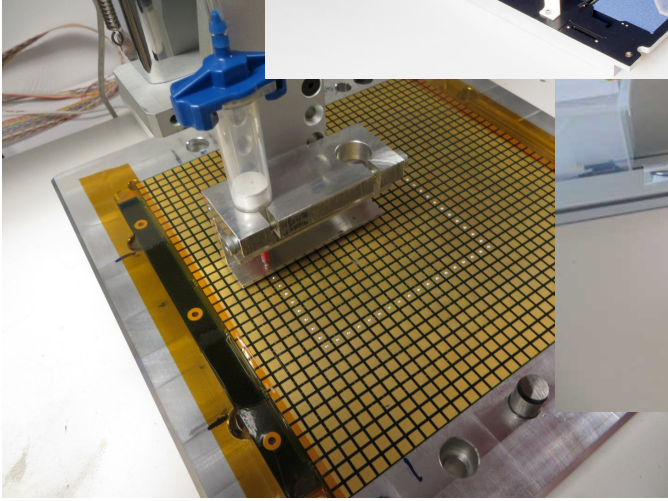
All prototypes (see presentation from Rémi)

- *Wafers: existing in LLR, Kyushu*
- *PCB*
- *Mechanics : in LPNHE*
- *Electrics (naked and equipped) : in LLR*
- *Gluing & testing : in LPNHE*
- *SLAB Assembly : in LAL*



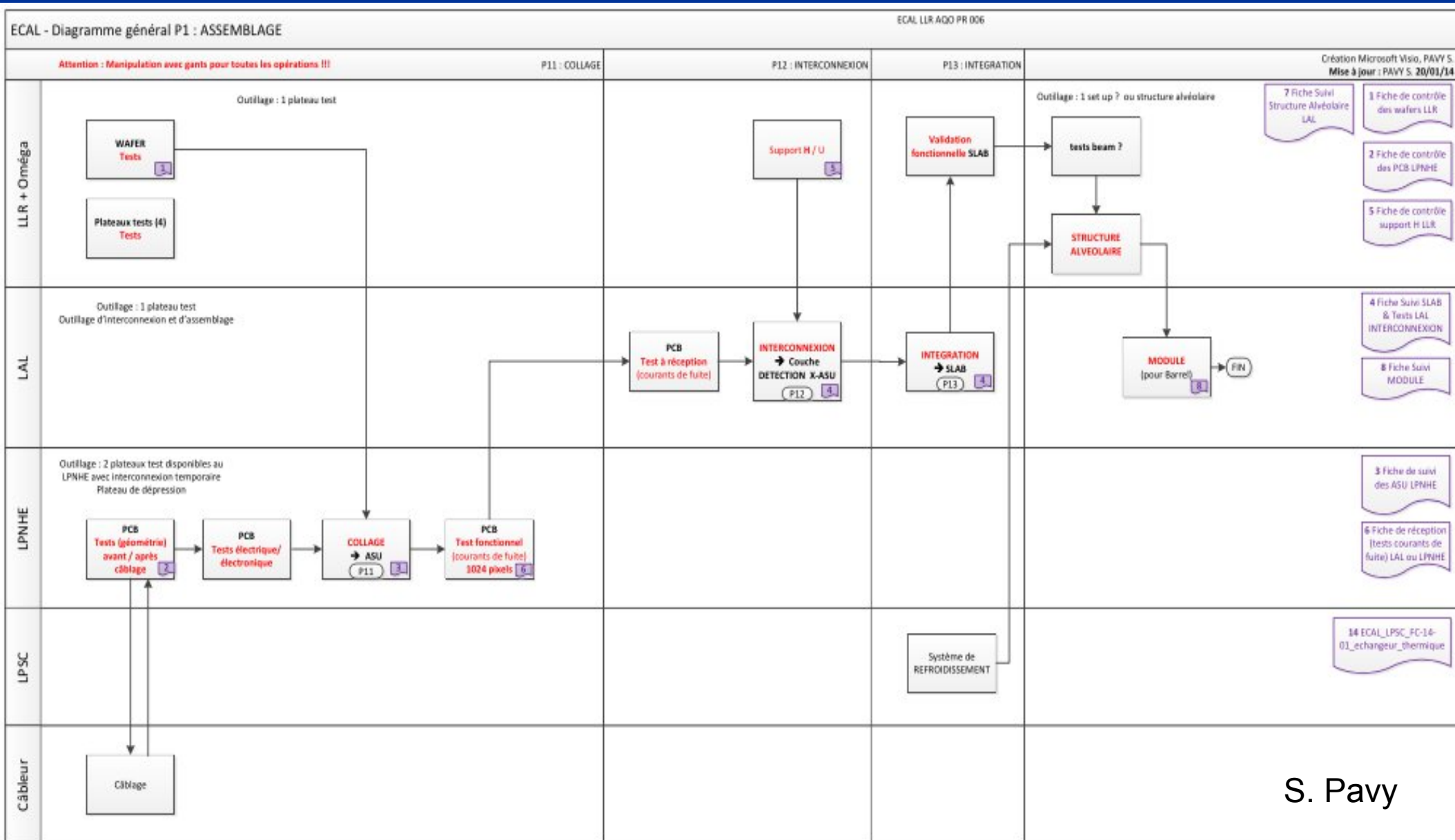
Final testing

- *Cosmics*
- *μ -beam ?*



Large Work needed for Automated tests (~20000 units)

Existing workflow with QA (x3-15 increase needed)



Landscape around the ILD-ECAL

Physics

⇒ Optimisation : no visible hard limits, shallow region

Model

⇒ Everything not yet fixed ⇒ smaller radius ?

⇒ realistic mechanics & simulation

Construction: Calorimeters among the first to be build

Segmented calorimeters : many many parts ⇒ industrialisation

So much to do... So few people

We need you !

project	Prototype	R&D	ILD	Industrialisation ?
Topic resp/coord (Present status)	LLR	??	(almost) Everything × 3 BARREL / ENDCAP / RING	
Mechanical Model	LLR		Scaling LLR / LPSC / ?? ILD interface ??	
Sensors Design Electric test Laser test Beam tests	(LLR/Kyushu/Tokyo/LPNHE) × PHIL LLR	several options LLR / TU / Kyushu Rad Kyushu Kyushu / Tokyo ?	Final Design	
VFE Test	(Omega) SK2 Omega LAL / LLR	SK2B ADC Omega LPSC	SK3 Omega	
ASU PCB Gluing Tests (electric, cosmic, aging) Transport Final DIF/ASU	(LPNHE) LLR LLR/Tokyo LPNHE LLR	PCB_COB PCB_BGA LAL LLR / TU	PCB (design, prod, test, aging) ? ? ? ? ?	
SLAB Structure (U) Interconnection Adapt Board Kapton Shielding Assembly Cosmic tests Rad test Storage/Transport	(LAL) LLR LAL LLR LAL LLR LAL LAL LAL	→ LLR → LAL × → LAL → ? → LAL Glue	? / ? / ? ? ? ? ? ? ? / ? / ?	
Modules Structure Metrology (FBG)	(LLR) LLR LLR	LLR LLR	? / ? / ? ? / ? / ?	
Services PS (PP)	(LPSC)	Power-Pulsing	Cooling LPSC LV ?? HV ??	
Tooling	(???)		Module mounting? Module rotation ?	
SCADA DAQ DIF Online Data quality Control	(LLR) LLR MAN/LLR LLR/LAL	DIF ? ? ?	DIF ? ? ?	

Somewhat outdated

but still much space
for new collaborators
in ILD...

Conclusion

Are we ready ?

- *Not yet !!!!*

We are ready ... to be ready

- *Technology in hands : validation in 2015 (long slabs) + TB*
 - Some choice to be done (sizes)
 - Critical limits to be established (limits on density of channels, fault tolerance, ...)
- *Industrial contacts for many part to be done*
 - Critical : Wafer production (started)
- *Place for new collaborators*
 - available
 - to be prepared if green light.