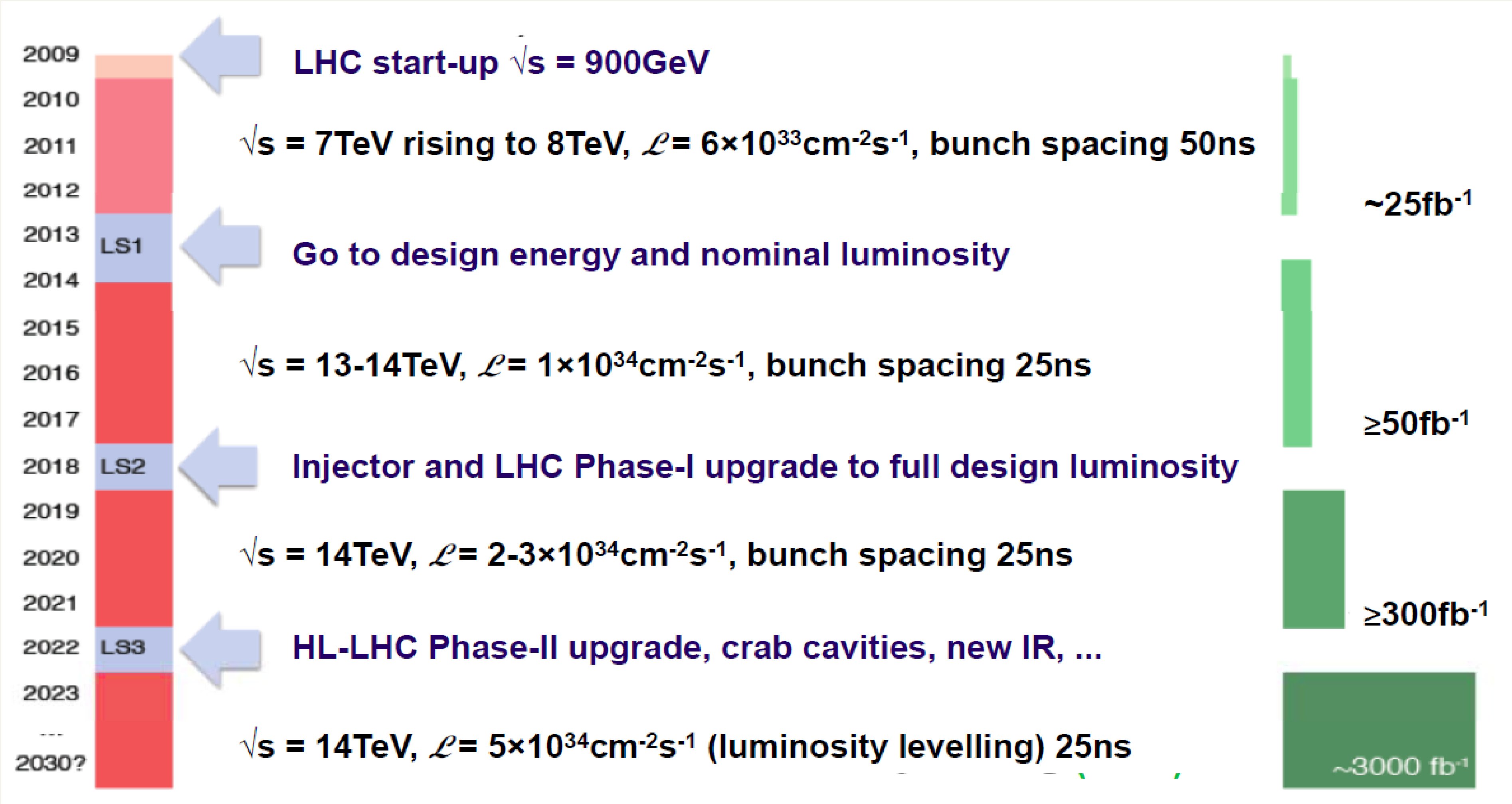
Point d’information sur les « upgrades » ATLAS

Evolutions depuis le CSTS de Novembre 2011

- Spectromètre a muon: New Small Wheel
- Trigger calorimètre électromagnétique
- ATLAS Forward Project

LHC PLANS


2009
2010
2011
2012
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2014
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2017
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2019
2020
2021
2022
2023
...
2030?
LS1
LS2
LS3
LHC start-up √s = 900GeV
√s = 7TeV rising to 8TeV, ℒ= 6×10³³cm⁻²s⁻¹, bunch spacing 50ns
Go to design energy and nominal luminosity
√s = 13-14TeV, ℒ= 1×10³⁴cm⁻²s⁻¹, bunch spacing 25ns
Injector and LHC Phase-I upgrade to full design luminosity
√s = 14TeV, ℒ= 2-3×10³⁴cm⁻²s⁻¹, bunch spacing 25ns
HL-LHC Phase-II upgrade, crab cavities, new IR, ...
√s = 14TeV, ℒ= 5×10³⁴cm⁻²s⁻¹ (luminosity levelling) 25ns
~25fb⁻¹
≥50fb⁻¹
≥300fb⁻¹
~3000 fb⁻¹

ATLAS UPGRADES

Phase 0 Upgrade 2013-2014

New inner pixel layer (IBL) : *Possible new Diamond Beam Monitor (DBM)*
Muon system completion
New neutron shielding
Potential replacement of Minimum Bias Trigger scintillators

+ AFP0

Phase I Upgrade 2018

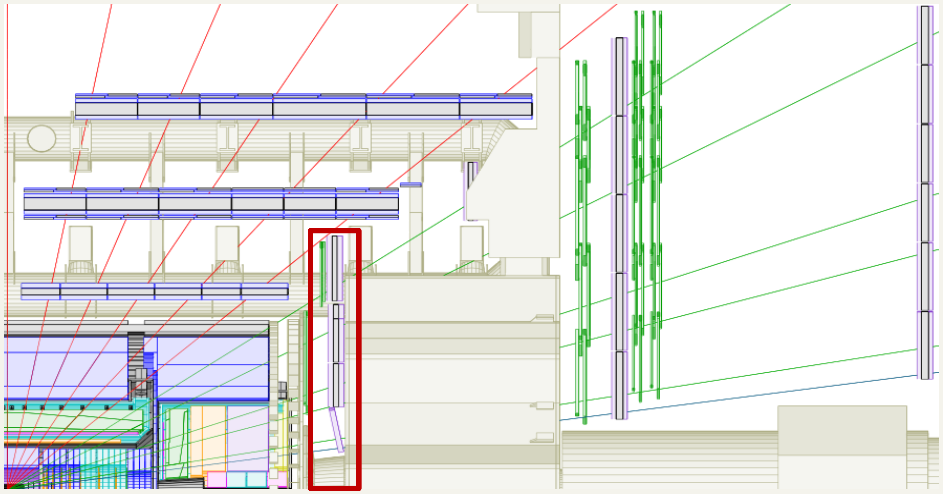
New Muon small wheels
Improved Granularity of Calorimeter trigger at level 1
Trigger and Data Acquisition upgrades including Fast Track Trigger
Under consideration: new pixel detector based on IBL experience

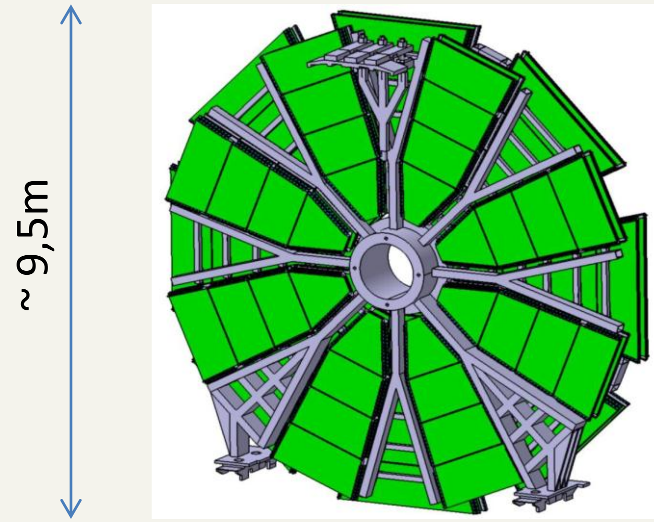
+ AFP1

Phase II Upgrade 2022

All new Tracking Detector
New Trigger and Data Acquisition system including Calorimeter electronics upgrades
New detectors for parts of Muon system + more neutron shielding
Possible upgrades for Forward and Hadronic EndCap Calorimeters

New Small Wheel





Rappel des motivations:

- Reconstruction des muons a l'avant (|η|>~1.5) en présence de très haut bruit de fond (muons directs, pile-up, cavern background) au HL-LHC
- Amélioration du trigger vers l'avant (>80% du taux vient de 2.4>|η|>1.5)

Les techniques candidates:

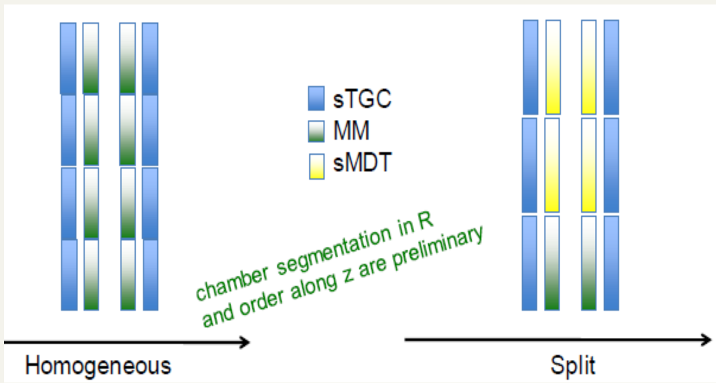
- sMDT: Small tube Monitored drift Tubes (D=1.5cm au lieu de 3cm)
- sTGC: Thin gap Chambers
- MM: Resistive Micromegas

NSW: Choix de la collaboration ATLAS

Approuve au Muon IB du 2 mai par 33/40 instituts

The single solution to recommend

- We recommend to adopt the Homogeneous solution for the following main reasons:
  - Redundancy in both trigger and tracking, especially on trigger
  - Strength of the community behind Micromegas that mitigate the worries on the R&D still needed
  - Simpler solution in terms of number of technologies and services distribution.
  - Development of a new powerful technology also for other possible uses in the future of ATLAS.



Baseline **Solution de repli**

(i) **Baseline** :
- Trigger : sTGC (toute la surface des roues)
- Tracking : **Micromegas**
(toute la surface des roues, 128 ch., ~2 M-canaux elx pour ~1000 m^2 de plans de MM)

(ii) **Solution de repli (milestones non remplis):**
- Trigger : sTGC (toute la surface des roues)
- Tracking :
  - **Micromegas (intérieur des roues : 32 à 64 ch., 400 à 800 k-canaux elx pour 200 à 400 m^2 de MM)**
  - sMDT (extérieur des roues ; sur la surface non-couverte par les Micromegas)

Il est demandé d'étudier la possibilité que :
- Les sTGC participent au tracking
- Les Micromegas participent au trigger (~30 k-canaux elx)

NSW: quelques paramètres

A few parameters of the homogeneous solution:

	sTGC	MM
Number of chambers	128	128
Number of layers	8	8
Number of readout channels	400k	2M
Number of trigger channels	64k	31k

Rough cost estimates:

Homogenous solution

Total: 10700 KCHF
– sTGC : 2300
– **MM : 6000** (5 kE/m^2)
– Common : 2300

Split solution

Total: 10100 KCHF
– sTGC : 2300
– **MM : 2800**
– sMDT : 2300
– Common : 2600

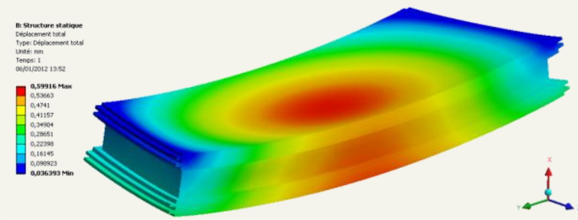
NSW: Milestones 2012

(co)Responsable
Participation
Implication possible

Micromegas specific
- M1: Validation of the detector resolution for inclined tracks
- M2: Realization of full size detector (~2m x 1m)
- M3: Possible damages by sparks with large ionization

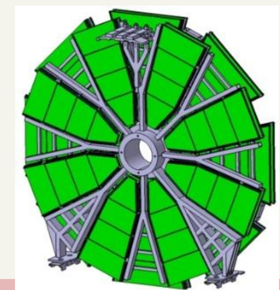
TGC specific
- T1: Validation of the proposed Trigger scheme

Common items
- C1: **Geometrical accuracy (goal: ~40µm)** and alignment scenarios
- C2 : Effects of magnetic field



Reporting items

The following are not milestones, but listed here as a reminder of critical items.



- R1: **MM Industrialization** — FJ responsable (avec Rui/Fabio Formenti)
- R2: MM trigger
- R3: Integrating the trigger information from TGC and MM
- R4: TGC production
- R5: Progress on Alignment
- R6: Progress on the New Small Wheel design and **layout (MM)**
- R7: Progress of long term aging tests of TGC and MM
- R8: Test of MM performance (efficiency, resolution, ...) under radiation background

Task Force en cours d'organisation (PPo+…)

NSW WP: Possibles implications de Saclay

Detector construction and integration :

- Follow-up of PCB/mesh production in industry + quality control (if possible through the Saclay lab at CERN).
- Participation to the definition of the chamber assembly process, in view of achieving the required mechanical precision (~40μm). Development of an internal alignment system for the control of deformations.
- Global Layout definition
- **Saclay could be one of the lab involved in the MM chamber construction.**

Global Alignment :

Reconstruction software. Database issues. Mechanical or optical interface with the EC alignment bars.

Production, quality insurance :

Participation to the final functional tests (and possibly checks of assembly precision) of chambers after construction, e.g. using a cosmic bench at CERN.

Front end electronics :

Development of a chip which would be missing in the chain between the BNL FE chip and the DAQ?

Trigger front end electronics :

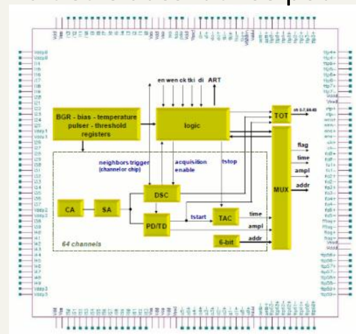
Interest in participating (or taking the responsibility) of the development of the electronic card which would interface the FE BNL Asic with the trigger back-end electronics.

Readout :

Possible implication (on both software and hardware). e.g. through SRS readout implementation.

NSW: Implication dans l’électronique?

(*) VMM1 : ASIC Front-End pour les Micromegas (devrait être aussi utilisé pour les TGC)



Implication a court terme (juillet-octobre 2012) :

- les tests pour le nouvel ASIC VMM1 (*) sont pris en charge par BNL (& al.)

Implication sur le long terme :

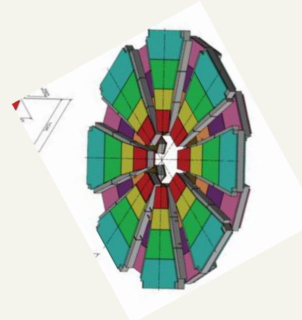
- Depuis mi-avril, premières participations aux réunions de travail pour se positionner (Hervé Le Provost, Christophe Flouzat, Shebli Anvar)

  (i) Partie **readout** (commun aux TGC+Micromegas) sera à redéfinir pour l’upgrade. Concurrence vive : SLAC, Nikhef, Italiens-“RPC”, RD51…

  (ii) **Trigger** Micromegas : algorithme à redéfinir complètement (comment combine-t-on l’info des Micromegas avec celle des TGC ?) :
    - Semblerait plus “ouvert”
    - Mais participation **indispensable** d’un physicien(ne) du SPP : MC, simulation traces (binôme électronicien – physicien !)

Groupe Atlas-upgrade Micromegas à Saclay

F.Bauer, P.Daniel-Thomas, E.Ferrer-Ribas, Ch.Flouzat, J.Galan, A.Giganon, P.-F.Giraud, P.Graffin, S.Herlant, F.Jeanneau (CdP), H.LeProvost, P.Ponsot, Ph.Schune (RS)
(IRFU - SEDI, SIS, SPP)



<u>Au sein et au delà du groupe, nos **atouts** sont :</u>

- Une expertise sur les Micromegas :
  - R&D-MAMMA, Clas-12, RD-51, etc. *(fonctionnement, vieillissement, industrialisation…)*
- Une expertise sur la mécanique :
  - Groupe Atlas, BE du SIS *(alignement, calcul, intégration, etc.)*
- Des infrastructures et des facilités :
  - Sur le site de Saclay : - CoCase -IRFU-, IRMA -IRSN-, etc. *(vieillissement)*
    - Le labo “bulk” *(tests mécanique, proto non-résistif)*
  - L’antenne du CERN *(faisceaux tests, tests détecteurs…)*
- Une expertise en électronique (front-end, trigger et readout)

Conclusions NSW

- Qualité des détecteurs MicroMegas et du travail de la collaboration Mamma avec sa forte contribution du groupe Saclay largement reconnue par la collaboration ATLAS:
  - MM choisis (avec sTGC) comme baseline de l'upgrade NSW

- Implication du groupe de Saclay potentiellement très importante mais évidemment dépendante de la contribution financière de la France pour l'upgrade ATLAS (dotation TGIR pour phases I + II) et du personnel disponible a l'IRFU (technique + physique)

- S'impliquer sur les Milestones-2012 est l'étape cruciale pour se positionner pour cet upgrade et avoir des taches et des responsabilités intéressantes et motivantes !

Upgrade Atlas Calorimètre -Trigger

- s-TBB : Upgrade Tower Builder: évolution par rapport au précédent CSTS

- Rappel de l'objectif principal: Augmentation de la granularité pour diminuer le taux de trigger pour faire face a l'augmentation de lumi.

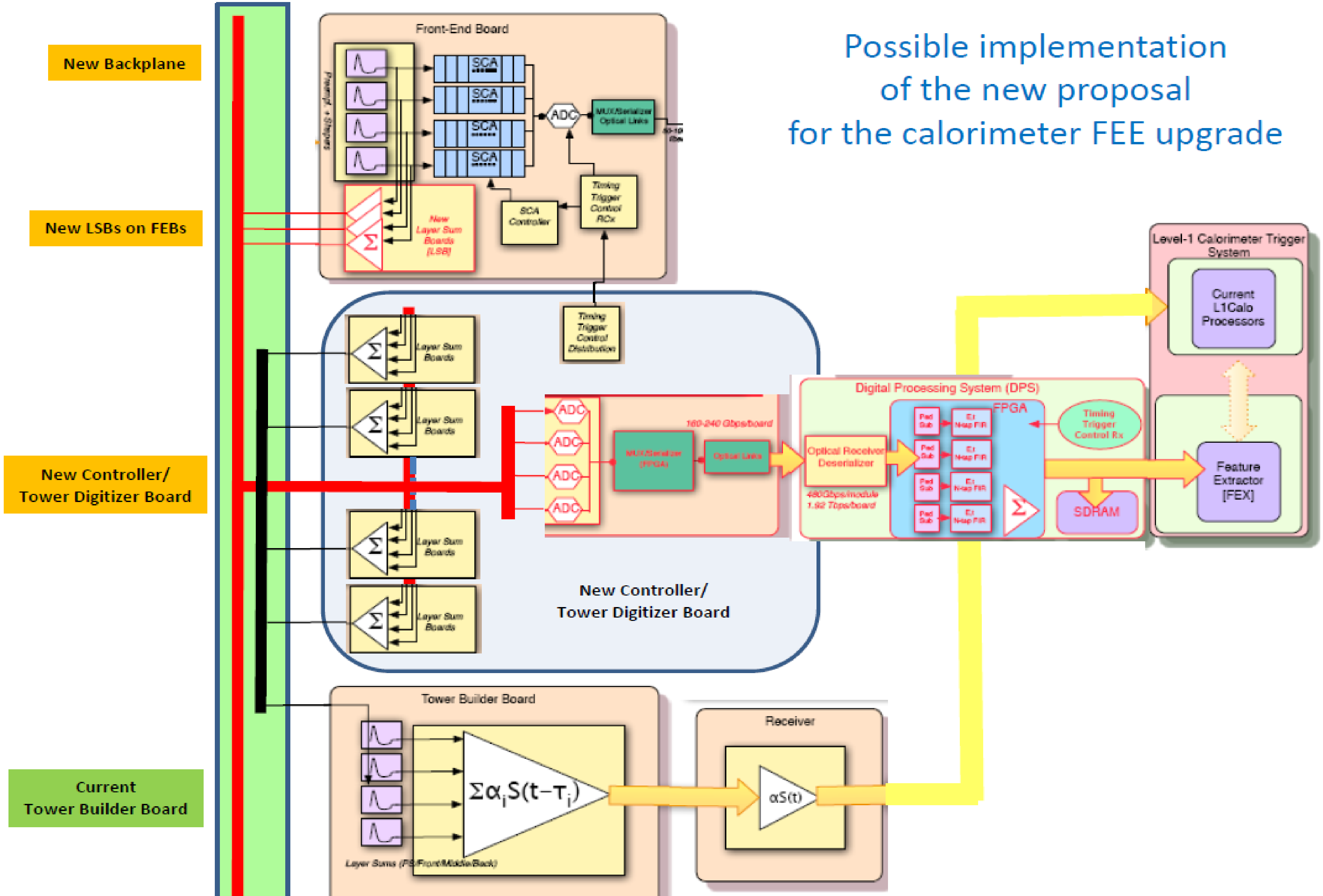
- Stratégie décidée: Réalisation de nouvelles cartes de numérisation pour les voies triggers

  LTDB = LAr Trigger Digitizer Boards

  - En parallèle du système actuel (solution « TBB mixte» (US) rejetée)
  - Cartes dans les crates Front-End
    - Modification des "baseplanes"
    - Signaux trigger: cartes frontend => LTDB's => numérisation => fibres

      ||=> Layer sums => Tower Builders actuels

Possible implementation of the new proposal for the calorimeter FEE upgrade

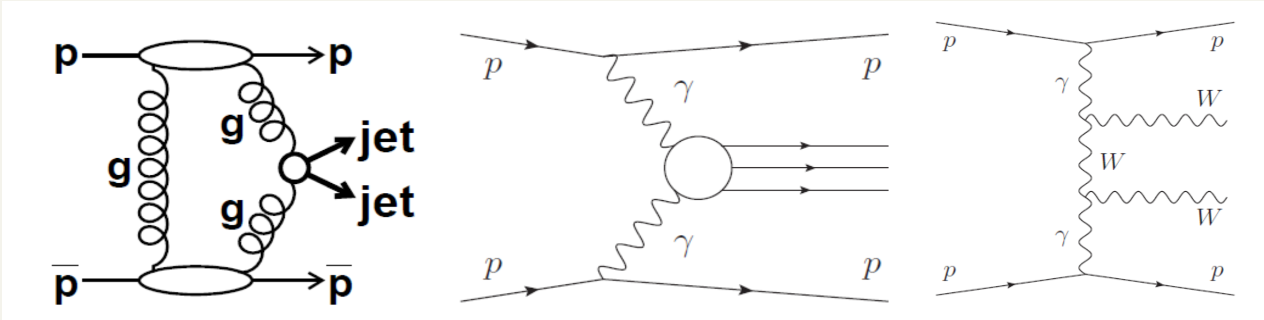


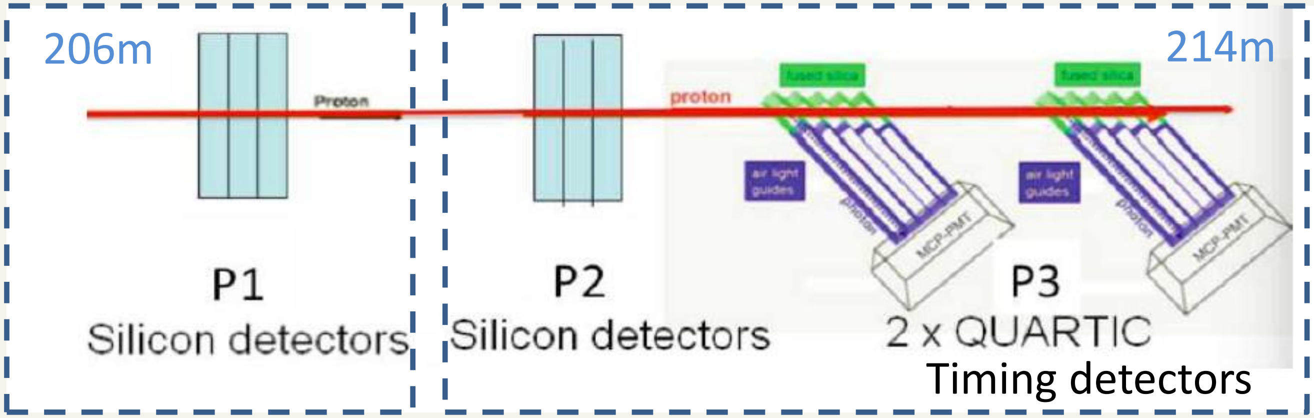
Upgrade calo: Situation aujourd'hui

- Saclay + LAL : proposent de prendre en charge ensemble la partie analogique du nouveau système:
  - baseplanes
  - Cartes mères LTDB *[cartes numériques = mezzanines]*
  - Mise en forme signaux avant numérisation (gain, temps de montée…)
  - Sommations analogiques (Layer Sum Boards)
- Saclay micro-électronique « intéressé » à participer à un (ou plusieurs) chip du numériseur, suivant évolution: ADC, multiplexer, serializer…
- Financement envisageable pour le projet: entre 0.5 et 1.0 Meuros (suivant type et taille de la participation).

- Hervé Deschamps a commencé sur le projet:
  - Reprise des simulations de la chaîne analogique de Xavier de la Broise.
  - Génération de fichiers de pulses pour nous et pour la collaboration
  - Discussions dans la collaboration.

ATLAS Forward Project (AFP)





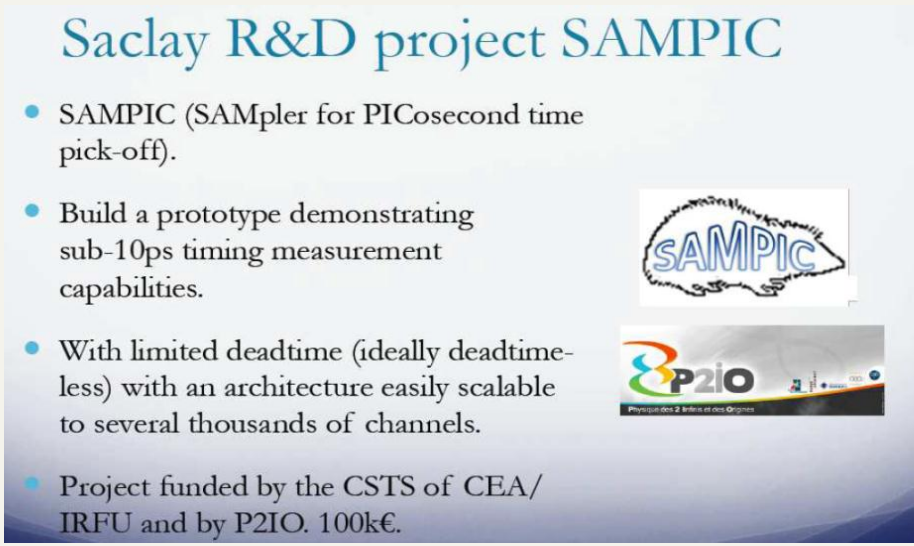
Reminder:

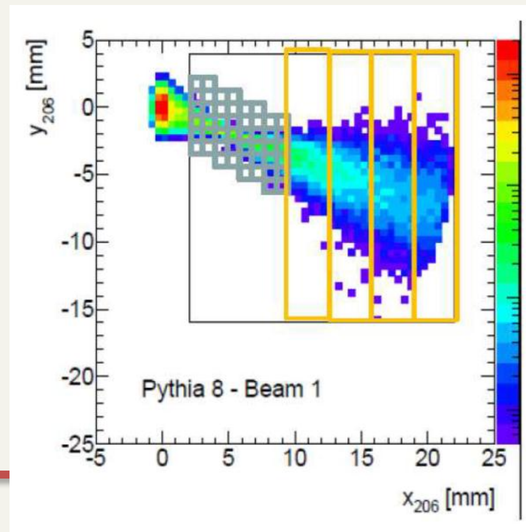
- Installation of movable beam pipes and 1 Si (3D, IBL type) and 1 timing detector on both sides by the 2013-14 shutdown
- 2015: installation of second Si detector during the Christmas shutdown
- 2017: installation of upgraded Si (3D edgeless) and timing detectors

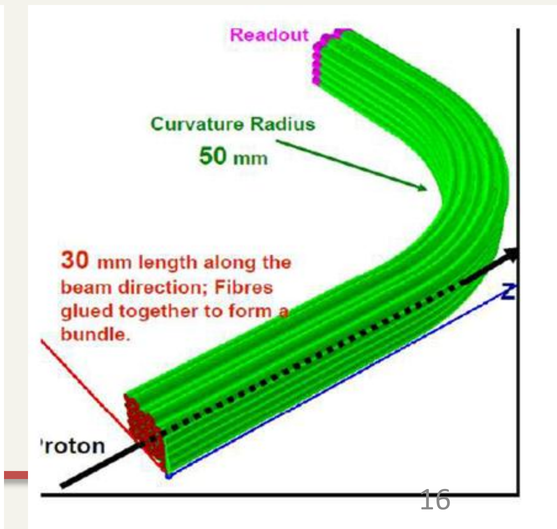
AFP: Saclay involvement

Position detectors (Si: 15μm):
- Phase 0: Use 3D Si detectors developed for IBL
- Phase I detectors: edgeless 3D in progress at SLAC
- Mechanics: study in progress in Saclay including cooling, alignment studies, being discussed with lab building prototype (Patrick Ponsot, Nathalie Grouas)

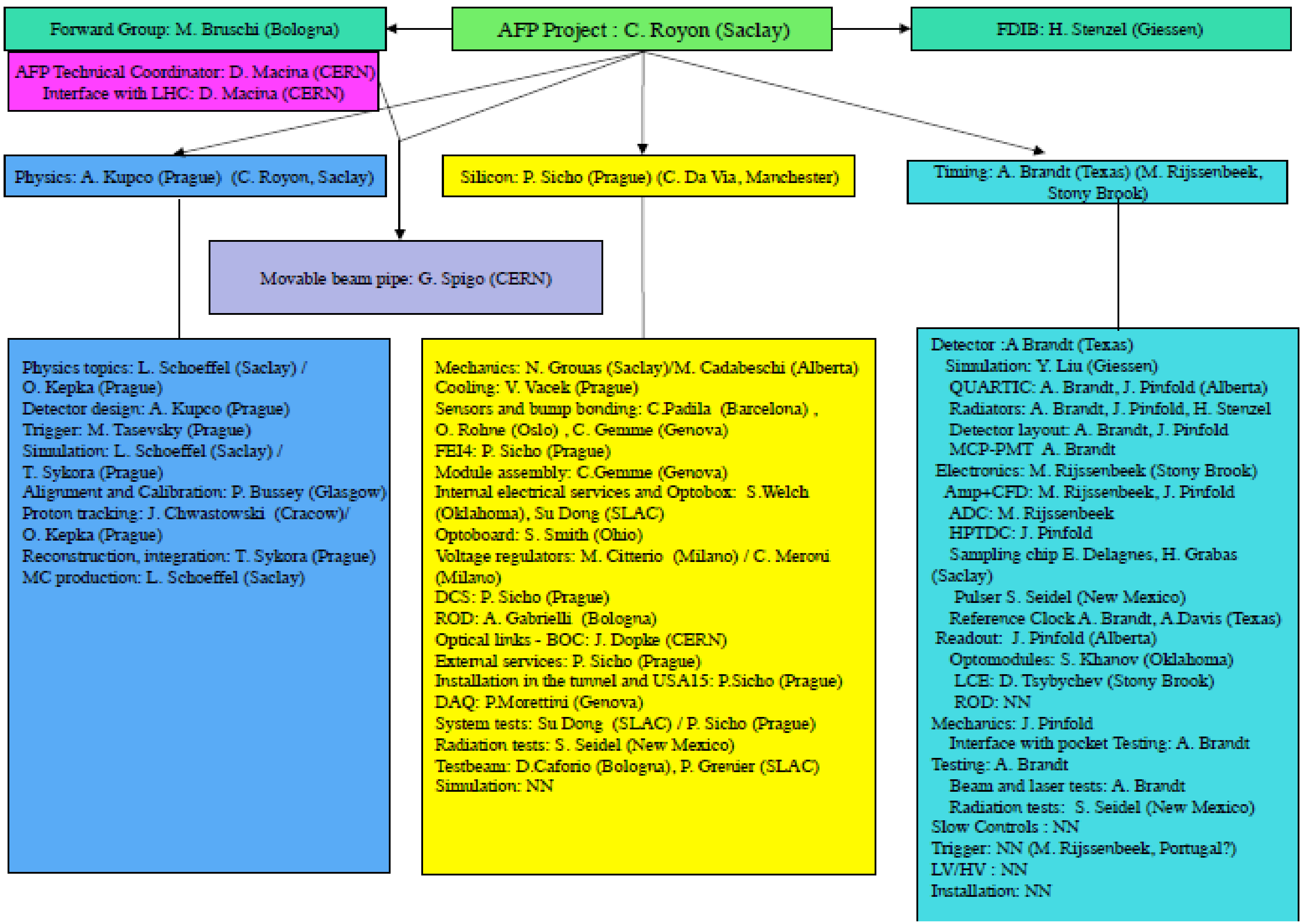
Timing detectors (10ps):
- Phase 0 timing detector: QUARTIC with 4 × 8 bars (each proton crosses 8 bars)
- Phase I detector requires better segmentation close to the beam
- Saclay can have a bigger impact on AFP and build the phase I timing detector **if resources allow.**
- Electronics for phase I: SAMPIC developed in Saclay (E. Delagnes, H. Grabas)







AFP organisation chart



AFP time line

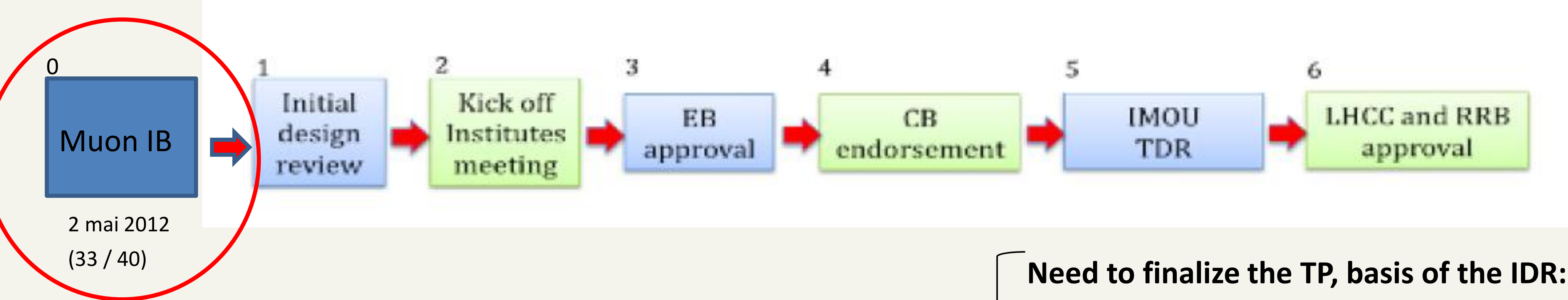
- AFP included in ATLAS Upgrade LOI: LOI was officially approved by the ATLAS collaboration at the previous ATLAS collaboration meeting (Feb 2012)
- AFP was presented at the last LHCC (C. Royon, Tuesday March 20):

> - The physics case for the AFP detector rests on the capability of using a proton double tag to constrain the centrally produced system and includes Higgs production and WW final states in a high-luminosity environment. Superb timing, at the 10 ps-level, will be required to associate the proper primary vertex and remove accidentals. Whereas the technical viability of the approach will have to be demonstrated this detector extends the physics capabilities without interfering with the upgrade work on the detector proper.
> - **The LHCC endorses the LOI and encourages the collaboration to present its plans to the RRB and FAs and to proceed to the next step of detailed TDR's for each upgrade.** 10

- AFP well received at April 2012 RRB meeting, funding plan approved
- TDR: due by November 2012, to be discussed at next AFP collaboration meeting on June 11/12
- Next Upgrade Steering Committee (June 28): define number of FTE from each institute and responsibilities within AFP
- Kick-off, physics and technical meetings in September, followed by an EB and CB vote at the October collaboration meeting
- Final AFP approval: 1st collaboration meeting in 2013 (January?) for an installation at the end of 2013/beginning of 2014
- MoUs: start writing them, IMoUs due by end of 2012

Back-up

NSW: procedure d'approbation

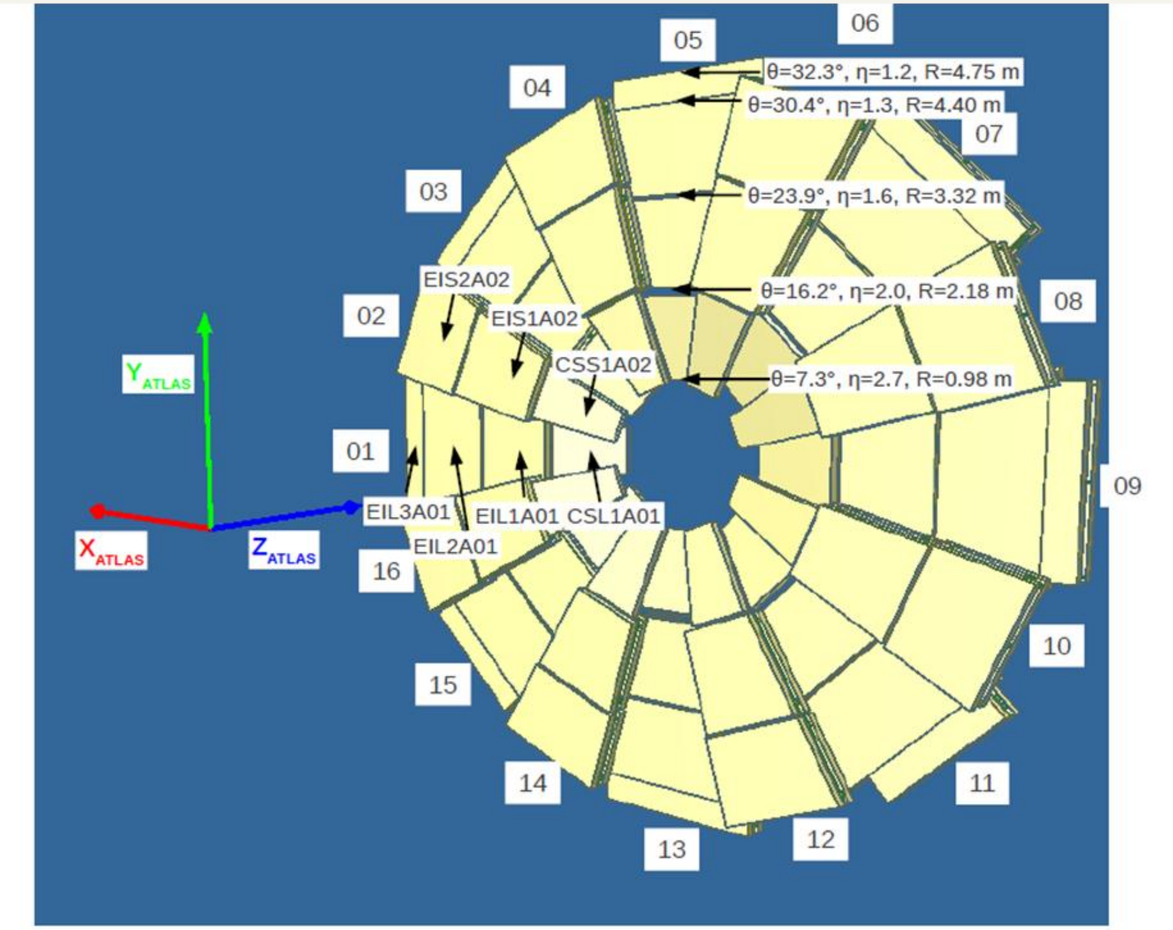


- Proposed timeline for the Approval process:
- Initial design review: August 29-30
- Kick off Meeting: August 31
- EB approval: September 14
- CB approval: October 5
- TDR & IMOU: for the spring RRB (April)

Need to finalize the TP, basis of the IDR:
- Specify the preferred solution
- Work out an initial mechanical design
- Define an initial chamber's layout
- Define number of electronics channels
- Work out a realistic **cost estimate**
- Simulation results

We should arrive to the Kick-off meeting with a reasonable proposal for **sharing the responsibilities** (avoiding the first-in first-served schema)

NSW: Mechanical requirements



TDR performance goals: (1997)

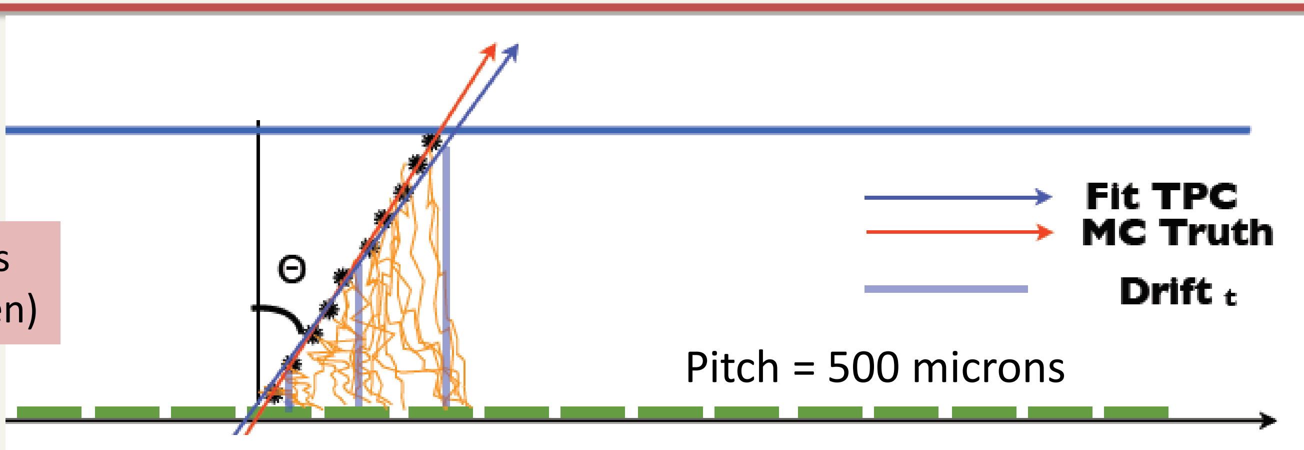
- Global detector performance goal: $\sigma(p_T)/p_T$ = 10% at p_T=1 TeV
- Total alignment performance goal: σ(sagitta) = 30 µm
- Mechanical tolerance of drift wires: 20 µm (r.m.s.)

Achieved performance: (2012)
(work in progress)

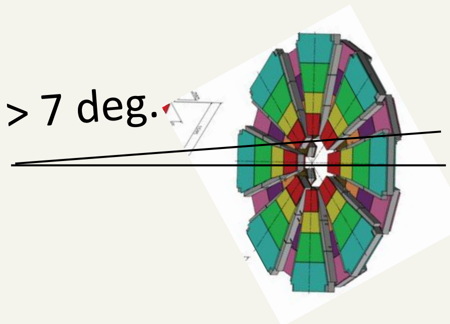
- Global detector performance: $\sigma(p_T)/p_T$ ~ 15% at p_T=1 TeV (depends on detector region)
- Total alignment performance: σ(sagitta) ~ 60 µm (depends on detector region)
- Mechanical tolerance of drift wires: 20-30 µm (r.m.s.) (depends on construction site)

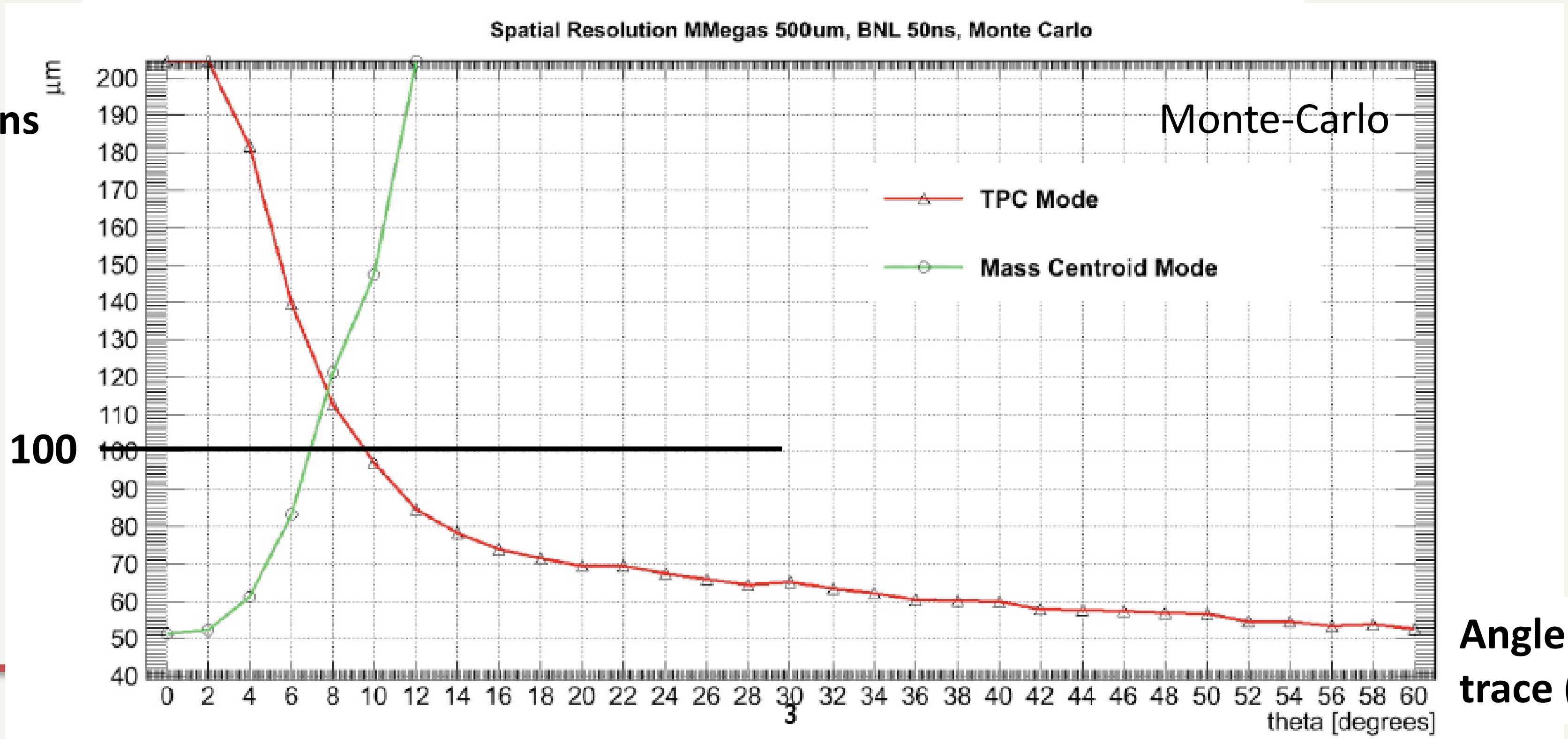
Résolution spatiale d'un plan MM

G.Iakovidis
(NTU Athen)



Θ > 7 deg.





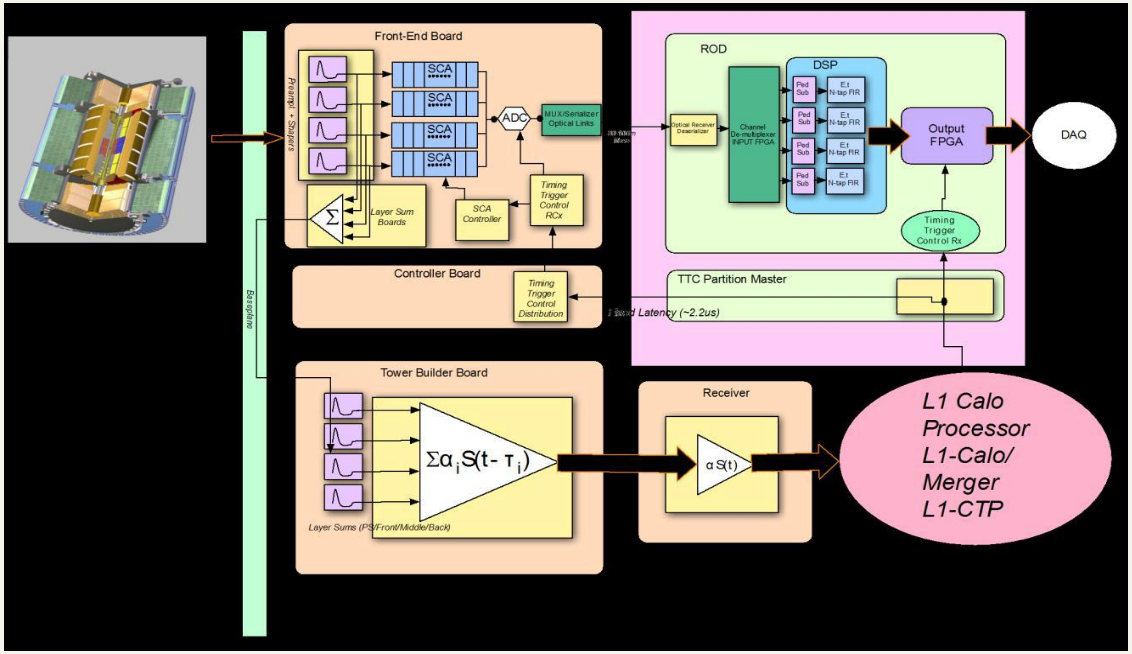
Angle de la trace (deg.)

Upgrade LARG -Electronique

- **Electronique actuelle:**
  - **Située dans les “Front-end Crates” sur les cryostats**

- **Lecture:**
  - **Pipe-Lines analogiques (Saclay et al.) (3 par voie: x1, x10, x100) 40 MHz, 144 cells**
  - **Numérisation si L1 accept: 12 bit 5MHz;**
  - **Transmission fibres optiques 1.6 Gbps**

  Conso: 0,7 W/voie !



- **Trigger:**
  - **Sommation analogique**

  $\Delta\eta\Delta\phi$ 0.1x0.1

  Par couche PS, EM1, EM2, EM3

  En tours PS+EM1+EM2+EM3
  - **Transmission signaux tours: câbles Cu**
  - **Hors caverne: Numérisation, Trigger Processor**

AFP: collaborators and cost estimate

- Canada: Alberta, Toronto
- Czech Republic: Prague (Institute of Physics, Charles university, Technical university), Olomuc
- France: Saclay
- Italy: Bologna, Genova, Milano
- Norway: Oslo
- Poland: Cracow (PAN, AGH)
- Spain: Barcelona
- Switzerland: CERN¡ University of Geneva, Bern
- UK: Glasgow, Manchester
- USA: Stony Brook, University of Oklahoma, Texas Arlington, Oklahoma State University, University of Oklahoma, New Mexico, SLAC

Costs (kCHF)

Det.	Type	Total	2012	2013	2014	2015	2016
Si	sensors	33		8	8		17
	FE-I4b	33		8	8		17
	Bump-bonding	220		55	55		110
	mechanics	103		26	26		52
	Assembly	97		24	24		48
Si Elec.	Readout	113		57			57
	Power	56		28			28
	cooling	110		55			55
	Integration	44		22			22
Movable Beam pipe		944	235	414	295		
Timing	Det.R& D	72	60	12			
	proto		50	50			
	final	201			101	101	
Elect.	R & D	18	18				
	Proto	93		93			
	Elec.	161			161		
	trigger	8			8		
	Ref. clock	45			45		
Tunnel	cables	100		50	50		
	HV, LV	90		45	45		
Total		2702	332	1042	877	101	350

Proposed Sharing of Phase 1 by Funding Agency

(Payments, in MCHF) DRAFT

4/5/2012

Funding Agency	nSW	LAr-E	TileC	FTK	TDAQ	AFP	total	technology options
Argentina							0.1	
Armenia							0.1	
Australia							0.1	
Austria							0.1	
Azerbaijan							0.1	
Belarus							0.1	
Brazil							0.1	
Canada							1.0	
Chile							0.1	
China NSFC+MSTC							0.1	
Colombia							0.1	
Czech Republic							0.1	
Denmark							0.2	
France IN2P3							1.5	
France CEA							3.0	1.2
Georgia							0.1	
Germany BMBF							3.0	
Germany DESY							0.4	
Germany MPI							0.5	
Greece							0.3	0.7
Israel							1.7	
Italy							2.5	
Japan							0.9	0.9
Morocco							0.1	
Netherlands							0.7	
Norway							0.3	
Poland							0.1	
Portugal							0.1	0.1
Romania							0.1	
Russia							1.5	
JINR							0.4	
Serbia							0.1	
Slovak Republic							0.1	
Slovenia							0.1	
South Africa							0.1	
Spain							0.7	
Sweden							0.6	
Switzerland							1.1	0.4
Taipei							0.1	
Turkey							0.1	
United Kingdom							2.5	
US DOE+NSF							7.6	2.3
CERN							3.4	
from deferrals							0.0	
from M&O (A+B)							0	0
total sub-detector	0.0	0.0	0.0	0.0	0.0	0.0	36.0	5.6
target (TDR)	9.3	8.0	0.4	3.6	12.0	2.7	36.0	

Notes:

1. All figures are tentative and indicative, while waiting for further clarifications from the Funding Agencies.
2. In some cases, they represent funding requests submitted, or being submitted.
3. Sub-projects of tentative interest are highlighted in yellow, subject to technology choices.
4. Column "technology options" indicate possibility of supplementary contributions, subject to technology choices.