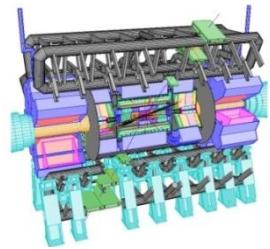


Upgrade Atlas in view of HL-LHC



- Why HL-LHC

Ph.S. - Cavern background
 - Micromegas : how to build a precision chamber

J.M. - Performance of anode-resistive Micromegas for HL-LHC

F.J. - Ageing studies of Micromegas

A proposal of building
new muon small wheels :
the NSW project

Draft 0.05 15.10.2011

[Abstract](#)

[abstract](#)

1 Introduction [TK]

The physics goal of the LHC includes among others discovery of Higgs boson, SUSY particles if they exist and other possible heavy particles which have not been explored at lower energy colliders. Once discovered the nature of what have been discovered should be studied in detail, and much data will be needed for it. Large integrated luminosity also allows access to rarer processes and higher centre-of-mass energies of colliding partons. Hence there is a plan of LHC upgrade by increasing its luminosity beyond the design value allowing for collecting much higher integrated luminosity than initially considered.

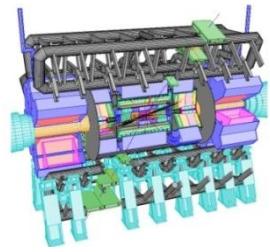
+ Lol - Atlas upgrade
(document in preparation)

Ph.Schune, J.Manjarrés, F.Jeanneau for the
Irfu – Atlas-MAMMA group

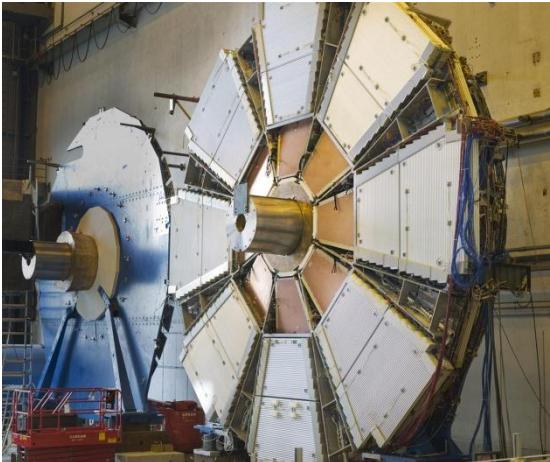
(D.A., M.B., Fl.B., G.C., E.F.-R., Javier G., A.G., P.-F.G., S.H., ...)

+ discussions with Saclay experts (I.G., Ph.D.-Th, P.Po., A.D., S.A., M.T., J.D., P.C., E.D., D.C., etc...)
 + discussions with CERN, Atlas experts (R.de.O., V.P., J.W., etc...)

New small wheel chambers proposals



$r \sim 5\text{m}$

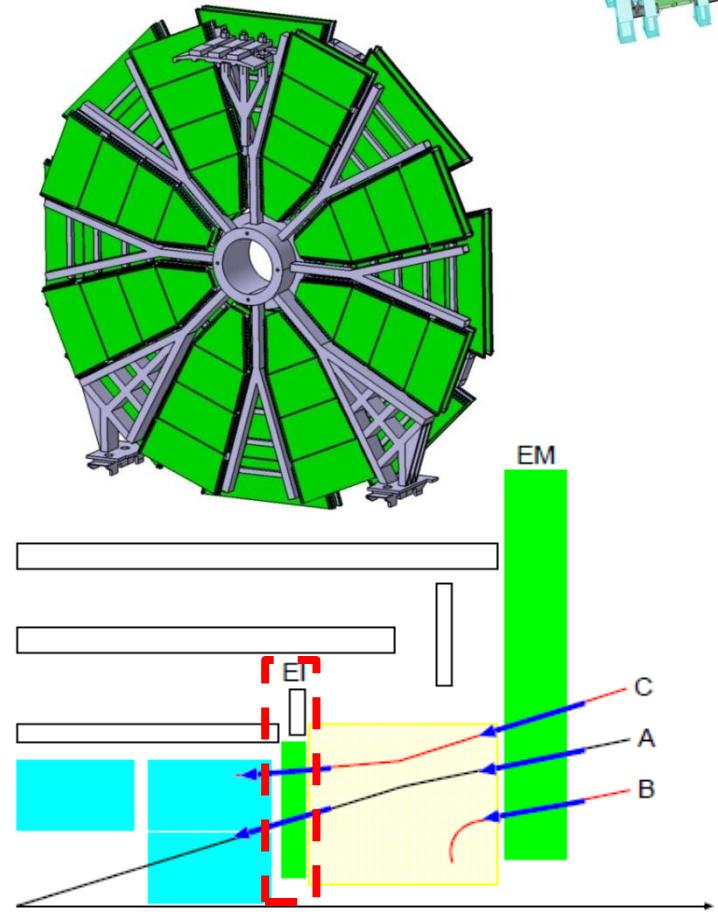


today -> HL-LHC



Present Small wheel equipped with:
MDT, CSC, TGC (2nd coor.)
 $r \sim 5\text{m}$

Resolution of a whole chamber ~50 microns !



L1 trigger resolution <1mrad
Otherwise trigger saturation

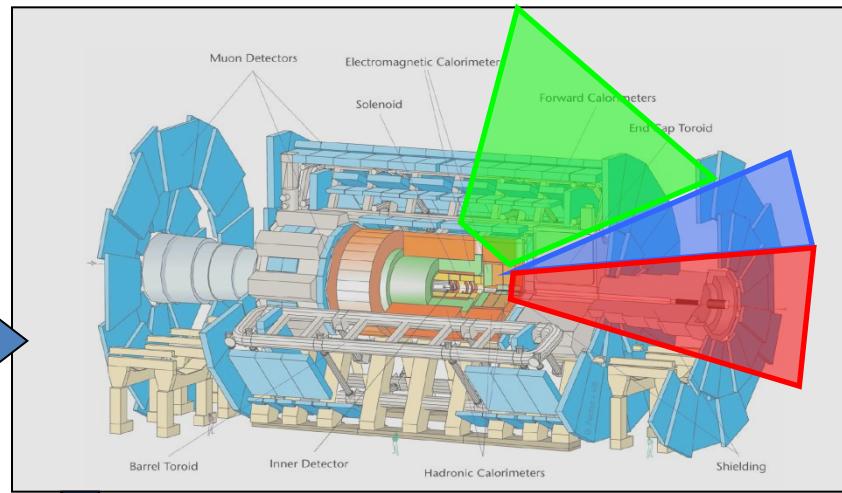
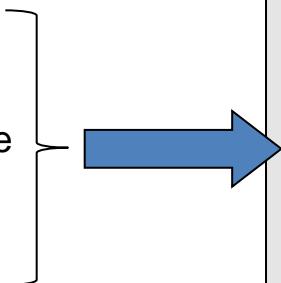
New Small wheel proposal (e.g. Micromegas)
Should also provide L1 trigger information (<1.2μs)

Background in Atlas cavern

Background comes from residues of p-p interactions

(through spallation process) :

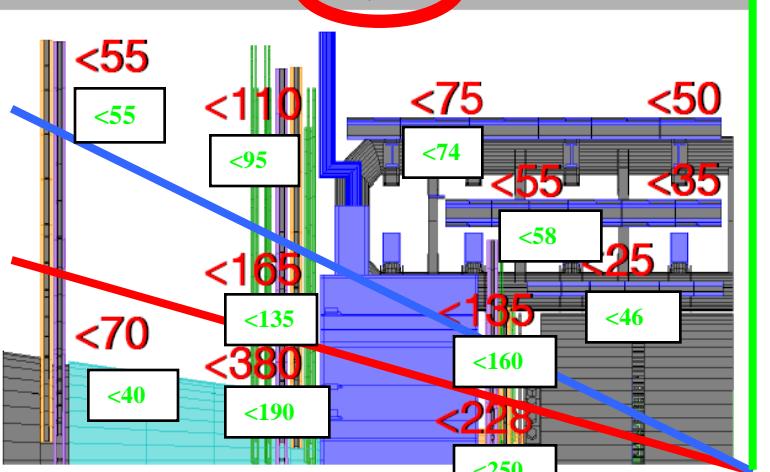
- Huge production of *neutrons*, thus creating γ , thus creating e, etc...
- Also at higher energy, n and γ create ionizing particle (mainly: p, e+, e-)
- Direct background: μ and punchthrough (smaller)



Neutron "gas" in the cavern
(-> therm. of neutrons)

$E_{\text{cin}}=10 \text{ MeV} : v_n \sim 15\% c$ (23 ns pour 1m)
 $10 \text{ keV} : \sim 5 \cdot 10^{-3} c$ (0.7 μs pour 1m), out of time

Background count rates [kHz/tube] at $L = 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$



(Numbers include a safety factor of 5.)
 • pp x section for part. prod. (~1.2)
 • had. propagation in calo. and shielding (~2.9)
 • γ efficiency in chambers (~1.4)

High rates in Small Wheel chambers
=> should be changed

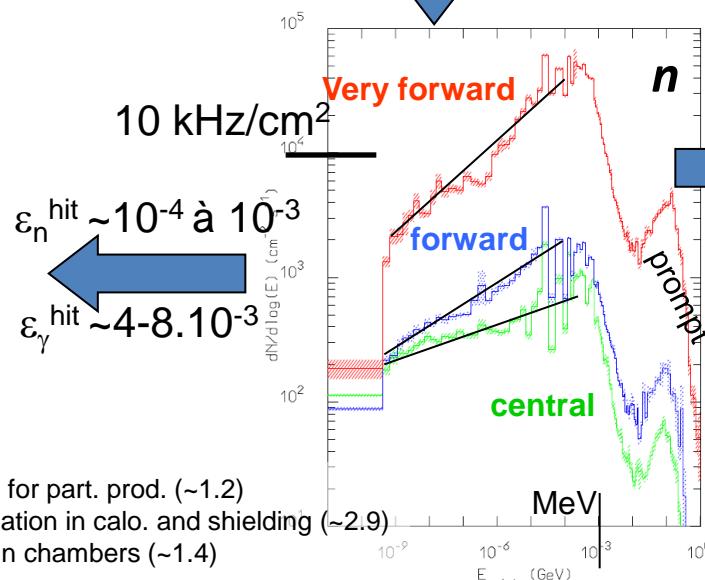


Figure 5-67 The expected neutron flux as a function of neutron energy in different rapidity regions of the muon spectrometer (top curve: $2.3 < \eta < 2.7$, middle curve: $1.4 < \eta < 2.3$ and bottom curve: $\eta < 1.4$).

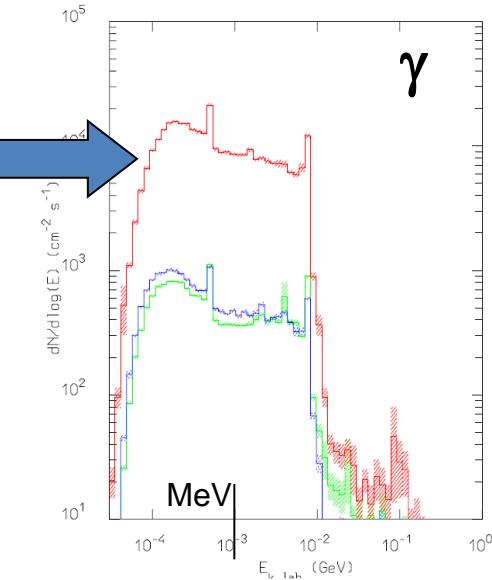
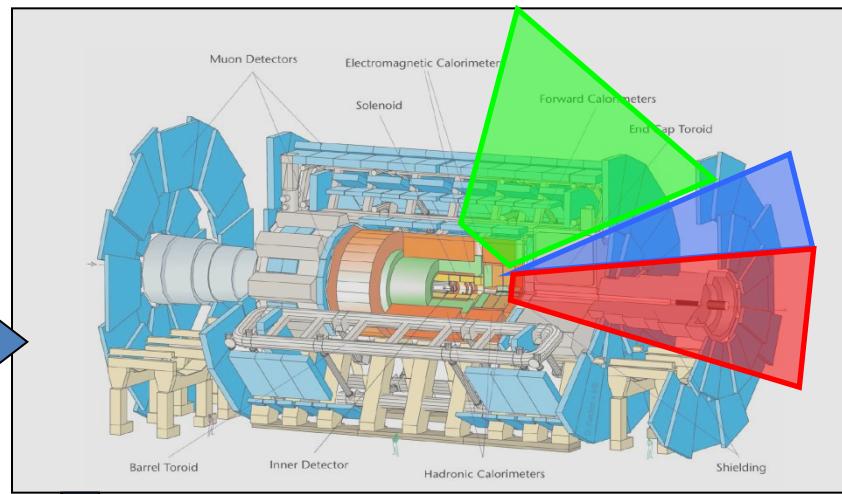
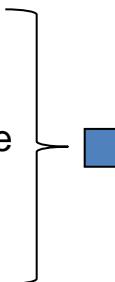


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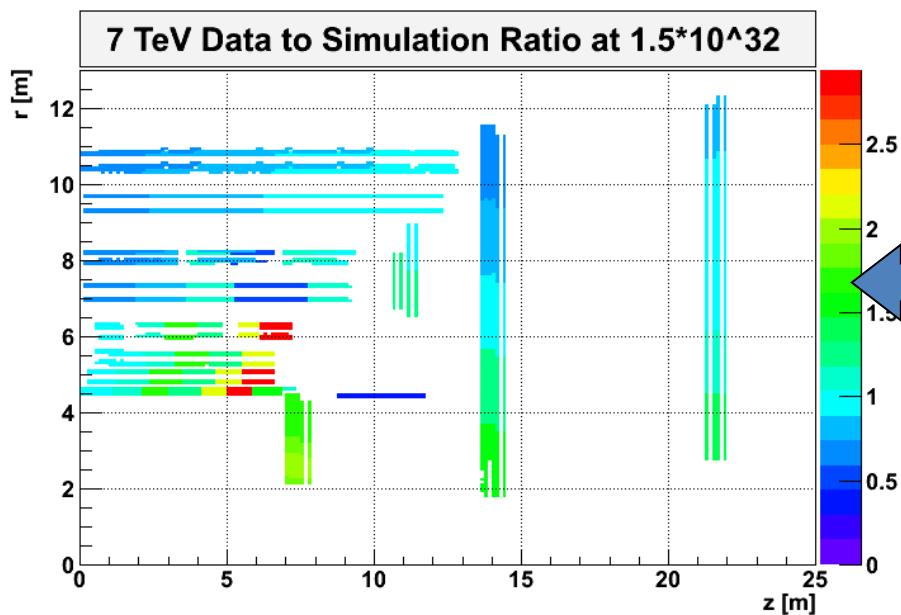
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(last simulation : security factor only $\sim x2$)

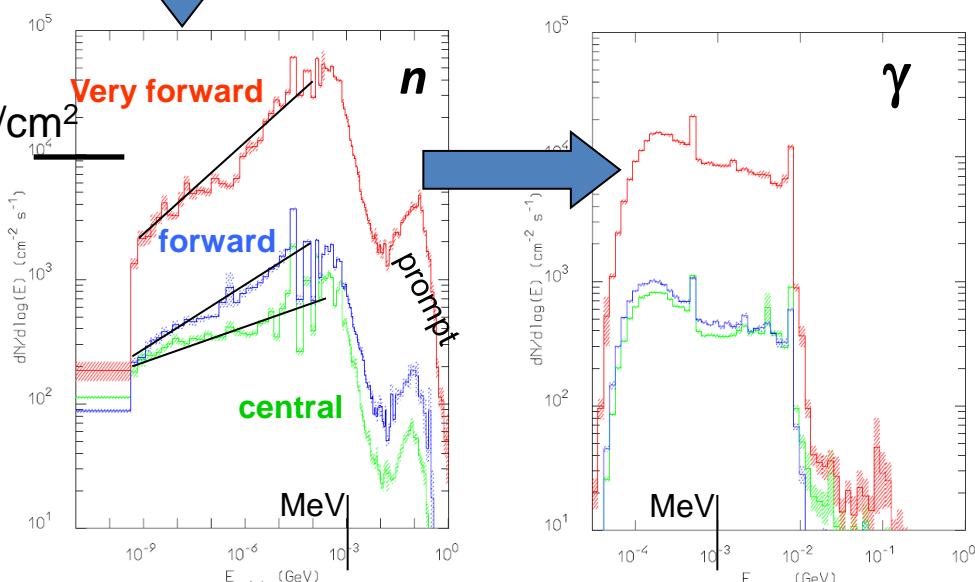


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- **Electroweak Physics (precision measurements)**
 - production of multiple gauge bosons ($n_V \geq 3$)
 - triple and quartic gauge boson couplings
- **Higgs physics (if Higgs discovered at LHC)**
 - Higgs rare decay modes
 - Higgs couplings to fermions and bosons
 - Higgs self-couplings
 - Heavy Higgs bosons of the MSSM
- **Strongly-coupled vector boson system (if Higgs not seen at LHC)**
 - $W_L Z_L, Z_L Z_L$ scalar resonance, $W_L^+ W_L^+$

And beyond standard model:

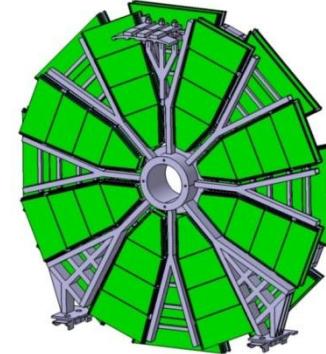
- **Supersymmetry**
 - Multi-TeV squarks and gluinos
- **Extra Dimensions**
 - Direct graviton production in ADD models
 - Resonance production in Randall-Sundrum models
- **New Gauge Bosons Z'**
- **Compositeness**
 - Quark substructure

*Le but est de mesurer les paramètres des particules trouvées et/ou des modèles testés
—A.Djaoudi— (Higgs in Saclay)*

Remarque : Il vaudrait mieux monter en énergie plutôt qu'en luminosité...
(et si possible les deux)

Precise Micromegas assembly

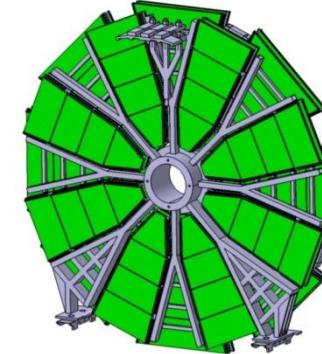
**Question : for Atlas, how to built a precise Micromegas chamber
i.e. with an internal precision of ~ or < 40 microns ?**



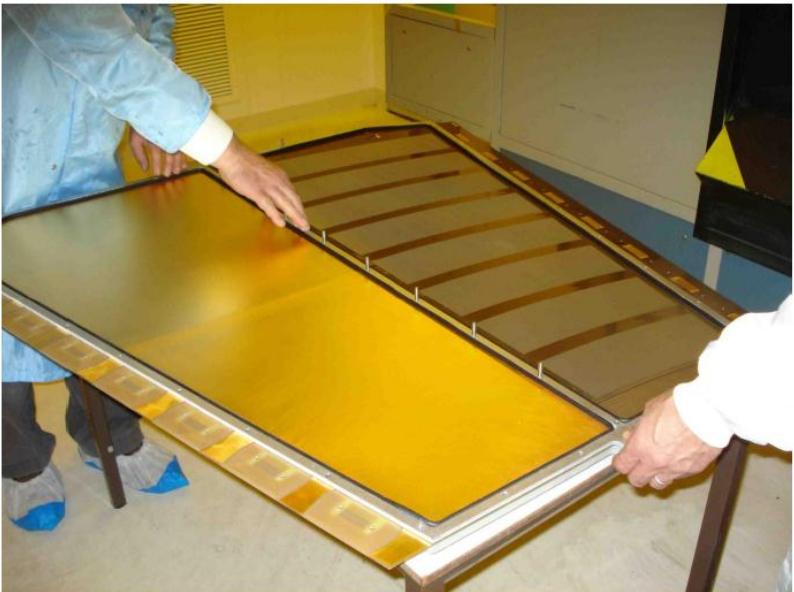
r~5m

Precise Micromegas assembly

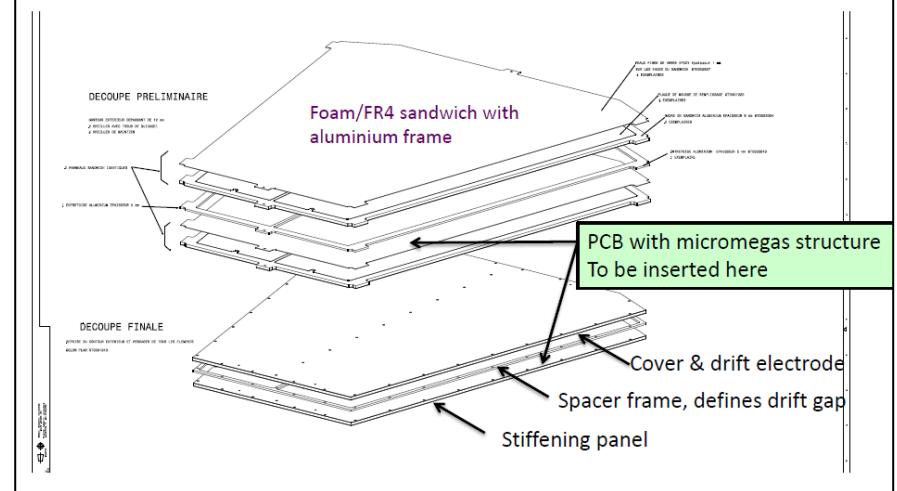
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i.e. with an internal precision of ~ or < 40 microns ?



r~5m



Mechanics – detector housing



- with new machine in Rui's lab go to up to ~1m chambers
- long strip capacity (< 10 pF / 10 cm)
- small-wheel channel # : ~2 M-channel (0.5 mm pitch)
- Next step : industrialize "bulk" + mesh support production (including resistive layer)

R.De Oliveira et
J.Wotschack

Precise Micromegas assembly

CSC internal structure problem:

- Positioning pins “area” not enough reinforce
- Drilling directly on fiber-glass: not enough precise
- etc...

⇒ CSC layer may slide and rotate w.r.t. other layers

Remark: have been corrected using tracks (but still parallelogram effect uncorrected)

Micromegas assembly:

Use of PCB + reinforce foil (Al., thickness to be determine)

+ PCB corners should be reinforced (see following slides)

+ have a special procedure (we are still thinking)

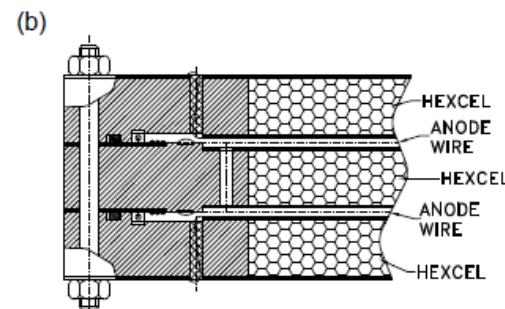
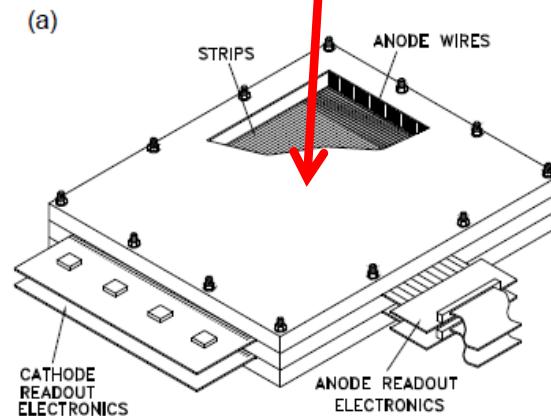
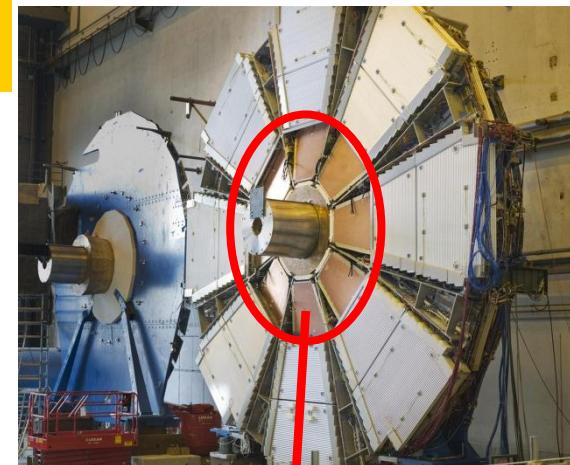


Figure 1: A two-layer module of the Cathode Strip Chamber.

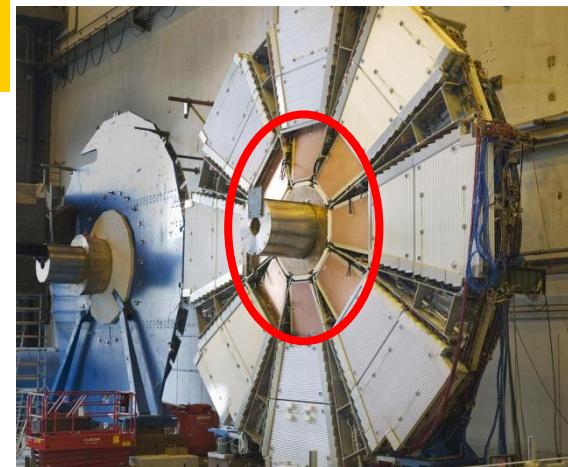
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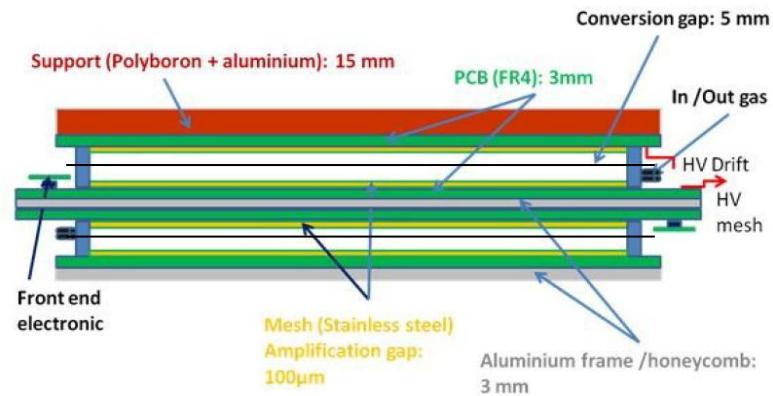
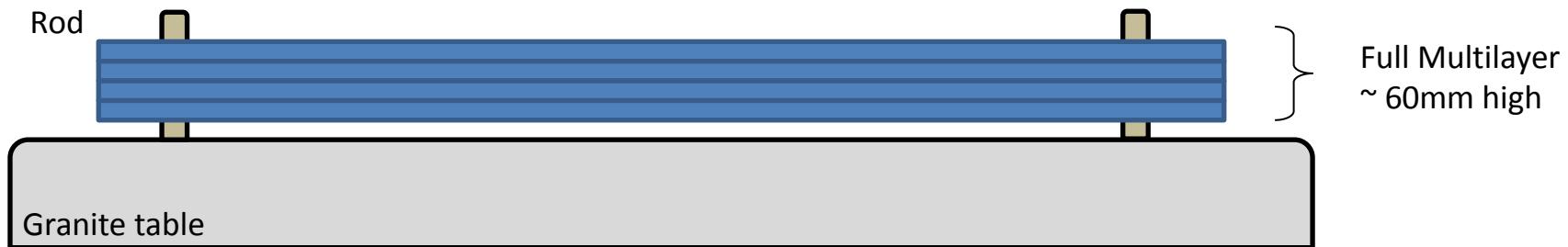


Figure 20 : Schéma d'un demi-multi-couches

Precise Micromegas assembly

How to built precisely (<30 microns) such a chamber ?!

Two rods, fixed on a granite table and fitting perfectly with the holes previously drilling in PCBs, enable a precise alignment between the inner detectors of a multilayer



Two options are possible:

Solution (1) : assemble each Multilayer one by one

Solution (2) : assemble half a Multilayer (4 half ML), i.e. like MDT assembly: spacer are used for final precision positioning

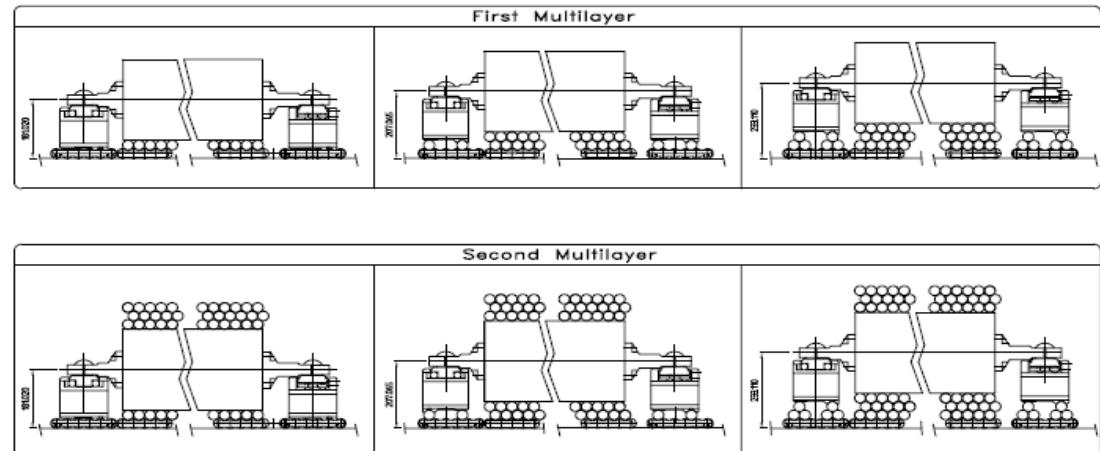
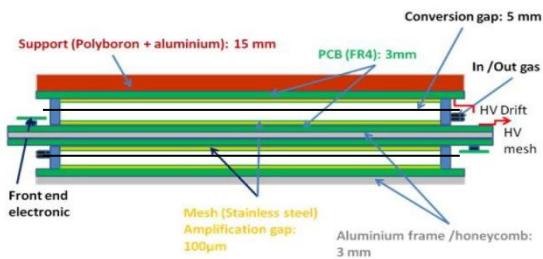
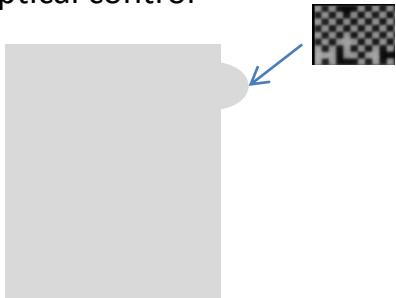


Figure 20 : Schéma d'un demi-multi-couches

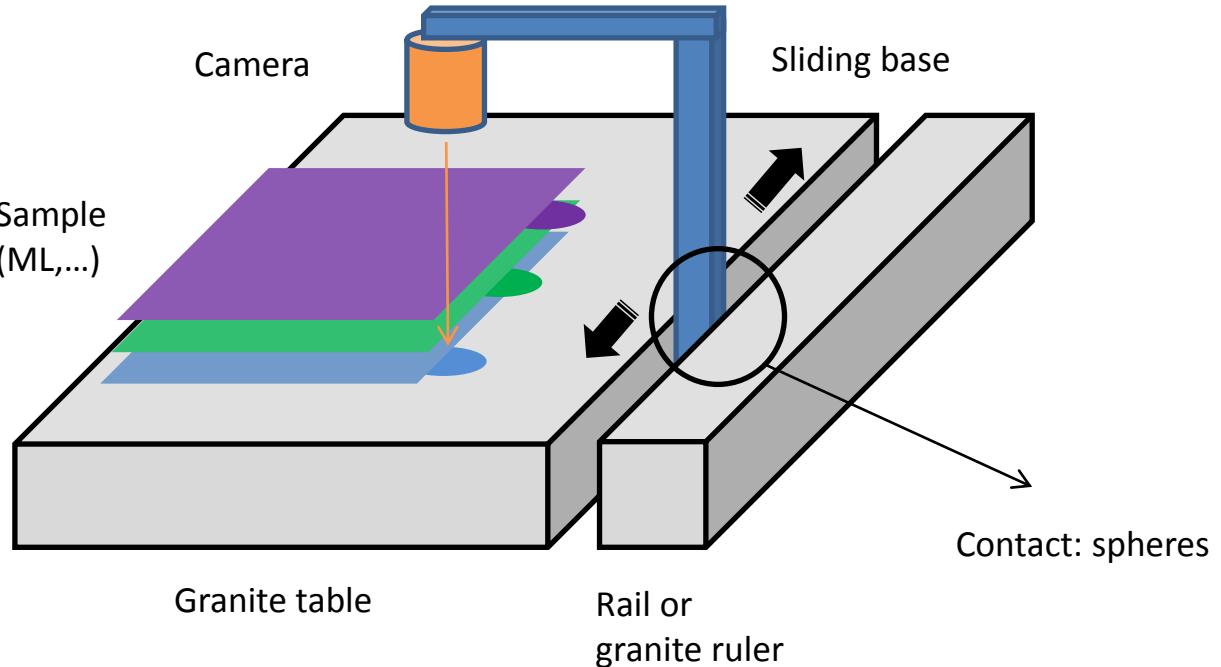
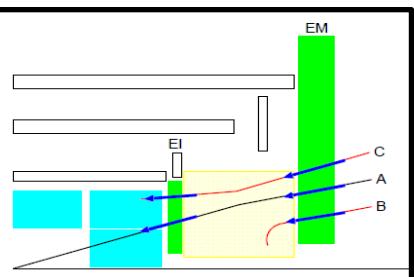
Quality and control

Have PCB with extension for optical control



For Micromegas technique, each (full) layer position depends only on 3 parameters: x_0 , y_0 , theta

- a camera-control on granite is possible
- a cosmic stand may be used



(some) pending questions:

Multilayer or half-a-Multilayer assembly ?

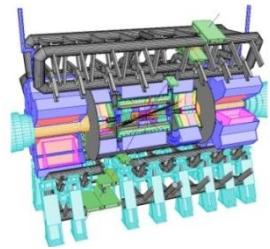
How to control PCB plane deformation ?

Material for spacer/X-plates ?

Duration of a full chamber assembly ?

Can we use Mask on PCB also for positioning w.r.t. existing alignment ? (or laser diode-LEDs)

Upgrade Atlas in view of HL-LHC



- Why HL-LHC

Ph.S. - Cavern background

- Micromegas : how to build a precision chamber

J.M. - Performance of anode-resistive Micromegas for HL-LHC

F.J. - Ageing studies of Micromegas

Ph.Schune, J.Manjarrés, F.Jeanneau for the
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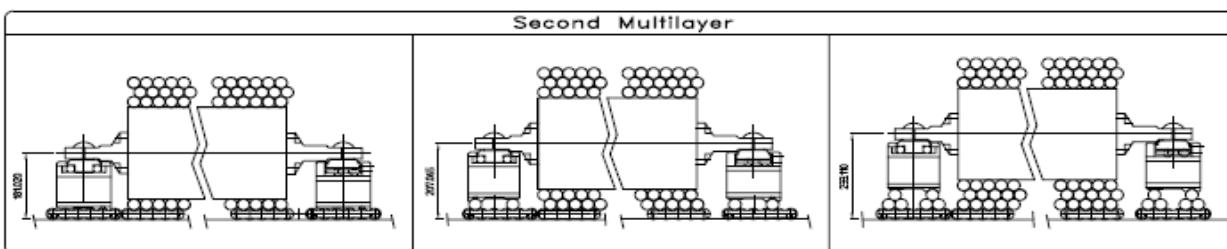
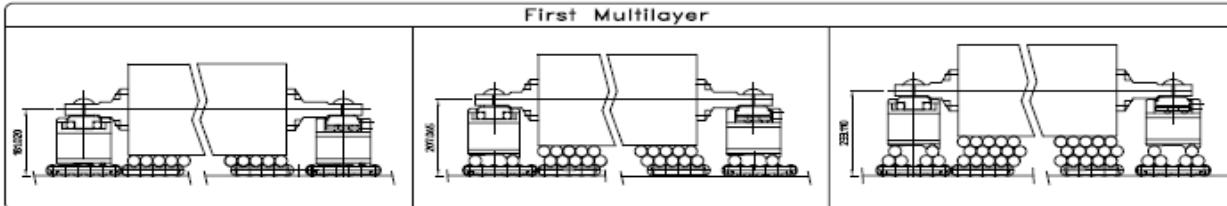
(D.A., M.B., Fl.B., G.C., E.F.-R., Javier G., A.G., P.-F.G., S.H., ...)

+ discussions with Saclay experts (I.G., Ph.D.-Th, P.Po., A.D., S.A., M.T., J.D., P.C., E.D., D.C., etc...)

+ discussions with CERN, Atlas experts (R.de.O., V.P., J.W., etc...)

Rab...

Multilayer assembly



Pending question: how long for assembling precisely a chamber (a Multilayer ?)

One can do something similar to MDT-chamber:

1- mount the spacer structure on spheres in contact with the cross-plates

2- Install (half) a ML on granite with rods, and glue it on the spacer

3- lift up and rotate the structure (monitoring the in-plane alignment)

3- install the second (half) ML

...

Remark : Cross-plates are positioned on granite via precise towers

As for MDT assembly, non-shrinking glue (3M DP-490) is used.

LHC schedule

New rough draft 10 year plan

Not yet approved!

2010	2011	2012	2013	2014	2015	2016
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D	J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D	J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D	J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D	J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D	J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D	J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D

LHC



4 or 5
TeV?
p-Pb
run

> 10 fb⁻¹

Machine: Splice Consolidation & Collimation in IR3
ALICE - detector completion
ATLAS - Consolidation and new forward beam pipes
CMS - FWD muons upgrade + Consolidation & infrastructure
LHCb - consolidations
?Cryo-collimation point

6.5 TeV?

LS1 + long si connection
du Linac-4 !

X-Mas maintenance

Linac-2->4 : 50->160 MeV

Gain en sortie du SPS : 1.15 -> >1.3.10¹¹ p/bunch

Injectors



Pile-up :

~3

10 à 20

~40

SPS upgrade

? SPS - LINAC4 connection & ? PSB energy upgrade

2022

LHC



> 50 fb⁻¹

Maintenance

Machine: Collimation & prepare for crab cavities & RF cryo system
ATLAS: new pixel detect. - detect. for ultimate luminosity.
ALICE - Inner vertex system
CMS - New Pixel, New HCAL Photodetectors. Completion of FWD muons upgrade
LHCb - full trigger upgrade, new vertex detector etc.

300 fb⁻¹

X-t

2022

LS3

Installation
of the
HL-LHC
hardware

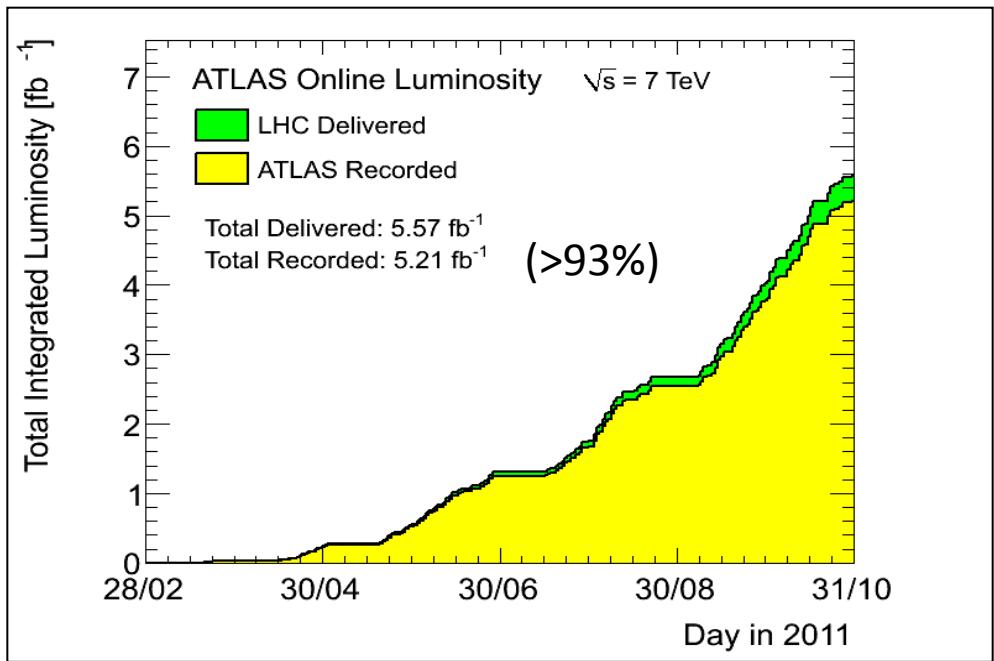
Injectors



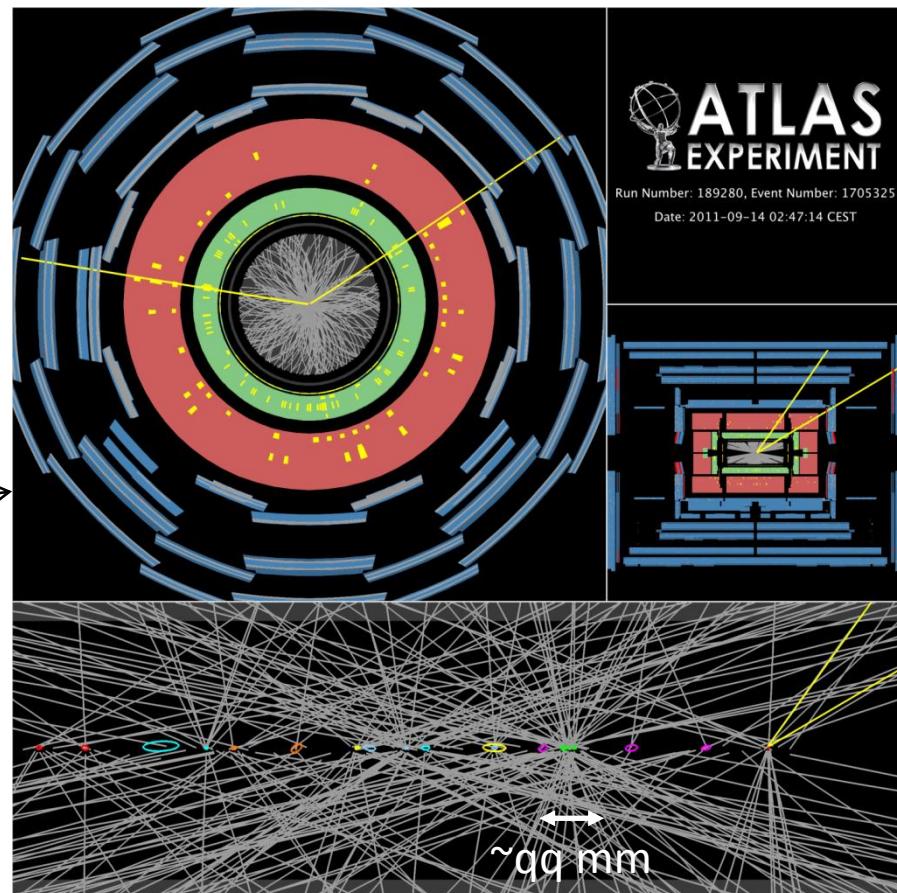
3000 fb⁻¹

+ d'infos après le workshop de Chamonix sur la machine LHC (01/2012)

Dernières nouvelles d'Atlas



Sunday 30 October at 17h : end of the
2011 p-p run
($L \sim 3.10^{33}$ et 50ns entre chaque X)

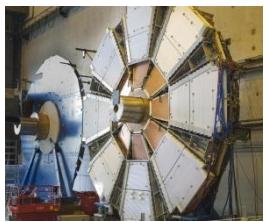


$Z \rightarrow \mu\mu$ with 20 reconstructed vertices

Event du 14/09/2011 ($\beta^* \sim 1m$)

p_T track threshold is 0.4 GeV and all tracks are required to have at least 2 Pixel and 7 SCT hits

The vertices shown are reconstructed using tracks with p_T greater than 0.4 GeV



Micromegas **choisies** par Atlas pour l'upgrade des Small-Wheel

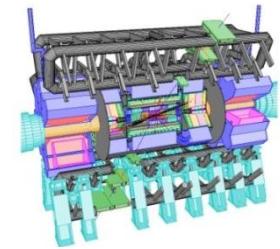


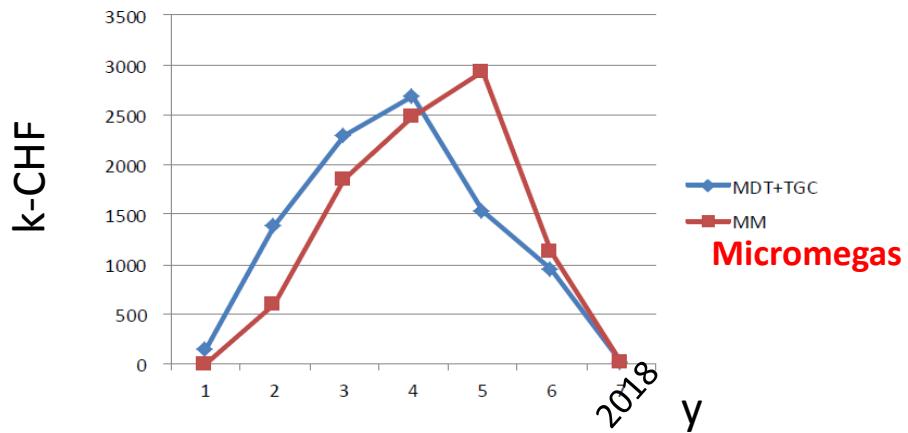
Table 19: Cost estimate (VERY VERY PRELIMINARY)

Item	Details	Nb of units	Cost/unit (CHF)	Costs (MCHF)
~1/3 ->	MM detectors	1024	2–3000/m ²	2–3
	Housing + supports	128	2–3000/pc	0.25–0.4
	Alignment			0.6
	Trigger, readout, LV	2 M	1.1/channel	2.2
	Front-end cards			0.6
	GBTx + fibres			0.4
	Cont. Addr. Memories			0.8
	Scalable Readout System			1.0
	HV supplies + cables	1280 ch	400/channel	0.5
	Gas distribution			0.1
TOTAL				8.5–9.6

(10/2011)

Voir document CSTS

CORE expenditures timeline for sMDT+TGC and Micromegas



Profil de dépense (total ~9 MCHF), incluant le travail d'installation et la mécanique l'alignement.
Le décalage du profil des dépenses s'explique par le retard des Micromegas à l'industrialisation.

Demande d'une implication de l'Irfu à hauteur de 10 à 15%. Cela permettrait :

- (i) D'avoir une visibilité sur le projet
 - (ii) D'acquérir une expérience et des compétences importantes sur :
 - Fonctionnement à haut flux
 - Industrialisation
 - Chambres multicouches
- (sans être trop exposé sur ce projet)

Cela représente déjà **~2x T2K-Micromegas** pour :
~100m² de détecteurs, ~200 k-canaux d'électronique à tester pour un investissement de ~1 M-euros.

Proposal to equip the New Small Wheel with Micromegas chambers

MAMMA Collaboration

Arizona, Athens (NTU, U, Demokritos), Brandeis, Brookhaven, U Carlton,
CERN, Istanbul (Bogaziçi, Doğuş), JINR Dubna, LMU Munich, MEPhI
Moscow, Naples, CEA Saclay, USTC Hefei, South Carolina, Thessaloniki

In collaboration with the CERN PCB workshop (Rui de Oliveira/TE-MPE)