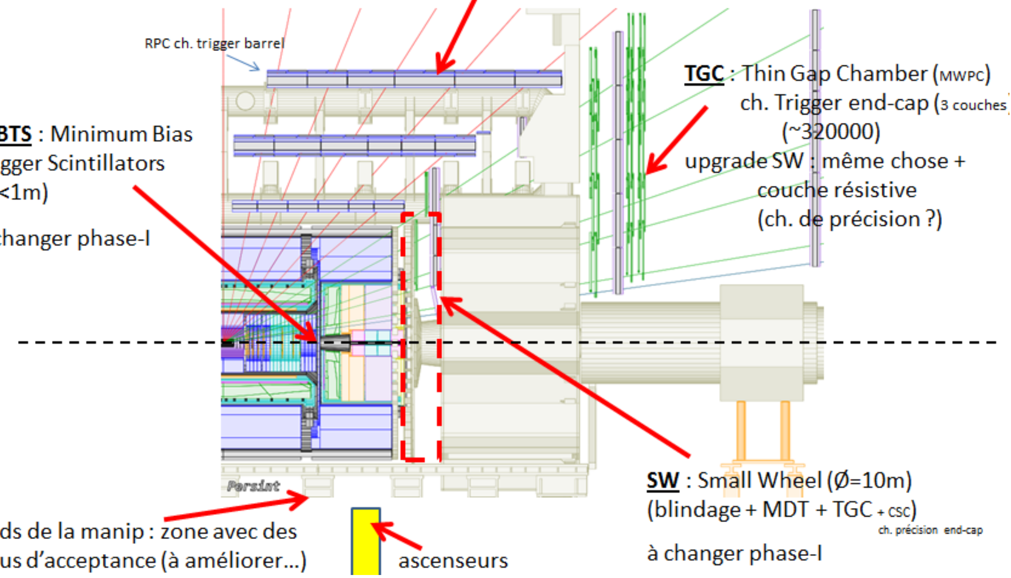
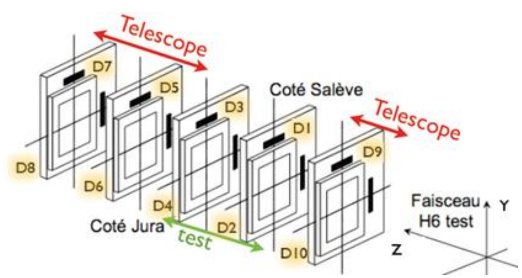
Upgrade (*) d'Atlas : partie spectromètre à muons



- Comment cela marche actuellement ?
  - Quelles techniques et où ?
- Problème du bruit de fond
- Upgrade (*)
  - Les différentes options
- Test-beam
- Conclusions

Philippe Schune

Pour le groupe HL-LHC Atlas-Saclay spectromètre à μ



irfu
cea
saclay

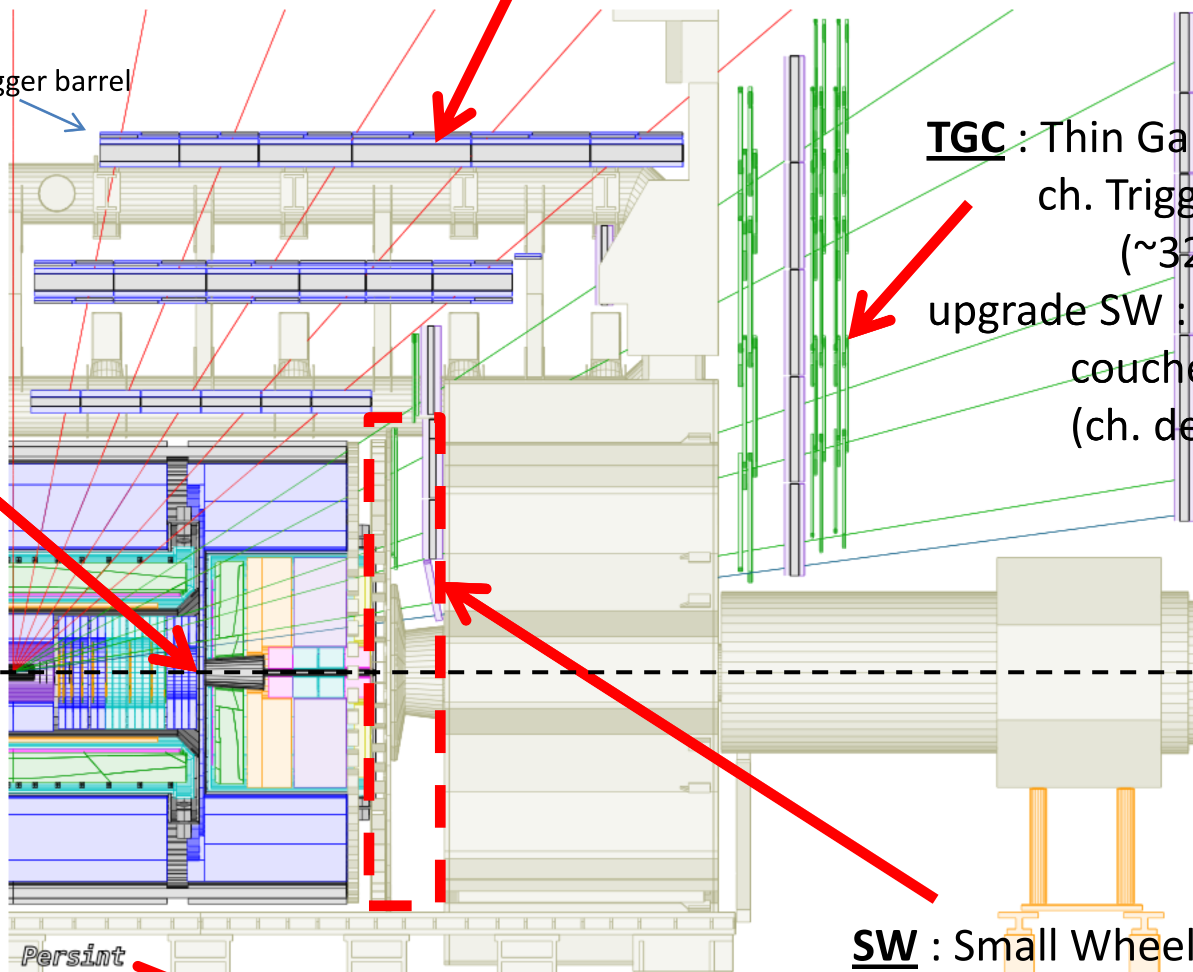
(*) amélioration / mise à jour / optimisation, etc…

Les noms / zones à retenir

(upgrade : Micromegas ?)

MDT : Monitored Drift Tube (~350000)
ch. de précision (tube Ø=30mm)
upgrade SW : **sMDT** (même chose 15mm)

RPC ch. trigger barrel



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ch. Trigger end-cap (3 couches)
(~320000)
upgrade SW : même chose +
couche résistive
(ch. de précision ?)

MBTS : Minimum Bias
Trigger Scintillators
(Ø<1m)

à changer phase-I

SW : Small Wheel (Ø=10m)
(blindage + MDT + TGC + CSC)
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à changer phase-I

Pieds de la manip : zone avec des
trous d'acceptance (à améliorer…)

ascenseurs

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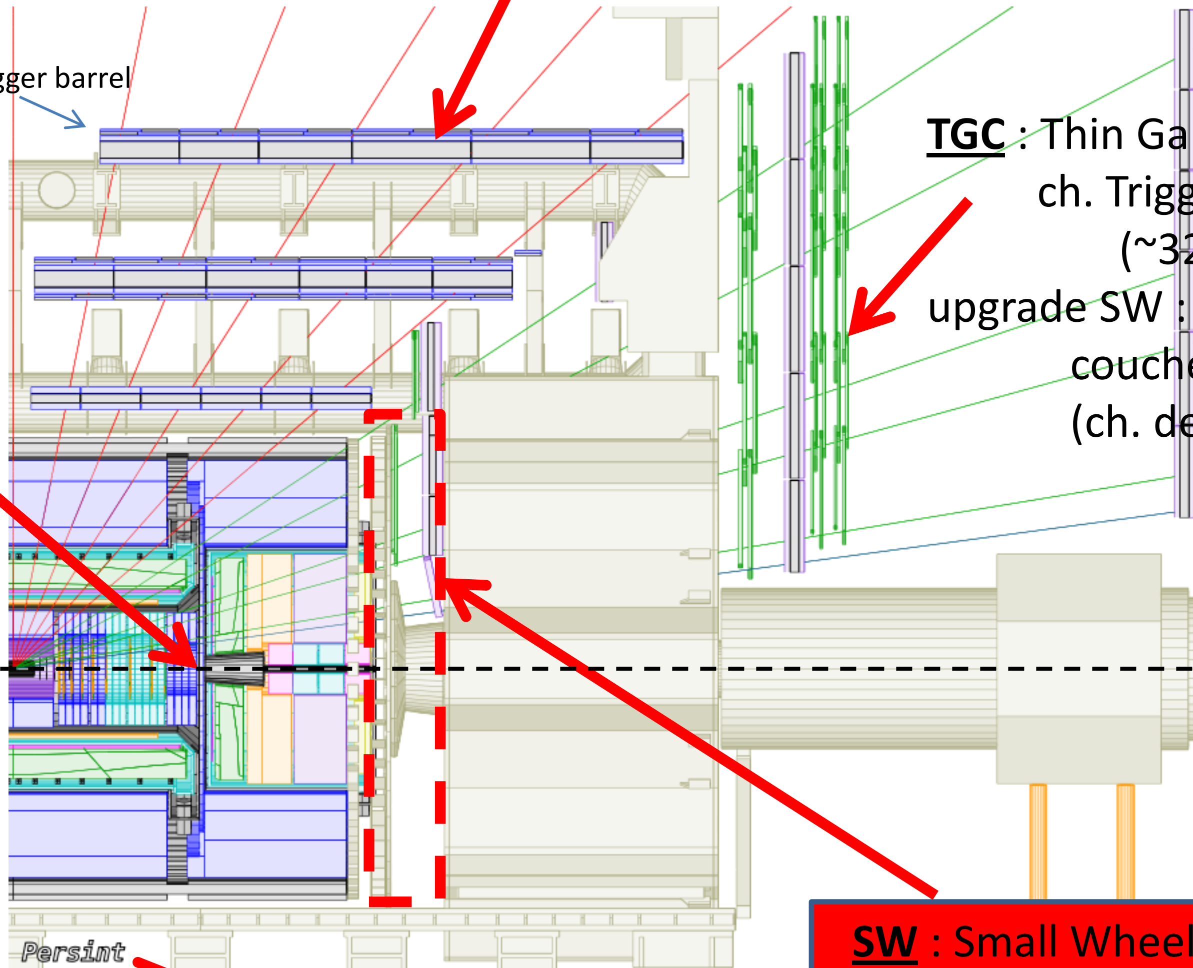

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ascenseurs

Principe de la mesure et du trigger L1 muon d'Atlas

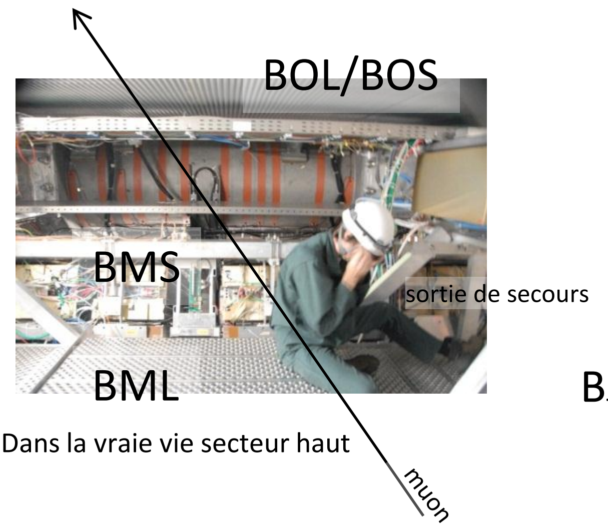
<u>Fenêtres de coïncidence telles que :</u>

ε = 90% au seuil donné pour μ+ et μ-

(en tenant compte des diff. effets)

Problème si seuil pas assez « raide » => saturation…

Sachant que : $\varepsilon_{RPC/TGC}$ ~ 10^{-4} (n) et ~5.10^{-3} (γ) en moyenne sur leur spectre



Dans la vraie vie secteur haut

Il existe deux types de seuils :

- **bas pt < 11 GeV**
- haut pt >= 20 GeV

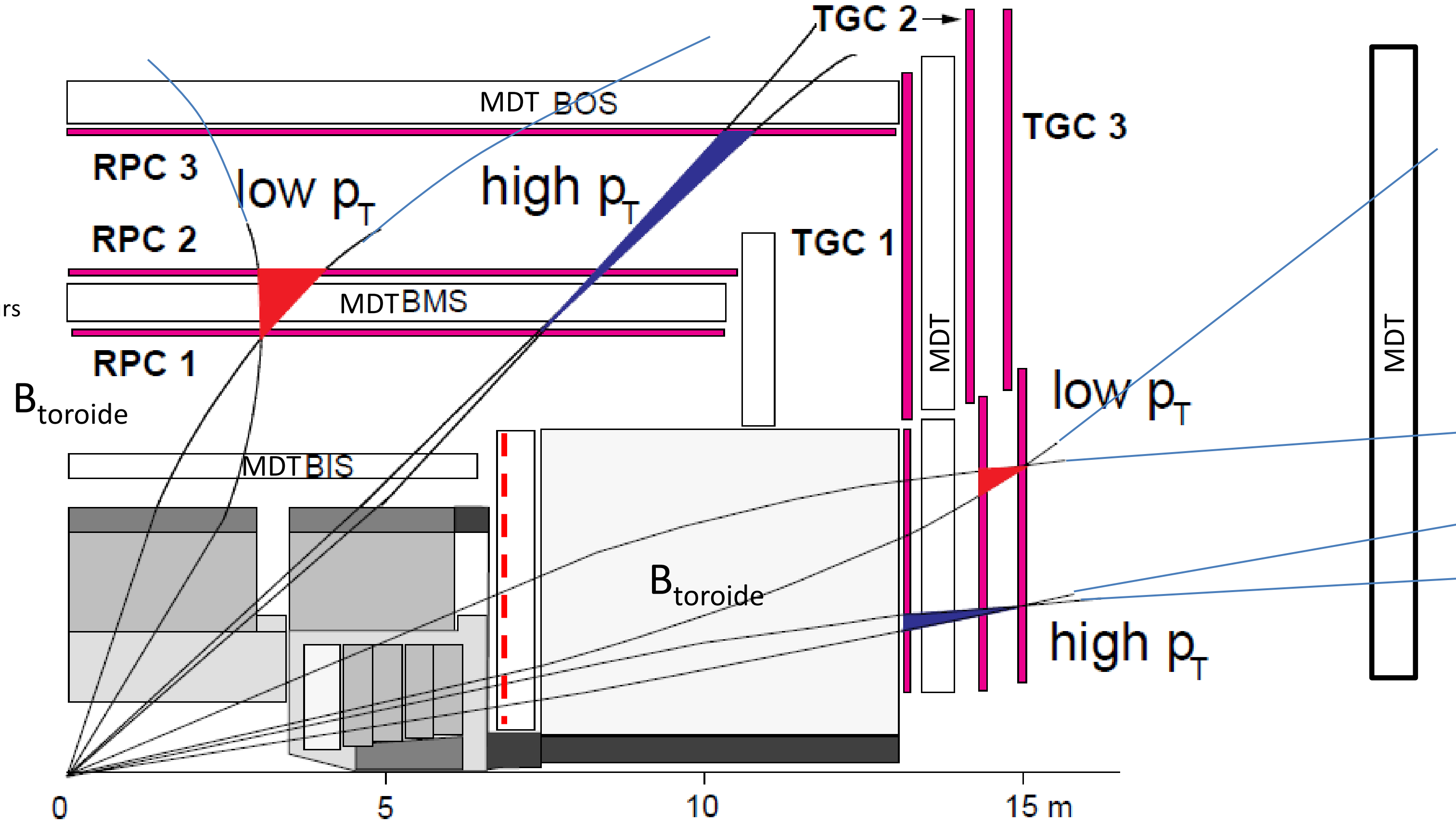
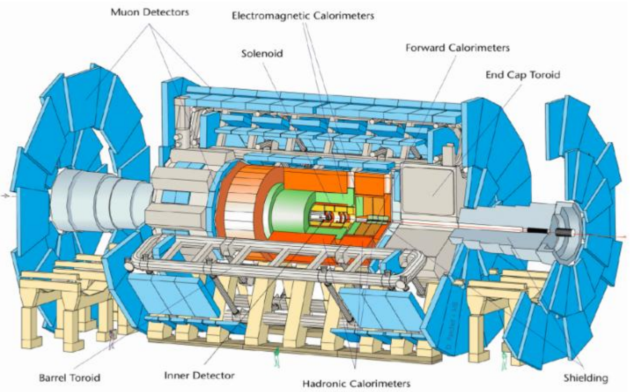
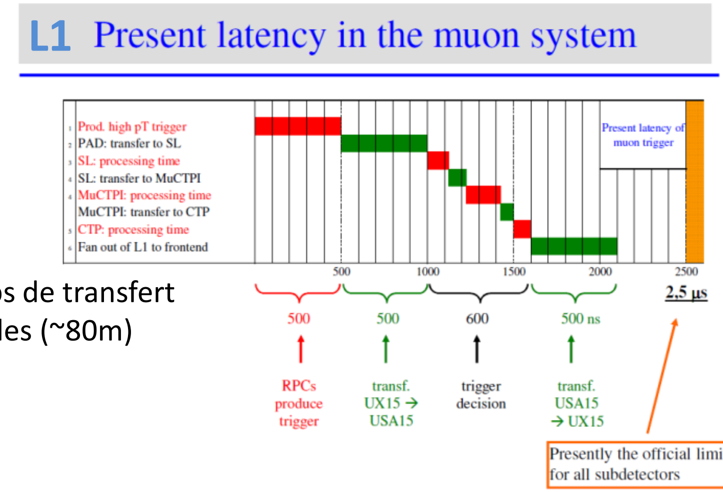


Figure 12-7 Level-1 muon-trigger scheme in the barrel and in the end-cap. The low-p_T trigger is based on two double layers of trigger chambers; the high-p_T trigger uses an additional double layer in the barrel and a triple layer in the end-cap. The shaded area represents the calorimeters and the absorber. Trajectories for positive and negative muons are shown.



Trigger : comment ca marche ?



~50% : temps de transfert dans les câbles (~80m)

<u>Le trigger (déclenchement) :</u> (collisions : 40 MHz)

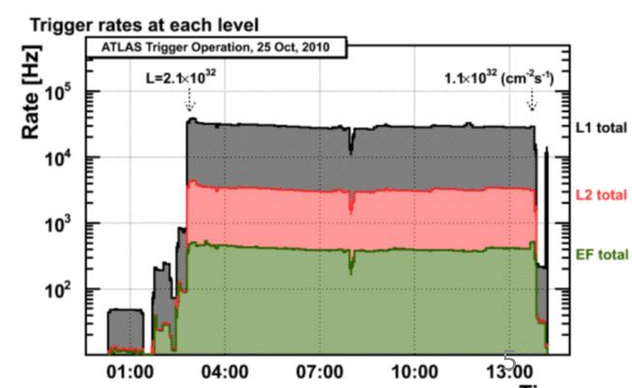
Actuellement trois niveaux : L1, L2, *event filter* (EF)	/ temps requis	/ freq. max
L1 : uniquement les détecteurs « rapides » TGC / RPC (*)	< 2,5 µs	~ 75 kHz
upgrade phase-II (>2020 ?)	~ 6 µs ou + ?	
L2 : ajout d'information des détecteurs MDT et CSC (**)		~ 3.5 kHz
EF : ferme de processeurs incluant une reconstruction de la trace		~ 200 Hz

L2 : (seulement dans les régions d'intérêts -RoI-, ie. *superhit in each chamber* => flèche effective + LuT)

HLT (soft.) : L2 + EF

EF : (incluant infos du détecteur interne, paramètre d'impact, χ^2 trace *inner-muon spectro*, etc.)

(aujourd'hui : L1 approche les 70 kHz et ~4% temps mort)



Sur bande : muon stream ~100 Hz

(*) L'effet dominant de la résolution en temps des détecteurs « rapides » est la fluctuation de la « première ionisation ». La résolution ultime est de l'ordre de 2 ns.
(**) Les détecteurs de traces ont une résolution par « layer » de ~100 microns.

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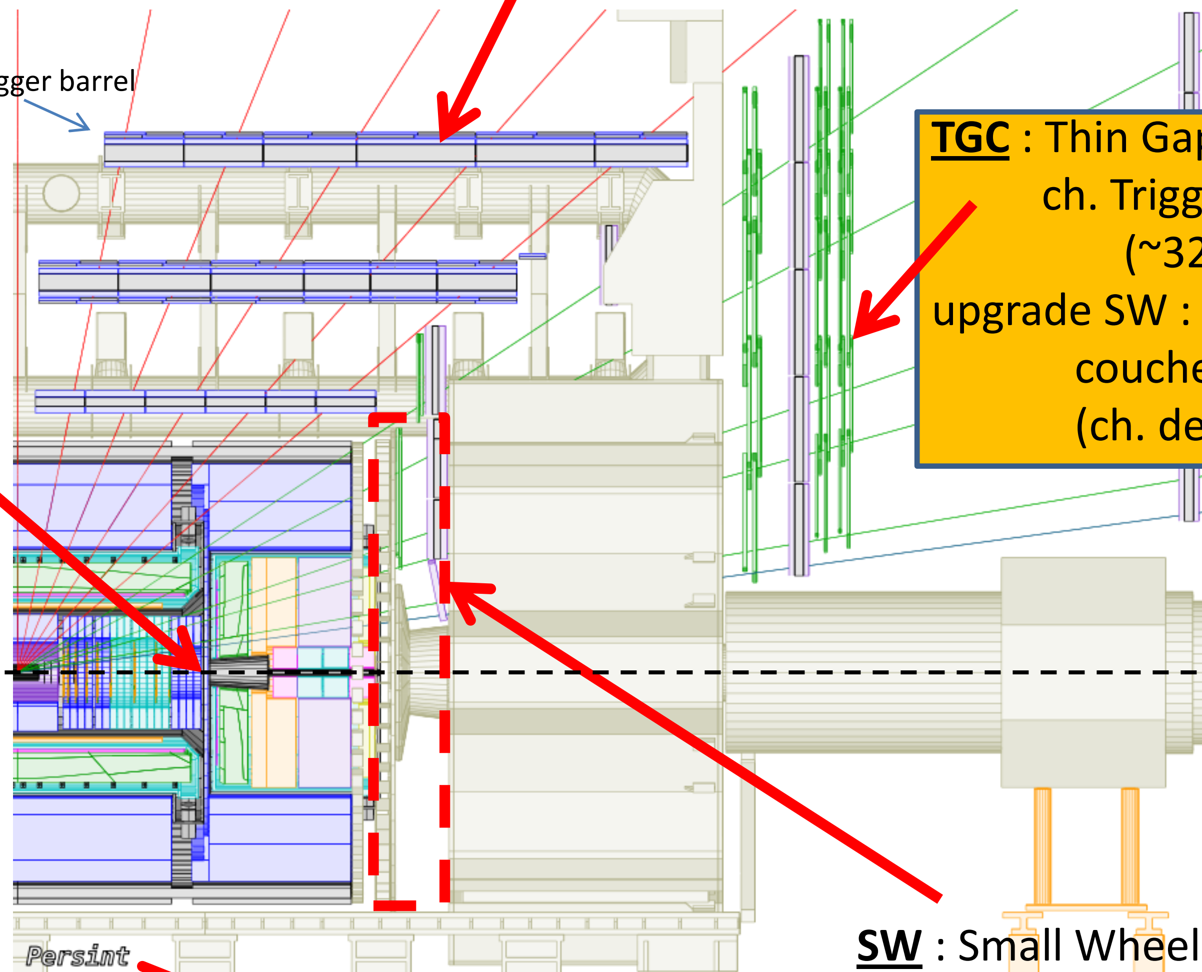

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à changer phase-I

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(ch. de précision ?)

SW : Small Wheel (Ø=10m)
(blindage + MDT + TGC + CSC)
ch. précision end-cap

à changer phase-I

Pieds de la manip : zone avec des trous d'acceptance (à améliorer…)

ascenseurs

Options concurrentes : TGC

G.Mikenberg (Tel-Aviv)

Thin Gap Chamber (Opal) = MWPC mode quasi-saturé

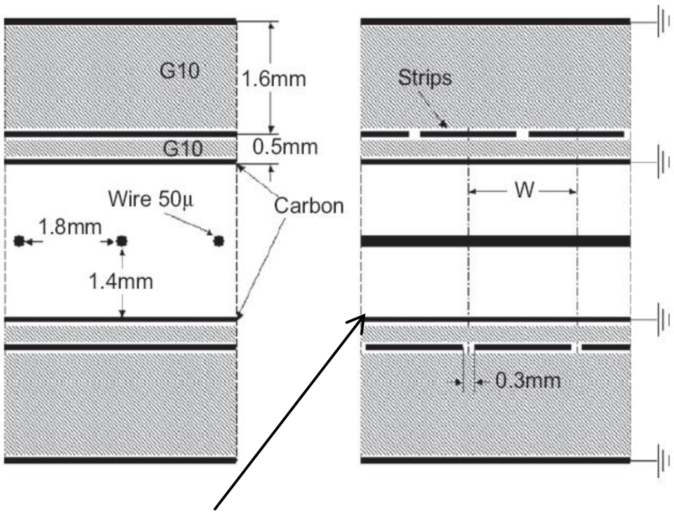
CO_2:n-C_5H_{12} 55:45 (- sensible au gap)

Résolution temporelle ~5ns

Déjà dans Atlas : + 2nd coordonnée

~320000 canaux (pas de fils cassés)

Fils regroupés en paquet (trigger ; résolution – critiques)



For HL-LHC: carbon coating

__Upgrade__ :

possibilité de lire : fils + *strip* dessus + *pad* dessous

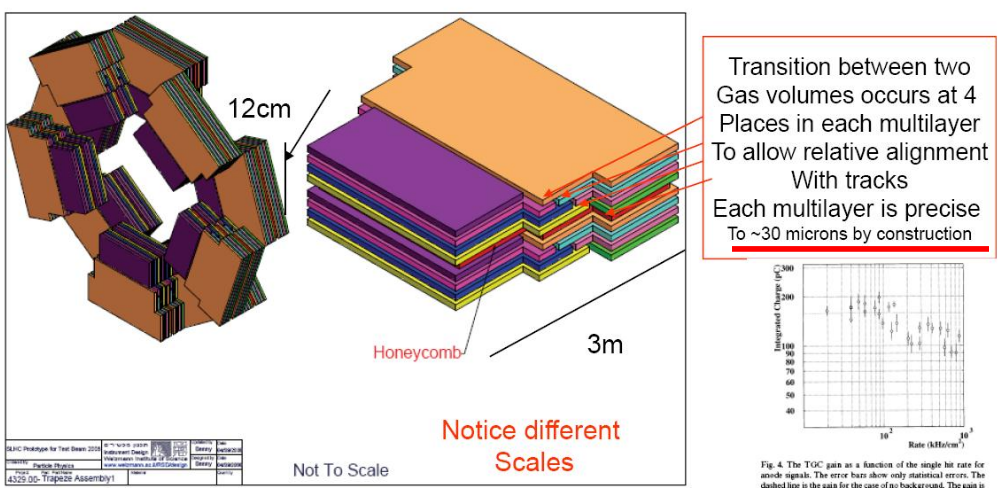
Couche résistive => pas de claquage jusqu'à 20kHz/cm^2

(NIM-A 628 (2011) 177… analyse dépôts sur les fils, etc.)

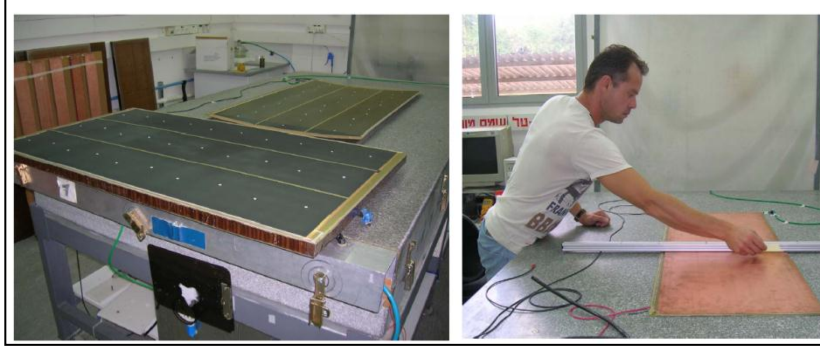
Résolution ~150 microns pour *strip* de 3mm (1/20 !)

2 prototypes ~échelle 1 construit (assemblable)

Proposed arrangement for SW



½ of the 8 gas-gaps for the protype have been completed



Options concurrentes : *small tube* MDT (Ø=15mm)

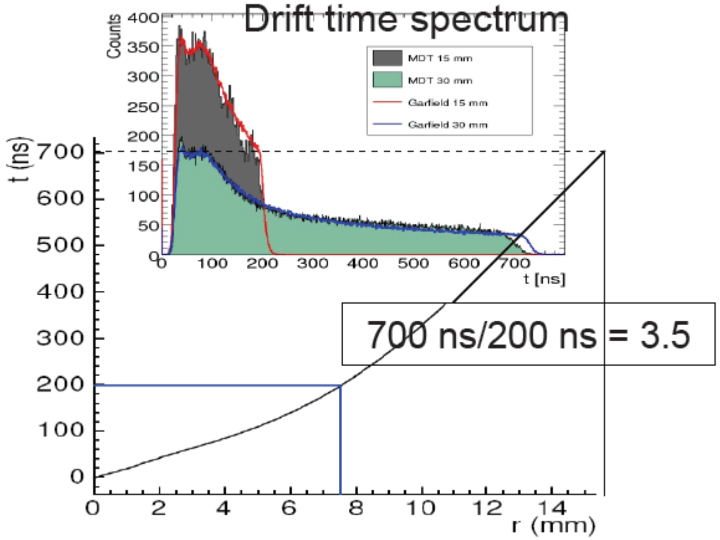
H.Kroha (MPI), Elbe, 26/05/2009

- sont à la limite (charge intégrée) si *safety factor* x5 ?
- ne peuvent pas servir de trigger L1 (sauf à rallonger le temps –Phase-II)

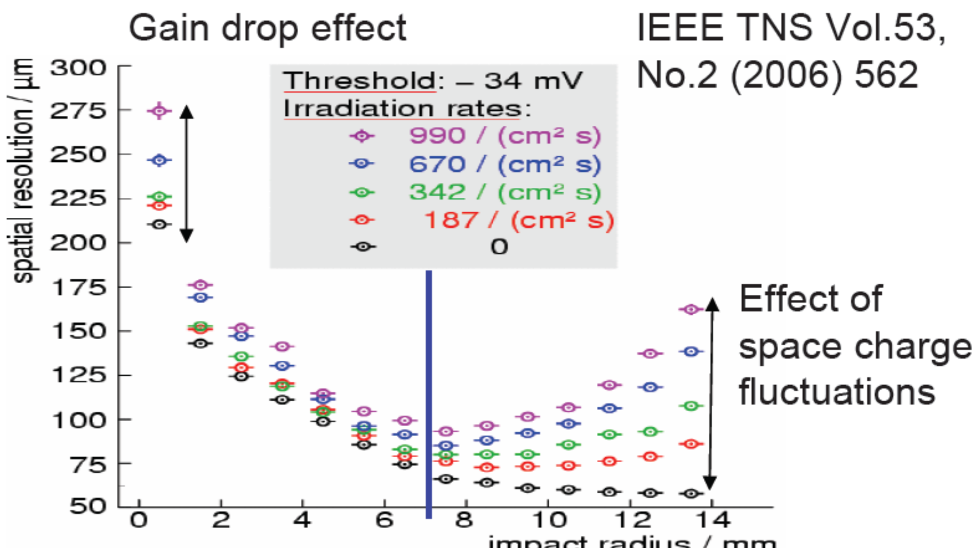
Baseline: 15 mm instead of 30 mm ∅ tubes, with tube length, drift gas and gas gain unchanged (i.e. 2730 V op. voltage):

- ❑ Occupancy proportional to max. drift time: 3.5 x smaller.
- ❑ Tube counting rate ~ tube circumference: 2.0 x smaller.

  Occupancy 7 x smaller in total!
- ❑ Gain drop (due to space charge) ~ tube radius $R^3 \ln(R/R_{wire})$: 10 x less.
- ❑ Degradation of spatial resolution due to radiation induced space charge fluctuations (non-linear r-t-relationship) and gain drop strongly reduced.



Space-drift time relationship



IEEE TNS Vol.53, No.2 (2006) 562

Single-tube resolution

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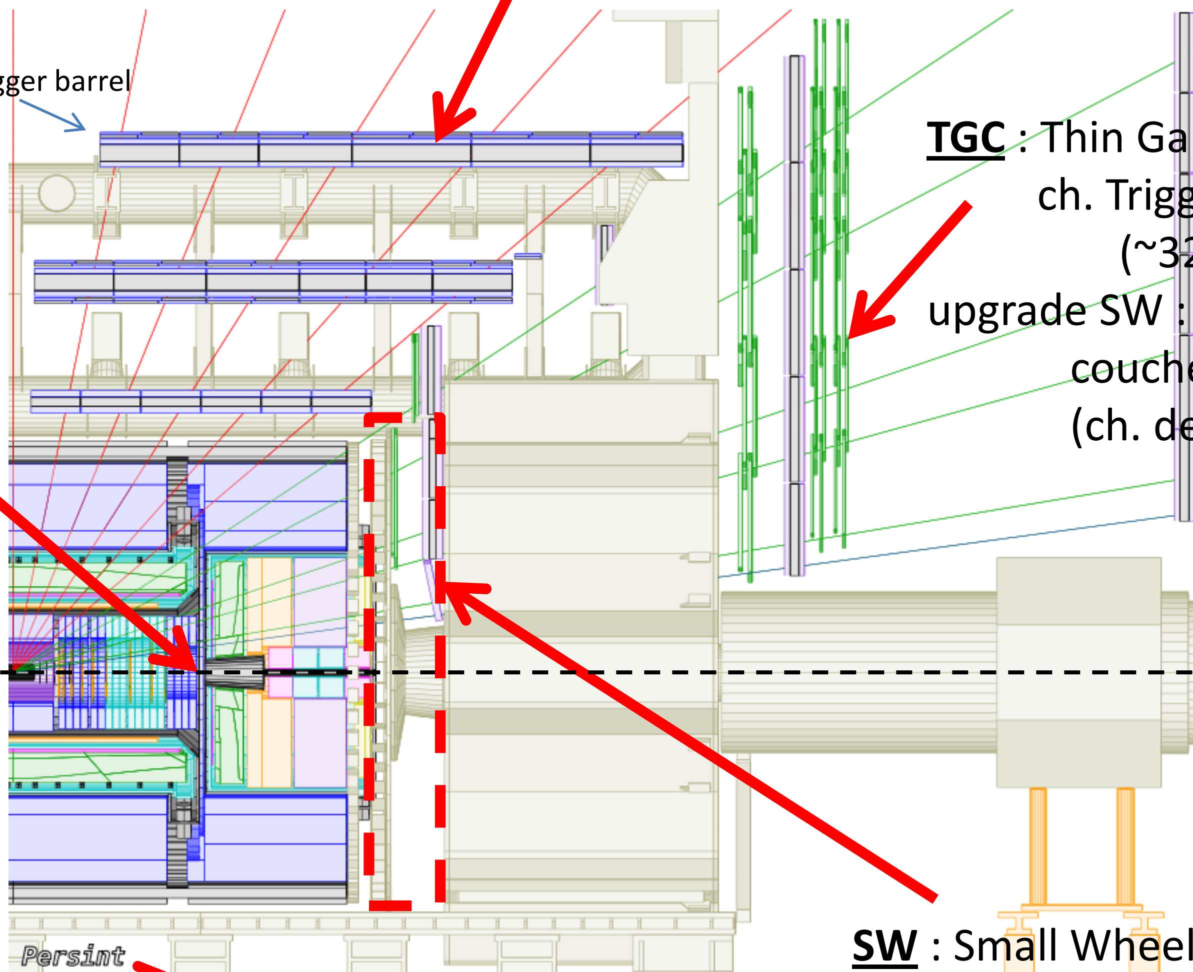

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à changer phase-I

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ch. précision end-cap

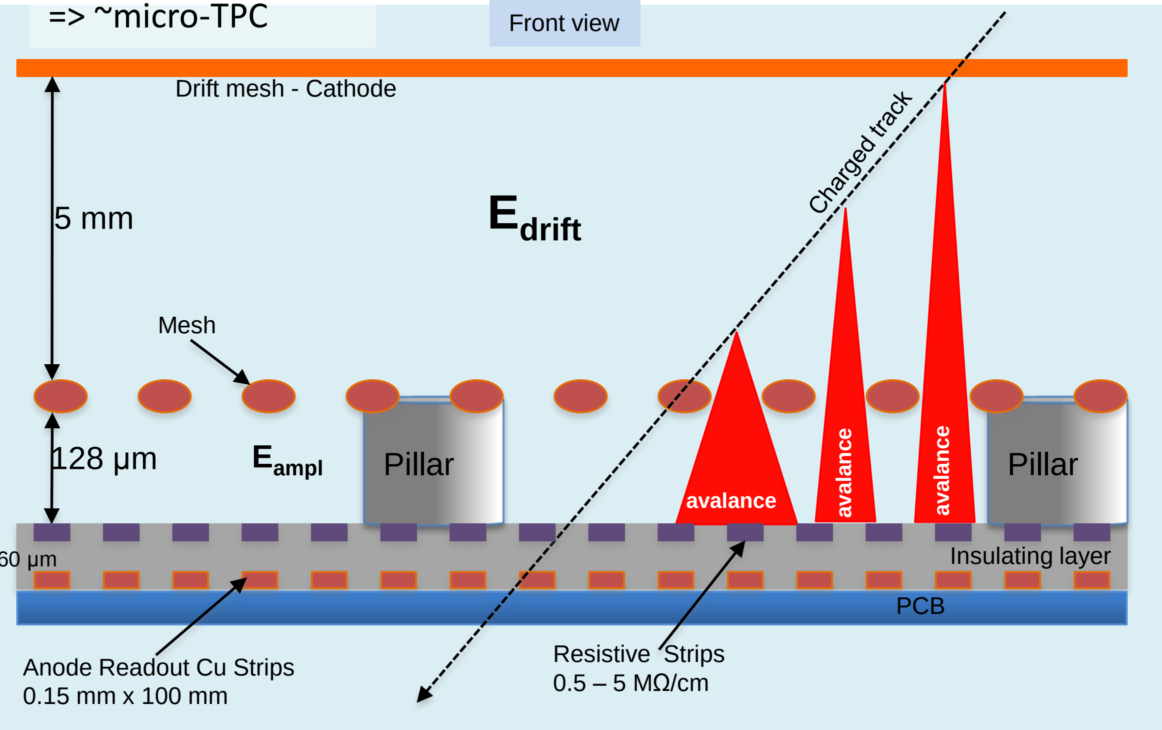
à changer phase-I

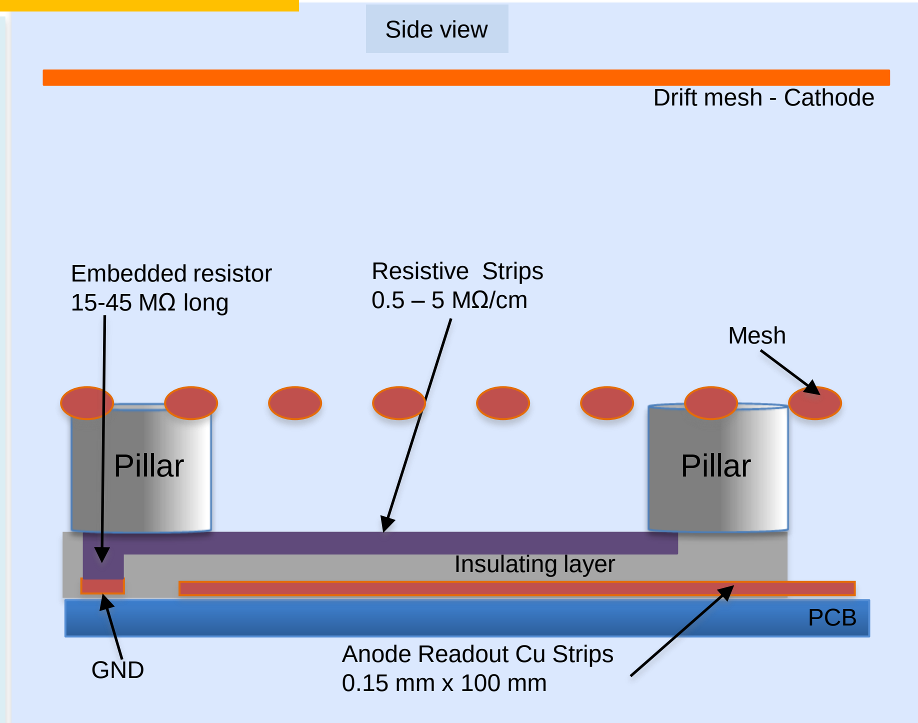
Pieds de la manip : zone avec des
trous d'acceptance (à améliorer…)

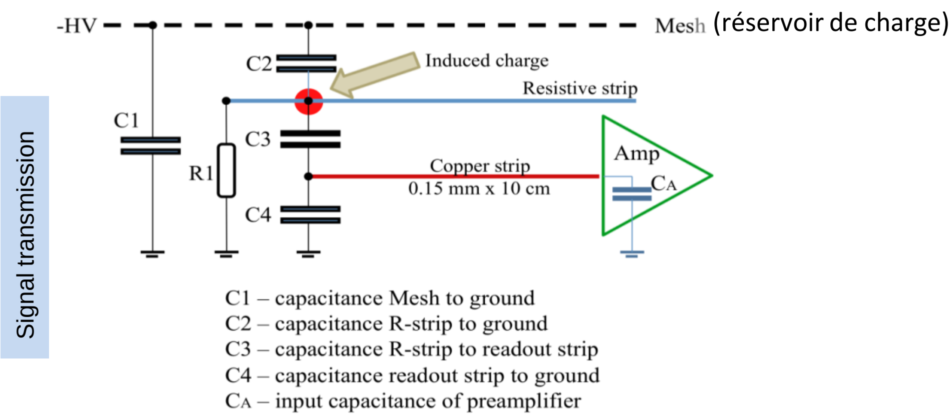
ascenseurs

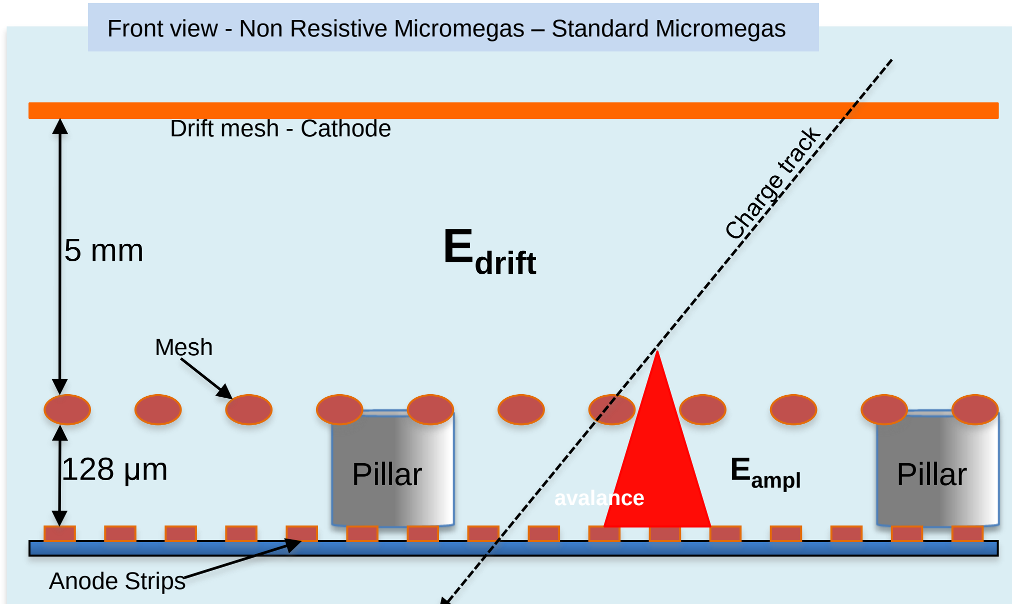
Resistive Micromegas Structure

si mesure du temps
=> ~micro-TPC









- Introduction d'un RC suffisant (~100 µs ?) pour étaler en temps (et en espace) le développement de l'avalanche.
- Si *strip-readout* croisés (~2D) signaux à diff. temps sur les *strips*.

Neutron beam test

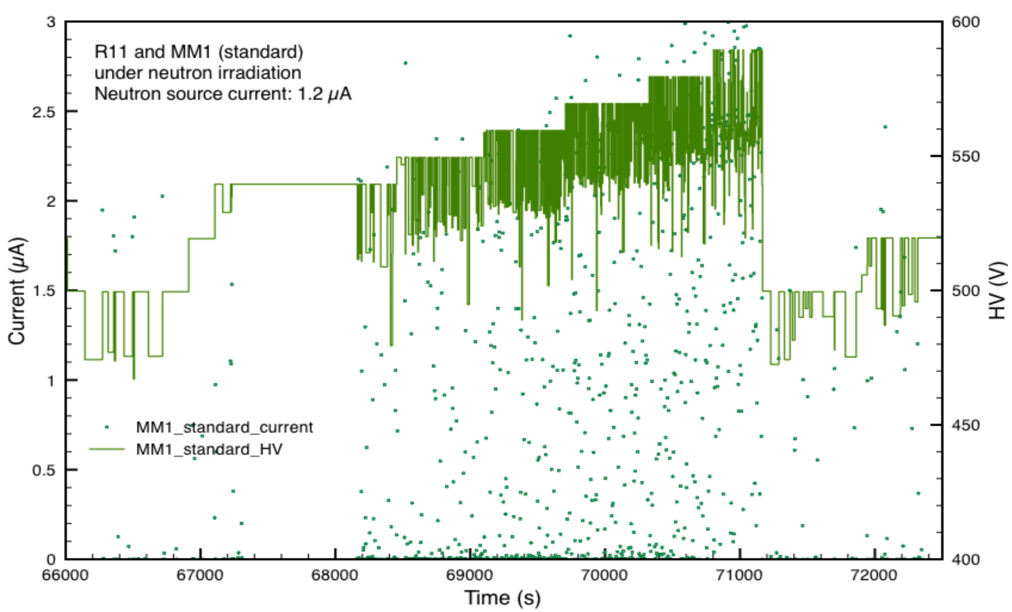
Theodoros Alexopoulos
NTU Athens

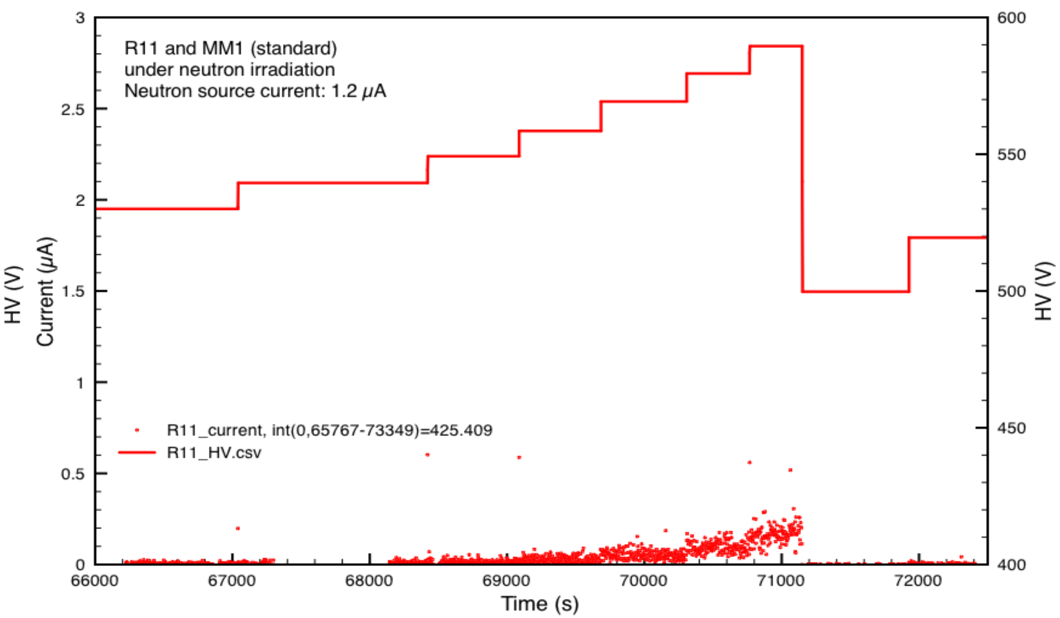
MM mesh currents in neutron beam   8 MeV

Gas: Ar:CO_2 (85:15)   Neutron flux: $\approx 1.5\mathrm{x}10^6$ n/cm^2 s

Standard MM:
Large currents
Large HV drops, recovery time O(1s)
Chamber could not be operated stably

R11:
Low currents
Despite discharges, but no HV drop
Chamber operated stably up to max HV

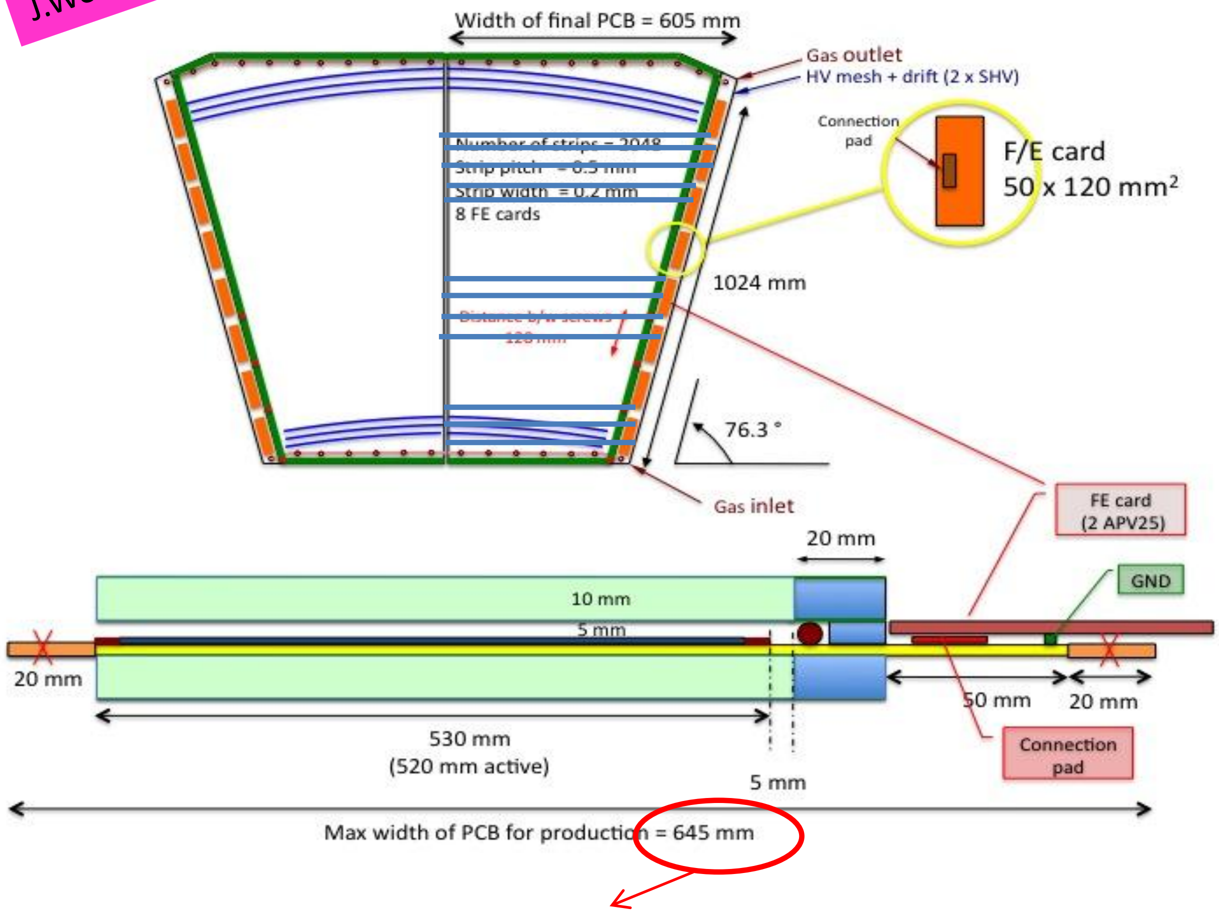




A Saclay irradiation complémentaire : X (8 KeV du Cu) + neutrons thermique ? (Orphée)

Micromegas (half-size) Chamber

J.Wotschack



- Passera à ~1m avec l'achat de nouvelle machine
- Problème de long strip : capa des strip (< 1pF / cm)
- strips en deux partie : localement x2 nombre de canaux
- small-Wheel : entre 0,5 et 2 millions de canaux
- Une question importante a laquelle il faut répondre : « industrialisation de la production du bulk + grille » ?

MicroMegas readout chip design

V.Polychronakos (BNL)

Actuellement uniquement : front-end + seuillage

- **BNL design** with the following features :
  - Data Driven System with Peak Amplitude and Time Detection
    - On-detector zero suppression, dramatic reduction of data bandwidth
  - Neighbor-channel enabling circuitry (allows for high thresholds without losing small amplitudes)
  - On-chip ADC (10-12 bits?)
  - Simultaneous read/write with built-in Derandomizing Buffers
  - 64 or 128 channels/chip to match detector element size
  - Able to provide Trigger Primitives for on-detector track finding logic
- Based on existing chip developed a few years ago for a TPC application
- Appropriate for a variety of detectors (mMegas, TGC, TPC, GEM, etc.) requiring amplitude and time measurement

- Demande d'aide de BNL
(visite BNL mi-juin à Saclay)

- Comment cela marche actuellement ?
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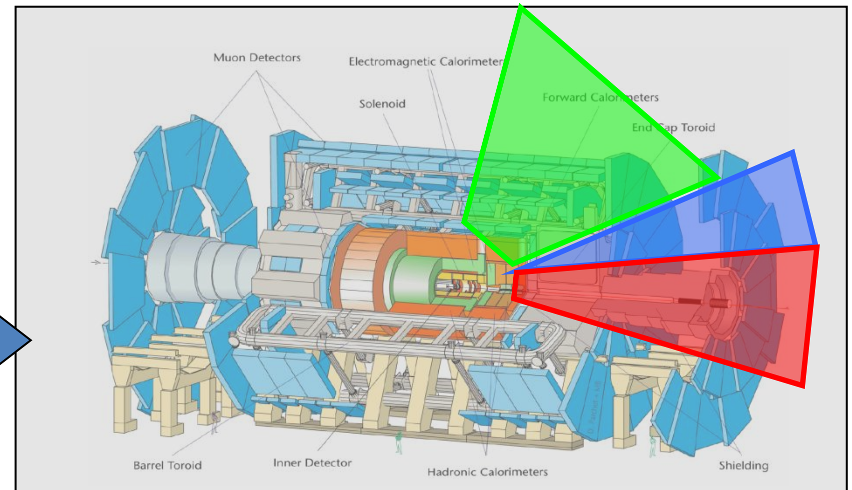
Background in Atlas cavern

Background comes from residues of p-p interactions (through spallation process) :

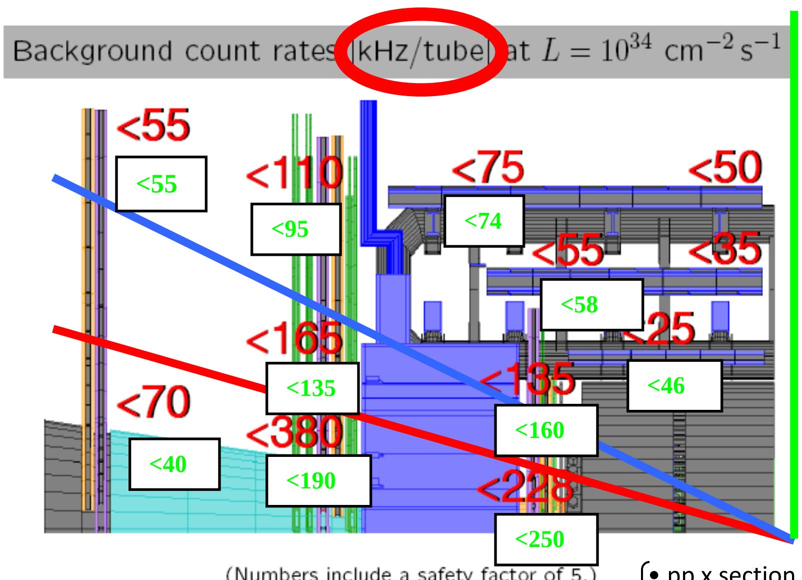
- Huge production of *neutrons*, thus creating γ, thus creating *e*, etc…
- Also at higher energy, *n* and γ create ionizing particle (mainly: p, e+, e-)
- Direct background: μ and punchthrough (smaller)



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

E_{cin}=10 MeV : v_n ~ 15% c (23 ns pour 1m)

10 keV : ~ 5.10^{-3} c (0.7 µs pour 1m), hors temps MDT



- pp x section for part. prod. (~1.2)
- ...d. propagation in calo. and shielding (~2.9)
- ...fficiency in chambers (~1.4)

10kHz/cm²

ε_n^{hit} ~1-3.10^{-4}

ε_γ^{hit} ~4-8.10^{-3}

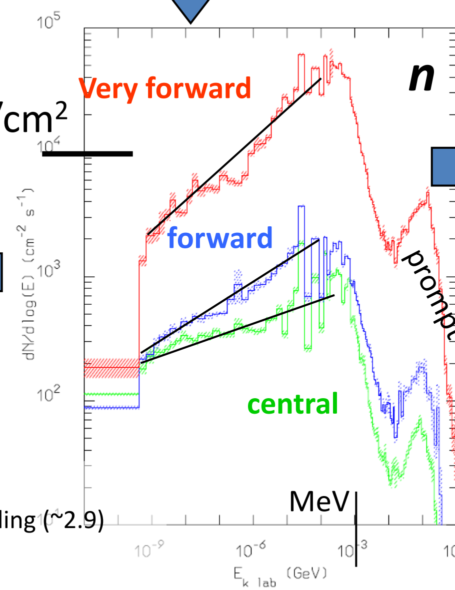


Figure 5-67 The expected neutron flux as a function of neutron energy in different rapidity regions of the muon spectrometer (top curve: 2.3 < η < 2.7, middle curve: 1.4 < η < 2.3 and bottom curve: η < 1.4).

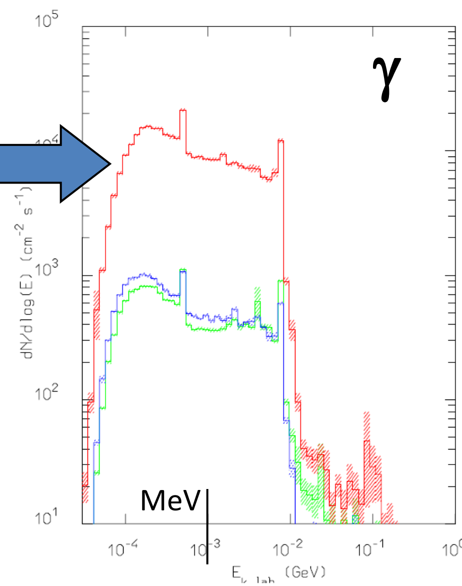


Figure 5-66 The expected photon flux as a function of photon energy in different rapidity regions of the muon spectrometer (top curve: 2.3 < η < 2.7, middle curve: 1.4 < η < 2.3 and bottom curve: η < 1.4).

Atlas needs to measure cavern background (using muon spectrometer) in order to reduce uncertainties on background for s-LHC.

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<u>(through spallation process)</u> :

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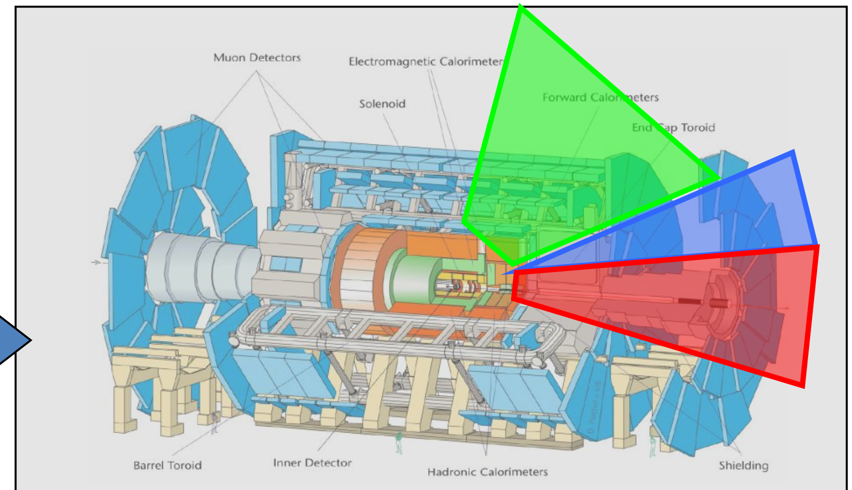

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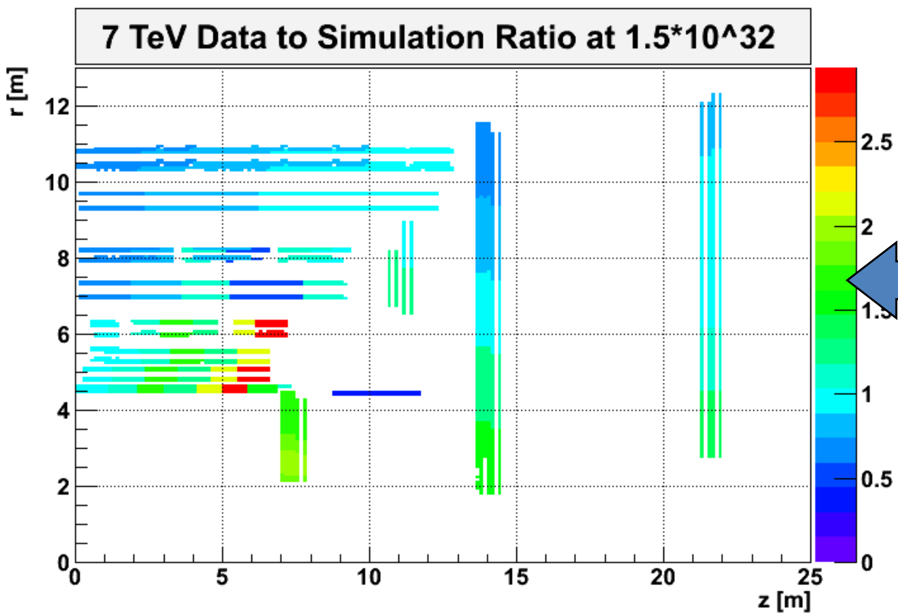
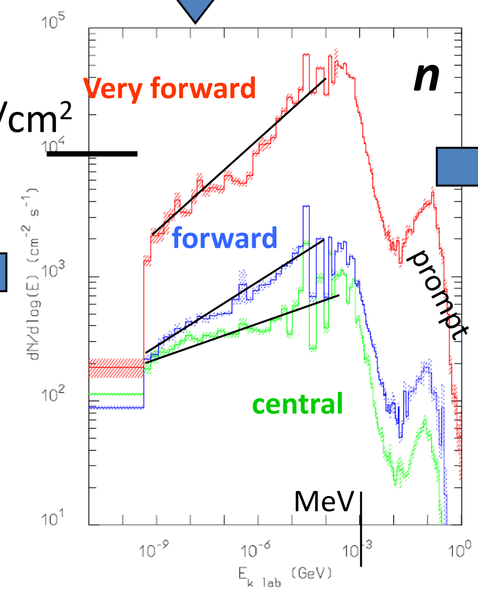


10kHz/cm²



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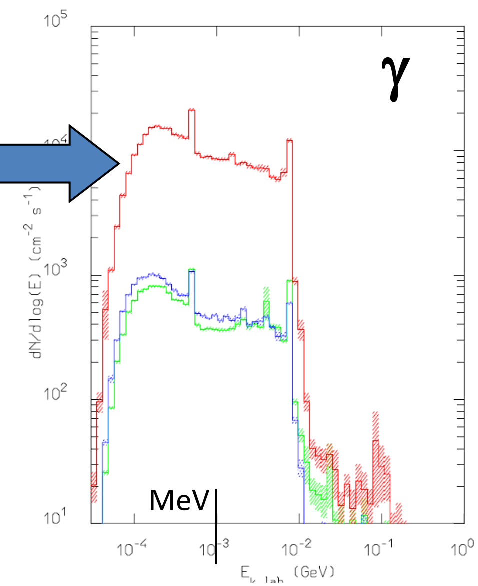

Figure 5-66 The expected <u>photon flux</u> as a function of photon energy in different rapidity regions of the muon spectrometer (top curve: $2.3 < \eta < 2.7$, middle curve: $1.4 < \eta < 2.3$ and bottom curve: $\eta < 1.4$).

(plutôt ~ x3 ?)

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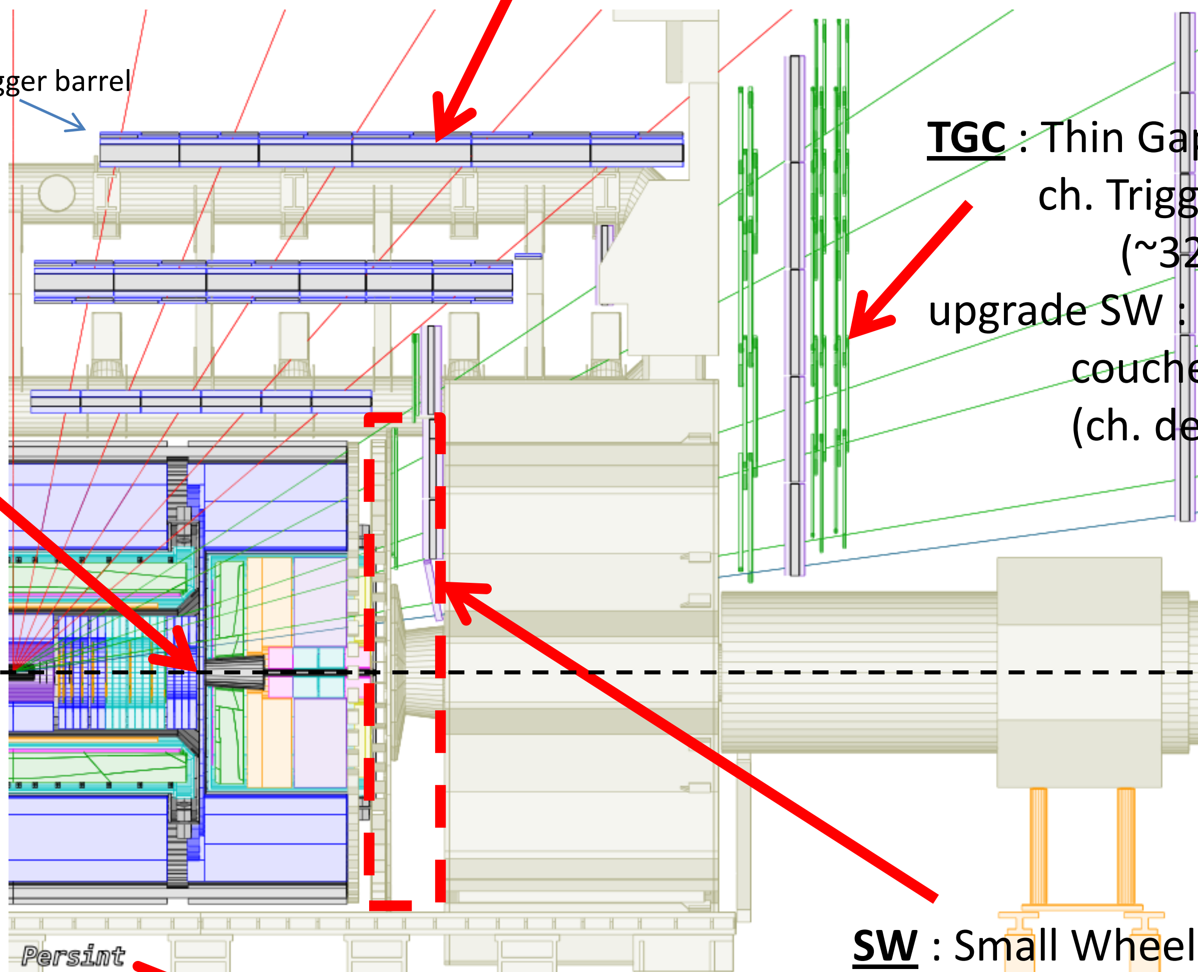

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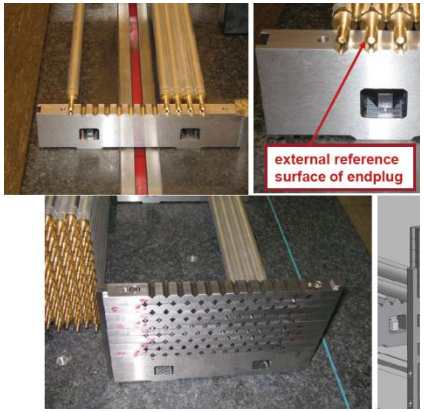
Pieds de la manip : zone avec des trous d'acceptance (à améliorer…)

ascenseurs

J.Dubbert (MPI-Munich)
(30/05/2011)

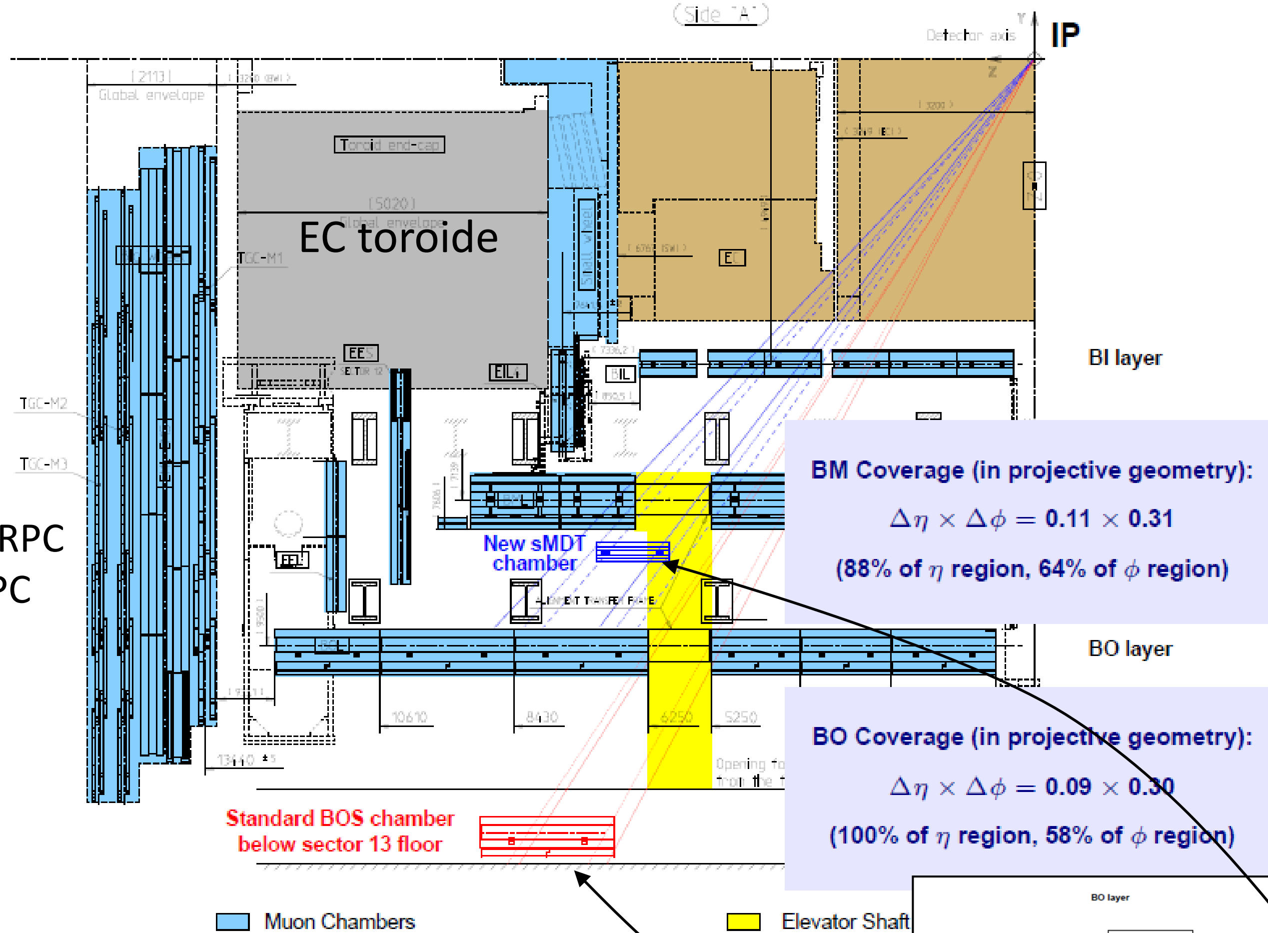
sMDT : small-tube chambers

Layout



Station Milieu (BM) : sMDT(2x4)+RPC
Station outer (BO) : spare BOS+RPC

Installation prévue 2013



BM Coverage (in projective geometry):

$\Delta\eta \times \Delta\phi = 0.11 \times 0.31$

(88% of η region, 64% of ϕ region)

BO Coverage (in projective geometry):

$\Delta\eta \times \Delta\phi = 0.09 \times 0.30$

(100% of η region, 58% of ϕ region)

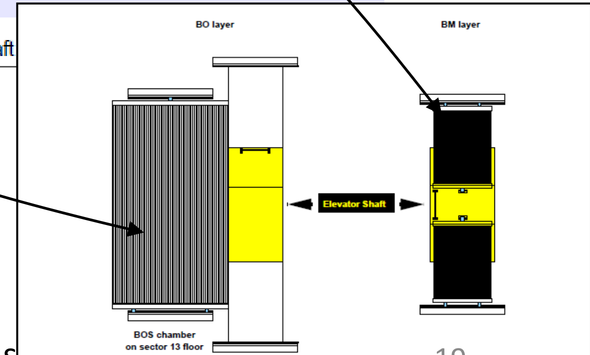


Figure 4: Layout of the new muon stations. View in the x-z plane. The BO (left) and BM (right) layers have been drawn separately for better visibility. The elevator shaft is marked in yellow.

Layer	Tracking (3rd station)	Low-p_T Trigger	High-p_T Trigger
BO	0.11×0.31 (0.51%)	—	0.10×0.29 (0.41%)
BM	0.09×0.30 (0.40%)	0.10×0.31 (0.45%)	0.10×0.31 (0.45%)
Total	0.91%	0.45%	0.86%

Acceptance in $\Delta\eta \times \Delta\phi$ per detector side (percentage of barrel region)

Vue de dessus

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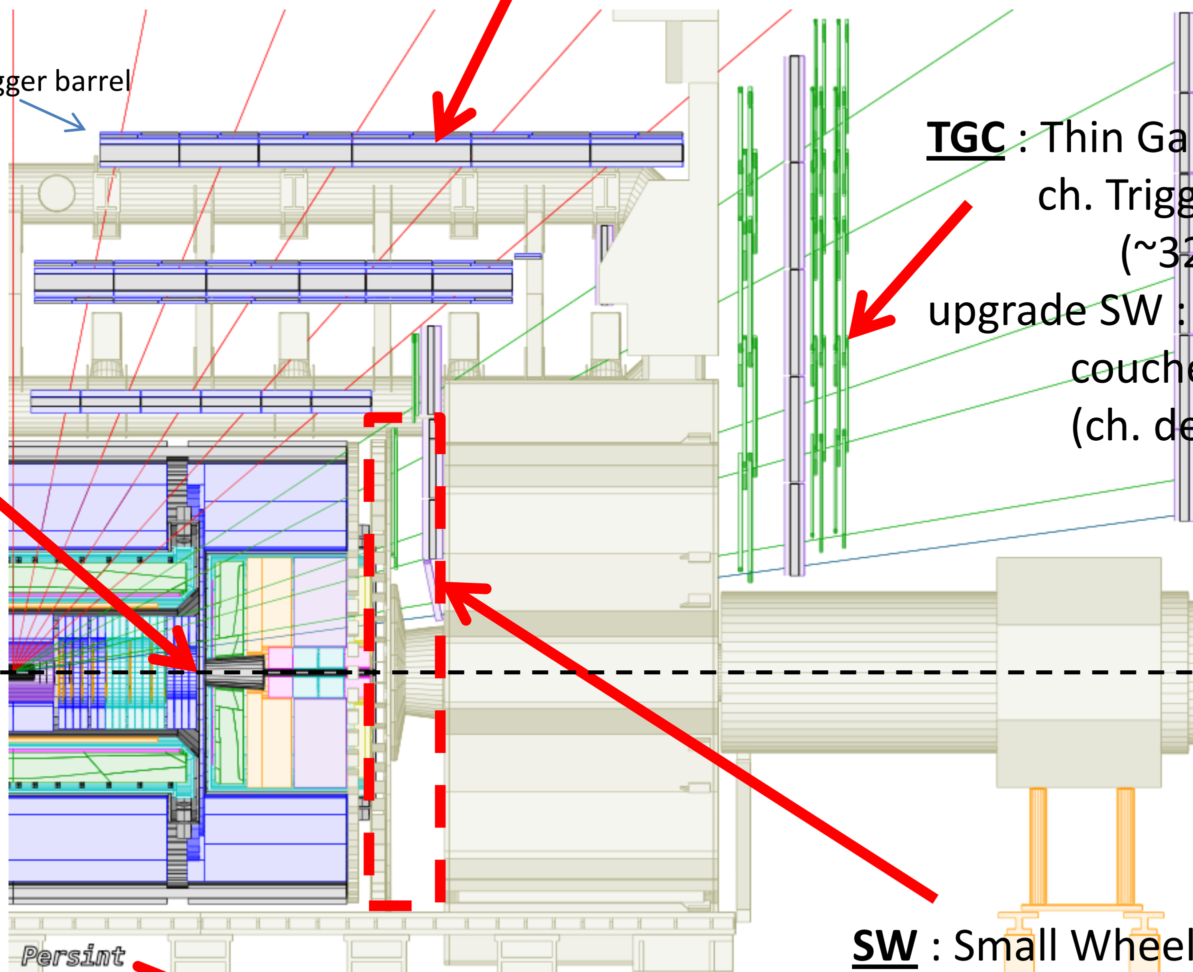
upgrade SW : **sMDT** (même chose 15mm)

RPC ch. trigger barrel



TGC : Thin Gap Chamber (MWPC)
ch. Trigger end-cap (3 couches)
(~320000)
upgrade SW : même chose +
couche résistive
(ch. de précision ?)

MBTS : Minimum Bias Trigger Scintillators (Ø<1m)

à changer phase-I

SW : Small Wheel (Ø=10m)
(blindage + MDT + TGC + CSC)
ch. précision end-cap

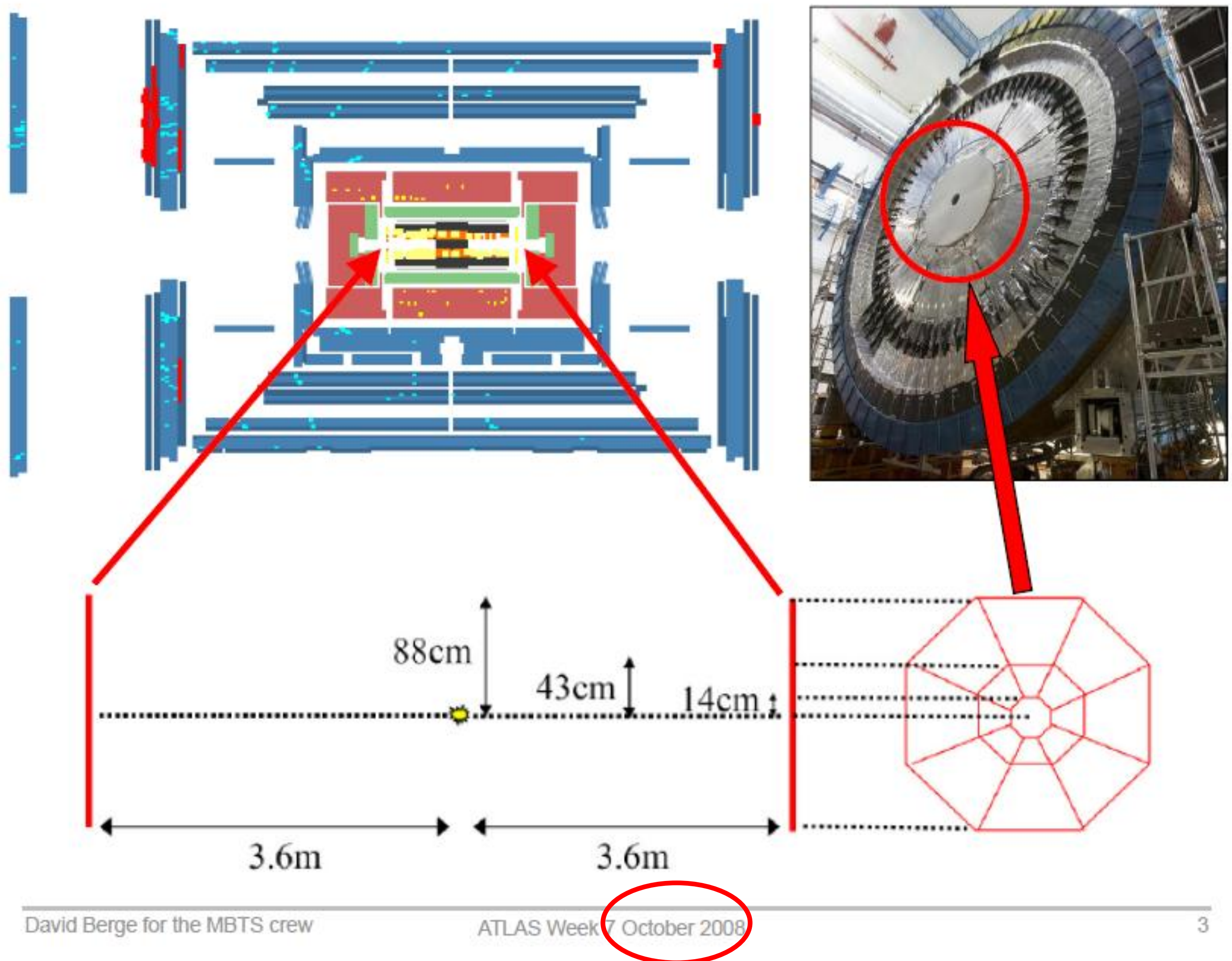
à changer phase-I

Pieds de la manip : zone avec des trous d'acceptance (à améliorer…)

ascenseurs

Minimum Bias Trigger Scintillators

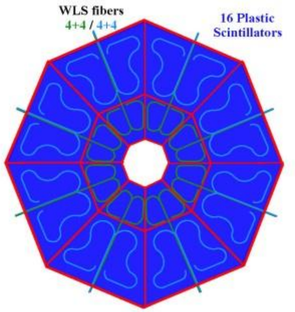
- Late add-on in front of the LAr Cryostat
- **2x16 scintillator paddles**, will be used for initial running only, usefulness limited to early running by both pile-up (all BCs will trigger) and by anticipated radiation damage to Scintillators
- Readout through TileCal trigger elx
- **Rapidity coverage 2.1 to 3.8**

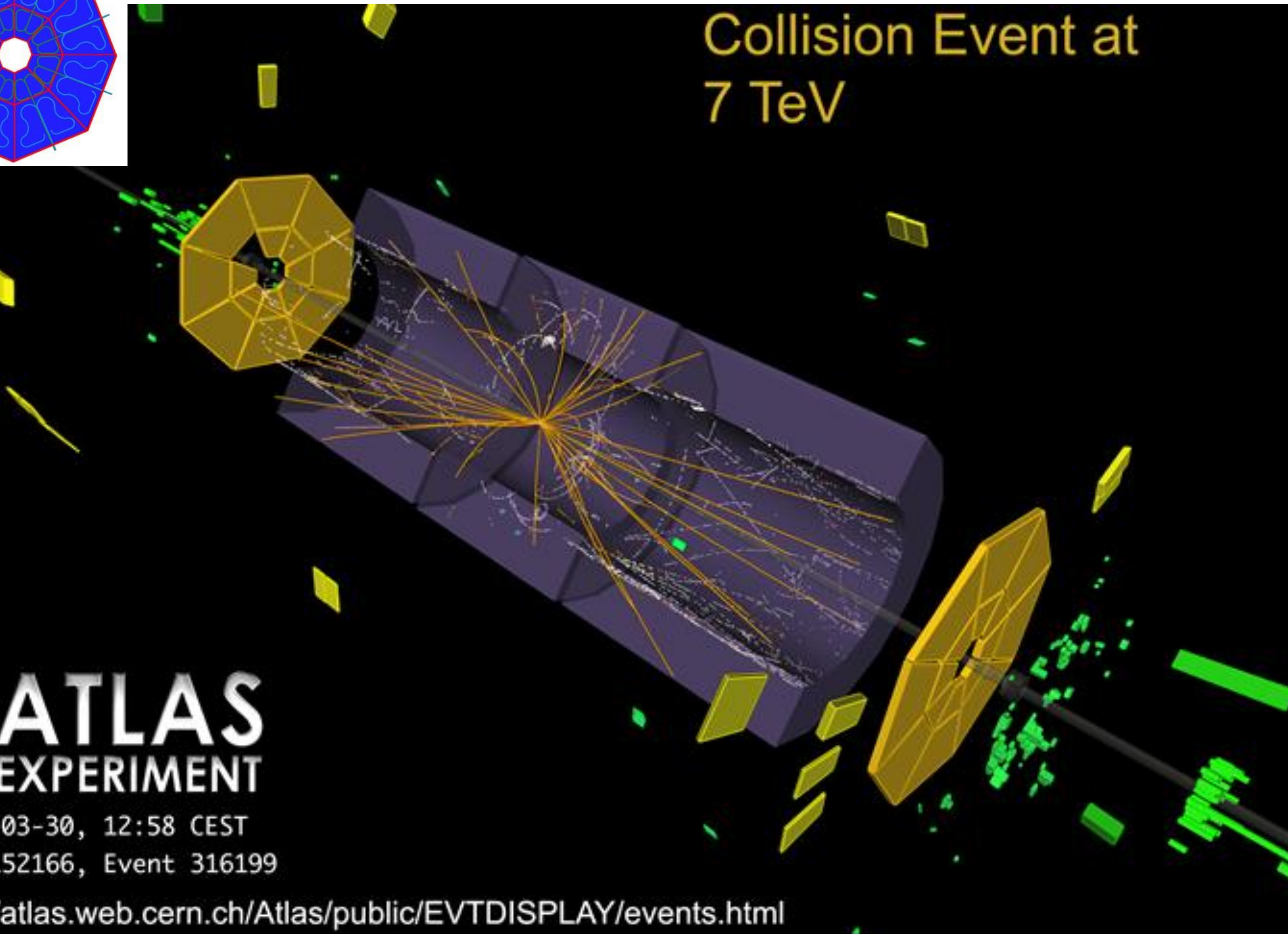


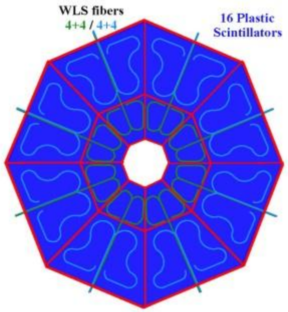
Appears to be very useful !
(for trigger/physics analyses)
To be replaced for HL-LHC

<u>Area totale (A+C sides) ~ 5 m^2</u>
A changer « bientôt »…

Minimum Bias Trigger Scintillators

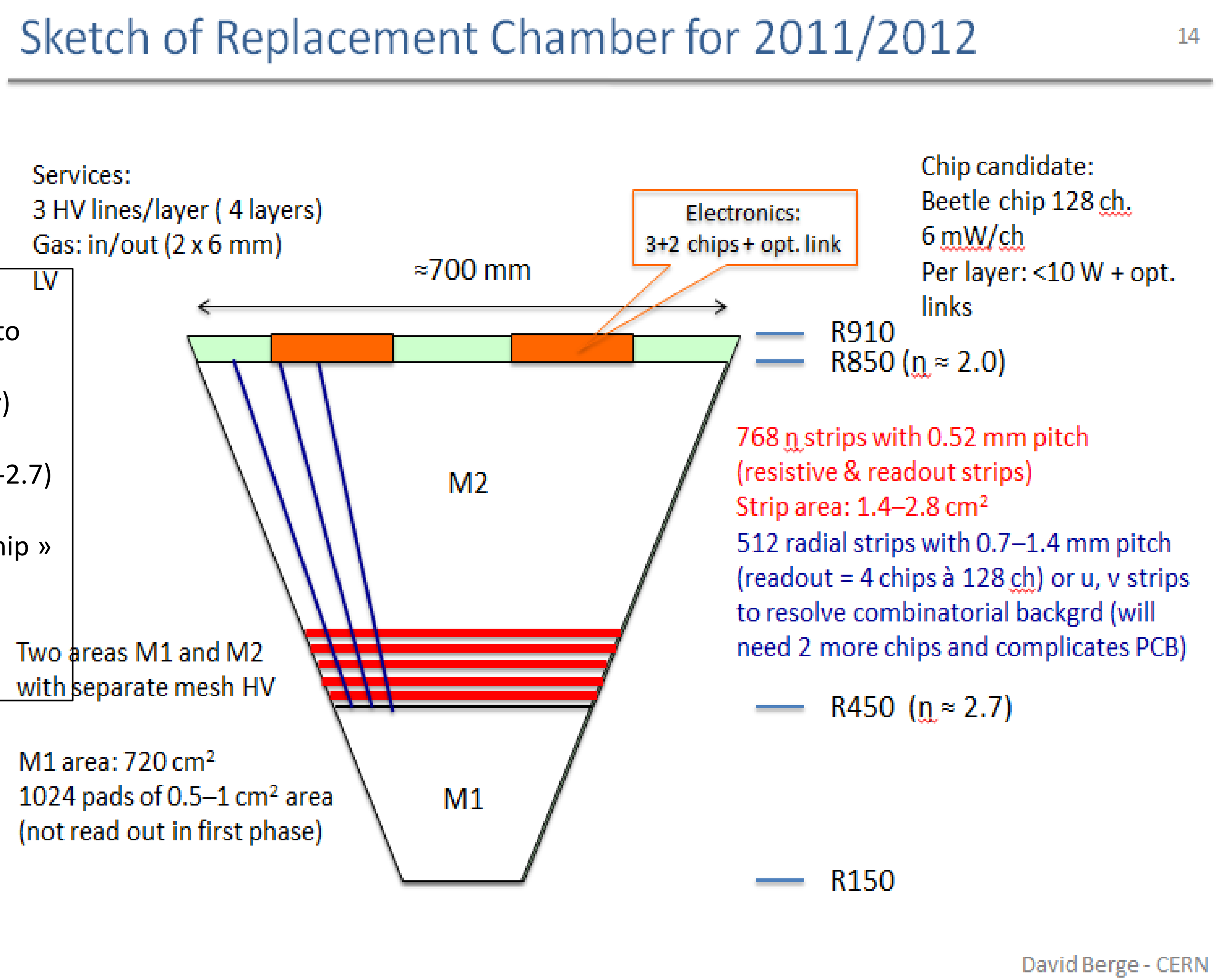






Dans un 1er temps :
- Tentative d'installation d'un proto durant hiver 2011 (1/8eme)
- Lecture uniquement (pas trigger)
- Support polyéthylène-bore
- Zone supérieure seulement (2.1-2.7)
- 1,5 à 2k / plan ; 4 plans (?)
- Électronique binaire (« beetle-chip » de LHCb)

Puis prochain long shutdown :
- tout remplacer ?



David Berger et al. (J.Wotschack)
open EB 10/05/2011

Présentation récente de ce projet : intéressant (mais « planning » à évaluer / discuter…)

Les noms / zones à retenir

(upgrade : Micromegas ?)

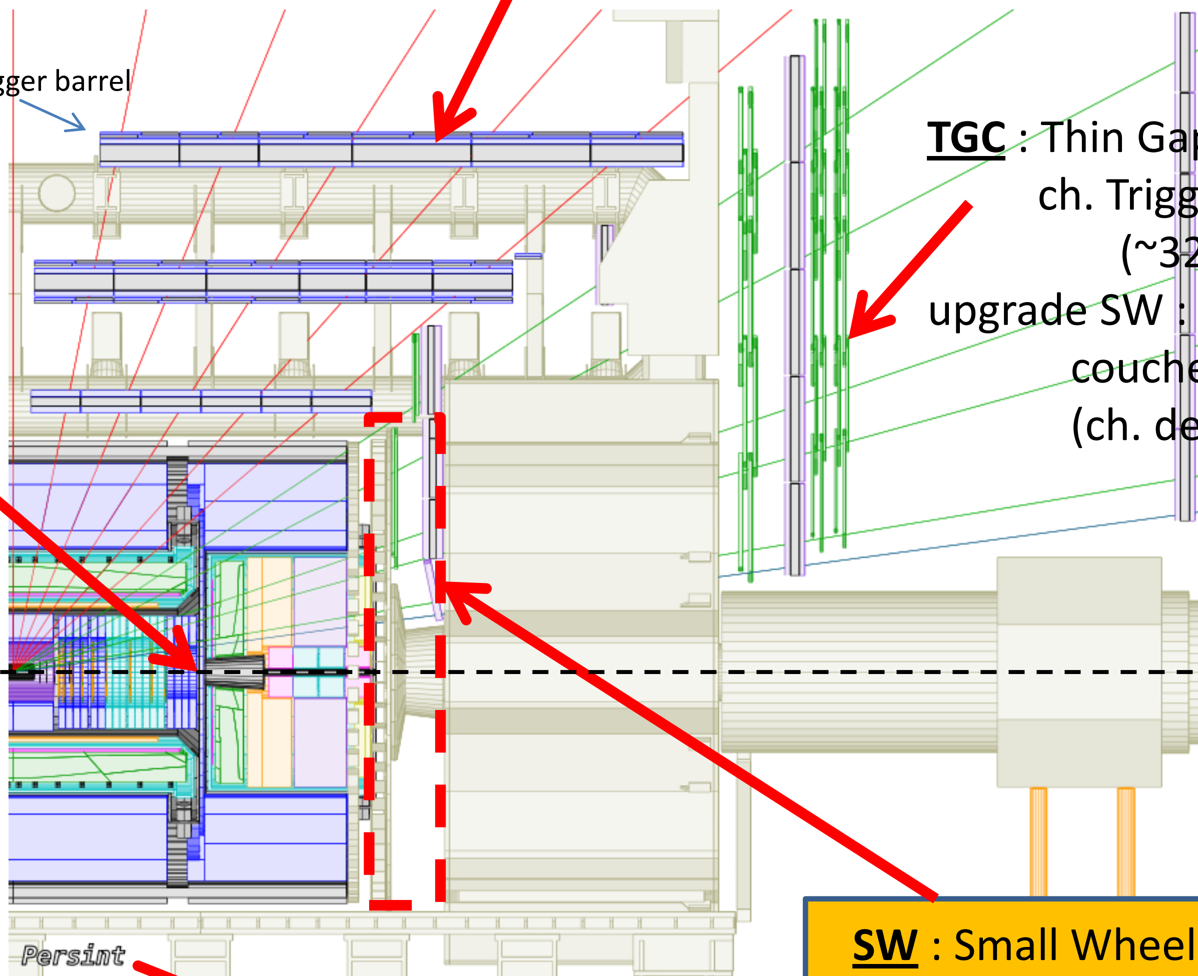
MDT : Monitored Drift Tube (~350000)
ch. de précision (tube Ø=30mm)
upgrade SW : **sMDT** (même chose 15mm)

RPC ch. trigger barrel

MBTS : Minimum Bias Trigger Scintillators (Ø<1m)

à changer phase-I

TGC : Thin Gap Chamber (MWPC)
ch. Trigger end-cap (3 couches)
(~320000)
upgrade SW : même chose + couche résistive
(ch. de précision ?)



Pieds de la manip : zone avec des trous d'acceptance (à améliorer…)

ascenseurs

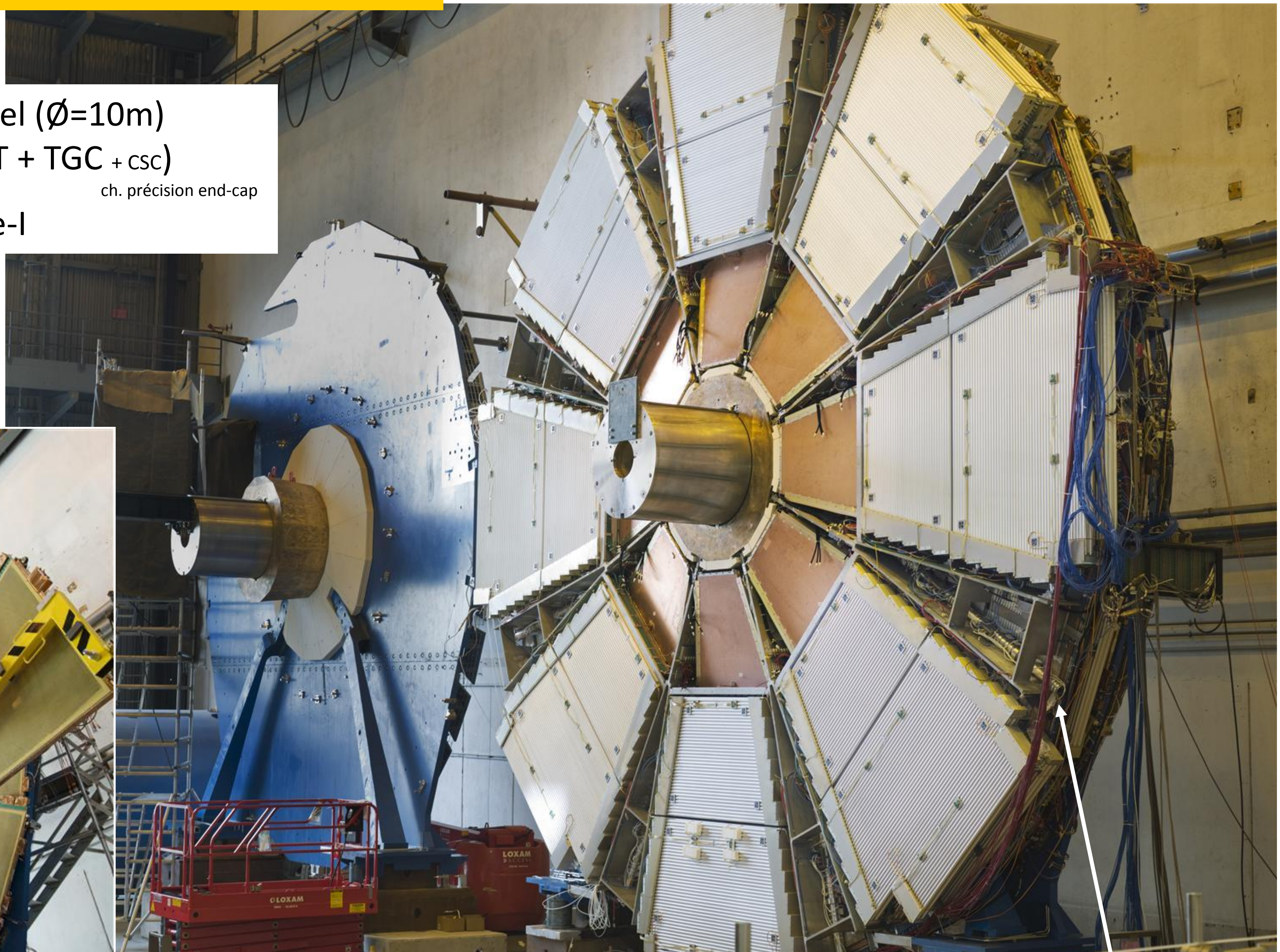
SW : Small Wheel (Ø=10m)
(blindage + MDT + TGC + CSC)
ch. précision end-cap

à changer phase-I

Present small wheel pictures

SW : Small Wheel (Ø=10m)
(blindage + MDT + TGC + CSC)
ch. précision end-cap

à changer phase-I



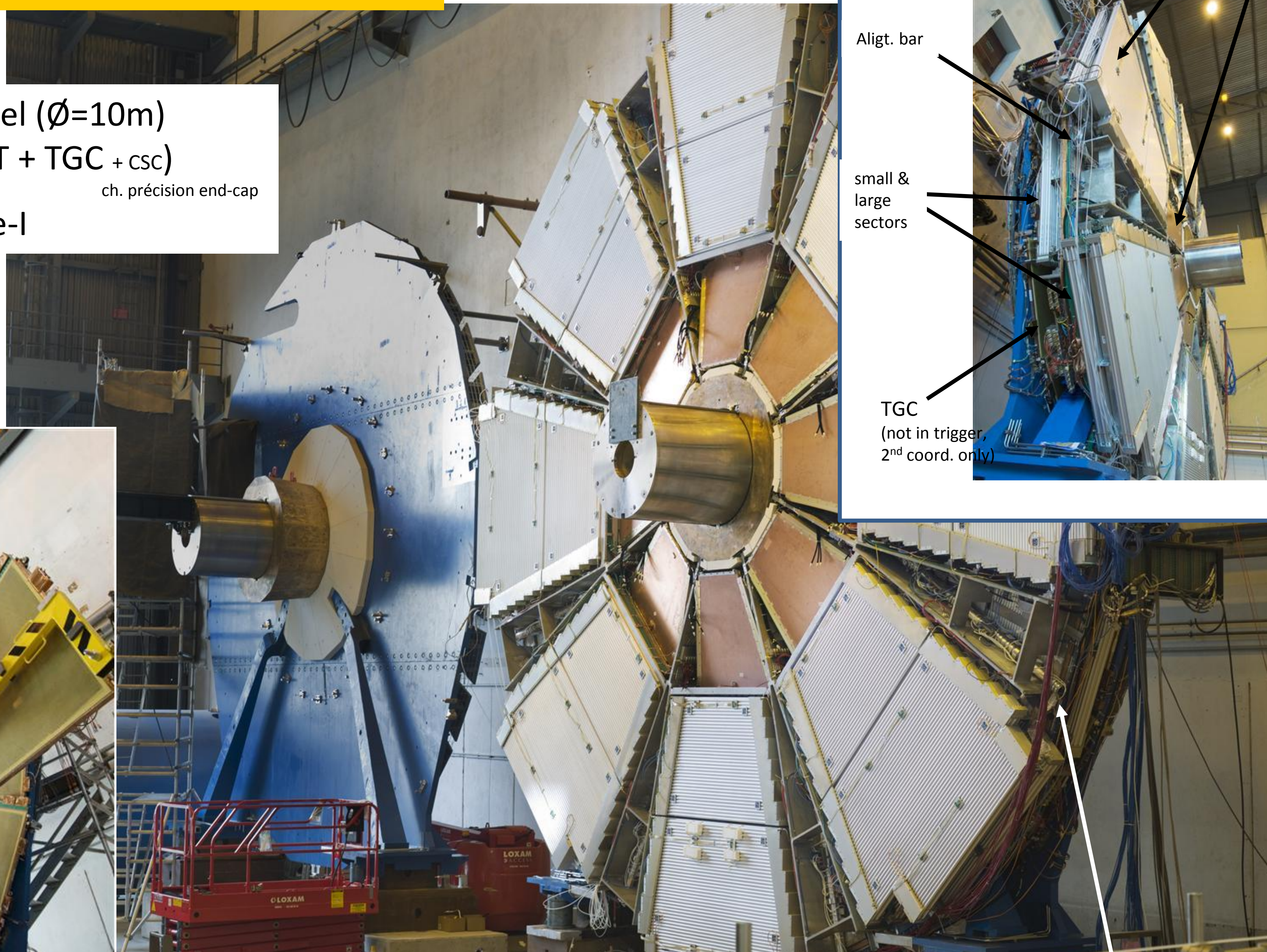
alignment bar

TGC installation

Present small wheel pictures

<u>SW</u> : Small Wheel (Ø=10m)
(blindage + MDT + TGC + CSC)
ch. précision end-cap

à changer phase-I



TGC installation

Future small wheel

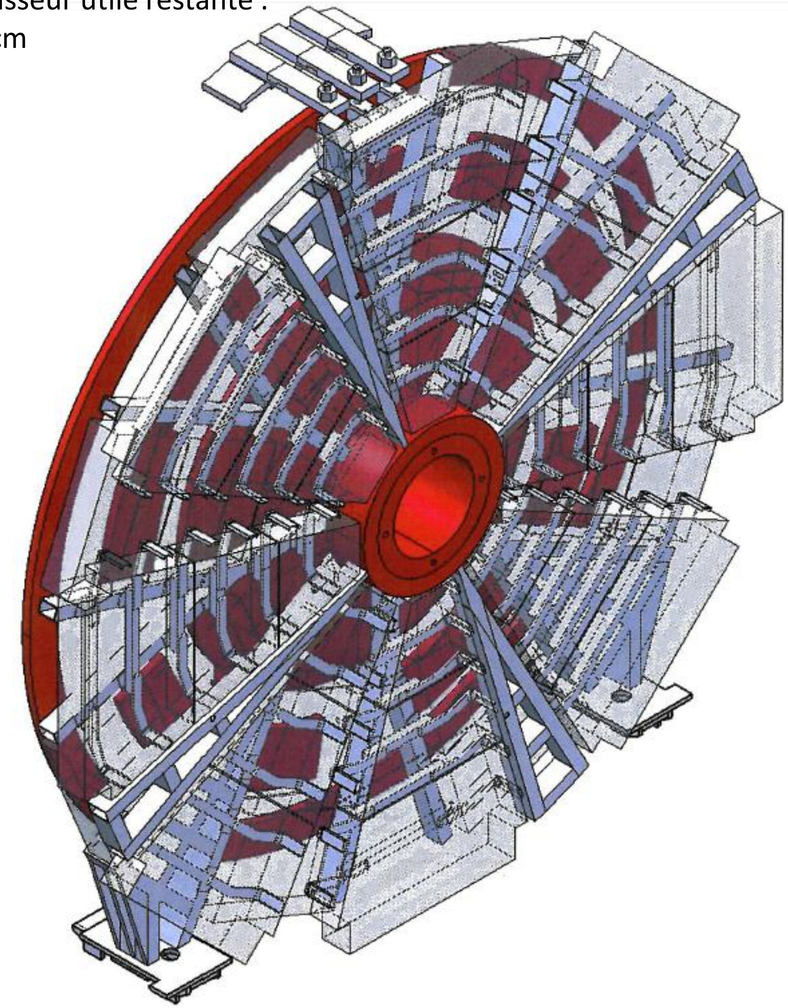
+ rajout d'une couche de blindage en polyéthylène ?

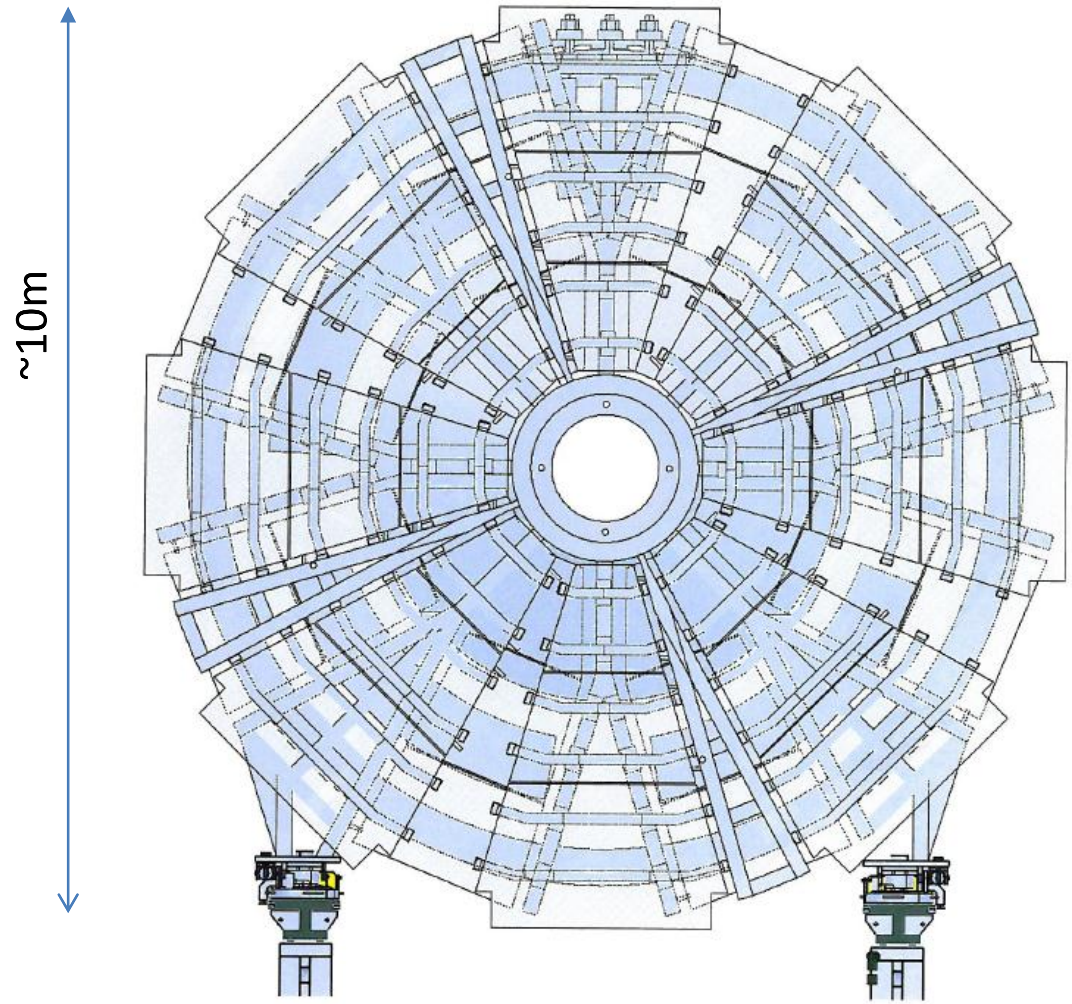
SIS, Seb.H.

Étape 1 : définir une chambre Micromegas

Étape 2 : intégration dans la nouvelle SW (services, alignement, etc.)

=> Épaisseur utile restante : ~2x40cm





Projet intéressant intrinsèquement :

premier dessin d'une « chambre » multicouches 2x 2 doublet tête-bêche de Micromegas ; taille ~1 m2

(problème de distribution de gaz, déformation du PCB (+ nid d'abeille ?), thermique, longueur strips -capa-, etc.)

Quelque soit l'issu dans Atlas, ces études pourront servir au design d'une chambre Micromegas utilisable par d'autres expériences…

Future small wheel

+ rajout d'une couche de blindage en polyéthylène ?

SIS, Seb.H.

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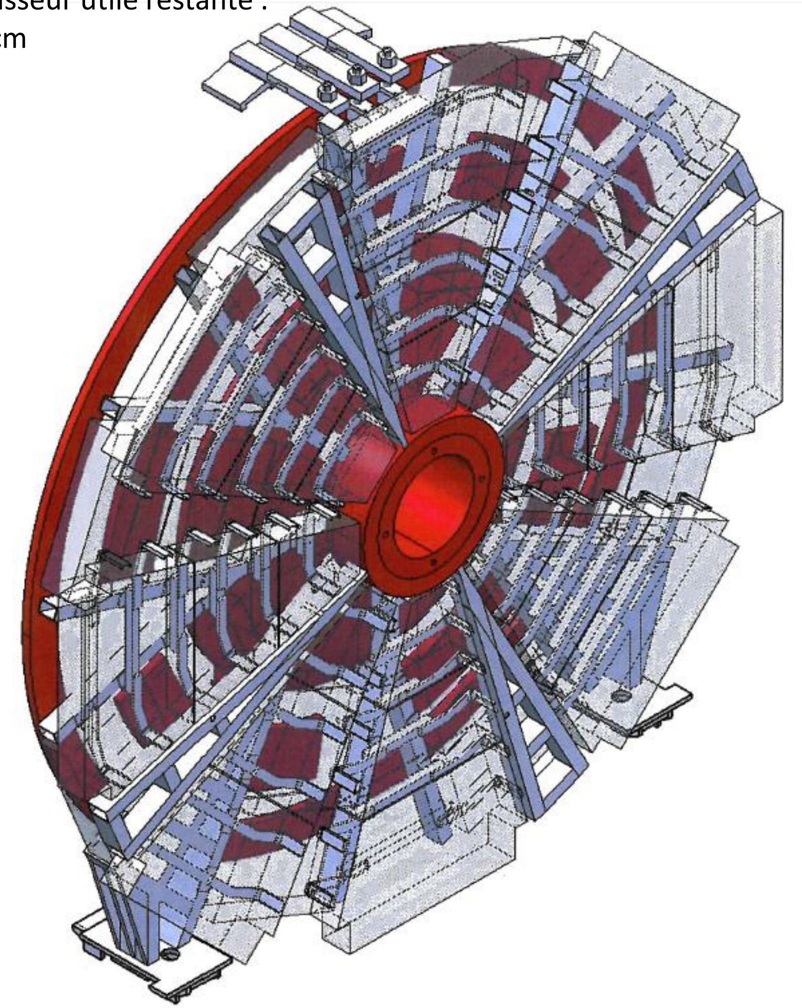
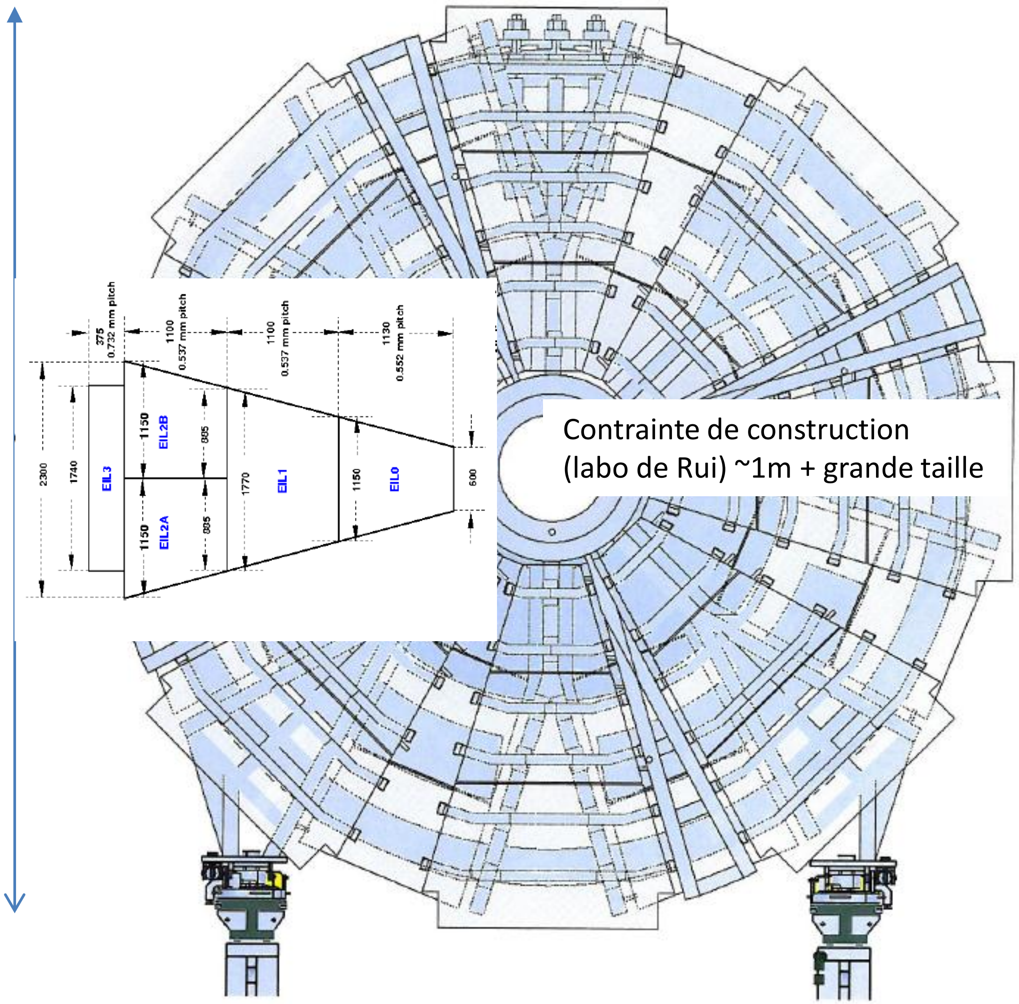
~2x40cm



~10m



Contrainte de construction
(labo de Rui) ~1m + grande taille

<u>Projet intéressant intrinsèquement :</u>

premier dessin d'une « chambre » multicouches de type Micromegas ; taille ~1 m2

(problème de distribution de gaz, déformation du PCB (+ nid d'abeille ?), thermique, longueur strips -capa-, etc.)

Quelque soit l'issu dans Atlas, ces études pourront servir au design d'une chambre Micromegas utilisable par d'autres expériences…

SIS, Seb.H.

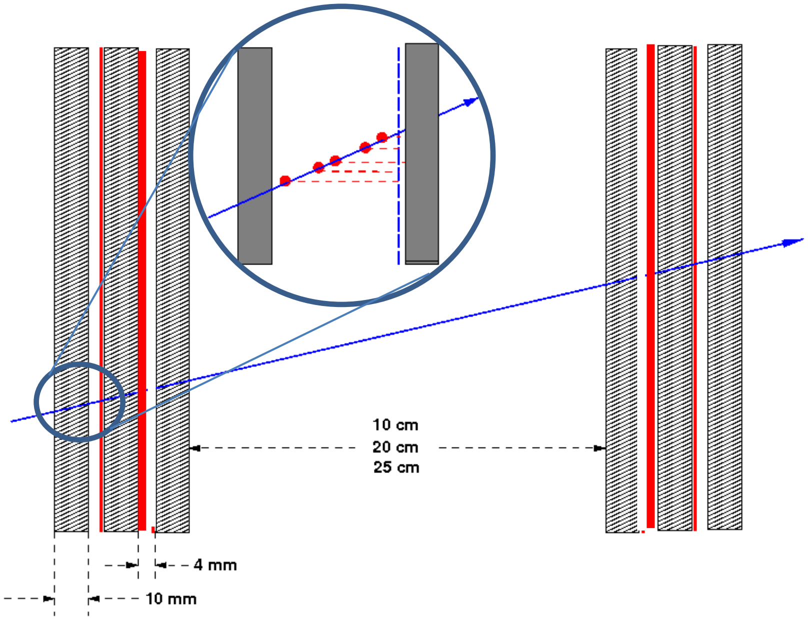
Future small wheel

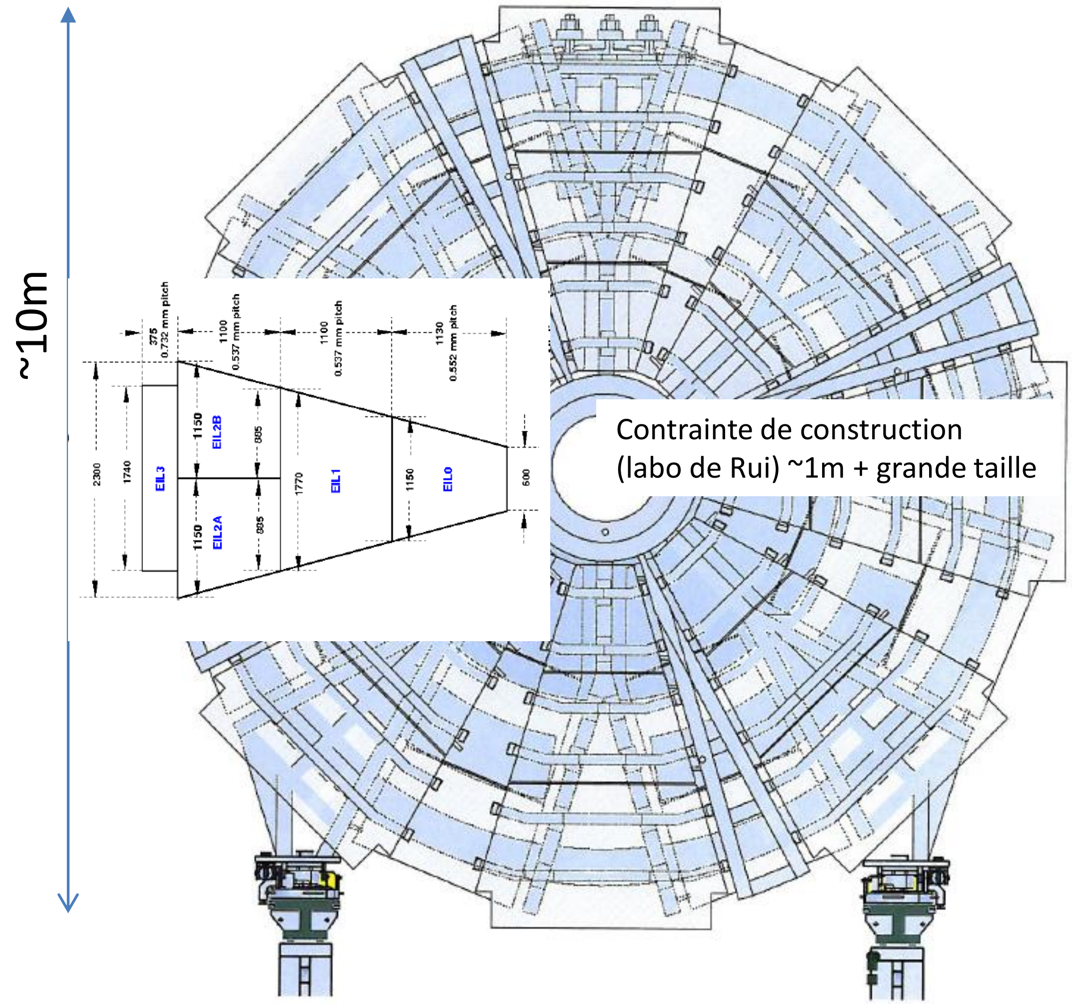
+ rajout d'une couche de blindage en polyéthylène ?

Étape 1 : définir une chambre Micromegas
Étape 2 : intégration dans la nouvelle SW (services, alignement, etc.)

=> Épaisseur utile restante : ~2x40cm

Agencement Micromegas possible (en mode micro-TPC) :





<u>Projet intéressant intrinsèquement :</u>

premier dessin d'une « chambre » multicouches de type Micromegas ; taille ~1 m2
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Quelque soit l'issu dans Atlas, ces études pourront servir au design d'une chambre Micromegas utilisable par d'autres expériences…

Cahier des charges petites roues SW (ici trigger)

Requirements on the new small wheel detector

Draft 0.1 05.05.2011

The primary purpose of this note is to provide a common and agreed upon reference for inviting proposals of new small wheel concept. This is also meant to be a concise document describing our present idea of muon upgrade in the endcap region for high luminosity.

Evolving nature of this document should be understood. The requirements are clearly not exhaustive, and may be updated or more items added reflecting the progress in understanding the detail of required performance,and also in view of technical feasibility.and other relevant points.

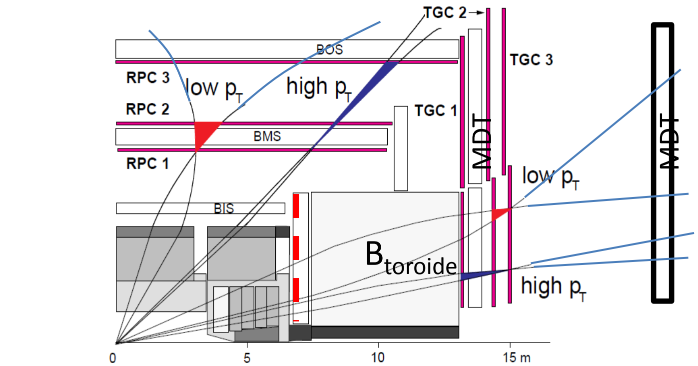


Figure 12-7 Level-1 muon-trigger scheme in the barrel and in the end-cap. The low-p_T trigger is based on two double layers of trigger chambers; the high-p_T trigger uses an additional double layer in the barrel and a triple layer in the end-cap. The shaded area represents the calorimeters and the absorber. Trajectories for positive and negative muons are shown.

Premier toy MC (V.Polychronakos) :
Semble jouable : resolution ~0.5mm par layer (qquesoit angle)
Eff ~100% si 3 ou 4 couches

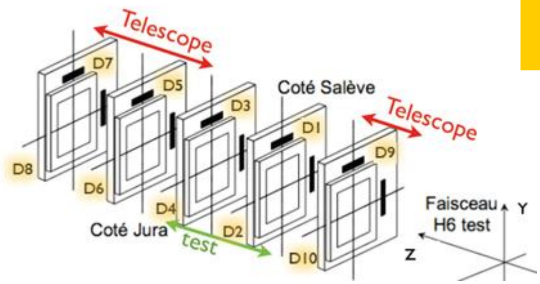
5 Level-1 trigger function

The small wheel detector and associated electronics should provide information for the L1 trigger upgrade in the endcap. The position and angle of small wheel segments are used to improve the quality of L1 high p_T decision by the big wheel TGCs.

1. The system should perform bunch-id and real-time reconstruction of track segments which are approximately pointing to the IP. The acceptance angle, in η and ϕ, should be optimised taking into account the expected angular range of good tracks from IP, detector alignment error, complexity of implementation and any physics requirements.
2. For each segment, a set of data (R, ϕ, $\Delta\theta$), or an equivalent set of information, should be provided. Here radial and azimuthal coordinates R and ϕ represent the position of the segment on small wheel at appropriately defined z coordinate Z. The quantity $\Delta\theta$ is a measure of how well the reconstructed segment is pointing to the nominal IP - the difference of segment polar angle with respect to the angle $\tan^{-1}(R/Z)$.
3. The track segment data (R, ϕ, $\Delta\theta$) should be transmitted to the trigger logic of corresponding trigger sector(s), where final endcap L1 signal is constructed (sector logic). Details such as maximum number of segments, data format and data transfer protocol are to be defined in the framework of overall trigger electronics design.
4. Angular resolution of $\Delta\theta$ must be 1 milliradian (RMS) or better.
5. Granularity of R and ϕ information should be matched to the size of ROI of the present endcap trigger (about 0.04×0.04 in η-ϕ).
6. The (R, ϕ, $\Delta\theta$) information should arrive the input of sector logic not later than the arrival time of the main trigger inputs from the big wheel TGC. The delay of the TGC signal is at present 1.088 μsec from the collision.
7. Efficiency of segment reconstruction should be high and robust. Rate of fake segments should be optimised so as not to affect significantly the trigger efficiency while maintaining good rejection power of fake L1 triggers.

This implies that the number of detector layers should not be too small - many layers will bring high efficiency, low fake rate, good angular resolution and also operational robustness due to redundancy. Long lever arm will be beneficial especially for angular resolution. Optimisation should be made taking into account elements including performance, complexity and limitations from available space which is shared by the detector and possible installation of additional shielding.

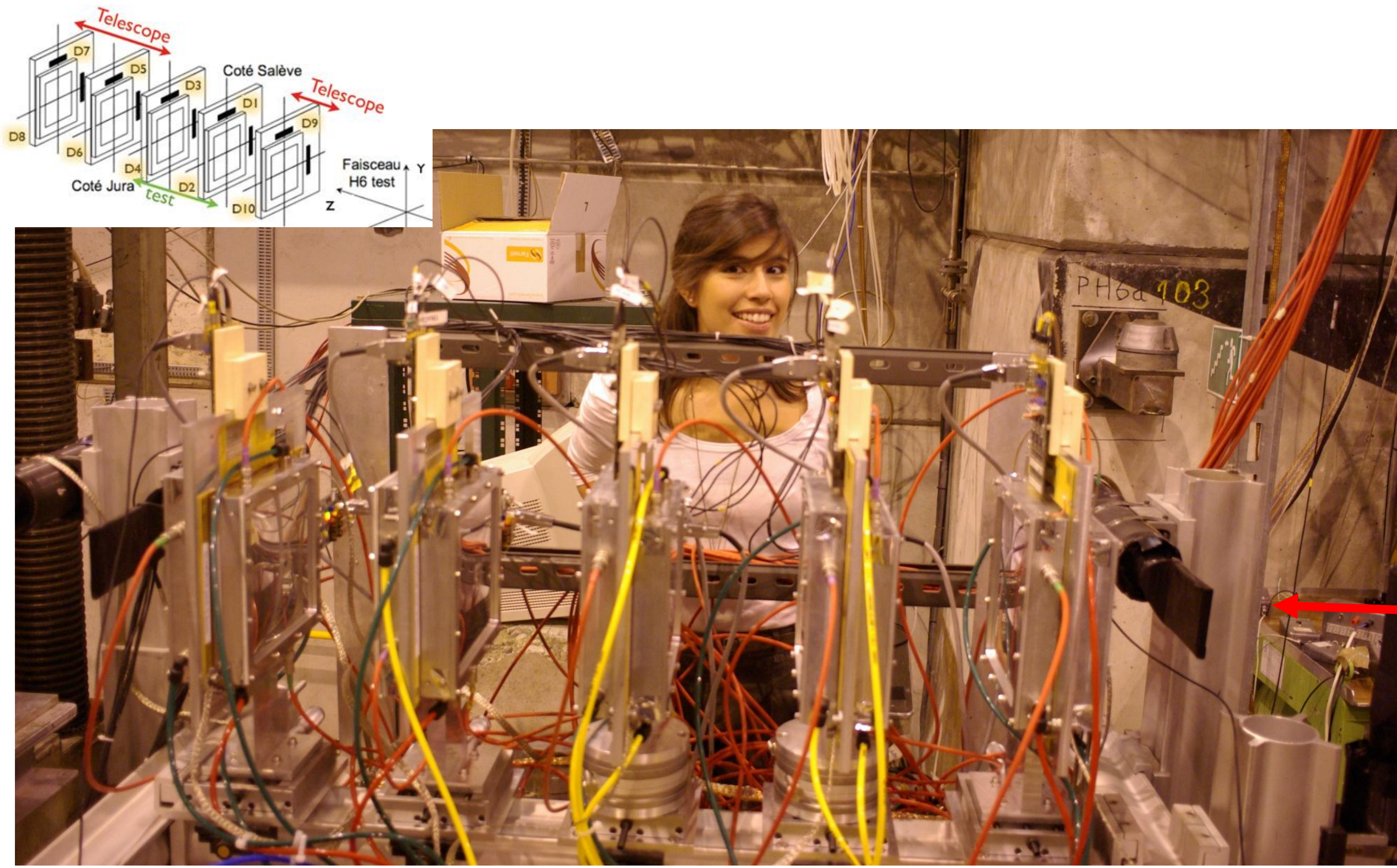
granularité ~10 cm (eta)x 8 cm (phi)



End of last year test beam (under analysis)

- Comment cela marche actuellement ?
  - Quelles techniques et où ?
- Problème du bruit de fond
- Upgrade (*)
  - Les différentes options
- Test-beam
- Conclusions

End of last year test beam (under analysis)



Pions

~150 GeV

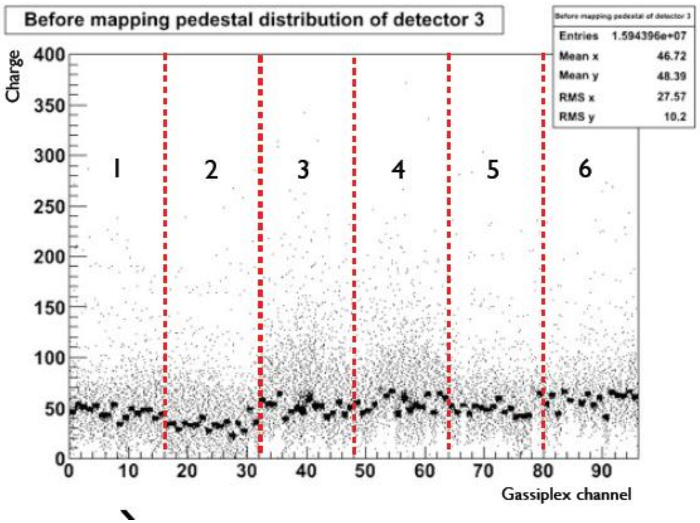
telescope

tested detectors

telescope

Zone H6

Quelques plots préliminaire venant du faisceau test



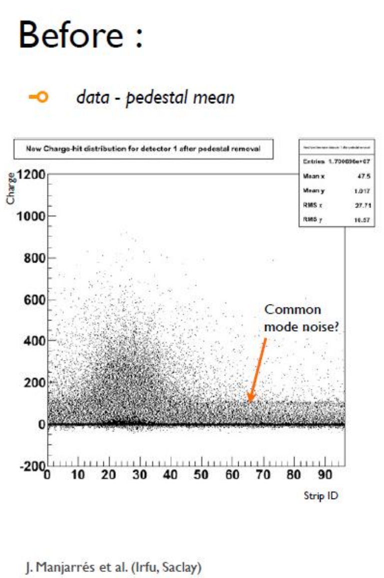
Faisceau test mis en place rapidement (et proprement).
Néanmoins quelques petits soucis avec l'électronique Gassiplex (canaux morts) et avec le DAQ (Thessalonik/Athens) : télescope peu redondant.

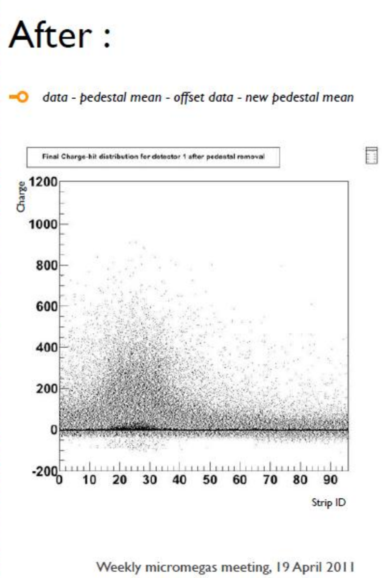
- Étude du piédestal optimisée

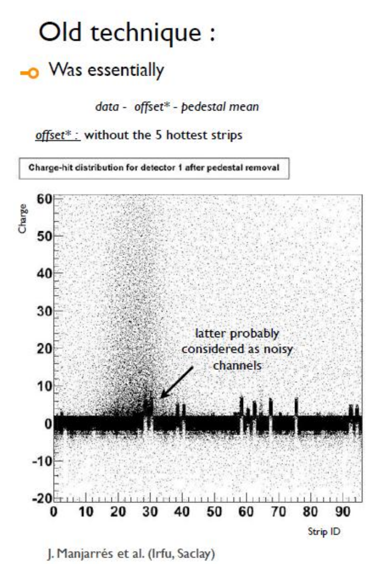
- Définition de traces (coupures)

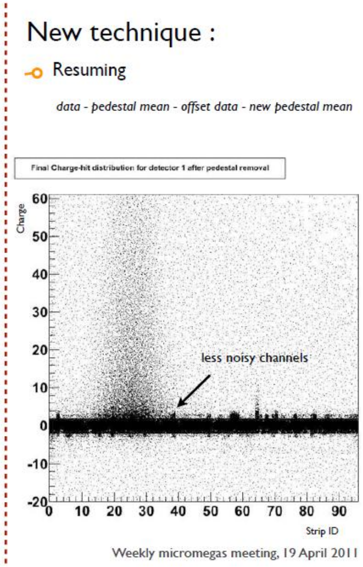
- Efficacités (préliminaire)

Joany Manjarres

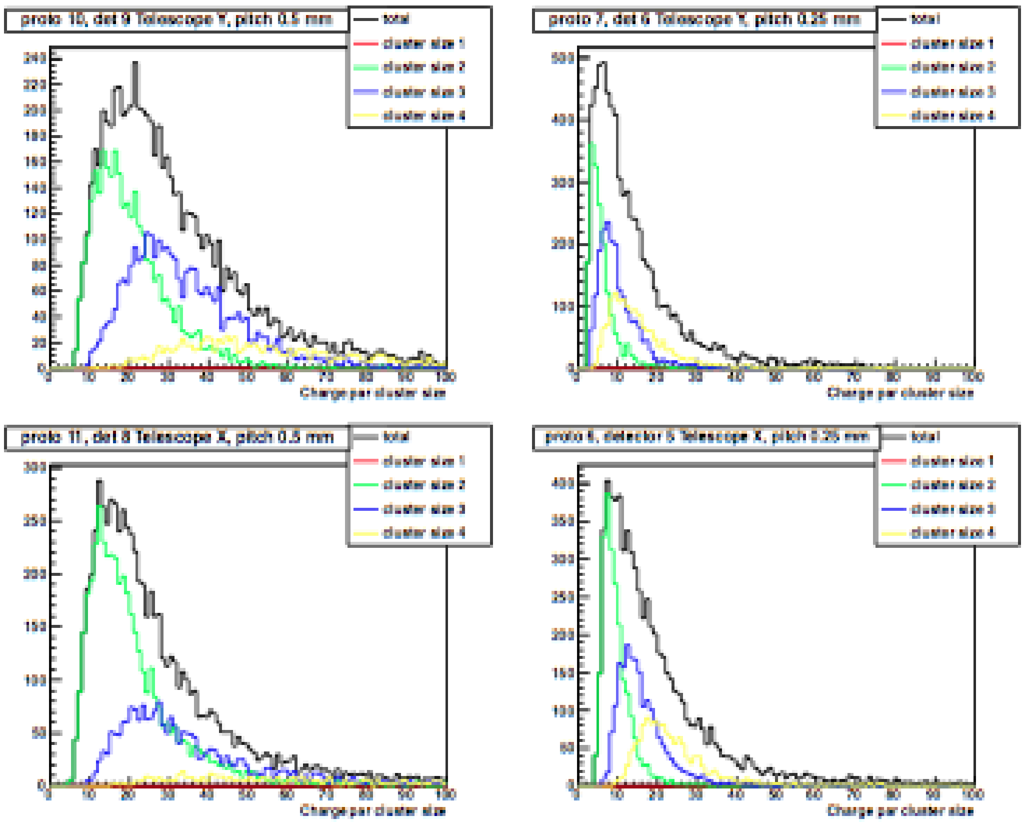








Landau / dE/dx



HV: test 350V/500V
telescope (X3=Y3=350) 330-500
(Run 8162)

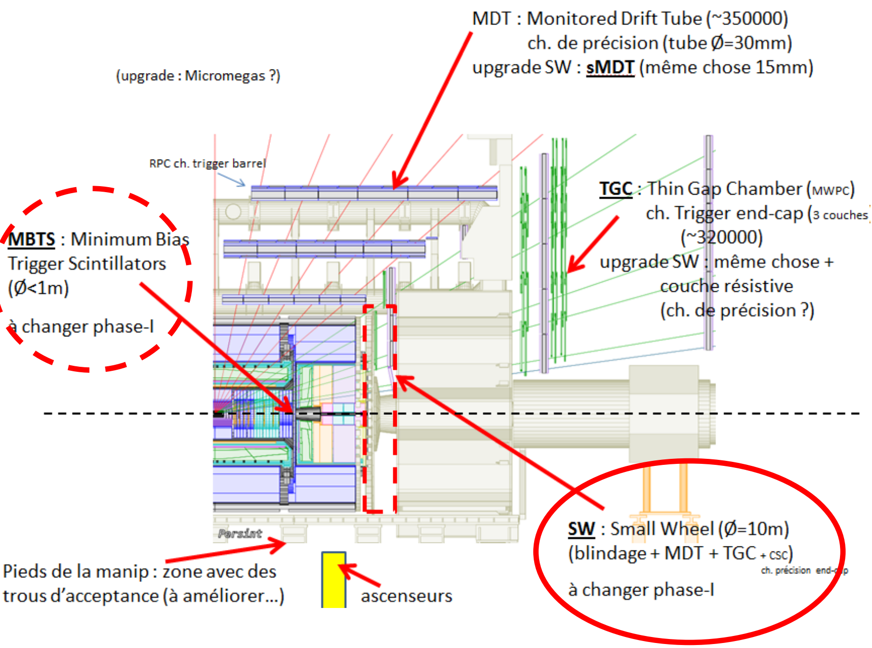
Définition des cuts des traces

Cut	Resistive	Non resistive
σ cut from pedestal	3.5 σ	3.5 σ
In cluster reconstruction strip gap	not allowed	not allowed
The event must to be in the detector	✔	✔
Cluster Charge	> 6 ADC counts < 220 ADC counts	>6 ADC counts <100 ADC counts
Cluster Size	No limit	< 3 mm
Bisecting line criteria *	✔	✔
Slope of the track	must be inside 3 σ of the slopes track distribution	must be inside 3 σ of the slopes track distribution

Résistif à étudier

télescope

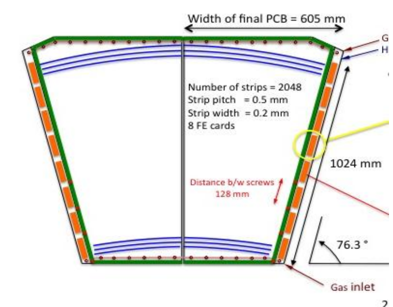
Contraintes spécifiques au projet dans l'environnement Atlas



Nous avons essayé de distinguer ce qui se fait dans la manip et ce que nous faisons (souhaitons faire)

Se rappeler qu'Atlas a ses propres contraintes (diff. de nous, par ex. : analyse indépendante du détecteur ?) et son propre planning : choix fin 2011 – deb. 2012 ?

Nous essayons d'avoir des objectifs (intermédiaires) clairs et de rester cohérents. Nous avons défini 4 thèmes de travail :



MAMMA
- (a) Intégration SW, installation, irradiation : SIS, SEDI
- (b) Test beams (Micromegas grande taille) : SEDI, SPP (CERN)

ATLAS
- (c) Electronic (readout et DAQ) : BNL, (avec SEDI ?) ⟷ valable pour les TGC !
- (d) Bruit de fond et simulation : SPP (aussi le SPhN ?)

irfu
cea
saclay

Environnement de travail du groupe dans Atlas

(avant et après être dans la collaboration MAMMA)

Atlas, partie muons (<1995-2009)		MAMMA (2008-…)
Allemagne	(Munich LMU et MPI, Freiburg)	
CERN		
Chine	(Beijing IHEP, N.Univ. et S.Univ., Hefei)	+ Shandong
États-Unis	(Ann Arbor, Boston, Brandeis, Brookhaven, Harvard, MIT, Northern Illinois, Stony Brook, Tufts, Tuckson, Seattle, Michigan Univ.)	+ Arizona, South Carolina, Washington
France	(Saclay)	
Grèce	(Thessalonique, Athènes TU, Athènes U)	
Israël	(Haïfa, Tel-Aviv, Weizmann)	+ Istanbul
Italie	(Bologne, Cosenza, Frascati, Lecce, Naples, Pavie, Rome I, II et III)	
Japon	(KEK, Kobe, Shinshu, Tokyo ICEPP, MU et UAT)	
Pays-Bas	(NIKHEF, Nijmegen)	
Russie	(Doubna JINR, Minsk, Protvino, St.Petersburg NPI)	

Remarques :

- Nombre de collaborateurs MAMMA pas si nombreux que ca…
- Malheureusement peu de laboratoires de P2IO… :-(

irfu cea saclay

Le groupe actuel

Service technique : personne à 100% !!

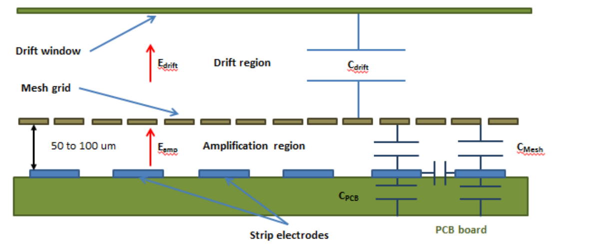
SEDI : D.Attié, M.Boyer, E.Ferrer-Ribas, A.Giganon, S.Herlant (stage applicatif diplôme ingénieur), F.Jeanneau (C.d.P.)

SPP : J.Manjarres-Ramos (PhD), Ph.Schune (Resp.Sc.)

(+ F.Bauer : installation proto MicroMegas en caverne Atlas)

Étude des claquages, irradiation :
J.Galan (SEDI, post-doc Miro)

Spark measurements have been performed with a standard Micromegas detector



The aim is to establish a methodology and electrical modeling of sparking phenomena.

In order to understand the different electronic responses measured by the different read-out systems and prototypes under development.

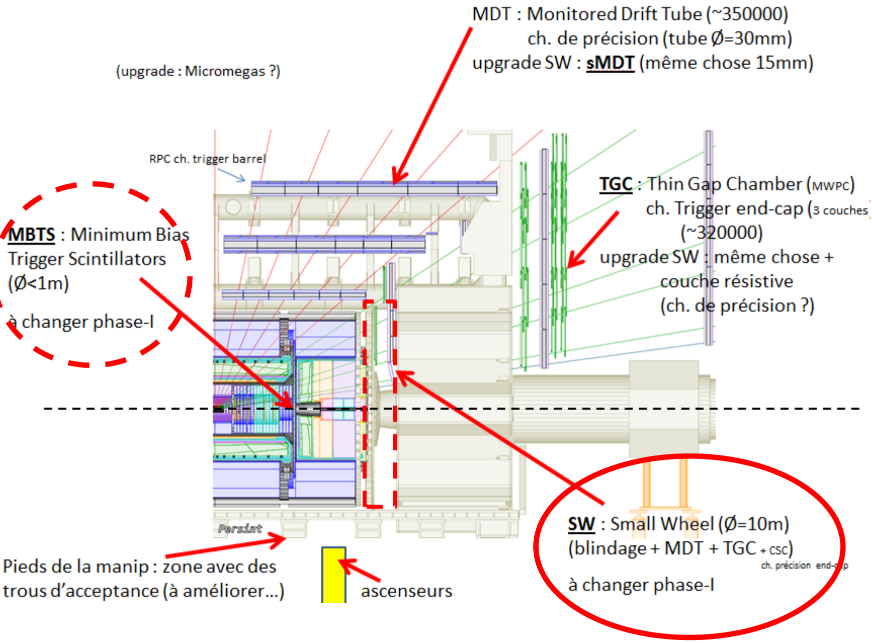
Required modeling of spark + modeling of electrical response

Experts : S.Aune, P.Colas, A.Delbart, JDerré, I.Giomataris, Th.Papaevangelou, M.Titov, S.Procureur, D.Neyret…

Experts hors Saclay : R.de Oliveira (CERN) -production prototypes-, J.Wotschack (CERN, resp. groupe MAMMA), V.Polychronakos (BNL, co-resp. MAMMA et devel. nouvelle électronique), etc…

MAMMA : Muon Atlas MicroMegas Activity

Contraintes spécifiques au projet dans l'environnement Atlas



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Se rappeler qu'Atlas a ses propres contraintes (diff. de nous, par ex. : analyse indépendante du détecteur ?) et son propre planning : choix fin 2011 – deb. 2012 ?

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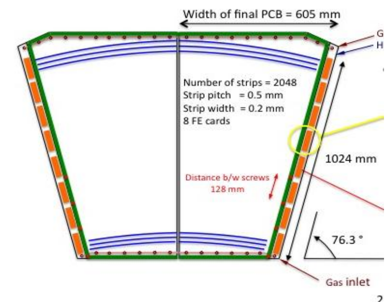

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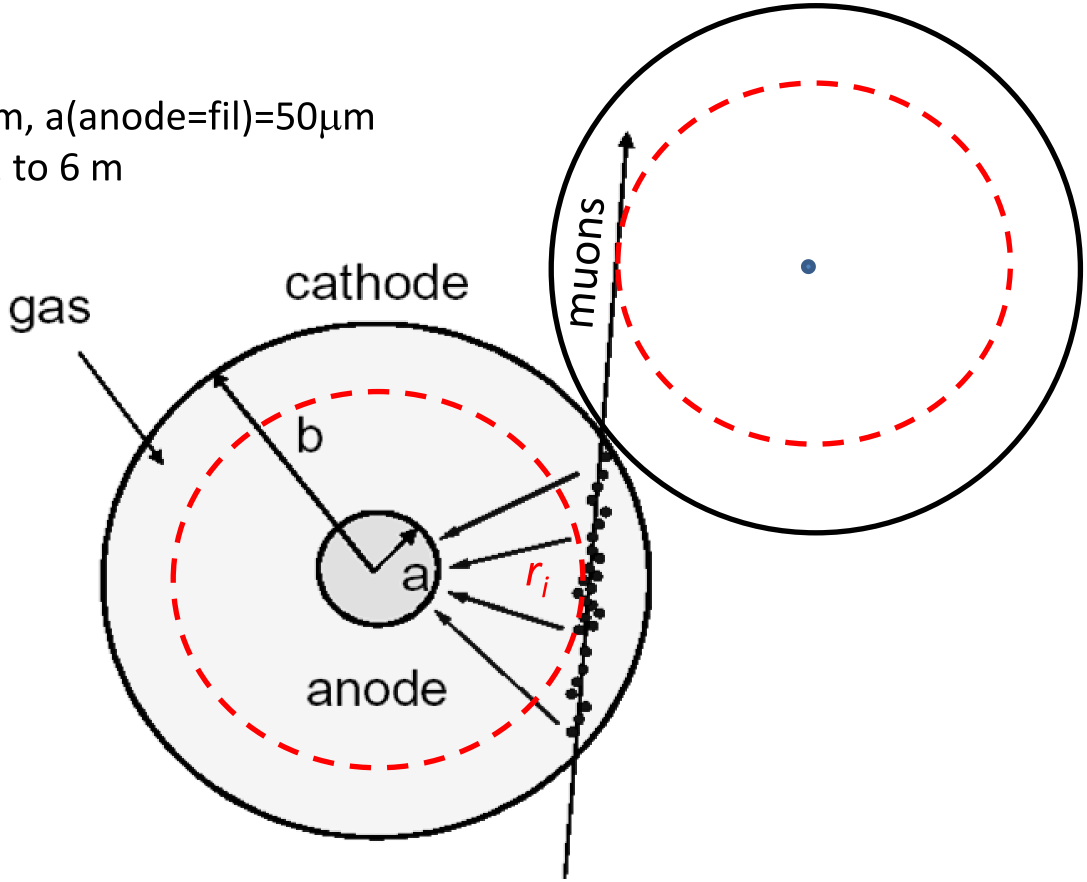
- (d) Bruit de fond et simulation : SPP (aussi le SPhN ?)

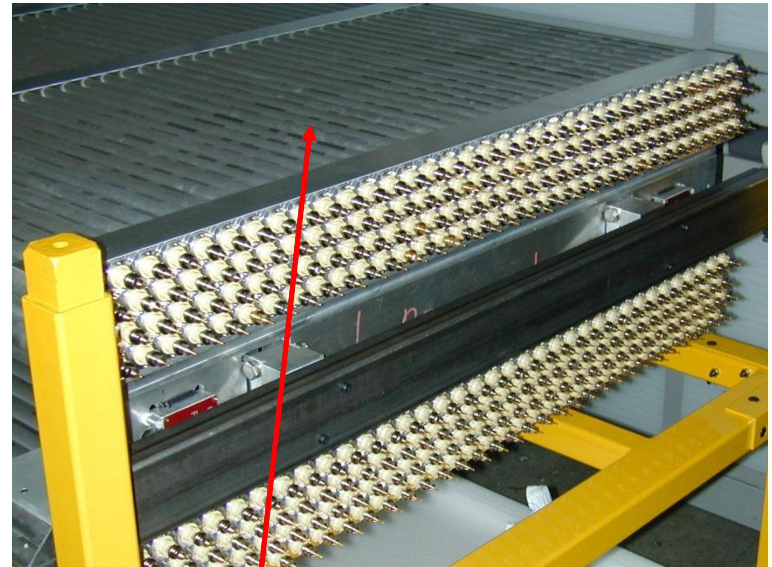
irfu cea saclay

Rab…

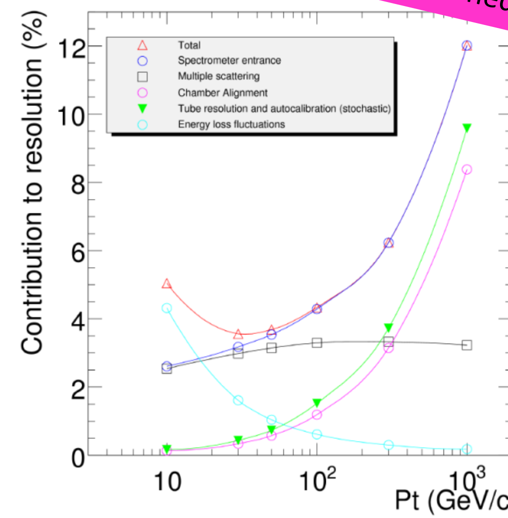
MDT : Monitored Drift Tubes

b=15 mm, a(anode=fil)=50μm
L from 2 to 6 m





Voir Apero-SPP
D'Eve LeMenedeu



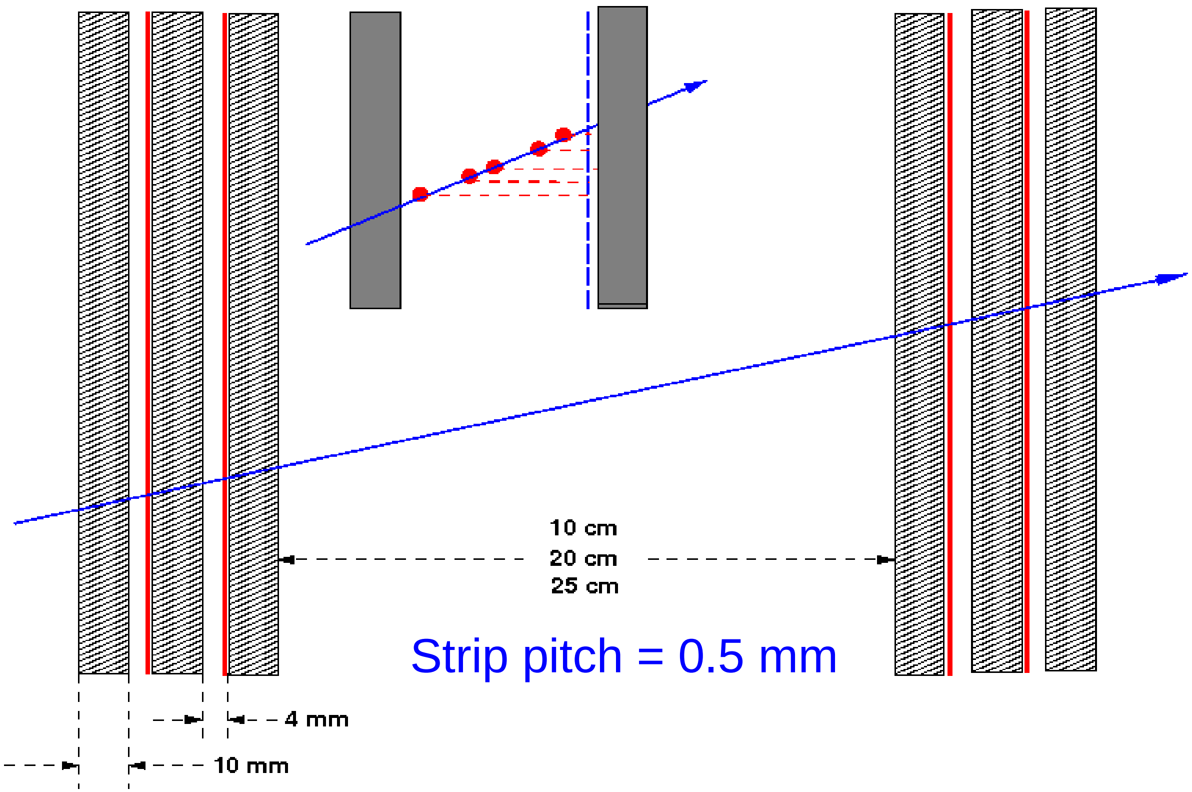
Ar:CO_2 93:7
p = 3 bar => ~3×100 pairs/cm (n_{Total}) ~ 12 keV au mip
Gain: 2.10^4
Max drift time of e- : 700ns, i.e. “slow” good for *Lorentz* angle limitation
v ~ 3 cm/μs (=30μm/ns)
Centring of wire < 100μm all along the tube (20μm at the end-plug)
Threshold at the ~25th e-
σ ~ 80 – 100 μm / tube => combining tubes of one chamber gives ~50μm locally

~350 000 canaux

ε_n^{hit} ~$1\text{-}3.10^{-4}$

MM Toy Monte Carlo

V.Polychronakos (BNL)

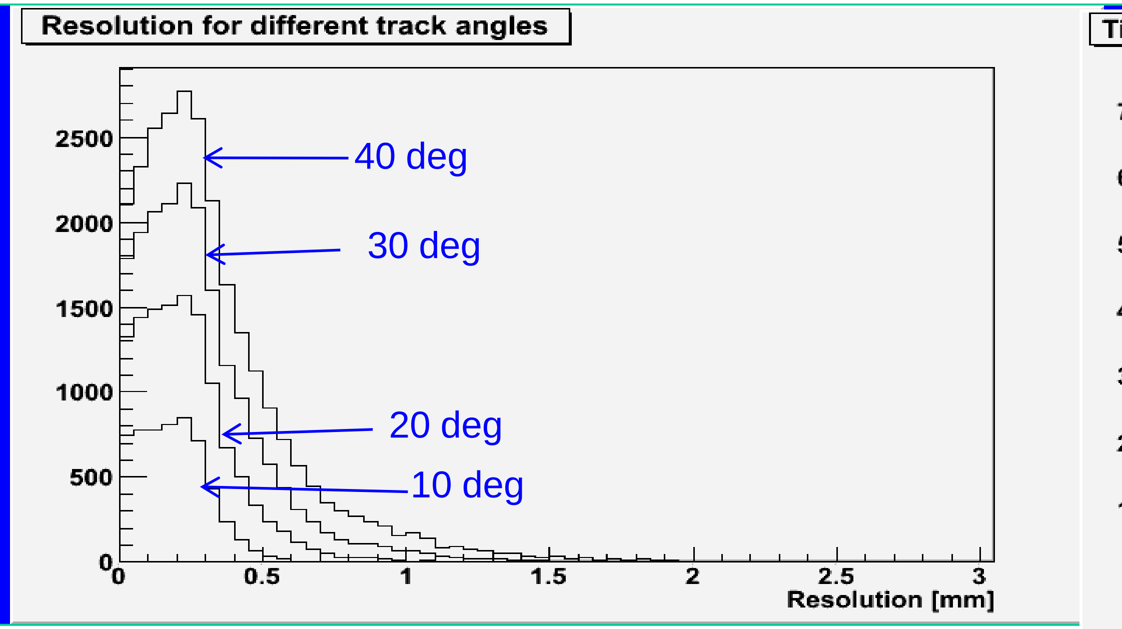


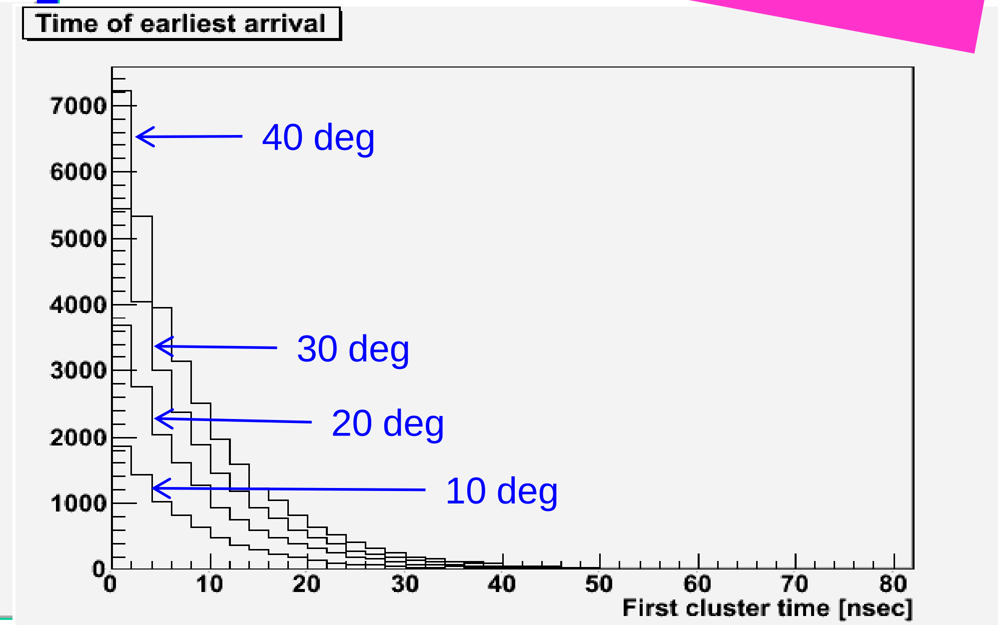
- Generate track at a given angle
- Track crosses a strip at a random position
- Generate primary ionization clusters Poisson distributed
- Generate number of electrons for each cluster
- Take strip with earliest time and charge over a certain threshold as the track's coordinate

Reconstruct track and compare slope with the generated one
No transverse diffusion considered but effect is negligible for the first arriving cluster

Position and Timing Resolution as a function of incidence angle

V.Polychronakos (BNL)





- Average spatial resolution below 0.5 mm for all angles in Small Wheel acceptance
- Time of first cluster above threshold mostly below 25 nsec
- Requiring, e.g, 3 out of 4 detectors to be within a BC should result in ~100% efficiency
- Address of strips can be directly used in a lookup table (e.g. Content addressable memories similar to FTK

La collaboration MAMMA

(cf. J.Wotschack, CERN, mi-mai)

University of Arizona :	faisceaux tests
Athens Demokrito :	test neutrons
Athens National Technical University :	test neutrons
Athen University :	simulation Garfield
Brookhaven :	simulation Garfield + électronique
CERN :	intégration mécanique
Harvard Univ. :	rien en pratique
Naples Univ. :	tests détecteurs (quelqu'un des RPC)
St Peterburg NPI :	travaille avec Brookhaven
Istanbul :	deux étudiants
Univ. of Science and Tech. of China (Hefei) :	veulent participer au faisceau test
Univ. South Carolina :	soft analyse data
Thessaloniki Aristotle Univ. (ex. MDT) :	analyses data
Shandong (?) China (ex. TGC, 10% prod.) :	participation faisceau (puis production ?)
Saclay :	claquage, segmentation

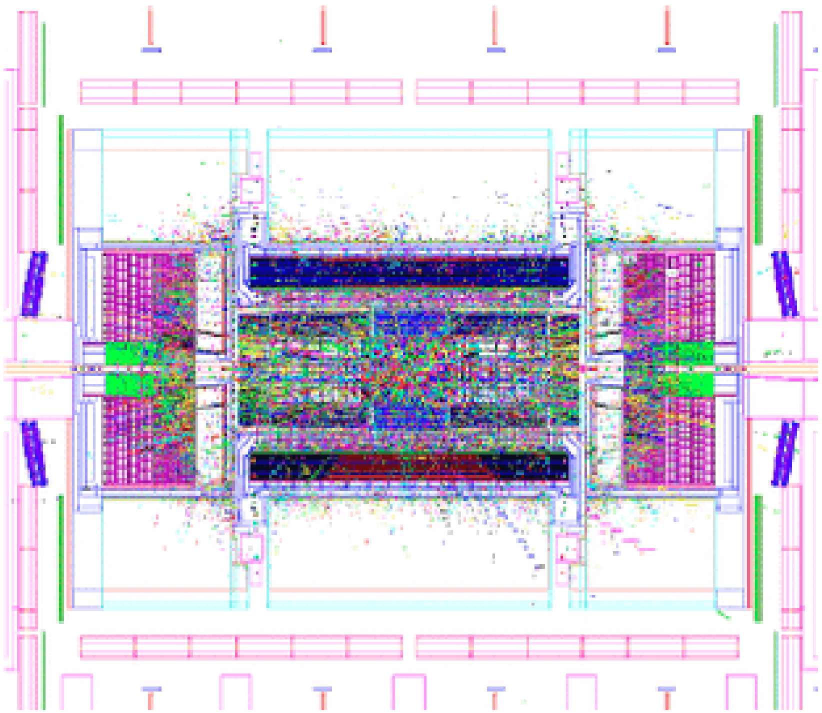
Prochaines étapes :

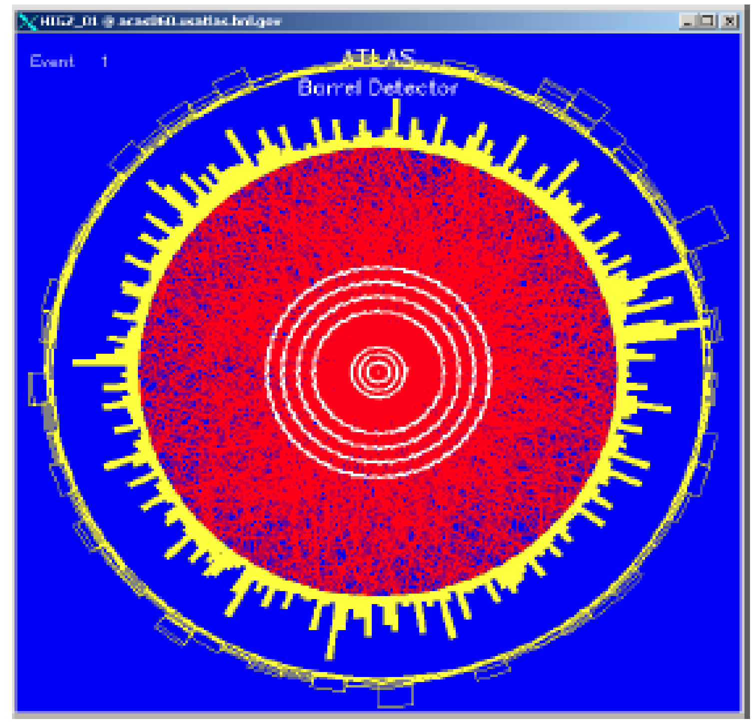
Proto échelle 1

Électronique : rooting (Brookhaven intéressé ?)

Simulation dans Atlas (?)

Muon Atlas MicroMegas Activity. J.Wotschak (CERN) et V.Polychronakos (BNL) sont les porte-paroles de ce groupe, interne à la collaboration Atlas.





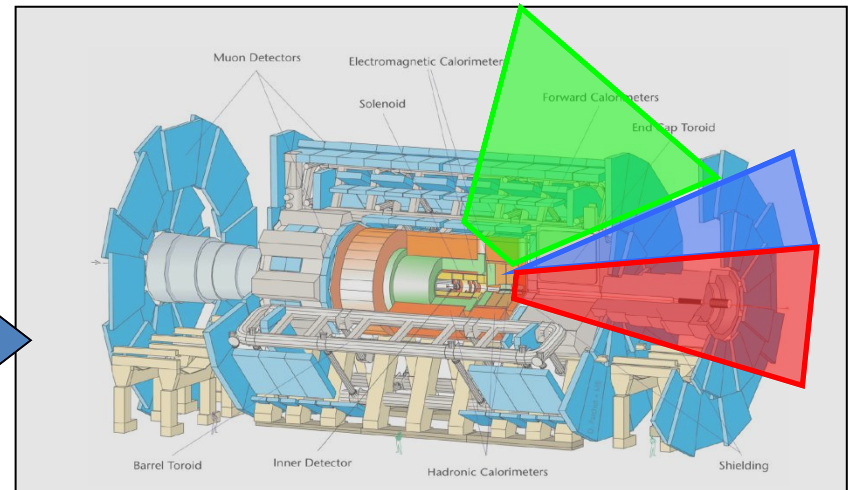
$N_{ch}(|y| \leq 0.5)$

HL-LHC : 230 min.bias collisions in bunch, ~ 10000 particles in $|\eta| \leq 3.2$,mostly low pT tracks

Background in Atlas cavern

Background comes from residues of p-p interactions (through spallation process) :

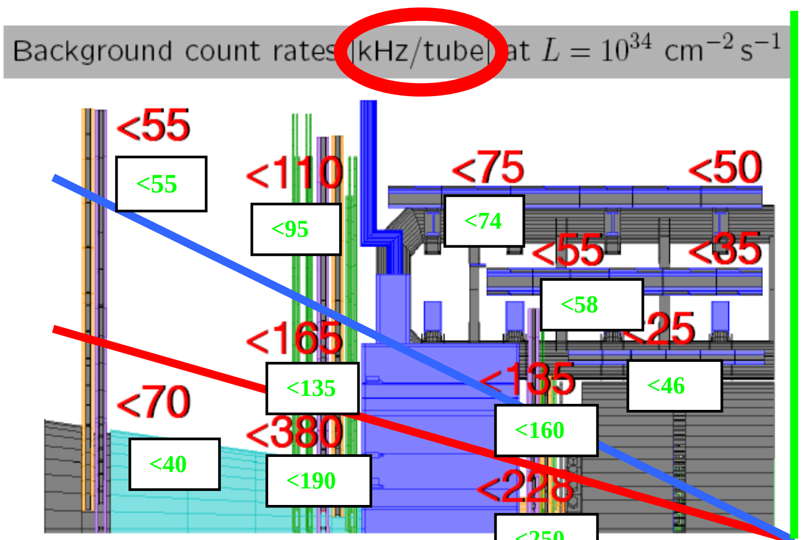
- Huge production of *neutrons*, thus creating γ, thus creating *e*, etc…
- Also at higher energy, *n* and γ create ionizing particle (mainly: p, e+, e-)
- Direct background: μ and punchthrough (smaller)



Neutron “gas” in the experiment cavern
(therm. of neutrons)

E_{cin}=10 MeV : v_n ~ 15% c (23 ns pour 1m)

10 keV : ~ 5.10^{-3} c (0.7 µs pour 1m), hors temps MDT



(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)

ε_n^{hit} ~1-3.10^{-4}

ε_γ^{hit} ~4-8.10^{-3}

10kHz/cm^2

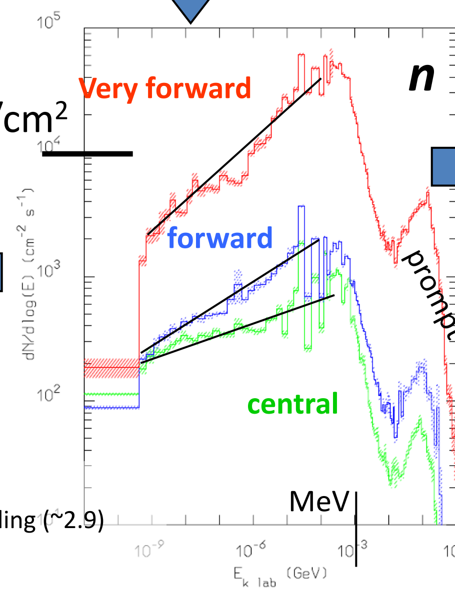


Figure 5-67 The expected neutron flux as a function of neutron energy in different rapidity regions of the muon spectrometer (top curve: $2.3 < \eta < 2.7$, middle curve: $1.4 < \eta < 2.3$ and bottom curve: $\eta < 1.4$).

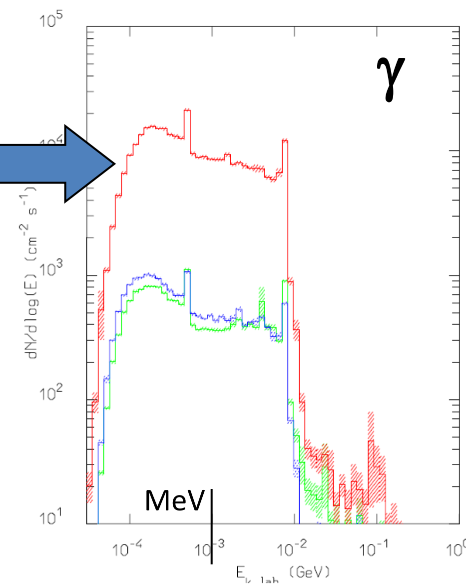


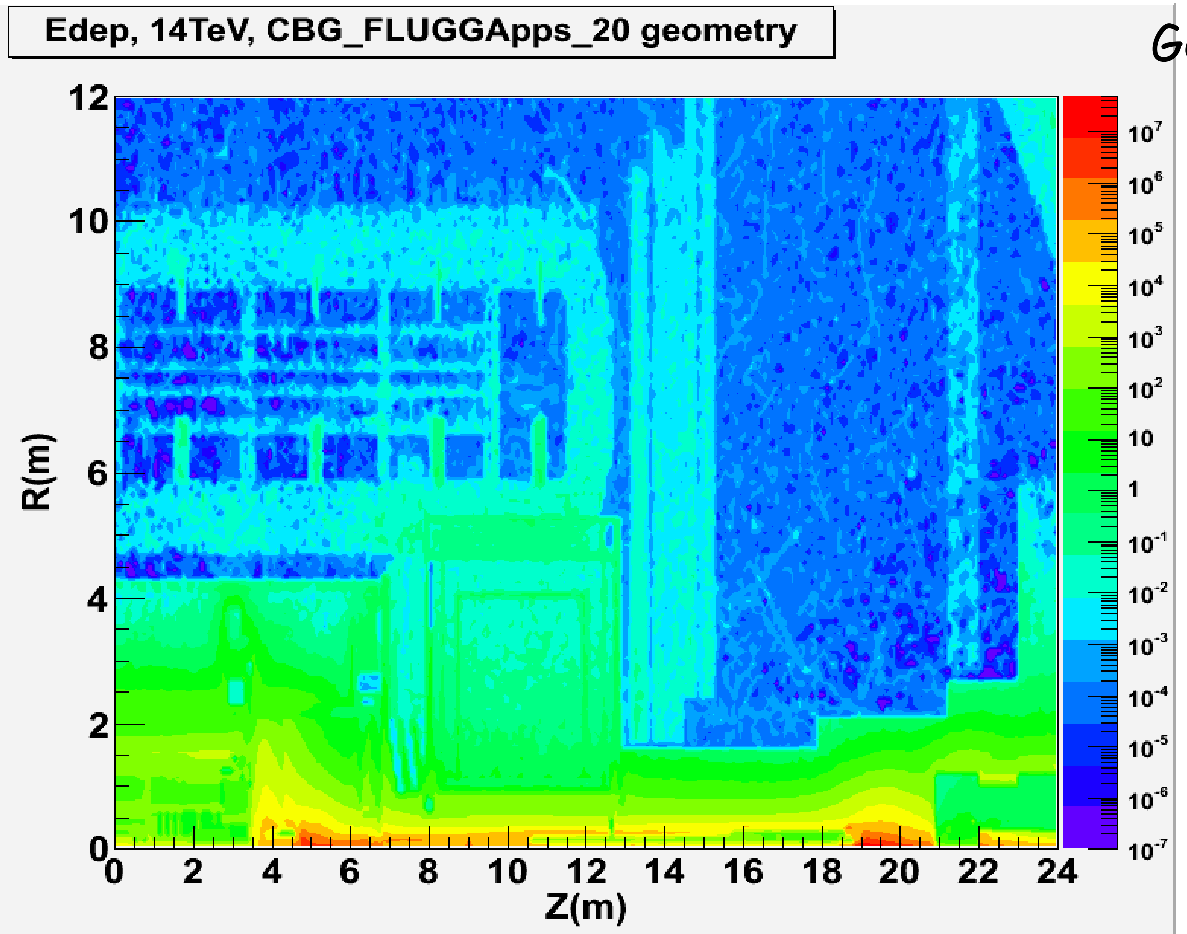
Figure 5-66 The expected photon flux as a function of photon energy in different rapidity regions of the muon spectrometer (top curve: $2.3 < \eta < 2.7$, middle curve: $1.4 < \eta < 2.3$ and bottom curve: $\eta < 1.4$).

Atlas needs to measure cavern background (using muon spectrometer) in order to reduce uncertainties on background for s-LHC.

Comparaison données-LHC avec simulation (pour extrapolation au HL-LHC)

Ch.Young (SLAC)
28/03/2011

Energy Deposition at 14 TeV



GeV/(cm^3 sec)

FLUGGApps

- Started ~2 years ago from geometry and material as in Radiation Background Task Force
  - See RBTF Report for details
  - Geometry defined with Geant4
  - Physics from FLUKA
- Many cross checks and updates since then, e.g.
  - Barrel toroids, planar barrel muon chambers, 2 (instead of 4) CSC chamber layers, addition of EE chambers, more realistic cavern including curved ceiling and end walls, shafts, ID description, missing forward shielding, etc
  - See "More Information" in report during Muon Upgrade meeting of 17/6/2010 for more information.

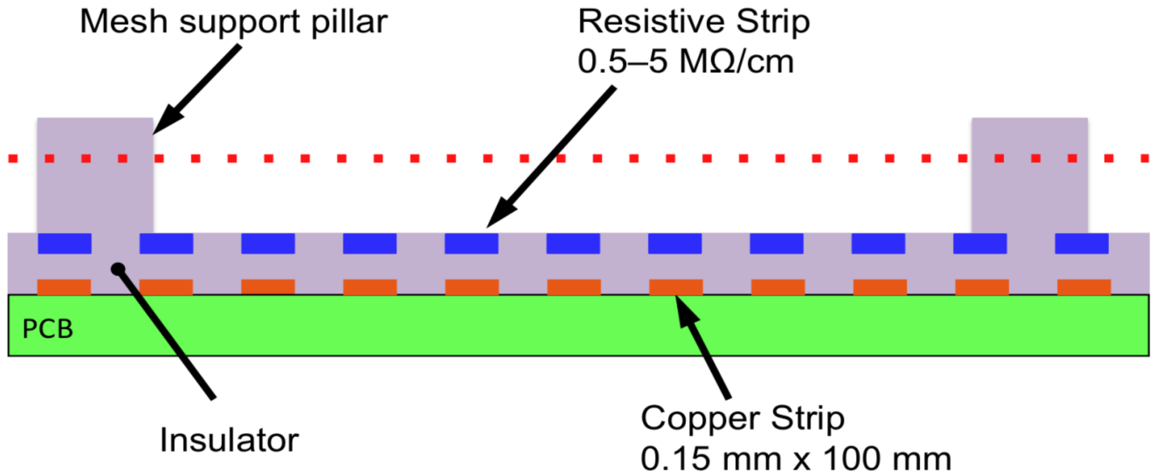
SLAC NATIONAL ACCELERATOR LABORATORY Cavern Background 4

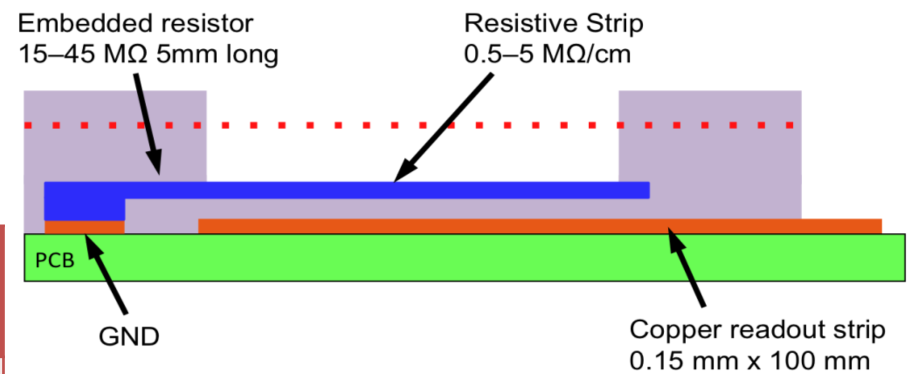
R11, R12 and R13

- Small 100 x 100 mm^2 chamber with 100 mm long strips and 250 μm strip pitch (similar to the previous prototypes – S3, R9, R10), 360 strips in total

Characteristics:

- Resistive strips connected to the ground
- Thin insulating layer between the resistive and readout strips
- AC coupling of signals
- Sparks are neutralized through the resistive strips to the ground

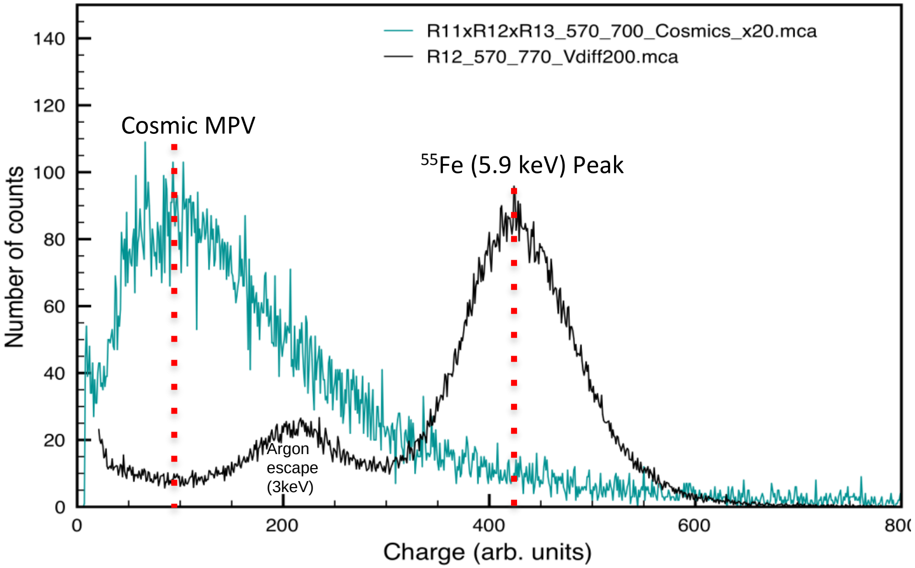


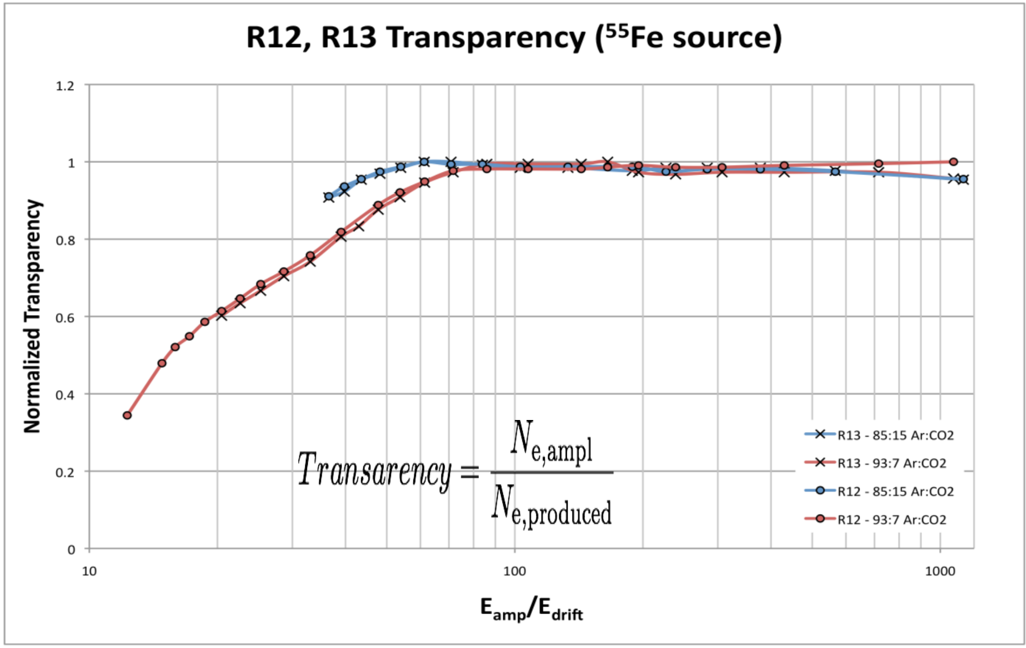


CHAMBER	R11	R12	R13
Resistance to Ground (MΩ)	15	45	20
Resistance along strip (MΩ/cm)	2	5	0.5

Laboratory tests (7)

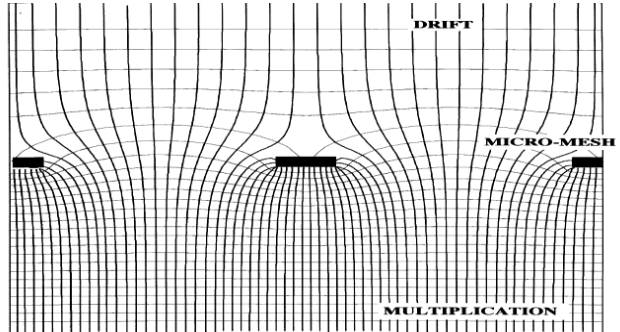
Cosmics & Transparency





- ^{55}Fe produces 225 e⁻ in drift region (5.9keV)
- Cosmics produce ≈ 50 e⁻ in 5mm drift region (~1.5keV) as was expected!

- Transparency
  - For good transparency, $E_{amp}/E_{drift} > 80$
  - 85:15 Ar:CO_2 rises faster, but shows similar behavior to 93:7 Ar:CO_2 in steady state



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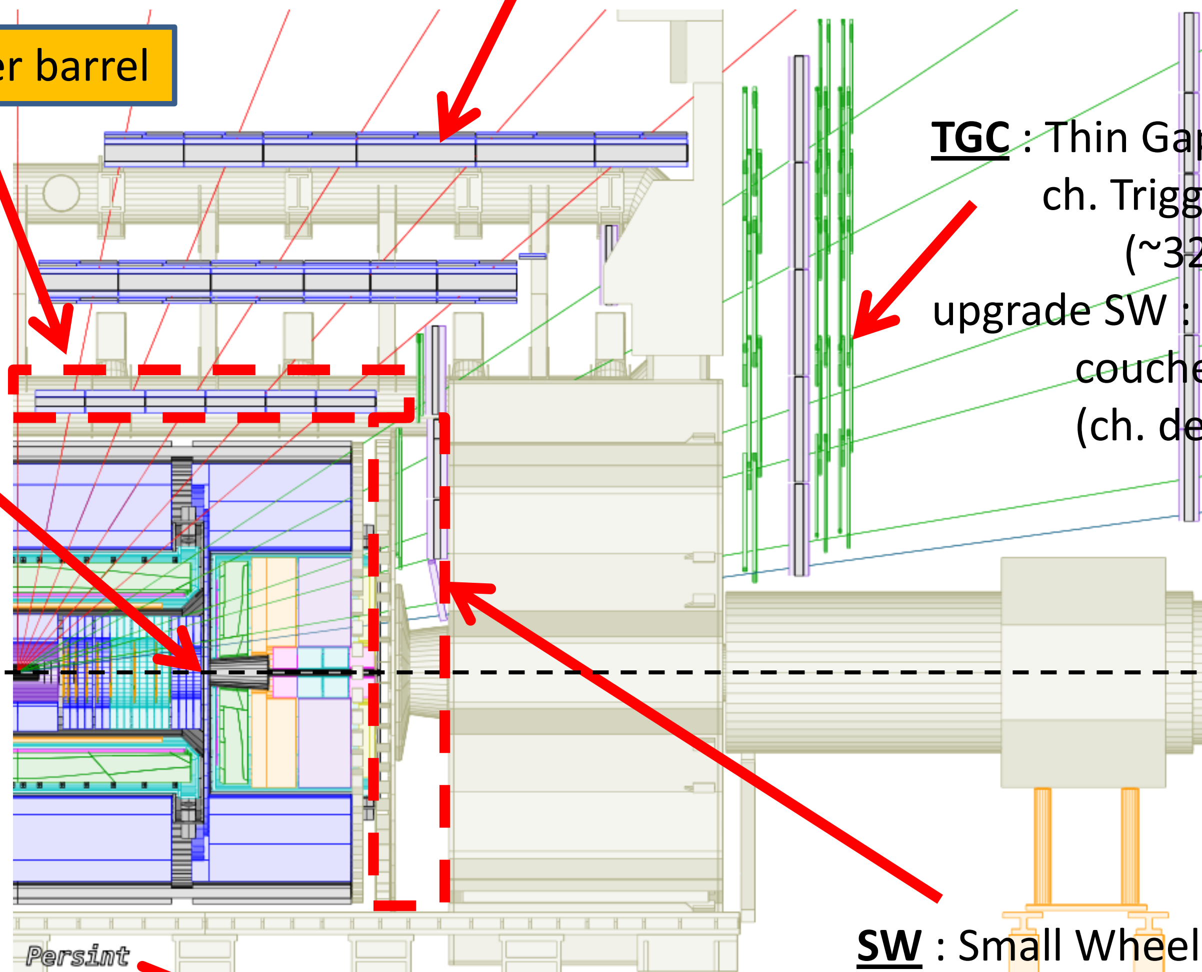
Les noms / zones à retenir

(upgrade : Micromegas ?)

MDT : Monitored Drift Tube (~350000)
ch. de précision (tube Ø=30mm)
upgrade SW : **<u>sMDT</u>** (même chose 15mm)

trigger barrel



<u>MBTS</u> : Minimum Bias Trigger Scintillators (Ø<1m)

à changer phase-I

<u>TGC</u> : Thin Gap Chamber (MWPC)
ch. Trigger end-cap (3 couches)
(~320000)
upgrade SW : même chose + couche résistive
(ch. de précision ?)

<u>SW</u> : Small Wheel (Ø=10m)
(blindage + MDT + TGC + CSC)
ch. précision end-cap

à changer phase-I

Pieds de la manip : zone avec des trous d'acceptance (à améliorer…)

ascenseurs

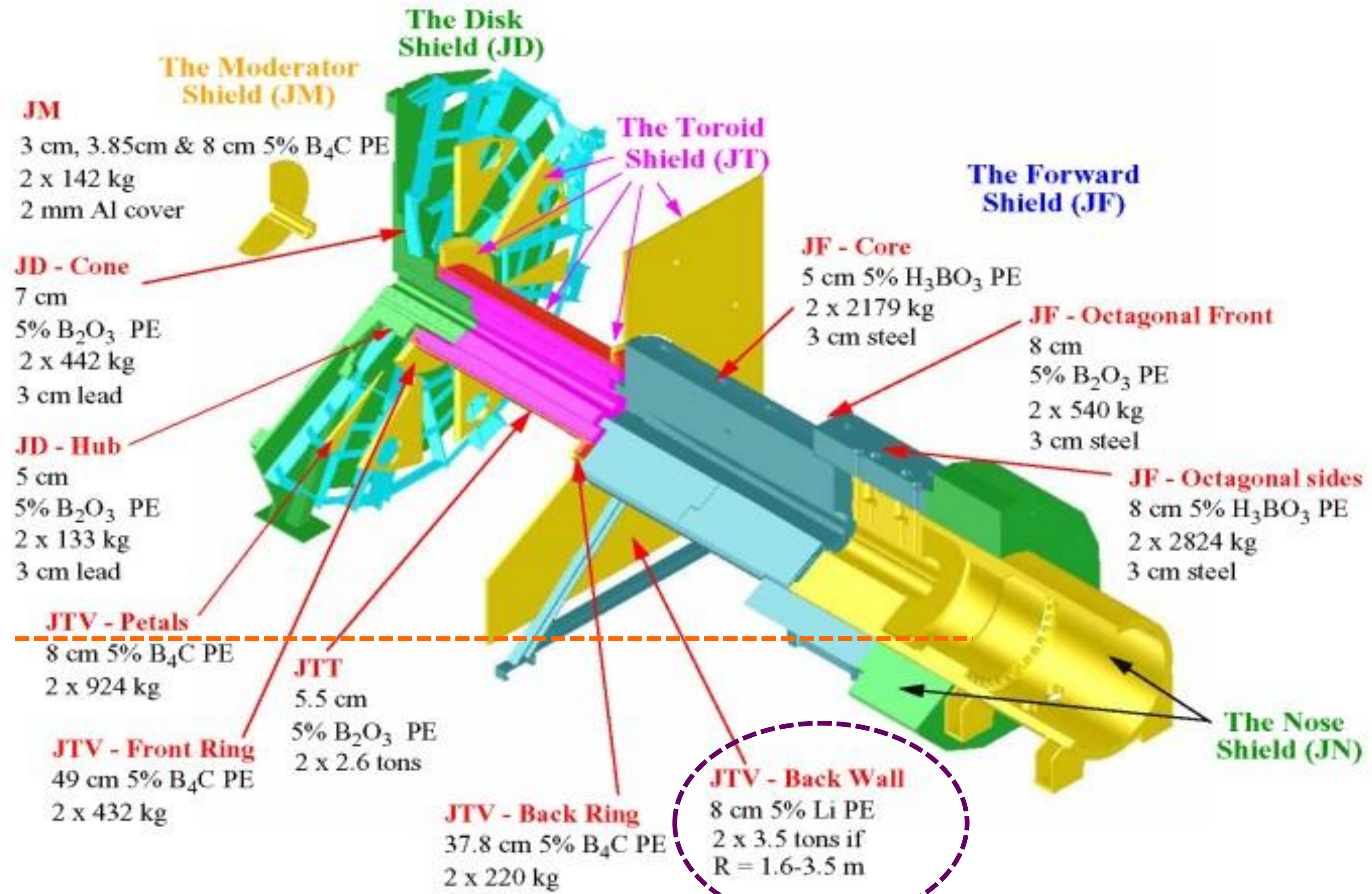
Other Atlas spectrometer upgrade ideas

In phase-2 upgrade (~2020 ?) there is an idea of adding a trigger capacity to the inner barrel layer, to improve online momentum resolution and sharpness of trigger as a function of momentum.

There are considerable technical obstacles to overcome like : the available space in that area... One may have to replace completely the barrel inner chambers with something else…

)

JTV Back Wakk



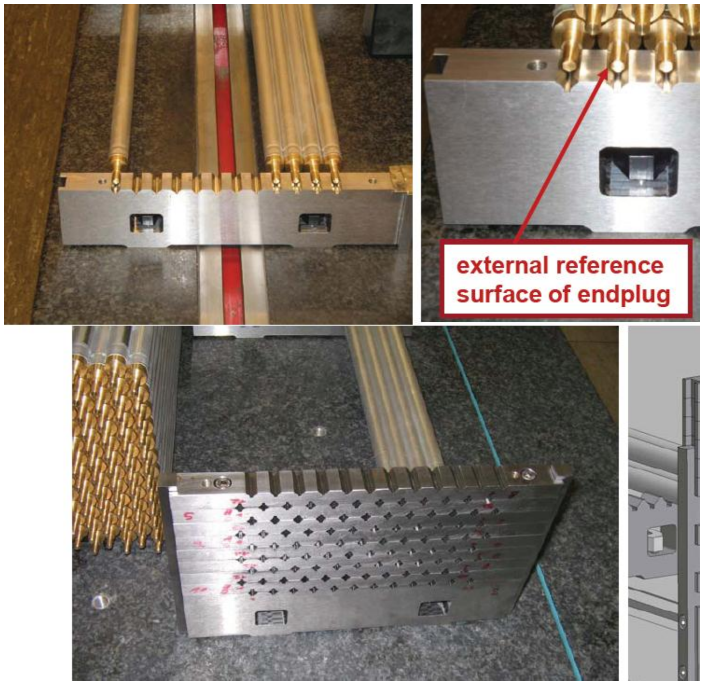
From Shielding Project web page

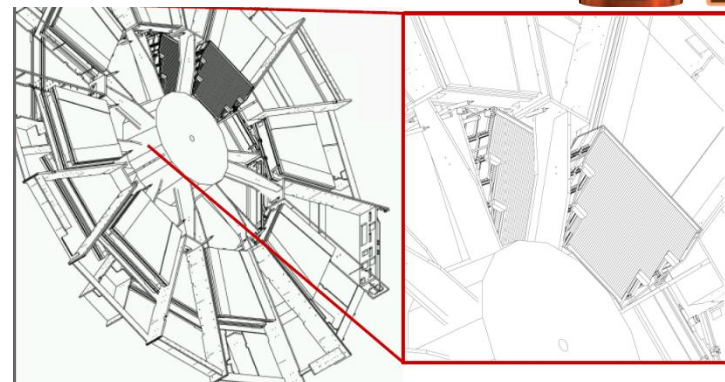
Options concurrentes : *small tube* MDT (Ø=15mm)

(3 ingénieurs +… sur le proto)

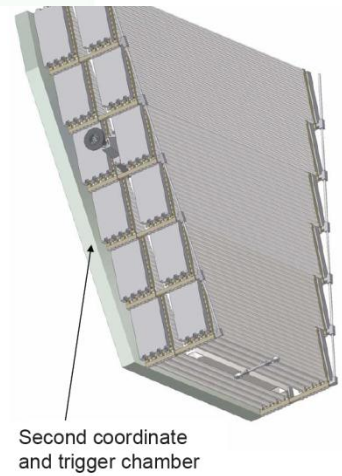
Etudes de constructions basées sur les MDT d'Atlas :

- 8 couches en 1 jour (2x4)
- 50 μm de précision (ok)





Intégration dans Atlas (alignement aussi)



TGC eventuellement.

- Études de tenu aux radiations ok pour LHC phase-I
  - i.e. points les plus chaud : ~1400Hz/cm^2 = 300kHz/tube
  - Au delà : 1500kHz/tube ? (en cours). Problème si *safety factor* = x5 ?
- Étude électronique avec nouveaux FPGA (en cours)
- Mais occupation jusqu'à ~30%, efficacité par tube basse, mais 8 couches