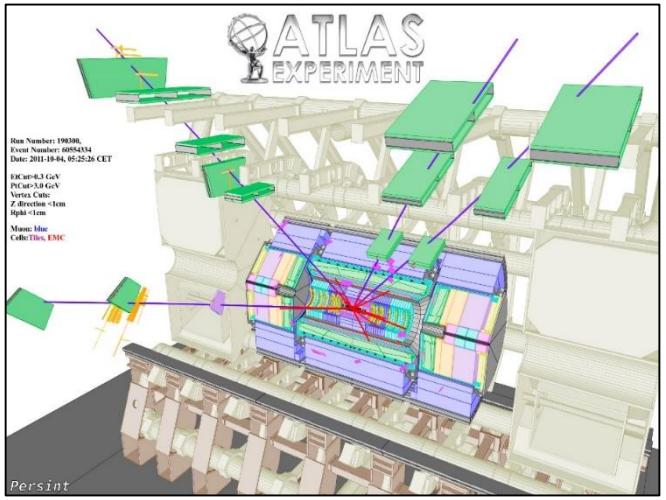
DE LA RECHERCHE À L'INDUSTRIE

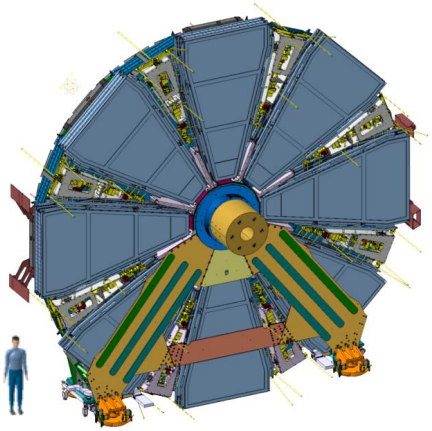
cea

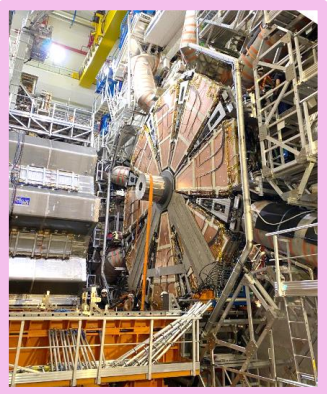
The ATLAS – NSW upgrade project

(New Small Wheel)

2nd update







Philippe Schune
for the ATLAS-Saclay NSW group

CEA, Paris – Saclay
Paris – Saclay University

France – Ukraine workshop
IJCLab, univ. Paris-Saclay, 28/10/2021

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Irfu.cea.fr

2019 layout :

- ATLAS NSW muon spectrom[illegible] LHC
- The NSW project
  - Description *(sTGC MWPC detector type)*
  - MM *MPGD detector type*
    - Design, construction and metrology
    - Functioning
    - Production
- NSW status as conclusion

2020 :

In this talk, we will discuss practical details, and some parameters and working conditions of our (built) Micromegas detectors.

2021 :

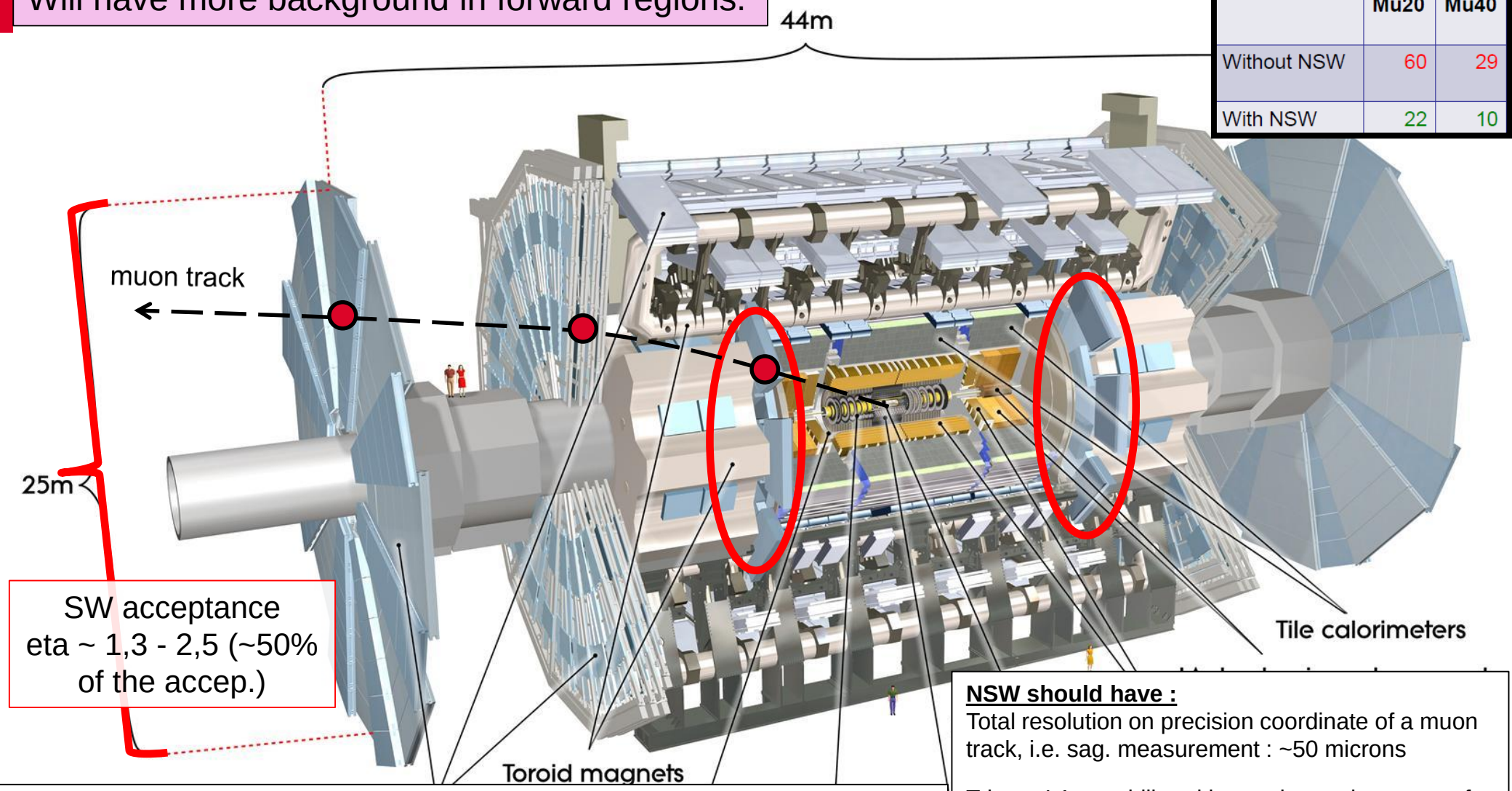
- Where do we stand ?
- (in a way for a better) understanding of the NSW MM working conditions ?

HL-LHC => x5 present Luminosity
Will have more background in forward regions.

At $L = 3x10^{34}$

Single μ L1 rate (kHz)

	Mu20	Mu40
Without NSW	60	29
With NSW	22	10



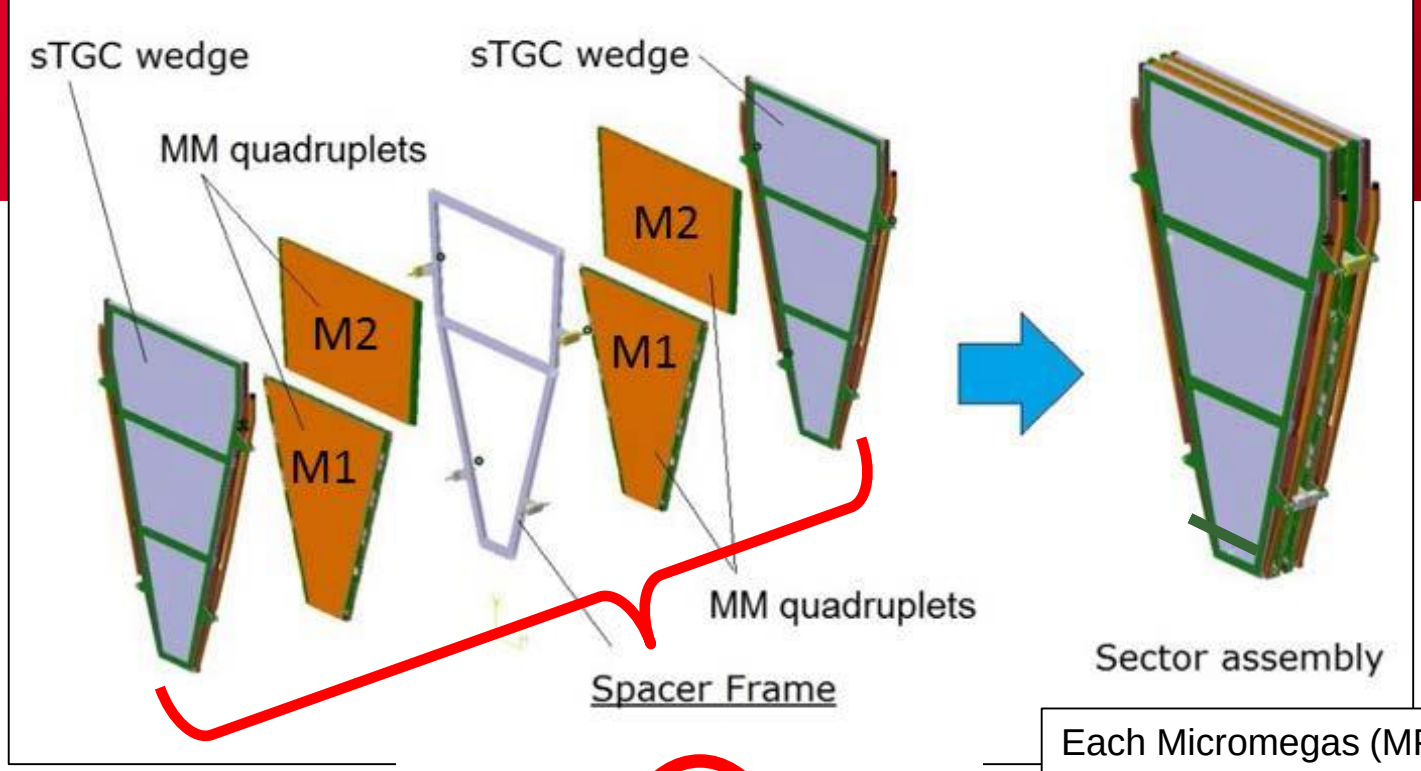
SW acceptance
eta ~ 1,3 - 2,5 (~50% of the accep.)

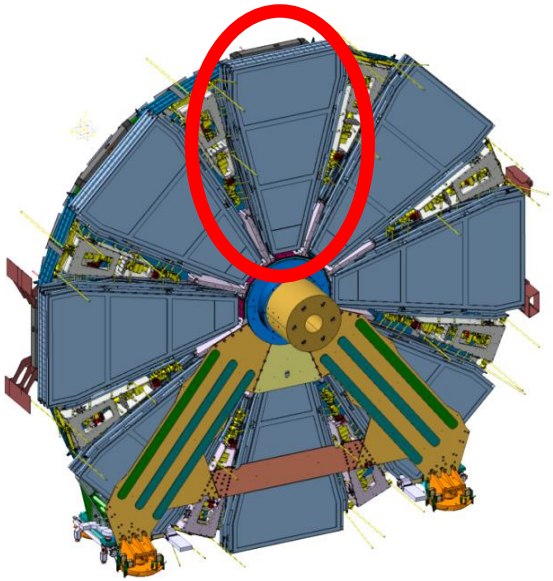
Muon sagitta is only ~500 micron at momentum of 1 TeV
15% measurement => 75 microns measurement precision
Thus detector resolution should be ~50 - 100 microns assuming alig^{t} +
B-field knowledge + detector construction negligible !

NSW should have :
Total resolution on precision coordinate of a muon track, i.e. sag. measurement : ~50 microns

Trigger L1 capability with angular track recons. of ~1mrad

Resist to high background from m.i.p. up to neutron deposit.

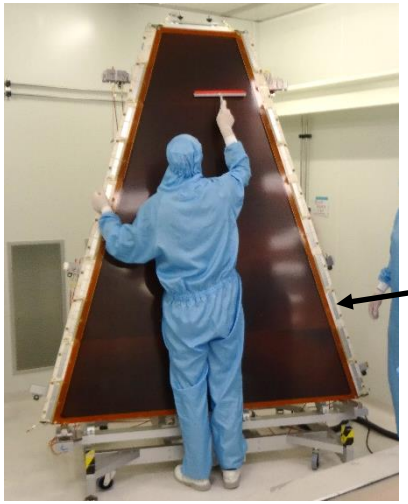


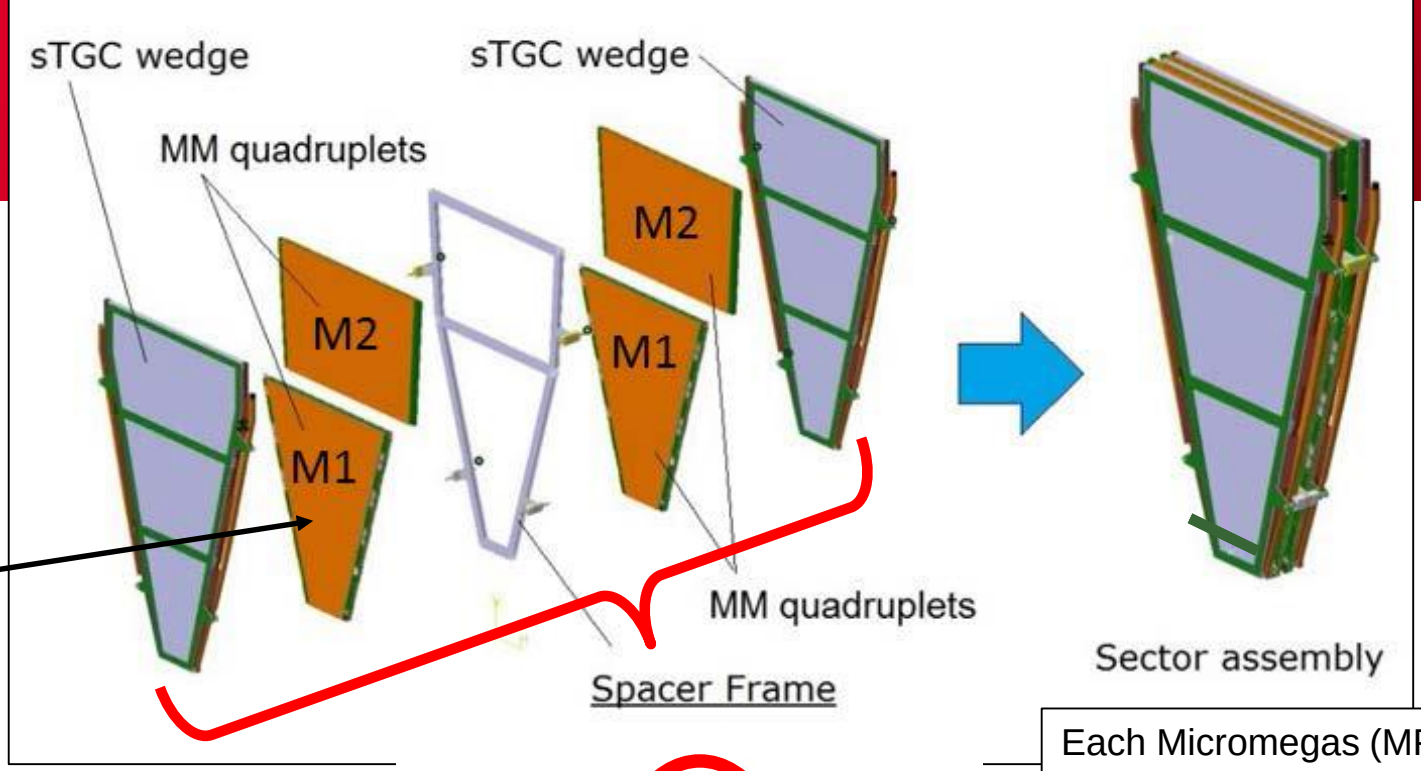


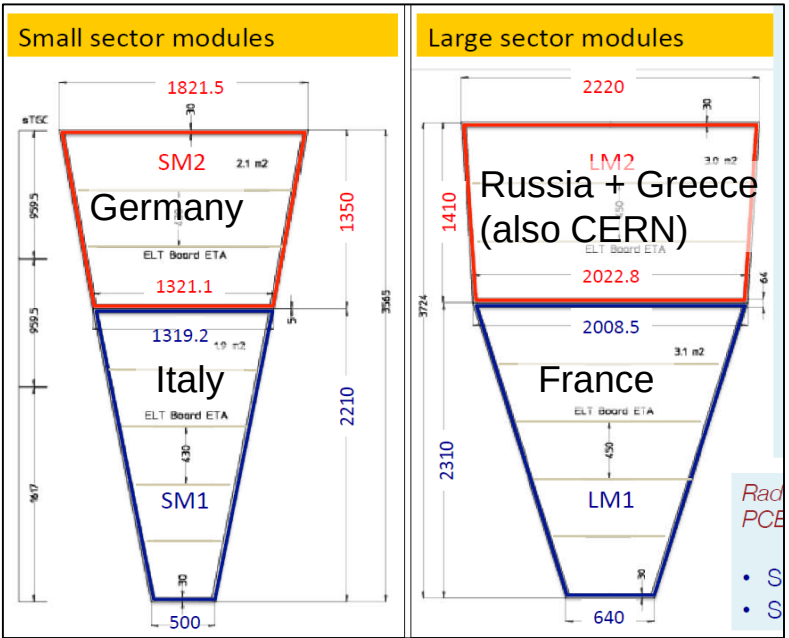
Each Micromegas (MPGD) and sTGC (MWPC) modules are 4 planes detector, **each ~2 to 3 m².**

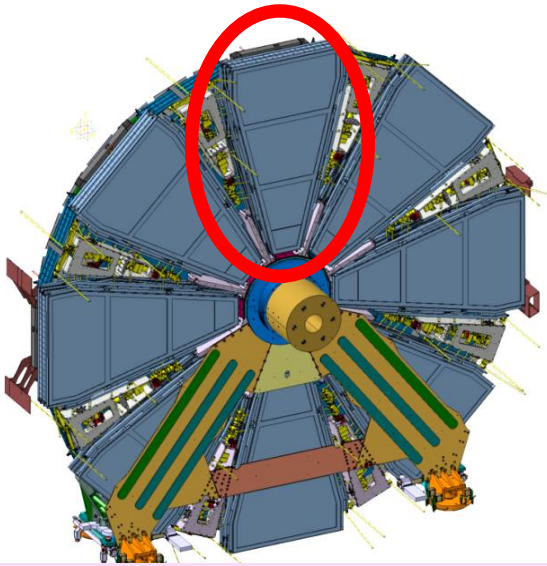
For Micromegas there is :
8 sectors x2 modules
x 2 wheels

=> **32 modules of each type to be build** (x4 types)









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=> **32 modules of each type to be build** (x4 types)

With some/lot sparking problems

End 2020, MM detectors build: Italy 100%, Germany 90%, Saclay 66%, Russia+Greece ~55%

Where do we stand ?

Production

M.Antonelli, NSW PL, muon IB, 08/10/2021

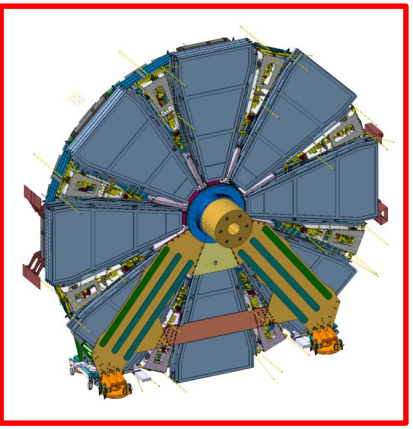
- MM production was completed
- sTGC quads for NSW-C all at CERN, except for 3 QS1s (delivered on schedule despite covid restrictions!)
- nSW-C installation sequence designed accordingly no impact on the schedule

Thanks! to all constructions sites

Where do we stand ?

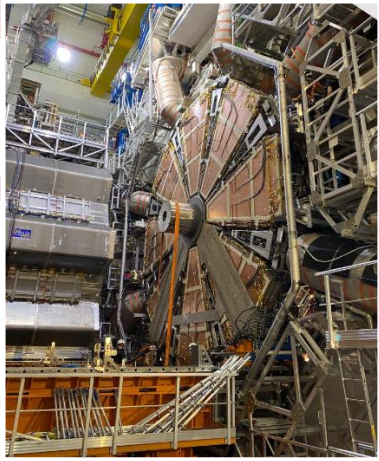
NSW-A in B191 on 28 May 2021

NSW-C in B191 on 13 September 2021



18 Oct.: the 2nd wheel NSW-C transported to ATLAS top area
4 Nov.: go down to ATLAS pit.

Where do we stand ?

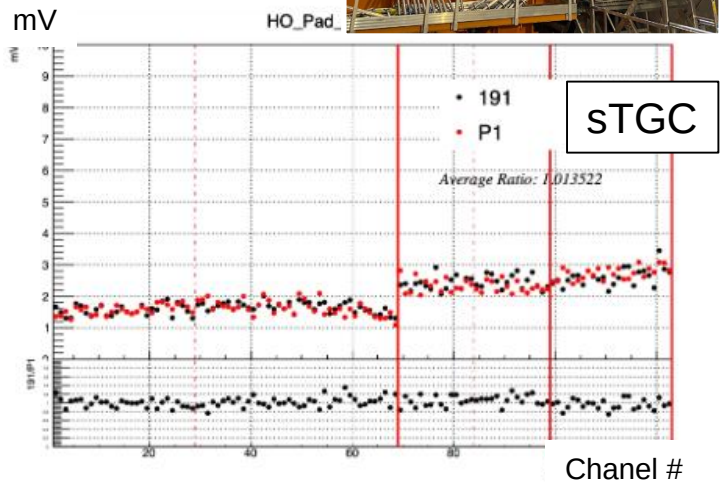


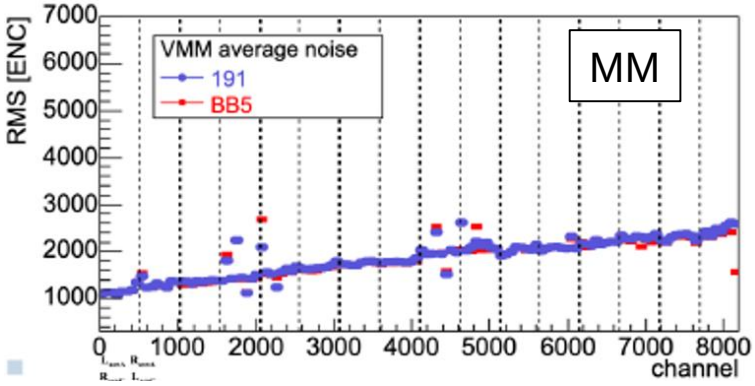
A lot of activity for the NSW-A commissioning and **integration in ATLAS experiment** :

- Dedicated elx noise TF before integration
- Recovering of detectors with problems
  (connectors, cooling, gas, **elx noise**, etc.)

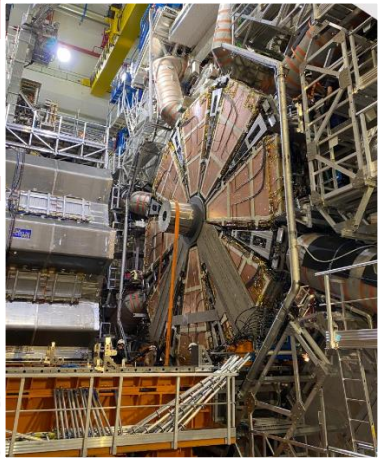
Integration work is progressing well thanks to huge involvements of institute participating of the construction : MM, sTGC and elx.

NSW-A *in situ* nois





Where do we stand ?



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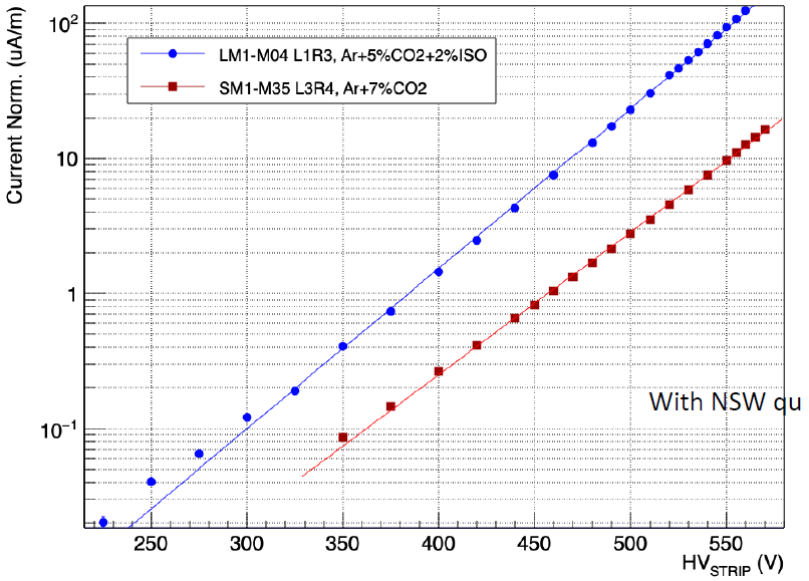
In // study of "long" term irradiation at GIF++ facility at CERN (14 TBq Cs source) for sTGC and MM (with different gases).



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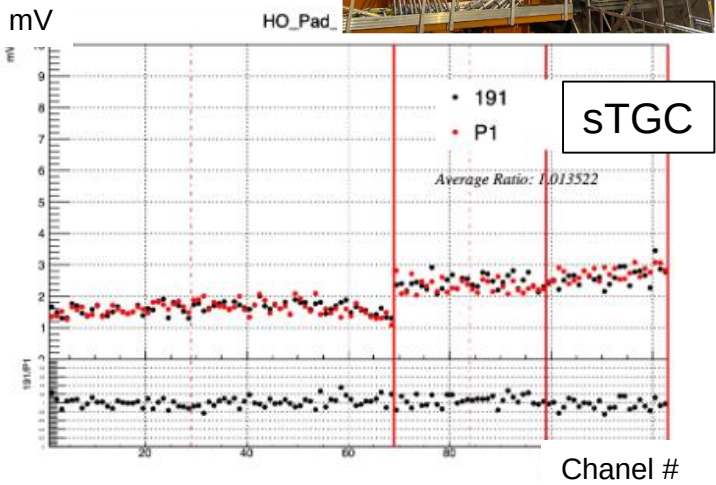

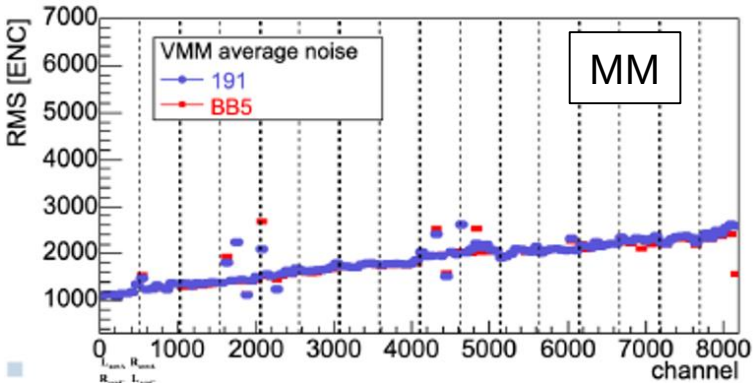

In conclusion : first NSW integration is progressing very well and 2nd wheel will be installed next week !

Where do we stand ?

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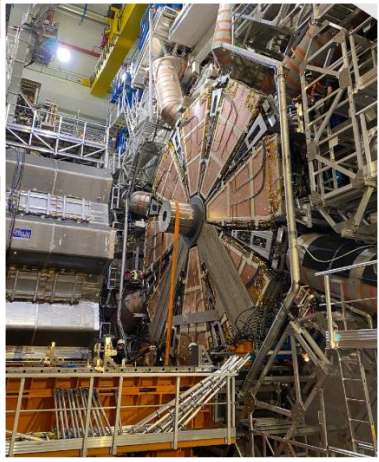

NSW-A *in situ* nois

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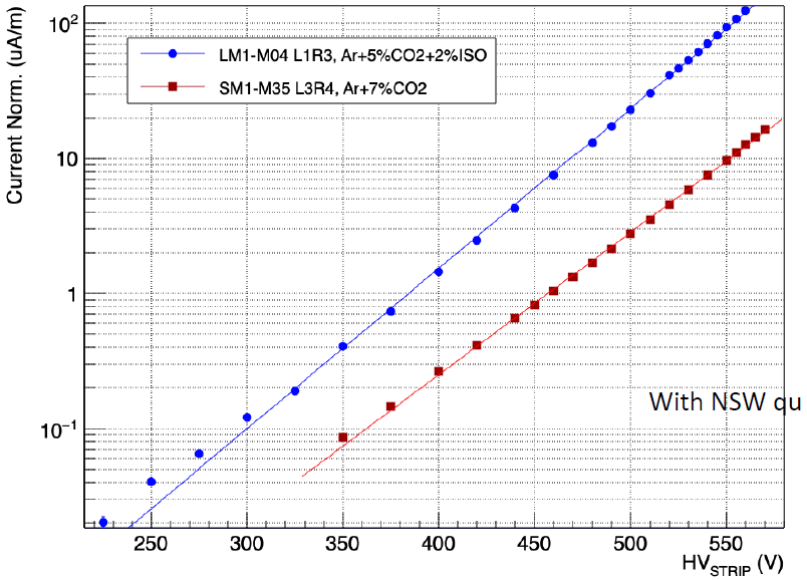
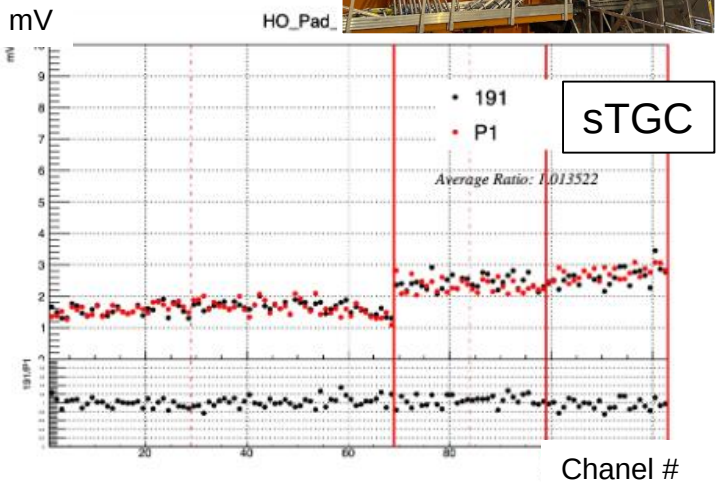
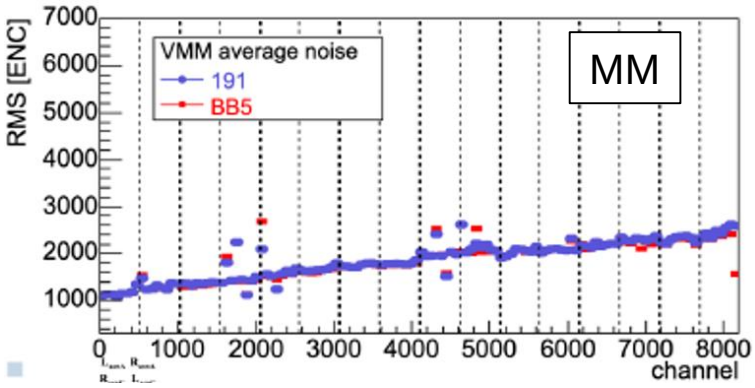
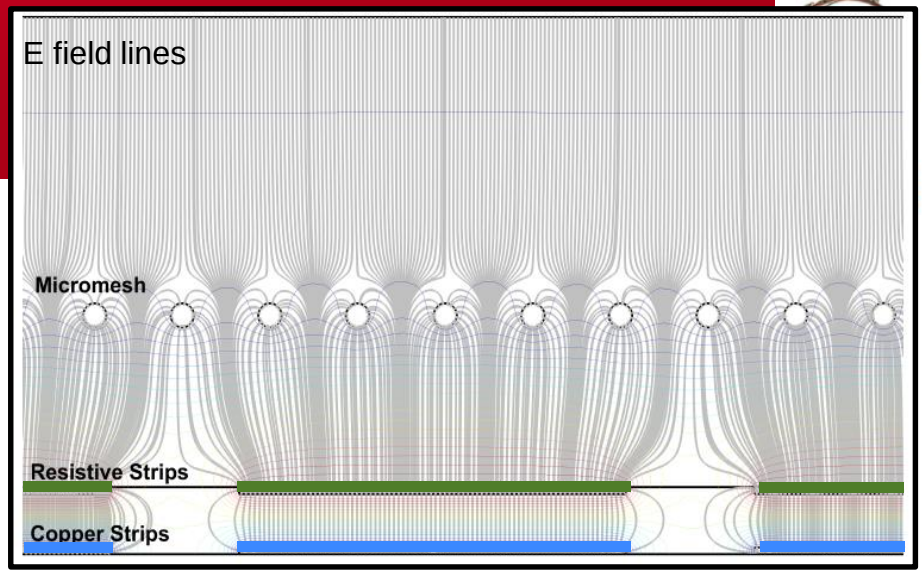






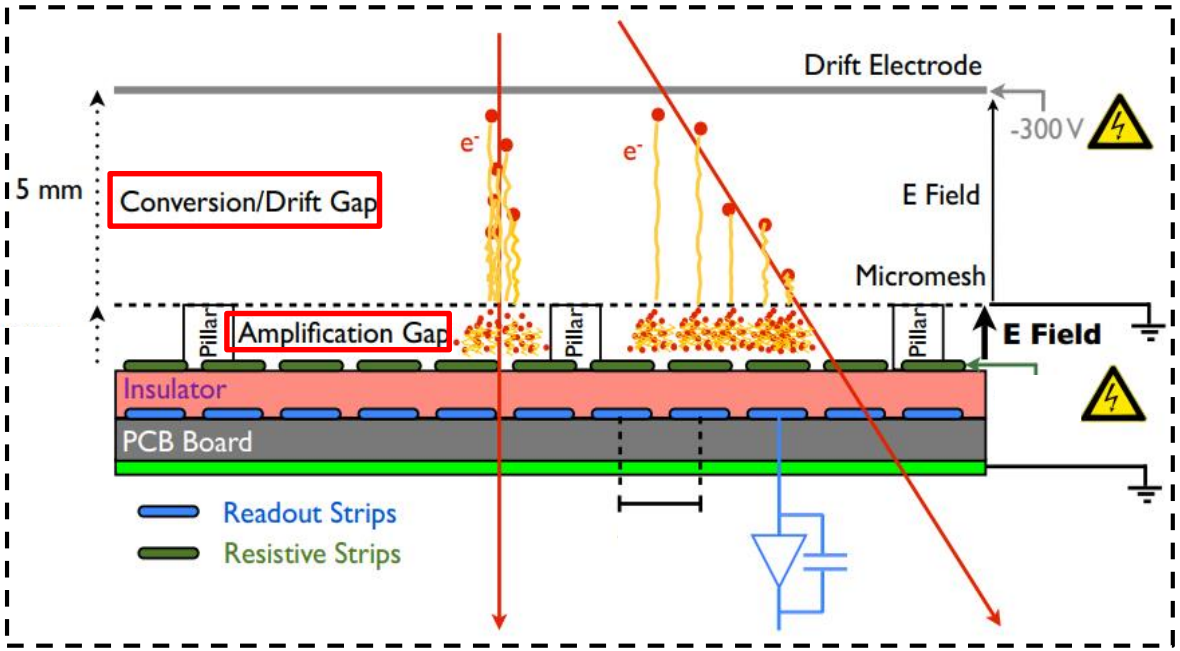
And also in //, some R&D is on-going in Saclay and Cosenza for understanding the MM sparking problems.

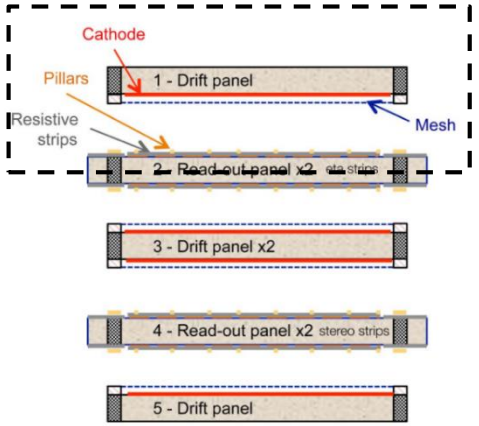
Principle of Micromegas



Nominal values :

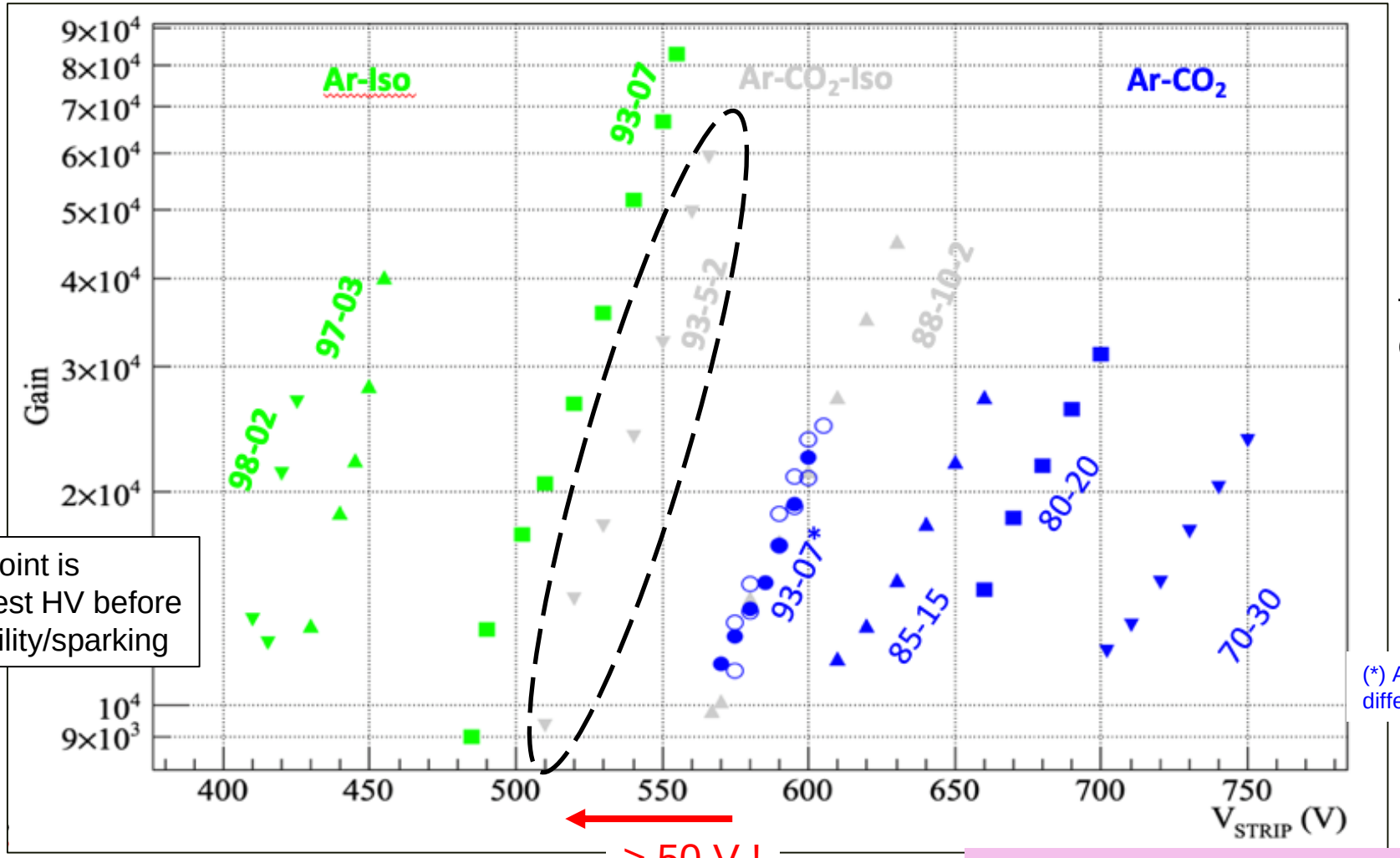
- 15 kHz / cm2 max flux
- Gas: Ar + 7% CO2 *(also considered to have +2% iso-C_4H_{10})*
- Drift HV: 300 V
- Nominal amplification HV: 570 V
- Pilars height ~120 μm *(should have been 128 μm)*
- Gain ~8000
- Micro-TPC mode *(for resolution)*
- 450 micron strips pitch
- 30-71 mesh





Where do we stand ?

NSW Micromegas Gain for some gas mixture



> 50 V !

Tests made in CEA-Saclay

(*) Ar/CO2 93-07 : 3 different measurements

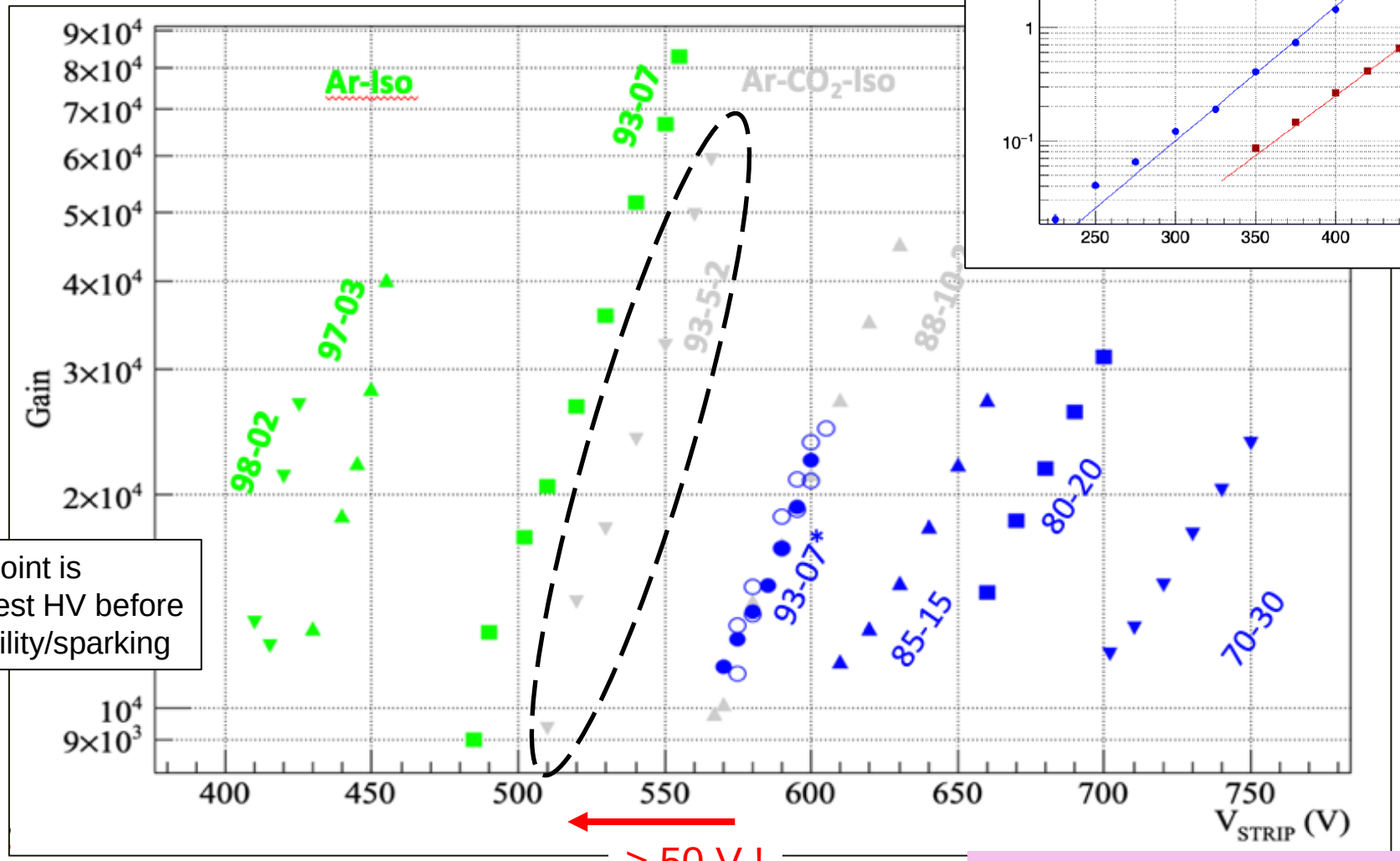
Last point is ~highest HV before instability/sparking

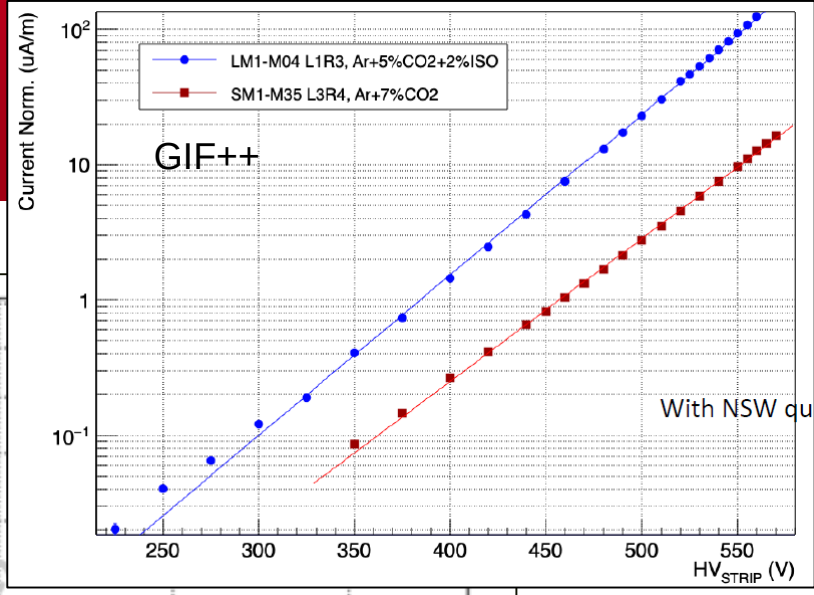
CO_2 and Iso-butane are both quencher gas.
Some penning effect occurs on Ar with iso-butane, increasing the number of primary e-

Review of irradiation/ageing studies for MM with iso-butane these days

Where do we stand ?

NSW Micromegas Gain for some gas mixture





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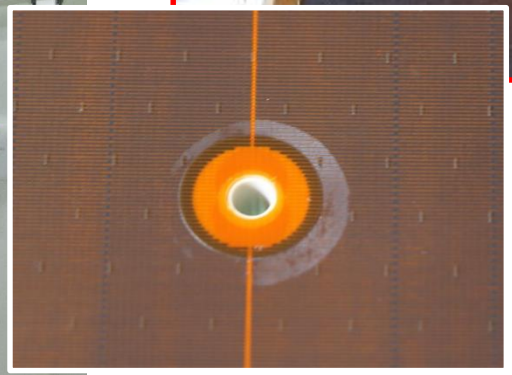
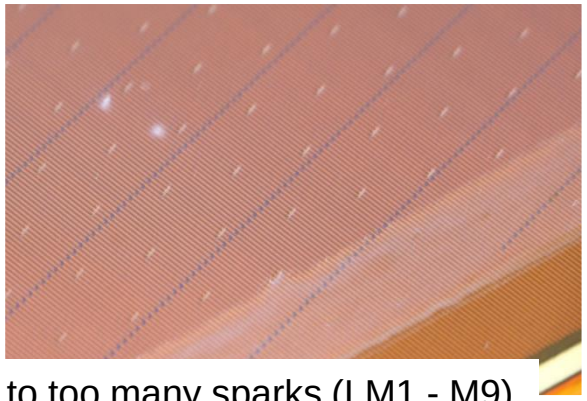
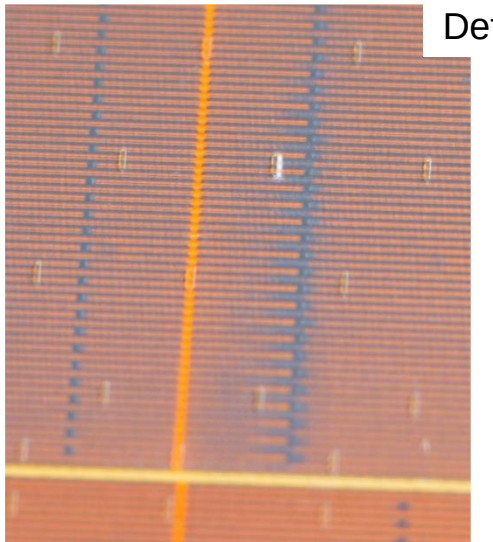
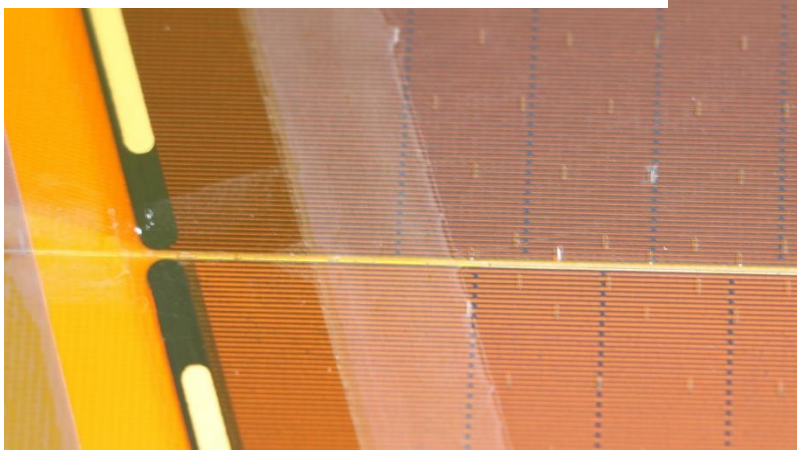
Details of a RC





Defects due to too many sparks (LM1 - M9)





What to do to understand MM sparking problems…

From now starts a discussion on MM sparking problems…
*(**not an ATLAS official presentation**)*

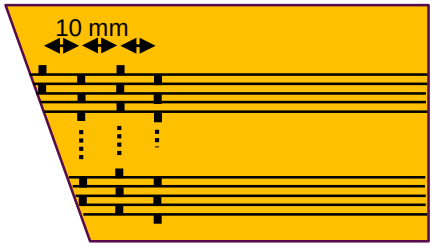
J.-F. Laporte, M. Schioppa, Ph. Schune and R. Méhu *et al*.
(Marc L., Mariam K., Philippe M., Arnaud G., Maxence V.)

PRELIMINARY

Calculations of PCB behavior

Do tests with real sparks

Spark analysis *(thermodynamics ?)*



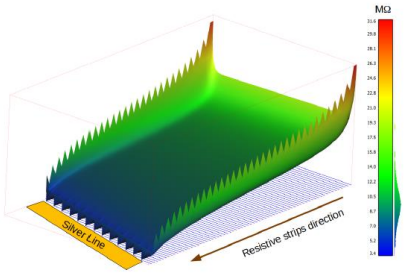
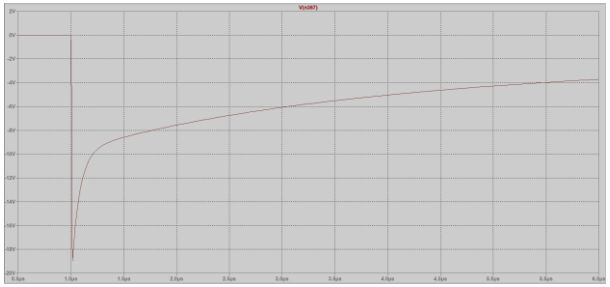
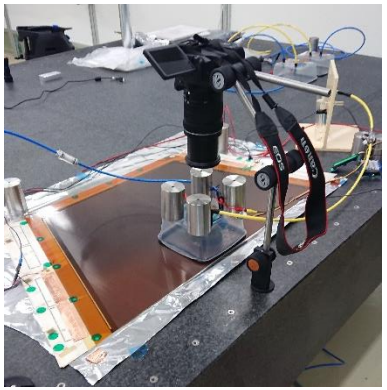
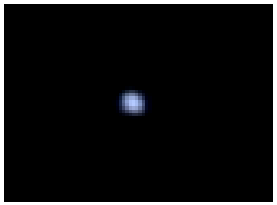


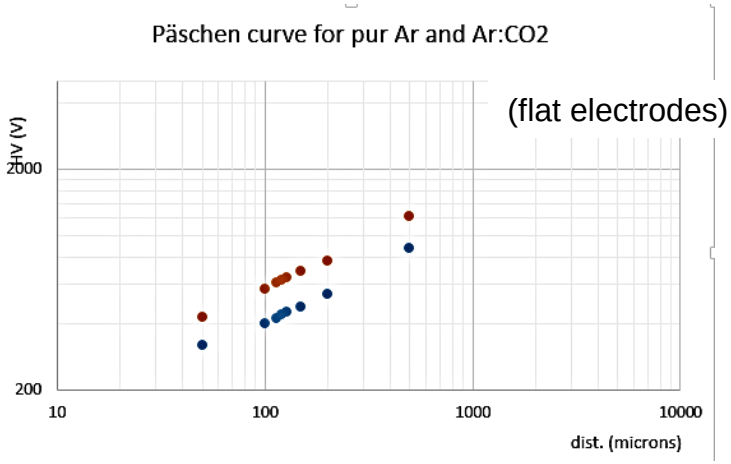
Figure 21: 3D Map of the resistance to ground at nodes of the active resistive area



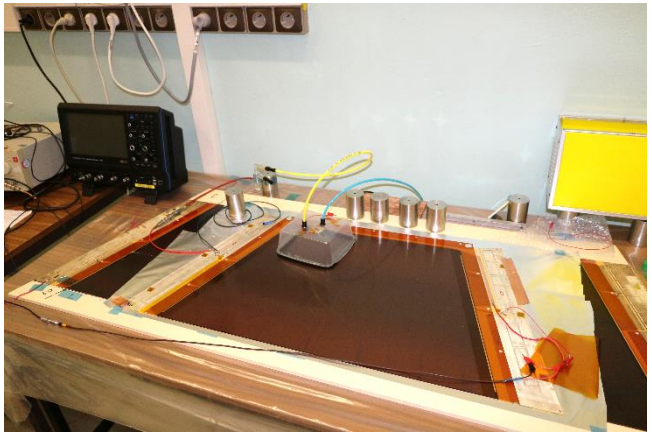
Almost full PCB simulation (LTSpice)





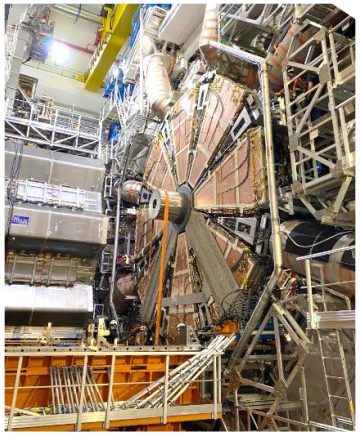


A tool for doing sparks in real conditions

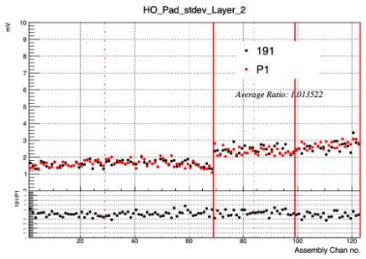


Measurements of real sparks

Conclusions



NSW-A *in situ* noise tests on sTGC Pads



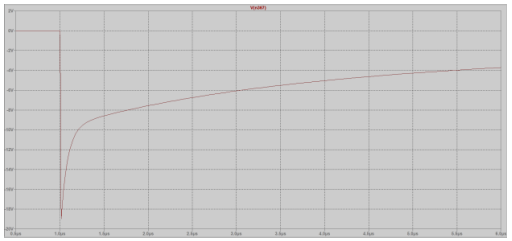
Soon, both NSW will be in position in ATLAS !
The commissioning in the cavern is progressing for NSW-A.

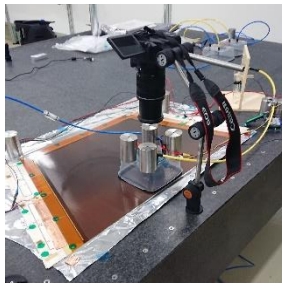
Unfortunately all NSW MM construction groups loose a lot of time, energy and money to fight with some problems which are almost solved today, even if not fully understood :

- Too low resistivity of the resistive layer
- Humidity problems, more important due to previous weakness (RH <8% needed)
- **The Ar+CO2+2% iso-butane gas mixture is considered** *(as proposed by Saclay >2 years ago)*
  - What about long term stability ? *(ageing under study)*

In my opinion, pushed by the previous ATLAS management, organizing the NSW project activities and decisions looking too much to the planning constraints was a mistake, especially at the beginning where more R&D would have been needed.

Some R&D is ongoing in Saclay and Cosenza in order to understand better the MM sparking problems.





Merci pour votre attention !

Thank you for your attention !

A suivre…

To be continued…

Commissariat à l'énergie atomique et aux énergies alternatives
Centre de Saclay | 91191 Gif-sur-Yvette Cedex

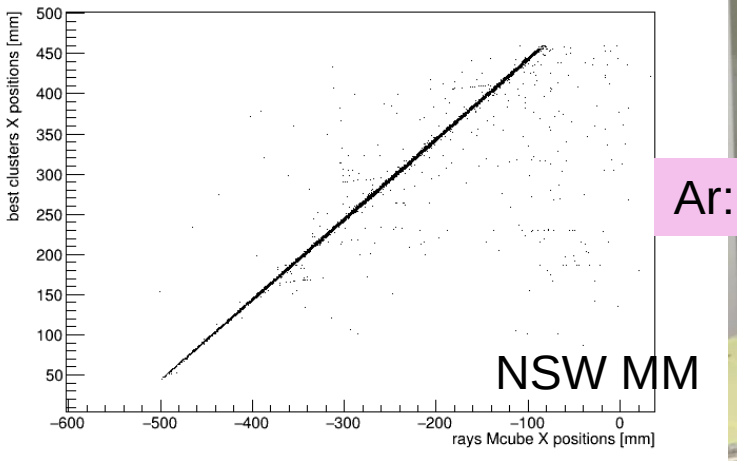
Etablissement public à caractère industriel et commercial | RCS Paris B 775 685 019

DRF - IRFU
CEA Paris - Saclay
Paris-Saclay University
France

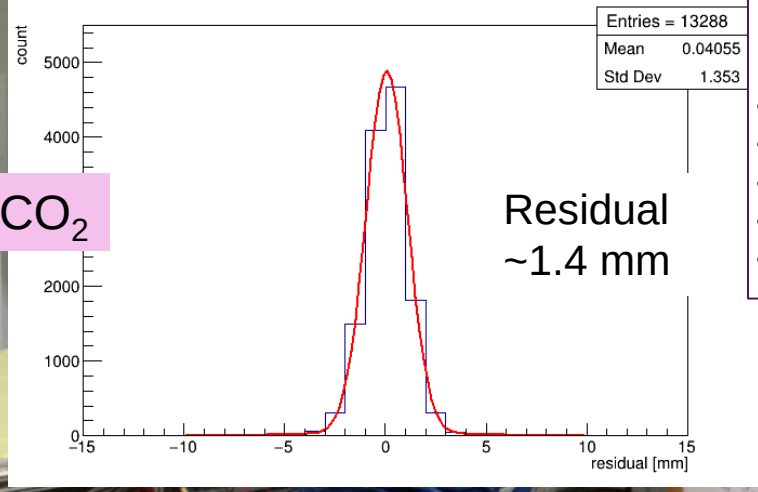
Cosmic bench to qualify a MM Module

- Gain curve values for each gap
- Efficiency values

Reference



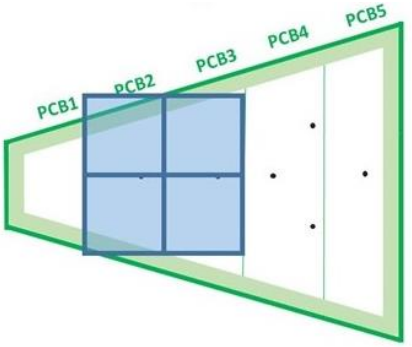
$Ar:CO_2$

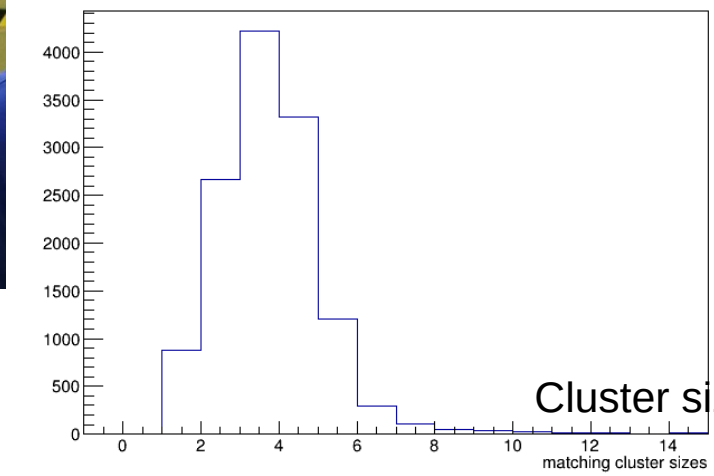


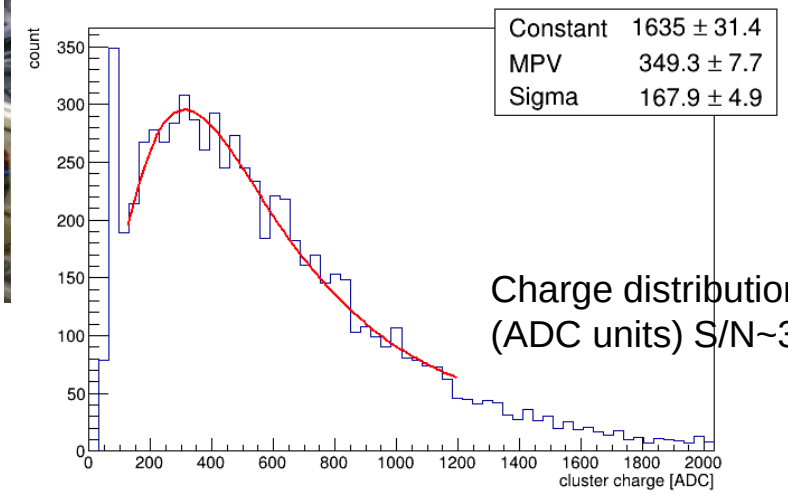
Residual
~1.4 mm

Cosmic bench composition:

- External tomograph (3 layers of 2D MM, 126 μm pilars, 1cm drift, 4x0.25m^2, 16 multipl.)
- DREAM elx - timing digitization
- Cabling – micro-coaxial
- 40 HV distribution
- Multiplexing x2
- Track reconstructing algorithm





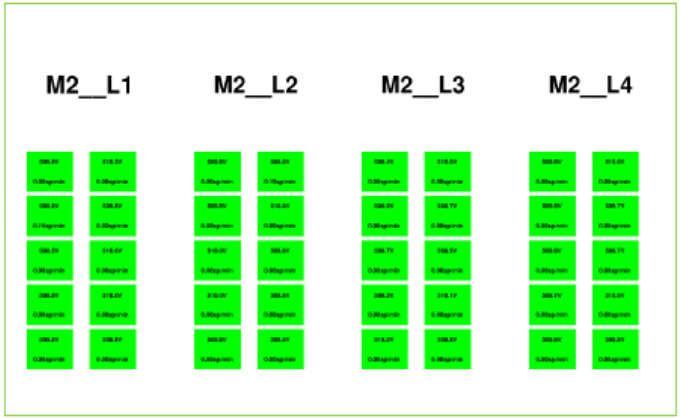


Charge distribution of clusters (ADC units) S/N~3.5

Cosmic bench to qualify a MM Module

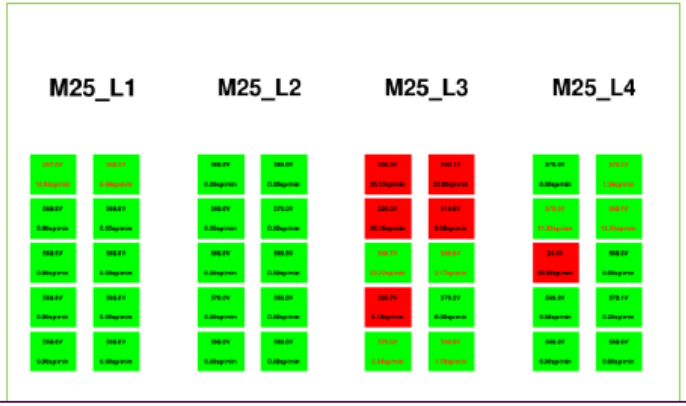
- **M2 HV performances :**
  - All sparking and HV recovered in iso
  - No correlation with performances in clean room at 850V in air …

Ar:CO_2

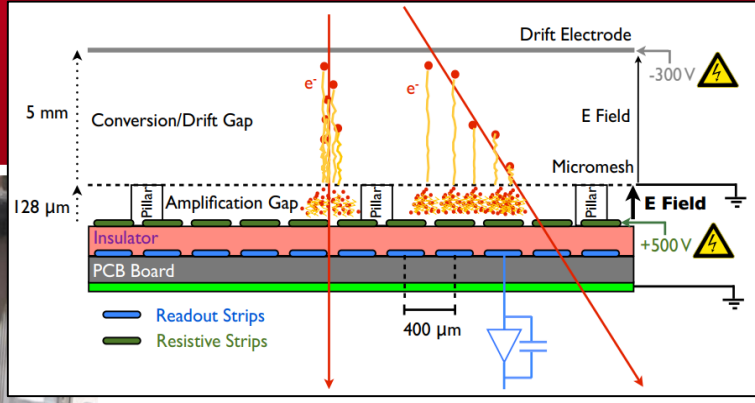


Ar:CO_2: iso-butane

- **M25 HV performances :**
  - All sparking and HV recovered in iso except one
  - The bad sector was good at beginning **then suddenly died in ar/co2**

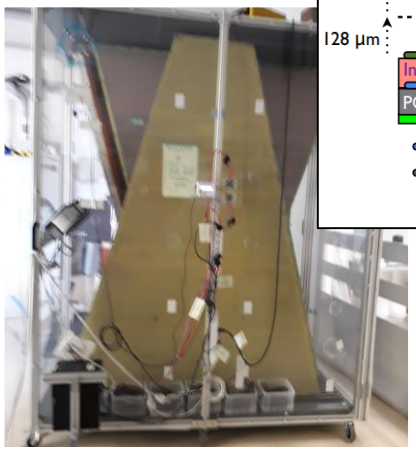


Fighting pollution, dusts, etc.

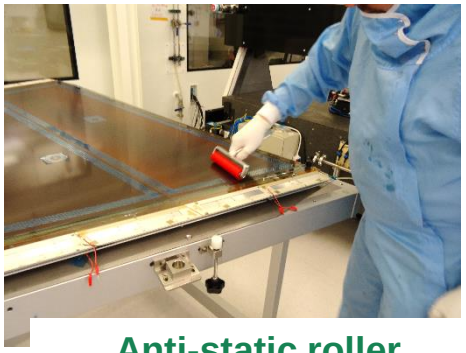


Readout panel washing

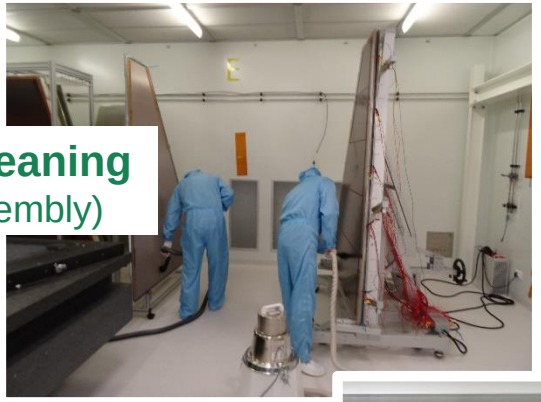
Mesh washing
before gluing to drift panel



Drying box for panels



Anti-static roller cleaning (before passivation)

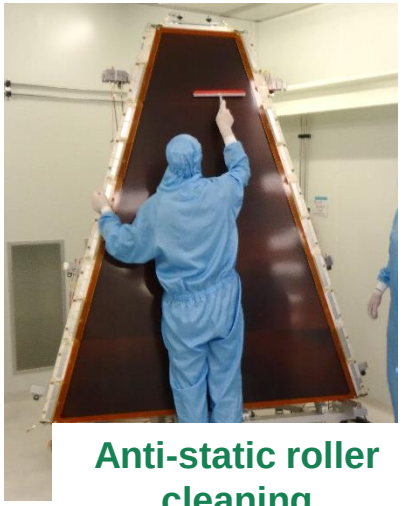


Vacuum cleaning
(before assembly)

Cleaning the Module assembly area

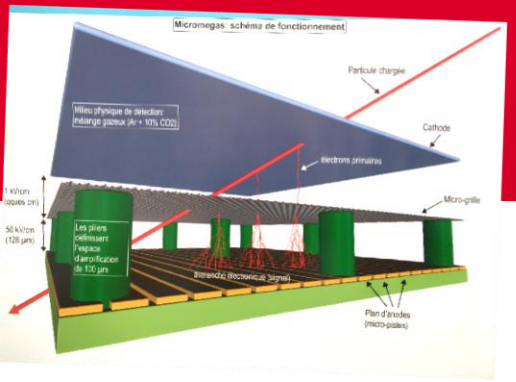
iso-propanol cleaning
(before assembly)

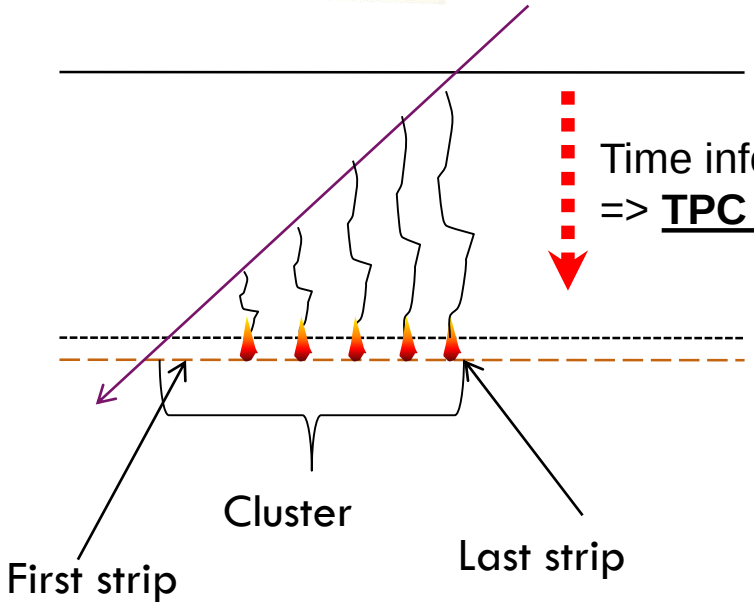
O-ring cleaning

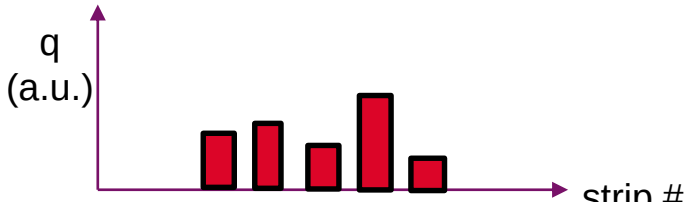


Anti-static roller cleaning

MICRO TPC MODE







in gaz (1 atm.) ~1 ionization cluster each ~200 microns