ATLAS NSW MM GIF++ studies

Ivan Gnesi
on behalf of the ATLAS NSW Collaboration

GIF++ Annual Users Meeting

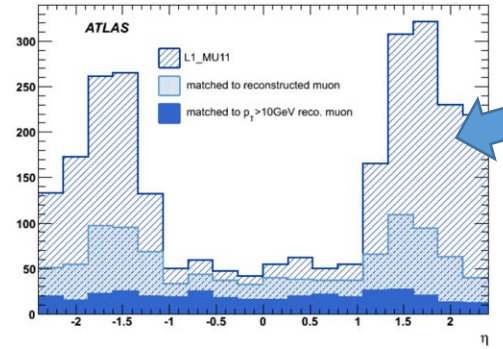
The ATLAS New Small Wheel

Important upgrade of the LS 2

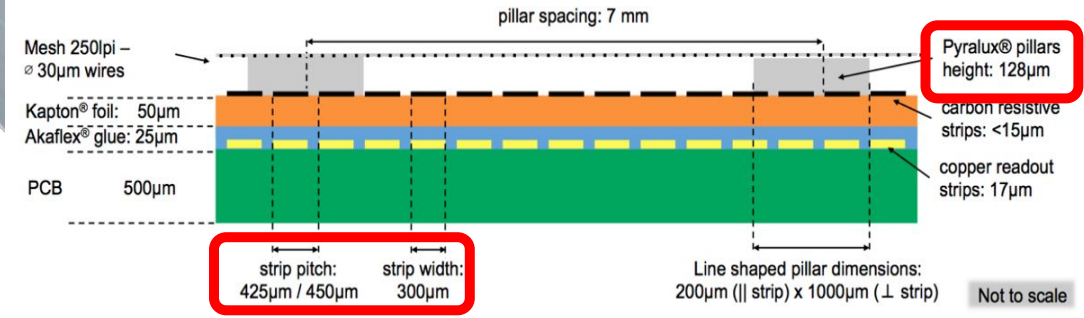
Expected to work at
~ 15 kHz/cm^2 @ |η| ~ 2.7
~ 500-600 Hz/cm^2 @ |η| ~ 1.3

Pseudorapidity range covered:
1.3 < |η| < 2.7

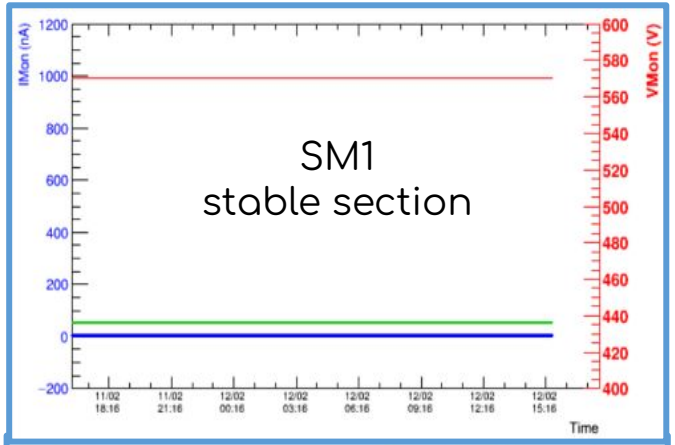
Single muon trigger efficiency
- P_T resolution better than 15% @ 1 TeV
- Huge fake trigger rate in the endcap



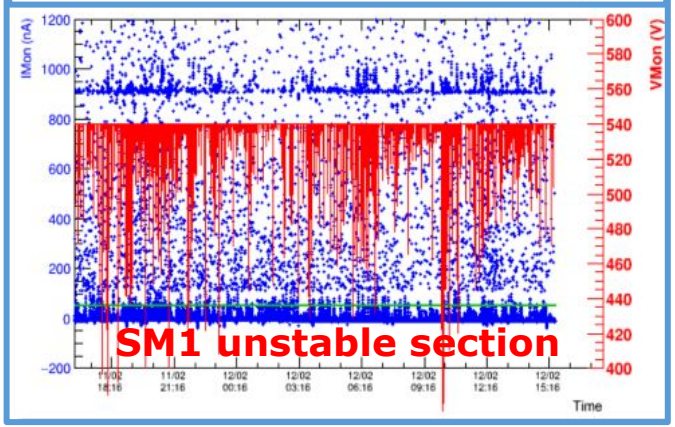
1 mrad + 100 μm (single hit) resolution needed



Main issue: ==> HV instability observed with $Ar:CO_2$ - 93/7 gas mixture-> passivation applied



SM1
stable section

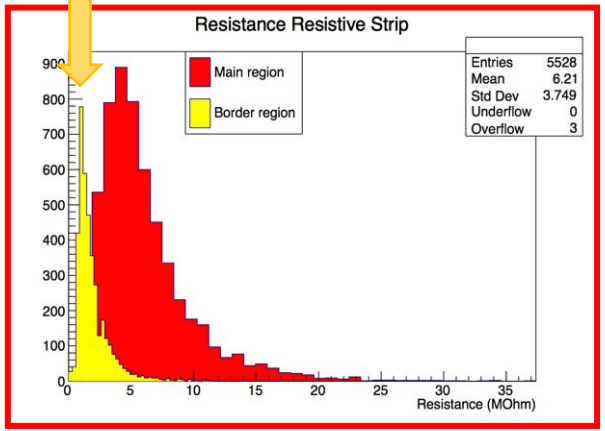


Resistive strips resistance

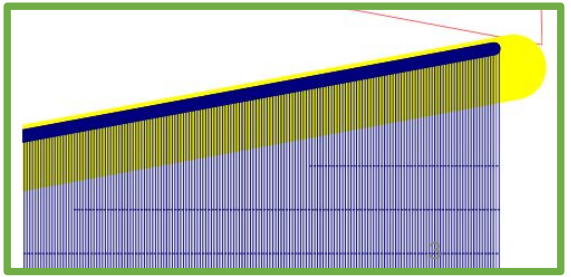
measured
with a 1x1 cm^2 probe

Yellow: @ 1cm from HV line:

several < 1 MΩ!



passivation with Araldyte close to the HV line ==>>> stability 10-20% improved

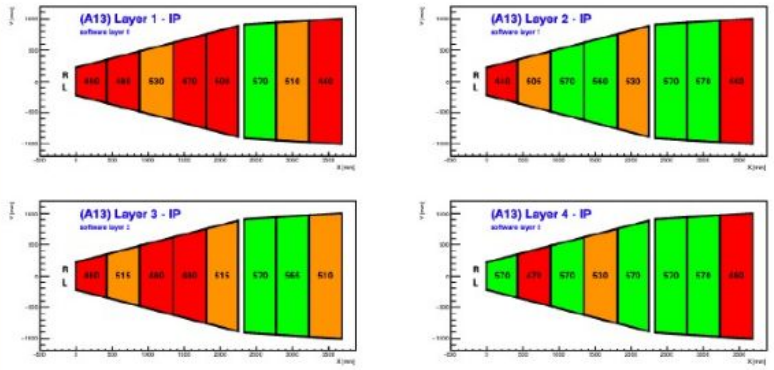


HV status for non-passivated unstable MM DW: +2 % isobutane improves the stability

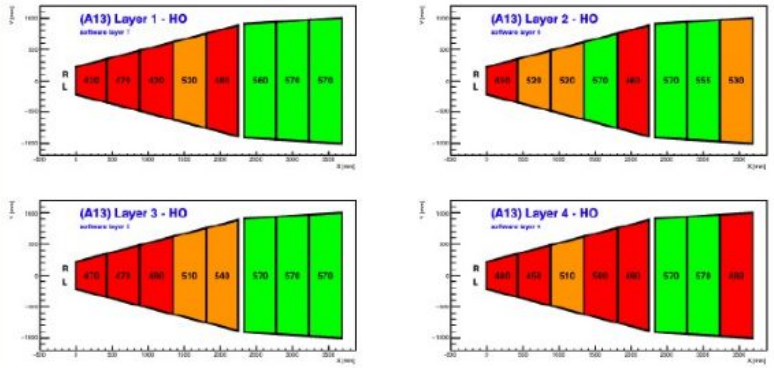
Necessary validate mixture in high radiation (10 y @ HL LHC ~ 0.3 C/cm^2)

$Ar:CO_2$ - 93:7

IP Side:



HO Side:



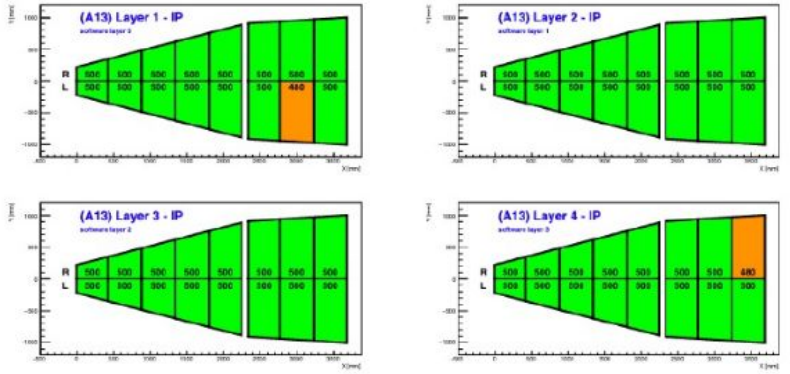
nominal HV

NOT @nominal HV

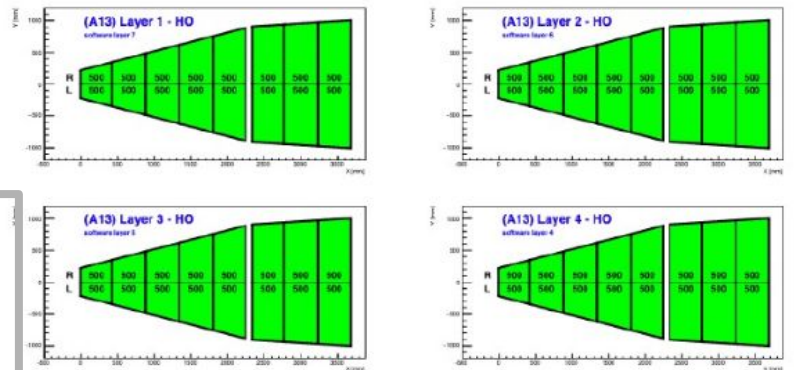
DW (Double Wedge) opened and passivated before the installation on the

$Ar:CO2:C_4H_{10}$ - 93:5:2

IP Side:



HO Side:

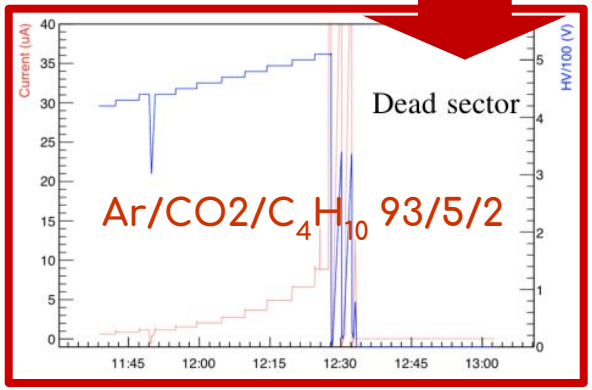


GIF++
early studies on LM2 M7

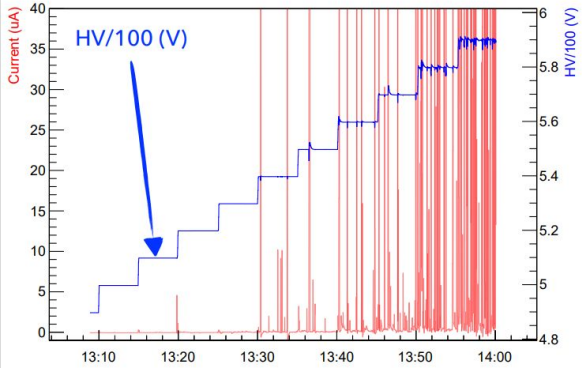
- Ar/CO_2 93%-7%
- Ar/CO_2 80%-20%
- $Ar/CO_2/C_4H_{10}$ 93%-5%-2%

photon flux: 40-50 kHz/cm^2
~ 2-3 x ATLAS HL LHC

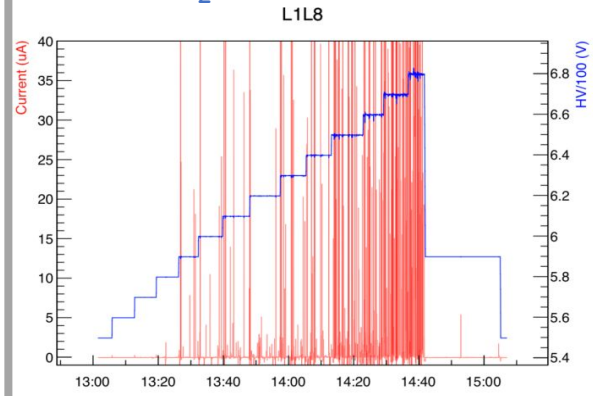
->Isobutane improves the HV stability
->Some not understood casualties



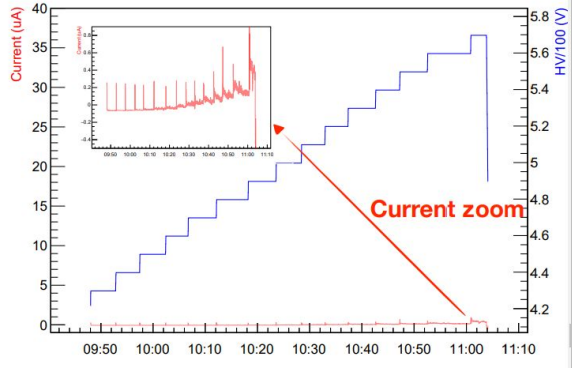
Ar/CO_2 93/7

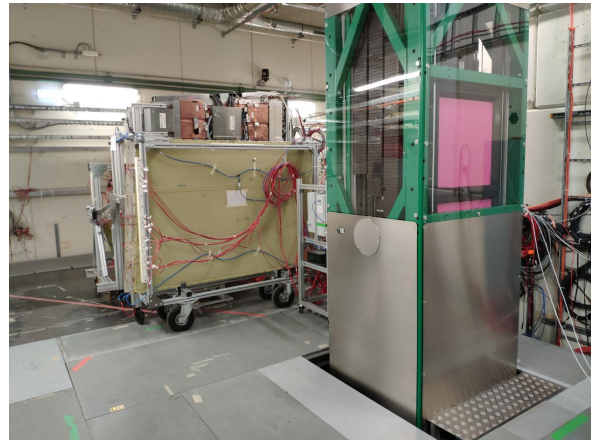


Ar/CO_2 80/20



$Ar/CO2/C_4H_{10}$ 93/5/2



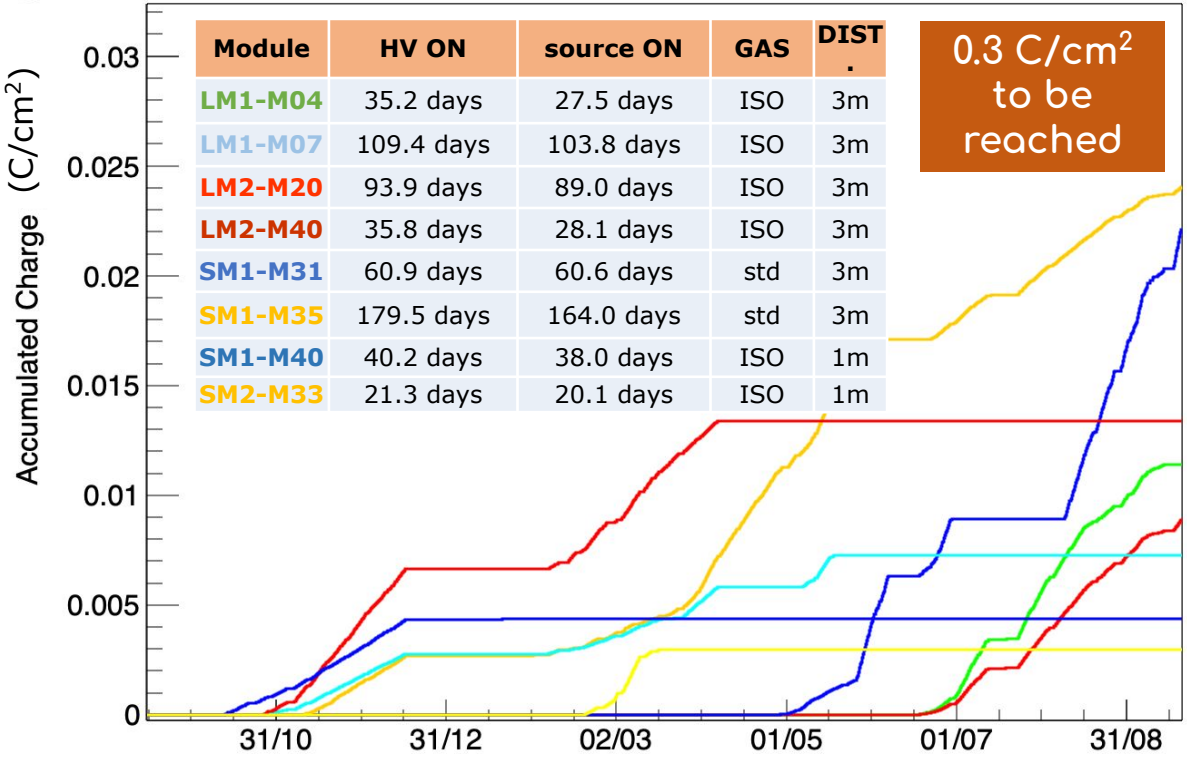


Summary of the GIF++ irradiation studies on 8 production detectors

- Cumulated more than **~600 days of irradiation at GIF**
- Not seen major degradation with Isobutane nor standard mixture
- **Higher gain up to a factor 10** has been **stably** reached in Isobutane
- Isobutane is more stable than standard mixture
- On bad detectors : many trips in standard mixture while only a **few bad trips in Isobutane**

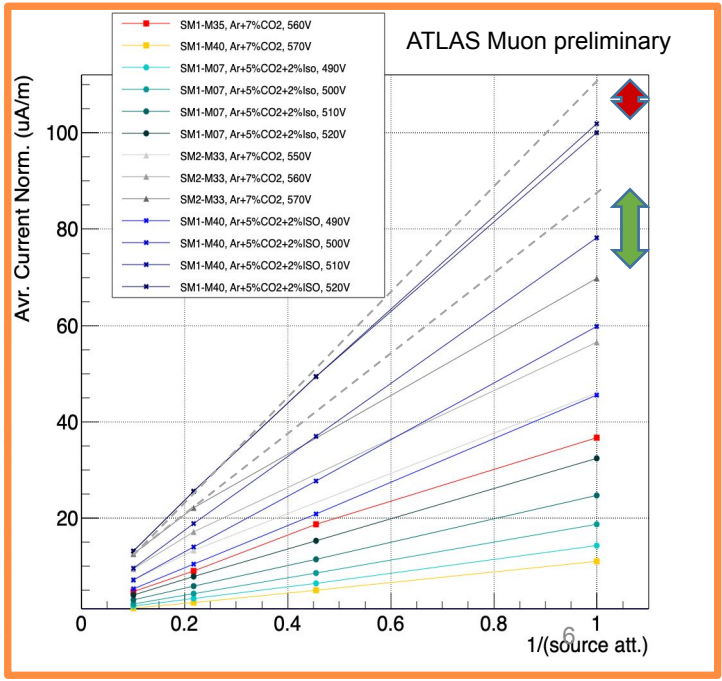
Module	HV ON	source ON	GAS	DIST.
LM1-M04	35.2 days	27.5 days	ISO	3m
LM1-M07	109.4 days	103.8 days	ISO	3m
LM2-M20	93.9 days	89.0 days	ISO	3m
LM2-M40	35.8 days	28.1 days	ISO	3m
SM1-M31	60.9 days	60.6 days	std	3m
SM1-M35	179.5 days	164.0 days	std	3m
SM1-M40	40.2 days	38.0 days	ISO	1m
SM2-M33	21.3 days	20.1 days	ISO	1m

0.3 C/cm^2 to be reached



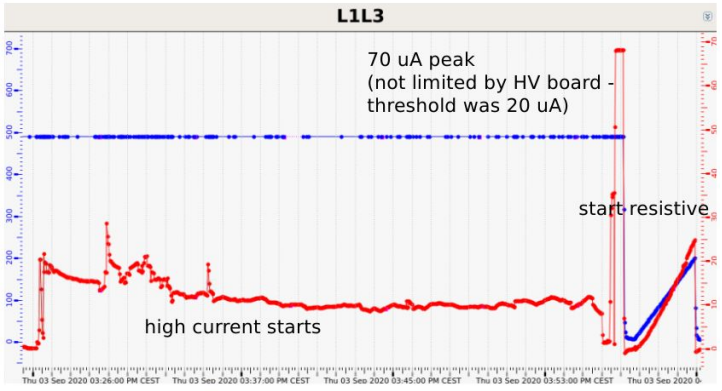
GAIN SATURATION studies on a detector (SM1 M40) @ 10 HL LHC

lower saturation found with Isobutane (~ 10%) w.r.t. standard mixture (~20%) at very high currents (10 x HL-LHC)



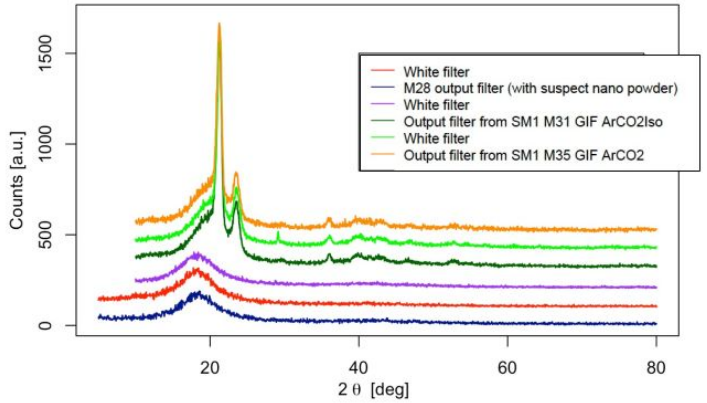
Studies on damages occured under Ar:CO2:C_4H_{10} - 93:5:2 in GIF++

A typical section loss behaviour

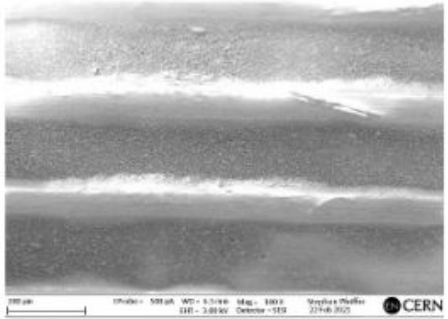


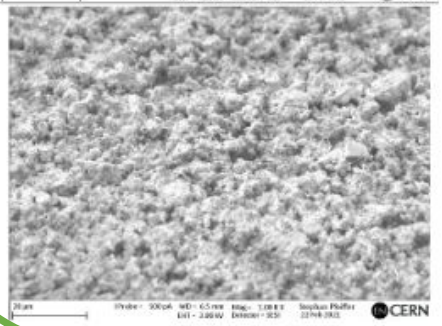
X-Ray search for hydrocarbons after irradiation

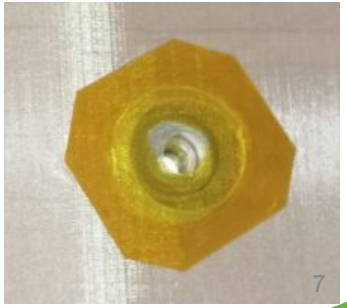
- **No evidence of contaminant**



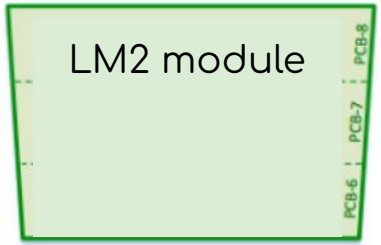
HV section where discharges occured were **reopened and inspected** for **hydrocarbon remnants** or carbon deposit due to isobutane
-> issues identified as weak points:
glue on the mesh, resistive blob, mesh dirt)
No issues to be related to isobuthane found



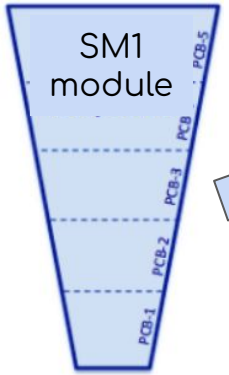




MM set up @ GIF++

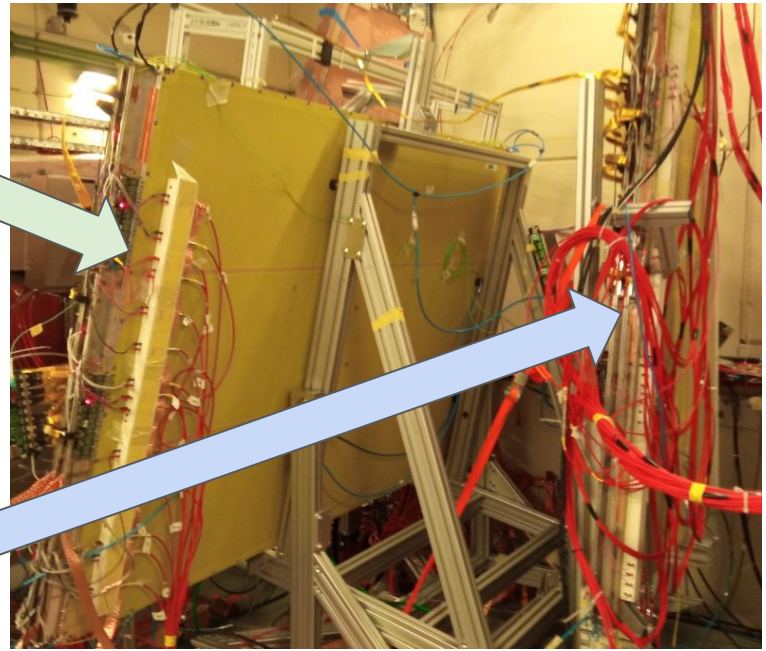


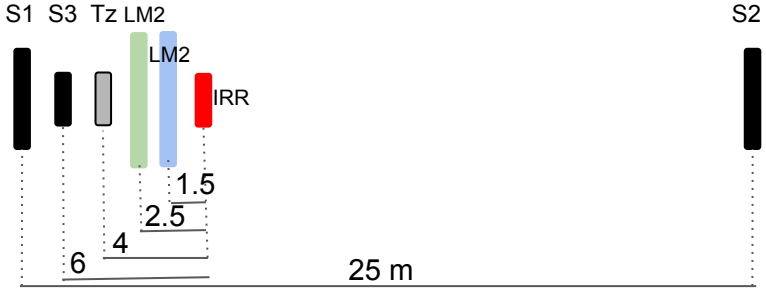
PCB 6-7 with elx



PCB 2-3 with elx

Tz module





Detectors

3 chambers (2 NSW MM + Tz)
4 PCB with full read out chain
>4000 elx channels

Triggers

- GIF++ (2 scint 40x40 cm)
-> muon rate max 2.5 kHz
-> triggered beam size 40 cm
- 4 scint (GIF++ && sTGC)
-> muon rate 30 Hz
-> triggered beam size 5 cm

Geometrical configurations

- Beam at 90 degrees
- Tilted by 20 degrees
- Tilted by 10 degrees

Gas mixtures

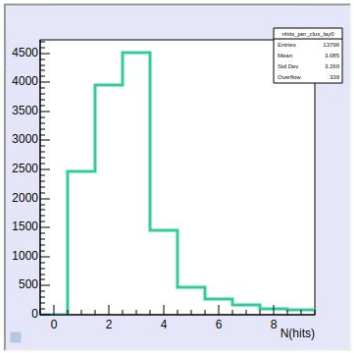
Ar/CO2 93/7
Ar/CO2/isobutane 95/3/2

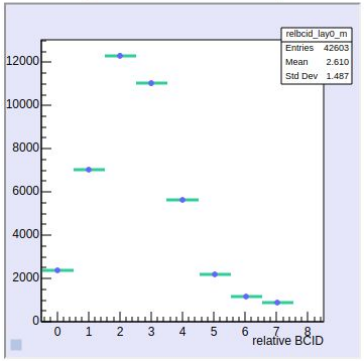
MM @ GIF++, first data taking period Oct 20 - Nov 3

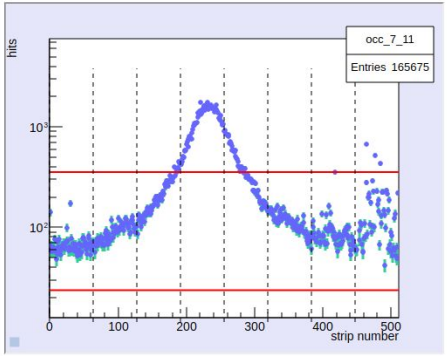
	Data taken during the first period			
Detector	Beam angle (degrees)	MAX / MIN γ bckg (interacting γs kHz/cm2)	HV values tested (V)	Events collected (first analysis and cluster recon done)
SM1	90	~50 -> ~2	570/560/550/540/530/520	~ 23 M events in Ar/CO2 ~ 18 M events in Ar/CO2/Iso TOT > 150 Runs
LM2	90/80/70	~20 -> ~1	570/560/550/540/530/520	
Tz	90	~7.5 -> ~0.3	530	

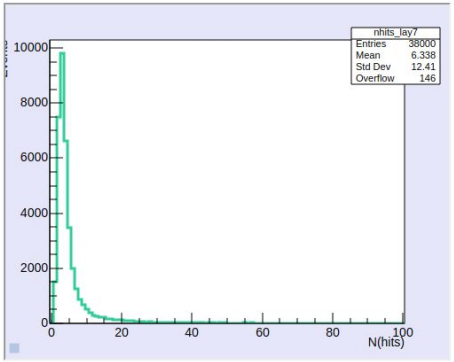
First observations Ar/CO2 (very preliminary)

source off

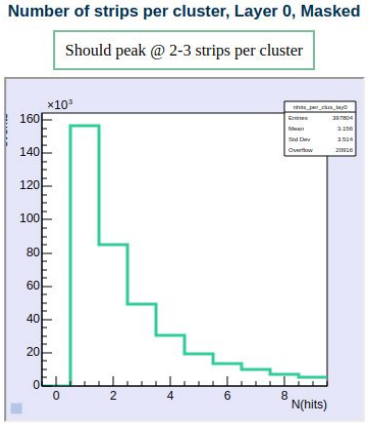


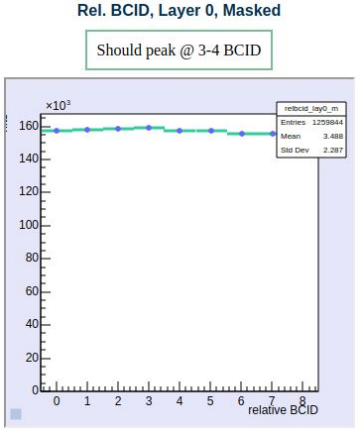


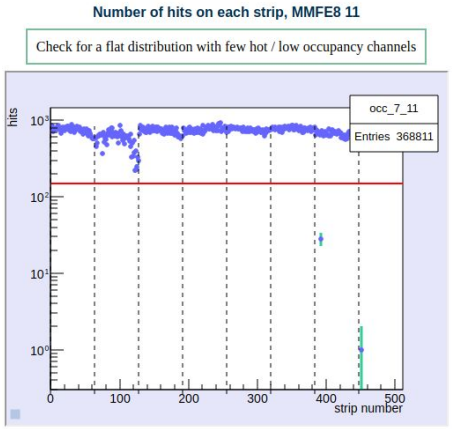


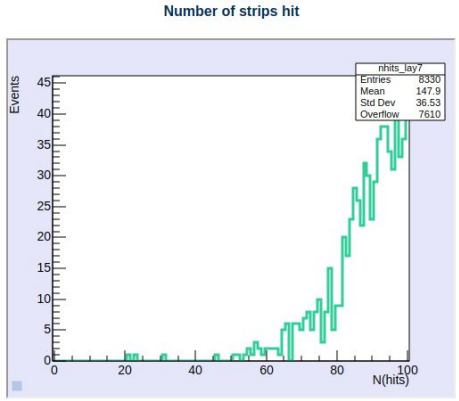


source on



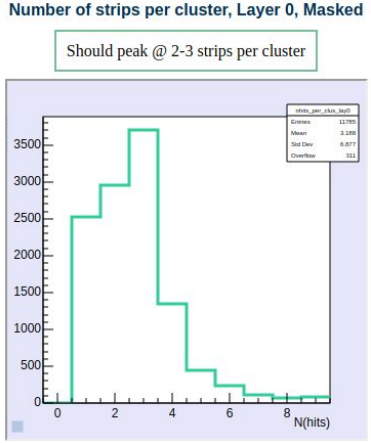


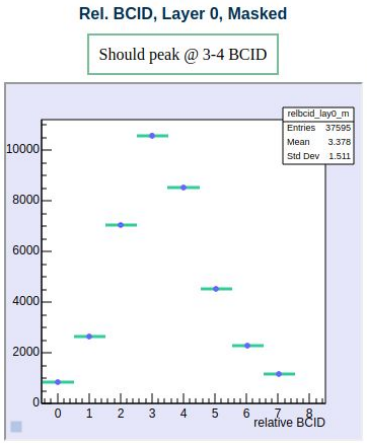


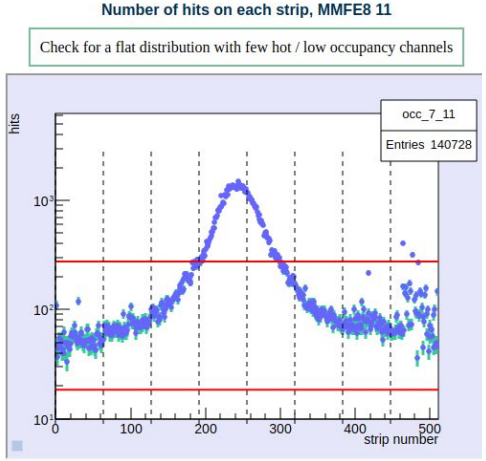


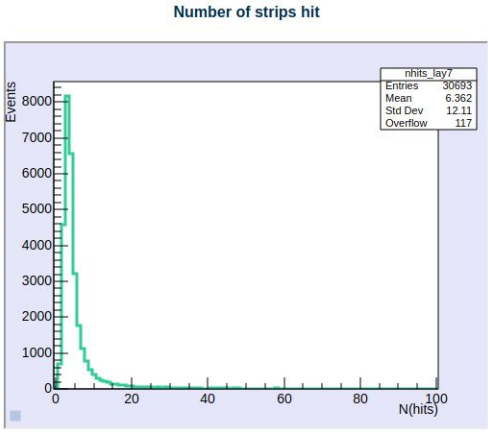
First observations Ar/CO2/Iso (very preliminary)

source off

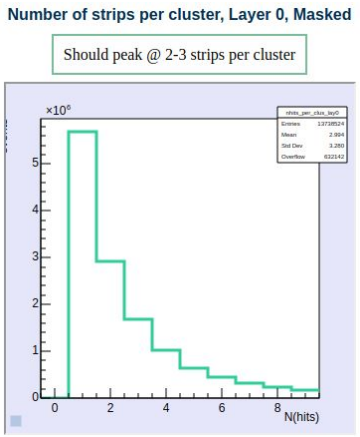


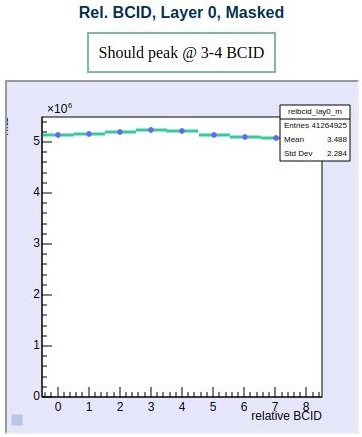


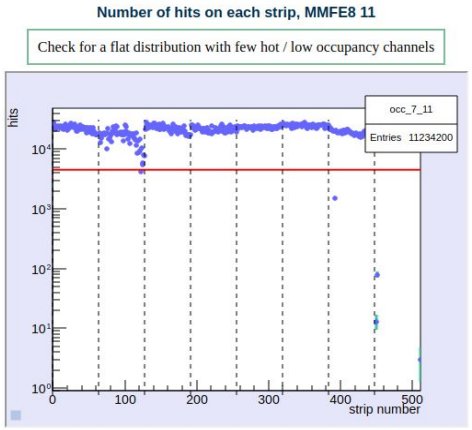


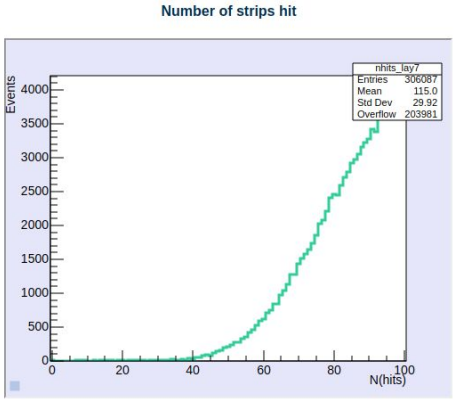


source on





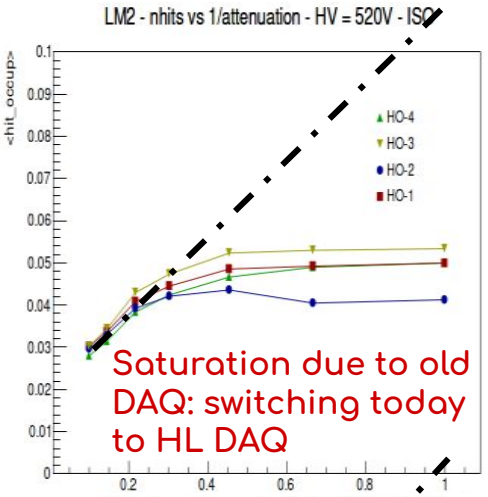


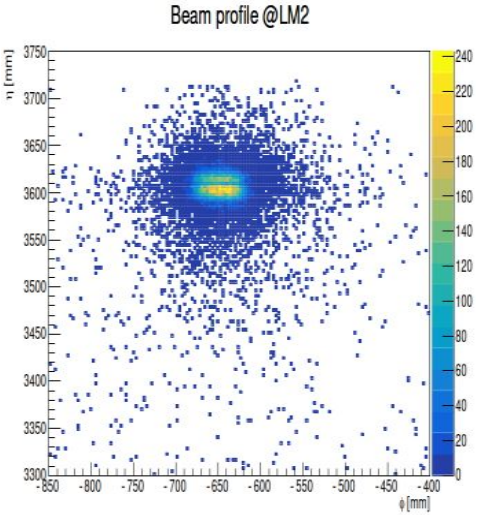


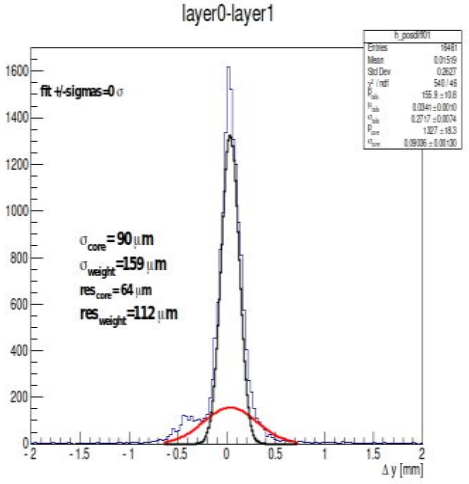
First look at analysis (by Chara): occupancy, beam profiles, residuals

ISO gas, hit occupancy
occupancy = nhits/1536
1536 strips/layer 1 ½ PCB
SM1: PCB 2 & 3
LM2: PCB 6 & 7

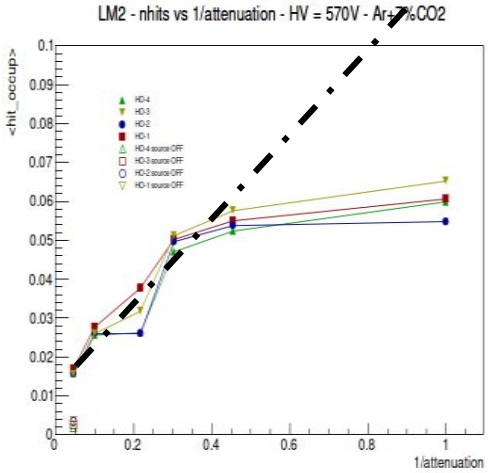
Both normalized to distance and surface

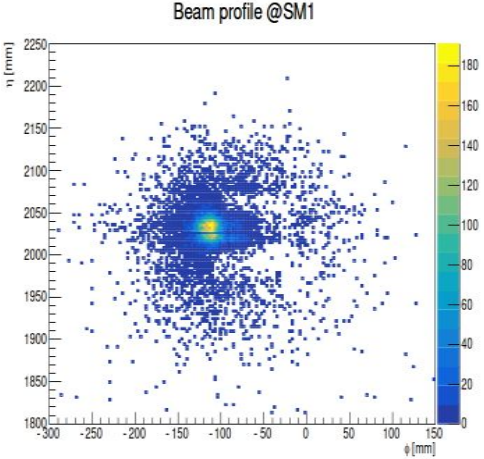


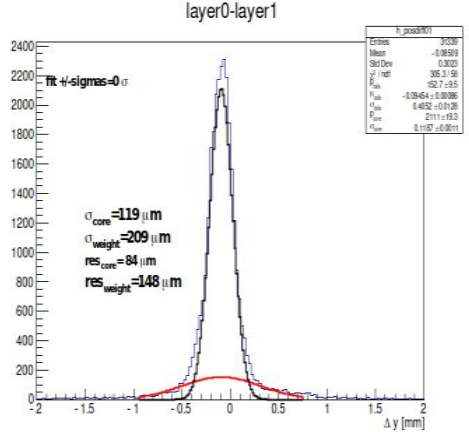




Ar + 7%CO2 gas, hit occupancy
occupancy = nhits/1536
1536 strips/layer 1 ½ PCB
SM1: PCB 2 & 3
LM2: PCB 6 & 7







Summary and Outlook

The NSW has chosen the **resistive readout MM technology** for the LS2 upgrade

Weaknesses found in HV stability due to low resistivity close to the HV distribution line

A new gas mixture Ar:CO2:C_4H_{10} - 93:5:2 has been tested under irradiation with gammas (@ GIF++/CERN)

HV stability strongly increased with isobuthane

suspect section loss triggered studies on ageing and hydrocarbons production

> 8 detectors accumulated ~0.03 C/cm^2 (10 y HL-LHC target is 0.3 C/cm^2)

> inspections and X-rays did not revealed any sign of Isobuthane-related ageing effect

Data taking with ELX @ GIF++ (first time ever for ATLAS NSW)

- Over 40M MIP trigger over gammas background
  - in Ar and Iso mixtures, Full HV scans,Angles 0->20 degrees
  - Up to 2.5 HL-LHC background
- First sight @ analysis shows
  - Cluster size 3 strips as expected
    - Shape to be understood when the background gammas is on
  - Occupancy @5% underestimated → HL DAQ to be installed starting today→ 12% foreseen

Plans:

> Isobutane ageing: Increasing the accumulated charge-->possibly to reach the 10 y HL-LHC

> Test beam: Analysis Ongoing

> Test beam: keep a MM with elx in GIF++ starting from January for studying the performances drift (if any)

> test the tracking algorithms + Phase II DAQ