Pisa Meeting on Advanced Detectors – La Biodola, 27 May - 2 June 2018

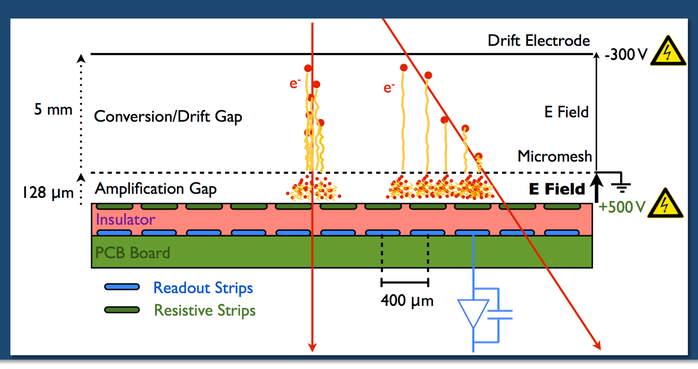
High Voltage stability and Cleaning procedure of 2m^2 Resistive Strip Micromegas Detectors

For the upgrade of the innermost station of the forward muon spectrometer of the ATLAS experiment 2 and 3 m^2 large micromegas detectors are foreseen with 4 active layers, each. Each of the four production sites has to deliver 32 quadruplets or 128 active planes, where the tiny 120 μm distance between the 600 V resistive strip anodes and the grounded micro-meshes requires at these large areas adequate and well adapted cleaning procedures to guarantee high voltage stability. This is particularly critical for strip shaped surfaces made from resistive material where remnants from the lithographic production processes must be completely removed. This includes:

- ✓ **The quality checks and the visual inspections to be carried on during cleaning and assembly procedures.**
- ✓ **The wet cleaning procedure to remove dust and possible ionic components of salts from the anode surfaces.**
- ✓ **The dry cleaning procedure to remove dust.**
- ✓ **The HV tests to be done to validate the cleaning, including definition of the test conditions and acceptance criteria.**

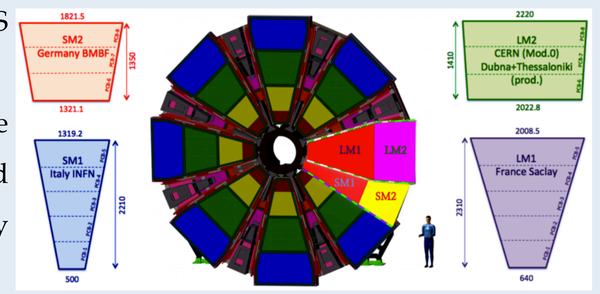
1) Operating principles [1,2]

- Charged particles ionize the detector gas (100 pairs/cm in Ar:CO_2 93:7 for muons)
- Ionization electrons produced in the conversion/drift gap, dritf towards the micro-mesh. Then they are amplified in avalanches after drift to the micro-mesh in the high field region between micro-mesh and the resistive anode strips
- High resolution (≈100μm): strip width 300 μm, strip pitch 425-450 μm
- ≈ 100% transparency of the micro-mesh guarantee by the large field ratio
- Fast evacuation of positive ions: 100 ns, capability to work in high luminosity environments (tested with high density fluxes > 7MHz/cm^2)

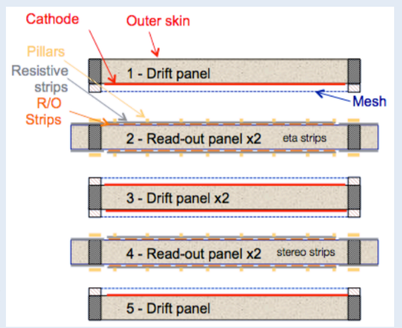


2) The MM chambers in ATLAS [3,4]

- MM chambers are part of the New Small Wheel for the upgrade of the inner end cap of the Muon Spectrometer of the ATLAS experiment (trigger and tracking performance)
- A MM chamber is composed by 4 active layers, 2 of them have anode strips perpendicular to eta (precision direction, defined by pseudo rapidity), 2 of them have anode strips inclined by ±1.5° to reconstruct the 2nd coordinate
- the NSW Micromegas are formed by 4 types of chambers whose production is distributed among the 4 sites: SM1 Italy, SM2 Germany, LM1 France, LM2 Greece-Russia-Cern



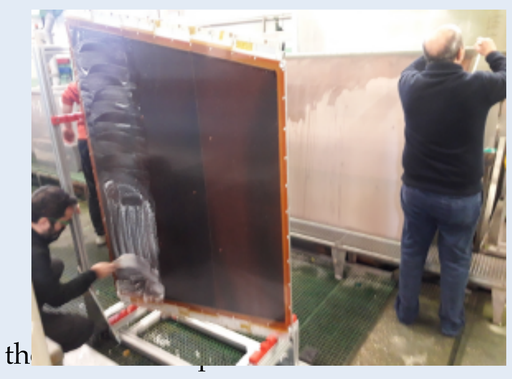
The grounded micro-meshes and the resistive strip anodes require at these large areas adequate and well adapted cleaning procedures to guarantee high voltage stability. This is particularly critical for the resistive strip surfaces where remnants from the lithographic production processes must be removed completely.



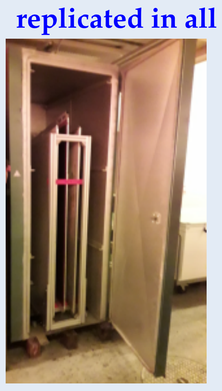
3) Cleaning Procedure [5]

The cleaning procedure of the 5 drift and readout panels directly before assembly removes all disturbing dust, dirt or lithographic remnants:

- wet cleaning uses a detergent : micro-crystal cleaner for RO panels NGL for drift panels applied using a brush;
- wash off all detergent residuals with tap water using a brush;
- clean with high pressurized deionized water;
- clean also all holes, the backsides and th… there might be hidden reservoirs of aluminum-chips, dirt or dust;
- dry the wet surfaces in an oven at about 40° C with circulating air, clean the panel surface using a brush on a vacuum cleaner;
- for final surface cleaning a sticky roller is used directly before the assembly in the clean room.



The procedure has been tested at CERN first (DT lab) and now is being replicated in all construction sites



4) Test of High Voltage stability

HV qualification: As the assembly happens in air the 1st step of qualification is performed under dry air while the 2nd step of qualification is performed under Ar / CO_2 93:7 Vol%.

(SM2 has 6 HV sectors per active area)

The goal is to establish a correspondence:

max. sust. voltage in dry AIR ⟷ **max. sust. voltage in Ar/CO_2**

here below screenshot of HV behaviour as obtained in air and in ArCO_2 at Munich by the SM2 group

Custom	Name	I0Set	V0Set	IMon	VMon	Pw	Status
02.000	CHANNEL00	0.030 uA	990.0 V	0.016 uA	989.8 V	On	
02.001	CHANNEL01	0.030 uA	990.0 V	0.000 uA	990.0 V	On	
02.002	CHANNEL02	0.030 uA	990.0 V	0.000 uA	989.8 V	On	
02.003	CHANNEL03	0.030 uA	990.0 V	0.004 uA	990.0 V	On	
02.004	CHANNEL04	0.030 uA	990.0 V	0.000 uA	990.0 V	On	
02.005	CHANNEL05	0.030 uA	990.0 V	0.000 uA	990.2 V	On	
02.006	CHANNEL06	0.030 uA	990.0 V	0.012 uA	989.2 V	On	
02.007	CHANNEL07	0.030 uA	990.0 V	0.000 uA	989.8 V	On	
02.008	CHANNEL08	0.030 uA	990.0 V	0.001 uA	989.8 V	On	
02.009	CHANNEL09	0.030 uA	990.0 V	0.000 uA	989.8 V	On	
02.010	CHANNEL10	0.030 uA	990.0 V	0.002 uA	989.8 V	On	
02.011	CHANNEL11	0.030 uA	990.0 V	0.008 uA	989.8 V	On	
04.000	GEM2_1	2.000 uA	300.0 V	0.007 uA	0.0 V	Off	
04.001	GEM2_2	1.000 uA	300.0 V	0.000 uA	0.0 V	Off	
04.002	GEM2_3	1.000 uA	0.0 V	0.000 uA	0.0 V	Off	
04.003	GEM2_4	2.000 uA	0.0 V	0.000 uA	0.0 V	Off	

…nd channel 6 ha

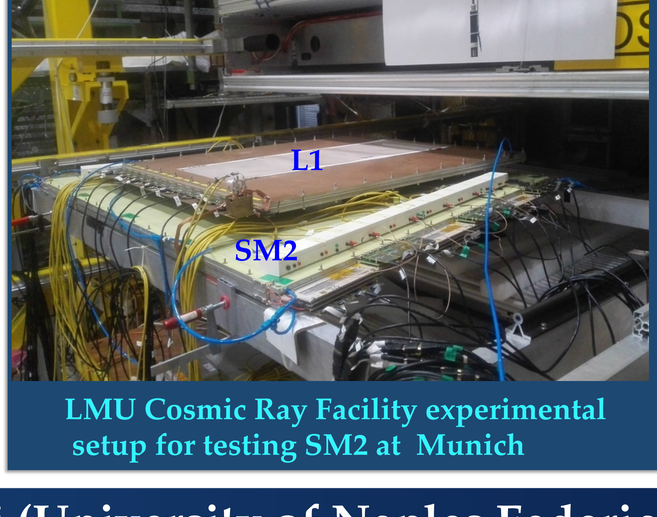
Custom	Name	I0Set	V0Set	IMon	VMon	Pw	Status
02.000	CHANNEL00	0.050 uA	600.0 V	0.015 uA	599.5 V	On	
02.001	CHANNEL01	0.050 uA	600.0 V	0.000 uA	599.8 V	On	
02.002	CHANNEL02	0.050 uA	600.0 V	0.000 uA	599.5 V	On	
02.003	CHANNEL03	0.050 uA	600.0 V	0.004 uA	599.8 V	On	
02.004	CHANNEL04	0.050 uA	600.0 V	0.000 uA	600.0 V	On	
02.005	CHANNEL05	0.050 uA	600.0 V	0.001 uA	600.0 V	On	
02.006	CHANNEL06	0.050 uA	600.0 V	0.011 uA	599.2 V	On	
02.007	CHANNEL07	0.050 uA	600.0 V	0.004 uA	599.8 V	On	
02.008	CHANNEL08	0.050 uA	600.0 V	0.000 uA	599.8 V	On	
02.009	CHANNEL09	0.050 uA	600.0 V	0.000 uA	599.5 V	On	
02.010	CHANNEL10	0.050 uA	600.0 V	0.003 uA	599.8 V	On	
02.011	CHANNEL11	0.050 uA	600.0 V	0.002 uA	599.8 V	On	
04.000	GEM2_1	2.000 uA	300.0 V	0.008 uA	0.0 V	Off	
04.001	GEM2_2	1.000 uA	300.0 V	0.000 uA	0.0 V	Off	
04.002	GEM2_3	1.000 uA	0.0 V	0.000 uA	0.0 V	Off	
04.003	GEM2_4	2.000 uA	0.0 V	0.000 uA	0.0 V	Off	

at 990 V there short discharges appear every few seconds
990 V seems to be the max. sust. voltage (< breakdown voltage)

at 600 V short discharges appear every few seconds
600 V seems to be the max. sust. voltage

for this SM2 doublet

5) Cosmic Ray Test

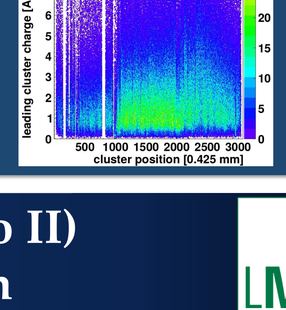


LMU Cosmic Ray Facility experimental setup for testing SM2 at Munich

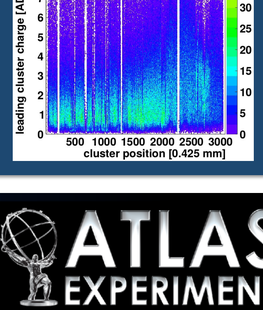
2 MDTs : tracking reference in precision direction of SM2

A 1x1 m^2 reference micromegas is laying on top of the SM2 doublet and is rotated by 90 degrees (alignment reference for 2nd coordinate)

all 12 channels work at I≈0 nA
U_{ampl} scan: 540 - 590 V



reasonable cluster charge observed over the full surface in cosmic tests



Bibliografia

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[2] T. Alexopoulos et al., A spark-resistant bulk-Micromegas chamber for high-rate applications, Nucl. Instrum. Meth. A 640 (2011) 110

[3] ATLAS collaboration, New Small Wheel, Technical Design Report, CERN-LHCC-2013-006 (2013)

[4] T. Alexopoulos et al., Development of large size Micromegas detector for the upgrade of the ATLAS muon system, Nucl. Instrum. Meth. A 617 (2010) 161

[5] Rui De Oliveira private comunication

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