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Quality tests for SM1 MicroMegas detector module

M. Del Gaudio(*)

Dipartimento di Fisica, Università della Calabria and INFN, Cosenza - Cosenza, Italy

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Summary. — The Phase-I ATLAS upgrade (2018) aims to improve the detector performance at high luminosity ($2 \times 10^{34}\,\text{cm}^{-2}\text{s}^{-1}$). In particular, the upgrade of the muon spectrometer focuses on the Small Wheels (SW) in the end-cap region, which cover $1.3 < |\eta| < 2.7$. The SW will be replaced by the *New Small Wheels* (NSW), which is a set of precision tracking and trigger detectors able to work at high rates with excellent real-time spatial and time resolution. Each NSW will be constituted by multiplet of planar gaseous detectors, with trapezoidal shape: small-strip Thin Gap Chamber (sTGC) and *Micro-MEsh Gaseous Structure* (MM). This paper describes some of the quality controls that the MM detectors must comply: planarity, thickness and gas tightness.

1. – Upgrade to the New Small Wheels

In 2018, after the second long shutdown, the LHC luminosity will be increased to $2 \times 10^{34}\,\text{cm}^{-2}\text{s}^{-1}$, therefore the ATLAS detector must be upgraded to have better performance at higher luminosity. In particular, an extrapolation from the observed rates at the lower luminosity conditions of the 2012 run to high luminosity, indicates a degradation of muon tracking performance, both in terms of efficiency and resolution in the SW. The NSW will ensure that the moment resolution will be better than 15% at $p_T \sim 1\,\text{TeV}$, therefore, it will able to work at high rates [1].

2. – Micromegas quadruplet: working, construction and quality controls

Each NSW consist, in the z-direction, by detectors in this order: sTGC-MM-MM-sTGC, where the MM detectors are arranged in quadruplets of trapezoidal shape and dimension of $2\,\text{m}^2$, schematically shown in fig. 1. Each quadruplet is constituted by 4 gas gaps (mixture 93:7 Ar:CO_2) between 5 panels: 2 external drift, 1 central drift, and

(*) E-mail: michela.delgaudio@cs.infn.it

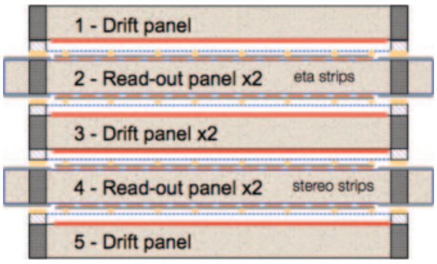

Fig. 1. – Schematic view of a quadruplet 4 gas gaps between 5 panels are visible.

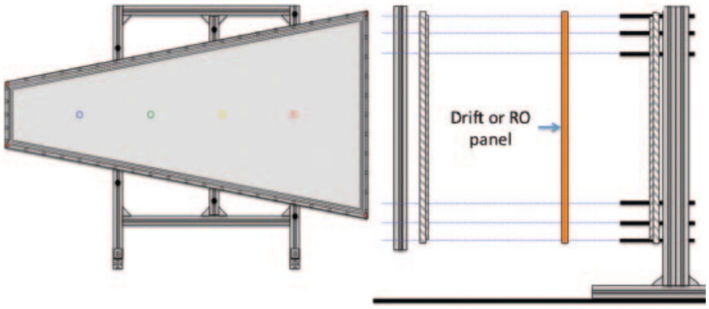

Fig. 2. – Scheme of the apparatus for the gas tightness test. The central holes (colored circles) are used to connect pressure and temperature sensors, gas inlet and outlet.

2 readout. The drift panels serve as cathode, gas distribution system and support for stainless steel mesh, which has pitch $\simeq 50\,\mu$m and divides each gas gap in two regions: drift and amplification. The readout panels serve to determine the hit position of an incoming particle by the strips [4]. The particularities of the MM detector are the high electric field [2, 3] (4050 kV/cm) in the amplification region, a high electrons and ions drift velocity (10 ns and 100 ns), and the spatial resolution $< 100\,\mu$m [5] for particles incident with impact angles $0° < \theta < 30°$.

The INFN deals with the construction of 32 quadruplets, constituted by panels made of pcb, aluminum honeycomb and frames, glued with $A2011$. The construction is made in clean room on a granite table, and includes the mechanical (or optical) alignment and fixing of pcb, and the use of vaccum bag (or stiffback) during the curing.

During the construction the check of the components' thickness and of the panels' planarity is made using the *Limbo test* on the granite table. It consists of a Bosh Al Profile of 132 cm with 8 micrometers which are read via computer while the bar is raised and lowered on the table. The deviation accepted is in the z-direction: $RMS \leq 80\,\mu$m and in the radial direction: $RMS \leq 30\,\mu$m.

The *gas tightness* test consists of two phases: the local test only for the panels, and the total test both for the panels that for the quadruplet. The local gas tightness test is made on all holes of the panels to ensure that the gas leak is under 0.6 mbar/s, using a cylinder (3.4 kg) which compress the NBR O-Ring and produce the overpressure of 5 mbar. Instead the total gas tightness test verifies that under an overpressure of 5 mbar, the gas leak, for a volume of 50 l, is under 0.6 mbar/h. To this end, the apparatus, shown in fig. 2, is constituted by a table structure and two vessels (formed by Al honeycomb).

The panel to test is inserted between the vessels and screwed at few mm of distance from them, creating two gaps which are filled (one by one) with compressed air, at the overpressure of 5 mbar, and the pressure drop is monitored. In these gaps are present some spacers to avoid deformations of the panels. The gas tightness test is made also on the quadruplet after the assembly.

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