IL NUOVO CIMENTO **43 C** (2020) 68
DOI 10.1393/ncc/i2020-20068-5

COLLOQUIA: IFAE 2019

The ATLAS New Small Wheel project: SM1 drift panels assembly and finalization

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received 8 June 2020

Summary. — The New Small Wheel project is going to provide the upgrade of the ATLAS end-cap Muon Spectrometer (ATLAS COLLABORATION, *ATLAS muon spectrometer: Technical design report*, CERN-LHCC-97-22, ATLAS-TDR-10) to benefit from the LHC luminosity increment planned for the coming years. The tracking system for the New Small Wheels are Micromegas detectors arranged in trapezoidal quadruplets with a surface variable between 2 and 3 m^2 which depends on the wheel sector (SM1, SM2, LM1, LM2). The SM1 drift panels assembly, finalization procedure and quality tests are presented.

1. – Introduction

The Micromegas [1] is a gaseous (Ar/CO_2 mixture at $\sim$3 mbar) planar detector characterized by high rate capability and good resolution track. The drift panel (fig. 1) and readout panel are coupled to form the detector active volume in which a stain-steel micro-mesh divides the gas gap in two parts, a 5 mm wide drift gap and a $\sim 128\,\mu$m wide multiplication gap. The drift gap works at -300 V while the mesh is groundend. The multiplication region works with an electric field of about 5 kV/mm.

2. – Assembly and finalization procedure, quality tests

The main DP assembly and finalization phases are:

- The drift electrode formed by 5 PCBs (fig. 1(right)) is aligned using a mask and placed with the copper face against the granite table. The external frames and aluminium honeycomb are glued on the electrode and pressed against the table surface using the vacuum bag technique and left to dry for 24 h. This garantees an excellent planarity of the drift electrode. The planarity measure is performed using the "limbo-tool" [2] (ATLAS spec. $[11.000 \pm 0.030]$ mm).

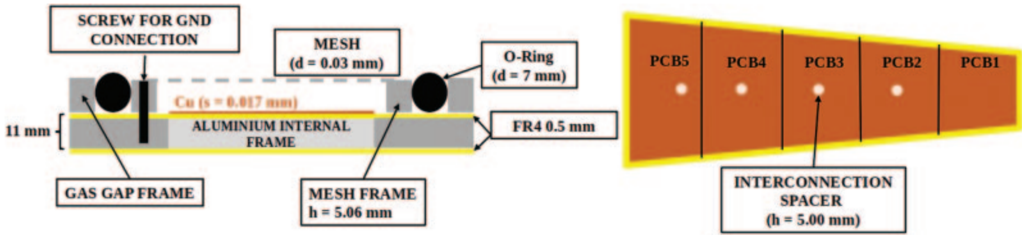

Fig. 1. – Transverse and frontal view of a DP. In evidence the main components. Not in scale.

- Interconnection spacers positioning and gluing are performed by a dedicated precision insert. The height of the interconnection drift spacers from the drift electrode surface is measured using a *Mitutoyo* digimatic indicator (ATLAS spec. $[5.000 \pm 0.030]$ mm).

- The mesh frame is glued at a distance of 19 mm from the edge of the panel with the help of an alignment rule. In order to have the mesh frame connected to the panel grounding, the mesh frame is also screwed to the panel aluminium frame. The height from the electrode surface is measured in 26 different points using a *Mitutoyo* digimatic indicator (ATLAS spec. $[5.060 \pm 0.030]$ mm).

- The gluing of the mesh is performed using a dedicated table. The mechanical tension of the mesh is measured by a tensiometer in 23 points uniformly distributed on the mesh surface (ATLAS spec. $[10 \pm 2\,\mathrm{N/cm}]$).

The Gas Tightness Test (GTT) is performed before the mesh-frame gluing. The drift panel is inserted in an aluminium vessel to form a gas gap volume. The vessel is forced in an exoskeleton structure to reduce its walls deformation caused by internal gas overpressure. The insertion of $\Delta V_0 = 200$ ml of air in the gap generates an overpressure of $\Delta P_0 \sim 4$ mbar. During the test the gas gap internal pressure $P(t)$ and temperature $T(t)$ are monitored continuously over 2 h. Due to vessel deformation it is possible to evaluate the gas leak by means of the ideal gas law as express by eq. (1),

$$V_{air}{}^{corr}(t) = \frac{\Delta V_0}{\Delta P_0} P(t) + \frac{V_0}{T_0}(T(t) - T_0), \tag{1}$$

where $\Delta V_0/\Delta P_0$ is the calibration factor and T_0 is the temperature at the beginning of the measurement. The second term of eq. (1) represents the temperature correction. Figure 2 shows an example of a GTT performed on a drift panel and the respective temperature correction (ATLAS spec. [leak rate Q_l less than 0.6 mbar/h or 10^{-5} Vol/min], gas gap volume ~ 7.5 l).

The high-voltage test is performed on the drift panels to verify the correct isolation between electrode surface and mesh. The cathode voltage with respect to the mesh is 500 V and the leak current is monitored for at least 10 min. This test is performed in a box with controlled relative humidity that should be less than 30% (ATLAS spec. [8–10] nA after 10 min at a tension of 500 V).

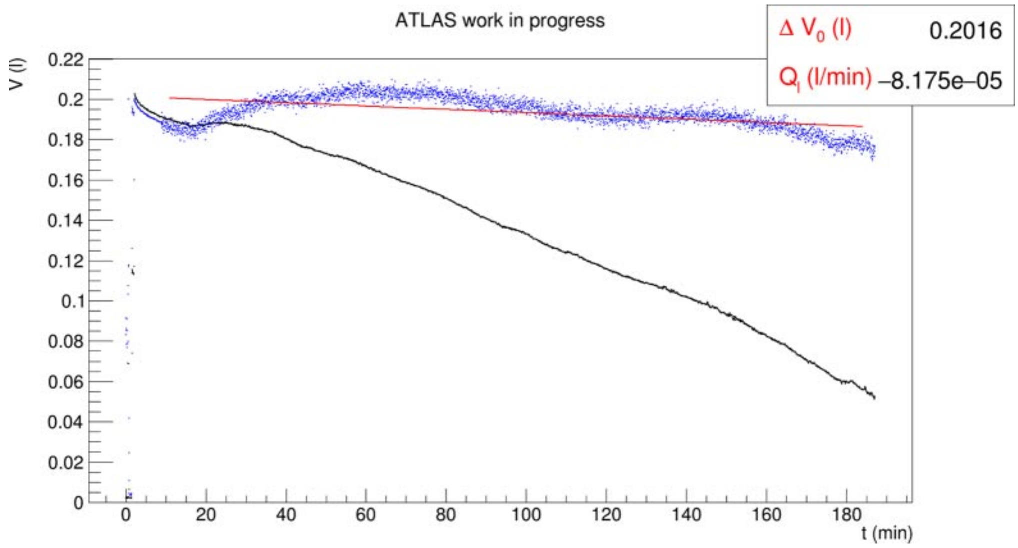

Fig. 2. – (ATLAS work in progress) Black dots: air volume not corrected for temperature. Blue dots: air volume corrected for temperature using eq. (1). The red line is a linear fit to estimate the leak rate Q_l (l/min) of the gas gap volume.

3. – Conclusions

We developed a very good assembly and finalization procedure and quality tests for the SM1 DPs. Till now we have assembled, finalized and validated 87/96 SM1 DPs.

REFERENCES

[1] Giomataris Y., Rebourgeard Ph., Robert J. P. and Charpak G., *Nucl. Instrum. Methods Phys. Res. Sect. A*, **376** (1996) 29.
[2] Alexopoulos T. *et al.*, *Nucl. Instrum. Methods Phys. Res. Sect. A*, **955** (2020) 162086.