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# Performaces of the ATLAS New Small Wheel micromegas chambers at the CERN Gamma Ray Irradiation Facility

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**Summary.** — One of the main upgrades of the ATLAS Experiment during Long-Shutdown II is the replacement of the forward muon spectrometer inner station, the Small Wheel. The New Small Wheel, covering the pseudorapidity region $1.3 < \eta < 2.7$, adopts micromegas micro pattern gas detectors for the muons precision tracking. Before the installation within the ATLAS Detector, micromegas chambers are tested under irradiation at the CERN Gamma Ray Irradiation Facility (GIF++).

## 1. – The ATLAS New Small Wheel micromegas detectors

The ATLAS New Small Wheel consists of four in line detectors: two external STGC chambers, with the primary task of triggering, and two internal micromegas chambers [1] dedicated to the precision tracking (fig. 1).

The NSW will integrate four types of small and large micromegas chambers for a coverage area of $1280\,\mathrm{m}^2$. The NSW micromegas chambers have the following features. A gas mixture of 93% Ar and 7% $CO_2$, spike absorbing resistive strips with a resistivity of $\simeq 10\,\mathrm{M}\Omega$ per cm, a drift voltage of 300 V with a drift gas gap of 5 mm and an amplification voltage of 570 V in an avalanche region of $128\,\mu$m.

## 2. – Micromegas chambers testing at GIF++

The extremely high voltage applied in the $128\,\mu$m avalanche gas gap may lead to constant discharges or spiking effects that would limit the detector tracking performances and damage the readout panels surface. Before being installed in the ATLAS Experiment, it is therefore mandatory to test each chamber high-voltage behavior under irradiation. At GIF++ [2] a 13 TBq $^{137}$Cs source provides a photon spectrum peaked at 662 keV. A set of filters allows the user to regulate the flux and guarantees a uniform irradiation per planes making the facility especially suitable for large-areas gaseous detectors. Given a photon flux of $6.4\times10^7$ photons/cm$^2$ s$^{-1}$ it is possible to induce a current at the avalanche

 

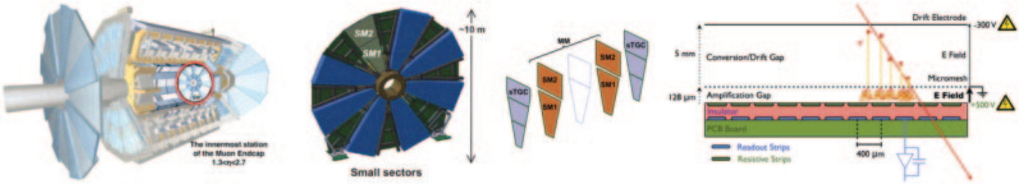


Fig. 1. – The ATLAS New Small Wheel (NSW) (left, center) and the NSW micromegas chambers structure (right).

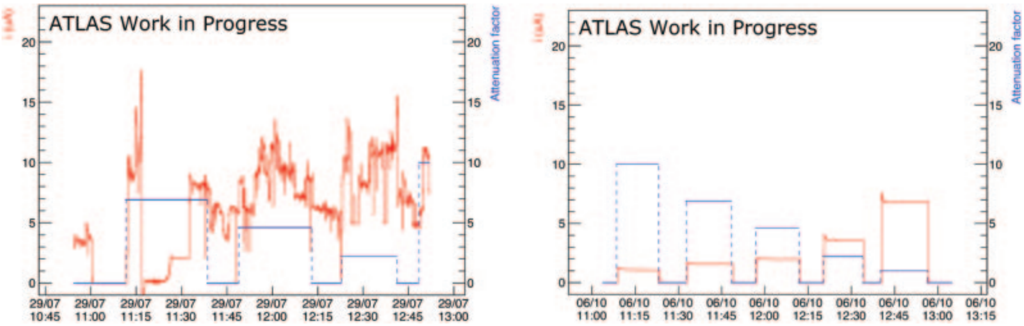


Fig. 2. – Induced current at the avalanche gap of the NSW micromegas chambers (red line) when different filters are applied to the GIF++ source (blue line). Comparison between a section before and after *passivation* (left and right, respectively).

stage compatible to the one foreseen at the High-Luminosity LHC operation, with an expected particle rate at the NSW surface of 15 kHz/cm$^2$.

Few production chambers suffer of discharging effects detected as current spikes. This behavior has been linked to the low resistivity of the resistive strips at the borders of the readout panels that creates a favorable path for charge discharging and evacuation. Figure 2 (left) shows the current induced in a micromegas chamber section (red line) when different attenuation filters are applied (blue line) for a chamber that suffers of discharging effects. The very problematic current behavior has been completely recovered, as shown in fig. 2 (right), when the resistive strips resistance at the border region was increased by covering them with araldite and kapton. This technique, known as *passivation*, is now a solid procedure to recover micromegas spiking issues.

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