The Lecce ATLAS Micromegas Cosmic Ray Test Setup

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1. Introduction

The Large Hadron Collider (LHC) will be upgraded in several phases in order to extend significantly its physics program. After the second long shutdown (LS2) in 2018, the accelerator luminosity will be increased to $(2 \div 3) \cdot 10^{34}$ cm^{-2} s^{-1}, thus allowing the ATLAS experiment to collect few hundreds fb^{-1}/year. Then, a further upgrade will result in the luminosity increasing to $5 \cdot 10^{34}$ cm^{-2} s^{-1} and will allow to reach an integrated luminosity of $\sim$ 3000 fb^{-1} after about 10 years of operation. In order to take advantage of the improved LHC operation the ATLAS [2] detector must be upgraded to reach a better performance at higher luminosities. The Phase-I upgrade of the ATLAS muon spectrometer focuses on the End-Cap region to improve tracking and triggering systems. ATLAS will replace the present muon End-Cap Small Wheels with the New Small Wheels (NSW) [3]. The NSW is a set of precision tracking and trigger detectors able to work at high rates with excellent spatial and time resolutions. These detectors can improve the muon Level-1 trigger exploiting a good angular resolution on online track segments, in order to confirm that muon tracks originate from the interaction point (IP) and thus drastically reducing fake tracks. The NSW consists of 16 detector planes arranged in two multilayers. Each multilayer consists of four small-strip Thin Gap Chambers (sTGC) and four Micromegas (MM) detector planes.
Because of Micromegas excellent spatial and time resolutions, these detectors fits well as main tracking system in an experimental setup with cosmic ray data.

2. The Micromegas detectors

The Micromegas, Micro Mesh Gaseous Structure, technology was developed in the middle of the 1990s [4] and relies on the construction of thin wireless gaseous particle detectors. MM detectors consist of a planar (drift) electrode, a gas gap of a few millimeters thickness acting as conversion and drift region and a thin metallic mesh placed on $100 \div 150$ μm height pillars whose distance from the readout electrodes creates the amplification region.
However, the prototypes used in the experimental setup are slightly different from the original design, because of their vulnerablity to sparking. Therefore a new spark protection system has been developed, hence the name of *Bulk Micromegas*: by adding a layer of resistive strips on top of a thin insulator, directly above the readout electrode, the MM become spark-insensitive, as the readout electrode is no longer directly exposed to the charge created in the amplification region. Moreover, instead of applying negative HV on the amplification mesh and keeping the resistive strips at ground potential, positive HV is applied to the resistive strips and the amplification mesh is connected to ground; therefore spark-induced current can be evacuated very quickly to ground through the mesh and its potential does not change.
The final scheme of bulk MM detectors is shown in Fig.1.

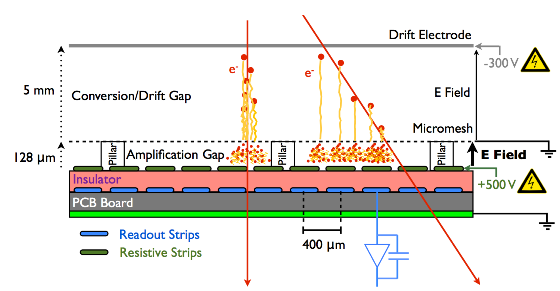

Figure 1. Bulk Micromegas with HV changes.

3. The experimental setup in Lecce

In order to study MM behaviour with cosmic rays, an experimental telescope was set up in Lecce to achieve this purpose: two bulk, *Tmm* prototypes were installed as tracking system, the separation between them being ~ 0.5 m along Z-coordinate: each one of the chambers is $10 \times$

10 cm^2 active area, with a double layer of orthogonal readout strips (X and Y coordinates) 150 μm wide and with a pitch of 250 μm; pillars are 128 μm high and the operating gas mixture is Ar:CO_2 (93:7). The readout electronics is based on 128-channels APV25 [5] cards, with 3 chips per layer. A total of 12 APV25 cards are read through an SRS Data Acquisition System connected to a Computer via Ethernet protocol. A software called *MMDaq* is used to acquire data on the computer.
Two scintillators provide the triggering system, being placed above and below the chambers; optionally a third scintillator could be used in order reduce accidental coincidences.
High Voltage for the two chambers and scintillators is supplied through a CAEN SY127 system, which can be controlled remotely via RS-232-C port. A Python software with Graphical User Interface (GUI) [6] has been set up in order to monitor HV for the different channels used, as shown in Fig.2.

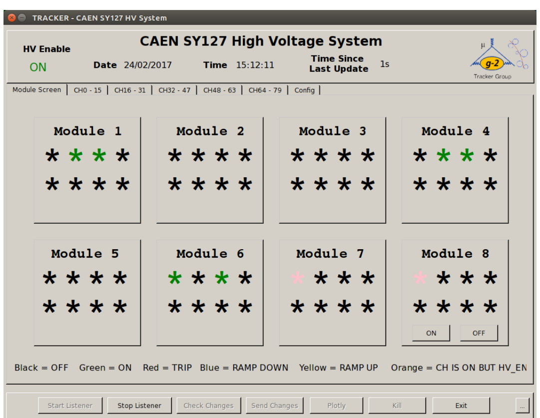

Figure 2. Main window of the Python GUI used to control CAEN SY127 power supply.

The *MMDaq* software used to acquire data comes with its own online event browser, useful for displaying some monitoring plots in order to analyze chamber behaviour during runs; Fig.3 is the typical main control panel. It is also available an offline event browser to check data which have been already taken while acquiring new ones.
Output data are stored in a root file which have to be processed by another software tool, *RecoMM* [7], providing a preliminary analysis of the APV Raw Data, with charge and time being extracted, and then clusterization of single strips is performed.

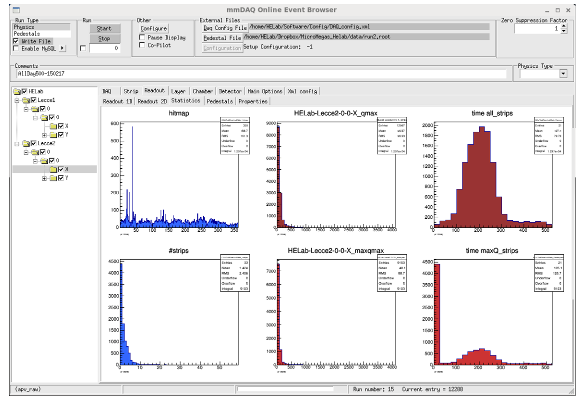

Figure 3. Main window of the acquisition software, the online event browser.

REFERENCES

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