IL NUOVO CIMENTO **41 C** (2018) 86
DOI 10.1393/ncc/i2018-18086-7

Colloquia: IFAE 2017

R&D on small-pad micromegas for the phase II upgrade of the ATLAS muon spectrometer

E. Rossi([1])([2])

([1]) *INFN, Sezione di Roma Tre - Roma, Italy*
([2]) *Università di Roma Tre - Roma, Italy*

received 21 April 2018

Summary. — In view of the ATLAS Phase II Upgrade, a proposal to extend the detector acceptance of the muon system up to $|\eta| \sim 4$ is being considered. The extension of the muon detection, together with the extension of the inner detector to the same range in η, has been demonstrated to enhance physics performance. The new high-η muon tagger should cope with extremely high particle rate, dominated by background hits up to about $10\,\mathrm{MHz/cm^2}$ in the most forward region. We present the development of resistive micromegas with $\mathrm{O(mm^2)}$ pad readout aiming at precision tracking in high rate environment without efficiency loss up to several $\mathrm{MHz/cm^2}$. A first prototype has been designed, constructed and tested. It consists of a matrix of 48×16 pads. Each pad has rectangular shape with a pitch of 1 and 3 mm in the two coordinates.

1. – Requirements for the high-η muon tagger

The extended coverage for muon detection associated with the ATLAS Phase II upgrade can be valuable for reconstructing low-mass final states whose decay products are produced with a very broad η distribution and for vetoing additional leptons from backgrounds [1].

The high-η muon tagger will be placed in the very forward regions, *i.e.* in the thin gaps at $z \approx \pm 6800\,\mathrm{mm}$ between the end-cap calorimeter cryostat and the JD shielding, covering a radial region between 25 and 93 cm from the beam axis.

The main requirements necessary to achieve the physics performance are: reconstruct a muon segment after the calorimeter; match with an ITK track (position, angle); high rate capability up to operation at $\sim 10\,\mathrm{MHz/cm^2}$; a position resolution of a few $100\,\mu\mathrm{m}$; an angular resolution of ~ 10 mrad.

2. – Development of small pad resistive micromegas

The proposed detector is based on resistive micromegas with small pad readout [2]. The anode copper pads are overlaid by an insulating layer carrying a pattern of resistive pads of the same size of the anode ones. The readout and resistive pads are connected

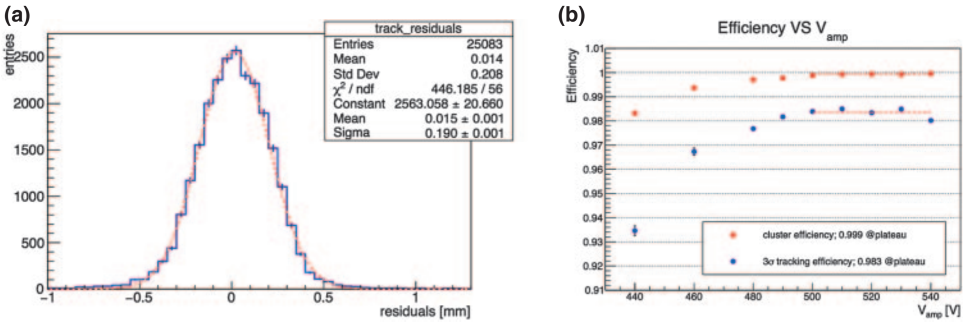

Fig. 1. – (a) Position resolution along x; (b) detector efficiency.

by intermediate resistors embedded in the insulating layer. The drift and amplification regions are 5 and 0.128 mm, respectively. Characterisation and performance studies have been carried out with ^{55}Fe sources, X-rays and high energy particle beams at SPS H4 beam line at CERN. Ar/CO_2 (93:7) was used as gas mixture.

The amplification factor has been measured to be $\sim 10^4$, with the chamber operating at $V_{amp} = 530$ V and $V_{drift} = 300$ V compatible with standard micromegas chambers.

Maximum mesh transparency (close to 100%) for electrons passing from the drift to the amplification region is reached for $E_{amp}/E_{drift} > 80$.

Efficiency and position resolution of the small pad micromegas have been measured with test-beam data. In fig. 1(a) the residuals of the reconstructed position of the detector under tests, with respect to reference tracks (obtained with other strip micromegas chambers in the set-up) are reported. A spatial resolution of about 190 μm was obtained. The turn-on efficiency curve (fig. 1(b)) is obtained by finding a cluster anywhere in the detector for any reference track ($\sim$100%) or by finding a cluster within 3σ from the extrapolated impact point of the reference track ($> 98\%$).

Preliminary results from data taken with X-ray source show very high stability and limited gain drop at rates up to $\sim$100 MHz/cm^2.

3. – Next steps

The key aspect of future developments is the possibility to scale the detector to larger size: a prototype with embedded electronics is under construction.

Further studies concern testing other readout configurations and resistivity values/layout. Background particle fluences are being revised for the large-η muon tagger. Ongoing simulation studies aim to implement a realistic description of the detector, along with the expected background hits at HL-LHC in order to evaluate efficiencies and fake rates.

* * *

The author acknowledges the RD51 Collaboration and the CERN MPT Workshop.

REFERENCES

[1] ATLAS Collaboration, *ATLAS Phase-II Upgrade Scoping Document*, CERN-LHCC-2015-020 (2015).
[2] Alviggi M. *et al.*, *JINST*, **12** (2017) C03077.