Performance Studies of a MicroMeGas Chamber in the ATLAS Environment

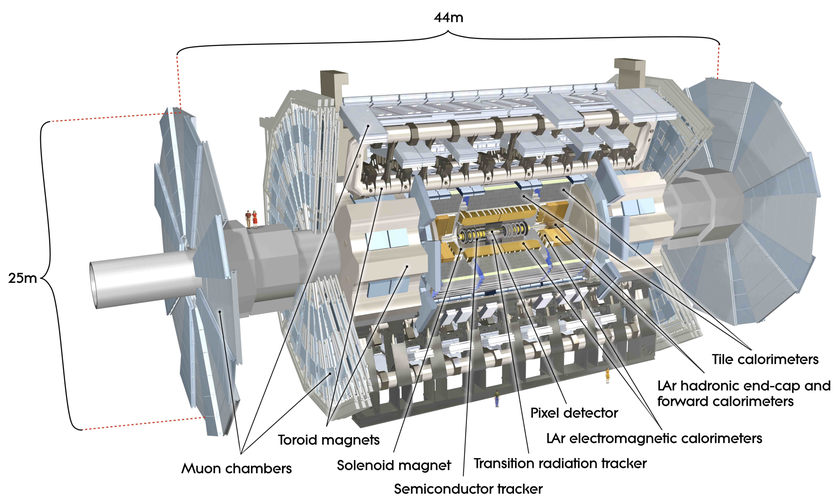
Y. Kataoka[1], S. Leontsinis[2,3], K. Ntekas[2]

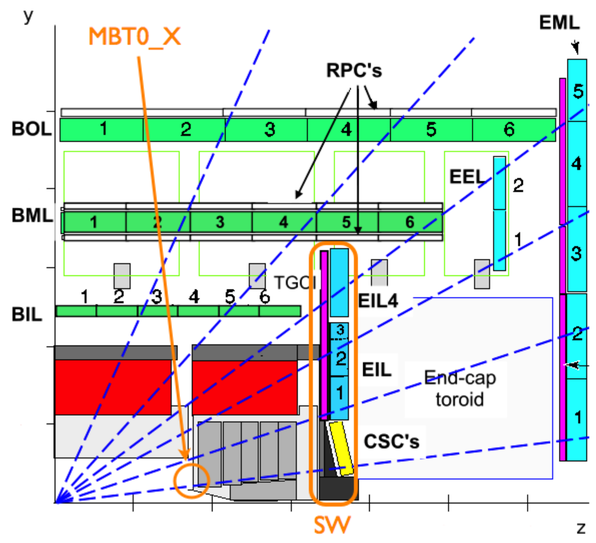
on behalf ot the MAMMA collaboration

[1]University of Tokyo, [2]National Technical University of Athens, [3]Brookhaven National Laboratory

Introduction

In order to test the micromegas detectors under realistic LHC conditions six small resistive micromegas chambers were installed in the ATLAS detector in February 2012. Two of the chambers (named MBT03 and MBT04) were installed in the high-rate environment in front of the electromagnetic end-cap calorimeter, $3.5\,\mathrm{m}$ from the interaction point in the z direction, at a radius of $r \sim 1\,\mathrm{m}$. The other four chambers were installed on the Small Wheel (SW) at $1.8\,\mathrm{m}$ distance from the beam pipe. All the chambers were read out using a random trigger ($\sim 62\,\mathrm{Hz}$) with $25\,\mathrm{ns} \times 21$ time bins.



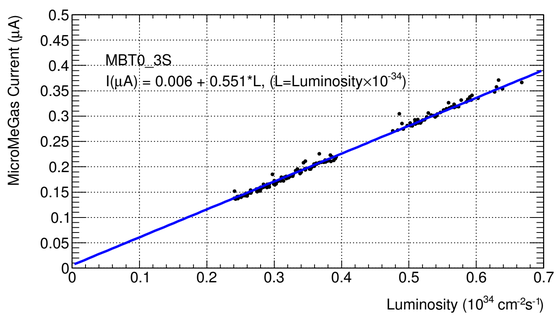


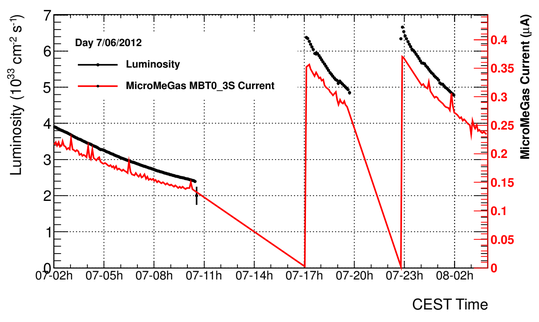
Chamber Specifications

	MBT chambers	R chambers
active area (cm^2)	9×4.5	10×10
drift gap (mm)	4.5	5
gas mixture	$\mathrm{Ar} : \mathrm{CO_2} - 93 : 7$	
readout strips	x, v ($\theta_{(x,v)} = 30°$)	x, y
pitch (mm)	x 0.5 / v 1.0	x 0.25 / y 0.25
Resistivity	$35\,\mathrm{MOhm/cm}$	$100\,\mathrm{MOhm/cm}$
FE Electronics	APV25 Hybrids readout with SRS	
HV Supply	CAEN A1821 (2 nA Resolution /20 nA $\mathrm{I_{set}}$)	

Current vs Luminosity

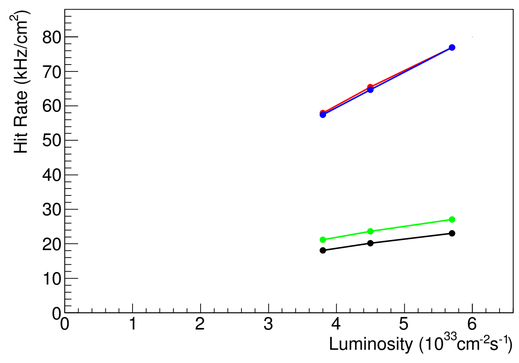
Using the PVSS, the instantaneous current of the chambers was monitored with an uncertainty limited by the hardware specifications and the user settings. The plots below show an example of the current of the MBT03 chamber recorded during three short fills on 7 June 2012. The micromegas current follows nicely the ATLAS luminosity measurement as shown in the right plot. In the left plot, the MBT03 current is plotted against the ATLAS luminosity for the three short fills. The data points are well fitted with a linear slope of $0.55\,\mu\mathrm{A}/10^{34}\,\mathrm{cm}^{-2}\mathrm{s}^{-1}$, indicating a stable response of the detectors up to $\sim 100\,\mathrm{kHz/cm}^2$ rate (at $\mathcal{L} = 7\times10^{33}\,\mathrm{cm}^{-2}\mathrm{s}^{-1}$).

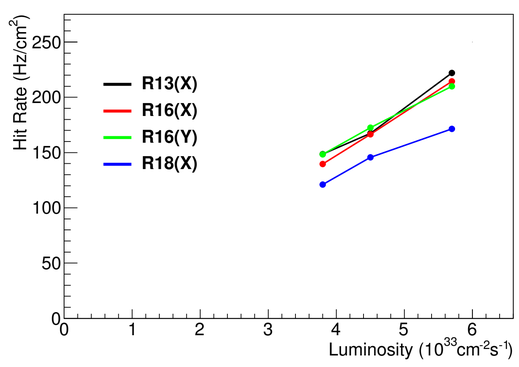




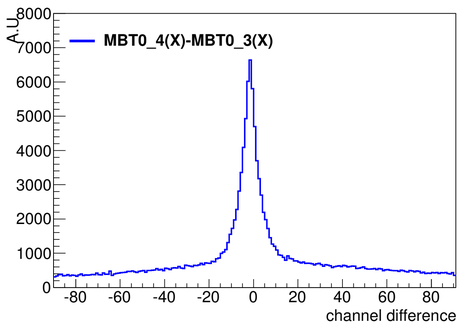
Hit Rate vs Luminosity

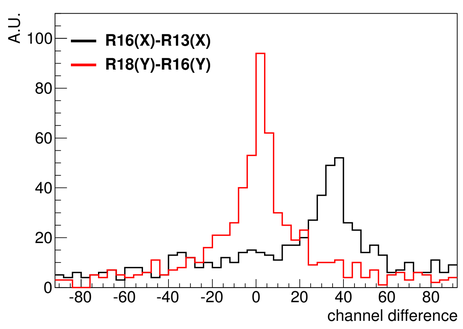
The figures below show the hit rates, in $\#\mathrm{clusters\,cm}^{-2}/\mathrm{s}$ versus luminosity for each chamber at LHC fill 2891. The hit rates of SW chambers are about $40\,\mathrm{Hz\,cm}^{-2}\,\mathrm{s}^{-1}$ per $\mathcal{L} = 10^{33}\,\mathrm{cm}^{-2}\,\mathrm{s}^{-1}$ (currently $38\,\mathrm{Hz\,cm}^{-2}\,\mathrm{s}^{-1}$ for CSC chambers) and almost proportional to the luminosity. For the MBT0 chambers is about $15\,\mathrm{kHz\,cm}^{-2}\,\mathrm{s}^{-1}$ per $\mathcal{L} = 10^{33}\,\mathrm{cm}^{-2}\,\mathrm{s}^{-1}$ and the extremely high hit rates deform the linearity a bit because the two hits are sometimes not separated in the clusterization. The v strips in MBT0 chambers, inclined by $30°$ to the resistive strips, show relatively low rates due to the wider clusters and shorter strips in some region.

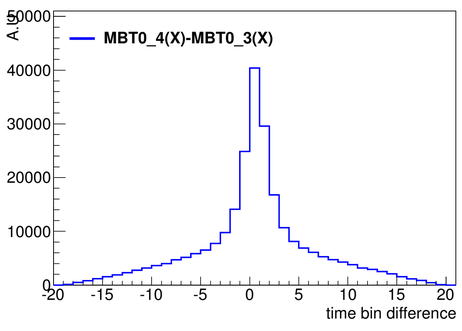


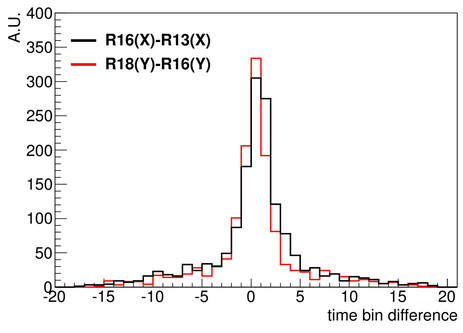


Track Identification





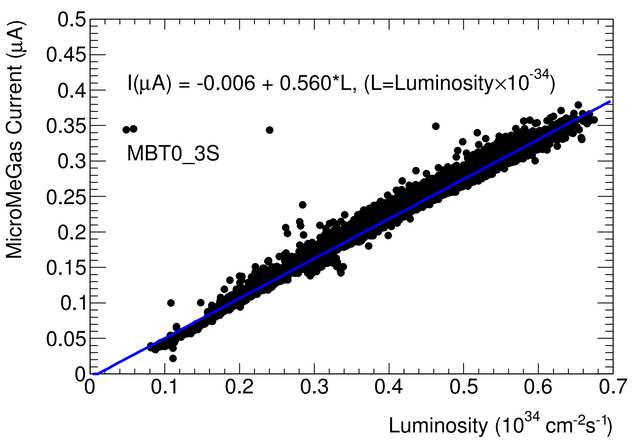




There are also correlated hits between chambers placed one after the other, which are considered as tracks passing through the chambers. These cases correspond to a 90% fraction of events in MBT0 chambers and about $10\% \sim 20\%$ in SW chambers. The rest are treated as isolated hits from neutrons or gammas. The figures illustrate the difference in position and time between two chambers, of the same area in the "real track events".

The strong correlation is evident in both time and position plots for the two different areas, although the position difference depends on incoming angle distribution especially when chambers have a large gap between them, as in the case of the SW chambers. The shift observed in the position difference for the x strips in SW chambers, in the order of 35 channels, corresponds to the polar angle from the interaction point. The long tails of MBT0 chambers come from combinatorial background due to the high rate.

Conclusions



Using the monitored current for the full 2012 run, together with the integrated LHC luminosity of $23.3\,\mathrm{fb}^{-1}$, we estimate the total charge accumulated by the MBT03 chamber during the 2012 run to add up to about $1.2\,\mathrm{C}$ or $0.03\,\mathrm{C/cm}^2$. This figure should be compared to the accumulated charge of $0.005\,\mathrm{C/cm}^2/\mathrm{year}$ that is expected in the micromegas operating at a gas gain of 10^4 at a rate of $10\,\mathrm{kHz/cm}^2$, the highest counting rate expected on SW. In other words, the one year long exposure of the MBT chambers located on the front face of the electromagnetic calorimeter is equivalent to six years of operating the micromegas on the New SW at $\mathcal{L} = 5 \times 10^{34}\,\mathrm{cm}^{-2}\mathrm{s}^{-1}$.

Concluding, the results presented do not indicate any ageing effects and are encouraging regarding the performance of the micromegas chamber in the ATLAS environment.

The present poster was co-funded by the European Union (European Social Fund ESF) and Greek national funds through the Operational Program "Education and Lifelong Learning" of the National Strategic Reference Framework (NSRF) 2007-1013. ARISTEIA-1893-ATLAS MICROMEGAS.

European Union European Social Fund · Operational Programme Education and Lifelong Learning · Investing in knowledge society · Ministry of Education & Religious Affairs, Culture & Sports · Managing Authority · NSRF 2007-2013 · European Social Fund

Co-financed by Greece and the European Union