Performance of the ALICE muon trigger system after the first year of data taking

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1 ALICE and the muon trigger

ALICE (A Large Ion Collider Experiment) is the LHC experiment dedicated to the study of heavy-ion collisions at very high energy density, where the formation of the Quark Gluon Plasma (a non-ordinary state of matter where quarks and gluons are deconfined) is expected. Starting from March 2010, the experiment collected data in pp collisions at $\sqrt{s} = 7$ TeV (7 months) and Pb–Pb collisions at $\sqrt{s_{\rm NN}} = 2.76$ TeV (1 month).

ALICE is composed by a central barrel, a set of forward detectors and a muon spectrometer.

Heavy flavor production is one of the key observables for the study of QGP: the goal of the muon spectrometer ($-4 \leqslant \eta \leqslant -2.5$) is the detection of J/$\psi$, Υ and open heavy flavors via their muonic decays. It is composed by an absorber, a muon tracking system, a magnetic dipole, a muon filter and a trigger system needed to reduce the background of the low-$p_{\rm T}$ muons coming from π and K decays.

The muon trigger system is composed by 4 planes of 18 resistive plate chambers (RPC) each. The RPC gas mixture is optimized for working in a highly saturated avalanche condition by applying a high voltage of the order of 10 kV. The signal is picked-up inductively by means of orthogonal copper strips of different pitch sizes (1, 2 and 4 cm) which provide the spatial information used to estimate the $p_{\rm T}$ via the relative angle with respect to a straight track from the interaction point.

The first level of the muon trigger decision is performed by a set of 234 electronics boards, called *local boards*. Single and dimuon trigger signals with two different $p_{\rm T}$ cuts are delivered.

2 Efficiency

Due to the redundancy of the trigger algorithm, which requires three planes out of four to be hit, the RPC efficiency can be computed from the ratio of 4/4 to 3/4 coincidences.

The efficiency is systematically monitored for checking the stability of the system: a mean value above 0.95 is mandatory for a good functioning of the whole apparatus.

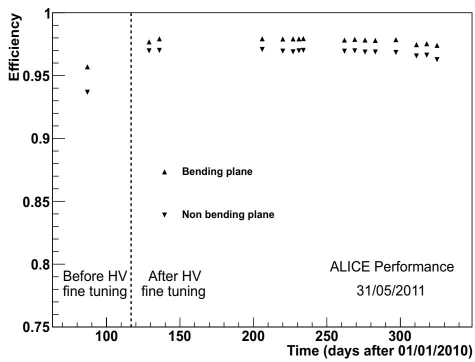

Figure 1: Efficiency of the muon trigger in 2010 for bending and non-bending planes.

A fine tuning of high voltages and discrimination thresholds was completed in May 2010: since then, the trend of the efficiency as a function of the time elapsed from the beginning of the collisions is flat and the average efficiency is about 97%.

There is a systematic difference between bending and non-bending plane of the order of $1 \div 2\%$: it can be explained with the different strip size and the different characteristic impedance of the x-strips with respect the y-strips. This feature does not affect the behavior of the apparatus.

3 Dark current

Dark current, measured in absence of collisions at nominal high voltage, is another important parameter for follow-up of stability of the detector performance.

This current circulates through the resistive electrodes when they are not well insulated from each other or through the external structure. Long term operation or an excessive high voltage could promote a relevant dark current value as well as imperfections on the internal electrodes surfaces. To prevent an early detector ageing, dark current value should be frequently monitored and kept as low as possible.

During 2010 a modest current increase has been observed (from 0.7 μA to 1.1 μA), but after the winter technical stop the average dark current returned to the original values.

4 Dark rate

Dark rate is the number of signals delivered by the front-end electronics (hence, above the front-end thresholds) per unit of time and surface. It is always measured in absence of collisions when the RPC are at nominal voltage: upon occurrence of a dedicated software trigger, the information of the scalers which count the signal of each RPC strip is readout. The dark rate is used to quantify the RPC intrinsic noise.

Imperfections in the electrodes inner surfaces are the usual source of noise in RPC; malfunctions in the electronics can also be an artificial source of dark rate.

During 2010, the average dark rate was 0.03 Hz/cm^2 with discrimination thresholds of 10 mV and 0.05 Hz/cm^2 after decreasing the threshold down to 7 mV.

5 Cluster size

Cluster size is the average number of adjacent strips on which a signal above the discrimination threshold is induced when a particle crosses the detector. Cluster size is measured separately for the three strip pitches: the average values are 1.2, 1.5 and 2 for strips with pitch 4, 2, and 1 cm respectively, at nominal running high voltage.

No significant difference was found between the cluster size values measured in pp and Pb-Pb collisions. This is a further evidence of the stability of the muon trigger system during the first year of data taking.

6 Conclusions

It is possible to conclude that during the first year of data taking, the muon trigger system had a stable behavior within design specifications. Also thanks to these good performance, the muon spectrometer recorded in 2010 more than 120M of single muons events.