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

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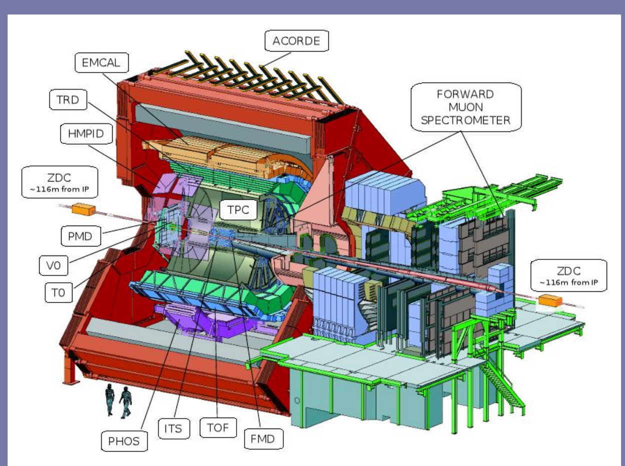
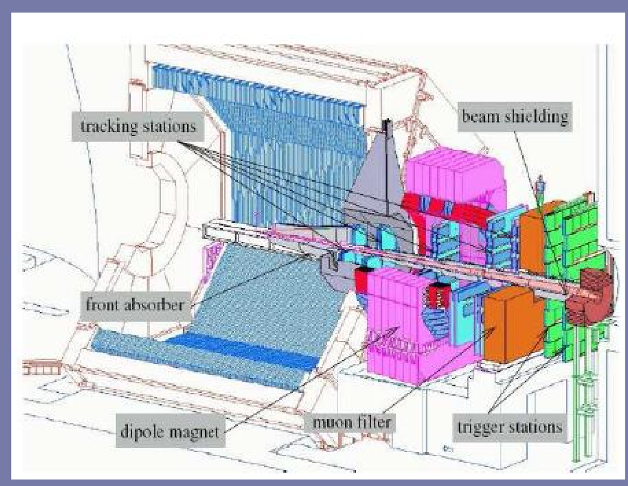
ALICE and the muon spectrometer

ALICE is the LHC experiment dedicated to the study of QGP: a non-ordinary state of the matter where quarks and gluons are deconfined. Starting from March 2010, it collected data in pp collisions at $\sqrt{s} = 7$ TeV and Pb–Pb collisions at $\sqrt{s_{\rm NN}} = 2.76$ TeV (for 1 month). ALICE is composed by a central barrel, a set of forward detectors and a muon spectrometer.

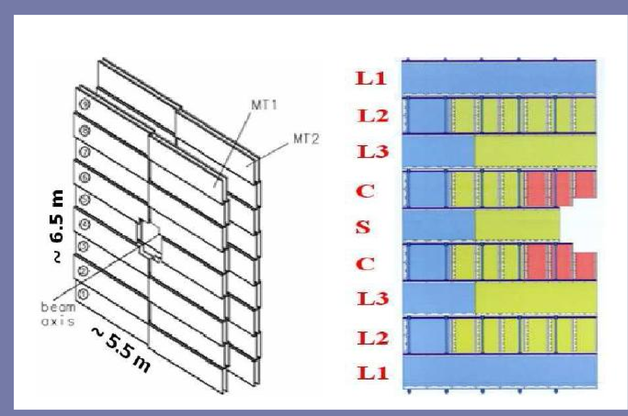


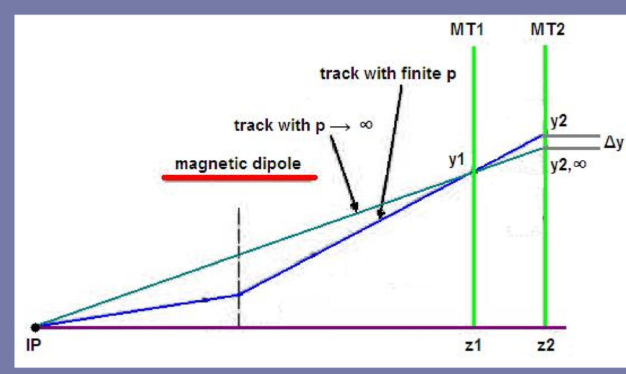


The goal of the muon spectrometer ($-4 \leqslant \eta \leqslant -2.5$) is the detection of quarkonia (J/ψ and Υ) and heavy flavor via their muonic decays. It is formed by a muon tracking system and a trigger system needed to reduce the background of the low-$p_{\rm T}$ muons coming from π and K decays.

Muon trigger system

The muon trigger system is composed by 4 planes of 18 resistive plate chambers (RPC) each. RPC are planar gaseous detectors with resistive electrodes. 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. The internal gap is filled by a gas mixture optimized for working in a highly saturated avalanche condition by applying a high voltage of the order of 10 kV.

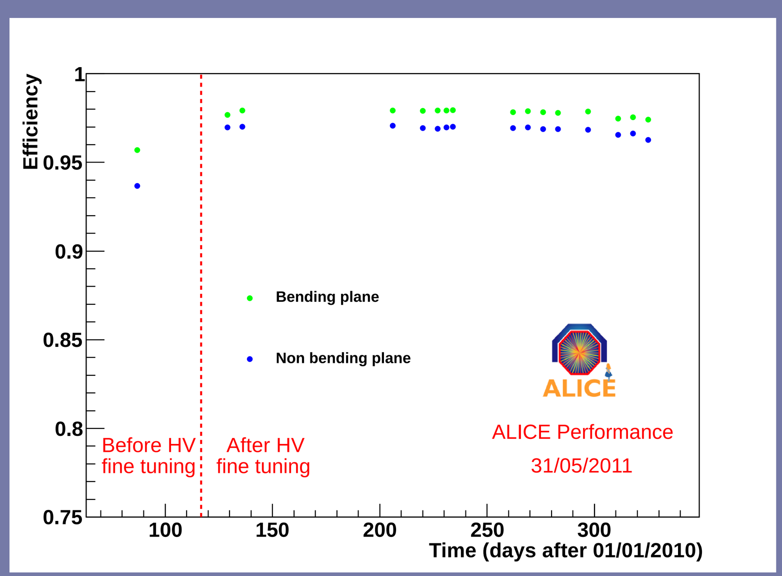




The spatial information of the four planes is used to estimate the $p_{\rm T}$ via the relative angle with respect to a straight track from the interaction point. Single and dimuon trigger signals with two different $p_{\rm T}$ cuts are delivered.

Efficiency vs time

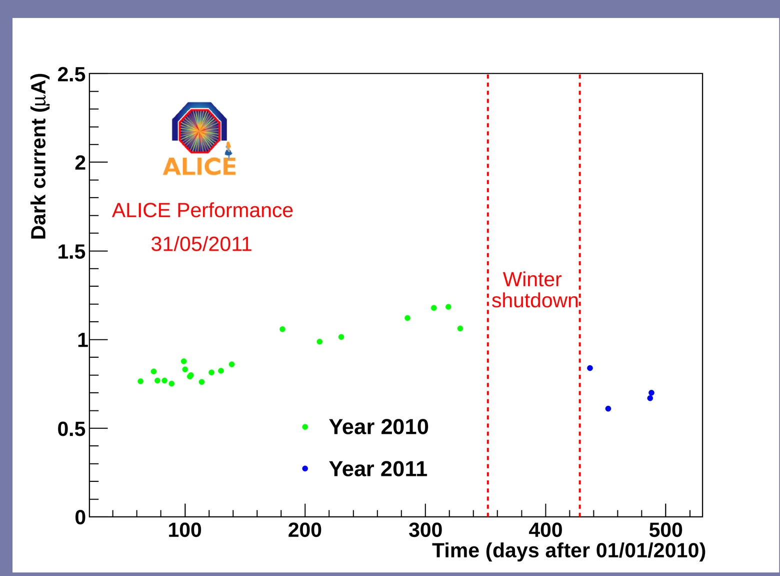
The efficiency is defined as the number of times the chambers of each plane give a signal divided by the times a muon (triggered by the other three planes) crosses the plane. A mean value above 0.95 is mandatory for a good functioning of the whole apparatus.



After the fine tuning of the 72 high voltages, the trend of the efficiency for the third plane as a function of the days is flat and always above 97%. The systematic difference between bending and non-bending plane is related to the different strip sizes with different characteristic impedance.

Dark current vs time

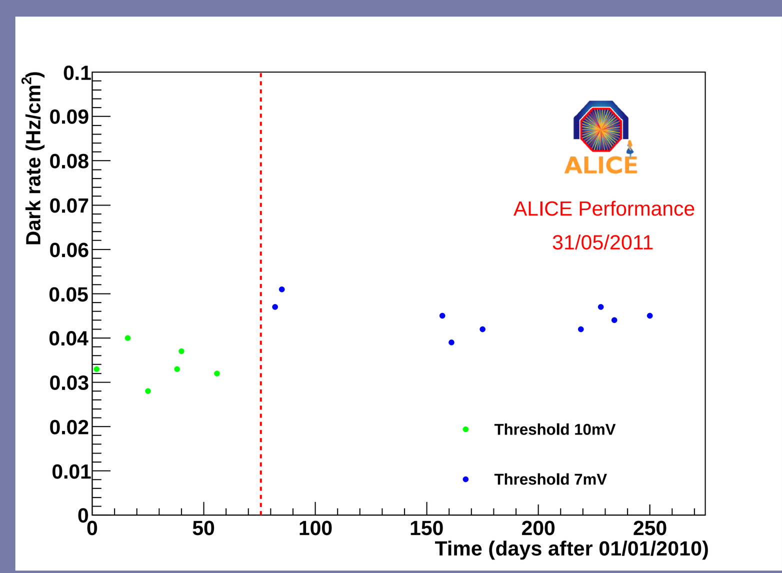
Dark current, measured in absence of collisions with nominal high voltage on, is an important parameter for the stability of the detector performance. The plot below shows the time trend of the average RPC current.



Despite a modest current increase during the 2010 run, it is possible to see that after the winter technical stop the average dark current returns to the original values.

Dark rate vs time

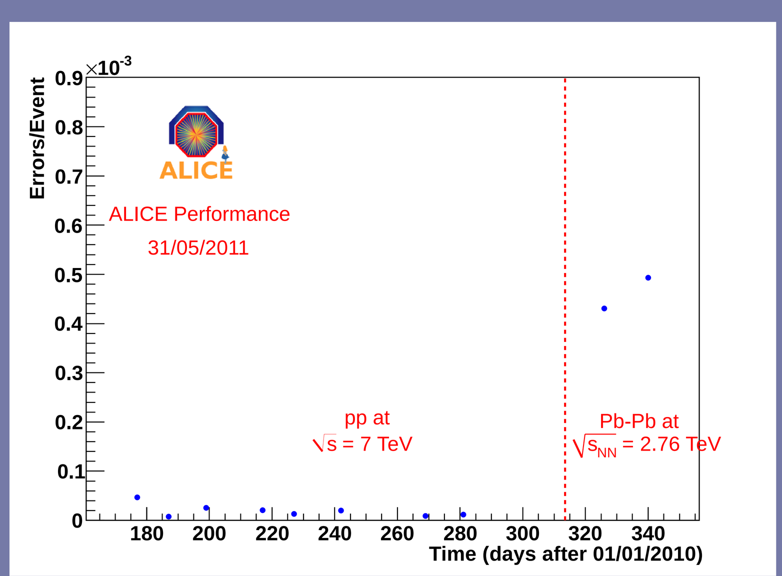
Dark rate is defined as the rate of signals delivered by the front-end electronics in absence of collisions. Imperfections in the electrodes inner surfaces are the usual source of noise in RPC; malfunctions in the electronics can also be an artificial source of dark rate.



After the decrease of the discrimination thresholds, only a modest increase is seen in the rate, which always remains below 0.1 Hz/cm^2.

Algorithm errors vs time

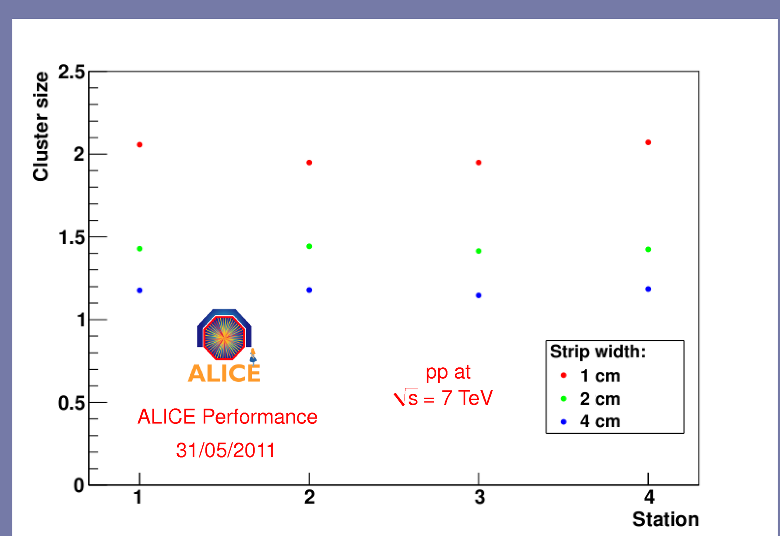
The number of trigger errors (the errors due to a wrong trigger algorithm decision) is an important quality parameter to monitor and to keep as low as possible.

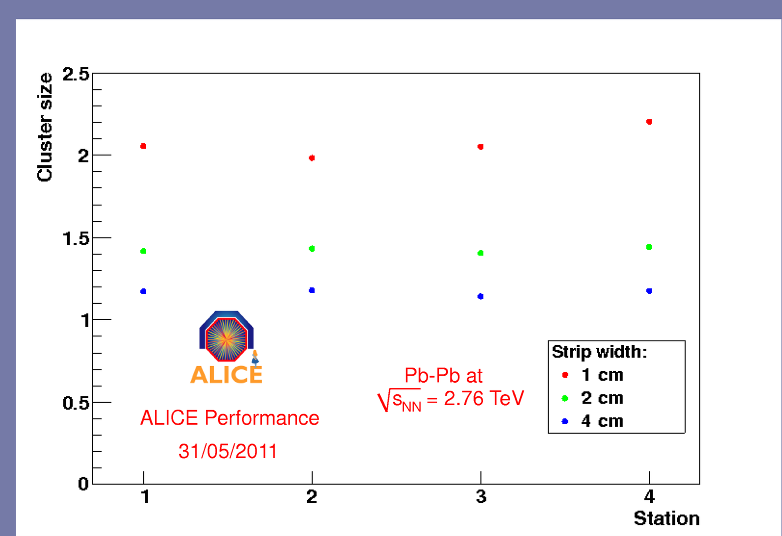


The higher number of muons produced in Pb–Pb collisions explains the increasing trend. Nevertheless, it is possible to see that the algorithm error is below 0.1% for both pp and Pb–Pb collisions.

Cluster size

Cluster size is the number of adjacent strips on which a signal above the discrimination threshold is induced when a particle crosses the detector. Since each plane contains three different segmentations it is necessary to take them into account during the analysis.





Depending on the pitch size, the average cluster size varies from 1.2 to 2.1 for the narrower strips. From pp to Pb–Pb collisions, no significant change in the values can be noticed. This confirms the stability of the muon trigger system during the first year of data taking.

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 and with trigger rates up to more than 1 kHz.