

Effects of electronic noise on the spectrometer performances

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Le but de cette étude est d'évaluer l'impact du bruit électronique observé sur les trois dernières stations du spectromètre sur les performance de ce dernier, et d'en extraire une limite supérieure acceptable.

The main objective of the muon spectrometer is to trigger and track muons to examine heavy flavour production via their muon decay channels. To separate different states of the Υ family an invariant mass resolution of about $100 \text{ MeV}/c^2$ is required. The equivalent spatial resolution is of the order of hundreds of μm in the tracking system bending plane and a few mm in the non bending one.

The chambers in the last 3 stations of the spectrometer present an anomalously high level of noise that will affect the performances of the detector. While we are working to track the origin of the noise and to reduce it, this study [1] has been carried out to evaluate its real impact on the spectrometer performances and determine the maximum level of noise that is acceptable from the physics point of view.

The project is carried out with the ALICE software "AliRoot", by simulating and reconstructing 5000 Υ with different level of uniform noise. The noise is applied channel by channel on the last 3 stations of the spectrometer during the simulation process by adding a randomly generated charge to the measured one. For the first 2 stations, the noise is fixed to 2 ADC which is the averaged value observed during the last cosmic runs. A dispersion of the electronic gain fixed to 10% (which is realistic according to the electronic tests performed so far) is also applied to each channel on the 5 stations at the beginning of the simulation. Another part of this project [1], not describe in this report, have shown that the gain dispersion has a relatively small effect on the spectrometer performances compared to the effect of the noise (bending resolution multiplied by 2, $+10 \text{ MeV}/c^2$ on the Υ mass resolution and no loss of reconstruction efficiency). The reconstruction parameters are

set in such a way that even the worst reconstructed cluster can still be taken into account when reconstructing the muon tracks, thus maximizing the tracking efficiency and making it independent of the level of noise. The drawback is the formation of fake tracks (random association of clusters), which are discarded by requiring the matching with the tracks reconstructed in the trigger chambers. The spectrometer performances are characterized by the chamber resolution (i.e. the resolution of the reconstructed clusters determined by the dispersion of the residuals between them and the track they belong to) and by the reconstruction efficiency and accuracy of Υ .

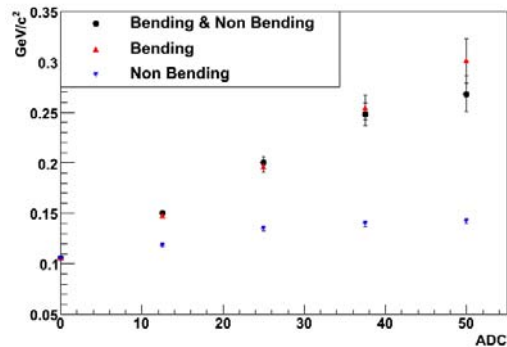


Fig. 1 : Υ mass resolution as a function of the electronic noise on bending (red) or non bending (blue) plane, and on both (black).

Five different levels of noise have been tested: 0, 12.5, 25, 37.5 and 50 ADC. The chamber resolution increases by a factor 2 in the non bending plane and by a factor 7 in the bending one when increasing the noise from 0 to 50

ADC, reaching 700 μm in the bending plane. At the same time, the Υ mass resolution goes from 100 to 300 MeV/c^2 while the reconstruction efficiency drops from 92 to 40 %, as shown by the black points on figures 1 and 2 respectively. Further studies have shown that this loss of efficiency is independent of the transverse momentum and the rapidity of muons.

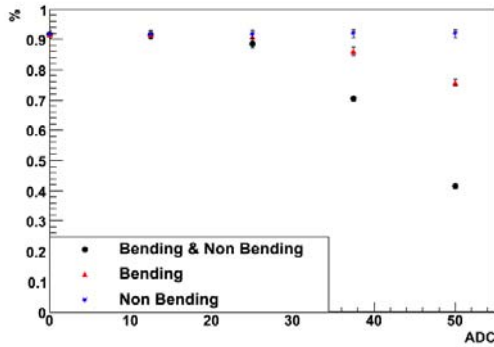


Fig. 2 : Reconstruction efficiency as a function of the electronic noise on bending (red) or non bending (blue) plane, and on both (black).

The two cathodes of the tracking chambers give information preferentially in either the bending or the non bending direction. The noise is then expected to have a different impact on the spectrometer performances depending on the affected cathode. Since the level of noise measured on both cathodes is different, the simulations have been performed again by applying the noise on one cathode at a time. The noise on the other cathode is fixed to 2 ADC like for stations 1 and 2. The effects observed on the reconstructed Υ will allow to extract a maximum acceptable value of noise on both cathodes separately.

Results presented on figures 1 and 2 clearly show that the detector performances are much more sensitive to the noise in the bending plane (red points) than in the non bending one (blue points). In the second case, the mass resolution increase to 140 MeV/c^2 and the efficiency is not affected. When the noise is on the bending plane, the mass resolution increase to 300 MeV/c^2 and the efficiency drops to 75%. We can also note that the combined effect of the noise on both cathodes has a dramatic effect on the reconstruction efficiency, while the mass resolution is more or less determined by the resolution in the bending plane only.

From these results, we can fix the maximum acceptable level of noise to about 5 ADC in the bending plane and about 20 ADC in the non bending one. Recent works done to reduce the electronic noise have revealed a problem of stability in the low voltage power supplies. This problem has been fixed and the level of noise observed is of the order of the limitation determined by this study. Under these conditions, all the physics studies foreseen with the MUON spectrometer are achievable.

Un des principaux objectifs du spectromètre est d'étudier la production des résonances de quarks lourds via leur canal de désintégration en deux muons. Une résolution en masse invariante de l'ordre de 100 MeV/c^2 est nécessaire pour identifier les paires de muons provenant des particules de la famille de l' Υ , ce qui correspond à une résolution spatiale du spectromètre de l'ordre de la centaine de microns dans la direction de courbure des traces et de l'ordre du millimètre dans la direction perpendiculaire.

Certaines des chambres de trajectographie du spectromètre présentent un bruit électronique anormalement élevé qui va affecter ses performances. Tandis que l'on travail à identifier l'origine de ce bruit et à le réduire, cette étude à été menée afin de déterminer l'impact exacte de celui-ci pour en extraire une limite supérieure acceptable du point de vue de la physique.

Les résultats montrent une grande sensibilité des performances lorsque le bruit est situé sur le plan de la chambre mesurant la position de la trace dans sa direction de courbure. Dans ce cas une limite d'environ 5 canaux ADC de bruit semble raisonnable, tandis qu'environ 20 canaux ADC reste acceptable sur l'autre plan.

Les derniers travaux effectués sur l'électronique des chambres, et notamment sur les générateurs de basse tension, ont permis de réduire le bruit au niveau des limites déterminées dans cette étude. Les performances attendues du spectromètre devraient donc être atteintes.

[1] C.Bianchin et al., « Effects of electronic noise on the spectrometer performances », To be published as an ALICE Internal Note