

Study of the background observed at PreSPEC *

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Introduction

The PreSPEC setup in combination with the relativistic rare isotope beams provided by the FRagment Separator (FRS) [1] provided unique opportunities for key nuclear structure studies on exotic nuclei. However, the large amount of background radiation co-produced is a great challenge for the data analysis process. Even after a detailed analysis and the application of strict conditions, a large component of the background can remain in the γ -ray energy spectra and often hamper the observation of the transition of interest. A dedicated analysis has been therefore performed in order to better disentangle the components of the background that affects γ -ray energy spectra and understand their nature and origin. Data of a PreSPEC experiment with the EUROBALL cluster array [2] have been used for the analysis reported here.

Analysis

The hits recorded in the cluster array were observed to be grouped in four energy ranges and to form four peaks in the time distribution. One time peak was composed by hits produced by the interaction of the beam in the target area (prompt γ -rays) and their energy values were in the expected range (i.e., for this data, from ~ 0.08 MeV to 6.8 MeV). A time peak preceding the prompt and two time peaks following it, instead, were formed by hits with energy values out of the standard range, which could be associated to a saturation of the front-end electronics. The relation between the time of the hits and the multiplicity of the hits per cluster and per event allowed to observe a peculiarity of the delayed hits: while the hits in the prompt time peak have mainly multiplicity one, the hits in the first delayed time peak have mostly multiplicity six (see Fig. 1).

This information, together with correlations with other observables as energy-loss, beam position at the target and distribution of the hits in the array, gave indications that the cluster array was hit by high-energy particles coming with the beam, which saturated the preamplifiers. Moreover, the deposition of very high energy provoked the alteration of the response of the other crystals in the same cluster and explains the detection of high multiplicity of energy signals. It can be noticed that the highest multiplicity value in Fig. 1 is six and not seven, which is the number of crystals in a cluster. This is due to the fact that the seventh hit was

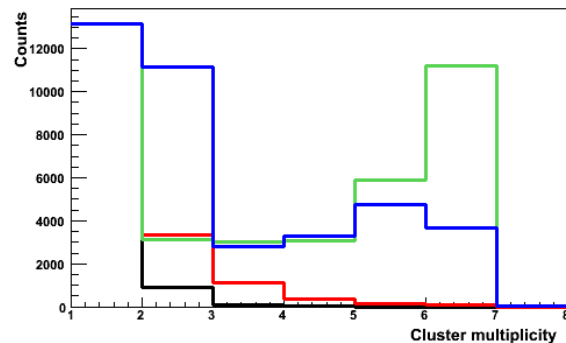


Figure 1: Cluster multiplicity of the hits according to different time ranges, normalized at the values for multiplicity one. No energy condition has been applied. For hits in the prompt time range (red line) and the one before the prompt (black line), the cluster multiplicity is mainly one. Hits in the first delayed peak (green line), in addition to the peak at multiplicity one, a peak at multiplicity six is also present. In the most delayed peaks (blue line), the cluster multiplicity is mainly one and two but higher multiplicities are also present in a considerable amount.

always recorded in the time range before the prompt.

Conclusion and Outlook

In addition to the known background radiation [3, 4], indications of high-energy particles interactions with the γ -ray spectrometer, provoking a loss of the detection efficiency and a worsening of the quality of the data, have been observed. The saturation of a full cluster was calculated to occur in more than 30% of the events. As these events are occurring mainly in the inner ring of the EUROBALL cluster array, which is also the ring with a better detection efficiency for the in-flight emitted γ rays¹, they can substantially reduce the detection efficiency of the array.

A continuation of the analysis using the tracking capabilities of AGATA [5] as well as other dedicated background measurements will further clarify the origin of this radiation and of other background components. However, from the new information obtained from this analysis on the background, several improvements of the setup can be suggested, in view of new challenging experiments in the future with HISPEC/DESPEC at the FAIR facility: implementation of high-energy thresholds for the hits in the γ -ray spectrometer, introduction of fast-reset modules in the

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front-end electronics and addition of a shield between the identification and tracking detectors and the target area.

References

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¹due to the Lorentz boost