NeuLAND test-beam data analysis with R3BRoot framework

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NeuLAND prototype

New Large Area Neutron Detector (NeuLAND) is a fully-active modular scintillator, which will be used in the future R3B experiment at FAIR for measurement of neutrons, stemming from the primary nuclear reaction in the target. In order to achieve good resolution of physics observables (such as the relative energy of neutrons and heavy fragment), one needs precise determination of neutrons momentum. On the detector level, this requires precise time and position measurement. A series of experiments was performed at GSI SIS18 by placing the full-size NeuLAND prototype in operation for the purpose of performance tests. In this report, we present the stages of reconstruction algorithms, developed within the R3BRoot framework, which allow to analyse the data from S438 experiment. We will focus on the detector channel mapping, time and position calibration and the velocity spectra of reconstructed hits.

Data analysis

The analysis of S438 experiment was performed by using the R3BRoot framework in the offline mode. Each reconstruction step was implemented as a task, derived from FairTask class. The parameters as the output of calibration tasks were stored in the local database using the functionality provided by FairRoot [1]. Functionality of the remote-event client, also presented in [2], was successfully tested directly during the run, and resulted in multiple corrections and improvements of the software.

Data unpacking and mapping

Experimental data come from the DAQ server (or local file) in the MBS format. Each sub-detector has a dedicated hexadecimal encoder, which stores the data in ROOT objects, supported by R3BRoot. Raw level hits with the values of hardware channels are mapped to the hits with real detector ID by applying cabling scheme.

Time calibration

Each detector module (scintillator bar) was calibrated separately. The distribution of time channels over the whole run data was converted into a time in nanoseconds, assuming that the width of such distribution corresponds to a full clock cycle and that the value of a channel growth linear.

Position calibration

Experimental run with cosmic particles was used for the position calibration of a module. First, the time difference between left and right photomultiplier was used to calculate the position along the bar. The distribution of coordinates per paddle was centered at zero and scaled to match with the length of the paddle (2.5 m). The same data set was used to synchronize time from the neighboring bars.
At this stage we have detector hits containing bar ID number, time and position along the bar.

Results

Figure 1 shows the hit velocity distribution. By applying a narrow cut around the beam velocity, one can effectively suppress low-energy gamma background in the energy deposit spectra.

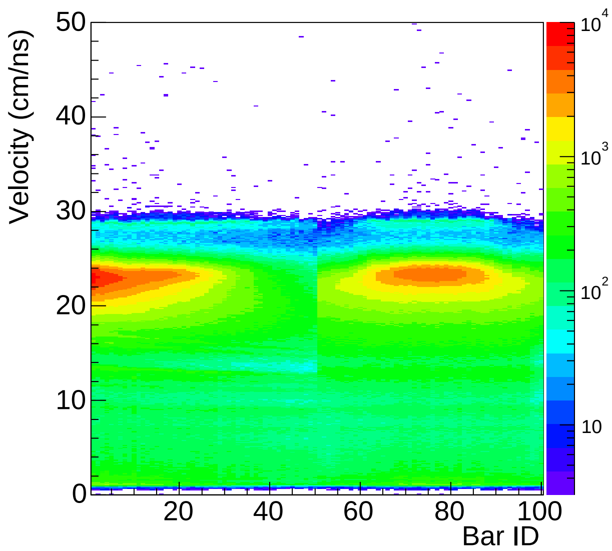

Figure 1: Distribution of the reconstructed velocity versus the detector number. First 50 bars - horizontal, second - vertical orientation. Contribution from gammas around 29 cm/ns is clearly separated from the neutron peak, which is located close to the beam velocity.

References

[1] M. Al-Turany et al., “Status of the FairRoot framework”, GSI Scientific Report 2013 (2014) 281

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