Recent Developments in NeuLAND Simulations

D. Kresan[1], *T. Aumann*[2], *K. Boretzky*[1], *D. Bertini*[1], *M. Heil*[1], *D. Rossi*[1], *and H. Simon*[1]
[1]GSI, Darmstadt, Germany; [2]TU, Darmstadt, Germany

The New Large Area Neutron Detector (NeuLAND) will be used in the R3B experiment at FAIR for high-precision multi-neutron recognition and measurement. It has a fully active large detector volume, constructed out of plastic crossed scintillator bars, read out from both ends with photomultipliers [1]. Detailed simulations of the performance in different measurement scenarios are strongly required. Such feasibility studies were done within the R3BRoot simulation and data analysis framework [2]. The description of the neutron tracking and reconstruction algorithm in NeuLAND can be found here [3].

Geometry interface

One of the major improvements in the R3BRoot framework is the support of flexible geometry description in the TGeo format (see ROOT home page for details [4]). This need is set by the large amount of the detector subsystems in R3B, each having several versions of geometry. This holds also for the LAND/ALADIN experiments.
Using this interface, provided by base classes of the FairRoot framework, one sets the geometry to be used in the simulation from the steering ROOT macro, which does not require recompilation of the code. In addition, it is also possible to describe the geometry of the complex detectors with very high granularity.

Improvements in multi-neutron tracking

The multi-neutron tracking in the NeuLAND consists out of two major steps: determination of the number of incident neutrons (based on the values of total energy deposit and number of clusters) and finding the first interaction of each incoming neutron.
As discussed in [3], very important step in the finding of neutrons first interaction is the elimination of secondary hits after the elastic scattering. This requires the measurement of the angle of the cluster, which becomes impossible if the cluster consists out of only one hit (fired bar). Thus, the clusters with the size smaller than 2 are skipped in the analysis of elastic scattering patterns. This modification results in the increase of the fraction of properly reconstructed tetra-neutrons from 58 to 63% (see Fig. 1).

Simulations for prototype test experiment

The first full-size NeuLAND prototype was tested in the deuteron beam in S406 experiment at GSI in October - November 2012. The goals of this beam time were to check the time resolution of the scintillator bars, compare total

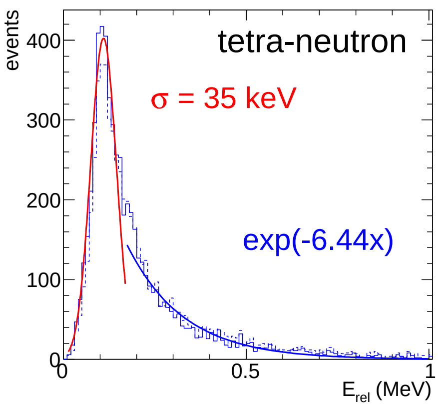

Figure 1: Simulated relative energy spectra of four-neutron events reconstruction at 600 AMeV beam energy. Dotted histogram - previous result, solid histogram - spectrum after improvement in the tracking algorithm. The absolute increase in the total efficiency of the order of 5% is observed. The fits with Gaussian and exponential tail are shown.

deposited energy versus simulation results and estimate the total neutron detection efficiency. The prototype was built out of 150 bars, organized in 15 planes, all in vertical direction.
Prior to the experiment, the required simulations were performed, including the calculations of:

- expected geometrical acceptance at different positions and beam energies;
- total neutron efficiency as a function of beam energy and detector thickness;
- trigger rate from the background (deuteron break-up in the start counter and beam straggling).

Analysis of the NeuLAND data from S406 experiment is ongoing and in future it should shed the light onto question of disagreement between total energy deposit when comparing Monte Carlo simulations versus real data.

References

[1] K. Boretzky et al., this report
[2] http://fairroot.gsi.de
[3] D. Kresan et al., GSI Scientific Report 2011, p. 175
[4] http://root.cern.ch