NeuLAND demonstrator performance in EOS experiments

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The NeuLAND demonstrator is a fraction of the neutron detector R^{3}B-NeuLAND[1)], which is being built at FAIR in Germany. Since the beginning of 2015, it has been used within the SAMURAI experimental setup at RIKEN. It consists of 400 plastic scintillator bars arranged in 8 planes with 50 bars oriented either horizontally or vertically. The size of each bar is $250\times250\times5$ cm^3 which makes the total depth of detector equal to 40 cm.

The detector is usually placed at 0° to the beam line downstream the SAMURAI magnet to detect neutrons from peripheral reactions of a radioactive beam particle on target, whereas charged particles are bent away. A VETO detector consisting of eight 1 cm thick plastic scintillator paddles is mounted in front of NeuLAND to reject background, mostly produced from charged particles in the charged fragment branch.

In the experiments S015 and S022 (April/May 2016)[2)] where the nuclear EOS was studied in central collisions of Sn isotopes, the detector was placed at an angle of 30° to the beam line. It was used to detect light hydrogen and helium ions together with neutrons and gammas. In these experiments, the VETO detector was necessary for the identification of all particles, not only for background rejection.

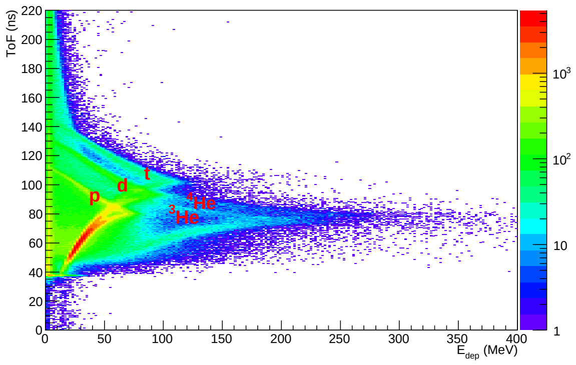

Fig. 1. Particle identification plot in the 1st plane.

For the first time, a considerable amount of light charged particles with a large range of energies was detected in the NeuLAND demonstrator. Figure 1 shows the Time-of-Flight vs deposited energy in the first plane of NeuLAND. The spectrum exhibits characteristic lines for the various charged particles, and protons, deuterons, tritons, ^{3}He, and ^{4}He are identified. For performance check, a strong VETO condition (reject events with valid VETO signal) is applied (Fig. 2). The charged particles are removed and only neutrons and gammas remain.

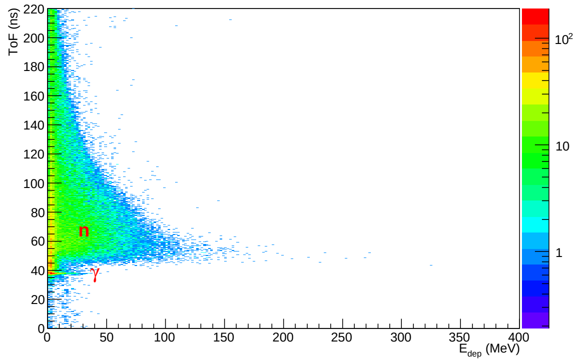

Fig. 2. Particle identification plot in the 1st plane with strong VETO condition.

A more elaborated VETO functionality is under investigation, including spatial correlation between hits in NeuLAND (x_N, y_N) and VETO (x_V, y_V) (Fig. 3), as well as timing correlations.

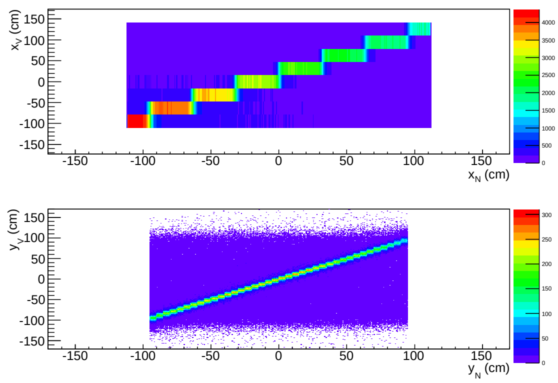

Fig. 3. Spatial corellation between hits in NeuLAND and VETO detectors.

The challenges in the analysis are the precision of the track determination and double hits in the VETO scintillators.

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References
1) http://www.fair-center.de/fileadmin/fair/experiments/NUSTAR/Pdf/TDRs/NeuLAND-TDR-Web.pdf.
2) R. Shane et al. Nucl. Instr. Meth. A **784**, (2015) 513.