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Simulation studies of a NeuLAND VETO wall

C. A. Douma[1], K. Boretzky[2], I. Gasparic[3], N. Kalantar-Nayestanaki[1], D. Kresan[2], J. Mayer[4], C. Rigollet[1], and the R^3B collaboration[2]*

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Simulation Procedure

Simulations were carried out to investigate a possible layout and need of a VETO detector in front of NeuLAND (New Large Area Neutron Detector) [1] in order to reduce the background from charged particles.

All simulations were performed with R^3BRoot [2] according to the multi-neutron simulation procedure [1, 3]. The Geant4 Monte Carlo engine was chosen to include nucleus-nucleus collisions (like the target reaction) [3]. The physics list was benchmarked against the S438 experiment [4] to provide a production ratio of charged and uncharged particles close to reality.

The full R^3B setup in cave C was simulated, including a simplified model of the scattering chamber behind the GLAD magnet. This model included all tracking detector materials and the 4 mm thick stainless steel neutron exit flange. The simulation geometry is displayed in figure 1. The source code is available upon request.

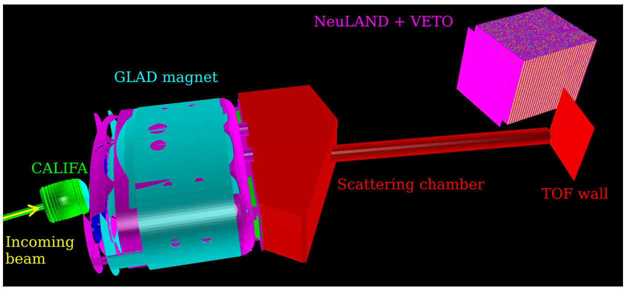

Figure 1: Simulated Geometry in R^3BRoot.

Several physics cases were investigated: a 1 GeV/u ^{208}Pb on a 500 mg/cm^2 lead target and a 600 MeV/u ^{48}Ca-beam on a 1.0 g/cm^2 carbon target and on a 2.2 g/cm^2 lead target. Results were evaluated by counting the number of successful events: events where the neutron multiplicity was correctly determined and all neutron interactions were correctly reconstructed and identified properly.

Design of the VETO wall

The VETO wall in the simulation was designed as a 250 cm × 250 cm wall of 16 distinct non-overlapping scintillators constructed from the same materials as NeuLAND [1] with 1.1 cm active scintillation crystal thickness, a time resolution below 300 ps and an energy deposition threshold below 1 MeV. This wall should be placed 30 cm in front of NeuLAND. Charged particles can then be eliminated by removing one neutron interaction point for each VETO signal. Our simulations show that this is the optimal design for the geometry and the position of the VETO detector.

Time Cuts

The background in NeuLAND originates from secondary scattering of projectiles (fragments) in the downstream detectors of the R3B setup. The neutron background was more than 50% higher than the charged background. To eliminate this neutron background, time cuts were applied on the raw data. This reduced the neutron background with a factor of 3.7 and the charged particle background with a factor of 5.7 while only 4% of the neutrons stemming from reactions in the target were lost. As a result, the number of successful events increased by 5%-25% (depending on neutron multiplicity). However, these time cuts influence the calorimetric properties of NeuLAND. This problem was solved by adjusting the neutron separation matrix accordingly [1].

VETO results

Our simulations show that about 1% of the target neutrons were eliminated by the VETO, while 46%-73% (depending on neutron multiplicity) of the contaminated events were turned into successful events. Due to the low number of charged background particles, this resulted in a small decrease in the total number of successful events in the configuration where the scattering chamber and the fragment arm are under vacuum making the VETO detector not very useful

However, with air in the scattering chamber, our ^{208}Pb physics case showed a significant increase in signal-to-noise ratio when using the VETO.

References

[1] The R^3B collaboration 2011 *Technical Design Report of NeuLAND* `http://www.fair-center.eu/fileadmin/fair/publications_exp/NeuLAND-TDR-Web.pdf`

[2] D. Bertini 2011 *J. Phys.: Conf. Series* **331** 032036 (2013) 56

[3] D. Kresan *R^3BRoot* `http://r3broot.gsi.de/`

[4] K. Boretzky *et al.* 2015 *NeuLAND - from double-planes to the demonstrator* GSI Report vol. 2015-1 MU-NUSTAR-NR-12

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