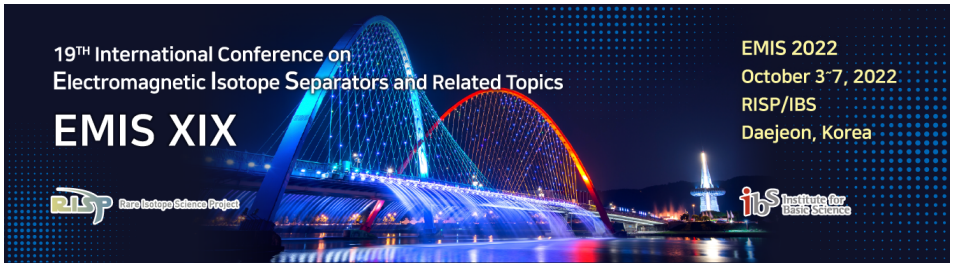

Contribution ID: **100** Type: **Poster Session**

Simulation and Determination of the absolute neutron detection efficiency in large neutron detectors

Tuesday, 4 October 2022 20:24 (8 minutes)

While neutrons emitted in intermediate heavy-ion collisions are essential to understand the properties of the strongly interacting baryonic matter, detection of neutrons and simulations of neutron detector performance and efficiencies are difficult. We have developed a SCINFUL-GEANT4 based on the reaction channels and cross-sections in the SCINFUL-QMD simulation code [1] which has a fixed cylindrical detector backed by one photo-multiplier. The fixed geometry in SCINFUL-QMD limits its use to non-cylindrical shaped detectors especially detectors with two or more photo-multipliers. By implementing the GEANT4 toolkit into SCINFUL-GEANT4, the new code can be applied to a variety of the detector geometries, including the Large Area Neutron Array (LANA) in and the Facility for the Rare Isotope Beams (FRIB), U.S.A. used to measure neutron emitted in heavy ion collisions. LANA consists of two walls. Each 2x2 m^2 wall has 25 rectangular pyrex bars stacked on top of each other. Each bar is a 2 meter long with a cross-sectional area of 7.62x6.35 cm^2 filled with NE-213 liquid scintillator. The Pyrex is 3 mm thick.
LANA has been used successfully in several heavy ion experiments at the National Superconducting Cyclotron Laboratory (NSCL) that measured both neutrons and charged particles in an effort to understand the symmetry energy term in the nuclear equation of state. Neutron spectra have been generated from the collisions of ^{40,48}Ca beams on ^{58,64}Ni and ^{112,124}Sn targets. To understand the properties of nuclear forces that depend on neutron-to-proton imbalance, the proton and neutron spectra obtained from reactions formed by different combinations of the projectile and targets will be compared. While proton detection with Si detectors is near 100% efficient, neutron detection is often less than 10% and requires accurate detection efficiency corrections. Comparison of the simulation results from SCINFUL-GEANT4 to the NSCL data including closure tests to verify our estimation about the neutron detection efficiencies of LANA will be discussed at the presentation.
This work was supported by the National Research Foundation of Korea under grant Nos. 2018R1A5A1025563 and 2013M7A1A1075764 and the U.S. Department of Energy, DE-NA0003908.

[1] Daiki SATOH, Tatsuhiko SATO, Akira ENDO, Yasuhiro YAMAGUCHI, Masashi TAKADA & Kenji ISHIBASHI(2006) Measurement of Response Functions of a Liquid Organic Scintillator for Neutrons up to 800 MeV, Journal of Nuclear Science and Technology, 43:7, 714-719, DOI: 10.1080/18811248.2006.9711153

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Session Classification: Poster Session