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Neutron energy spectrum from 120 GeV protons on a thick copper target

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Neutron energy spectrum from 120 GeV protons on a thick copper target was measured at the Meson Test Beam Facility (MTBF) at Fermi National Accelerator Laboratory (FNAL), USA. The data allows for evaluation of neutron production process implemented in theoretical simulation codes. It also helps exploring the reasons for some disagreement between calculation results and shielding benchmark data taken at high energy accelerator facilities, since it is evaluated separately from neutron transport.
The experiment was carried out using a 120 GeV proton beam of 3E5 protons/spill. Since the spill duration was 4 seconds, proton-induced events were counted pulse by pulse. The intensity was maintained using diffusers and collimators installed in the beam line to MTBF. The protons hit a copper block target the size of which is 5cm x 5cm x 60 cm long. The neutrons produced in the target were measured using NE213 liquid scintillator detectors, placed 5 m away from the target, at 30 and 90 degrees with respect to the proton beam axis. The neutron energy was determined by time-of-flight technique using timing difference between the NE213 and a plastic scintillator located just before the target. A detection efficiency of NE213 was determined on basis of experimental data from the high energy neutron beam line at Los Alamos National Laboratory, USA. The neutron spectrum was compared with the results of multi-particle transport codes, PHITS and MARS, to validate the implemented theoretical models. The apparatus would be applied to future measurements to obtain a systematic data set for secondary particle production on various target materials.

Primary author: Dr SHIGYO, Nobuhiro (Kyushu university)

Co-authors: Dr LEVELING, Anthony (FNAL); Dr MEYHOEFER, Aria (FNAL); Dr BOEHNLEIN, David (FNAL); Dr JENSEN, Doug (FNAL); Dr LEE, Hee-Seock (PAL); Dr YASHIMA, Hiroshi (Kyoto university); Dr VAZILI, Kamran (FNAL); Dr SAITO, Kiwamu (KEK); Dr HAGIWARA, Masayuki (KEK); Dr HIROSHI, Nakashima (JAEA); Dr MOKHOV, Nikolai (FNAL); Dr ERIK, Ramberg (FNAL); Dr COLEMAN, Richard (FNAL); Dr YUKIO, Sakamoto (JAEA); Dr SANAMI, Toshiya (KEK); Mr KAJIMOTO, Tsuyoshi (Kyushu university); Dr KASUGAI, Yoshimi (JAEA); Mr IWAMOTO, Yosuke (JAEA)

Presenter: Dr SHIGYO, Nobuhiro (Kyushu university)

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