CHARACTERIZATION OF THE FOOT NEUTRON DETECTORS FOR NUCLEAR FRAGMENTATION MEASUREMENTS AT THE n_TOF FACILITY

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FOOT (FragmentatiOn Of Target) is an applied nuclear physics experiment with the aim of performing high precision cross section measurements for fragmentation reactions of interest in hadrontherapy and radiation protection in space. An in-depth knowledge of the physical and biological effects caused by nuclear fragments is in fact of great interest for both the improvement of hadrontherapy treatment planning and the development of effective spacecraft shielding systems in long-term human missions in deep space (e.g. Mars explorations). However, the data needed to accurately model the behavior of nuclear fragments in these fields are currently scarce or totally unavailable in literature. This is particularly true for what concerns the production of secondary neutrons, whose impact is very difficult to evaluate in radiation risk assessment studies.

To fill in the gaps in nuclear databases, the FOOT collaboration will perform a set of measurements with light ion beams, such as C and O, in the energy range of 100-800 MeV/n interacting with tissue-like and shielding material targets. The FOOT experiment allows for a precise identification of the produced nuclear fragments through the measurement of their kinematic characteristics. The setup was initially conceived for the detection of charged fragments but, in 2021, the Collaboration started the study of possible solutions for neutron detection.

Two detection systems have been proposed as potential upgrades of the FOOT setup: on the one hand, a system based on BC-501A liquid scintillators with neutron/γ discrimination capabilities, which could be added to the current FOOT setup; on the other hand, a system based on BGO crystals operated in phoswich mode, which could potentially represent a future upgrade of the existing FOOT calorimeter.

In 2022, a dedicated data acquisition campaign was carried out at the n_TOF facility at CERN to accurately evaluate the capabilities of the two systems. First, the neutron/γ discrimination efficiency of the BC-501A system was studied using radioactive sources. Then, the two systems were placed in the n_TOF experimental area to study their neutron detection efficiency under a well characterized neutron beam. The n_TOF facility is particularly suitable for this measurement since it can provide a neutron beam with an energy spectrum that spans up to 1 GeV.

In this contribution, after an overview of the current status of the FOOT experiment, the first results concerning the characterization of the two possible neutron detectors are presented.