Neutron Flux Determination for NEAR Station at the CERN n_TOF Facility Using the SAND II Unfolding Code

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After the second CERN long shutdown for upgrade purposes, a new experimental area at the n_ToF facility has been installed to investigate material radiation strength and reactions relevant to Nuclear Astrophysics by irradiation and activation of short-lived radioactive isotopes or small mass materials. Unlike the experimental areas EAR1 and EAR2, located at ~185m and ~20m, respectively from the lead spallation target, the new experimental area, called "NEAR station", is only 3 meters away and thus exploits the high neutron flux that the facility provides from the thermal region to few GeV neutron energy. With this intense flux level and short flight path, none of the time-of-flight active detectors can provide the area with the required neutron energy resolution and in that case a multi foil neutron activation technique was much more suitable for the characterization of the neutron beam.

Following the foil irradiation that has been performed from the 28th of September until the 20th of October 2021 and the data analysis, the unfolding SAND II code was necessary to determine the neutron flux specifically from 10^{-10} to 18MeV energy range. The code uses the experimental measured reaction's saturated activities from the irradiated foils, giving us the information we need for spectrum characterization within the energy range of each threshold and capture reaction. In addition, an accurate group cross section for each reaction and for each SAND II energy interval was necessary to precisely deconvolute the energy bins. The IRDFF library, which creates group cross sections for the mentioned code, was ideal for this purpose. It must be noted that all correction factors that includes self-absorption of gamma-rays and self-shielding of neutrons in the samples, were taken from MCNP simulations.

In the present work, the experimental unfolded energy spectrum of the neutron flux at the NEAR station will be provided with respect to the FLUKA neutron flux simulation, alongside the basic mathematics of SAND II code algorithm.