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MACS measurements for nuclear astrophysics at n_TOF/NEAR: Feasibility study and first results

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Half the atomic nuclei heavier than iron are created through the s-process, i.e. a series of neutron captures and subsequent beta decays. Accordingly, the accuracy of neutron capture rates is of significant importance for these astrophysical calculations and for our understanding of the observed isotopic abundances [1]. In particular, fundamental input can be provided through the determination of Maxwellian Averaged Cross-Sections (MACS) of neutron capture reactions for temperatures matching stellar environments[2].
During CERN's Long Shutdown 2 (2019-2021), a new experimental area was constructed at the n_TOF facility. This new experimental area, NEAR, is a high-flux irradiation station only 3m away from the facility's spallation target, suitable for the study of radiation effects on materials and electronics, as well as for measuring neutron-induced reaction cross-sections through the activation technique[3].
The energies of the neutrons reaching the irradiation station cover a wide energy range, from thermal up to the GeV region. With the use of proper materials as filters and moderators and with a careful choice of their dimensions, the neutron beam of NEAR can be shaped into Maxwell-Boltzmann distributions corresponding to different stellar temperatures. In this way, the MACS of various isotopes can be directly measured by means of the activation technique[4].
In this work, the feasibility study of MACS measurements at NEAR/n_TOF will be presented, along with the first results coming from the experimental validation of the filtering method to be used for the shaping of the neutron beam.

References:
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[3] M. Ferrari et al., Design development and implementation of the near area and its neutron irradiation station at the n_TOF facility at CERN (2022)
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