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Re-TOF: A novel detector for the measurement of the fission cross section induced by high energy neutrons

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Neutron-induced fission reaction cross sections are crucial in various fields of nuclear science and technology. Experimental data from these reactions play a key role in understanding nuclear processes at high excitation energies, contributing to the development and refinement of models describing spallation, nuclear fragmentation, and binary fission. Moreover, accurate cross-section data are essential for numerous technological applications. The enhancement of safety in current nuclear reactors and the development of next-generation systems, such as Accelerator Driven Systems (ADS) and Generation IV Fast Neutron Reactors, require precise data across a broad energy spectrum, from thermal energies to several tens of MeV. Additionally, a deeper understanding and modeling of nuclear fission, including nuclear matter properties like viscosity, are necessary for accurately describing fission dynamics. These considerations extend the relevant energy range into the hundreds of MeV, where such phenomena can be more directly characterized.

The neutron time-of-flight facility n_TOF at CERN offers the possibility to study neutron-induced reactions over an extensive energy range, from sub-meV to GeV of neutron kinetic energy. The key features of the facility, such as high energy resolution and the intense instantaneous neutron flux, make it particularly well-suited for high-accuracy, high-resolution fission cross-section measurements.

Recently, a dedicated measurement campaign was conducted to obtain precise cross-section data for the ^{235}U(n,f) reaction, covering the entire energy range from thermal up to several hundreds of MeV. This included the first experimental data above 200 MeV, extending to 440 MeV. Fission yields were measured simultaneously with the neutron flux, which was determined relative to neutron-proton elastic scattering, the main reference for nuclear reactions induced by high energy neutrons. The upper energy limit was constrained by the setup used for the reconstruction of the incident neutron flux. To overcome this limitation, a novel detection system using fast plastic scintillators for recoil proton detection via the time-of-flight (TOF) technique is under development. This advanced detector is designed to extend the energy range up to 1 GeV, enabling a new series of measurements to determine fission cross sections relative to n-p elastic scattering across a continuous spectrum from a few tens of MeV to the GeV region.

This contribution presents a review of the current status and preliminary results from the first detector tests performed in the first experimental area at n_TOF. The potential of this new system for neutron flux determination at very high neutron energies will be discussed.

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