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Recent results from the n_TOF facility at CERN

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Nuclear data in general, and neutron-induced reaction cross sections in particular, are important for a wide variety of research fields. The neutron time-of-flight facility (n_TOF) at CERN has been one of the leading international facilities for high-precision neutron-induced reaction studies for over two decades. Conceived in the late 1990s by Carlo Rubbia [1], n_TOF was designed to provide accurate neutron-induced cross section data for nuclear astrophysics [2], nuclear technology [3], and fundamental physics.

n_TOF is distinguished by its unique combination of a high instantaneous neutron flux, a broad neutron energy spectrum extending from thermal energies to several GeV, and exceptional energy resolution. The facility comprises two experimental time-of-flight beamlines: EAR1 (185 m flight path) optimized for high-resolution measurements and in operation since 2001 [4]; EAR2 (20 m flight path), which became in 2014 a world-leading facility in terms of instantaneous neutron flux [5], making it well suited for time-of-flight experiments on small mass or highly radioactive samples.
In recent years, significant upgrades have been implemented to further enhance n_TOF's capabilities. In 2021, a new, nitrogen-cooled spallation target was installed [6] to improve neutron beam characteristics, particularly for EAR2, while preserving the excellent resolution for EAR1 [7]. Moreover, the recently established NEAR station, located at only 3 m from the neutron source, provides a high-flux experimental area for activation measurements, mainly intended for astrophysical studies [8]. These developments have expanded the experimental potential of the facility, particularly for studies involving radioactive samples.
This contribution will present a comprehensive overview of n_TOF, focusing on its unique features, recent scientific highlights (e.g. [9]) and latest detector developments (e.g. [10]). Looking ahead, the n_TOF Collaboration is pursuing an ambitious research programme including, among other aims, the expansion of the (n,cp) measurements using innovative detector concepts, neutron capture measurements on shorter-lived unstable nuclei of astrophysical relevance, the first inelastic scattering studies using high resolution detectors or the recently launched programme to measure total cross sections by means of transmission. These future projects that are being driven by an outstanding effort in detector R&D, will allow n_TOF to stay among the world-leading facilities for neutron-induced cross section measurements.

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