New perspectives for neutron capture measurements in the upgraded CERN-n_TOF Facility

J. Lerendegui-Marco[1], A. Casanovas[1], V. Alcayne[2], V. Babiano-Suárez[1], M. Bacak[3], J. Balibrea[1], D. Cano-Ott[2], C. Domingo-Pardo[1], F. García-Infantes[3,4], C. Guerrero[5,6], F. Gunsing[7], C. Massimi[8,9], E. Mendoza[2], A. Mengoni[10], E. Musacchio-González[11], J. A. Pavón-Rodríguez[3,5], M. Sabaté-Gilarte[3], V. Vlachoudis[3], The n_TOF Collaboration.

1 Instituto de Física Corpuscular (CSIC-UV), Spain
2 CIEMAT, Madrid, Spain
3 European Organization for Nuclear Research, CERN, Switzerland
4 University of Granada, Granada, Spain
5 University of Seville, Dept. of Atomic, Molecular and Nuclear Physics, Seville, Spain
6 Centro Nacional de Aceleradores (US-CSIC), Sevilla, Spain
7 CEA Irfu, Université Paris-Saclay, Gif-sur-Yvette, France
8 Instituto Nazionale di Fisica Nucleare, INFN, Bologna, Italy
9 Physics and Astronomy Dept., University of Bologna, Bologna, Italy
10 Agenzia nazionale per le nuove tecnologie (ENEA), Bologna, Italy
11 Laboratori Nazionale di Legnaro (LNL-INFN) , Padova, Italy

Neutron capture cross-section measurements are of great interest for various nuclear data applications, such as the slow neutron capture (s-) process of nucleosynthesis in stars, innovative nuclear technology or medical applications. The neutron energy range of interest varies depending on the application and, hence, pulsed white neutron sources combined with the time-of-flight (TOF) technique are the best suited facilities for these measurements.

Since 2001, the high resolution neutron time-of-flight facility CERN-n_TOF-EAR1 [1] has provided neutron capture cross sections with an excellent energy resolution and broad energy range up to 1 MeV [2]. In 2014, the n_TOF Collaboration built a new vertical beam line, so-called n_TOF-EAR2 [3], with a flight path of only 20 m, approximately ten times shorter than the 185 m of n_TOF-EAR1. Given its high instantaneous flux [4], this new neutron beam line opened the door to challenging measurements of samples with high activity, available only in small quantities or with small cross sections [5, 6, 7].

The n_TOF facility has just undergone in 2021 a major upgrade with the installation of its third generation spallation target that has been designed to optimize the performance of the two n_TOF time-of-flight lines. This contribution will present the first results of reference capture measurements in the two beam lines of the upgraded n_TOF facility.

The performance and new possibilities for (n,ɣ) measurements at n_TOF will be presented and compared with the currently most competitive time-of-flight facilities worldwide featuring white neutron beams. Several key aspects for capture measurements will be discussed, focusing on the maximum neutron energy limit, of relevance for astrophysics and fast reactor applications, the instantaneous neutron fluence, which determines the signal to background ratio in the case of radioactive samples, and the energy resolution. The latter is a key factor for both increasing the signal-to-background ratio and obtaining accurate Resonance Parameters [8]. In particular, the energy resolution has been clearly improved for the 20 m long vertical beam line with the new target design, according to our very preliminary results (see Fig. 1) while keeping the remarkably high resolution of the long beamline n_TOF-EAR1 [1].

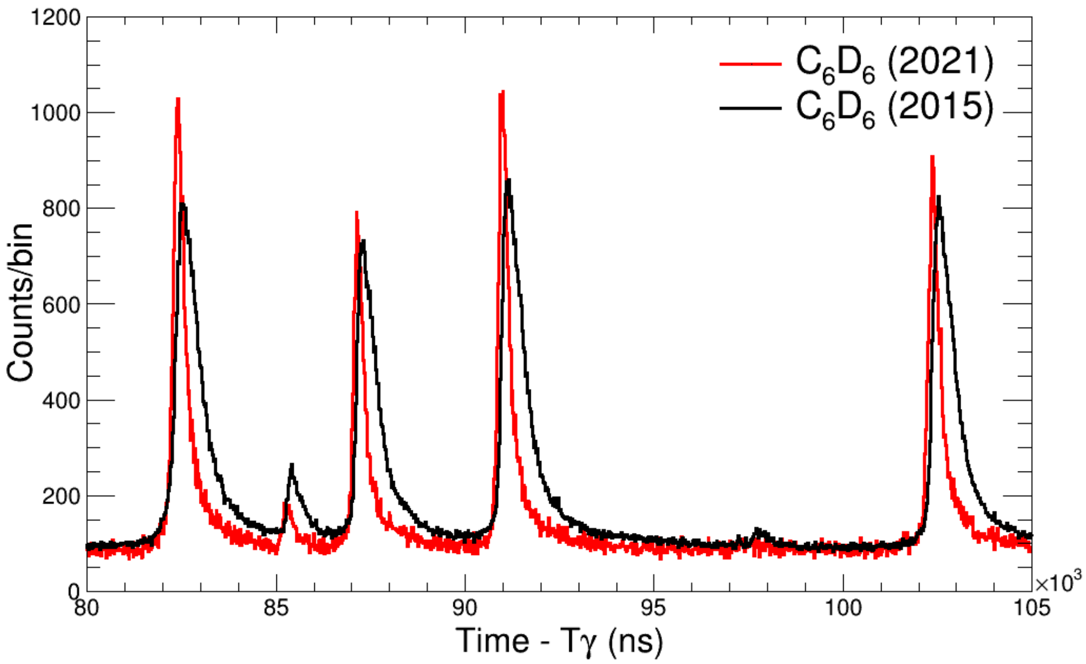

Fig. 1.- Time-of-flight spectrum of $^{197}Au(n,\gamma)$ measured with C_6D_6 detectors at n_TOF-EAR2 (measuring position at 19.5 m) with the previous (2015) and the upgraded (2021) spallation target. The neutron energy between 200 and 300 eV is displayed.

Last, current experimental limitations for capture measurements at CERN n_TOF will be discussed together with some of the on-going detector R&D projects that will try to tackle them in the upcoming years [9].

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