Neutron-induced fission studies of the NTUA at the neutron facility of NCSR "Demokritos" *

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Studies of neutron-induced fission reaction cross section data are required in nuclear reactor applications, for the development of new generation nuclear systems and alternative fuel cycles since they affect the quality of the nuclear system modeling. Furthermore, the fission process is one of the most interesting and complicated phenomena in nuclear physics, and the development of appropriate theoretical models able to predict observables, such as the cross section, is still ongoing. Thus, the provision of high-accuracy experimental and evaluated data is still required to improve on one hand, the parameterization of the phenomenological models and, on the other hand, the predictability of the microscopic models.

In this framework, over the past 10 years, an extensive study of neutron-induced fission cross-sections at and above the fission threshold of various actinides has been carried out at the neutron beam facility of the National Centre for Scientific Research "Demokritos" by the Nuclear Physics Group of the National Technical University of Athens. The measurements were carried out with quasi-monoenergetic neutron beams produced via charged particle reactions on solid and gas targets, while the detection of the fission fragments was achieved with the use of Micromegas detectors. Special attention was given to the estimation of the parasitic neutrons, through experimental techniques, as well as Monte Carlo simulations of the neutron beam and experimental setup. The actinide targets were characterised via alpha-spectroscopy and the Rutherford Backscattering Spectrometry Technique. Many experimental data of these measurements are published and available in the Experimental Nuclear Reaction Data library (EXFOR).

An overview of the above-mentioned measurements at this facility will be presented and discussed.

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Calibration of Neutron Techniques for the Characterisation of Historical Bronzes: the Bragg Edge Neutron Transmission Analysis Approach*

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Ancient metallurgy is crucial for understanding the artistic and technological evolution of various civilisations. Neutron-based techniques offer a non-destructive means to determine alloy and phase composition of ancient artefacts [1][2].

The work here presented is part of the CHNet_BRONZE project, aiming to quantitatively calibrate neutron techniques for the analysis of Cu-based archaeological items. Three methods are employed: Time-of-Flight Neutron Diffraction (ToF-ND), Neutron Resonance Transmission Imaging (NRTI) and Bragg-Edge Neutron Transmission imaging (BENT). Initially, a reference set of samples with known structure and composition is analysed to optimise the experimental parameters for the analysis of historical artefacts and help with data interpretation.

The work will focus on the measurements carried out with the BENT technique, a non-destructive method that reveals composition, texture and microstructure of materials. Exploiting a 2D imaging detector, position-dependent Bragg-edge transmission spectra are acquired, enabling reconstruction of phase spatial distribution. These characteristics make this technique appealing also for cultural heritage applications [3].

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Neutron fluence measurements with activation foils in the JET Torus Hall during DD, TT and DT campaigns*

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In the frame of EUROfusion JET3 and Preparation of ITER Operation (PrIO) projects, neutronics benchmark experiments were performed at the Joint European Torus (JET) during the 2015-2023 Deuterium-Deuterium (D-D), Tritium-Tritium (T-T) and Deuterium-Tritium (D-T) campaigns, aimed at validating in a real fusion environment the computational tools and nuclear data used in ITER nuclear analyses. In particular, the validation of neutron fluence calculations in areas surrounding the tokamak and its biological shield is important, since the large physical extent of the reactor plant, the complexity of the geometry and the combination of deep penetration and long streaming paths make these calculations quite challenging.

In the present work, neutron measurements using sets of activation foils were performed in the JET Torus Hall at several positions close and far from the tokamak. The activity of each foil was determined using gamma-ray spectrometry. The experimental values were compared against neutronic calculations using the MCNP and ADVANTG codes and a very good agreement was observed. Therefore, the results of this study provide data for supporting validation of nuclear computational tools and libraries used in the preparation of ITER nuclear phase. Moreover, the methodology developed at JET can be applied in other fusion neutron fields to monitor the neutron fluence outside the biological shield, as well.

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