Study of n+^{63,65}Cu reactions for advanced nuclear technologies*

Cristian Massimi[1], and the n_TOF Collaboration[2]

[1] *University of Bologna and INFN Bologna, Via Irnerio 46, 40126 Bologna, Italy*
[2] *www.cern.ch/ntof*

Neutron-induced cross sections in copper are relevant for both advanced nuclear technologies and stellar nucleosynthesis. In the context of advanced nuclear technologies, the global interest in decarbonizing energy systems has spurred research in fast reactors. The RSV–TAPIRO reactor, located at the ENEA-Casaccia Research Centre, near Rome, Italy, serves as a fast spectrum zero-power reactor which plays a significant role in various aspects of nuclear research, including fast reactor development, nuclear data adjustment, and validation of neutronic codes. Recent sensitivity studies highlighted a clear need for new copper cross-section data in a wide energy range, as the existing literature data is scarce and occasionally discrepant. More in detail, capture, elastic and inelastic channels for both copper isotopes rank on top among the contributors to the total uncertainty associated with irradiation experiments in RSV TAPIRO. Therefore, new measurements for a reassessment of copper isotopes' cross-sections (capture, elastic and inelastic) are required to fill the existing gaps in nuclear data libraries, significantly improving precision in the cross-section data and their associated uncertainties which are currently not even available for all evaluated nuclear data libraries.

From an astrophysical perspective, copper's nucleosynthesis pathways in stellar environments remains doubtful in terms of origin. Precise Maxwellian Average Capture cross Section (MACS) values for copper isotopes are essential for understanding stellar nucleosynthesis, yet significant uncertainty exists in these values, necessitating further investigation.

These motivations have prompted a new measurement campaign studying n+^{63,65}Cu nuclear reactions at the neutron time-of-flight facility n_TOF, at CERN. This contribution presents a detailed elucidation of the motivations, with particular emphasis on RVS-TAPIRO sensitivity studies, behind the planned experiment campaign, currently underway at n_TOF, as well as the first results obtained so far.

* Part of the EU-project APRENDE

Abstract submitted to ANP2024

New Techniques and Innovative Detectors for Applied Nuclear Physics Measurements at the n_TOF Facility

G. Tagliente

The n_TOF facility at CERN utilizes a spallation neutron source to measure neutron cross sections relevant to nuclear astrophysics and various applications (energy, imaging, medicine, etc.). Over its two decades of operation, the facility has developed several detection systems and techniques to address increasingly challenging measurements. These advancements include:

- High-granularity, high solid-angle capture setups for improved detection efficiency.
- Diverse fast ionization chambers, including miniaturized versions, for fission measurements.
- Silicon-based apparatuses for charged particle detection.

Recently, new high-performance detection systems have been specifically designed for application-oriented measurements. Examples include fast and high-efficiency scintillators for inelastic and (n,xn) measurements. These advancements aim to address neutron damage in future fusion reactors and high-energy accelerator complexes.

Furthermore, the n_TOF applied nuclear physics program has been bolstered by the construction of a new experimental area and associated instrumentation focused on activation measurements. This high-flux station, named NEAR due to its proximity to the spallation target, provides valuable capabilities for these studies.

This talk will present the new techniques and instrumentation implemented at n_TOF in recent years for applied nuclear physics measurements. Particular emphasis will be placed on activities related to neutron damage on structural materials and electronics for energy and accelerator applications.

Cross-section measurement of the ^{243}Am(n,f) reaction at high neutron energies at the n_TOF facility [1]

Nikos Kyritsis[1 2], Maria Diakaki[1], Veatriki Michalopoulou[1], Zinovia Eleme[1,2], Nikolaos Patronis[2], Michael Kokkoris[1] Roza Vlastou[1] and the n_TOF collaboration [3]

[1] *National Technical University of Athens, Department of Physics, Zografou Campus, Athens,*
[2] *University of Ioannina, University Campus, Ioannina, Greece*
[3] *www.cern.ch/ntof*

In the context of the international need for new high-accuracy nuclear data for neutron-induced fission cross-section on actinides, necessary for the design and operation of advanced nuclear systems, two new measurements of the ^{243}Am(n,f) cross-section were performed at the experimental areas 1 and 2 (EAR1, EAR2) of the n_TOF facility at CERN, with the goal of covering the neutron energy range from thermal up to hundreds of MeV. Micromegas detectors have been used for these measurements, while the high purity samples for ^{243}Am and reference targets have been produced at JRC, Geel (Belgium). Am has been classified as high level nuclear waste from conventional reactors, while it could be used as burnable fuel in future reactors. However, for the ^{243}Am(n,f) reaction, only few data are available in the EXFOR data base, with many discrepancies among them. The experimental campaign was successfully completed.

The present contribution focuses on the measurement at the EAR1 in the high neutron energy region (i.e. above the first chance fission threshold). An attempt was made to extend the measurement of the ^{243}Am(n,f) cross-section, as well as the reference reactions ^{235}U(n,f) and ^{238}U(n,f) to as high energies as possible with the micromegas detectors, of the order of 500MeV and beyond. The challenges inherent in such an attempt, as well as the dedicated analysis procedure, along with some preliminary results will be presented.

1 This project has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 847594 (ARIEL). This project has received funding from the European Unions Horizon Europe research and innovation programme under grant agreement No 101057511. This project is carried out within the framework of the National Recovery and Resilience Plan Greece 2.0 funded by the European Union – NextGenerationEU (Implementation body: HFRI)

2 Presenting author email: nikolaos.kyritsis@cern.ch