



Pole for Doctoral Studies  
Center for Doctoral Studies  
Sciences, Technologies, and Medical Sciences

## ANNOUNCEMENT OF DOCTORAL THESIS DEFENSE



**M. DRISSI EL-BOUZAIIDI Mohamed**

**Will present here research work with the aim of earning a  
Doctorate**

**Doctoral program: Mathematical Sciences, Physics and New Technologies**

**Discipline: Physics**

**Specialty: Nuclear Physics**

**On 04/10/2025 at 10H00 at the Thesis Defense Hall, Faculty of  
Sciences of Tetouan, UAE**

**Under the Theme**

**Development of Artificial Intelligence-Based Codes for Neutron  
Spectrum Unfolding and Effective Neutron Cross-Section  
Calculation**

**Front of the jury composed of :**

First Name & Last Name	Establishment	Designation
Pr. EL HAJJAJI Otman	FS of Tétouan, UAE	President
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Pr. AZAHRA Mustapha	FS of Tétouan, UAE	Examiner
Pr. EL YOUNOUSSI Chafik	CNESTEN of Rabat	Guest
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## Abstract



This thesis explores the integration of artificial intelligence (AI) techniques to develop tools for neutron spectrum unfolding and neutron activation calculations. Activation detectors were employed for neutron spectrum reconstruction. In parallel, a library of effective cross-sections was developed to perform neutron activation calculations..

Initially, two unfolding neutron spectra codes were developed: one based on genetic algorithms, the other on artificial neural networks. These algorithms enable accurate reconstruction of neutron spectra. The genetic algorithm-based code was applied to unfold the spectrum in the ARC-700 reactor, where it outperformed the conventional iterative method in accuracy. The artificial neural network-based code was applied to four different positions in the TRIGA MARK II reactor and demonstrated high accuracy in spectrum reconstruction across all positions. The two codes were validated by comparing reconstructed spectra with reference data and calculated reaction rates with those produced in the reactor. Secondly, a library of effective neutron cross-sections based on neural networks has been developed.

This library enables the calculation of self-shielding factors and multi-group cross-sections for any sample geometry and isotopic composition. The adopted approach significantly improves computational speed and the accuracy of results. The validation of the library was performed by comparing self-shielding factors, effective cross-sections, and induced reaction rate to reference data. This code provides a powerful alternative to traditional tools for neutron activation applications. In addition, the simulation of a NaI(Tl) detector was performed by modifying the OpenMC code and including Gaussian energy broadening. The obtained results were compared with experimental and simulation data (using MCNP and GEANT4) to validate the detector modeling approach.

The results confirm the robustness, efficiency, and predictive reliability of the tools developed. Potential applications include nuclear safety, radioisotope production and the automation of detection systems. Additionally, there is potential to extend these tools to other applications.

**Keywords** : Artificial Intelligence; Neutron Spectrum Unfolding; Artificial Neural Networks; Genetic Algorithms; Neutron Cross-Sections; Gamma Detector Simulation