



# Neutron spectrum deconvolution by Bayesian methods

CEA/DES/IRENE/SMTA/LMN

**This internship project is aiming on improving neutron spectrum deconvolution methods for reactor applications.**

The ability to accurately reconstruct the neutron spectrum in reactors is a key challenge for many applications [1,2]. The deconvolution of a neutron spectrum relies on solving a complex inverse problem, generally addressed using various algorithms [3,4,5]. These algorithms often require some prior (or reference) spectrum as input.

In recent years, several Bayesian approaches have been proposed to tackle this inverse problem [6,7]. Recent studies [8] that have implemented these approaches have shown promising results. There is therefore growing interest in applying these methods in reactor applications and evaluating their performance.

Activation detectors are commonly used to measure the neutron spectrum in contexts of high fluence and mixed gamma/neutron fields. To determine this spectrum, several foils made of different elements are irradiated. Neutrons interact with the isotopes of these elements through nuclear reactions, producing radioactive nuclei. The induced activity level is mainly determined by the cross section of the considered reactions. These cross sections are then used to build the response matrix of the activation detectors.

The objective of this internship is to explore and apply iterative Bayesian methods, such as D'Agostini's method [6,8], to data acquired by the activation method. A comparative evaluation of their performance against classical methods (e.g., maximum entropy [9]) will also be carried out.

Overall, during this internship the candidate will acquire skills in Bayesian statistical methods, the processing and management of neutron spectra, as well as their analysis methods that are used in various fields both on scientific and industrial level. They will also have the opportunity to work in a multidisciplinary laboratory with recognized expertise in research related to nuclear instrumentation (e.g. Bonner spheres).

## References :

1. Vladimir Radulović et al., [Nature Scientific Reports 14, 28604 \(2024\)](#)
2. E. Belfiore et al., Nuc. Sci. And Eng. (under review, 2025)
3. K. Mikszuta-Michalik et al., [Fusion Engineering and Design 173, 112934 \(2021\)](#)
4. S.P. Tripathy et al., [Nuc. Inst. Meth. Sec A. 583, 421 \(2007\)](#)
5. G. Grégoire et al., [EPJ Web of Conf. 106, 07006 \(2016\)](#)
6. G. D'Agostini, [arXiv:1010.0632v1 \[physics.data-an\] \(2010\)](#)
7. G. Chouladakis, [arXiv:1201.4612v4 \(2012\)](#)
8. A. Pérez de Rada Fiol et al., [Radiation Physics and Chemistry 226, 112243 \(2025\)](#)
9. M. Reginatto et al., [Nuc. Inst. Meth. Sec. A. 476, 242 \(2002\)](#)

## ■ Desired schooling :

Engineering School

Master 2

## ■ Duration :

6 months

## ■ Method/software(s):

Bayesian Inference  
Numerical Simulation  
Python

## ■ Key words :

Bayesian Methods, Neutron Spectroscopy, Deconvolution

## ■ Thesis opportunity :

No

## ■ Contact :

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