

Internship proposal - 2026-2027

Title : Application of the Total Monte Carlo method to the calculation of fission yields distribution and decay heat

Tutor :

- Lydie Giot - Associate-Professor, SUBATECH Laboratory, IMT Atlantique

Address : 4, rue Alfred Kastler - La Chantrerie - 44307 Nantes Cedex 3, FRANCE

Phone : +33 (0)2 51 85 86 66

Email : giot@subatech.in2p3.fr

Web page : <https://www.imt-atlantique.fr/fr/personne/lydie-giot>

Context:

One of the current industrial challenges is the knowledge of the uncertainties due to nuclear data on reactor calculations, which have also an impact on safety studies. The CNRS Molten Salt team (LPSC & SUBATECH laboratories) is working on the developing the CoCo codes (Coconust and Cocodrilo codes) to determine the impact of the nuclear data uncertainties (ex: cross-sections, mean decay energies, fission yields ...) on key reactor parameters such as multiplication factor, fuel inventories or decay heat. The method chosen to propagate the uncertainties is the Monte Carlo approach, which involves repeating the simulation a large number of times, each time using a different set of nuclear data.

Internship proposal:

The main objective of this internship is to develop scripts for producing fission yields distributions using the GEF code in conjunction with a Total Monte Carlo approach, and then to use these fission yields distributions for decay heat calculations with the Cocodrilo code (python wrapper coupled to the SERPENT code).

GEF is a code designed to provide predictive descriptions of fission observables, such as the distribution of fission yields and associated quantities (e.g. prompt neutrons and gamma rays), for a wide variety of nuclei and excitation energies. During the first part of the internship, the intern will adapt existing scripts and the GEF code to automate the calculation of fission yield distributions by sampling the most important GEF parameters describing the fission process. The intern will also study the physics associated to the input parameters and the impact of the sampling choices on the produced fission yield distributions.

Recent inverse kinematics measurements carried out at the GANIL facility have given access for the first time to the distribution of neutron-induced ^{239}Pu fission yields at different excitation energies, which are of interest for the design of GEN IV reactors. During the second part of her/his stay at the SUBATECH laboratory, the intern will perform decay heat calculations for ^{239}Pu fission at different neutron energies and compare the results, obtained using fission yield distributions and associated uncertainties produced per the GEF code or from the GANIL measurements.

Developed skills:

- Reactor physics, Monte Carlo method
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- Nuclear physics, especially on the fission process
 - Python3
 - Codes and softwares : SERPENT, GEF, Cocodrilo
 - Use of cluster computing facilities

The skills developed during this internship will be valued in the industry or in a laboratory.

Required Profile:

- Engineering school student (A2/A3) or Master's M1/M2 student with prior knowledge of nuclear physics, numerical simulation, and Monte Carlo methods
 - 4 – 6 months internship
 - Good proficiency in the use of computer tools (Linux, computer clusters...), and/or languages such as Python, C or C++ will be an asset
 - Definite interest in programming and physics requested.
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