Internship Proposal – 2019-2020

Title : Development of the Total Monte Carlo method with the SERPENT code applied to fission pulses

Group : Nuclear structure and Energy

http://www-subatech.in2p3.fr/fr/recherche/nucleaire-et-environnement/sen/presentation

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Tutor:

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Context:

The determination of decay heat is a major safety issue for a reactor in operation but also for the transport of burnt fuel and for the nuclear waste management. It is in particular a key parameter for the design of the safety systems of Generation IV reactors but also for the use of innovating fuels. The calculation of decay heat relies on the combination of reactor simulations to estimate the fuel inventory and on nuclear data on decay properties of the fission products and actinides but also fission yields and cross sections. One of the industrial challenge is to estimate and propagate uncertainties within fuel depletion calculations.

Objectives of the internship:

The Nuclear Structure and Energy group of the SUBATECH laboratory performs decay heat calculations with the Monte Carlo depletion code SERPENT 2 for fission pulses, fuel assemblies but also reactor cores. The aim is to work on the propagation of uncertainties associated to nuclear data. One of the methods which can be used is the Total Monte Carlo method (TMC) based on repeating many times a calculation with each time a different set of initial nuclear data.

As a first step, the internship will focus on the uncertainties associated to independent fission yields. The main objective is to develop scripts needed to apply the TMC method and propagation of the uncertainties associated to independent fission yields to some SERPENT2 calculations for fission pulse cases (^{235,233}U and ^{239,241}Pu). The independent fission yields distributions will be calculated using a Gaussian sampling for the input parameters of the GEF code. Part of the expected work is also the physics understanding of the input parameters of the GEF code and their impacts on the results.

This M2 internship is linked to a PhD offer (funding request on going) on the following topic : Decay heat uncertainty calculations with associated sensitivity studies : Impact of nuclear data. A study case will be the Molten Salt Reactor with Fast neutron spectrum (MSFR) for Th/U and U/Pu fuel cycles which is a Gen IV reference case initiated by the LPSC laboratory in Grenoble. The S.E.N team contributes in decay heat calculations for the core part, emergency draining system and fuel treatment unit.

Developed skills:

- Reactor Physics,
- Modeling, Monte Carlo method
- Nuclear physics especially on the fission process
- Computing in C++, PYTHON.
- Codes and softwares : SERPENT, GEF and ROOT

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

Intern's Profile :

- Student in an engineering school or in M2 with some knowledge in reactor physics, nuclear physics, Monte Carlo methods, modeling, numerical methods/modeling
- Linux experience, programming approach and some experience with a reactor code will be greatly valued.