Innovative nuclear system and fuel cycle dynamics calculations

Laboratory / Team	Institute of Nuclear Physics, Orsay (IPNO) – physics and radiochemistry of nuclear energy - Back-end of the Nuclear Fuel Cycle and Spallation Physics Team (PACS)
Contact	Xavier Doligez: doligez@ipno.in2p3.fr Marc Ernoult: ernoult@ipno.in2p3.fr
Main topics	Nuclear reactor core simulation of innovative systems and associated dynamic fuel cycle studies
Objectives/context	Dynamic fuel cycle studies; Quantification of the increased life expectancy of PWRs; optimization of transition to Generation IV nuclear reactors.
Equipment / resources / tools / software used	Good knowledge of C++ required LINUX environment
Level / Duration / Period **Number of trainees**	L3, M1, M2 / 3 to 5 months / November 2018 - July 2019 2 students / course period

Course description / main tasks

Since 2012, various CNRS/IN2P3 teams (especially the PACS group) have been developing the CLASS (Core Library for Advanced Scenario Studies) package in collaboration with IRSN (French Institute for Radiation Protection and Nuclear Safety), to study the dynamics of electro-nuclear fuel cycle. The code is now able to simulate all installations needed to operate a whole fleet of nuclear power plants (from manufacture of new fuel to storage of waste) that may use various fissile material recycling methods in various reactors.

The topic proposed during this internship is to use this code to study different possible optimization for current reactor involved in a transition strategy threw a full SFR reactor fleet over various timescales. It may involve an increasing of reactor burn-ups, reactor lifespans, and, on a second time, a second plutonium recycling process in MOX fuels in PWR, for instance. These studies all assume constant power and a quantity of plutonium available in the cycle at the end of the transition.

A first part of the course is devoted to understanding the calculation tools and methods. A study on the physical models used, their uncertainties and the consequences on different typical observables will help the student to become familiar with the dynamic fuel concepts. The next step is to simulate a reference scenario, that will be very close to the French scenario, with a reactor renewal in 2 phases (2/3 PWR, then SFR). The optimization research is then carried out on the 3rd generation reactors deployed before the SFRs. The evaluation criteria are the following: possible date for SFR deployment, needs for reprocessing units to produce GEN IV fuel, needs for uranium 235 and waste production.

Skills acquired on completion of the course

- Physics of the back-end fuel cycle
- Modeling nuclear scenarios