**Nuclear Energy**

Nuclear energy will most probably play an important role in the future in a context where fossil fuels are limited resources and CO2 emissions must be reduced. Moreover, highly populated and emergent regions ask for more and more energy. Fukushima’s accident reminds us that fission nuclear energy is a particular technology: a substantial and continuous improvement of its safety is necessary for its social acceptability. Moreover, optimization of uranium resources consumption and current and future waste management remain major challenges.

Paris region teams participate in the national research effort to ensure the viability of energy policy on the long term both in the nuclear energy production cycle itself and in the management of the various wastes. The law of June 28, 2006 which superseded Bataille’s law (1991) has defined, for the period of 2006-2015, a global working framework for research. Research axes developed by P2IO’s teams are neutronic simulation of innovative systems and the study of related scenarios, nuclear data needed for future reactors, including studies of the fission process, safety aspects of the core (thermal hydraulic coupling/neutronics), waste transmutation either to burn them in a reactor or to use them as fuel to generate electricity, fuels chemical reprocessing, materials for nuclear and geological storage of long-lived waste.

One of the most critical concerns for the development of the nuclear materials (structural and cladding materials, nuclear fuels, transmutation or immobilisation matrices) is the evaluation of the effects of radiation on the structural stability of the material. Such investigations can be performed on model systems in well-defined conditions (the so-called *experimental simulation*) by the use of energetic ions provided by the JANNuS-Orsay facility. Indeed they allow three major issues to be addressed: (i) the simulation by ion irradiation of the radiation damage which alters the structure of the crystalline solid; (ii) the doping of the matrix with a stable element which simulates the species to be confined: (iii) the characterisation of the material by nuclear microanalysis techniques and transmission electron microscopy. Such methods are currently applied to a wide class of nuclear materials, ranging from metallic systems (e.g. behaviour of insoluble He gas in steels under irradiation, ODS synthesis by ion implantation) to advanced ceramics considered for the forth generation of nuclear reactors (e.g. radiation damage in SiC, TiC, ZrC, UC, UO2).