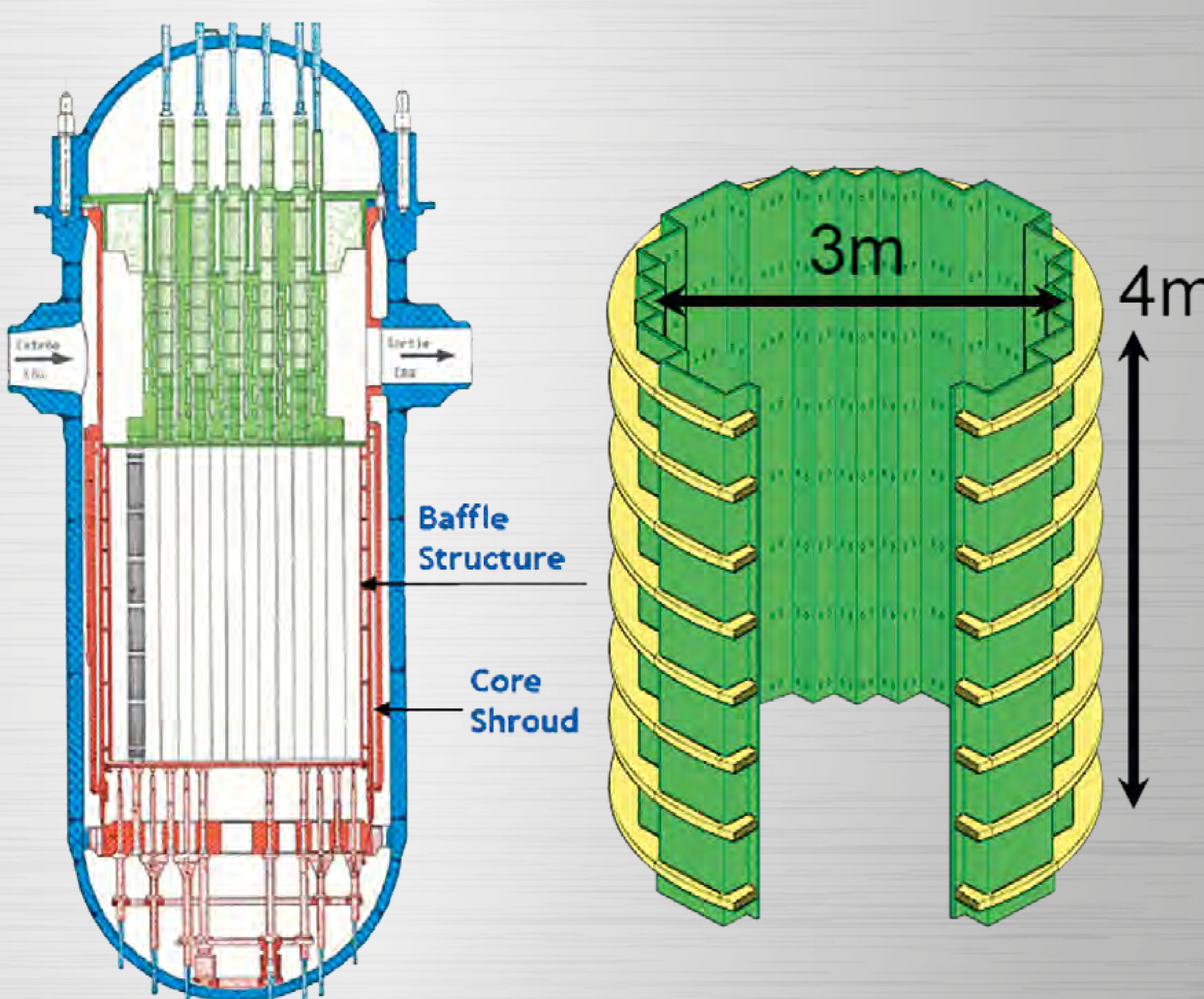
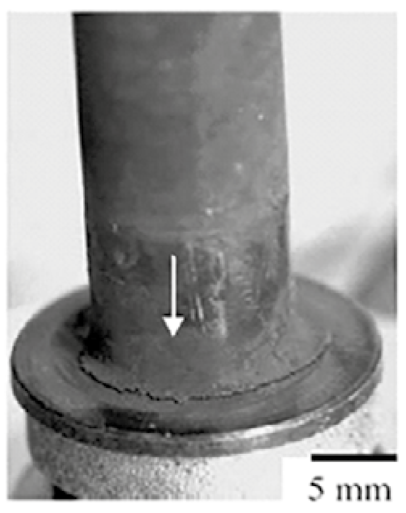
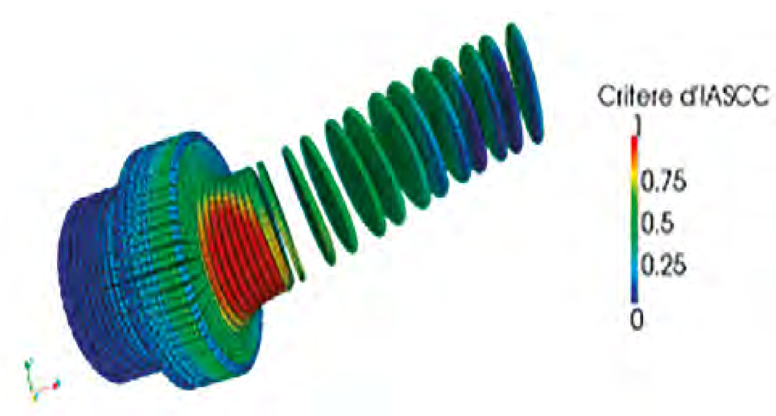
VESSEL INTERNAL PROJECT:
Ageing of Lower Core Internals Components

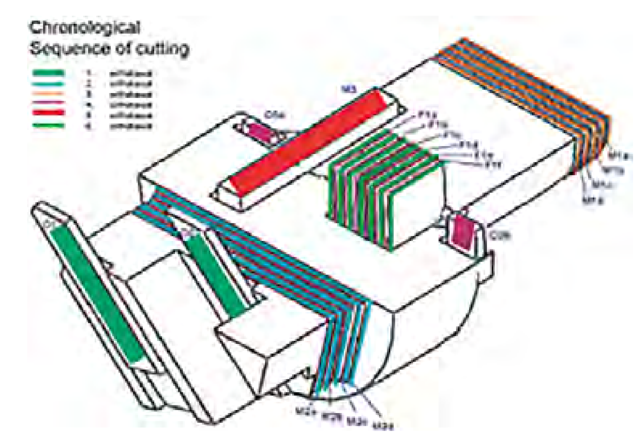
The functions of the internal components of PWR vessels are to position and support the core and provide an accurate control of reactor coolant flow into each fuel assembly by canalizing the fluid. Moreover, the lower core internals contributes to the neutron protection of the reactor pressure vessel by absorbing most of the neutron flux from the core. The internals lifetime has an important impact on the nuclear power plant lifetime because of the cost and difficulty of their replacement.

The MAI Vessel Internals Project seeks to consolidate calculation methodologies and our understanding of materials degradation for such a structure. It focusses on Loading calculations, Void Swelling, and IASCC. The specific objectives of the MAI Vessel Internals Project 2015-2019 determine the structure of the project. Each major objective is studied in a work package.









The major work packages of INTERNALS are:

- Loading Calculations: Validate the neutronics and thermal calculation models through a benchmark approach (heavy reflector, sensitivity analysis) and experimental validations.
- Void Swelling: Assess the swelling mechanisms due to irradiation of austenitic stainless steels constitutive of the Lower Core Internal structures (baffle plates, formers, baffle bolts, core barrel, core barrel bolts,…) in PWR conditions.
- Microstructure Analysis: Improve our physical-based understanding of irradiation induced mechanisms through a full description of the microstructure.
- IASCC mechanism: Improve understanding on IASCC in internals stainless steels through both experiments and analysis of decommissioned components.
- Modelling: Utilize multi-scale simulation tools to assess the microstructure and the micro-mechanical behavior of the irradiated austenitic steels in PWR conditions.

One of the successful study concern the IASCC Microstructure. PWR baffle to former bolts have been known to crack. The underlying mechanism, Irradiation Assisted Stress Corrosion Cracking (IASCC), is due to a combination of the effects of primary environment, stress and the irradiation induced evolution of the microstructure. The MAI program VIP aimed at providing a physically based understanding of this ageing mechanism. One key result was the full characterization of the microstructure of a cracked bolt extracted from a French PWR.