Chemical analysis and imaging of elements implanted in metallic alloys for nuclear applications	
Laboratory / Team	Center for Nuclear Sciences and Material Sciences (CSNSM) Materials and Irradiation team https://www.csnsm.in2p3.fr/Materiaux-et-Irradiation
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Main topics	Materials synthesis by ion implantation, characterization by transmission electron microscopy (TEM, STEM) and related analytical techniques (EDX, …), Calibration and optimization of the new EDX detector (@ JANNuS-Orsay)
Objectives/context	Calibrate and optimize the new EDX detector, to determine the spatial distribution and quantity of an element introduced by ion implantation in metallic alloys for nuclear applications (e.g. ODS steel)
Equipment / tools / software used	Tools for preparation of thin foils for TEM; transmission electron microscope (TEM) and ion accelerators (JANNuS-Orsay) and analytical techniques (EDX, …); SRIM, Digital Micrograph, ESPRIT2.1 Brucker softwares
Level / Duration / Period **Number of trainees**	Master 1 / 1 to 3 months / April-July 2019 Only one student

Course description / main tasks

- Determination of the experimental conditions needed for ion implantation in thin foils of a high purity metallic alloy: use of SRIM simulation code.
- Calibration of the new EDX detector using reference specimens.
- Measurement in the transmission electron microscope of the EDX spectra (Energy-Dispersive X-ray Spectroscopy) of the implanted material, and acquisition of corresponding images.
- Analysis of images and EDX spectra obtained: use of Digital Micrograph and ESPRIT Brucker softwares. Obtaining quantity and spatial distribution of elements implanted in the matrix.
- Update the procedure for EDX experiments (in TEM and STEM modes)

Skills acquired on completion of the course

- Estimation of the range of charged particles in a material - use of a SRIM Monte-Carlo simulation code; principle of an ion implanter.
- Knowledge of vacuum, ion accelerator and transmission electron microscopy techniques.
- Principle of Energy-Dispersive X-ray Spectroscopy to determine spatial distribution and quantity of elements contained in a metallic alloy, and its calibration.
- Acquisition and analysis of images and EDX spectra: determination of the type of implanted elements, extraction of spatial distribution and quantity of elements implanted in the alloy.
- Writing a procedure for the users