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FIB/SEM in a hot cell
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Introduction
A FIB/SEM is an instrument combining a Focus Ion Beam and a high resolution field emission Scanning Electron Microscope. It provides many capabilities for ion and electron imaging, material deposition and ablation of materials. In case of Radioactive sample characterization, attentiveness is strongly required to avoid detectors and electronic devices damaged by radiation, radioactive sputtered material redeposition and personal protection.
Many solutions have been carried out to overcome these constraints.

Method
In the project study, basic data give the maximum sample activity evaluated between 1 and 12 Ci (1 Curie = 3,7.Bq) and Gamma dose rate measured at 5cm of 1Gy/h. The different detectors that have to be protected against radiation are EDS (Energy Dispersive Spectrometer), EBSD (Electron Backscattered Diffraction), SE detector (Everhart-Thornley). For EDS and EBSD, an automatic movable shield in Densimet© is used to protect those detectors in retracted position. The SE detector has been modify using a bended light guide to avoid direct Gamma rays to hit PMT (Photo Multiplier Tube) and Pre-amplifier.
With Electronics devices and control unit outside the Hot cell and the instrument remotely controlled, operators work in safe conditions, for this purpose, all cables are lengthened.
To keep external parts of instrument clean and to avoid contamination, the FIB/SEM is connected sealed to a glove box. An assembly type DPTE system is used to maintain confinement and allow FIB/SEM Glove box separation in case of service maintenance needs.
Sample manipulation is an important point, so mechanical solution has been found to avoid sample fall in the glove box or inside FIB/SEM chamber. Two edged tray are placed above and under motorized stage. Because sample transfer requires operator action a STM (Sample transfer Module) has been developed to secure sample manipulation with ball joint arm or telemanipulator arm.
As mentioned above, A FIB system is used mainly for ablation of material and a fundamental question has been raised : "Where do sputtered materials go ". For this purpose a scientific study has been carried out to determine angular distribution of sputtered particles, an innovative solution has been found out.

Conclusion
In one of those projects, other developments have been carried out like, Retractable NanoIndentor and Micromanipulator. A removable STEM detector is also available.
In one of this project, the difficulty was to adapt the FIB/SEM with its dedicated glove box in an existing hot cell
All these developments comply with CEA regulation and safety and some of them are actually in the way to be patented.
The first FIB/SEM nuclearized will be installed on site in July and the next one in October 2014.

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