In situ Tritium measurements and control by laser techniques

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During Tokamak operation, high energy and particle fluxes interact with Plasma Facing Components (PFCs). This leads to direct tritium implantation or to wall materials erosion, transport and redeposition in layers able to trap tritium. The accumulation of tritium in the vacuum vessel is limited due to safety constraint and the evaluation and control of the in vessel tritium inventory is of crucial interest.

In order to measure the in situ tritium inventory, the spectroscopic analysis of the plasma produced by laser ablation of the PFCs and/or of the redeposited material, known as laser-induced breakdown spectroscopy (LIBS), is a promising technique. In the following, a parametric study performed to determine the optimised operational conditions for LIBS with tokamak samples will be first described. The influence on the LIBS properties of the irradiation conditions (laser wavelength and pulse duration) and of the gas pressure and nature are investigated. Usually, quantitative LIBS analyses require calibration measurements using standard samples having compositions close to that of the material to be analyzed. Calibration during tokamak operation is always difficult due to the complex material produced. For ITER application, it is proposed to apply a *calibration-free* LIBS procedure that will be exemplified with real Tokamak samples. Then, the first LIBS experimental results obtained in Tokamak are recalled. It is observed that the complexity of the Tokamak environment leads to a complicated diagnostic especially if all the surface of the in vessel components must be analysed. The extrapolation of the LIBS diagnostic to ITER is then addressed with a special insight on embarked diagnostic able to scan the entire vessel walls.

In order to control the in vessel Tritium inventory, laser ablation has proven its efficiency and reliability. Results obtained with carbon based Tokamak samples and in the Tokamak environment will be presented. It will be shown that when adjusting the laser parameters, a cleaning rate of $1m^2/h$ with 100W laser power is obtained, results that is mandatory to treat large surfaces as required in ITER. Extrapolation to ITER metallic samples comparable to beryllium deposited layers will be also presented.