Overview of the activities on the ITER fast-ion loss detector

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Latest advancement of the design of the Fast-Ion Loss Detector (FILD) diagnostic for the ITER tokamak are detailed in this contribution. Advanced Hamiltonian full-orbits simulations are executed to estimate the velocity-space of the fast-ion fluxes on the diagnostic probe head. Using the ASCOT code, these fluxes are characterized for different spatial spectra of externally applied 3D fields and probe head insertion depths. The probe head is inserted in the plasma periphery (roughly flush with the first wall) using a reciprocating system which allows a total radial stroke of 50 cm. Thermomechanical modeling of heat loads acting on the probe head enables to estimate mechanical stresses as well as the scintillator operating temperature. Commercially available scintillators have been irradiated at room and high temperatures (up to 400ºC) enabling to characterize their efficiency and lifespan.

The light pattern emitted by the scintillator is calculated applying the FILDSIM code, which considers the results of these irradiations, thermal analyses, and orbit simulations. A complex optical relay (>14 m long), featuring freeform mirrors and radiation hardened lenses, collects and images the light from the scintillator plate into a shielded cabinet in the port cell. It contains the instrumentation required for the data acquisition of Faraday Cups as well as photomultiplier tubes and charge couple device cameras. Monte Carlo simulations are applied to estimate the radiation-induced noise on the scintillator as well as the effectiveness of the DAQ shielding in the interspace. Together, these advancements ensure an acceptable signal to noise ratio of the loss alpha monitor over the entire ITER lifespan.