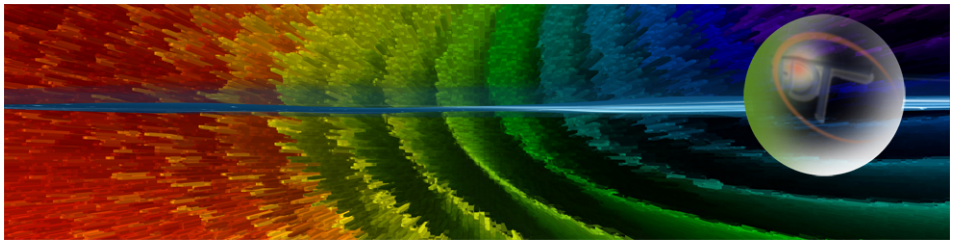

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ITER perspective on fusion reactor diagnostics - A spectroscopic view

The ITER tokamak requires diagnostics that on the one hand have a high sensitivity, high spatial and temporal resolution and a high dynamic range, while on the other hand are robust enough to survive in a harsh environment.

In recent years significant progress has been made in addressing critical challenges to the diagnostic development. This presentation uses the spectroscopic diagnostics of ITER to highlight these challenges and the proposed solutions:

- First mirror protection and cleaning: First mirror in ITER are subject to a significant particle flux from the plasma, leading to erosion of and deposition on the mirror. R&D is progressing on techniques to reduce the plasma flux (shutters, custom geometries & baffles, gas puffing ...) and to recover the optical properties of damaged mirrors.
- Nuclear confinement: ITER is a nuclear device and its vacuum vessel also provides the primary nuclear confinement. In order to extract the spectroscopy signals from the plasma, while ensuring all (safety) requirements on the confinement, several optical, mechanical, fluid and electrical feedthroughs that are nuclear grade and at the same time optimized for diagnostic use are under development. Also for vacuum spectroscopy systems, vacuum extensions, fulfilling the nuclear requirements are being assessed.
- Radiation mitigation strategy for optical and electronic components: At full power DT operation ITER will produce significant neutron and gamma fluxes, causing a significant radiation load on the components of spectroscopy systems located close to the plasma. The expected effects on optical and electronic components are being assessed and strategies to mitigate the impact of radiation on the performance of the spectroscopic diagnostics are developed.
- High resolution/sensitivity detection: Due to the 3 items mentioned above, the signal reaching the actual spectrometer/detector can be significantly attenuated. Spectrometer/detection systems are, therefore developed that aim at a high throughput and detection sensitivity while keeping a high spectral resolving power.
- Calibration strategies: Access to the ITER vessel is severely limited. Techniques are investigated allow both 'off-line' and in-situ calibration of wavelength and intensity. This includes recent developments in X-ray sources (compact EBIT), (quasi-)real time calibration, exploitation of the full spectral information et cetera.
  This contribution presents an overview of recent achievements in the above mentioned topical areas.

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