Active Correction of Window Faraday Effects for ITER Laser Diagnostics

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Measurement of the change in polarization of a laser beam traversing a magnetized plasma is a standard diagnostic technique for extracting key plasma parameters, including density and current profile. Depending on the polarization orientation of the incident laser beam relative to the plasm magnetic field the polarization change is denoted either Faraday or Cotton-Mouton effect. On ITER three laser diagnostics will make use of this effect to make their measurements. Unfortunately, this effect is also evident when the laser beam passes through the vacuum window. The large magnetic field and finite Verdet constant of the window material mean that on ITER this effect – in particular Faraday rotation – are non-negligible, and needs to be disentangled from the desired measurement parameter. The Toroidal Interferometer-Polarimeter and Density Interferometer-Polarimeter, in particular, are affected. Both diagnostics use lasers in the 5-10 µm range, and will use zinc-selenide (ZnSe) as the vacuum window material.

In order to compensate for this a sensor is being developed to monitor the magnetic field perpendicular to the window and actively compensate for the Faraday rotation in real time. The sensor consists of an inductive coil closely fitting just in front of the window disc. It comprises several turns of fine wire in center-tap configuration. Both the raw voltage signal, as well as the integrated signal, will be monitored to estimate the magnetic field through the window disk. The system is designed to measure fields up to B<1T with an accuracy of 0.01T, at frequencies of D.C. to 1kHz. Alternatively, the raw signal specifications are dB/dt <0.5 T/s with a sensitivity of 0.001 T/s. The backend will use standard integrators developed for other ITER magnetics systems. Using the real-time magnetic field information, in conjunction with published and/or measured data on the Verdet constant of the ZnSe window material, in-house developed software will estimate the Faraday rotation induced on passing through the window

Initial prototypes of the sensor and results from preliminary characterization trials of the system will be presented. Detailed testing is planned for the future using the DIP system prototype currently under development.

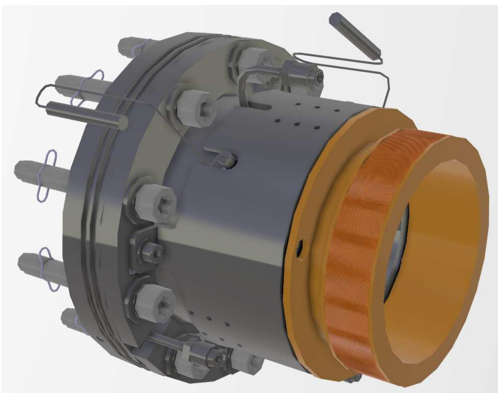

Figure 1. CAD model of magnetic sensor (orange) mounted on ITER window assembly.

The views and opinions expressed herein do not necessarily reflect those of the ITER Organization.

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