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## **P4.156 In-vessel viewing system prototype performance measurements and simulation of measurement quality across the ITER in-vessel components**

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The In-Vessel Viewing and Metrology System (IVVS) is a fundamental tool for the ITER machine operations, aiming at inspecting plasma facing surfaces of in-vessel components for both damage and erosion, both of which are related to the amount of mobilised dust present in the Vacuum Vessel.

Key design improvements from the on-going IVVS preliminary design have recently been incorporated into a prototype system, using the latest COTS opto-electronic components incorporated in a custom opto-mechanical probe. This report describes the results from testing of that prototype and the development of a simulation tool, parameterised by the measured prototype performance, to predict IVVS performance across the ITER in-vessel components.

The IVVS prototype has a modular, flexible layout to allow testing of multiple different technologies and design options, including both AM and FM Light Detection and Ranging (LIDAR). The prototype shows best performance precisions of ~15 microns at 10 degrees incidence angle, and <50 microns at up to 70 degrees incidence angle, at 4m target distance, far exceeding the ITER requirements.

Prototype measurement noise has been experimentally demonstrated to be dominated by the variation in the return power of the light scattered off the surface. The Bi-direction Reflection Distribution Function (BRDF) of a divertor monoblock prototype was measured, and an analytic microfacet surface reflection model was developed to calculate return power as a function of target incidence angle and distance.

Based on this model, an IVVS simulator was built that allows calculation of the measurement noise across detailed models of the full ITER vacuum vessel. Using this simulator, we show the coverage and measurement performance in high detail over the ITER first wall and divertor, and develop statistical representations of the accuracy of full-vessel measurements using the IVVS.

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