Conceptual Design of the Tangential Interferometer Polarimeter for ITER Density Measurements

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One of the systems planned for the measurement of electron density in ITER is a multi-channel tangentially viewing interferometer and polarimeter (TIP). This work discusses the current status of the design, including a preliminary optical table layout, calibration options, error sources, and performance projections based on a CO_2/CO laser system. In the current design, two-color interferometry is carried out at 10.59 μm and 5.42 μm, and a separate polarimetry measurement of the plasma induced Faraday rotation, utilizing the so-called rotating wave technique, is made at 10.59 μm. The inclusion of polarimetry allows the two-color system to recover unambiguously from fringe skips at all densities, up to and beyond the Greenwald limit as well as the potential to use the polarimeter itself for feedback density control. The system features five chords with independent first mirrors to reduce risks associated with deposition, erosion, etc., and a common first wall hole to minimize penetration sizes. Simulations of performance for a projected ITER baseline discharge show the diagnostic will function as well as, or better than, comparable existing systems for feedback density control. Calculations also show that finite temperature effects will be significant in ITER even for moderate temperature plasmas and can lead to an underestimate of electron density. A secondary role for the system is to measure density fluctuations with frequencies up to 1 MHz. Using a Toroidal Alfvén Eigenmode (TAE) as an example, simulations show TIP will be capable of resolving coherent mode fluctuations as low as $\delta nl/nl \sim 10^{-5}$-$10^{-6}$.

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