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Design of the Collective Thomson Scattering diagnostic for the next-generation fusion experiment ITER

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Abstract

Nuclear fusion has the potential to provide a safe, clean, and virtually inexhaustible energy source for the future. In order to help realise this potential and to assess the fusion performance and safe operating regimes of next-step fusion devices, knowledge of the spatial and energy distribution of fusion-born alpha-particles in the plasma is required. For this purpose, a collective Thomson scattering (CTS) diagnostic is being designed for ITER, the next-step fusion experiment currently under construction in France. The diagnostic is based on characterizing light scattered by the interaction between a powerful injected source beam and ion-driven fluctuations in the plasma. The primary role of the diagnostic is to deliver spatially resolved information on the alpha-particle velocity distribution, with supplementary roles regarding measurements of the ion temperature, plasma rotation, and possibly the fuel-ion ratio. Here we motivate the measurement goals of the ITER CTS diagnostic and describe its current design, which involves a backscattering system operating at a frequency around 60 GHz, multiple mirrors for directing the scattered radiation into the receiver electronics, and viewing lines with no active CTS signal for improved background subtraction. This design draws on the experience from previous CTS systems while also addressing the challenges specific to ITER.