Laser aided diagnostics of JT-60SA

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JT-60SA is currently the largest superconducting tokamak device in the world, which aims to contribute to early realization of fusion energy by supporting the exploitation of ITER and by complementing ITER in resolving key physics and engineering issues for DEMO reactors [1]. Target performance of JT-60SA is breakeven equivalent class high temperature deuterium plasmas and high-β steady-state plasma. Laser diagnostics for control and physics understanding are necessary for JT-60SA to reach its operational targets and will be developed by overcoming challenges specific to large tokamaks.

Diagnostic system development for JT-60SA is being carried out step-by-step in accordance with project phases. In the operation phase 1 (OP1), a two-color CO_2 interferometer has been installed to evaluate fundamental plasma performance and demonstrate control [2-3]. For OP2, where additional systems including heating and magnets are installed, a polarimeter and Thomson scattering system (TSS) [4-8] are being developed for detailed physics studies. For OP3, installation of a phase contrast imaging (PCI) system is planned, aiming at advanced investigation of turbulent transport and its application to plasma control [9].

Although the interferometer has a long path length of 214 m, the noise floor is maintained near $2x10^{19}$ m^{-2} by a beam axis stabilizing system. The system also features fringe-jump detection and real-time processing, enabling density feedback control. The polarimeter uses the same CO_2 laser as the interferometer, and its polarization angle resolution is required to be less than 0.05 degree. The TSS is required to provide electron temperature with adequate resolution for both core and edge. In the core, measurements in the range of 0.1–30 keV with a spatial resolution of 25 mm at 50 Hz are required. In the edge, for example for pedestal studies, measurements in the range of 0.01–10 keV with higher spatial resolution of 5.5–25 mm at 100 Hz are required. The PCI is designed to provide wavenumbers mainly in an ion-scale instability range and optionally electron-scale instability. The spatial resolution is less than 5% of minor radius at the pedestal and near the magnetic axis.

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