Development and recent progress of advanced plasma diagnostics on Thailand Tokamak-1

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Thailand Tokamak-1 (TT-1), a compact tokamak commissioned in 2023, has a major radius of 0.65 m and a minor radius of 0.20 m, and is designed to operate with plasma currents up to 100 kA and toroidal magnetic fields up to 1 T. As a compact fusion device, TT-1 provides a cost-effective platform for the development and validation of advanced plasma diagnostics, enabling experimental verification and diagnostic optimization while supporting plasma physics research. Several advanced diagnostic systems have been developed on TT-1 to support plasma physics studies and diagnostic innovation. Among these systems, a hard X-ray (HXR) diagnostic system, comprising two $LaBr_3$(Ce) scintillation detectors [1], a plastic scintillator, and a GAGG(Ce)-SiPM detector, has been developed to investigate runaway electron phenomena. Preliminary measurements have revealed anisotropic HXR emissions, suggesting a directional distribution of high-energy electrons. Analysis of the measured HXR spectra enabled the reconstruction of the electron energy distribution, revealing the presence of high-energy electrons with energies of up to approximately 6.5 MeV [2]. Complementing the HXR measurements, an integrated soft X-ray (SXR) diagnostic system has been developed to investigate plasma radiation, electron temperature, impurity transport, and magnetohydrodynamic activity. The system consists of a Si-based spectrometer [3], an SXR imaging system, and horizontal and vertical fan-shaped SXR cameras for tomographic reconstruction of plasma emissivity profiles, providing complementary spectral, spatial, and temporal measurements of plasma behavior in TT-1. In addition to passive diagnostic measurements, electrode biasing experiment has been initiated to actively modify the edge radial electric field and improve plasma confinement. Furthermore, a heavy ion beam probe (HIBP) diagnostic is under development to enable direct measurements of plasma potential and fluctuation dynamics, providing valuable insights into plasma transport and electric field structures [4]. This work reports the recent progress in the development of advanced diagnostics on TT-1 and highlights their contributions to plasma physics research on TT-1. These developments continue to enhance TT-1 as a versatile platform for plasma fusion research.

Reference

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