

Plasma equilibrium and fluctuation measurements in the plasma edge using a Rogowski probe in the TST-2 spherical tokamak

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Measurement of the local current density in the plasma edge region in Ohmic plasma discharges was performed successfully using a Rogowski probe in the TST-2 spherical tokamak ($R_0 = 0.36$ m, $a = 0.23$ m, $B_t < 0.3$ T) [1]. The Rogowski probe consists of two multi-layer Rogowski coils, five magnetic field pick-up coils and two Langmuir probes, and it can be moved along the major radius of the tokamak and rotated around the shaft axis (in the toroidal-poloidal plane). Thus, the measurement of the current density profile in the major radial direction, including the angular dependence in the toroidal-poloidal plane, can be accomplished. The current density profile was measured in outboard-limited and inboard-limited Ohmic plasma discharges. In TST-2, the antenna limiter on the outboard side is located at $R_{\text{ant-lim}} = 585$ mm. In inboard-limited plasmas, current was observed behind the limiter (i.e., $R > R_{\text{ant-lim}}$), and the measured current density profile did not agree with the profile calculated by EFIT. On the other hand, for in inboard-limited plasmas, such current was not observed, and the measured current density profile agreed with the calculated profile.

Significant positive spikes and oscillations in both positive and negative directions were observed in the measured local current. Using a fast camera (up to 1,000,000 frames per second) and a Langmuir probe placed on the Rogowski probe, visible light emissions from the probe and ion saturation current spikes were observed at the time of the current spike. It is inferred that current spikes are due to a locally dense filamentary structure passing through the Rogowski coil.

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[1] H. Furui, et al., Rev. Sci. Instrum. 85, 11D813 (2014).