Multi-Dimensional Incoherent Thomson Scattering System in PHAse Space MApping (PHASMA) Facility

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A multi-dimensional incoherent Thomson scattering diagnostic system capable of measuring electron temperature anisotropies at the level of the electron velocity distribution function (EVDF) is implemented on the PHAse Space MAppgin (PHASMA) facility to investigate electron energization mechanisms during magnetic reconnection. This system incorporates two injection paths (perpendicular and parallel to the axial magnetic field) and two collection paths, providing four independent EVDF measurements along four velocity space directions. For strongly magnetized electrons, a three-dimensional EVDF comprised of two characteristic electron temperatures perpendicular and parallel to the local magnetic field line is reconstructed from the four measured EVDFs. Validation measurements of isotropic electrons were performed in a single magnetic flux rope and a steady-state helicon plasma. Measurements in merging flux rope experiments show spatial gradients of anisotropic electron heating (perpendicular greater than parallel) in the region around the magnetic X-point.

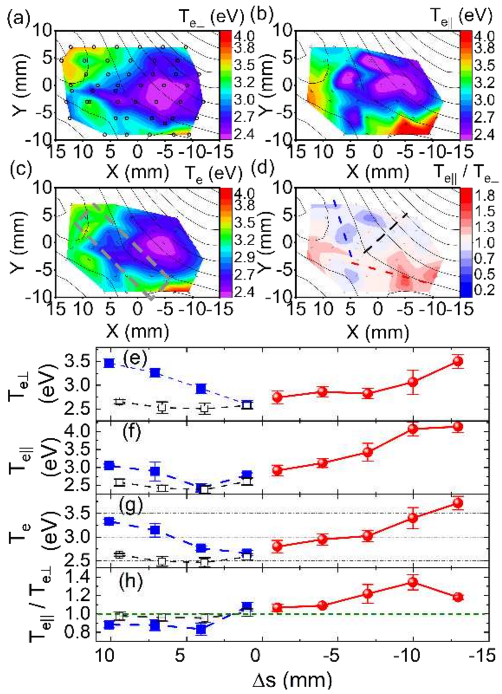

Figure 1. 2D spatial profile of (a) perpendicular electron temperature $T_{e\perp}$ (b) parallel electron temperature $T_{e\parallel}$ (c) effective electron temperature T_e and (d) anisotropy $T_{e\perp}/T_{e\parallel}$. Black lines are in-plane magnetic field projections and 43 gray dots show the measurement locations. The dashed rectangle in (c), half of the electron diffusion region, is used to calculate energy fluxes. The corresponding 1D profiles along separatrix I (red points for the red dashed line in (d)), II (blue solid squares for the blue dashed line in (d)) and the inflow direction (black open squares for the black dashed line in (d)): (e) $T_{e\perp}$ (f) $T_{e\parallel}$ (g) T_e and (h) $T_{e\perp}/T_{e\parallel}$. Δs is the distance from the X-point.

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