Measurements of Plasma Parameters Using Fast Sweeping Langmuir Probe in VINETA-II magnetic reconnection experiment

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VINETA-II is a linear experiment developed for the study of a driven magnetic reconnection [1]. Characterization of VINETA-II plasma properties is important to relate the magnetic reconnection events to the response of the plasma. The strongly transient characteristics of the reconnection drive make measurements, however, a challenging task. For this a novel fast-sweep Langmuir probe has been constructed and successfully operated. The developed probe setup makes measurements of the reconnection current sheet plasma during the reconnection possible on a fast time scale. The probe is biased by means of a time-dependent sinusoidal voltage signal with a fixed frequency. Current - voltage characteristics are measured along the falling and rising slopes of the applied signal. The probe permits sweep frequency up to 400 kHz. The circuit response has been tested by measuring the known current - voltage characteristics of resistors and capacitors. The axial plasma current in VINETA is driven by plasma gun pulsed with the time scale of 60 µs. Probe results present the first time dependent measurement of $n_e$, $T_e$, $\phi_{fl}$, $\phi_p$ of the plasma with and without magnetic reconnection. The $n_e$ measurements agree favorably with those derived from interferometer measurements.

The developed probe setup allows us to characterize the electrostatic radial electric field, which is discussed to be a main contributor to ion heating within the current sheet. Also, the information about the radial profile of a plasma pressure $\nabla p$ allows to estimate the residual between $\nabla p$ and $j \times B$ terms in the in-plane MHD force balance equation. The key question in the magnetic reconnection is which terms in the generalized Ohm’s law are important. Answering this questions requires the measurements of an axial electrostatic electric field, which opposes the externally driven inductive electric field. The results on the axial electric field measurements are also presented in the work.

Literatur