LIF-Dip Probe Diagnostic for Pulsed Electron Plasma Source

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A modified Laser Induced Fluorescence Dip (LIF-Dip) diagnostic [1] is applied to study the time evolution of plasma parameters of a cathode plasma during the extraction of a pulsed electron beam by an external electrical field. Plasma parameters are estimated from measurements of the spatial electric field distribution around a small conductive probe submerged in the bulk of the cathode plasma. It is well known that the disturbance of the plasma due to the probe is screened out by the formation of a plasma sheath, a region of space charge imbalance which extends in Debye length scale towards the undisturbed plasma. The sheath´s characteristics, plasma potential and spatial field distribution, are determined exclusively by the plasma parameters of the local unperturbed plasma. The plasma parameters are obtained by matching the measured electric field distribution to the field resulting from the numerical solution of the Poisson equation. The space charge density in the Poisson equation is described by the plasma parameters, which are varied in an iterative process until an optimal fit with the measurement is achieved. The measured cathode plasma parameters at different stages of the discharge and under different pulsed electron source regimes are presented.

[1] W. An, Z. Wang, A. Weisenburger, and G. Mueller, “Laser-induced fluorescence-dip spectroscopy of Rydberg states of xenon for electric field measurement in plasma,” Review of Scientific Instruments, vol. 93, no. 2, Feb. 2022, doi: 10.1063/5.0064676.

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