Seminar

Institute for Plasma Research

Title : Spectroscopic measurements of electric and magnetic field distributions in a relativistic self-magnetic-pinch diode

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Date : 24th October 2019 (Thursday)

Time : 11.00 AM

Venue : Seminar Hall, IPR

Abstract:

The collective motion of charged particles in the gaps of high-current diodes are rather complex, and have been the subject of numerous computations. The only direct approach known for experimental investigation is the measurements of electric (E) and magnetic (B) fields [1, 2]. While the spatial distribution of B yields the current-flow distribution, the integral and the derivative of E give, respectively, the potential and the charge distributions. The measurements of this work were performed on a self-magnetic-field (SMP) diode of Sandia National Laboratories, NM, USA used as an intense focused radiation source [3]. The electron beam focusing on the anode center gives $\gtrsim$1 MA/cm2 current density. Visible emission due to plasma formed over the anode surface was used to obtain the Stark shift and Zeeman splitting, giving the axial distribution of E and B at various radii. Fiber arrays and gated ICCD cameras allowed for line shape analysis with resolutions of ~0.5 mm and ~10 ns. The data required detailed analysis of line shapes observed along chords in which a number of factors (Zeeman, Stark, and Doppler effects) needed to be discriminated. The axial B-field distribution demonstrated quantitatively the shielding of the field by the anode plasma, and allowing for determining reliably the plasma conductivity from the magnetic field diffusion. The axial E-field distribution revealed significant reduction in the effective anode-cathode gap. Explanation of these detailed results provides challenge for present simulation code [4].

*Work performed at Weizmann Institute of Science, Israel in collaboration with Sandia National Laboratories, USA.

[1] Y. Maron et al, Phys. Rev. A 36, 2818 (1987); J. E. Bailey et al, Phys. Rev. Lett. 74, 1771 (1995).
[2] Y. Maron et al, Phys. Rev A 39, 5856 (1989); E. Stambulchik et al, Phys. Rev. Lett. 98, 225001 (2007); R. Doron et al HEDP 10, 56 (2014).
[3] K. D. Hahn et al, IEEE Trans. Plasma Sci. 38, 2652 (2010).
[4] M. G. Mazarakis et al, Phys. Plasmas 25, 043508 (2018); N. Bennett et al, Phys. Plasmas 22, 033113 (2015)