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By

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Investigation of electric fields in plasmas under pulsed currents

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Abstract

Interaction of the magnetic field with plasmas is an intriguing subject of modern plasma physics. Detailed and reliable measurements of the key plasma parameters, as well as the development of the diagnostic methods, are highly required for improving the understanding of this rather complicated problem and for the progress in theoretical modelings. Here described is a novel application of spectroscopy to investigate the electric fields in plasmas as a function of time and spatially resolved in 3D under high-current pulses. The method is based on active laser spectroscopy combined with plasma doping, which allow for electric field measurements using line-shape analysis of the dopant emission. The study is carried out in a coaxial-pulsed-plasma configuration (commonly referred to as Plasma Opening Switch). The temporal evolution of electric fields in the plasma is investigated for the first time during the current conduction, achieving simultaneous high temporal and spatial resolutions.

The data obtained provide information that is important for the understanding of the magnetic-field penetration into low-collisionality plasmas. The field penetration, seen to be significantly inconsistent with diffusion, has been studied extensively, although no satisfactory understanding is available as yet. It is found that the electric fields here observed can be attributed to the Hall electric field generated due to sharp gradients of the magnetic field. The relatively strong fields seen provide an evidence

of the dominant role of the Hall-mechanism in the magnetic field evolution in the plasma. In addition, turbulent electric fields, which are also observed, are suggested to cause an increase in plasma resistivity, that is likely to affect the magnetic field distribution in the plasma, by enhancing the diffusion process. Another interesting finding is that turbulence is observed in the surface-flashover-produced plasma used to prefill the A-K gap. This turbulence in the injected plasma, prior to the application of the current-pulse driven into the plasma, may affect the evolution of the magnetic field in the plasma, a consideration that has not been accounted for previously.