# Diagnostics of Electric Fields in Current-Carrying Plasmas

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The study of non-equilibrium current carrying plasmas is important for the understanding of basic phenomena in laboratory plasmas, astrophysics, and various other applications. A fundamental question underlying the various attempts to describe a current carried through the plasma concerns the formation of non-neutral regions and generation of strong electric fields. Theories and numerical simulations, predicting the development of these regions with turbulent and quasi-DC electric fields in pulsed plasmas, use assumptions that limit the validity of such theories for experimental systems. We investigate experimentally the phenomenon of electric field generation, to determine characteristics and the spatial distribution of these fields, to study the formation of non-neutral regions, the acceleration of charged particles and generation of instabilities. This study is performed in a Plasma Opening Switch (POS) configuration. Non-intrusive spectroscopic methods, including Laser Induced Fluorescence and plasma doping methods, are implemented to achieve high temporal, spectral, and spatial resolutions simultaneously.

# Collisionless Shock Breakout in Type II Supernovae: TeV Neutrinos and GeV Photon Emission

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We show that, contrary to the common view, the radiation dominated shock, which propagates through a type II supernova progenitor, becomes collisionless as it approaches the stellar surface. Inelastic nuclear collisions of protons accelerated in the shock produce a ~1 hr long flash of TeV neutrinos and 10 GeV photons, about 10 hr after the thermal (10 MeV) neutrino burst from the cooling neutron star. A Galactic supernova in a red supergiant star would produce a neutrino flux easily detectable by km-square neutrino detectors under construction, and a photon flux well above the detection threshold of gamma-ray satellites.