

Self-Generated Magnetic Field Distributions in Multiple-Beam Produced Plasmas

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The importance of self-generated magnetic fields and heat transport inhibition in ignition-scale hohlraums is currently receiving much theoretical attention. In particular, the spatio-temporal evolution of the self-generated magnetic fields and their affect on the plasma evolution inside the hohlraum are not well understood. Megagauss level thermoelectric magnetic fields, attributable to the $\nabla T_e \times \nabla n_e$ mechanism, may be sufficiently large inside gas-filled hohlraums to affect the electron energy distribution by magnetizing the electrons ($\omega_c \tau_e > 1$) and reducing the thermal conductivity $\kappa \approx (1 + \omega_c^2 \tau_e^2)^{-1}$, altering the x-ray emission and uniformity inside the hohlraum, laser-beam propagation and pointing to the inner wall surfaces, parametric instabilities, and beam filamentation.

Here, we report on recent measurements taken using the VULCAN laser facility at the Rutherford Appleton Laboratory, wherein the blow-off plasma generated from planar Au and Al solid targets were characterized. The blow-off plasma was generated by single and double long-pulse (ns-duration) f/10 beam configurations at approx. $10^{14-15} \text{Wcm}^{-2}$.

X-ray emission from the target was monitored from the front surface of the target by a filtered pinhole camera and a fast-gated, four-frame x-ray camera (SLIX). The self-generated magnetic fields due to the laser-solid interaction were measured using the Faraday rotation of a 263nm, 10ps pulse-duration probe beam passed transverse to the target. Simultaneous measurements of the electron density profiles were made using a modified Nomarskii interferometer.

Temperature gradients were measured inside the blow-off plasma using the Thomson scattering of a focused 263nm, 1ns pulse-duration probe beam. The scattered light was spectrally dispersed using a high dispersion, 1m spectrometer (3600 lines/mm grating) coupled to a streak camera.

Target-surface plasma non-uniformities were imaged using high resolution (micron-scale) proton radiography and deflectometry transverse to the target surface using the short-pulse (1ps), high intensity (10^{19}Wcm^{-2}) arm of VULCAN.

We also present some preliminary 2D resistive magneto hydrodynamic code results, modeling the plasma and self-generated magnetic field distributions from single and two-beam planar target interactions.