

Second Beam Test and Numerical Investigation of the Imperial College Plasma (Gabor) Lens Prototype

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The design of the ‘Laser-hybrid Accelerator for Radiobiological Applications’ (LhARA) is based on a series of plasma lenses to capture, focus, and select the energy of the ions produced in the laser-target interaction. A second beam test of the first plasma lens prototype built at the Imperial College London took place in October 2017 at the Ion Beam Centre of the University of Surrey. 1.4 MeV proton pencil beams were imaged 0.67m downstream of the lens on a scintillator screen over a wide range of settings. On top of the focussing effect, the electron plasma converted pencil beams into rings. The intensity of each ring shows a different degree of modulation along its circumference. Analysis of the results implies non-uniformity and an off-axis rotation of the electron plasma.

The effect on the beam is presented and compared to results of a simulation of the plasma dynamics and proton beam transport through the lens. Both a particle-in-cell code and a particle-tracking code were used to study the impact of plasma instabilities on the focusing forces produced by the lens. The $m = 1$ diocotron instability was associated with the formation of ring spots from the pencil beams.