Inertial Confinement Fusion (ICF): collimation of fast electrons for plasma ignition

A paper has recently been published on Physical Review Letters [F. Pérez *et al.*, Phys. Rev. Lett. **107**, 065004 (2011)] reporting on a recent experiment aimed at studying the fast (relativistic) electron beam propagation through a compressed plasma. One of the most promising approaches to the Inertial Confinement Fusion (ICF) relies on a laser-produced high-current, relativistic electron beam to deliver the required energy to a pre-compressed plasma and trigger its ignition. This approach, called “fast ignition”, was proposed in 1994 [M. Tabak *et al.*, Phys. Plasmas **1**, 1626 (1994)]. One of the main obstacles to this approach is the need of an energy deposition into a very small region, which requires a very collimated electron beam, whose collimation was also not so much affected by the propagation inside the compressed plasma. The reported experiment lead to the identification of a well defined regime suitable for this approach.

The experiment was carried out at the Central Laser Facility of the Rutherford Appleton Laboratory (UK), in the framework of the preparatory phase of the EU project of large scale infrastructure HiPER (High Power laser Energy Research facility). Research teams from a variety of EU countries have been involved in the experiment proposal, design and experimental phase; among them, a team of researchers from the Intense Laser Irradiation Laboratory (ILIL, http://ilil.ino.it) of the INO section in Pisa.

Physical Review Letters

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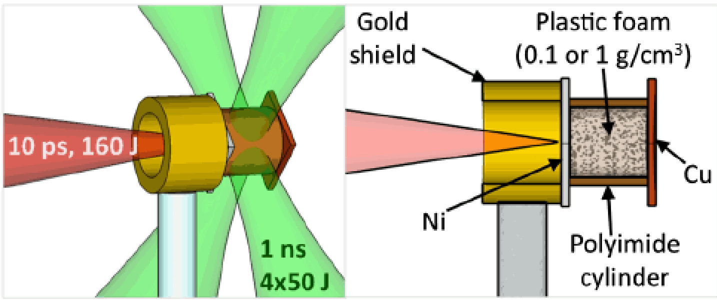
PRL 107, 065004 (2011) PHYSICAL REVIEW LETTERS week ending 5 AUGUST 2011

Magnetically Guided Fast Electrons in Cylindrically Compressed Matter



As shown in the figure (taken from the published paper), an ICF-like compressed plasma was created by radially compressing an ah-hoc cylindrical target by laser ablation using four laser beams focused on its surface. Using a further laser beam, a relativistic electron beam was produced, whose propagation occurred through the compressed plasma, along the direction of the cylinder axis. The propagation of this beam was studied in different conditions, looking at the size of the beam at the exit of the cylinder by advanced X-ray imaging techniques.The experimental data were compared to numerical simulations obtained by advanced numerical codes. As it came out, self-generated magnetic fields can lead, in well defined plasma density and temperature conditions, to a guiding of the electron beam through the compressed plasma.

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