Spatially and spectrally resolved X-ray measurements in Intense Laser-Plasma Interactions

Haydn W. Powell, Xiaohui Yuan, David C. Carroll, Mireille Coury, Ross J. Gray, Ceri M. Brenner*, Mark N. Quinn, Olivier Tresca, David MacLellan, Paul McKenna

SUPA Department of Physics, University of Strathclyde
Glasgow, G4 ONG UK

Bernhard Zielbauer

PHELIX Department, Gesellschaft für Schwerionenforschung mbH, Planckstrasse 1, D-64291 Darmstadt, Germany

X. X Lin, Y. T. Li

State Key Laboratory of Transient Optics and Photonics, Xi’an Institute of Optics and Precision Mechanics, Chinese Academy of Sciences, Xi’an 710119, China

David Neely

*Central Laser Facility, Rutherford Appleton Laboratory, Oxfordshire OX11 0QX, UK

A novel spectrometer designed to enable simultaneous spectral and 1D imaging measurements of X-rays emitted in intense laser-plasma interactions is presented [1]. This new diagnostic enables X-ray emission from a large region of the plasma to be characterised, facilitating for example temperature measurements over extended regions of the target.

The spectrometer was fielded on a recent laser-solid interaction experiment using the PHELIX laser at GSI Darmstadt, with the aim of probing the generation and transport of fast electrons in thin foil interactions. Results from the experiment are presented, together with a 1D numerical model, which was developed to investigate the properties of the fast electron population. It is found that the efficiency of coupling laser energy to fast electrons increases with laser intensity, in agreement with previous results, and that the scaling is sensitive to the laser pulse intensity contrast. The spectrometer was also applied to measure the transport properties of fast electrons on the surfaces of thin foil targets irradiated by intense picosecond laser pulses. Surface guiding of fast electrons along the front surface and subsequent accumulation at the target edges are observed under low-contrast laser irradiation.

The results are important for many topics in high power laser-solid interactions and will help inform the optimum intensity for the fast ignition approach to inertial confinement fusion.