Collective Thomson scattering measurements of electron temperature and electron density in laser-driven EUV plasmas during the laser irradiation

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Plasma temperature (T_e) and density (n_e) are the critical physical properties of laser produced plasma (LPP) to reveal the ablation dynamics, energy transport, and hydrodynamic evolution. In the time window during the drive laser irradiation, experimental data are very scarce so that the early-time LPP dynamics remain poorly understood, while such knowledge is of great importance for the extreme ultraviolet (EUV) lithography. In this talk, we demonstrate collective Thomson scattering (CTS) is a robust tool for characterizing T_e/n_e spatio-temporal evolutions in LPPs at this early stage, for low-Z to high-Z target materials. We investigated LPPs generated from planar solid targets of several metals using a 1.064 μm Nd:YAG laser with a power intensity ranging from 10^9 to 10^{10} W cm^{-2} and a spot size of approximately 550 μm. The study was focused on the dynamics of LPPs during the 7 ns pulse duration (FWHM) of the drive laser. The results demonstrate LPP undergoes a one-dimensional isothermal expansion during and immediately after the drive laser pulse. A comparison between experimental data and the radiative hydrodynamic code STAR shows good agreement. This enables the use of simulation results to predict and understand the dynamics of LPP and plasma-laser interactions in the region close to the target. The combined study of early-time LPP using both experimental and computational approaches provides novel insights into LPP behaviors and offers the potential for optimizing existing EUV-LPP sources.

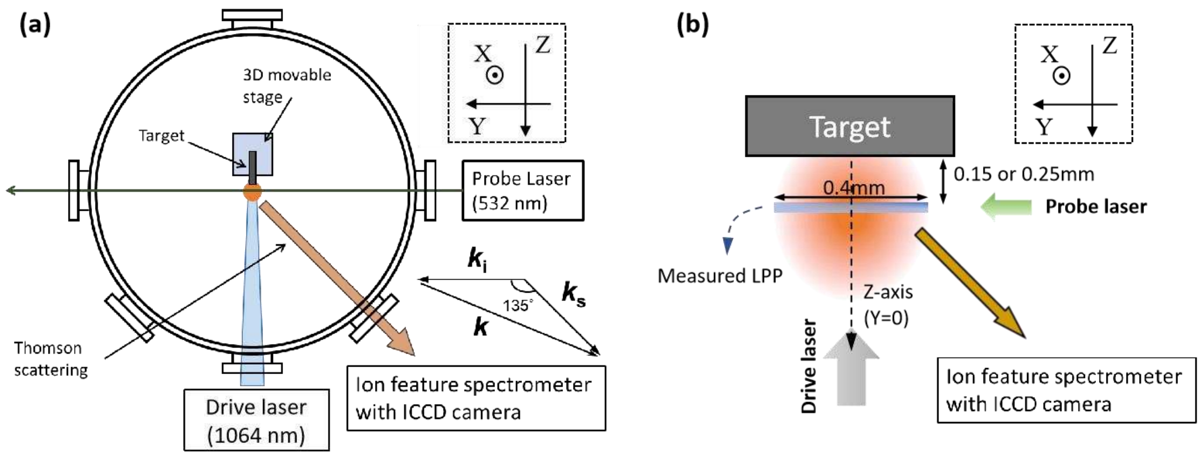

Figure 1. (a) Schematic illustration of the experimental arrangement. (b) Zoomed-in view of the region close to the target.

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