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Shadowgraphy of the plasma evolution around water micro-droplets irradiated by high-power laser pulses

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We present the results of an experiment at the POLARIS laser system (at 1030 nm) using an off-harmonic optical probe, in which the laser-plasma interaction with water micro-droplets was investigated. In contrast to experiments with thin foils, the spherical symmetry of droplets facilitates a direct imaging of the plasma expansion process using shadowgraphy. In the experimental setup, a jet of water was broken up into droplets with a diameter of 20 µm. The POLARIS main laser pulses were focused onto the water droplets to intensities of $4 \cdot 10^{19}$ W/cm^2. The plasma expansion process was probed in a temporal window between 0 ps and 258 ps after the arrival of the main laser pulse. The strong light emission from the laser-induced plasma at the fundamental and second harmonic frequencies was suppressed by using an off-harmonic probe with a bandpass filter. The probe pulses were generated with a synchronized NOPA (µJ-level pulse energy and 750 . . . 950 nm bandwidth). The plasma emission was further reduced by a polarization and a spatial filter. A detailed analysis of the shadowgraphy images allowed us to estimate the plasma expansion velocity of the front ($v_{\text{front}} = 1.27(6)$ µm/ps) and rear side ($v_{\text{rear}} = 0.77(5)$ µm/ps) at the beginning of the expansion process.

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