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Tracking the surface motion of nanometer-scale foils during interactions with ultra-intense laser pulses MATTHEW STREETER, ZULFIKAR NAJMUDIN, Imperial College London, STEVEN COUSENS, BRENDAN DROMEY, MARK YEUNG, MATT ZEPF, Queen's University Belfast, JIANHUI BIN, CHRISTIAN KREUZER, WENJUN MA, Ludwig-Maximilians-Universitat Muenchen, JÜRGEN MEYER-TER-VEHN, JÖRG SCHREIBER, Max-Planck-Instituts fur Quantenoptik, PETA FOSTER, RAJEEV PATTATHIL, CHRISTOPHER SPINDLOE, Central Laser Facility — The surface motion of nanometer-scale foils during irradiation by a relativistically intense ($> 10^{20}$ W/cm^{-2}) laser pulse has been measured using frequency resolved optical gating (FROG) revealing the acceleration of the plasma boundary due to radiation pressure of the laser. Extreme acceleration $\approx 10^{20}$ ms^{-2} leads to velocities ≈ 1 % of the speed of light within the duration (50 fs FWHM) of the incident pulse. This gives maximum proton energies from hole-boring acceleration of a few MeV, lower than the experimentally observed maximum energy. This indicates that acceleration of ions beyond the critical surface is occurring, such as is described by sheath acceleration where fast electrons propagate through the plasma to create an accelerating field at the rear surface. For these interactions, which had a pulse contrast of 10^6 at 1 ps, evidence of initial plasma expansion towards the laser was observed, followed by inward acceleration during the most intense period of the pulse. Targets thinner than the relativistic skin-depth appear to become significantly transparent to the laser.

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