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Ultrafast phase-contrast imaging of laser driven shocks using LWFA Betatron X-rays DAVID CHAPMAN, MICHAEL RUTHERFORD, DANIEL EAKINS, Institute of Shock Physics, Imperial College London, JONATHAN WOOD, KRISTJAN PODER, NELSON LOPES, STUART MANGLES, John Adams Institute for Accelerator Science, Imperial College London —
In recent years Betatron X-rays produced within a laser-plasma wakefield accelerator (LWFA) have emerged as a potential alternative to advanced photon sources, such as Synchrotrons and X-ray free-electron lasers. LWFA Betatron X-rays offer the attractive combination of high brilliance, short pulse duration, and high-energy polychromatic X-rays, which make them particularly suitable for imaging highly transient events such as shock wave evolution in solids. We describe pioneering experiments on the 400 TW Astra Gemini laser at the Rutherford Appleton Laboratory, UK, imaging laser driven targets using Betatron X-rays. Shock waves were driven into thick aluminum foils using a 30J IR long-pulse (30ns), and stroboscopically radiographed perpendicular to the shock propagation direction using a ≈ 40 fs Betatron X-ray pulse (10-30 keV). The resulting high resolution (4 μm) radiograph time-sequence captured the shock wave propagation, and ultimate evolution of jets and spallation formed on the rear grooved surface of the aluminum targets. The measured dynamic radiographs are compared to 2D Hyades simulations, demonstrating a new capability to benchmark radiation-hydrocode modeling of laser-target interaction.

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