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Title: Single-shot Double-pulse Method Used to Determine Deposited Energy in Laser Ablation Plasmas

Abstract

We investigate a double-pulse technique to determine the laser-produced plasma (LPP) detonation energy based on a Sedov blast model fit to two distinct time frames on a single ablation laser shot. The method serves as a single-shot diagnostic for the laser-target interaction during the laser ablation (LA) process. We plan to implement this tool to investigate the mechanisms which lead to the signal formation during long-distance, multi-filament ablation of solid targets. Multi-filamentation involves the formation of numerous detonation sites on the target surface. For laser peak powers greatly exceeding the critical power for self-focusing, several intense filament cores nucleate from noise and other beam instabilities. Conventional methods to determine the energy deposited in the target no longer provide the resolution to distinguish between detonation sites from these cores; moreover, the cores typically form sporadically and vary in position significantly from shot to shot. Methods that are commonly used to determine laser-target coupling efficiency include the measurements of the ablation crater, mass removal, target recoil, and tracking the expansion rate of the LPP shockwave, which is then analyzed using the Sedov blast model. We validate the proposed single-shot, double-pulse method based on blast model analysis by comparing with a multi-shot, scanning approach and a single-shot recoil-based technique.