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Application of the 3-frame interferometry and the crater replica method for investigation of laser accelerated macroparticles interacting with massive targets in the Prague Asterix Laser System (PALS) experiment

Stefan Borodziuk, Andrzej Kasperczuk, Tadeusz Pisarczyk, Nikolay N. Demchenko, Sergey Yu. Gus'kov, Vladislav B. Rozanov, Milan Kalal, Jiri Limpouch, Jiri Ullschmied, Karel Rohlena, Jiri Skala, Vladimir N. Kondrashov, Pawel Pisarczyk

Keywords

laser produced plasma, three-frame interferometry, optical microscopy, macroparticle, single and double targets, crater, classical inverse bremsstrahlung absorption, shock wave, efficiency of laser radiation absorption, ablation loading efficiency

Abstract

In the present paper results from our experiments with macroparticles, accelerated at first to high speeds by the PALS iodine laser and subsequently hitting massive targets and creating craters, are presented. The main aim of these investigations concerned the influence of wavelength on the efficiency of macroparticles acceleration and creation of craters. To this end, two different harmonics of the PALS laser beam (λ_1 = 1.315 μm and λ_3 = 0.438 μm) and several types of targets (simple massive planar Al targets as well as much more elaborated double targets consisting of 6 μm thick Al foils or disks placed in front of the massive target at the distance of either 200 μm or 500 μm) were used. All these targets were irradiated by the iodine laser beam with its parameters very much the same for both harmonics: the energy of 130 J, the focal spot diameter of 250 μm, and the pulse duration of 400 ps. Velocities of accelerated extracted foil fragments or disks as well as electron density distributions of plasma streams were determined by means of the 3-frame interferometry. Shapes and volumes of craters were obtained employing the crater acetate cellulose replica technology and microscopy measurements. The data from these experiments provided valuable information concerning the ablative plasma generation and crater creation processes.