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IMPROVEMENT OF THE TWO-STAGE LIGHT-GAS ACCELERATORS PERFORMANCE BY USING THE PHOTONIC DOPPLER VELOCIMETRY (PDV)

Abstract

Earth impacts by asteroids and comets have taken place frequently throughout geological history. One strategy to prevent such a collision with a Near Earth Object is to use a kinetic impactor. In the EU project NEOShield, Fraunhofer EMI has conducted laboratory impact experiments of small projectiles on asteroid-like materials in order to investigate this solution. To investigate such solutions, also for other applications such as spacecraft protection, the performance of the gun accelerator is the key to understanding the involved physics. Current state-of-the-art laboratory two-stage light-gas accelerators are limited to exit velocities of approximately 8 to 9 km/s. In order to achieve a better understanding of the impact process in higher velocity ranges, it is necessary to increase the achievable impact velocities in a laboratory environment. Important key elements for achieving this goal are the investigation and a better understanding of the acceleration process of the projectile in the barrel. To this purpose, tests were conducted with a Photonic Doppler Velocimetry (PDV) system at the Fraunhofer Institute for High-Speed Dynamics, Ernst-Mach-Institut, EMI, to measure the axial velocity, displacement and acceleration of a projectile during the acceleration in the barrel. Based on these results, improvements to increase the performance of the accelerators can be derived. This paper starts with an analysis of the significance of increasing the currently achieved impact velocities. Next, the Photonic Doppler Velocimetry (PDV) technique used at EMI is described as well as the results of initial tests performed at different velocities. The paper describes the improvement in performance of a two-stage light-gas accelerator that can be achieved using a sabot design that is tailored to the actual acceleration versus time profile.