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Hollow targets for efficient acceleration of ions by ultrashort laser pulses

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The efficiency of ion acceleration driven by high-power femtosecond laser pulses strongly depends on the target thickness as well as on the absorption of laser pulse energy into ionized solid target. The absorption can be enhanced by using submicron structures deposited on the target laser-irradiated surface. For example, previous experiments demonstrated increased efficiency of ion acceleration from the targets with deposited layer of closely-packed nanospheres on the laser-irradiated side (the so-called nanosphere targets). On the other hand, the layer of deposited structures may increase the overall target thickness, which is not favorable for the acceleration efficiency.

Here, the employment of hollow targets is proposed, which enables to enhance the absorption of laser-pulse energy and to maintain a very small target thickness at the same time. It is demonstrated by full 3D particle-in-cell simulations that the efficiency of proton acceleration from hollow targets substantially exceeds the efficiency of the acceleration from flat foils of the same thickness. One can also observe that the enhanced proton acceleration is maintained with a larger incidence angle of the laser beam on the hollow target in contrast to the nanosphere target. Moreover, the fabrication of the first prototype of the proposed target by focused ion beam milling is briefly described.

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