Laser ion acceleration from tailored solid targets with micron-scale channels

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Laser ion acceleration is a promising concept for generation of fast ions using a compact laser-solid interaction setup. In this study, we theoretically investigate the feasibility of ion acceleration from the interaction of petawatt-scale laser pulses with a structured target that embodies a micron-scale channel filled with relativistically transparent plasma. Using 2D and 3D Particle-In-Cell (PIC) simulations and theoretical estimates, we show that it is possible to generate GeV protons with high volumetric charge and quasi-monoenergetic feature in the energy spectrum. We interpret the acceleration mechanism as a combination of Target Normal Sheath Acceleration and Radiation Pressure Acceleration. Optimal parameters of the target are formulated theoretically and verified using 2D PIC simulations. 3D PIC simulations and realistic preplasma profile runs with 2D PIC show the feasibility of the presented laser ion acceleration scheme for the experimental implementation at the currently available petawatt laser facilities.