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Enhanced Target Normal Sheath Acceleration of heavy ions using nanostructured targets

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Target normal sheath acceleration (TNSA) is one of the best-known laser-plasma interaction mechanism of ion acceleration, capable of generating multi-MeV collimated ion beams. The conventional TNSA (flat-foil target) has a few inherent limitations, such as poor coupling efficiency of the laser energy into hot electrons and short ion acceleration distance at the back of the target. By means of a 3D particle-in-cell simulations, we show that the interaction of ultra-intense ultrashort laser pulses with a periodic nano-trenched M-shaped Si structures [1] can produce highly collimated, energetic vacuum-accelerated [2] electron bunches in the nano-trench. This results in a substantial enhancement in both the total and cutoff energies of the produced Si ion beams. The numerical studies reveal the optimal laser-target parameters, such as nano-trench thickness, periodicity of structures, laser wavelengths and energies.

1) Shcherbakov, M.R., Sartorello, G., Zhang, S. et al. Nat Commun 14, 6688 (2023).
2) Jiang S. et al., Phys. Rev. Lett.,116, 085002 (2016); Naumova N. et. al., Phys. Rev. Lett., 93, 195003, 2004; Curtis A., Calvi C., Tinsley J. et al., Nat. Comm. 9, 1077 (2018).

Working group

WG2 : Laser-driven plasma acceleration of ions

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