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Simulation of optimized TNSA via temporal pulse shaping under realistic laser contrast conditions

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Controlling the spatio-temporal coupling of laser energy into plasma electrons is crucial for achieving predictable beam parameters of ions accelerated from ultra-high intensity (UHI) laser-driven solid density plasmas. Especially for highest maximum energies, the most promising and readily available targets are foils of a few ten to hundred nanometers thickness. When working with targets of such small scales, meticulous control and precise metrology of the driving UHI laser pulses are paramount to avoiding premature plasma expansion that would lead to losses in absorption efficiency as well as lower accelerating fields. Recently, significant proton beam quality enhancement was reported from the Draco Petawatt facility at HZDR via spectral phase control of the driving laser pulse. In support of these experiments, we present a numerical simulation study with particle-in-cell codes taking into account realistic temporal intensity contrast features. In particular, we focus on the influence that manipulations of spectral phase terms applicable in laboratory experiments have on the acceleration of ions. We furthermore show how the state of the target and transient femtosecond plasma dynamics are encoded into time-integrated observables giving more insight into the previously obtained experimental results.

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