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Proton energy enhancement by controlled preplasma formation

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The continuous development of laser systems, now easily reaching the petawatt level, is posing an interesting challenge related to understanding the effect of the prepulse. This effect is important even when using lower power systems, if the main pulse intensity on target is enough to work in Target Normal Sheath Acceleration conditions. Every time we irradiate with such a laser system a solid target, a preplasma made by the prepulse is created. This poses a serious challenge to understand its effects, due to its importance even in high-contrast experimental conditions. Several phenomena can lead both to an enhancement of the quality of the beam or to a severe decrease. Depending on the prepulse duration, intensity and temporal shape we can have many different target configurations when the main pulse arrives on it. In this work, we will investigate those conditions through a multi parametric 2D particle-in-cell scan. From the results of this systematic numerical study, we will discuss the optimal working conditions also in view of the attempt to model the experimental results for a particular case which is related to the ILIL/INO Laser system installed in Pisa.

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