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Enhancing of deuteron acceleration with spectral phase modulation of few-cycle laser pulses

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Characteristics of ions accelerated in laser plasma depend on the parameters of the irradiating laser pulse, especially on its temporal contrast and pulse duration. The latter can be varied also by introducing chirp to the spectral phase of the pulse. Recent studies have revealed such an effect with the use of 100 TW peak power lasers. However, the temporal contrast was probably not high enough in such an experiments for providing an unambiguous explanation.

We have carried out series of systematic experiments to study the dependence of laser-accelerated deuterons on the temporal shape of the laser pulses. The TW peak power, 12 fs laser pulses of the SEA laser in ELI-ALPS exhibit a temporal contrast better than 10^11 at the leading edge. A DAZZLER varied both the linear (GDD) and nonlinear chirp (TOD) on a broad range.

Two types of ultrathin targets were investigated, both promising for laser-based neutron generation: deuterated foils and heavy water leafs. The cut-off energy of the ions and the maximum total energy of an ion bunch were measured by Thomson ion spectrometers. The studies revealed that the least cutoff and yield were achieved with transform limited pulses, while the highest values were obtained with pulses of negative GDD. However, at zero GDD, the deuteron yield and cutoff energy varied a factor of two, depending on the sign and the amount of TOD. Such phenomena, supported by 2D PIC simulations, can be explained by self-induced transparency and post-acceleration.

Working group

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