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Enhanced laser-driven ion acceleration using nanometer targets

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Radiation Pressure Acceleration is quite promising for ion acceleration. In order to improve the laser energy transmission efficiency and restrain instabilities such as RTI and hole boring, an ultra-high intensity, ultra high contrast laser pulse with steep front is required and therefore a plasma lens with near critical density is proposed. When the laser passes through the nearly critical dense Plasma lens, the transverse self-focusing, longitudinal self-modulation and prepulse absorption can be synchronously happened. The enhanced ion acceleration using plasma lens can be implemented by a DLC foil attached by a nanotube foam target. In recent experiments at RAL in UK and GIST in Korea, it was testified that the proton and ion energy can be enhanced by 2-3 times.
Prompted by the possibility to produce high energy, single-cycle laser pulses with tens of Petawatt power, we have also investigated laser-matter interactions in the few optical cycle and ultra relativistic intensity regimes. A particularly interesting instability-free regime for ion production was revealed leading to the efficient generation of monoenergetic ion bunches with a peak energy greater than GeV. Of paramount importance, the interaction is absent of the Rayleigh Taylor Instabilities and hole boring that plague techniques such as target normal sheath acceleration and radiation pressure acceleration.

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