Effective sources of high-energy protons and electrons from innovative low-density targets

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As presented here, modern techniques for producing films of assembled single-wall carbon nanotubes (SWNTs), including hydrogen doping, with desirable mass densities and thicknesses [1] open ways to implement them for laser-triggered ion generation. Such SWNT films are well suited for the recently proposed synchronized acceleration of protons by slow light (SASL) [2]. Based on 3D PIC simulations, we have shown the extraordinary efficiency of proton acceleration by relativistically strong laser light in terms of maximum proton energy from low-density carbon nanotube targets with hydrogen as a surface contamination and as a volumetric impurity. The energy conversion efficiency to the protons with energy in excess of laser ponderomotive potential increases almost proportionally to the partial hydrogen density until the latter stays considerably less than a carbon density and reaches about 1%. This open a way for further increase of energy conversion efficiency with SASL if new low-density strongly hydrogenized targets could be produced.

An innovative SWNT targets are also very useful to produce high-energy electron bunches of several tens of nC with effective temperature suitable for deep gamma-radiography. Corresponding 3D simulation results for spectral and angular distributions for forward-accelerated electrons from low-density targets are presented.

We hope that presented results will motivate future experimental works on high-energy particle acceleration from low-density targets, especially because SWNT targets are currently available.

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References