Advanced study of laser triggered proton acceleration from low-density target

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Here we discuss the recently proposed concept of proton synchronized acceleration by slow light (SASL) from low-density targets by powerful laser pulses [Brantov et.al, Phys.Rev.Lett. 116, 085004 (2016)]. In SASL regime ions are accelerated by laser ponderomotive electric sheath, which propagates in a plasma with the same velocity as a laser pulse. Monotonic increase of the pulse group velocity during propagation of light makes ions possible to move in sync with accelerating electrostatic sheath. We extend the general idea of SASL concepts on the low-density targets available in practice and present the 3D PIC simulations of proton acceleration from low-density carbon nanotube target with hydrocarbon contaminated edges or bulk target volume. It has been shown that maximum proton energy is rather independent on the hydrogen density inside low-density target unless it does not exceed 10% of carbon density. The pre-pulse effect on proton acceleration efficiency has been also studied by modeling the targets by given pre-plasmas or by using picosecond wings for incident laser pulse. We have demonstrated as well, that using of circular polarization allows laser pulse to enter SASL regime at considerably lower intensity, as compared to earlier reported value at the level of about 10^{21} W/cm^2. The discussion of advances of circularly polarized laser pulses for ion acceleration is addressed in details.

This work was supported by the Russian Science Foundation (grant 17-12-01283).