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Intense Short Laser Interactions with Tailored Structured Targets

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Laser-solid interactions has many applications in laser fusion, the production of energetic particles and X ray or Ka source. Some kinds of tailored structured targets were proposed to enhance laser-target coupling and improve the qualities of fast electrons.

When an intense propagates in a vacuum capillary, its profile is reshaped due to laser-plasma interaction near the entrance of capillary. Only the relatively low-intensity periphery of the reshaped pulse interacts with the capillary-wall plasma, so that the high-intensity center of the pulse can propagate in the narrow vacuum channel over a distance much larger than the Rayleigh length. Furthermore, the quality of the laser pulse can be greatly improved by such a vacuum capillary.

A hollow cone with two opens can be used to focus an intense laser to a tiny and highly localized spot. The interaction creates a new self-consistently evolving light-plasma boundary, which greatly reduces reflection and enhances forward propagation of the light pulse. The hollow cone can thus be used for attaining extremely high light intensities for applications in high energy-density physics and other areas. When a thin foil is attached to the tip of the cone, the cone-focused light pulse compresses and accelerates the ions in its path and can punch through the thin target, creating highly localized energetic ion bunches of high density.

A novel copper nanobrush target was proposed to achieve brighter Ka X ray. Compared to a regular planar target, the simulations show that the laser absorption efficiency by the particular target is remarkably enhanced to near 80%. The depth of laser energy penetration is larger than the skin length and more fast electrons are generated, so the laser coupling efficiency is greatly increased. The physics on the enhancement of Ka photon yield and conversion efficiency from laser to Ka x-ray is studied by combining Monte Carlo simulations and previous particle-in-cell simulation results. Subsequently, the conical nanolayered, cone-nanolayered and tailored cone-nanolayered targets are proposed to enhance coupling efficiency and control the emission angles of fast electrons. They are very promising in designing high brightness X-ray or Ka sources.

Finally, some recent research on laser interactions on solid target with external magnetic fields will be presented.

References

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