Laser interaction with microstructured media for radiation and nuclear application

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The use of microstructured targets in interaction with intense ultrashort femtosecond laser pulses is considered to be uniquely convenient approach for the development of a compact versatile pulsed source of secondary radiation. Innovative nano and micro-sized targets, including sub-microwire array target, droplet and micro cluster media, allow effectively absorb laser energy, generate high energy electrons and, as a result, increase the production of accelerated ions, x-rays, neutrons, etc [1-3].

In this work, the target parameters are optimized for efficient volumetric heating of a sub-microwire array target and cluster media by a relativistically intense ultrashort laser pulse using 3D PIC simulation. For micro-cluster plasma such heating is clearly illustrated by the first time discovered plateau in the energy distribution of hot electrons with super-ponderomotive energy, which opens up new possibilities for creation of the X-ray source with a cluster target. Using the obtained results of large-scale structural target optimization, which provides its best heating by femtosecond laser pulses of moderate intensity, we estimated of thermonuclear neutrons yield from various deuterated sub-micro-sized targets [4-5].

It is shown that, for modern laser technologies, femtosecond lasers of low (multi-mJ) energy are even more preferable for creating a neutron source than more powerful (~1 J) lasers due to the practically available mode of high (~1 kHz) pulse repetition rate. We expect a neutron yield of $5 \cdot 10^7$ neutron/s (for deuterated wires) and 10^9 neutron/s (for wires containing deuterium and tritium) at a laser pulse energy of 25 mJ. Micro-layers (relief) on the irradiated side and micro-cluster media are considered as alternative microstructured targets.

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References

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