Simulation of the interaction of an ultrashort high-intensity laser pulse with a structured medium of large volume

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The concept of maximizing deuteron yield from laser-heated large volume of deuterium-containing microstructured target by matching the focal spot size and structural scales of target to the laser pulse intensity was confirmed. We demonstrate this concept using microcluster targets as an example. For this purpose, the three dimensional PIC-GEANT4 simulations have been performed by zoning of the large interaction domain. While considering a small domain of the entire interaction volume, which is partitioned into successive zones along laser propagation direction a special algorithm was proposed allowing to reconstruct integral spectrum of deuterons and D-D neutron yield. Using the spectral fitting functions for deuterons based on the so-called support functions received from the PIC (particle-in-cell) simulations we also propose here an easy-to-use fitting formula for the neutron yield.

We show that it makes possible to specify high-performance laser-cluster neutron source following this concept. For the submicron heavy water droplets heated by femtosecond laser pulse of the intensity 3×10^{19} W/cm^2 a D-D neutron yield may reach 10^7 neutrons per 1 J of deposited laser energy if the intensity contrast ratio prevents premature cluster destruction. Such yield is considerably higher than achieved to date for microstructured targets.