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NUMERICAL SIMULATION OF LASER-TRIGGERED ION ACCELERATION FROM LARGE VOLUMES OF STRUCTURED MEDIUM *)

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The interaction of high-power ultrashort laser radiation with structured targets is of great interest both from the point of view of increasing the average energy of charged particles and the total charge of laser-heated particles compared to traditional flat solid targets for possible use in nuclear physics, physics of extreme states of matter, and radiography. One type of structured media is large sub-micro-sized cluster and/or droplet targets. Interest in a cluster medium is due to the fact that, on the one hand, it is transparent to laser radiation, and on the other hand, the solid-state density of clusters ensures almost complete absorption of laser energy and a large number of laser-heated particles. The peculiarities of cluster targets also make it difficult to simulate large volumes of laser-cluster interaction, including for the case of high-power PW laser systems (for example, the XCELS project [1]). Performing simulations requires both high spatial resolution due to the solid-state cluster density and a large simulation area.

The goal of this work is to optimize the characteristics of laser-plasma interaction based on numerical simulation using the “particle-in-cell” method to obtain the maximum number of energetic laser-accelerated deuterons and DD neutrons from large volumes of the cluster medium. The results obtained in [2] for moderately relativistic laser intensity irradiating a medium of sub-micron D2O clusters have been generalized to the case of high intensities (up to 5×10^19 W/cm2). A algorithm is proposed based on dividing the region of interaction of laser radiation with plasma into successive zones with decreasing intensity along the radiation depletion length. The approach is adapted for an arbitrary value of the laser amplitude from the range of intensities under consideration, which makes it possible to significantly reduce the number of simulations required to reconstruct the full spectrum of deuterons over the entire laser-plasma interaction region, compared with direct numerical modeling for the full interaction region. Using the algorithm, it was shown that the neutron yield exceeds 107 pcs. per joule of laser energy.The work was supported by the Federal Scientific and Technical Program for the Development of Synchrotron and Neutron Research and Research Infrastructure for 2019-2027 No. 2021-951-FP5-3 of September 29, 2021, Agreement No. 075-15-2021-1361 of October 7, 2021 with the Ministry of Education and Science of Russia.

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