Extremely-high flux neutron source realized by laser

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Laser-driven neutron sources (LANS) are attracting interest as an alternative that can replace conventional neutron sources based on nuclear reactors or accelerators. However, because of its low efficiency on the neutron generation yield, LANS still remains at the stage of basic research at present.

Recently, efficient ion acceleration has been achieved with picosecond (ps) relativistic-intensity laser [1]. Here, we report on the efficient neutron generation via nuclear reactions between laser-accelerated MeV-energy deuterons and beryllium (Be), as a neutron converter. We successfully generated 4×10^{11} neutrons with a 1-kJ laser pulse in 4π direction from a 5-mm-square Be block. Considering that the temporal duration of the neutrons is around 10-100 ps, the neutron flux reaches 2×10^{21} $s^{-1}cm^{-2}$.

The high-flux burst of neutrons achieved here leads to several advanced applications including high-speed imaging of fast phenomena, turbulence in piping for instance, and time-of-flight neutron absorption analysis of matters with higher resolution. At the same time, our LANS can pave a way toward novel nuclear physics and laboratory astrophysics. The feasibility for future applications will also be discussed.

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[1] A. Yogo et al., “Boosting laser-ion acceleration with multi-picosecond pulses.” Sci. Rep. 7, 42451 (2017).