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A Bright Neutron Source Driven by a Short Pulse Laser[1]

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Neutrons are a unique tool to alter and diagnose material properties, and to exciting nuclear reactions, for many applications. Accelerator based spallation sources provide high neutron fluxes for research, but there is a growing need for more compact sources with higher peak brightness, whether fast or moderated neutrons. Intense lasers promise such as source, readily linkable to other experimental facilities, or deployable outside a laboratory setting. We present experimental results on the first short-pulse laser-driven neutron source powerful enough for radiography. A novel laser-driven ion acceleration mechanism (Breakout Afterburner), operating in the relativistic transparency regime, is used. Based on the mechanism's advantages, a laser-driven deuteron beam is used to achieve a new record in laser-neutron production, in numbers, energy and directionality. This neutron beam is a highly directional pulse < 1 ns at ~ 1 cm from the target, with a flux $> 40/\mu^2$, and thus suitable for imaging applications with high temporal resolution. The beam contained, for the first time, neutrons with energies of up to 150 MeV. Thus using short pulse lasers, it is now possible to use the resulting hard x-rays and neutrons of different energies to radiograph an unknown object and to determine its material composition. Our data matches the simulated data for our test samples.

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