Particle acceleration and fusion neutrons with few-cycle relativistic intense laser pulses

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We present an experimental demonstration of ion acceleration for fusion neutron generation with sub-12 fs, 25 mJ laser pulses [1]. The proton beams of maximum 1 MeV energy were observed leaving both sides of the target foil, namely, along forward and backward directions. The point-projection imaging measurement [2] carried out with these proton beams demonstrated a collimated particle beam (divergence < 5-degree) and a few µm effective source size. The combined effect of these two features can help in minimizing the transverse emittance of the beam, which defines the merit of beam transport and the ultimate focal spot.

For fusion neutrons, the deuterium ions, having similar maximum energy (~ 0.8 MeV) as protons, were accelerated by irradiating homemade 200nm thin deuterated polyethene foils. The products of DD reaction, where accelerated deuterons hit a deuterated catcher, were characterized by various plastic scintillators connected to fast PMT. In the time-of-flight signals collected over 300 single shots, the initial strong gamma peak separates from the neutrons (after 90 ns). From the captured neutron events and their multiplication, we have concluded, that an average of 2500 neutrons was generated in a shot. With the development of a high repetition rate primary target system, the neutron yield/second would reach the flux achieved with present PW class lasers.

References

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