# High-repetition rate neutron source by few-cycle intense laser pulse

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We present an experimental demonstration of fusion neutron generation with sub-12 fs, 25 mJ laser pulses [1]. The inherent high-temporal contrast of the laser architecture [1] allowed irradiating a few nm of ultra-thin foils with a peak intensity of $10^{19}$ W/cm$^2$, without employing contrast enhancement methods such as frequency-doubling or plasma mirrors. 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 two unique features – i) collimated particle beam with divergence as low as 5-degree and ii) the effective source size being as small as a few μm. 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 ultimate focal spot.

For fusion neutrons, the deuterium ions were accelerated by irradiating homemade 200nm thin deuterated polyethene foils. The calibrated Thomson spectrometer suggests that during the acceleration process deuterium ion carry significant flux and have similar maximum energy (~ 0.8 MeV) as protons (Fig. 1d and 1f). The accelerated deuterons hits a deuterated catcher. The products of DD reaction were characterised by various plastic scintillators connected to fast PMTs. In the time-of-flight signals collected over 300 single shots (Fig. 1e), the initial strong gamma peak clearly 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 development of high repetition rate primary target system, the neutron yield/second would reach the flux achieved with present PW class lasers.

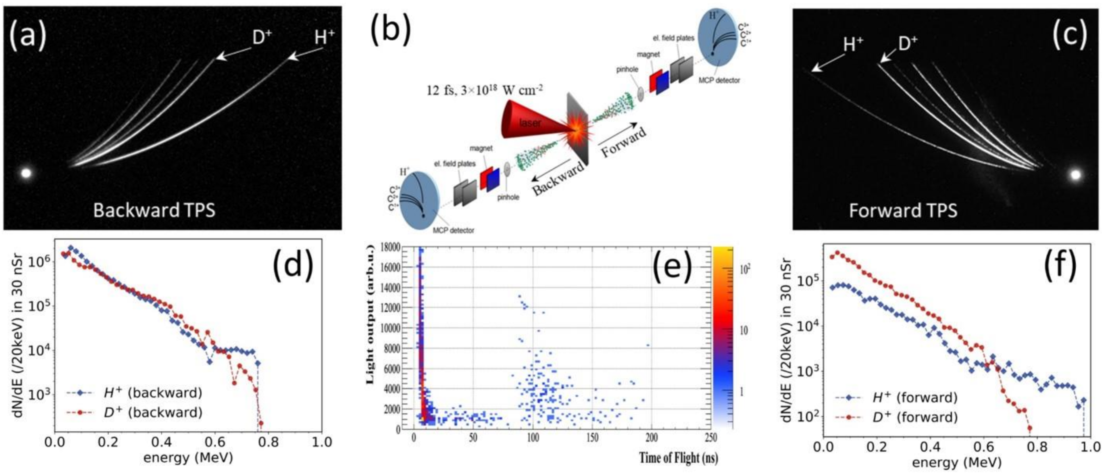


Figure 1. a) and c) simultaneously recorded backward and forward TPS traces. d) and f) respective evaluated spectrum for deuterium and protons along both directions. b) Experimental set up. e) Neutron time-of-flight.

**References:**

[1] S. Toth et al., J. Phys. Photonics 2, 045003 (2020).

[2] P. K. Singh et al., Sci. Reports. 12, 8100 (2022).