Efficient Generation of Fusion Neutrons in Recent Z-Pinch Experiments

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The characteristic property of z-pinches is very efficient conversion of stored electrical energy into plasmas. Nowadays, the high intrinsic efficiency of dense z-pinches is often used for the efficient generation of x-ray radiation. Nevertheless, z-pinches might also be very efficient sources of fast electrons, ions and other particles. Recently, there has been a growing interest in neutron production in z-pinches. There are three main reasons for this renewed attention: (i) the MagLIF project [1], (ii) high DD neutron yield of 4×10^{13} in a 15 MA deuterium gas puff on the Z machine [2], and (iii) a need for pulsed sources of fast neutrons. Even though the neutron production in z-pinches has been studied for more than 50 years, it is still a source of debate.

In order to research ion acceleration mechanisms and neutron production in z-pinches, the experiments with deuterium gas puffs have been carried out on the GIT-12 generator at the Institute of High Current Electronics in Tomsk. Recently, a novel configuration of a deuterium gas puff z-pinch has been used to accelerate deuterons and to generate fast neutrons [3]. When an inner deuterium gas puff was surrounded by an outer hollow cylindrical plasma shell injected from plasma guns, high energy (>2 MeV) bremsstrahlung radiation and high energy deuterons up to 40 MeV were produced. Neutron yields from the DD reaction exceeded 3×10^{12} at 3 MA current. High neutron yields resulted from the generation of high energy deuterons and from their magnetization inside plasmas. Since the energy input into plasmas was 60 kJ, the number of DD neutrons per one joule of stored plasma energy reached the value of 5×10^{7}. This implies that deuterium z-pinches belong to the most efficient plasma-based sources of DD neutrons.

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