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Evidence for thermonuclear neutron production from a sheared-flow stabilized (SFS) Z-pinch.[1]

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Plasma confinement and heating via a Z pinch is one of the oldest and more straightforward fusion-energy concepts. However, if not adequately stabilized, the configuration is prone to virulent MHD instabilities that accelerate high-energy ion beams. Such ions can generate non-thermal, beam-target fusion and have caused significant misinterpretation of past Z pinch experiments. In this work, we present the first direct evidence of non-beam, thermonuclear fusion on the Fusion Z-pinch Experiment (FuZE). FuZE is a sheared-flow stabilized (SFS) Z-pinch that uses radially sheared, axial plasma flows to limit growth of MHD instabilities [Y Zhang *et al.*, PRL 2019]. The confined, plasma column is 50 cm-long with a <6 mm diameter and operates with pinch currents up to 400 kA. The device has achieved neutron yields up to 1e7 with durations up to 8 s. The axial extent of the neutron emitting region (34 cm) is comparable to the length of the plasma column (50 cm) [JM Mitrani *et al.*, NIMA 2019]. Neutron signals are measured with plastic scintillator detectors operating in pulse-counting mode and digitized with a high bandwidth oscilloscope. Neutron energies are determined by constructing pulse integral spectra from measured neutron traces. Pulse integral spectra are a function of the energies of recoil protons in plastic scintillators, which in turn are a function of incident neutron energies. Analysis of pulse integral spectra from detectors placed upstream and downstream of the plasma column indicates spatially isotropic neutron energy emission within 200 keV, which precludes the presence of axial, deuteron beams with energies >20 keV. This result rules out axial, beam-target fusion reactions as the dominant source of neutron emission and is encouraging for scaling SFS Z pinches toward reactor conditions.

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