Abstract

Configuring the dense plasma focus to maximize ion beams and neutron yield

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Intense neutron sources are needed for survivability testing of electronics, flash neutron imaging, and other applications. One candidate source is the dense plasma focus (DPF). The DPF is a co-axial plasma rail gun that serves to couple the slow rise time of a capacitor bank (microseconds) with a fast Z-pinch event that accelerates ions into a gas target and produces neutrons in the presence of deuterium or deuterium/tritium gas. The DPF's discharge ends in a 10-100 ns neutron pulse, with total demonstrated yield of up to 10^{12} for deuterium fill gas (10^{19} n/s peak) into 4π, with ~1 MegaJoule of stored energy. It is one of the brightest neutron sources in existence and can be made compact. A MJ DPF could be designed to fit on a pick-up truck. Although DPFs have been around for 50 years, until recently these devices have been optimized empirically due to lack of a predictive model. While the device itself is physically simple, the physics behind the ion beam acceleration is complex and not well understood. Our group in conjunction with Voss Scientific has developed the first fully kinetic model of these devices, in the particle-in-cell (PIC) code, LSP. It has been benchmarked to both kJ-scale and MJ-scale DPFs. Our model includes the electrode geometry and pulsed power circuit at the anode-cathode boundary. I will discuss how the model can be used in conjunction with experiments to optimize the DPF design for desired yield and pulse shape through varying electrode shape, insulator properties, and driver properties, and through the use of solid targets.

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