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Experimental observations of a high-pressure, 750-kJ dense plasma focus

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Verus Research designed, built, and operates a dense plasma focus (DPF) in Albuquerque, NM, providing a high-flux fusion neutron source for Test & Evaluation applications. Our DPF operates in direct drive with a 750-kJ capacitor bank providing 1.5-3 MA at 30-50 kV, producing $10^{11} - 10^{12}$ neutrons in a sub-microsecond pulse using >10 Torr deuterium background gas. This report focuses on unique physics considerations driving machine operation at high pressure. Running at high pressure enhances neutron production by enabling hot-target interactions with increased volume species in the pinch region; however, high-pressure operation brings additional concerns not encountered in low-pressure operation. We report on the highly ablative characteristics of the plasma due to the large mass content, where downstream surfaces are subject to high momentum impact from accelerating particles. We discuss the impact of ablation/desorption on all surfaces, as well as operational concerns including obliteration of target substrates and asymmetries. We also report an observed bimodal operation correlating \dot{I} diagnostic against yield. Our shot sequences at nominal voltage typically show distinct \dot{I} trace characteristics, alternating between “shallow”(small \dot{I}) and “deep”(large \dot{I}) traces, comparing the trace post-pinch back-end. “Deep” traces average 25% greater yield than “shallow” traces, and we observe operations can favor a single mode. We discuss the appearance of bimodal operation, including the effect of contamination on pinch characteristics and/or the dominance of mode instabilities in the pinch.

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