HIGH ENERGY DENSITY PHYSICS EXPERIMENTS WITH INTENSE HEAVY ION BEAMS

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The US heavy ion fusion science program has developed techniques for heating ion-beam-driven warm dense matter (WDM) targets. The WDM conditions are to be achieved by combined longitudinal and transverse space-charge neutralized drift compression of the ion beam to provide a hot spot on the target with a beam spot size of about 1 mm, and pulse length about 1-2 ns. As a technique for heating volumetric samples of matter to high energy density, intense beams of heavy ions are capable of delivering precise and uniform beam energy deposition dE/dx, in a relatively large sample size, and the ability to heat any solid-phase target material. Initial experiments use a 0.3 MeV K+ beam (below the Bragg peak) from the NDCX-I accelerator. Future plans include target experiments using the NDCX-II accelerator, which is designed to heat targets at the Bragg peak using a 3-6 MeV lithium ion beam. The range of the beams in solid matter targets is about 1 micron, which can be lengthened by using porous targets at reduced density.

We have developed a WDM target chamber and a suite of target diagnostics including a fast multi-channel optical pyrometer, optical streak camera, VISAR, and high-speed gated cameras. Initial WDM experiments will heat targets by compressed NDCX-I beams and will explore measurement of temperature and other target parameters. Future experiments are planned in areas such as dense electronegative targets, porous target homogenization and two-phase equation of state.

Supported by the U.S. Department of Energy under Contract No. DE-AC02-05CH11231.