March 1999 Highlights of the Pulsed Power Inertial Confinement Fusion Program

Fig. 1. View of hardware for one-sided z-pinch-driven hohlraum shots, showing beryllium spokes and end-on hohlraum in which diagnostic foam target will be suspended. (See Jan. 1999 *Highlights*.)

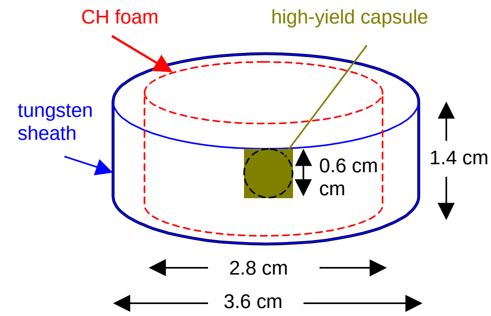

Fig. 2. High-yield dynamic hohlraum design simulated on Lasnex. Radiation wave and shock are generated when imploding tungsten strikes the foam. Tungsten sheath is assumed to be initially 1 mm thick.

We had 18 shots on Z. Most of the shots had nested wire arrays. On five shots the effect of the orientation of the wires between the two arrays (aligned or anti-aligned) was assessed. Following on the success of the dynamic hohlraum shots in previous months that used a central foam cylinder to increase the x-ray source temperature, several nested array shots had an on-axis foam. On four shots the nested arrays struck a plastic or copper annulus. On two additional shots, the inner array was deuterated carbon fibers rather than the usual tungsten wires. The one LANL weapon physics shot had a nested-array z-pinch source and an on-axis foam cylinder. A single array was used on one power flow shot and on three z-pinch-driven hohlraum shots to evaluate one-sided radiation drive (Fig. 1).

Using 2D integrated Lasnex calculations, we have designed a preliminary high-yield dynamic hohlraum target and capsule. Initially, we started with George Allshouse's 1995 high-yield design but we have made significant improvements both in the performance and the calculations. The design is relatively simple in that it consists of a capsule embedded in a low-density 5 mg/cc CH foam (Fig. 2). The radiation foot pulse at the capsule is produced as a result of the imploding tungsten plasma striking the foam and its subsequent compression; the main radiation pulse is produced when the imploding tungsten plasma stagnates against the expanding capsule ablator. The 6-mm-diameter capsule contains a low density DT gas fill, a cryogenic DT main layer, a thin copper-doped beryllium preheat layer, and a beryllium ablator. With the radiation temperature exceeding 350 eV, the preheat layer is initially thicker at the capsule poles to compensate for the late-time, pole-hot drive resulting from stagnation of the tungsten. Currently, the peak drive current is 54 MA, the total drive energy is 12 MJ, and the absorbed capsule energy is 2.4 MJ with a 2D yield of 550 MJ and a 1D yield of 600 MJ. At this point, neither the imploding tungsten/foam configuration nor the capsule design are optimized. Higher-resolution calculations with better radiation treatment and inclusion of z-pinch instabilities are underway to establish computational credibility. Future work will focus on reducing the pulsed power requirements for achieving high yield while maintaining a simple and credible design.

To make deuterium equation of state (EOS) measurements on Z, a planar shock wave generated in an aluminum plate must couple into a thin layer of liquid D_2. In collaboration with AWE, LLNL, and LANL, we are planning Z experiments to verify the unexpectedly large compressibility above 1 Mbar that was seen on Nova during molecular dissociation of small deuterium samples to a metallic phase. In preparation for the experiments, a cryocell was fielded on several recent shots. Assembly of the cryogenic system adds no more than 90 minutes to the total setup time and the cooling process does not add significantly to the normal shot preparation time.

Contact: Jeff Quintenz, Inertial Confinement Fusion Program, Dept. 1602, 505-845-7245, fax: 505-845-7464, email: jpquint@sandia.gov.

Highlights are prepared by Mary Ann Sweeney, Dept. 1602, 505-845-7307, fax: 505-845-7890, email: masween@sandia.gov.
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