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Title: MEASUREMENTS OF SOLID LINER IMPLOSION FOR MAGNETIZED TARGET FUSION

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Measurements of Solid Liner Implosion for Magnetized Target Fusion **IC**

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Data are presented on the implosion symmetry of a 1-mm-thick 10-cm-diameter 30-cm-long solid aluminum cylinder (called a liner.) At the moment when radial compression of more than 10:1 is achieved, the inward velocity of the inner liner surface is 5 km/sec and liner symmetry is excellent (rms variation in radius less than 10%). This technology is important for Magnetized Target Fusion, the approach being developed where magnetically insulated plasma is compressed to fusion conditions by means of an imploded liner. Progress on developing a high-density field-reversed configuration (n ~ 10^{17} cm^{-3} with T ~ 300 eV) to serve as the plasma target will also be reported.

Measurements of Solid Liner Implosion for Magnetized Target Fusion* **IC**

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Magnetized Target Fusion (MTF) is an approach to achieve fusion conditions by compressional heating of a magnetized target plasma [1,2]. This represents a cheaper, faster method for a fusion break-even experiment in the short run, and an innovative pathway to fusion energy for the longer term [3]. Among the various possible MTF configurations, we have chosen a cylindrical liner shell imploding a Field Reversed Configuration (FRC) [4]. We show data demonstrating liner characteristics that exceed our requirements for liner compression of an FRC, namely high compression ratio and symmetry for a cylindrical aluminum liner with 3:1 length to diameter aspect ratio. Radiographs are consistent with experimental measurements of magnetic flux compression of a seed magnetic field, and a novel ZnSe Faraday rotation diagnostic with high sensitivity and dynamic range. These all indicate the time history of an aluminum liner's radial position and speed agreeing with models. To achieve 10-keV temperature and interesting thermonuclear burn of fuel in a 10:1 cylindrical compression requires formation of a dense FRC ($n \sim 10^{17}$ cm^{-3}) with $T \sim$ 300 eV. Progress on the design and construction of an experiment to test the required FRC formation, resembling work originally done in the late 1960s, will also be described.

Liner experiments without plasma were carried out at AFRL Kirtland, using the SHIVA Star capacitor bank. The 1300-μf capacitor bank, marxed to 80 kV (5 MJ stored energy) uses low-inductance star-configured current feeds to drive the liner. The coaxial current feed assembly operates under vacuum. These initial experiments used a cylindrical 270-gram 30-cm long aluminum liner with inner radius 4.89 cm and wall thickness 0.11 cm. The cylinder was press fit between upper and lower conical glide planes that provide electrical contact during the implosion. Current maximum was 11 MA at 10 μs, which coupled 1.4 MJ of kinetic energy to the liner during the 24 μs collapse. Radiographs in Figure 1 show three snapshots of the contracting liner. On axis is a 0.635-cm diameter stationary SS tube that contains Bdot probes and a novel ZnSe Faraday rotation diagnostic to measure the compression of an initial 60-90 Gauss seed field. At the last frame, a small 0.05 cm gap exists between the inside of the liner and the diagnostic SS tube. This indicates a final radial compression ratio of 13:1, which exceeds the 10:1 design goal for MTF compression. Not shown are an axial and azimuthal array of 16 optical impact probes located at a radius of 0.5 cm at the other end of the liner. The optical probes show that the final cylindrical shape was distorted to an oval, but symmetry was better than ± 300μm at the 0.5-cm probe radius. After correcting for the time-dependent magnetic diffusion through the SS tube, magnetic probe data allow the liner inner radius to be determined as a function of time. Figure 2 shows the radius from Bdot data, over laid with the measurements from the radiographs, optical fiber arrival time, and Faraday data. Excellent agreement is found between the different measurements.

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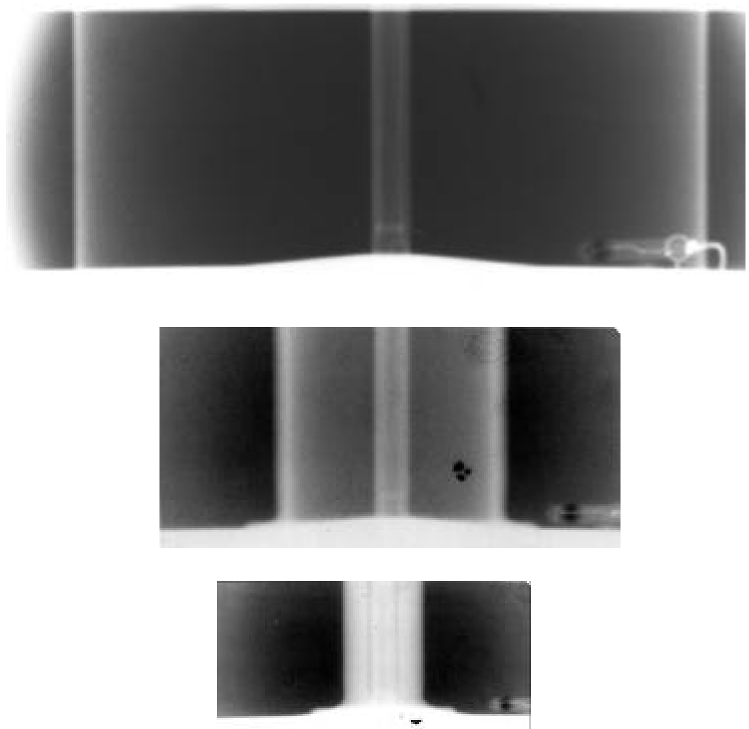

Fig. 1. Implosion symmetry test of a 10 cm-diameter, 30 cm-long aluminum liner. Side-on radiographs are taken at t=0.0, 20.0, and 23.5 μsec. The central column contains magnetic and optical probes.

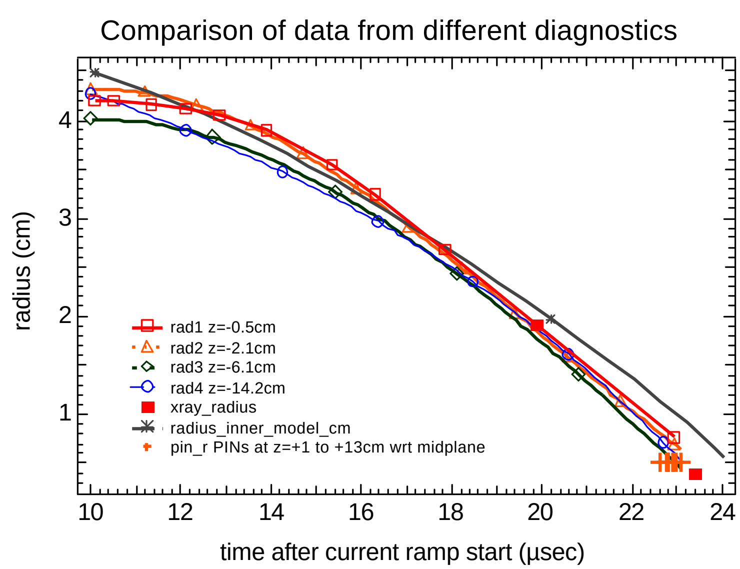

Fig. 2. Liner radius vs. time.

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