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Recent liner experiments confirm plans for Magnetized Target Fusion

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The premise of Magnetized Target Fusion is that fusion gain can be produced inexpensively using “liner” compression of a magnetized plasma. For adiabatic compression of a Field-Reversed Configuration (FRC), 10:1 radial compression gives impressive heating: 10 keV from an initial temperature of 250 eV. Recent experiments at the Air Force Research Laboratory will be described that have demonstrated how a 10-cm-diameter 1-mm-thick aluminum cylinder can be imploded using shock-free electromagnetic forces. The dimensions and energy density (liner velocity of 4 mm per microsecond) are the same as needed for interesting FRC compression. Although 10:1 radial compression implies considerable elastic-plastic deformation and thickening of the liner, experiments indicate highly symmetric deformation, and the inner surface of the metal remains a smooth cylinder according to an array of impact probes and side-on radiography. The time history of the radial implosion inferred by measuring the compression of a small magnetic field agrees with computer models of the implosion. Some further development of the liner implosion technique is necessary before liner-on-plasma experiments begin, but for the immediate future emphasis in MTF research has shifted to preparation of a suitable plasma target. Using models based on previous FRC experiments, LANL and AFRL are designing an experiment at Los Alamos that can generate a 5T pulse of magnetic field in 2.5 microseconds, giving FRC density ~ $10^{17}cm^{-3}$ and T ~ 250 eV. The FRC dimensions (separatrix radius ~ 2.5 cm and length ~ 30 cm) allow the FRC after formation to be translated and trapped in a liner close to the same size as that used for the liner implosion experiments. Diagnostics for FRC experiments will include a magnetic probe array to measure separatrix radius vs. axial position, side-on interferometry for density (and temperature by pressure balance), optical imaging for global stability, Thomson scattering for Te (and density independently), and spectroscopy for impurity content.