Test of an Indirect Drive Fast Ignition Target Concept*

R.B. Stephens
General Atomics, P.O. Box 85608, San Diego, California 92186-5608 USA
e-mail: rich.stephens@gat.com

S.W. Hatchett and R.E. Turner
Lawrence Livermore National Laboratory, Livermore, California 94551 USA

K.A. Tanaka and R. Kodama
Institute of Laser Engineering, Osaka University, Osaka, Japan

J. Soures
Laboratory for Laser Energetics – University of Rochester, Rochester, New York USA

The separation of compression and ignition in the Fast Ignition (FI) concept requires a new approach to target design. The strict symmetry and smoothness requirements of a target compressed so as to generate and enclose an ignition spark by dense, cold fuel are replaced by a different set of considerations. The fusion burn is optimized by creation of a uniformly dense fuel mass. The symmetry of that mass is relatively unimportant, but its igniting surface region must be pure DT, and accessible to an ignition beam. The ignition energy must be delivered by a short-pulse laser, but the compression drive can be accomplished by any means – laser (direct and indirect drive), heavy ion beam, or z-pinch.

We have developed and modeled an indirect-drive cone-in-shell FI target concept [Fig. 1(a)]: A hollow cone is inserted in the side of the shell to provide a protected line of sight to the assembled fuel mass. This modeling suggests that the presence of the cone substantially changes the target's implosion dynamics [Fig. 1(b)]; surprisingly, one should achieve the most compact target with a deliberately asymmetric drive [Fig. 1(c)]. The modeling might not properly capture details of the flow as the shell slides down along the cone surface; there is a concern that high-Z material from the cone might mix into the assembled fuel mass, and hinder ignition. We have tested this model [Fig. 2(a)], scaled to be driven by a scale 1 hohlraum at Omega. Each collapse was radiographed with an x-ray framing camera which took a sequence of 16 x-radiographs. With this we were able to find implosion velocity and diameter, density, radial structure, and symmetry at stagnation. We also took pictures alternately through different filters to identify any gold contamination in the assembled fuel. At a gross level, the experimental radiographs were very similar to that predicted by

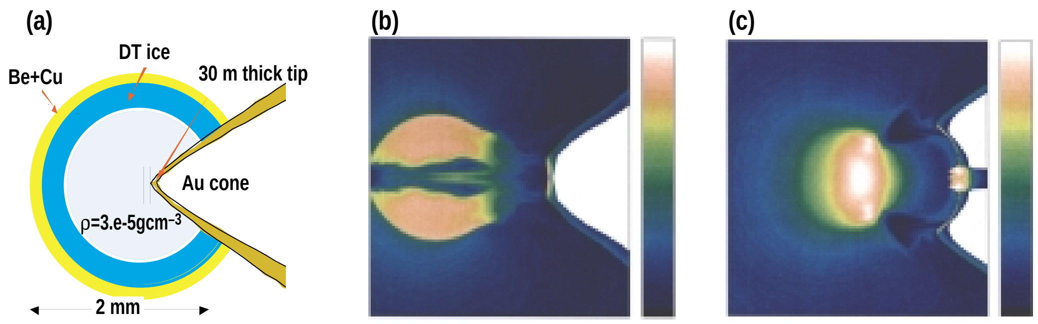

Fig. 1. (a) Cross-section of a FI cryotarget designed to implode to _R~2 g/cm^2 when driven by 190 eV hohlraum. (b) Density cross-section of target at stagnation when driven symmetrically. (c) Density cross-section when drive is 10% hotter on the side away from the cone.

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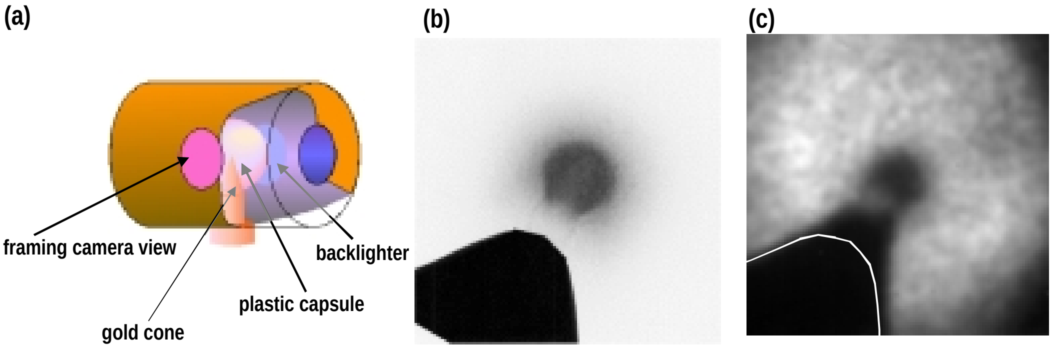

Fig. 2. (a) Sketch of the target design used in the Omega experiments; the cone is inserted along an axis orthogonal to the LEH axis, and the backlighter foil and windows allow x-radiography along an axis orthogonal to both the LEH and cone axis, (b) simulated and (c) experimental radiograph of a shell implosion at stagnation showing the fuel mass assembling at the tip of the cone. The original cone shape is drawn in white on the experimental image.

LASNEX simulations [Fig. 2(b) and 2(c)]; collapse time, 3.3 ps, size, and density 20 g/cc were reasonably close to predicted values. There were significant difference in some details beyond the scope of the LASNEX model. Most significant, there seems to be entrainment of gold vapor in the flow of material from the cone toward the shell; in addition, the collapsed target seemed solid rather than a hollow shell. We will discuss details of these results, the possible sources of the differences between experiment and model, and the consequences of this behavior for the cone-in-shell fast ignition target concept.