DPP06-2006-020040

Abstract for an Invited Paper
for the DPP06 Meeting of
the American Physical Society

Cryogenic DT and D_2 Targets for Inertial Confinement Fusion[1]

T.C. SANGSTER, Laboratory for Laser Energetics, U. of Rochester

Nearly all inertial confinement fusion ignition target designs are based on a spherical ablator containing a solid, cryogenic-DT-fuel layer. The uniformity of the inner surface of this layer is a critical factor in determining target performance. This talk will describe how cryogenic targets are made, characterized, and imploded on the 60-beam OMEGA laser. While cryogenic D_2 targets have been routinely imploded for several years, only recently have targets containing DT-fuel layers been possible. Several of these targets have been imploded on OMEGA and most have had inner-ice-surface uniformity between 1- and 2-μm rms (very close to the ignition specification). These are the first laser-imploded targets to be formed exclusively using beta layering. The creation of these high-uniformity DT layers depends on understanding and controlling many diverse physics processes. These include sublimation and condensation at the inner ice surface (the heart of the layering process), phase transitions of multi-isotopic hydrogen ice, heat flow in the ice, heat flow in the exchange gas surrounding the ice, the geometry of the layering sphere that surrounds the target, and the time that the target is exposed to ambient radiation before being irradiated. In addition, a unique optical shadowgraphic technique has been developed to accurately characterize the 3-D ice-layer-thickness distribution for model comparisons and input to multidimensional hydrocode simulations. The talk will be placed in a historical context, describing previous approaches that worked with smaller targets and, more importantly, the approach being followed for the National Ignition Facility (NIF). It will describe the mutual constraints that target-design requirements and cryogenic system practicalities impose upon each other, for both direct and indirect drive, and how lessons learned on OMEGA can be used to improve the prospects for a successful ignition campaign on the NIF. Finally, implosion results from the first DT-cryogenic target shots will be presented, including neutron yields, ion temperature and fuel-areal-density measurements, and the dependence of target performance on ice smoothness. Contributors: R. S. Craxton, J. A. Delettrez, D. H. Edgell, R. Epstein, V. Yu. Glebov, V. N. Goncharov, D. R. Harding, R. L. Keck, J. D. Kilkenny, J. P. Knauer, S. J. Loucks, L. D. Lund, J. A. Marozas, F. J. Marshall, R. L. McCrory, P. W. McKenty, D. D. Meyerhofer, P. B. Radha, S. P. Regan, W. Seka, V. A. Smalyuk, J. M. Soures, C. Stoeckl, and S. Skupsky, *UR/LLE*; J. A. Frenje, C. K. Li, R. D. Petrasso, and F. H. Séguin, *MIT.*

[1]This work was supported by the U.S. Department of Energy Office of Inertial Confinement Fusion under Cooperative Agreement No. DE-FC52-92SF19460.