High density implosion experiments at Helios

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It is essential for the success of the laser fusion program that adiabatic implosion processes be demonstrated experimentally. With eight beams delivering a total of up to 5 kJ on target in about 1 ns, the Helios CO_2 laser now provides sufficient power to implode targets adiabatically to density higher than that of solid DT.

In our first sequence of high density experiments, glass microballoon (GMB) targets are coated with different thicknesses of parylene (0–100 μm) which are designed for systematic investigation of high density pellet compression. Low-density parylene ablators are used to provide shielding of the target interior against electron preheat. Each GMS is 300 μm in diameter with a wall thickness of 1 μm and is filled with 30 atm of D-T gas.

We have developed ultra-fast neutron detectors which are capable of measuring implosion time to within 200 ps and fuel temperature in the sub-kev regime. It is also possible to measure the burn time, which should then provide information on final fuel density. At present, direct measurement of density is provided by time integrated X-ray pinhole pictures. In selected shots, spatially resolved X-ray spectrometry to image Ar-seeded DT fuel and radiochemical techniques to determine the pusher ρR were employed.

The measured yield, implosion time, ion temperature, and fuel density as functions of parylene ablator thickness are compared with the throretical predictions. The results provide strong evidence of adiabatic implosion, and the overall target performance of these high density targets, illuminated by 1 ns CO_2 laser beams, appear to be within the expected range of design predictions.

HELIOS 装置的高密度聚爆实验

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从实验上演示绝热聚爆过程对于激光聚变计划的成功是必要的。由于 Helios CO_2 激光器可以以 8 束激光在 1 毫微秒时间内释放全部 5 千焦耳的能量到靶上，它现在已可以提供足够高的功率将靶绝热地向心压缩到高于固体 DT 靶的密度。

在我们的第一阶段高密度实验中，玻璃微球外涂上了不同厚度（0～100微米）的 Parylene 材料，以便系统地研究高密度靶丸压缩。低密度 Parylene 烧蚀体用于屏蔽靶心以免出现电子预热。每一微球靶直径约为300微米，壁厚为 1 微米，充有30大气压的 DT 气体。

我们已经发展了能测量达微微秒聚爆时间和低于千电子伏范围燃烧温度的超快中子探测器。它还能够测量燃烧时间。而后者则能提供最终燃料密度的情况。目前时间积分X光针孔象提供密度的直接测量。在选择的几次打靶中，利用了使含 Ar 的示踪 DT 燃料成象的空间分辨X射线谱仪及判定推进层 ρR 值的放射化学技术。

将测量到的产额、聚爆时间、离子温度、燃料密度同 Parylene 烧蚀体厚度的函数关系与理论预言作了比较。其结果提供了有力的绝热压缩的证据。看来这些由 1 毫微秒 CO_2 激光辐照的高密度靶的全部性能都在所预计的范围之内。