GA–A24286

HIGH SPATIAL RESOLUTION IMAGING OF INERTIAL FUSION TARGET PLASMAS USING BUBBLE NEUTRON DETECTORS

FINAL REPORT FOR THE PERIOD NOVEMBER 1, 1999 THROUGH FEBRUARY 28, 2001

by
R.K. FISHER

Work prepared under
Department of Energy Grant
No. DE-FG03-00SF22019 and
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DISCLAIMER

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HIGH SPATIAL RESOLUTION IMAGING OF INERTIAL FUSION TARGET PLASMAS USING BUBBLE NEUTRON DETECTORS

Principal Investigator: Raymond K. Fisher in collaboration with University of Rochester, Laboratory for Laser Energetics; Association Euratom-CEA; and Lawrence Livermore National Laboratory

Bubble detectors, which can detect neutrons with a spatial 5 to 30 μ, are the most promising approach to imaging NIF target plasmas with the desired 5 μ spatial resolution in the target plane. Gel bubble detectors are being tested to record neutron images of ICF implosions in OMEGA experiments. By improving the noise reduction techniques used in analyzing the data taken in June 2000, we have been able to image the neutron emission from $6 \cdot 10^{13}$ yield DT target plasmas with a target plane spatial resolution of ~140 μ, as shown in Fig. 1. As expected, the spatial resolution was limited by counting statistics as a result of the low neutron detection efficiency of the easy-to-use gel bubble detectors. The results have been submitted for publication and will be the subject of an invited talk at the October 2001 Meeting of the Division of Plasma Physics of the American Physical Society.

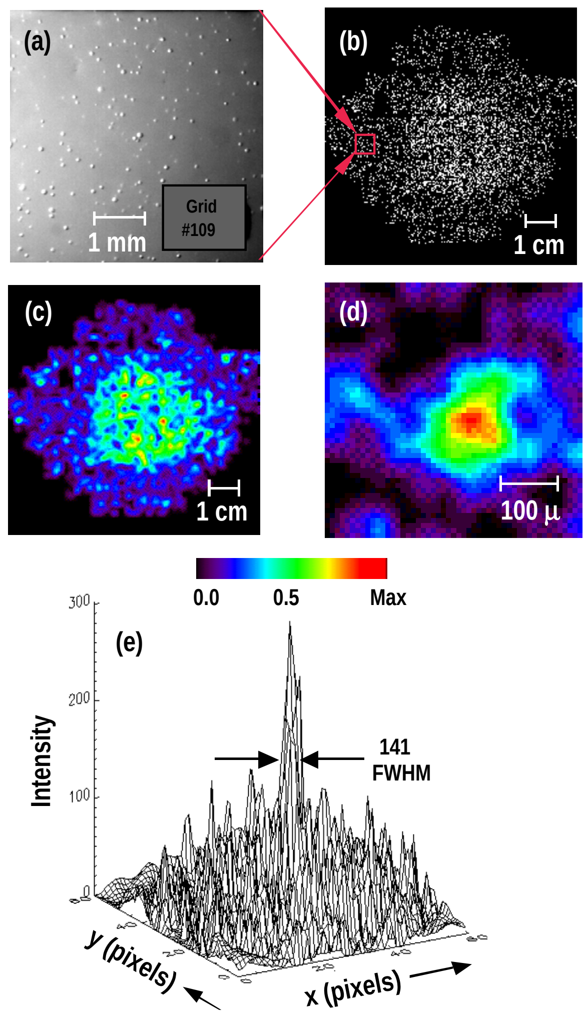

Fig. 1. Bubble detector images from a $6 \cdot 10^{13}$ yield OMEGA shot, including (a) microscope photograph of 60 μm diameter bubbles in a single grid location, (b) x-y plot of bubble locations, (c) coded false color image in detector plane, (d) and (e) unfolded neutron image in target plane.

To improve the counting statistics, data was taken in May 2001 using a stack of four gel detectors and integrated over a series of up to seven high-yield DT shots. Analysis of the 2001 data is still in its early stages. Gel detectors were chosen for these initial tests since the bubbles can be photographed several hours after the neutron exposure. They consist of ~5000 drops (~100 μ in diameter) of bubble detector liquid/cm^3 suspended in an inactive support gel that occupies ~99% of the detector volume. Using a liquid bubble chamber detector and a light scattering system to record the bubble locations a few microseconds after the neutron exposure when the bubbles are ~10 μ in diameter, should result in ~1000 times higher neutron detection efficiency and a target plane resolution on OMEGA of ~10 to 50 μ.

This is a report of research performed at the National Laser Users Facility of the University of Rochester Laboratory for Laser Energetics and supported by the U.S. Department of Energy under Grant No. DE-FG03-00SF22019 and Contract No. W-7405-ENG-48.