GA-A24287

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

**FINAL REPORT FOR THE PERIOD
NOVEMBER 1, 2000 THROUGH OCTOBER 31, 2002**

**by
R.K. FISHER**

**Work prepared under
Department of Energy Grant
No. DE-FG03-00SF22228 and
Contract No. W-7405-ENG-48**

MAY 2003

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

GA-A24287

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

**FINAL REPORT FOR THE PERIOD
NOVEMBER 1, 2000 THROUGH OCTOBER 31, 2002**

**by
R.K. FISHER**

**Work prepared under
Department of Energy Grant
No. DE-FG03-00SF22228 and
Contract No. W-7405-ENG-48**

**GENERAL ATOMICS PROJECT 30085
MAY 2003**

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 resolution of 5 to 30 μ , are a promising approach to high-resolution imaging of NIF target plasmas. Gel bubble detectors were used in successful proof-of-principle imaging experiments on OMEGA. The results were presented in an invited talk at the October 2001 meeting of the Division of Plasma Physics of the American Physical Society and published in *Physics of Plasmas* [1].

Until recently, bubble detectors appeared to be the only approach capable of achieving neutron images of NIF targets with the desired 5 μ spatial resolution in the target plane. In 2001, NIF reduced the required standoff distance from the target, so that diagnostic components can now be placed as close as 10 cm to the target plasma. This will allow neutron imaging with higher magnification and may make it possible to obtain 5 μ m resolution images on NIF using deuterated scintillators.

Having accomplished all that we can hope to on OMEGA using gel detectors, we suggested that our 2002 NLUF shots be used to allow experimental tests of the spatial resolution of the CEA-built deuterated scintillators. The preliminary CEA data from the June 2002 run appears to show the spatial resolution using the deuterated scintillator detector array is improved over that obtained in earlier experiments using the proton-based scintillators.

Gel detectors, which consist of ~ 10 μ m diameter drops of bubble detector liquid suspended in an inactive support gel that occupies $\sim 99\%$ of the detector volume, were chosen for the initial tests on OMEGA since they are easy to use. The bubbles could be photographed several hours after the neutron exposure. Imaging NIF target plasmas at neutron yields of 10^{15} will require a higher detection efficiency detector. Using a liquid bubble chamber detector should result in ~ 1000 times higher neutron detection efficiency which is comparable to that possible using scintillation detectors.

A pressure-cycled liquid bubble detector will require a light scattering system to record the bubble locations a few microseconds after the neutron exposure when the bubbles have grown to be ~ 10 μ m in diameter. The next major task planned under this grant will be to perform experimental tests to determine how accurately the spatial distribution of the bubble density can be measured under the conditions expected in NIF. The bubble density will be large enough to produce significant overlap in the two-dimensional images, so that we will need to be able to measure bubbles behind bubbles. One of the goals of these tests is to determine if a simple light transmission approach is feasible. One of the concerns at very high bubble densities is that light scattered out of the path can be rescattered back into the transmitted light path by bubbles in neighboring paths.

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-FG03-00SF22228 and Contract No. W-7405-ENG-48.

[1] R.K. Fisher, et.al., *Phys. Plasmas* **9**, 2182 (2002).