DOE/NV/15946--194

Improved Gamma Bang Time Measurements on Omega and Implications for the National Ignition Facility

H.W. Herrmann, S.E. Caldwell, S.C. Evans, J.M. Mack, P. Sanchez, T. Sedillo, C.S. Young
Los Alamos National Laboratory, Los Alamos, New Mexico. USA
C. J. Horsfield, D. Drew
Atomic Weapons Establishment, Aldermaston, Reading, Berkshire, RG7 4PR. U.K.
E. K. Miller
National Security Technologies / Special Technologies Laboratory, Santa Barbara, CA
V. Yu. Glebov
Laboratory for Laser Energetics, University of Rochester, Rochester, New York. USA.

The time of peak fusion reactivity with respect to the impingement of laser light on an ICF capsule is known as Bang Time (BT). This is an essential parameter in the understanding of ICF implosions. Traditionally, BT has been determined through temporal measurements of 14 MeV fusion neutrons. Because the neutron energy spectrum is Doppler broadened, the detector must be positioned close to target-chamber-center in order to minimize the neutron temporal spreading which can compromise such a measurement. Fusion gammas, on the other hand, are not subject to temporal spreading, making proximity of the detector to the source a lesser concern. However, the low branching ratio for DT fusion reactions producing gammas (~1e-4) presents detector sensitivity challenges.

A Gas Cherenkov Detector (GCD) has been developed to overcome these challenges. Fusion gammas are converted to relativistic electrons primarily through Compton scattering in a beryllium window on the front of the detector. These electrons then produce Cherenkov radiation as they travel faster than the speed of light in a pressured CO_2 gas cell. This UV/visible light is then collected onto an ultra-fast photomultiplier tube and the signal is recorded on high bandwidth recorders. Alternatively, this light can be collected and transported to a shielded streak camera to obtain even higher bandwidth reaction histories.

By relating the peak of the GCD gamma signal to laser timing fiducials, and cross calibrating the resulting raw bang time to the neutron bang time obtained using the absolutely calibrated Neutron Temporal Diagnostic (NTD), we have been able to demonstrate a precision of better than 25 ps on Omega.

Bang time and reaction history (RH) data are essential components of diagnosing failed attempts at ICF ignition, making the Gamma BT/RH diagnostic a tier one ignition diagnostic for the NIF. Gammas are preferred over neutrons for this application due to the unacceptably large neutron temporal spreading resulting from detector standoff limitations on the NIF. The NIF System Design Requirement specifies a gamma bang time accuracy of better than 50 ps. This talk will discuss Gamma BT/RH results obtained on Omega and explore issues related to meeting the NIF requirements.