Characterization of neutron time-of-flight instrument response functions using 14-MeV neutron sources

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Neutron time-of-flight (nTOF) detectors are one of the most important diagnostics for measuring the neutron energy spectral variance for inertial confinement fusion (ICF) experiments conducted at several facilities in the U.S., including the Z pulsed-power accelerator, the National Ignition Facility, and the Omega Laser Facility. Typically, the instrument response functions (IRFs) for these detectors are characterized using photons or cosmic rays instead of neutrons. This requires additional calculations to translate the photon or cosmic-ray response to an actual neutron response. This may, in some cases, have a notable effect on the IRF and lead to misinterpretation of nTOF data. At Sandia National Laboratories, we are characterizing nTOF detector IRFs directly to neutron sources at the Ion Beam Laboratory, typically using the 14-MeV neutrons produced by a 175-keV, 2-μA deuteron beam striking a tritiated target. Using kinematic relationships, the charged particle and its associated neutron interacting with the nTOF detector can be measured in coincidence to obtain the IRF.

We present IRFs measured for different types of nTOF detectors that utilize EJ-228 (BC-418 equivalent) and EJ-232Q (BC-422Q equivalent) scintillators and different photomultiplier tubes (PMTs) including gatable Photek and Hamamatsu PMTs. We also present IRF data obtained from cosmic rays and other neutron and photon sources for comparison. Future work to obtain IRFs with 2.45-MeV neutron sources is discussed. Other aspects of the IRF, particularly unique to the high neutron-scattering Z environment, are also presented.

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