Centrifugally Tensioned Metastable Fluid Detector (CTMFD) vs. Ludlum Neutron Detector Performance Comparisons for Neutron Monitoring with a Plutonium-Beryllium Source

Vanderkolk, Eli (School: Lafayette Jefferson High School)

Neutrons constitute highly penetrating, neutral radiation particles with immense impact on a multitude of nuclear related disciplines. Monitoring for neutrons is of fundamental importance. This study demonstrates the capability and efficiency of Centrifugally Tensioned Metastable Fluid Detector (CTMFD) technology as it compares to a conventionally used neutron detector. CTMFDs utilize centrifugal force to tension fluid, subjecting it to negative pressure (Pneg), in specifically designed apparatus. As the fluid inside the detector is tensioned it can reach a metastable state. If a single 10-27kg neutron of only 1 MeV (~0.1 pJ) energy collides with the nucleus of atoms within the CTMFD's pretensioned fluid, the process can astoundingly cause localized boiling of the fluid, to then be able to nucleate cavitation bubbles from the nano-to-macro scales that can be physically seen-heard and recorded. The ability to vary the Pneg of the fluid offers unique sensitivity variability in the pretensioned fluid region of the device, offering the impact on to a large scale of applications than most other detectors. This study used a Plutonium-Beryllium (PuBe) neutron source shielded by various thicknesses of differing materials to measure the capacity and efficiency of the CTMFD, over a range of Pneg states to detect neutrons, as compared to the Ludlum 42-49BTM neutron detector. Additionally, Monte Carlo N-Particle Transport (MCNP) code simulations were used support the measurement results. The CTMFD was shown to be more capable than the Ludlum detector. The Ludlum detector showed an inability to detect neutrons at a lower shielding thickness than the CTMFD. CTMFD technology shows great promise towards improving the efficiency and sensitivity of conventional neutron detectors.