# Toward Temperature Dependent Spectroscopy in Centrifugally Tensioned Metastable Fluid Neutron Detectors

Abstract

Spectroscopic neutron detectors are often used to determine the spectrum of radiative energies emitted by some source, be it in an industrial setting, a research setting, or even in the detection of nuclear weapons. The centrifugally tensioned metastable fluid neutron detector (CTMFD) is one such detector that uses centrifugal force to generate negative pressure within a volume of liquid. Under negative pressure, the liquid is in a metastable state. An incident neutron may, if it deposits enough energy within a critical diameter in the metastable fluid, create an explosive vaporization (a cavitation). This event indicates the presence of neutrons. Changing the ambient temperature in which this system operates has been shown to have an effect on the sensitivity of the detector. Both the extent of this effect and the amount of energy necessary to create a cavitation are unknown. Thus, data has been collected using this detector and a neutron source at varying temperatures. To collect data with the CTMFD, a constant temperature apparatus was designed and constructed. This required the creation of a chamber with high thermal inertia and the implementation of heating and cooling components. To control the temperature changing components, a PID algorithm was designed and implemented via microcontroller. Neutron transport simulations of the experimental setup were performed to determine the energies of the neutrons incident upon the sensitive volume of the detector. With the experimental data and simulated spectra, a theoretical relation was created to better predict the sensitivity of the CTMFD and explain the temperature dependency of the detector's sensitivity. To determine the effectiveness of this relation, a semi-deterministic optimization of the threshold energy's dependence on temperature and negative pressure is being performed. If sufficiently optimal, this could be used to determine the energy spectra of unknown neutron sources. This work is helpful in better understanding the temperature-dependency of the CTMFD's sensitivity, which in turn allows for enhanced fielding of the detector. Enhanced fielding of the detector in turn allows for its use in various settings, potentially to detect nuclear weapons are to assess the safety of people around an industrial radiation source.