Abstract

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Development of 16N and 17N Sources for Calibration of a Large Gd-Doped Water Cherenkov Detector

The detection of antineutrinos from nuclear reactors may provide information on the presence of undeclared reactors or the operation of known reactors, which would be useful for verification applications. One prominent detector design, now under consideration by the WATCHMAN-AIT collaboration, relies on a multi-kiloton tank of gadolinium-doped water to detect inverse beta-decay (IBD) events caused by antineutrino interactions. In such large-volume detectors, calibration is a considerable challenge, and carefully designed sources are needed which can both mimic the expected response to IBD events and be easily moved to different locations inside the detector volume. One proposed calibration source is 16N, which emits a beta-correlated gamma -ray with energy of 6.1 MeV, providing a time-taggable source near the high-energy range of the gamma-ray cascade produced by neutron captures on gadolinium. Current designs for the 16N calibration source are based on the Sudbury Neutrino Observatory (SNO) design, where 16N was produced by irradiating CO2 gas with 14.1 MeV neutrons, then transferred to a small decay chamber inside the detector volume. Another little-considered feature of this design is that by substituting CO2 gas enriched with 17O, 17N can be produced using the same mechanism. 17N may also be interesting as a potential calibration source, as it emits beta-correlated delayed neutrons. We present initial studies on producing and characterizing 16N using large NaI(Tl) detectors, as well as Monte Carlo simulations of the expected 16N and 17N production rates and emission spectra for various source design configurations.