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Development and performance of the BNL 30-ton scale Water-based Liquid Scintillator detector

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Water-based Liquid Scintillator (WbLS) is an innovative material for constructing large-scale detectors in neutrino and dark matter research. The tunable light yield, enabled by an inline circulation system, allows for flexible detector optimization for different physics searches. With adequate photosensor coverage, detecting low-intensity light can reconstruct the momentum of energetic charged particles while enhancing sensitivity to low-energy events, thereby improving background suppression in kiloton-scale neutrino detectors. Adding metallic elements like Gadolinium further enhances WbLS as a candidate for outer detectors optimized for neutron background tagging. A 30-ton WbLS demonstrator has been constructed at Brookhaven National Laboratory (BNL) to assess its stability, optical properties, and circulation process, providing valuable insights for designing large-scale detectors. With almost a year of running, the 30-ton demonstrator has accumulated a substantial amount of high-quality data. A multi-step WbLS injection has been performed to understand the light production mechanism. Furthermore, the neutron deployment system along with the nanofilteration system and Gd system have been actively designed and tested. In this talk, current effort on all aforementioned developments will be discussed. Initial WbLS stability and performance results will be shown.

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