Form 8

Research Result Report
ICRR Inter-University Research Program 2024

Research Subject: Water Purification System R&D for Precision Neutrino Detectors

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Participating Researchers:

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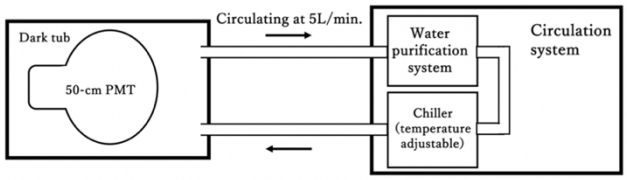
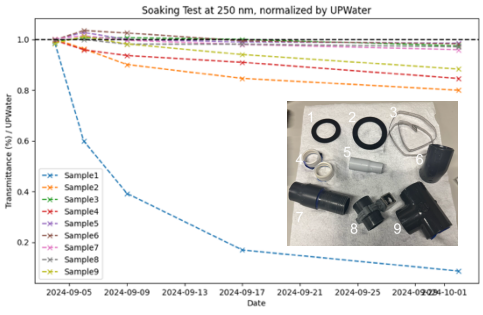
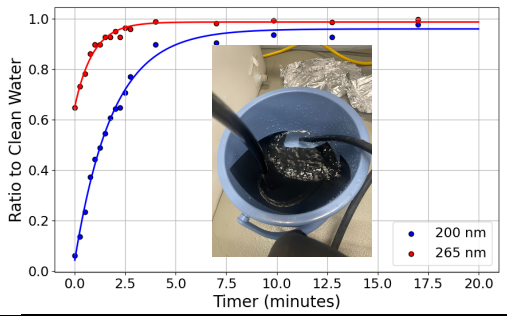
Summary of Research Result :

The water purification system in ICRR has provided temperature-controlled ultra-pure water to the Hyper-K PMT test experiment in a dark tub, shown in the diagram to the right. We achieved measurements between 13.7 – 24.7 °C that show variation of gain and relative quantum efficiency within ±1% and dark rate within ±5%. An air vs water difference in gain of 1.4% was observed. We will continue measurements to improve the accuracy to less than the required 1% for Hyper-K.



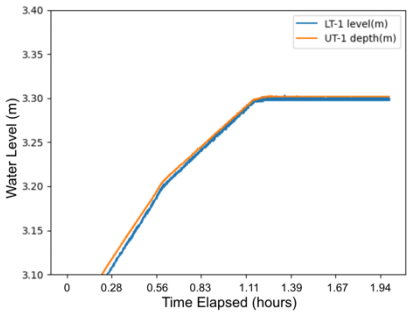
Detector materials for the Hyper-K Intermediate Water Cherenkov Detector (IWCD) and CERN Water Cherenkov Test Experiment (WCTE) were soaked in ultra-pure water, then measured the water transparency as a function of wavelength by spectrophotometer. The below-left figure shows how the transmittance of 250 nm light varied over time (worst case wavelength; above the 300 nm PMT sensitive region, the transmittance is much better).

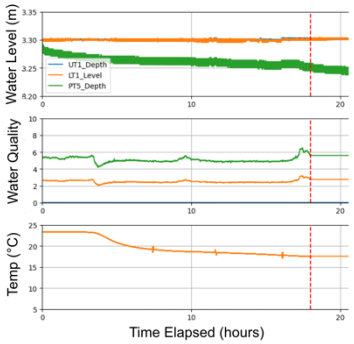




A rubber gasket (1 and 2 in above photo) affected the transparency the most, followed by parts with PVC glue contamination (7), as expected. These will be in small quantities or with less exposure in the detector, so should be manageable by the purification system. The bottom-right figure on previous figure shows how fast the transparency can be recovered when turning on the circulation system, after soaking a (rubber) geomembrane candidate material for the IWCD outer barrier.

An ultrasonic water level sensor (LT-1) and all-in-one sensor (UT-1) measuring water quality (conductivity, salinity, TDS), depth, and temperature were purchased by this grant for IWCD and tested at WCTE. The plot directly above shows a detector level precision of a few mm when filling. The far-right plot shows monitoring of the water quality and temperature in the detector during initial cooling. These sensors are acceptable candidates for HK-IWCD.





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