Form 8

Research Result Report
ICRR Inter-University Research Program 2023

Research Subject:

A water monitoring system for Hyper-Kamiokande

Principal Investigator:

Xiaoyue Li

Participating Researchers:

Xiaoyue Li (Research Scientist, TRIUMF, Canada)
Akira Konaka (Senior Research Scientist, TRIUMF, Canada)
Sahar Taghayor (PhD student, University of Victoria, Canada)

Summary of Research Result :

The water monitoring system (WMS) described in this proposal addresses a crucial issue for water Cherenkov detectors – that we must be able to detect the water quality changes over a short period of time. The WMS utilizes newly developed pulsed UV-VIS LEDs with sub-ns pulse widths and photomultipliers to measure the light transmission over a horizontal water pipe with a length of 3-20 m. The WMS would be able to detect a percentage level change in the water transparency, which is an indication of the existence of contaminants in water.

The original proposal was to construct and deploy such a system based on the prototype being developed at TRIUMF in the 第二総合研究棟 305 号室ニュートリノグループ光検出器水中測定室 where a 150 L/hr Gd-compatible water purification system is being tested. This would allow us to dynamically soak test components that would go into future water Cherenkov detectors. The planned hiring of a postdoctoral researcher to lead the WMS development at TRIUMF did not materialize, and as a result the prototype development has been behind schedule, and we did not have sufficient person-power to build and operate a WMS at ICRR. Nevertheless, a prototype has been successfully built and operated at TRIUMF since 2022. Procedures were developed to align the optical components such that the light traveling through the water volume has a divergence of less than 0.5 mrad. A data acquisition system based on PicoScope USB PC oscilloscope is used to record the signals from the PMTs that measure the light intensities at the source side and after transmission through water, respectively. Currently we are finalizing the

construction of the water filtration unit and control unit, and commissioning has started recently where we have observed stable light output and transmission through purified water. The current prototype will be shipped to CERN in September where it will be used to monitor the water quality of the Water Cherenkov Test Experiment (WCTE) that will take data in a test beam in October 2024.

In the process of developing the prototype, several unforeseen issues related to the optical components and the LEDs have been identified, such as the parasitic light emission from UV LEDs and unknow optical parameters in the UV range. These problems required dedicated studies to address, and we have been able to procure parts required by these studies using the ICRR Inter-University research grant, including an optical enclosure, optical filters, photodiodes, and various accessories for optical measurements, etc. The studies are currently ongoing, and we plan to complete them prior to shipping the WMS prototype to CERN.

No.