Form 8

Research Result Report
ICRR Inter-University Research Program 2023

Research Subject: New Photogrammetry Calibration for Super-Kamiokande and Hyper-Kamiokande

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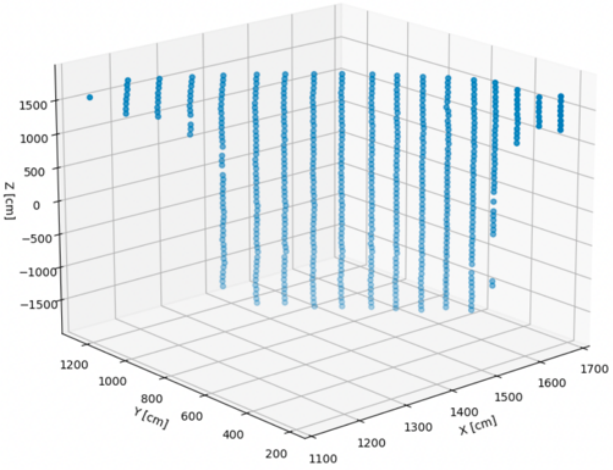
Summary of Research Result :



A demonstration of geometry reconstruction was performed with ~6 rings of barrel PMTs (648 in total) in 2021 and a set of PMTs (588 in total) neighbouring the vertical column of light injectors (LIs) in 2023. The (now graduated) MSc student developed a new manual-labeling software, which a small team at IPMU and ILANCE used to identify all the PMTs in these LI photos. We started from the previously traditionally (not ML) detected feature points and modified them to ensure their accurate positioning on PMT dynodes and bolts, then labeled based on position relative to the LIs. The reconstruction code was updated to accept these inputs and produce the measured PMT positions in the right figure (bolt positions omitted for clarity). A quick check showed a $\sigma = 1.1$ cm (0.5 cm) radial (tangential) spread from a line fitted to one column of PMTs. Further analysis of these results is needed. The challenge to label the rest of the detector (without any visual references) remains. The fitting code was updated to output the fitted errors on each point to give a measure of the significance of any deviation from the design geometry, but a complete systematic error analysis is still to do. The seed (design) geometry in the fitter was updated to the realistic polygonal structure (rather than cylindrical) with the help of the Okayama group, resulting in improved agreement with the measurement, reducing the mean of the residuals from 1.3 to 0.9 cm. Eventually, the measurement will be used in the SK (Geant4) and WCSim (for Hyper-K, IWCD, and WCTE) detector simulations, in which we now implemented variation of the detector shape.

Following last year's successful pressure tests at Lab-F in Kamioka, 8 camera housings were constructed in Canada (one example in left figure) and begun calibrating for deployment in WCTE at CERN this summer. After WCTE, these housings will be used in the IWCD.

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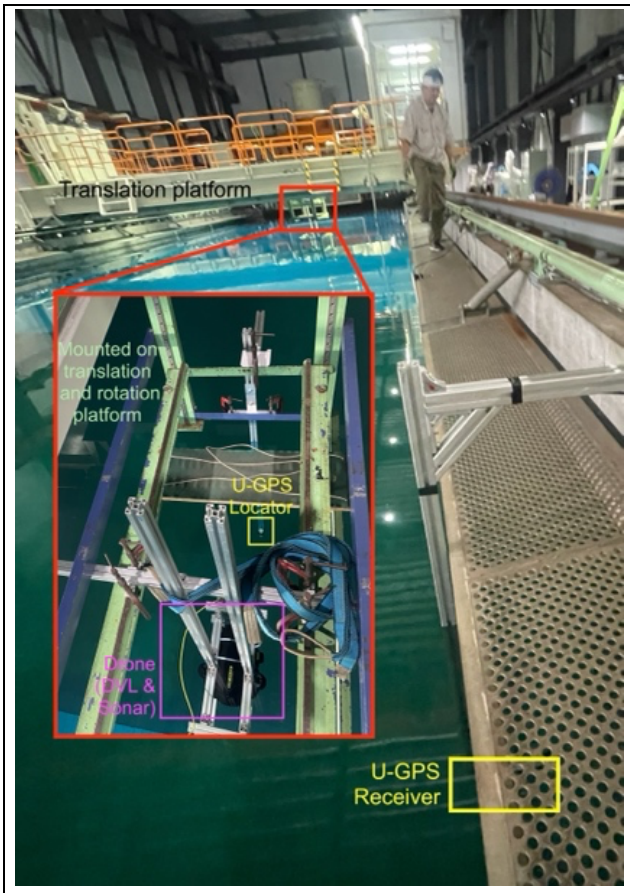
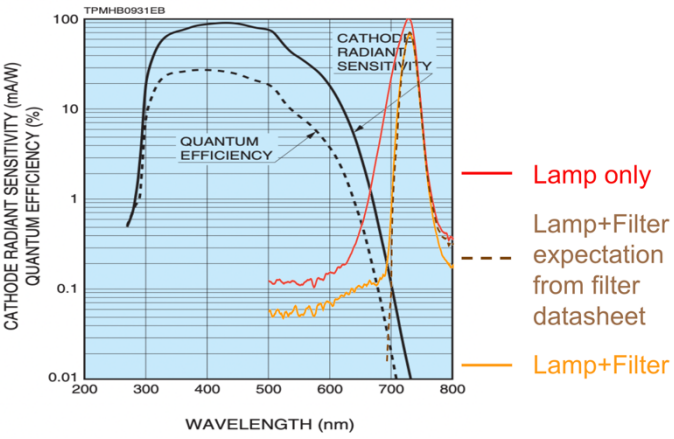


The Institute of Industrial Science (IIS) Ocean Engineering Basin (OEB), a 50x10x5m pool was rented for 1 week, in part by these funds. The remove operated vehicle (ROV) absolute positioning systems: onboard sonar, short baseline ultrasonic transmitter & receivers (U-GPS), and a Doppler Velocity Log (DVL), were purchased by TRIUMF and this ICRR grant for R&D, and tested on the well-calibrated (mm level) translation and rotation platform of the OEB, shown in the left figure. The analysis is ongoing, and a preliminary result shows the U-GPS and DVL systems tracking the motions well.



The deep-sea red lamp that was purchased last year was tested with an R14374 PMT, which unfortunately showed a 39% increase in count rate when turning on the lamp (20% with a 720 nm cut-off filter), indicating a significant overlap in wavelength of the light and PMT's quantum efficiency. This was also indicated by measurements of the lamp spectrum, including the 720 nm filter, overlayed with the typical 3" PMT sensitivity curve in the left figure. This means we should not use this lamp while the detector is on, but can still be used in WCTE or IWCD when the detector is off (to minimize PMT activation compared to white light).

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