Research Result Report
ICRR Inter-University Research Program 2022

Research Subject:

New Photogrammetry Calibration for Super-Kamiokande and Hyper-Kamiokande

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Summary of Research Result :

Precious photogrammetry data was taken during the last SK tank open work (TOW) in February 2020 and a first demonstration of geometry reconstruction performed with a few rings of barrel PMTs in 2021, as shown in the right figure, reported in more detail last year.

Now we managed to apply the traditional (not yet the machine learning semantic segmentation) PMT detection algorithm we developed to the majority of photos (across the entire detector), for example the right photo. However, the challenge to label them all with the correct PMT IDs is ongoing. Furthermore, the position of the center of the dynode (red points) could not be accurately identified for all PMTs, and so a new GUI has been developed to manually adjust the points across all 1795 photos.
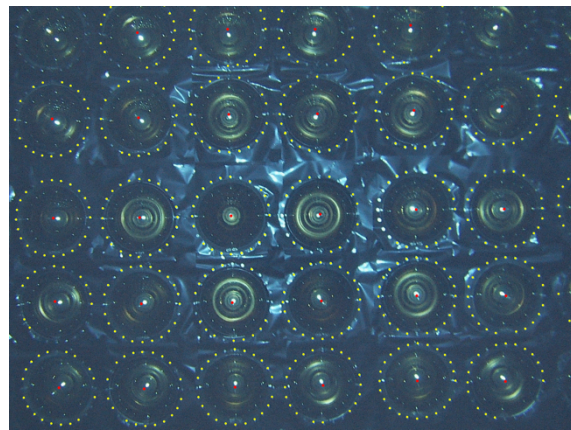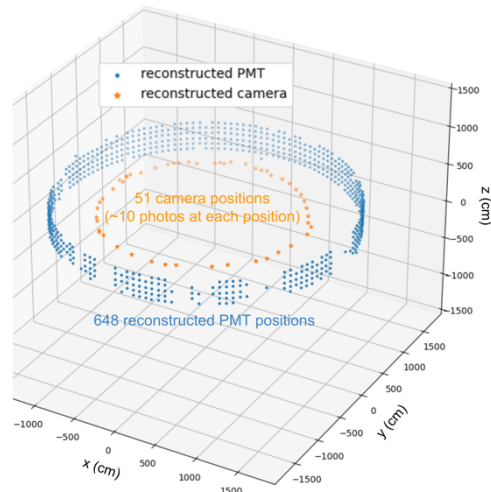
This manual detection/labeling campaign is ongoing now. Systematic error analysis in the feature detection and how to propagate to the geometry reconstruction has begun, to provide an error estimation for the reconstructed position of each PMT. Eventually, this will be used in the SKG4 (Super-K Geant4) detector simulation, which we have now implemented the functionality to vary the detector shape and PMT positions without geometry overlaps. This will enable the physics studies using particle gun simulations, cosmic muons, and eventually neutrino simulations.
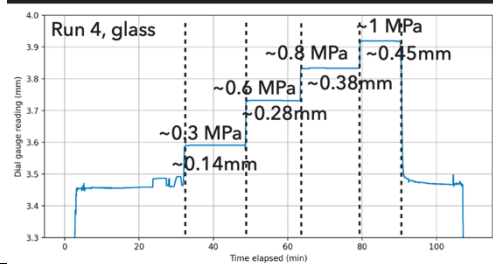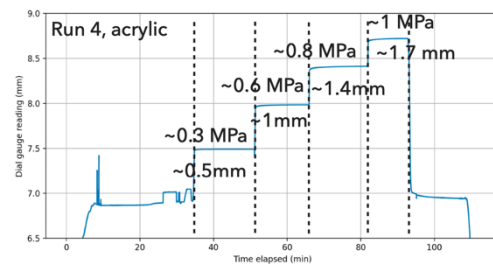
The underwater red lamp purchased last year to evaluate if it was possible to illuminate PMTs while they are energized was tested by counting a 3" PMT hit rate. Unfortunately, even with a 700 nm cutoff red light filter, the PMT showed a non-negligible increase in hit rate with the lamp on. However, the lamp can still be used with the PMTs off, for example inside WCTE before physics data taking.

Prototypes of the fixed camera systems for Hyper-K, IWCD, and WCTE have been produced in Canada and pressure tested at Lab-F in the Kamioka Mine, as shown in the right photo. Travel expenses and several components were purchased from this grant to enable measurements of the dome distortion with a strain gauge, dial gauge, and optically with the camera inside. We observed more distortion of the acrylic dome compared to the glass dome as expected, as shown in bottom right figures, and a corresponding larger optical shift in a calibration pattern, which suggests glass would be necessary for Hyper-K depth.

The TRIUMF underwater drone absolute positioning systems showed preliminary good measurements, but will need more detailed experiments, which is planned in a Kashiwa pool laboratory.

Recent progress has been presented at two national conferences.

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