

**Research Report**  
**ICRR Inter-University Research Program 2019**

Research Subject: New Photogrammetry Calibration and Machine Learning (ML)  
Event Reconstruction for Super-Kamiokande and Hyper-Kamiokande

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Summary of Research Result : We have developed a ML platform that can be applied to water Cherenkov simulations. A workshop was conducted in April 2019 to train Super-K and Hyper-K collaborators in its use. A new consortium, WatChMaL, was initiated to facilitate knowledge transfer across collaborations. The developed methods include pre-processing of simulated data to input to a convolutional neural network (CNN) and other architectures, training, and evaluation metrics. The preliminary result shows some promise in electron/gamma discrimination, a first for water Cherenkov detectors, and critical towards background reduction in the Hyper-K neutrino oscillation experiment.

An underwater remote operated vehicle (drone) was purchased. Photogrammetry calibration procedures using this drone and GoPro cameras in a “360 camera” housing have been demonstrated to the 2 mm level with an ideal checkerboard pattern in a swimming pool. The “360 housing” has been tested at Kamioka for compatibility with ultra-pure and gadolinium water, high pressure, and size of the Super-K access ports, for potential future deployment. The drone was deployed during a very rare Super-K tank-open work in Feb. 2020 to provide critical monitoring of the water system upgrade. This was also an excellent opportunity to survey the detector, without disturbing normal data taking, producing over 10000 photographs of the whole inner surface. Analysis of this precious data has begun.

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