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Photogrammetry in Water Cherenkov Neutrino Detectors

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Precision measurements of neutrino interactions being pursued in the current Super-K detector, the next-generation Hyper-K detector, and its Intermediate distance Water Cherenkov Detector (IWCD) necessitate improved calibrations. Photogrammetry will be used to reduce the position uncertainty on the photomultiplier tubes (PMTs) and calibration source locations within the detector. The positioning of PMTs within the detector and of calibration sources in the detector may slightly deviate from the design, and these deviations may cause biases in event reconstruction. Calibrating these positions through direct measurement can allow the related systematic errors to be constrained further than has been achieved previously. Photographs of the PMTs lining the walls of the detectors are used to create a 3D reconstruction of their positions, starting from the 2D PMT positions obtained in each image via image processing and machine learning methods. These positions, in combination with camera calibration parameters, are used to determine the location and orientation of the camera and reconstruct a 3D position for each PMT. This talk describes the photogrammetry efforts in Super-K, using an underwater drone survey to obtain images of all PMTs, as well as future applications to the Hyper-K and IWCD via a built-in camera and lighting system.

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