

# International Workshop on Next generation Nucleon Decay and Neutrino Detectors (NNN19)



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## Multi-photomultiplier tube module development for the next generation Hyper-Kamiokande neutrino experiment

Hyper-Kamiokande (Hyper-K) is a next generation, water Cherenkov neutrino detector with 260,000 metric tons of ultra-pure water. It will measure accelerator, cosmic and atmospheric neutrinos to discover CP violation in neutrino oscillations, determine the neutrino mass ordering, as well as potentially discover proton decay. Hyper-K is the far-detector of the 300 km long-baseline neutrino experiment in Japan. We are also proposing a new Intermediate Water Cherenkov Detector (IWCD) located at a baseline of 1-2 km away from the neutrino source at J-PARC to cancel the neutrino flux and cross section uncertainties.

Hyper-K is developing new multi-PMT (mPMT) optical modules, housed in a pressure vessel with an acrylic dome for 19 front-facing 3-inch PMTs. The IWCD requires 500 modules and more are being considered for a portion of the Hyper-K photosensors. The advantages of mPMTs over traditional single 20-inch PMT detector are increased granularity and improved timing resolution. Each of the 19 3-inch PMTs have different orientations with a particular field of view, thus providing information on the direction of each detected photon, which can improve dark hit discrimination and event reconstruction. Each vessel conveniently houses digitization electronics and calibration sources. This work presents the mechanical design and assembly of the first mPMT prototype at TRIUMF, and manufacturing techniques for future mass production.

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