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Design, manufacturing and installation of multi-PMT vessel for Hyper-Kamiokande

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Hyper-Kamiokande (Hyper-K) is a cutting-edge water Cherenkov detector 70 m tall and 70 m in diameter using 260,000 metric tons of ultra-pure water to detect neutrinos from accelerators, cosmic phenomena, and atmospheric activities. It aims to explore CP violation in neutrino oscillations, determine neutrino mass hierarchy, and investigate proton decay. As the far-detector in Japan's 300 km long-baseline neutrino experiment, it works in tandem with the proposed Intermediate Water Cherenkov Detector (IWCD), located 1-2 km from the J-PARC neutrino source, to address flux and cross-section uncertainties.

Innovations at Hyper-K include the development of multi-PMT (mPMT) optical modules, each containing 19 small (3-inch) photomultiplier tubes within a pressurized vessel, enhancing the detector's resolution and timing precision. Planned production includes around 2000 modules, enhancing the capabilities of the Hyper-K detector array. These mPMTs offer superior spatial and temporal resolution over traditional single large (20-inch) PMTs and are designed with unique orientations to improve photon directionality tracking, noise discrimination, and event reconstruction. This presentation will cover the mechanical design, assembly, and testing of these mPMT prototypes produced by the Hyper-K international community and the potential for large-scale production and installation.

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