

The Calibration and Evaluation of 140 20-inch Box and Line Photomultiplier Tubes Designed for Hyper-Kamiokande

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As the next generation of water Cherenkov detector, Hyper-Kamiokande (Hyper-K) has the potential to advance the study of a variety of physics ranging from proton decay to neutrino oscillations. With the first Hyper-K tank's construction scheduled in 2020, it is vital to validate the feasibility of mass production for the 20" Box and Line (B&L) photomultiplier tubes (PMTs) designed for Hyper-K. By this summer, we have finished the measurement of around 140 new B&L PMTs that arrived at Super-Kamiokande (SK) and replaced the Venetian blind PMTs inside during the SK tank opening. Important parameters including the voltage supply (HV), collection efficiency, transit time spread, magnetic field effect, dark rate, etc. were recorded for each individual PMT and used for simulation of group performance inside SK. Our purpose was to know the quality of these PMTs and to select those qualified for installation in SK. In addition, the results of this calibration are also used as a reference to improve the upcoming Hyper-K PMT production, for which the most important goal is to understand the stabilized dark rate through long term operation in SK. In our sample group, we have observed no systematic issue or unqualified PMTs. Over 90% of the PMTs from our sample group have been installed at different vertices in the SK tank. By comparing these newly installed PMTs to the old ones, the Hyper-K's physical reach can be double checked with the SK detector simulation including the new B&L PMTs.

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