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Characterization of the 20-inch Photomultiplier Tubes for the JUNO Central Detector

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The primary physics goal of the Jiangmen Underground Neutrino Observatory (JUNO) is to resolve neutrino mass hierarchy, taking the advantage of the copious antineutrinos from two powerful nuclear power plants at distances of ~53 km in Guangdong Province, China. To meet this goal, JUNO has designed a 20 kt underground liquid scintillator (LS) detector which deploys 20,000 high quantum efficiency (HQE) photomultiplier tubes(PMTs) to reach an energy resolution of 3%/√(E/MeV) and an energy scale uncertainty better than 1%. Such performance numbers on such a massive LS detector are unprecedented, which places stringent requirements on the two types of the 20-in PMTs used by JUNO, the Hamamatsu HQE PMT and the newly developed micro-channel plate (MCP) PMT. To select qualified PMTs and to supply the detector simulation with precise PMT performance data, we have developed two PMT characterization systems, an industrial container-based mass PMT testing system and a PMT photocathode uniformity scanning station. This talk will explain the requirements on the two types of JUNO PMTs in connection to its physical goals, the technical designs of the two PMT evaluation systems, the PMT testing strategy and the preliminary JUNO 20-inch PMT characterization results.

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