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Double Calorimetry System in JUNO Experiment

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The Jiangmen Underground Neutrino Observatory (JUNO) is a multipurpose neutrino-oscillation experiment, with a 20 kiloton liquid scintillator detector of unprecedented 3% energy resolution (at 1 MeV) at 700-meter deep underground. There are ˜18,000 20-inch photomultiplier tubes (PMTs) in the central detector with an optical coverage greater than 75%. Control of the systematics of the energy response is crucial to archive the designed energy resolution as well as to reach 1% precision of the absolute energy scale. The detected number of photoelectrons in each PMT differs by two orders of magnitude in the reactor antineutrino energy range in such a large detector, which is a challenge to the single channel charge measurement. JUNO has approved a new Small-PMT system, including up to 36,000 3-inch PMTs, installed alternately with 20-inch PMTs. The individual 3-inch PMT receives mostly single photoelectrons, which provides a unique way to calibrate the energy response of the 20-inch PMT system by a photon-counting technology. Besides, the Small-PMT system naturally extends the dynamic range of the energy measurement to help the high-energy physics, such as cosmic muons and atmospheric neutrinos. We will present the physics concept of this double calorimetry, the design and implementation of the 3-inch PMT and its readout electronics system.

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