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Dory: An Optical Monitoring and Calibration Module for the nEXO Outer Detector

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Neutrinoless double beta decay ($0\nu\beta\beta$) is a hypothetical nuclear process in which two neutrons in a nucleus transform into two protons and two electrons without emitting electron antineutrinos. Its observation would demonstrate lepton number violation in weak processes and confirm that neutrinos are Majorana particles. Next-generation $0\nu\beta\beta$ searches using candidate isotopes aim to reach half-life sensitivities beyond 10^{28} years. nEXO is a proposed experiment targeting this regime using ^{136}Xe in a liquid xenon (LXe) time projection chamber (TPC). The LXe TPC is housed within a vacuum insulated cryostat and shielded by a 12.3 m diameter, 12.8 m high tank containing 1.5 kilotonnes of ultra-pure water, instrumented with 125 photomultiplier tubes (PMTs). The water tank and the PMT array form the nEXO water Cherenkov muon veto system, also known as the Outer Detector (OD).

To ensure the long-term stability and performance of OD, a monitoring and calibration system is under development. In this system laser light is delivered via optical fibers to optical modules, called Dory, deployed inside the water tank. Each Dory module consists of a PTFE plug and sphere that together form the diffuser. The diffuser is housed inside a pressure enclosure composed of a glass dome window and inner and outer flanges. The Dory modules emit light isotropically, enabling water quality monitoring and PMT timing calibration.

We are preparing a setup for Dory prototype to verify its isotropic emission profile. The system uses a two-axis rotary stage on which the Dory module is mounted, allowing 4π angular coverage. A fixed PMT records the light intensity at each orientation of the module, producing a map of its emission profile.

In this talk, I will present the design and current development status of Dory, discuss the required upgrades identified during prototyping, describe the Dory test setup, and show first measurements of its light emission profiles.

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