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Development of the front-end electronics for the new optical module "D-Egg" for IceCube-Gen2

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IceCube-Gen2 is an extension of IceCube Neutrino Observatory at the South Pole to significantly enhance the detection sensitivity to high-energy as well as low energy neutrinos. It occupies $\sim$8 km^3 of Antarctic ice and an array of $\sim$10,000 optical modules to capture Cherenkov photons efficiently from the secondary charged particles produced in the neutrino interactions.

The novel optical module called "D-Egg" is being developed as a main component of the IceCube-Gen2 detector. A D-Egg contains two 8-inch high-QE PMTs facing up and down inside the ellipsoid vessel made of UV transparent borosilicate glass along with the front-end electronic board. Photo-electron signals from two PMTs are digitized with two 250 MSPS 14 bit ultra-low power ADCs and processed in an FPGA before being sent to the surface DAQ system, located 1.5–2.5 km above the array of optical modules.

This presentation focuses on the evaluation of the first prototype of the front-end board for D-Egg. The location of the detector places constraints on power consumption ($<$4 W). All components must work at low temperature (-40°C). Small dead-time ($<$1%) and wide dynamic range of 1–300 photo-electrons/10 ns are required for the best physics performance. The first prototype shows that the design of the current board satisfies the physics requirements with small modifications. Performances of the prototype board at low temperature are also verified. Results of the first evaluations as well as the future prospects for D-Egg developments are discussed in this contribution.

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