Hamamatsu Photonics supports IceCube Upgrade, strengthening neutrino measurements in Antarctic ice

New optical instrumentation deployed in the South Pole is expanding IceCube Neutrino Observatory's sensitivity for lower-energy neutrino measurements.

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Hamamatsu Photonics marks the successful deployment of the IceCube Upgrade at the U.S. National Science Foundation's Amundsen–Scott South Pole Station, delivered by the IceCube Collaboration. The newly installed sensor strings deployed deep into Antarctic ice enhance IceCube's ability to record the faint Cherenkov light produced when neutrinos interact in the ice, supporting more precise measurements across an expanded energy range.

Photo: Credit: Yuya Makino, IceCube/NSF

Collaboration details

The IceCube Neutrino Observatory is a large-scale scientific facility embedded in approximately one cubic kilometer of exceptionally clear Antarctic ice. Its mission is to detect faint flashes of light produced by neutrino interactions, enabling researchers to investigate fundamental questions in astrophysics. Hamamatsu Photonics supports the project by providing photodetector technologies and expertise in qualification and integration for operation in the challenging Antarctic environment.

Hamamatsu works with the IceCube Collaboration on photodetector performance, qualification and integration for reliable operation in the Antarctic environment. For the Upgrade, IceCube is introducing new optical module designs that integrate multiple PMTs within a single pressure housing, increasing effective photocathode area and improving angular coverage of detected light. These design choices, combined with calibration improvements, are intended to strengthen event reconstruction and reduce sources of measurement uncertainties.

Project initiative details

The recent Upgrade involved the installation of five new instrumented strings, reaching depths of up to 2,400 meters and adding more than 650 new photodetectors and calibration devices. A key innovation is the use of multi-PMT optical modules, which increase the effective detection area and improve the directional coverage of light signals. These enhancements are expected to improve IceCube's sensitivity to lower-energy neutrinos, support more precise studies of neutrino oscillations, and strengthen the observatory's ability to detect astrophysical phenomena such as supernovae.

*"**IceCube is a remarkable collaboration that continues to expand how neutrinos can be measured and understood**."* explains Dr. Florian Briechle, Sales Engineer – Academic, at Hamamatsu Photonics. *"**Our role is to work closely with the scientists and engineers to support their endeavors, providing customized photodetector technologies for specific project requirements, working alongside the team on qualification and integration**."*

Working on IceCube's scientific legacy

Since beginning full operations in 2010, IceCube has reported major results in neutrino astronomy, including evidence for high-energy astrophysical neutrinos and progress toward identifying potential neutrino sources. Notable achievements include the association of a high-

energy neutrino with the blazar TXS 0506+056 and evidence for neutrino emission from the active galactic nucleus in Messier 77 (NGC 1068). These discoveries depend on the ability to detect and reconstruct faint, time-resolved light patterns across many sensors, a process that relies on high-performance photodetectors and careful calibration.

Hamamatsu's contribution includes providing photodetector technologies used in IceCube's optical modules and supporting qualification activities for reliable long-term operation. The company works closely with the collaboration to align detector characteristics and quality requirements with IceCube's system-level needs. Looking ahead, the Upgrade also serves as a foundation for future expansions such as IceCube-Gen2.

For further details on the IceCube experiment visit [The IceCube Neutrino Observatory gets a major upgrade beneath the ice – IceCube].





Photos courtesy of the IceCube Collaboration https://icecube.wisc.edu/gallery/the-icecube-upgrade/

About IceCube Neutrino Observatory

The IceCube Neutrino Observatory (IceCube) is a research facility at the South Pole in Antarctica. IceCube is maintained and operated by the Wisconsin IceCube Particle Astrophysics Center (WIPAC) with funding from the U.S. National Science Foundation (NSF) and other international funders. Scientific analysis is performed around the world by members of our international IceCube Collaboration. https://icecube.wisc.edu/