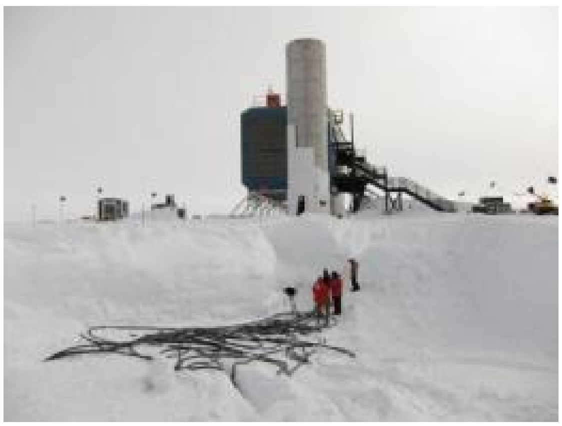
IceCube neutrino observatory nears completion

August 31 2010

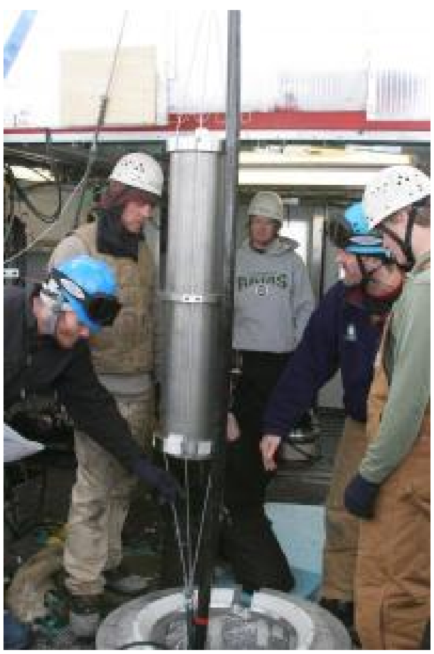


Signals from the sensors are carried by cables to the IceCube counting house that houses a large cluster of computers to reconstruct in real time some 2,000 muon tracks every second. Credit: J. Haugen

In December 2010, IceCube -- the world's first kilometer-scale neutrino observatory, which is located beneath the Antarctic ice -- will finally be completed after two decades of planning. In an article in the AIP's *Review of Scientific Instruments,* Francis Halzen, the principal investigator of the IceCube project, and his colleague Spencer Klein of Lawrence Berkeley National Laboratory provide a comprehensive description of the observatory, its instrumentation, and its scientific mission -- including its most publicized goal: finding the sources of cosmic rays.

"Almost a century after their discovery, we do not know from where the most energetic particles to hit the Earth originate and how they acquire their incredible energies," says Halzen, a professor of physics at the University of Wisconsin in Madison.

After light, neutrinos, which are created in the decay of radioactive particles, are the most abundant particles in the universe. High-energy neutrinos are formed in the universe's most violent events, like exploding stars and gamma ray bursts. Because the neutrino has no charge, essentially no mass, and only interacts weakly with matter, trillions of neutrinos pass through our bodies each day, without effect. On extremely rare occasions, a neutrino will strike the nucleus of an atom, creating a particle, called a muon, and blue light that can be detected with optical sensors. The trick is spying those collisions—and, in particular, the collisions of high-energy neutrinos. IceCube does it by sheer virtue of its size.



IceCube scientists deploy a calibration light source, called the Standard Candle in one of the 2.5 km deep holes. Each of the 86 holes contains a string of 60 Digital

Optical Modules (DOMs) that detect the blue light from neutrino events in the deep, clear ice. Credit: J. Haugen

At 1 kilometer on a side -- with 5,160 optical sensors occupying a gigaton of ice -- the observatory is orders of magnitude bigger than other neutrino detectors; the Superkamiokande detector in the Japanese Alps, for example, is only 40 meters on a side.

"IceCube has been totally optimized for size in order to be sensitive to the very small neutrino fluxes that may reveal the sources of cosmic rays and the particle nature of dark matter," Halzen says.

More information: The article, "IceCube: An instrument for neutrino astronomy" by Francis Halzen and Spencer R. Klein appears in the journal *Review of Scientific Instruments*. See: rsi.aip.org/resource/1/rsinak/v81/i8/p081101_s1

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