

Research Program as well as operation of three active U.S. research stations in Antarctica, including the Amundsen-Scott South Pole Station. The South Pole is a geophysically unique site for important research in astronomy and astrophysics. The clear ice and location on the earth's axis provide one of the best sites to search for distant phenomena such as the formation of stars and galaxies, and the growth and structure of the universe.

Neutrinos are high-energy subatomic particles produced by the nuclear reactions such as decay of radioactive elements, and are relics of high energy events that occur in the universe. Unlike photons of other charged particles, neutrinos can travel long distances unaffected by interference from magnetic fields or matter. These characteristics make neutrinos a valuable tool for the study of the universe. Searches for neutrinos from Supernova, dark matter, point sources of muon neutrinos and diffuse sources of high energy electron and muon neutrinos have demonstrated the physics potential of a deep ice neutrino detector.

In the late 1980's, the National Science Foundation funded a R&D proposal for construction and operation of the first high-energy neutrino telescope in the ice sheet at the South Pole, known as the Antarctic Muon and Neutrino Array and Detector (AMANDA). AMANDA is a prototype neutrino telescope which serves as a large volume detector to study very high energy cosmic ray neutrinos using a system of optical modules (*i.e.*, photomultiplier detectors) installed in the thick ice sheet at the South Pole. The AMANDA project was conducted in several phases (AMANDA-A, AMANDA-B10, AMANDA-II), and included the installation of over 900 optical modules at depths up to 2,350 meters in the ice sheet. During the AMANDA project, techniques were developed and later refined for drilling holes and deploying strings of optical modules deep into the ice sheet. The scientific results that are available from the AMANDA project have verified the function of the detector at the required level of sensitivity over several energy ranges, and have enabled the reconstruction of more than one hundred atmospheric neutrino events, thereby demonstrating the "proof of concept".

The successful deployment and operation of the AMANDA detector has shown that the Antarctic Ice sheet is an ideal medium and location for a large neutrino telescope and that a proven technology is available. However,

results from the AMANDA detector has shown that a much larger detector is needed to provide optimum angular and energy resolution and achieve the sensitivity required to detect a wide diversity of possible signals from distant sources. Based on AMANDA's performance, researchers have calculated that a telescope of one cubic kilometer in volume would be needed to achieve these scientific goals and meet the required level of performance. Project IceCube represents the neutrino telescope system designed to meet these objectives.

Project IceCube would feature the design, installation and operation of a second-generation high-energy neutrino telescope at the South Pole. The telescope would be located approximately 0.5 kilometers from the Amundsen-Scott Station and adjacent to the existing aircraft skyway. Project IceCube would capitalize upon the technologies developed in the AMANDA project and would consist of a deep and surface array of systematically-placed optical modules within a cubic kilometer of ice at the South Pole. The deep portion of the array would consist of 4,800 digital optical modules arranged in 80 vertical strings and placed at a depth up to 2,400 meters. The surface portion of the array would serve as an air shower detector for calibration purposes and would comprise 320 digital optical modules placed at a depth of 1 meter at locations adjacent to the vertical strings. Each component of the array would be connected to a data processing facility centrally located within the array pattern. Project IceCube would also encompass the existing AMANDA neutrino detector and the SPASE-2 air shower detector.

It is anticipated that the deep and surface components of the array will be installed over six summer seasons, beginning during the 2004/05 season. Deployment of the array strings will involve the use of a series of dedicated facilities and equipment (*i.e.*, Drilling Camp). The Drilling Camp will contain the infrastructure needed to support drilling and array deployment operations, including the power generation, water heating, fuel distribution and management. The Drilling Camp will be mobilized for operation each austral summer, and would operate 24-hours a day for approximately 59 days each year with dedicated Project staff. Penetrations into the ice sheet would be created using a Enhanced Hot Water Drill (EHWD) system which heats water to high temperature and pumps it under high pressure through a drill nozzle to create

a precise hole in the ice. The EHWD design represents an evolution of the AMANDA drill optimized to more efficiently drill and deploy detector strings in the ice sheet thereby meeting Project IceCube requirements. Consistent with the experience gained through AMANDA, each hole will be filled with hot water as it is drilled and the deep array string of detectors will be lowered to its target depth and allowed to freeze, securing the string in the ice sheet.

Supplementing the resources dedicated to Project IceCube (*e.g.*, personnel, equipment), additional resources would be shared with the Amundsen-Scott Station including personnel support facilities and services (*e.g.*, berthing, food), cargo, fuel, waste handling facilities, and communications services to facilitate data upload. Logistical support for the transportation of Project materials and personnel from McMurdo Station, Antarctica, to the South Pole would be provided by the existing fleet of LC-130 aircraft. Most materials and equipment would be expected to be transported to McMurdo Station by ship. Because the South Pole Station Modernization Project (SPSM) will be ongoing through 2007, careful planning of shared resources, particularly personnel support facilities and services, would be needed to ensure that the requirements of ongoing station operations, SPSM, and Project IceCube can be met without significant compromise. Selected resources from the old station scheduled to be decommissioned during SPSM (*e.g.*, Summer Camp) may be made available to Project IceCube as they become available.

The proposed action to initiate installation of the Project IceCube detectors in 2004/05 austral summer season using supplemental support from the Amundsen-Scott Station represents the preferred alternative (Alternative A). Other alternatives that have been considered in the CEE include the installation of Project IceCube using supplemental support from the Amundsen-Scott Station resources but following completion of SPSM in 2007 (Alternative B), the installation of Project IceCube as an independently operated facility with minimal support from the Amundsen-Scott Station (Alternative C), and the No Action Alternative, that is not proceeding with Project IceCube (Alternative D). Several additional alternatives were identified but were eliminated from consideration because they either failed to meet the scientific objectives of the Project or were not logistically feasible.