New Results From T2K

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The following news release on a multinational long-baseline neutrino oscillation experiment located in Japan was issued by KEK, the High Energy Accelerator Research Organization in Tsukuba, Japan. The experiment uses superconducting corrector magnets made by physicists and engineers in the Magnet Division at the U.S. Department of Energy's Brookhaven National Laboratory with funding from the DOE Office of Science. For more information about Brookhaven's role in the research, contact Karen McNulty Walsh, kmcnulty@bnl.gov [1], 631 344-8350.

New Results From T2K

Tokai to Kamioka Long Baseline Neutrino Oscillation Experiment

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Physicists from the Japanese-led multi-national T2K neutrino collaboration announced today that over the weekend they detected the first neutrino events generated by their newly built neutrino beam at the J-PARC accelerator laboratory in Tokai, Japan. Protons from the 30-GeV Main Ring synchrotron were directed onto a carbon target, where their collisions produced charged particles called pions. These pions travelled through a helium-filled volume where they decayed to produce a beam of the elusive particles called neutrinos. These neutrinos then flew 200 metres through the earth to a sophisticated detector system capable of making detailed measurements of their energy, direction, and type. The data from the complex detector system is still being analysed, but the physicists have seen at least 3 neutrino events, in line with the expectation based on the current beam and detector performance.

This detection therefore marks the beginning of the operational phase of the T2K experiment, a 474 physicist, 13 nation collaboration to measure new properties of the ghostly neutrino. Neutrinos interact only weakly with matter, and thus pass effortlessly through the earth (and mostly through the detectors!). Neutrinos exist in three types, called electron, muon, and tau; linked by particle interactions to their more familiar charged cousins like the electron. Measurements over the last few decades, notably by the Super Kamiokande and KamLAND neutrino experiments in western Japan, have shown that neutrinos possess the strange property of neutrino oscillations, whereby one type of neutrino will turn into another as they propagate through space. Neutrino oscillations, which require neutrinos to have mass and therefore were not allowed in our previous theoretical understanding of particle physics, probe new physical laws and are thus of great interest in the study of the fundamental constituents of matter. They may even be related to the mystery of why there is more matter than anti-matter in the universe, and thus are the focus of intense study worldwide.

Precision measurements of neutrino oscillations can be made using artificial neutrino beams, as pioneered by the K2K neutrino experiment where neutrinos from the KEK laboratory were detected using the vast Super Kamiokande neutrino detector near Toyama. T2K is a more powerful and sophisticated version of the K2K experiment, with a more intense neutrino beam derived from the newly-built Main Ring synchrotron at the J-PARC accelerator laboratory. The beam was built by physicists from KEK in cooperation with other Japanese institutions and with assistance from the US, Canadian, UK and French T2K institutes. Prof. Chang Kee Jung of Stony Brook University, Stony Brook, New York, leader of the US T2K project, said "I am somewhat stunned by this seemingly effortless achievement considering the complexity of the machinery, the operation and international nature of the project. This is a result of a strong support from the Japanese government for basic science, which I hope will continue, and hard work and ingenuity of all involved. I am excited about more ground breaking findings from this experiment in the near future". The beam is aimed once again at Super-Kamiokande, which has been upgraded for this experiment with new electronics and software. Before the neutrinos leave the J-PARC facility their properties are determined by a sophisticated "near" detector, partly based on a huge magnet donated from CERN where it had earlier been used for neutrino experiments (and for the UA1 experiment, which won the Nobel Prize for the discovery of the W and Z bosons which are the basis of neutrino interactions), and it is this detector which caught the first events.

The first neutrino events were detected in a specialize detector, called the INGRID, whose purpose is to determine the neutrino beam's direction and profile. Further tests of the T2K neutrino beam are scheduled for December, and the experiment plans to begin production running in mid-January. Another major milestone should be observed soon after – the first observation of a neutrino event from the T2K beam in the Super-Kamiokande experiment. Running will continue until the summer, by which time the experiment hopes to have made the most sensitive search yet achieved for a so-far unobserved critical neutrino oscillation mode dominated by oscillations between all three types of neutrinos. In the coming years this search will be improved even further, with the hope that the 3-mode oscillation will be observed, allowing measurements to begin comparing the oscillations of neutrinos and anti-neutrinos, probing the physics of matter/ anti-matter asymmetry in the neutrino sector.

The T2K collaboration consists of 474 physicists from 67 institutes in 12 countries (Japan, South Korea, Canada, the United States, the United Kingdom, France, Spain, Italy, Switzerland, Germany, Poland, and Russia). The experiment consists of a new neutrino beam using the recently constructed 30 GeV synchrotron at the J-PARC laboratory in Tokai, Japan, a set of near detectors constructed 280m from the neutrino production target, and the Super Kamiokande detector in western Japan.

The U.S. participation in the T2K experiment is supported by the U.S. Department of energy. The U.S. collaboration consists of 60 physicists from 8 institutions (Brookhaven National Laboratory, University of Colorado, Boulder, Colorado State University, Louisiana State University, University of Pittsburgh, University of Rochester, Stony Brook University, and University of Washington).

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