SUDBURY
NEUTRINO
OBSERVATORY

BACKGROUND INFORMATION ON THE SUDBURY NEUTRINO OBSERVATORY AND SNOLAB

The Sudbury Neutrino Observatory (SNO) is a unique neutrino telescope, the size of a ten-storey building, two kilometers underground in Inco's Creighton Mine near Sudbury, Ontario. SNO was planned, constructed and operated by a 130-member team of scientists from Canada, the United States and the United Kingdom. Through its use of heavy water, the SNO detector provides new ways to detect neutrinos from the sun and other astrophysical objects and measure their properties.

For many years, the number of solar neutrinos measured by other underground detectors has been found to be smaller than expected from theories of energy generation in the sun. This had led scientists to infer that either the understanding of the Sun is incomplete, or that the neutrinos are changing from one type to another in transit from the core of the Sun. SNO scientists have used the capability of the SNO detector to measure all three types of neutrinos to determine that solar neutrinos are changing their type en-route to Earth, thus providing answers to questions about neutrino properties and solar energy generation.

The SNO detector consists of 1000 tonnes of ultra-pure heavy water enclosed in a 12-meter diameter acrylic plastic vessel, which in turn is surrounded by ultra-pure ordinary water in a giant 22-meter diameter by 34-meter high cavity. Outside the acrylic vessel is a 17-meter diameter geodesic sphere containing 9,456 light sensors or photomultiplier tubes, which detect tiny flashes of light emitted as neutrinos are stopped or scattered in the heavy water. The flashes are recorded and analyzed to extract information about the neutrinos causing them. At a detection rate on the order of 10 per day, many days of operation are required to provide sufficient data for a complete analysis. The laboratory includes electronics and computer facilities, a control room, and water purification systems for both heavy and regular water.

The construction of the SNO Laboratory began in 1990 and was completed in 1998 at a capital cost of $73M CDN with support from the Natural Sciences and Engineering Research Council of Canada, the National Research Council of Canada, the Northern Ontario Heritage Foundation, Industry, Science and Technology Canada, Inco Limited, the United States Department of Energy, and the Particle Physics and Astronomy Research Council of the U.K. The heavy water is on loan from Canada's federal agency AECL with the cooperation of Ontario Power Generation, and the unique underground location is provided through the cooperation and support of CVRD-Inco Limited.

The SNO detector has been in almost continuous operation since November 1999 when, after a period of calibration and testing, its operating parameters were set in their final configuration. Measurements from the initial phase with pure heavy water were reported in 2001 and 2002 and showed clearly that about two-thirds of the electron type neutrinos created in the Sun changed their type to muon- or tau-type neutrinos in transit to the Earth. This transformation appears to arise from a finite mass for neutrinos, a finding beyond the current Standard Model of Elementary Particles. The measurements of all three neutrino types showed very good agreement with the expected numbers of neutrinos generated in the Sun, confirming current theories of energy generation in the Sun.

Further background information can be found on the SNO website:
www.sno.phy.queensu.ca .

SNO INSTITUTE MEMBERS
Queen's University, Laurentian University, Carleton University, University of Guelph

PARTICIPATING INSTITUTIONS
University of British Columbia, Oxford University, University of Pennsylvania, Los Alamos National Laboratory, Louisiana State University, LIP, Lawrence Berkeley National Laboratory, University of Washington, Brookhaven National Laboratory, TRIUMF, University of Texas, Massachusetts Institute of Technology.

SNOLAB – Exciting New Science Deep Within The Earth

SNOLAB - Canada's most important facility for particle astrophysics - is now nearing completion deep underground at CVRD-Inco's Creighton Mine near Sudbury Ontario. Building on the outstanding international success of the Sudbury Neutrino Observatory and its exciting measurements, SNOLAB includes an expansion of the SNO underground laboratory space (by nearly 150%) and a new surface building where collaborative groups will develop, assemble and operate new experiments in particle physics. SNOLAB is the deepest laboratory in the world available for this work, and the facility has attracted over 16 letters of interest, from experiment development groups around the world, for space that will provide them with the lowest possible interference from radioactivity in their experiments.

Over the past 25 years, experiments in underground sites have been developed to address questions in particle physics which cannot be investigated in other ways. Experiments at SNOLAB will measure fundamental properties of neutrinos and will look for Dark Matter particles thought to make up about 25% of our universe. They will also seek rare radioactive decays that can provide insight on how the matter in the universe was formed. SNOLAB's exceptional underground environment enables very low rates to be observed by excluding other competing background effects. The underground environment is essential to the successful observation of tiny signals often at very low rates. SNOLAB will be at the forefront of this work, providing the best location for many new experiments. Canadian university groups are key members of a number of experiments that could be located at SNOLAB.

The underground laboratories of SNOLAB are funded by a $ 38.9 million grant from the International Joint Venture program of the Canada Foundation for Innovation. The Ontario Innovation Trust, the Northern Ontario Heritage Fund Corporation, FedNor and CFI have provided grants for a new surface facility with grants totaling $ 10.4 million. The City of Greater Sudbury is also providing a 5 year $ 125,000 grant for public education and publicity for the new developments at SNOLAB.

Further information is available on the SNOLAB website: www.snolab.ca.

SNO Participating Institutions
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Queen's University, Carleton University, Laurentian University, University of Guelph, University of British Columbia, TRIUMF Laboratory,

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Lawrence Berkeley National Laboratory, Los Alamos National Laboratory, University of Pennsylvania, University of Washington, Brookhaven National Laboratory, University of Texas, Austin, Louisiana State University, Massachusetts Institute of Technology

United Kingdom
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