Sudbury Neutrino Observatory, Neutral Current Detectors

K.T. Lesko, Y.D. Chan, M. Dragowsky, M. Isaac, M.E. Moorhead†, E.B. Norman, A. Schuelke‡, and R.G. Stokstad

With SNO's ability to observe both the Neutral Current (NC) and Charged Current (CC) reaction rates we are able to deduce the existence of neutrino oscillations with two distinct signatures. The first signature is obtained by a measurement of the CC/NC ratio. The second method is based on observing deviations in the predicted shape of the CC spectrum.

SNO is developing two techniques to observe the neutrons liberated by the NC reaction: $\nu_x + D \Rightarrow p + n + \nu_x$, Q = -2.2 MeV. The first technique uses the addition of a salt to the D_2O, which captures the neutrons and generates γ-rays that are subsequently observed through their Compton scattering and associated Cerenkov light. The salt selected by SNO is MgCl. The second technique uses an array of ~100 ^{3}He proportional detectors[1]. The neutrons are detected via the ^{3}He(n, p+t) reaction. SNO anticipates using both techniques to reduce the affects of the different systematic errors associated with each technique.

The groups at the University of Washington, Los Alamos National Laboratory, and Lawrence Berkeley National Laboratory have received funds from the Department of Energy to develop the array of ^{3}He proportional counters, or "NCDs". The past year much work as gone into developing and producing the nickel tube detector bodies with low levels of uranium and thorium contamination (~1 ppt U has been achieved). The technology required for the production of the counters has advanced to the point where prototype counters were produced at the end of 1996.

Our group has applied our experience in engineering, contamination control, and low level counting to assist with the production of the counters. In particular we have drafted cleanliness procedures for the production of the counters, assisted in the selection and production of various NCD components , drafted quality assurance plans for the NCDs, and coordinated much of the low level counting performed at the Oroville facility. We designed, fabricated, and installed the underground facility in the SNO control room for the long-term storage of the detectors while the ^{56}Co decays and the detectors are operated to determine their contamination levels and operational characteristics.

Nickel in the array is activated by cosmic rays and ^{56}Co is produced. This activity adds a significant contribution to the NC backgrounds (γ-rays > 2.2 MeV) unless i) steps are taken to minimize the exposure of the components to cosmic rays and ii) the finished counters have a "cool-down" period (~6 months) during which ^{56}Co will decay ($\tau_{1/2}$ = 77.27 day).

We have begun simulations of the NCDs in SNO and are pursuing studies of *in situ* measurements of the NCD backgrounds using a neutron poison.

Footnotes and References

† Present address, Oxford University, Oxford, UK OX13RH

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1. Neutral-Current Detection in the Sudbury Neutrino Observatory, Proposal to the Department of Energy FIN-94-ER-E-324, January 31, 1992, T. Bowles, *et al.*