Sudbury Neutrino Observatory - Measurements of Surface Contamination on SNO Detector Components

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The Sudbury Neutrino Observatory (SNO) is a heavy-water Čerenkov detector designed to detect solar neutrinos at substantially greater rates than earlier detectors. The solar neutrino spectrum extends down to energies where uranium and thorium and their decay daughters in even trace amounts result in significant backgrounds and ultimately limit the energy threshold of the experiment. We established an extensive effort to measure and control both the intrinsic contamination (uranium and thorium contained within bulk detector elements) and the contamination which is deposited on detector components in the long process of fabricating and assembling the detector (usually in the form of mine-dust). We report here a summary of our recent measurements of the surface contamination on many of the detector elements in the SNO cavity. The surface contamination could be substantially larger than initially estimated due to the extended detector assembly time and the difficulties encountered in building the detector.

The intrinsic contamination measurements have been previously reported[1] and relied on direct-counting of bulk material samples. In contrast, surface contamination requires the collection and analysis of integrated surface deposits. We developed an X-ray fluorescence detector for this analysis. Using specially prepared adhesive tape collectors we sampled the surface contamination on many detector components including the acrylic vessel, PMT faces, light concentrations, ABS plastic holders and stainless steel support structure, PMT cables, and the cavity walls and floors. SNO's sensitivity to contamination increases as the distance from detector components to the heavy water decreases, requiring that the acrylic vessel have the lowest level of contamination, followed by the PMT array, and finally by the outer cavity walls. Our measurements, although extensive, represent a partial sampling of the total surface area of the detector (>12,000 m^2).

The details of our work is presented in an internal SNO report[2]. In summary, we find that the levels of surface contamination on all the detector components that have been suspended in the cavity for the past two years are higher than originally estimated and that the actual deposition rate was up to a factor 20 greater than early estimates. However, SNO's remedial measures (covers and cleaning) resulted in acceptable levels of surface contamination on the PMT Support Structure. Measurements of the most sensitive elements, the acrylic vessel and chimney, were typically below our detector thresholds indicating very low levels of surface contamination on the vessel.

We are investigating several alternative fates for the surface contamination once the detector is filled with water. Using the SNOMAN Monte Carlo code we are modeling the consequences of the contamination which could go into solution so that there could be significant redistribution of backgrounds-causing contamination.

With these studies we will be able to better model the initial detector response and understand the background signals near our anticipated threshold of 5 MeV.

Footnotes and References

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1. PMT Support Structure Group Notes and Internal Memos; Private Communication Al Smith; SNO-STR-94-013 Skensved and Robertson.

2. SNO-STR-97-046, Lesko, Schülke, Doe and Evans and 1995-96 NSD Annual Report pg. 127