Counting Requirements for Next Generation Solar Neutrino Experiments

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Future solar neutrino experiments will strive to lower thresholds well below the MeV level in order to detect the pp neutrinos. The experiments will all require real time counting capabilities and have both charged-current (CC) and some neutral-current (NC) sensitivity. The neutral-current experiments by necessity must detect the neutrinos via elastic-scattering (ES) interactions. Stringent radiopurity requirements for the materials used in the construction of these experiments are needed. The choice of materials and the subsequent quality insurance during construction and assembly will in turn require the use of sensitive radio-assay techniques. The following discusses the ranges of counting technologies that will be required, along with sensitivities, for the next generation experiments.

Two strong candidates for CC detection are MOON and LENS. Both use passive detection methods. LENS for example will use Indium or Ytterbium targets, but loaded into liquid scintillator. To reduce backgrounds, the scintillator will have to be highly segmented. Purity requirements for the scintillator would be on the order of that used for Borexino or KamLAND (10^{-16} g/g U and Th). Similarly, the loading element will have to be of extreme purity as well. MOON will use Molebdium as a target. One possibility is to use Mo in the form of foils surrounded by large sheets of plastic scintillator. Purity levels for the inner detector volumes would have to be at the 10^{-13} g/g U and Th levels. These experiments will have to use techniques (NAA, etc.) similar to those used in Borexino. Also, because of the segmentation, surface contamination will be of concern and methods to assay and test these large surfaces will be required. Finally, both LENS and MOON will have to be sealed from Radon. All components in which there is a potential Rn migration path to the inner target and detection volumes will therefore have to be tested.

Candidates for ES detection are HERON, CLEAN, and TPC. Both HERON and CLEAN propose to use cryogenic fluids as targets. The advantage of such targets would be the ability to reach very high purity levels in the main target volumes and the defence of cryogens against the migration of radon. Both HERON and CLEAN would consist of a single large target volume which in turn would have a separate detection readout array. The concern in both experiments is therefore gamma-rays from the external support, cryostat, and readout hardware. For example, CLEAN would have a central target volume surrounded by a cryogenic containment and photoarray structure. This structure presumably would be as complex as that of the SNO detector and would require the assay of 100's of components. The counting sensitivity would be on the order of ??? for U/Th and ??? for K. Components would include those that make up the cryostat, the PMTs, the PMT bases, cables, etc. The material for the outer shield containment vessel would also have to be assayed. HERON would also require counting of cryostat parts as well as the thousands of optical/phonon readout detectors. In some instances large cryostat components would require whole body counting capabilities. The solar neutrino TPC project will also require very stringent purity with the overall levels not exceeding the 10^{-13} g/g U/Th. Parts would include the plastics, wires, etc. needed in the construction of a large TPC. Direct counting methods, enhave via neutron activitation analysis methods, would certaintly be required along with the ability to test for radon emanation.

Above, it is shown that the experiments will be extremely complicated systems with many components. Many assay techniques will be required.