Contribution ID: **91** Type: **not specified**

Liquid Scintillator Purification and Assay R&D at SNO+

The SNO+ detector is a renewal of the Sudbury Neutrino Observatory heavy water Cherenkov detector, whereby the original heavy water has been removed, and is to be replaced by organic liquid scintillator for the study of low energy solar neutrinos, geo-neutrinos, and neutrino-less double beta decay. The detector reuses the same 12m diameter acrylic containment vessel (AV), which will have a new hold-down net installed to support the buoyant force of the liquid scintillator within the water-filled cavity.

The science program requires extremely low levels of high-energy beta and gamma-ray background activities from 214Bi, 212Bi, and 210Bi, all from the 238U and 232Th chains, and from 40K. The initial phase of the SNO+ experiment uses the scintillator components, linear alkylbenzene (LAB) and wavelength shifter PPO, both carefully prepared with multi-stage distillation and vacuum gas stripping. To enable the removal of activity from the U-chain (most likely due to mobility of 222Rn) and from the Th chain, a re-purification system (used during the experiment) is being designed to remove effectively these radio-contaminants and their daughters (Ra, Rn, and Pb). It is also known from the SNO experiment that ex-situ radio-assay of the removed contaminants is a very valuable part of the physics analysis.

The re-purification system must have sufficient flow rate (about 150 LPM) to process the full 795 tonnes of scintillator within several days, so as not to interfere with the physics data, and also so that the scintillator can be purified on a time scale similar to the 224Ra and 222Rn half-lives (ie. about 4 days). Additionally, the purification processes must be stable against removal of the PPO, and the loaded Nd metal compound for the double-beta decay studies in a later phase. The research and development work has focused on three methods for the re-purification: liquid-liquid extraction using water (effective for Ra and K), surface-functional metal scavenging (effective for Pb and Ra), and vacuum steam stripping (effective for Rn and O2 removal). The assay method will use acid to strip and methanol to regenerate the metal scavenger media columns, followed by chemical recovery of the activity from the acid. This activity is then counted in custom beta-alpha counters using a coincidence pulse shape discrimination technique. To test the efficiencies of these methods and finalize the design for the re-purification plants, a program using "natural" radioactive spikes with 212Pb and 224Ra for the LAB has been developed. Since these contaminating elements are not soluble in organic solvents in the traditional way, recoil implantation procedures have been developed to make stable radioactive spike cocktails.

In this poster, current results for the spike production and characterization, and for purification tests for LAB with the water-extraction and metal scavenger techniques are given. The design for the full-scale purification and liquid-handling plants is also presented, along with an outline of plans for further purification and assay tests.

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