Low Energy Background Analysis at the Sudbury Neutrino Observatory

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There are two ways that $\beta - \gamma$ decays from the natural U and Th chains can contaminate the solar neutrino signal in the SNO detector. They are:

1. *Photodisintegration of the deuteron*: γ rays with an energy greater than 2.2 MeV can photodisintegrate the deuteron. The resulting neutron from this process is indistinguishable from the neutral-current neutrino signal. Near the bottom of the natural Th and U chains, γ rays that are energetic enough are emitted in the decays of ^{208}Tl and ^{214}Bi. The light isotropy from these two decays are different due to the difference in the number of particles emitted. This difference can be used to determine the U and Th concentration in the D_2O, from which the photodisintegration background can be determined. Figure 1 shows the difference in the isotropy measure $\langle\theta_{ij}\rangle$, which is the mean opening angle between all the hit photomultiplier tube pairs. Results from this light isotropy study and chemical assays are consistent with each other. Figure 2 shows their comparison. Identical techniques are used to determine the radioactivity in the H_2O region. From these measurements, the neutron background that have to be subtracted from the neutral-current signal are found to be $44.3^{+8.2}_{-9.1}$ counts in the D_2O and $11.2^{+5.5}_{-3.6}$ counts in the H_2O.

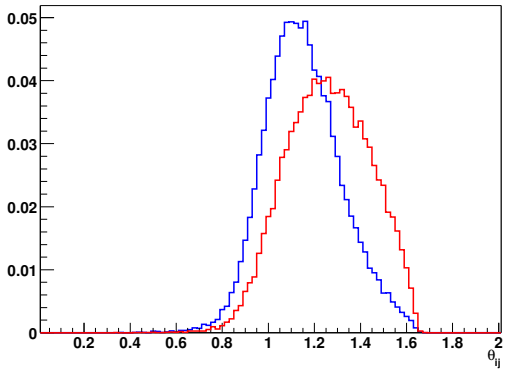

FIG. 1: Difference in the light isotropy measure between daughters in the U (^{214}Bi) and the Th (^{208}Tl) chains.

2. *Cherenkov Tail*: A small portion of the high energy tail of the $\beta - \gamma$ decays from internal U and Th contamination in the D_2O is present above the solar neutrino analysis threshold. In addition, mis-reconstruction of $\beta - \gamma$ decay events originating from the H_2O region can contribute to a background signal inside the anlaysis fiducial volume. To understand this source of background, we have deployed low energy background calibration sources to different regions of the detector. By performing a fit to the radial distribution of the background, we found that a total of $45.5^{+17.1}_{-11.4}$ counts in the reduced data set of 2928 neutrino candidate events can be attributed to this type of Cherenkov tail events.

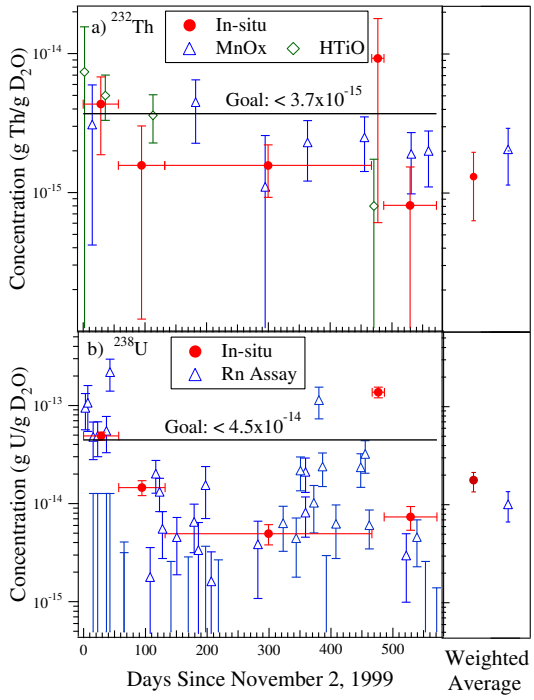

FIG. 2: Comparing the in-situ (light isotropy study) and ex-situ (chemical assay) results of the U and Th concentration in the D_2O.