Analyses of Radioactive Backgrounds in SNO

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The primary physics backgrounds in the SNO detector come from radioactive decays of various nuclei in the natural Uranium and Thorium decay chains. The decays of ^{208}Tl and ^{214}Bi nuclei have the largest potential effects on neutrino signals because these two decays have largest Q values amongst the $\beta\gamma$ nuclei in their respective decay chains. More importantly, their decay products include gamma rays with energy higher than the 2.223 MeV needed to photodisintegrate the deuteron.

The neutrino analysis threshold depends on the level of these two decays in the detector A knowledge of these background levels is also critical for correctly interpreting the neutral-current background in the SNO detector. The SNO collaboration has developed a complex water assay program to measure the U/Th concentration levels in both the heavy and the light water. We developed a completely different technique to determinethe background levels in the SNO detector directly. This technique uses the difference between the hit patterns of the ^{208}Tl and ^{214}Bi decays (as shown in figure 1 where θ_{ij} is a paramter used to describe the isotropy of a hit pattern) to distinguish between these two types of decays statistically. Monte Carlo can then be used to deduce background event rates.

The main advantages of such technique are:

- It is capable of determining background levels *in situ* and in real time.
- Unlike the water assay technique, it directly measures the rates of the ^{208}Tl and ^{214}Bi decays. So it doesn't need to make the assumption of secular equilibrium within the decay chains.
- This technique is completely different from those used in the water assay so that it is subject to completely different systematics and its results can be compared with results of the water assay to produce a fairly robust estimate of background levels in the detector.

We have used this technqiue on some of the SNO physics data. Although background calibration sources are essential to make a conclusive evaluation of the technique, some preliminary results are very promising [1]. We have also studied trends of background levels within in the detector, results agreed with reports from the water assays.

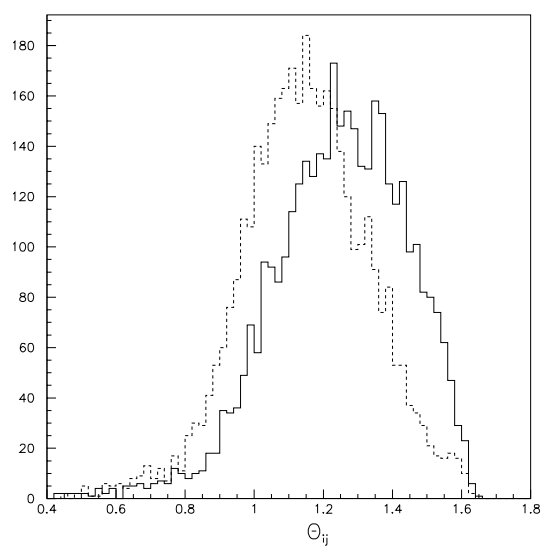

Figure 1: θ_{ij} distributions for ^{208}Tl (solid line) and ^{214}Bi (dashed line) decays in the heavy water.

References

[1] LBNL SNO Group; Preliminary Studies of low Nhits data, SNO-STR-99-029, 12/7/1999.