External High Energy γ-ray Background in the SNO Detector

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There are several high-energy backgrounds that one must consider in the extraction of the solar neutrino flux at SNO. One would expect these backgrounds, whether it is γ rays from the cavity wall or the PMT support structure, to be inward-going ($\hat{u} \cdot \hat{R}_{fit}$<0, where $\hat{u}$ and $\vec{R}_{fit}$ are the fitted direction and vertex of the event). Figure 2 shows the $\hat{u} \cdot \hat{R}_{fit}$ distribution as a function of $(R_{fit}/R_{AV})^3$, where R_{AV} is the radius of the acrylic vessel (=600 cm). The dominant source of this external background is the γ rays from the cavity wall. In Figure 1, the detector zenith angle ($\cos\theta$) distribution for inward-going events in several spherical shells in the H_2O are shown. γ rays from the cavity wall have the shortest path lengths to traverse near the equator, resulting in the higher count rate near $\cos\theta$=0.

One can estimate the high energy background rate from these external γ rays in the D_2O fiducial volume using the ^{16}N calibration data taken at large radial distances in the H_2O. If we assume that the fitters reconstruct the high energy background events with the same efficiencies as the ^{16}N events in the H_2O, then the number of high energy background events in the D_2O during solar neutrino data taking is εN_ν, where ε is the ratio between the number of ^{16}N calibration events that are reconstructed to within the D_2O to that for a monitoring window Ω in the H_2O, and N_ν is the number of events in the neutrino data set that are reconstructed to within Ω. We performed this analysis on the first 241 live days of SNO data. The number of events with $N_{hits}\geq$50 (E ~6 MeV) that are reconstructed to within 5.5 m is $6.0\pm2.8(\text{stat.})^{+3.5}_{-4.1}(\text{sys.})$ events.

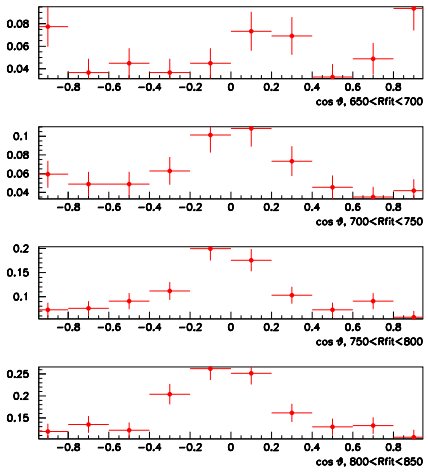

Figure 1: $\cos\theta$ distributions for inward-going events in different spherical shells in the H_2O.

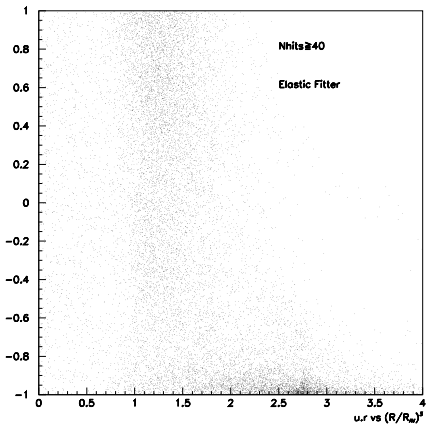

Figure 2: $\hat{u} \cdot \hat{R}_{fit}$ versus $(R_{fit}/R_{AV})^3$ for events with $N_{hits}\geq$40.