Removal of Instrumental Backgrounds in Phase III of the SNO Experiment

N. Tolich[1], Y.-D. Chan[1], C.A. Currat[1], R. Henning[1], K.T. Lesko[1], A.W.P. Poon[1], G. Prior[1] for SNO collaboration
[1]*Nuclear Science Division, Lawrence Berkeley National Laboratory, Berkeley, California 94720*

This analysis deals with data from the 40 proportional counters deployed in the D_2O of the SNO detector. These proportional counters are also referred to as Neutral Current Detectors or (NCDs). The signal from each NCD passes through a preamp and a logamp before being recorded by an oscilloscope. Before passing through the logamp the signal from each NCD is split, and also passes directly to a shaper which records an estimate of the total ionization energy deposited in the proportional counter. The shaper is triggered separately from the waveform and shows up as a separate event $\sim 9\,\mu$s after the waveform. Processes other than deposition of ionization energy in the NCDs can trigger the electronics generating waveforms which contaminate the ionization energy spectrum. The algorithms described here removes these other processes from data sample.

There is no robust way for characterizing all contaminating waveforms. The contamination characteristics presented here have generally been identified by higher event rates on a particular NCD, or events which have a particular parameter which clearly isolates them from known neutron events (or likely alpha events). All NCDs have a significant number of waveforms that do not appear to have any significant pulse, and probably triggered on a small deviation in the noise. These are not a problem if we require a coincidence with a shaper event since the shaper triggers on a long integration time it is unlikely to trigger the shaper. Two NCDs have a significant number of events characterized by two very narrow pulses separated by $\sim$85 ns with a third smaller pulse another $\sim$85 ns later. These are probably the result of a micro discharge in the NCD. A number of NCDs have events characterized by a single very short pulse. They can occur on top of a much broader pulse; however they can also occur without a broader pulse which makes them easier to identify. A few NCDs also have events characterized by an oscillation with a frequency of $\sim$4 MHz. These rarely have an associated shaper event, and often have multiple waveforms at the same time. Finally, there is one NCD which has a clear excess of events. Some of these excess events appear to be spikes, and others appear to have multiple pulses. However, there is no clear signature for some of the remaining excess events.

A number of different parameters to define the shape of the waveform have been defined. Many of these use the power spectrum of the waveform, which is particularly good at isolating the "fork" like events and oscillations. Figure 1 shows the shaper spectrum before and after the data reduction cuts. After the data reduction cuts the neutron peak at shaper value $\sim$130($\sim$760 keV) becomes visible. Also the alpha distribution which is peaked at $\sim$800 appears to continue down to low energy with a reasonable flat distribution, as expected.

The neutron data loss is calculated using neutron sources deployed at various positions throughout the detector. Figure 2 shows the fractional data loss as a function of the shaper value. It is clear that the AmBe and Cf runs have similar behavior and that the fractional data loss is typically less than 0.01, increasing at low energy.

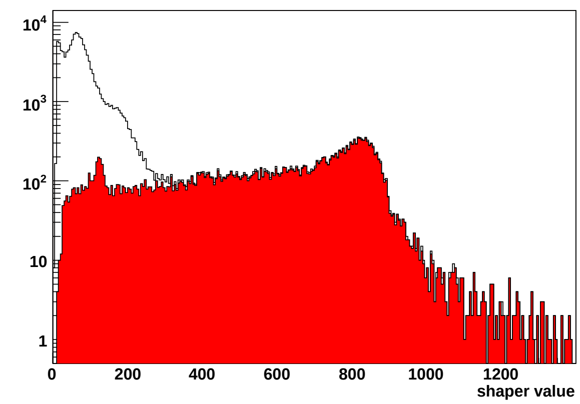

FIG. 1: Distribution of shaper value. The white histogram only has the correlated shaper cut, and the red histogram has all the data reduction cuts.

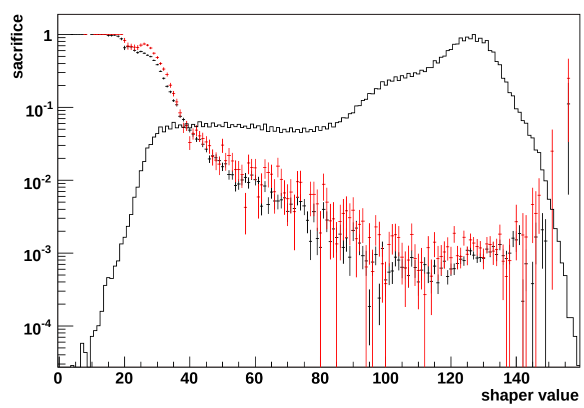

FIG. 2: Fractional data loss as a function of shaper value. Red and black points are for Cf and AmBe runs, respectively, where the errors are one sigma two-sided statistical errors. The black histogram is the scaled shaper value distribution.