Discussion of analysis procedure

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Goals of the Analysis Procedure

Analyze n^3He data to produce valid asymmetries and uncertainties with cuts that are motivated by the properties of the apparatus, beam, and n^3He physics and that have minimal operator discretion.

Chopper phase cut

NPDgamma, we calculated the chopper phases by looking at the initial rise and final fall of the neutron yield vs. time bin. We solved for the time at which the yield vs. time crossed half the maximum yield. For NPDgamma a small fraction of the data were rejected by the chopper phase cut. Because of the difficulty of determining the polarization for runs with the choppers unlocked, the only recourse is to cut such runs.

If a neutron passes through the spin flipper when the spin flipper is off, the neutron polarization is unchanged. When the spin flipper is on, neutrons are rotated by calculable amounts. Starting from a perfect pulse and knowledge of the spin flipper RF field strength as a function of time, one can determine the polarization for prompt as well as wrap-around neutrons. Approximately 10% of the neutrons have wrapped around. The corrections to the polarization are ~ few %.

Statistical properties of A and B type run sequences

We are now analyzing type A and type B runs separately. We need to determine if the probability of getting a type A run is independent of the history of run types. The simplest situation would be that the type of each run was independent of the type history and that A and B runs were equally probable. We could investigate this question by finding a long uninterrupted sequence of runs and assigning a 1 or -1 to types A and B. If the auto correlation of the sequence is a delta function, then we have independence of history. If not, we need to find out what governs the probability of A and B.

Physics (P) and Machine (M) asymmetries

We are now taking 600 pulse sequences as the objects to be analyzed for asymmetries, PV or PA. Every run consists of =42 600-t0 sequences. In a given run, the first pulse after every deliberately dropped pulse is always spin up (type A) or always spin down (type B). There are two types of asymmetries in the data;
1. Asymmetries caused by the interaction of the neutron with the ^{3}He target (P=physics asymmetries).
2. Asymmetries caused by the change in beam properties caused by deliberately dropping pulses, (M=machine asymmetries). In the above analysis, the only feature that showed an M type asymmetry was a dependence of the monitor yield as a function of pulse number after the dropped pulse. The intensity changed by approximately 10^{-3} in 10 seconds, the duration of a spin sequence. The intensity variation causes an average false asymmetry of ~ 0.6 10^{-6} for a sequence. Neither the P or M asymmetries showed the "horn" feature. An important difference in the present analysis and analyses performed earlier is that in the present analysis the DC offsets for each detector were subtracted before forming the asymmetries. It may be that the DC offsets caused the horns.

The average asymmetry of type A runs is M+P and the average for type B runs is M-P. If both P and M enter the value of the measured linearly, then M=(A+B)/2 and P=(A-B)/2. Kabir analyzed approximately 30,000 runs that had no randomly dropped pulses and determine the M and the PV n^{3}He asymmetry and 1000 runs to determine the M and PA n^{3}He asymmetry. The results were:

PV = (1.1 ± .9) 10^{-8}
PC = (-43 ± 5) 10^{-8}

Dropped Pulse Cuts

A substantial fraction of sequences have dropped pulses. I argue that we should establish a criterion for identifying and cutting dropped pulses. For example, for each run we determine the maximum intensity of all pulses and then histogram the ratio of each pulse to that of the maximum pulse (fractional intensity). From the fractional intensity histogram, we could determine the fractional intensity for which the number of events is minimal and take this fractional to be the cut level.

The definition of the physics asymmetry is P=(A-B)/2. Dropped pulses in A and B runs will affect P oppositely. The average value of P is not shifted by cutting dropped pulse pairs. However, cutting dropped pulse pairs will affect the fluctuations in P from sequence to sequence and run to run. dropped pulses in B runs.

Recall that the change in the asymmetry of a pulse pair is ~ 0.6 10^{-6}. I estimated the statistical uncertainty in a pulse pair from the statistical uncertainty in the PV asymmetry:

$$\sigma_{PV} = \sigma_{Pair} \frac{1}{\overline{G}} \sqrt{\# \det ectors \times \# Runs \times \# Pulse\ Pairs / Run}$$

$$\sigma_{Pair} = 10^{-4}$$

The change in P for a randomly dropped pulse pair is 2 orders of magnitude larger than the statistical fluctuations in a pair asymmetry. Therefore the uncertainty determined from sequences with randomly dropped pulses is expected to be the approximately same as for perfect sequences.

Conclusion

The analysis procedures discussed above will produce valid physics asymmetries and uncertainties. There are few if any personal choices to be made in the analysis.

Loose Ends

1. Include correlations between detector signals in the analysis.
2. Calculate average polarization including wrap-around neutrons.
3. Develop intensity cut algorithm for dropped pulses.
4. Demonstrate that “horn” feature was indeed caused by not subtracting DC offsets from detector signals.

Cut 1:

The fundamental objects are perfect sequences: All 599 pulses have approximately the same intensity. Chris Crawford developed an algorithm to determine the number neutrons vs. TOF frame overlap as well as prompt neutrons. His technique is to subtract the arrival-time profile of deliberately dropped pulses from a long sequence of pulses having the same intensity. This analysis gives us knowledge of a multi-frame “perfect pulse” analogous to that used in the NPDG analysis.