n3He Frequency Analysis - Fast Fourier Transform Method 2

> M. McCrea University of Manitoba

> > January 05, 2018

イロン イロン イヨン イヨン 三日

1/10

Motivation

The goal of the FFT analysis is to look at the frequency components of the measured wire yields, and to see if it can offer a cause the oscillations in the asymmetry correlations. If the cause of the variations is resonance with the wires from an external then each wire is expected to have a consistent frequency somewhat near 210 Hz, but each wire is expected to differ somewhat.



Figure: Correlations for time bins 0,1,2 wire 0 run 17785

n3He DAQ Time Binning

- neutron pulses are at 60 Hz
- ▶ 1/60 = 0.0166667 seconds between neutron pulses
- Clean DAQ
 - 50 kHz sample rate
 - 16 samples averaged for each of 49 recorded time bins per pulse
 - 16/(50 kHz) = 0.32 ms per time bin
 - $\blacktriangleright~15.68~{\rm ms}$ of data taking per neutron pulse
 - \blacktriangleright 0.98 ms dead time per pulse

• $t(t, k) = (16.6667 \times k + 0.32 \times t) \text{ ms}$

Section 4.2.4 of Kabir, Md Latiful, "A MEASUREMENT OF THE PARITY VIOLATING ASYMMETRY IN THE NEUTRON CAPTURE ON 3He AT SNS" (2017). Theses and Dissertations–Physics and Astronomy. 45.

Resampling Motivation

- Resampling increases the number of data points by interpolating between the measured pulse values
- Resampling does not increase accuracy of FFT but does create evenly spaced time bins to allow FFT algorithms to be applied.
- Each additional time bin increases the FFT processing and memory requirements during analysis.
- The goal is then to minimize the number of new samples while smoothly interpolating between the existing data points.
- ▶ Initial sample rate is 60 * 49 = 2940 samples per second
- ▶ By Nyquist Theorem maximum possible frequency is 1470 Hz

Resampling Method

- Each Chamber pulse has up to 833 un-averaged samples
- This is divisible by seven for 119 samples per pulse that are 0.1401 ms wide
- Each current 0.32 ms time bin is repeated 16 times at the 833 samples per pulse
- ▶ Remaining (833 49 × 16 =)49 time bins can be interpolated from the value of the last time bin of the current pulse and the first time bin of the next pulse.
- These 833 time bins can be averaged in groups of seven to reduce to 833 times bins to 119 if required to decrease processing time.
 - ▶ 49 × 25000 = 1225000
 - ▶ 119 × 25000 = 2975000
 - If required runs can be examined fractions at a time depending on the processing performances of the SapSimServer at the U of M.
- The benefit of this method is that minimal interpolation is required.

Interpolation Results - First 6 pulses



Red is original data points, blue interpolated data points.

Interpolation Results - First 600 pulses



□ › < 圊 › < 볼 › < 볼 › 볼 · ∽ 옷 ○ 7 / 10

FFT Magnitude - r38085 w1 First 600 Pulses



□ ▶ ◀ ⓓ ▶ ◀ 볼 ▶ ◀ 볼 ▶ 월 - ∽ ९ ↔ 8/10

FFT Magnitude - r38085 w1 First 600 Pulses



WireYield-FFT-Mag-r38085-w0

FFT Phase - r38085 w1 First 600 Pulses



WireYield-FFT-Phase-r38085-w0