LEGS

SASY Technical Note # 4

Tagger Timing Alignment

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Version 1.0

1 Introduction

The tagger TDCs need to be aligned in order to group data from various counters. We've recently realized that we're very sensitive to errors in timing due to short flight paths for nucleons in the PN bars. To boot, the tagger PMTs seem to have a time jitter of the order $\sigma = 0.6ns$. The bottom line is that we need to be cautious with timing alignment.

In order to align the elements, we need a fixed reference time. The SASY event strobe which starts the TDCs does not provide this due to a large dispersion in timing between elements of the XTAL Box, so we need to take the time relative to a PN bar or Pb Glass block. Again, because of differences between channels, we need to look at a single detector. Lastly, we need to have particles of similar flight times.

Tagger alignments can also be obtained using XSCAN, with the electron OR signal starting the tagger and the individual signals stopping the TDCs. This accounts for differences in transit times for the various channels through the repeaters, but does not account for different transit times through the PMT itself. This may or may not be good enough for alignment.

2 PN bars

I have been examining run 3854. This is a 6 hour XT·TAG run from Spring 1997 with 28 million tagged SASY events. A single bar was used in the alignment data presented (L2-10). In order to constrain the flight path and TOF, electrons which interacted in the finger were selected. The TOF was then examined as a function of tagging counter.

Figure 1 shows the ΔE-E spectrum using the energy deposited in Finger 3 plotted against the energy deposited in L2-10. A cut was placed at PF3 $<$ 0.25 MeV and PN L2-10 $>$ 10 MeV, and the tagger counter was plotted against TOF for L2-10. This plot is shown in Figure 2.

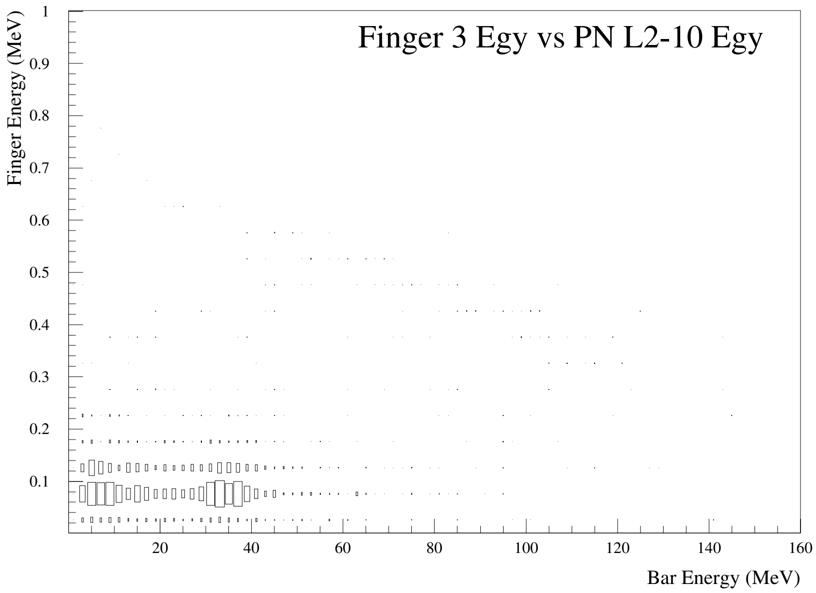

Figure 1: Particle identification using PN Finger 3 as ΔE and PN Bar L2-10 as E.

For the TOF values, the slew-corrected TDCs were averaged, calibrated to ns, and corrected by the tagger TDC value (also calibrated and roughly-aligned).

The previous tagger alignment values came from XSCAN earlier in the Spring. An offset was added to the TOF to align this counter with the Monte Carlo. A single true hit in the focal plane *was not* required for the selected sample of data. This means the TOF periodically chooses the wrong tagging counter with which to correct. This is why the accidental peak shows up.

Figure 3 shows four typical spectra and the accompanying Gaussian fits. For each peak, a window was selected by hand around the true peak. The error in the peak determination ranged around $\sigma = 0.1ns$ or less. At first the fits were done with 1.0 ns bins. It was repeated with 0.5 ns bins. The peaks were also fit using 0.25 ns bins. The peaks as a function of counter are shown in Figure 4(a). The difference between the 1.0 and 0.5 ns fits is shown in 4(b). Because of statistics, the fits seem to get poorer going from 0.5 to 0.25 ns. This could be solved by using the time difference instead of the finger and taking a larger solid angle, or by simply adding together several runs.

Details: The NTUPLE used was PNFING_3854A_ALL.NTP, which was obtained by requiring at least one finger firing in the event. At least two PN bars needed to fire, and the Vetos and Bars eached required a nominal 0.2 MeV in the sum over the detector.

The histograms and figures were compiled on the VAX under [LUCAS.ANAL.SASYRAW.PNSLEW].

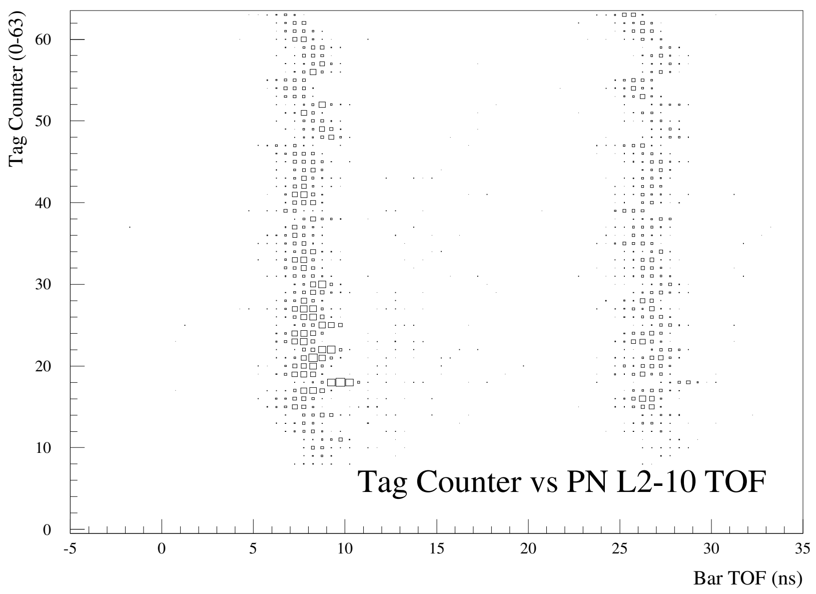

Figure 2: Tagger alignment using L2-10 TOF.

3 Aligned Spectra

Using the 0.5 ns binned peaks, I aligned the tagger focal plane. The plots in figures 5 through 7 show the results after alignment. Most notably, the peaks align to within ±150 ps for counters above 15. Those counters below are either lacking in statistics or suffering from the contamination of protons. A more consistent selection of fitting window might help.

The final figure (Figure 7) shows the result of combining counters 40–44 to show that there is negligible widening of the peak when summing counters. The individual peaks have sigmas ranging from 0.73 to 0.77 ns. The sum peak is 0.75 ns.

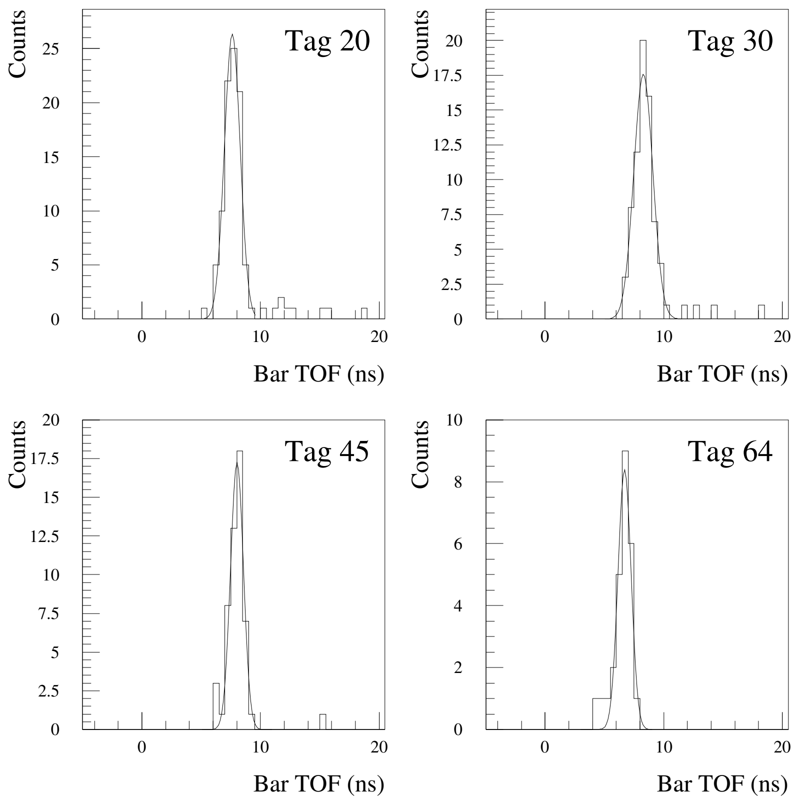

Figure 3: Sample TOF peaks for individual tagging counters (numbered 1–64). The bins are 0.25 ns wide.

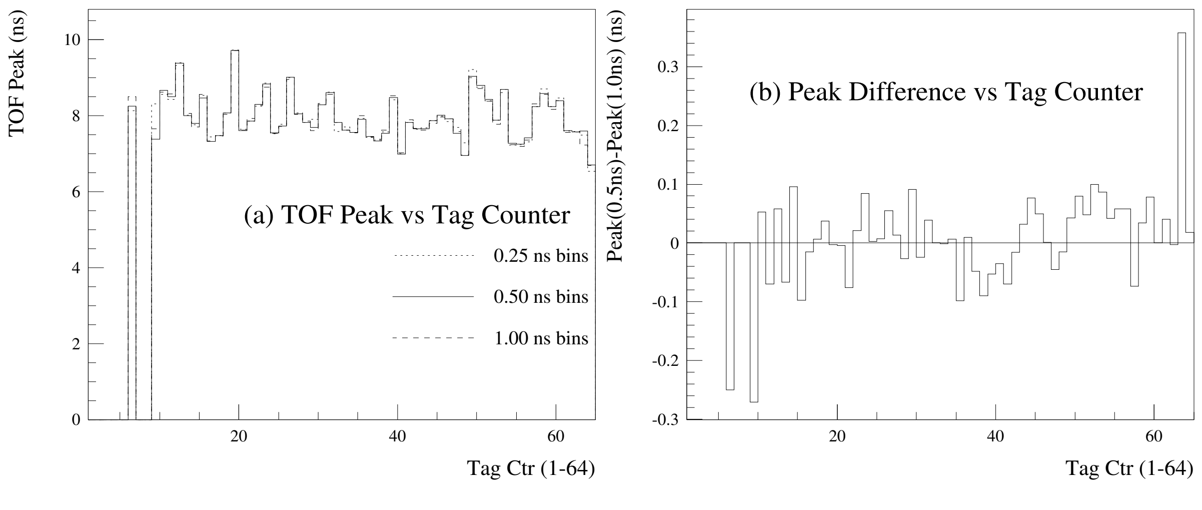

Figure 4: TOF peaks for full focal plane. Solid line shows peaks obtained with 0.50 ns/bin histograms. Dashed line shows coarser resolution. The dotted line shows 0.25 ns/bin fit results. This gives some idea of resolution of fitting procedure.

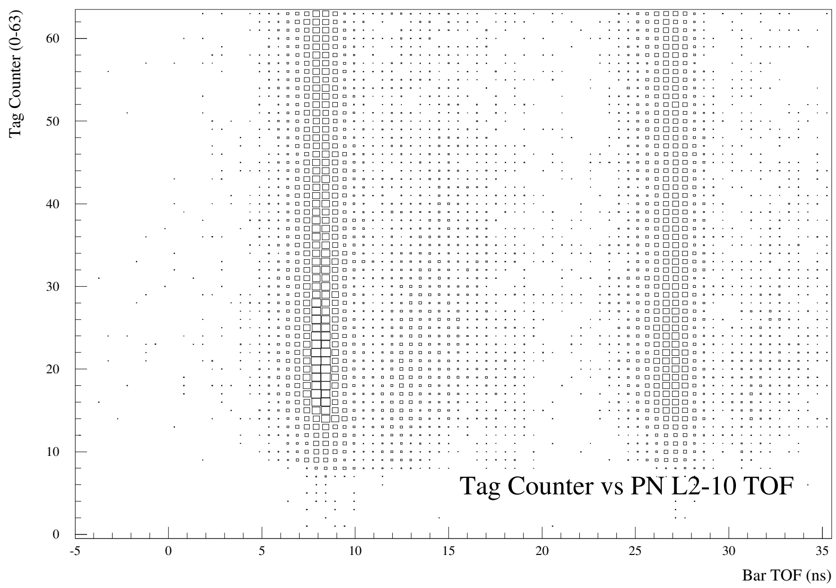

Figure 5: Tagger vs. PN TOF after alignment.

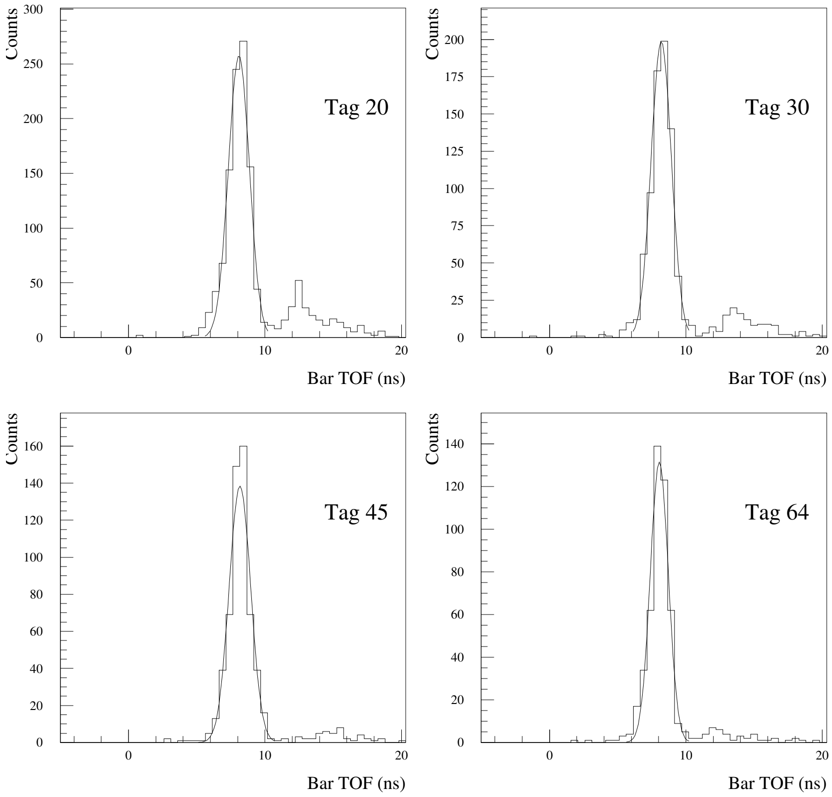

Figure 6: Sample TOF peaks after aligning focal plane.

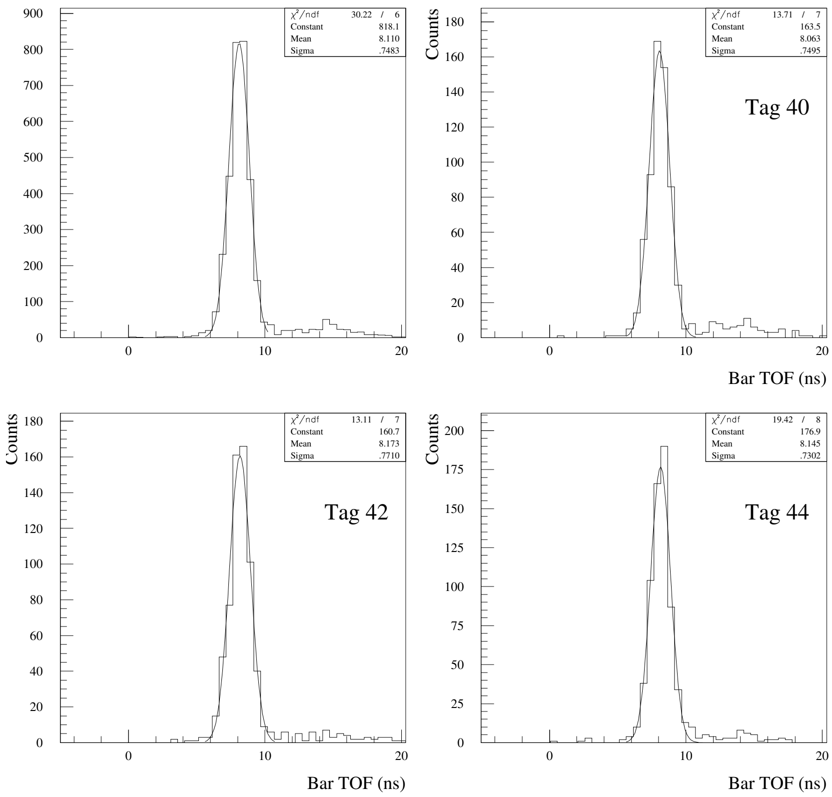

Figure 7: TOF peaks from counter 40, 42, and 44 (1–64) and the sum of 40–44. The sum fits to a sigma of 0.75 ns — equivalent to the individual components.