Primex Note #12

Tagger Calibration Documentation

Timing and Energy Calibration

Eric Clinton, PrimEx collaboration, Feb. 2003

Introduction

Due to the composite nature of the Hall B photon tagger, a detector external to the tagger must be used to provide a common TDC start to calibrate the timing of the E and T counters. In the low intensity runs of the August 2002 PrimEx beam test, the Total Absorption Counter (TAC) is a very convenient choice. The rate in the TAC is sufficiently high to get enough statistics in less than a score thousand events. For the higher luminosity runs, the TAC must be removed and a calibration must be done using another common TDC start signal. The Pair Spectrometer (PS) is another composite detector, but since it is independent of the tagger, we can use one of its component detectors as our common TDC start. After looking at a plot of TDC counts versus PS id, PS id = 5 was arbitrarily chosen since the was no single PS paddle that was discernibly more active/sensitive than any other. Also, an effort has been made to develop TAC energy calibration histograms. This effort will also be discussed in some detail.

General specifications

In general, the Tagger calibration code (primex/src/programs/monitor/tagger_calib) makes four text files and one root file. Only two of the text files are good for any given run, while the root file contains interesting histograms. If tagger_calib is run over a low intensity run, any text file names or root histograms with “TAC” as part of the name contain valid data with a cut on the TAC trigger. Any text file names or root histograms with “PS” in the name contain valid data (with a cut on PS id = 5) for high current runs. Some root histograms contain no “TAC” or “PS” designations. These are either generic histograms that do not rely on TAC or PS triggers or they are pseudo-vestigial histograms from attempts to calibrate the TAG/tagger energy spectrum. See Energy Calibration for more information on these histograms.

The text files are given the following naming conventions. “Tag*MeanValues$$$@@@.txt” where the “*” is either an “e” or “t” denoting E or T counter data sets (respectively), “$$$” is either “TAC” or “PS” (respectively), and “@@@” gives the run number. The text files themselves are either a 61 (T counter) or 384 (E counter) line ASCII file with one floating point number per line. These numbers are the TDC calibration constants that get put into the database. A “-1” entry on a line in these files denotes a dead or bad channel.

Specifics on the root (timing) histograms

The root files contain a relative wealth of histograms that show the before and after effects of calibration. A description of each of the moderately important and useful histograms will be presented now.

1.) tagt_vs_tdc(_TAClatch/_PSlatch) are tagger T counter TDC hits versus TDC id. If _TAClatch or _PSlatch are tacked on, only events that happened in co-incidence with the TAC or PS id =5 are used to fill the histogram, respectively.

2.) tage_vs_tdc(_TAClatch/_PSlatch)-see tagt_vs_tdc. Substitute “E” for “T”. The histograms, tagt_vs_tdc and tage_vs_tdc, are the precursor histograms to both the _TAClatch and _PSlatch histograms. They represent the complete timing statistics. The _TAC/_PSlatch histograms contain the timing information relevant to when either the TAC or PS id=5 provided a common start, respectively.

3.) tagt_vs_ps are tagger T counter TDC hits versus PS id. All PS paddles were included.

4.) tage_vs_ps-see tagt_vs_ps. Substitute “E” for “T”. From this histgram and tagt_vs_ps, it was noticed that no one PS channel was overly sensitive are had more viable statistics than any other. PS id = 5 is arbitrary in the sense that it is no different, in terms of statistics, than any other paddle.

5.) tagt_vs_t(_TAClatch/_PSlatch) are the tagger T counter TDC hits versus "time". "Time" in this case includes a geometry cut and inclusion of any calibration constants from the database. See tagt_vs_tdc for description of _TAClatch and _PSlatch.

6.) tage_vs_t(_TAClatch/_PSlatch)-see tagt_vs_t and substitute "e" for "t". This histogram and tagt_vs_t(_TAClatch/_Pslatch) are the final products. The goal of tagger_calib is to align all of the T and E counter channels at a common time. The analysis program appears to work well.

How timing calibration is done

In tagger_calib.cc, tagt_vs_tdc(_TAClatch/_Pslatch) or tage_vs_tdc(_TAClatch/_Pslatch) is brought into memory. Using Root, 1-dimensional projections of each vertical bin (corresponding to a TDC channel) are made. Then, the bin with the largest number of entries serves as the starting point for the rest of the analysis. Three bins on either side of the maximum are queried for the number of hits in them. A simple arithmetic average ((sum over (bin value times number of entries in bin)) / (total entries)) is then calculated. This average is our calibration constant. However, this only works if we have an active channel. We do not wish to record spurious calibration constants if possible. Therefore, Root is instructed to try to fit a gaussian curve across 100 bins. The mean, sigma, and error of this gaussian fit are calculated. These fit values and a check of the total number of hits in our arithmetic fit are used to determine the quality of data. If there is a dead channel or somehow no hits (division by zero) in the arithmetic calculation, a value of "-1" is output to the datafile. A dead channel will have either empty bins in the specified range or the calculated gaussian fit parameters are identical to each other. This provides enough constraint to reliably pull out good calibration constants.

Energy Calibration

The other histograms that carry a "TAC" designation are e_t_time_diff(*), t_vs_e_(*), e_gamma_(*), tac_vs_tag_(*), tagm_vs_t_(*), tagt_vs_tact_TAC, tagm_time_TAC where (*) stands for _TAClatch. Other vestigial histograms include tac_vs_tag(number) where (number) is a number such as 700 or 1100. Please keep in mind that these histograms are not truly vestigial, they are just not pertinent to timing calibration.

Provided below is a comprehensive listing and description of current TAC energy calibration histograms.

1.) e_t_time_diff is the timing difference between the tagm E counter and T counter ID's.

2.) e_t_time_diff_TAClatch is the same as e_t_time_diff but with a TAC trigger cut.

3.) e_gamma is the fully recontructed photon energy.

4.) e_gamma_TAClatch is the same as e_gamma but with a TAC trigger cut.

5.) t_vs_e is the E counter ID vs. T counter from the tagm bank. The tagm bank contains the fully reconstructed photon energy.

6.) t_vs_e_TAClatch is the same as t_vs_e with a cut in the TAC trigger.

7.) tac_vs_tag is the recontructed photon energy versus the TAC ADC spectrum

8.) tac_vs_tag_TAClatch is the same as tac_vs_tag but with a TAC trigger cut.

9.) tac_vs_tag_latched_4 id the same as tac_vs_tag but with a Master OR trigger cut.

10.) tagm_vs_t is the reconstructed photon energy versus reconstructed time.

11.) tagm_vs_t_TAClatch is the same as tagm_vs_t but with a TAC trigger cut.

12.) tac is simply the TAC ADC spectrum.

13.) taca_vs_tact is the TAC ADC versus TDC spectrum.

14.) tagt_vs_tact is the TAC TDC versus T Counter spectrum.

15.) tagt_vs_tact_TAC same as tagt_vs_tact but with TAC trigger cut.

16.) trig_latch histograms how often each trigger fired.

17.) tac_vs_tag*** is the reconstructed photon energy versus TAC ADC value, plotted so look at that spectrum around what appears to be a correlation. The number '***' corresponds to the width about the correlation we wish to investigate.

18.) tagm_time_TAC is the tagm bank time spectrum

19.) calib_const is an attempt to pull out the calibration constant (slope of the correlation in tac_vs_tag***) from TAC and reconstructed photon energies. This histogram has not been fully developed and tested due to lack of statistics.

Energy calibration of the TAC would be realized, given enough statistics, by using tac_vs_tag_TAClatch to look for a correlation between TAC ADC values and the reconstructed photon energy. Other histograms, like tac_vs_tag***, could be used with the Master OR trigger to check any correlation. Namely, there might not be enough low energy events with TAC triggers to reliably pull out an ADC pedestal. The extra histograms detailed above are still useful as diagnostic tools if some of the energy calibration histograms have problems. It is also required to note that while the TAC timing data can be gleaned from about twenty thousand events or so, energy calibration takes more statistics. It is currently not known how much more, but judging from current histograms, the required statistics are less than an order of magnitude greater than what is required for timing calibration.

This document should be a complete listing and explanation of current Tagger timing and energy calibration histograms. If there are any questions, please email Eric Clinton (eclinton@jlab.org) or call (x6356).