Tagger Accidentals and Scaling

B. Zihlmann

June 15, 2020

1 Introduction

R. Jones showed [**?**] that the accidental tagger hits underneath the prompt timing peak do not scale one to one with the accidental hits on the side peaks. This observation was confirmed by J. Stevens and showed that there is a significant run dependence of this scaling factor [**?**]. This document outlines the determination of the tagger accidental scaling factor step by step. It is evaluated independently for tagger hodoscope and microscope data for both methods, the energy difference between tagger and pair spectrometer (Method 2) and pure accidentals (Method 1). In the following only PS trigger events (0x8 Trigger Bit) with a single pair-spectrometer pair are considered.

2 Method 2

In this method the the relative time between any tagger hodoscope hit an the pair-spectrometer pair is evaluated and plotted also in a one dimensional histogram that exhibits the know feature of a *picket fence* (see fig. 1) with a prominent peak around zero and smaller peaks on either side separated by 4.008 ns. The highest peak is at zero if the detectors have been calibrated and the distance between two peaks represents the RF bunch frequency provided by the accelerator.

Two selection criteria are tested, one is this time difference between tagger and pair-spectrometer pair at 0 ± 2.004 ns in which case we call this the prompt peak, or is this time difference in one of the side peaks. In the following we consider different numbers and locations of side peaks. It needs to be mentioned here that the code does not loop directly over the the tagger hits but rather over the DBeamPhoton objects and then determine which tagger counter is associated with the beam photon at hand. This approach takes advantage of the implemented code of the DBeamPhoton factory and avoids code duplication and mistakes.

If the time difference falls within the prompt peak at zero we call this *In Time* and filled the energy difference between the tagger hit and the pair spectrometer pair into a histogram. If the time difference is *Out Of Time* and falls within a side peak that is selected for the analysis the energy difference between this tagger and the pair-spectrometer pair is filled into a separate histogram. This is done separately for all tagger hodoscope and microscope counters.

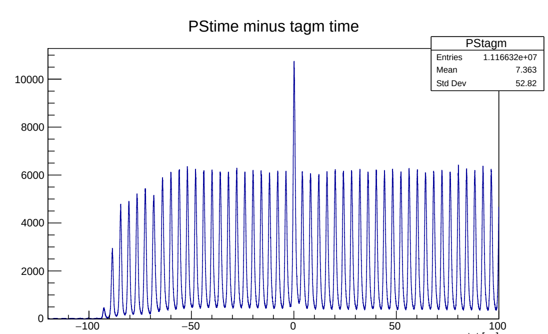

Figure 1: Example of the time difference between tagger microscope hits and pair-spectrometer pair time. The prompt peak at zero refers to *in time* hits while the *out of time* hits are to either side.

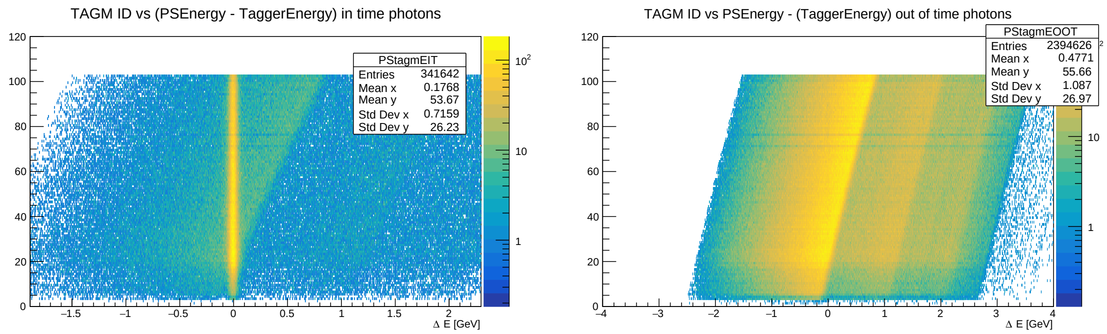

Figure 2: Example of the energy difference between tagger microscope hits and pair-spectrometer pairs for *in time* (left) and *out of time* (right) hits.

An example of these two energy-difference histograms is shown in figure 2 below:

One can now match the background on either side of the energy-difference peak between the *in time* and *out of time* histograms provided that one is sufficiently far away from zero (peak) in particular on the negative side where there is a substantial tail due to energy resolution and radiation. Also note that the background shape changes as a function of the counter number because the counter number is correlated with the beam energy and the background depends significantly on the intensity distribution of the beam as a function of energy, in particular in the case of a diamond radiator. This can be nicely seen in figure 2 (right side) where the background variation due to the various coherent peaks is significant (Note the logarithmic scale).

2.1 Results for a few selected runs

In the following the results for the scaling factor of three different runs are shown. These are run 61358 of the spring 2019 running period and run 72071 and 72073 of the fall 2019 run period with amorphous and diamond radiator respectively. In addition several "side peak" scenarios are tested.

- 2 bunches, one on either side (omitting the first) ±1
- 12 bunches, 6 on either side (omitting the first) ±6
- only the 2nd right bunch $+1$
- only the 4th right bunch $+1 >> 2$

Run	Tagger	±1	±6	$+1$	$+1 >> 2$
61358	Mic	1.051	1.054	1.055	1.053
	Hod	1.101	1.102	1.094	1.100
	Hod u	1.117	1.117	1.115	1.115
	Hod d	1.078	1.080	1.069	1.077
72071	Mic	1.055	1.051	1.064	1.042
	Hod	1.046	1.055	1.047	1.059
72073	Mic	1.051	1.051	1.051	1.047
	Hod	1.042	1.045	1.040	1.064

3 Method 1

In this method only *out of time* accidental tagger hits are considered where the condition is that the time difference between the tagger hit and the pair-spectrometer hit is larger than 6.012 ns. For these *out of time* hits a range of hits is selected between the 10th and 20th side peak on the positive side of the picket fence to which the time difference of all *out of time* hits are calculated. The result is another "picket fence" histogram consisting of accidental tagger hits only and an example is shown below in figure 3. Two additional conditions are enforced one that ensures a minimum distance between two counters to be separate by at least eight counters and secondly the energy sum of two counter has to be more than 200 MeV smaller than the full beam energy.

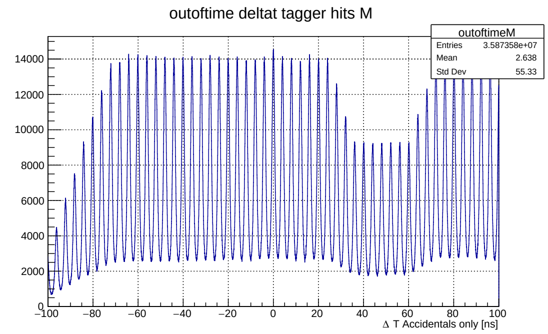

Figure 3: Example of the "picket fence" histogram for accidental microscope hits only as described above.

As can be seen from the "picket fence" histogram of purely accidenals there is only a limited range where the data is valid to be used to determine the averate of the peak integrals to the peak integral at the *prompt* peak location. The the following 3 peaks on either side of the *prompt* peak are used.

Run	Mic	Hod
61358	1.195	1.090
72071	1.050	1.080
72073	1.047	1.073