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Calculating number of photons per run per T-channel

1 Number of photons per run per T-channel

The number of tagged photons per T-channel N_{γ_i} can be calculated as:

$$N_{\gamma_i} = N_{e_i} \times R_i \tag{1}$$

where N_{e_i} is the number of electrons per T-channel and R_i is the tagging ratio, which is determined in TAC analysis. N_{e_i} can be computed as:

$$N_{e_i} = \frac{n_{e_i}}{W \times n_{trigs}} \times Live1 \tag{2}$$

n_{e_i} is the number of electrons in the T-channel i, within some TDC window W, accumulated over n_{trigs} trials. So $\frac{n_{e_i}}{W \times n_{trigs}}$ is basically the average rate in T-channel i. Currently in the code W is taken to be $7\mu s$.

Using $Live1$, a scaler driven by $200kHz$ and gated by DAQ, instead of astrological duration of the run takes care of dead time.

This is so called "Sampling of out of time hits" method for electron counting.

Equation (2) assumes Poisson statistics for "out of time electrons" and it means that we assume constant electron rate per T-counter. To simulate constant electron rate the whole run can be divided into small time intervals and the number of photons per T-channel can be calculated for each time interval (currently 5 seconds). This also has an advatage of having an option to discard any particular, small part of the run due to whatever reason. The total number of electrons per T-channel can be found by adding the values for each interval.

For detailed description of the method see CLAS-NOTE 2005-005 by E. Pasyuk and PRIMEX-NOTE 2003-13 by D. Lawrence. For detailed discussion of photon flux calculation for PrimEx see PRIMEX-NOTE 2003-14 by Dan Dale et al..

The number of electrons for compton on carbon (radiator b), π^0 on carbon (radiator b) and π^0 on lead (radiator any) runs are calculated. The files with numbers can be found at: /work/hallb/primex/pdisk/flux/ in respective directories: compton_carbon_b, pio_carbon_b, pio_lead
Each run was divided into 5 second intervals: the first column is the begining of the interval, the 2nd column is the end of the interval, the 3rd column is the value of Live2 for that interval, the 4th column is the value of Live1 for that interval, the 5th column is the number

of clock triggers in that interval, and then we have the numbers of electrons in T-channels within 5 second interval (going from T-channel 1 to T-channel 121).

2 Live2/Live1 problem

Analysis showed that the values of Live1 and Live2 (gated and ungated scalers driven by $200kHz$ clocks) recorded in the data are compromised due to a hardware design flaw.

From time to time the value of Live2 jumps by 2^{16} or by 2^{24} or by $2^{16} + 2^{24}$ and then it self corrects. The simplest way to correct this is to look at the difference in Live2 for two adjacent events and subtract the corresponding number.

In addition to the anomaly described above Live1 goes through jumps of 2^8. This anomaly is cumulative and doesn't correct itself over time. To correct the value of Live1 we again look at the difference Live1$_i$− Live1$_{i-1}$ and make sure that it satisfies the following criteria: 1) It's smaller than Live2$_i$− Live2$_{i-1}$, 2) It's positive. And also we require that Live1<Live2.

If any of this conditions is not satisfied we subtract or add $2^8 = 256$ until all 3 criteria are satisfied.

It's been shown that to a very good approximation ($\sim 0.02\%$) one can assume that the data aquasition has a fixed dead time of 4.9 scaler counts ($\sim 25\mu s$). Then the value of Live1 can be calculated if one knows the value of Live2:

Live1$_i$ = Live1$_{i-1}$+ Live2$_i$ - Live2$_{i-1}$ - 4.9 (algorithm suggested by Eric Clinton).

or

Live1$_i$ = Live2$_i - n \times 4.9$ where n is the number of events. All three methods agree within $\sim 0.02\%$.