Deadtime Analysis Progress

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1 Deadtime computations

1.1 Live/Raw scaler rates

The deadtime is defined as the ratio of the number of "live" events going into the electronics or computers to the total number of events. The deadtime calculations are crucial for the calibration process after an experiment. The electronic and computer deadtime need to be quantified and applied in order to eventually extract precision measurements of the cross section.

The live and raw events are represented by live and raw scalers, and we can use Equation 1 to obtain the raw rate. We can calculate the livetime from Equation 2 and subsequently the deadtime from 3:

$$Raw\ rate = \ Live\ rate \times \frac{1}{1 - Deadtime} \tag{1}$$

$$Livetime = \frac{Live\ scaler\ rate}{Raw\ scaler\ rate} \tag{2}$$

$$Deadtime = 1 - Livetime \tag{3}$$

2 DVCS Normalized rates

Since the DVCS normalized rates were dependent on the current, we decided to study the accidentals between the DVCS calorimeter and the Left High Resolution Spectrometer (LHRS). In order for a DVCS event to occur, both the photon from the calorimeter and electron from the LHRS have to be in coincidence. Accidentals are any coincidences with photons and electrons from the DVCS calorimeter and LHRS. Real coincidences are when the photon and electron are simultaneously in coincidence with one another, each coincidence categorized as a "signal".

Current (μA)	S2m&&Cer LT	Rate: no cuts	DIS Normalized Rate	DVCS Normalized Rate	DVCS $\frac{signal}{total}$
10.61	0.985	9.27	3.422	5.212	0.7915
15.32	0.976	10.26	3.450	5.615	0.7397
20.53	0.965	11.26	3.449	5.936	0.6547

Table 1: Table showing the different rates. DIS rates had tracking (ntr) & TDC & Cer & trigPatW&0x00080 cuts applied, DVCS rates had tracking (ntr) & TDC & Cer & trigPatW&0x00100 cuts applied. Rates were normalized with the S2m && Cer livetime and have units ($\frac{Hz}{\mu A}$).

3 Subtraction of Accidentals

Our goal is to analyze the calorimeter clusters in order obtain an accidental rate, and subtract it from the DVCS normalized rate. We have used the waveform analyzed root files to obtain a time spectrum distribution of blocks $E_\gamma > 1$ GeV. The CEBAF beam structure is demonstrated in these figures and are in segments of 4 ns windows.

The main coincidence peak is centered at [-2,2] which shows us the photons, electrons and accidentals, and are shown in Figure 1 for all three currents. Taking the integral over a main coincidence peak gives the total which contains both the real coincidences and accidentals, as shown in Equation 5.

$$Real\ Coincidences = Integral\ over\ main\ coincidence\ peak\ or\ Total - Integral\ over\ accidental\ 4ns\ peak,\ or\ sidel \quad (4)$$

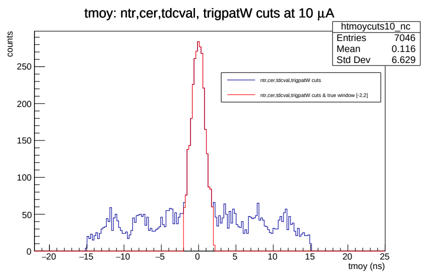
$$Integral\ over\ main\ coincidence\ peak\ or\ Total = Signal + Background \quad (5)$$

We chose another window with the same width in order to obtain the accidentals, specifically at [-10,-6]. We could have chosen any 4 ns window from [-15,15] since these regions are not time dependent. The accidentals were calculated by taking an integral over this 4 ns window, as shown for each current in Figure 1. We then calculated the ratio of the real coincidences (signal) to the total as in Equation 6, and applied it to our DVCS normalized rates.

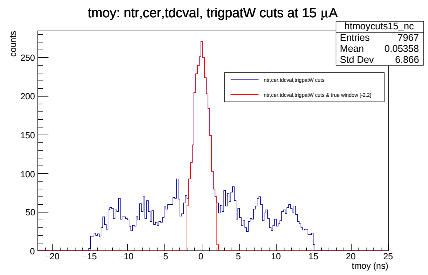
$$Signal/Total = \frac{Real\ Coincidences}{Integral\ over\ main\ coincidence\ peak} \quad (6)$$

3.1 DIS Triggers

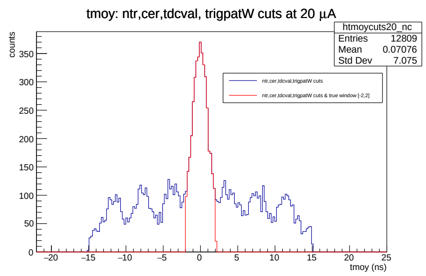
Some general calculations were required to arrive at the DVCS corrected normalized rates shown in Table 1. Beginning with Equation 7 and acquiring the DVCS signal to total ratio, we can apply this ratio to arrive at the corrected DVCS normalized rate by Equation 8. A sample calculation for 10 μA is shown in Equation 9.



(a)



(b)



(c)

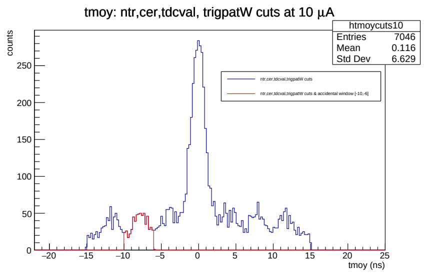
Figure 1: Main coincidence peaks (red) highlighted shown at [-2,2] for 10, 15, 20 μA. The integral over this range has the total amount of hits including photon, electron and background.

Equation 7 was used to calculate the values under the column "DIS signal/total", and Equation 8 for "DVCS Normalized Rate Corrected" in Table 2. Table 2 shows the DVCS rates after applying the correction of the ratio of the signal to the background.

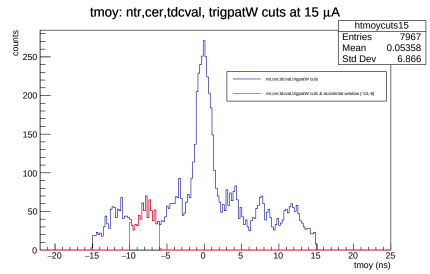
$$DIS\ signal\ to\ total\ ratio\ for\ each\ \mu A = \frac{Real\ Coincidences}{Integral\ over\ main\ coincidence\ peak} \tag{7}$$

$$DVCS\ normalized\ rate\ corrected = \frac{DVCS\ rate \times DIS\ signal\ to\ total\ ratio}{I\ (\mu A) \times S2M\&\&Cer\ LT} \tag{8}$$

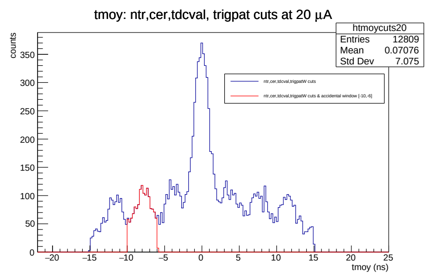
$$DVCS\ corrected\ normalized\ rate\ at\ 10\ \mu A = \frac{54.47\ \frac{Hz}{\mu A} \times 0.6828}{10.61\ \mu A \times 0.985} = 3.559\ \frac{Hz}{\mu A} \tag{9}$$



(a)



(b)

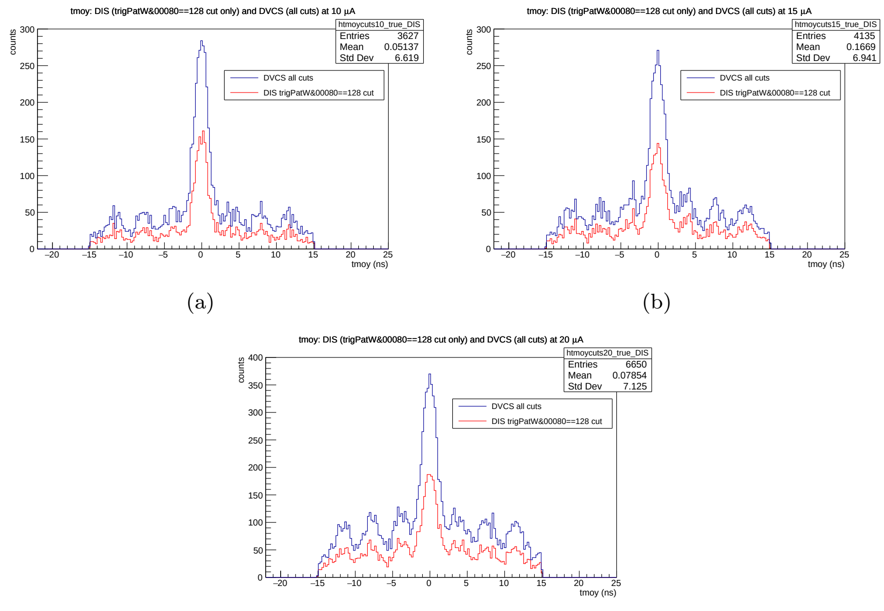


(c)

Figure 2: Accidentals shown in red at [-10,-6] for 10, 15, 20 μA.

4 Outlook and next steps

We had previously thought to scale our DVCS normalized rates to an effective ADC gate width. However, such a scale would not work since our study relies on DIS triggers only. We may also have to look at the script generating the output trees with the coincidence time distribution again try to figure out if our method is the best way to get rid of the DVCS rate current dependence. We still need to determine a correct method to employ when subtracting the accidentals from the DVCS rates.



(a) (b) (c)

Figure 3: DVCS and DIS time spectra overlayed for 10, 15, 20 μA.

Current (μA)	S2m&&Cer LT	Rate: no cuts	DIS Normalized Rate	DVCS Normalized Rate	DIS $\frac{signal}{total}$	DVCS Normalized Rate corrected
10.61	0.985	9.27	3.422	5.212	0.6828	3.559
15.32	0.976	10.26	3.450	5.615	0.6320	3.548
20.53	0.965	11.26	3.449	5.936	0.5199	3.086

Table 2: Table showing the different rates. DIS rates had tracking (ntr) & TDC & Cer & trigPatW&0x00080 cuts applied, DVCS rates had tracking (ntr) & TDC & Cer & trigPatW&0x00100 cuts applied. Rates were normalized with the S2m && Cer livetime and have units ($\frac{Hz}{\mu A}$). DVCS corrected rates are accidental subtracted.