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

2.1 Subtraction of accidentals

Since the DVCS normalized rates were dependent on the current, we decided to study the accidentals between the calorimeter and the LHRS. Our goal was to analyze the calorimeter clusters in order obtain an accidental rate and subtract it from the DVCS normalized rate.

We 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 an example is shown in Figure 1.

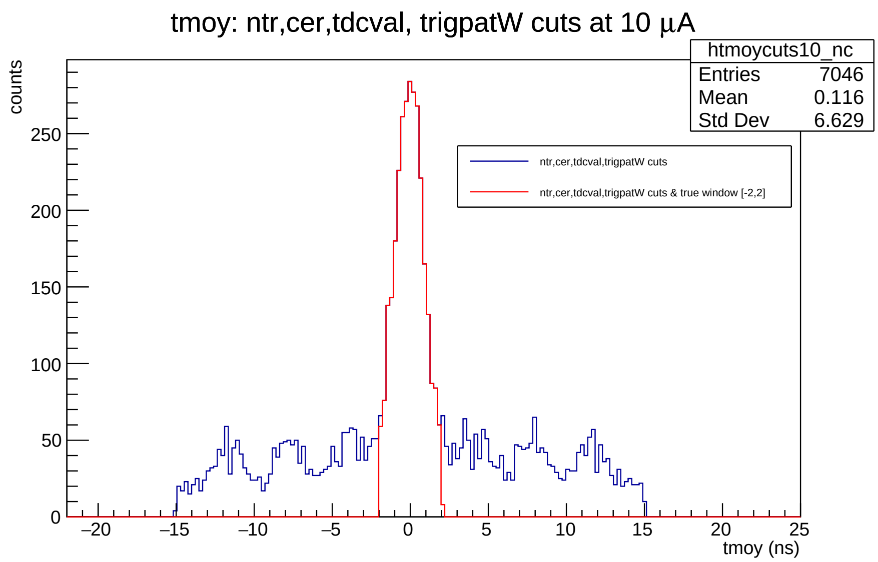

Figure 1: Main coincidence peak (red) shown at [-2,2] for 10 μA.

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.

Figure 2 shows an example of an accidental cut in this region. The accidentals were calculated using Equation 4. We obtained a ratio of the accidentals to the real coincidences and applied it to our DVCS normalized rates. The DVCS correction was calculated using Equation 5.

$$Accidentals = real\ coincidences - accidentals \tag{4}$$

$$Signal/Background\ scaled = \frac{Accidentals \times Effective\ ADC\ gate\ width}{real\ coincidences} \tag{5}$$

2.2 Scaling accidentals to a time window of the online trigger

The online trigger for this experiment was the ADC, thus we need to choose a time window to scale our accidentals to, which corresponds to the effective ADC gate width. Previously, we were thinking about using the ADC integration gate for each ADC per block of the trigger crate which was 100 ns for the run number 13418. However, this was not the correct choice for the time window since the timing in the ADC integration gate is unreliable (e.g. ADC values in ADC gate either occur too early or too late).

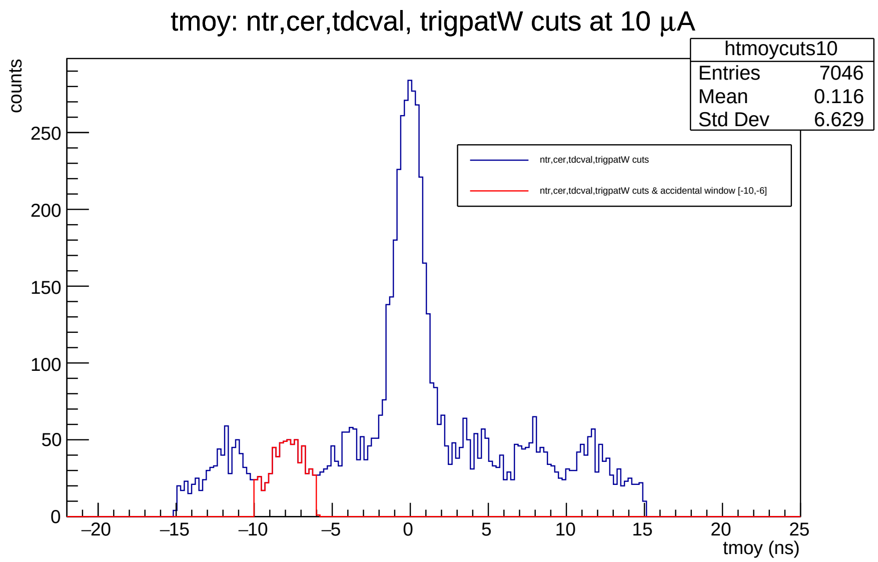

Figure 2: Accidentals shown in red at [-10,-6] for 10 μA.

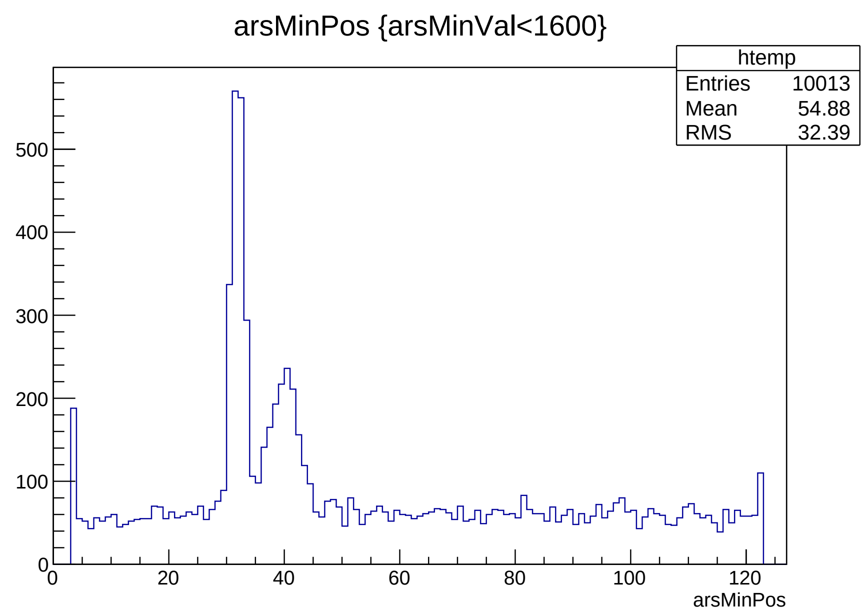

Figure 3: ARS minimum value for spectrum shown with the peak time at 40 ns or the nominal ARS peak time. A cut of the ARS signal or pulse amplitudes (arsMinVal) <1600 was applied. The first peak is the pedestal.

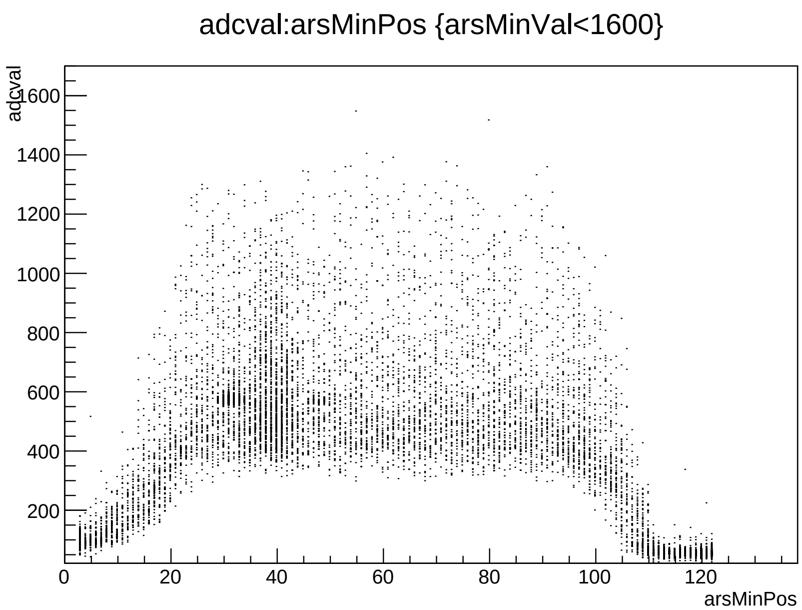

Figure 4: Plot of efficiency of ADC trigger shown, with ADC/ARS as a function of the ARS peak time. The effective ADC gate width is 80 ns.

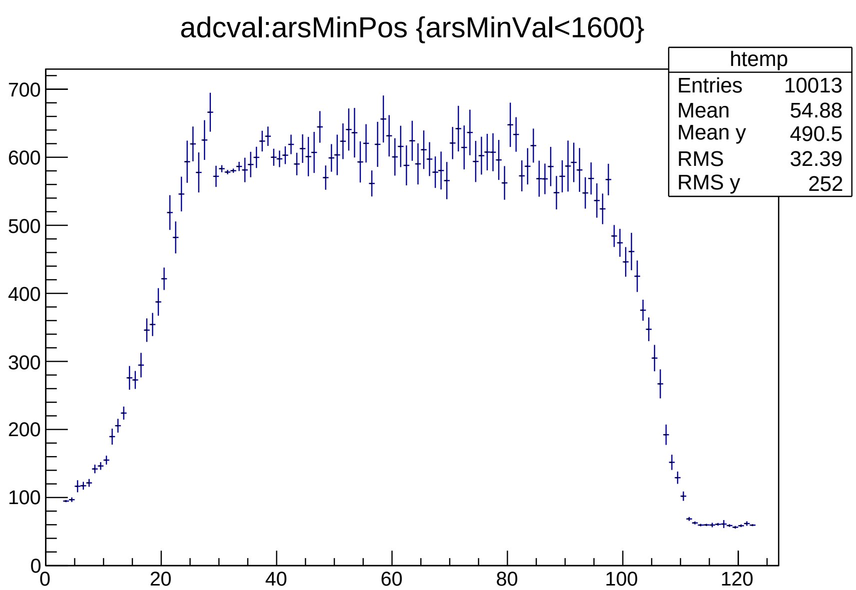

Figure 5: Profile of ADC/ARS as a function of the ARS peak time. The effective ADC gate width is 80 ns.

Current (μA)	S2m& Cer LT	Rate: no cuts ($\frac{Hz}{\mu A}$)	$\frac{DISRt}{S2m\&Cer}$ ($\frac{Hz}{\mu A}$)	$\frac{DVCSRt}{S2m\&Cer}$ ($\frac{Hz}{\mu A}$)	DVCS $\frac{sig}{bkgrnd}$ scaled	$\frac{DVCSRt}{S2m\&Cer}$ scaled ($\frac{Hz}{\mu A}$)
10.61	0.985	9.27	3.422	5.212	15.83	82.51
15.32	0.976	10.26	3.450	5.615	14.79	83.07
20.53	0.965	11.26	3.449	5.936	13.09	77.73

Table 1: 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. The DVCS scaled signal/background ratio was obtained by using Equation 5 with 80 ns as the scale factor, or the ADC effective gate width, as noted in the previous section.

We need to scale our accidentals to the time window which is dependent on the ADC gate width. The effective gate width of the ADC is related to the ARS peak time as the ARS peak time shifts in the ADC gate. The ARS peak time, or the nominal time is at 40 ns, as shown in Figure 3. To examine the efficiency of the ADC trigger, we have to see how the ADC values correspond to the ARS signal as a function of ARS peak time. This is demonstrated in Figure 4.

2.3 Application of scaling

We now have an effective time window of 80 ns to scale the accidentals. If we divide the result from Equation 5 by 4 ns, then we can obtain the accidentals per ns of the time spectrum which is summarized by Equation 6. Some additional general calculations were required to arrive at the DVCS scaled normalized rates shown in Table 1. Beginning with Equation 7 and acquiring the DVCS signal to background ratio, we can apply this ratio to arrive at the scaled DVCS normalized rate by Equation 8. A sample calculation for 10 μA is shown in Equation 9.

$$Accidentals\ per\ ns = \frac{Accidentals \times Effective\ ADC\ gate\ width}{4\ ns} \tag{6}$$

$$scaled\ DVCS\ signal\ to\ background\ ratio = \frac{Accidentals\ per\ ns}{real\ coincidences} \tag{7}$$

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

$$scaled\ DVCS\ normalized\ rate\ at\ 10\ \mu A = \frac{54.47\ \frac{Hz}{\mu A} \times 15.83}{10.61\ \mu A \times 0.985} = 82.51\ \frac{Hz}{\mu A} \tag{9}$$

Equation 7 represents the values under the column "DVCS sig/bkgrnd", and Equation 8 under column "DVCS Rt/S2m&Cer" in Table 1. Table 1 shows the DVCS rates after scaling to an effective time window and applying it to the accidentals. This reduces the discrepancy down to 5.8% per 10 μA. It should be noted that previously, the unscaled (without the scaling of the effective ADC gate width) DVCS normalized rates had the same discrepancy of 5.8% per 10 μA.