Report on Electronic Deadtime
(updated 4/17/2001)

For e97111 the electronic deadtime (EDT) could be measured directly or indirectly. The main cause of EDT in the trigger circuit is expected from the the strobe signal which is sent to the first MLU. This strobe signal is 100ns wide and has a high rate since it is an OR of all the signals from the right scintillator PM tubes. The MLU unit has a deadtime of 45ns. To measure the EDT, a pulser sent a scintillator-type signal to a linear-or with the S3 paddle 1 and S3 paddle 1 in each arm (for early part of the running the signal was also sent to S1). The pulser signal was also sent to a TDC channel in each arm so that the event was tagged as a pulser event. In addition for each arm, the pulser was sent to a scaler,S_{pul} and also the logical AND of the pulser and trigger was sent to the scalar, $S_{pul\&trig}$. So the direct way to measure EDT is 1 - $S_{pul\&trig}/S_{pul}$. The scalars are not gated by beam being on, so in replay a cut was placed on the average current to eliminate beam off periods which would artificially lower the EDT. The EDT can be measured for each arm separately.

Next, the indirect method of measuring the electronic deadtime (EDT) is described. The EDT was determined from the global computer deadtime (CDT) and the combination of computer and electronic deadtime (ECDT) assuming the following:

$$\begin{aligned} ECDT &= 1-(1-EDT)*(1-CDT) = EDT+CDT-EDT*CDT \\ EDT &= (ECDT-CDT)/(1-CDT) \end{aligned}$$

The ECDT was determined dividing the number of pulser events in the datastream,N_{pul}, by the number of initial pulser events measured by the scaler, S_{pul}.

$$ECDT = 1-\frac{\sum N_{pul}}{\sum S_{pul}/PS}$$

The pulser event was identified by putting a cut between 1650 and 1750 on the TDC channel 84 in slot 9 for the hadron and a cut between 2650 and 2750 on TDC channel 84 in slot 19 for the electron. In practice the prescales for T1 and T3 were set so high that there were only pulser events for T5 events. The CDT was determined by

$$CDT = 1 - \frac{\sum N_i}{\sum \frac{S'_i}{PS_i}}$$

$$S'_1 = S_1 - \frac{S_5}{PS_5} - N_{14} \quad ; \quad S'_3 = S_3 - \frac{S_5}{PS_5} - N_{14}$$

$$S'_{2,4,5} = S_{2,4,5} \quad ; \quad S'_6 = S_6 - \frac{S_3}{PS_3}; \quad S'_{14} = N_{14}$$

where S_i is the scaler for each trigger and PS_i is the prescale factor. i is the trigger types 1,2,3,4,5,6 and 14 and N_i is the number of triggers accepted for each event type. N_{14} is the number of trigger 14 which occurs when there is an overlap of 10ns between triggers at the trigger supervisor. There were very few trigger 14 in any of the runs. With high prescales on all trigger types except T5 meant that the global computer deadtime was basically equal to the T5 computer deadtime. The data was selected so that only when the current was above 5 μA was the deadtime determined. For the low current runs ($<$ 5 μA) then limit was 1 μA . With the indirect method, one only measures the combined EDT for the two arms.

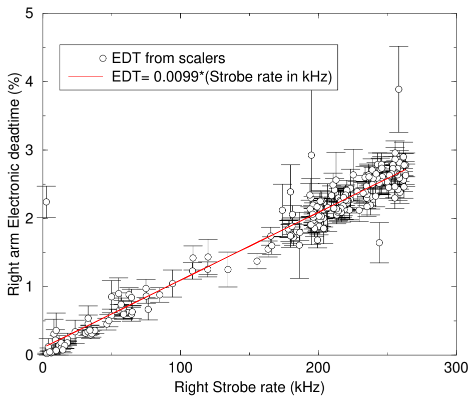

Figure 1:

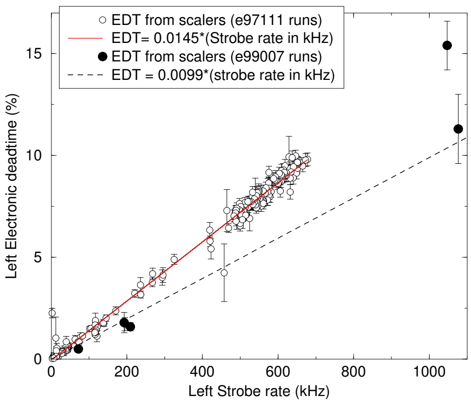

Figure 2:

In Fig. 1 is shown the EDT determined by the scalers versus strobe rate for the right spectrometer during E97-111. Fitting the data gives a deadtime of 99 ns. In Fig. 2 is shown the EDT determined by the scalers versus strobe rate for the left spectrometer during E97-111. Fitting the data gives a deadtime of 145 ns. In Fig 3 is the combined EDT calculated from the indirect method compared to the combined EDT determined from the scalers. The EDT from the indirect method is consistent with both spectrometers having a deadtime of 100 ns while the direct method has a larger deadtime because of the 145ns deadtime in the left arm. Bob Michaels speculated that the overlap between the pulser signal and the trigger signal was marginal in the left arm which means that number of $S_{pul\&trig}$ is artifically reduced creating the wrong deadtime. After E97-111, Bob corrected this problem and during E99-007 some EDT measurements were made and are plotted in Fig. 2. The results are consistent with a EDT of 100 ns.

The EDT measured during E97-111 of 100 ns is consistent with what one would expect for deadtime induced by the strobe signal on the MLU in the trigger circuitry. The remaining questions is why is the EDT deadtime during E97-111 and later experiments is lower then the EDT measured during E91-011 (the previous experiment to E97-111). For E91-011 the EDT was only measured by the indirect method. Unfortunately the EDT measured during E91-011 were inconsistent below a combined strobe rate of 500 kHz and ranged between 145 to 284 ns. Above 500 kHZ the measured EDT was 190 ns. At this point it is unknown why there was a change in the EDT.

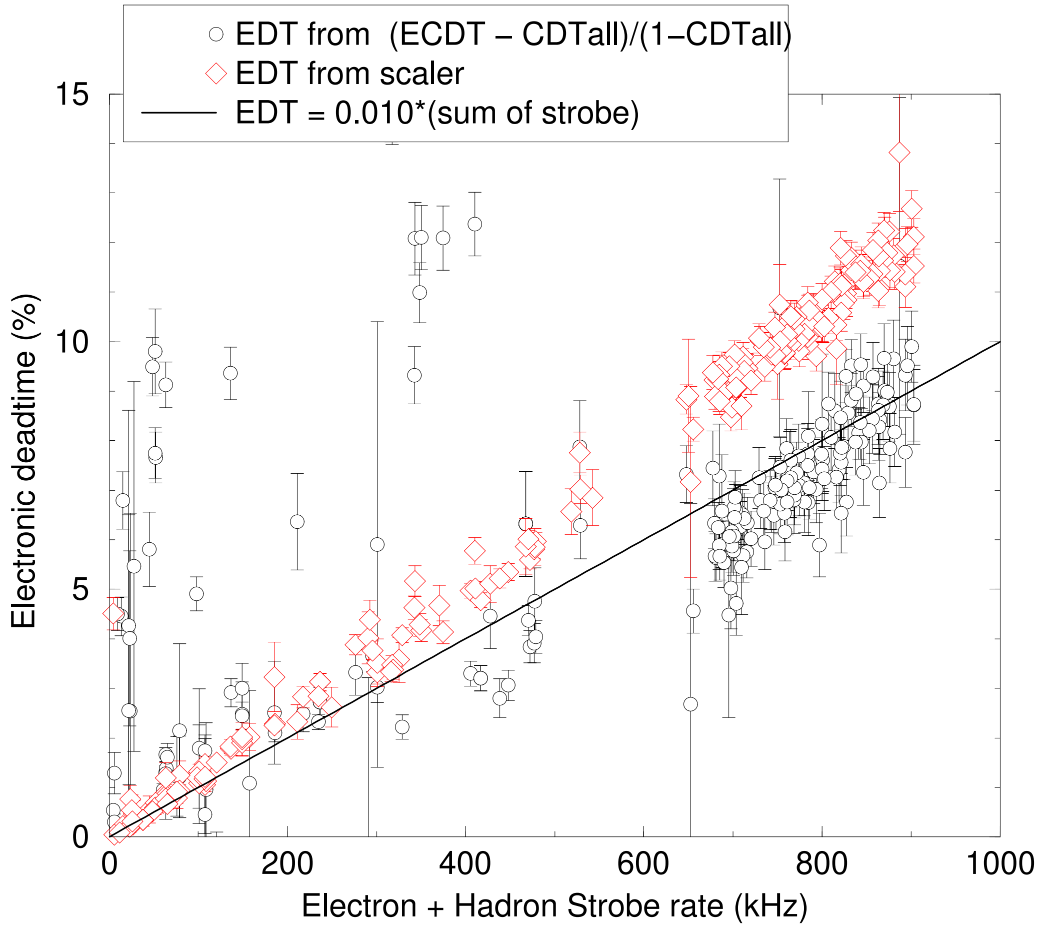
EDT from (ECDT – CDTall)/(1–CDTall)
EDT from scaler
EDT = 0.010*(sum of strobe)
Electronic deadtime (%)
Electron + Hadron Strobe rate (kHz)
0
5
10
15
0
200
400
600
800
1000

Figure 3: