Determining the CSC Cross Talk using the Buckeye External Pulser

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The CFEB/DAQMB pulser system was designed to measure all constants needed for cathode position reconstruction. With the Slice test reaching a mature stage it is time to revisit determining these constants.

Pulser data for this calculation was taken at the Pre-Slice test setup at Point 5. The external capacitors were shifted to pulse channel 8. The pulser amplitude was set to 1.0 Volts. All planes and all cards (5 cards x 6 buckeyes = 30 strips) of ME2/2 chamber mounted on the disk were pulsed simultaneously. Thirty-one separate pulses correspond to increments of 6.25 nsec delay were taken. Data collected for a typical pulsed strip are shown below.

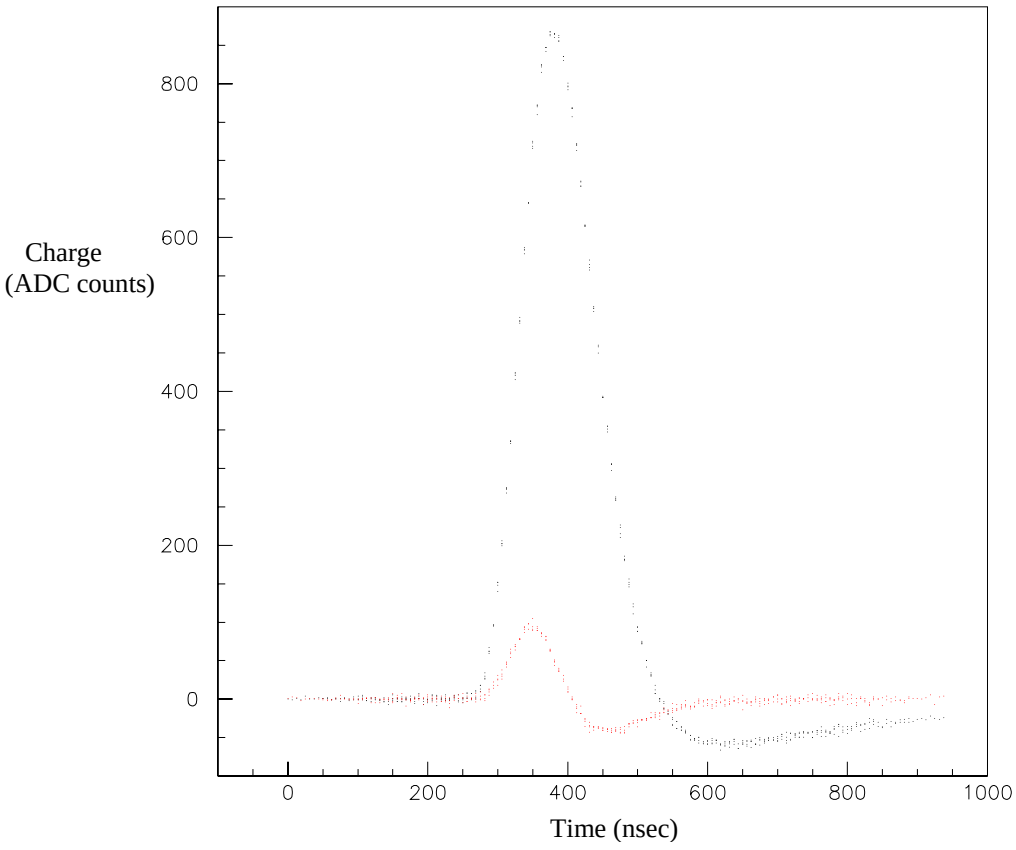

Figure 1: Raw charge on pulsed strip (black) and adjacent strip (red) for a given card and buckeye chip on a ME2/2 chamber.

These shapes are basically the Buckeye amplifier's response to a delta function charge input. To use them for cross talk determination we need to convolute them with the ion drift distribution (1/(t+2.5)) and the distribution of the individual electrons cascading. For simplicity I have taken the distribution for the electron arrival as flat for a period of 50 nsec. The results of the analysis prove insensitive to this choice. Convoluting the square wave with the 1/(t+2.5) distribution yields the function.

$$F(t) = \begin{pmatrix} \ln(t+2.5) - \ln(2.5), t < 50 \\ \ln(t+2.5) - \ln(t-50+2.5), t \geq 50 \end{pmatrix}$$

This function was convoluted with the distributions in Fig. 1 using a computer algorithm employing 6.25 nsec bins. Shown in Fig. 2 are the results for the strip data in Fig. 1.

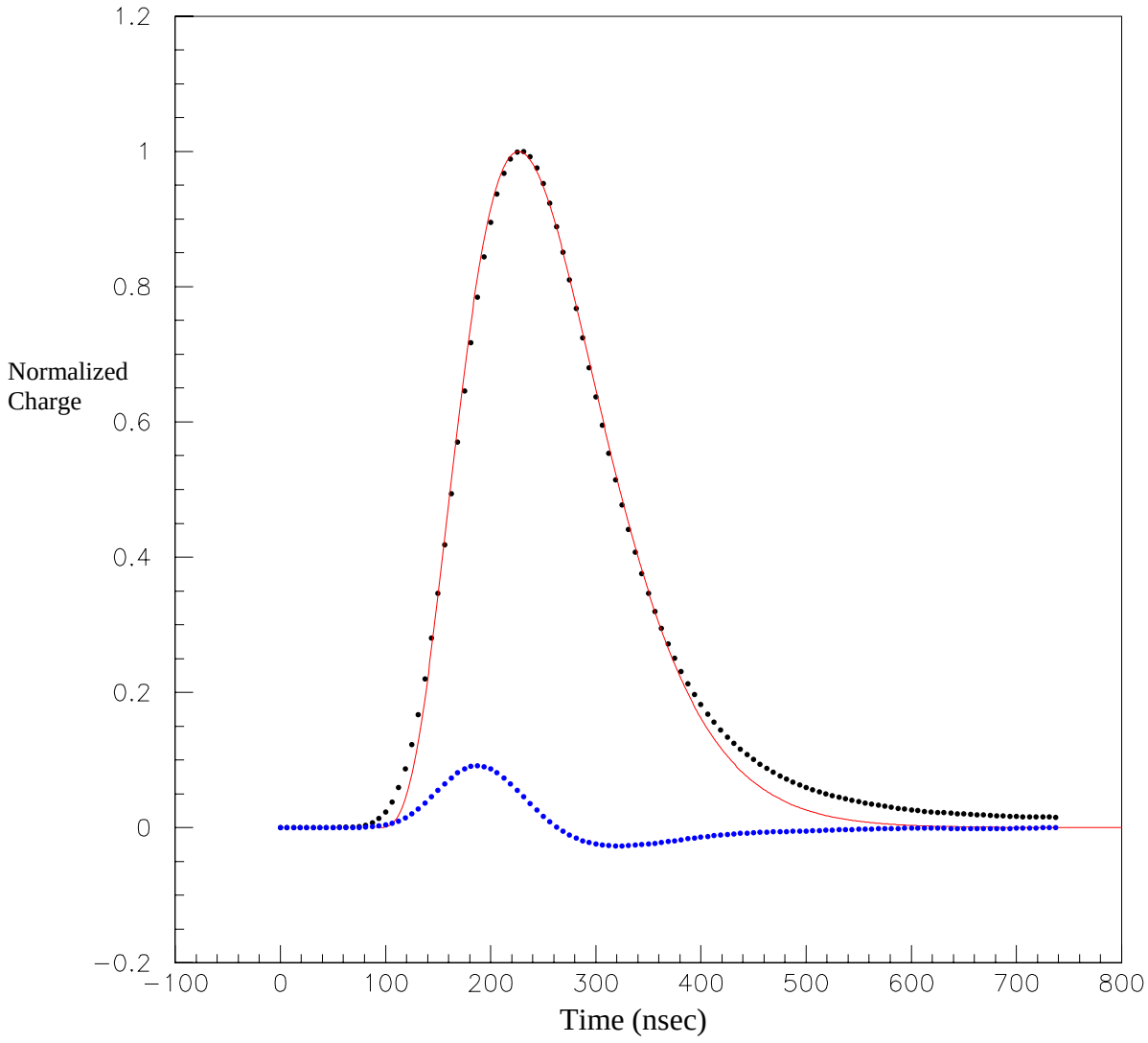

Figure 2: Convolution for pulsed strip (black) and adjacent strip (blue) for a given card and buckeye chip on a ME2/2 chamber. The red curve is a fit to the peak describe in the text.

The central peak is fit to the semi-Gaussian distribution $(t-t_o)^4 e^{-(t-t_o)/t_c}$ (shown as the red curve). The peaking time is found to be $t_{peak}=4*t_c=134$ nsec, which agrees well with measurement of test beam muon pulses observed in ME2/2 chambers. Tails are not modeled well by the simple semi-Gaussian which is not particularly surprising.

For a given time bin taking the ratio of one side pulse to the central pulse plus both side pulses yields the cross talk curve (blue) shown below.

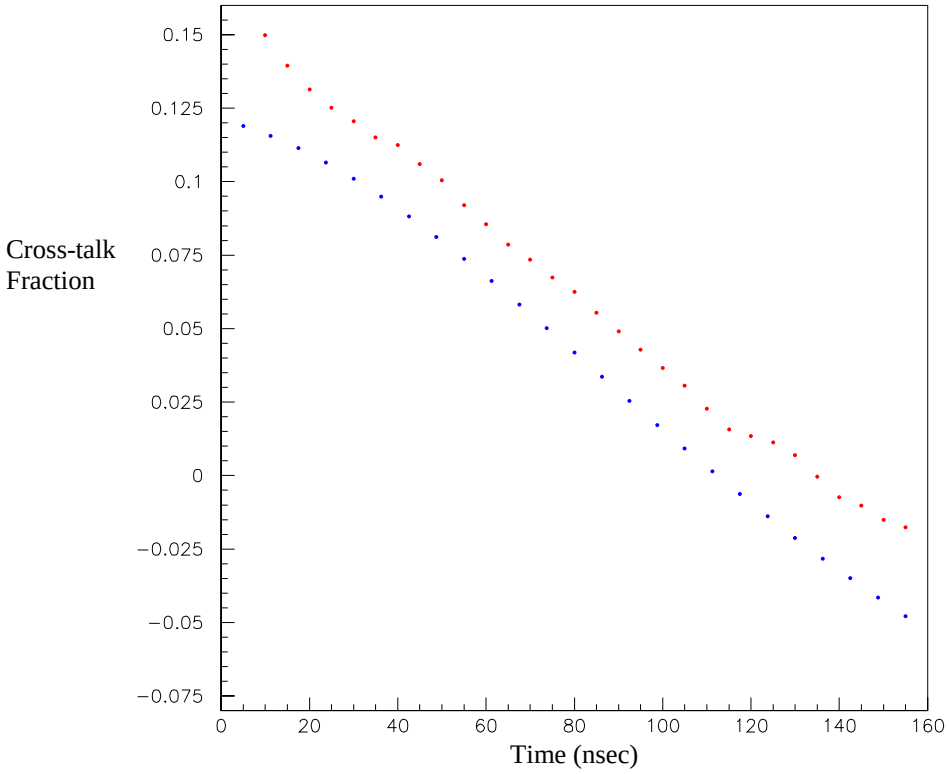

Figure 3: Cross talk (blue) extracted from the data in Fig.2. The Cross talk shown in red was measured by fitting the Gatti distribution to test beam muon data. The time of the pulse peak was arbitrarily set to 80 nsec.

It is seen the slope of the derived cross talk distribution (red) agrees well with the slope of the cross talk obtained by fitting test beam hits to the Gatti distribution[1,2]. The systematic offset in time must be due to insufficient understanding of the Gatti shape used in our test beam fits.

It is interesting to analyze the cross talk on all of the 30 strips pulsed during this test. The buckeye amplifiers cause small variations in peaking time (Figure 4).

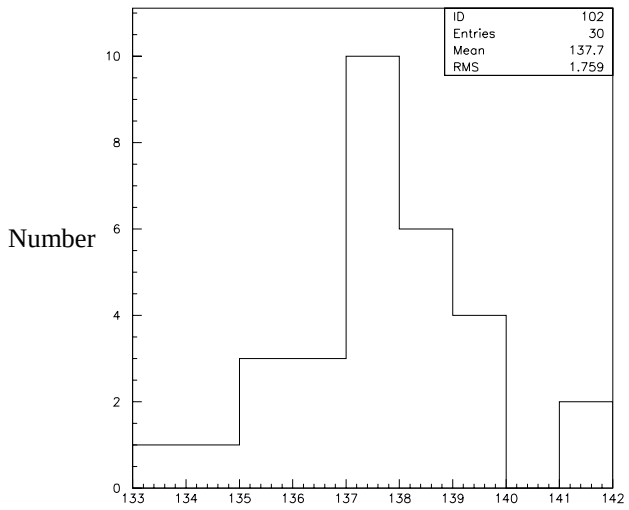

Figure 4: Peak time distribution for convoluted pulsed strips.

Correcting for this peak time variation I plot the convoluted data for 30 strips adjacent to the pulsed strips in Figure 5.

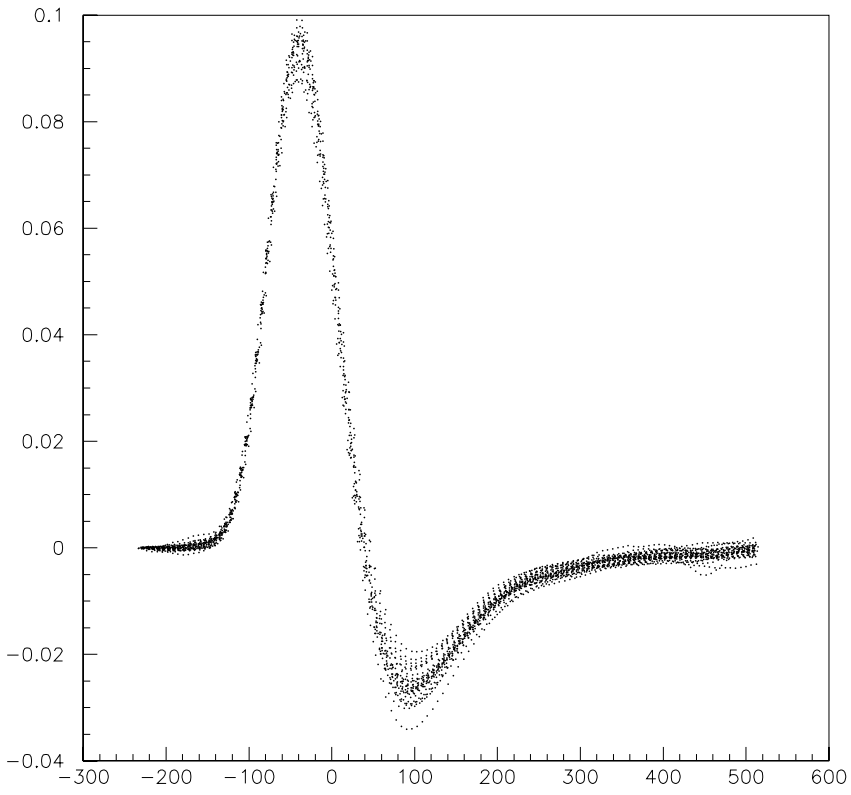

Figure 5: The convoluted data for 30 strips adjacent to the pulsed strip.

Deriving the cross talk fraction as before we obtain the following measurement (Figure 6).

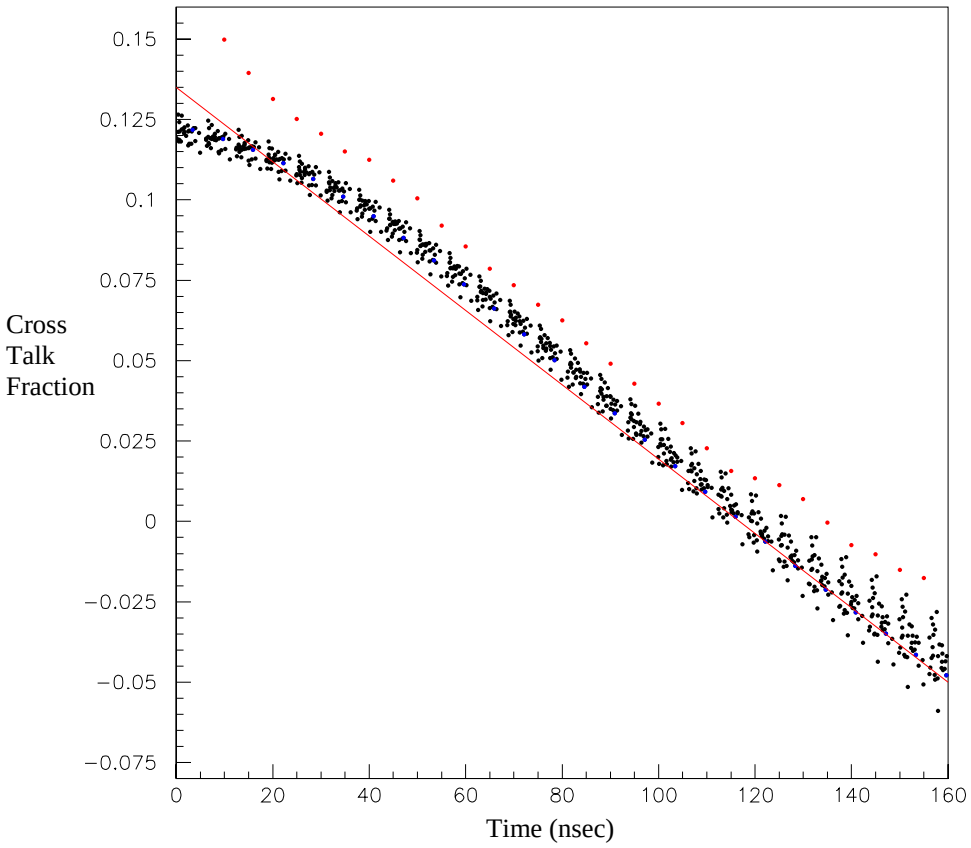

Figure 6: The black points measure the cross-talk fraction for our thirty strips adjacent to the pulse strip. The test beam measured cross talk is once again plotted in red. The red line is discussed in the text. The time of the pulse peak is arbitrarily set to 80 nsec.

To determine the variation of these thirty cross talk measurements we plotted the difference of each cross talk point from the red line (cross talk= 0.185*(t-160)-0.05) in the Figure 7. It is seen that the deviation from a smooth curve is far less than one percent over the central region of the pulse.

To take this analysis any further requires real muon tracks with associated pulser constants for a given chamber. We look forward to the Slice test this fall which should supply us with these data.

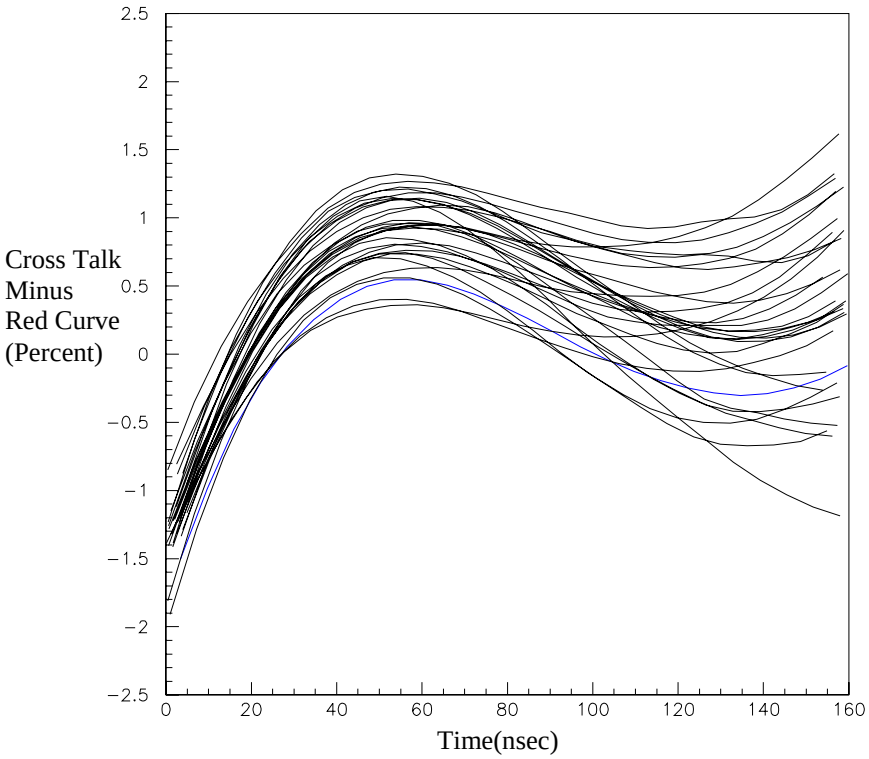

Figure 7: The black curves measure the deviation of the cross talk(percent) from the red line in Figure 6 for thirty strips adjacent to the pulse strip. 80 nsec corresponds to the time of the pulse peak.

References

1. S. Durkin, http://www.physics.ohio-state.edu/~durkin/testbeam03/trackfit.htm.
2. Y. Zheng, http://agenda.cern.ch/askArchive.php?base=agenda&categ=a051194&id=a051194s7t2/transparencies

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