Brief GlueX Note
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BCAL Time Resolutions for Run 2334

Time Difference Resolutions

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Following discussions with Stefano Miscetti and Elton Smith after the calorimeter review (2/19-20/08) I revisited the BCAL time difference resolution for Run 2334 where the photon beam was normally incident at the center of the BCAL module. I used the Run 2334 data file that was re-generated by David Lawrence during Summer 2007. My understanding is that the TDC data from the module were re-processed since the original data file for this run written in December 2006. Details about the re-processing are not know at this time.

In this analysis I use PMT-10-N as the time reference and plotted the resulting TDC versus corresponding ADC for PMT's 7, 8 and 9 - both North and South. Recall that for normal incidence at the center, segments 7, 8 and 9 receive the bulk of deposited energy and segment 7 is furthest upstream relative to the beam direction. The time walk observed in the TDC vs ADC plots were fitted to a form $TDC = a/\sqrt{ADC} + b$ and then the corresponding TDC's were corrected using this function. For segment 9 a small correction by including a term linear in ADC was added - this was a small correction. In all the time difference plots the time-walk corrected TDC values are used.

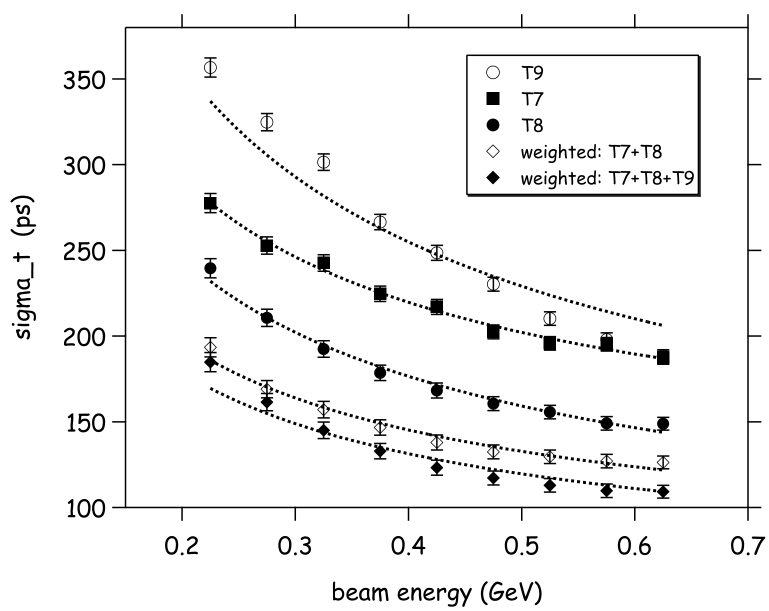

Figure 1: The time difference resolution as a function of beam energy for Run 2334 - details are given in the text.

The distribution in $(T_N - T_S)/2$ for each of the three segments for nine bins in beam energy was fitted to a Gaussian and the resulting σ_t is plotted in Figure 1 for segments 7 (filled square), 8 (filled circle) and 9 (open circle). Following the procedure outline in the KLOE paper[1] by A. Antonelli *et al.* was used to form an energy-weighted time difference.

[1] A. Antonelli *et al.*, Nucl. Instr. & Meth. **A354** (1995) 352.

To form the energy-weighted time difference using segments 7, 8 and 9:

$$\Delta t = \frac{1}{2} \frac{\sum_{i=7}^{9} E_{av}^{i} (T_N^i - T_S^i)}{\sum_{i=7}^{9} E_{av}^{i}}$$

where E_{av}^{i} is the geometric mean of the ADC's for North and South PMTs for segment i. The resulting σ_t from fitting the distribution in this quantity is shown as filled diamonds in Figure 1. We followed a similar procedure to find σ_t using only segments 7 and 8 (open diamonds).

The curves in Figure 1 are the result of fits to a function of the form:

$$\sigma_t(\mathrm{ps}) = \frac{a}{\sqrt{\mathrm{E(GeV)}}} \oplus b$$

The fit parameters are summarized in Table 1 below.

Time Difference	a	b	Comments
Segment 7	121.7 ± 3.5	106.0 ± 9.5	Reasonable fit
Segment 8	107.9 ± 3.2	45.2 ± 17.9	Reasonable fit
Segment 9	158.1 ± 1.0	50 ± 0	Poor fit - floor term fixed
Weighted 7 and 8	83.2 ± 3.4	61.4 ± 10.8	Reasonable fit
Weighted 7, 8 and 9	76.8 ± 1.0	50 ± 0	Floor term fixed

Table 1: Summary of fit parameters for curves shown in Figure 1.

The contribution to the beam width should add about 30 ps in quadrature to the floor term. Clearly the fit to T9 is very poor - the floor term was fixed at 50 ps. At low beam energies, segment 9 receives little energy but the fraction deposited increases with beam energy. Not much effort has been put into understanding the stability of the fits.

Energy weighting makes a difference. I will next look at the mean time resolution.