

Estimate of number of photoelectrons in the active degrader

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Abstract

Using Monte Carlo and $K_{\mu 2}$ data, I estimate that the number of photoelectrons per MeV in the active degrader is 0.44. The number of ADC counts per MeV is 6.22. The guestimated uncertainty on these results is 10%.

The energy deposited in the scintillator from Toshio's simulation of the active degrader [1] is shown in Figure 1. I extracted the points around the peak and fitted them to a gaussian as shown in Figure 3.

The distribution of ADC counts for active degrader sectors on the kaon path as determined by the beam wire chambers and B4 hits in $K_{\mu 2}$ taken from a plot made by Ilektra [2] is shown in Figure 2. I extracted a sample of points and fitted them with a gaussian over the full and restricted range of ADC counts as shown in Figure 3.

The results of the fits are summarized in Table 1. To estimated the mean number of photoelectrons I assume that the fitted width σ to the ADC distributions is $\sigma^2 = \sigma_{\text{pe}}^2 + \sigma_{\text{int}}^2$ where σ_{pe}^2 is the contribution to the width due to photostatistics and σ_{int}^2 is the "intrinsic" contribution to the width and is taken from the fitted width to the simulation results.

By equating the fitted means of the simulation and the data, I determine that the number of ADC counts per MeV is 6.22 and that the width of the kaon peak in the data is 7.45 MeV. The number of photoelectrons is $N_{\text{pe}} = (\text{mean}/\sigma_{\text{pe}})^2 = 10.5$ which corresponds to 0.44 pe/MeV using the results of the fit to the "Narrow" ADC range. My rough estimate of the systematic uncertainty on these results is 10%.

If this energy calibration is correct for photons in the AD, then the maximum number of ADC counts in the AD at track time on $K_{\pi 2}$ "kink" events (Figure 4) of ~ 600 corresponds to about 44 photoelectrons or 100 MeV of energy deposited in the scintillator. That seems rather incredible given that the total available photon energy is ~ 220 MeV and that the vast majority of the energy should be deposited in the copper of the AD.

It would probably be useful to do a more careful fit to the data points and also to repeat the procedure for pion events as a cross-check.

Quantity	MC	Narrow	Wide
Mean	23.85 ± 0.04 MeV	148.3 ± 0.8 (ADC)	145.9 ± 0.8 (ADC)
σ	1.212 ± 0.031 MeV	46.3 ± 0.9 (ADC)	52.7 ± 0.8 (ADC)
$\sigma(\text{calib})$	—	7.45 MeV	8.62 MeV
ADC/MeV	—	6.22	6.12
N_{pe}	—	10.5	7.82
N_{pe}/MeV	—	0.44	0.33

Table 1: The fit results, calibration and calculated average number of photoelectrons for kaons. The “MC” column contains the results of a gaussian fit to the distribution of energy deposited in AD scintillator from simulation [1]. The columns labelled “Narrow” and “Wide” contain results of gaussian fits for the restricted and full range of the ADC distribution for $K_{\mu 2}$ events as shown in Figure 3.

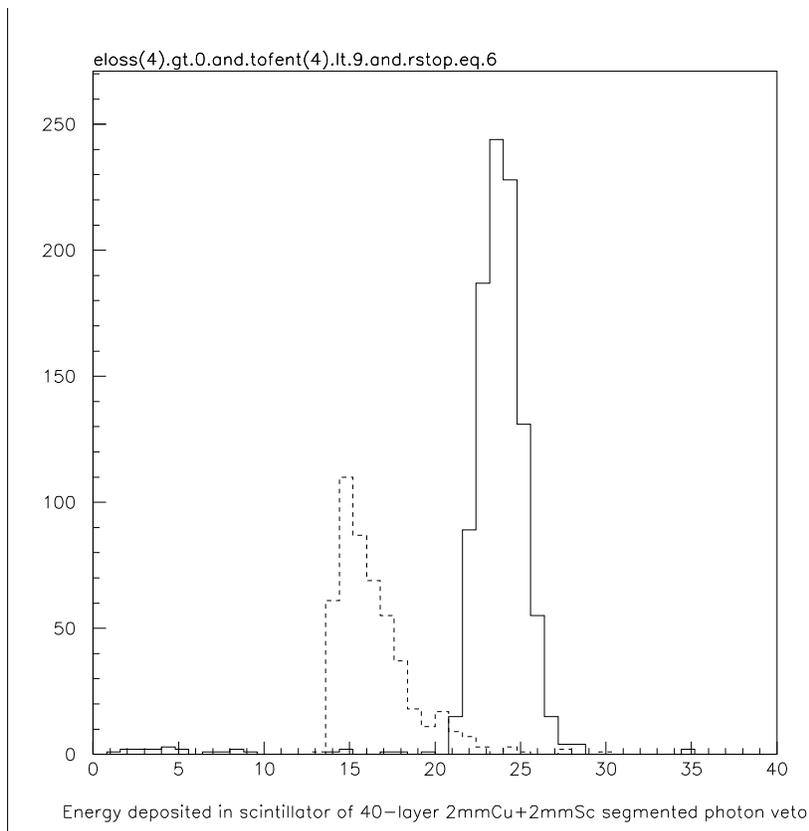


Figure 1: Figure 13 of K020 [1]. The energy deposited in the scintillator of the active degrader for kaons (solid) and pions (dashed) from simulation. I assume the energy is in MeV.

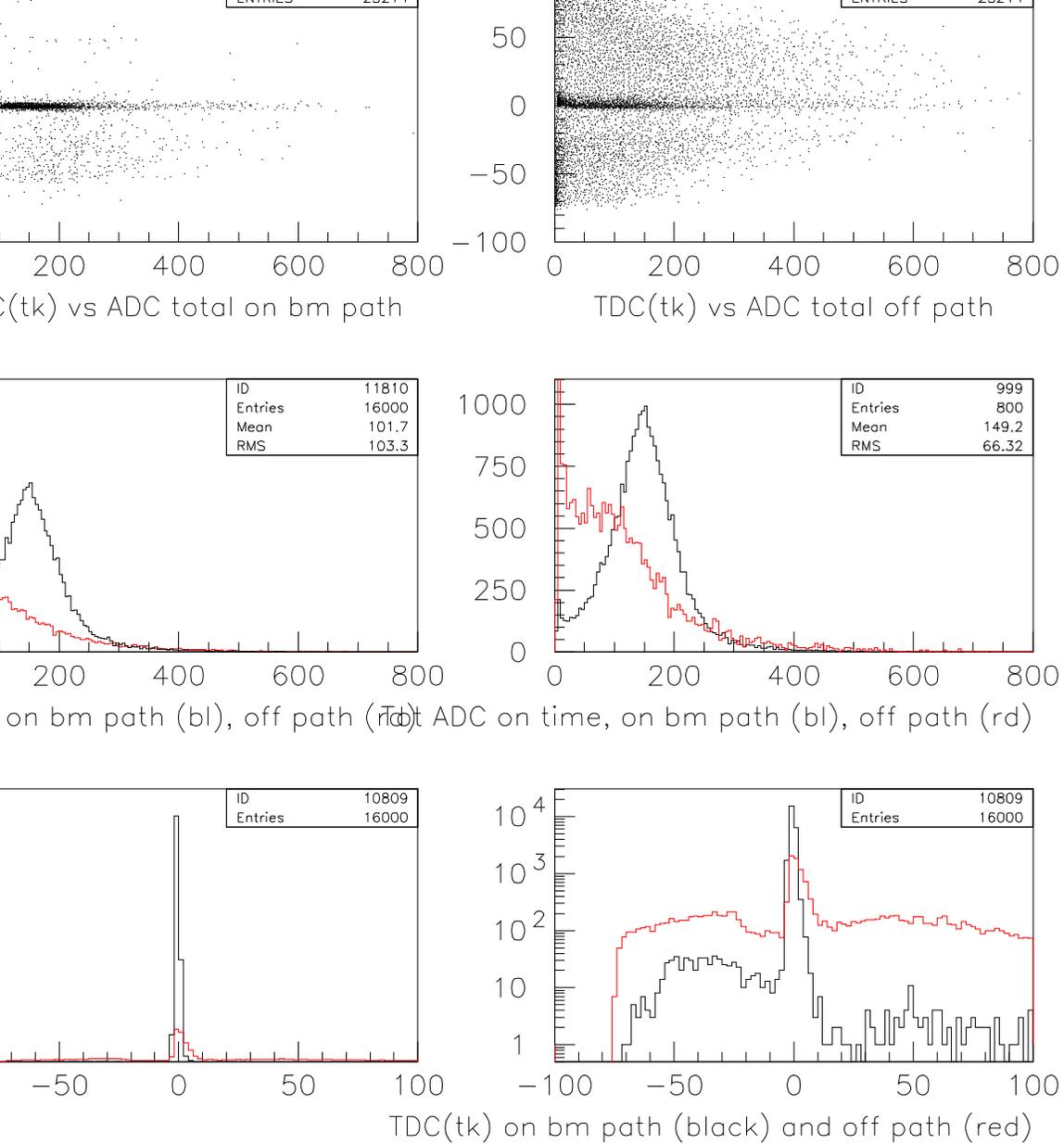


Figure 2: The black curve in the middle figure in the right hand column is the ADC distribution summed over active degrader sectors along the calculated kaon path in $K_{\mu 2}$ events from Ref. [2]

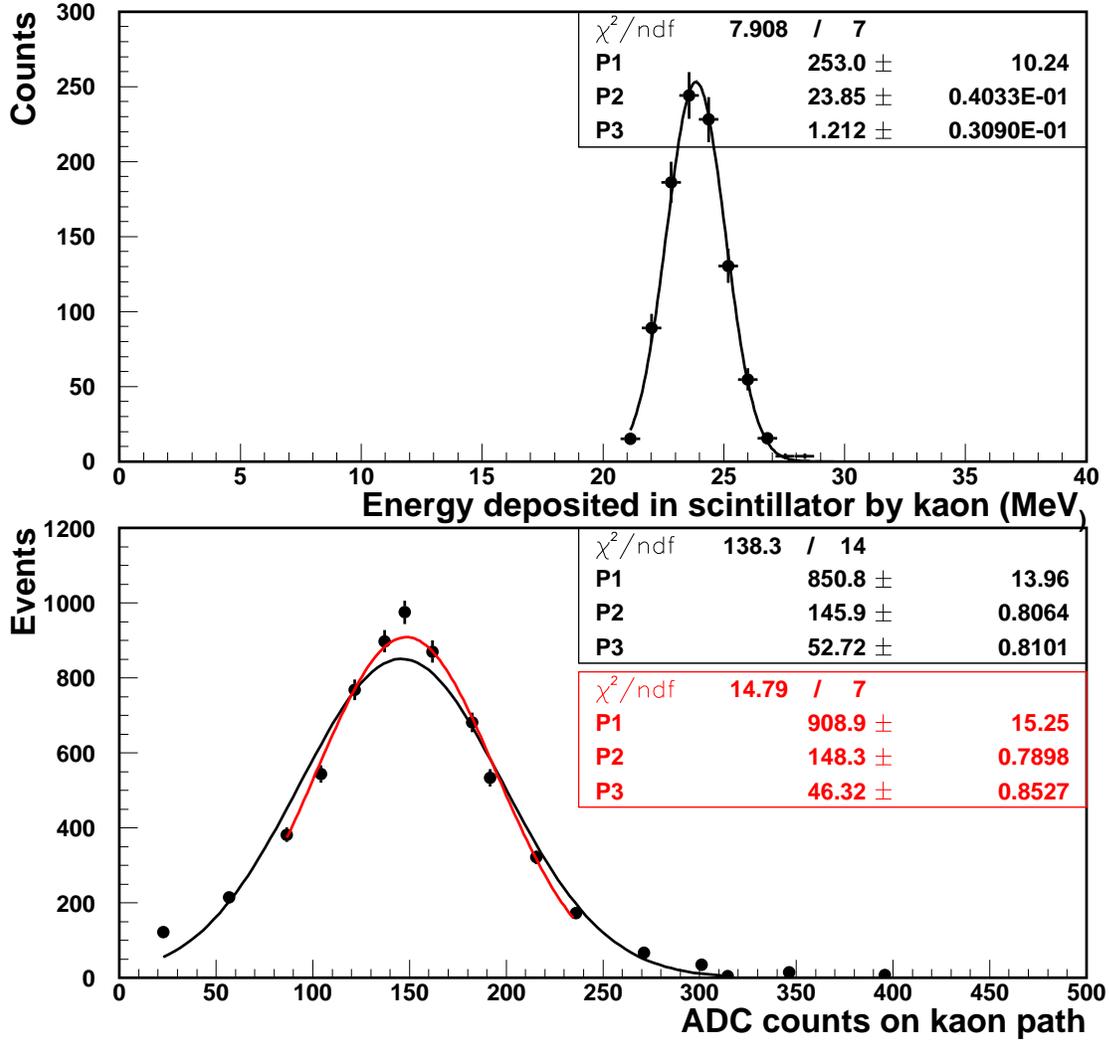


Figure 3: The fits to the distributions extracted from Figures 1 and Figures 2. In the lower plot, the black (red) curve is the result of the fit to the “wide” (“narrow”) range.

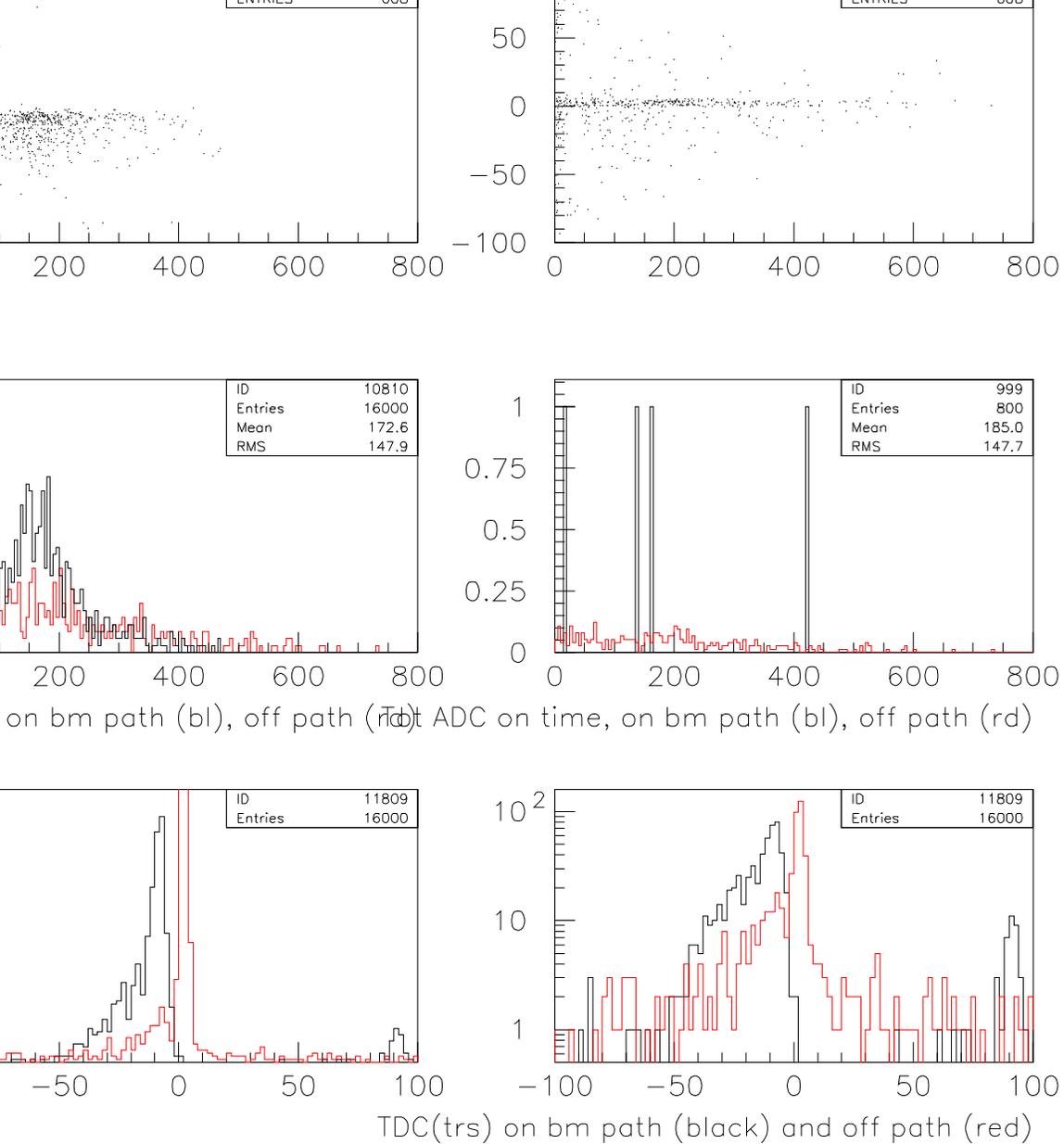


Figure 4: The red curve in the middle figure in the right hand column is the ADC distribution summed over active degrader sectors along the calculated kaon path in $K_{\pi 2}$ “kink” events from Ref. [3]

References

- [1] G.H. Coombes, P. Kitching, J.A. MacDonald and T. Numao, “Tests of prototype E949 beam instrumentation”, E949 Tech note K-020, 15 June 2001.
- [2] Transparencies for $K_{\mu 2}$ events for 11 May 2006 video meeting from Ilektra Christidi, http://www.phy.bnl.gov/e949/software/meetings/video/norm_km21.ps.
- [3] Transparencies for $K_{\pi 2}$ “kink” events 11 May 2006 video meeting from Ilektra Christidi, http://www.phy.bnl.gov/e949/software/meetings/video/norm_kinks.ps.