CLAS NOTE 1999-007
CVS: docs/clas_notes/ec_thresh

DETERMINATION OF ELECTRON ENERGY CUT DUE TO THE CLAS EC THRESHOLD

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1 Motivations

One of the trigger components in electroproduction experiments with CLAS is the Electromagnetic Calorimeter (EC). The calorimeter electronics provide a signal to the Level 1 trigger which is proportional to the total energy deposited in each sector. A threshold can then be set to require a minumum energy for the trigger. For a given EC hardware threshold value the spectrum of the detected electrons should cut off at the corresponding energy. However, due to amplitude fluctuations of the EC response this cut is not sharp, which leads to a distortion of the actual energy (as well as Q^2, W, etc.) spectrum near the threshold. These fluctuations arise from the overall EC energy resolution, as well as uncertainties in the EC output summing electronics. Due to the latter, making corrections to the measured spectrum seems problematic. Therefore, to get undistorted spectra a minimal cut on the electron energy should be determined for every EC threshold. In this note a method to determine the safe value of the electron energy cut (EEC) is desribed. Also recommended EEC values are presented.

2 The Method

Let us consider the inclusive inelastic electron scattering on a proton. The cross section for this process is well known and at CEBAF energies can be calculated using the Bodek parametrization with $\approx 10\%$ accuracy. In Fig.1 some of the results of these calculations for 2.445 GeV beam energy and at 7 electron scattered angles are shown.

One of the main features of these data is that at a fixed scattering angle in the lower range of electron energy (at high W) the cross section is a smooth and monotonically decreasing function of E_e. This behavior of the cross section will be used.

Due to the CLAS acceptance, for every scattering angle there is some minimum electron energy. This can be seen on the energy-angle scatter plots shown in Fig.2. In Fig.1 these minimum values of electron energy are presented by dashed line. If the threshold energy is much smaller than the corresponding minimum energy, the EC-threshold will not affect the experimental data and the cross section is expected to be sharply cut at the corresponding minimum electron energy.

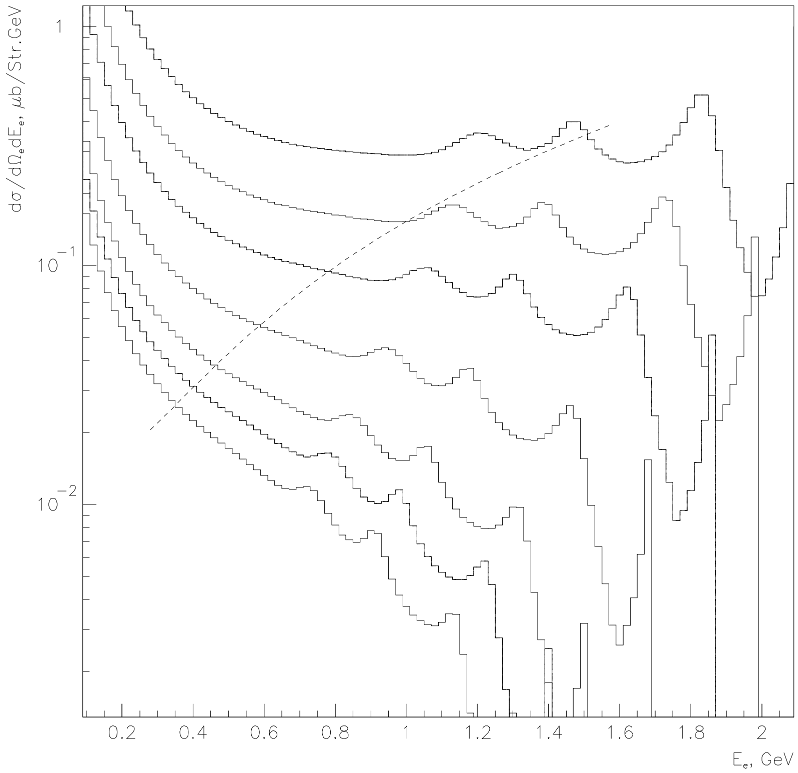

Figure 1: Calculated (with Bodek parametrization) cross sectuions of inclusive inelastic (ep) scattering at 2.445 GeV for 20^o (upper), 24^o, 28^o,34^o, 40^o, 44^o and 48^o (bottom). Dashed line shows minimum (due to the acceptance) values of electron energy.

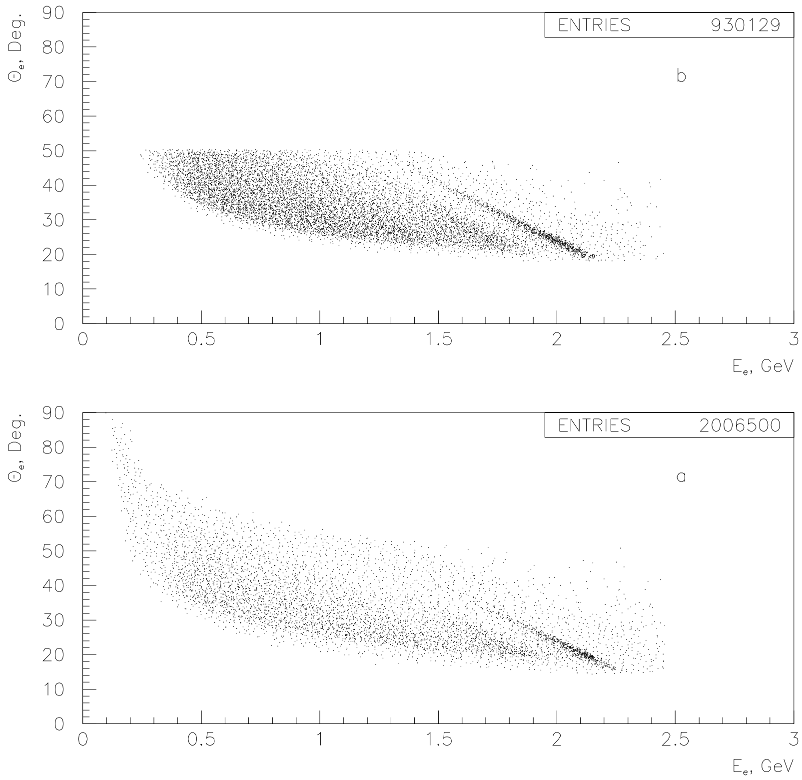

Figure 2: E$_e$ - θ_e plots at 2.445 GeV without (a) and with (b) fiducial cut.

For instance, if the threshold energy is 500 MeV then it should be expected that in energy region $\leq$ 500-600 MeV the cross sections will be distorted by the threshold effects at $\theta_e \geq 34^o$.

3 Results

In Fig.3 the theoretical and the experimental cross sections as a function of E_e are shown for 4 scattering angles.

The experimental data were obtained at an EC threshold of 125 mV which corresponds to an electron energy $\approx$ 0.350-0.375 GeV. One can see that at $E_e \leq 0.5$ GeV and $\theta_e \geq 40^o$ the experimental spectra are significantly distorted. On the other hand, at $\theta_e = 36^o$ the experimental spectrum abruptly falls at an electron energy of $\approx$ 0.42-0.45 GeV which is close to the calculated minimum acceptance energy ($\approx$ 0.415 GeV).

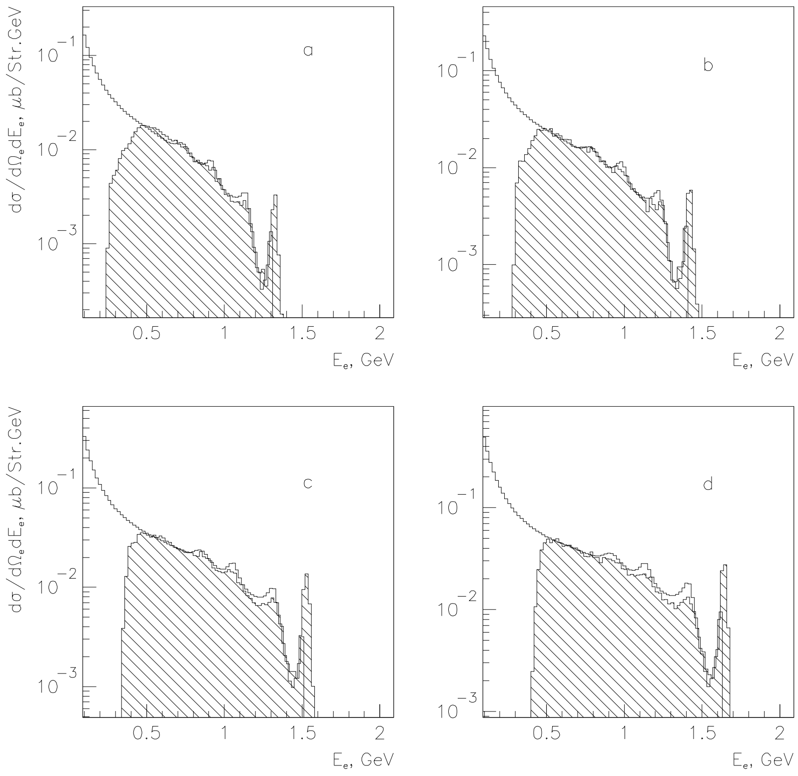

Figure 3: Calculated (solid lines) and experimental (shadowed) inclusive inelastic (ep) cross sections at 2.445 GeV for scattering angles of (a) 48^o, (b) 44^o, (c) 40^o, (d) 36^o. EC-threshold was 125 mV.

In Fig.4 ratios of experimental to the theoretical cross sections are presented for $\theta_e = 40^o, 42^o, 44^o, 46^o$ and 48^o. Starting from $E_e \approx 0.5$ GeV the ratios are independent of the electron energy and the scattering angle. Therefore, at this incident energy (2.445 GeV) and the EC-threshold (125 mV) the EEC may be chosen at 0.5 GeV.

The same procedure has been used to obtain EEC for different primary energies and thresholds. Results are displayed in Table.1. From these data one can conclude that EEC is almost independent of primary energy and the CLAS torus magnetic field.

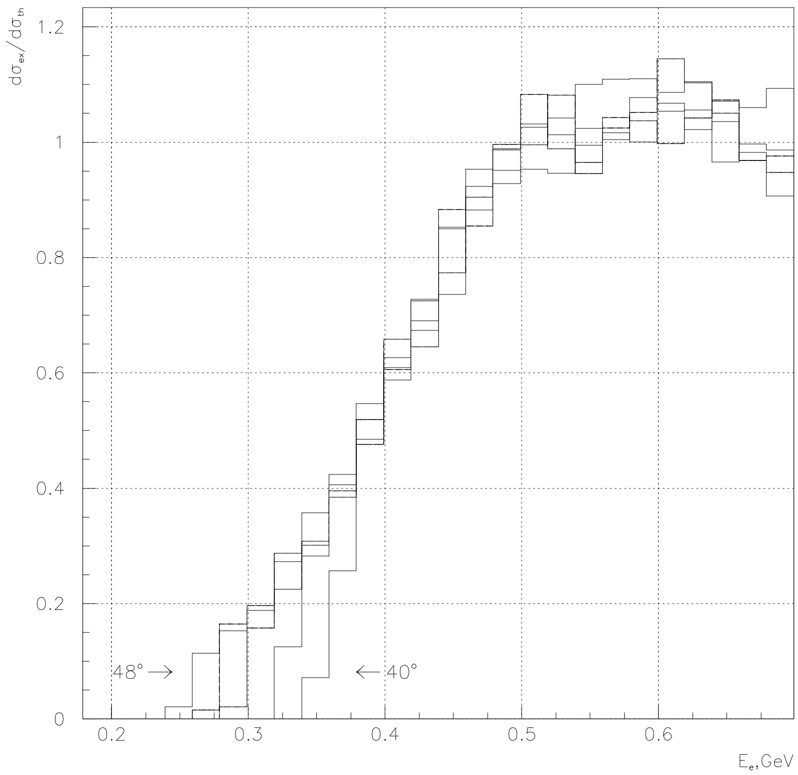

Figure 4: Ratios of experimental to calculated cross sections at $\theta = 40^o$-48^o.

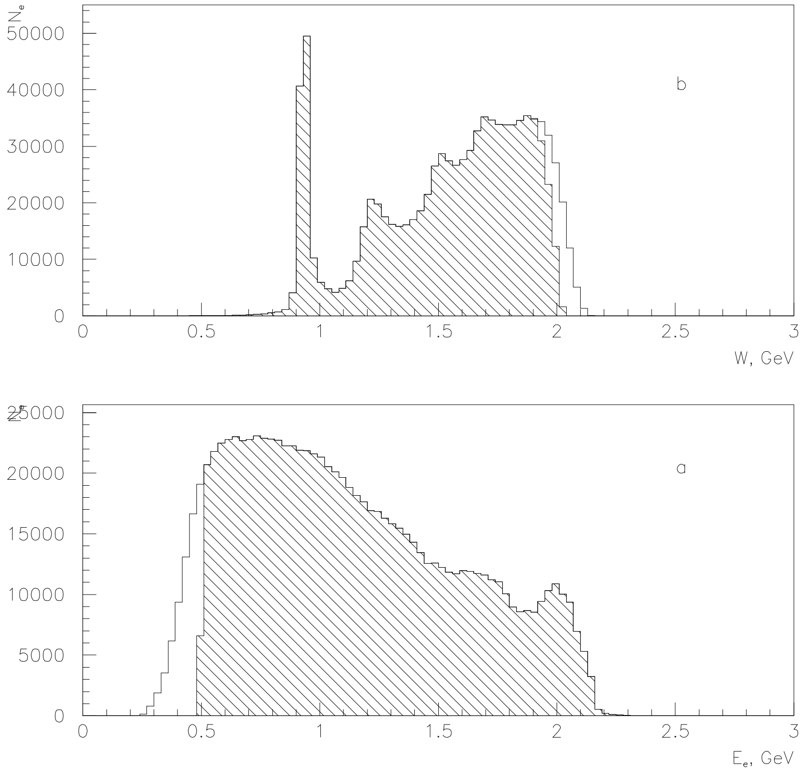

Figure 5: Electron energy (a) and W spectra (b) of inclusive (ep) scattering at 2.445 GeV and EC-threshold of 125 mV. Shadowed histograms show safe cuts at EEC = 500 MeV.

4 EEC effects

To illustrate the effect of these cuts E_e and W spectra for 2.445 GeV beam energy are shown in Fig.5 with and without the safe cut (EEC = 500 MeV; see Table 2). In Fig.6 (W, Q^2) scatter plots are displayed for the same cases.

5 Recommended values of EEC

Using data from Table 1 we obtained averaged EEC values which are listed in Table 2 and shown in Fig.7.

Thus, to obtain the safe electron energy cut one can use either Table 2 (for the thresholds already used) or in the more general case, equation (1).

$$EEC\ (in\ MeV) = 214 + 2.47 \times EC_{threshold}(in\ mV) \tag{1}$$

Energy, GeV	1.645		2.445	4.045					
Field	1500	2250	2250	2250		3375			
Threshold, mV	150	75	125	75	200	75	150	200	250
EEC, MeV	600	450	500	425	700	400	550	700	850

Table 1: The EEC values for different beam energy, torus magnetic field and the EC-Threshold.

Threshold, mV	75	125	150	200	250
EEC, MeV	425	500	575	700	850

Table 2: The (averaged) EEC recommended values for fixed EC-Thresholds

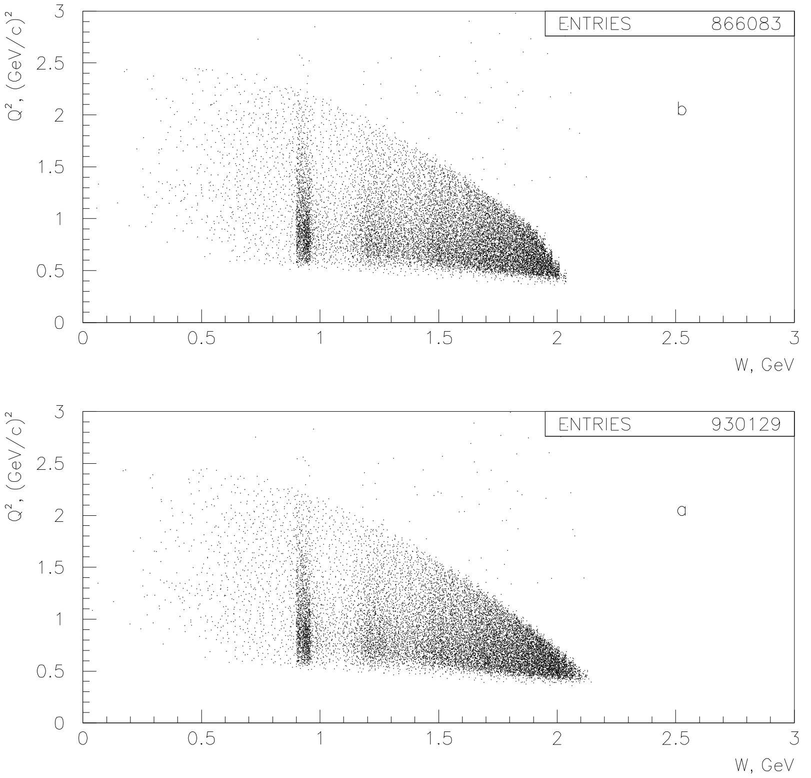

Figure 6: W - Q^2 plots with (b) and without (a) safe cut.

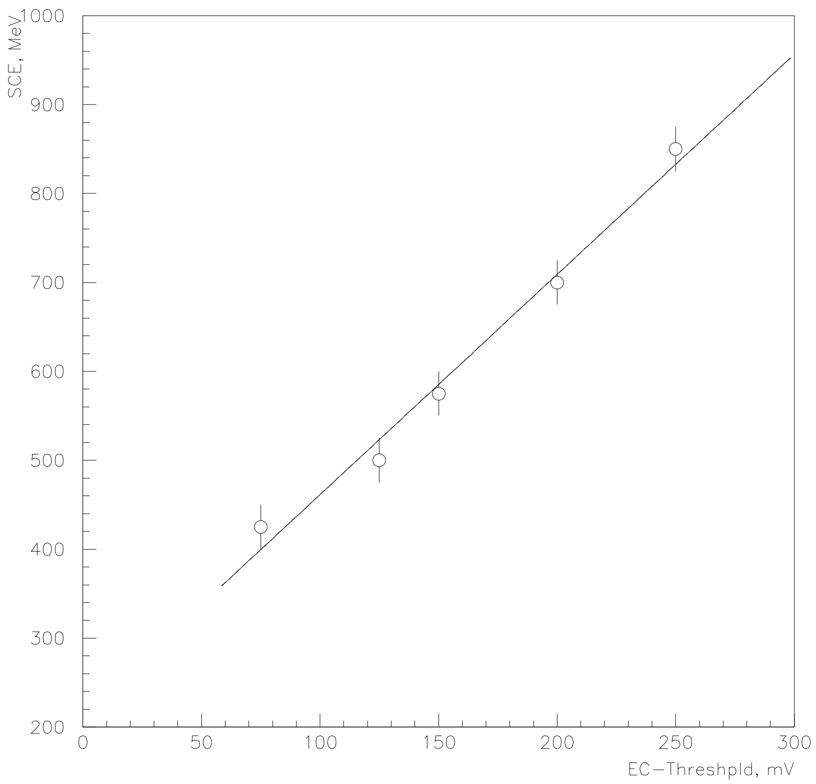

Figure 7: EEC dependence of EC-threshold. Solid line is a fit to eq (1).