0.1 GENERAL FEATURES OF LEPTON DATA IN *g12*

Electron and positron energy deposition while propagating through a material was briefly explained in Sec. ?? and ??. To identify electrons and positrons properly in CLAS, quantities obtained from the CC and EC are used to reject charged pions. The CC collects the number of photo-electrons caused by Cherenkov radiation and the EC records the energy deposition of electrons/positrons as well as photons. A previous CLAS experiment *g7* analyzed the properties of medium modifications from the decay of vector mesons through the leptonic decay channel. This experiment derived a set of cits for identifying electron/positrons pairs in CLAS by employing specific cuts to the number of photo-electrons (NPE) detected in the CC, a match in azimuthal angle ϕ from a charged track in the DC to the ϕ of the CC, as well as comparing the momentum of the charged track to the energy deposited in the EC. These cuts can be found in Table 1. To validate the *g7* electron/positron

TABLE 1. Cuts applied to the CC and EC to perform electron/positron PID

Subsystem	Quantity	Cut
CC	# of photo-electrons (NPE)	NPE > 2.5
	DC ϕ & CC ϕ	DC ϕ = CC ϕ
EC	$q^{\pm}$ momentum threshold (p_{thres}) & EC deposited energy (E_{calo})	$p_{thres}^{high} < E_{calo} < p_{thres}^{low}$

PID scheme for *g12*, a comparison of the CC and EC quantities was performed for all charged tracks CC/EC hit signatures and while selecting events from π^0 decay. To separate the π^0 events from the $\pi^+\pi^-$ events, all charged pions were assigned the mass of electrons and cuts were placed on the missing energy of $\gamma p \to pe^+e^-$ as well as a cut on the missing mass squared of $\gamma p \to p$, values found in Table 2. A graphical depiction of the cuts applied to separate π^0 events from the $\pi^+\pi^-$ events is seen in Fig. 1. The values of the threshold momentum are calculated from empirical

TABLE 2. Cuts applied to seperate π^0 evetns from $\pi^+\pi^-$ events

Cut Topology	Topology Quantity	Value
$\gamma p \to pe^+e^-$	Missing Energy (M_E)	> 0.075 GeV
$\gamma p \to p$	Missing mass squared (M_x^2)	< 0.0779 GeV^2 for π^0 events > 0.0779 GeV^2 for $\pi^+\pi^-$ events

studies and are based upon calculations using the momentum obtained from the DC

p under the following criteria;

$$\mathrm{p}_{\mathrm{thres}}^{\mathrm{low}} = \alpha p * (p + EC_{P\_LO})/p$$
$$\mathrm{p}_{\mathrm{thres}}^{\mathrm{high}} = \alpha p * (p + EC_{P\_HIGH})/p$$

where $EC_{P\_LO} = -0.3$, $EC_{P\_HIGH} = 0.5$ and

$$\alpha p = \begin{cases} .23 * p + .071p^2 - .032p^3, & p < 1.0 \text{ GeV} \\ 0.272p, & p > 1.0 \text{ GeV} \end{cases}$$

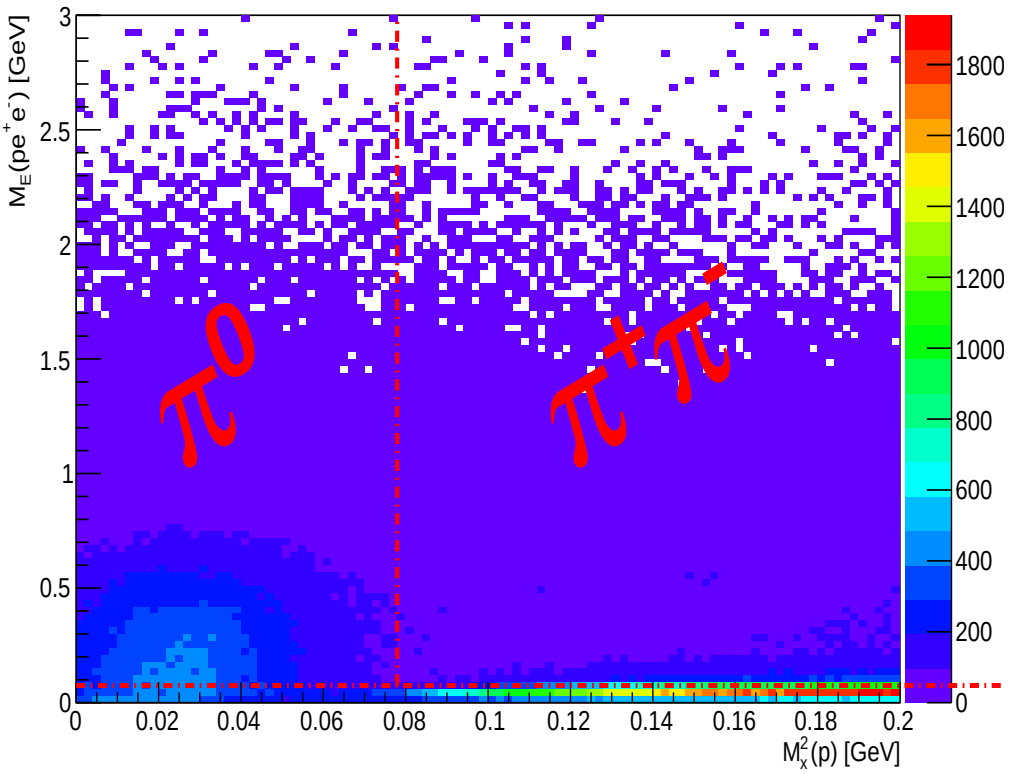

FIG. 1. Plot of missing mass squared of off proton (horizontal) vs. missing energy of proton e^+e^- (vertical). The red dashed vertical line depicts the $\pi^+\pi^-$ threshold mass cut while the horizontal red dashed line represents the missing energy cut-off used to sepertate $\pi^+\pi^-$ from π^0 .

CC Comparison

The NPE measured by the CC for all positron/electron (e^+/e^-) candidates can be seen in Fig 2. The sharp decline prior to 2.5 NPE is due to photo-electrons created by

electron/positrons, pions traveling through the CC or pions producing delta-electrons which pass through the CC. Delta-electrons are created as an effect of the ionization of gases that could be present when the pion travels through the DC. These types of electrons are typically lower in momentum than the electrons obtained from particle decays in CLAS and thus according to eq. ?? should emit less NPE per unit length.

Through mass conservation, as discussed in Sec. ??, the particles in the π^0 events must be e^+/e^- pairs. In comparison to fig. 2, fig. 3 plots the NPE measured by the CC for all e^+/e^- pairs for π^0 events selected as shown in fig. 1. It can be seen that the sharp decline prior to NPE = 2.5 is reduced leaving mostly electrons or positrons signatures in the CC concluding that the $g7$ CC NPE cut is valid for identifying e^+/e^- pairs while rejecting π^+/π^- pairs.

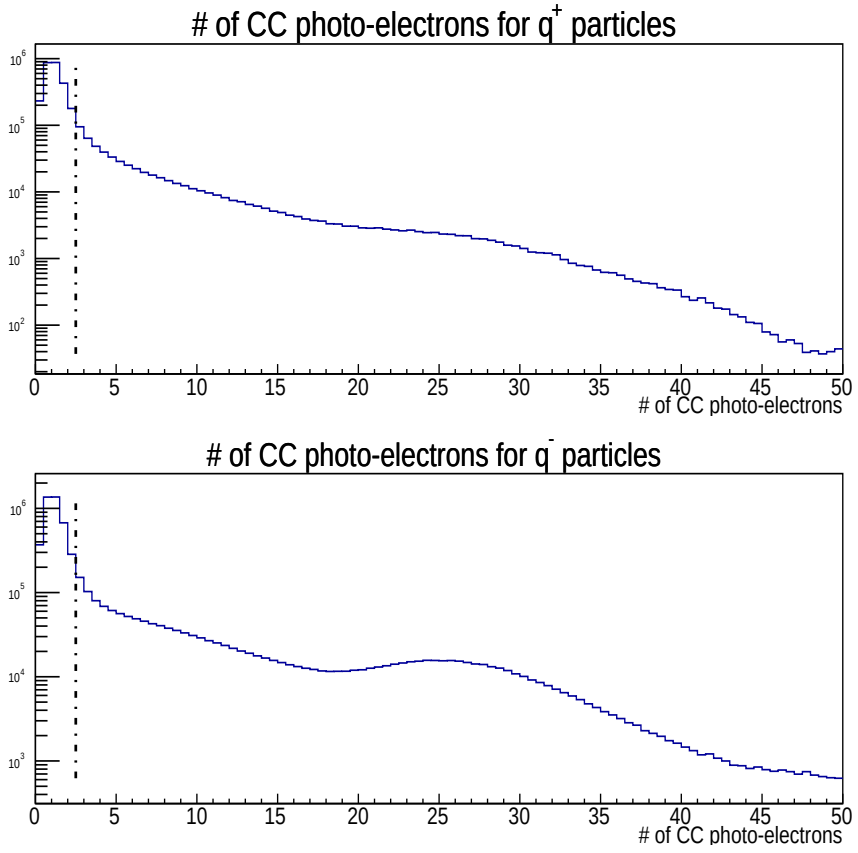

FIG. 2. Plot of NPE measured by CLAS CC subsystem for positron/electron candidates top/bottom respectively. The dashed dotted vertical line depicts the cut applied if using the $g7$ lepton PID scheme.

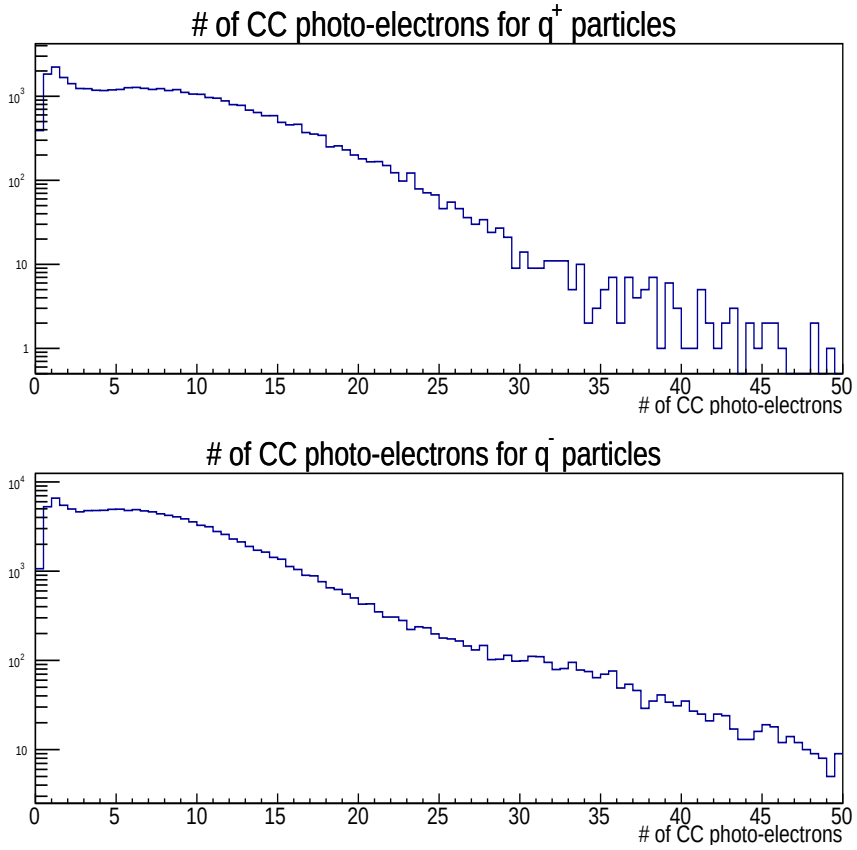

FIG. 3. Plot of NPE measured by CLAS CC subsystem when selecting π^0 events seen in Fig 1, positron/electron candidates top/bottom respectively.

EC Comparison

Similarly to the CC comparison, figures 4, 5, 8, 9 depict the p^{low}_{thres} and p^{low}_{thres} cuts listed in Table 1 for the q^- and q^+ tracks respectively. After π^0 event selection, seen in figures 6, 7 , 10 , 11, the bulk of e^+/e^- events reside within the region of the cut acceptance therefore it is evident that the $g7$ EC cuts are valid for identifying e^+/e^- pairs. The following four plots are for electron(e^-) PID validation of the $g7$ EC cuts described in Table 1.

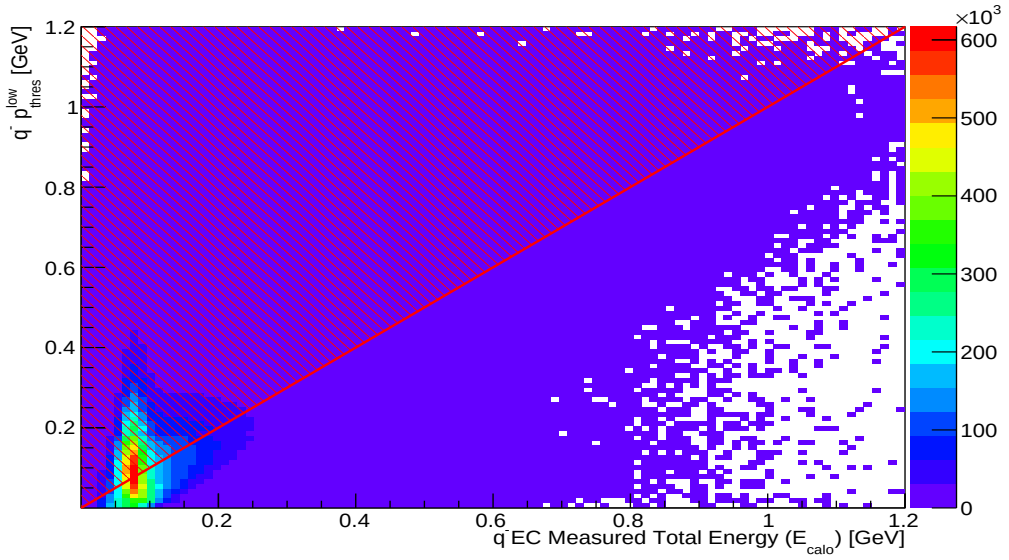

FIG. 4. Plot of energy deposited measured by `EC` vs. track momentum p_{thres}^{low} for negative charged tracks. The red region depicts the cut that would reject events in the $g7$ lepton `EC PID` scheme.

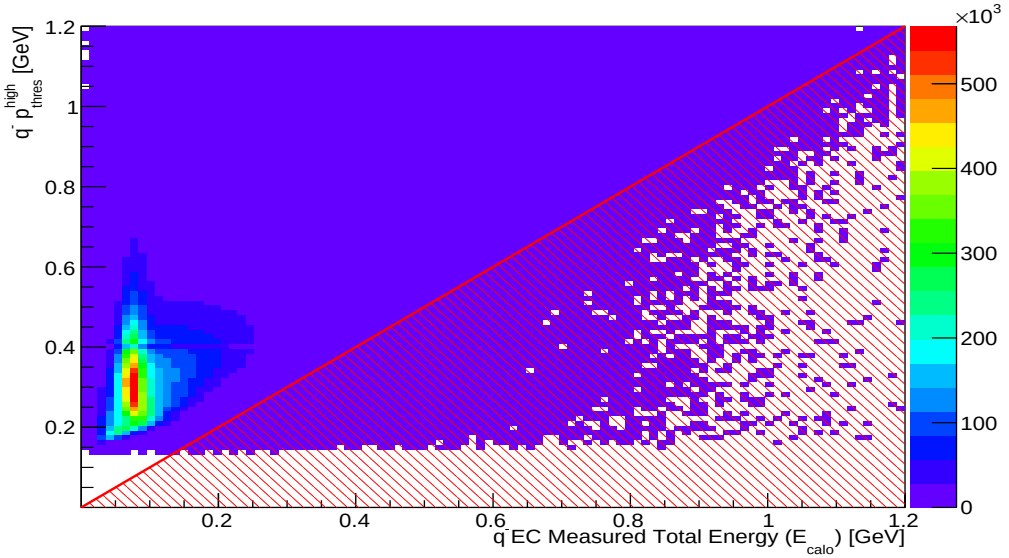

FIG. 5. Plot of energy deposited measured by `EC` vs. track momentum p_{thres}^{high} for negative charged tracks. The red region depicts the cut that would reject events in the $g7$ lepton `EC PID` scheme.

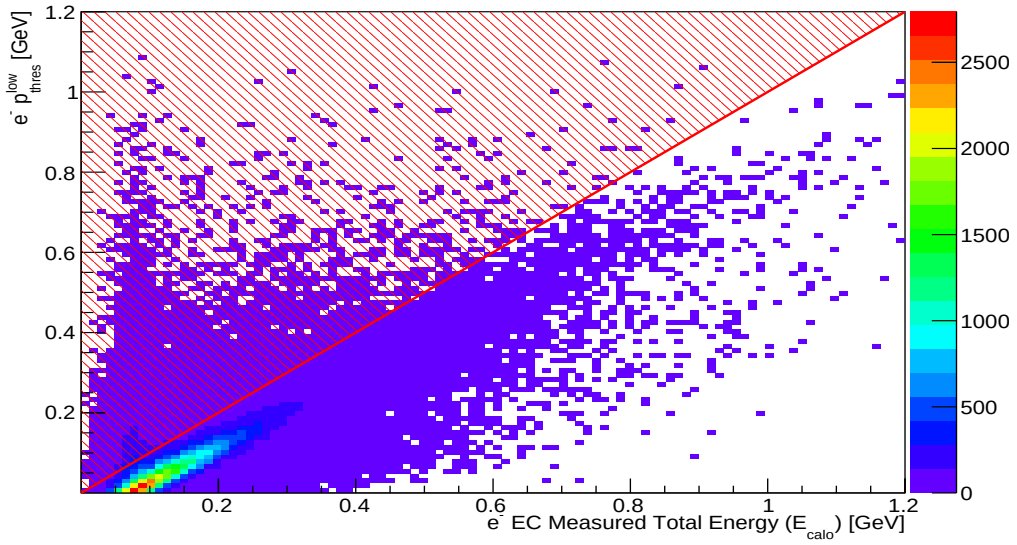

FIG. 6. Plot of energy deposited measured by EC vs. track momentum p^{low}_{thres} for electrons from π^0 events without the $g\gamma$ lepton EC PID scheme applied. The red region depicts the cut that would reject events in the $g\gamma$ lepton EC PID scheme.

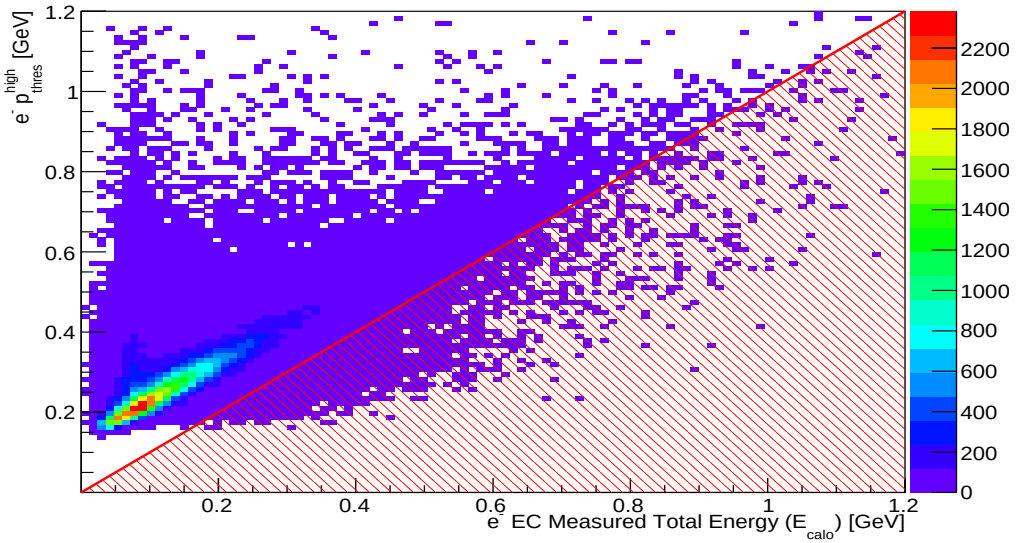

FIG. 7. Plot of energy deposited measured by EC vs. track momentum p^{high}_{thres} for electrons from π^0 events without the $g\gamma$ lepton EC PID scheme applied. The red region depicts the cut that would reject events in the $g\gamma$ lepton EC PID scheme.

The following four plots are for positron(e^+) PID validation of the $g7$ EC cuts described in Table 1.

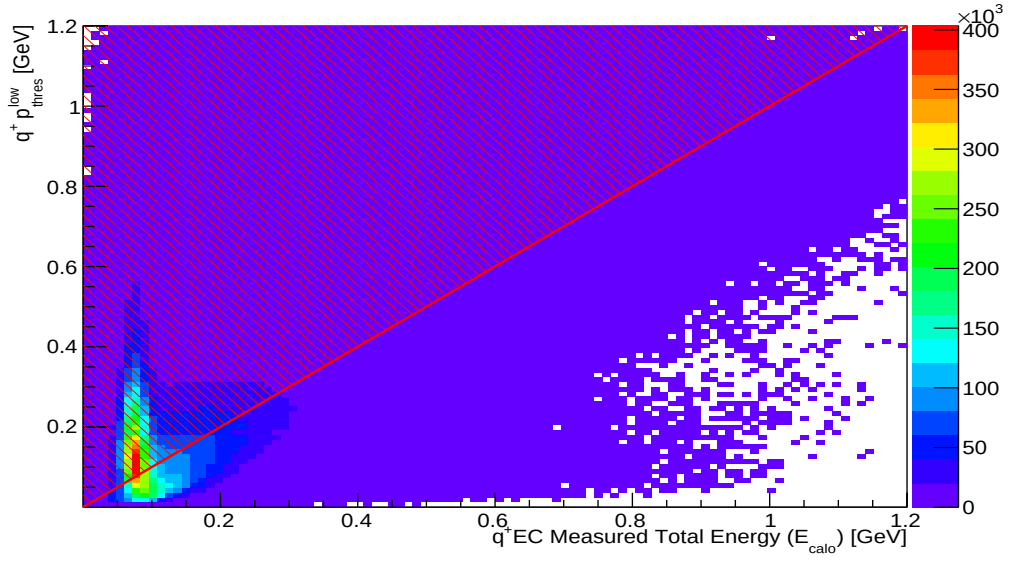

FIG. 8. Plot of energy deposited measured by EC vs. track momentum p^{low}_{thres} for positive charged tracks. The red region depicts the cut that would reject events in the $g7$ lepton EC PID scheme.

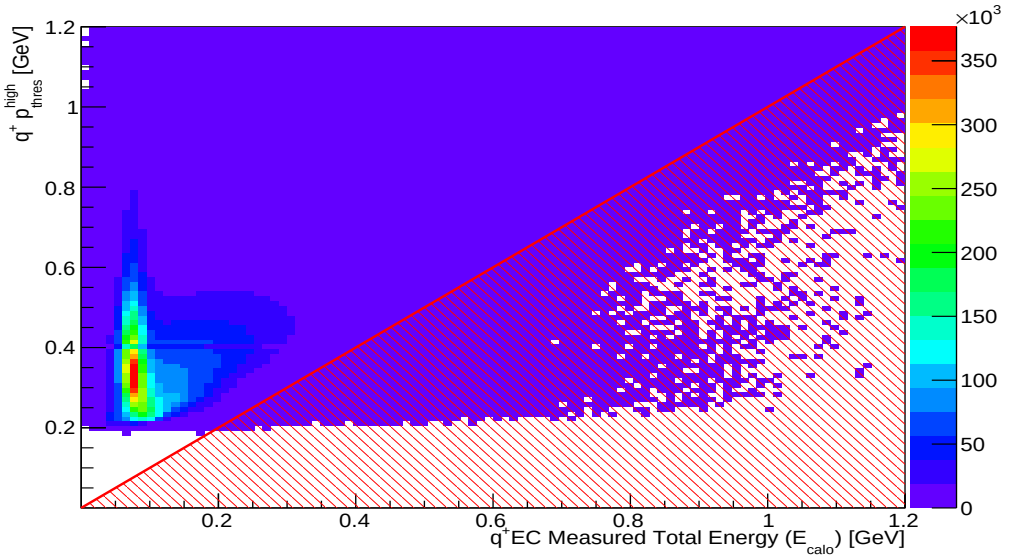

FIG. 9. Plot of energy deposited measured by `EC` vs. track momentum p^{high}_{thres} for positive charged tracks. The red region depicts the cut that would reject events in the $g7$ lepton `EC PID` scheme.

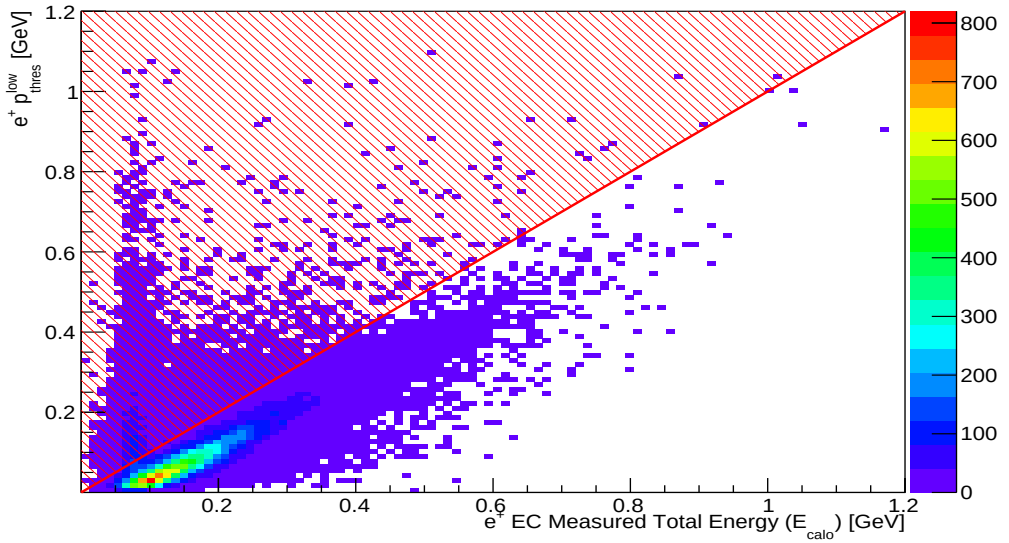

FIG. 10. Plot of energy deposited measured by `EC` vs. track momentum p^{low}_{thres} for positrons from π^0 events without the $g7$ lepton `EC PID` scheme applied. The red region depicts the cut that would reject events in the $g7$ lepton `EC PID` scheme.

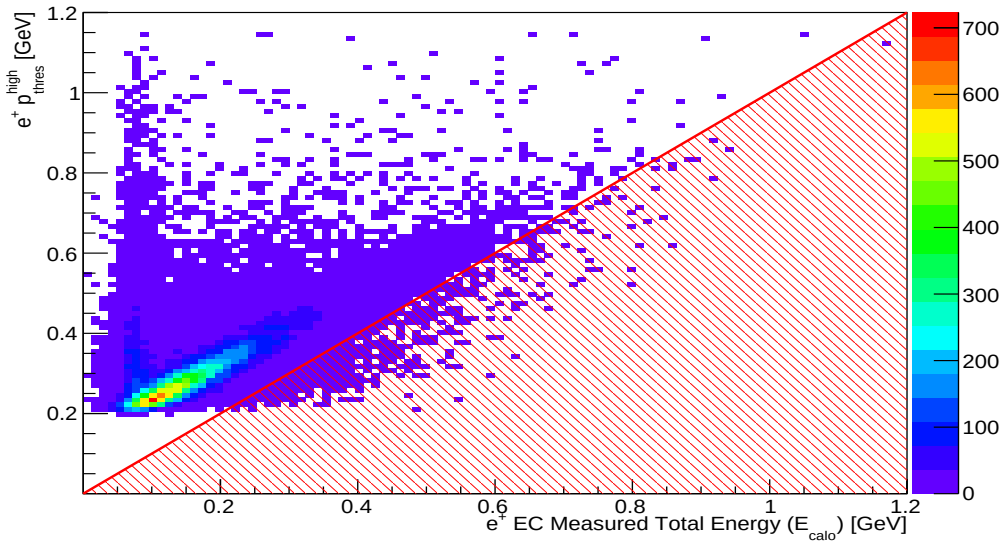

FIG. 11. Plot of energy deposited measured by `EC` vs. track momentum p^{high}_{thres} for positrons from π^0 events without the $g7$ lepton `EC PID` scheme applied. The red region depicts the cut that would reject events in the $g7$ lepton `EC PID` scheme.