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Backward Neutral Veto: Background reduction in $\eta_c \rightarrow \gamma\gamma$

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Several upgrades of the E760 detector have been discussed at various stages. One of these considered the possibility of covering with a photon detector the backward region (i.e. lab. polar angle $\theta_{lab} > 70^o$).

In this memo I limited the study to the effect of an extensive coverage in the backward region on the $\gamma\gamma$ background at the η_c. This is a rather important channel. In effect at this time and as far as I know, we don't have a clear signal and the Signal/Background ratio is poor. (Signal/Background$\simeq$ 1. $\div$ 1.5 are the values so far obtained from different analyses). Nevertheless the $\gamma\gamma$ final state remains our "strong channel" for the η_c detection.

I considered as background sources the $\pi^o\pi^o$ and $\pi^o\gamma$ final states and I required $|cos\theta^*| < 0.25$. Events $p\bar{p} \rightarrow \pi^o\pi^o$ and $\pi^o\gamma$ were Monte Carlo generated at $E_{CM} = 2.985$ GeV with the angular distribution as measured by E760 [1].

Background from $\pi^o\pi^o$

2 γ's out of 4 escape detection because they are outside acceptance or below energy threshold to be detected. Ignoring the hole in the Forward Calorimeter ($\theta_{lab} < 2^o$), three cases are possible for the two missing γ's: a) both γ's in the backward region; b) one γ in the backward region and one within the calorimeter acceptance but below energy threshold; c) both γ's inside the acceptance but below energy threshold. To simplify the problem I made the following choices: cases a) and c) only the most energetic γ has been considered; case b) the γ outside acceptance has been considered. In this way, one is left to one missing γ per event, which is the most energetic or the only one outside the acceptance. The energy of the missing γ has been plotted in Fig.1 as a function of θ_{lab}.

Background from $\pi^o\gamma$

One of the two γ's from the π^o decay escapes detection. The energy of the missing γ has been plotted in Fig.2 as a function of θ_{lab}.

Results

The background reduction will depend on the characteristics of the Backward Neutral Veto, namely the covered region and the energy threshold for photon detection. Assuming that all the backward region is covered then in Fig. 3 is shown the background reduction as a function of the threshold energy for the photon detection: circles refer to $\pi^o\pi^o$ while boxes refer to $\pi^o\gamma$.

Without any backward coverage, the estimated background from $\pi^o\pi^o$ in the above defined angular acceptance at $E_{CM} = 2.985$ GeV is 4.6 pb, while the contribution from $\pi^o\gamma$ is 46.5 pb, for a grand total of 51.1 pb. These values have been evaluated starting from the measured $d\sigma/dcos\theta^*$ as reported on Ref. 1.

It is straightforward to compute the remaining background as a function of the energy threshold for photon detection of the Backward Neutral Veto. Results are shown in Fig. 4. Notice that for an asymptotically increase of the energy threshold the remaining background tends to 51.1 pb, which is the limit for no backward coverage.

From this analysis, with a Backward Neutral Veto the reduction of the $\gamma\gamma$ background at the η_c is extremely poor if the energy threshold of the detector is $\sim 25 \div 30$ MeV. With a threshold of 0.5 MeV the reduction goes up to $\sim 30\%$.

References

[1] A brief description of the Monte Carlo can be found in the E760 memo: G. Govi et al., Determination of the $\pi^o\gamma$ cross section

Fig. 1 $\pi^0\pi^0$ background: energy of the γ escaping detection (see text) vs. lab. polar angle.

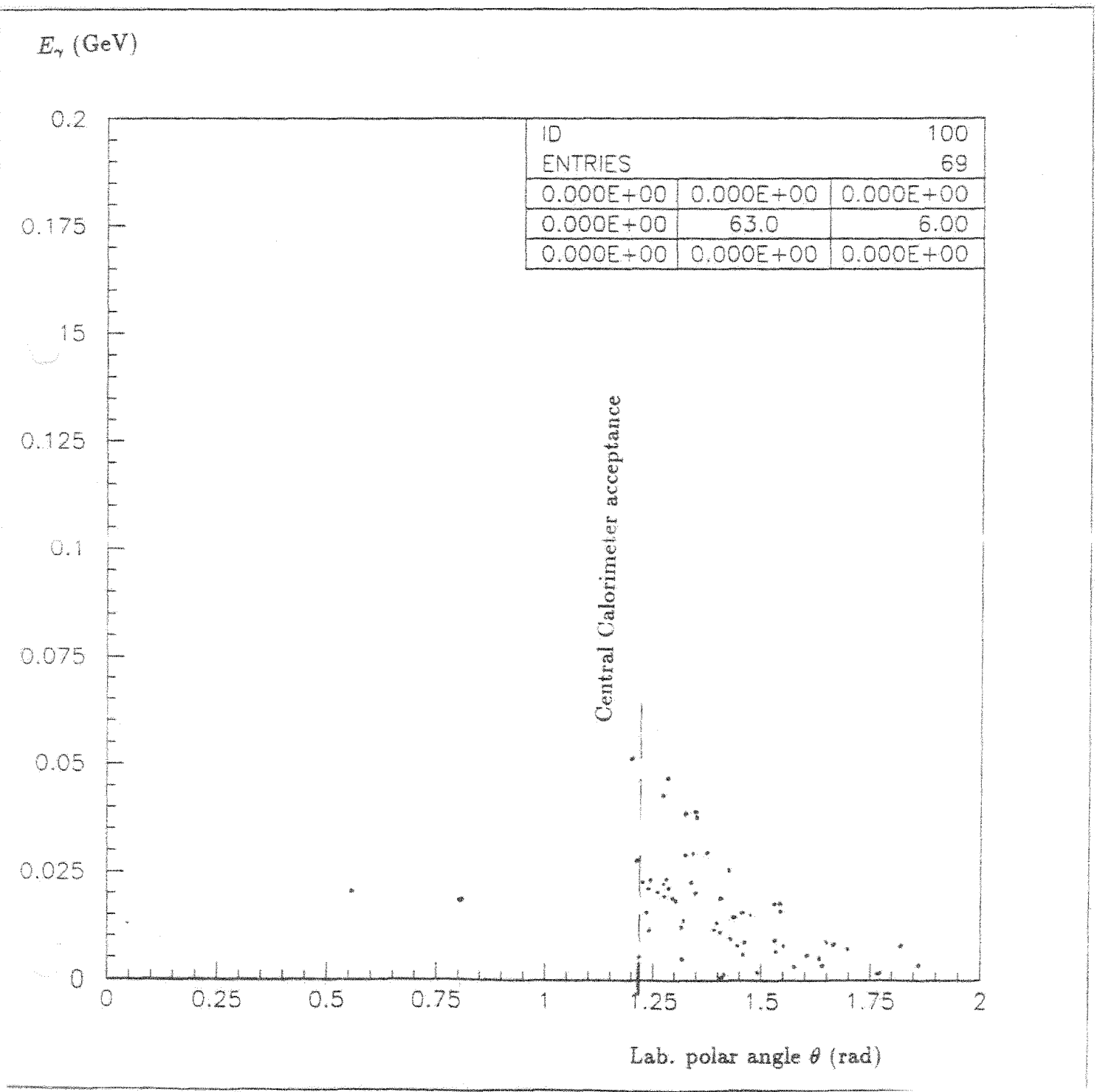

Fig. 2 $\pi^0\gamma$ background: energy of the γ escaping detection (see text) vs. lab. polar angle.

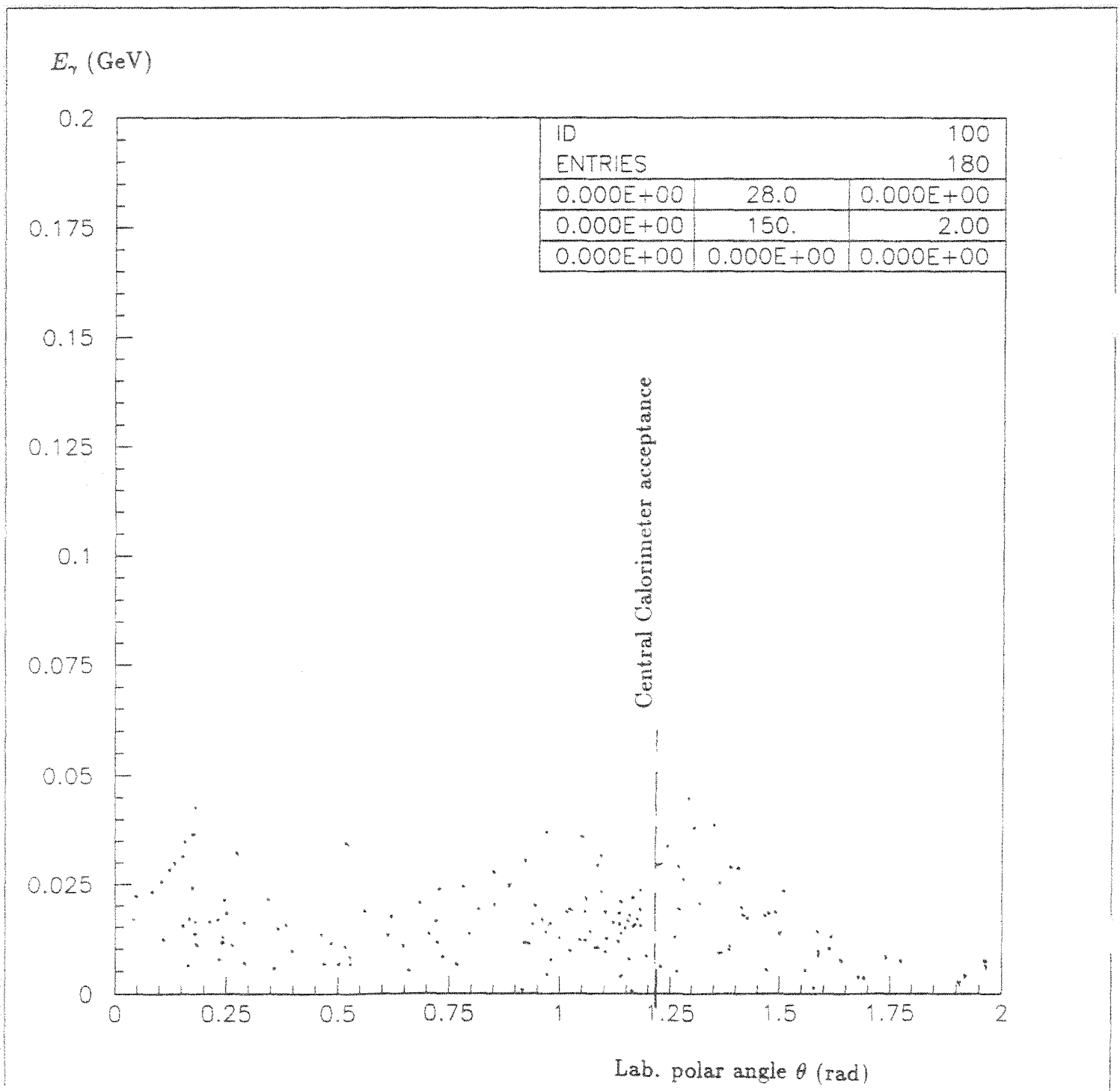

Fig. 3 Background reduction vs. γ energy detection threshold (MeV); ○ for $\pi^o\pi^o$ and □ for $\pi^o\gamma$

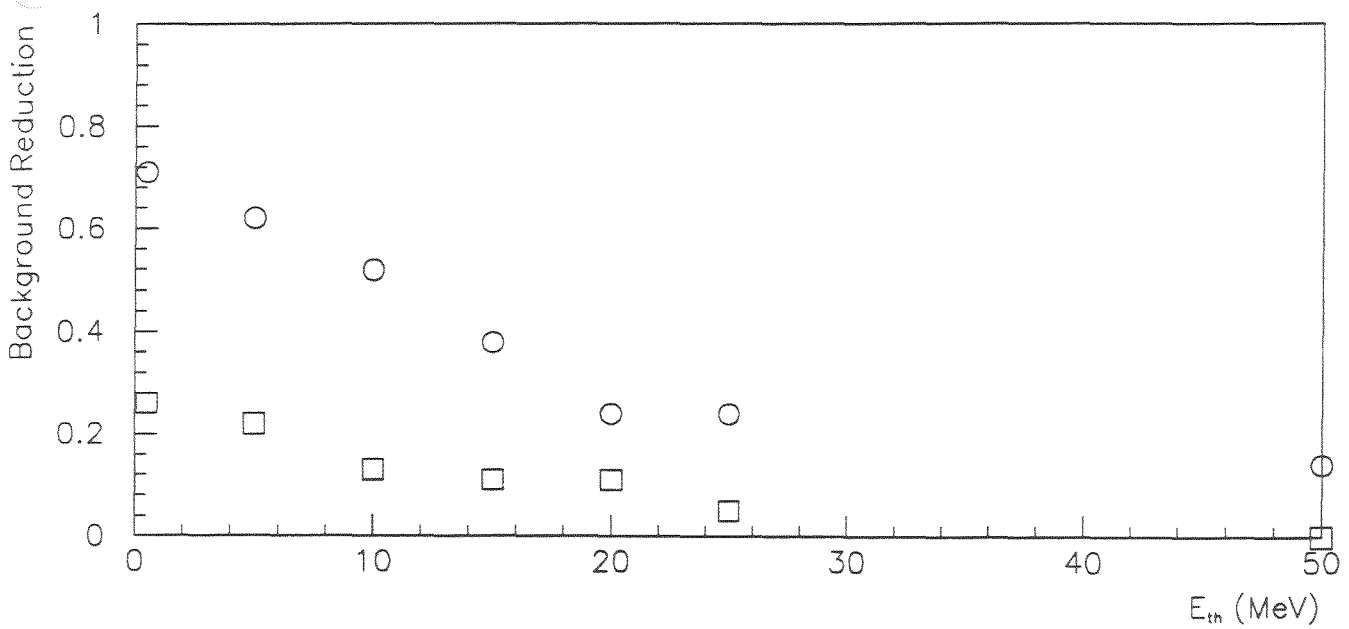
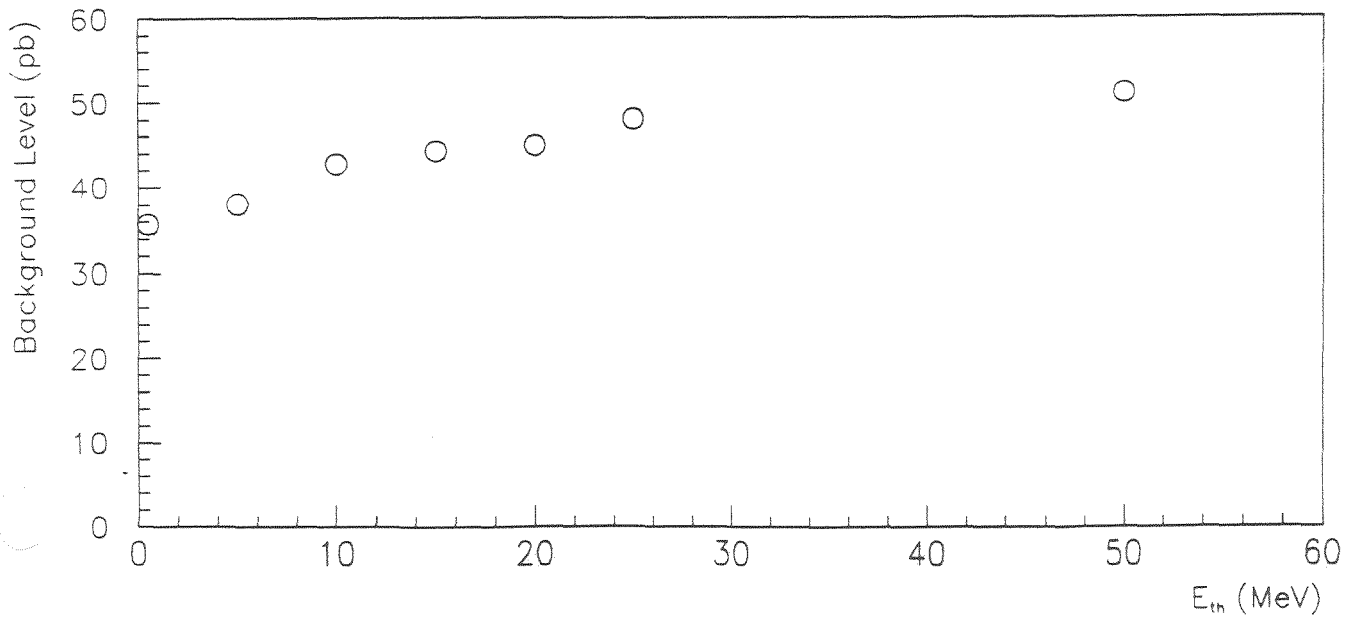
Fig. 4 Remaining background (pb) vs. γ energy detection threshold (MeV)