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A Luminosity Trigger With Asymmetric Energy Thresholds

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Abstract

This note presents arguments for having a luminosity trigger with asymmetric energy thesholds.

1 Introduction

There are several reasons why a trigger with different energy thresholds should be prepared for the start of LEP. One reason is that the symmetric trigger is only a special case of the asymmetric trigger thus allowing more freedom when we start taking data.

The expected observed energy depends on the position in the detector and it is equal to the beam energy well inside the detector.

Both energy thresholds must be well below the expected observed energy in the point of the detector under investigation.

The question is now how one within the background rate restriction best can reduce the thresholds, in a symmetric or an asymmetric fashion, in order to study the energy spectra and to reduce the errors.

The arguments for the asymmetric cuts fall in two clases. One which is of geometric origin and one which has to do with the energy measurement itself.

2 Geometrical reasons

We would at least in the beginning like to use a large acceptance region in an effort to have as small as possible statistical errors which means that we would like to go close to the edge of the detector.

A change δr in the distance from the edge changes the expected energy with δE:

$$\delta E = \frac{dE}{dr} \cdot \delta r$$

where dE/dr is of the order 1 GeV/mm for a 50 GeV electron. This means that geometrical uncertainties near the edge of the detector leads to a change in the expected energy distribution.

Higher order terms in the matrix elements make the electrons not colinear and make the expected energy distributions broader as they are maded up of several particles, photons and electrons, each of which might loose energy if they fall near the edge.

Another reason for asymmetric energy thresholds come from the uncertainties along the beam axis such as survey errors in the position of the detectors and the distribution of the vertex. Define the following quantities:

z_0 distance from nominal common center of the two detectors to one detector.

δz_0 change in z_0 due to measurement errors.

δz absolute value of distance between actual detector center and the vertex position.

x_L minimum cut on the distance from the beam axis at the side with the most restrictive cut.

x_S minimum cut on the distance from the beam axis at the side with the least restrictive cut.

The lowest order cross section for a vertex at the nominal center is changed dependent on the size of δz. It is for

$$\delta z \leq (z_0 + \delta z_0) \cdot \frac{x_L - x_S}{x_L + x_S}$$

equal to [1]:

$$\frac{\delta\sigma}{\sigma} = 2 \cdot \frac{\delta z_0}{z_0} + \frac{\delta z_0^2 + \delta z^2}{z_0^2}.$$

It is for larger values of δz:

$$\frac{\delta\sigma}{\sigma} = \frac{x_L^2 - x_S^2}{2 \cdot x_S^2} + (2 \cdot \frac{\delta z_0 - \delta z}{z_0} + (\frac{\delta z_0 - \delta z}{z_0})^2) \cdot (1 + \frac{x_L^2 - x_S^2}{2 \cdot x_S^2}).$$

The relative change in the cross section must be averaged over the vertex position δz. This leads to an error if the vertex distribution around the actual common center of the to detectors is not correctly known.

It is clear that the dependence on δz is reduced with an increasing difference of the inner radius cuts.

These arguments are valid for the geometrical cuts but are also true for the energy cuts through the energy distance relation.

3 Energy reasons

If the threshold on one side is lowered enough then on gets a long energy range to study the energy spectrum on that side. This gives confidence in the ability to predict the energy spectra. It is however true that if the background rate is low enough then both thresholds can be lowered to a level, where they again are equal.

It has been observed during the test beam and in the laboratory tests that the signal of 32 storeyes suddenly are reduced by a factor two. This is believed to originate from faulty ADC modules. The problem is that the error goes away again after some time.

It can be detected in the pedestal evaluation and in the gaincalibration and leads only to a $\sqrt{2}$ deterioration in the energy resolution of the storeyes in question.

If it however happens during a run then it will influence the trigger rate unless the thresholds are well below 50 % . That it happened can be observed offline through a non-uniformity of the distribution of accepted events and it can be corrected for. However it is obviously best if at least one threshold is well below 50 % as it is much less likely that it happens for two opposite towers, which are read by different ADC's, than for one tower.

References

[1] J. D. Hansen - ALEPH Note 88-30/ PHYSICS 88-10.