

Preliminary Trigger Studies for the PEP-N Detector

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A very preliminary study for a trigger for the PEP-N experiment is presented. Its aim is to show the feasibility of a very efficient trigger for multihadronic events based on energy releases in the electromagnetic calorimeter. Though the efficiency of such a trigger is very high and simple topology requirements can be applied to reduce cosmic background, an accurate study of machine background is going to be made to provide final trigger design and performance.

1. INTRODUCTION

The PEP-N experiment needs a very efficient trigger in order to minimize the systematics. In particular, the exclusive approach [1] is very demanding from this point of view, requiring a well known efficiency for each channel. Moreover, luminosity measurement [2] requires full efficiency for Bhabha events.

On the other hand, background rejection is a crucial point [3]. At this stage, machine background has not been extensively studied. In this paper, a very preliminary evaluation of trigger efficiency for multihadronic channels is presented. Proposed trigger criteria still do not take into account the effect of machine background; aim of this study is to demonstrate the possibility to build a very efficient trigger and to apply some simple topological criterium to cut cosmic background without affecting the efficiency. A final trigger design will be heavily driven by the machine background characteristics.

In the following, some results are shown for a simple trigger based on energy deposits in the electromagnetic calorimeter.

2. MULTIHADRONIC EVENTS

The trigger efficiency for multihadronic events has been studied generating some thousands of events for each channel and following the particles up to the electromagnetic calorimeter. The energy release has been simulated according to the experimental data from the KLOE calorimeter [4] for forward and barrel modules. An accurate Monte Carlo describing calorimeter modules, including lead, fibers and glue, has been used to simulate the thin pole and backward modules, comparing results with the KLOE ones. Impact angles and border effects have been taken into account. Signals coming from low energy incident particles have been weighted according to the proper efficiency.

As a minimum bias trigger criterium, two energy deposits over a given threshold have been required. A few photoelectrons can be seen by our calorimeter, that is fully efficient

yet for 40 MeV incident gammas. In our case, we accepted events with at least two releases over 2 MeV in fibers (corresponding to about 15–20 MeV incident gammas). This requirement is very realistic, being based on the behaviour of the 4m-long modules of the KLOE calorimeter, which is now working in Frascati. The different energy deposit in the pole and backward calorimeter, which has a different thickness, has been taken into account looking at the results of the simulation. Low energy signals have been weighted taking into account the efficiency of the calorimeter for the appropriate particle at that energy.

In Figure 1 the results for the reaction $e^+e^- \rightarrow k^+k^-\pi^+\pi^-$ are shown as an example. The trigger efficiency for this channel is plotted as a function of the VLER [5] beam energy (in MeV).

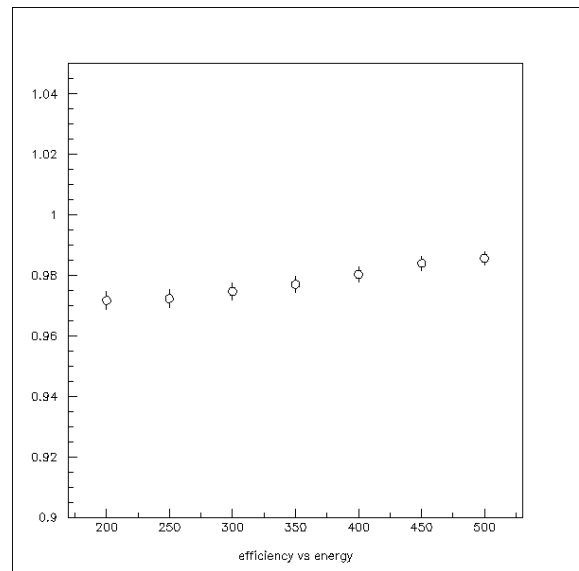


Figure 1: Trigger efficiency for the reaction $e^+e^- \rightarrow k^+k^-\pi^+\pi^-$.

The trigger efficiency for the most significant hadronic channels at two energies is shown in Table I.

Table I Minimum bias trigger efficiency for the most significant hadronic channels at 1.58 and 2.1 GeV in the centre of mass.

Reaction	VLER energy (MeV)	Efficiency
$\pi^+\pi^-2\pi^0$	200	.999
	350	1
$2\pi^+2\pi^-$	200	.991
	350	.995
$\pi^+\pi^-4\pi^0$	200	1
	350	1
$2\pi^+2\pi^-2\pi^0$	200	1
	350	1
$k^+k^-\pi^+\pi^-$	200	.972
	350	.977
global	200	.994
	350	.995

3. BHABHA EVENTS

Trigger efficiency on the Bhabha channel is very important, in particular on the events concurring to the luminosity measurement.

The production angles for electron and positron in a Bhabha event in the laboratory system are strongly correlated (Figure 2).

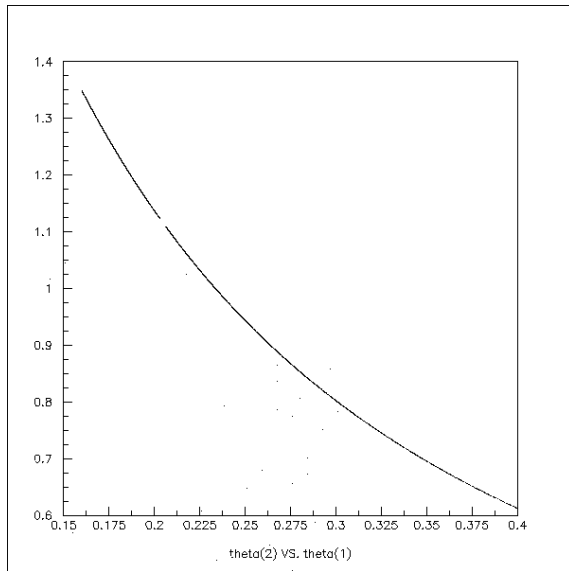


Figure 2: Angular correlation of Bhabha events.

If we analyse the events with a particle between $\theta = 0.3$ and $\theta = 0.4$ in the laboratory system (the ones used for the luminosity measurement, according to M. Mandelkern's document [2]), they are, depending on the energy of the electron beam, both in the forward calorimeter, or one in the forward and the other in the barrel or pole.

In the worst case, the lowest energy particle will hit the thin pole calorimeter. The distribution of released energy for that

particles is shown in Figure 3.

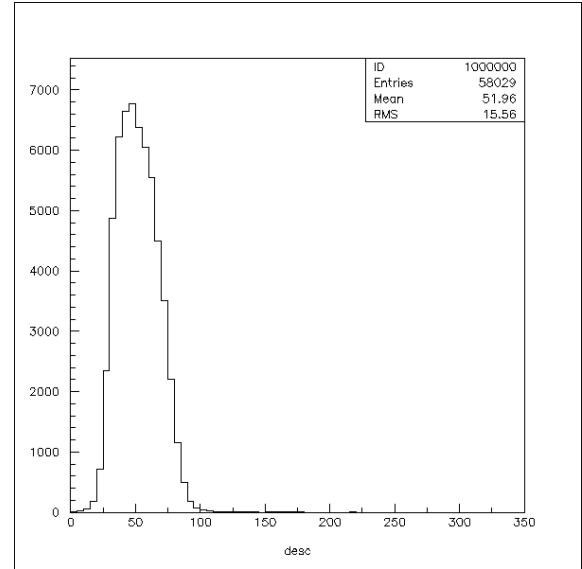


Figure 3: Energy deposited in fibres by the low energy particle in a bhabha event.

With our threshold, we have full efficiency. Also with higher thresholds (~ 10 MeV deposited per particle) the efficiency is almost full.

4. COSMIC BACKGROUND

Though they are not the most important source of background, it is useful to show that cosmic rays can be reduced by just applying simple topological criteria. Due to the boost in the laboratory system and the angular coverage of the detector, a very few events produce only two hits in the barrel or pole calorimeter. If we choose not to trigger on these events, a reduction factor of at least 3 in cosmic ray background is expected.

According to the plot of Figure 2, luminosity bhabha cannot be affected by this requirement. In Figure 4 the trigger efficiency for the reaction $e^+e^- \rightarrow k^+k^-\pi^+\pi^-$ after cosmic background reduction is shown.

A comparison with Figure 1 shows that the effect of the topological criterium is negligible. This consideration applies for all the hadronic channel. The overall efficiency for hadronic processes is again .994 at 200 MeV of VLER energy and .995 at 350 MeV, to be compared with the results in Table I.

5. FINAL CONSIDERATIONS AND FURTHER WORK

The overall trigger rate at a luminosity $10^{31} \text{ cm}^{-2} \text{ s}^{-1}$ can be anticipated to be the sum of the contributions in Table II.

Provided we can take under control the trigger rate due to machine background, these rates are not challenging for a modern data acquisition system, considering an expected event size of some kByte. Data can be processed and filtered online both

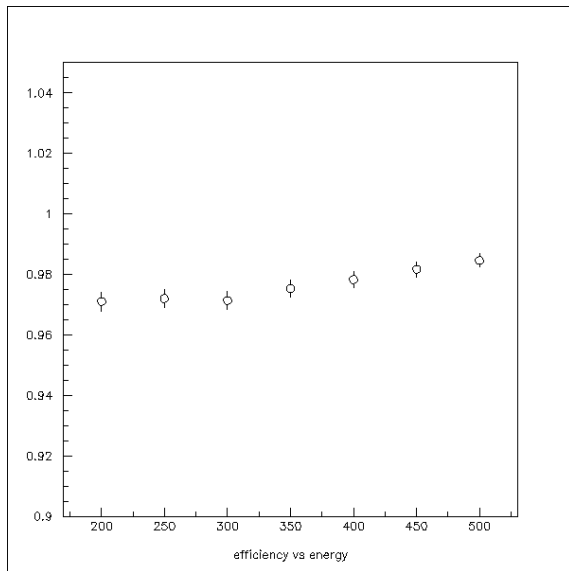


Figure 4: Trigger efficiency for the reaction $e^+e^- \rightarrow k^+k^-\pi^+\pi^-$ with cosmic background reduction.

with a hardware or a software second level trigger, thus lowering the background level.

Table II Trigger rates.

hadrons + muons	~ 1 Hz
bhabha (cutting on $\theta = 0.16$)	~ 20 Hz
cosmics	~ 150 - 200 Hz
machine background	?

Work is in progress to study the effect of the machine background. In general, we can expect many background events firing the trigger. Background rejection could be improved adding some topological information or requiring more hits in the calorimeter for many-body events. In the latter case, angular correlation provides the way to accept two-body events.

An accurate study of machine background characteristics has been started to provide final trigger design and performance.

REFERENCES

- [1] D. Bettoni, "Detector layout," Workshop on e^+e^- Physics at Intermediate Energies, SLAC, April–May 2001.
- [2] M. Mandelkern, "Luminosity measurement," Workshop on e^+e^- Physics at Intermediate Energies, SLAC, April–May 2001.
- [3] L. Keller, "Background," Workshop on e^+e^- Physics at Intermediate Energies, SLAC, April–May 2001.
- [4] P. Patteri, "Electromagnetic calorimeter," Workshop on e^+e^- Physics at Intermediate Energies, SLAC, April–May 2001.
- [5] J. Seeman, "Accelerator layout," Workshop on e^+e^- Physics at Intermediate Energies, SLAC, April–May 2001.