Endcap Trigger Upgrade

Jianhui Gu
(Institute of High Energy Physics, Beijing)

June 17, 1998

1 What is endcap trigger

The endcap is the detecter part covered by the Endcap Shower Counter. Fig1 shows the endcap of BES. From the interaction point, the endcap includes Vertex Chamber, Inner part of Main Drift Chamber, Endcap TOF and ESC. The Endcap Trigger is used to trigger the events in the endcap of the detecter.

In BES-II, the Vertex Chamber has replaced the Central Drift Chamber in old BES. This makes the reconstruction of endcap tracks possible. And it will increase the reconstruction coverage by more than 10%. In accordance with this improvement, the trigger system should trigger the endcap events (tracks).

In the old system, the Endcap Trigger is designed for endcap Bhabha events. After the upgrade, the Endcap Trigger will trigger the endcap events (the events has only endcap tracks) and increase the trigger efficiency for the events with endcap track/tracks. And it will be used for on-line endcap luminosity measurement.

2 Endcap Trigger design

Fig2 is the proposed Endcap Trigger. The VC Trigger and ETOF Trigger is the same as the old one, so no improvement is necessary. The *ESC radial*, *ESC Etot disc*, will also use the old one. There is BSC trigger improvements, but this is not the topic here. There will be redesign of ESC front-end trigger and the design of *VC, ETOF, ESC match*.

2.1 Front-end ESC trigger

The ESC Front-end Trigger includes the *cluster search*, the *total energy sum* and the *total energy discrimination* for each block (A, B, C, D) The ESC structure is discribed in detail in [BES]. Considering the designed ESC electronics, a *cluster* is consisted of four cells, each cell consists of 24 wires. Each block gives one signal, there is *cluster* or no *cluster*. Each block cluster will be combined in the *ESC radial* circuit, and gives the ESC radial trigger condition, which is used mainly for neutral event trigger in the first level trigger.

The *total energy* for each block is obtained by the summing circuit. It's an anolog signal. The height of the signal represents the energy deposited in this block. The energy signal for each block will be added together. And the added energy signal will be discriminated by the ESCetot_h threshold in *ESC Etot disc*, and gives the ESCetot_h trigger condition, which is used mainly for neutral event trigger.

The total energy for each block will be discriminated by the ESC block threshold, and gives the block hit information, which will be used in the matching logic (*VC ETOF ESC match*).

2.2 *VC, ETOF, ESC match*

If the track comes from the interaction point, it will hit the VC, (possibly the inner part of MDC), ETOF, ESC consequently. That is to say, if there is a track hit in VC, there should be adjacent hits in ETOF and ESC. Fig3 shows the schematic plot of VC, ETOF, ESC matching. The matching of VC, ETOF, ESC can suppress the background trigger by the random hits in VC, ETOF and ESC. The east ETOF matchs with east ESC, and west ETOF matchs with west ESC. This matching gives three trigger conditions: *One Track*, which means at least one matched hit in VC, ETOF and ESC; *One Paired Track*, which means at least one track in the east endcap and one track in the west endcap; *Two Tracks*, which means at least two tracks in the Endcaps (east or west). Among the three condition, *One Track* is the loosest, and *One paired Track* is the tightest.

3 Endcap trigger setting

3.1 Possible trigger conditions

The possible endcap trigger conditions are:
ETOF: *ETOF_BB*, $N_{ETOF} \geq 1$, $N_{ETOF} \geq 2$;
VC: $N_{VC} \geq 1$, $N_{VC} \geq 2$;
ESC: *ESC_Radial*, *ESC_etot_h*;
MET: *One Track*, *One Paired Track*, *Two Tracks*.
MET means Matched Endcap Track.

3.2 Endcap trigger types

Considering the background level and trigger efficiencies, the trigger types would be:
HADRON: $N_{VC} \geq 1$ & $N_{ETOF} \geq 1$ & MET
NEUTRAL: ESC_Radial & ESC_etot_h
LUMI: ETOF_BB & MET & ESC_etot_h
Where & means "AND". HADRON is mainly for charged events. NEUTRAL is mainly for purely neutral events, and it can trigger some charged events. LUMI is a tight selection of endcap Bhabha events, which is used for the endcap luminosity measurement. This setting can be easily changed to adapt to the datataking conditions.

4 Improvement over the old system

Comparing with the old trigger system, the main improvements are: The amplification factor is 5 for the total energy deposited in ESC. In the old system, the amplification factor is only 1. There

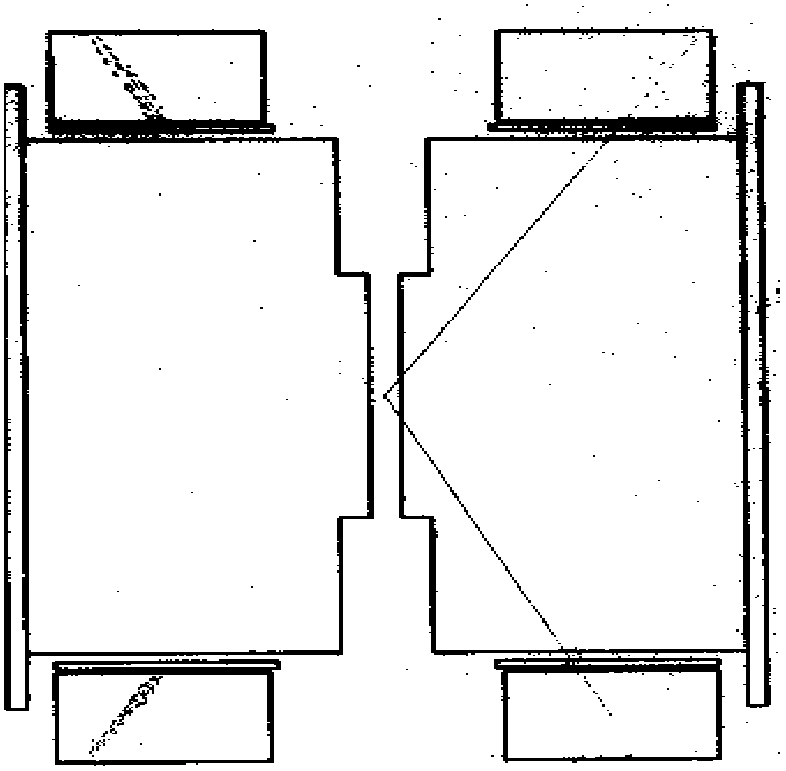

Figure 1: Endcap of BES: VC, MDC, ETOF, ESC

will be relatively lower cable pick-up noise; ESC_Radial is designed. This will make the endcap pure neutral events trigger possible; *VC ETOF ESC matching*, this will lower the combinatorial background by the random hits in VC, ETOF and ESC; Threshold setting. The threshold will be set by the online computer. In the old system, some threshold is set by an adjustable resistor in the BES hall, so the threshold adjustment will be easier and faster.

5 Time table for the upgrade

Before September, 1998, all the new boards will be designed and produced. After September and the BES-II setup, the endcap trigger will be tuned for datataking.

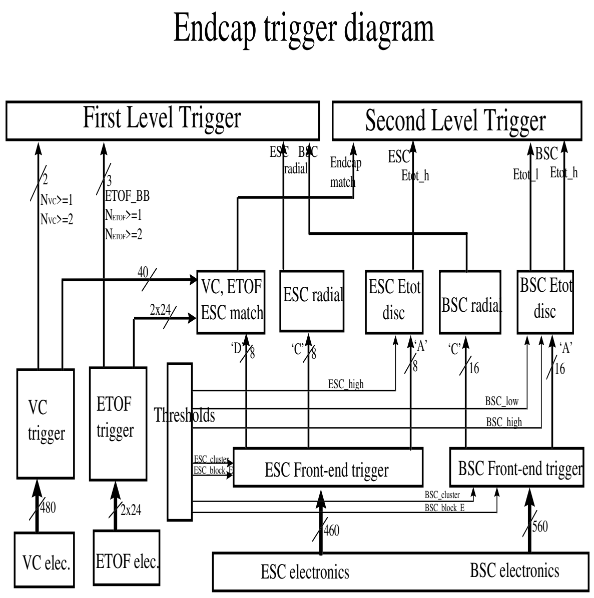

Figure 2: Schematic of Endcap trigger for BES

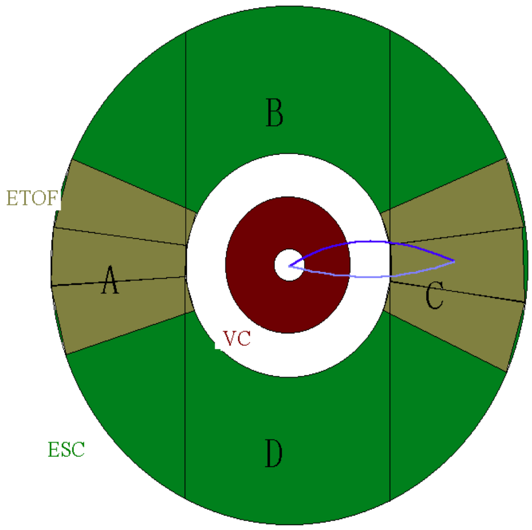

Figure 3: ESC cluster definition