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TRIGGER FOR DECAYS OF B-MESONS PRODUCED AT 20 TeV

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1. Introduction. A magnet spectrometer can be considered at present as a most spreaded type of the detector at high energy experiments on extracted beams. Such kind of detector on the SSC accelerator is expected to be used, which is to be constructed in USA in the nearest future. The efficiency of operation of this detector highly depends on a selection criteria, used for registered events, i.e. on trigger.

It has been shown earlier /1/,/2/, that one can use rather a simple trigger for selection charmed particles decays at 70 GeV and B-meson at 3 TeV. In the present paper we are investigating the possibility to apply the same trigger for B-meson registration at the SSC accelerator.

2. Simulation. As in paper /2/ for simulation of events the packages PYTHIA and TWIST were used. On the first stage, with PYTHIA the banks of events were created with information about secondary products of proton-proton interaction at 20 TeV. For each event of the bank three components of momentum of each particle as well as its mass and identificator were written. Two banks of events were created. The first one contained all the events with no selection. A total number of events in this bank was 12,000. The second bank contained only events with B-mesons production. In this bank 2,000 events were written.

On the second stage with the help of package TWIST the decays of unstable particles were simulated and charged secondary particles were traced through the spectrometer. In this paper we assumed (like in paper /2/) that B^0 and $\overline{B^0}$ are decaying via the following channels

$$\begin{array}{l} B^0 \rightarrow \psi + K^0_S \rightarrow \pi^+\pi^- \\ \quad\;\; \hookrightarrow \mu^+\mu^- \end{array} \qquad (1)$$

$$\begin{array}{l} \overline{B^0} \rightarrow D^*\mu^-\nu_\mu \\ \qquad\;\; \hookrightarrow D^0\pi^+ \\ \qquad\qquad \hookrightarrow K^-\pi^+ \end{array} \qquad (2)$$

Decay mode (1), chosen for B^0-meson, is interesting from a theoretical point of view, since it has connection with the CP-violation problem. For the $\overline{B^0}$ meson mode (2) is one of the most probable modes.

An experimental setup, which charged particles were traced through, in main features coincided with the SFT-spectrometer /5/. The essential point for our calculational results is a location of the magnets, their apertures and magnetic fields. The main part of results was obtained with two magnets configuration of the spectrometer. However, some results are presented also for the case of additional magnet, placed immediately after the target.

A total number of drift chambers as well as their locations is not important for our analysis. To generate a trigger signal, information from only one coordinate plane is used, which is placed just after the second (the last) magnet. We do not discuss here the specific type of this decision making plane; it could be either the drift chamber plane, scintillator or the Cherenkov counters hodoscope.

3. Selection criterion. Like in Refs. /1/ and /2/, the proposed selection criterion is based on two common features of events with a high mass production. These events are characterized by rather a wide cone of decay products and by comparatively high momenta of these products. The combination of both these features is essential. If, for example, one uses only wide cone sign, the majority of the selected events would consist of background with soft particles which directed backward in the center of mass system (so-called target fragmentation events). On the other hand, selection only by high momentum value would provide background events related to beam fragmentation. The selection of high-momentum secondary particles proceeds in magnetic spectrometer quite naturally. Soft particles are rejected by the magnetic field and due to this reason, the decision-making hodoscope should be placed after the second (or, better to say, last one) magnet. The magnetic field is directed vertically (along the Y-axis), so the charged particles are deflecting in a horizontal plane. Due to this reason, the information about initial decay cone is conserved only in the Y-plane, hence the trigger hodoscope should measure Y-coordinates of the particles.

The above-said gives a general idea of the trigger. The events with high mass production should have the coordinates in the trigger hodoscope at rather a large distance from the central horizontal plane. One can imagine different realizations of the idea. In Ref. /1/, for example, the following selection rule was suggested: at least two charged particles in event should have Y-coordinates in the horizontal plane no less than some definite value d. One of these particles should be directed upward from the horizontal plane and another - downward.

In the Ref. /2/, together with this criterion, another criterion, more powerful one, was tested. For its realization, one has to measure the distances of all particles hits in the hodoscope plane from the central line of the hodoscope and to summarize them. Then one has to select those events, which have the sum greater, than some definite value.

At the present work we apply this criterion.

4. The results. The possibility of practical realization of such a type of trigger is demonstrated on Fig.2. For each event a particle is chosen, which has a biggest Y-coordinate in the hodoscope plane (by absolute value). The distribution of these extreme coordinates is presented on Fig.2 both for background and B-events. We are interested only in qualitative comparison of these distributions, so they are presented in arbitrary scale. One can see that two distributions on Fig.2 are very different. The background distribution has maximum at Y=0 and the shape like gaussian, whereas B-events distribution has minimum at Y=0 and two symmetrical maxima approximately at Y=±20 cm.

As was said above, as a selection criteria we suggest to use the sum of absolute values of all coordinates in the hodoscope for given event ($S=\Sigma |Y_i|$). Two relevant distributions of the S-value are presented on Fig.3. One can see, that selecting events, for which S is greater than some threshold value S_{min}, we can reject the essential part of background. For some chosen S_{min} the ratio B-events to background is Q times higher. At the same time some part of B-events is lost. In Fig.4 the dependence of Q-factor on S_{min} is shown. Also, losses of B-events are presented.

The calculations, the results of which are presented on Fig.2,3,4 were performed for the case of spectrometer with two magnets and field in each of them was 15 kGs. It's point of interest also, what is dependence of such a kind of the trigger on the magnetic field. On Fig.5 we present a factor of enrichment Q versus the percentage of survived B-events. The curves (1) and (2) correspond to two-magnet setup with field in each of them 15 kGs and 28 kGs, respectively. For instance, for the threshold S_{min}, at which 50% of B-events survive, factor of enrichment Q would be around 8 for 15 kGs field and around 14 for 28 kGs. If there is third magnet, placed just after the target with field 60 kGs, one can get

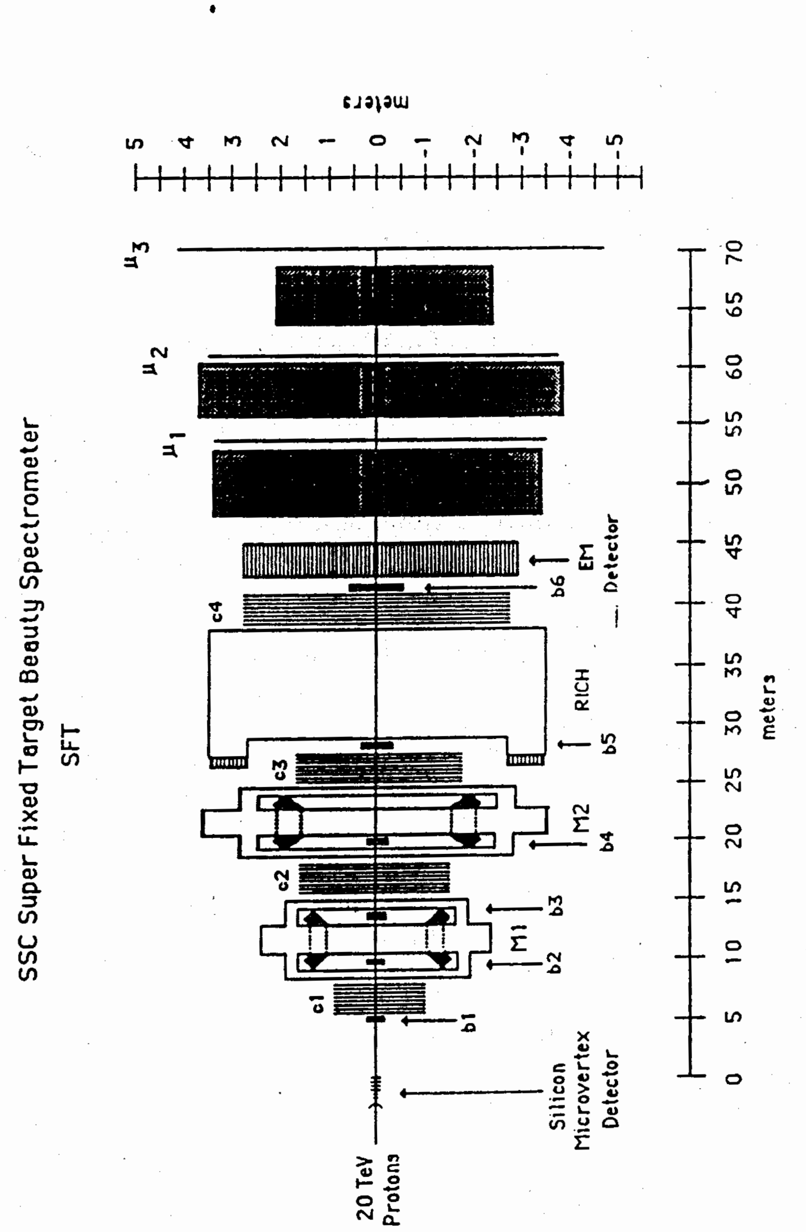

Fig.1. The SFT spectrometer experimental setup.

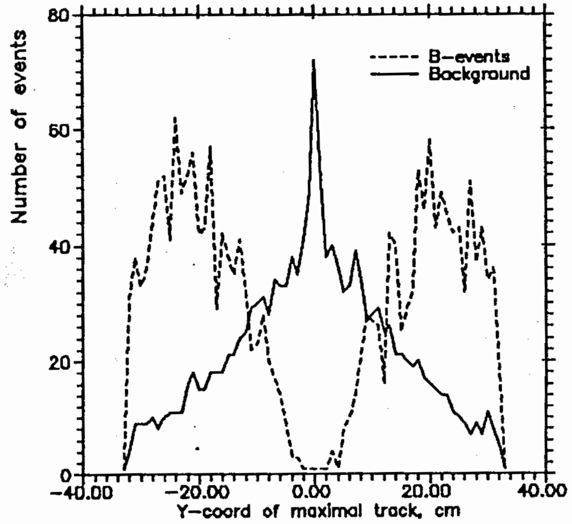

Fig.2. The distribution of the of the extreme Y-coordinate in the decision-making plane.

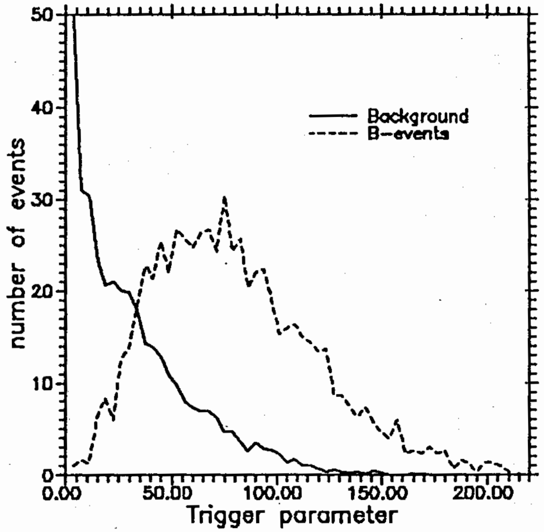

Fig.3. The S-value distribution for B-events and for background.

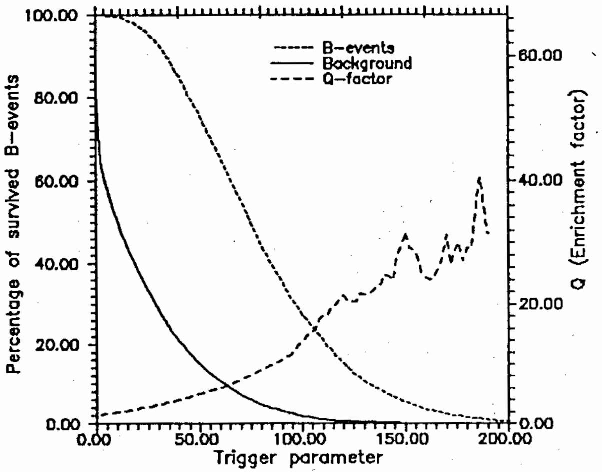

Fig.4. The dependance of Q-factor and losses of B-events on S_{min}.

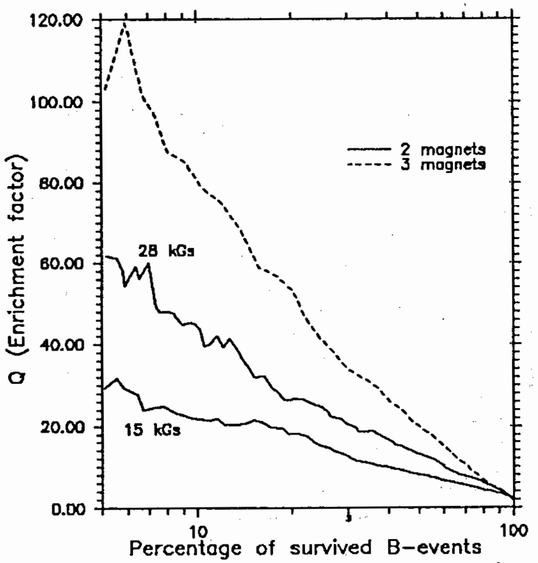

Fig.5. Q-factor versus percentage of survived B-events at different magnetic fields.

enrichment factor Q=20 at the same losses of B-events. Fields of two others magnets were taken as 15 kGs.

The following conclusions can be done on the base of the present work and Refs. /1/ and /2/:

1. There exists rather a simple possibility to improve signal-to-background ratio in magnetic spectrometer experiments with charmed and beauty mesons by factor of ten, or around that.

2. Kinematical characteristics of heavy particle decay, allowing to get this gain are quite stable, because the same effect was found in the energy range from 70 GeV to 20 TeV and various methods of simulating both background and useful events.

3. One can hope that such a trigger might be useful for registration of any heavy particle decays and its efficiency would be the higher the more energy is released at the decay.

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