DISCLAIMER

PRELIMINARY RESULTS FROM FERMILAB E789

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Abstract

Fermilab experiment 789 studies low-multiplicity decays of neutral D and B mesons in a high-rate fixed-target environment. Preliminary results from the 1991 run are presented.

INTRODUCTION

Experiment 789 at Fermilab was designed to measure low multiplicity decays of B mesons produced in a high rate fixed target environment. The existing E605/E772 spectrometer, which was used in previous experiments to detect hadron and lepton pairs with good mass resolution and high rate capability, was significantly upgraded for E789 (Figure 1). In particular, a silicon microstrip vertex spectrometer and a vertex trigger processor were installed. The main goals of the E789 experiment are 1) to measure the B production cross section at 800 GeV via the detection of inclusive $B \to J/\psi + X$ decays, 2) to search for charmless dihadron decay modes such as $B \to \pi^+\pi^-, K\pi, K^+K^-, p\bar{p}$. The sensitivity for these measurements clearly depends on the rate capability of the spectrometer and on the performance of the silicon microstrip detectors in this high rate environment (which is similar to those anticipated in future SSC experiments). Preliminary results from analysis of a fraction of the data taken in the 1991 fixed target run are presented in this paper.

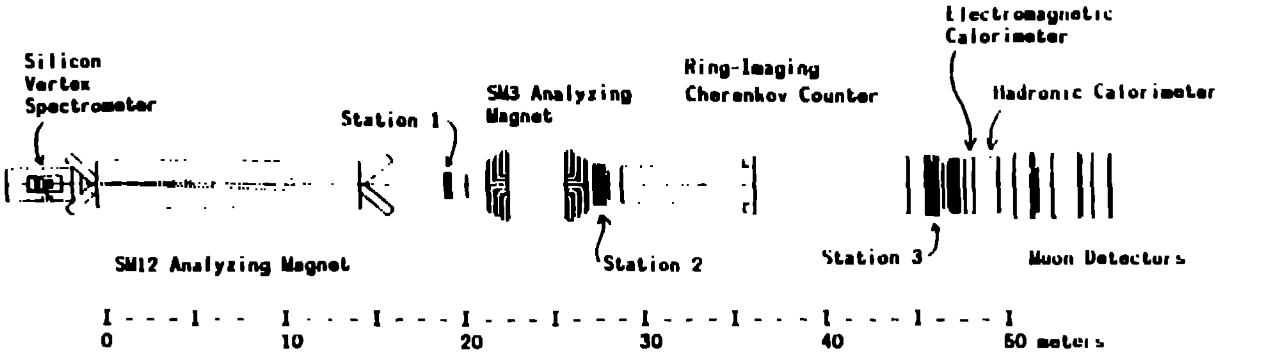


Figure 1. E789 apparatus (plan view).

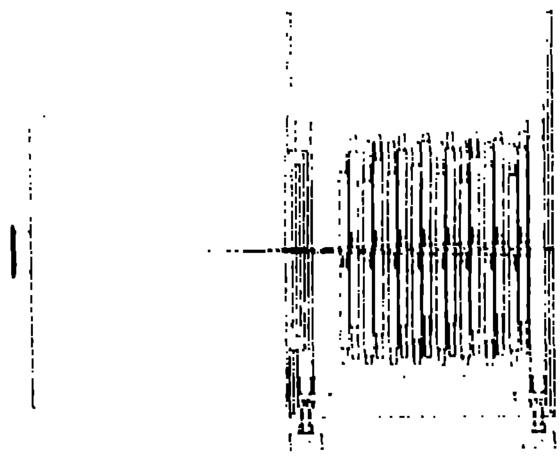


Figure 2. E789 silicon spectrometer.

SUMMARY OF E789 1991 RUN

During the 1991 run, an 800 GeV proton beam was incident on one of several thin wire targets, ranging from 0.1 mm to 0.2 mm high and 0.8 mm to 3 mm thick. Sixteen silicon microstrip detectors (SMD's) were positioned downstream of the target to cover the angular range from 20 mr to 60 mr above and below the beam axis (Figure 2). The silicon detectors, type 'B' from Micron Semiconductor, have 5×5 cm^2 area, 300 μm thickness, and 50 μm pitch. The SMD's were oriented to measure either the Y (vertical) or the U,V coordinates (5° stereo angle). Signals from 8,544 silicon strips were individually read out via Fermilab 128 channel amplifier cards[1] and LBL discriminators[2] synchronized to the accelerator RF. The discriminated signals were then transmitted through 400 ns of multiconductor cable to coincidence registers. A vertex processor[3], which finds tracks in the silicon detectors and selects events with decay vertices downstream of the target, was also implemented and functional. The use of a thin target localizes the primary interaction vertex and greatly simplifies the design of the vertex processor, which only needs to determine the decay vertex.

Two different settings of the spectrometer, which separately optimize the acceptance for charm or beauty decays, were used in the 1991 run. The charm running served to check the performance of the SMD's and the vertex trigger processor. In addition, the nuclear dependence of D meson production was measured on beryllium and gold targets, which should provide information related to the origin of the J/ψ A dependence observed[4] in E772 at the same beam energy. The vertex

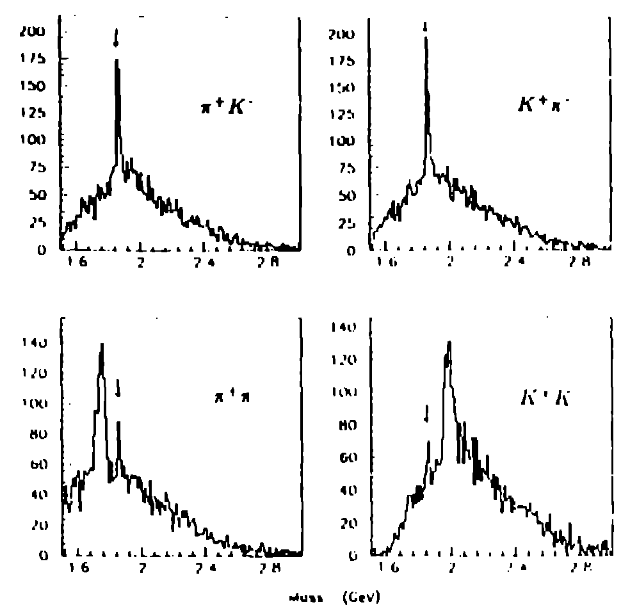


Figure 3 Mass spectra for dihadron events reconstructed with various assumptions for the hadron species. The arrows indicate the D decay peaks.

trigger processor and the upgraded data acquisition system enabled us to take up to 10^{10} protons per beam spill on a 1.5 mm-thick gold target (4 MHz interaction rate).

For the beauty running, the spectrometer was set at a configuration to accept both $B \to J/\psi X$ and $B \to h^+h^-$ decays. We took data at 5×10^{10} protons per pulse on a 3-mm-thick gold target, corresponding to a 50-MHz interaction rate, without using the vertex trigger processor.

PRELIMINARY RESULTS FROM E789

Figure 3 shows the dihadron mass spectra obtained from an analysis of ≈ 10 % of our charm data sample. To effectively reject the dihadron background, we require that both tracks do not point back to the target, and that the proper lifetime is greater than 0.6 ps. The efficiency of each silicon plane is found to be better than 90 % and the impact parameter resolution of ≈ 30 μm gives a Z vertex resolution of ≈ 1 mm for typical D events. More details on the performance of the SMD's in this high rate experiment have been reported elsewhere[5]. Information from the ring-imaging Cherenkov detector has not yet been used for π/K identification, and the plots in Fig. 3 are obtained by assigning either pion or kaon mass to the hadrons. The $D^0 \to \pi^+K^-$, $\bar{D}^0 \to K^+\pi^-$, and $D^0, \bar{D}^0 \to \pi^+\pi^-$, K^+K^- decays are clearly visible in Fig. 3. Although the D^0 mass resolution shown in Fig. 3 is ≈ 10 MeV, more recent studies show that a 5 MeV mass resolution is obtained with an improved field map of the analyzing magnet.

Figure 4 shows the dimuon mass spectrum from a preliminary analysis of ≈ 15 % of our beauty data sample. Good silicon tracks are required for events shown in Fig. 4, but no vertex cuts are applied. Approximately 15,000 J/ψ and 300 ψ' events are observed. To search for $B \to J/\psi X$ events, the impact parameters of both muon tracks are required to be greater than 150 μm and the decay vertex is required to be at least 7 mm downstream of the target (7 mm < Z_{decay} < 5 cm). Fig. 5(a) shows that

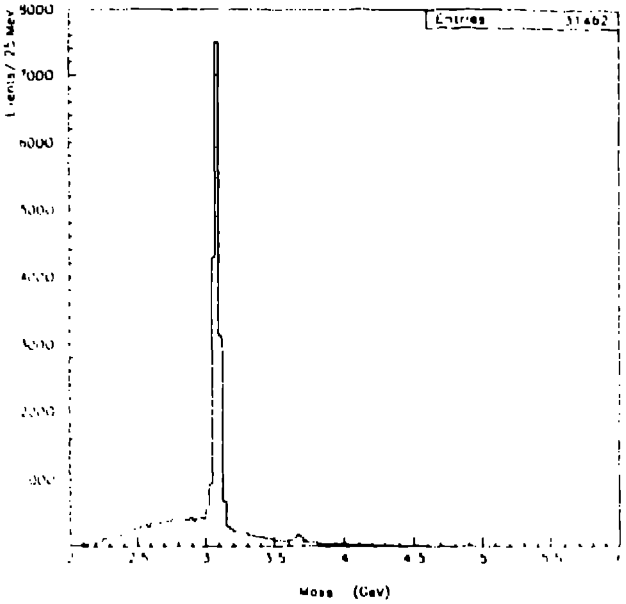
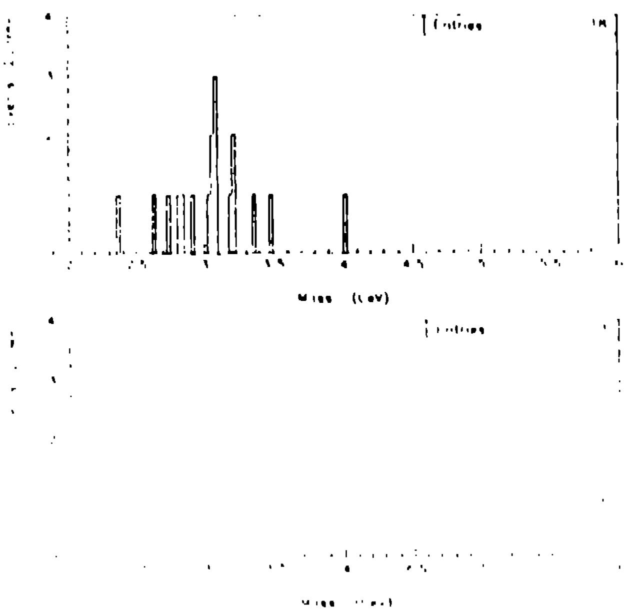


Figure 4. Mass spectrum for dimuon events.



F[illegible] Ma[illegible] dimuon event[illegible] [illegible] upstream Z vertex [illegible]

a total of eighteen events, six of them in the J/ψ mass region, survive these cuts. These six events are considered candidate events for $B \to J/\psi X$ decays. To estimate the background which might be caused by silicon tracking errors, we also select events with decay vertices upstream of the target, namely - 5 cm $< Z_{vertex} <$ - 7 mm. Fig. 5(b) shows that this background is unimportant. More data need to be analysed before a more definitive b signal and b-production cross section can be obtained.

In summary, the E789 experiment explores the feasibility to study b-physics in a high-rate fixed-target environment. Preliminary results show that the silicon vertex spectrometer works well. Six $B \to J/\psi X$ candidate events were observed from an analysis of $\approx$ 15 % of the dimuon data sample.

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