## RESULTS ON B-PHYSICS FROM UA1

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**ABSTRACT**

**New results on B-physics from the UA1 experiment at the CERN proton -antiproton collider are reported. They are based on the data collected in 1988-89, corresponding to a total of 4.7 pfcr' integrated luminosity. The B°B° mixing parameter X has been measured to be 0.144±0.037. Upper limits for the branching ratios of the rare decays B -» u+u", B-» u+u"X, and Bd u+u" K*° have been determined. Some results on the search for the exclusive decay channels B~>Jyy+K*° and B->JA|/-Hj> are presented.**

### INTRODUCTION

**The cross section for the reaction**

$$pp\text{-»}bbX \qquad (1)$$

**is of the order of 10 \ib at Vs=630 GeV as measured by the UA1 experiment [1], UA1 can detect the production of b-quarks through their decay into muons with its large acceptance muon detector [1], capable of recording muons up to pseudorapidity T)=2. The momenta of the muons are measured through bending in the magnetic field, the momentum resolution being**

$$dp/p = 0.01p[GeV/c] \qquad (2)$$

**The cross section for reaction (1) with at least one of the b-quarks having transverse momentum larger than 6 GeV/c and pseudorapidity smaller than 1.5 was measured to 4.8 ± 1.7 mb [2]. This corresponds to 2.5x10⁷ events in the data collected by UA1 during the runs in 1988-89. Hence appreciable samples of b-events could be obtained even with detection efficiencies less than 10%.**

**The data have been used to determine the B°-B° mixing parameter % and upper limits for the branching ratios of rare decays of B°'s into muons. In addition, some results have been obtained for the exclusive decays of B°'s into JA|/ and K*° or <j>.**

### B° - B^ MIXING

**B°-B° mixing was discovered by UA1 in 1985 [3] through the excess of like sign dimuon events over the expected number of like sign events from B°B° production with a second generation charm decaying into a muon. The excess was interpreted as B°B°-events where one of the B's "mixes". The amount of mixing was estimated using the different shapes of the pt distributions of the muons from the primary B-decays and the secondary charm decays, respectively.**

**From this analysis %= 0.16 ± 0.06 [3] was obtained, where % is the fraction of events with a B° decaying into a wrong sign (negatively charged) lepton. The statistical and systematic errors contribute roughly equally to the total error.**

**In the analysis of the 1988-89 data a different, more sensitive method was used to separate the contributions of different processes to the dimuon events. Namely, the transverse momentum relative the b-jet axis, $p_t^{rel}$, was calculated for each muon. The distributions of $p_t^{rel}$ again have different shapes for the different processes contributing to dimuon events. With this method some statistics is lost because $p_t^{rel}$ cannot be defined for all events.**

**The value %= 0.144 ± 0.037 was obtained from the analysis. Since a large part of the measurement error still comes from statistics, we combine here the value**

from the 1985 analysis with the new result. This gives X= 0.15 ±0.03.

In order to determine the mixing parameter % separately for $B^{\circ}_{d}$ and $B^{\circ}_{s}$ the probabilities *U* and $f_s$ are needed that the beauty quark hadronizes into a B°d and a $B^{\circ}_{s}$ meson, respectively. By assuming $f_s$=0.18 and $f_d$=0.36 [3] we get the result shown in Fig. 1.

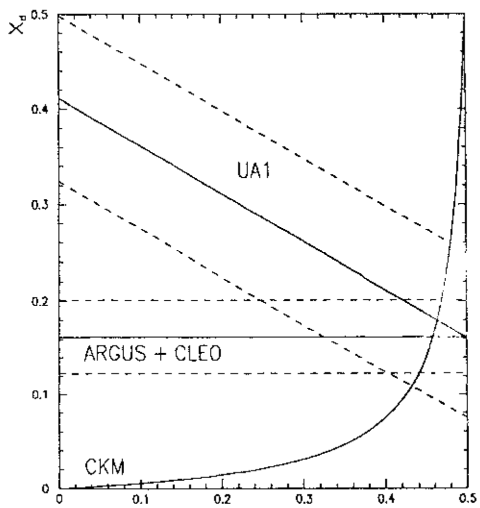


**Fig. 1. Plot of Xs vs.xd from UA1 (1985 and 1988-89 measurements combined). The combined value of xd f*°" CLEO and ARGUS as well as the region allowed by the present constraints from the CKM matrix are also shown.**

Combining the UA1 measurement with the measurement of *u* fr<>" ARGUS and CLEO a 90% CL lower limit Xs= 0.12 is obtained. By combining this with the CKS matrix constraint the limit becomes much higher.

SEARCH FOR RARE B-DECAYS

In the Standard model the decays

B-*|i+|T (3)

B -» Jl+Ji-X, (4)

are forbidden at the tree diagram level as flavour changing neutral current processes. They are possible through higher order mechanisms described by "penquin" and box diagrams.

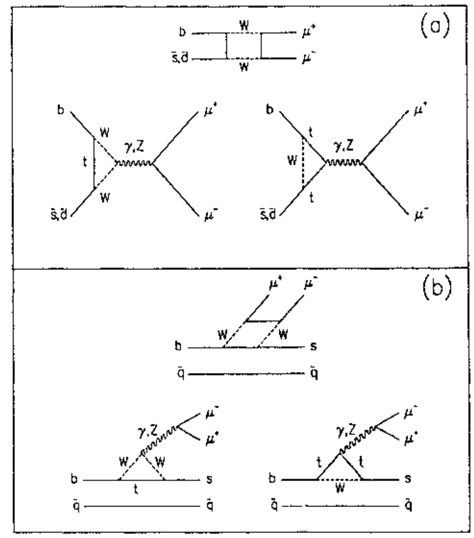


**Fig. 2a. The diagrams contributing to the decay B -> u+u" (a) and to the decay B -» u+u"X, (b).**

The branching ratios predicted by the minimal standard model are $10^{-9}$ for reaction (3) and 10"5 for reaction (4).

The best experimental upper limits for the branching ratios so far are from CLEO and ARGUS, $5x10^{-5}$ for reaction (3) and 2.4x10-**3** for reaction (4) [4].

B-mesons can decay into a muon pair also through the channels

B->JA|f + X (5)

B~> y' + X (5')

The branching ratio for decay channel (5) is three orders of magnitude larger than for the non-resonance decays. The amplitudes of channels (5)-(5') and of channels (3) and (4) can interfere, leading to structures in the dimuon mass distribution near the J/y and masses [5].

The data sample used to look for decays (3)-(4) was chosen from the data collected with the dimuon trigger. Combining the 1985 and 1988-89 runs gives a total of 5.3 $pb^{-1}$ integrated luminosity.

To reduce the fake muon background the transverse momenta of the muon candidates were required to be larger than 3 GeV/c. In order to obtain a uniform efficiency and maximum sensitivity for channels (3) and (4) the transverse momentum of the dimuon system was required to be larger than 7 GeV/c. This selection leads to 331 events, for which the dimuon mass distribution is shown in Fig. 3.

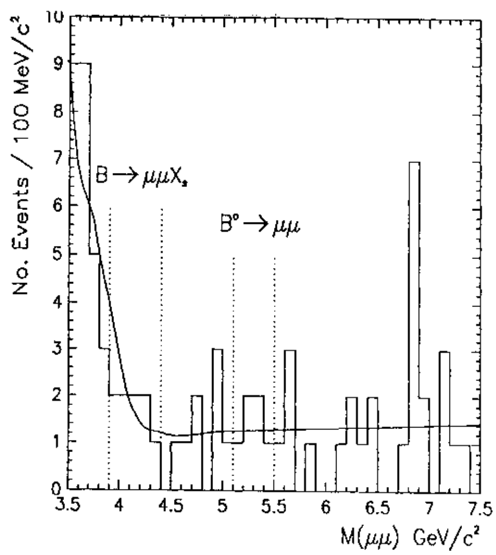


Fig. 3 Mass distribution of the U-+U- system.

This mass distribution was parametrized with a function linear in plus two gaussians for J/y and y, respectively, also shown in the Fig 3.

In order to search for decay (3) we looked for enhancements in the dimuon mass around the mass of the Bdor the $B_s$ meson (we use m(Bd) =5.28 GeV/$c^2$ and assume m($B_s$)= 5.38 GeV/$c^2$). The mass interval between 5.1 and 5.5 GeV/$c^2$ was chosen corresponding to the estimated mass resolution in this mass region. No signal is seen in that region in Fig.2. There are 6 events in this mass bin while the fit to the dimuon mass distribution gives a background estimate of 5±1 events. The acceptance for the production of a B-meson and its decay into channels (3)-(5) was estimated with ISAJET and a full detector simulation Monte Carlo program. For channel (3) the acceptance 4% was obtained. With these numbers the upper limit $8\times10^{6}$ is obtained for the branching ratio at 90% CL. Note that the limit applies for $B°_s$ and $B°_d$ together.

When searching for process (4) we wanted to avoid the interference effects with channel (5) and therefore limited our search to the mass region 3.9 GeV/$c^2$ < < 4.4 GeV/$c^2$ above the y ' resonance. No excess of events is seen in this case either. There are 9 events in the chosen mass bin to be compared to an estimated background of 8.7±1.7 events. The acceptance is 1.110.5%. This gave an upper limit for the branching ratio of $5.0\times10^{5}$ at 90% CL, which is three orders of magnitude more stringent than the result from CLEO. Here again the branching ratio is for an unseparated mixture of Bd, B* and $B°_s$.

We also looked for the exclusive decay process

$B_d$ - > ^ - K * ° (6)

Here the mass window was kept the same as above but the dimuon transverse momentum cut was relaxed to 4 GeV/$c^2$ because of the additional constraints on the K*. In order to pick up the K*° decays we selected the events with at least two tracks in the central detector having $p_t$ > 100 MeV/c within a cone AR<1 around the dimuon system. For further enhancement of the K* signal the $p_t$ of the Ktc system was required to be more than 2 GeV/c and the momentum of the kaon more than half of the momentum of the pion. We looked for the signal of channel (6) within ±40MeV/$c^2$ of the K* mass (896 MeV/$c^2$) and within ±0.2 GeV/$c^2$ of the $B_d$ mass. Two events were observed. The background was estimated to be 2.8±0.7 events and the acceptance 2.3%. This gave an upper limit 1.1x1O"$^5$ for the branching ratio at 90% CL.

Since the amplitude of channel (4) involves the mass of the top quark the upper limit for the branching ratio of of this channel can be used to set a limit for the mass of the top. This limit is independent of any earlier measured limits. Using the calculation of ref. [6] we obtained $m_{top}$ < 440 GeV/$c^2$ at 90% CL.

## DECAY CHANNELS B->J/y + K*°/Φ

We have also searched for the exclusive decay channels

B->J/f + K*° (7)

B->J/y + Φ (8)

To do this we first selected a sample of the inclusive decays

B->J/y + K*°+X (9)

by requiring the same cuts as for reaction (6). The Kπ invariant mass for the selected events is shown in Fig. 4

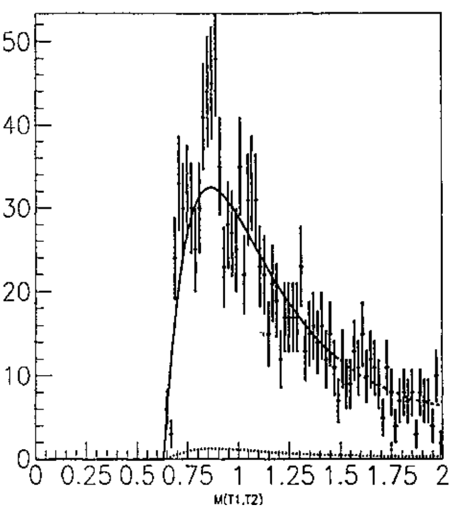


Fig. 4 Mass distribution of two oppositely charged tracks fulfilling the selection described in the text

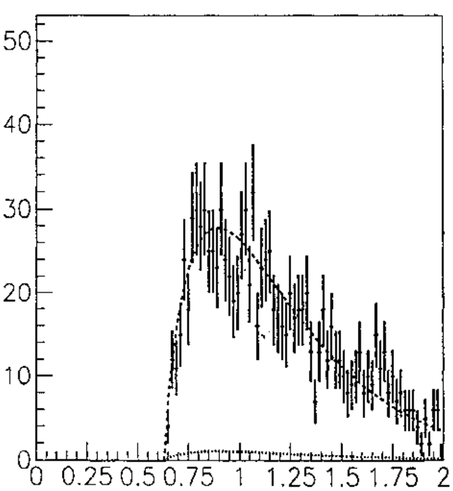

Fig. 5. Mass distribution of two same sign charged tracks fulfilling the selection described in the text

The background curve is determined by Monte Carlo simulation and agrees well with the mass distribution of two same sign charged tracks fulfilling the above cuts, shown in Fig. 5.

The K* signal is visible in Fig. 4. We next looked at the JA^Kπ mass. In Fig. 6. we plot the mass difference m(J/fKπ)-m(J/v|T).

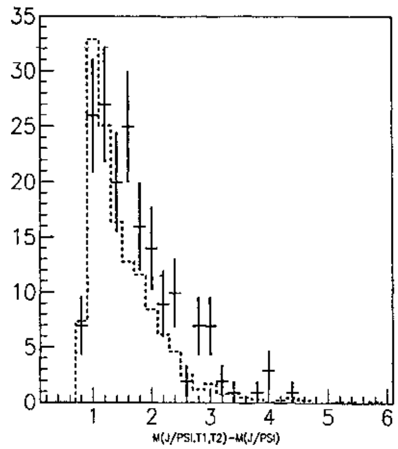


Fig.6. Distribution of the mass difference m(JA|(K7i)-m(J/y).

No peak is observed at the place of the K*, around 2.18 GeV/$c^2$. On the other hand, from the Monte Carlo calculation we expect 4 ± 3 events from decay channel (6) (the branching ratio $B_d$-> J/\|H-K*° = 0.11 ±0.05 ± 0.03 % from CLEO was used), which is consistent with the number of events in the K* region in Fig. 6.

To search for the Φ signal we looked for charged kaon tracks within the cone AR<1. around the b-jet axis. The expected number of events for channel (7), using the theoretical prediction 0.5% for the branching ratio and a Monte Carlo estimate for the acceptance, is *6*5.* This is consistent with one event found in the relevant mass bin.

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DISCUSSION

*Q.* **H. Newman** *(Caltech):* In searching for rare *B* decays involving inclusive pairs, do you see off-shell photons from final state radiation from the quarks? Is the background from these /x"*>~ pairs understood?

A. **J. Tuominiemi** : Yes, we have studied the low mass spectrum exclusively and it is well understood. We have published results on it earlier.