Wrong-sign $D^0 \to K^+\pi^-$ Signal

Text for the blessed web page – CDF note 7116

The CDF Collaboration

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Abstract

We present four plots demonstrating the signal for $D^0 \to K^+\pi^-$ + c.c. decay channel. Assuming no CPV or D-mixing, this mode is the doubly-Cabibbo suppressed decay.

Using the approximately 60 pb^{-1} of integrated luminosity taken by CDF II from February 2002 through January 2003, the signal is 254 ± 47 (stat.) events. By comparison, the Cabibbo favored decay ($D^0 \to K^-\pi^+$) has over 200 times as many events.

The analysis is leading towards a measurement of D-mixing. These plots are an intermediate step, showing that CDF has a clear signal. No systematic errors have been calculated.

1 Description

Between February 2002 and January 2003, CDF II collected approximately 60 pb^{-1} of integrated luminosity, using the hadronic decay trigger. While designed for bottom mesons, the trigger is also efficient for charm mesons. This analysis uses charm mesons to investigate D-mixing.

We reconstruct D^0 decaying to a kaon and a pion. An additional pion is attached to form D^* candidates. "Right-sign" (RS) mesons are where both pions from the D^* have the same charge. The Cabibbo favored decay $D^0 \to K^-\pi^+$ is right-sign. "Wrong-sign" (WS) mesons are where both pions from the D^* have opposite charge. The doubly Cabibbo suppressed decay $D^0 \to K^-\pi^+$ is wrong-sign.

An investigation of D-mixing requires knowing how the number of RS and WS D^0s change over time. D-mixing is expected to be very small, unlike kaon and bottom meson mixing. Experimental results have set upper limits on mixing parameters. An easier measurement is the time-integrated ratio of WS to RS D^0s, making the assumption that there is no CP violation or mixing going on.

A major source of background is from RS D^0s, where the kaon and pion are misassigned to form a WS candidate. Events consistent with RS D^0s are excluded from WS plots, and events consistent with WS D^0s are excluded from RS plots.

The plots presented show a clear WS signal from the CDF data being used. We want these plots blessed, to demonstrate the capabilities of the CDF II detector, and to have images that can be shown when discussing the analysis with people outside the CDF collaboration. No systematic errors have been calculated for these plots.

The analysis will use data collected from February 2002 through August 2004, using improved analysis code and calibrations. That sample should provide a publishable ratio of time-integrated WS/RS D^0s, with systematic errors. The time-dependent study is also planned. That part of the analysis is outside the scope of these plots being presented.

2 Blessed Numbers

This section summarizes the numbers which are to be blessed for this analysis.

Using the approximately 60 pb^{-1} of integrated luminosity taken by CDF II from February 2002 through January 2003, the $D^0 \to K^+\pi^- + c.c.$ signal is 254 ± 47 (stat.) events. By comparison, the Cabibbo favored decay ($D^0 \to K^-\pi^+$) has over 200 times as many events.

3 Blessed Figures

The following figures are to be blessed for the wrong-sign signal. More text can be found in CDF note 7116.

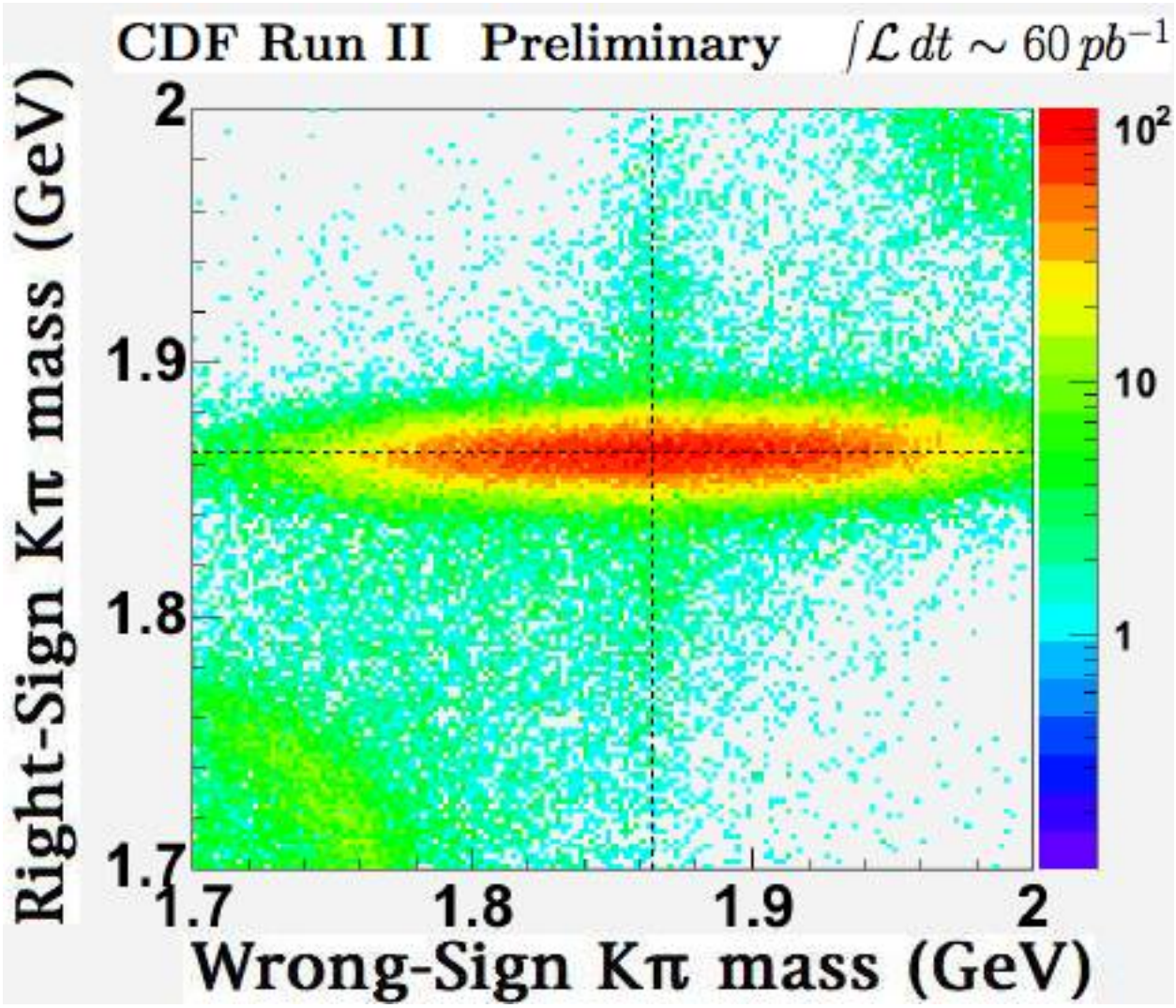


Figure 1: $K\pi$ events plotted with both RS and WS mass interpretations.

For the first figure, the dashed lines are the PDG D^0 mass of 1.8645 GeV. A cut requiring a good (WS) D* tag is used to reduce background. The bins are 3 MeV wide, along each axis. The brown regions are used to get the WS signal. The mass window (along the x-axis) is narrowed to prevent contamination from $D^0 \to KK, \pi\pi$ events that populate the upper right and lower left corners. The middle region is excluded to reduce background from RS D^0s.

For the second figure, the PDG values for the D^0 and D^* are shown by the dashed lines. The $K\pi$ axis is in 2 MeV bins, the mass difference $(m_{K\pi\pi^*} - m_{K\pi} - m_\pi)$ axis is 0.5 MeV

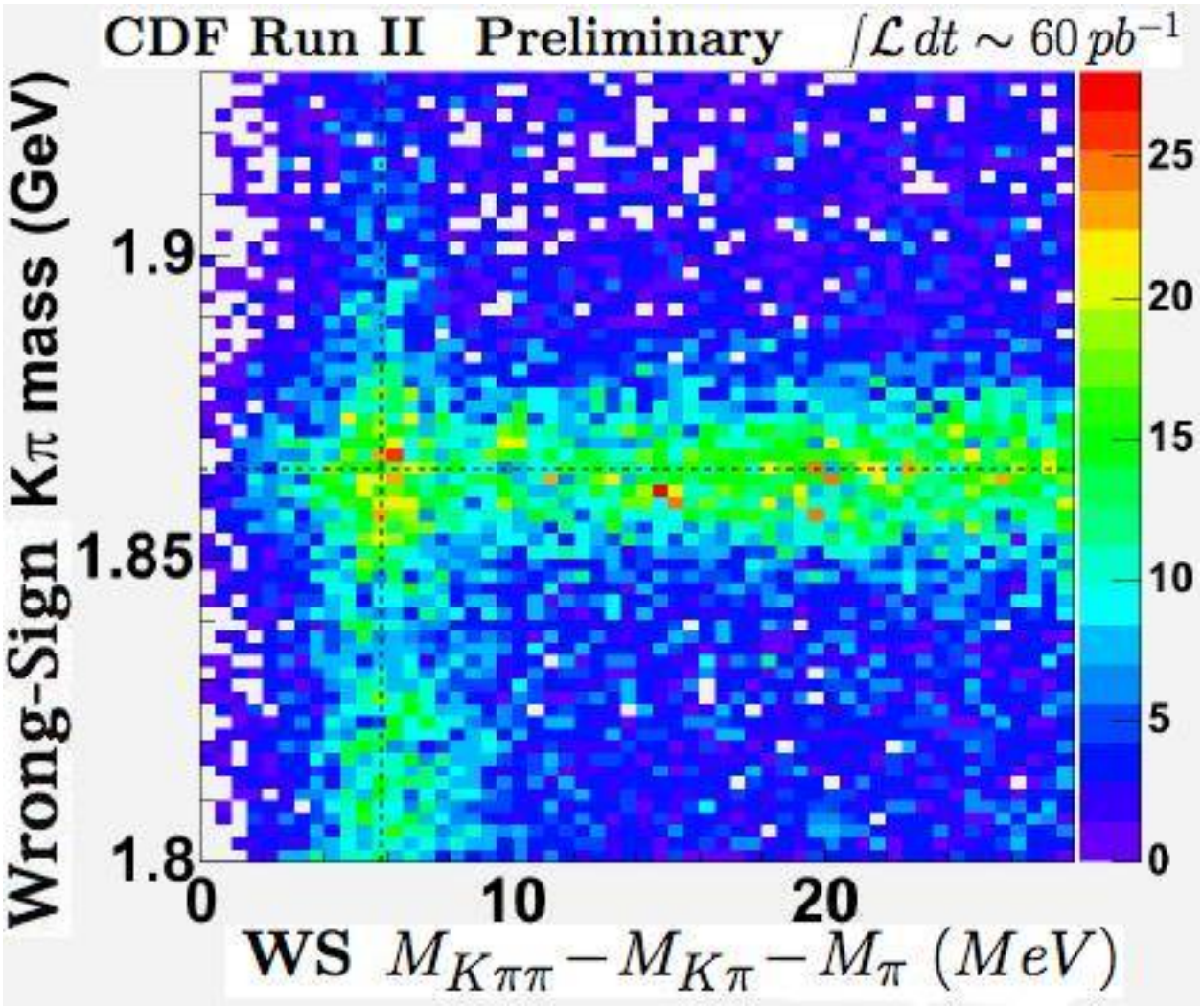
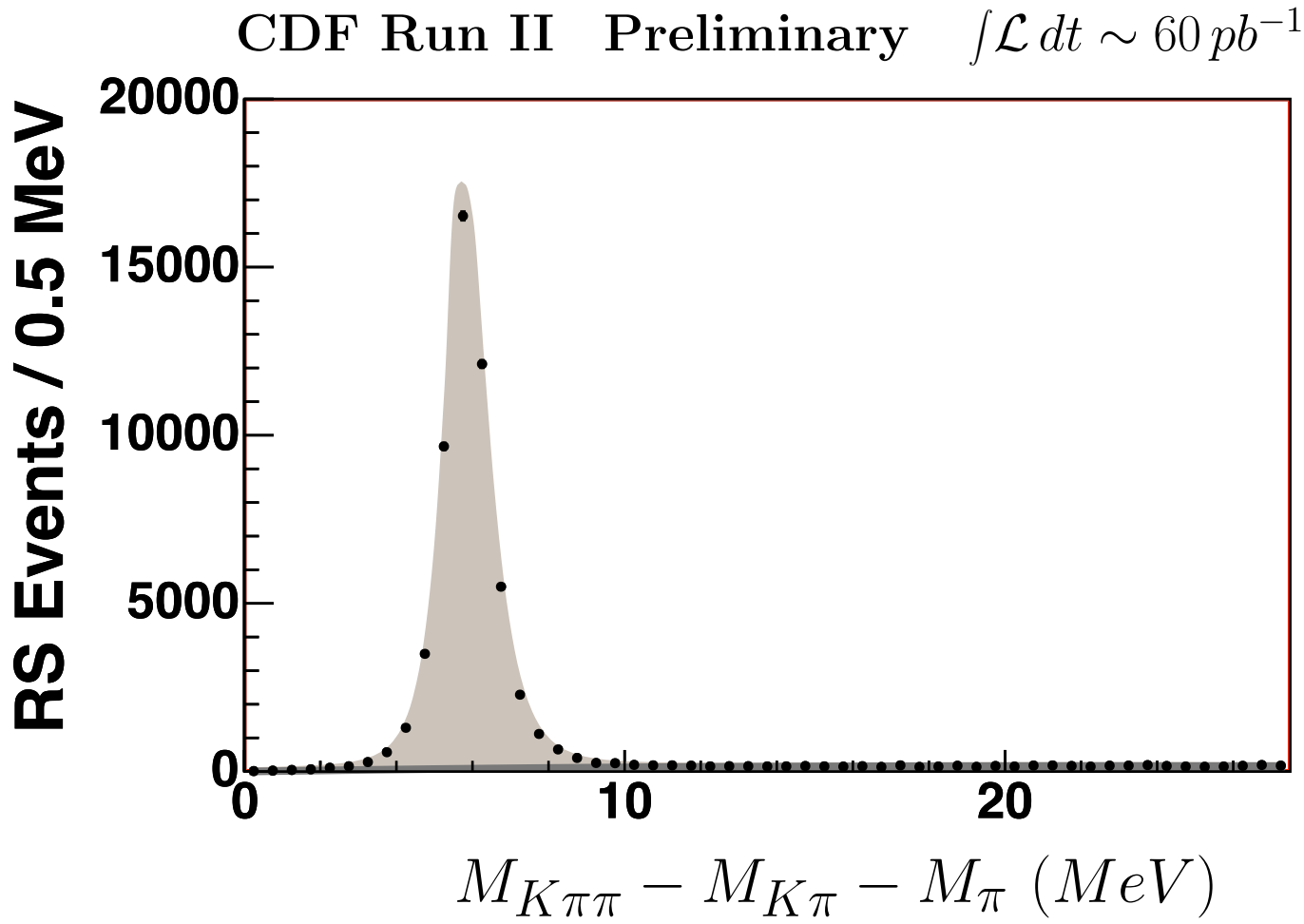


Figure 2: WS $K\pi$ mass versus D^* Mass Difference

bins. Events consistent with RS D^0s have been excluded. The background in the horizontal band are from real D^0s that are falsely tagged as WS D^*s due to an unassociated pion track being attached. The background in the vertical band are from real D^*s, where the D^0 does not decay to a kaon and a pion. (For instance, a possible source is $D^0 \to \pi^+\pi^-\pi^0$, where the π^0 is lost, and one of the pions is incorrectly assigned as a kaon.)

For the last two figures, the data is divided into slices of mass difference. For each slice, the $K\pi$ distribution is fit. The fit signal will give the number of real, correctly reconstructed D^0s. The signal yield for each slice is then plotted as a function of mass difference, with the error bars taken from the signal uncertainty of each slice. This leaves two possibilities: a real D^* (signal), or a D^0 with a fake tag (background). In the plots, light grey is the signal fit, dark grey is the background. The optimized cuts are described in detail in CDF note 7116.


CDF Run II Preliminary $\int \mathcal{L}\, dt \sim 60\, pb^{-1}$
RS Events / 0.5 MeV
20000
15000
10000
5000
0
0
10
20
$M_{K\pi\pi} - M_{K\pi} - M_{\pi}\ (MeV)$

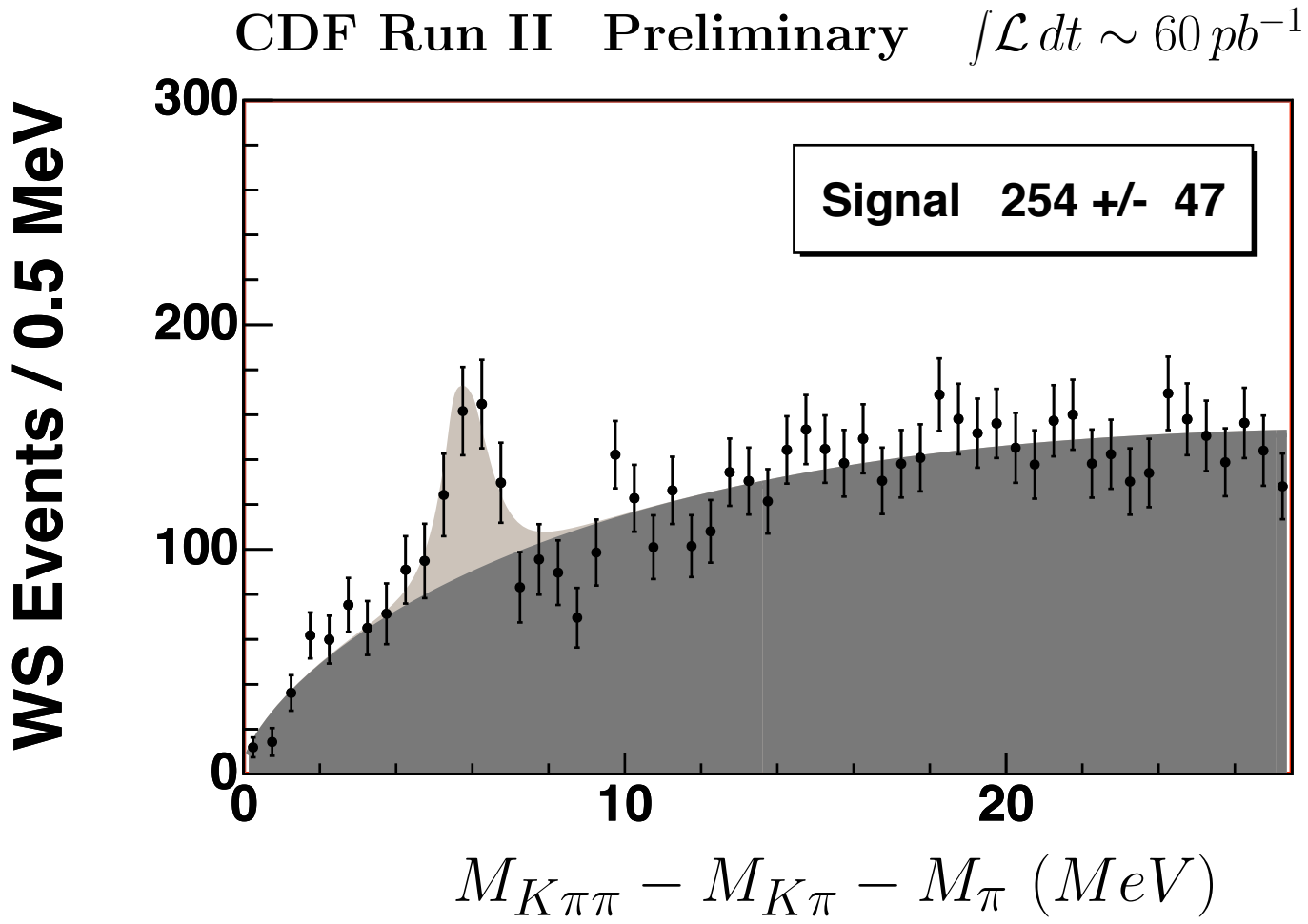


Figure 3: D* yields for RS and WS events