$D^*_{sJ}(2317)^+$, $D_{sJ}(2457)^+$ and limits on neutral D-meson mixing

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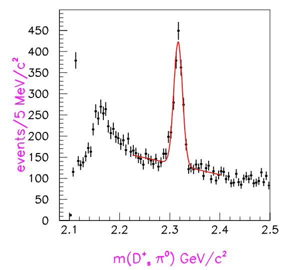
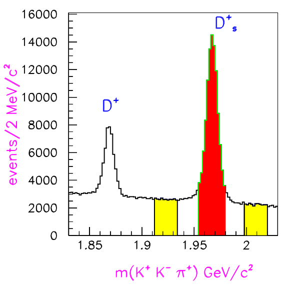
New States $D^*_{sJ}(2317)^+$ and $D_{sJ}(2457)^+$ Observed in *BABAR*

A new charmed meson with mass near 2.32 GeV/c²…

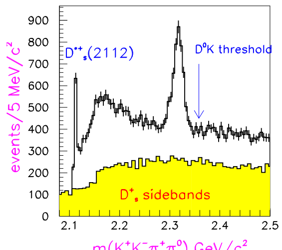
Results obtained from a 91 fb⁻¹ data sample recorded both on and off the Υ(4*S*) resonance by the ***BABAR*** detector at the PEP-II asymmetric-energy e^+e^- storage ring.



The $D^+_s\,\pi^0$ mass distribution has a very narrow peak near 2.32 GeV/c² which can be seen in the decay $D^+_s \to K^+K^-\pi^+$ shown at left [1]. The fit function drawn as a red line comprises a Gaussian function describing the 2.32 GeV/c² signal and a third-order polynomial background distribution function. The fit yields 1267 ± 53 candidates in the signal Gaussian with mass (2316.8 ± 0.4) MeV/c² and standard deviation (8.6 ± 0.4) MeV/c² (statistical errors only).



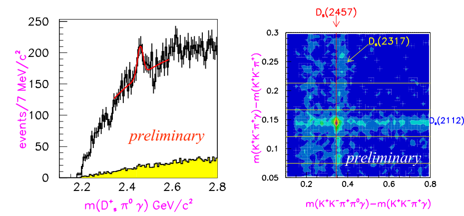
Also shown is the distribution of $K^+K^-\pi^+$ mass for candidates which pass selection cuts based on mass and helicity angle (|cos θ_h| > 0.5). The two decay channels $\phi(1020)\,\pi^+$ and $K^+\bar{K}^*(892)$ are selected. The D^+_s signal peak, consisting of approximately 80,000 events, is centered at a mass of (1967.20 ± 0.03) MeV/c² (statistical error only). The D^+_s sideband regions are colored yellow.



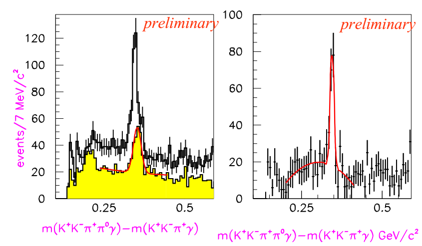
The $D^+_s\,\pi^0$ mass distribution for candidates in the D^+_s signal and $K^+K^-\pi^+$ sideband regions is shown at left.

[1] B. Aubert *et al*. [BABAR Collaboration], "Observation of a narrow meson decaying to D/s+ pi0 at a mass of 2.32-GeV/c**2,, Phys. Rev. Lett. **90**, 242001 (2003) [arXiv:hep-ex/0304021]

… and another near 2.46 GeV/c² !



The mass distribution for all selected $D^+_s\,\pi^0\gamma$ combinations shows a peak near 2.46 GeV/c²; the yellow region is from D^+_s sidebands. A scatter plot of mass differences shows that this peak lies at the intersection of two bands: $D^*_s(2112) \to D^+_s\gamma$ decay combined with unassociated π^0 candidates (horizontal band) and $D^*_s(2317) \to D^+_s\,\pi^0$ decay combined with unassociated γ candidates (nearly vertical band).

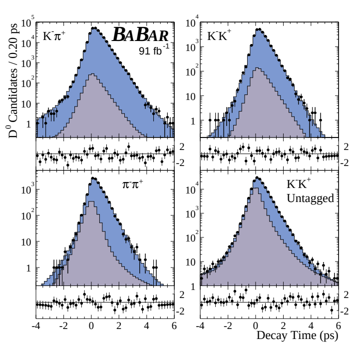


Events in the $D^*_s(2112)$ signal region (white) are plotted with events from $D^*_s(2112)$ sideband regions (yellow) to reveal an enhancement over a background from $D^*_s(2317)$ combined with a γ candidate. This background peaks at a mass slightly higher than the signal. The background subtracted plot shows a narrow signal which we label $D_s(2457)$.

A preliminary analysis based on the shape of the $D^+_s\,\pi^0$ and $D^+_s\gamma$ distributions indicates that the most probable decay channel is through $D_s(2457) \to D^*_s(2112)\,\pi^0$ (producing a narrow $D^+_s\gamma$ distribution and a wide $D^+_s\,\pi^0$ distribution).

New Limits on D^0 Mixing from *BABAR*

Ratio of lifetimes from $K^-\pi^+$, K^-K^+, and $\pi^-\pi^+$ decays



to appear in Phys.Rev.Lett. (arXiv:hep-ex/0304021)

The decay-time distributions for four D^0 samples are used to search for mixing and possible *CP* violation. Let τ^0 represent the lifetime for the decays $D^0 \to K^-\pi^+$ and τ^+ (τ^-) represent the lifetime for D^0 ($\bar{D}^0$) into K^-K^+ or $\pi^-\pi^+$, we measure the level of mixing as

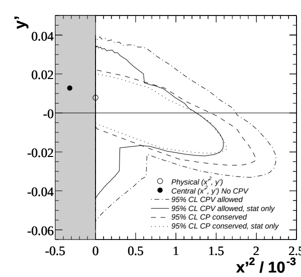
$$Y = \frac{\tau^0}{\langle\tau\rangle} - 1 \quad \langle\tau\rangle = (\tau^+ + \tau^-)/2$$

Sample	Y (%)
K^-K^+	$1.5 \pm 0.8 \pm 0.5$
$\pi^-\pi^+$	$1.7 \pm 1.2\,^{+1.2}_{-0.6}$
Untagged K^-K^+	$0.2 \pm 0.5\,^{+0.5}_{-0.4}$
Combined	$0.8 \pm 0.4\,^{+0.5}_{-0.4}$

Lifetime distribution of $D^0 \to K^+\pi^-$ decays

The "wrong sign,, decay $D^0 \to K^+\pi^-$ can occur either through a doubly Cabibbo-suppressed process or through mixing. At right is shown 95% confidence contours for the level of mixing consistent with a maximum likelihood fit of the decay-time distribution of wrong-sign decays. Mixing is measured through the parameters x'^2 and y', defined in the equation below for the proper time signal distribution. $T_{RS}(t)$ is proportional to an exponential decay.

$$T_{\mathrm{WS}}(t) = T_{\mathrm{RS}}(t)\left(R_{\mathrm{D}} + \sqrt{R_{\mathrm{D}}}\,y'\,t + \frac{x'^2 + y'^2}{4}t^2\right)$$



submitted to Phys.Rev.Lett. (arXiv:hep-ex/0304007)