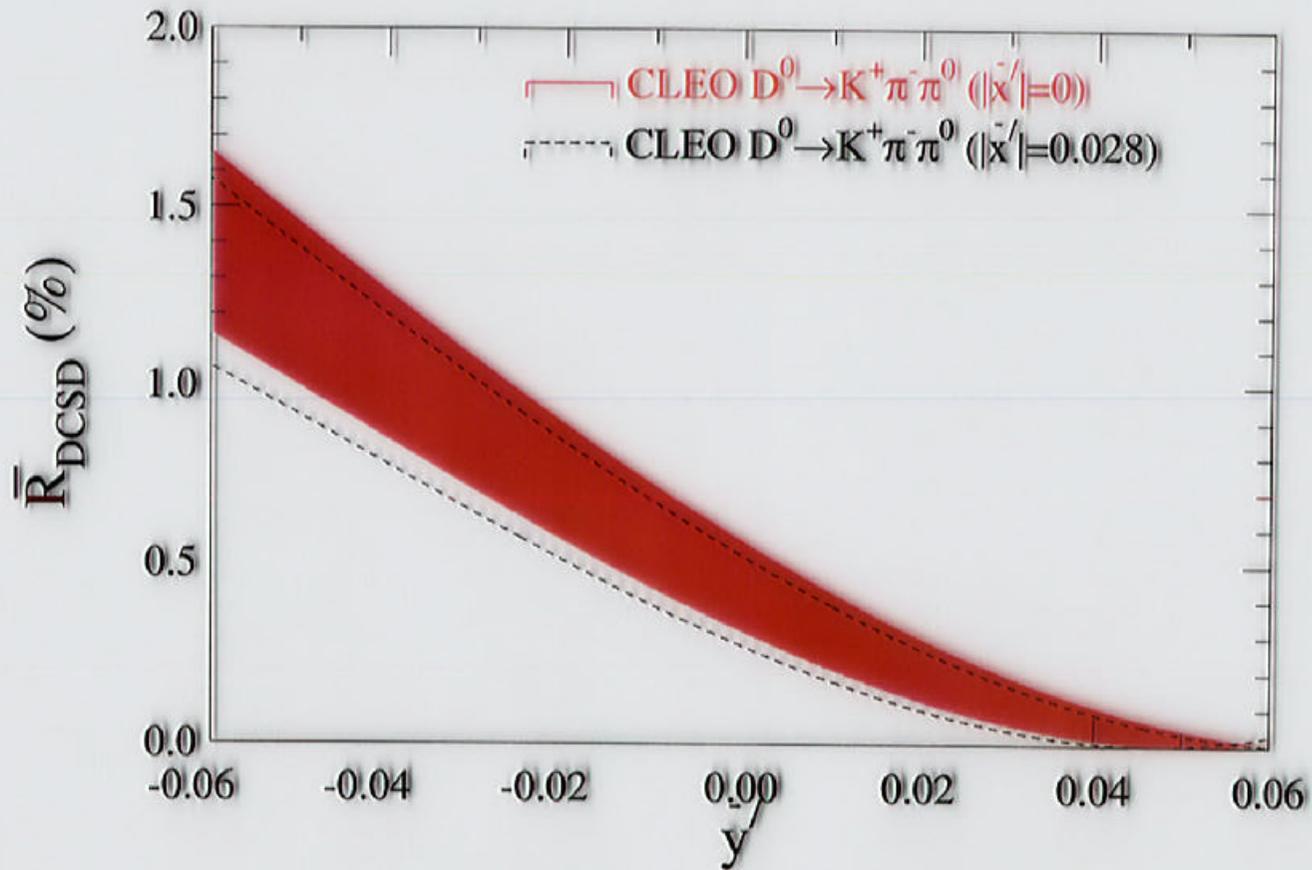
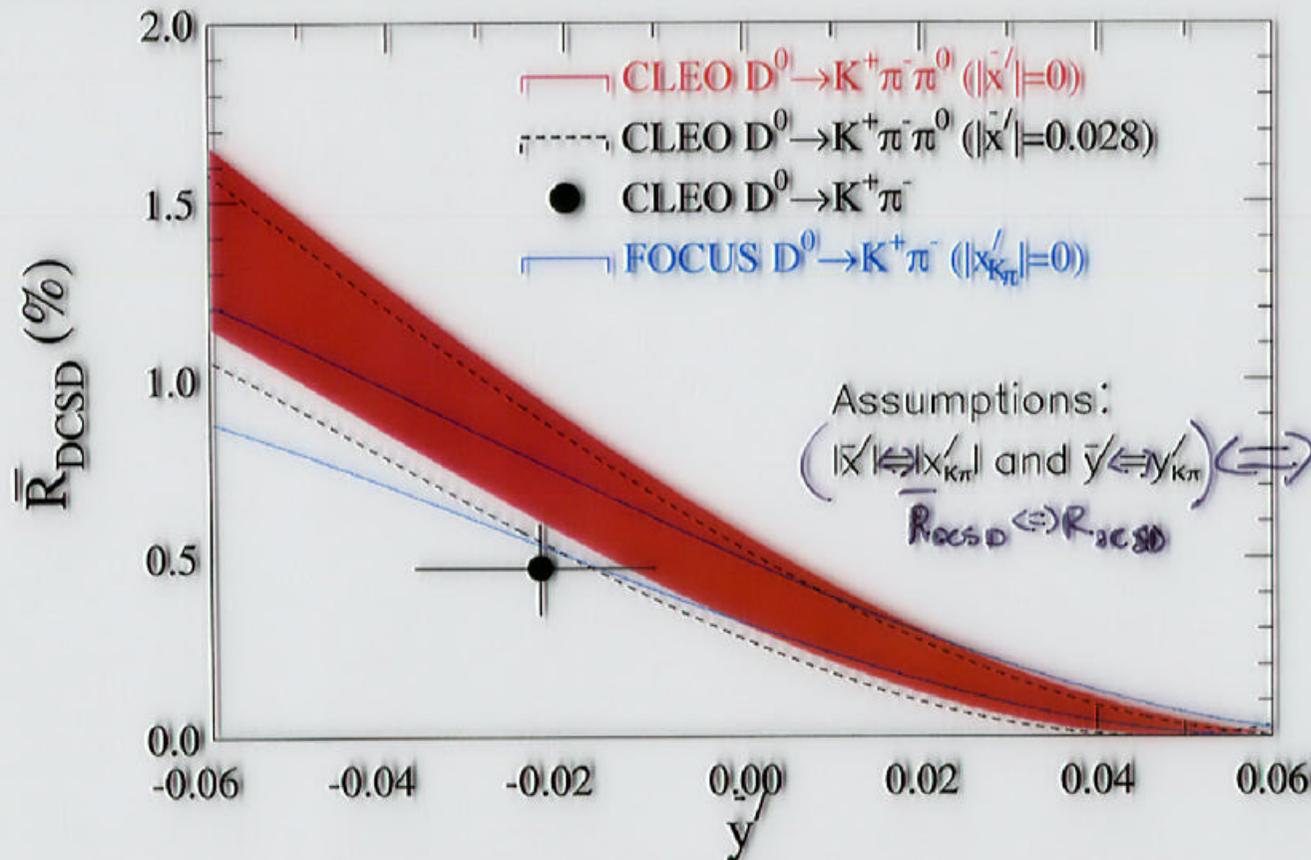


Mixing and DCSD Limits



Mixing and DCSD Limits

Note: If $D^0 \rightarrow X \rightarrow K\pi\pi^0$ and $D^0 \rightarrow K\pi$ do not have the same strong phase, then x' , y' , and R_{DCSD} are not necessarily the same variables for different decays



Searches for Direct CP Violation in D^0 Decays

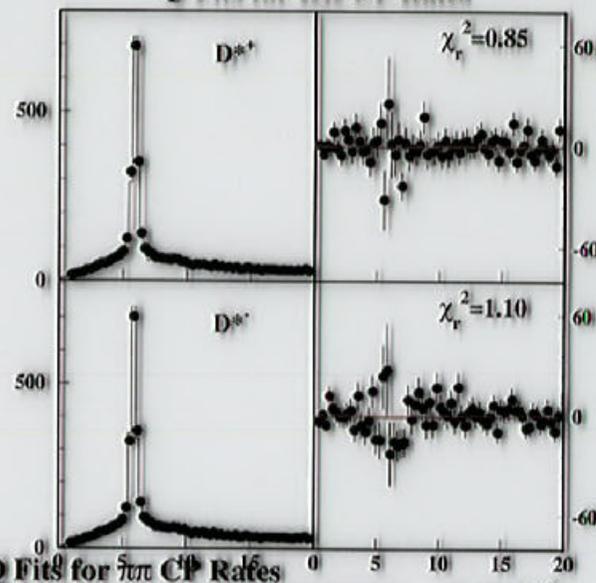
- Cabibbo-suppressed charm decays are a good place to look for non-Standard Model effects:
 - Expected to be small in Standard Model
 - Multiple paths to same final state with a weak phase difference
 - Large final state interactions likely
 - Enhance CP violation
- Search in the channels: $D^0 \rightarrow K^+K^-$, $\pi^+\pi^-$, $K_S^0\pi^0$, $\pi^0\pi^0$, and $K_S^0K_S^0$
- Experimentally, we measure the asymmetry for final state f :

$$A = \frac{\Gamma(D^0 \rightarrow f) - \Gamma(\overline{D^0} \rightarrow f)}{\Gamma(D^0 \rightarrow f) + \Gamma(\overline{D^0} \rightarrow f)}$$

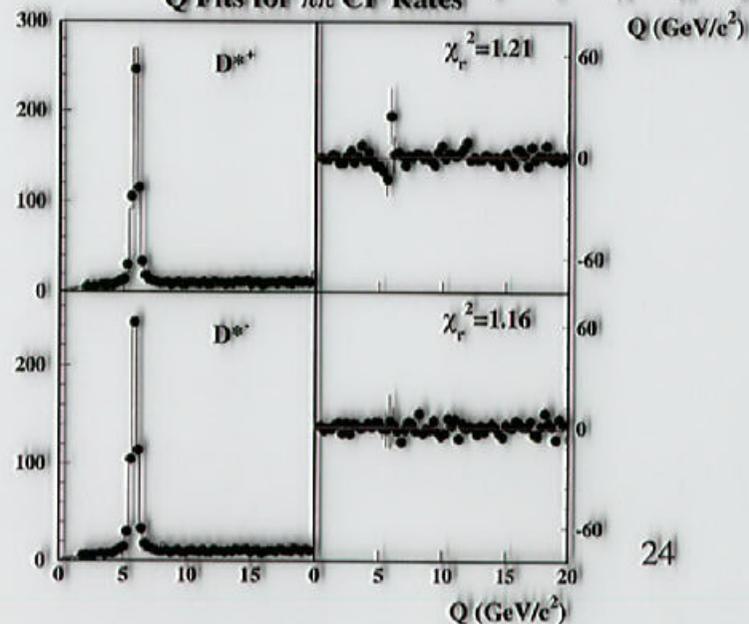
Searches for CP Violation in $D^0 \rightarrow K^+K^-, \pi^+\pi^-$

- D^0 flavor tagged by pion charge in $D^{*+} \rightarrow D^0\pi^+_{\text{slow}}$
- Refit π^+_{slow} through intersection of D^0 and run-averaged beam spot
- **Fit Q spectrum to obtain yields**
 - Monte Carlo simulation of backgrounds
 - Fit in bins of D^0 momentum
- Dominant systematic errors:
 - Fitting procedure (0.69%)
 - Reconstruction bias (0.48%)

Q Fits for KK CP Rates



Q Fits for $\pi\pi$ CP Rates



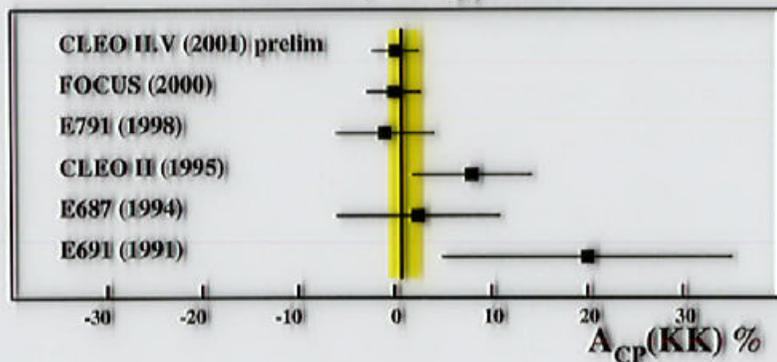
Searches for Direct CP Violation in $D^0 \rightarrow K^+K^-, \pi^+\pi^-$

$$A(K^+K^-) = 0.0005 \pm 0.0218 \text{ (stat)} \pm 0.0084 \text{ (syst)}$$

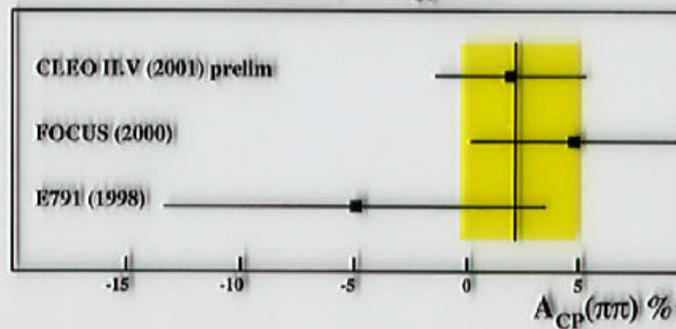
$$A(\pi^+\pi^-) = 0.0195 \pm 0.0322 \text{ (stat)} \pm 0.0084 \text{ (syst)}$$

Preliminary

Summary of $A_{CP}(KK)$



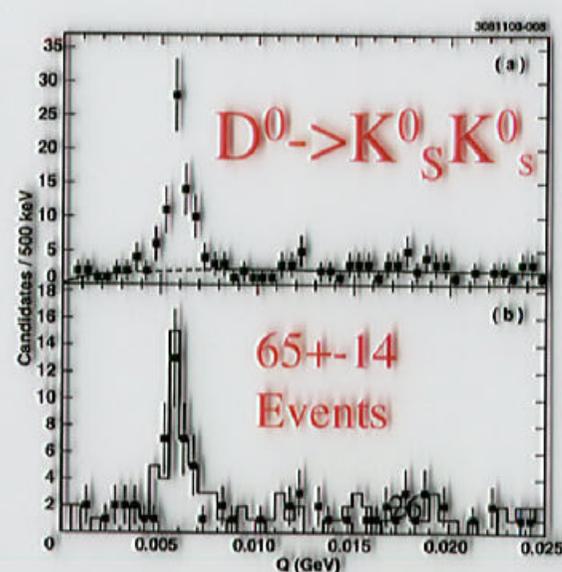
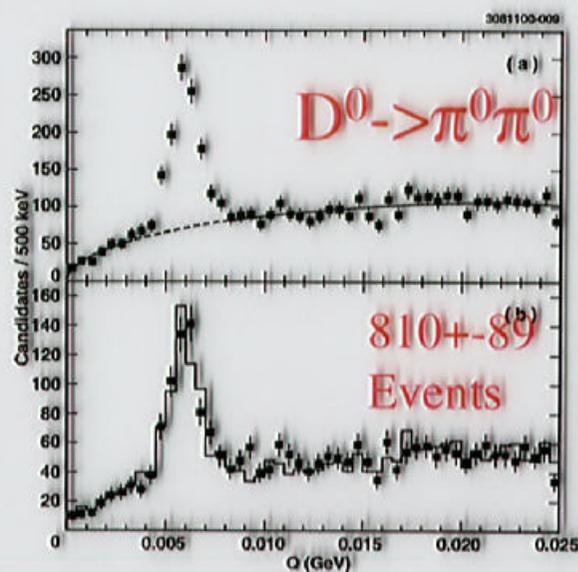
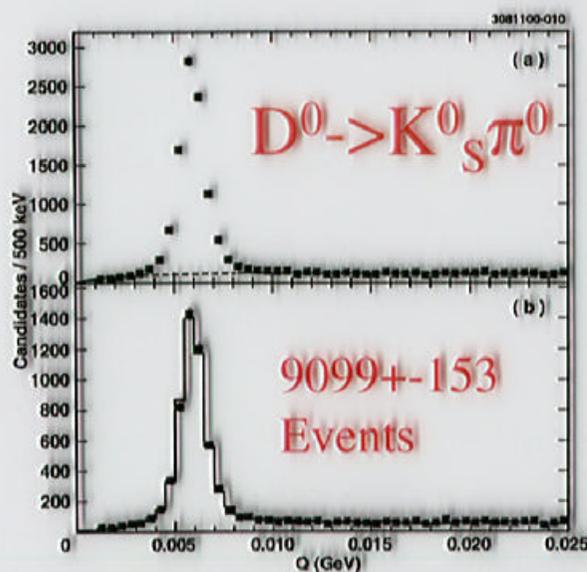
Summary of $A_{CP}(\pi\pi)$



Searches for Direct CP Violation in

$$D^0 \rightarrow K_S^0 \pi^0, \pi^0 \pi^0, \text{ and } K_S^0 K_S^0$$

- Do not have well-reconstructed D^0 direction to refit slow pion
- 13.7 fb⁻¹ from both CLEO II and CLEO II.V configurations
 - No benefit from silicon vertex detector in this mode
- Analysis method:
 - Reconstruct K_S^0 in $\pi^+\pi^-$ mode
 - Select candidate events near D^0 mass
 - Fit to Q side bands
 - Background subtract to obtain yields
 - Implicit assumption of no CP asymmetry in background



Searches for Direct CP Violation in

$$D^0 \rightarrow K_S^0 \pi^0, \pi^0 \pi^0, \text{ and } K_S^0 K_S^0$$

- Systematic errors: Potential false asymmetries from
 - Fit method: 0.5%
 - Background: 0.35% in $K_S^0 \pi^0$, 12% in $K_S^0 K_S^0$, negl. in $\pi^0 \pi^0$
 - Slow pion finding: 0.19%
- Asymmetry results:
 - Significant improvement over previous measurement in $K_S^0 \pi^0$ channel
 - First measurements in $\pi^0 \pi^0$, and $K_S^0 K_S^0$ channels

$$A(K_S^0 \pi^0) = (+0.1 \pm 1.3 \text{ (stat + syst)})\%$$

$$A(\pi^0 \pi^0) = (+0.1 \pm 4.8 \text{ (stat + syst)})\%$$

$$A(K_S^0 K_S^0) = (-23 \pm 19 \text{ (stat + syst)})\%$$

preliminary

Measurement of y Using CP-even Decays of D^0 to K^+K^- and $\pi^+\pi^-$

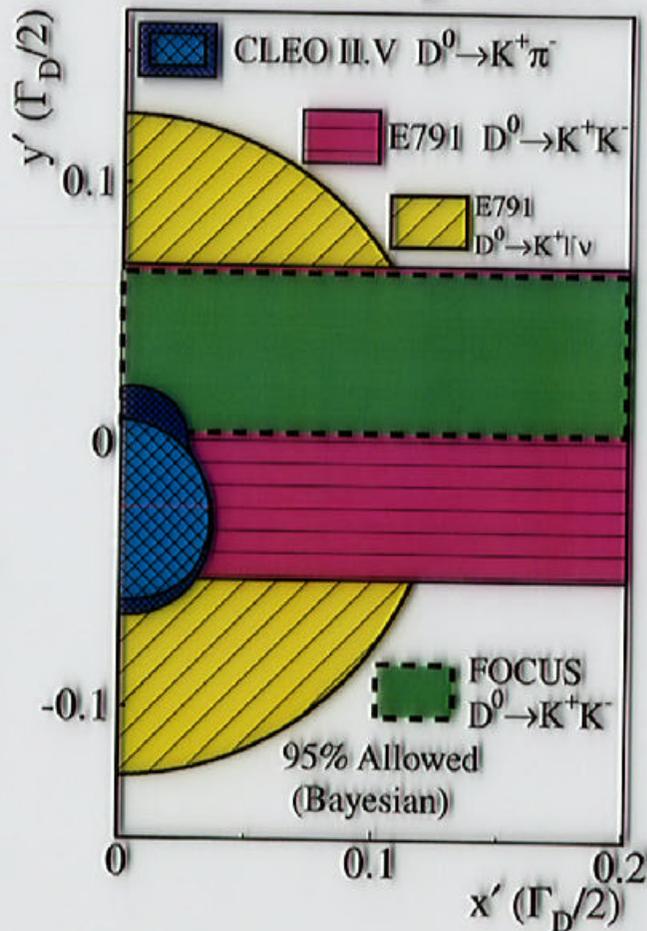
- Theorists trying to reconcile CLEO $D^0 \rightarrow K^+\pi^-$ and FOCUS $D^0 \rightarrow K^+K^-$ measurements

A. Petrov, hep-ph/0009160

- Possible explanations:
 - y of order few percent?!
 - Would be very surprising
 - Very large strong phase between Cabibbo-favored decay and DCSD (very large SU(3) symmetry breaking)
- Experimentally, we compare lifetime with well-measured $D^0 \rightarrow K^-\pi^+$ mode:

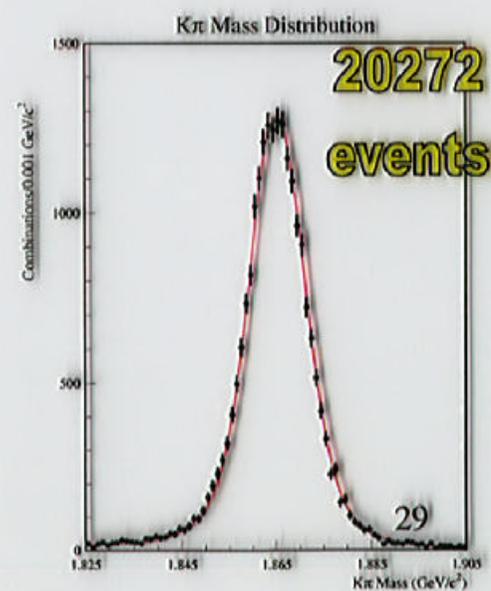
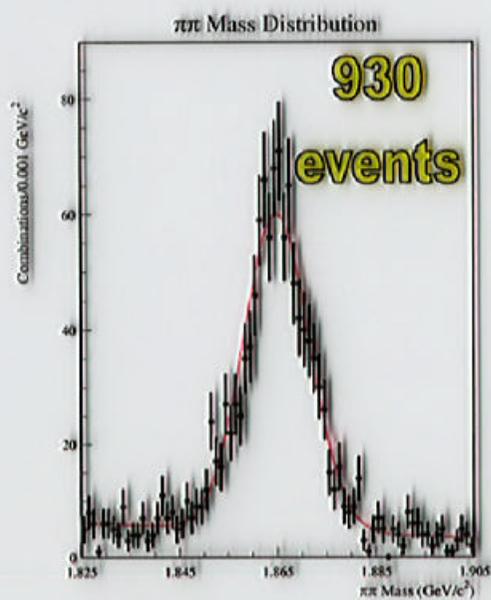
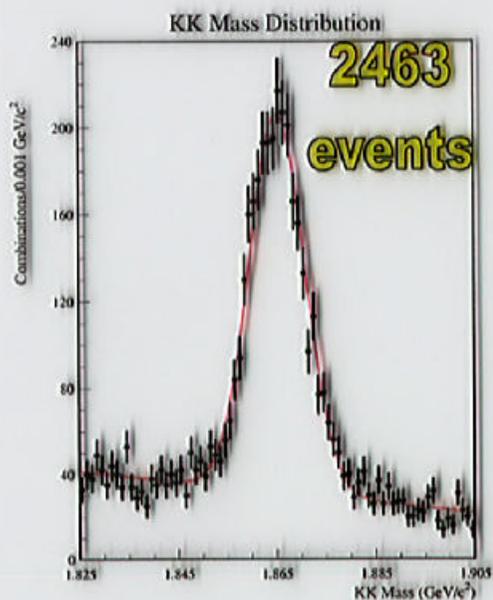
$$y = \frac{\tau_{\overline{CP}}}{\tau_{CP^+}} - 1, \quad \overline{CP} \equiv CP \text{ neutral state}$$

D^0 - \overline{D}^0 Mixing Limits

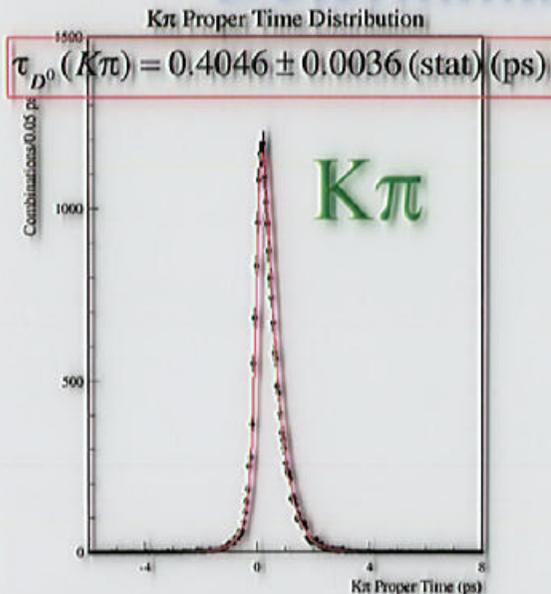


Analysis Technique

- Use $D^{*+} \rightarrow D^0 \pi^+$ tag to reduce background
 - Select signal region in Q
- Reconstruct D^0 proper time
- Fit the proper time distribution to determine the D^0 lifetime



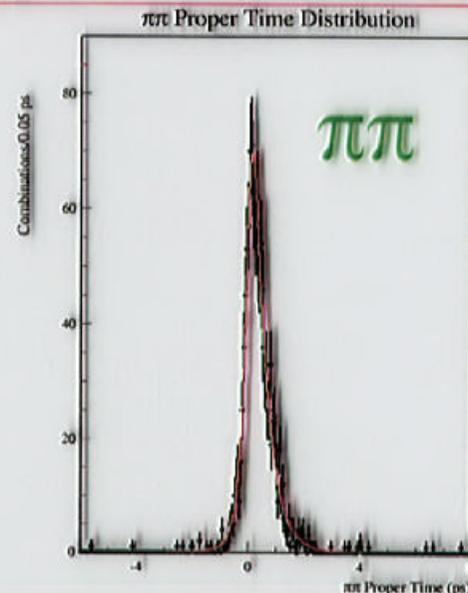
Determination of D^0 Lifetime in $D^0 \rightarrow K^-\pi^+$, K^+K^- , $\pi^+\pi^-$



$\tau_{D^0}(KK) = 0.411 \pm 0.012$ (stat) (ps)



$\tau_{D^0}(\pi\pi) = 0.401 \pm 0.017$ (stat) (ps)



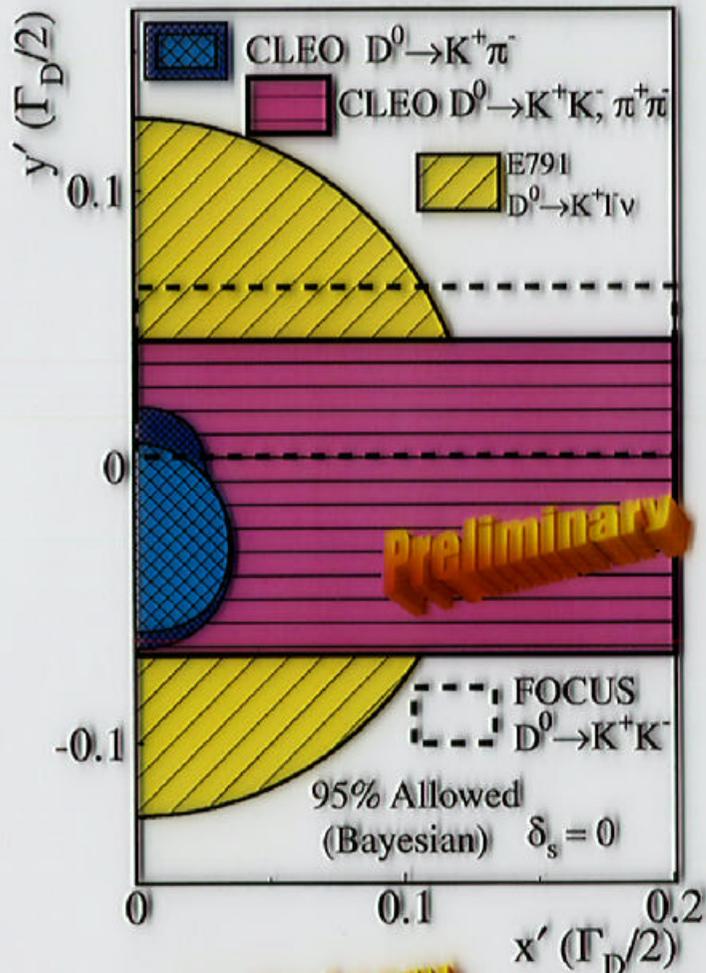
- **Unbinned maximum likelihood fit to proper time**

- Resolution from **measured proper time error and two Gaussians**

- Parameters of fit:

- Number of signal events
- D^0 lifetime
- Background fraction
- Fraction of background with lifetime
- Lifetime of background
- Fraction of mismeasured events
- Error of mismeasured events

D⁰-D̄⁰ Mixing Limits



y Results

- Consistent with
 - CLEO D⁰->K⁺π⁻ measurement
 - FOCUS D⁰->K⁺K⁻ measurement
 - E791 measurement (not shown)
- Dominant systematic errors due to:
 - Stat. uncertainty of MC lifetime correction study (0.009ps)
 - Background description (0.008 ps)
 - Proper time resolution model (0.005 ps)
 - Fit procedure (0.005 ps)

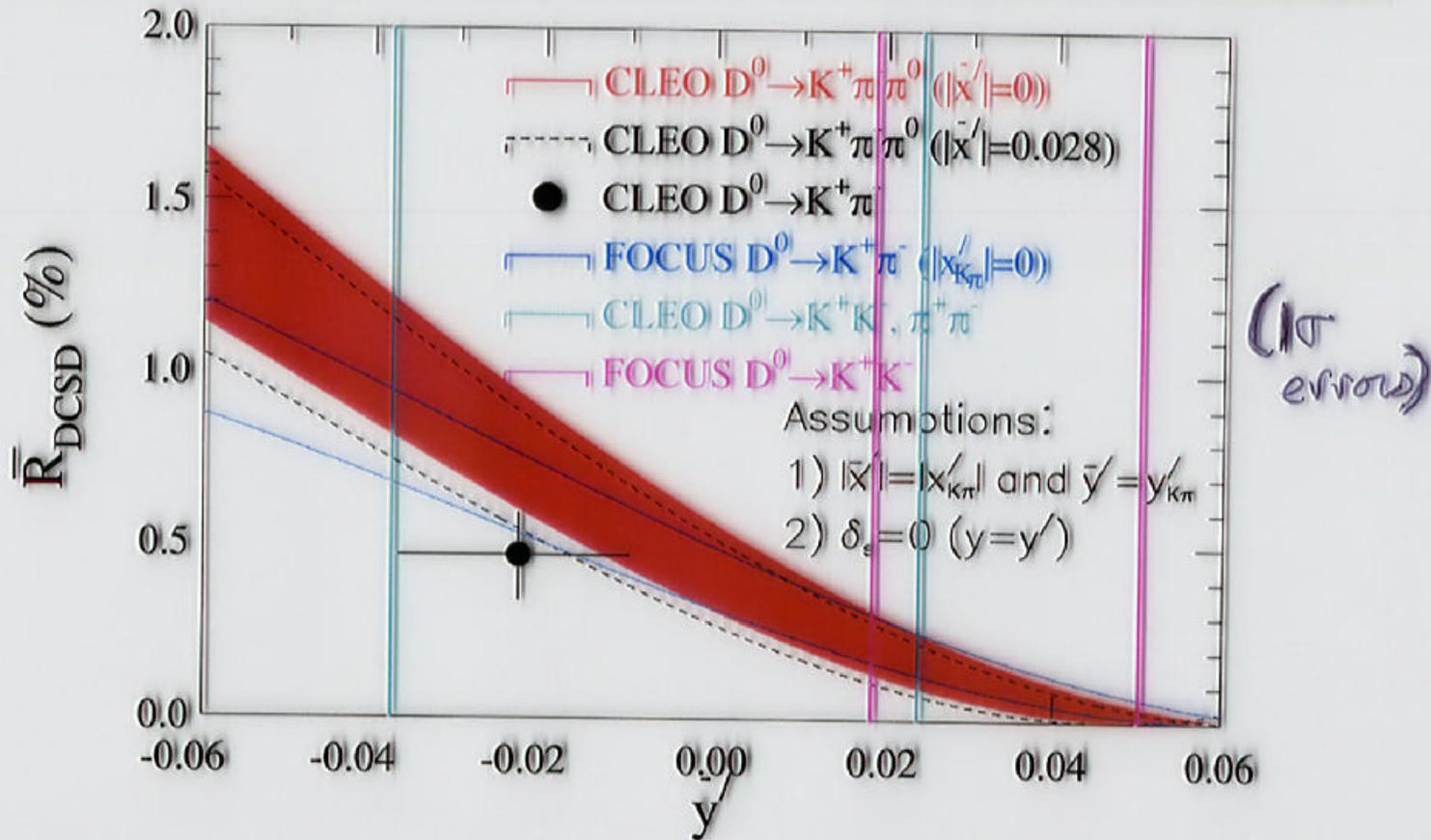
$$y_{K^+K^-} = -0.019 \pm 0.029 \text{ (stat)} \pm 0.016 \text{ (syst)}$$

$$y_{\pi^+\pi^-} = 0.005 \pm 0.043 \text{ (stat)} \pm 0.018 \text{ (syst)}$$

$$y = -0.011 \pm 0.025 \text{ (stat)} \pm 0.014 \text{ (syst)}$$

Mixing and DCSD Limits

Assuming strong phase, δ_s , between CFD and DCSD of zero



Conclusions

- Best measurement of the D^{*+} width:

$$\Gamma(D^{*+}) = 96 \pm 4 \text{ (stat)} \pm 22 \text{ (syst)} \text{ keV} \text{ Preliminary}$$

- First measurement of “wrong sign” rate in $D^0 \rightarrow K^+ \pi^- \pi^0$:

$$R_{WS} = (0.43_{-0.10}^{+0.11} \text{ (stat.)} \pm 0.07 \text{ (syst.)})\% \text{ Preliminary}$$

– Combined proper time/Dalitz fit under study -- stay tuned!

- New direct CP violation search results

$$A(K_S^0 \pi^0) = (+0.1 \pm 1.3 \text{ (stat + syst)})\%$$

$$A(\pi^0 \pi^0) = (+0.1 \pm 4.8 \text{ (stat + syst)})\%$$

$$A(K_S^0 K_S^0) = (-23 \pm 19 \text{ (stat + syst)})\%$$

$$A(K^+ K^-) = 0.0005 \pm 0.0218 \text{ (stat)} \pm 0.0084 \text{ (syst)}$$

$$A(\pi^+ \pi^-) = 0.0195 \pm 0.0322 \text{ (stat)} \pm 0.0084 \text{ (syst)}$$

- New y measurement:

$$y = -0.011 \pm 0.025 \text{ (stat)} \pm 0.014 \text{ (syst)} \text{ Preliminary}$$