Branching Fraction Measurement of $D^+ \to \pi^+\pi^0$ and $D^+ \to K^+\pi^0$

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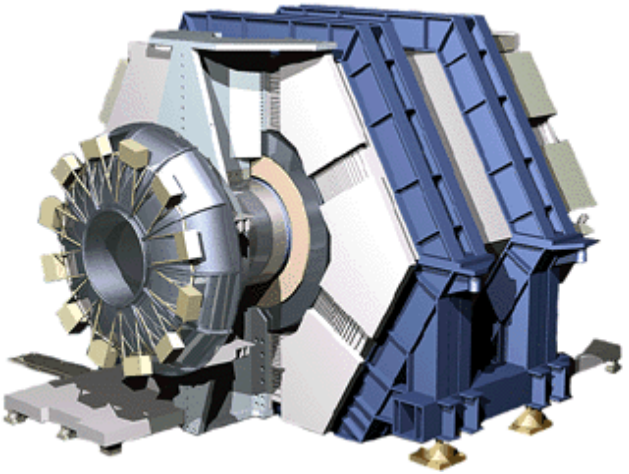
(on behalf of the BaBar Collaboration)



Introduction

Status :

- Analysis basically done, have preliminary results (not shown here)
  still under review
- Final results available soon

Motivation and currently know BF :

- Measurement of the branching fraction $D^+ \to \pi^+\pi^0$ and $D^+ \to K^+\pi^0$

  $BF(D^+ \to \pi^+\pi^0) = (2.6 \pm 0.7) \times 10^{-3}$ (PDG2004)

  $BF(D^+ \to \pi^+\pi^0) = (1.31 \pm 0.17 \pm 0.09 \pm 0.09) \times 10^{-3}$
  $BF(D^+ \to K^+\pi^0) < 4.2 \times 10^{-4}$ (Phys.Rev.D69:071102,2004)

- provide insights into violation of *SU*(3) flavor symmetry
- $D^+ \to K^+\pi^0$ is doubly Cabbibo-suppressed decay
- neutral equivalent to $D^+ \to K^+\pi^0$ decay is a background to D^0 mixing

Method and Data/MC samples used

Method :

- Reconstruct in a $D^{*+} \rightarrow D^{+}\pi^{0}$ decay chain
- Use D^{*+}-D^{+} mass difference for background suppression
- Relative measurement to the reference mode $D^{+} \rightarrow K^{-}\pi^{+}\pi^{+}$
- Reconstruct reference and signal mode as similar as possible
  (reduces systematic errors)

Data sample :

- collected from 1999-2003, total integrated luminosity of 124 fb^{-1}
  (on and below $\Upsilon(4S)$ resonance)

MC sample :

- Signal MC for signal and reference modes (to calculate efficiencies)
- Generic MC (only for consistency checks)

Reconstruction

Charged tracks :

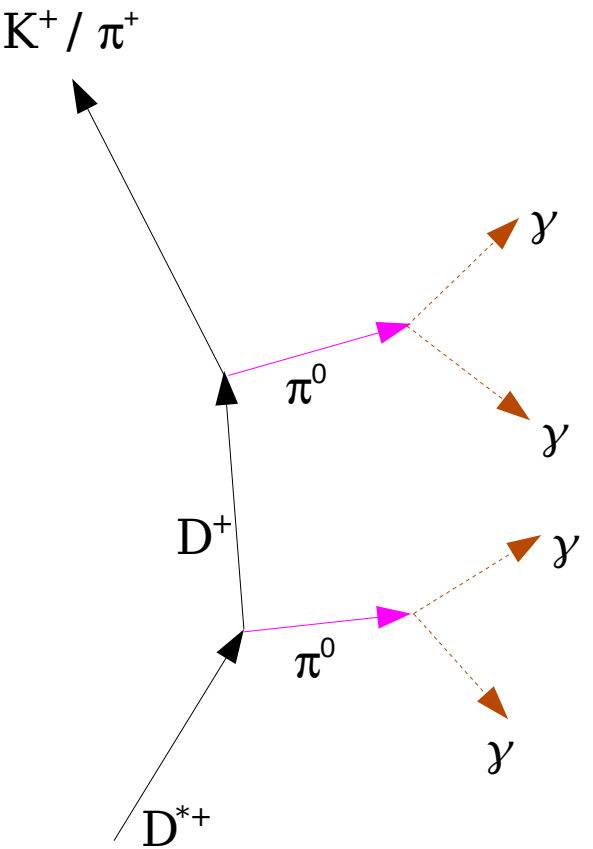
- 'Well measured' tracks (beam spot constraint)

Particle ID :

- Use dE/dx (DCH) and Cherenkov detector (DIRC) to identify pions and kaons

π^0 (have two, one from D^{*+}, one from D^+) :

- Minimum photon energy is 30 MeV
- Shower consistent with electromagnetic hypothesis
- 115 MeV/c^2 < $M_{\gamma\gamma}$ < 150 MeV/c^2
- Combine two photons with mass-constrained fit
- π^0 from D^{*+} is soft , 150 MeV/c < p_{π^0} < 450 MeV/c
- π^0 from D^{*+} has higher momentum , p_{π^0} > 200 MeV/c

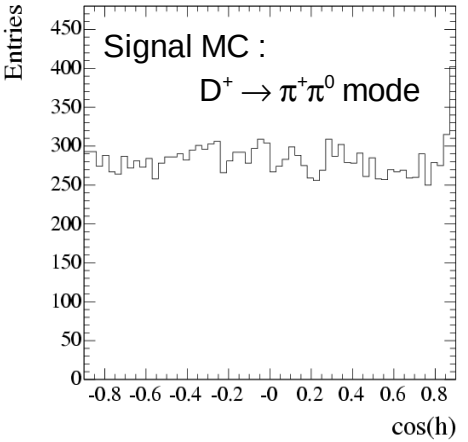


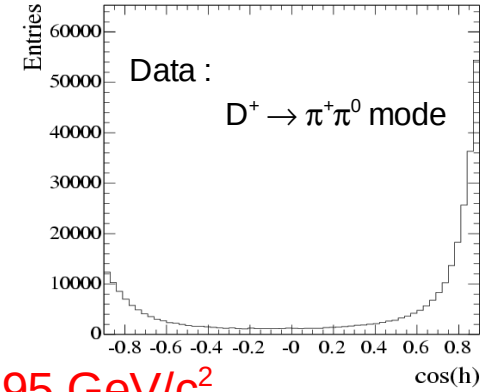
Candidate Selection

$D^{*+} \to D^+ \pi^0_{soft}$, $D^+ \to \pi^+(K^+)\, \pi^0$ candidate :

- D^+ mass $1.7\ GeV/c^2 < m_D < 2.0\ GeV/c^2$
- D^{*+}-D^+ mass difference $0.132\ GeV/c^2 < \Delta M < 0.155\ GeV/c^2$
- Cosine of pion(kaon) helicity $|\cos(h)| < 0.8(0.7)$
- Normalized momentum of D^+ $x_D > 0.6$

$$x_D = \left| p_D^{CMS} \right| / \sqrt{E_{Beams}^2/4 - m_D^2}$$





Reference mode $D^{*+} \to D^+ \pi^0_{soft}$, $D^+ \to K^-\pi^+\pi^+$ candidate :

- D^+ mass distribution narrower (no π^0) $1.78\ GeV/c^2 < m_D < 1.95\ GeV/c^2$
- Same x_D and ΔM cut , no helicity cut

Multiple candidates in event :

- Select candidate with highest D^{*+} momentum

Maximum Likelihood Fit

Fit Input :

- D^+ mass signal PDF (gaussian) and background PDF shape
- Signal PDF parameter for $K^+\pi^0$ mode extracted from data $\pi^+\pi^0$ fit

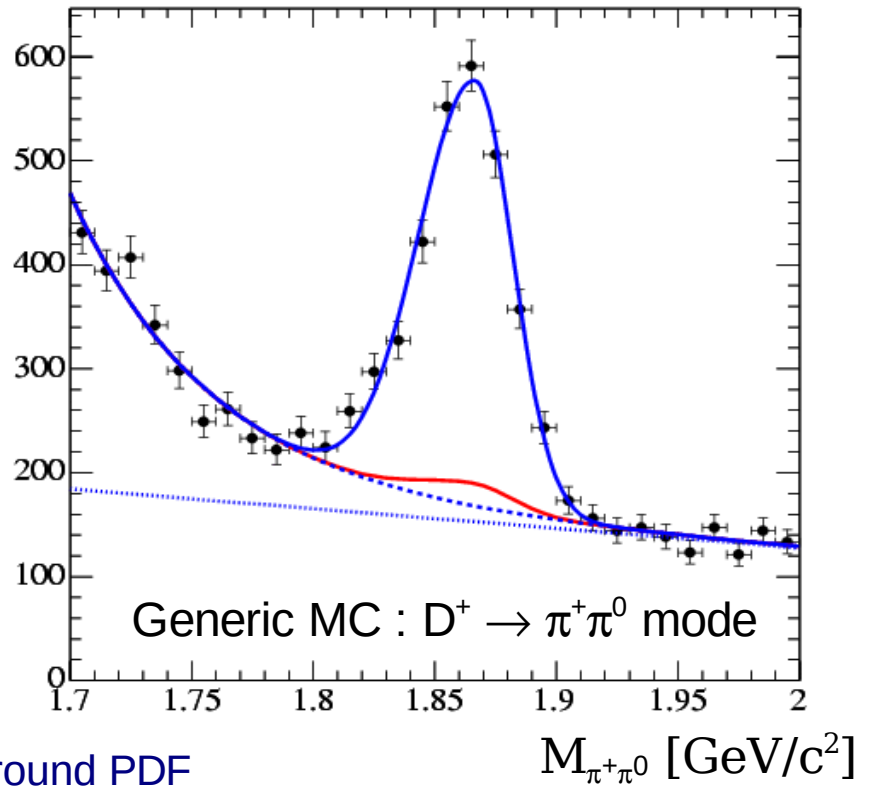
Fit Output :

- Signal/background PDF parameters
- Signal/background yields

Goal :

- Extract the D^+ event yield for

$$D^{*+} \rightarrow D^+\pi^0_{soft}\,,\; D^+ \rightarrow \pi^+(K^+)\pi^0$$

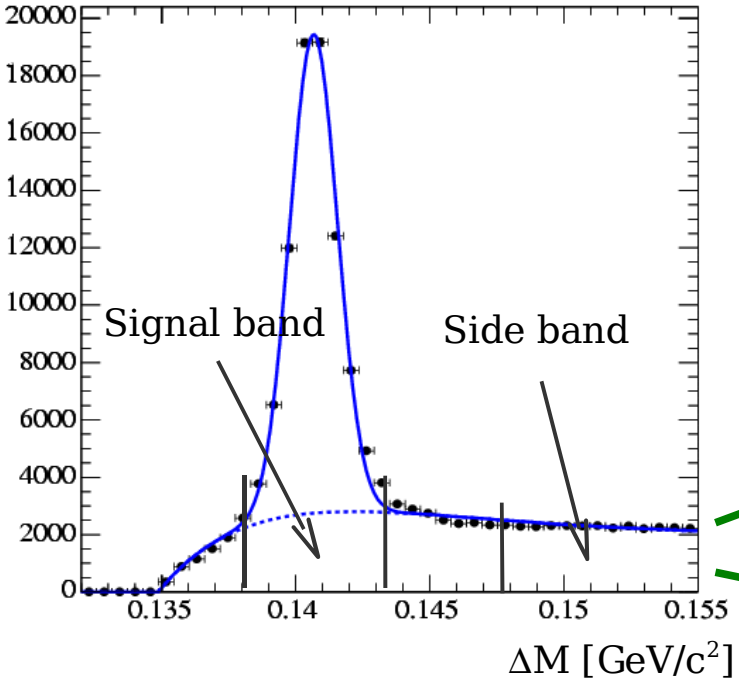


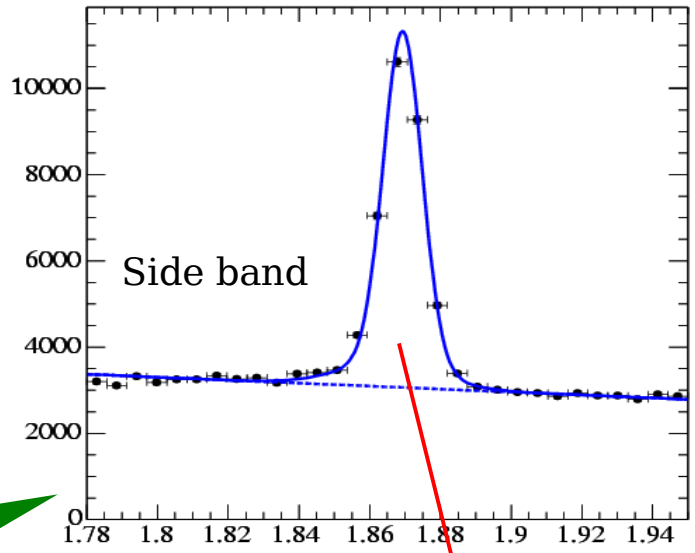
Problems :

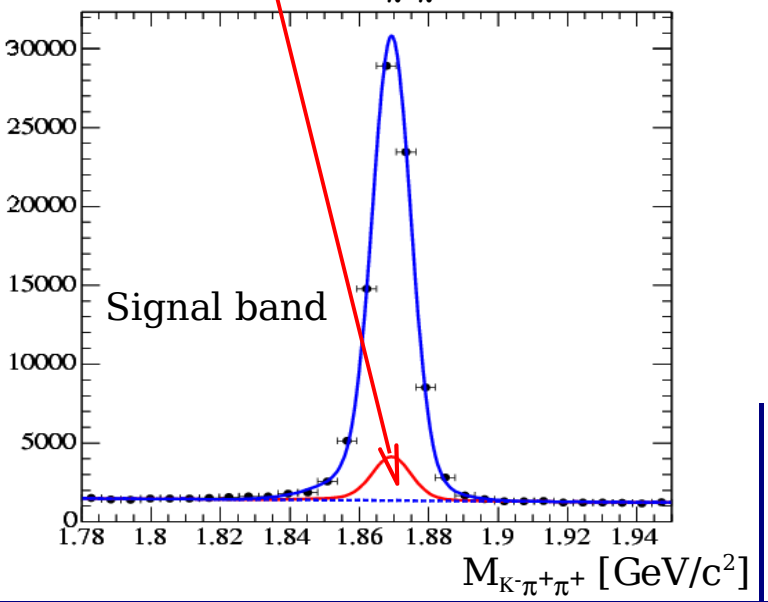
- Left side rise in D^+ mass distribution
- 3-body decays where only 2 of the 3 decay products are used ($D^+ \rightarrow K_S\pi^+$, $K_S \rightarrow \pi^0\pi^0$)
- Use linear function plus exponential for background PDF
- $D^+ \rightarrow \pi^+(K^+)\pi^0$ not from $D^{*+} \rightarrow D^+\pi^0_{soft}$ considered background
- peak in D^+ mass distribution $\rightarrow$ signal yield too high

Peaking Background Subtraction

Generic MC : $D^+ \to K^-\pi^+\pi^+$ reference mode





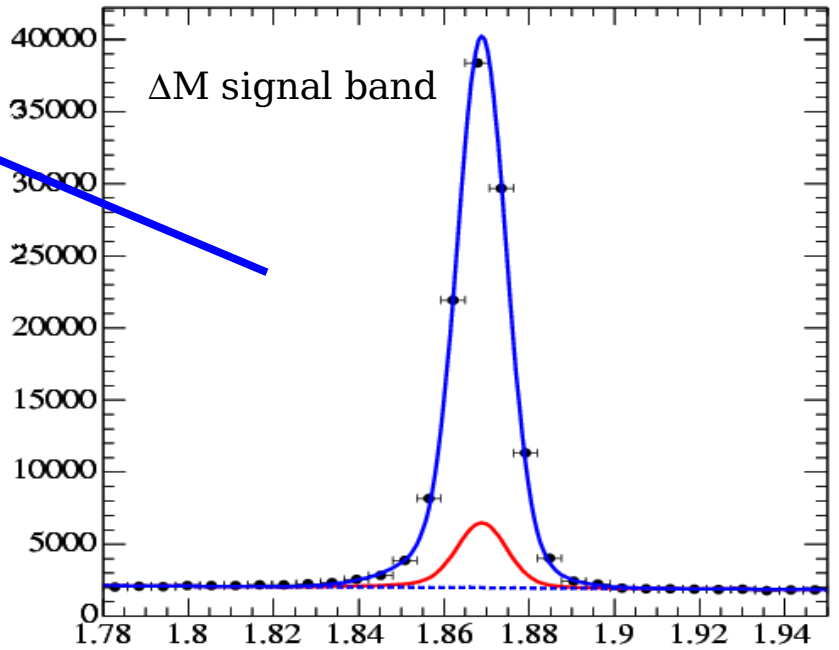


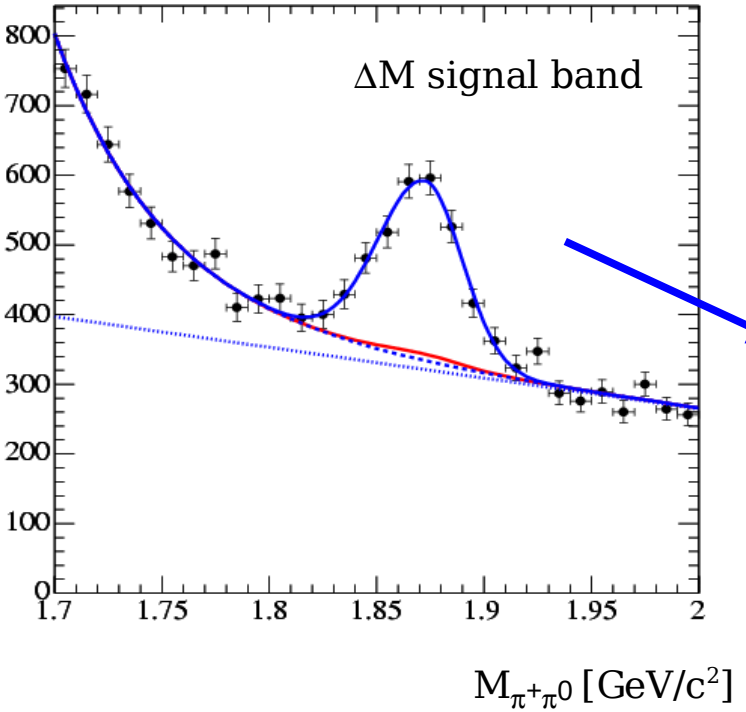
- Divide ΔM into 2σ signal and >5σ side band
- Fit D^+ mass distribution separately
  (signal pdf parameters are set to be the same)
- Substract side band yield from signal band yield
  (adjusted by scale factor)

Data fits

$D^+ \to K^-\pi^+\pi^+$ reference mode

signal yield = 93520 ± 417(*stat.*)





$D^+ \to \pi^+\pi^0$ signal mode

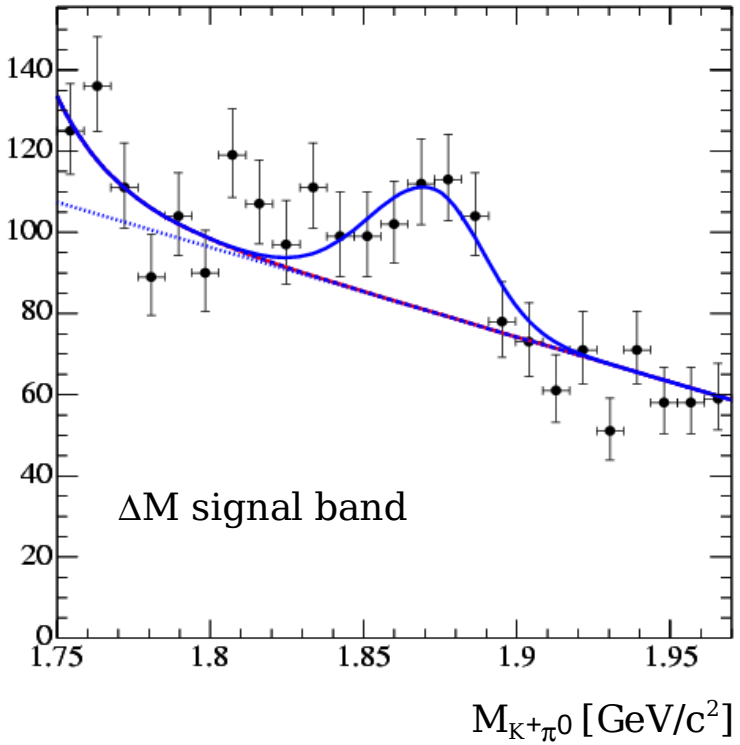
signal yield = 1230 ± 98(*stat.*)

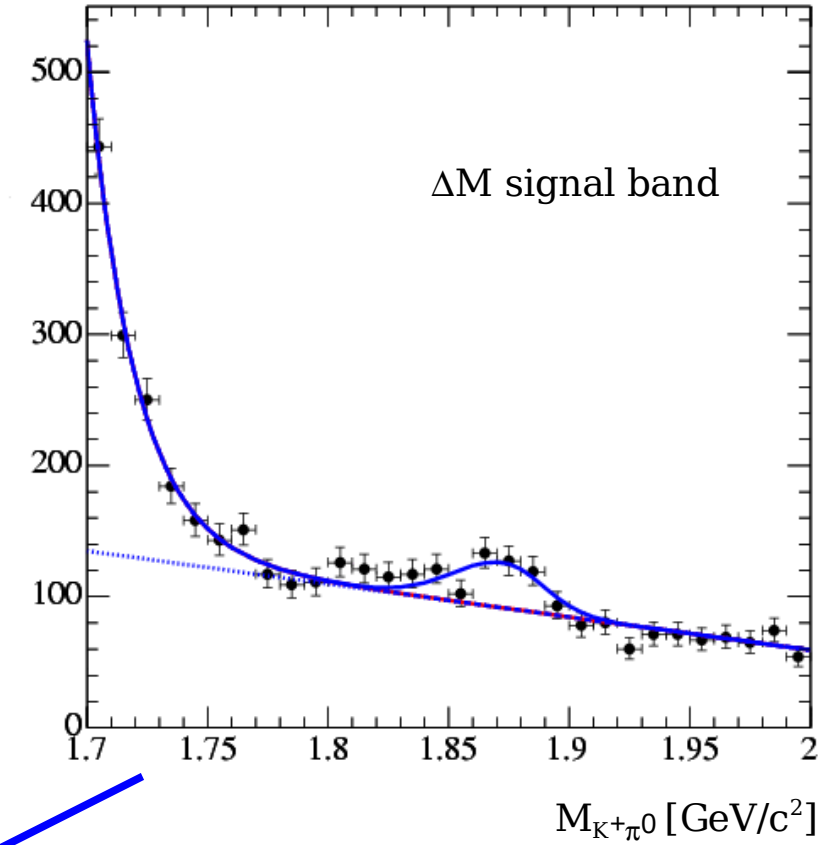
Data fits

$D^+ \rightarrow K^+\pi^0$ signal mode

signal yield = 162 ± 33(*stat*.)

Fixed peaking background to zero





Errors

Can't present our result yet, but can show errors

	$D^+ \to \pi^+\pi^0$	$D^+ \to K^+\pi^0$
Statistical error	8%	21%
Systematic error	7%	7%
Uncertainty on BR($D^+ \to K^-\pi^+\pi^+$)	7%	7%

Largest systematic error contributions

- π^0 reconstruction (3.2%)
- Differences in ΔM shape between signal and reference mode (5%)

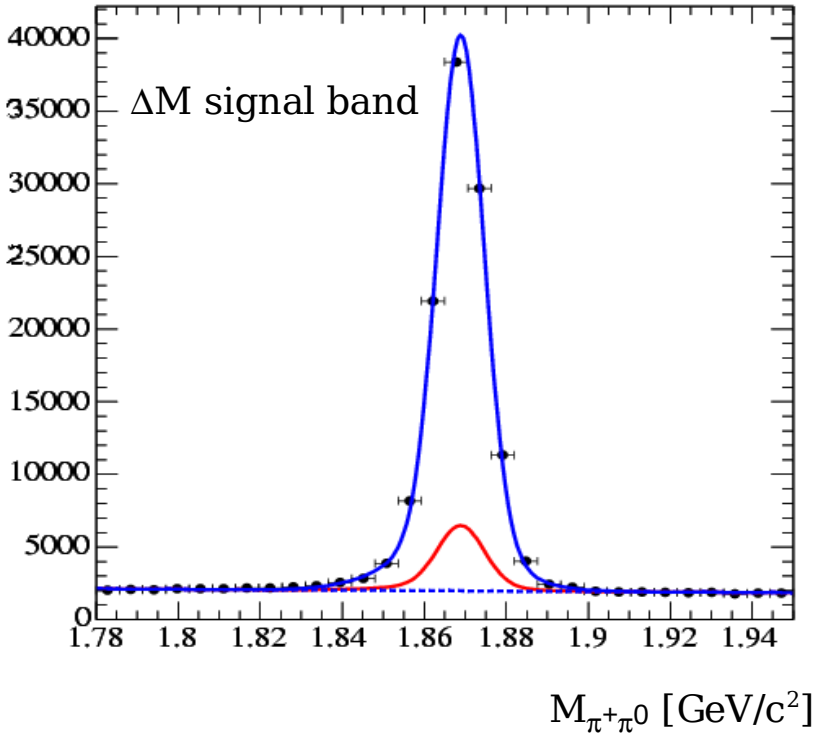
Conclusions and Outlook

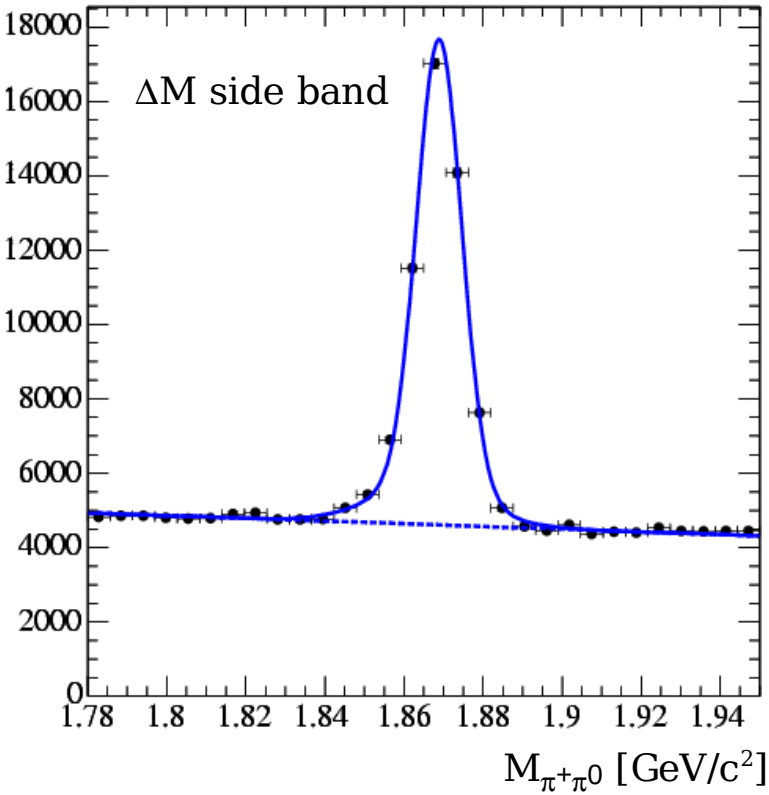
- Analysis complete, selection criteria are optimized
- MC tests return the input branching fractions
- Have preliminary results for $D^+ \to \pi^+\pi^0$ and $D^+ \to K^+\pi^0$

  still under internal review

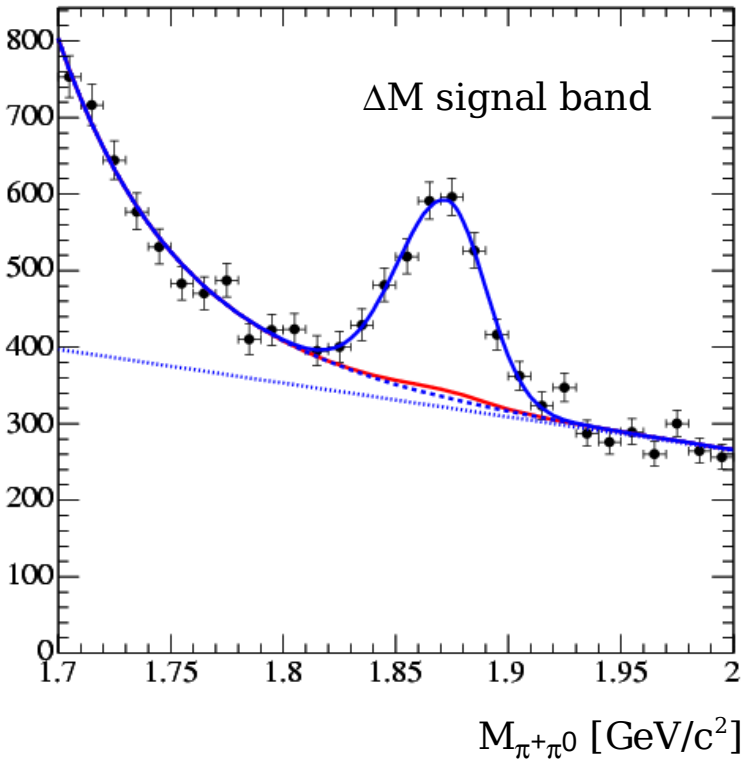
Backup Slides

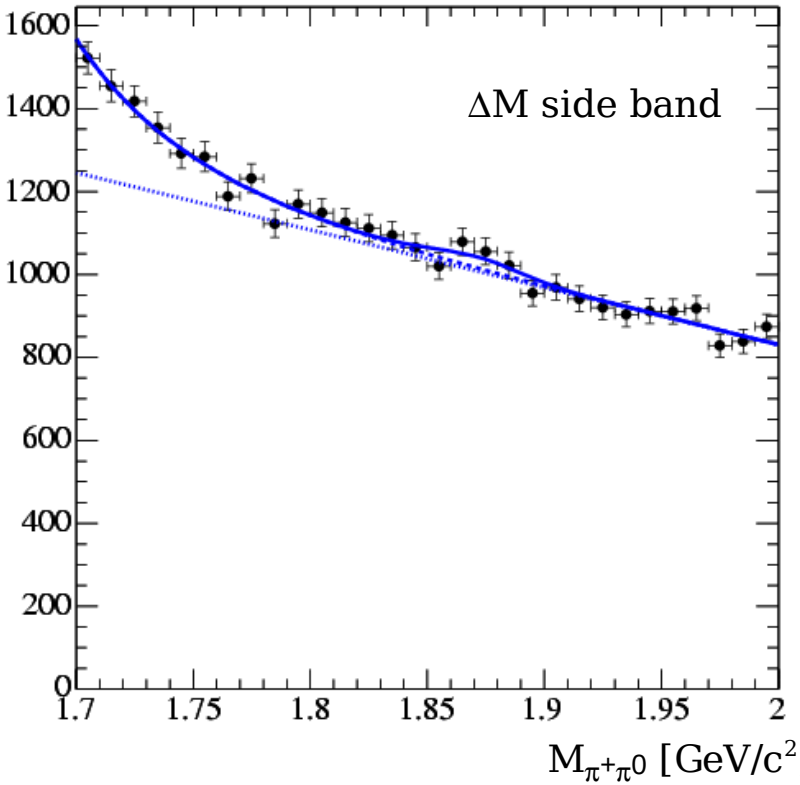
Data fit $D^+ \to K^-\pi^+\pi^+$ reference mode



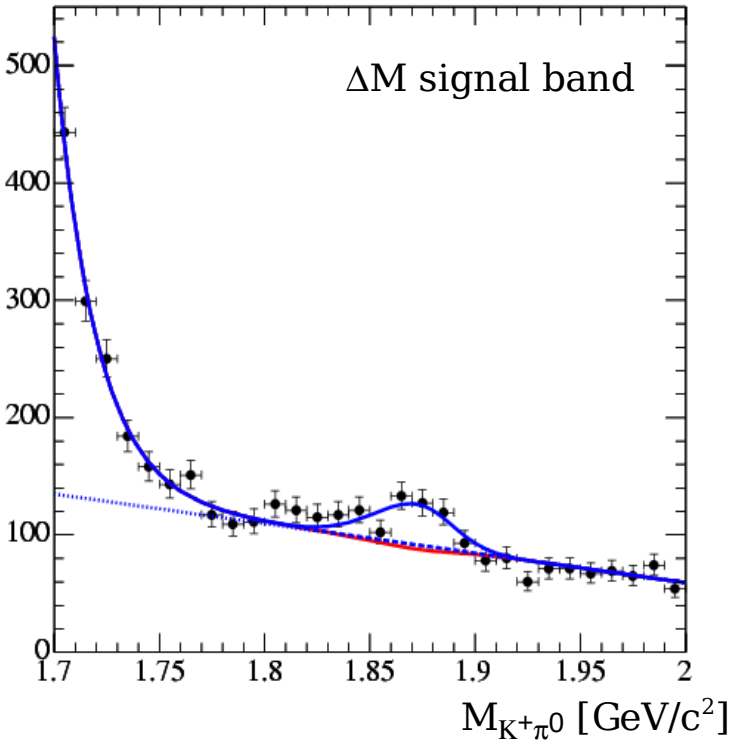


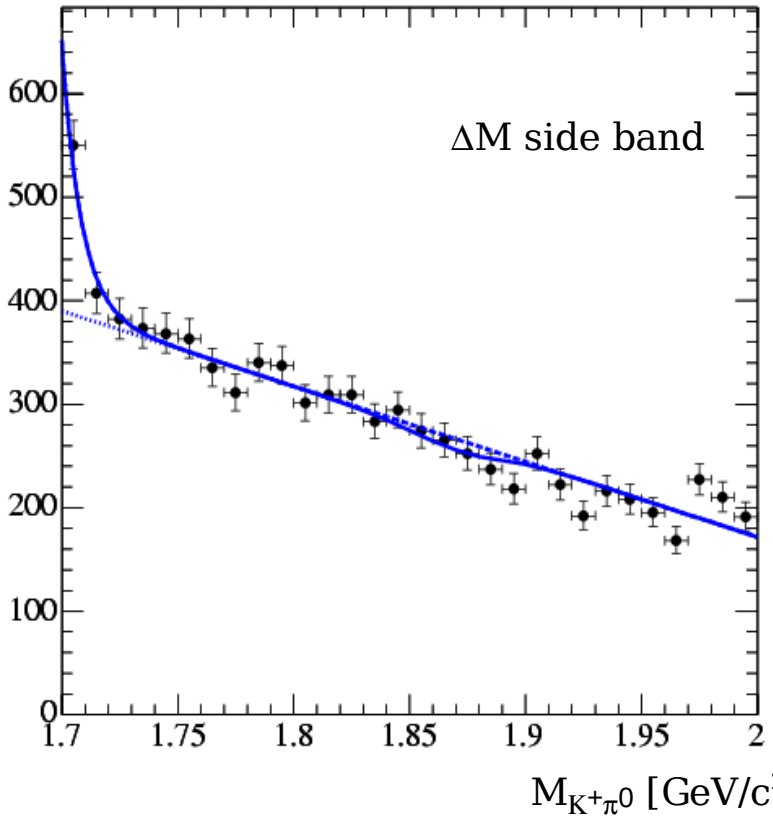
Data fit $D^+ \to \pi^+\pi^0$ signal mode





Data fit $D^+ \to K^+\pi^0$ signal mode





Systematic Errors

Efficiency Ratio Systematics			
Description	$\sigma_\epsilon(K^-\pi^+\pi^+)$	$\sigma_\epsilon(\pi^+\pi^0(K^+\pi^0))$	$\sigma_{\epsilon-Ratio}$
Tracking	2.4 %	0.8 %	1.6 %
Particle Identification	0.7 %(–)	0.6 %(0.4 %)	0.9 %(0.4 %)
π^0 reconstruction	–	3.2 %	3.2 %
Monte Carlo Statistics	0.4 %	1.0 %(1.1 %)	1.1 %(1.2 %)
ΔM_D Shape	–	–	5.0 %
ΔM_D Data / MC	1.0 %	1.0 %	1.4 %
Signal Parametrization	1.5 %	3.0 %(+ 2.2 %)	1.5 %(2.7 %)
Total	–	–	**6.6 % (7.0 %)**
Other Systematics			
Peaking D^+ Background	3.5 %	3.5 %	N/A
Fit Weight Function	1.2 %	0.8 %	N/A