Rare charmless hadronic B decays from BABAR

David Hutchcroft,
University of Liverpool
for the BABAR Collaboration

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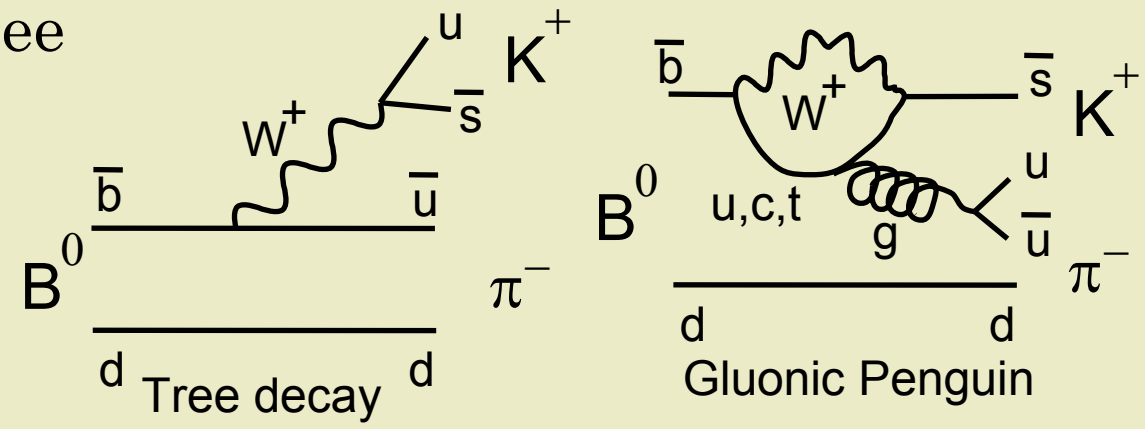
Rare charmless hadronic *B* decays from BABAR

- Charmless *B* decays can be used to study
  - Interfering standard model amplitudes
  - Amplitudes of CKM parameters and angles
  - Effects of higher mass particles in loops
- Many amplitudes are not well known
  - Measurements are used to improve theoretical models
- Charmless *B* decays are rare as the processes are suppressed by small CKM magnitudes
- Usually both tree diagrams and penguins can contribute



Data

- BABAR collects data at the PEP II asymmetric e^+e^- collider operating at the $\Upsilon(4s)$ resonance
- Around 227–232 x 10^6 $B\overline{B}$ events have been used in these analyses
- All results presented are preliminary

Variables

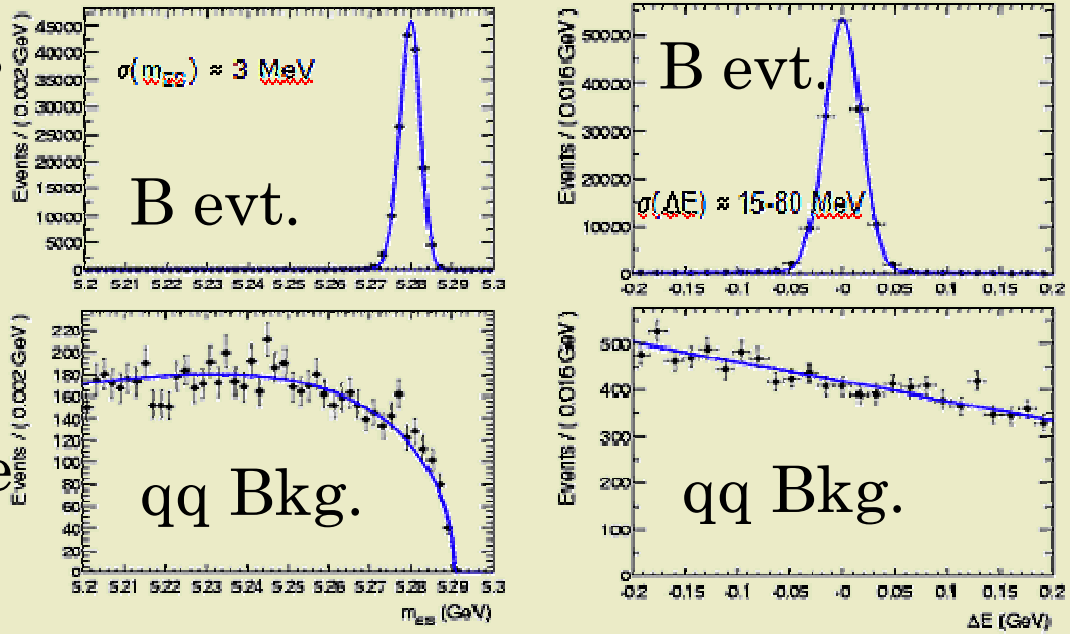
- To select signal events two variables are defined:

m_{ES} the beam–energy substituted mass

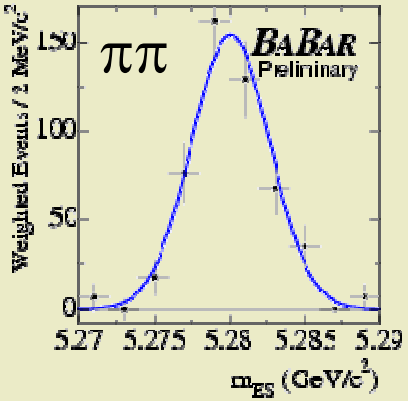
ΔE the Energy difference

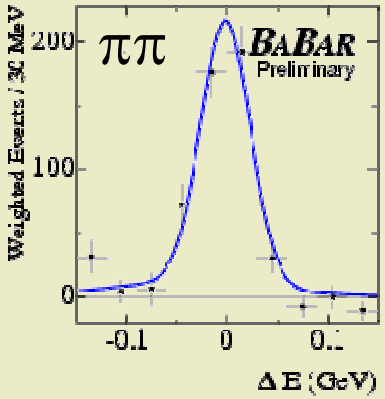
$$m_{ES} = \sqrt{E^{*2}_{beam} - p^{*2}_{B}}$$

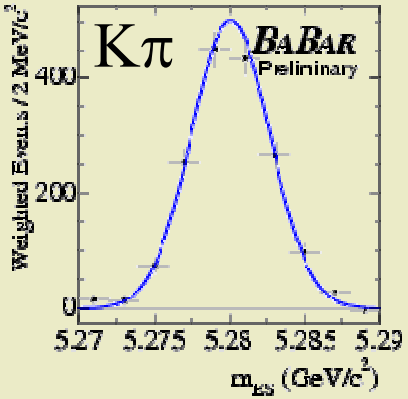
$$\Delta E = E^{*}_{B} - E^{*}_{beam}$$

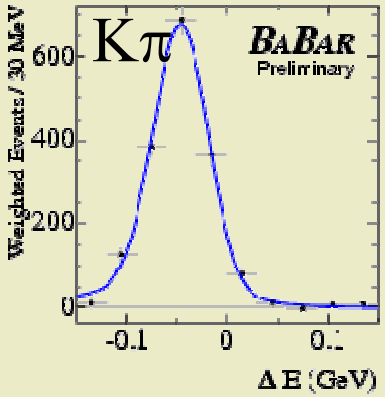


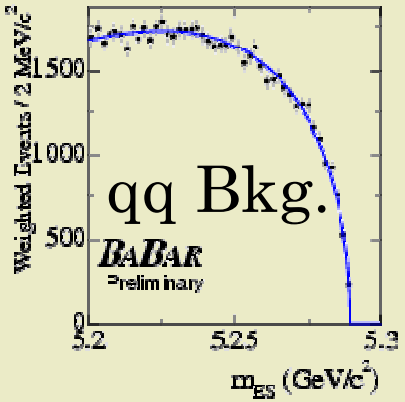
New $\mathcal{B}r$ measurements of $B^0 \to K,\pi$

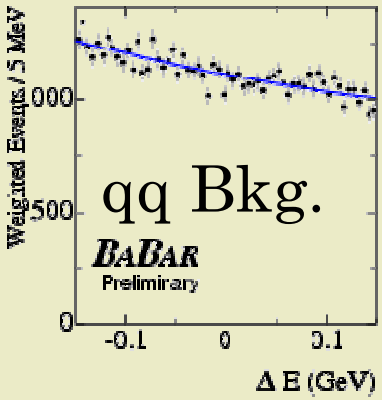












Signal probability weighted m_{ES} and ΔE distributions

Purity:

- 40% ππ, 60% Kπ

Corrections for final state radiation from the mesons:

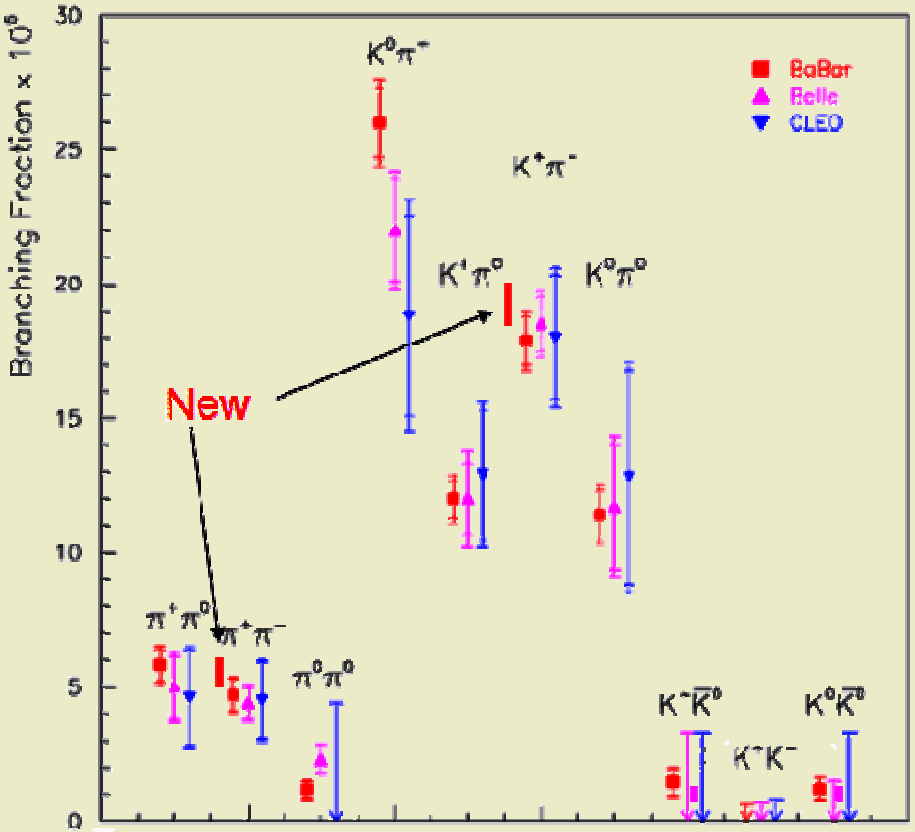
- +6% for Kπ and +8% for ππ

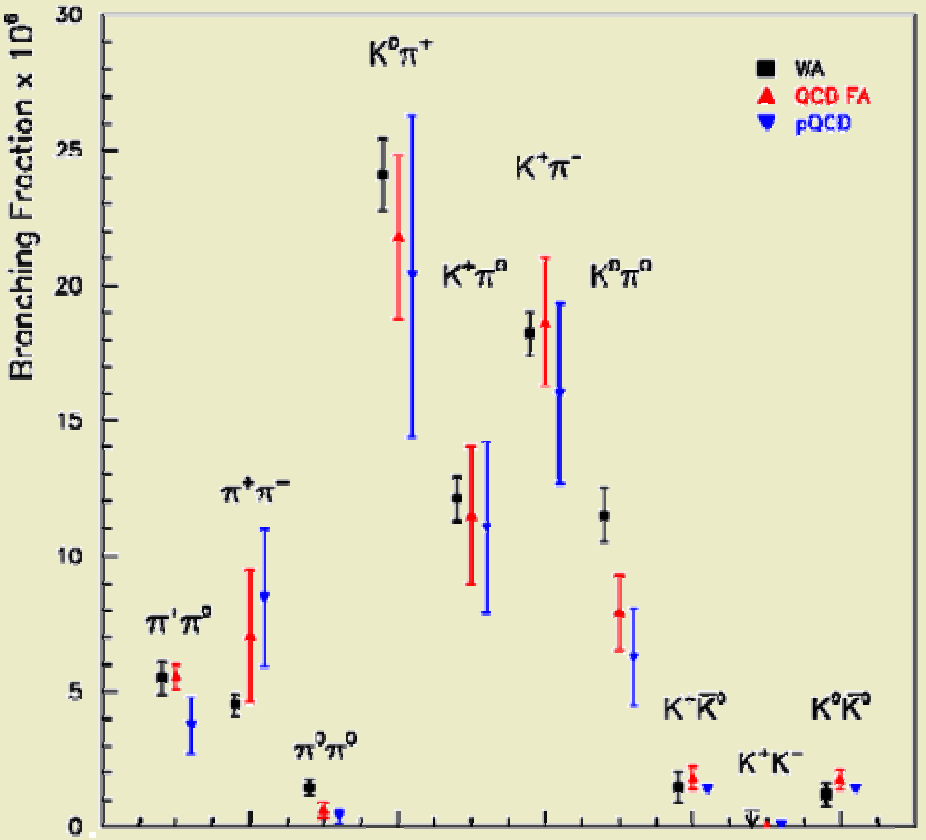
Mode	$\mathcal{B}(10^{-6})$
$\pi^+\pi^-$	$5.5 \pm 0.4 \pm 0.3$
$K^+\pi^-$	$19.2 \pm 0.6 \pm 0.6$
K^+K^-	< 0.40 (90% C.L.)

Compare measured rates and some theoretical predictions

BABAR (old and new)
Belle
CLEO

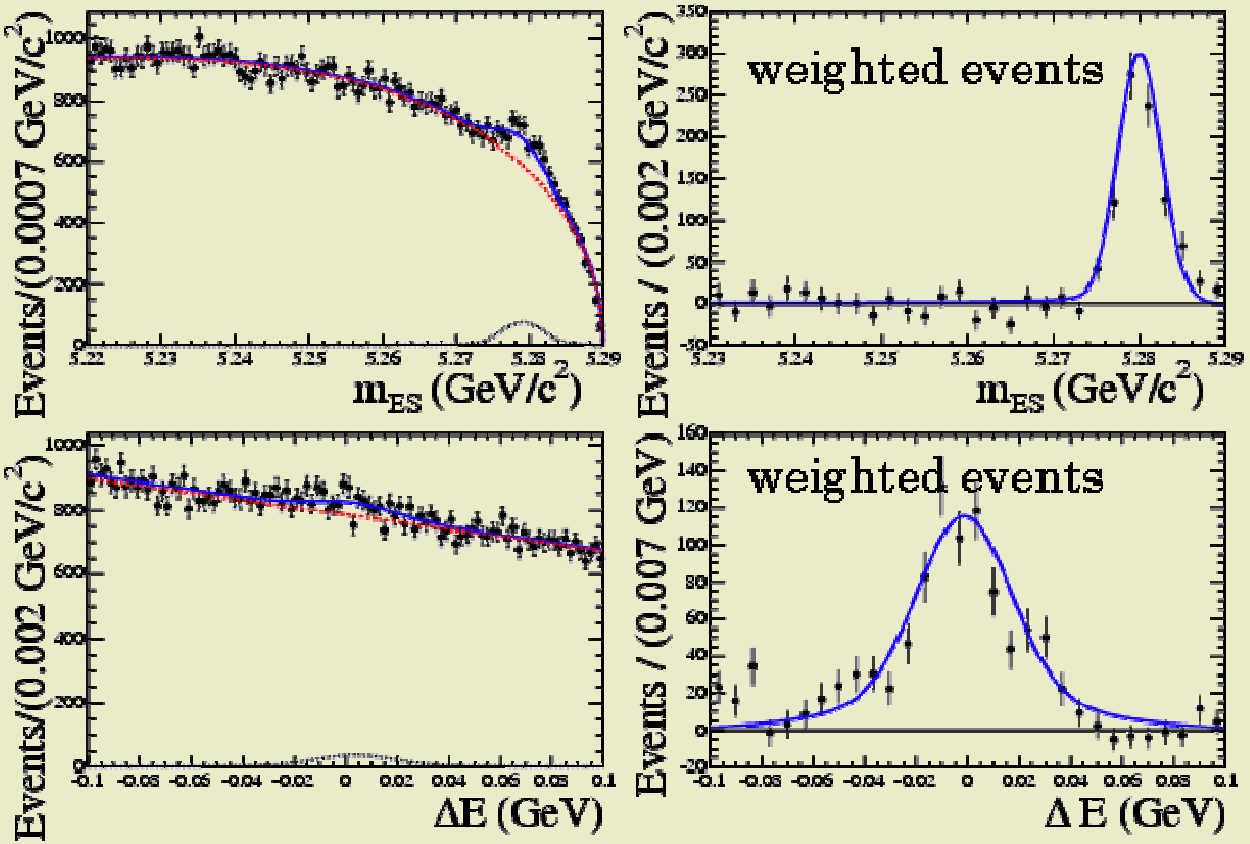
WA World average
QCD FA Beneke and Neubert (hep-ph/0308039)
pQCD Keum (hep-ph/0410337)





$B^0 \to K_s^0 \pi^+ \pi^-$

- Select only $K_s^0 \to \pi^+ \pi^-$
- Choose very wide windows in selection variables to measure backgrounds



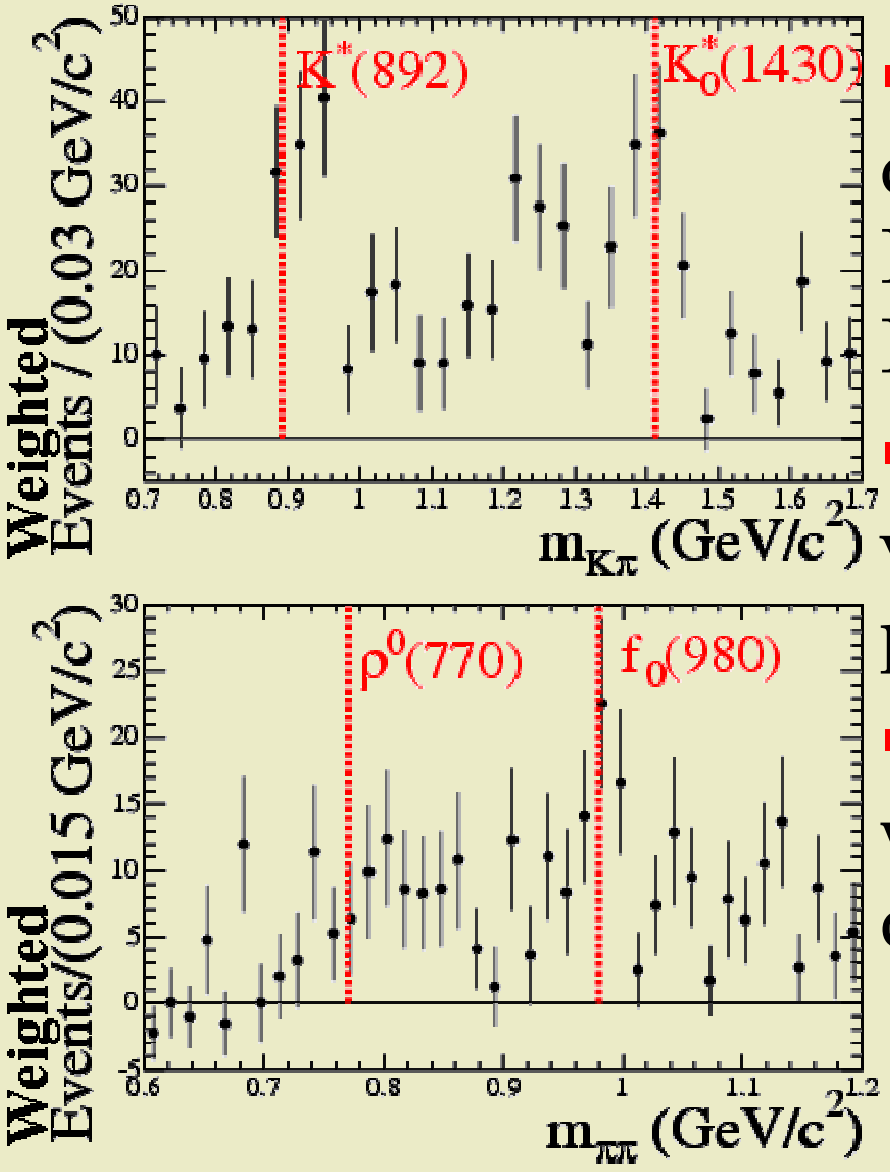
Blue line (left):
Signal + Background

Red dashed line (left):
Background

Dotted line (left):
Signal

Blue line (right):
Signal distribution

Dalitz analysis of $K_s^0\pi^+\pi^-$



- Often final state from quasi-two body decays: $B^0 \to K^0 f_0(\to \pi^+\pi^-)$ and $B^0 \to K^{*+}(\to K^0\pi^+)\pi^-$
- Correct for efficiency variations across the Dalitz plot
- Use projections with weighted events to check distributions used in the fit

Fit results for $B^0 \to K_s^0 \pi^+ \pi^-$

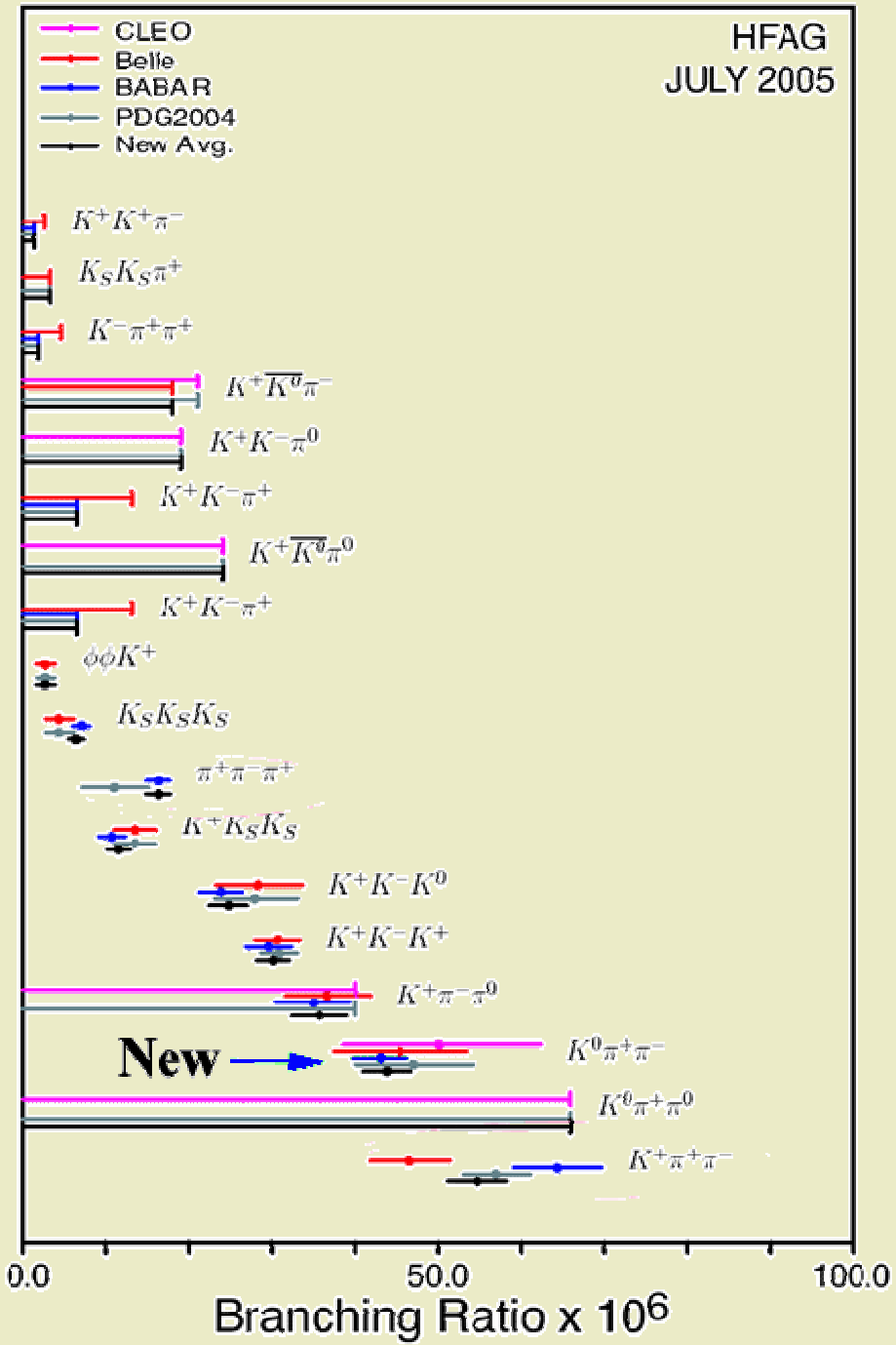
Mode	Signal Events	Branching Ratio (x 10^{-6})
$B^0 \to K^0 \pi^+ \pi^-$	860 ± 47	$43.0 \pm 2.3 \pm 2.3$
$B^0 \to K^0 f_0(\pi^+ \pi^-)$	120 ± 16	$5.5 \pm 0.7 \pm 0.6 \pm 0.3$
$B^0 \to K^{*+} \pi^-$	140 ± 19	$11.0 \pm 1.5 \pm 0.5 \pm 0.4$

Errors are statistical, systematic and interference uncertainties

- $B^0 \to K^{*+} \pi^-$ shows direct CP asymmetry

$$\mathcal{A}_{K^*\pi} = \frac{\Gamma_{\overline{B}^0 \to K^{*-}\pi^+} - \Gamma_{B^0 \to K^{*+}\pi^-}}{\Gamma_{\overline{B}^0 \to K^{*-}\pi^+} + \Gamma_{B^0 \to K^{*+}\pi^-}}$$

- $\mathcal{A}_{K^*\pi} = -0.11 \pm 0.14 \pm 0.05$



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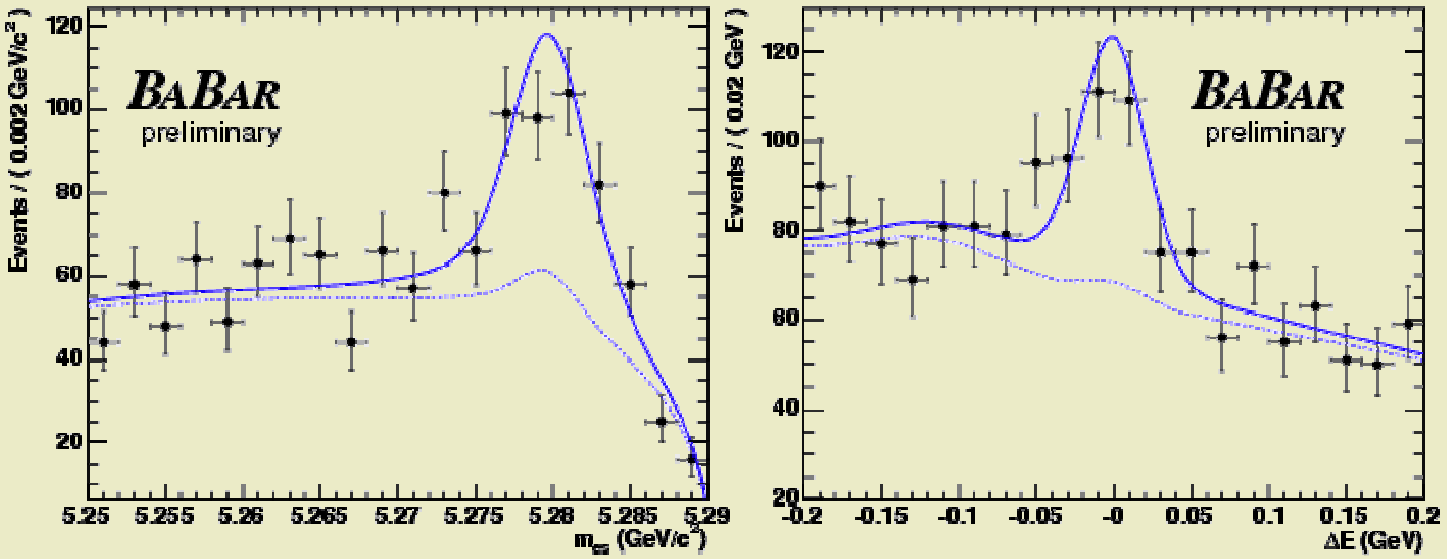
- Beginning to have a comprehensive set of 3-body decays measured
- Low branching ratios and significant backgrounds make these challenging
- Complement the two body decay channels
- They provide strict constraints on the QCD calculations

$B^0 \to a_1^+(1260)\pi^-$

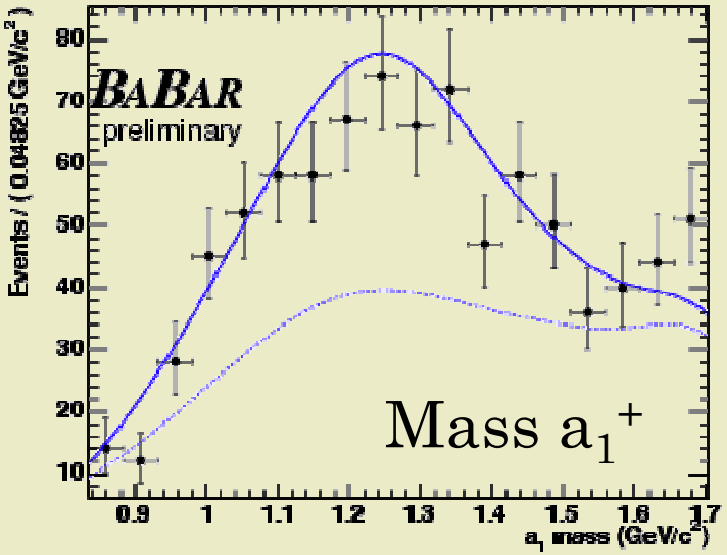
- Select the $a_1^+(\to \pi^+\pi^-\pi^+)$
- a_1^+ is poorly known: all $(\pi^+\pi^-\pi^+) + \pi^-$ events are accepted in a wide mass window
  - a_1^+ mostly decays via $(\pi^+\pi^-)_\rho\pi^+$ or $(\pi^+\pi^-)_\sigma\pi^+$ resonances



Blue solid curve Signal + Background

Blue dashed curve Background

$B^0 \to a_1^+(1260)\pi^-$



Analysis results

Mass a_1^+	1.22 ± 0.02 GeV/c²
Γ a_1^+	0.423 ± 0.050 GeV/c²
Efficiency	19.8%
Signal yield	867 ± 85
$\mathcal{B}r$	$(40.2 \pm 3.9 \pm 3.9) \times 10^{-6}$

Blue solid Signal + Background
Blue dashed Background

- The parameters of the a_1^+ are extracted from the data
- $a_2^+(1320)$ and $\pi^+(1300)\pi^-$ are considered as backgrounds
- This mode is sensitive to α and with higher statistics will be used to measure it

Conclusion

New measurements of

- $B^0 \to K^+K^-, \pi^+\pi^-, K^+\pi^-$ BaBar–Conf–05/013
  - Very low K^+K^- $\mathcal{B}r$ provides strong constraints on new loop diagrams
  - Slightly higher $\pi^+\pi^-$ closer to QCD predicted range
- $B^0 \to K_s^0\pi^+\pi^-$ BaBar–Pub–05/033
  - Add to 3-body decay tables and resonance decays
  - Measured CP asymmetry $\mathcal{A}_{K^*\pi}$
- $B^0 \to a_1^+(1260)\pi^-$ hep–ex/0507029
  - 2nd largest 2 body $\mathcal{B}r$ measured
  - Improve knowledge of properties of the $a_1^+(1260)$