Study of Radiative B Meson Decays
B –>

H. Schwarthoff (The Ohio State University)

May 27, 2000
at CIPANP2000 conference, Quebec Hilton, Quebec City, Canada

Radiative B decays at CLEO

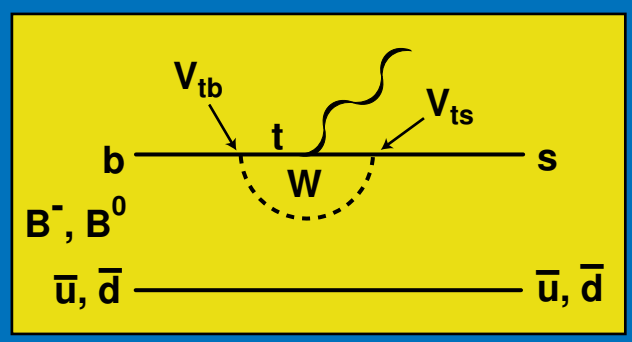
b –> s penguins, W exchange

Exclusive measurements/searches

Branching fractions B^0 –> $K^{*0}(892)$,
B^+ –> $K^{*+}(892)$, B –> $K_2^*(1430)$, B –> / ,
B^0 –> D^{*0}

New upper limit on BR(B –>)

Radiative B decays



b -> s penguin

First observed 1993 at CLEO

B -> K*

No flavor changing neutral currents

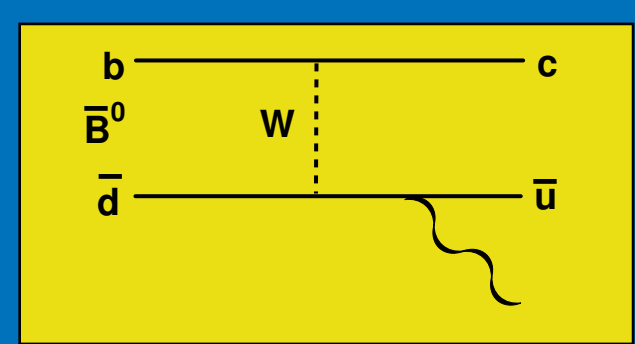
Loop dominated by t quark - V_{tb} V_{ts} (SM)

Non-SM physics (loop)

CP asymmetry (talk by V.Frolov)

Non-penguin

B^0 -> D^{*0}

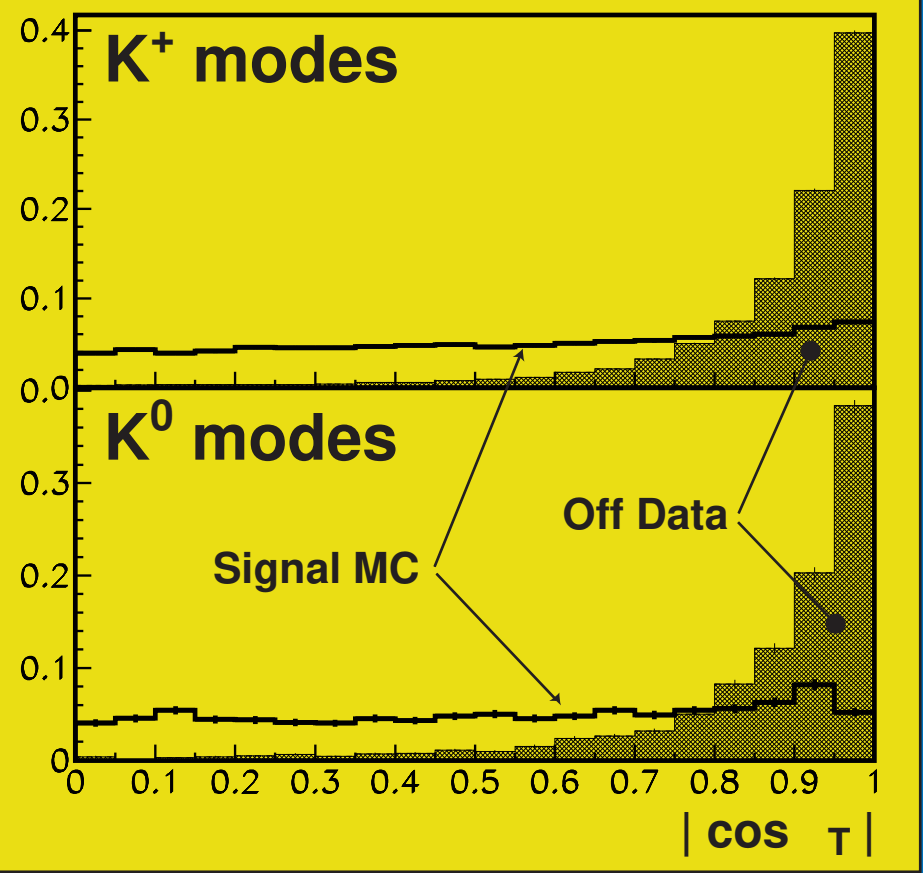


Exclusive decays: B -> K* , / /

Signature:

- High energy (2.1GeV < E < 2.7GeV)
- Background: $e^+e^- \to q\bar{q}$ from ISR or ^{0},
- Use only barrel calorimeter $|\cos\ | < 0.71$
- for suppression of continuum background
- $_T$: angle between B thrust axis and rest of event
- Veto for ^{0}

Spectrum of signature



Exclusive decays: B –> K* , / /

Reconstruct

B^0 –> $K^{*0}(892)$, B^+ –> $K^{*+}(892)$, B –> $K_2^*(1430)$

K^+ $^-$, K_s^0 ^{0}, K^+ ^{0}, K_s^0 $^+$ (+ C.C.)

B –> /

^{0} –> $^+$ $^-$; $^+$ –> $^+$ ^{0}; –> $^+$ $^-$ ^{0} (+ C.C.)

B –> (non-penguin)

–> K^+K^-

Suppress background

through event shape

E_B cut: E = | $E_{Resonance}$ + E - E_{beam} | < 300MeV (K*)

M_B cut: $M_B^2 = E_{beam}^2 - p_B^2$

5.2GeV < M_B < 5.3GeV

Exclusive decays: B -> K*

Yield: $88.3^{+12.2}_{-11.5}$

BF(90% c.l.) =
$(4.55^{+0.72}_{-0.68} \pm 0.34) \times 10^{-5}$

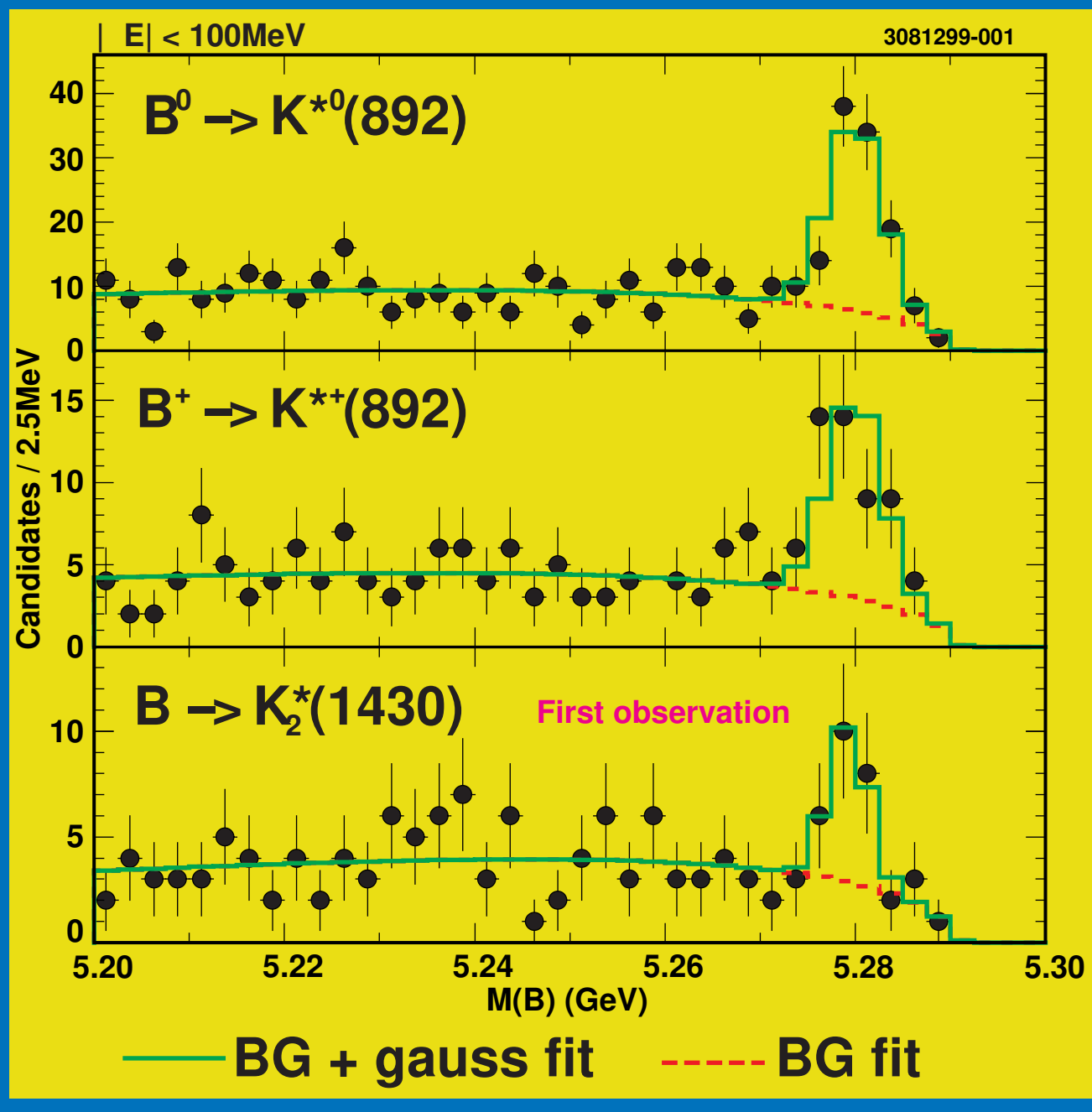
Yield: $36.7^{+8.3}_{-7.6}$

BF(90% c.l.) =
$(3.76^{+0.89}_{-0.83} \pm 0.28) \times 10^{-5}$

Yield: $15.8^{+5.7}_{-5.1}$ (3.3)

BF(90% c.l.) =
$(1.66^{+0.59}_{-0.53} \pm 0.13) \times 10^{-5}$

sum of K_2^{*+} and K_2^{*0}



Exclusive decays: B -> K*

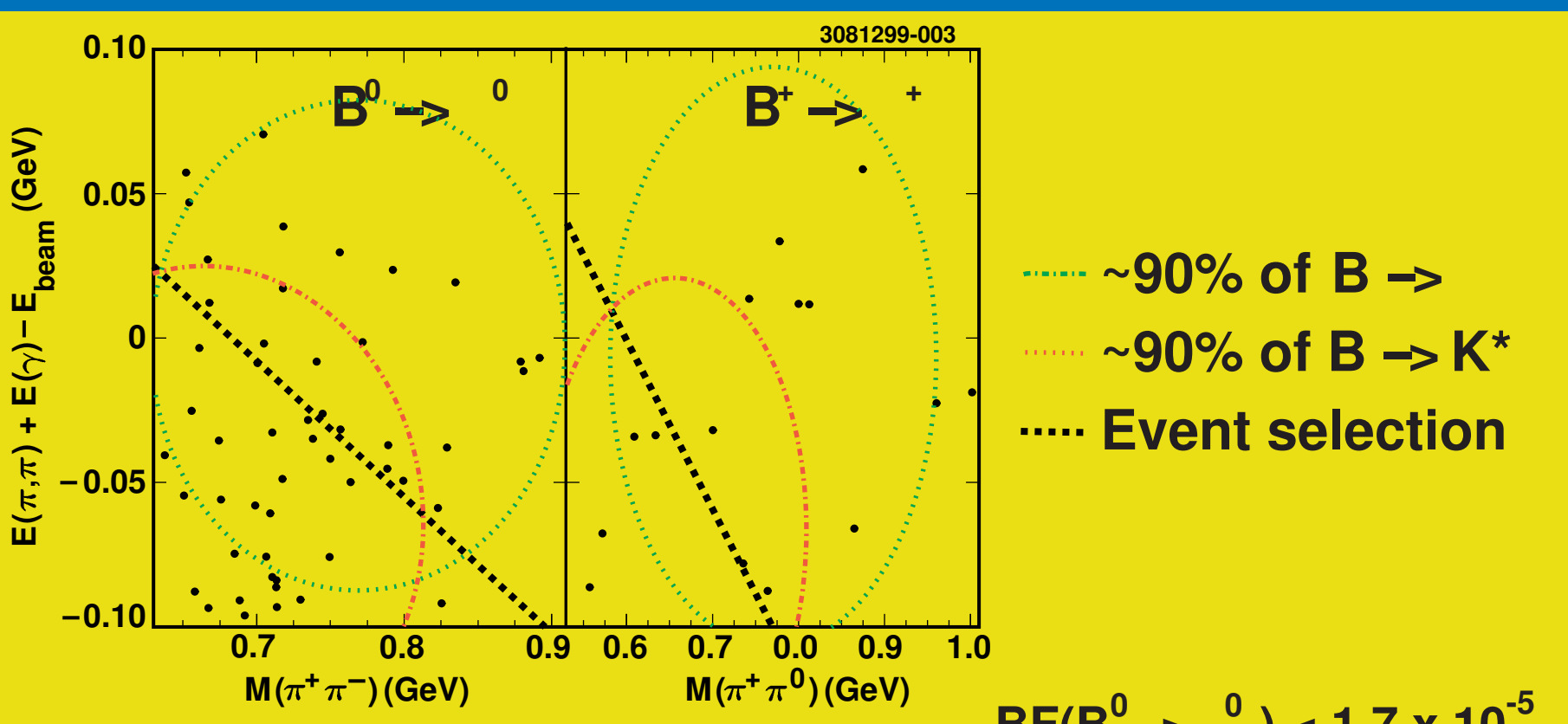
Theory:

	CLEO meas.	prediction
$\frac{BF(B \to K^*_2(1430))}{BF(B \to K^*(892))}$	$0.39^{+0.15}_{-0.13}$	0.37 ± 0.10 (Phys. Lett. B 367 1996, 309) $3.0 -- 4.9$ (Phys. Lett. B 298 1993, 195)

Exclusive decays: B ->

Background

B -> : continuum, B -> K* (id K^+ as $^+$)



~90% of B ->

~90% of B -> K*

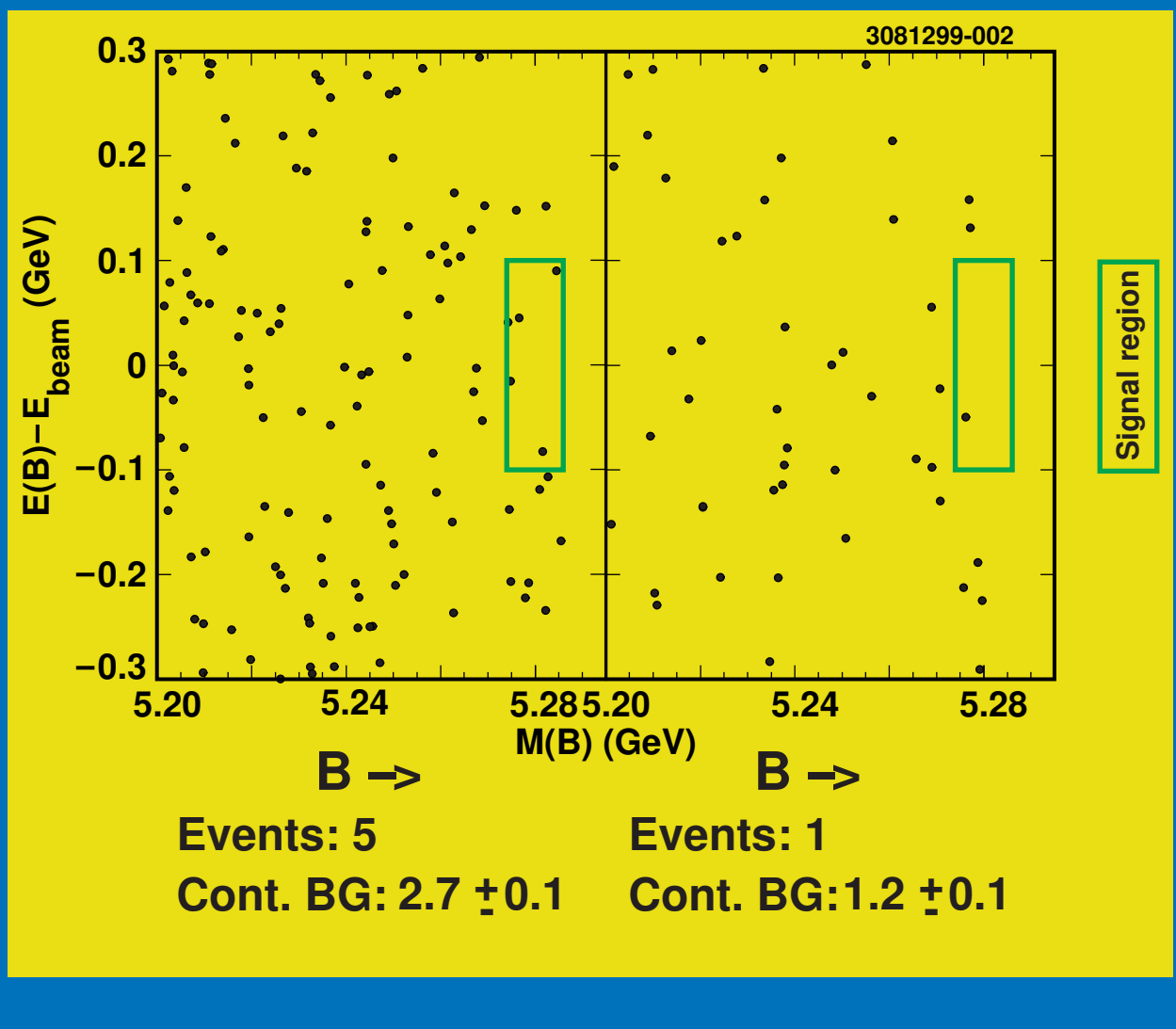
Event selection

Events: 24
Cont. BG: $9.3^{+0.6}_{-0.5}$
K* BG: 5.4 ± 0.8

Events: 10
Cont. BG: 5.2 ± 0.4
K* BG: 2.6 ± 0.6

BF(B^0 -> ^{0}) < 1.7×10^{-5}
BF(B^0 -> $^+$) < 1.3×10^{-5}
(90% c.l.)

Exclusive decays: B -> /



B ->

Events: 5

Cont. BG: 2.7 ± 0.1

B ->

Events: 1

Cont. BG: 1.2 ± 0.1

Background only continuum

Upper limits:

BF(B^0 ->) < 0.92 x 10^{-5}

BF(B^0 ->) < 0.33 x 10^{-5}

(90% c.l.)

Exclusive decays: B -> / /

$|V_{td}/ V_{ts}|$

$$\frac{BF(B \to \quad)}{BF(B \to K^* \ )} = |V_{td}/ V_{ts}|^2$$

= form factor ratio (/K*): 0.58 < < 0.91 (models)

Assume

BF(B ->) = BF(B^+ -> $^+$) = 2BF(B^0 -> ^{0}) = 2BF(B^0 ->)

-> Limit: $| V_{td}/ V_{ts} | < 0.79$ (95% c.l.)

Current best limit (LEP/SLD/CDF): $| V_{td}/ V_{ts} | < 0.24$ (95% c.l.)

Wait for CLEO III!

Exclusive decays: $B^0 \to D^{*0}$

Analysis similar to $B \to K^*$

Reconstruct

$D^{*0} \to D^0 \ ^0$, D^0

$D^0 \to K^+ \ ^-$, $K^- \ + \ ^0$, $K^- \ + \ - \ +$

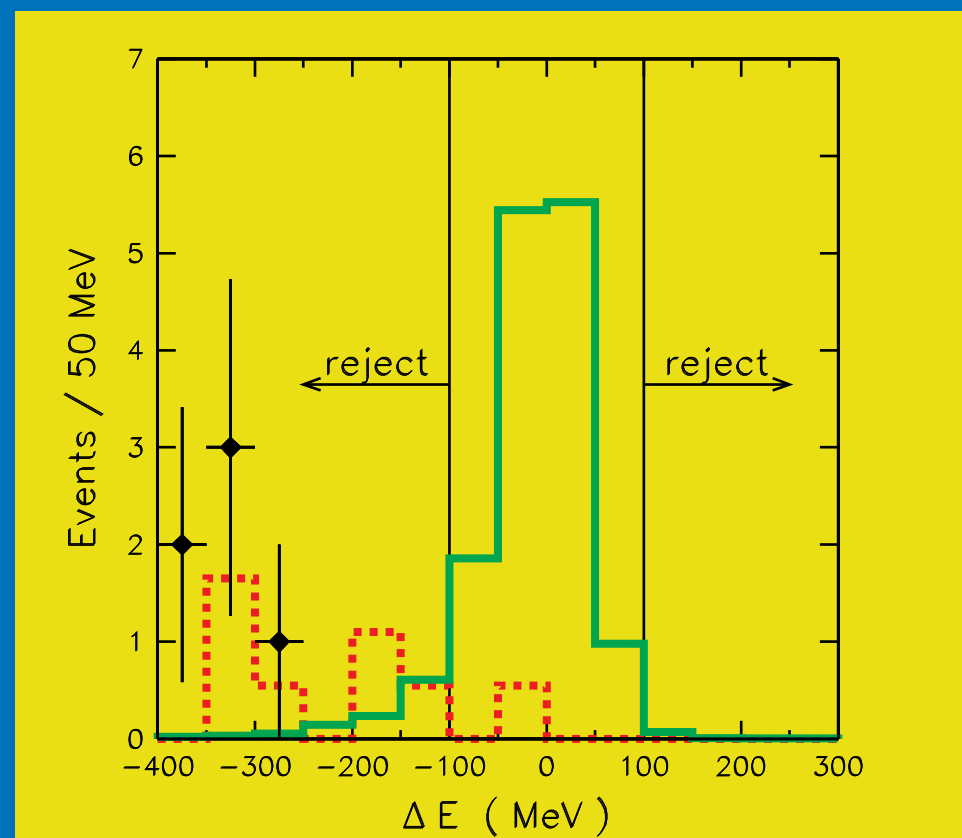
Background: continuum, $B \to D^{*0} \ ^0$

$BF(B \to D^{*0} \ ) < 5.0 \times 10^{-5}$(90%)

Together with

$BF(B^0 \to \quad) < 0.33 \times 10^{-5}$

Indication that radiative B decays are dominated by $b \to s$.



Leptonic decays: $B^+ \to \ ^+$

Motivation:

$$BF(B^+ \to l^+ \ _l) = \frac{G_F^2 m_B m_l^2}{8}(1 - m_l^2/m_B^2)\, f_B^2\, |V_{ub}|^2 \ _B$$

m_l = lepton mass

- BF largest for
- Extract $f_B\,|V_{ub}|$

Full reconstruction of charged B

D^0, D^{*0} (n)$^+$, n = 1-5

D^0 : 8 K modes → net efficiency ~16%

D^{*0} : D^0 ^{0}, D^0 , constraint on D^{*0} mass

reconstruction

→ (e $_e$, ,) (46% of BF)

Require single charged track

Leptonic decays: $B^+ \to \ ^+$

Background suppression

q^2 cut (signal has small q^2 = invariant mass^2 of (n)$^+$)

$|\cos_{\text{thrust}}|$ cut

(continuum background dominates at large values)

No charged tracks left (besides track)

little leftover shower energy

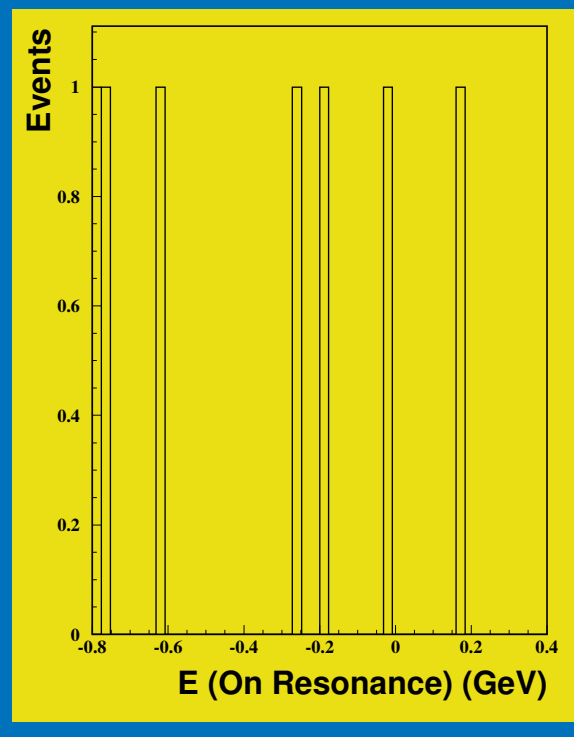
$E_{\text{rest}} < 400\text{-}600$ MeV, ^{0} veto

Find 6 events on resonance

Likelihood fit: 0.96 signal events

BF($B^+ \to \ ^+$) $< 8.4 \times 10^{-4}$ (90% c.l.)

still above SM prediction ($2\text{-}10 \times 10^{-5}$)



Summary

New measurements

$BF(B^0 \to K^{*0}(892)) = (4.55^{+0.72}_{-0.68} \pm 0.34) \times 10^{-5}$

$BF(B^+ \to K^{*+}(892)) = (3.76^{+0.89}_{-0.83} \pm 0.28) \times 10^{-5}$

$BF(B \to K^*_2(1430)) = (1.66^{+0.59}_{-0.53} \pm 0.13) \times 10^{-5}$ first observation

$A_{CP}(B \to K^*) = 0.08 \pm 0.13$

No evidence for B -> , B^0 -> , B^0 -> , $B^0 \to D^{*0}$

$|V_{td}/V_{ts}| < 0.79$ (95% c.l.)

radiative B decays dominated by b -> s

New analysis of B^+ -> $^+$

$BF(B^+ \to {}^+) < 8.4 \times 10^{-4}$ (90% c.l.)

New opportunities with CLEO III