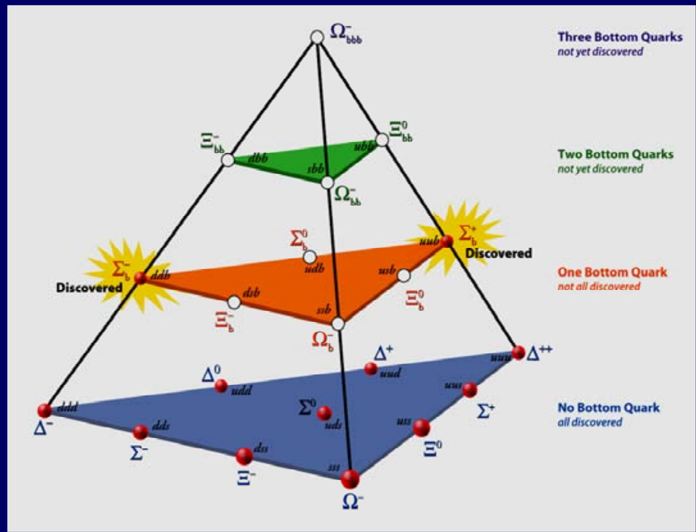
Latest results on b-spectroscopy from CDF



Elena Vataga (Univ. of New Mexico, USA)
On behalf of the CDF Collaboration
CERN - October 31, 2006

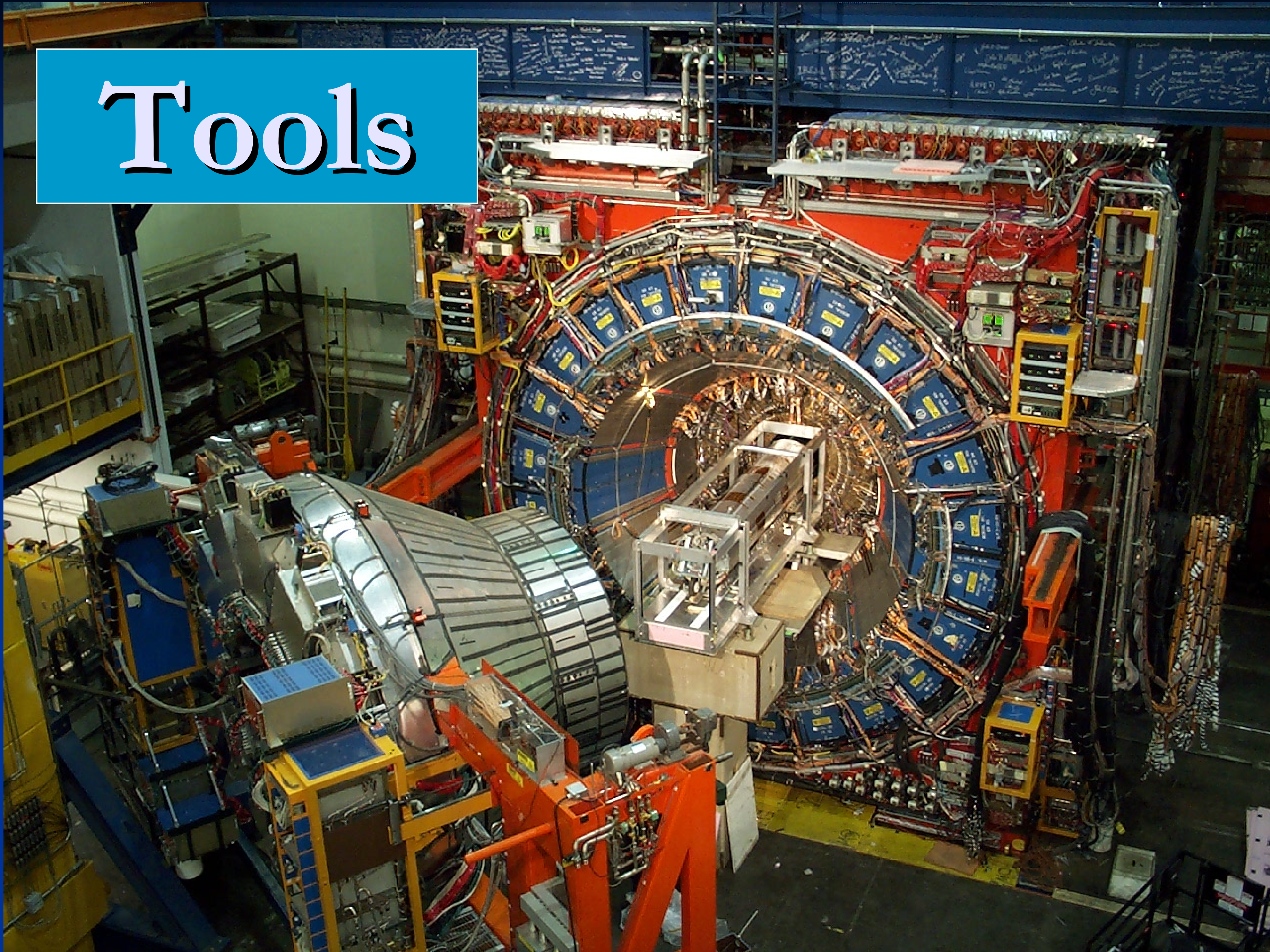
Why B spectroscopy?

- We are not looking for New Physics (but may find subtle discrepancy…)
- Standard Model is extraordinary. Deserves thorough elucidation.
- B-quark discovered in 1977. Wealth of b-mesons is found. Only one b-baryon well established so far.
- Effective theories derived from QCD needed for dynamical understanding: HQET
  - $m_c, m_b, m_t >> \Lambda_{QCD} >> m_u, m_d, m_s \Rightarrow$ Heavy Quark Symmetry
- HQET extensively tested for *Qq* systems; interesting to check predictions for *Qqq* systems

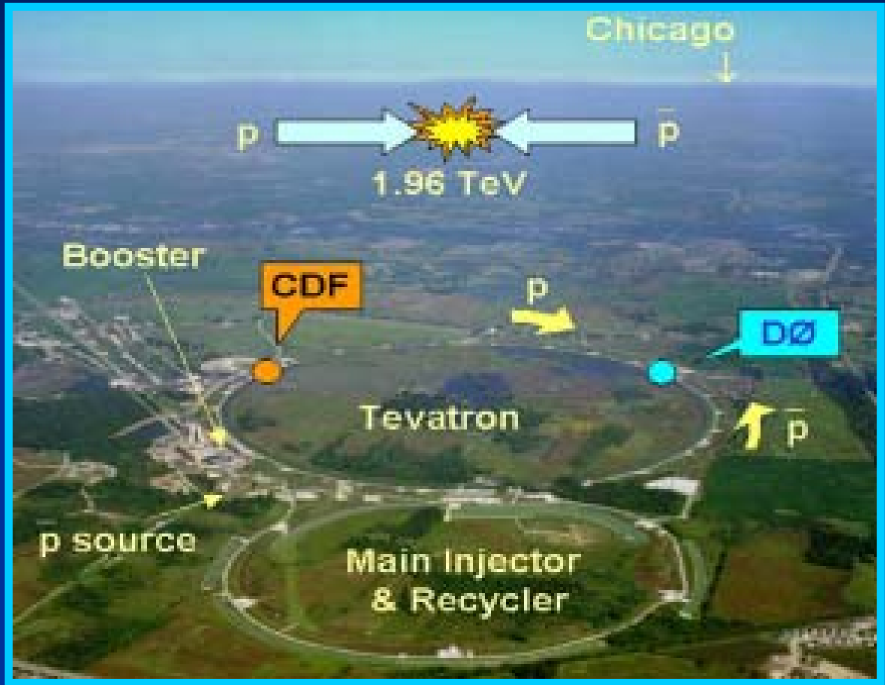
What's new?

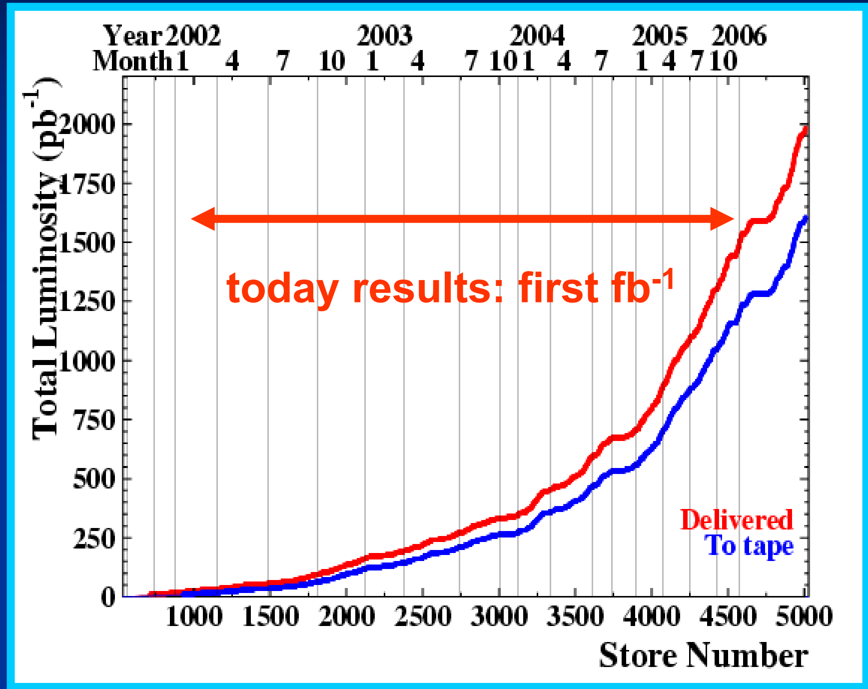
- Observation of orbitally excited B_s^{**} mesons
- Observation and mass measurement of $B_c \rightarrow J/\psi\,\pi$
- Search for $\eta_b \rightarrow J/\psi\,J/\psi$
- Observation of new beauty baryons $\Sigma_b^{\pm(*)}$

Tools



Tevatron





- Excellent performance of Tevatron in last years
- Record Instantaneous luminosity > 2×10^{32} $cm^{-2}\,s^{-1}$
- Now: delivered $\int Ldt=1.8\ fb^{-1}$
- Good for b-physics on tape $\int Ldt=1.3\ fb^{-1}$

The CDF II detector

96 layer drift chamber

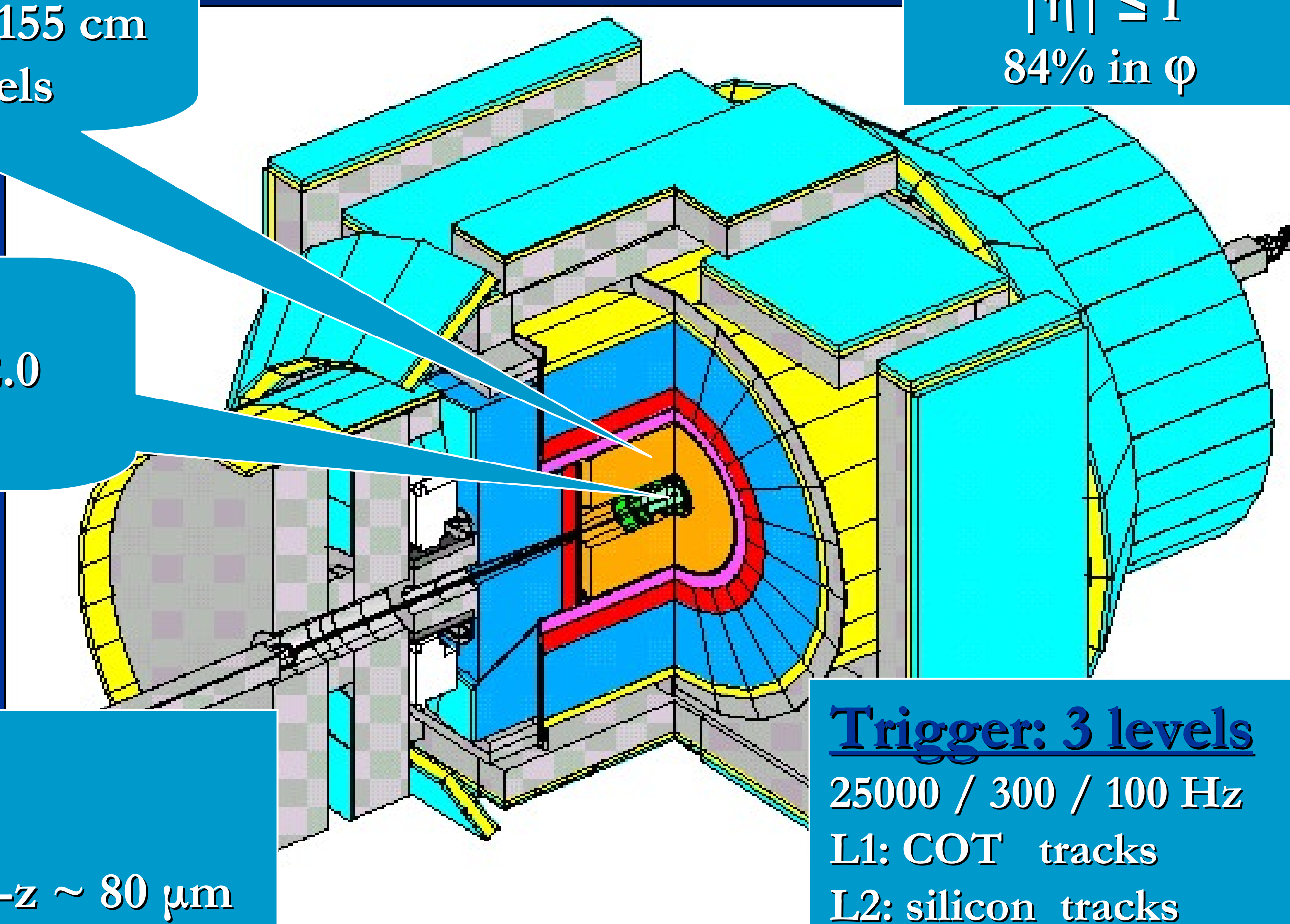
44< r <132 cm, |z|<155 cm

|η| ≤ 1.0, 30k channels

μ coverage

$|\eta| \leq 1$

84% in φ



silicon layers:

90 cm long, $|\eta| \leq 2.0$

$r_{00} = 1.3 \div 1.6$ cm

Resolution:

$p_T \sim 0.15\%\ p_T$

vertex r-φ ~ 30 μm ; r-z ~ 80 μm

J/ψ mass ~14 MeV/c^2

Trigger: 3 levels

25000 / 300 / 100 Hz

L1: COT tracks

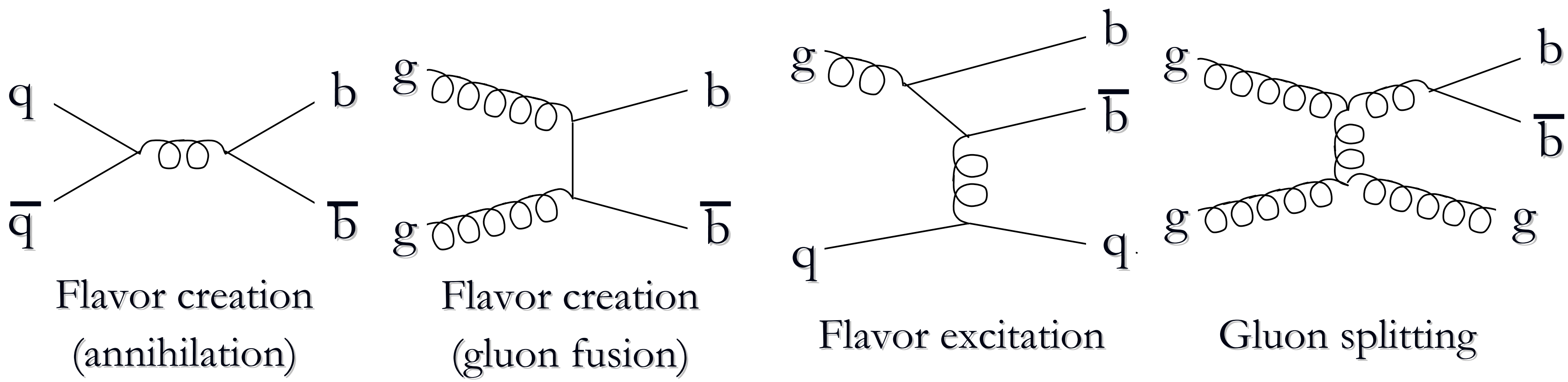
L2: silicon tracks

dead time < 5%

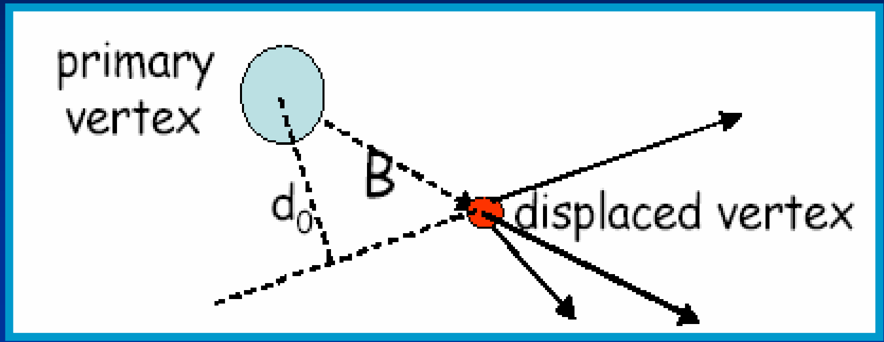
B physics @ Tevatron

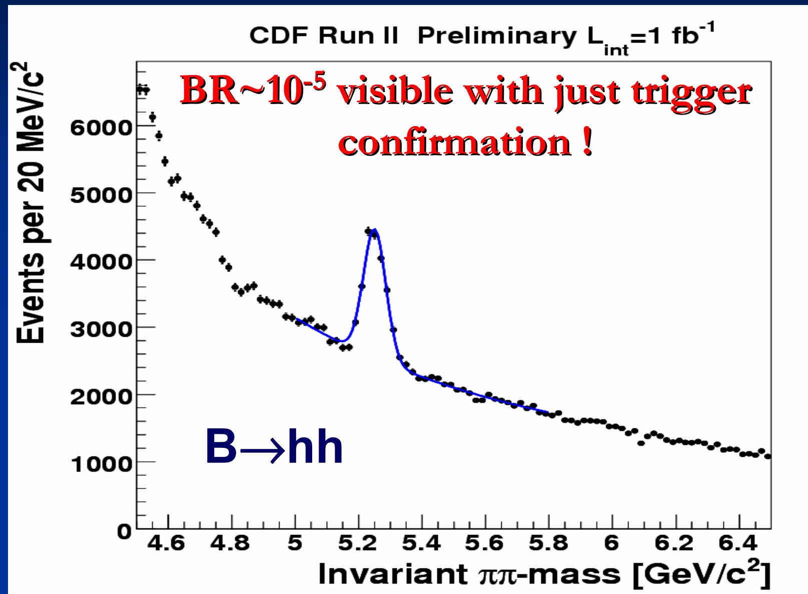
Compared to e^+e^- experiments on Υ(4S) or Z^0

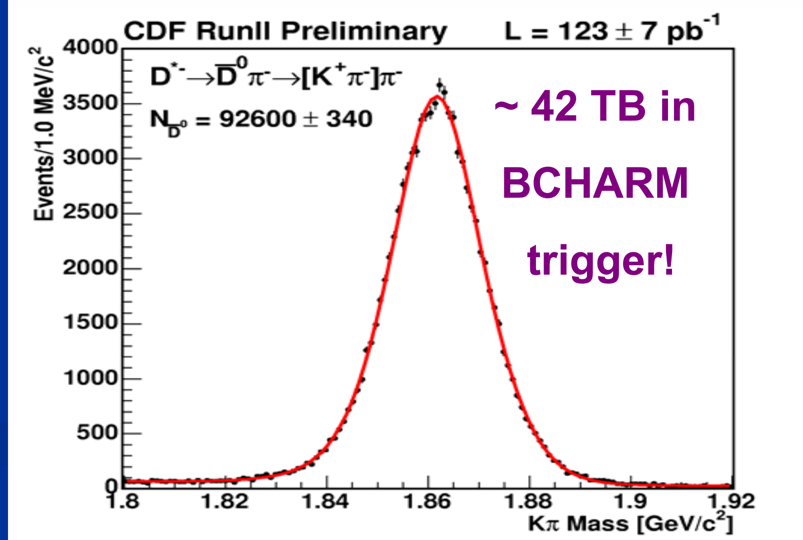
- **Pro:**
  - $p\bar{p} \rightarrow b\bar{b}$ x-section is >1000 times larger (~10 μb)
  - All species of b-hadrons: not just $B^\pm/B^0$, also B_s^0, B_c, Λ_b^0
- **Contro:**
  - QCD background ×10^3 larger than $\sigma(bb)$
  - multiple interactions, large combinatorics.
  - Collision rate ~1.7 MHz → tape writing limit ~100 Hz



B physics @ CDF: triggers are crucial







Trigger configurations:

- Di-muon
- Lepton plus displaced track
- 2 displaced tracks

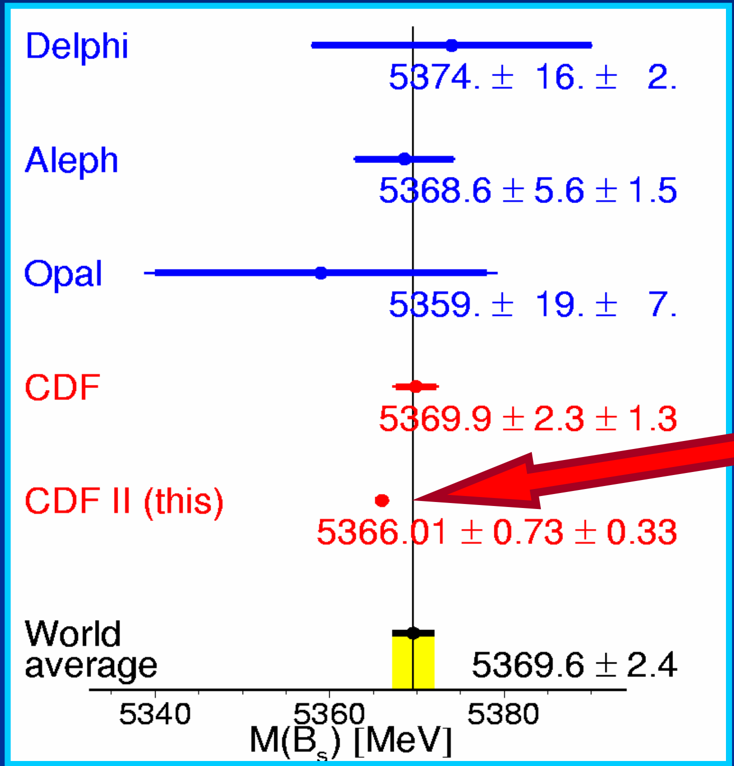
Secondary Vertex Trigger (SVT) is unique to CDF!

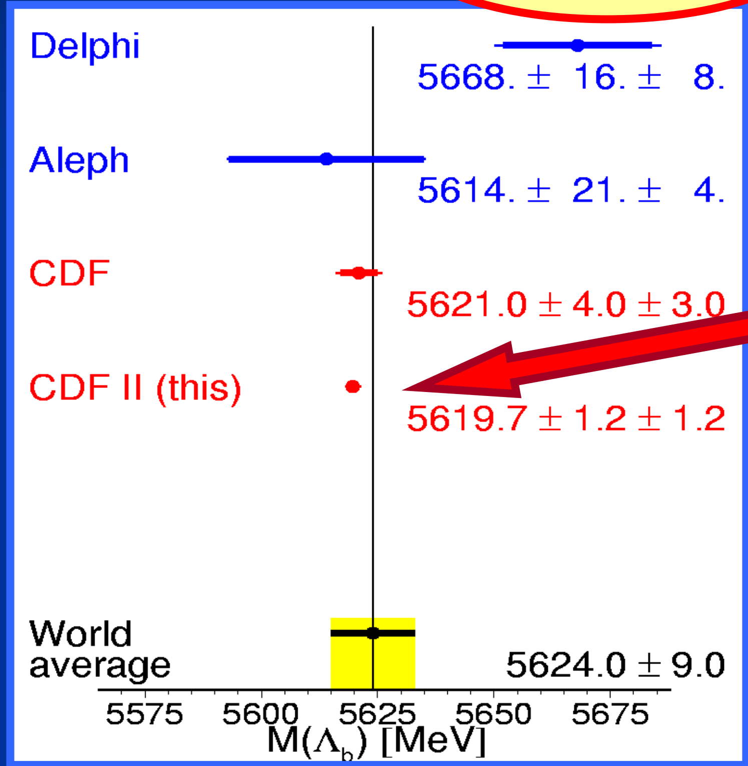
First of its kind to trigger on fully hadronic b/c decays

B_s and Λ_b mass measurements

PRL 96, 202001 2006

220 pb $^{-1}$

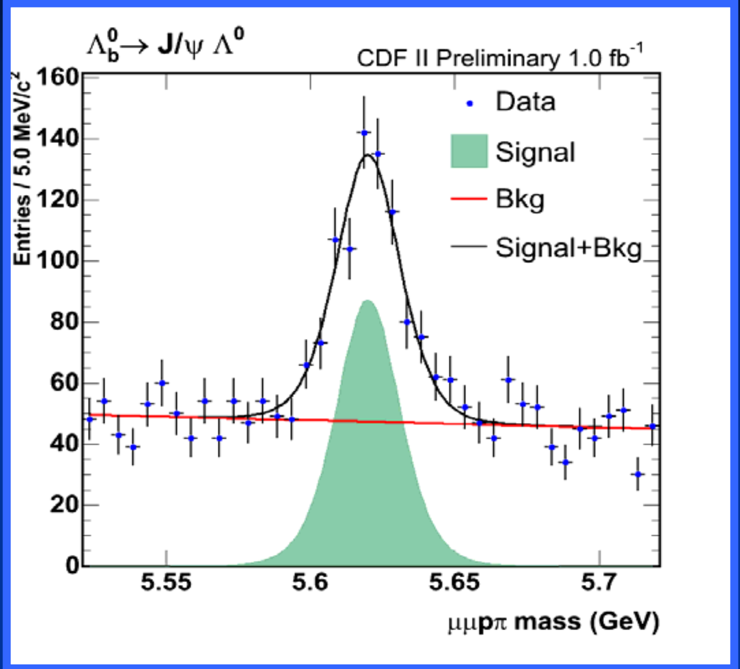


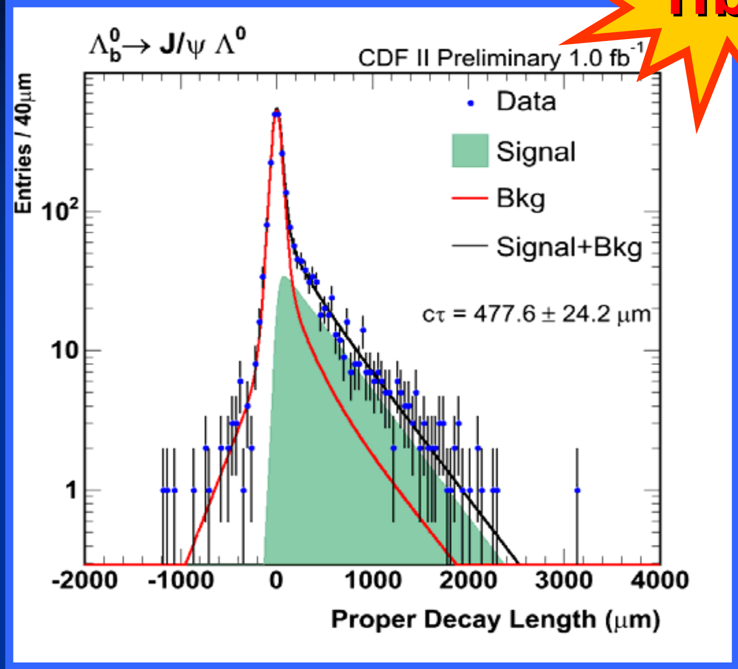


better precision than the current world overage!

Λ_b Lifetime

1fb $^{-1}$

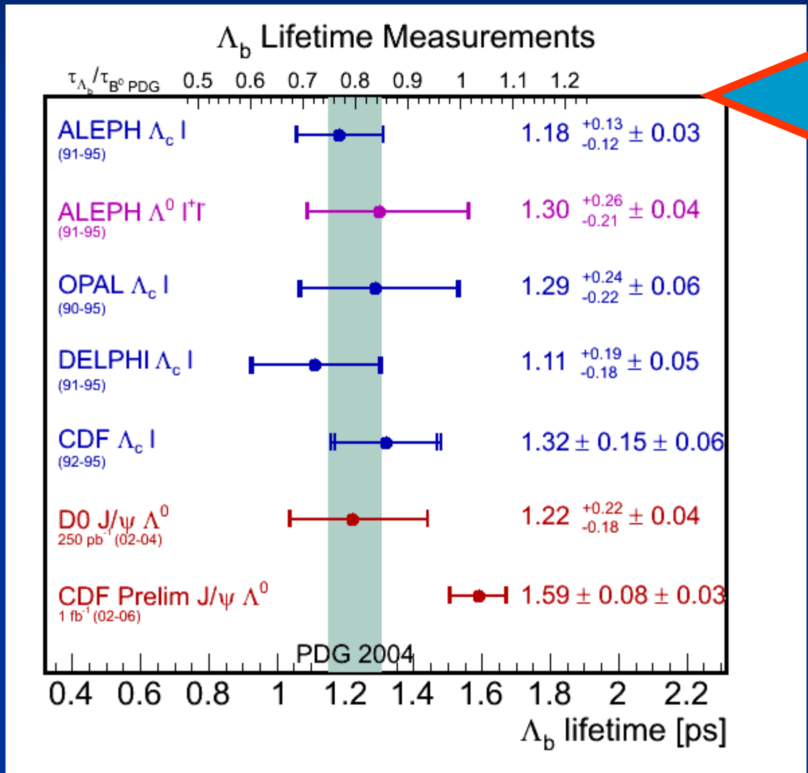




- Measured with fully reconstructed $\Lambda_b \to J/\psi\ \Lambda^0$ decay
- 542 Λ_b candidates
- World best $\tau(\Lambda_b)$ measurement !

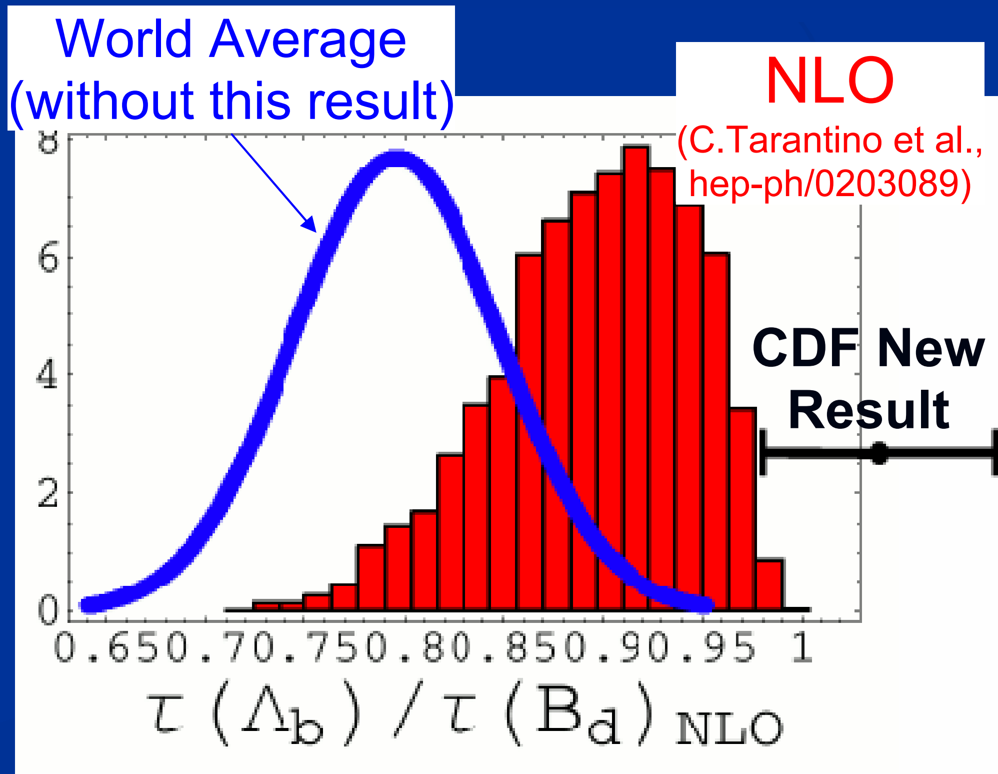
$$\tau(\Lambda_b^0) = 1.593\ ^{+0.083}_{-0.078}(stat) \pm 0.02(syst)\ \text{ps}$$
$$\tau(\Lambda_b^0)/\tau(B^0) = 1.037 \pm 0.058\ (\tau(B^0)\ \text{from World Average})$$

Λ_b Lifetime vs theory



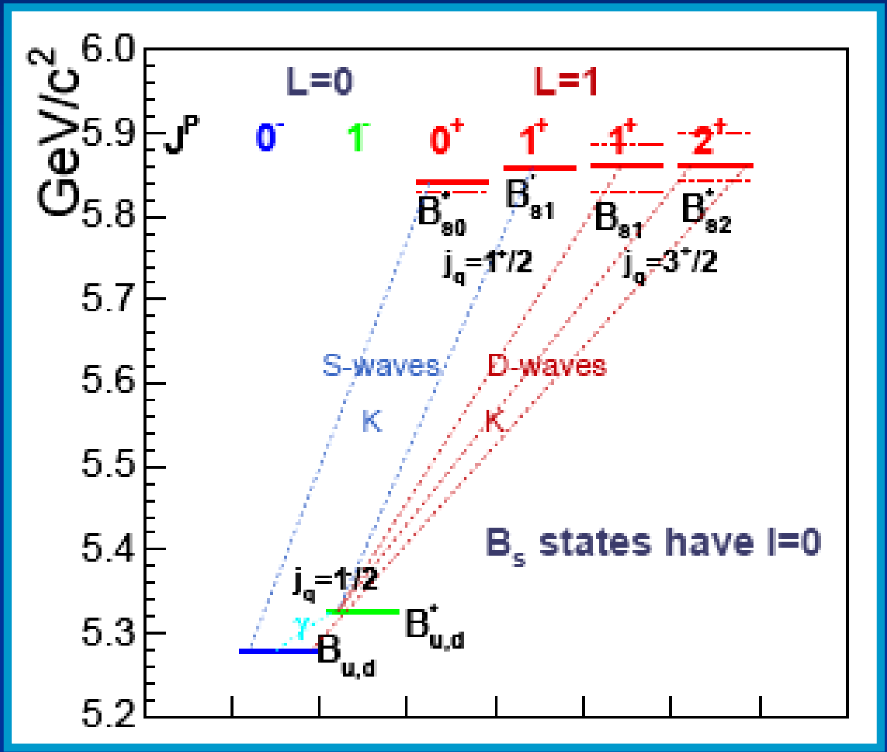
As precise as previous world average

3.1 σ different though!



Observation of orbitally excited (L=1) B_s^{**} mesons

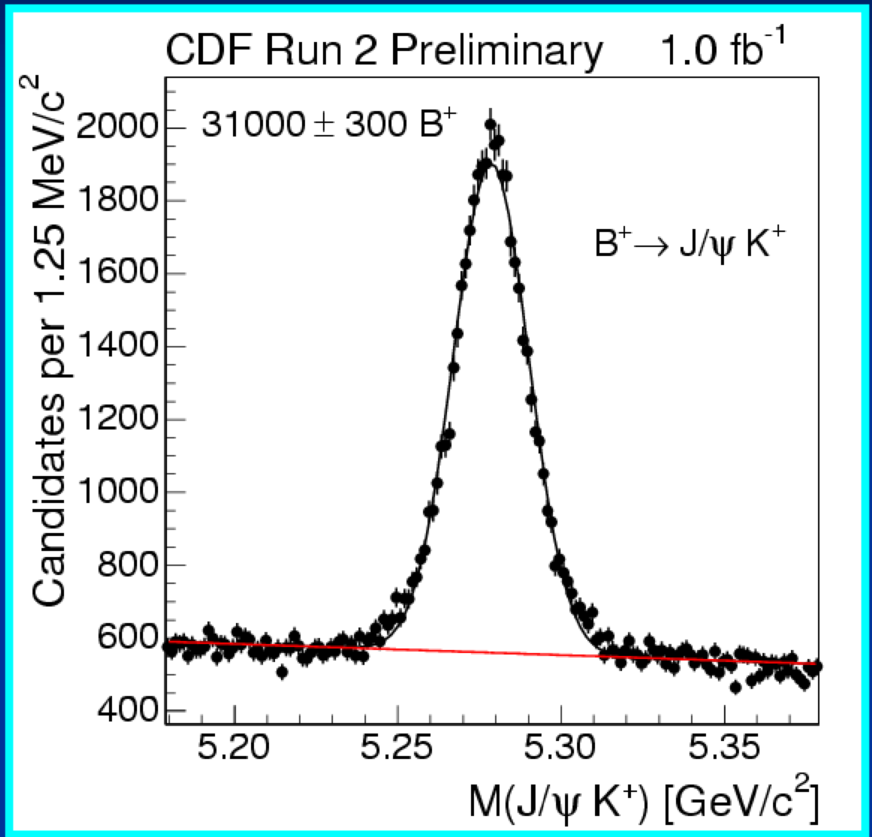
Orbitally Excited B_{sJ} Mesons

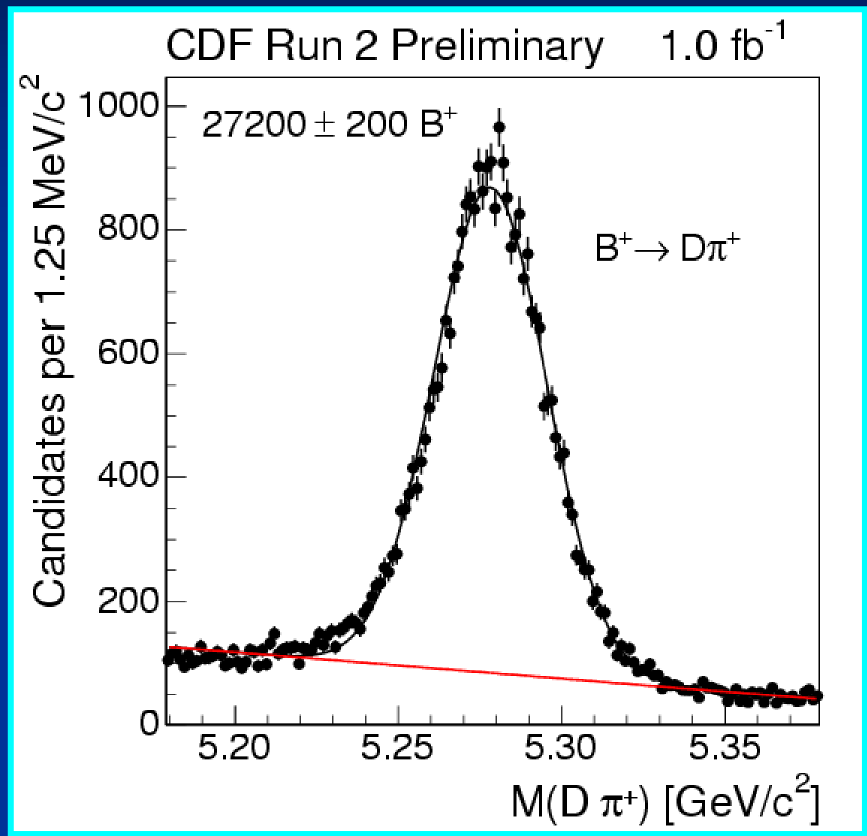


j_q	J^P	B_s^*	Decay	Width
1/2	0^+	B_{s0}	BK	Broad (S-wave)
1/2	1^+	B_{s1}	B^*K	Broad (S-wave)
3/2	1^+	B_{s1}	B^*K	Narrow (D-wave)
3/2	2^+	B_{s2}^*	BK, B^*K	Narrow (D-wave)

- $B^{*+} \to B^+\gamma$, where γ is undetected
- Shift of possible B_{s2}^*, B_{s1} peaks by $\Delta M(B^{*+} - B^+) = 45.78$ MeV/c^2 (see PDG)
- Two channels: $B^+ \to J/\psi K$, $B^+ \to D\pi$

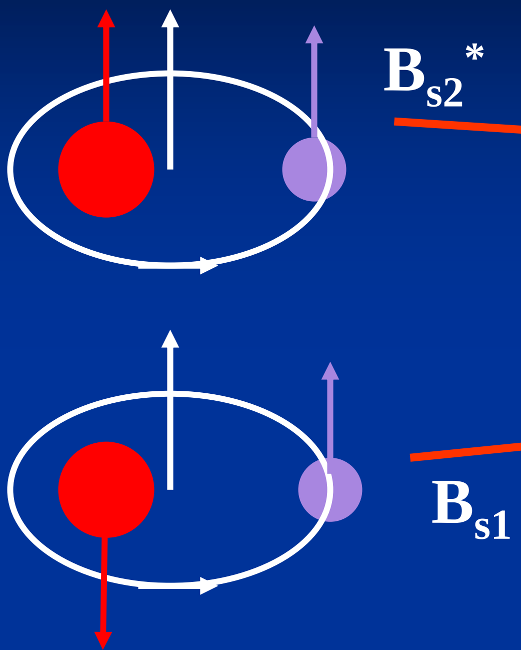
B^+ sample: ~58 000!

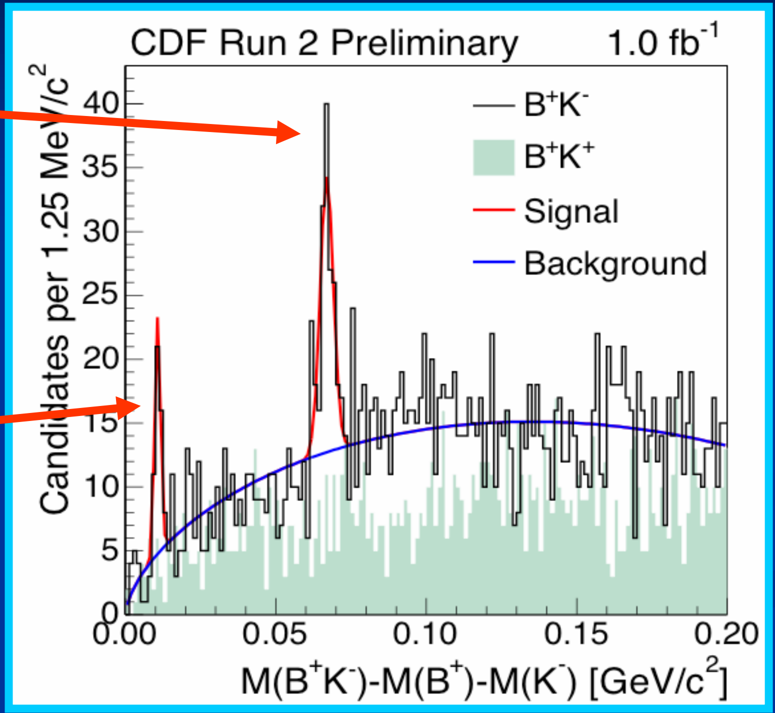




Use Neural Network to optimize both B^+ and B_s^{**}

Orbitally Excited B_s-mesons



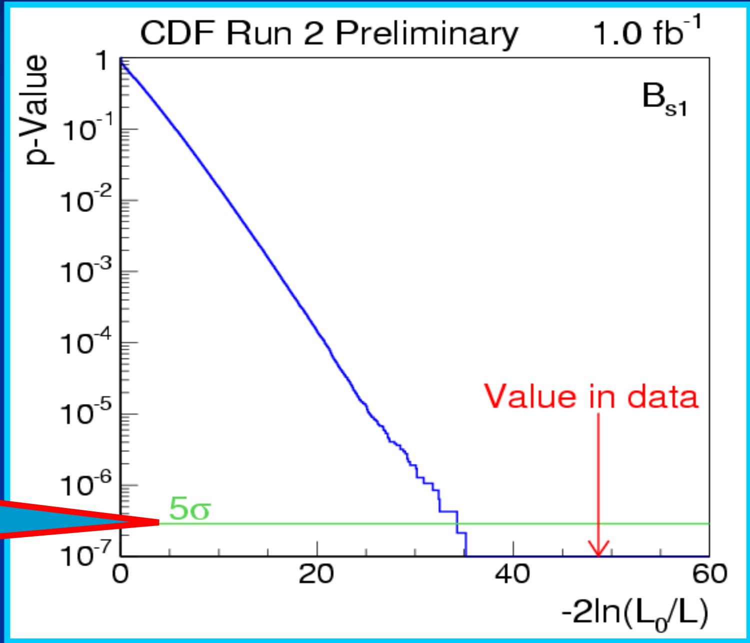


Two signals:

- B^*_{s2} already seen by OPAL, DELPHI and DØ
- B_{s1} ⇒ first observation!

Discovery of B_{s1}

- $N\ (B^*_{s2}) = 94.8 \pm 23.4(\text{stat})$
- $N\ (B_{s1}) = 36.4 \pm 9.0(\text{stat})$

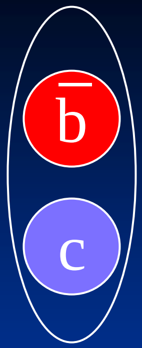


P-value from Toy MC ~ 2×10-7

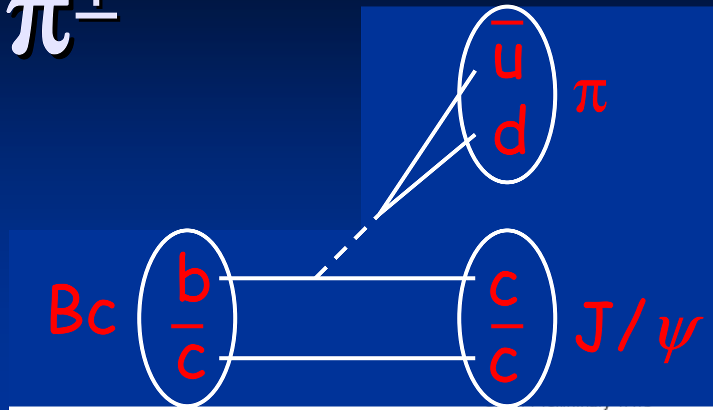
Greater than 5 σ !

$$m(B_{s1}) = 5829.41 \pm 0.21\,(\text{stat}) \pm 0.14\,(\text{syst}) \pm 0.6\,(\text{PDG})\ \text{MeV}/c^2$$
$$m(B^*_{s2}) = 5839.64 \pm 0.39\,(\text{stat}) \pm 0.14\,(\text{syst}) \pm 0.5\,(\text{PDG})\ \text{MeV}/c^2$$

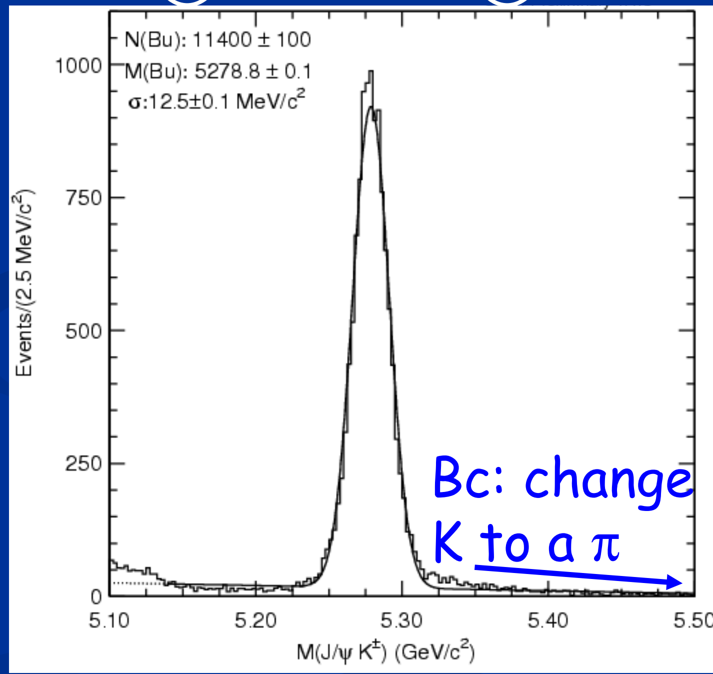
Observation of $B_c \rightarrow J/\psi\ \pi$ and mass measurement of B_c



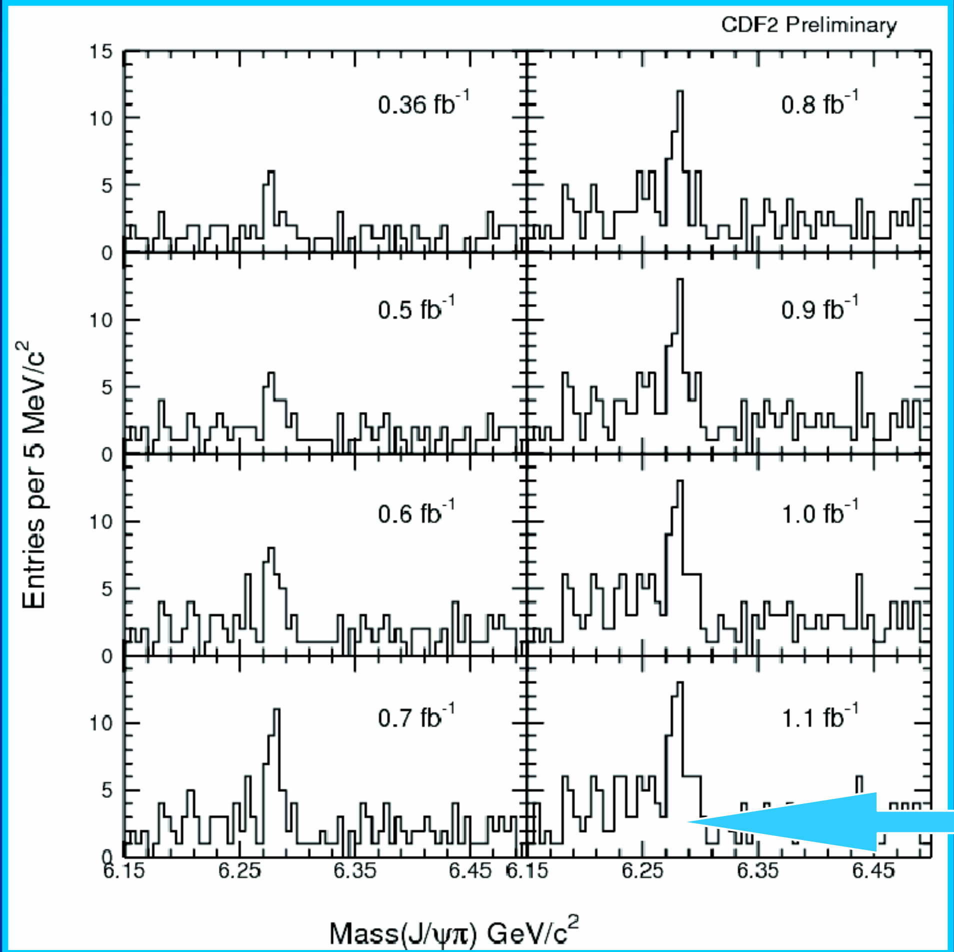
$B_c^{\pm} \rightarrow J/\psi\ \pi^{\pm}$

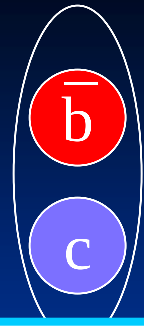


- B_c is not produced at B factories
- Observed in semileptonic mode
- Full reconstruction allows for precise mass measurement
- New analysis
  - Tune selection on $B^{+} \rightarrow J/\psi\ K^{+}$
  - After approval, "open box".
  - Wait for significant excess
  - Measure properties of the Bc

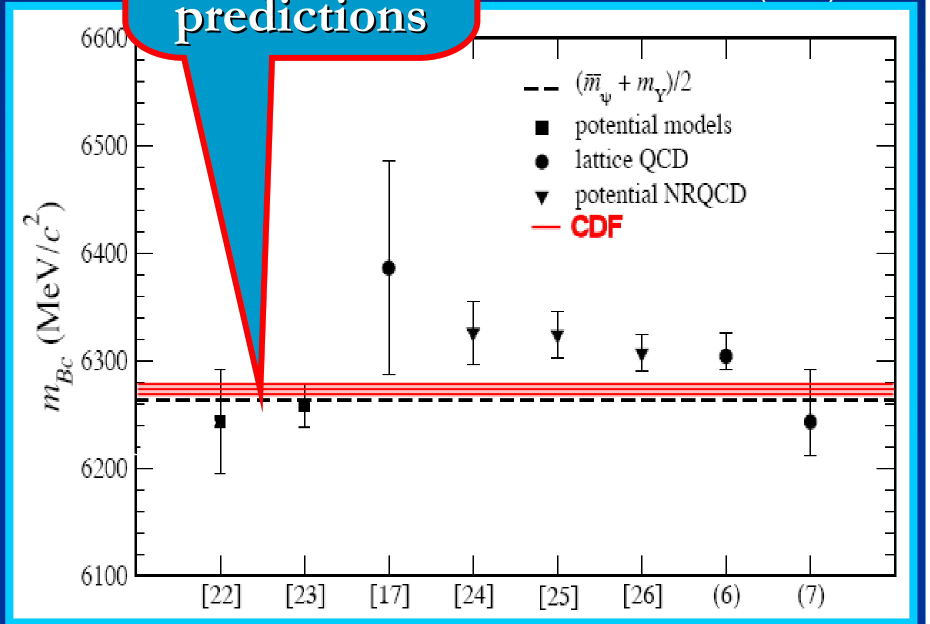


$B_c^{\pm} \rightarrow J/\psi\ \pi^{\pm}$





Challenges theoretical predictions

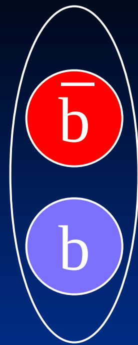


$N(B_c) = 45.2 \pm 9.4$, $S/\sqrt{B} = 7.5$

$m(B_c) = 6276.5 \pm 4.0$ (stat) $\pm$ 2.7(syst) MeV/c^2

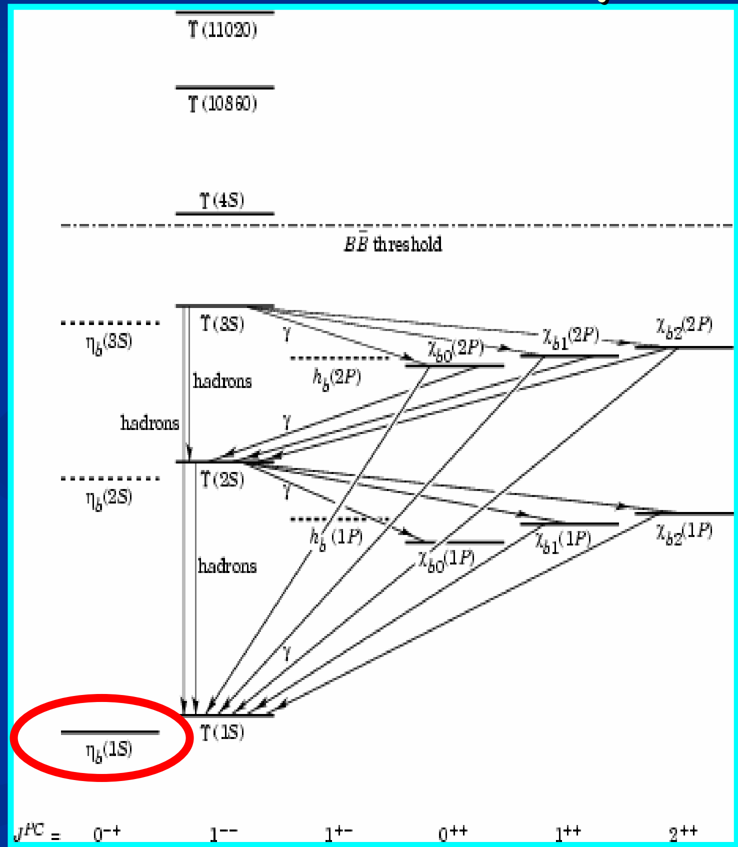
Search for $\eta_b \rightarrow J/\psi \, J/\psi$

Introduction



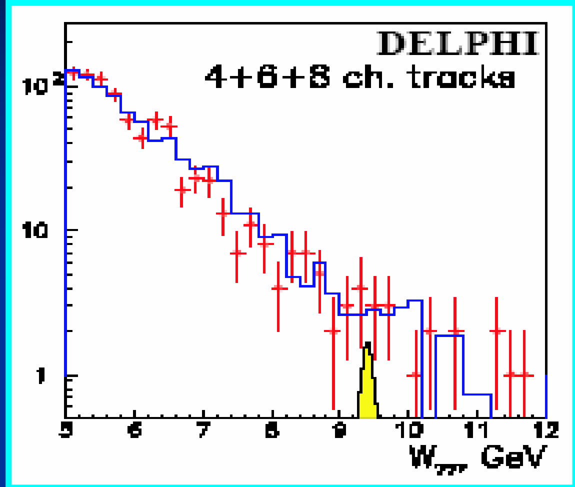
- Spin-singlet $b\bar{b}$ bound state
- $\sigma(p\bar{p} \to \eta_b X) \sim \mu b$ level at Tevatron energy scale
- Large uncertainty on decay branching fraction:
  - $BR(\eta_b \to J/\psi J/\psi \to \mu\mu\mu\mu) \sim 10^{-7 \div -5}$

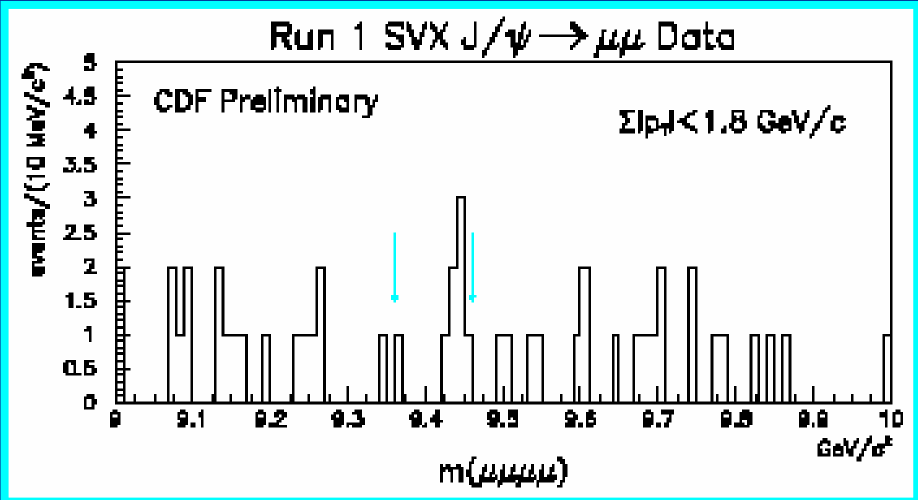
The Bottomonium system

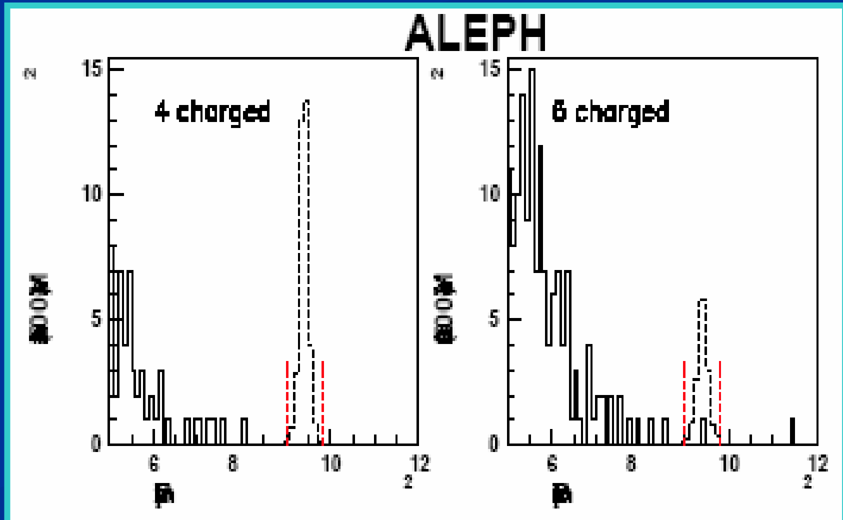


Search for $\eta_b \to J/\psi J/\psi$

- Exclusive search from CDF RunI and LEP
- Inclusive search from CLEO
  ($\Upsilon(nS) \to \eta_b \gamma$; $h_b \to \eta_b \gamma$)
- No significant evidence yet.







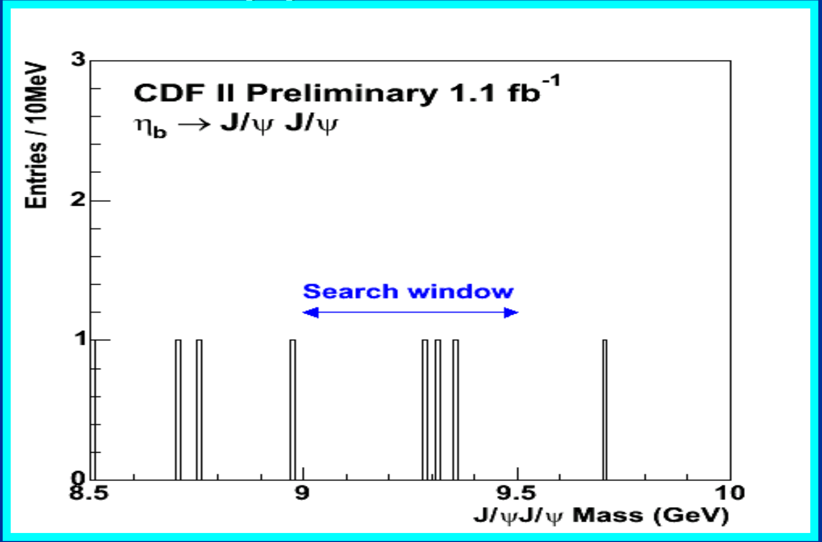
Run I history (80 pb^{-1}):

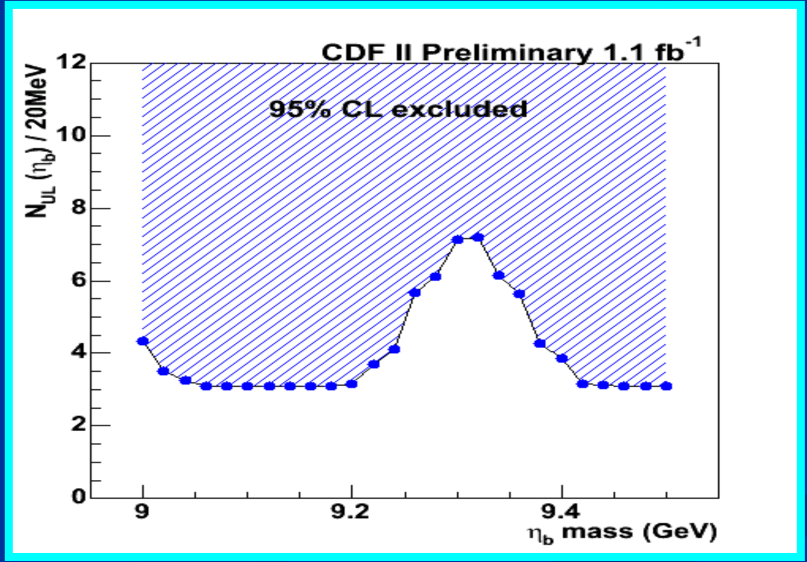
- 7 events observed/ 1.8 backgr. (2.2 σ)
- Upper limit 18 pb

Results

- Expected 3.6 bkg events; observe 3 events
- Set upper limit for

$$\frac{\sigma(p\bar{p} \to \eta_b X) \cdot Br(\eta_b \to J/\psi J/\psi)}{\sigma(p\bar{p} \to b \to J/\psi X)} < 4.98 \times 10^{-3}$$





$$\sigma(p\bar{p} \to \eta_b X, |y(\eta_b)| < 0.6, p_T(\eta_b) > 3GeV) \cdot Br(\eta_b \to J/\psi J/\psi) \cdot [Br(J/\psi \to \mu\mu)]^2 < 2.6 \text{ pb}$$

Observation of new beauty baryons $\Sigma_b^{\pm(*)}$

http://www.fnal.gov/pub/presspass/press_releases/sigma-b-baryon.html

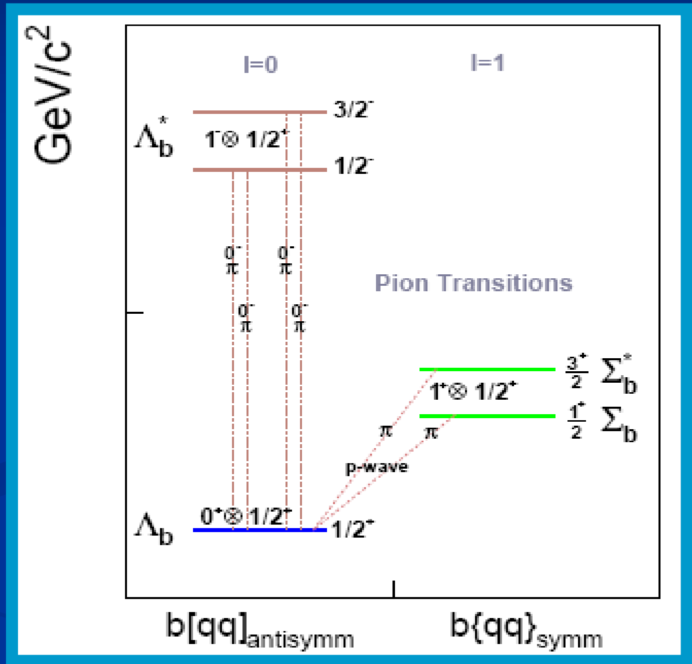
Bottom Baryon States with B=1,C=0,J^P = $1/2^+$, $3/2^+$

Notation	Quark content	J^P	SU(3)	(I,I_3)	S	Mass
Λ_b^0	**b[ud]**	**$1/2^+$**	**3***	**(0,0)**	**0**	**5619.7±1.2±1.2 MeV**
Ξ_b^0	b[su]	$1/2^+$	3*	(1/2,1/2)	-1	5.80 GeV
Ξ_b^-	b[sd]	$1/2^+$	3*	(1/2,-1/2)	-1	5.80 GeV
Σ_b^+	**buu**	**$1/2^+$**	**6**	**(1,1)**	**0**	**5.82 GeV**
Σ_b^0	b{ud}	$1/2^+$	6	(1,0)	0	5.82 GeV
Σ_b^-	**bdd**	**$1/2^+$**	**6**	**(1,-1)**	**0**	**5.82 GeV**
$\Xi_b^{0\prime}$	b{su}	$1/2^+$	6	(1/2,1/2)	-1	5.94 GeV
$\Xi_b^{0\prime}$	b{sd}	$1/2^+$	6	(1/2,-1/2)	-1	5.94 GeV
Ω_b^0	bss	$1/2^+$	6	(0,0)	-2	6.04 GeV
Σ_b^{*+}	**buu**	**$3/2^+$**	**6**	**(1,1)**	**0**	**5.84 GeV**
Σ_b^{*0}	bud	$3/2^+$	6	(1,0)	0	5.84 GeV
Σ_b^{*-}	**bdd**	**$3/2^+$**	**6**	**(1,-1)**	**0**	**5.84 GeV**
Ξ_b^{*0}	bus	$3/2^+$	6	(1/2,1/2)	-1	5.94 GeV
Ξ_b^{*-}	bds	$3/2^+$	6	(1/2,-1/2)	-1	5.94 GeV
Ω_b^{*-}	bss	$3/2^+$	6	(0,0)	-2	6.06 GeV

Mass predictions from hep-ph/9406359

Predictions on $\Sigma_b^{-(*)}/\Sigma_b^{+(*)}$ properties

Σ_b property	Expected val. (MeV/c²)
$m(\Sigma_b) - m(\Lambda_b)$	$180 \div 210$
$m(\Sigma_b^*) - m(\Sigma_b)$	$10 \div 40$
$m(\Sigma_b^-) - m(\Sigma_b^+)$	$5 \div 7$
$\Gamma(\Sigma_b)$, $\Gamma(\Sigma_b^*)$	~8, ~15

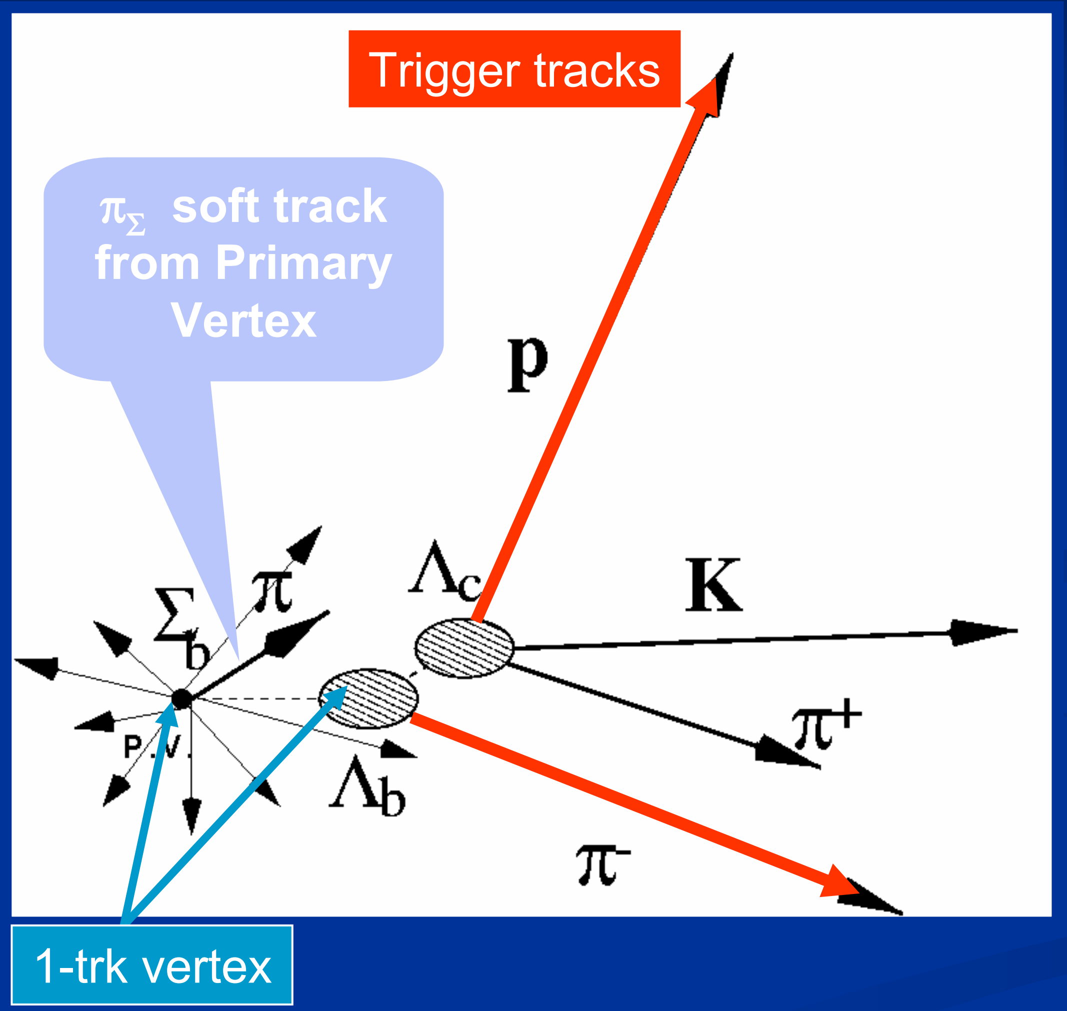


- NRQCD, HQET
- Potential models
- $1/N_c$ expansions
- Lattice QCD calculations

Strong decay with π emission:

$$\Sigma_b \to \Lambda_b \pi$$

Methodology



Decay chain:

$\Sigma_b^{-(*)} \to \Lambda_b^0 \pi^-$

$\Lambda_b^0 \to \Lambda_c^+ \pi^-$

$\Lambda_c^+ \to p K^- \pi^+$

Strategy

Optimize Λ_b yield

Blind Σ_b signal region

Check for possible reflections from other B decays

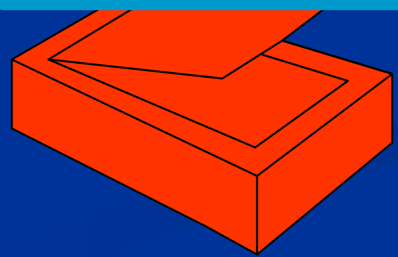
Evaluate different background contributions

Optimize Σ_b selection (MC)

Estimate detector resolution for Σ_b (MC)

Understanding of background is crucial!

OPEN THE BOX



Set the limit

Measure Σ_b yields and Masses

Discriminating variable

- Search for narrow resonances in
  - $Q = m(\Lambda_b \pi) - m(\Lambda_b) - m(\pi)$
- Blinded region $0.03 < Q < 0.10$ GeV/c^2
- Work with 2 distributions

  (expect $m(\Sigma_b^-) > m(\Sigma_b^+)$)
  - Same Charge (SC):

    $\Sigma_b^{-(*)} \rightarrow \Lambda_b^0 \pi^- \rightarrow \Lambda_c^+ \pi^- \pi^-$ (+ c.c)
  - Opposite charge (OC):

    $\Sigma_b^{+(*)} \rightarrow \Lambda_b^0 \pi^+ \rightarrow \Lambda_c^+ \pi^- \pi^+$ (+ c.c)

Remove Λ_b resolution

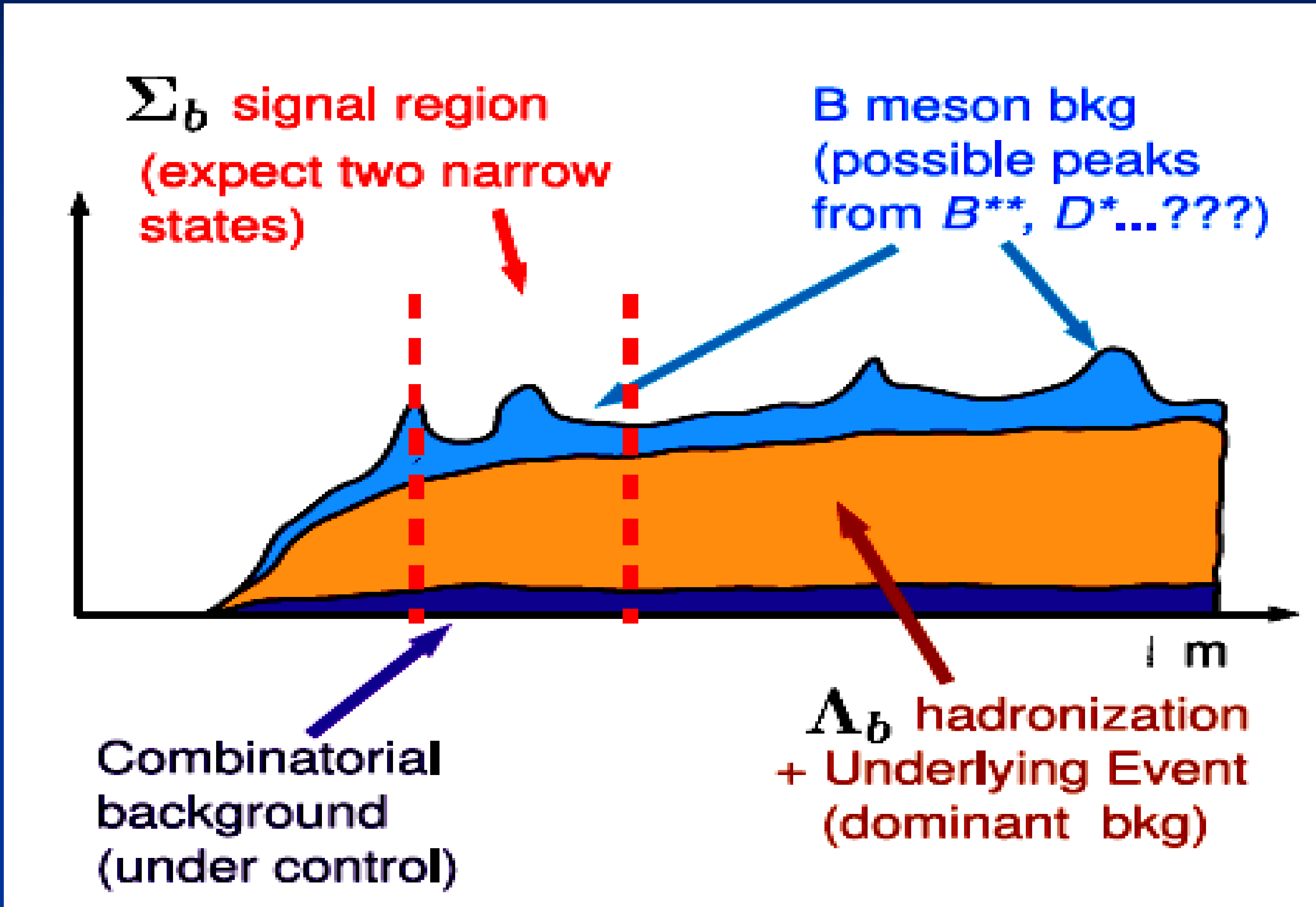
$5.787 < m(\Sigma_b) < 5.857$ GeV/c^2

Σ_b^-(bdd) and anti-Σ_b^-

Σ_b^+(buu) and anti-Σ_b^+

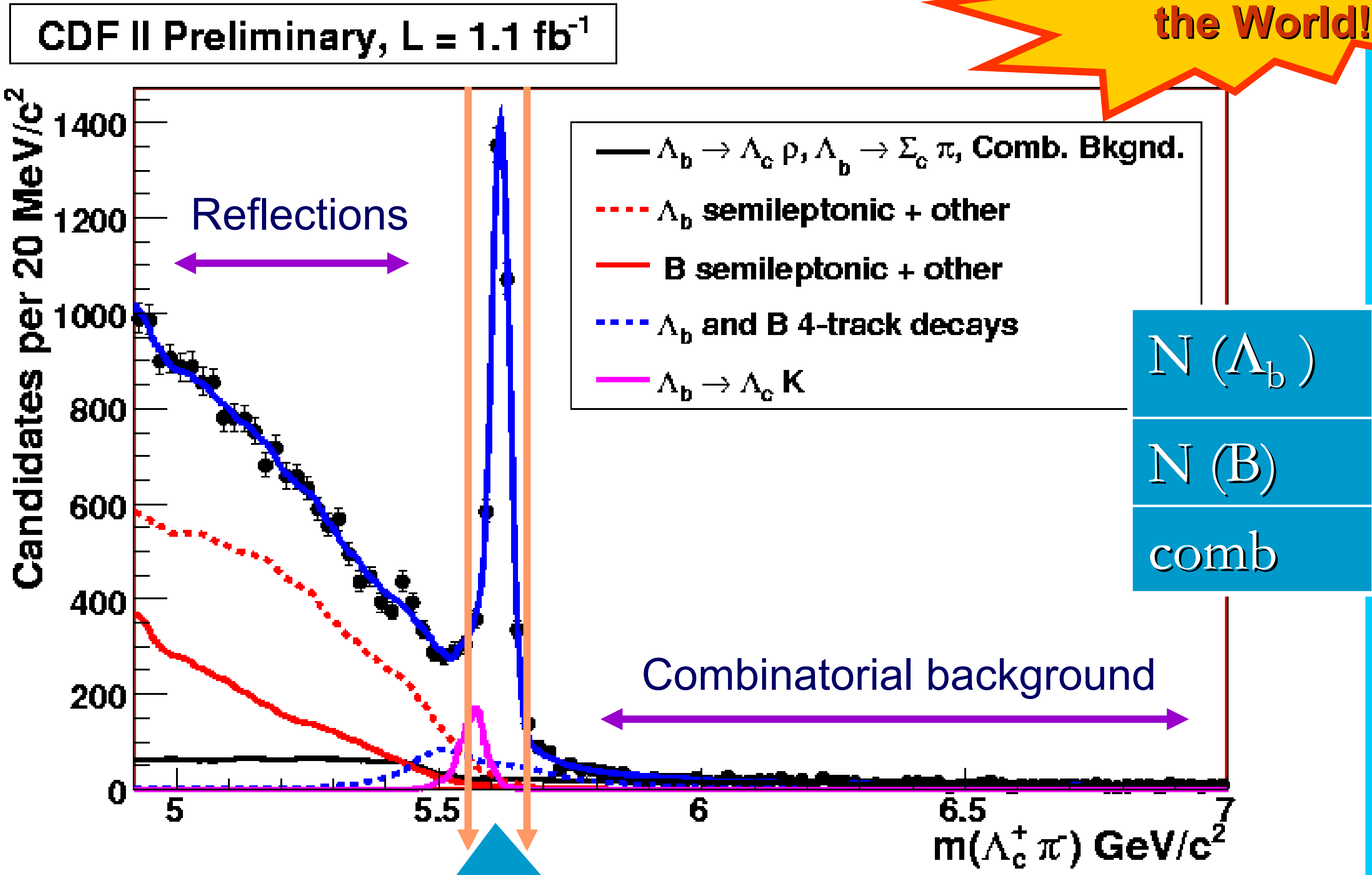
Two π have same/opposite charge

Expected background



Λ_b sample

Largest in the World!



N (Λ_b)	86 %
N (B)	10 %
comb	4 %

Signal region: [5.565, 5.670]

Σ_b optimization

- Cut are optimized with signal region blinded.
- Signal is taken from PYTHIA
- Background is taken from the sidebands.
- Optimization is done maximizing FOM $\varepsilon(S)/\sqrt{B}$
- No cut on p_T (π_Σ)

cross-check on $D^* \to D^0 \pi$, included in systematic

Cut	Value
P_T (Σ_b)	> 9.5 GeV/c
$\lvert d0/\sigma(d0) \rvert$ (π_Σ)	< 3
$\cos\theta^*$ (π_Σ)	> -0.35

Background Composition

Background type		Sample	Contribution
Λ_b HA+UE		PYTHIA	Dominant
Combinatorial		Upper Λ_b sideband $m(\Lambda_b) \in$ [5.8, 7.0]	Small (~ 5%)
B mesons		data	Small (~10%)
~~B meson reflections~~	~~π_Σ from B HA+UE~~	~~PYTHIA~~	~~Dominant within B~~
	~~π_Σ from B decay (D*, D**)~~	~~Inclusive BGen~~	~~negligible~~
	~~π_Σ from B**~~	~~B0 PYTHIA~~	~~negligible~~

replaced

Corrections to MC samples

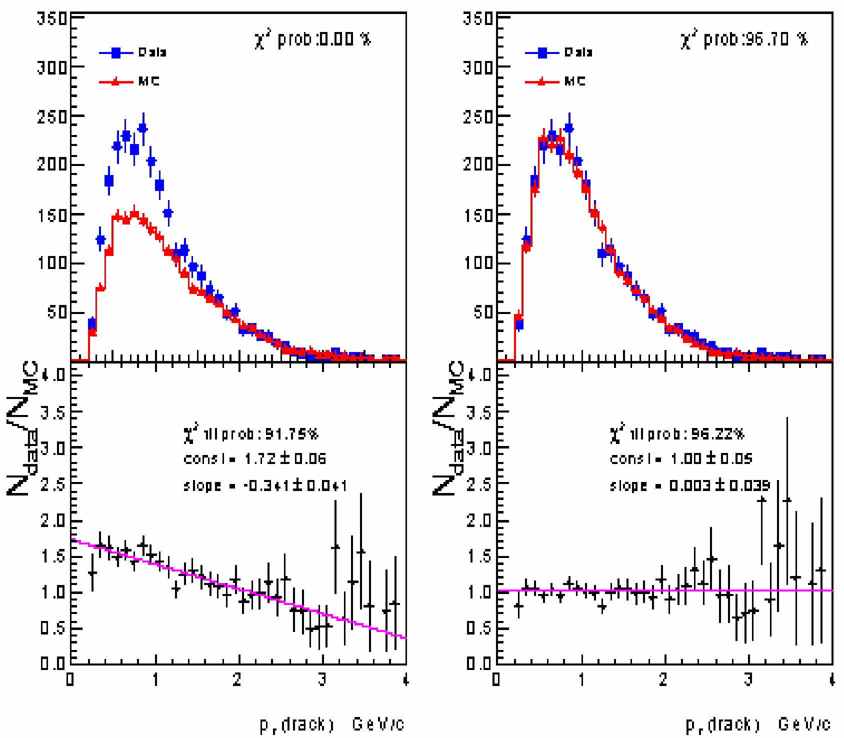
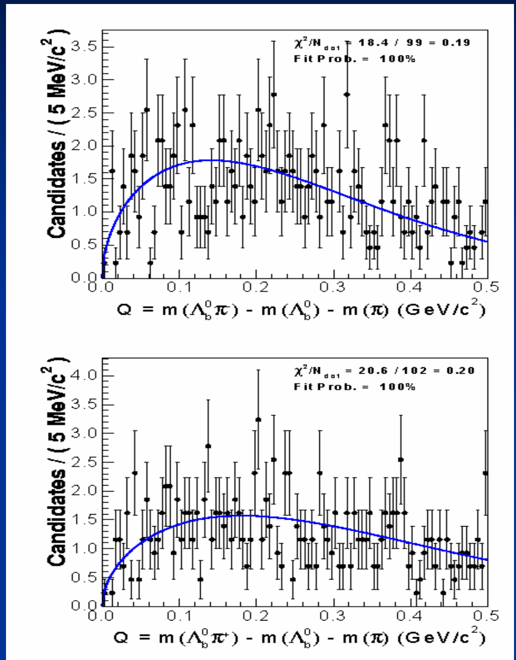


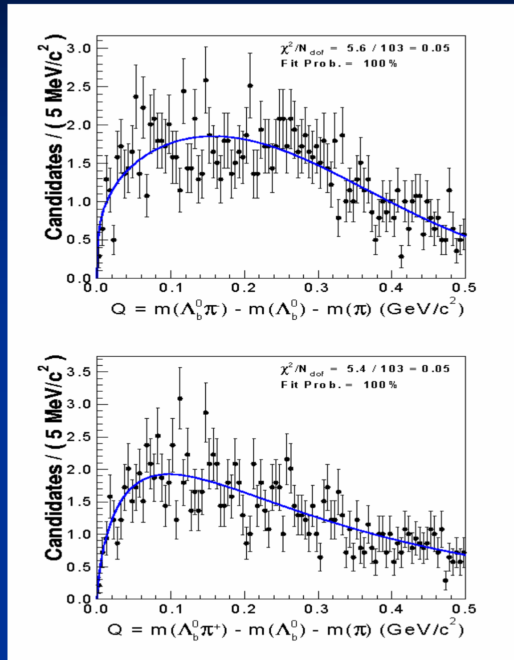
Figure 19: Data-MC comparison of track p_T before (left) and after (right) reweighting for track p_T.

- PYTHIA $\Sigma_b \rightarrow \Lambda_b \pi$
- Do not expect perfect description for b-baryons – experimental data are limited
- Needs reweighting
  - $P_T(\Sigma_b)$
  - $P_T(\text{soft } \pi)$
- Included in systematic

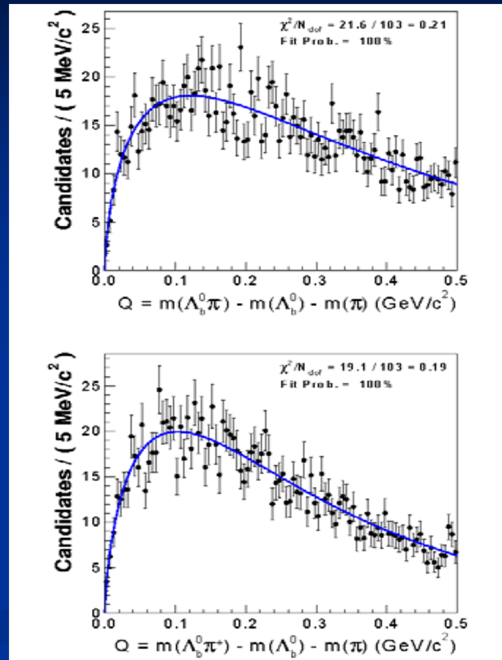
Fitting background



Combinatorial



B mesons

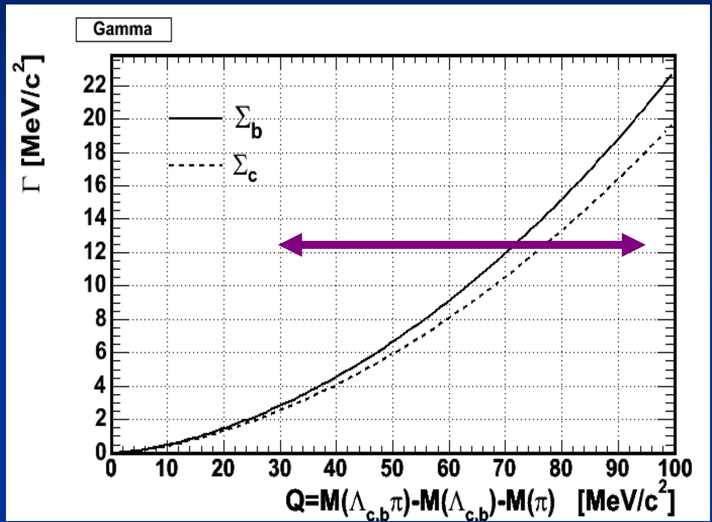


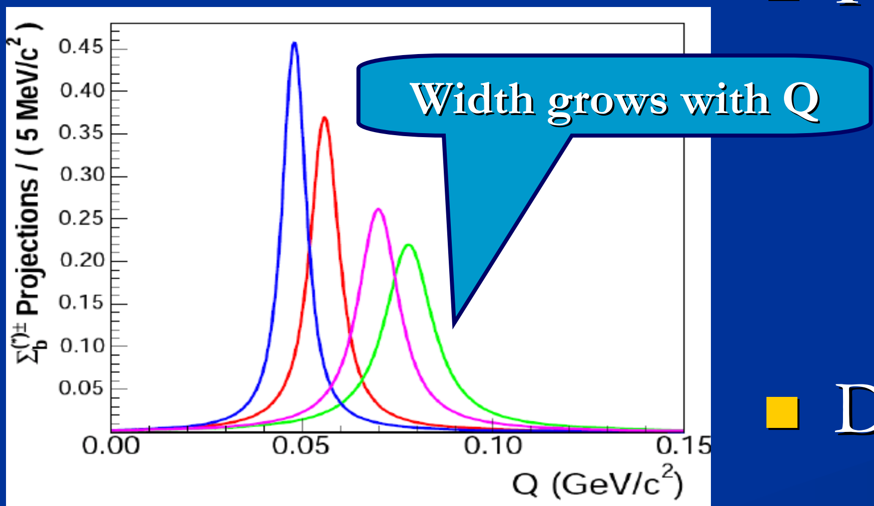
Λ_b HA+UE

$$f(Q;\alpha,Q_{max},\gamma) = \left(\frac{Q}{Q_{max}}\right)^{\alpha} e^{-\frac{\alpha}{\gamma}\left(\left(\frac{Q}{Q_{max}}\right)^{\gamma}-1\right)}$$

alternative fit shapes in systematics

Detector resolution and signal width





- Estimated detector resolution from MC generating signal with 0 natural width ~ 2 MeV/c^2
- Cross-check on $D^* \to D^0\pi$ (MC)
- $\Gamma(\Sigma_b)$ is predicted by HQET:

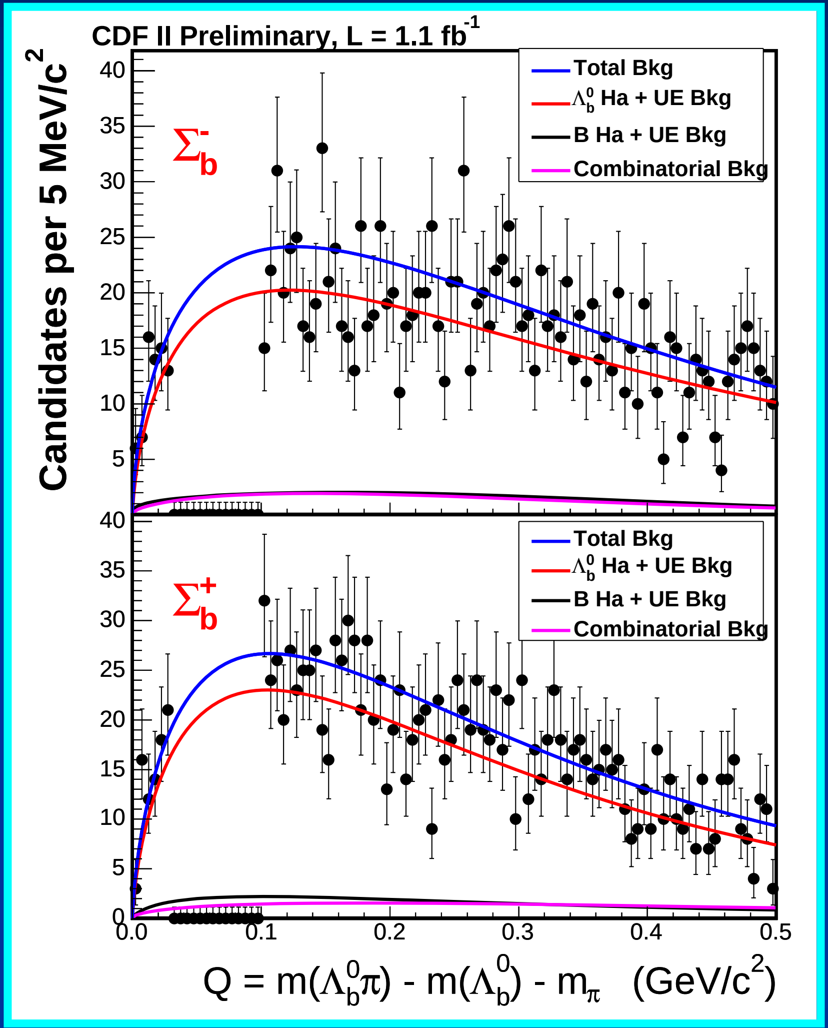
$$\Gamma_{\Sigma_q \to \Lambda_q \pi} = \frac{1}{6\pi} \frac{M_{\Lambda_q}}{M_{\Sigma_q}} \, |f_p|^2 \, |\vec{p}_\pi|^3$$

$$f_p \equiv g_A / f_\pi ; \; g_A = 0.75 \pm 0.05$$

hep-ph/9406359

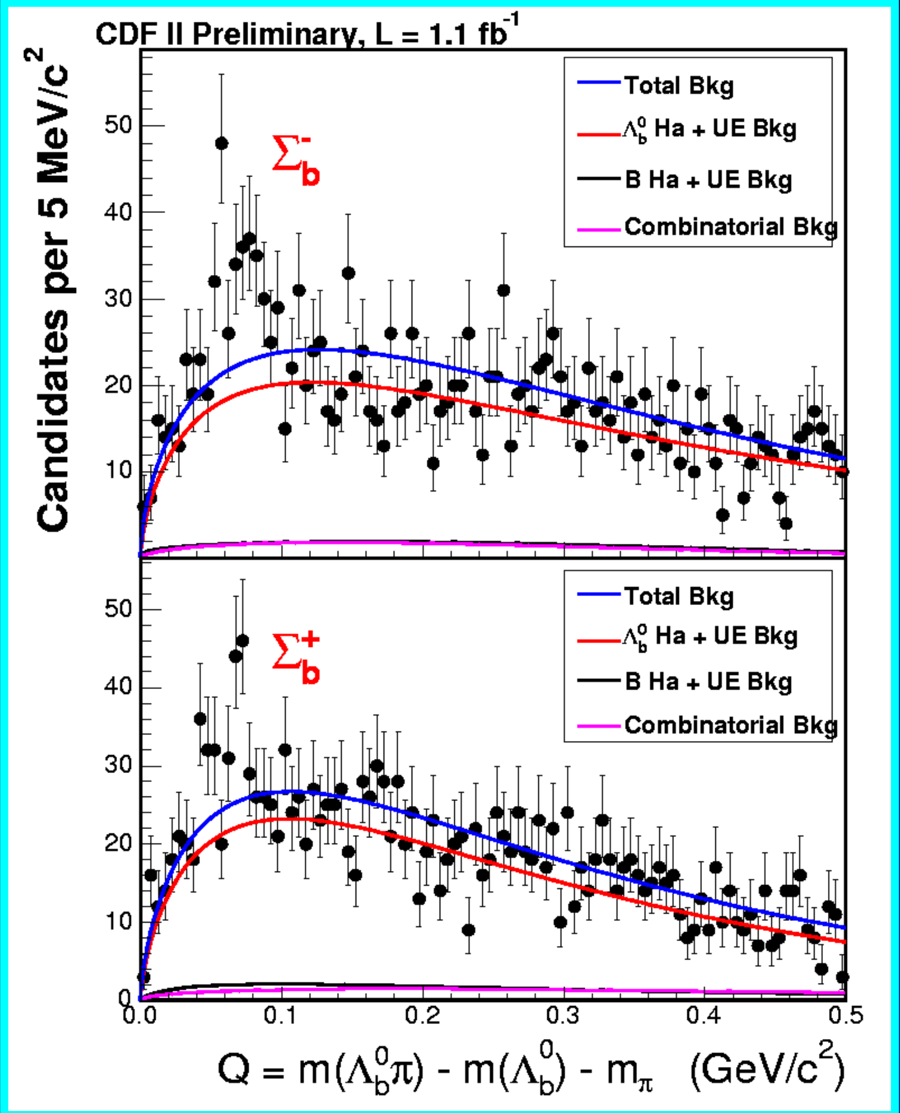
- Dominated by natural width

Sum of Background Fits



- Smooth background shape in signal window
- Fixed fit parameters before opening the box

Unblinded Q distribution



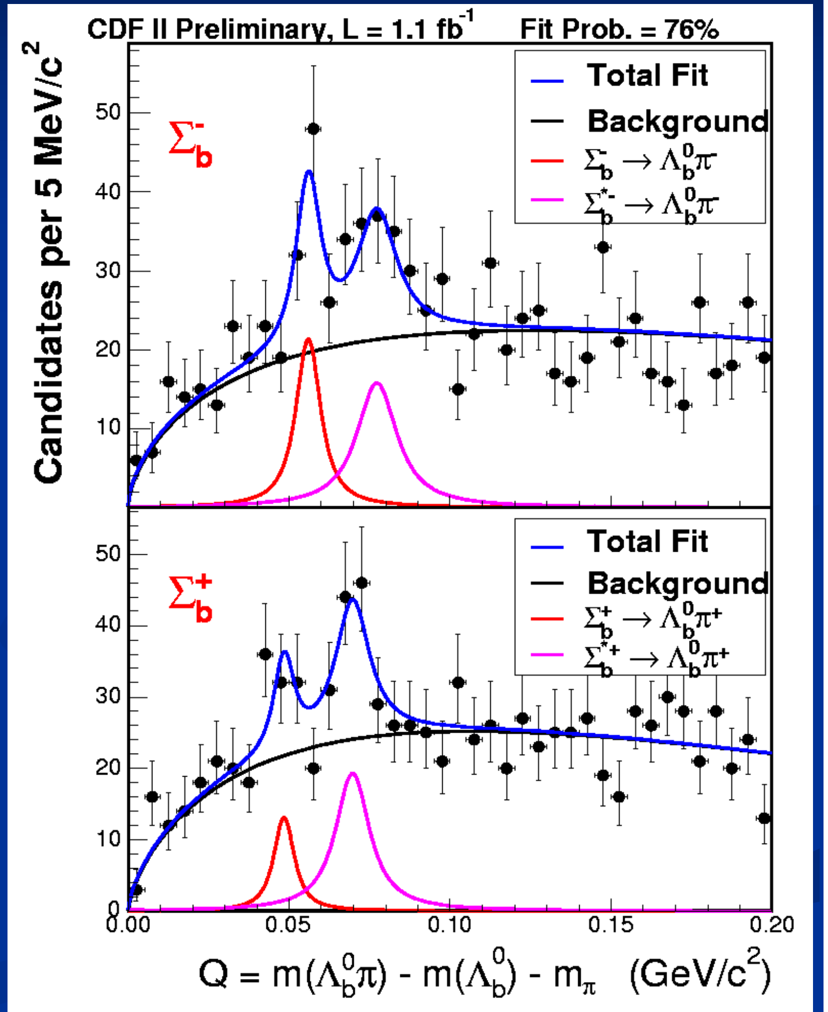
Significant excess in both distributions!

Sample	Data	Bkg	Excess
SC	416	268	148
OC	406	298	108

- Naïve $S/\sqrt{(S+B)} \sim 9\ \sigma$

Fitting the signal

- Simultaneous unbinned NLL fit for both $\Sigma_b^{-(*)}/\Sigma_b^{+(*)}$ distributions
- Background frozen
- 4 peaks:
  Breit-Wigner ⊗ Gaussians
- $\Gamma(\Sigma_b)$ = function (Q)
- 7 Floating parameters:
  - Num of events in 4 peaks: N (Σ_b)
  - $Q(\Sigma_b^-)$ and $Q(\Sigma_b^+)$
  - Common parameter $Q(\Sigma_b^*)$-$Q(\Sigma_b)$



Fit: values and errors

Parameter	Value	Errors
Q (Σ_b^-) [MeV/c^2]	55.9	-0.96, +0.99
Q (Σ_b^+) [MeV/c^2]	48.4	-2.29, +2.02
N (Σ_b^-)	60	-13.8, +14.8
N (Σ_b^+)	29	-11.6, +12.4
N (Σ_b^{*-})	74	-17.4, 18.2
N (Σ_b^{*+})	74	-16.3, 17.2
Q (Σ_b^*) - Q (Σ_b) [MeV/c^2]	21.3	-1.94, 2.03
NLL	-24553.5	

Signal significance

- Naïve: 9σ
- P-value calculation: > 5σ (not enough Toy MC)
- Evaluate Likelihood Ratio for different hypothesis:

$$LR \equiv \frac{L_{\text{no peak fit}}}{L_{\text{4 peak fit}}}$$

4 peaks are 2.6 ×10^{19} more likely then no peak at all

➡ ***Background fluctuation is statistically excluded***

➡ ***Hypothesis with 4 peaks in the most favorable***

Hypothesis	Δ(-ln(£))	1/LR
"NULL"	**44.7**	**2.6e19**
"Two Peaks"	**14.3**	**1.6e6**
No Σ_b^- peak	**10.4**	**3.3e4**
No Σ_b^+ peak	**1.1**	**3**
No Σ_b^{-*} peak	**10.1**	**2.4e4**
No Σ_b^{+*} peak	**9.8**	**1.8e4**

Summary

- We observe four $\Lambda_b\pi$ resonant states 240 events in total
- The significance of the signal > 5σ
- The signal is consistent with the lowest lying $\Sigma_b^{\pm(*)}$ states
- We measure Q values:

- $m(\Sigma_b^-) - m(\Lambda_b^0) - m(\pi) = 55.9^{+1.0}_{-1.0}$ (stat) ± 0.1 (syst) MeV/c^2
- $m(\Sigma_b^+) - m(\Lambda_b^0) - m(\pi) = 48.4^{+2.0}_{-2.3}$ (stat) ± 0.1 (syst) MeV/c^2
- $m(\Sigma_b^{*-}) - m(\Sigma_b^-) = m(\Sigma_b^{*+}) - m(\Sigma_b^+) = 21.3^{+2.0}_{-1.9}$ (stat) $^{+0.4}_{-0.2}$ (syst) MeV/c^2

Plans

- Increase statistics by
  - $\Lambda_b^0 \rightarrow \Lambda_c^+ \pi^-$ from different triggers (~1000)
  - $\Lambda_b^0 \rightarrow J/\psi\ \Lambda^0$ (~ 500)
  - $\Lambda_b^0 \rightarrow \Lambda_c^+\ 3\pi$
- Measure $\Delta m = M(\Sigma_b^*) - M(\Sigma_b)$ for "+" and "–" separately
- Measure widths

Conclusions

- CDF makes fundamental contributions in b-spectroscopy
- Performing the world most precise measurements of Λ_b B_c B_s B^+ B^0 masses
- Discovering new particles:
  - $\Sigma_b^{\pm(*)} \rightarrow \Lambda_b \pi$
  - $B_{s1} \rightarrow B^* K$
  - $B_c \rightarrow J/\psi\, \pi$
- Setting new limits:
  - $\eta_b \rightarrow J/\psi\, J/\psi$
- And all these with only THE FIRST fb^{-1} !

BACKUP

$\Sigma_b^{\pm(*)}$ masses

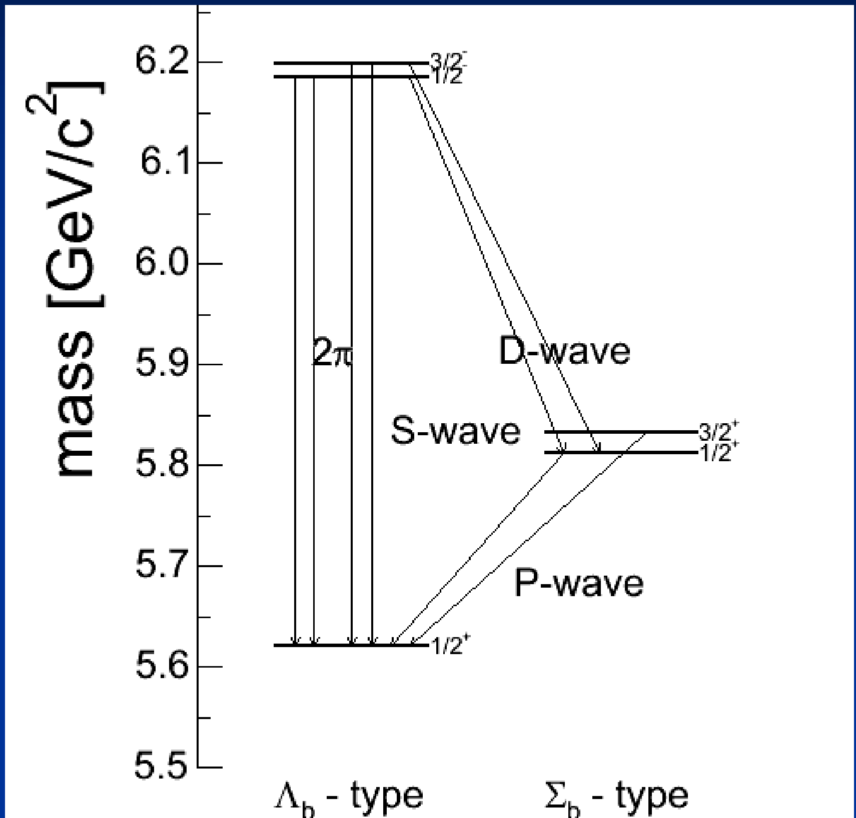
- Using $m(\Lambda_b) = 5619.7 \pm 1.2(\text{stat}) \pm 1.2(\text{syst})$

$$m(\Sigma_b^-) = 5816^{+1.0}_{-1.0}\ (\text{stat}) \pm 1.7\ (\text{syst})\ \text{MeV}/c^2$$
$$m(\Sigma_b^+) = 5808^{+2.0}_{-2.3}\ (\text{stat}) \pm 1.7\ (\text{syst})\ \text{MeV}/c^2$$
$$m(\Sigma_b^{*-}) = 5837^{+2.1}_{-1.9}\ (\text{stat}) \pm 1.7\ (\text{syst})\ \text{MeV}/c^2$$
$$m(\Sigma_b^{*+}) = 5829^{+1.6}_{-1.8}\ (\text{stat}) \pm 1.7\ (\text{syst})\ \text{MeV}/c^2$$

Systematic Errors

Parameter	*Tracking*	*Λ_b Comp.*	*Λ_b Norm.*	*Λ_b Shape*	*reweight*	*Det. Res.*	*Σ_b width*	*Total*
Σ_b^- Q (Mev/c^2)	0.06 -0.06	0.00 -0.03	0.009 -0.002	0.000 -0.011	0.04 -0.0004	0.0 -0.011	0.009 -0.005	0.07 -0.07
Σ_b^+ Q (Mev/c^2)	0.06 -0.06	0.03 0.0	0.013 -0.013	0.013 0.0	0.0 -0.11	0.0 -0.014	0.01 -0.02	0.07 -0.13
Σ_b^*-Σ_b Q (Mev/c^2)	0.06 -0.06	0.05 0.0	0.14 -0.13	0.04 0.00	0.32 0.0	0.02 0.0	0.07 -0.07	0.37 -0.16
Σ_b^- events	0.0 0.0	0.7 0.0	2.2 -2.2	0.3 0.0	7.4 0.0	0.3 0.0	3.4 -3.4	8.5 -4.0
Σ_b^+ events	0.0 0.0	3.3 0.0	2.1 -2.1	1.2 0.0	2.3 -1.8	0.3 0.0	1.8 -2.0	5.0 -3.4
Σ_b^{*-} events	0.0 0.0	0.4 0.0	4.8 -4.7	0.3 0.0	14.7 0.0	0.1 0.0	1.7 -1.7	15.6 -5.0
Σ_b^{*+} events	0.0 0.0	7.3 0.0	4.8 -4.8	2.8 0.0	4.6 -2.9	0.2 0.0	0.8 -0.8	10.3 -5.7

Σ_b Motivation



Σ_b property	Expected values (MeV/c^2)
m(Σ_b) - m(Λ_b^0)	180 – 210
m(Σ_b^*) - m(Σ_b)	10 – 40
m(Σ_b^-) - m(Σ_b^+)	5 – 7
$\Gamma(\Sigma_b), \Gamma(\Sigma_b^*)$	~8, ~15

- Λ_b only established *B* baryon
- Enough statistics at Tevatron to probe other heavy baryons
- Next accessible baryons:

Σ_b: b{qq}, q = u,d;

$$J^P = S_Q + s_{qq}$$

$= 3/2^+ (\Sigma_b^*)$

$= 1/2^+ (\Sigma_b)$

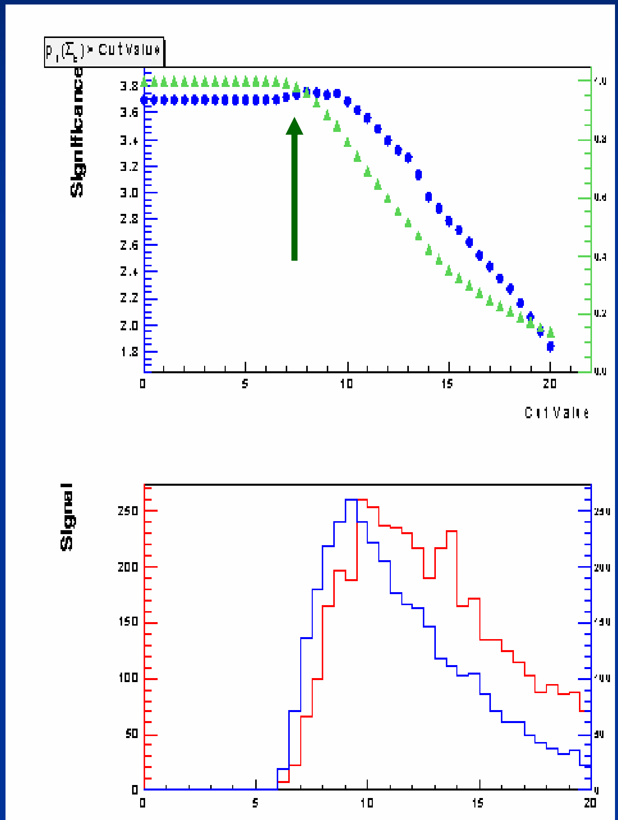
- *HQET extensively tested for Qq systems; interesting to check predictions for Qqq systems*
- *Baryon spectroscopy also tests Lattice QCD and potential quark models*

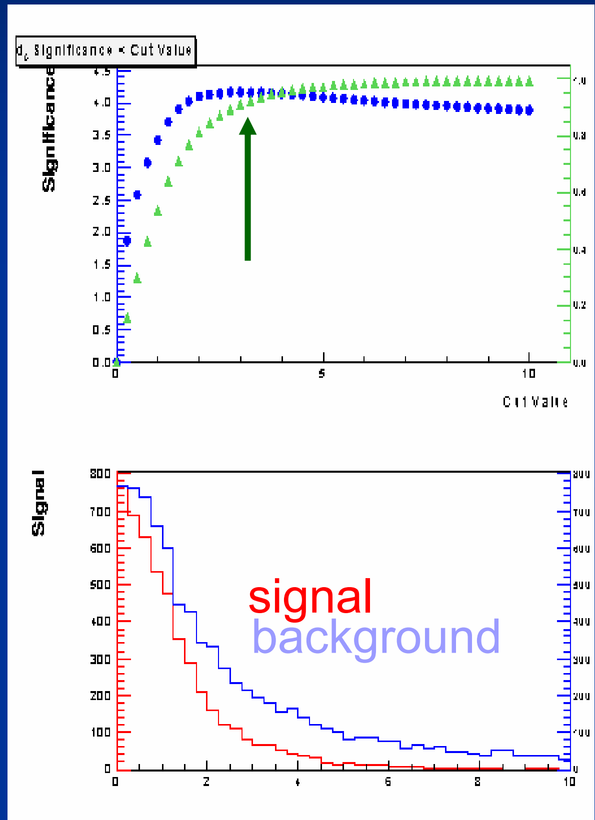
Fit: correlation coeff.

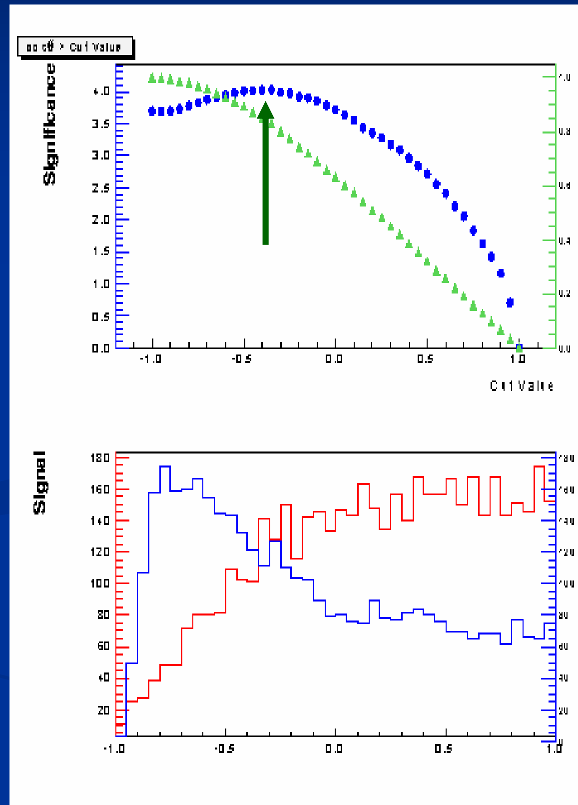
Parameter	Global	1	2	3	4	5	6	7
1 Σ_b^- Q	0.31202	1.000	0.156	0.175	-0.014	-0.114	-0.018	-0.246
2 Σ_b^- events	0.29891	0.156	1.000	-0.060	0.005	-0.241	0.006	0.084
3 Σ_b^+ Q	0.71323	0.175	-0.060	1.000	-0.028	0.001	-0.012	-0.712
4 Σ_b^+ events	0.17878	-0.014	0.005	-0.028	1.000	-0.000	-0.162	0.057
5 Σ_b^{*-} events	0.25346	-0.114	-0.241	0.001	-0.000	1.000	-0.000	-0.002
6 Σ_b^{*+} events	0.19252	-0.018	0.006	-0.012	-0.162	-0.000	1.000	0.074
7 Σ_b^* - Σ_b Q	0.72939	-0.246	0.084	-0.712	0.057	-0.002	0.074	1.000

Σ_b^+ peak is small – relies on Σ_b^*- Σ_b to determine it's mean value

Σ_b N-1 scan







PT (Σb) > 9.5 GeV/c

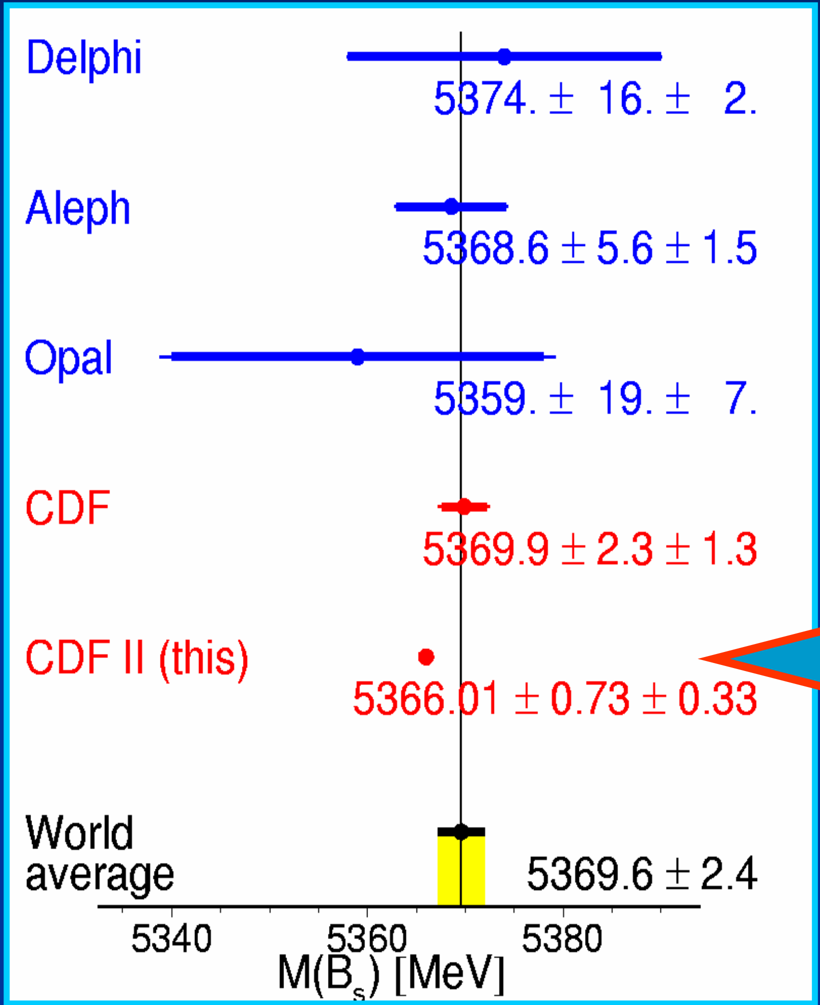
|d0/σ(d0) | < 3.

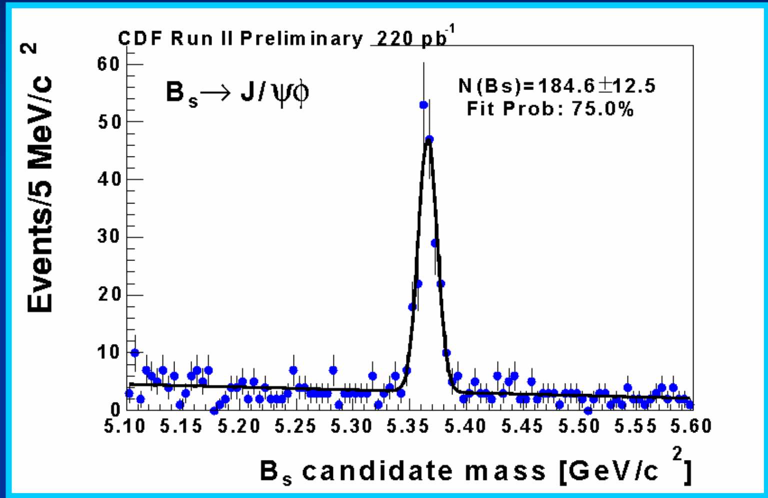
cos θ∗ > -0.35

Why b baryons?

- B-quark discovered in 1977
- Wealth of b-mesons is found
- Only one b-baryon well established so far
- Finding and studying b-baryons completes tests of SM
- Systematic expansion of QCD: Heavy Quark Eff. Theory:
- $m_c, m_b, m_t \gg \Lambda_{QCD} \gg m_u, m_d, m_s \Rightarrow$ Heavy Quark Symmetry
- Masses and decay rates test HQET
- HQET extensively tested for *Qq* systems; interesting to check predictions for *Qqq* systems

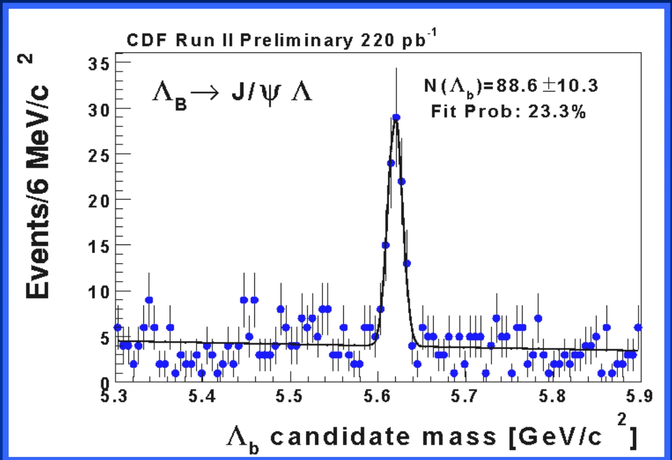
B_s mass measurement

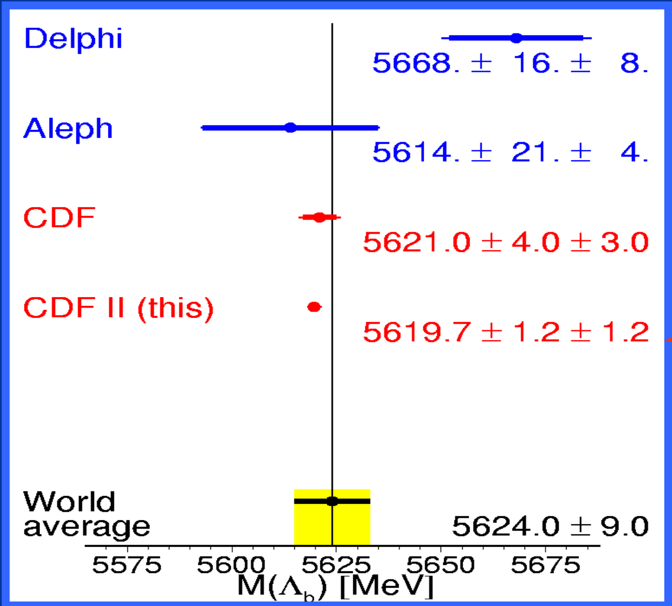




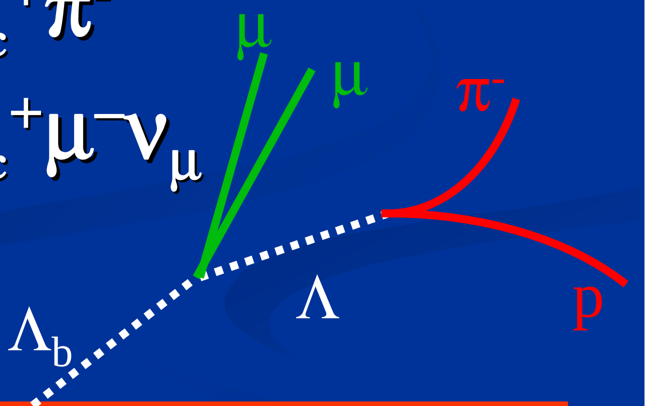
better precision than the current world overage!

Λ_b mass measurements





- <u>Observed Λ_b decays</u>:
  - $\Lambda_b^0 \to J/\psi\ \Lambda^0$
  - $\Lambda_b^0 \to \Lambda_c^+ \pi^-$
  - $\Lambda_b^0 \to \Lambda_c^+ \mu^- \nu_\mu$



better precision than the current world overage!

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