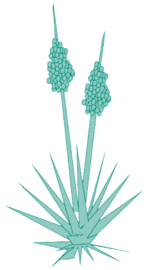
Heavy Hadron Spectroscopy and Production at Tevatron



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On behalf of CDF and D∅ Collaborations

XIV International Conference on Hadron Spectroscopy HADRON 2011

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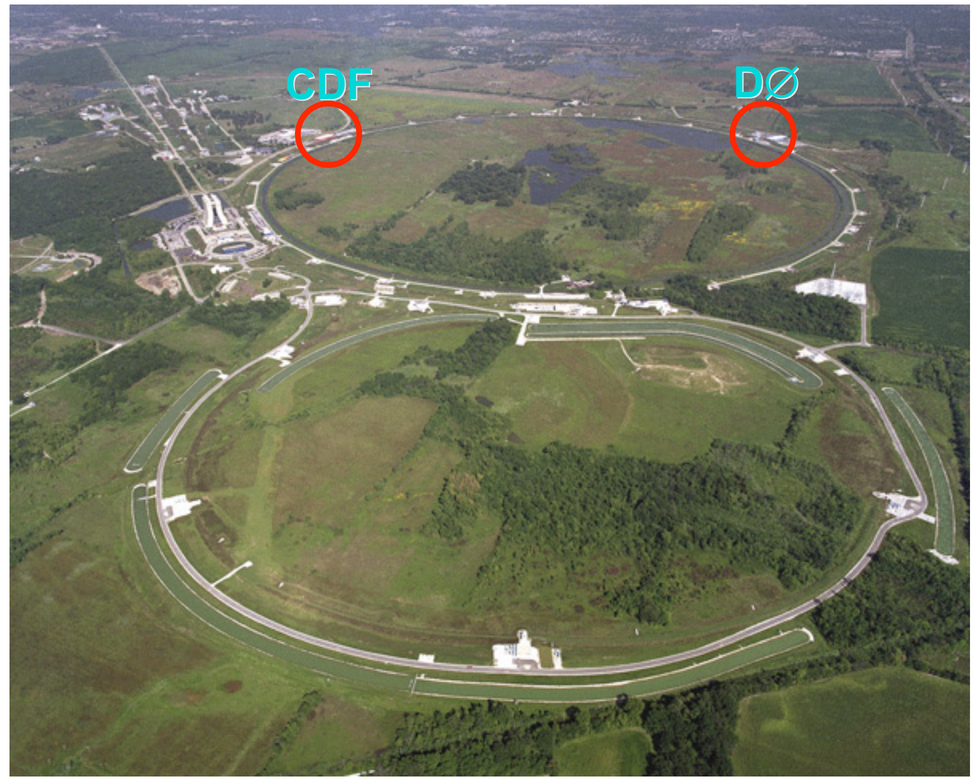
Künstlerhaus,

München, Bayern

Outline

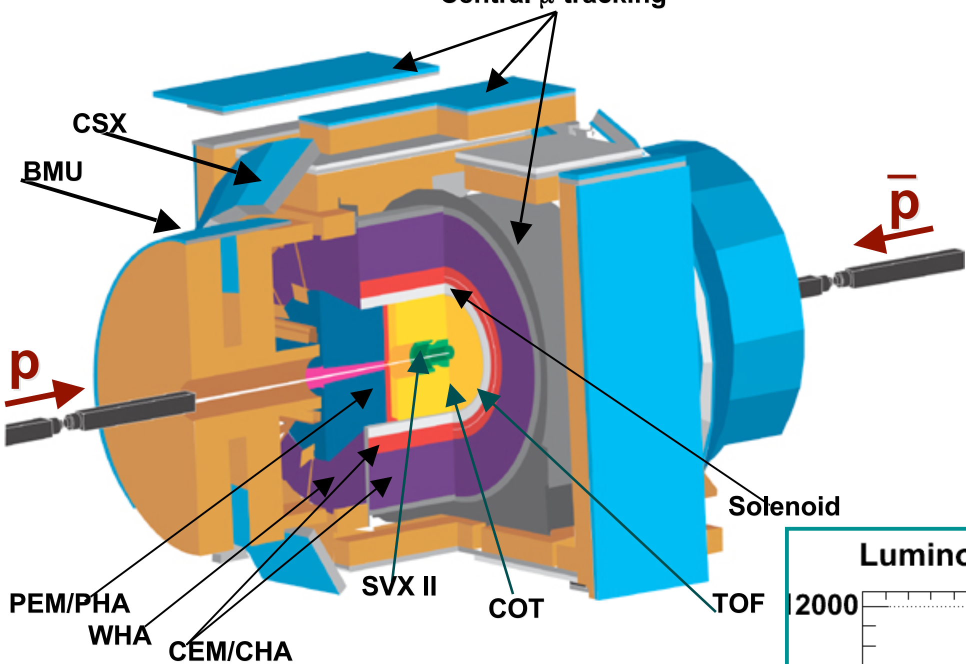
- Experimental Apparatus
- Heavy Baryons (CDF)
    - Bottom Baryon Resonances
    - Charm Baryon Resonances
    - Comparison of Exp. Results
- Y(4140) (CDF)
- Measurement of Production Fraction $f(b \to \Lambda_b^0) \times BR(\Lambda_b^0 \to J/\Psi \Lambda^0)$ (DØ)
- Summary

Results from Tevatron



- p and $\bar{p}$ beams
- 36 × 396 ns bunches of 980 GeV
- collision points: CDF and DØ
- $E_{c.m.s.}$ = 1960 GeV

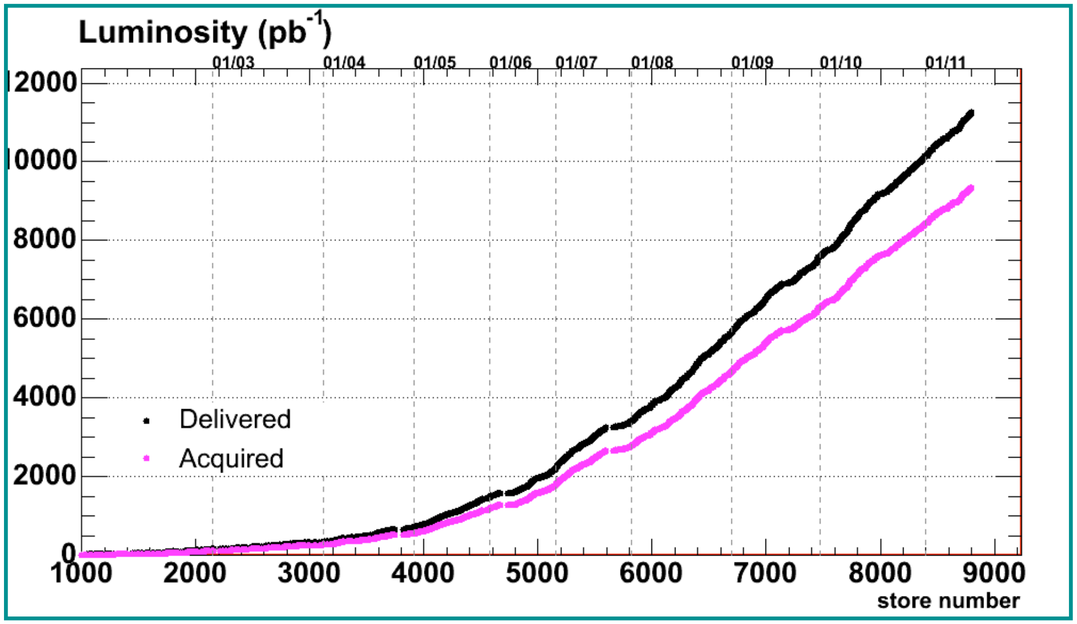
CDF II Detector



- Tevatron delivered
  $\int Ldt > 11\ fb^{-1}$
- And processed total luminosity (CDF):
  - Recorded $\int Ldt \cong 9.5\ fb^{-1}$
  - Presented analyses based:
    up to $\int Ldt \cong 6.0\ fb^{-1}$

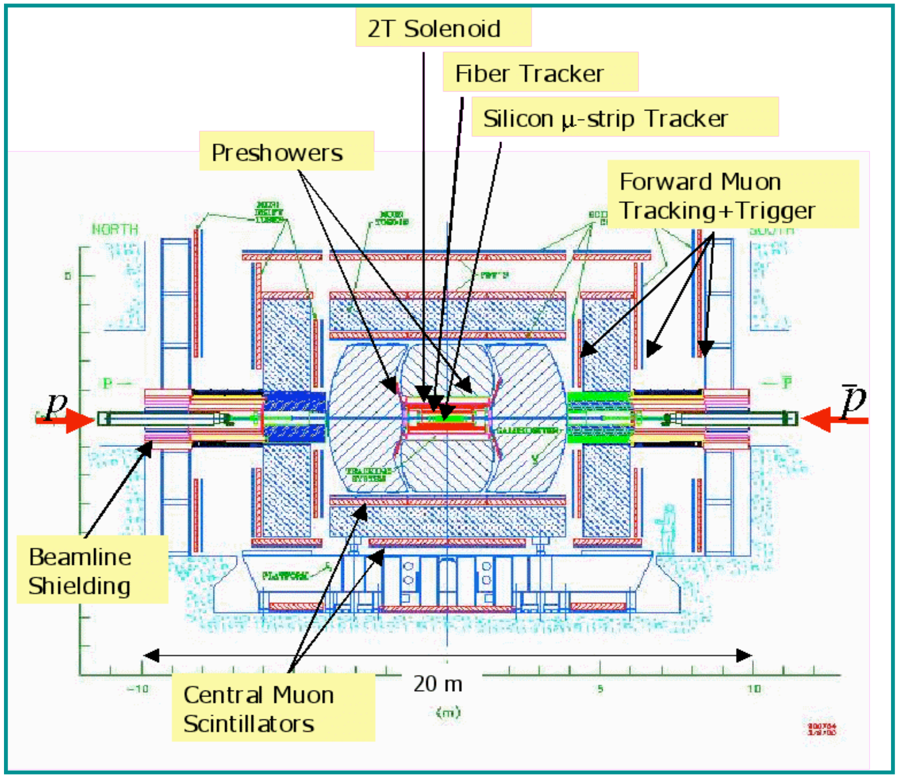
Multipurpose detector:

- VX tracking
- Central tracking
- μ-tracking ID
- EM/HA calorimeters
- multi-tiered triggers
  - di-muon ($J/\Psi \rightarrow \mu^+\mu^-$)
  - Displaced Two Track Trigger



DØ Triggers and Data (III)

- **Trigger on Di- muons ($\mu^+\mu^-$) .**
  - **$J/\Psi \to \mu^+\mu^-$ mode is triggered**
  - **Level 1: hardware to form roads defined by hits in two layers of the muon scintillator system.**
  - **Level 2: uses digital signal processors to form track stubs defined by hits in the muon drift-chamber and muon scintillator systems.**
  - **Level 3: full reconstruction**
- **The suite of the single muon ($\mu^\pm$) triggers.**
  - **with the option to trigger on a displaced muon tracks**

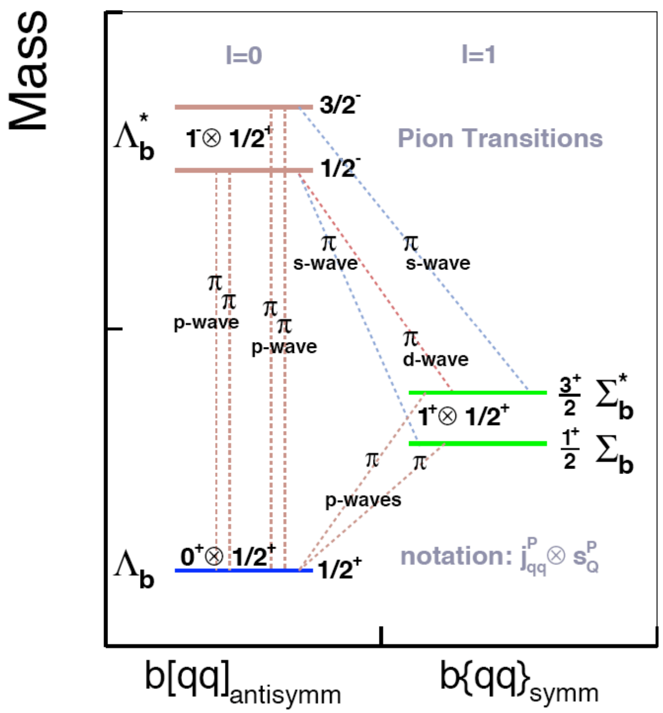


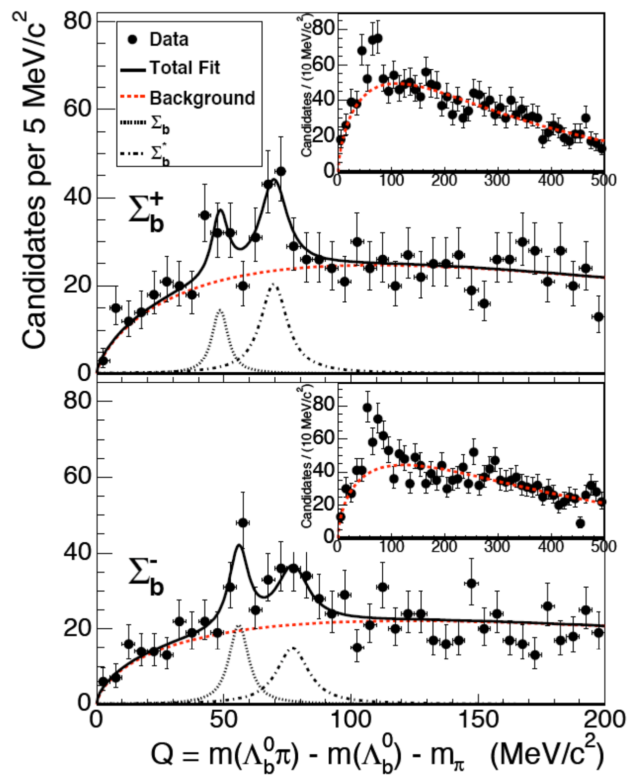
Σ_b Baryons: Resonance Properties (I)

- Measurements of masses/widths of heavy baryons provide an input to critical tests of different non-perturbative QCD approaches to a spectroscopy of bottom hadron states
  - HQET framework
  - Potential models
  - $1/N_c$ expansion methods
  - and finally several large scale projects on Lattice QCD calculations
- The measurement of widths:
  - dynamical aspect of bottom baryon resonances governed by strong forces,
  - the comparison of our width measurements with few available theoretical calculations.
- **Goal of the analysis: confirm the observation of discovered $\Sigma_b^{(*)\pm}$ states with a data driven method and measure their resonance properties.**

Σ_b Baryons: Resonance Properties (I)

Published Discovery (Sep 2006) on Heavy Baryons Σ_b and Σ_b^* with CDF II





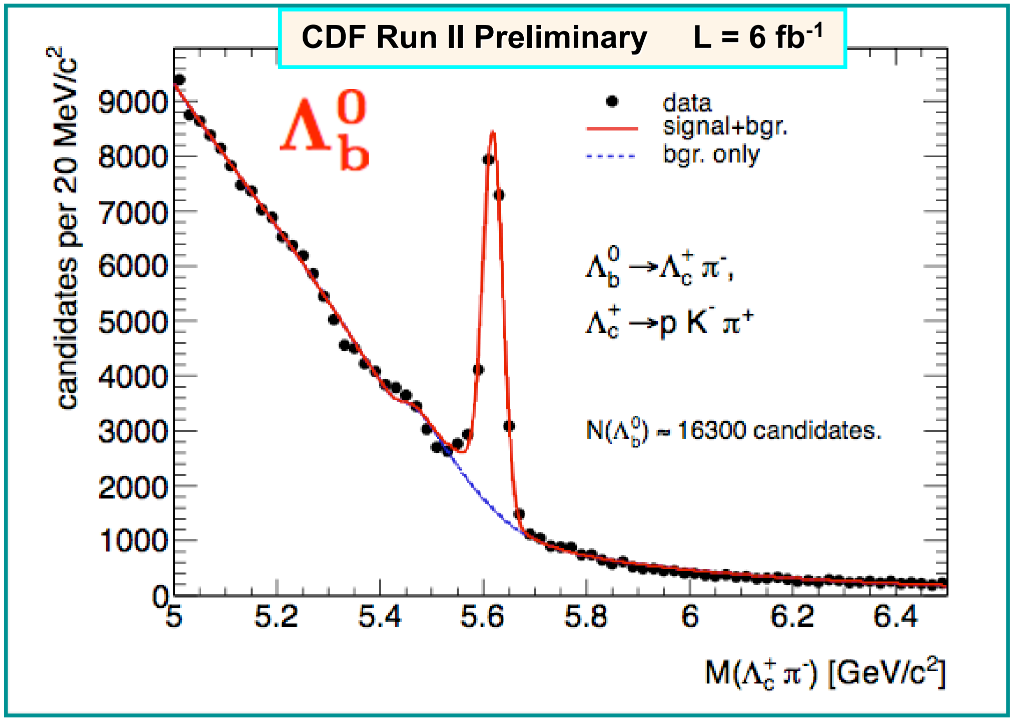
$Q = M(\Lambda_b^0 \pi_{soft}) - M(\Lambda_b^0) - m(\pi^{\pm})$

...was based on $\int \mathcal{L}\, \mathbf{dt} = \mathbf{1}.1\ \text{fb}^{-1}$

- PRL **99**, 202001 (2007)
- *SPIRES topcite 50+ paper*

Σ_b Baryons: Resonance Properties (II)

- **Luminosity: $\int \mathcal{L}\,dt \approx 6.0\,\mathrm{fb}^{-1}$**
- Data collected by CDF **Two Track Trigger**
- Reconstruct inclusive base Λ_b^0 signal as $\mathbf{M(\Lambda_b^0 \to \Lambda_c^+ \pi_b^-)}$ with $\mathbf{\Lambda_c^+ \to pK^-\pi^+}$, applying vertex fits both to Λ_c^+ and Λ_b^0 with $\mathbf{M(pK^-\pi^+)} = \mathbf{M_{PDG}}$ constraint.
  - require long decay path $c\tau(\mathbf{\Lambda_b^0})$
  - fast decay pion π_b^-
- Combine Λ_b^0 signal candidates with soft pions to reconstruct $\mathbf{\Sigma_b^{(*)\pm} \to \Lambda_b^0 \pi_{soft}^\pm}$ candidates.
  - loose cuts on the soft pion $\pi_{soft}^\pm$ track



Σ_b Baryons: Resonance Properties (III)

We reconstruct $\Sigma_b^{(*)\pm}$ candidates in a mass difference spectrum: Q-value

$$\mathbf{Q = M(\Sigma_b^{(*)} \rightarrow \Lambda_b^0 \pi^{\pm}_{soft}) - M(\Lambda_b^0) - m(\pi^{\pm})_{PDG}}$$

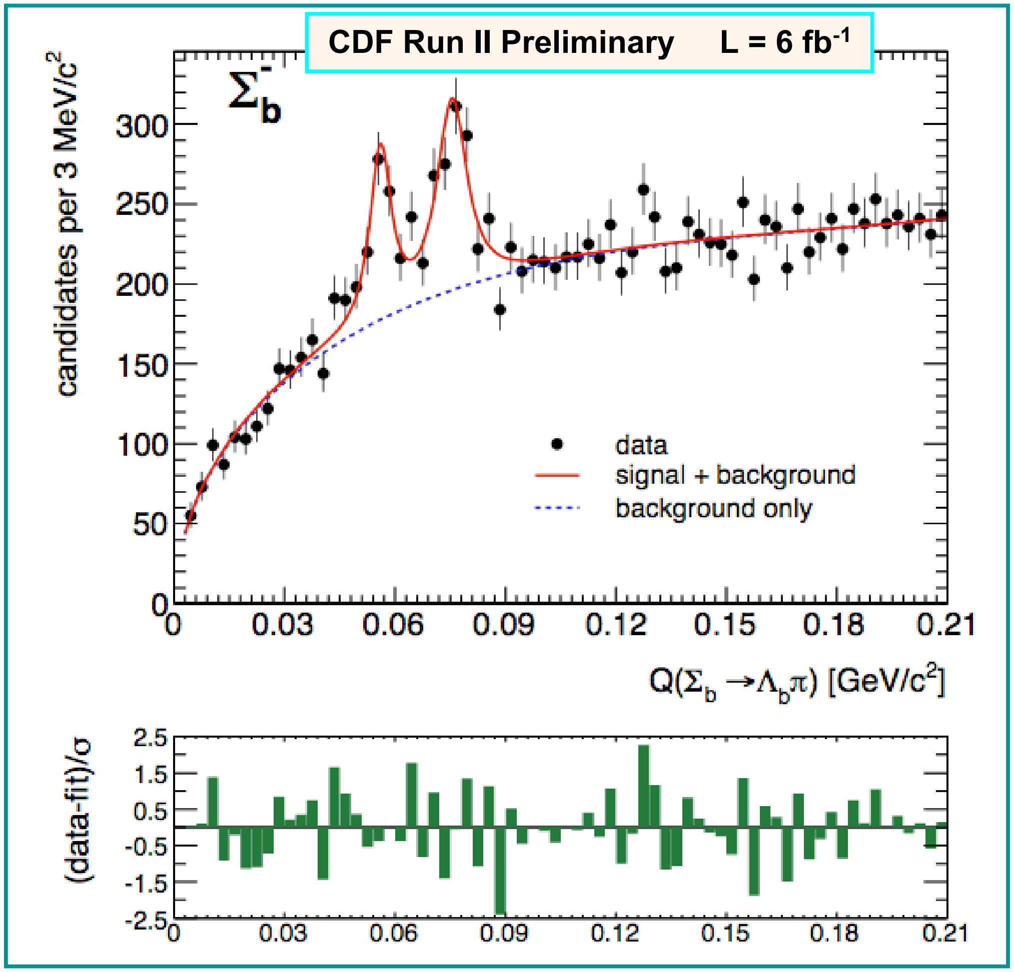
Improved resolution as Λ_b^0 contribution and many systematic uncertainties get canceled leaving only $\pi^{\pm}_{soft}$ contribution.

- The signal is described by non-relativistic Breit-Wigner function
  - convoluted with a double Gaussian to model the detector resolution: σ_1, σ_2 and fraction f_1 are fixed from MC.
  - the width of the Breit-Wigner is modified by P-wave factor $\mathbf{\Gamma_0 \cdot \left(\frac{p^*_\pi}{p^{*0}_\pi}\right)^3}$

- Phase space motivated background:

$$\mathcal{BGR} = \sqrt{(\mathbf{Q + m_\pi})^2 - \mathbf{m_T^2}} \cdot (\mathbf{C + b_1 \cdot Q + b_2 \cdot (2 \cdot Q^2 - 1)})$$

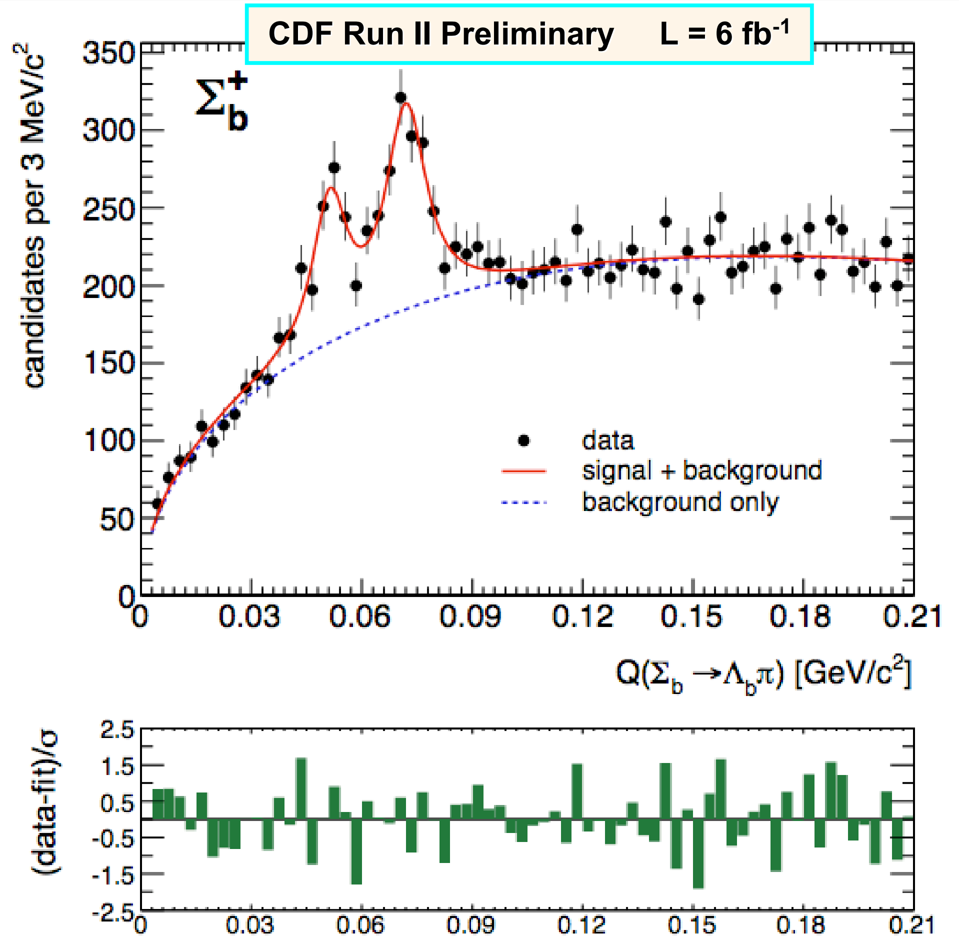
Σ_b Baryons: Resonance Properties (V)



Σ_b^- and Σ_b^{*-}	
Parameters	**Value**, MeV/c^2
Q_0, pole Σ_b^-	$56.2^{+0.6}_{-0.5}$
Q_0^*, pole Σ_b^{*-}	75.7 ± 0.6
Γ_0, width Σ_b^-	$4.3^{+3.1}_{-2.1}$
Γ_0^*, width Σ_b^{*-}	$6.4^{+2.2}_{-1.8}$
Parameters	**Value**, evts
N_s, yield Σ_b^-	333^{+93}_{-73}
N_s^*, yield Σ_b^{*-}	522^{+85}_{-76}

The projection of the unbinned LH fit onto the binned Q- distribution of $\Sigma_b^{(*)-}$ candidates.

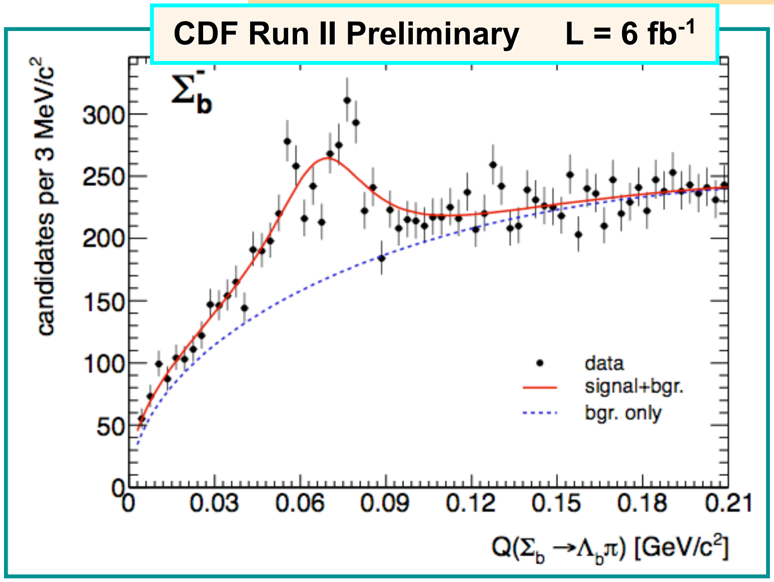
Σ_b Baryons: Resonance Properties (VI)

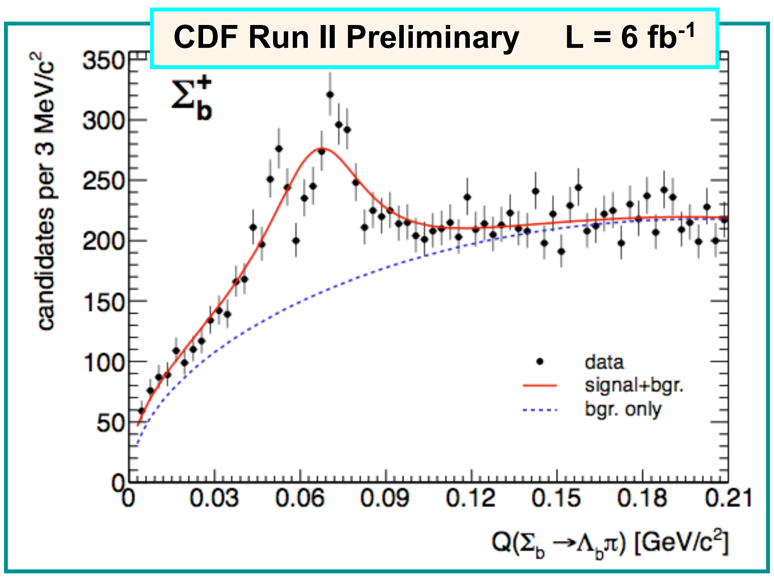


Σ_b^+ and Σ_b^{*+}	
Parameters	**Value**, MeV/c^2
Q_0, pole Σ_b^+	$52.0^{+0.9}_{-0.8}$
Q_0^*, pole Σ_b^{*+}	72.7 ± 0.7
Γ_0, width Σ_b^+	$9.2^{+3.8}_{-2.9}$
Γ_0^*, width Σ_b^{*+}	$10.4^{+2.7}_{-2.2}$
Parameters	**Value**, evts
N_s, yield Σ_b^+	468^{+110}_{-95}
N_s^*, yield Σ_b^{*+}	782^{+114}_{-103}

The projection of the unbinned LH fit onto the binned Q- distribution of $\Sigma_b^{(*)+}$ candidates.

Σ_b Baryons: Resonance Properties (VII)





- Both $\mathbf{\Sigma_b^{(*)-}}$ and $\mathbf{\Sigma_b^{(*)+}}$ signals are tested against several null hypotheses

  0 Most conservative: any single peak instead of the two ones is observed, *shown at the left.*

  1 The signal Σ_b^* is observed but the Σ_b has been missed.

  2 The signal Σ_b is observed but the Σ_b^* has been missed.

  3 The background model fluctuating to the single peak.

  4 The background model fluctuating to the Σ_b and Σ_b^* peaks.

- our $(\mathbf{\Sigma_b}, \mathbf{\Sigma_b^*})$ signals hypothesis is always $\gtrsim \mathbf{6} \cdot \sigma$ away from any of the listed null ones.

Σ_b Baryons: Resonance Properties (VIII)

Systematic Uncertainties

- Mass Scale: B field knowledge, uncertainties of dE/dx corrections to the momentum scale.
- Detector resolution model and its parameters.
- Choice of a Background Model.
- Fit procedure.
- Systematics propagated from the external source:

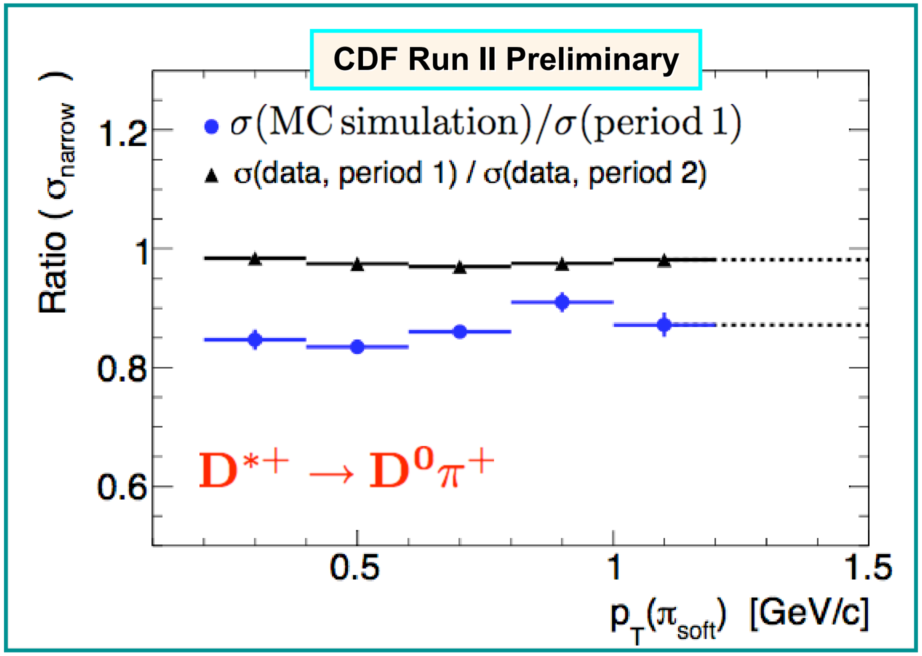
$$M(\Lambda_b^0) = 5619.7 \pm 1.2(\text{stat}) \pm 1.2(\text{syst}),\ \text{MeV}/c^2$$

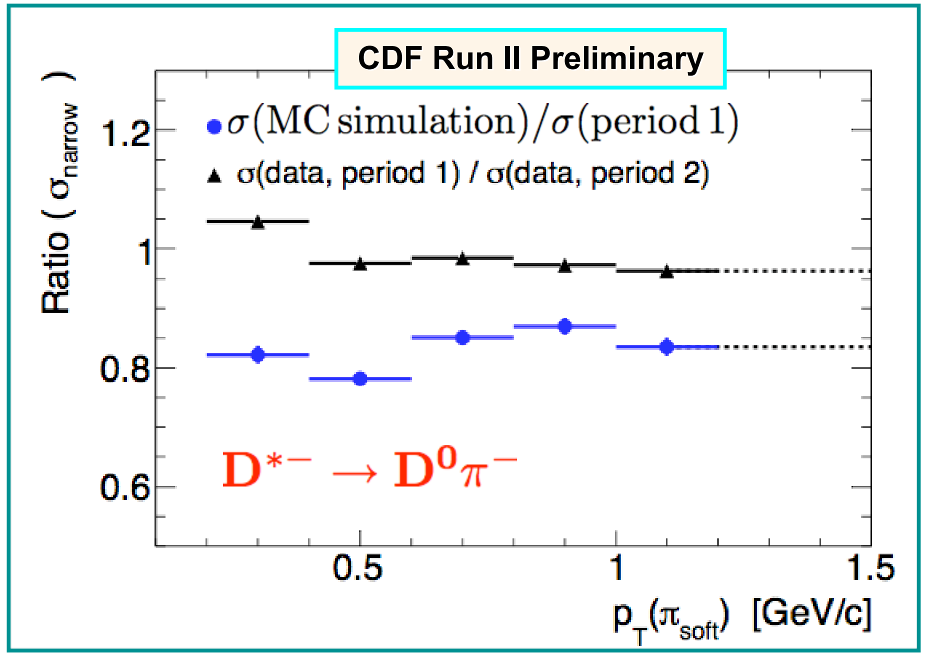
taken from CDF published results.

Σ_b Baryons: Resonance Properties (IX)

Systematic Uncertainties: Signal Resolution

Detector resolution is a critical parameter for our measurements especially for the fits of natural widths. D^{*+} is a good candle, has a similar $p_T(\pi_{soft})$ spectrum but very narrow intrinsic width.





Fitted Gaussian σ of D^{*+-} : various data taking periods w.r.t. Monte Carlo predictions.

Conservative 25% (1.25×σ(MC)) is included into systematic uncertainties

Bottom Baryons: Σ_b Resonances (XI)

Summary of the Final Results

State	Q-value, MeV/c^2	Absolute Mass, m, MeV/c^2	Natural Width, Γ, MeV/c^2
Σ_b^+	$52.0^{+0.9}_{-0.8}{}^{+0.09}_{-0.4}$	$5811.2^{+0.9}_{-0.8} \pm 1.7$	$9.2^{+3.8}_{-2.9}{}^{+1.0}_{-1.1}$
Σ_b^-	$56.2^{+0.6}_{-0.5}{}^{+0.07}_{-0.4}$	$5815.5^{+0.6}_{-0.5} \pm 1.7$	$4.3^{+3.1}_{-2.1}{}^{+1.0}_{-1.1}$
Σ_b^{*+}	$72.7 \pm 0.7^{+0.12}_{-0.6}$	$5832.0 \pm 0.7 \pm 1.8$	$10.4^{+2.7}_{-2.2}{}^{+0.8}_{-1.2}$
Σ_b^{*-}	$75.7 \pm 0.6^{+0.08}_{-0.6}$	$5835.0 \pm 0.6 \pm 1.8$	$6.4^{+2.2}_{-1.8}{}^{+0.7}_{-1.1}$
	Isospin Mass Splitting, MeV/c^2		
$m(\Sigma_b^+) - m(\Sigma_b^-)$	$-4.2^{+1.1}_{-0.9}{}^{+0.07}_{-0.09}$		
$m(\Sigma_b^{*+}) - m(\Sigma_b^{*-})$	$-3.0 \pm 0.9^{+0.12}_{-0.13}$		

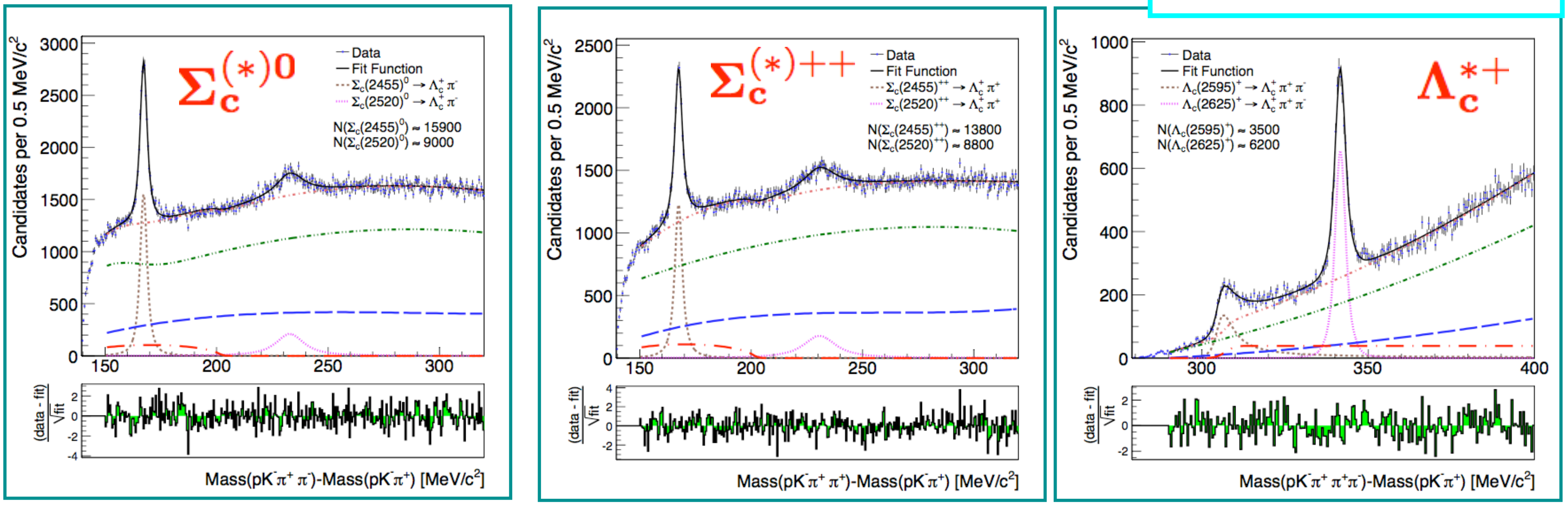
Bottom Baryons: Σ_b Resonances (XII)

Summary of the Final Results

- The first observation of $\Sigma_b^{(*)\pm}$ **confirmed:**
  - the found signals are significant with $\gtrsim 6\sigma$.
- The **direct mass difference measurements** have been found
  - in agreement with the published CDF results,
  - with a statistical precision by a $\gtrsim 2.3$ better.
- **The isospin mass splitting** within isotriplets Σ_b and Σ_b^* is measured for the **first time.**
- **The natural widths** of both $\Sigma_b^{\pm}$ and $\Sigma_b^{*\pm}$ are measured for the **first time.**
  - Good agreement with the theoretical predictions by Korner *et al.*, [*arXiv:hep-ph/9406359*], by Guo *et al.*, [*arXiv:0710.1474 [hep-ex]*].

Charm Sector: Baryon Resonances Σ_c, Σ_c^* and Λ_c^* (I)

arXiv:1105.5995 [hep-ex]. Submitted to PRD.



- **Luminosity: $\int \mathcal{L}\,dt \approx 5.2\,\mathrm{fb}^{-1}$**
- Data collected by CDF **Two Track Trigger**
- Reconstruct inclusive base $\mathbf{\Lambda_c^+ \to pK^-\pi^+}$ using neural network NeuroBayes package with several tracking and kinematical input quantities
- Combine Λ_c^+ signal candidates (output of the network) with soft pions to reconstruct final candidates again using neural networks
- reconstruct the candidates in the mass difference spectra
  - $\mathbf{\Sigma_c^{(*)0,++} \to \Lambda_c^+\pi^\pm_{soft}}$ cand.
  - $\mathbf{\Lambda_c^{*+} \to \Lambda_c^+\pi^+_{soft}\pi^-_{soft}}$ cand.
- $\mathbf{\Delta M = M(\Lambda_c^+\pi_{soft}(\pi_{soft})) - M(\Lambda_c^+)}$

See plenary talk made by Thomas Kuhr yesterday

Charm Sector: Baryon Resonances
Σ_c , Σ_c* Fits

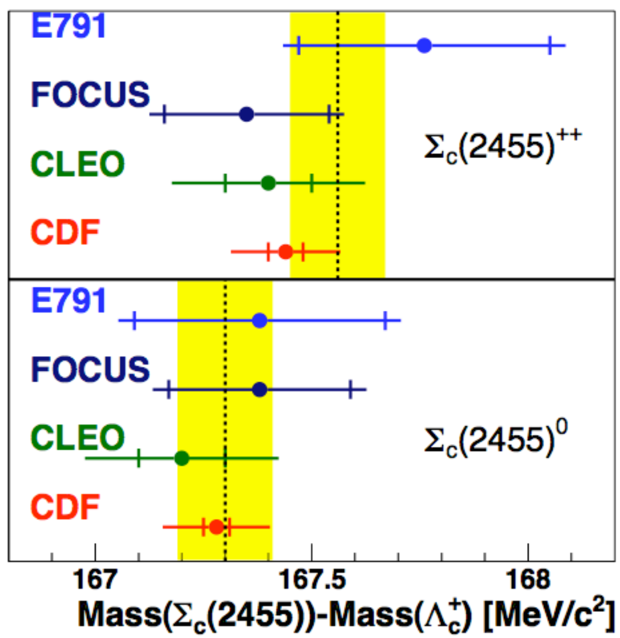
Signal Model for $\mathbf{\Sigma_c^{(*)0,++} \rightarrow \Lambda_c^+ \pi^\pm}$ Spectra

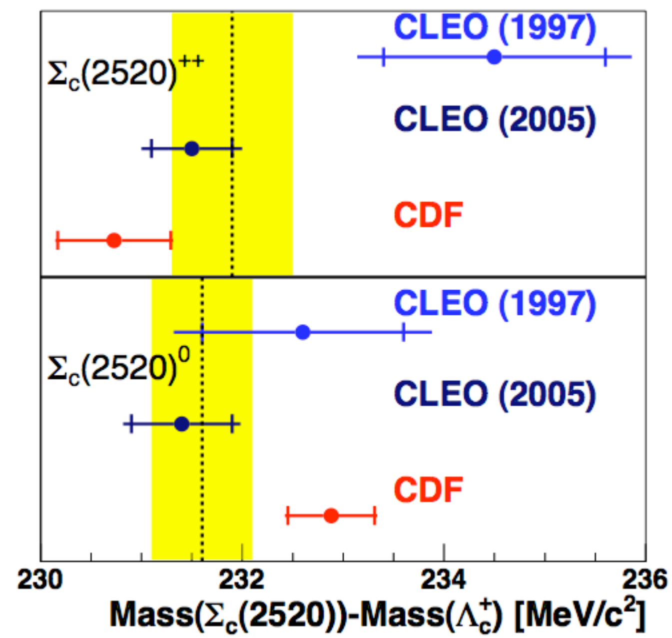
- Non-relativistic Breit-Wigner function,
- convoluted with the resolution function,
  - described by a triple Gaussian

Background Model for $\mathbf{\Sigma_c^{(*)0,++} \rightarrow \Lambda_c^+ \pi^\pm}$ Spectra

- Combinatorial contribution
  - SideBand($\mathbf{\Lambda_c^+}$)$\pi^\pm$, 2nd order polynomial.
  - Gaussian for $\mathbf{D^{*+}}$ reflection into $\mathbf{\Sigma_c^0}$
- $\mathbf{\Lambda_c^+}$ with random $\pi^\pm$: 3rd order polynomial
- $\mathbf{\Lambda_c(2625)^+ \rightarrow \Lambda_c^+ \pi^+ \pi^-}$ feed down
  - derived from $\mathbf{\Lambda_c(2625)^+ \rightarrow \Lambda_c^+ \pi^+ \pi^-}$ signal yield
  - contributes to the threshold area of $\mathbf{\Sigma_c(2520)^{++}}$, $\mathbf{\Sigma_c(2520)^0}$

Charm Sector: Baryon Resonances Σ_c, Σ_c^* and Λ_c^* (II)





Hadron	(J^P)	ΔM [MeV/c^2]	Γ [MeV/c^2]
$\Sigma_c(2455)^{++}$	$(\frac{1}{2}^+)$	$167.44 \pm 0.04 \pm 0.12$	$2.34 \pm 0.13 \pm 0.45$
		167.56 ± 0.11 (PDG)	2.23 ± 0.30 (PDG)
$\Sigma_c(2455)^0$	$(\frac{1}{2}^+)$	$167.28 \pm 0.03 \pm 0.12$	$1.65 \pm 0.11 \pm 0.49$
		167.30 ± 0.11 (PDG)	2.2 ± 0.40 (PDG)
$\Sigma_c(2520)^{++}$	$(\frac{3}{2}^+)$	$230.73 \pm 0.56 \pm 0.16$	$15.03 \pm 2.12 \pm 1.36$
		231.9 ± 0.6 (PDG)	14.9 ± 1.9 (PDG)
$\Sigma_c(2520)^0$	$(\frac{3}{2}^+)$	$232.88 \pm 0.43 \pm 0.16$	$12.51 \pm 1.82 \pm 1.37$
		231.6 ± 0.5 (PDG)	16.1 ± 2.1 (PDG)

The appropriate treatment of the $\Lambda_c(2625)^+$ contribution into the $\Sigma_c(2520)$ threshold area results in mass values moved apart from the CLEO (2005) data points.

Isospin (*I* =1) Mass Splitting: Σ_c vs Σ_b

Group	(J^P)	$\Sigma_c^{++} - \Sigma_c^0$, MeV/$c^2$ $(cuu) - (cdd)$	$\Sigma_b^+ - \Sigma_b^-$, MeV/c^2 $(buu) - (bdd)$
PDG	$(\frac{1}{2}^+)$	$+0.27 \pm 0.11$	–
CDF	$(\frac{1}{2}^+)$	$+0.16 \pm 0.05(\text{stat})$	$-4.2^{+1.1}_{-0.9}(\text{stat})\ ^{+0.07}_{-0.09}(\text{syst})$
PDG	$(\frac{3}{2}^+)$	$+0.3 \pm 0.6$	–
CDF	$(\frac{3}{2}^+)$	$-2.15 \pm 0.71(\text{stat})$	$-3.0 \pm 0.9(\text{stat})\ ^{+0.12}_{-0.13}(\text{syst})$

- $\Sigma_c(2455)$, $J^P = \frac{1}{2}^+$ isotriplet is fairly degenerated
  - consistent with previous CLEO, FOCUS results
  - contrary to Σ_b partners
- $\Sigma_c(2520)$, $J^P = \frac{3}{2}^+$ gets now to be consistent with the bottom partners, relaxing slightly a well known controversy of the Σ_c isospin mass splitting held since ARGUS, CLEO measurements.
- $M(\Sigma_b^{(*)+}) < M(\Sigma_b^{(*)-})$
  - both for $J^P = \frac{1}{2}^+$ and $J^P = \frac{3}{2}^+$
  - follow a known pattern for most of known isospin multiplets.
- experimental $\Delta M(\Sigma_b^*) - \Delta M(\Sigma_b)$ supports the theoretical estimate of $+0.40 \pm 0.07\ \text{MeV}/c^2$, J. Rosner (PRD **75**, 013009 (2007))

Spectroscopy of Exotic States: *Y(4140)* (I)

Motivation:

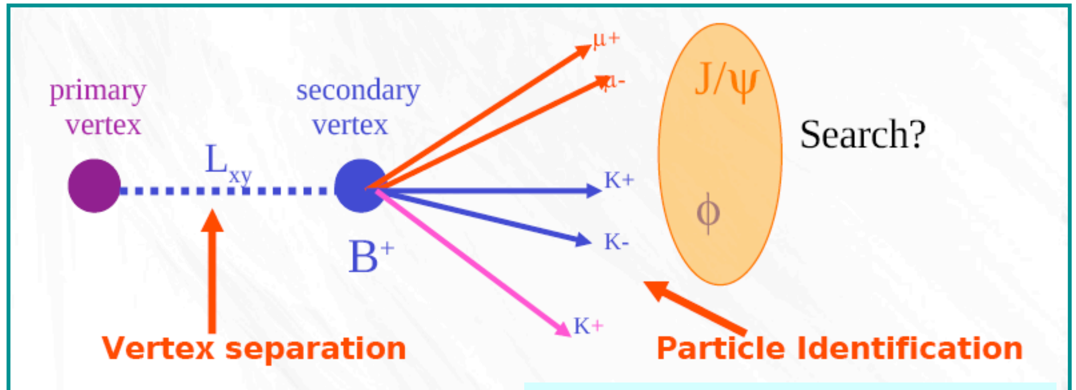
Renewed interest in a charmonium spectroscopy since few states with seemingly exotic quantum numbers have been observed, to be specific

- **Discovery X(3872) →VV**
- **Observation Y(3940) →$J/\Psi\ \omega$ (VV)**
  - ***Belle, PRL 94, 182002 (2005)***
  - ***Belle, PRL 101, 082001 (2008)***
- **$e^+e^- \to \gamma_{ISR}$Y(4260), Y(4260) →$J/\Psi\ \pi^+\pi^-$**
  - ***BABAR, PRL 95, 142001 (2005)***
- **$(0, 1, 2)^{-+}$ triplet predicted by theory**
  - **Y → $J/\Psi\ \varphi$ could be a candidate.**
- **CDF has undertaken the search of the exotic states within a B-meson decay mode**
  - **$B^+ \to K^+ J/\Psi\ \varphi$**
  - **evidence of near threshold bump at m($J/\Psi\ \varphi$) ~4140 MeV,**
  - **with $\int dt \cdot L = 2.7\ fb^{-1}$, *PRL 102, 242002 (2009)***

Spectroscopy of Exotic States: *Y(4140)* (II)

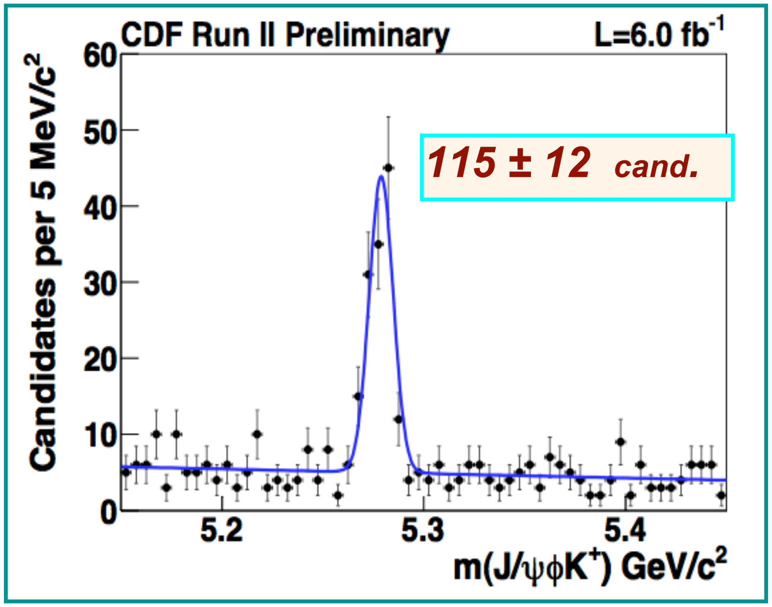
- **Near Threshold Structure identified as a mass within B^+**
  - **$B^+ \to Y K^+$, $Y \to J/\Psi\, \varphi$**
  - **$J/\Psi \to \mu^+\mu^-$, i.e. J/Ψ di-μ triggered sample**
  - **$\varphi \to K^+K^-$**
  - **exclusively reconstructed B-meson**
    - **$B^+ \to J/\Psi\, \varphi\, K^+$**
    - **additional mass constraint reduces the background**
    - **search for a signature in $m(J/\Psi\, \varphi)$**

Analysis Criteria



Picture courtesy of Dr. J.-P. Fernandez (CIEMAT)

Spectroscopy of Exotic States: $Y(4140)$ with $\int dt \cdot L = 6\ fb^{-1}$ (III)



M($J/\Psi\ \varphi$ K+) fit:

- *Gaussian (σ = 5.9 MeV/c2) + Poly. (1st)*
- *115 ± 12 (stat) candidates*.

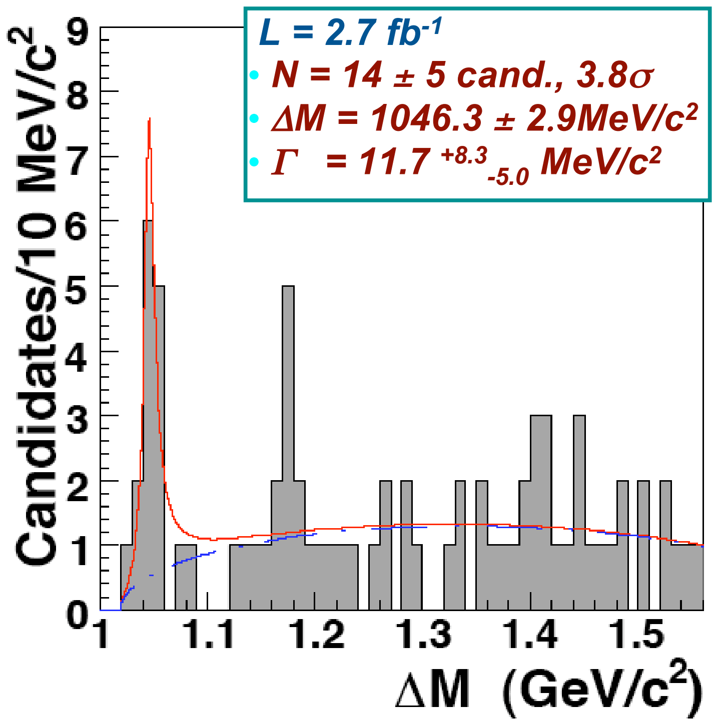
- **The analysis criteria and cuts have been frozen to *PRL pub. , based on 2.7 fb^{-1}***
- **Changes w.r.t. the PRL published analysis**
  - **background model changed**
    - **from: PhaseSpace(3-body) + flat (combinat.)**
    - **to: PhaseSpace(3-body) only.**
    - **any tests done with more data and/or loosening cuts has shown no deviation from PhaseSpace model, what has justified our choice.**

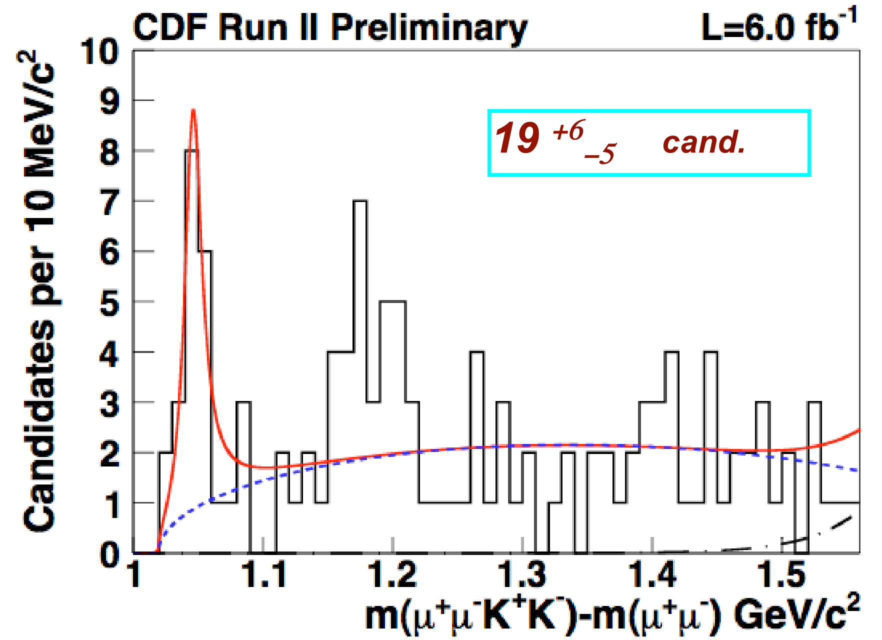
Reconstruct the mass difference:

$\Delta M = M(\mu^+\mu^- K^-K^+) - M(\mu^+\mu^-)$

- **The signal model:**
  - **(S-wave Rel. B-W) ⊗ *Gaussian (σ = 1.7MeV/c^2)***
  - ***the ($\mu^+\mu^-$ K$^-$K$^+$) taken from B-signal ±3σ area***
  - ***the spectrum is blinded***
    - ***opened only when stat. MC trials show >75% chances to observe 5σ signal***

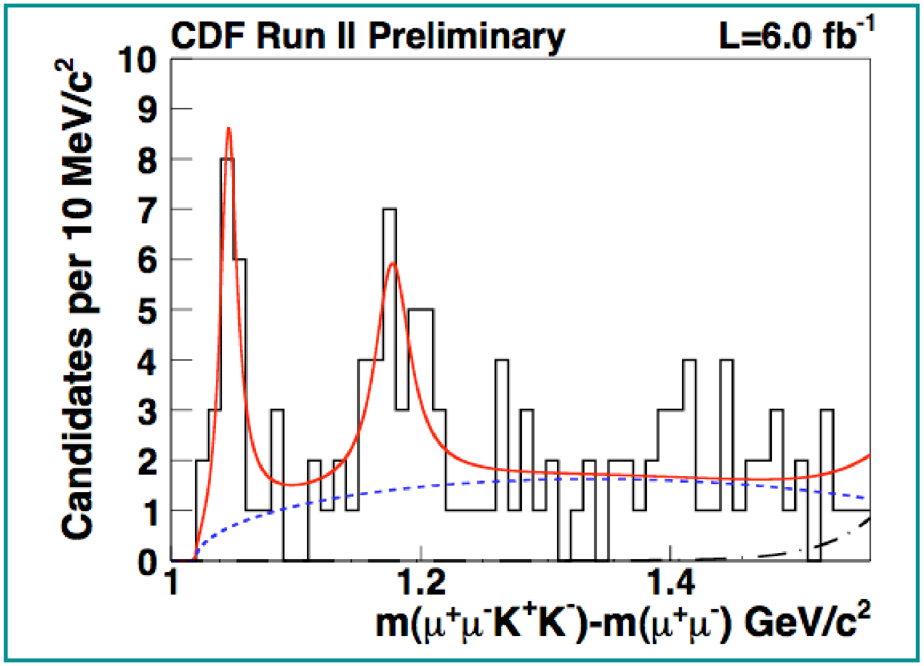
Spectroscopy of Exotic States: $Y(4140)$ with $\int dt \cdot L = 6\ fb^{-1}$ (IV)





- use *log-LH* ratio:
  - $\sqrt{(-2\times\ln(L_{max} / L0))} = 5.9$ in exp. data
  - $-2\times\ln(L_{max} / L0)$ calculated for every stat. trial
  - count the number of entries above 5.9^2
  - estimated significance: $p = 2.3\times10^{-7}$, 5σ
- *The unbinned LH fit results:*
  - $\Delta M = 1046.7^{+2.9}_{-3.0}$ MeV/c^2
  - $\Gamma = 15.3^{+10.4}_{-6.1}$ MeV/c^2
  - $N = 19^{+6}_{-5}$ candidates.

Spectroscopy of Exotic States: *Y(4140)* with $\int dt \cdot L = 6\ fb^{-1}$ (V)



- An excess of events appears *at $\Delta M \sim 1.18\ GeV/c^2$* with the full luminosity *$L = 6\ fb^{-1}$*
- Fitting both bumps together (same bgr. model) yields
  - *$\Delta M(1) = 1046.7^{+2.8}_{-2.9}\ MeV/c^2$*
  - *$\Gamma(1) = 15.0^{+8.5}_{-5.6}\ MeV/c^2$*
  - *$N(1) = 20 \pm 5$ candidates, 5σ significance*
    - *$\Delta M(2) = 1177.7^{+8.4}_{-6.7}\ MeV/c^2$*
    - *$\Gamma(2) = 32.3^{+21.9}_{-15.3}\ MeV/c^2$*
    - *$N(2) = 22 \pm 8$ candidates, 3σ significance*

Spectroscopy of Exotic States: $Y(4140)$ with $\int dt \cdot L = 6\ fb^{-1}$ (VI)

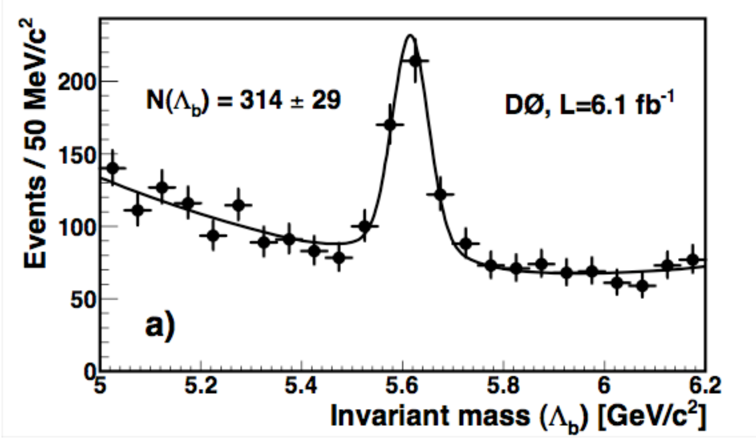
- An increased with $6\ fb^{-1}$ sample of $B^+ \to J/\Psi\ \varphi\ K^+$ allowed further advances in the study of $m(J/\Psi\ \varphi)$ spectrum and its properties at the kinematical threshold area.
- the mass, width measurements of the $Y(4140)$ peak are consistent with the previously published ones
  - *the significance of the Y(4140) signal became* ***5σ***
  - *well above the threshold for open charm decays but the BR($Y \to J/\Psi\ \varphi$) ~15%*
    - ***does not behave like a charmonium***
  - *the decay mode is very near the kinematical threshold*
    - ***similar to*** **Y(3940) $\to J/\Psi\ \omega$**
- Hint of a possible second state *at ~4270 MeV/c^2*
  - *3σ significance*

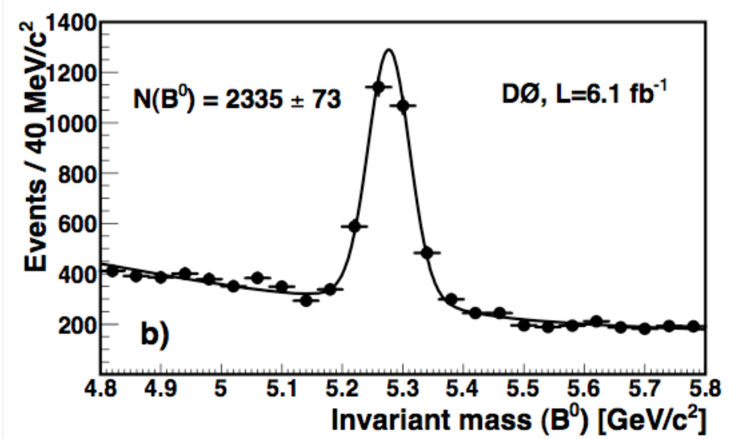
State	M [MeV/c^2]	Γ [MeV/c^2]
$Y(4140)$ $\gtrsim 5 \cdot \sigma$	$4143.4^{+2.9}_{-3.0}(\text{stat}) \pm 0.6(\text{syst})$	$15.3^{+10.4}_{-6.1}(\text{stat}) \pm 2.5(\text{syst})$
$(\mathcal{B}(B^+ \to YK^+) \cdot \mathcal{B}(Y \to J/\psi\,\phi)/\mathcal{B}(B^+ \to J/\psi\,\phi K^+) = 0.149 \pm 0.039(\text{stat}) \pm 0.024(\text{syst}))$		
$Y(4270)$ $\gtrsim 3.1 \cdot \sigma$	$4274.4^{+8.4}_{-6.7}(\text{stat})$ $(N = 22 \pm 8(\text{stat}),\ \text{candidates})$	$32.3^{+21.9}_{-15.3}(\text{stat})$

Measurement of Production Fraction $f(b\to\Lambda_b^0)\times BR(\Lambda_b^0\to J/\Psi\Lambda^0)$

$$\sigma_{\rm rel} = \frac{\sigma(b)\cdot f(b\to\Lambda_b^0)\cdot\mathcal{B}(\Lambda_b^0\to J/\psi\,\Lambda^0)}{\sigma(b)\cdot f(b\to B^0)\cdot\mathcal{B}(B^0\to J/\psi\,K_S^0)} = \frac{N_{\Lambda_b^0\to J/\psi\,\Lambda^0}}{N_{Bd\to J/\psi\,K_S^0}}\cdot\frac{\mathcal{B}(K_S^0\to\pi^-\pi^+)}{\mathcal{B}(\Lambda^0\to p\pi^-)}\cdot\varepsilon$$

- $\int\mathcal{L}\,dt = 6.1\,\mathrm{fb}^{-1}$
- $\sigma_{\rm rel} = 0.345\pm0.034(\mathrm{stat})\pm0.033(\mathrm{syst})\pm0.003\ (\mathrm{PDG})$
- Using the world average value of $f(b\to B^0)\cdot\mathcal{B}(B^0\to J/\psi K_s^0) = (1.74\pm0.08)\times10^{-5}$
- obtain: $f(b\to\Lambda_b)\cdot\mathcal{B}(\Lambda_b\to J/\psi\Lambda) = (6.01\pm0.60\ (\mathrm{stat.})\pm0.58\ (\mathrm{syst.})\pm0.28\ (\mathrm{PDG}))\times10^{-5}$
- factor 3 improvement
- submitted to PRD-RC, arXiv:1105.0690 .





Summary

- A significant progress is made in a sector of heavy quark baryons with the new CDF measurements presented in this talk
  - on bottom baryon resonance states
  - and their partners in a charm quark sector
- With presently available statistics of 9 fb^{-1} CDF and D∅ are continuing their vigorous programs of heavy quark baryon Σ_b resonances, strange Ξ_b , double strange Ω_b
- An update on an exotic state Y(4140) with the enlarged statistics has been presented
  - The near threshold signal at 4140 MeV/c^2 is confirmed with a *>5* σ significance
  - The evidence of a structure at 4270 MeV/c^2 has been reported
- Advancing XYZ states program: new states, confirm B-factories, determination of quantum numbers, leading mass measurements.
- CDF and D∅ Collaborations have collected large samples of data still to be analyzed : a few exciting years of competition with LHCb

Backup Slides

Bottom Baryons: Σ_b Resonances (X)

Systematic Uncertainties: summary table

Signal Pars.	Mass Scale	Fit Procedure	Res.	Back.	Total	%
Σ_b^+ Q	 -0.35		0.07 -0.12	0.05 -0.05	0.09 -0.37	0.2 1
Σ_b^+ Γ	0.20 -0.20	 -0.38	0.94 -0.89	0.40 -0.40	1.04 -1.07	11 12
Σ_b^+ events			16 -11	9 -9	18 -15	4 3
Σ_b^- Q	 -0.38		0.05 -0.07	0.04 -0.04	0.07 -0.39	0.1 1
Σ_b^- Γ	0.20 -0.20	 -0.27	0.85 -0.87	0.50 -0.50	1.01 -1.06	23 25
Σ_b^- events			9 -8	34 -34	35 -35	11 10
Σ_b^{*+} Q	 -0.52		0.06 -0.13	0.10 -0.10	0.12 -0.55	0.2 1
Σ_b^{*+} Γ	0.20 -0.20	 -0.29	0.64 -1.01	0.50 -0.50	0.83 -1.18	8 11
Σ_b^{*+} events			7 -13	24 -24	25 -27	3 4
Σ_b^{*-} Q	 -0.56		0.06 -0.08	0.06 -0.06	0.08 -0.57	0.1 1
Σ_b^{*-} Γ	0.20 -0.20	 -0.23	0.65 -0.96	0.30 -0.30	0.74 -1.05	12 16
Σ_b^{*-} events			7 -8	28 -28	29 -29	6 6