Latest B-Physics Results from the DØ Experiment

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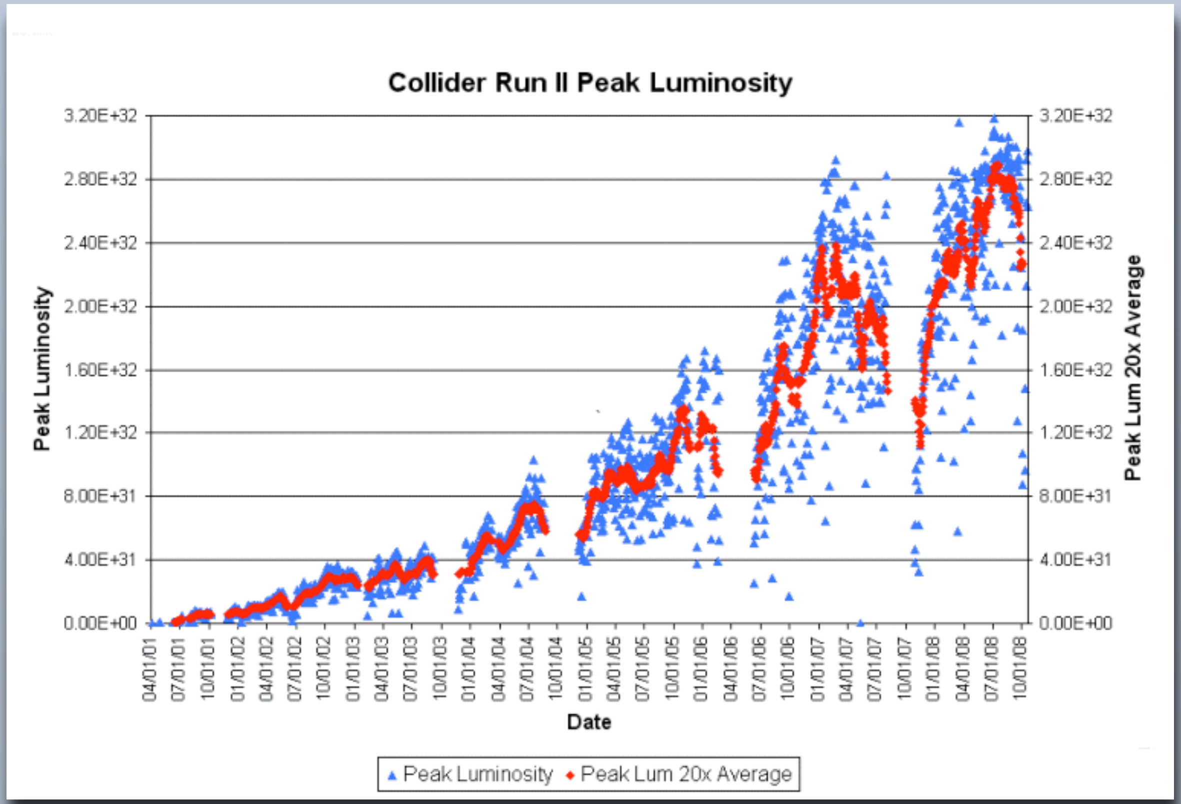
On behalf of the DØ Collaboration

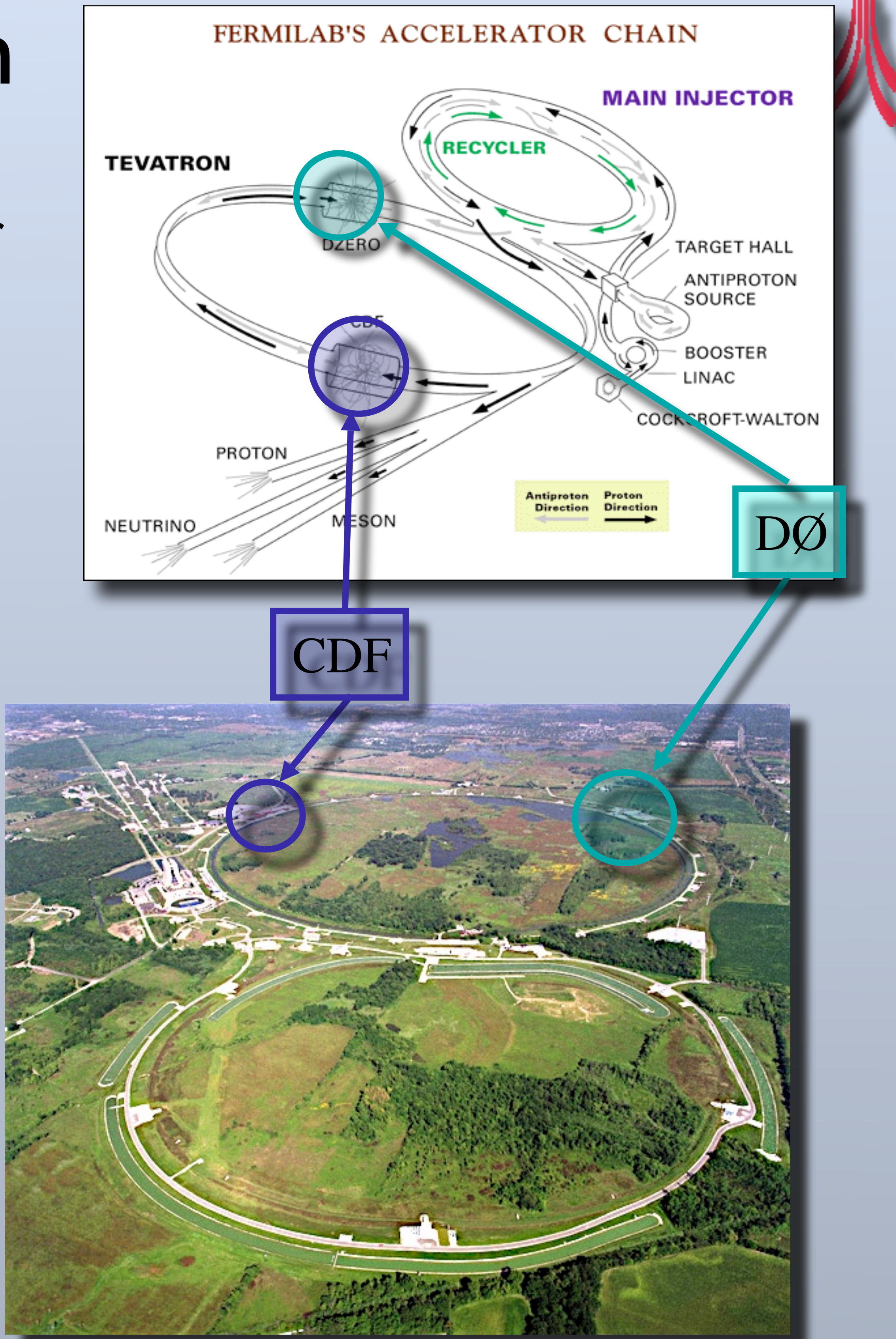
Outline

- Tevatron
- DØ detector
- Recent results in B-physics for:
  - Lifetime of neutral B-mesons
  - Lifetime of $B_c^{\pm}$ meson
  - Semi-leptonic B_s CP violation asymmetry measurement
  - Discovery of the baryon: $\Omega_b^{\pm}$ (ssb)
- Summary

Tevatron

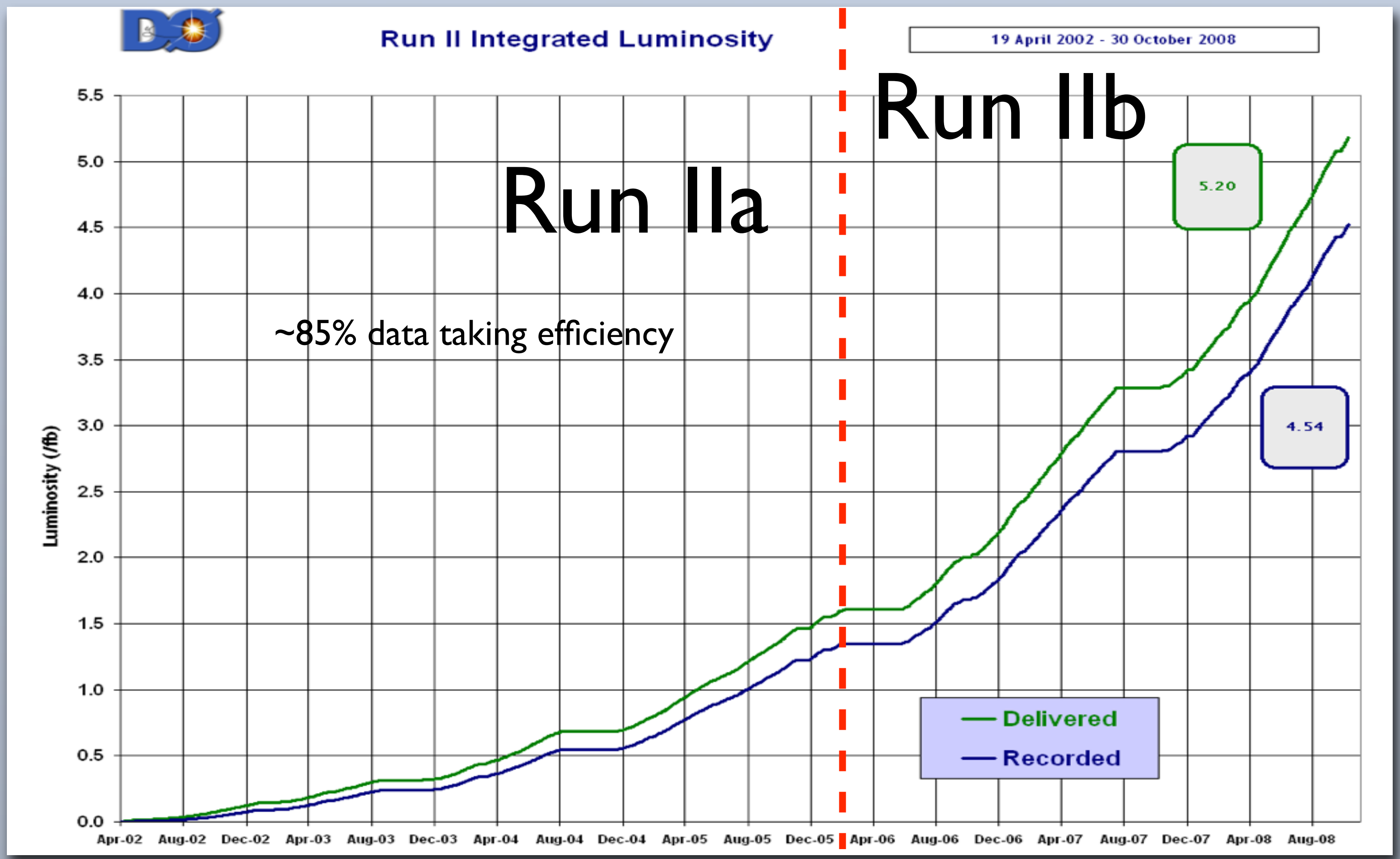
- The Tevatron: ~6 km circumference accelerator
  - Protons and anti-protons accelerated to $\sqrt{s}$=1.96 TeV
  - Rate of collisions ~1.7 MHz
  - Bunch spacing 396 ns
- Peak luminosity instantaneous ~3 x $10^{32}cm^{-2}s^{-1}$



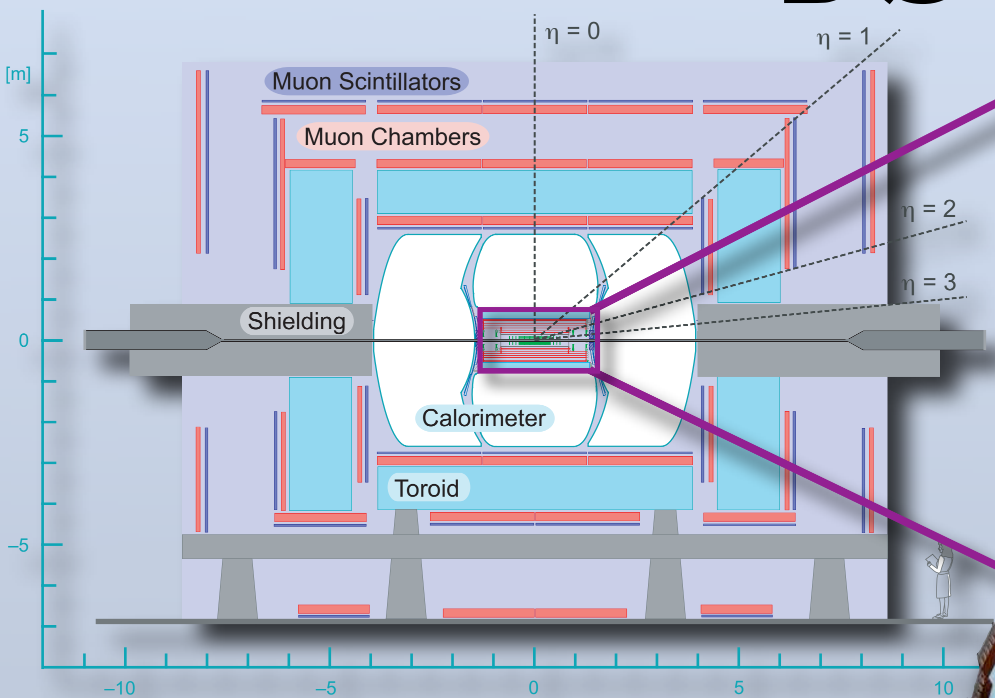


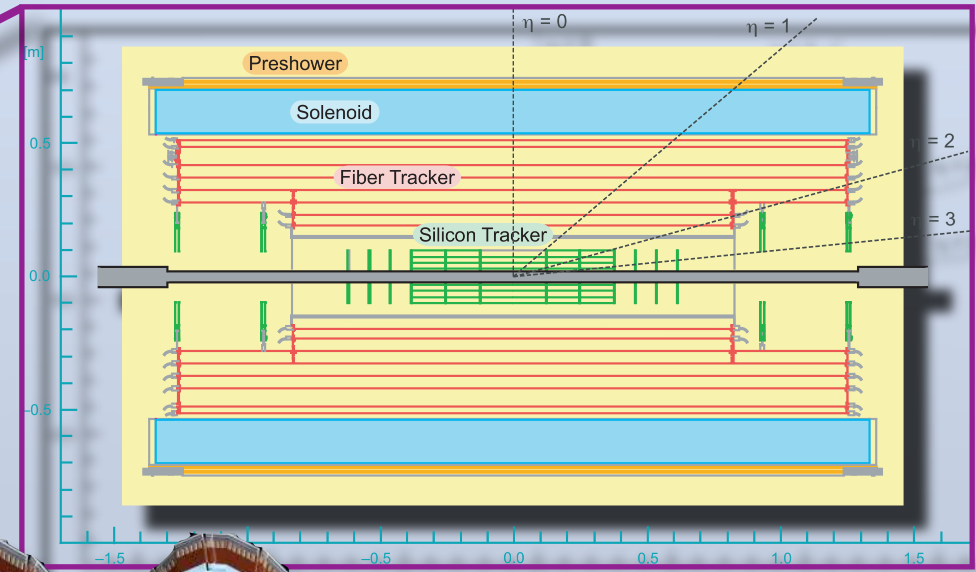
Tevatron: Current Status

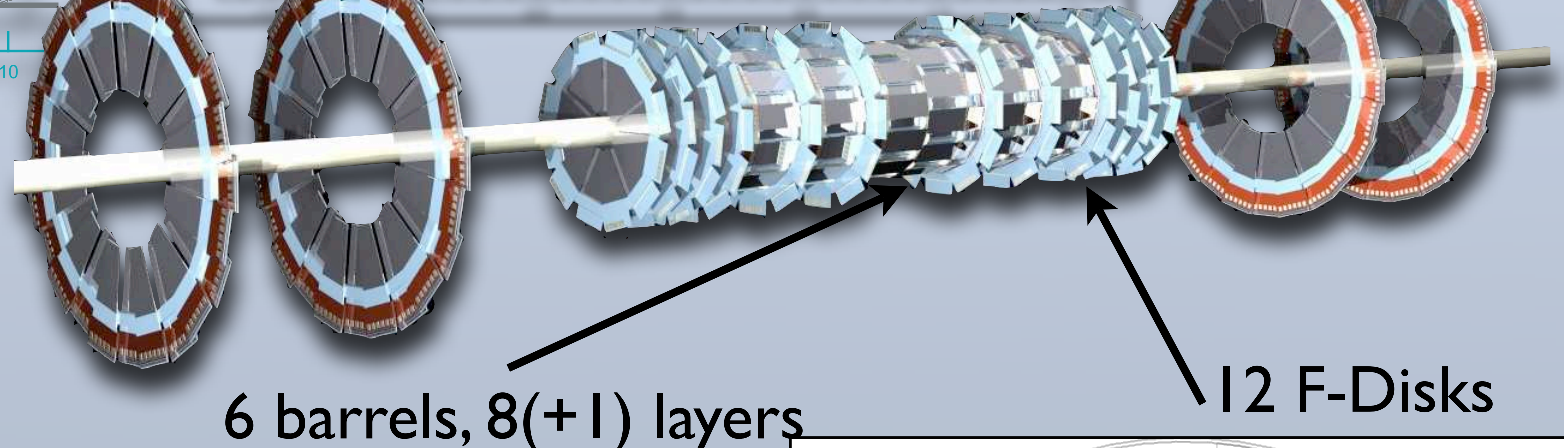
- From Run IIa ~1.3 fb^{-1} was recorded by DØ for analysis.
- To date:
  - 5.20 fb^{-1} delivered by Tevatron,
  - 4.54 fb^{-1} recorded by the DØ detector,
- Projected ~7–8 fb^{-1} recorded integrated luminosity by end of Tevatron running.
- Results presented here based on data from Run IIa, and Run IIa + Run IIb.



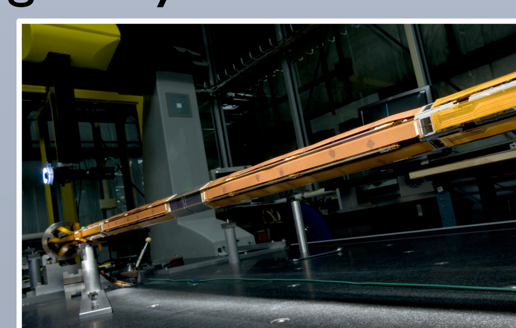
DØ Detector

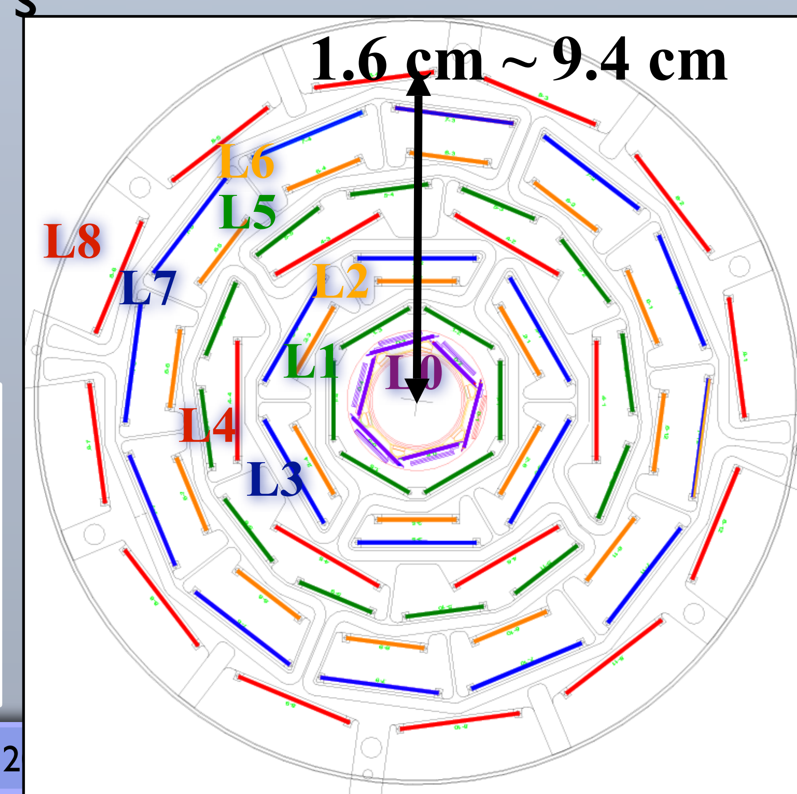




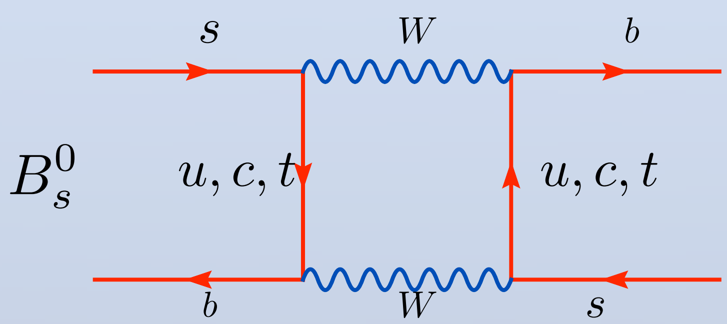


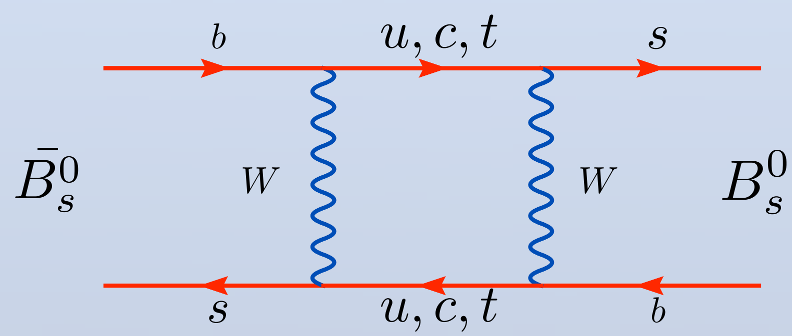
- Run II detector a significant upgrade from Run I.
- Tracking system allows coverage |η|<3, enclosed by 2T solenoid.
- Muon system |η|<2; heavily used in b-physics.
- DØ's ability to flip polarity of both magnet systems utilised in asymmetry measurements.
- Further improvements for Run IIb: Layer-0





Neutral B Meson Properties





$$M_s = \frac{M_H + M_L}{2}$$

$$\Delta m_s = M_H - M_L \sim 2|M_{12}|$$

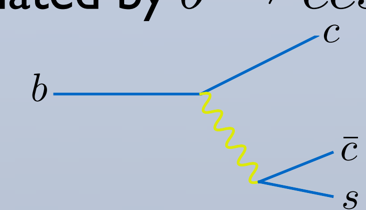
M_{12} dominated by $b \rightarrow t\bar{t}s$

$$\Gamma_s \equiv \frac{1}{\bar{\tau}_s} = \frac{\Gamma_L + \Gamma_H}{2}$$

$$\Delta\Gamma_s = \Gamma_L - \Gamma_H \sim 2|\Gamma_{12}|\cos\phi_s$$

$$i\frac{\mathrm{d}}{\mathrm{d}t}\begin{pmatrix} B_s^0 \\ \bar{B}_s^0 \end{pmatrix} = \begin{pmatrix} M - \frac{i}{2}\Gamma & M_{12} - \frac{i}{2}\Gamma_{12} \\ M_{12}^* - \frac{i}{2}\Gamma_{12}^* & M - \frac{i}{2}\Gamma \end{pmatrix}\begin{pmatrix} B_s^0 \\ \bar{B}_s^0 \end{pmatrix}$$

Γ_{12} dominated by $b \rightarrow c\bar{c}s$



- Neutral mesons, flavour and mass eigenstates different:
- $|B_H\rangle = p|B_s^0\rangle + q|\bar{B}_s^0\rangle$
  $|B_L\rangle = p|B_s^0\rangle - q|\bar{B}_s^0\rangle \qquad p^2 + q^2 = 1$
- If CP is conserved, then $|B_H\rangle = |B^{\mathrm{CP-odd}}\rangle$, $|B_L\rangle = |B^{\mathrm{CP-even}}\rangle$
- In SM the CP violating phase is very small:
  $$\phi_s^{SM} = -2\beta_s = -2\arg\left(-\frac{V_{ts}V_{tb}^*}{V_{cs}V_{cb}^*}\right) \approx 0.04$$
- New physics effects may enhance this value. $\phi_s \equiv -2\beta_s + \phi_s^{\Delta}$

- Oscillation rate dependent on mass difference:
  $$\Delta m(B_d) = 0.507 \pm 005\mathrm{ps}^{-1}$$
  $$\Delta m(B_s) = 17.77 \pm 0.12\mathrm{ps}^{-1} \quad \text{(PDG)}$$
- In Bd system ΔΓ ~0;
  Bs ΔΓs / Γs ~ O(10%)
- CP-violating effects may be seen in studies relating to the off-diagonal element Γ_{12}

Lifetime Results from Neutral B-Mesons

- Two recent analyses from DØ:
  - Time-dependent tagged lifetime of $B_s^0 \to J/\psi\phi$
  - Time-dependent untagged relative lifetimes of:
    - $B_s^0 \to J/\psi\phi$
    - $B_d^0 \to J/\psi K^{*0}$
- Tagged analysis increases precision, removes sign ambiguity in ϕ_s
- Simultaneous measurement of B_s and B_d is performed to allow direct comparison of angular and lifetime parameters.
- Data corresponds to data-taking period 2003—2007, of ~2.8 fb^{-1} integrated luminosity

$B_s^0 \to J/\psi\phi$

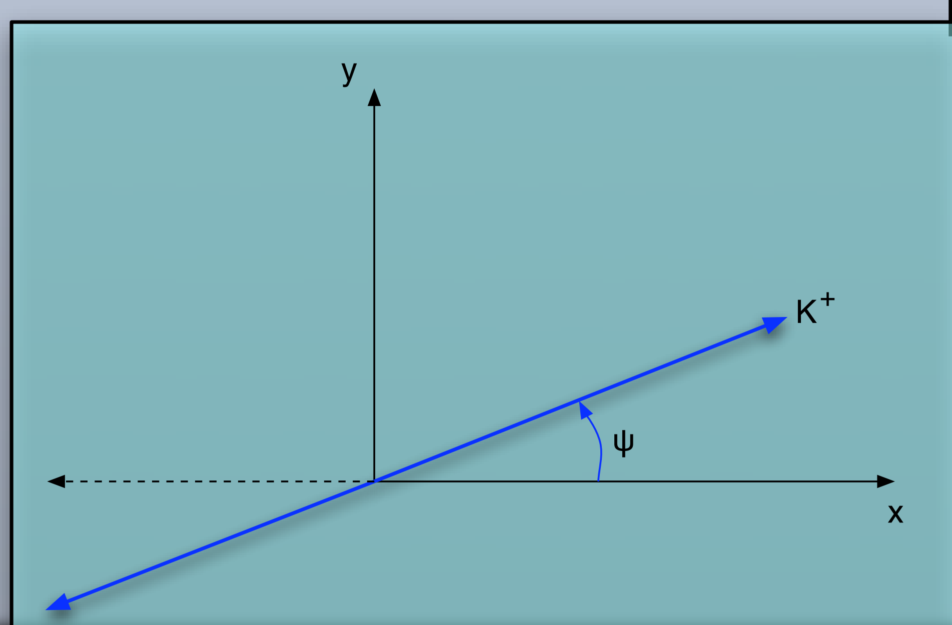
- A ‘golden’ channel in B-physics analyses:
- Pseudoscaler to Vector Vector decay
- CP-even: Amplitudes A_0 , $A_\perp$
  CP-odd: Amplitude $A_{||}$
- Separation of even and odd modes with time-dependent angular analysis of final-state particles,
- Decay chain:

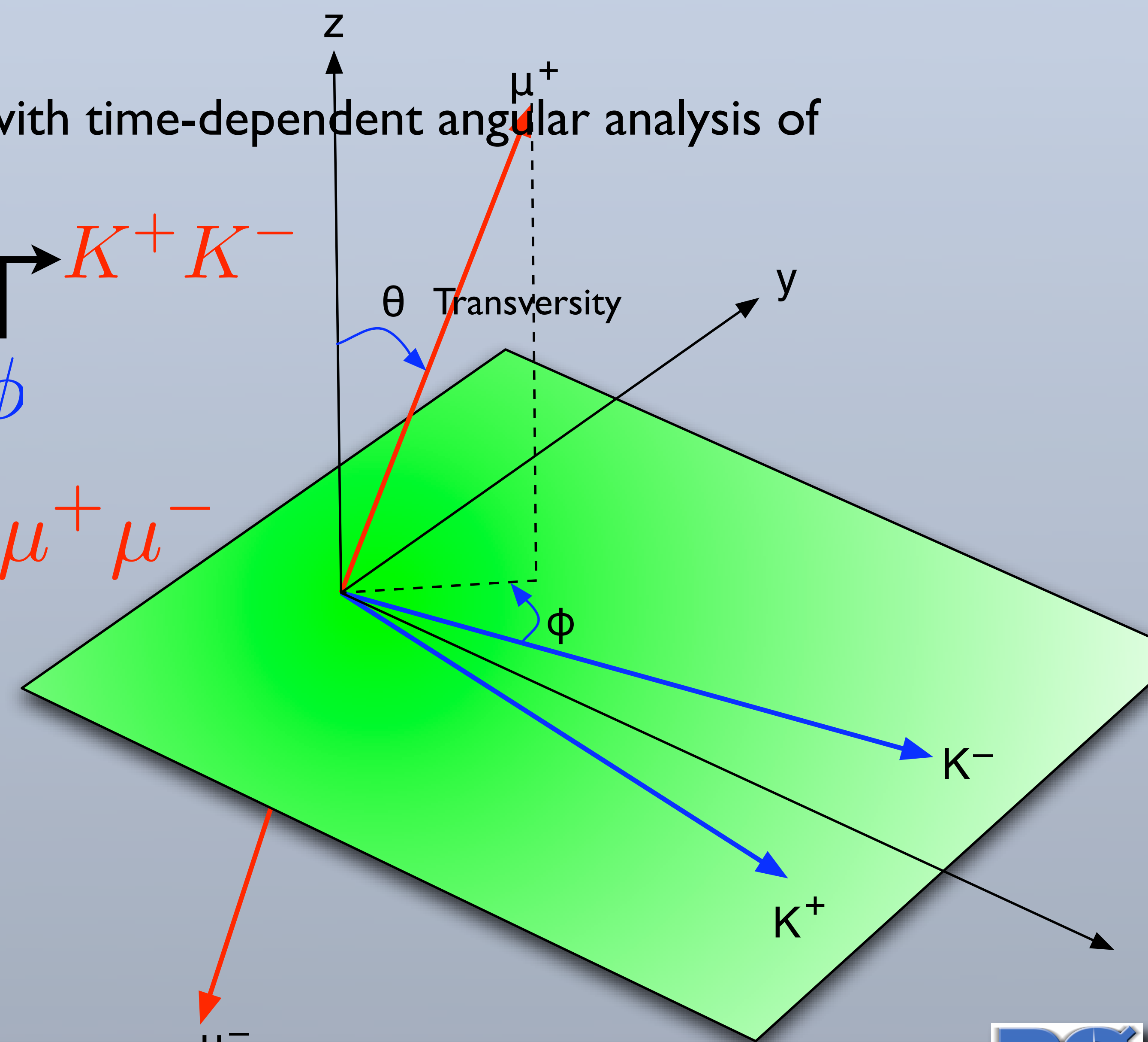
$$B_s^0 \to J/\psi\phi$$

$\phi \to K^+K^-$

$J/\psi \to \mu^+\mu^-$

- Clean final state



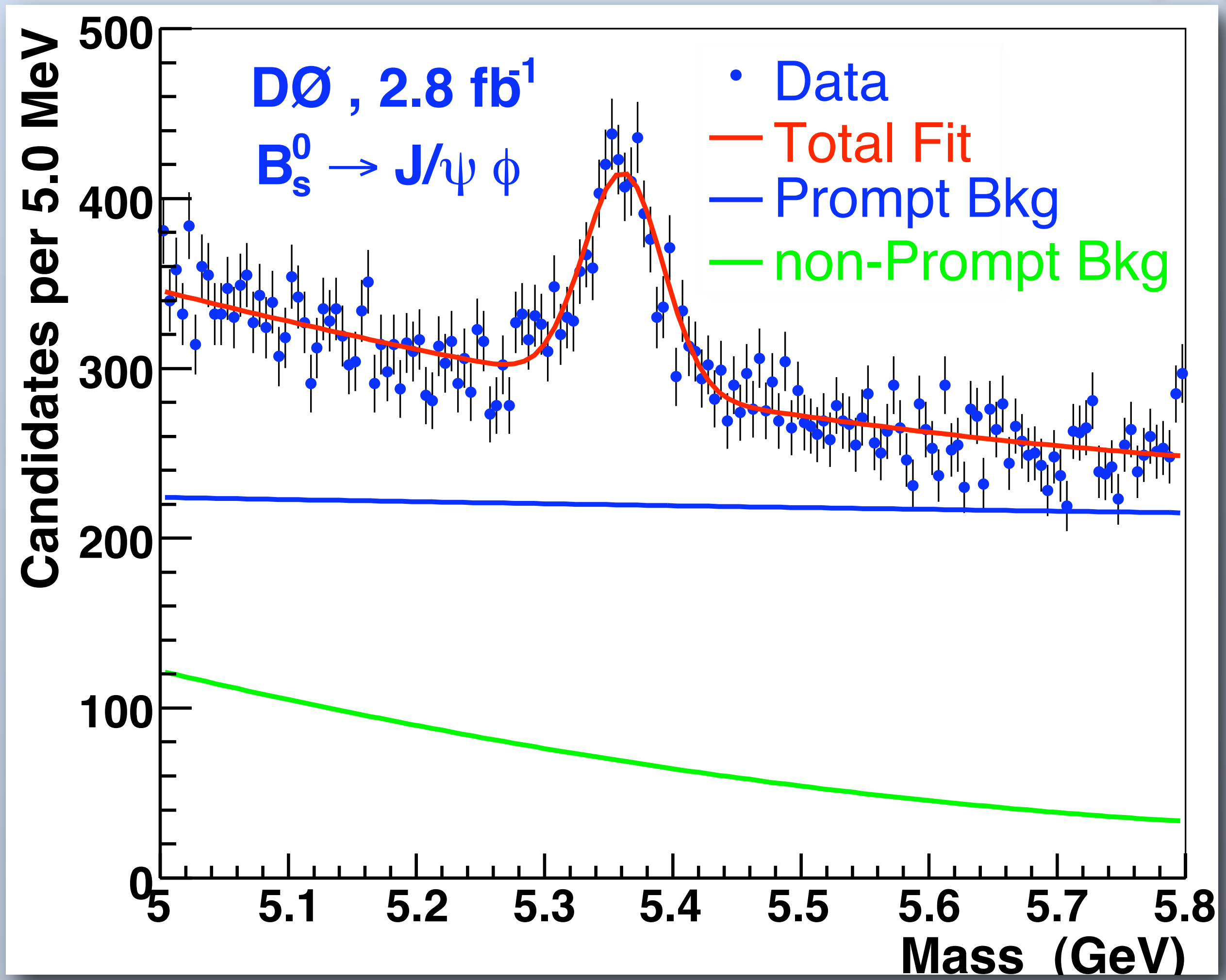


Initial-state Tagging

- Initial-state same-side and opposite-side tagging increase precision, removes ambiguity on ϕ_s for given $\Delta\Gamma_s$
  - Event charge variables are formed for opposite-side tags:

$$Q_r = \frac{\sum_i (q \cdot p_\alpha)^k}{\sum_i (p_\alpha)^k} \qquad \alpha = \{T, L\} \qquad r = \{\mu, \mathrm{EV}, \mathrm{SV}, \mathrm{e}\}$$

  - Same-side tagging uses correlations in b-quark flavour and kaon charge from hadronisation.



- Combined together in a likelihood ratio method:
  - Tagging power estimated using MC and data comparison.

$$\epsilon\mathcal{D}^2 = (4.68 \pm 0.54)\%$$

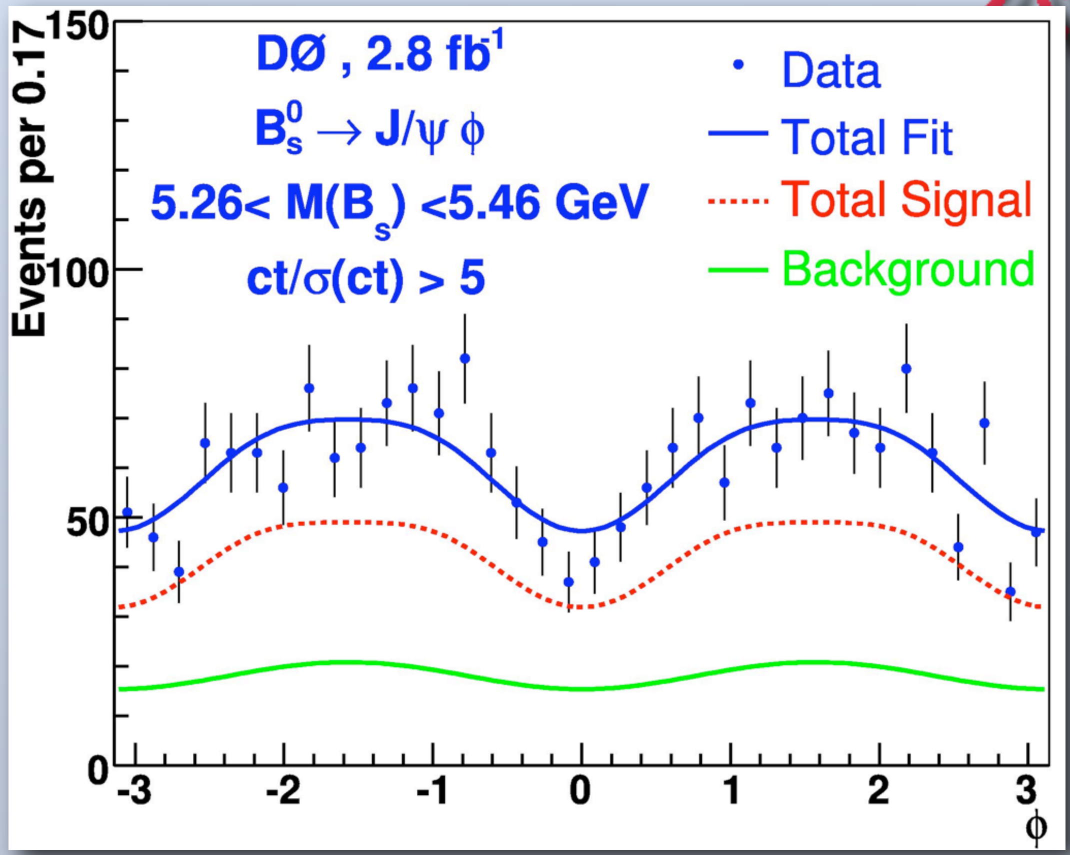
$$\epsilon = \frac{N_c + N_w}{N_{\mathrm{Total}}}$$

$$\mathcal{D} = \frac{N_c - N_w}{N_c + N_w}$$

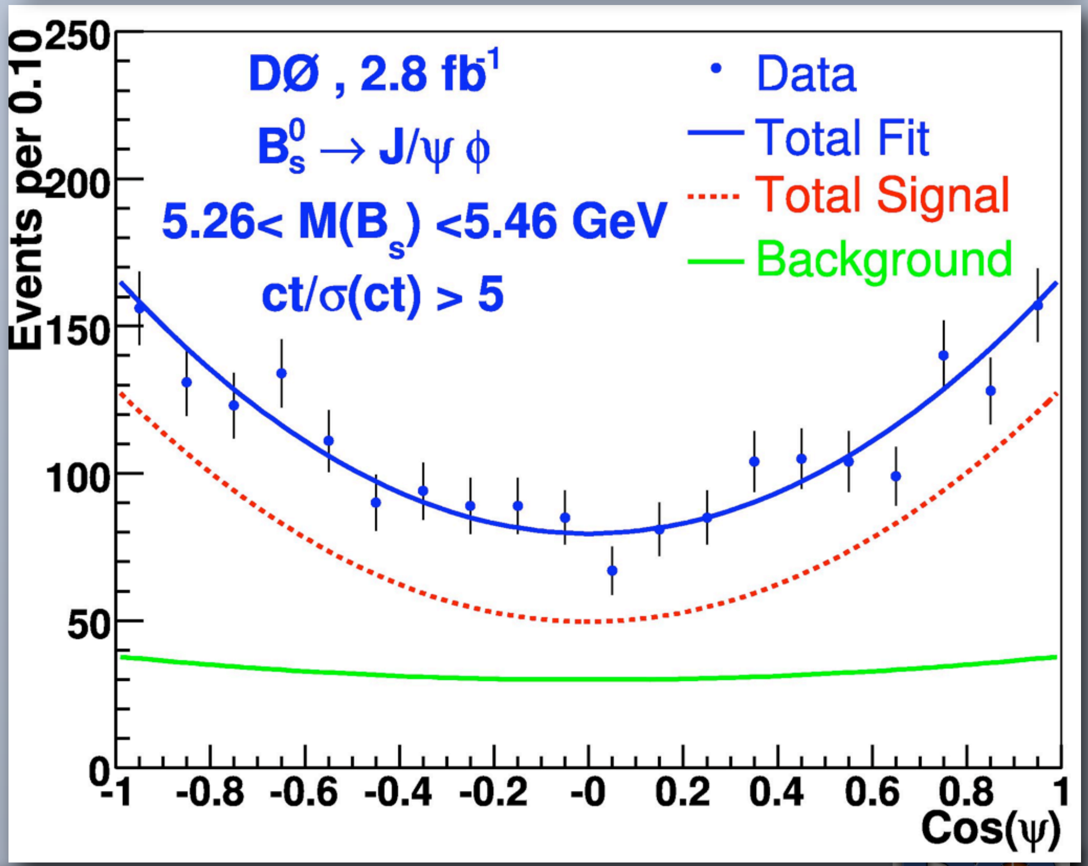
    - 2x improvement from oppsite-side only

Angular Distributions

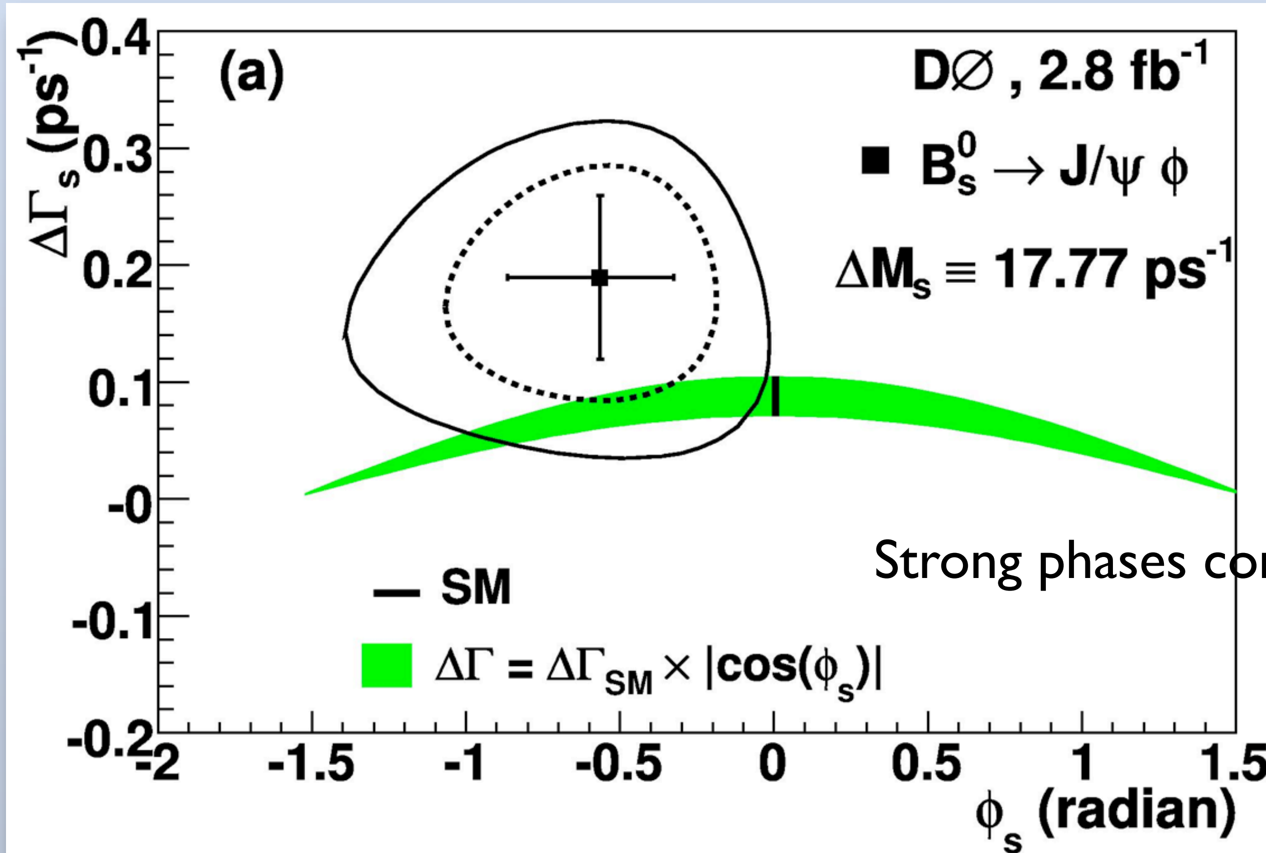
- 48k candidate $J/\psi, \phi$ after selections; ~2000 B_s mesons extracted from fit:
- Unbinned maximum likelihood fit used:
  m(B_s),
  proper decay time,
  and the three angles that characterise the final state.



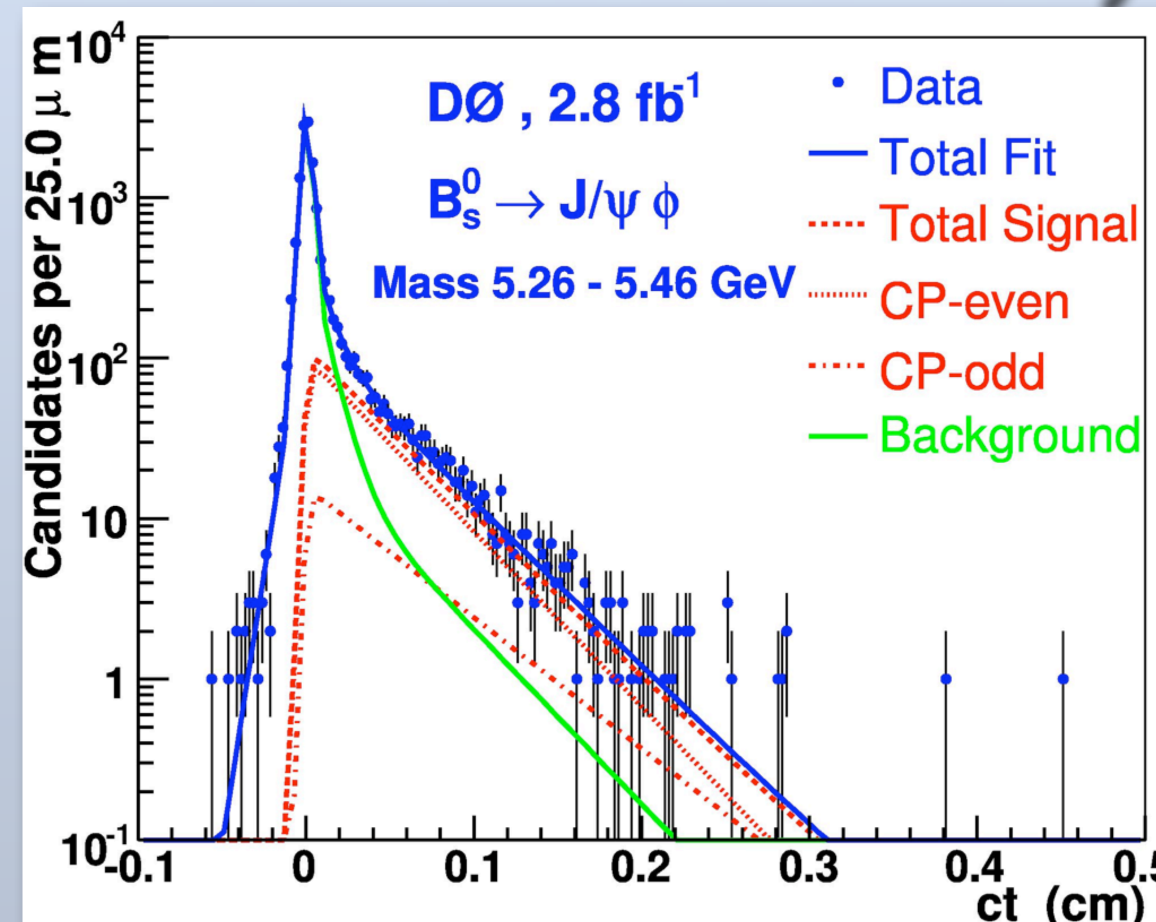
- Background distributions separated into:
  - Prompt: Directly produced J/ψ with other tracks,
  - Non-prompt: J/ψ from B decay with tracks from had. or multi-body decay of B-hadrons

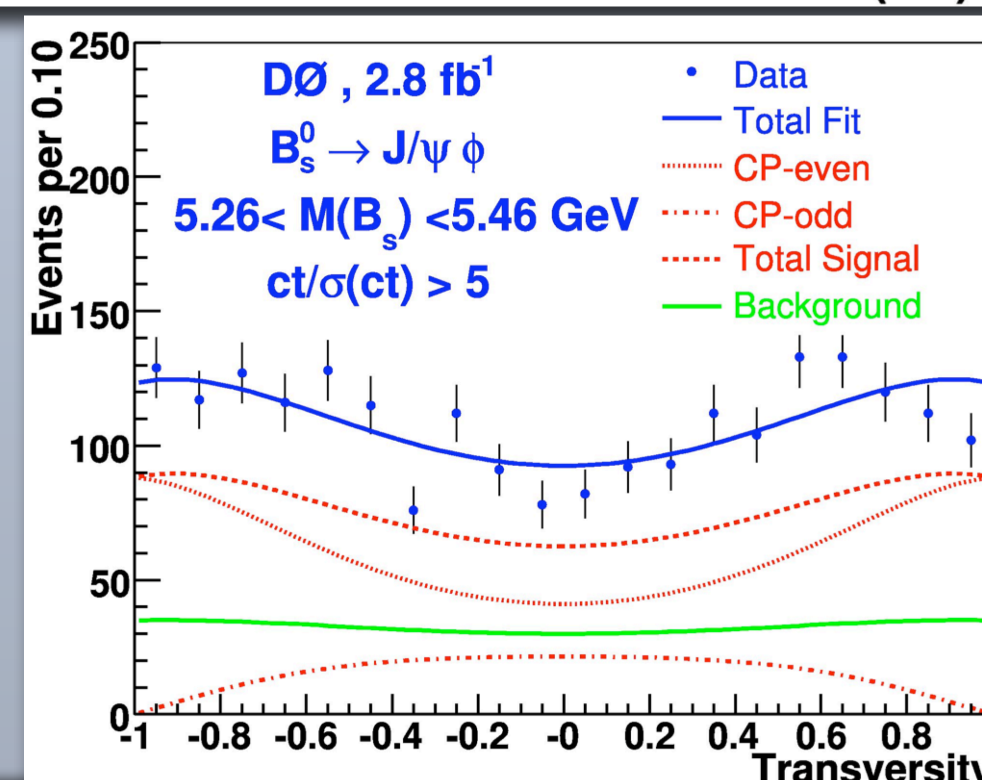


Lifetime Results



Strong phases constrained





$$\bar{\tau}_s = 1.52 \pm 0.05(\mathrm{stat}) \pm 0.01(\mathrm{syst})\ \mathrm{ps}$$

$$\Delta\Gamma_s = 0.19 \pm 0.07(\mathrm{stat})^{+0.02}_{-0.01}(\mathrm{syst})\ \mathrm{ps}^{-1}$$

$$\phi_s = -0.57^{+0.24}_{-0.30}(\mathrm{stat})^{+0.07}_{-0.02}(\mathrm{syst})$$

hep-ex:/0802.2255 Acepted PRL

Simultaneous Measurement of $B_{d,s}$ Lifetime

- Simultaneous measurement of B_s and B_d is performed; allows direct comparison of angular and lifetime parameters.
- B_s meson decay using $B_s^0 \to J/\psi\phi$
- B_d meson decay $B_d^0 \to J/\psi K^{*0}$

$$K^{*0} \to K^{\pm}\pi^{\mp}$$

$$J/\psi \to \mu^+\mu^-$$

  - Selected for similar final state topology.

CP-even: Amplitudes A_0 $A_\perp$

CP-odd: Amplitude $A_{||}$

- Selection requires two good muons, forming J/ψ. Combine with two oppositely charged tracks (within correct invariant mass window) forming a common vertex.
- CP-conservation assumed in the B_s system.
- CP-conserving strong phases: $\delta_1 \equiv \arg[A_{||}^* A_\perp]$ $\delta_2 \equiv \arg[A_0^* A_\perp]$

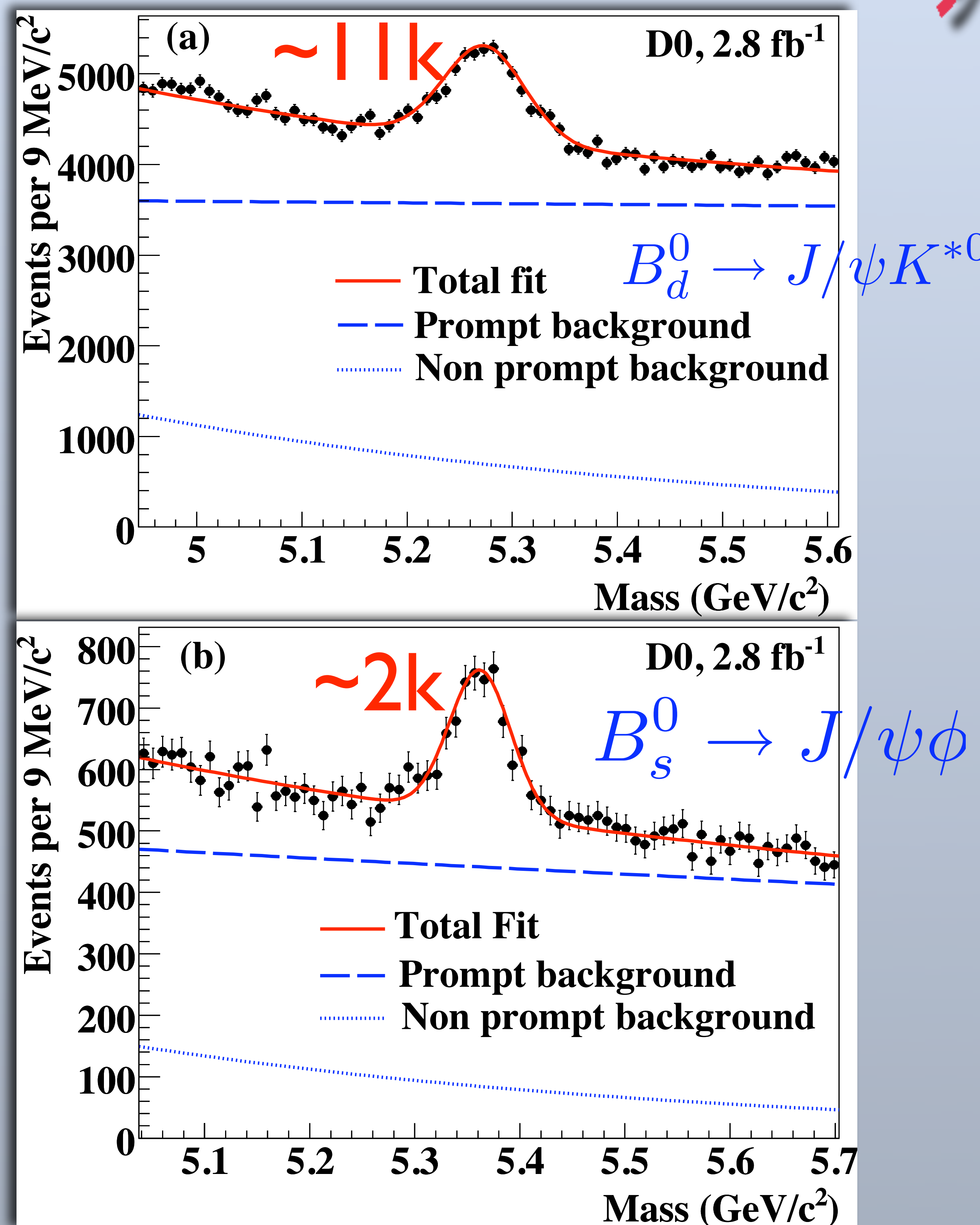
$$\delta_0 \equiv \arg[A_0] = 0$$

- Measured phase $\delta_{||} = \arg[A_0^* A_{||}]$ related by

$$\delta_{||} = \delta_2 - \delta_1$$

Mass Distribution

- After selections we find:
  334k B_d candidates and
  42k B_s candidates.
- A simultaneous unbinned likelihood fit is performed to both samples.
- Background contributions used in the PDF:
  - Prompt component from J/ψ and tracks from hadronisation
  - Non-prompt: J/ψ from B decay, tracks for ϕ meson from hadronisation or multi-body decays of same B meson.
- Plots are projected results of the fit for the invariant mass.

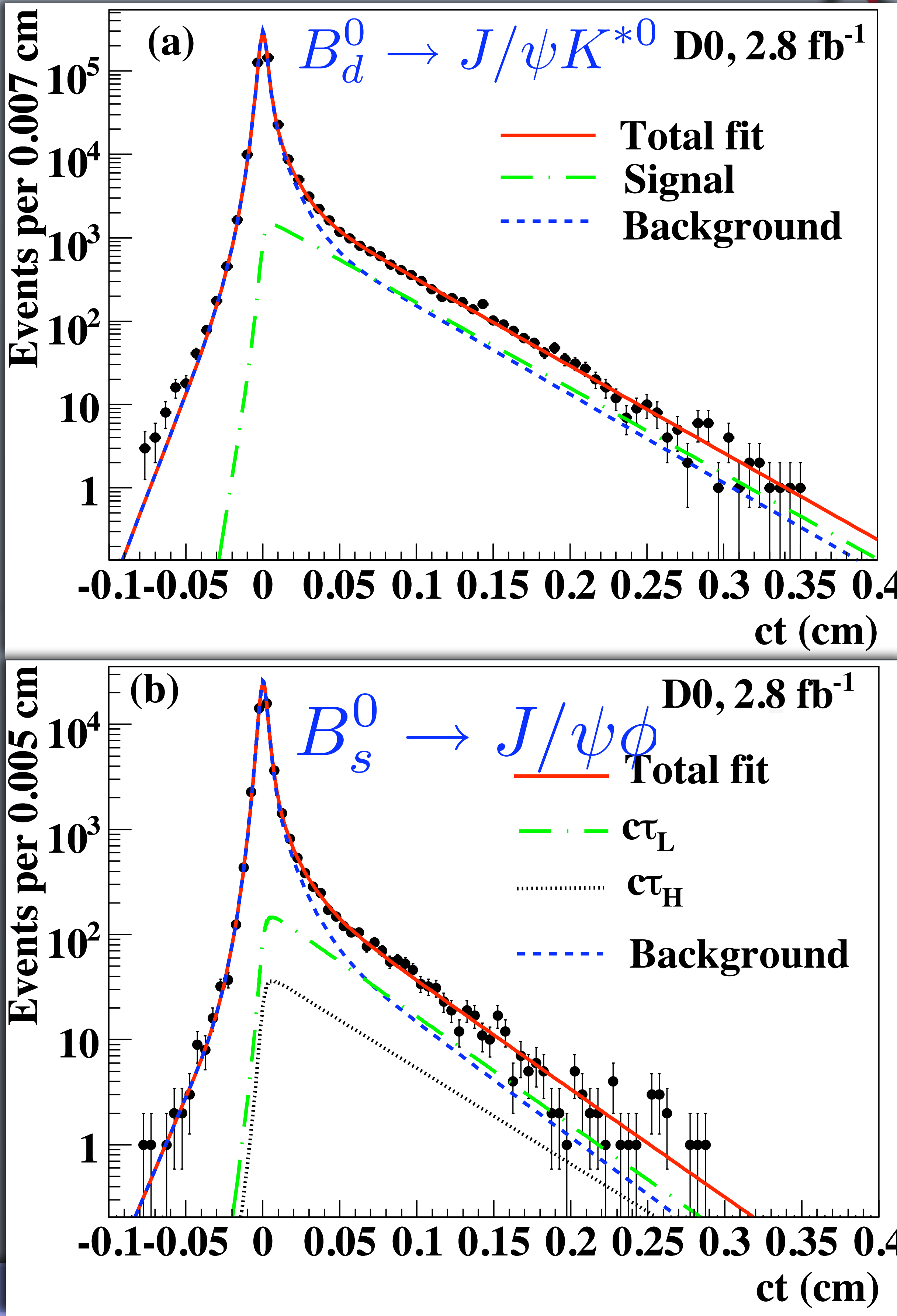


Results from $B_{s,d}$ Combined Analysis

- Projected results of the fit to the proper decay length distributions plotted
- Fit results:

Parameter	B_d^0	B_s^0	Units
$\lvert A_0\rvert^2$	0.587 ± 0.011	0.555 ± 0.027	–
$\lvert A_\parallel\rvert^2$	0.230 ± 0.013	0.244 ± 0.032	–
δ_1	-0.38 ± 0.06	–	rad
δ_2	3.21 ± 0.06	–	rad
$\delta_\parallel$	–	$2.72^{+1.12}_{-0.27}$	rad
τ	1.414 ± 0.018	1.487 ± 0.060	ps
$\Delta\Gamma_s$	–	$0.085^{+0.072}_{-0.078}$	ps^{-1}
N_{sig}	11195 ± 167	1926 ± 62	–

- Systematic uncertainties from:
  Alignment,
  PDL resolution,
  Mass background distributions,
  Likelihood fitting robustness.



$B_{d,s}$ Lifetime: Results

- Ratio of lifetimes:

$$\frac{\bar{\tau}_s}{\tau_d} = 1.052 \pm 0.061(\mathrm{stat}) \pm 0.015(\mathrm{syst})$$

- Width difference in the B_s system:

$$\Delta\Gamma_s = 0.085^{+0.072}_{-0.078}(\mathrm{stat}) \pm 0.006(\mathrm{syst})\,\mathrm{ps}^{-1}$$

- The polarisation amplitudes in the two system are consistent:

B_d:
$$|A_0|^2 = 0.587 \pm 0.011(\mathrm{stat}) \pm 0.013(\mathrm{syst})$$
$$|A_{||}|^2 = 0.230 \pm 0.013(\mathrm{stat}) \pm 0.025(\mathrm{syst})$$

B_s:
$$|A_0|^2 = 0.555 \pm 0.027(\mathrm{stat}) \pm 0.006(\mathrm{syst})$$
$$|A_{||}|^2 = 0.244 \pm 0.032(\mathrm{stat}) \pm 0.014(\mathrm{syst})$$

Babar: PRD 71, 032005 (2005)

$$|A_0|^2 = 0.566 \pm 0.012 \pm 0.005,$$
$$|A_{||}|^2 = 0.204 \pm 0.015 \pm 0.005,$$
$$|A_\perp|^2 = 0.230 \pm 0.015 \pm 0.004,$$

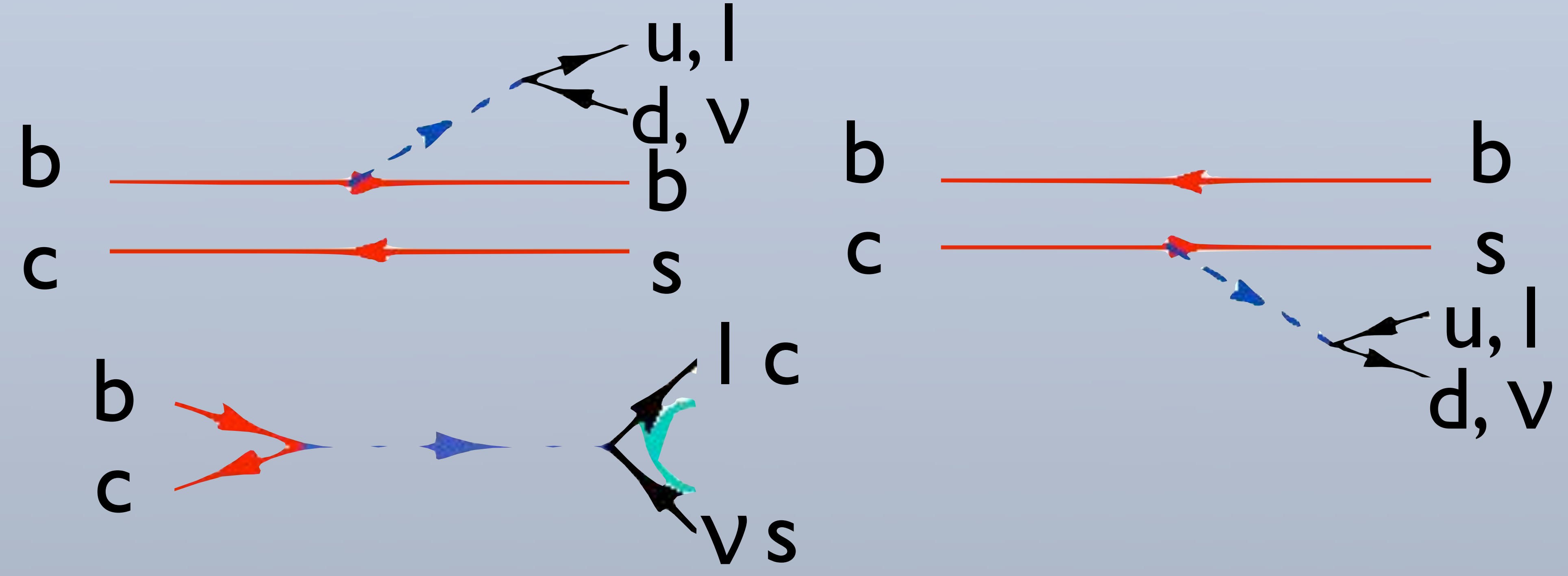
BELLE: PRL 95, 091601 (2005)

	B^0	$\overline{B}^0$
$\|A_0\|^2$	0.571 ± 0.015	0.578 ± 0.016
$\|A_{\|\|}\|^2$	0.216 ± 0.017	0.244 ± 0.018
$\|A_\perp\|^2$	0.213 ± 0.017	0.178 ± 0.017

hep-ex: 0810.0037 sub. PRL

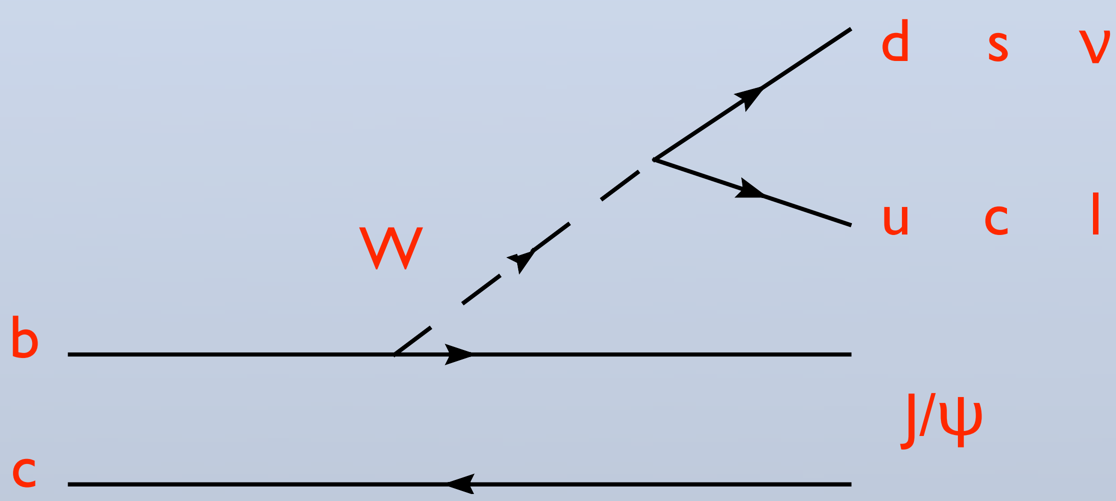
B_c Lifetime

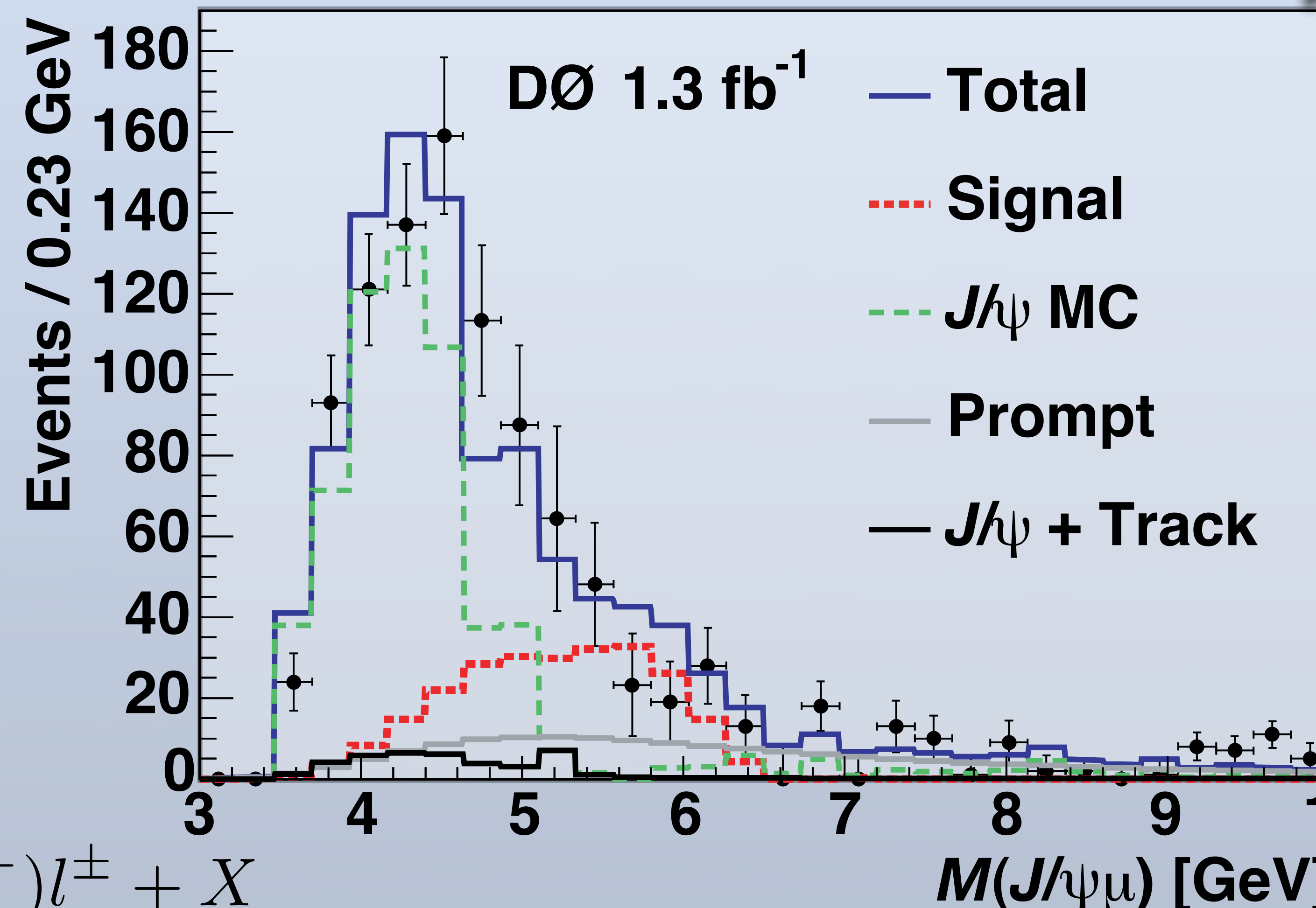
- B_c differs from $B_{u,d,s}$ due to heavy mass of the c-quark.
- B_c decays via weak decays of b or c quark (other quark spectates), or via annihilation.
  Additional decay modes – shorter lifetime (predicted: ~1/3)



- Analysis from Run IIa dataset, corresponding to ~1.3 fb^{-1} integrated luminosity

B_c Lifetime





- Select decay $B_c^{\pm} \rightarrow J/\psi(\mu^+, \mu^-) l^{\pm} + X$
- First identify selection of tracks of opposite charge, compatible with a muon, with $2.90 < m(\mu^+, \mu^-) < 3.26\,\mathrm{GeV/c^2}$
- A third muon is selected and combined with J/ψ in mass window $3 < m(J/\psi, \mu^{\pm}) < 10\,\mathrm{GeV/c^2}$
- Template method used in fitting background contributions.
- ~15k events selected.
- B_c signal is observed with significance 6.4σ.

B_c Lifetime

- Background contributions from 'fake' tracks, non-correlated J/ψ, μ, $B^{\pm} \rightarrow J/\psi(\mu,\mu)K^{\pm}(\mu^{\pm}\nu)$ and $c\bar{c}$ with prompt J/ψ production are accounted for using MC and data.

- Lifetime determined using:
  - Displacement of B meson from PV, $\vec{d}_{xy} = \vec{x}_{pv} - \vec{x}_{sv}$
  - Visible proper decay length (VPDL), $L_{xy} \cdot \frac{m(J/\psi\mu)}{p_T(J/\psi\mu)}$

$$L_{xy} = \frac{\vec{d}_{xy} \cdot \vec{p}_T}{p_T}$$

$$c\tau(B_c) = L_{xy} \cdot \frac{m(B_c)}{p_T(B_c)}$$

- Semileptonic decay means $p_T(B_c)$ not fully reconstructed (neutrino). From MC, the 'K' factor is determined in 6 bins of M(J/ψ μ).

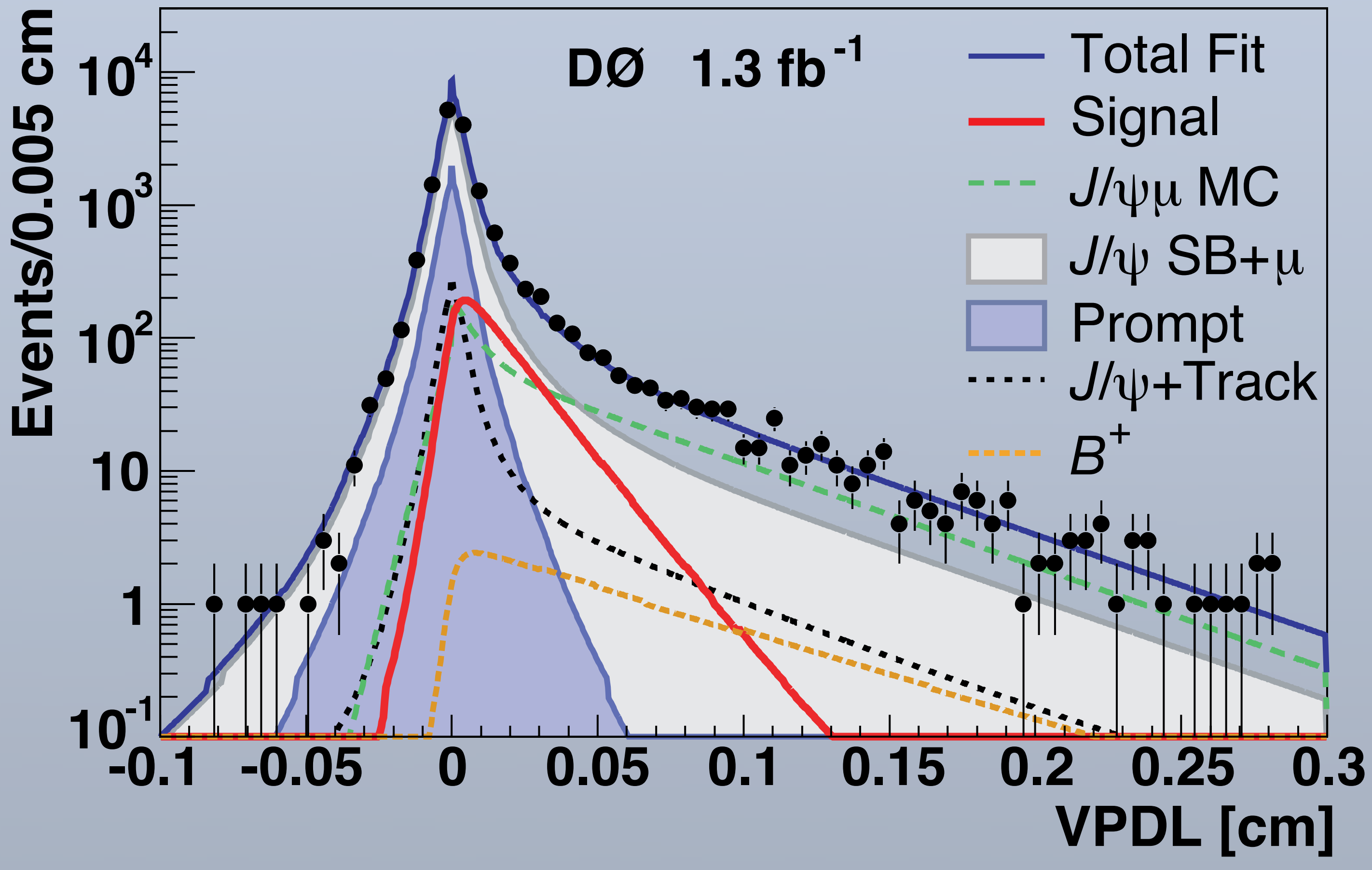
$$K = \frac{p_T(J/\psi\mu)}{p_T(B_c)}$$

B_c Lifetime

- $$c\tau(B_c) = L_{xy} \cdot \frac{m(B_c)}{p_T(J/\psi/mu)} \cdot K$$ $$K = \frac{p_T(J/\psi\mu)}{p_T(B_c)}$$
- Full unbinned simultaneous maximum-likelihood fit to lifetime distribution and mass used to extract lifetime.

$$\tau(B_c^{\pm}) = 0.448^{+0.038}_{-0.036}\,(\mathrm{stat}) \pm 0.032\,(\mathrm{syst})\ \mathrm{ps}$$

~880 B_c mesons estimated from fit



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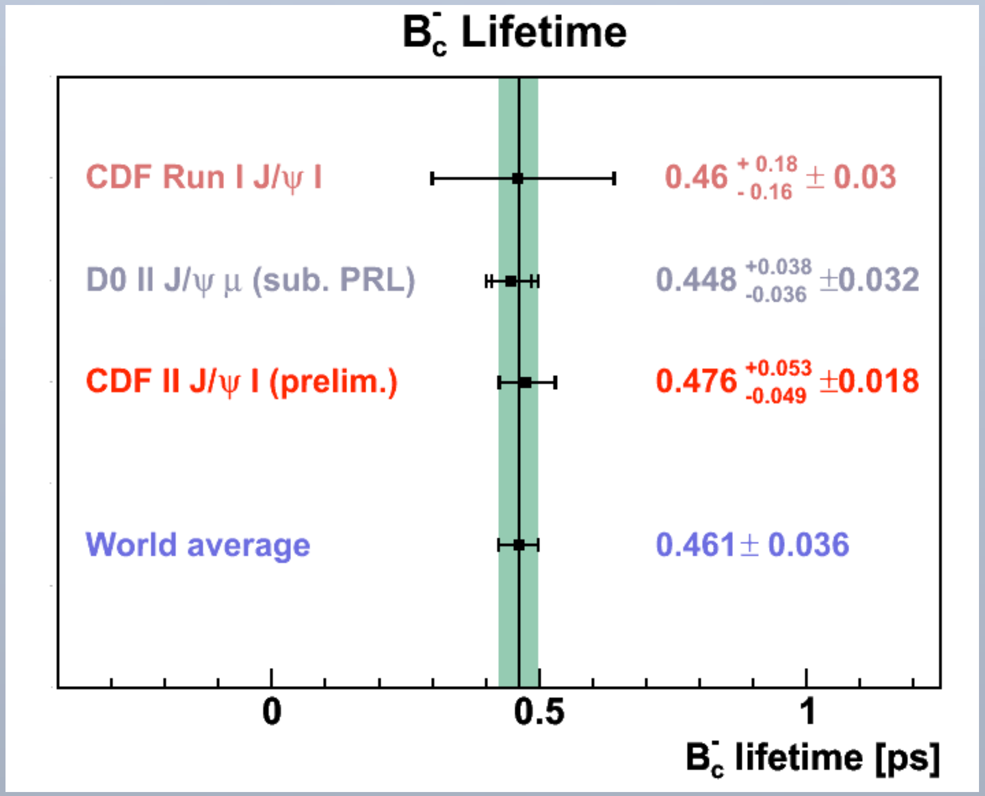


Theory ~0.55±0.15 ps

Searches for CP violation in Bs Decays

- Search for CP violation in the semi-leptonic decays of B_s-mesons.
- Events selected in the decay: $B_s \to D_s^- \mu^+ \nu X$

$$D_s^- \to \phi \pi^-$$

$$\phi \to K^+ K^-$$

- Charge asymmetry measurement:

$$A_{SL}^s \sim \frac{N(\mu^+ D_s^-) - N(\mu^- D_s^+)}{N(\mu^+ D_s^-) + N(\mu^- D_s^+)}$$

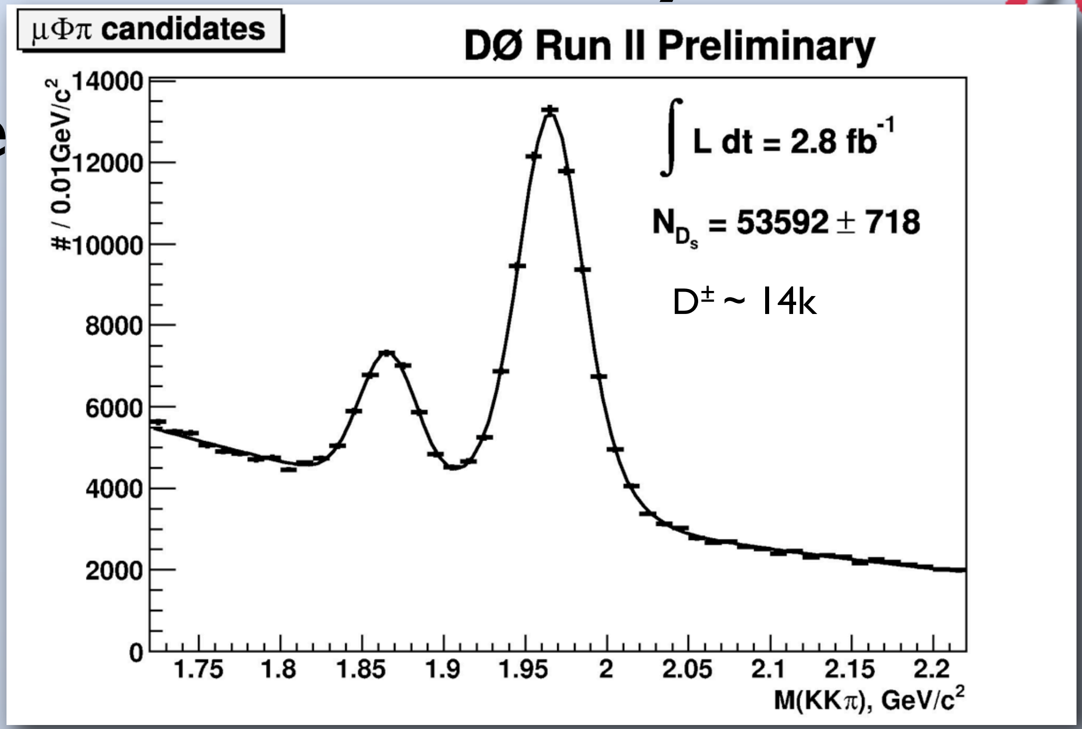
- Final-state B_s flavour determined from muon charge
- Initial-state flavour from opposite-side and same-side tagging techniques
- Time-dependent fit improves on previous untagged time-integrated analysis

PRL 98, 151801 (2007)

- Integrated luminosity 2.8 fb^{-1}.

Searches for CP Violation in Bs Decays

- After selections ~54k D_s candidates are obtained in the fit.



- Must account for asymmetries from sources: detector, range-out, toriod-polarity, *sign*(muon pseudo-rapidity).

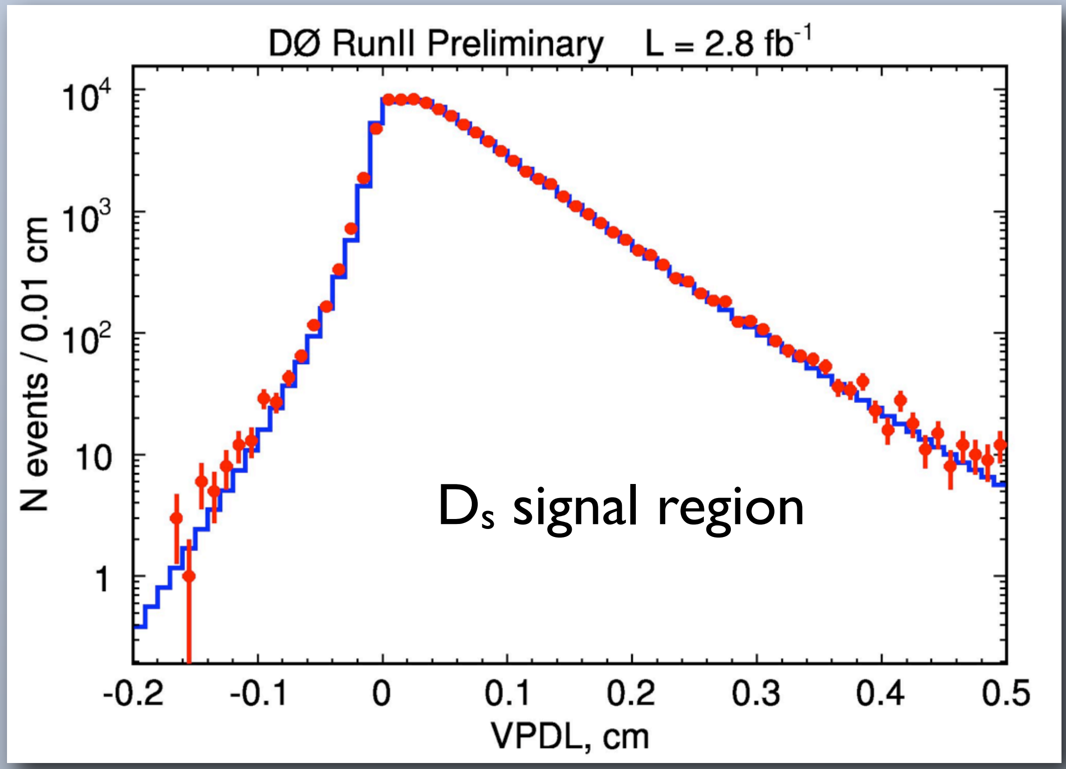
$$p^{q\beta\gamma}(x,K,d_{pr}) = p_{VPDL}(x,K,d_{pr}) \cdot \epsilon^{\beta}(1+q_\mu\gamma_\mu A_{fb})(1+\gamma_\mu A_{det})(1+q_\mu\beta\gamma_\mu A_{ro})(1+\beta\gamma_\mu A_{\beta\gamma})(1+q_\mu\beta A_{q\beta}),$$

- Proper decay length also requires K-factor

$$c\tau_{B_s} = x \cdot K$$

$$x = \frac{\vec{d}_T^B \cdot \vec{p}_T^{\mu D_s^-}}{(p_T^{\mu D_s^-})^2} \cdot cM_B$$

$$K = \frac{p_T(\mu^+ D_s^-)}{p_T(B_s)}$$



Semileptonic CP asymmetry: Results

Parameter	RunII, $\int L dt = 2.8\ \mathrm{fb}^{-1}$
a_{sl}^{s}	-0.0024 ± 0.0117
a_{sl}^{d}	-0.0787 ± 0.0371
a_{bg}	-0.0182 ± 0.0271
A_{fb}	0.0000 ± 0.0021
A_{det}	0.0001 ± 0.0021
A_{ro}	-0.0323 ± 0.0021
$A_{\beta\gamma}$	-0.0005 ± 0.0021
$A_{q\beta}$	0.0029 ± 0.0021

- Time-dependant tagged semi-leptonic charge asymmetry measured as:

$$a_{sl}^{s} = -0.0024 \pm 0.0117(\mathrm{stat})^{+0.0015}_{-0.0024}(\mathrm{syst})$$

DØ preliminary result

with 2.8 fb^{-1} integrated luminosity

- Main sources of systematic uncertainty from efficiency curve estimation and cc background contribution to the sample.
- Previous result: *PRL 98, 151801 (2007) :*

$$\frac{\Delta\Gamma_s}{\Delta m_s} \tan\phi_s = 0.0245 \pm 0.0193(\mathrm{stat}) \pm 0.0035(\mathrm{syst})$$

- Most precise direct measurement to date.

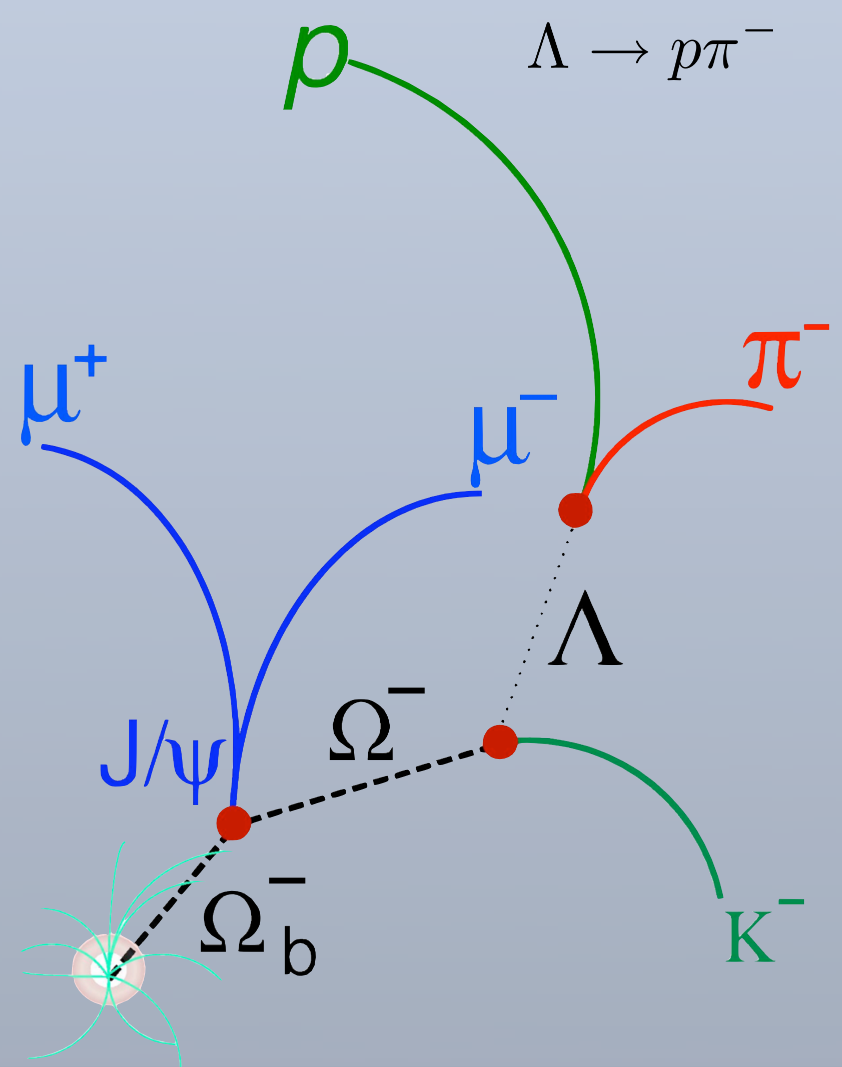
Doubly-Strange Baryon: Ω_b

- DØ reported first observation of $\Omega_b\ (bss)$ baryon.
- Analysis made using Run IIa (~1.3 fb^{-1}) dataset.
- Fully reconstructed decay: $\Omega_b^- \to J/\psi\Omega^-$
  (similar to Ξ_b^- analysis)

$$\Omega^- \to \Lambda K^-$$

$$\Lambda \to p\pi^-$$

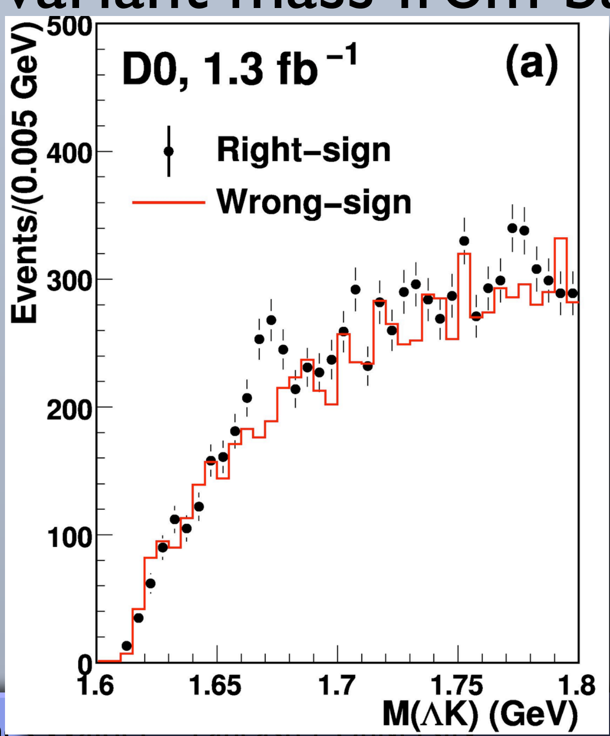
- Long-lived decay chain, requires extended tracking

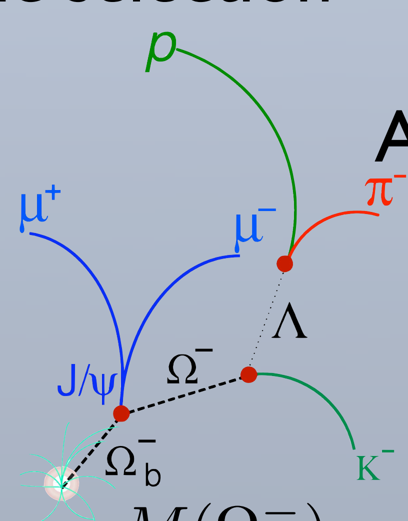


Ω_b: Selection

- As usual, a J/ψ candidate is required from two good, oppositely charged muons.
- Events passing this selection are re-reconstructed using the extended version of our tracking algorithm;
  provides increased efficiency in reconstructing low-p_T, high impact parameter tracks.
- $\Lambda \to p\pi^-$ is constructed from two tracks $p_T > 0.2\,\mathrm{GeV}/c$
  $1.108 < m(p\pi^-) < 1.126\,\mathrm{GeV}/c^2$
- The Ω^- candidate is formed from Λ and a track forming a common vertex (assumed a kaon).
- A Boosted Decision Tree selection is also formed using quality and kinematical variables of the daughter particles.

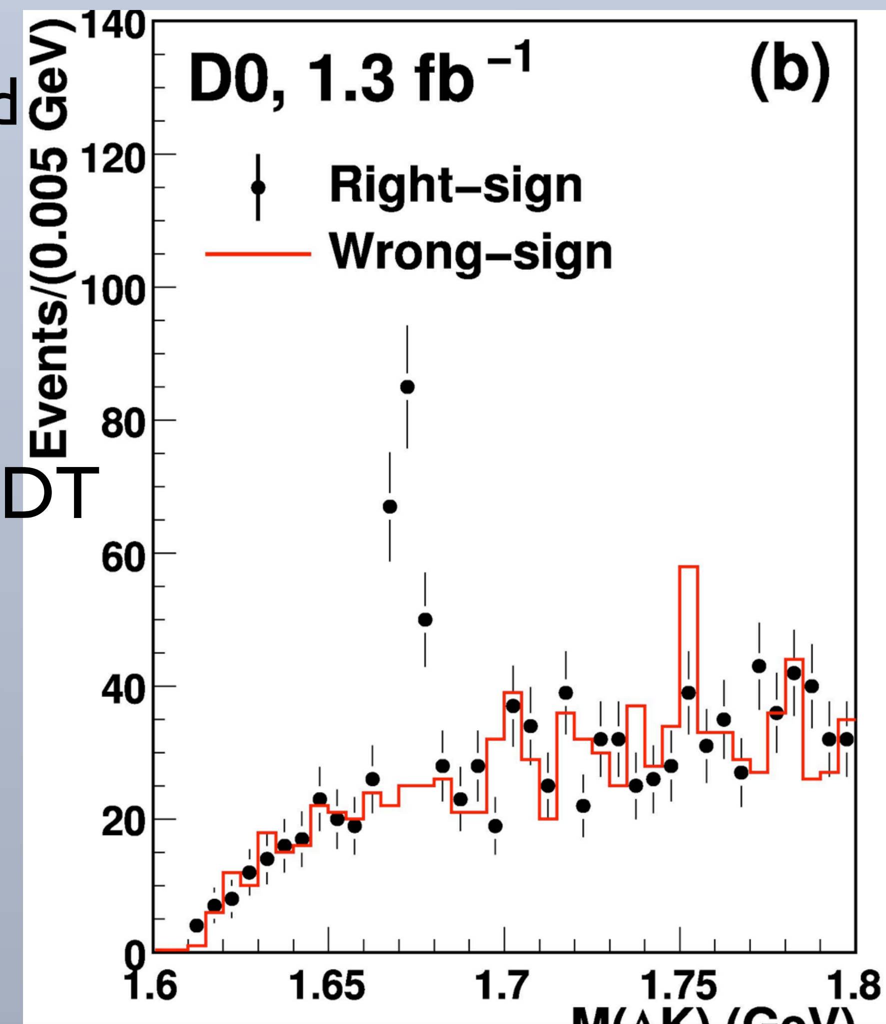
Invariant mass from basic selection





$$M(\Omega^-) = 1.672\,\mathrm{GeV}/c^2$$

After applying BDT selection



Ω_b: Mass

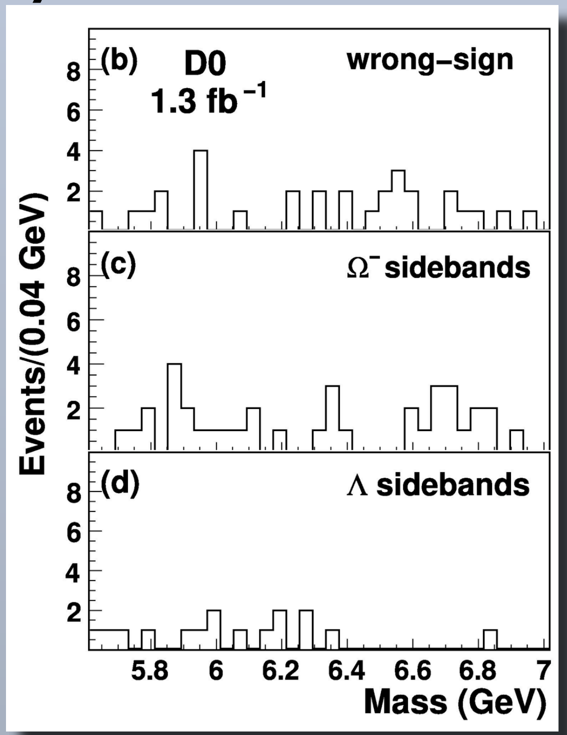
- Ω^- candidates with $1.662 < m(\Lambda K^-) < 1.682\,\mathrm{GeV}/c^2$ were combined with J/ψ candidates to form a common vertex.

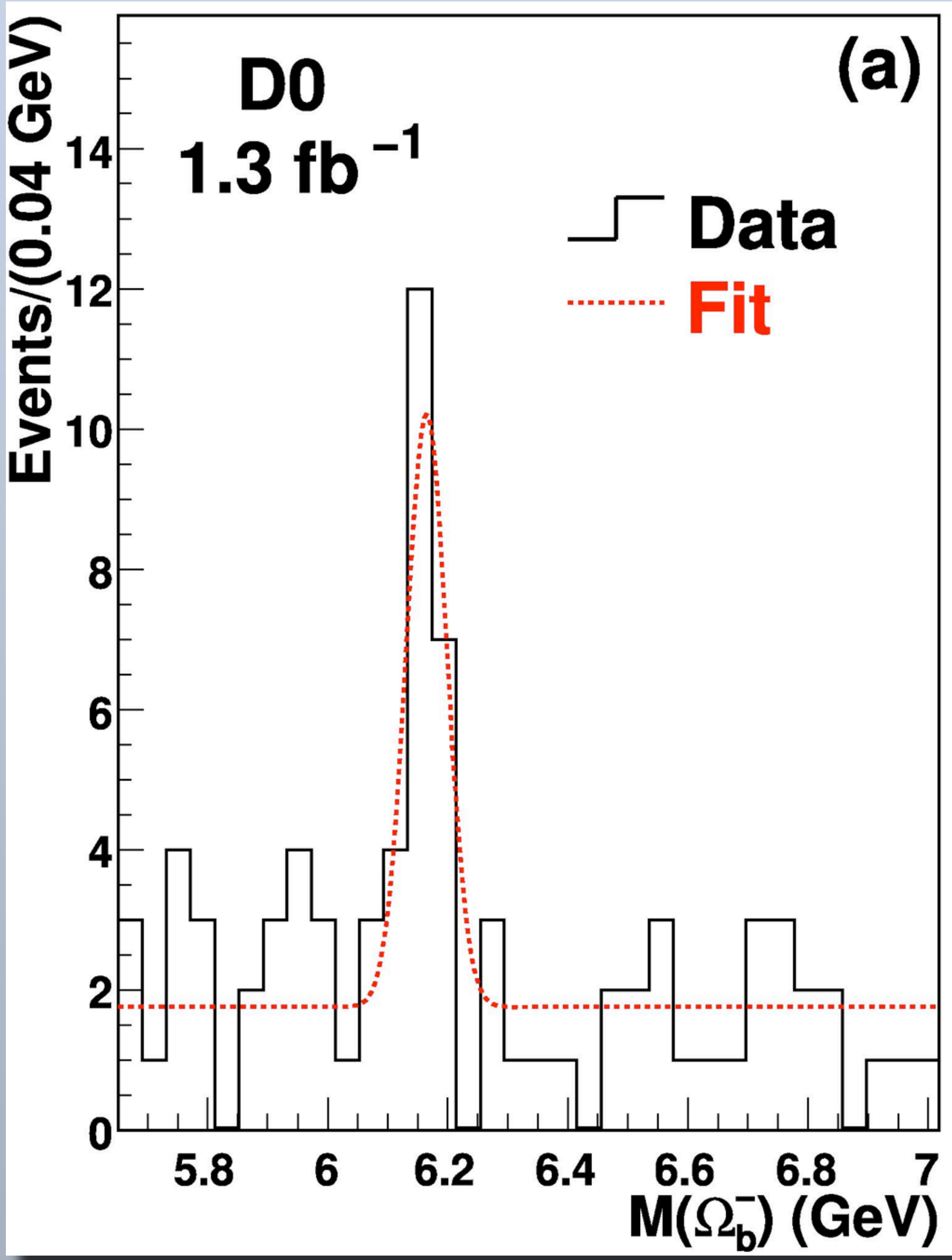
- Mass resolution is improved using variable:

$$
\begin{aligned}
M(\Omega_b^-) \quad = \quad & m(J/\psi\Omega^-) + \\
& [\hat{M}(J/\psi) - m(\mu^+\mu^-)] + \\
& [\hat{M}(\Omega^-) - m(\Lambda K^-)]
\end{aligned}
$$

- From 79 candidates fit yields:
  17.8 ± 4.9 (stat)
  signal events.

- Wrong-sign (ΛK^+) sample shows no excess





Ω_b: Observation

- A 5.4σ statistical significance is observed; Probability of 6.7 x 10^{-8} of background fluctuation to signal level (or greater).
- Systematic uncertainties obtained through varying event selection criteria, signal and background models, and momentum scale.
- $M(\Omega_b^-) \quad = \quad 6.165 \pm 0.010\,(\mathrm{stat}) \pm 0.013\,(\mathrm{syst})\,\mathrm{GeV}/c^2$

hep-ex: 0808.4142, accepted PRL

- Using the results from recent Ξ_b^- observation

$$\mathcal{R} = \frac{f(b \to \Omega_b^-)}{f(b \to \Xi_b^-)} \cdot \frac{\mathcal{B}(\Omega_b^- \to J/\psi\Omega^-)}{\mathcal{B}(\Xi_b^- \to J/\psi\Xi^-)} = 0.80 \pm 0.32(\mathrm{stat})^{+0.14}_{-0.22}(\mathrm{syst})$$

- Allows an estimate to be made of: $\frac{f(b \to \Omega_b^-)}{f(b \to \Xi_b^-)} \approx 0.07 - 0.14$

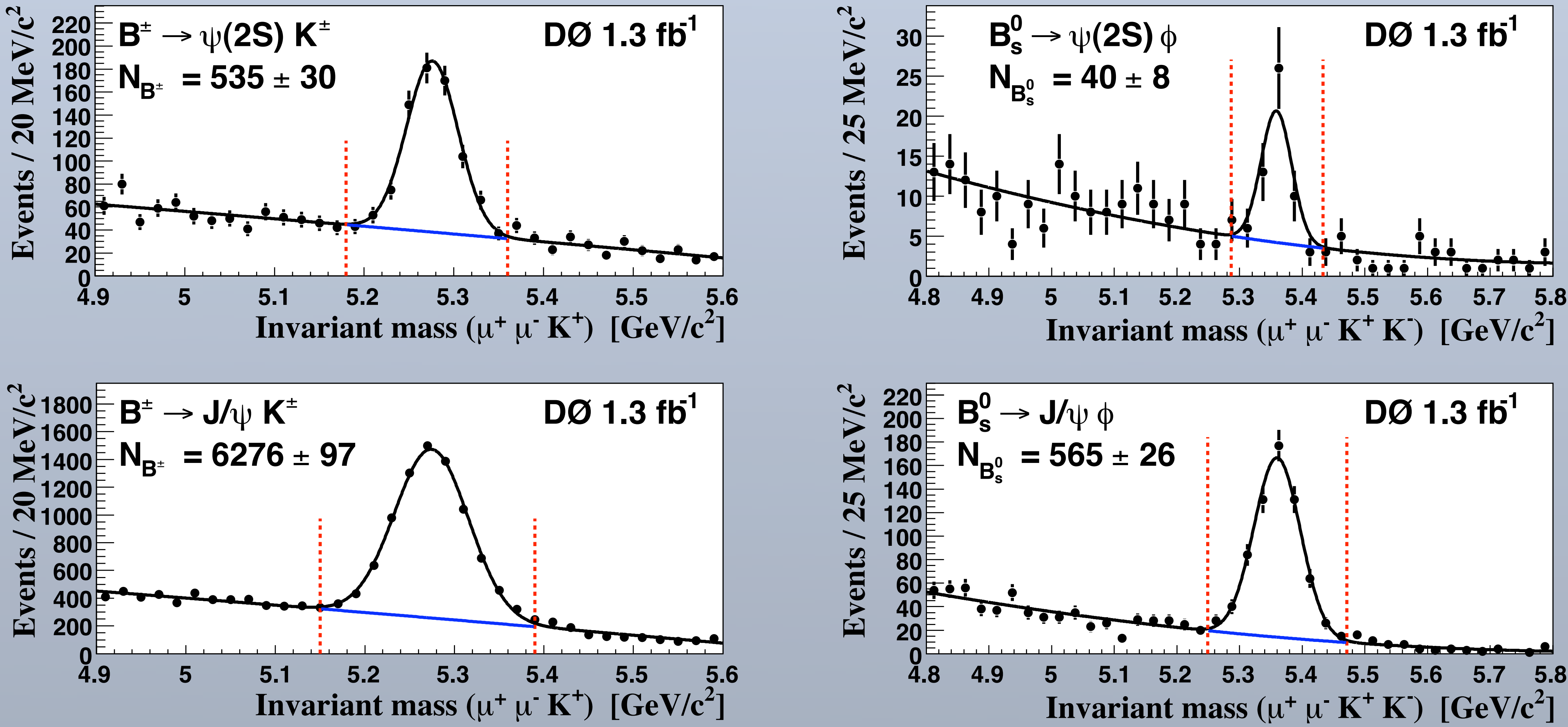
B_s decays to J/Ψ and Ψ(2S)

- Main search for CP violation through B_s decays use the decay $B_s^0 \to J/\psi\phi$,
- Results are currently statistically limited;
  so establishing new decay channels gives possibility for increased precision.
- Select the decays $B_s^0 \to \psi(2S)\phi$ $\quad B^\pm \to J/\psi K^\pm$ $\quad B_s^0 \to J/\psi\phi$ $\quad B^\pm \to \psi(2S)K^\pm$

  where, $J/\psi \to \mu^+\mu^-$, $\psi(2S) \to \mu^+\mu^-$, $\quad \phi \to K^+K^-$
- Analysis dataset based on 1.3 fb^{-1} integrated luminosity.
- Only events passing the di-muon trigger considered.

Invariant Mass

- Two muons combined to form J/ψ, ψ(2S) and momenta corrected using mass constrained fit.
- ϕ constructed from two kaons with $1.008 < m(K^+K^-) < 1.032\ \mathrm{GeV}/c^2$
- Discriminate from prompt decays with IP significance cuts
- Invariant mass distributions



Bs decays to J/Ψ and Ψ(2S)

- Relative yields given by:

$$\frac{\mathcal{B}(B \to \psi(2\mathrm{S})M)}{\mathcal{B}(B \to J/\psi M)} = \frac{N_{\psi(2\mathrm{S})M}}{N_{J/\psi M}} \cdot \frac{\epsilon_{J/\psi M}}{\epsilon_{\psi(2\mathrm{S})M}} \times \frac{\mathcal{B}(J/\psi \to \mu^+\mu^-)}{\mathcal{B}(\psi(2S) \to \mu^+\mu^-)},$$

- Efficiencies and Yields:

Decay	Efficiency	Yield
$B^\pm \to J/\psi K^+$	$(1.07 \pm 0.02) \cdot 10^{-3}$	6276±97
$B^\pm \to \psi(2S) K^+$	$(1.14 \pm 0.04) \cdot 10^{-3}$	535±30
$B_s^0 \to J/\psi\, \phi$	$(14.4 \pm 0.7) \cdot 10^{-5}$	565±26
$B_s^0 \to \psi(2S)\, \phi$	$(15.2 \pm 0.6) \cdot 10^{-5}$	40±8

- Results:

Observation of $B_s^0 \to \psi(2S)(\mu^+\mu^-)\phi(K^+K^-)$ at DØ, with 40 ± 8 signal events,

Relative decay rates:

$$\frac{\mathcal{B}(B_s^0 \to \psi(2S)\phi)}{\mathcal{B}(B_s^0 \to J/\psi\phi)} = 0.55 \pm 0.11\ (\mathrm{stat}) \pm 0.07\ (\mathrm{syst}) \pm 0.06(\mathcal{B})$$

$$\frac{\mathcal{B}(B^\pm \to \psi(2S)K^\pm)}{\mathcal{B}(B^\pm \to J/\psi K^\pm)} = 0.65 \pm 0.04\ (\mathrm{stat}) \pm 0.03\ (\mathrm{syst}) \pm 0.07(\mathcal{B})$$

$(J/\psi, \psi(2S)) \to \mu^+\mu^-$

hep-ex:0805.2576 sub. PRD-RC

Summary

- Brief summary of recent DØ B-physics results; complements and competes with B-factories.
- First direct observation (>5σ) of $\Omega_b^- \ (bss)$ bayron.
  $$M(\Omega_b^-) = 6.165 \pm 0.010\,(\text{stat}) \pm 0.013\,(\text{syst})\ \text{GeV}/c^2$$
- Tagged analysis in B_s system yield CP violating phase:
  $$\phi_s = -0.57^{+0.24}_{-0.30}(\text{stat})^{+0.07}_{-0.02}(\text{syst})$$
- Lifetime measurements made on simultaneous $B^0_{\{d,s\}}$, and in $B^\pm_c$ mesons.
  $$\tau(B_d^0) = 1.414 \pm 0.0178\ (\text{stat})\ \text{ps} \qquad \tau(B_s^0) = 1.487 \pm 0.060\ (\text{stat})\ \text{ps}$$
  $$\tau(B_c^\pm) = 0.448^{+0.038}_{-0.036}\,(\text{stat}) \pm 0.032\,(\text{syst})\ \text{ps}$$
- Relatives decay rates measured in $B_s^0 \to J/\psi\phi \quad B_s^0 \to \psi(2S)\phi$
  $$\frac{\mathcal{B}(B_s^0 \to \psi(2S)\phi)}{\mathcal{B}(B_s^0 \to J/\psi\phi)} = 0.55 \pm 0.11\ (\text{stat}) \pm 0.07\ (\text{syst}) \pm 0.06(\mathcal{B}) \qquad \frac{\mathcal{B}(B^\pm \to \psi(2S)K^\pm)}{\mathcal{B}(B^\pm \to J/\psi K^\pm)} = 0.65 \pm 0.04\ (\text{stat}) \pm 0.03\ (\text{syst}) \pm 0.07(\mathcal{B})$$
- No significant deviation from SM processes observed.
- Many analyses to be forthcoming with increased datasets, using Run IIb data.
- Most results statistics limited – DØ will improve as more data collected.