

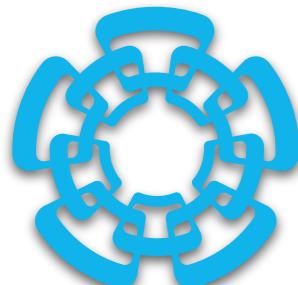
Observation of the Doubly Strange b -Baryon Ω_b^- with the DØ Detector

Jesus Orduna

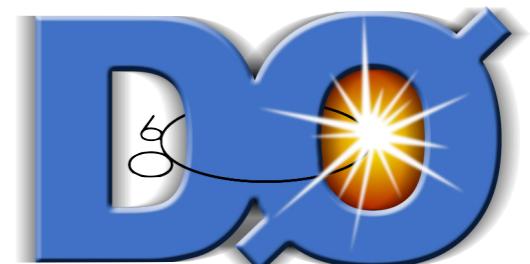
CINVESTAV Mexico

jjesus@fnal.gov

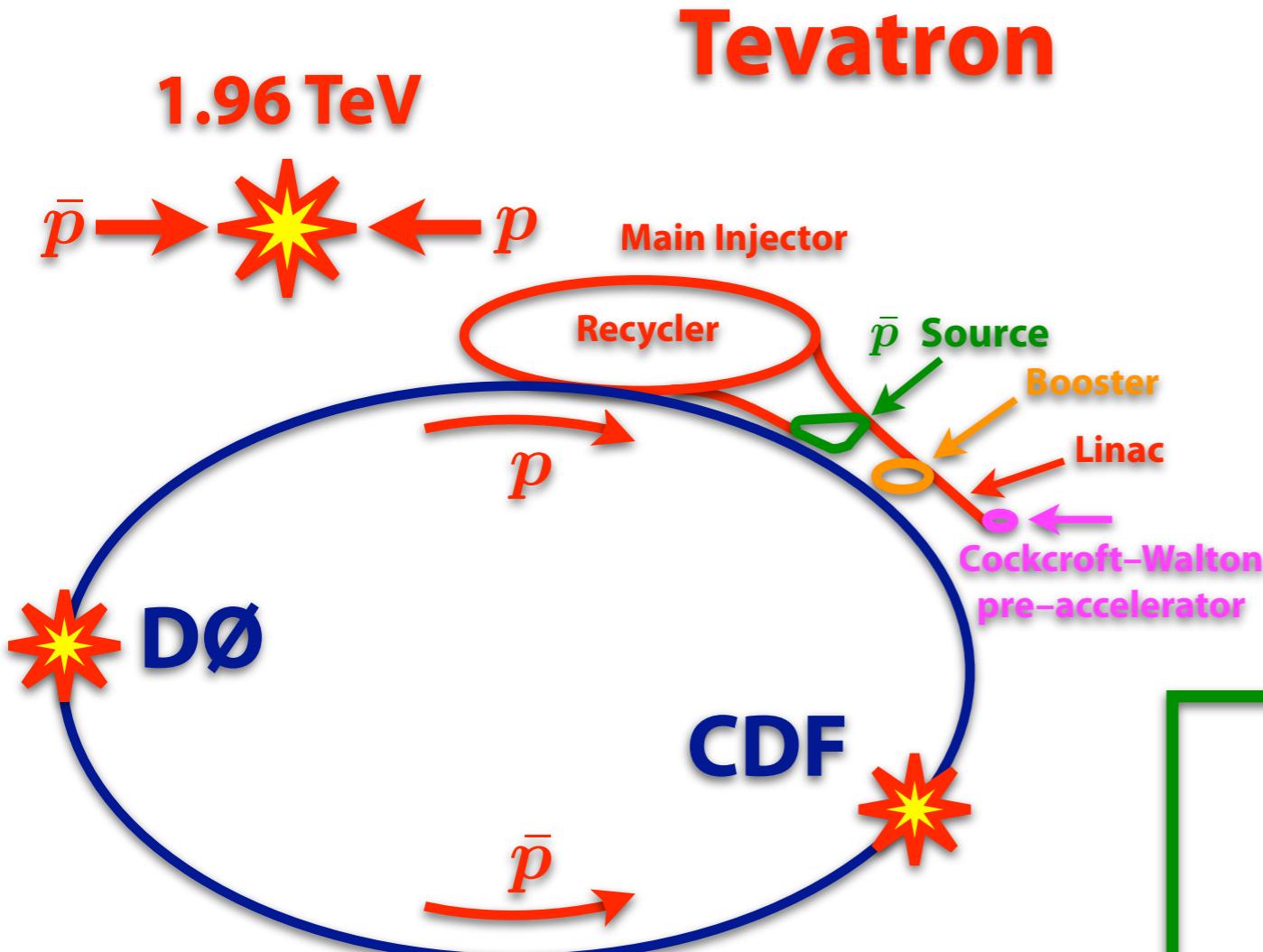
On behalf of the DØ Collaboration



July 18, 2009



Tevatron & b -Baryon Observation



Currently the only place to look for b -Baryons

[1] Phys. Rev. Lett. **99**, 202001 (2007)

[2] Phys. Rev. Lett. **99**, 052001 (2007);

Phys. Rev. Lett. **99**, 052002 (2007)

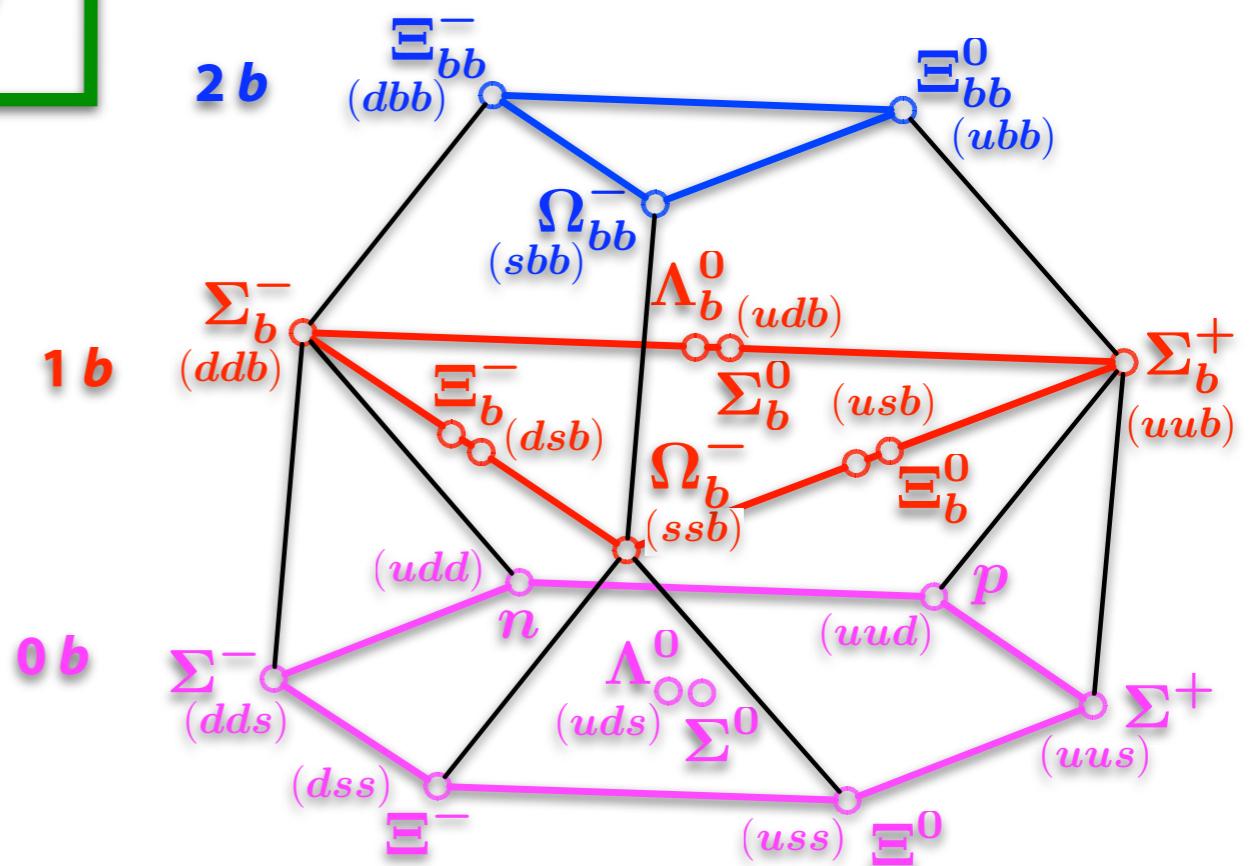
Before Tevatron RunII

$$\Lambda_b^0$$

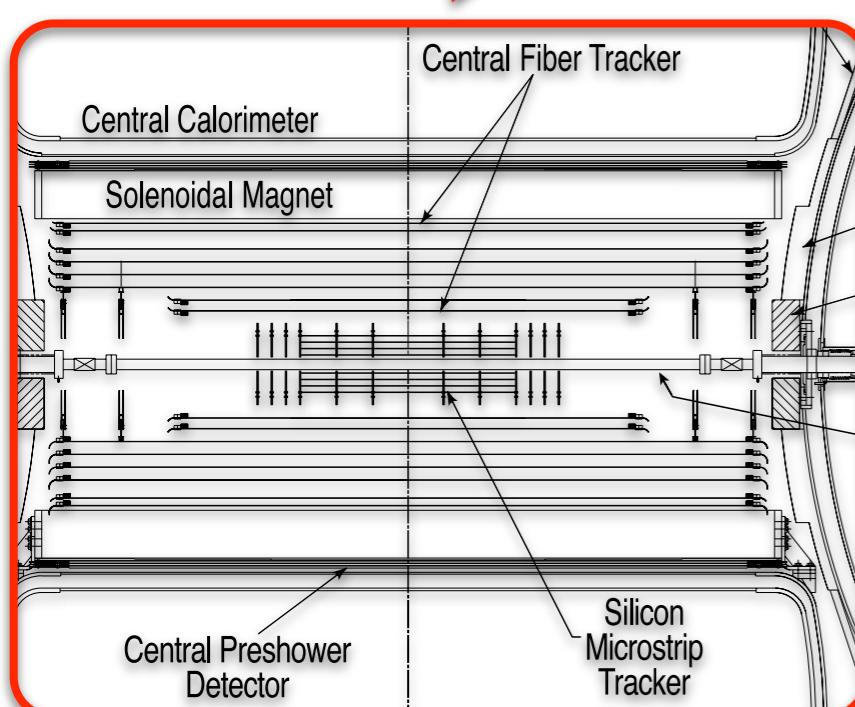
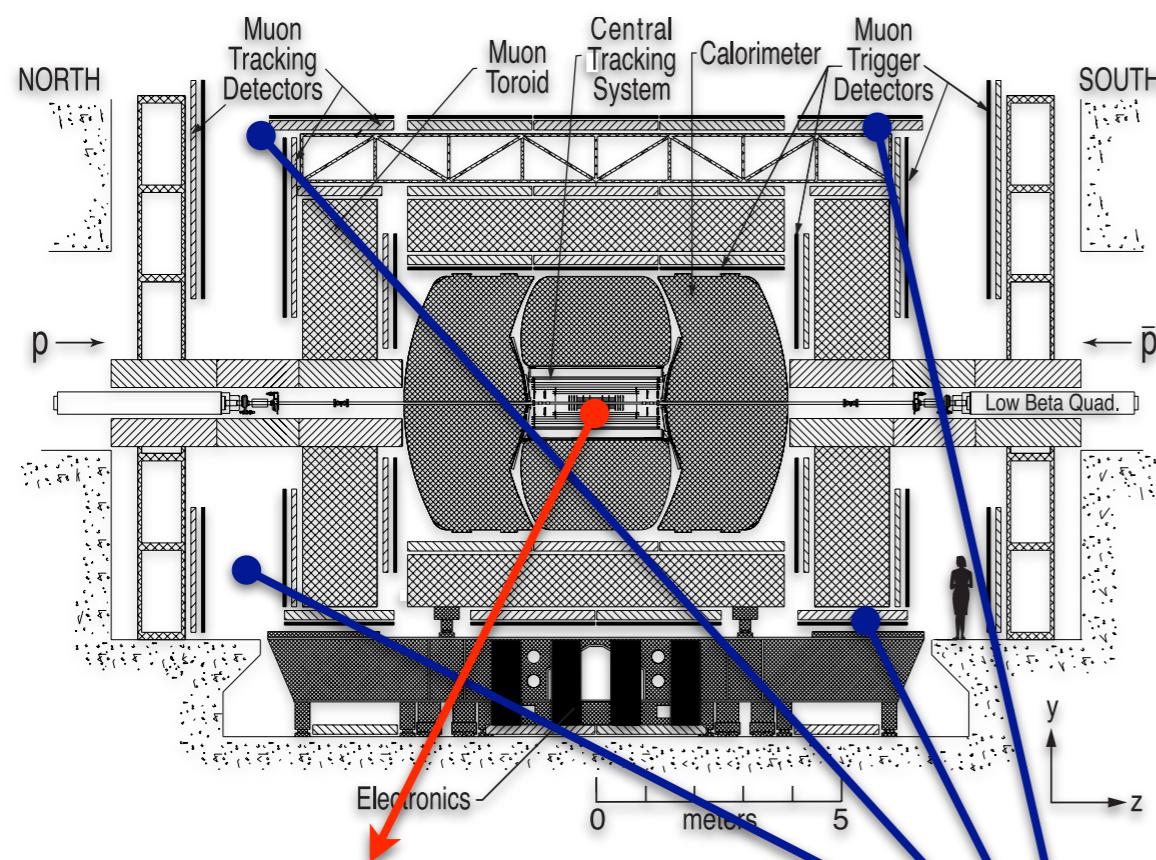
Tevatron RunII Since 2002

$\Sigma_b^+ & \Sigma_b^{*+}$ CDF, 2006^[1]

Ξ_b^- DØ and CDF, 2007^[2]



DØ



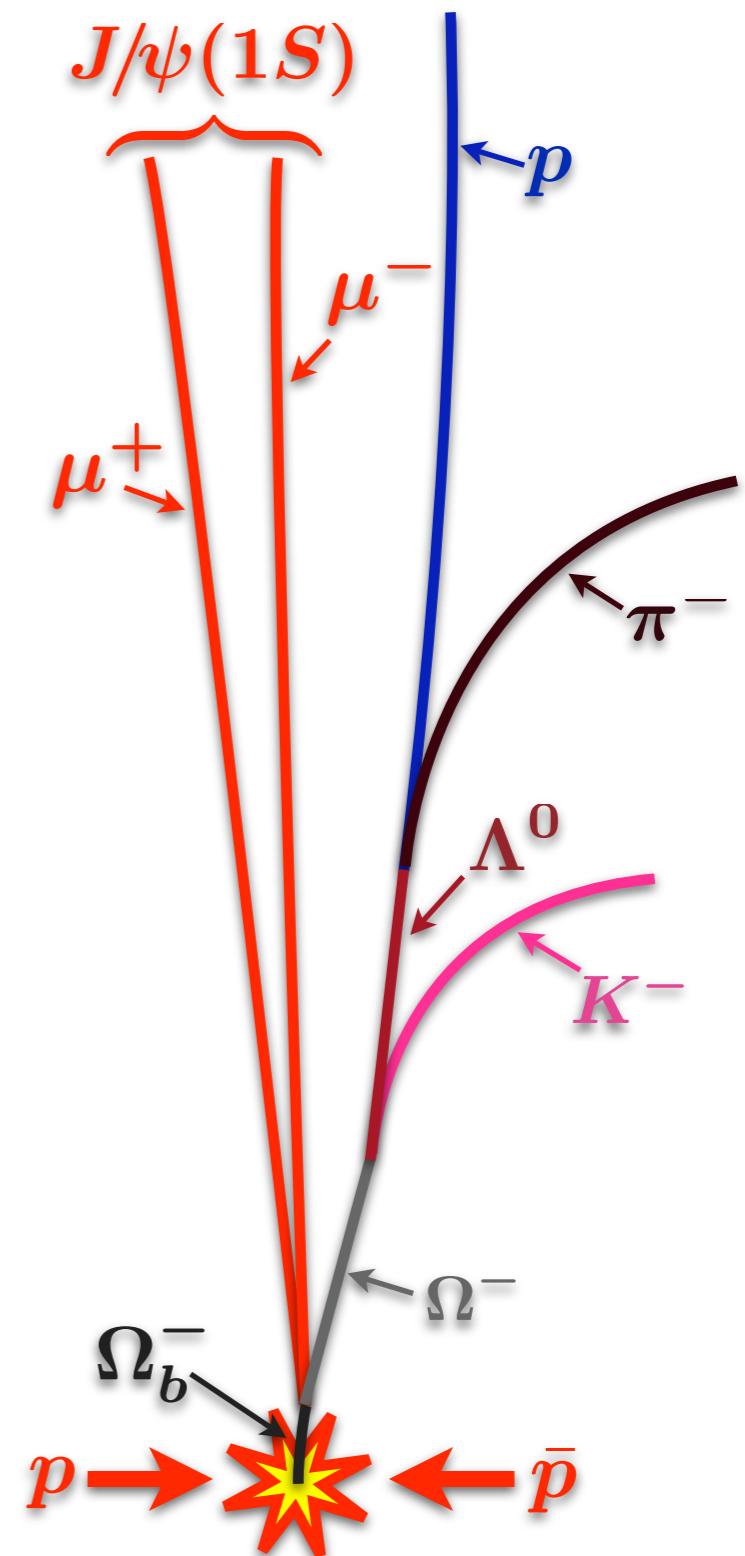
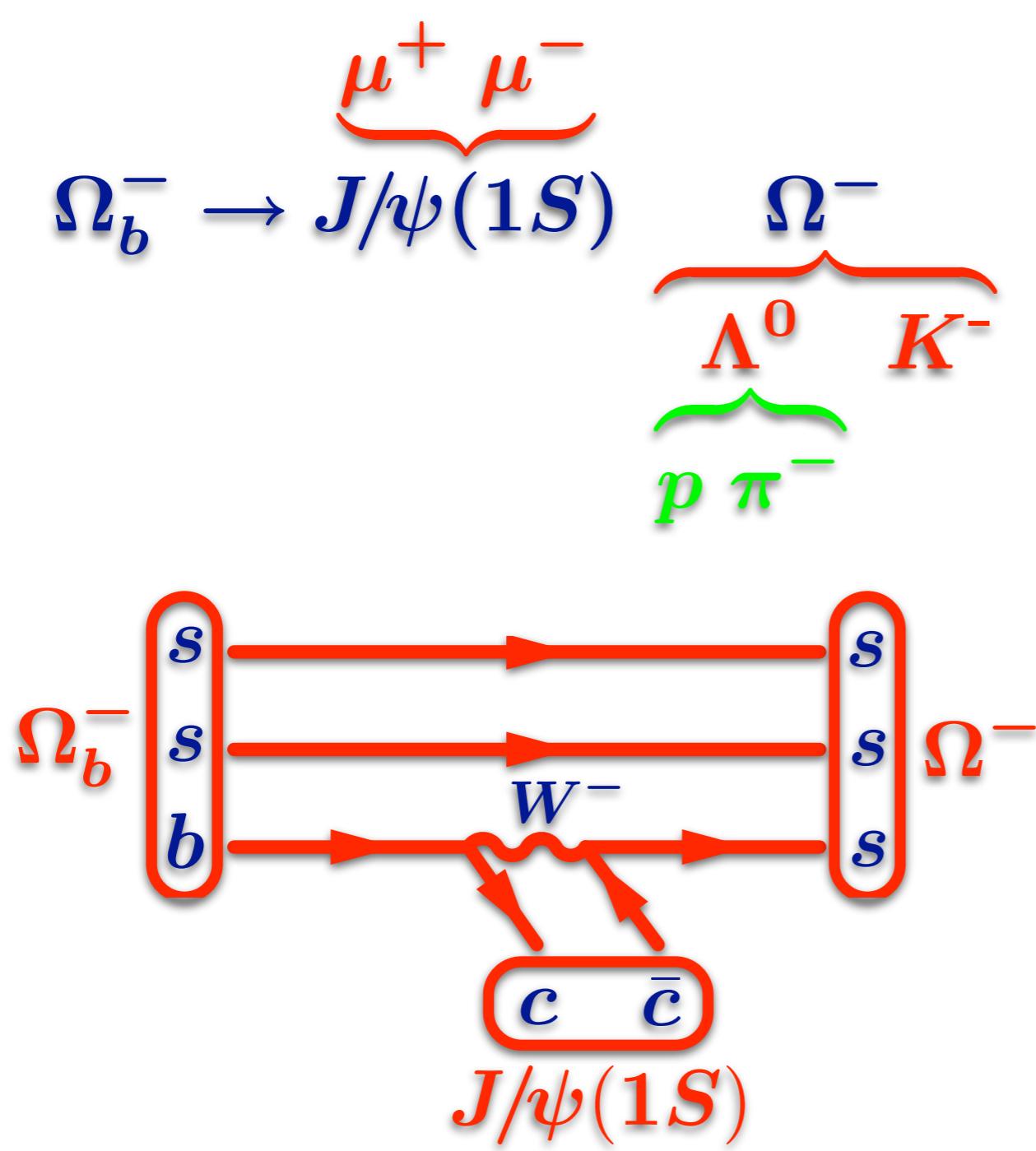
Central Tracking System

Muon System

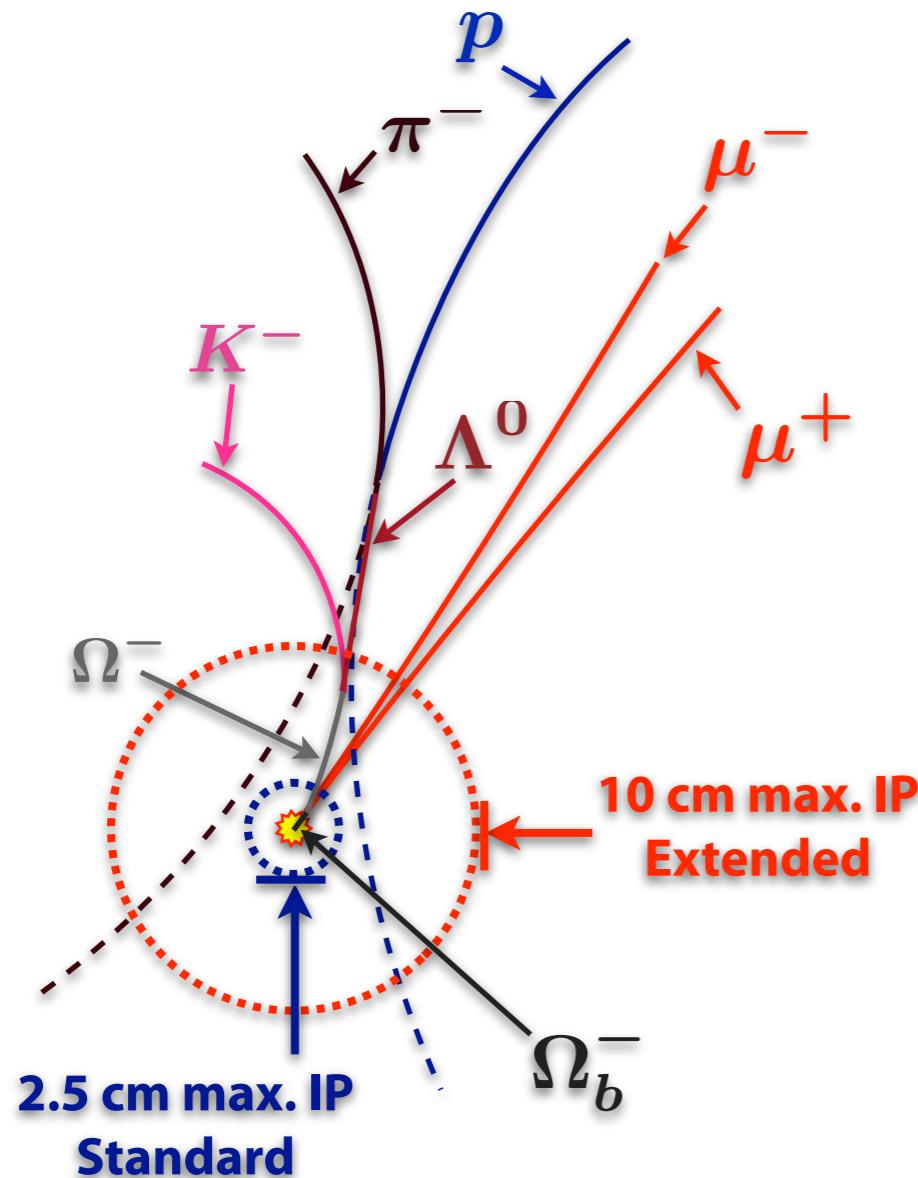
Tevatron RunII Apr 19, 2002 – Jun 14 2009



Decay Channel



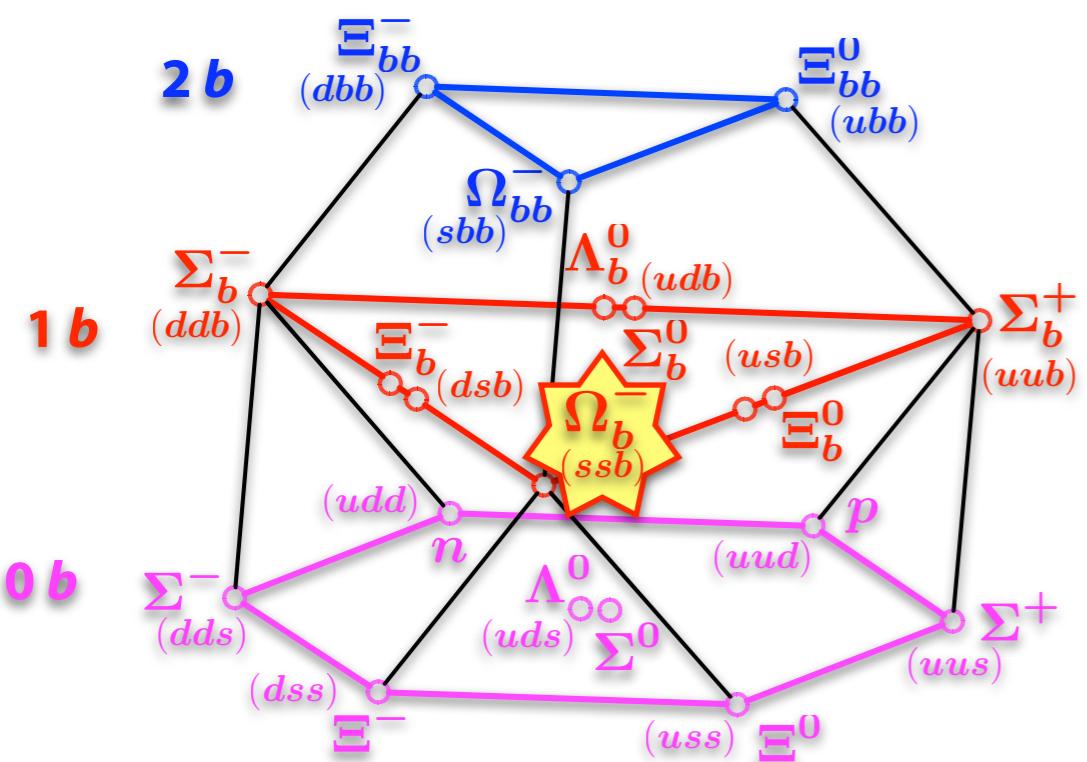
Special Tracking Reconstruction



Extending the maximum IP of reconstructed tracks increases the efficiency in the identification of long-lived particles like:



Ω_b^-



- **Mass predictions (GeV/c²)^[1]**

$$5.94 < M(\Omega_b^-) < 6.12$$

$$M(\Lambda_b^0) < M(\Omega_b^-)$$

- **Lifetime prediction (ps)^[2]**

$$0.83 < \tau(\Omega_b^-) < 1.67$$

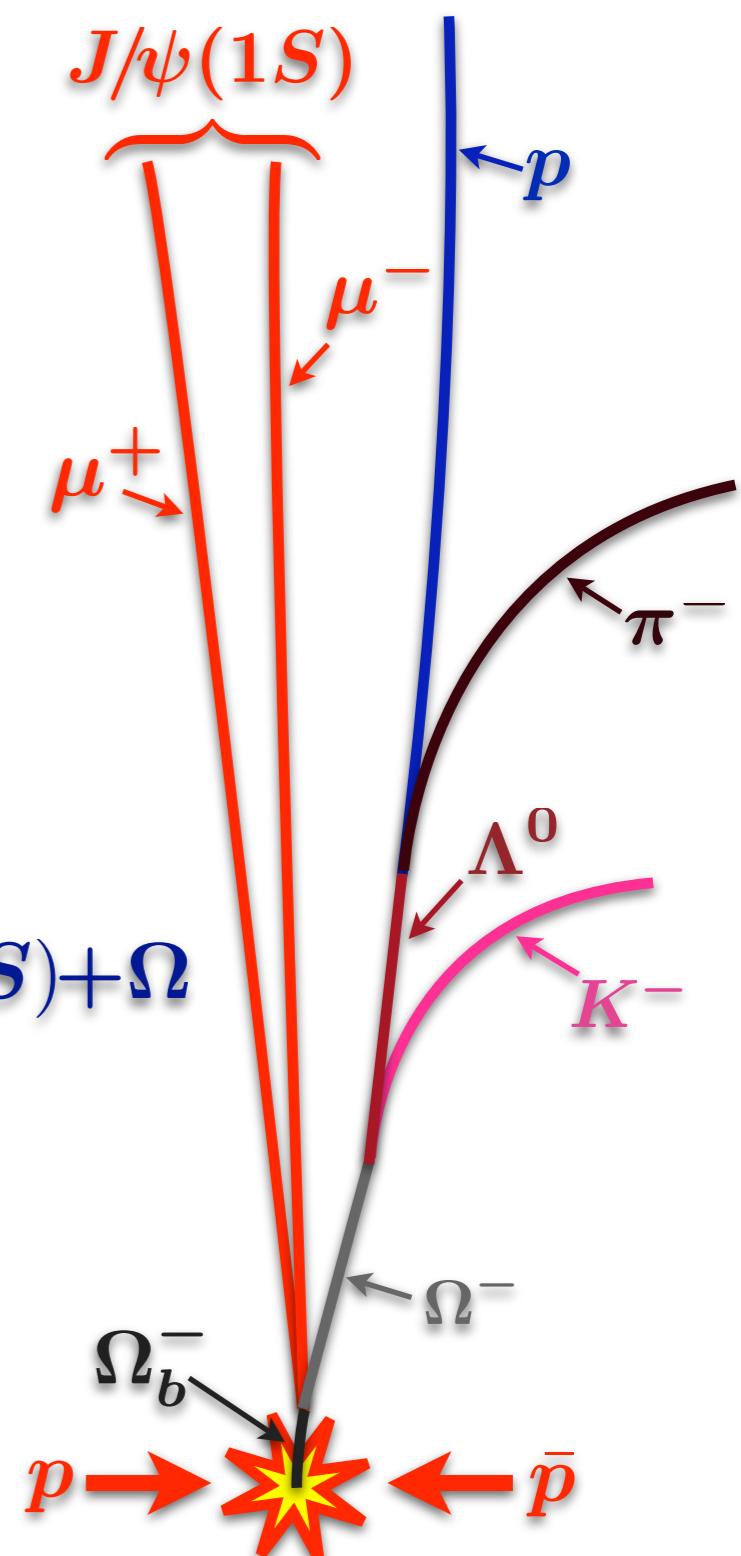
[1] Phys. Rev. D **77**, 014031 (2008)

arXiv:0708.4027 [hep-ph] (2007).

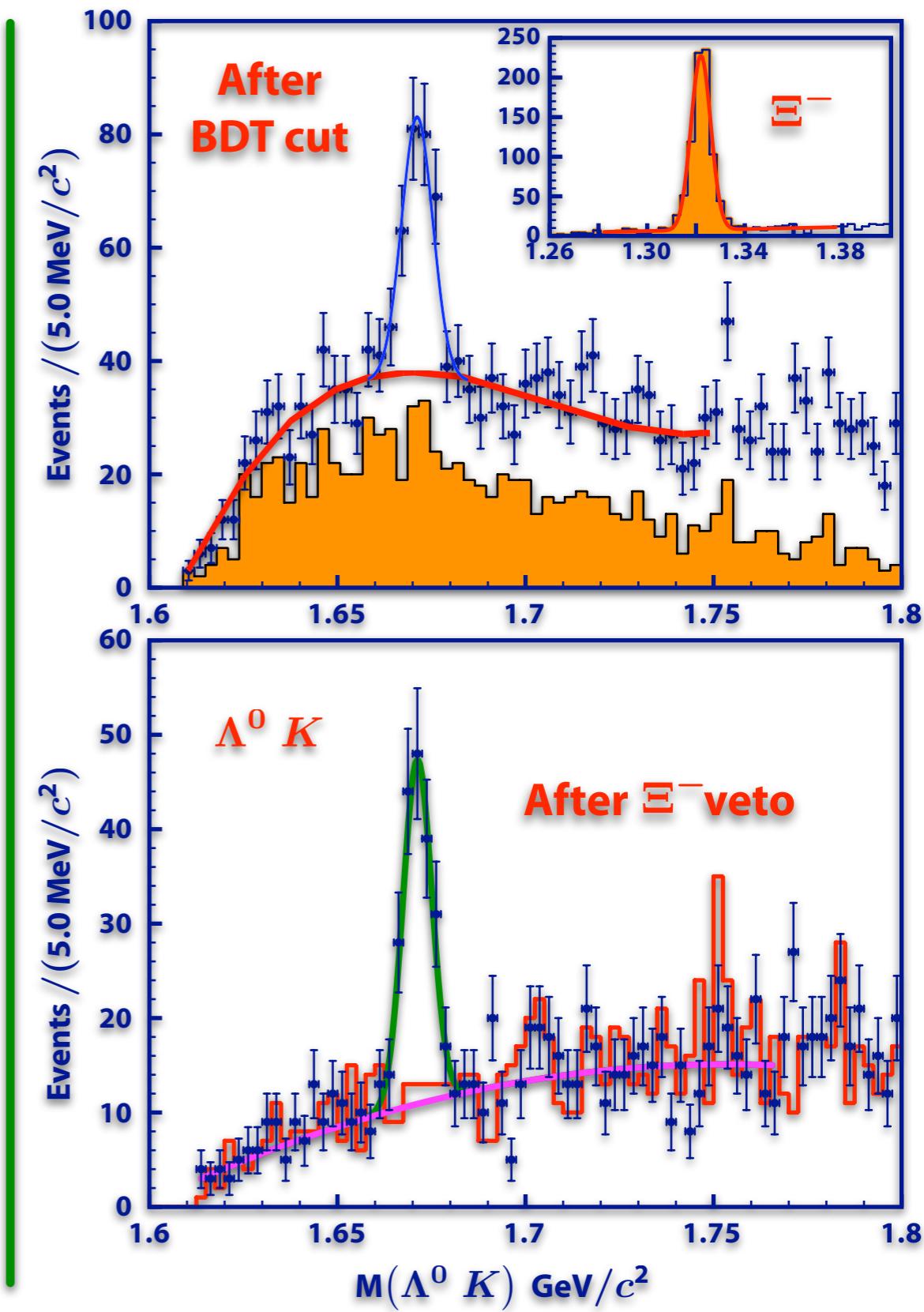
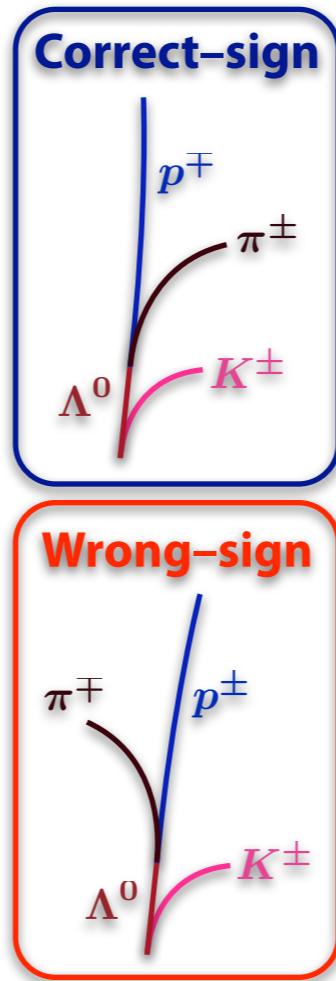
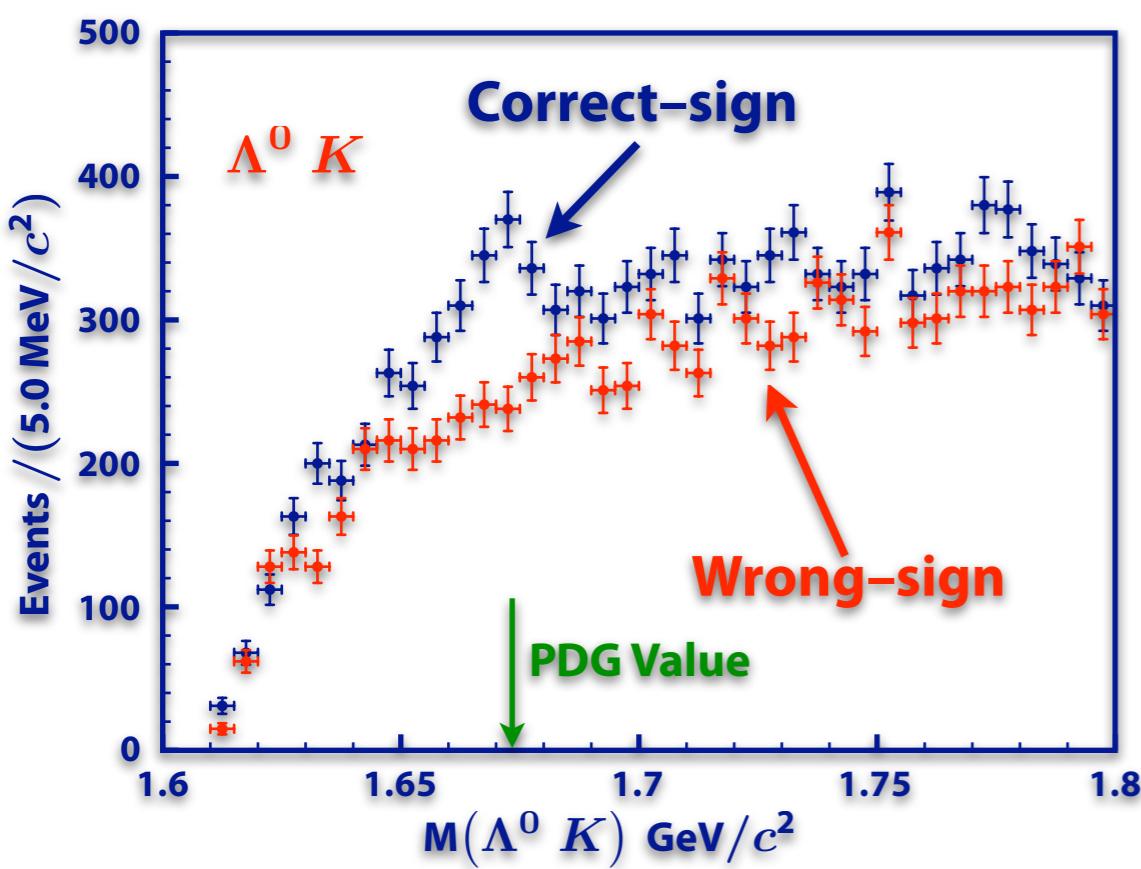
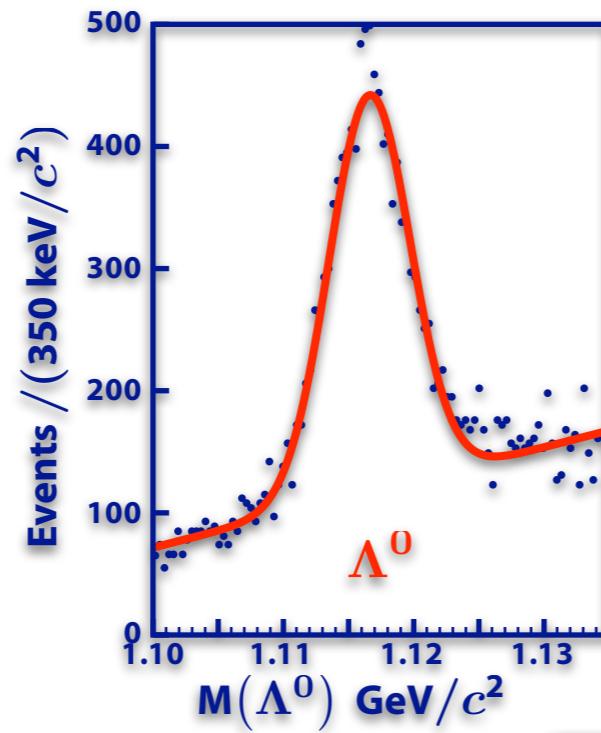
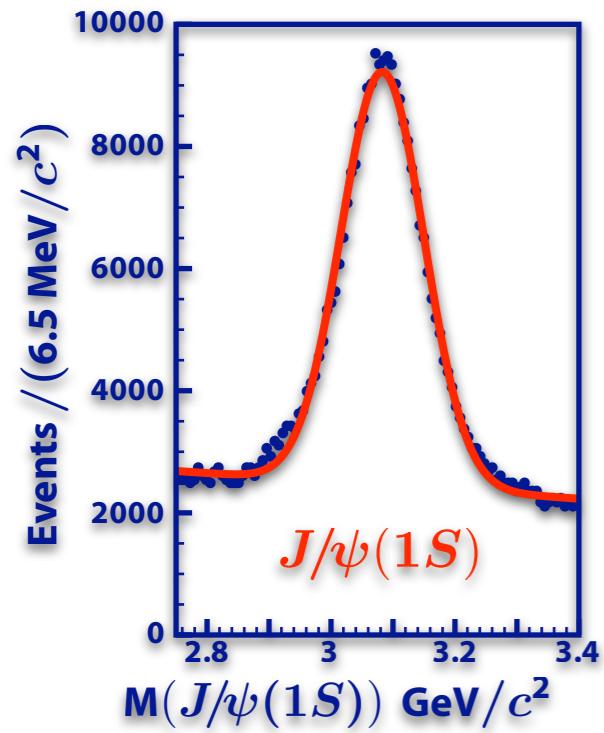
[2] arXiv:hep-ph/9705402

Analysis

- **$J/\psi(1S)$ skim**
- **Λ^0 selection and Ω reconstruction**
- **Combination $J/\psi(1S)+\Omega$**
- **Validation**



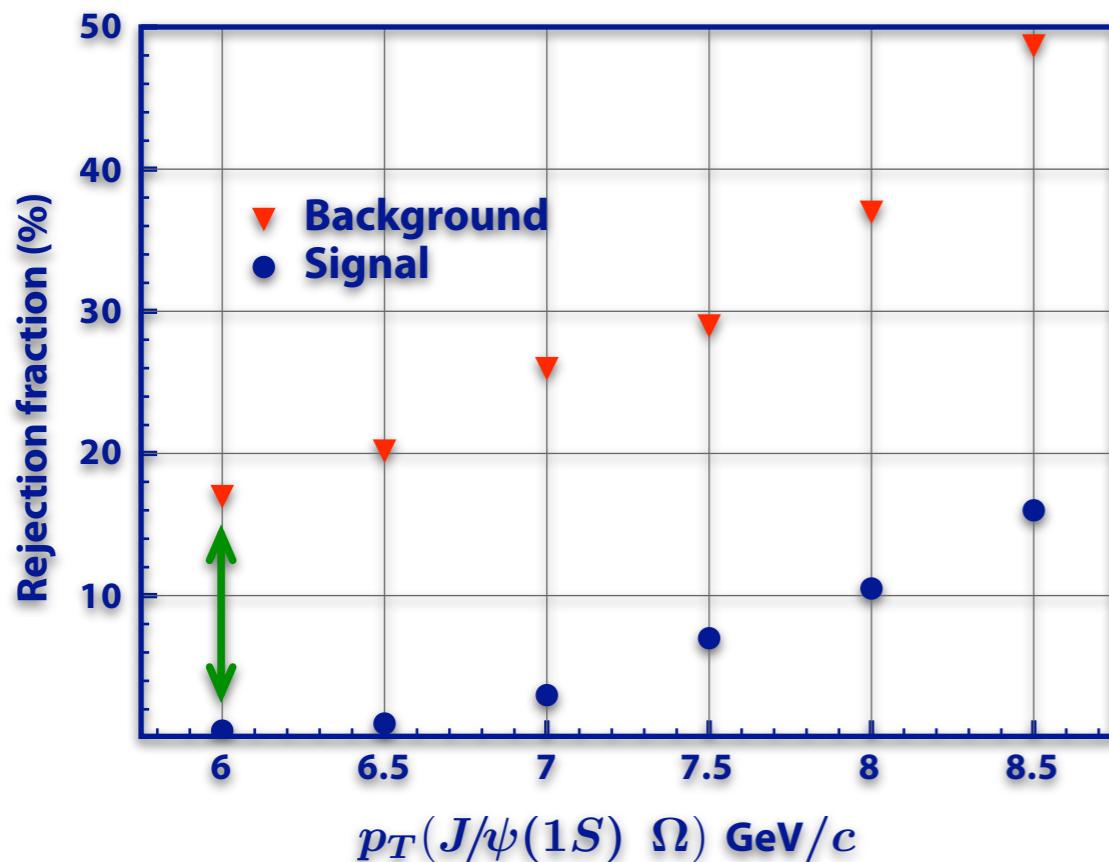
Reconstruction



Final Optimization

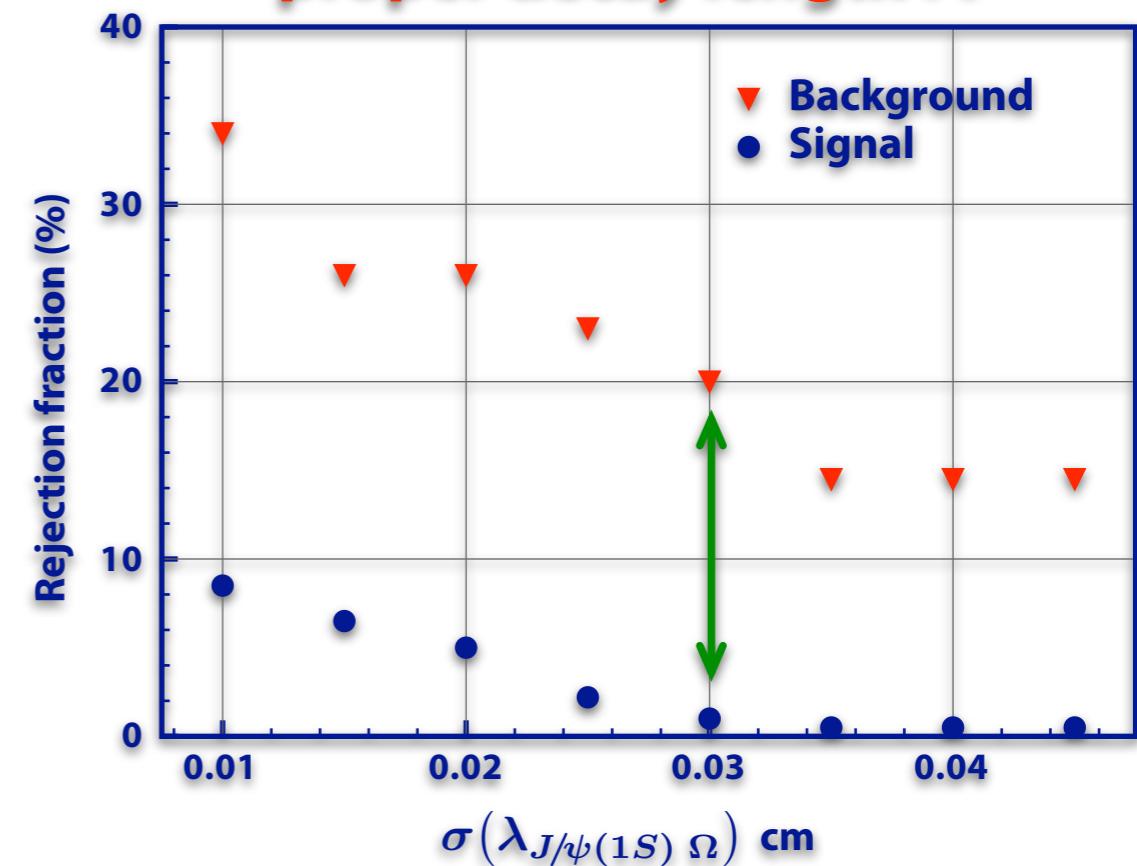
MC signal and Wrong-sign

Cut on p_T



$p_T(J/\psi(1S) \Omega) > 6.0 \text{ GeV}/c$

Cut on uncertainty in the proper decay length λ



$\sigma(\lambda_{J/\psi(1S)} \Omega) < 0.03 \text{ cm}$

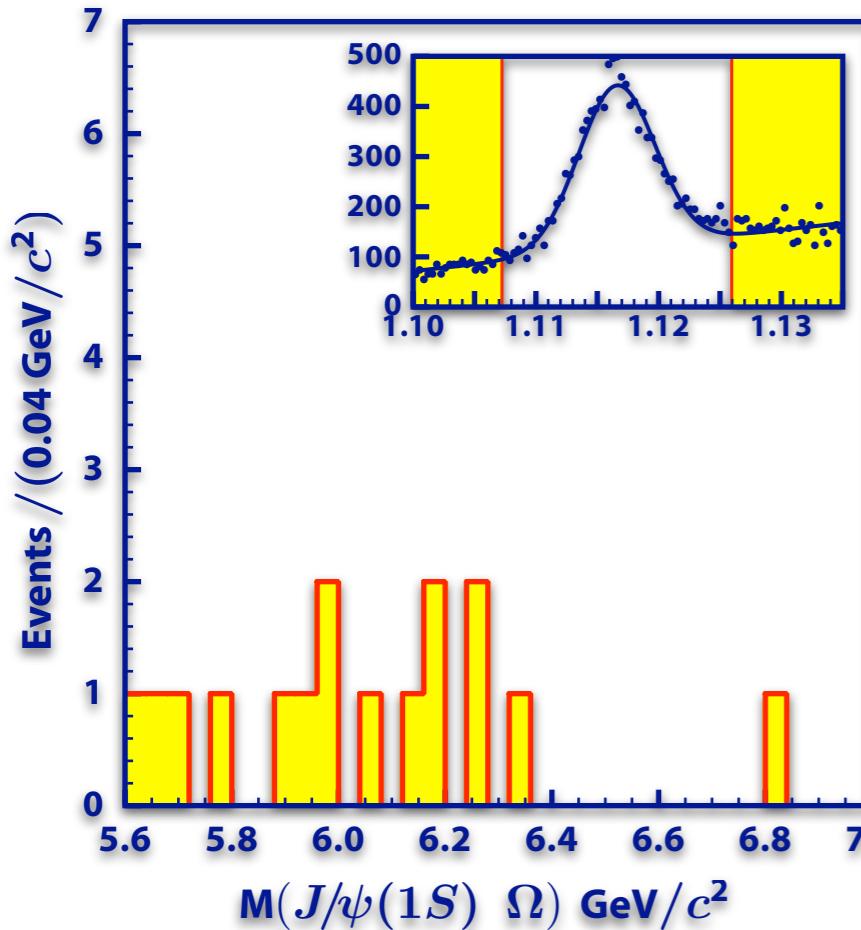
To improve the mass resolution:

$$M \equiv M_{J/\psi \Omega} - M_{J/\psi} - M_\Omega + M_{J/\psi}^{\text{PDG}} + M_\Omega^{\text{PDG}}$$

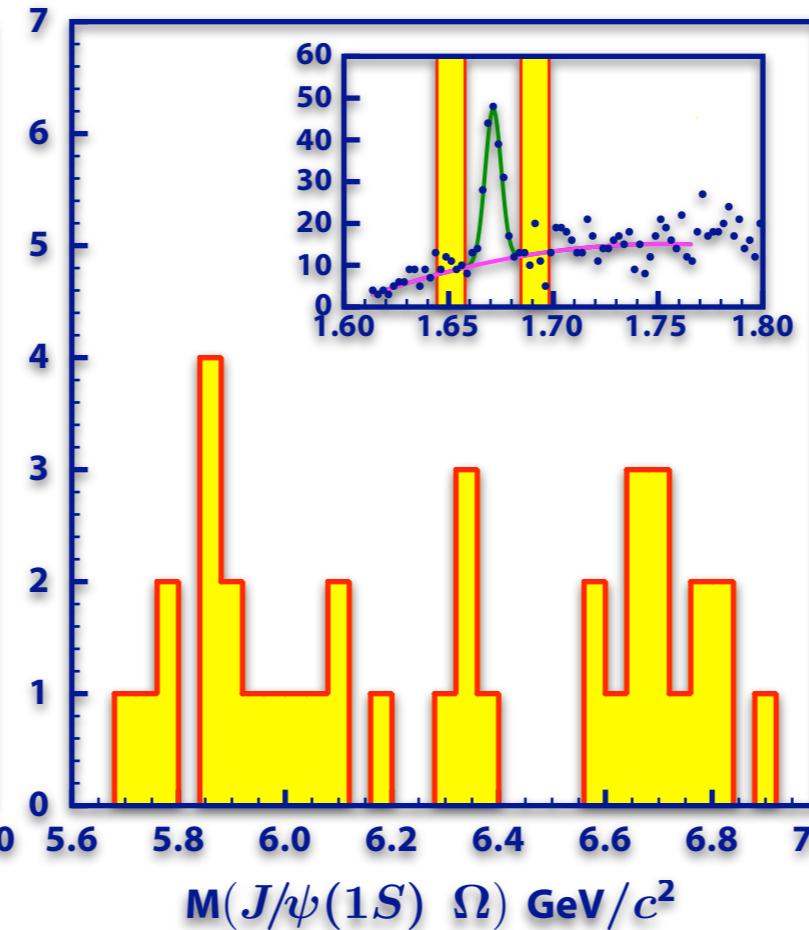
Mass window to search (GeV/c^2): 5.6–7.0

Control Samples

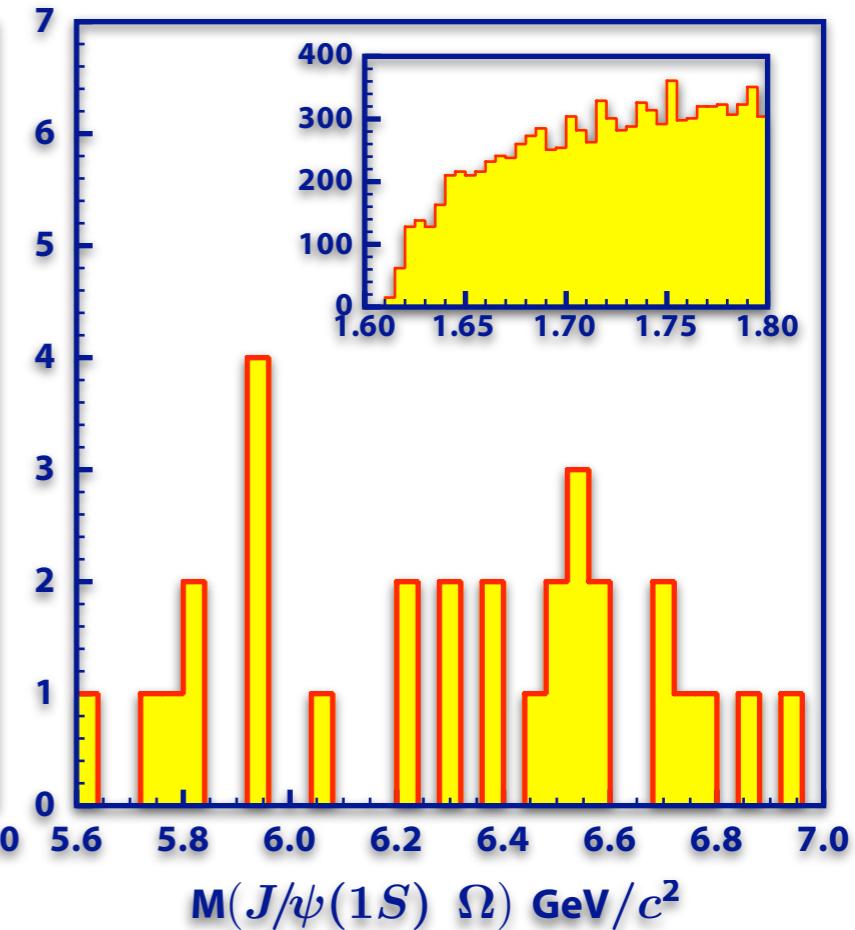
Λ^0 Sidebands



Ω^- Sidebands



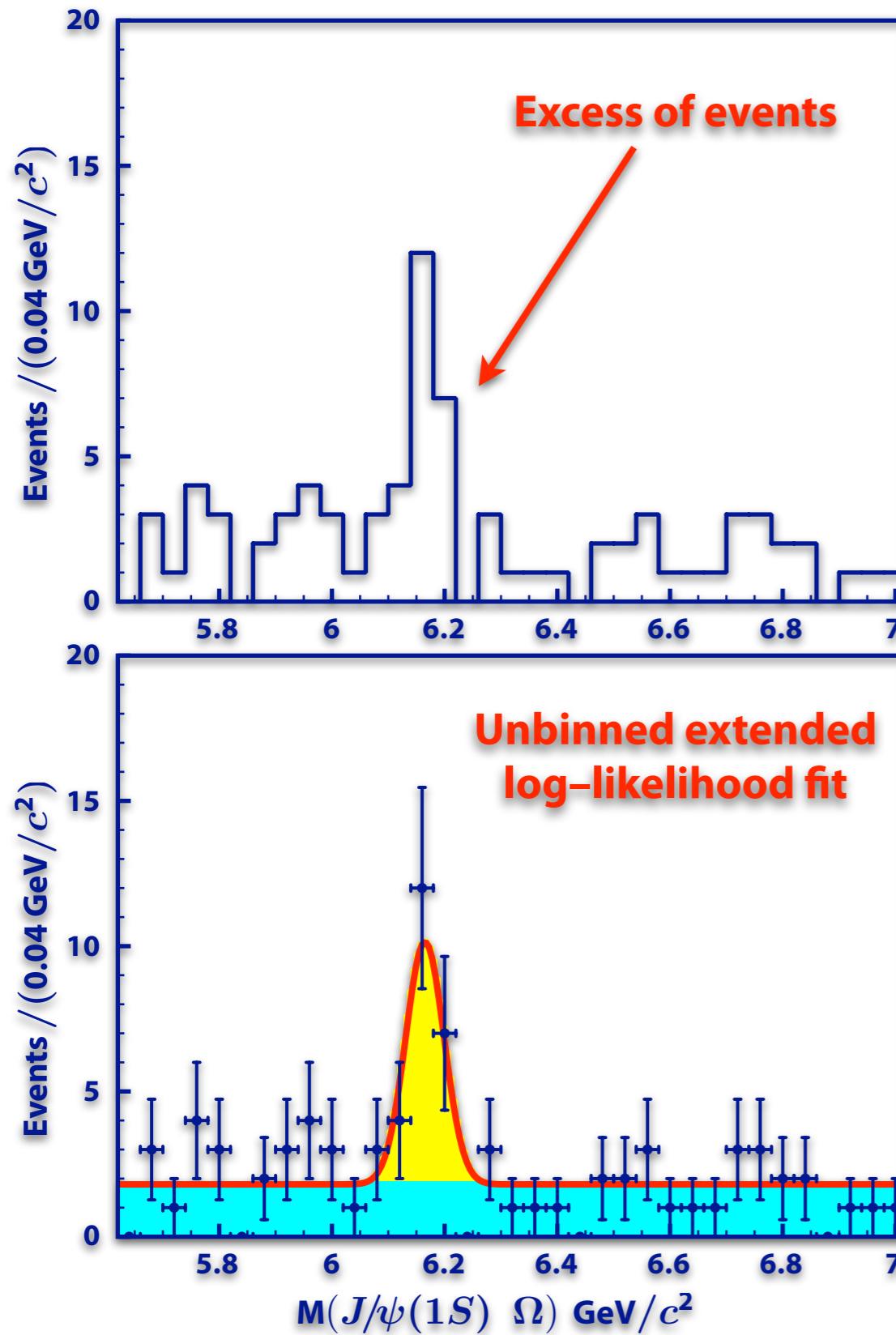
Wrong-sign combinations



Also high statistics MC samples

- $\Lambda_b^0 \rightarrow J/\psi(1S) \quad \Lambda^0 \rightarrow (\mu^+ \mu^-) (p \pi^-)$
- $\Xi_b^- \rightarrow J/\psi(1S) \quad \Xi^- \rightarrow (\mu^+ \mu^-) ((p \pi^-) \pi^-)$
- $B^- \rightarrow J/\psi(1S) \quad K^*(892)^- \rightarrow (\mu^+ \mu^-) ((\pi^+ \pi^-) \pi^-)$

Right-Sign Combination



Signal events

$17.8 \pm 4.9 \text{ (stat)} \pm 0.8 \text{ (syst)}$

Mass

$6.165 \pm 0.010 \text{ (stat)} \pm 0.013 \text{ (syst)} \text{ GeV}/c^2$

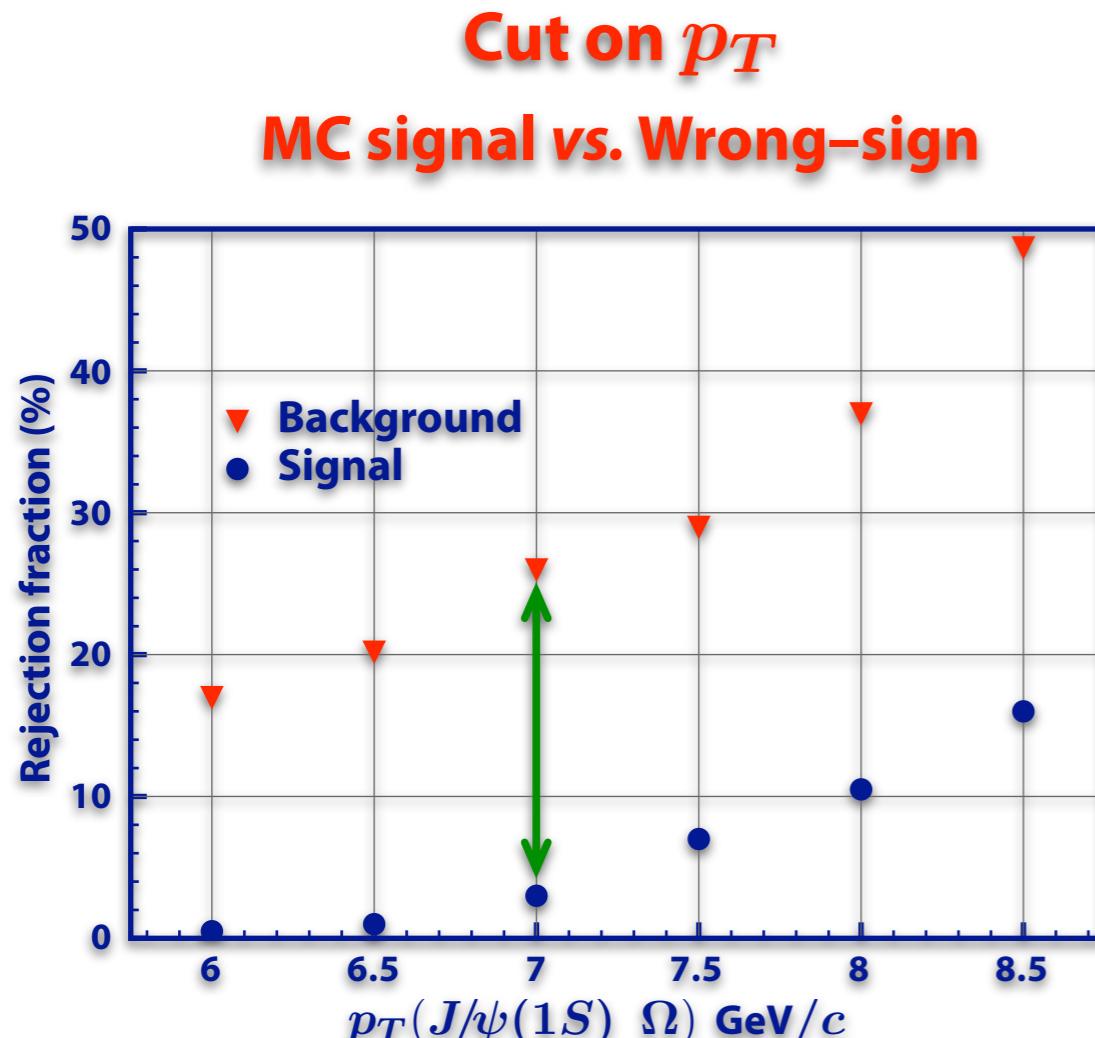
Significance

$$\sqrt{-2\Delta \ln L} = \sqrt{-2 \ln \left(\frac{L_B}{L_{S+B}} \right)} = 5.4 \sigma$$

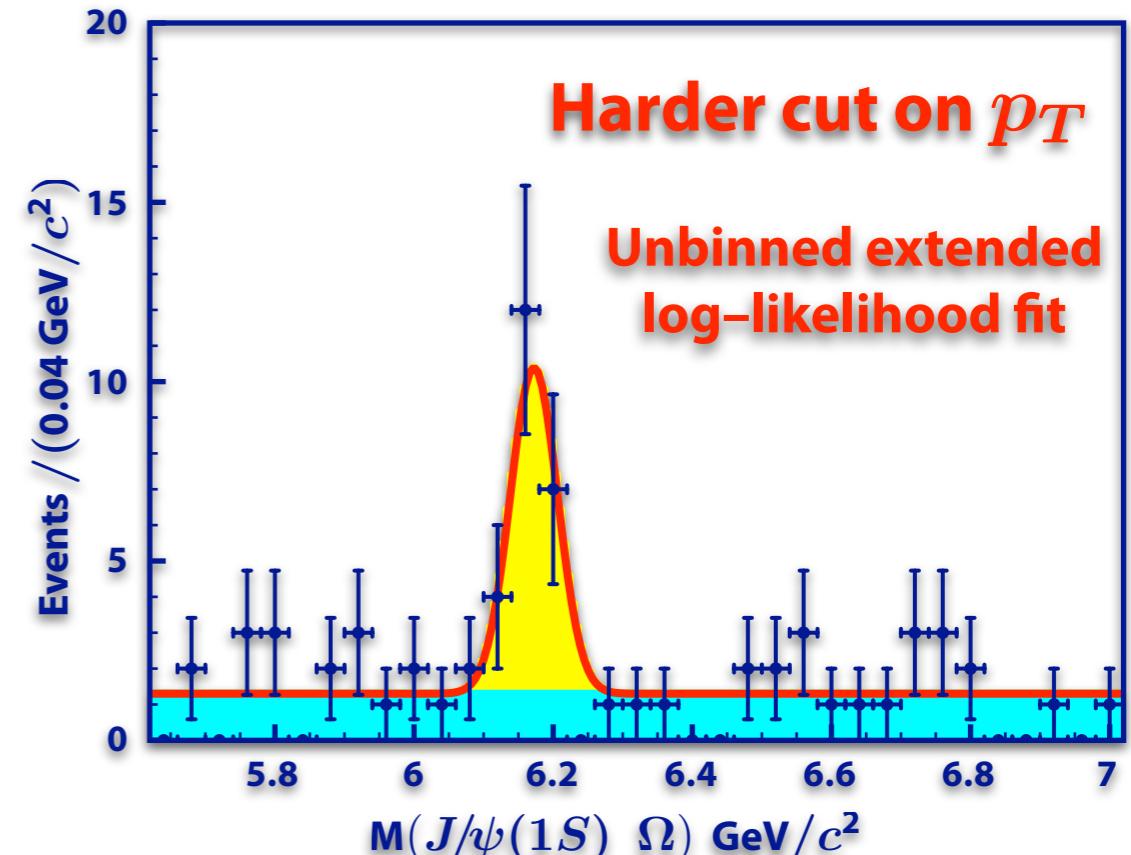
Mass Systematic Uncertainties

Source	Contribution (MeV/c^2)
Linear Background	Negligible
Variation in Gaussian width	3
Momentum Scale Correction	4
Event Selection	12

Crosscheck (1)



$p_T(J/\psi(1S)\ \Omega) > 7.0\text{ GeV}/c$

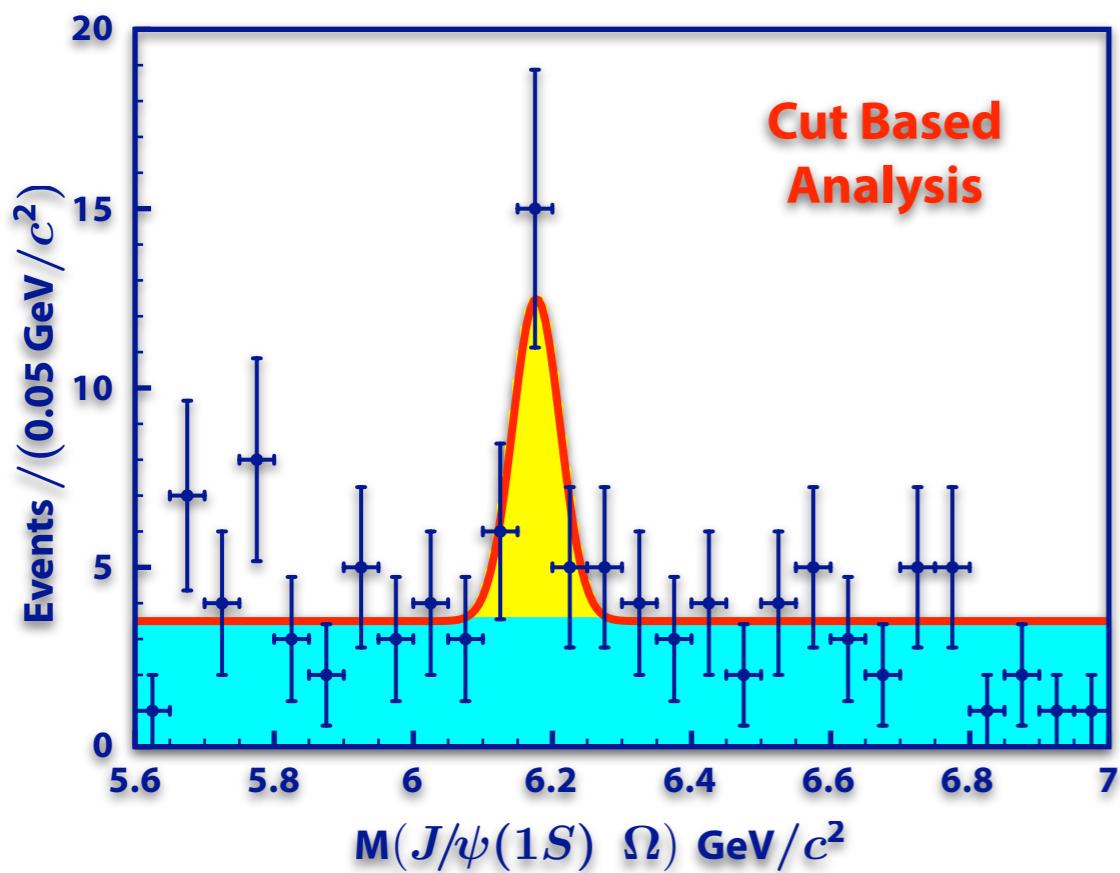


Significance

Greater than 6.0σ

Consistent mass

Cut Based Crosscheck (2)



Signal events

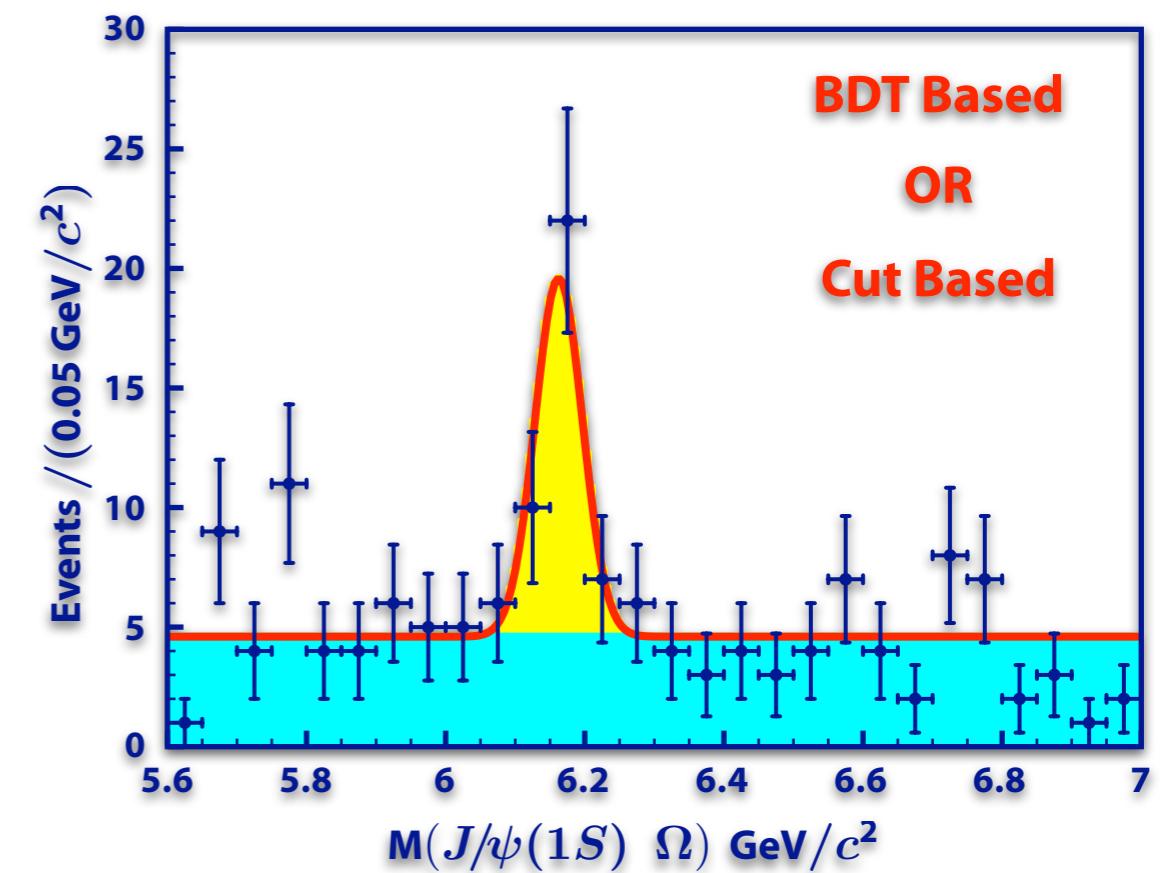
$$15.7 \pm 5.3 \text{ (stat)}$$

Mass

$$6.177 \pm 0.015 \text{ (stat)} \text{ GeV}/c^2$$

Significance

$$3.9 \sigma$$



Signal events

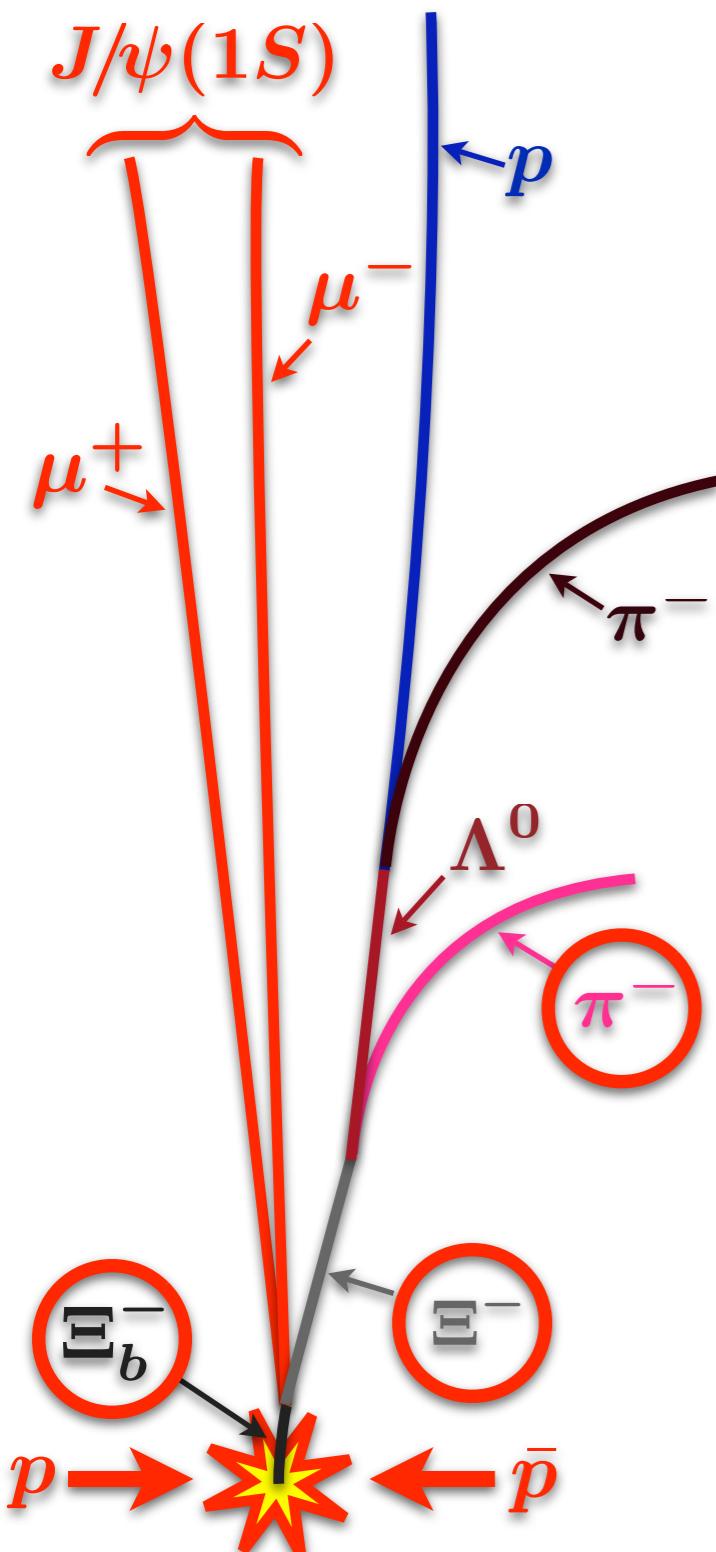
$$25.5 \pm 6.5 \text{ (stat)}$$

Significance

$$5.4 \sigma$$

Consistent number of events, masses and reconstructed efficiencies.

Production Ratio



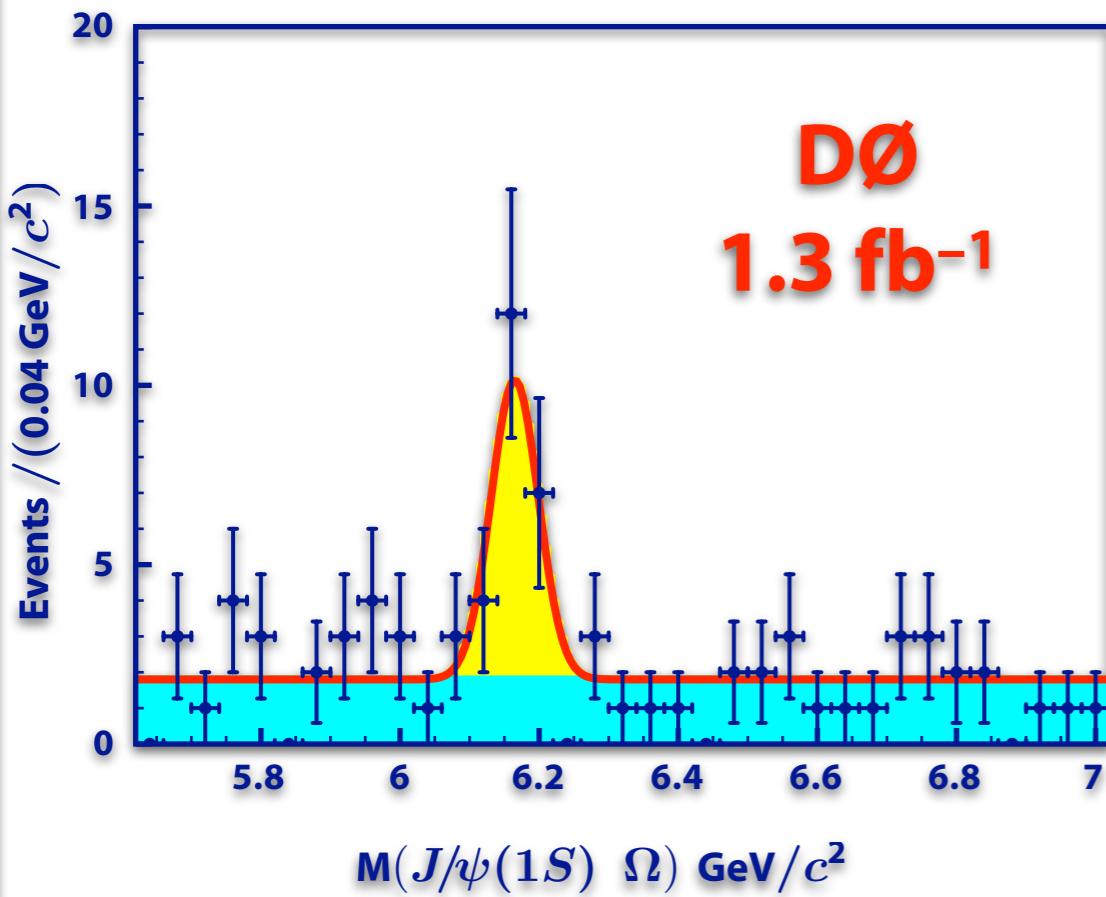
Ξ_b^- as Normalization Channel

$$\frac{f(b \rightarrow \Omega_b^-) Br(\Omega_b^- \rightarrow J/\psi(1S) \Omega^-)}{f(b \rightarrow \Xi_b^-) Br(\Xi_b^- \rightarrow J/\psi(1S) \Xi^-)} = \frac{\varepsilon(\Xi_b^-) N(\Omega_b^-)}{\varepsilon(\Omega_b^-) N(\Xi_b^-)}$$

$$\frac{\varepsilon(\Omega_b^-)}{\varepsilon(\Xi_b^-)} = 1.5 \pm 0.2 \text{ (stat)}$$

$$\boxed{\frac{f(b \rightarrow \Omega_b^-) Br(\Omega_b^- \rightarrow J/\psi(1S) \Omega^-)}{f(b \rightarrow \Xi_b^-) Br(\Xi_b^- \rightarrow J/\psi(1S) \Xi^-)} = 0.80 \pm 0.32 \text{ (stat)}^{+0.14}_{-0.22} \text{ (syst)}}$$

Summary – Outlook



$17.8 \pm 4.9 \text{ (stat)} \pm 0.8 \text{ (syst)}$
 $6.165 \pm 0.010 \text{ (stat)} \pm 0.013 \text{ (syst)} \text{ GeV}/c^2$
 5.4σ
 $\frac{f(b \rightarrow \Omega_b^-) Br(\Omega_b^- \rightarrow J/\psi(1S) \Omega^-)}{f(b \rightarrow \Xi_b^-) Br(\Xi_b^- \rightarrow J/\psi(1S) \Xi^-)} = 0.80 \pm 0.32 \text{ (stat)}^{+0.14}_{-0.22} \text{ (syst)}$
A new b –Baryon observed! 😊

Working on the update of the analysis to include the remaining data.

