Fermilab

Jesus Orduna

CINVESTAV Mexico

jjesus@fnal.gov

November 3, 2009

1980

Mexico City

1980

José de Jesús Fabián Hernández Orduña

Mexico City

1980

Mexico City

José de Jesús ~~Fabián~~ Hernández Orduña

José de Jesús Hernández Orduña

1980

Mexico City

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1980

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José de Jesús ~~Fabián~~ Hernández Orduña

José de Jesús Hernández Orduña

1980

Mexico City

José de Jesús ~~Fabián~~ Hernández Orduña

José de Jesús Hernández Orduña

Jesus Orduna

Jesus

Education History

Education History

1982–1984 Kindergarten.

Education History

1982–1984 Kindergarten.

1984–1990 Elementary school.

Education History

1982–1984 Kindergarten.

1984–1990 Elementary school.

1990–1993 Middle school.

Education History

1982–1984 Kindergarten.

1984–1990 Elementary school.

1990–1993 Middle school.

1993–1997 High school.

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1984–1990 Elementary school.

1990–1993 Middle school.

1993–1997 High school.

1997 University...

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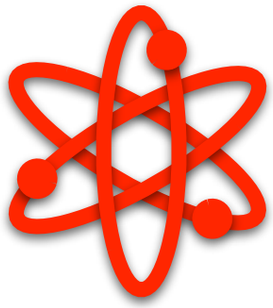
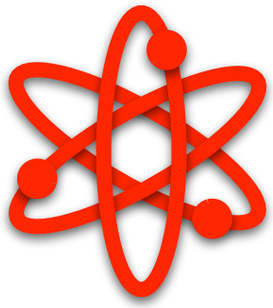
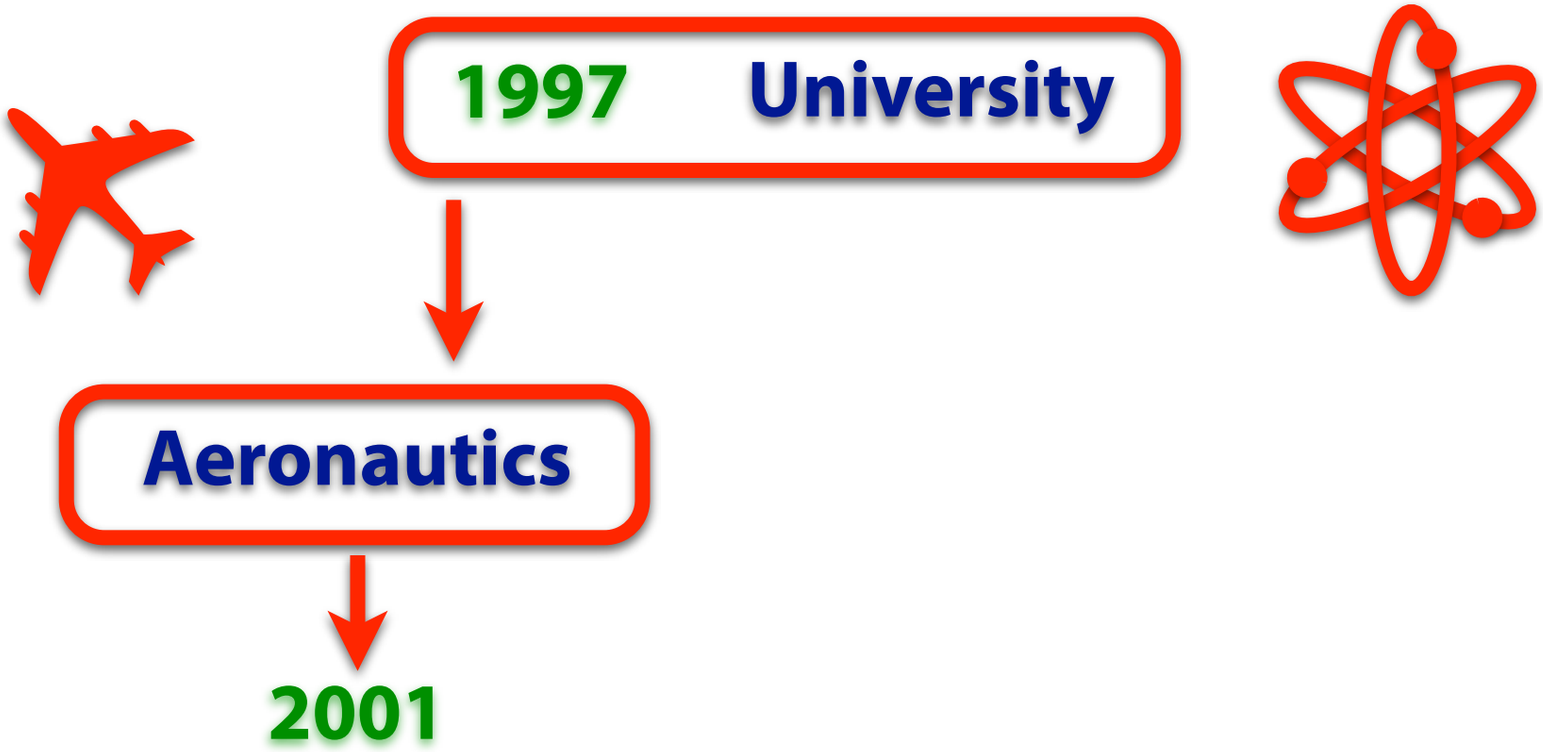
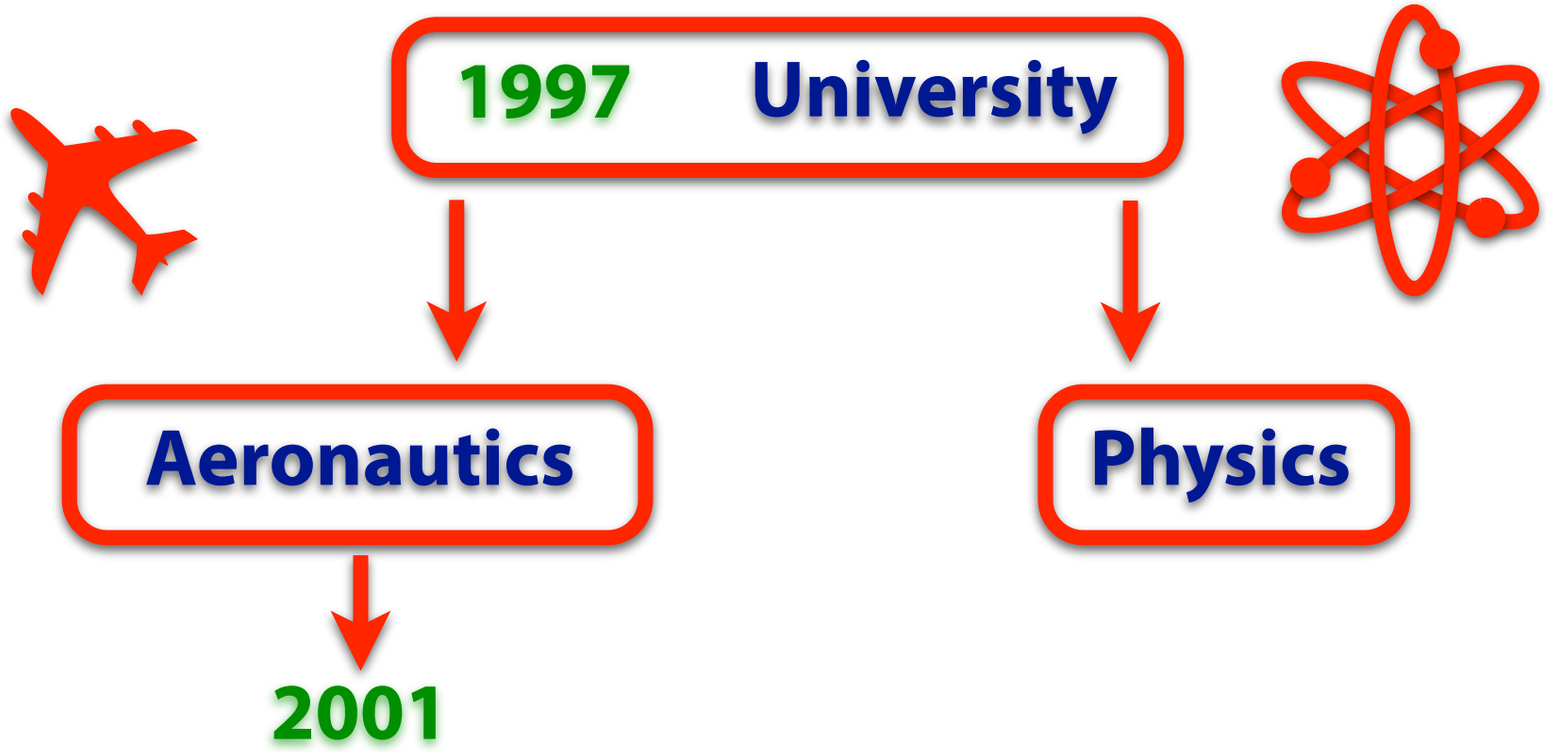


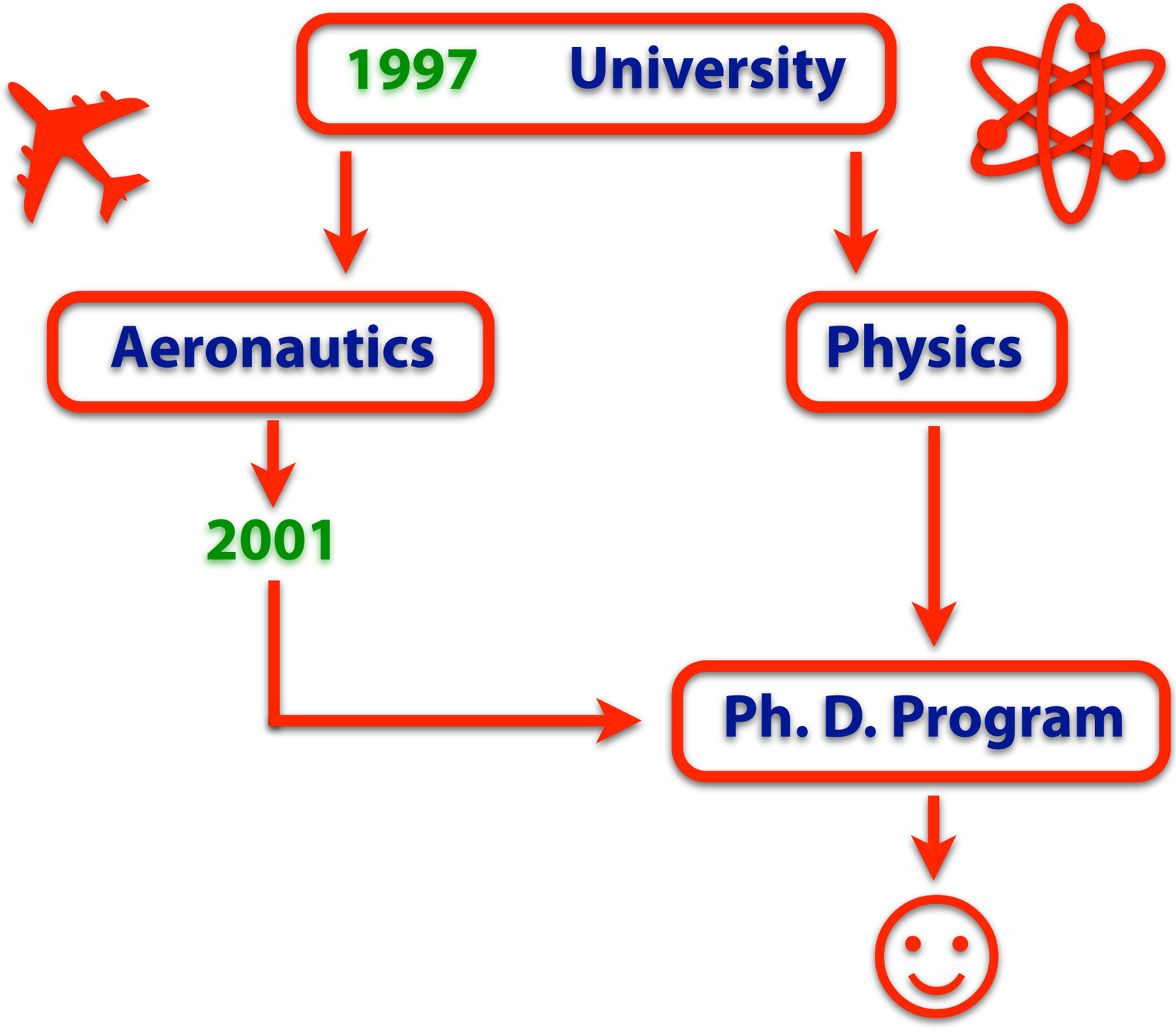
1997 University



Aeronautics


1997
University
Aeronautics
2001


1997 University
Aeronautics
Physics
2001


1997
University
Aeronautics
Physics
2001
Ph. D. Program

2003 Ph. D. Program

2003 Ph. D. Program

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CINVESTAV

Research and Advanced Studies Centre

2003 Ph. D. Program

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CINVESTAV
Research and Advanced Studies Centre

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2006 Qualifiers

2003 Ph. D. Program

↓

CINVESTAV
Research and Advanced Studies Centre

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2006 Qualifiers

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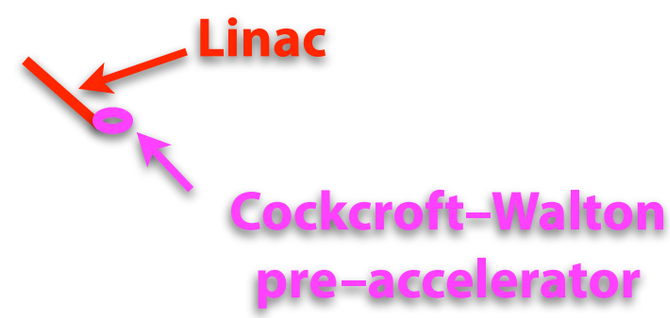
Tevatron

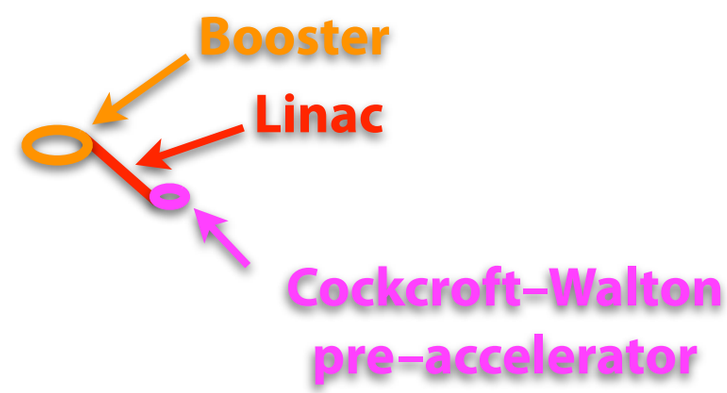
Tevatron

Cockcroft–Walton
pre–accelerator

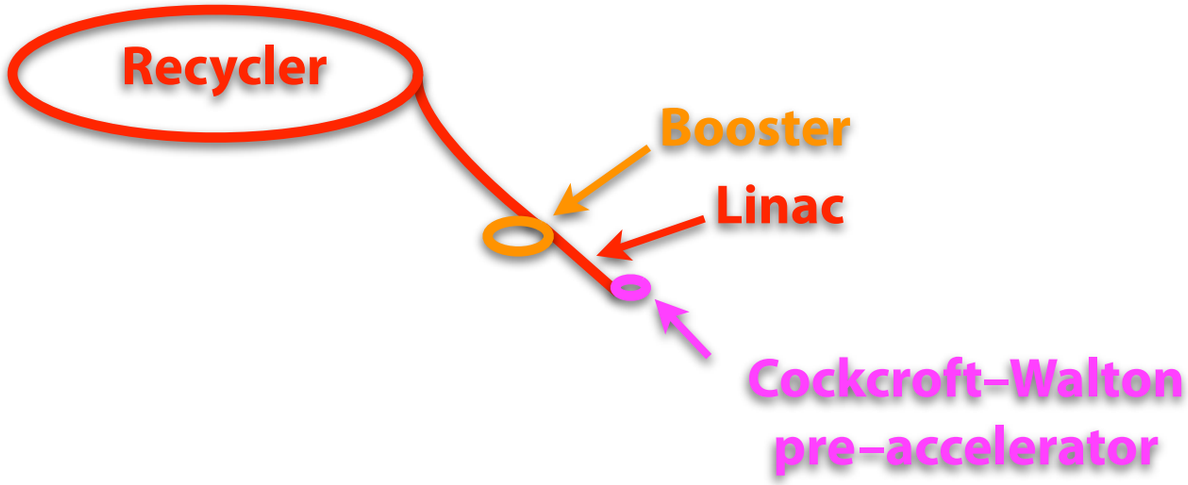
Tevatron



Tevatron



Tevatron



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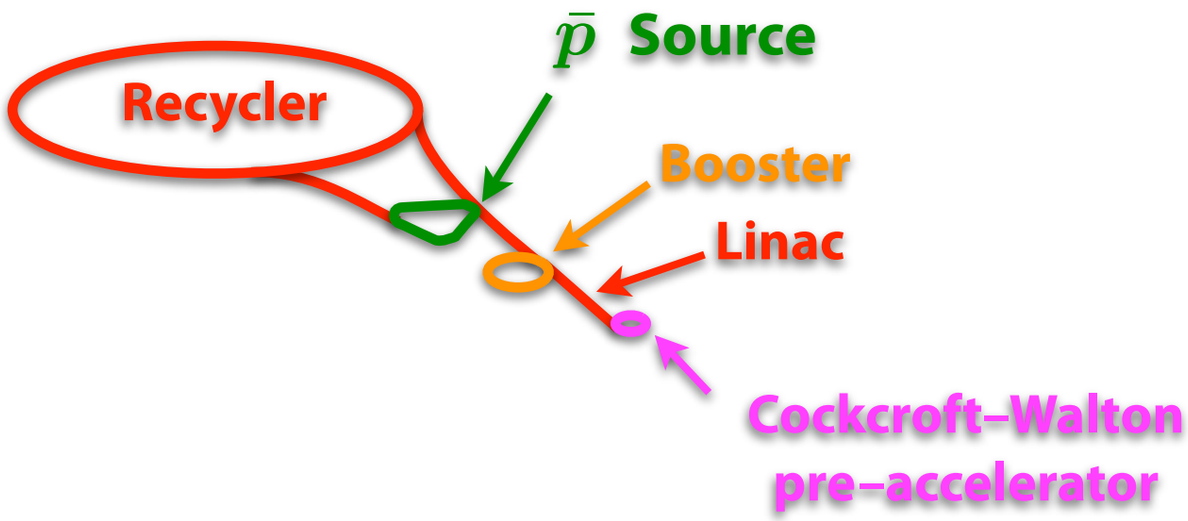
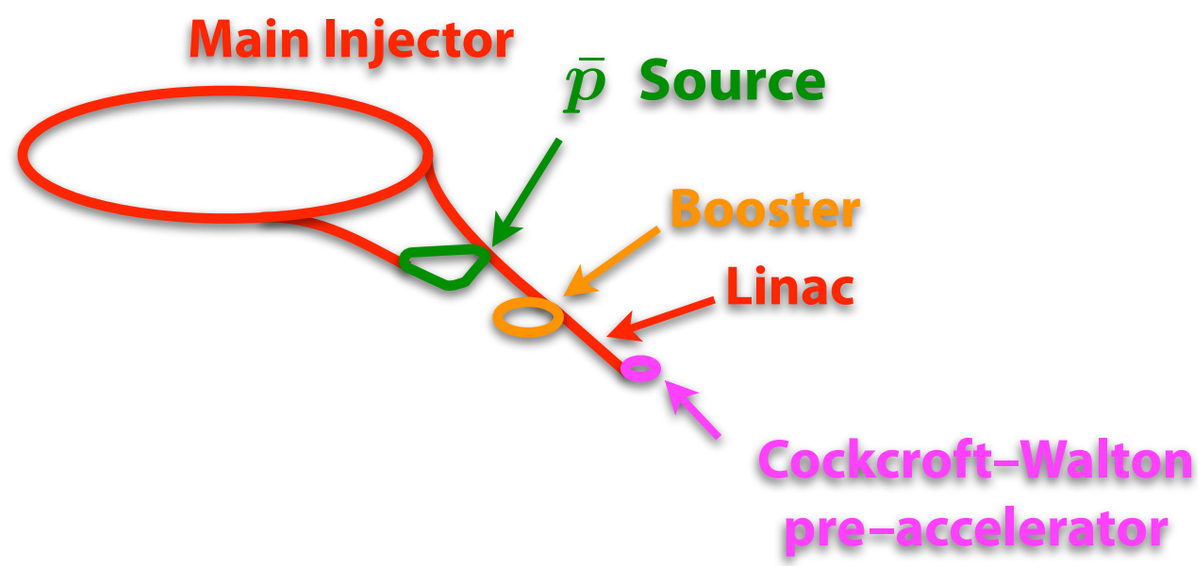
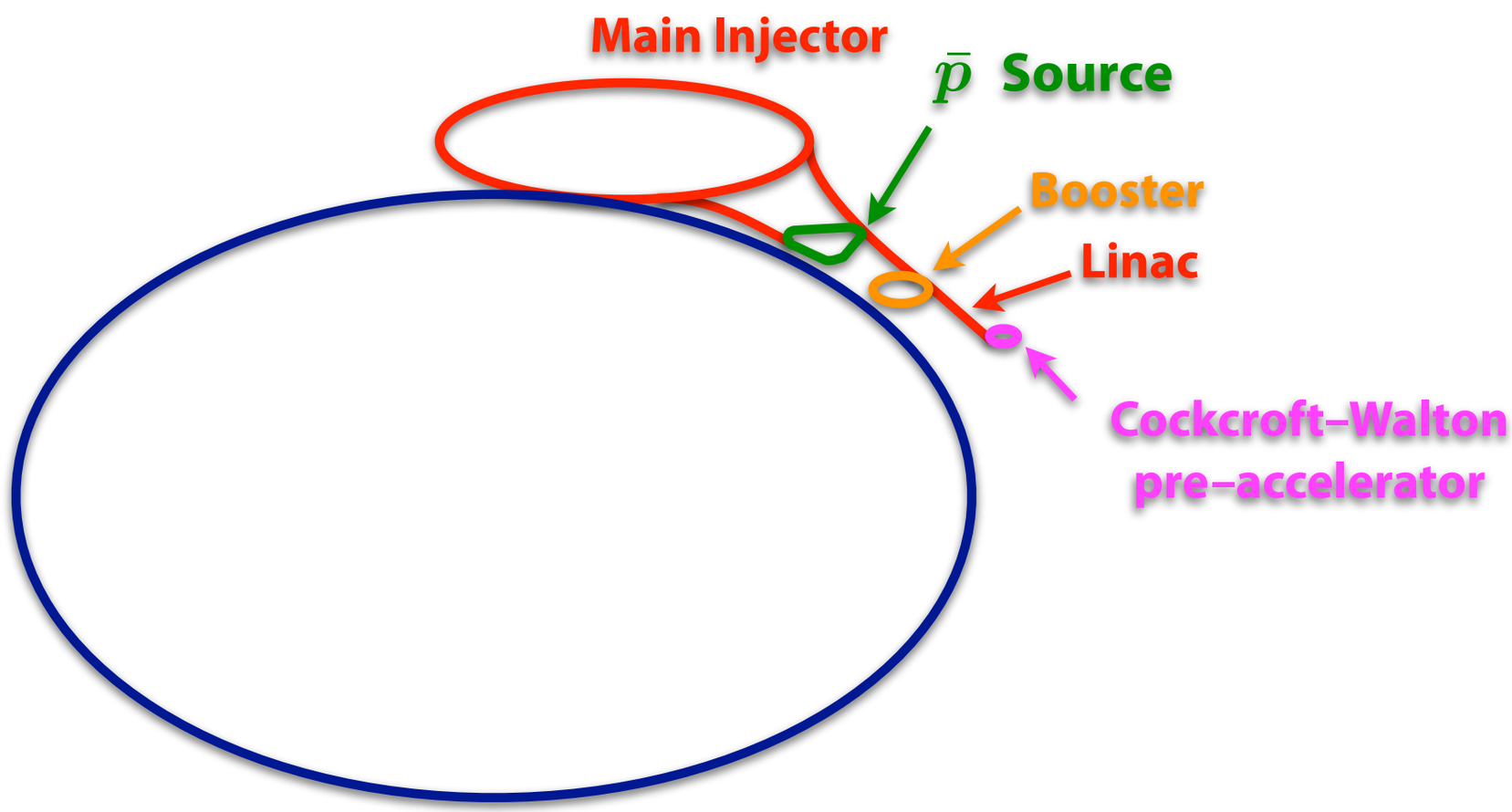

$\bar{p}$ Source
Recycler
Booster
Linac
Cockcroft–Walton
pre–accelerator

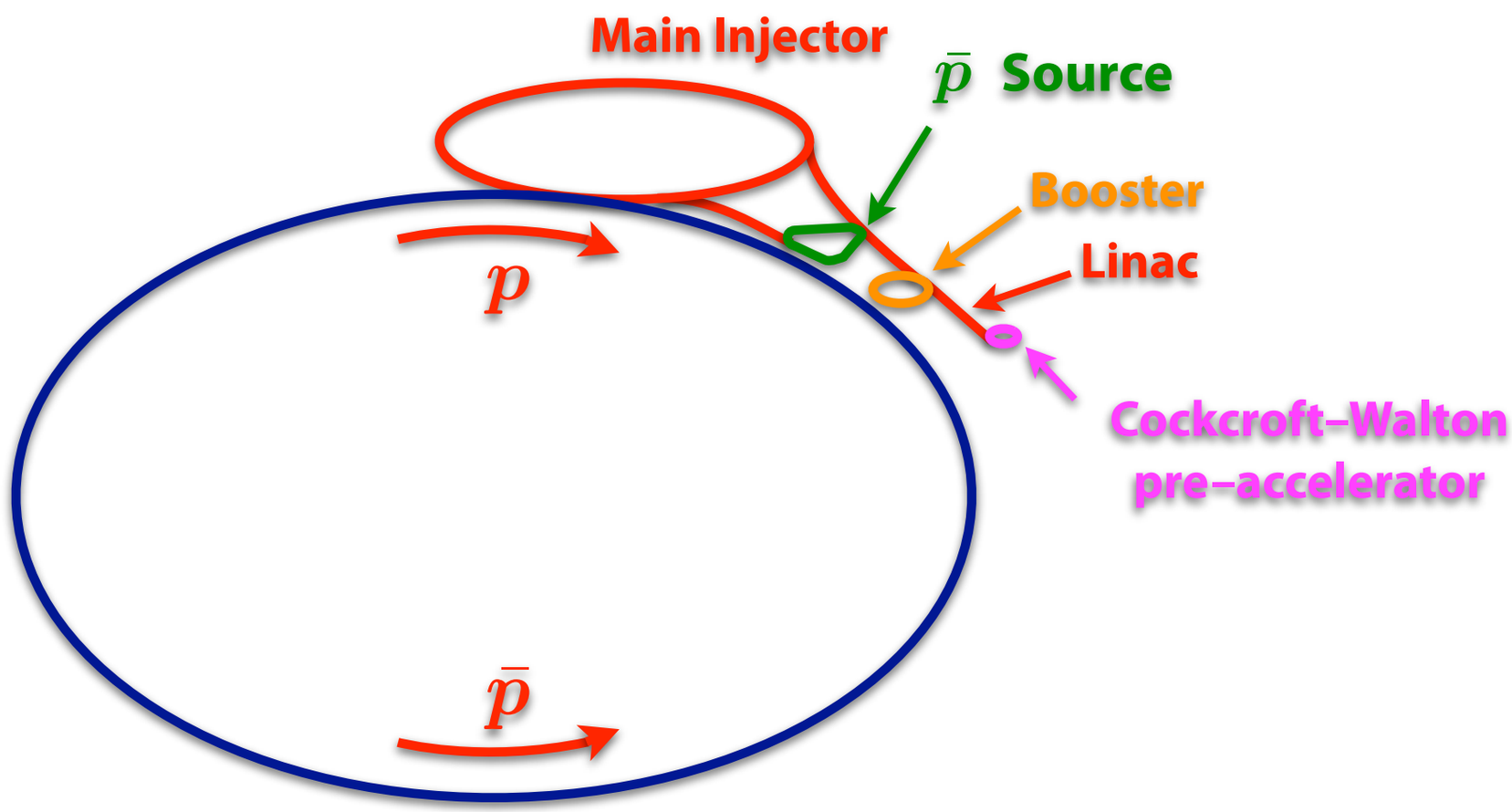
Tevatron


Main Injector
$\bar{p}$ Source
Booster
Linac
Cockcroft–Walton
pre–accelerator

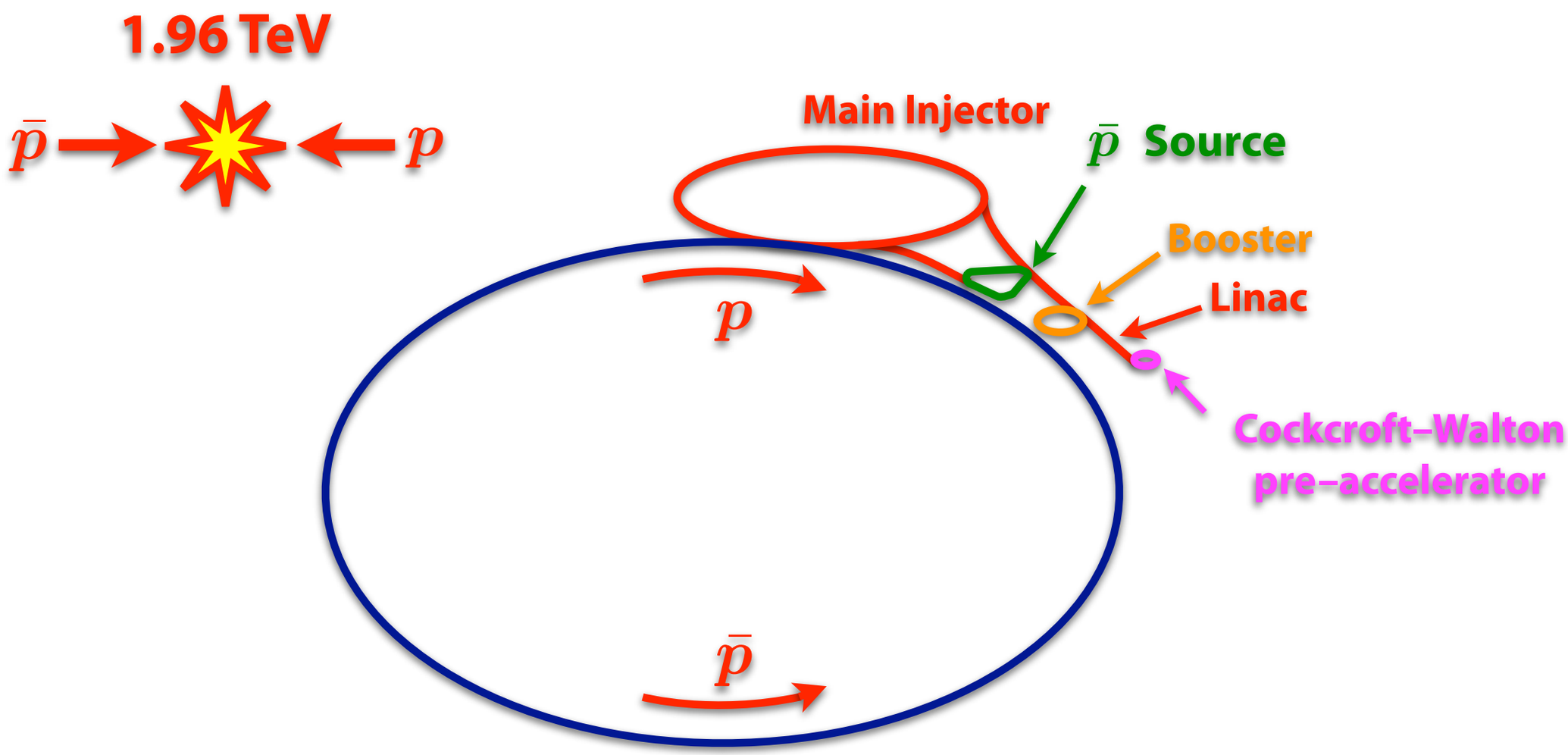
Tevatron


Main Injector
$\bar{p}$ Source
Booster
Linac
Cockcroft–Walton
pre–accelerator

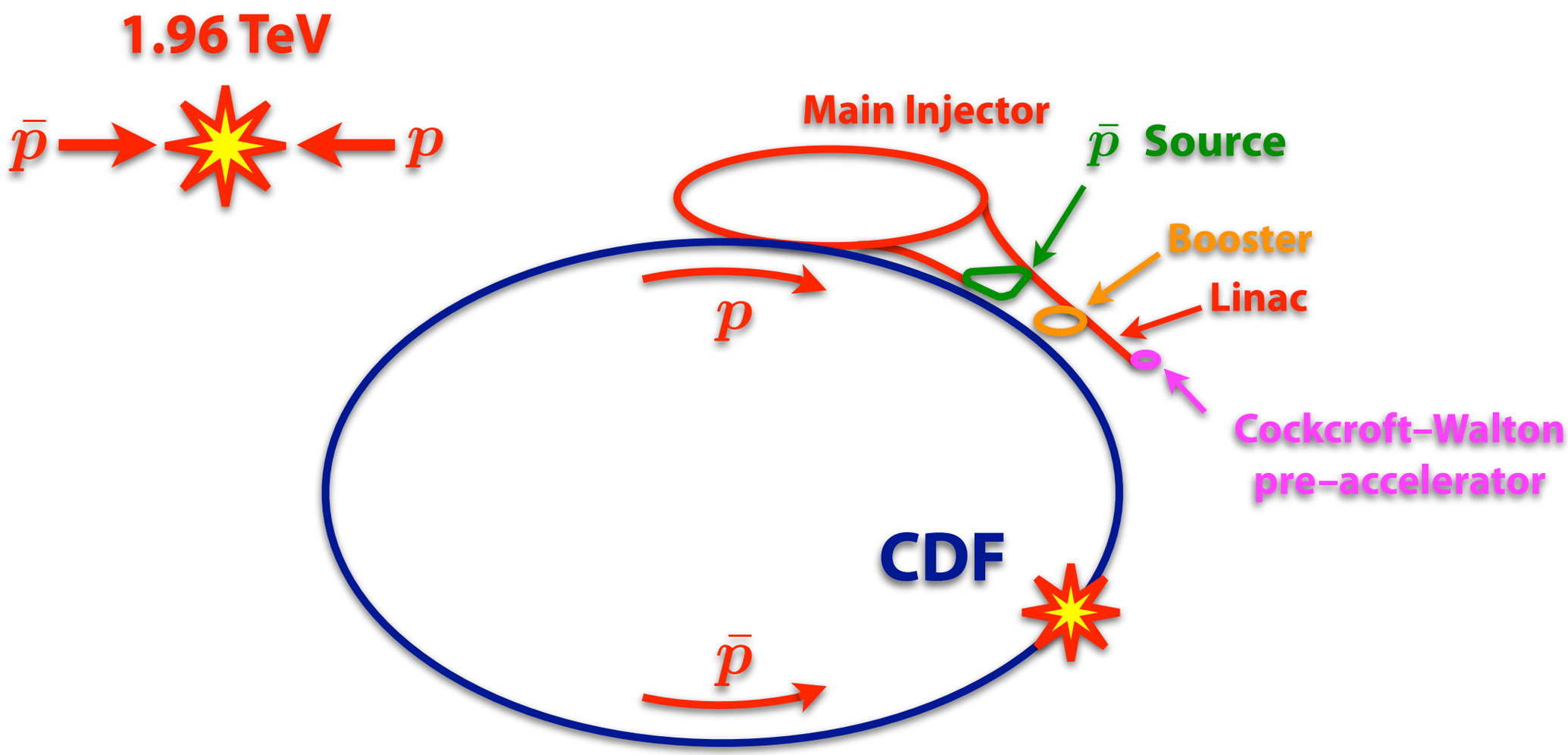
Tevatron


Main Injector
$\bar{p}$ Source
Booster
Linac
Cockcroft–Walton
pre–accelerator
p
$\bar{p}$

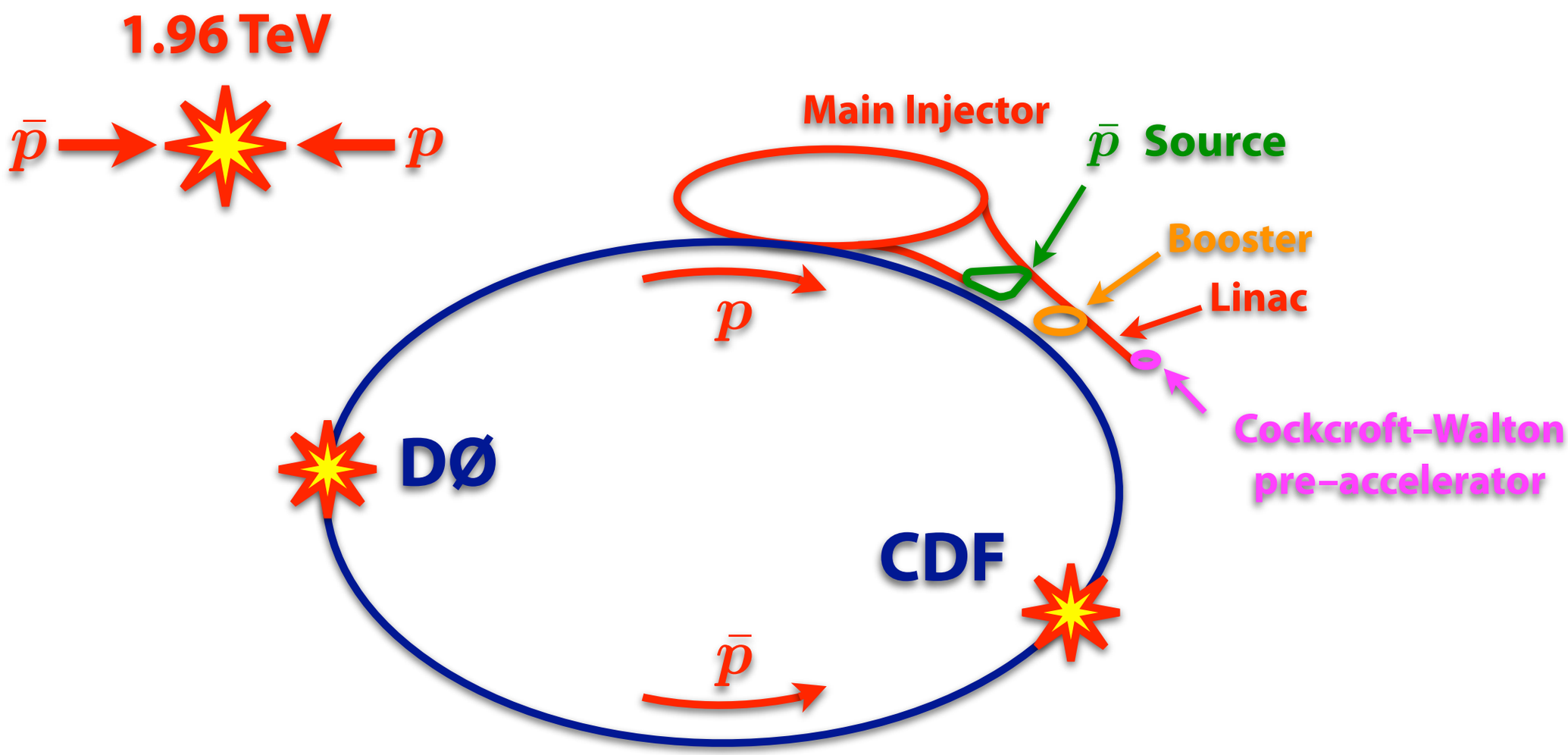
Tevatron


1.96 TeV
$\bar{p}$
p
Main Injector
$\bar{p}$ Source
Booster
Linac
Cockcroft–Walton
pre–accelerator
p
$\bar{p}$

Tevatron


1.96 TeV
$\bar{p}$
p
Main Injector
$\bar{p}$ Source
Booster
Linac
Cockcroft–Walton
pre–accelerator
p
CDF
$\bar{p}$

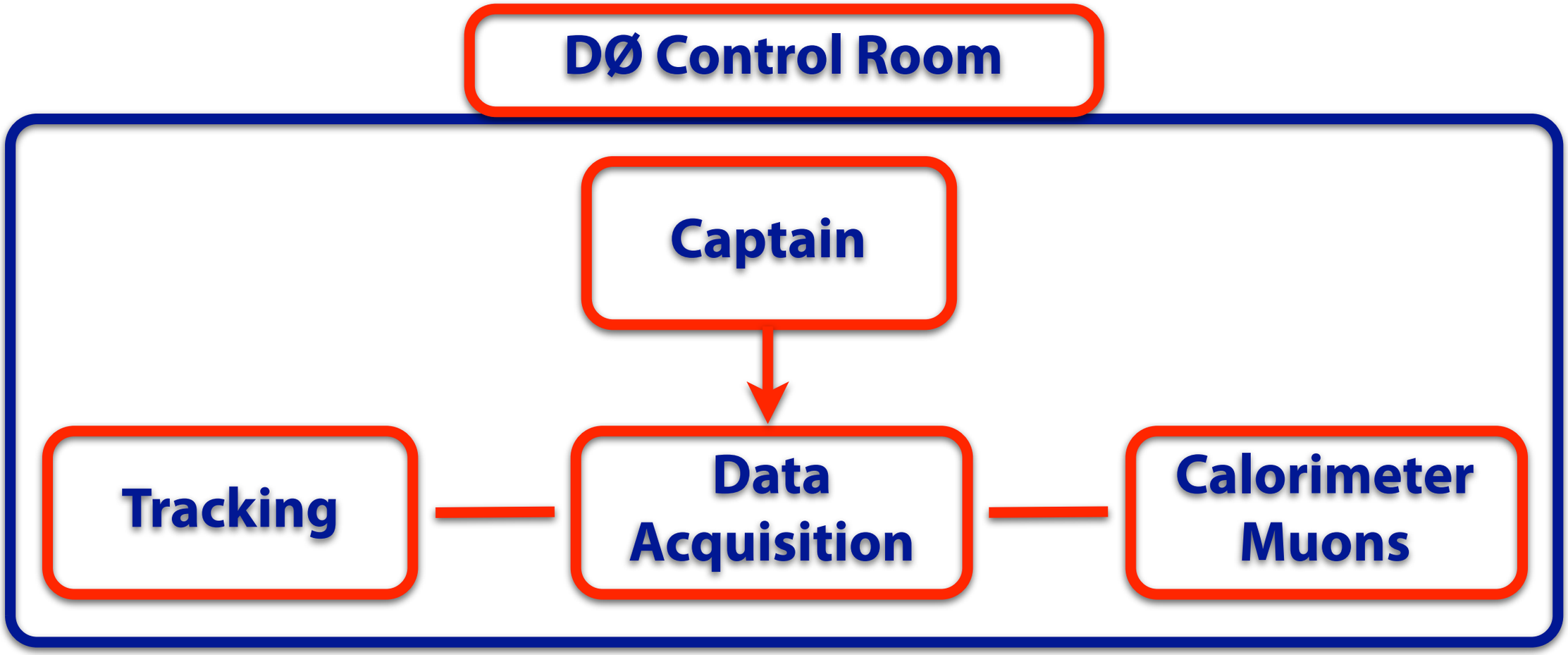
Tevatron


1.96 TeV
$\bar{p}$
p
Main Injector
$\bar{p}$ Source
Booster
Linac
Cockcroft–Walton
pre–accelerator
p
DØ
CDF
$\bar{p}$

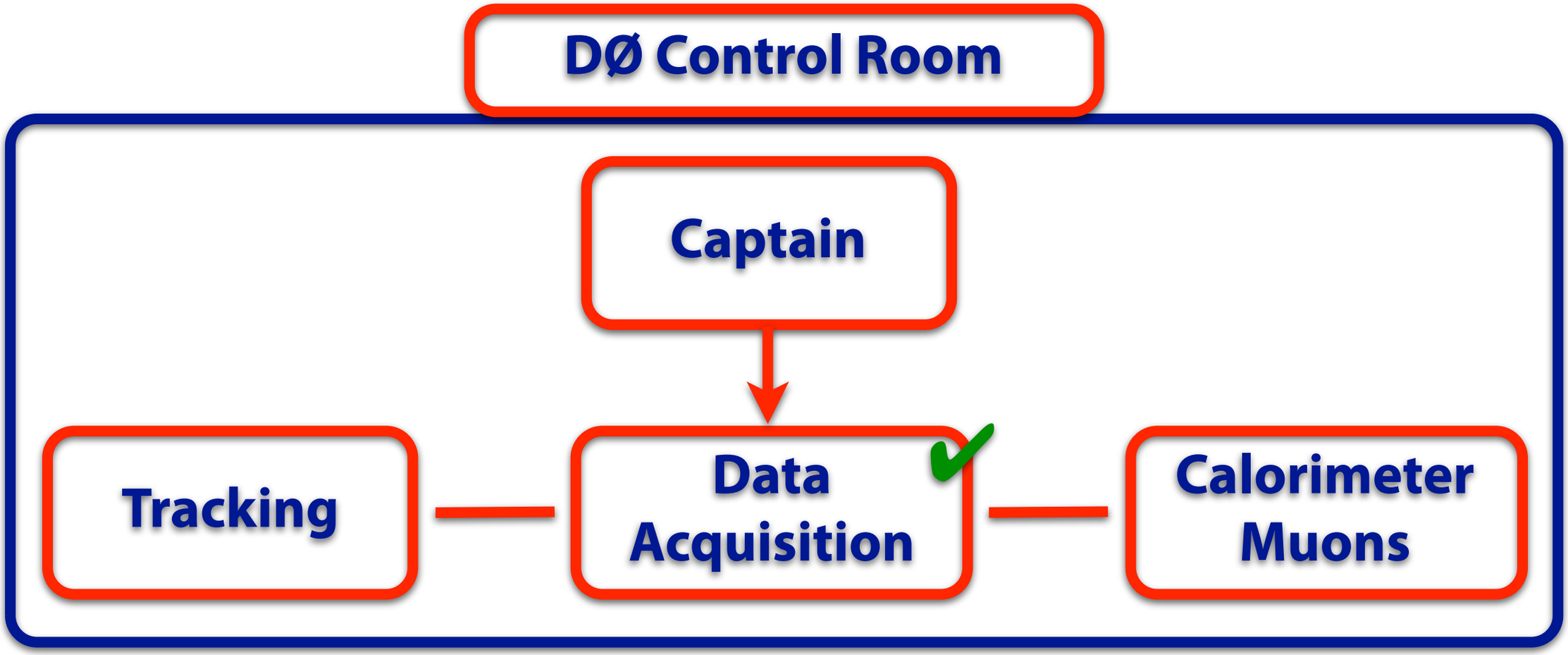
DØ Detector Operations

DØ Control Room

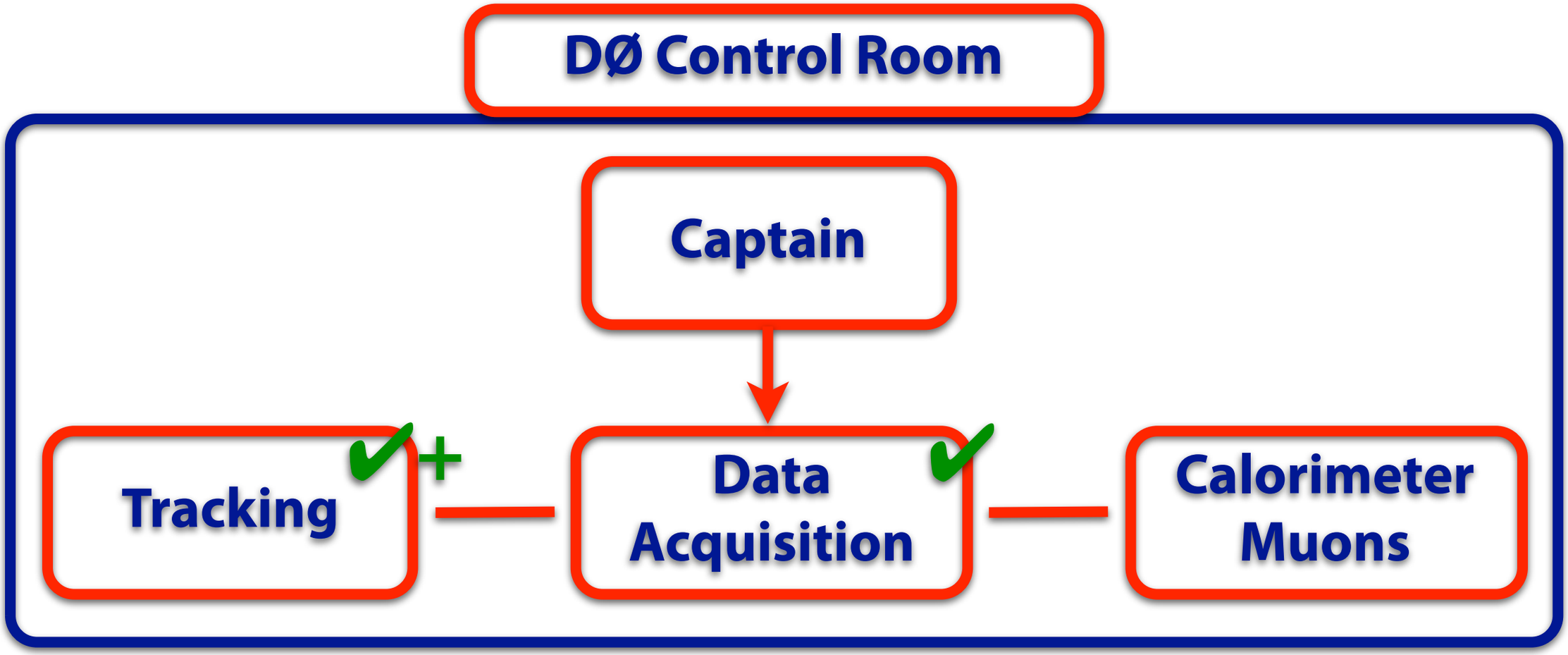
DØ Detector Operations



DØ Detector Operations



DØ Detector Operations



Operations at DØ

Data Acquisition

Operations at DØ

Data Acquisition →

- **700+ hrs.**

Operations at DØ

Data Acquisition →

- 700+ hrs.
- Training

Operations at DØ

Data Acquisition →

- 700+ hrs.
- Training
- Resources of information

Operations at DØ

Data Acquisition →

- 700+ hrs.
- Training
- Resources of information

Tracking

Operations at DØ

Data Acquisition →

- 700+ hrs.
- Training
- Resources of information

Tracking →

- 500+ hrs.

Operations at DØ

Data Acquisition →

- 700+ hrs.
- Training
- Resources of information

Tracking →

- 500+ hrs.
- In charge of four subsystems

Operations at DØ

Data Acquisition →

- 700+ hrs.
- Training
- Resources of information

Tracking →

- 500+ hrs.
- In charge of four subsystems

↓

SMT Expert

Operations at DØ

Data Acquisition →

- 700+ hrs.
- Training
- Resources of information

Tracking →

- 500+ hrs.
- In charge of four subsystems

↓

SMT Expert →

- Availability around the clock

Operations at DØ

Data Acquisition →

- 700+ hrs.
- Training
- Resources of information

Tracking →

- 500+ hrs.
- In charge of four subsystems

↓

SMT Expert →

- Availability around the clock
- Nine weeks as primary expert

Operations at DØ

Data Acquisition →

- 700+ hrs.
- Training
- Resources of information

Tracking →

- 500+ hrs.
- In charge of four subsystems

↓

SMT Expert →

- Availability around the clock
- Nine weeks as primary expert
- Training of new shifters

Operations at DØ

Data Acquisition →

- 700+ hrs.
- Training
- Resources of information

Tracking →

- 500+ hrs.
- In charge of four subsystems

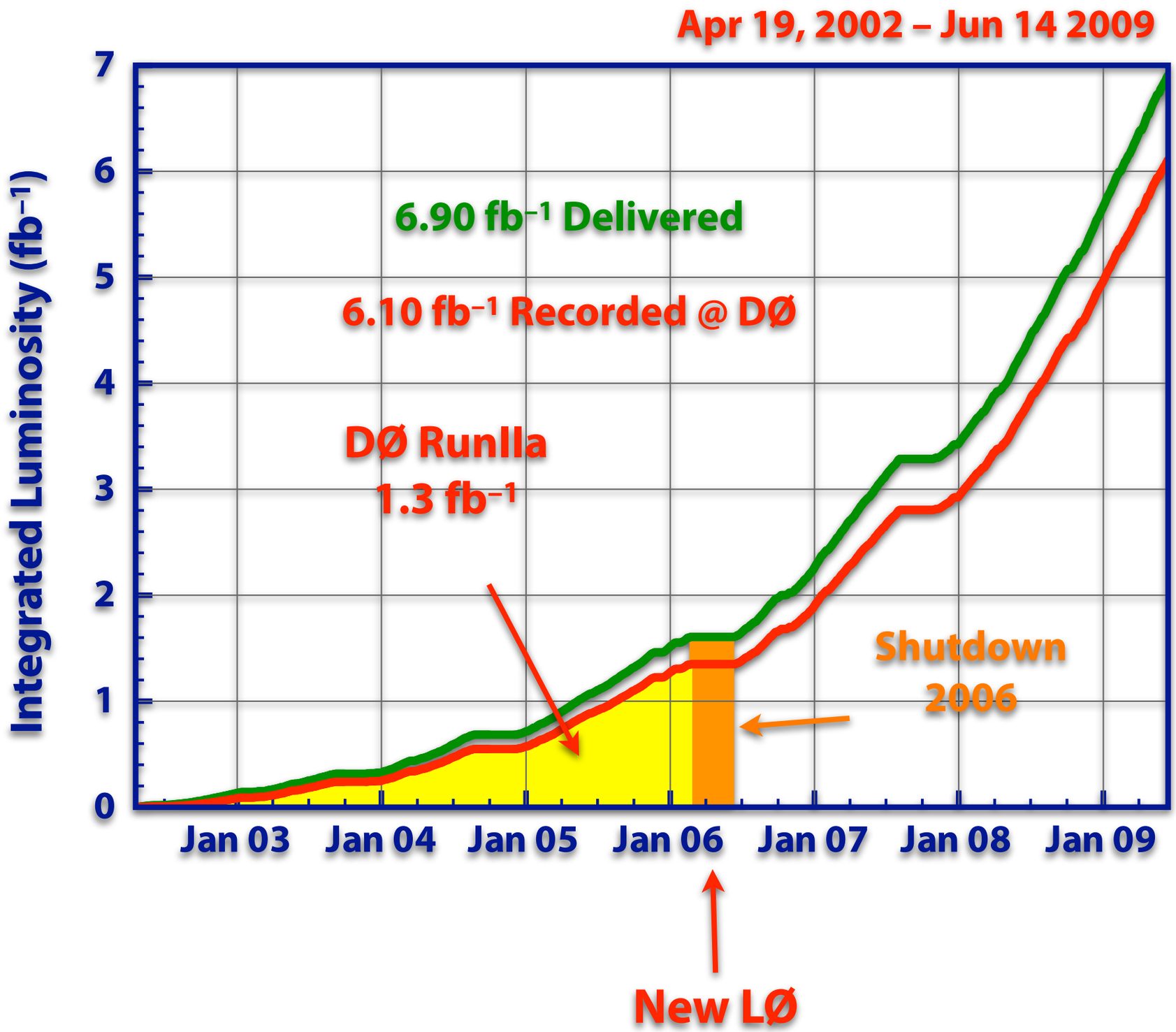
↓

SMT Expert →

- Availability around the clock
- Nine weeks as primary expert
- Training of new shifters
- Hardware testing and general support

Analysis
(thesis)

Tevatron RunII



Tevatron & b–Baryon Observation

Currently the only place to look for $b-$Baryons

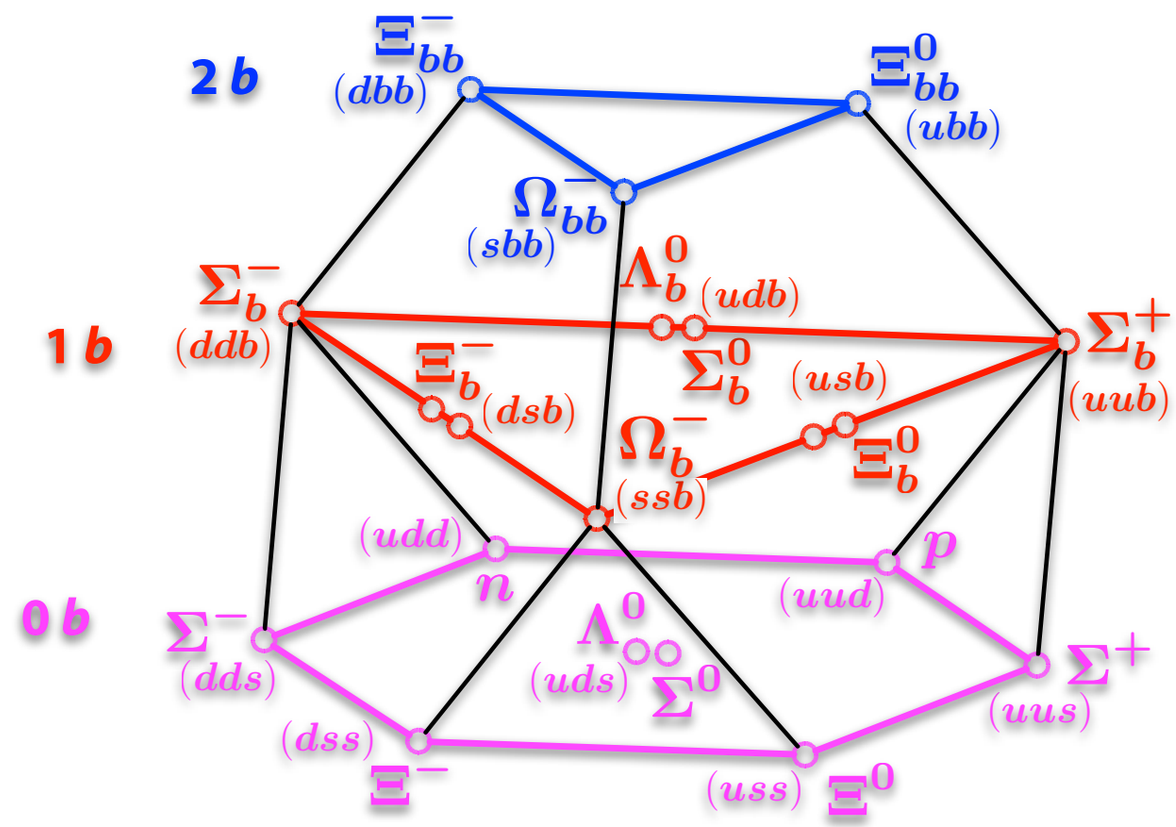
Before Tevatron RunII

Λ_b^0

Tevatron RunII Since 2002

Σ_b^+ & Σ_b^{*+} CDF, 2006[1]

Ξ_b^- DØ and CDF, 2007[2]

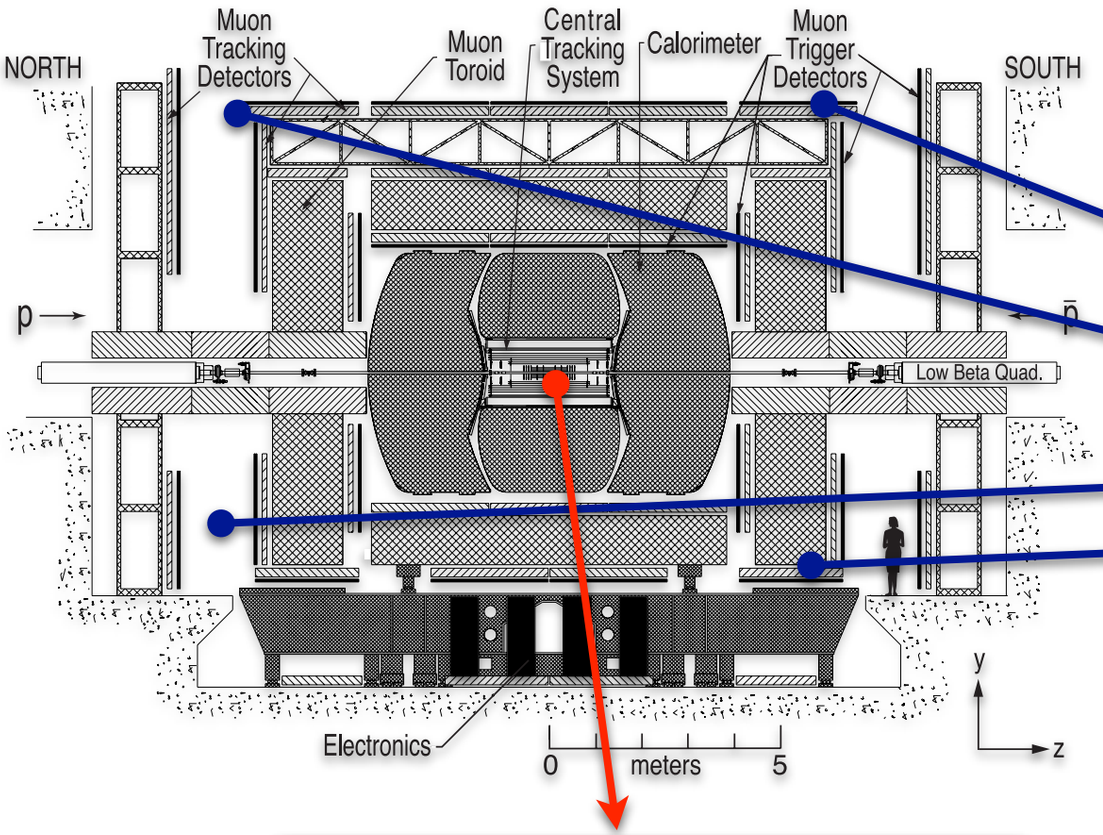


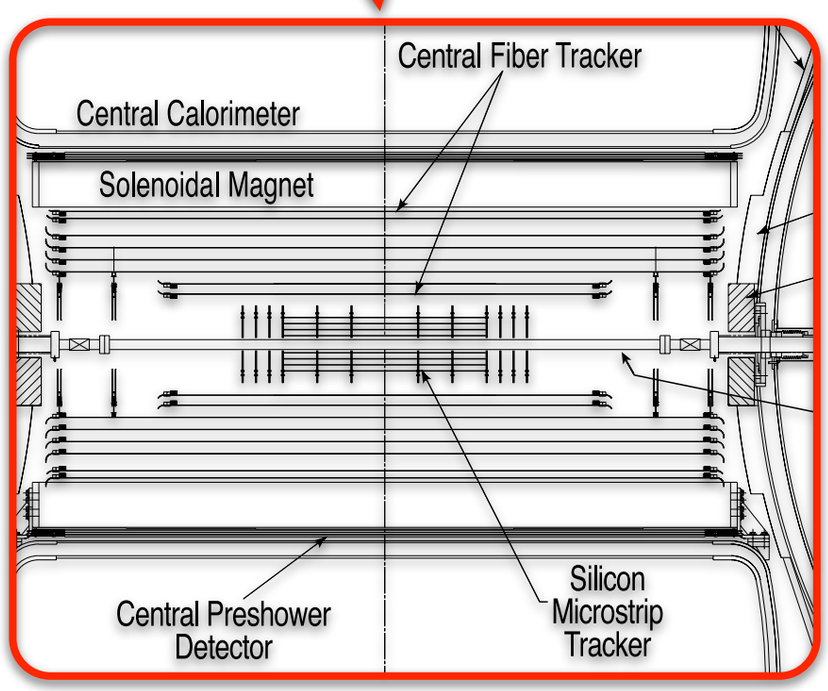
[1] Phys. Rev. Lett. **99**, 202001 (2007)

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

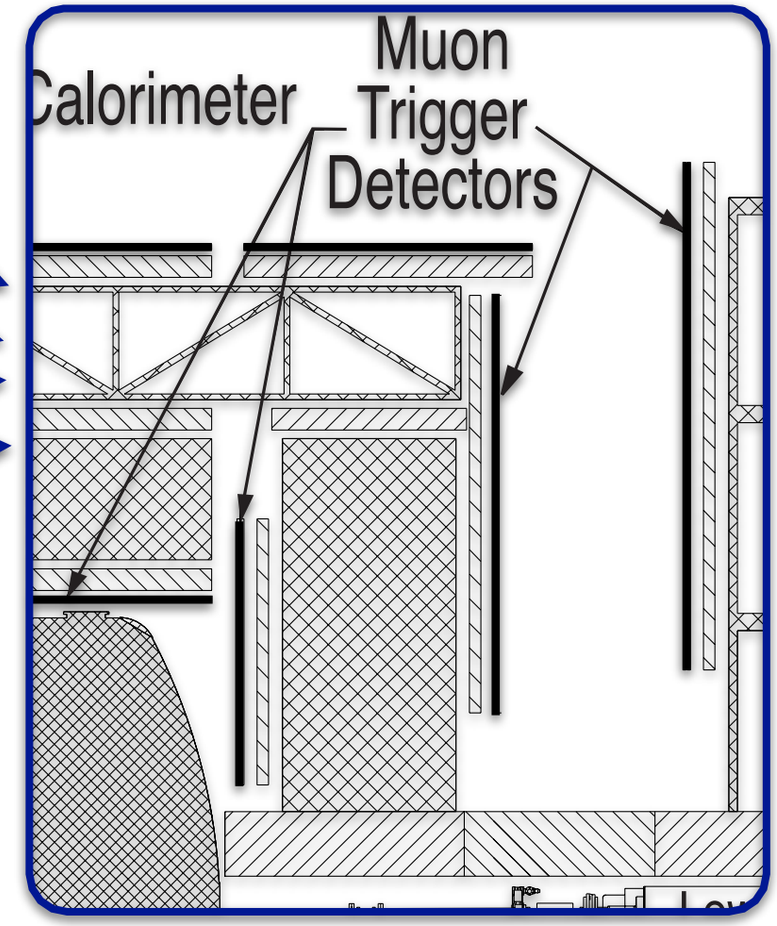
Phys. Rev. Lett. **99**, 052002 (2007)

DØ Detector





Central Tracking System



Muon System

Decay Channel

$$\Omega_b^- \to \overbrace{J/\psi(1S)}^{\mu^+\ \mu^-} \quad \overbrace{\Lambda^0 \quad K^-}^{\Omega^-}$$

$$\underbrace{p\ \pi^-}_{\Lambda^0}$$

Decay Channel

$$\Omega_b^- \to \overbrace{J/\psi(1S)}^{\mu^+\ \mu^-} \quad \overbrace{\Lambda^0 \quad K^-}^{\Omega^-}$$

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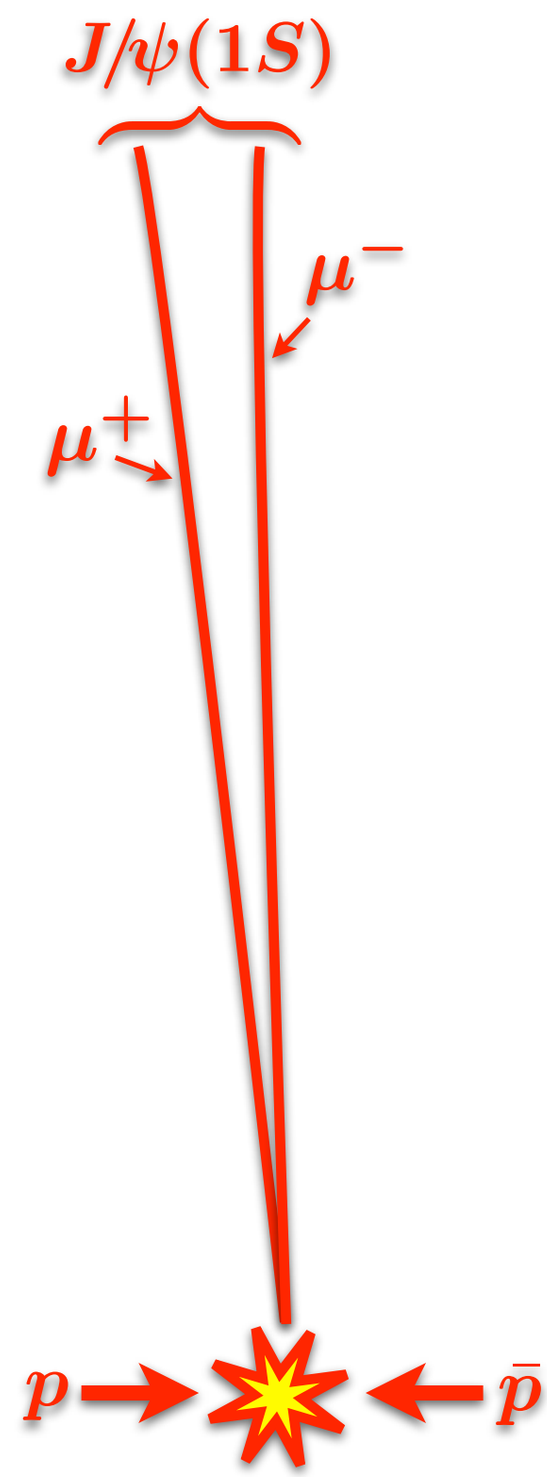

Decay Channel

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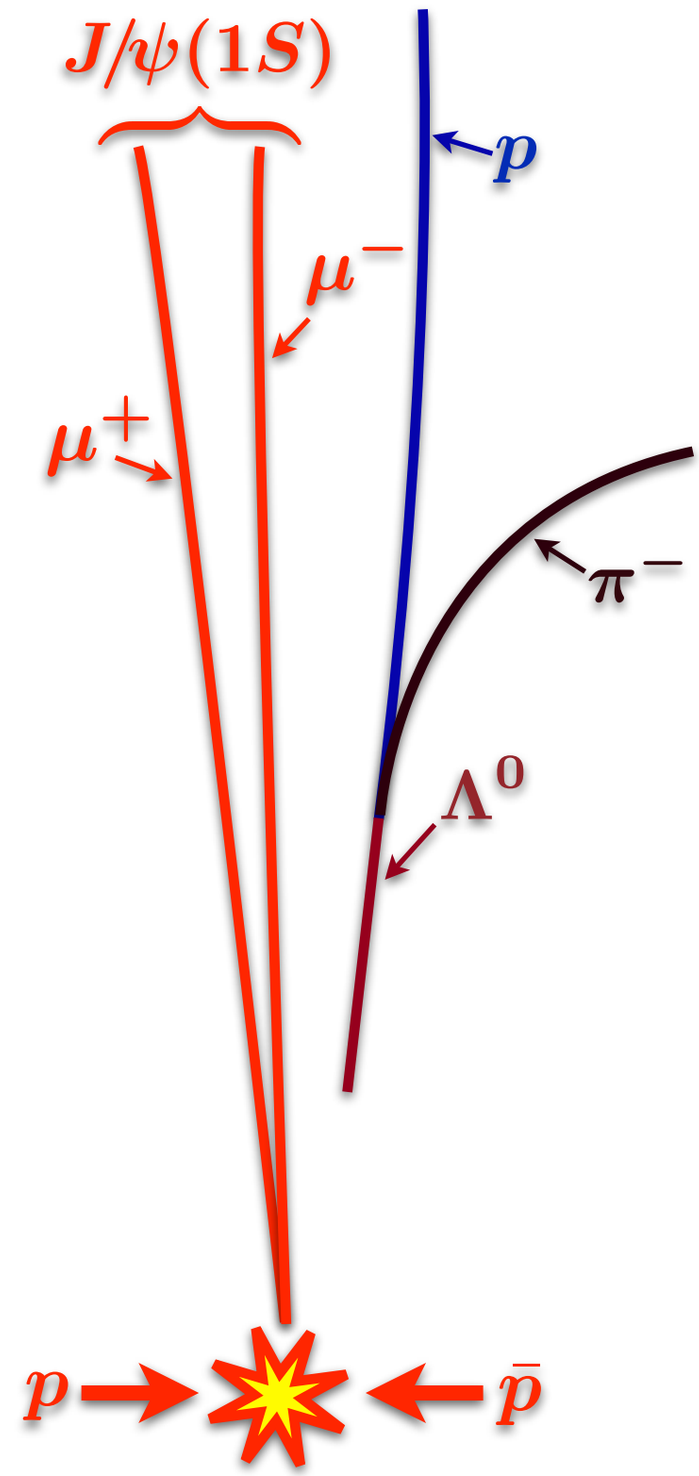

Decay Channel

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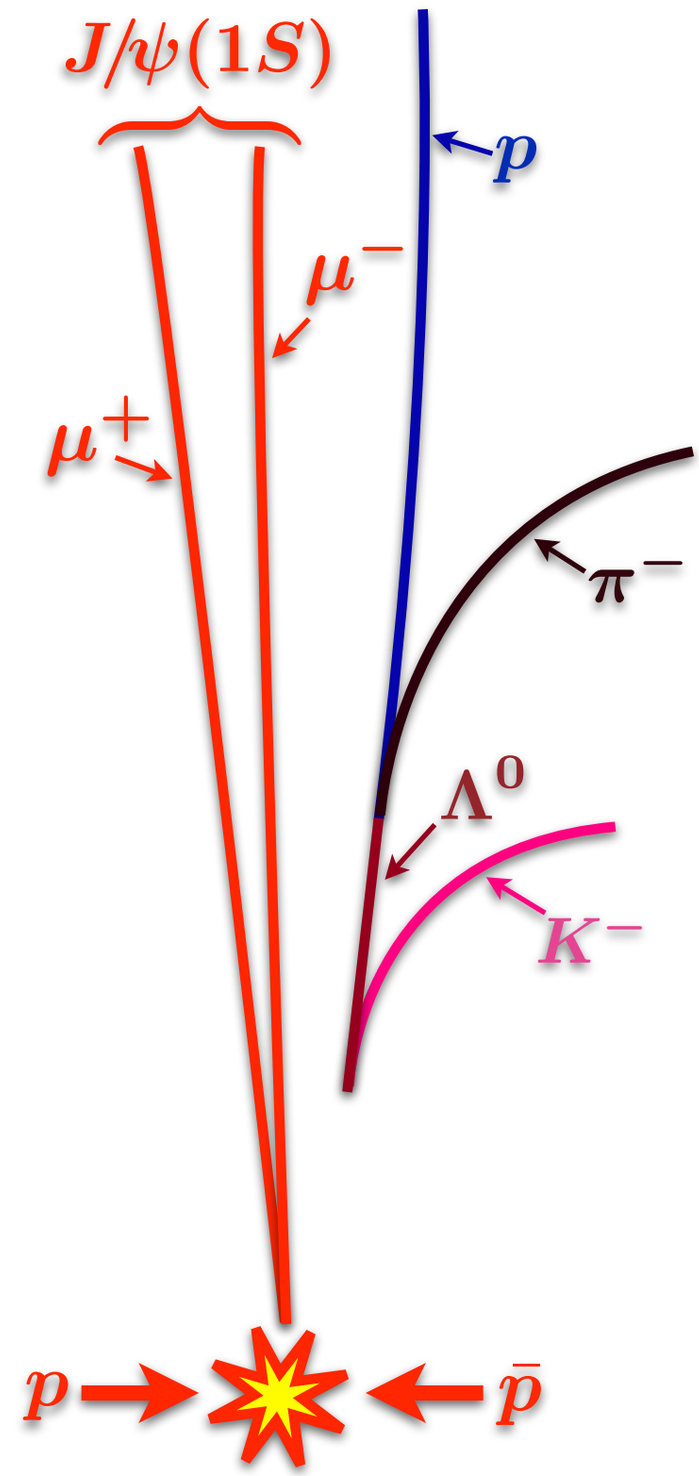

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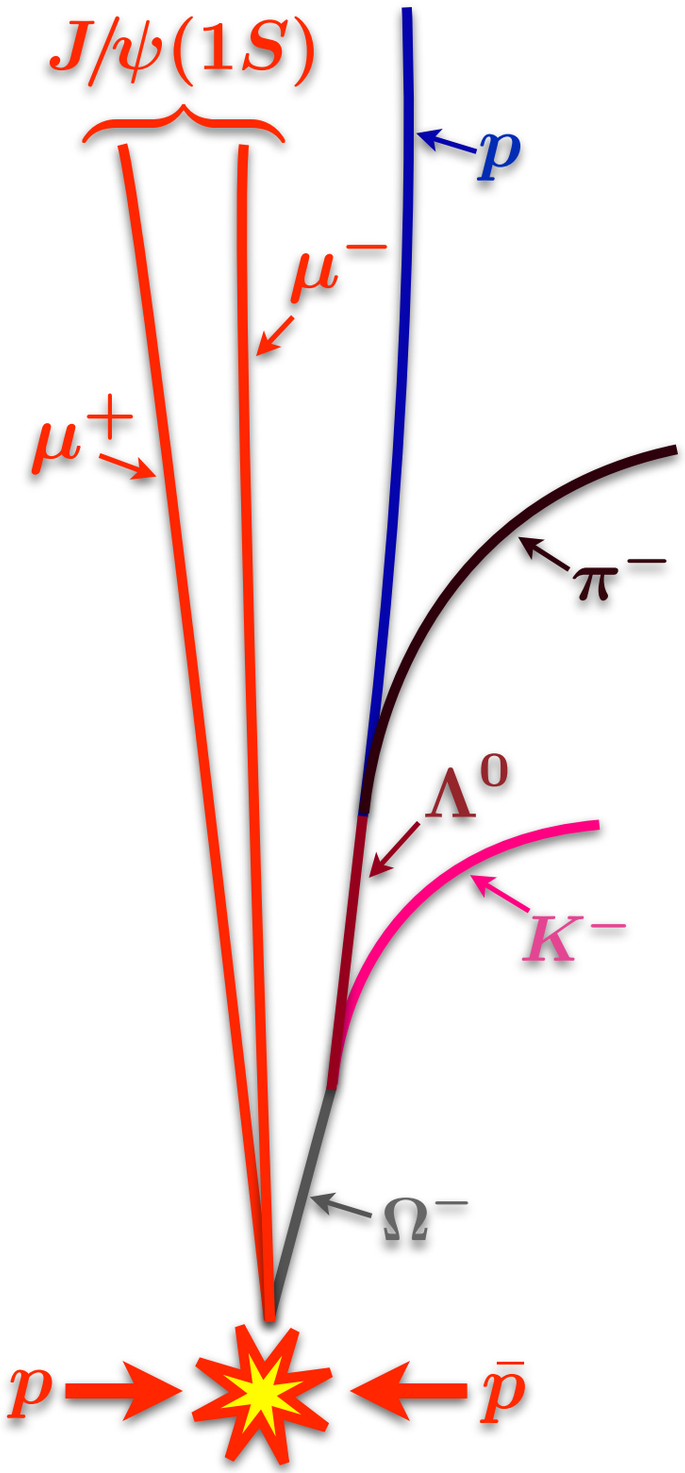

Decay Channel

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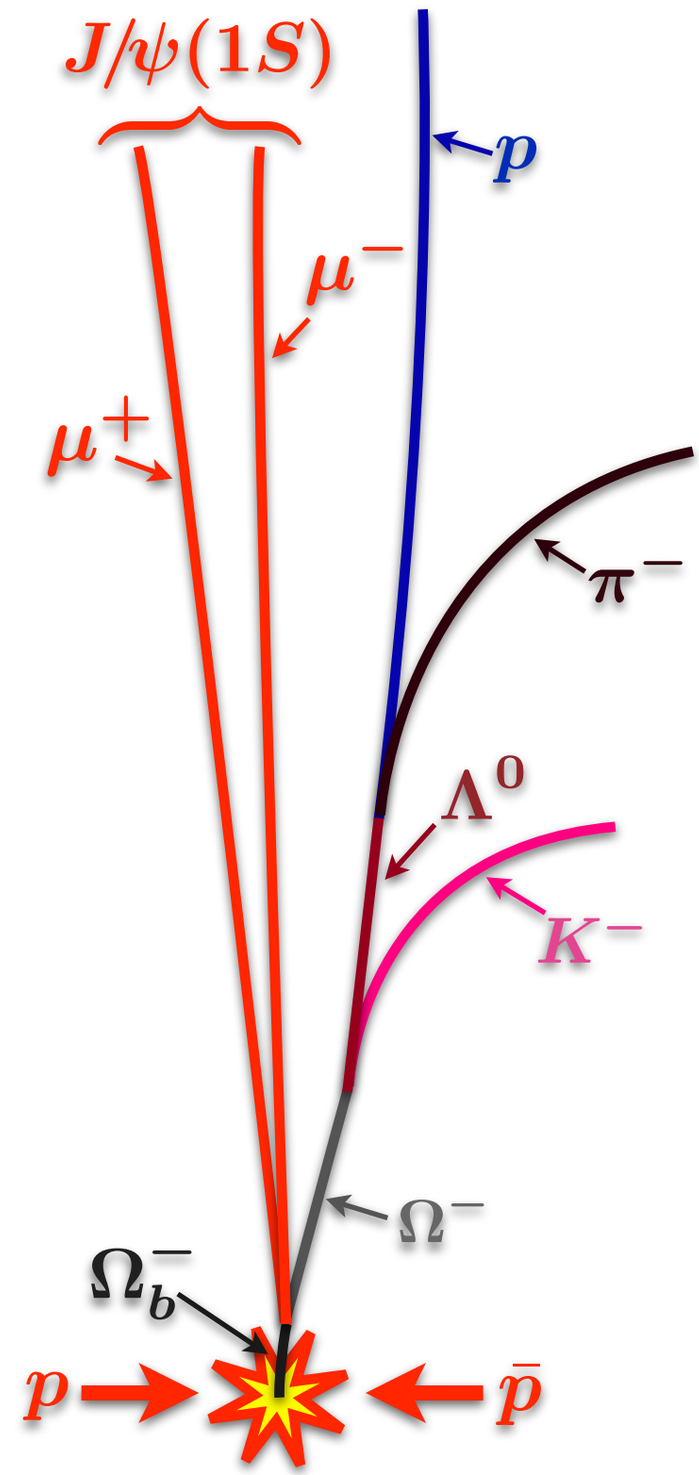
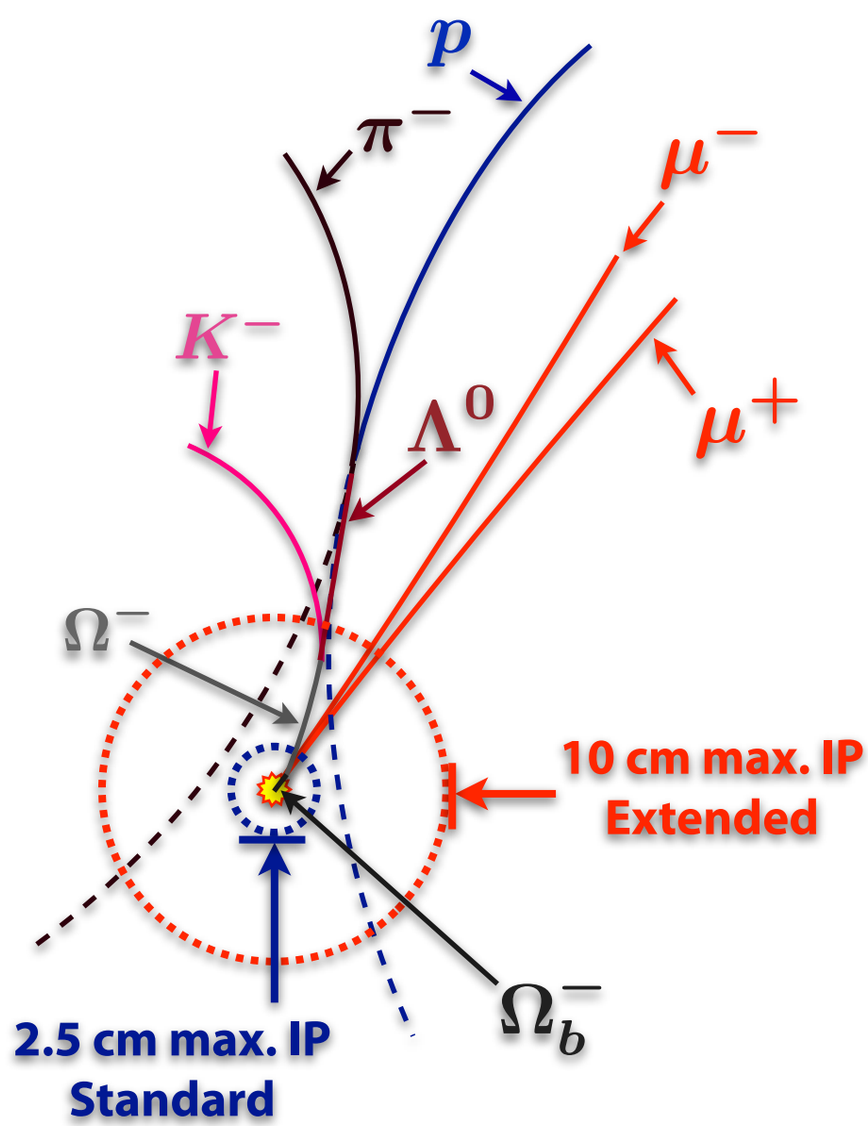
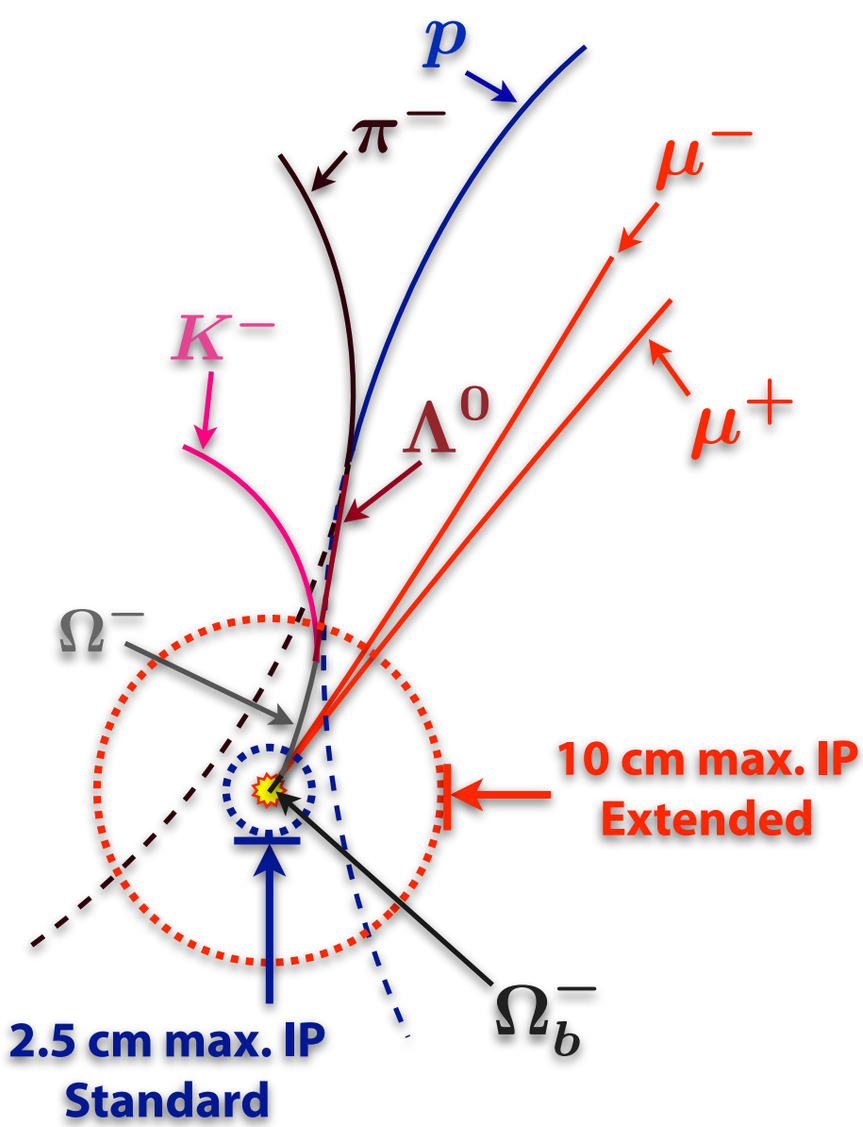


Special Tracking Reconstruction



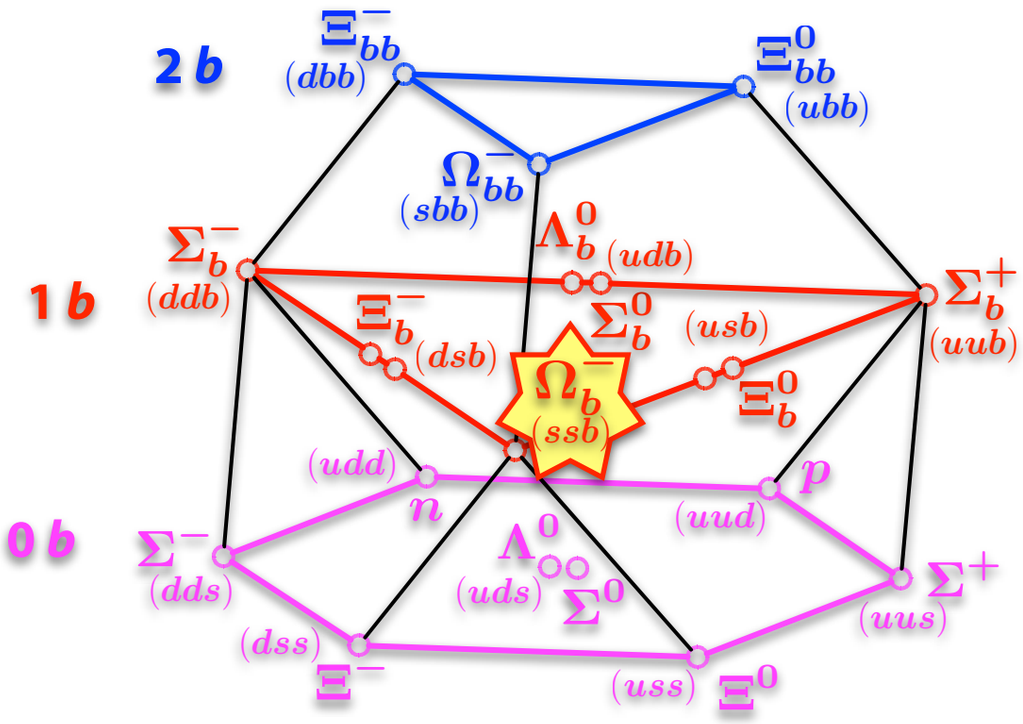
Special Tracking Reconstruction



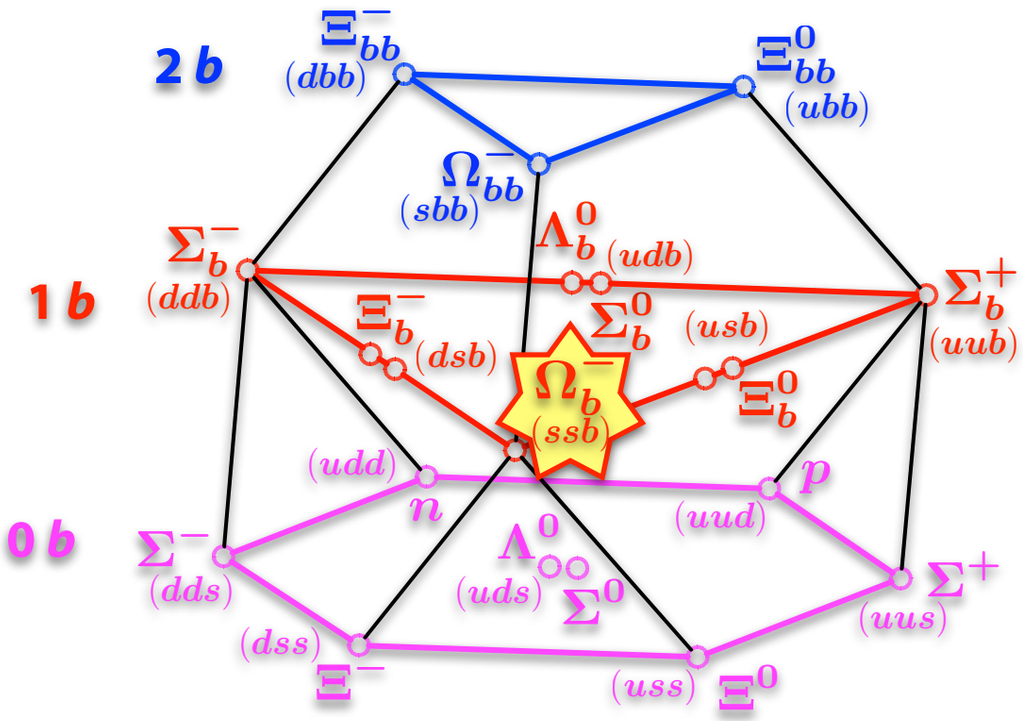
Extending the maximum IP of reconstructed tracks increases the efficiency in the identification of long-lived particles like:

$$\Lambda^0 \longrightarrow p\,\pi^-$$

Ω_b^-


2 b
1 b
0 b
Ξ_{bb}^- (dbb)
Ξ_{bb}^0 (ubb)
Ω_{bb}^- (sbb)
Λ_b^0 (udb)
Σ_b^- (ddb)
Σ_b^+ (uub)
Ξ_b^- (dsb)
Σ_b^0
(usb)
Ξ_b^0
Ω_b^- (ssb)
(udd) n
p (uud)
Σ^- (dds)
Λ^0 (uds)
Σ^0
Σ^+ (uus)
(dss) Ξ^-
(uss) Ξ^0

Ω_b^-



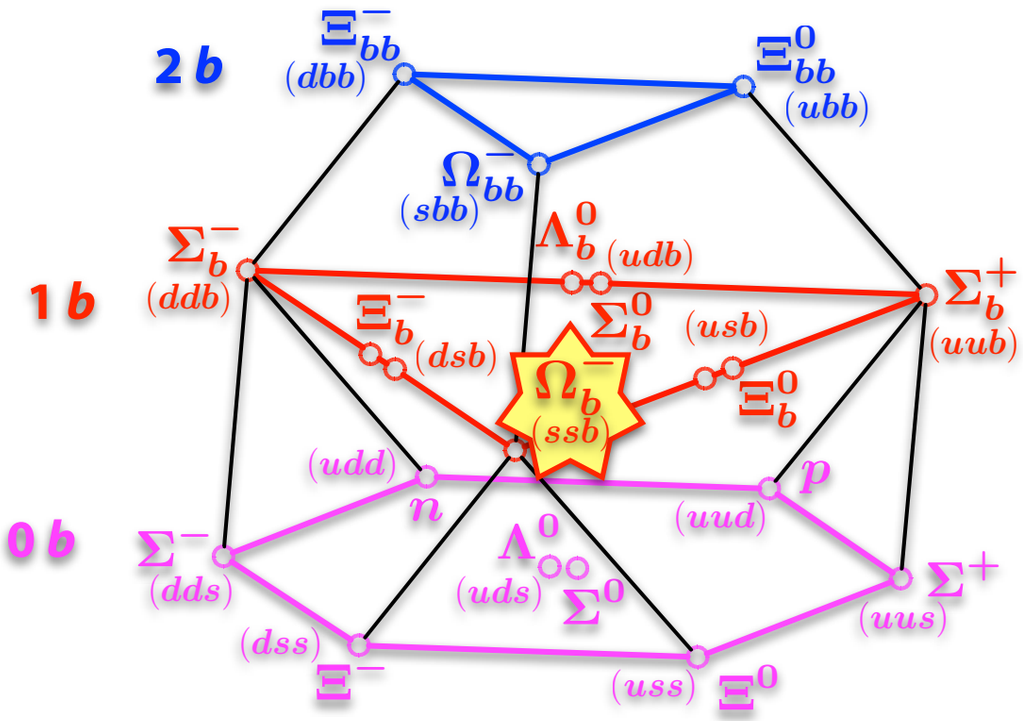
- **Mass predictions (GeV/c^2)[1]**

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

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

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

Ω_b^-



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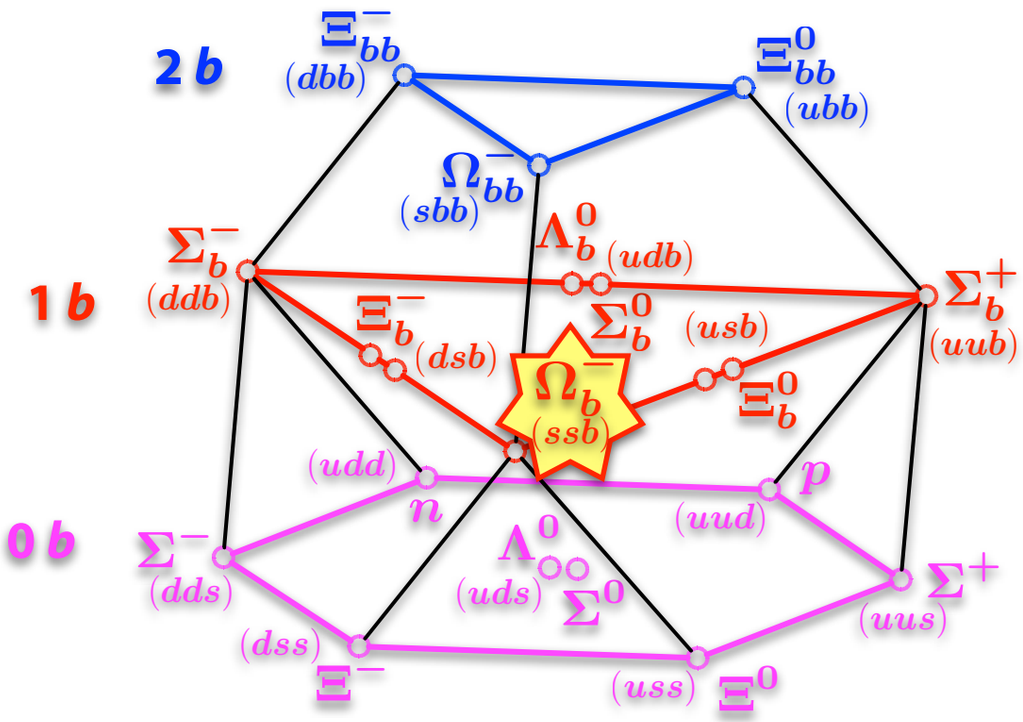
- **Lifetime prediction (ps)[2]**

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

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

[2] arXiv:hep-ph/9705402

Ω_b^-



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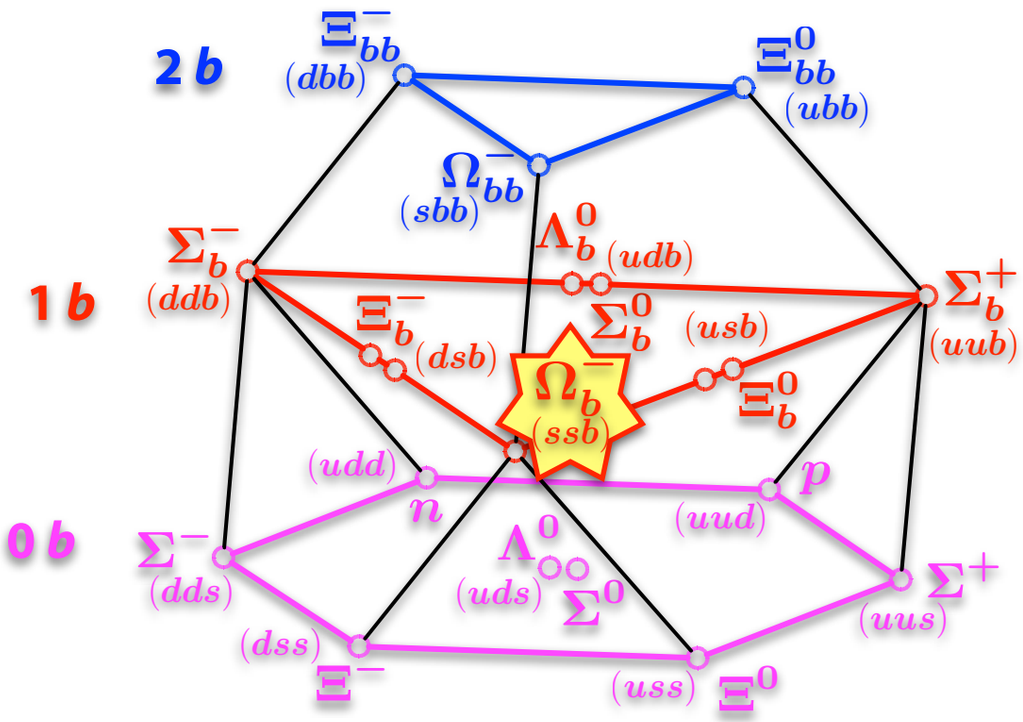
Analysis

Ω_b^-



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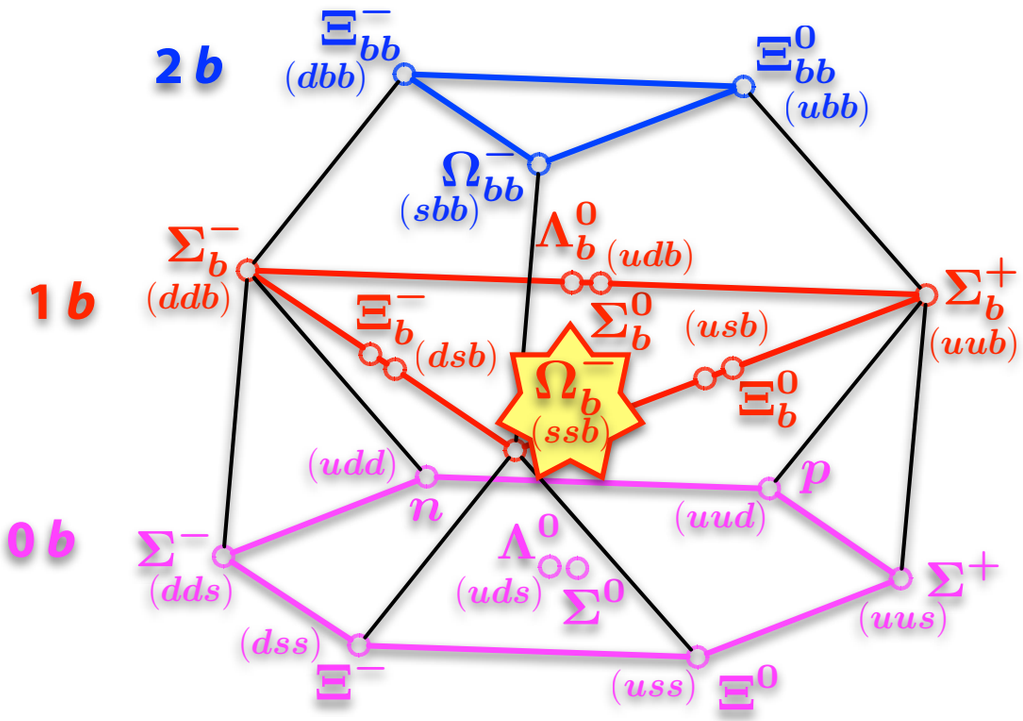
Analysis

Ω_b^-



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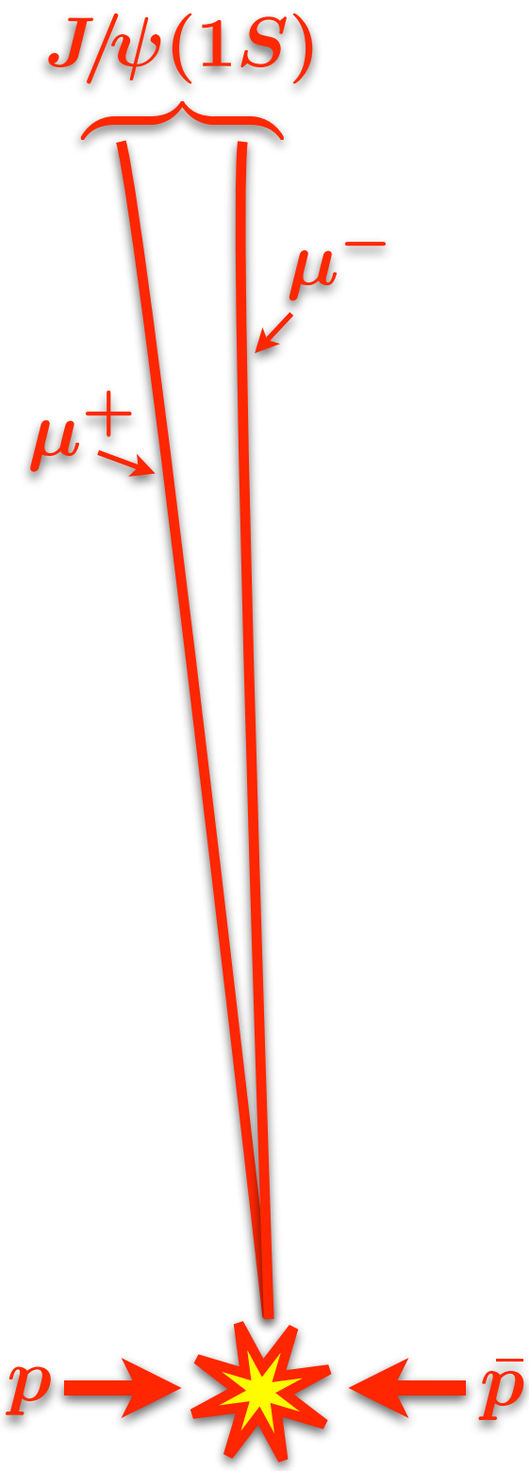
[1] Phys. Rev. D **77**, 014031 (2008)

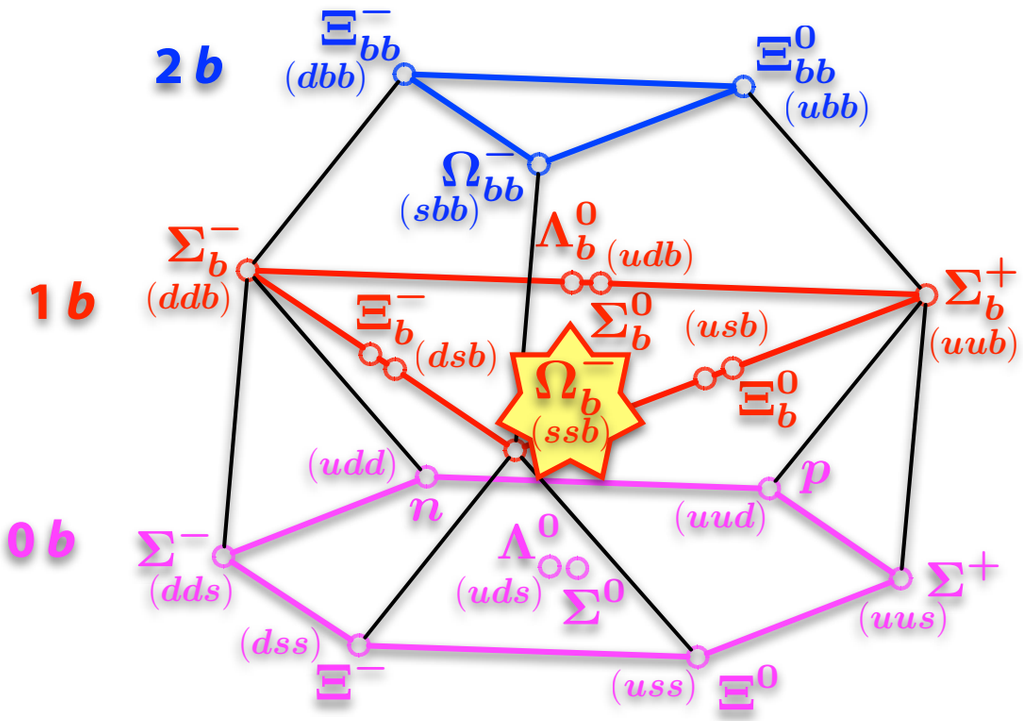
[2] arXiv:hep-ph/9705402

Analysis

- $J/\psi(1S)$ **skim**



Ω_b^-



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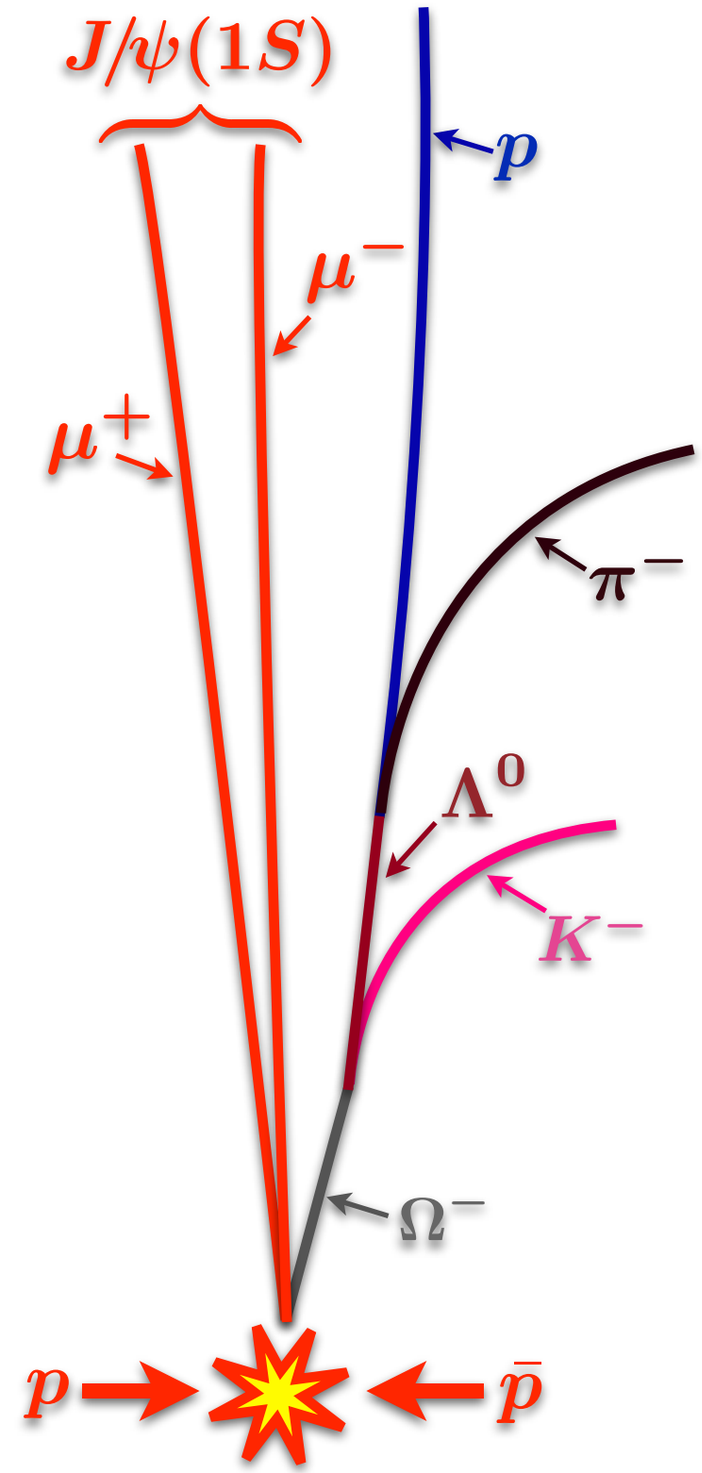
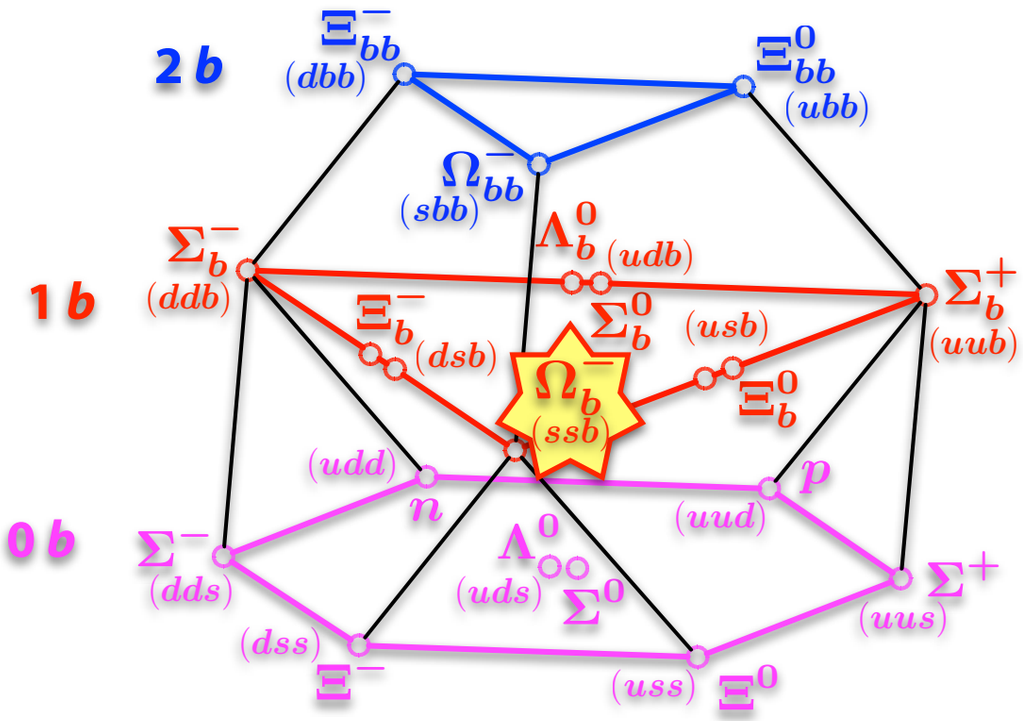
[2] arXiv:hep-ph/9705402

Analysis

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



Ω_b^-



- **Mass predictions (GeV/c^2)[1]**

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

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

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

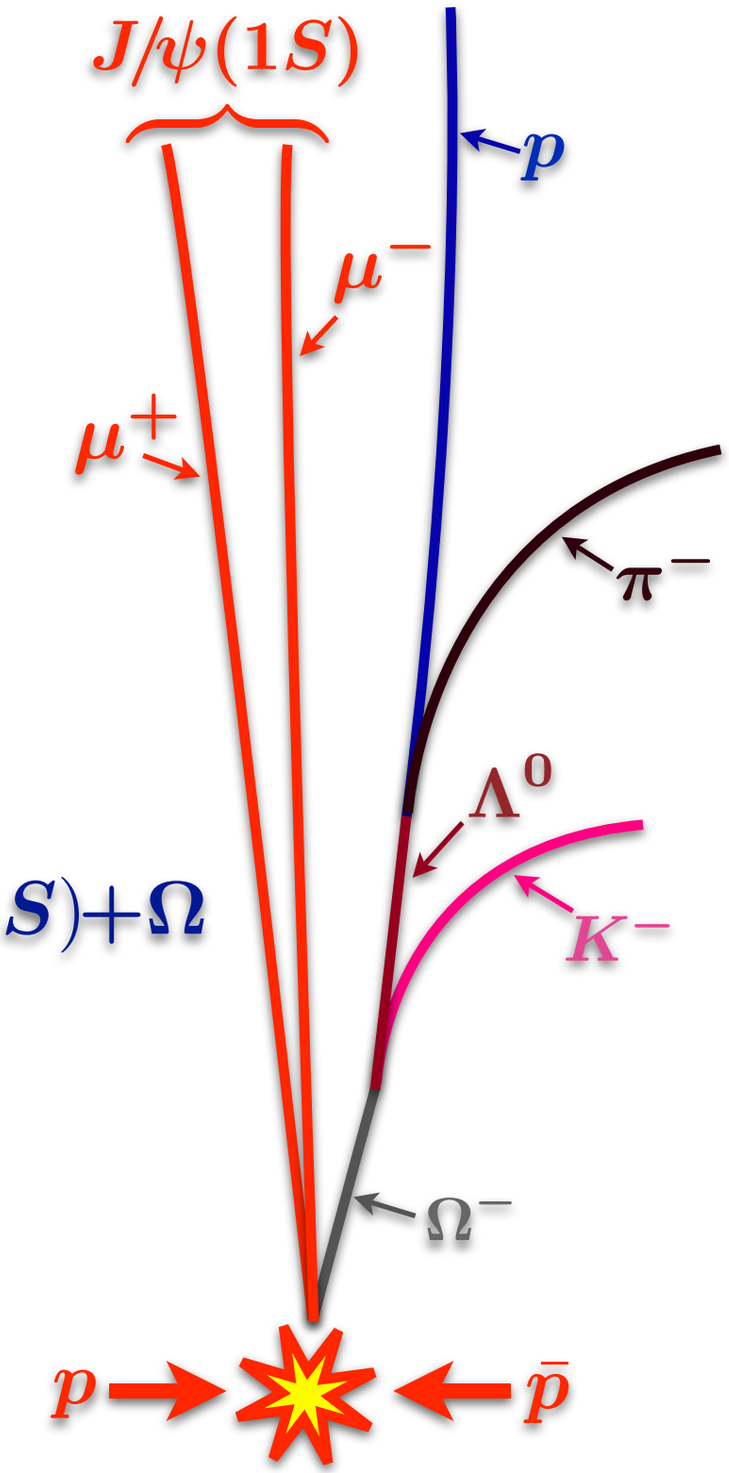
$$0.83 < \tau(\Omega_b^-) < 1.67$$

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

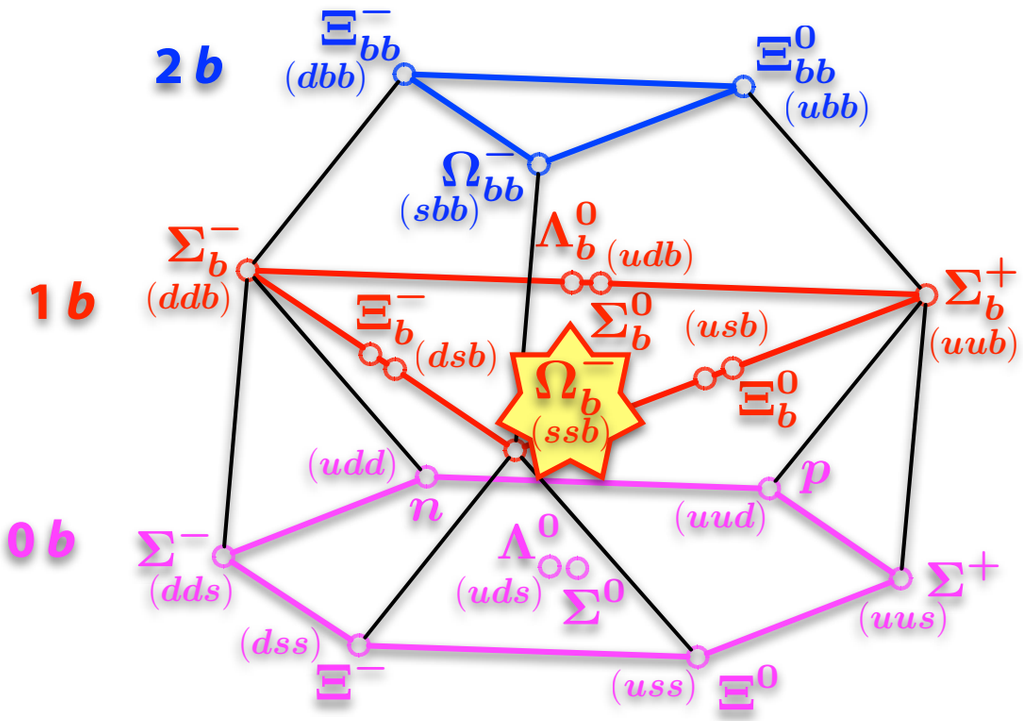
[2] arXiv:hep-ph/9705402

Analysis

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



Ω_b^-



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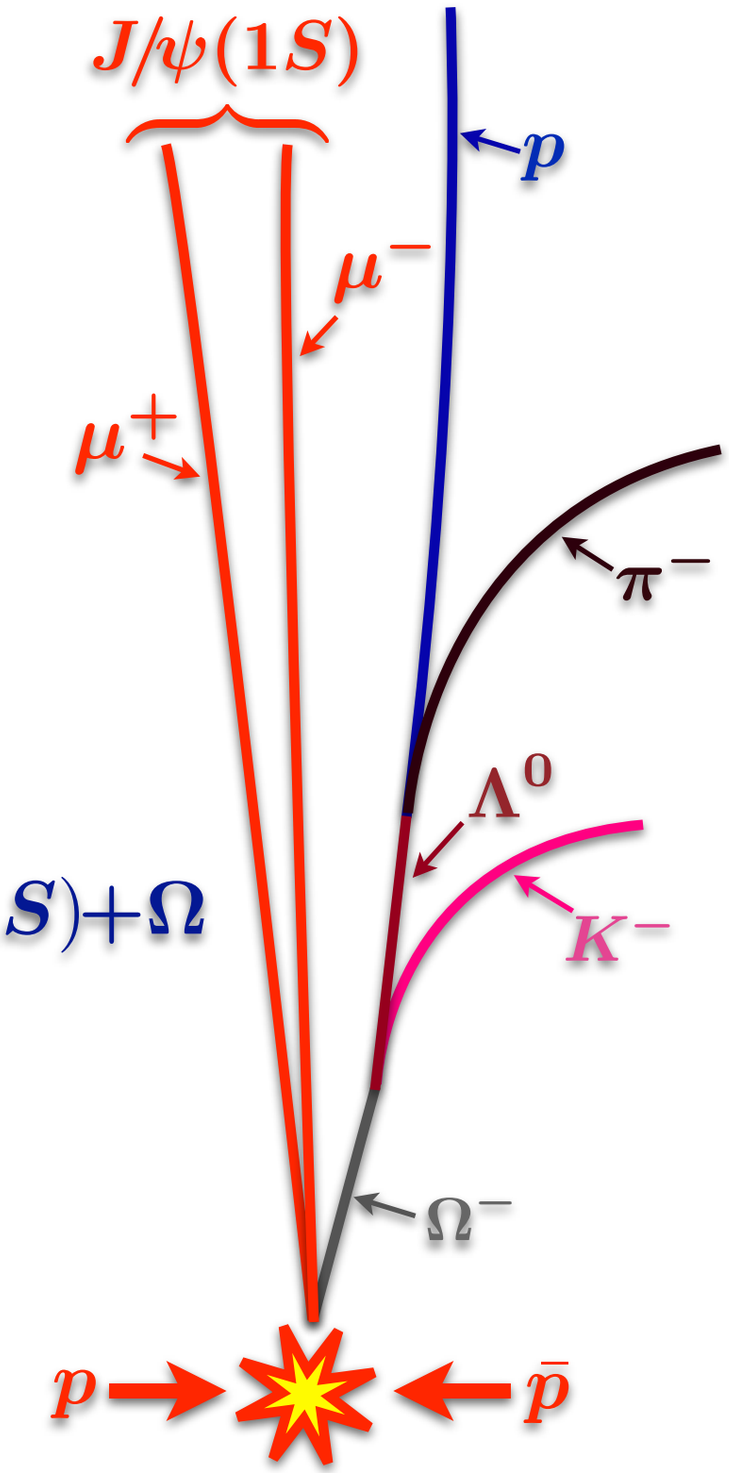
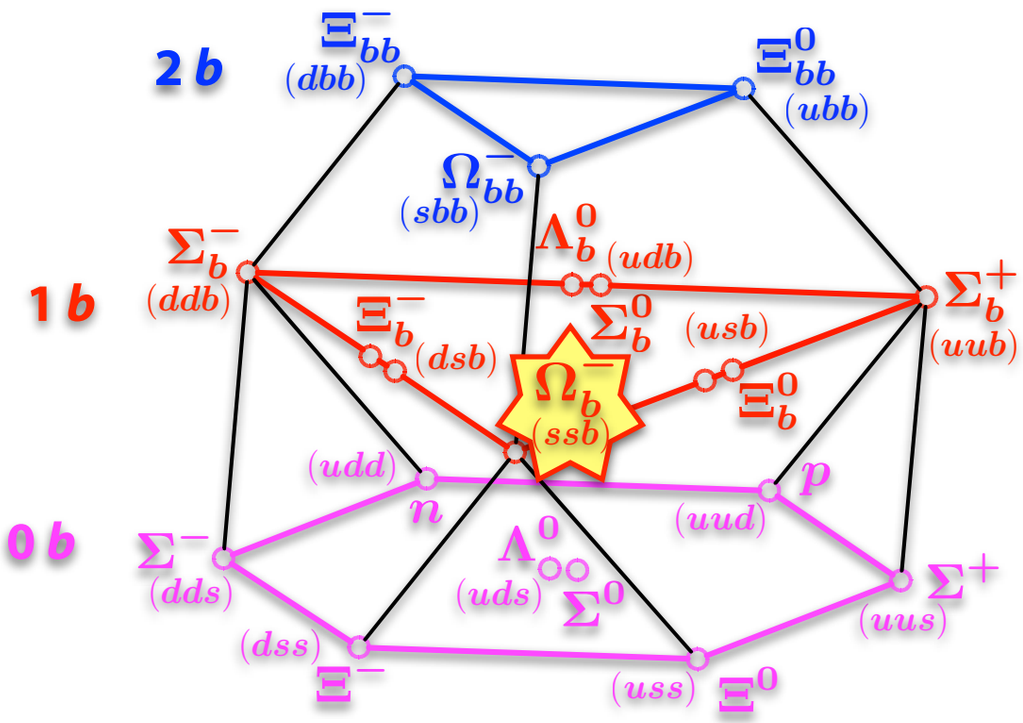
- **Combination** $J/\psi(1S)+\Omega$
- **Validation**



Ω_b^-



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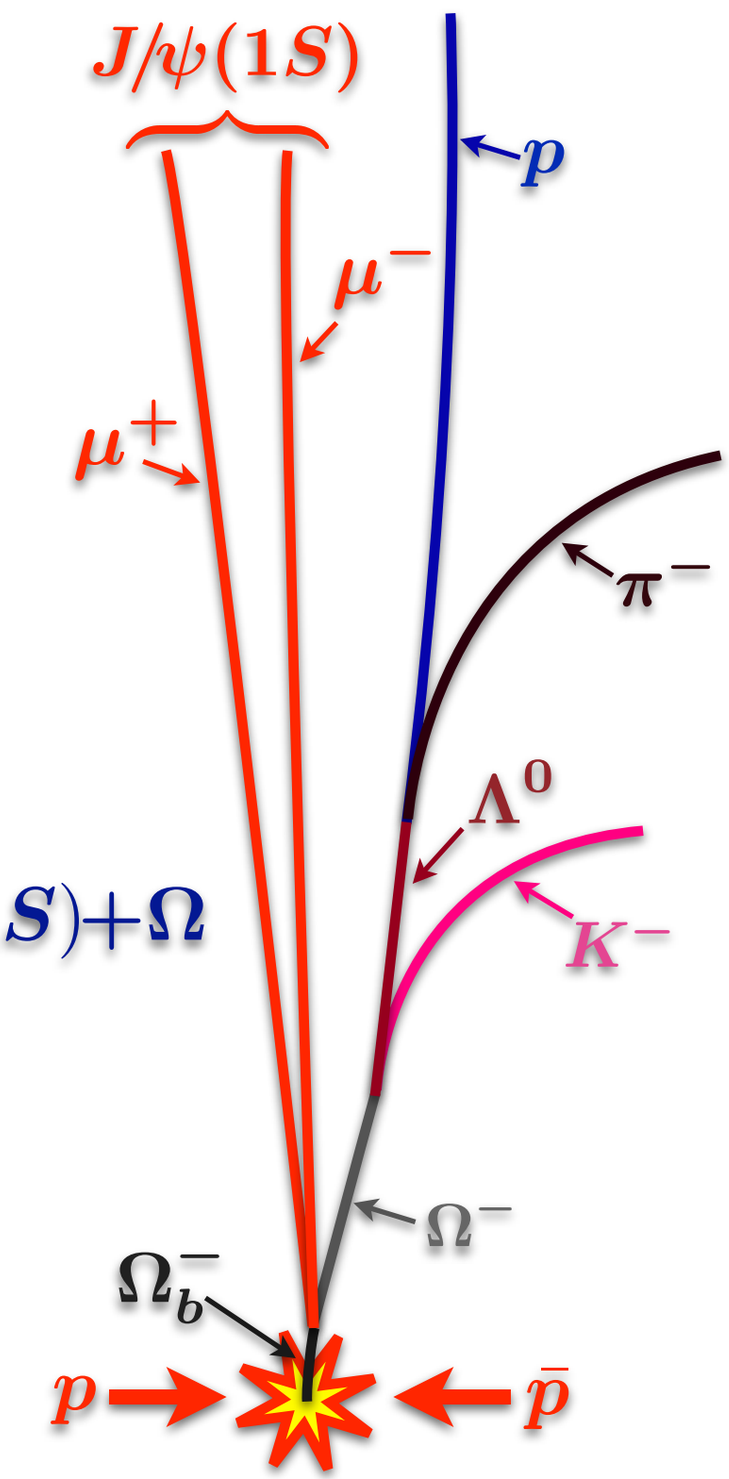
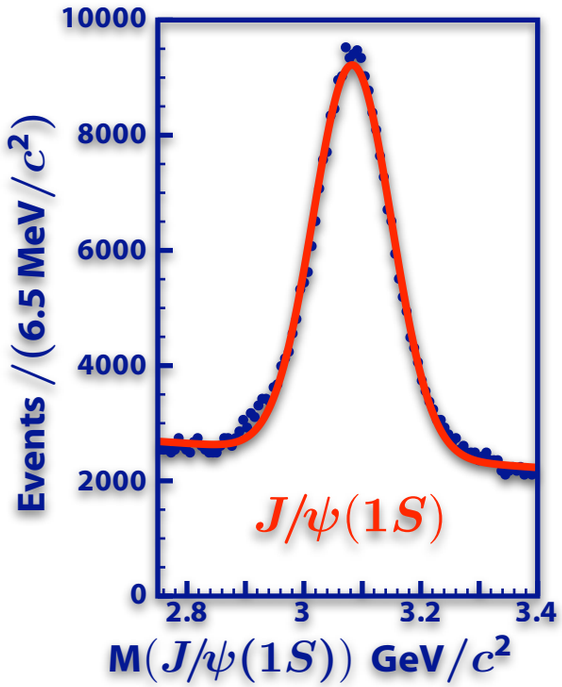
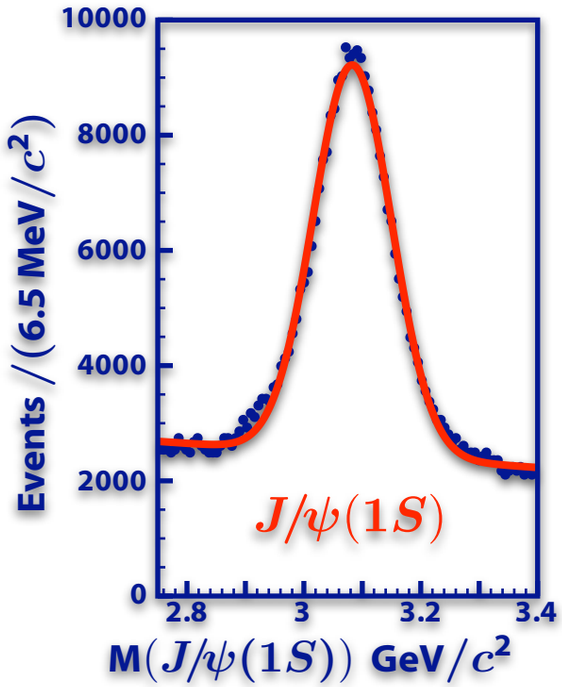
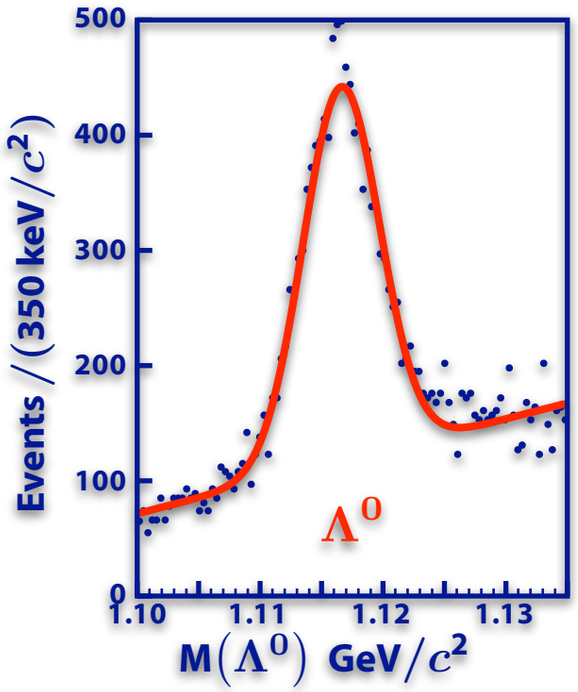


Reconstruction

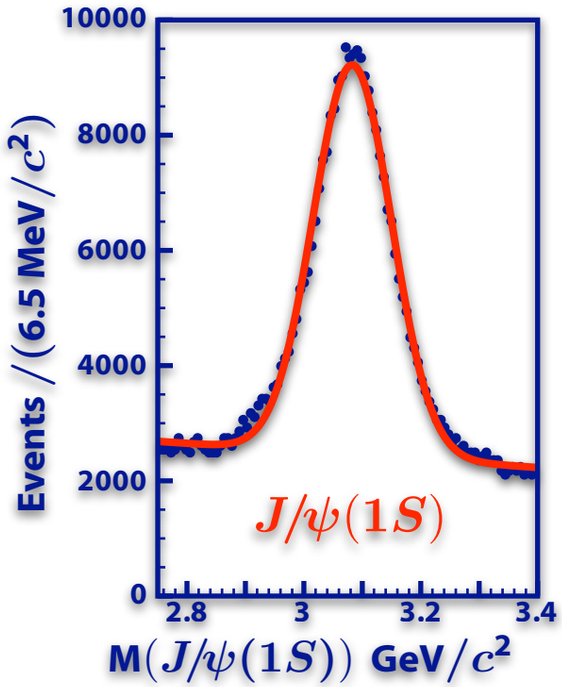


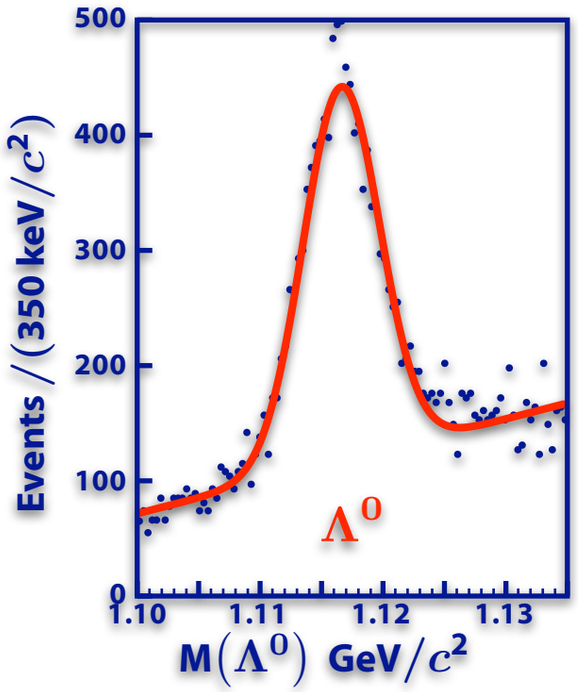
Reconstruction

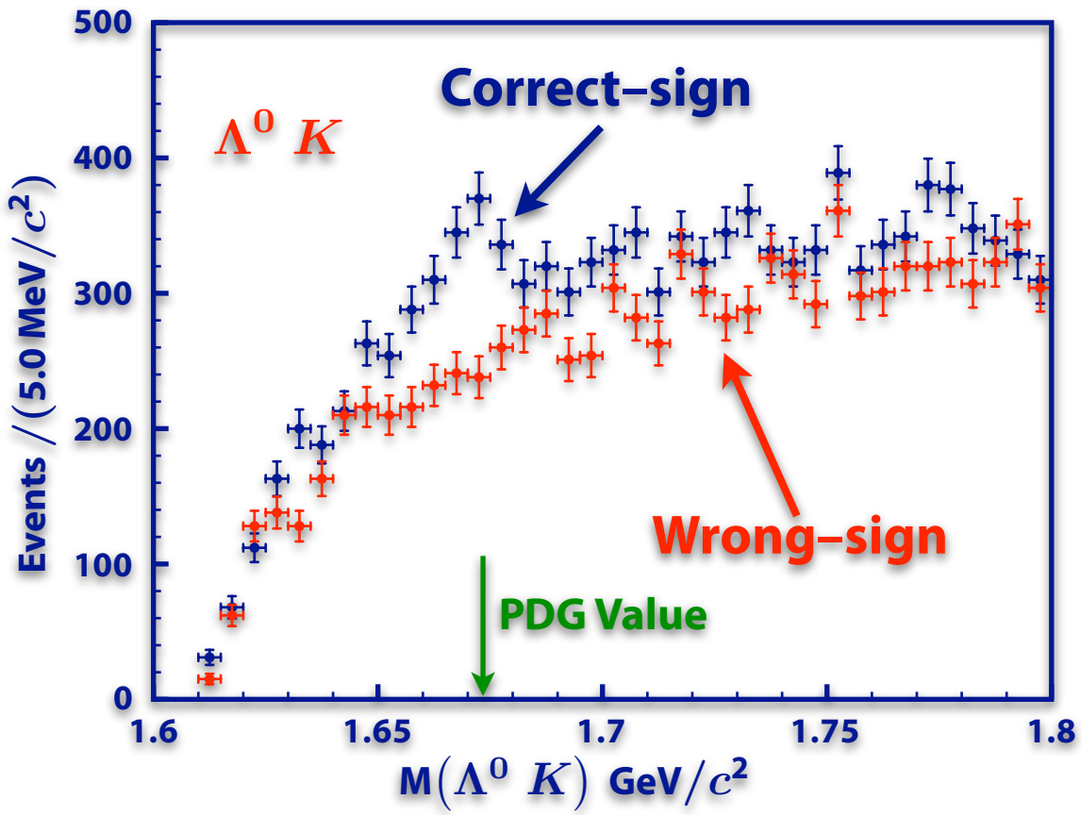




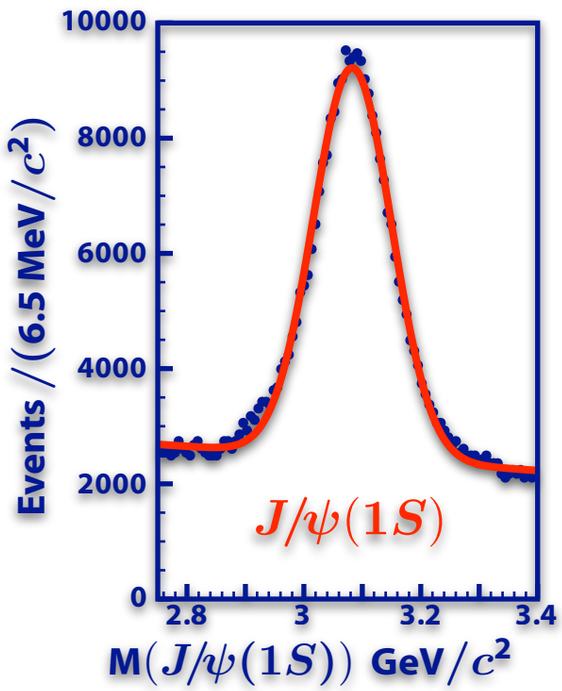
Reconstruction

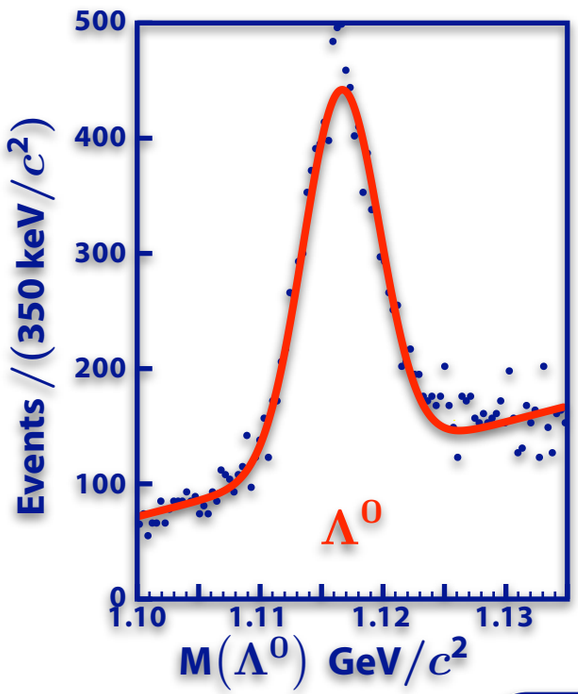


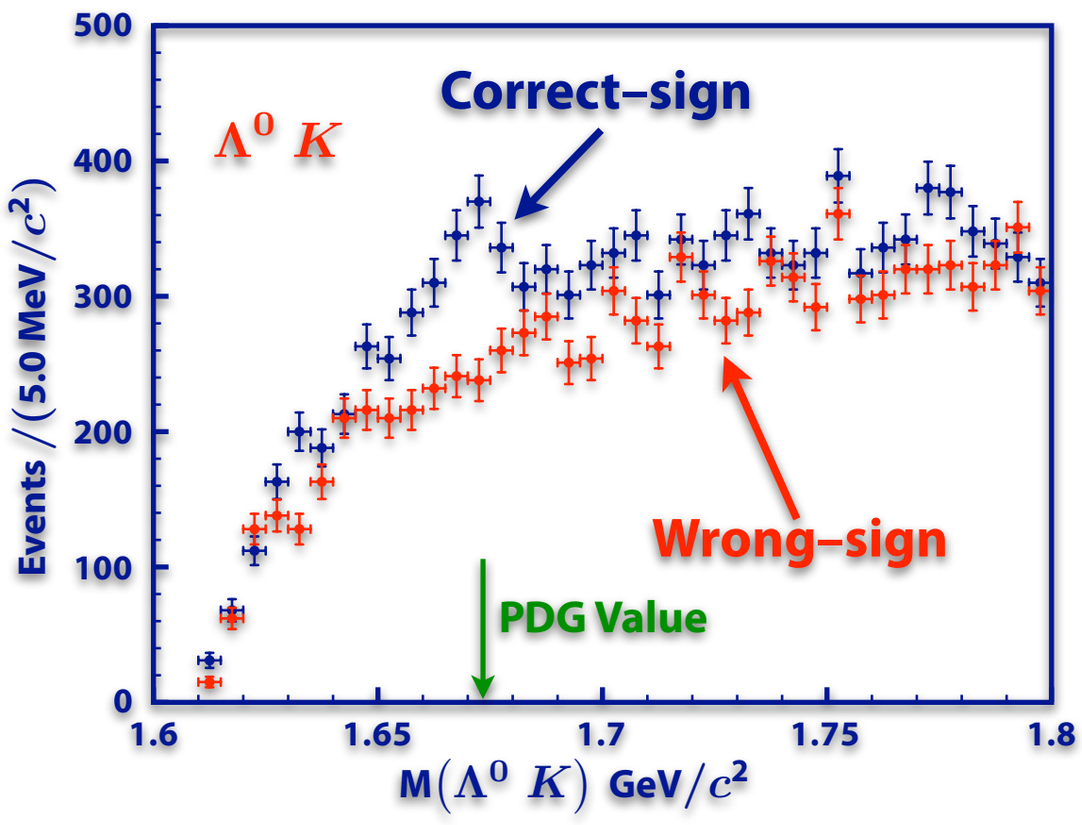


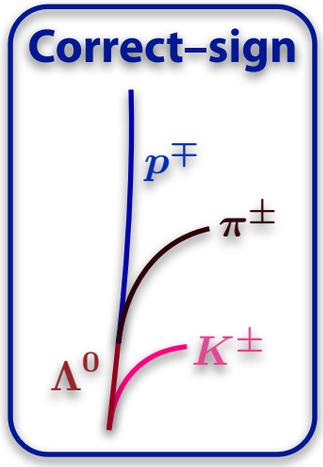


Reconstruction









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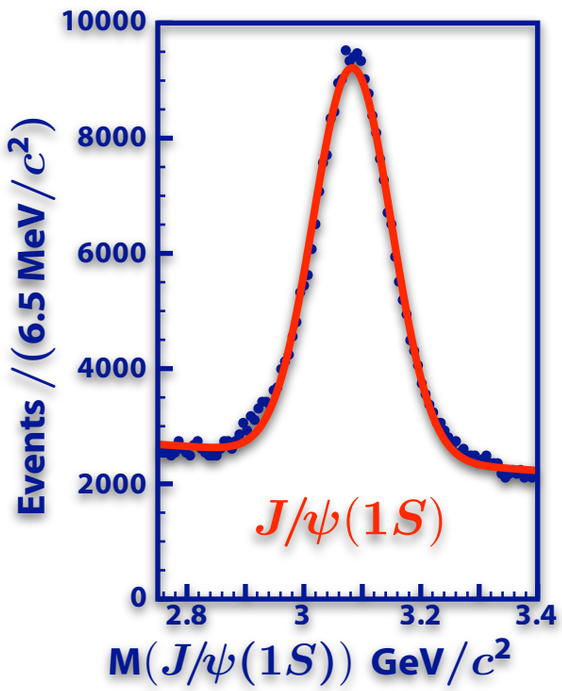

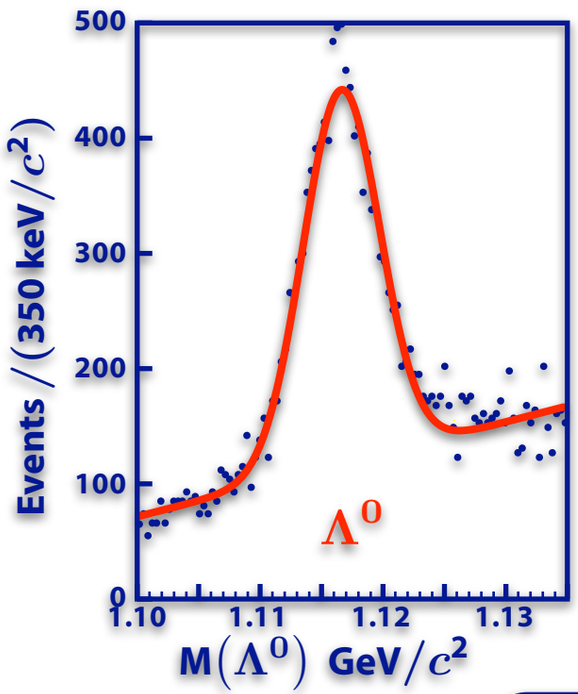

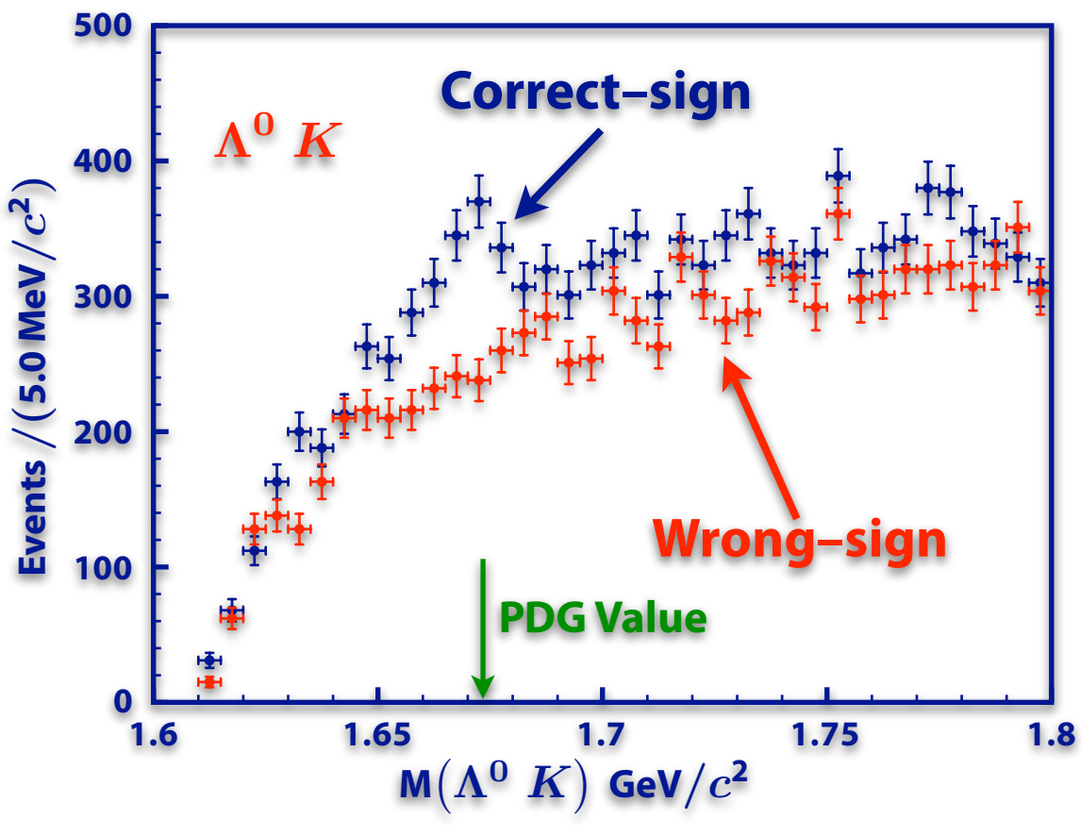

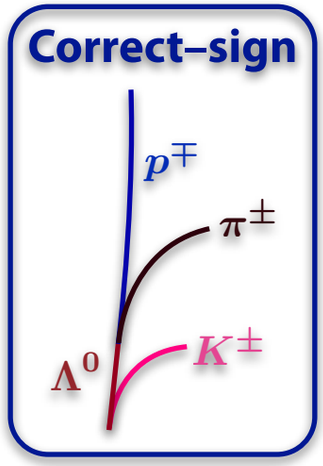

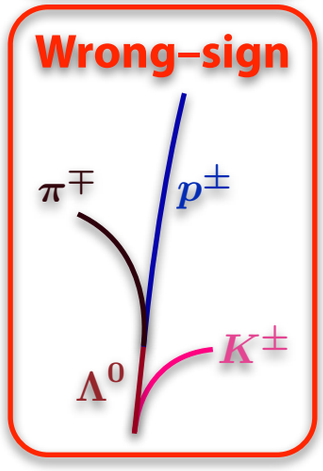

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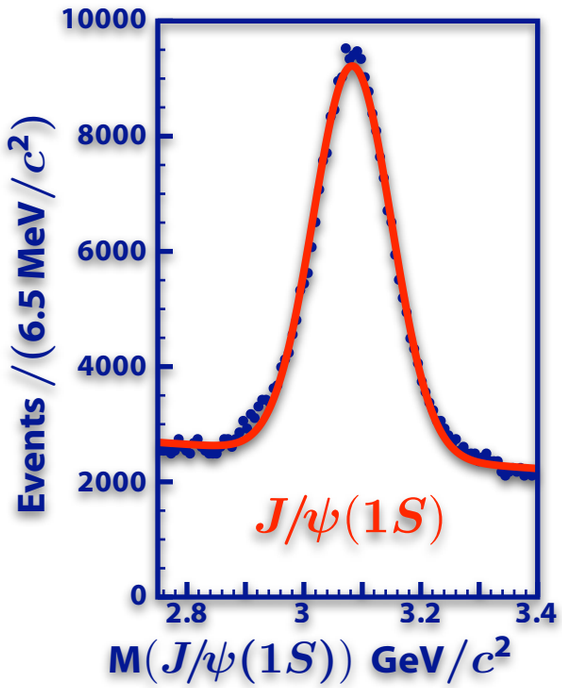

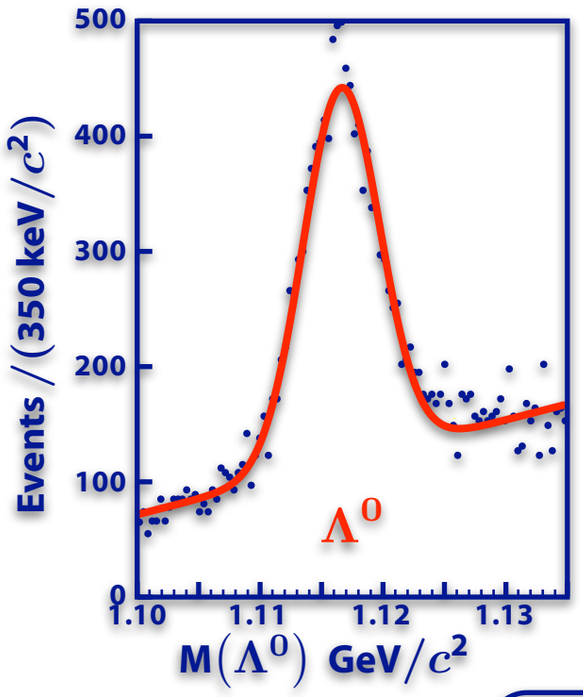

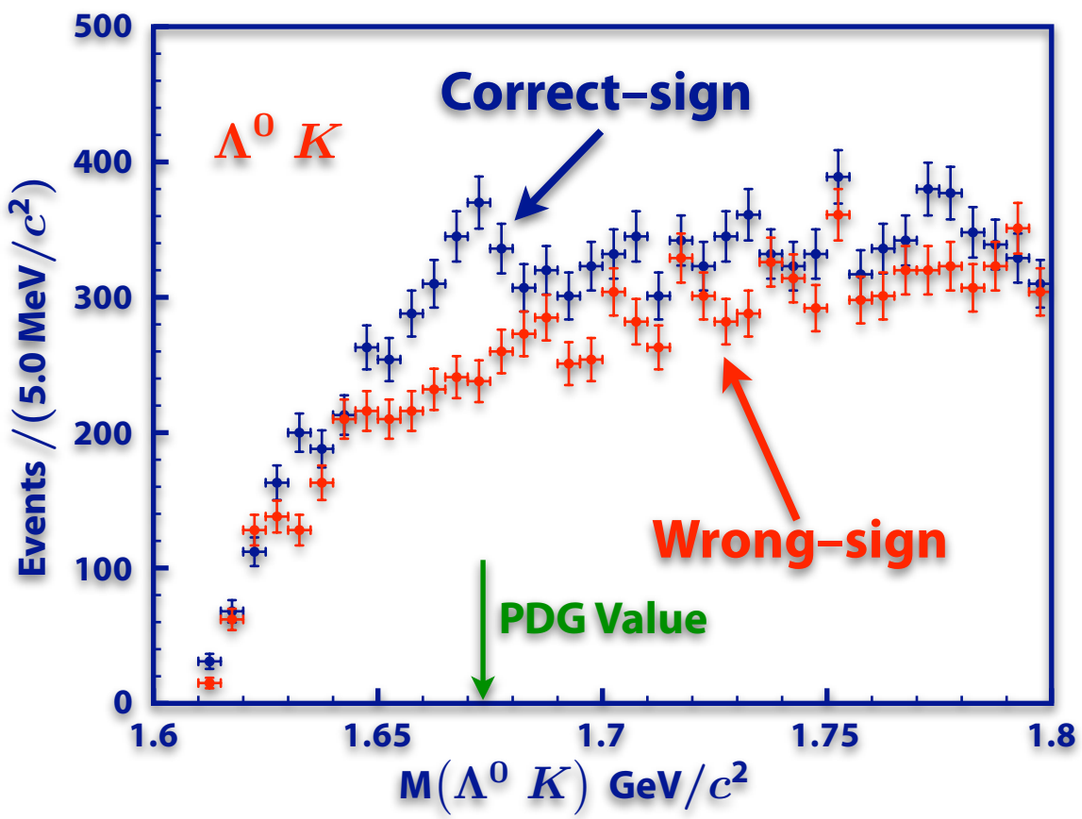

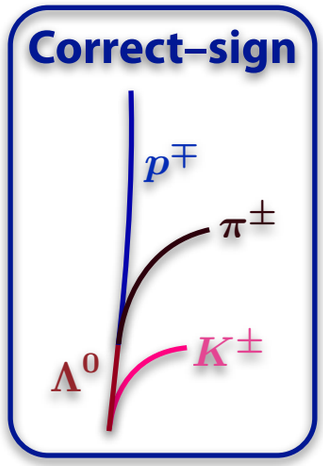

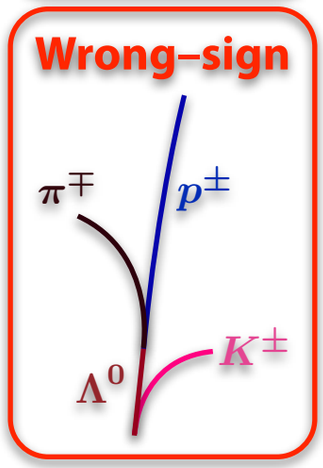

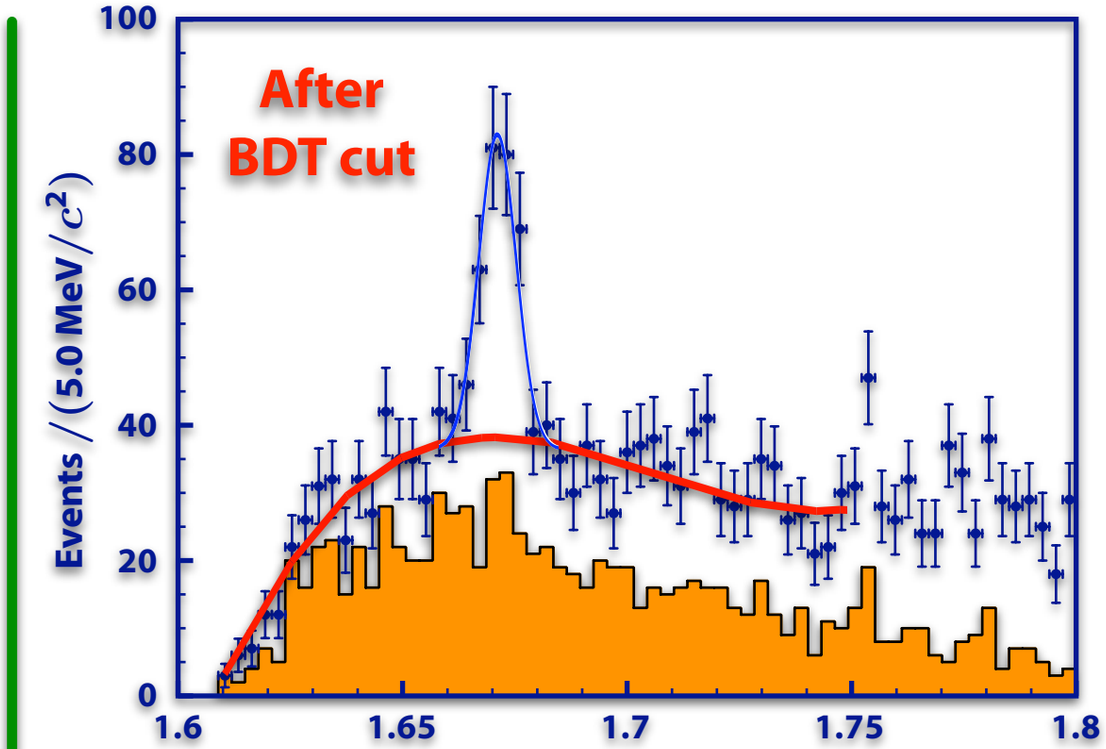

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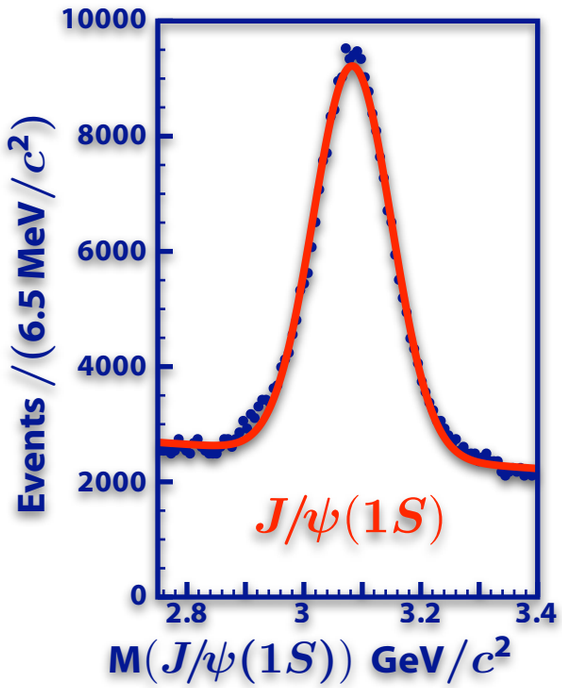

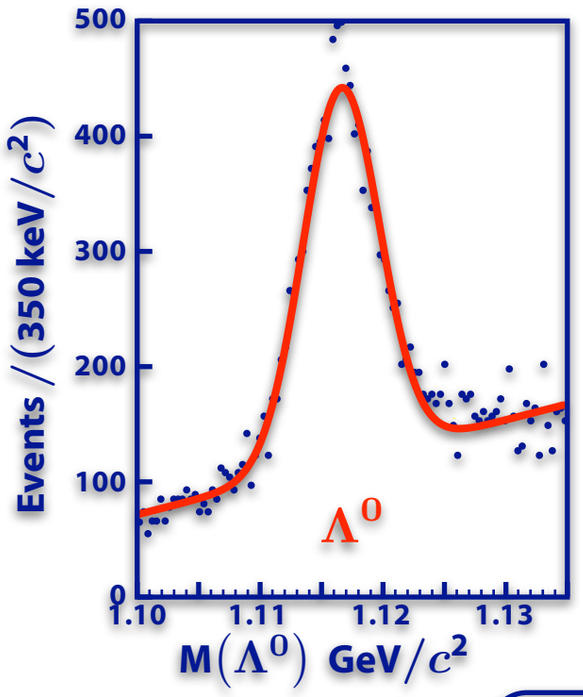

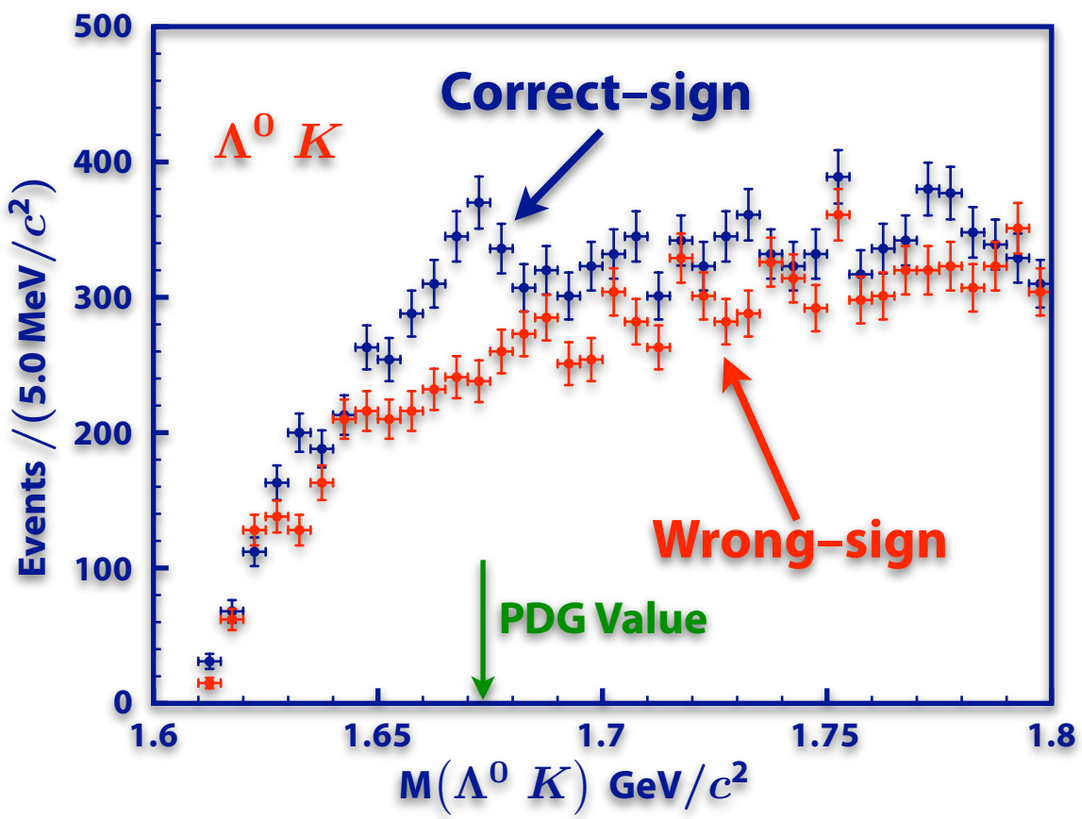

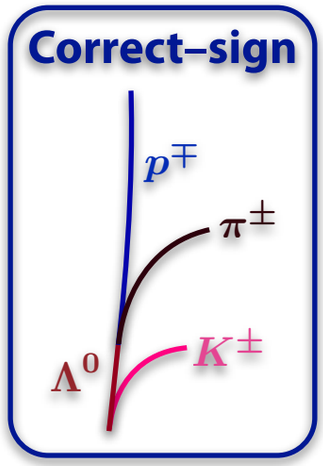

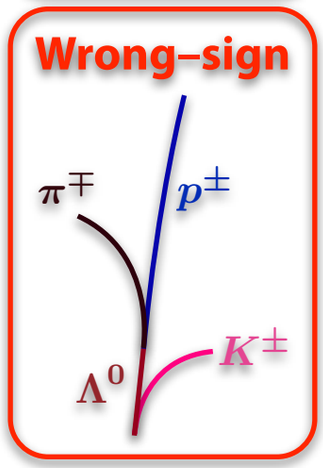

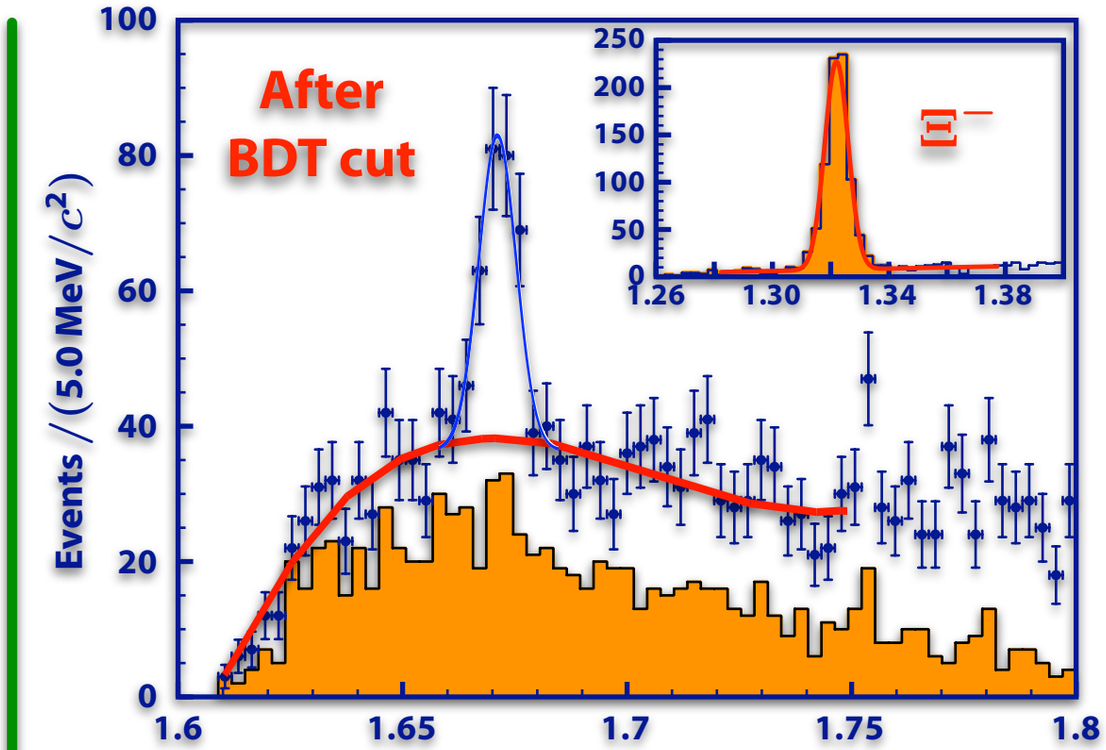

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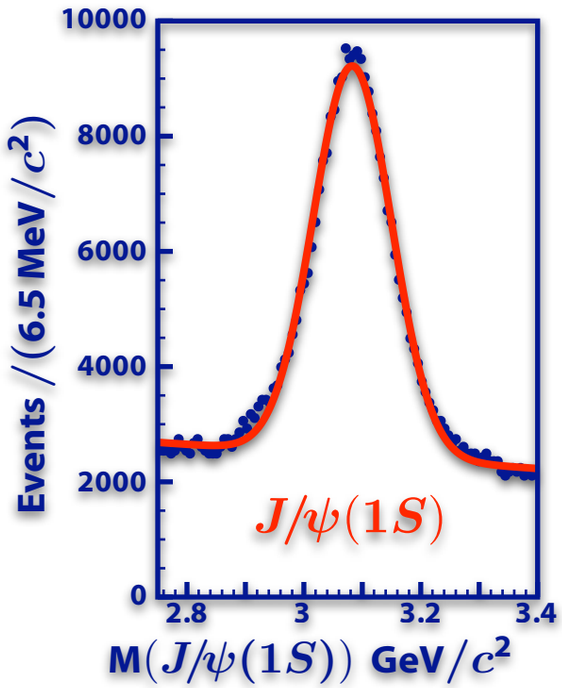
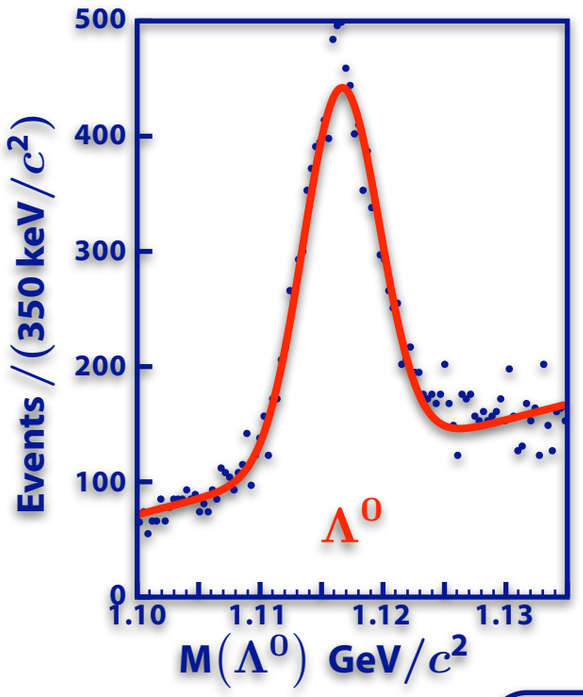
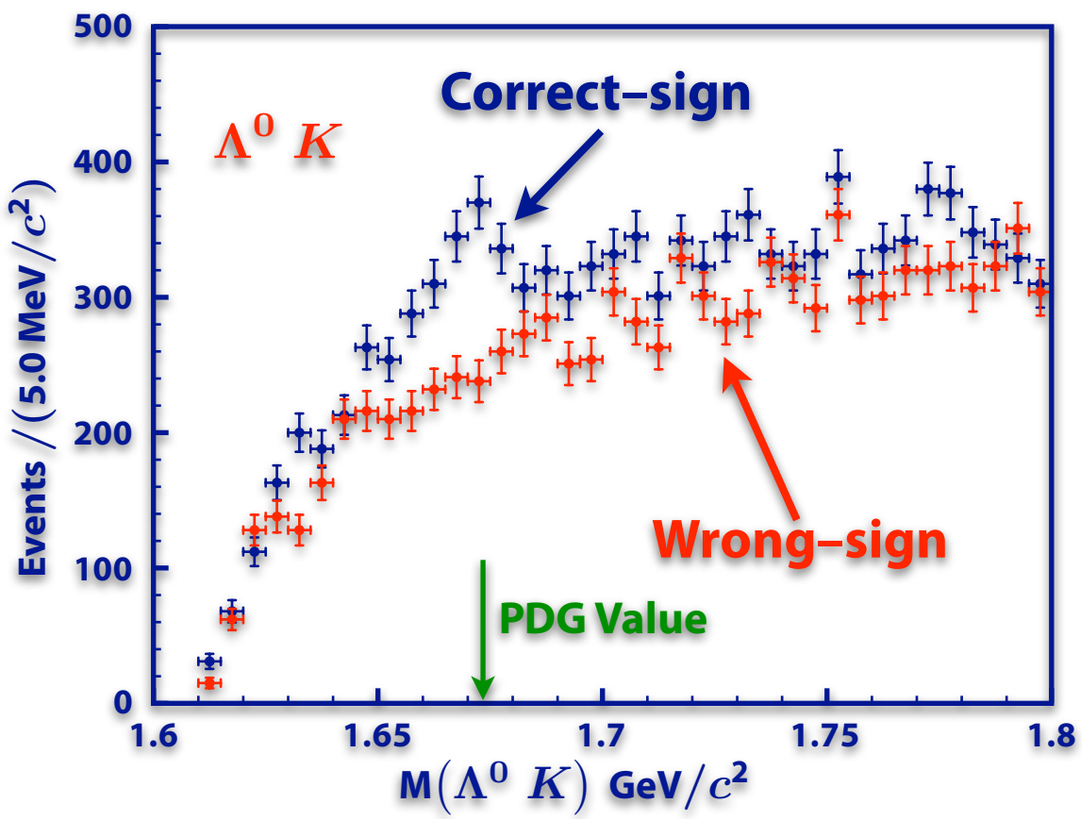
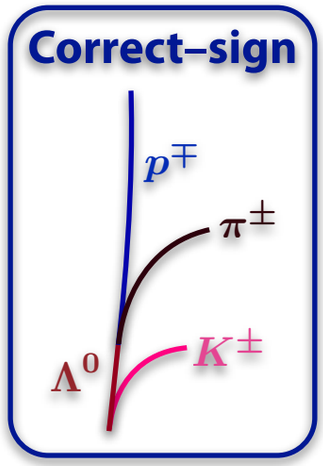
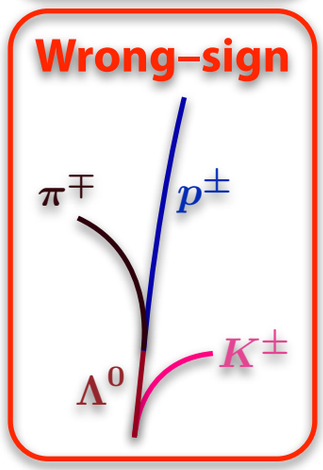
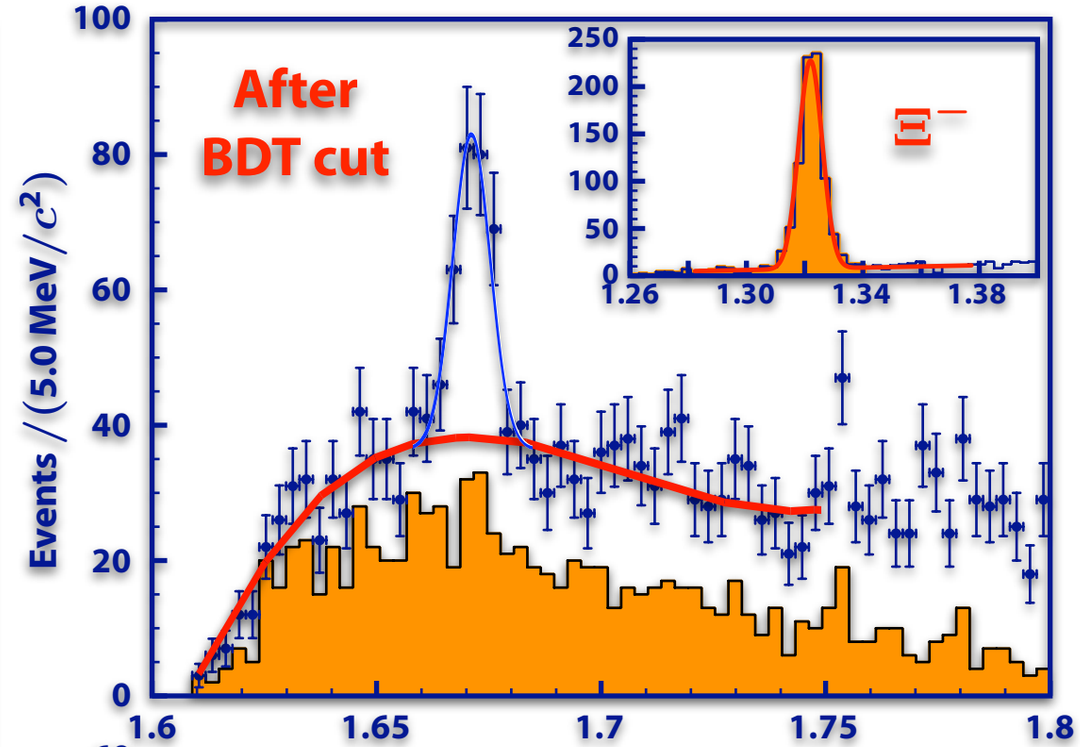


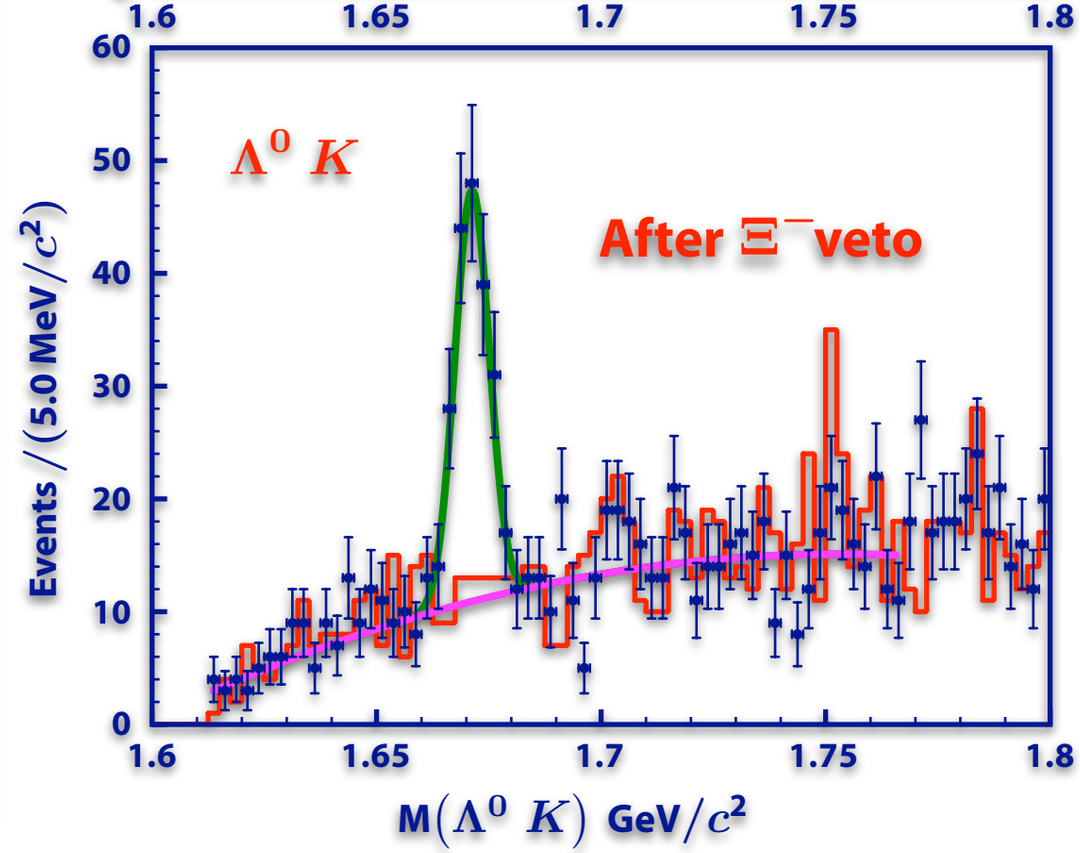








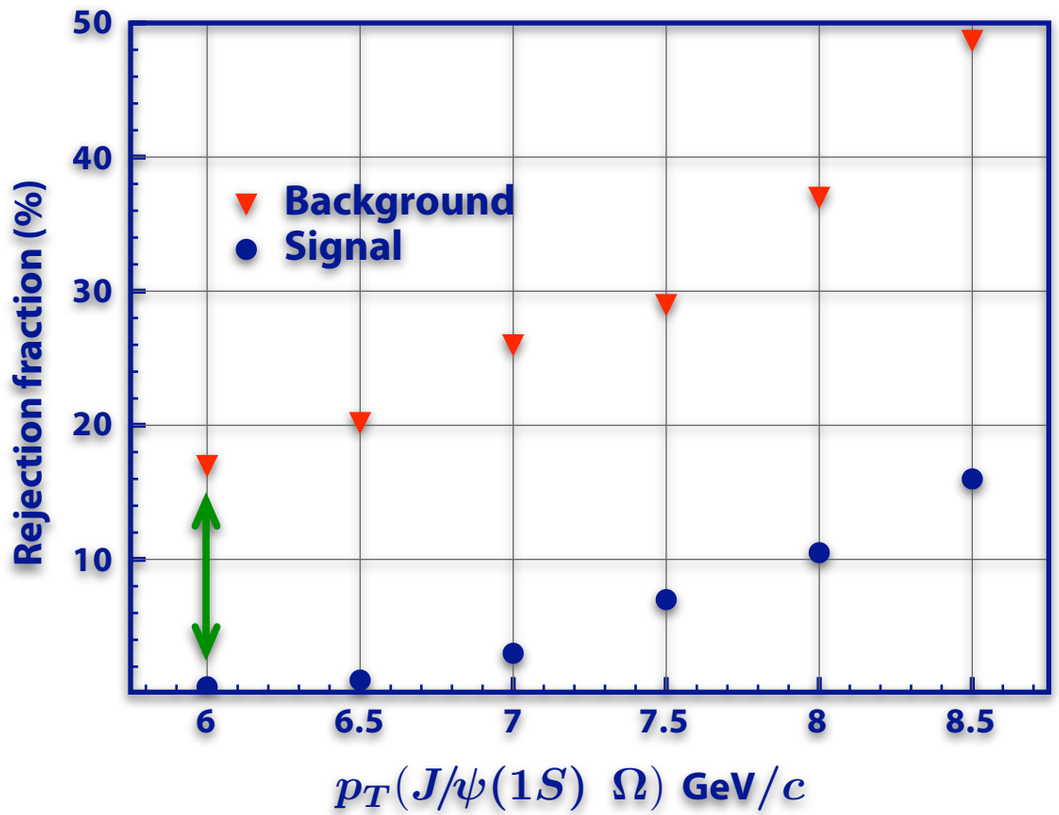




Final Optimization

MC signal and Wrong–sign

Cut on p_T



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

Final Optimization

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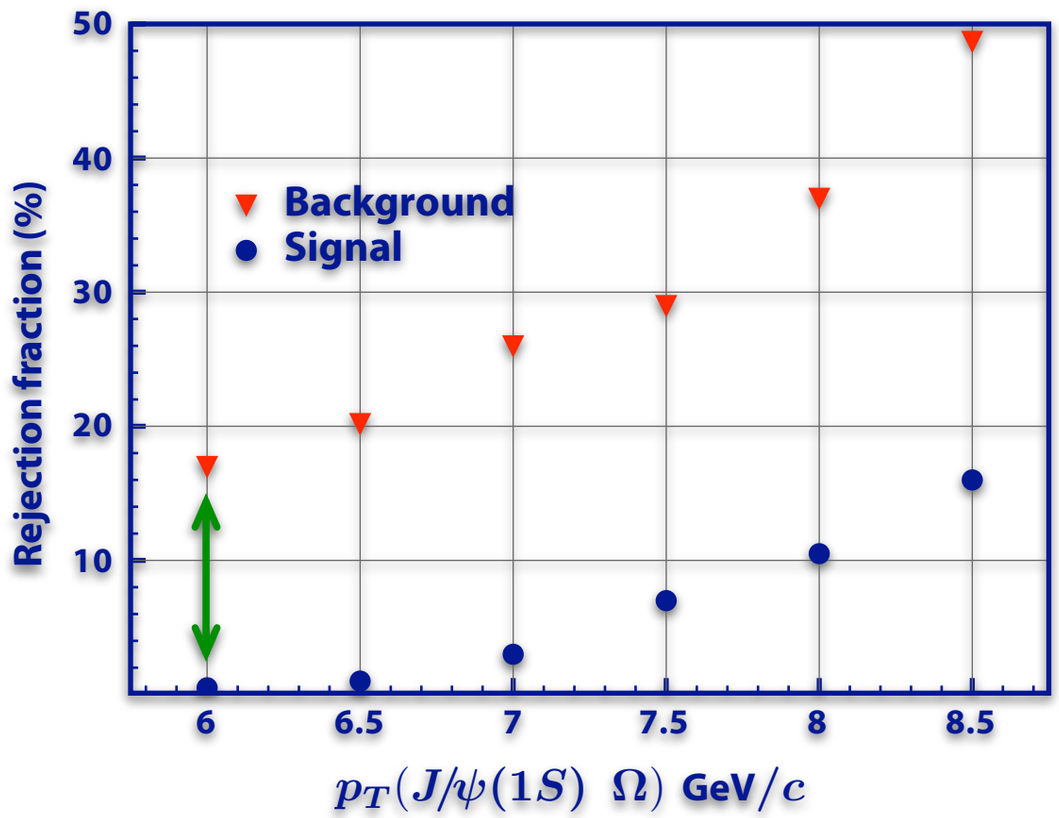
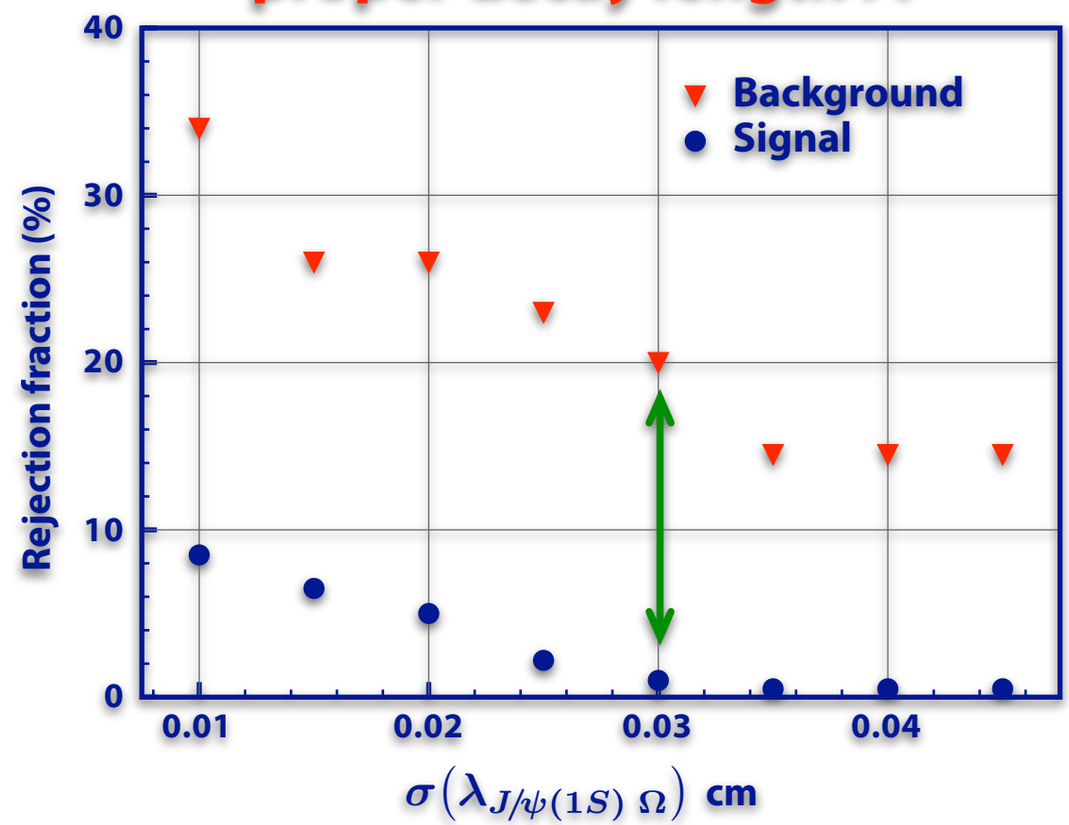


$p_T(J/\psi(1S)\ \Omega) > 6.0$ GeV/c

Cut on uncertainty in the proper decay length λ

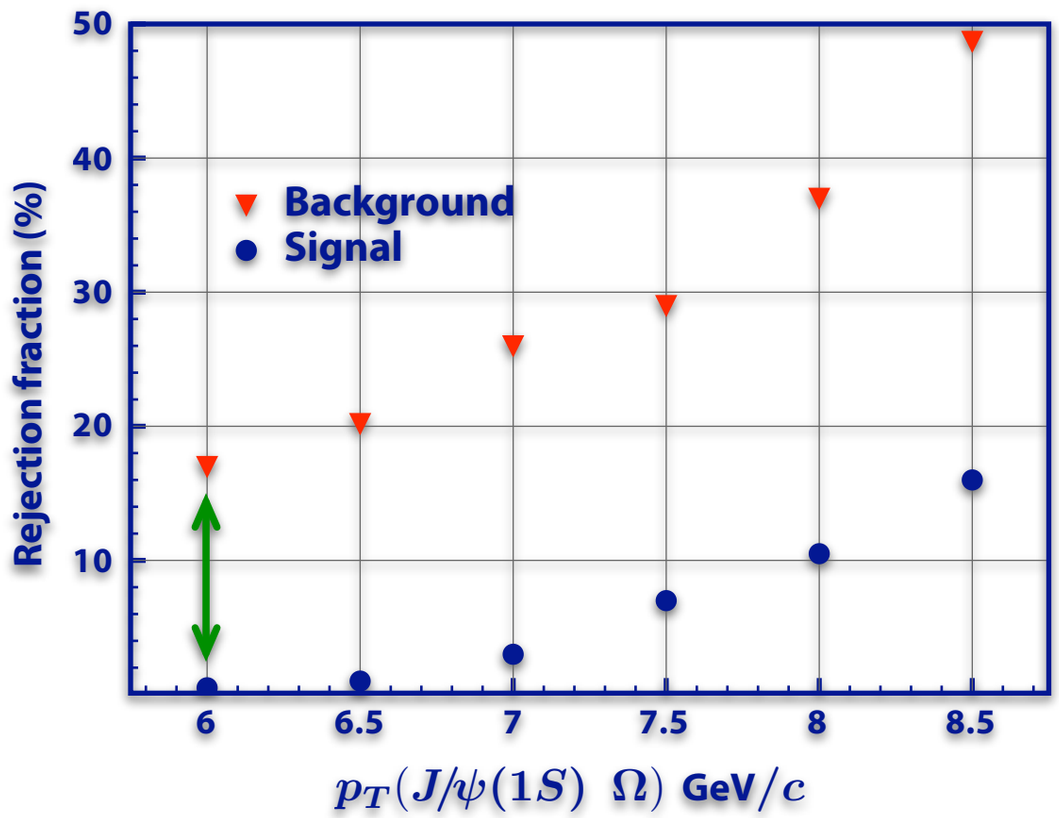


$\sigma(\lambda_{J/\psi(1S)\ \Omega}) < 0.03$ cm

Final Optimization

MC signal and Wrong–sign

Cut on p_T



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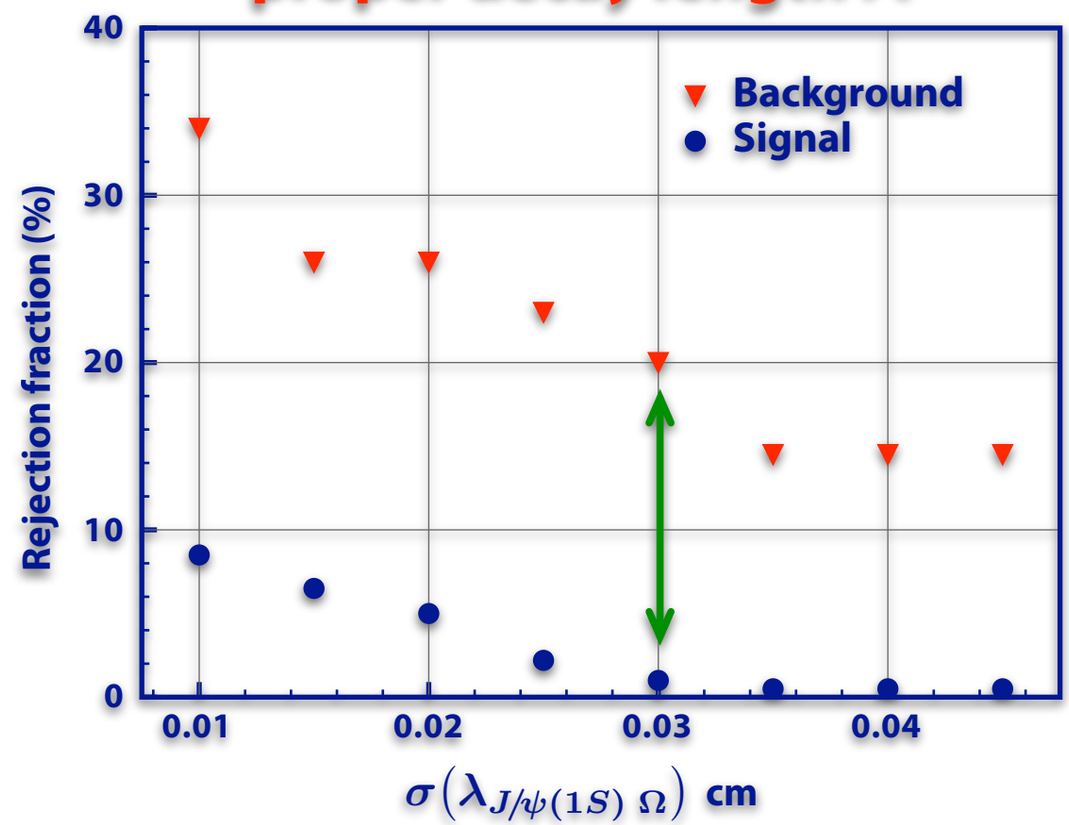


$\sigma(\lambda_{J/\psi(1S)\ \Omega}) < 0.03$ cm

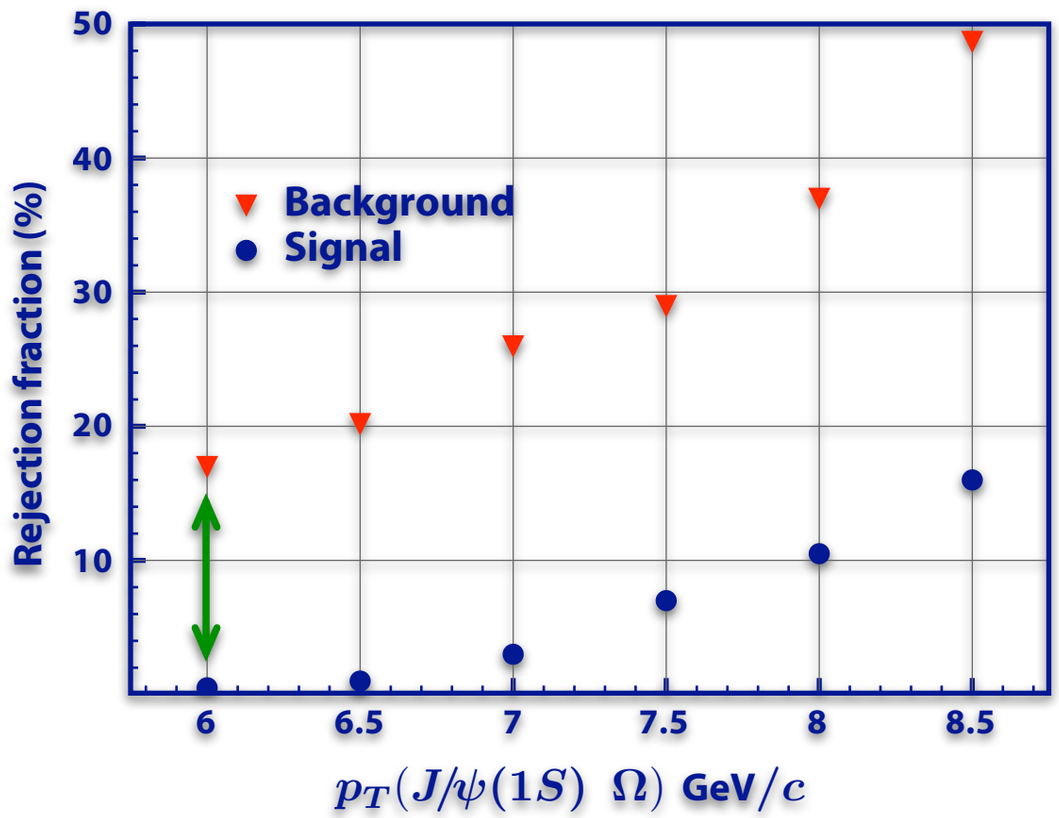
To improve the mass resolution:

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

Final Optimization

MC signal and Wrong–sign

Cut on p_T



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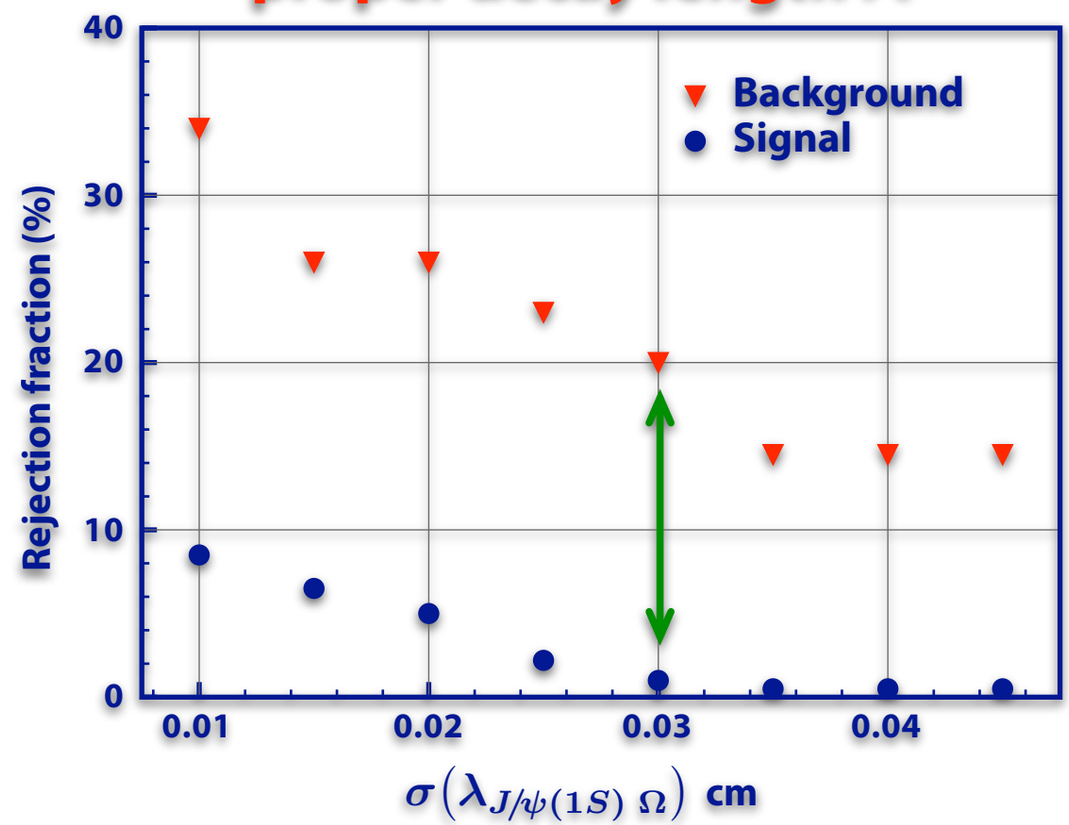

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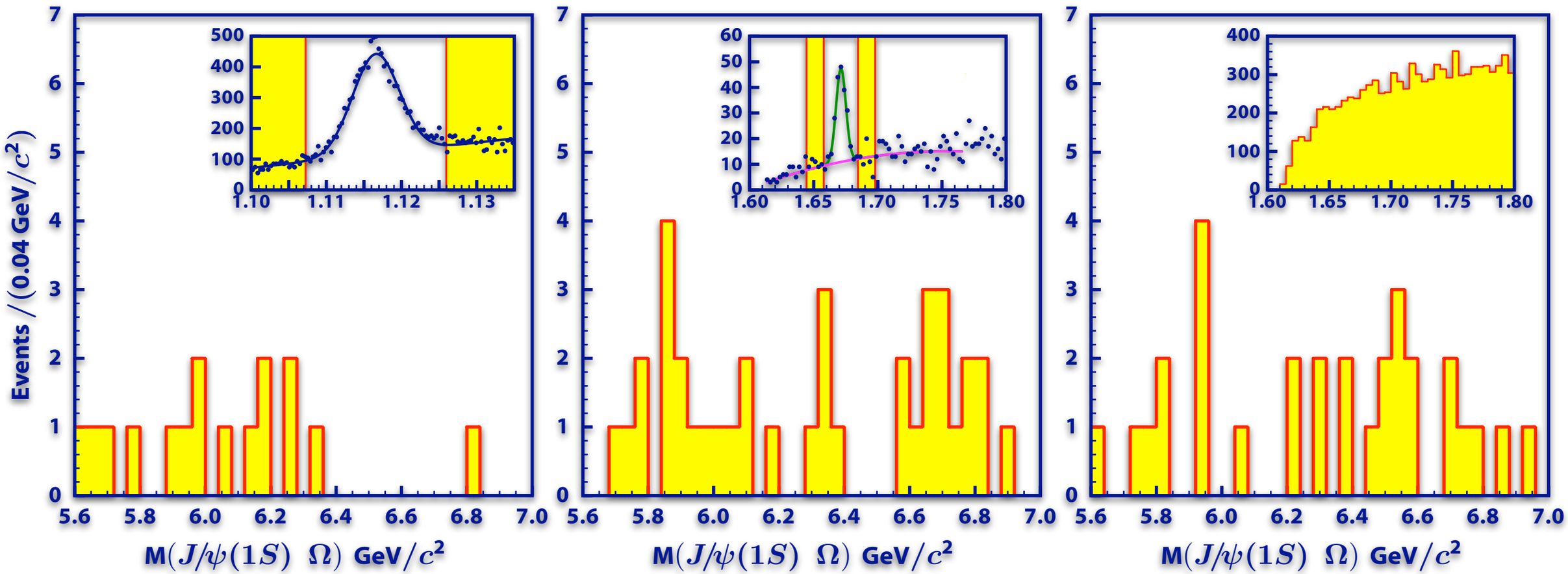
Mass window to search (GeV/c^2): 5.6–7.0

Control Samples

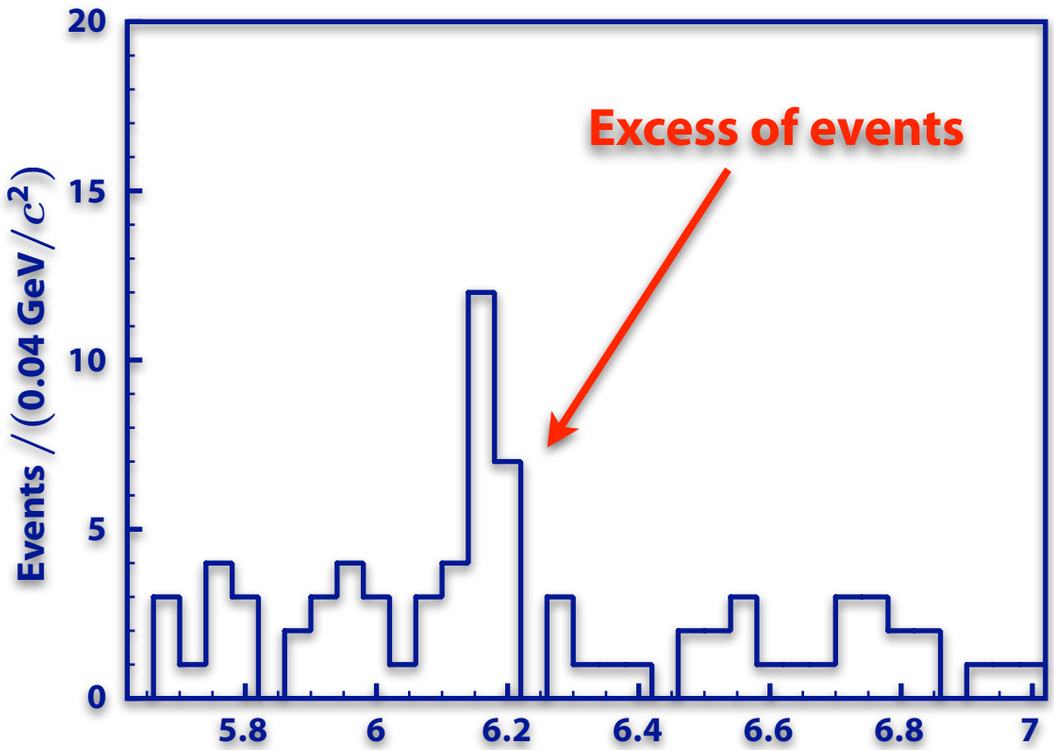
Λ^0 Sidebands | Ω^- Sidebands | Wrong–sign combinations



Also high statistics MC samples

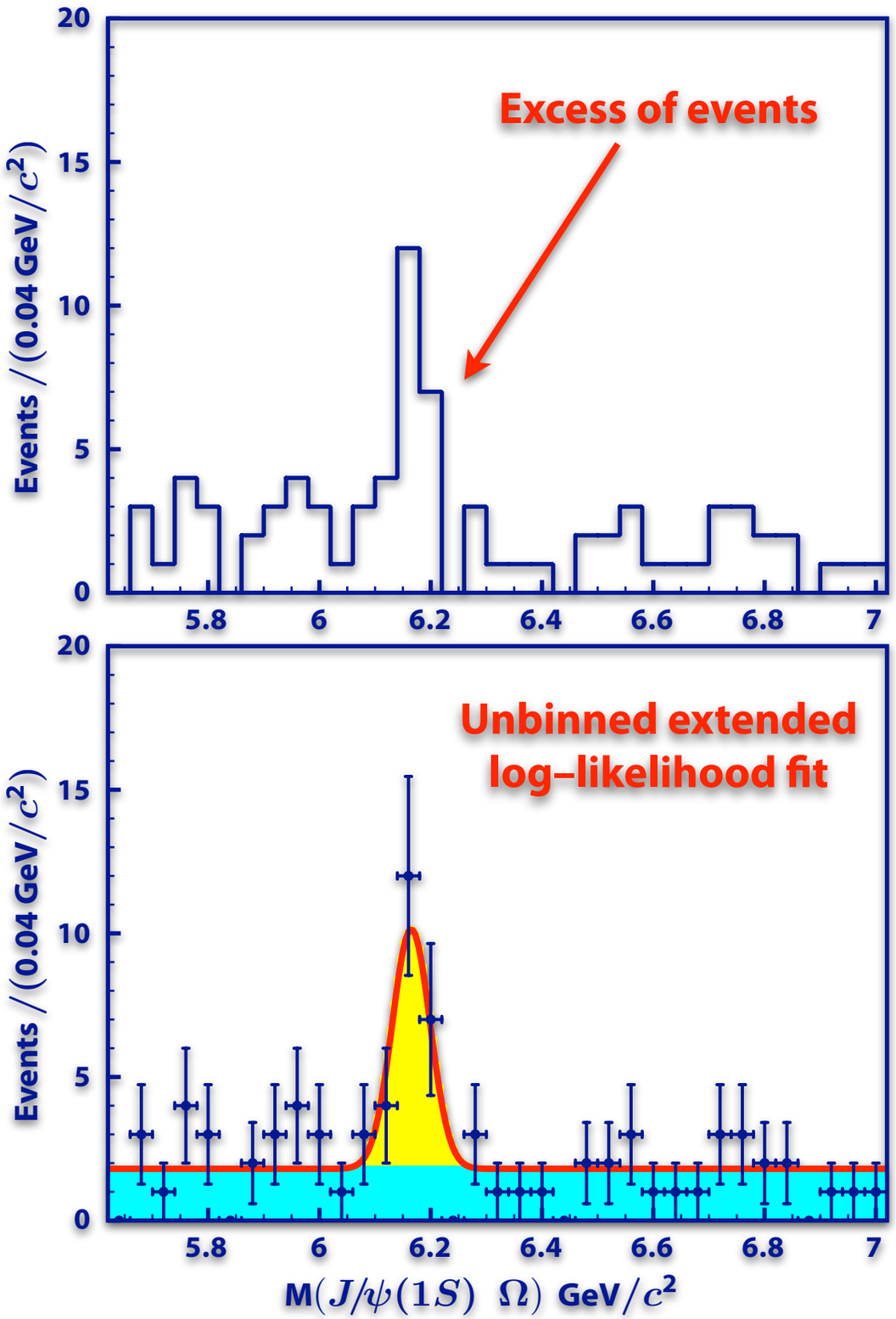
- $\Lambda_b^0 \to J/\psi(1S)\ \Lambda^0 \to (\mu^+\mu^-)\ (p\,\pi^-)$
- $\Xi_b^- \to J/\psi(1S)\ \Xi^- \to (\mu^+\mu^-)\ ((p\,\pi^-)\,\pi^-)$
- $B^- \to J/\psi(1S)\ K^*(892)^- \to (\mu^+\mu^-)\ ((\pi^+\pi^-)\,\pi^-)$

Right–Sign Combination



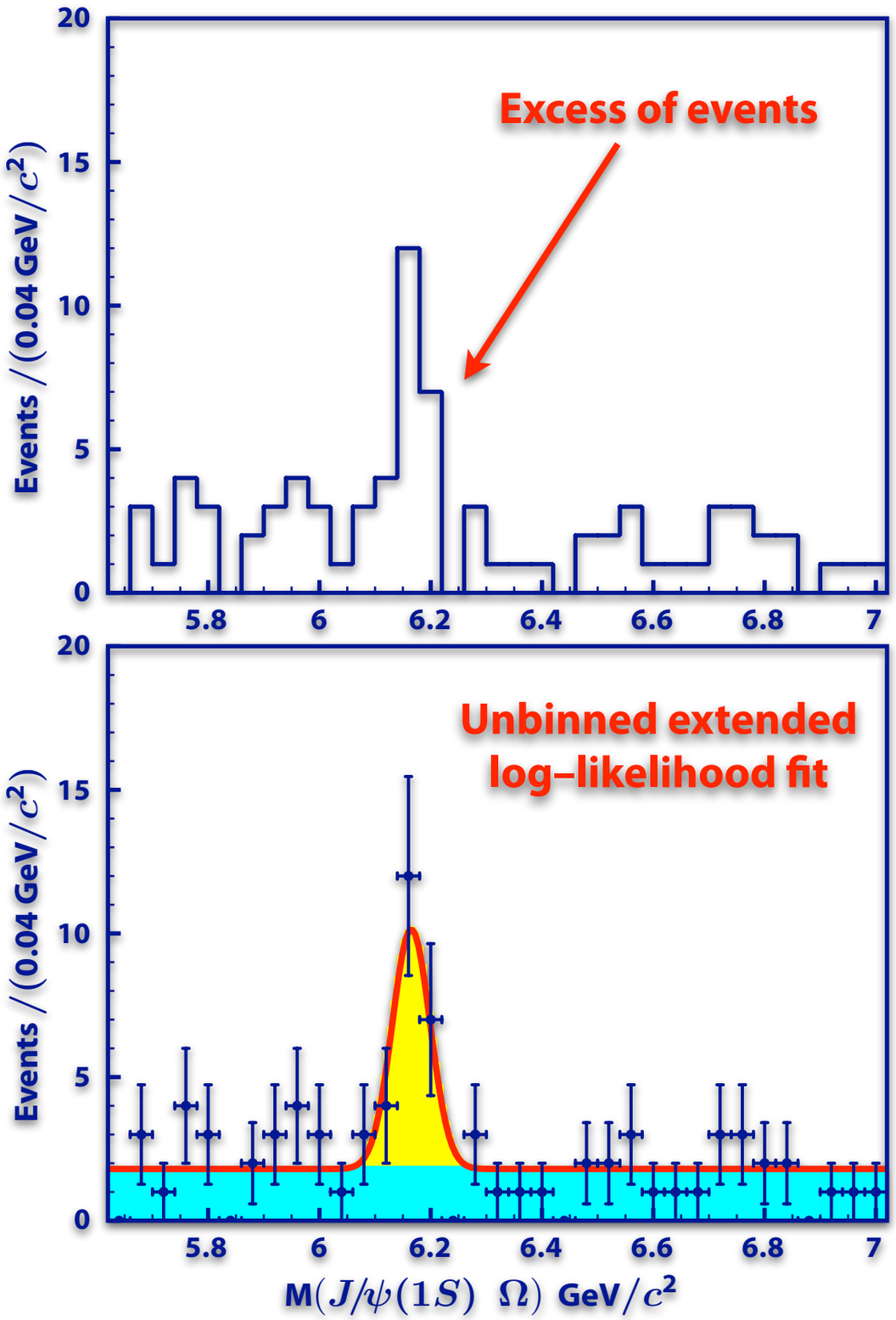
Contribution (MeV/c^2)

Right–Sign Combination



Contribution (MeV/c^2)

Right–Sign Combination



Signal events

17.8 ± 4.9 (stat) $\pm$ 0.8 (syst)

Mass

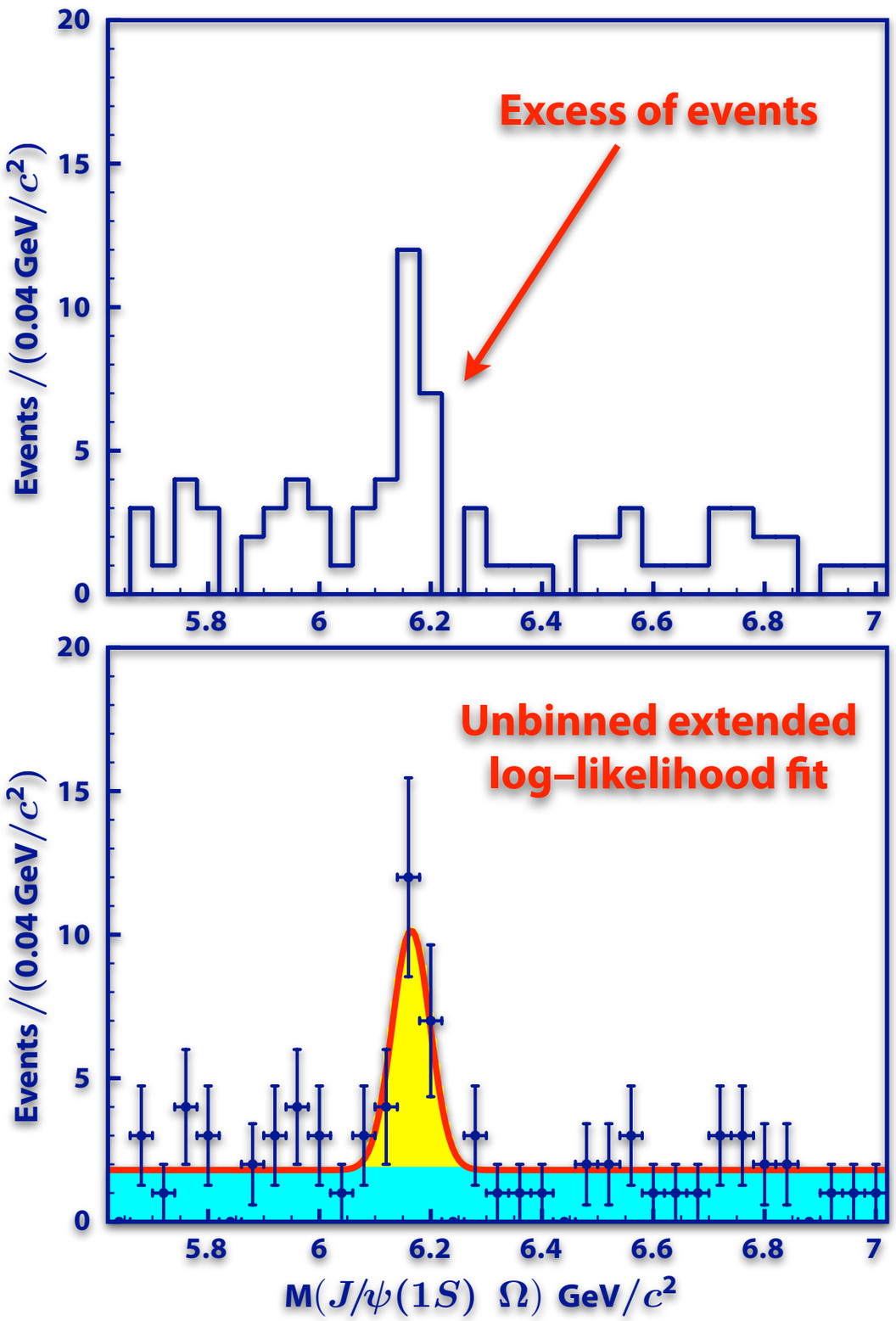
6.165 ± 0.010 (stat) $\pm$ 0.013 (syst) GeV/c^2

Significance

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

Contribution (MeV/c^2)

Right–Sign Combination



Signal events

17.8 ± 4.9 (stat) $\pm$ 0.8 (syst)

Mass

6.165 ± 0.010 (stat) $\pm$ 0.013 (syst) GeV/c^2

Significance

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

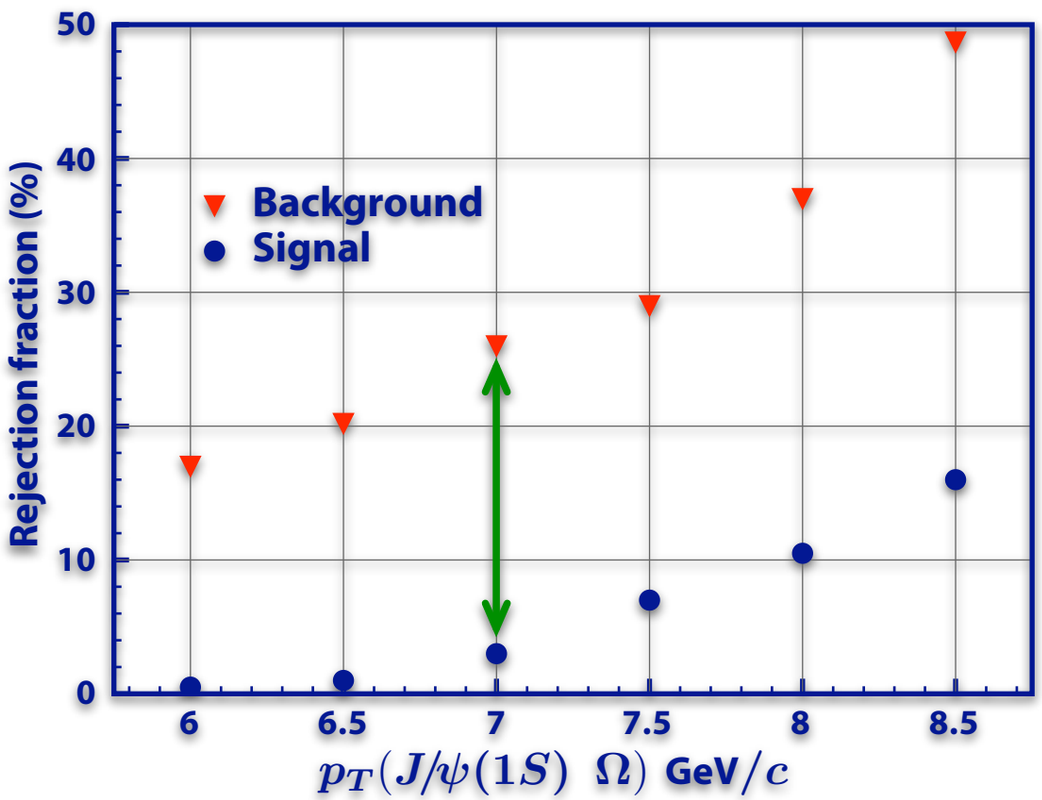
Mass Systematic Uncertainties

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

Crosscheck (1)

Cut on p_T

MC signal *vs.* Wrong–sign



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

Crosscheck (1)

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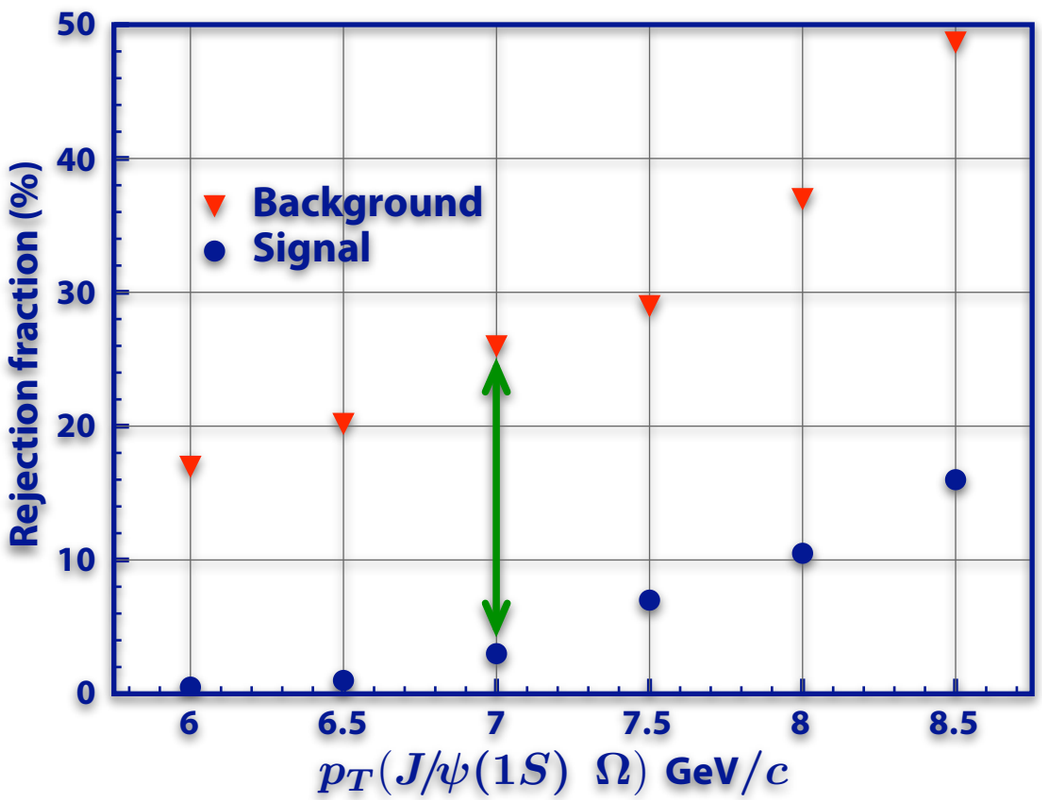
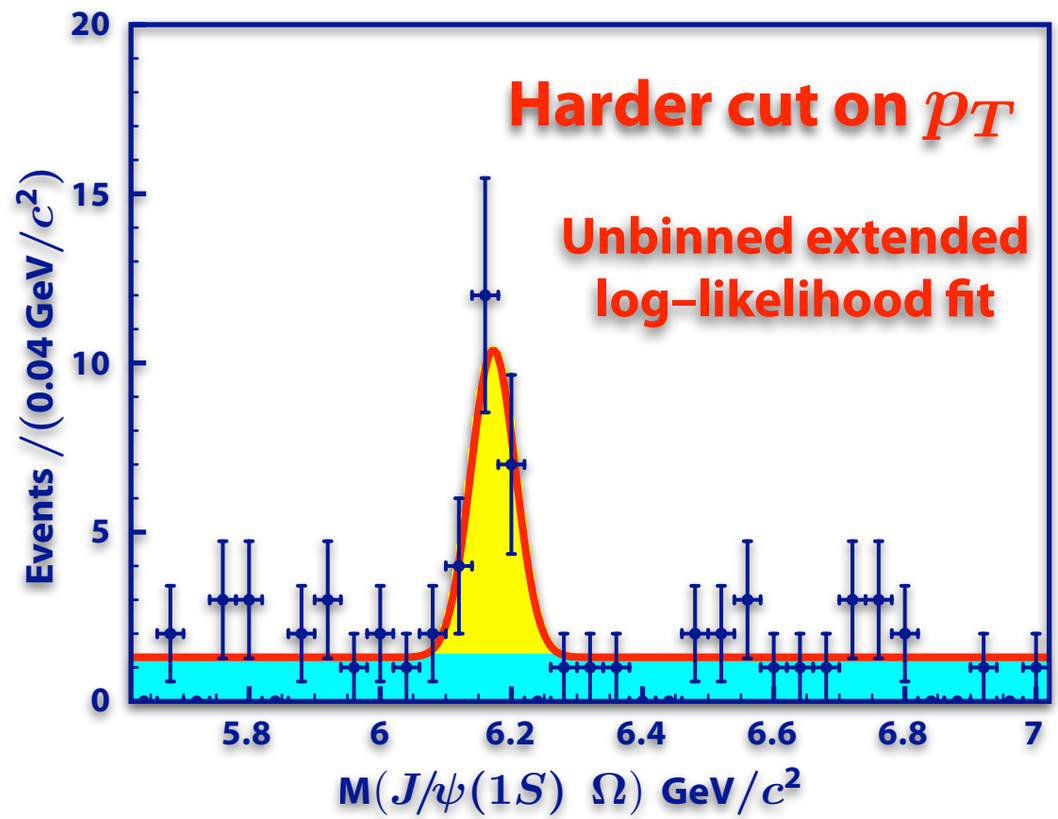


$$p_T(J/\psi(1S)\ \Omega) > 7.0\ \mathrm{GeV}/c$$

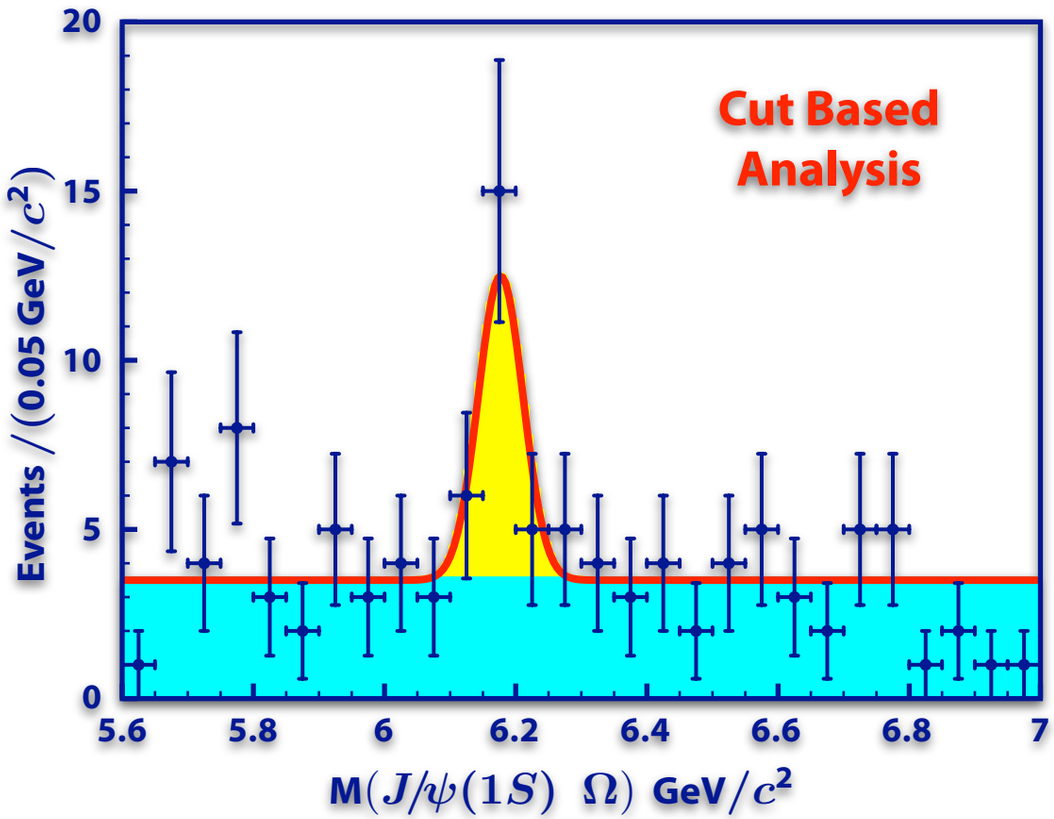


Significance

Greater than 6.0 σ

Consistent mass

Cut Based Crosscheck (2)



Signal events

15.7 ± 5.3 (stat)

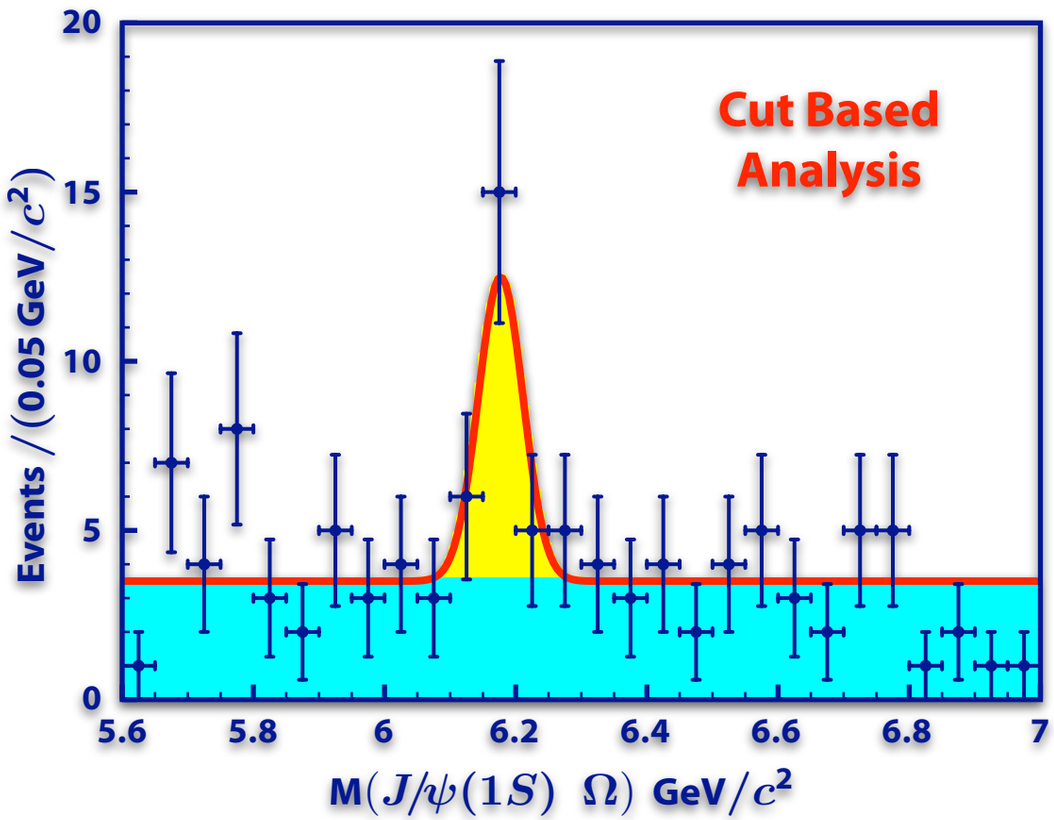
Mass

6.177 ± 0.015 (stat) GeV/c^2

Significance

$3.9\,\sigma$

Cut Based Crosscheck (2)



Signal events

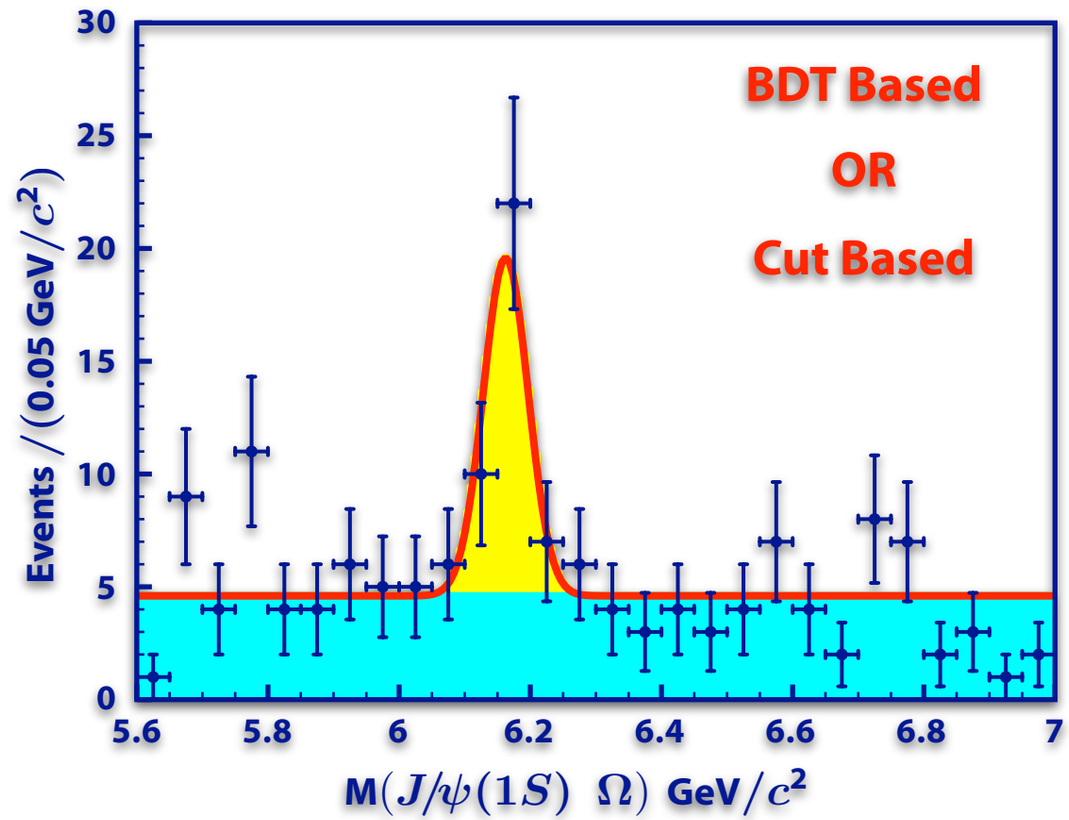
15.7 $\pm$ 5.3 (stat)

Mass

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

Significance

3.9 σ



Signal events

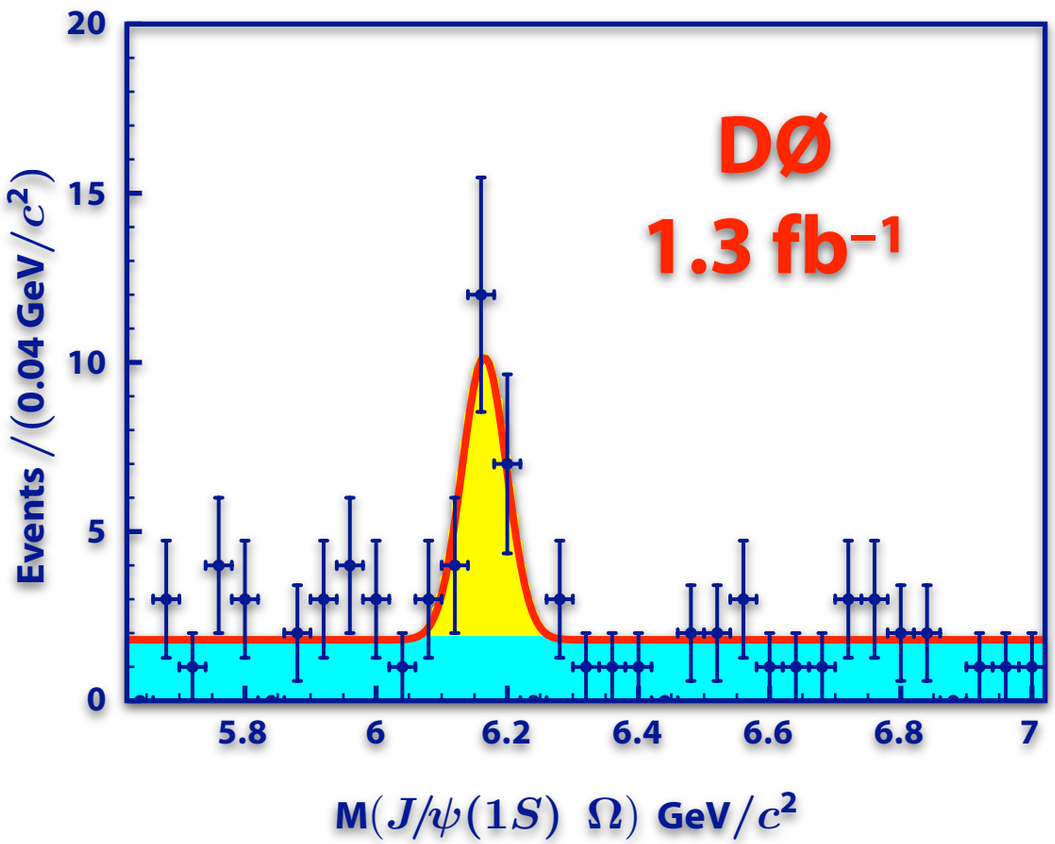
25.5 $\pm$ 6.5 (stat)

Significance

5.4 σ

Consistent number of events, masses and reconstructed efficiencies.

Summary



17.8 ± 4.9 (stat) $\pm$ 0.8 (syst)

6.165 ± 0.010 (stat) $\pm$ 0.013 (syst) GeV/c^2

5.4 σ

A new $b-$Baryon observed! ☺

Few others...

Few others...

- DØ Author since January 2009.

Few others...

- DØ Author since January 2009.
- Tevatron activities.

Few others...

- DØ Author since January 2009.
- Tevatron activities.
- Resources of information

Future Projects

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A lot of room for improvement

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A lot of room for improvement and learning!

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Update these and other analyses to the whole data set we already have

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Update these and other analyses to the whole data set we already have and expect to collect.

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Plenty of new analyses to be made in the *b*–Physics group...

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Я хочу говорить по русски

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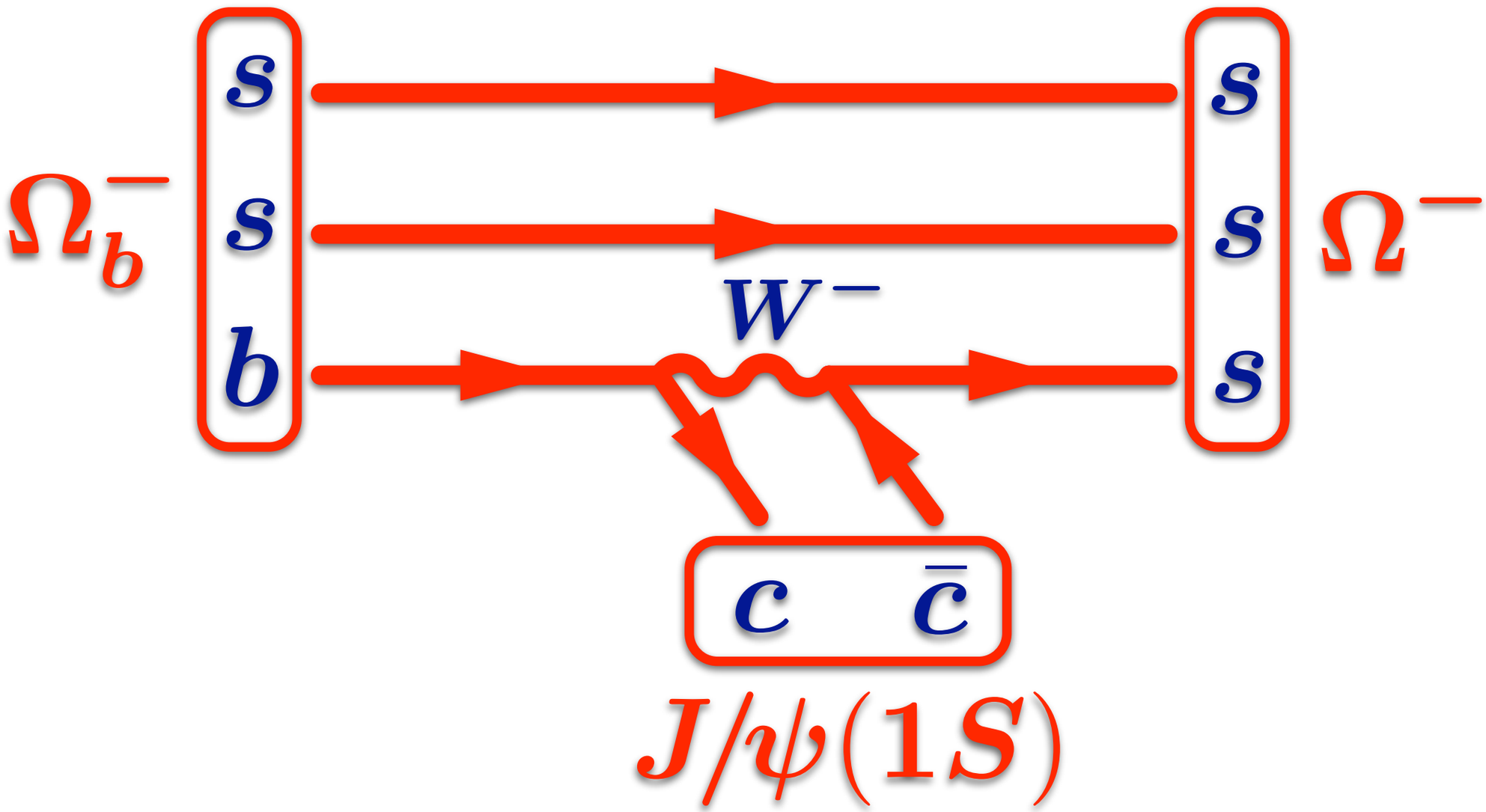
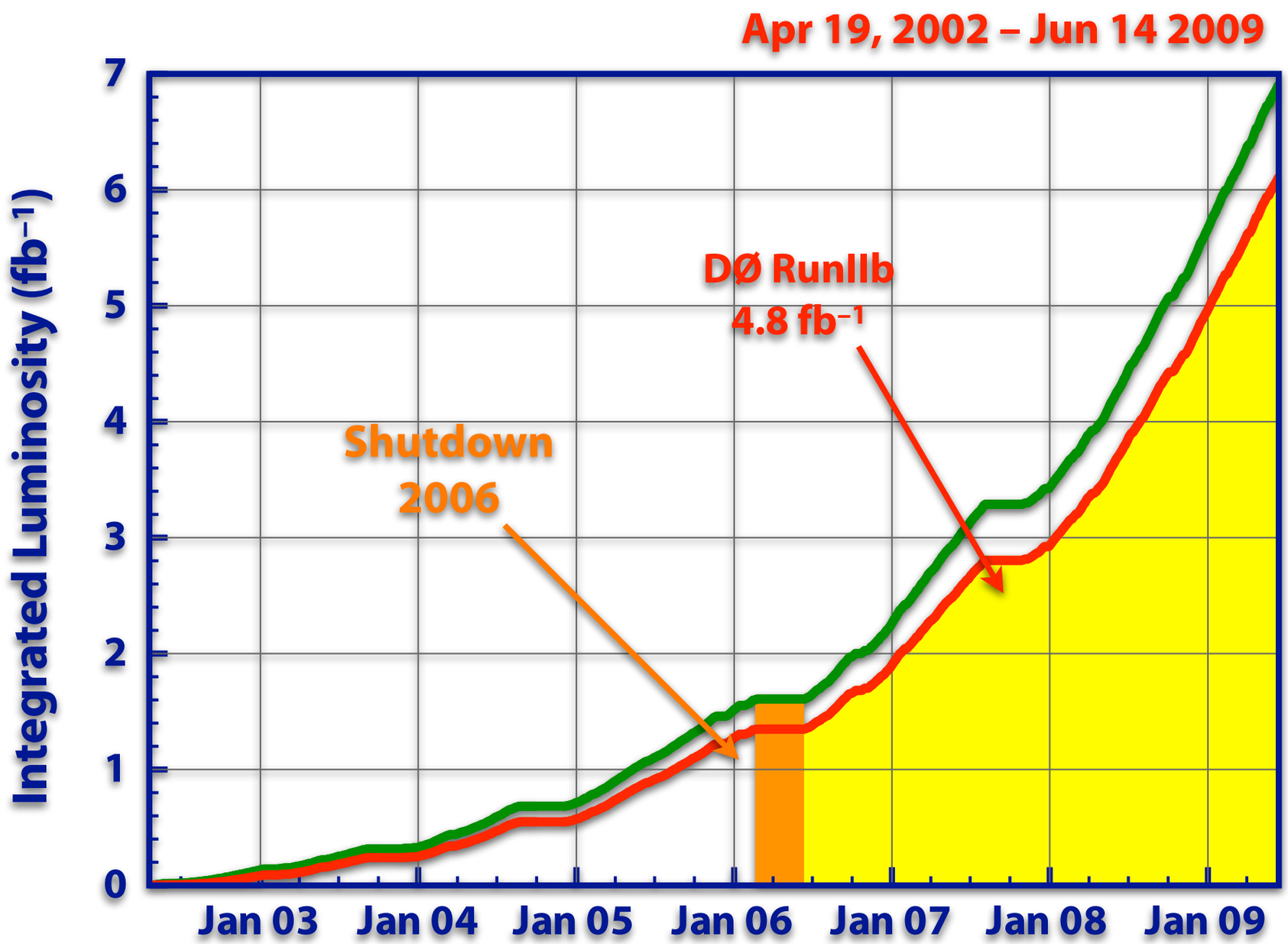
und auf Deutsch sprechen.

Thank you!

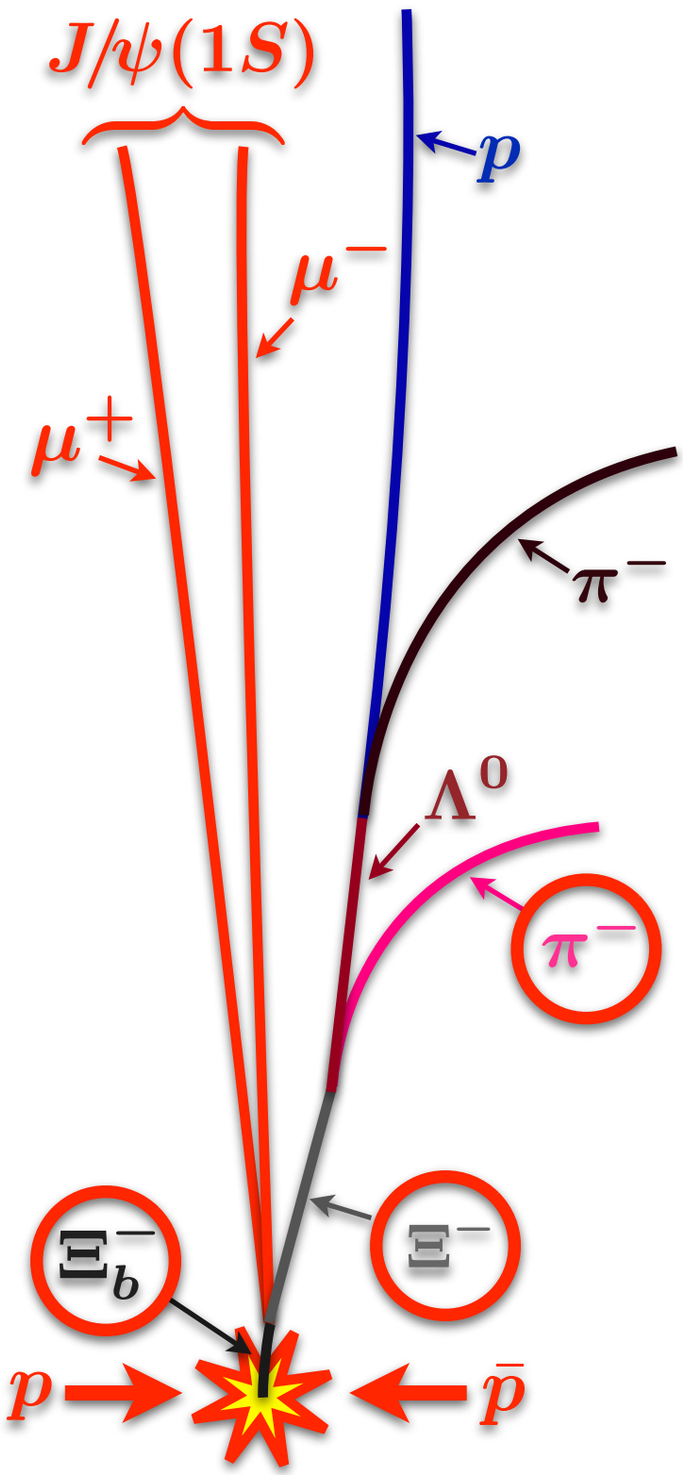
Back up


Ω_b^-
s
s
b
W^-
s
s
s
Ω^-
c
$\bar{c}$
$J/\psi(1S)$

Tevatron RunII



Production Ratio



Ξ_b^- as Normalization Channel

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

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

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