Physics Results from CDF and Prospects for a FY 2011 Run

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DOE S&T Review of Scientific User Facilities

June 30 – July 2, 2009

U.S. DEPARTMENT OF ENERGY

Fermilab

Outline

- **Collaboration**
- **Recent physics results**
- **Perspectives on a possible FY 2011 run**

The CDF Collaboration

North America

- 33 institutions

Europe

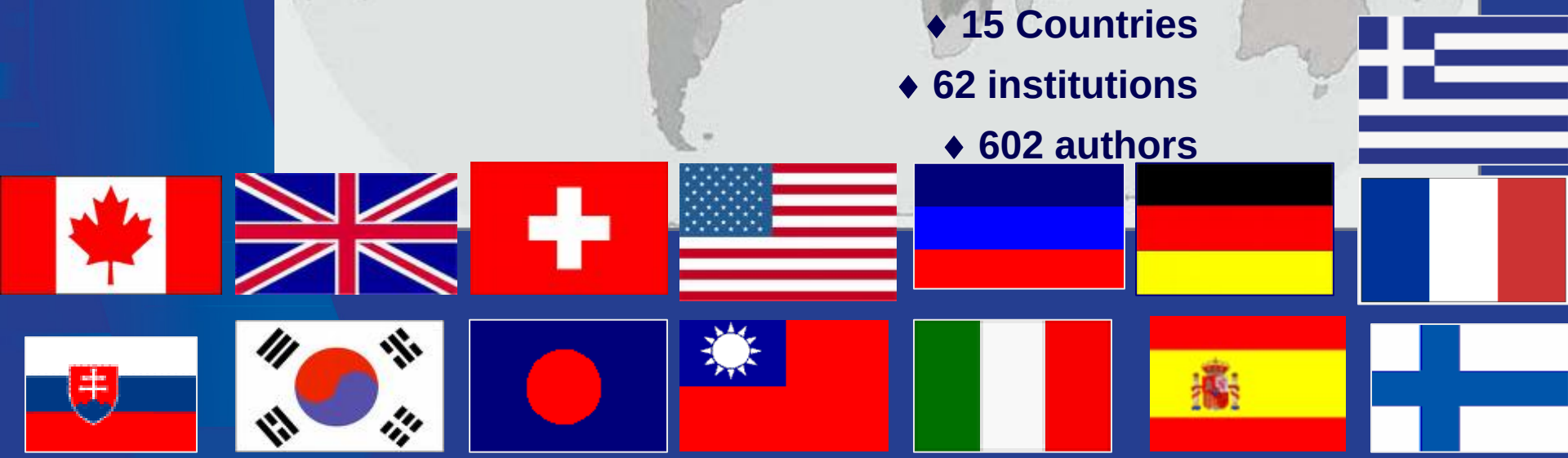
- 21 institutions

Asia

- 8 institutions

The CDF Collaboration

- 15 Countries
- 62 institutions
- 602 authors



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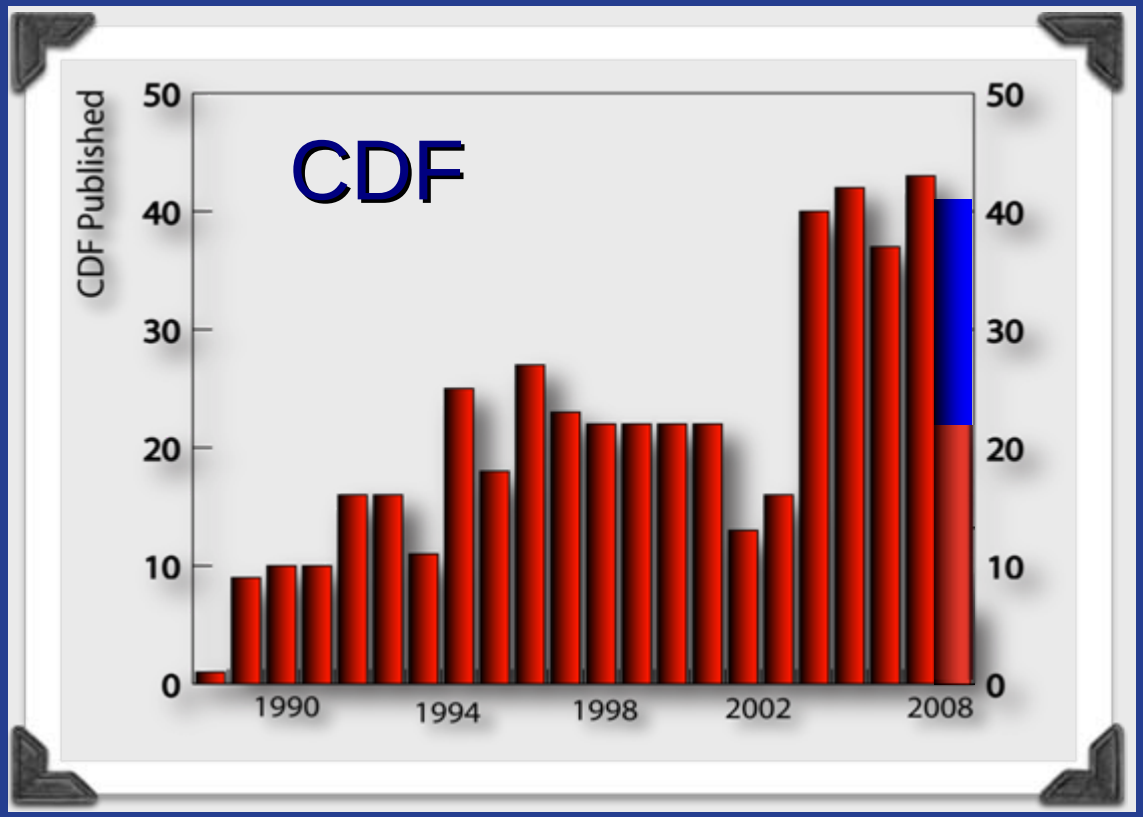
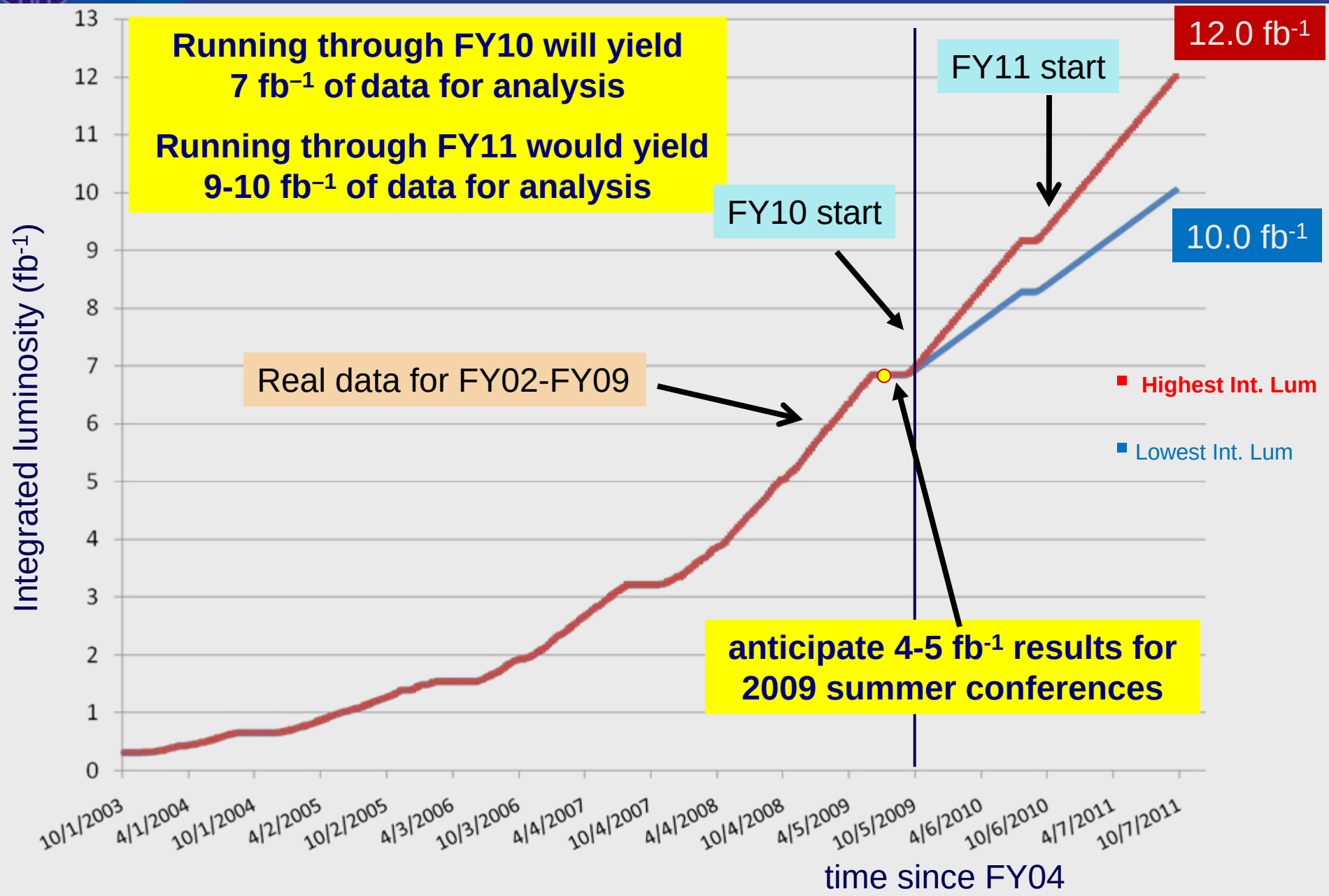
Physics Output

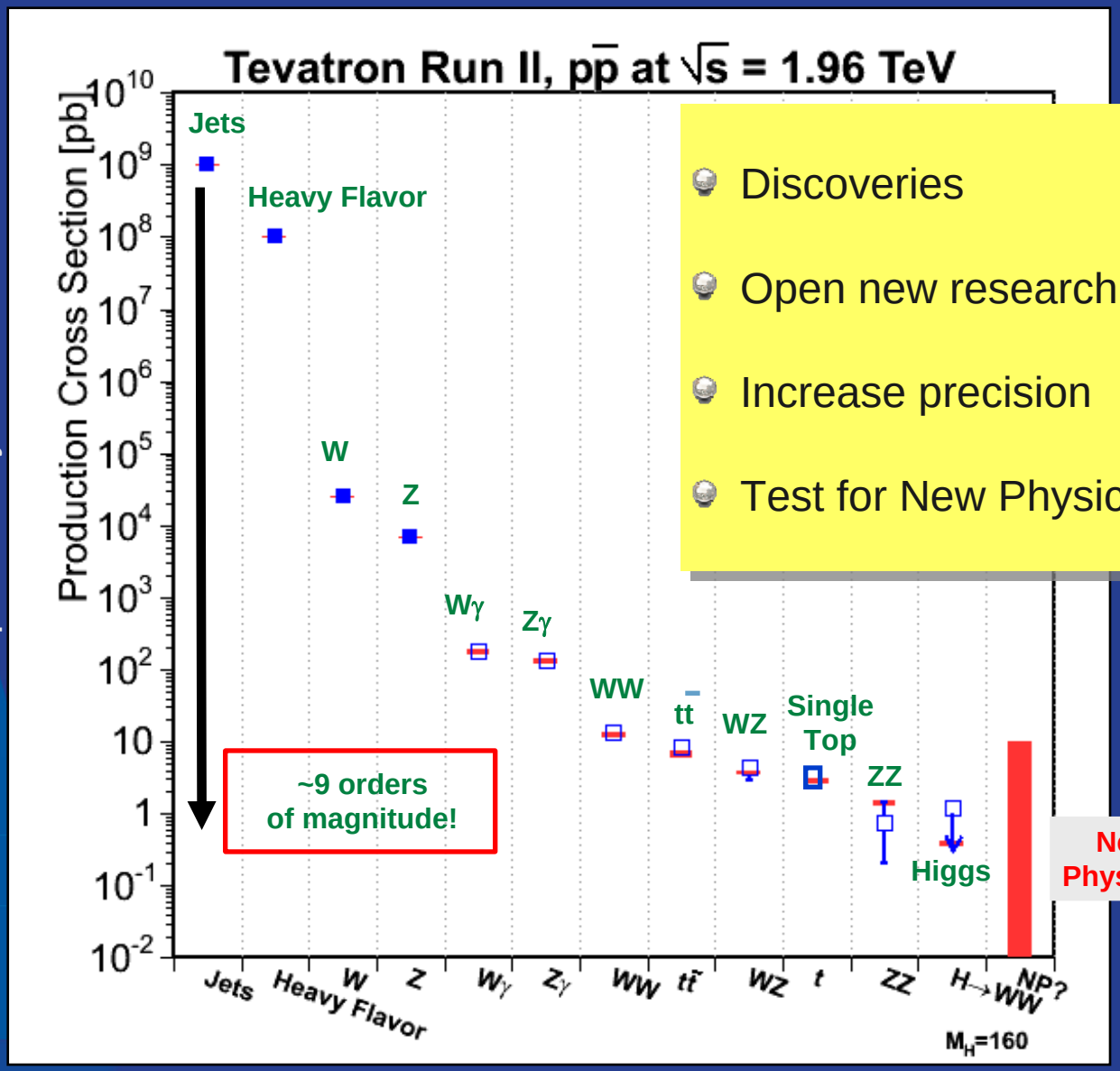


- Averaging 30 Ph.D.'s per year
- So far in calendar 2009:
  - 100+ CDF talks given in conferences
  - 28 papers submitted (more than one per week!)

Luminosity Performance and Projection



The Tevatron: A Luminosity Story



- Discoveries
- Open new research
- Increase precision
- Test for New Physics

probability

process

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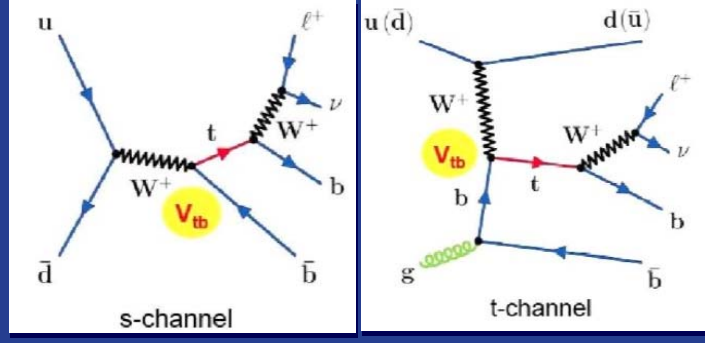
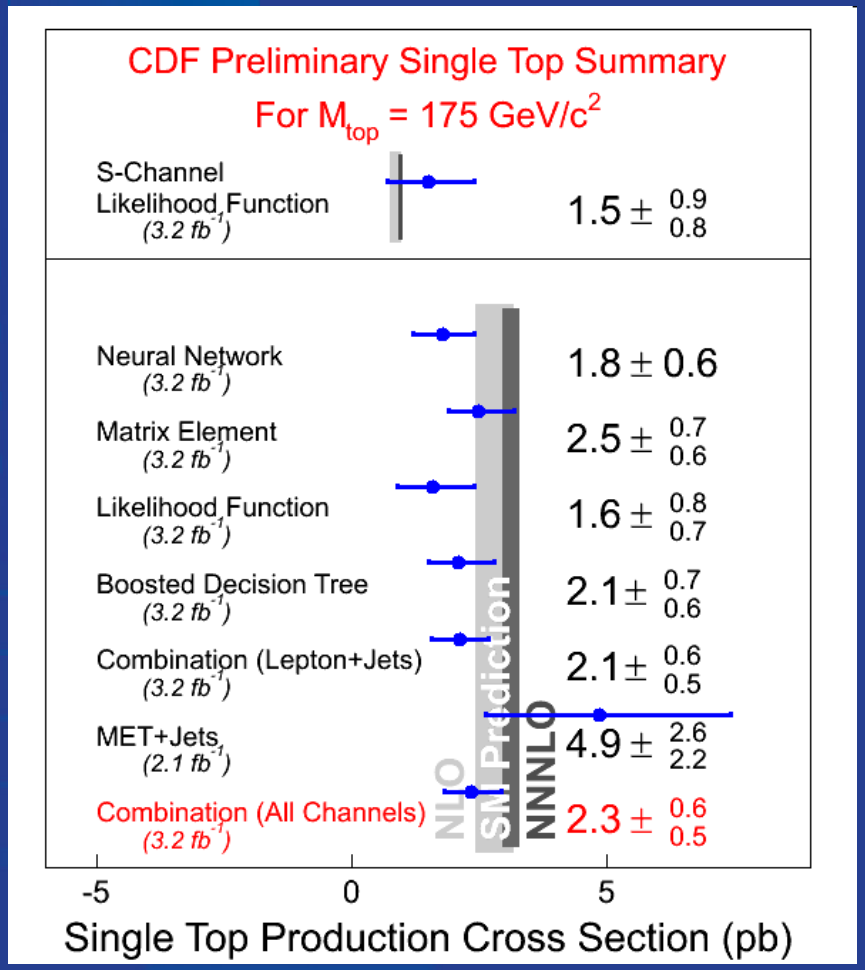
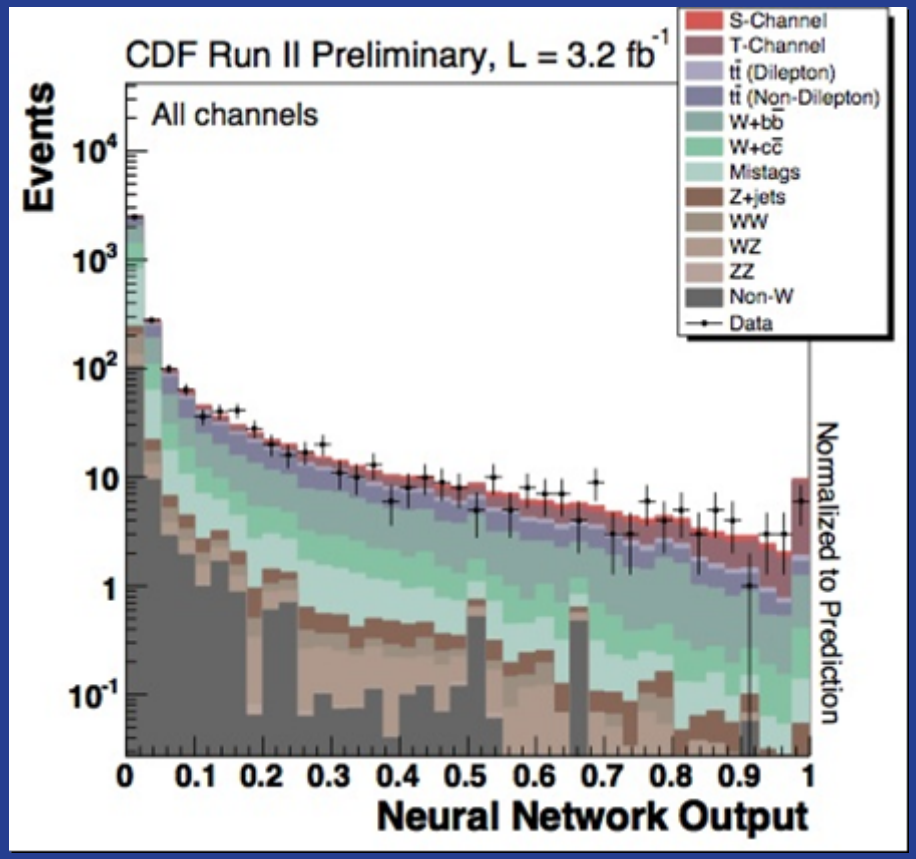
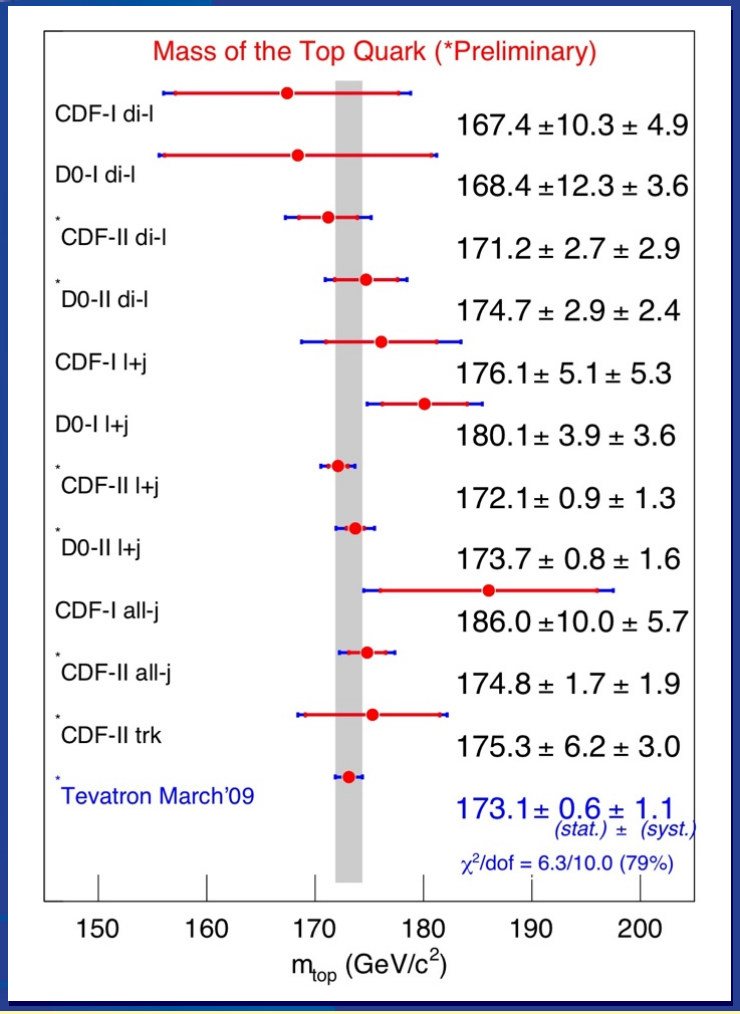
Electroweak top quark production

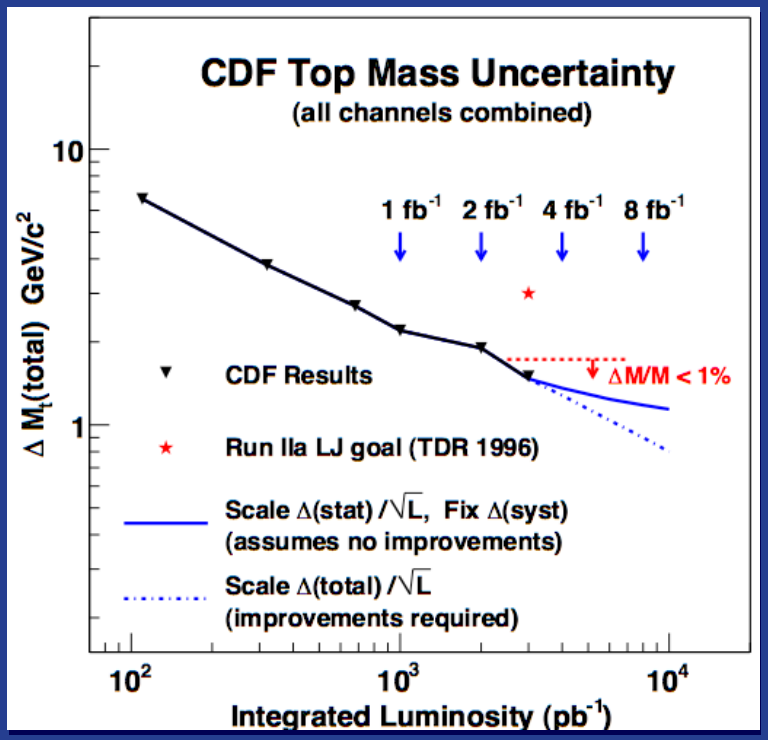






Precision: M_{top}



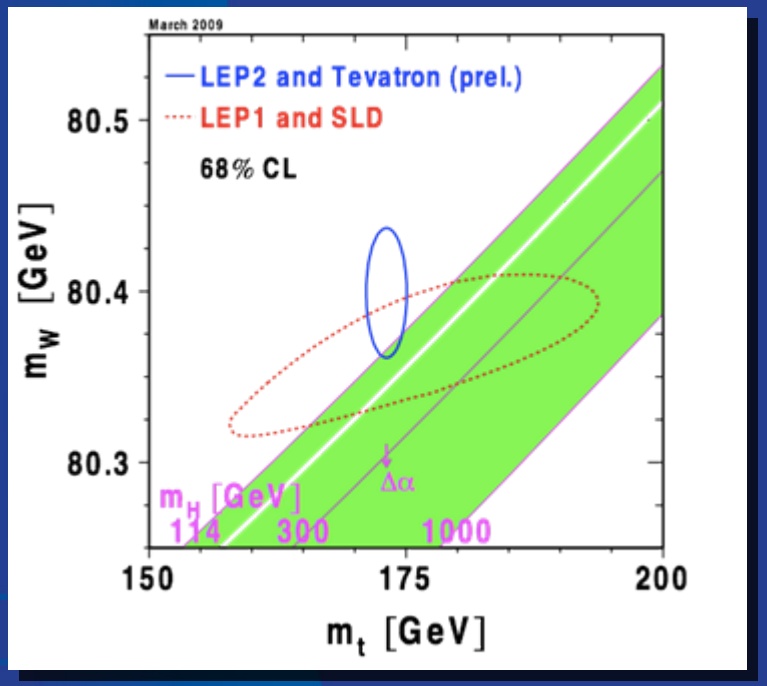


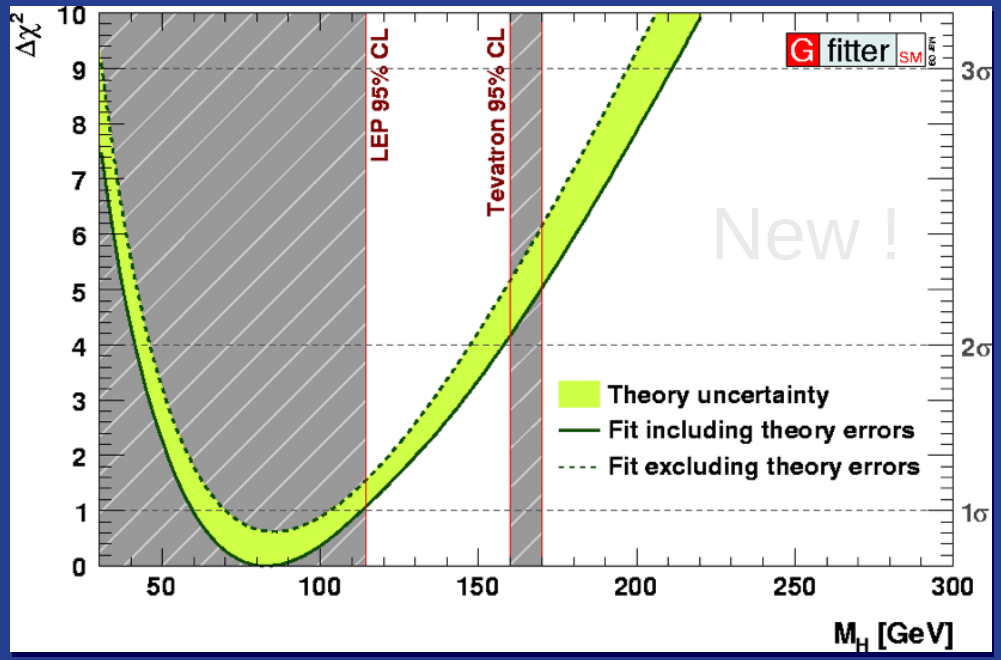
At ~10 fb^{-1} the top mass uncertainty is expected below 1 GeV

Mtop = 173.1 ± 0.6(stat) ± 1.1(syst) GeV/c^2

Legacy measurement: nearly impossible to beat at a hadron collider

Precision m_{top}, m_W ⇒ Higgs constraints





Expected now with all constraints :

$M_H = 90\ ^{+36}_{-27}$ GeV

$M_H < 163$ GeV @ 95 % CL

With 10 fb^{-1}

If δM_W=15 MeV and δM_{top}=1 GeV [for Mw= 80.400] expect

$M_H = 71\ ^{+24}_{-19}$ GeV

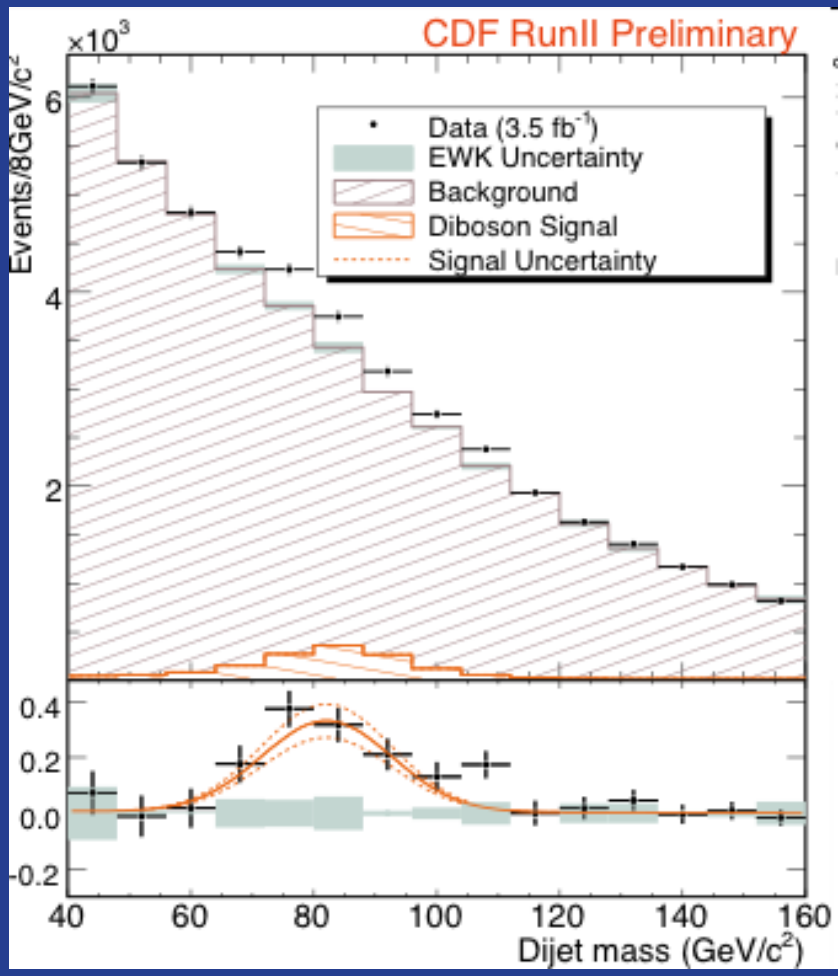
$M_H < 117$ GeV @ 95% CL!

Observation of Diboson Production in $\not{E}_T$+jj

- Sensitive to WW/WZ/ZZ
- QCD background well-modeled
- Signal significance 5.3σ
- Measure:

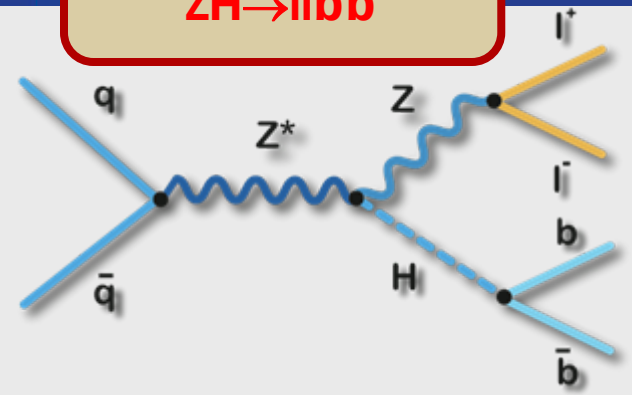
  18.0 ± 2.8(stat) ± 2.4(syst) ± 1.1(lumi) pb

  theory: 16.8 ± 0.5 pb

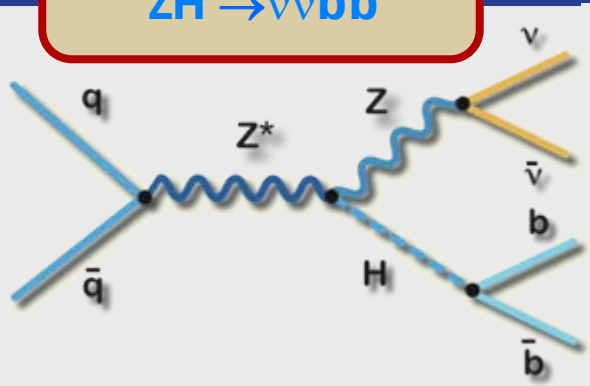


Higgs Production at the Tevatron

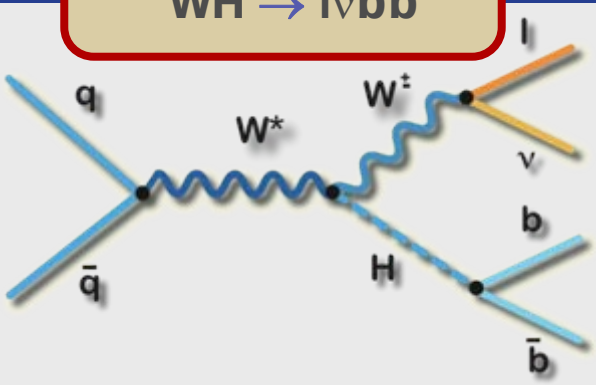
ZH→llbb



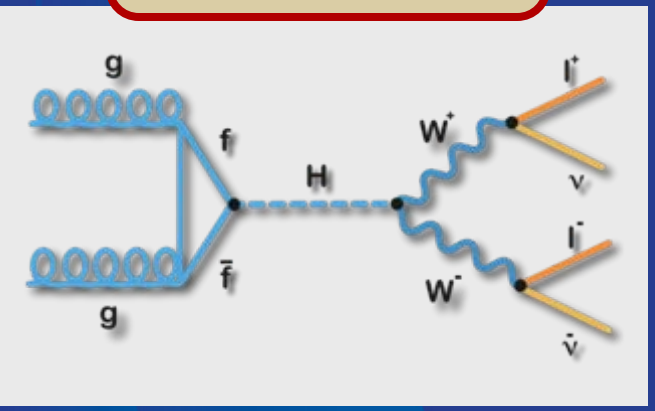
ZH →ννbb

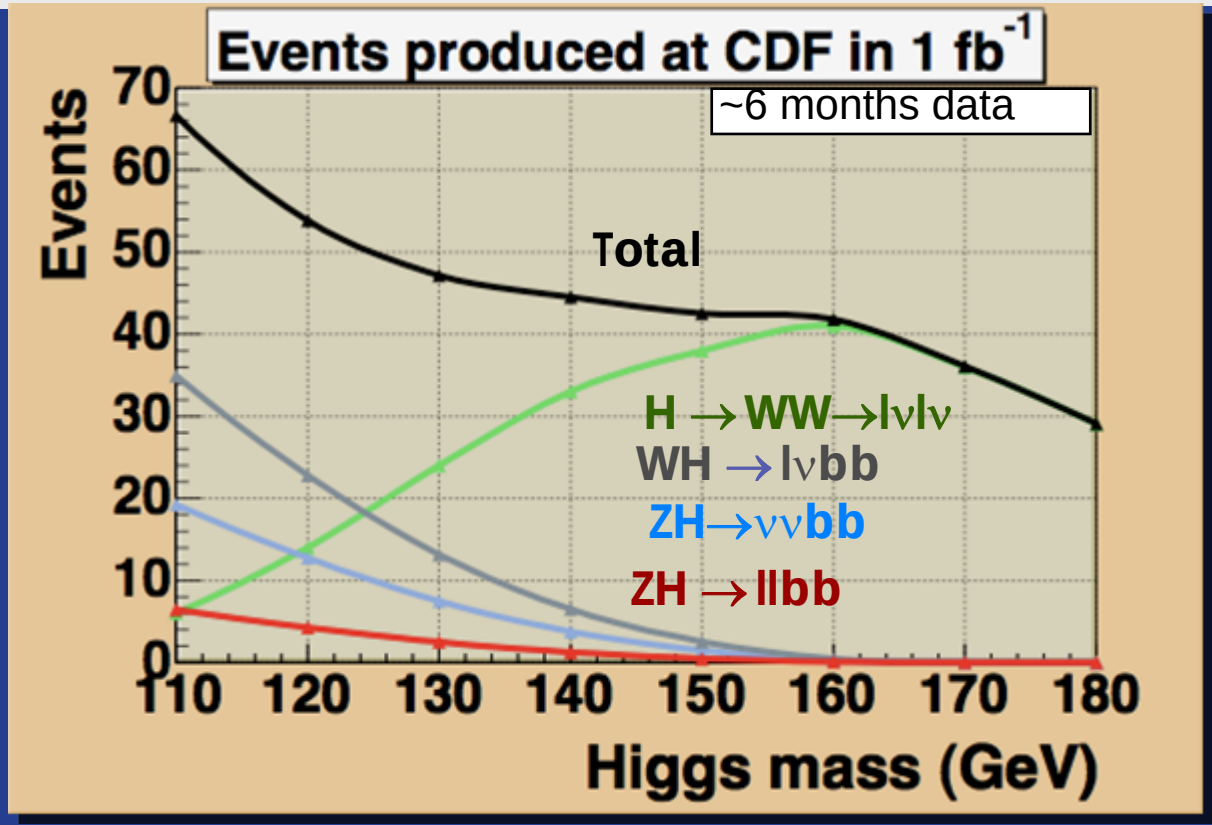


WH → lνbb

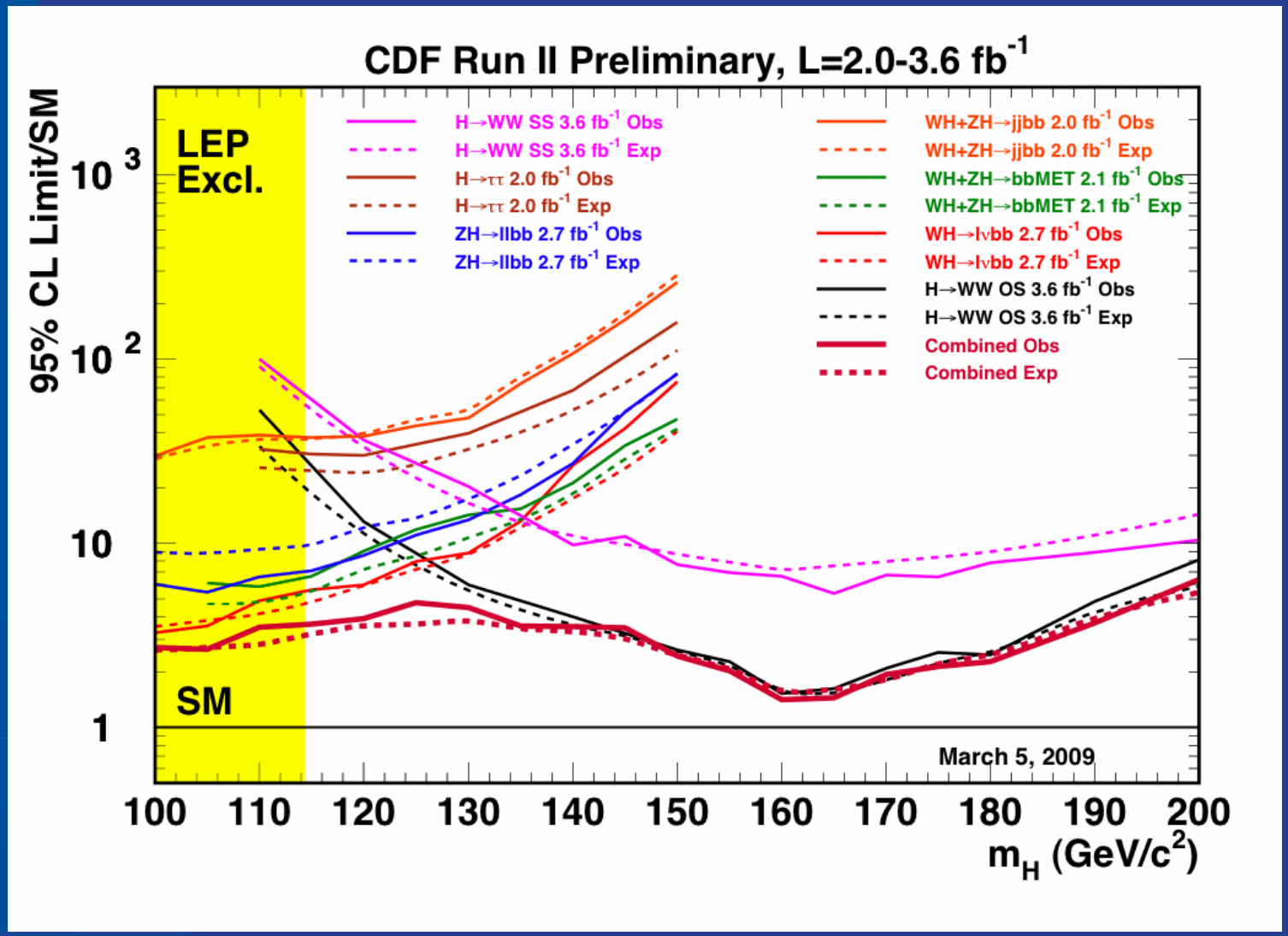


H → WW → lνlν

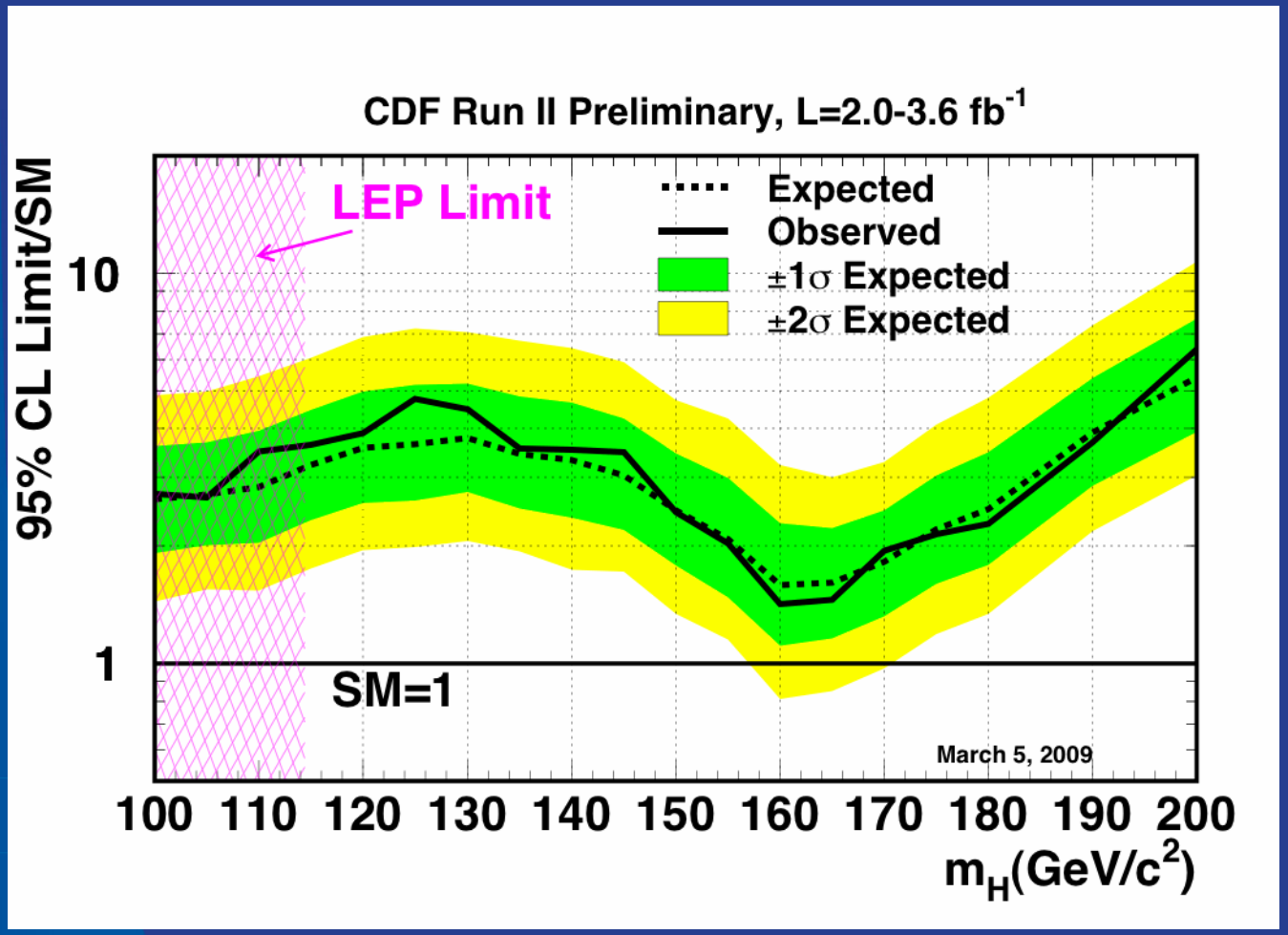




Higgs Search: many channels, large effort

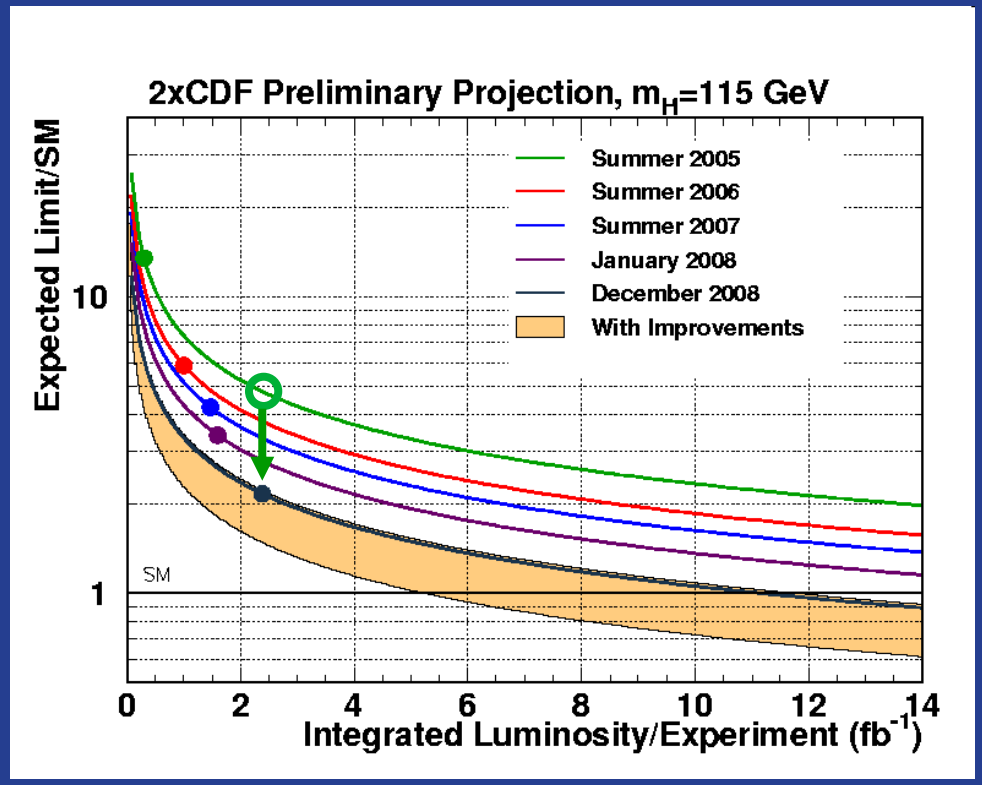


CDF Higgs Search Combination

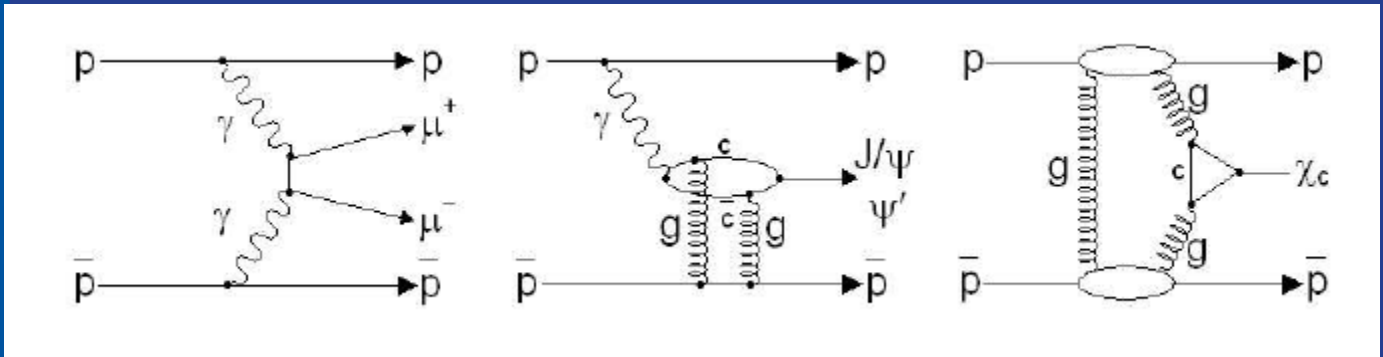


Outlook for the Higgs search

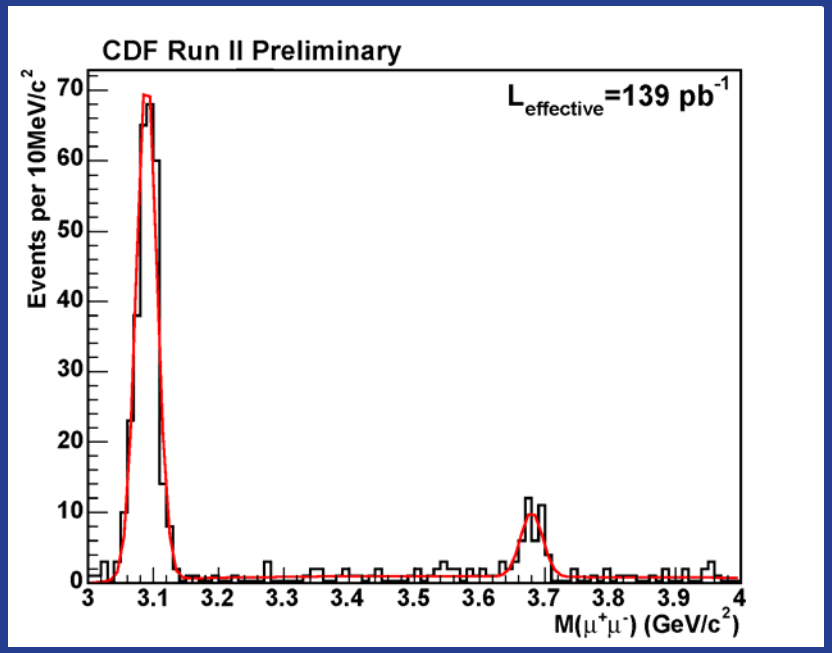
- Recent improvements include:
  - better lepton acceptance
  - smarter triggering
- More improvements in the pipeline
  - Better flavor tagging
  - Complementary triggers
  - Tau identification
  - Better jet, $\not{E}_T$ resolution



Observation of Exclusive Charmonium Production

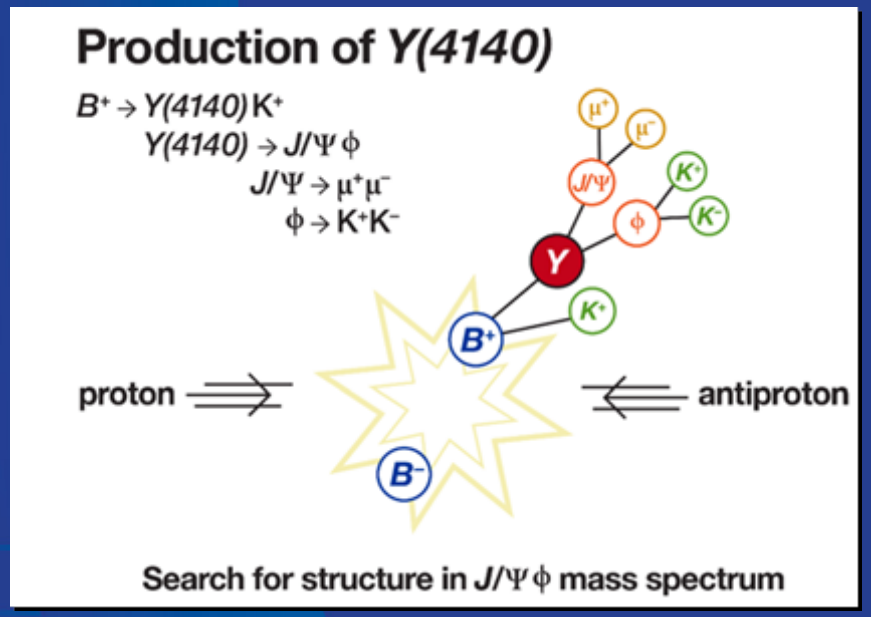


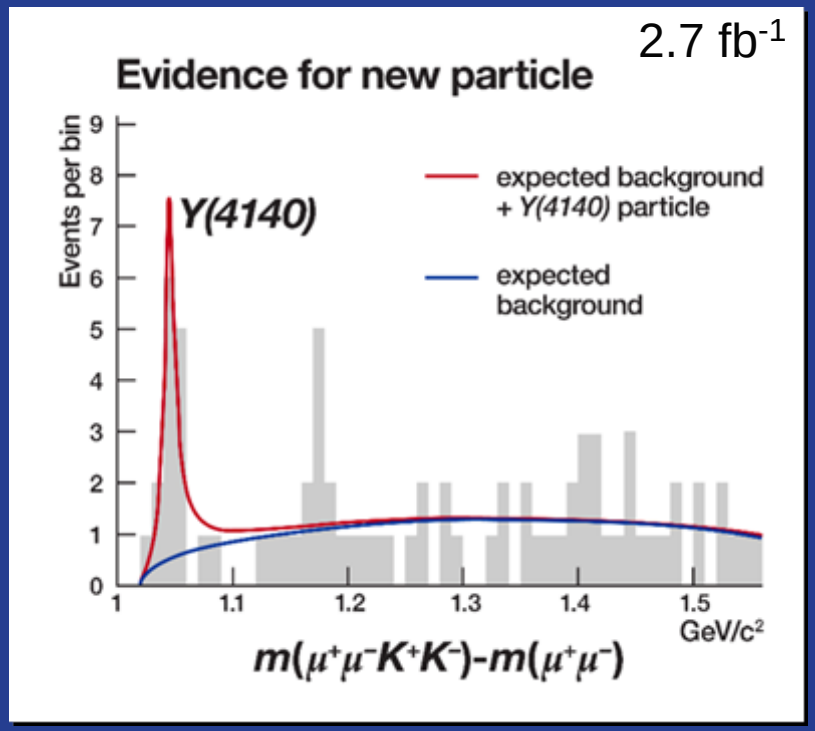
- Four new processes observed



Evidence for a new state of unknown composition

Y(4140)





These new discoveries yield a few events/fb^{-1} $\Rightarrow$ new areas of research @ 10 fb^{-1}

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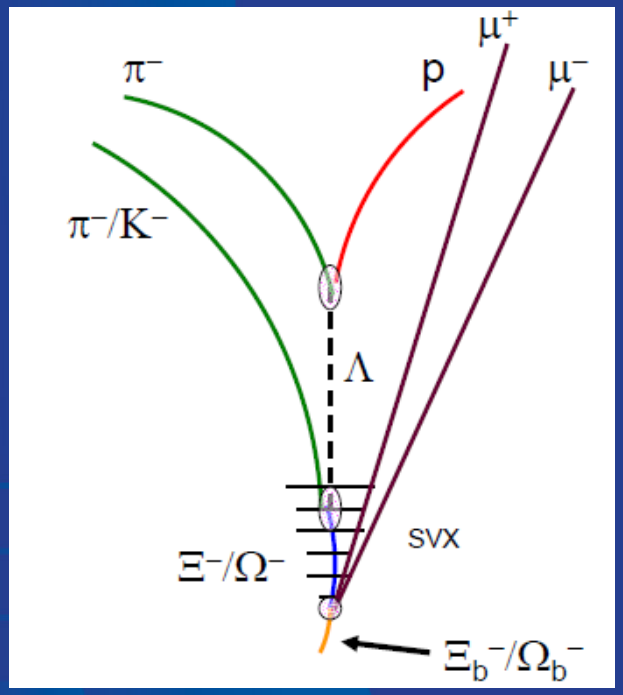
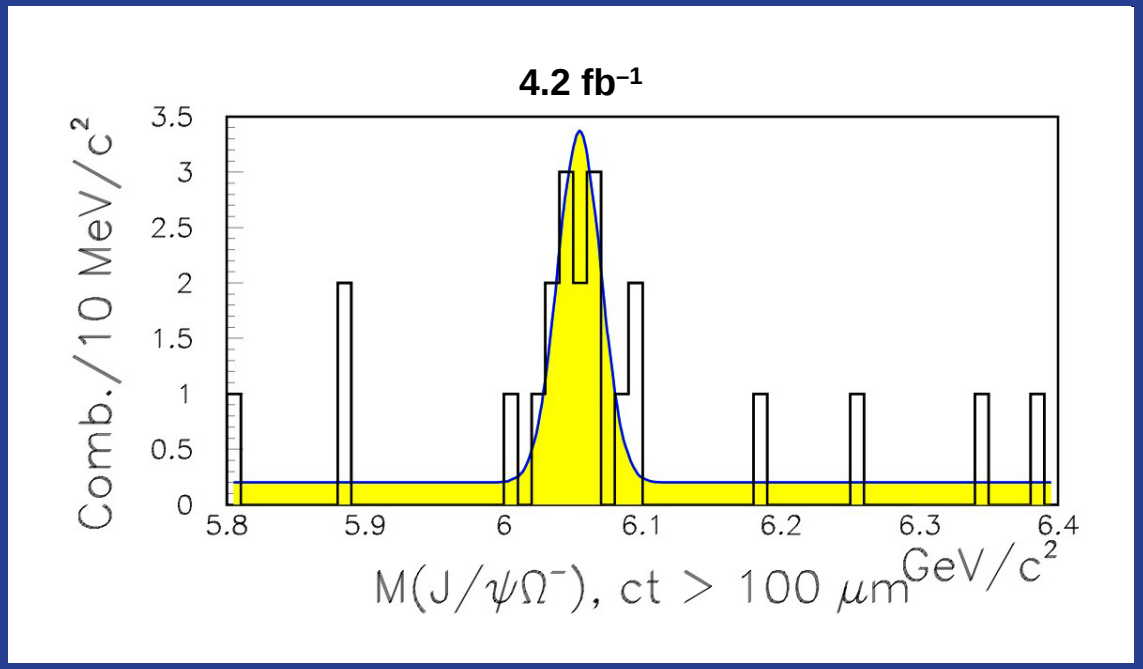
Measurements of b-baryon properties

- Observation of Ω_b (= |bss>) baryon in $\Omega_b \rightarrow J/\psi\Omega$
  - Precise mass measurement
  - First fully reconstructed lifetime measurement



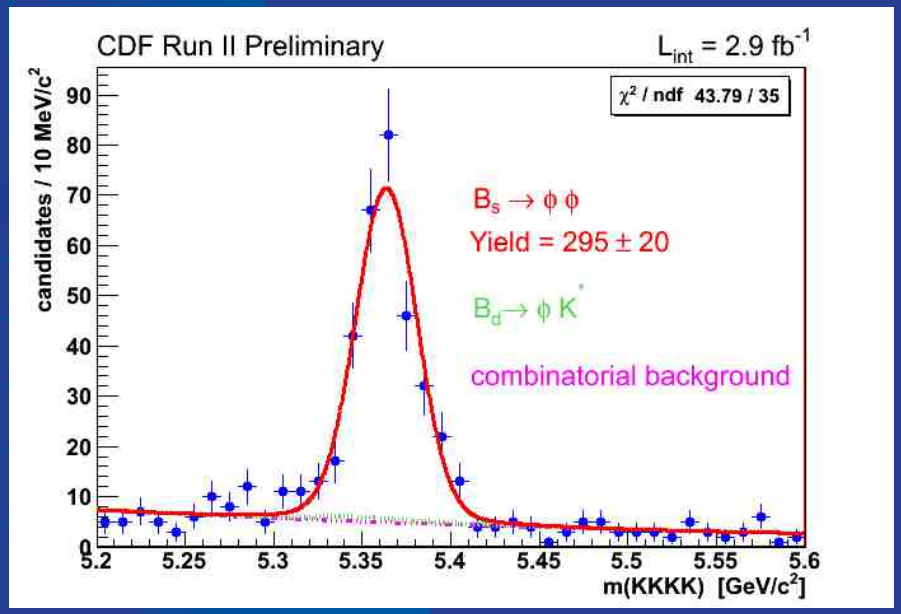


- Precise mass and lifetime measurements of Ξ_b

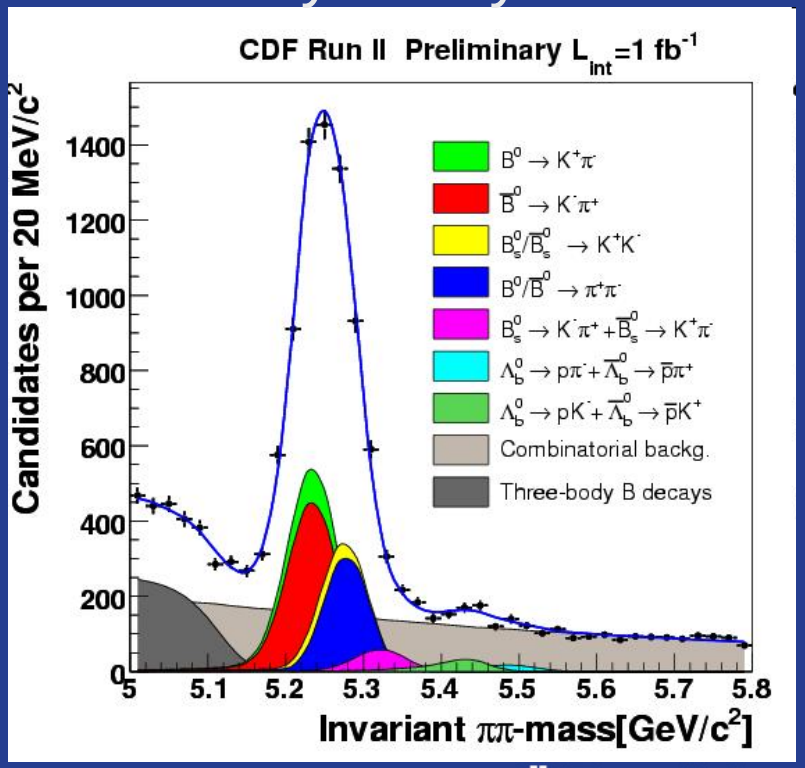
Hadronic B physics

- CDF displaced track trigger continues to provide a unique window to flavor physics

$B_s \to \phi\phi$ gluonic penguin

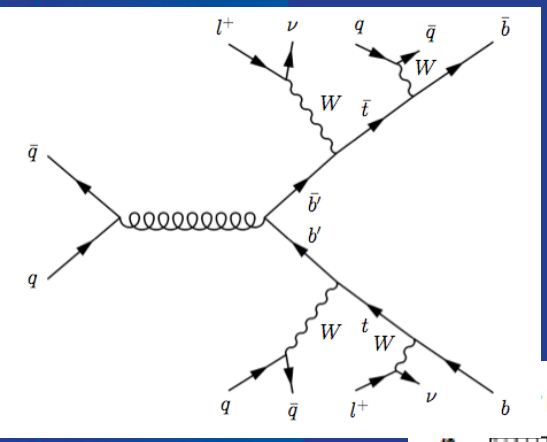


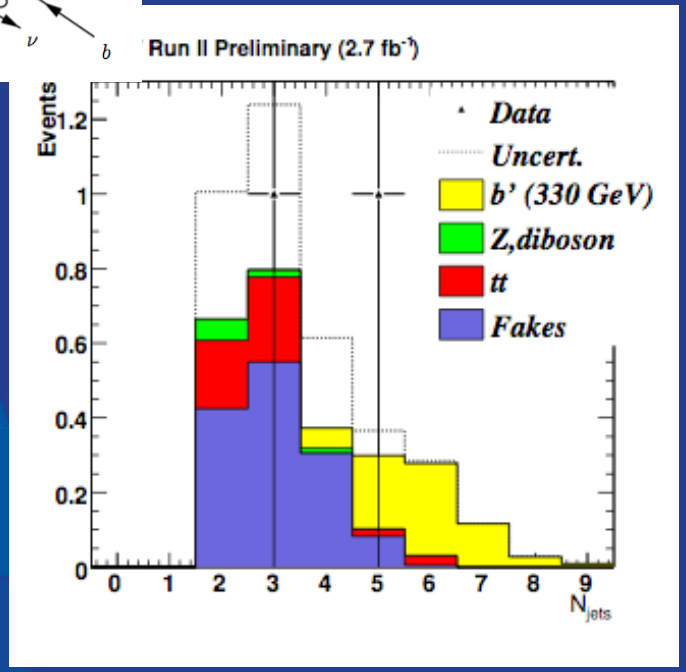
$B^0/B_s/\Lambda_b \to hh^{(\prime)}$ charmless two-body decays

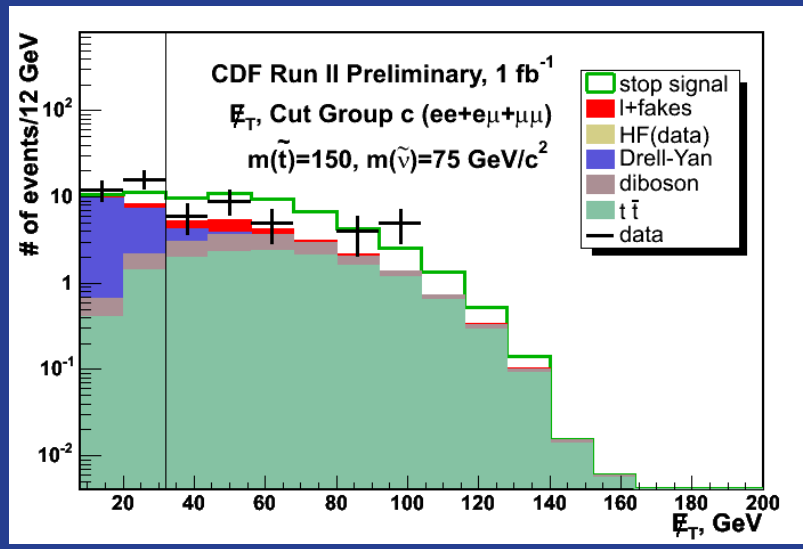


Searches for New Physics

- Continue to actively look for new physics in lots of channels
- Two examples of dilepton searches: b' and stop







Data Processing

- Resources:
  - 1 THz CPU @ Fermilab for data processing (FARM)
  - 8 THz CPU @ Fermilab for user analysis and MC generation
  - 2.5 THz CPU off-site for Monte Carlo generation
  - Also exploits GRID (Tevatron experiments were also instrumental in pioneering use of GRID technologies in operating experiments)
- FARM can process 30M events per day
  - We log 4-5 M events per day (unlikely to change significantly)
- CDF uses a one pass data processing scheme
  - Data processed every 6-8 weeks
  - Use final calibration, alignment, reconstruction
- Significant progress over the last few years in automating many steps of the calibration, alignment, reconstruction, ntuple production and validation.

Resources Needed - numbers

The "Effort" Numbers Detailed… (FTE's)

	CY 07	CY 09
Detector Ops	56	51
Offline	26	20
Algorithms	32	21
Management	10	10
Total for Ops	124	102

"Algorithms" category include

- **reconstruction efficiencies, B tagging (efficiency, SF, mistag matrix), Jet energy Scale,Simulation, Trigger (development and efficiencies)**

Preliminary Collaboration Survey re:2011

	2009	2010	2011	2012
tot FTE	~300	~250	~190	~140
U.S.	~46%	48%	50%	52%
postdocs	~75	~60	~40	~25
students	~95	~70	~50	~25
fac. level	~130	~120	~100	~90

Notes:

- **Preliminary #'s from ~2/3 survey (will complete the survey very soon)**
- **#'s are in FTE**
- **faculty level = teaching and non-teaching faculty + lab scientists**

Summary

- **Tevatron physics program compelling and as vibrant as it has ever been.**
  - Discoveries
  - Opening new areas for research
  - Improving precision
  - Test for New Physics
- **Physics output shows no evidence of decline**
- **Significant collaboration interest and manpower to run in FY2011.**