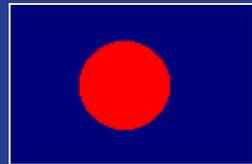


# CDF Detector Operations, Physics and Analysis Plans

Robert Roser  
Fermilab PAC  
June 24, 2011

# The CDF Collaboration



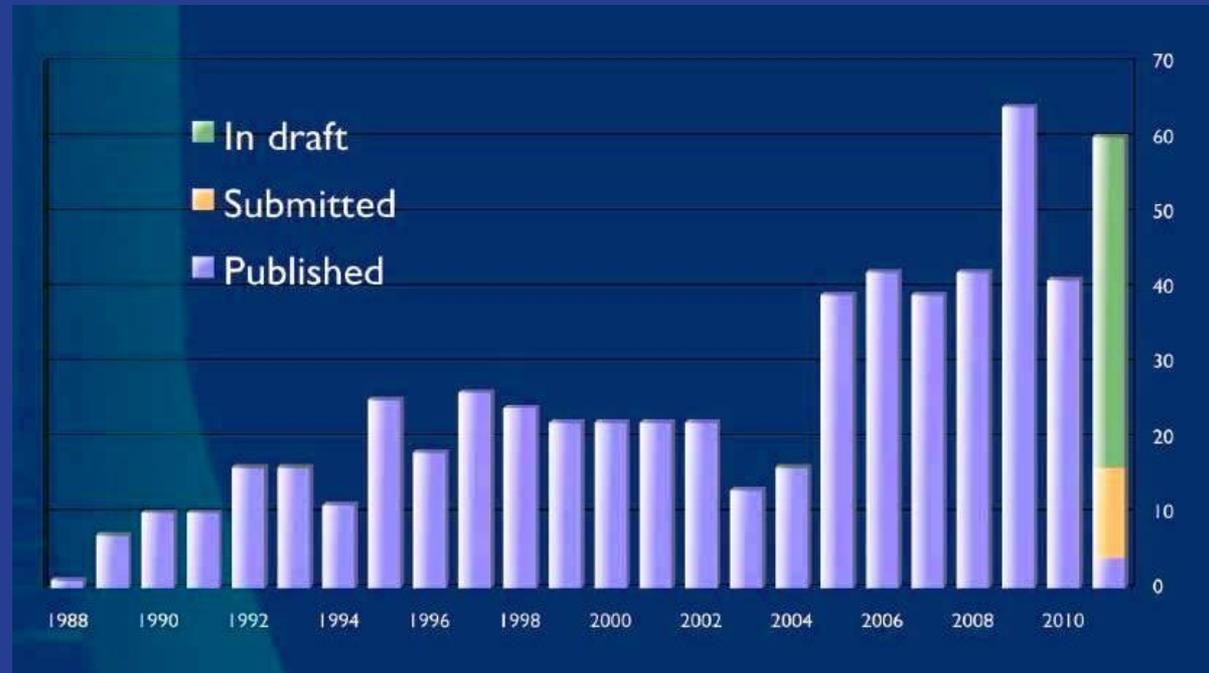
# CDF is Going Strong!

- Ph.D. Theses

- ▶ 270 in Run II,  
26 in CY10
- ▶ 70 more  
expected

- Publications

- ▶ 360 in Run II,  
41 in CY10
- ▶ 29 submitted in CY11 so far



Expect another 70-80 publications before we are done

# Operations

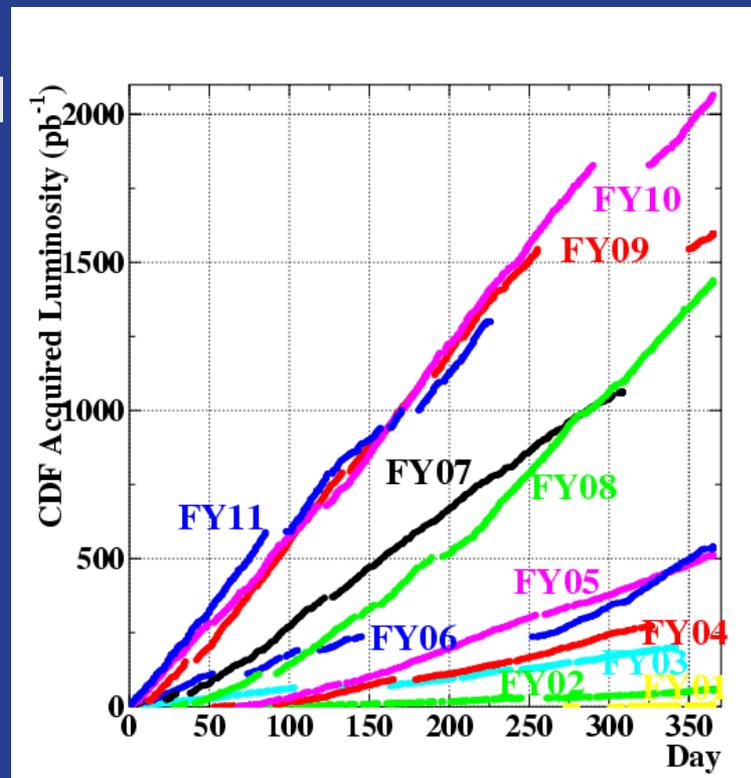
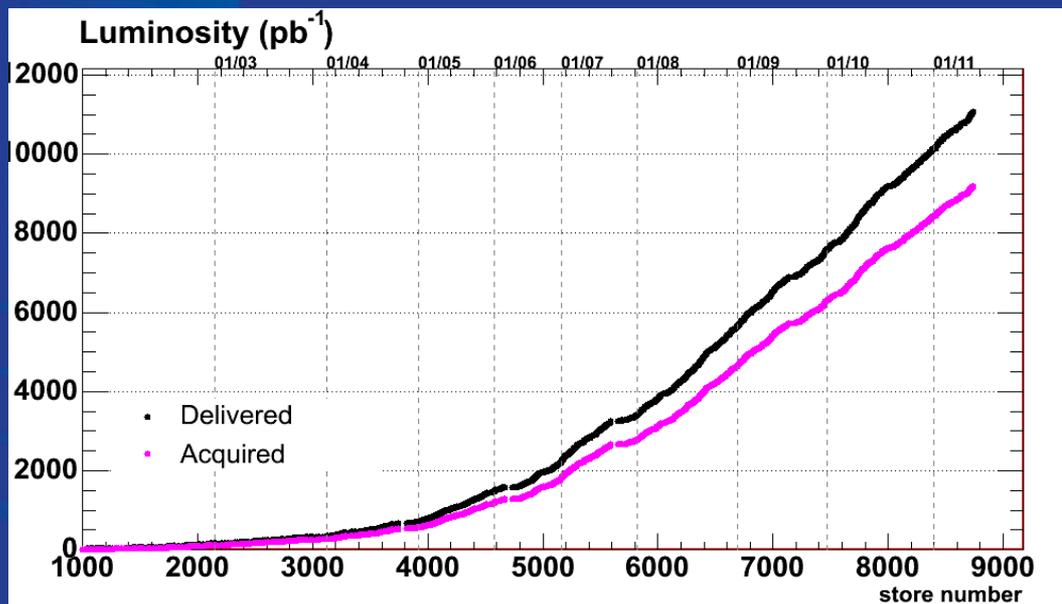
Total:

11.2 fb<sup>-1</sup> delivered 9.2 fb<sup>-1</sup> collected

Anticipated final dataset:

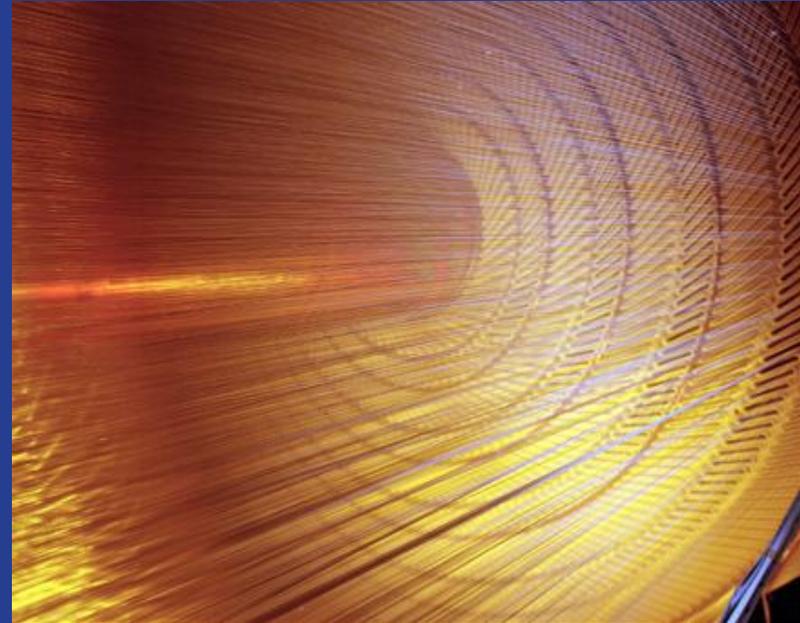
12 fb<sup>-1</sup> delivered 10 fb<sup>-1</sup> collected

Efficiency : similar to previous years



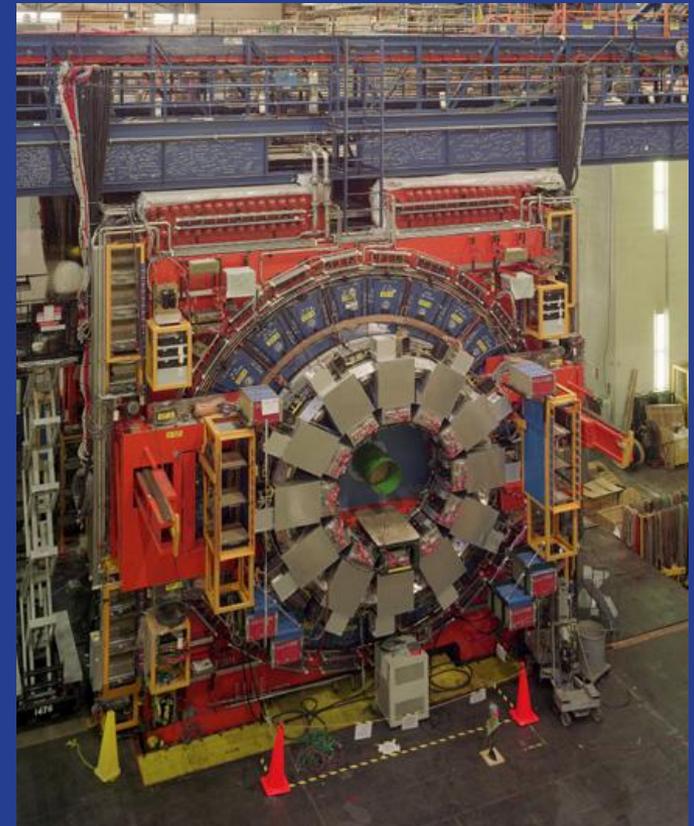
# Operations

- Smooth running, experienced crew
  - ▶ broken COT wire, minimal data loss
  - ▶ replaced db machine
- Record luminosities
  - ▶ running at  $405E30$
  - ▶ no trips or other detector problems
  - ▶ dead-time high ( $\sim 35\%$  for short period) , but behaved as predicted
- 5 ▶ this is effective running!



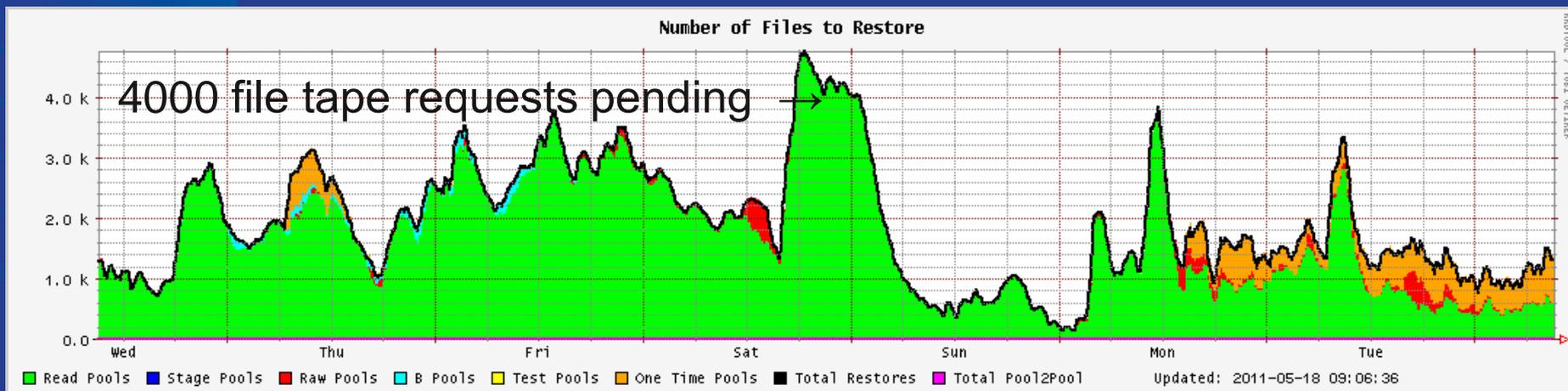
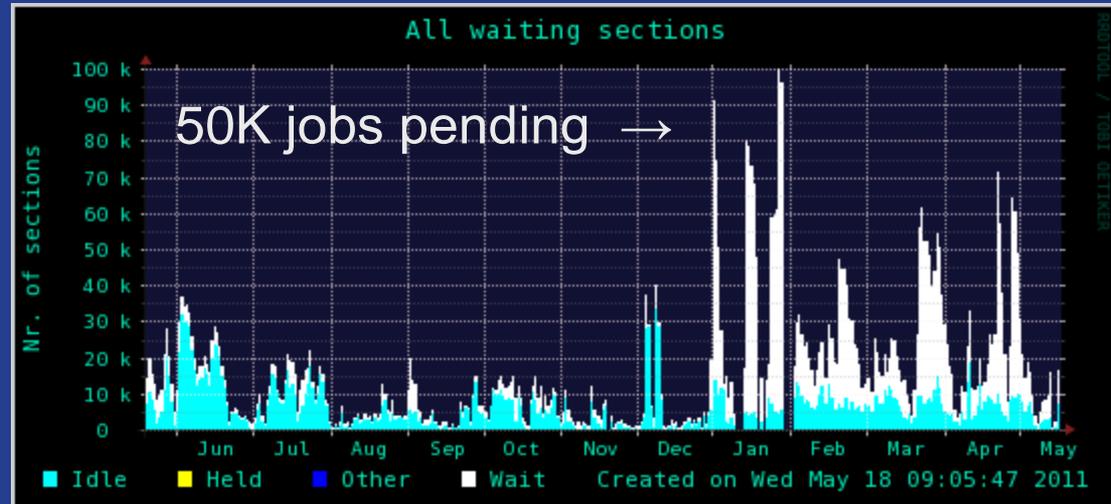
# Operations – End of Life

- Oct 1, 2011 – secure CDF
  - ▶ no cosmic runs
  - ▶ perform final detector survey
  - ▶ warm cryogenics
  - ▶ purge gas
  - ▶ drain water
  - ▶ re-purpose L3 computing
  - ▶ turn B0 over to D&D plan



# Computing Resources

- demand similar to previous years
- CPU at capacity
- tape drive capacity a notable annoyance
- major dCache upgrade



# Computing Plans

- At capacity last year
- Expectation to continue at capacity in FY12
  - ▶ surge for final Higgs results
  - ▶ final data milestone legacy activity
  - ▶ scheduled special projects
  - ▶ small probability of a large reprocessing
- Anticipate a notable decrease in demand for FY13

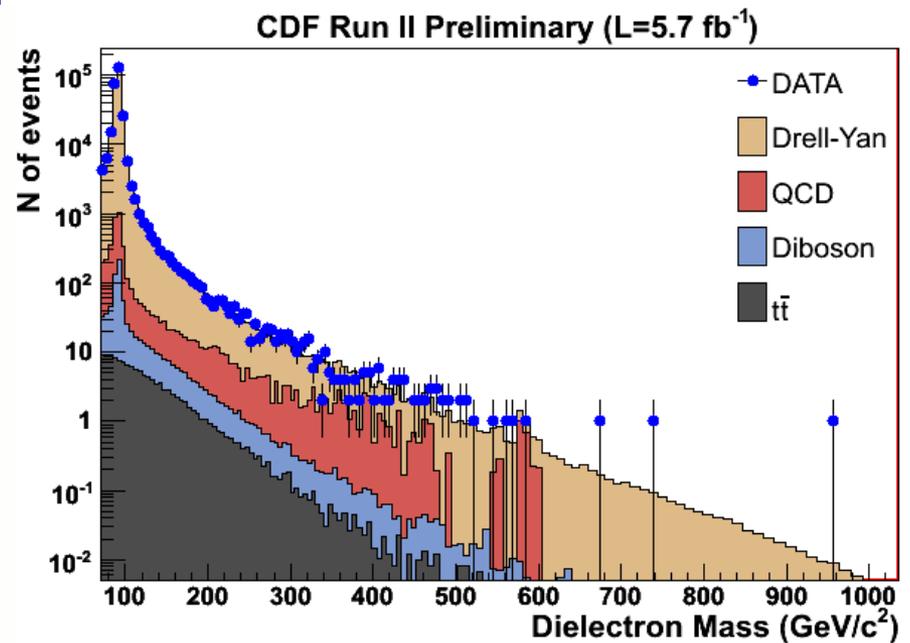
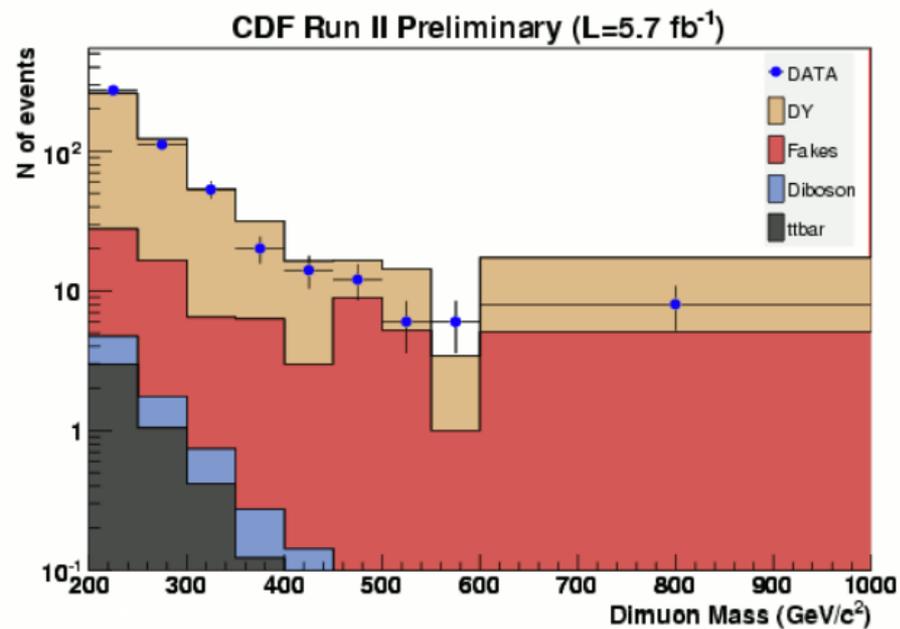
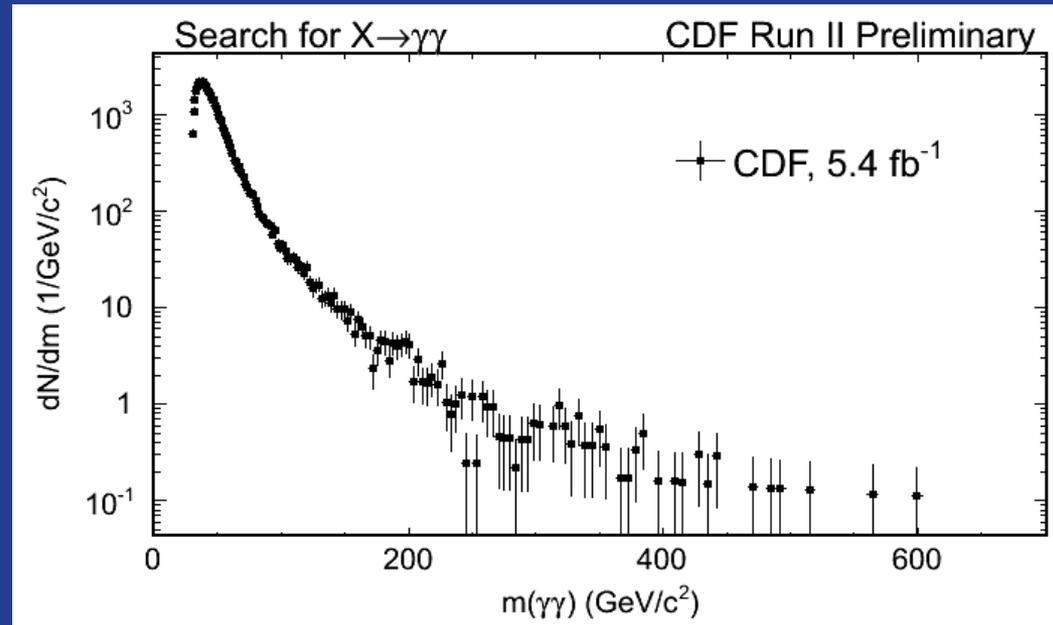
# Data Preservation

- Continue full physics capability for 5 years
  - ▶ requires:
    - farm and interactive CPU
    - access to all data
    - production and ntupling capability
    - full MC simulation, with standard generators
  - ▶ 1y full capacity (FY12), 1 reduced, 3 with capacity negotiated
  - ▶ requires planning and funding (for ex. tape migration)
- Continuing past 5 years
  - ▶ concepts under discussion
  - ▶ how will LHC discoveries overlap Tevatron data?
  - ▶ will require funding and attracting/retaining experts

# Exotics

# High mass Searches

- Sensitive to narrow peaks
- $\gamma\gamma$ ,  $e^+e^-$  and  $\mu^+\mu^-$  spectra
- world's highest?  $e^+e^-$  candidate so far...



# Exotics Group Plans

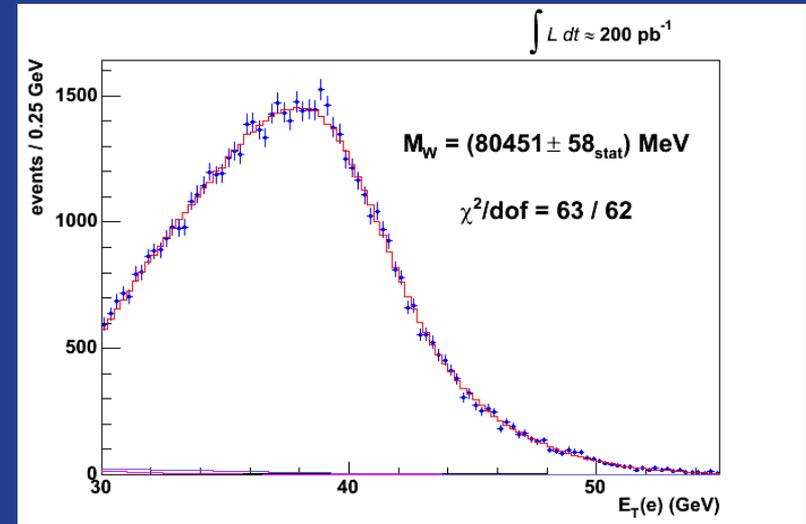
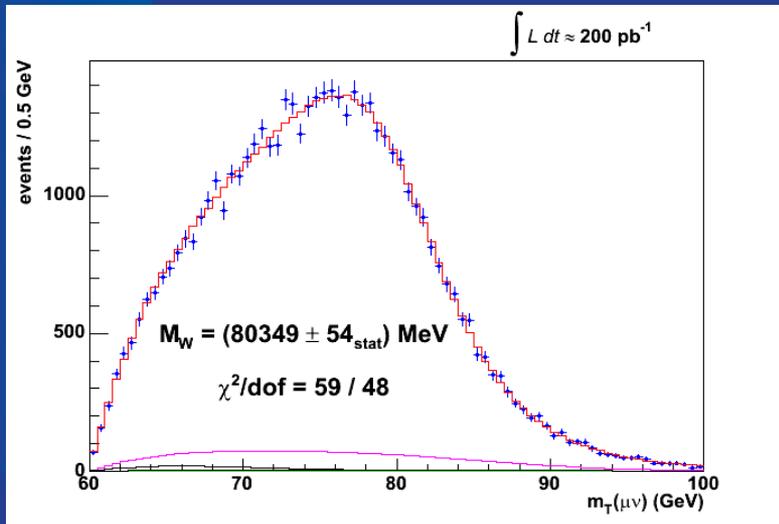
- Severe case of LHC-itis
- wrap up current work and publish
- follow up on LHC discoveries!?

# Electroweak

# W mass

Efforts from 2000 to 2007...

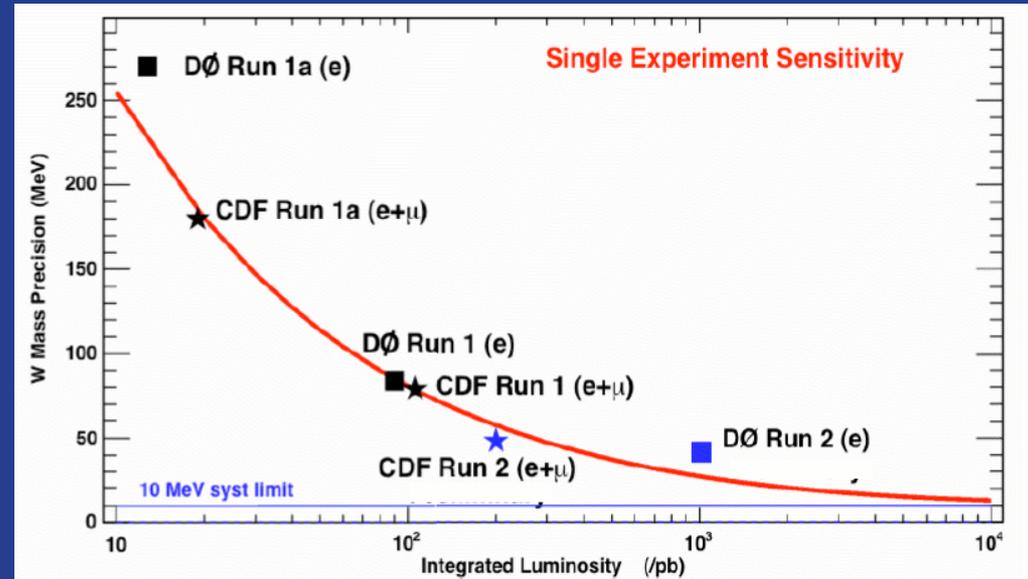
- CDF 200pb<sup>-1</sup> 80413 ±34<sub>stat</sub> ±34<sub>syst</sub> MeV = 80413±48 MeV
- Combined with DØ 1.2fb<sup>-1</sup> 80420 ± 31 MeV  
more precise than LEP combined...



# W mass

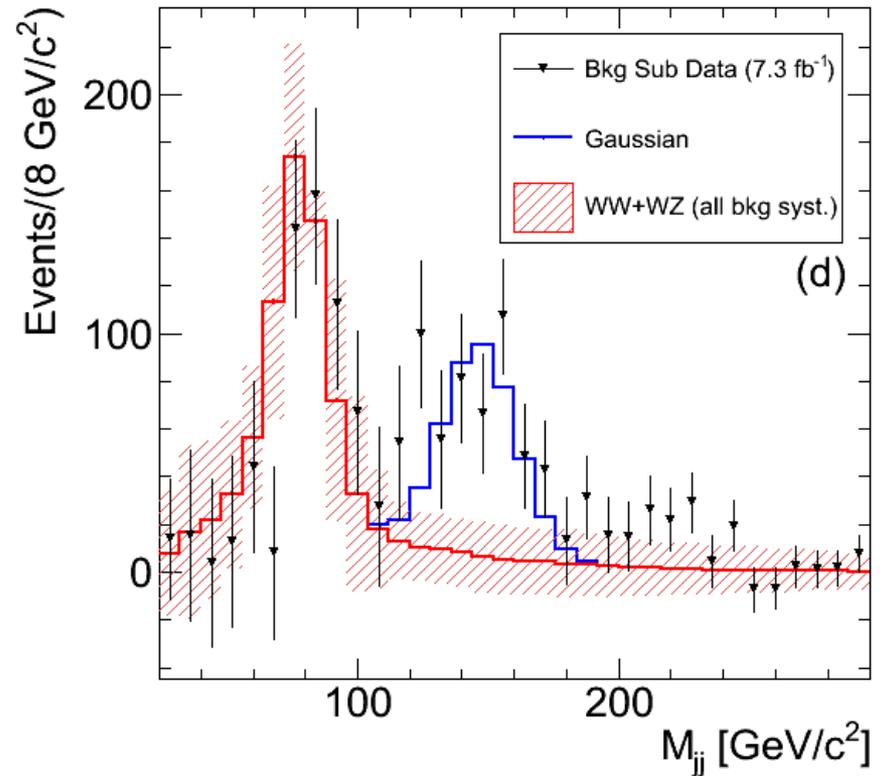
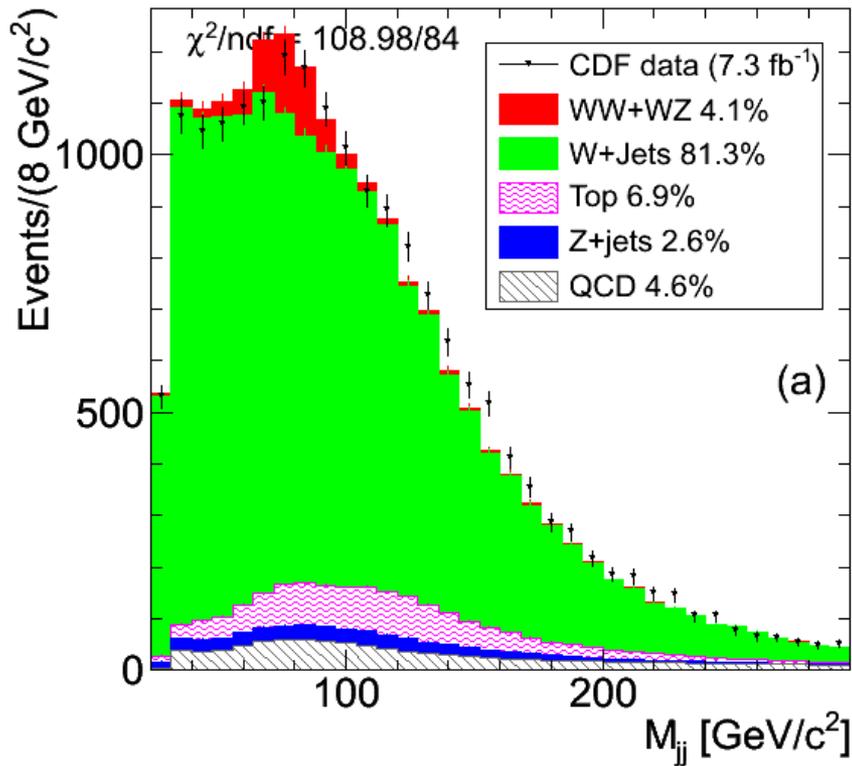
- leading systematics are statistical (green)
- improvements in QED models available
- improved W asymmetry would help PDF
- significant improvement in tracker and calorimeter understanding
- goals is  $\delta M = 20$  MeV
- $2\text{fb}^{-1}$  analysis is well underway – result this summer
- interest in  $10\text{fb}^{-1}$

	<i>electrons</i>	<i>muons</i>	<i>common</i>
W statistics	48	54	0
Lepton energy scale	30	17	17
Lepton resolution	9	3	-3
Recoil energy scale	9	9	9
Recoil energy resolution	7	7	7
Selection bias	3	1	0
Lepton removal	8	5	5
Backgrounds	8	9	0
production dynamics	3	3	3
Parton dist. Functions	11	11	11
QED rad. Corrections	11	12	11
Total systematic	39	27	26
Total	62	60	



# W +2jets

7.3 fb<sup>-1</sup>



- present in e and  $\mu$
- $M=147\pm 4$
- width consistent with res.

- $4.1 \sigma$  w/trials factor and syst

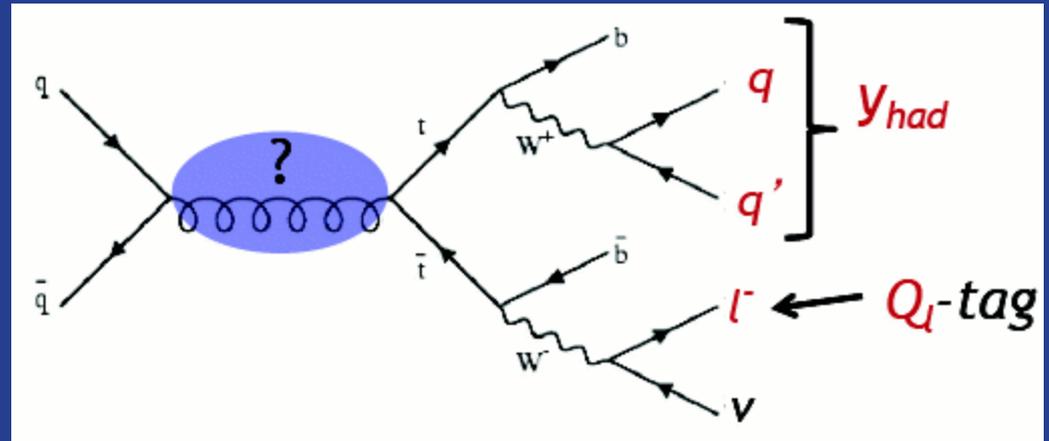
# Electroweak Group Plans

- W mass  $2\text{fb}^{-1}$  underway
- W mass  $10\text{fb}^{-1}$  under consideration
- planning  $\sin \theta_W$  from Z kinematics
- full dataset WW/WZ
- final W asymmetry
  
- investigations with W+2j excess

Top

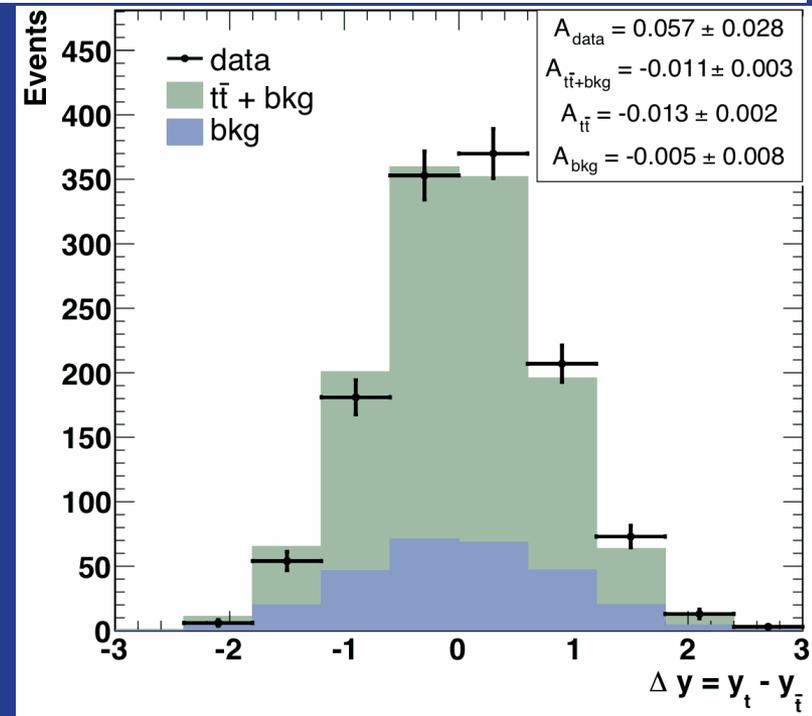
# Top Charge Asymmetry

- an asymmetry could indicate a interference with new physics



- $5.3 \text{ fb}^{-1}$
- reconstructed  $t\bar{t}$  in  $l+jets$
- $t$  and  $t\bar{t}$  consistent (CP)
- parton level,  $t\bar{t}$  frame

Obs:  $0.158 \pm 0.075$  (stat+sys)  
 QCD:  $0.058 \pm 0.009$  (MCFM)



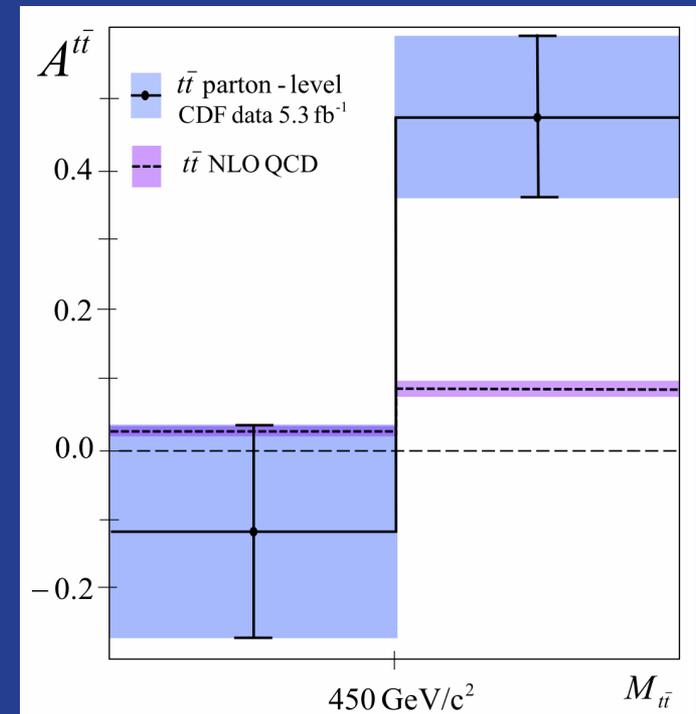
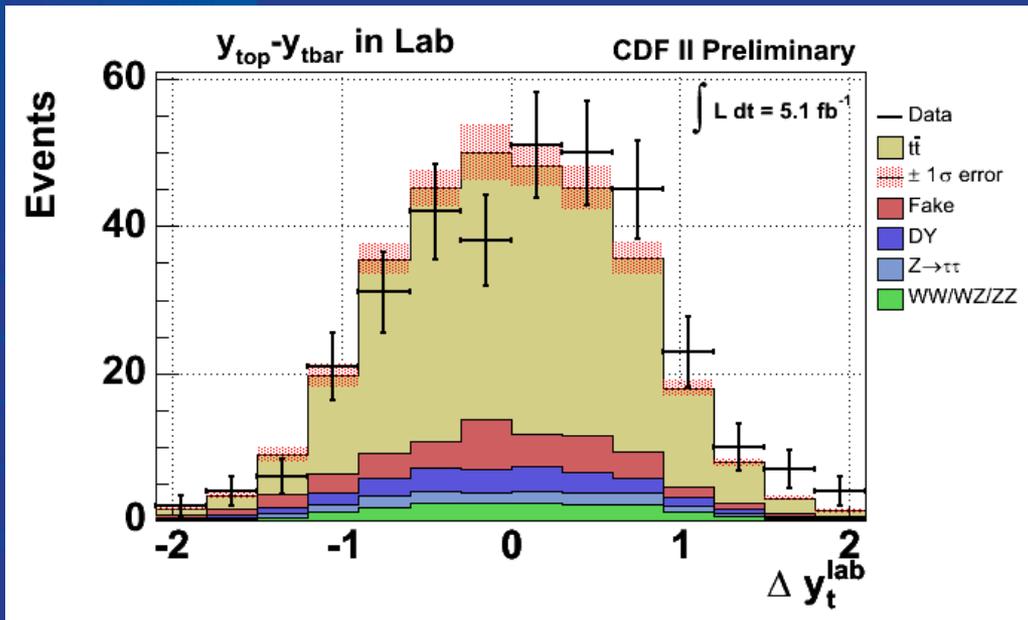
# Top Charge Asymmetry

- dileptons are consistent (parton level, tt frame)

$$A_{fb (corr)} = 0.42 \pm 0.15_{stat} \pm 0.05_{syst} \quad A_{fb (theory)} = 0.06 \pm 0.01$$

- strongly enhanced for  $M(tt) > 450$  GeV

$$A_{fb (corr)} = 0.475 \pm 0.114 \quad A_{fb (theory)} = 0.088 \pm 0.013$$



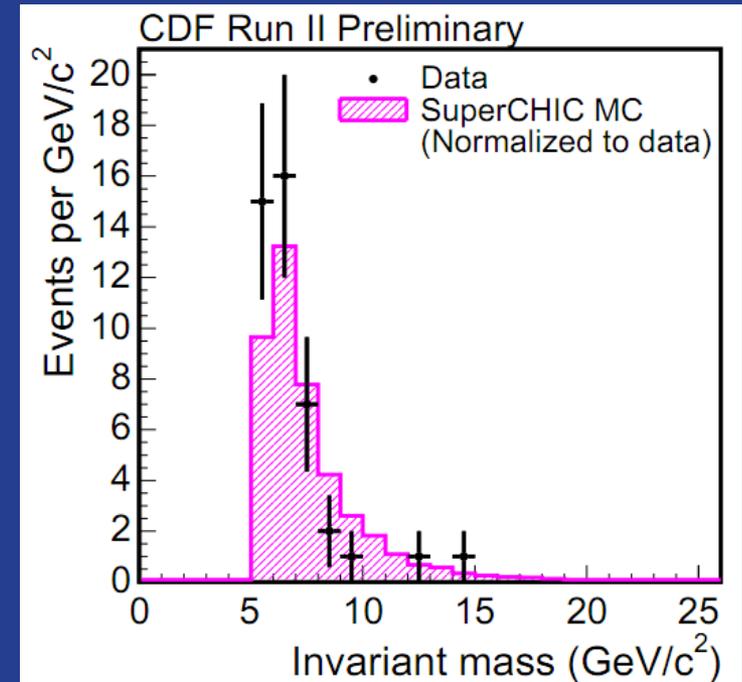
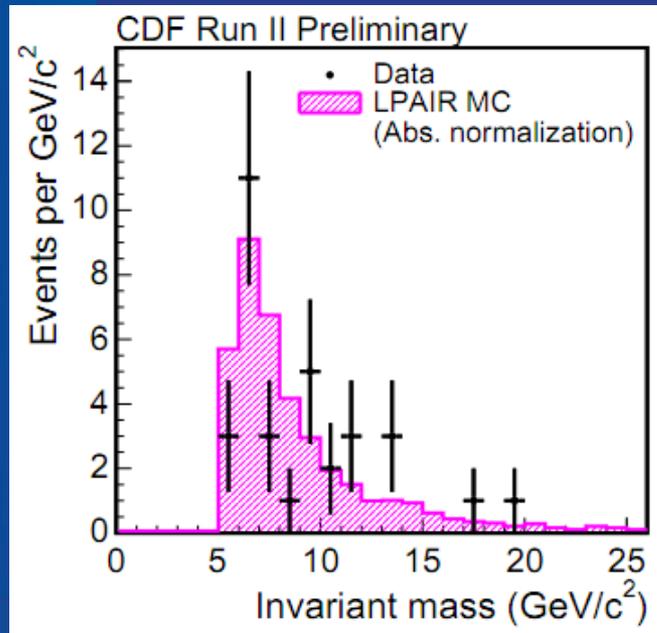
# Top Group Plans

- Completing the CDF top suite
  - ▶ single top (S+T channels)
    - this summer and final sample
  - ▶ final top mass measurement and combination
    - this summer and final sample?
  - ▶ kinematics of top events
  - ▶ measurements of spin correlations
- Investigating hints
  - ▶ top asymmetry
  - ▶ top polarization as a function of asymmetry
  - ▶ investigate top charge further

# QCD

# Exclusive Diphoton Production

- colorless exchange
- $1.1 \text{ fb}^{-1}$
- $E_T > 2.5 \text{ GeV}$
- 32 exclusive  $e^+e^-$  events (a QED control sample)
- 43 exclusive  $\gamma\gamma$  events,  $<16\%$   $di-\pi^0$



# QCD Group Plans

- most measurements are unique to the Tevatron, but ...
- fundamentals have been addressed
- many are systematics or theory limited
- limited personpower

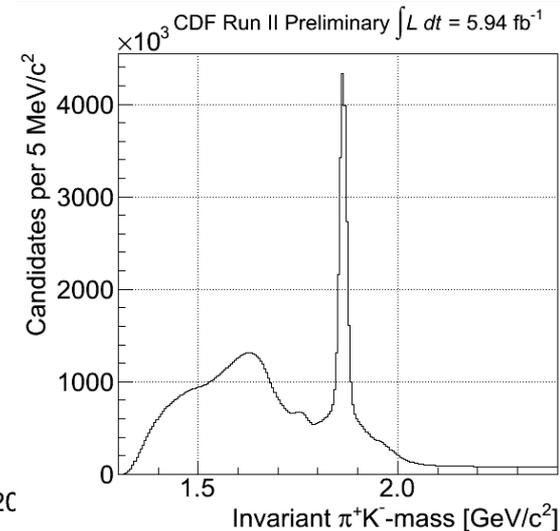
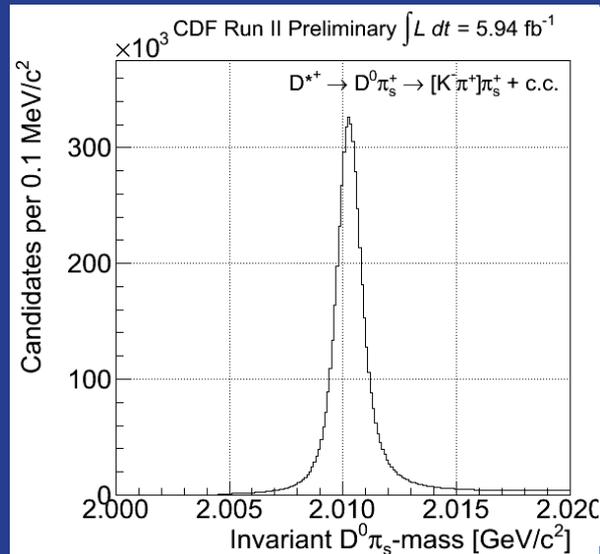
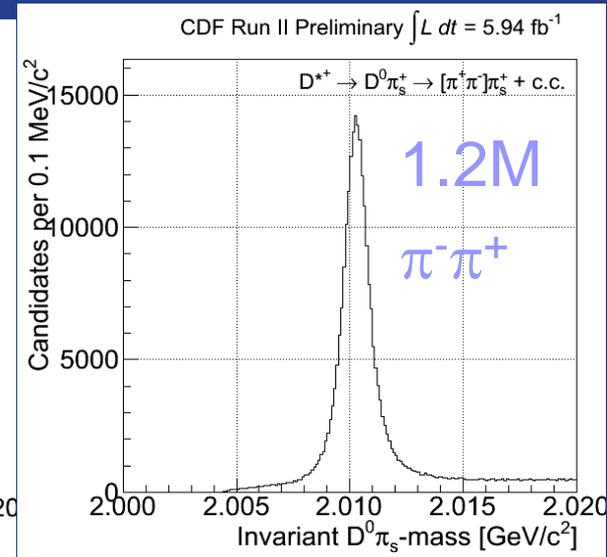
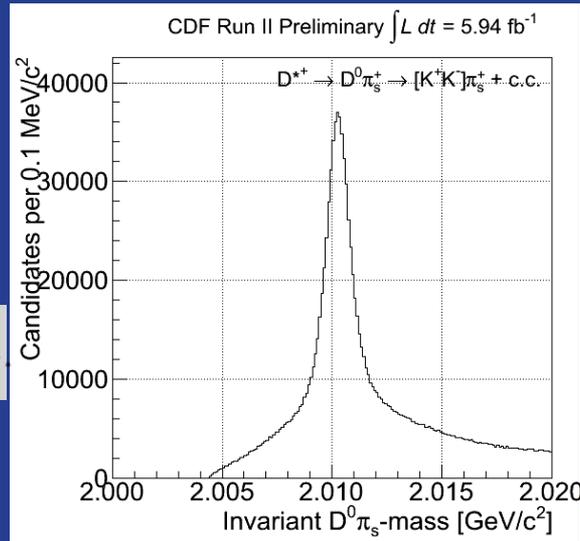
# B Physics

# CP Violation in Charm Decays

- CPV in charm would point to new physics
- Asymmetry

$$A_{CP}(h^+h^-) = \frac{\Gamma(D^0 \rightarrow h^+h^-) - \Gamma(\bar{D}^0 \rightarrow h^+h^-)}{\Gamma(D^0 \rightarrow h^+h^-) + \Gamma(\bar{D}^0 \rightarrow h^+h^-)}$$

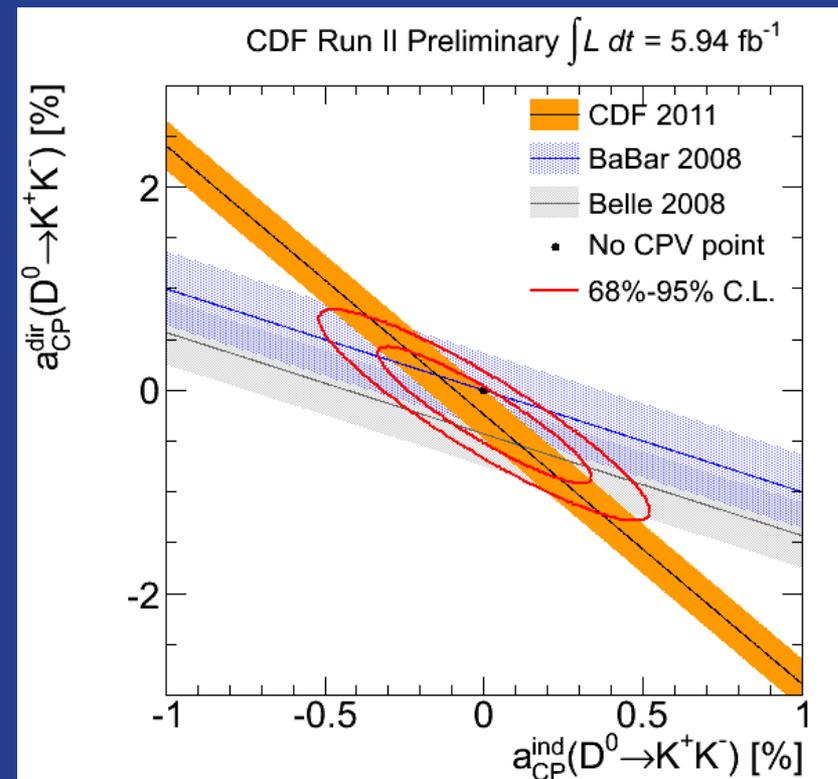
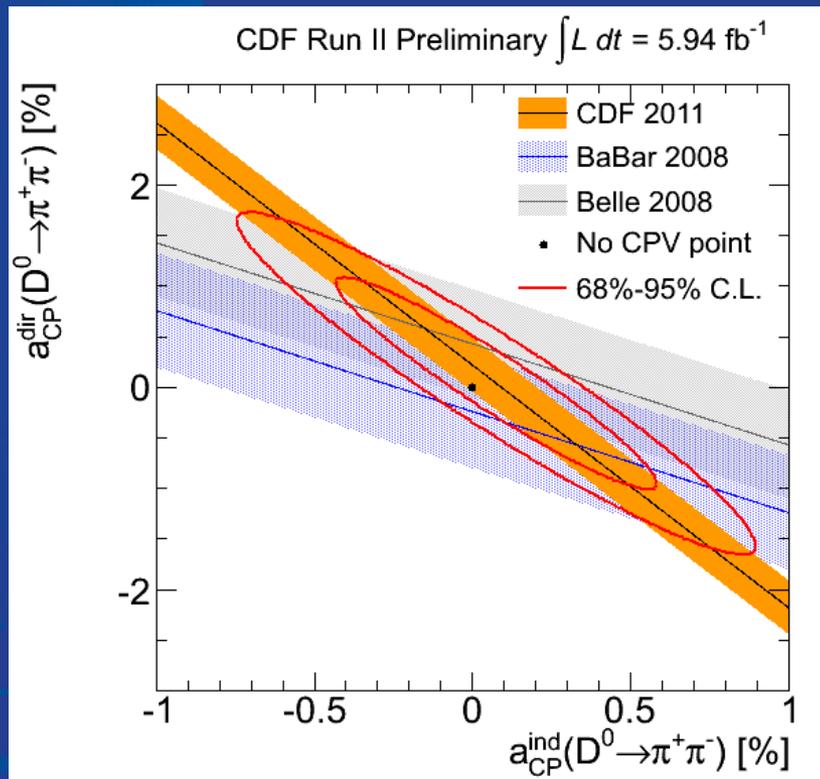
- Negligible penguin contribution to charm decays in SM
- $D^*$  tag for charm or anti-charm
- Use data to correct for detector asymmetry



# CP Violation in Charm decays

$$A_{CP}(D^0 \rightarrow \pi^+ \pi^-) = [+0.22 \pm 0.24 \text{ (stat.)} \pm 0.11 \text{ (syst.)}] \%$$

$$A_{CP}(D^0 \rightarrow K^+ K^-) = [-0.24 \pm 0.22 \text{ (stat.)} \pm 0.10 \text{ (syst.)}] \%$$



- Expect to be world's best for several years!

# B Physics Group Plans

## Finishing shortly

- $B_{d/s} \rightarrow \mu\mu$
- $\sin 2(\beta_s)$
- $B_{d,s} \rightarrow hh$
- $B \rightarrow K(^*)\mu\mu$
- D mixing

## Mid term

- $B_s \Delta\Gamma$  from  $B_s \rightarrow D_s D_s$ ,
- measurement of Y polarization
- $A_{SL}$  measurement in response to DØ

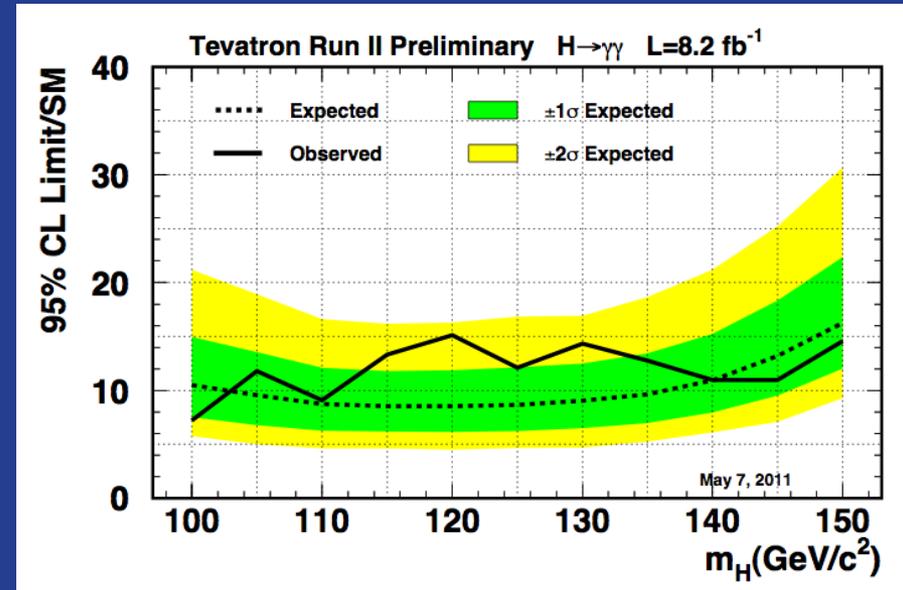
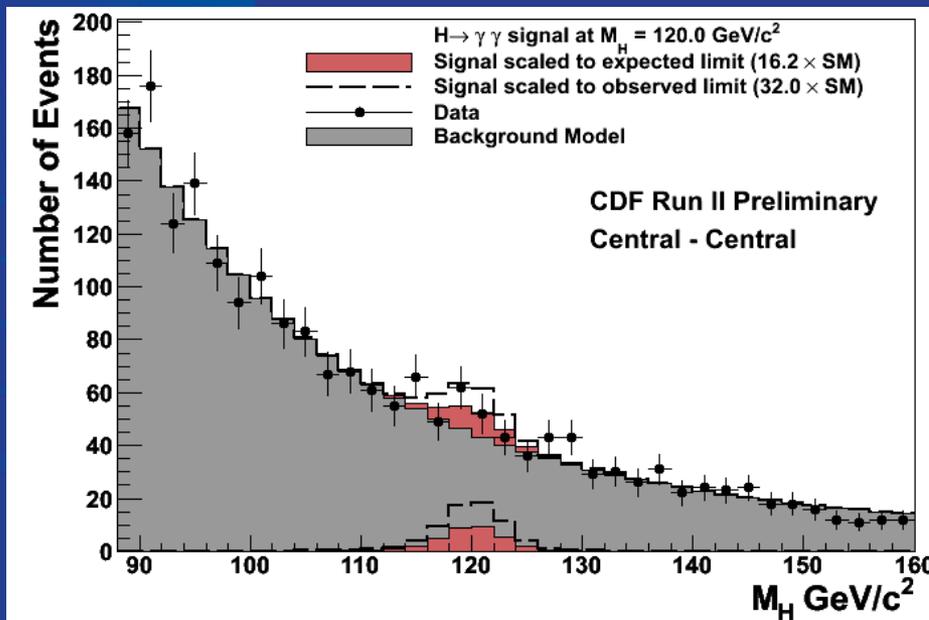
## Unique in the long term

- production cross-sections, polarizations, etc...
- precise CPV where p-pbar collisions are crucial to ensure no CP-asymmetry is present at production

# Higgs

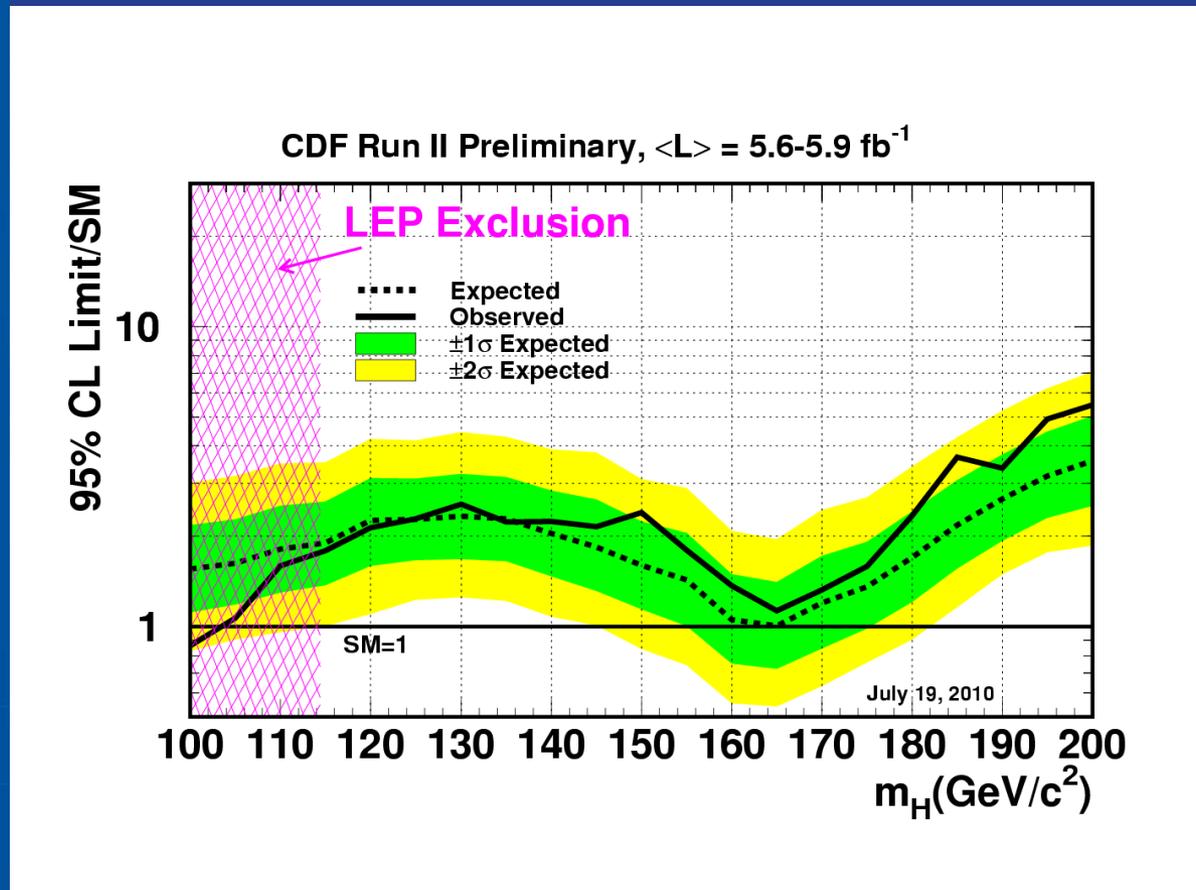
# SM $H \rightarrow \gamma\gamma$

- two photons+
- several firsts in techniques!
- CDF limits  $\sim 13xSM$ ,  
combined with DØ's:  $\sim 8 xSM$
- derived fermiophobic limit  
 $H > 114 \text{ GeV}$  – world's best!



# SM Higgs - Low-mass

SM Higgs limit, CDF-only, low and high mass analysis, 5.9 fb<sup>-1</sup>

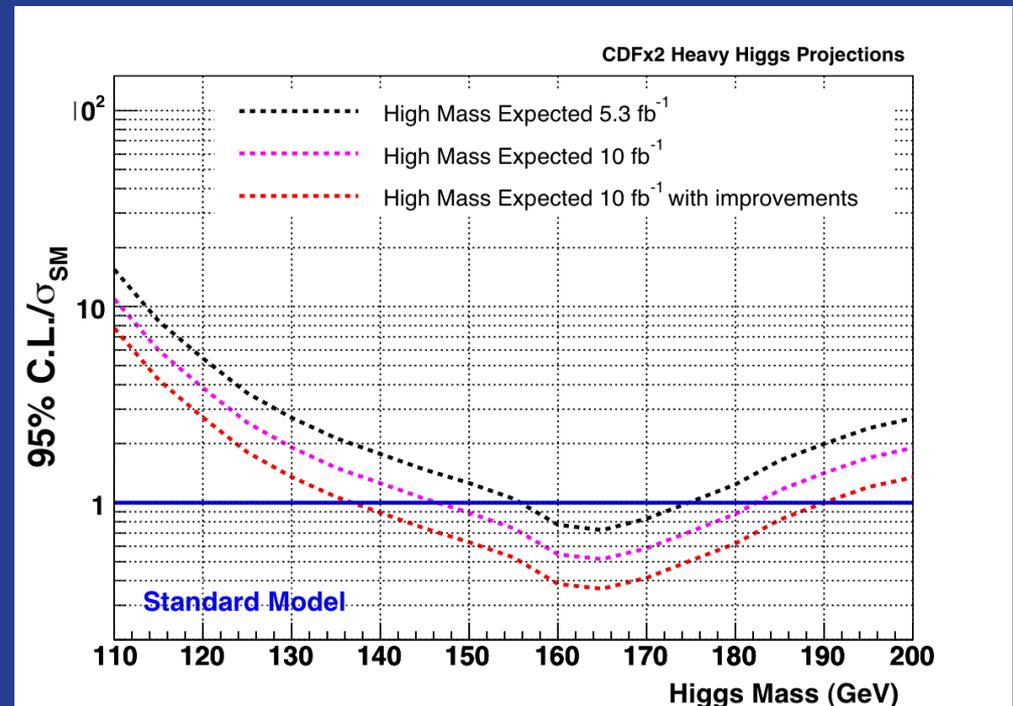


## SM Higgs - Low-mass, Plans

- New combination for summer 2011 - not all improvements will be available or included in all channels
- In progress
  - ▶ lepton ID: advanced selection, using all that were triggered
  - ▶ mass resolution: incorporating particle flow ideas, optimized energy corrections, event techniques
  - ▶ B-tagging:
    - 10% improvement in 40% of data from reprocessing – done!
    - 10+% additional from combined, re-optimized algorithms
- Final combination for winter 2012, or summer 2012 if necessary – will get below advertised expected sensitivity in 2012
- LHC competitive with  $H \rightarrow \gamma\gamma$  with few  $\text{fb}^{-1}$ , WH with 30  $\text{fb}^{-1}$

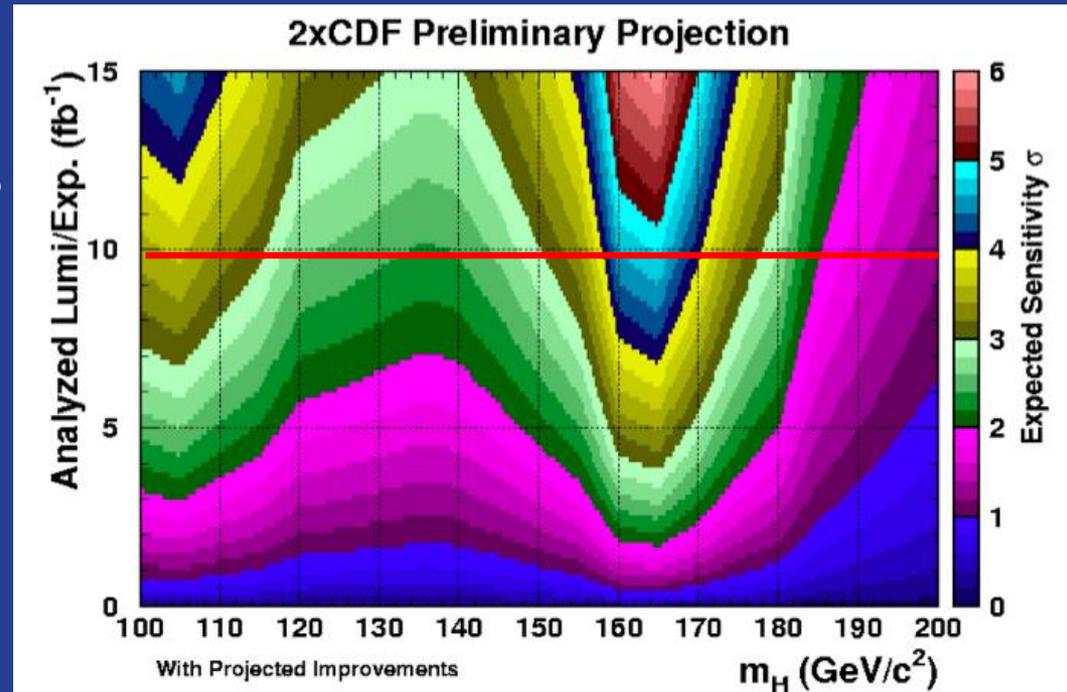
# SM Higgs - High-mass plans

- New combination for summer 2011
  - ▶ lepton isolation overlaps
  - ▶ improved plug ID
  - ▶ new categories
- expect to achieve projected improvements
- LHC expected to be competitive summer 2011



# SM Higgs Final Word

- Expect to collect  $10 \text{ fb}^{-1}$  by October
- Significant improvements for this summer
- More improvements for the final result in 2012
- We expect to be able to at least meet these sensitivity projections in 2012



# Coming Down the Stretch

# Transition to analysis-only collaboration

Spoke with LEP, BABAR and DESY spokes who navigated their “end games” to get their thoughts on what they did right and wrong...

- Being ‘active’ in CDF now cannot be defined by taking shifts, as there won’t be any more to cover.

- ⑩ Still plan to produce results for few years - will not freeze the authors list yet.

- ⑩ CDF duties soon defined by offline/calibration/analysis

- ⑩ We surveyed the collaboration, asking all institutions to provide a list of the physics results they consider important goals for CDF - Results on next page

- ⑩ Will define “task forces” for a number of key analyses to insure timely publication

## Collaboration answers to:

“What are the most important physics results do you want CDF as a collaboration to produce on the timescales of 2011/12”

Question was open-ended, no topics were suggested...

SM Higgs search	88%
Top production and AFB	63%
W mass	54%
B/Bs decays	42%
beta_s	21%
B->μμ	17%
Top mass	38%
Single top	33%
W+jets anomalies	33%
Dibosons	21%
CPV	17%
Charm physics	17%
SUSY	17%
MSSM Higgs	8%
Exotics	8%
ZZ , WW resonances	4%
Backgrounds for LHC	4%

## CDF Collaboration (in FTE)

	2009	2010	Today	2012
Tot FTE	292	278	207	133
U.S.	46%	51%	50%	46%
postdocs	71	72	63	40
students	100	91	51	33
fac. level	121	115	93	60

Based on Survey this Spring, 09/10 numbers presented to you last August

Senior Collaboration -- PD/Students will complete their work and take their next step

Very Few new students being added ~6 in the last 6 mo.

# Guests and Visitors

- Very important to the success of the experiment! Traditionally, funds evenly split between
  - detector operations
  - offline operations
  - physics “service”
- G+V funds/people come from several sources
  - Non-US contributions from Operations “tax”/PhD
  - International Fellows (lab-wide program)
  - Lab budget
- Current budget far from optimal – would spend more if avail.
- short falls in G+V funding will put physics goals in jeopardy
- with downsizing workforce and ambitious goals, we strive to maximize the effectiveness of each analyzer - traveling to and working at the lab is a huge help ! (keeps people focused)

# Take Away Message!!!

- CDF (and Tevatron) had another banner year of physics – expect >50 NEW CDF results for EPS with 7.5/fb or more.
- For FY12, expect to need analysis resources (computing) at level of FY11 – physics productivity will be similar to 2011
  - plan full Higgs combinations this summer and final combination for winter 2012, possibly summer 2012. We expect significant improvements at each step!
  - other analysis will surge, triggered by the availability of the full dataset, then decrease over the year
- For FY13, expect substantial decrease in analysis activity
- Our greatest challenge in completing the CDF legacy is in maintaining the high level of analysis effort – people!
- Sprinting across the finish line still an option – if support exists