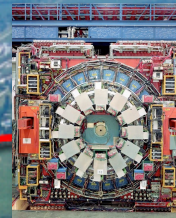


# Stato e Prospettive di CDF

15 Settembre 2009



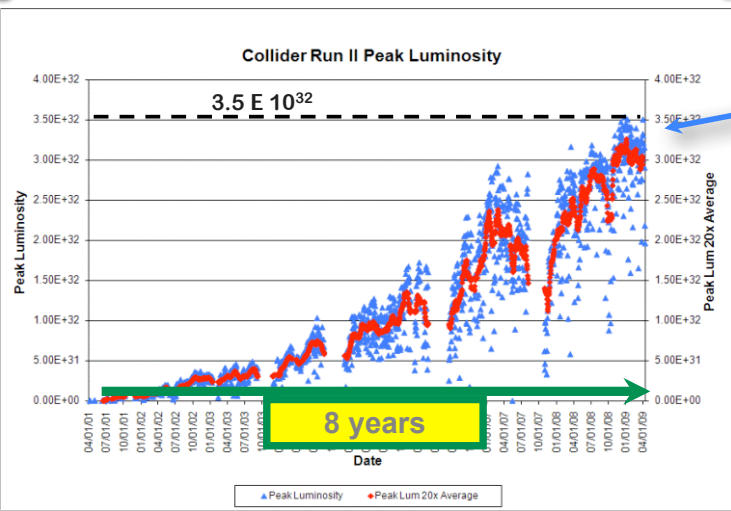
CDF

*Luciano Ristori*





# Run 2 Luminosity Progress



Record peak inst. luminosity

$$3.6 E 10^{32} \text{ cm}^{-2} \text{ s}^{-1}$$

Record luminosity/week

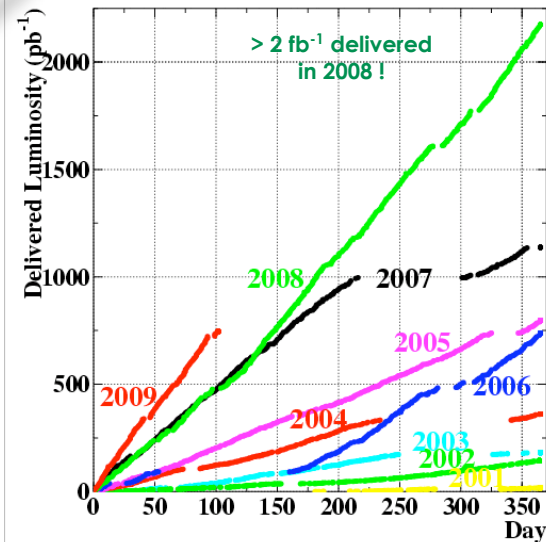
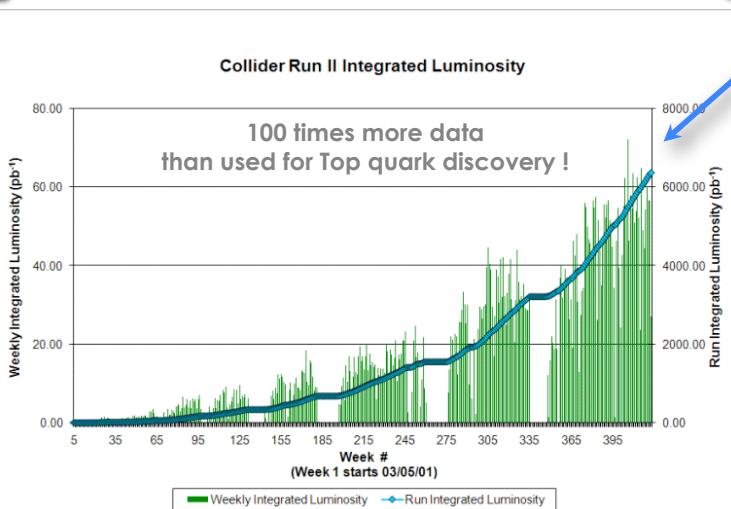
$$73 \text{ pb}^{-1}$$

Record luminosity/month

$$250 \text{ pb}^{-1}$$

Total Luminosity delivered

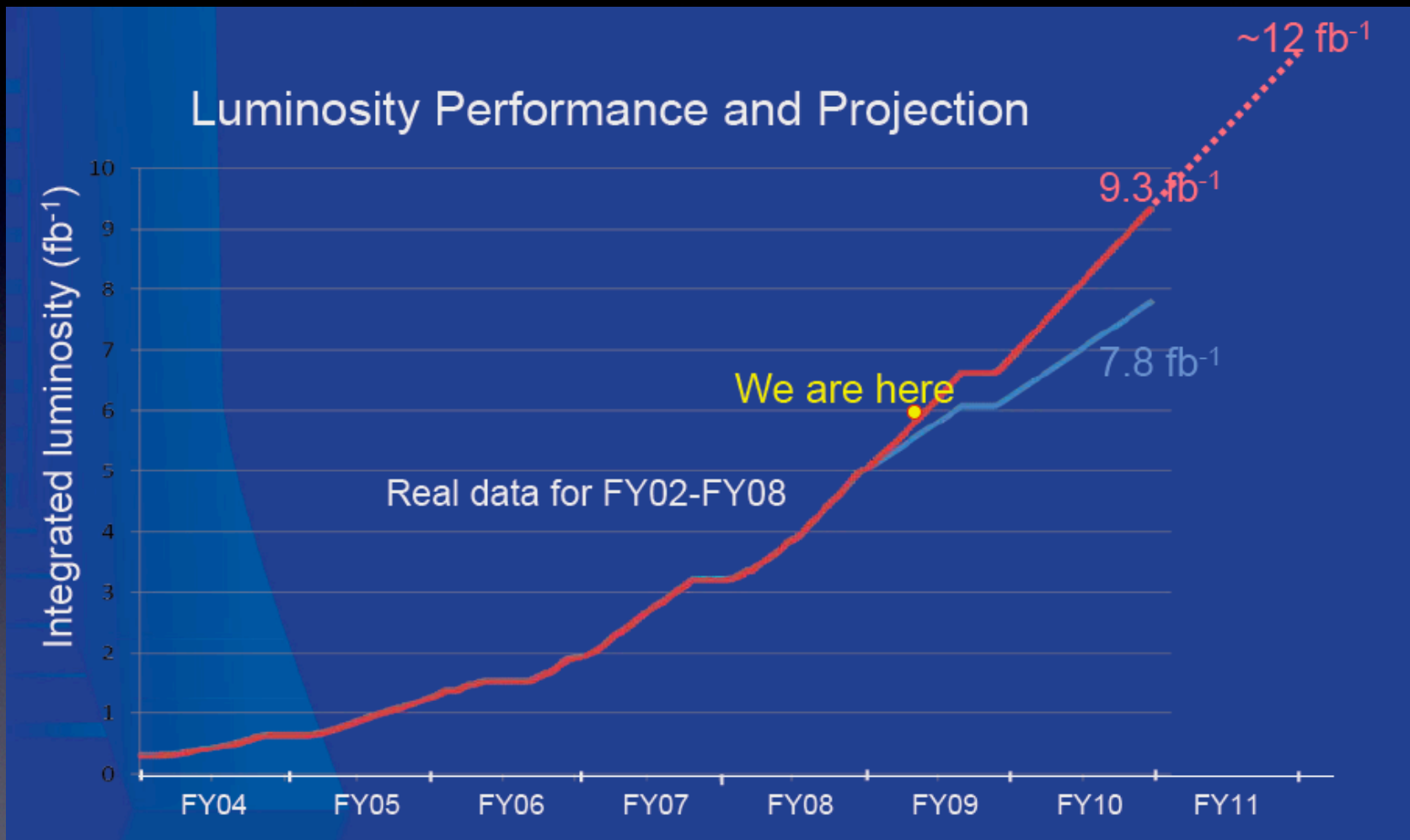
$$6.9 \text{ fb}^{-1}$$





# Projected TeVatron Performance

Pier Oddone - March 20, 2009

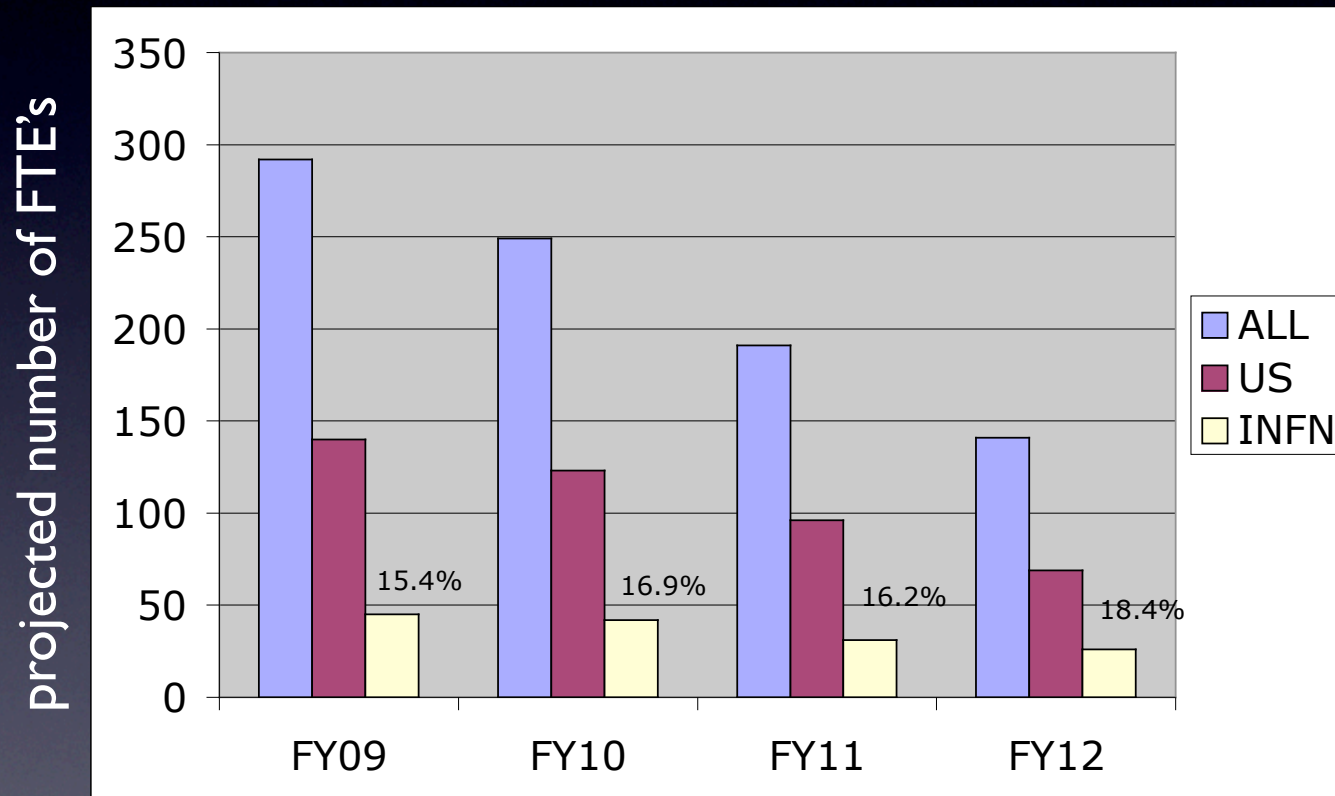




# FTE projection



result of a recent survey of all CDF institutions







# FTE CDF-Italia



	2009	2010
BO	5.8	5.5
LNF	3.1	2.5
PD	4.5	4.3
PI	22.1	21.3
TS	3.7	4.2
UD	2.2	2.0
PV	1.0	1.0
RM	1.6	1.3
TN	0.6	0.0
<b>Totale</b>	<b>44.6</b>	<b>42.1</b>

-5.6%

# Responsabilità italiane nel 2009

Convener of B Physics Group: Giovanni Punzi (PI)

Member of Statistics Committee: Giovanni Punzi (PI)

Chairman Speakers Committee: Giorgio Chiarelli (PI)

Membro Speaker's Committee: Franco Bedeschi (PI)

Membro Spokeperson's Paper Reading Group: Giorgio Bellettini (PI)

Chair of CDF Authorship Board: Giorgio Bellettini (PI)

Co-Head of Trigger and Dataset Working Group: Laura Sartori (PI - Borsa Marie Curie)

DAQ ACE: Patrizia Barria (PI)

DAQ ACE: Viviana Cavaliere (PI - International Fellow)

DAQ ACE: Angelo Di Canto (PI)

DAQ ACE: Paola Garosi (PI)

Co-Head of Computing: Donatella Lucchesi (PD)

Membro Spokeperson's Paper Reading Group: Tommaso Dorigo (PD)

DAQ ACE: Maria D'Errico (PD)

Manutenzione e calibrazione Hadron Calorimeter: Fabio Happacher, Paolo Giromini et al. (LNF)

Operation Manager: Gianluca Introzzi (PV)

DAQ ACE: Manuel Mussini (BO)

**Head of Detector Operations: Massimo Casarsa (Guest Scientist)**

**Convener of B Mixing and Lifetimes and CP Violation (BMLCPV) sub-group: Diego Tonelli (Lederman Fellowship)**

**Responsabile calibrazione dE/dx: Diego Tonelli (Lederman Fellowship)**

**Manutenzione SVT: Michael Morello (Borsa CDF-LHC)**

**Manutenzione SVT: Paolo Mastrandrea (Borsa CDF-LHC)**

**Convener of "B Mixing and Lifetime and CP Violation" (BMLCPV) sub-group: Michael Morello (Borsa CDF-LHC)**

**Operation Manager: Michele Giunta (Borsa CDF-LHC)**





# New Results Since Winter 09



## CDF public web pages

<http://www-cdf.fnal.gov/physics/S09CDFResults.html>

Top Physics		
Analysis	Luminosity	More Information
CDF top quark mass combination	$3.2 \text{ fb}^{-1}$	<a href="#">WebPage</a>
Twofold top quark mass combination	$3.6 \text{ fb}^{-1}$	<a href="#">WebPage</a>
Observation of single top quark production	$3.2 \text{ fb}^{-1}$	<a href="#">WebPage</a>
Combined search for single top quark production	$3.2 \text{ fb}^{-1}$	<a href="#">WebPage</a>
Search for single top quark production MET+jets	$2.1 \text{ fb}^{-1}$	<a href="#">WebPage</a>
Search for single top quark production using a neural network	$3.2 \text{ fb}^{-1}$	<a href="#">WebPage</a>
Search for single top quark production using a boosted decision tree	$3.2 \text{ fb}^{-1}$	<a href="#">WebPage</a>
Search for single top quark production using a multivariate likelihood function	$3.2 \text{ fb}^{-1}$	<a href="#">WebPage</a>
Search for single top quark production using a matrix element discriminant	$3.2 \text{ fb}^{-1}$	<a href="#">WebPage</a>
Measurement of the forward-backward asymmetry in top pair production	$3.2 \text{ fb}^{-1}$	<a href="#">WebPage</a>
Measurement of $t\bar{t}$ Cross Section in lepton+jets using a neural network	$2.8 \text{ fb}^{-1}$	<a href="#">WebPage</a>
Measurement of $t\bar{t}$ Cross Section in lepton+jets using a secondary vertex tag	$2.7 \text{ fb}^{-1}$	<a href="#">WebPage</a>
Ratio of $t\bar{t}$ /Z Cross Sections in lepton+jets using a neural network	$2.8 \text{ fb}^{-1}$	<a href="#">WebPage</a>
Measurement of $t\bar{t}$ /Z Cross Sections in lepton+jets using a secondary vertex tag	$2.7 \text{ fb}^{-1}$	<a href="#">WebPage</a>
Measurement of $t\bar{t}$ differential cross section	$2.7 \text{ fb}^{-1}$	<a href="#">WebPage</a>
Measurement of the top quark mass using a template-based method	$3.2 \text{ fb}^{-1}$	<a href="#">WebPage</a>
Measurement of top mass in lepton + jet events using soft muon tags	$2.0 \text{ fb}^{-1}$	<a href="#">WebPage</a>
Measurement of top mass in lepton + jet events using lepton $p_T$	$2.7 \text{ fb}^{-1}$	<a href="#">WebPage</a>
Measurement of top mass in lepton + jet events using a matrix element method	$3.2 \text{ fb}^{-1}$	<a href="#">WebPage</a>
Measurement of top mass in lepton + jet and dilepton events using a template method	$3.0 \text{ fb}^{-1}$	<a href="#">WebPage</a>
Measurement of top mass in the all-hadronic mode using a template method	$2.9 \text{ fb}^{-1}$	<a href="#">WebPage</a>

Higgs Physics		
Analysis	Luminosity	More Information
CDF Higgs Combination	$3.0 \text{ fb}^{-1}$	<a href="#">WebPage</a>
Search for $WH \rightarrow MET + bb$ Events	$2.1 \text{ fb}^{-1}$	<a href="#">WebPage</a>
Search for $WH \rightarrow l\nu + bb$ Events	$2.7 \text{ fb}^{-1}$	<a href="#">WebPage</a>
Search for $ZH \rightarrow l^+l^- + bb$ Events	$2.7 \text{ fb}^{-1}$	<a href="#">WebPage</a>
Search for $WH \rightarrow WW$	$2.7 \text{ fb}^{-1}$	<a href="#">WebPage</a>

QCD Results		
Analysis	Luminosity	More Information
Exclusive Charmonium Production	$1.6 \text{ fb}^{-1}$	<a href="#">WebPage</a>
K $_T$ Distributions of Particles in Jets	$0.8 \text{ fb}^{-1}$	<a href="#">WebPage</a>
Search for Exclusive Z Production	$2.2 \text{ fb}^{-1}$	<a href="#">WebPage</a>
Measurement of Inclusive Photon Production	$2.5 \text{ fb}^{-1}$	<a href="#">WebPage</a>
Measurement of Dijet Production	$2.5 \text{ fb}^{-1}$	<a href="#">WebPage</a>
Search for Quark Substructure in Dijet Angular Distributions	$1.1 \text{ fb}^{-1}$	<a href="#">WebPage</a>

Exotic Physics		
Analysis	Luminosity	More Information
Search for High-Mass Resonances with Lepton Flavor Violating Decays	$1 \text{ fb}^{-1}$	<a href="#">WebPage</a>
Search for Gluino-Mediated Sbottom Production	$2.5 \text{ fb}^{-1}$	<a href="#">WebPage</a>
Search for Fermiophobic Higgs Boson Decaying to Diphotons	$3.0 \text{ fb}^{-1}$	<a href="#">WebPage</a>
Search for Anomalous Diphoton + X Production	$2.0 \text{ fb}^{-1}$	<a href="#">WebPage</a>
Search for a Heavy Resonance Decaying to ZZ	$2.9 \text{ fb}^{-1}$	<a href="#">WebPage</a>
Search for GMSB SUSY Models in the $\gamma\gamma$ +MET Final State	$2.0 \text{ fb}^{-1}$	<a href="#">WebPage</a>

Bottom Physics		
Analysis	Luminosity	More Information
Evidence for a Narrow Structure in the $J/\psi \phi$ mass spectrum in $B \rightarrow J/\psi \phi$ K decays	$2.7 \text{ fb}^{-1}$	<a href="#">WebPage</a>
A Precision Determination of the mass of $X(3872)$ using $J/\psi \pi \pi$ Decays	$2.4 \text{ fb}^{-1}$	<a href="#">WebPage</a>

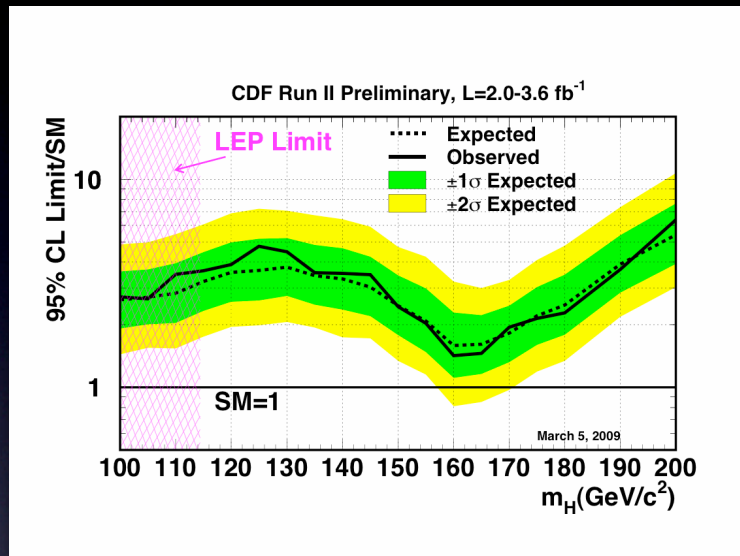
Electroweak Physics		
Analysis	Luminosity	More Information
Limits on Anomalous Triple Gauge Couplings using WZ events	$1.9 \text{ fb}^{-1}$	<a href="#">WebPage</a>

HIGGS

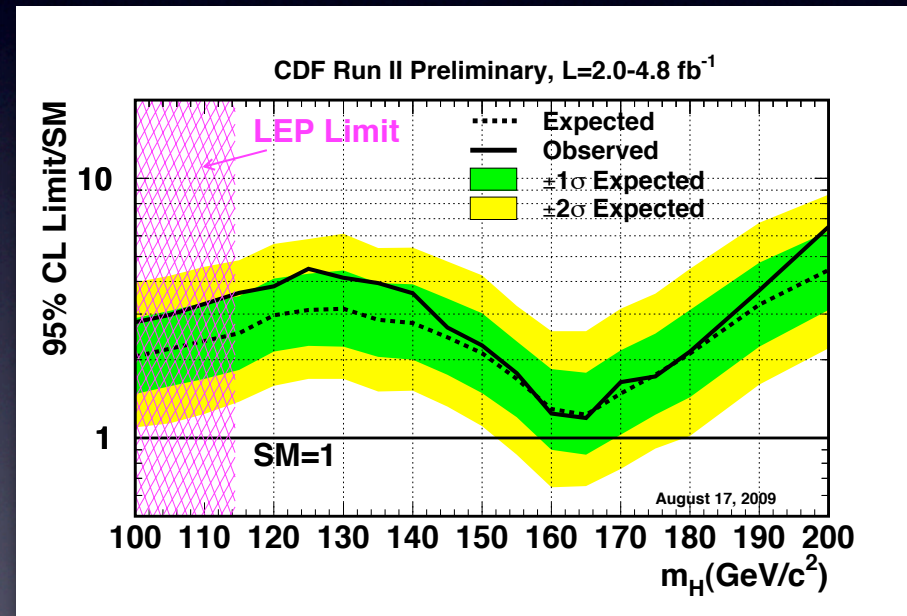




# SM Higgs exclusion by CDF



Winter 09



Summer 09

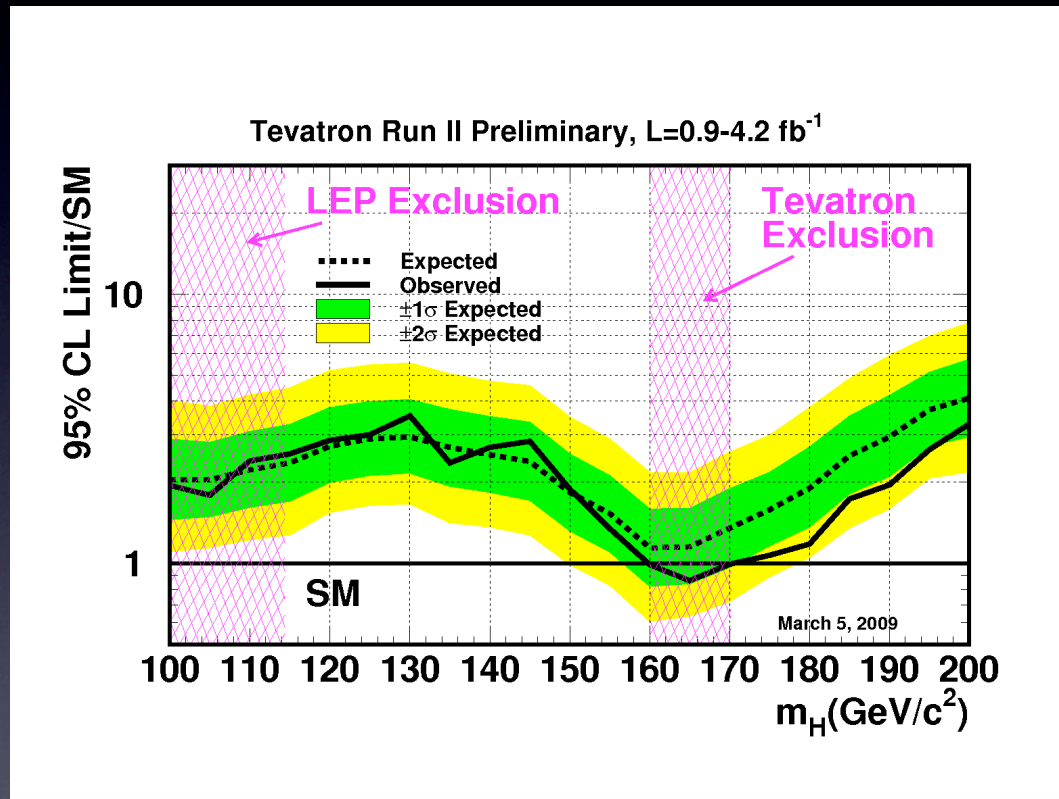


# CDF-D0 Combined Exclusion



result from Winter 09

not updated



160 GeV <  $M_H$  < 170 GeV is excluded at 95% CL !

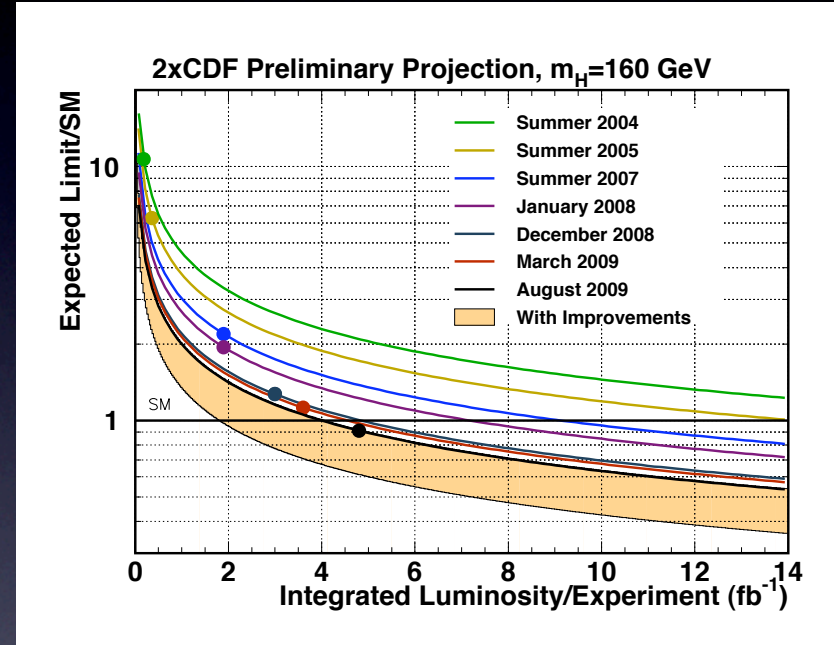
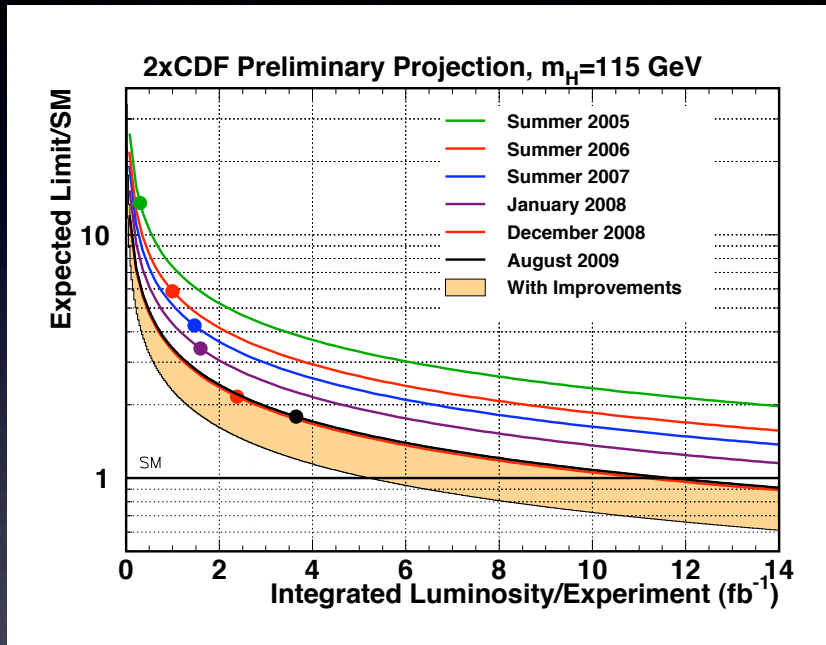




# SM Higgs Limit Projections



CDF x 2



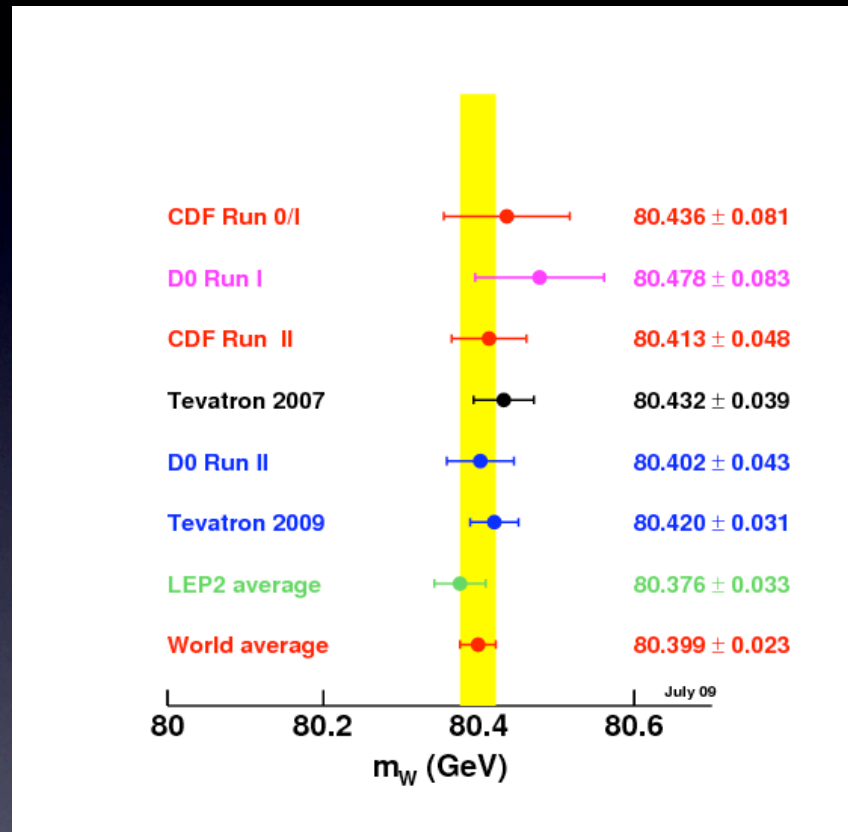
with 10/fb CDF+D0 could reach SM cross section down to 115 GeV

# ELECTROWEAK





# W mass



TeV:  $M_W = 80.420 \pm 0.031$   
world:  $M_W = 80.399 \pm 0.023$



# Diboson production



CDF/ANAL/ELECTROWEAK/CDFR/9807  
Version 2.0  
June 22nd, 2009

$$WW/WZ \rightarrow l\nu jj$$

important italian contribution

Search for Diboson production in  $WW/WZ \rightarrow l\nu jj$   
using  $3.9 \text{ fb}^{-1}$

Alberto Annovi<sup>1</sup>

INFN Frascati, Italy

Pierluigi Catastini<sup>2</sup>

Viviana Cavaliere<sup>3</sup>

Maria Agnese Ciocci<sup>4</sup>

Januscia Duchini<sup>5</sup>

University of Siena and INFN Pisa, Italy

Paolo Mastrandrea<sup>6</sup>

Fermilab

Marco Rescigno<sup>7</sup>

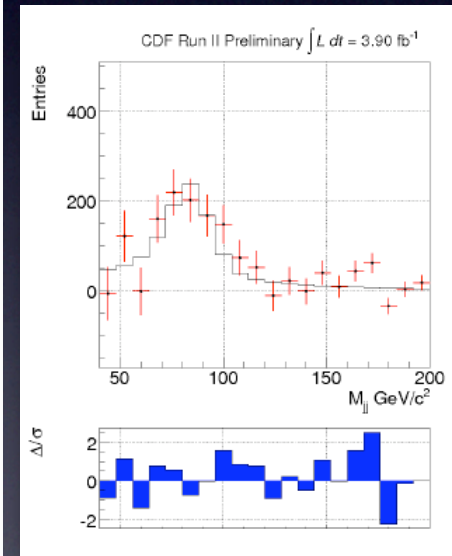
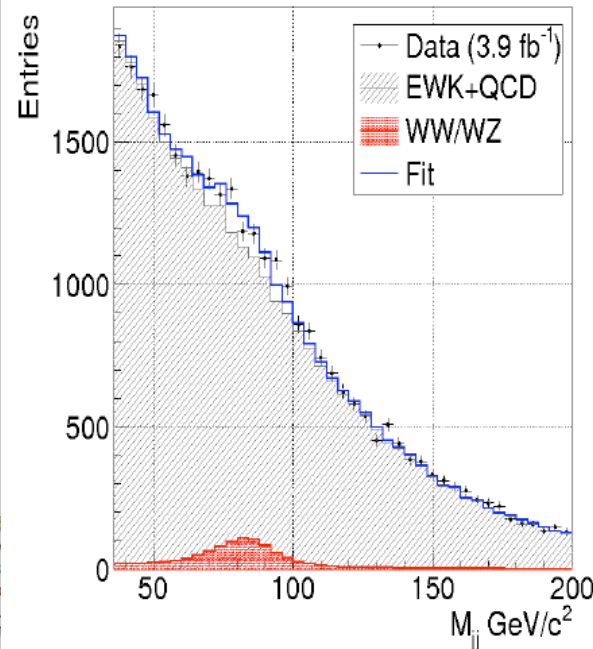
INFN and University of Rome, Italy

Anna Sfyrla<sup>8</sup>

University of Illinois

### Abstract

We describe a search for  $WW/WZ \rightarrow l\nu jj$  processes. A data sample of high  $p_T$  electrons and muons corresponding to approximately  $3.9 \text{ fb}^{-1}$  of integrated luminosity is used to reconstruct  $W$  boson. We look for another boson candidate in the event by selecting two additional jets. A fit to the invariant mass distribution  $M_{jj}$  of the two jets is performed. We found  $1079 \pm 232 \text{ (stat.)} \pm 86 \text{ (syst.)}$   $WW/WZ \rightarrow l\nu jj$  events, corresponding to a statistical significance of  $4.4\sigma$ . We also measure  $\sigma_{WW/WZ} = 14.4 \pm 3.1 \text{ (stat.)} \pm 2.2 \text{ (syst.) pb}$ .



$$\sigma_{WW/WZ} = 14.4 \pm 3.1 \text{ (stat.)} \pm 2.2 \text{ (syst.) pb}$$



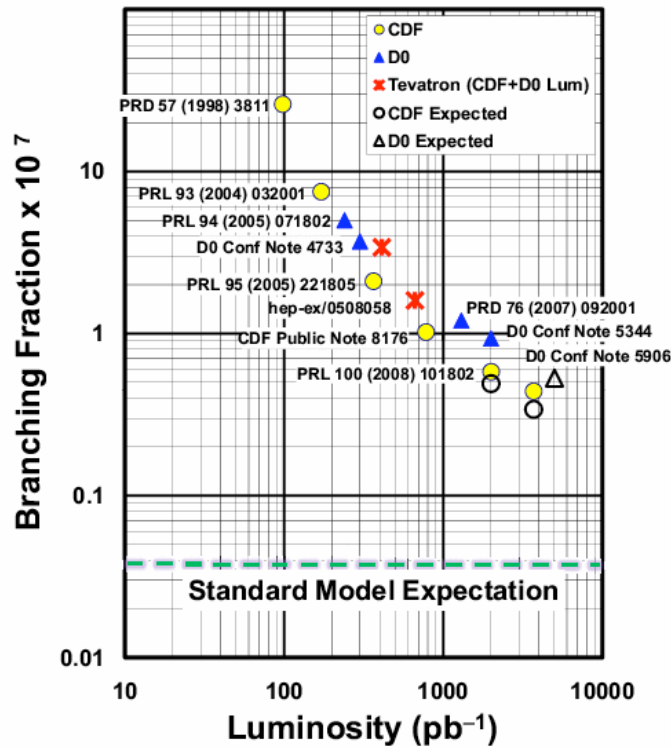
# RARE DECAYS



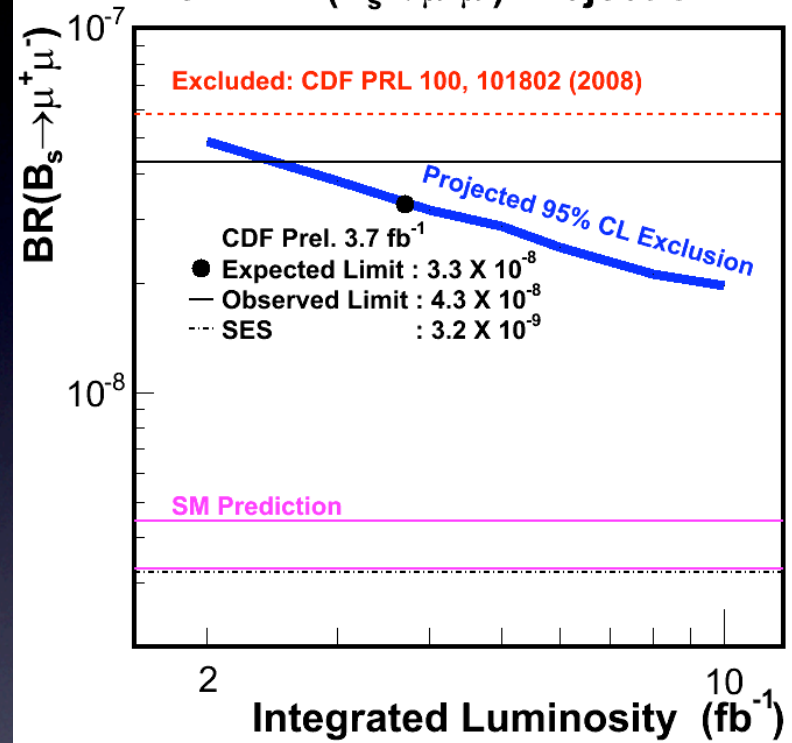
# $B_s \rightarrow \mu^+ \mu^-$



## 95% CL Limits on $\mathcal{B}(B_s \rightarrow \mu\mu)$



## CDF $\mathcal{B}(B_s \rightarrow \mu^+ \mu^-)$ Projection



## Result: World's best limits

$\mathcal{B}(B_s \rightarrow \mu\mu) < 4.3 \times 10^{-8}$  @95% CL  
 $\mathcal{B}(B_d \rightarrow \mu\mu) < 7.6 \times 10^{-9}$  @95% CL



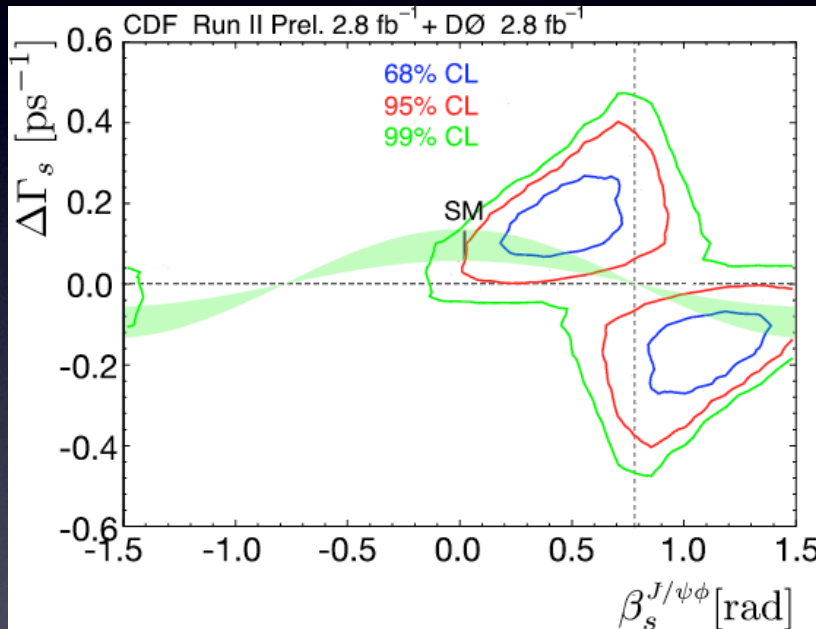
# FLAVOR PHYSICS



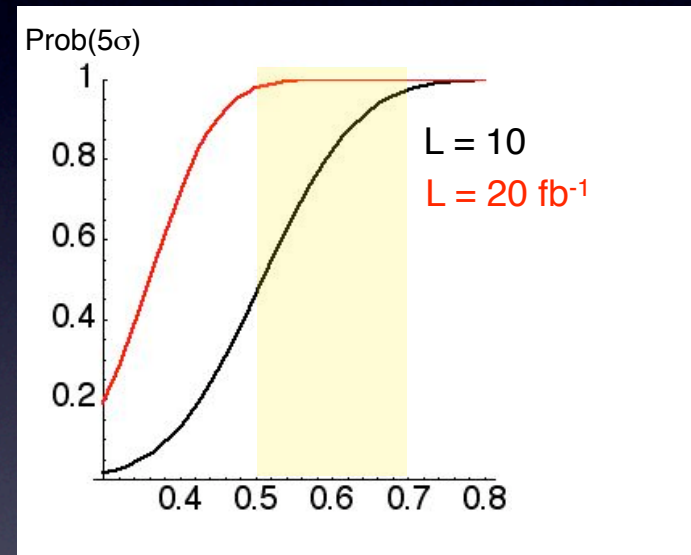
# $B^0_s$ mixing phase: $B^0_s \rightarrow J/\psi \phi$



- $B^0_s$  sector unique to Tevatron and fully unexplored
- $\Delta m_s$  excluded large NP magnitude in  $B^0_s$  mixing (2006)
- NP phase still unconstrained
- Probe it through time-evolution of  $B^0_s \rightarrow J/\psi \phi$  decays
- CDF and DØ observe a consistent fluctuation (same direction, same significance)



Assuming the standard model predictions of  $\beta_s^{J/\psi\phi}$  and  $\Delta\Gamma_s$ , the probability of a deviation as large as the level of the observed data is 3.4%, corresponding to 2.12 Gaussian standard deviations.



If NP phase is large ( $>0.5$ )  
Tevatron will observe it

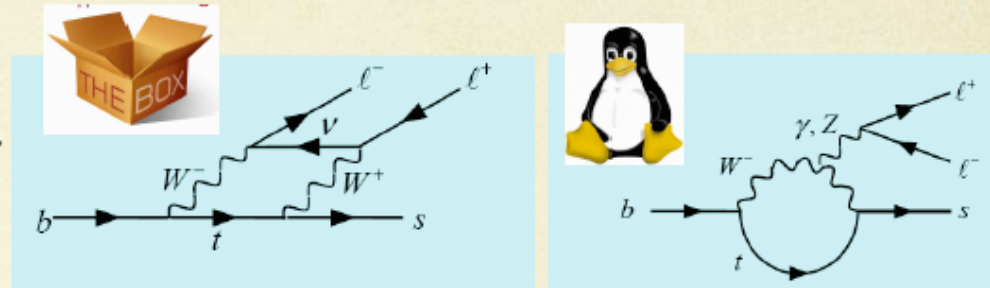
- NP expectations  $\beta_s = 0.5 \div 0.7$   
[Hou et al., Phys.Rev.D76:016004,2007]



$$B^+ \rightarrow \mu^+ \mu^- K^+, \quad B^0 \rightarrow \mu^+ \mu^- K^{*0}(892),$$

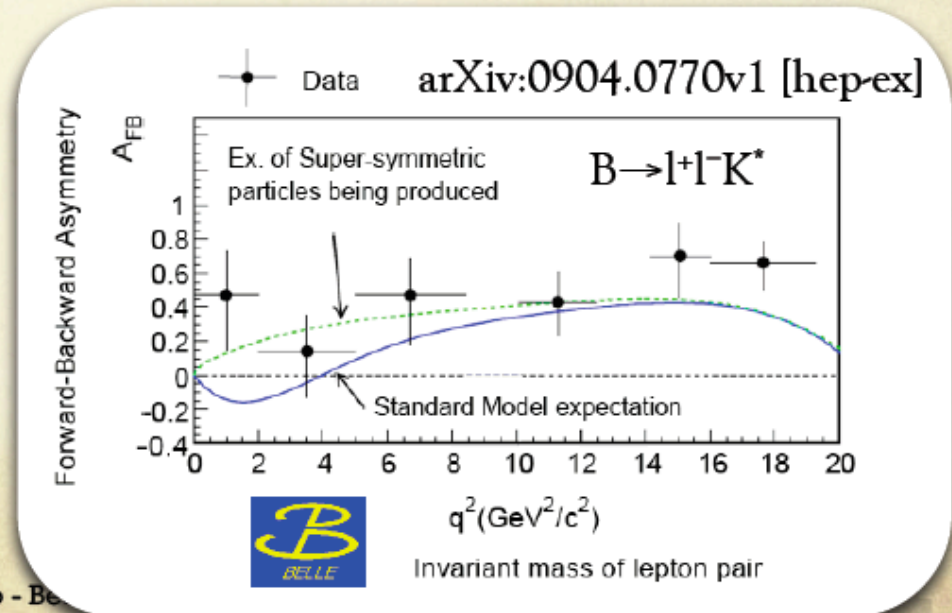
$$\text{and } B_s^0 \rightarrow \mu^+ \mu^- \phi$$

Non-resonant FCNC  $b \rightarrow \mu\mu s$  processes can occur via box or penguin diagram, as  $B \rightarrow \mu\mu$ . Sensitive to NP via internal loops. **Angular distribution ( $A_{FB}$ ) of decay products may be different from SM expectations.**



$B^+$  and  $B^0$  modes already observed by B-factories in agreement with SM.  
 Already observed (BaBar, Belle)  
 $B^+ \rightarrow \mu\mu K^+$  - PRD 73, 092001 (2006)  
 $B^0 \rightarrow \mu\mu K^*$  - PRL 96, 251801 (2006)

Missing:  $B_s^0 \rightarrow \mu\mu\phi$ , Prediction:  
 $BR(B \rightarrow \mu\mu\phi) = 1.6 \times 10^{-6}$   
 J. Phys. G 29, 1103 (2003)



# B $\rightarrow$ $\mu^+\mu^-h$ - Results

Missing:  $B_s^0 \rightarrow \mu\mu\phi$ , Prediction:  $BR(B \rightarrow \mu\mu\phi) = 1.6 \times 10^{-6}$  J. Phys. G 29, 1103 (2003)

$BR(B^+ \rightarrow \mu\mu K^+) = [0.59 \pm 0.15(\text{stat.}) \pm 0.04(\text{syst.})] \times 10^{-6}$  ( $4.5\sigma$ ) Phys. Rev. D 79, 011104 (2009)

$BR(B^0 \rightarrow \mu\mu K^{*0}) = [0.81 \pm 0.30(\text{stat.}) \pm 0.10(\text{syst.})] \times 10^{-6}$  ( $2.9\sigma$ )

$BR(B_s^0 \rightarrow \mu\mu\phi) / BR(B_s^0 \rightarrow J/\psi\phi) < 2.3(2.6) \times 10^{-3}$  @ 90(95)%CL. ( $2.4\sigma$ )



$L_{\text{int}} = 1/\text{fb}$

$BR(B_s^0 \rightarrow \mu\mu\phi) / BR(B_s^0 \rightarrow J/\psi\phi) < 4.4 \times 10^{-3}$  @ 95%CL.

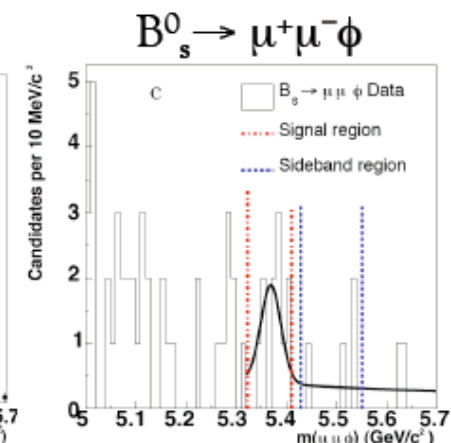
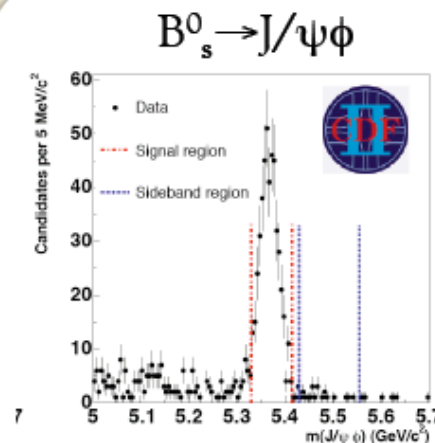


Phys. Rev. D 74, 031107 (2006)

$L_{\text{int}} = 0.45/\text{fb}$

Analysis on 4.4/fb in progress. CDF should observe all decays. Expected about 140 signal events for  $B^+$ , 100 for  $B^0$  and 30 for  $B_s^0$  with significance larger than  $5\sigma$ .

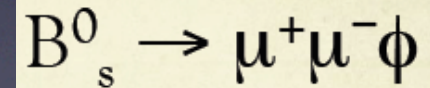
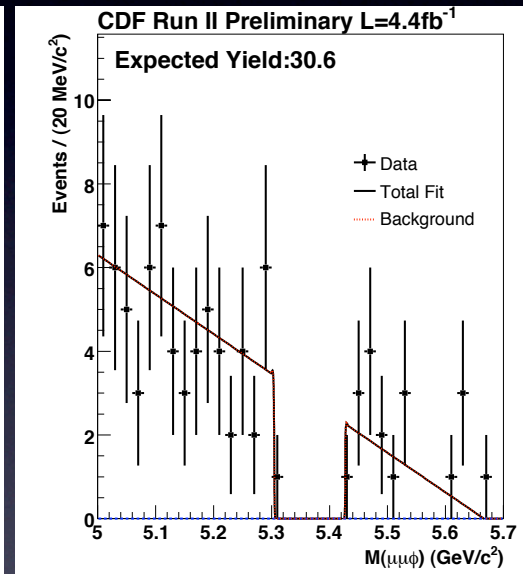
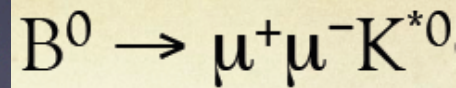
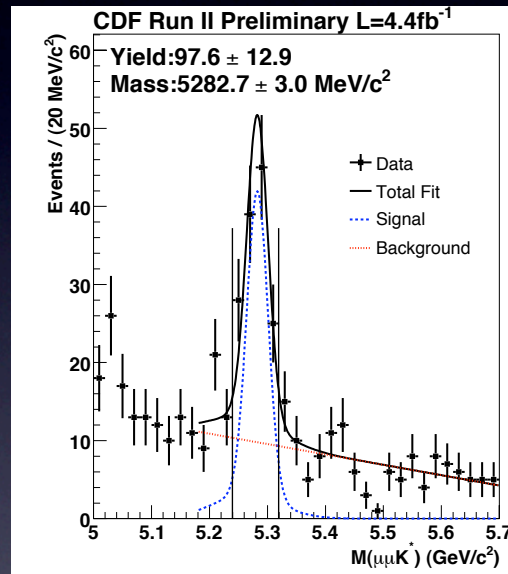
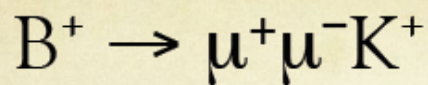
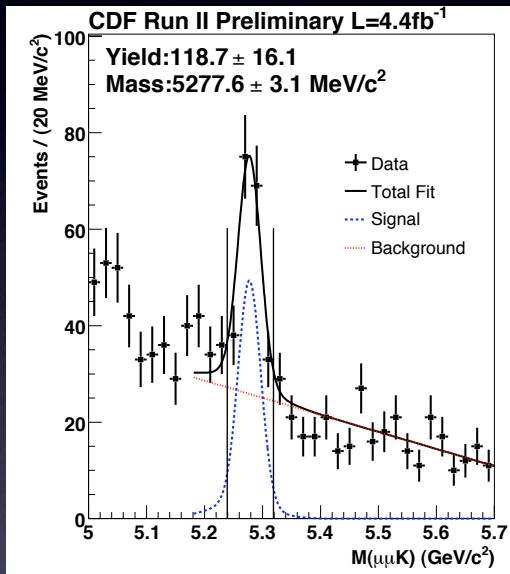
Measurement of  $A_{\text{FB}}$  soon.



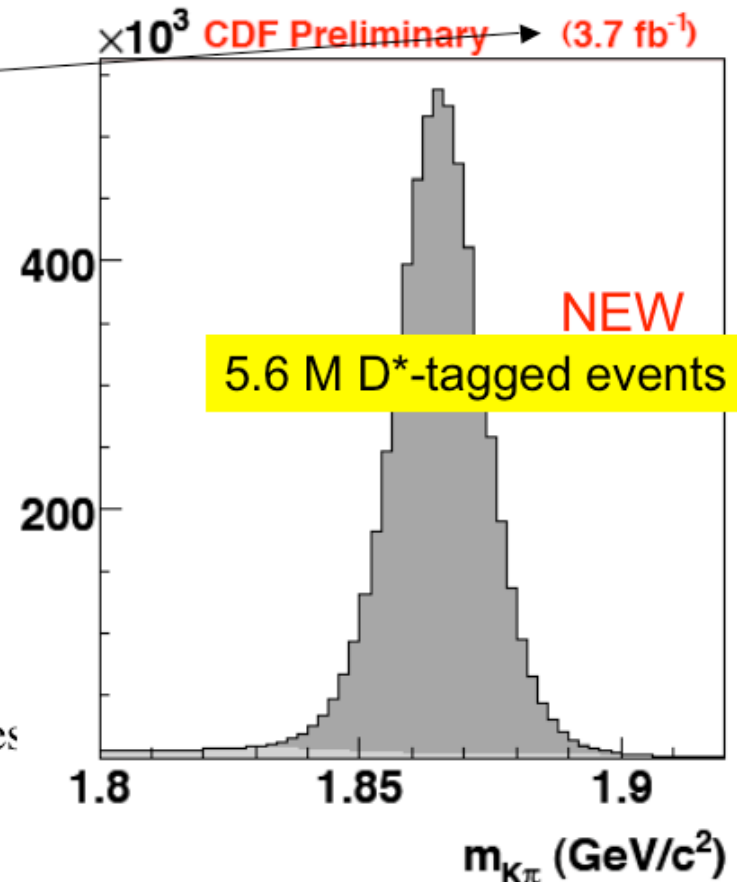
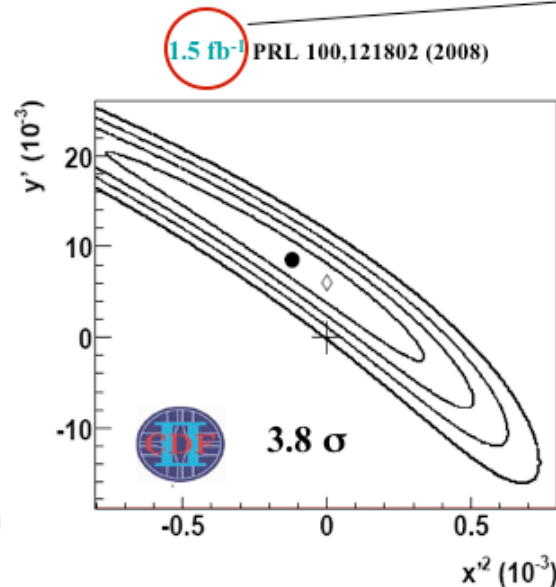
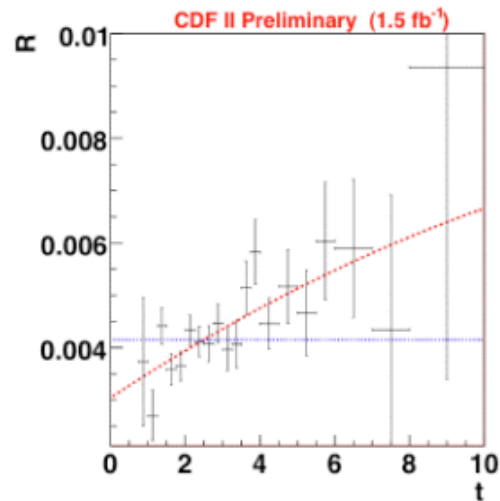




# Latest update with 4.4 /fb



# D<sup>0</sup> mixing



- Babar and CDF very similar results and significances for D<sup>0</sup> → Kπ mixing (3.9σ/3.8σ). (Belle disagrees).
- Globally strong evidence for D<sup>0</sup> mixing, but no single experiment >5σ
- Current CDF sample 4x larger than this → if mixing is real, should be >5σ
- Large *ct* lever-arm helps determine parameters

Currently accumulating  
~4M/year (~10xBelle)



# CPV in Cabibbo-Suppressed modes

CPV in  $D^0$  is unambiguous sign of NP (SM  $\sim 10^{-4}$ ). CS modes are likely to show NP effects of  $O(1\%)$ . [Grossmann et al., Phys.Rev.D75:036008,2007]

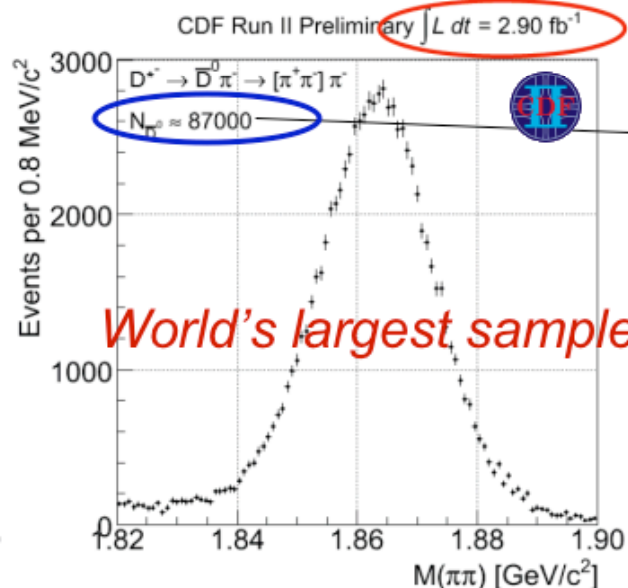
Mode	$D^0$	$\bar{D}^0$	Total
$K\pi$	$88,310 \pm 330$	$92,600 \pm 340$	$180,910 \pm 480$
$KK$	$8,190 \pm 140$	$8,030 \pm 140$	$16,220 \pm 200$
$\pi\pi$	$3,660 \pm 69$	$3,674 \pm 68$	$7,334 \pm 97$

PDG 2008 (Babar/Belle/CDF)

$$A_{CP}(D^0 \rightarrow \pi\pi) = 0.2 \pm 0.4\%$$

includes CDF 2005 ( $0.13\text{fb}^{-1}$ )

$$\sigma(A_{CP}) = 1.3\%$$



(New) Analysis in progress:  
 $\sigma(A_{CP}) = 0.24\%$

On tape ( $6 \text{ fb}^{-1}$ )  
 $\sigma(A_{CP}) = 0.17\%$

By 2011 ( $12 \text{ fb}^{-1}$ )  
 $\sigma(A_{CP}) = 0.12\%$

**If an effect is there to be seen, the Tevatron is going to see it.**

# CPV in Cabibbo-Suppressed modes

CPV in  $D^0$  is understood? (Cabibbo-suppressed modes are likely to show CPV [Beneke et al., hep-ph/08,2007])

Mode	CPV (BR/CPV) (BR/CDF)
$K\pi$	$2 \pm 0.4\%$
$KK$	
$\pi\pi$	$0.13\text{fb}^{-1}$

latest CDF update with  $\sim 5/\text{fb}$ :

$\sim 100$  Million  $D^0$

$\sim 12$  Million  $D^*$

$\sim 450\text{K } D^* \rightarrow \pi$  ( $D^0 \rightarrow \pi\pi$ )

Progress:

If an effect is there to be seen, the Tevatron is going to see it.







# Stato delle milestones 2009



- Misura della asimmetria CP diretta nel canale Bs in K pi con almeno 2.5 fb-I  
31 luglio 2009 **60%**
- Misura del branching ratio e della asimmetria CP del modo B+ in Ddcs pi  
31 luglio 2009 **80%**
- Aggiornamento della misura di Beta\_s con 3 fb-I di luminosita' integrata  
30 giugno 2009 **95%**
- Risultati di fisica ottenuti con almeno 4 fb-I presentati alle conferenze internazionali  
31 dicembre 2009 **100%**
- Sviluppo di un metodo basato su utilizzo di storage element per trasferimento  
dei dati Monte Carlo prodotti su grid a Fermilab  
31 dicembre 2009
- Completamento degli studi sul K0s con dati da offline g7  
31 dicembre 2009 **100%**
- Studio sulla possibilita' di individuazione di heavy flavor a basso Pt nel minimum Bias  
31 dicembre 2009 **100%**
- Limite sulla massa del bosone di Higgs sfruttando il canale di decadimento H -> WW  
usando 4 fb-I di dati  
31 luglio 2009 **100%**
- Estrazione del segnale Z -> bb dal campione di dati raccolto col b-tag trigger  
31 dicembre 2009



# Milestones 2010



- Misura della asimmetria CP diretta nel canale  $B_s$  in  $K \pi$  con almeno 3 fb<sup>-1</sup>  
31 luglio 2010
- Misura del branching ratio e della asimmetria CP del modo  $B^+$  in  $D^0 \pi$  con 5 /fb di luminosita' integrata  
31 luglio 2010
- Aggiornamento della misura di  $Beta_s$  con 5 fb<sup>-1</sup> di luminosita' integrata  
31 Luglio 2010
- limite (o osservazione)  $WZ \rightarrow \nu b \bar{b}$  con 5 fb<sup>-1</sup>  
31 Dicembre 2010

to be completed...





# Richieste per il 2010



## PREVENTIVO GLOBALE DI SPESA PER L'ANNO 2010

In K€

Struttura	A carico dell'I.N.F.N.										A carico di altri enti
	interno	estero	consumo		trasporti	licenze-SW	manutenzione	inventario	apparati	TOTALI	
<b>BO</b>	6.00	94.50	13.50	5.00				3.50		<b>117.50</b>	<b>5.00</b>
<b>CNAF</b>											
<b>LNF</b>	3.00	60.00	7.00					3.00	4.00	<b>77.00</b>	
<b>PD</b>	10.00	70.00	9.00					3.00		<b>92.00</b>	
<b>PI</b>	35.00	504.00	315.00		5.00	1.00		15.00		<b>875.00</b>	
<b>PV.DTZ</b>	2.00	20.00	3.00							<b>25.00</b>	
<b>RM1.DTZ</b>	3.00	24.00	3.00					2.00		<b>32.00</b>	
<b>TN.DTZ</b>											
<b>TS</b>	3.00	48.50	3.50					1.50		<b>56.50</b>	
<b>UD</b>	3.00	39.00			1.00		5.00	2.00		<b>50.00</b>	
<b>Totali</b>	<b>65.00</b>	<b>860.00</b>	<b>354.00</b>	<b>5.00</b>	<b>6.00</b>	<b>1.00</b>	<b>5.00</b>	<b>30.00</b>	<b>4.00</b>	<b>1,325.00</b>	<b>5.00</b>

Mod. EC/EN 4

(a cura del responsabile nazionale)