Highlights di Fisica

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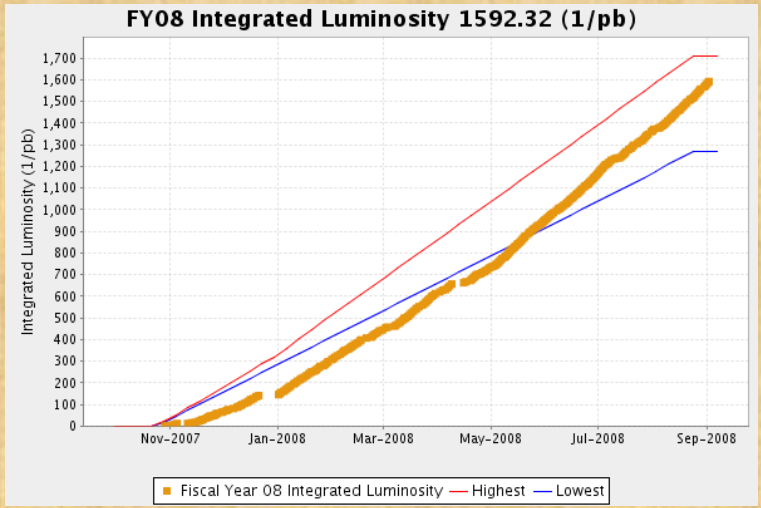
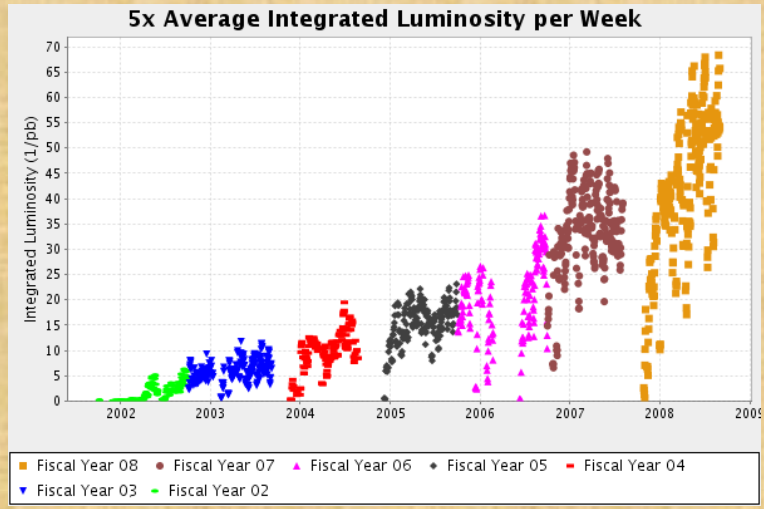
Incontro con i referee
5 Settembre 2008

Topics

- Tevatron
- Highlights da ICHEP08
- Italians & Outlook

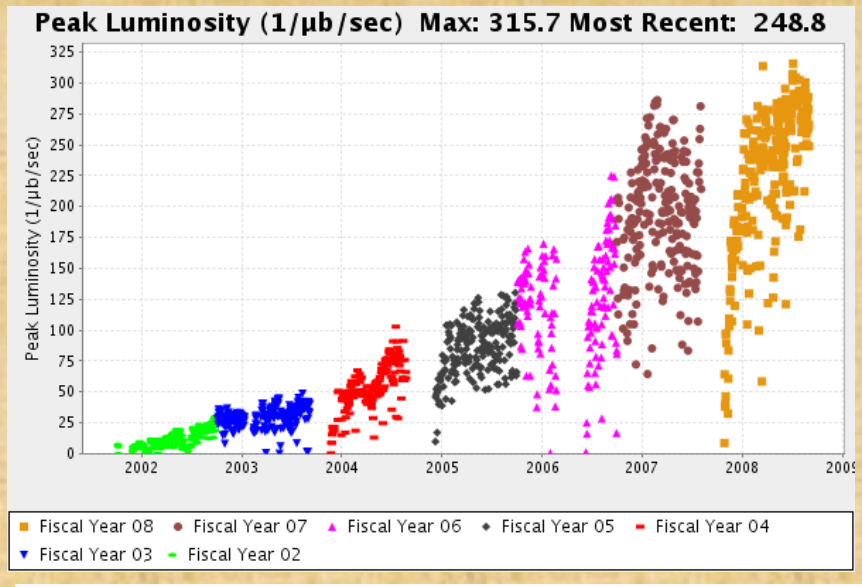
Tevatron Running



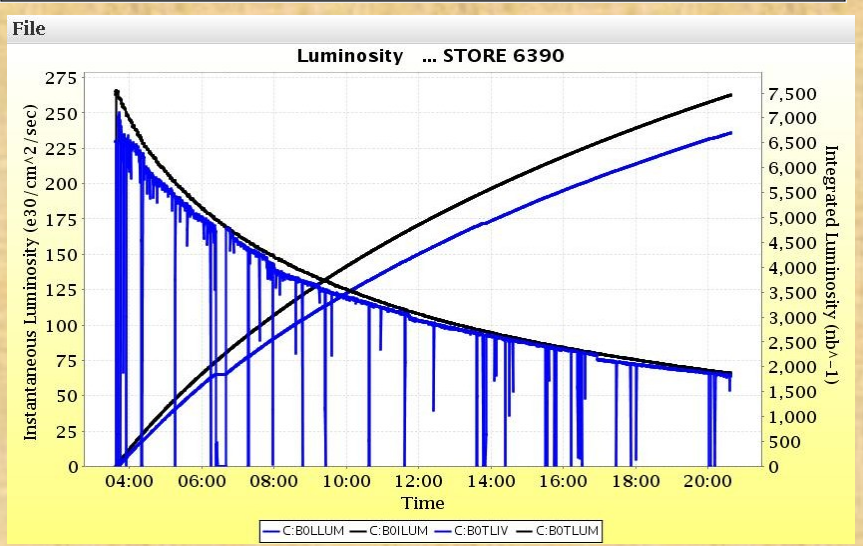


- Raggiungeremo il goal di luminosita' di design (1.7 fb^{-1} nel FY)
- Integriamo consistentemente 50 pb^{-1}/settimana

Tevatron Running



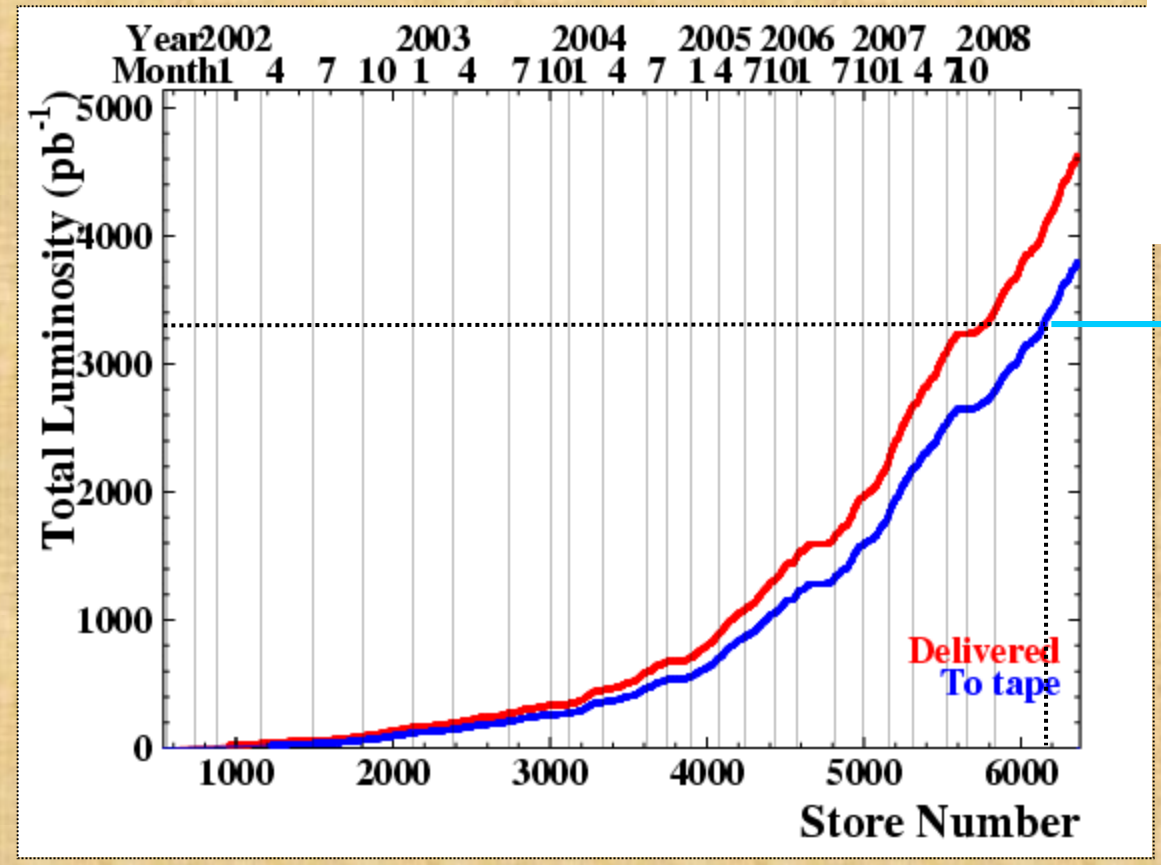
Peak luminosity stabile

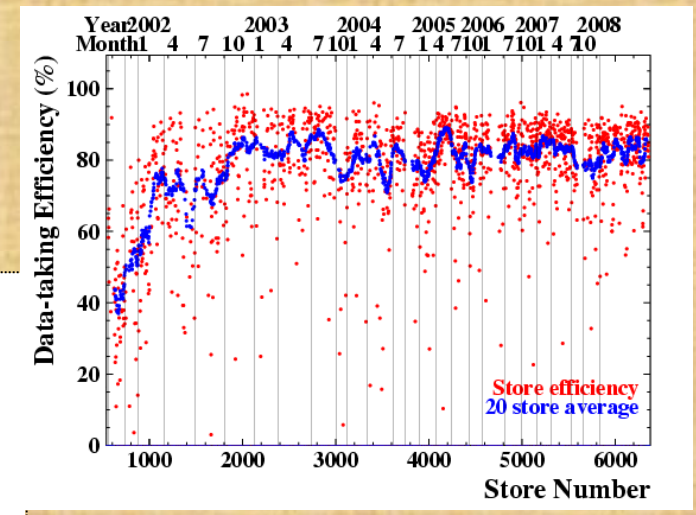


Accumulazione di antiprotoni affidabile e relativamente veloce, gli store vengono droppati prima a luminosita' piu' alte che in passato

CDF data

- Circa 4 fb^{-1} su nastro in questo momento





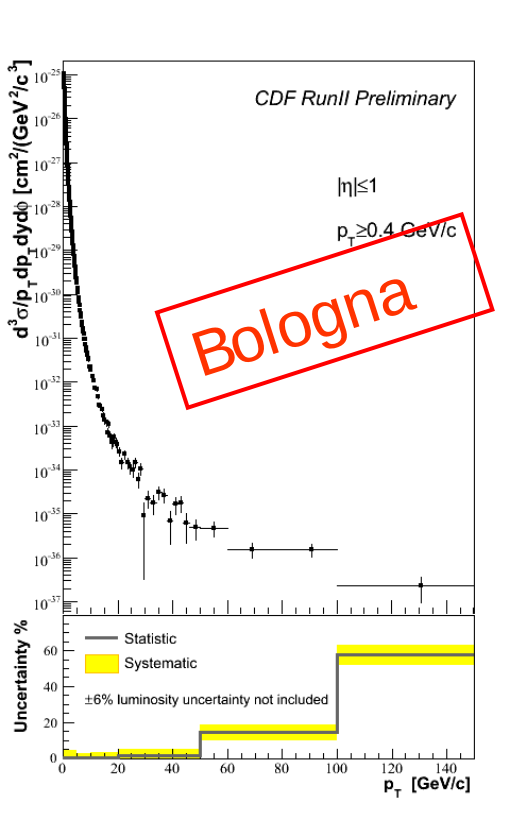
- ICHEP sample ~3.0 fb^{-1} per la gran parte delle analisi: core detector "good"
- Dati raccolti fino ad Apr 08:
  - Rapido turnaround dalla control room ai risultati di fisica…

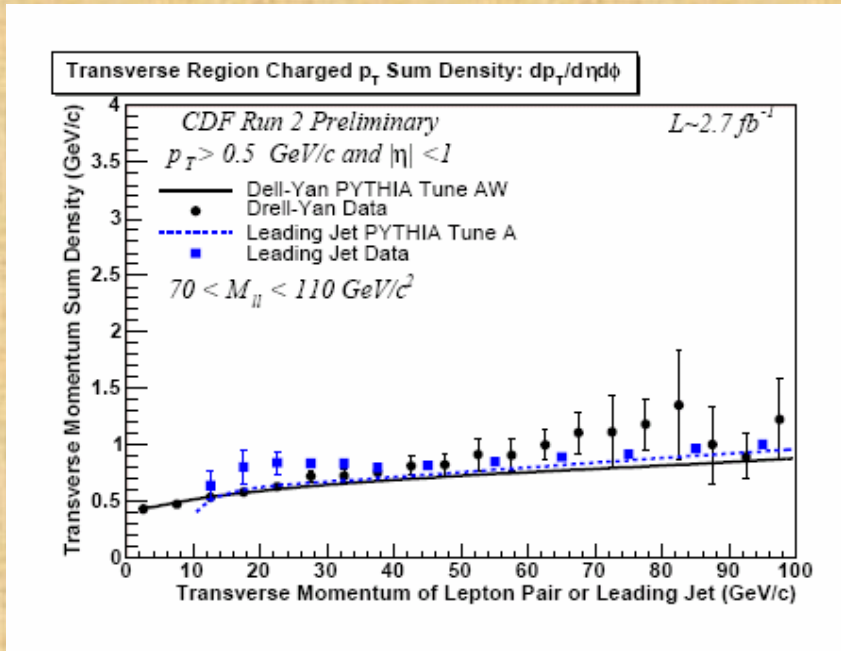
Risultati Recenti

- Rispetto all'ultimo report in Comm.1 moltissimi risultati preparati per ICHEP :
  - 7 B-physics
  - 2 EWK
  - 10 Susy/Exotics
  - 6 Higgs
  - 5 QCD
  - 21 Top/Single Top
- Lista completa su:
  - http://www-cdf.fnal.gov/physics/S08CDFResults.html
- Utilizzati tipicamente 2 fb^{-1} – 3 fb^{-1}
- Molte misure nuove o migliorate → Ancora molti gruppi attivi in tutti i campi (Higgs e Top su tutti)
- Scelta difficile: qualche dettaglio in piu' nel talk a Pisa tra 2 settimane

Back to Basics (1)

- Minimum Bias xsec
  - Utile per modellare color reconnection in top events (hep-ph/0703081)
- Underlying event in Drell-Yan processes

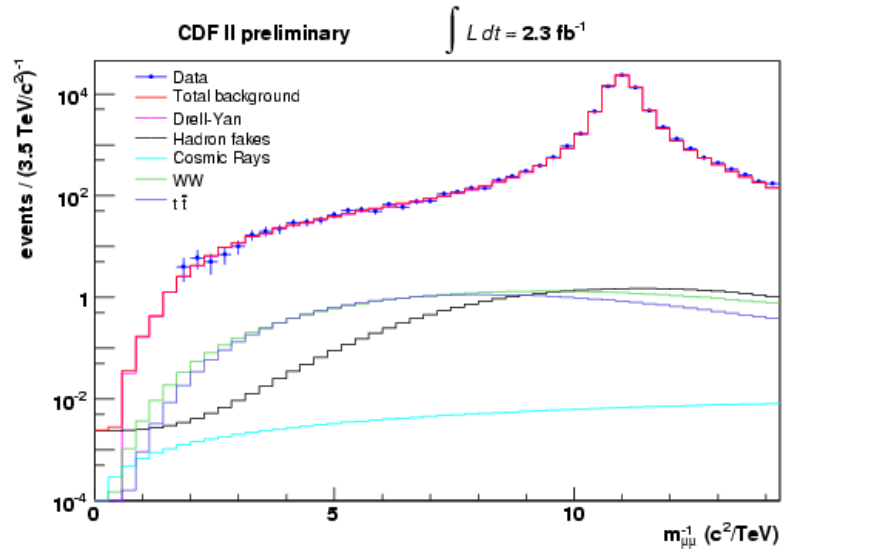




- Presto queste misure con i primi dati ad LHC…

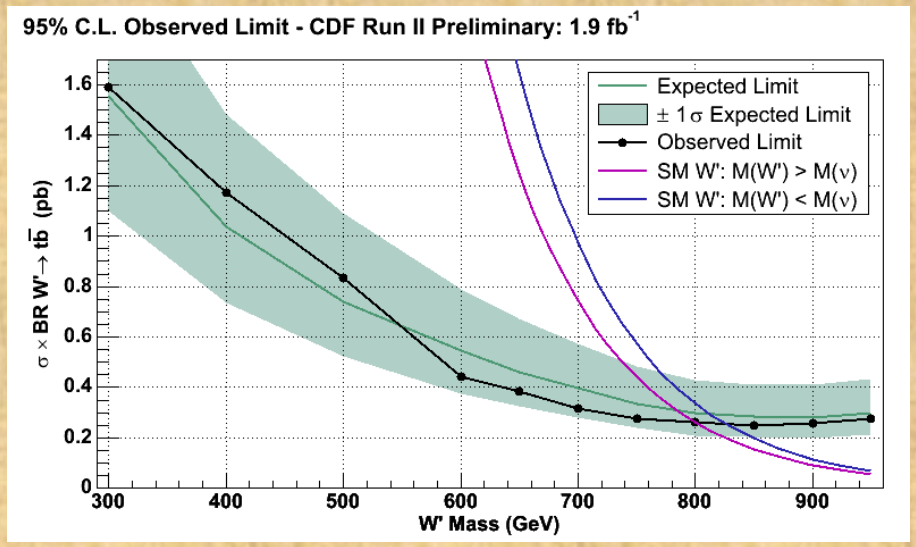
Back to Basics (2)

- Z' → μμ



Model	Mass Limits, 95% CL (GeV/c^2)
Z' (SM)	1030
Z' (η)	975
Z' (χ)	892
Z' (ψ)	878
Z' (N)	861
Z' (I)	789
Z' (sq)	754

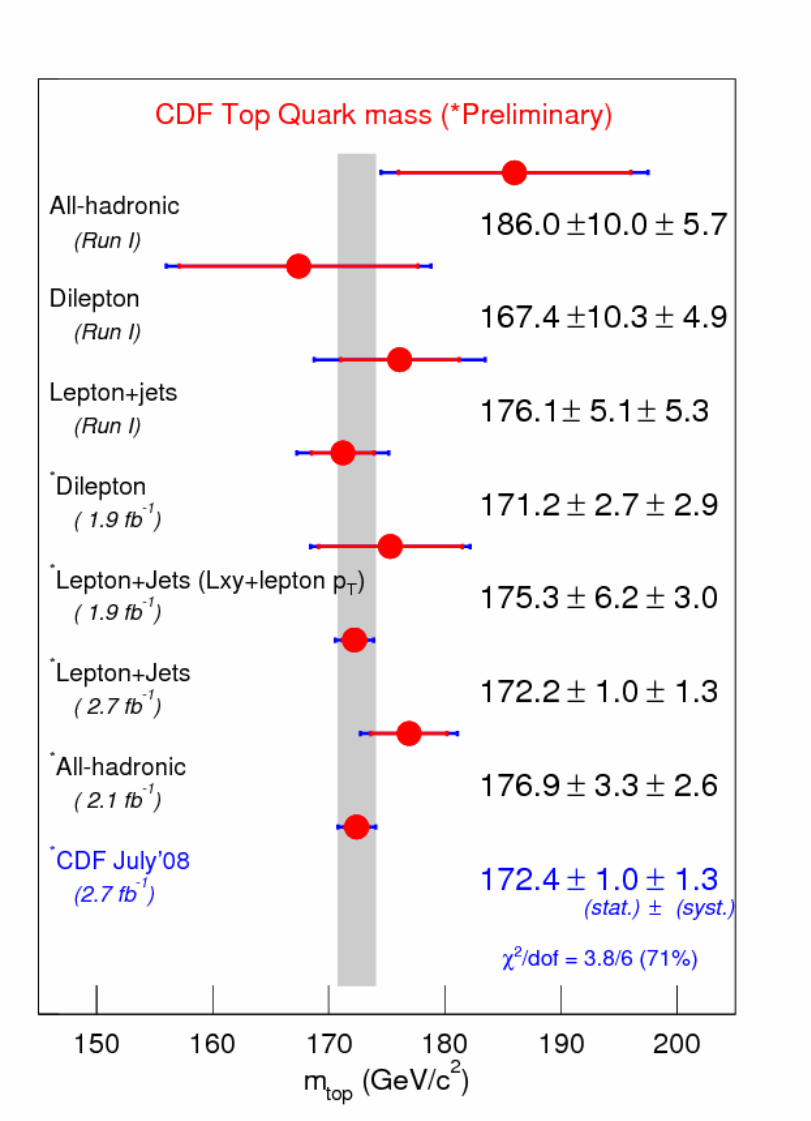
- W'→tb



- Bump searching in M(tb) usando il sample W+ 2,3 jet (come nel single top)
- Con coupling come SM (95% CL):
  - $M_{W'}$<800 GeV/c^2 ($M_{W'}$>Mν')
  - $M_{W'}$<825 GeV/c^2 ($M_{W'}$<Mν')

- Qui LHC andra' molto oltre, ma questo intanto e' il punto di partenza

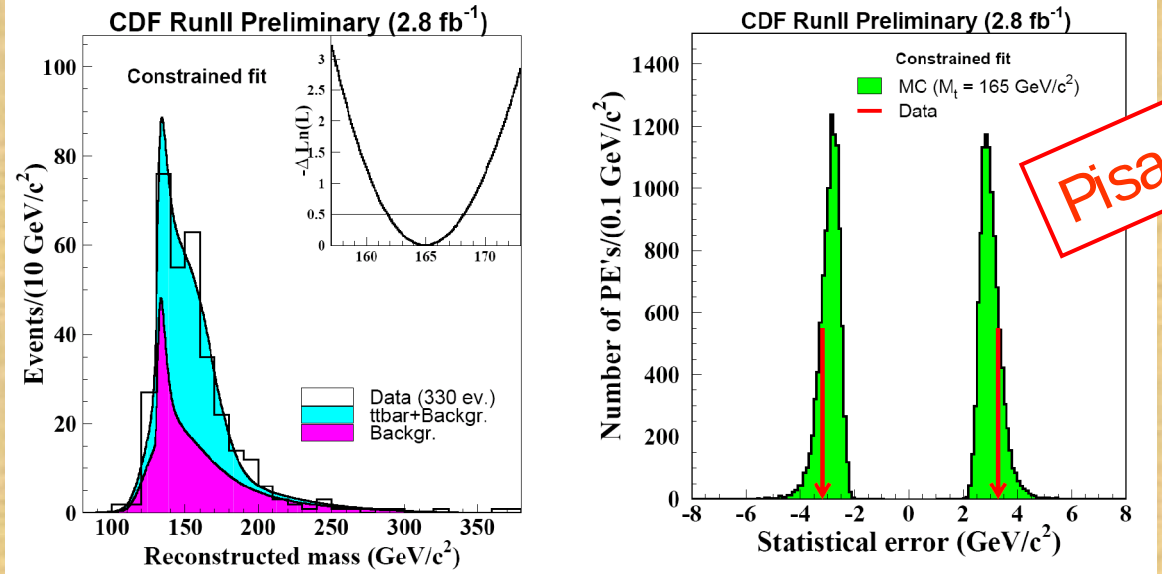
m_{top} status a CDF



Winter 08 mt= 172.9+-1.2+-1.5

- Nuovi risultati nel canale tutto adronico con il fit alla scala di energia dei Jet dai W evento per evento
- Metodi indipendenti dalla misura dei jets (Lxy, lepton pt) avvicinano la precisione dei metodi tradizionali
- Misure prossime ad essere dominate da incertezze sistematiche in tutti i canali
- Precisione complessiva < 1%
- Discussioni in corso su come affrontare/capire/ridurre le incertezzetere teoriche

m_{top} nel canale lepton+track



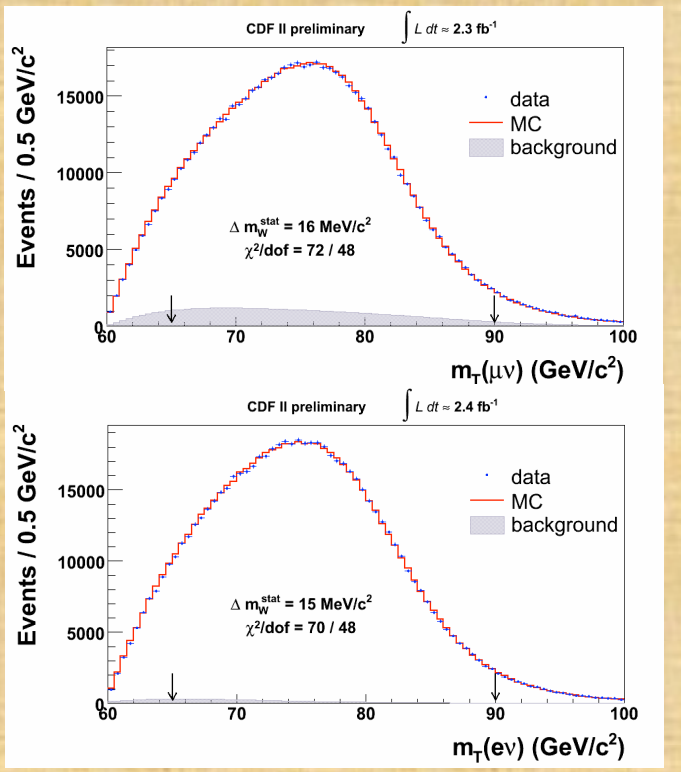
- 330 eventi selezionati con leptoni + tracce isolate (background 139± 17 ev.)
- Ricostruzione massa top e risoluzione ambiguita' cinematiche con la tecnica del neutrino ϕ weighting
- Likelihood fit finale per l'estrazione di m_{top} con shape da MC:

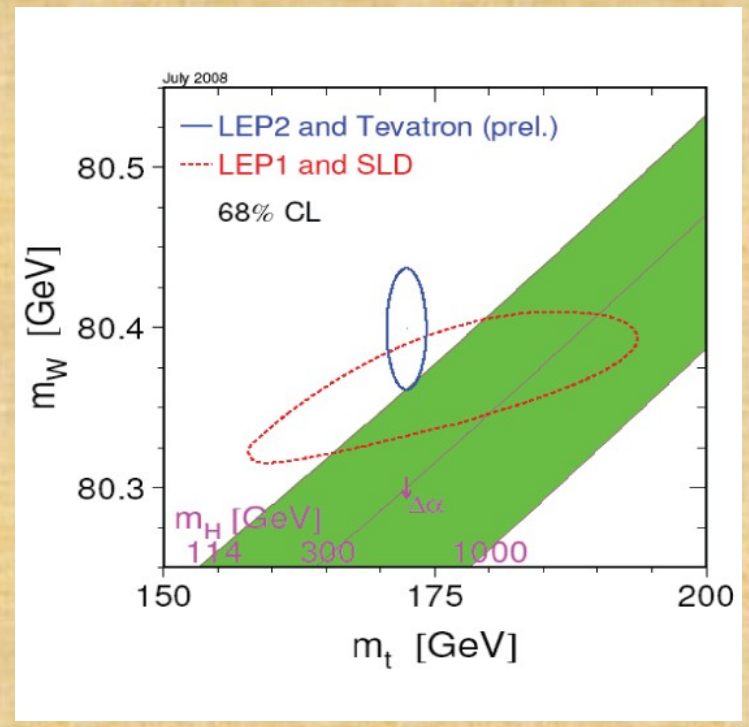
$$m_{top} = 165.1^{+3.3}_{-3.2}(stat.) \pm 3.1(syst.)$$

- Incertezza sistematica dominata da Jet energy scale

m_{top} vs m_W

- CDF $\sigma(m_w)$=48 MeV/c^2 [PRL 99, 151801 (2007)]
- Con 2.3 fb^{-1} si prevede $\sigma(m_w)$=25 MeV/c^2
- Con una analisi "blind" previsioni rispettate:
  - risoluzioni in momento (mu) e in energia (e) non significativamente degradate dall'aumento (x5) della luminosita' media rispetto alla pubblicazione (200 ob^{-1})

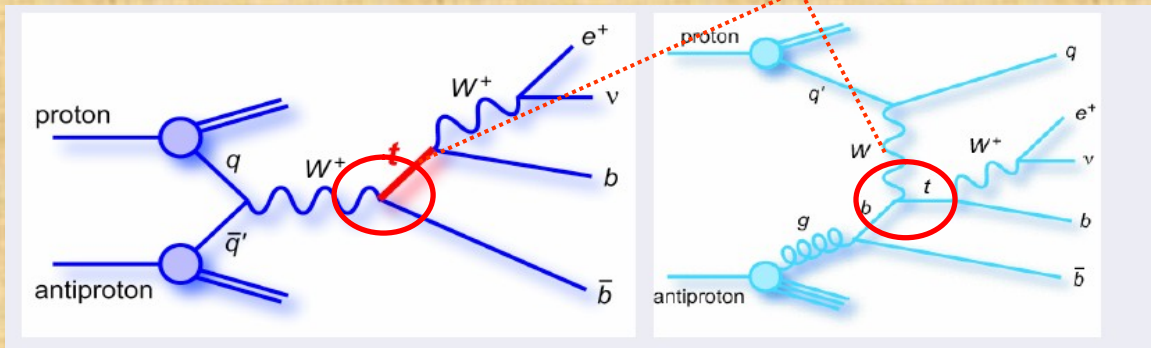


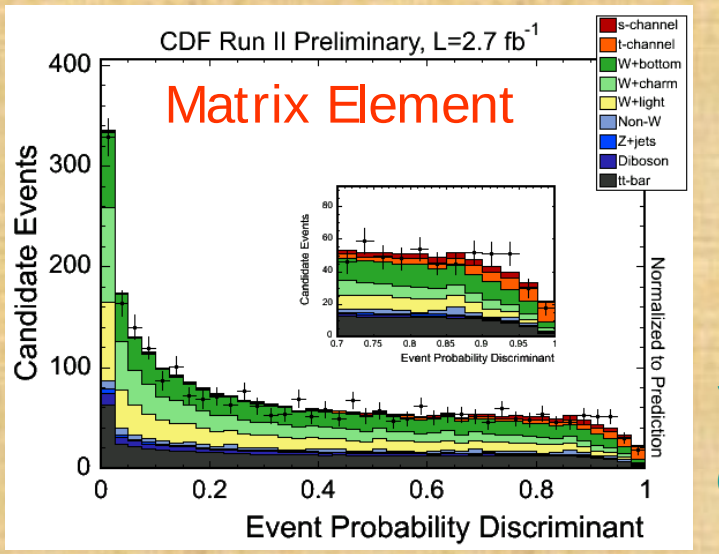


- Contributo significativo del Tevatron ai fit EWK
- Potrebbe essere interessante rivedere questo fit dopo l'update di m_W da CDF (e D0!)

Single Top

- Indubbiamente tra le misure piu' difficili, molte analogie con l'analisi dell'Higgs a bassa massa, diverse misure
- Sensibilita' alla nuova fisica (W') e misura di $|V_{tb}|$ (diretta)





$$\sigma(s+t) = 2.7^{+0.8}_{-0.7}\ \text{pb}$$

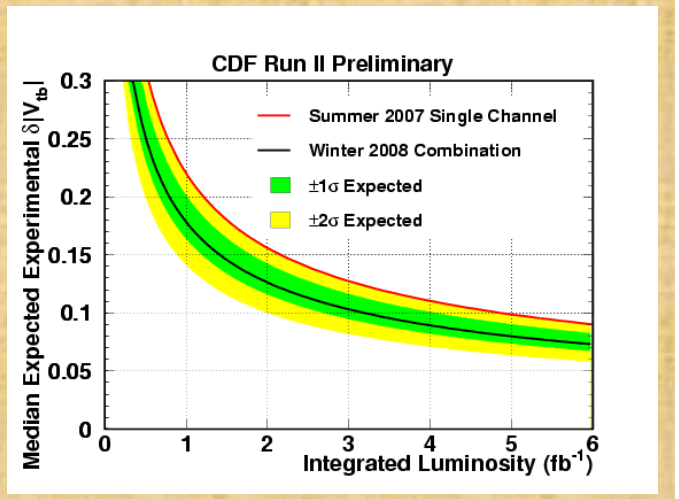
$$\text{p - value} = 9\text{E - 6}\ (4.2\,\sigma)$$

$$\text{expected}\ 4.8\,\sigma$$

$$|\,\text{Vtb}\,| = 0.97 \pm 0.13\,(\text{exp}) \pm 0.07(\text{theory})$$

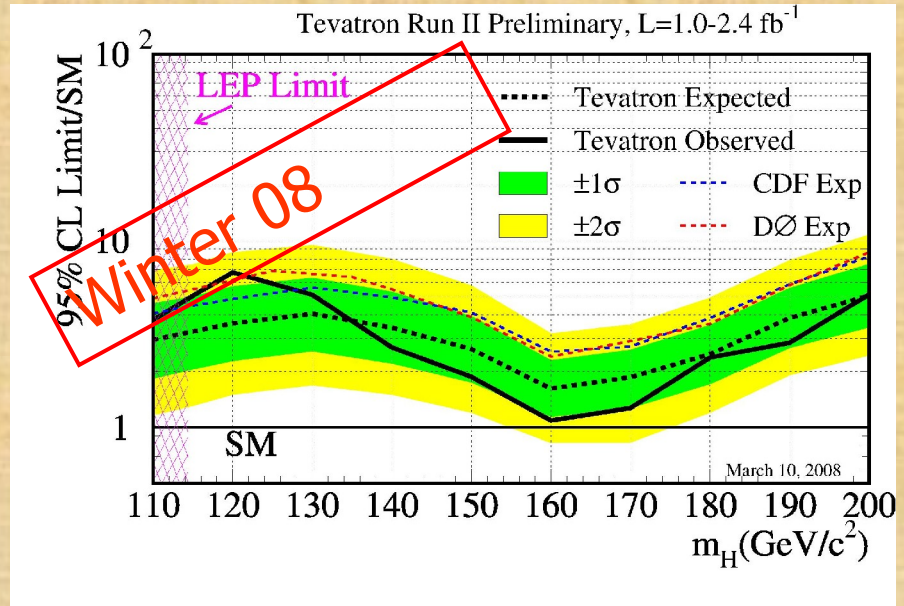
Singole misure sotto le 5 sigma…

Combinazione in corso



SM Higgs

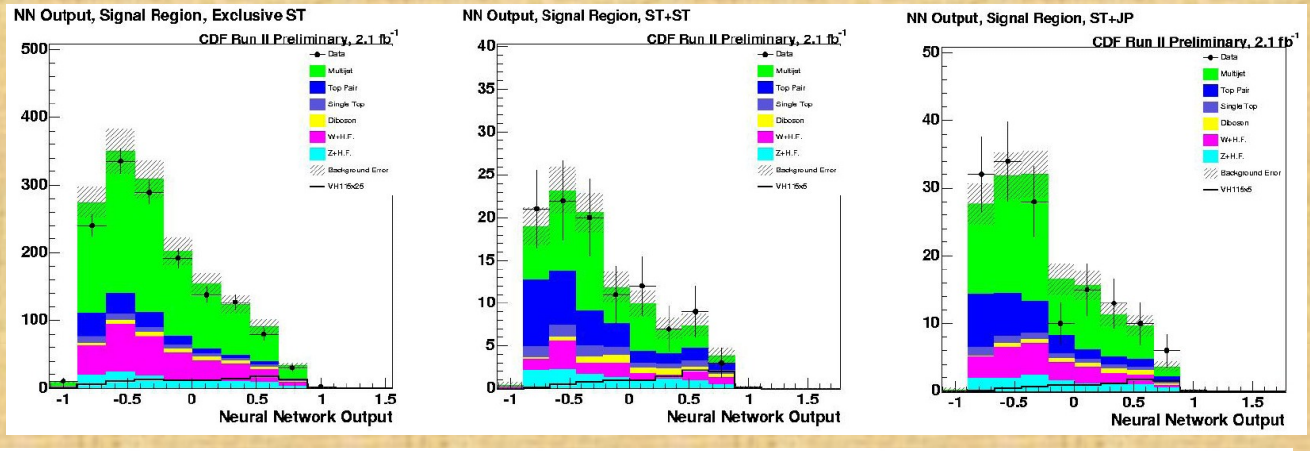
- Analisi tradizionalmente divise in bassa massa ($M_H < 135$ GeV/c^2) → produzione associata W/Z + H e alta massa → produzione diretta di H→WW(*)



- Risultati continuano a migliorare molto più di quanto prevedibile in base al solo aumento della luminosità integrata:
  - Nuovi canali, nuove tecniche
  - Detector performance stabili
  - Entusiasmo e interesse non scemano

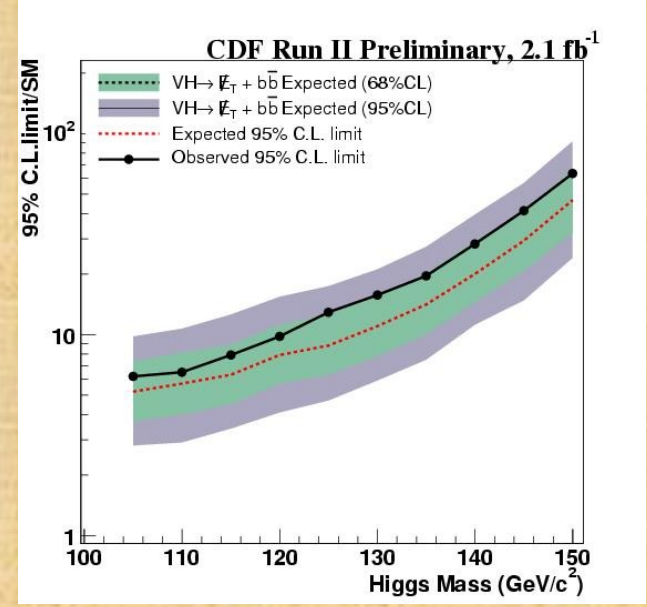
SM Higgs (bassa massa)

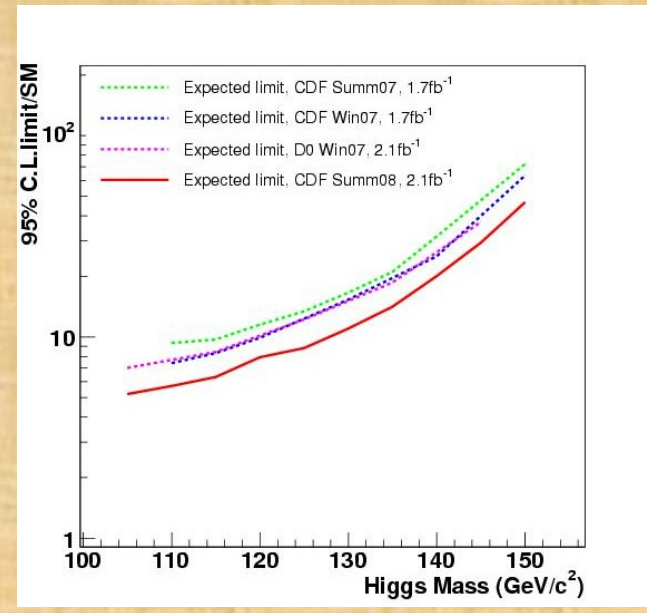
- Analisi sempre piu' raffinate in tutti i canali: esempio canale Met + 2 bjet: ZH→νν̄bb + WH→(l)νbb



Process	Exclusive 1Tag	ST+ST	ST+JP
QCD + Mistags	944.6 ± 57.9	43.8 ± 11.9	79.8 ± 15.3
Single Top	42.3 ± 8.1	6.9 ± 1.5	6.0 ± 1.4
Top Pair	121.3 ± 15	25.8 ± 4.0	26.1 ± 4.5
Di-boson	35.6 ± 6.6	4.9 ± 1.1	4.3 ± 1.1
W + h.f.	296.9 ± 128.4	11.0 ± 6.0	21.0 ± 10.1
Z + h.f.	107.3 ± 45.7	10.9 ± 5.1	11.3 ± 5.4
Total Exp	1547.8 ± 149.2	103.2 ± 14.9	148.5 ± 19.7
Observed	1443	105	148

SM Higgs (bassa massa)

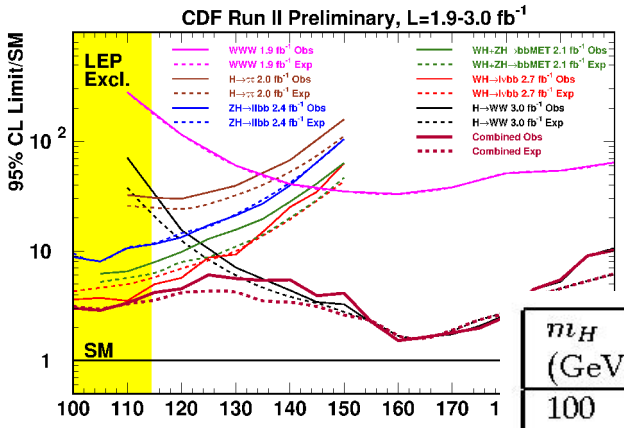




- Improvements:
  - Utilizzo del sample con 3 Jet per la prima volta:
    - gluon radiation recovery
    - WH→τνbb (hadr. τ decay)
  - Utilizzo del tracking per complementare l'informazione calorimetrica di MET
  - Migliore separazione cinematica

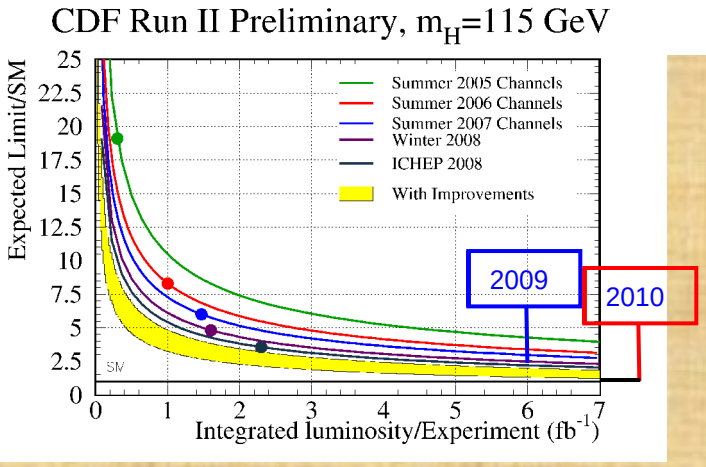
- Complessivamente sensibilita' accresciuta del 15-20% in questo canale
- In futuro: utilizzo dei dati del nuovo trigger calorimetrico → promettente

SM Higgs (bassa massa)



- Combinazione su tutto il range di massa per l'estate solo da CDF
- Ci si aspetta un limite nel range 2-3 * SM a 115 GeV da CDF+ DØ

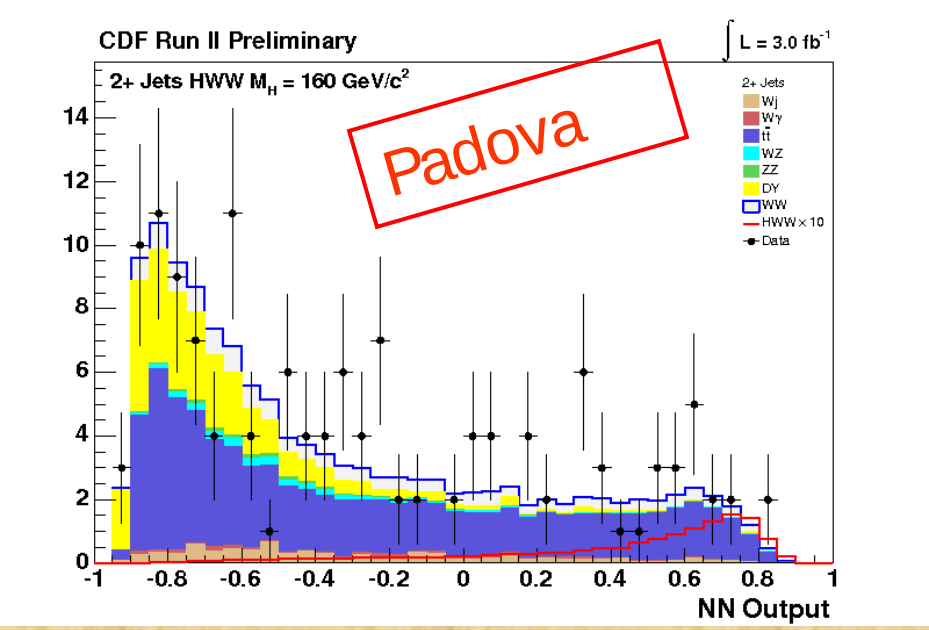
m_H (GeV/c^2)	Observed limit/SM	-2σ expected	-1σ expected	median expected	$+1\sigma$ expected	$+2\sigma$ expected
100	3.01	1.43	2.07	3.13	4.78	7.10
105	2.87	1.30	1.91	2.98	4.62	6.95
110	3.34	1.47	2.15	3.29	5.00	7.35
115	4.19	1.58	2.32	3.56	5.43	8.05
120	4.53	1.93	2.75	4.15	6.29	9.31
	6.04	1.87	2.77	4.29	6.55	9.72
	5.62	1.99	2.80	4.21	6.38	9.46



- La curva di sensibilita' in funzione della luminosita' assomiglia sempre piu' al goal (curva gialla)
- Se si raggiunge sara' possibile escludere MH=115 GeV/c^2 al 95% CL nel 2010

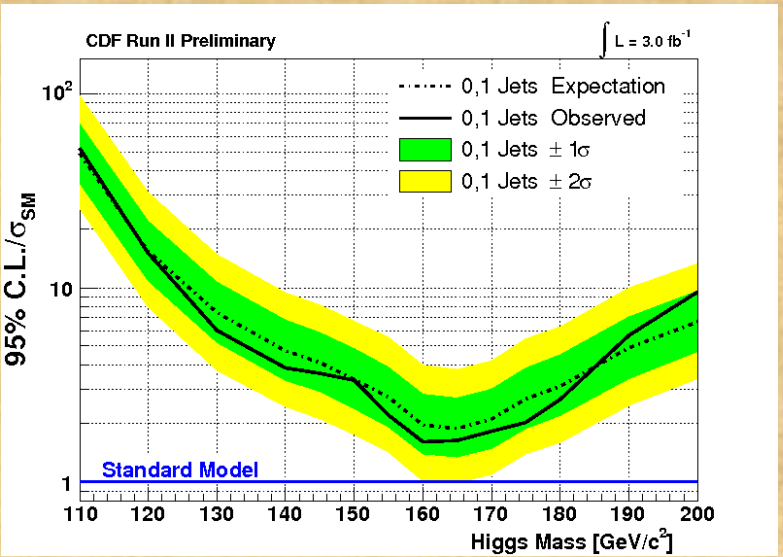
SM Higgs (alta massa)

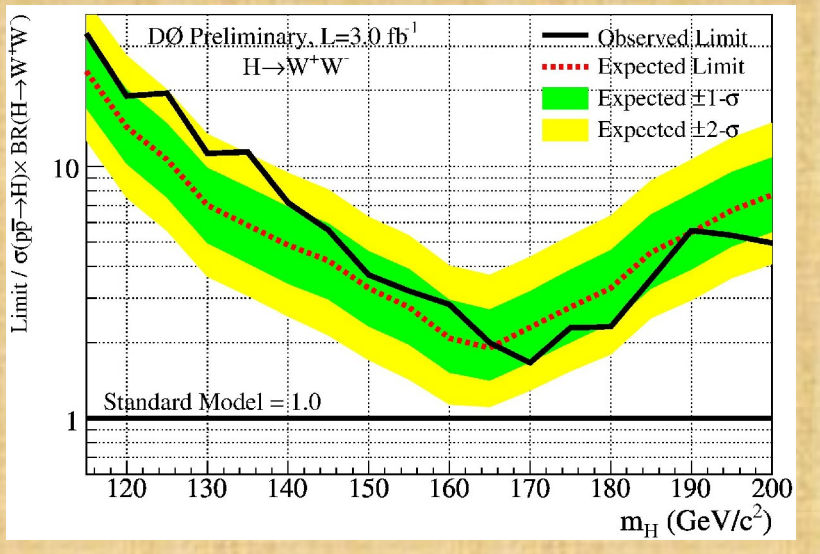
- LHC sweet-spot (MH= 160 GeV/c^2) si e' rivelato tale anche al Tevatron !
- Al tradizionale canale H→WW->lνlν +0,1 Jet quest'estate si aggiunge per la prima volta il canale con 2 jet

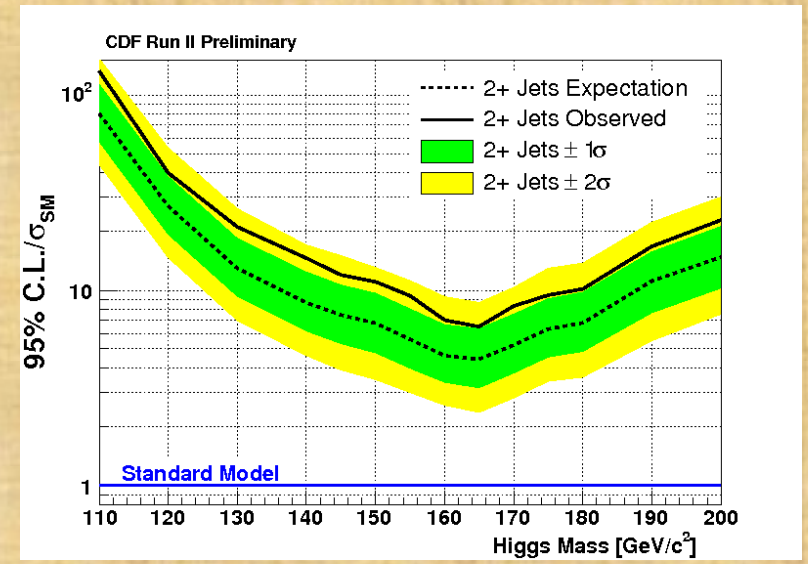


CDF Run II Preliminary	$\int \mathcal{L} = 3.0$ fb^{-1}		
$M_H = 160$ GeV/c^2			
$t\bar{t}$	70.34	±	14.46
DY	27.74	±	6.75
WW	15.68	±	2.47
WZ	3.33	±	0.53
ZZ	1.35	±	0.21
W+jets	8.38	±	2.27
$W\gamma$	1.80	±	0.47
Total Background	**128.62**	±	**20.19**
$gg \rightarrow H$	1.52	±	0.26
WH	1.18	±	0.16
ZH	0.59	±	0.08
VBF	0.61	±	0.10
Total Signal	**3.90**	±	**0.45**
Data	**139**		
			HWW ≥ 2 Jets

SM Higgs (alta massa)

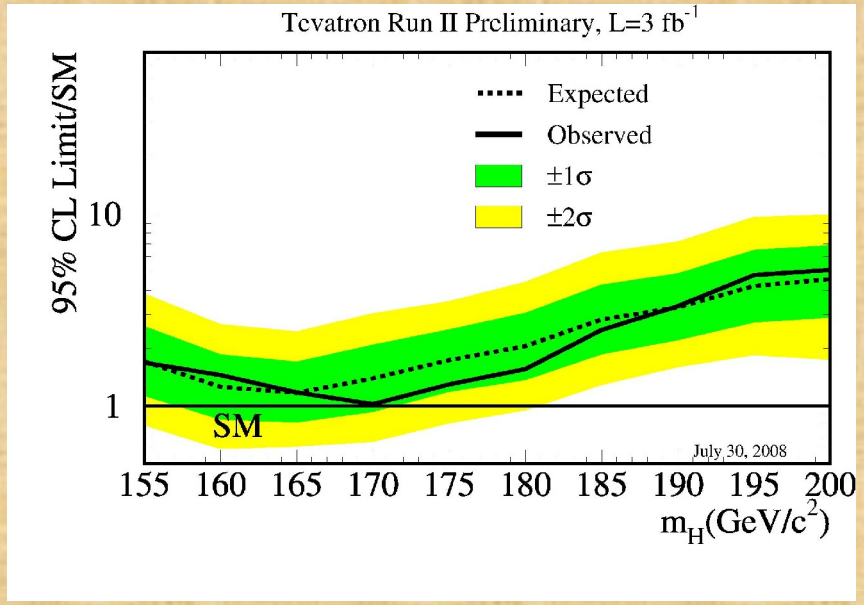


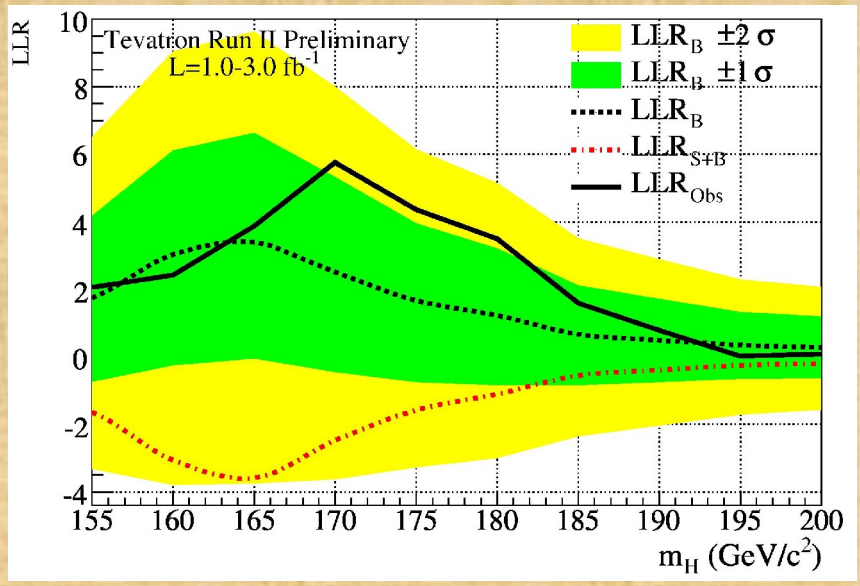




- +15% di sensibilita' dal canale a 2 jet a CDF
- Ulteriori canali di decadimento allo studio per il prossimo update
- Sensibilita' di DØ (con 3 fb-1) equivaente

SM Higgs combinazione (alta massa)

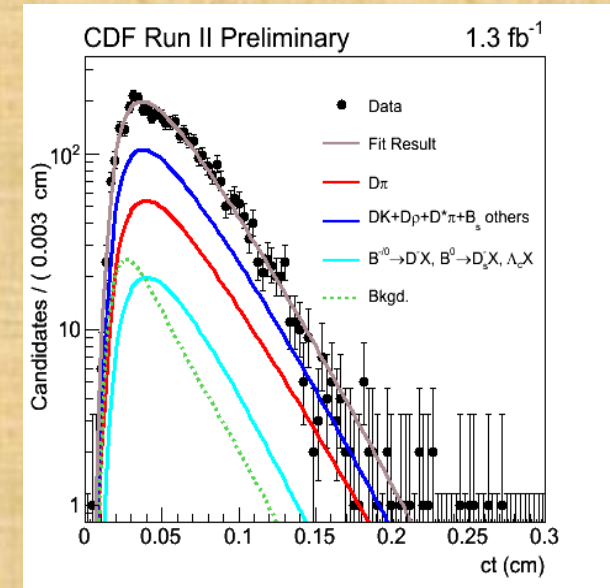


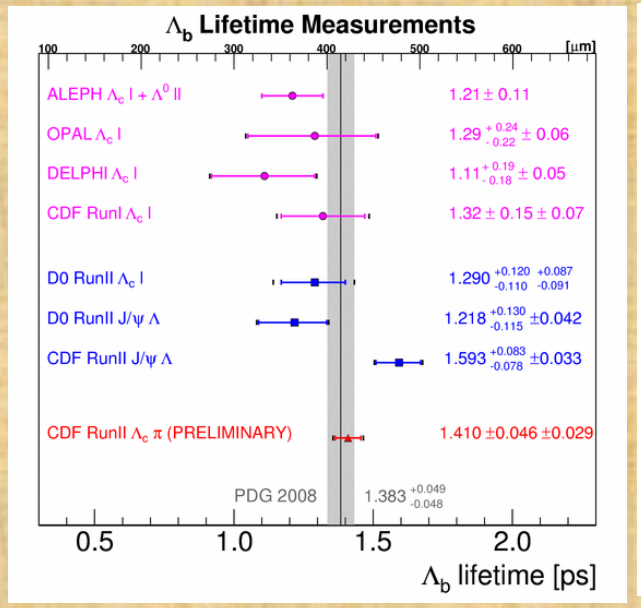


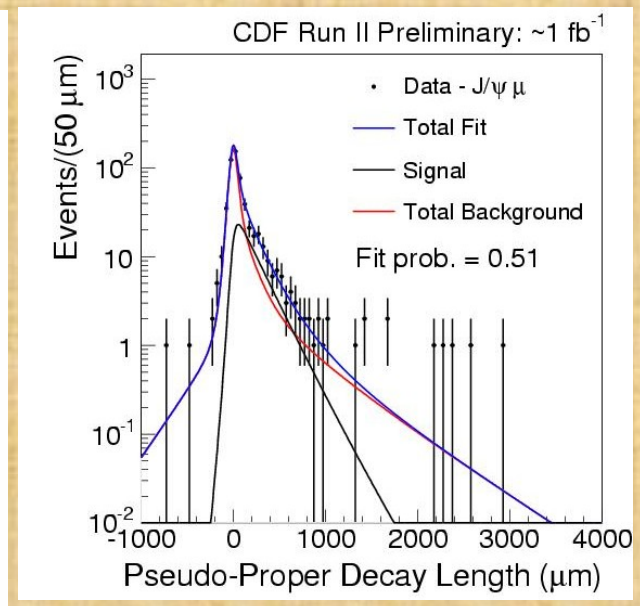
- Finalmente il limite osservato e' inferiore alla sezione d'urto SM, piccola fluttuazione fortunata
- Un Higgs SM di 170 GeV e' escluso al 95% CL!
- Fondate prospettive di allargare la zona di esclusione in un intervallo attorno a 160 -170 GeV

B-physics - back to basic

- Precision lifetime measurements (B_s, Λ_b, B_c)







From Hadronic trigger!

$\tau(B_s)^{f.s.}$=

1.518± 0.041± 0.025 ps

World Best!

From Hadronic trigger!

t_Λ/t_{B0}= 0.922± 0.039

World Best, solve problem with theory

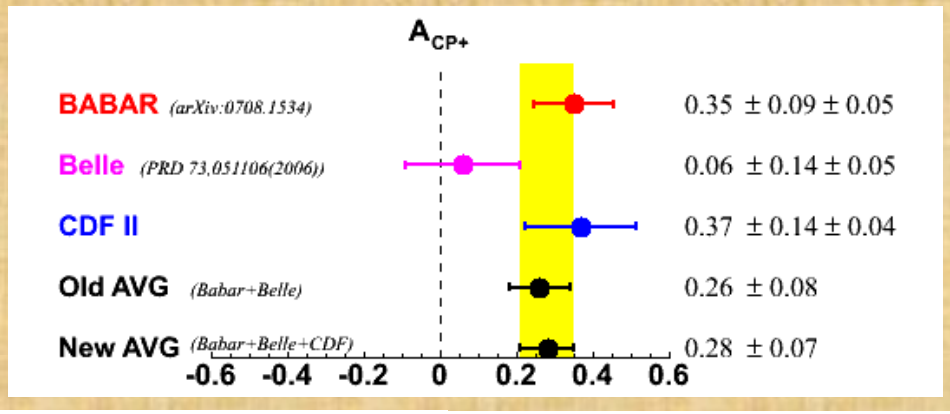
$B_c \rightarrow J/\Psi\ l\ \nu$ (l=e,μ)

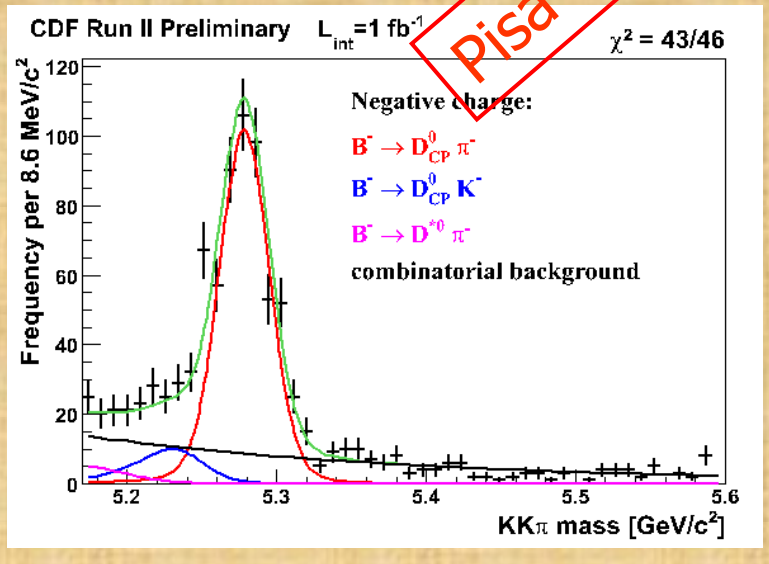
$\tau(B_c)$=0.475+0.053-0.049(stat)± 0.018(sys) ps

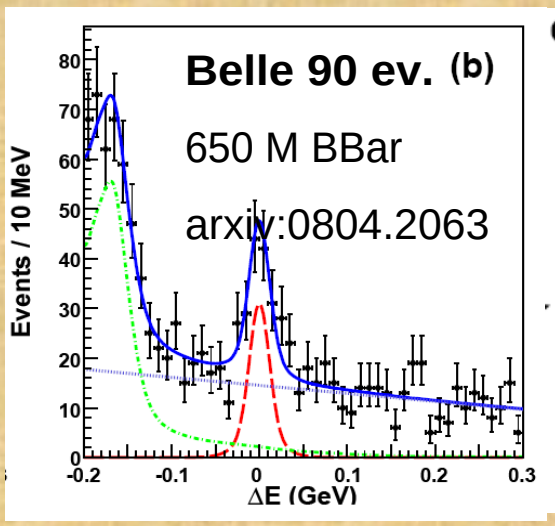
DCPV $B^{\pm} \rightarrow DK^{\pm}$ at CDF

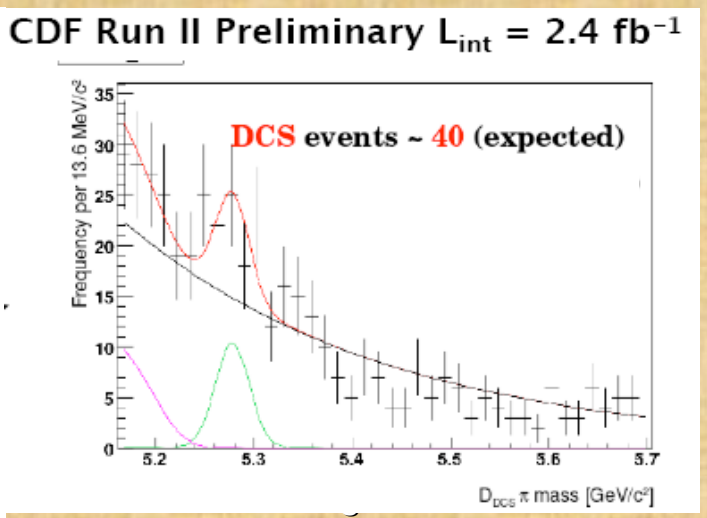
Pisa-Siena

- Significant number of $B^{\pm} \rightarrow DK^{\pm}$ events (this analysis ~120 $B \rightarrow D_{CP}K$ events)
- Cabibbo suppressed D^0 decays (CP+) firmly established: kinematics + PID separation, resolution as Babar/Belle



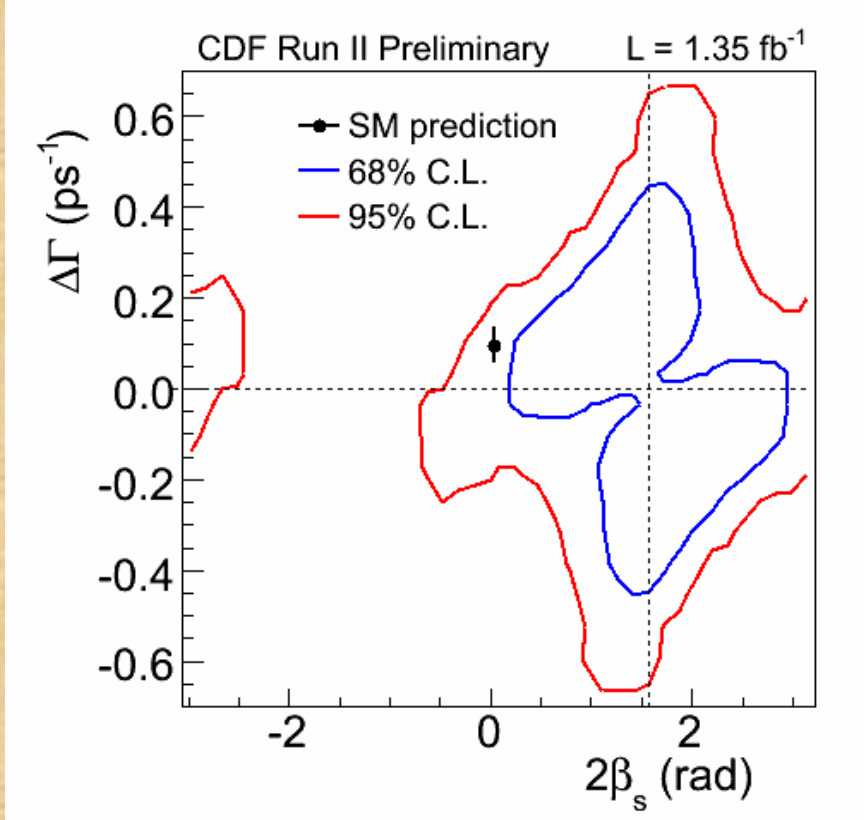


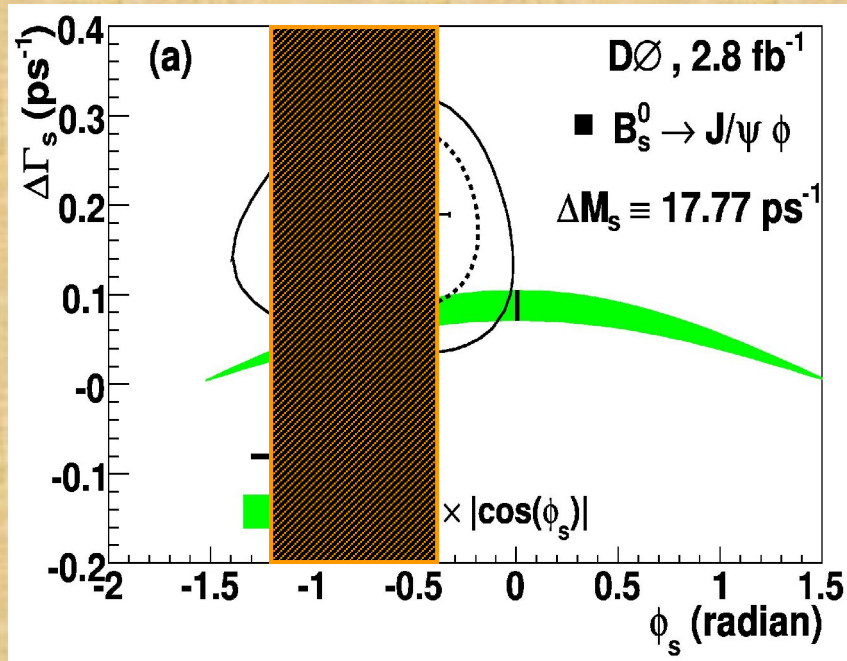




CDF contributing to "γ" via GLW method, now looking also for double Cabibbo suppressed D^0 modes for ADS method

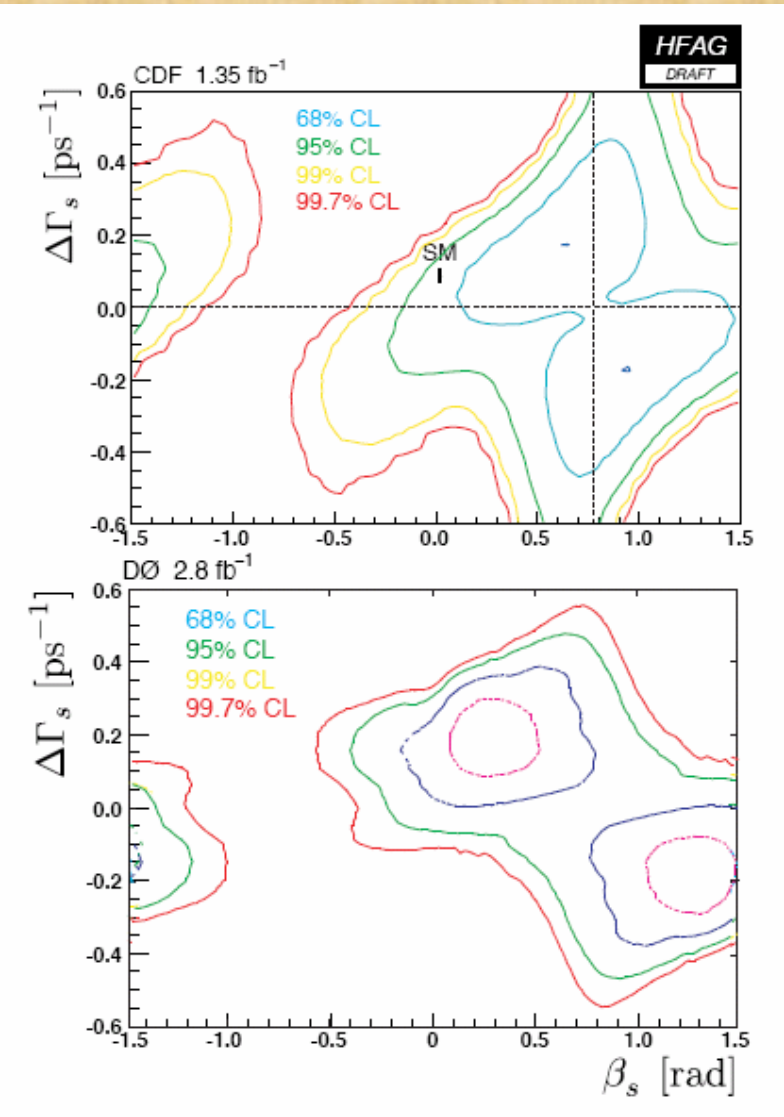
B_s CPV saga/ inverno





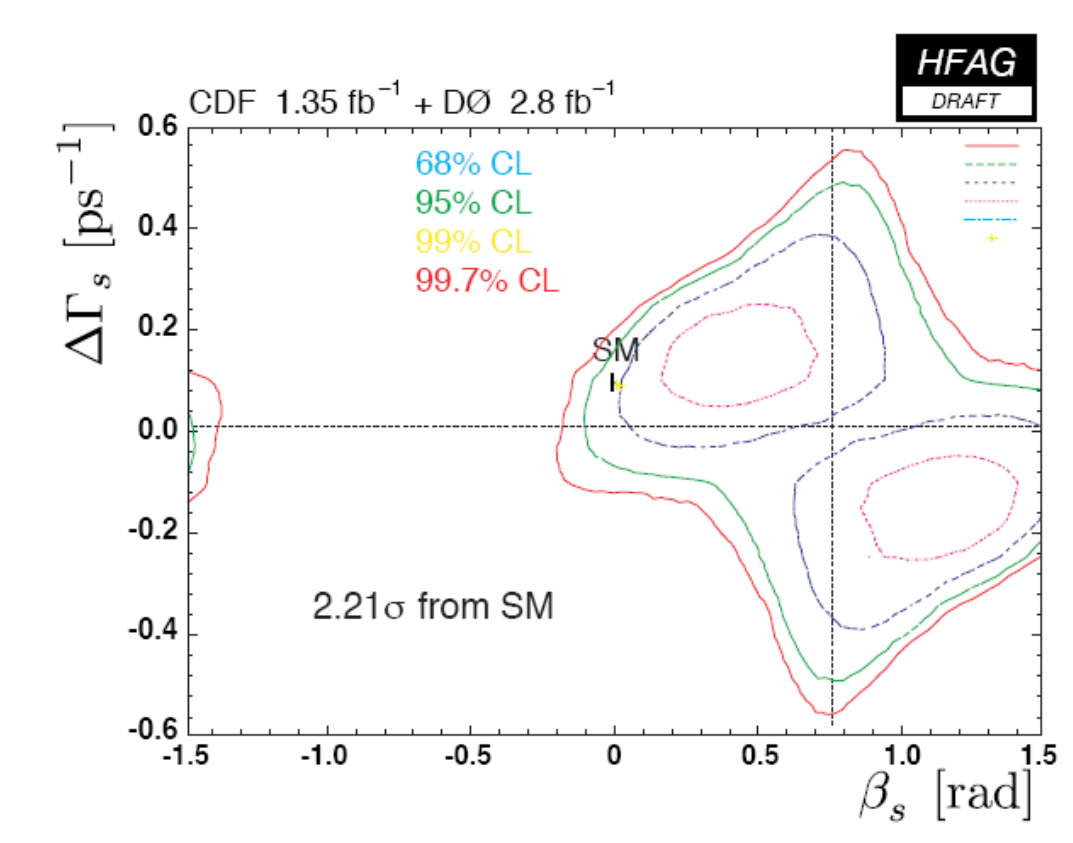
- CDF SM p-value = 15%
- DØ SM p-value (with constraints)= 6.6 % (n.b. $\phi_s = -2\beta_s$)

B_s CPV saga/ estate (1)



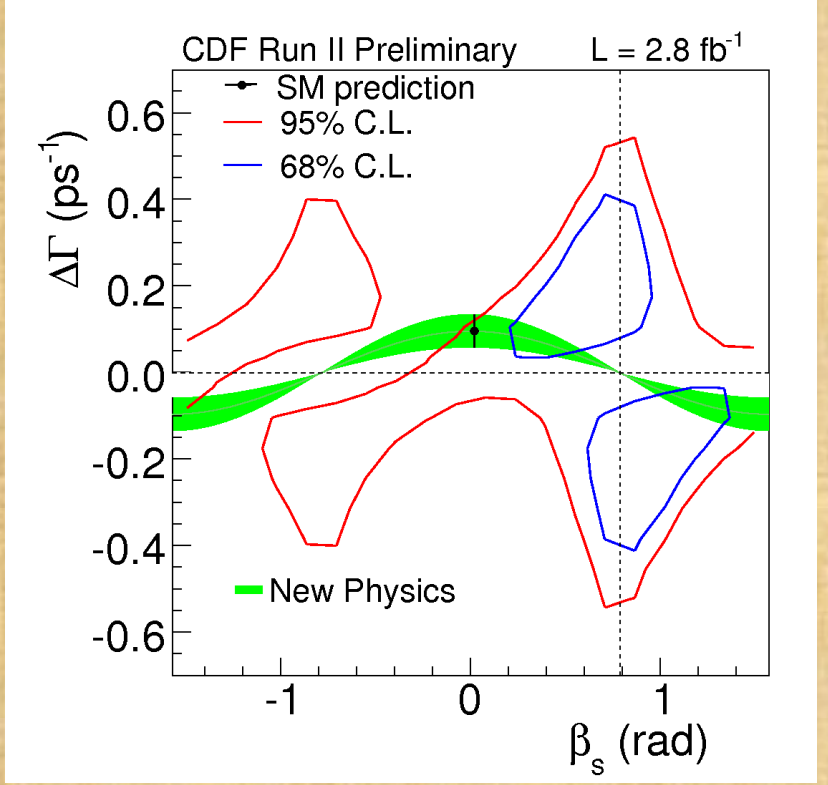
- DØ redid the analysis without questionable constraints in order to proceed to a proper combination
- DØ SM p-value = 8.5 % (1.7 σ)

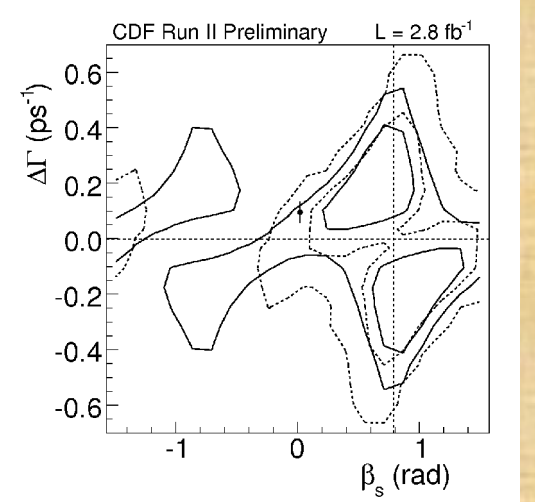
B_s CPV saga/ estate (2)

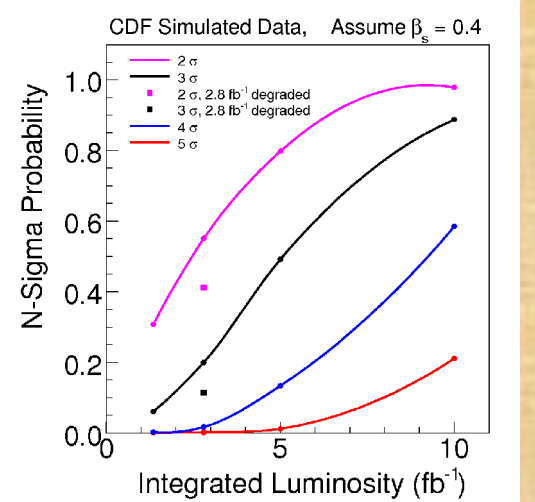


- 90% probability range: $0.15 < \beta_s < 0.74$ or $0.82 < \beta_s < 1.18$
- Discrepancy with SM point = 2.2 σ (includes stat. and syst.)
- Using additional exp. & theory constraints UTfit and CKMfitter quote 2.5-2.6 σ

B_s CPV saga/ CDF update







- x2 data: SM p-value from 15% to 7%
  - Caution: this preliminary result do not include yet TOF/dEdx and Same Side Kaon Tagging in the analysis
- B-group actively working on several improvements for next updates

Italiani in CDF

- CDF continua ad essere attrattivo per giovani
  - 8 tesi dottorato in corso (costanti rispetto agli anni scorsi): B-physics, Higgs, QCD
  - Altrettante tesi laurea specialistica
  - Summer student program molto soddisfacente → possibilita' nuovi giovani
- 3 borsisti INFN basati a FNAL hanno appena preso servizio → rafforzamento significativo gruppo italiano
- Numerose posizioni di responsabilita' nell'analisi a livello di conveener (B-group) e sub-conveener di gruppi di fisica
- In ottima posizione per continuare una storia di successo fino al termine del Run II

Planning per il run del 2010 e outlook

- La comunita' ha saputo reagire con forza ai tagli di bilancio approvati a Dicembre 07
  - Come risultato e' stato garantito un supplemental appropriation bill a Luglio (+$62.5M per DOE office of Science) che ha sollevato il budget di Fermilab
- Il laboratorio (incoraggiato informalmente dal DOE) ha tra i progetti prioritari garantire il funzionamento del Tevatron per il 2010: in attesa del cambio di amministrazione per la decisione finale.
- CDF si prepara al 2010 come se fosse approvato
- Shutdown previsto non prima di Aprile 2009 (durata ancora incerta)
- In ogni caso facile prevedere nuovi e significativi risultati anche per il 2009!

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