Stato di CDF

Luciano Ristori

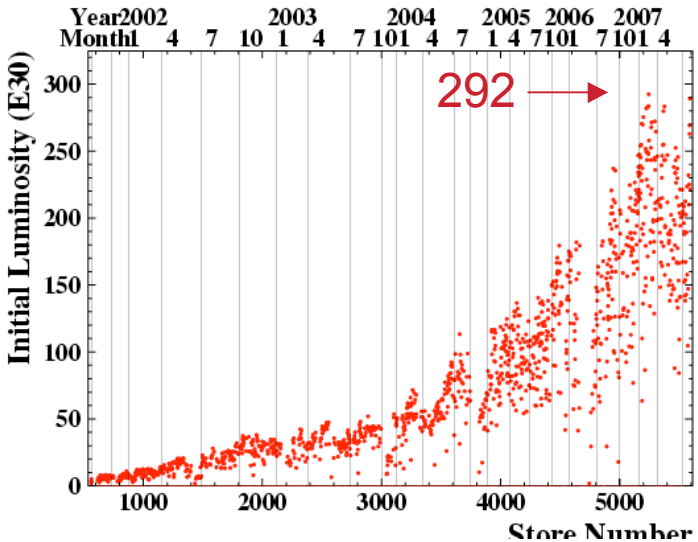
19 Settembre 2007

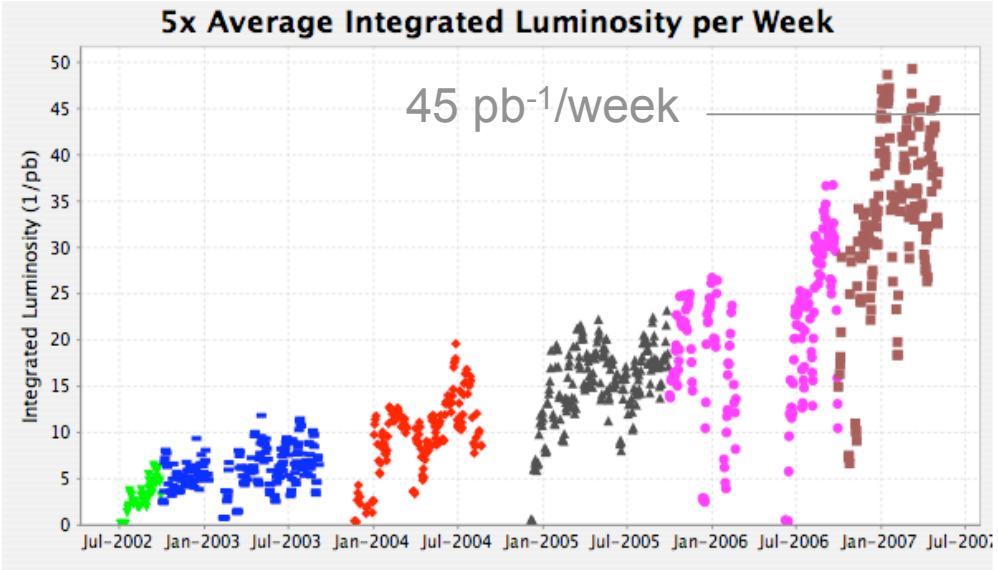
Stato di CDF in breve

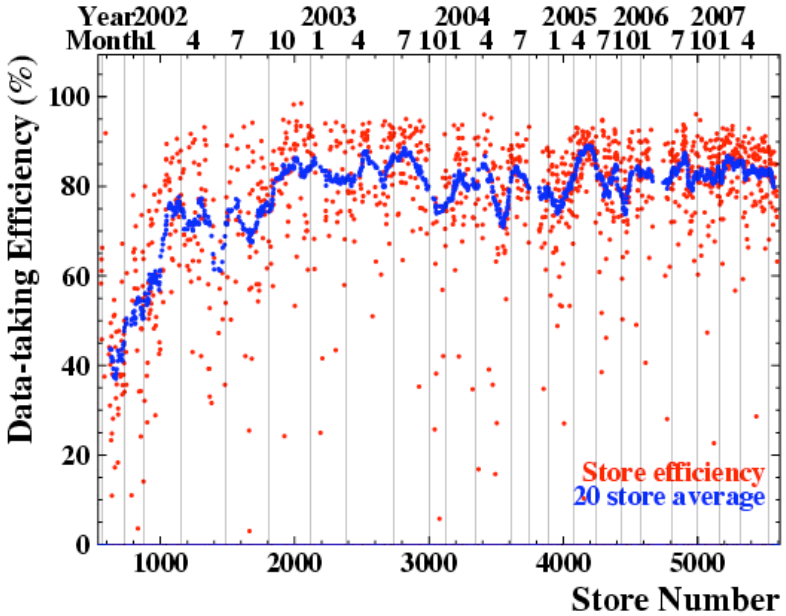
- Il Tevatron e CDF godono di ottima salute
- La luminosita' di picco ha raggiunto ~$3x10^{32}$
- Il Run II e' stato ufficialmente esteso fino alla fine del 2009
- Si sta considerando la possibilita' di una ulteriore estensione
- Tevatron shutdown in progress: 10 weeks + 2 weeks studies
  - Aug 6 - Oct 29
  - ISL/Layer00 cooling in riparazione
- ~50 nuovi (*) risultati presentati a Lepton-Photon 2007
- I recenti upgrades del trigger e studi specifici in corso migliorano le prospettive di CDF nella ricerca del bosone di Higgs

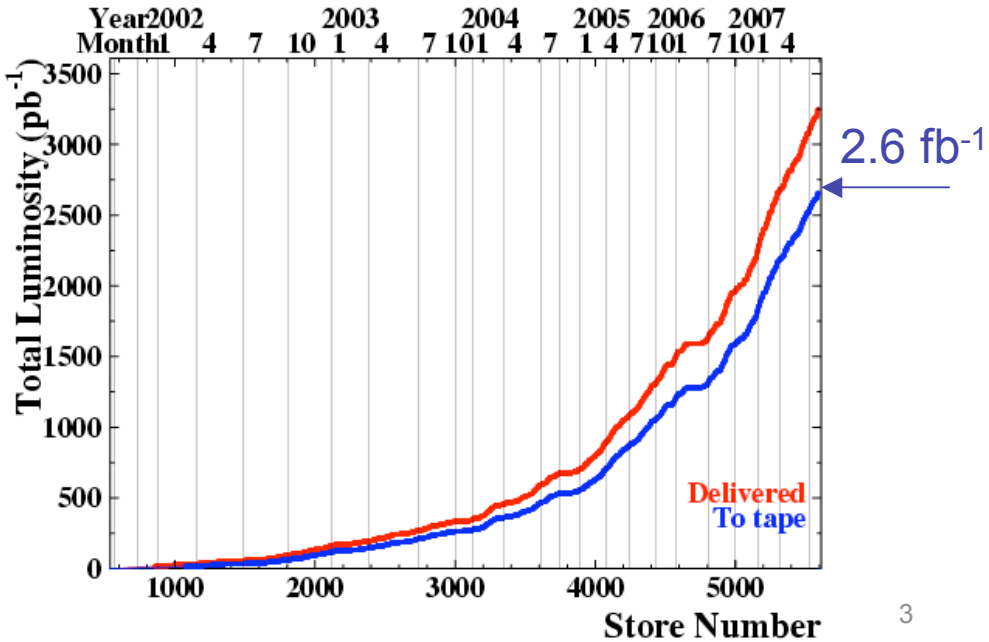
(*) post winter 07 conferences

CDF and Tevatron performance

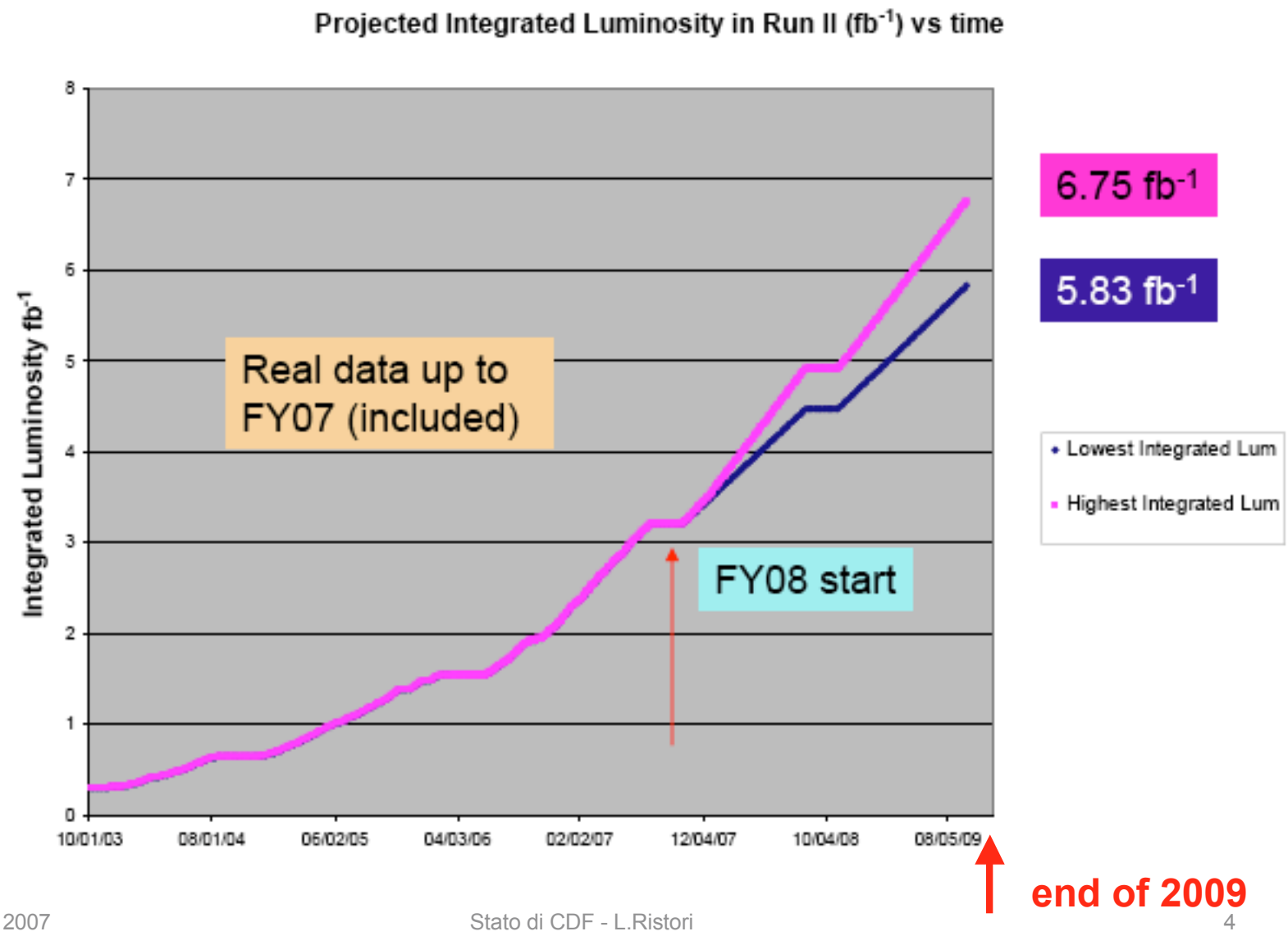






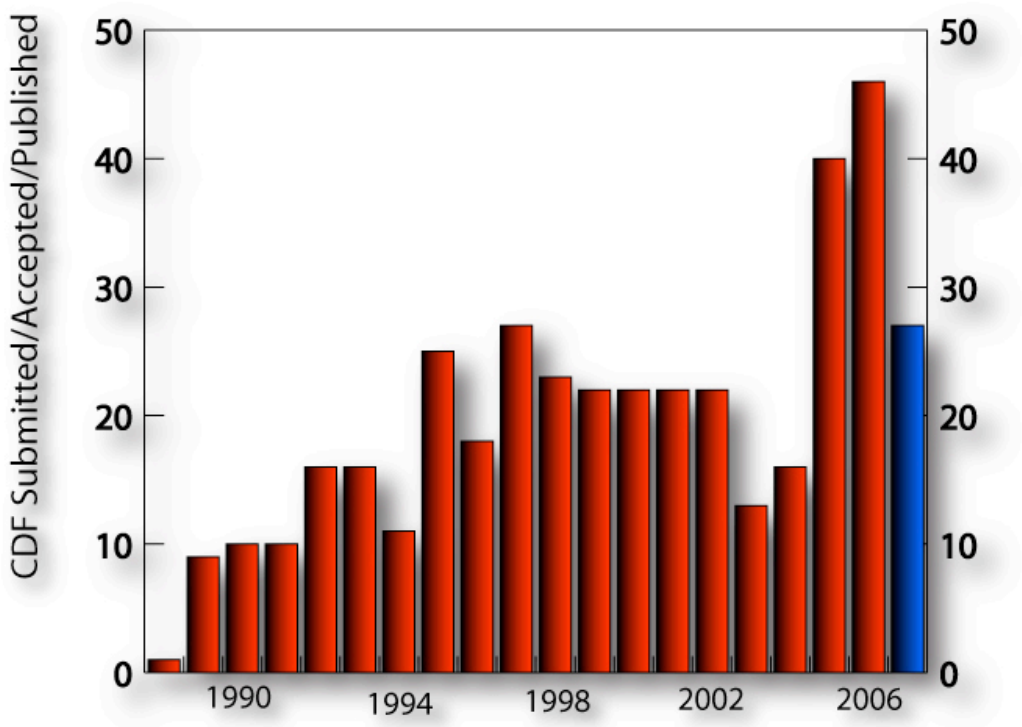


Integrated Luminosity Projection



Publication Status

- Publications submitted+accepted+published
  - 137 Run II publications and 17 papers submitted but not published
  - We also have >50 additional papers under internal review !
  - On track for 40+ publications in 2007



Fisica: nuovi risultati

Ultimo aggiornamento sulla fisica di CDF in
Commissione I a Maggio
(vedi talk di Tommaso Dorigo)

51 nuovi risultati presentati da CDF alle conferenze estive
sono listati e documentati in questa pagina pubblica:

http://www-cdf.fnal.gov/physics/S07CDFResults.html

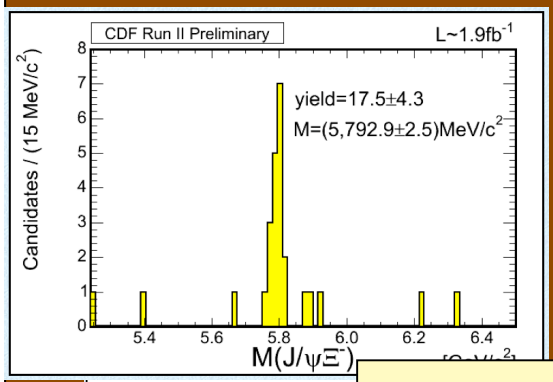
CDF Physics at Lepton-Photon 2007

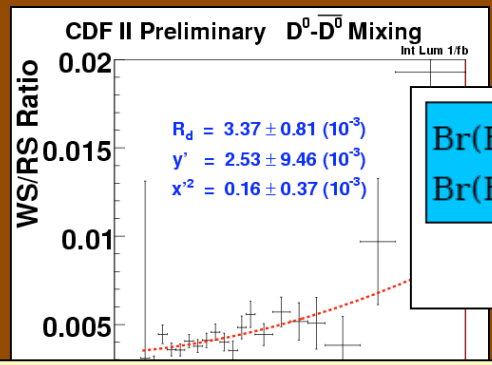
- Per Lepton-Photon 2007 la CDF ha prodotto:
  - **~50 nuovi risultati da Aprile 07**
  - ~30 usano tutti i dati disponibili (~2 fb-1)
- Questo risultati coprono tutto lo spettro della fisica di CDF
  - QCD/Jets
  - Heavy Flavors (bottom e charm)
  - Electroweak
  - Top
  - Higgs
  - Ricerca di Nuova Fisica

LEPTON-PHOTON 2007
XXIII International Symposium on Lepton and Photon Interactions at High Energy Aug 13-18, Daegu, Korea

http://chep.knu.ac.kr/LP07/

New CDF results: highlights

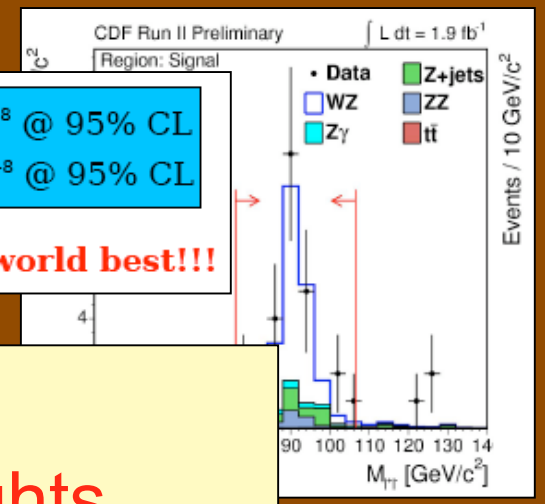


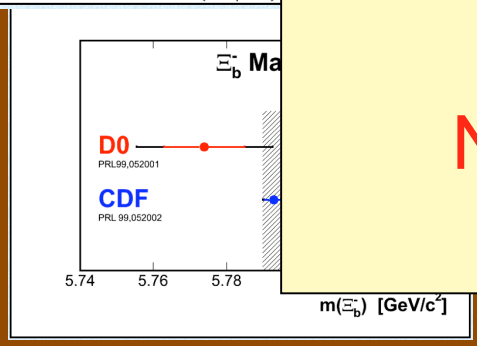


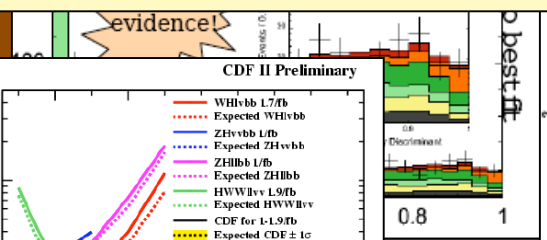
$Br(B_s \to \mu\mu) < 5.8 \times 10^{-8}$ @ 95% CL

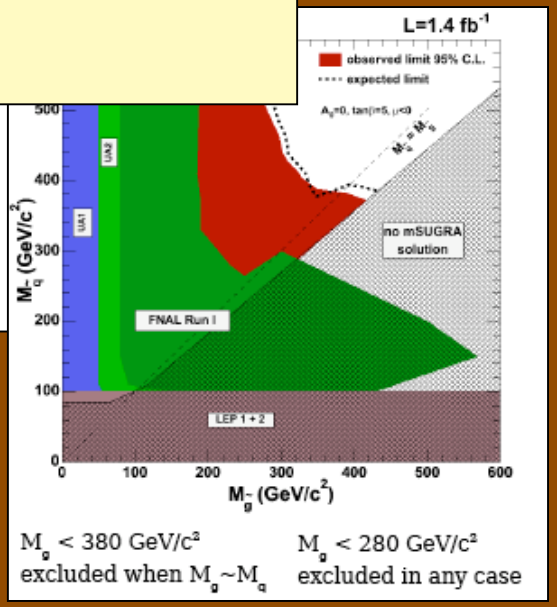
$Br(B_d \to \mu\mu) < 1.8 \times 10^{-8}$ @ 95% CL

Both limits are world best!!!





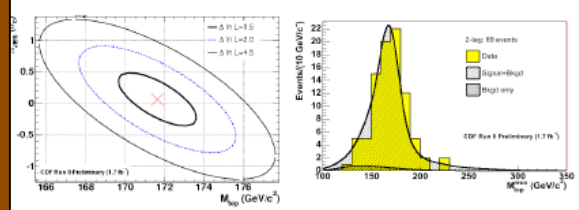




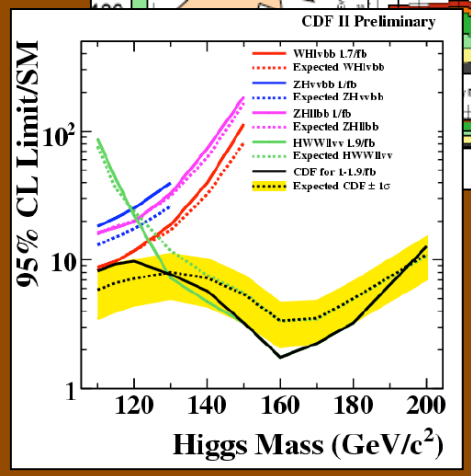
$M_{\tilde{g}} < 380$ GeV/c^2 excluded when $M_{\tilde{g}} \sim M_{\tilde{q}}$

$M_{\tilde{g}} < 280$ GeV/c^2 excluded in any case

most precise lepton + jets channel:

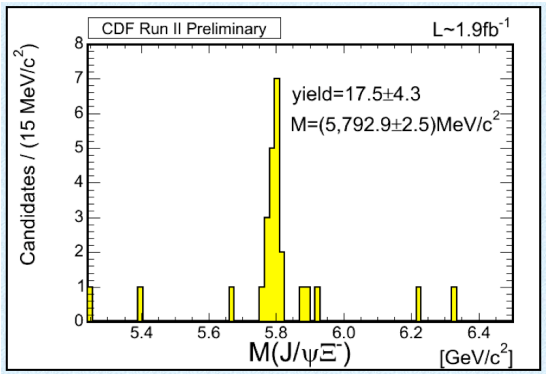


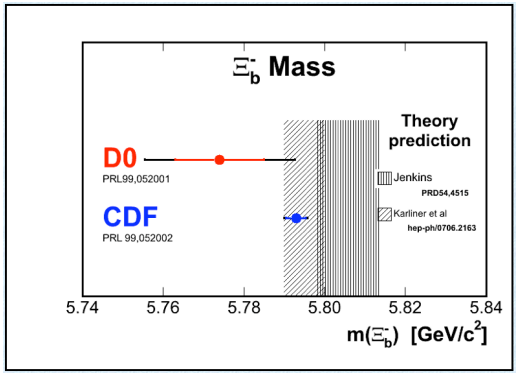
M_{top}=171.6 ± 2.4 (stat+syst) GeV/c^2



Highlights (1)

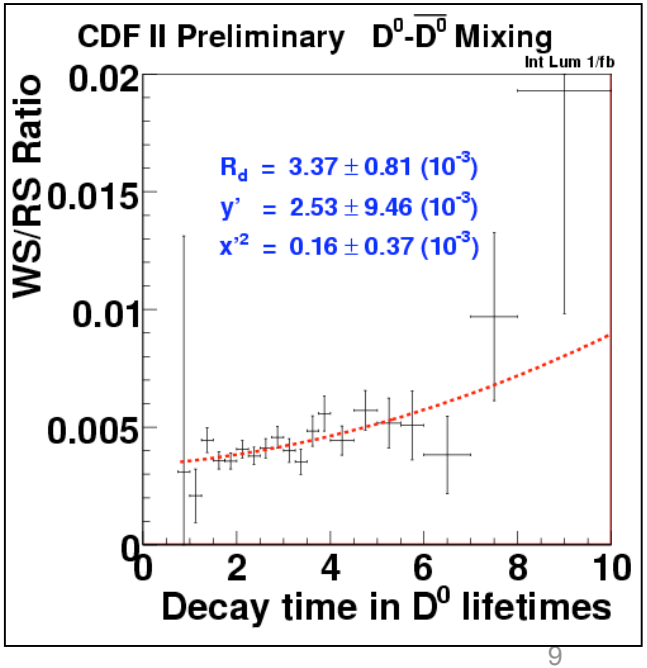
- Observation of Cascade b





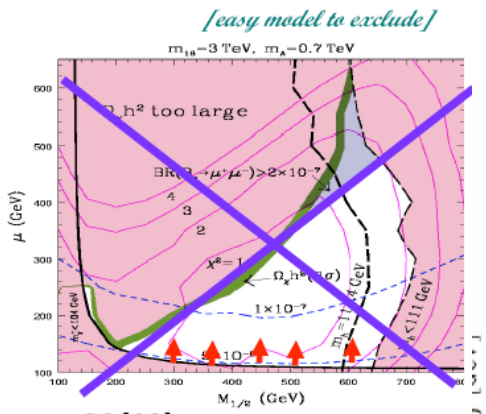
- D^0 mixing confirmed at *3.2* σ

$$R(t) = R_D + y'\sqrt{R_D}\,t + \frac{x'^2 + y'^2}{4}\,t^2$$



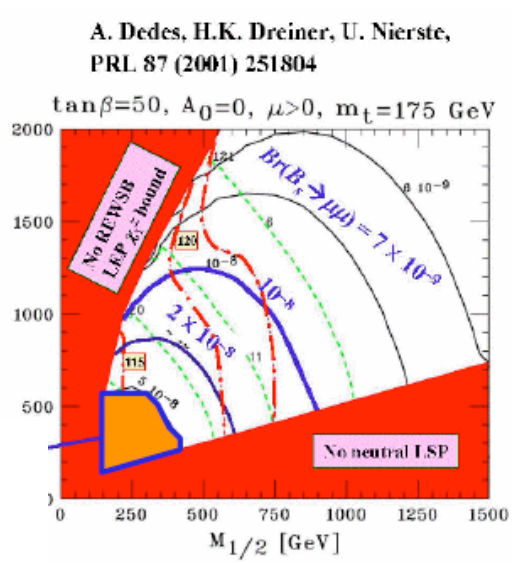
Highlights (2)

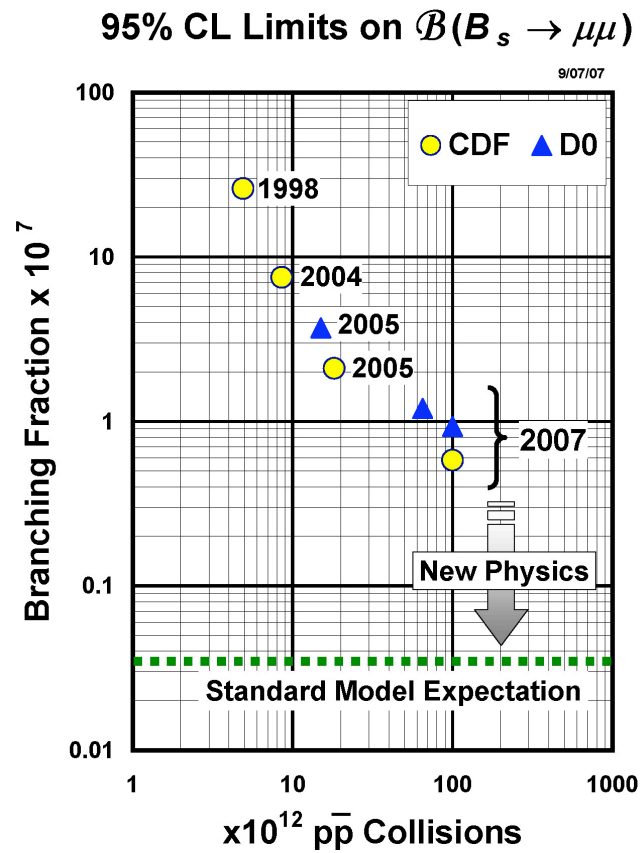
- $B_{d,s} \rightarrow \mu^+ \mu^-$
  - mSUGRA phase space reduced
  - SO(10) model now excluded



SO(10)

R. Dermisek *et al.*, hep-ph/0507233 (2005)





$Br(B_s \rightarrow \mu\mu) < 5.8 \times 10^{-8}$ @ 95% CL

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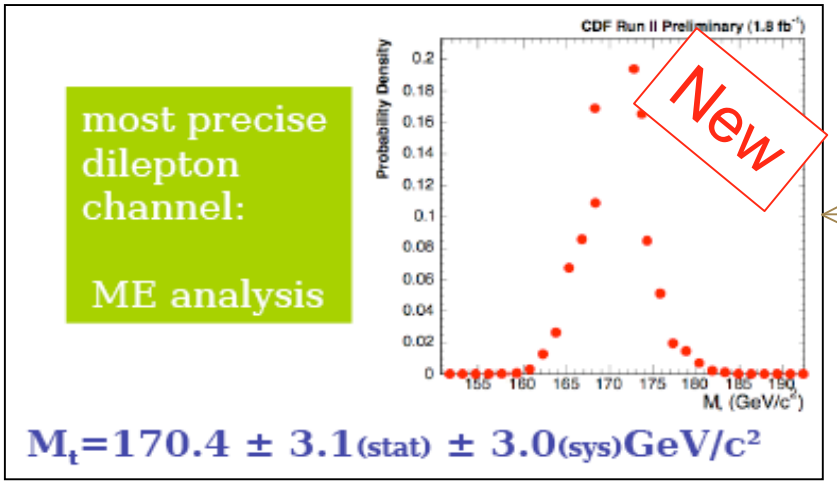
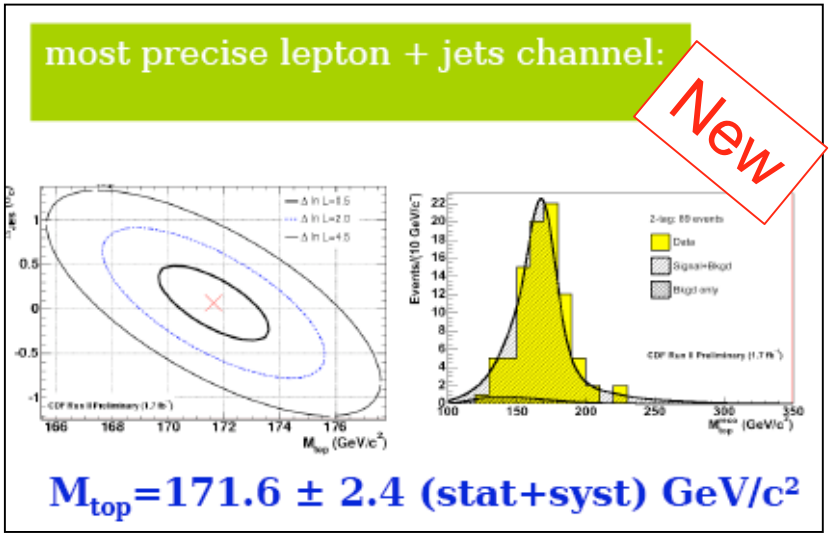
Both limits are world best!!!

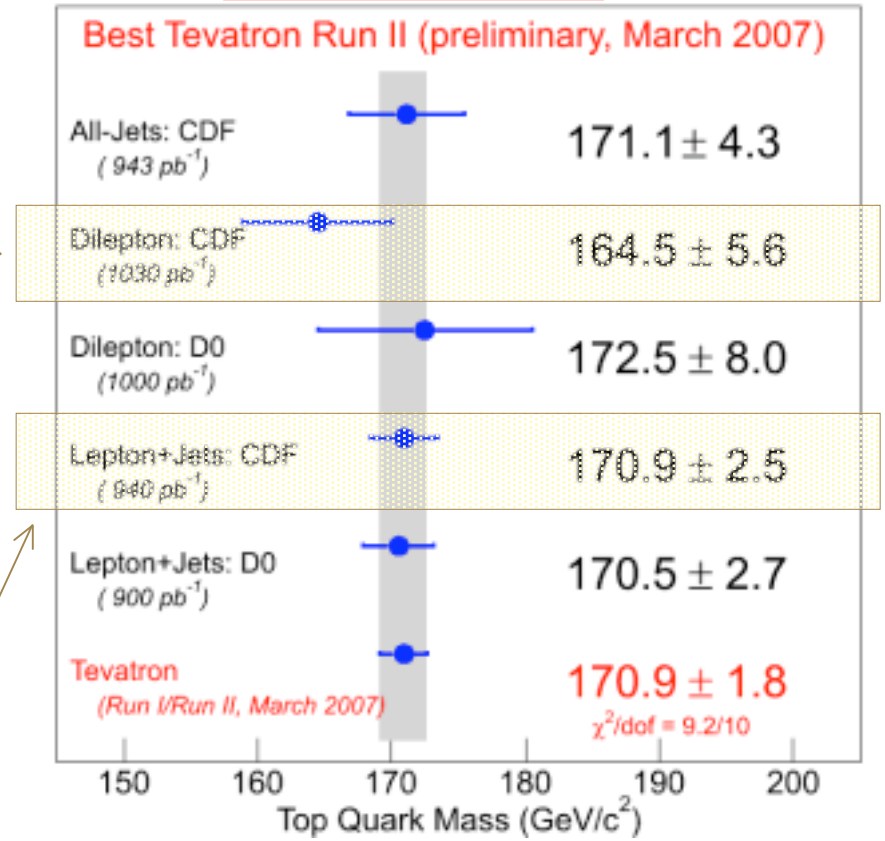
Highlights (3)

- M_{top} keeps improving





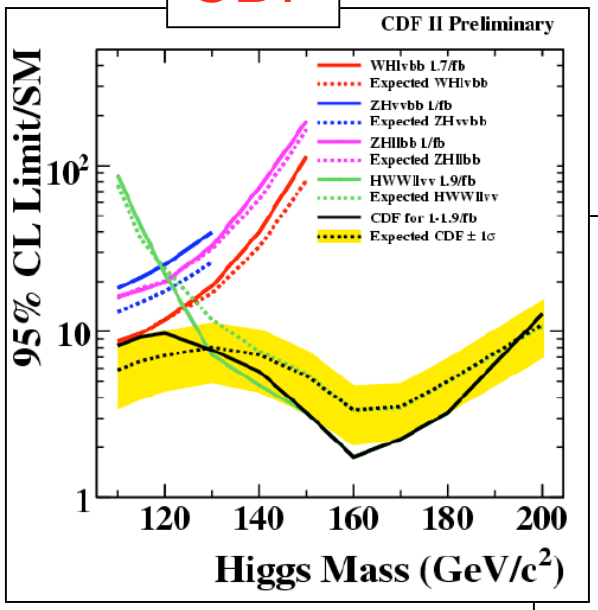
March 2007



m_{top} = 170.9 ± 1.1 ± 1.5 GeV/c

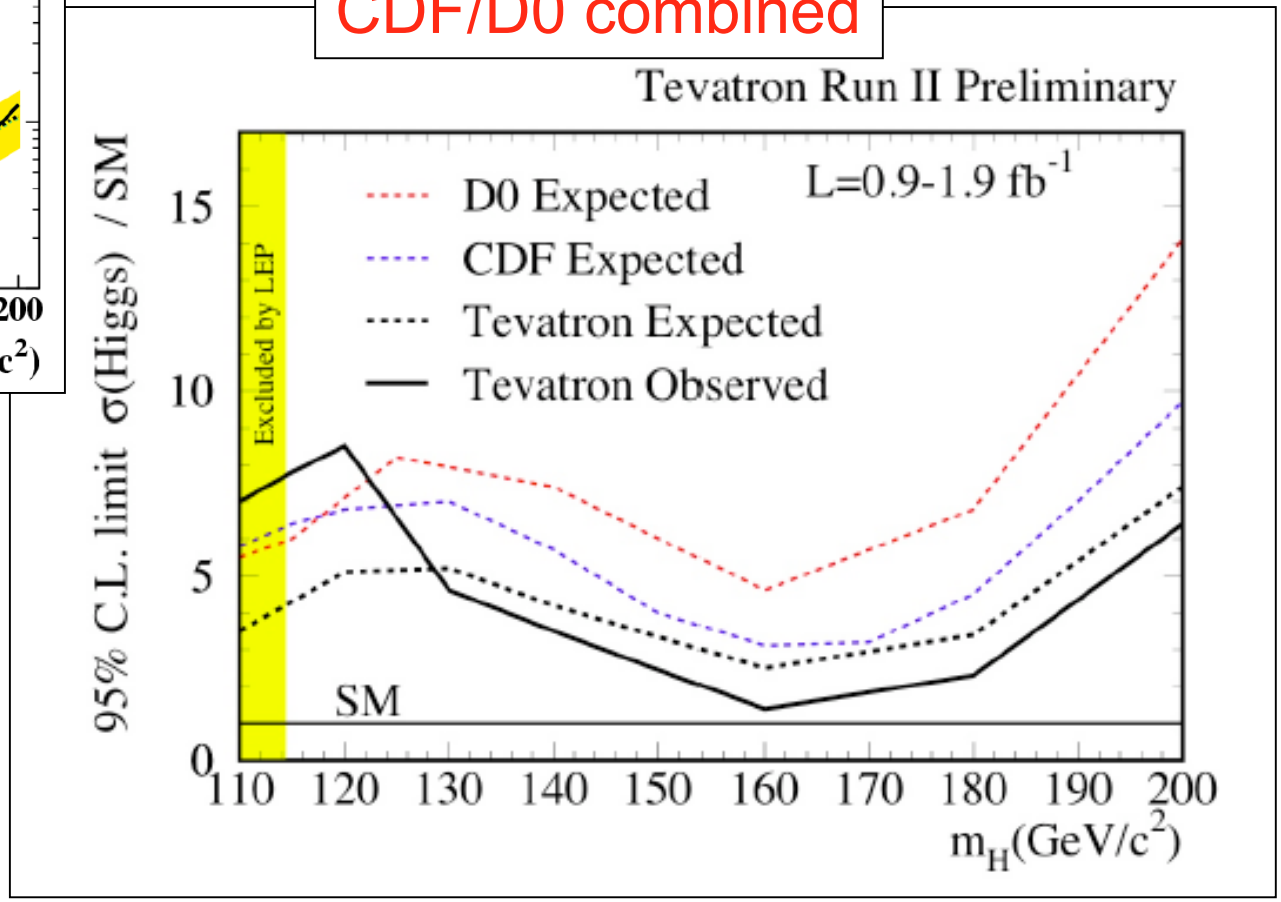
Higgs Limits

CDF



Now very close to begin excluding a mass region for SM Higgs

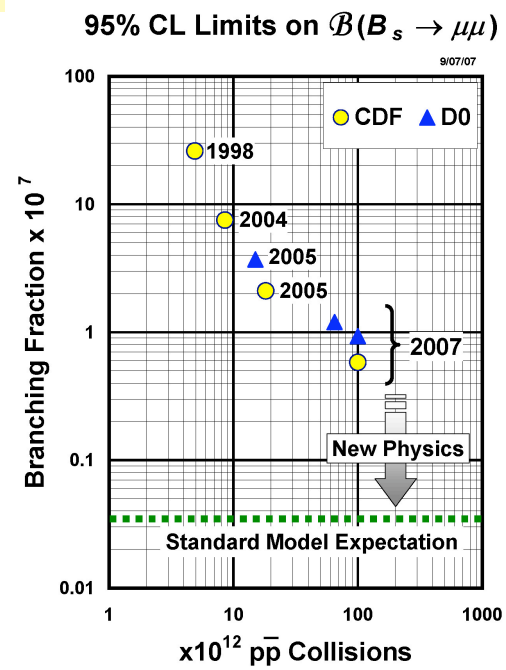
CDF/D0 combined

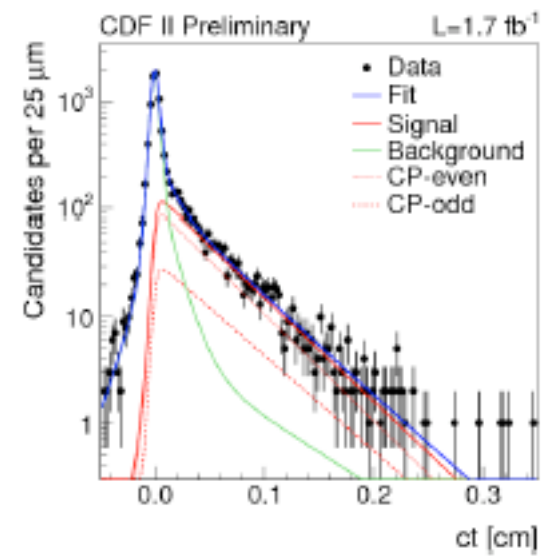


CDF Prospects for Flavor Physics

CDF prospects for flavor physics (1)

- $B_s \to \mu\,\mu$
  - ~ 1-2 10^{-8} con 6 fb^{-1}
- $\Delta\Gamma_s$ e ϕ_s da $B_s \to J/\psi\ \phi$
  - $\sigma(\Delta\Gamma_s)$ 0.04 con 6 fb^{-1} (2σ)
- CP Asymmetry in $B_s \to K\,\pi$
  - 6% con 6 fb^{-1} (6σ)
- CP Asymmetry in $B_d \to K\,\pi$
  - 1% con 6 fb^{-1}
- World best lifetimes
  - B_s, Λ_b, B_c, Σ_b, new states... ???
- D^0 mixing
  - migliore misura di frequenza?
  - sensibile ad ACP



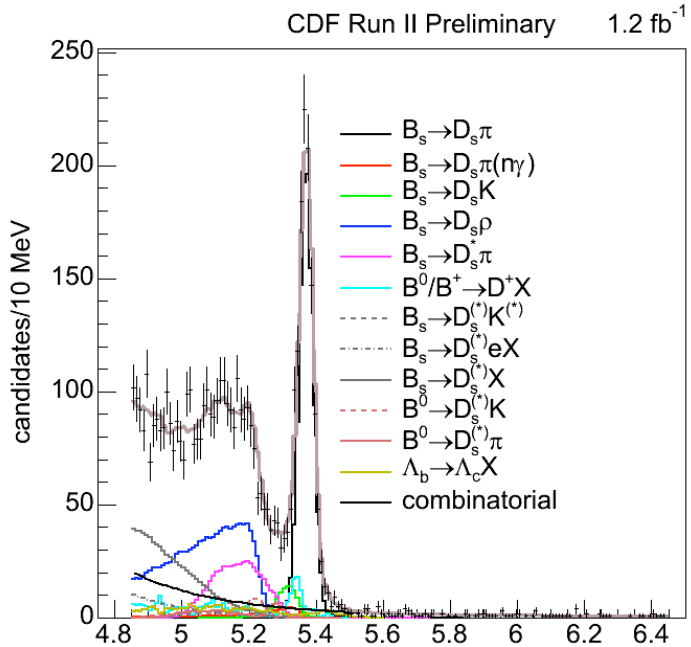


CDF prospects for flavor physics (2)

- Charmless B_s decays
  - Estrazione di γ dai BR di $K\pi$ KK $\pi\pi$ (few degrees)
  - Sensibile ai loop diagrams - interessante confrontare con DK

- $B^+ \rightarrow D^0K^+$; $D^0 \rightarrow KK, K\pi, \pi\pi, K\pi_{DCS}, \phi K_s$ ...
  - Tree level diagrams

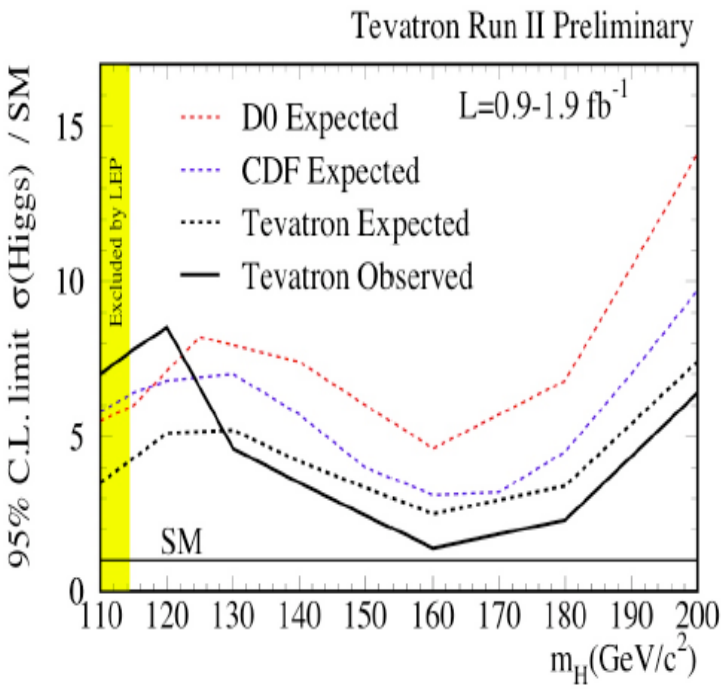
3 fb^{-1} di CDF corrispondono a circa 1000 fb^{-1} di B factory



CDF Prospects for Higgs Search

CDF Prospects for Higgs Search

- Siamo vicini a raggiungere la sensibilita' per SM
- Contiamo di fare meglio del solo incremento statistico
  - E' spesso successo in passato che i risultati hanno superato le nostre proiezioni basate solo sulla statistica
    - e.g. Top mass, $B_s \rightarrow \mu\mu$, K tagging
- Miglioramenti del trigger
  - L2 upgrade
  - Higgs Trigger Task Force
- Miglioramento tecniche di analisi
  - NN b-tagging (e.g. Roma tagger)
  - Multivariate techniques tipo $B \rightarrow hh$



L2 Calorimeter Upgrade

- Official CDF *sign-off* on Aug 14th

- Brian Winer, for the l2 Upgrade Review Committee:

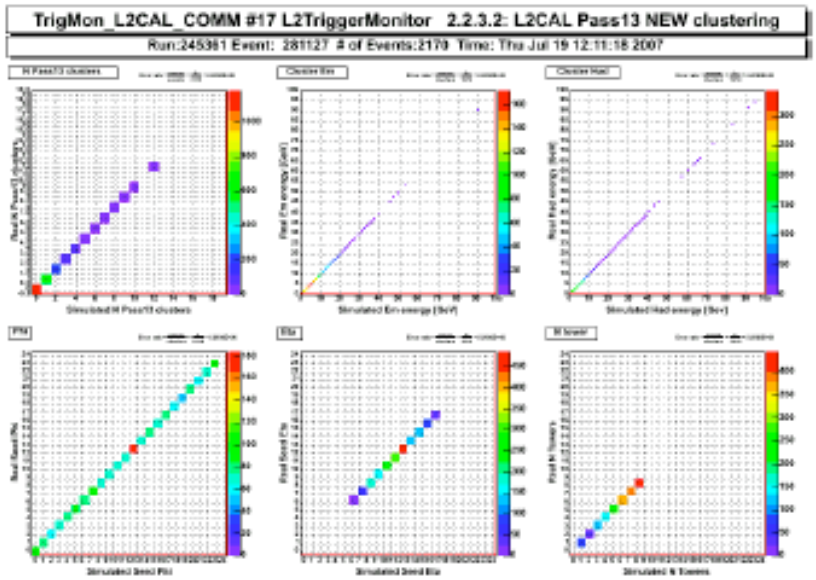
"*We want to congratulate all the people that worked to develop this system in such a short time. They have created a trigger system that is both robust and flexible and will serve CDF extremely well through the end of Run II*"

- Details (hardware and trigger efficiency) in the CDF Note 8940
- "Level-2 calorimeter trigger upgrade at CDF", L.Sartori for L2Cal team, 2006, San Diego, IEEE.
- "Level-2 calorimeter trigger upgrade at CDF", G.Flanagan for L2Cal team, 2007, Fermilab, Real Time IEEE.

- "A High Quality Exclusive trigger Selection for the HW Discovery Channel at CDF", M. Casarsa for **HTTF**, IEEE 2007 NSS.

L2CAL Upgrade: italian contribution

- A New Mezzanine to interface Pulsar with the LVDS cables from Dirac.
- Key Word: TEST!!! (LVDS cables, LVDS mezzanine, pulsars)

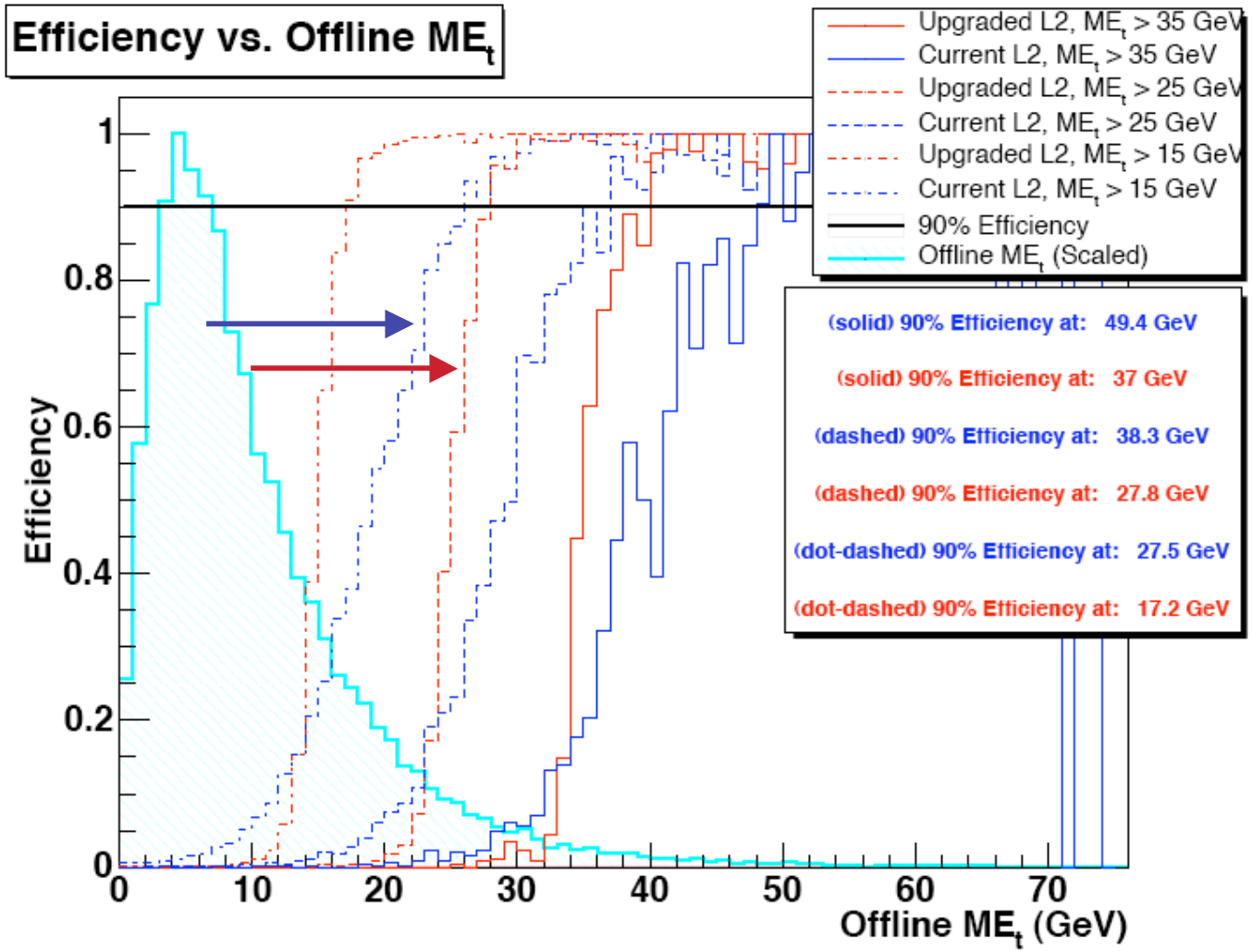


- Monitoring and feedback for hardware/firmware/software issues (Giorgio Cortiana)
- Readout code (Massimo Casarsa)
- L2CAL simulation (Simone Donati)

Hardware-firmware Team:

Marco Piendibene, Lucas Rogondino, Virginia Greco, Laura Sartori

Post-upgrade MET turn-on curves



New MET threshold is much sharper!

Higgs Trigger Task Force

CDF/ANAL/HIGGS/CDFR/8875
June 27, 2007
Version 1.0

Report of the Higgs Trigger Task Force

S. Amerio, A. Anastassov, A. Annovi, A. Apresyan, V. Boisvert, D. Bortoletto, A. Buzatu, S. Camarda, F. Canelli, A. Canepa, E. Cartman, B. Casal, M. Casarsa, G. Chiarelli, M. Convery, G. Cortiana, G. De Lorenzo, J. Donini, S. Donati, R. Erbacher, C. Ferrazza, G. Flanagan, R. Forrest, I. Furic, J. Garcia, P. Giannetti, D. Glenzinski, O. Gonzalez, C. Group, A. Heijboer, B. Heinemann, M. Herndon, A. Ivanov, E. James, M. Jones, T. Junk, B. Kilminster, Y.-K. Kim, N. Krumnack, M. Kruse, K. Lannon, S. Leone, J. Lewis, A. Lister, T. Liu, R.-S. Lu, D. Lucchesi, T. Maruyama, A. Mitra, O. Norniella, C. Neu, E. Nurse, S. Pagan Griso, E. Pianori, K. Pitts, L. Ristori, V. Rusu, R. St.Denis, L. Sartori, M.A. Schmidt, F. Sforza, A. Sidoti, A. Soha, A. Taffard, S. Torre, P. Totaro, V. Veszpremi, M. Vidal, S.-M. Wang, A. Warburton, D. Waters, P. Wilson, T. Wright, A.M. Zanetti, X. Zhang

Abstract

This report outlines a strategy on how to trigger on the Higgs boson in the most optimal way for the remainder of CDF Run II. Taking advantage of the CDF Run 2b trigger and data acquisition upgrades, we find that we can improve the purity of our triggers and significantly improve our acceptance for the Higgs.

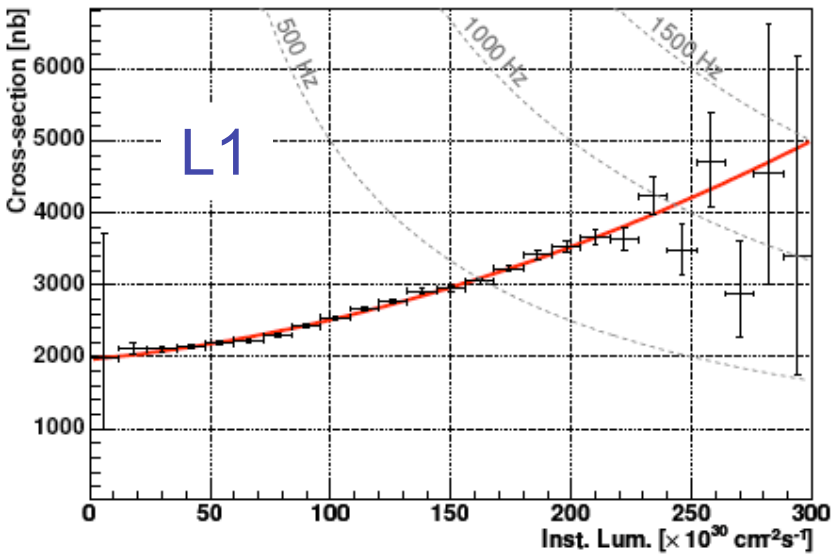
"This report outlines a strategy on how to trigger on the Higgs boson in the most optimal way for the remainder of CDF Run II. Taking advantage of the CDF Run 2b trigger and data acquisition upgrades, we find that we can improve the purity of our triggers and significantly improve our acceptance for the Higgs"

mode	current acceptance	proposed acceptance
$WH \to e\nu_e b\bar{b}$	45%	89%
$WH \to \mu\nu_\mu b\bar{b}$	42%	88%
$ZH \to e^+e^- b\bar{b}$	71%	90%
$ZH \to \mu^+\mu^- b\bar{b}$	60%	96%
$ZH \to \nu\bar{\nu} b\bar{b}$	74%	96%
$H \to l\nu l\nu$	66%	82%

Esempi di studi di trigger

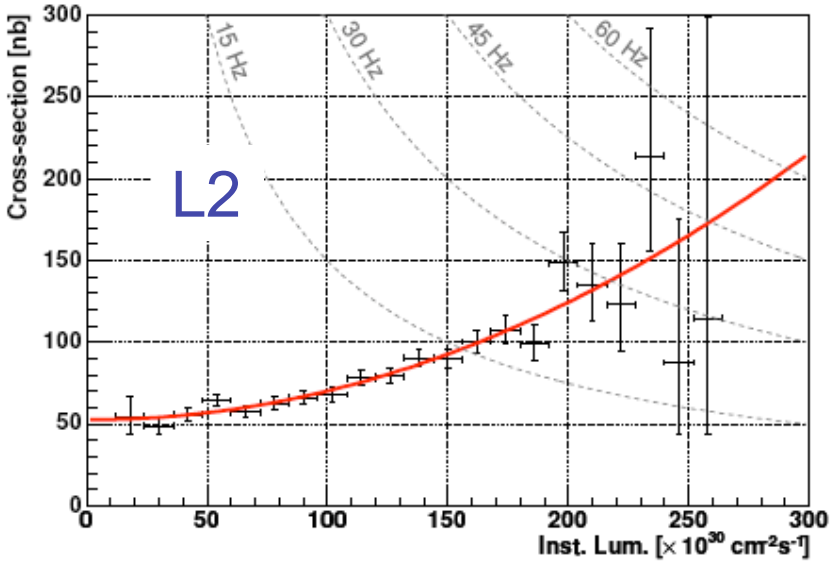
- Missing Et + 2 jet *(MET_JET)*
  - Per produzione associata WH e ZH
- SVT b-tag
  - Higgs to b-bbar
- Muon b-tag
  - Higgs to b-bbar

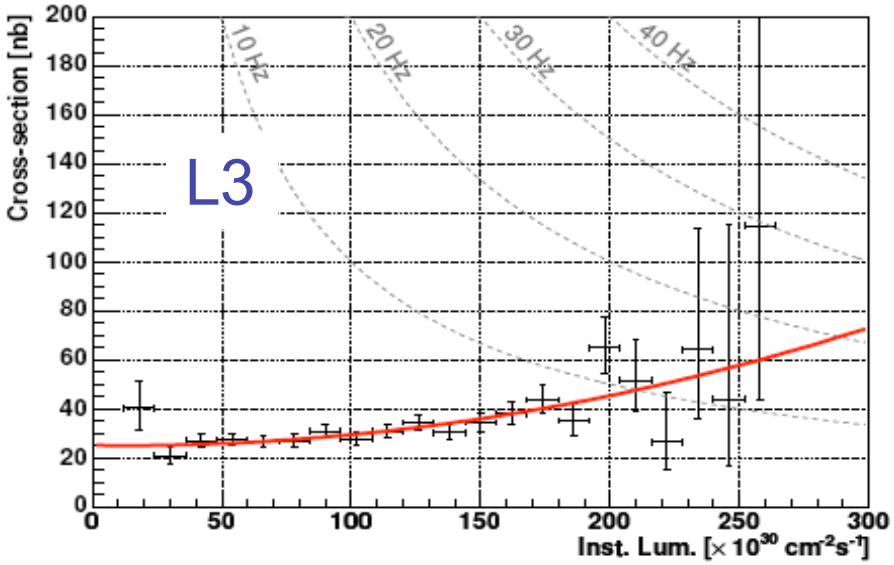
MET_JET trigger: rates



Cross sections as a function of instantaneous luminosity

	MET (GeV)	JET1 (GeV)	JET2 (GeV)	Rate @300E30
L1	15	10		1.5 KHz
L2	26	24	3	60 Hz
L3	28	28	10	20 Hz





MET_JET trigger: efficiencies

	WH			ZH	
	$\to e\nu_e b\bar{b}$	$\to \mu\nu_\mu b\bar{b}$	$\to \tau\nu_\tau b\bar{b}$	$\to \nu\nu b\bar{b}$	$\to \mu\mu b\bar{b}$
L1 eff. [%]	91.8	85.5	84.5	87.3	85.8
L2 eff. [%]	78.2	72.7	69.2	75.9	73.1
L3 eff. [%]	67.9	61.1	58.5	63.5	61.8
num. of Higgs in 5 fb^{-1}	37	34	32	44	7

Table 1: MET_JET cumulative trigger efficiencies for $M_H = 120GeV$.

	$M_H = 110$	$M_H = 115$	$M_H = 120$	$M_H = 130$
L1 eff. [%]	86.2	87.0	87.3	88.8
L2 eff. [%]	71.9	72.9	73.4	75.7
L3 eff. [%]	59.7	61.7	62.5	65.2
num. of Higgs in 5 fb^{-1}	143	120	103	65

Table 2: MET_JET cumulative trigger efficiencies for $WH \to \ell\nu_\ell b\bar{b}$ and for different Higgs mass hypotheses.

B-tag trigger

Motivation

Extend physics reaches for **SM H->bb** and for **MSSM phi->bb**

(4 b-jets in the final state)

Goal

Develop b-tag trigger exploiting **new trigger capabilities**

(L2CAL and L2XFT upgrades)

Proposed triggers

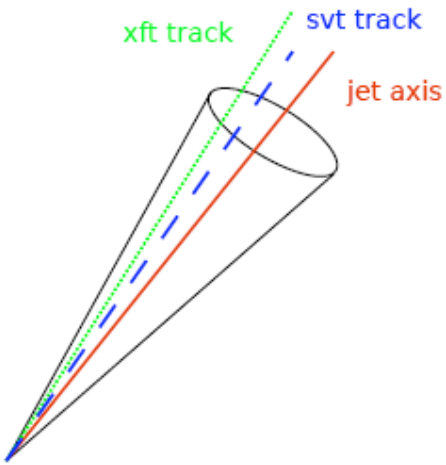
SVT b-tag trigger

displaced tracks matched to energetic jets

Muon b-tag trigger

soft muons from b decay matched to energetic jets

SVT b-tag trigger

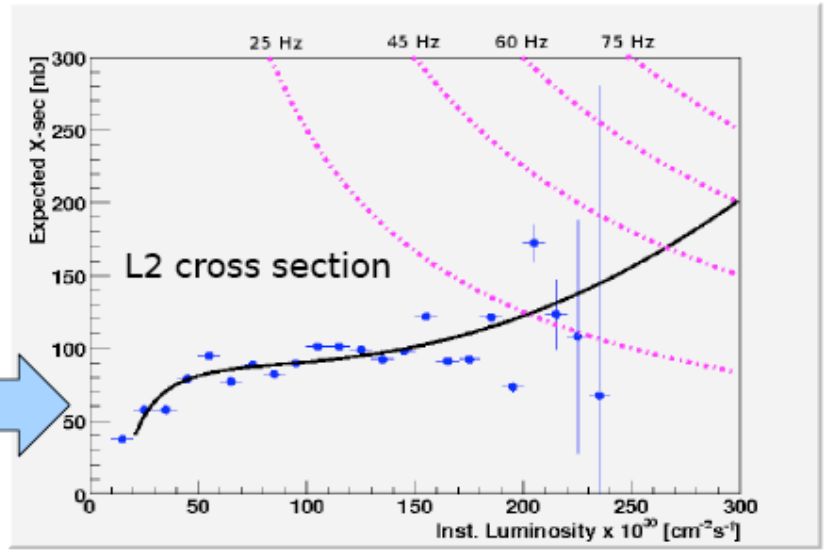


1) match SVT track – XFT track
2) match track – central energetic jet
3) further selection on b-jet decay length and track impact parameter

- more precise jet axis estimate (L2 cal upgrade)
- 3D track at L2 (XFT upgrade)

EFFICIENCIES on Signal:
hbb -> 12%
phibb -> 11%

rates under control up to high luminosity!



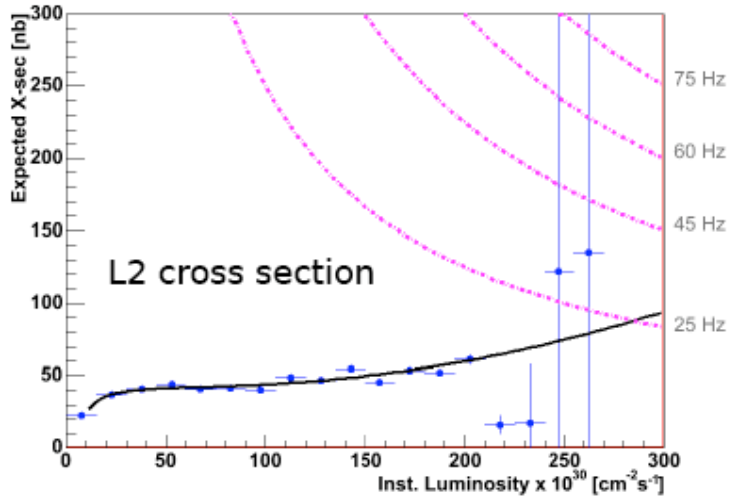
Muon b-tag trigger

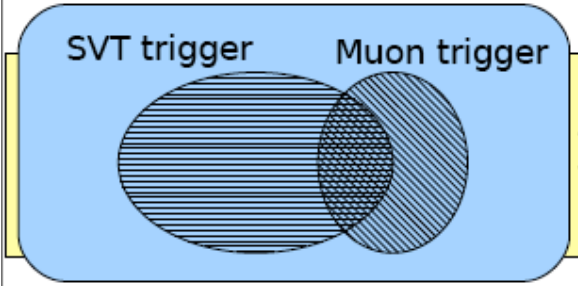
- match central energetic jet to low Pt muon

3D track at L2 -> great rejection of fake muons

EFFICIENCIES on Signal:
hbb -> 5%
phibb -> 6%

rates under control
up to high luminosity!



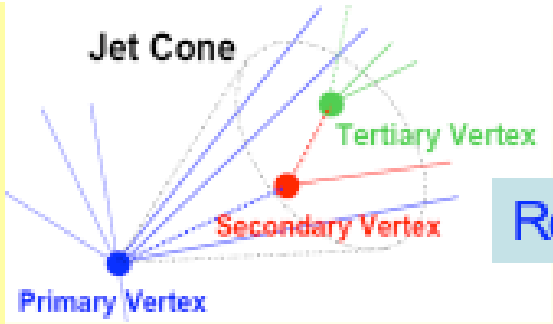


cumulative efficiency on signal = 15%

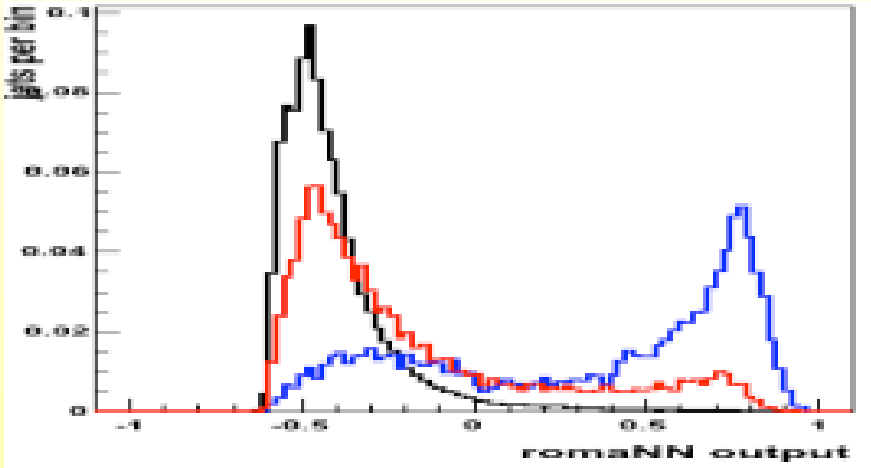
signal overlap = 10%

The new *Roma-Tagger* for H.F. jets

- The underlying idea is improving the ability to boost performance exploiting *as much information as possible*:
  - number of vertices (not just ***A SINGLE*** secondary vertex a' la SecVtx) and their masses;
  - displaced but un-vertexed tracks (tracks not belonging neither to secondary vertex nor to the primary);
  - Soft leptons, JetProb, global jet variables
- Best to combine all info together in a single discriminant: use (a series of) *Neural Networks* (NN)
- NN training performed on generic sample to be used in different analysis (top, single top, low mass Higgs, ...)



Roma NN b-tag

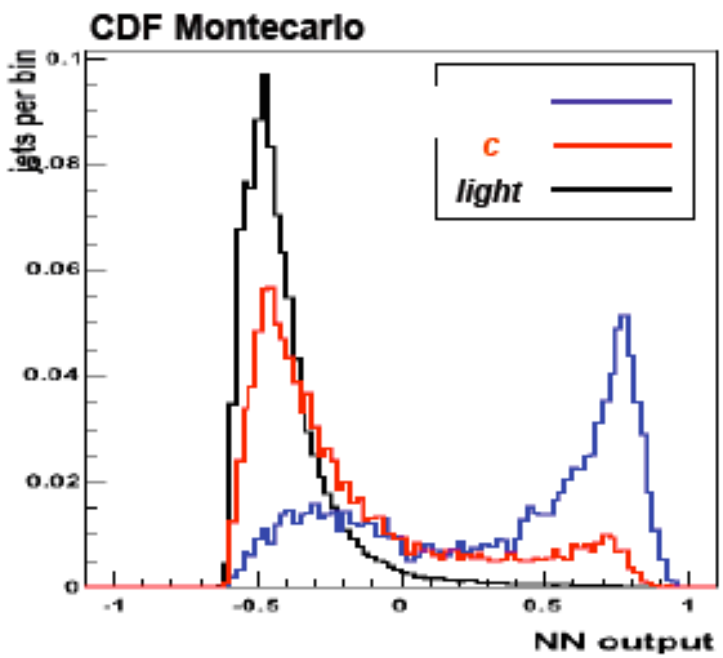


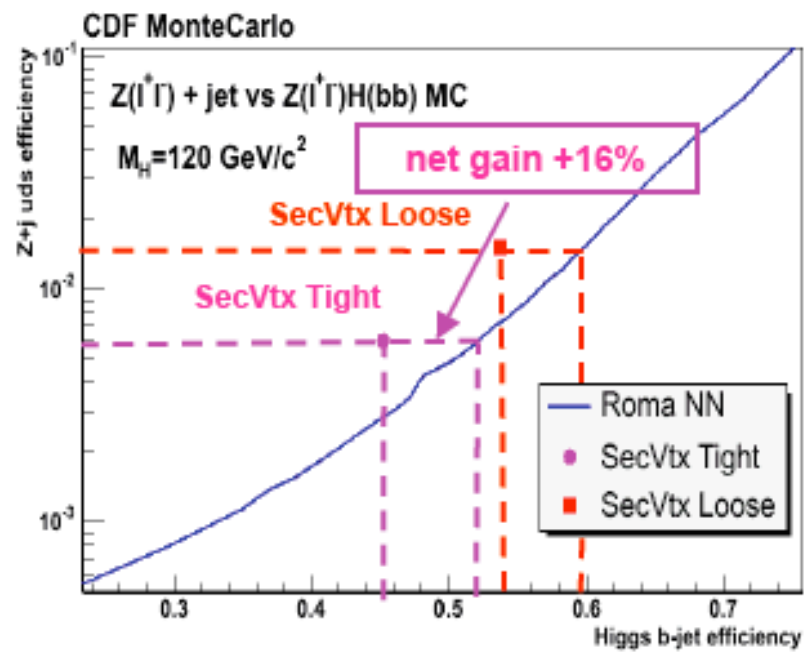
Advantages of the *Roma-tagger*

- **A *Continuous* tagging** variable allow weighting events to get the most of it in terms of search sensitivity
- **GOOD *b-c-uds statistical separation*** allows the fraction of c jet to be more reliably studied, HIGH Jet taggability: ~ 75%
- **Increased *per-jet efficiency*** at same background rate than SecVtx:

  +30% (relative) on a p-pbar _ q-qbar di-jet MC

  +16% (relative) for Z+j compared to ZH(120) MC





Sommario

- *"The Tevatron and CDF are alive and well!"*
- Il gruppo italiano e' in prima linea sia nella analisi dei dati che nei continui miglioramenti al rivelatore necessari per affrontare le alte luminosita' ed estendere la sensibilita' di CDF a sezioni d'urto sempre piu' piccole
- L'Higgs SM appare ormai come una meta raggiungibile

"It's harvest time for CDF"

Harvest Time **by Mirja Clement**