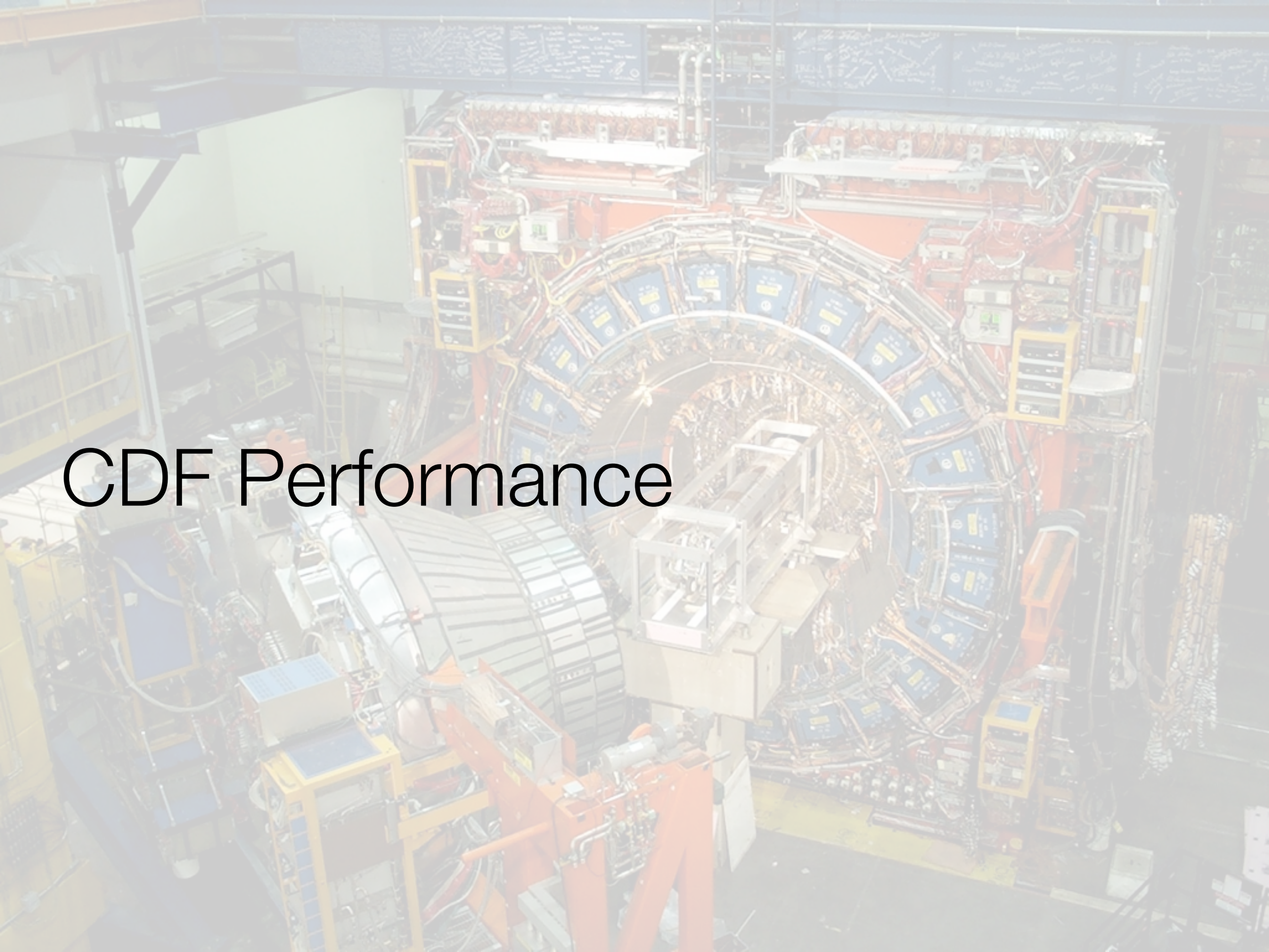
CDF 2011 Summer Results
Joint Experimental-Theoretical Seminar, Fermilab

Ankush Mitra, Academia Sinica
on behalf of the CDF Collaboration

Introduction

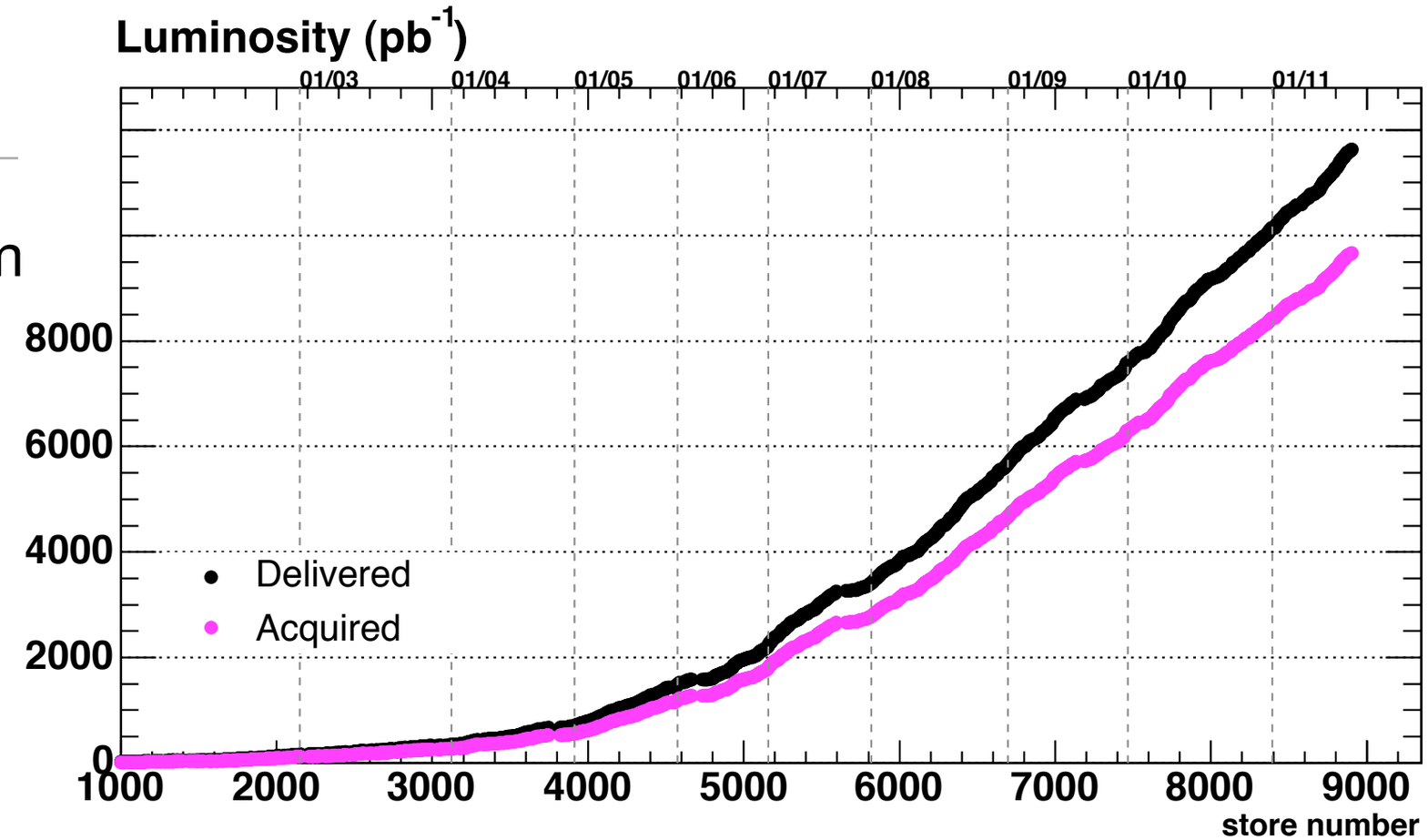
- Another great set of results from CDF
- 27 new results
  - 8 are new analyses at CDF
  - 6 are world's best measurement
  - 2 are first observations
  - 1 has first evidence

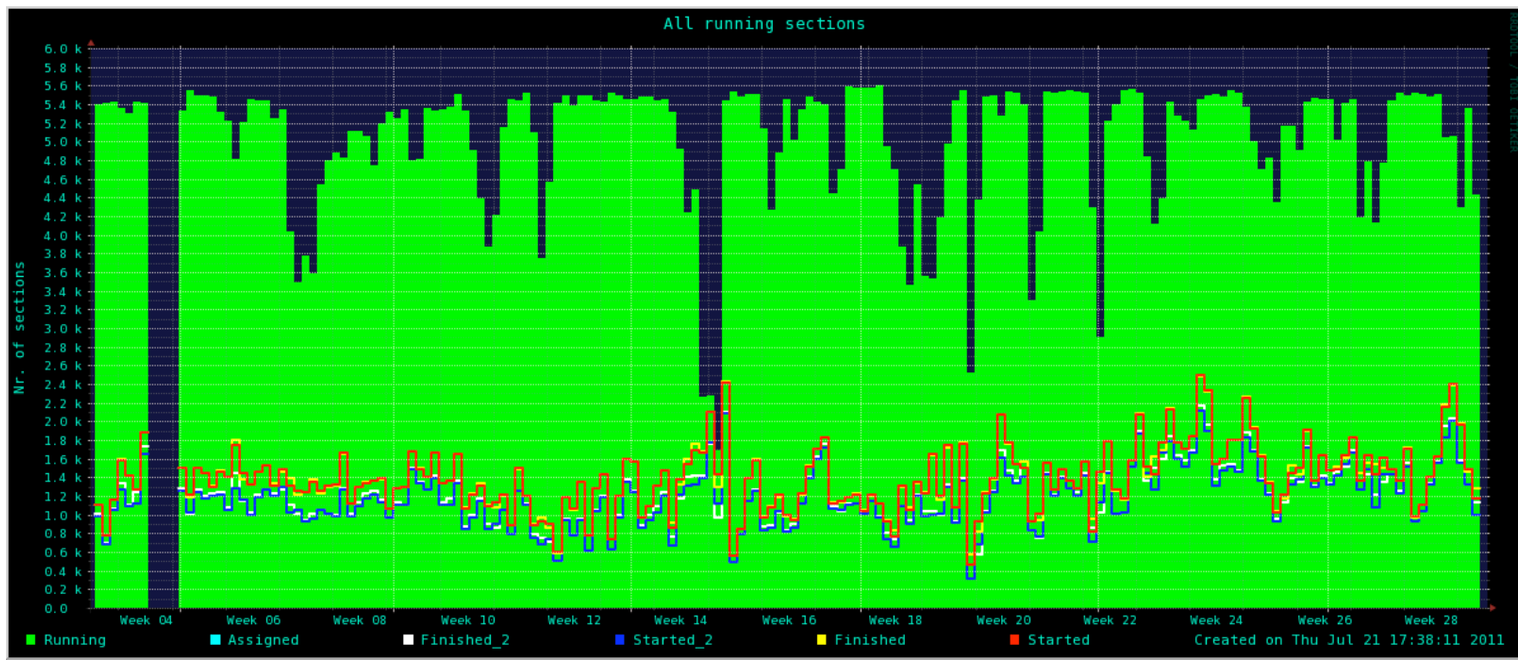


CDF Performance

CDF Data

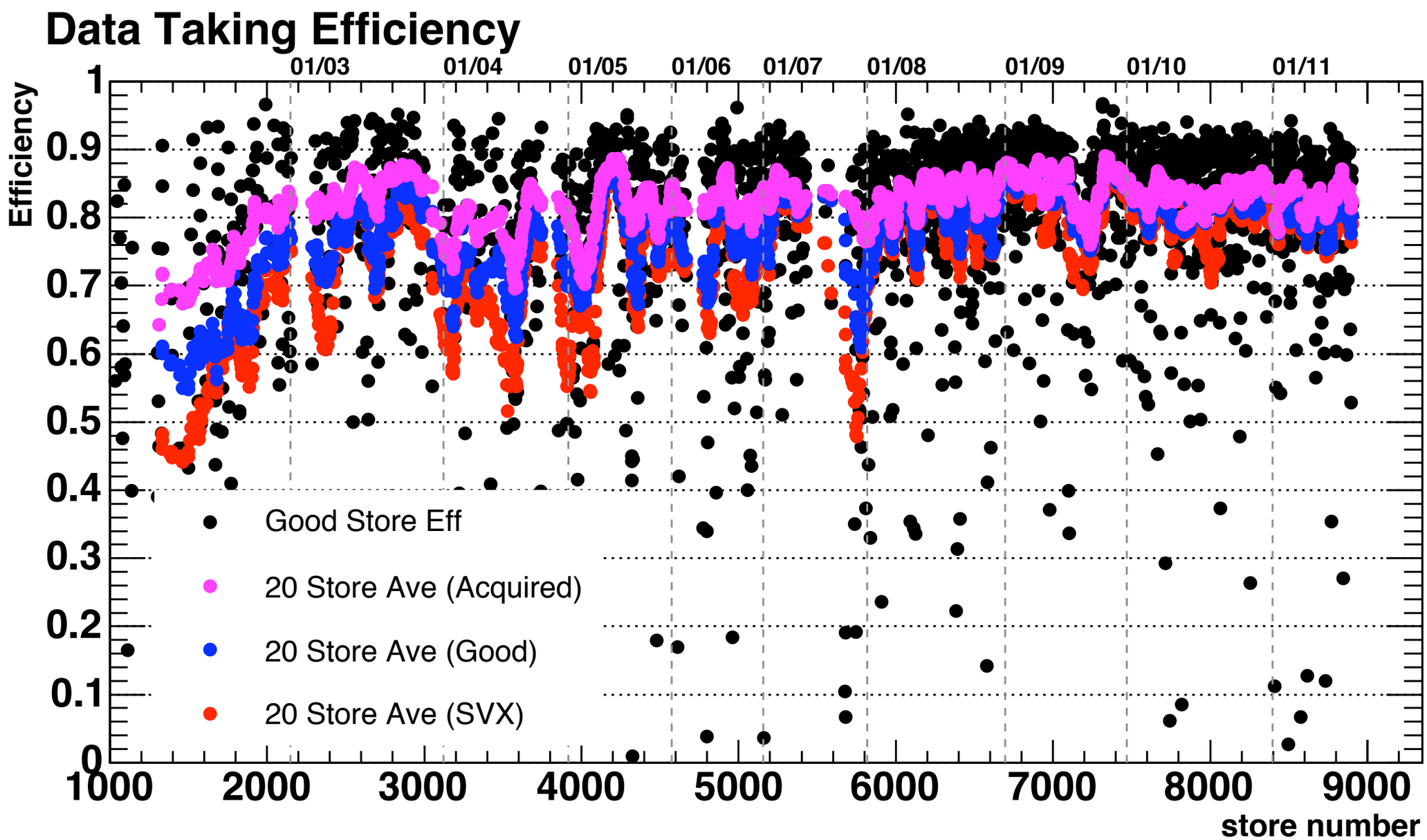
- Summer 2011 results are from 2-8 fb^{-1}
- Delivered 11.6 fb^{-1}
- Acquired 9.6 fb^{-1}
- Expect 10 fb^{-1} by then end of Run II
- ***Thank you AD & CD for all your hard work !***





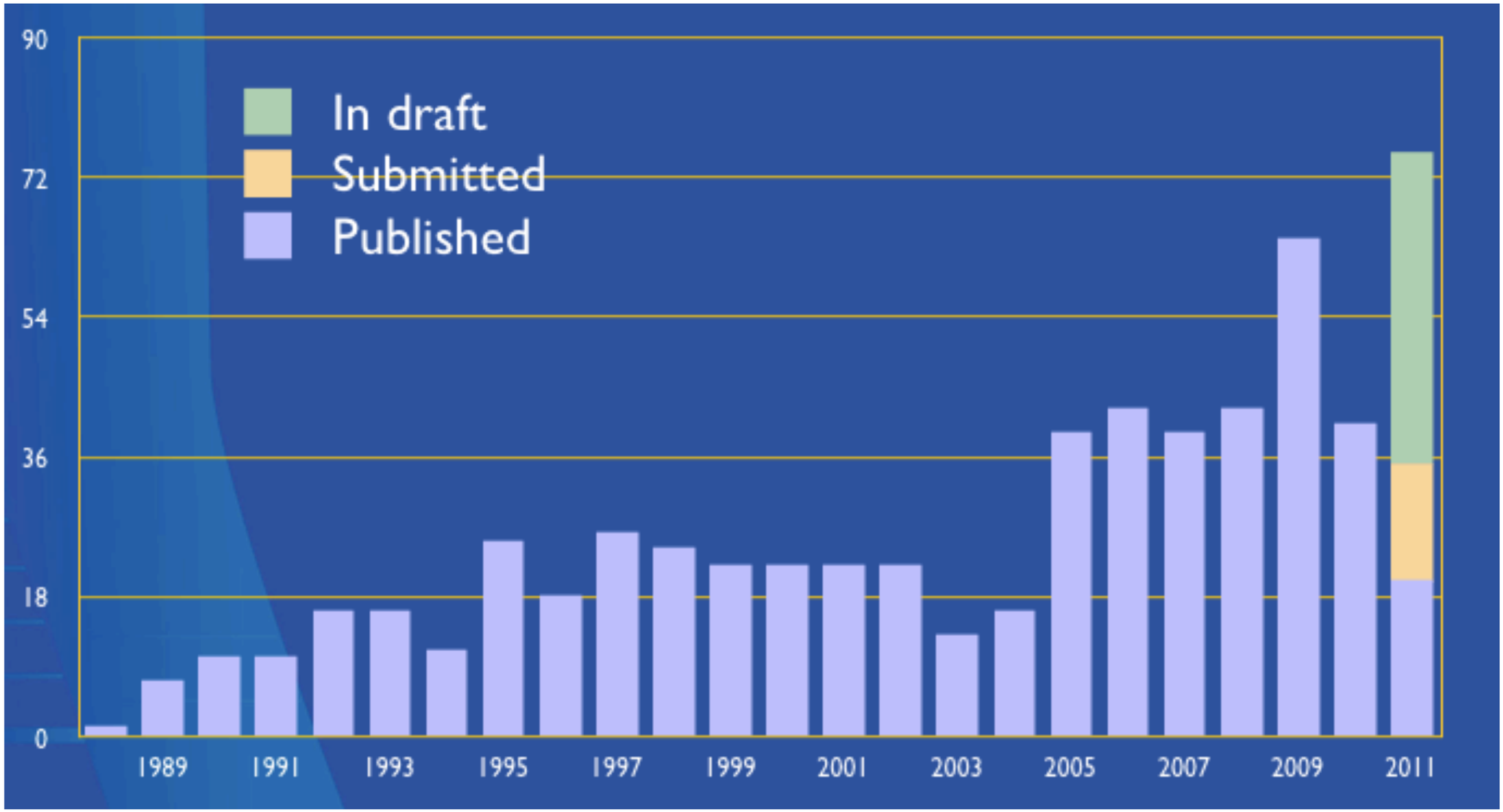
CDF Performance

- Maintaining good performance
- ***Thanks to all CDF detector experts, operations staff & techs***

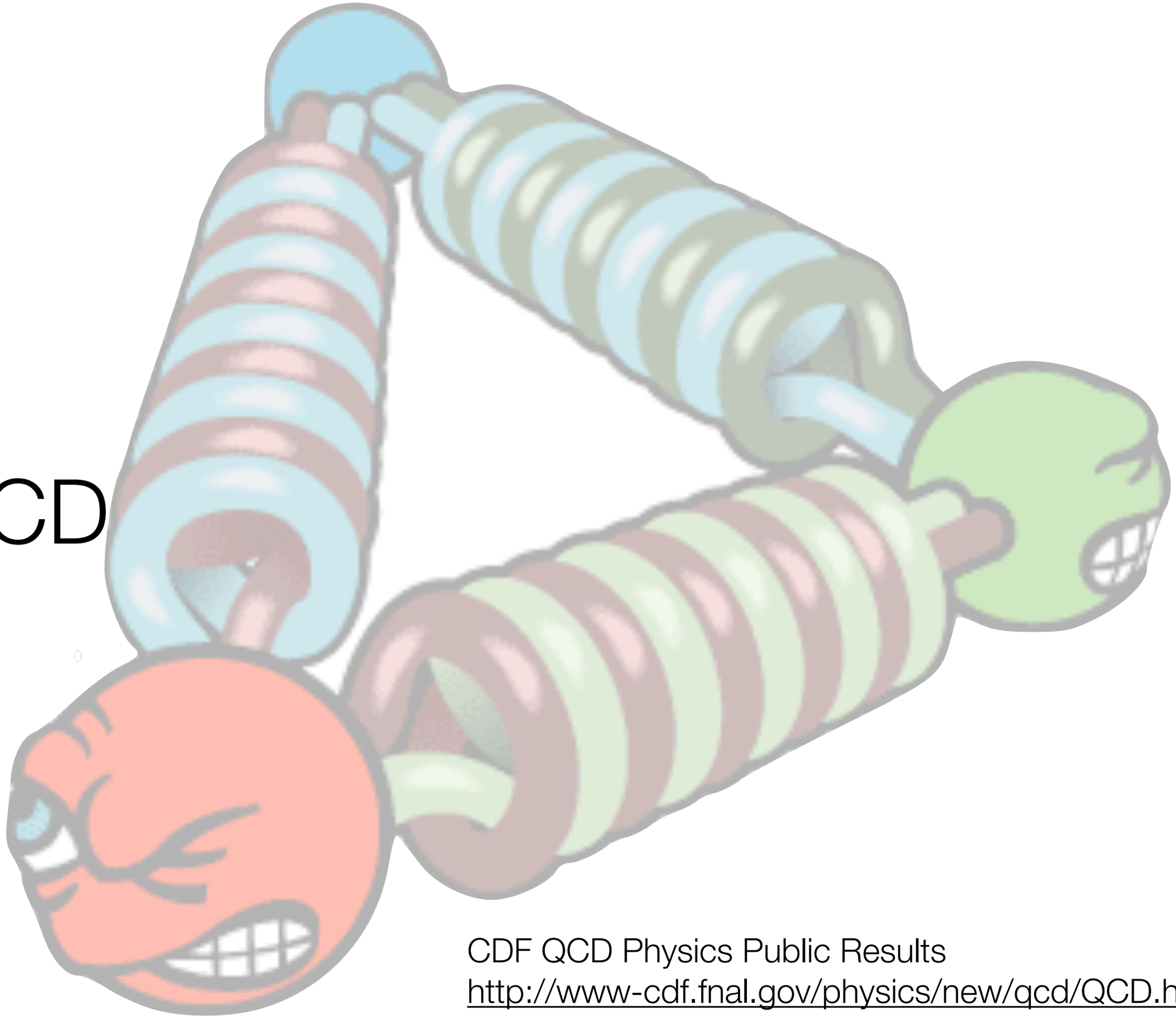


CDF Papers

- Only half way through the year and submitted & published papers are almost same as published for 2010



QCD

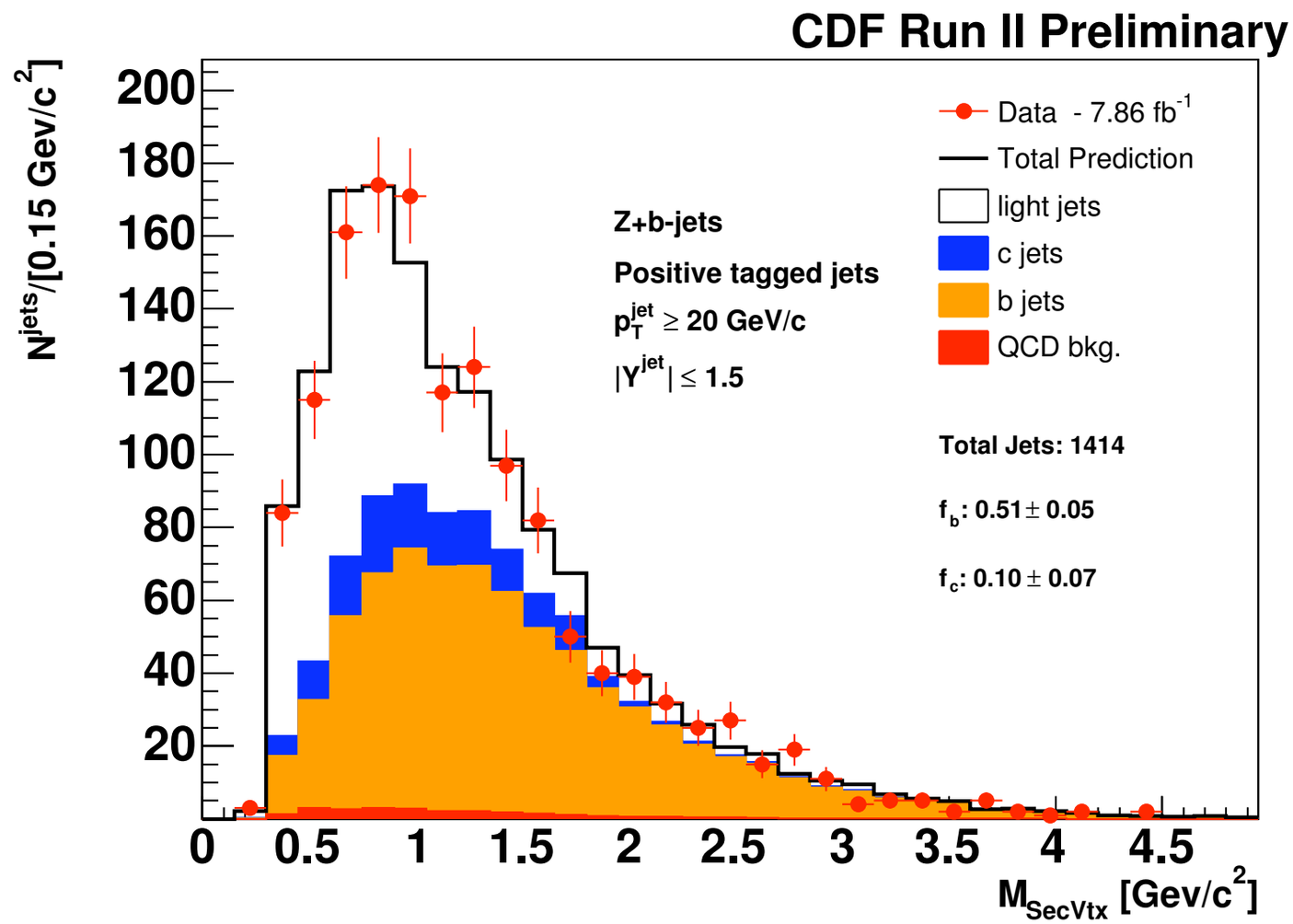


CDF QCD Physics Public Results
http://www-cdf.fnal.gov/physics/new/qcd/QCD.html

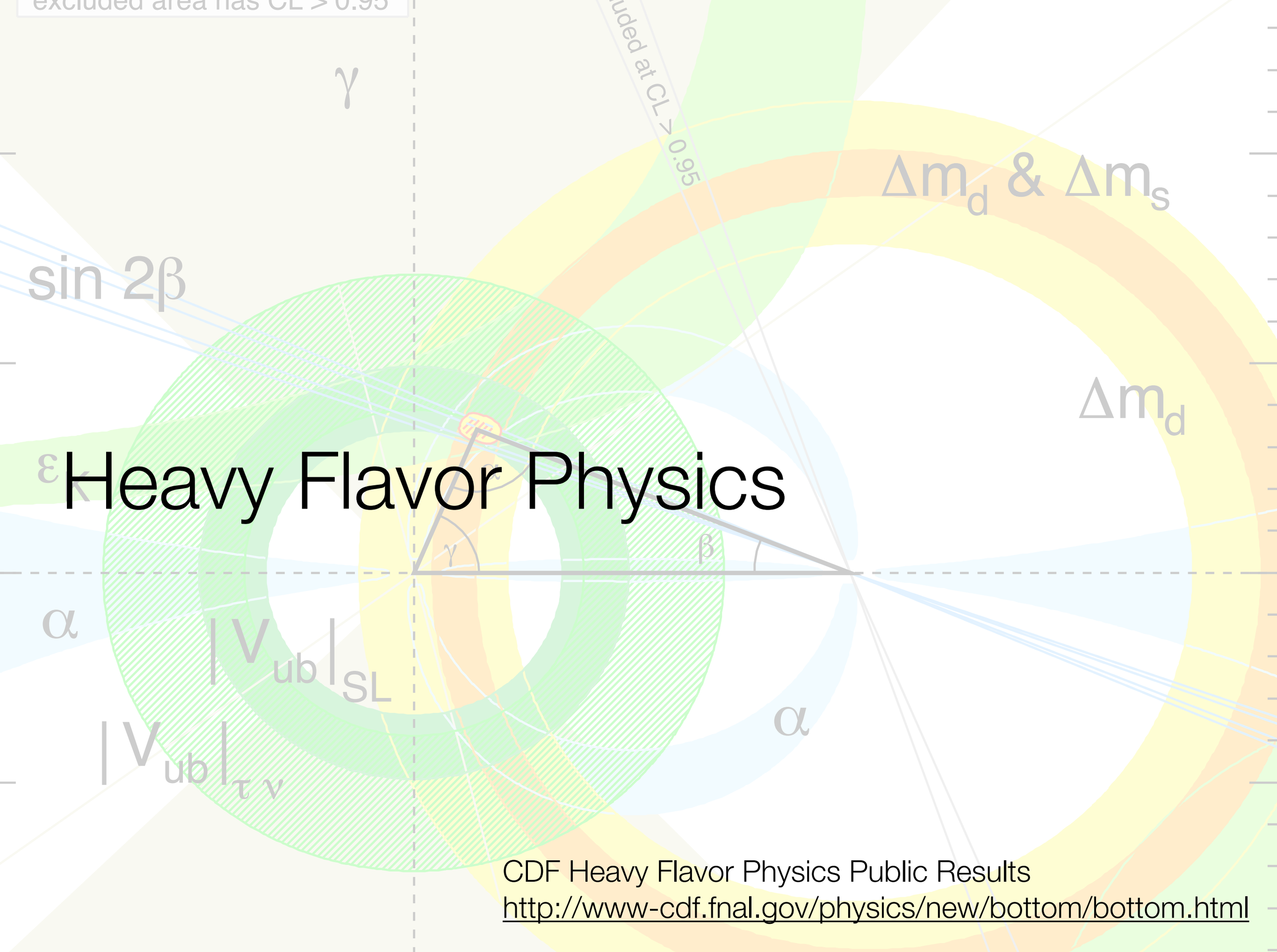
Z(→ll)+b-jets Cross-Section Measurement [7.8 fb^{-1}]

CDF Note 10594

- Precise test of perturbative QCD
- Test/validation of Monte-Carlo generators
- Main background to ZH→llbb search
- Neural network used to improve muon ID - 30% gain
- Improved precision tests NLO and scale-variation



	Measured	NLO $Q^2 = m_Z^2 + p_{T,Z}^2$	NLO $Q^2 =< p_{T,jet}^2 >$
$\frac{\sigma(Z+\mathrm{b})}{\sigma(Z)}$	$2.84 \pm 0.29 \pm 0.29 \times 10^{-3}$	2.3×10^{-3}	2.8×10^{-3}
$\frac{\sigma(Z+\mathrm{b})}{\sigma(Z+\mathrm{jet})}$	$2.24 \pm 0.24 \pm 0.26 \times 10^{-2}$	1.8×10^{-2}	2.2×10^{-2}



Heavy Flavor Physics

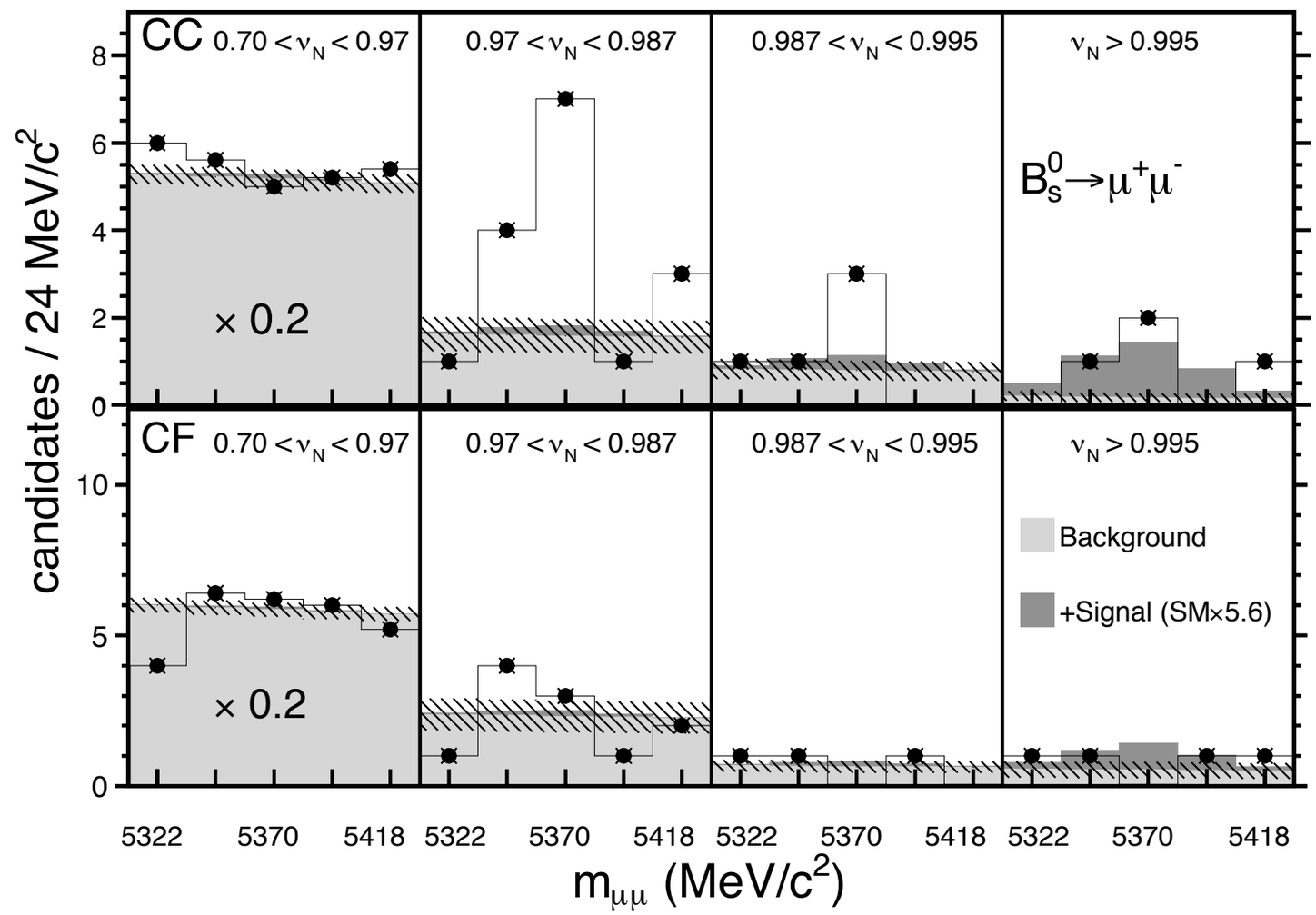
CDF Heavy Flavor Physics Public Results
http://www-cdf.fnal.gov/physics/new/bottom/bottom.html

First Two Sided Limit of $B_s/B^0 \rightarrow \mu\mu$ [7 fb^{-1}]

ArXiv:1107.2304v1 [hep-ex]

W+C 15 July 2011

- Can occur in SM only through higher order processes (3×10^{-9})
- Any excess could be hint to new physics
- Improvements
  - Signal acceptance improved by 20%
  - NN doubled background rejection for same signal efficiency
- Result: larger than SM but still compatible



$$4.6 \times 10^{-9} < BR(B_s \rightarrow \mu^+\mu^-) < 3.9 \times 10^{-8} \text{ at } 90\% \text{ CL}$$

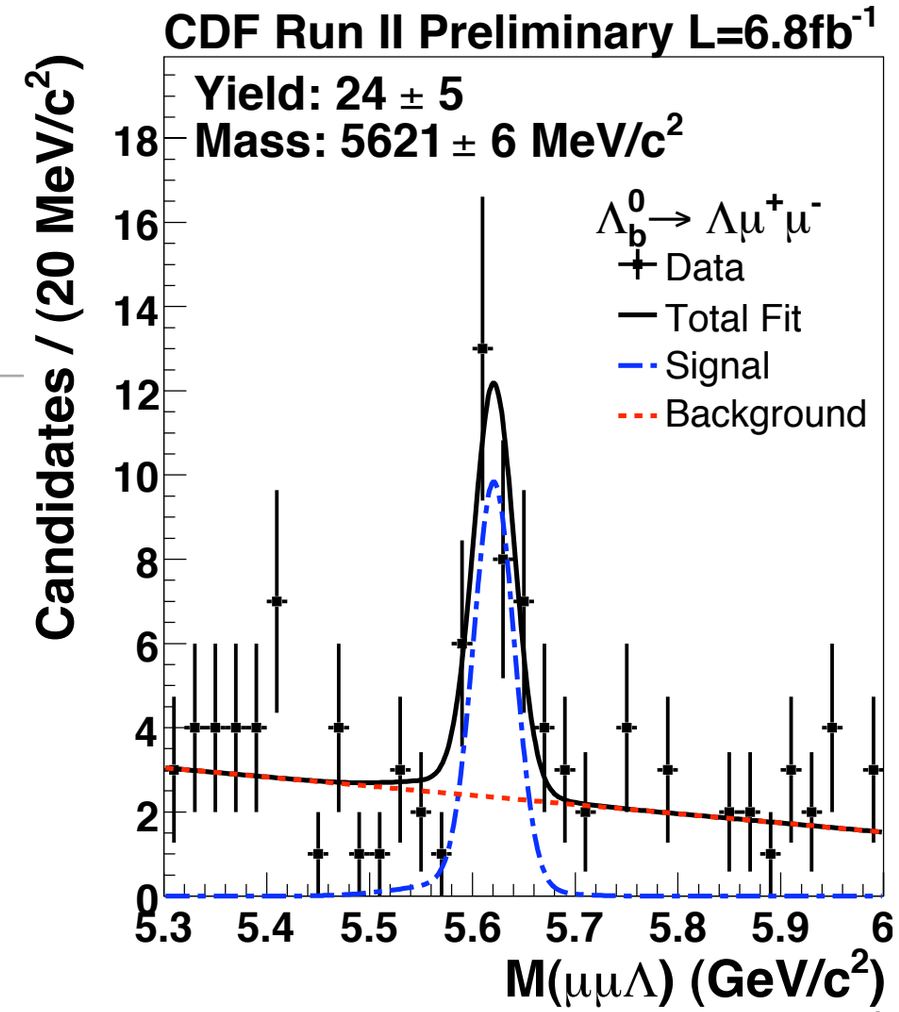
$$BR(B_s \rightarrow \mu^+\mu^-) = 1.8^{+1.1}_{-0.9} \times 10^{-8} \begin{pmatrix} P_B < 0.27\% \\ P_{SB} < 1.9\% \end{pmatrix}$$

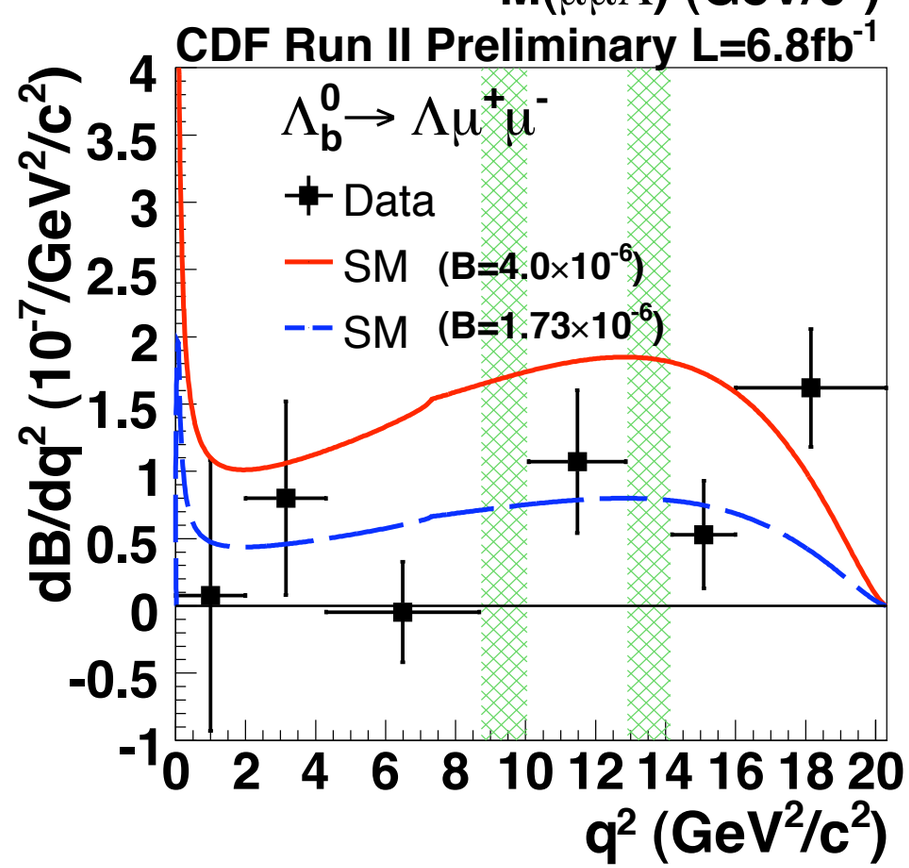
$$BR(B^0 \rightarrow \mu^+\mu^-) < 6.0 \times 10^{-9} \text{ at } 95\% \text{ CL}$$

Observation of FCNC $\Lambda_b \to \Lambda\mu\mu$ [6.8 fb^{-1}]

ArXiv:1107.3753v1 [hep-ex]

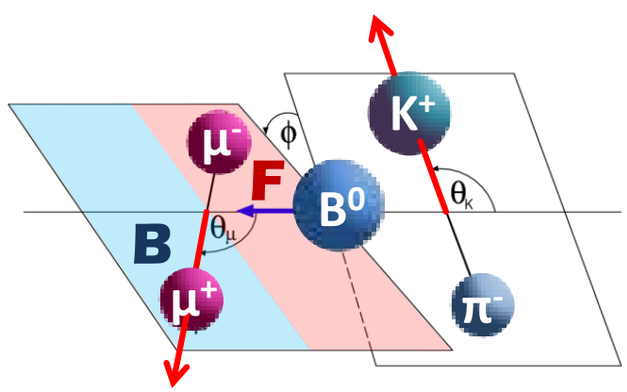
- $b \to s\mu\mu$ is rare process in SM ($\sim 10^{-6}$). Can be enhanced by new physics
- Comprehensive analysis involving 6 signal & 6 control channels
- First observation of FCNC $\Lambda_b \to \Lambda\mu\mu$ (6σ)
- *and also...*
  - 8 first measurements at hadron collider
  - 2 first measurements of differential BR
  - World's most precise $b \to s\mu\mu$ BR measurement





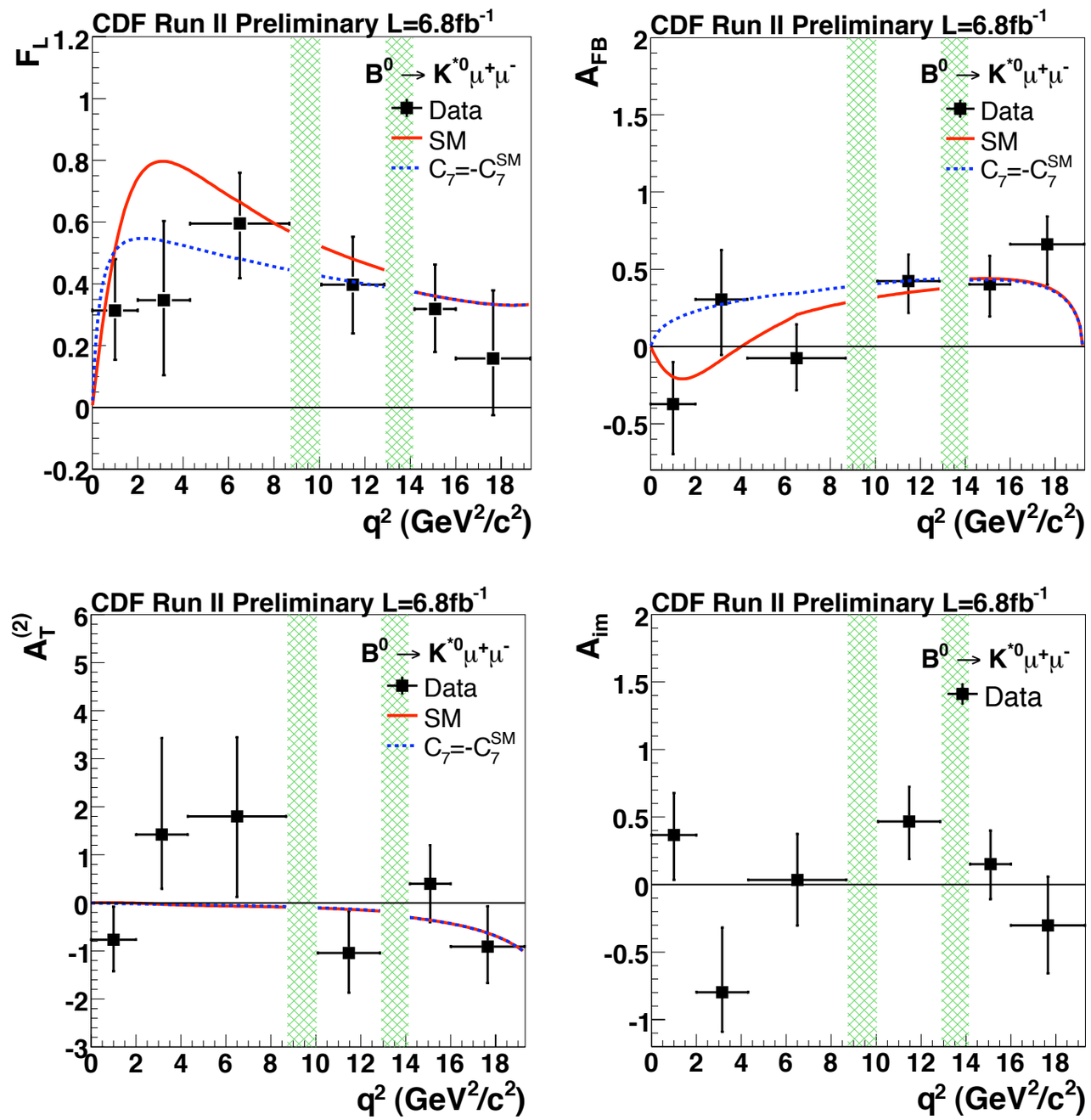
Measurements of b→sμμ rare decays: [6.8 fb^{-1}] Angular Correlations

- World's most precise A_{FB} measurement
- First measurement of right-handed sensitive variables of b→sμμ, $A_T^{(2)}$, A^{im}



$B^0 \to K^{*0}\mu\mu$ decay plane

$$A_{FB}(q^2) \equiv \frac{\Gamma(q^2, \cos\theta_\mu > 0) - \Gamma(q^2, \cos\theta_\mu < 0)}{\Gamma(q^2, \cos\theta_\mu > 0) + \Gamma(q^2, \cos\theta_\mu < 0)}$$



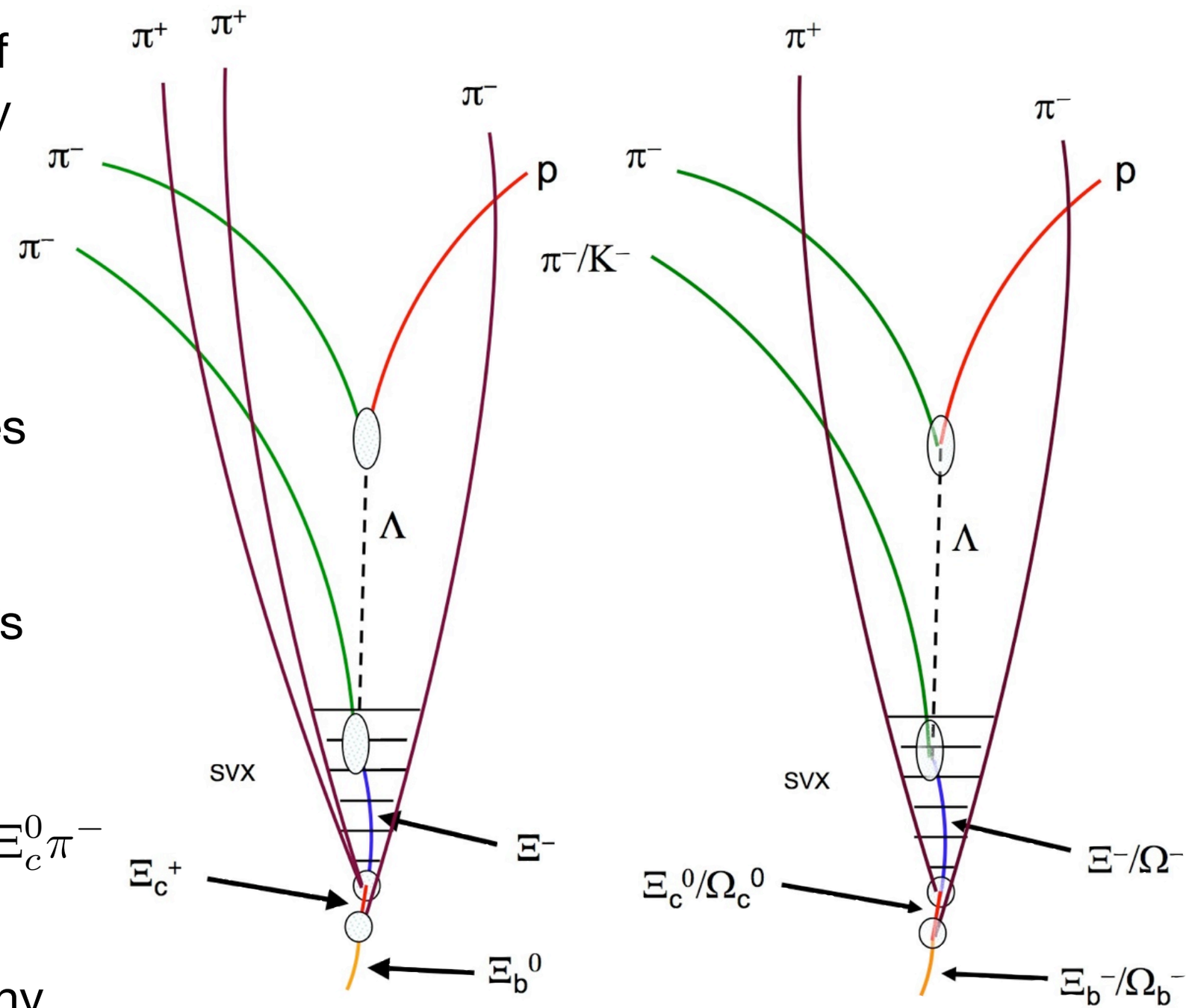
- CDF's results are as precise as Belle's
- No discrepancy with SM (yet!)

Observation of Ξ_b^0 [4.2 fb^{-1}]

ArXiv:1107.4015v1 [hep-ex]

W+C 20 July 2011

- Complete reconstruction of $\Xi_b^0/\Xi_b^- \to \Xi_c^+/\Xi_c^0\ \pi^-$ decay chain
  - Complex, hadronic final state
  - Multiple tracks & vertices
  - No muons to trigger on
  - Only possible with CDF's unique displaced track trigger (SVT)
- First observation of $\Xi_b^- \to \Xi_c^0 \pi^-$ in this hadronic mode
- First observation of Ξ_b^0 in any mode (6.8σ)



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W+C 20 July 2011

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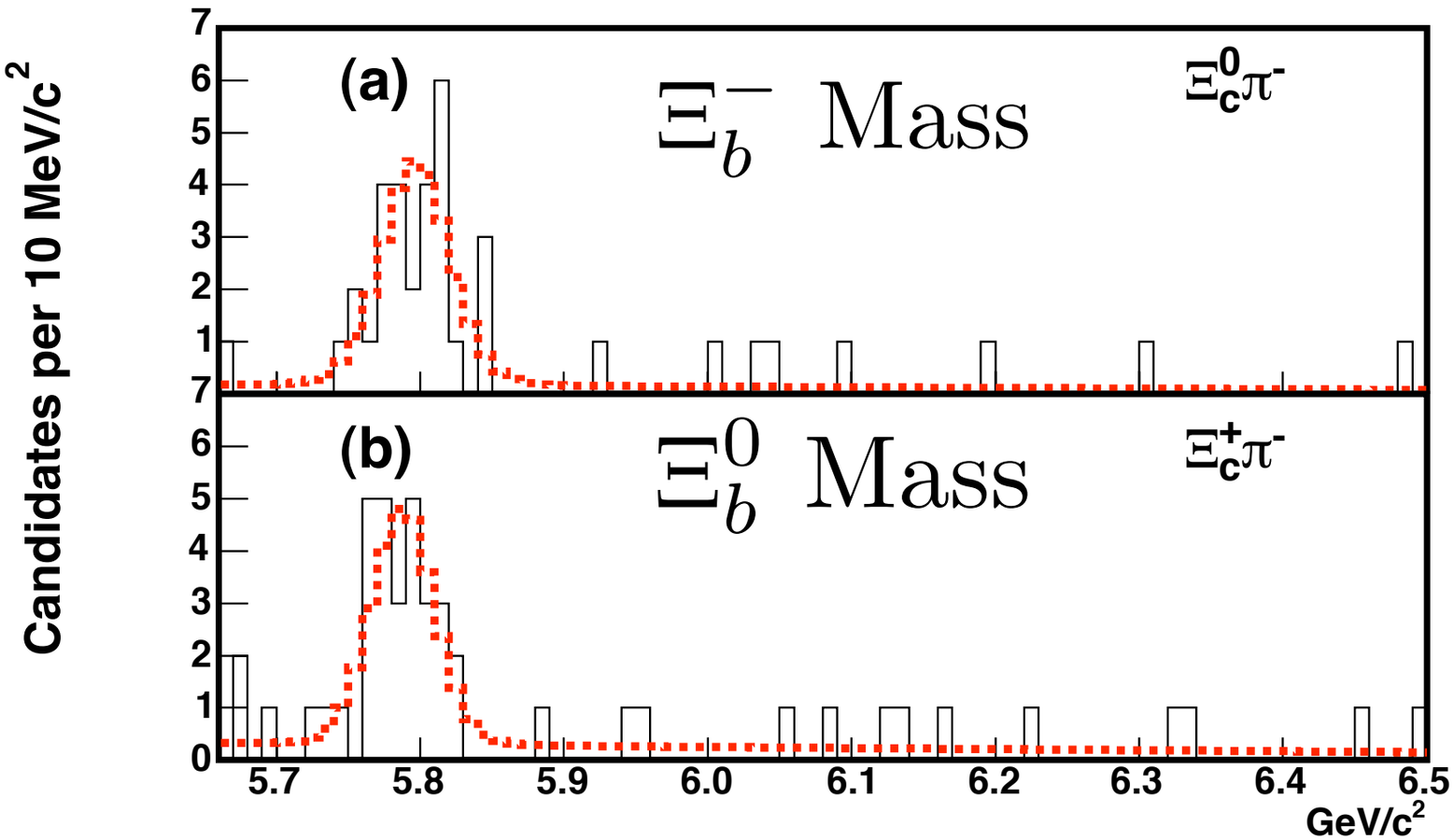
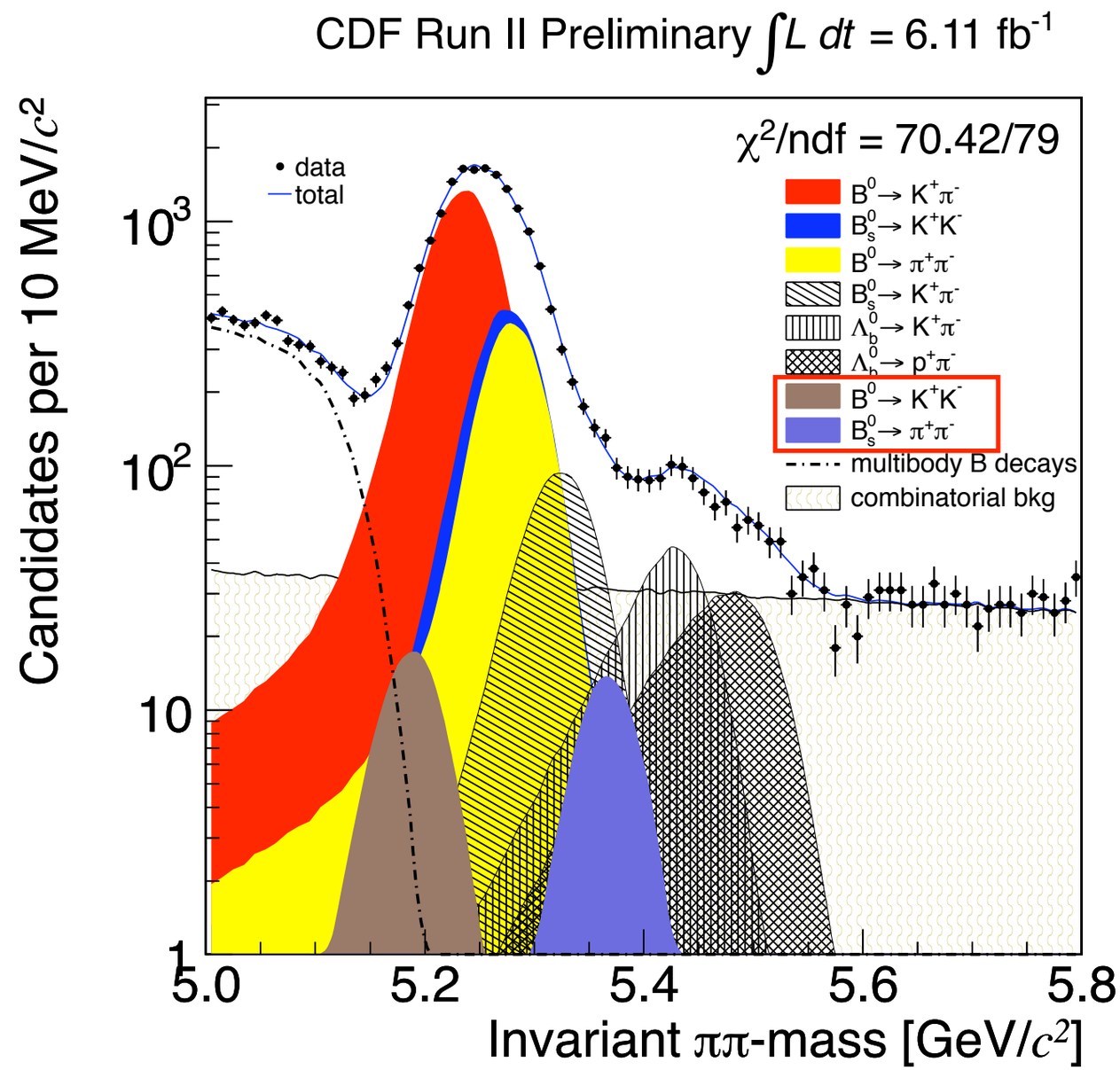


$$
\begin{aligned}
M(\Xi_b^-) &= 5796.7 \pm 5.1(\text{stat}) \pm 1.4(\text{syst})\,\text{MeV}/c^2 \\
M(\Xi_b^0) &= 5787.8 \pm 5.0(\text{stat}) \pm 1.3(\text{syst})\,\text{MeV}/c^2 \\
M(\Xi_b^-) - M(\Xi_b^0) &= 3.1 \pm 5.6(\text{stat}) \pm 1.3(\text{syst})\,\text{MeV}/c^2
\end{aligned}
$$

First evidence of $B_s^0 \to \pi\pi$ [6 fb^{-1}]

CDF Note 10498

- First B_s annihilation decay to a charmless final state
- Tests accuracy of effective model of strong interaction
- Can be sensitive to new physics if larger rate observed



$$BR(B_s^0 \to \pi^+\pi^-) = (0.57 \pm 0.15(\text{stat}) \pm 0.10(\text{syst})) \times 10^{-6}$$
$$BR(B^0 \to K^+K^-) \in [0.05, 0.46] \times 10^{-6} \text{ at } 90\% \text{ CL}$$

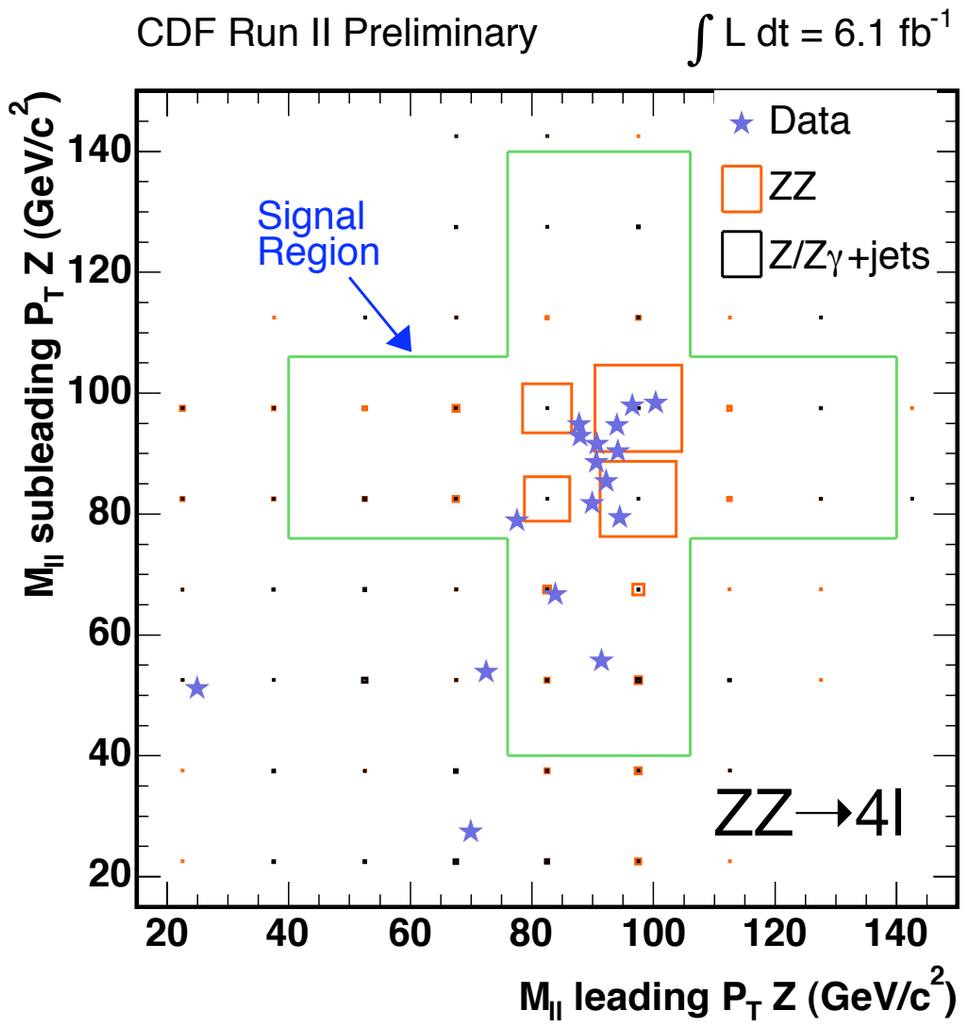
Electroweak

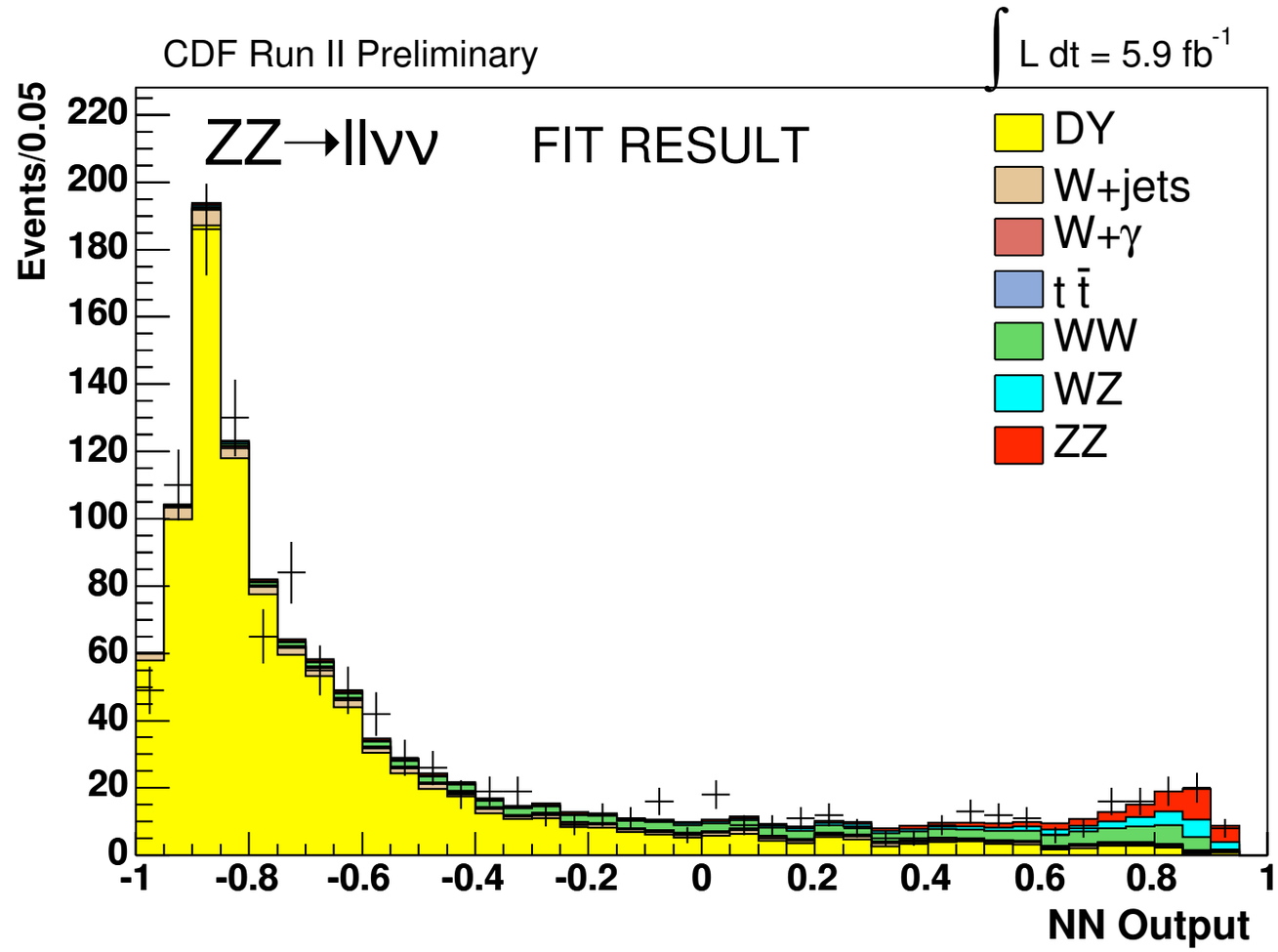
CDF Electroweak Physics Public Results
http://www-cdf.fnal.gov/physics/ewk/

ZZ Cross-Section
[6.1 fb^{-1}(4l) / 5.9 fb^{-1}(llνν)]

CDF Note 10480
CDF Note 10358

- Cross-section measured for ZZ→4l and ZZ→llνν and their combination.





$$\sigma(p\bar{p} \to ZZ) = 2.18 \pm 0.63(\text{stat}) \pm 0.30(\text{syst})\ \text{pb}\ [4\ell\ \text{channel}]$$
$$= 1.45^{+0.45}_{-0.42}(\text{stat})^{+0.41}_{-0.30}(\text{syst})\ \text{pb}\quad [\ell\ell\nu\nu\ \text{channel}]$$
$$= 1.64^{+0.32}_{-0.31}(\text{stat})^{+0.31}_{-0.24}(\text{syst})\ \text{pb}\quad [\text{combination}]$$

WZ→lllν cross-section & triple gauge coupling measurement [7.1 fb^{-1}]

CDF Note 10176
CDF Note 10595

- Cuts against trilepton+track which reduced ZZ background by 36%
- Most precise WZ cross-section measurement to-date.
- Fit to Z P_T distribution to extract TGC couplings

CDF Results at 7.1fb^{-1}

	λ^Z	Δg_1^Z	$\Delta\kappa^Z$
1.5TeV	-0.08 - 0.10	-0.09 - 0.22	-0.42 - 0.99
2.0TeV	-0.09 - 0.11	-0.08 - 0.20	-0.39 - 0.90

CDF Expected Limits at 7.1fb^{-1}

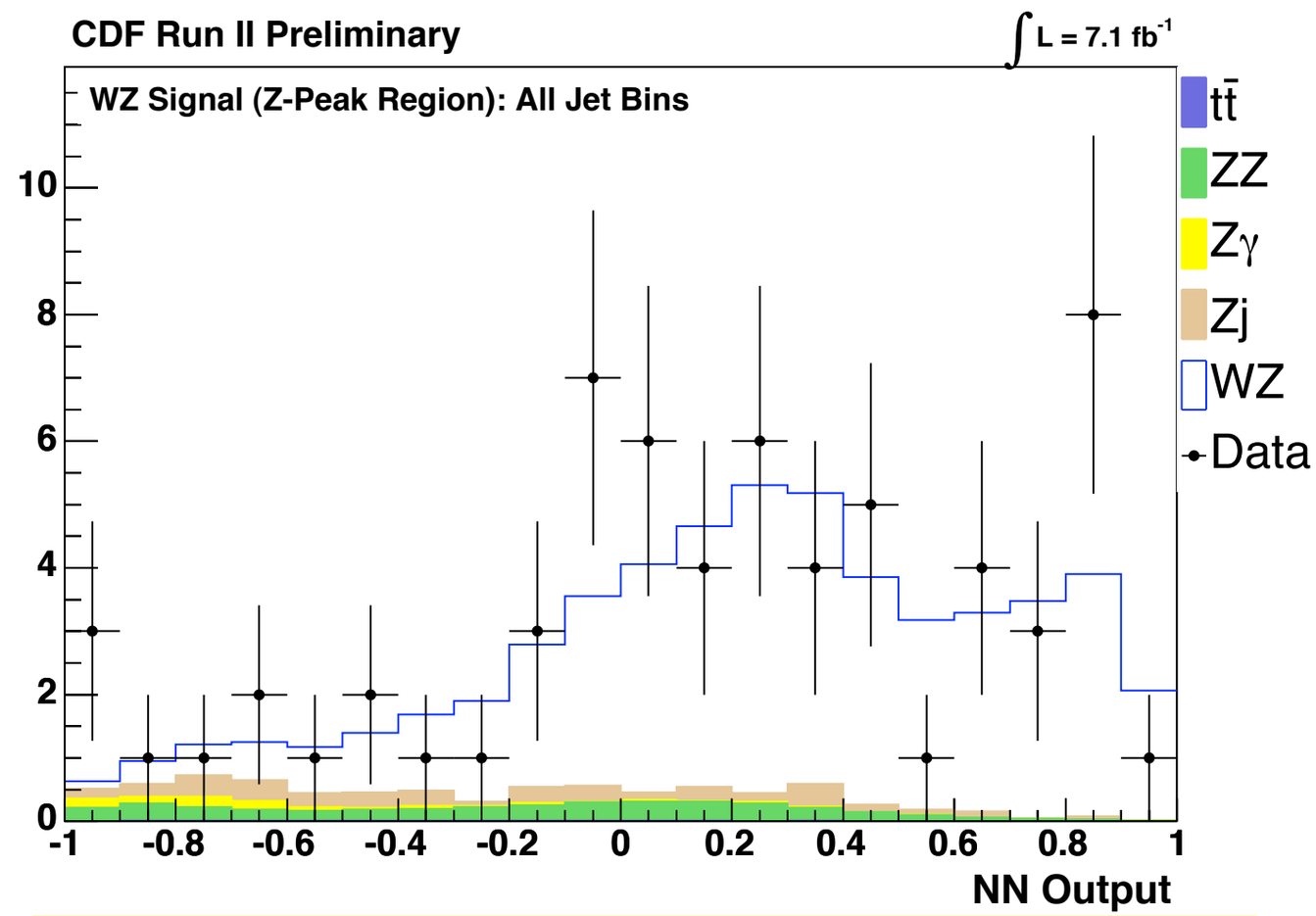
	λ^Z	Δg_1^Z	$\Delta\kappa^Z$
2.0TeV	-0.10 - 0.10	-0.11 - 0.20	-0.53 - 0.86
1.5TeV	-0.11 - 0.12	-0.12 - 0.23	-0.58 - 0.94

CDF Results at 1.9fb^{-1}

	λ^Z	Δg_1^Z	$\Delta\kappa^Z$
1.5TeV	-0.14 - 0.15	-0.14 - 0.25	-0.81 - 1.29
2.0TeV	-0.13 - 0.14	-0.13 - 0.23	-0.76 - 1.18

Published D0 Results at 0.3fb^{-1}

	λ^Z	Δg_1^Z	$\Delta\kappa^Z$
1.5 TeV	-0.48 - 0.48	-0.49 - 0.66	
1.0 TeV	-0.53 - 0.56	-0.57 - 0.76	-2.0 - 2.4

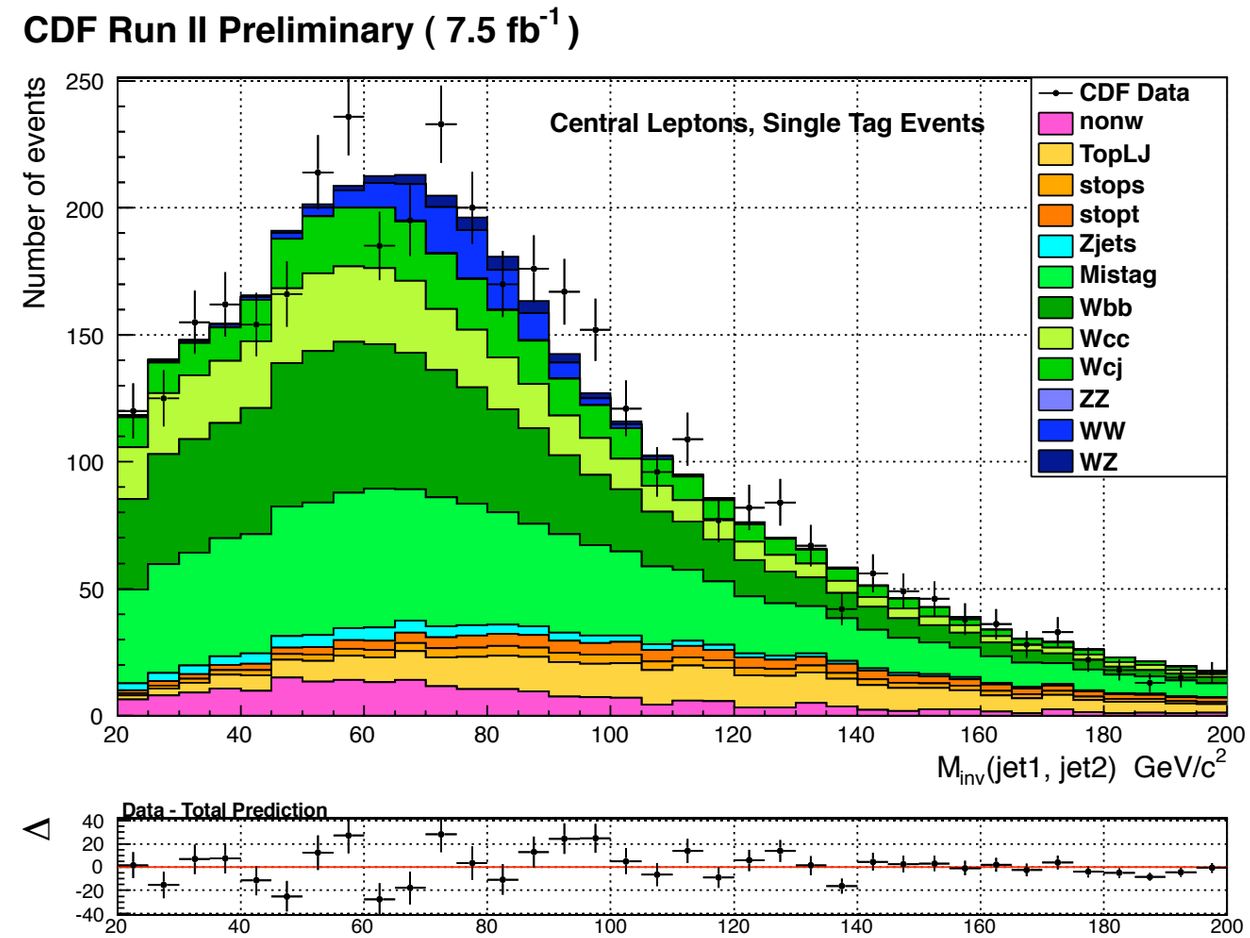


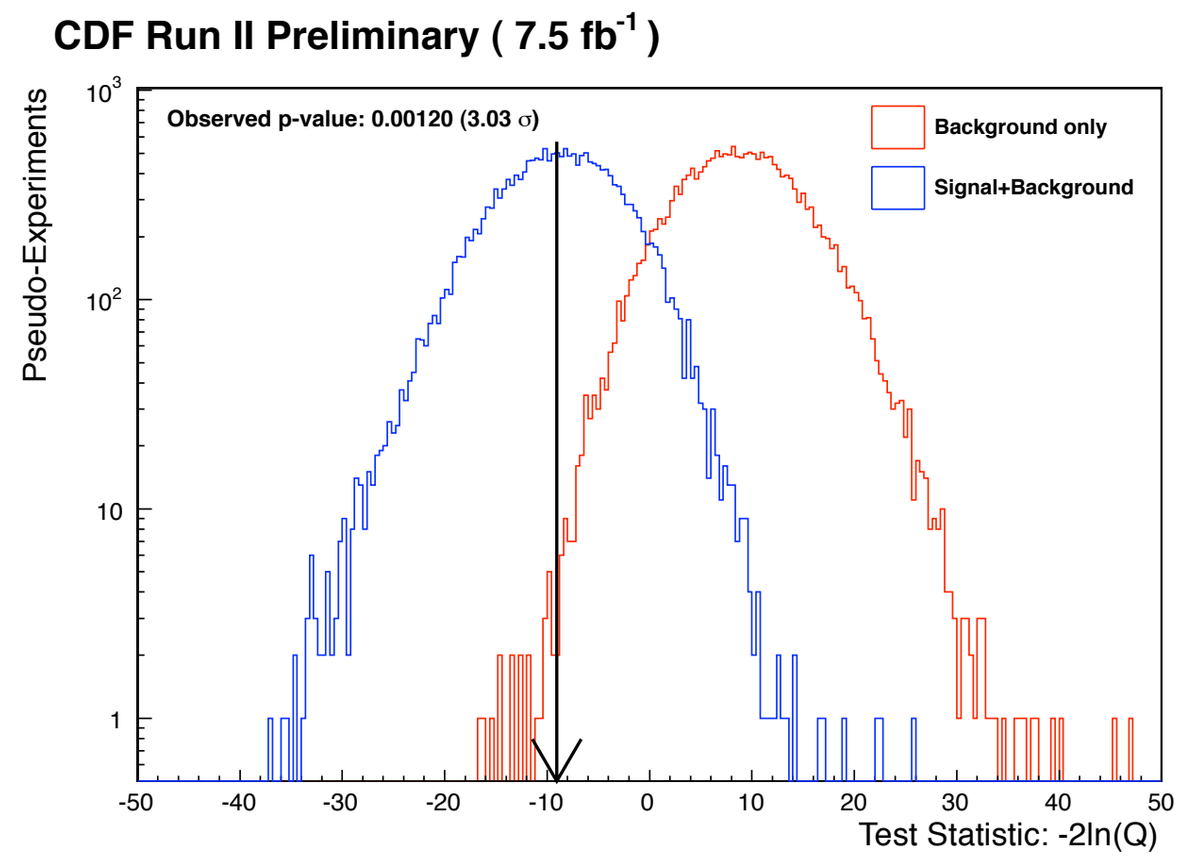
$$\sigma(WZ) = 3.9^{+0.6}_{-0.5}(\text{stat})^{+0.6}_{-0.4}(\text{syst})\ \text{pb}$$

Evidence for WW/WZ→lν+HF [7.5 fb^{-1}]

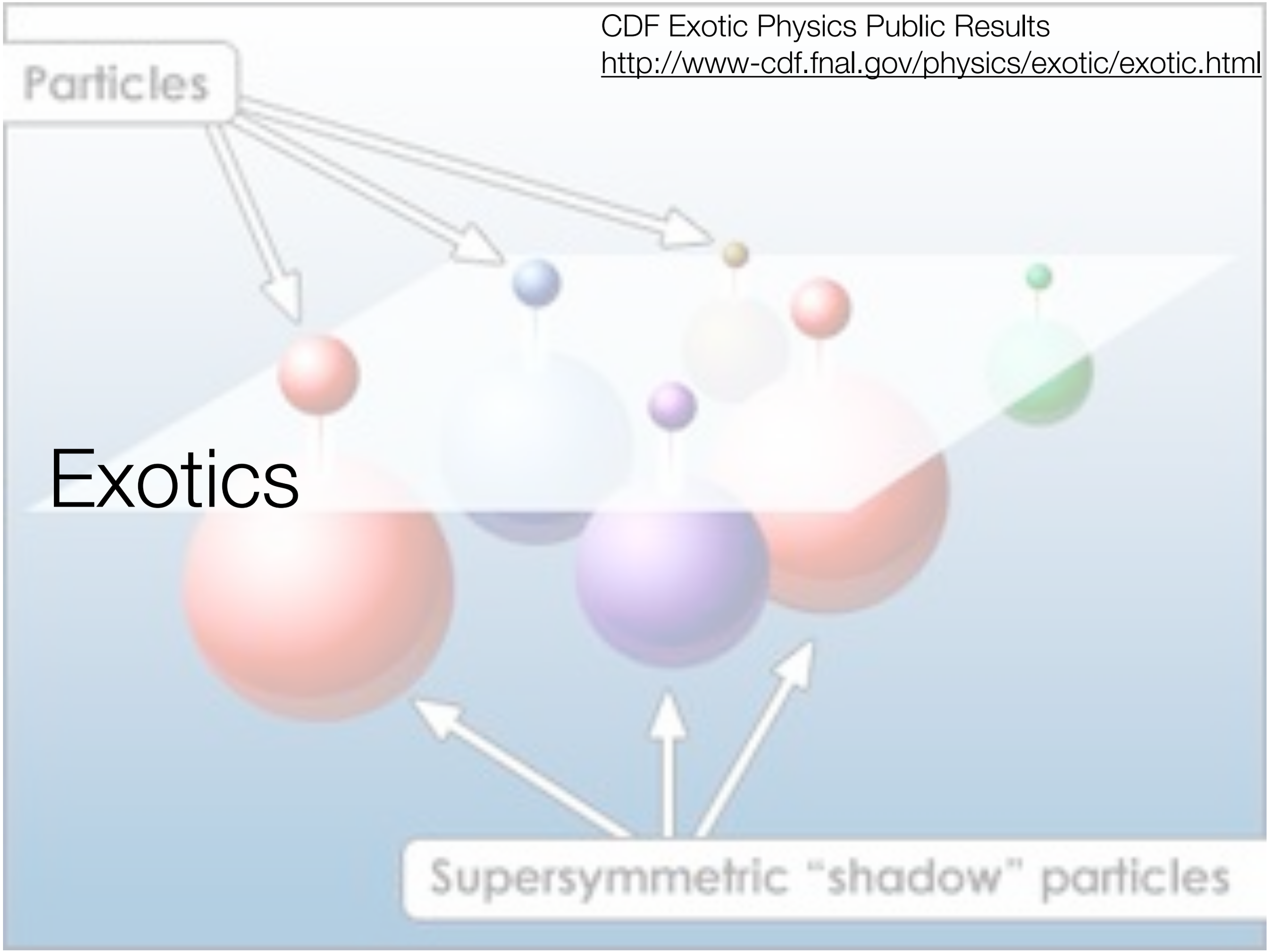
CDF Note 10598

- Search for WZ/WW→lν + heavy flavors
- Identical final state as WH→lνbb Higgs search
- Uses identical tools & techniques as WH Higgs search
- 3σ evidence with p-value=0.12%
- $\sigma(WW/WZ \to \ell\nu + \mathrm{HF}) = 1.08^{+0.26}_{-0.40} \times \mathrm{SM}$
- Excellent validation of Higgs analysis techniques





CDF Exotic Physics Public Results
http://www-cdf.fnal.gov/physics/exotic/exotic.html



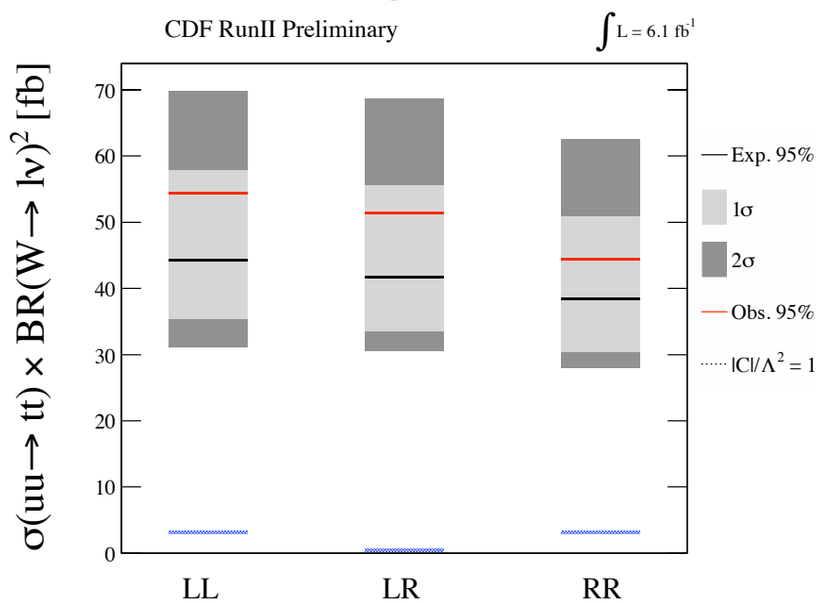
Exotics

Same-sign dilepton search [6.1 fb^{-1}]

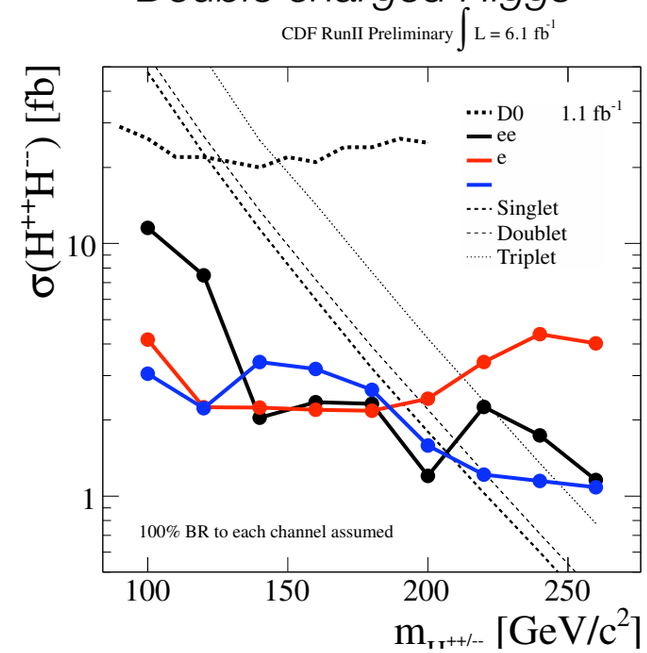
CDF Note 10464
CDF Note 10465
CDF Note 10466
CDF Note 10509

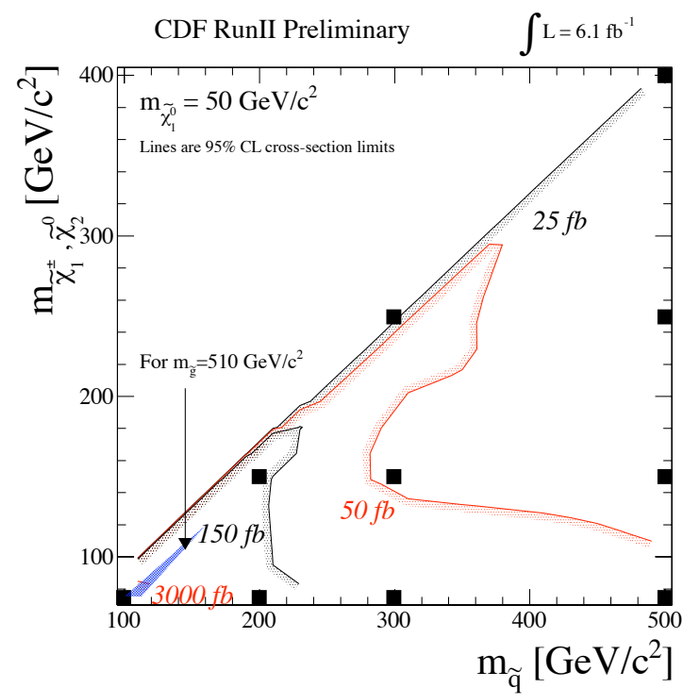
- Generic search for events with two high-pT, same-sign leptons
- Analysis can be applied to many new physics models
  - Standard Model check
  - Supersymmetry
  - Double charged bosons
  - Like-sign top quarks

Like-sign top

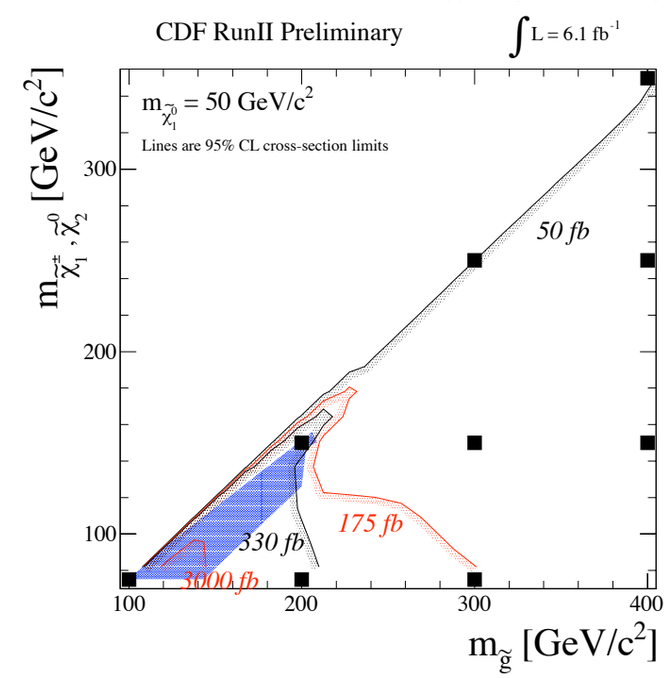


Double charged Higgs





Squark limits



Gluino limits

Search for Heavy Neutrino in ZZ+$\not{E}$t [4 fb^{-1}]

CDF Note 10539

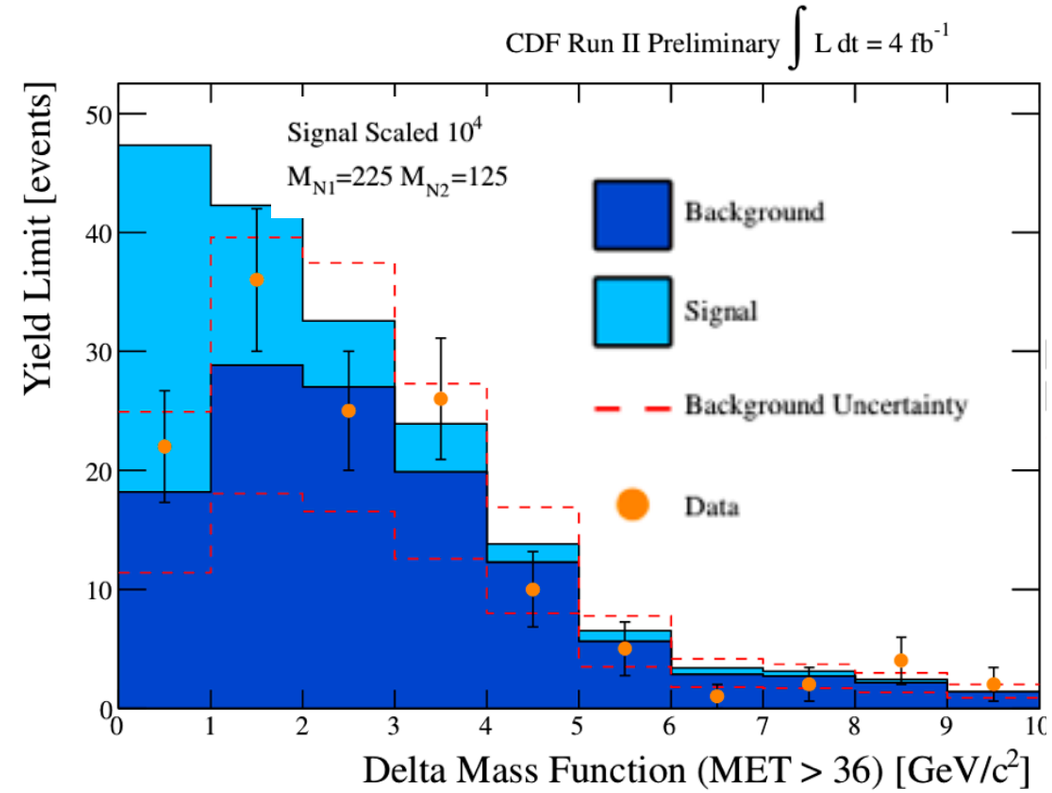
- Search for heavy 4th generation heavy neutrino N_1, N_2

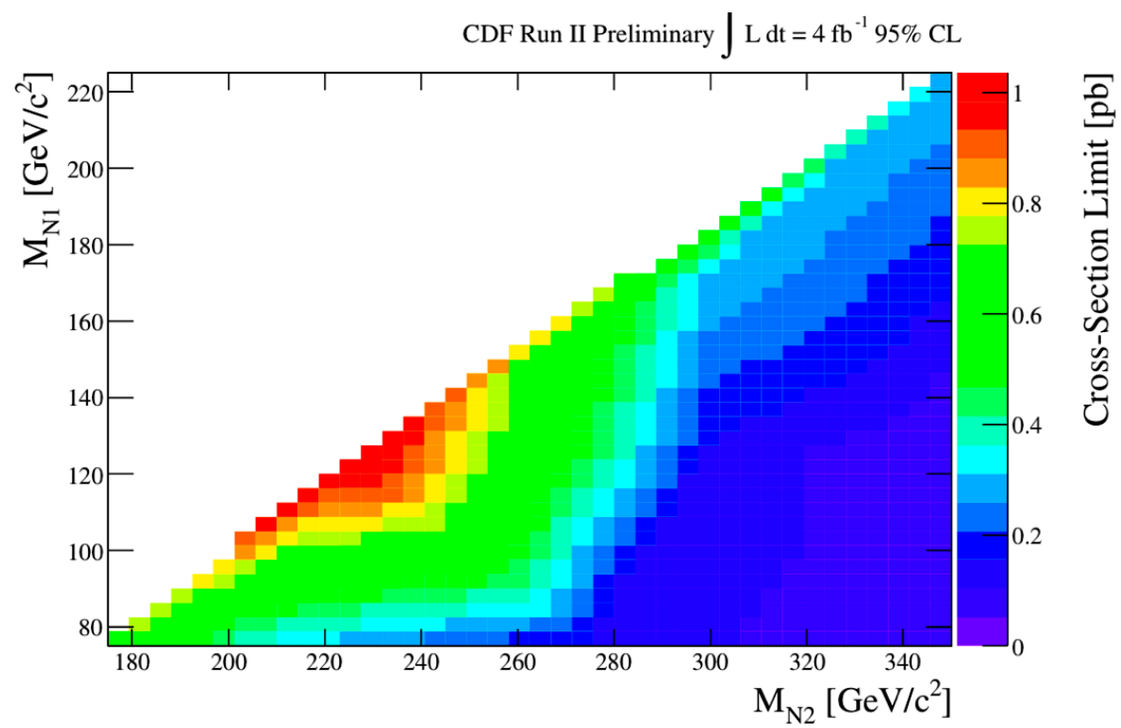
$$p\bar{p} \to Z/\gamma^* \to N_2 N_2 \to ZZ N_1 N_1 \to \ell\ell q q N_1 N_1$$

- As signal peaks in Mll and Mjj, the Delta Mass Function is defined as the discriminant

$$\text{Delta Mass Function} = \sqrt{\left(\frac{M_{\ell\ell} - M_Z}{\sigma_Z}\right)^2 + \left(\frac{M_{jj} - M_Z}{\sigma_Z}\right)^2}$$

- Set limits on cross-section ≲ 300 fb at 95% CL

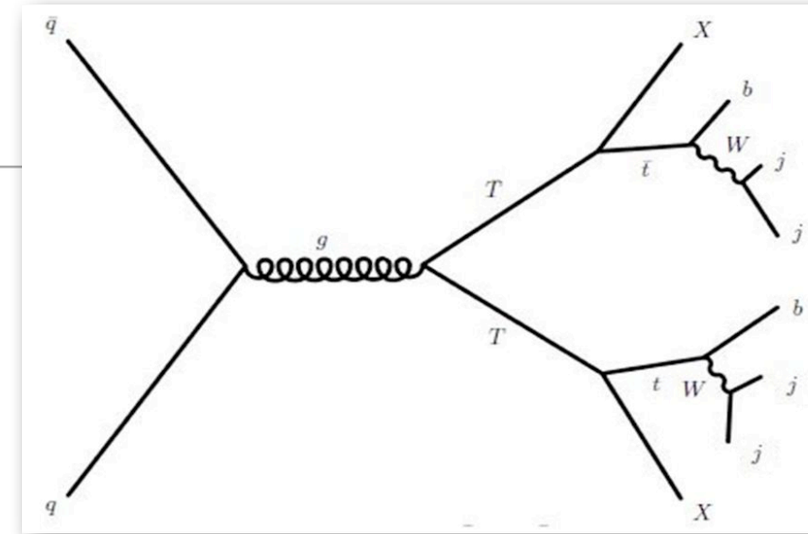




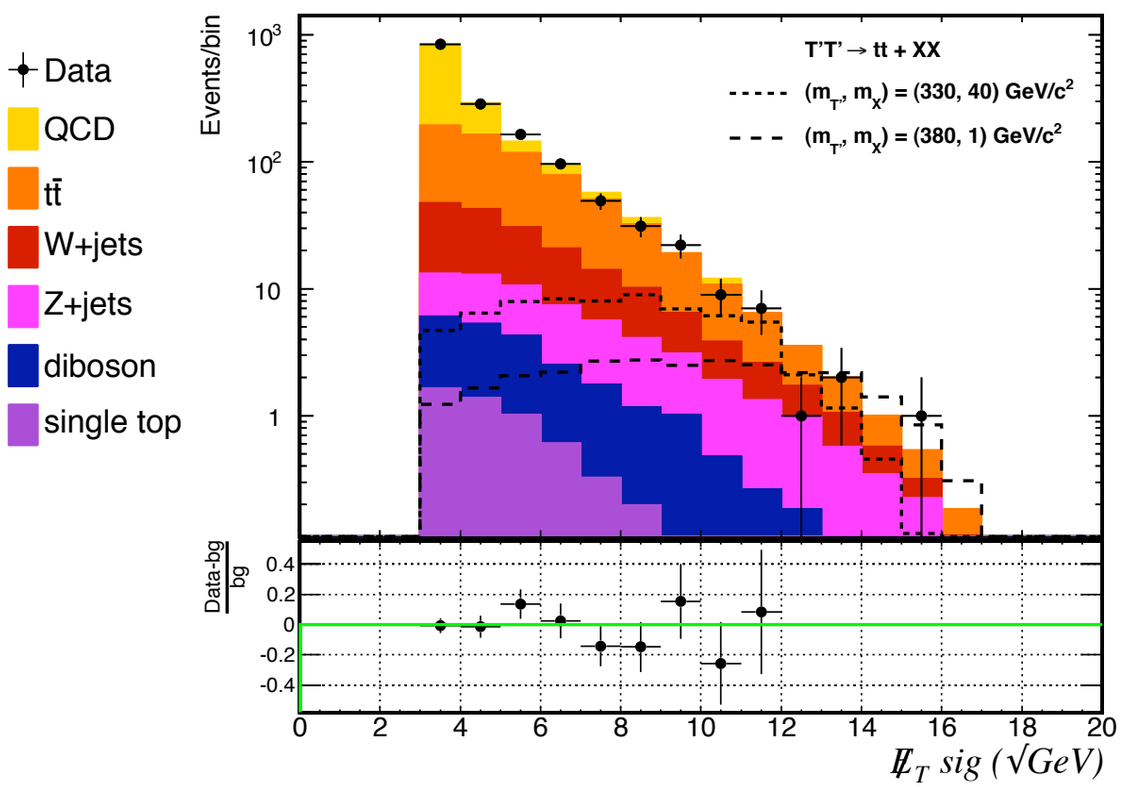
$M_{N1/N2}$: N1/N2 heavy neutrino mass

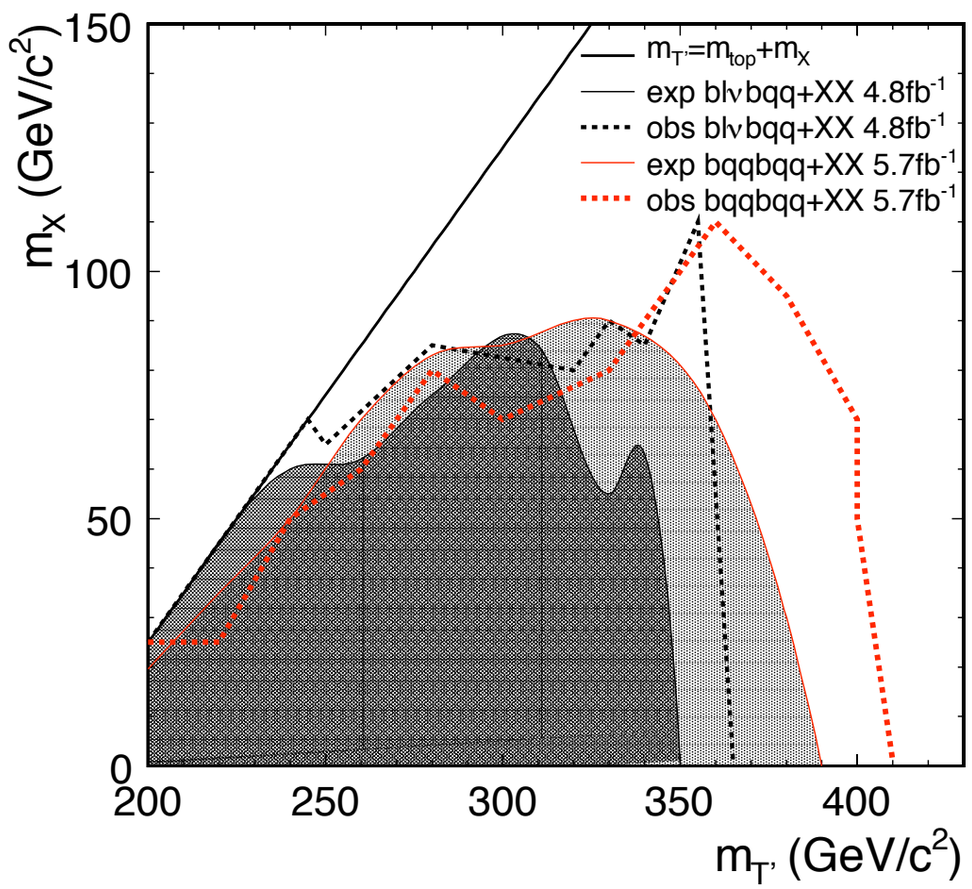
Dark Matter Search with Top [5.7 fb^{-1}]

arXiv:1107.3574v1 [hep-ex]



- Dark matter search at a collider
- Search for exotic 4th generation T´ decay to t+X, where X is the dark matter particle



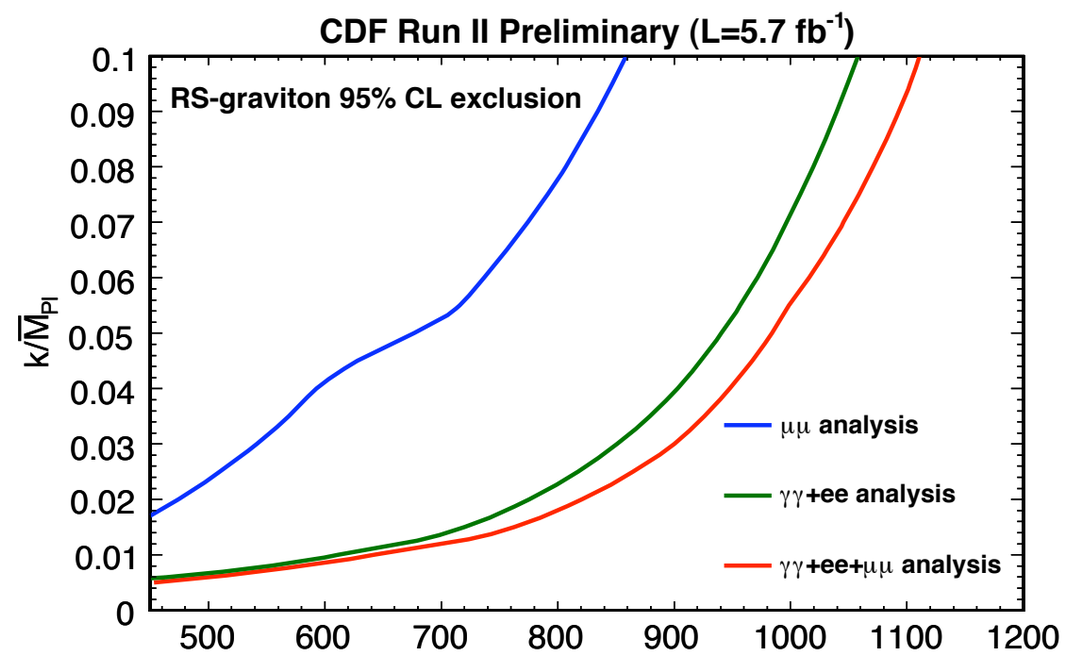


$$m_X \leqslant 70\,\mathrm{GeV}/c^2 \text{ for } m_{T'} = 400\,\mathrm{GeV}/c^2 \text{ at } 95\%\ \mathrm{CL}$$

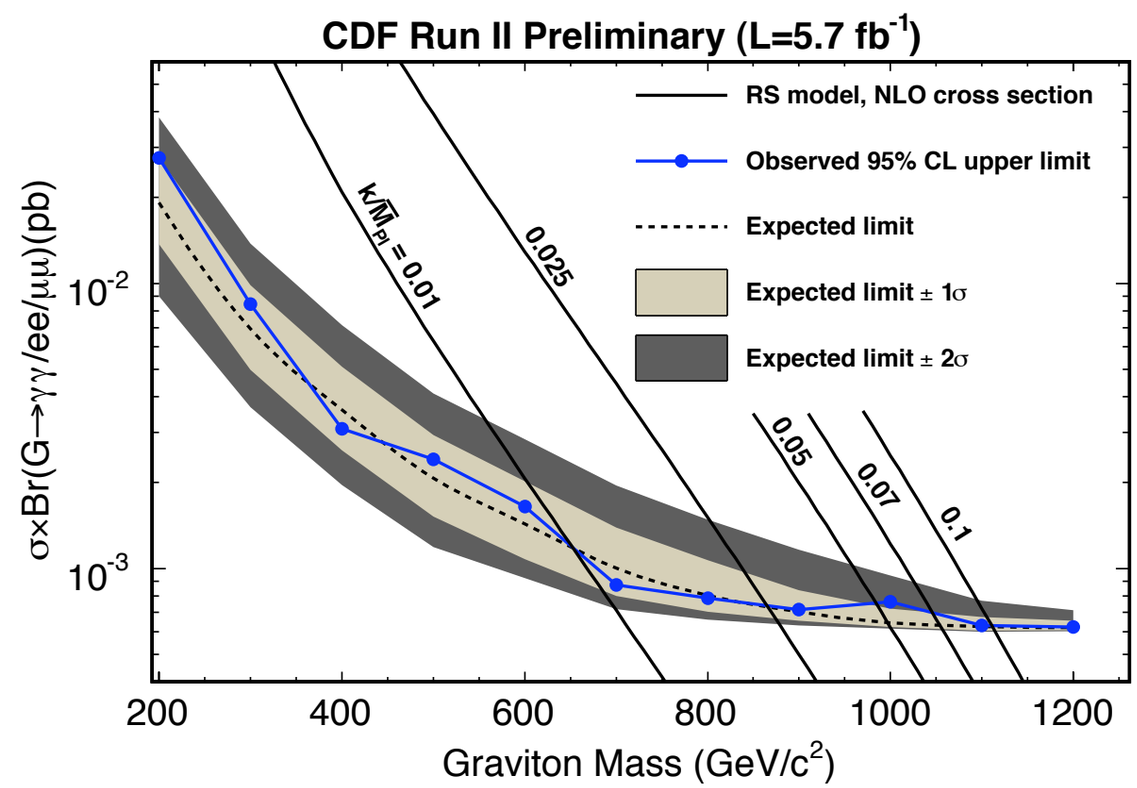
RS Graviton Search [5.7 fb^{-1}]

CDF Note 10479

- Search for RS Graviton decay
- Winter results had ee and γγ channels
- Now includes μμ channel



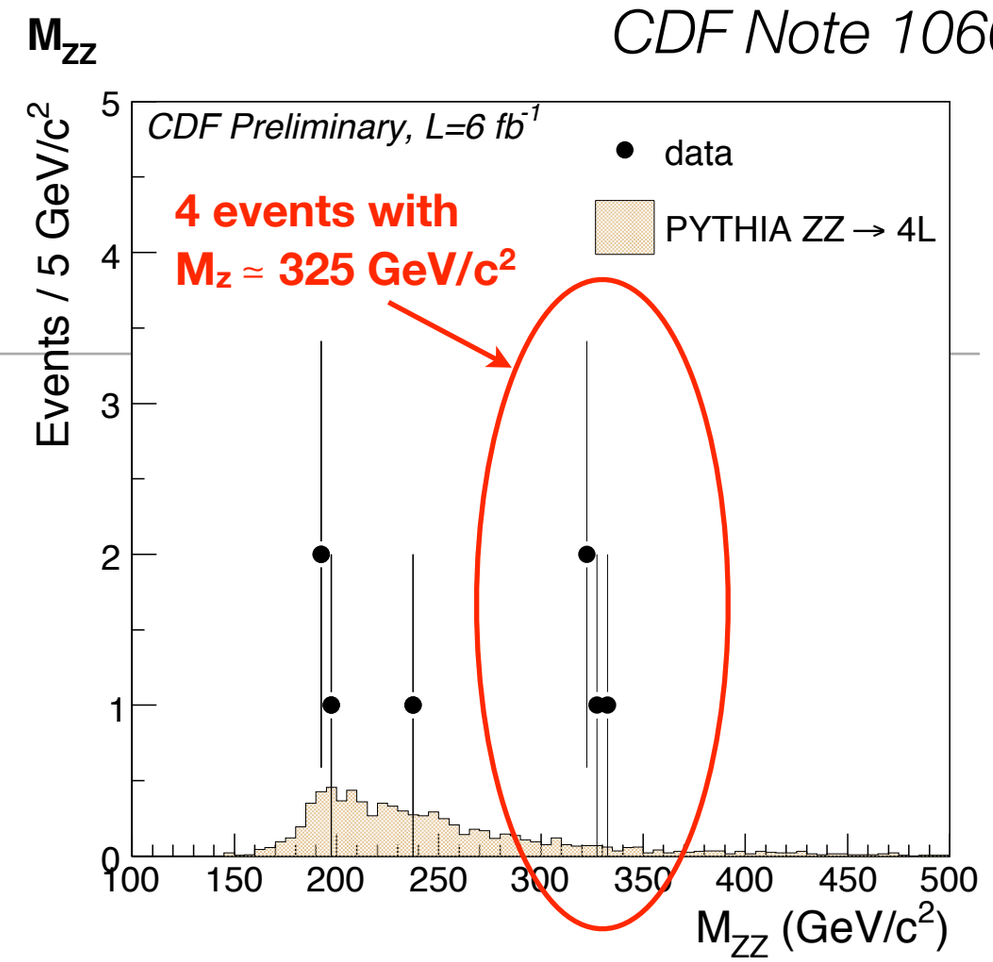
RS-graviton mass limits (GeV/c^2)		
$k/\overline{M}_{Pl}$	$\mu\mu$ analysis	$\mu\mu + ee + \gamma\gamma$ analysis
0.01	327	642
0.025	510	865
0.05	677	984
0.07	774	1046
0.1	859	1111

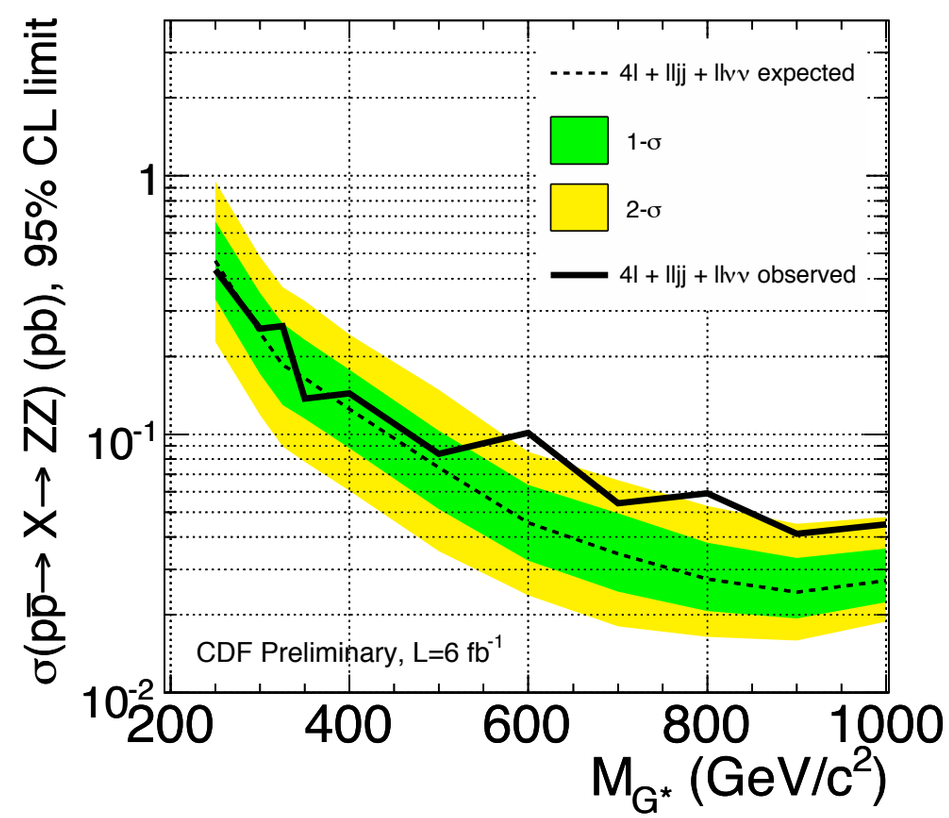


Search for high-mass ZZ Resonance [6 fb^{-1}]

CDF Note 10603

- Search for exotic particle decaying to ZZ
- ZZ→llll, ZZ→llνν, ZZ→lljj final states analyzed
- 4 lepton channel observed 4 events with M_{ZZ}≃325 GeV/c^2 with unexpected high P_T(ZZ)
  - Other channels consistent with background
- Limit for RS-Graviton M_{G^*}≃325 GeV/c^2
  - S-channel resonance: 0.19(Exp)/0.26(Obs) pb
  - Boosted resonance: 0.17(Exp)/0.28(Obs) pb





Top Quark

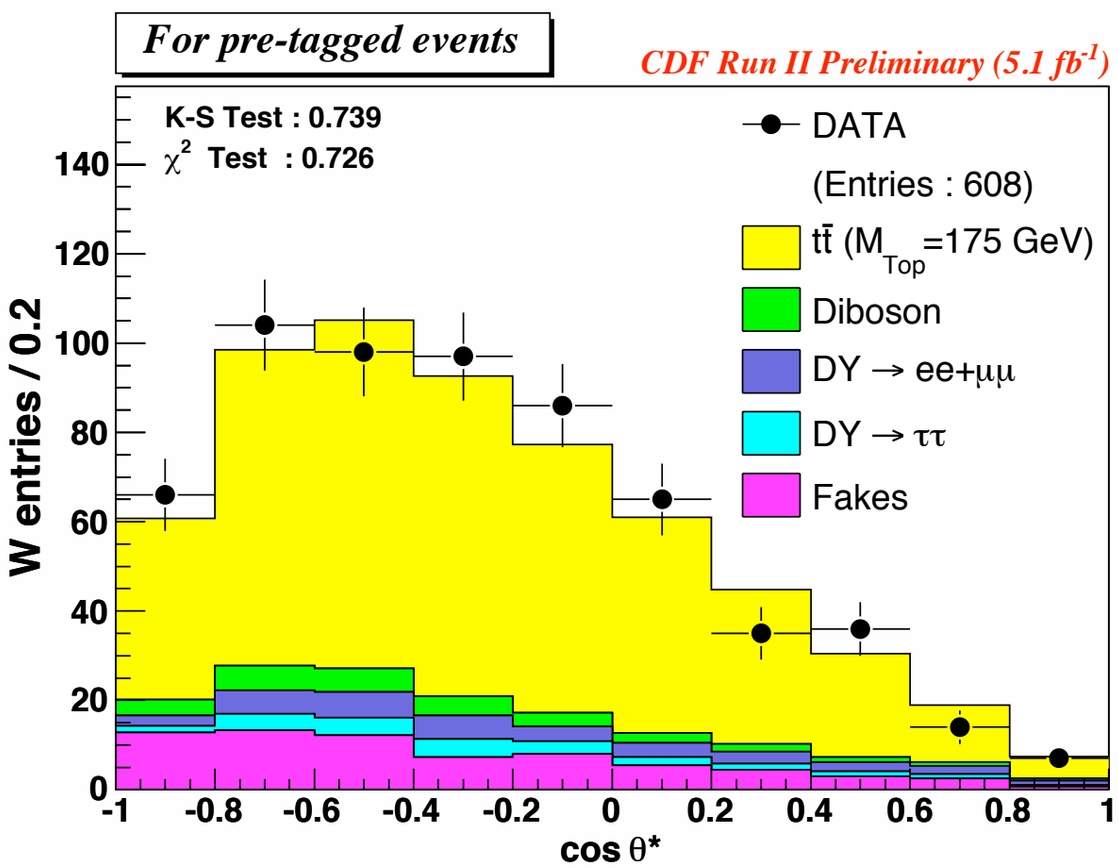
CDF Top Quark Physics Public Results
http://www-cdf.fnal.gov/physics/new/top/top.html

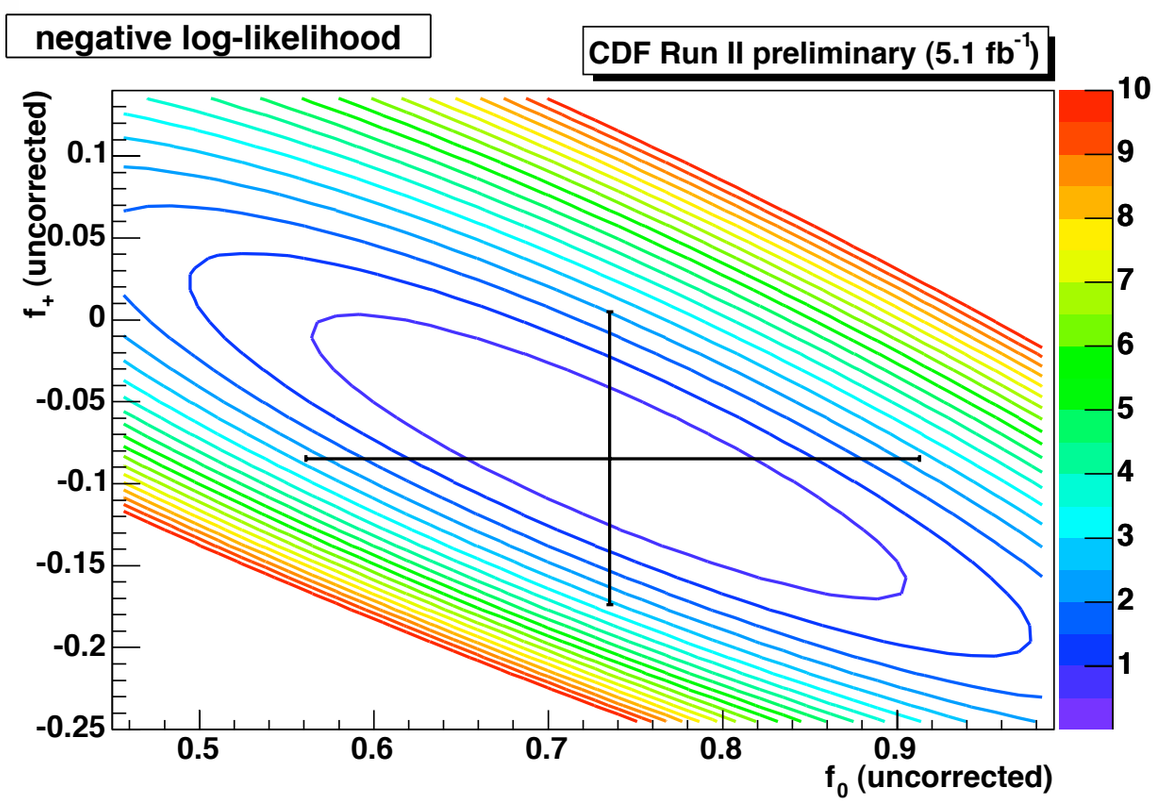
W-Helicity Measurement in Top-dilepton events [5.1 fb^{-1}]

CDF Note 10543

- First model independent, measurement of W boson helicity exclusively in dilepton channel
- Results are consistent with SM

$$f_0 = 0.74^{+0.18}_{-0.17}(\text{stat}) \pm 0.06(\text{syst})$$
$$f_+ = -0.09 \pm 0.09(\text{stat}) \pm 0.04(\text{syst})$$

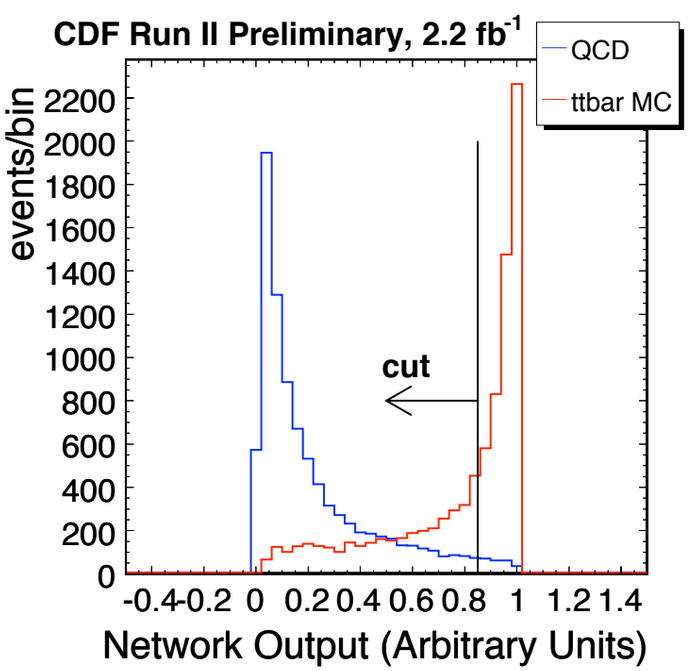


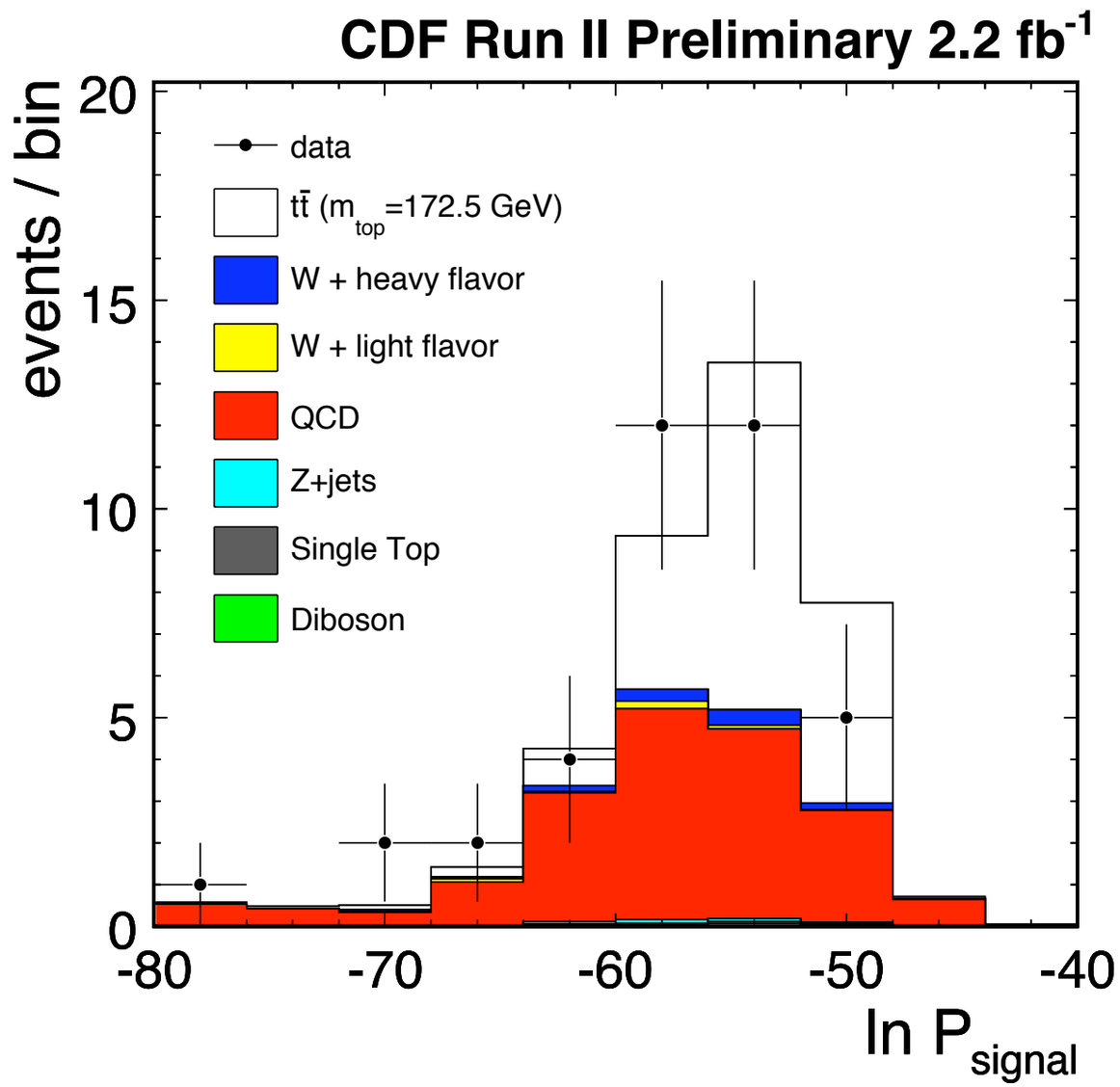


Top properties in Hadronic-τ + Jets [2.2 fb^{-1}]

CDF Note 10562

- First measurement of top properties in hadronic τ + jet channel
- Measurement of top cross-section and mass
- Neural network removes 86% of dominant QCD multijet background

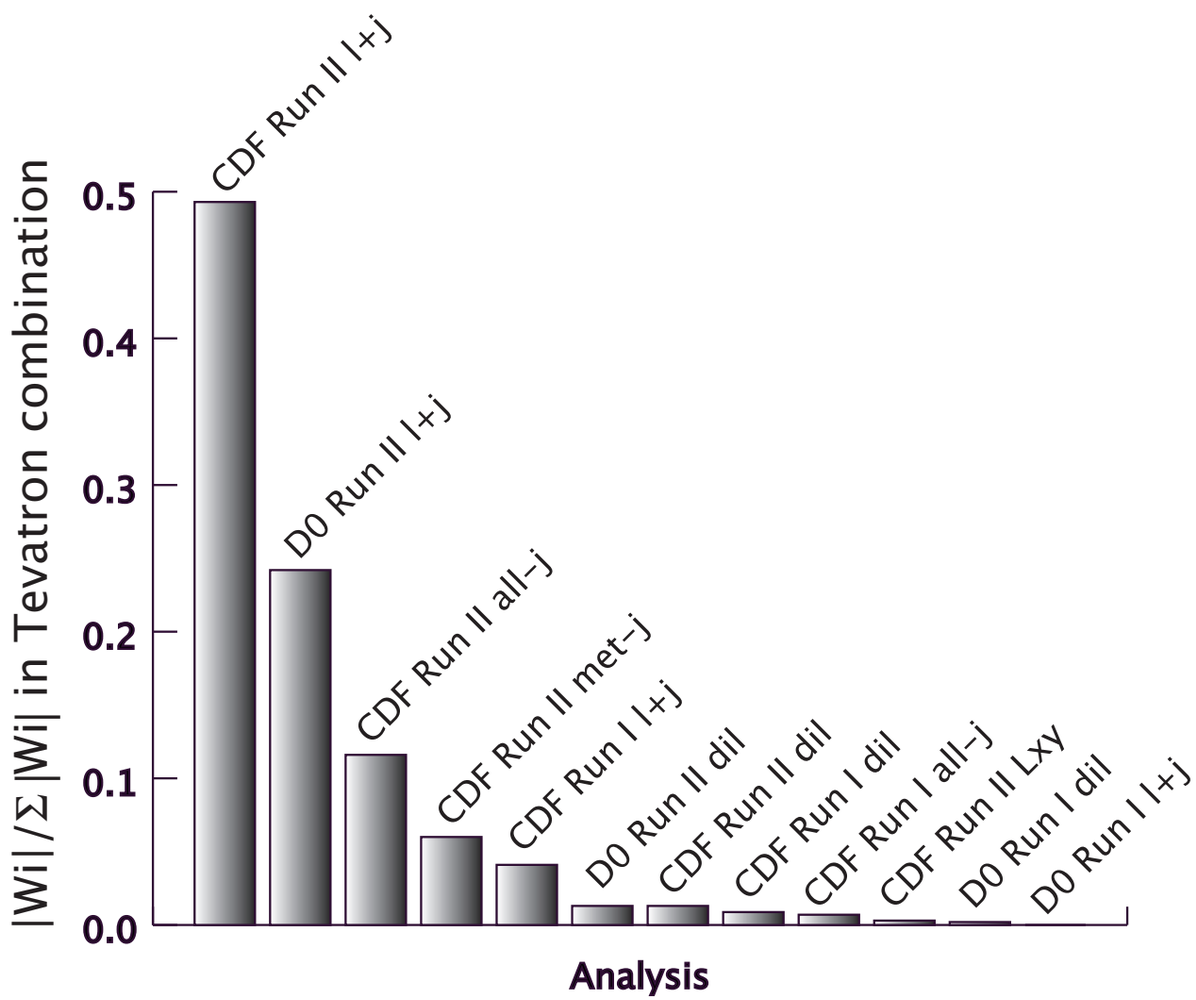


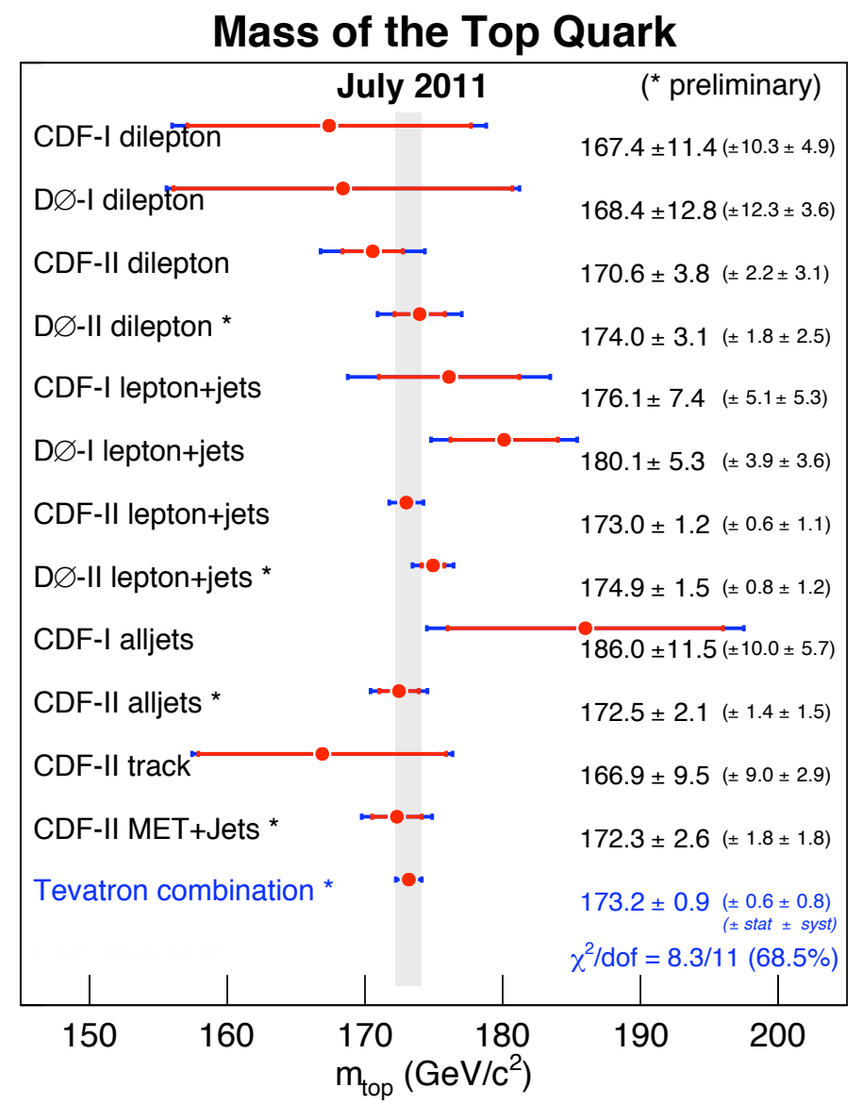


$$\sigma(t\bar{t}) = 8.8 \pm 3.3(\text{stat}) \pm 2.7(\text{syst})\,\text{pb}$$
$$M_t = 172.7 \pm 9.3(\text{stat}) \pm 3.7(\text{syst})\,\text{GeV}/c^2$$

Tevatron Top Mass Combination [5.8 fb^{-1}]

CDF Note 10549





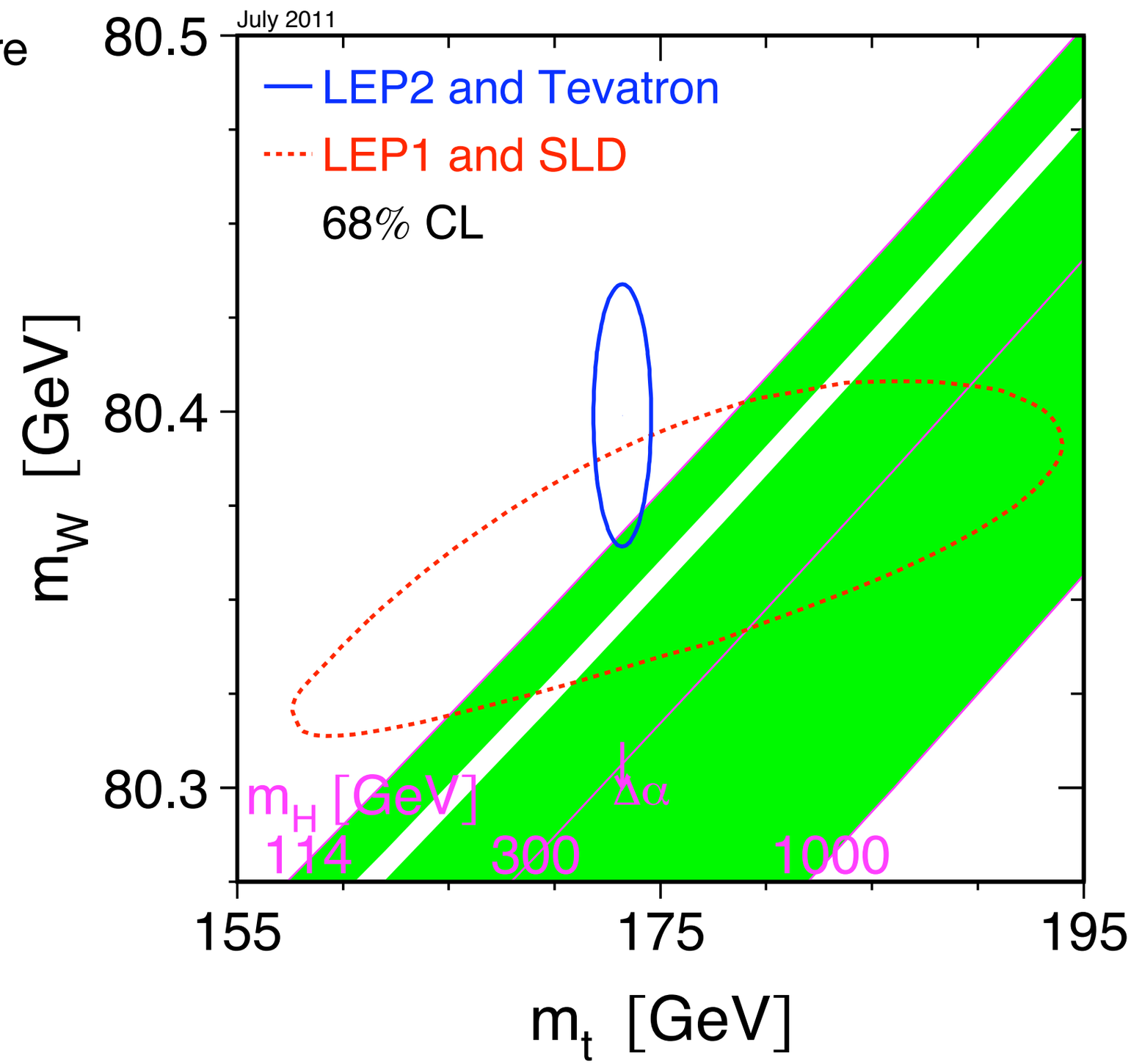
$$M_t = 173.2 \pm 0.9\,\mathrm{GeV}/c^2$$

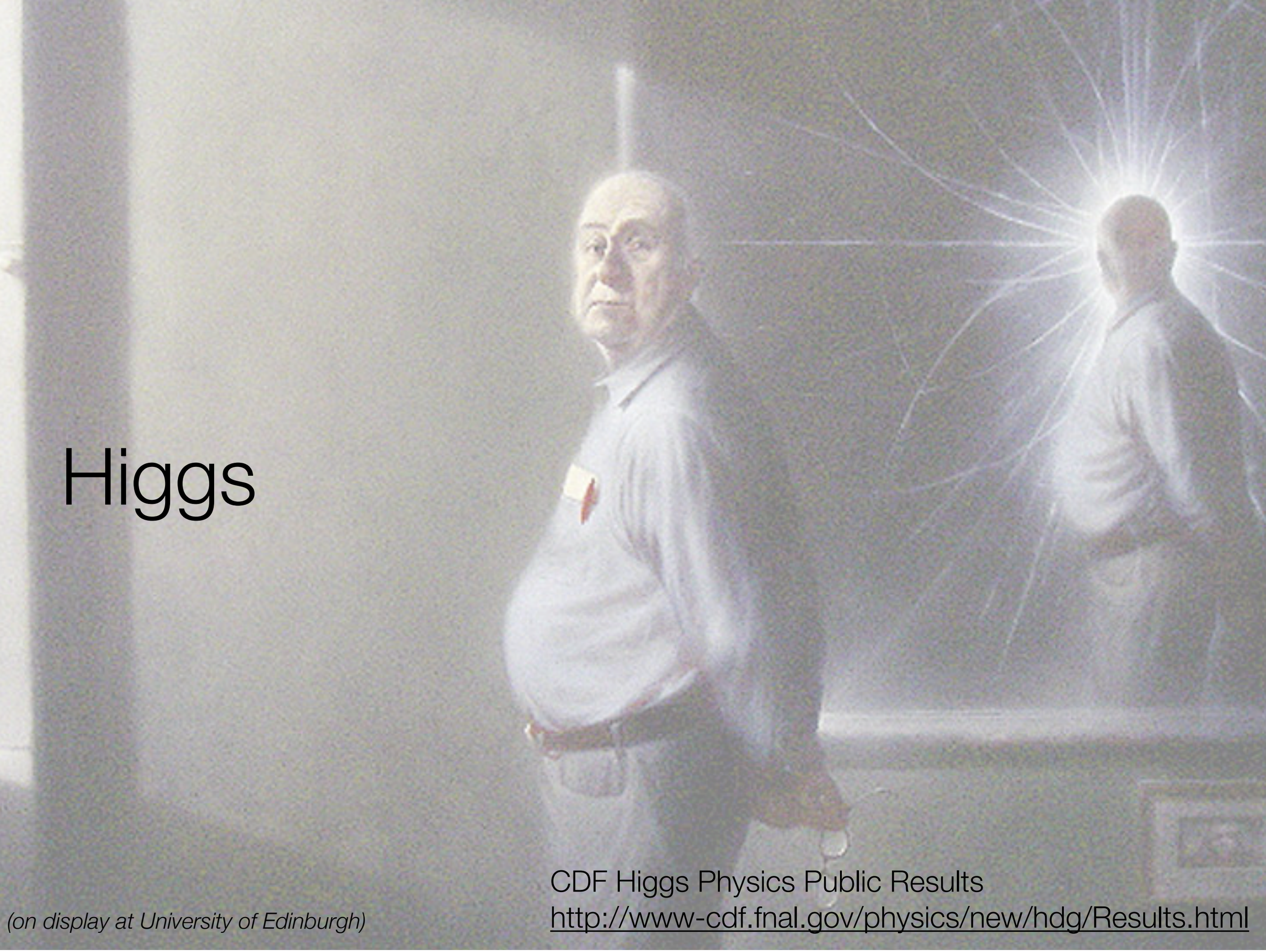
<1 GeV/c^2 precision!!

$$= 173.2 \pm 0.6(\mathrm{stat}) \pm 0.8(\mathrm{syst})\,\mathrm{GeV}/c^2$$

Tevatron Top Mass Combination: Impact on Electroweak fits

- Squeezing out places where the Higgs could be hiding





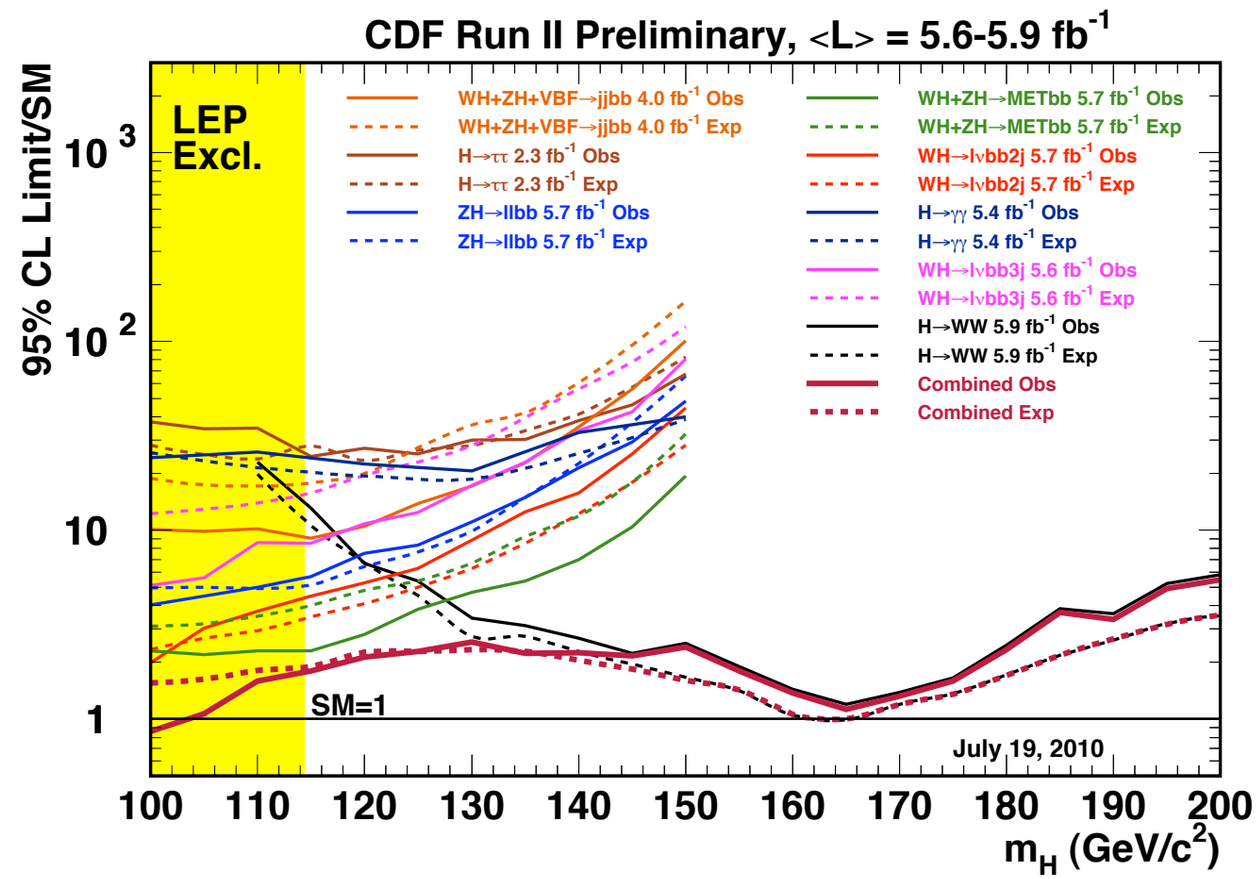
Higgs

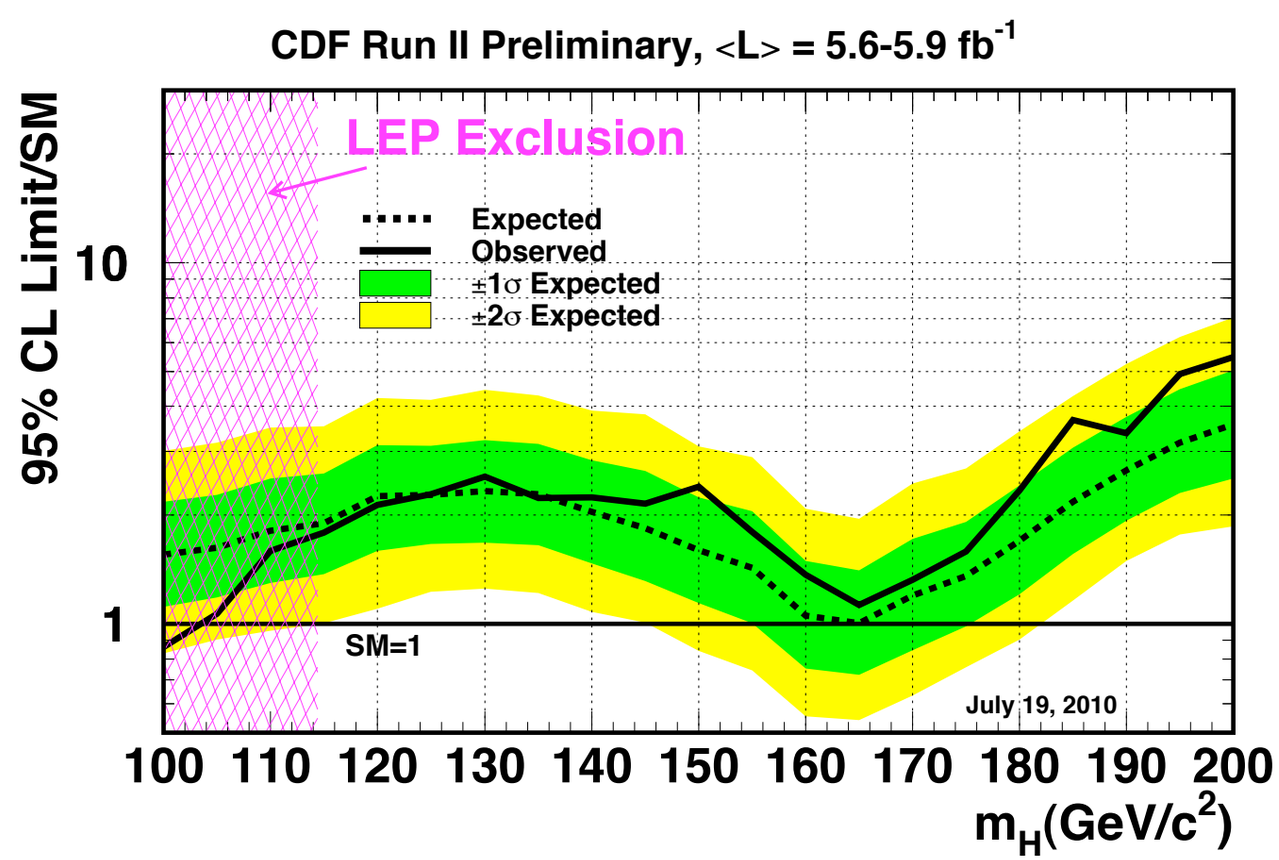
CDF Higgs Physics Public Results
http://www-cdf.fnal.gov/physics/new/hdg/Results.html

(on display at University of Edinburgh)

Higgs

- 9 new Higgs search results
  - 5 updated search results with improvements
  - 4 completely new search results
- All updated results have 10%-15% sensitivity improvements above that expected from luminosity increase alone
- Last summer, we were close to CDF-alone exclusion...

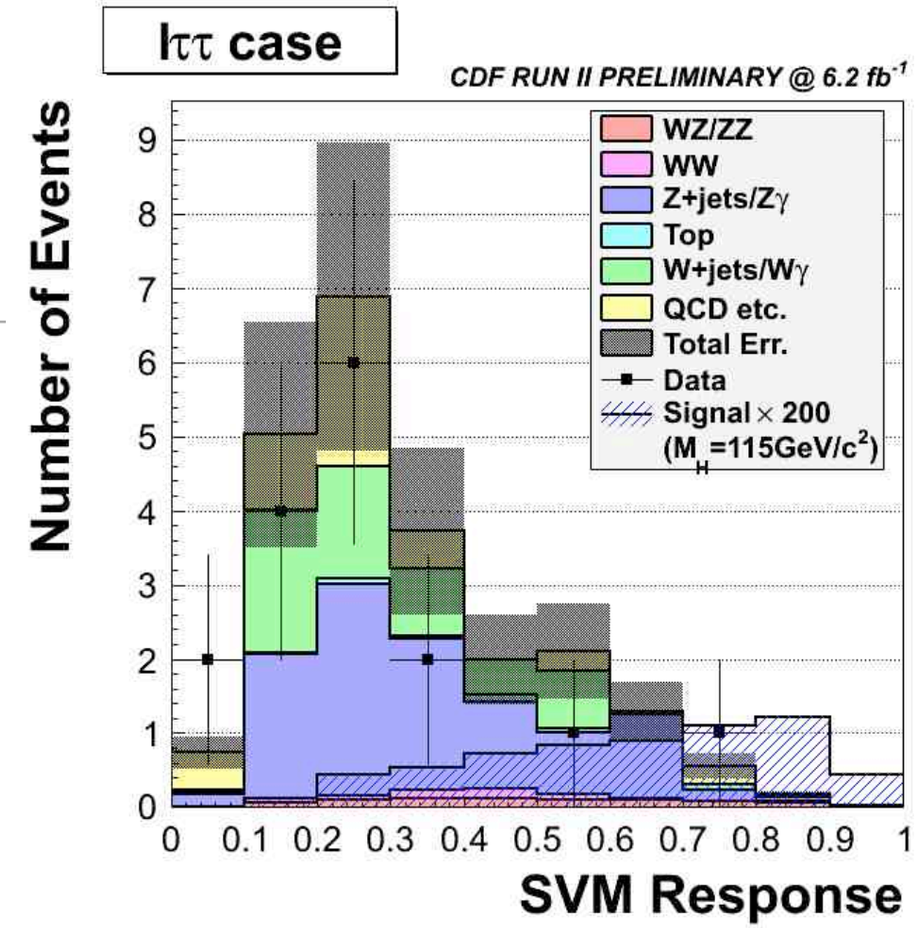


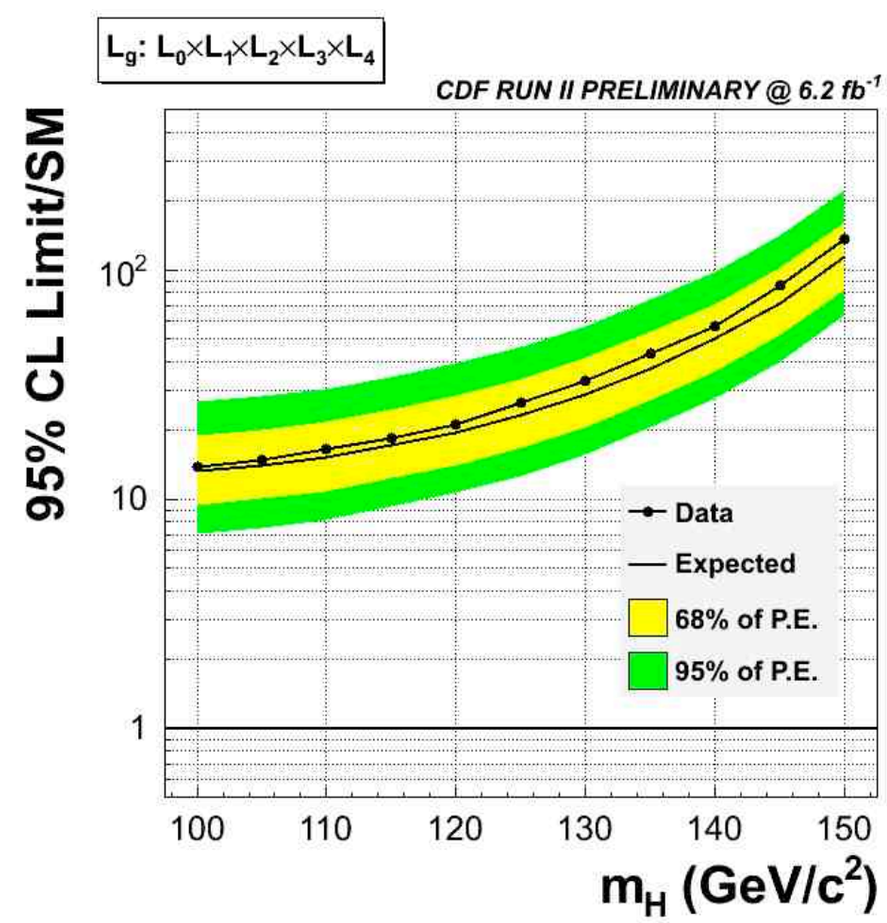


$WH \rightarrow \tau\tau + l\nu$ / $ZH \rightarrow \tau\tau + ll$ [6.2 fb^{-1}] *CDF Note 10500*

- Event signature: 3 or 4 leptons (including hadronic τ)
- Support Vector machine trained to separate signal from each background
- Limit: 19.7(Exp)/21.2(Obs) x σ_{SM} for M_H=120 GeV/c^2

New Higgs channel for Summer 2011



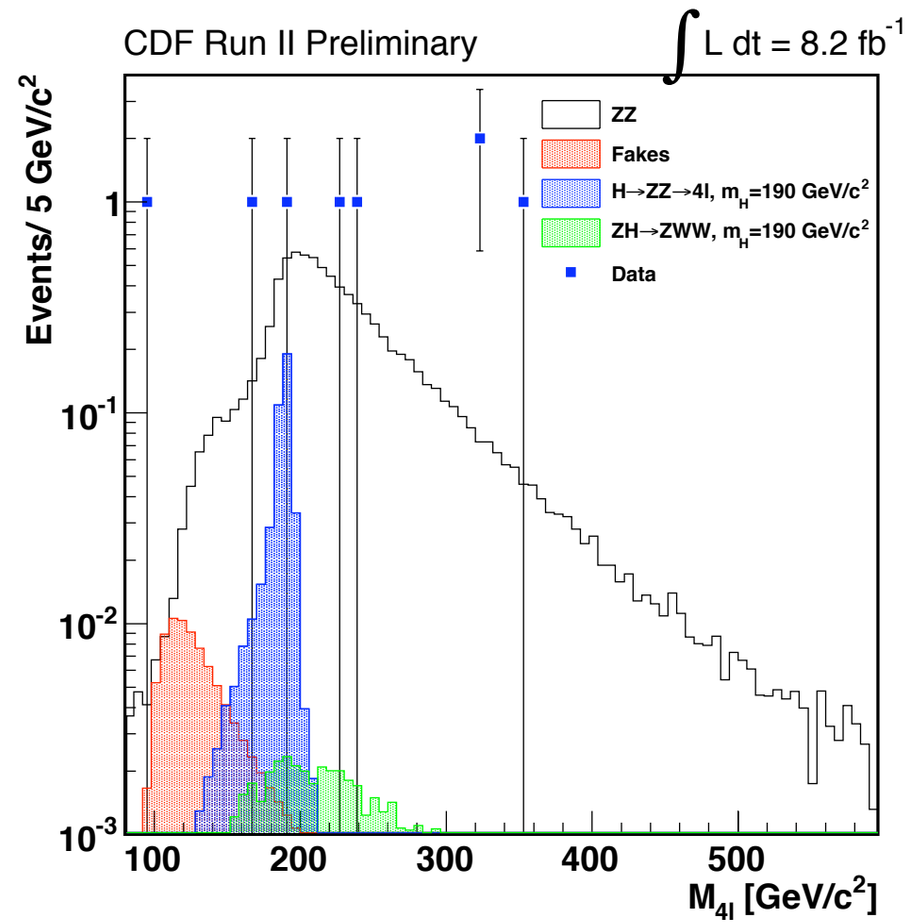


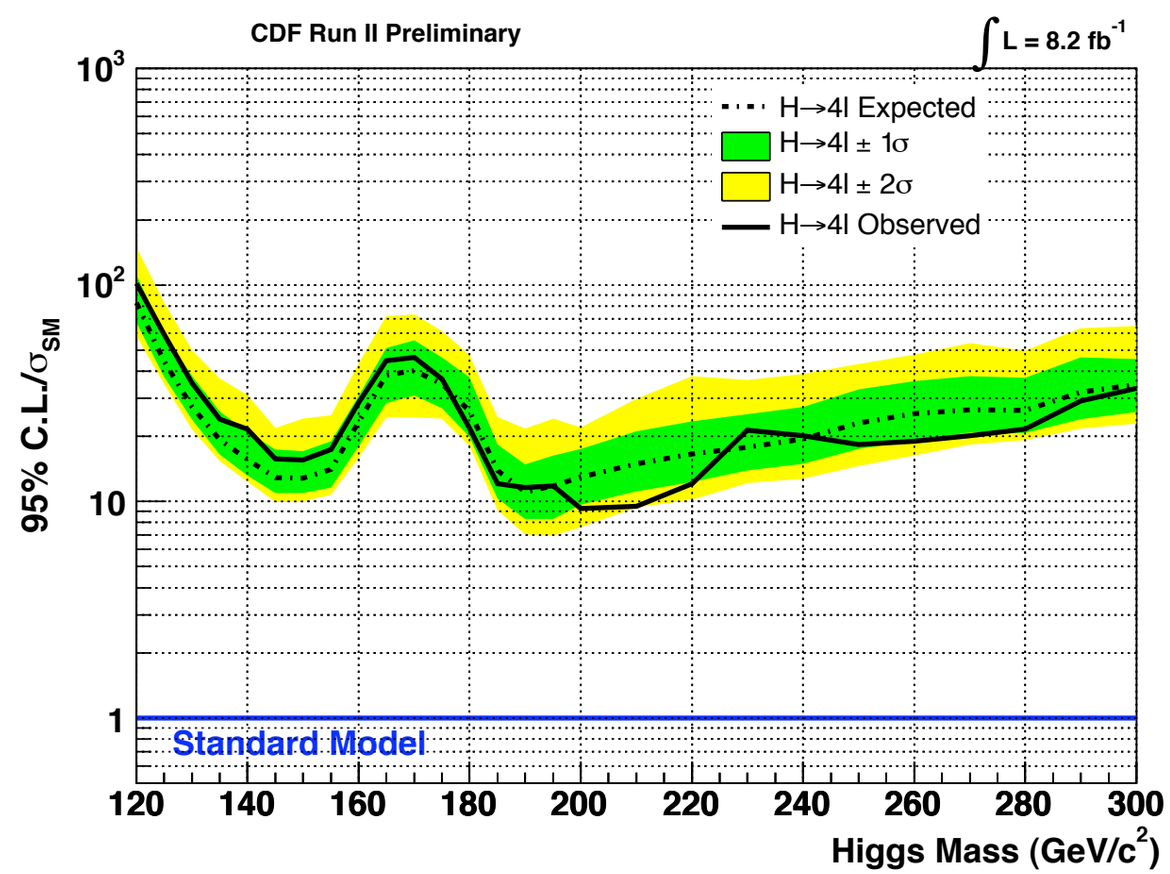
H→4l [8.2 fb^{-1}]

CDF Note 10573

- Search for Higgs in 4 lepton final state (4e,4μ,2e+2μ)
- Most sensitive to H→ZZ decay ….but also some acceptance from ZH→ZWW
- Limit: 11.1(Exp)/11.6(Obs) x σ_{SM} for M_H=190 GeV/c^2

New Higgs channel for Summer 2011



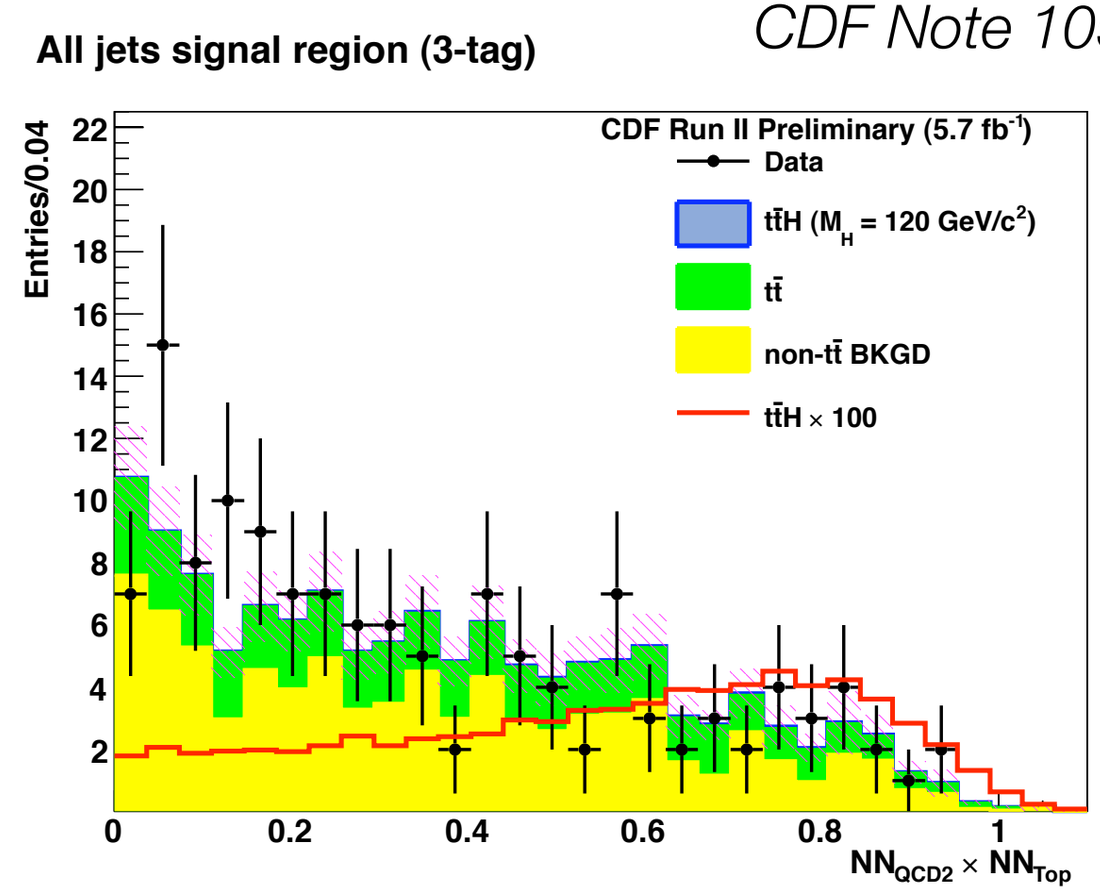


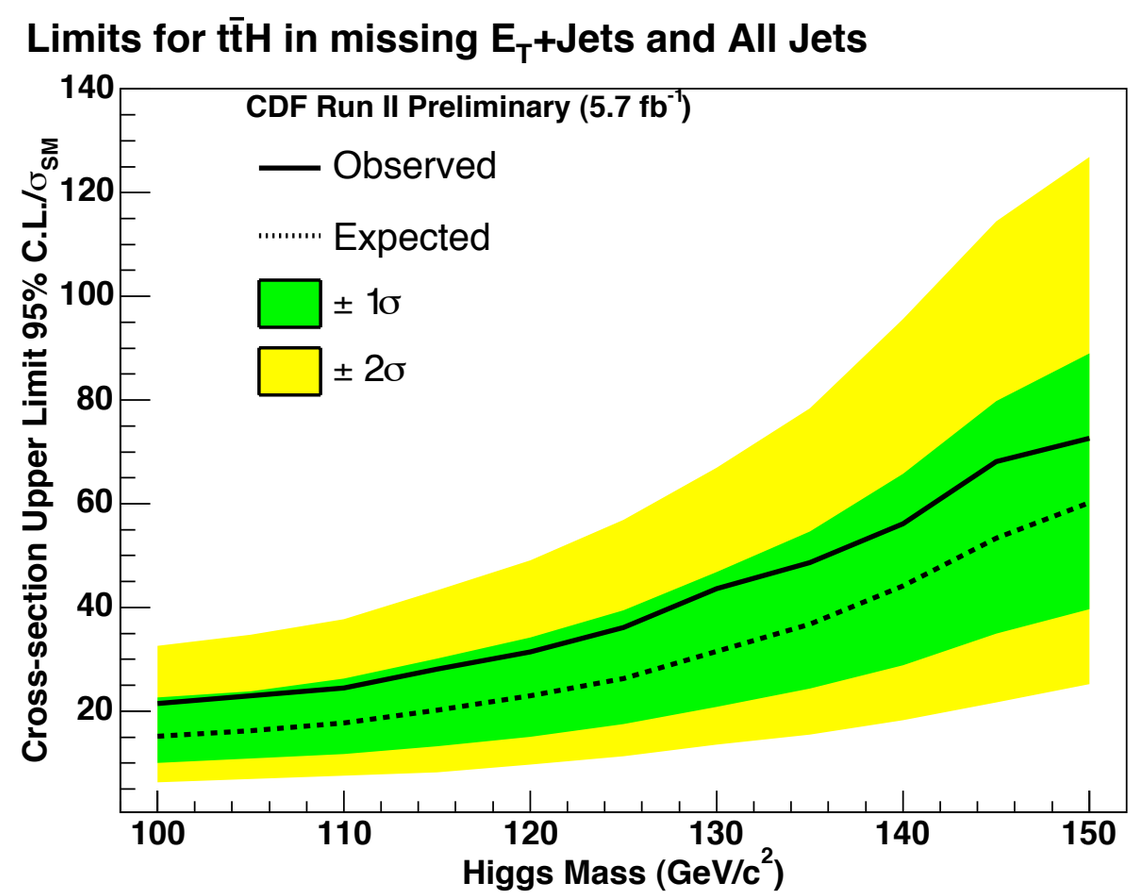
ttH - No lepton final state [5.7 fb^{-1}]

CDF Note 10582

- Search for ttH production in all jets and $\not\!\!E_T$+jets final state.
- Sensitive all non-leptonic tt decay modes
- Multiple NN used to remove the dominant QCD multijet background
- Limit: 22.9(Exp)/31.4(Obs) x σ_{SM} for M_H=120 GeV/c^2

New Higgs channel for Summer 2011

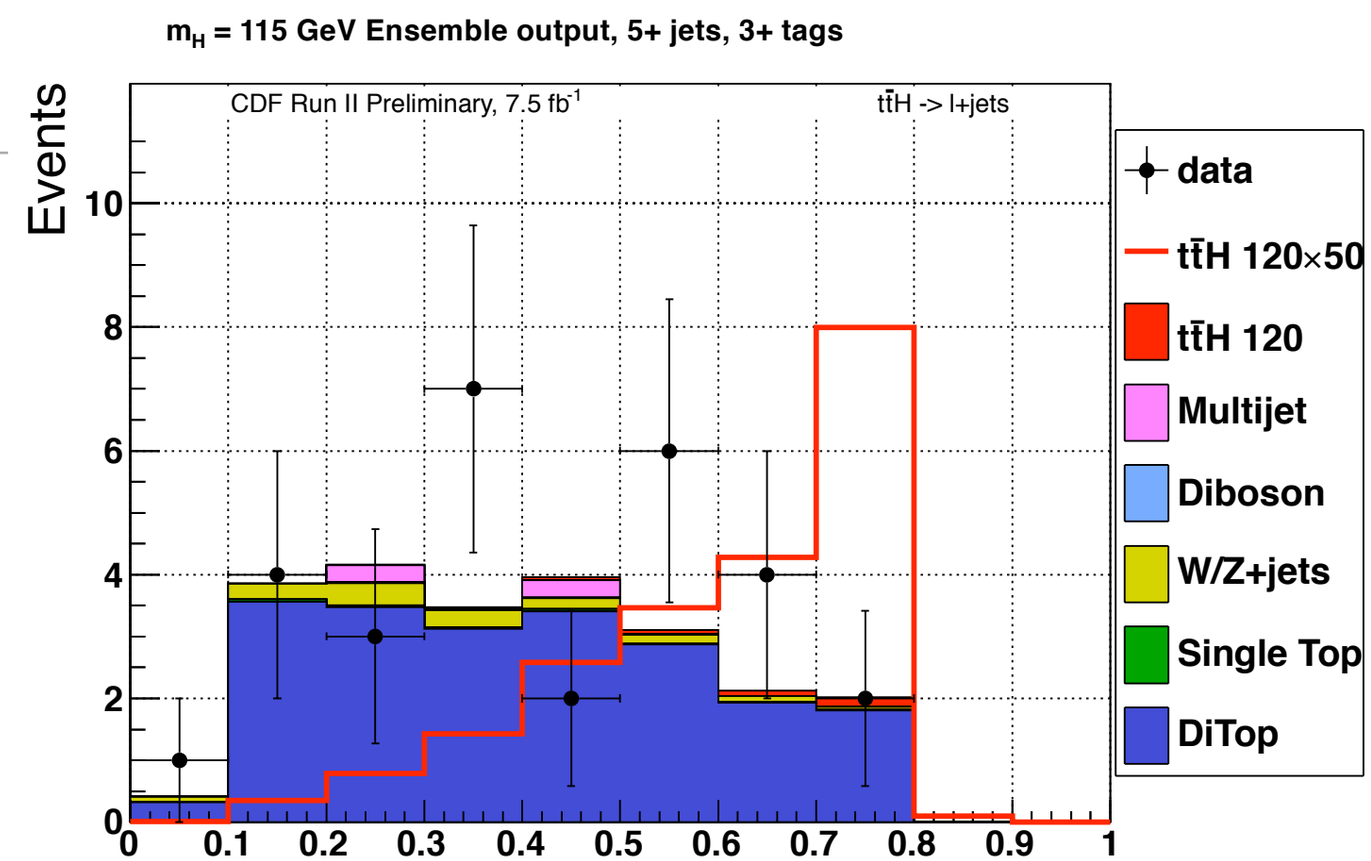


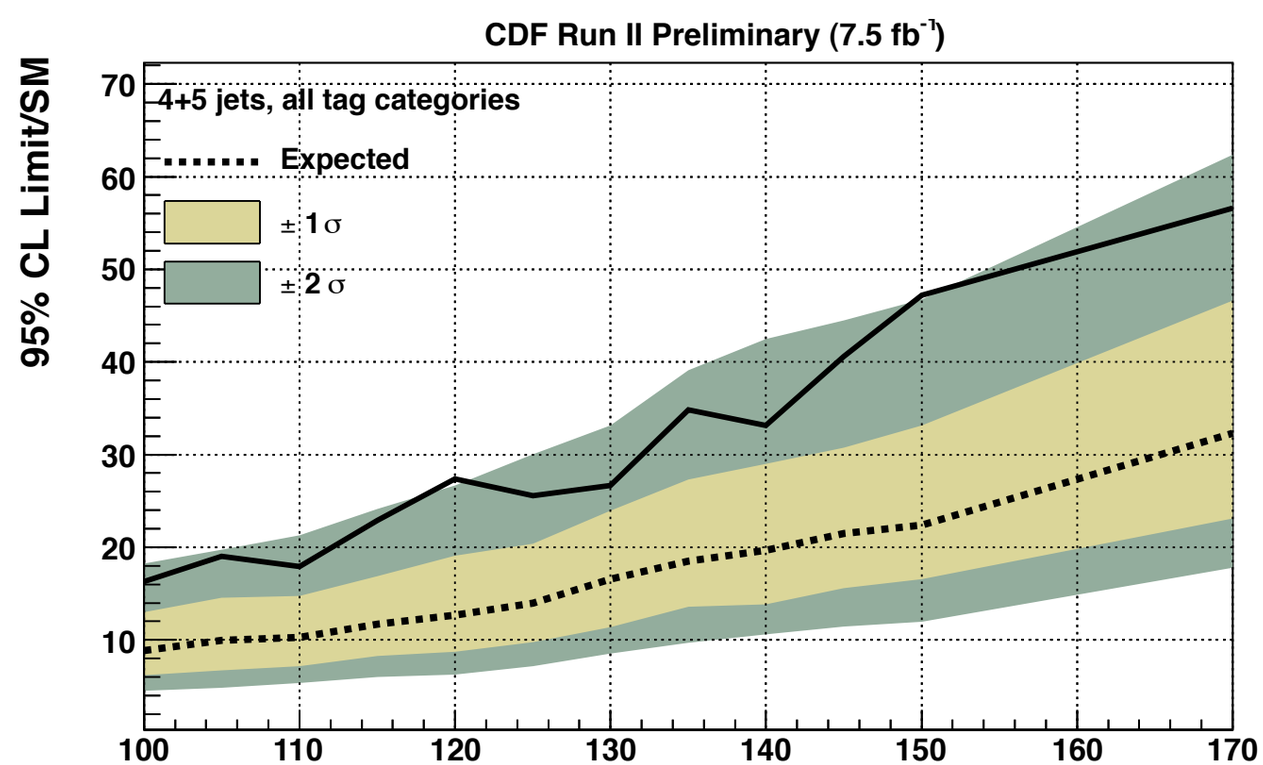


ttH - Leptons+jets final state [7.5 fb^{-1}] *CDF Note 10574*

- Complementary analysis to the previous ttH analysis
- Sensitive all Higgs decay modes
- Uses "ensemble" of NN to separate signal from background
- Limit: 12.7(Exp)/27.4(Obs) x σ_{SM} for M_H=120 GeV/c^2
- ttH has better sensitivity for M_H=130-140 GeV/c^2 than ZH & WH analysis as it sensitive to all Higgs decay modes.

New Higgs channel for Summer 2011

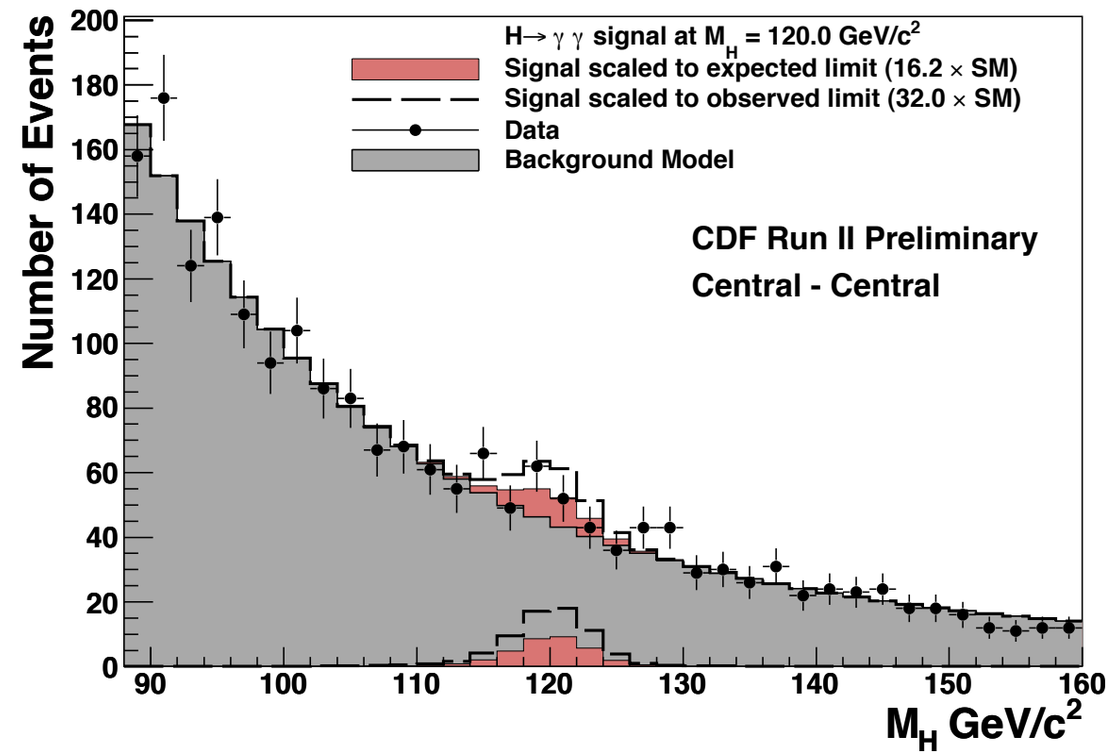


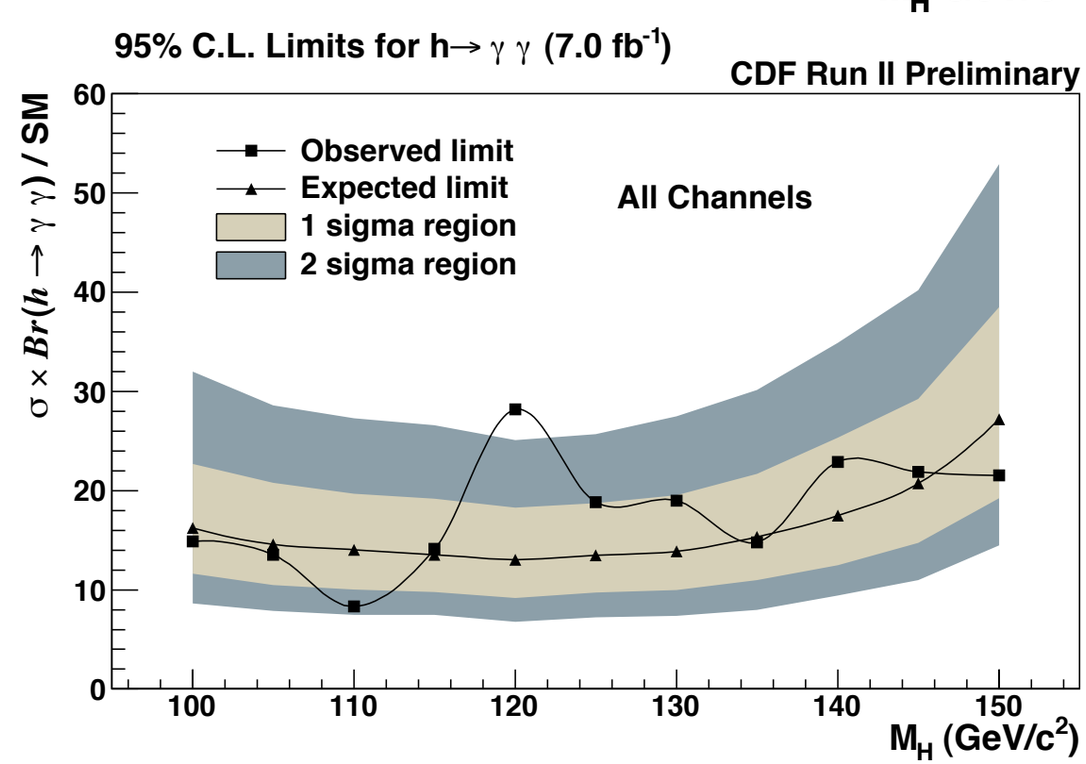


$H \rightarrow \gamma\gamma$ [7 fb^{-1}]

CDF Note 10485
W+C 20 May 2011

- 1.6 fb^{-1} data added
- Forward photons included
- photons converted to e^+e^- included
- NN to select central photon candidates
- 3 additional photon categories
- 33% improvement on limit
- Limit: 13.0(Exp)/28.2(Obs) x σ_{SM} for M_H=120 GeV/c^2
- Excess at M_H=120 GeV/c^2 is <2σ after trials factor taken into account

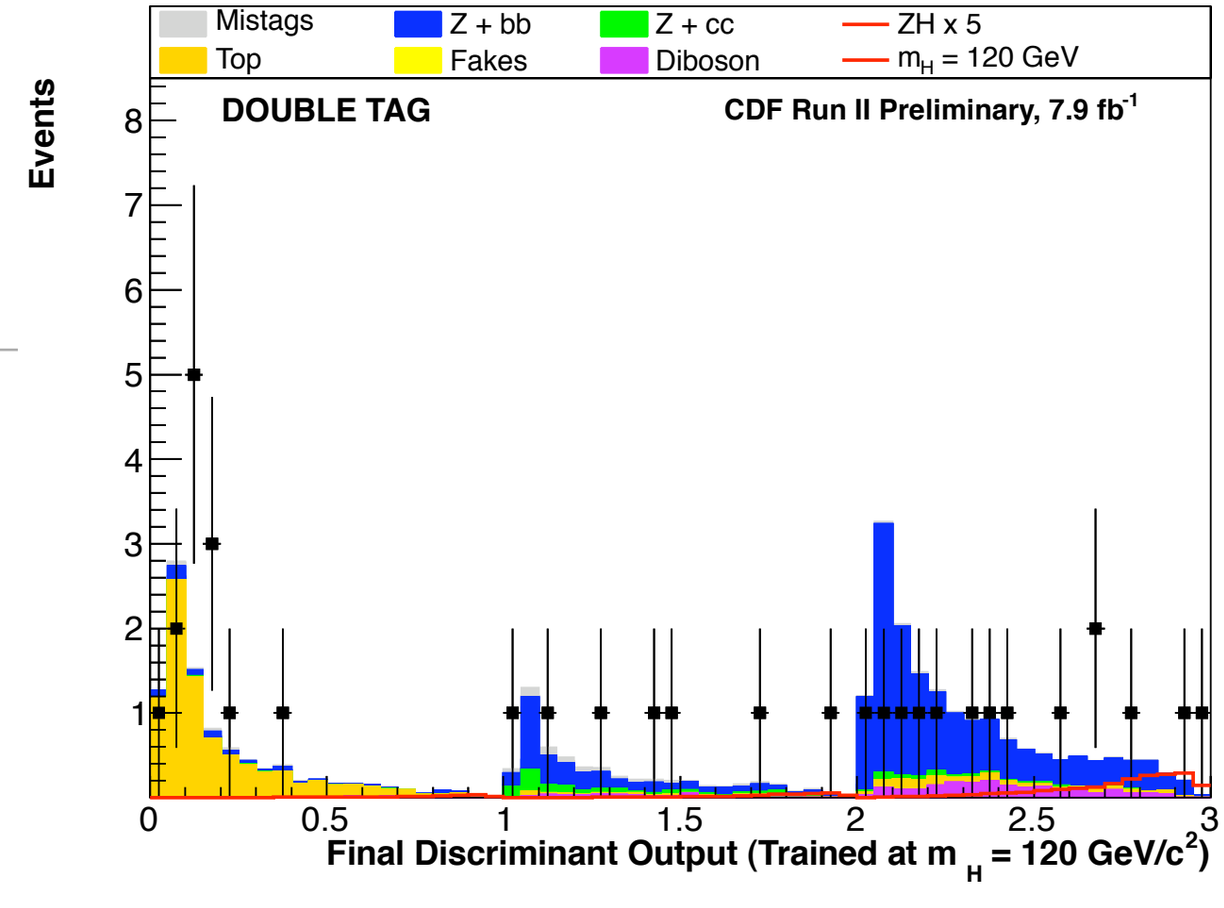


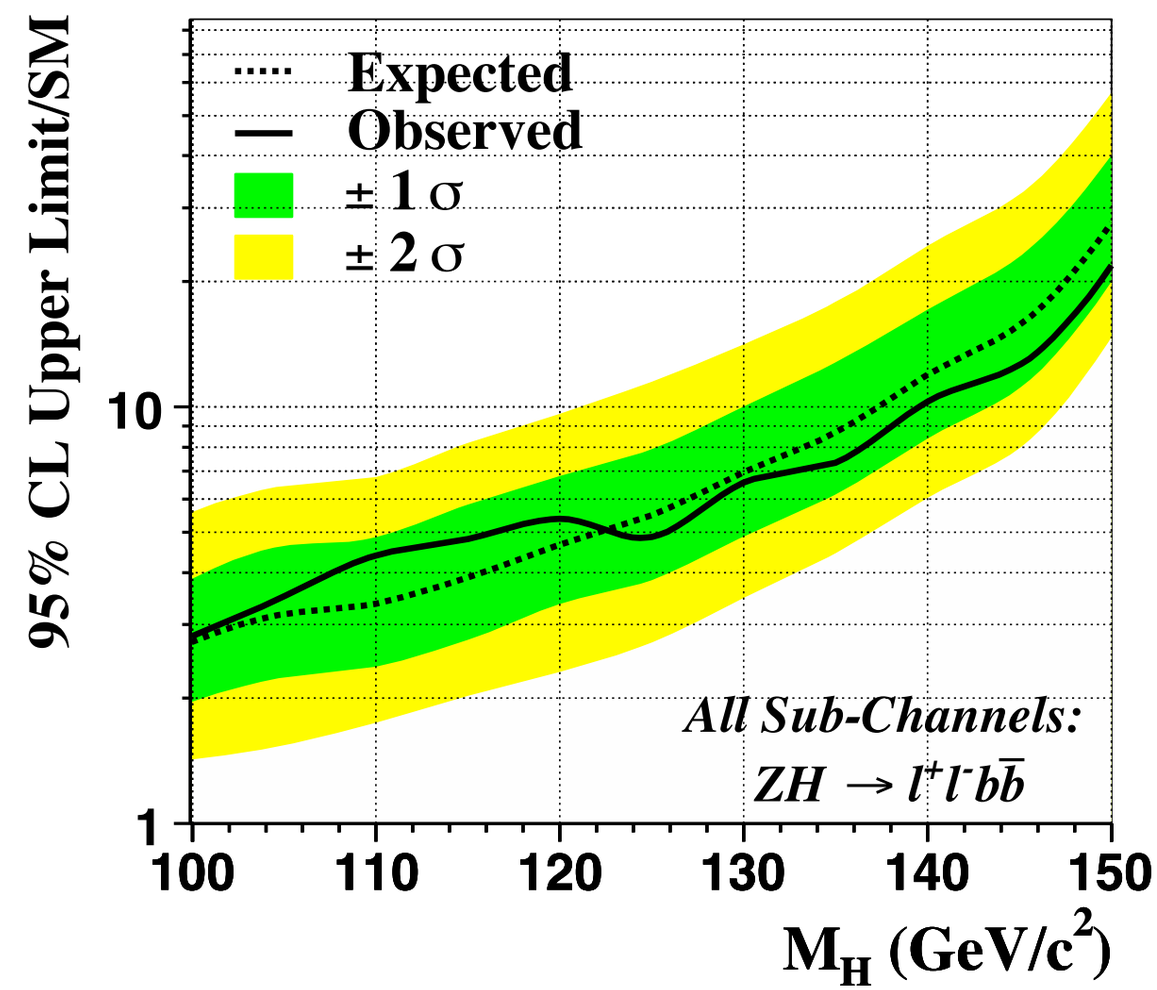


ZH→llbb [7.5 fb-1(ee) / 7.9 fb-1(μμ)]

CDF Note 10572
CDF Note 10593

- Multivariate lepton ID: largest improvement to limit
- NN modeling of trigger: allows use of additional triggers and turn-on regions
- Use of expert-discriminants to isolate $t\bar{t}$, Z+jets & light-flavor jets
  - Helps to in-situ constrain mistags & b-tag SF
- 40% improvement compared to Summer 2010 result
- Limit: 4.67(Exp)/5.38(Obs) x σ_{SM} for M_H=120 GeV/c^2

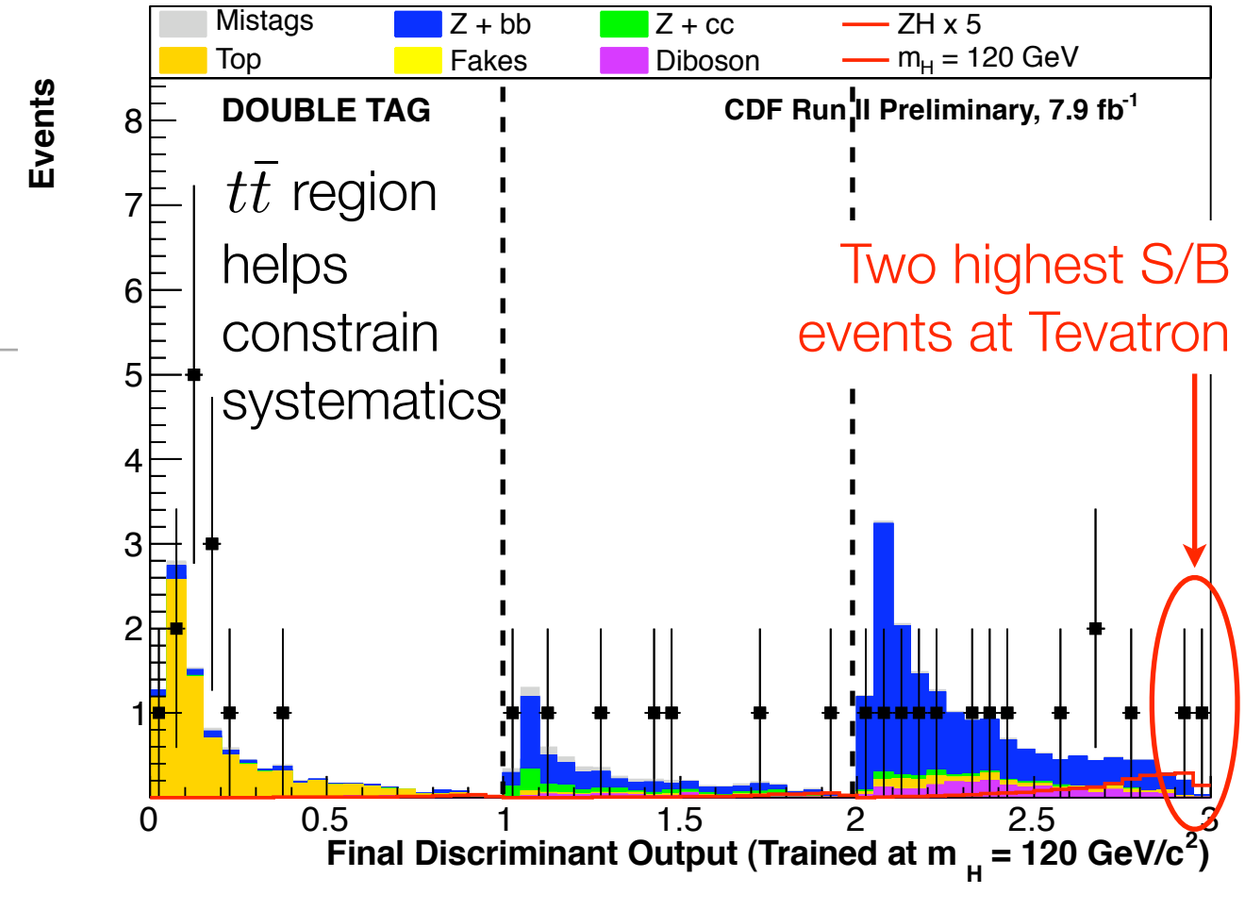


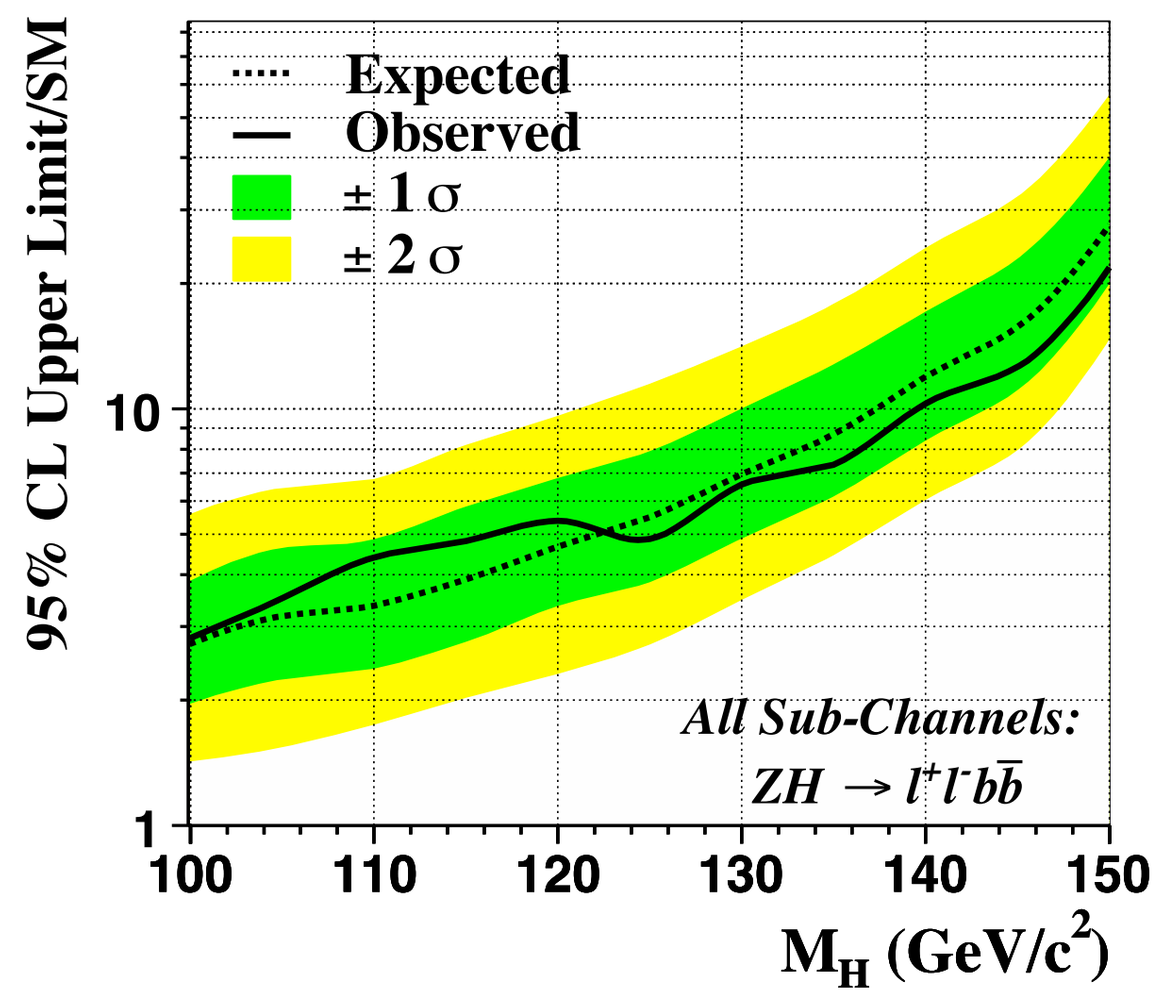


ZH→llbb [7.5 fb-1(ee) / 7.9 fb-1(μμ)]

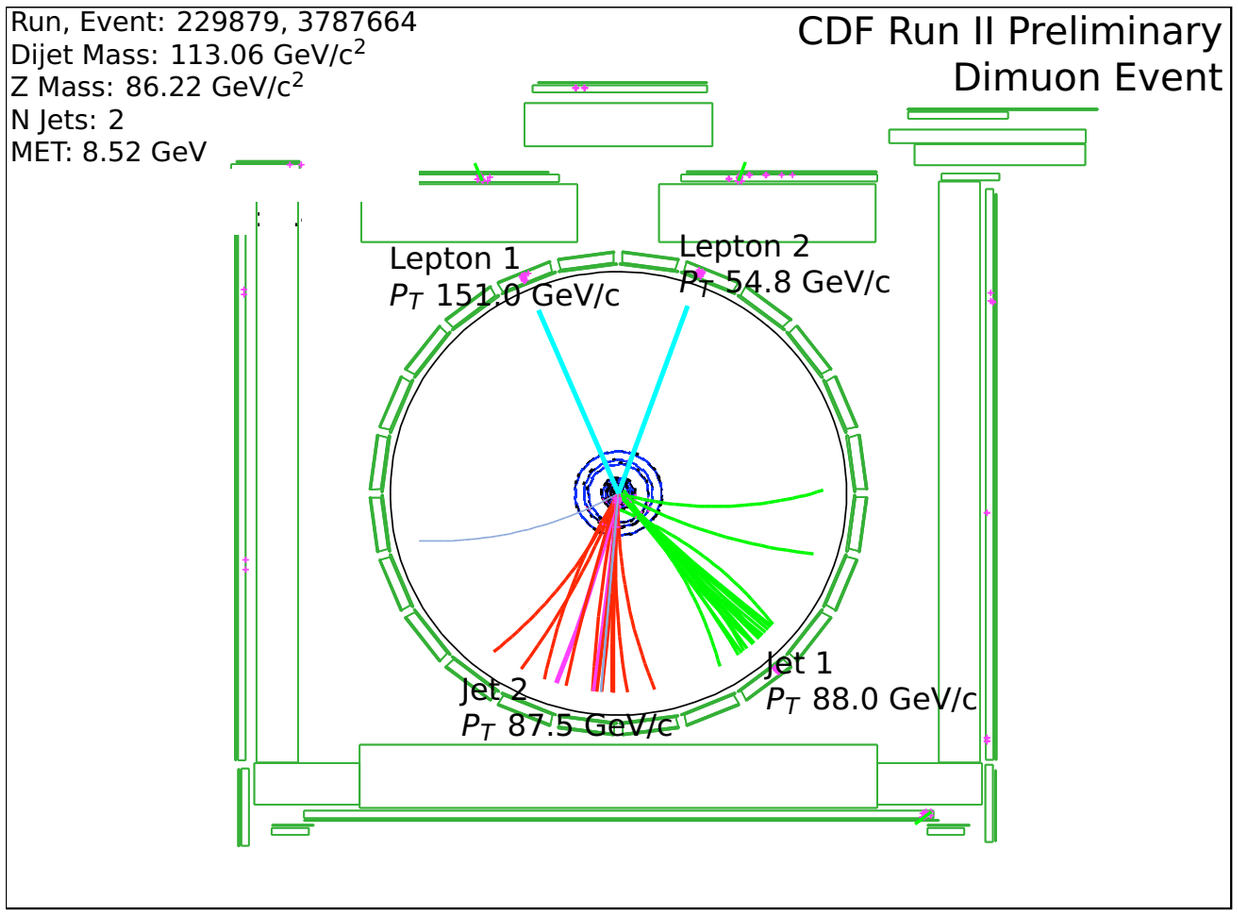
CDF Note 10572
CDF Note 10593

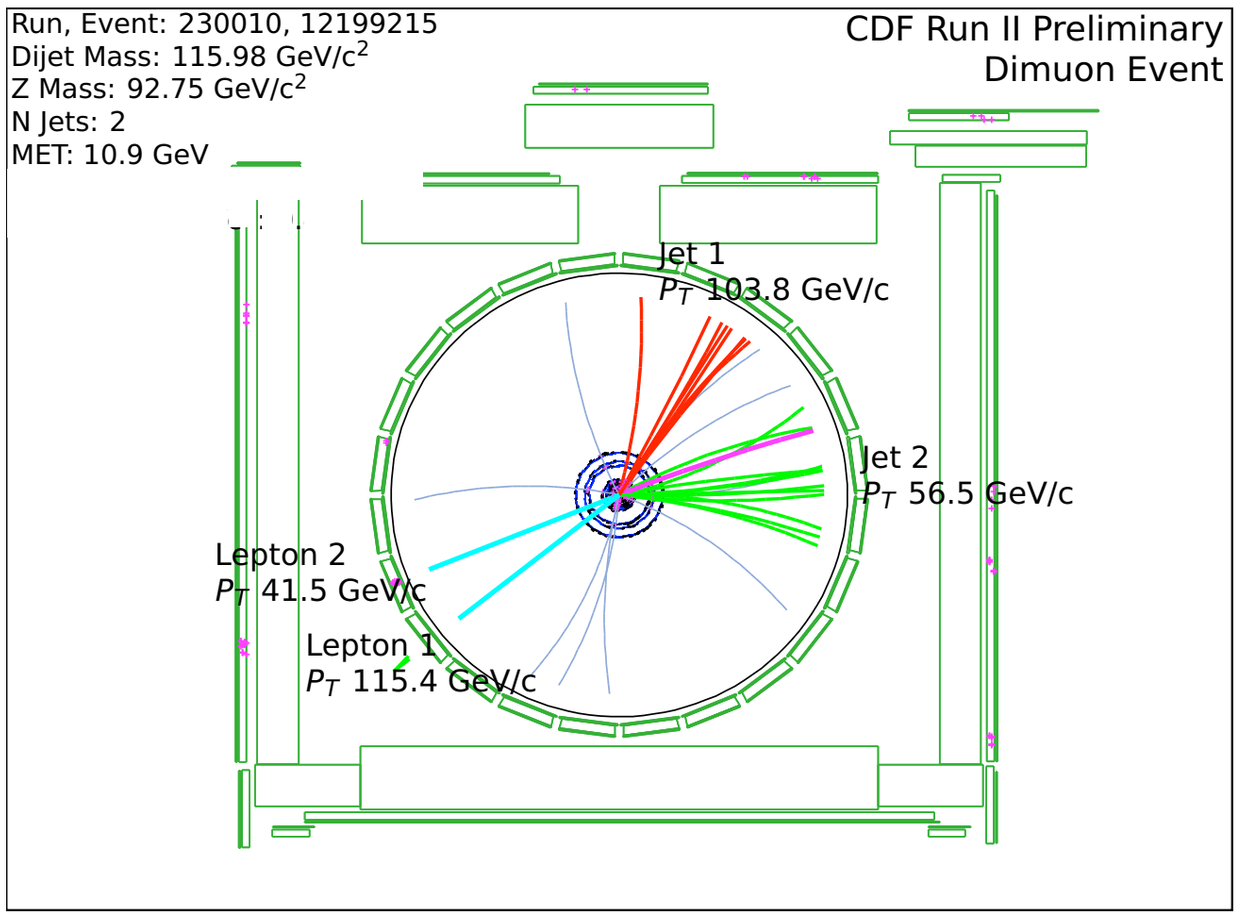
- Multivariate lepton ID: largest improvement to limit
- NN modeling of trigger: allows use of additional triggers and turn-on regions
- Use of expert-discriminants to isolate $t\bar{t}$, Z+jets & light-flavor jets
  - Helps to in-situ constrain mistags & b-tag SF
- 40% improvement compared to Summer 2010 result
- Limit: 4.67(Exp)/5.38(Obs) x σ_{SM} for M_H=120 GeV/c^2





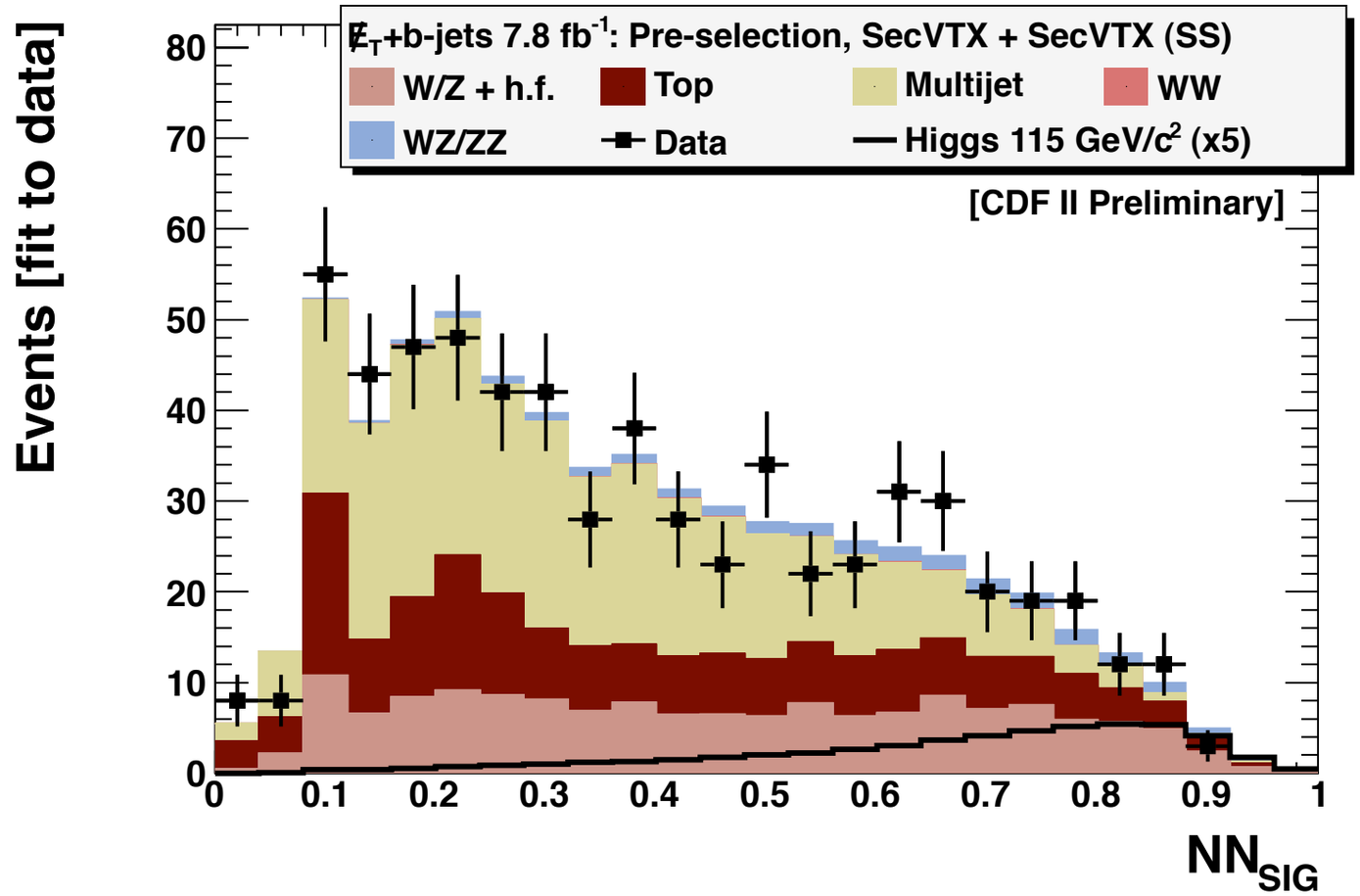
ZH→llbb : High S/B candidates

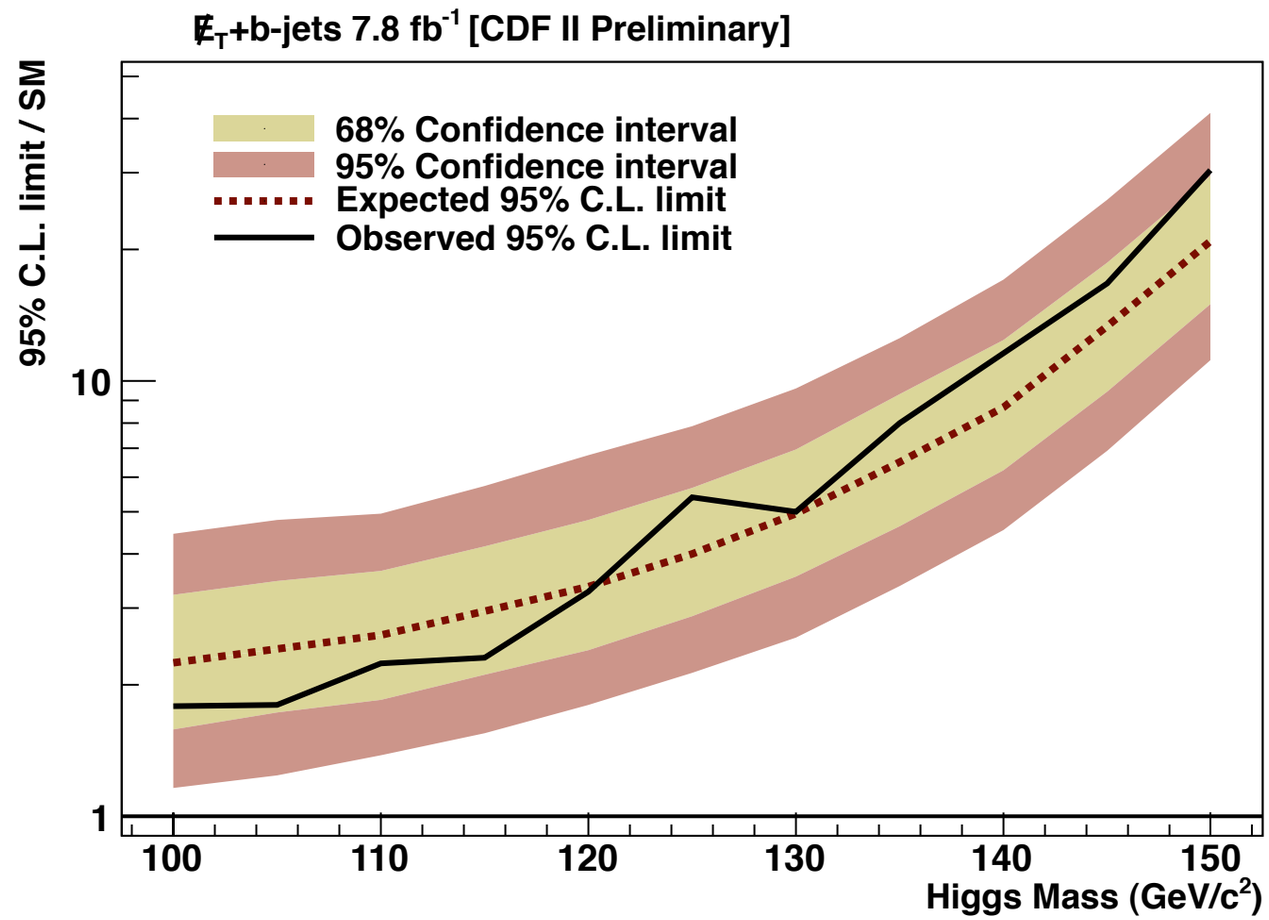




W/ZH → $\not\!\!E_T$ + bb [7.8 fb^{-1}] *CDF Note 10583*

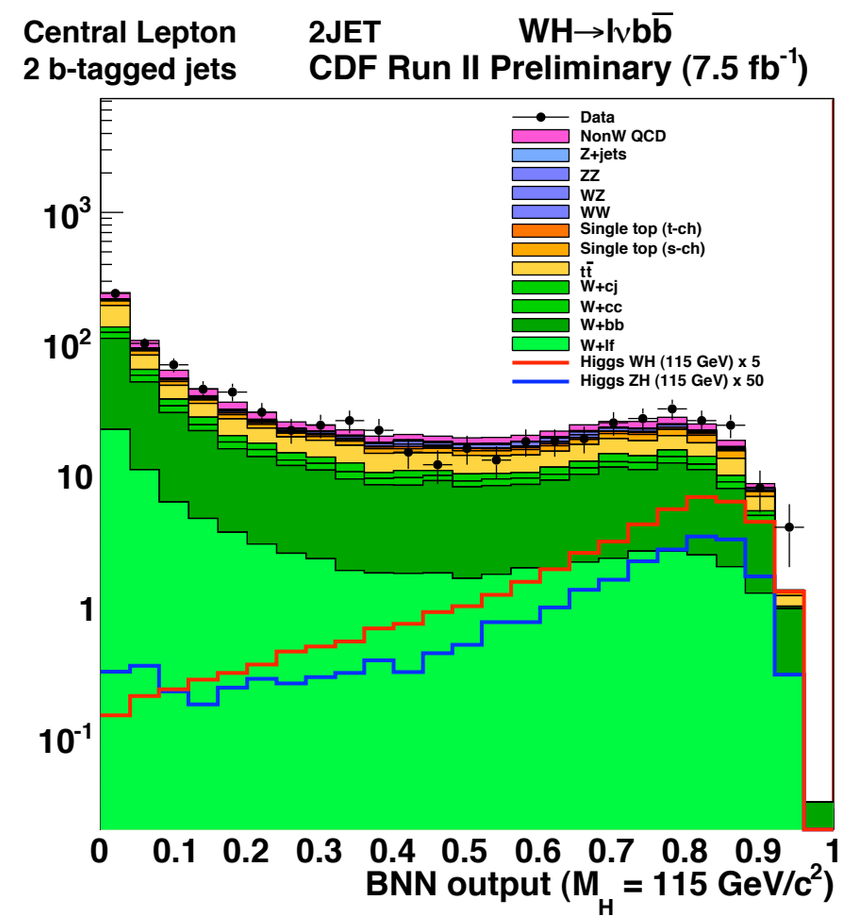
- Improved background modeling (W/Z+Jets & Multijet QCD) ➠allowed event selection cuts to be relaxed (30%-40% gain)
- Improved QCD multijet rejection
- NN modeling of trigger: allows all triggered events to be used: ~5% gain
- Limit: 3.4(Exp)/3.3(Obs) x σ_{SM} for M_H=120 GeV/c^2

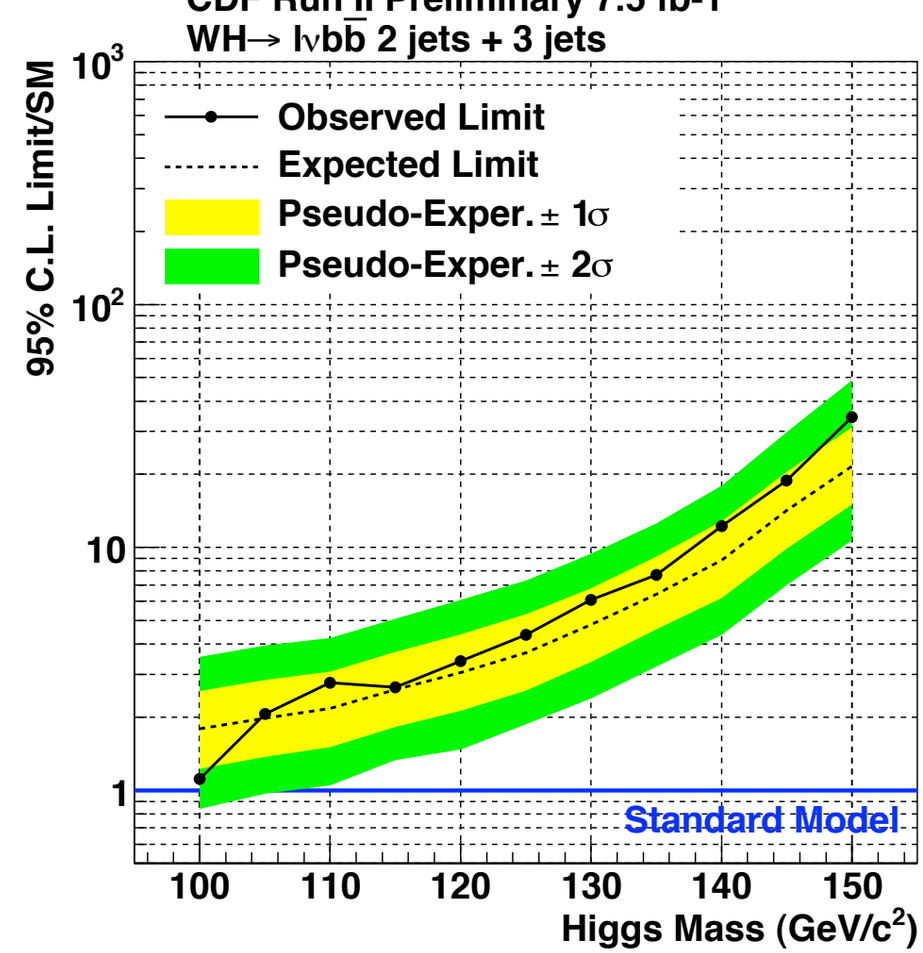




WH→lνbb [7.5 fb^{-1} (2-jet)] *CDF Note 10596*

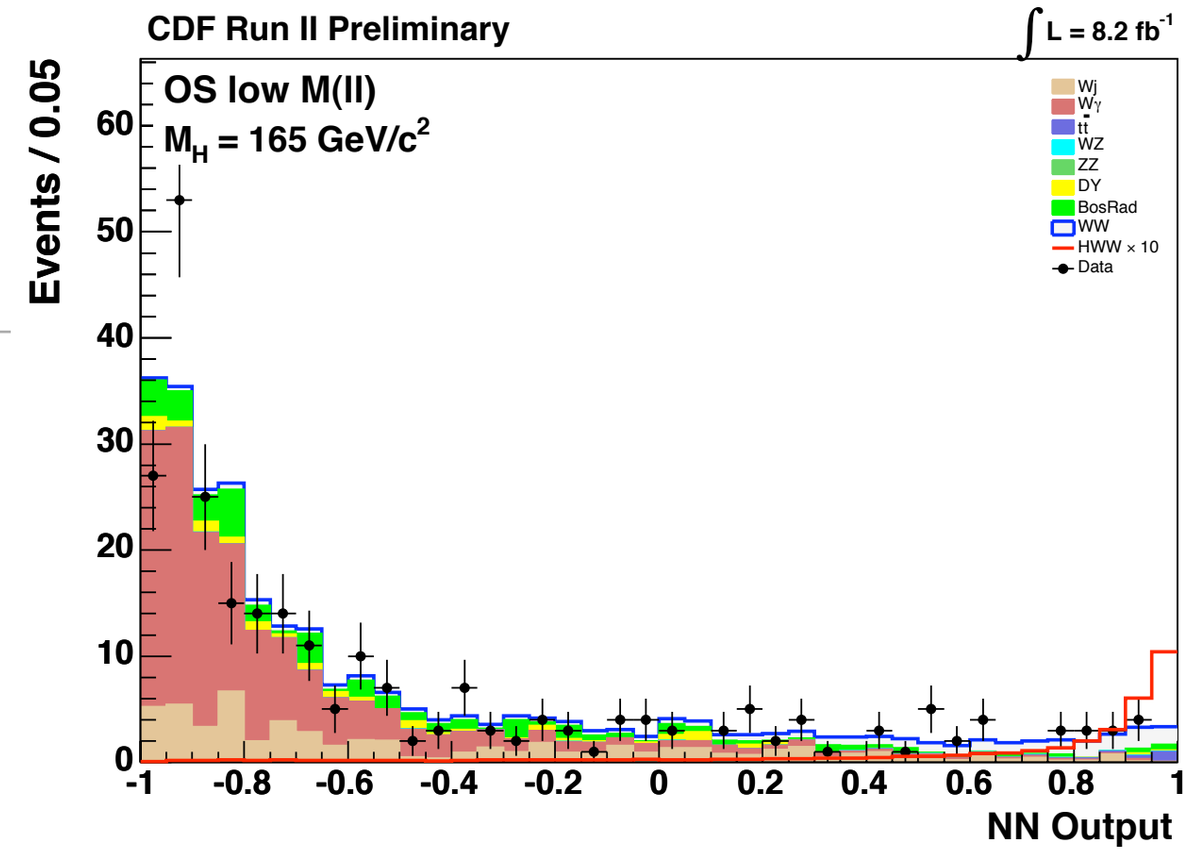
- 1.9 fb^{-1} data added
- Multivariate loose electron ID to pick-up missed electrons
- SVM QCD rejection for single-tag events
  - allow $\not\!\!E_T$ cut to be relaxed with increased signal acceptance without increase in background
- Data from jet & jet+$\not\!\!E_T$ triggers included
- 17% improvement compared to previous 5.7 fb^{-1} analysis
- Limit: 3.06(Exp)/3.40(Obs) x σ_{SM} for M_H=120 GeV/c^2

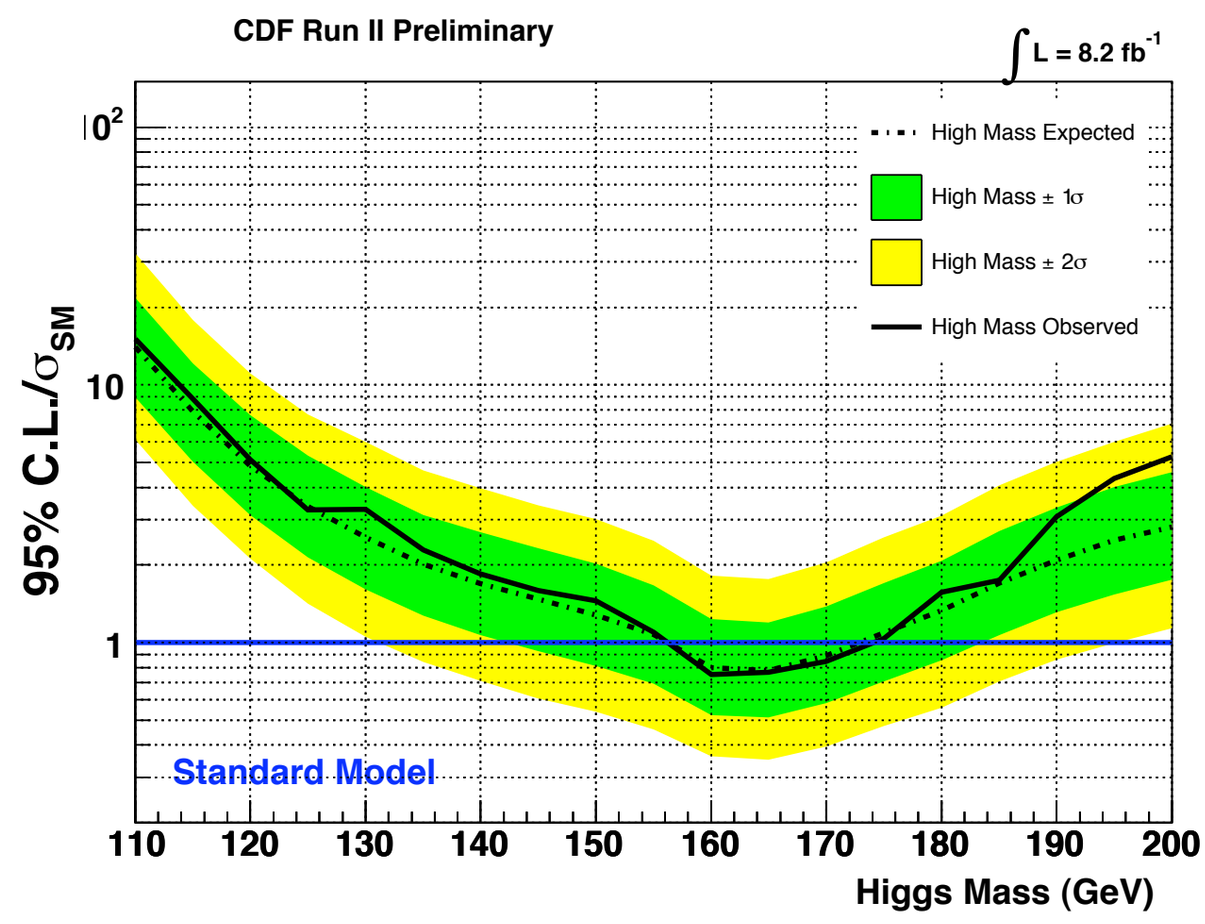




$H \rightarrow WW^* \rightarrow l\nu l\nu$ [8.2 fb^{-1}] *CDF Note 10432*

- Additional 1.1 fb^{-1} data added
- Lepton isolation algorithm was modified to prevent self-spoiling of lepton pair that lie in each other's isolation cone
  - Events with opposite-sign, low dilepton mass now included: improve low mass limit from ~9xSM to ~3XSM
- 20% improvement on limit relative to previous 7.1 fb^{-1} analysis;13% from analysis
- Limit: 0.78(Exp)/0.77(Obs) x σ_{SM} for M_H=165 GeV/c^2
- Excludes M_H=156-175 GeV/c^2





CDF Higgs Combination: List of channels

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cdf15 <> CDF VH->MET bb 1S 7.8 fb-1
cdf16 <> CDF VH->MET bb SS 7.8 fb-1
cdf17 <> CDF VH->MET bb SJ 7.8 fb-1
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cdf29 <> CDF HWW 8.2fb LowSB0J
cdf30 <> CDF HWW 8.2fb HighSB1J
cdf31 <> CDF HWW 8.2fb LowSB1J
cdf32 <> CDF HWW 8.2fb 2JOS
cdf56 <> CDF WH WWW 8.2 fb-1 like-sign
cdf57 <> CDF H->WW 8.2 fb-1 low-mll
cdf64 <> CDF WH ME 5.6 fb-1 3J SVJP
cdf65 <> CDF WH ME 5.6 fb-1 3J SVJP loose
cdf66 <> CDF WH ME 5.6 fb-1 3J SVnoJP
cdf67 <> CDF WH ME 5.6 fb-1 3J SVnoJP loose
cdf68 <> CDF WH ME 5.6 fb-1 3J SVSV
cdf69 <> CDF WH ME 5.6 fb-1 3J SVSV loose
cdf84 <> CDF H->WW Trilepton NoZ  8.2 fb-1
cdf85 <> CDF H->WW Trilepton InZ 1jet 8.2 fb-1
cdf86 <> CDF H->WW etau 8.2 fb-1
cdf87 <> CDF H->WW mutau 8.2 fb-1
cdf88 <> CDF H->WW Trilepton InZ 2jet  8.2 fb-1
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cdf102 <> CDF Htautau 1jet  6.0 fb-1
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cdf106 <> CDF jjbb VBF SJ 4fb-1
cdf112 <> CDF H->gammagamma 7.0 fb-1 CC
cdf113 <> CDF H->gammagamma 7.0 fb-1 CP
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cdf121 <> CDF ttH MET+jets 2btag 5.7 fb-1
cdf122 <> CDF ttH MET+jets 3btag 5.7 fb-1
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cdf126 <> CDF mumubb LJP 7.9 fb-1
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cdf130 <> CDF eebb DT 7.5 fb-1
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cdf139 <> CDF WHAM NN 7.5 fb-1 SVTSVT ISOTRK with BNN
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cdf155 <> CDF WH NN 7.5 fb-1 2JET SVTSVT LOOSE ISOTRK
cdf156 <> CDF WH NN 7.5 fb-1 2JET SVTJP05 LOOSE ISOTRK
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cdf158 <> CDF WH NN 7.5 fb-1 2JET SVTnoJP05noRoma LOOSE ISOTRK
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cdf168 <> CDF ttH 1+5J STJPJP 6.3 fb-1
cdf169 <> CDF ttH 1+5J STJP 6.3 fb-1
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CDF Higgs Combination: List of channels

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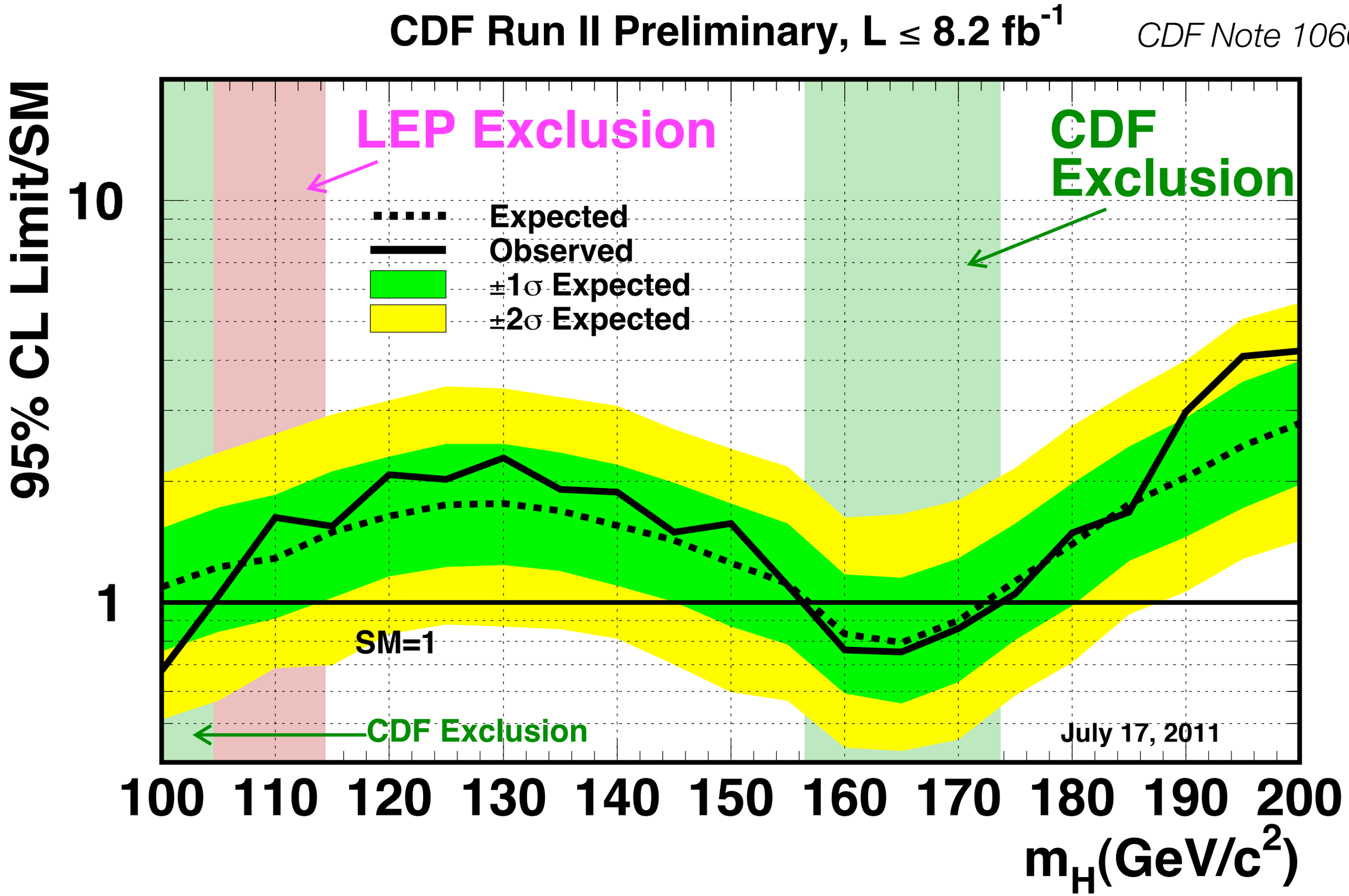
cdf15 <> CDF VH->MET bb 1S 7.8 fb-1
cdf16 <> CDF VH->MET bb SS 7.8 fb-1
cdf17 <> CDF VH->MET bb SJ 7.8 fb-1
cdf28 <> CDF HWW 8.2fb HighSB0J
cdf29 <> CDF HWW 8.2fb LowSB0J
cdf30 <> CDF HWW 8.2fb HighSB1J
cdf31 <> CDF HWW 8.2fb LowSB1J
cdf32 <> CDF HWW 8.2fb 2JOS
cdf56 <> CDF WH WWW 8.2 fb-1 like-sign
cdf57 <> CDF H->WW 8.2 fb-1 low-mll
cdf64 <> CDF WH ME 5.6 fb-1 3J SVJP
cdf65 <> CDF WH ME 5.6 fb-1 3J SVJP loose
cdf66 <> CDF WH ME 5.6 fb-1 3J SVno
cdf67 <> CDF WH ME 5.6 fb-1 3J SVno loose
cdf68 <> CDF WH ME 5.6 fb-1 3J SVSV
cdf69 <> CDF WH ME 5.6 fb-1 3J SVSV loose
cdf84 <> CDF H->WW Trilepton NoZ 8 fb
cdf85 <> CDF H->WW Trilepton InZ 1jet 8.2 fb-1
cdf86 <> CDF H->WW etau 8.2 fb-1
cdf87 <> CDF H->WW mutau 8.2 fb-1
cdf88 <> CDF H->WW Trilepton InZ 2jet  8.2 fb-1
cdf101 <> CDF Htautau 2jets 6.0 fb-1
cdf102 <> CDF Htautau 1jet  6.0 fb-1
cdf103 <> CDF jjbb SS 4fb-1
cdf104 <> CDF jjbb SJ 4fb-1
cdf105 <> CDF jjbb VBF SS 4fb-1
cdf106 <> CDF jjbb VBF SJ 4fb-1
cdf112 <> CDF H->gammagamma 7.0 fb-1 CC
cdf113 <> CDF H->gammagamma 7.0 fb-1 CP
cdf114 <> CDF H->gammagamma 7.0 fb-1 CC Conv
cdf115 <> CDF H->gammagamma 7.0 fb-1 CP Conv
```

```
cdf117 <> CDF Vtautau lltau 6.2 fb-1
cdf118 <> CDF Vtautau emutau 6.2 fb-1
cdf119 <> CDF Vtautau ltautau 6.2 fb-1
cdf121 <> CDF ttH MET+jets 2btag 5.7 fb-1
cdf122 <> CDF ttH MET+jets 3btag 5.7 fb-1
cdf123 <> CDF ttH All 2btag 5.7 fb-1
cdf124 <> CDF ttH All 3btag 5.7 fb-1
cdf125 <> CDF mumubb ST 7.9 fb-1
cdf126 <> CDF mumubb LJP 7.9 fb-1
cdf127 <> CDF mumubb DT 7.9 fb-1
cdf128 <> CDF eebb ST 7.5 fb-1
cdf129 <> CDF eebb LJP 7.5 fb-1
cdf130 <> CDF eebb DT 7.5 fb-1
cdf131 <> CDF WHAM NN 7.5 fb-1 SVTSVT TIGHT with BNN
cdf132 <> CDF WHAM NN 7.5 fb-1 SVTJP[illegible] TIGHT with BNN
cdf133 <> CDF WHAM NN 7.5 fb-1 SVTno[illegible]5Roma TIGHT with BNN
cdf[illegible] WHAM NN 7.5 fb-1 SVTno[illegible]5n[illegible] TIGHT with BNN
cdf[illegible] <> CDF WHAM NN 7.5 fb-1 SVTSVT PHX with BNN
cdf[illegible] <> CDF WHAM NN 7.5 fb-1 SVTJP[illegible] PHX with BNN
cdf[illegible] <> CDF WHAM NN 7.5 fb-1 SVTno[illegible]5Roma PHX with BNN
cdf[illegible] <> CDF WHAM NN 7.5 fb-1 SVTno[illegible]5n[illegible] PHX with BNN
cdf139 <> CDF WHAM NN 7.5 fb-1 SVTSVT ISOTRK with BNN
cdf140 <> CDF WHAM NN 7.5 fb-1 SVTJP05 ISOTRK with BNN
cdf141 <> CDF WHAM NN 7.5 fb-1 SVTnoJP05Roma ISOTRK with BNN
cdf142 <> CDF WHAM NN 7.5 fb-1 SVTnoJP05noRoma ISOTRK with BNN
cdf155 <> CDF WH NN 7.5 fb-1 2JET SVTSVT LOOSE ISOTRK
cdf156 <> CDF WH NN 7.5 fb-1 2JET SVTJP05 LOOSE ISOTRK
cdf157 <> CDF WH NN 7.5 fb-1 2JET SVTnoJP05Roma LOOSE ISOTRK
cdf158 <> CDF WH NN 7.5 fb-1 2JET SVTnoJP05noRoma LOOSE ISOTRK
cdf159 <> CDF HZZ mLLLL 8.2 fb-1
cdf160 <> CDF ttH l+5J STSTST 6.3 fb-1
cdf161 <> CDF ttH l+5J STSTJP 6.3 fb-1
cdf162 <> CDF ttH l+5J STST 6.3 fb-1
cdf163 <> CDF ttH l+5J STJPJP 6.3 fb-1
cdf164 <> CDF ttH l+5J STJP 6.3 fb-1
cdf165 <> CDF ttH l+5J STSTST 6.3 fb-1
cdf166 <> CDF ttH l+5J STSTJP 6.3 fb-1
cdf167 <> CDF ttH l+5J STST 6.3 fb-1
cdf168 <> CDF ttH l+5J STJPJP 6.3 fb-1
cdf169 <> CDF ttH l+5J STJP 6.3 fb-1
```

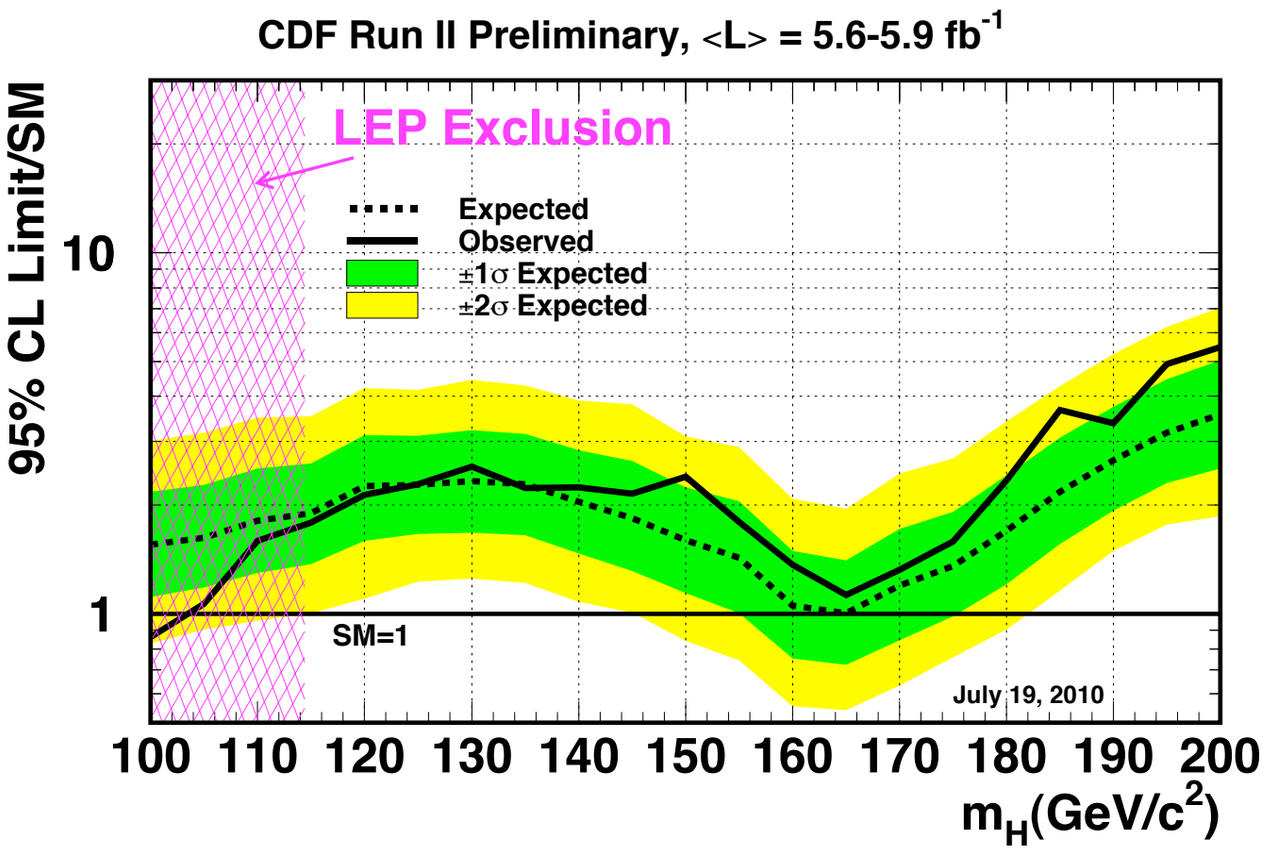
71 channels



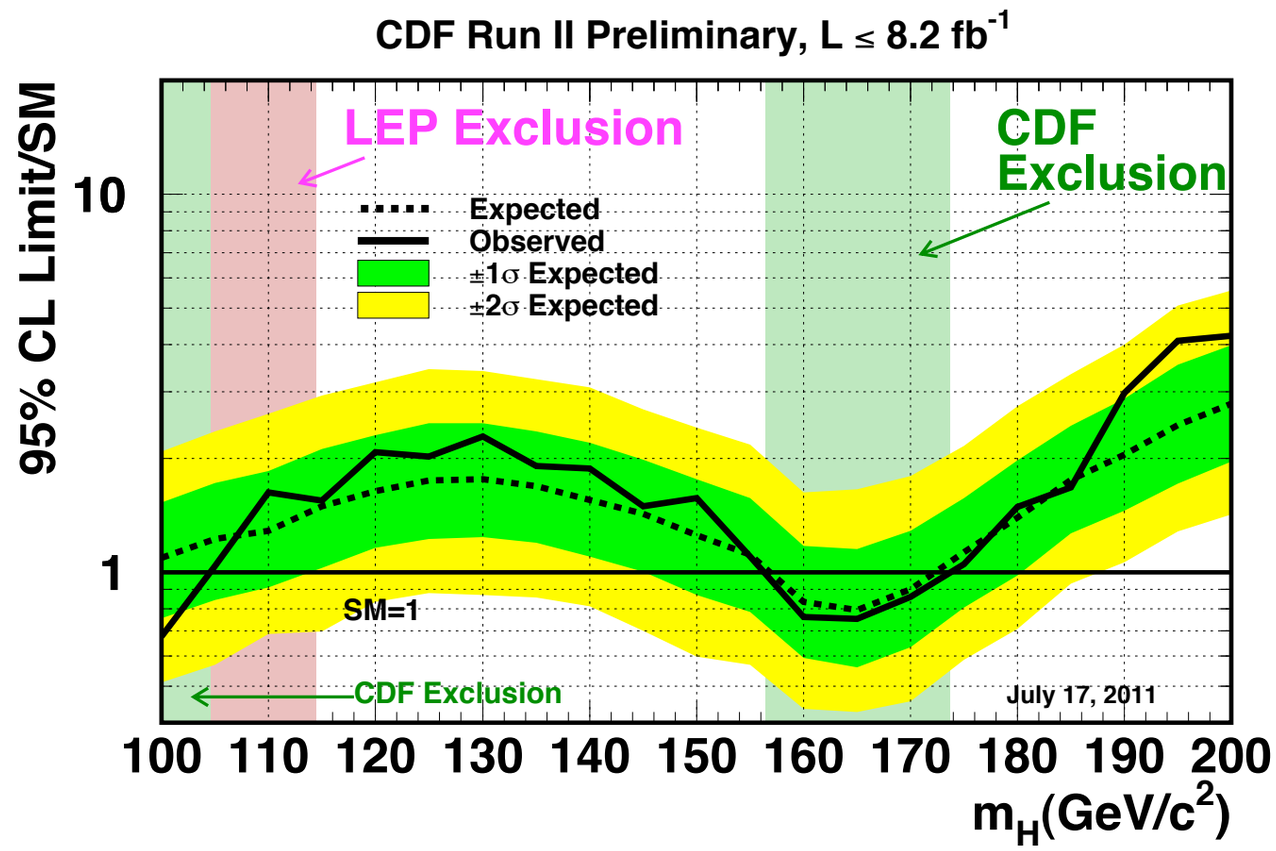
- Expected exclusion: 157.0 < m_H < 172.2 GeV/c^2
- Observed exclusion: 100 < m_H < 104.5 and 156.5 < m_H < 173.7 GeV/c^2

CDF Higgs Combination: Comparison with last year

CDF Summer 2010



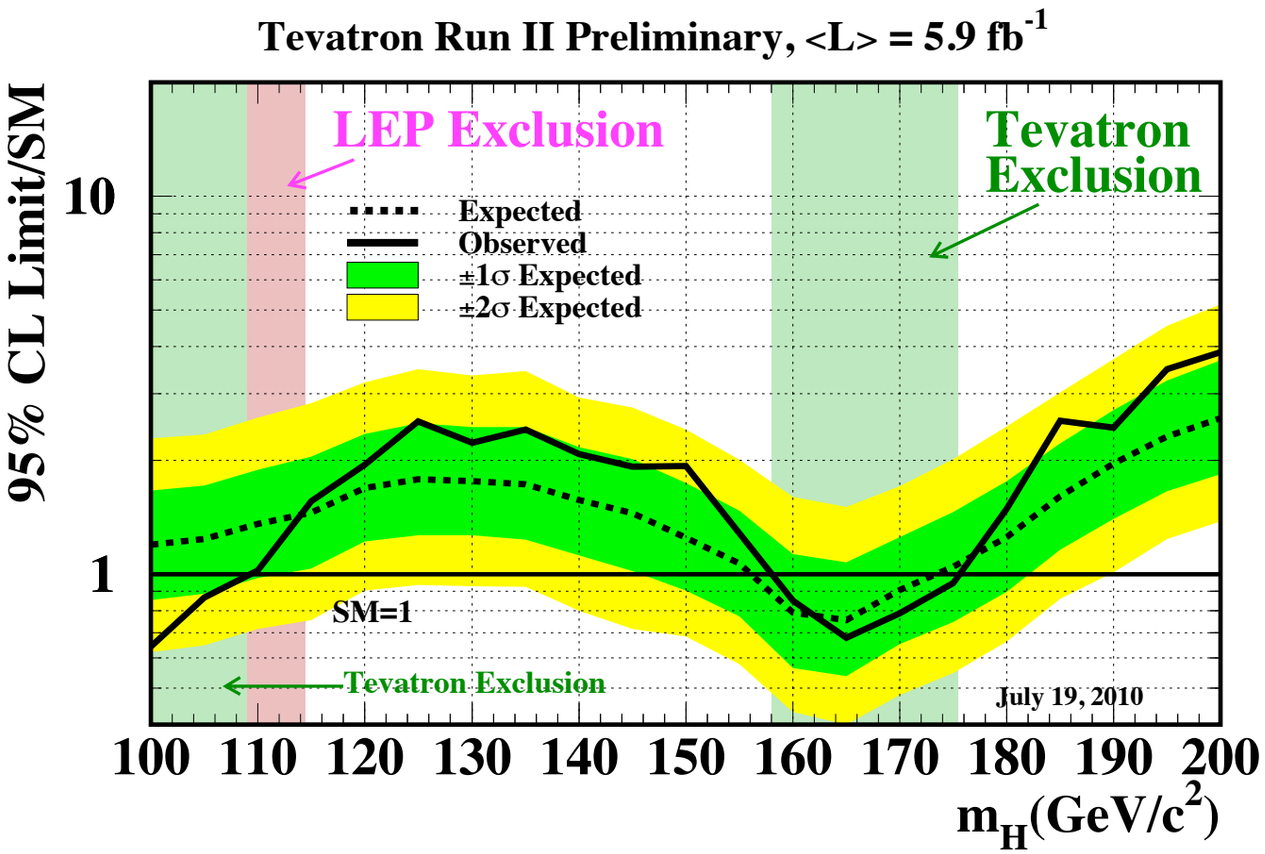
CDF Summer 2011



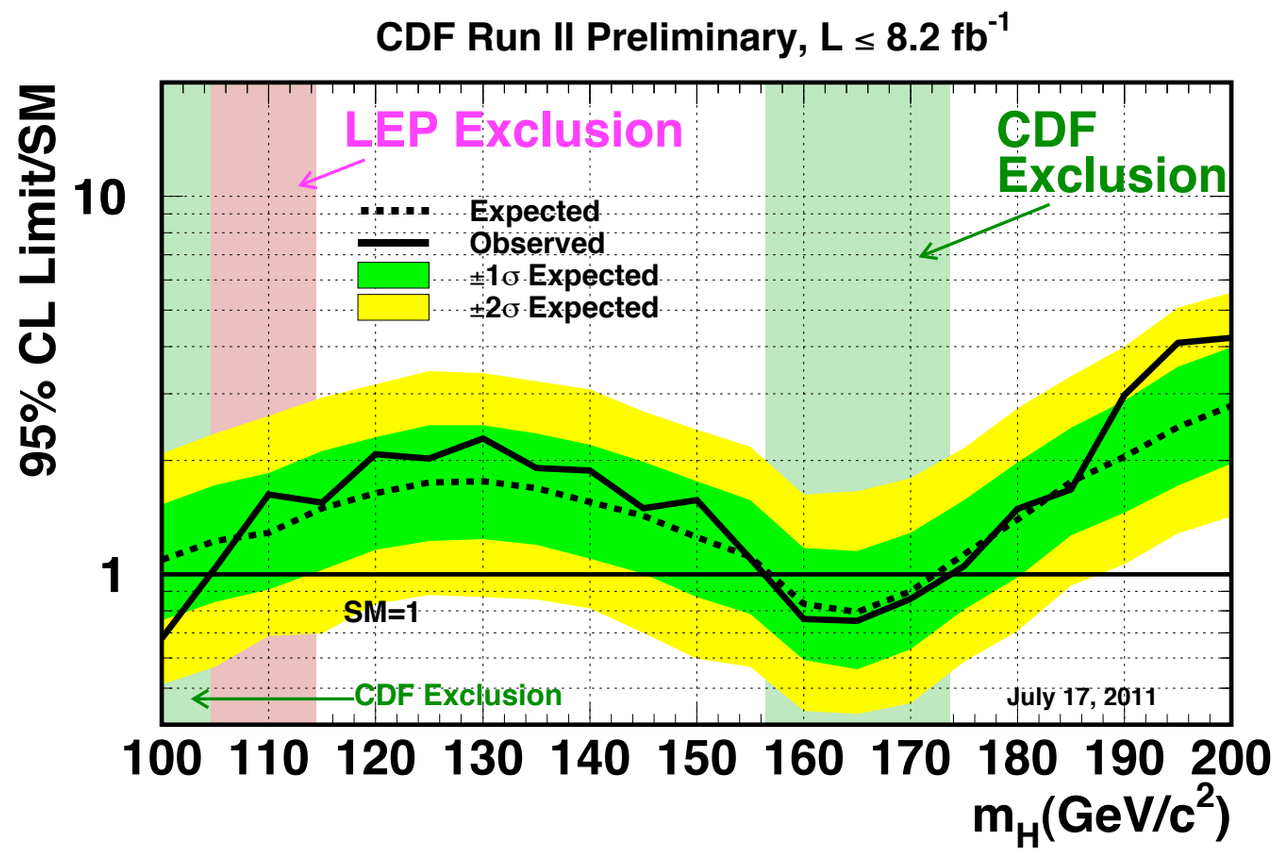
We now have CDF-alone exclusions!

CDF Higgs Combination: Comparison with Tevatron 2010 combination

Tevatron Summer 2010



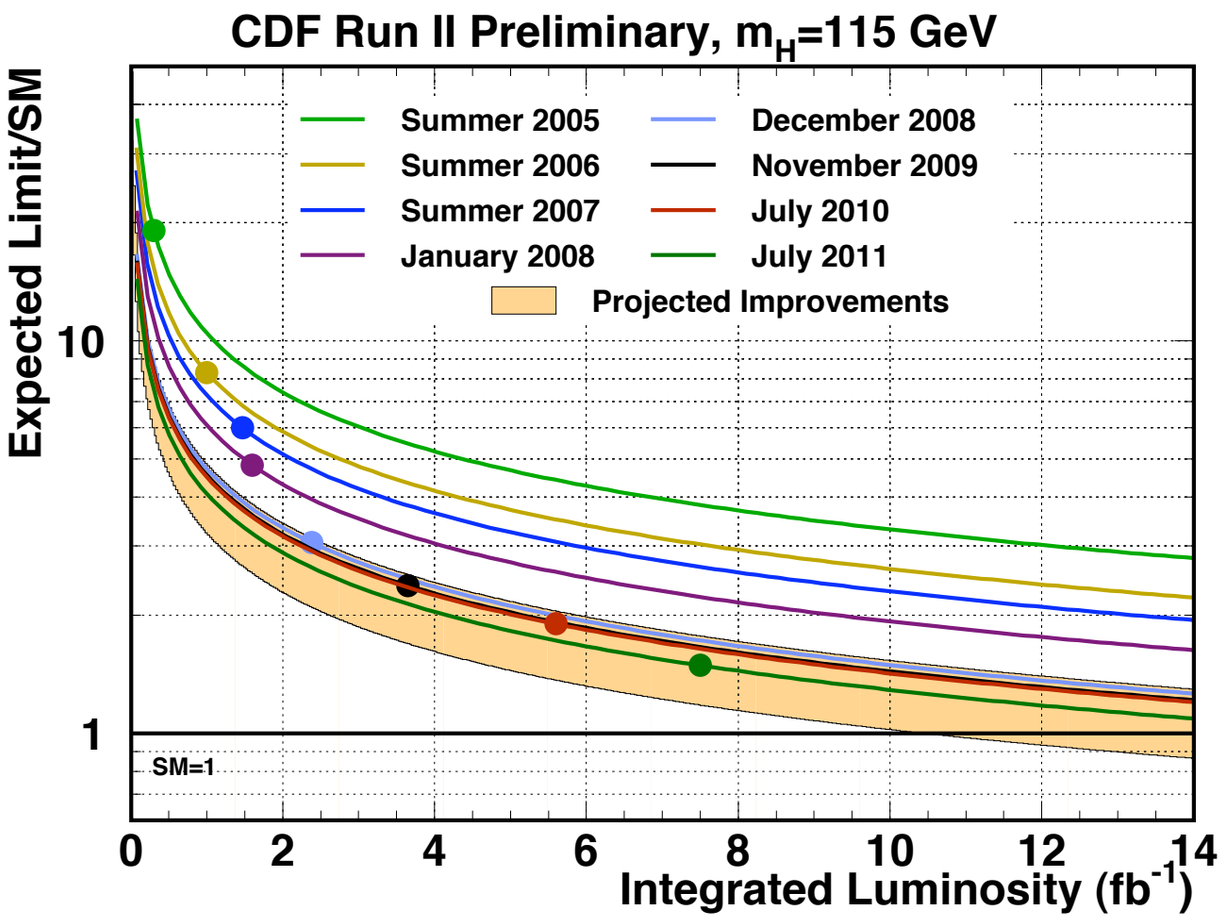
CDF Summer 2011

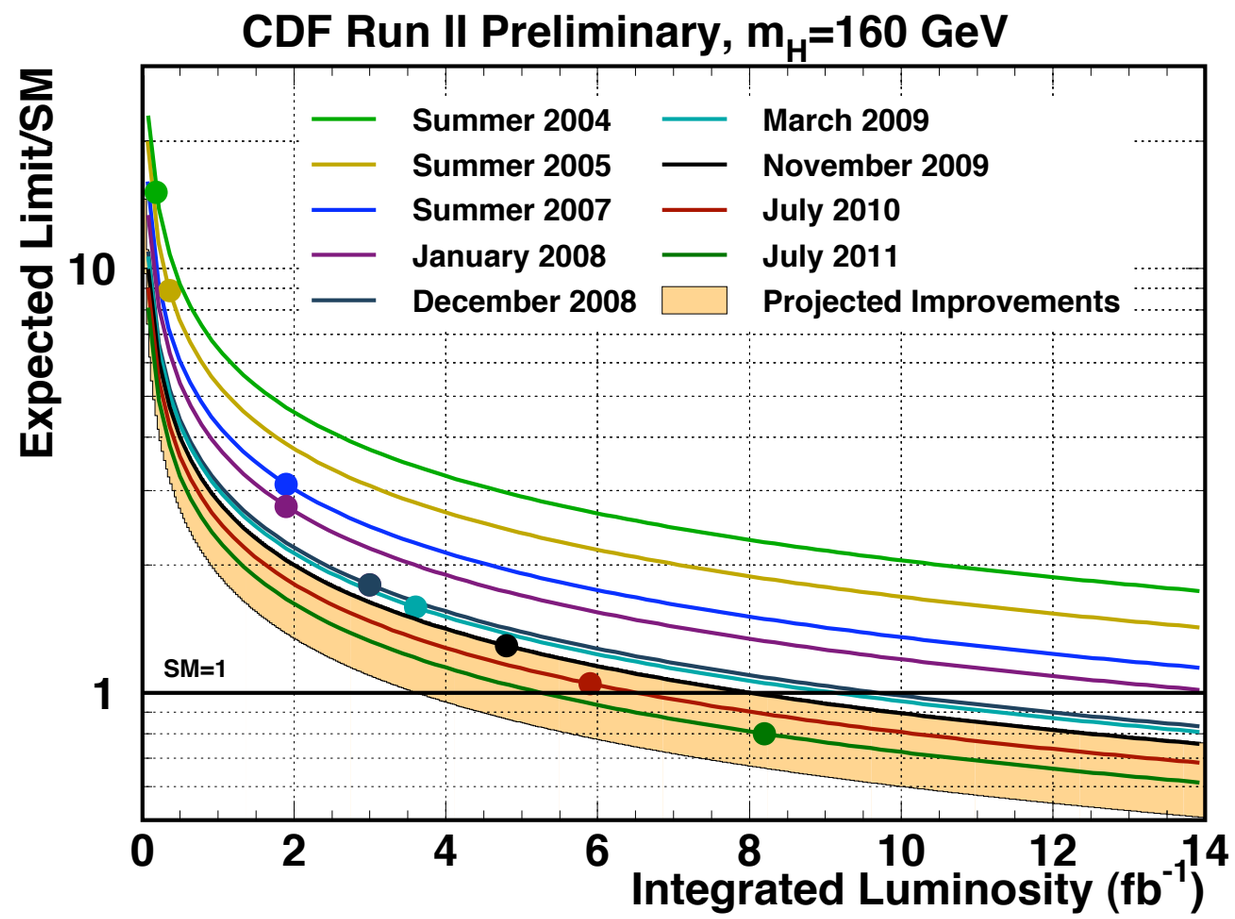


This year's CDF combination is the same as last year's Tevatron combination.

All this in just 1 year !

CDF Combination:
How well are we doing ?





- Our analyses are improving faster than just integrated luminosity gain for low and high mass Higgs analysis
- We are marching forward and meeting our aggressive goals

Results missed out

- ….and apologies to the authors for missing their results:
  - First observation of exclusive two-photon production ➟ W+C June 3 2011
  - $7fb^{-1}$ $B \rightarrow DK$ analysis
  - $B_s \rightarrow J/\psi\ f_0$ ➟ Lifetime & improved BR (arXiv:1106.3682v1 [hep-ex])
  - $WW/WZ \rightarrow$ leptons + jets search
  - MSSM Higgs ➟ W+C July 8 2011
  - 4th Generation Higgs limits: $H \rightarrow WW$ and new inclusion of $H \rightarrow ZZ$
  - Fermiophobic Higgs: $H \rightarrow WW$ and $H \rightarrow \gamma\gamma$
  - Hidden valley $h \rightarrow HV + HV \rightarrow bbbb$ search

Summary - Sprinting to the finish

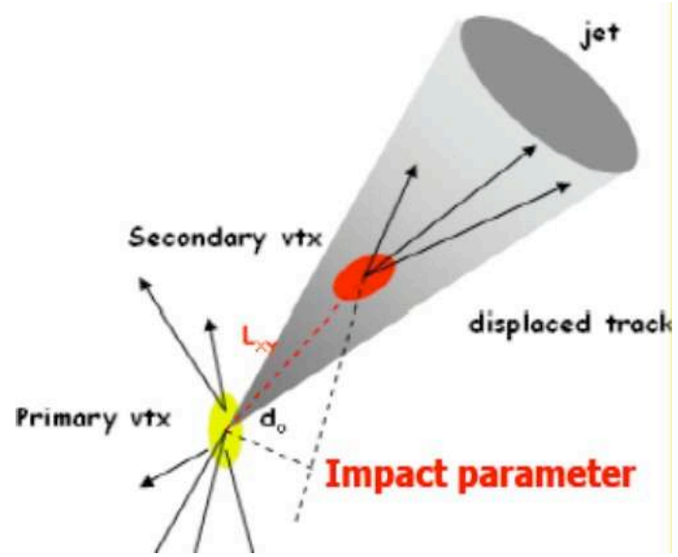
- Run II ends Friday 30 September, 2pm ➠But we're not slowing down !
- Coming soon….
  - Tevatron Higgs combination next week
  - New single-top, top-A_{FB} and W+jj
  - Higgs $H \to \tau\tau$ and bbjj channels to be updated
  - New b-tagger for Higgs analysis
- CDF legacy measurements
  - Top mass
  - Top cross-section combination
  - $H \to bb$ will still be competitive for some time
  - 15 MeV/c^2 precision W mass measurement
- Many other CDF summer results available on the public web pages

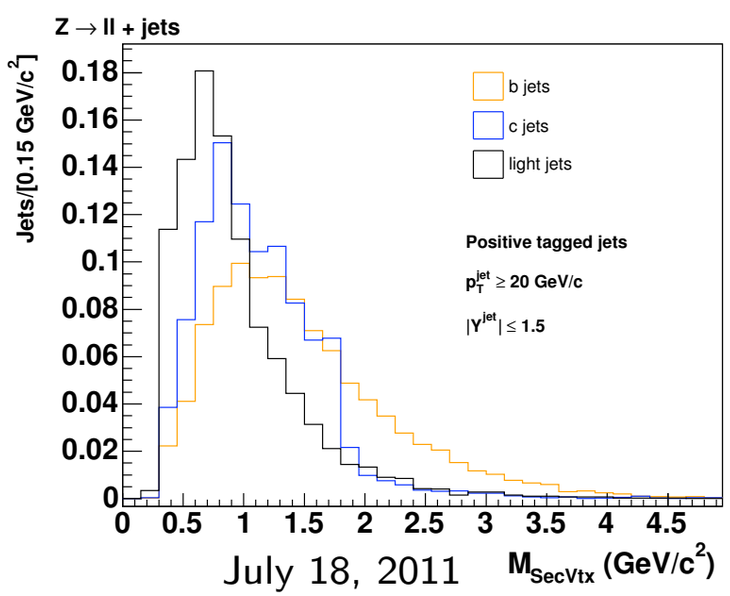
Backup

Z + b-jets Measurement definition

- Measure $\frac{\sigma(Z+\mathrm{b})}{\sigma(Z)}$ and $\frac{\sigma(Z+\mathrm{b})}{\sigma(Z+\mathrm{jet})}$ to reduce systematic uncertainties
- $Z \rightarrow l^+ l^-$, where l could be muon and electron
- Improve muon identification efficiency with ANN $\Rightarrow$ 30 % gain in Z acceptance

- jets
  - Midpoint algorithm
  - $\Delta R_{cone} = 0.7$
  - $p_T^{jet} \geqslant 20\ GeV/c$
  - $|Y^{jet}| \leqslant 1.5$



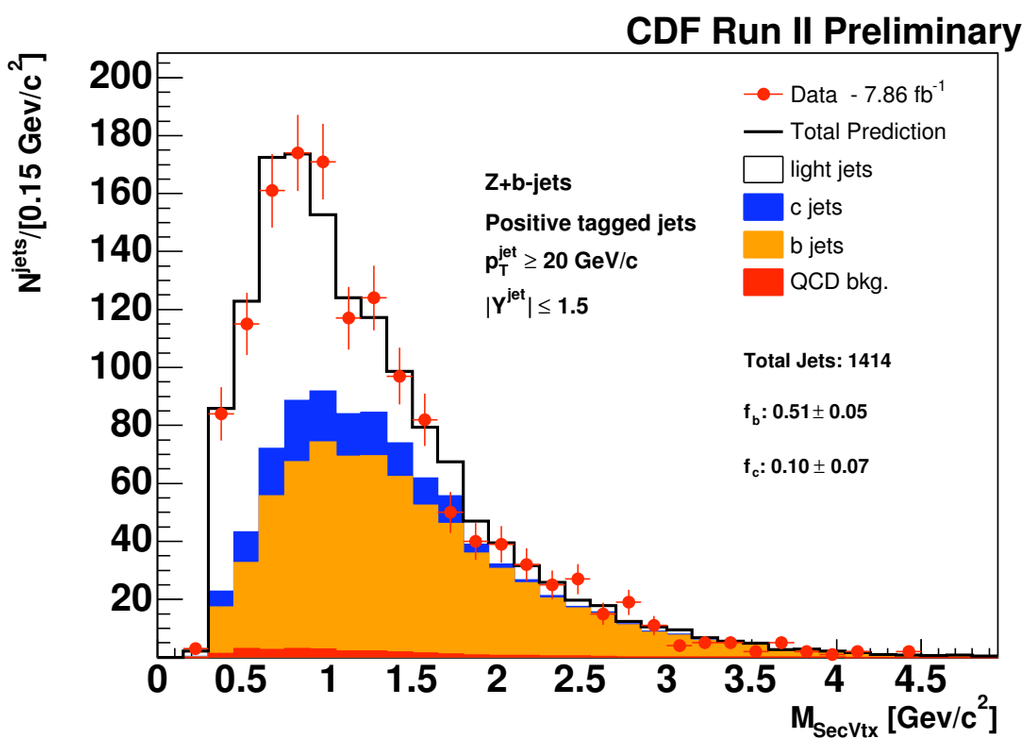


- b identification
  - Secondary Vertex Tagger
  - Extract b-jet composition from a fit to Secondary Vertex Mass

July 18, 2011

1

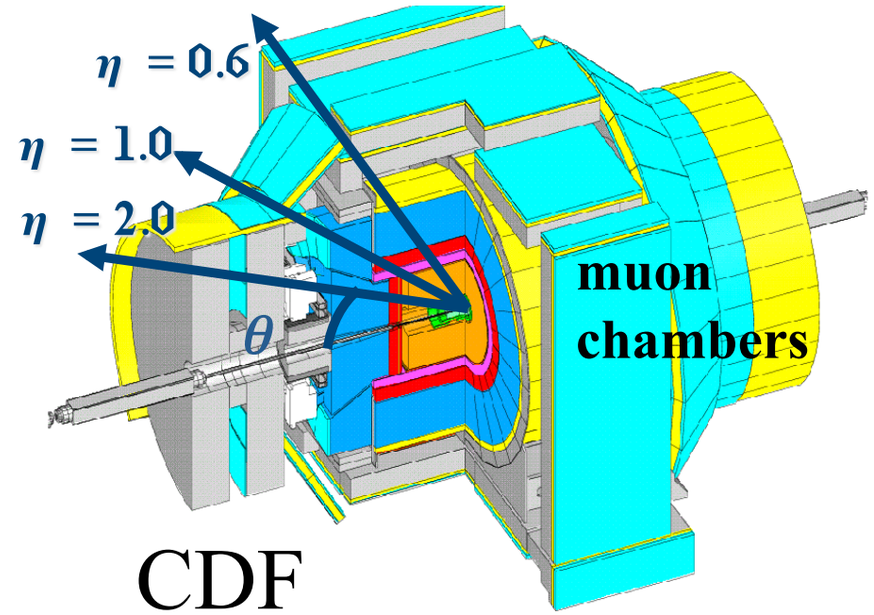
Z + b-jets Results with 8 fb^{-1}



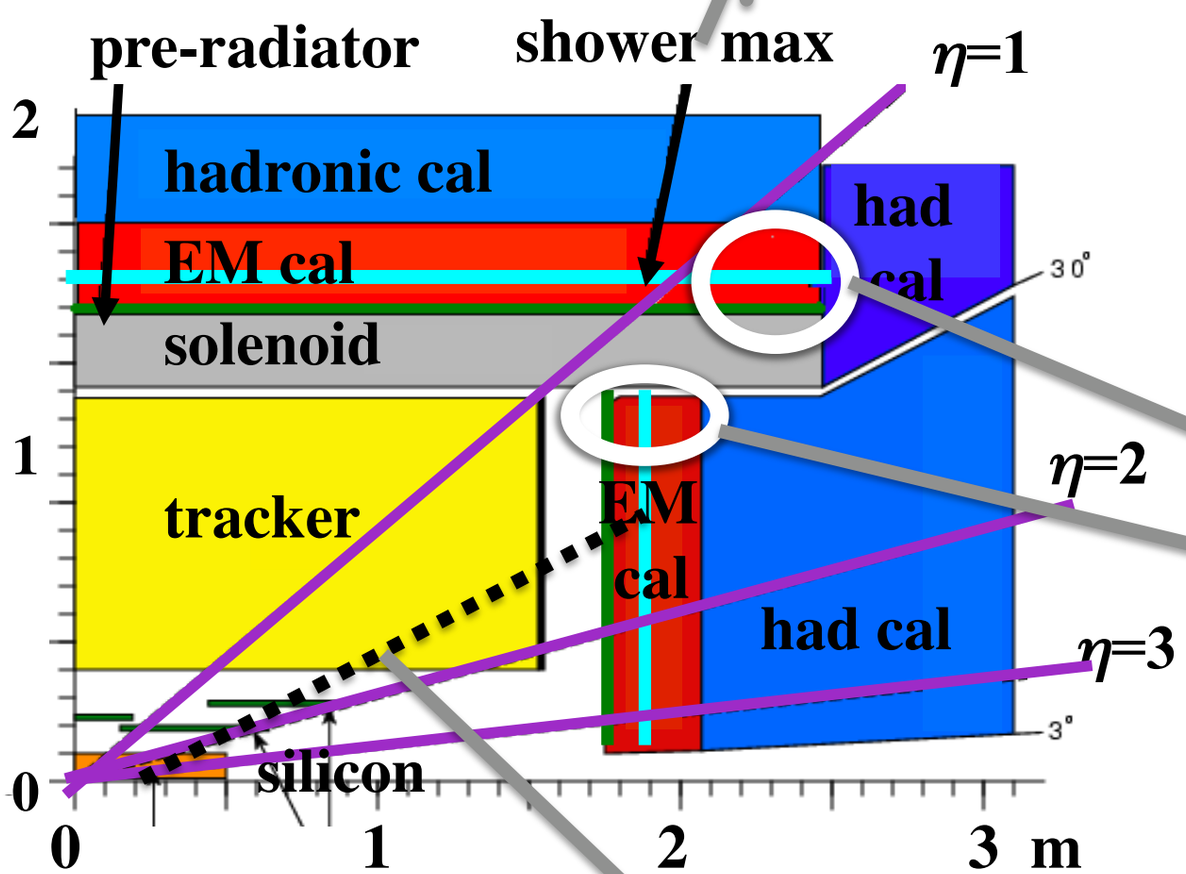
Main Systematic uncertainty due to vertex mass template modeling ($\sim 9\%$).
Other systematics coming from b tag efficiency, JES and backgrounds.

	Measured	NLO $Q^2 = m_Z^2 + p_{T,Z}^2$	NLO $Q^2 =< p_{T,jet}^2 >$
$\frac{\sigma(Z+\mathrm{b})}{\sigma(Z)}$	$2.84 \pm 0.29 \pm 0.29 \times 10^{-3}$	2.3×10^{-3}	2.8×10^{-3}
$\frac{\sigma(Z+\mathrm{b})}{\sigma(Z+\mathrm{jet})}$	$2.24 \pm 0.24 \pm 0.26 \times 10^{-2}$	1.8×10^{-2}	2.2×10^{-2}

Acceptance improvements for 4ℓ



Improved shower max clustering



Include outer rings of calorimeters in electron ID

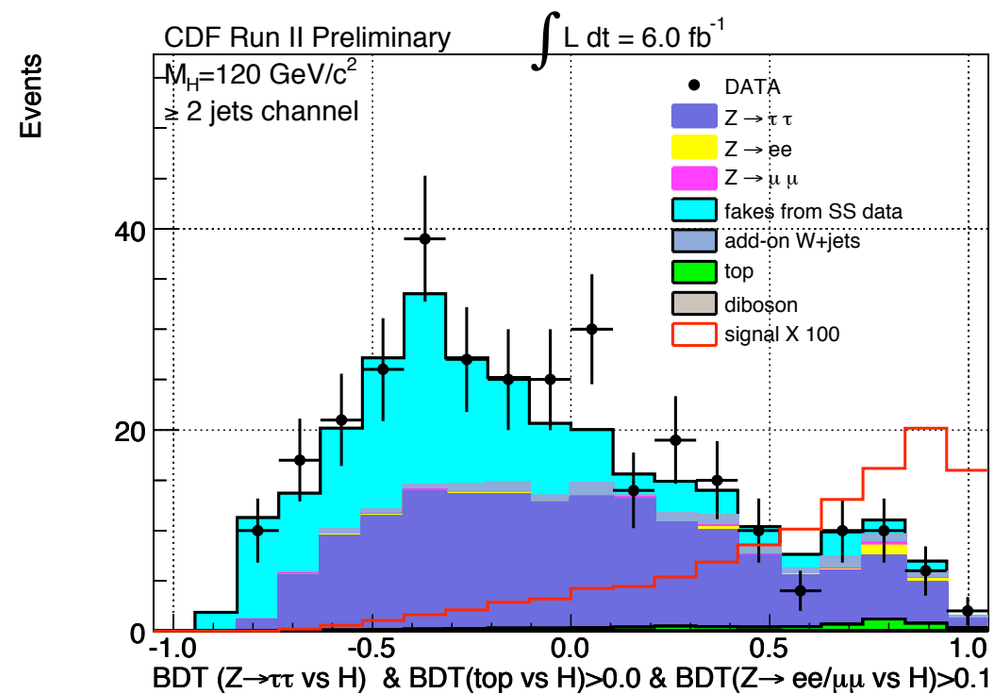
retrack for 4l, and add central tracker hits to forward silicon tracks

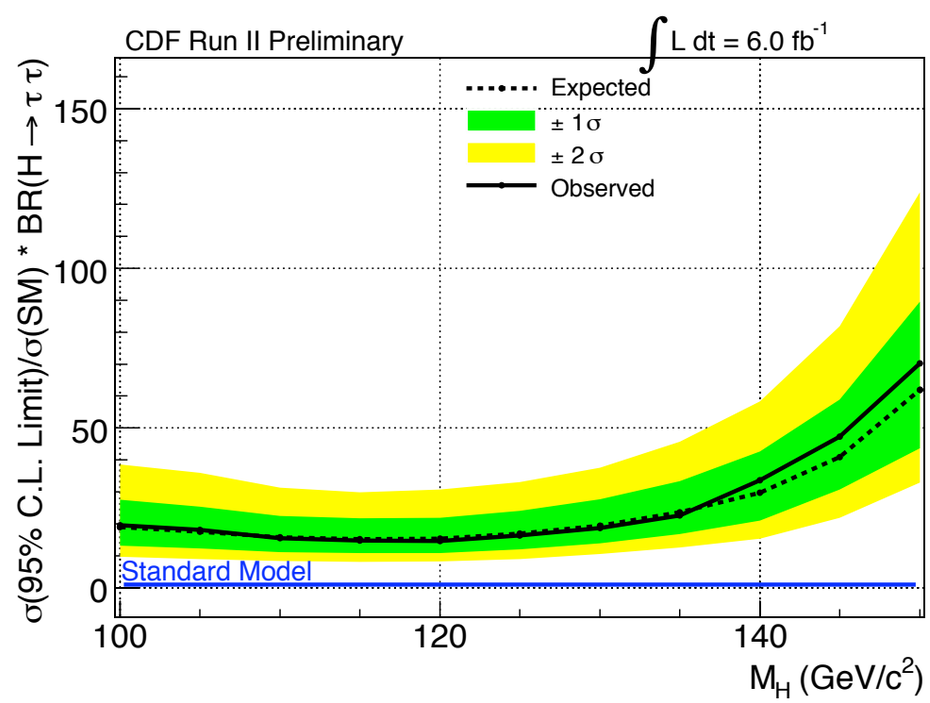
(taken from A.Robson's EPS talk)

$H \rightarrow \tau\tau$ [6fb^{-1}]

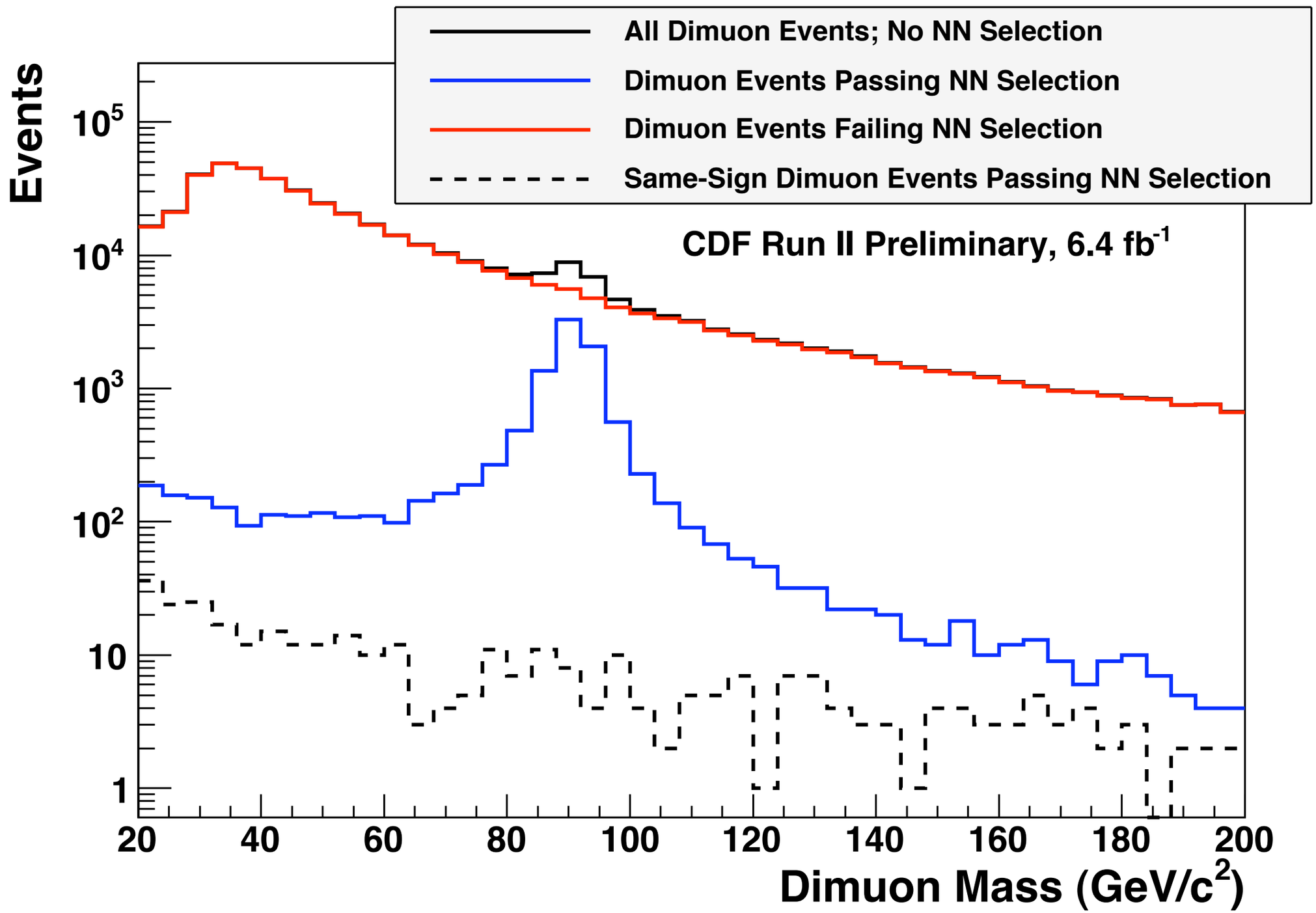
CDF Note 10439

- Search for $H \rightarrow \tau\tau$ produced via WH,ZH,ggH and VBF
- Signature:1 leptonic-τ ,1 hadronic-τ & $\geqslant$1jet
- Improvements
  - added 3.7 fb^{-1} data
  - optimized BDT cuts on t ID increased acceptance 15%
- Limit:15.3(Exp)/14.6(Obs) x σ_{SM} for M_H=120 GeV/c^2

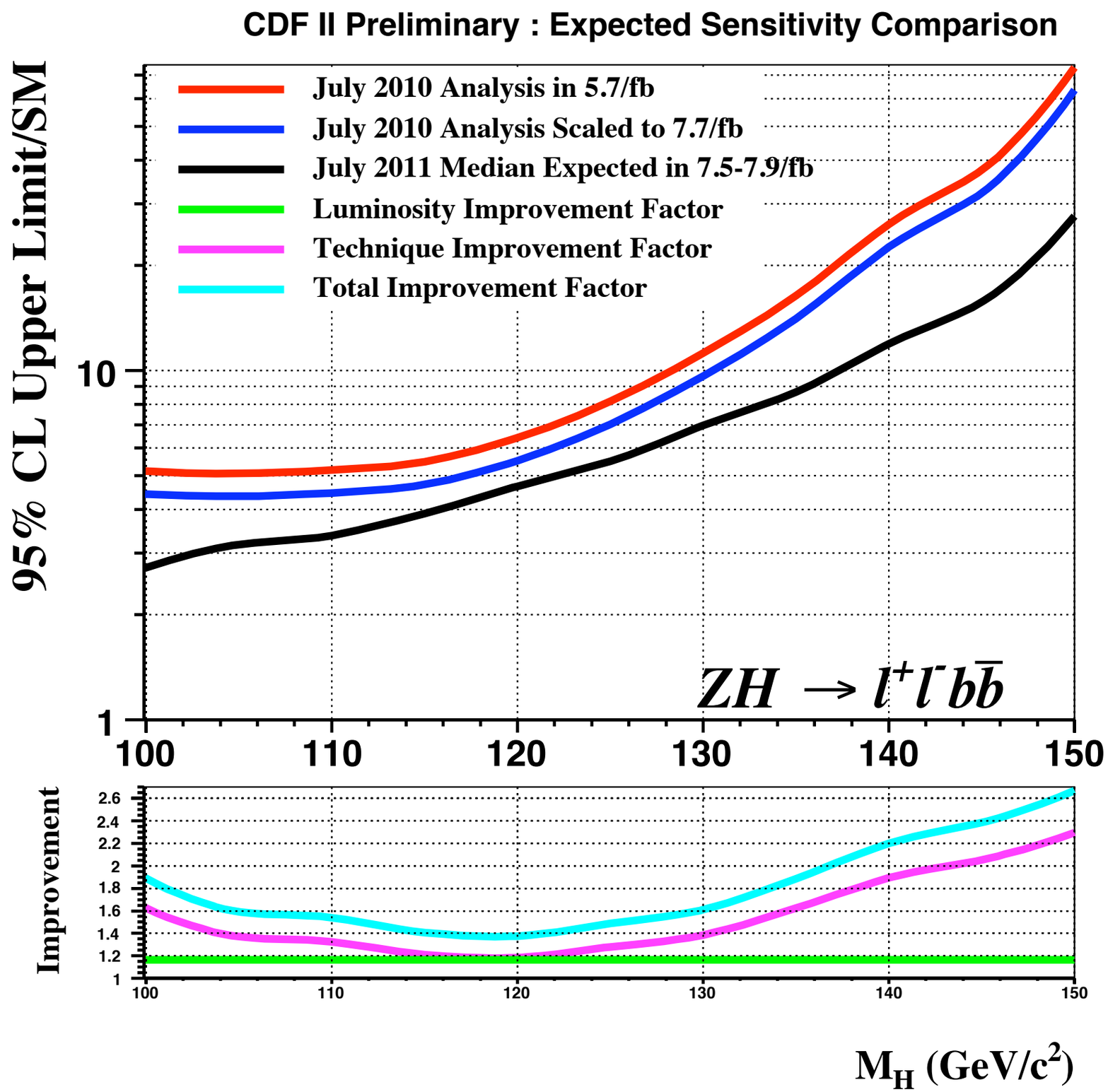




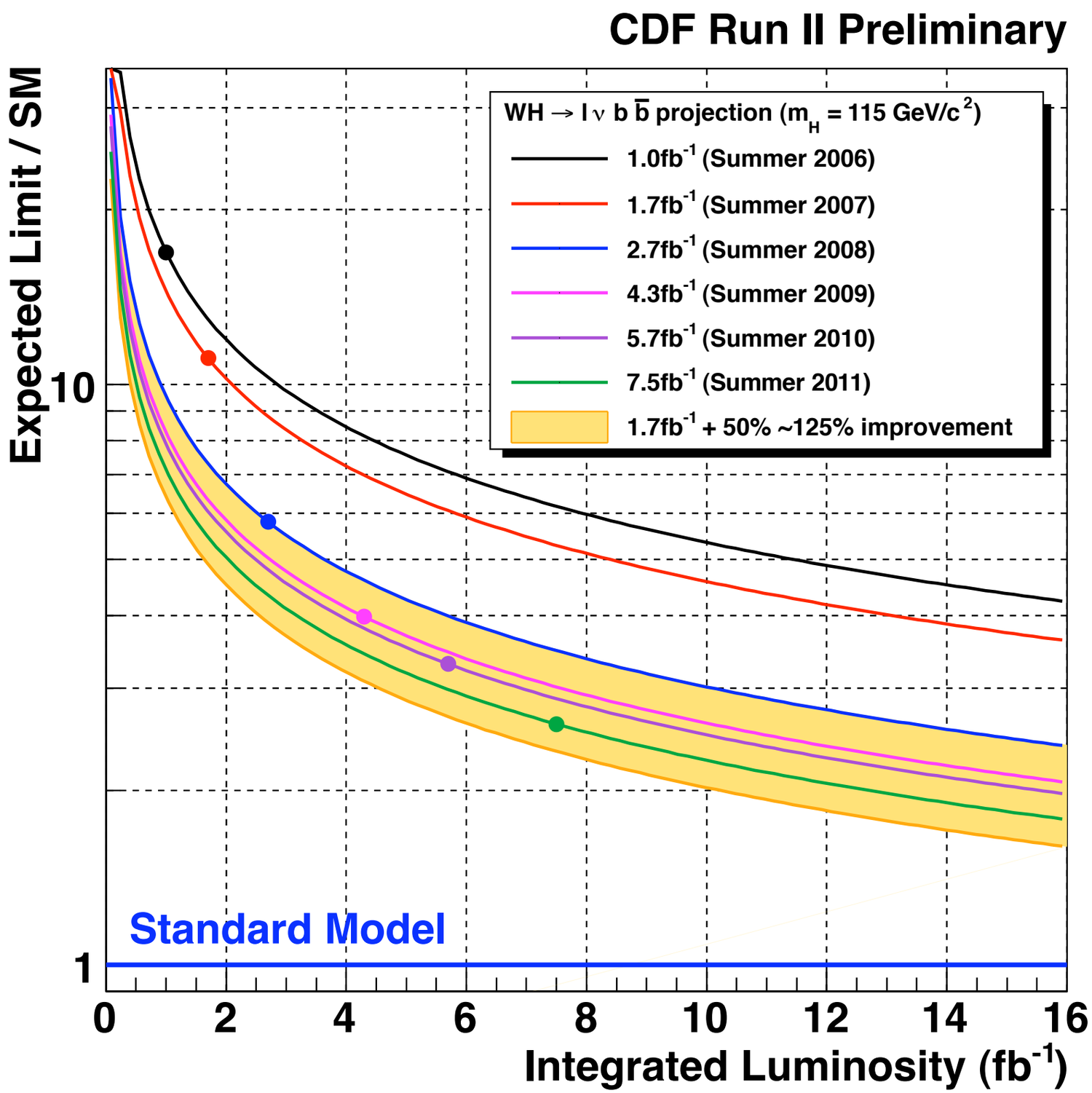
ZH→llbb
Multivariate Muon ID Performance



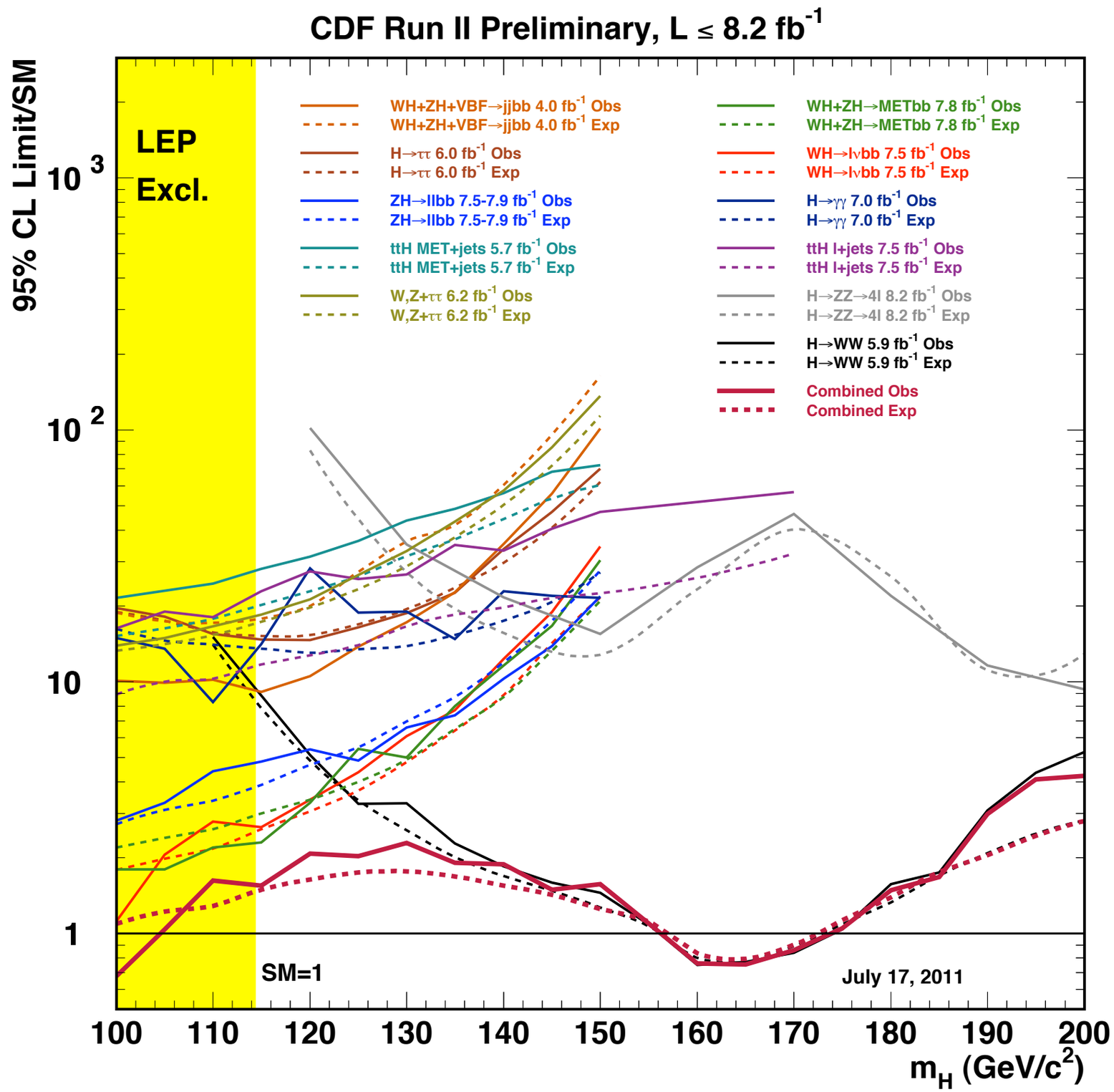
ZH→llbb
Evolution of performance



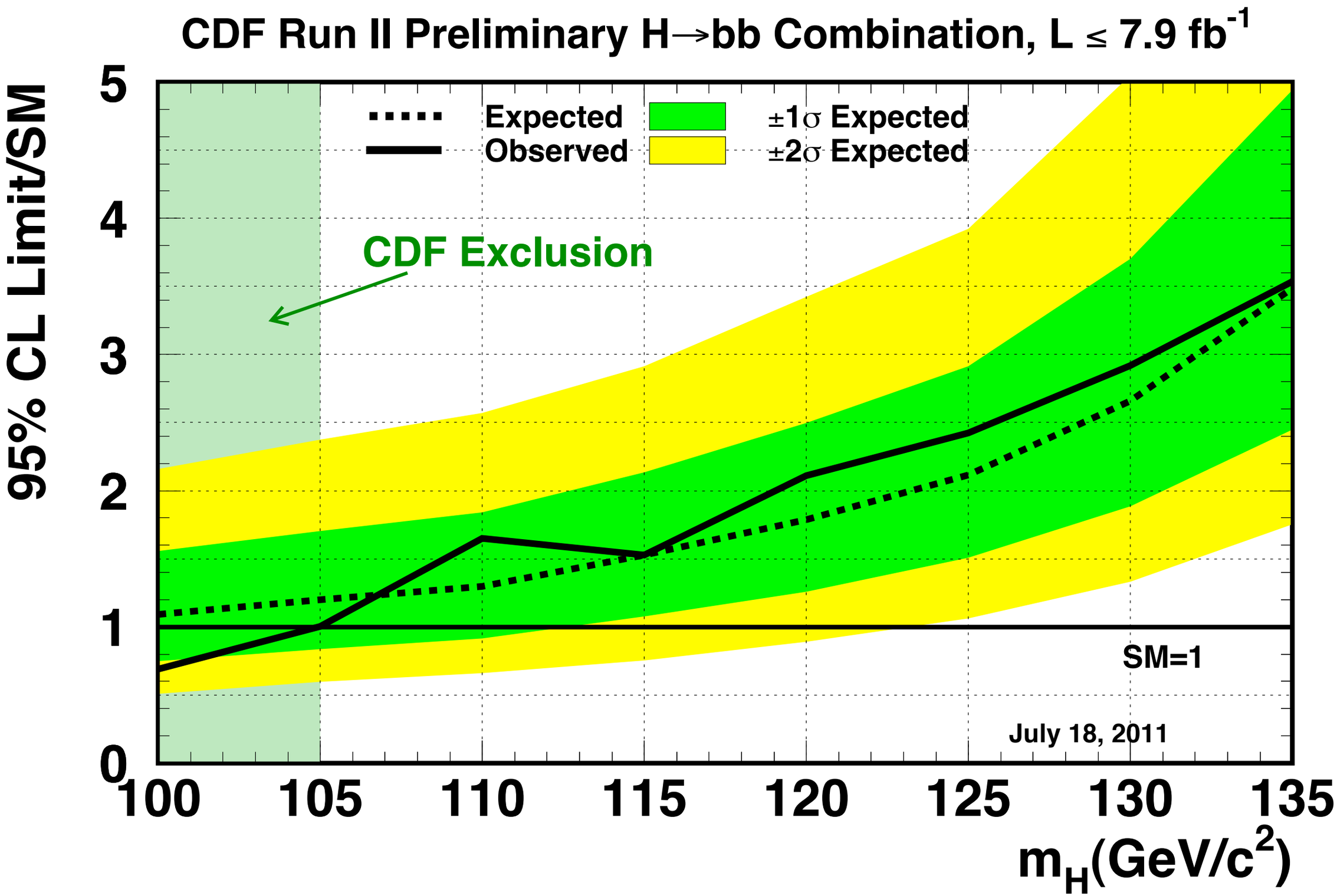
WH→lνbb
Evolution of performance



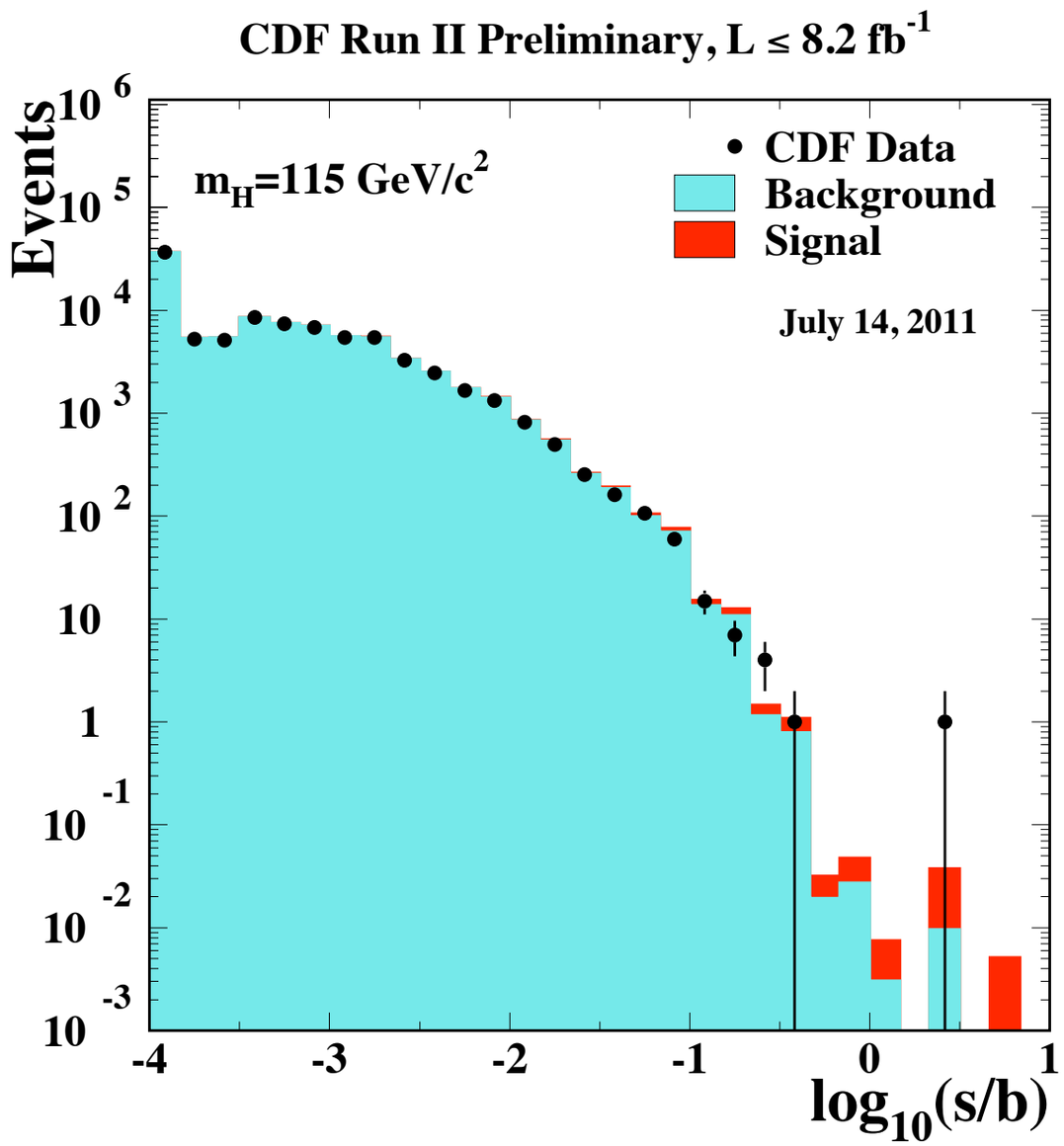
CDF Higgs Combination: Individual Channels

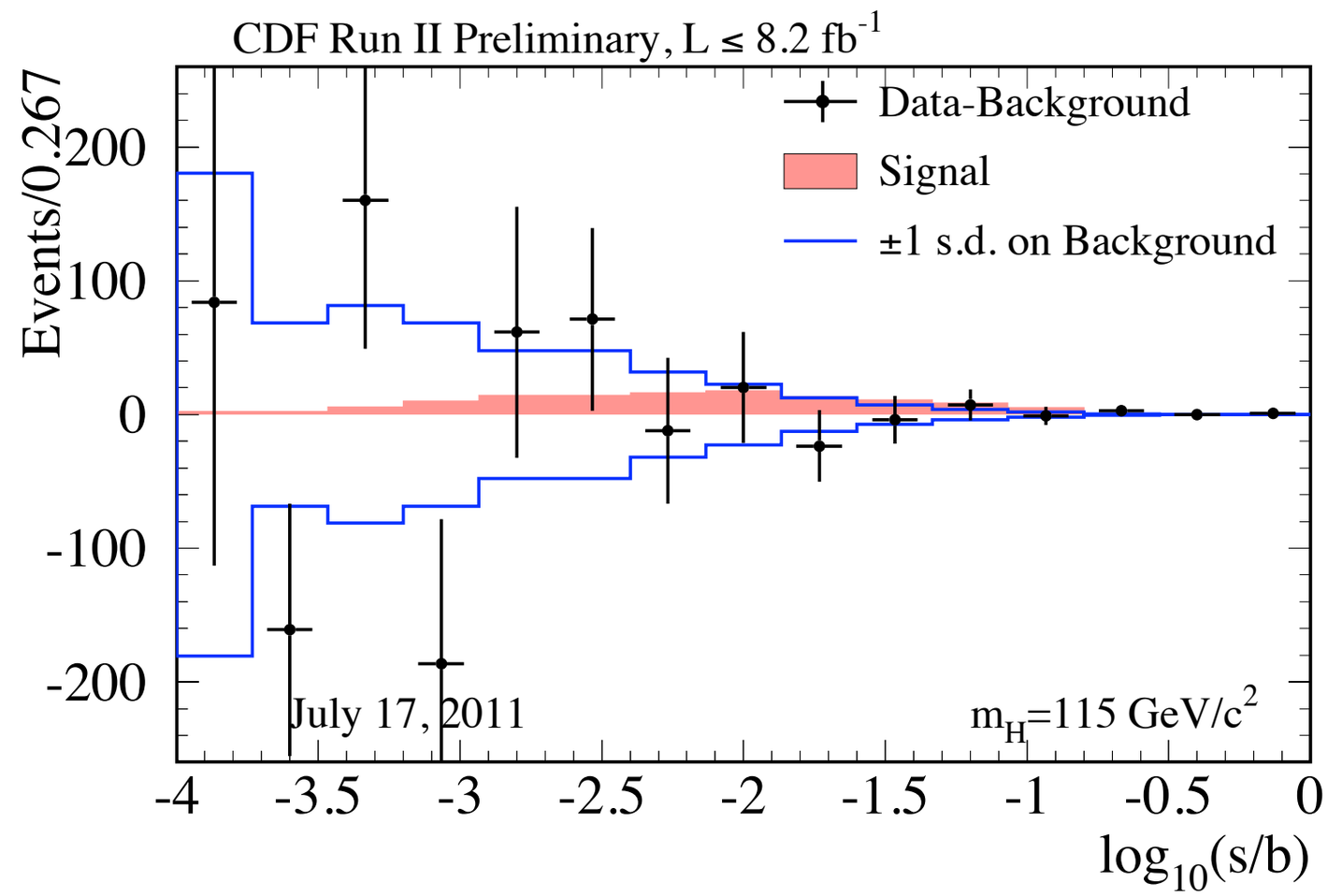
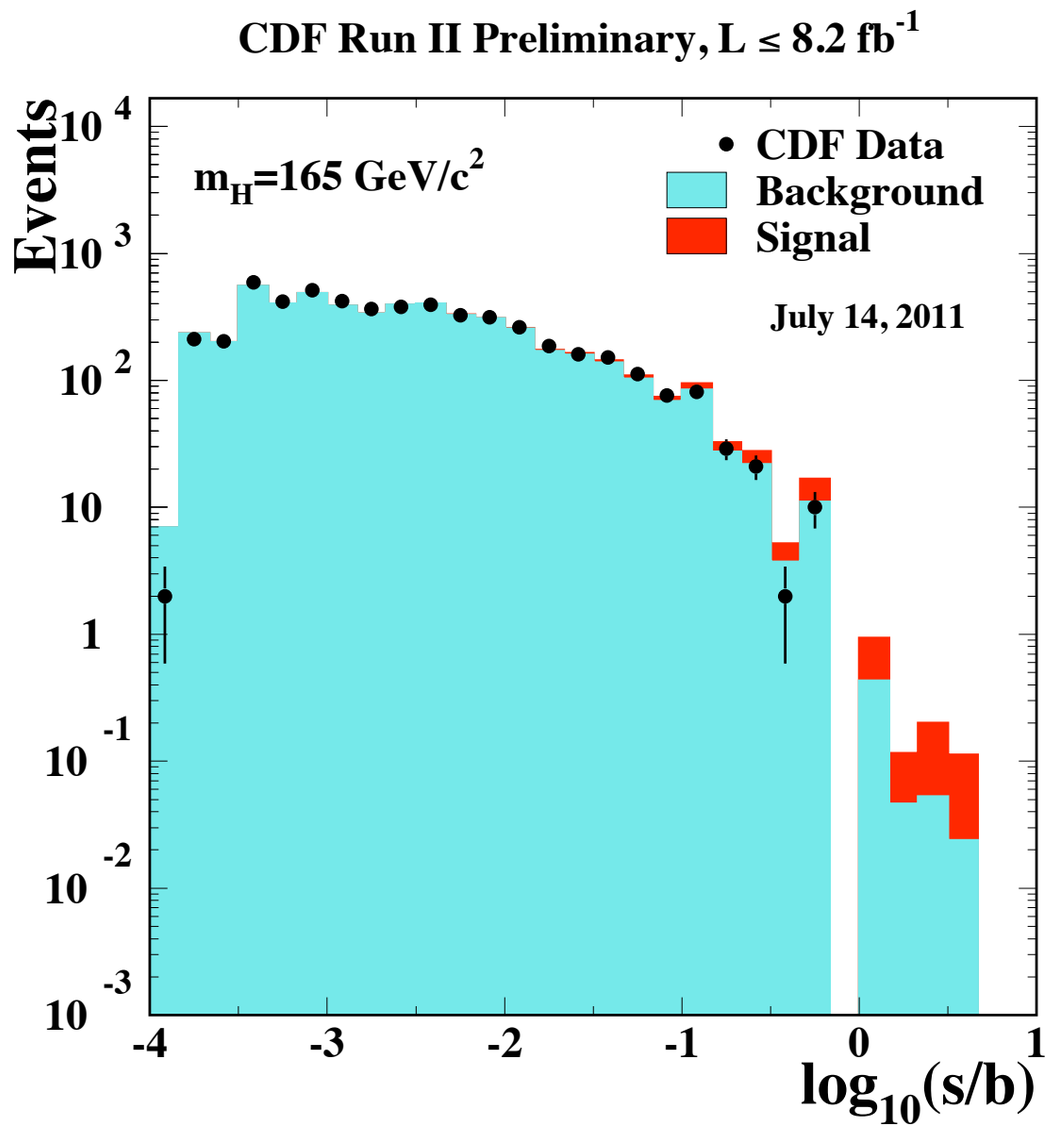
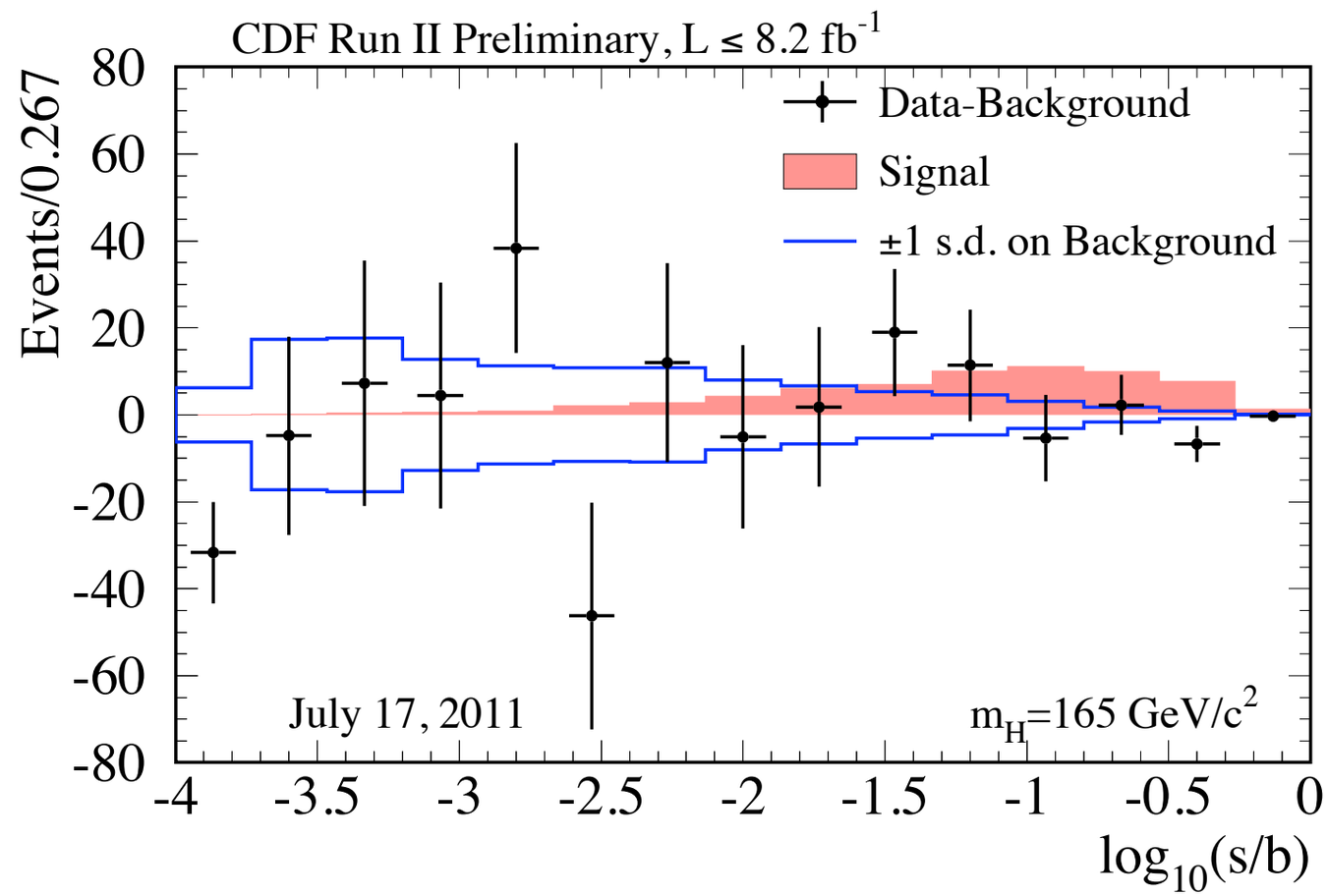


CDF Higgs Combination:
Just H→bb channels



CDF Higgs Combination: All Low-Mass Channels





CDF Higgs Combination: All High-Mass Channels