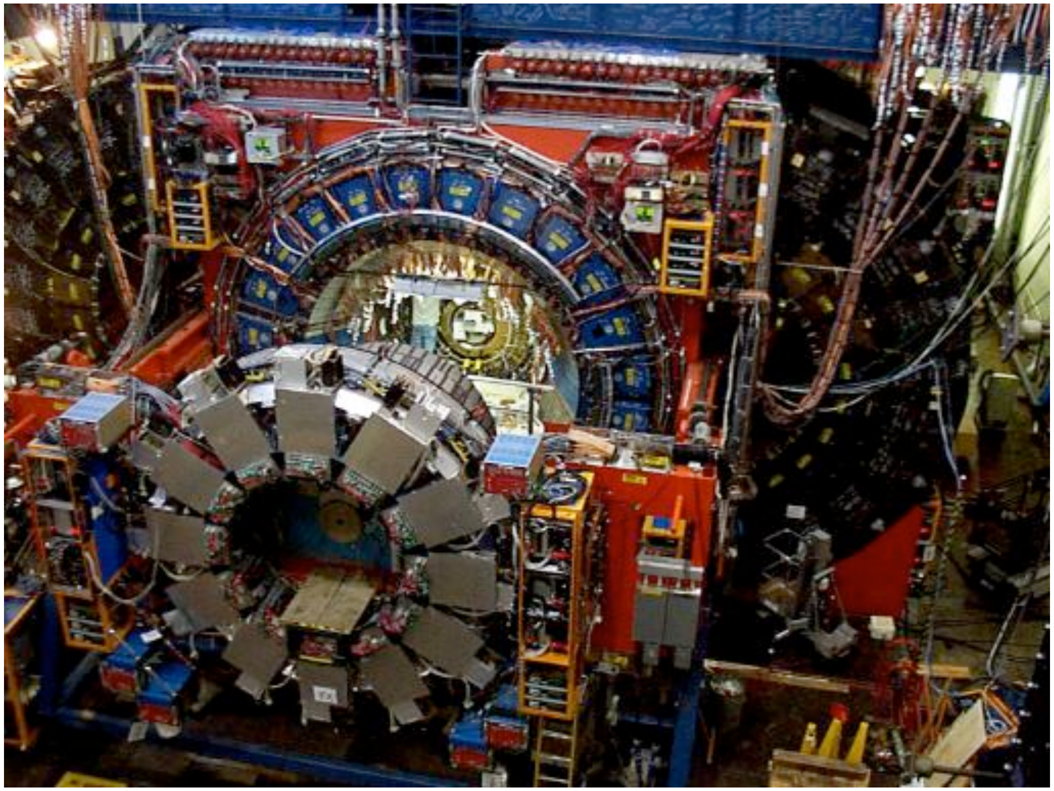
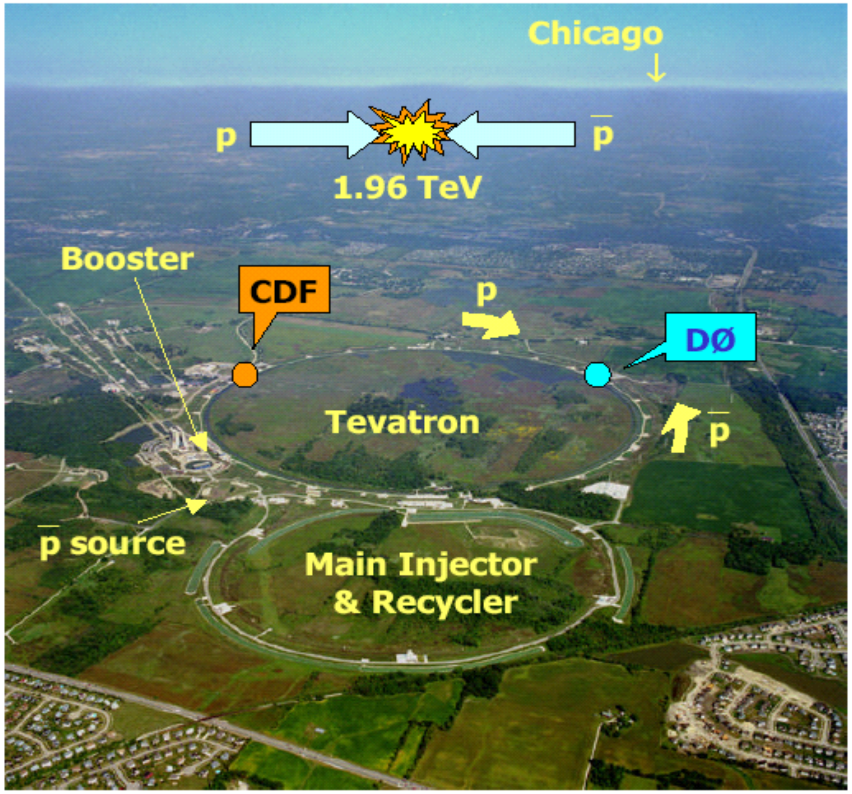
Task E: Cont.



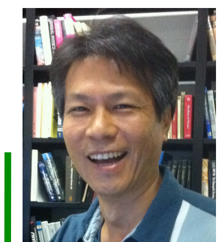


- Physics and Tracking

Overview

- Wisconsin involved in BMU detector maintenance, detector operations, trigger, software operations, tracking and BMU software, silicon and BMU muon data validation, shifts, GP, leadership, and physics!

- Discussed here:
- Tracking software, silicon data validation, and impact on physics Herndon



- Application of BMU to physics

- B-physics Herndon Pursley
- SM diboson physics and Higgs physics

Herndon Pursley Nett

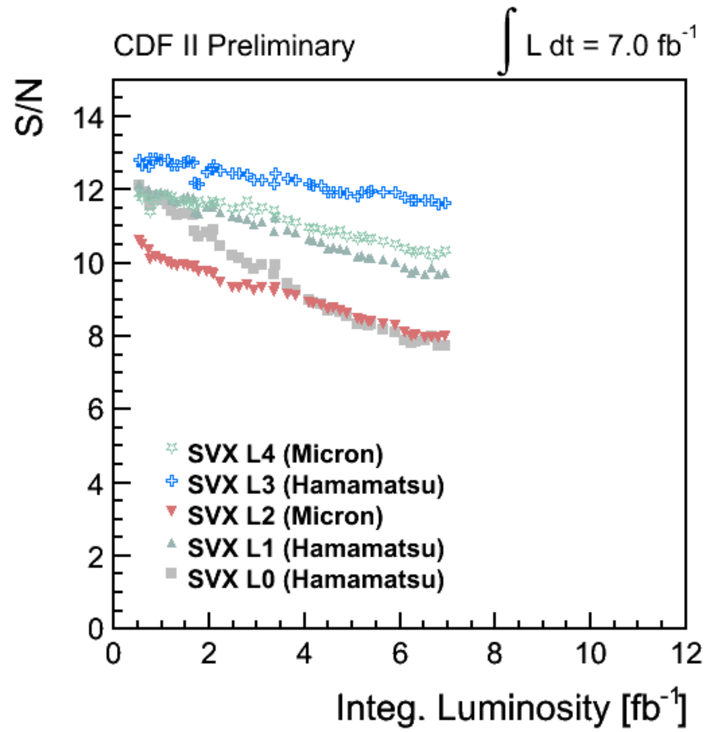
Also note on computing

Note on Computing

- Support 10% Rader and Radtke
- Benefits:
  - Desktop computing support at UW
  - Wisconsin computing farm access and support
  - Wisconsin farm configured as CDF compatible glideCAF computing farm. Used for MC production. This usage has reduced as LHC has come online.

Silicon Tracking

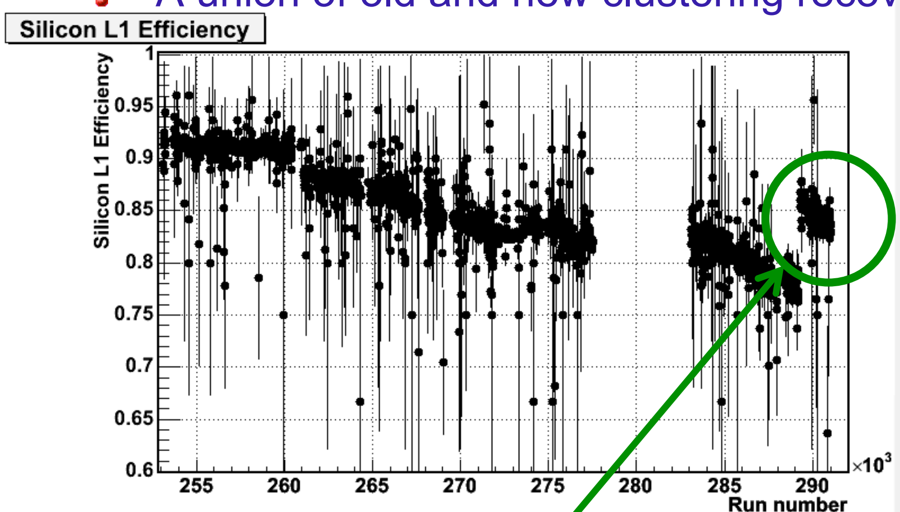
- Continued work on improvements to CDF silicon tracking
- Last year: Improved execution time of forward silicon tracking.
  - Reduced overall time to produce CDF data by 50%
  - Eliminated polynomial growth of tracking time at high instantaneous luminosity
- This year: Re-optimizing silicon hit finding
  - Silicon hit finding exhibits substantial inefficiency in latest data
  - Effects silicon tracking efficiency and b-tagging performance: -20% relative b-tag efficiency!
  - Problem traced to degraded signal to noise on silicon detectors. L0 and L2 of SVXII
  - Recover efficiency by re-optimizing silicon clustering parameters with looser criteria
  - New production executable in effect July 2010



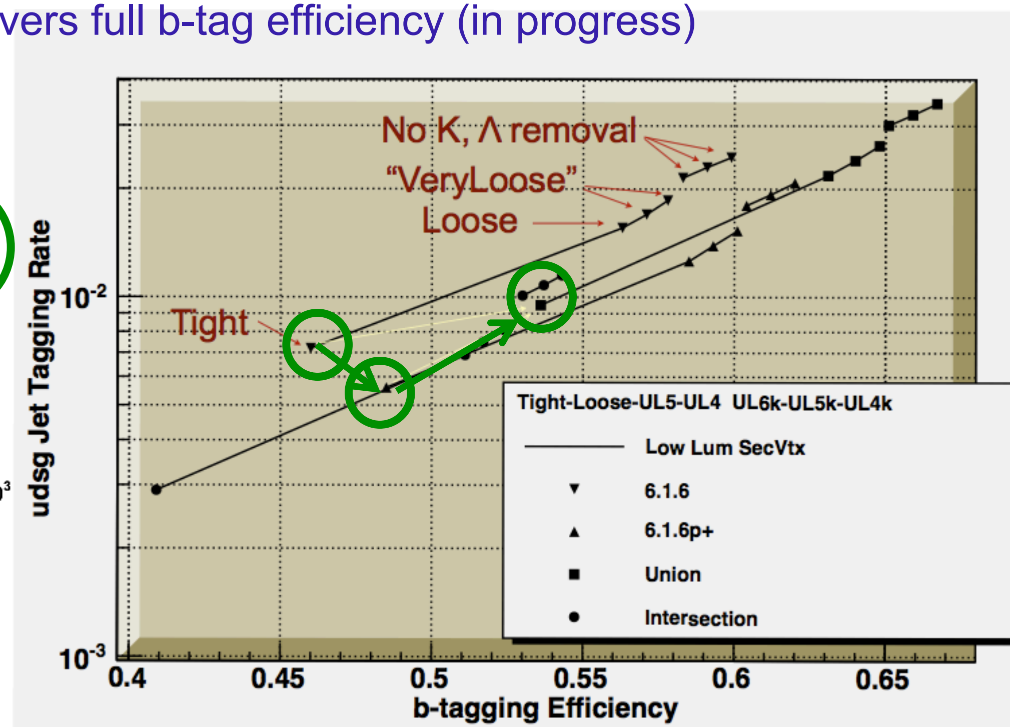
Silicon Tracking

- Silicon clustering improvements
  - Less stringent requirement on hit signal to noise
  - Partially recovers loss of efficiency on L0 (L1offline) and L2.
  - No increase in mis-measured track rate
  - A union of old and new clustering recovers full b-tag efficiency (in progress)

Herndon



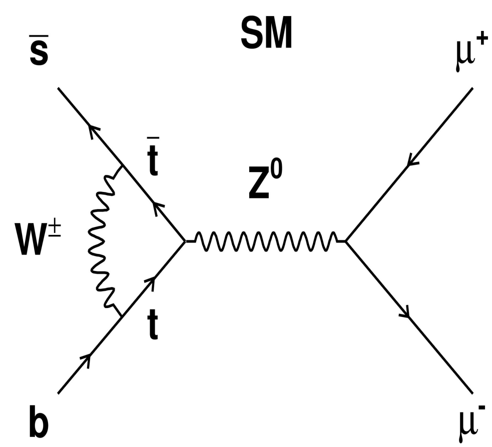
Improved silicon clustering

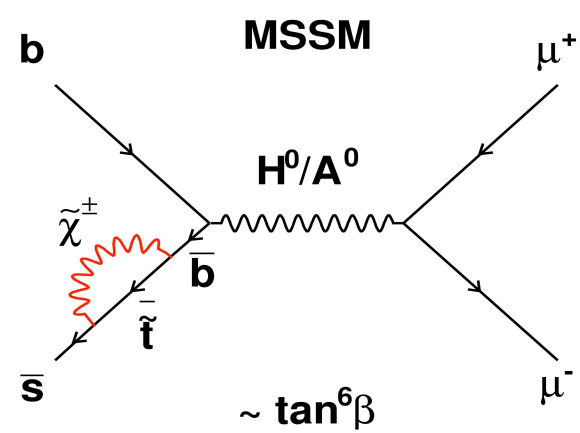


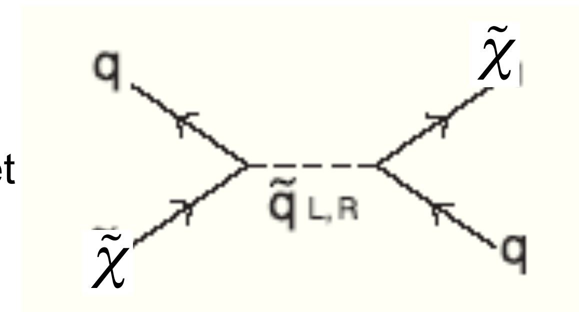
- Continued work on L00 clustering, primary vertex finding, b-tagging

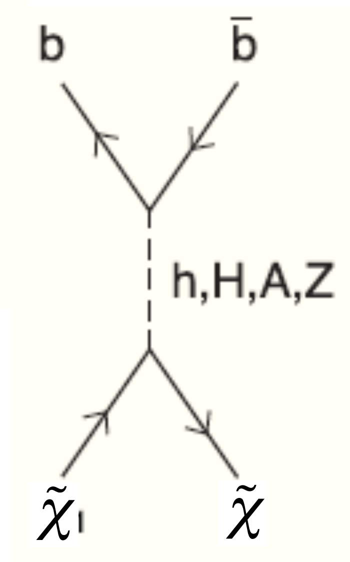
$B_{s(d)} \to \mu^+\mu^-$ Beyond the SM

- Look at processes that are suppressed in the SM
- Excellent place to spot small contributions from non SM contributions
- $B_{s(d)} \to \mu^+\mu^-$
  - SM:
    - No tree level decay
    - CKM ,GIM and helicity suppressed
    - BF($B_s \to \mu^+\mu^-$) = 3.86×10^{-9}
  - New Physics:
    - Loop: MSSM: mSugra, Higgs Doublet
    - 3 orders of magnitude enhancement
    - Rate $\propto \tan^6\beta/(M_A)^4$





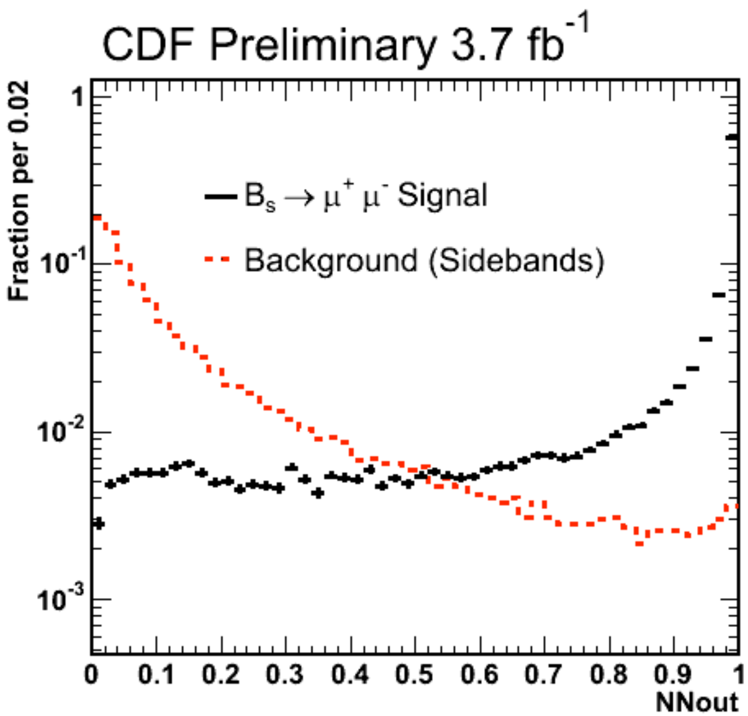


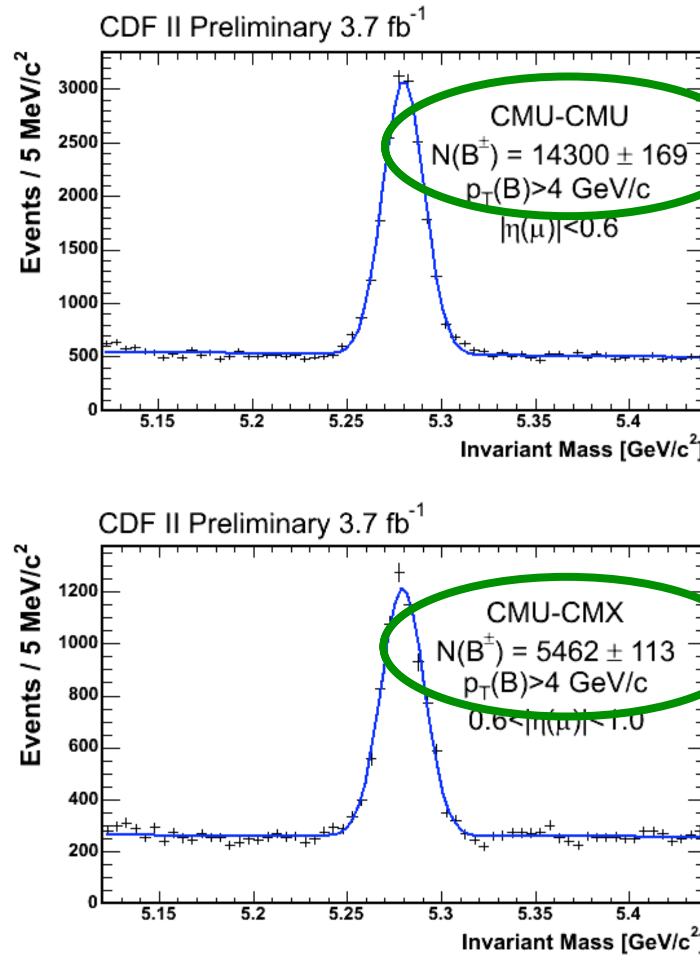


Same particles/vertices occur in both *B* decay diagrams and in dark matter scattering or annihilation diagrams

$B_{s(d)} \rightarrow \mu^+\mu^-$ Method

- Relative normalization search
  - Measure the rate of $B_{s(d)} \rightarrow \mu^+\mu^-$ decays relative to $B \rightarrow J/\psi K^+$
- Preselect to achieve good S/B then use a multivariate discriminant





CDF sensitive to 3 X 10^8 B_s events!

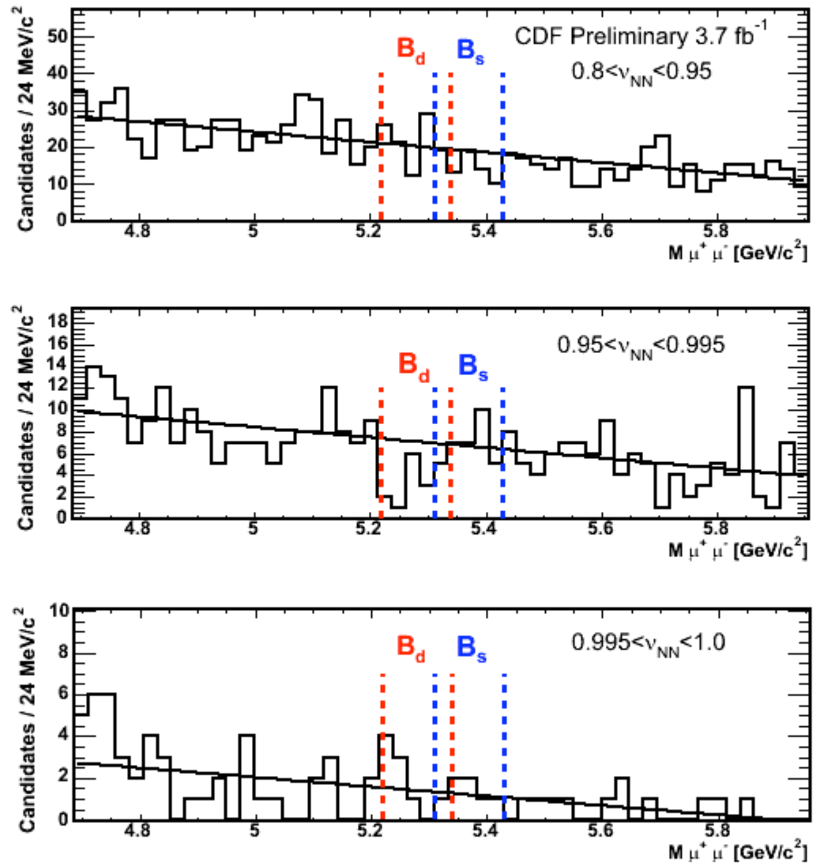
$B_{s(d)} \rightarrow \mu^+\mu^-$ Search Results

NN	Total Background	Observed Events
0.995-1.0	6.1	7

- Now expect 1.2 events at the SM rate!

***BF*($B_s \rightarrow \mu^+\mu^-$) < 4.3x10^{-8} at 95% CL**

***BF*($B_d \rightarrow \mu^+\mu^-$) < 7.6x10^{-9} at 95% CL**



- **Worlds best result**
- 6 People(2UW), 2FTE(1UW)

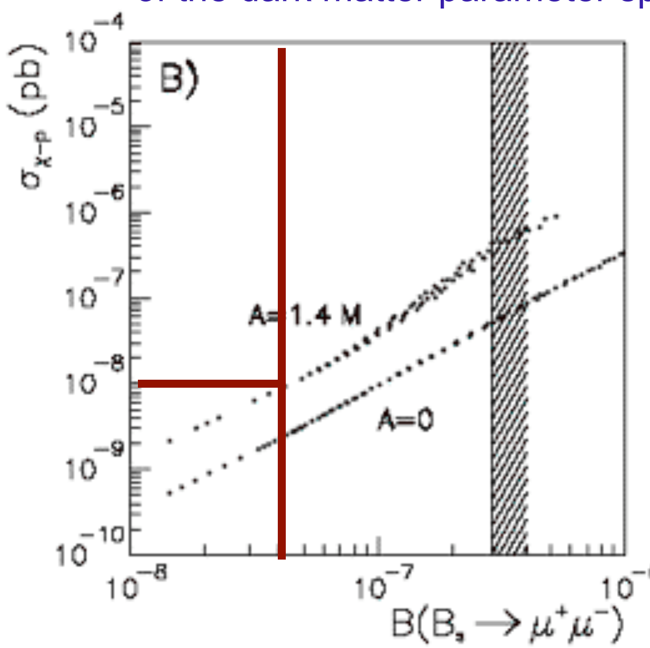
Herndon and ugrad Sperka graduated → grad school @ BU

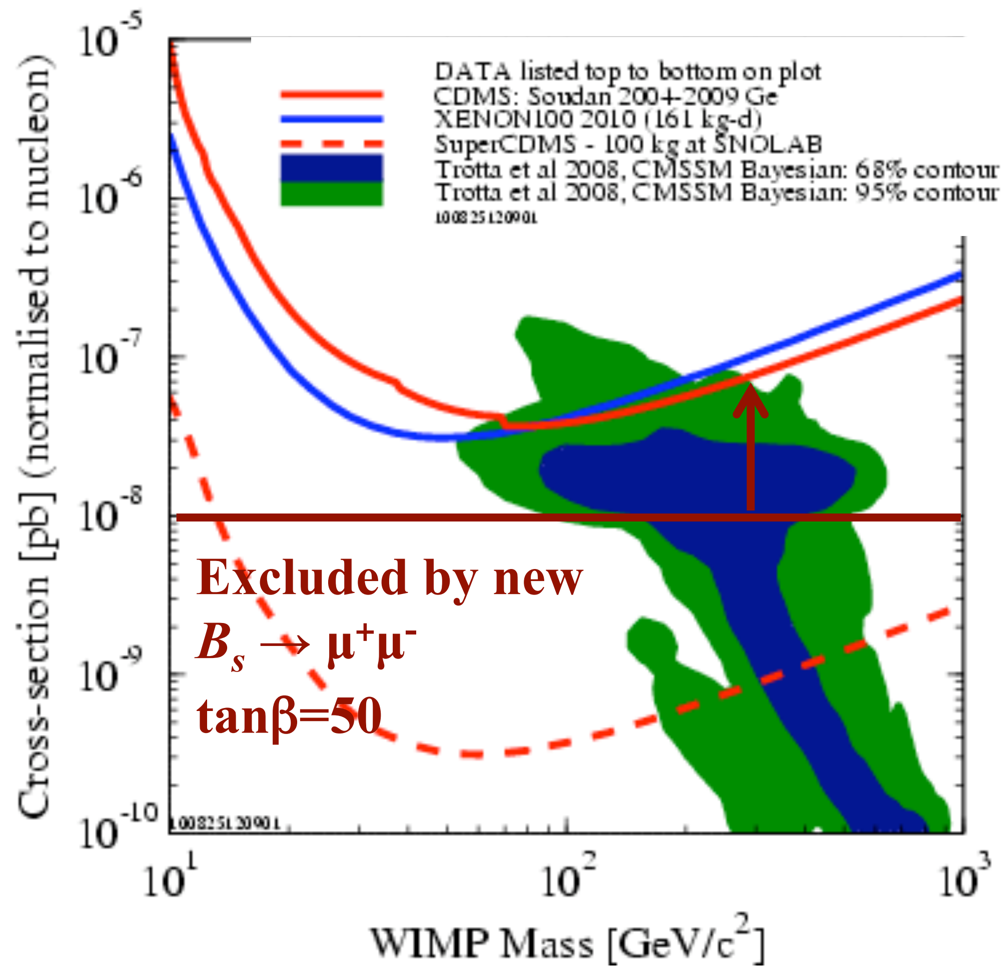
$B_s \rightarrow \mu^+\mu^-$ and Dark Matter

- $B_s \rightarrow \mu^+\mu^-$ correlated to dark matter searches
- CMSSM supergravity model

S. Baek, D.G. Cerdeno Y.G. Kim, P. Ko, C. Munoz, JHEP 0506 017, 2005

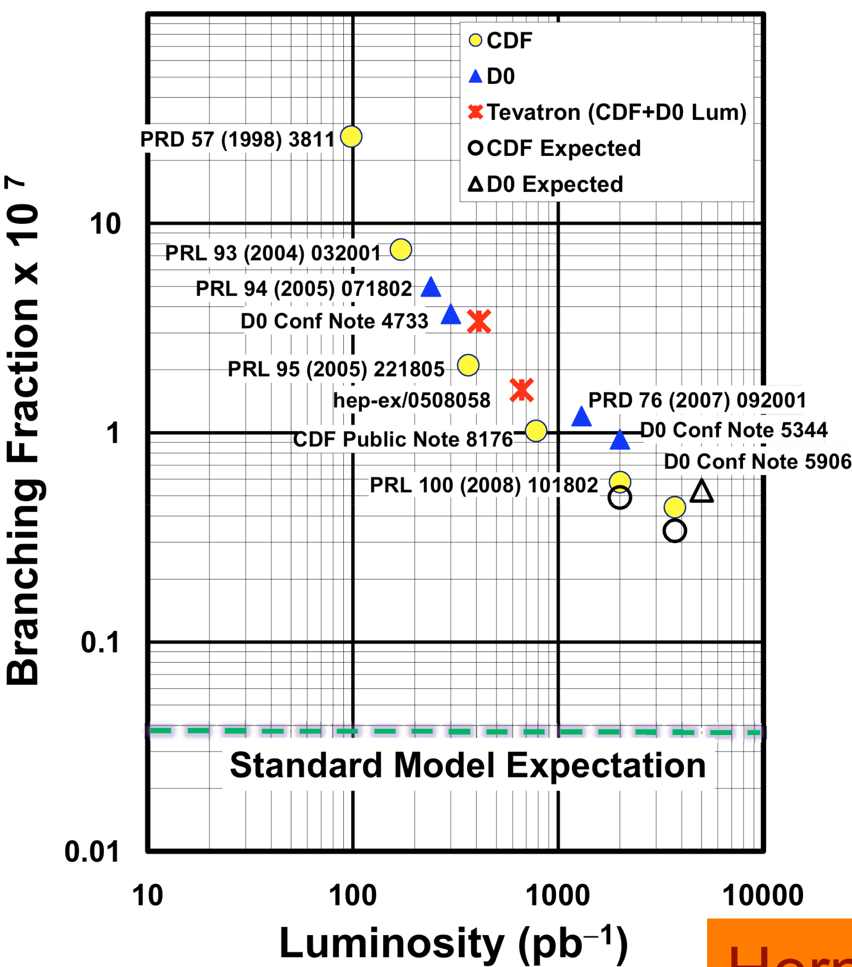
- $B_s \rightarrow \mu^+\mu^-$ and neutralino scattering cross sections are both a strong function of tanβ
  - In focus point region , high tanβ(50), positive μ, favoured in CDM allowed fits
  - Current bounds on $B_s \rightarrow \mu^+\mu^-$ exclude parts of the dark matter parameter space



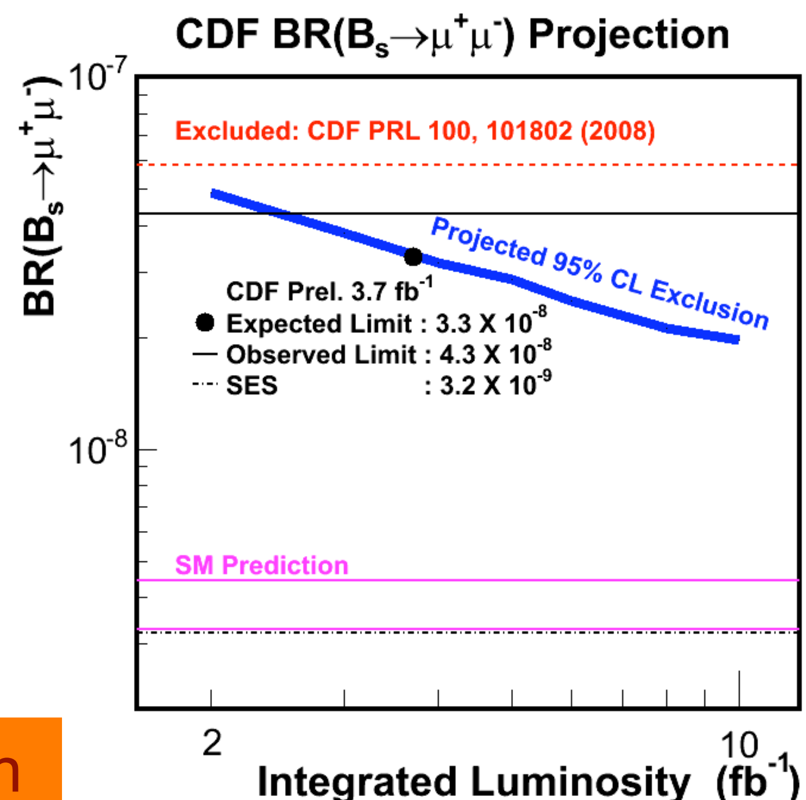


Expectations

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

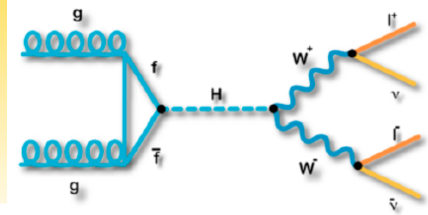


- •Now analyzing 6fb^{-1}
- •Improvements to silicon performance and NN.
- •Expect linear progression of the limit
- •Final Expected Limit ≈ 2 x 10-8



Herndon

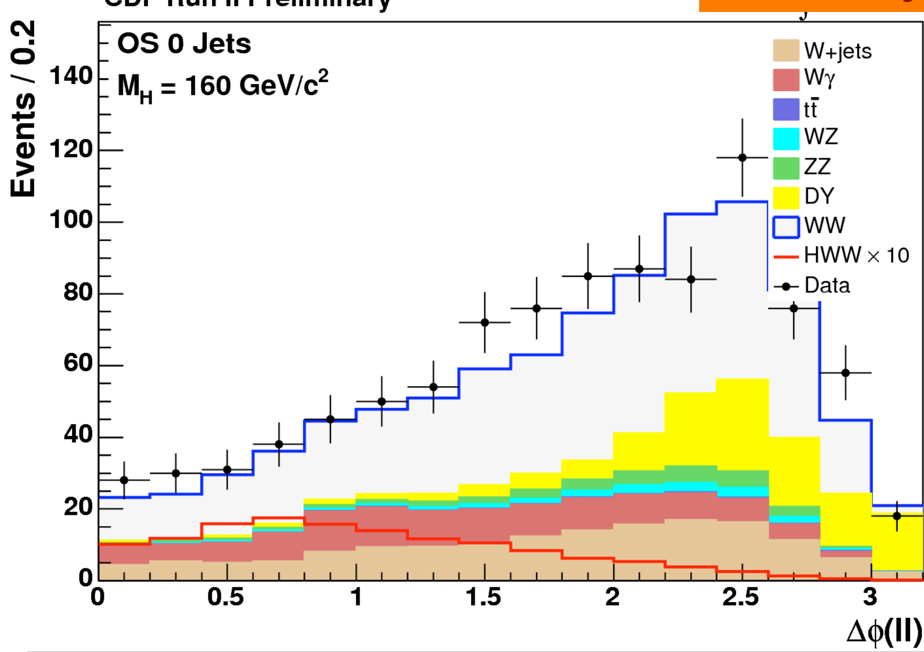
SM Higgs: H→WW

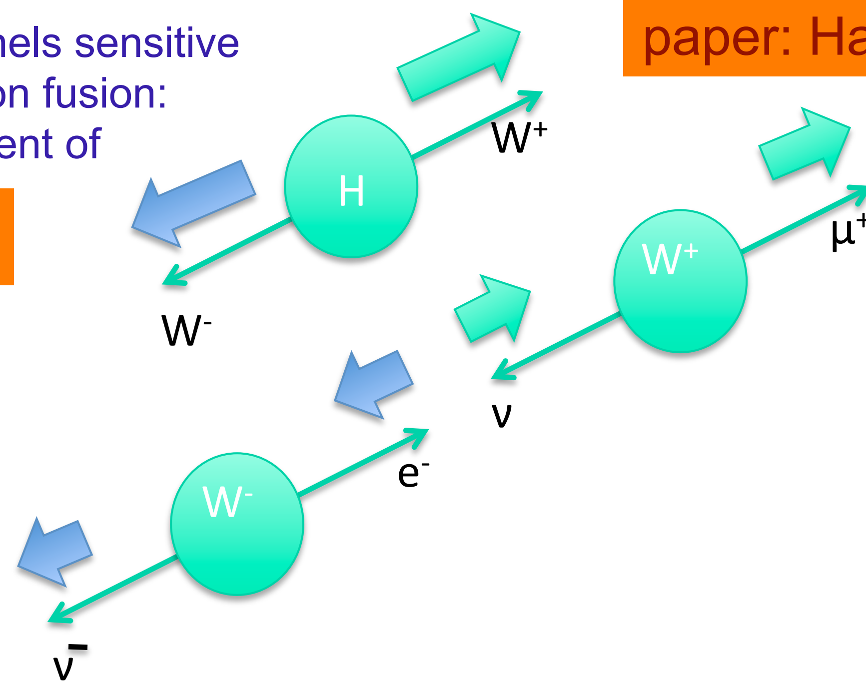


- H→WW→lνlν - signature: Two high p_T leptons and MET
  - Primary backgrounds: SM diboson (WW, WZ, ZZ) and top in di-lepton decay channel
  - Key issue: Maximizing signal acceptance
  - UW innovations. Adding channels channels sensitive to associated production and vector boson fusion: +50% acceptance! Also designed treatment of systematic uncertainties.

First Pheno paper: Han

Pursley

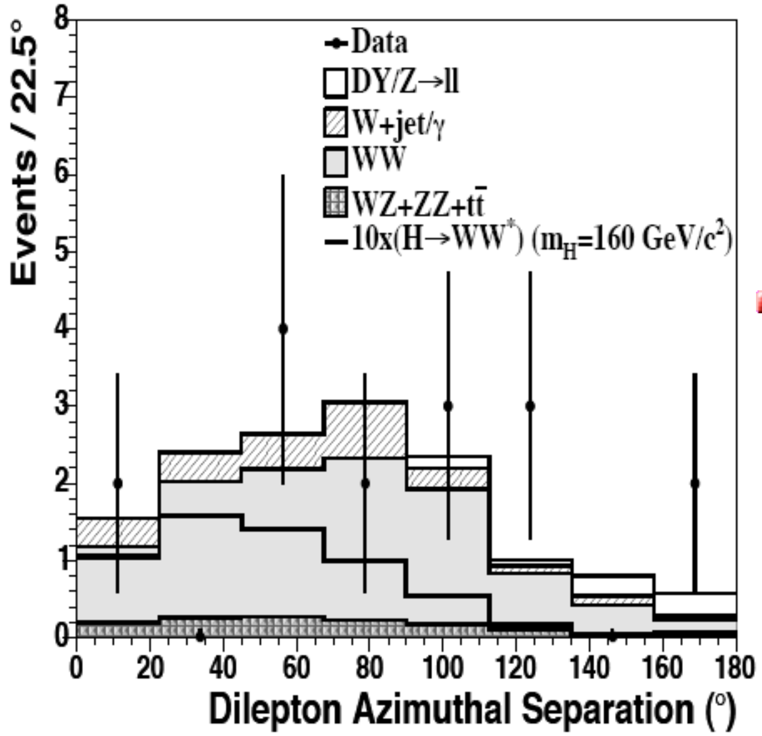




Spin correlation: Charged leptons go in the same direction

H→WW: Δφ Analysis

- Initial analysis: PRL 97, 081802 (2006)
  - gg → H production only
  - Purely based on signal vs. background discrimination of Δφ variable
  - Used standard CDF high p_T lepton Id



Results: mH = 160GeV : 95%CL Limits/SM

Analysis	Lum (fb^{-1})	Higgs Events	Exp. Limit	Obs. Limit
CDF: Δφ	0.36	0.58	8.9	8.2

- Compared to current analysis
  - Higgs acceptance improved: ~x3.8
  - 4 years, 15 people(3UW) , 8FTE(2UW)
  - Interestingly acceptance improvement and new data almost accounts for current sensitivity: Naive expectation: 1.2xSM

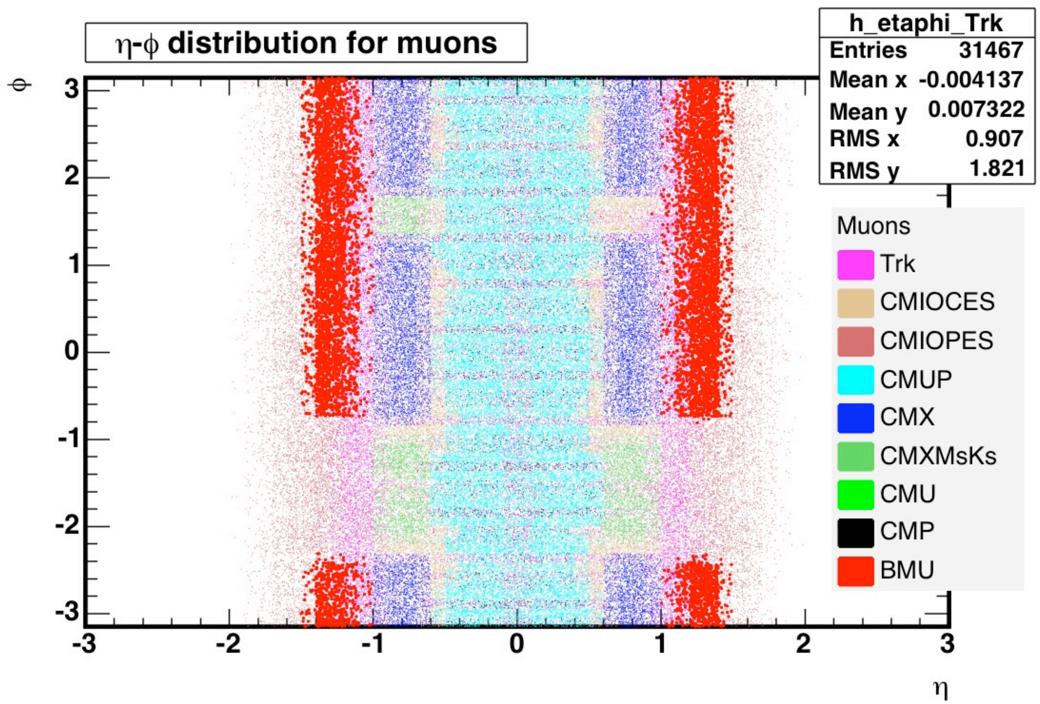
H→WW Improvements

- Lepton acceptance: x2.5 effective statistics
  - Based on lepton selection of WZ and ZZ discovery analyses: x2.2
  - Electrons in calorimeter gaps
  - Muons in forward region and detector gaps
  - 8 μ(with BMU), 2 e and 1 e/μ type
  - Also in Bs Osc., single top, VV

Bellinger Pursley

  - Performance validated in 31 DY and 14 Z→ττ control regions
- Factor of 1.5 from associated production and >=2 jet channel

Pursley

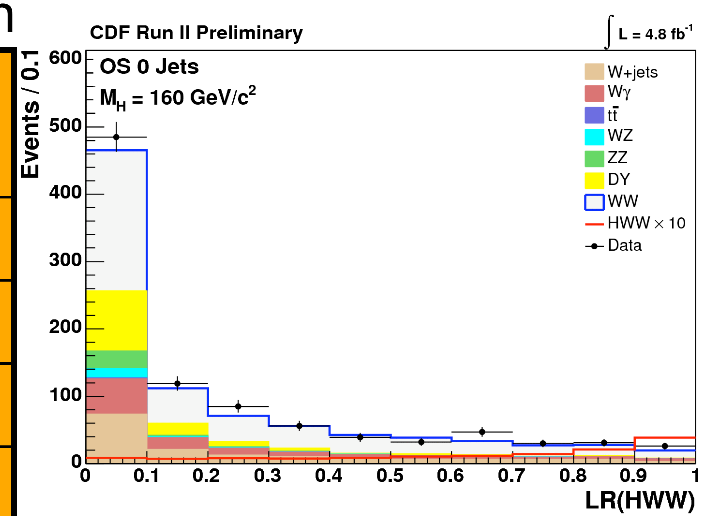


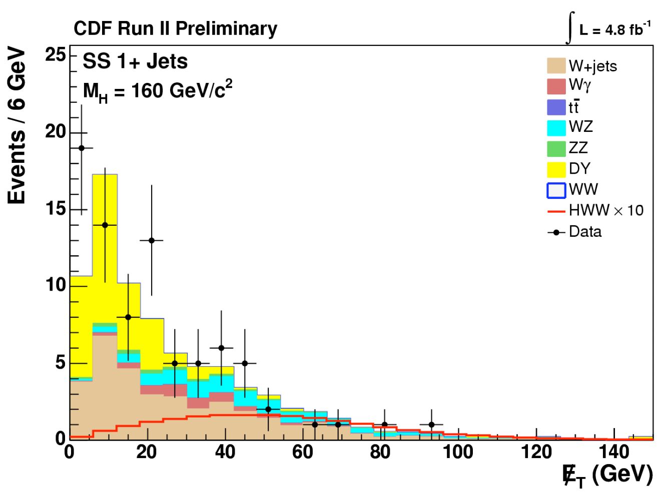
SM Higgs: H→WW

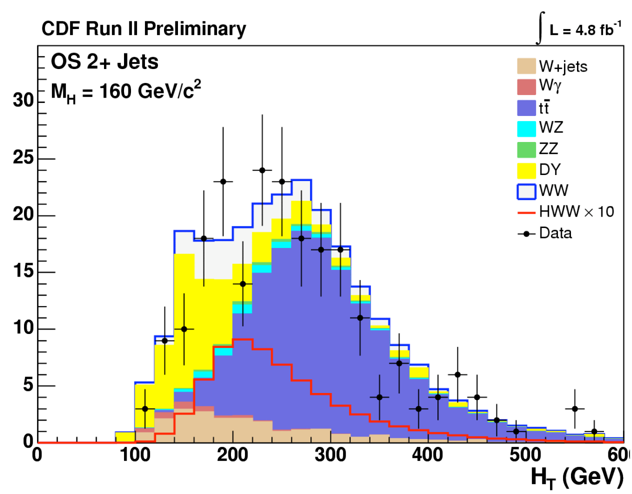
- CDF: Inclusive H→WW analysis: lνlνMET - signature
- Optimize in jet bins & lepton charge configuration

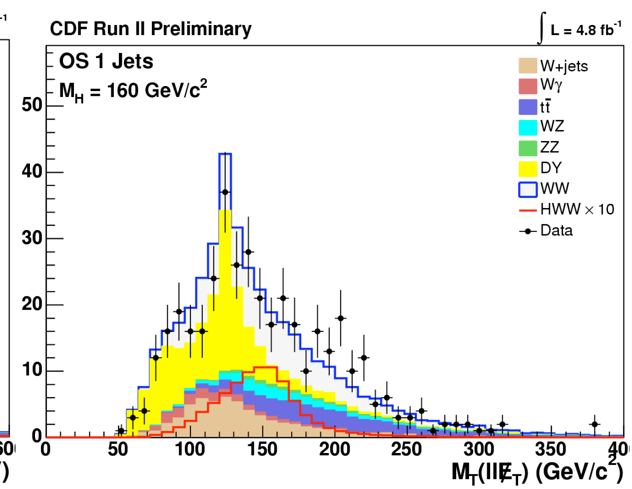
Channel	Signal	Primary background	Primary discriminants
0 Jets	gg→H	WW, DY	Δφ/R,MET,ME
1 Jet	gg→H,VH,VBF	WW, DY	Δφ/R,MET,m_{TH}
2+Jets (UW)	gg→H,VH,VBF	Top dilepton	MET,HT,m_{TH}
1+Jets SS lep (UW)	VH	W+Jets	Good lepton ID, MET

Pursley









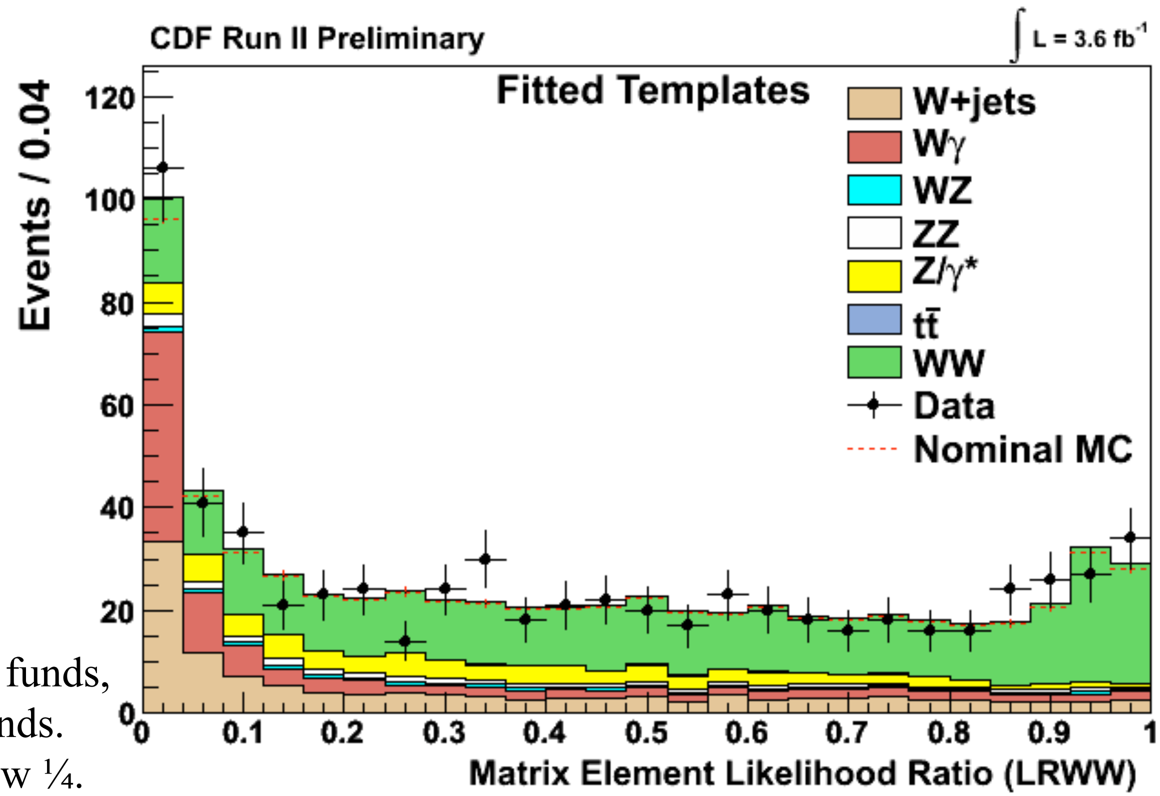
SM WW Production

- Measurement of direct standard model WW Production
- Using a matrix element based technique.

Pursley
→ Harvard Med.

World's most Sensitive measurement of the WW cross section

Also TGC limits



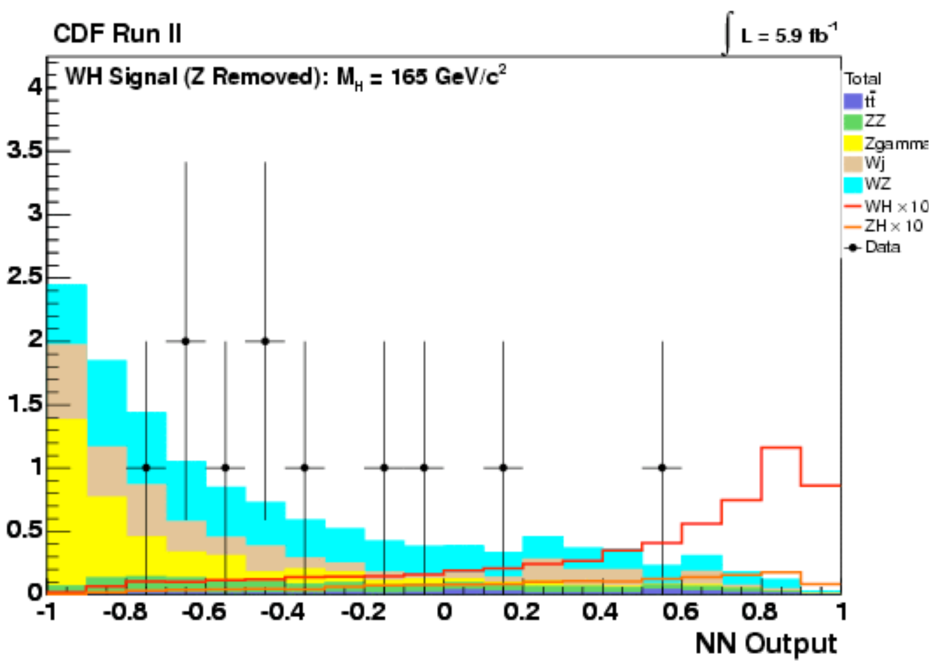
Research supported primarily from startup funds, UW funds, and now DOE supplemental funds. Base grant funding reduced 2006-2010: now ¼.

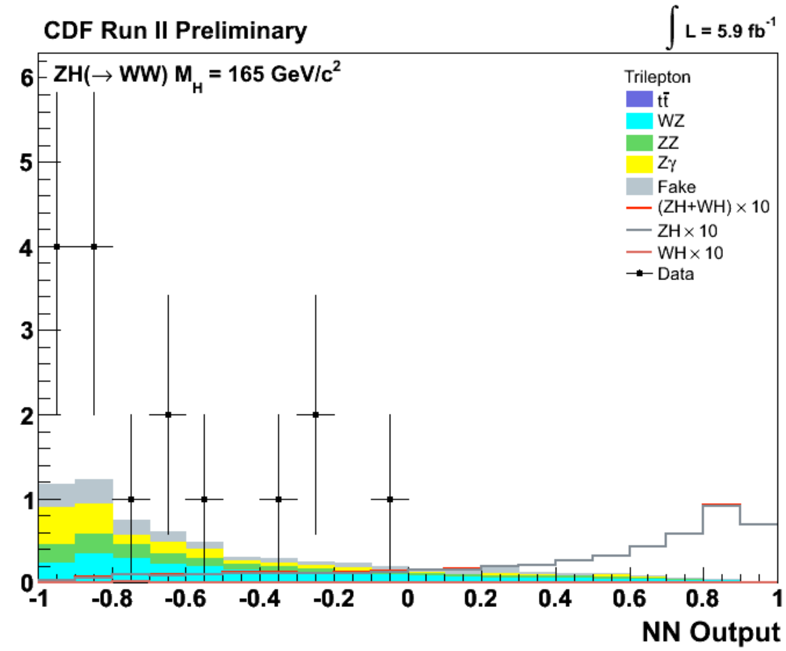
$$\sigma(p\bar{p} \rightarrow WW) = 12.1 \pm 0.9(\mathrm{stat})\ ^{+1.6}_{-1.4}(\mathrm{syst})\ \ [\mathrm{pb}]$$

Trilepton Higgs Search

- Search for associated WH/ZH Higgs production with H→WW, VH→VWW
- Very low background Higgs search: S:B ~ 1/1
- 1.5 Higgs events expected!

Nett





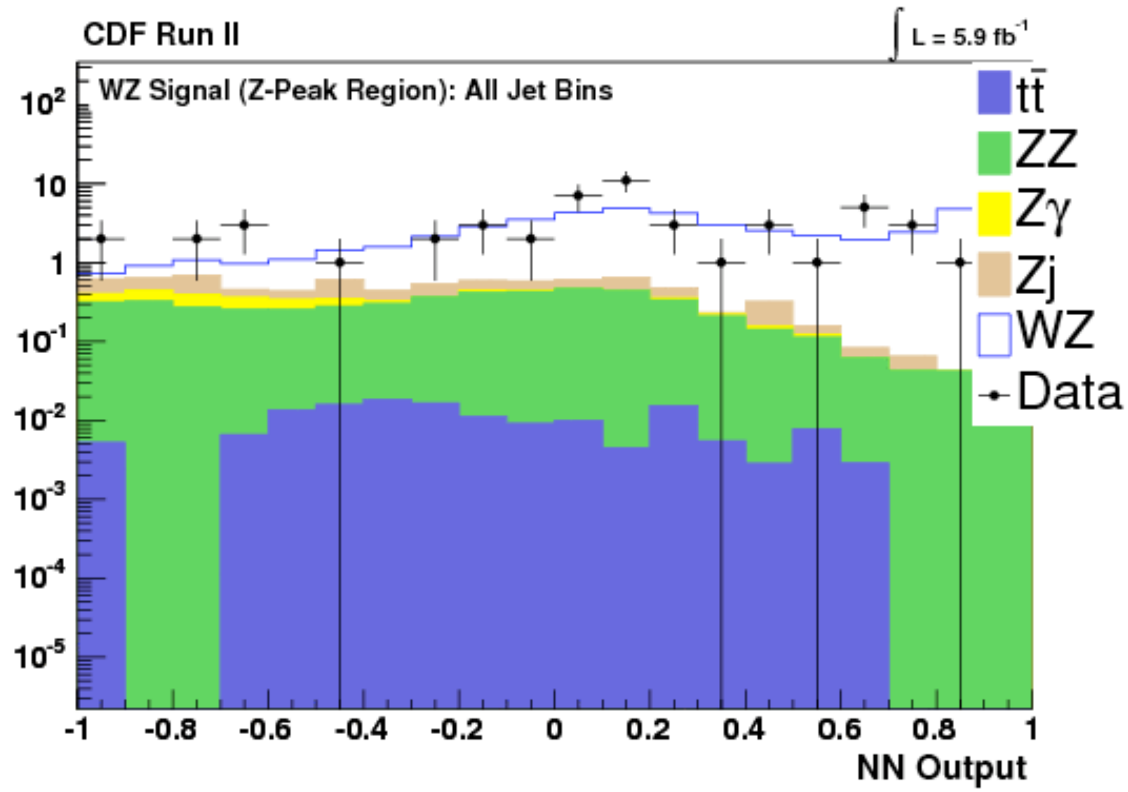
Expected limits 4.62xSM

SM WZ Production

- Measurement of direct standard model WZ Production.
- Uses 0 Jet control region of Higgs ZH→ZWW analysis

Grad. Nett graduated → postdoc Texas A&M

World's most Sensitive measurement of the WZ cross section

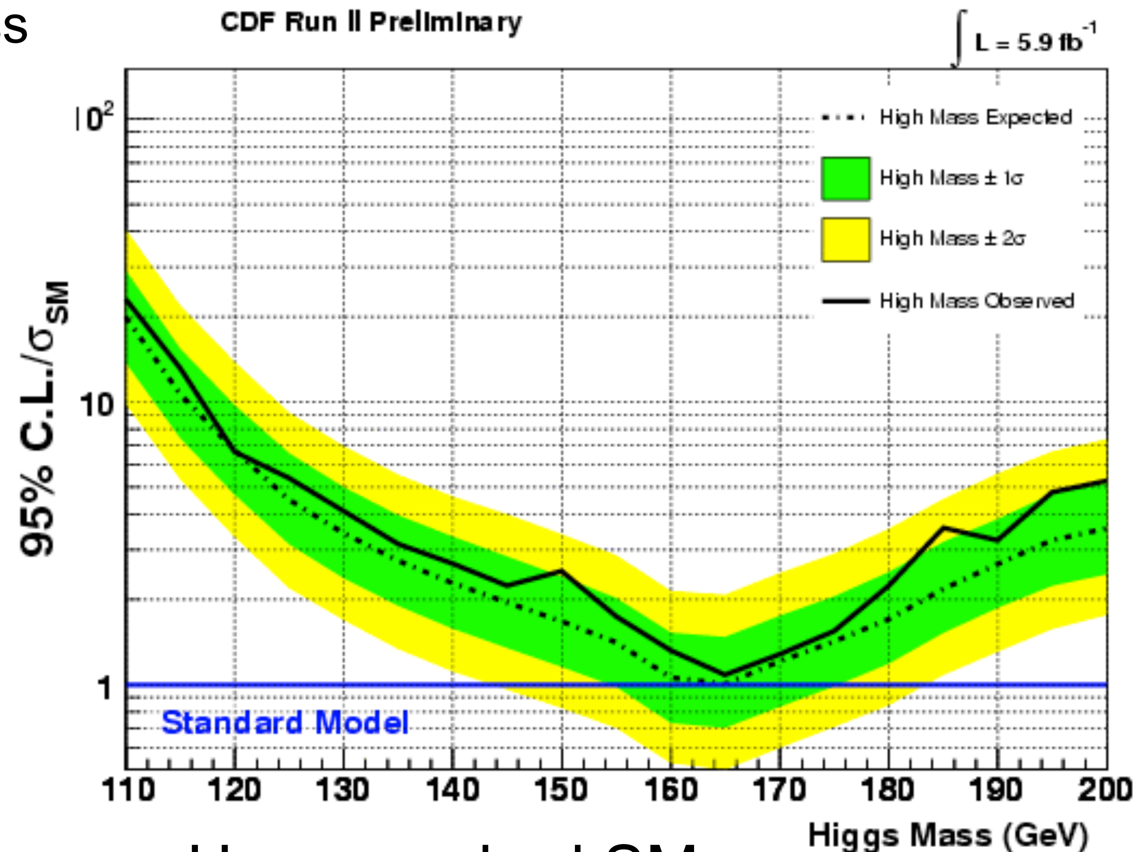


$\sigma(WZ) = 3.7\times10^{-9} \pm 0.6 \pm 0.5$ pb

CDF H→WW Search

- Inclusive search for high mass Higgs with H → WW
- High mass analysis the most sensitive analysis for m_H > 128GeV

H→WW Channels: Limits @ 165 GeV	Exp. Limit
gg→H: 0 Jets	1.67
gg→H: 1 Jet + VH, VBF	2.35
gg→H, VH, VBF: 2+ Jets	3.16
VH: Trilepton	4.62
VH: SS leptons	4.86
gg→H: low m_{ll}	11.2
gg→H: τl	14.5
Combined	1.00

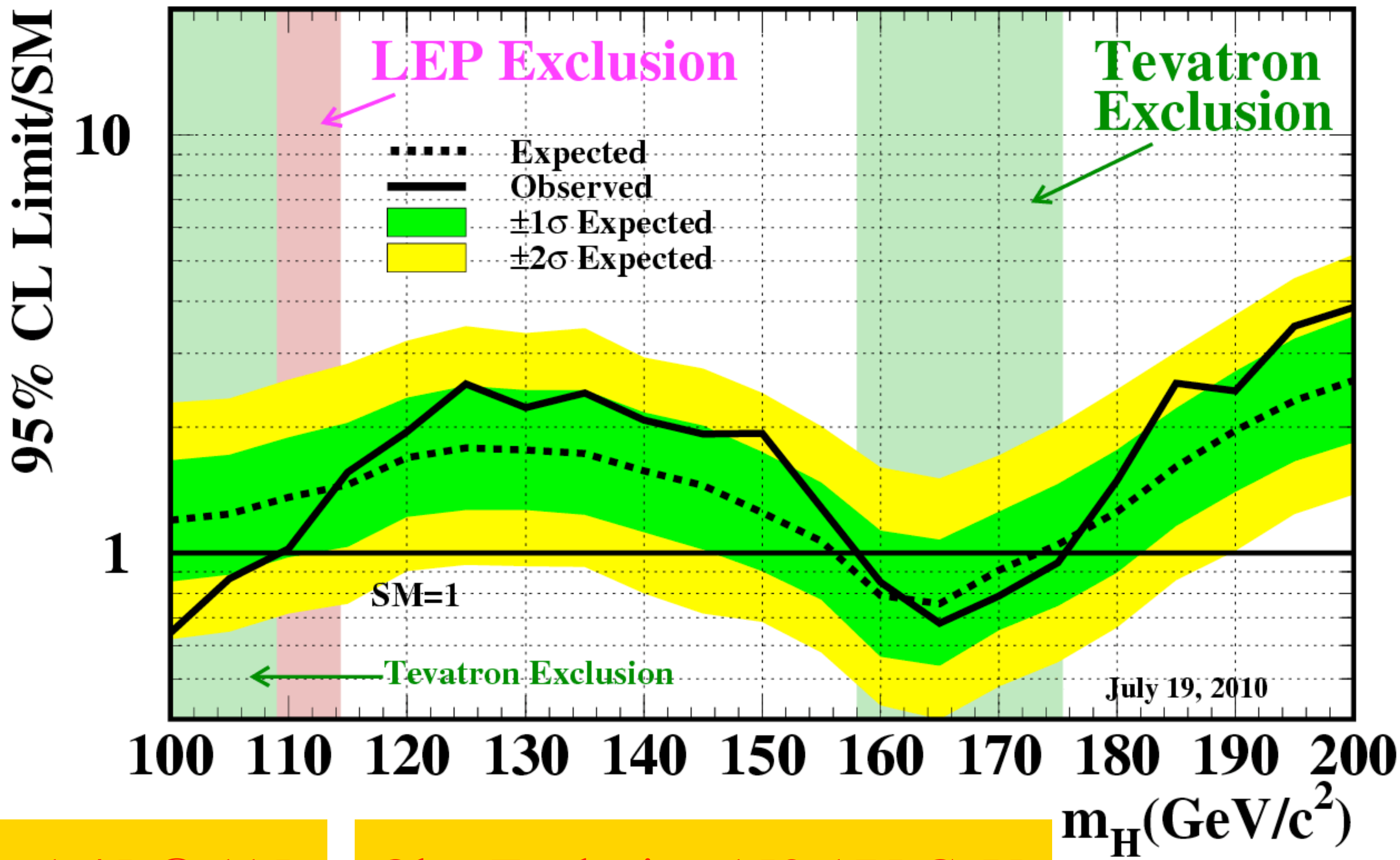


- Have reached SM sensitivity at high mass!

Research by Jason Nett, Jen Pursley and Matt Herndon

Tevatron Higgs Search

Exp. Exclusion 156-173 GeV: 0.76xσ_{SM} @ 165 GeV

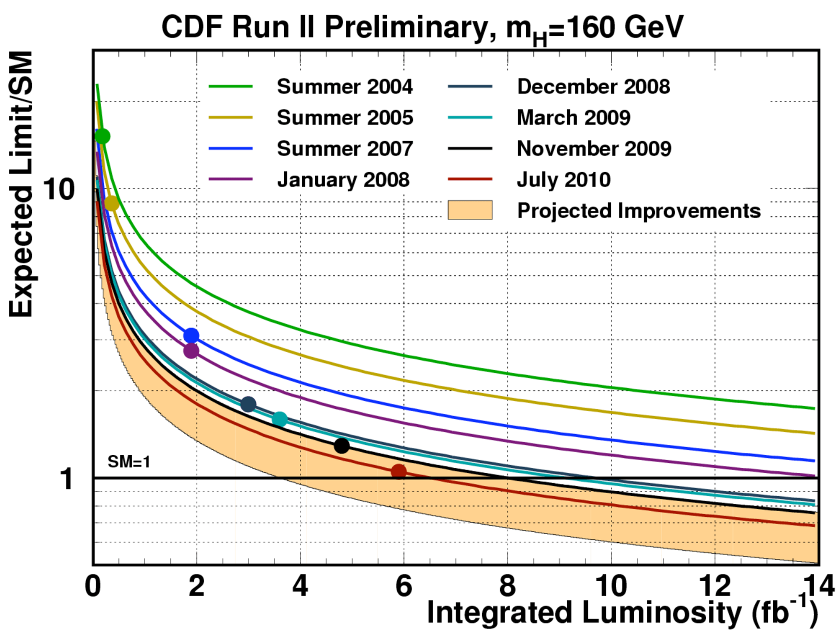


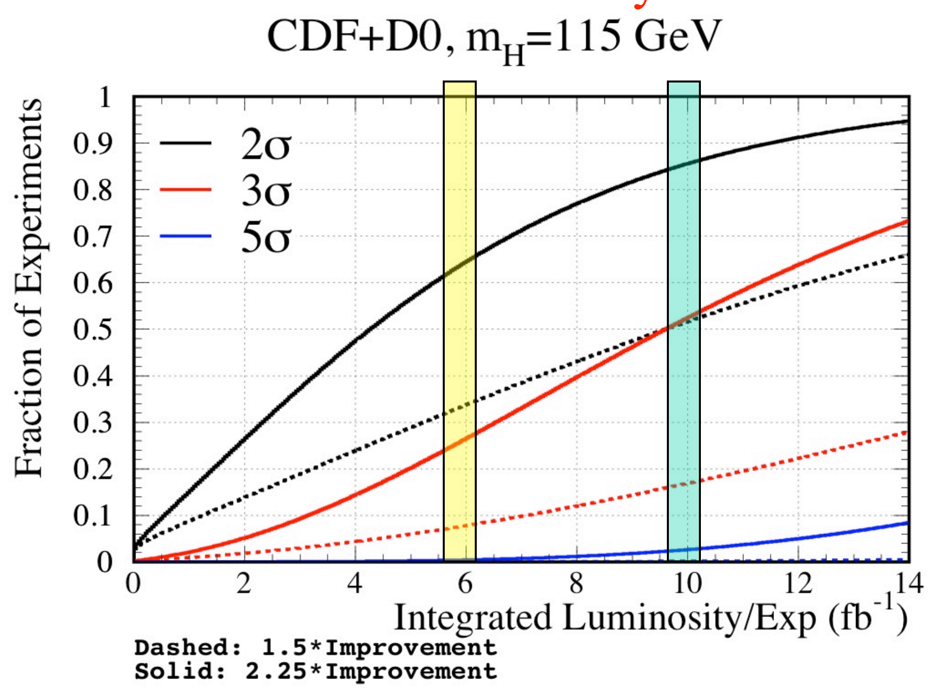
Exp. 1.45 @ 115

Obs. Exclusion 158-175 GeV

Discovery

- Discovery projections: chance of 3σ discovery
  - Two factors of 1.5 improvements examined relative to 2007 analyses.
  - Achieved conservative improvements. Working on aggressive improvements.
  - Result: exclusion m_H 158-175 GeV. H→WW primary channel m_H > 128 GeV
  - Expect exclusion from CDF alone this year
  - Sensitivity for order 135-185GeV exclusion from Tevatron in one year





Publication Overview

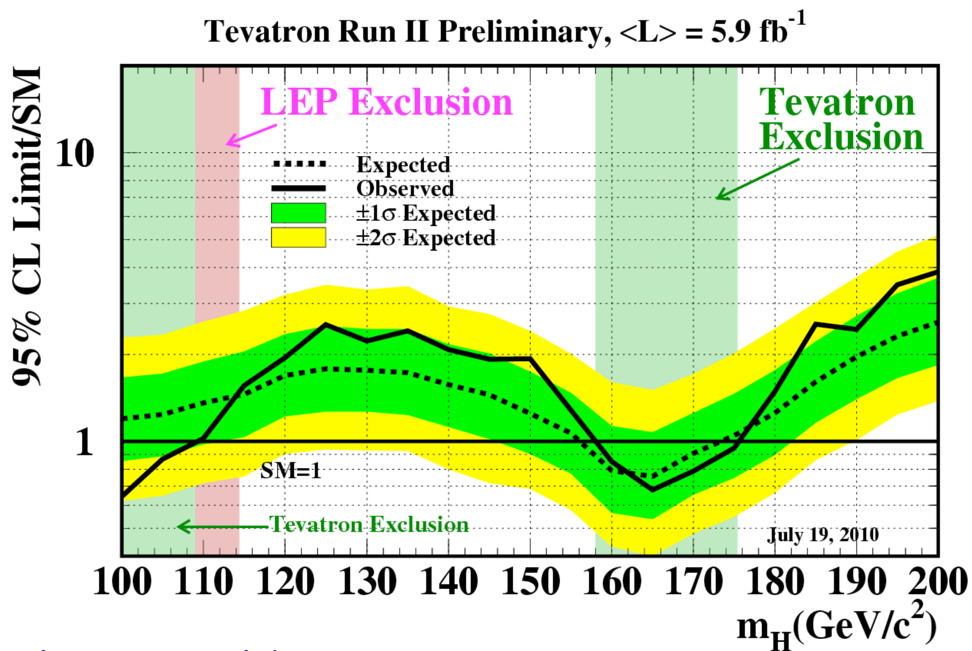
- Published Wisconsin B Physics Results:
  - Orbitally Excited B^0 Mesons Dr. J. Pursley, PRL 102, 102003, 2009
  - Observation B_s - B_s Oscillations Prof. M. Herndon, PRL 100, 082001,2008 (2nd UW pub.)
  - Search for $B_s \rightarrow \mu^+\mu^-$ Prof. M. Herndon, PRL 100:101802,2008 (3rd)
- Published Wisconsin Higgs results
  - $H \rightarrow WW \rightarrow l\nu l\nu$ Prof. M. Herndon and Dr. J. Pursley PRL, 102, 021802, 2009(2nd)
  - Inclusive $H \rightarrow WW$ Prof. M. Herndon and Dr. J. Pursley PRL, 104, 061803, 2010(3rd)
  - Tevatron $H \rightarrow WW$ Prof. M. Herndon and Dr. J. Pursley PRL, 104, 061802, 2010
  - Cover of PRL, PRL suggested reading, PRL special spotlight article.
  - $H \rightarrow WW$ 4th Gen Prof. M. Herndon and Dr. J. Pursley Submitted to PRDRC 2010
- Published Wisconsin EW Physics Results:
  - $\sigma(WW)$ Dr. Jennifer Pursley PRL, 104, 201801, 2010 (2nd)
- Expected 2010 publications: CDF only Higgs exclusion and $\sigma(WZ)$ Prof. M. Herndon, Dr. J. Pursley, and J. Nett.

Conclusions

- Wisconsin is leading a vibrant physics program at CDF of the highest scientific interest.
- Covers from the fundamental issues of understanding QCD and vector boson production to the central issues in the field such as the origin of mass.
- The Higgs boson search is in its most exciting era ever

SM Higgs Excluded:

m_H = 158-175 GeV



Expect large exclusion, or evidence,

with full Tevatron data set