Searches for Higgs Bosons at the DØ Experiment

- ✗ **Standard Model & SUSY Higgs boson searches**
- ✗ **New results since Moriond '07**

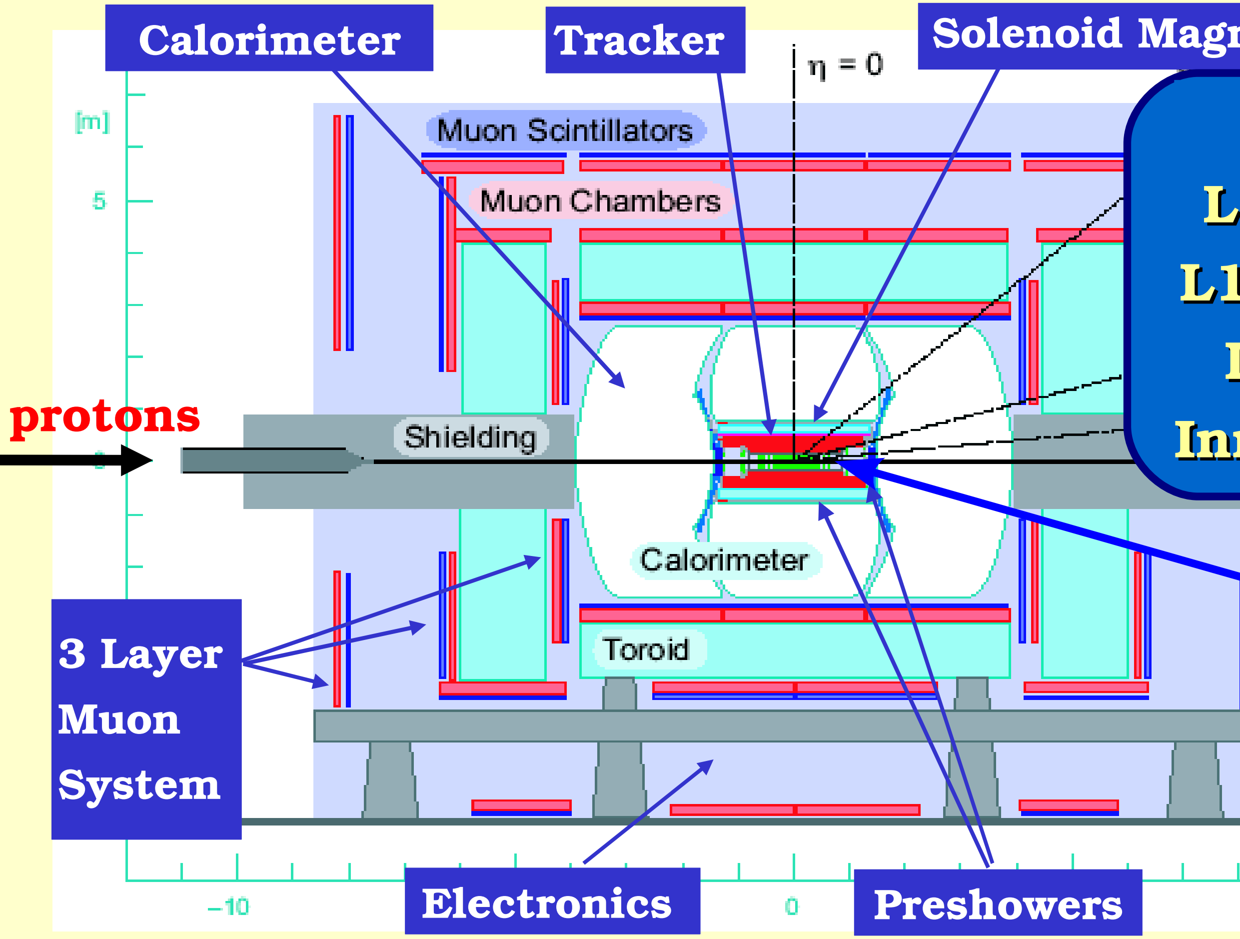
Wade Fisher

Fermilab

On behalf of the DØ Collaboration


The
DØ
Collaboration
18 Countries
81 Institutions
645 Scientists

The DØ Detector



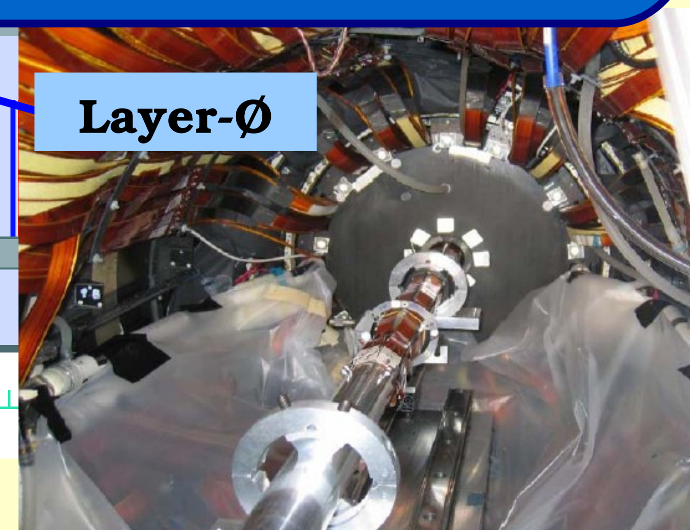
RunIIB upgrades*:

L1 Cal trigger system

L1 Central track trigger

L1 Cal+Track trigger

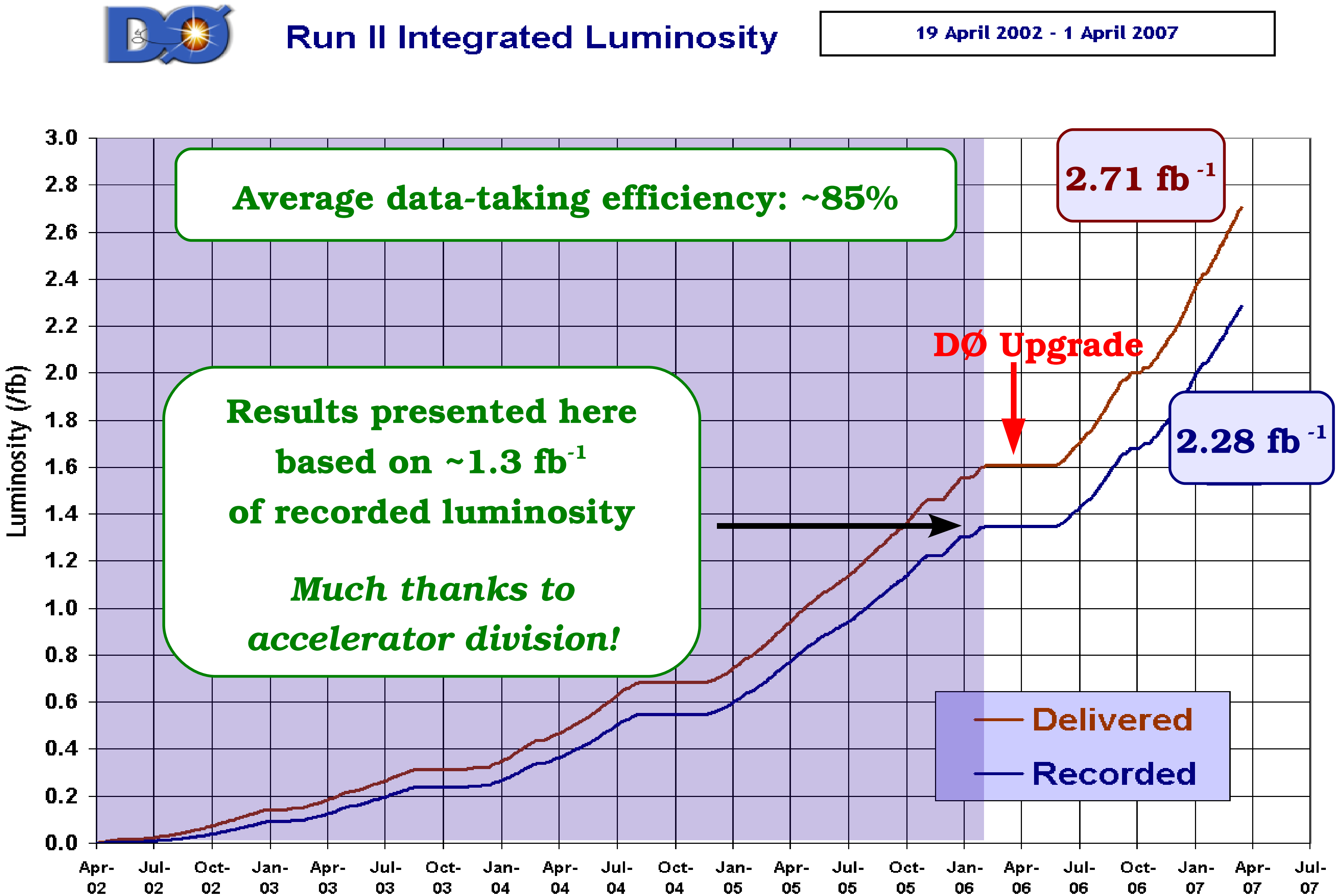
Inner layer for SMT (LØ)



New silicon detector close to beam pipe: improved tracking

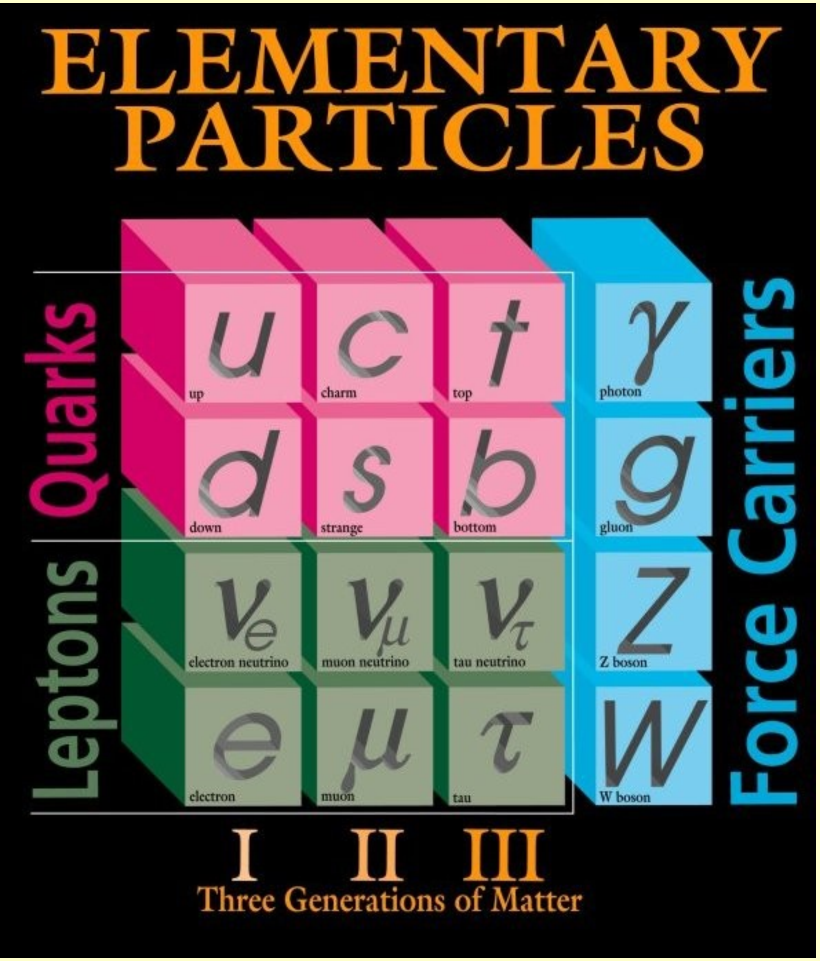
	$\|\eta\|$
Muon ID	**~2**
Tracking	**~2.5**
EM / Jets	**~4**

Dataset


Run II Integrated Luminosity
19 April 2002 - 1 April 2007
Average data-taking efficiency: ~85%
2.71 fb -1
DØ Upgrade
2.28 fb -1
Results presented here
based on ~1.3 fb-1
of recorded luminosity
Much thanks to
accelerator division!
Luminosity (/fb)
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Apr-02
Jul-02
Oct-02
Jan-03
Apr-03
Jul-03
Oct-03
Jan-04
Apr-04
Jul-04
Oct-04
Jan-05
Apr-05
Jul-05
Oct-05
Jan-06
Apr-06
Jul-06
Oct-06
Jan-07
Apr-07
Jul-07
Delivered
Recorded

The Case for the Higgs

- Many years of work have led to our current description of matter and its interactions: ***Standard Model***

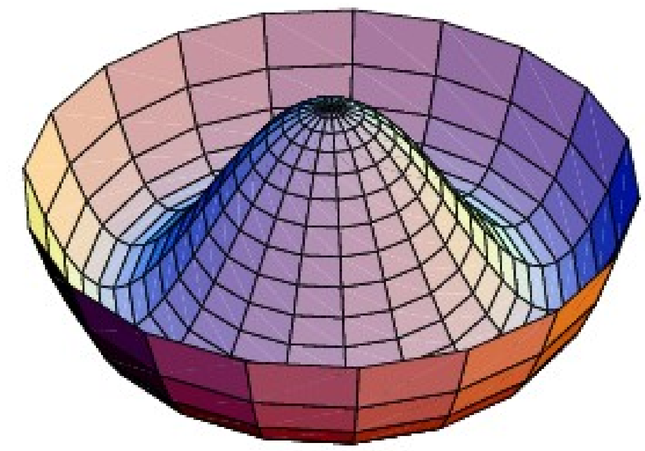


- Cast of characters includes
  - Matter particles (fermions): quarks and leptons
  - Force carriers (bosons): photon, gluon, $W^{\pm}/Z^{0}$
- Highly successful predictive model
  - *But there's a problem!! No explanation for particle masses*

The Case for the Higgs

- Electroweak model is very powerful
  - $SU(2)_L \times U(1)_Y$ is well tested in collider experiments
  - *But it is not a symmetry of our vacuum* – otherwise quarks, leptons, and gauge bosons would all be massless
- Higgs mechanism provides a natural solution
  - Add one complex doublet of scalar fields in a Φ^4 potential
- Symmetric solution unstable, broken EW symmetry creates non-zero VEV
  - $W^{\pm}/Z^0$ longitudinal polarizations absorb three degrees of freedom, remaining one becomes neutral scalar (Higgs boson)
  - Ground state VEV parameterizes W/Z masses
  - *Higgs mass not predicted:* $m_H \propto \mu$ ☹

$$V_{Higgs} = -\mu^2 \phi^\dagger \phi + \lambda (\phi^\dagger \phi)^2$$



$$\phi_0 = \pm\sqrt{-\mu^2/2\lambda}$$

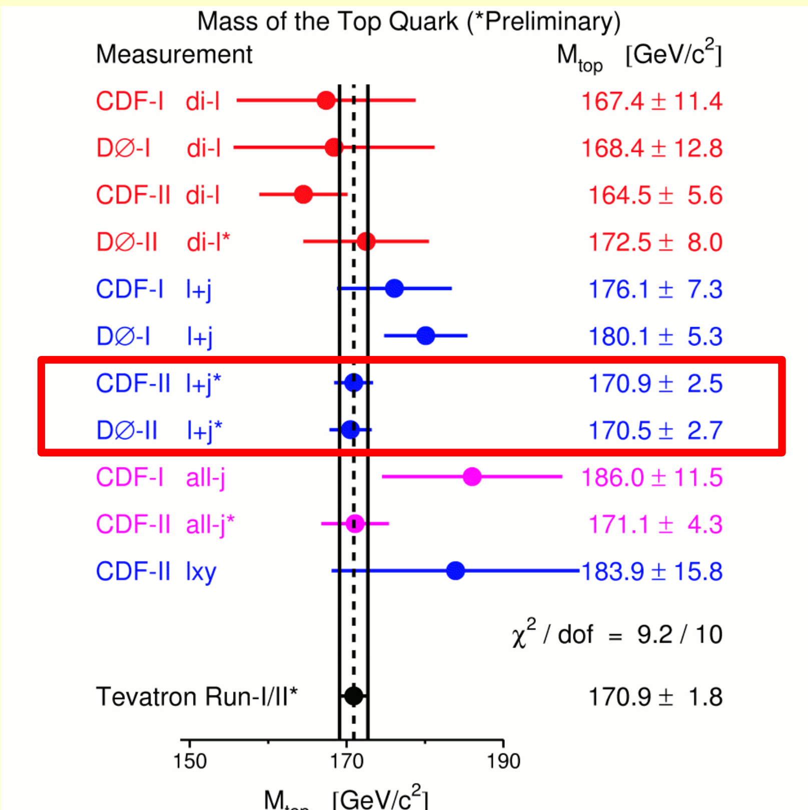
Cornering the Higgs

Indirect Constraints:

Top, W-boson masses

Direct searches at LEP II:

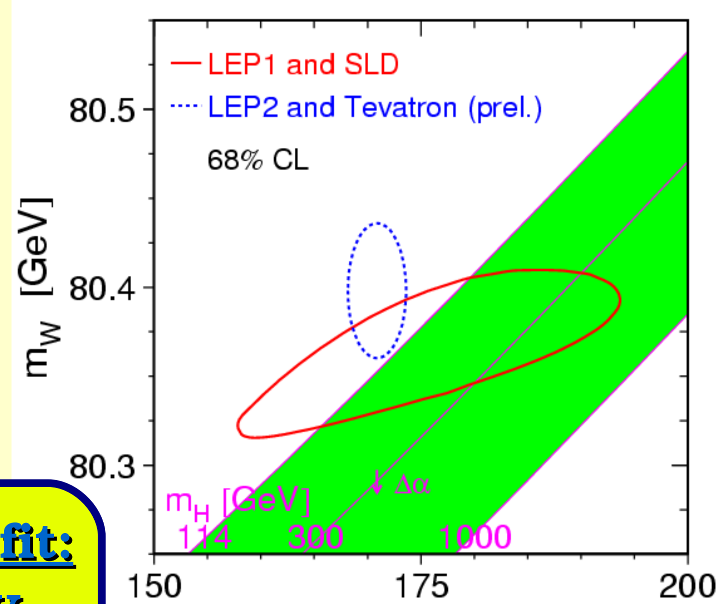
m_H>114.4 GeV @ 95% CL

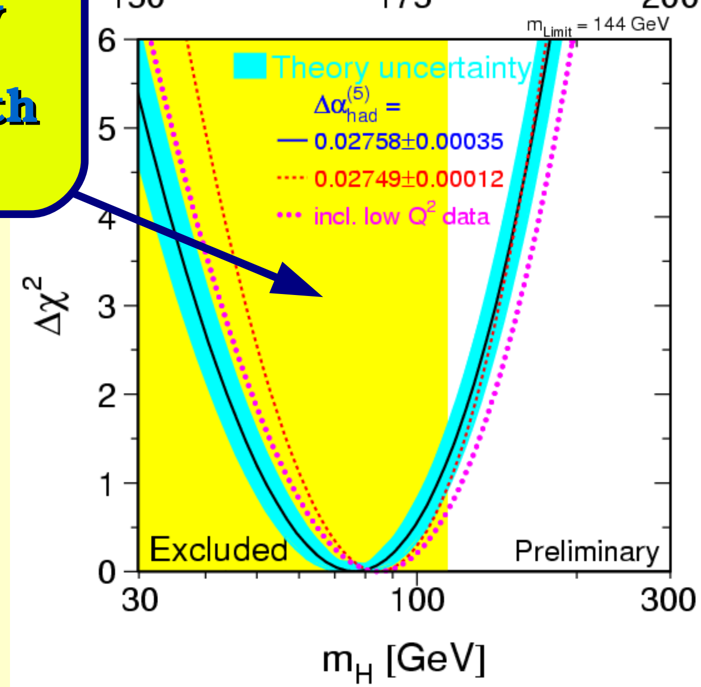


Precision EW fit:

m_H<144 GeV

(<182 GeV with LEPII Limit)

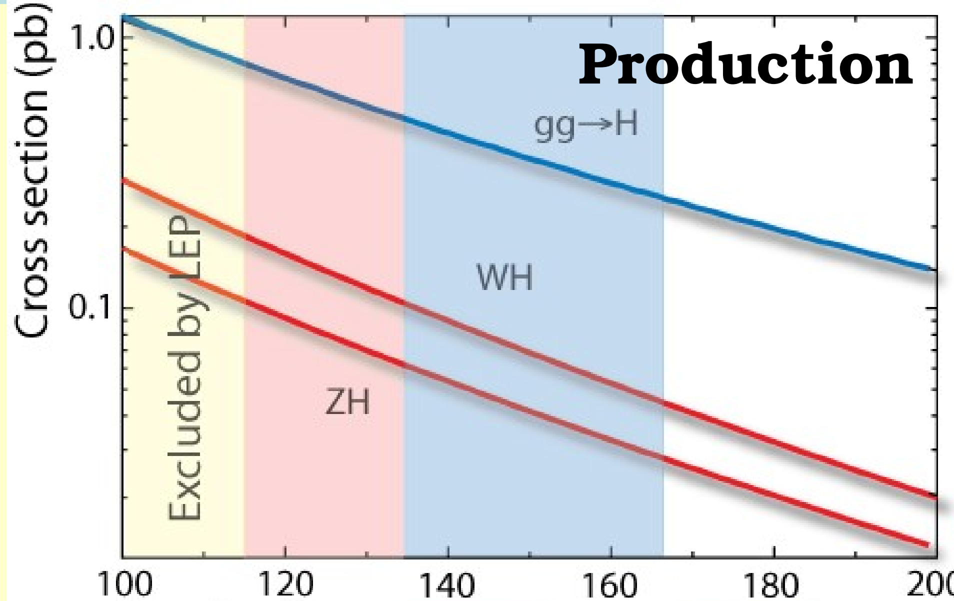




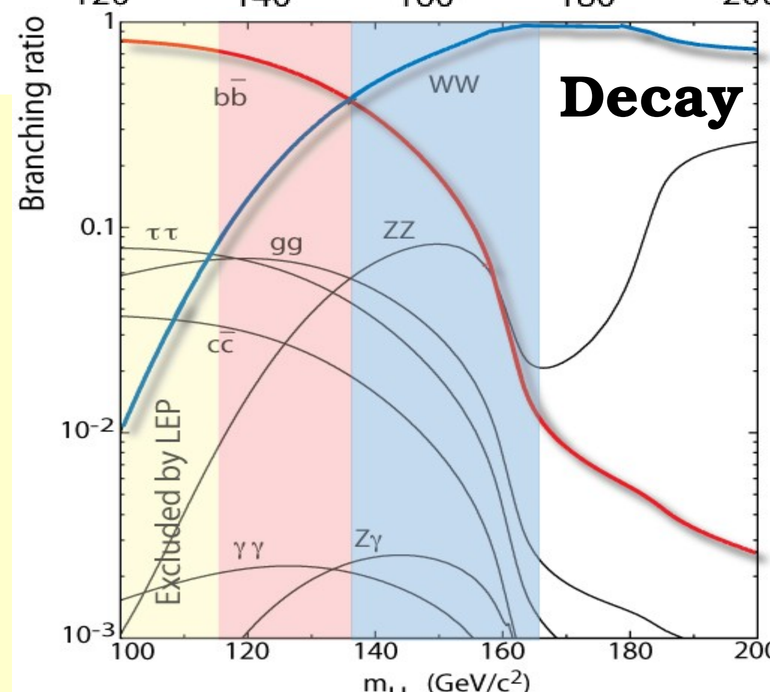
SM Higgs at the Tevatron

Wine & Cheese
April 6th, 2007

- Gluon fusion dominates for hadron colliders
  - Large backgrounds restrict useful Higgs decay channels
- Next largest is associated production of W/Z + Higgs
  - Leptonic decays of W/Z bosons provide tag for trigger and analysis

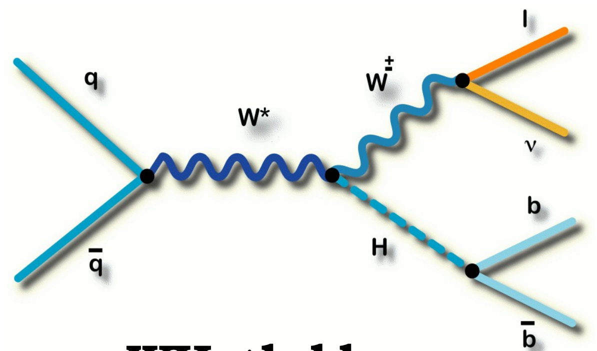


- Low-mass Higgs (m_H<135 GeV) prefers to decay to bottom-quark pairs
  - Need efficient ID of bottom quarks to reduce backgrounds
- At high-mass (m_H>135 GeV), search for $H \rightarrow WW^*$ decays
  - Off-shell W boson allows off-resonance production

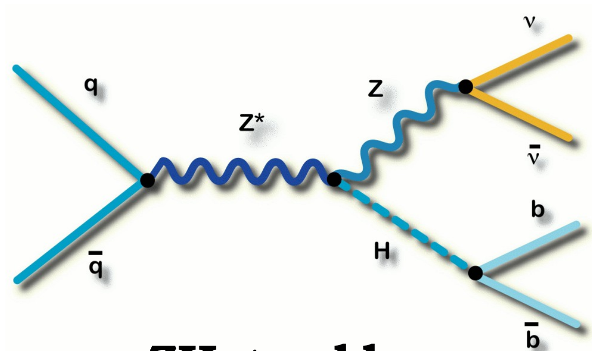


Standard Model Search Channels

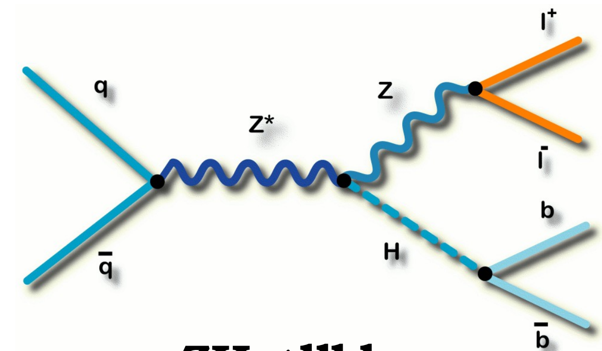
<u>Associated Production:</u> Low mass only, 3 final states



WH→lνbb



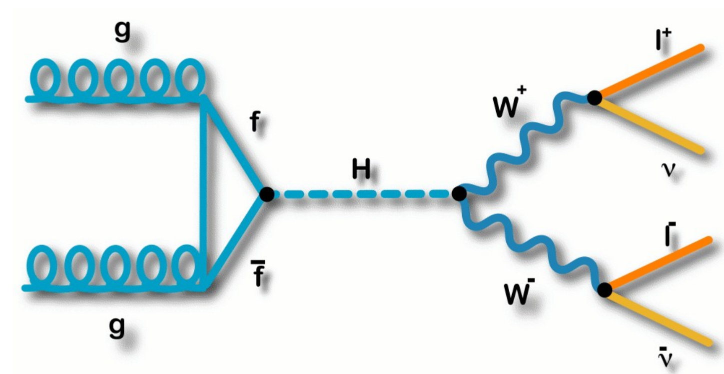
ZH→ννbb



ZH→llbb

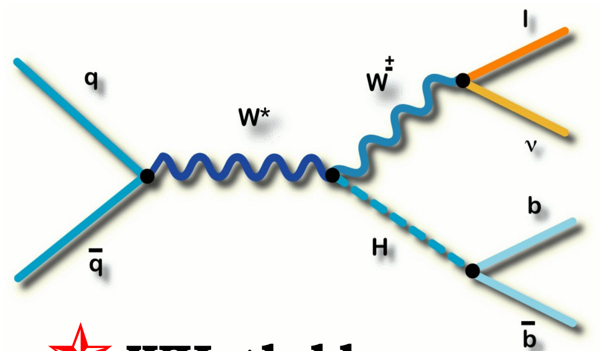
<u>Gluon Fusion Production:</u>

Maximum sensitivity at high mass, also useful at low mass

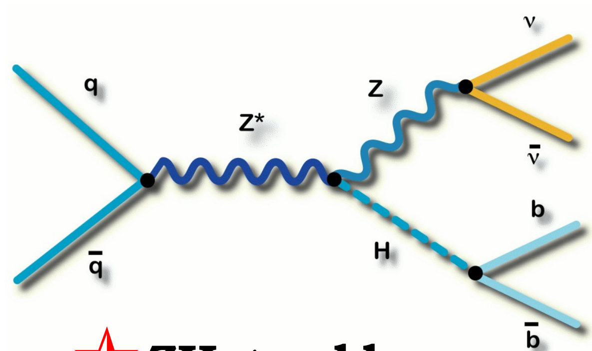


Standard Model Search Channels

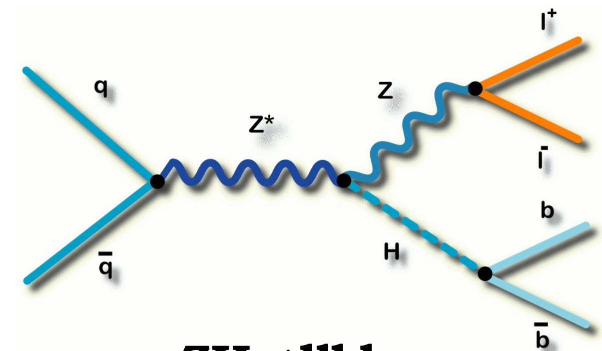
Associated Production: Low mass only, 3 final states



☆ WH→lνbb



☆ ZH→ννbb

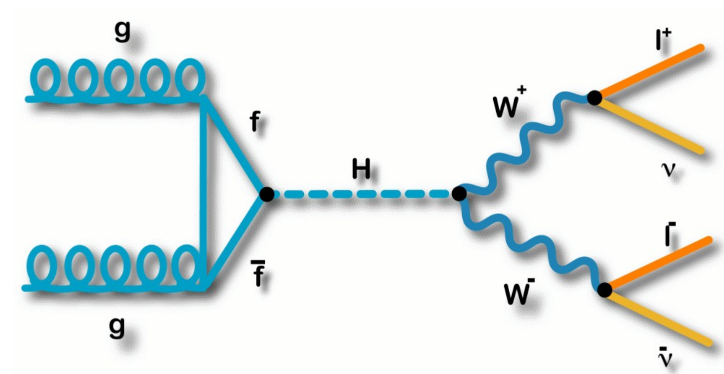


ZH→llbb

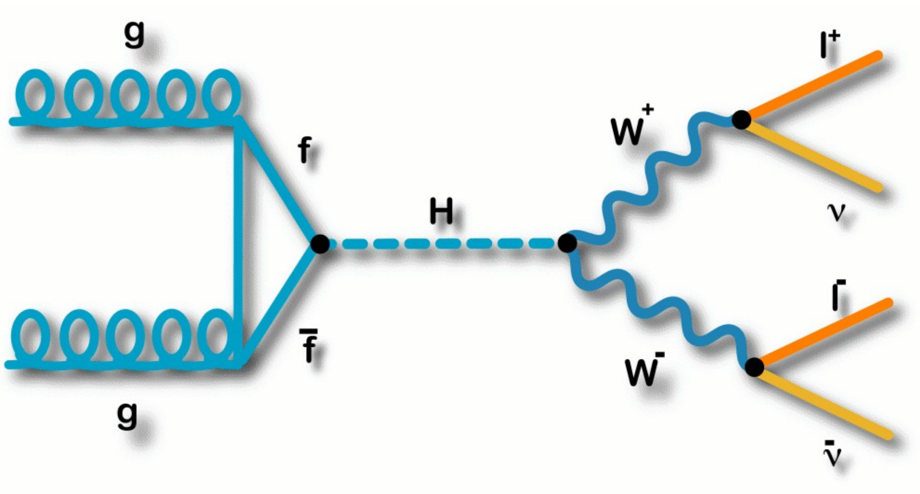
☆ New since mid-March + 1fb^{-1} combined limit

Gluon Fusion Production:

Maximum sensitivity at high mass, non-negligible at low mass



Gluon Fusion Higgs Production



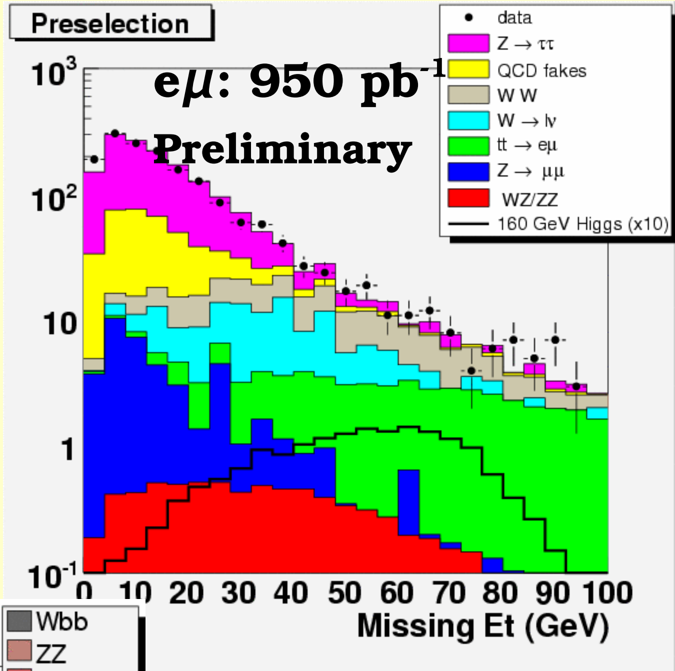
Experimental Signature

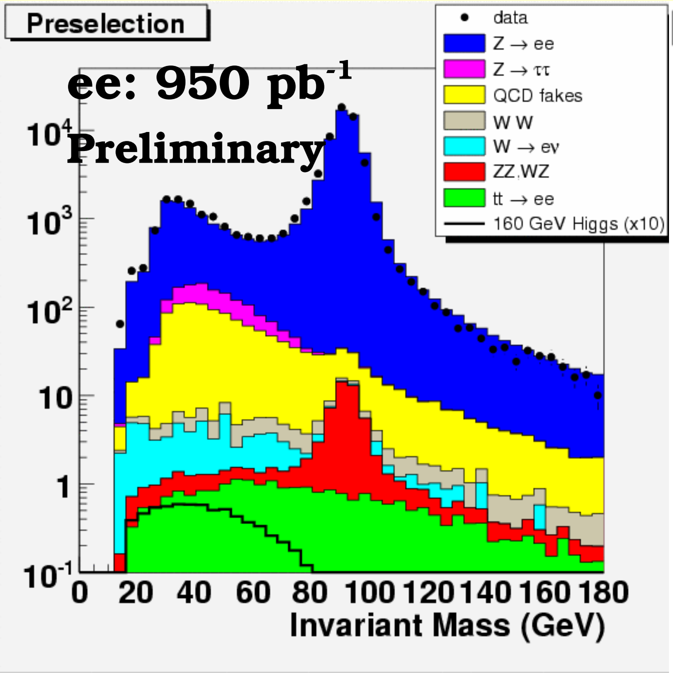
- ✗ Two high-pT leptons from W-boson decays (e or μ)
- ⇒ 3 final states: ee, eμ, $\mu\mu$
- ✗ Significant missing transverse energy from neutrinos
- ✗ Highest sensitivity individual search channels!

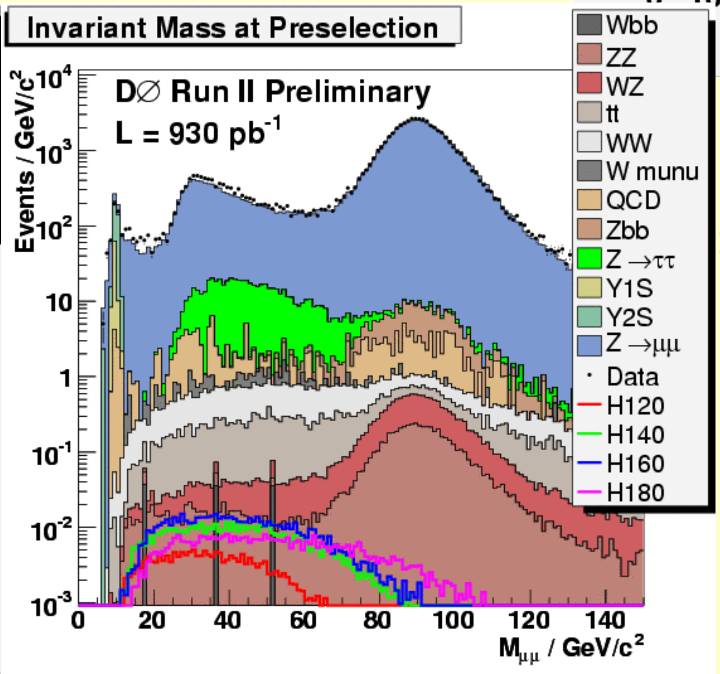
Searching for $H \rightarrow W^+W^-$ *(ICHEP)*

Wine & Cheese
April 6th, 2007

- ✗ Select high-pT leptons (pT > 15/10 GeV, electrons & muons)
  - ✗ Use Z-peak for normalization (ee/$\mu\mu$), veto region after norm
- ✗ Require large missing transverse energy signature from neutrinos (MET > 20 GeV)
- ✗ Restrict sum of MET + lepton pT (scalar and vector)





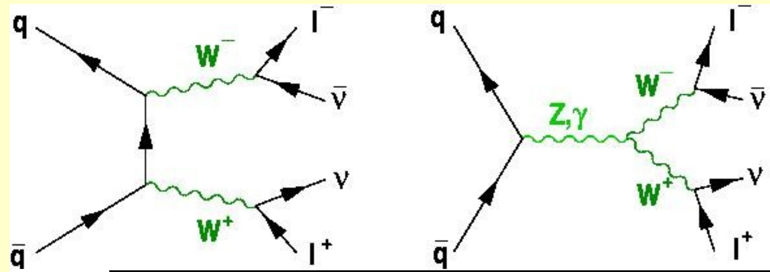


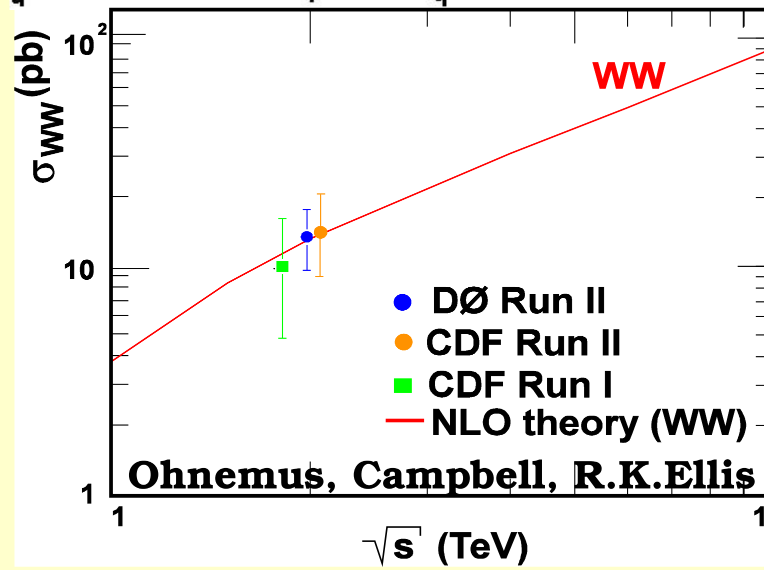
Preselection removes W/Z+jets, but SM W^+W^- still large!

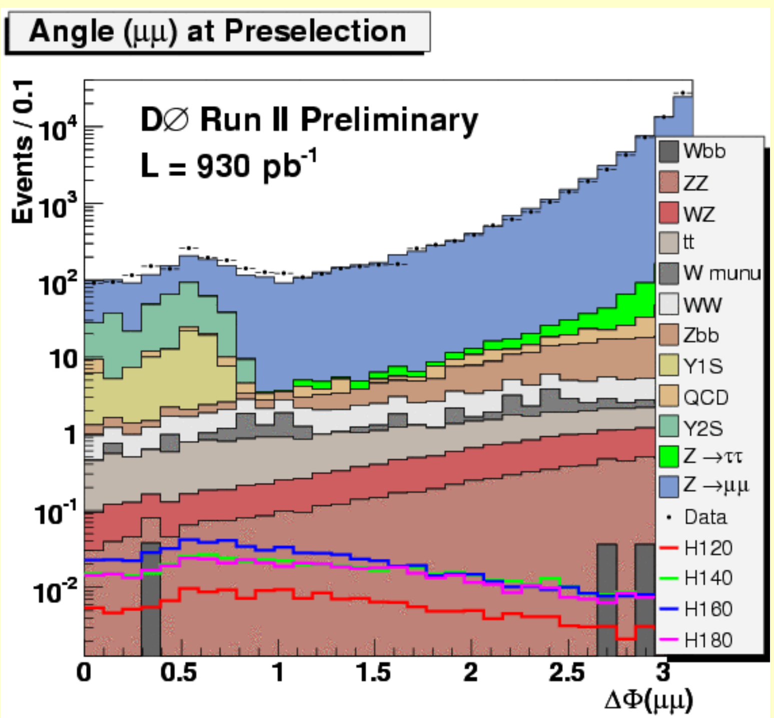
Searching for $H \to W^+W^-$ *(ICHEP)*

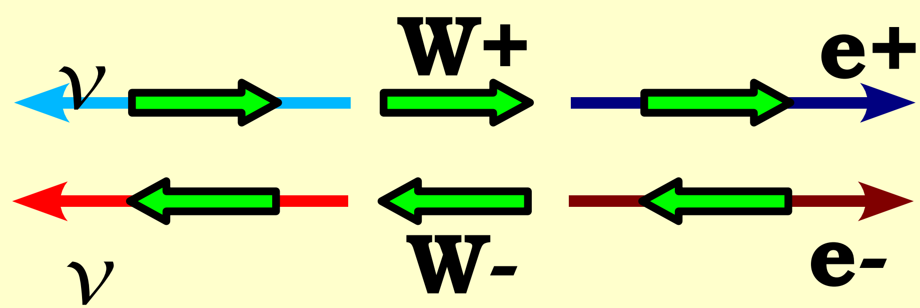
Wine & Cheese
April 6th, 2007

- Largest background is Standard Model W^+W^- production
  - Well-measured at both DØ and CDF
- Scalar higgs (spin-0) provides natural discrimination due to spin correlation!
  - Leptons prefer to be collinear: $\Delta\phi(l,l)$ excellent discriminant!









Searching for $H \to W^+W^-$ (ICHEP)

Wine & Cheese
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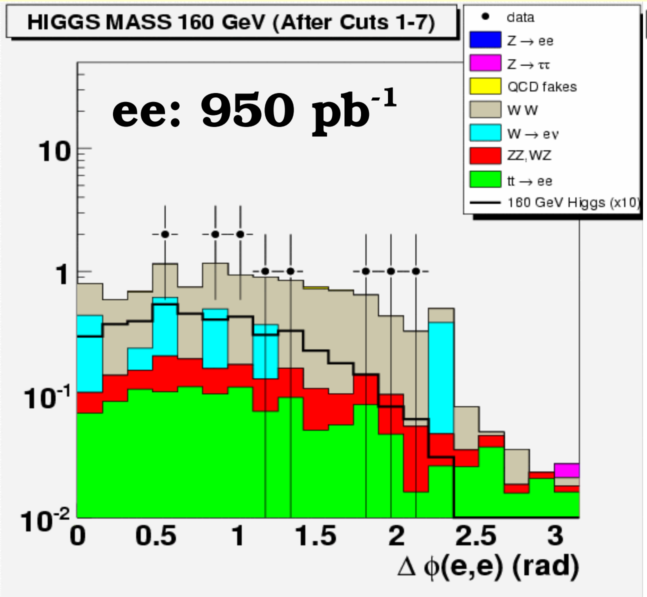
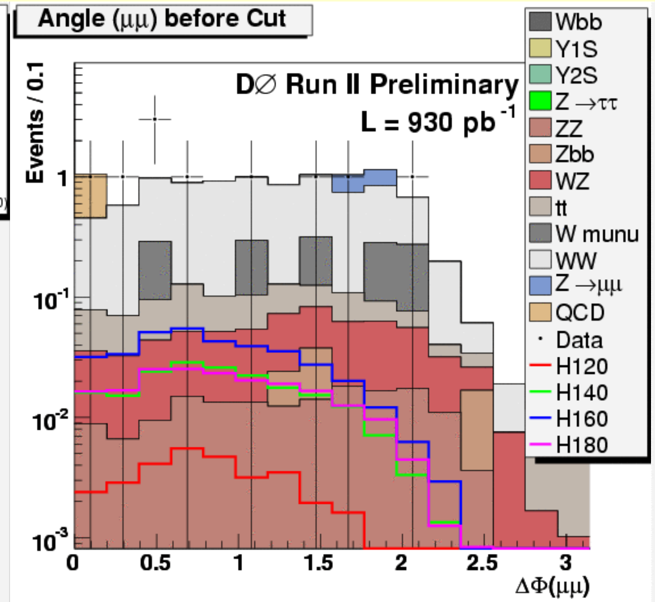
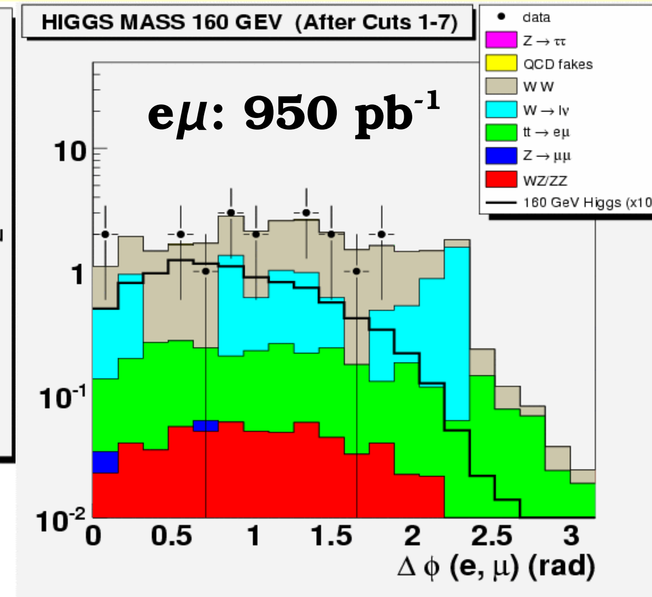




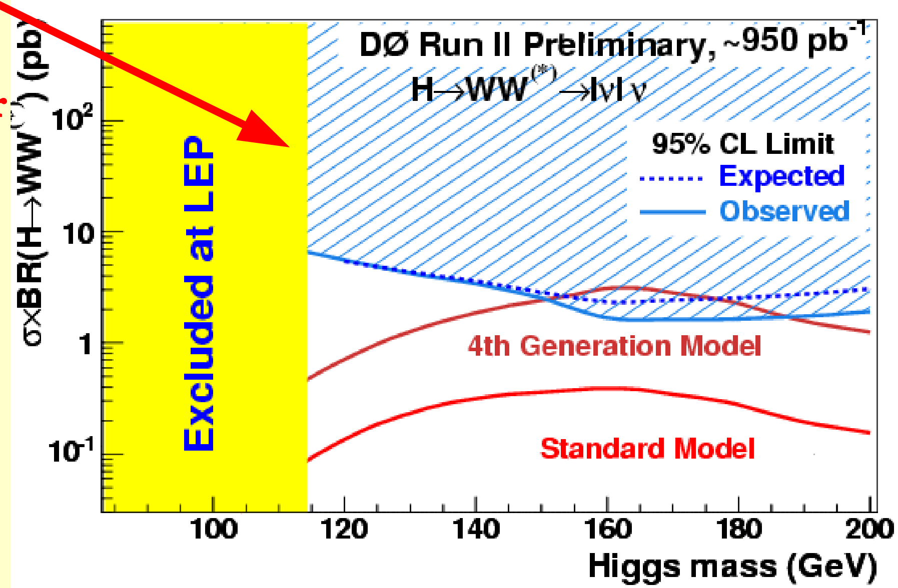


ICHEP: CLs limit excludes 4th generation model for $150<m_H<185$

Today: New limit calculation, more on this later

Expected/Observed Events in 1.0fb^{-1}
mH=160 GeV

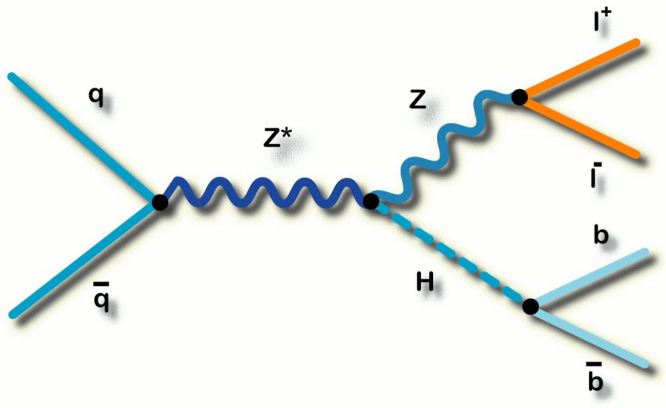
Channel	Signal	Bkgd	Data
ee	0.42	10.3	10
eμ	0.97	24.4	18
μμ	0.35	9.8	9

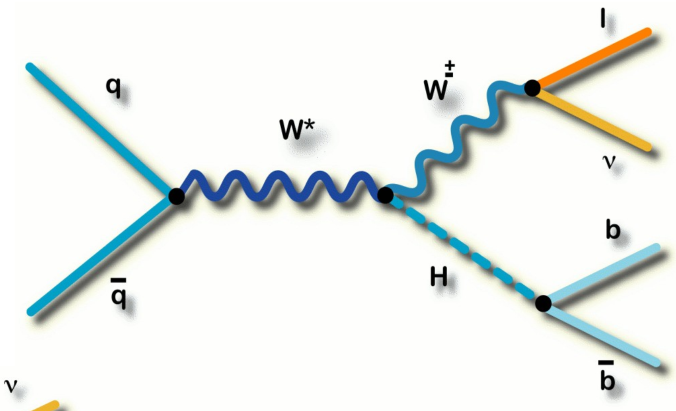


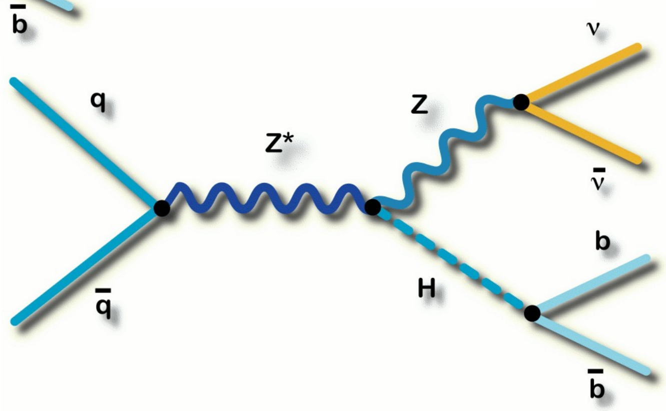
Associated Higgs Production

Experimental Signature

- ✗ Leptonic decay of W/Z bosons provides "handle" for event
- ✗ Higgs decay to two bottom-quarks helps reduce SM backgrounds



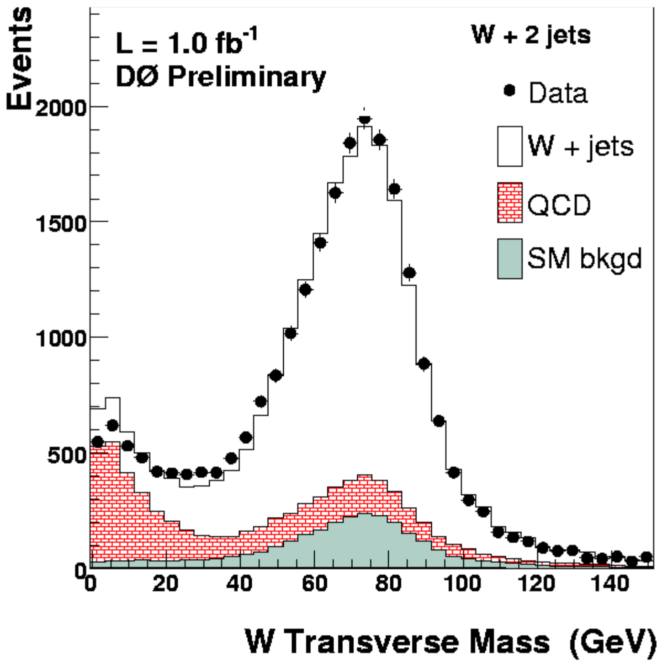


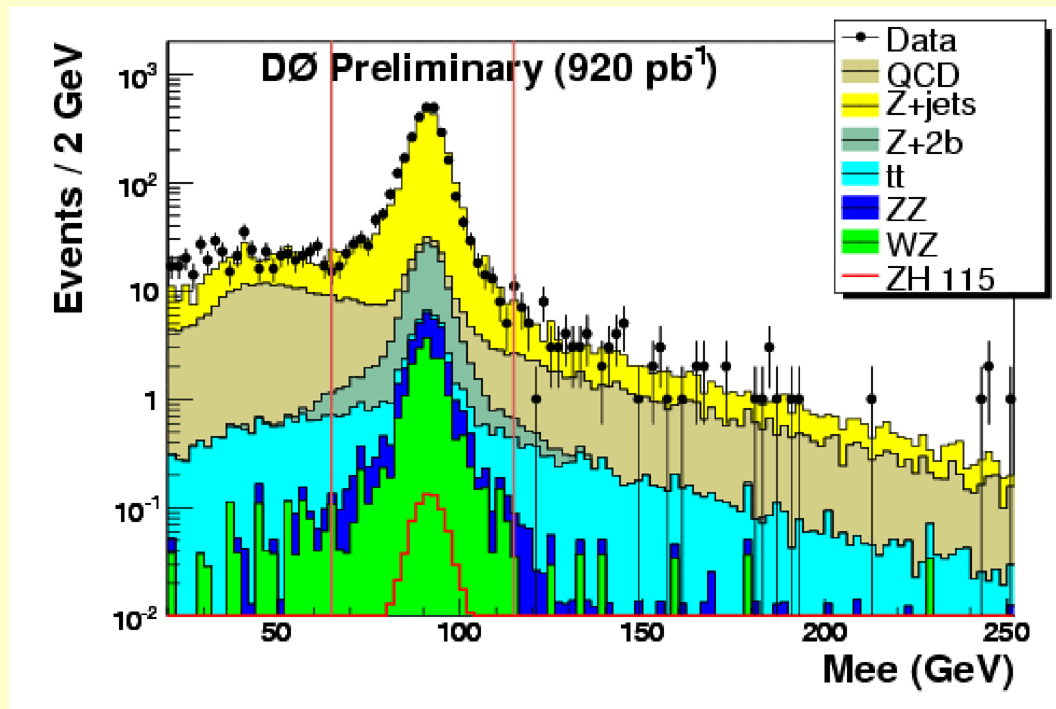


Selecting $W \rightarrow l\nu$ & $Z \rightarrow ll$

- Select events by utilizing vector-boson decay signatures
  - Require **one**(**two**) high-pT leptons: pT > **20**(**15**) GeV)
  - Neutrinos manifest as missing transverse energy
    - WH→lνbb: **MET > 20 GeV**, ZH→llbb: **MET *should be small!!***
  - Reconstruct vector boson mass
- Use "OR'ing" of muon triggers: 100% efficiency & +15% in sensitivity

$$M_W^{trans} = \sqrt{2\, p_T^l ME_T (1 - \cos(\Delta\phi))}$$



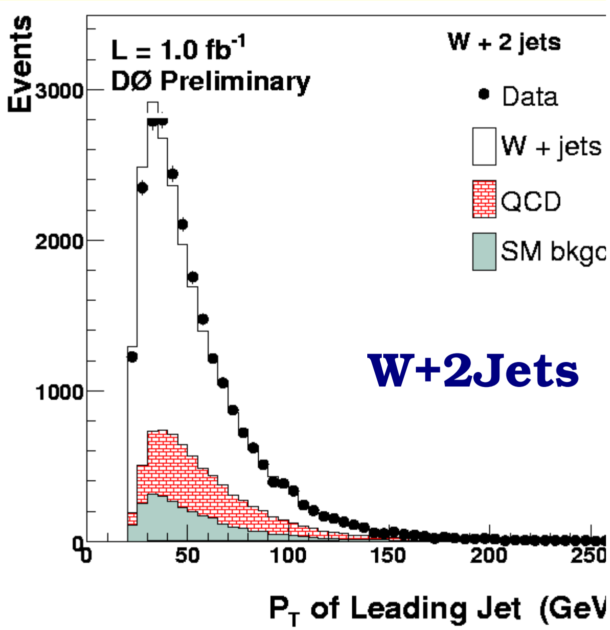


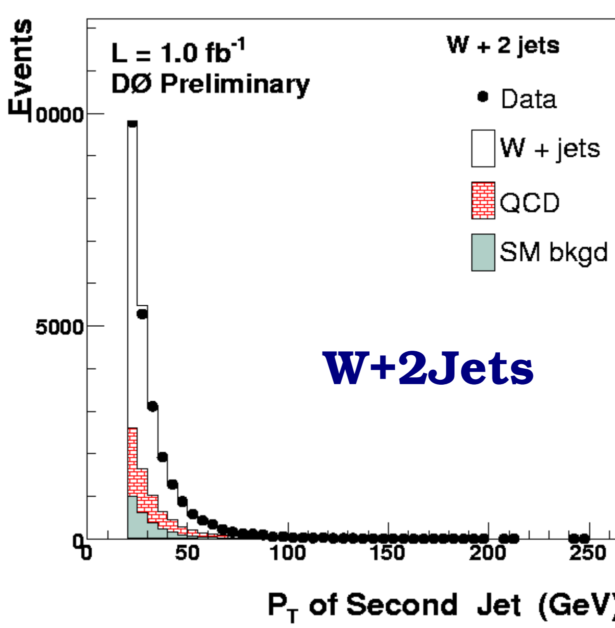
$W \to l\nu$ & $Z \to ll$ + Jets

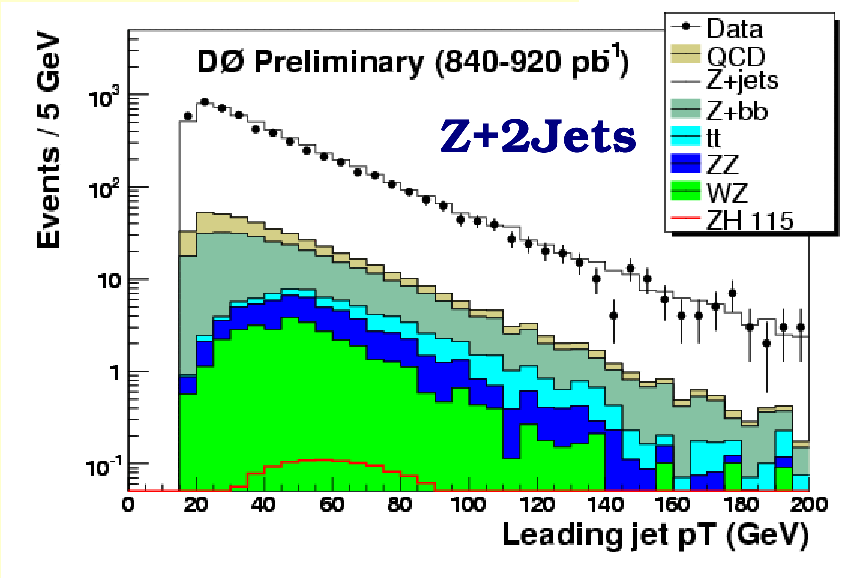
- ✗ Select high-pT, central jets as a first step towards a Higgs signature

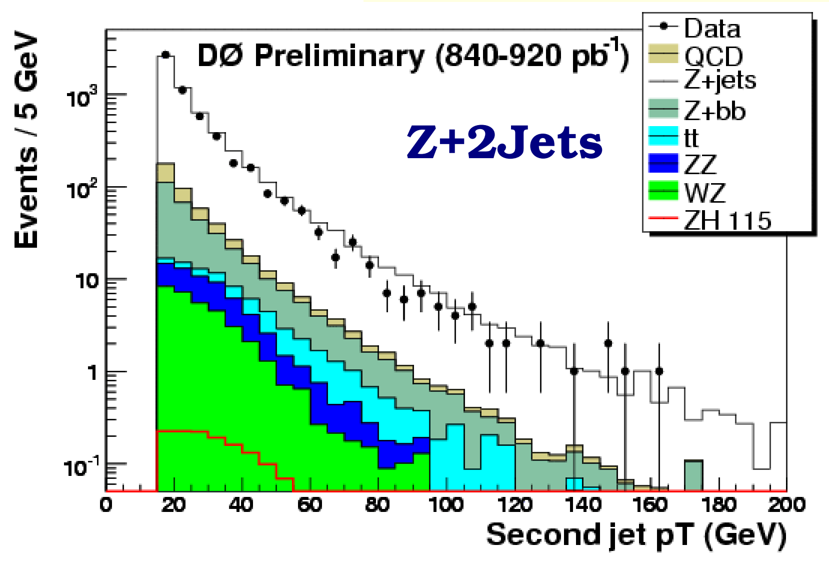
  WH→lνbb: pT>20 GeV, |η|<2.5

  ZH→llbb: pT>15 GeV, |η|<2.5







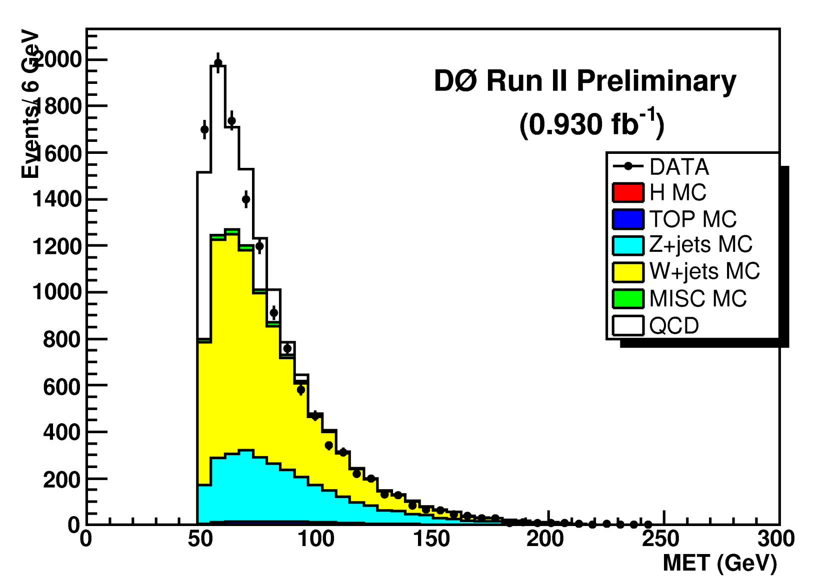


Selecting $Z\rightarrow\nu\nu$ + Jets

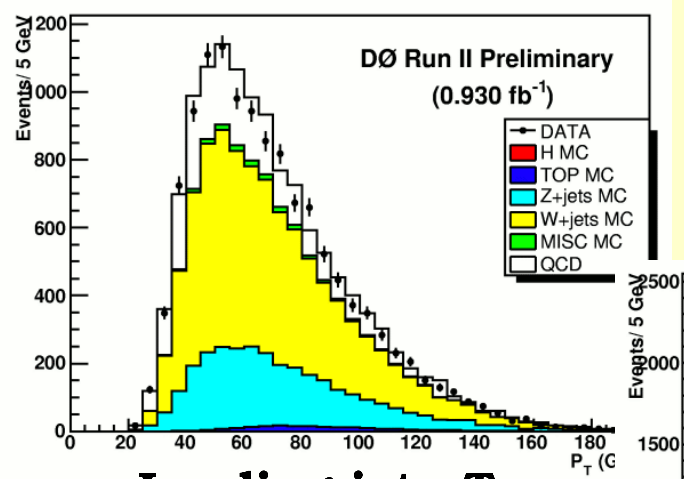
- For $ZH\rightarrow\nu\nu bb$ the search is more difficult: no charged leptons!
  - Rely on large MET (neutrinos!)
  - Backgrounds

  "Physics": Z+jets, W+jets, top-pair, ZZ, WZ

  "Instrumental": QCD multijets with mismeasured jets

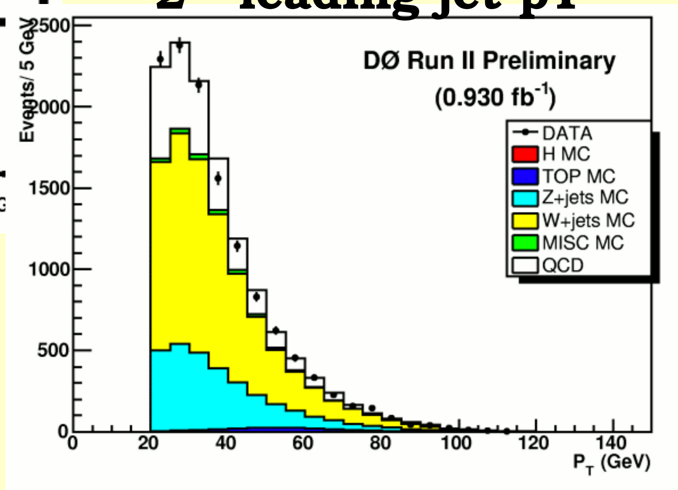


- **Background reduction:**
  - Trigger on large missing HT (vector sum of jet ET), select large MET:>50 GeV
  - Select two high-pT jets to define final state (pT>20 GeV, $|\eta|<2.5$)
  - Veto back-to-back jets: $\Delta\phi<165^{\circ}$



Leading jet pT

2nd leading jet pT



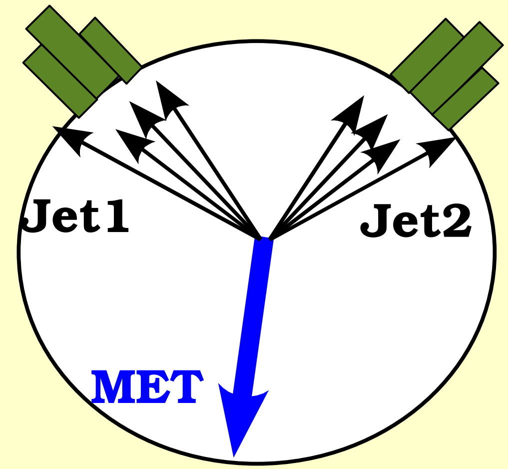
Selecting $Z \rightarrow \nu\nu$ + Jets

- Reduction of Instrumental background:
  - Define missing energy/momentum variables:

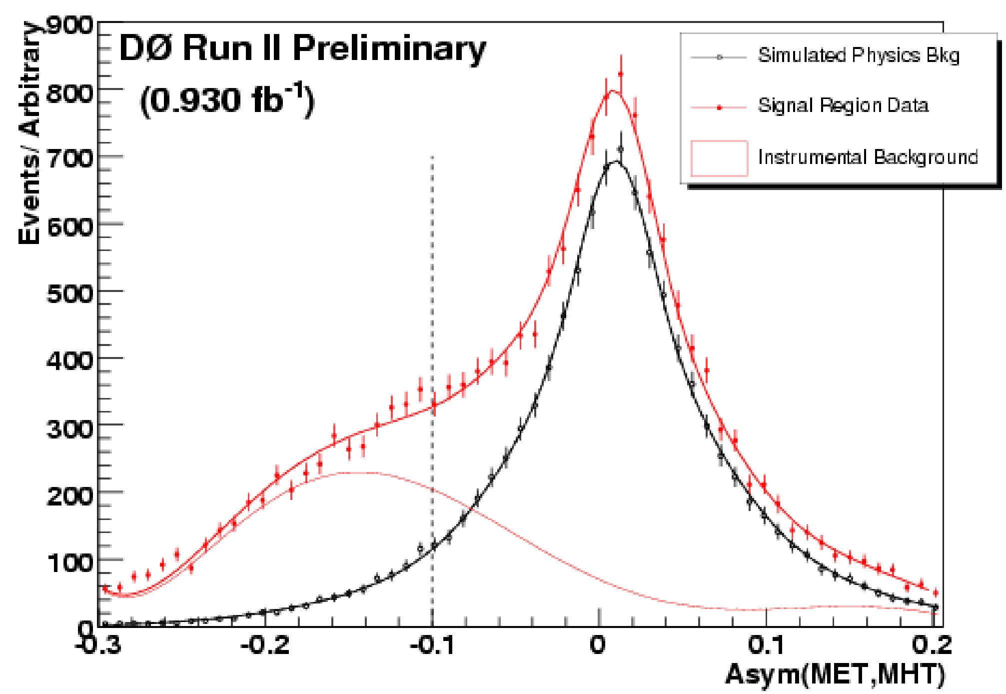
<u>Missing ET (MET)</u>: calculated using calorimeter cells

<u>Missing HT (MHT)</u>: calculated using jets

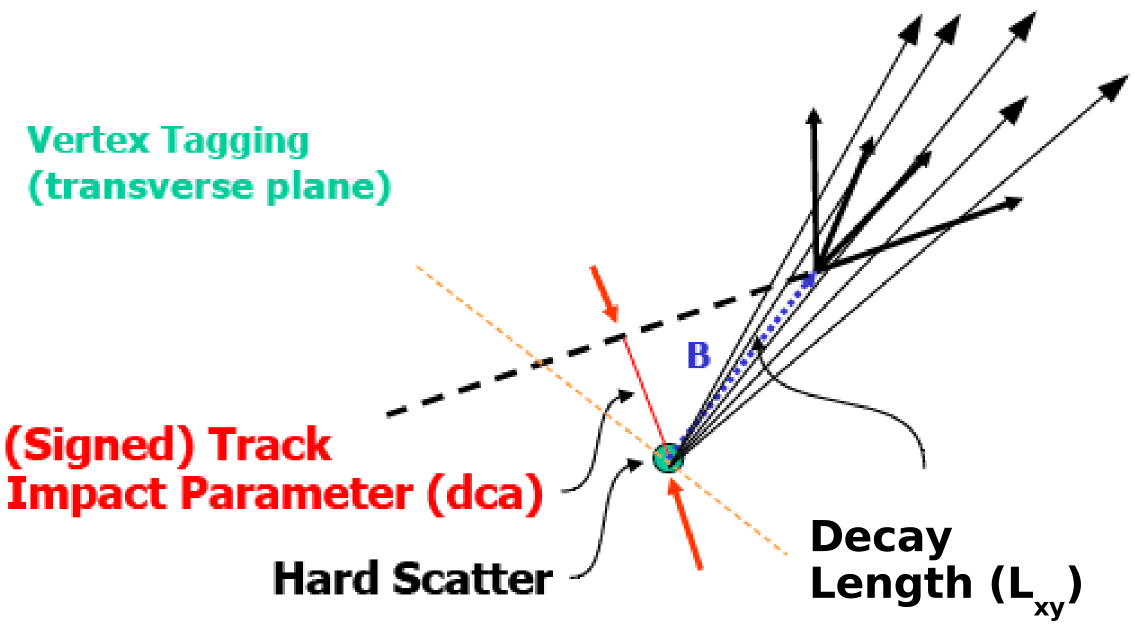
<u>Missing Trk pT:</u> calculated using tracks

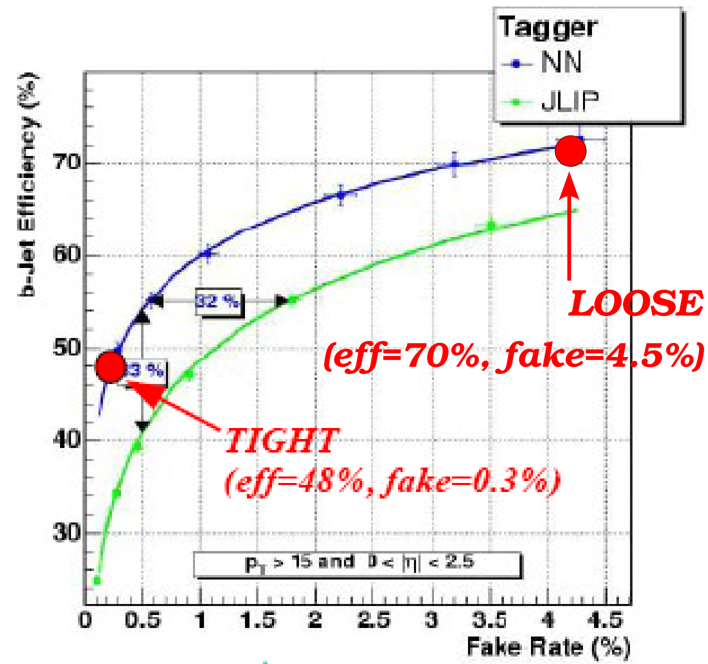


- Select events based on the assymetry in these variables
  - Asym(MET,MHT) = (MET-MHT)/(MET+MHT) > -0.1
  - Expected shape for real physics bkgds obtained from MC
- Further restrict bkgds
  - $\Delta\phi$(MET,jets) > 0.15 rad
  - $\Delta\phi$(MET,MTrkPt) < $\pi/2$



B-Jet Tagging at DØ





Two main categories:

✗ **Impact Parameter based**

✗ **Secondary Vertex reconstruction**

Combine in Neural Network:

- vertex mass
- vertex number of tracks
- vertex decay length significance
- chi2/DOF of vertex
- number of vertices
- two methods of combined track impact parameter significances

Tagging B-Jets

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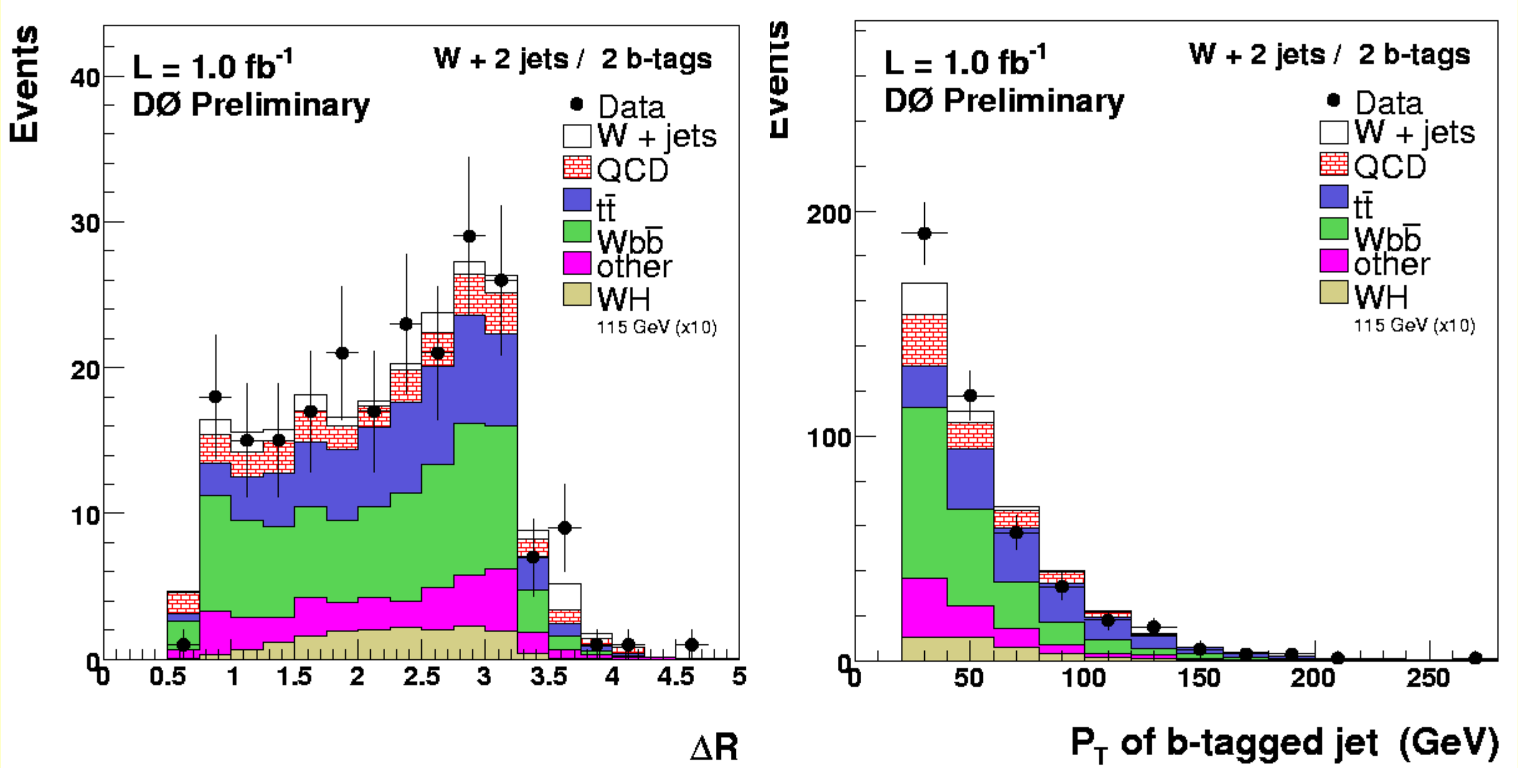
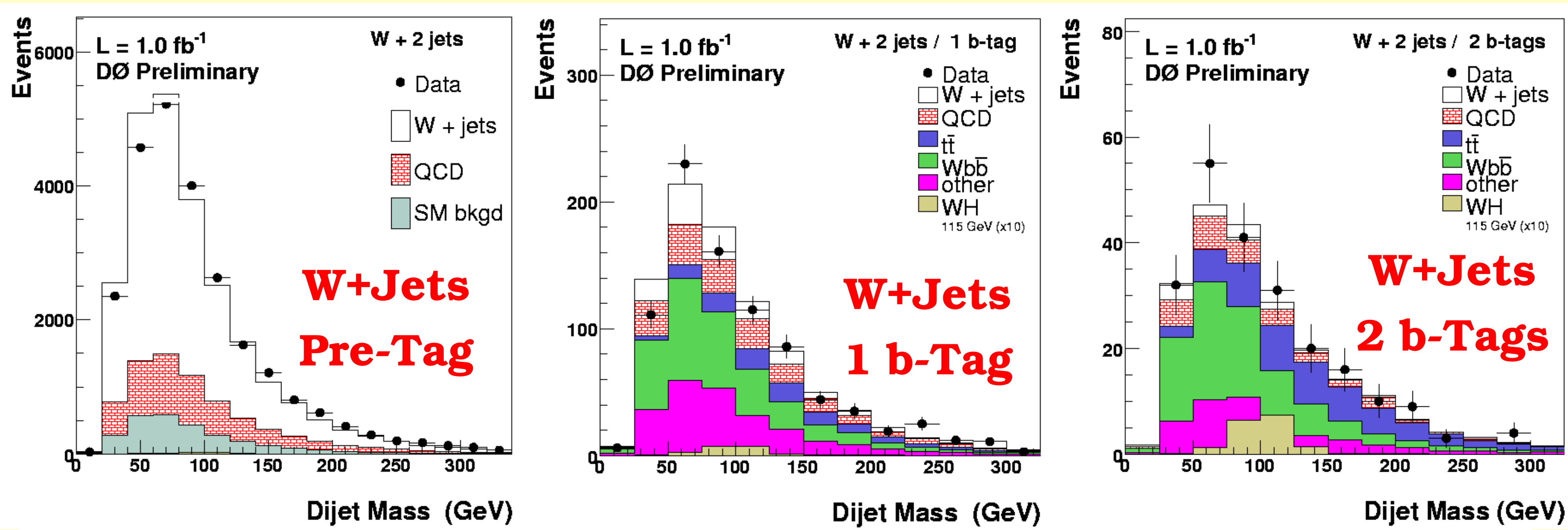
April 6th, 2007

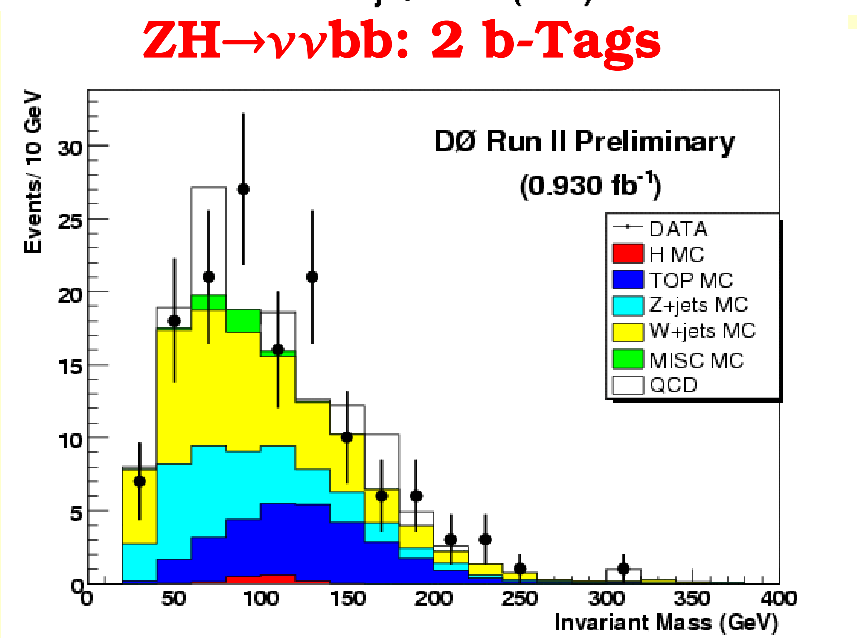
- Update b-Tagging optimization (as compared to Single-Top result)
  - Use asymmetric *TIGHT* + *LOOSE* b-Tagging thresholds for double-tagged jet sample (*gain ~40% in sensitivity*)
  - For WH→lνbb, separate orthogonal 2 b-tag and 1 b-tag samples to salvage lost efficiency (*gain ~15% in sensitivity*)

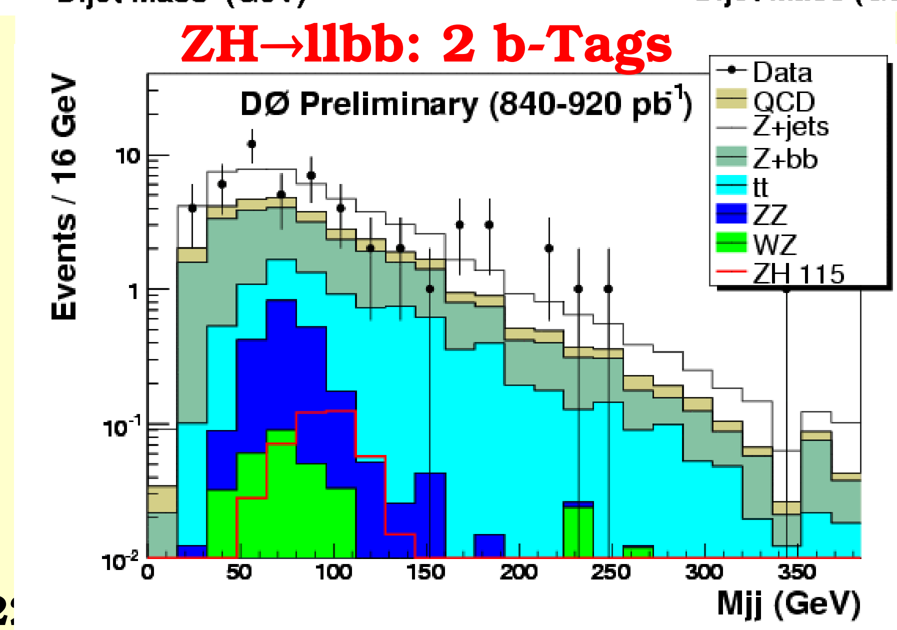
W+ 2 b-Tag control plots



Selecting $H \to bb$ Events







Searching for H→bb

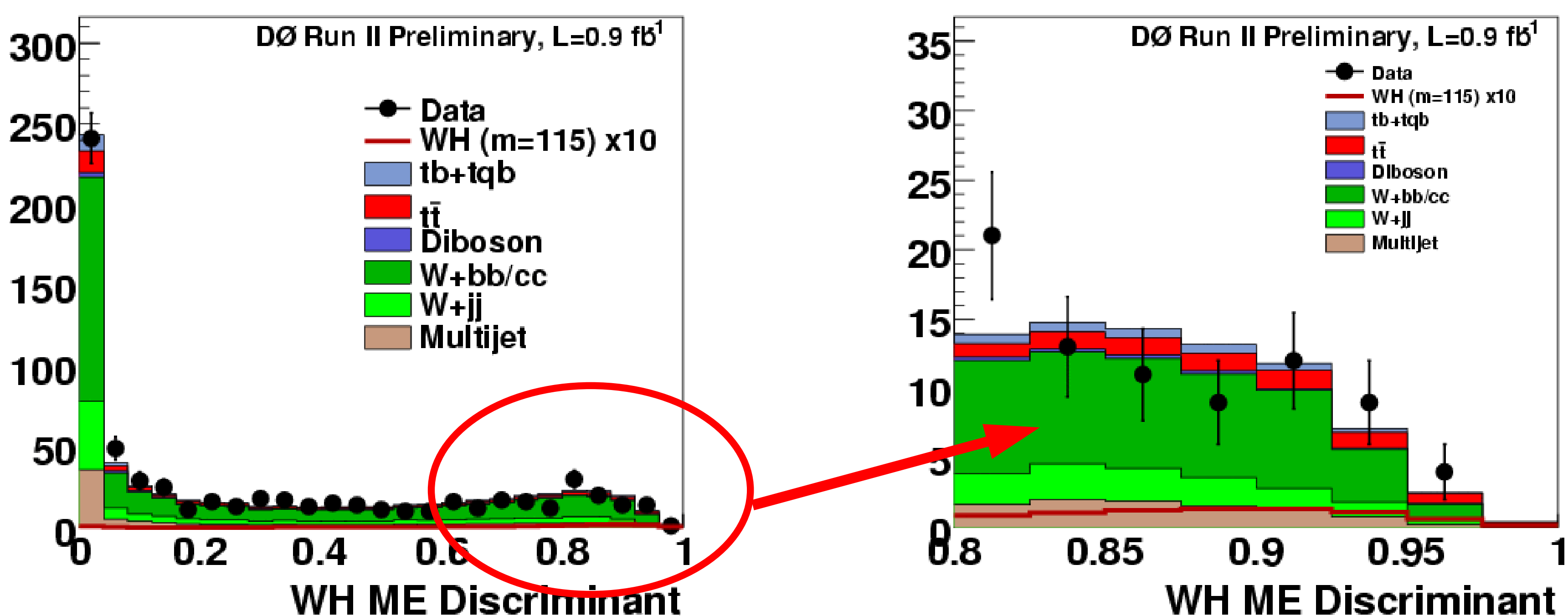
- Interesting consideration: ZH→ννbb channel has large cross efficiency from WH signal (lost/undetected lepton + hadronic W→τν)
  - Treat as separate WH channel for proper accounting:
    - ZH signal ⇒ ZH limits, WH signal ⇒ WH limits
    - Same background!! Sum signals for full combination of results

Expected/Observed Events in 1.0fb^{-1}
mH=115 GeV, 70<djMass<130 GeV

Channel	Signal	Bkgd	Data	S/sqrt(B)
WH→lνbb, 2Tag	1.45	86.6	91	0.156
WH→lνbb, 1Tag	1.48	365.2	339	0.077
ZH/WH→MET+bb	0.83/0.54	55.3	63	0.184
ZH→llbb	0.37	19.8	17	0.083

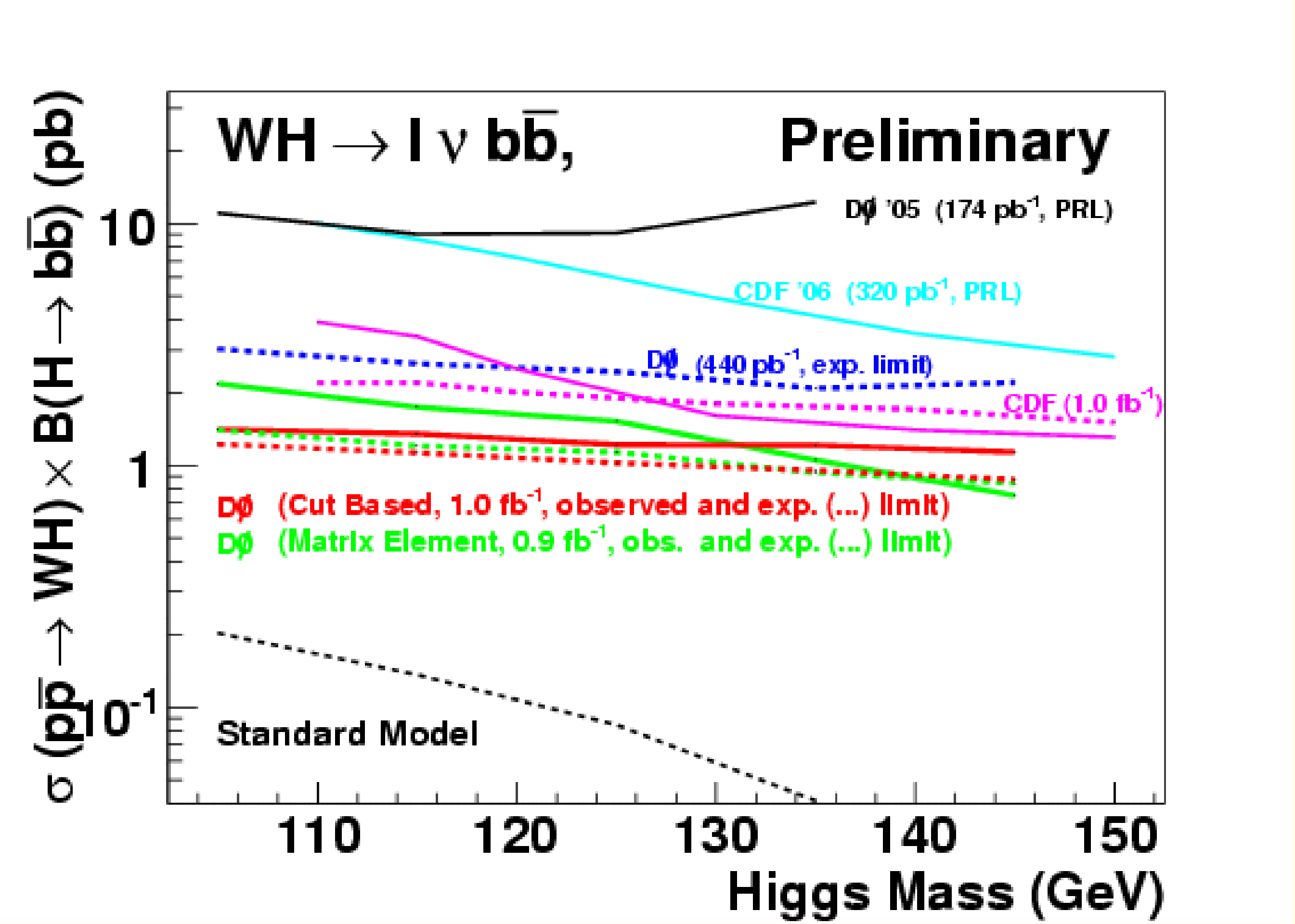
Advanced Analysis Techniques

- WH/ZH system is very rich, don't need to rely on dijet mass alone
  - Multivariate analyses isolate regions of signal density in N-dimensions
  - Under development, but Matrix Element analysis approved
    - *Despite selection 30-40% less sensitive (optimized for single-top search & uses smaller dataset), ME analysis achieves similar final sensitivity*
  - Use signal/bkgd production Matrix Elements (tree-level) to form likelihood discriminant: *~35% improvement in sensitivity*! (in single b-tag channel, similar optimization point)



Advanced Analyses

- Comparison of cut-based and ME analyses
  - Despite optimization point, achieves similar sensitivity
  - Steady progress in this channel



Setting Limits

- In the absence of signal, we set limits on Standard Model Higgs boson production
  - We calculate limits via the CLs prescription:

$$CL_s = \frac{CL_{s+b}}{CL_b}$$

  - Using a Log-Likelihood Ratio test statistic:

$$Q(\vec{s},\vec{b},\vec{d}) = \prod_{i=0}^{N_{Chan}} \prod_{j=0}^{N_{bins}} \frac{(s+b)_{ij}^{d_{ij}} e^{(s+b)_{ij}}}{d_{ij}!} / \frac{b_{ij}^{d_{ij}} e^{b_{ij}}}{d_{ij}!} \qquad LLR = -2 \times Log Q$$

d_{ij} refers to "data" for model being tested

- Distributions of simulated outcomes are populated via Poisson trial with mean values given by B-only or S+B hypotheses
  - Systematics are folded in via Gaussian marginalization
  - Correlations held amongst signals and backgrounds

Tools of the Trade

- To counteract the degrading effects of systematic uncertainties, we actually integrate over the Profile Likelihood distributions
  - Obtained by fitting MC expectations to "data" for each outcome
  - Capitalizes on shape and statistics of data to constrain background fluctuations
- Must define the best fit of our MC model to data
  - **Assume:** $B_i \rightarrow B_i \prod_k (1+\sigma_i^k \rho_k)$

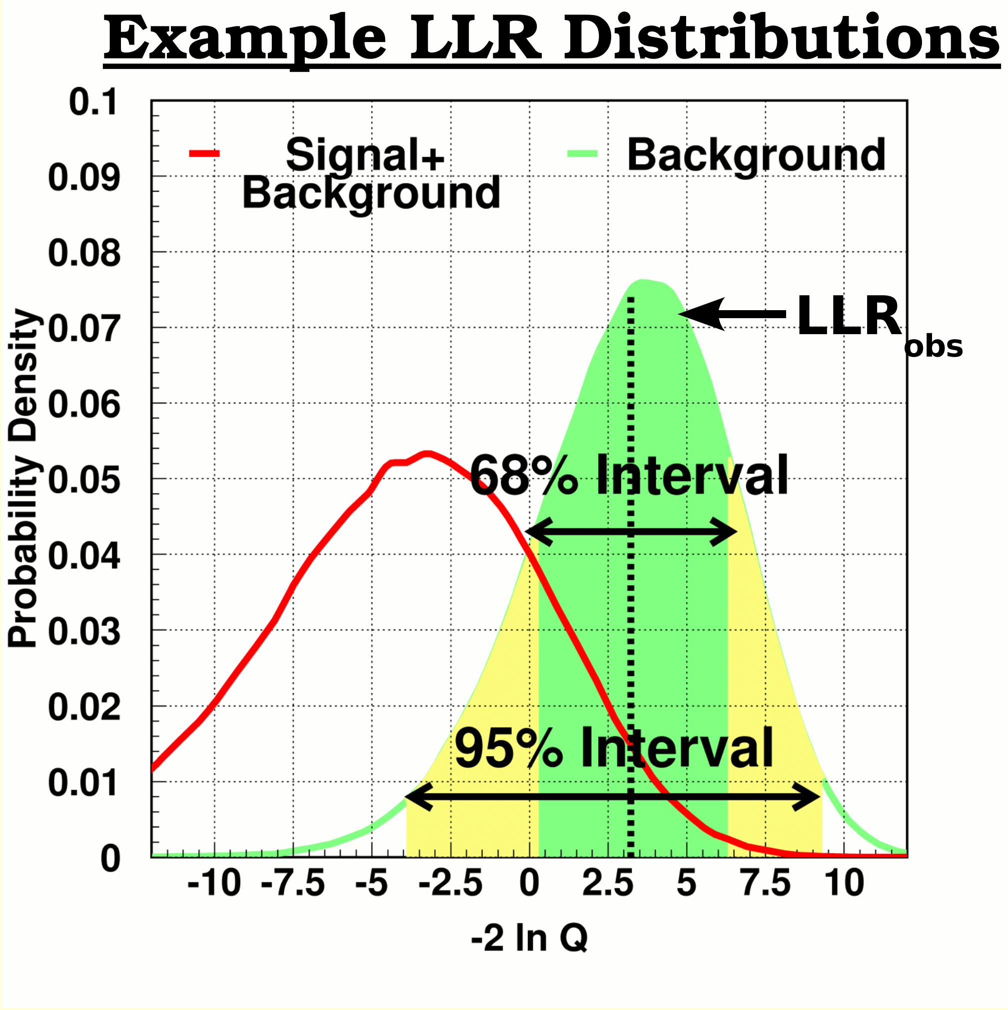
    Where ρ_k has a mean of 0 and width of 1
  - Minimize Poisson estimator by varying S_k values

Marginalizing!

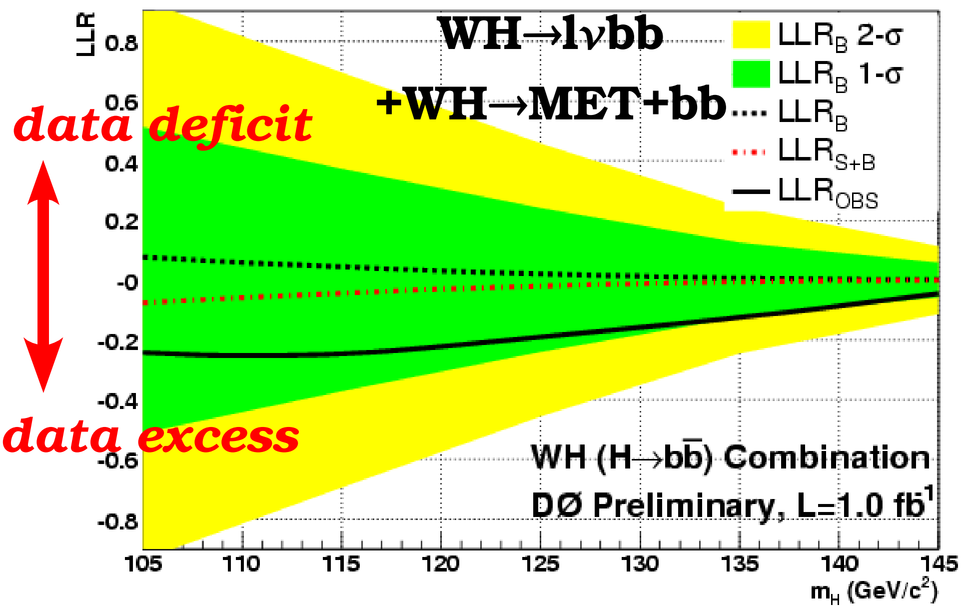
$$\chi^2 = 2\sum_i (B_i - D_i) - D_i \ln\left(\frac{B_i}{D_i}\right) + \sum_k \rho_k^2$$

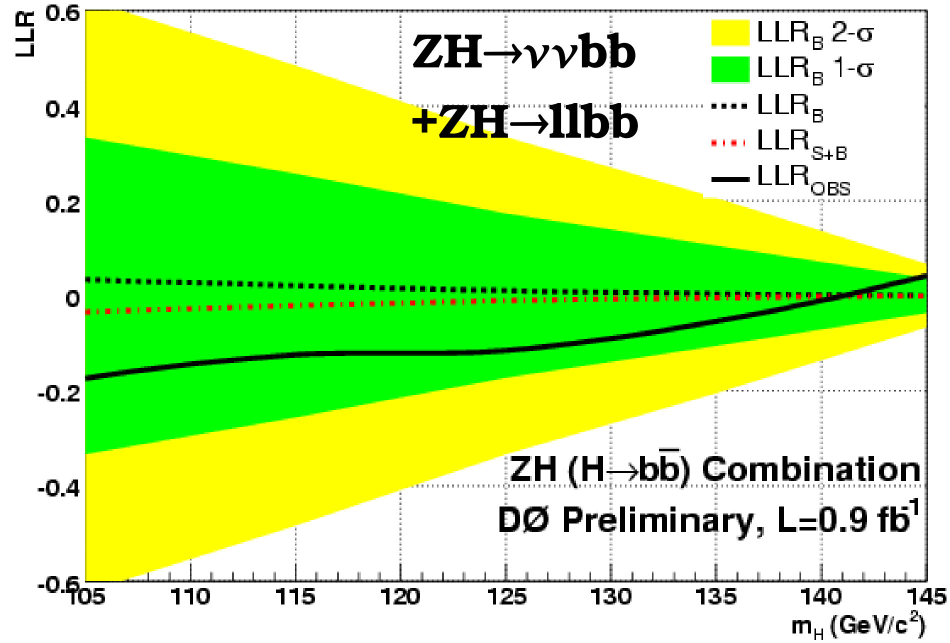
CLs in Pictures

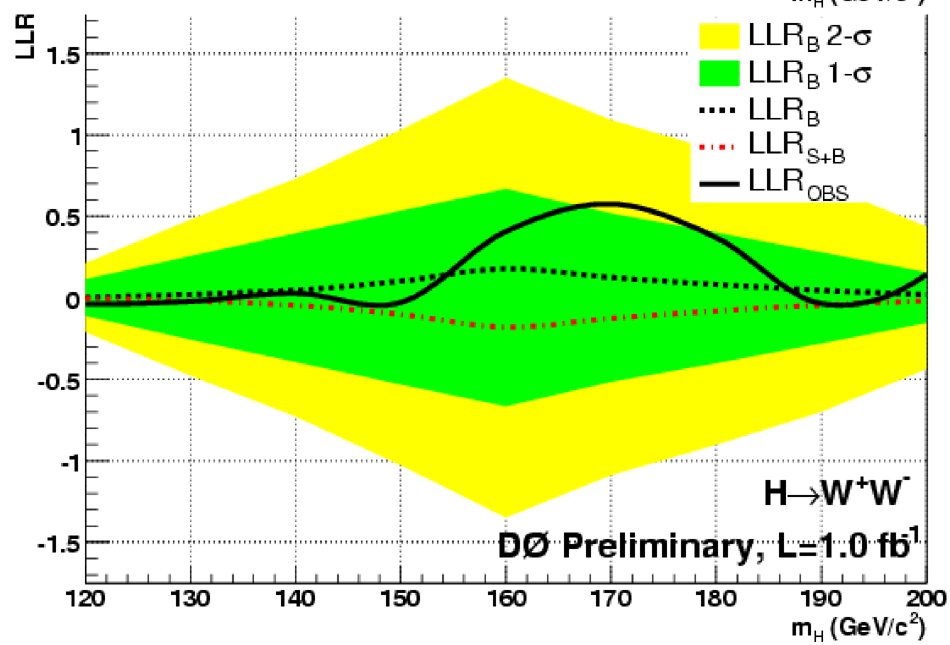
- Black dashed line: Observed LLR value (LLR_{obs})
- Green: Bkgd-only hypothesis
  - CL_b is region to right of LLR_{obs}
  - Equals ~50% for good bkgd/data agreement
- Red: Signal+bkgd hypothesis
  - CL_{s+b} is region to right of LLR_{obs}



Setting Limits

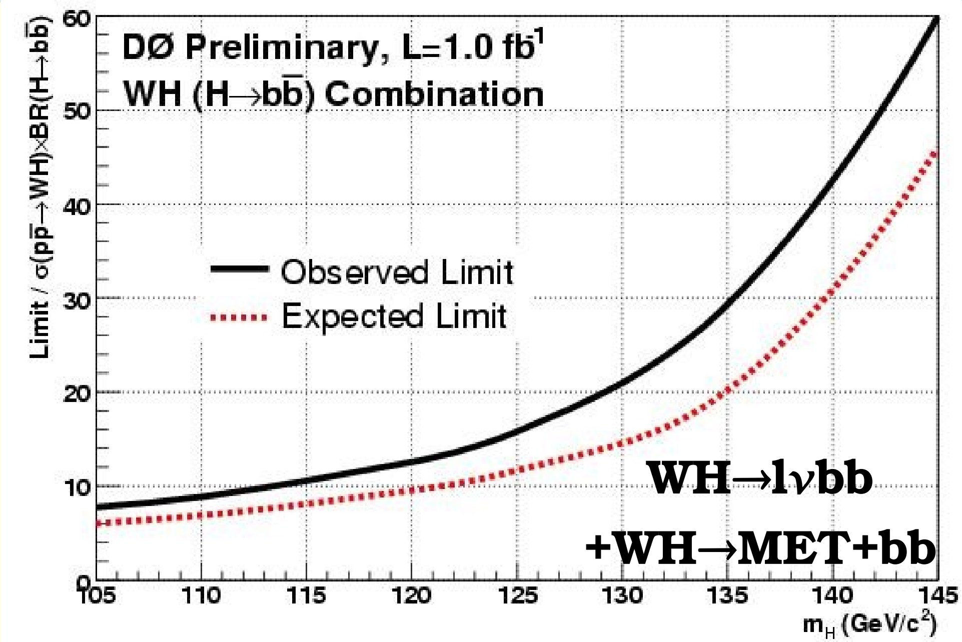


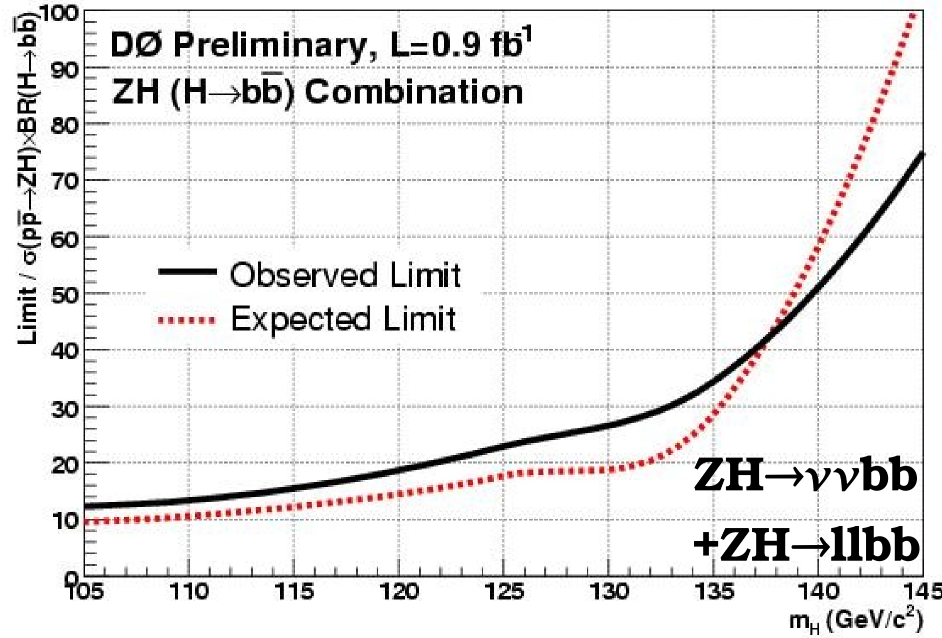




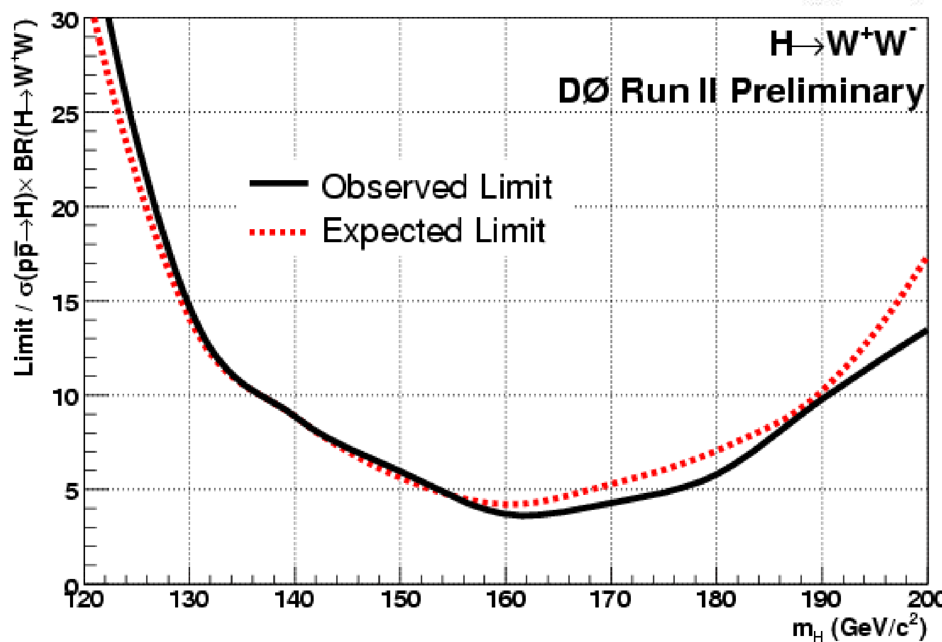
- LLR profile vs Higgs mass
  - Dashed lines show **S+B** and **B-Only** mean value
  - Shaded bands indicate 1- and 2-σ variation of B-only distribution
  - Solid black line indicates **data observation**

Setting Limits

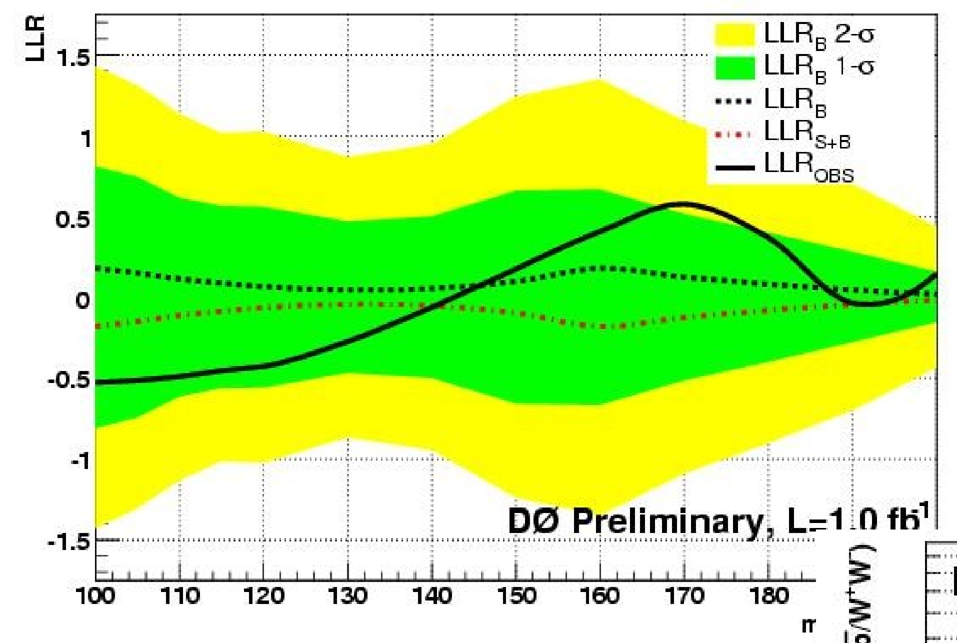




- ✗ Limits presented as ratios to the expected Standard Model cross section
  - ✗ 95% CL exclusion when ratio=1.0
  - ✗ Facilitates flexible combination of channels, interpretation of model

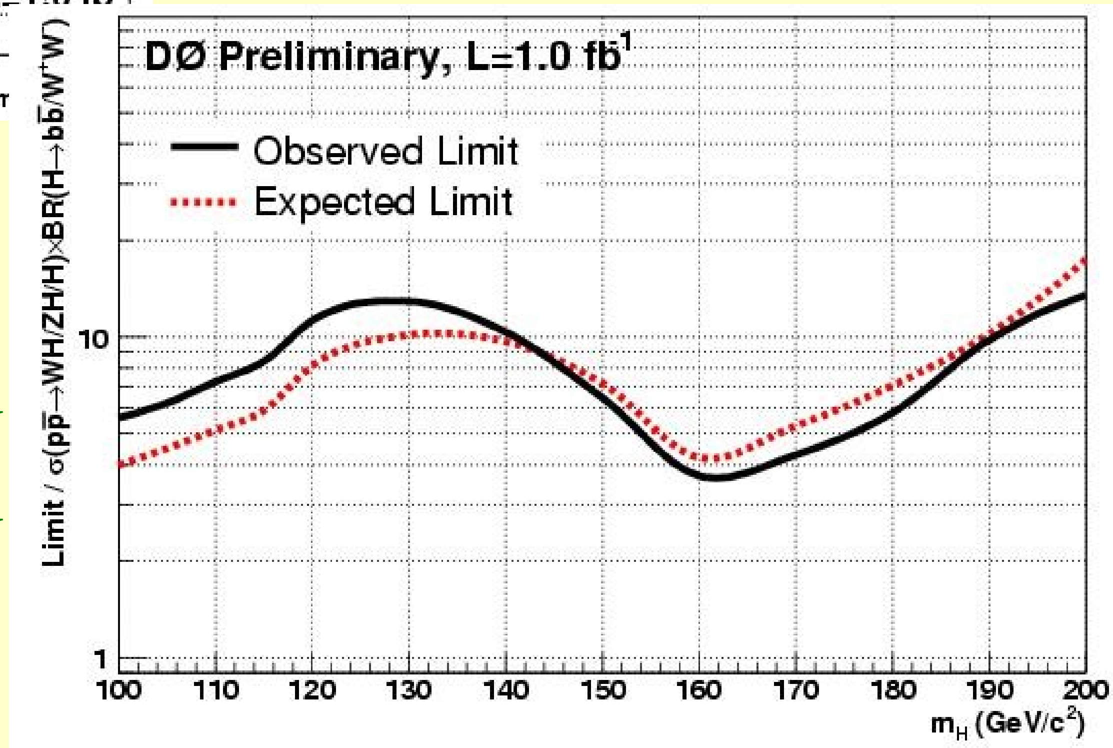


Combined SM Limits

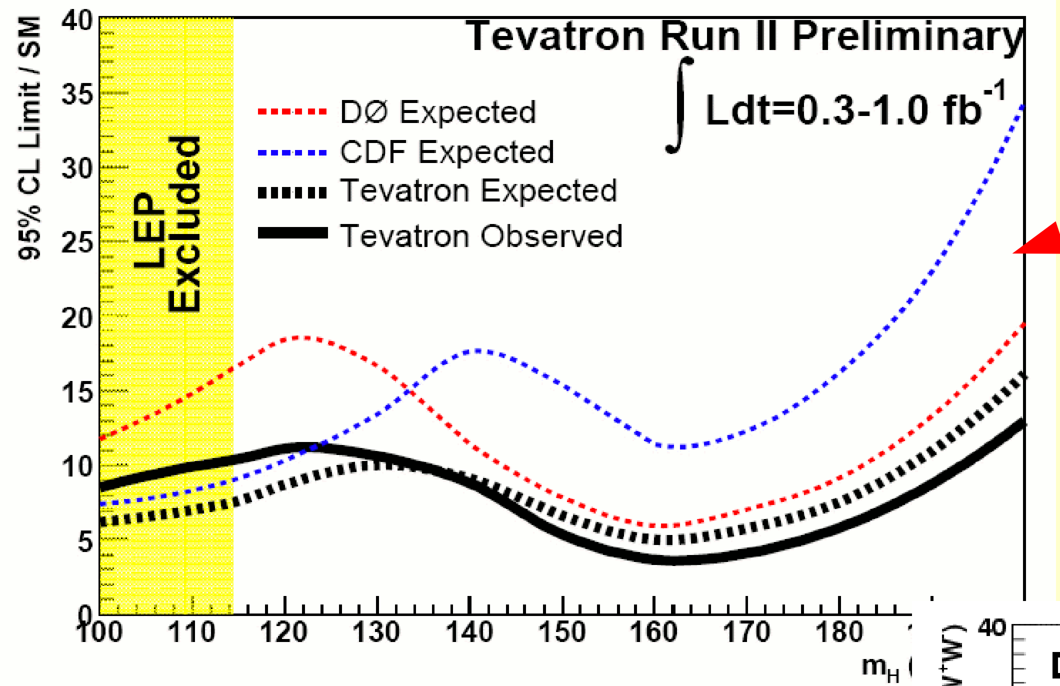


- Combination includes:
  - WH (m_H=100-150 GeV)
  - ZH (m_H=100-150 GeV)
  - H→WW (m_H=120-200 GeV)

- Limit ratios:
  - observed (expected)
  - 8.4 (5.9) @ m_H = 115 GeV
  - 3.7 (4.2) @ m_H = 160 GeV

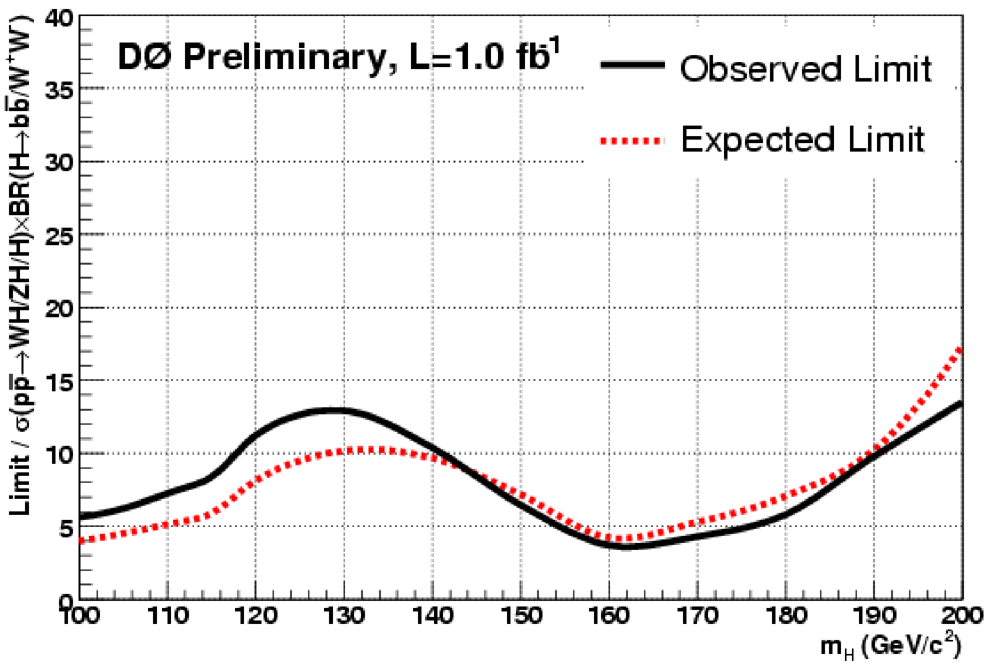


Progress?



ICHEP '06 Combined Results

- ✗ Large improvement at low mass: *factor of 3!*
  - ✗ Better than luminosity increase alone: $\text{sqrt}(L_{new}/L_{old}) = 1.7$



An Emerging Path…

- Though we're not quite there, we know we're missing pieces
  - Advanced analysis selections (NN,ME) provide factor of ~1.5-1.7 in equivalent luminosity
  - Missing channels (WH→WWW, single-tag for ZH)
  - New channels (taus, H→ZZ, hadronic H→WW) in the pipeline
  - Many systematics currently statistics limited

Ingredient	Equiv Lumi Gain	Xsec Factor MH=115 GeV	Xsec Factor MH=160 GeV
Today with 1fb^{-1}	-	5.9	4.2
Lumi = 2 fb^{-1}	2	4.2	3.0
b-Tag (Shape + LayerØ)	2	3.0	3.0
Multivariate Techniques	1.7	2.3	2.3
Improved mass resolution	1.5	1.8	2.3
New Channels	1.3/1.5	1.6	1.9
Reduced systematics	1.2	1.5	1.7

DZero only!

→At 115 GeV need ~4.5 fb^{-1}

At 160 GeV need ~6 fb^{-1}

An Emerging Path...

- Though we're not quite there, we know we're missing pieces
  - Advanced analysis selections (NN,ME) provide factor of ~1.5-1.7 in equivalent luminosity
  - Missing channels (WH→WWW, single-tag for ZH)
  - New channels (taus, H→ZZ, hadronic H→WW) in the pipeline

Ingredient	Equiv Lumi Gain	Xsec Factor MH=115 GeV	Xsec Factor MH=160 GeV
Today with 1fb^{-1}	-	5.9	4.2
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Improved mass resolution	1.5	1.8	2.3
New Channels	1.3/1.5	1.6	1.9
Reduced systematics	1.2	1.5	1.7
Two Experiments	2	1.1	1.2

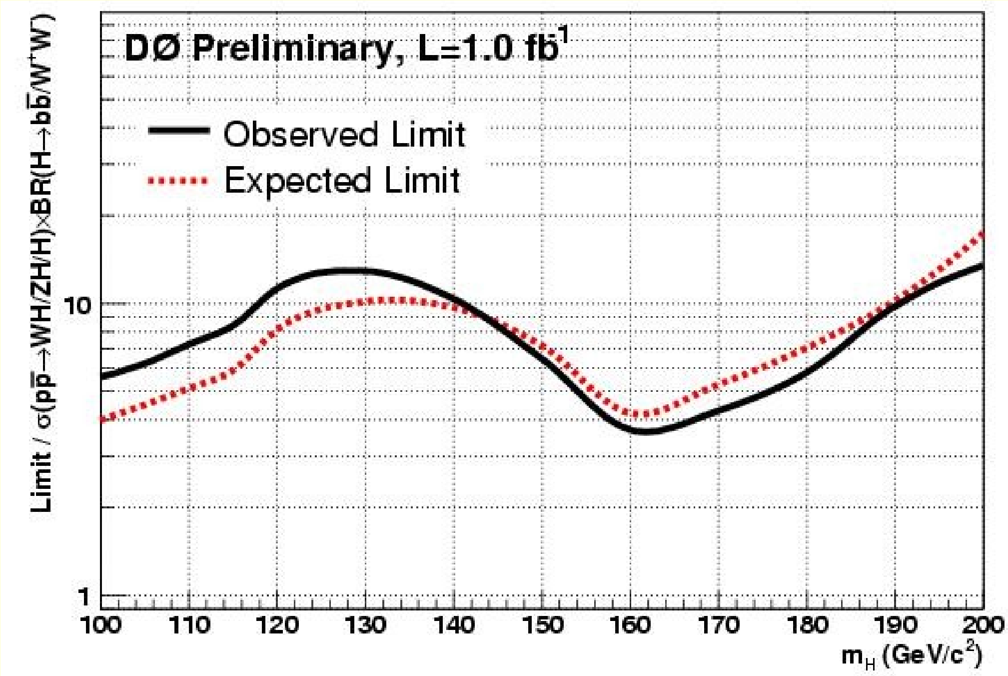
Add another experiment ☺

→At 115 GeV need ~2.5 fb^{-1}

At 160 GeV need ~3 fb^{-1}

What if we succeed?

- What does success mean?
  - Exclusion? Observation?
- Either way, the story does not end with the Standard Model Higgs search

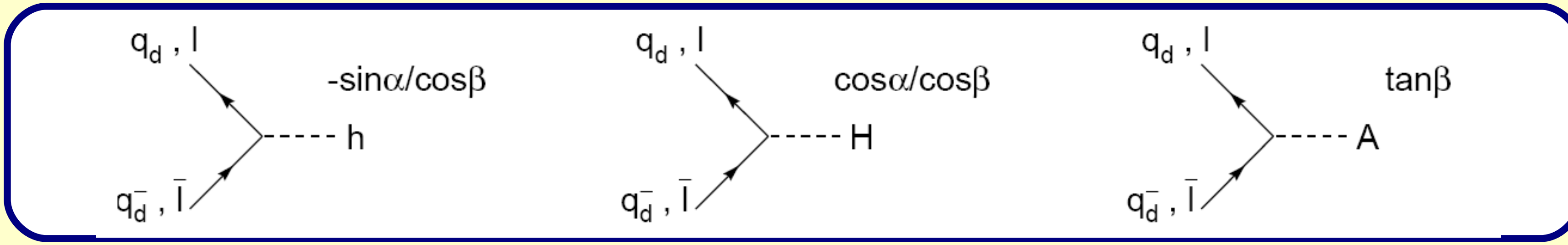


- Exclusion would be great, but what do we learn?
- 3-σ evidence might not be enough to measure properties
  - What does it ***look*** like?
  - Does it ***fit*** the SM?

Higgs Bosons in the MSSM

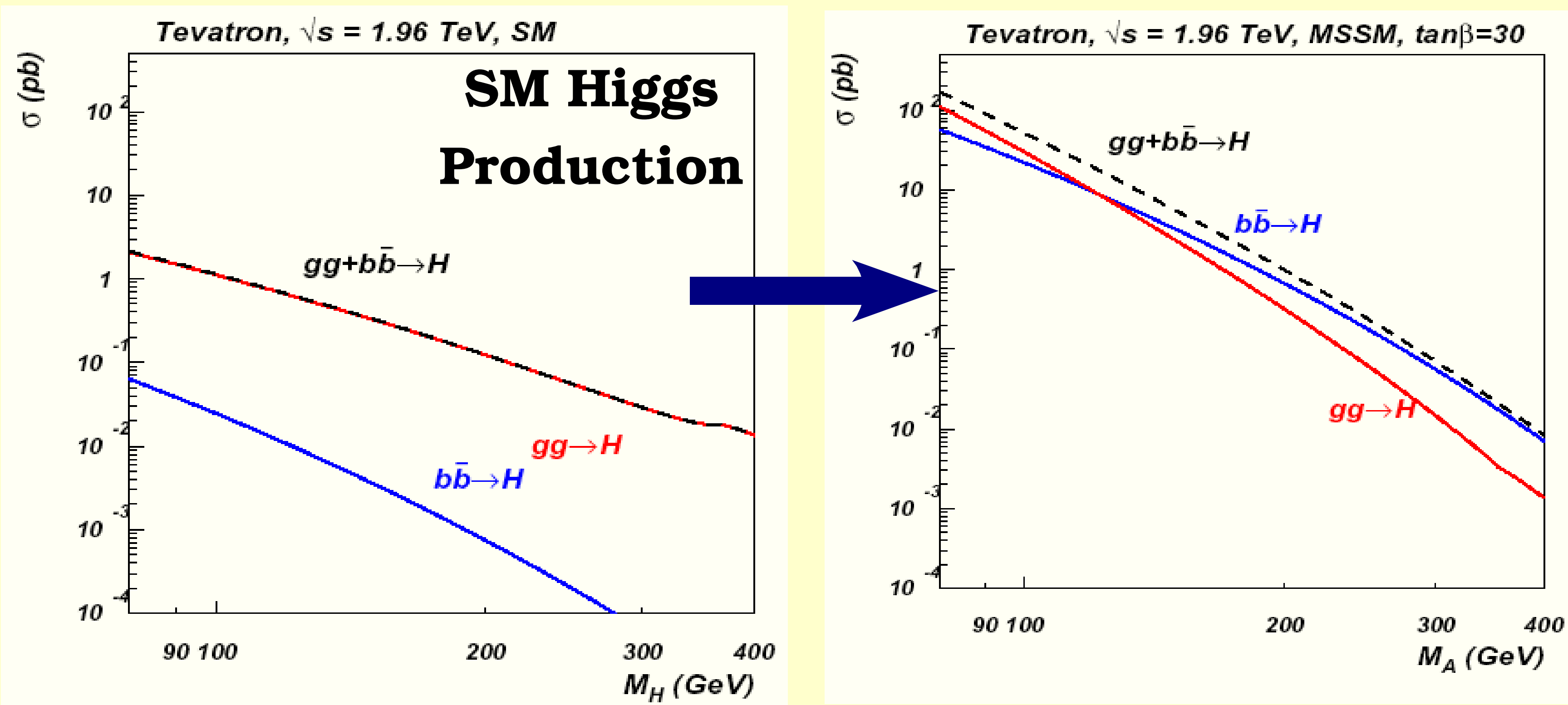
- Super-Symmetry (SUSY) provides a robust EWSB solution
  - Introduces supersymmetric "partners" for all existing particles
  - Requires ***two*** doublets of complex scalar fields: Two Higgs-Doublet Model (2HDM)
    - Eight degrees of freedom: Three go to $W^{\pm}/Z^{0}$ polarization states: this leaves ***five*** Higgs bosons providing all particle masses: four scalars (h, H, $H^{\pm}$) and one pseudoscalar (A)
  - The minimal description of SUSY is referred to as MSSM
    - Higgs sector described by to base parameters:
      - $\tan\beta$ (ratio of VEV for h,H) & m_A
    - Prefers a light higgs: $m_h < 140$ GeV
- But supersymmetric "sparticles" have not been observed
  - New particle masses must be large
  - This is OK, as it introduces a natural energy scale at ~1-2 TeV

Higgs Bosons in the MSSM

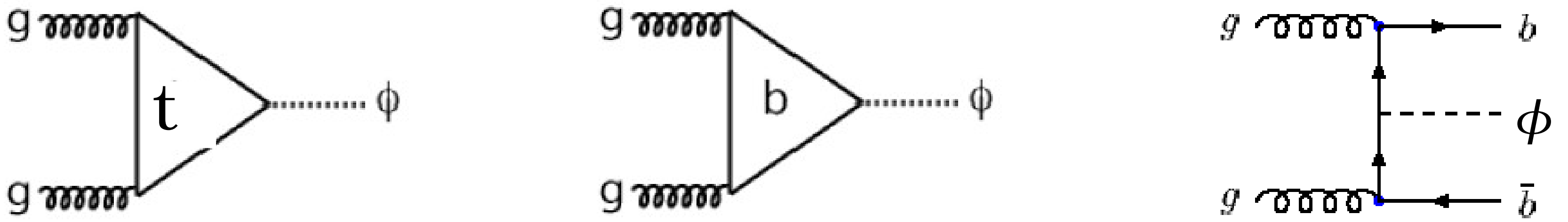


✗ In MSSM, coupling to down-type quarks enhanced as $\tan\beta$

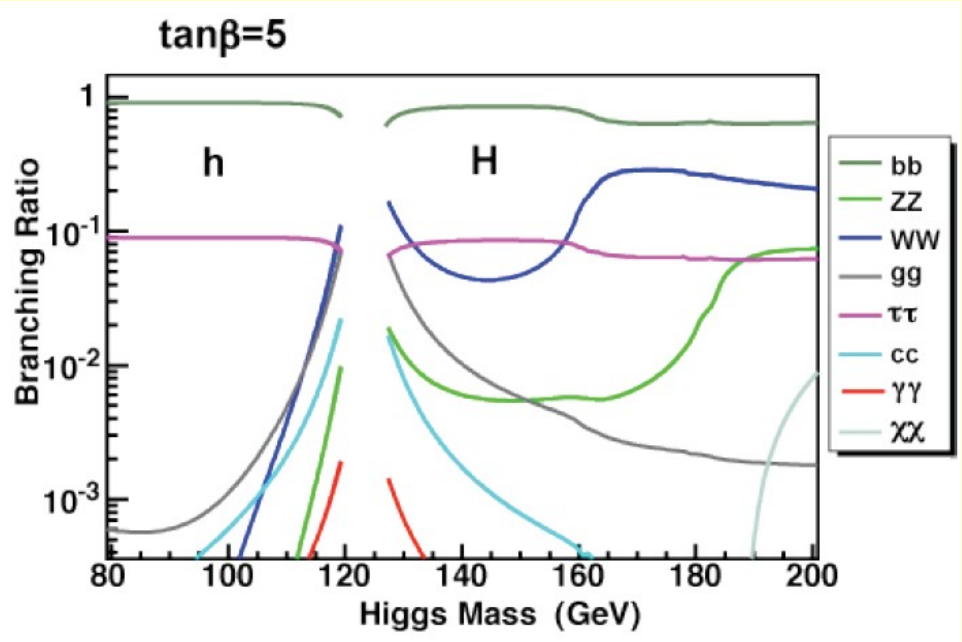
⇒ cross-section is enhanced as $\tan^2\beta$



Higgs Bosons in the MSSM



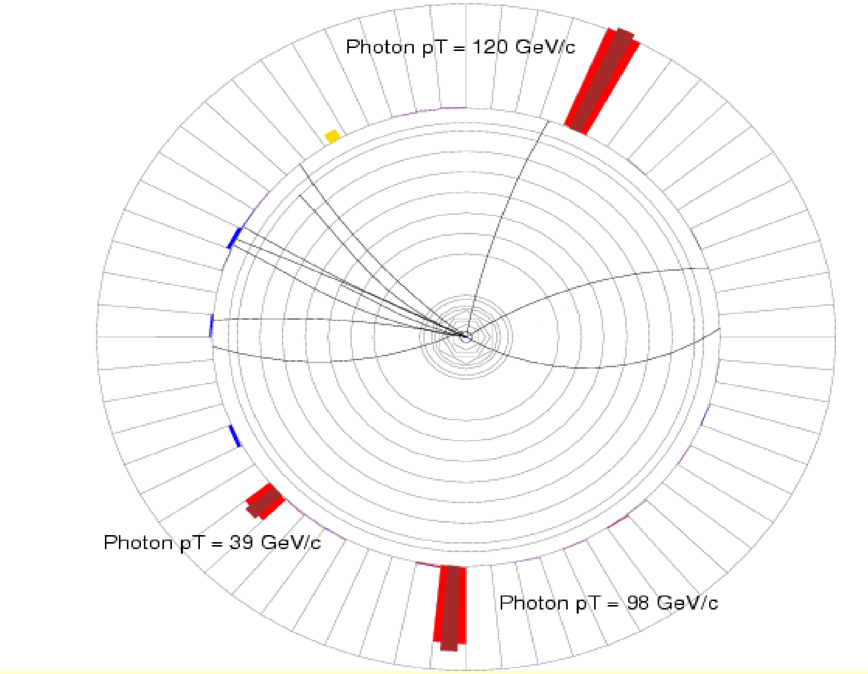
- For large tanβ, H/h and A (collectively called ϕ) are nearly mass degenerate
  - Br($\phi \to$bb) ~90% and Br($\phi \to \tau\tau$) ~10% almost independent of tanβ



Fermiophobic Higgs Bosons

Wine & Cheese
April 6th, 2007

- For certain 2HDM, coupling of light Higgs to fermions is suppressed
  - *Fermiophobic Higgs:* decays 100% $h_F \rightarrow \gamma\gamma$ if light enough
- Look for associated $h_F H^{\pm}$ production, with $h_F H^{\pm} W^{\pm}$ coupling
  - Decay constraint defines 3(4)γ final state



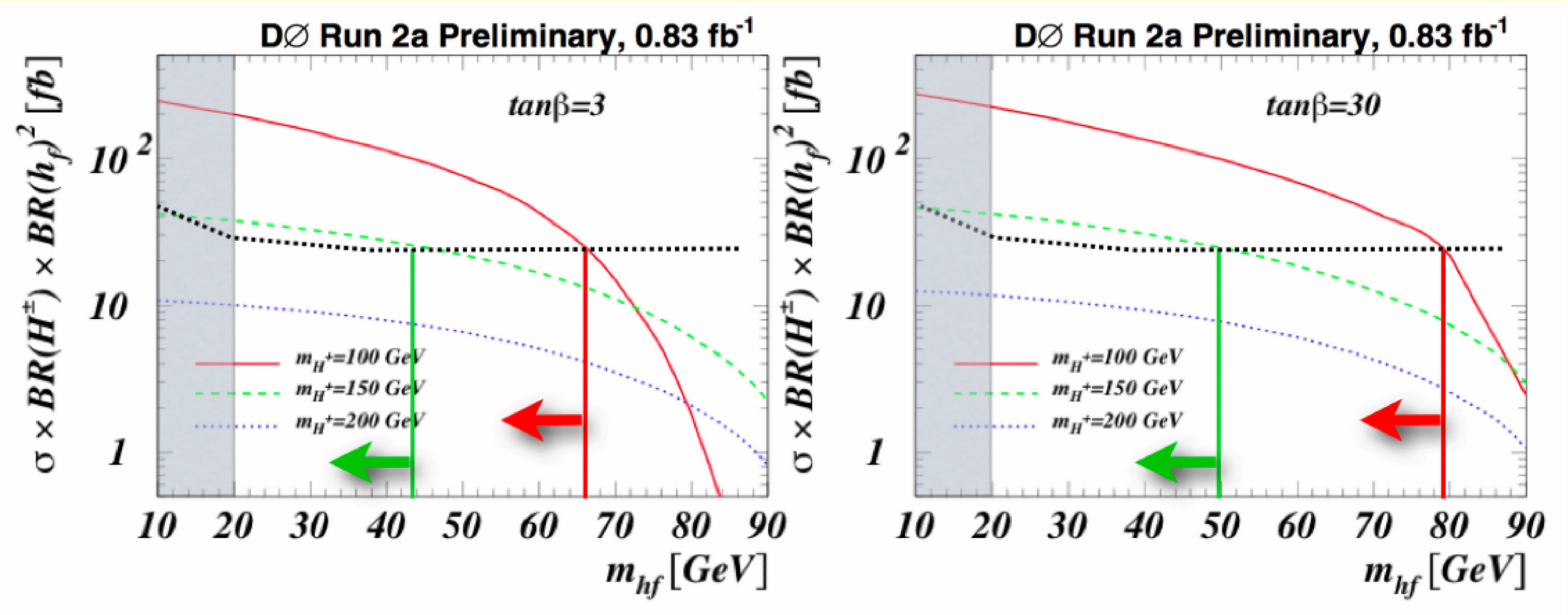
$$p\bar{p} \rightarrow h_F H^{\pm} \rightarrow h_F h_F W^{\pm} \rightarrow \gamma\gamma\gamma(\gamma) + X$$

- Experimentally, look for 3γ+X to maximize acceptance
  - Select 3γ with E_T > 30, 20, 15 GeV and $p_T(3\gamma)$>25 GeV
- Main background: direct triple photon production
  - Estimate from MC, corrected by ratio of two photon data/MC

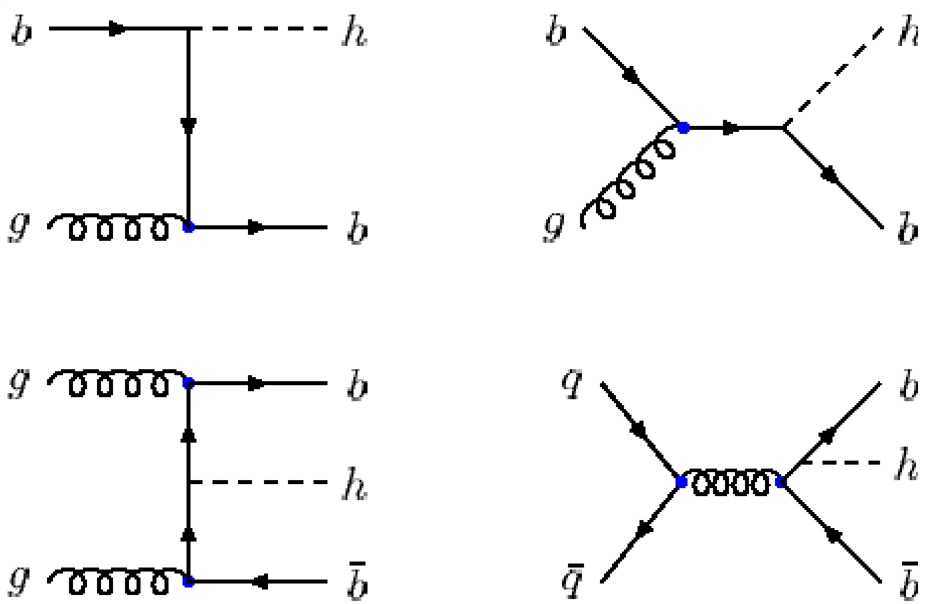
Fermiophobic Higgs Bosons

- Upper limit on *associated* production of h_F, $\sigma(h_F H^{\pm}) < 25.3$ fb at 95% CL
- Interpret in terms of 2HDM parameter space
  - Depends strongly on $m_{H\pm}$, weakly on $\tan\beta$

Expected events	1.1 ± 0.2
Observed	0
Acceptance	0.16 ± 0.03



Associated SUSY-Higgs Production

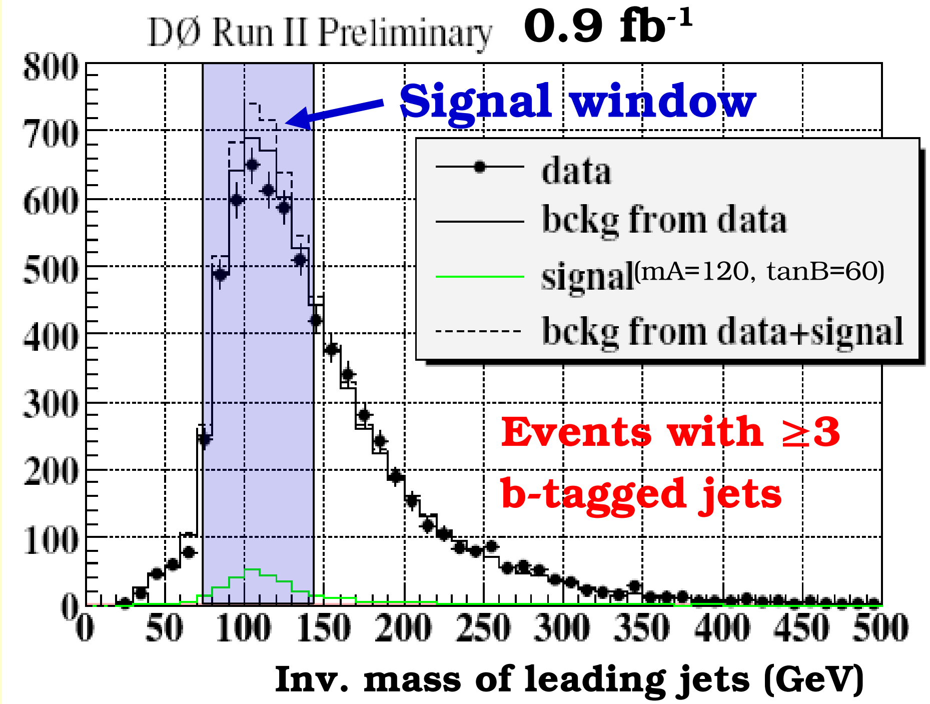


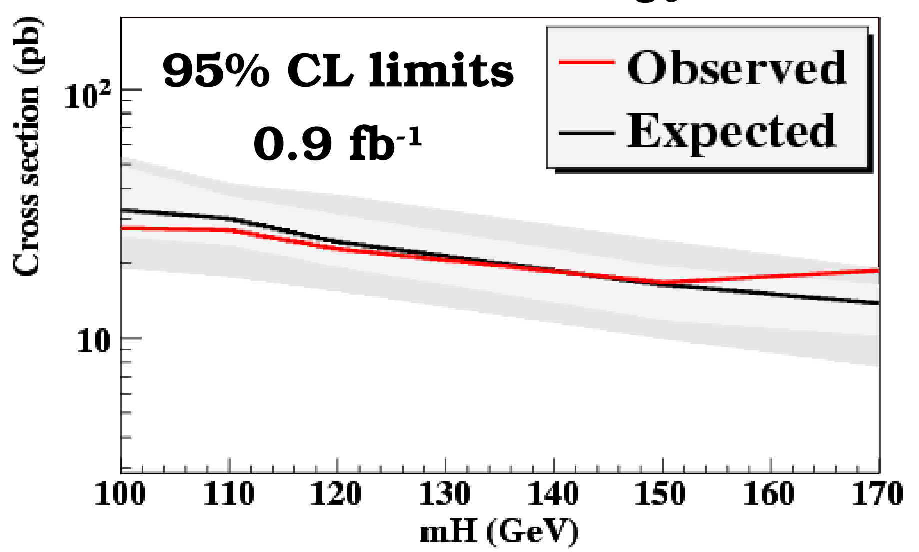
Experimental Signature

- Higgs decays to two high-pT b-quark jets
- One or two extra associated b-quarks define final state
- Search for peak in dijet invariant mass spectrum

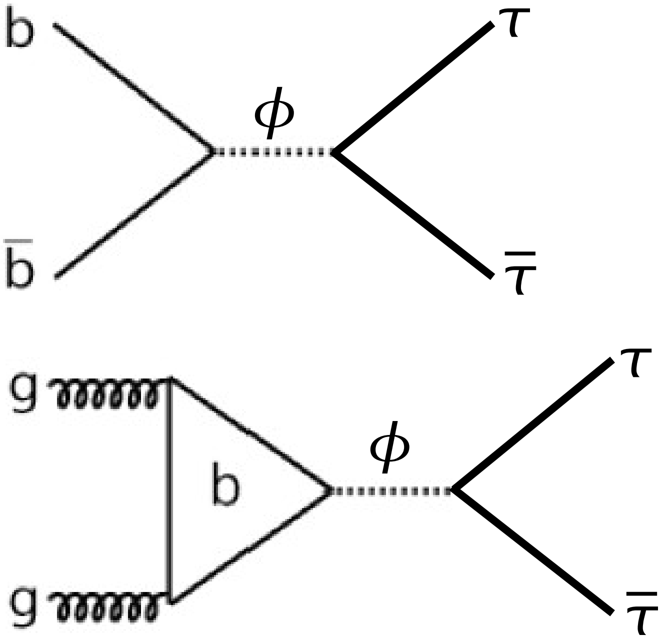
$\phi \rightarrow bb+b[b]$ Search

- Select at least three b-tagged jets with $p_T > 40, 25, 15$ GeV
  - Invariant mass of two leading jets peaks at Higgs mass
- Backgrounds estimated from data
  - Shape taken from double-tagged dijet mass spectrum
  - Rate normalized outside signal window for each point in m_A and $\tan\beta$ plane
- Reasonable agreement between data and predicted background: proceed to set upper limits on MSSM $\phi \rightarrow bb$ production
  - Preliminary analysis being optimized to maximize sensitivity





Di-Tau SUSY-Higgs Decays

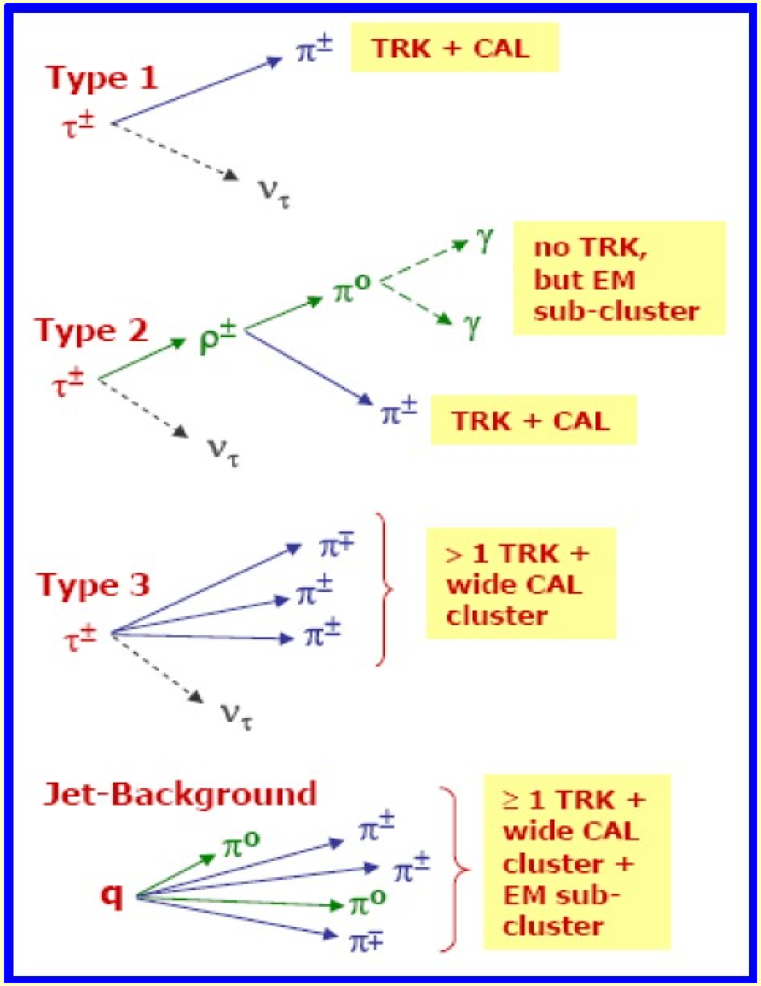


Experimental Signature

- ✗ Higgs decays to two tau leptons
- ✗ Further decays of tau leptons defines final states

Tau Identification at DØ

- Neural network-based ID
- 3 NNs for 3 distinct τ types:

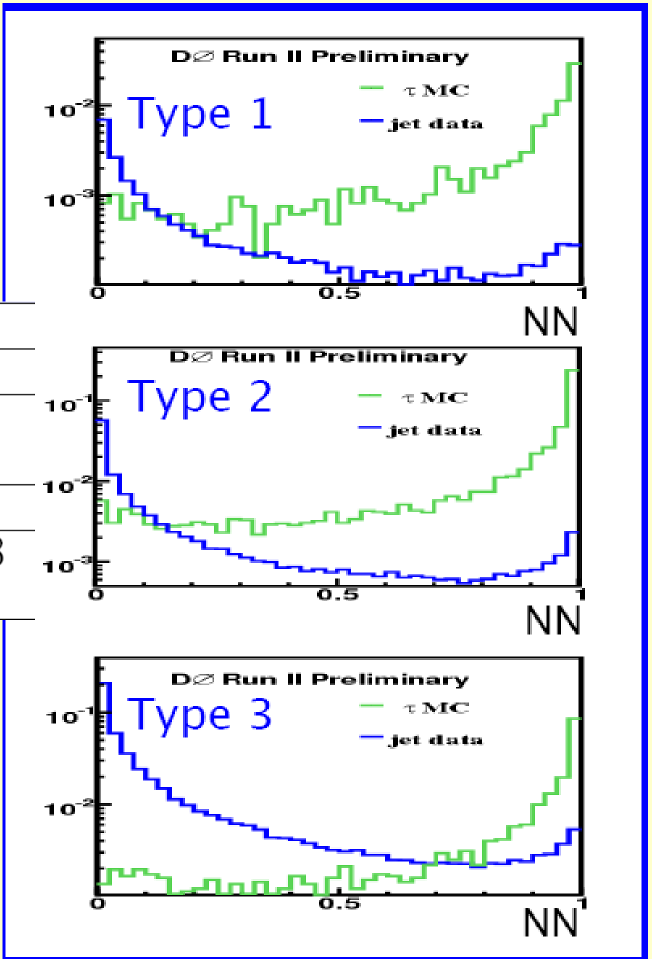


Performance for p_T>15 GeV

Agreement with $Z \to \tau\tau$ decays

Factor ~40 reduction in bkgd for 30% loss in tau signal

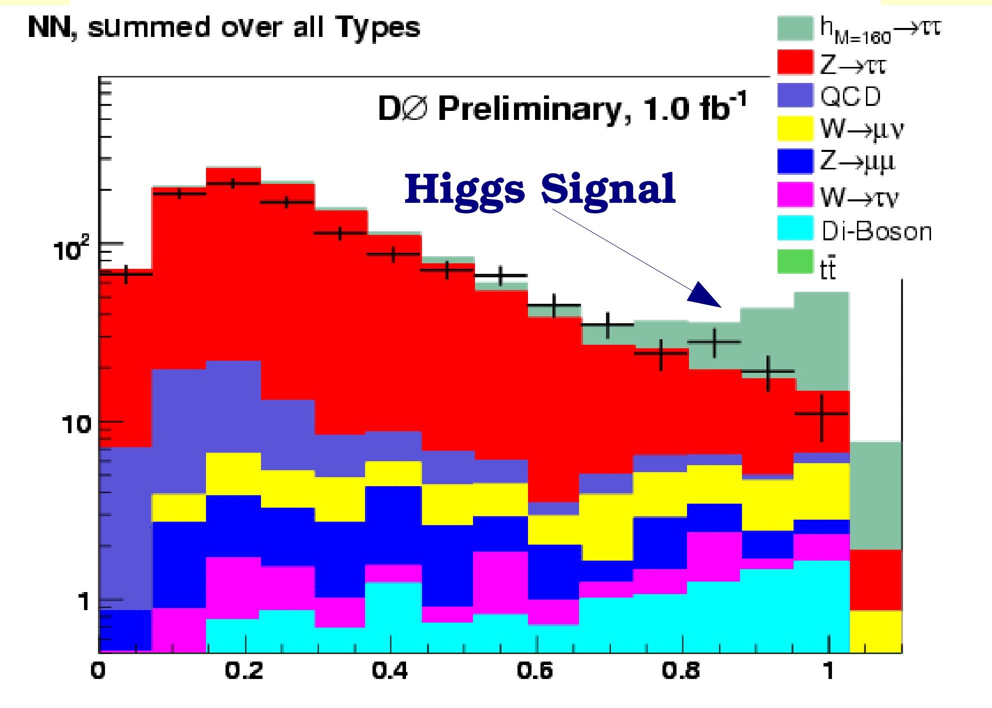
Tau Type	1	2	3
Reconstruction			
Jets	1.5	10	38
Taus	9.1	50	20
NN > 0.9			
Jets	0.04	0.2	0.8
Taus	5.8	37	13

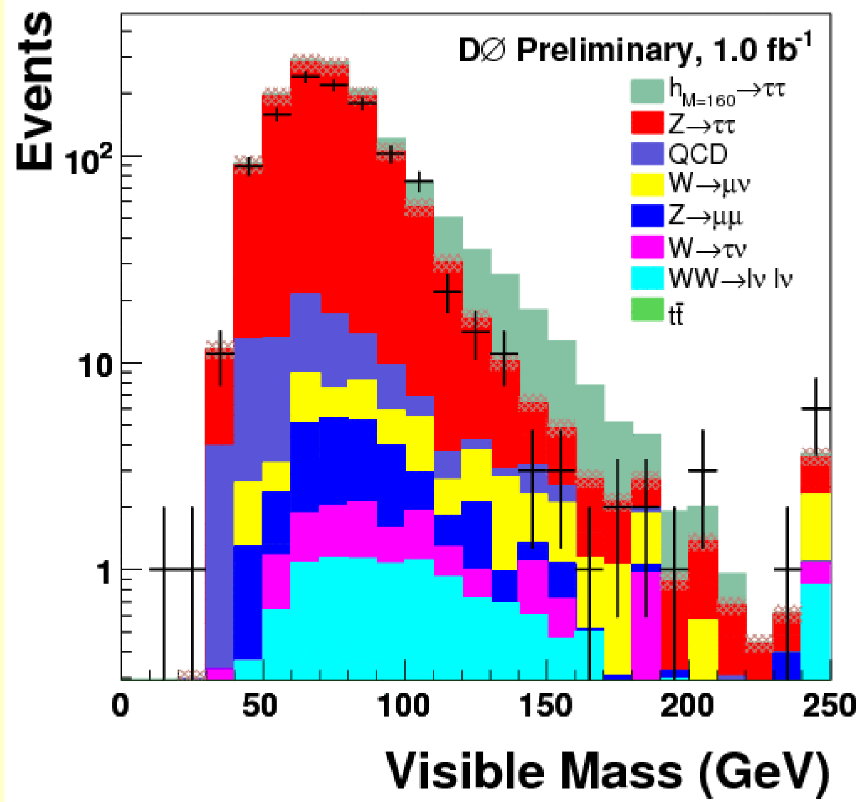


$\phi \to \tau^+\tau^-$ Search

- $\phi \to \tau^+\tau^- \to \mu\nu + \tau_h$
- Largest bkgds: $Z \to \tau\tau$, QCD-jet fakes
  - **NN>0.9, $\Delta R(\mu,\tau)$>0.5**
  - **M^{vis}_W < 20 GeV to remove W bkgd**

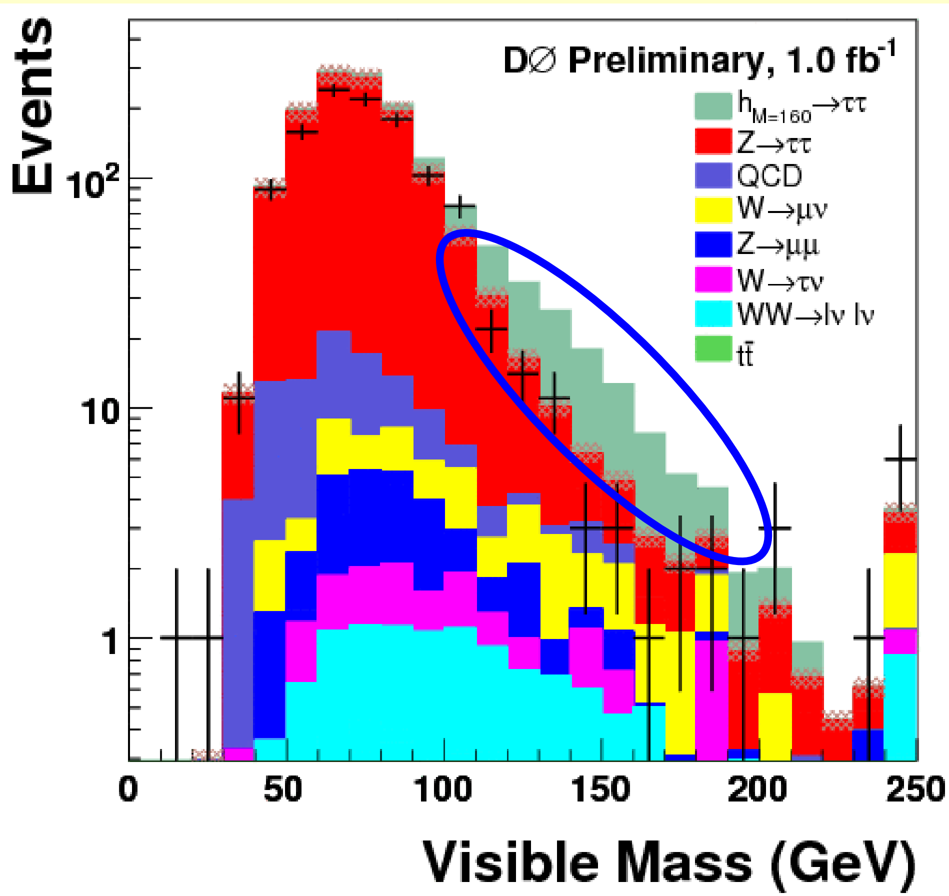
$$M_W^{vis} = \sqrt{2\, E_\mu\, ME_T \frac{p^\mu}{p_T^\mu} (1 - \cos(\Delta\phi))}$$



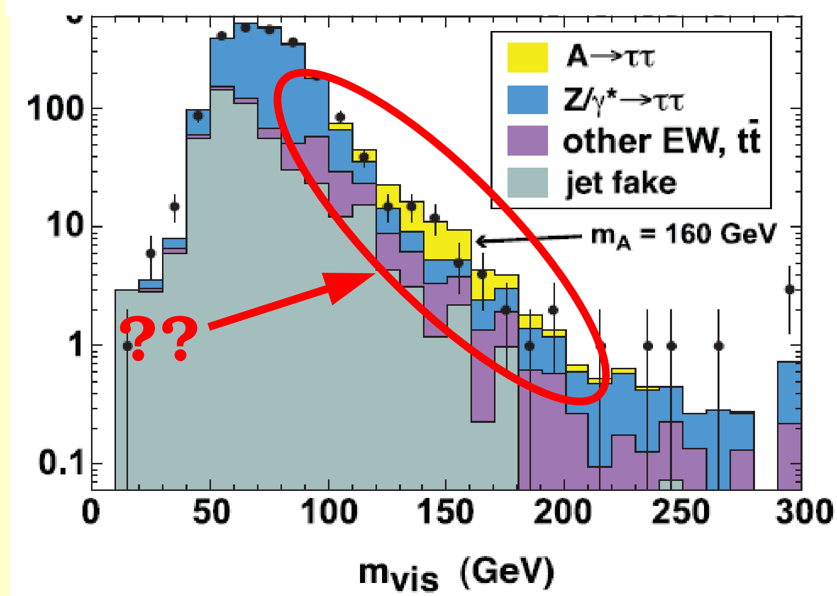


- Mass-dependent NN optimization for signal/bkgd separation (M^{vis}, mu, tau kinematic variables)

$\phi\rightarrow\tau^+\tau^-$ Search

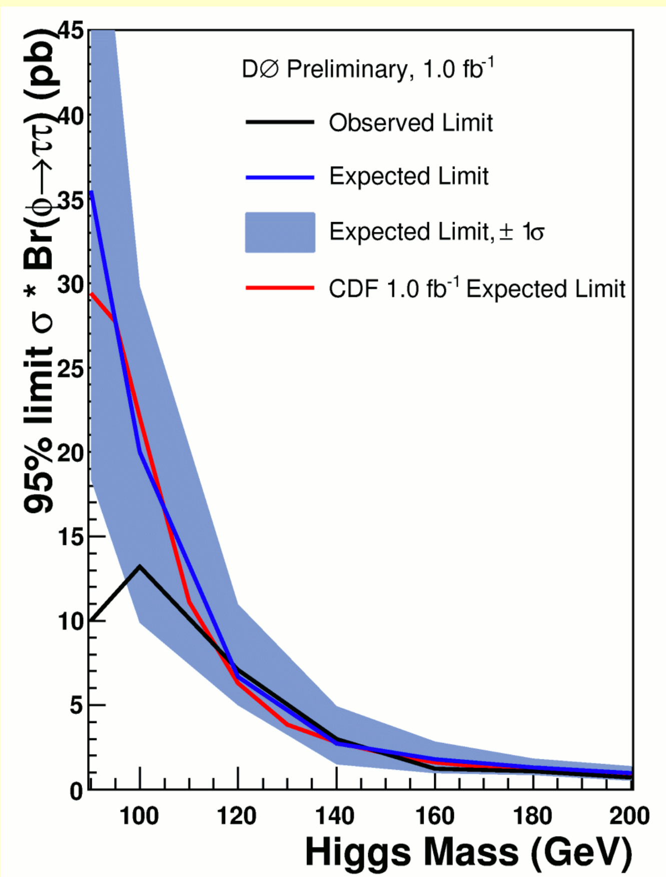


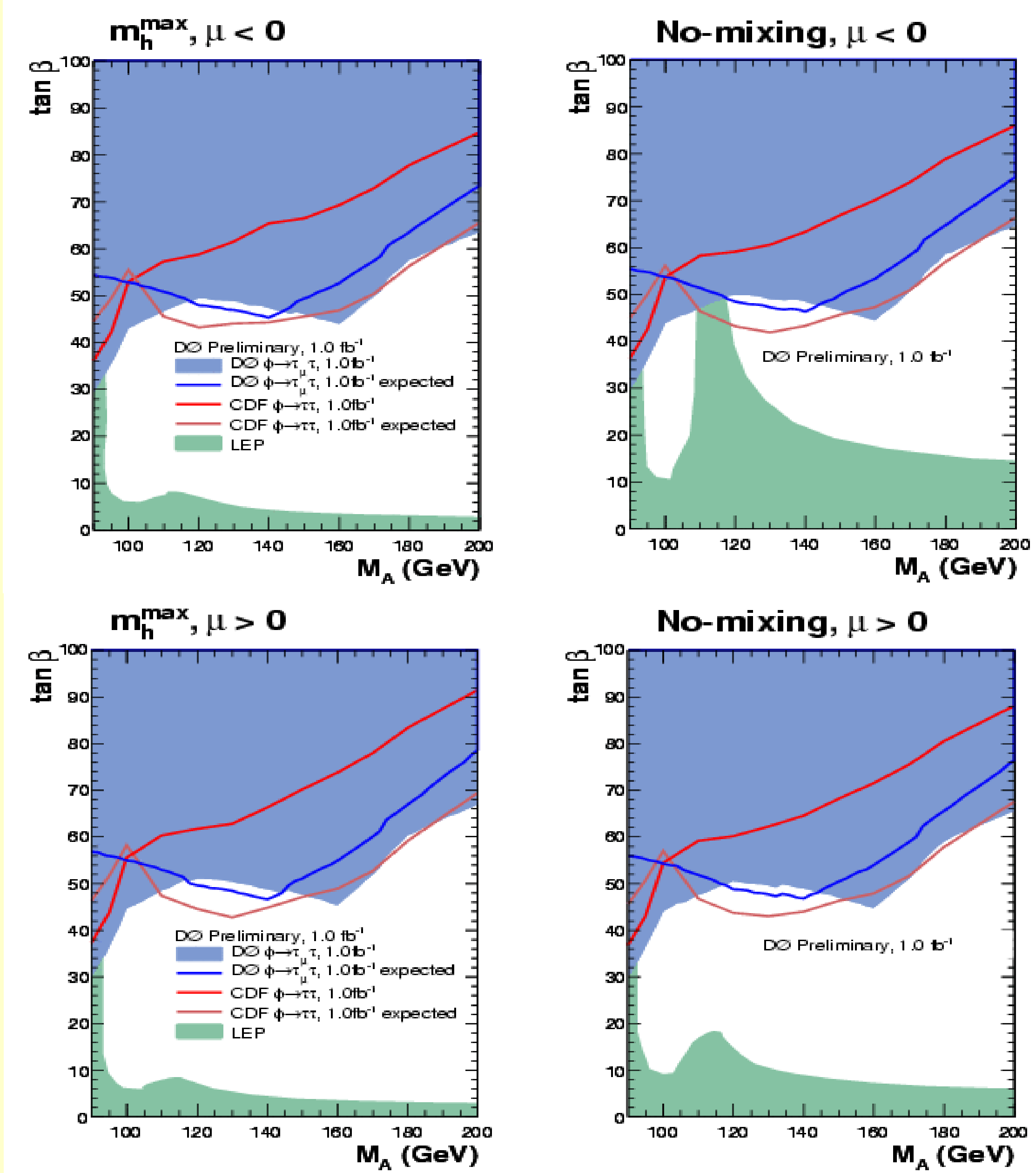
- ✗ Similar analysis at CDF
  - ✗ **Combines e+h, μ+h, e+μ tau decays**
  - ✗ **Best fit: m_ϕ=160 GeV, tanβ~50**



$\phi\to\tau^+\tau^-$ Search

- DØ preliminary 1.0fb^{-1} 95% CL limits, interpreted in:
  - $\sigma \times \mathrm{Br}(\phi\to\tau\tau)$
  - MSSM parameter space





Summary of Results

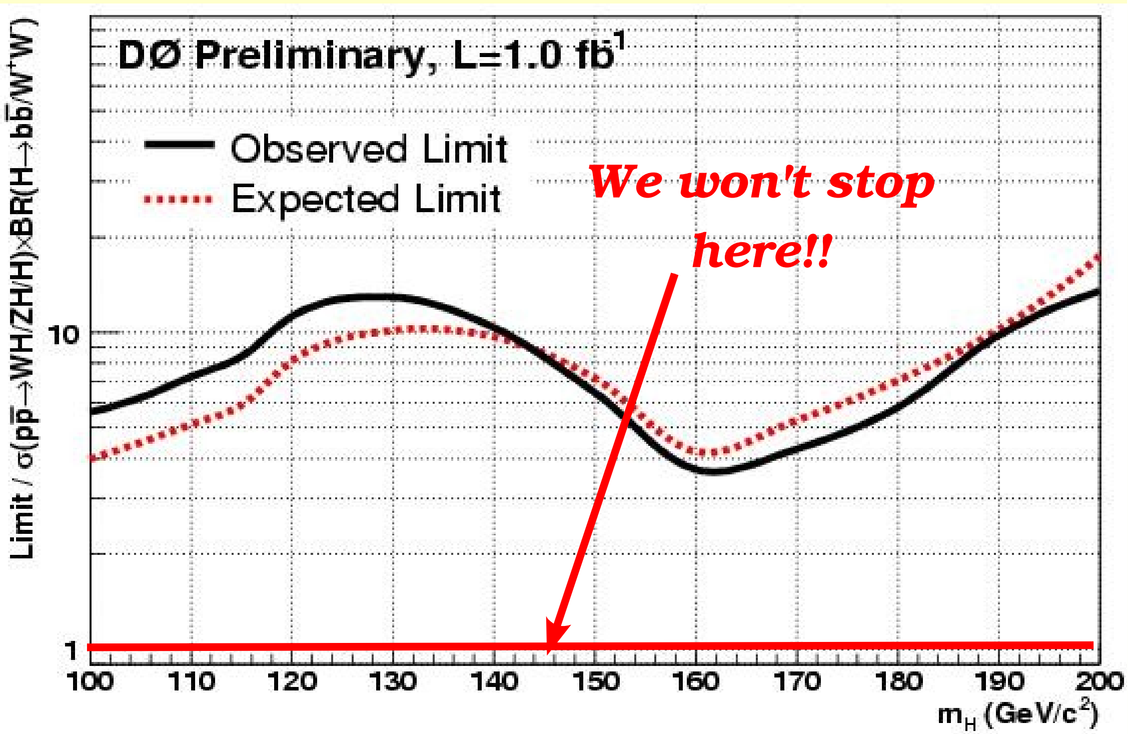
Wine & Cheese
April 6th, 2007

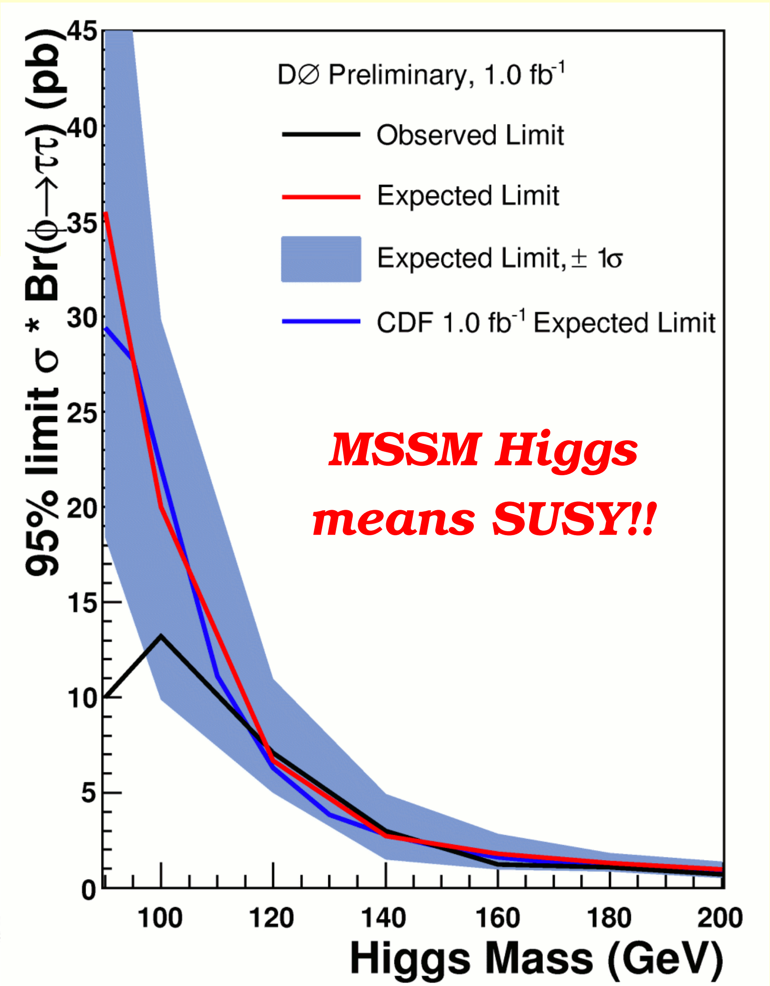
Analysis	CDF limit ($1fb^{-1}$) factor above SM observed (expected)	D0 limit ($1fb^{-1}$) factor above SM observed (expected)
Z/WH→MET+bb @ 115		
Technique: M_{jj}	16 (15)	14 (9.6)
WH→lνbb @ 115		
Technique: M_{jj}	26 (17)	11 (8.8)
Technique: ME	-	12 (9.5)
ZH→llbb @ 115		
Technique: M_{jj}	-	23 (22)
Technique: NN2D	16 (16)	-
H→WW→lνlν @ 160		
Technique: $\Delta\phi$(l,l)	9.2 (6.0)	3.7 (4.2)
Technique: ME	3.4 (4.8)	-
$\Phi\rightarrow\tau\tau$ @ 160		
μ<0, no mixing	$\tan\beta$ < 69 (47)	$\tan\beta$ < 44 (54)

Conclusions

Higgs physics in Run II of the Tevatron looks promising: ***very exciting time to be working here!!***

Great collaboration and FNAL support allows us to push the boundaries of our knowledge: $\geq 3\sigma$ Higgs is reachable if Higgs is light or near 160 GeV





Acknowledgements

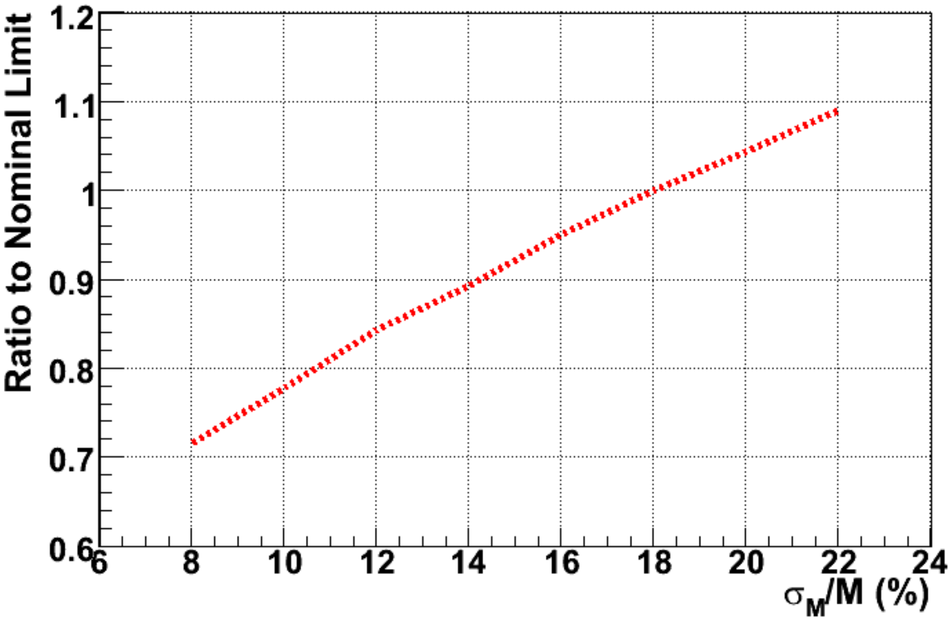
- Thanks to all the hard work at DZero needed to deliver these results
  - Not just the Higgs group!!!
- Accelerator division keeps our analyses well-fed
  - Cannot find the Higgs without luminosity!
- Thanks to all whose slides were robbed
  - Gregorio Bernardi, Andy Haas, Yuji Enari, Greg Landsberg (*et al*)
  - Mark Owen & Stefan Soldner-Rembold for working on Easter break
  - Nice Feynman diagrams and figures from Ben Kilminster's Moriond QCD '07 talk

Backup Slides

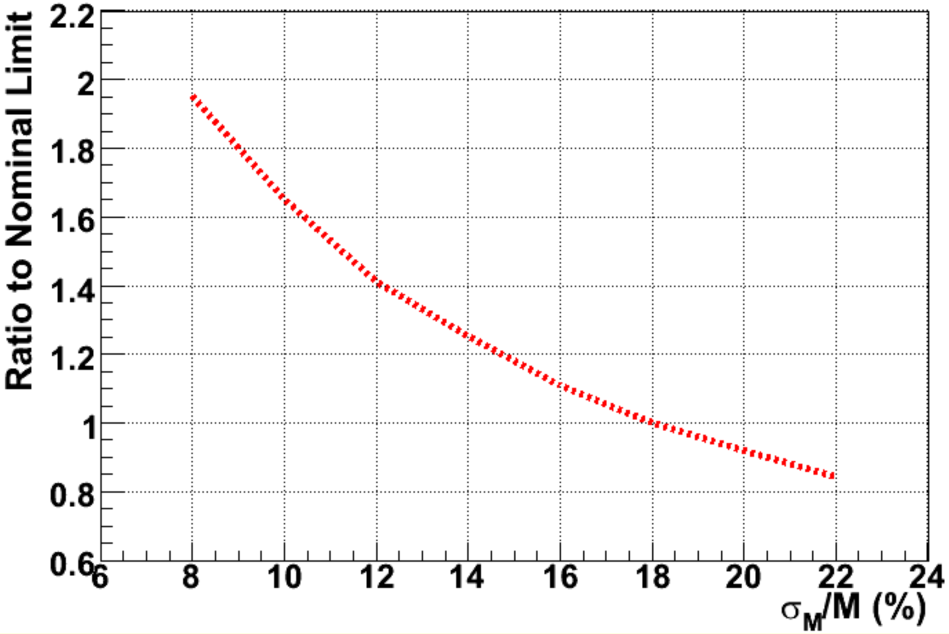
Di-Jet Mass Resolution

- SHWG/HSG quoted at 10% dijet mass resolution
  - Bad news: We're currently at 17-18%
  - Good news: Don't need 10% to get expected factor in lumi
- Several techniques available: energy-flow algorithms, constrained fitting of jets+MET system, ISR/FSR jet recovery

Change in Limit



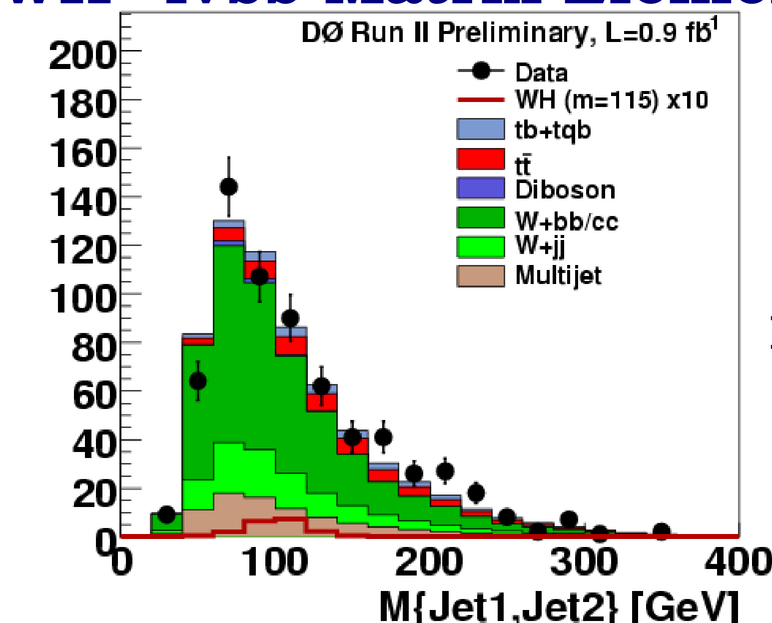
Effective Lumi



Multivariate Analyses

- Many mature techniques (*ready for final vetting*)
  - Matrix Element, Neural Networks
    - Observe 35-50% improvement in limit
- Not limited to H→bb or low mass!!
  - Very large improvement possible for m_H~135 GeV, where top-pair/single-top begin to dominate

WH→lνbb Matrix Element



Weight by ME discrim