Standard Model Higgs Prospects at the Tevatron

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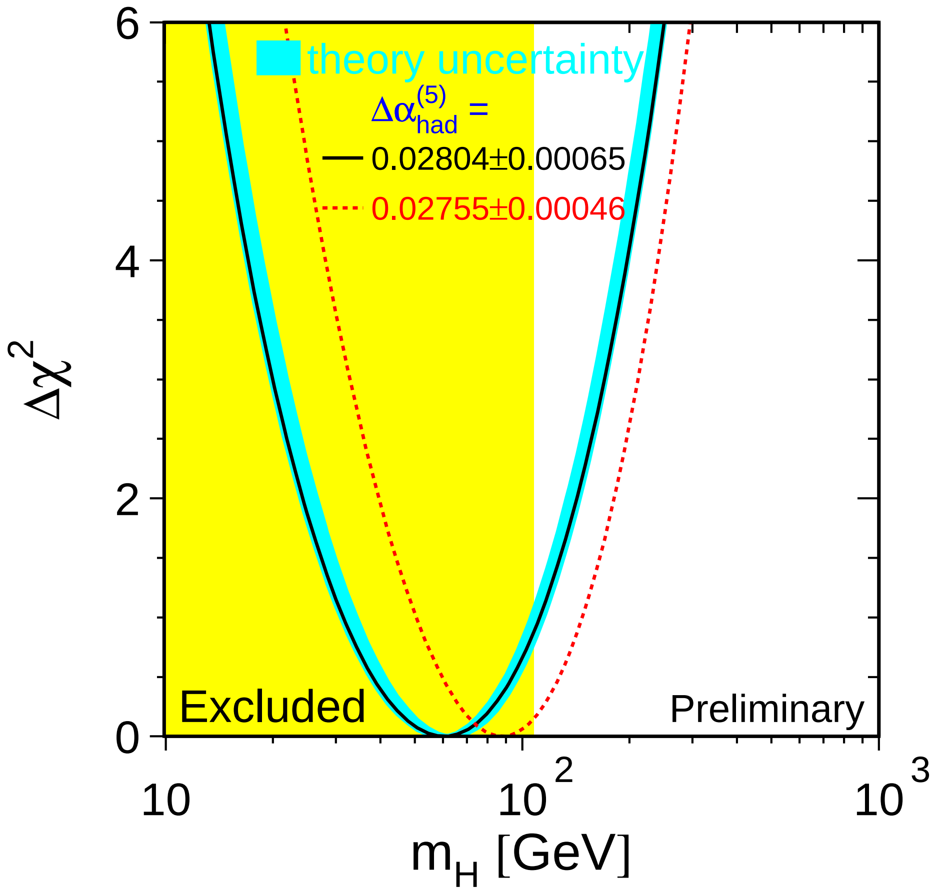
- Standard Model Higgs Mass Constraints:
  Experiment and Theory
- Searches for $M_{\mathrm{H}} \lesssim 130$ GeV
  Review of the Run II Workshop results
- Searches for $M_{\mathrm{H}} \gtrsim 130$ GeV
  How to extend the reach of the Tevatron
- Conclusions

- Fits to Precision Electro-Weak Data (LEP EWWG)



LEP EW Working Group Summer 00

$$\boldsymbol{M_{\mathrm{H}} = 62^{+53}_{-30}\ \mathrm{GeV}}$$

$$\boldsymbol{M_{\mathrm{H}} \lesssim 170\ \mathrm{GeV\ at\ 95\%\ CL}}$$

- Intepretation of recent BES results affects $\Delta^{(5)}_{had}$

  Will push up preferred fit value

  Expect 95% CL upper limit $\rightarrow\sim$ 210 GeV

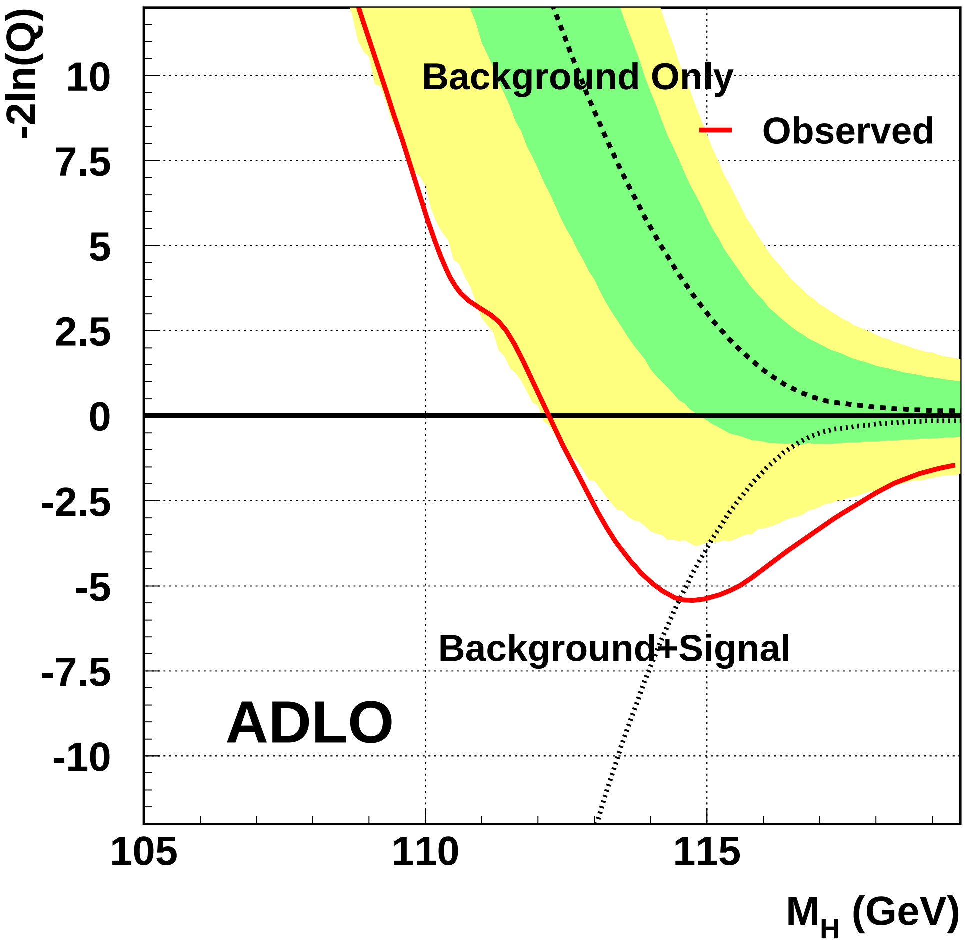
- Direct Searches: Preliminary LEP Combined (LEPC)

  Is the glass half empty or half full?

$M_H > 112.3$ GeV at 95% CL

OR

2.6σ Excess at 114.9 GeV

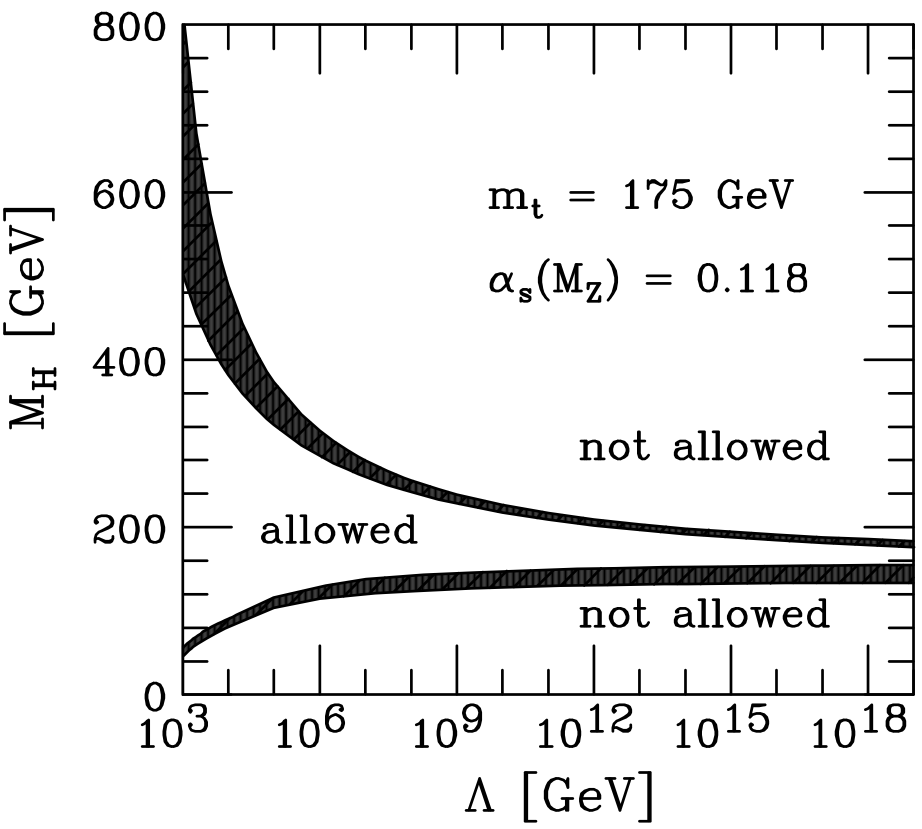


LEP Higgs Working Group Sept 00

- The phenomonologically interesting mass regions:
  1. The MSSM requires $M_h \lesssim 125 - 130$ GeV
  2. Any weakly coupled SUSY theory requires $M_h \lesssim 200$ GeV
  3. The Standard Model requires $130 \lesssim M_{\mathrm{H}} \lesssim 180$ GeV

     Vacuum Stability $\Longrightarrow$ Lower bound

     Landau Pole $\Longrightarrow$ Upper bound

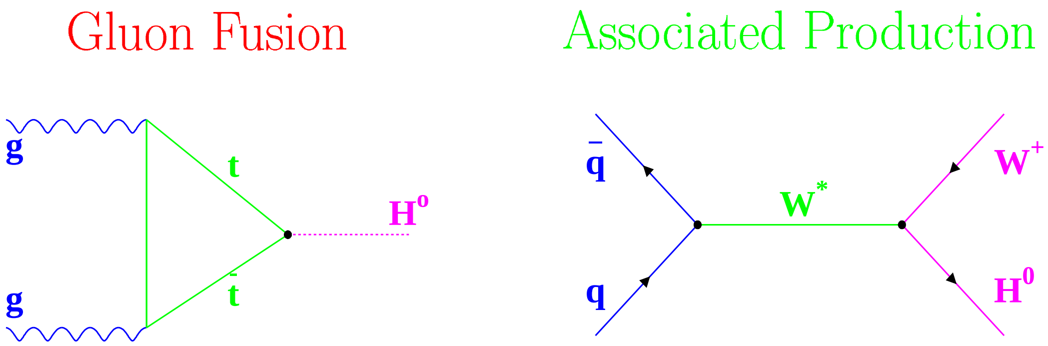


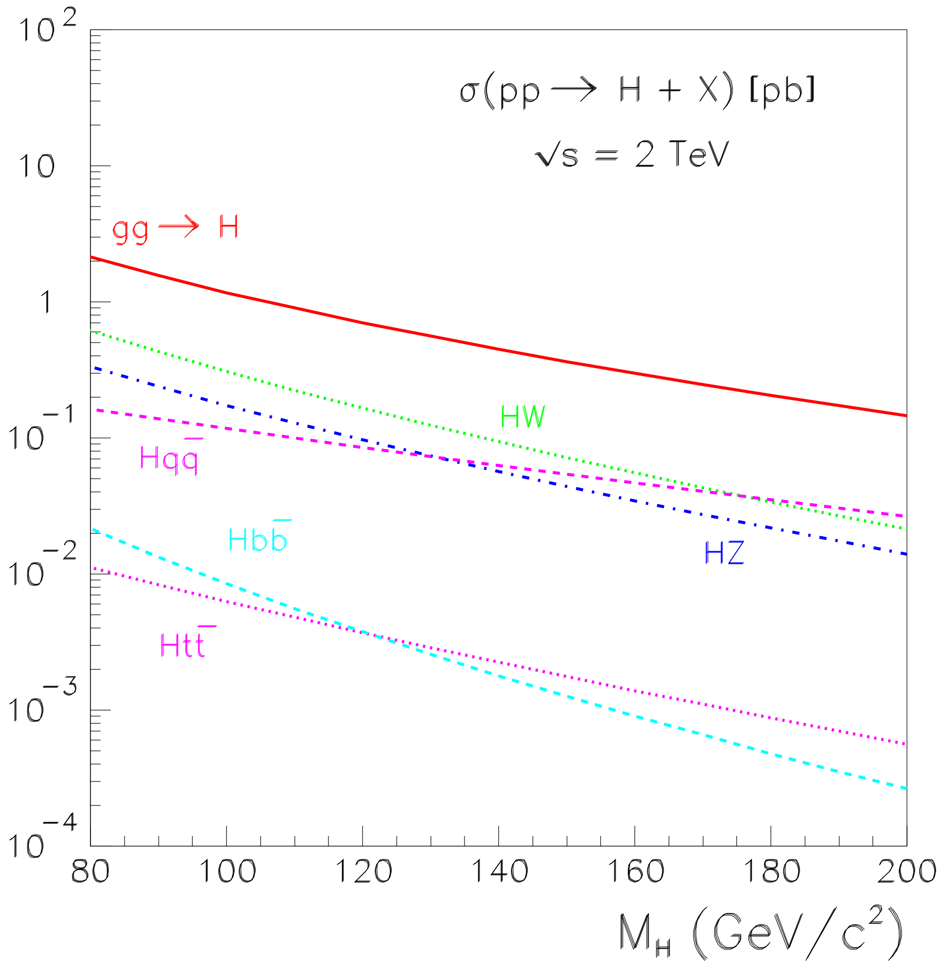
Risselmann, hep-ph/9711456

- If one could probe the SM Higgs up to ~ 180 GeV...

  $\Longrightarrow$ Profound implications for $\Lambda_{\text{New Physics}}$

SM Higgs Production Cross sections

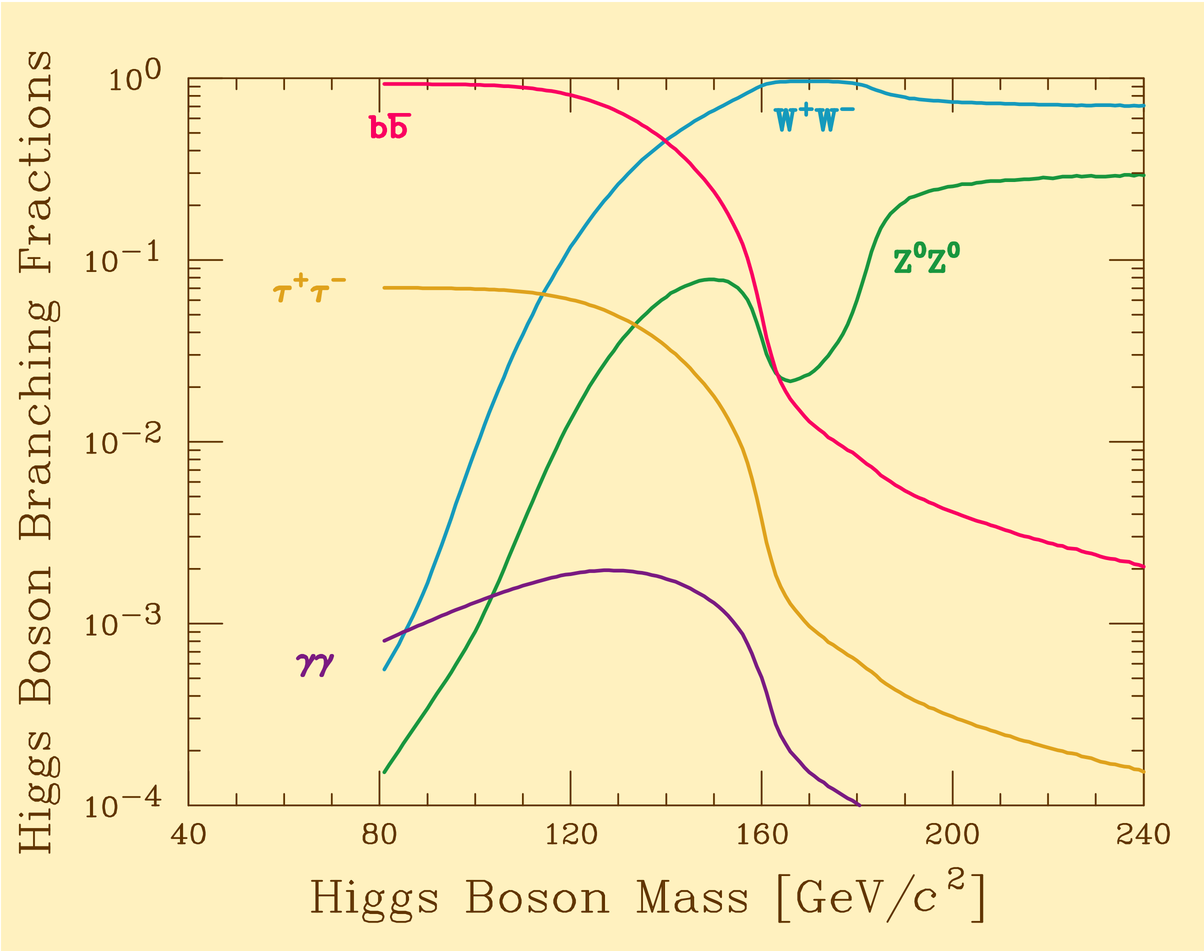




- Gluon fusion has the largest cross-section, but ...

  ... WH/ZH production is most accessible

- *Can* $gg \rightarrow H^0$ be used at the Tevatron?



- For $M_{\rm H} \lesssim 135$ GeV:

  $\rm H^0 \to b\bar{b}$ dominates ... but rate is falling rapidly

  QCD background precludes using $gg \to \rm H^0 \to b\bar{b}$

  The tau mode is tantalizing ...

- For $M_{\rm H} \gtrsim 135$ GeV:

  Gauge boson decays take over

  In particular: $\rm H^0 \to WW^{(*)}$

- Fermilab Run II Higgs/SUSY Workshop

  http://fnth37.fnal.gov/higgs.html

  Check it out!

- Workshop Goals:

  1. Perform comprehensive survey of final states
  2. Study effect of improved b tagging and $b\bar{b}$ mass resolution
  3. Determine the integrated luminosity needed for

     95% C.L. exclusion (1.96σ)
     3σ Observation: P(Background) < 0.00135
     5σ Discovery: P(Background) $< 2.7 \times 10^{-7}$

     as a function of Standard Model Higgs mass

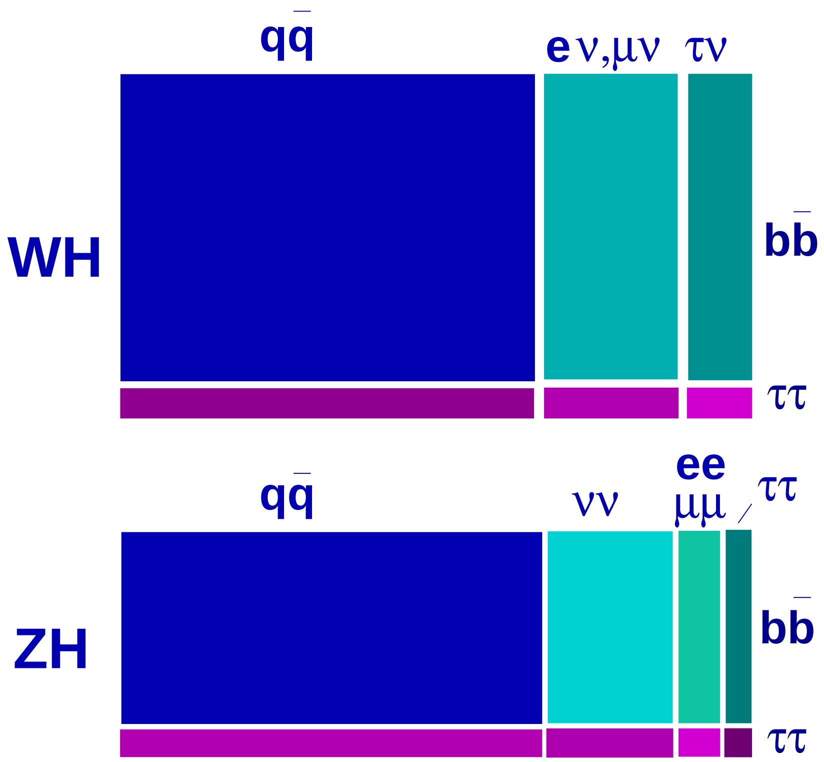
- Workshop conclusions included a few surprises:

  Effect of combining all search channels (à la LEP)

  Effect of new channels

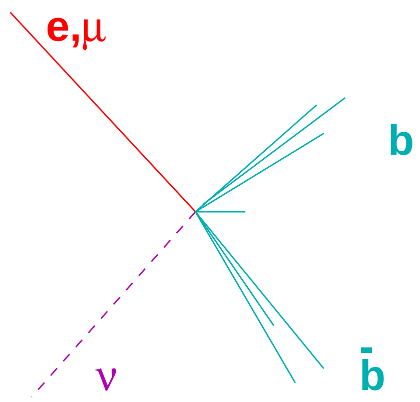
- The Tevatron Higgs coverage had been *underestimated*

- For $M_{\rm H} \lesssim 130$ GeV, BR($H^0 \to b\bar{b}$) $\gtrsim 60\%$
  $\Longrightarrow$ focus on associated production (WH/ZH)



- Best prospects for final states with leptonic W/Z decays
  as QCD backgrounds prohibitive for $q\bar{q}b\bar{b}$ channel
- SM background processes include:
  $Wb\bar{b}$, $Zb\bar{b}$ $t\bar{t}$, ZZ, WZ, $W^* \to t\bar{b}$
- Ultimately the sensitivity will depend on
  Performance of b-tagging algorithms
  Jet-jet mass resolution:

Barberis, Yao, Bhat, Prosper, Bokhari, Gilmartin



- Inclusive high-p_T lepton trigger OR Jets + $\not\!\!E_T$
- Central e or μ with $p_T > 20$ GeV and $\not\!\!E_T > 20$ GeV
- Two b-tagged jets: tight SVX with loose SVX or SLT
- Multivariate Analysis $\Longrightarrow$ Increased sensitivity

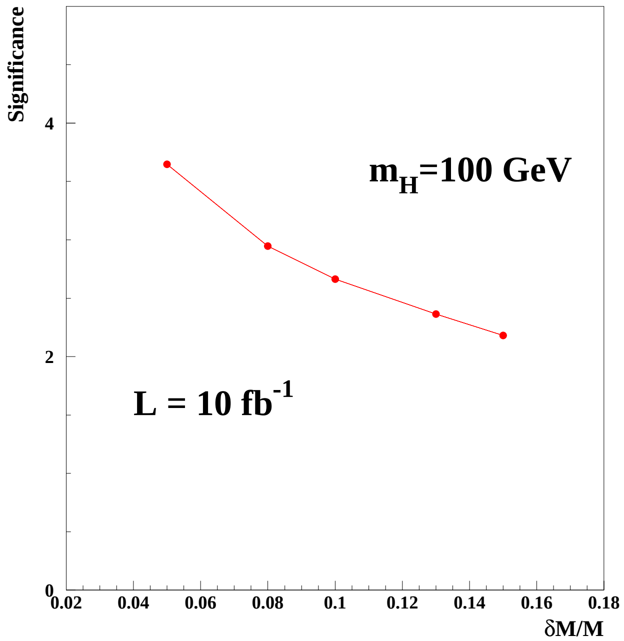
Expected Events and Sensitivity per fb^{-1}					
Mass (GeV)	90	100	110	120	130
S	8.7	9.0	4.8	4.4	3.7
B	28	39	19	26	46
$S/\sqrt{B}$	1.6	1.2	1.1	0.9	0.5

- Potential for improvement in WH *vs* W$b\bar{b}$

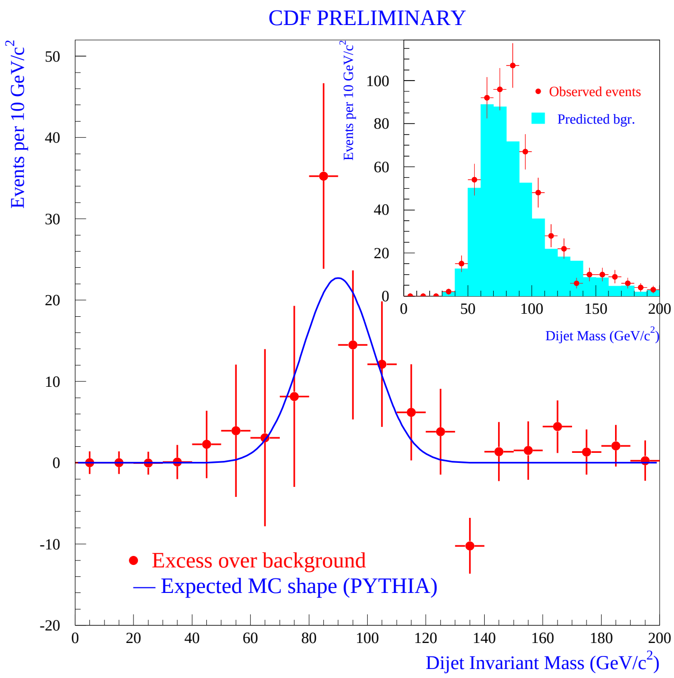
  Use angular correlations: Parke, Veseli `hep-ph/990321`
- W+jets bgd normalization from Run I data (recall $t\bar{t}$!)

- Dependence of signal significance on $b\bar{b}$ mass resolution

For Run II
Aim for $\sigma(M_{b\bar{b}}) \sim 10\%$
30% better than Run I

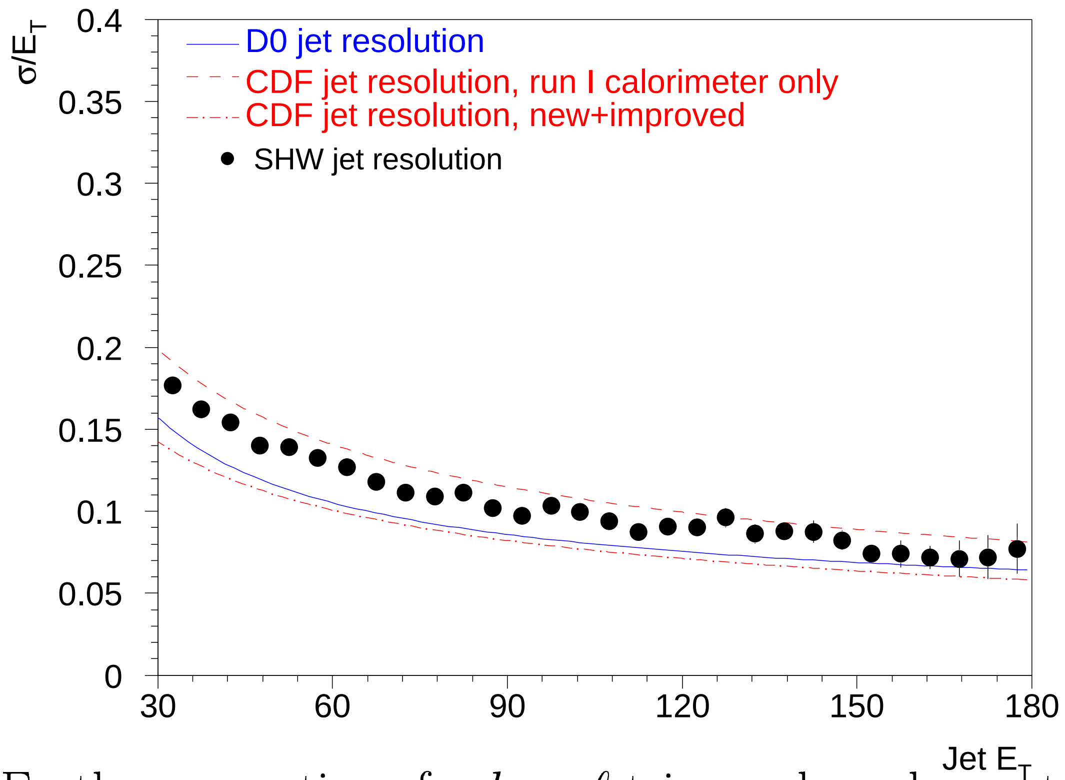


Barberis



CDF Run I: $Z^0 \to b\bar{b}$
"Calibration" for
Run II Higgs

- Run I Jet E_T resolution vs. Fast MC



Hobbs

- Further corrections for $b \to \ell$ triggers have been studied

  Can get 12% at $M = 120$ GeV

  Effect verified in Run I for $Z^0 \to b\bar{b}$

- Factor of at least 20 in γ−jet statistics

  $\Longrightarrow$ *improved jet energy scale*

- Significant sample $Z^0 \to b\bar{b}$ events

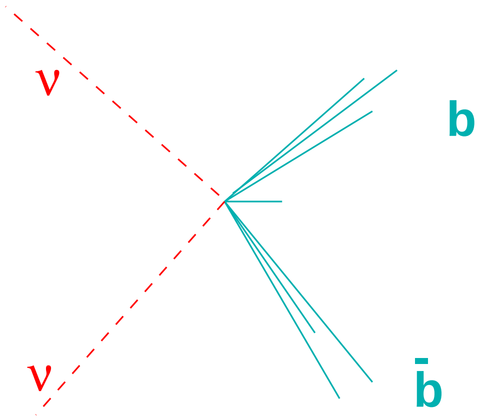
  Both Lepton and SVX based triggers

- If only 12% mass resolution is obtainable

  Increases needed $\int \mathcal{L}dt$ by 20%

SM Higgs Search: $H^0Z^0 \rightarrow \nu\bar{\nu}b\bar{b}$ Channel

Yao, Jesik, Demina, Bokhari, Kilminster, Hedin



- $\not\!\!E_T$ + jets trigger ($\not\!\!E_T > 35$ GeV)
- Two b-tagged jets: $p_T^1 > 20$ GeV, $p_T^2 > 15$ GeV, $|\eta| < 2$
- Veto isolated "leptons"
- Jet-$\not\!\!E_T$ cut: $\Delta\phi_{b-\not\,E_T} > 0.5$
- $t\bar{t}$ veto: $\Sigma E_T^{jet} \equiv H_T < 175$ GeV

Expected Events and Sensitivity per fb^{-1}					
Mass (GeV)	90	100	110	120	130
S	11.	7.	5.3	3.7	2.6
B	54	30	24.	20	21
$S/\sqrt{B}$	1.5	1.3	1.1	0.8	0.6

- QCD di-jet background:

  Original studies "ignored" this contribution

- Difficult to measure:

  Large cross-section and low efficiency

- From Run I CDF $H^0Z^0 \to \nu\bar{\nu}b\bar{b}$ analysis

  QCD background 50% of total

  1.9 ± 0.4 *events of* 3.9 ± 0.6 *total*

  http://cdfsg6.lbl.gov/~weiming/zh_run1_nunubb.html

- DØ Run I Jets + $\not{E}_T$ analyses

  Stop search: SM background 16.7 ± 1.7 *events*

  QCD contribution 0.4 ± 0.4

  Caveat: Lower luminosity (Run IA)

  Aside: $\sigma(\not{E}_T) = 1.08 + 0.019 \times (\sum E_T)$

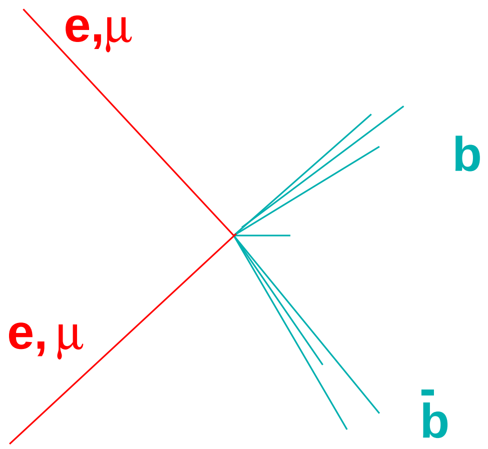
- Current studies disagree at the 20-30% level

  Conservatively take most pessimistic result

  QCD background as 50% of total

  i.e. *equal to the SM contribution*

Yao, Jesik, Kruse, Kilminster



- Inclusive high p_T lepton trigger
- Two like-type leptons: $p_T^1 > 20$ GeV, $p_T^2 > 10$ GeV, $|\eta| < 2$
- Consistency with a Z^0 hypothesis: $|M_{\ell\ell} - M_Z| < 15$ GeV
- Two b-tagged jets: $p_T^1 > 20$ GeV, $p_T^2 > 15$ GeV, $|\eta| < 2$
- Small rate but good S/B
- Kinematic fit can be used to further enhance sensitivity

Expected Events and Sensitivity per fb^{-1}					
Mass (GeV)	90	100	110	120	130
S	1.2	0.8	0.5	0.5	0.3
B	4.2	2.7	2.3	2.0	1.9
$S/\sqrt{B}$	0.6	0.5	0.3	0.3	0.2

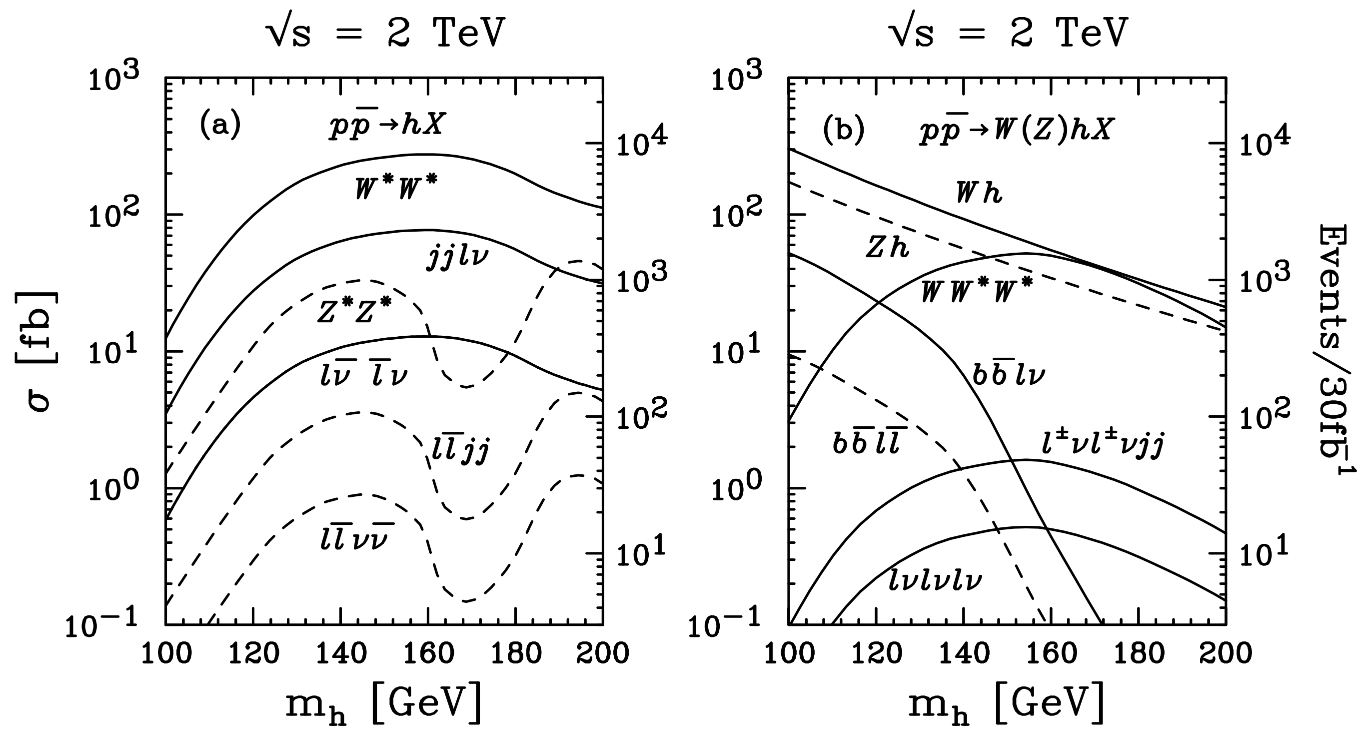
- Associated production with $H^0 \to b\bar{b}$ peters out at 130 GeV

  How to extend the reach of the Tevatron?

- Make use of the rising $H^0 \to WW^{(*)}$ branching ratio

  Exploit the large $gg \to H^0$ cross section

  Identify final state topologies with small SM contribution



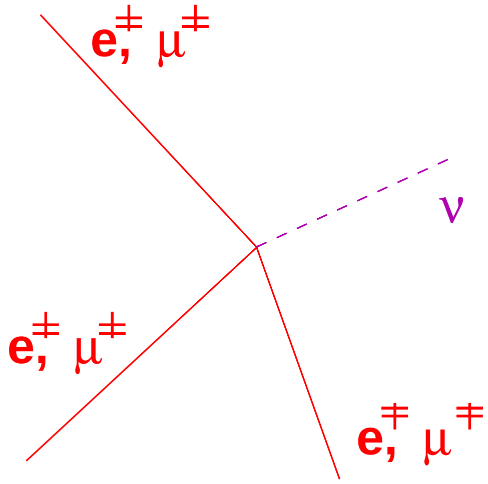
Han, Turcot and Zhang

- Focus on leptonic Gauge Boson Decays:

  Excellent trigger topologies

  QCD-related backgrounds less of a problem

Schmitt



- Associated production: $VH \rightarrow WWW^{(*)}/ZWW^{(*)}$
- First considered by Baer & Wells (hep-ph/9710368)
- Inclusive di-lepton trigger: $p_T^1 > 10$ GeV, $p_T^2 > 5$ GeV
- "Golden" modes (like-sign-like-type leptons) OR

  tight kinematic cuts to deal with WZ and ZZ
- Small rate:

  Limited sensitivity to SM Higgs but ...

  New Physics can lead to observable enhancements

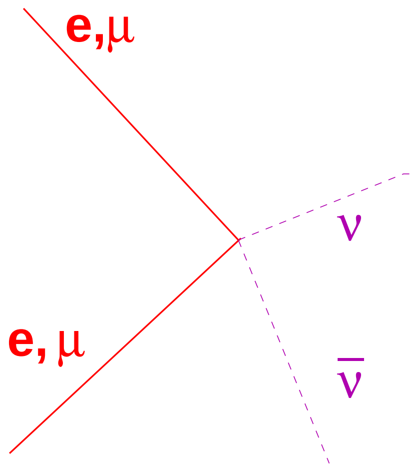
Expected Events and Sensitivity per fb^{-1}							
Mass (GeV)	120	130	140	150	160	170	180
S	0.011	0.025	0.039	0.050	0.057	0.033	0.033
B	0.07	0.07	0.07	0.07	0.07	0.07	0.07
$S/\sqrt{B}$	0.07	0.16	0.25	0.32	0.36	0.21	0.21

History: $gg \to H^0 \to WW^{(*)}$

- Glover *et al.* (Phys. Rev. **D37**, 3193 (1988))
  First study for the SSC
- Barger *et al.* (Phys. Rev. **D43**, 779 (1991))
  Parton level study for the SSC
  Positive conclusions
- Gunion and Han (Phys. Rev. **D51**, 1051 (1995))
  Study of SM Higgs detection for 4 TeV Tevatron
  Large $\ell\nu\ell\nu$ rate but huge backgrounds
- Dittmar and Dreiner (Phys. Rev. **D55**, 167 (1997))
  For $155 \le M_H \le 180$, "Easy Pickins' at the LHC"
- Han and Zhang (Phys. Rev. Lett. **82**, 25 (1999)
  Idealized parton level study for the Tevatron
  Conclude $3-5\sigma$ *signal possible for 30* fb^{-1}
  combinining $\ell\nu\ell\nu$ *and* $\ell\nu jj$ *significances*
- Han, Turcot and Zhang (Phys. Rev. **D59**, 093001 (1999))
  1. *First detector level study*
  2. *Based on fast simulation interfaced with Pythia*
  3. *Conservative assumptions re: detector performance*
  4. *First comprehensive study to address experimental issues*

- Consider inclusive production:

$$p\bar{p} \to HX \to WW^{(*)}X \to \ell\nu\ell'\bar{\nu}'$$



- Leading contribution from gluon fusion channel

  Estimated using HIGLU, CTEQ4M PDF's and HDECAY

$\sigma(gg \to \mathrm{H}^0) \times \mathrm{B}(\mathrm{H}^0 \to \mathrm{WW}^{(*)}) \times \mathrm{B}(\mathrm{W} \to \mathrm{e}, \mu)^2$

Mass (GeV)	140	150	160	170	180	190
$\sigma \times B$ (fb)	11.2	12.8	13.9	12.2	9.8	6.9

- Standard Model backgrounds:

  WW$\to \ell\nu\ \ \ell'\bar{\nu}'$: 1090 fb $\quad$ $\tau^+\tau^- \to \ell\nu\nu\ \ \ell'\nu\nu$: 23 pb

  $t\bar{t} \to b\ell\nu\ \ \bar{b}\ell'\nu$: 722 fb $\quad$ WZ, ZZ, and tW: $\sim$ 220 fb

- $\sum$ Background. $\approx$ 25 pb $\Longrightarrow S/B \sim 4 \times 10^{-4}$

- 2 and only 2 leptons of opposite sign
  $|\eta_\ell| < 1.5$, $p_T^e > 10$ GeV/c , $p_T^\mu > 5$ GeV/c
  Require leading lepton to have $p_T > 10$ GeV/c
  Require $\triangle R(\ell j) > 0.4$
- Jet Veto: (Jet $\equiv p_t > 15$, $|\eta| < 3$)
  $p_T^{j1} < 95$ GeV/c, no b-tag
  $p_T^{j2} < 50$ GeV/c, no b-tag
  Veto events with > 2 jets
- $m(\ell\ell) > 10$ GeV/c^2 (conversions, J/ψ, $\Upsilon \ldots$)
  $p_T(\ell\ell) > 20$ GeV/c $\not\!\!E_T > 10$ GeV
- Dilepton opening angle in transverse plane: $\triangle\phi(\ell\ell) < 160°$
- Dilepton 3-d space angle: $\triangle\theta(\ell\ell) < 160°$
- $m(\ell\ell) < 78$ GeV if e^+e^- or $\mu^+\mu^-$, $m(\ell\ell) < 110$ GeV if $e\mu$
- Correlation of $\not\!\!E_T$ and $p_t(\ell\ell)$: $\cos\theta_{\ell\ell-Et} < 0.5$
- Helicity angle of ℓ_1 in $\ell\ell$ restframe

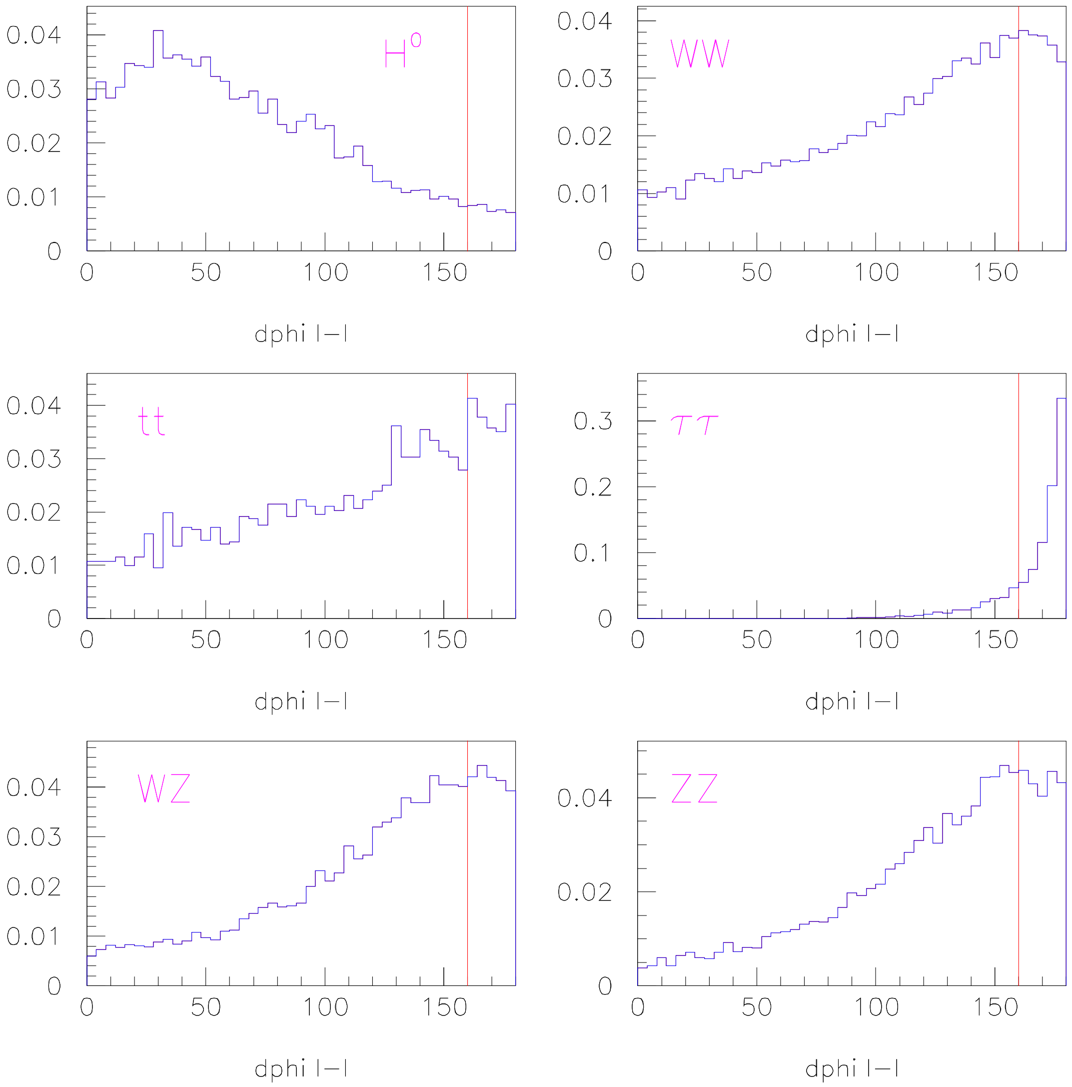
$$-0.3 < \cos\theta^*_{\ell 1} < 0.8$$

- Lepton-$\not\!\!E_T$ Tranverse Masses:

$$M_T(\ell - \not\!\!E_T)^2 = 2p_t(\ell_i)\not\!\!E_T(1 - \cos\theta_{(\ell-Et)}) > 20^2 \ \text{GeV}^2$$

$gg \to H^0 \to WW^{(*)}$: Transverse Opening Angle

- Require $\triangle\phi(\ell\ell) < 160°$



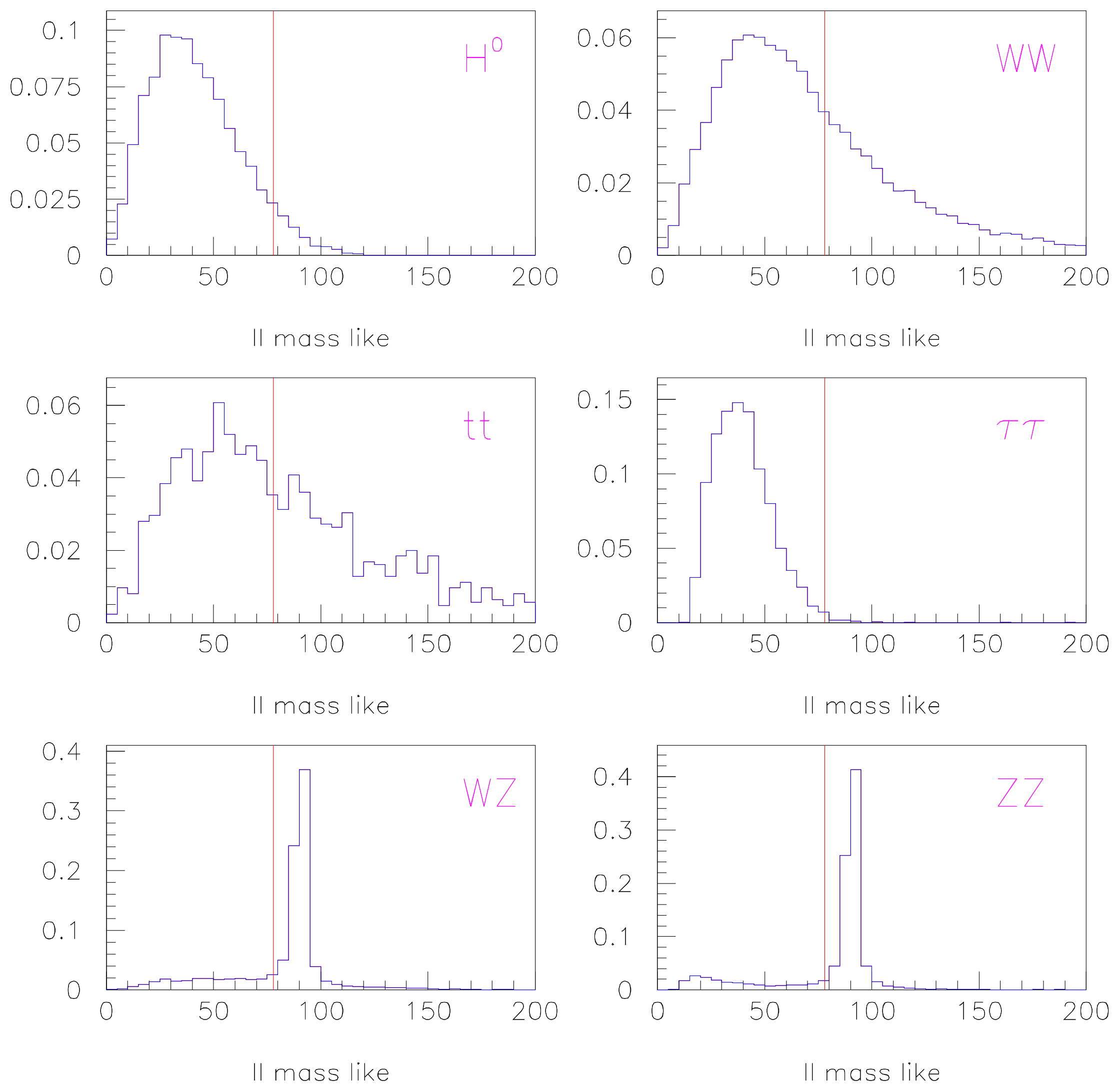
- Note effect of spin 0 WW production:

  Signal leptons tend to be in same hemisphere

  Background tends to be back-to-back

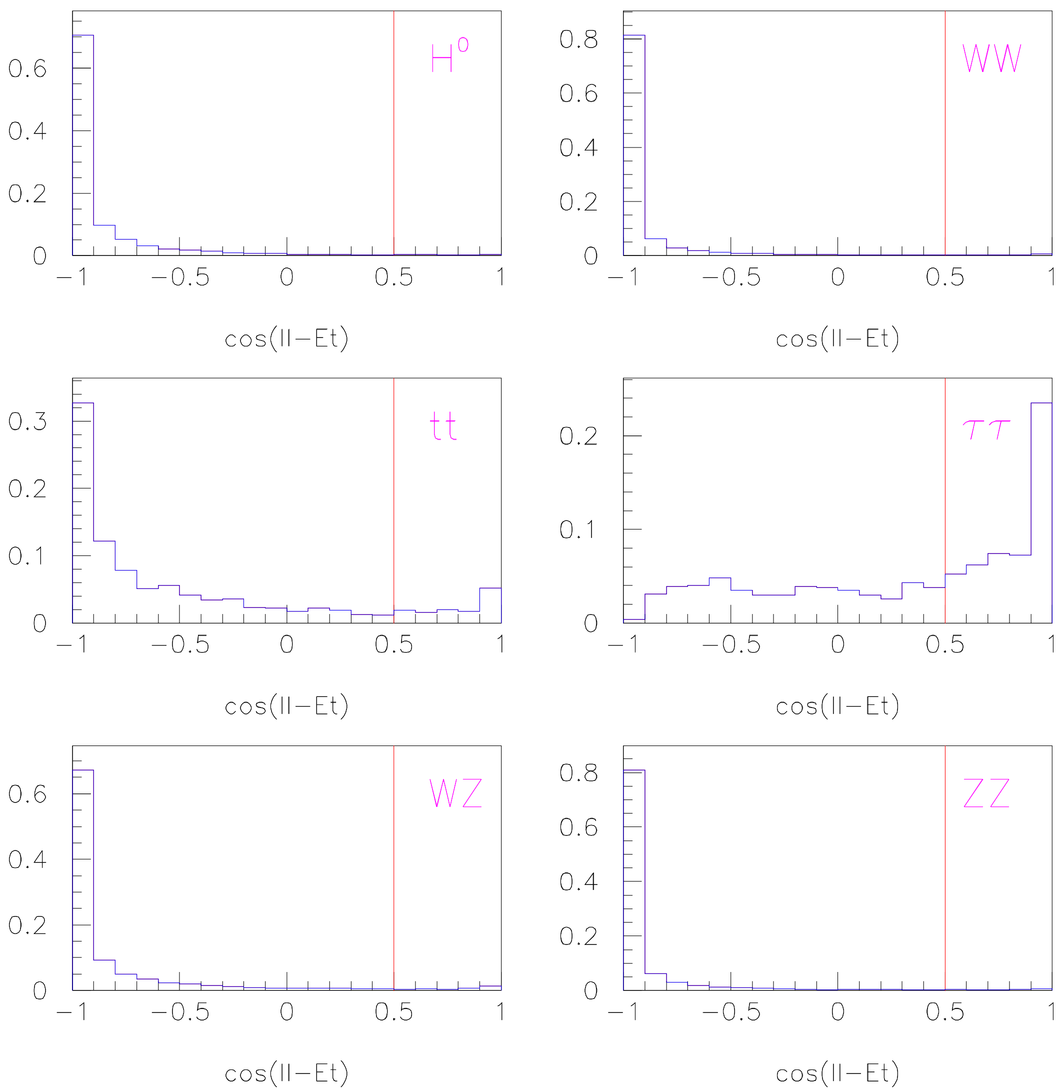
$gg \rightarrow H^0 \rightarrow WW^{(*)}$: Like Type Dilepton Mass

- Require $m(\ell\ell) < 78$ GeV if e^+e^- or $\mu^+\mu^-$



- Primarily a Z^0 veto but also effective for WW and $t\bar{t}$

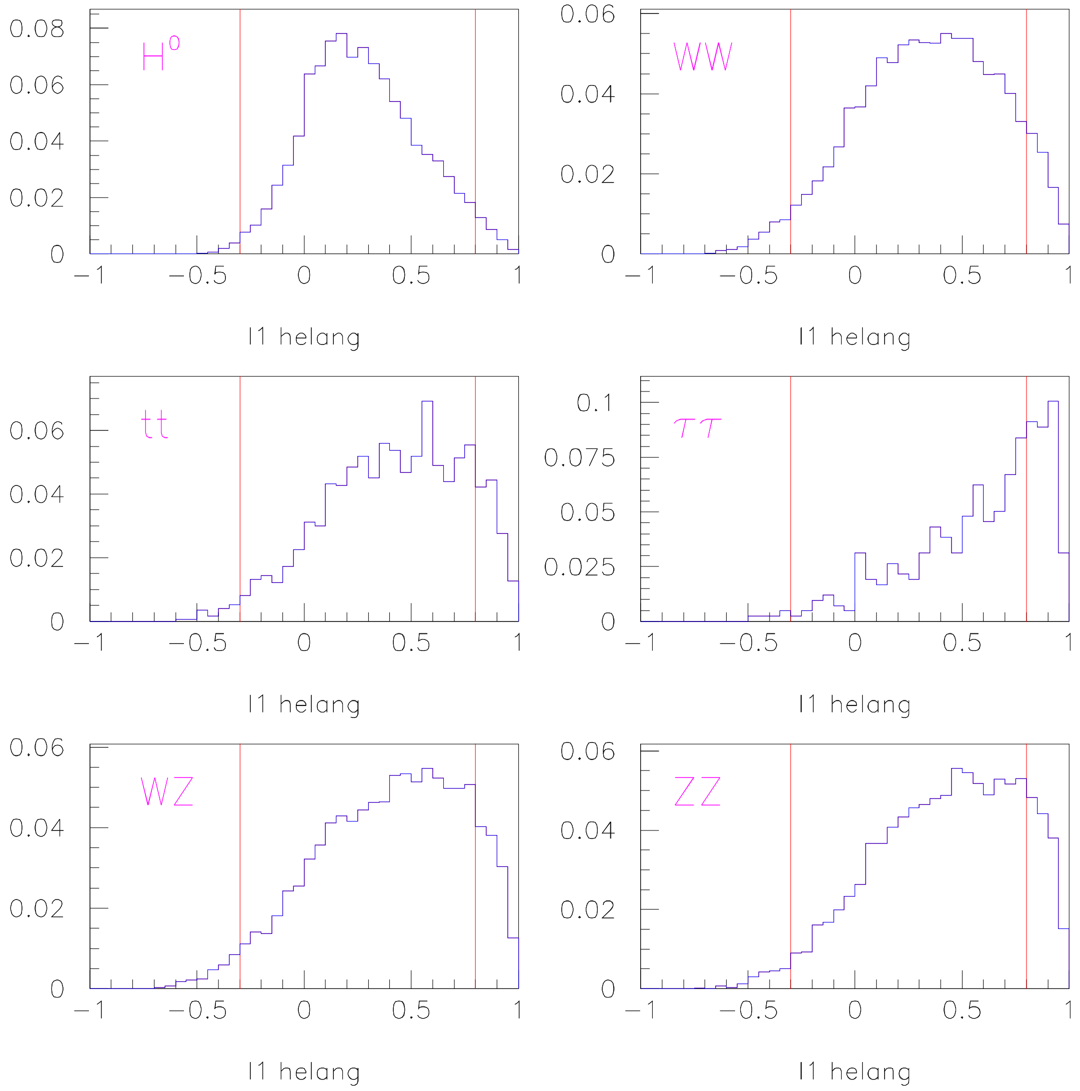
- Require $\cos\theta_{\ell\ell-Et} < 0.5$



- $\not{E}_T$ from $\tau^+\tau^-$ preferentially in same direction
  Semi-leptonic b decays from $t\bar{t}$

$gg \to H^0 \to WW^{(*)}$: Leading Lepton Helicity Angle

- Compute angle of leading lepton with respect to the boost direction in the $\ell\ell$ rest frame
- Require $-0.3 < \cos\theta^*_{\ell 1} < 0.8$

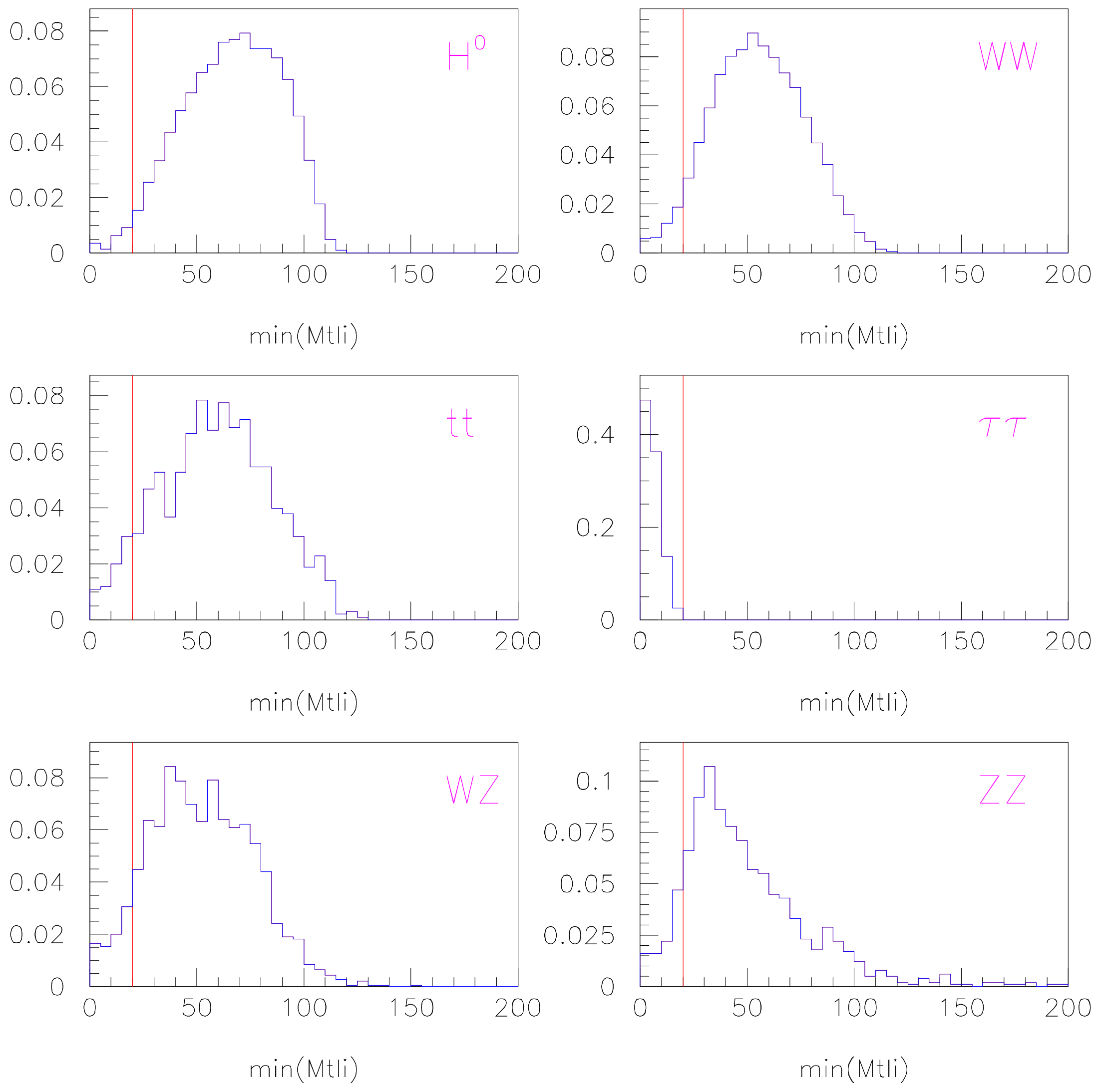


- First noted by Dittmar and Dreiner

$gg \to \mathrm{H}^0 \to \mathrm{WW}^{(*)}$: Lepton-$\not{E}_T$ Tranverse Masses

- Compute transverse mass of each lepton with $\not{E}_T$
  Require each lepton to satisfy

$$M_T(\ell)^2 = 2p_t(\ell_i)\not{E}_T(1 - \cos\theta_{(\ell - \not{E}_T)}) > 20^2 \ \ \mathrm{GeV}^2$$



- Effective against $\tau^+\tau^-$ and $W^\pm$+ fake
- Extremely powerful for $M_\mathrm{H} \gtrsim 160$ GeV ($M_T > M_\mathrm{W}$)

- Step 1: Basic Cuts:

  Maintain high efficiency while reducing $\tau\tau$ and $t\bar{t}$

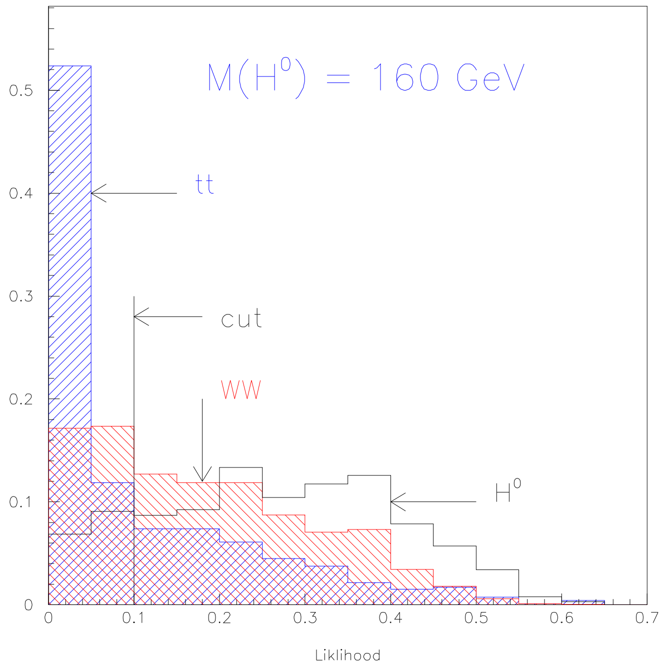
Backgrounds (fb)

$\sum$ Bgd.	WW	$t\bar{t}$	$\tau\tau$	WZ	ZZ	tW	W+fake
165	127	12.7	< 0.1	4.44	2.36	0.6	17.8

W+fake evaluated assuming $P(j \to e) = 10^{-4}$

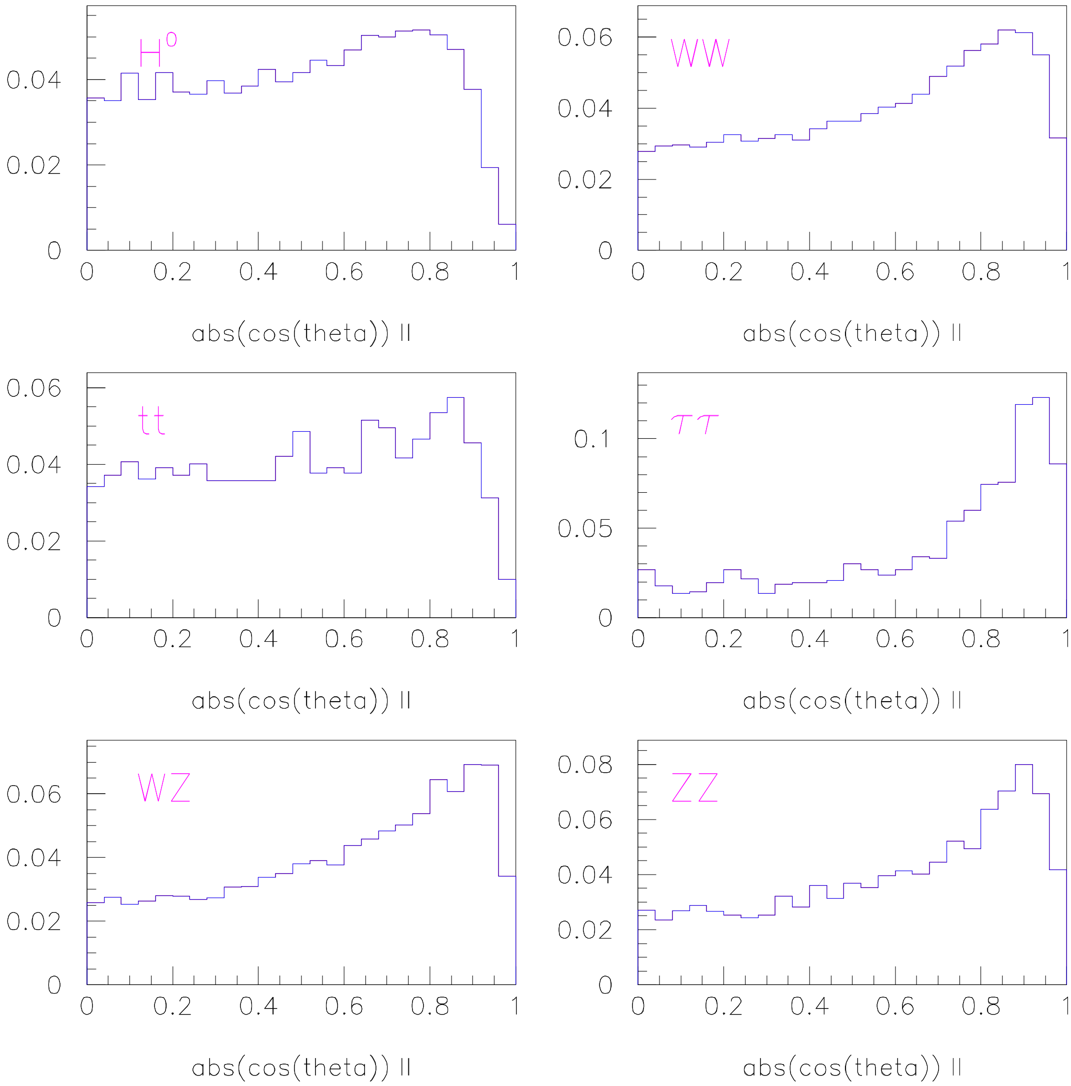
- Step 2: Construct a simple 5 class 6-variable Likelihood

1) $\cos\theta_{\ell\ell}$	2) $\triangle\phi(\ell\ell)$	3) $\triangle\theta(\ell\ell)$
4) $\cos\theta_{\ell\ell-Et}$	5) p_t^{j1}	6) p_t^{j2}



Require $\mathcal{L} > 0.10$ for all Higgs Masses

- Polar angle of dilepton with respect to the beam axis
- Signal is flatter and more central



- First noted by Dittmar and Dreiner

- Step 3: Background Normalization

  Dominated by WW and W plus fake ($j \rightarrow e$)

Post-$\mathcal{L}$ Backgrounds (fb)

$\sum$ Bgd.	WW	$t\bar{t}$	$\tau\tau$	WZ	ZZ	tW	W+fake
106	83	4.5	~ 0	3.1	1.8	0.6	13

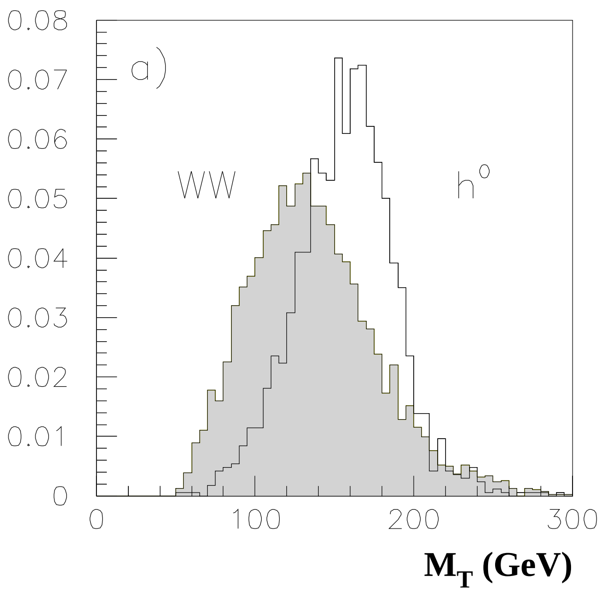
- Step 4: Final Selection:

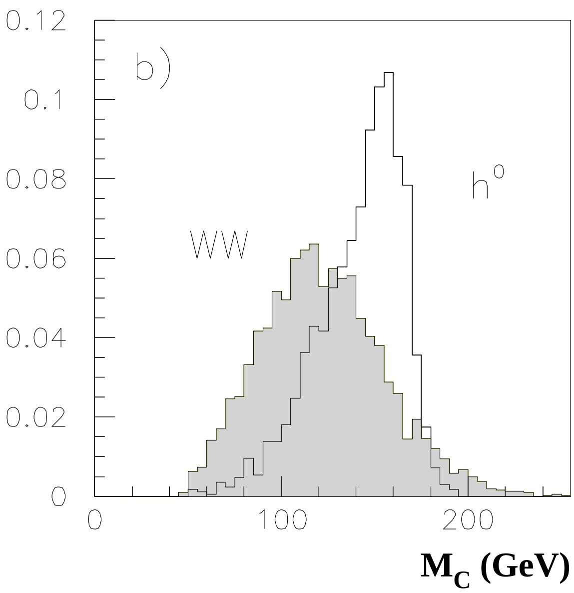
  Define *Tranverse Mass*:

$$M_T = 2\sqrt{p_T(\ell\ell)^2 + m(\ell\ell)^2}$$

  Define *Cluster Transverse Mass*:

$$M_C = \sqrt{p_T(\ell\ell)^2 + m(\ell\ell)^2} \quad + \not{E}_T$$





- Tighten basic cuts to test a Higgs mass hypothesis

  Exploit different kinematics of WW *production*

  Continuum vs. *at threshold via a spin 0 resonance*

  Utilize angular correlations between the leptons and $\not\!\!E_T$

  Force leptons to be parallel

  Require large lepton-$\not\!\!E_T$ *masses*

- Perform mass dependent cut optimization for:

$$M_H - 60 < M_C < M_H + 5 \text{ GeV}$$

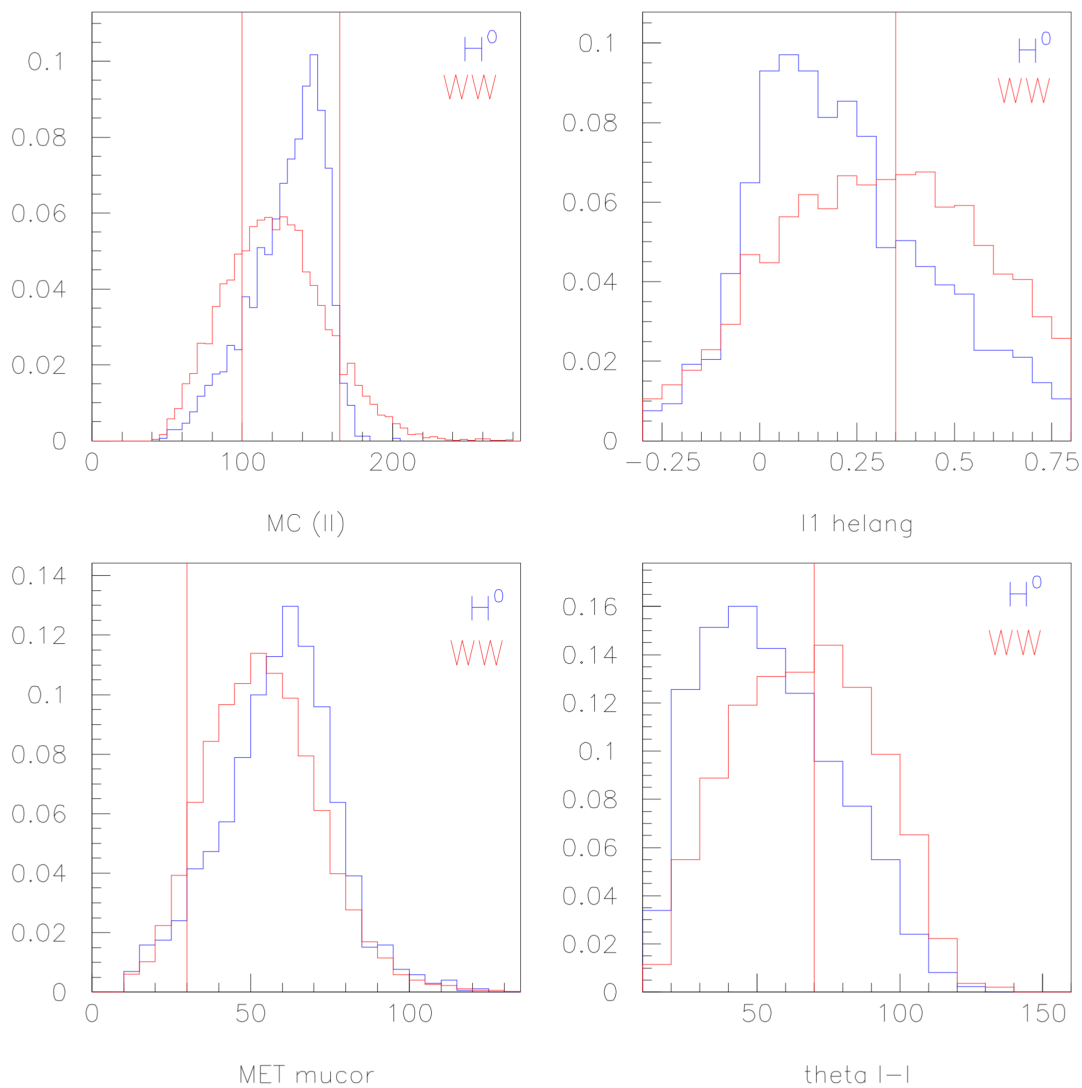
M_H [GeV]	140	150	160	170	180	190
$\cos\theta^*_{\ell_1}$	-	<0.6	0.35	0.35	0.55	0.75
$\not\!\!E_T$	>25	25	30	35	40	40
$\min[M_T(\ell_i \not\!\!E_T))]$	>40	40	75	80	85	75
$M_T(\ell_1 \not\!\!E_T)$	>60	60	-	-	-	-
$m(\ell\ell)$	<65	65	65	75	85	-
$p_T(\ell\ell)$	>40	50	65	70	70	70
$\theta(\ell\ell)$	<100	100	70	70	90	90
M_T	-	>110	120	130	140	140

- Ideally suited for a Multivariate approach

  i.e. Neural Network

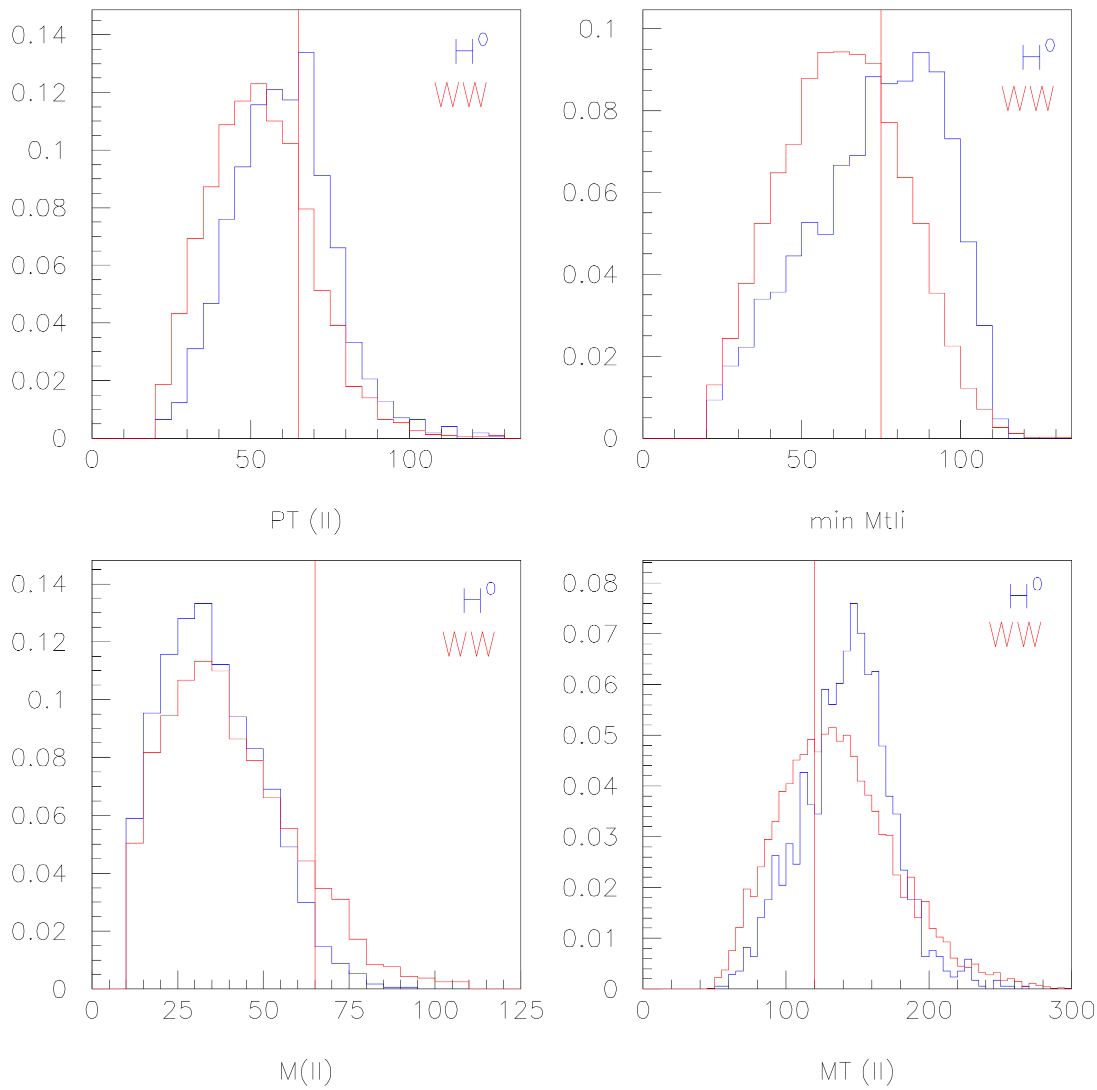
- Final Cuts: $M_H = 160$ GeV

  Note: Cuts are not shown sequentially!

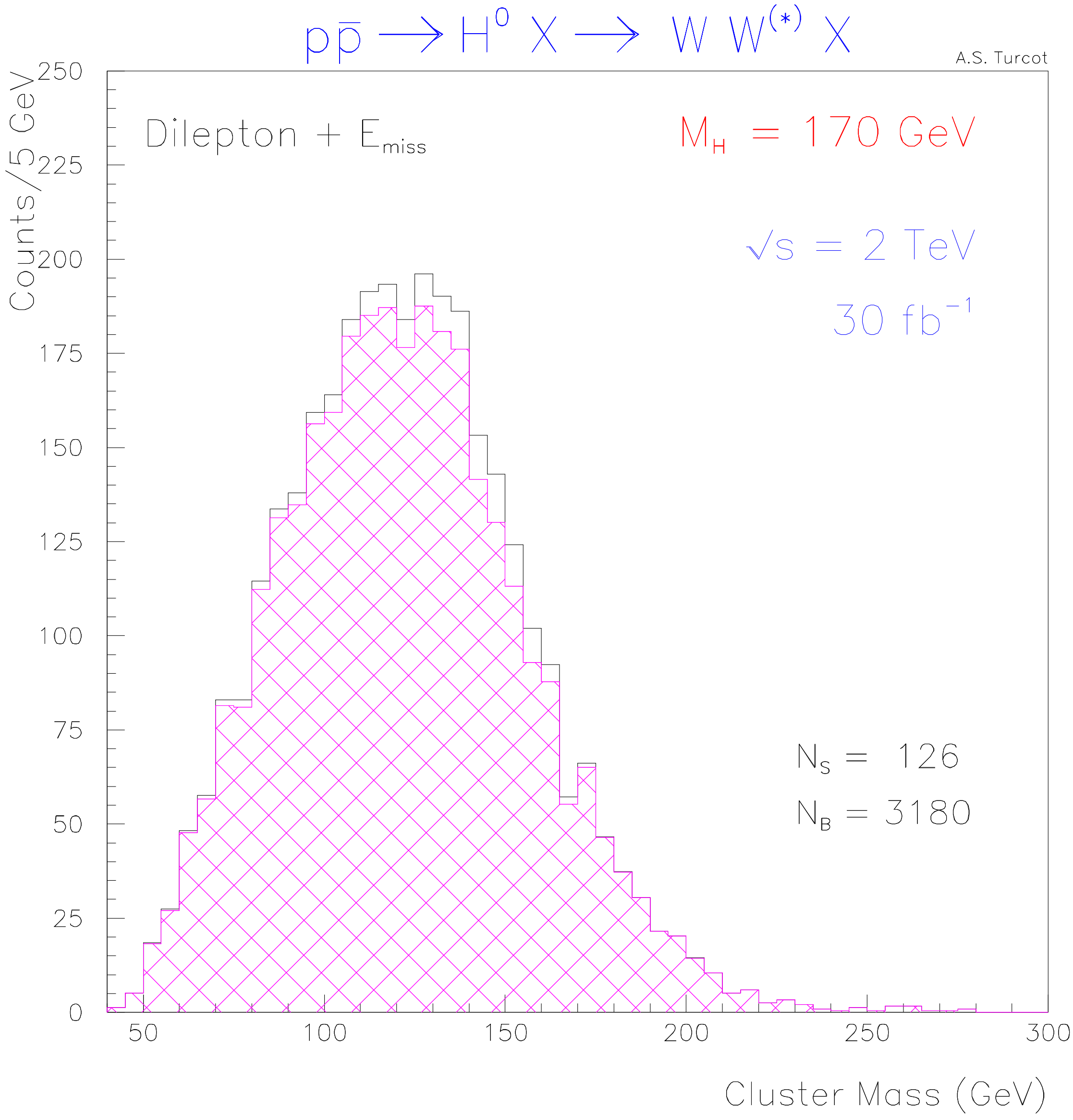


- Force leptons and neutrinos to be back-to-back

- Final Cuts: $M_\mathrm{H} = 160$ GeV



- Before "Turning the Screw"



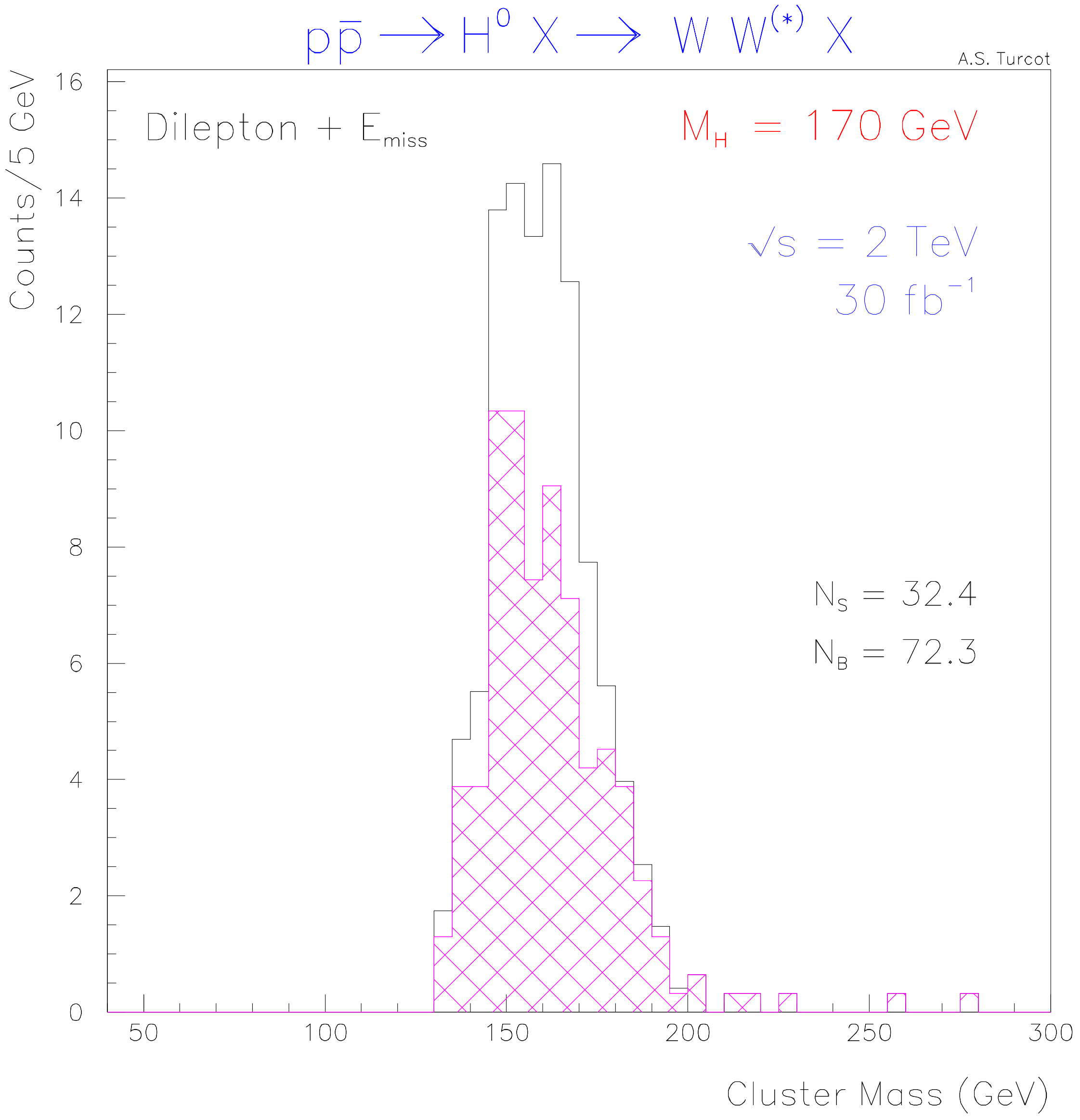
- Normalization of the Background

  10 fb^{-1} $\Rightarrow$ 3.1% statistical error

  Higgs "contamination": $S/B \sim 3 - 5\%$

$gg \rightarrow H^0 \rightarrow WW^{(*)}$: Cluster Mass

- After "Turning the Screw"



- WW background reduced by a factor of 40! ($M_H = 170$)
- Clear excess from Higgs production

$gg \to \mathrm{H}^0 \to \mathrm{WW}^{(*)}$: Final Tally

- Selection has non negligible efficiency for:

  Associated Prod.: $\mathrm{W/Z\,H^0} \to \mathrm{W/Z\,WW}^{(*)}$

  Vector Boson Fusion: $\mathrm{VV} \to \mathrm{H}^0 \to \mathrm{WW}^{(*)}$

  Include $W \to \tau \to \ell$ contribution

The Final Tally

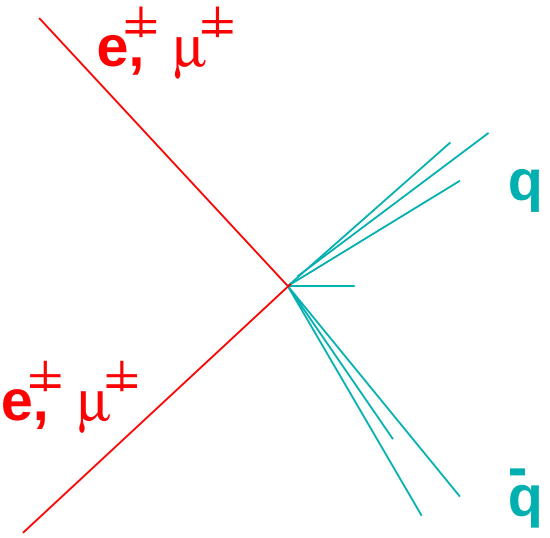
M_{H} [GeV]	140	150	160	170	180	190
$gg \to \mathrm{H}^0$ [fb]	2.2	2.4	1.3	0.93	0.85	0.73
associated VH [fb]	0.26	0.31	0.13	0.09	0.06	0.06
VV fusion [fb]	0.12	0.12	0.09	0.06	0.05	0.05
signal sum [fb]	2.6	2.8	1.5	1.1	0.96	0.83
SM bckgrnds [fb]	39	27	4.1	2.3	3.8	7.0
fake $j \to e$ [fb]	5.1	3.4	0.34	0.15	0.08	0.45
bckgrnds sum [fb]	44	30	4.4	2.4	3.8	7.5
S/B [%]	5.8	9.4	34	45	25	11
$S/\sqrt{B}$ [30 fb^{-1}]	2.1	2.8	3.9	3.9	2.7	1.7

- For $M_{\mathrm{H}} \gtrsim 160$ GeV, it is possible to *maintain constant* $S/\sqrt{B}$ while increasing the background by a factor of 5 and the signal by 2.5

  $\Longrightarrow$ Any excess is stable

  $\Longrightarrow$ Powerful check of the background shape

Schmitt, Turcot



- Distinct Signature: $\ell^{\pm}\ell^{\pm}$ *jet jet* X

  Standard *New Physics* search topology

- First proposed for H^0 search by Marciano, Stange and Willenbrock (Phys. Rev. **D49**, 1354 (1994))

- Four contributions to consider

  W H → W W W → $\ell^{\pm}\nu$ $\ell^{\pm}\nu$ jj

  Z H → Z W W → $\ell'\ell'$ $\ell^{\pm}\nu$ jj

  W H → W Z Z → $\ell^{\pm}\nu$ $\ell'\ell'$ jj

  Z H → Z Z Z → $\ell\ell$ $\ell'\ell'$ jj

- Veritable minefield of SM backgrounds to consider:

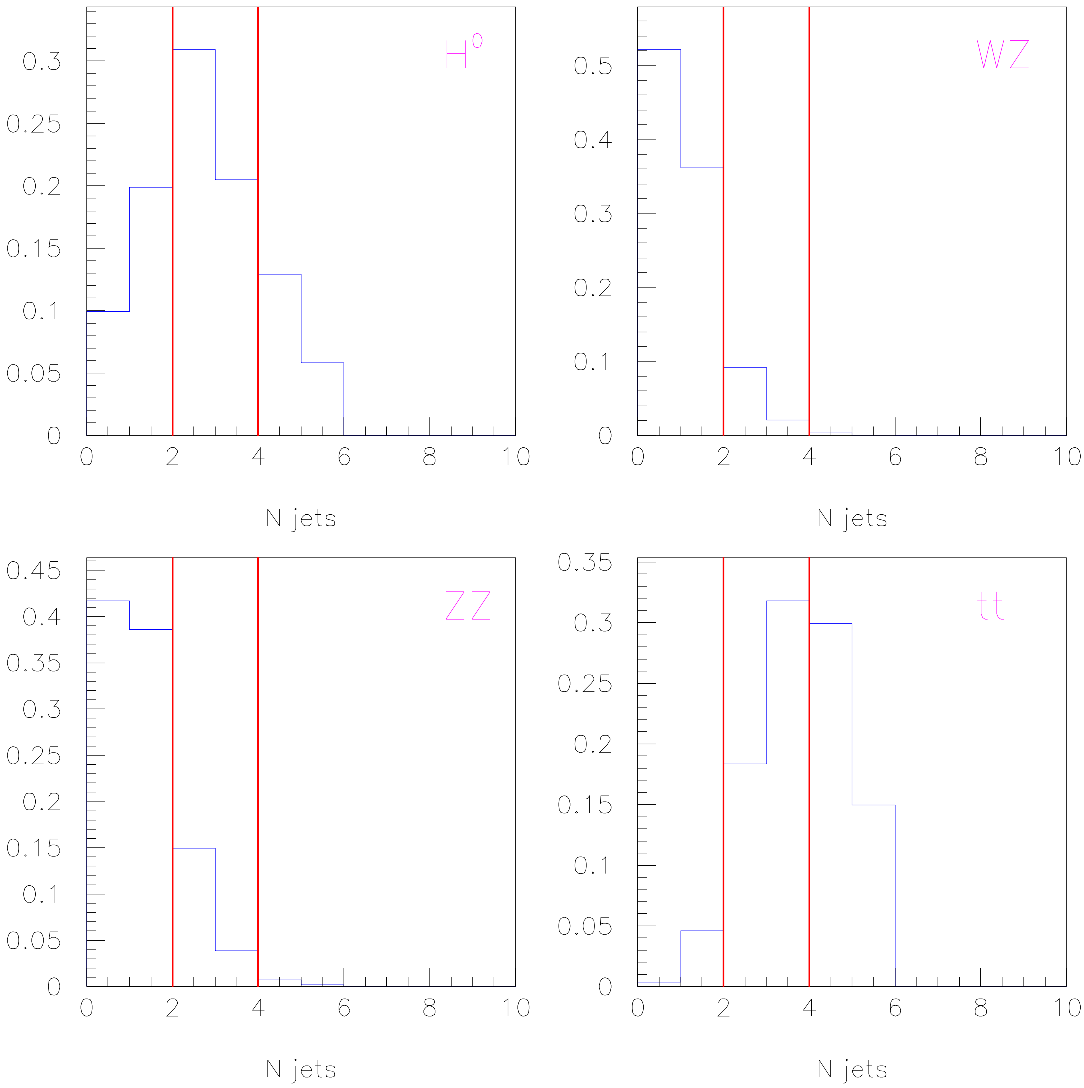
  Di-boson, $t\bar{t}$, Tri-boson, $t\bar{t}V$, fakes ...

Typical Selection:

- 2 or more leptons: $|\eta_\ell| < 1.5$, $p_T > 10$ GeV/c
  Require 2 leading leptons to be of same sign
- Require $0.3 < \triangle R(\ell j) < 6.0$
- For muons: require $\sum p_{\mathrm{tracks}}$ within a 30° cone defined by the muon to be $< 0.6 \times p_\mu$
- $m(\ell\ell) > 10$ GeV/c^2, $\not{E}_T > 10$ GeV
- Jet Criteria: (Jet $\equiv p_T > 15$, $|\eta| < 3$)
  1. Number of jets $2 \leq N_{\mathrm{jet}} \leq 3$
  2. Require leading jet: $|\eta| < 1.5$, $2 < N_{ct} < 12$
  3. Require trailing jet: $|\eta| < 2.0$
  4. Veto if $p_T^{j3} > 30$ GeV
  5. Veto if any jet is b-tagged
- Jet-Jet Mass cut: $m(jj) < 110$ GeV
- Scaler p_T sum: $\sum_j |p_t^{ji}| < 150$ GeV
- Require Helicity angle of ℓ_1 in $\ell\ell$ restframe

$$\cos\theta^*_{\ell 1} < 0.95$$

- Number of jets $2 \leq N_{\rm jet} \leq 3$

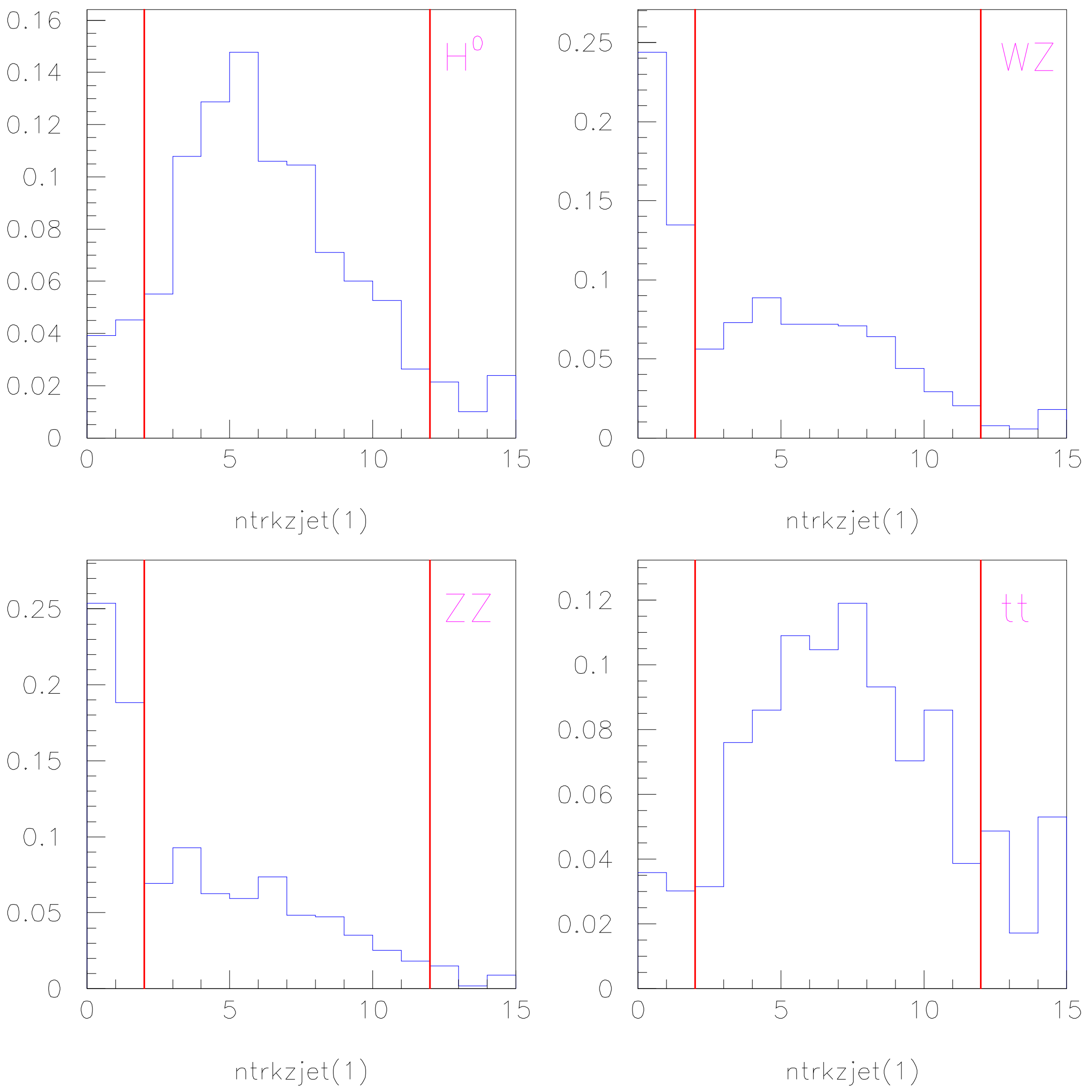


- $\rm H^0 \equiv$ Average of $M_{\rm H} = 120 \ldots 190$ GeV

Like-sign leptons + jets: Charged Track Multiplicity

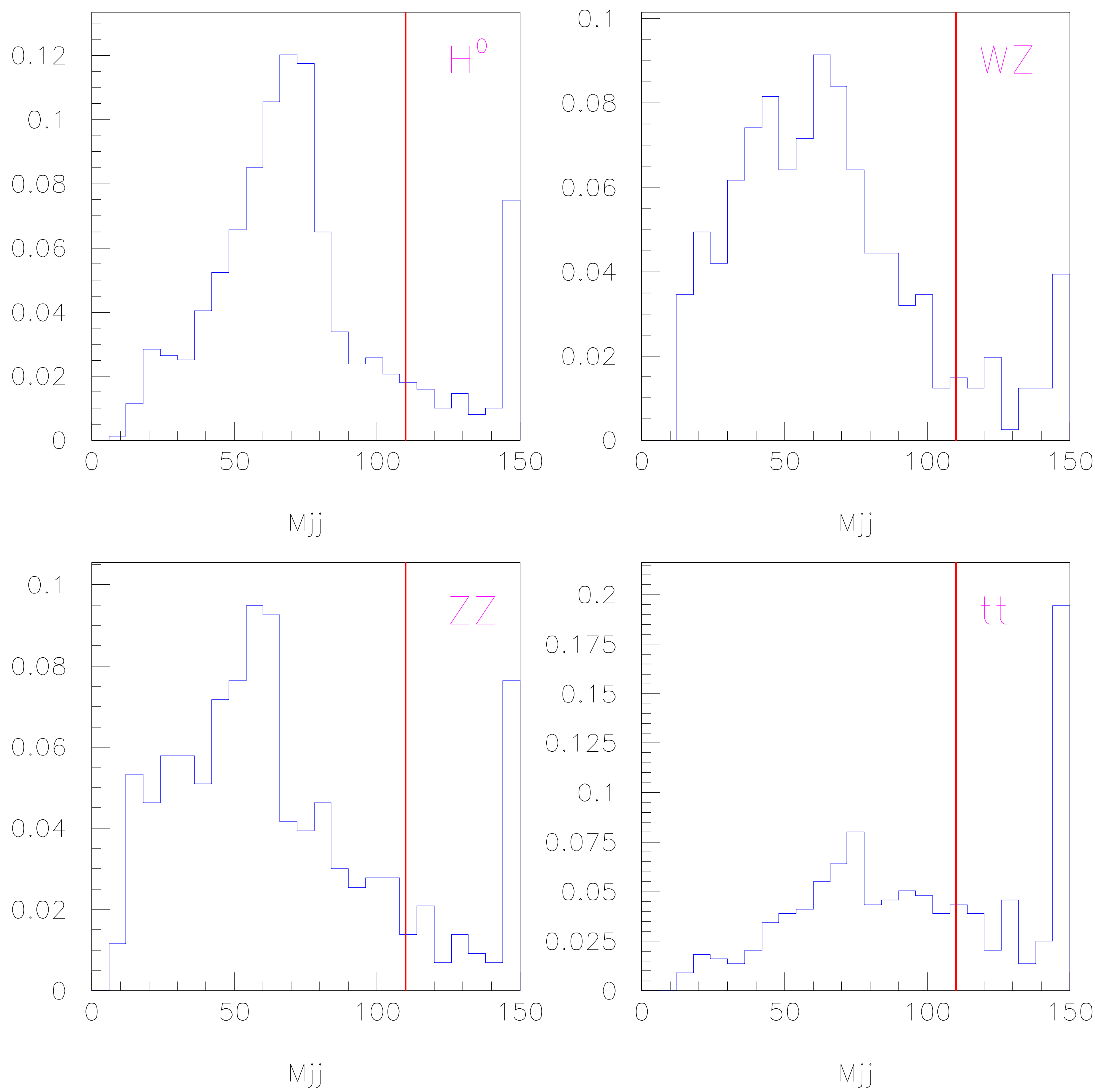
- Leading jet charged track multiplicity $2 < N_{ct} < 12$

  Effective against $Z^0 \rightarrow \tau^+\tau^-$



- Jets must be consistent with coming from a Gauge Boson

  $\Longrightarrow$ Require Jet-Jet Invariant Mass : $m(jj) < 110$ GeV



Like Sign Leptons + Jets: Results

- Two different selections:
- Accepted signal cross sections (fb)

M_H (GeV)	120	130	140	150	160	170	180	190	200
σ (fb)(1)	0.09	0.20	0.34	0.52	0.45	0.38	0.29	0.20	0.16
σ (fb)(2)	0.08	0.15	0.29	0.36	0.36	0.29	0.28	0.17	0.16

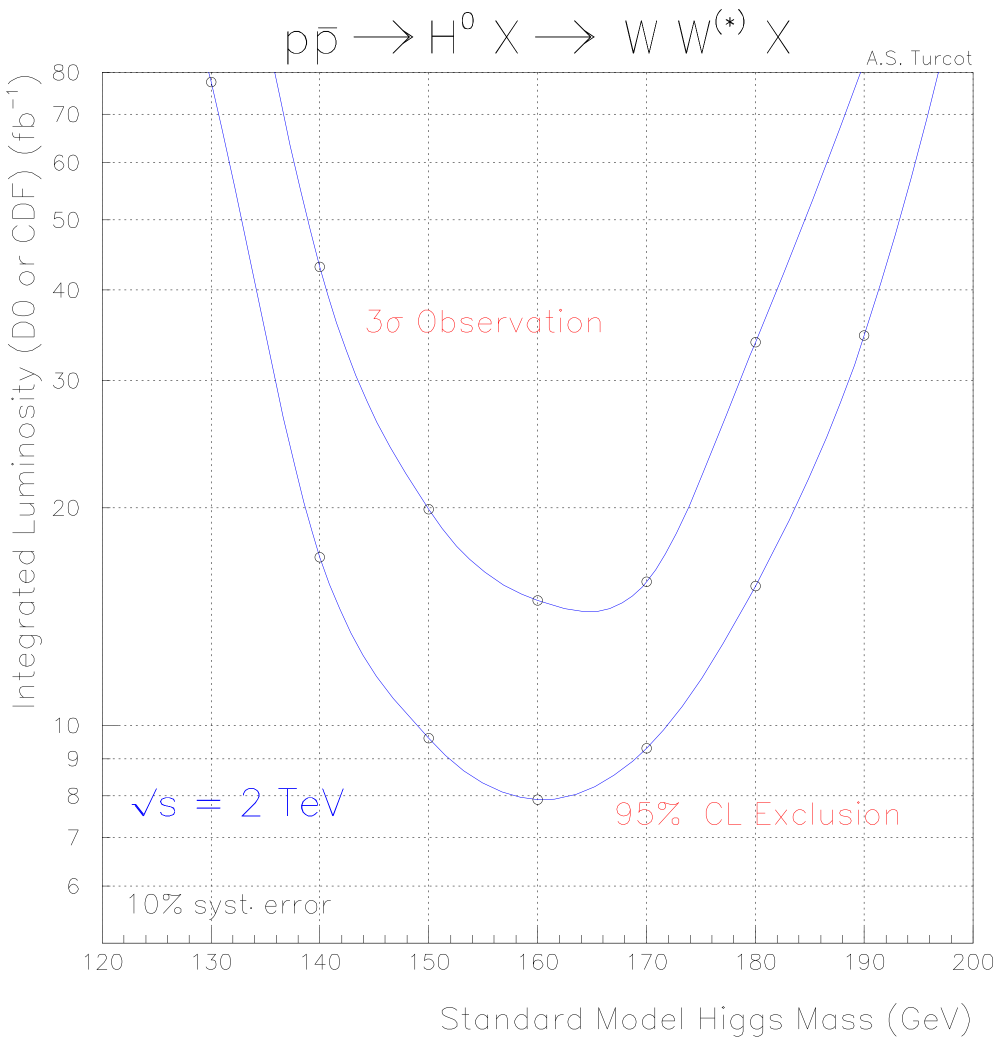
- Accepted background cross sections (fb)

Sum	WW	WZ	ZZ	$t\bar{t}$	VVV	$t\bar{t}$V	W/Zjjj
0.83 (1)	< 0.01	0.27	0.06	0.15	0.07	0.02	0.26
0.40 (2)	< 0.01	0.16	0.006	0.024	0.05	0.01	0.15

- Z/Wjj + fake rate determined from D0 Run I W+3j rates
- Good S/B but low rate limits statistical significance
- $H^0 \to ZZ$ becomes important at high mass
- Control of systematics will be challenging

- Combination of the two high mass topologies:

  Background scaled by 1.1 *and* Signal by 0.9



- For One Experiment:

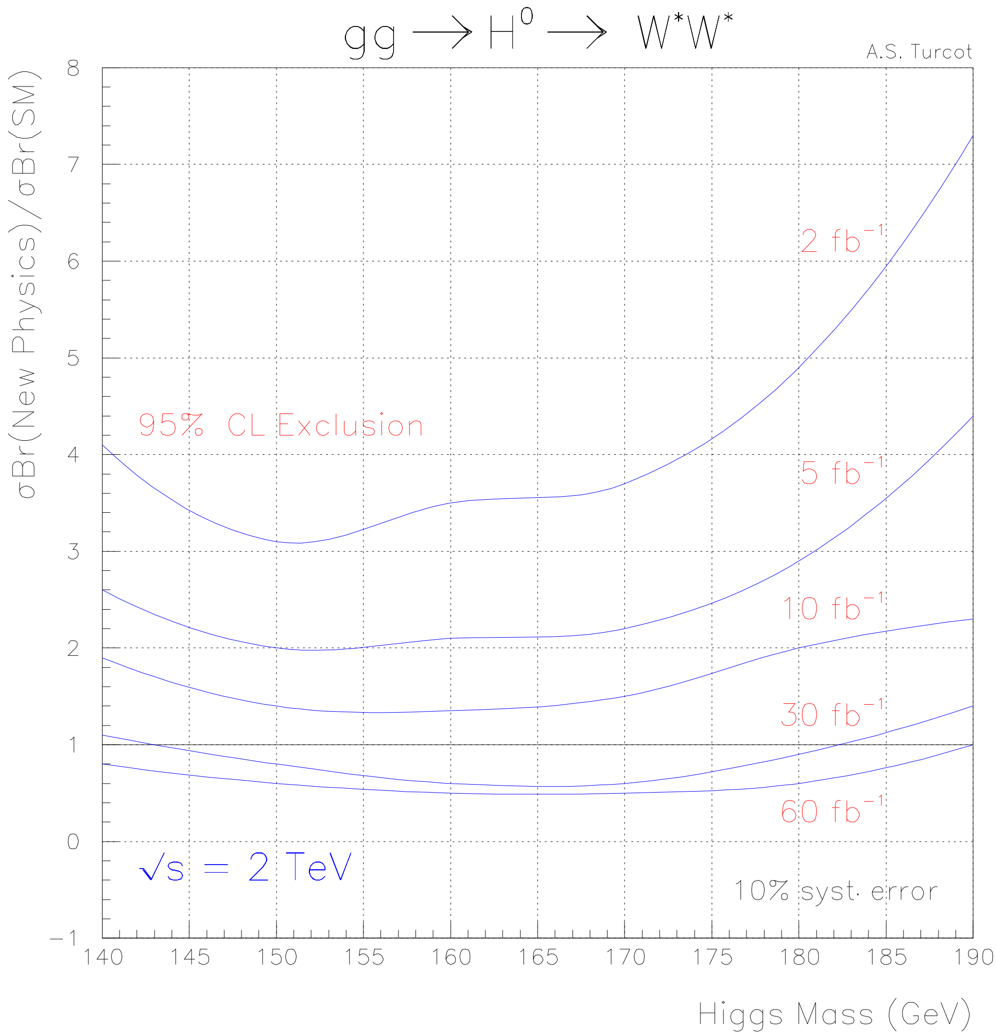
  10 fb^{-1} $\Longrightarrow$ can exclude $150 \lesssim M_{\rm H} \lesssim 175$ GeV

  20 fb^{-1} $\Longrightarrow$ 3σ observation over same mass window

  30 fb^{-1} $\Longrightarrow$ Exclusion or 3σ observation over most of "theoretically allowed" SM Higgs mass range

- What if $gg \to H^0$ has an enhanced rate?

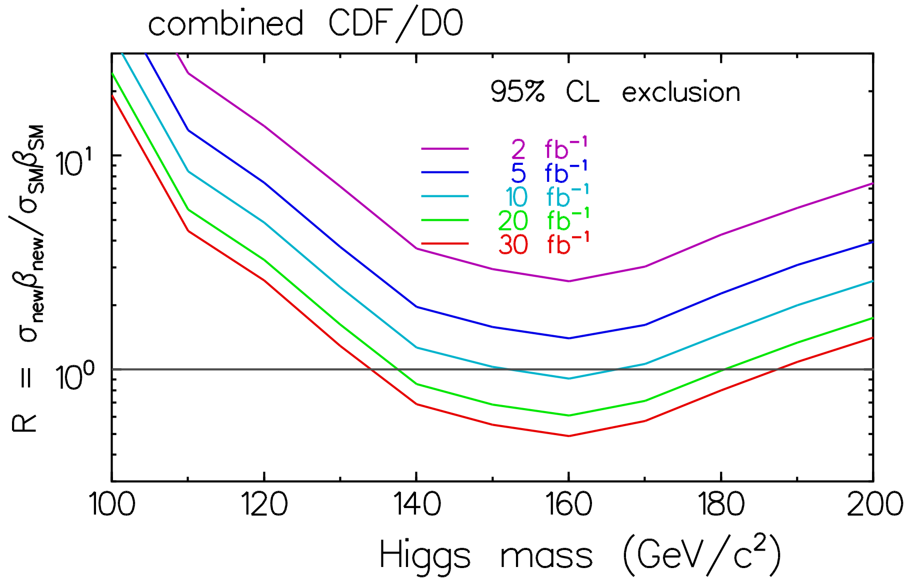
$$R \equiv \frac{\sigma(\text{New Physics}) \times BR(\text{New Physics})}{\sigma(\text{SM}) \times BR(\text{SM})}$$

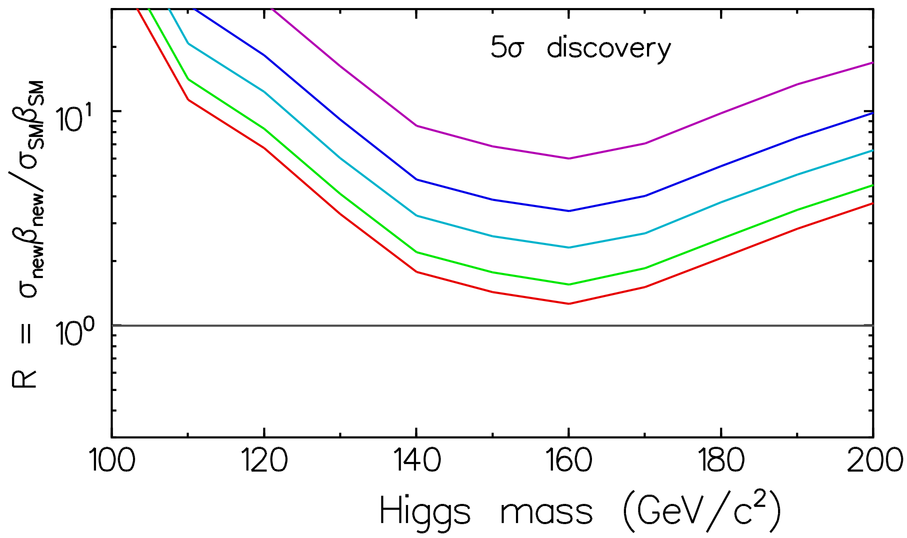


- Many models can enhance the SM rate

  e.g. 4th generation $\Longrightarrow$ $R \sim 8$ (Ginzberg *et al.*)

- What if W/Z H^0 with $H^0 \to WW^{(*)}$ has an enhanced rate?
- Combine tri-lepton and like-sign lepton plus jets channels:





- Sensitivity for models with suppressed $H^0 \to b\bar{b}$

  Can arise in SUSY, Top Condensates ...

- Bayesian combination: All channels and both experiments:

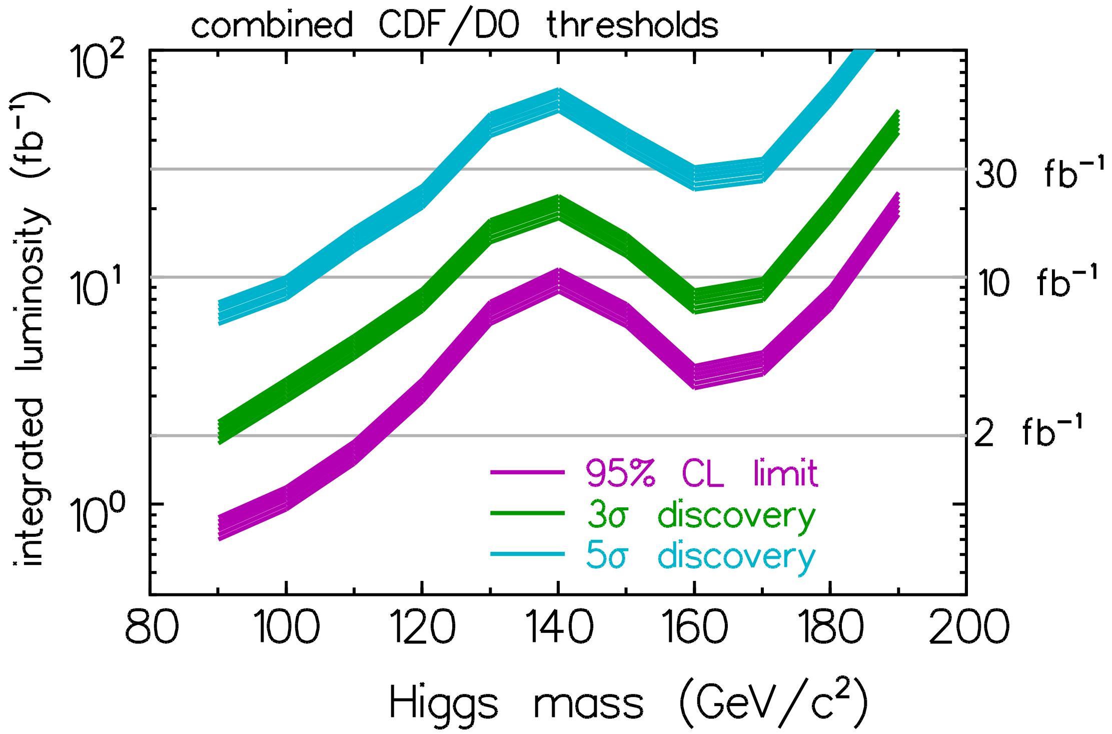
  Assume 10 % $m_{b\bar{b}}$ resolution

  Neural network analysis for $H^0 \to b\bar{b}$ *channels*

  Conservative *treatment of QCD bgd. for* $H^0Z^0 \to b\bar{b}\nu\bar{\nu}$

  Systematic error: Min. of 10% or $1/\sqrt{\int \mathcal{L}dt \times B}$

  Bands represent 30% effect from in $m_{b\bar{b}}$, ϵ_b, bgds.



- 95% CL exclusion up to ∼ 185 GeV for 10 fb^{-1}
- 3σ or better observation up ∼ 180 GeV for ∼ 20 fb^{-1}
- 5σ discovery up ∼ 125 GeV for ∼ 30 fb^{-1}

- The Tevatron will be able to probe the EWSB sector:

  At masses far beyond what was thought possible
  For realistic expectations of integrated luminosity

- If there is no Standard Model Higgs:

  Exclusion at 95% CL up to **185 GeV** for 10 fb^{-1}

- If there is a Standard-Model like Higgs

  Discovery at the $3 - 5\sigma$ level up to **185 GeV** for 30 fb^{-1}

- Need to combine all channels and both detectors
  to fully exploit Tevatron potential

- High mass sensitivity coincides with the "chimney"

  Test validity of Minimal SM Higgs up to M_{Planck}

- Who knows? Something may be lurking at 170 GeV
  The Tevatron has a good chance to see it *first*

- Lots of work still to do ... and it has only just begun

The End