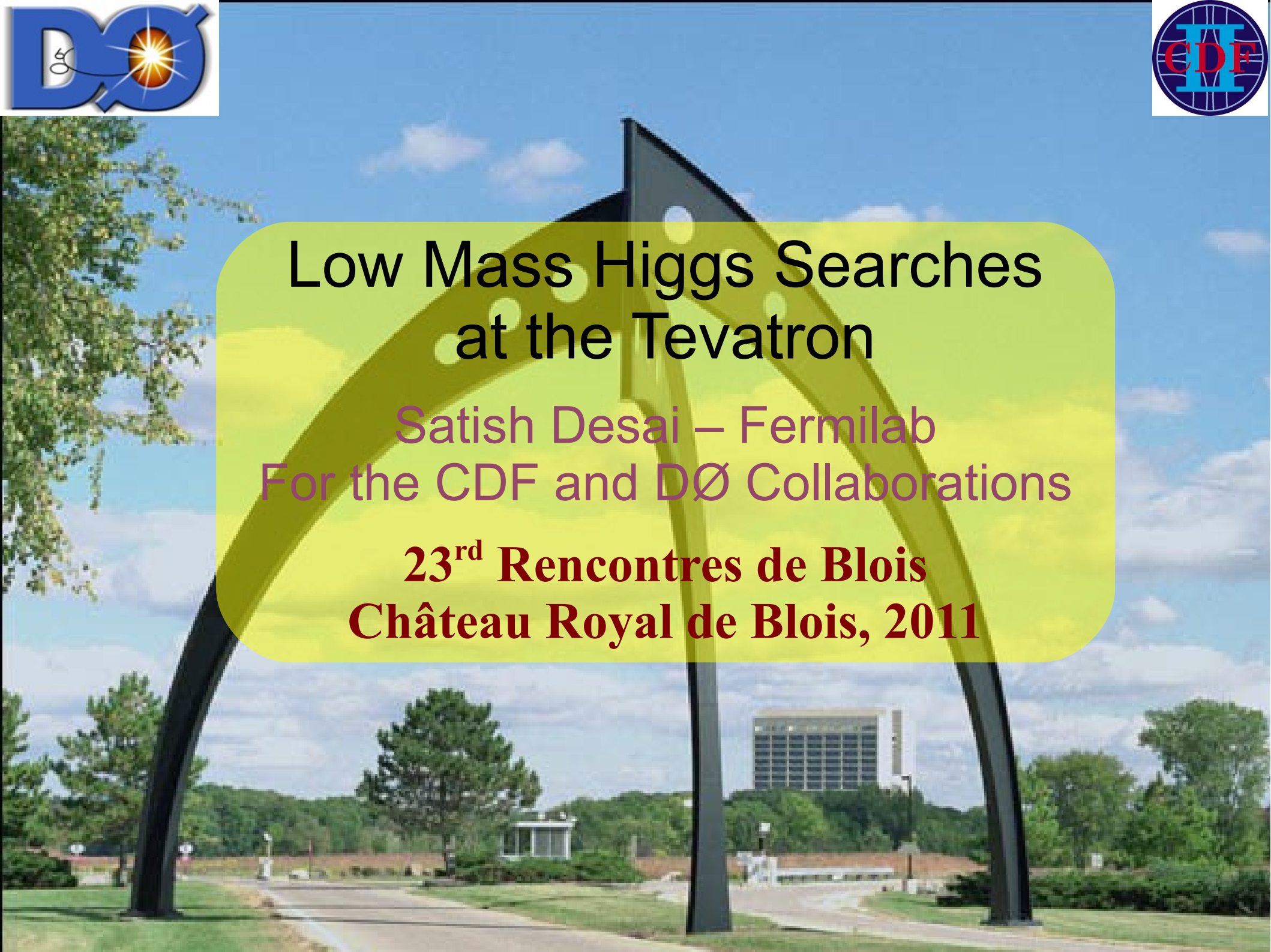


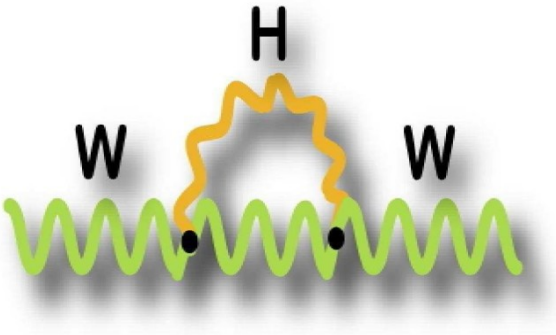
Low Mass Higgs Searches at the Tevatron

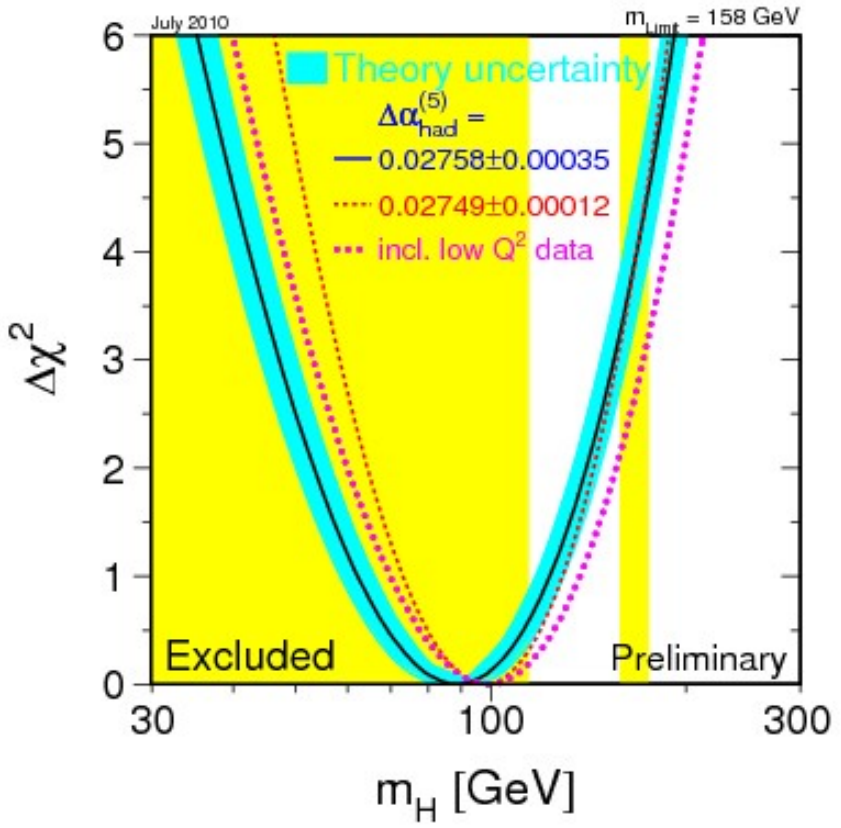
Satish Desai – Fermilab
For the CDF and DØ Collaborations

23rd Rencontres de Blois
Château Royal de Blois, 2011

Fits and Constraints

- Electroweak symmetry breaking is a cornerstone of the standard model
- Higgs mechanism provides mass for the W and Z
- A consequence of this is the Higgs boson
- Mass is not predicted





M_H < 158 GeV (indirect constraints)

M_H < 185 GeV (include LEP search)

Leave No Higgs Behind

This Talk

Channel	DØ	CDF
$WH \rightarrow l\nu b\bar{b}$	5.3 fb^{-1}	5.7 fb^{-1}
$ZH \rightarrow \nu\nu b\bar{b}$	6.2 fb^{-1}	5.7 fb^{-1}
$ZH \rightarrow llb\bar{b}$	6.2 fb^{-1}	5.7 fb^{-1}
$H \rightarrow \gamma\gamma$	8.2 fb^{-1}	7.0 fb^{-1}
$H+X \rightarrow \tau\tau jj$	5.4 fb^{-1}	6.0 fb^{-1}

Updated Since Moriond

- Comprehensive search program
- Look everywhere we can
- High mass searches contribute too

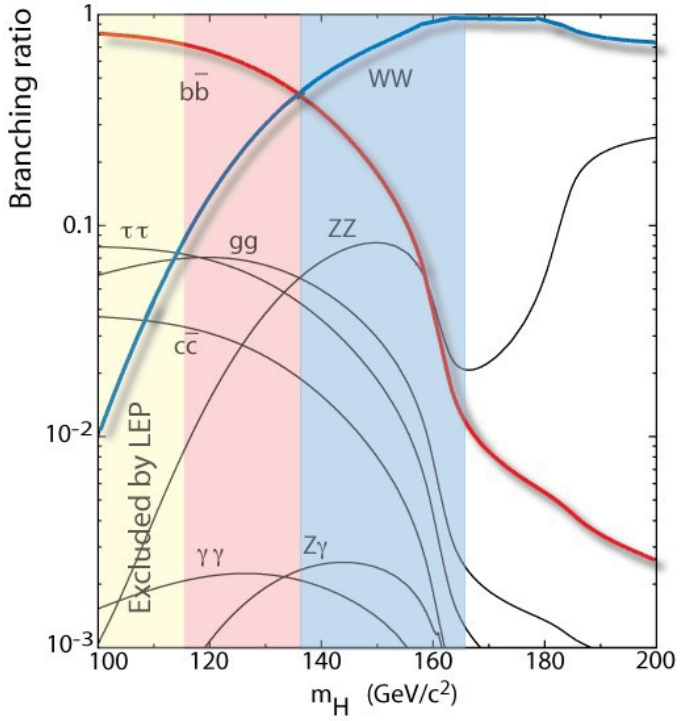
And $H \rightarrow WW \rightarrow l\nu jj$

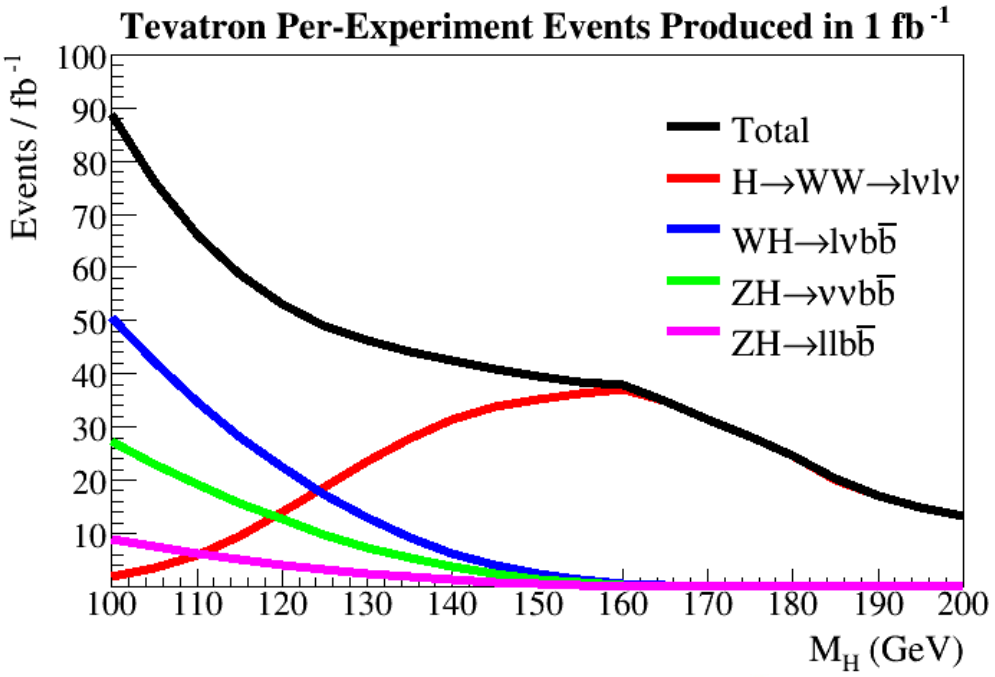
And $H \rightarrow WW \rightarrow l\nu l\nu$

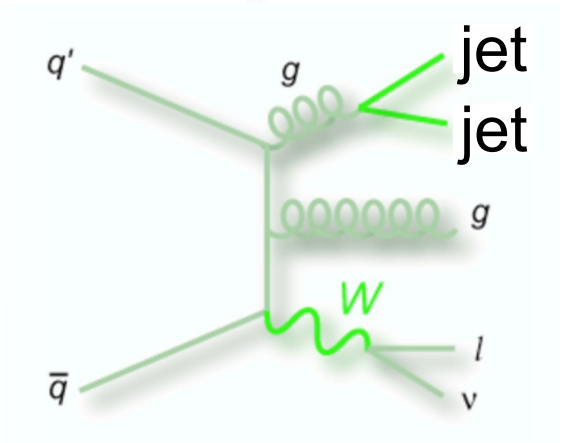
And same sign dilepton

And...

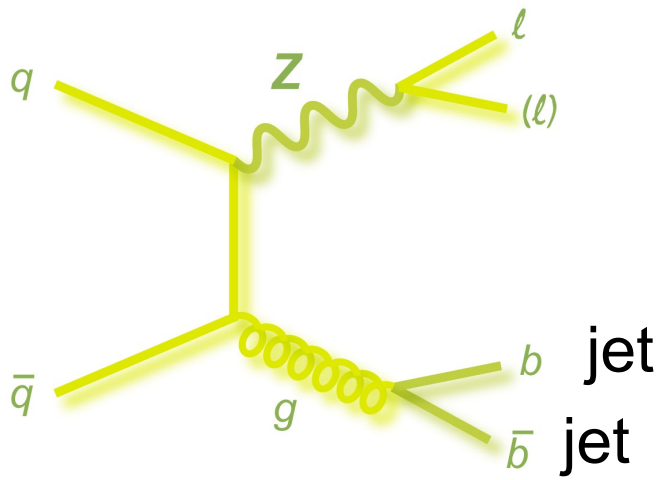
Signals and Backgrouds





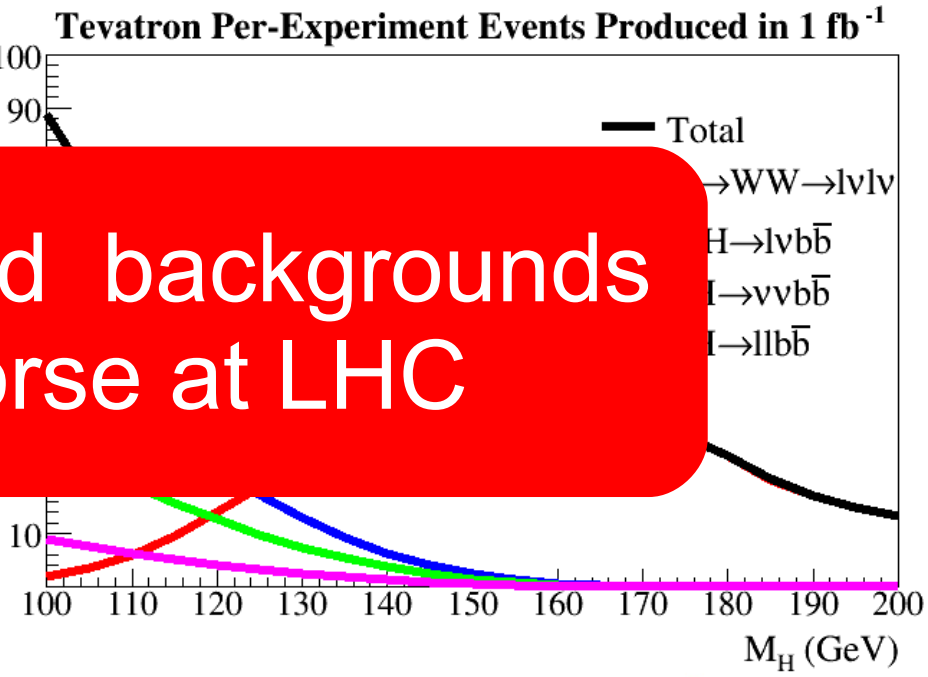


σ×BR ~ 470,000 fb

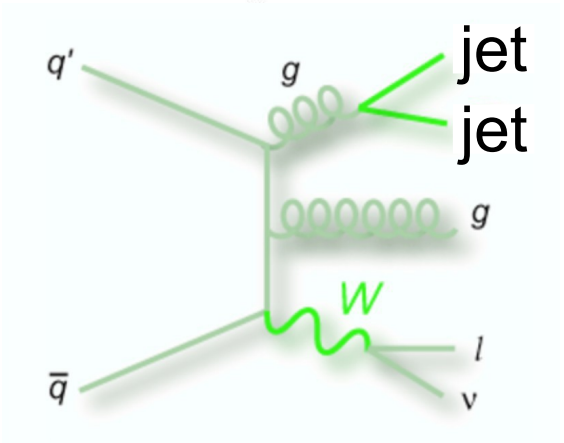


σ×BR ~ 78,000 fb

Signals and Backgrounds



Gluon intiated backgrounds
Even worse at LHC



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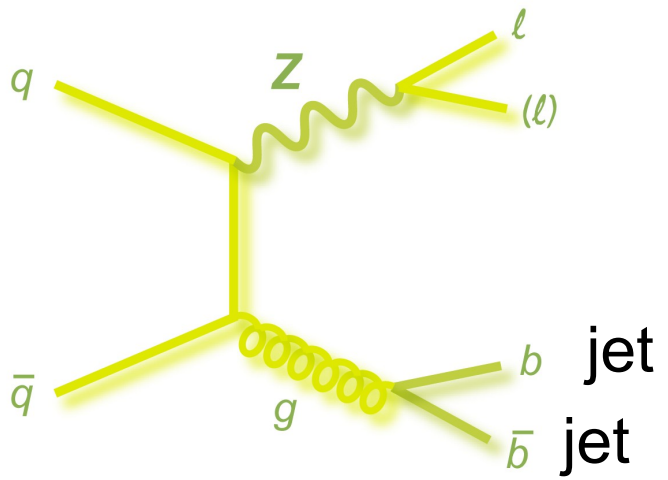
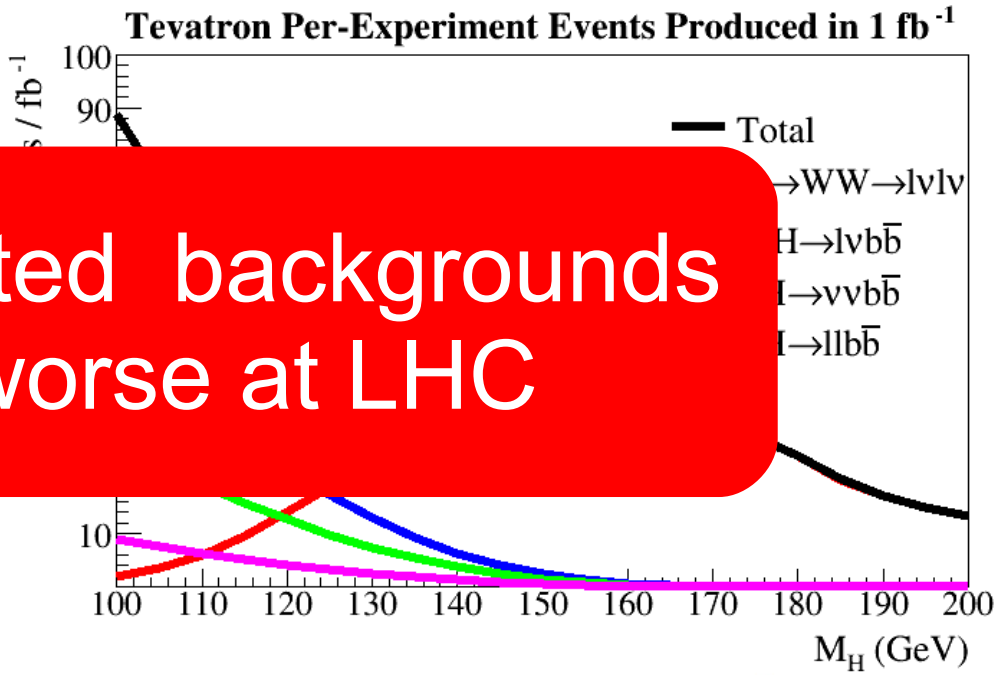


σ×BR ~ 78,000 fb

Signals and Backgrounds



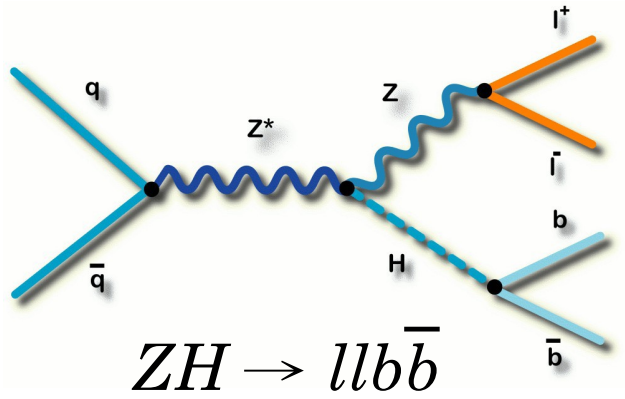
Gluon intiated backgrounds
Even worse at LHC

The Tevatron is still the place to look for H → $b\bar{b}$

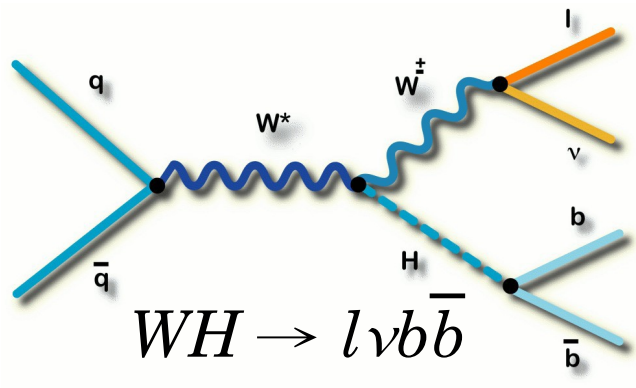
σ×BR ~ 470,000 fb

σ×BR ~ 78,000 fb

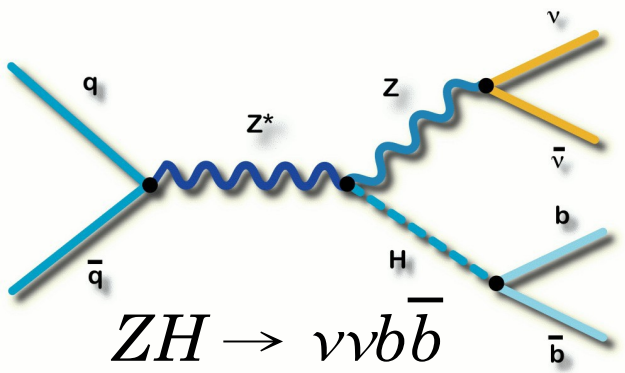
Associated Production Searches



$ZH \rightarrow llb\bar{b}$



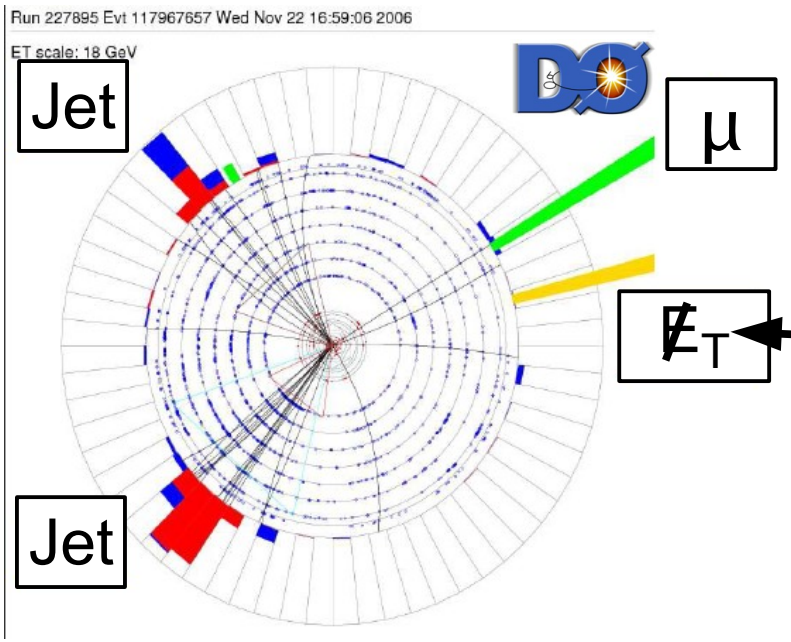
$WH \rightarrow l\nu b\bar{b}$



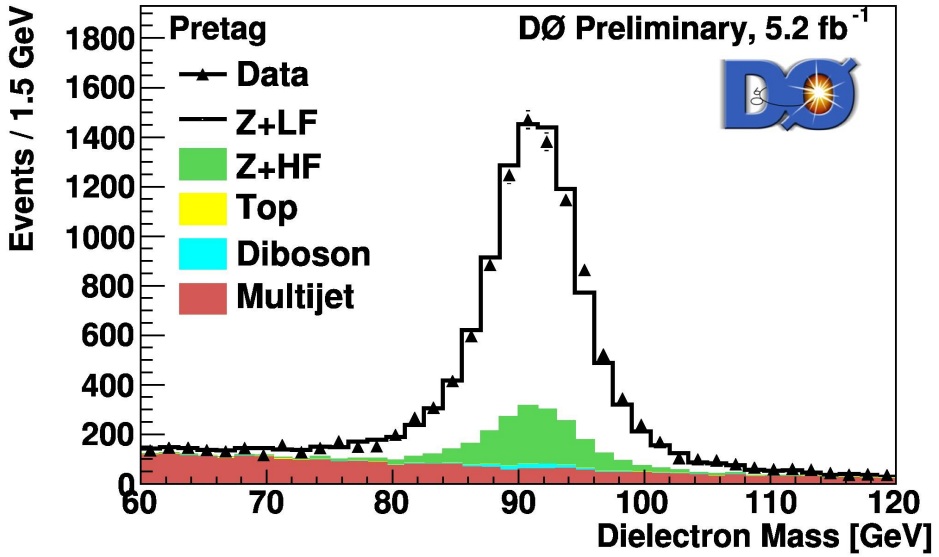
$ZH \rightarrow \nu\nu b\bar{b}$

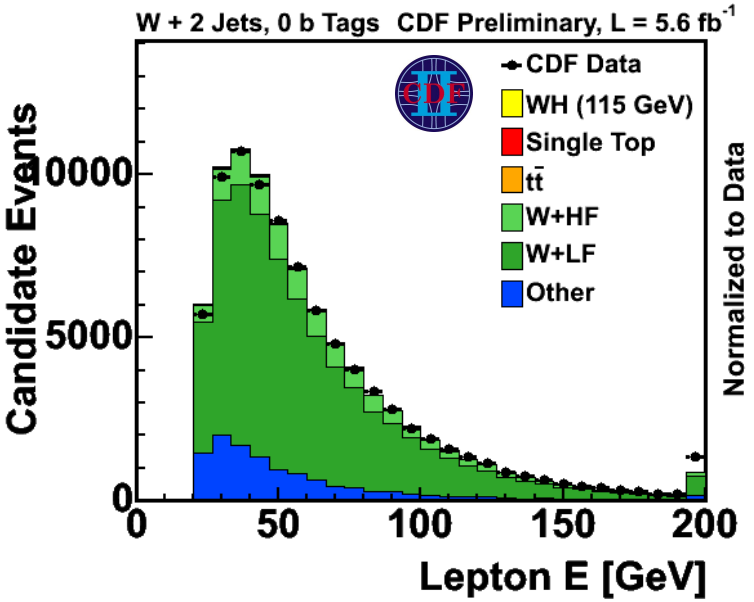
- Crucial ingredients
  - Maximize lepton acceptance
  - Efficient b-tagging
  - Multivariate discriminants

Leptons and Jets



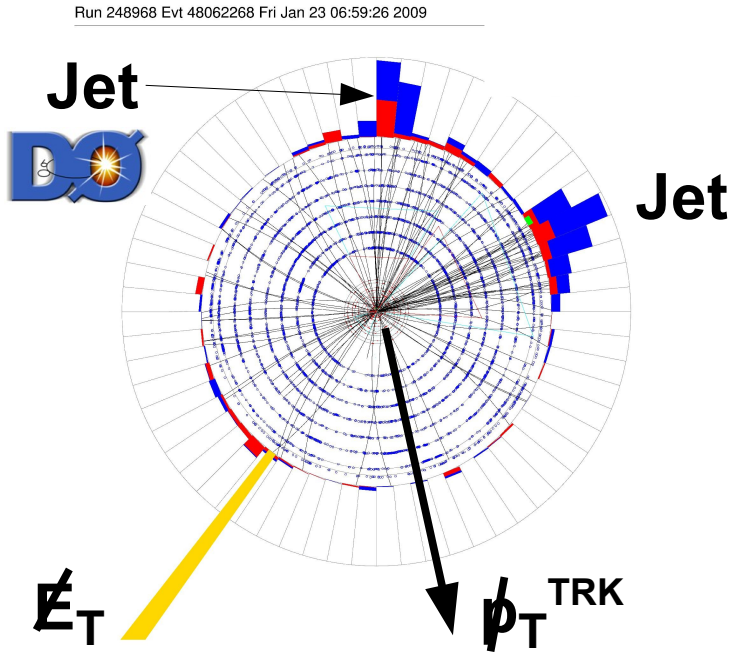
- One or two high p_T electrons or muons
- Infer neutrinos from p_T imbalance (missing E_T)
- Two Jets
- At least one b-tag

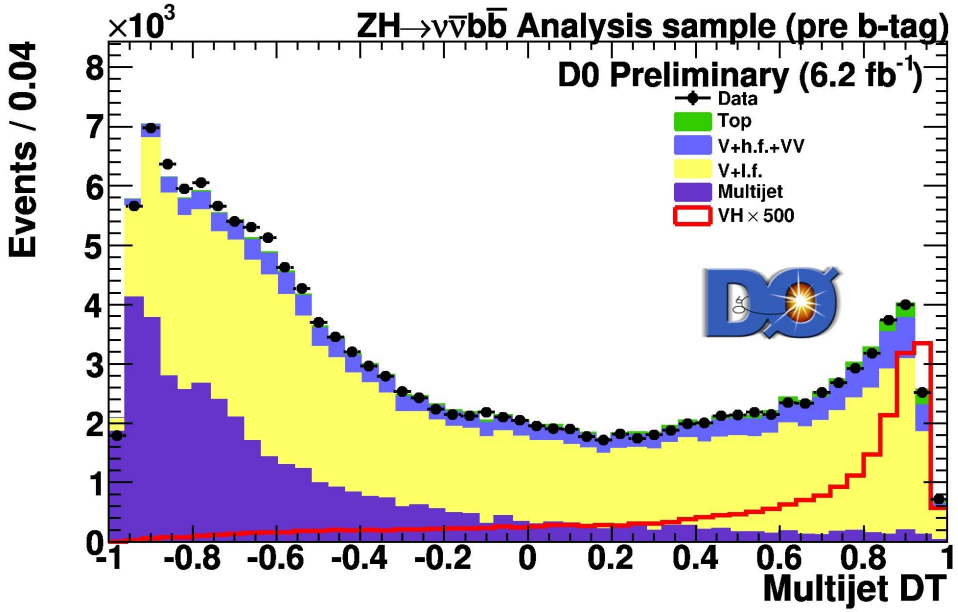


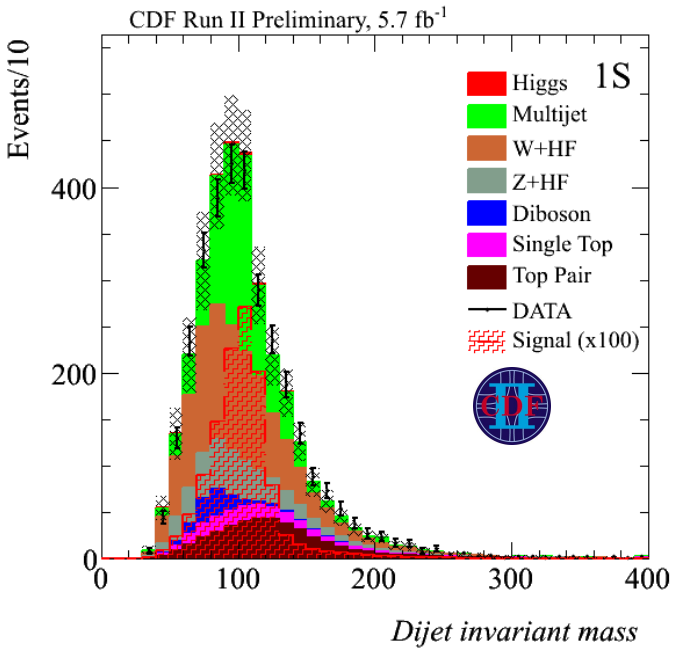


$ZH \rightarrow \nu\nu b\bar{b}$

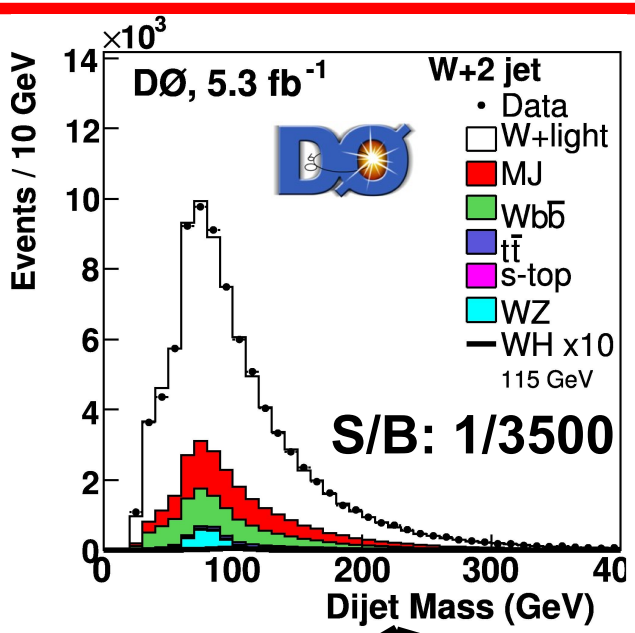
- Recovers events from WH
- Large missing E_T
- Two high p_T jets
- At least one b-tag



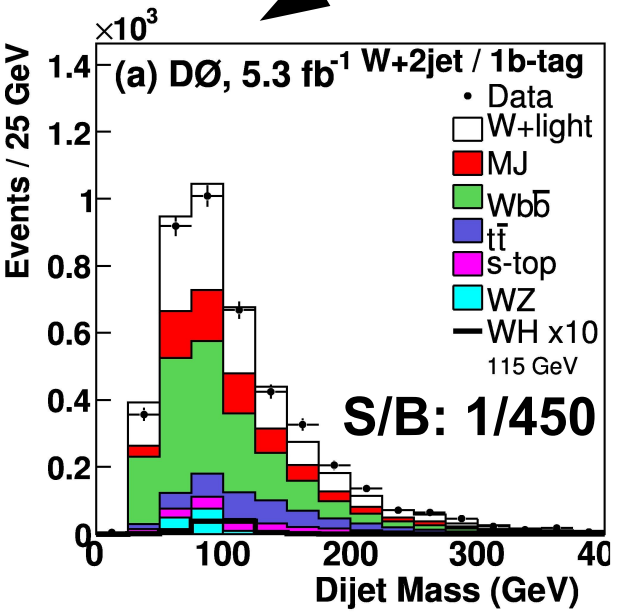


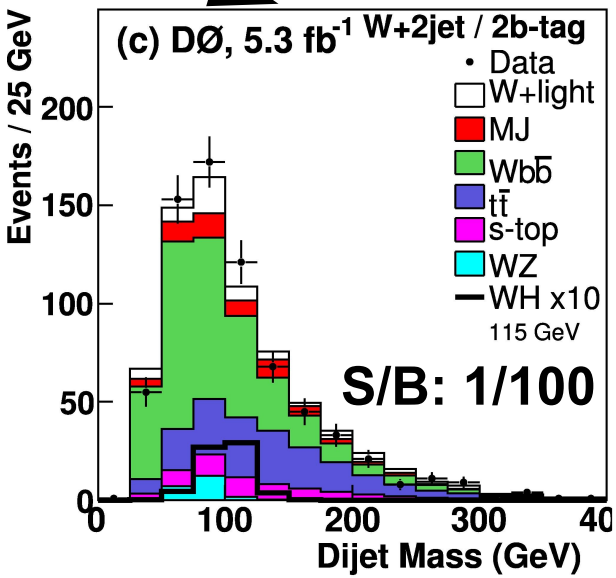


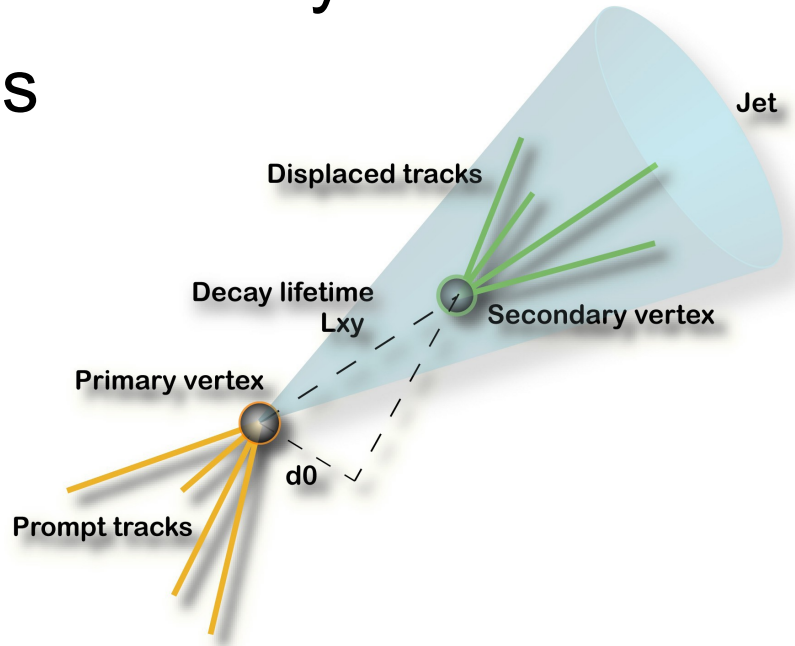
b-tagging



- Tag b-jets using
  - Impact parameter and
  - Reconstructed decay vertex
  - Soft leptons



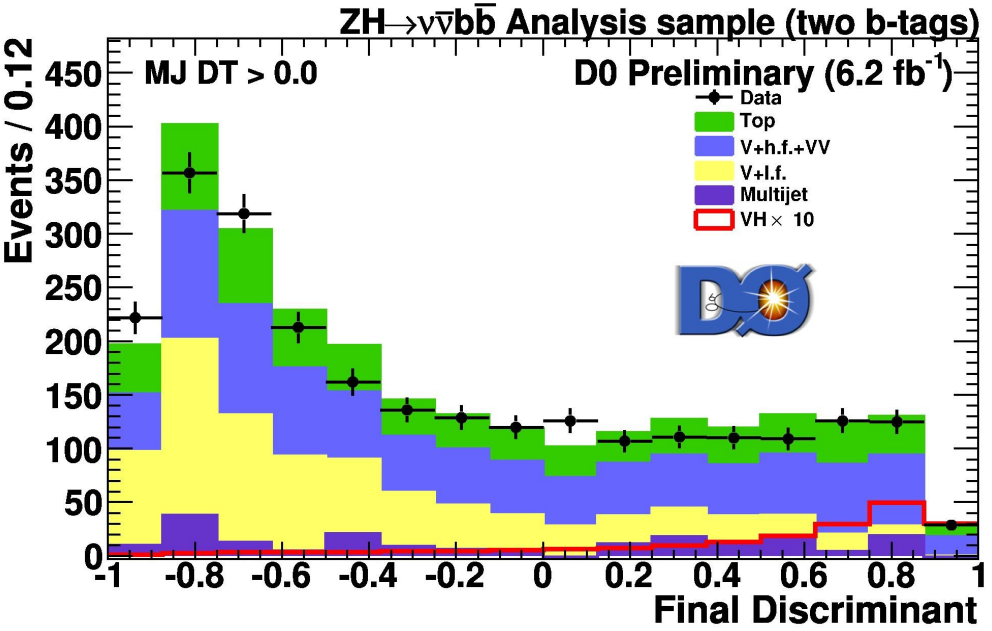




	Efficiency
b-jets	50%-70%
light jets	0.5%-4.5%

How to Get a Limit

- Train multivariate discriminants
- Exploit full distribution by doing counting experiment for each bin

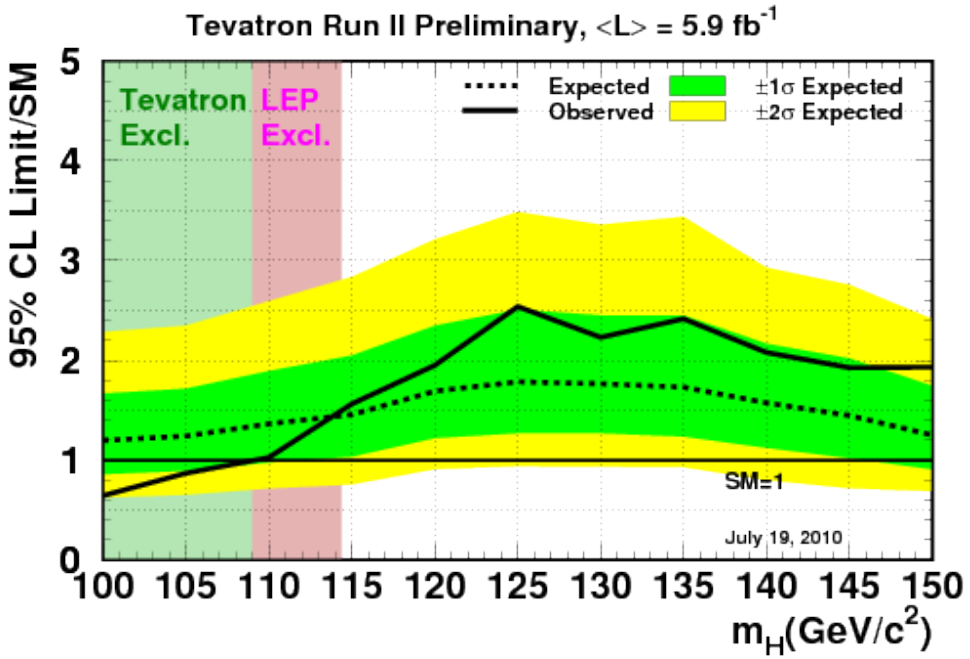


- Combine by multiplying per bin likelihoods
- Track correlations of uncertainties across bins
- Combination of many channels becomes straightforward (in concept) – just add more bins

Limits

Results at M_H = 115 GeV

Channel	DØ		CDF	
	Expected	Observed	Expected	Observed
$WH \rightarrow l\nu b\bar{b}$	4.8	4.5	3.5	3.6
$ZH \rightarrow \nu\nu b\bar{b}$	4.0	3.4	4.0	2.3
$ZH \rightarrow llb\bar{b}$	5.7	8.0	5.5	6.0



Updated since combination

Combined limits @ 115 GeV:
Exp: 1.45 × σ_{SM}
Obs: 1.56 × σ_{SM}

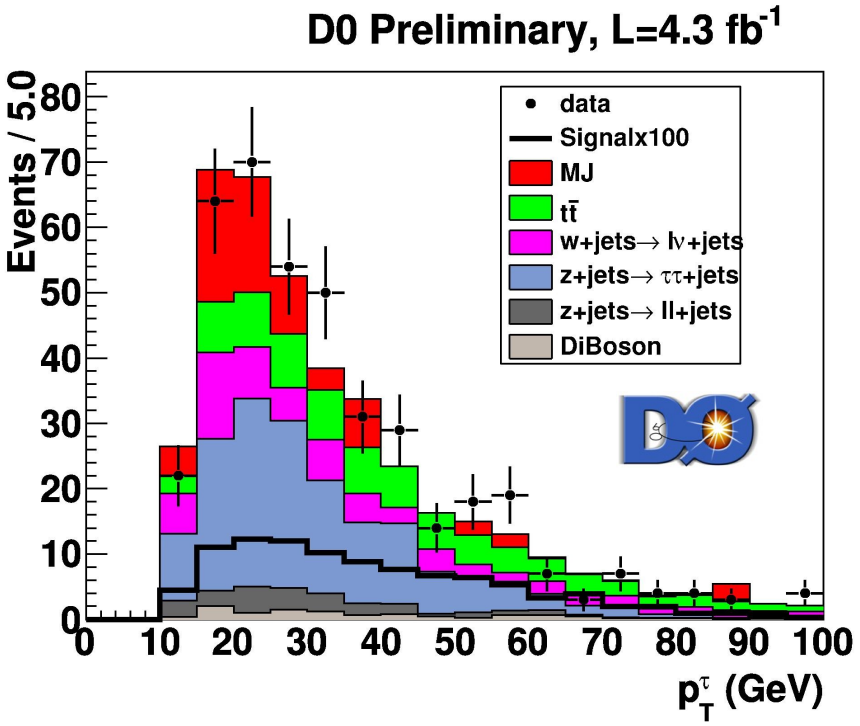
Exclude M_H < 109 GeV

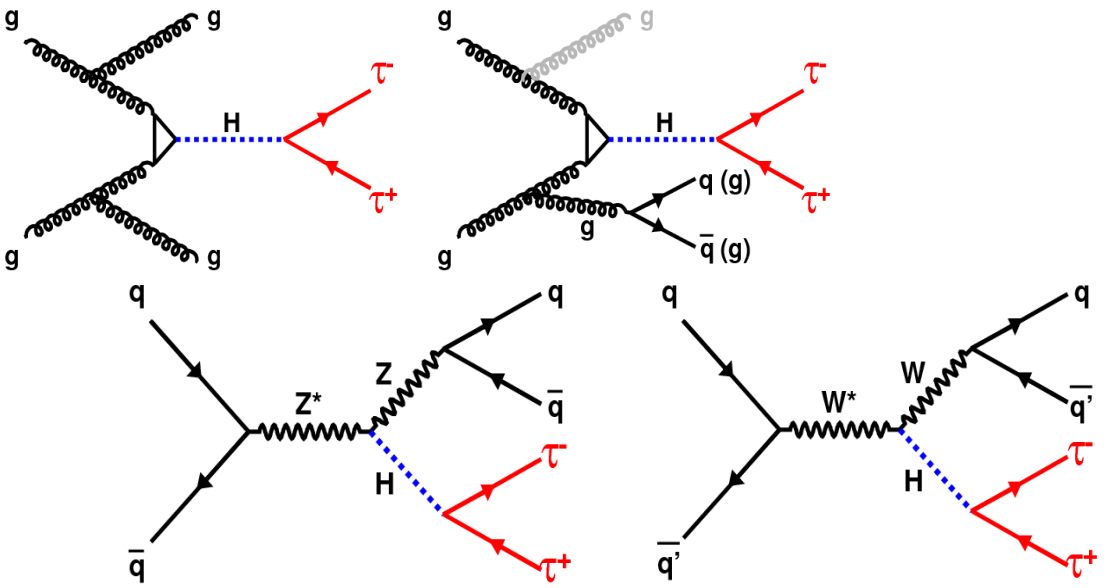
More Recent Results

Channel	DØ	CDF
$WH \rightarrow l\nu b\bar{b}$	5.3 fb^{-1}	5.7 fb^{-1}
$ZH \rightarrow \nu\nu b\bar{b}$	6.2 fb^{-1}	5.7 fb^{-1}
$ZH \rightarrow llb\bar{b}$	6.2 fb^{-1}	5.7 fb^{-1}
$H \rightarrow \gamma\gamma$	8.2 fb^{-1}	7.0 fb^{-1}
$H+X \rightarrow \tau\tau jj$	5.4 fb^{-1}	6.0 fb^{-1}

Updated Since Moriond

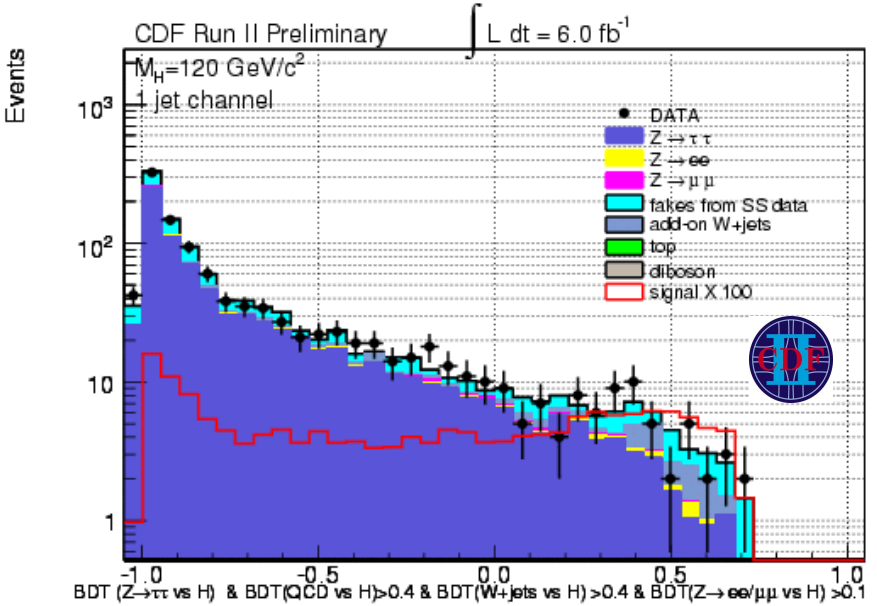
Searches in ττ plus jets channels



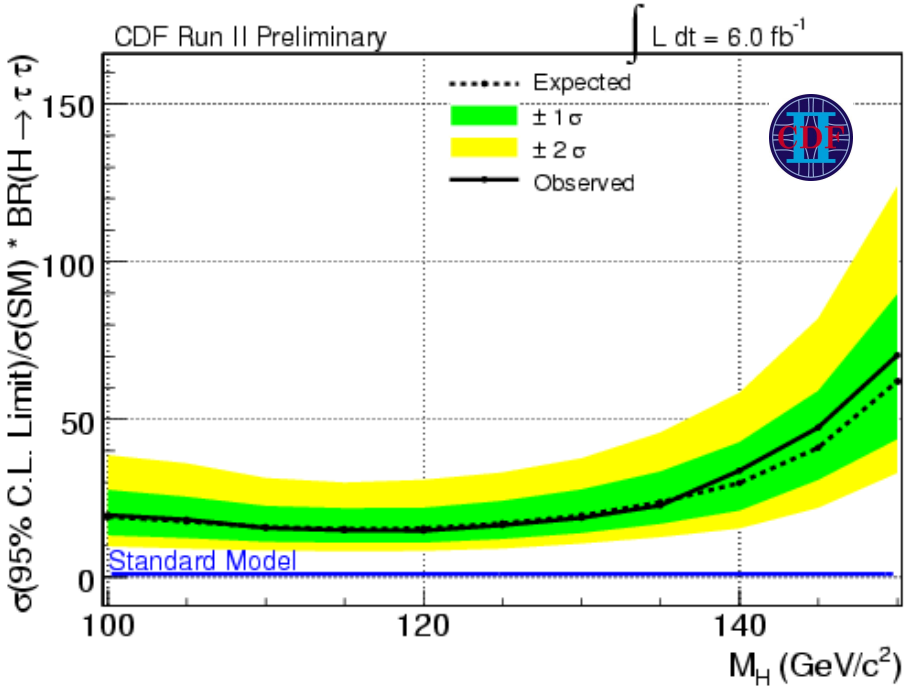


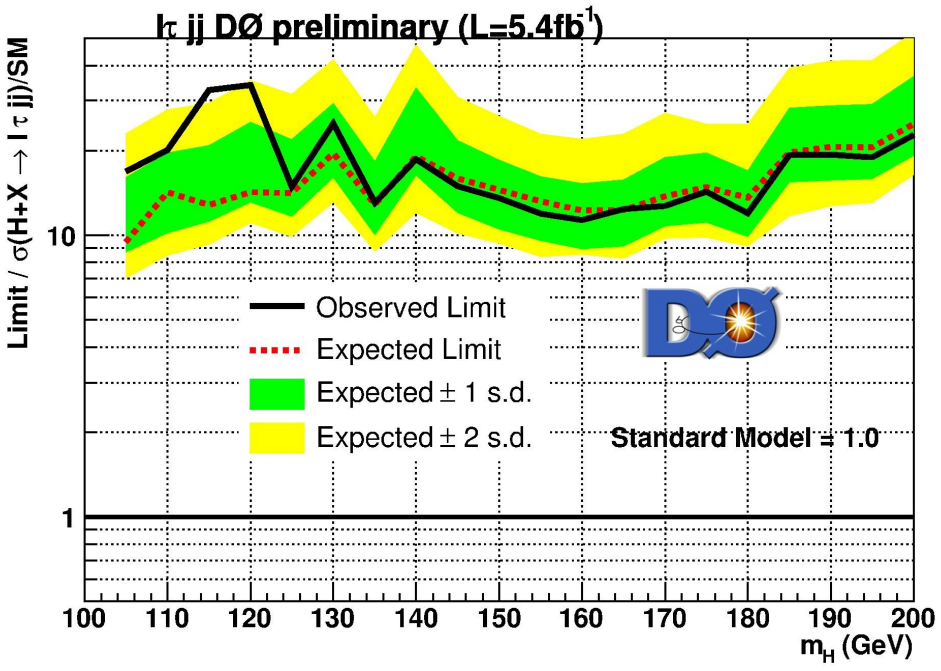
Selection:

One hadronic τ
One electron or μ
At least one jet



Searches in ττ plus jets channels



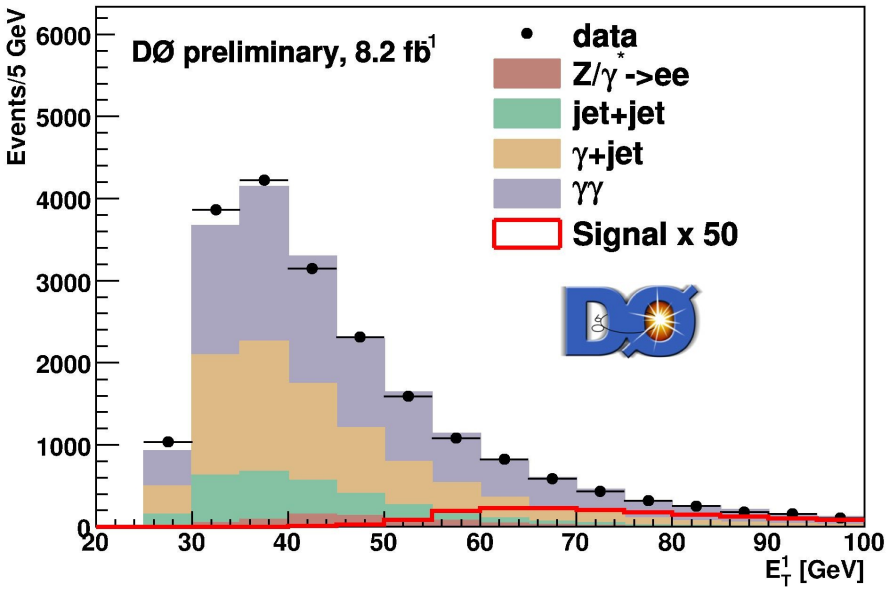


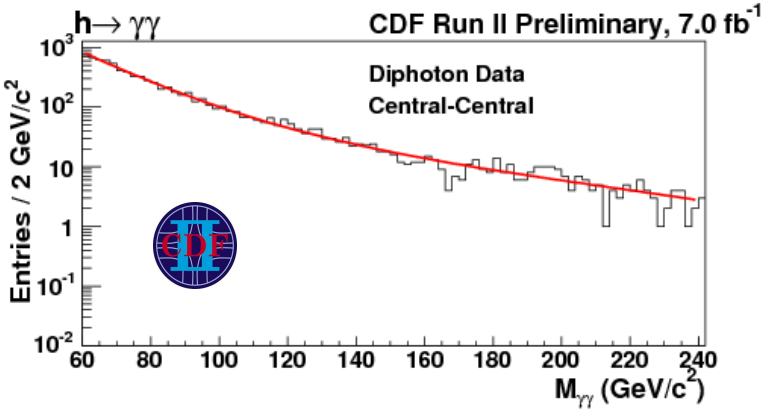
CDF Limits @ 115 GeV:
Exp: 15 × σ_{SM}
Obs: 35 × σ_{SM}

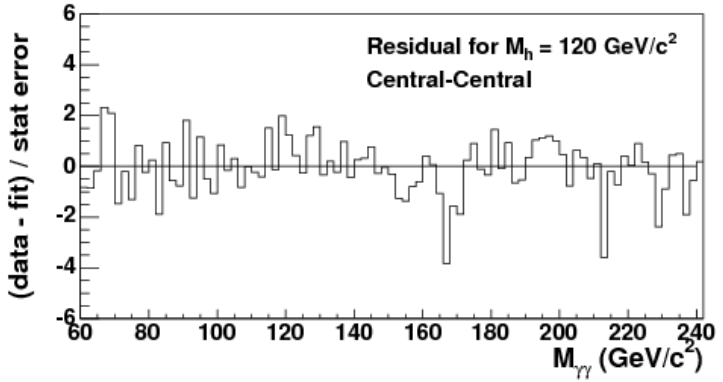
DØ Limits @ 115 GeV:
Exp: 13 × σ_{SM}
Obs: 33 × σ_{SM}

Diphoton final states

Simple event selection: two photons







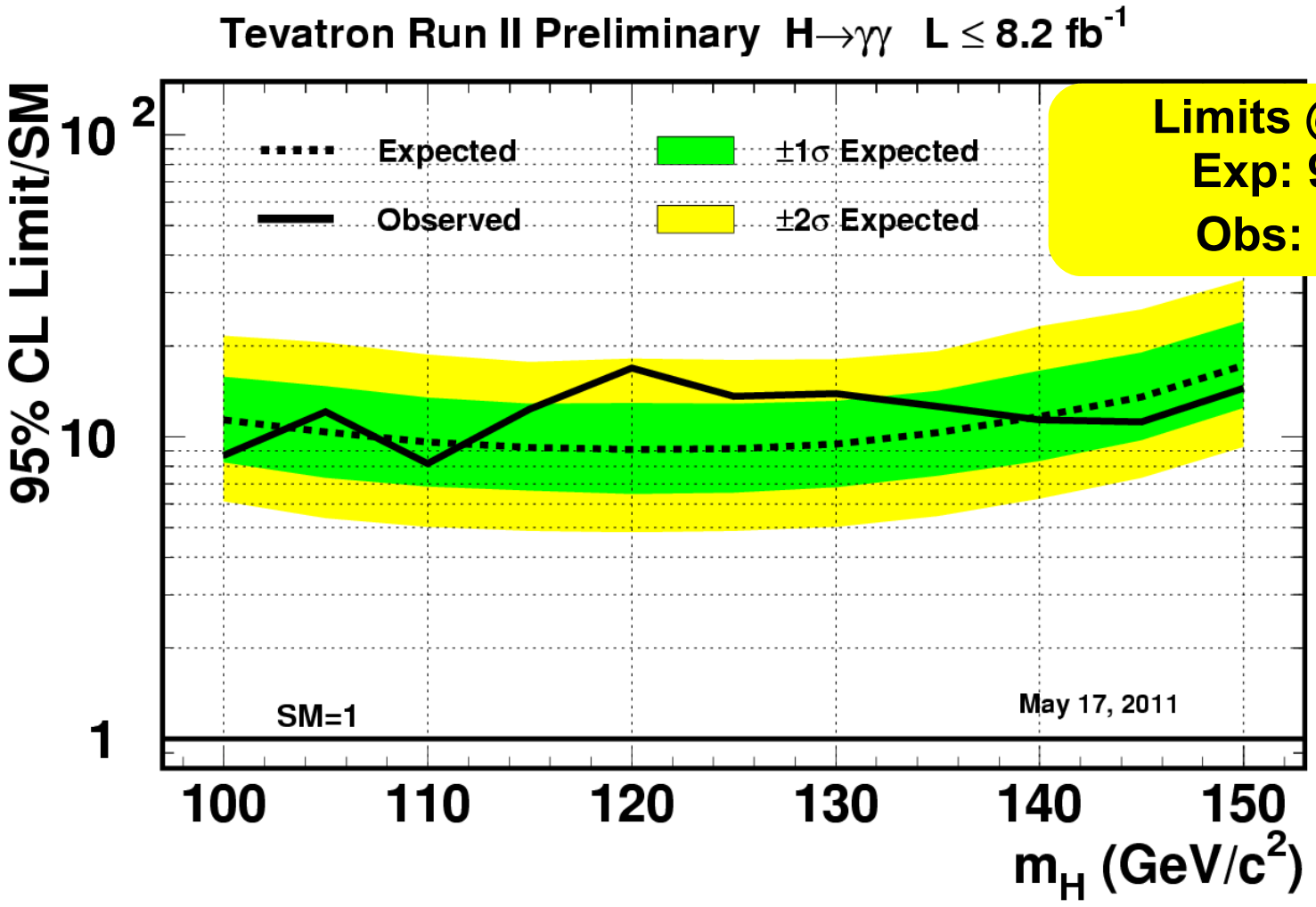
Backgrounds from control samples and Monte Carlo

Multivariate analysis to enhance sensitivity

Background from sideband method

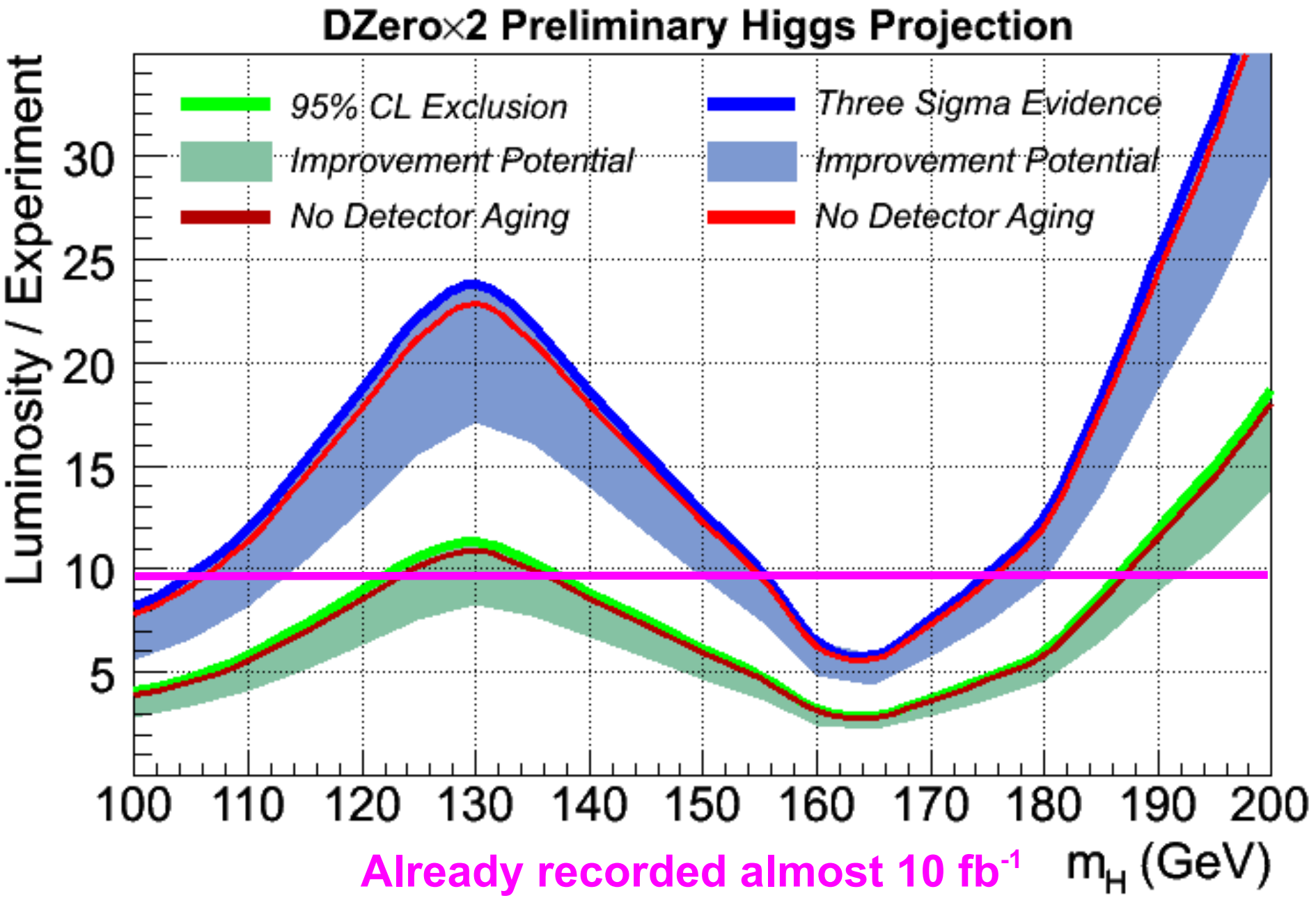
Extended selection: forward photons conversions

Diphoton final states



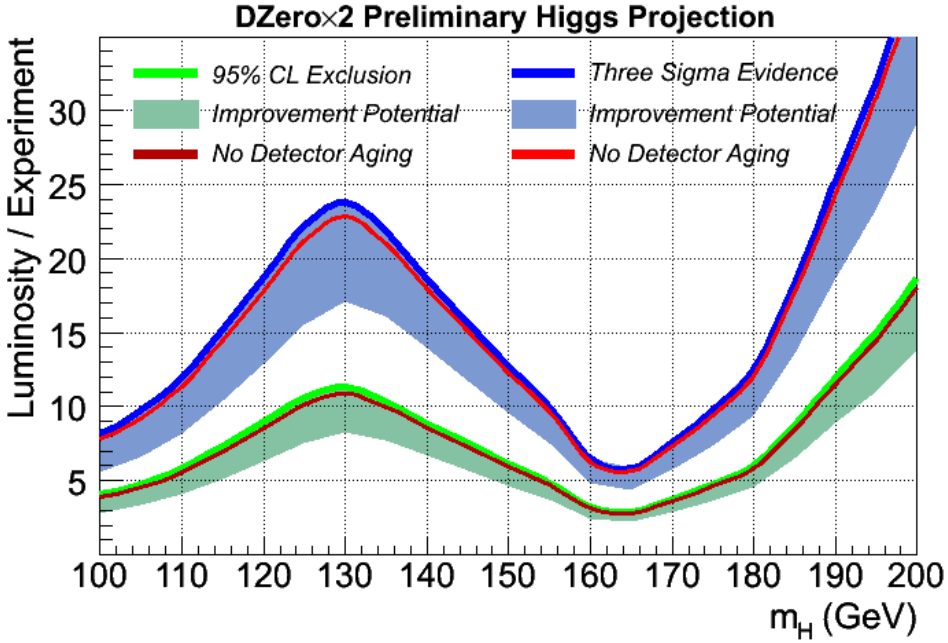
Limits @ 115 GeV:
Exp: 9.2 × σ_{SM}
Obs: 12 × σ_{SM}

Projections



Outlook

- All major channels will be updated for EPS
- Expect analyzed datasets of 8-9 fb^{-1}
- Will soon start pushing past the LEP lower bound



- Sensitivity across entire mass range by the winter conferences

http://www-d0.fnal.gov/Run2Physics/WWW/results/higgs.htm

http://www-cdf.fnal.gov/physics/new/hdg/hdg.html

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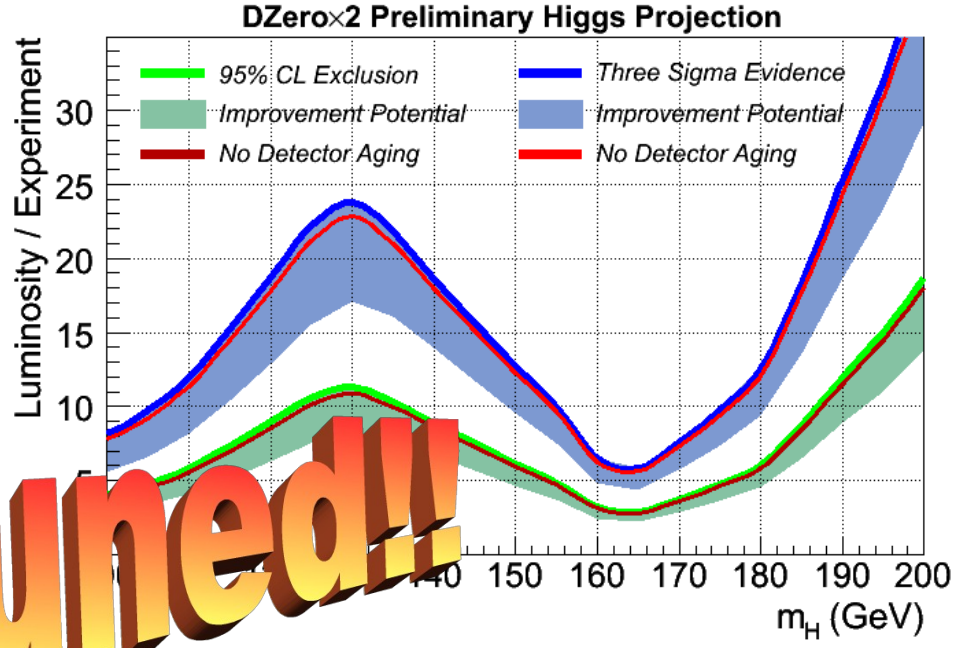

Stay Tuned!!

http://www-d0.fnal.gov/Run2Physics/WWW/results/higgs.htm

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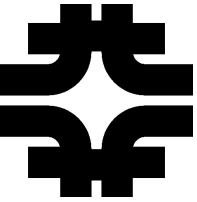
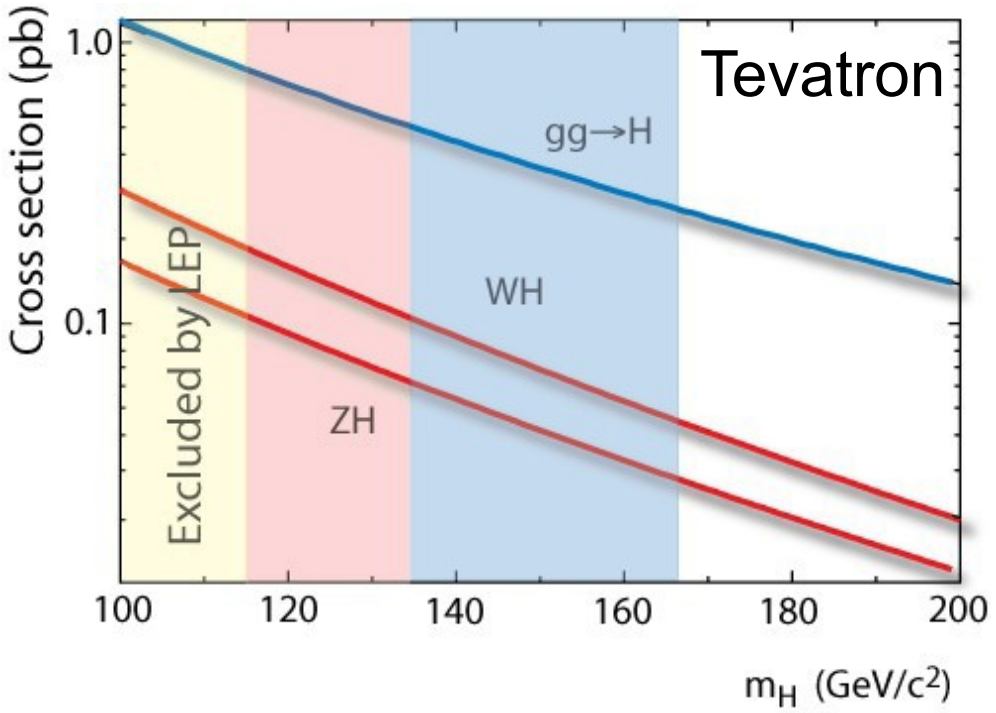
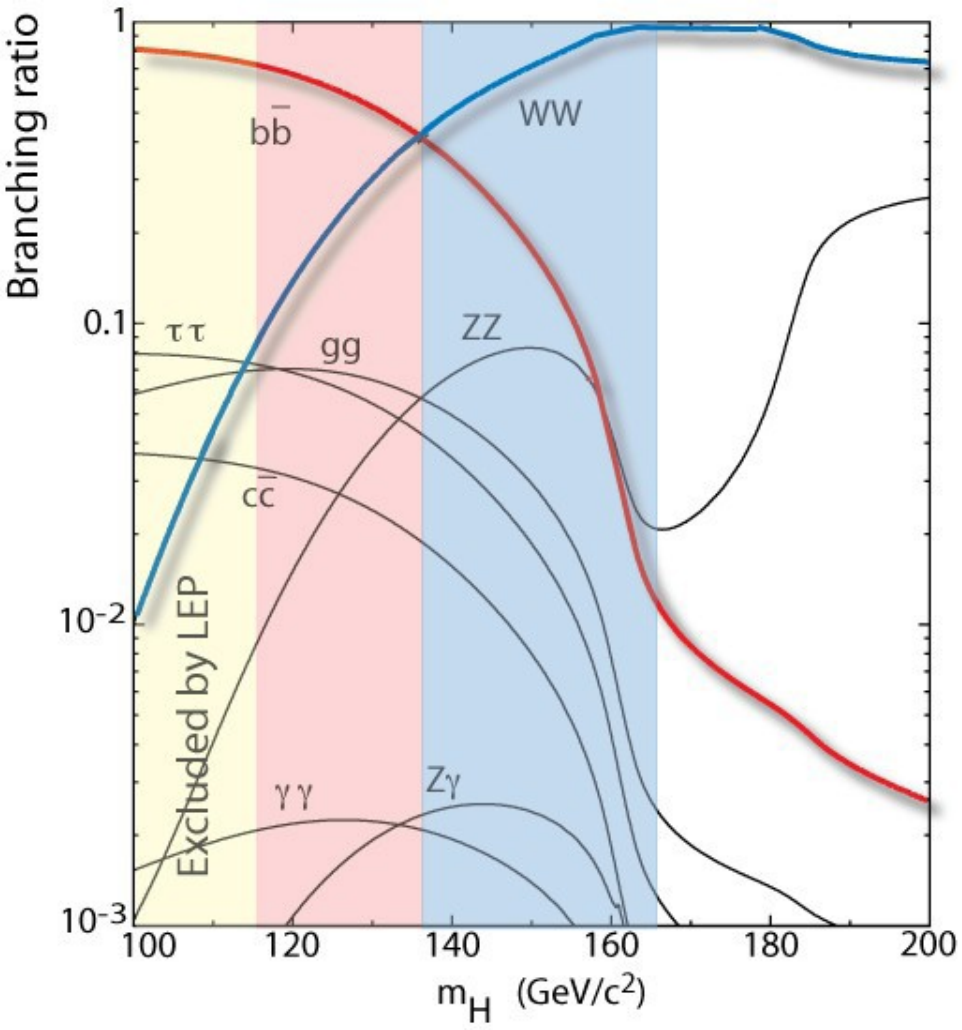


Backup Slides

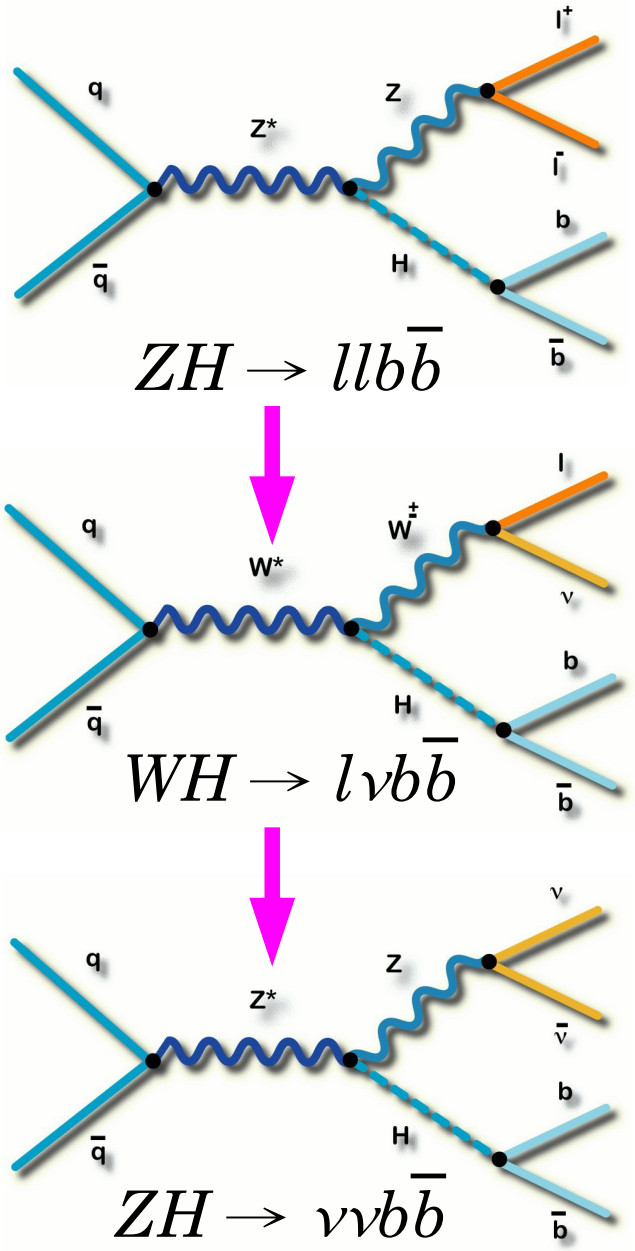
Production and Decay



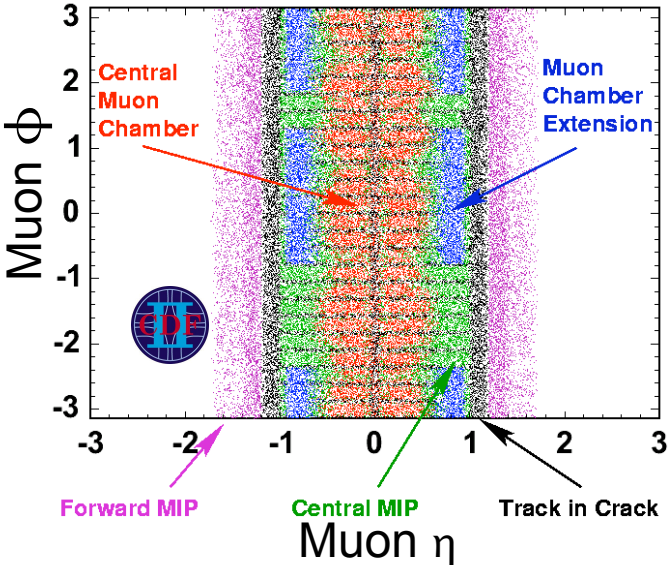


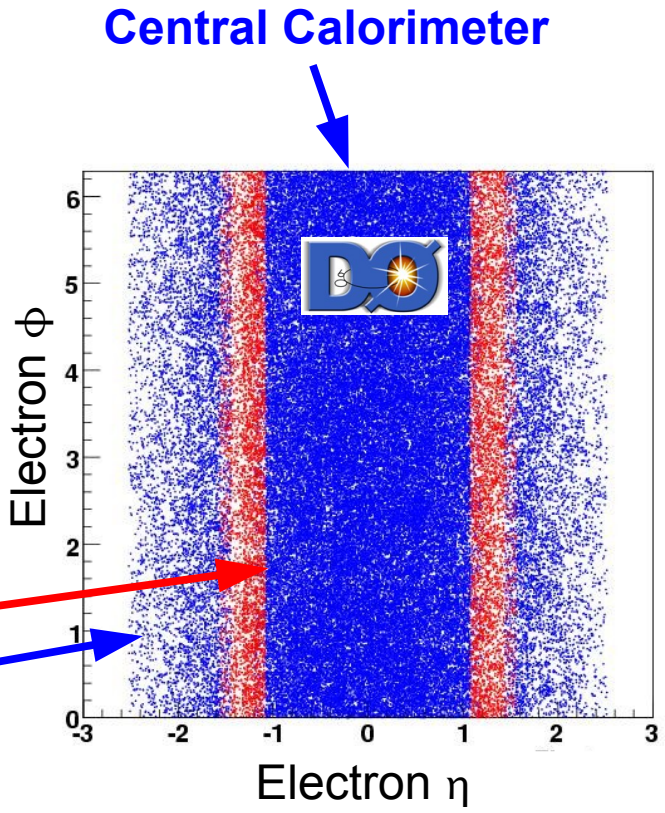
- Use leptons to suppress backgrounds
- When $H \rightarrow b\bar{b}$ dominates, need associated W or Z

Associated Production Searches



Use specialized lepton ID to improve acceptance





Resolving the Mass Peak

- For $H \rightarrow b\bar{b}$, dijet mass is the key variable
- Better mass resolution gives better sensitivity
- In llbb channels expect minimal missing E_T
  - Exploit to improve jet energy measurement