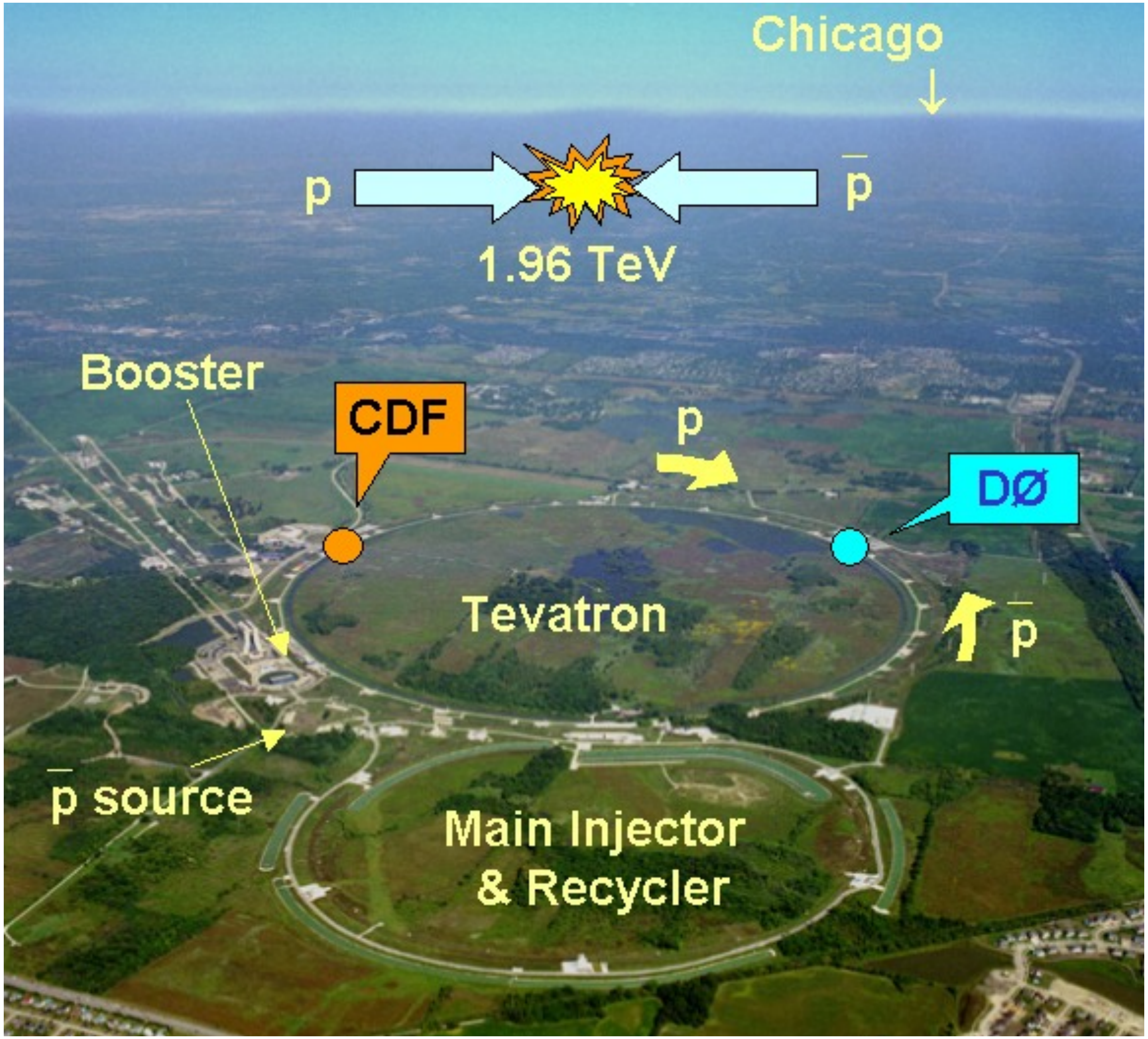
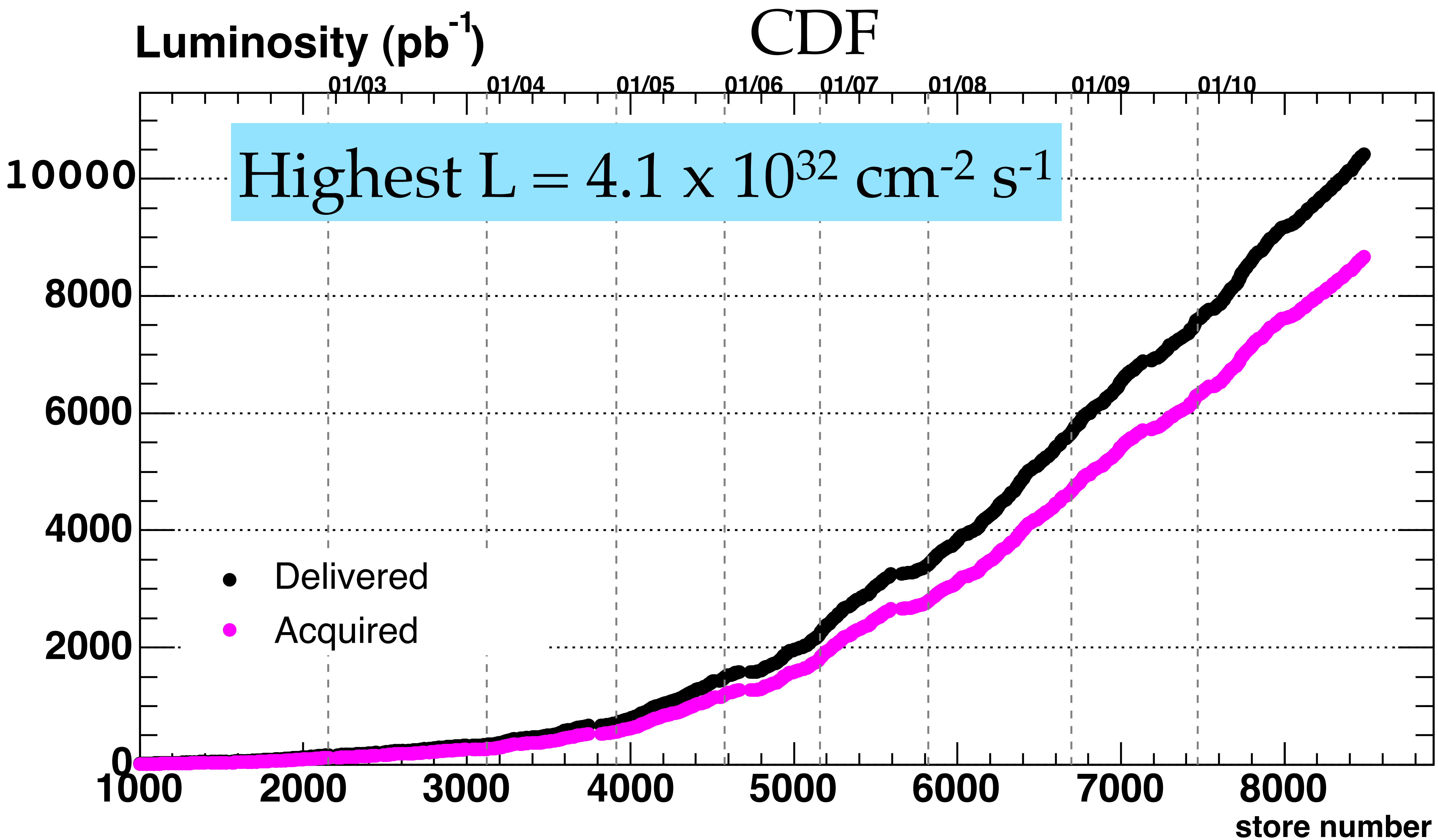
Hunting the Higgs at CDF

Tevatron


Chicago
p
$\bar{p}$
1.96 TeV
Booster
CDF
p
DØ
Tevatron
$\bar{p}$
$\bar{p}$ source
Main Injector
& Recycler

Tevatron Performance



What we know:

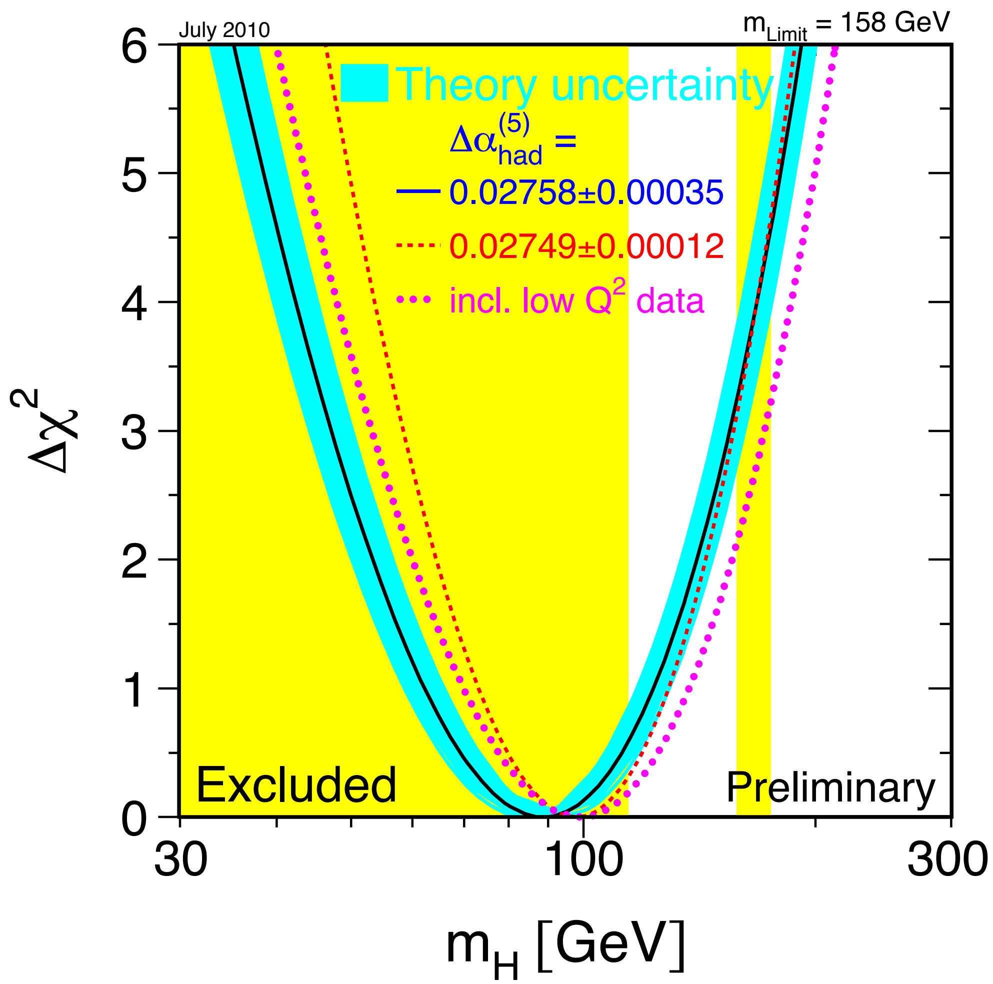
- **Direct search at LEPII:**

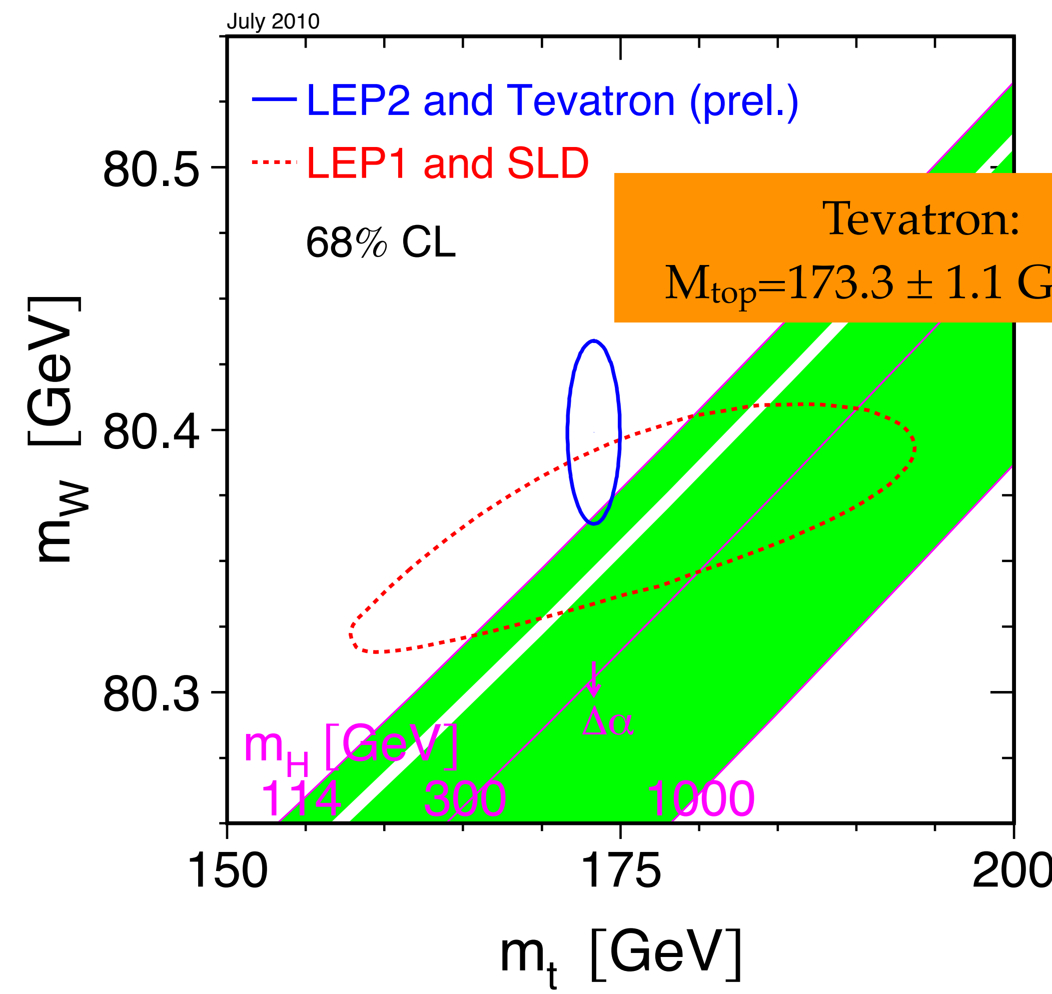
  Mh > 114 GeV/c2 @95% CL

- **Precision EWK meaurements (top mass, W mass, etc):**

  $M_h = 89.0^{+35}_{-26}$ GeV/c^2

  $M_h < 158$ GeV/c^2 @95% CL

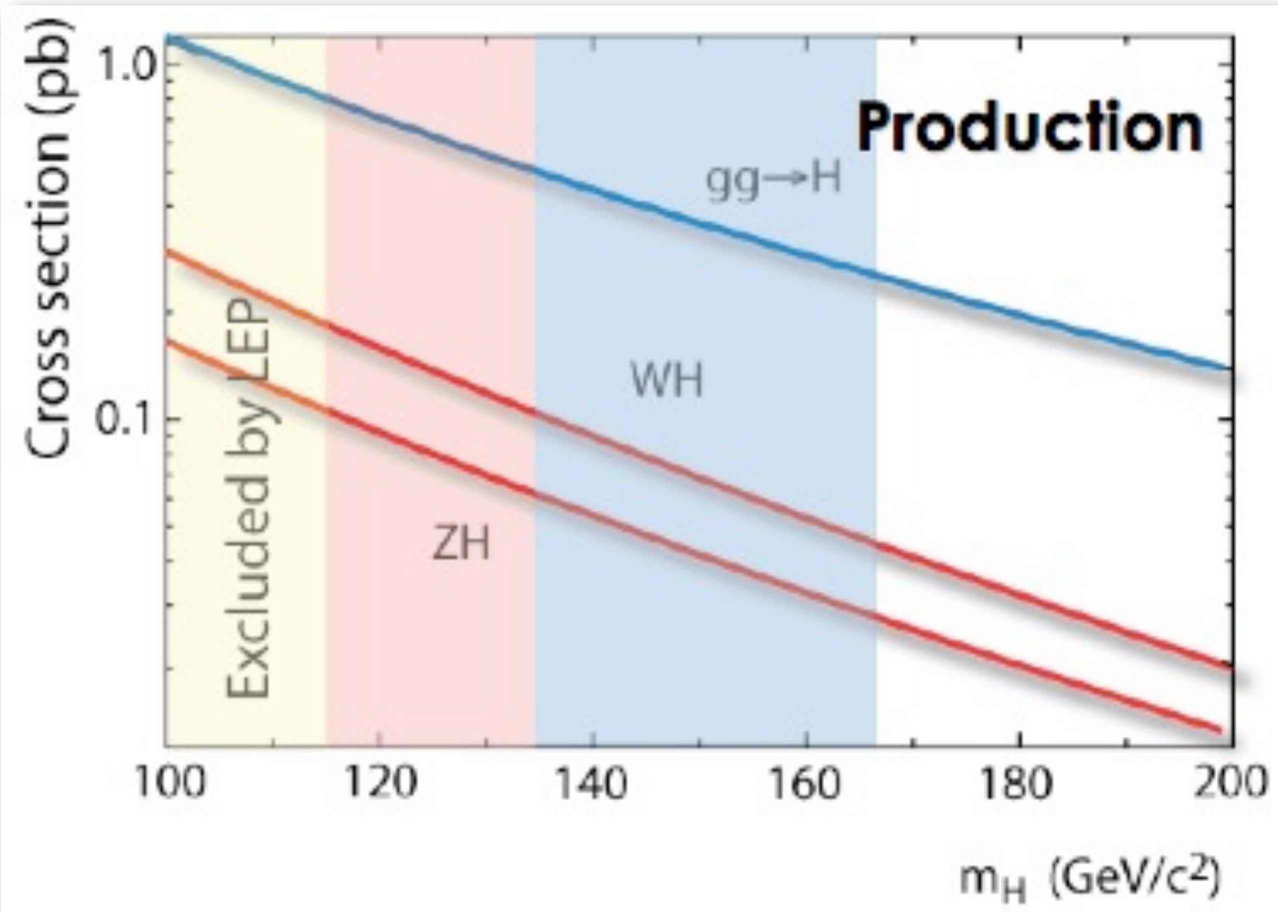




Tevatron:
M_{top}=173.3 ± 1.1 GeV / c^2

Production and Decay

Production and Decay



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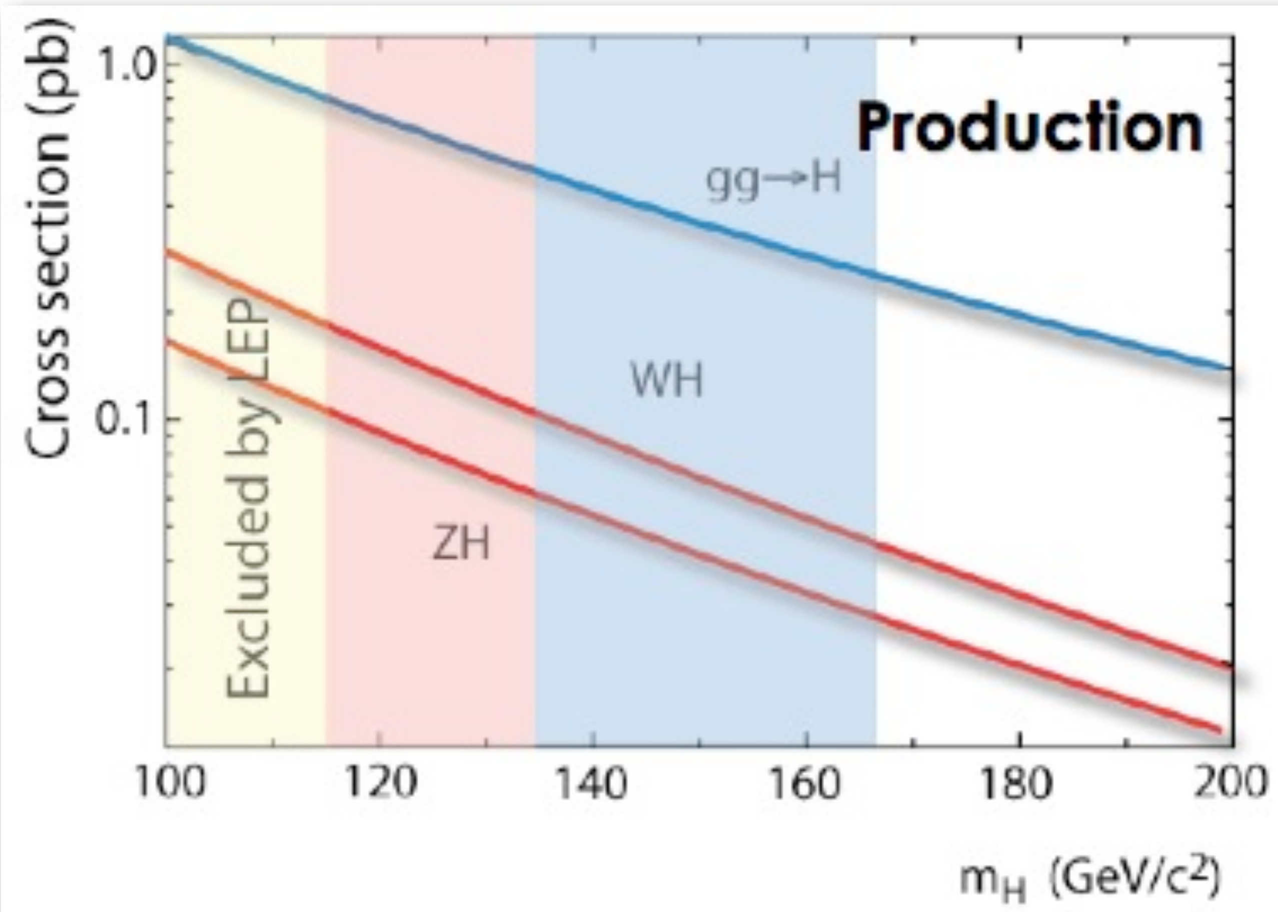

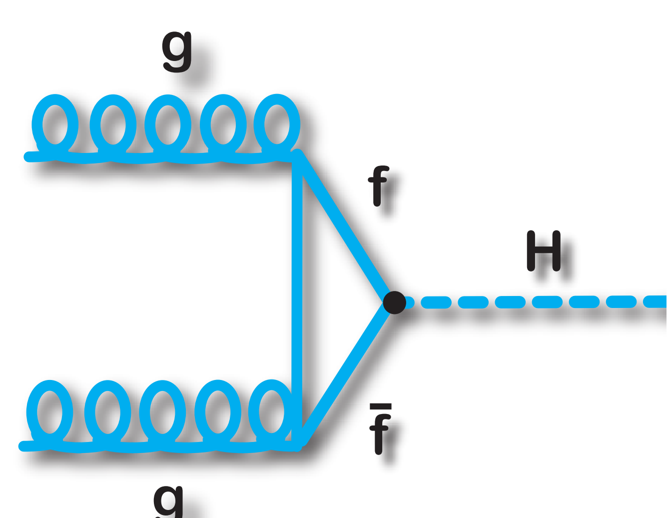

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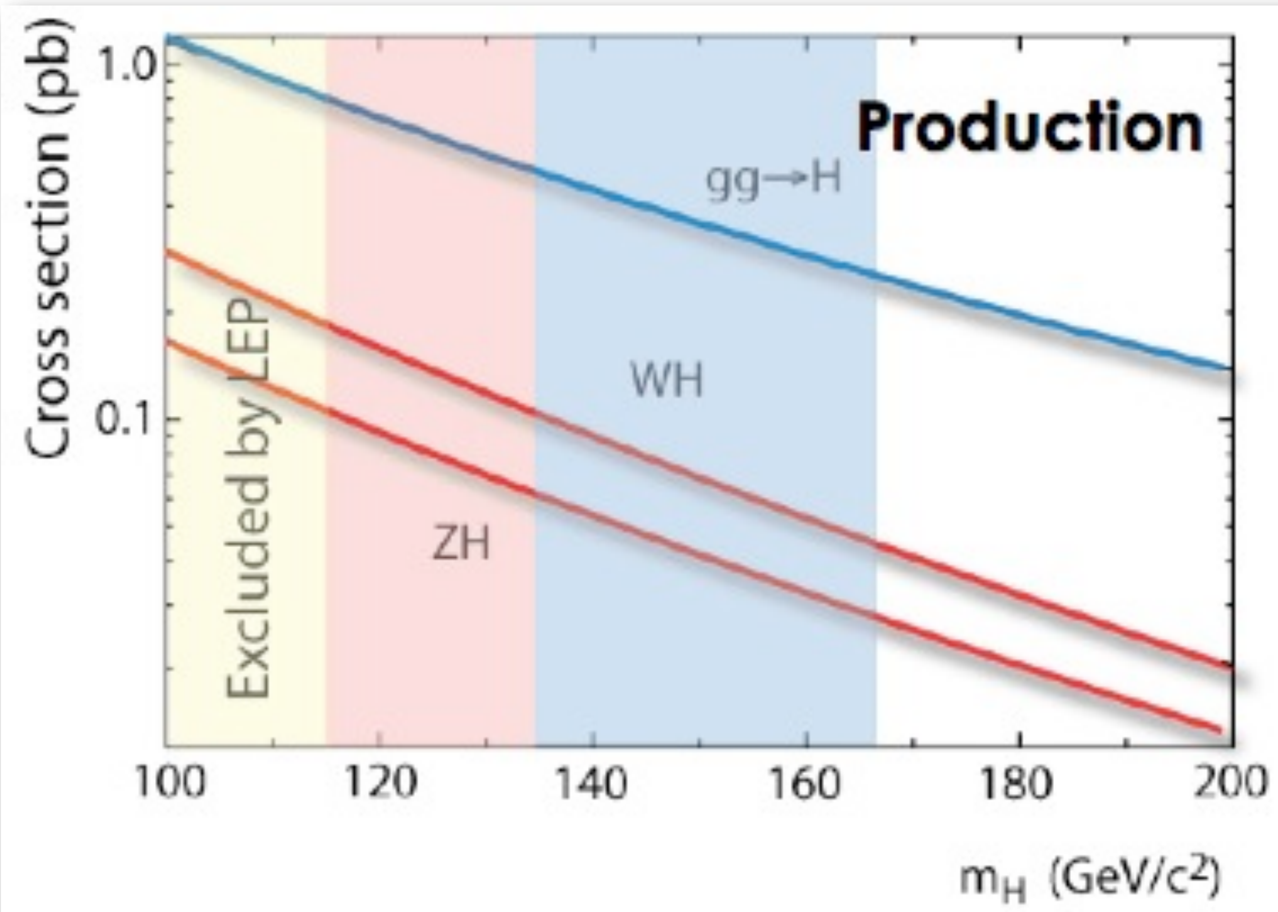

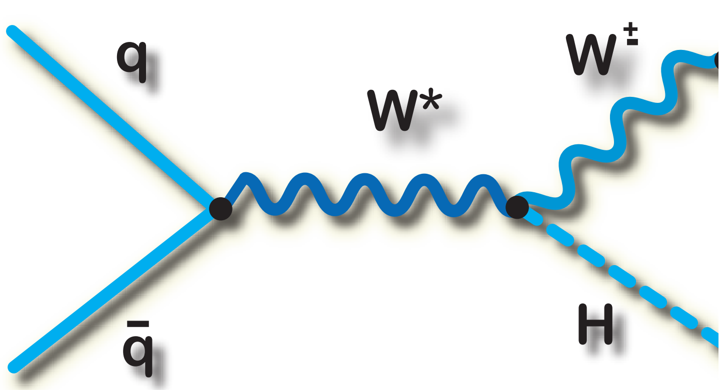

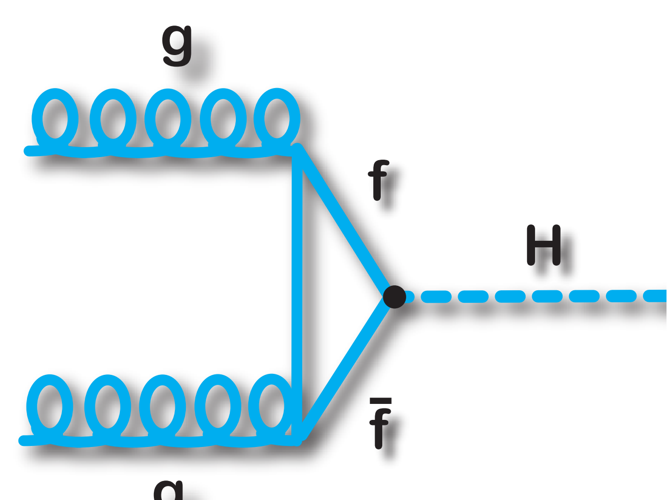

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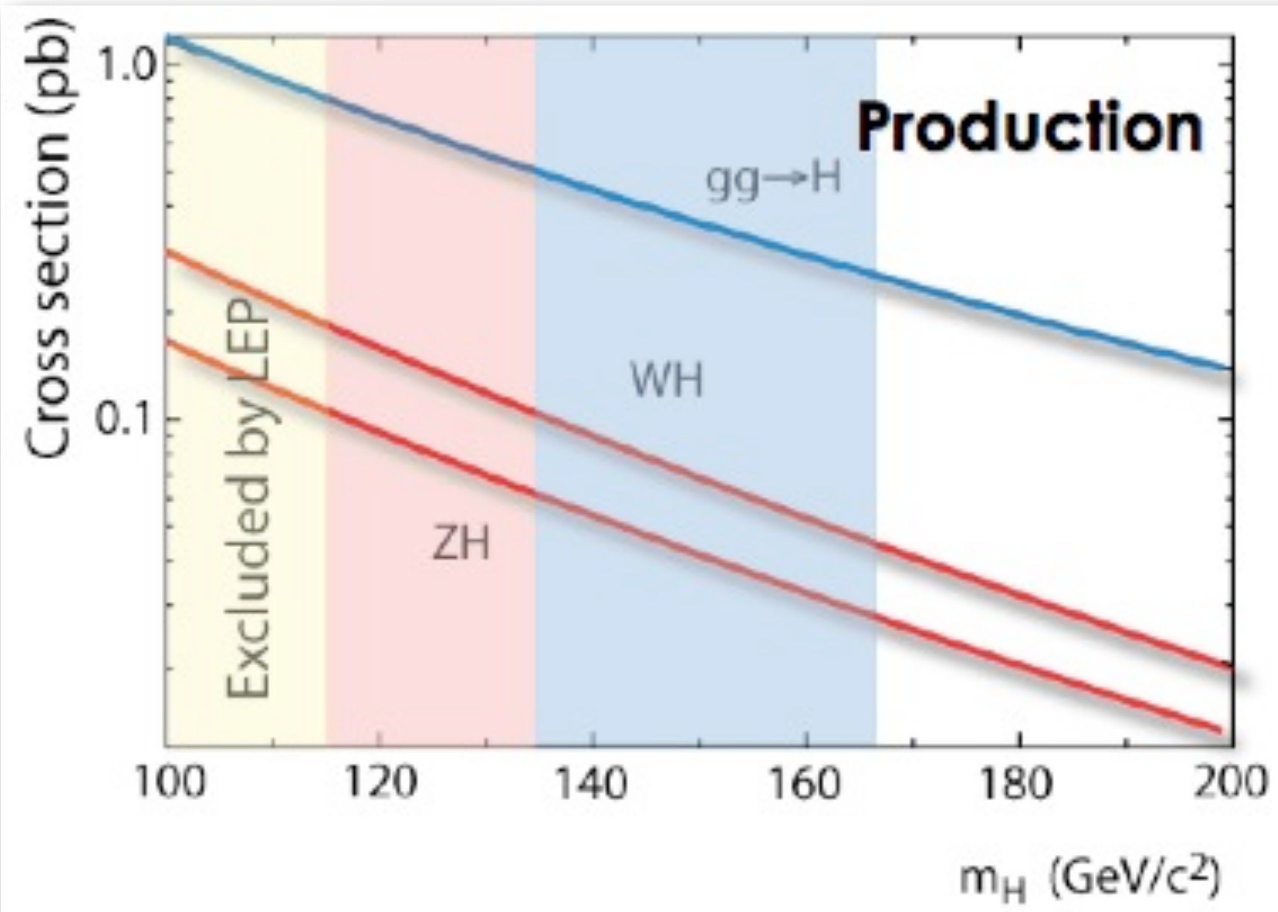

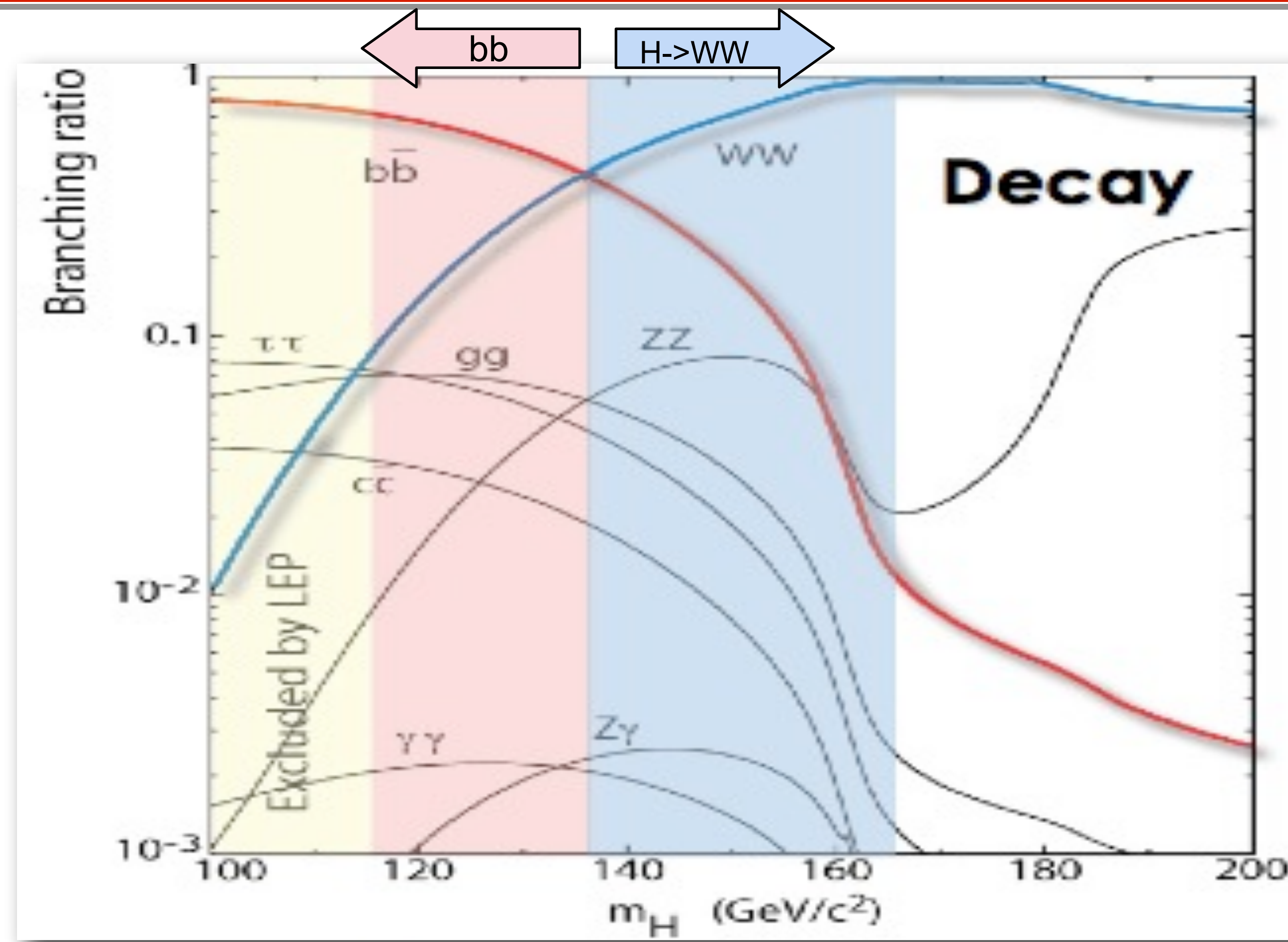

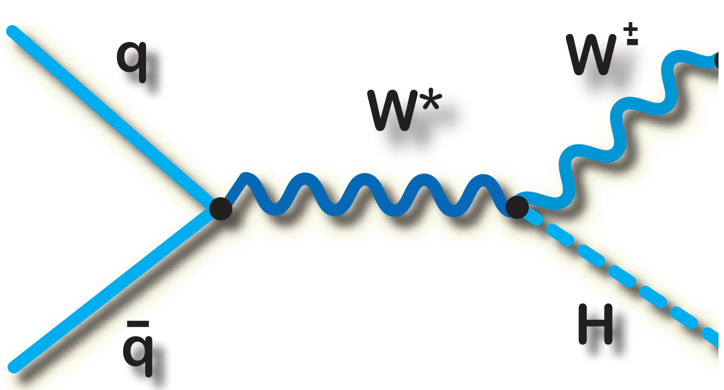

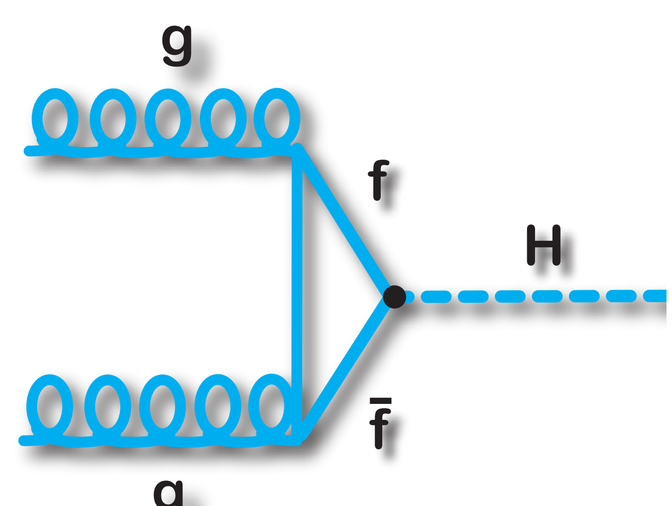

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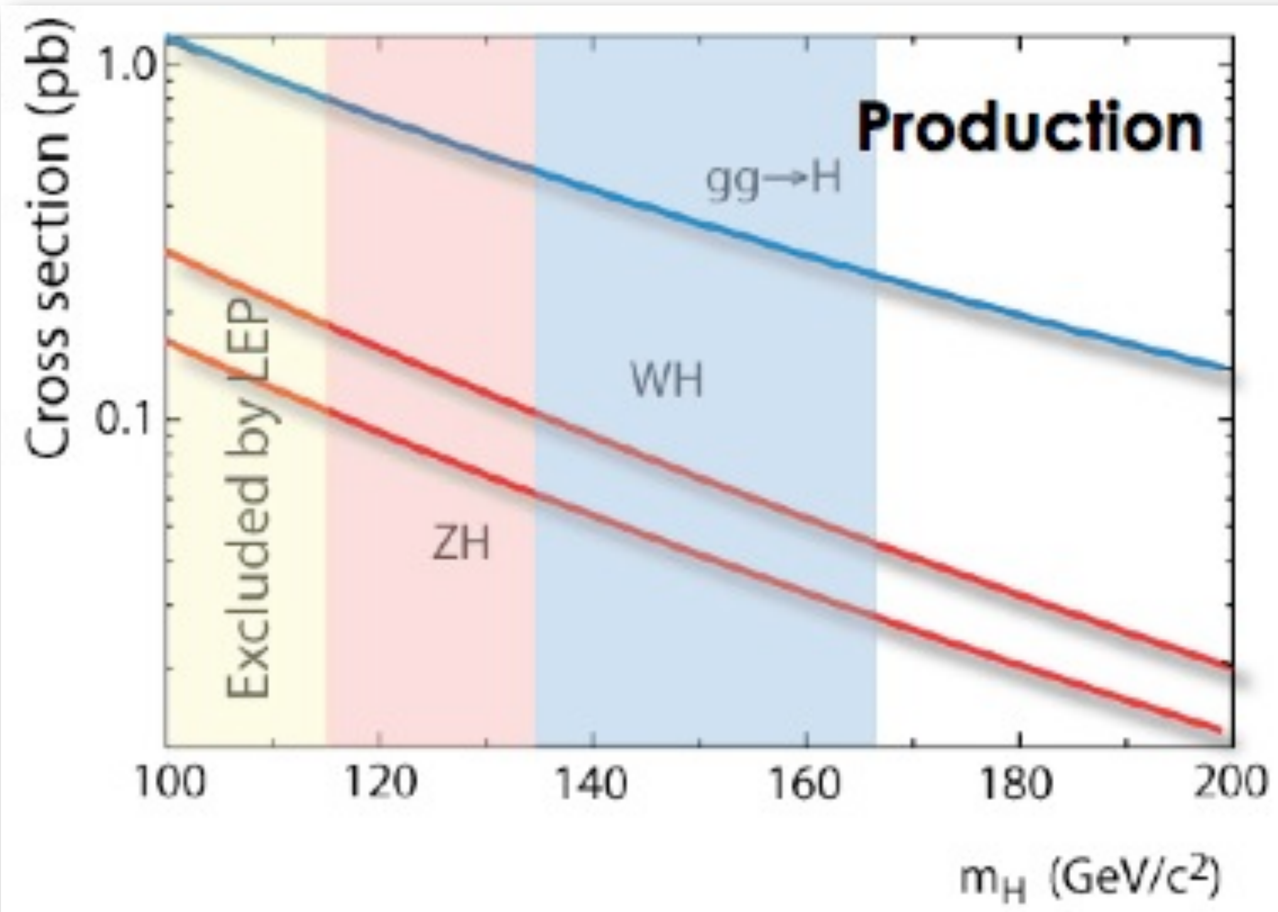
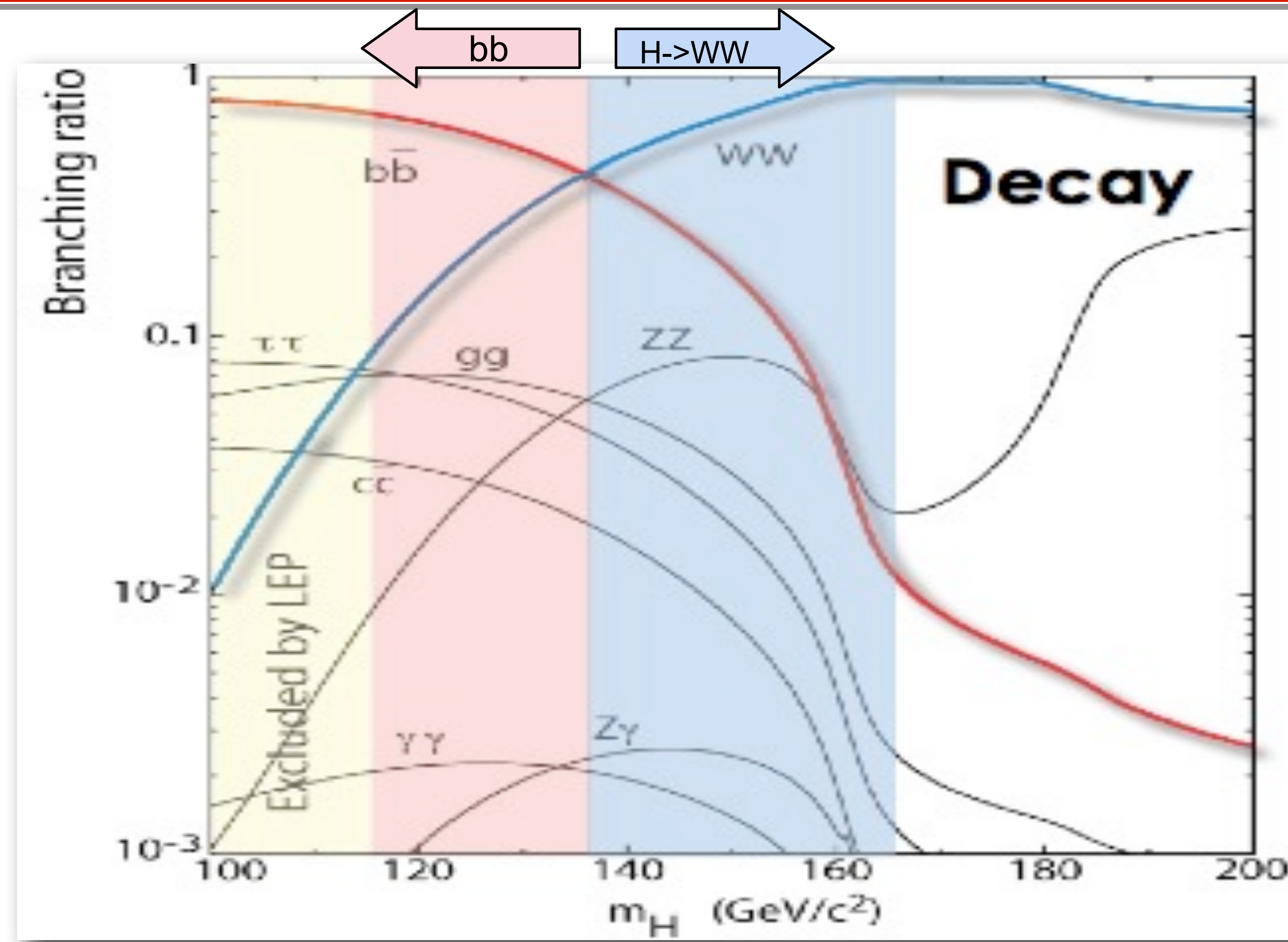
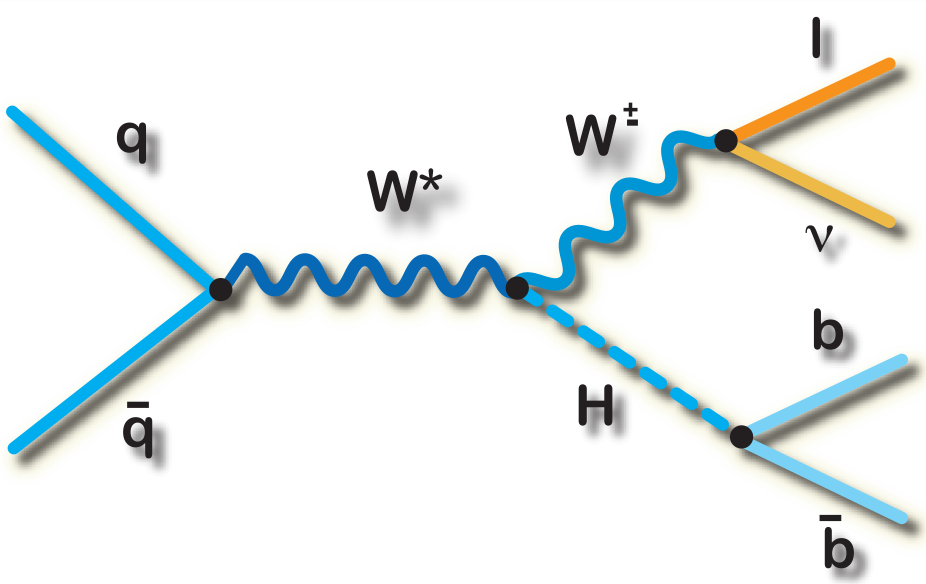
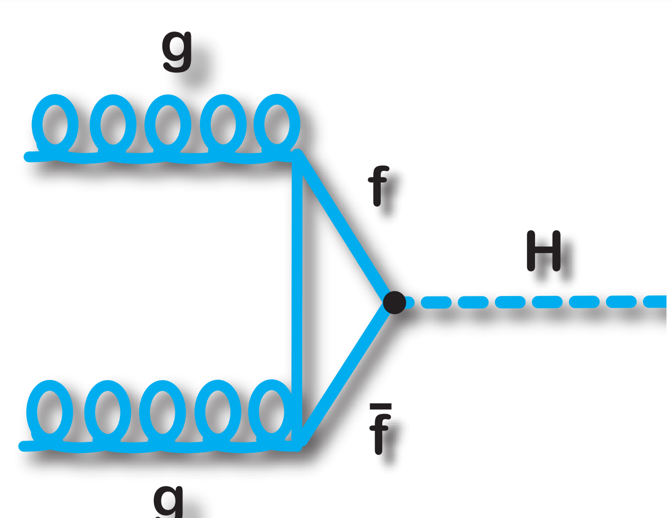


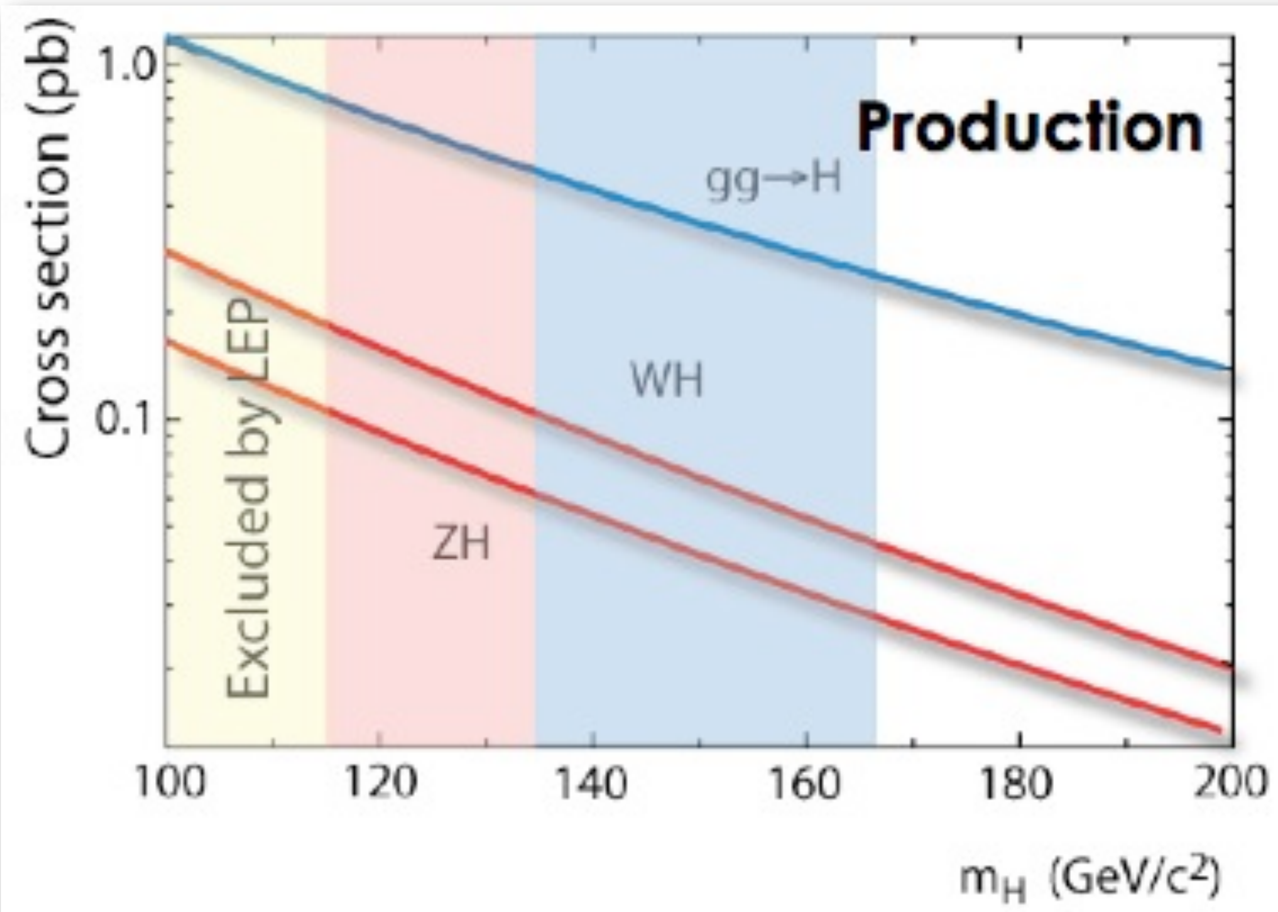


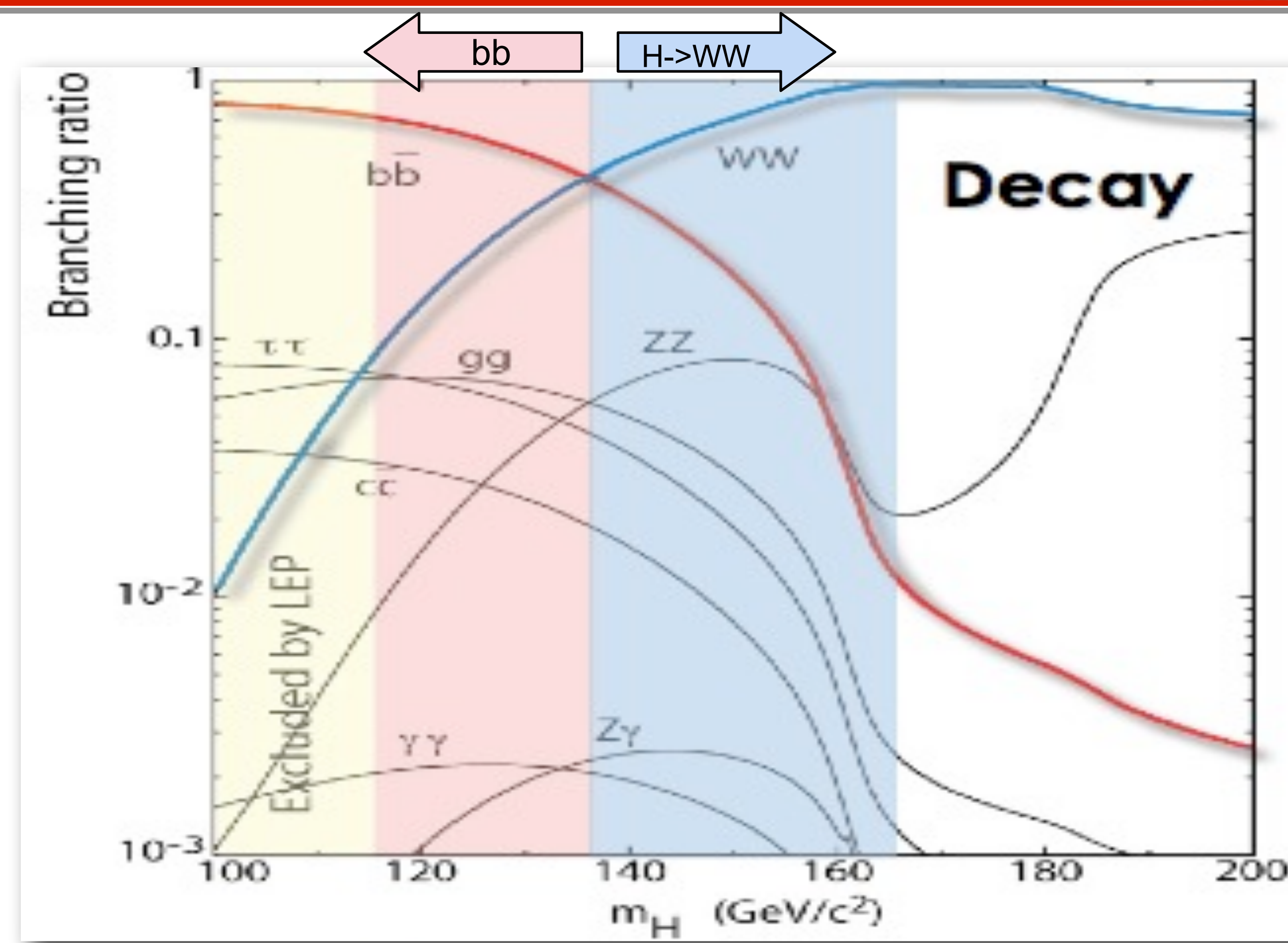


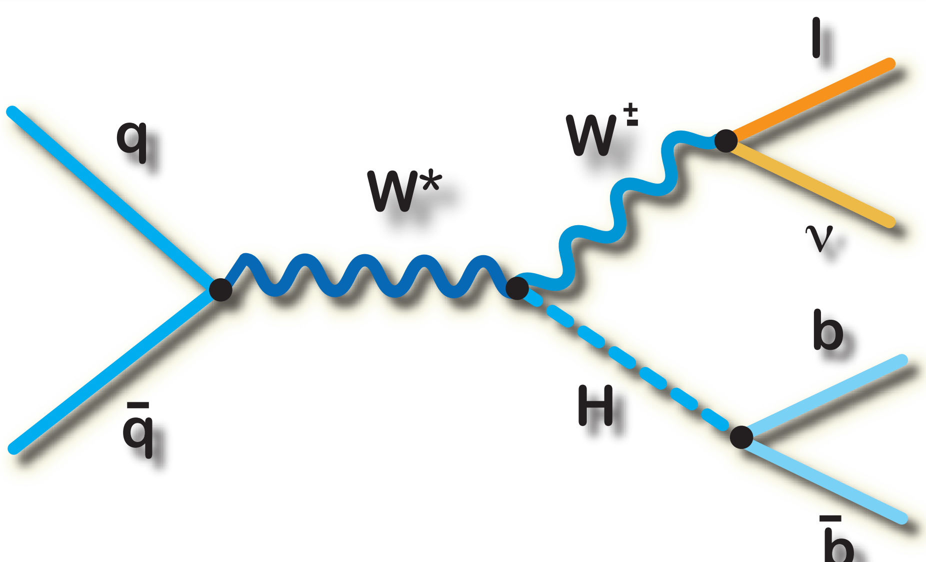


Low Mass Decay

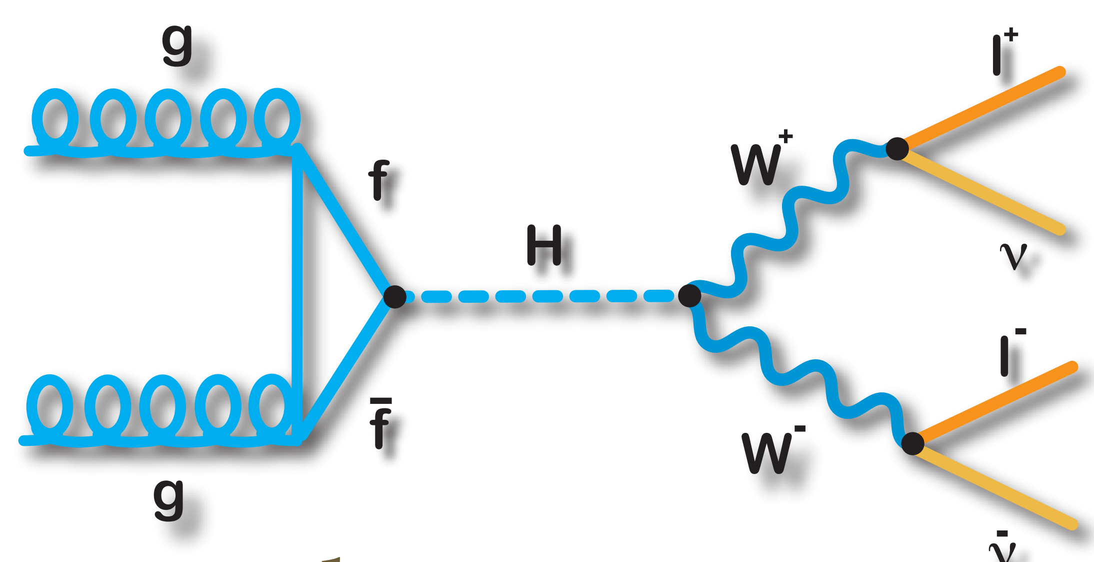
Production and Decay







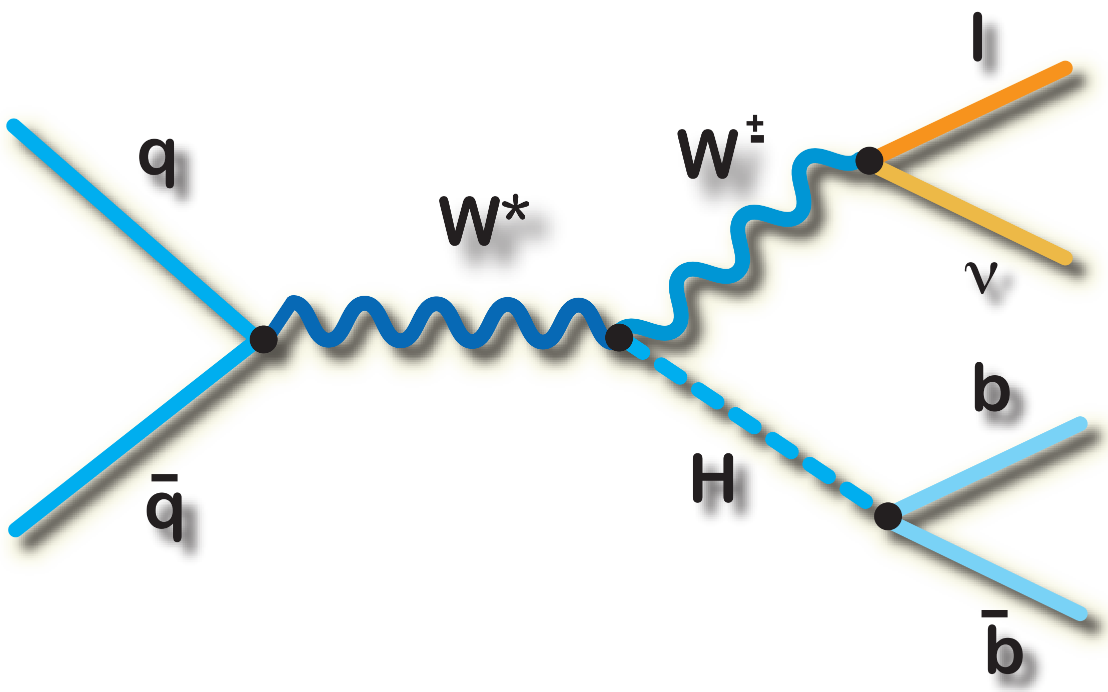
Low Mass Decay

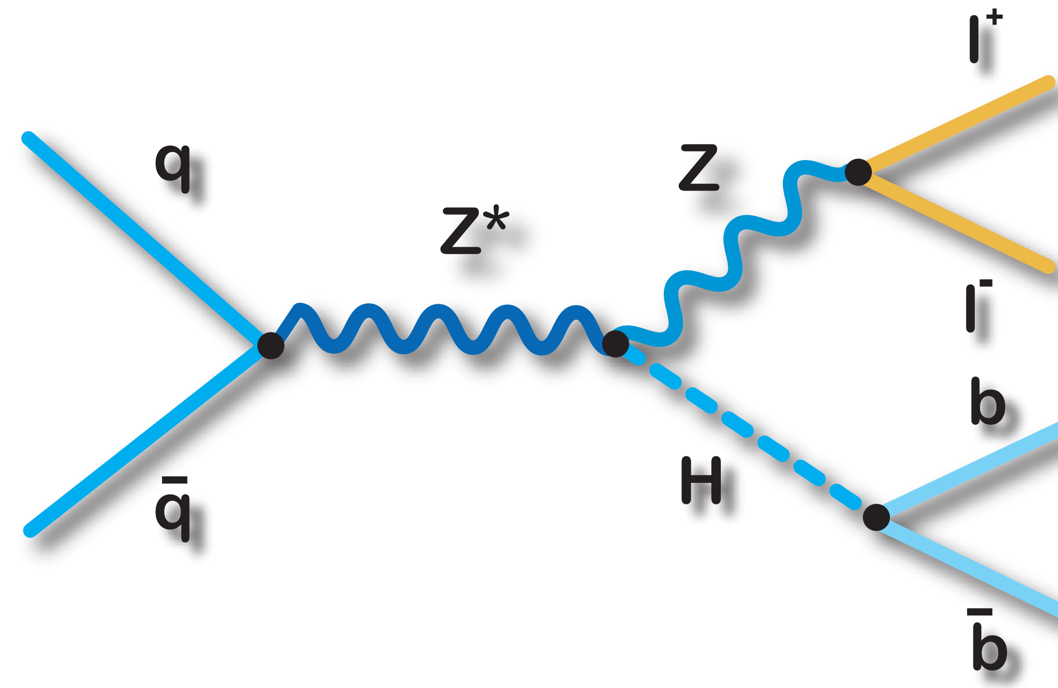


High Mass Decay

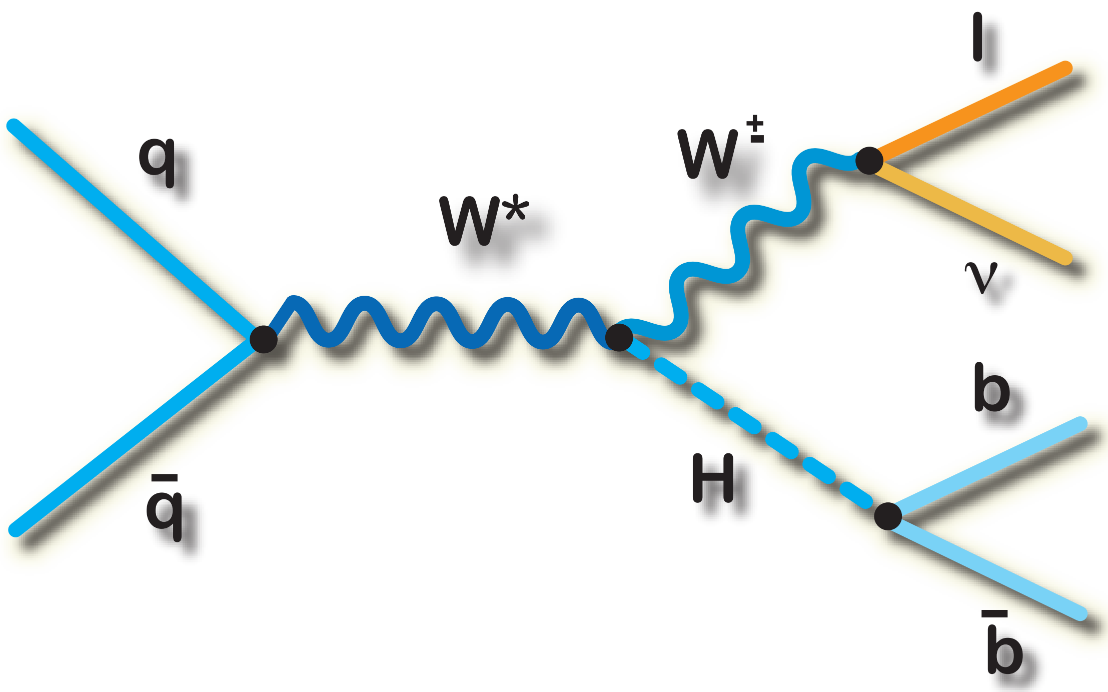
Low Mass Final States

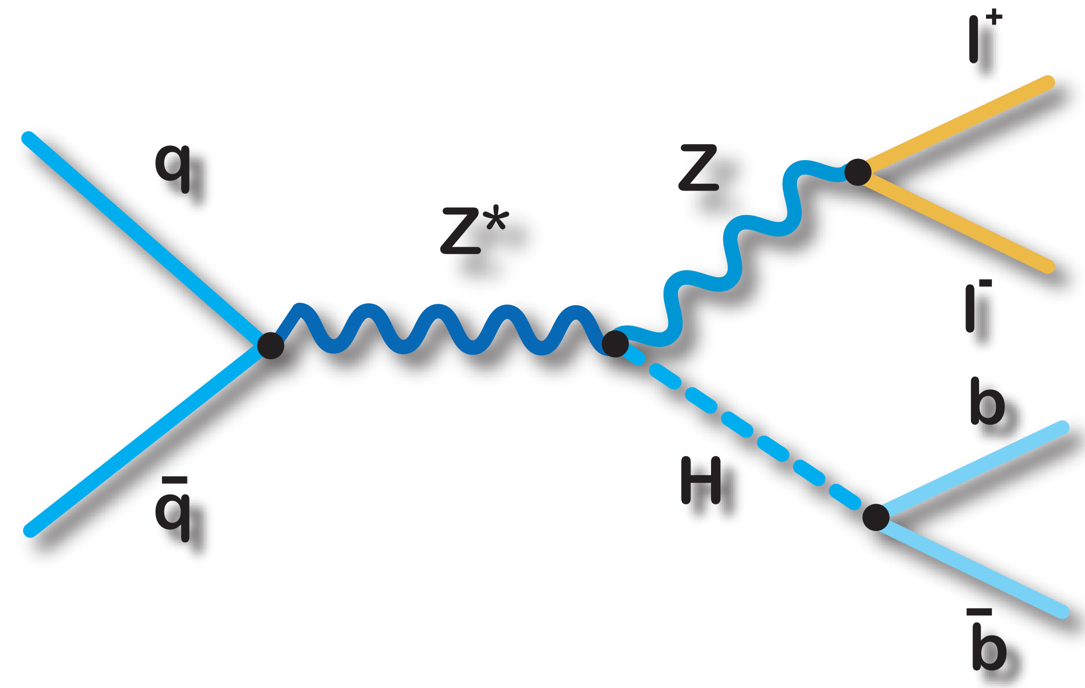
Primarily: $H \to b\bar{b}$





Primarily: $H \to b\bar{b}$

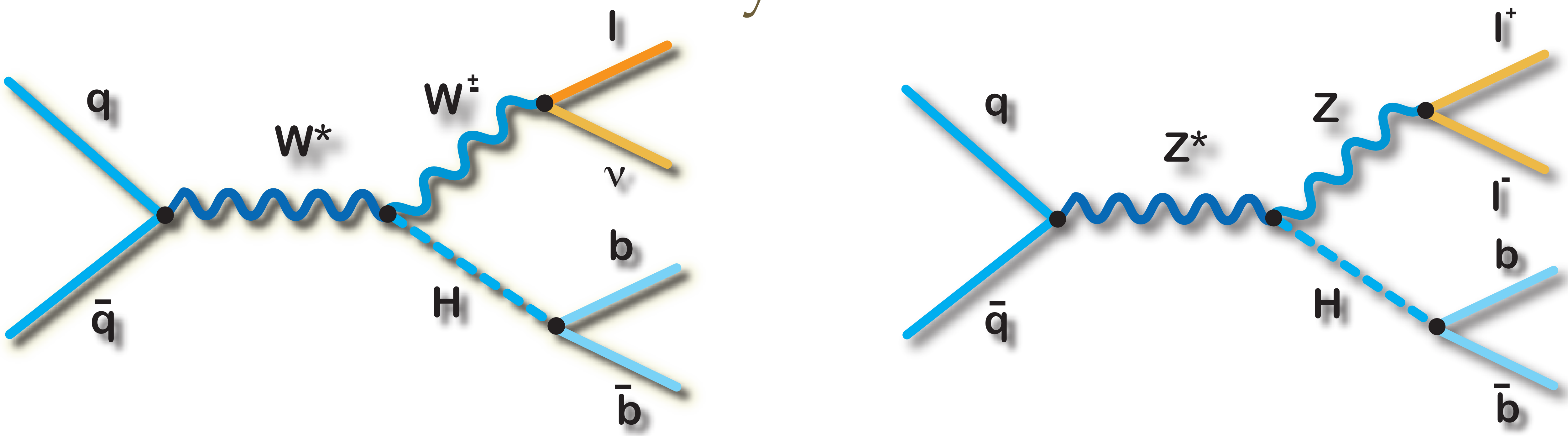




$WH \to \ell\nu b\bar{b}$ → 1 High P_T Lepton + $\not{E}_T$ + b jets

Low Mass Final States

Primarily: $H \to b\bar{b}$

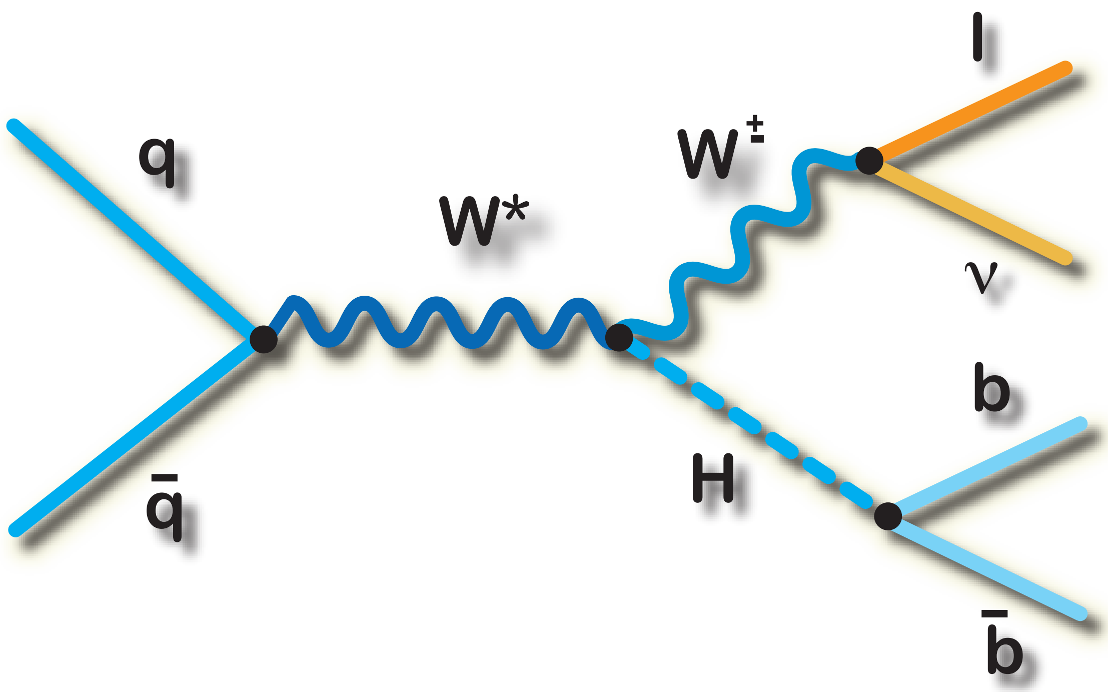


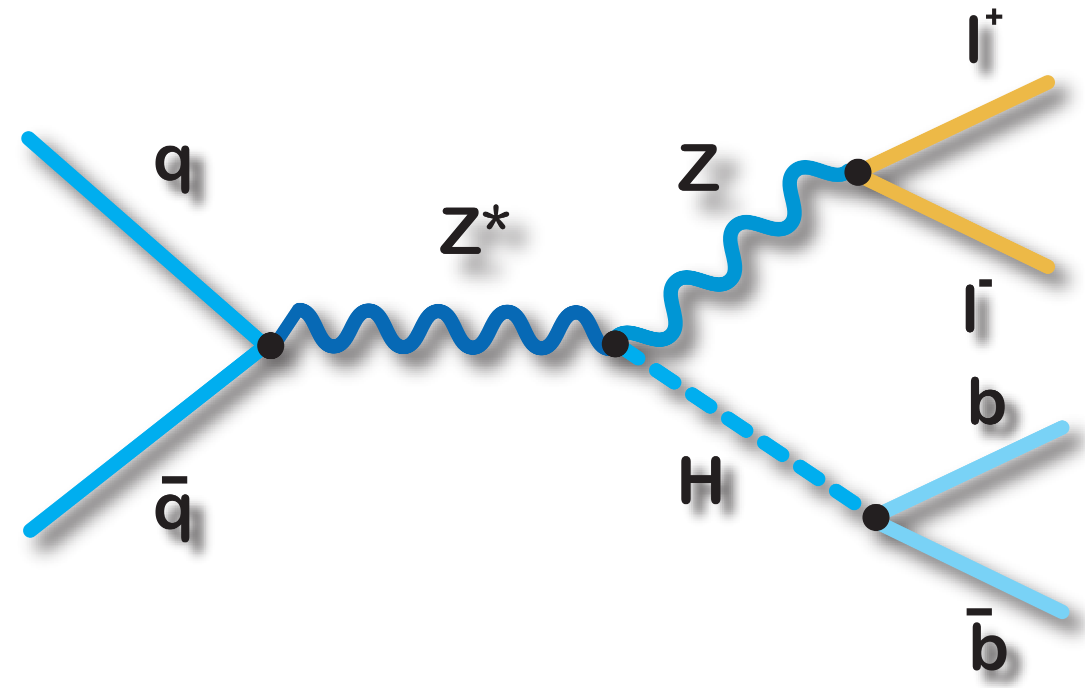
$WH \to \ell\nu b\bar{b}$ → 1 High P_T Lepton + $\not{E}_T$ + b jets

$ZH \to \ell\ell b\bar{b}$ → 2 High P_T Leptons + b jets

Low Mass Final States

Primarily: $H \to b\bar{b}$





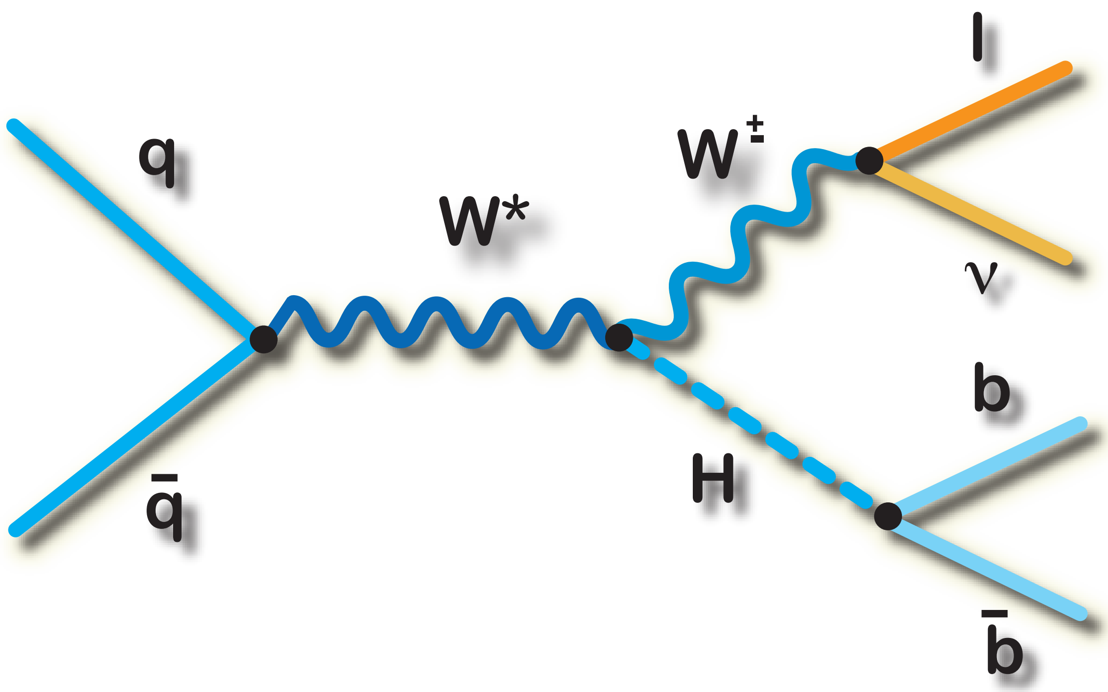
$WH \to \ell\nu b\bar{b}$ → 1 High P_T Lepton + $\not{E}_T$ + b jets

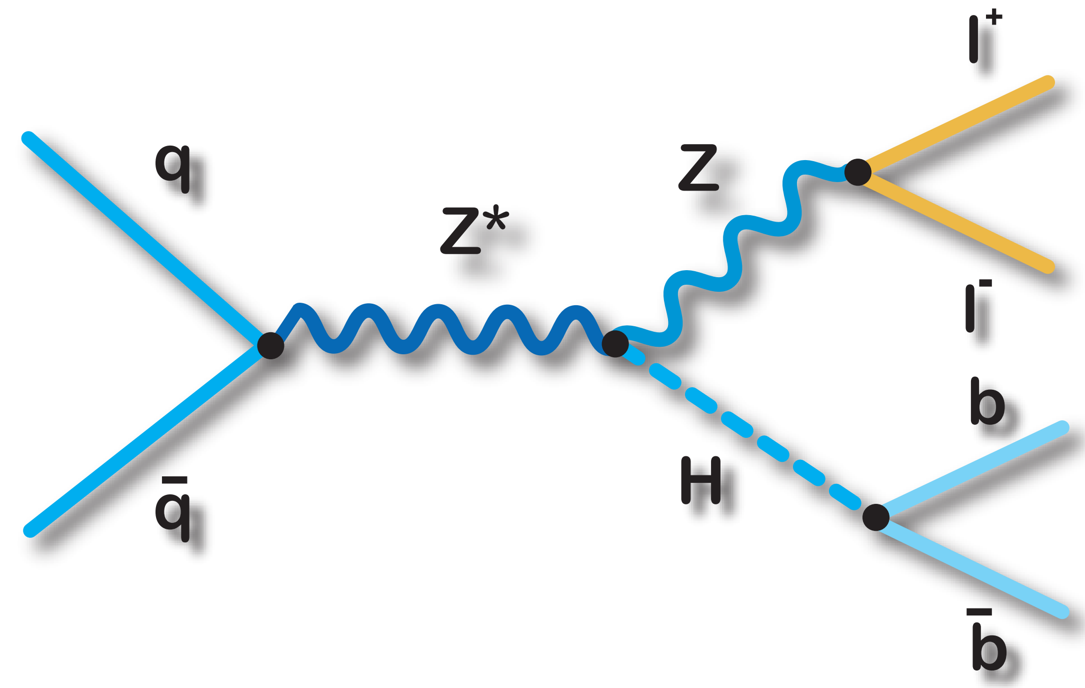
$ZH \to \ell\ell b\bar{b}$ → 2 High P_T Leptons + b jets

$ZH \to \nu\nu b\bar{b}$
$WH \to (\ell)\nu b\bar{b}$ → 0 High P_T Leptons + $\not{E}_T$ + b jets

Low Mass Final States

Primarily: $H \to b\bar{b}$





$WH \to \ell\nu b\bar{b}$ → 1 High P_T Lepton + $\not{E}_T$ + b jets

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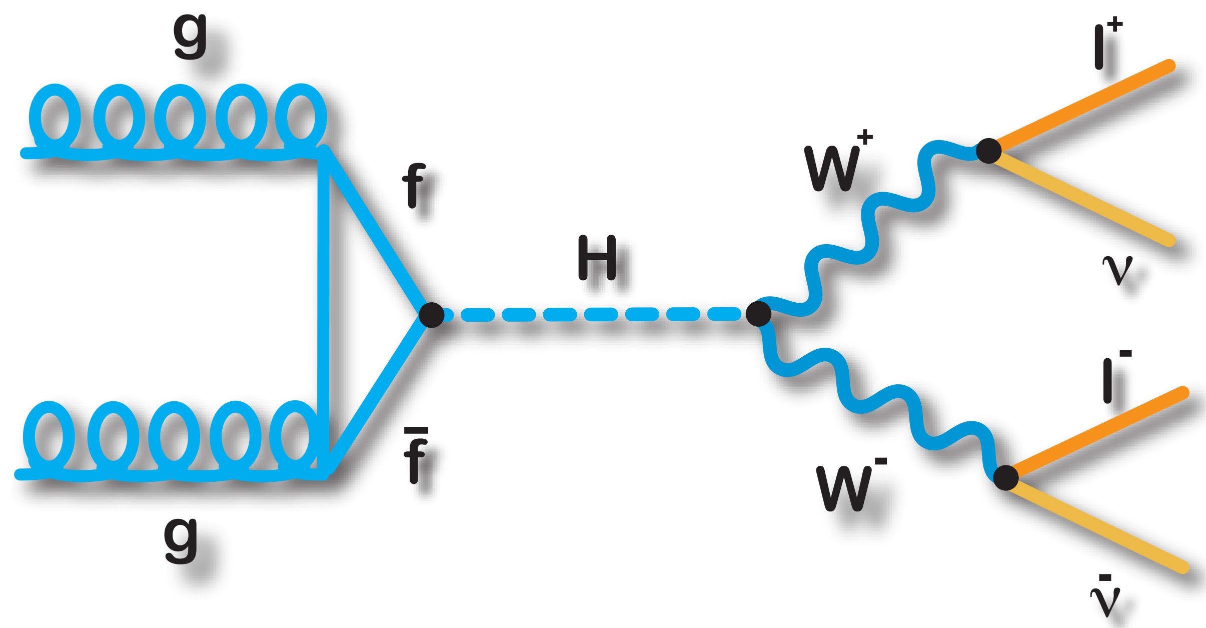
$ZH \to \nu\nu b\bar{b}$
$WH \to (\ell)\nu b\bar{b}$ → 0 High P_T Leptons + $\not{E}_T$ + b jets

$VH,\ VBF, H \to \tau\tau + 2j$ → 1 Lepton + Trk(s)+ jets

Primarily: $H \rightarrow WW$

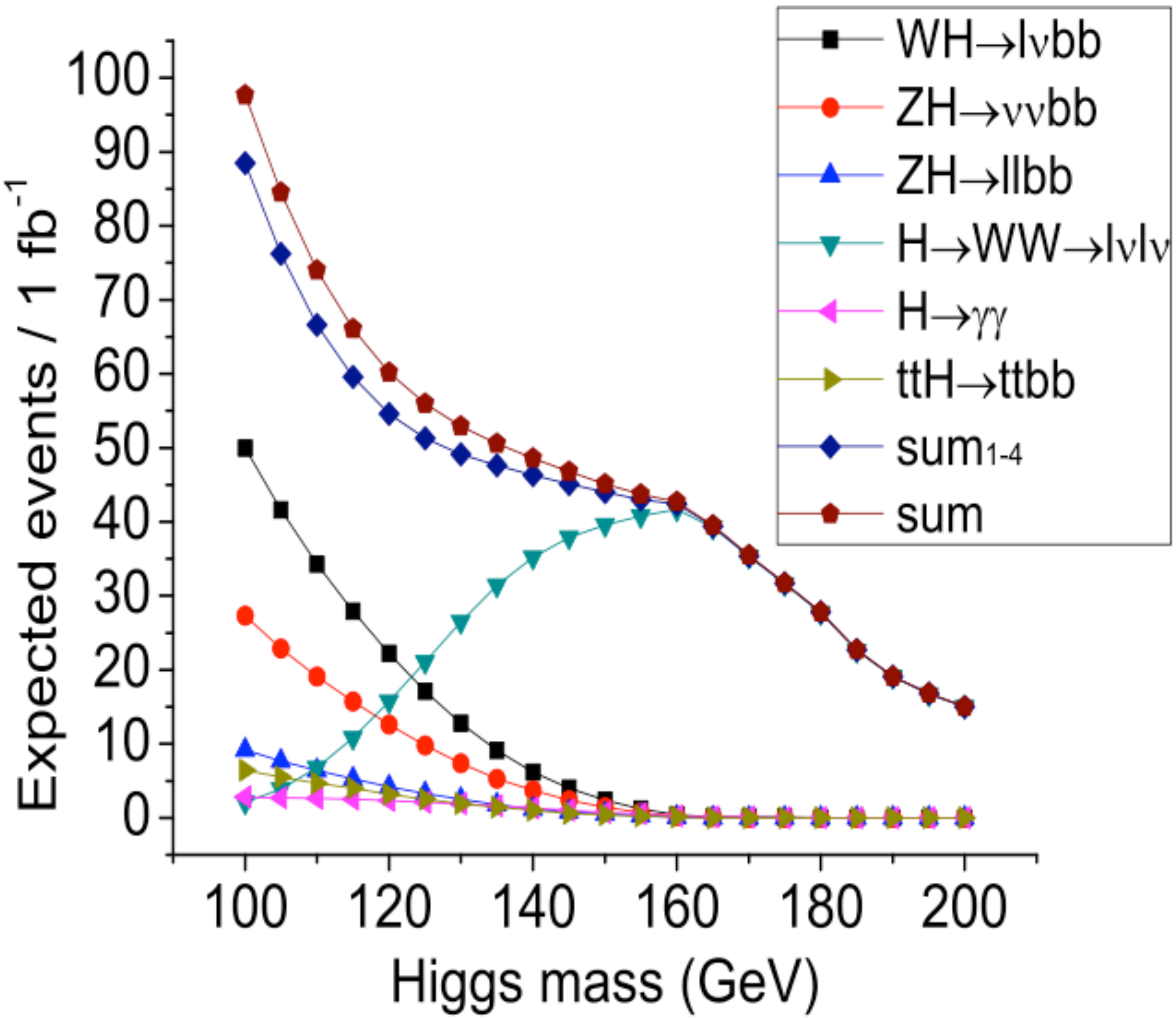


$$p\bar{p} \longrightarrow H \longrightarrow WW^*$$

$$p\bar{p} \longrightarrow VH \longrightarrow VWW^*$$

Decay of W's will determine final state configuration

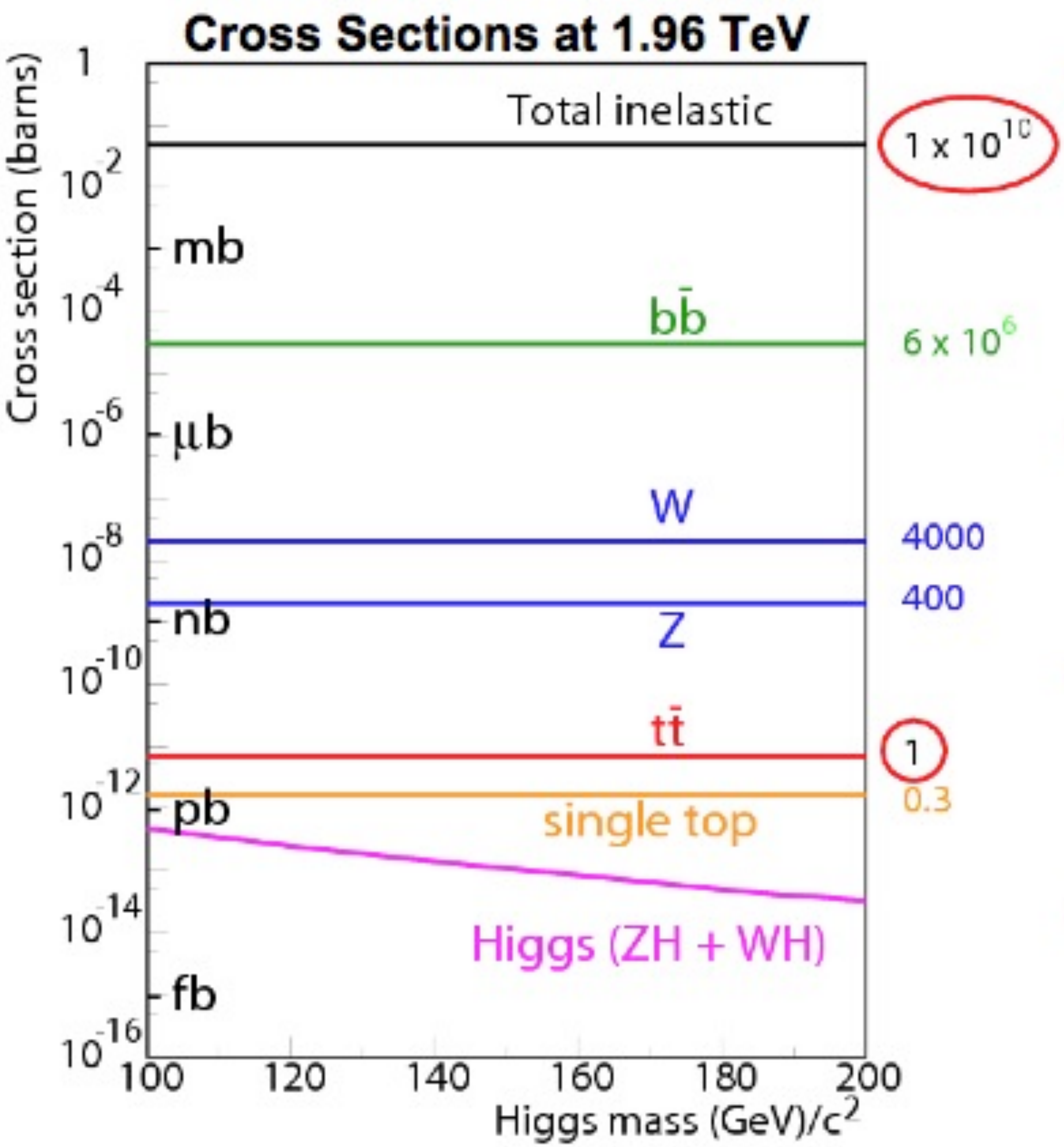
Higgs Bosons by Process



Double tags:

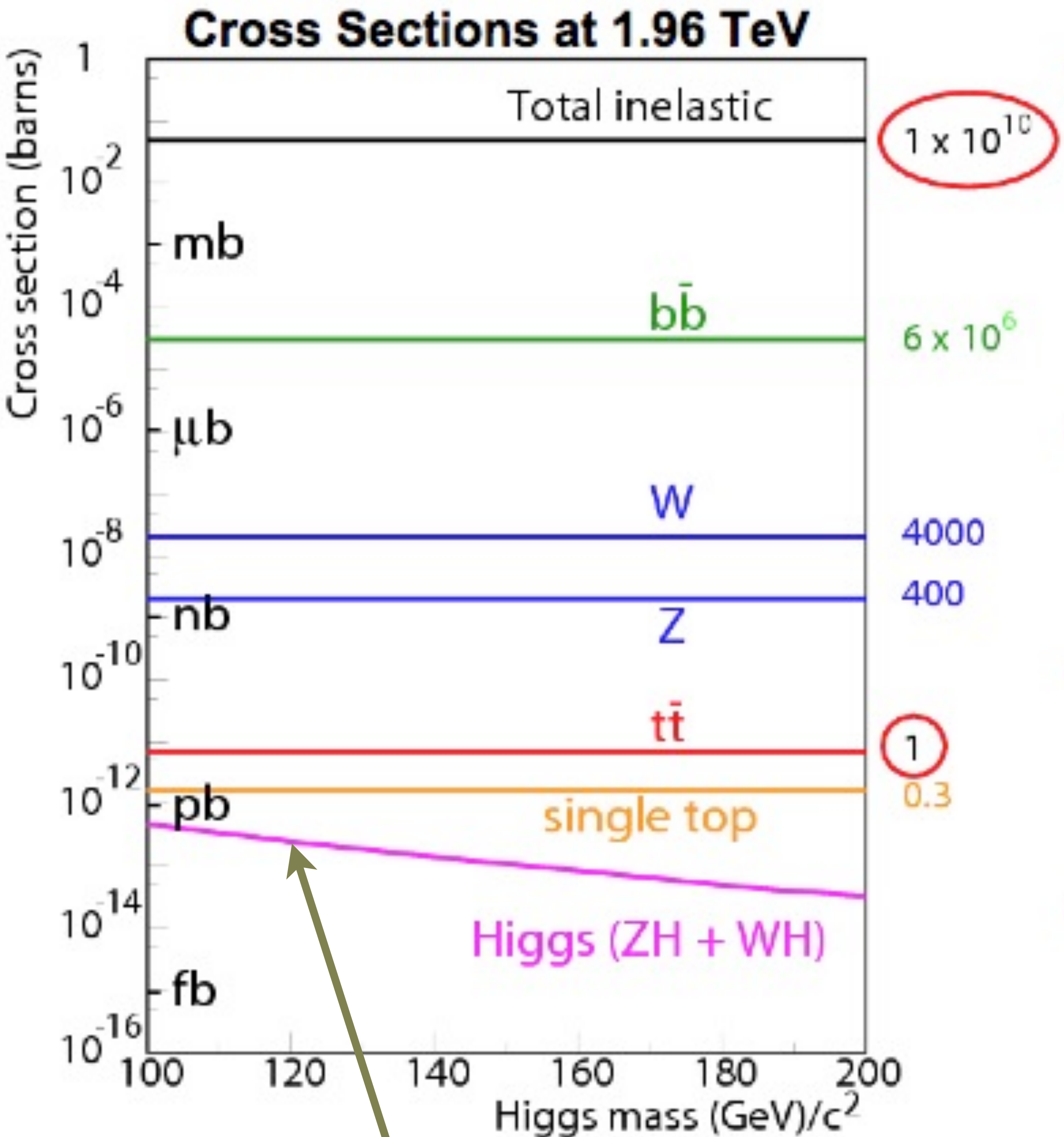
1. **~5 evts/ 6fb^{-1}**
2. **~10 evts/ 6fb^{-1}**
3. **~1 evts/ 6fb^{-1}**

The Challenge...



- Higgs Production is a low rate process at the Tevatron.
- Backgrounds are many orders of magnitude larger.
- Challenge: Separate Signal from Background

The Challenge...



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Before Anything S:B ~ 1:10^{11}

Strategy

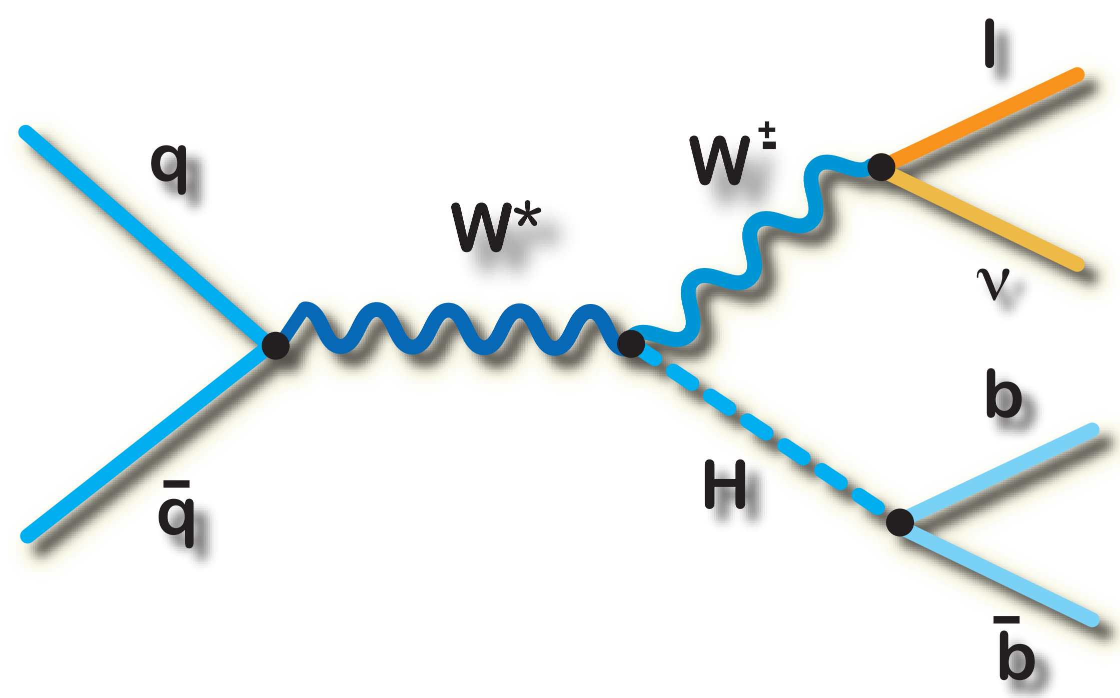
- Select High P_T leptons (e,μ,τ).
- Select Events with Missing Energy (neutrino(s))
- Select Events with jets from b-quarks (low M_H)
- Details for each analysis slightly different

Now

$S{:}B_{1\text{-btag}} \sim$ 1:400

$S{:}B_{2\text{-btag}} \sim$ 1:50-100

WW ~ 1:50



Strategy

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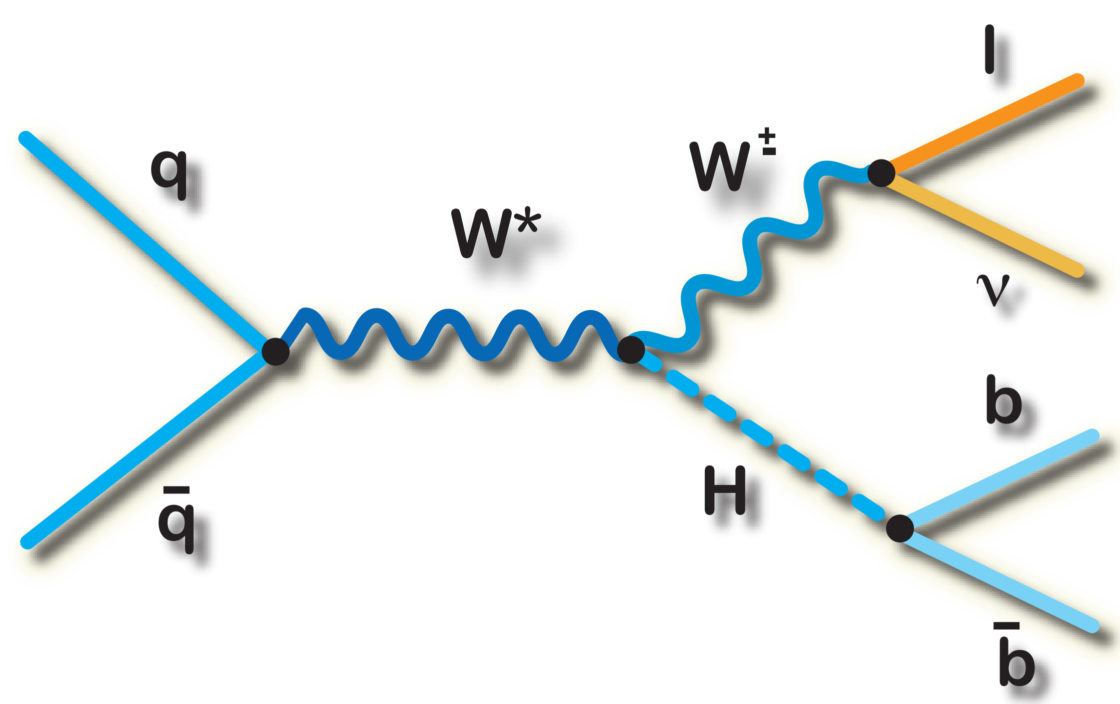
- Details for each analysis slightly different

Now

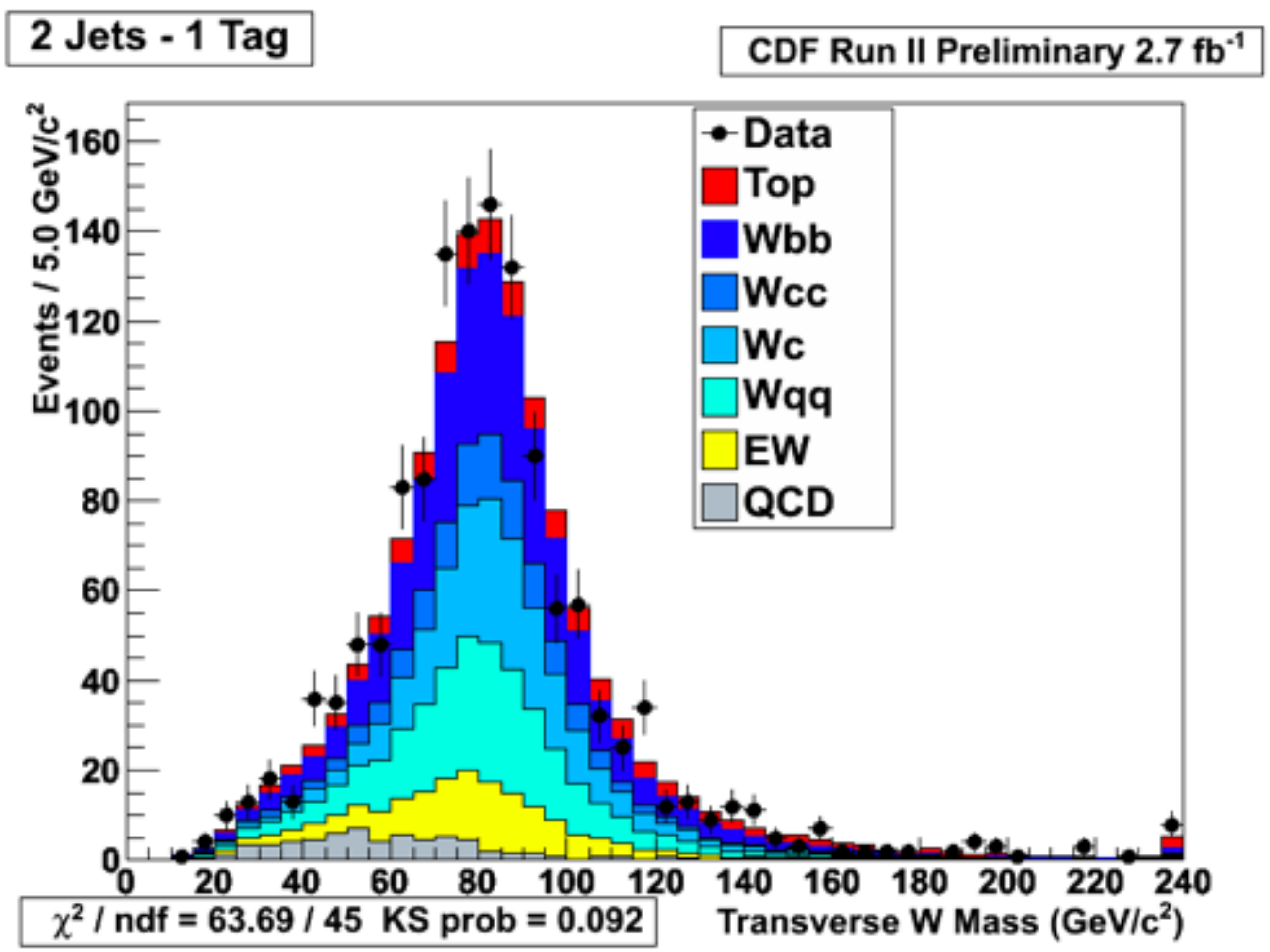
So the first factor of ~1 billion is "easy".

WW ~ 1:50

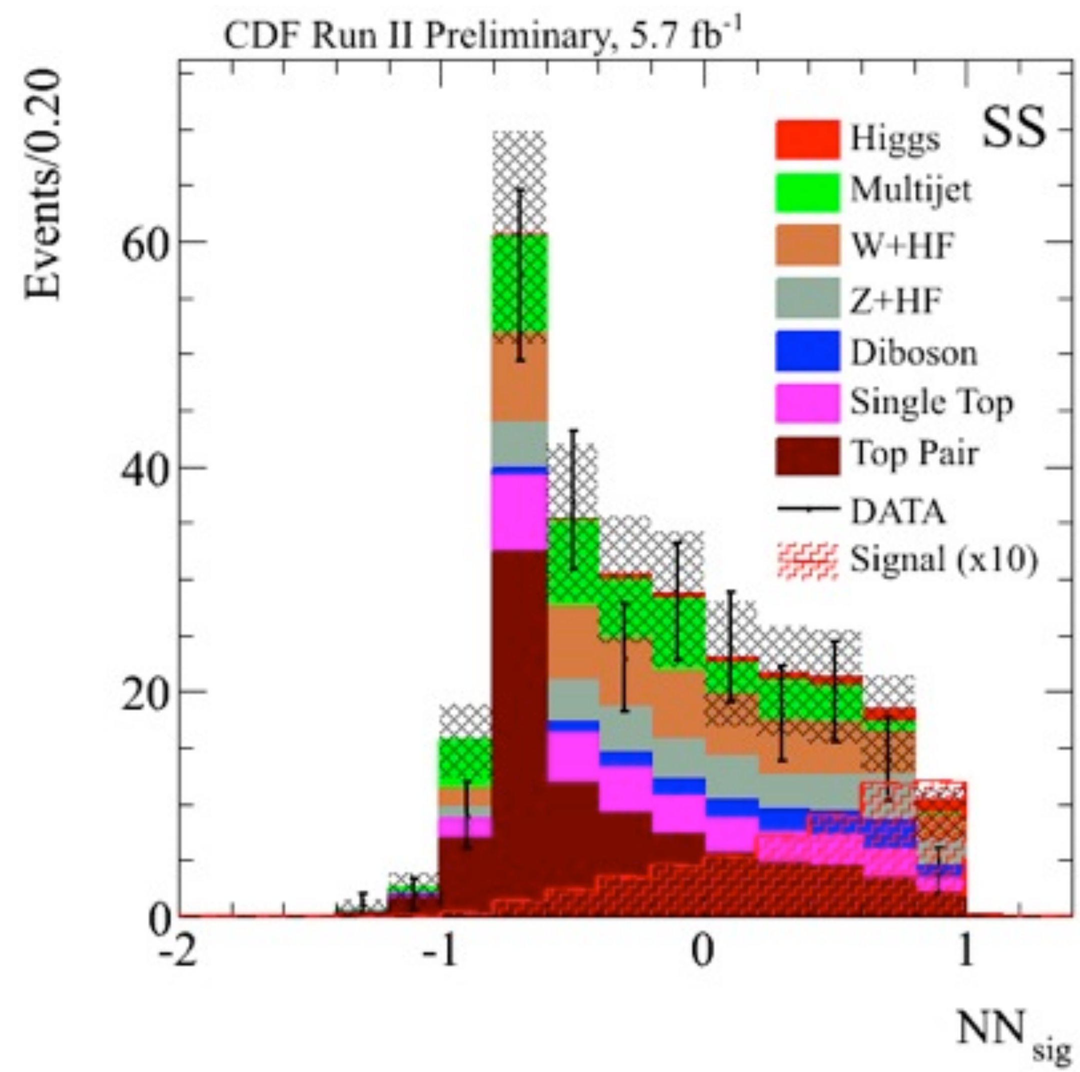


Modeling of Backgrounds

W+2 jets; 1 B-tag

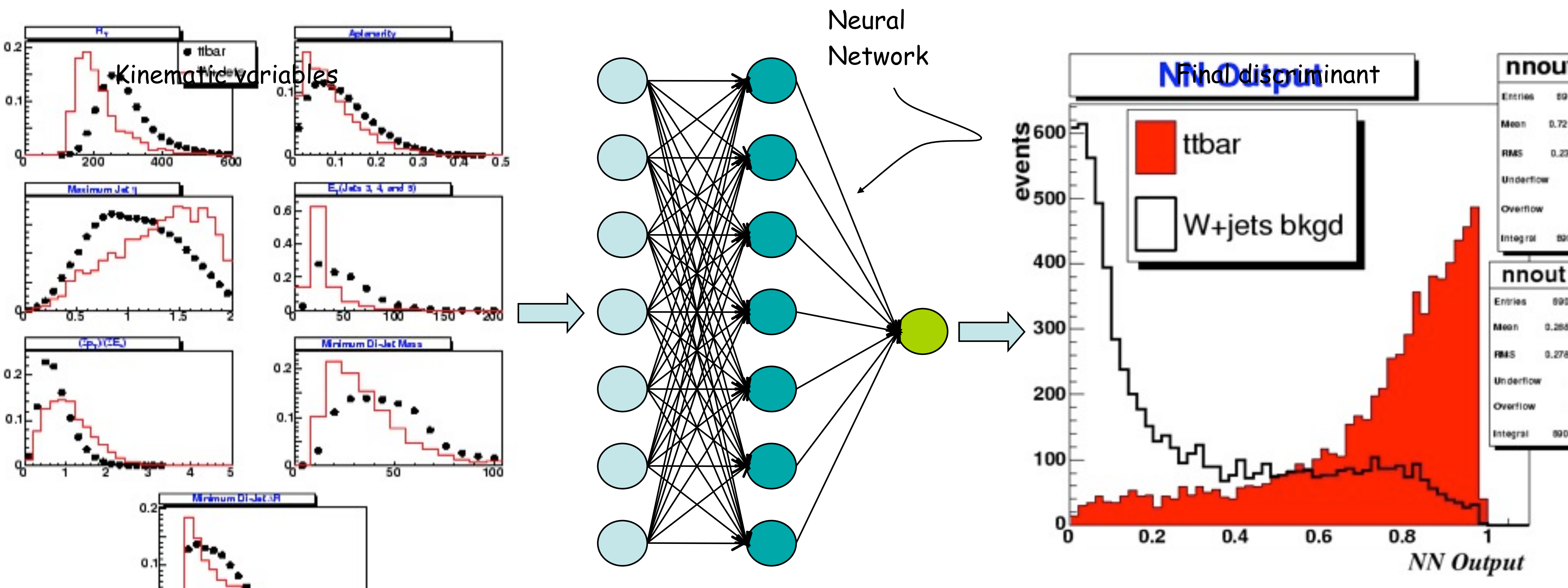


MET+jets; 2 B-tags



Using Advanced Algorithms

- Variety of methods: Artificial Neural Networks (ANN), Boosted Decision Trees (BDT), Matrix Element (ME)
- Example: ANN can be used to combine information from different kinematic variables: both Energy-based and Shape-based
- Improved discrimination and less sensitive to systematic effects



6.80 ± 0.38 (stat) ± 0.61 (syst) ± 0.39 (lumi) pb

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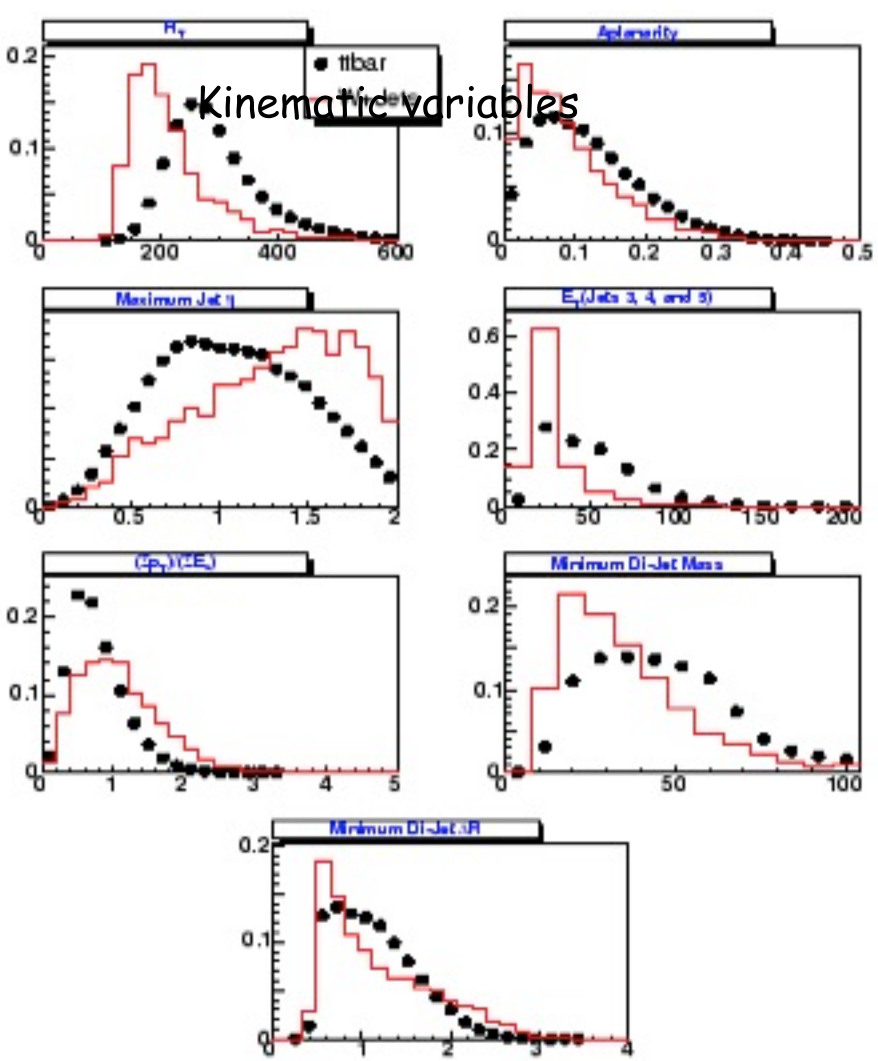

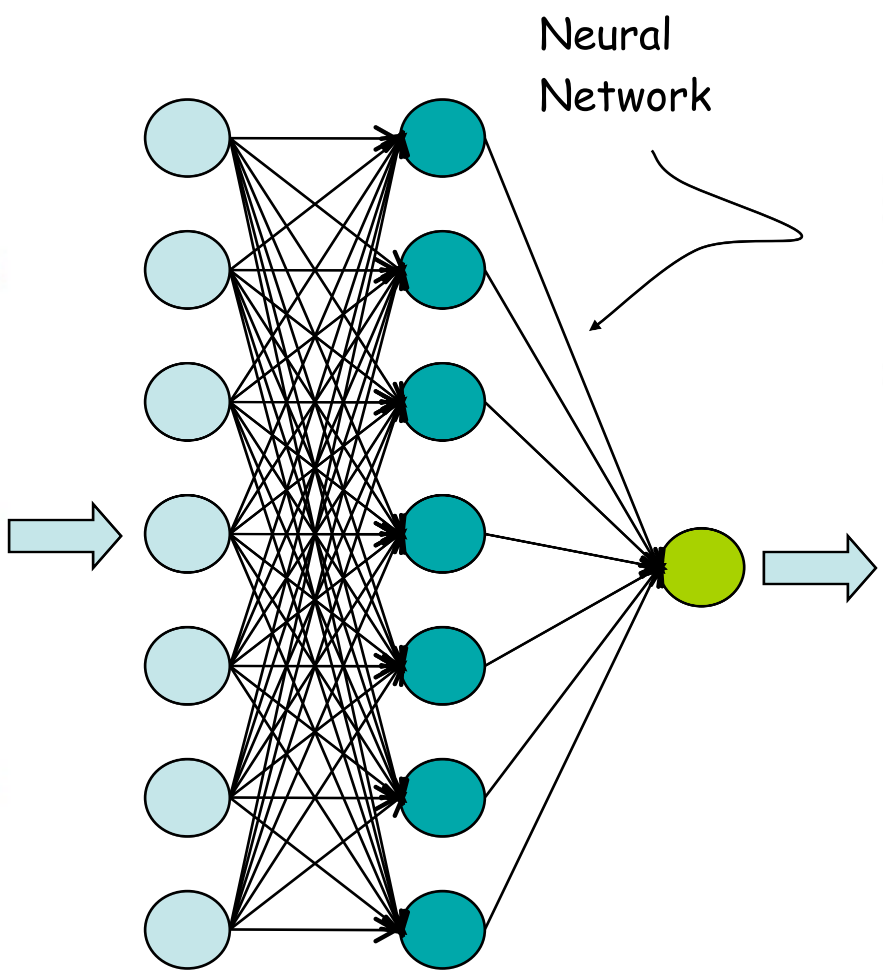

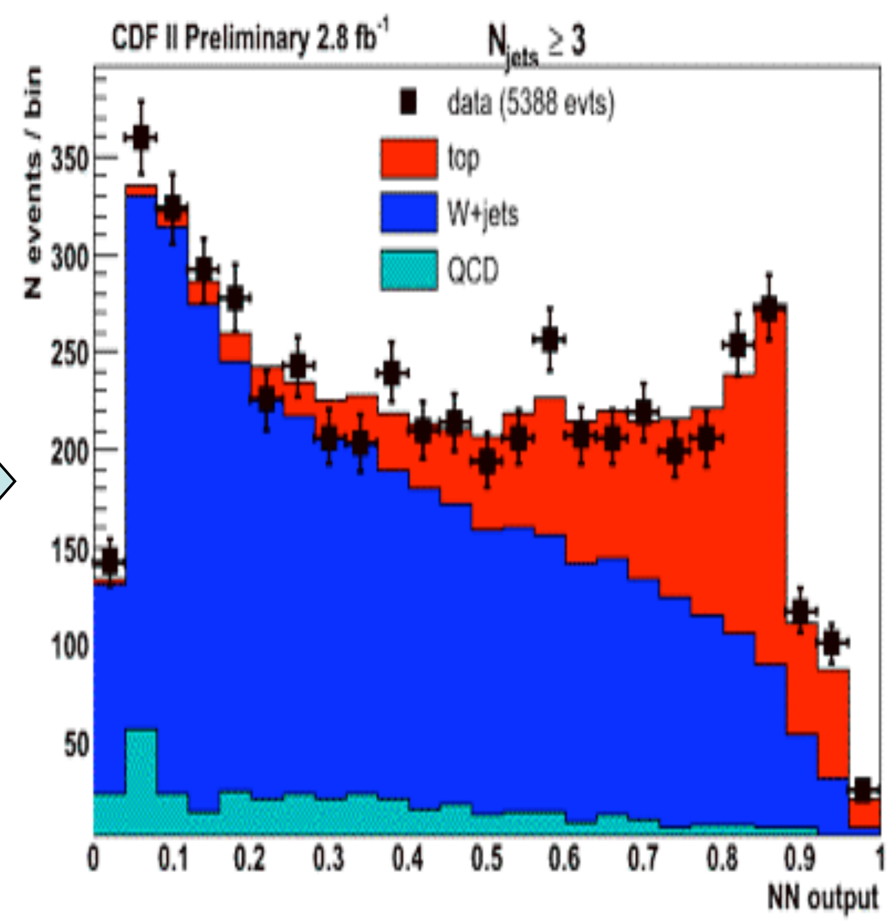

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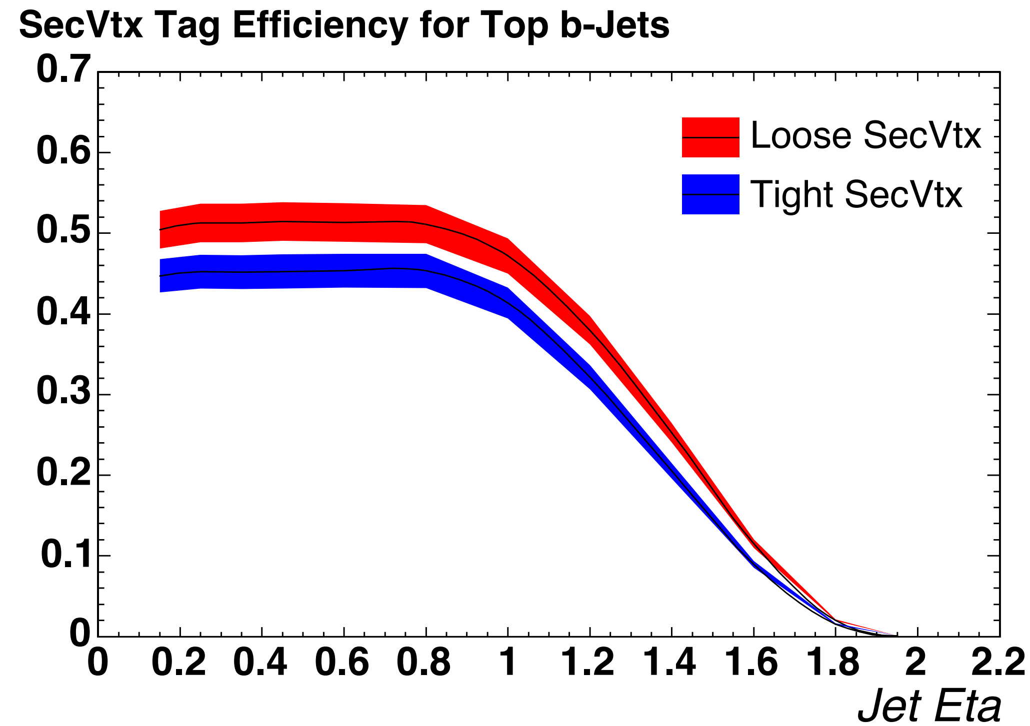
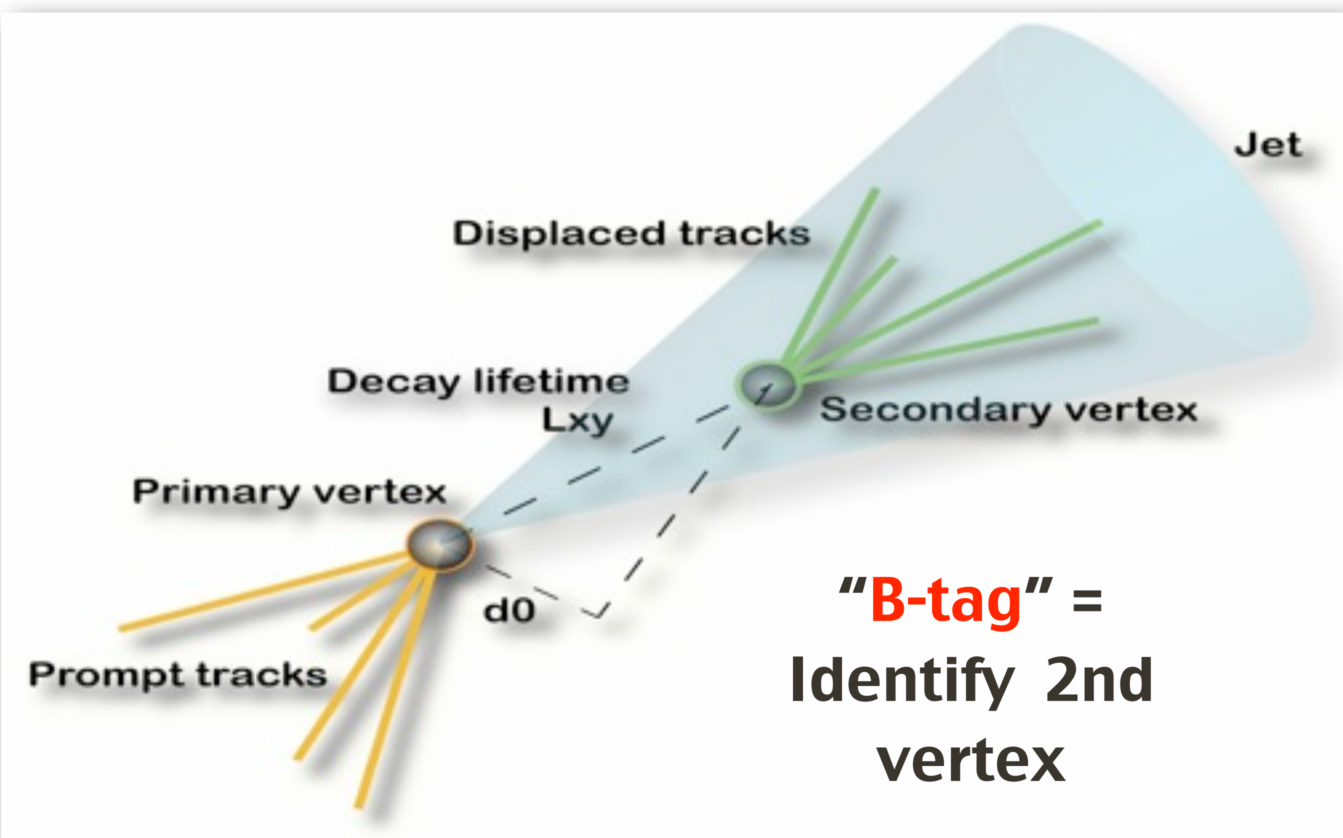
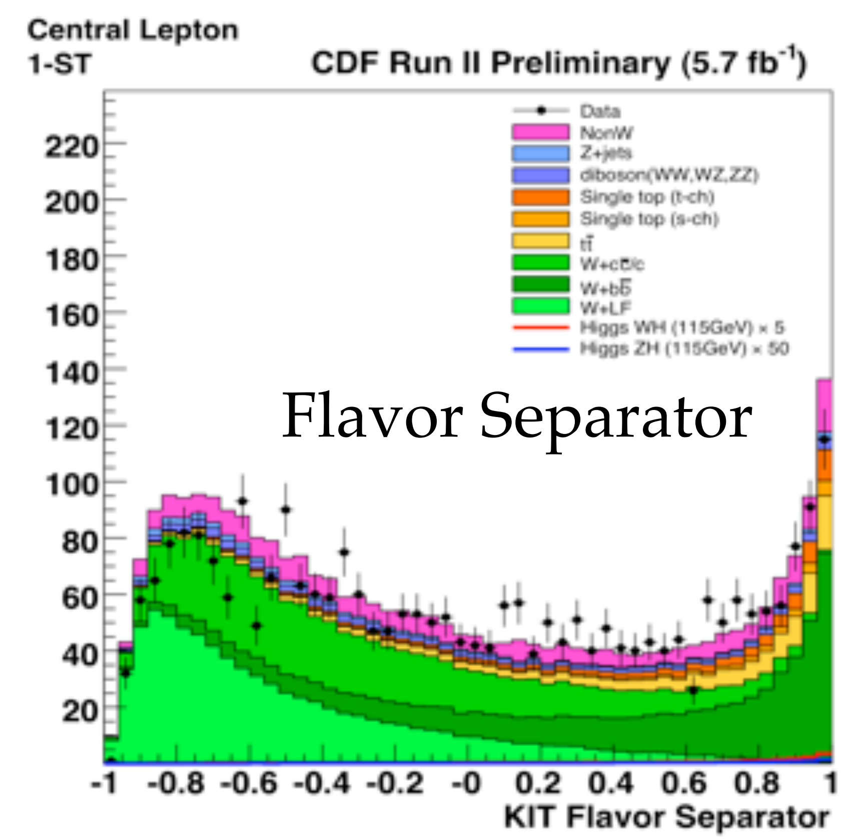
B-jet identification (1)

- ~45-55% Efficient
  - E_T and η dependent
- Mistag rate ~ 1-2%
- Loose tagging helpful

in double tagging







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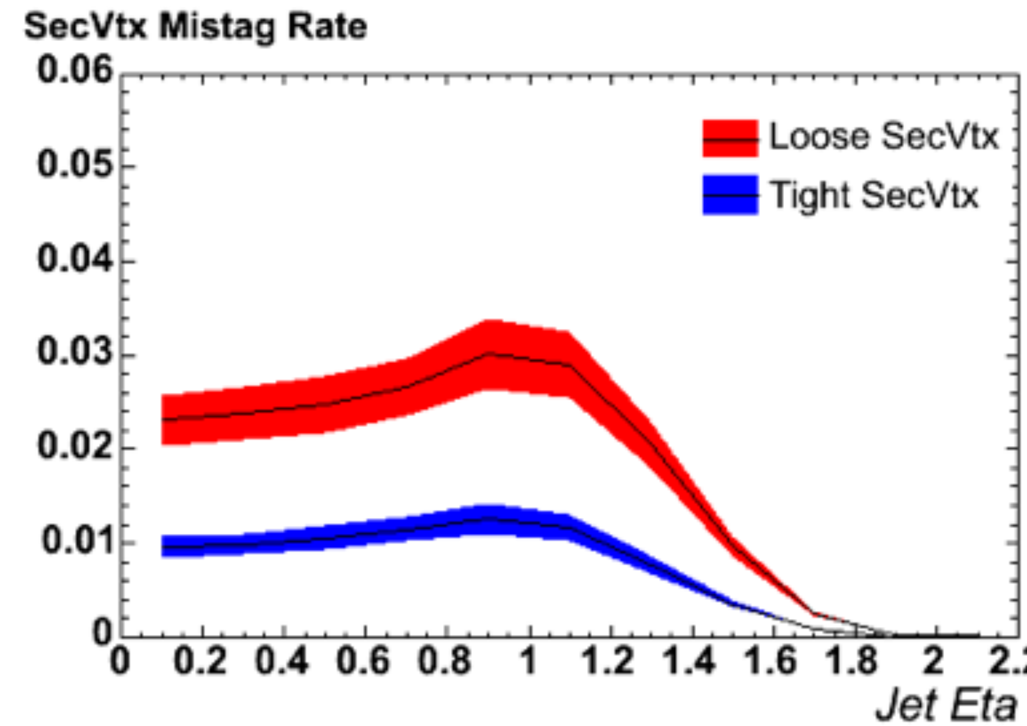
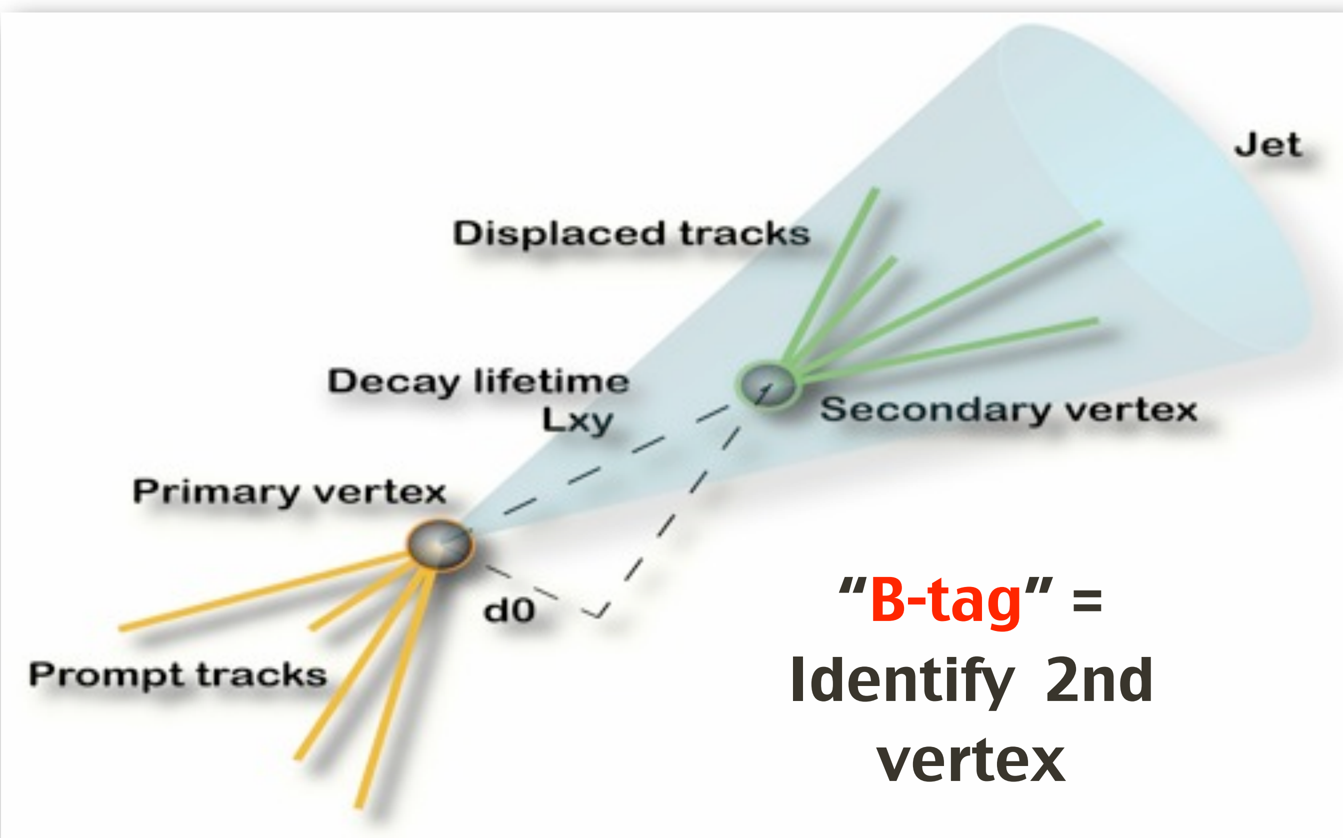
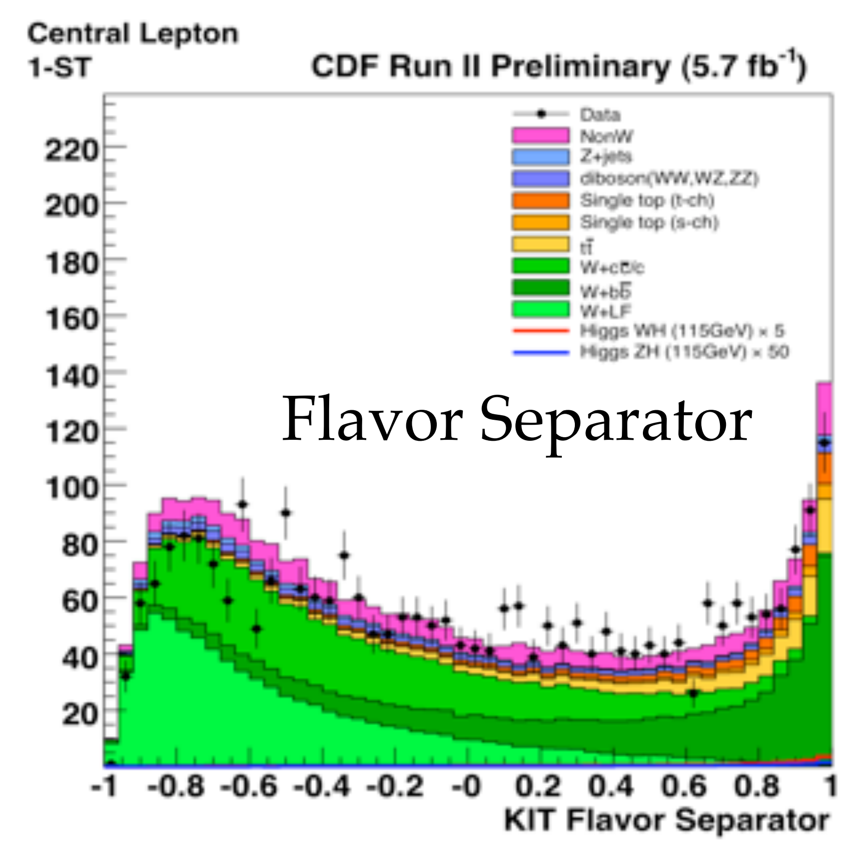
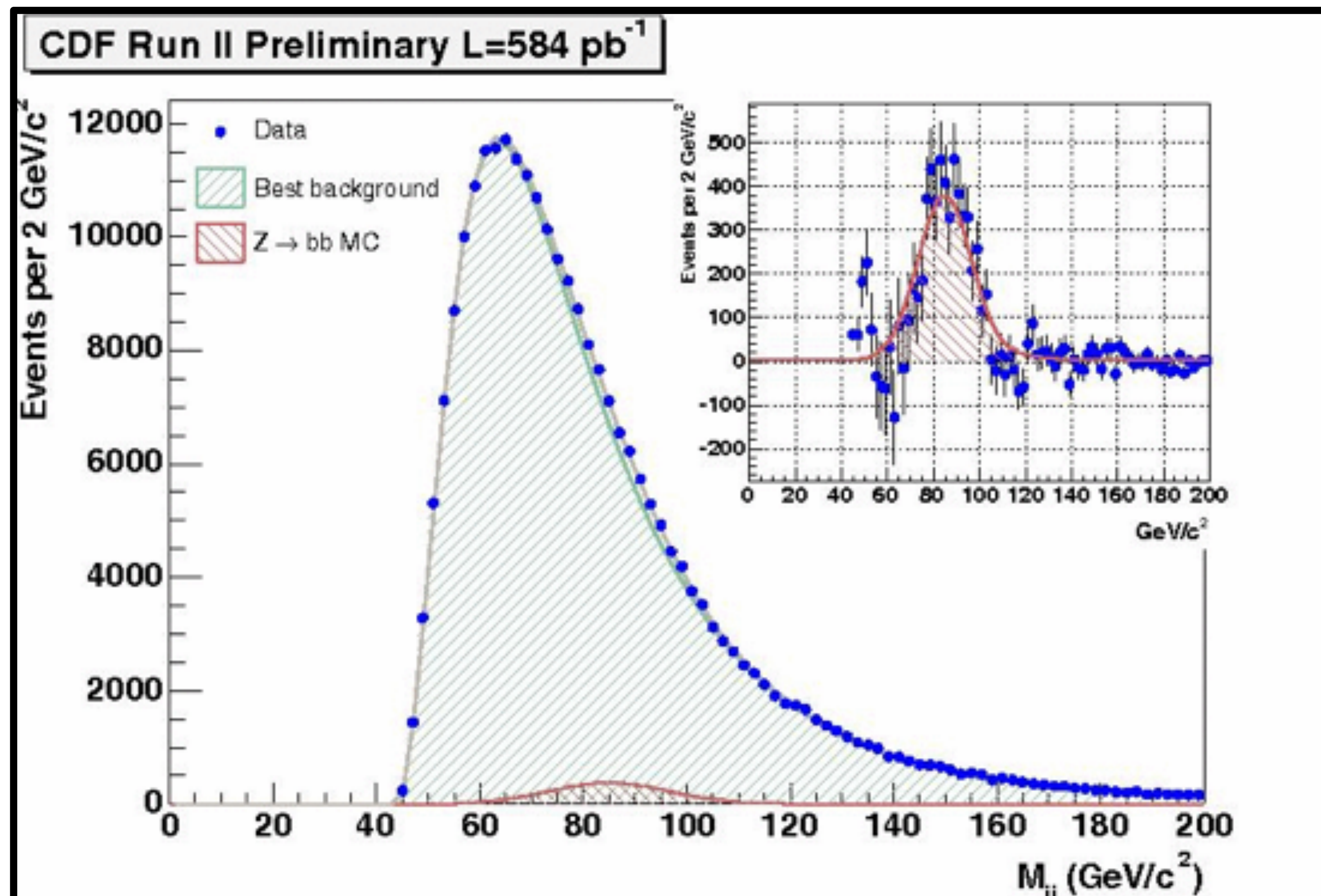






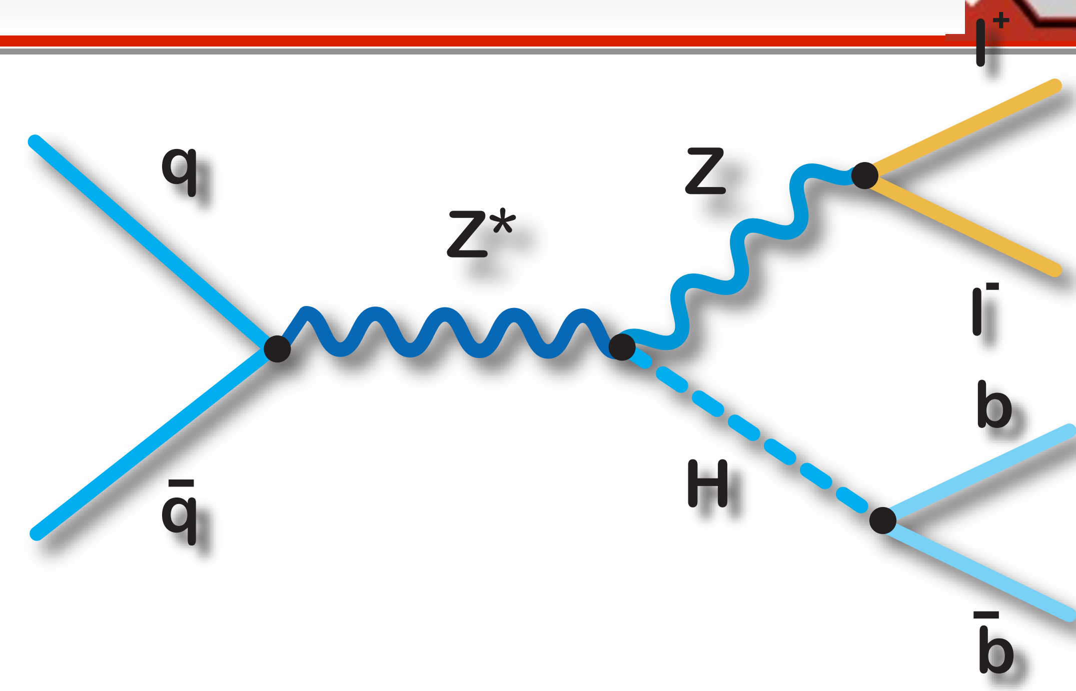
B-jet identification (2)

- Look in double b-tagged dijet events
- Background is derived from data
- Signal distribution from Monte Carlo
- Fit returns
  - Signal Evts: 5674 ± 448
  - b-JES: 0.974 ± 0.011



$ZH \to \ell\ell b\bar{b}$ Channel

- Two High P_T ee or μμ
- No (direct) Missing E_T
- 2 jets
  - Split up 1 and 2 b-tags



Features:

1. Small σ⋅BR
2. Several tight constraints
   i. $M_{ll} \cong M_Z$
   ii. "$\not{E}_T$" → improve jet resol.
3. ~1 evt/fb^{-1}

Primary Backgrounds

$Zb\bar{b}$, $Zc\bar{c}$, Zqq'

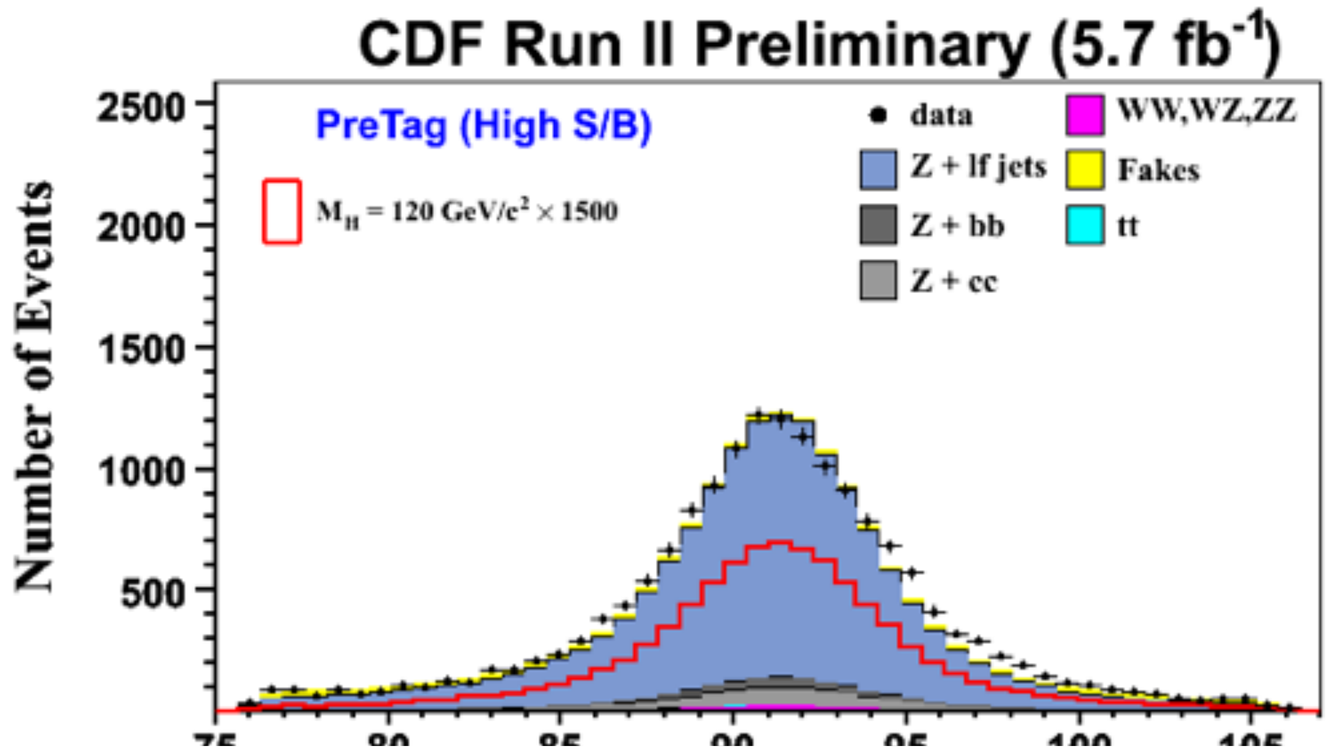
$t\bar{t}$

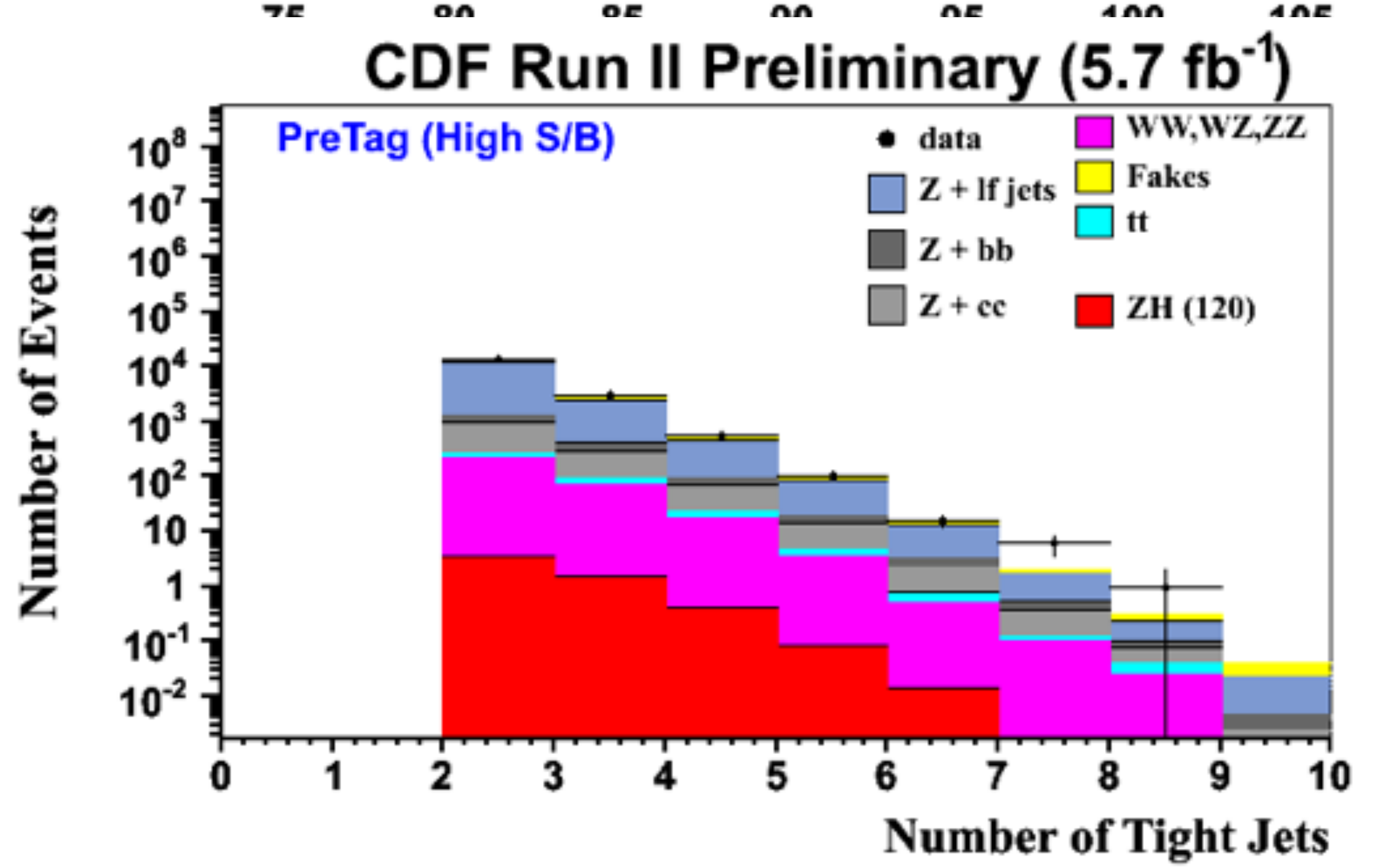
$WW+jj$, WZ, ZZ

$Z \to \tau\tau$

Selecting the Z Sample

- Require at least one tight muon
  - Pt > 18 GeV/c
  - |η| < 1.1
- Require at least one tight electron
  - Et > 18 GeV
  - |η| < 3.6
- 76 GeV/c^2 ≤ M_{ll} ≤ 106GeV/c^2
- Require another loose lepton of same flavor, opposite sign
- At least two tight jets
- Require at least one tight electron
  - one with Et > 25 GeV/c
  - one with Et > 15 GeV/c
  - |η| < 2.0
- >=1 tag

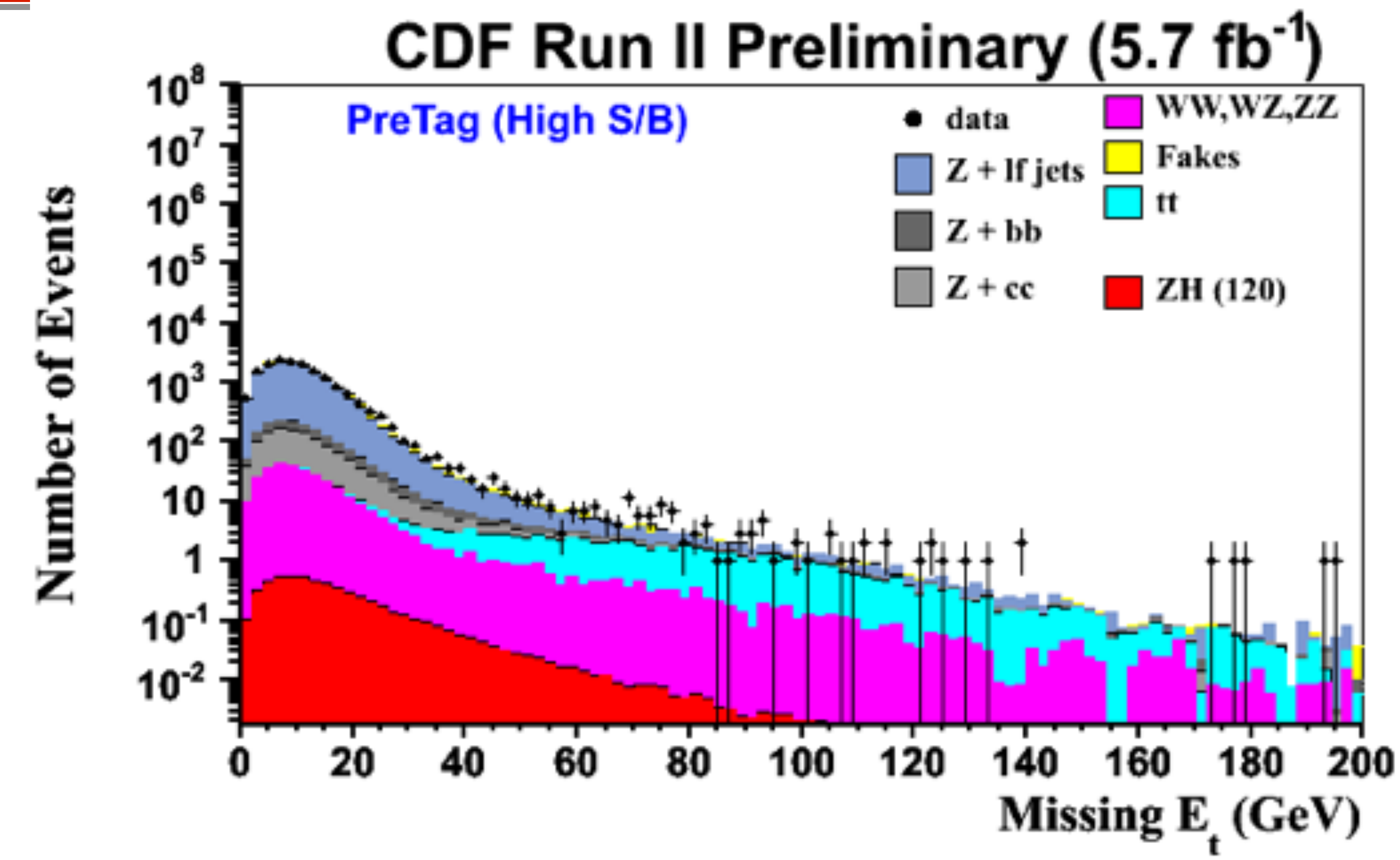


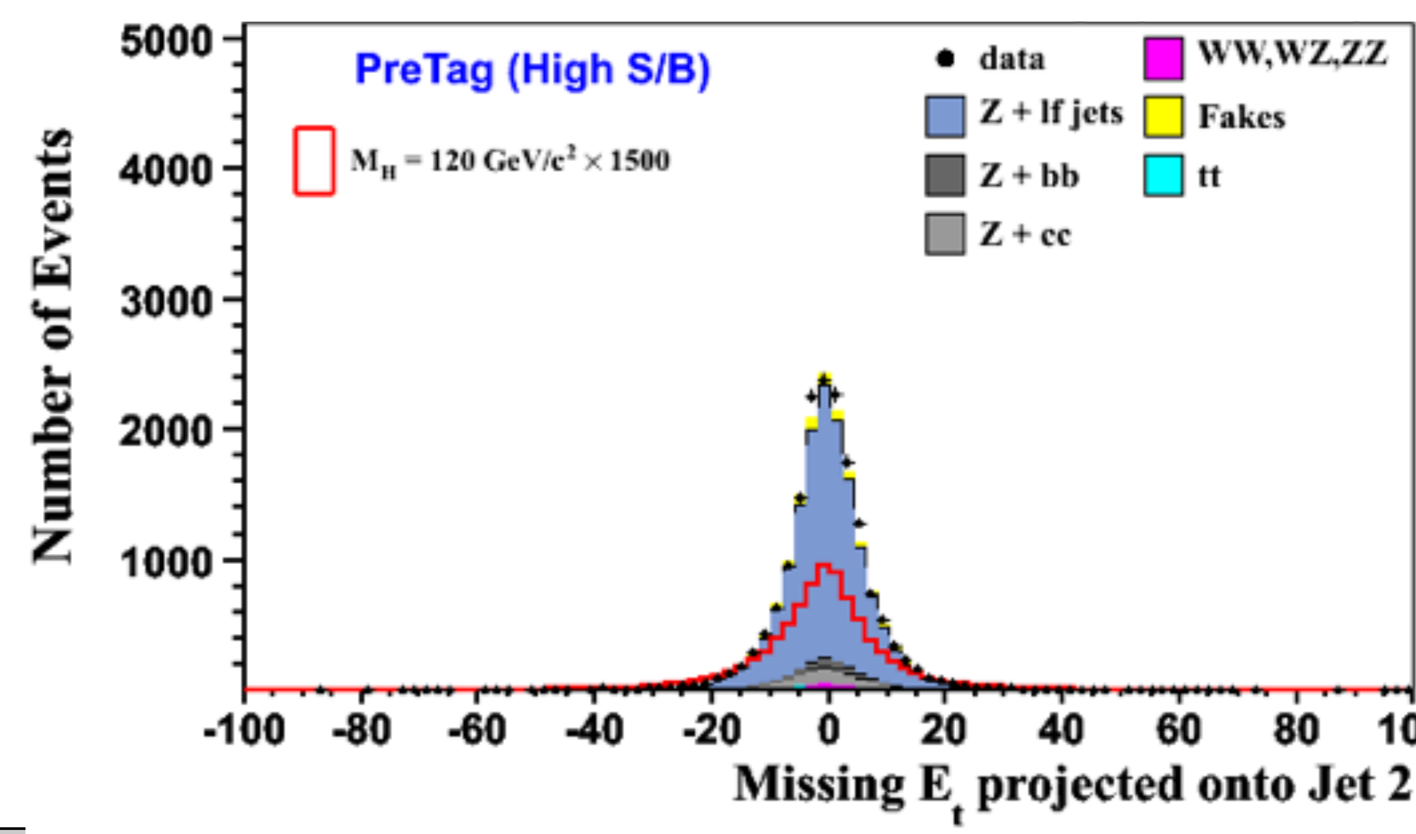


Improve the Dijet Mass (1)

- uses a NN, with inputs of observed jet energies and directions, MET magnitude and direction, to correct the two highest Et jets

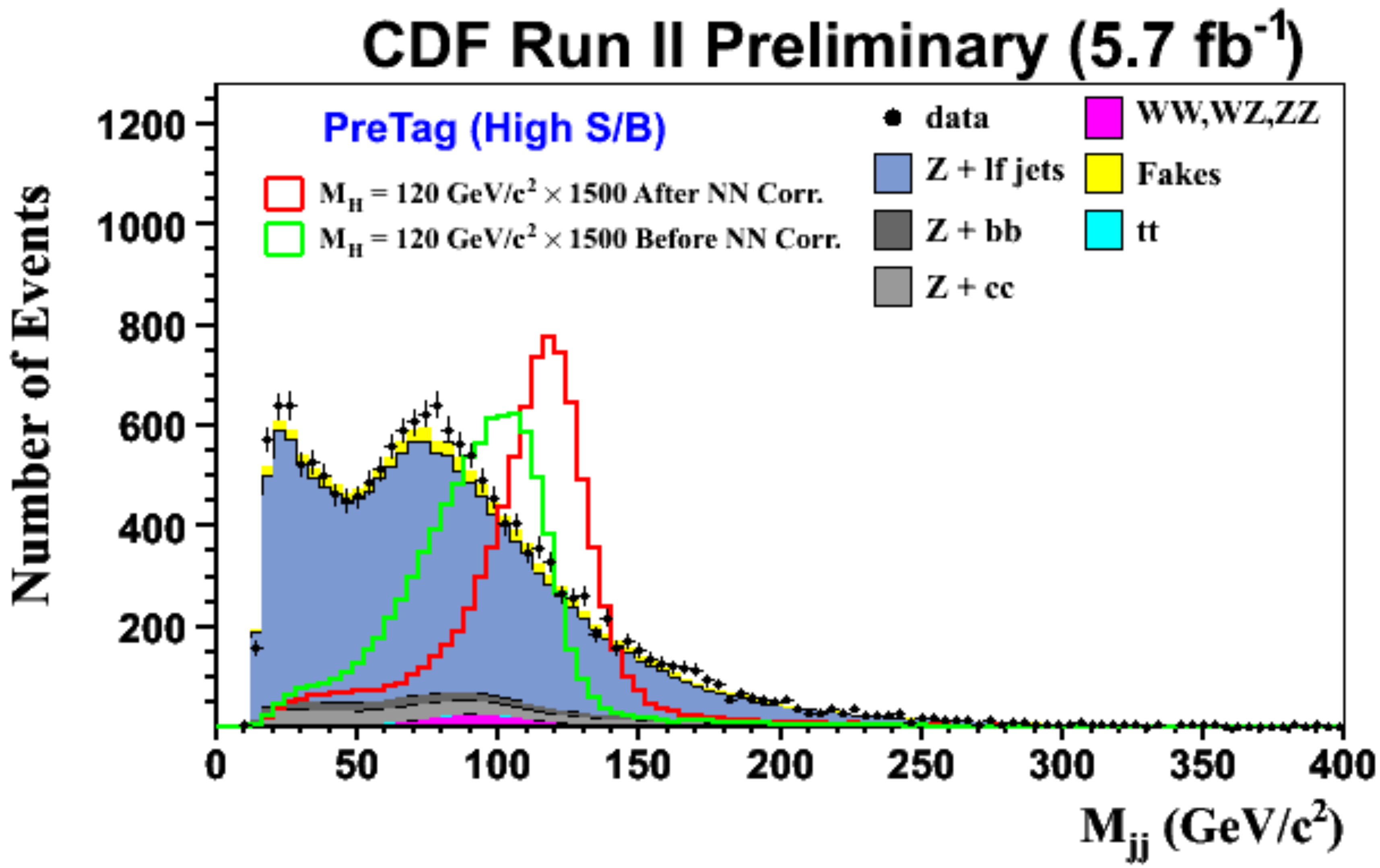
L5 Jet 1 E_T
L5 Jet 2 E_T
Jet 1 η
Jet 2 η
$\Delta\phi(jet1, jet2)$
$\Delta\phi(\not{E}_T, jet1)$
$\Delta\phi(\not{E}_T, jet2)$
Jet 1 Projection onto $\not{E}_T$
Jet 2 Projection onto $\not{E}_T$
$\not{E}_T$ magnitude





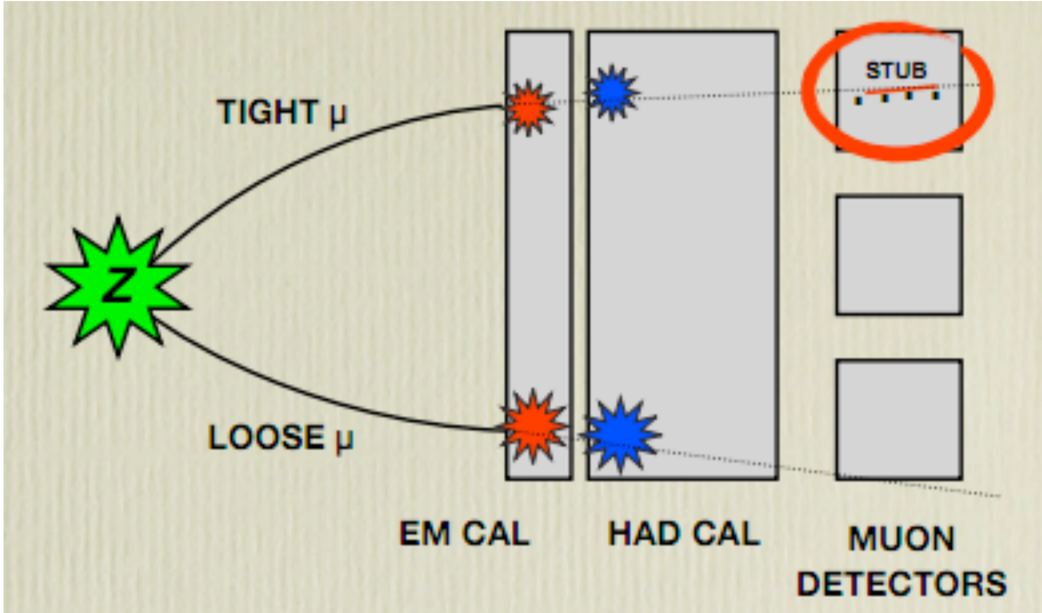
Improve the Dijet Mass (2)

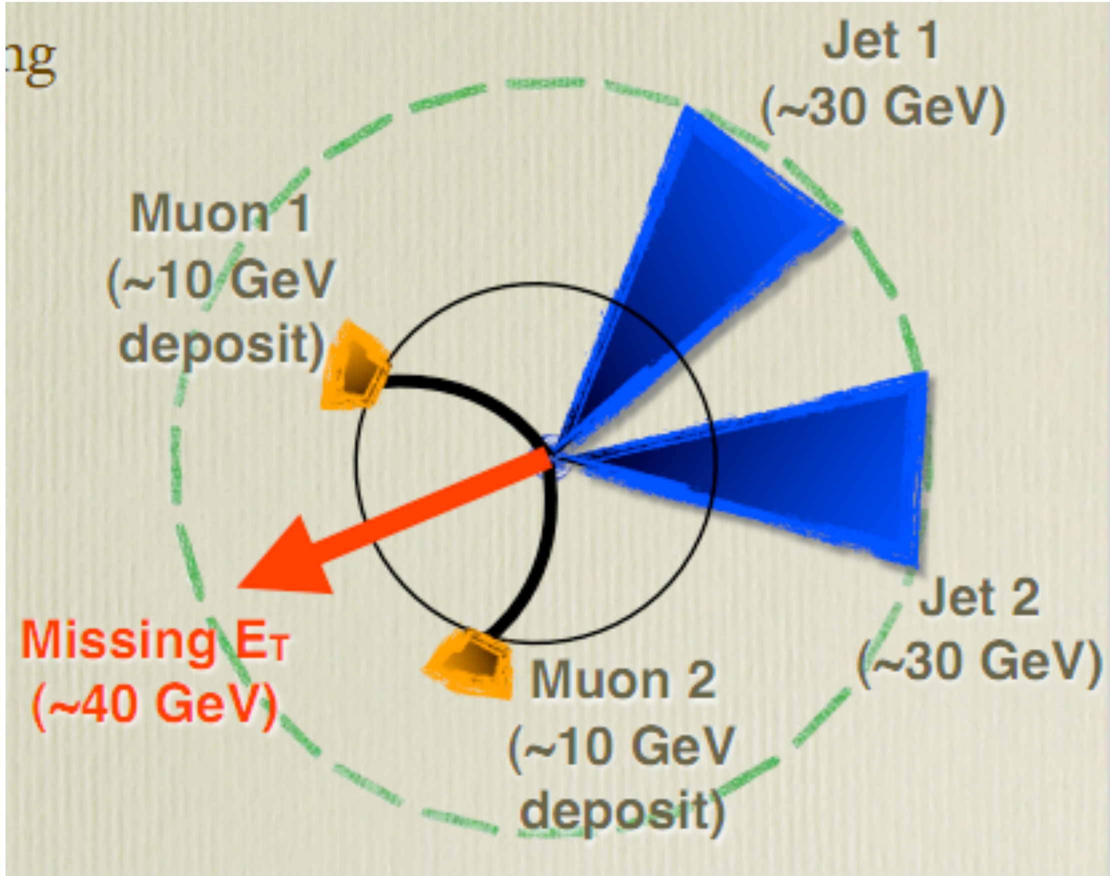
Higgs mass	L5 jetcorr	Gen 5 NN	Gen 6 NN
110	17.2 %		10.8 %
120	17.7 %	10.5%	10.5 %
130	17.3 %		9.7 %
150	16.8 %	10.0%	9.5 %



Adding Trigger Acceptance

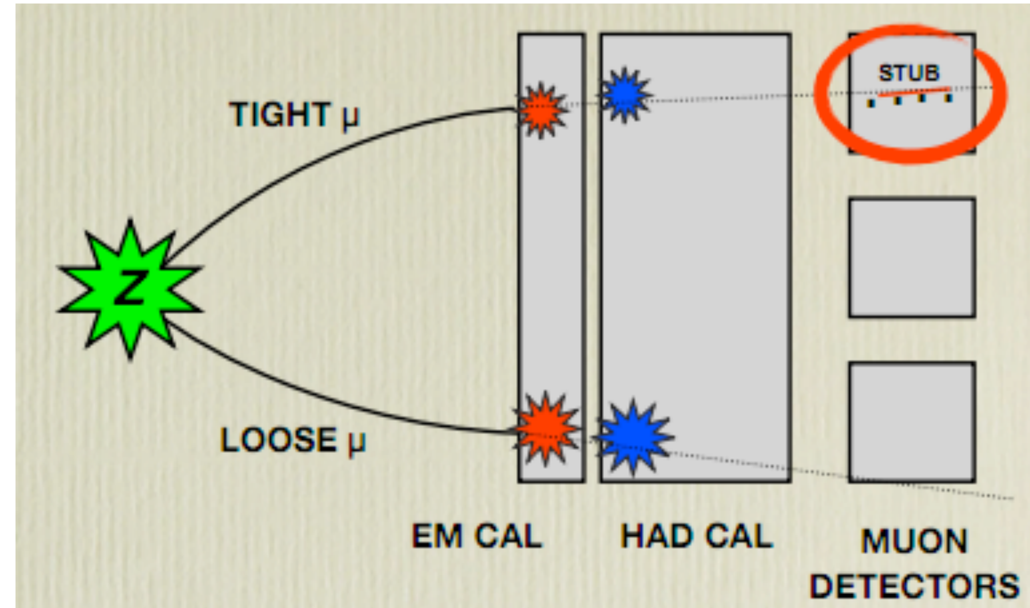
- Default trigger for $Z \rightarrow \mu^+\mu^-$ requires at least one muon with "stub" in muon chambers
- The other muon can be "loose"
- Allowing two loose IS possible - but requires a different trigger → MET +jets

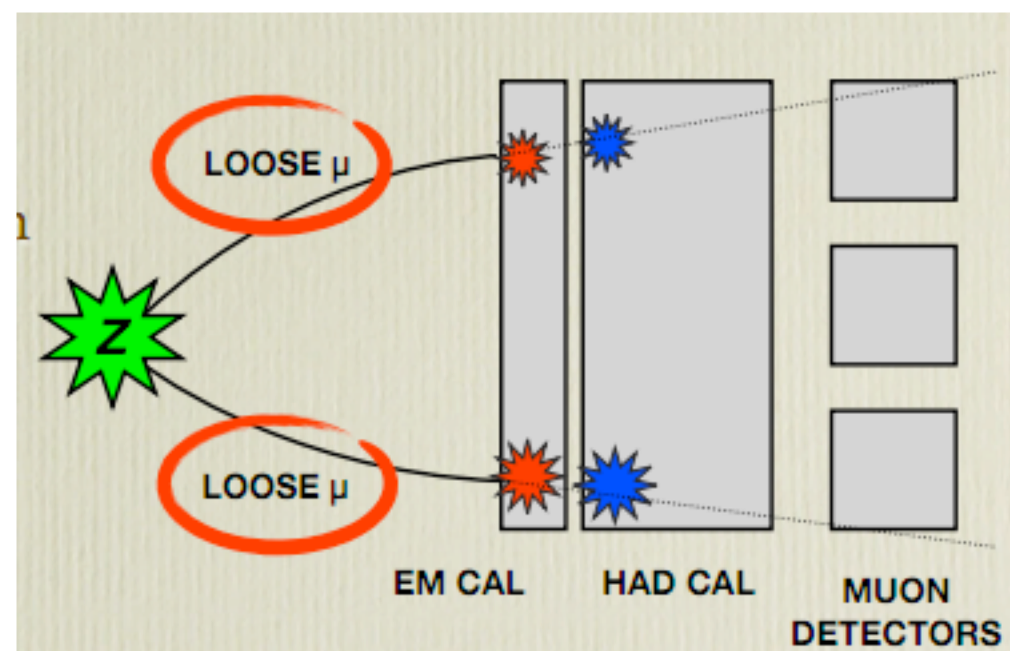




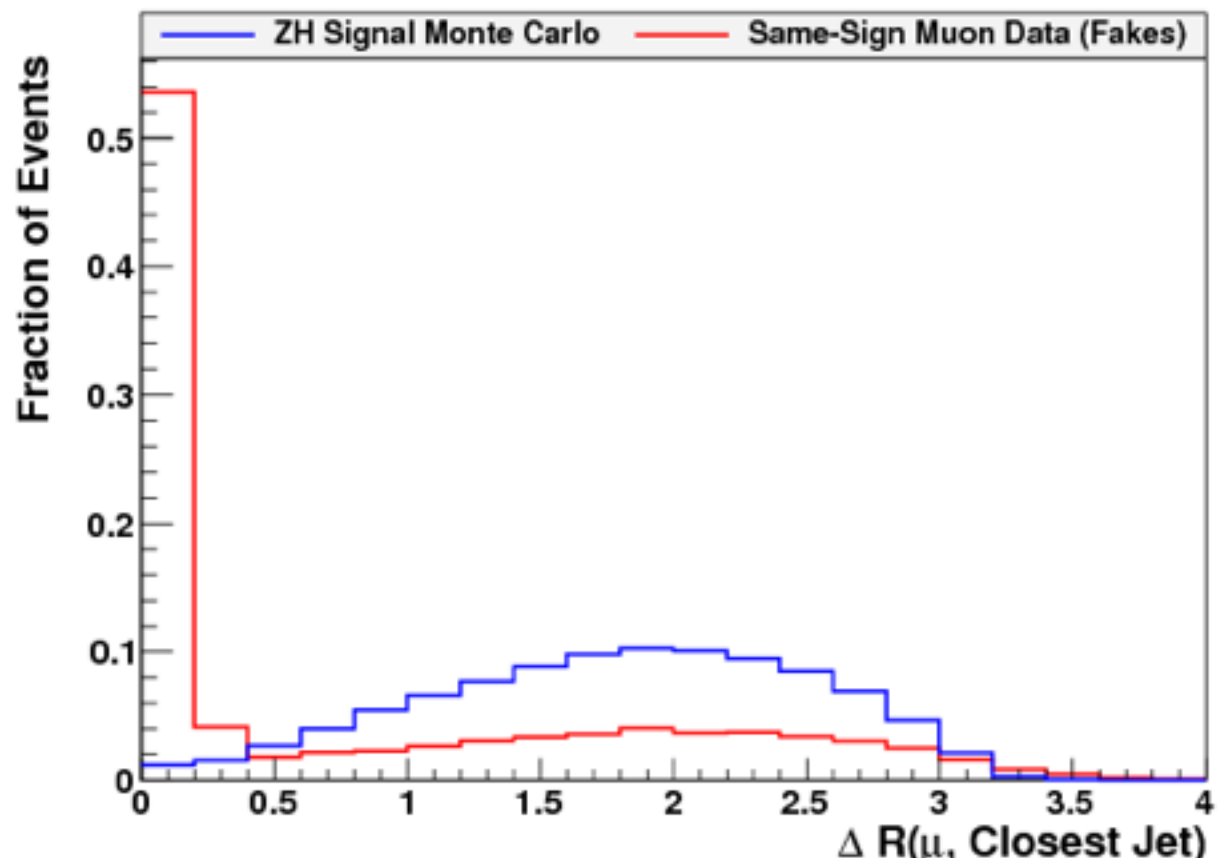
Adding Trigger Acceptance

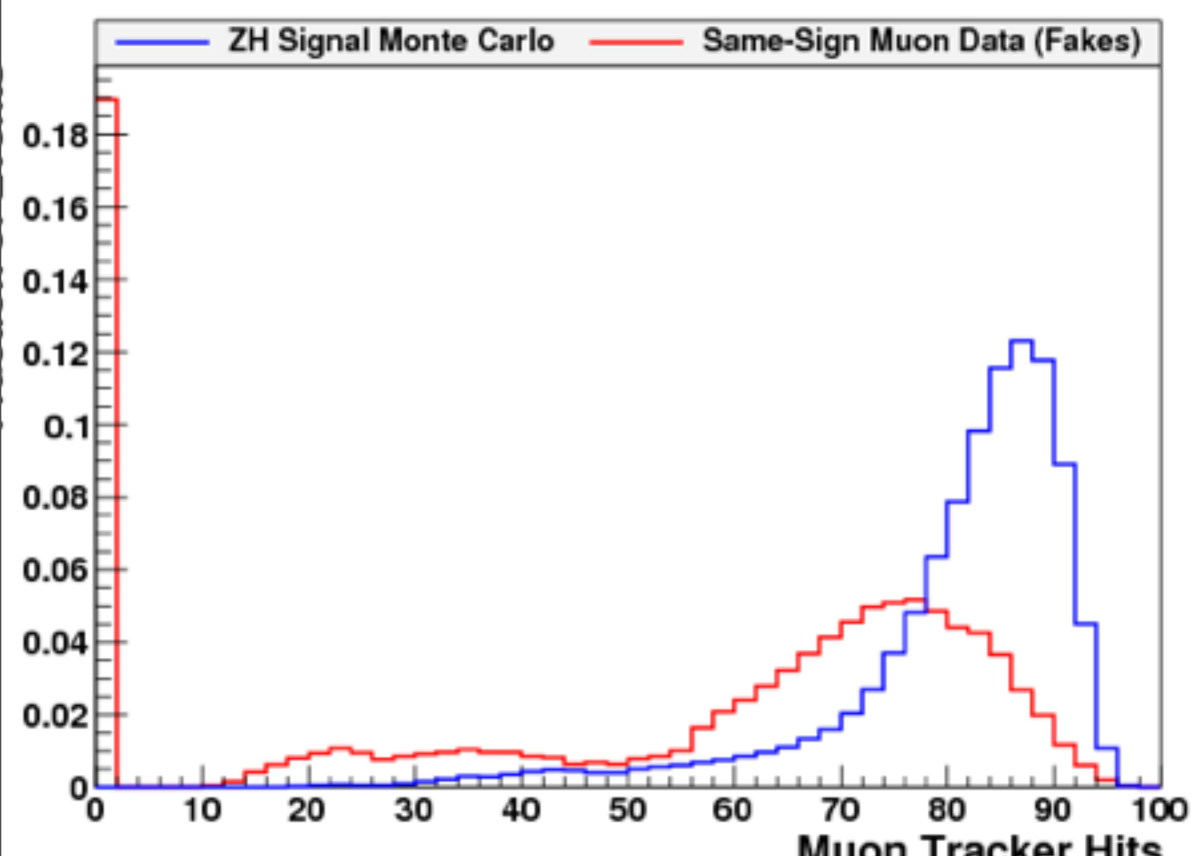
- Default trigger for $Z \rightarrow \mu^+\mu^-$ requires at least one muon with "stub" in muon chambers
- The other muon can be "loose"
- Allowing two loose IS possible - but requires a different trigger → MET +jets

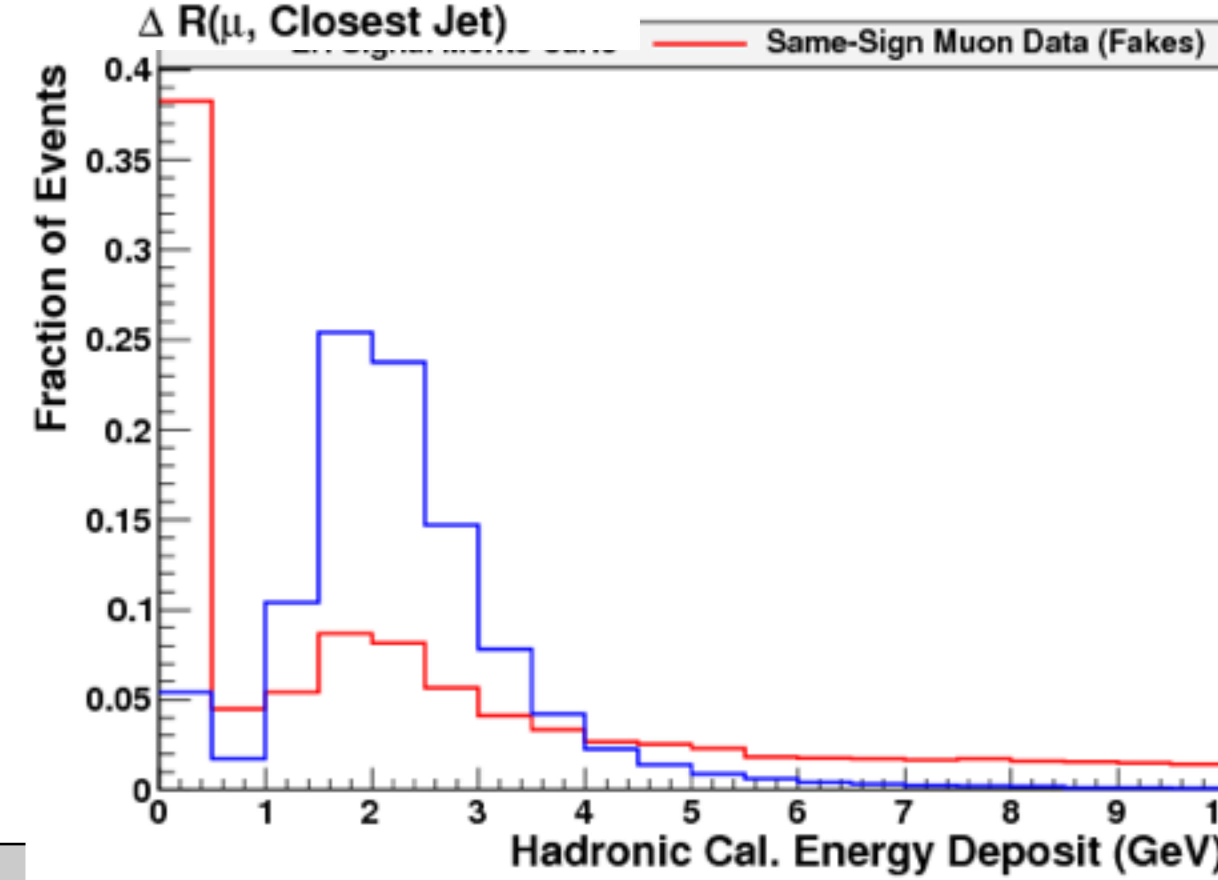




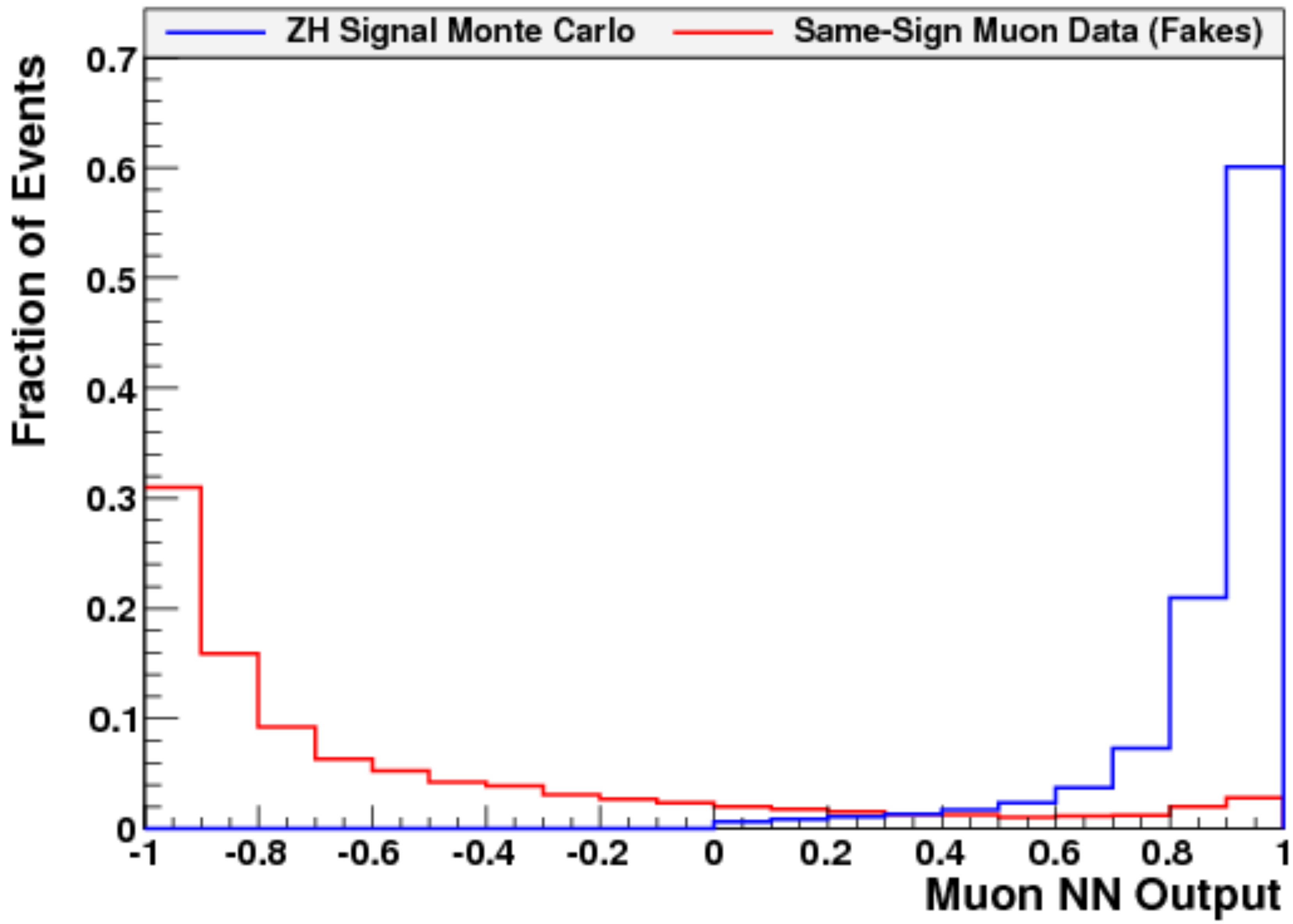
Looking for Loose Muons





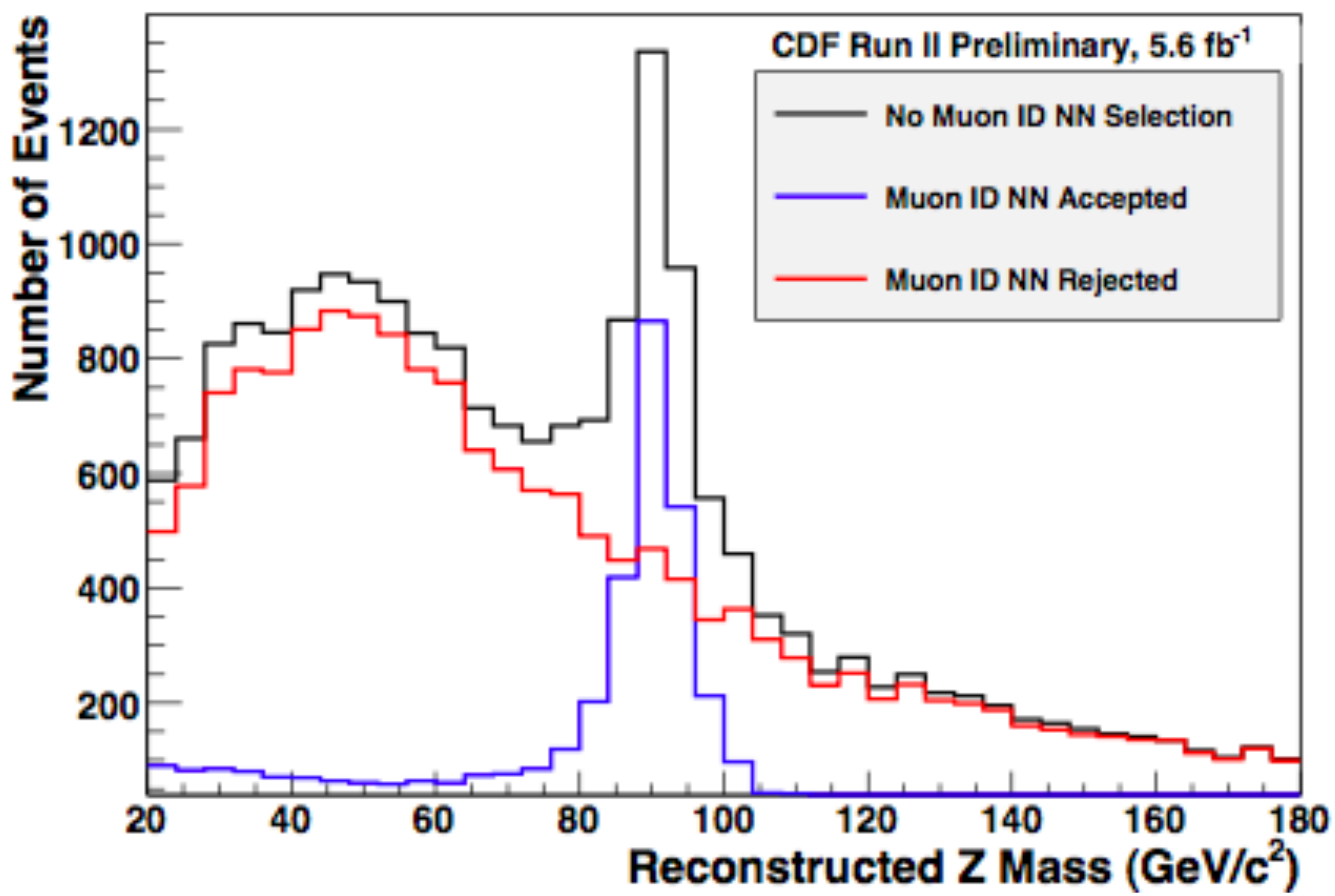


Looking for Loose Muons



Impact of new muons

Reconstruct Z candidate using two <u>loose</u> muons AND non-muon trigger!



Event totals - double tight tags

	High $S/\sqrt{B}$			Low $S/\sqrt{B}$		
ZH	0.7	±	0.1	0.1	±	0.02
$t\bar{t}$	9.9	±	1.5	4.4	±	0.7
WW	0.02	±	0.003	0	±	0.0
WZ	0.1	±	0.02	0.03	±	0.004
ZZ	3.6	±	0.5	0.7	±	0.1
$Z \to \ell\ell + b\bar{b}$	22.1	±	9.2	4.6	±	1.9
$Z \to \ell\ell + c\bar{c}$	2.4	±	1.0	0.5	±	0.2
$Z \to \ell\ell + l.f.$	1.2	±	0.2	0.5	±	0.1
fakes	0.9	±	0.5	2.1	±	1.0
Total Bkg	40.3	±	9.4	12.7	±	2.3
Total Data	37			14		

"Standard"

$Z \to \mu^+\mu^-$ and

$Z \to e^+e^-$

	ST Category	LJP Category	DT Category
$Z + q\bar{q}$ (Mistags)	33.8 ± 4.8	2.18 ± 0.8	0.22 ± 0.06
$Z + c\bar{c}$	8.5 ± 3.4	1.8 ± 0.7	0.20 ± 0.08
$Z + b\bar{b}$	17.1 ± 6.9	5.1 ± 2.1	2.29 ± 0.93
$t\bar{t}$	3.9 ± 0.8	2.3 ± 0.5	1.33 ± 0.28
WW	0.03 ± 0.004	0.01 ± 0.001	–
WZ	0.66 ± 0.09	0.08 ± 0.01	–
ZZ	1.82 ± 0.24	0.75 ± 0.10	0.32 ± 0.04
Fakes	0.24 ± 0.12	0.01 ± 0.005	–
ZH_{120}	0.25 ± 0.02	0.14 ± 0.01	0.08 ± 0.007
Total Background	66.1 ± 9.1	12.2 ± 2.4	4.36 ± 0.98
Data	68	5	4

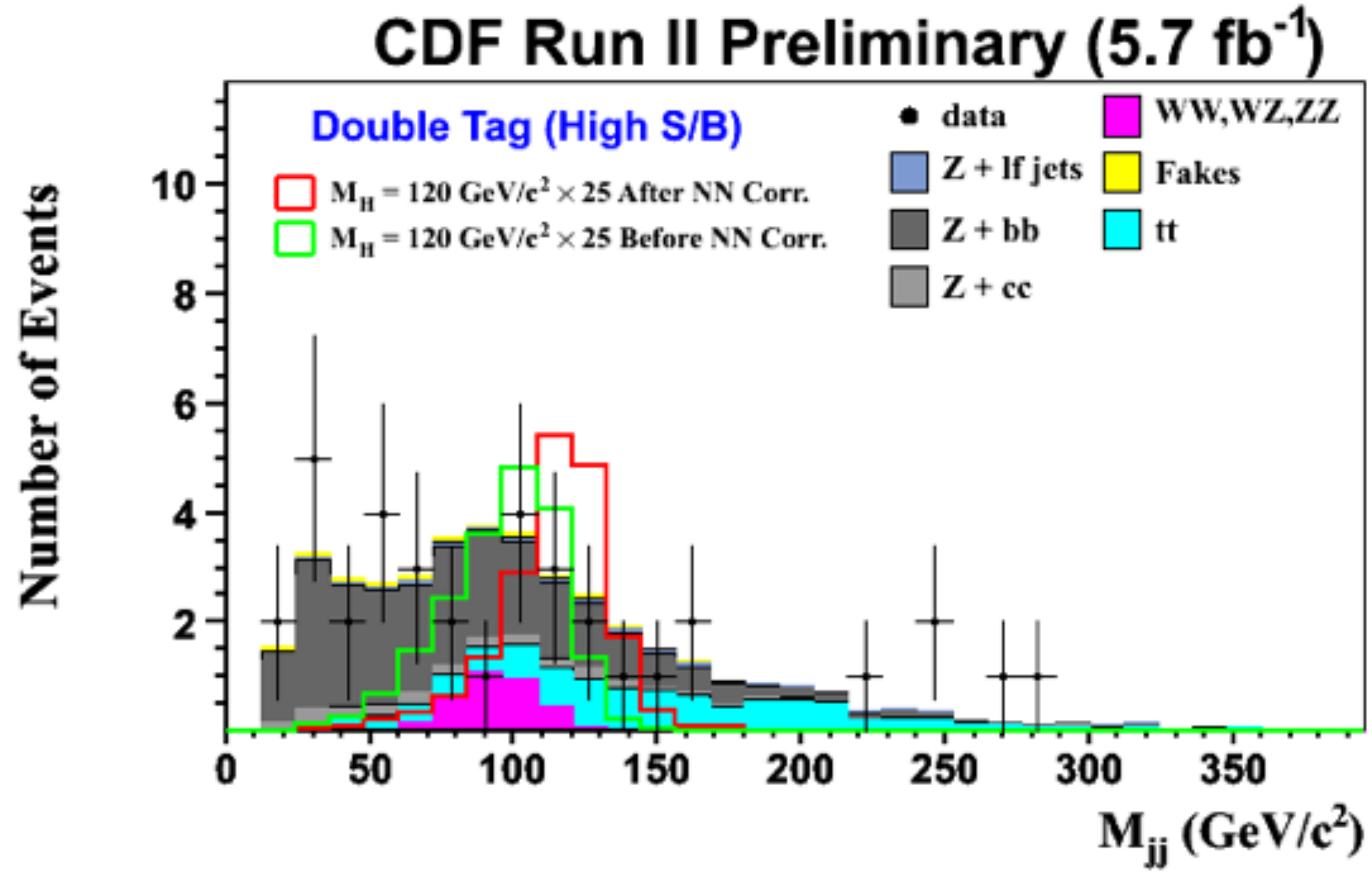
"Loose" $Z \to \mu^+\mu^-$

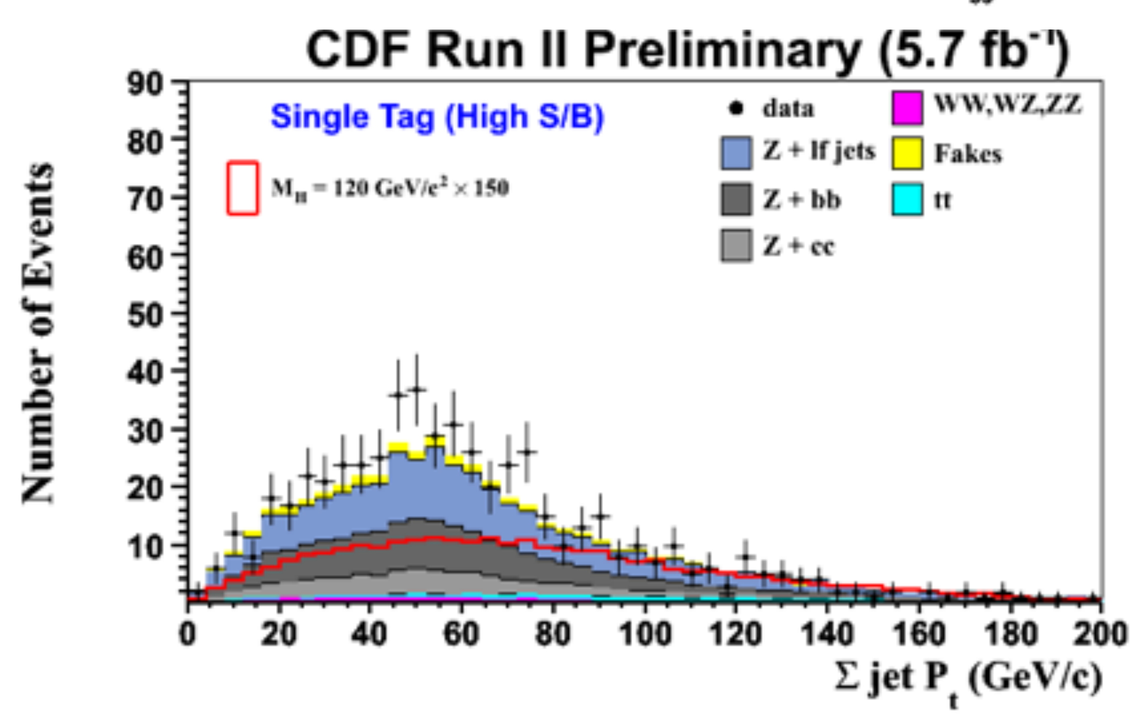
Discriminant Inputs

Single Tight SecVtx	Loose SecVtx + 5% JetProb	Double Tight SecVtx
P_{jj}	$\not\!\!E_T$	$\not\!\!E_T$
$\not\!\!E_T$	M_{jj}	M_{jj}
P_{zh}	P_{tt}	P_{tt}
P_{tt}	P_{jj}	P_{zh}
M_{jj}	$P_T(\text{jet 1}) + P_T(\text{jet 2})$	$P_T(\text{jet 1}) + P_T(\text{jet 2})$
Karlsruhe Output		N jets
$\not\!\!E_T$ projection on Jet 2		Sphericity
$P_T(\text{jet 1}) + P_T(\text{jet 2})$		

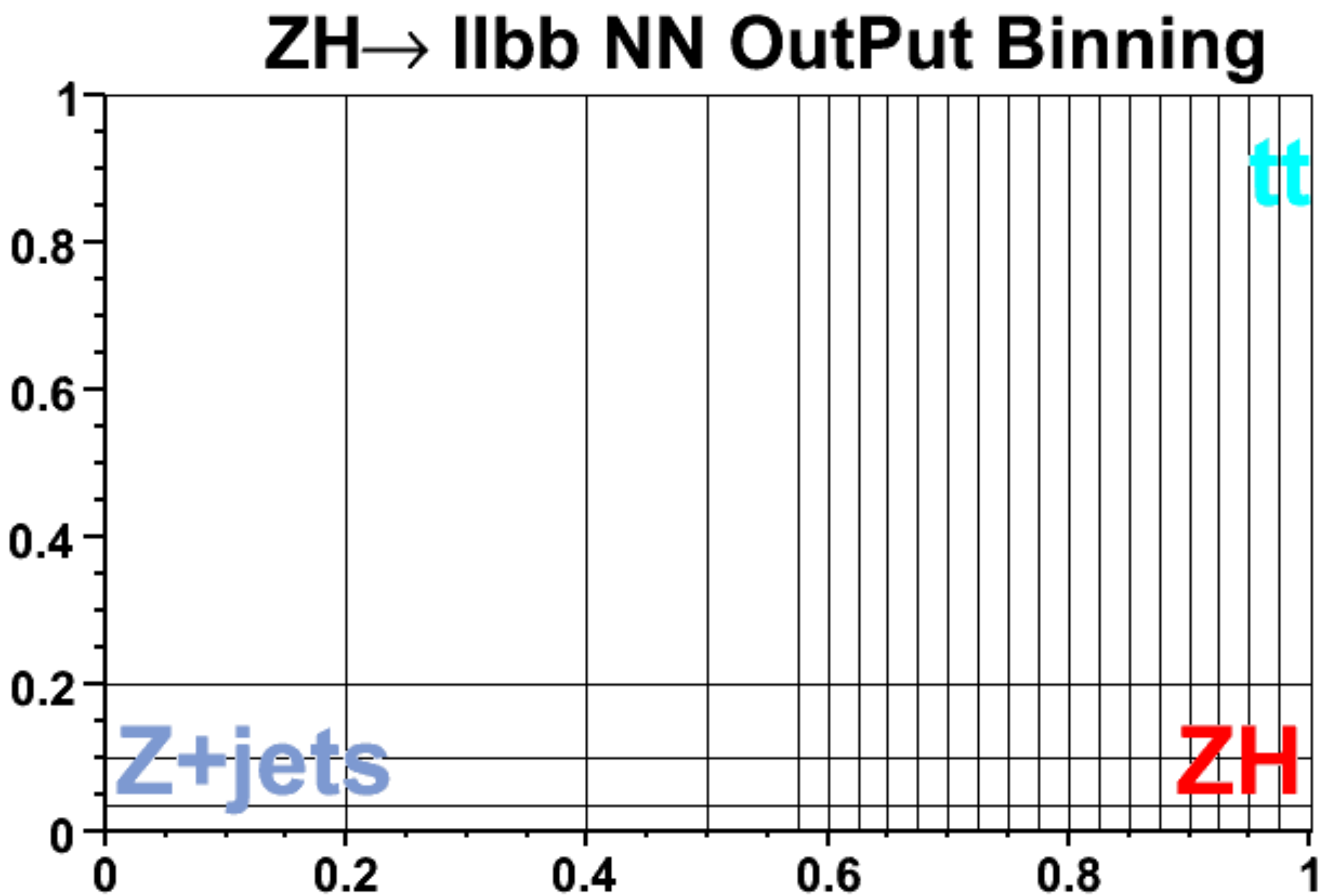
- Start with a large number of possible discriminant variables
- Loop over these to find the single best 1-input NN
- Loop over remaining variables to find the best 2-input NN
- Continue this process, adding variables until the addition of inputs not longer improves the testing error.
- Once the algorithm has found the optimal inputs for each b-tag category the final NNs are trained.

Discriminant

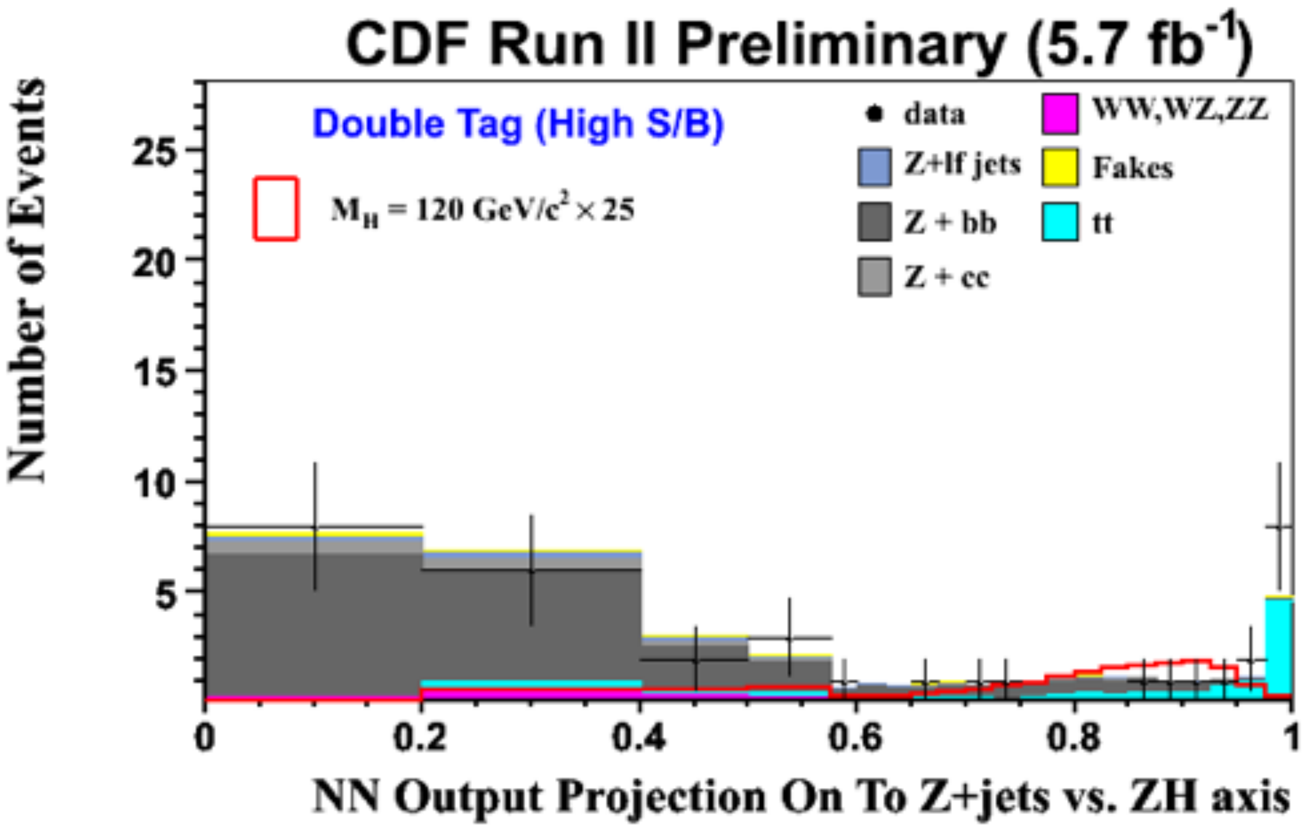


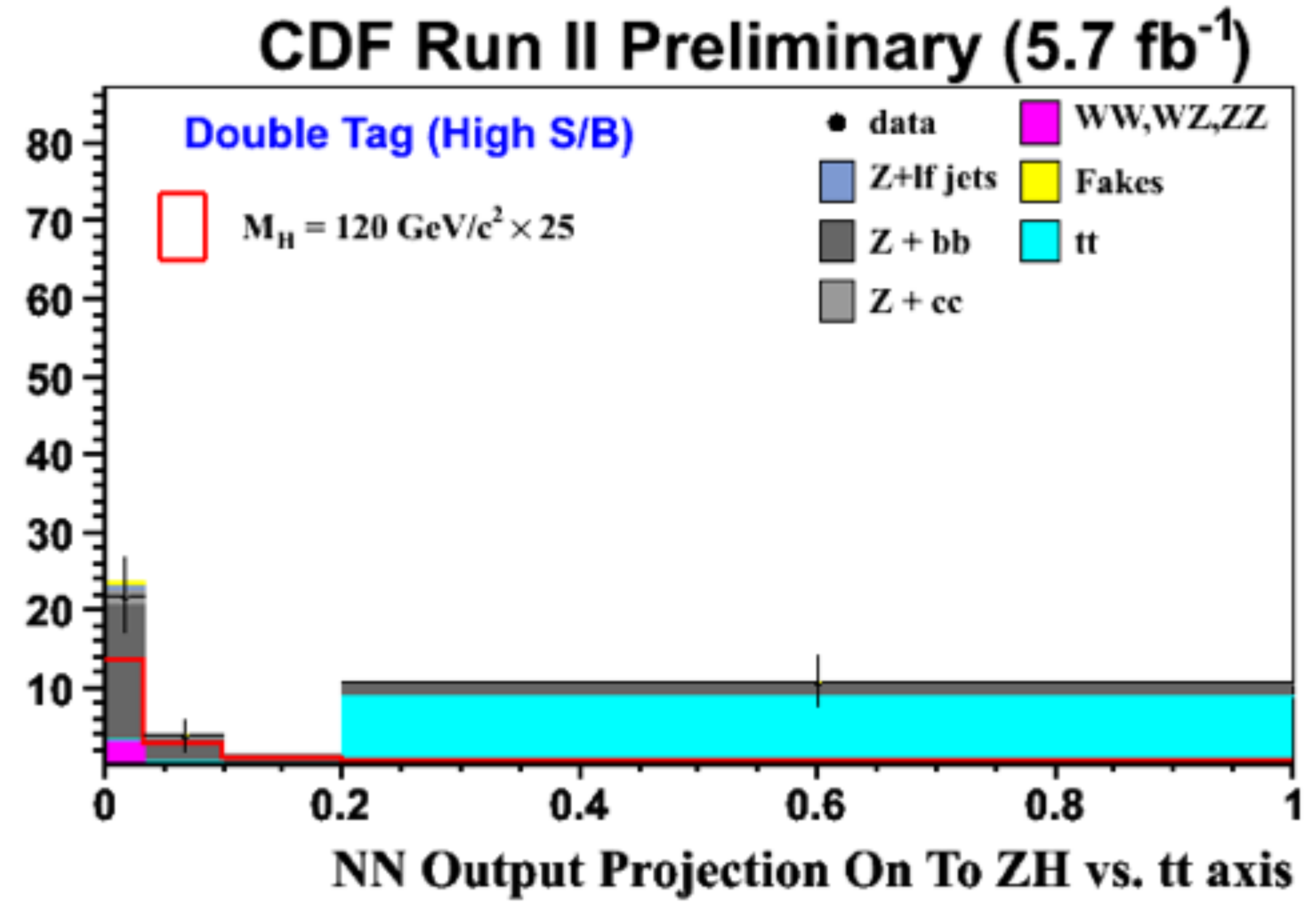


2D Neural Network for ZH

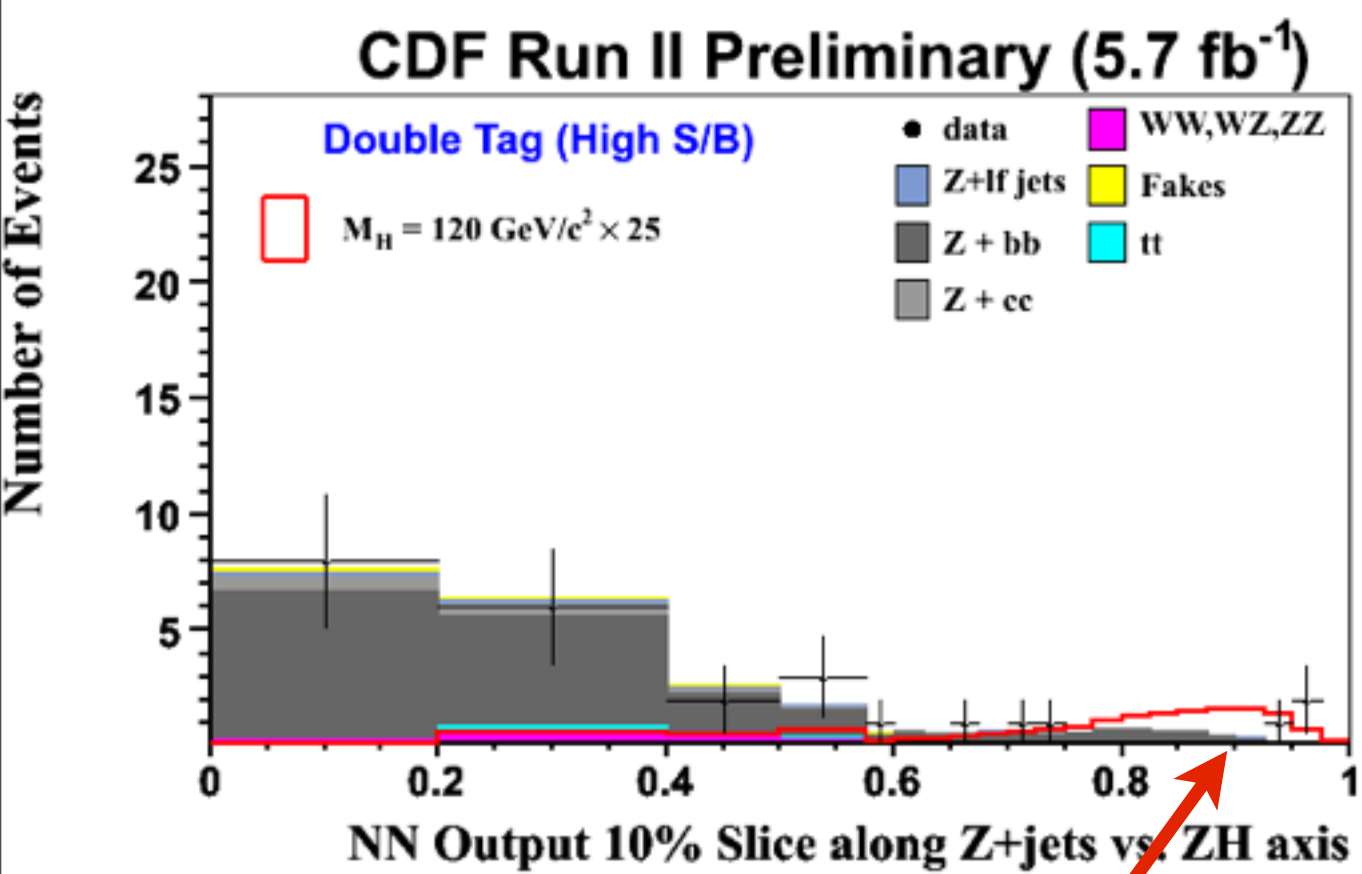


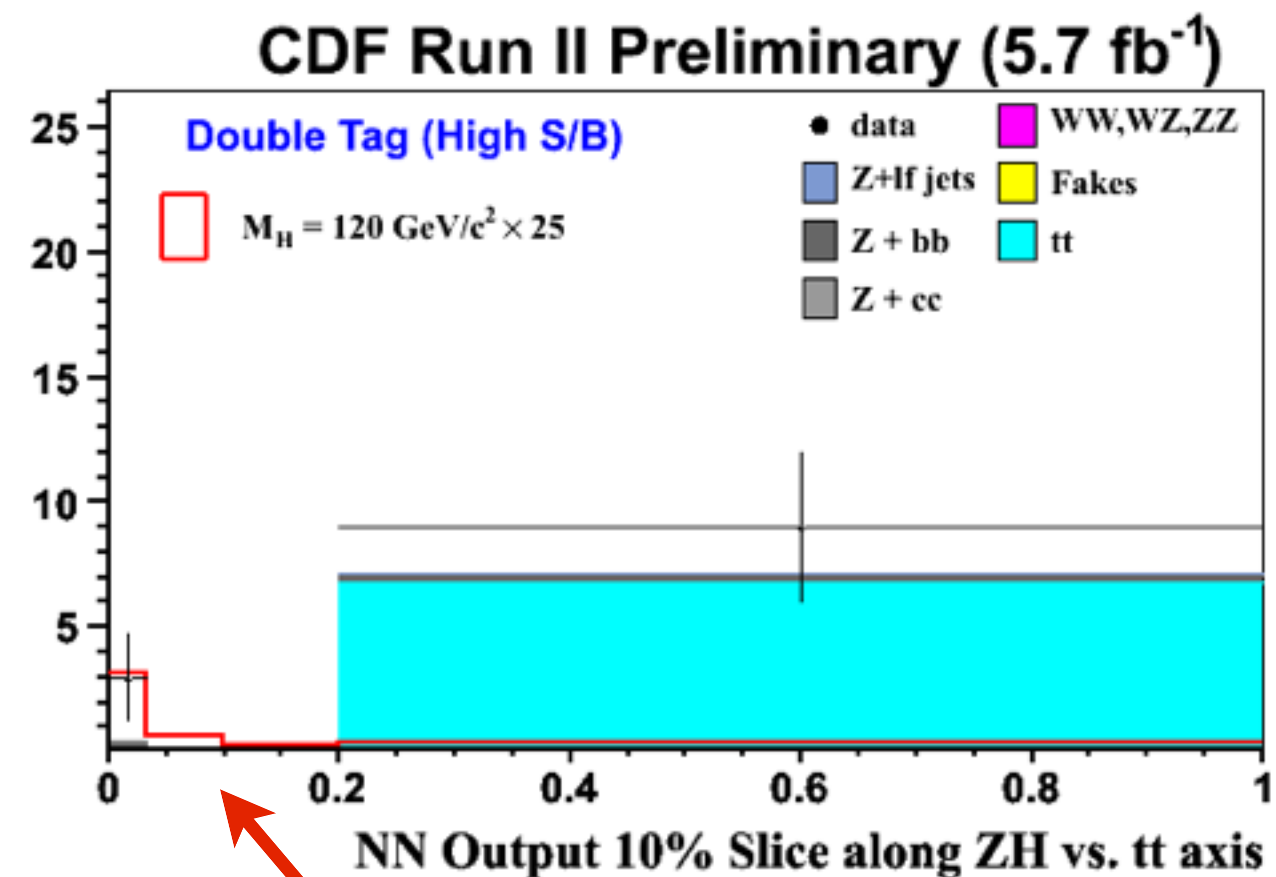
Discriminant Output





Discriminant Output

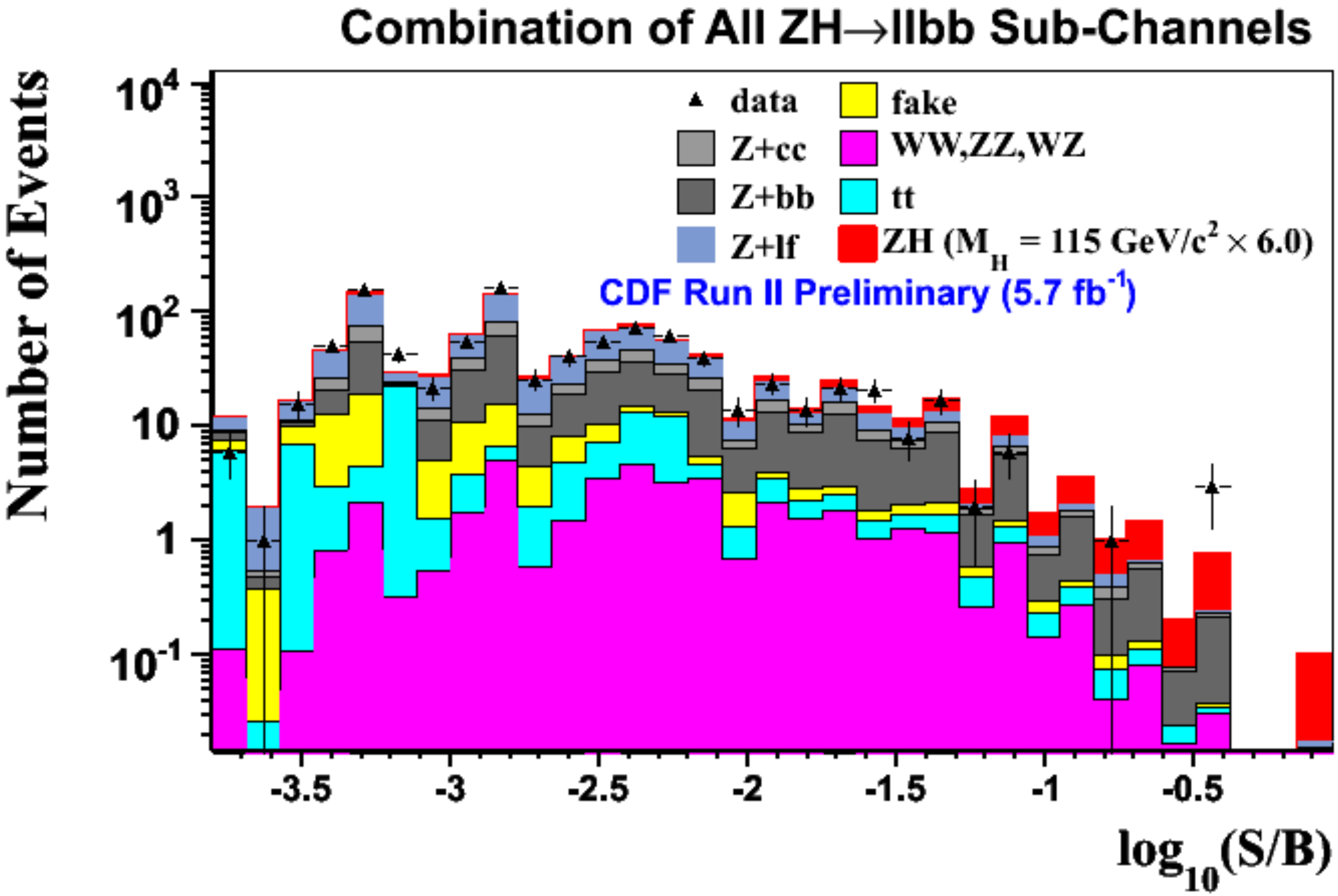




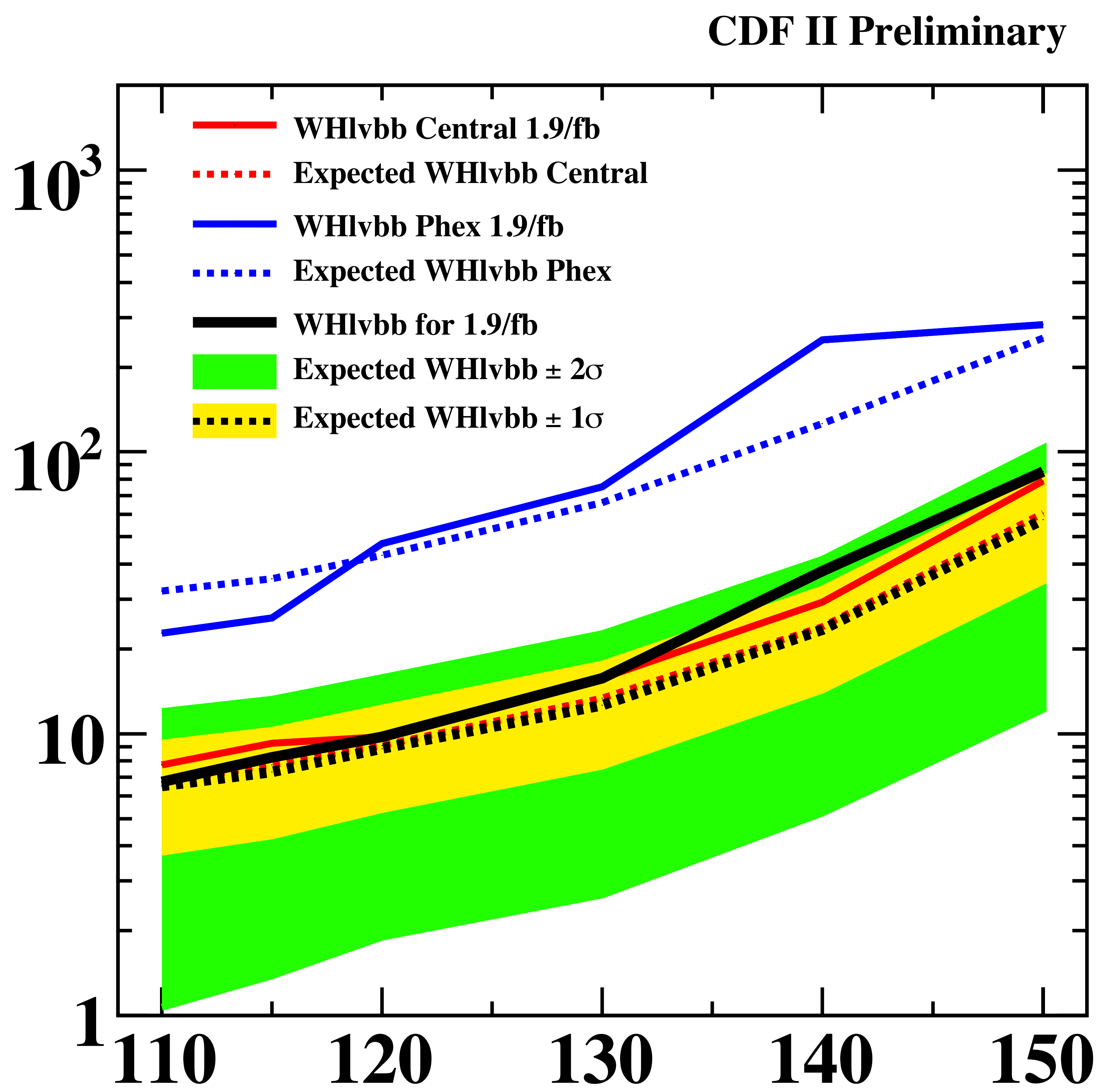
Z+jets contribution reduced

top contribution reduced

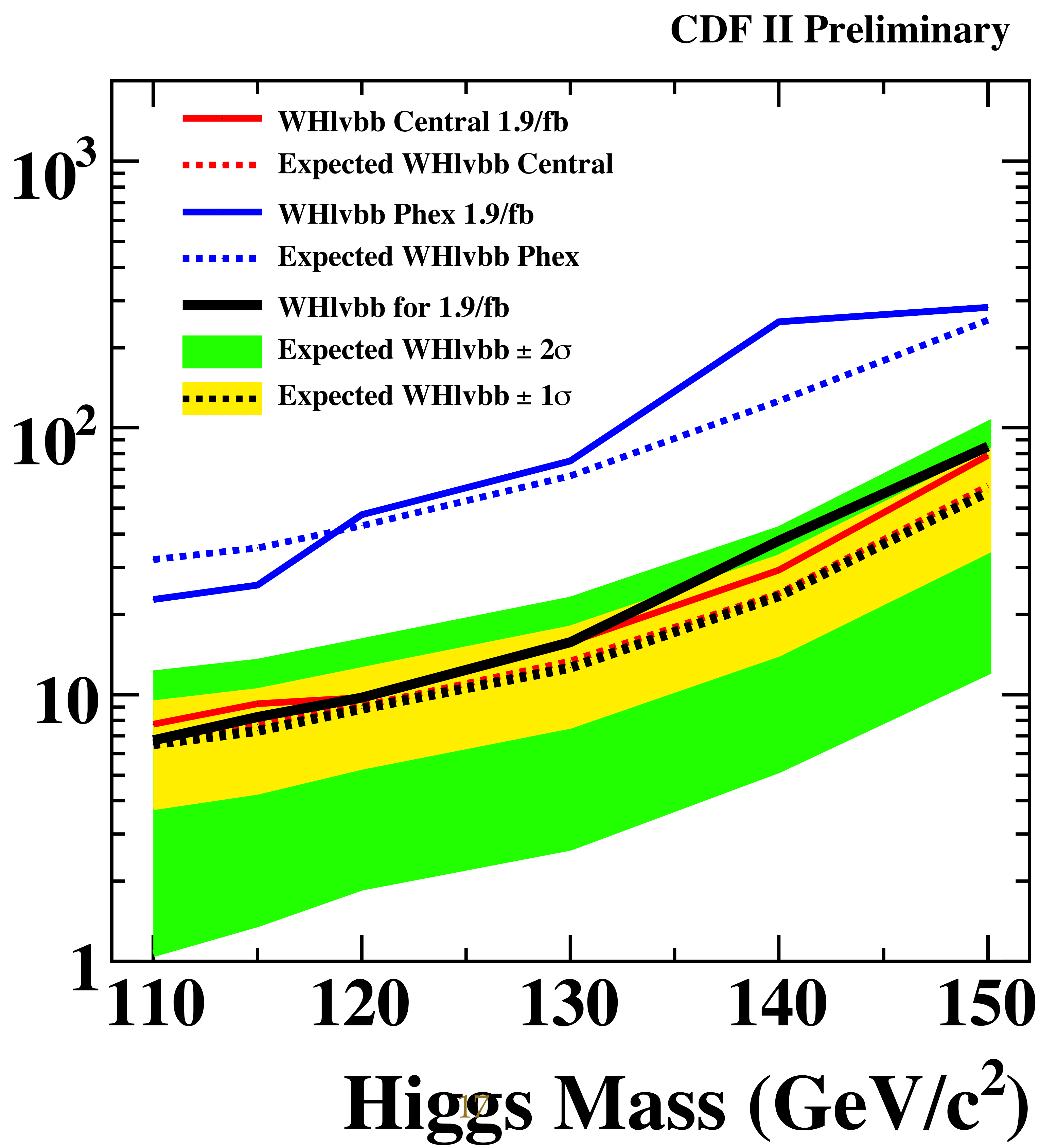
Displaying Data in bins of S/B



Decoding Limit Plots 101

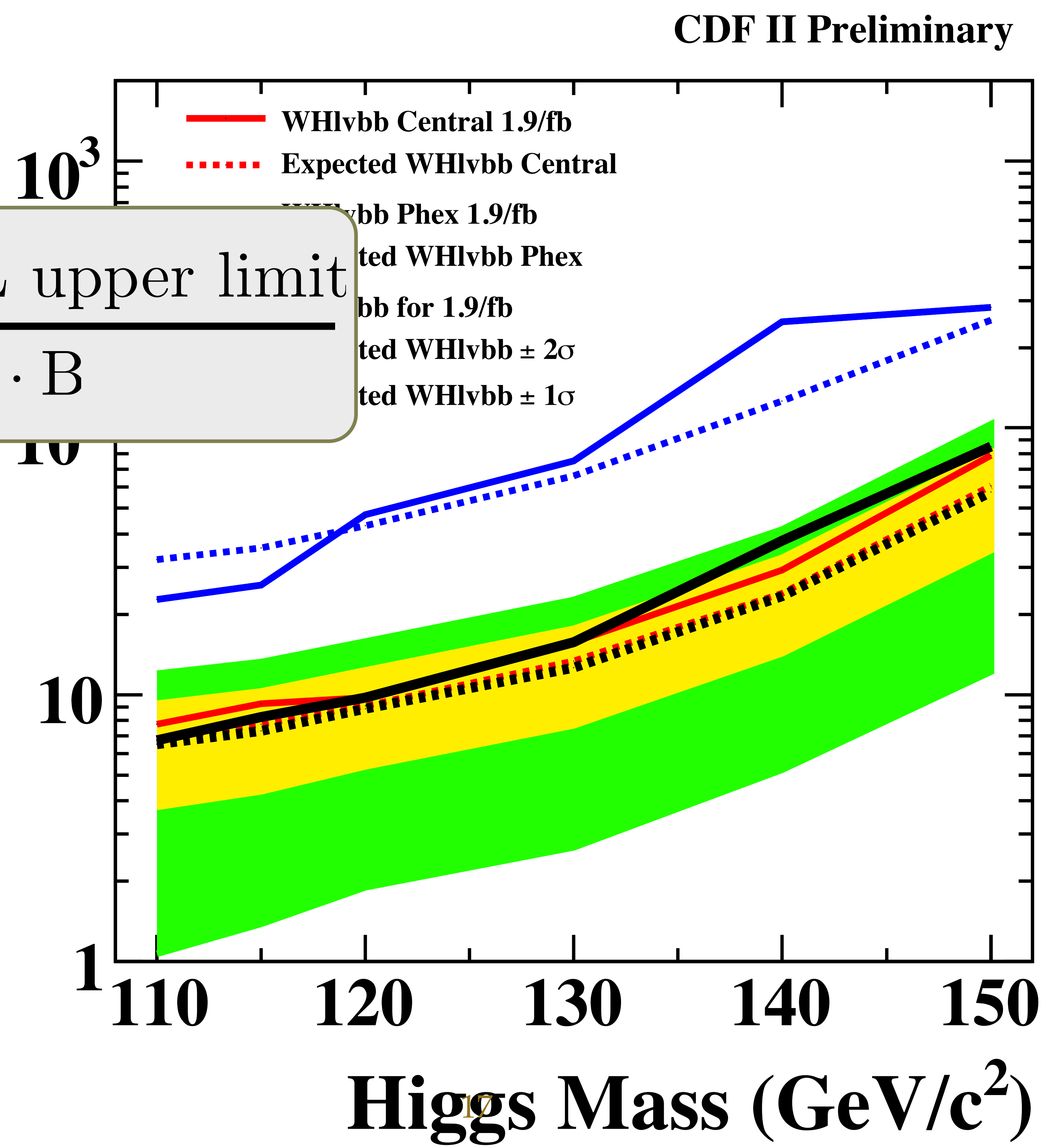


Decoding Limit Plots 101

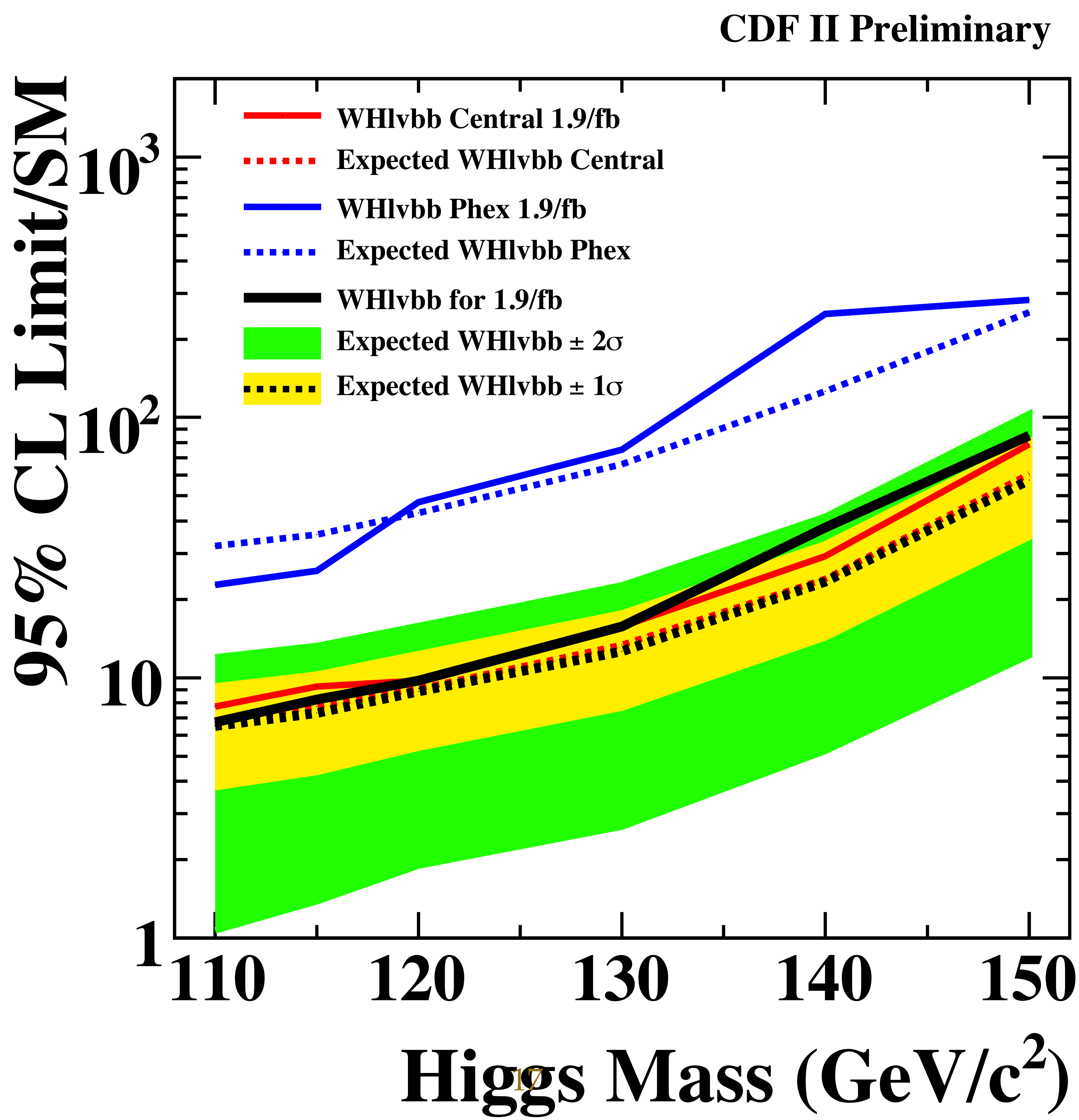


Decoding Limit Plots 101

$$\frac{\sigma \cdot B \;\; 95\% \text{ CL upper limit}}{\text{SM } \sigma \cdot \text{B}}$$

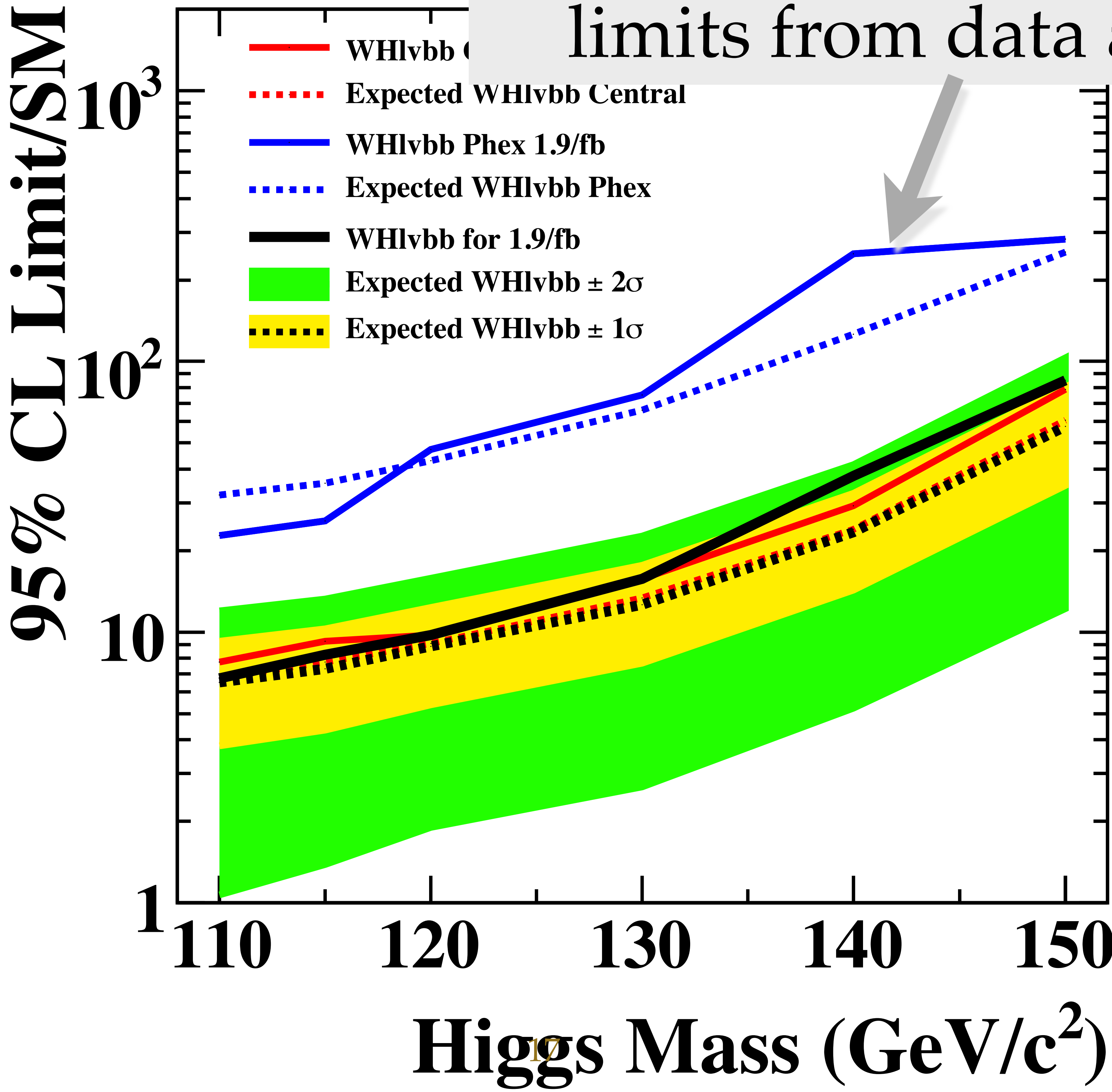


Decoding Limit Plots 101

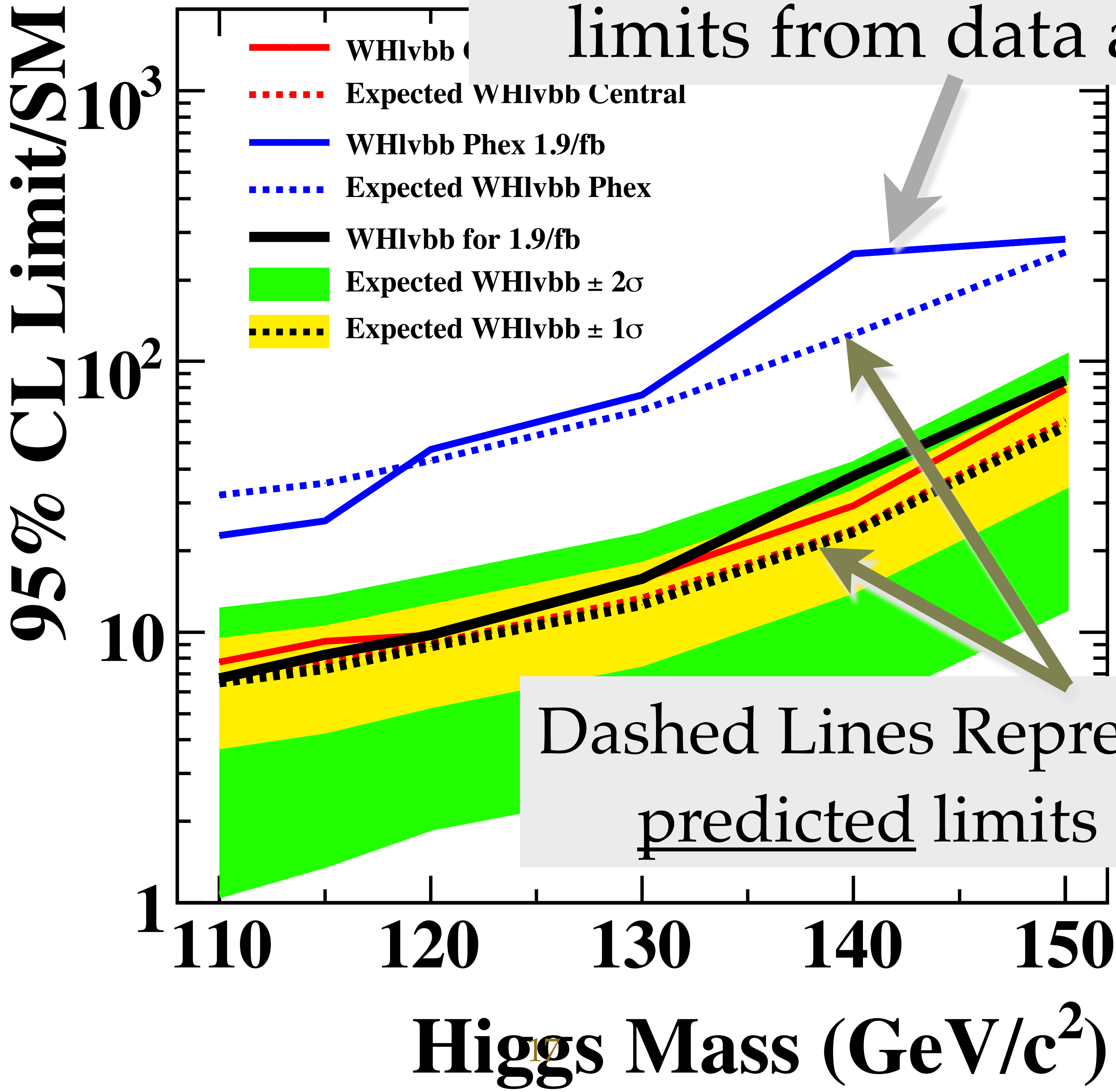


Decoding Limit Plots 101

Solid Lines represent observed limits from data analysis.



Decoding Limit Plots 101

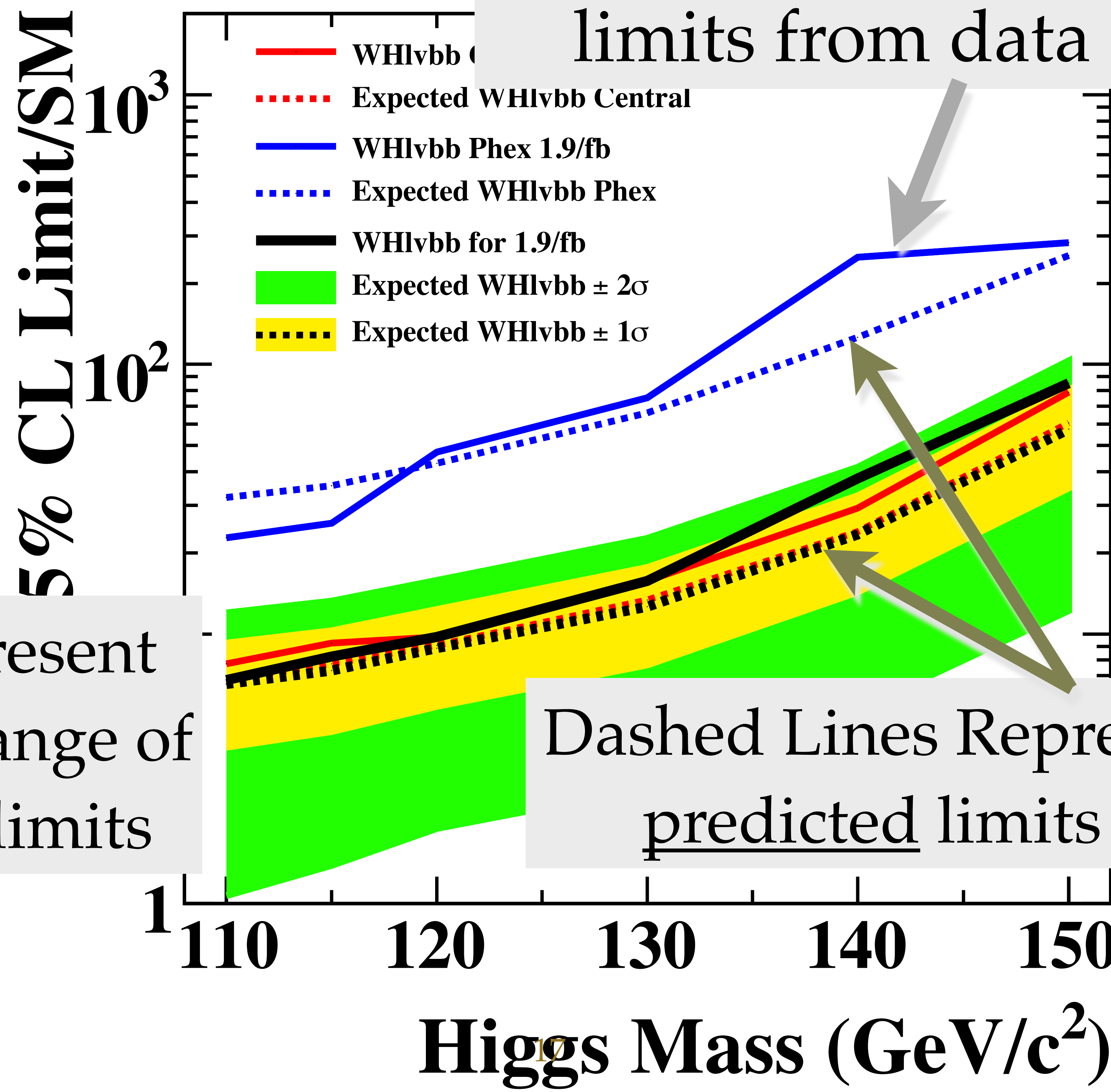


Solid Lines represent observed limits from data analysis.

Dashed Lines Represent median predicted limits from MC

Decoding Limit Plots 101

Solid Lines represent observed limits from data analysis.

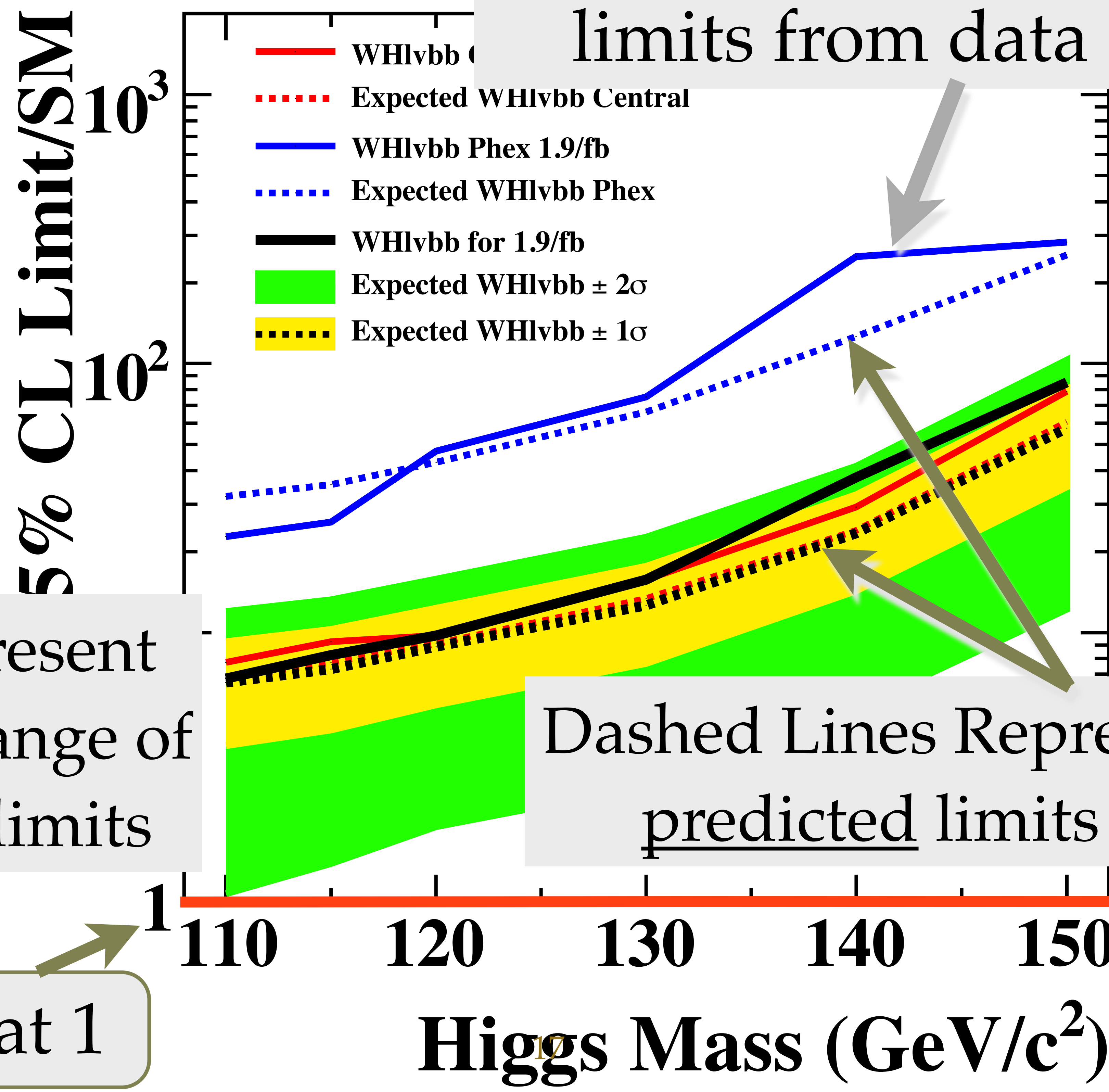


Bands represent 1σ and 2σ range of predicted limits

Dashed Lines Represent median predicted limits from MC

Decoding Limit Plots 101

Solid Lines represent observed limits from data analysis.

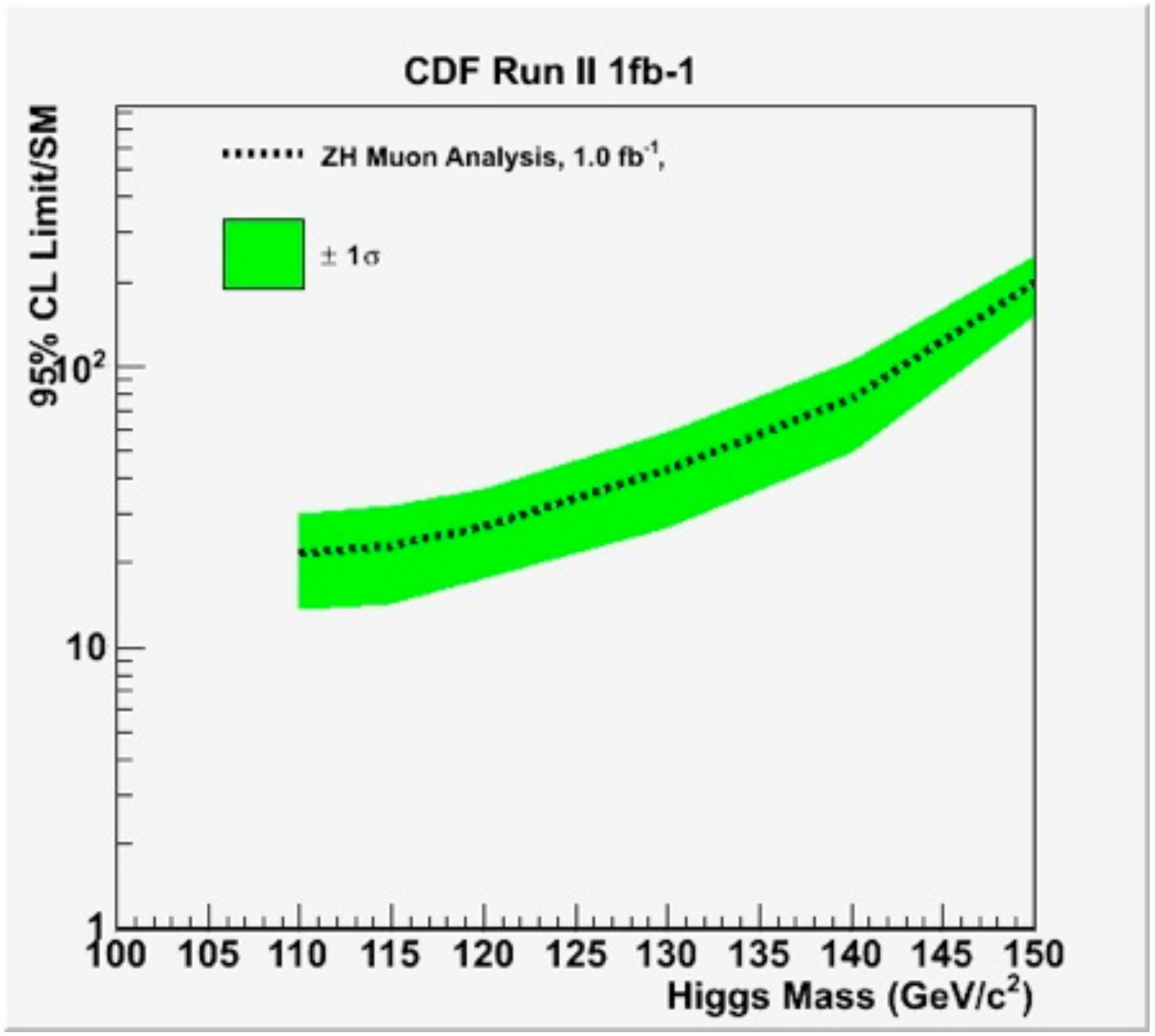


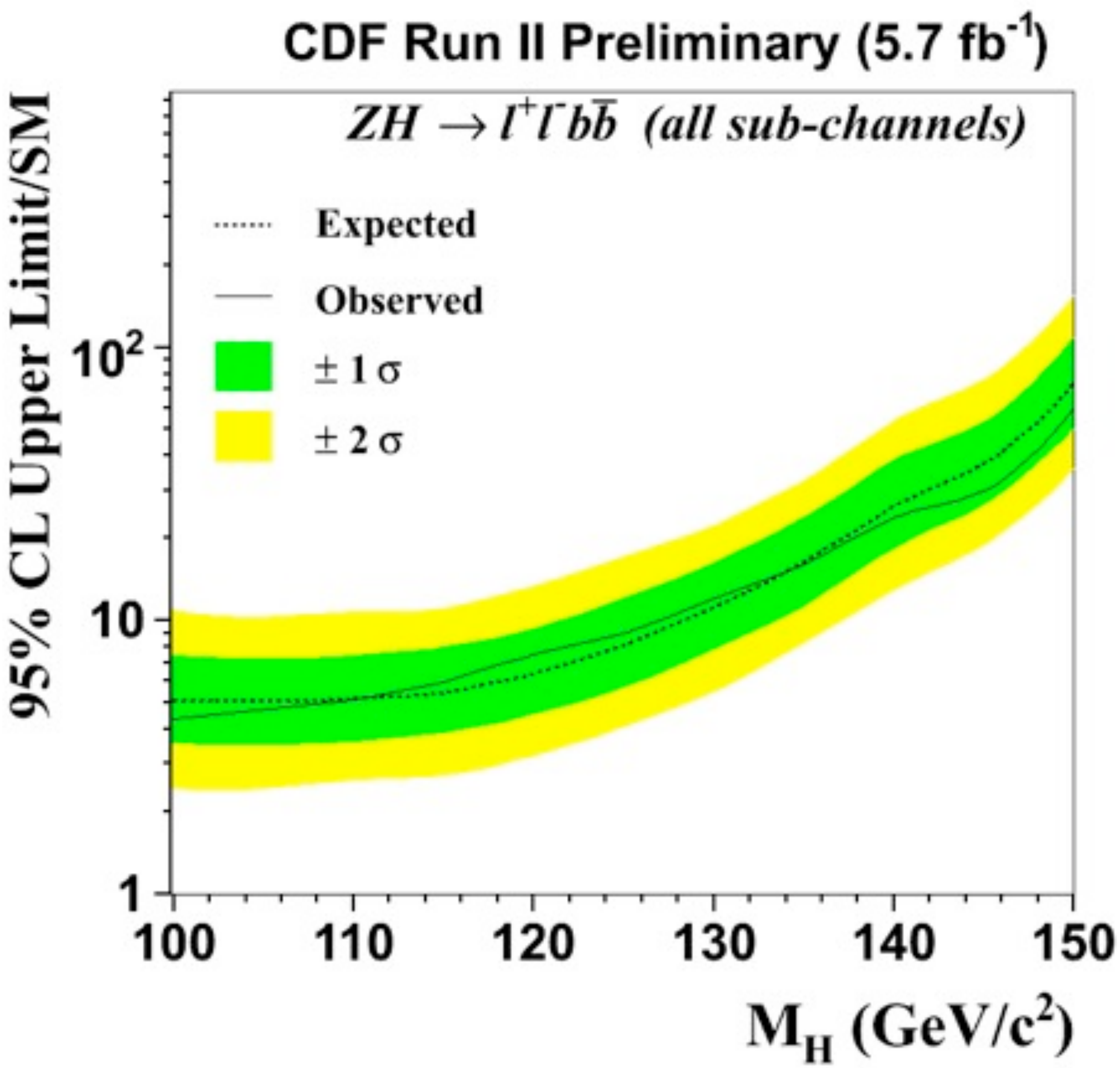
Bands represent 1σ and 2σ range of <u>predicted</u> limits

Dashed Lines Represent median <u>predicted</u> limits from MC

SM $\sigma \cdot$ B at 1

$ZH \rightarrow \ell\ell b\bar{b}$ Limits





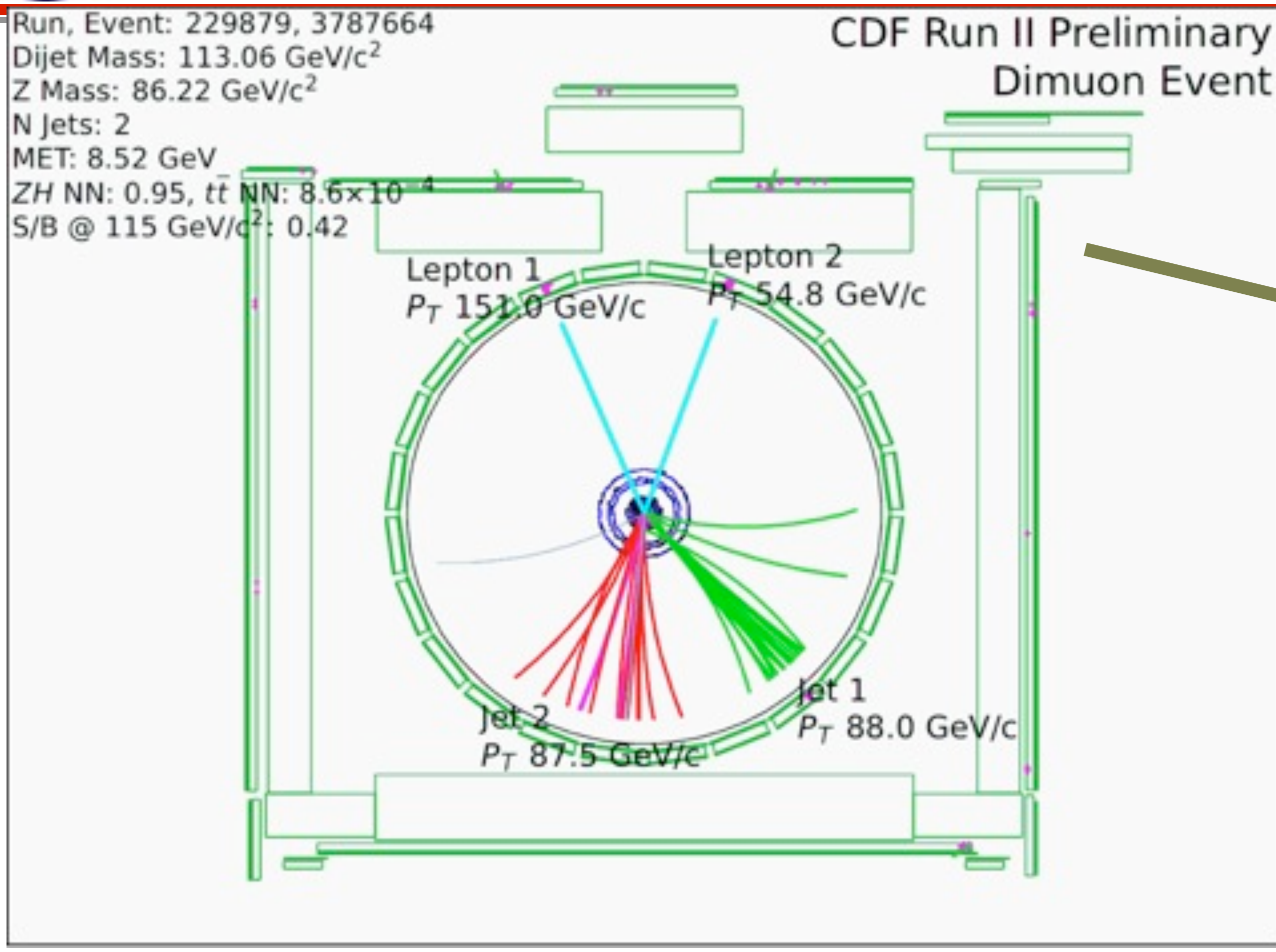
Channel	Lum	Obs/SM	Exp/SM
Old $ZH \rightarrow \ell\ell b\bar{b}$	1.0 fb^{-1}	26.0	26.0
New $ZH \rightarrow \ell\ell b\bar{b}$	5.7 fb^{-1}	7.5	6.4

Analysis Improvements vs Time

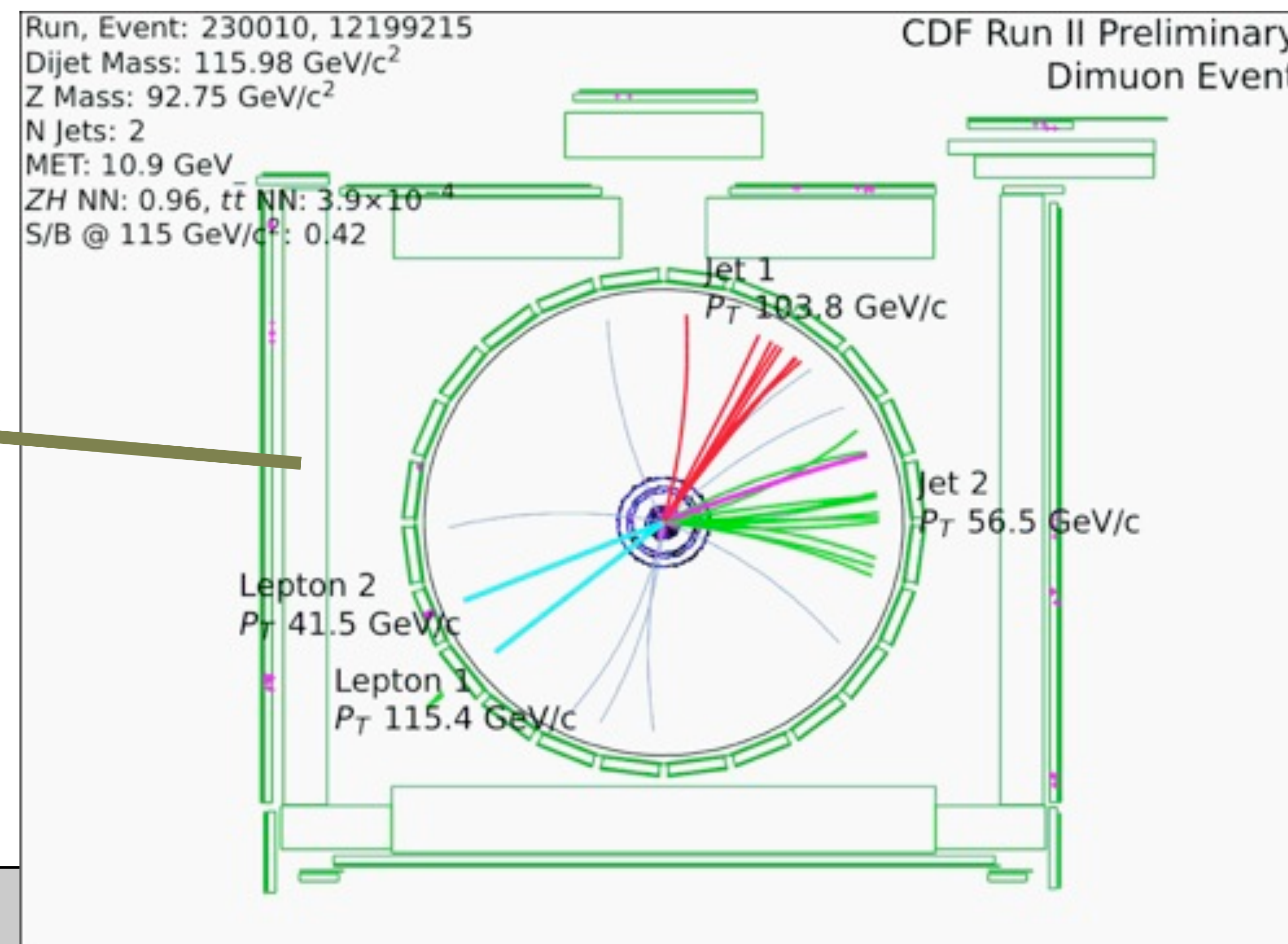
Date	Lum (fb^{-1})	Improvements	95%CL Limit/SM	Improvement beyond Lum (Rel to Jul06)	Improvement beyond Lum (Rel Previous)
Jul 2006	1.0	Neural Network	26	---	---
Jul 2008	2.4	Tagging Categories, NN Jet corrections, Lepton categories	14.5	15%	15%
Jan 2009	2.7	Looser b-tags	12.2	30%	11%
Aug 2009	4.1	Add JetProb tags, Matrix elements, flavor seperator	8.5	51%	16%
Jul 2010	5.7	Add trigger, muon NN ID	6.4	70%	13%

CDF: tight double tag (TDT) high s/b $ZH \to \ell\ell b\bar{b}$ channel relative uncertainties (%)								
Contribution	Fakes	Top	WZ	ZZ	$Z + b\bar{b}$	$Z + c\bar{c}$	Z+mistag	ZH
Luminosity ($\sigma_{\text{inel}}(p\bar{p})$)	0	3.8	3.8	3.8	3.8	3.8	0	3.8
Luminosity Monitor	0	4.4	4.4	4.4	4.4	4.4	0	4.4
Lepton ID	0	1	1	1	1	1	0	1
Lepton Energy Scale	0	1.5	1.5	1.5	1.5	1.5	0	1.5
ZH Cross Section	0	0	0	0	0	0	0	5
Fake Leptons	50	0	0	0	0	0	0	0
Jet Energy Scale (shape dep.)	0	$^{+1.5}_{-1.1}$	$^{+0.0}_{-0.0}$	$^{+1.8}_{-2.7}$	$^{+5.9}_{-6.9}$	$^{+6.0}_{-6.0}$	0	$^{+1.6}_{-0.3}$
Mistag Rate (shape dep.)	0	0	0	0	0	0	$^{+30.9}_{-26.8}$	0
B-Tag Efficiency	0	8	8	8	8	8	0	8
$t\bar{t}$ Cross Section	0	10	0	0	0	0	0	0
Diboson Cross Section	0	0	6	6	0	0	0	0
$\sigma(p\bar{p} \to Z + HF)$	0	0	0	0	40	40	0	0
ISR (shape dep.)	0	0	0	0	0	0	0	$^{-2.1}_{+0.4}$
FSR (shape dep.)	0	0	0	0	0	0	0	$^{-1.7}_{-0.7}$

Some Interesting Events



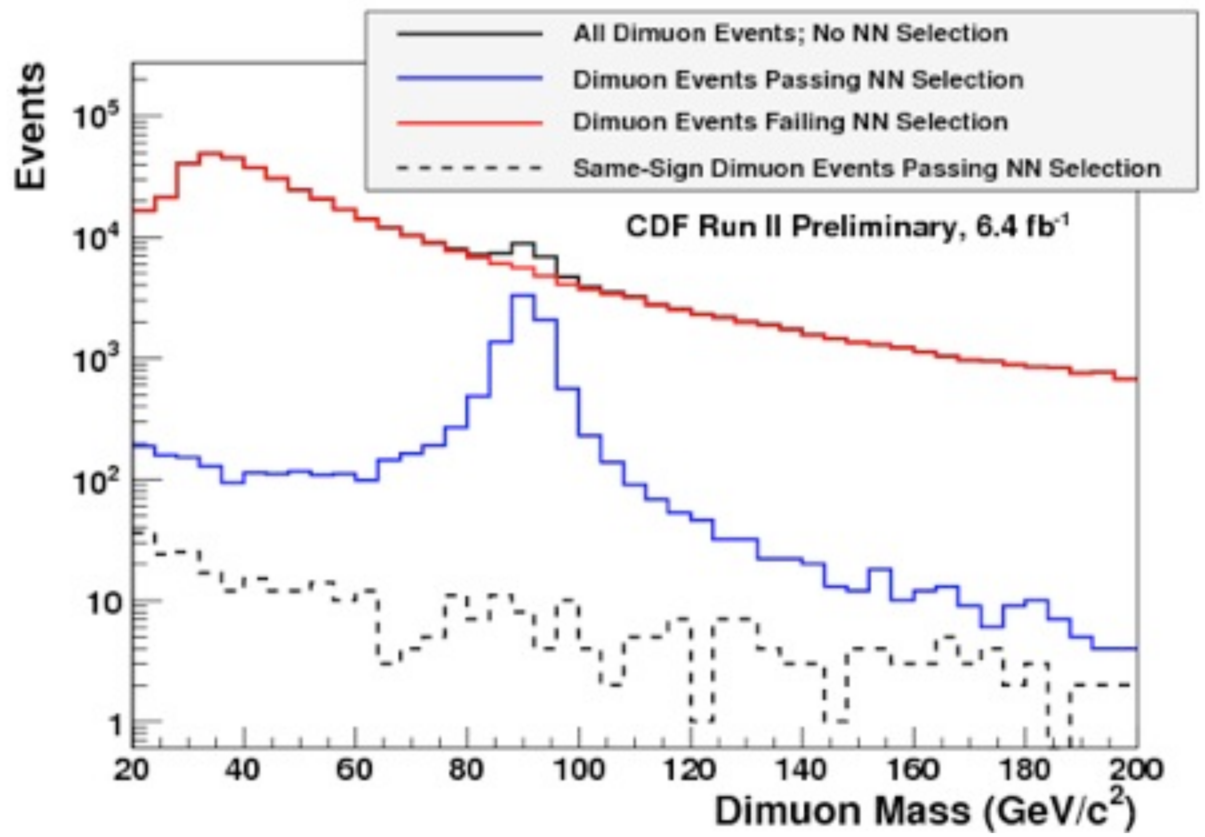
Dijet Mass = 113 GeV / c^2
Z Mass = 86.2 GeV / c^2
MET = 8.5 GeV
NN_{ZH} = 0.95; NN_{tt} = ~10^{-3}

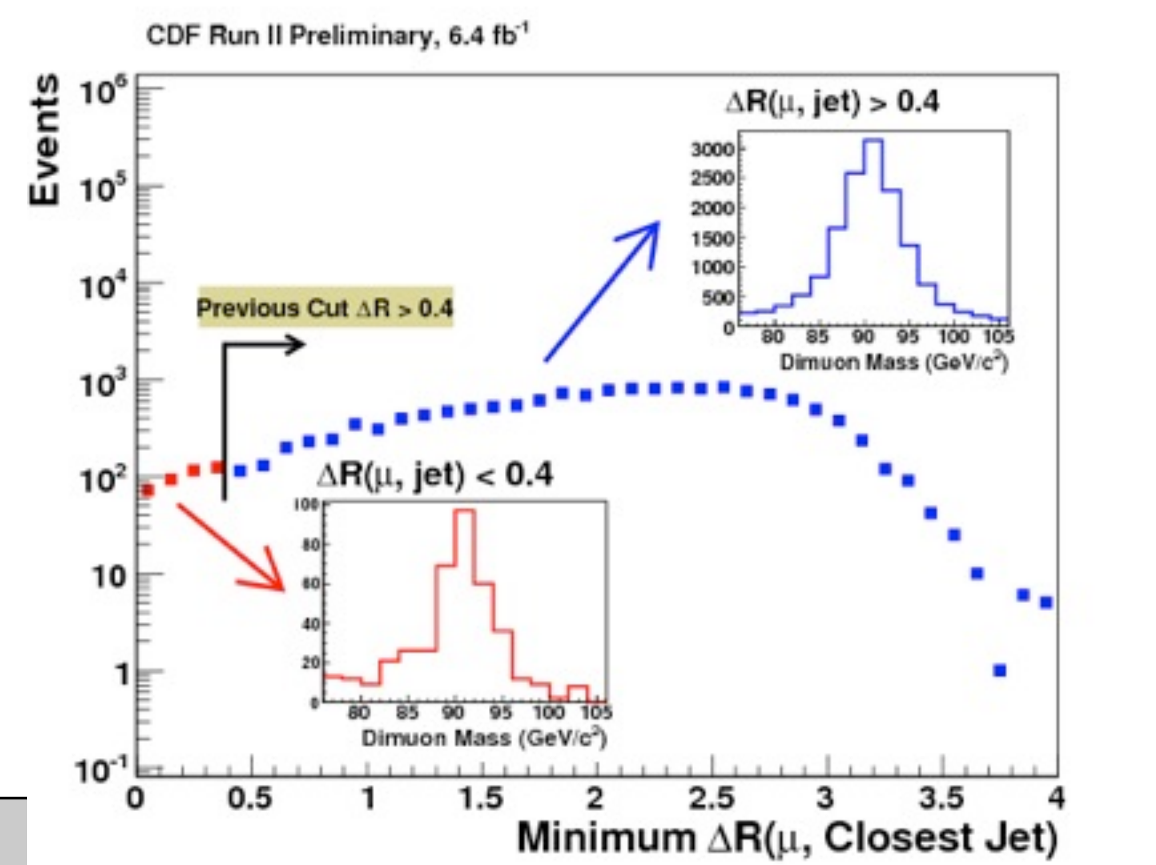


Dijet Mass = 116 GeV / c^2
Z Mass = 92.8 GeV / c^2
MET = 10.9 GeV
NN_{ZH} = 0.96; NN_{tt} = ~10^{-3}

Adding Acceptance: NN

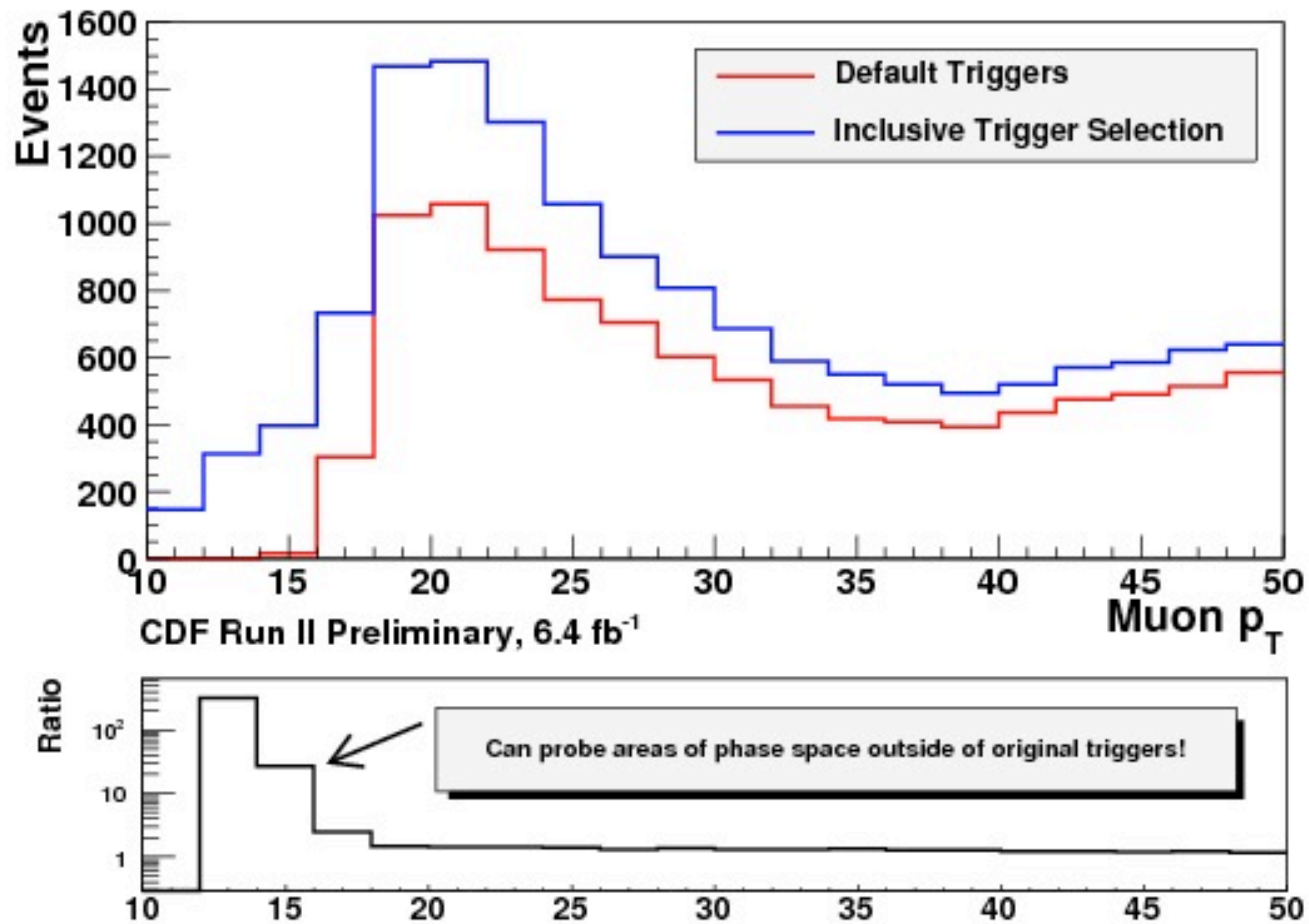
- Current analysis uses muon NN only for
  - Loose muon which is partnered with tight muon from muon triggered events
  - Loose-Loose muons which come from MET+jets triggered events
- Will remove tight cut requirements
  - All muons passed through muon NN





Improving Trigger Selection

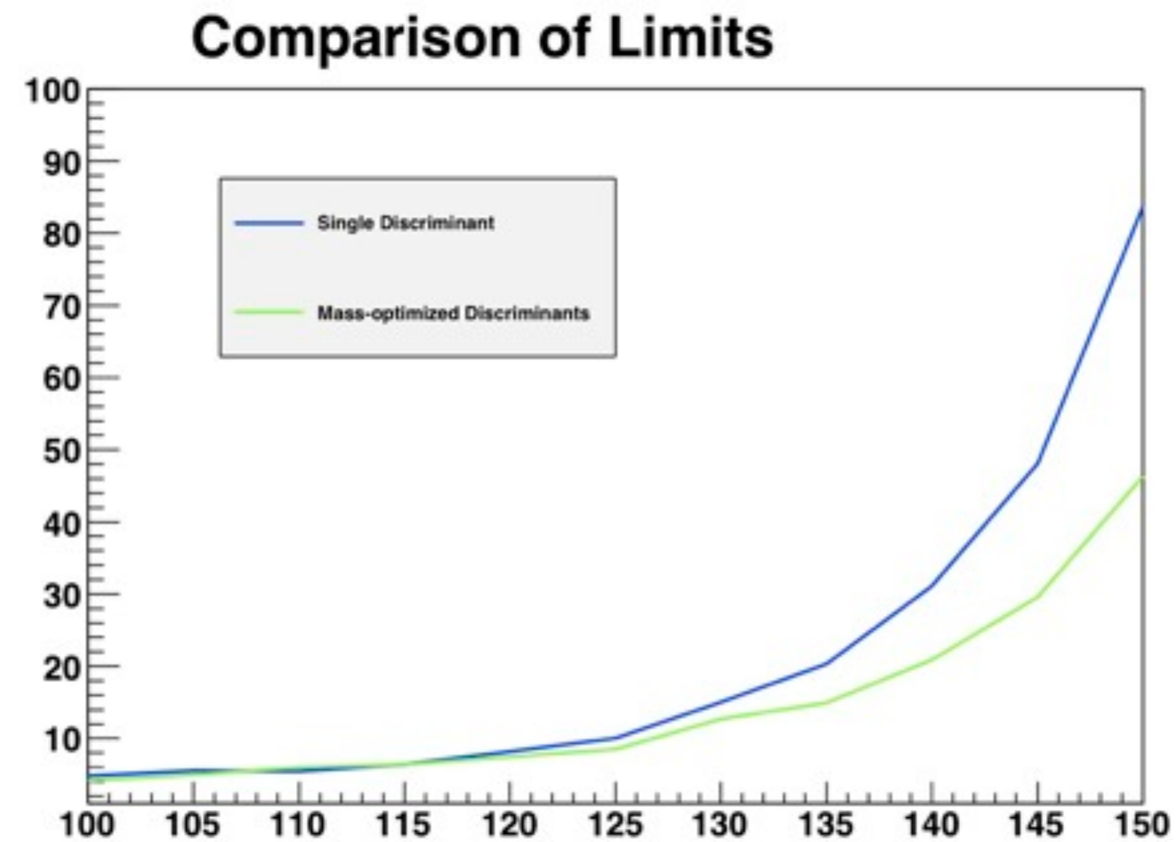
- Current analysis uses specific triggers coming in on two streams:
  - High Pt Muon trigger in muon stream
  - MET+jets from MET stream
- Will Switch to "stream-based" trigger selection
  - Accept any trigger from the above streams
  - Play two streams off one another to measure trigger efficiency



Plot shows impact of addition of MET Triggers PLUS Stream Triggers

Mass Dependent Improvements

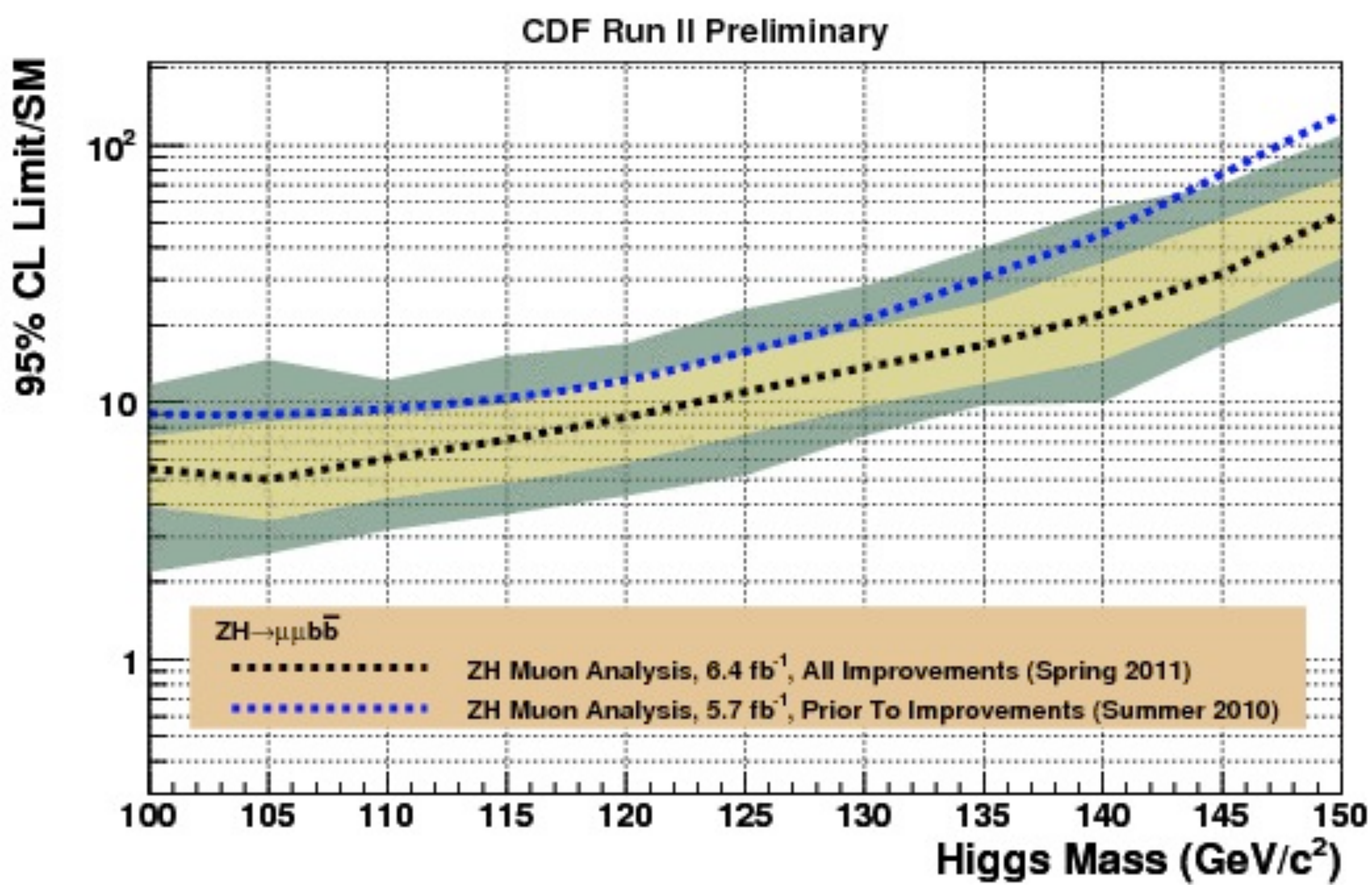
- Currently: Use single discriminant tuned for a higgs mass of 120 GeV.
- Improvement: Use mass dependent discriminants
  - Impact is modest at low mass: ~5%
  - Substantial impact at high mass: ~50%



ZH MUON ANALYSIS IMPROVEMENTS	
Data Increase	12%
Adding Loose + Loose Zs	~20%
Adding Muon NN ID	~20%
Stream Triggers	~10%
ACCEPTANCE IMPROVEMENTS	**~60%**
Mass-Optimized Discriminants Sensitivity Increase	~5% (low mass), ~50% (high mass)
EXPECTED LIMIT IMPROVEMENT	**30% (120 GeV) - 60% (200 GeV)**

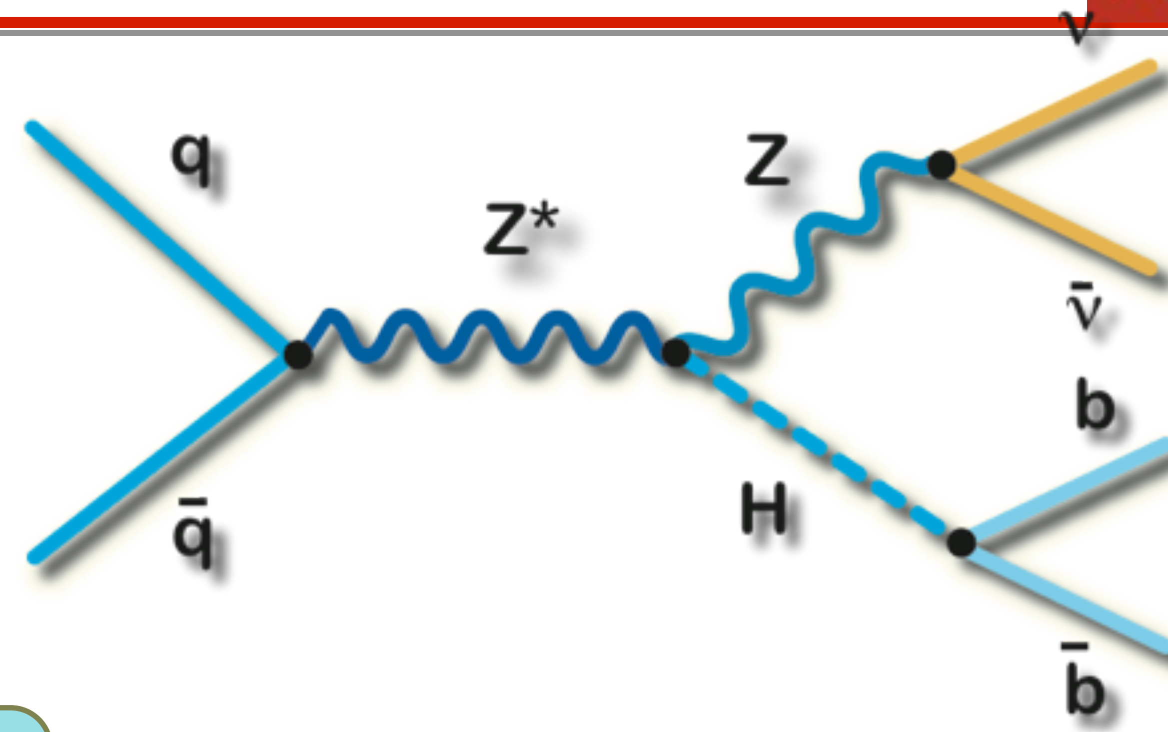
Expected Impact

- The plot below shows the full impact of these improvements on the ZH muon channel alone.
- Demonstrates that significant improvements are possible using existing tools and techniques in a very mature analysis



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

- No High P_T Leptons
- Large Missing E_T
- 2/3 Jets, 1/2 b-tags



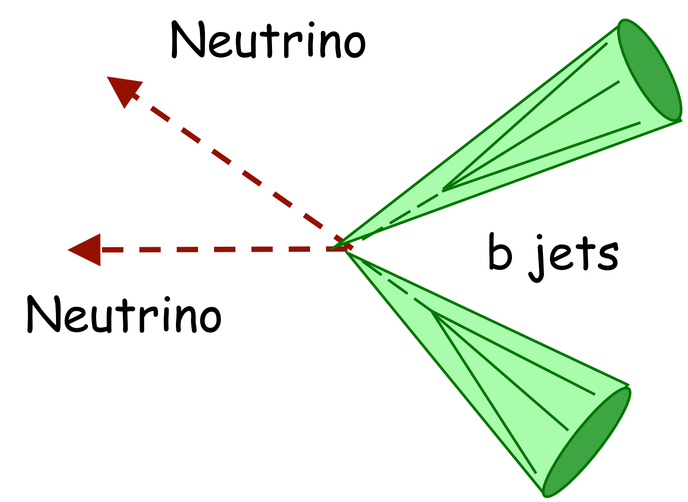
Features:

1. **Trigger is more challenging**
2. **Large QCD/Fake Bkg: Difficult to Simulate: *use data***
3. **Use tracks to help bkg identification.**
4. **Large contribution (~50%) from WH**
5. **~10 evts/ 6fb^{-1} (double tags)**

Primary Backgrounds
QCD Heavy Flavor,
$t\bar{t}$, $W/Z + b\bar{b}/c\bar{c}$,
Single Top,
ZZ, WZ, WW

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

- No High P_T Leptons
- Large Missing E_T
- 2/3 Jets, 1/2 b-tags



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Primary Backgrounds

QCD Heavy Flavor,

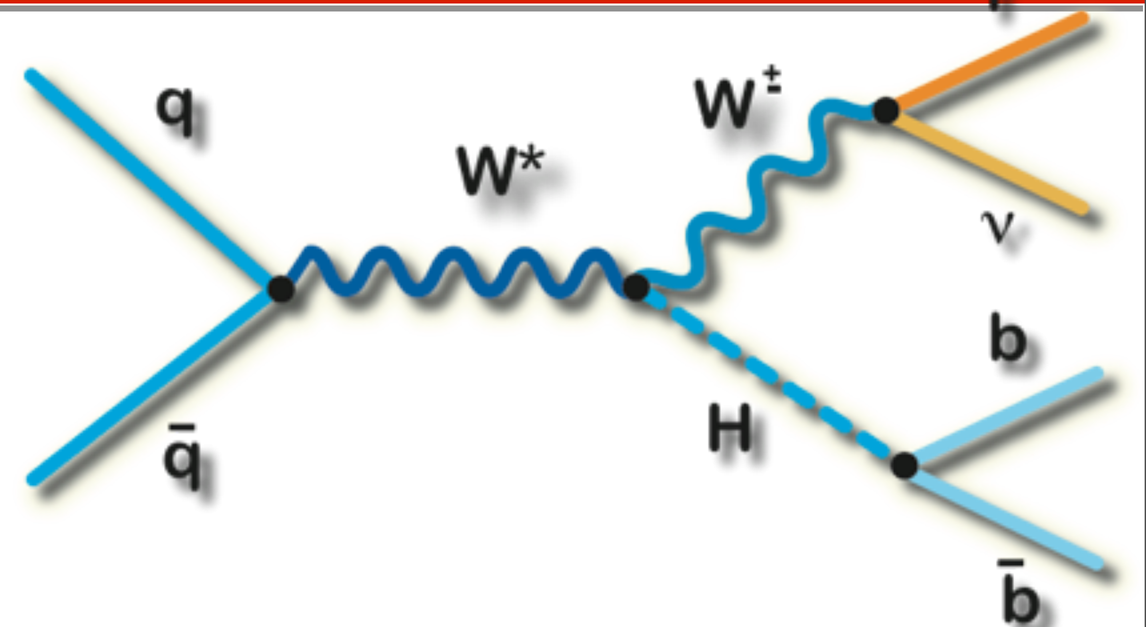
$t\bar{t}$, $W/Z + b\bar{b}/c\bar{c}$,

Single Top,

ZZ, WZ, WW

$WH \to \ell\nu b\bar{b}$

- High P_T Lepton
- Missing E_T
- 2/3 Jets, 1/2 b-tags



Features:

1. **Good Acceptance**
2. **Final state similar to single top prod.**
3. **~5 evts/ 6 fb^{-1} (dbl tags)**

Primary Backgrounds

$Wb\bar{b}$, $Wc\bar{c}$, Wqq'

$t\bar{t}$

Single top

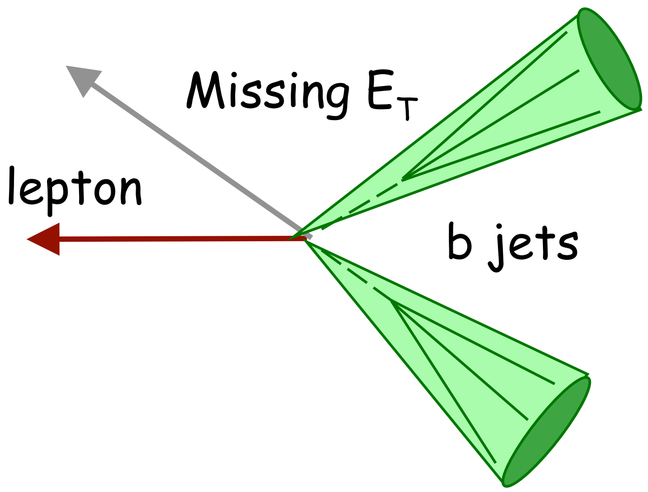
non − W QCD

WZ, WW

$Z \to \tau\tau$

$WH \to \ell\nu b\bar{b}$

- **High P_T Lepton**
- **Missing E_T**
- **2/3 Jets, 1/2 b-tags**



Features:

1. **Good Acceptance**
2. **Final state similar to single top prod.**
3. **~5 evts/ 6 fb^{-1} (dbl tags)**

Primary Backgrounds

$Wb\bar{b}$, $Wc\bar{c}$, Wqq'

$t\bar{t}$

Single top

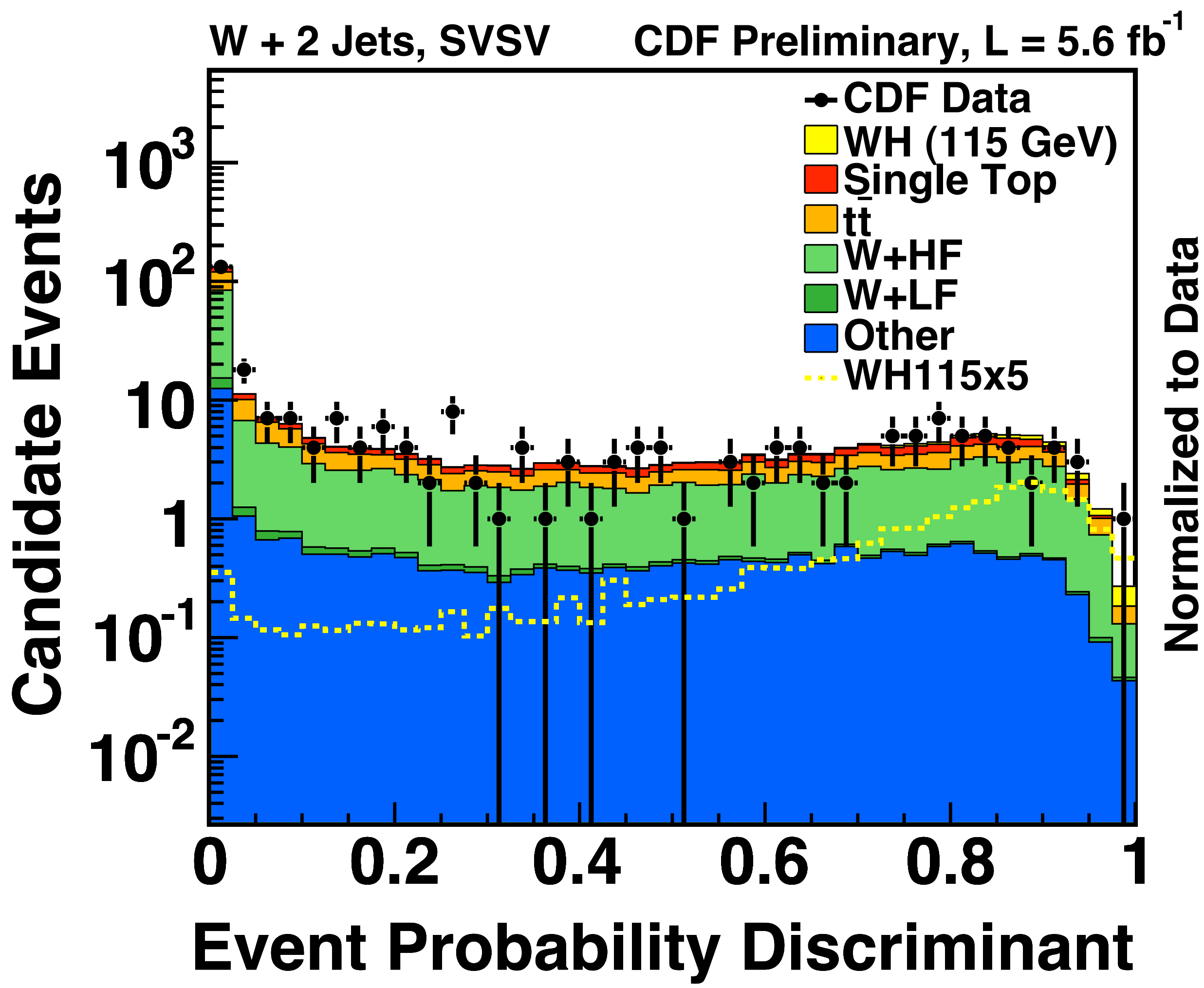
non − W QCD

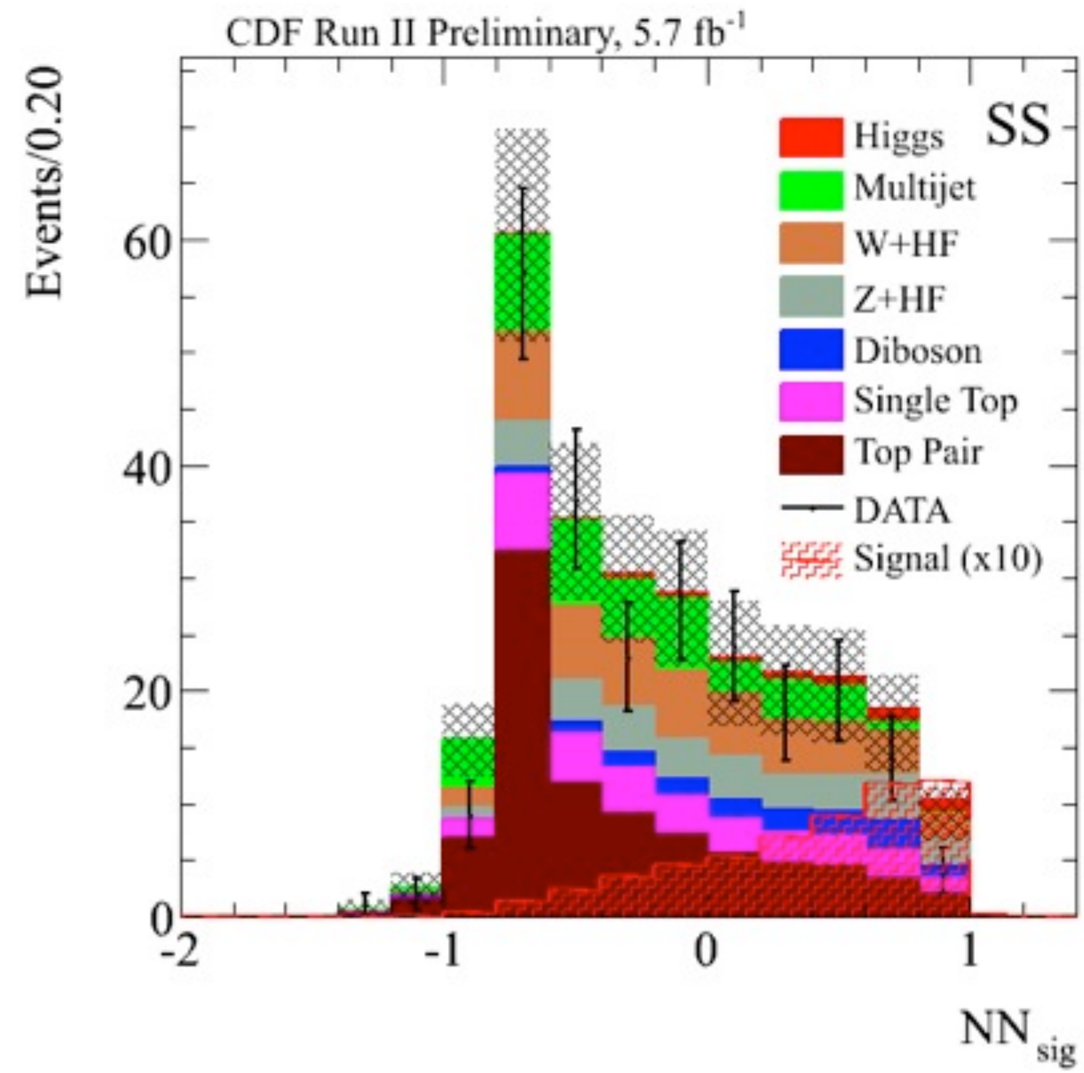
WZ, WW

$Z \to \tau\tau$

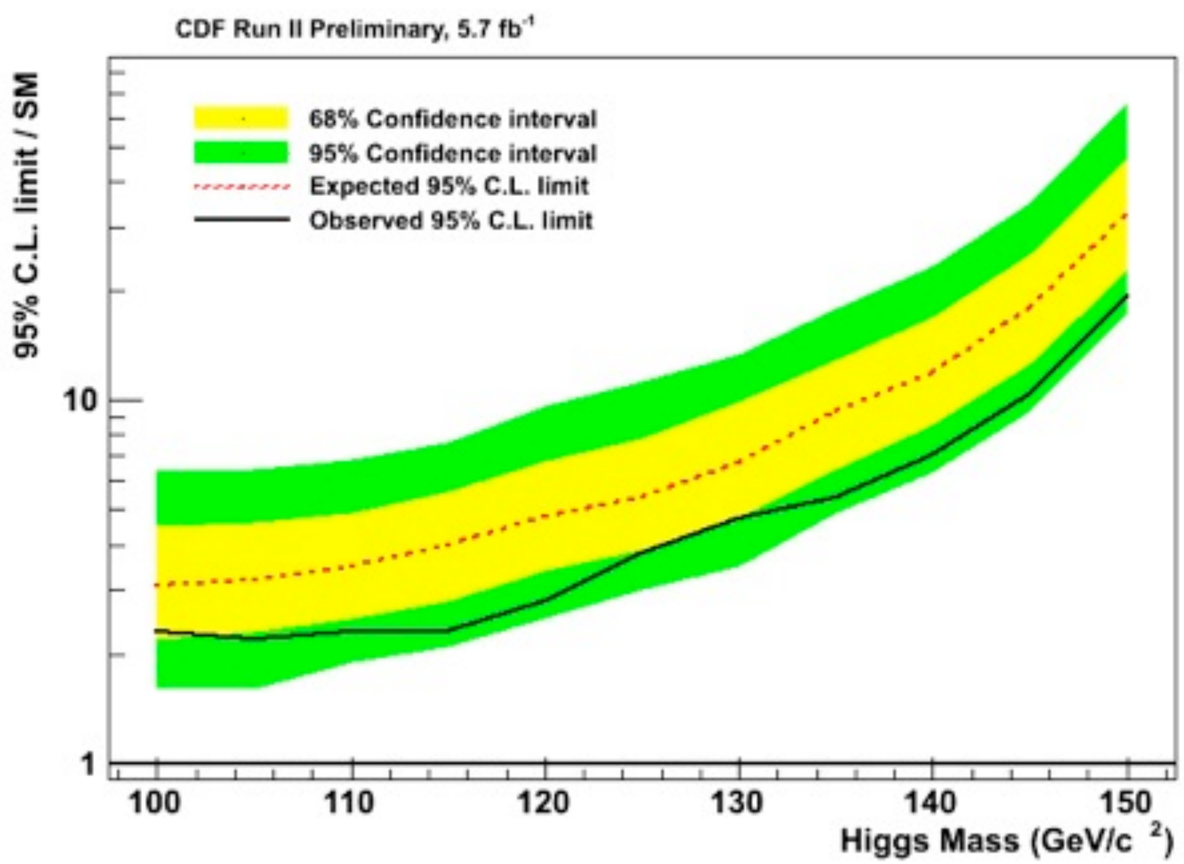
$ZH \rightarrow \nu\nu b\bar{b}$

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

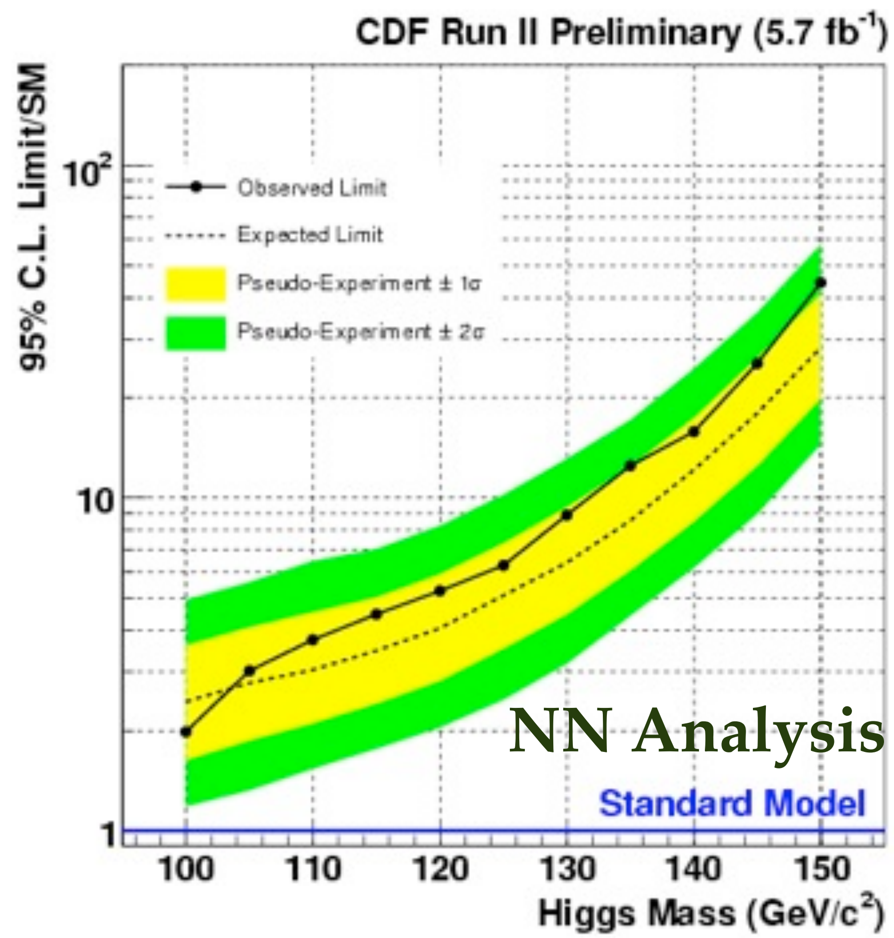




$ZH \rightarrow \nu\nu b\bar{b}$



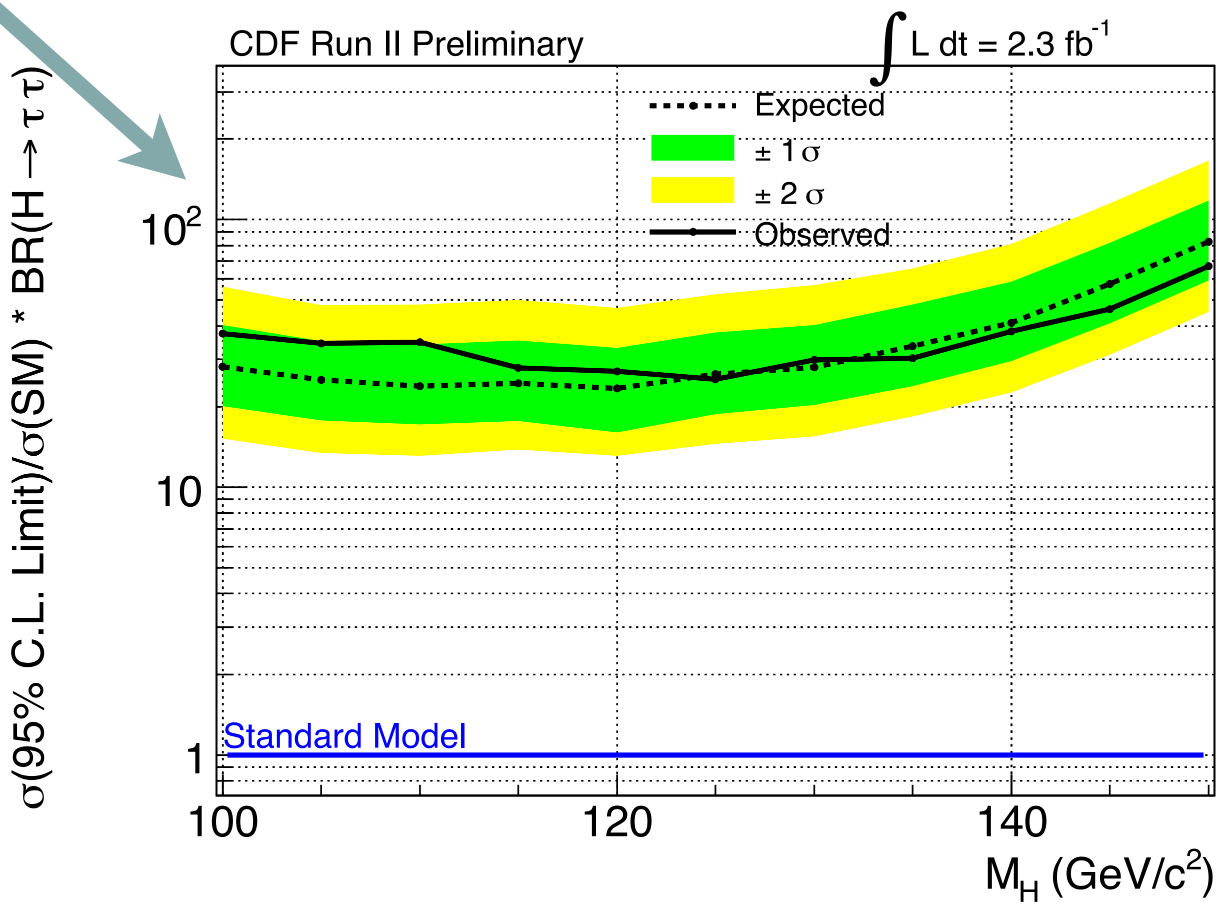
$WH \rightarrow \ell\nu b\bar{b}$



Experiment	Lum	Obs/SM	Exp/SM
CDF Metbb	5.7 fb^{-1}	2.3	4.0
CDF WH	5.7 fb^{-1}	3.6/4.5	3.5/3.4

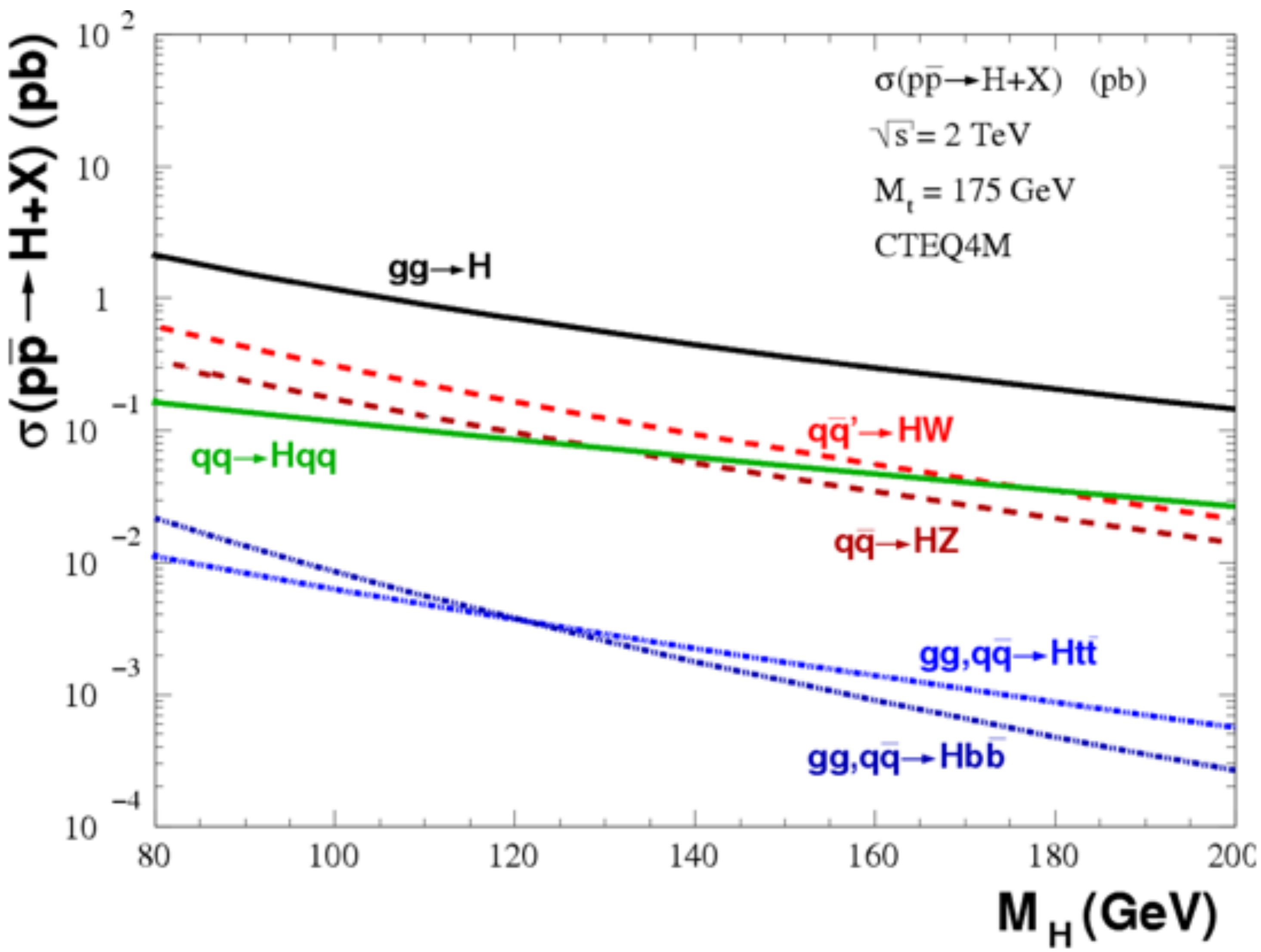
Other Channels...

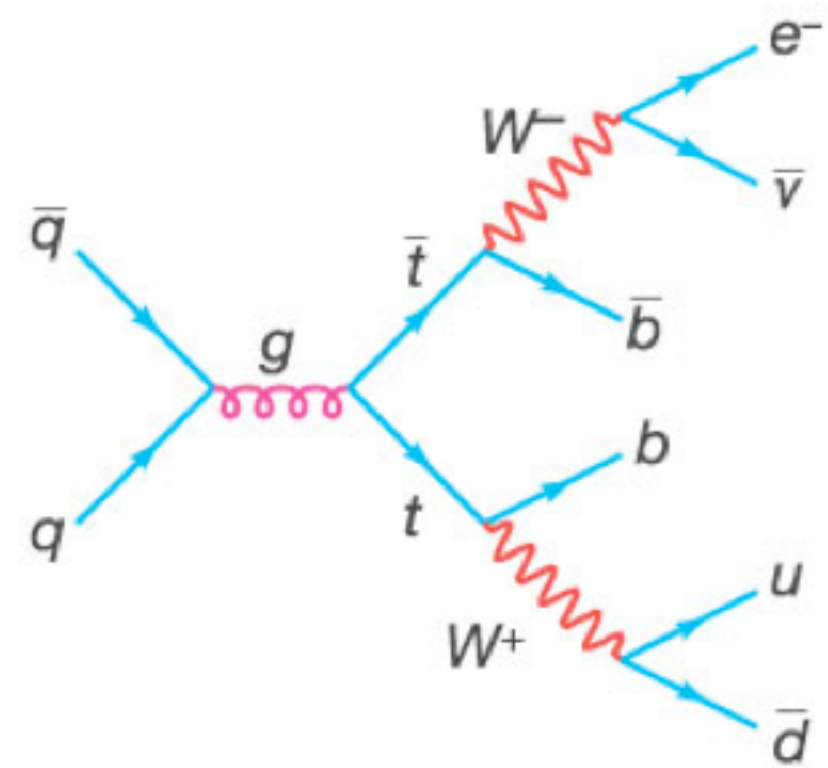
$$t\bar{t}H \rightarrow \ell\nu qq'bbbb$$
$$WH \rightarrow WWW^*$$
$$VH,\ VBF, H \rightarrow \tau\tau + 2j$$

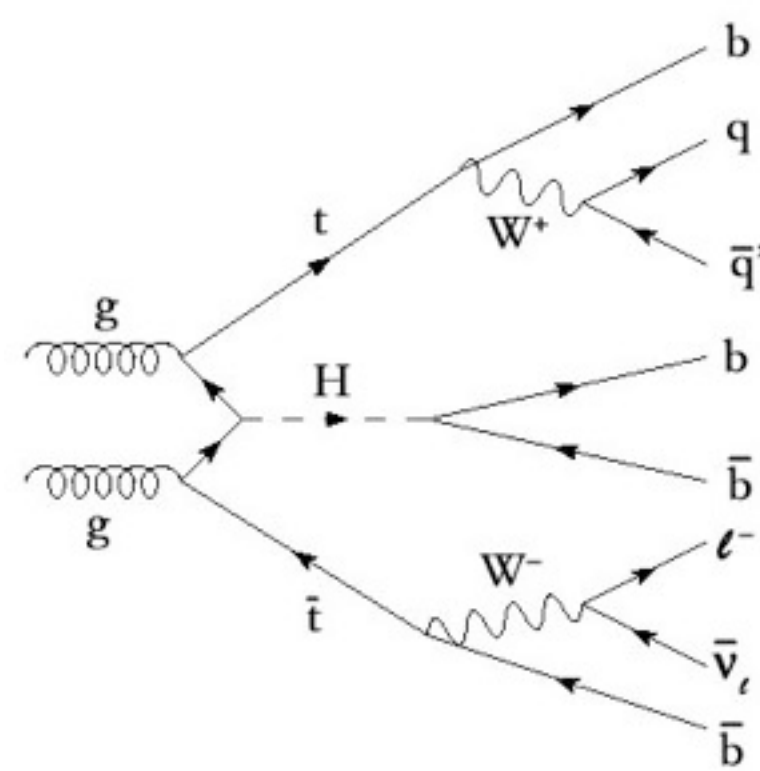


- Other decay chains are also being considered
- IF the SM is correct, these are not as sensitive
- BUT, <u>every little bit helps</u> and <u>nature could be different</u>.

Higgs Production via ttH

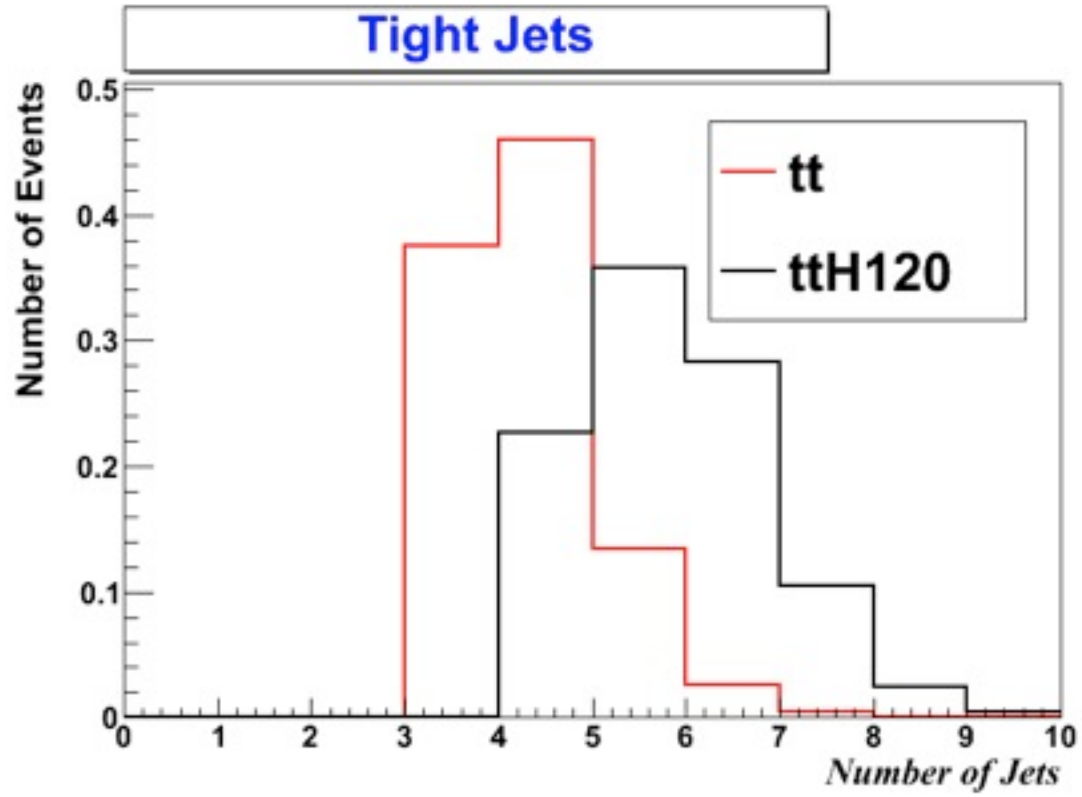


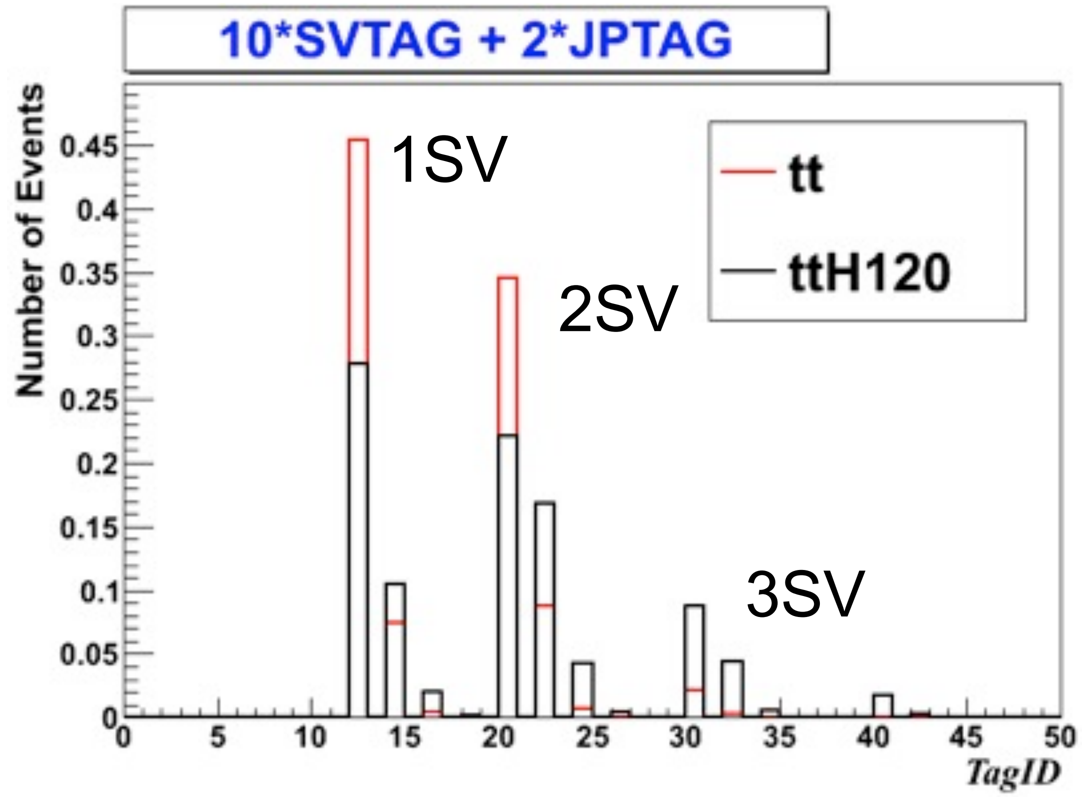




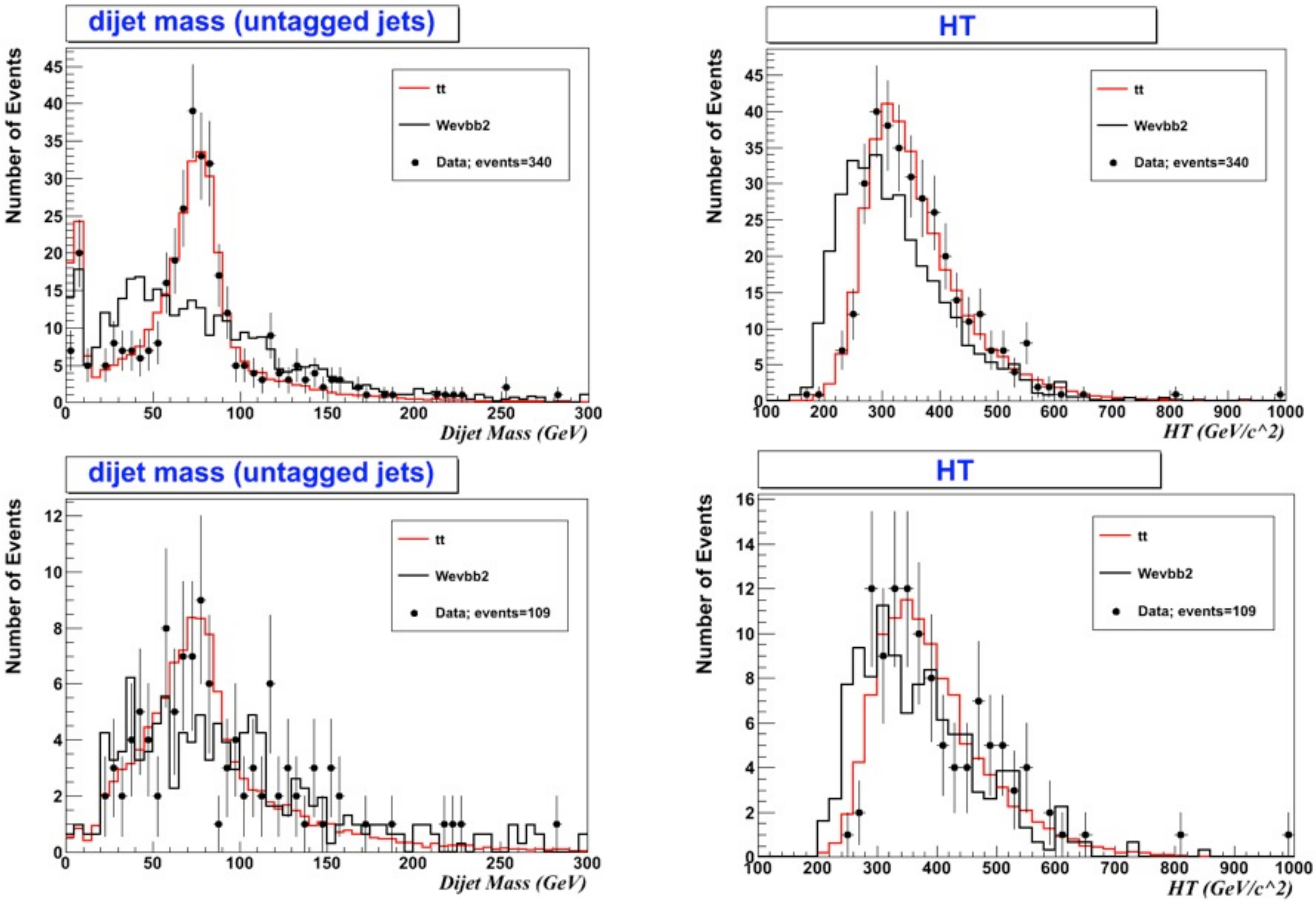
ttH Search Strategy

- Take advantage of the fact that ttH has 4 b's in the final state, plus many jets
  - Require W in final state (hi pt lepton plus met)
  - Require >=5 jets
    - Et > 20 GeV (L5 corrected)
    - |Detector Eta| < 2.0
  - Require >= 2 tags
    - Separate samples based on tagging categories:
      - triple SVX tagged: SVSVSV
      - double SVX+ single JP tagged: SVSVJP
      - single SVX + single JP
      - etc

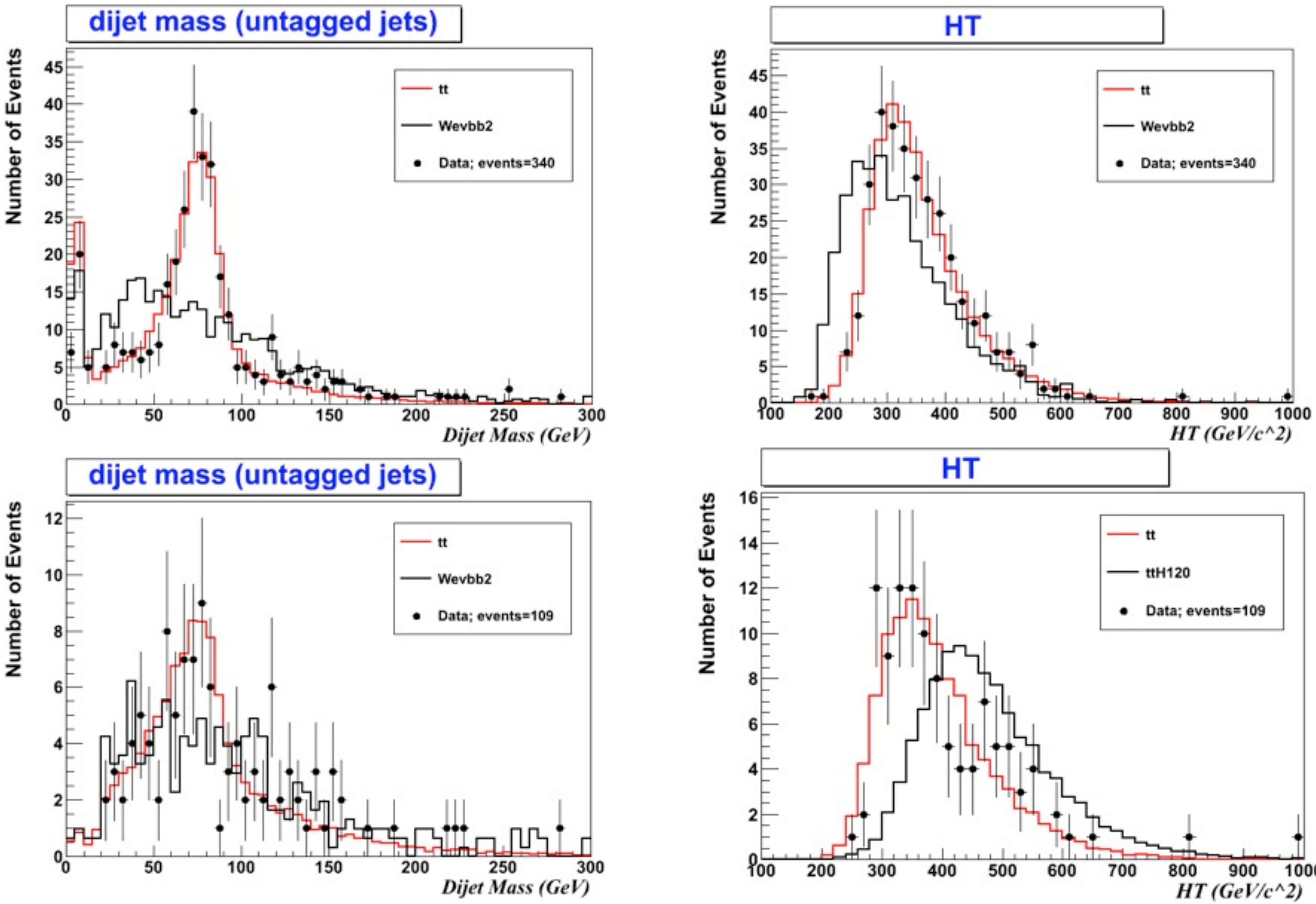




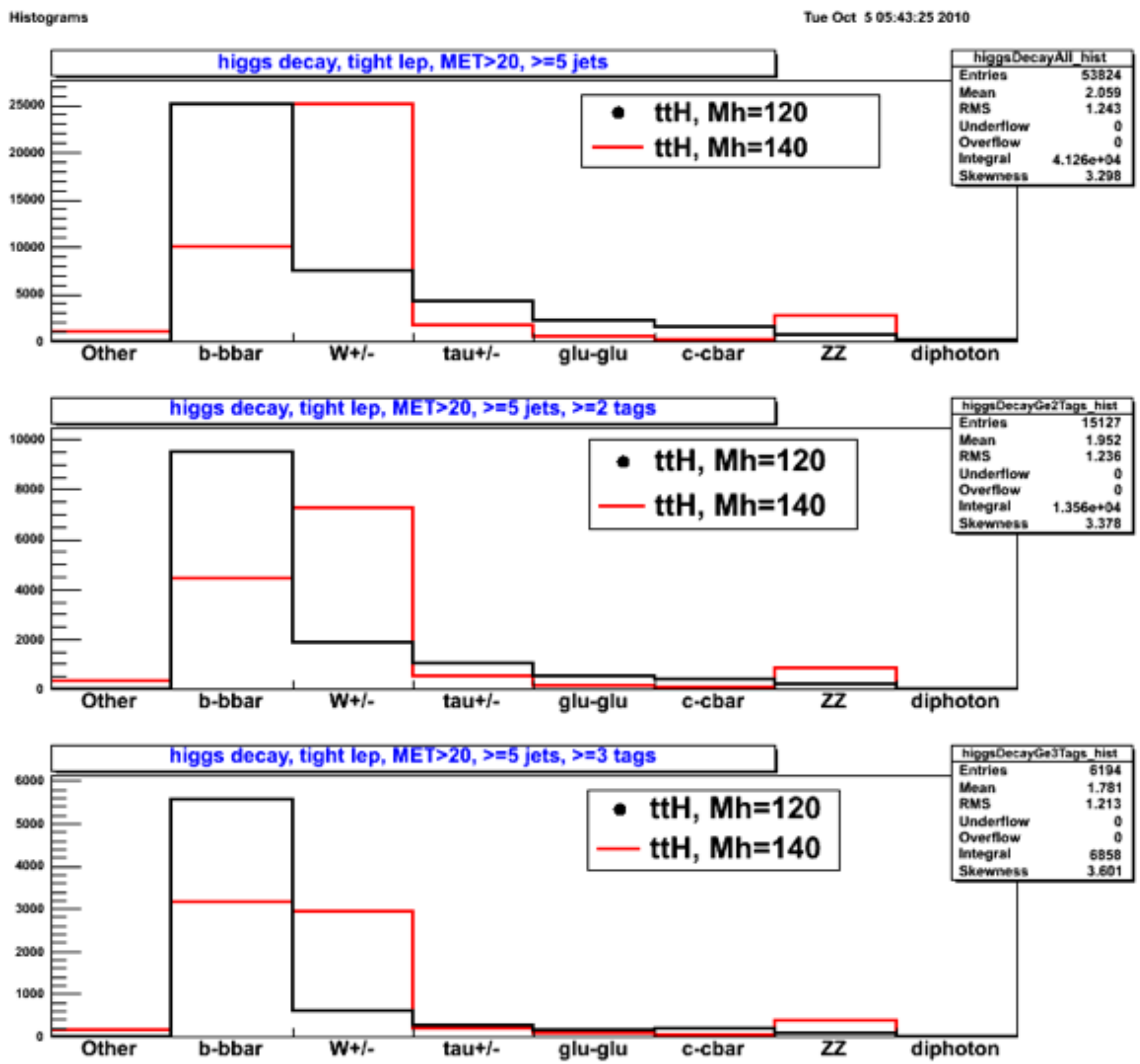
Lepton+MET+>=4Jets+>=2tags...Mostly top



Lepton+MET+>=4Jets+>=2tags...Mostly top



Tagging Contributions for ttH



Requiring 1 tight lepton, MET, plus >=5 jets:

1) It is clear that H->WW decays contribute ALOT to >=2 tags (>20% of bbbar decays) even at Mh=120 GeV.

2) They are even significant for >= 3 tags at 120 GeV.

3) WW decays dominate at 140 GeV for >=2 tags and are about equal to b-bbar decays for >=3 tags.

4th Step...Channel Combination

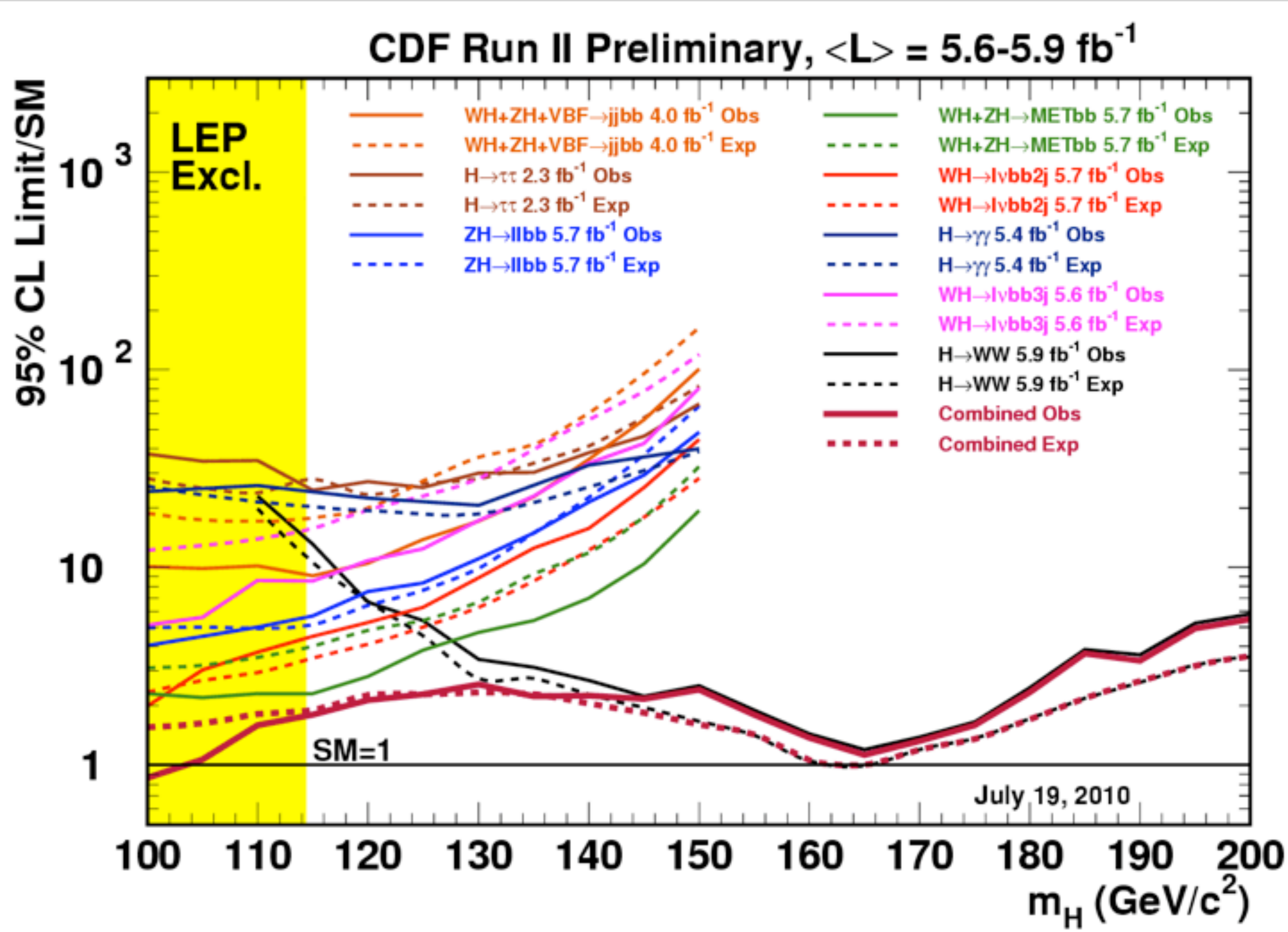
4^{th} Step...Channel Combination

No Single Decay Channel Has Sufficient Power to reach the SM prediction.

4th Step...Channel Combination

No S[...] fficient

- Statistically Combine Channels.

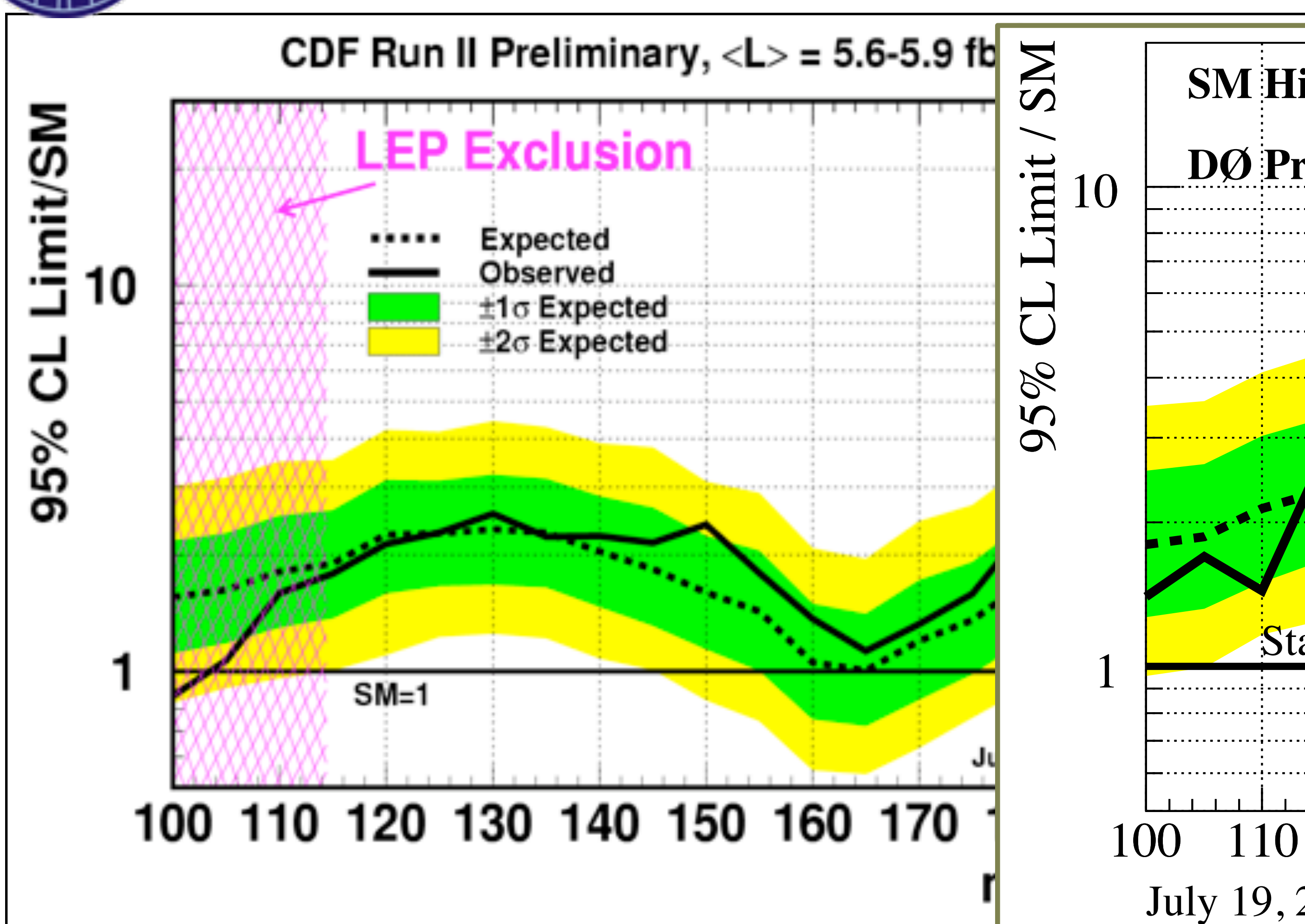


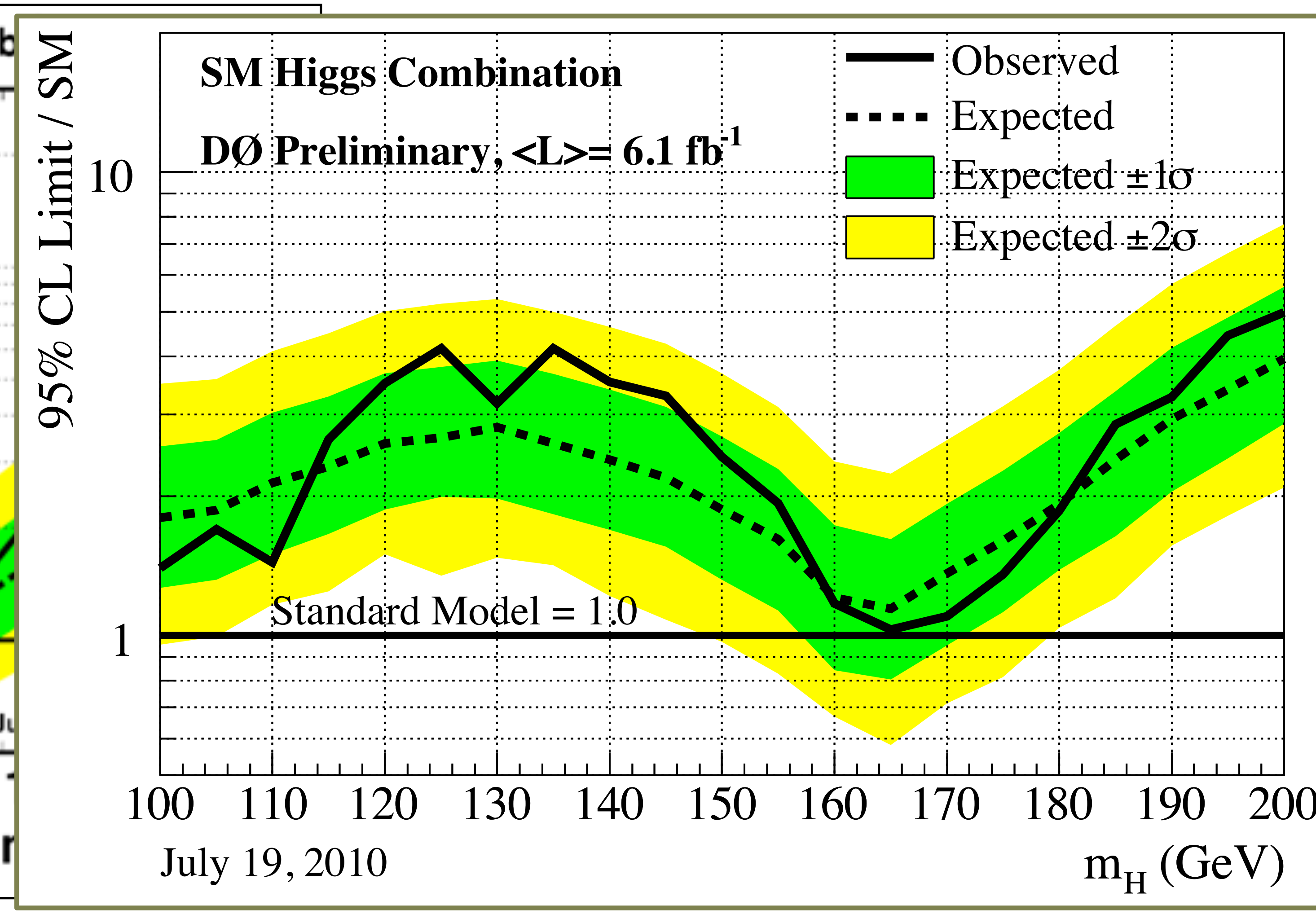
4^{th} Step...Channel Combination

No S fficient

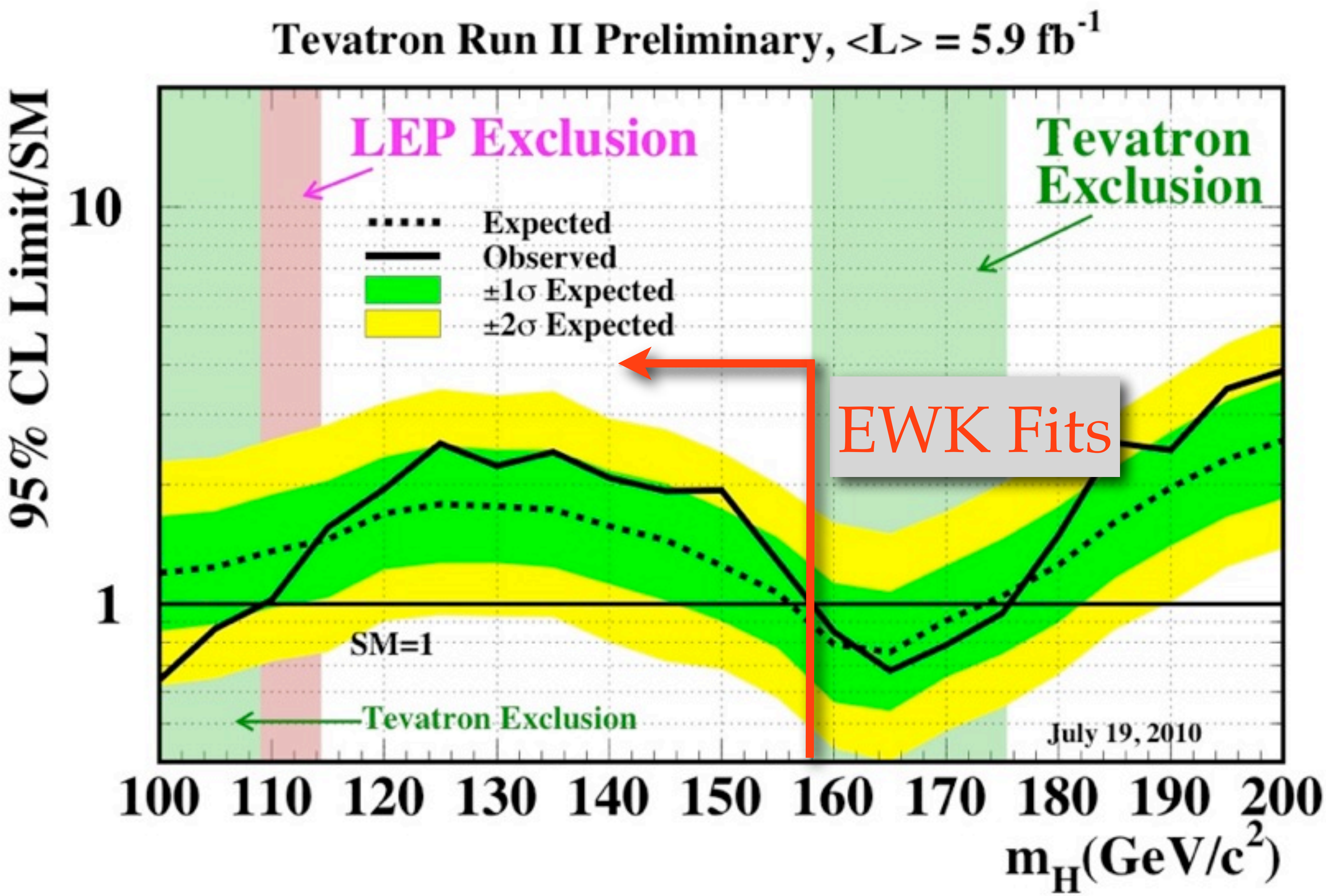
P ion.

- Statistically Combine Channels.
- Use a procedure to properly account for correlated uncertainties.

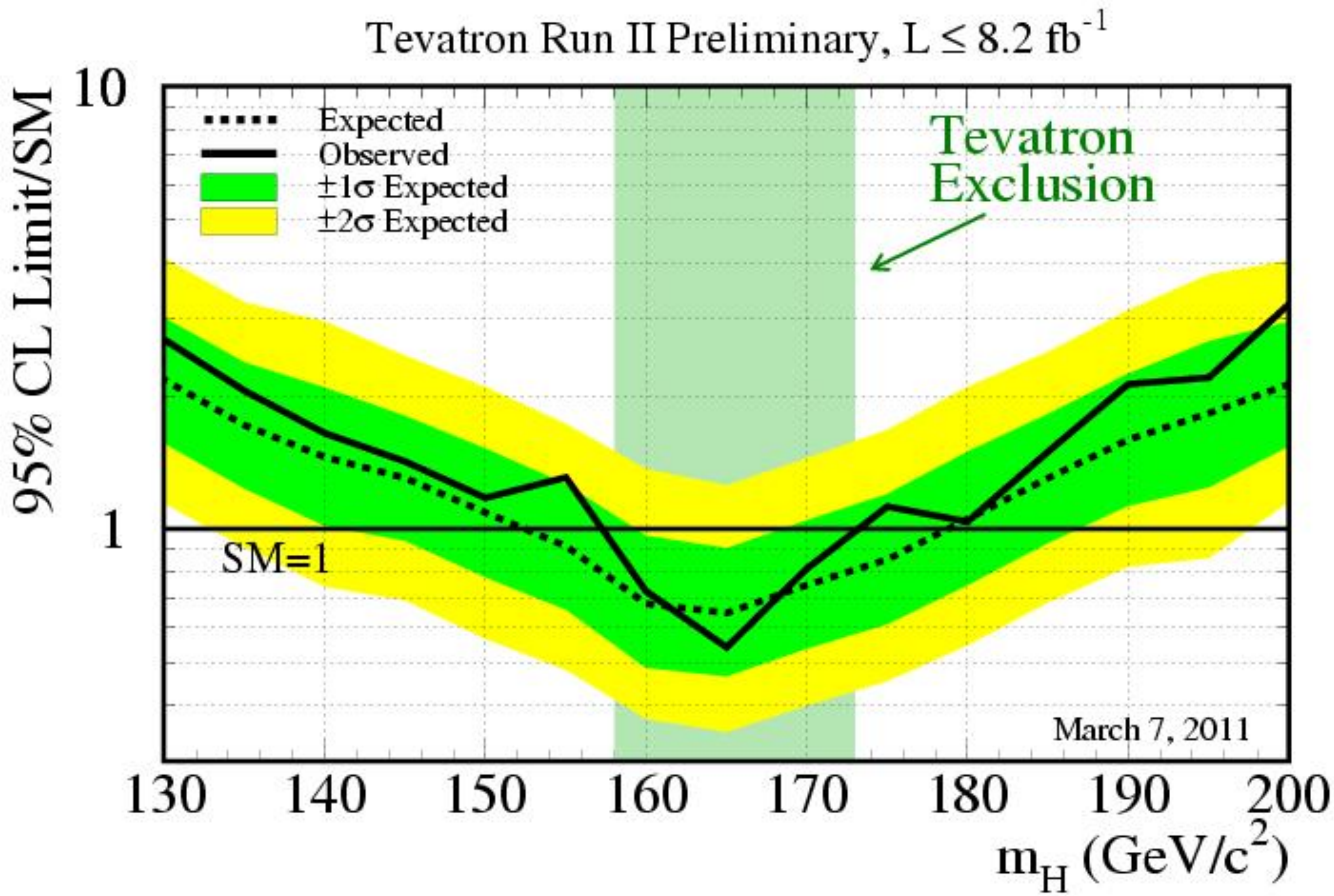




Final Step...Tevatron Combination



Latest High Mass Combination

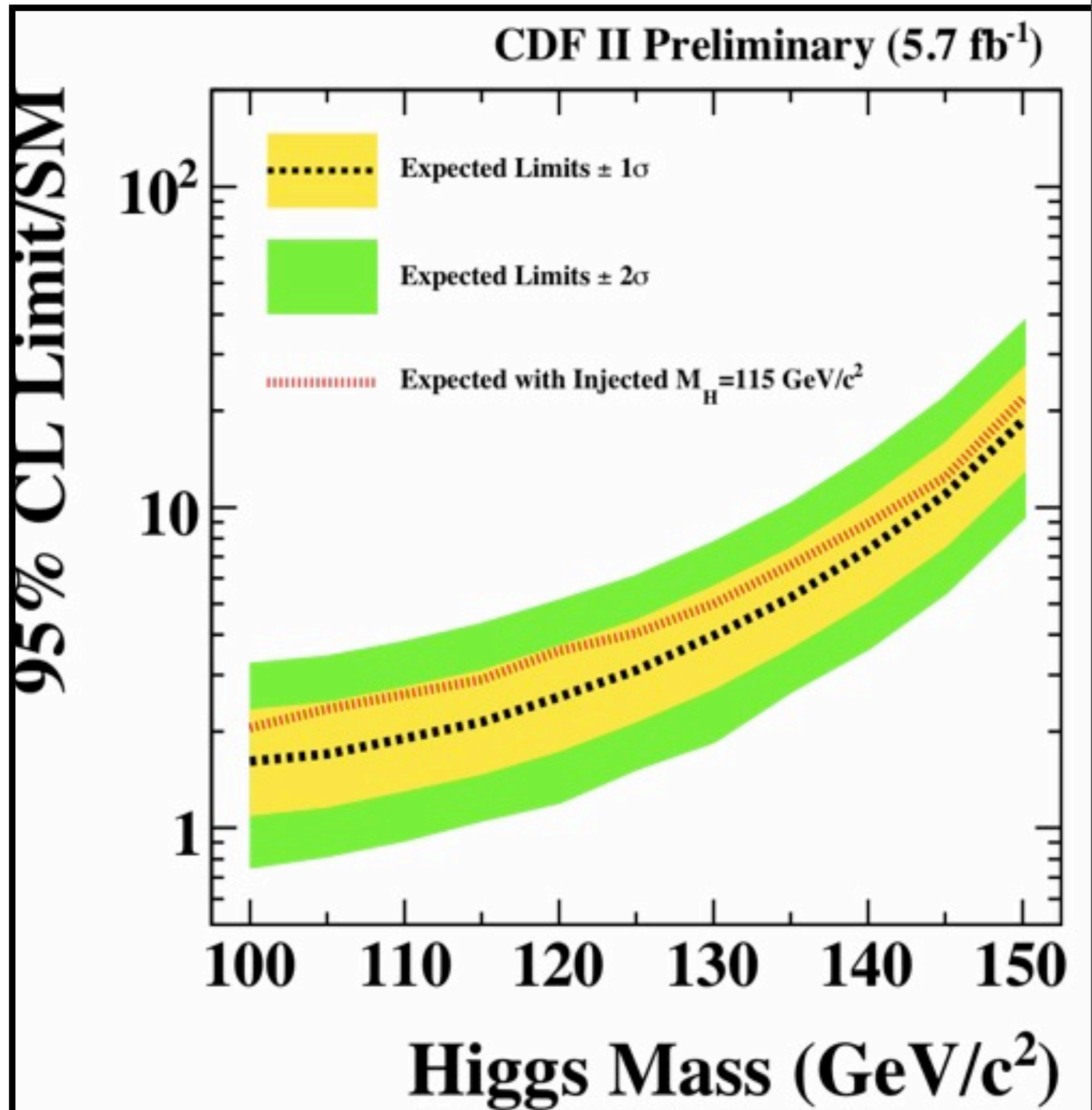


Range Excluded at 95% CL: $158 < m_H < 173$ GeV

Expected Exclusion: $153 < m_H < 179$ GeV

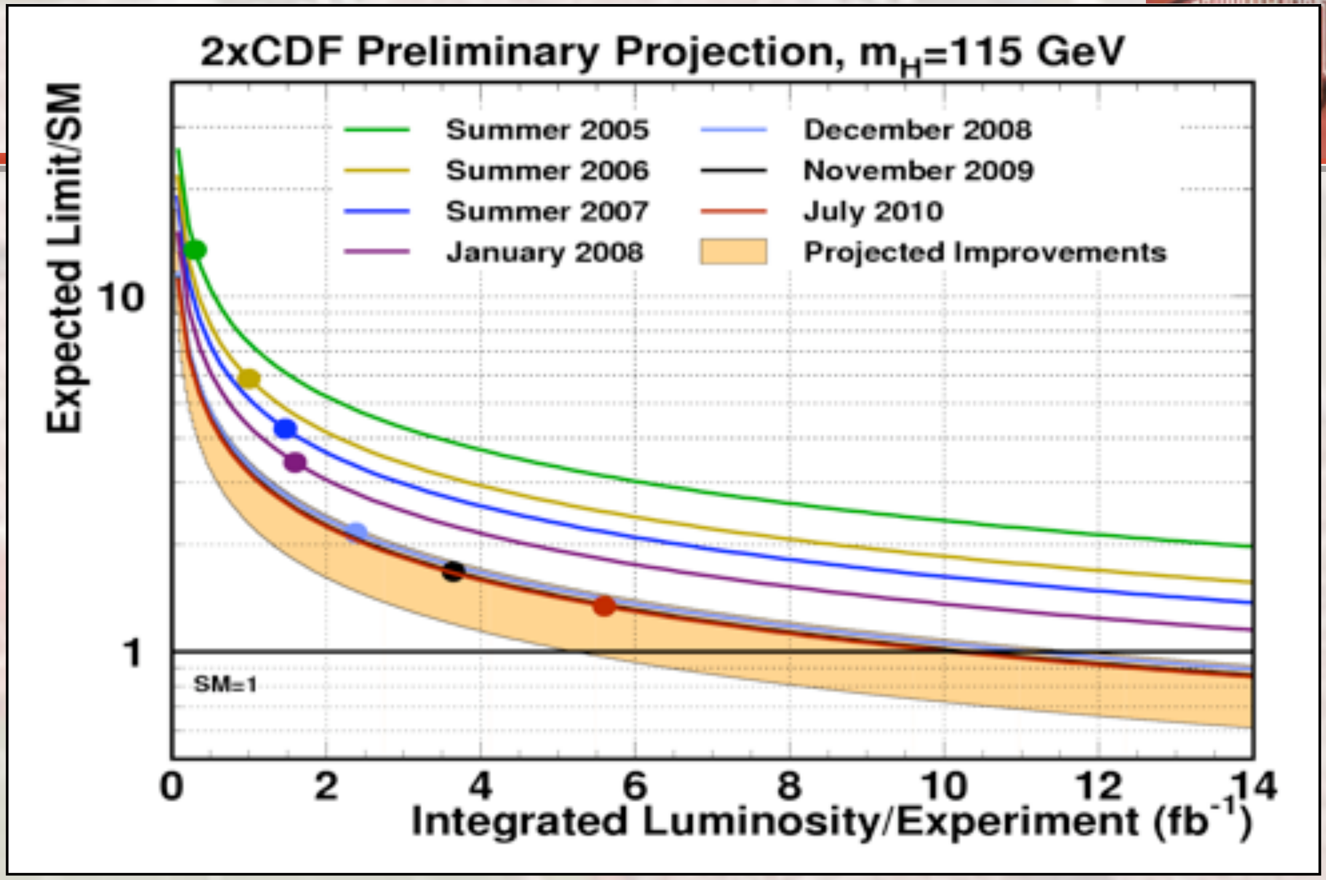
If Higgs is there…what would limit plots look like?

- lvbb, METbb, and llbb channels included
- Inject SM*1.0 signal at m_H=115 GeV on top of SM backgrounds, and generate pseudoexperiments with that.
- Analyze 115 signal+background pseudoexperiments at other test masses –100 GeV to 150 GeV
- Find the median expected limit with injected signal and compare with the distribution of limits when the signal is completely absent.

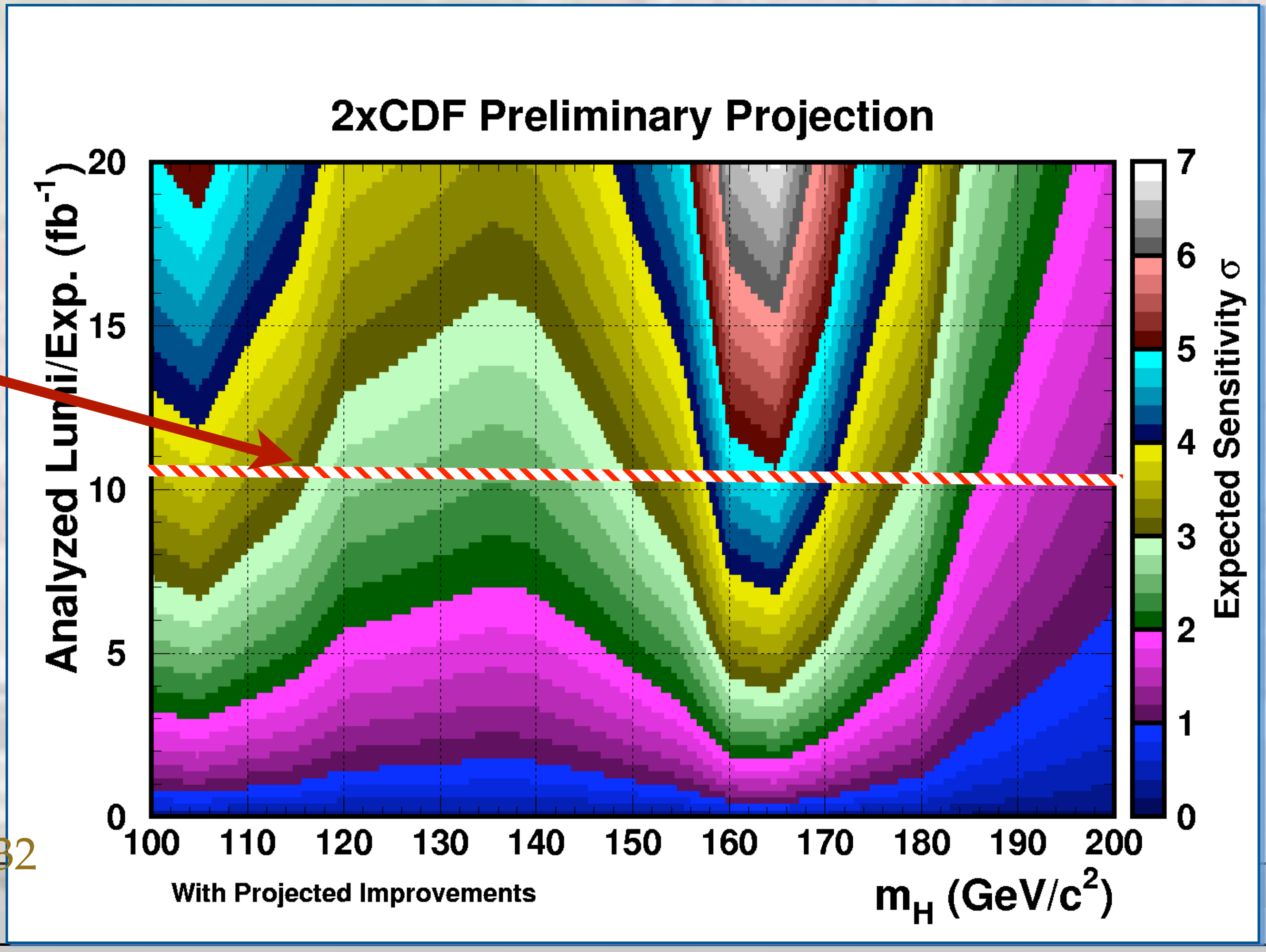


Future Expectations

Delivered luminosity now ~9 fb^{-1} per experiment
Tevatron will deliver ~11 fb^{-1} per experiment by September 2011



Sensitivity to SM Higgs with 10 fb^{-1} per experiment
➡**Better than 2.4 σ expected sensitivity from 100 – 185 GeV**
➡ **3 σ @ 115 GeV**



Future Prospects

Future Prospects

Department of Energy
Office of Science
Washington, DC 20585

Office of the Director

JAN 6 2011

Professor Melvyn Shochet
Chairman, High Energy Physics Advisory Panel
Department of Physics
University of Chicago
5630 S. Ellis Ave
Chicago, IL 60637

Dear Professor Shochet:

I am writing to convey the Office of Science's response to the recent High Energy

Unfortunately, the current budgetary climate is very challenging….operation of the Tevatron will end in September…

program by HEP. P5 therefore recommended that extension of the operation of the Tevatron be approved only if additional funds were available to HEP, and encouraged the funding agencies to find the necessary resources. Unfortunately, the current budgetary climate is very challenging and additional funding has not been identified. Therefore, based in part on the P5 recommendation, operation of the Tevatron will end in FY 2011, as originally scheduled.

The strategic plan for the U.S. particle physics program, developed by P5, attacks the most important scientific questions in three broad areas of the field: the Energy, Intensity,

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Conclusions

- Tevatron program continues to play a strong role in Higgs Physics
- We are continuing to expand the exclusion of the Higgs at high mass
- We are continuing to push on a variety of improvements at low mass
- The experience with the ZH search discussed implies that there are still large improvements which can be made to existing searches at the Tevatron
- Broader implications for searches in progress at the LHC are left to grad students in the audience!