# $H \rightarrow WW$ Trilepton Analysis: Jet Energy Scaling Systematic, $t\bar{t}$ with $b$-jet Matching, Limits Status

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# Summary

# JES Systematic

Jet Energy Scaling: ZH analysis removes NJet=0 bin, so jet energy scaling may be off. We ran separate MC samples with J.E.S. raised/lowered by one standard deviation to determine systematic.

- We adopted no JES systematics for the *WH* analysis
- For the *ZH* analysis, we adopted the following systematics (I double checked these values to make sure there were no rounding errors and revised them slightly):
  - $WZ$: 0.097[1]
  - $ZZ$: 0.052[2]
  - $Z\gamma$: 0.088[3]

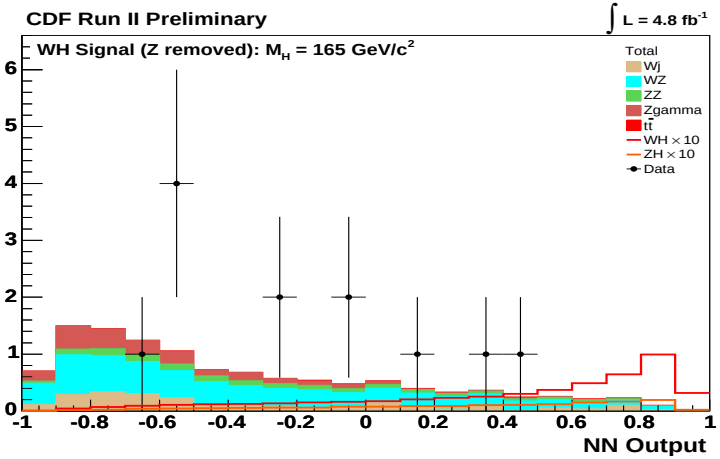
[1] Revised from 0.098
[2] Revised from 0.053
[3] Revised from 0.086

# JES **Shape** Systematic

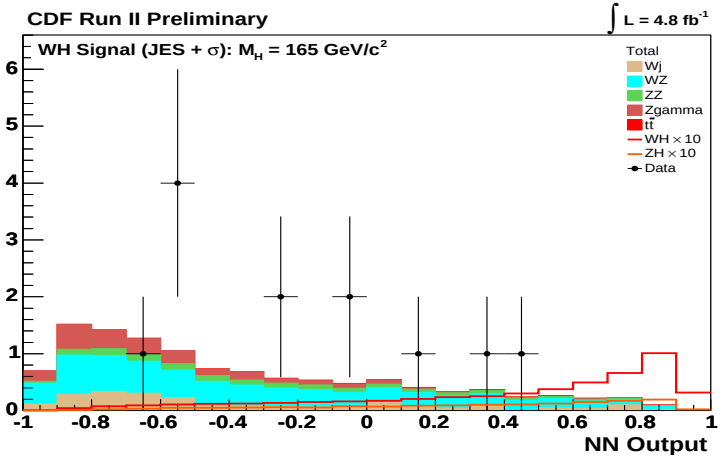
We adopted a few systematics based on the total count, but does the **shape** of the neural net output change even if the count does not? A change in shape could affect the limits–even if the total count remains the same– if there is a shift toward or away from the signal region.

*WH* **($m_H = 165$ GeV) Analysis–Shape Comparison:** Again, the *WH* analysis does not remove jet bins, so the jet energy scaling should not be affected.

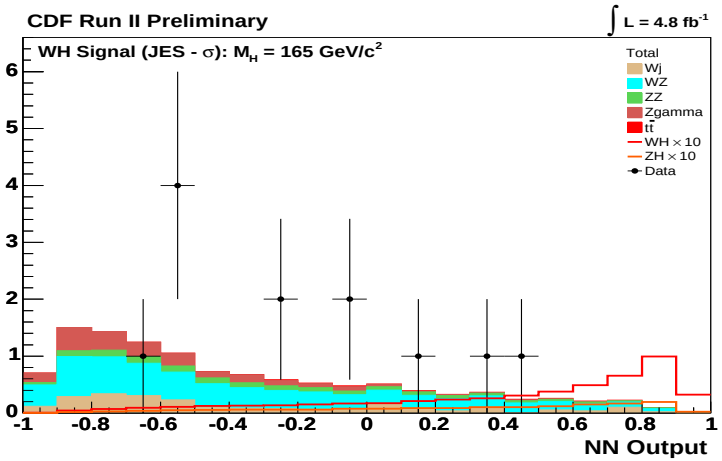
Standard




JES $+1\sigma$




JES $-1\sigma$



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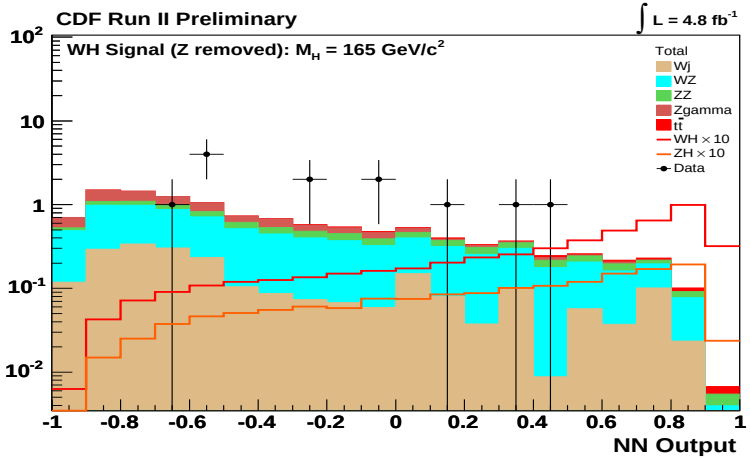
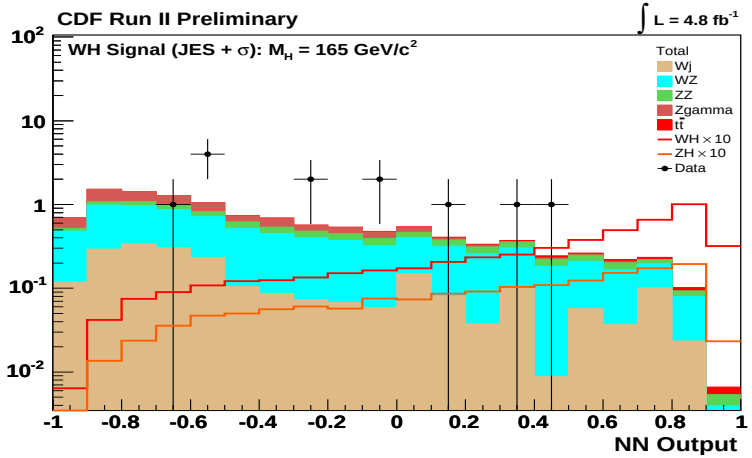
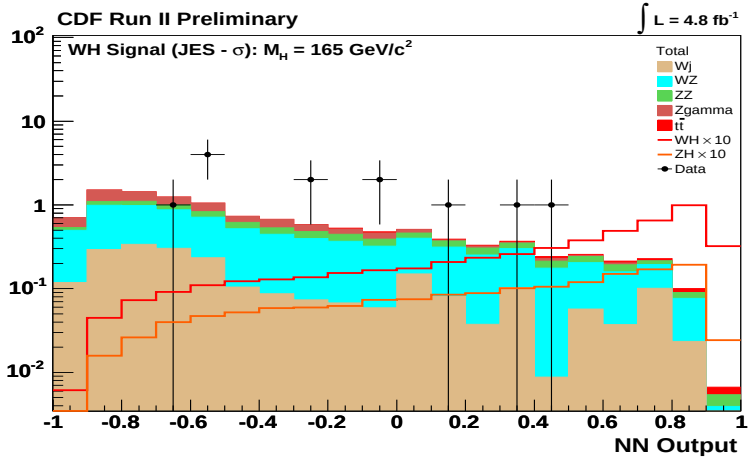



JES +1$\sigma$

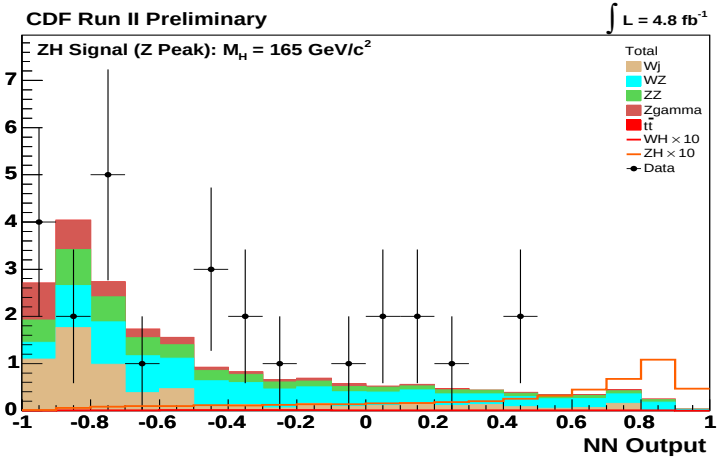



JES -1$\sigma$

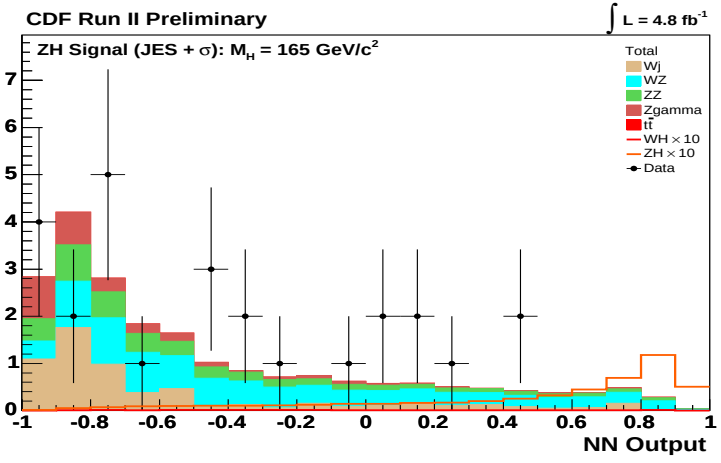


*ZH* **($m_H = 165$ GeV) Analysis–Shape Comparison:** The *ZH* analysis does remove the NJet$=$ 0 bin as a control region, so could be affected.

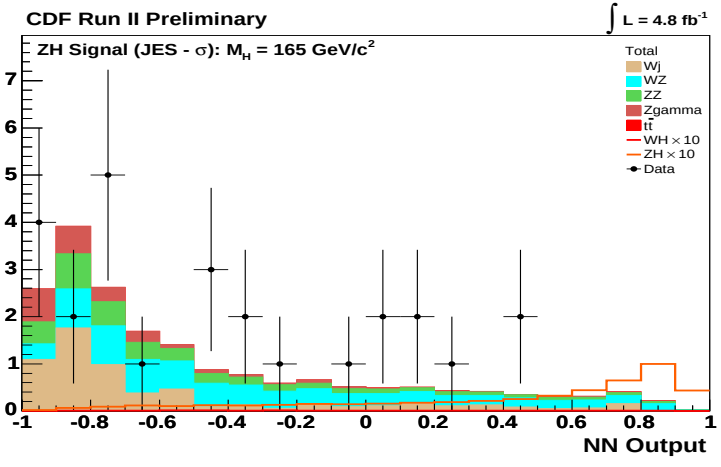
Standard




JES +1$\sigma$

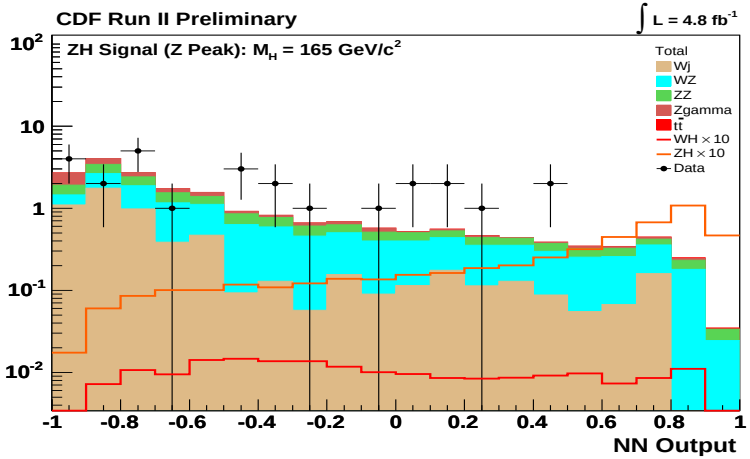



JES -1$\sigma$

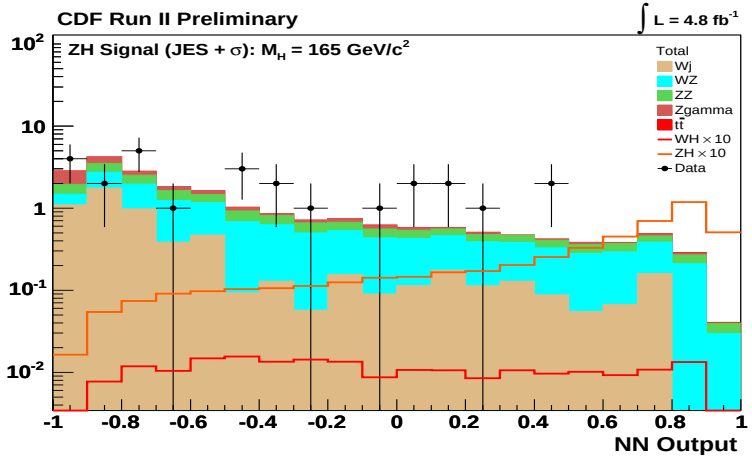


**$ZH$ ($m_H = 165$ GeV) Analysis–Shape Comparison:** The $ZH$ analysis does remove the NJet$=0$ bin as a control region, so could be affected.

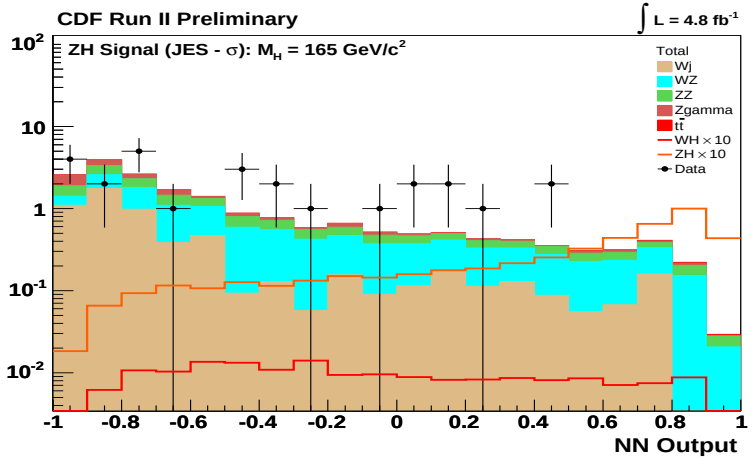
Standard




JES $+1\sigma$




JES $-1\sigma$



# $t\bar{t}$ w/ $b$-Jet Matching

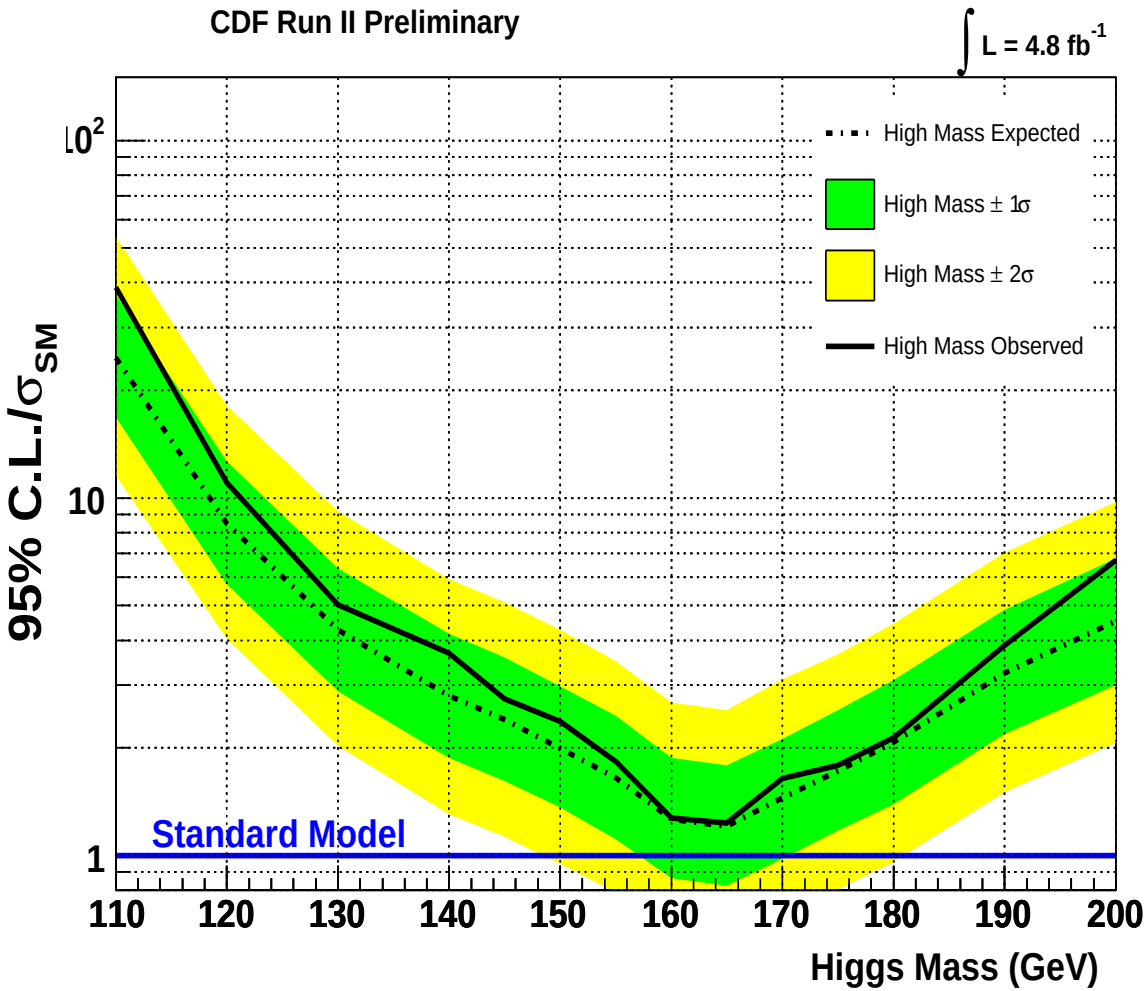
- In preblessing, my result used the standard $t\bar{t}$ sample, but I should have been using the $t\bar{t}$ MC sample that allows leptons to match to generator-level $b$-jets (in addition to leptons and photons). There was a problem with this causing the limit calculation to crash.
- Problem solved: there were undefined cross section, branching fraction, and filter efficiency values in the ntuple.

# $H \rightarrow WW$ Limits Without Trileptons

Without trileptons, the $H \rightarrow WW$ limits stand at [at $m_H = 165$ GeV]:

- Expected: 1.21
- Observed: 1.23

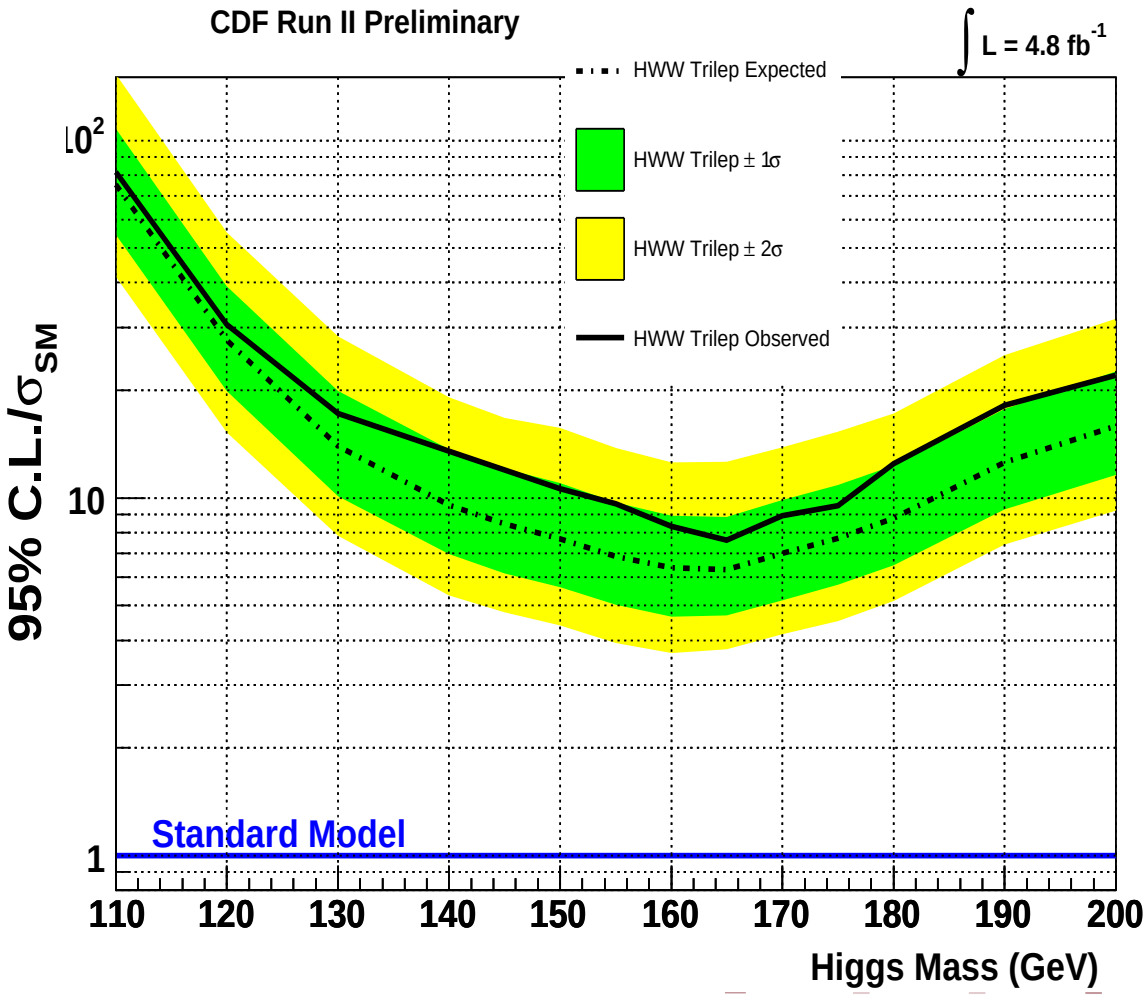
Note that the observed limits are higher than expected limits.



# Trilepton Limits Alone

Here also, the observed limits are higher than expected limits in the 165 GeV bin.

- Expected: 6.37
- Observed: 8.33

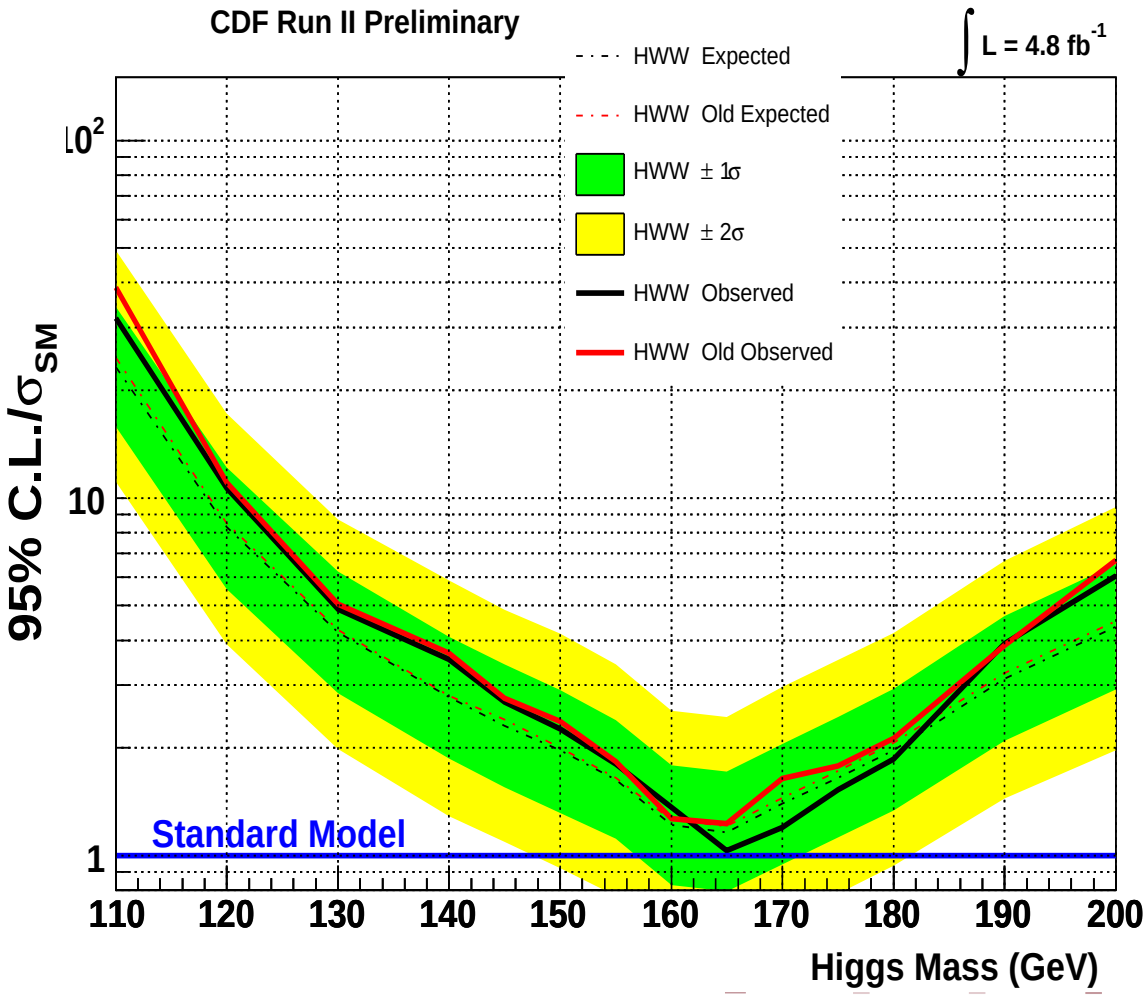


# $H \rightarrow WW$+Trileptons

Although both the old $H \rightarrow WW$ limits and trilepton-alone limits show observed higher than expected, together the observed limit drops below the expected. Is this possible? The $H \rightarrow WW$+trileptons limits stand at [at $m_H = 165$ GeV]:

- Expected: 1.15
- Observed: 1.03

Hypothesis: The trilepton limits constrain backgrounds higher in the other $H \rightarrow WW$ analyses, leaving less room for signal.

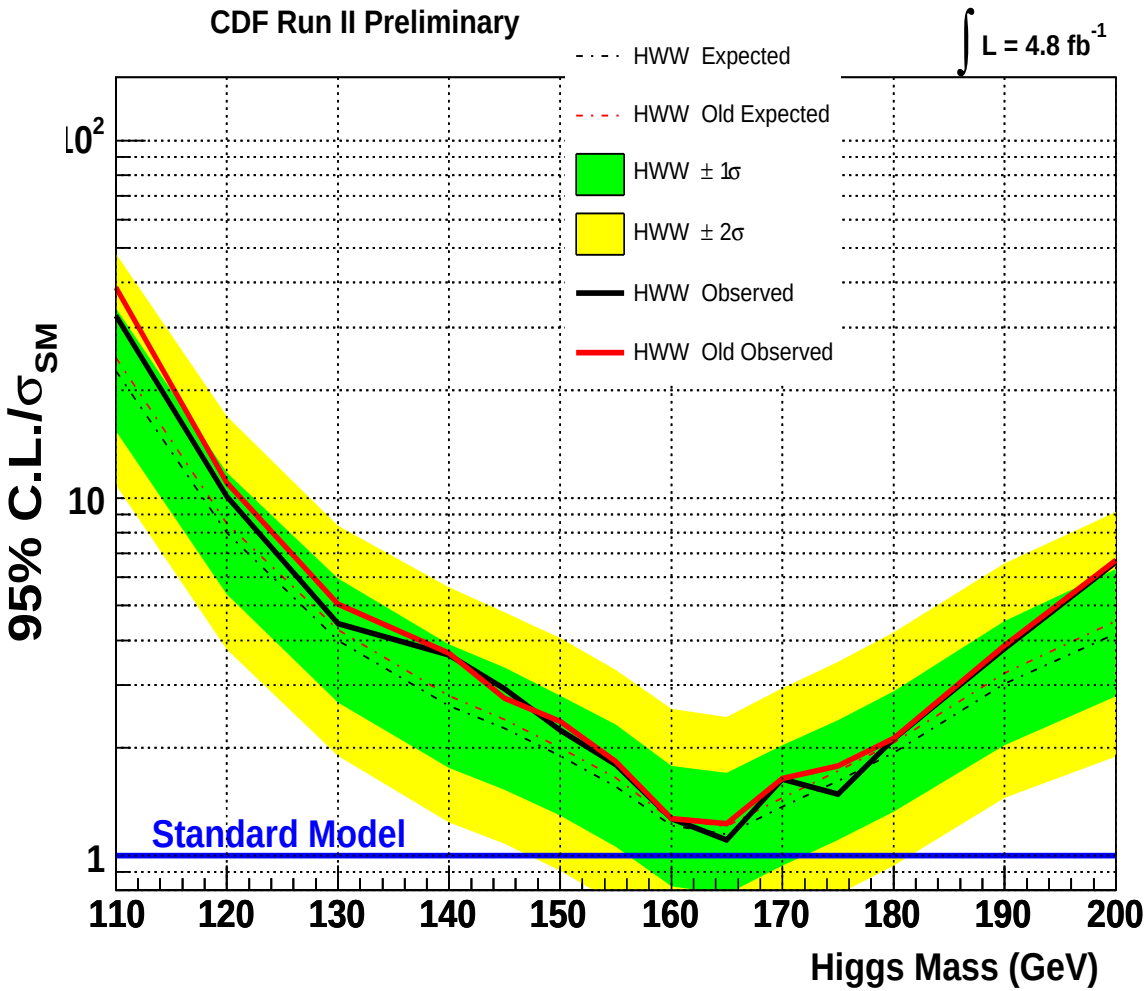


# $H \rightarrow WW$+Trileptons

We decorrelated the systematic errors on the $WZ$ and $ZZ$ backgrounds from the rest of the analyses and the observed limit rose from 1.03 to 1.10. So this appears to be at least part of the answer. The $H \rightarrow WW$+trileptons limits stand at [at $m_H = 165$ GeV]:

- Expected: 1.14
- Observed: 1.10

Anything else? $Z\gamma$ has a 12% systematic correlated to the $W\gamma$ background of the dilepton analyses–still waiting on CAF for this one.



# Conclusions

- Jet energy scaling shape systematic probably not necessary.
- Proper $t\bar{t}$ MC sample now being used.
- Dip in observed limits partially explained by correlation between $WZ$ ,$ZZ$ backgrounds in the trilepton analyses and those in the dilepton analyses.
- To-Do:
  - Check for gluon fusion signal in Fakes background.
  - Update the trilepton note [CDF10020].