Closing in on Higgs at CDF

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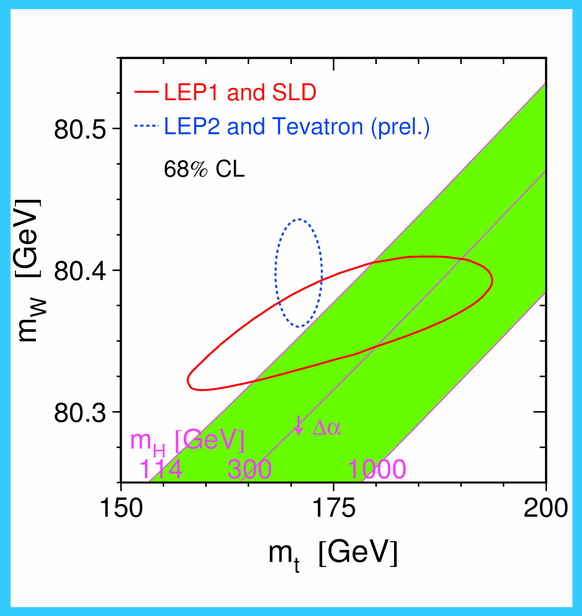
Higgs: The Last Piece of the Standard Model . . . .

The Higgs mechanism in the Standard Model explains:

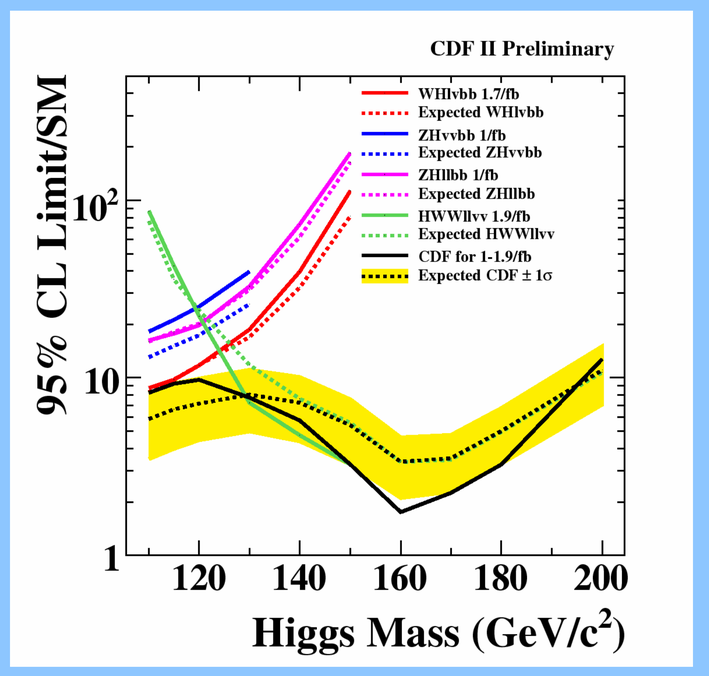
- Electroweak symmetry breaking
- Particle masses

Discovering the Higgs boson would help provide answers to these remaining fundamental questions of the Standard Model



LEP determined the Higgs mass > 114 GeV
Indirect evidence prefers a Higgs mass < 144 GeV

Combined CDF Limits for Standard Model Higgs



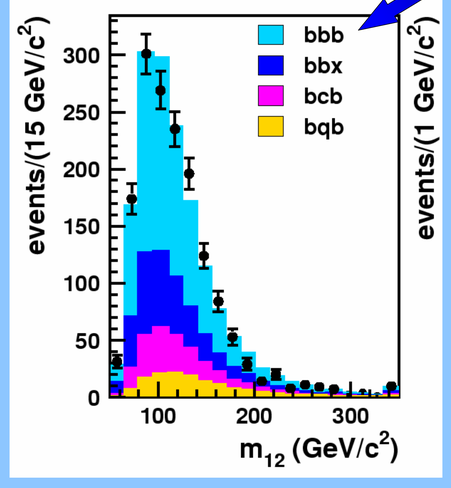
- CDF searches in many different channels
- No evidence yet → Set upper limit
- Enormous strides in last couple of years due to Tevatron performance, greater understanding of data, and advanced analysis techniques

Must combine results from multiple searches to cover all possible Higgs masses

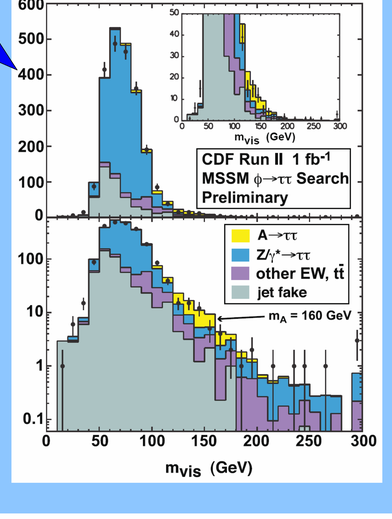
. . . Or a Part of a New Model: Supersymmetry

Minimal supersymmetry (MSSM) predicts 5 Higgs bosons

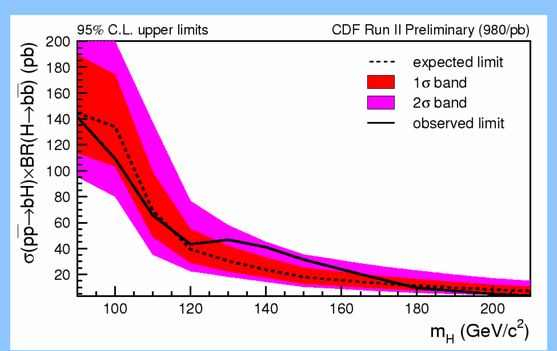
- One neutral MSSM Higgs may be similar to Standard Model Higgs with greatly enhanced cross section
- Look for evidence in $b\bar{b}$ or $\tau^+\tau^-$ final states

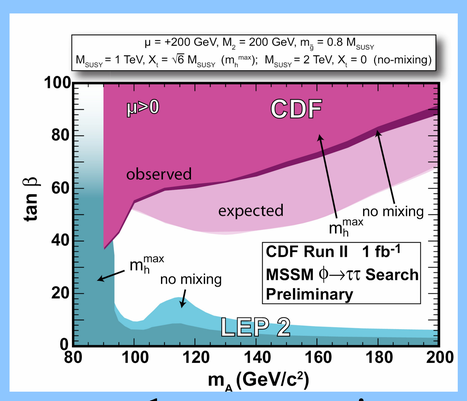


Higgs signal would appear as resonance in invariant mass distribution



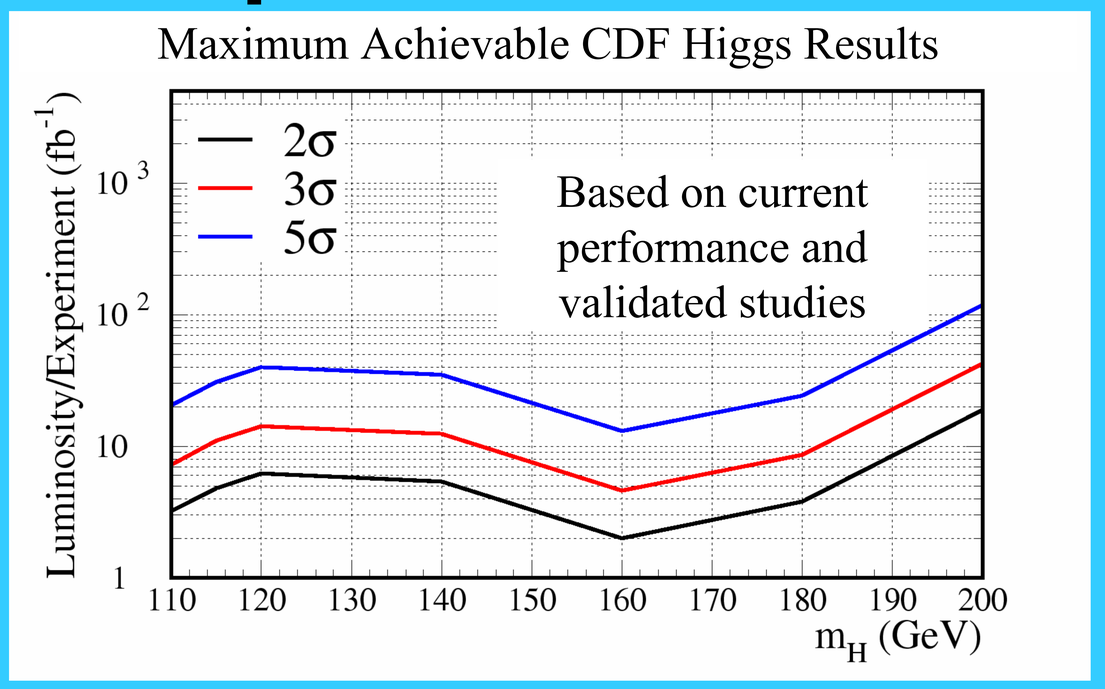
No signal observed → Set upper limits on σ×BR





Limits interpreted as constraints on MSSM parameters

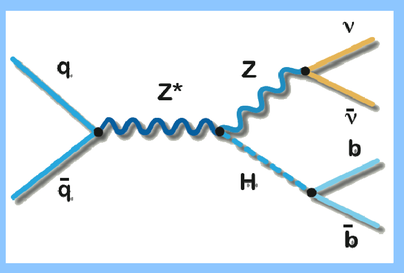
Prospects for the Future



Luminosity required for exclusion (2σ), evidence (3σ) and observation (5σ), assuming more aggressive analysis improvements are realized:

- Increases in trigger acceptance and efficiency
- Inclusion of tau decay modes
- Improved *b*-tagging and forward tracking
- Improved jet energy resolution
- More sophisticated multivariate analysis techniques

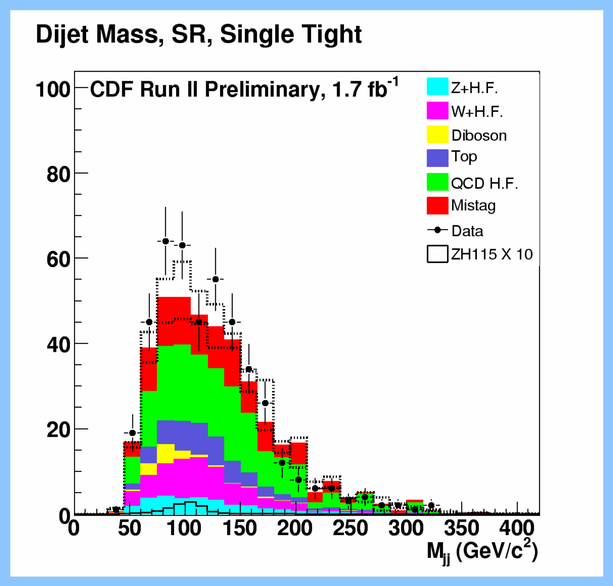
Plenty of ideas to improve on current results!



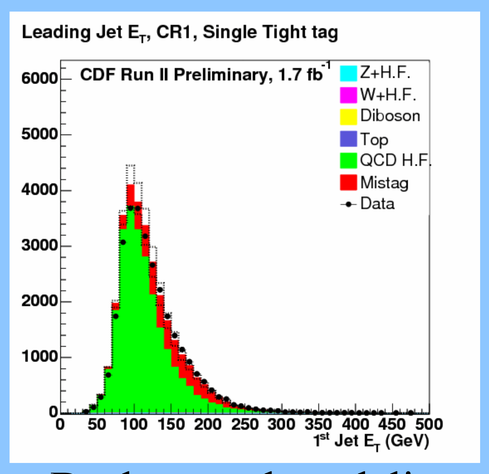
ZH→ ννbb̄

Signature: Large missing transverse energy (MET) and two *b* jets

- Leading background: QCD $b\bar{b}$ production
- Also sensitive to WH production in case of failure to reconstruct charged lepton from W

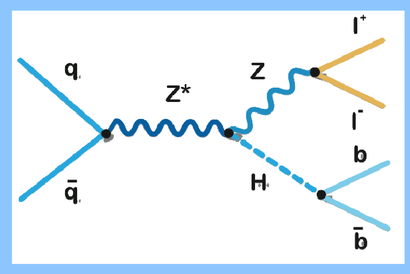


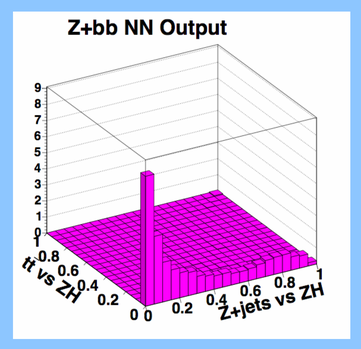
Search for dijet invariant mass resonance

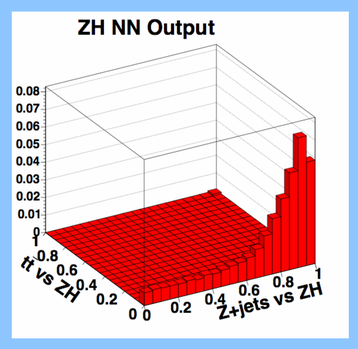


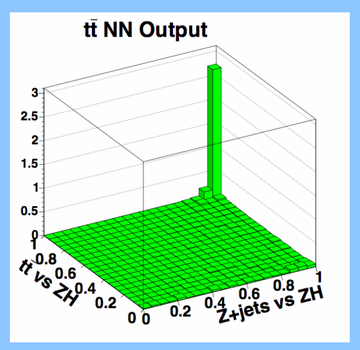
Background modeling tested in control regions

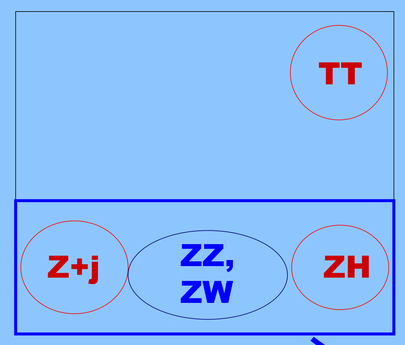
ZH→ *llbb̄*







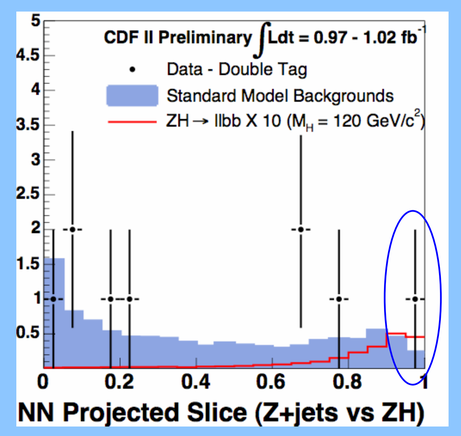




Two dimensional neural network combines kinematic information to separate ZH signal from backgrounds

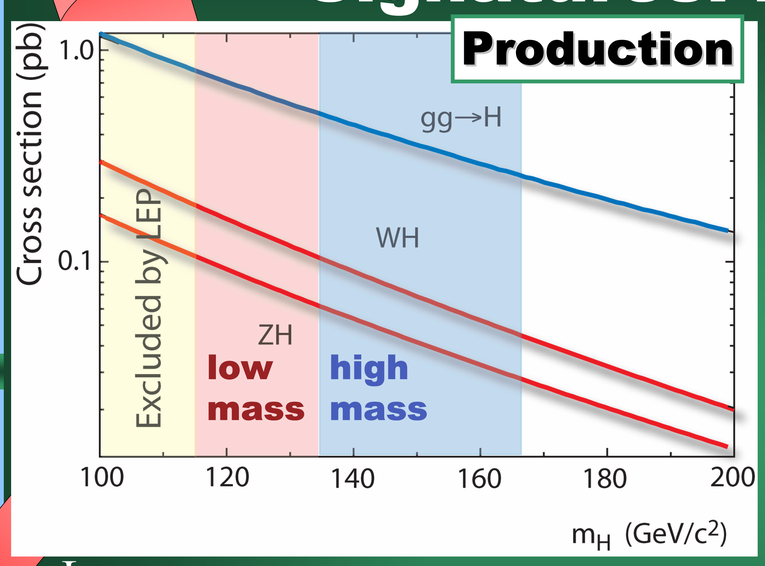
Search for an excess in the "ZH corner"

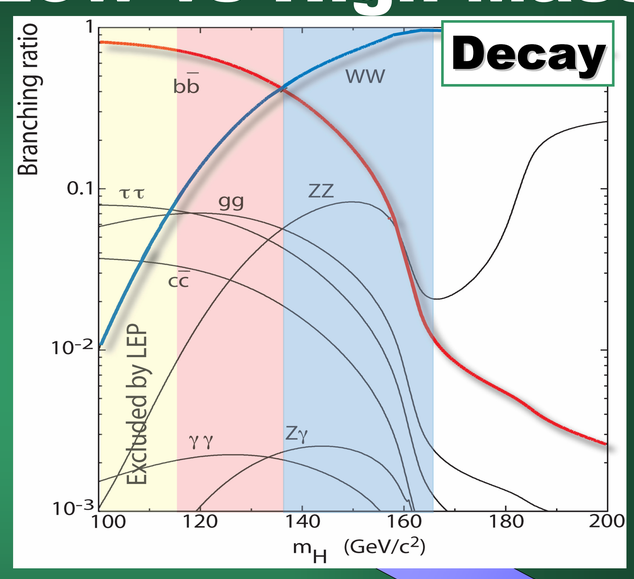
Z+jets slice



Observe one event in bin with S:B ~ 1:4!

Signatures: Low vs High Mass





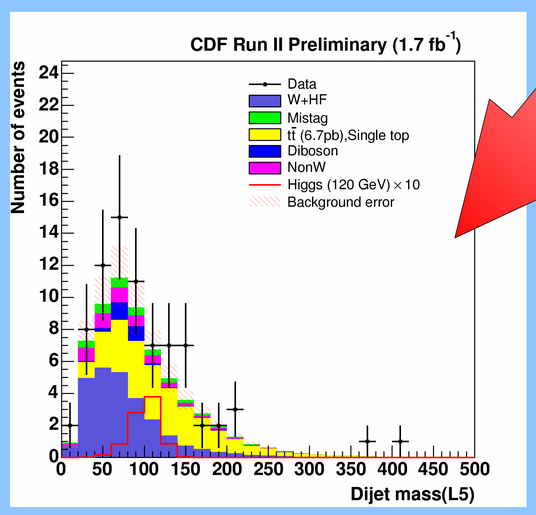
Low mass

- Mainly H→$b\bar{b}$
- Search for associated production: manageable backgrounds

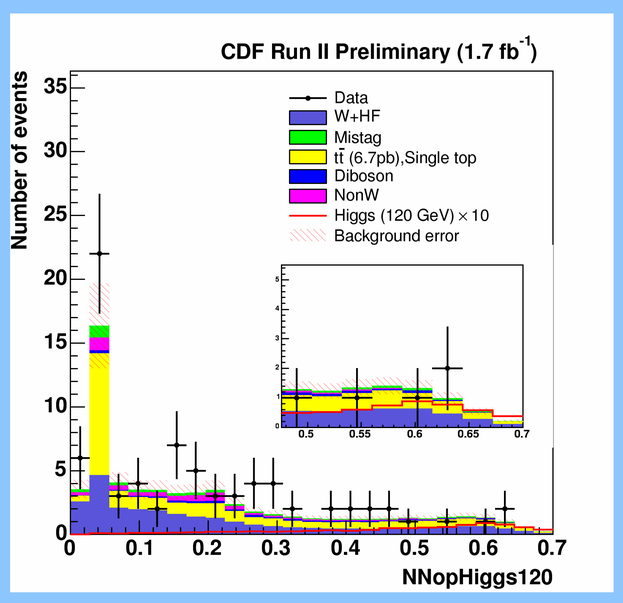
High mass

- Mainly H→*WW*
- Clean signal: search for direct production

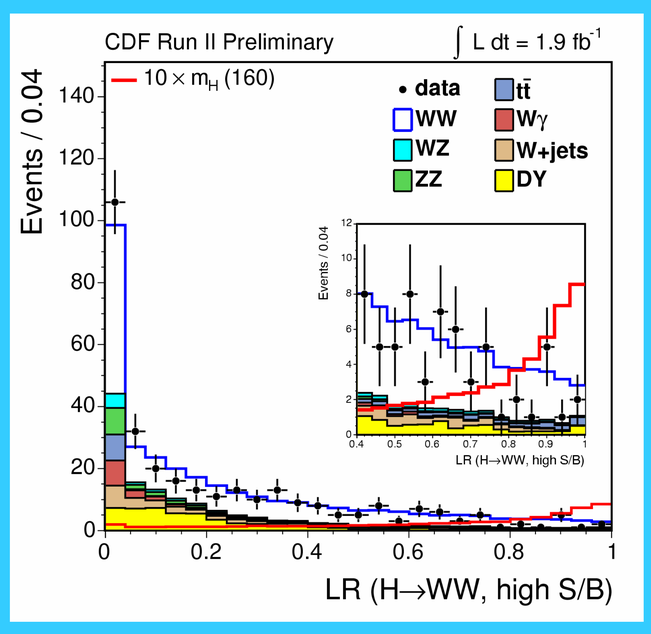
- Use matrix element for H→WW signal and backgrounds to calculate likelihood ratio discriminant
- Special lepton identification to maximize acceptance
- Combining with NN analysis for increased sensitivity



- Combine multiple *b*-tagging algorithms for increased signal acceptance
- Combine kinematic information in an artificial neural network to improve signal to background separation over dijet mass alone

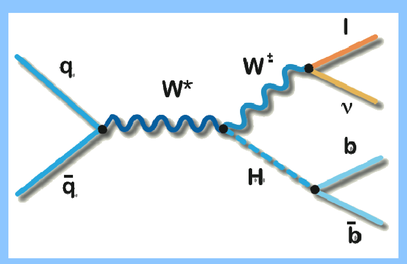


Search for an excess in high NN output values



Search for an excess of events with high value of likelihood ratio

Limit at Higgs mass of 160 GeV only a factor of two above Standard Model expectation!



WH→ *lνbb̄*

H→ WW