Search for a Low Mass Standard Model Higgs Boson at DØ

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on behalf of the DØ Collaboration

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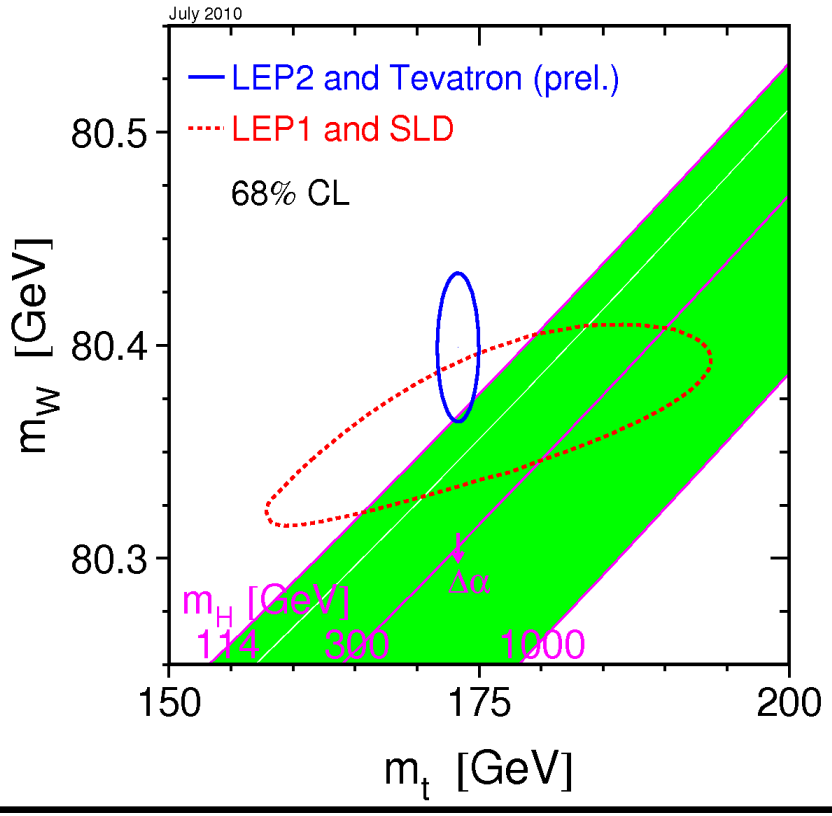
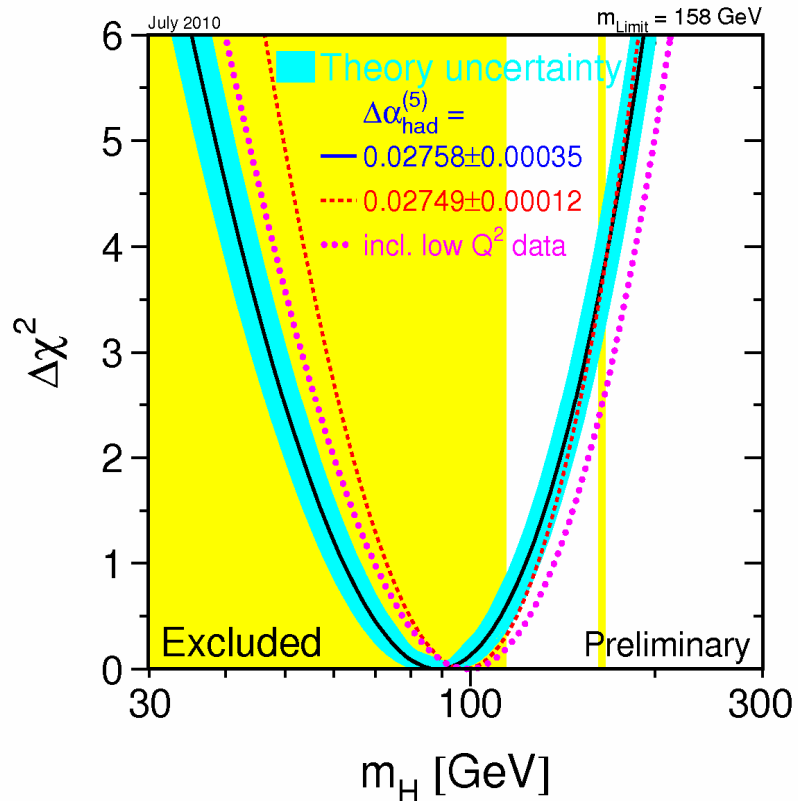
Standard Model Higgs Boson

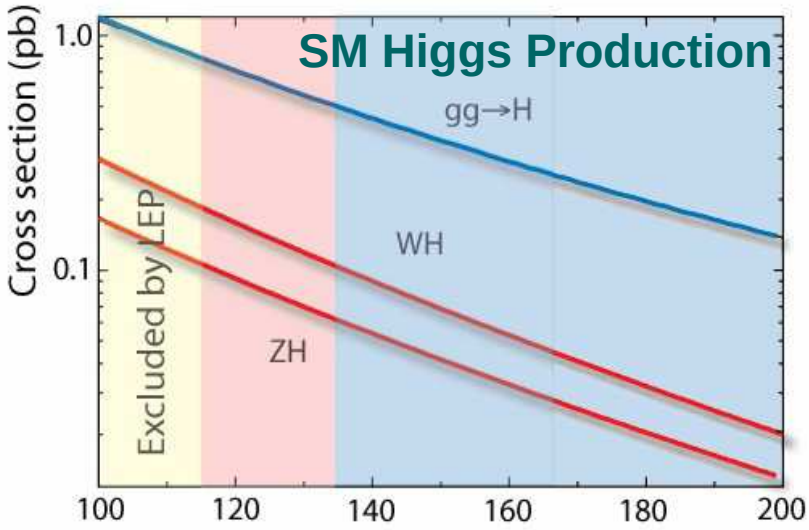
- The Higgs mechanism in the SM predicts a neutral, spin 0 boson, but not the Higgs mass
- If it exists, its mass must be determined experimentally
  - Direct searches at LEP2: $m_H > 114.4$ GeV @ 95% CL
  - EW global fit: $m_H < 158$ GeV @ 95 %CL

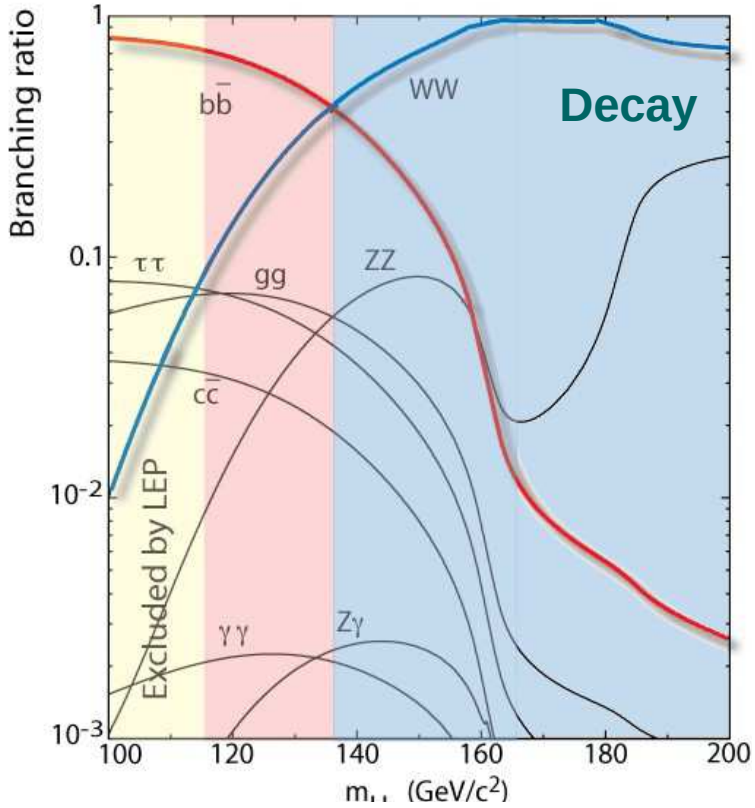




Low Mass SM Higgs Search

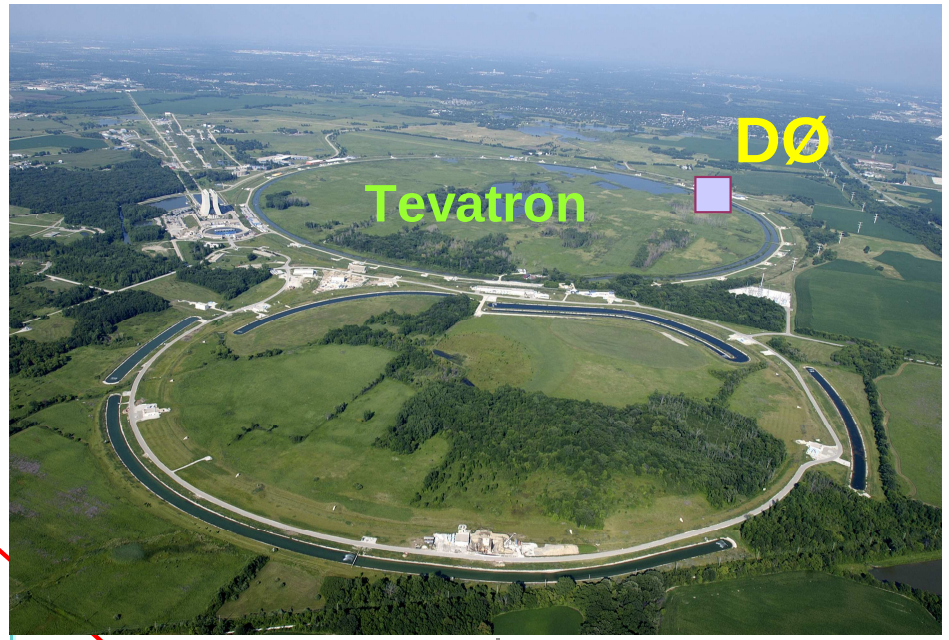
- At the Tevatron, the gg→H production dominates
- For $m_H < 135$ GeV, the H→bb decay dominates
- gg→H→bb overwhelmed by multijet background
- Associated productions WH, ZH provide next highest rate, and leptonic decays of W,Z enhance background suppression
- Requires efficient triggering, lepton, b identification, good jet resolution

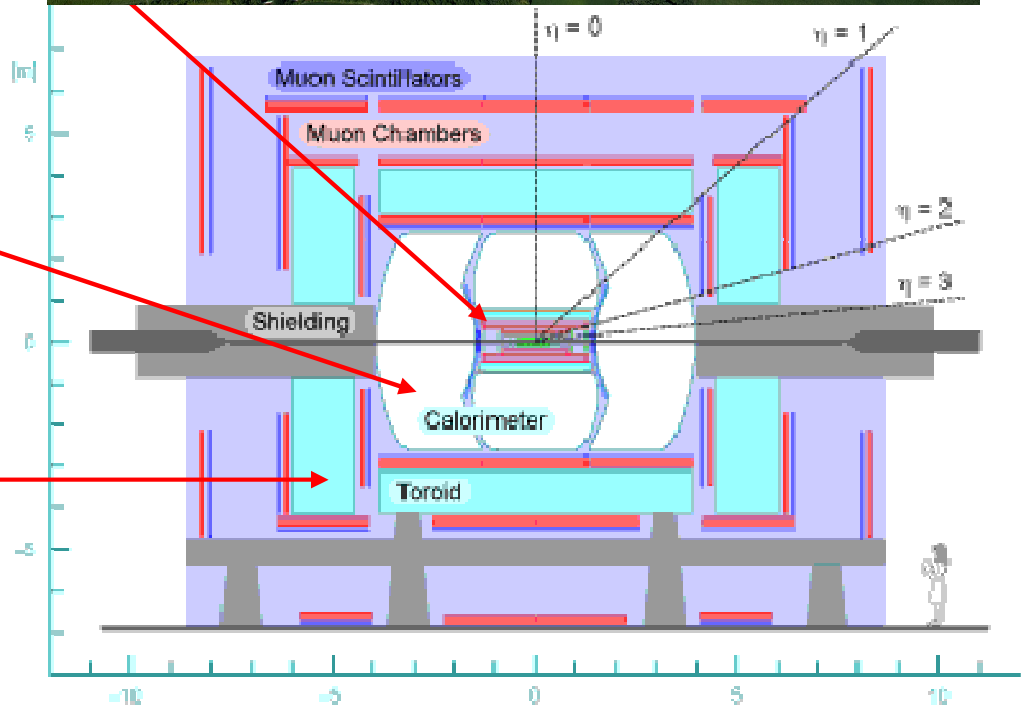




The DØ Detector

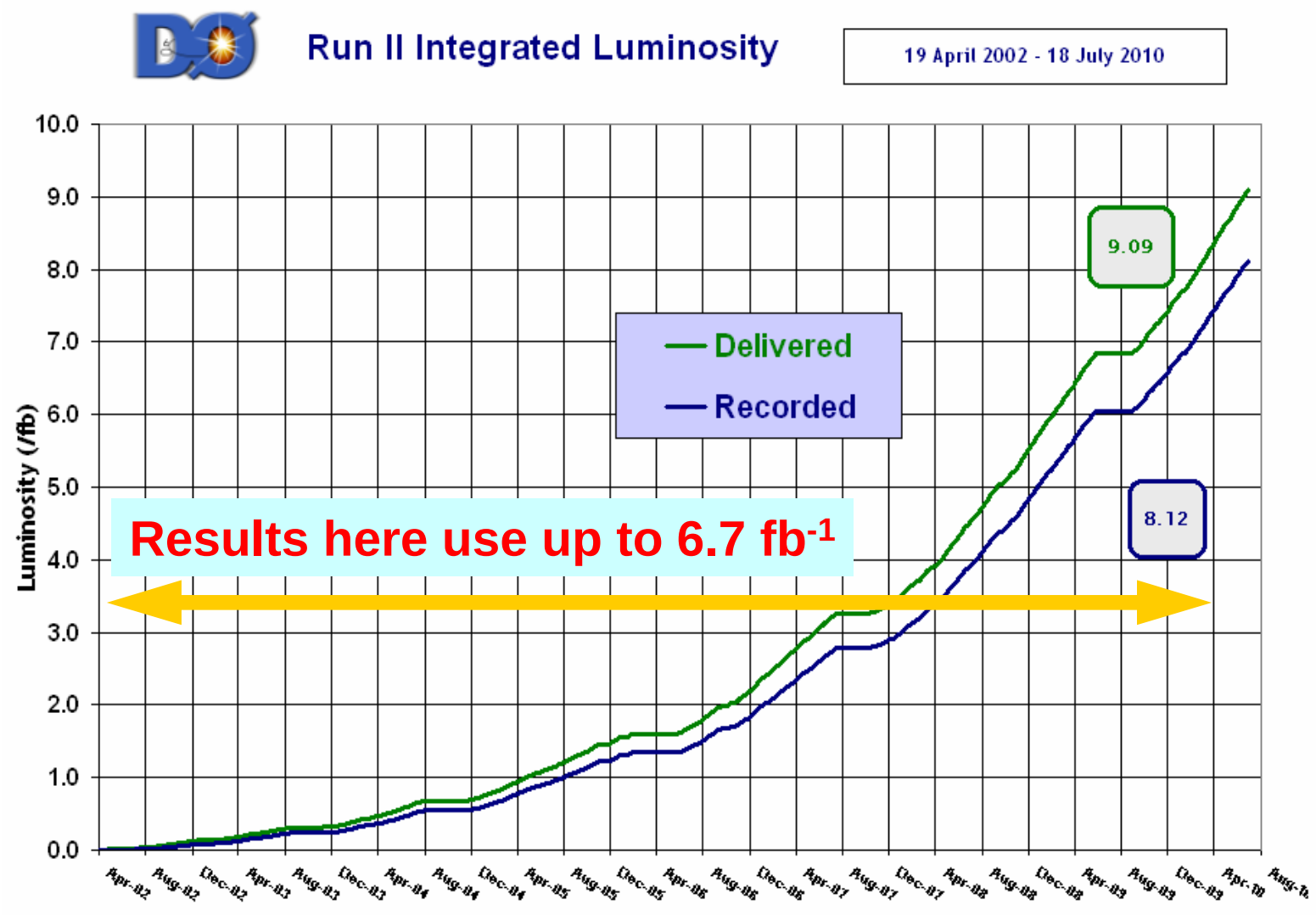
- Multipurpose detector
- Tracking systems
  - charged tracks, vertex
  - essential for b-jet identification (b-tag)
- Calorimeters
  - electrons
  - jets
  - missing E_T (MET)
- Muon systems



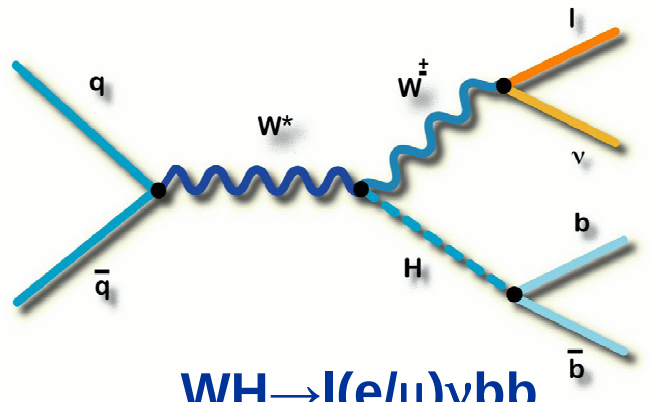


Data

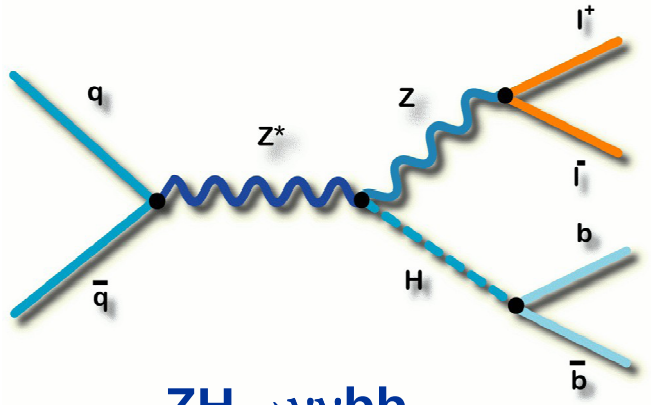
- More than 9 fb^{-1} delivered and 8.1 fb^{-1} recorded
- Data taking efficiency ~ 90%, peak efficiency at 93%



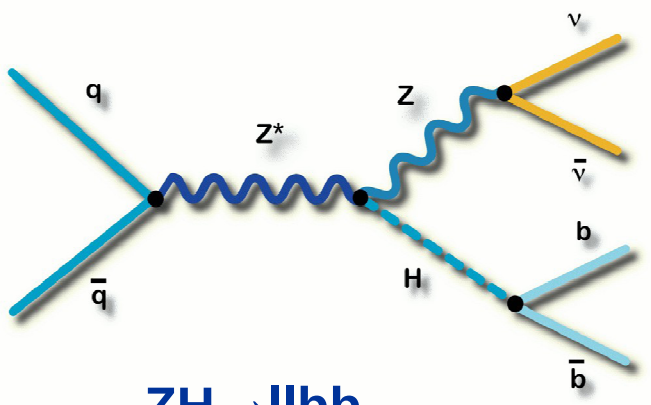
Main Search Channels



WH→l(e/μ)νbb

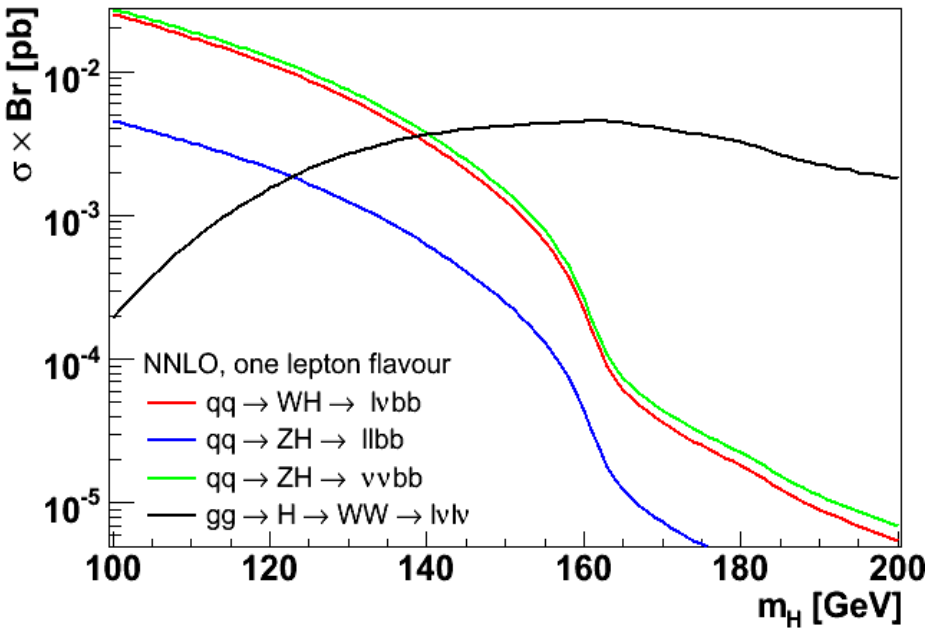


ZH→ννbb



ZH→llbb

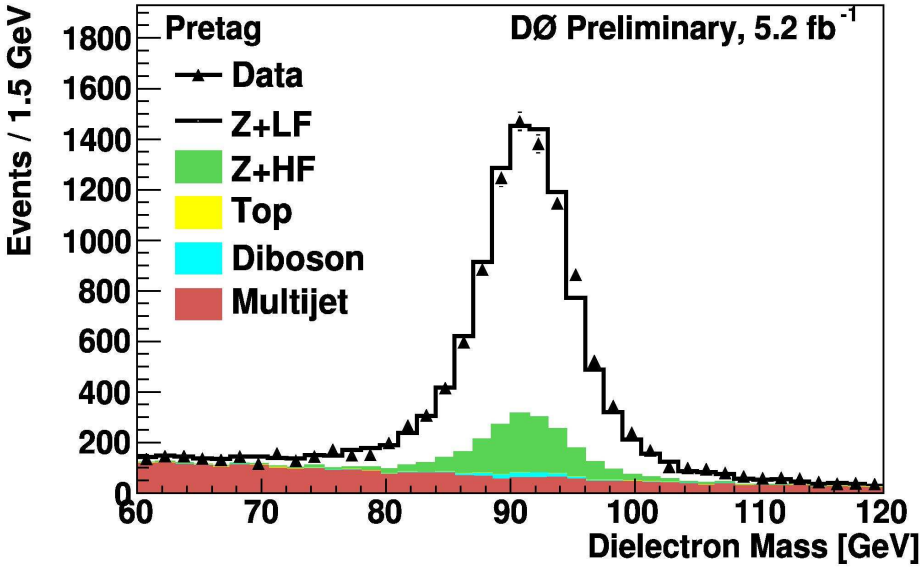
- Identify Vector Boson (W/Z) through their leptonic decay signatures
- Apply b-tagging to select H→bb candidates
- Perform multivariate analysis to further discriminate Higgs signal from SM backgrounds
- Search up to m_H = 150 GeV

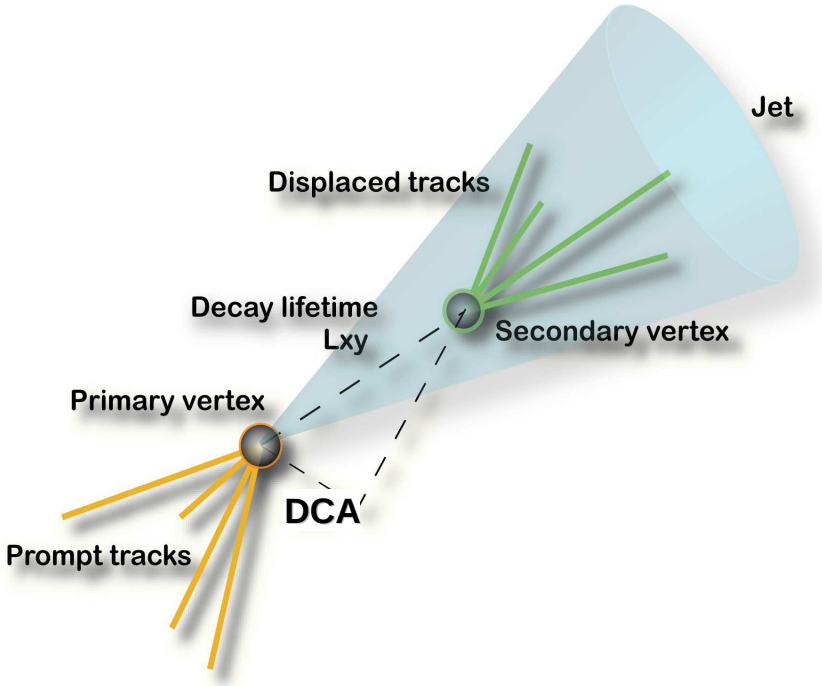


ZH → llbb

6.2 fb^{-1}

- 2 high pT leptons (e/μ) from Z
- Lowest σ x B but best signal efficiency and multijet suppression

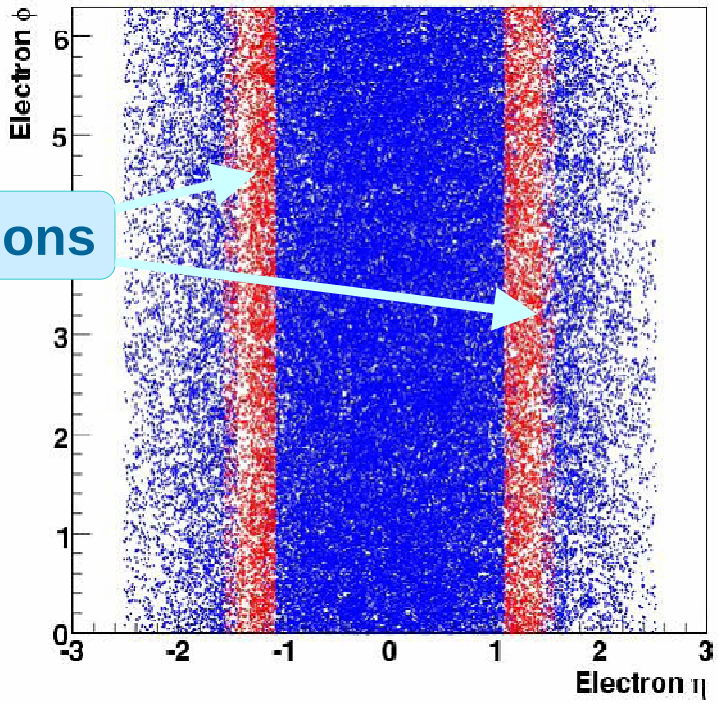




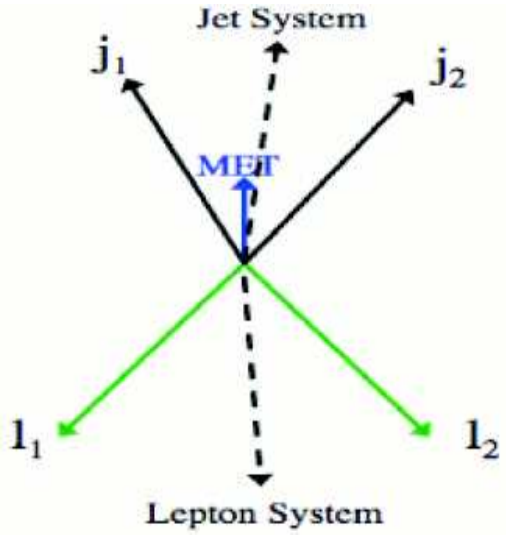
- b-jets are identified by their secondary vertices and impact parameter (DCA)
- b-tag efficiencies:
- ~50-70% for b-jets
- ~0.5-4.5% for light jets
- 1 tight or 2 loose tags

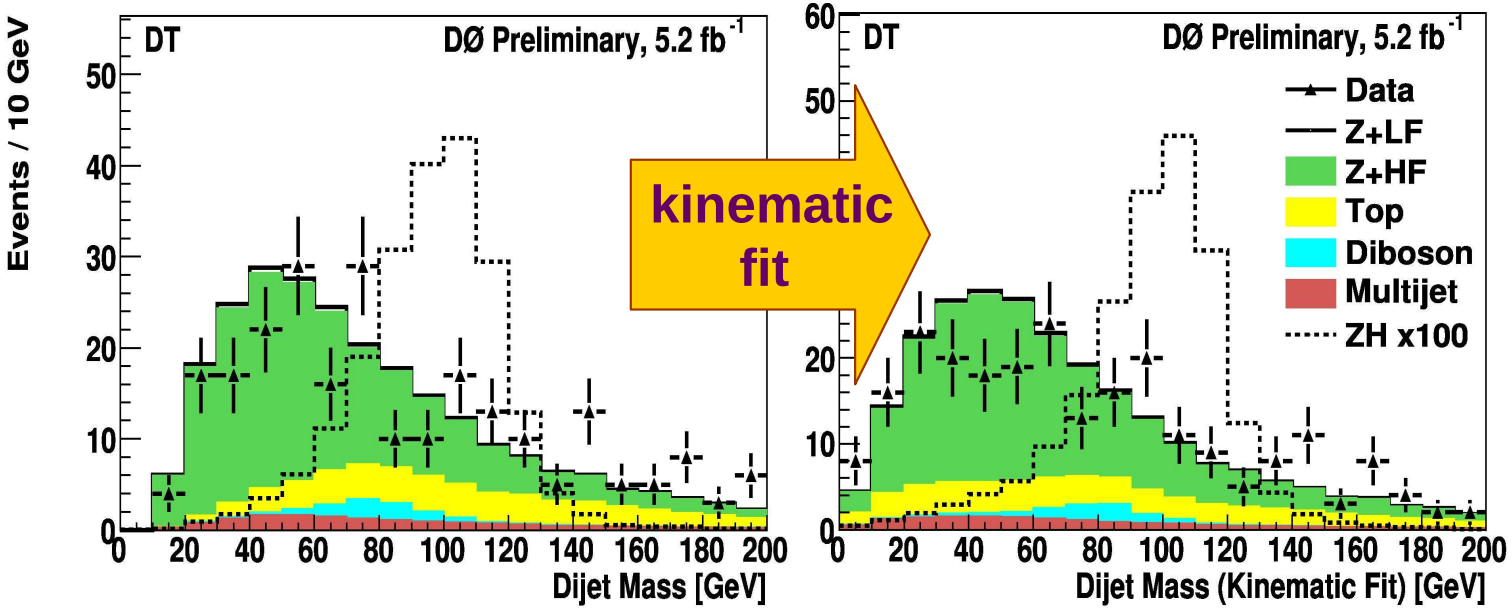
Improvements

- Additional analyses with leptons in less-instrumented region of the detector
  - 15% acceptance gain



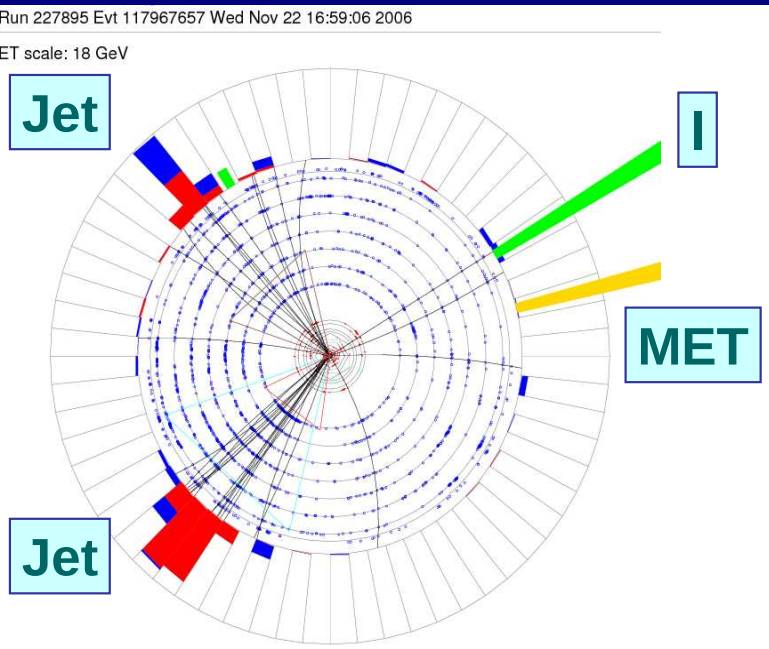
- Kinematic fit: Constrain jet energies with knowledge of Z mass and ZH (llbb) system momentum – zero
  - 15% improvement on dijet mass resolution



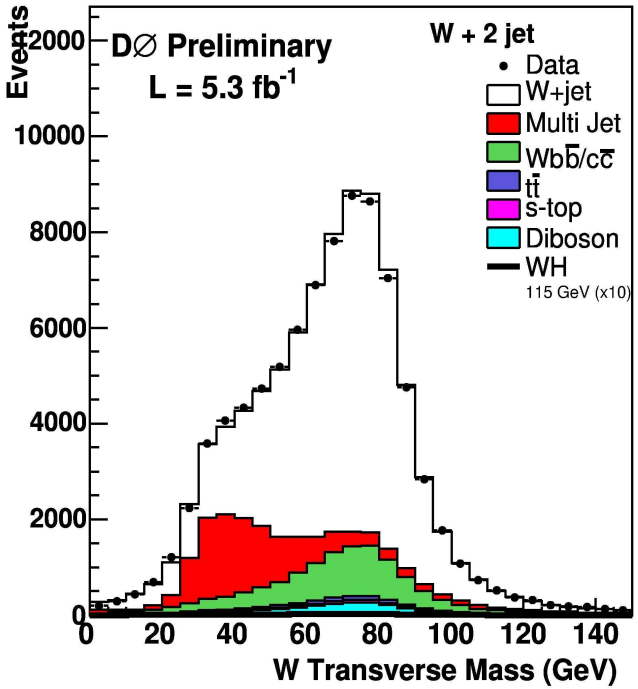


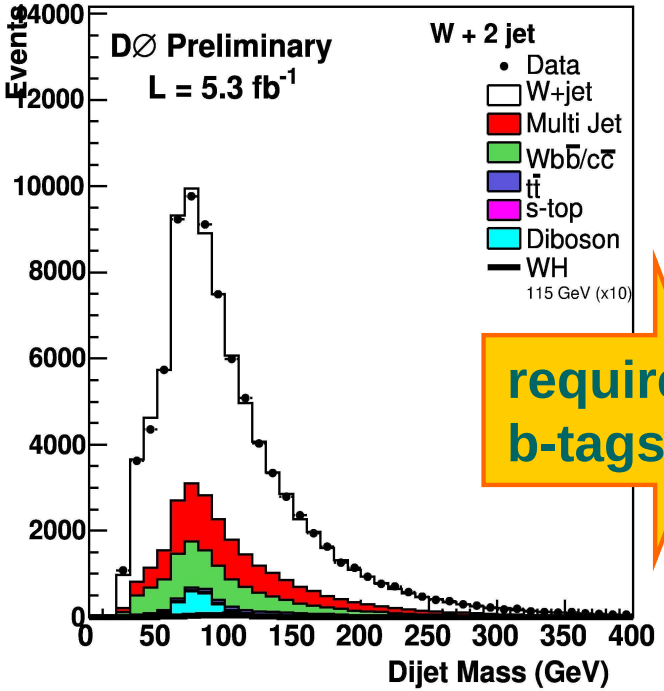
WH→lνbb

5.3 fb^{-1}

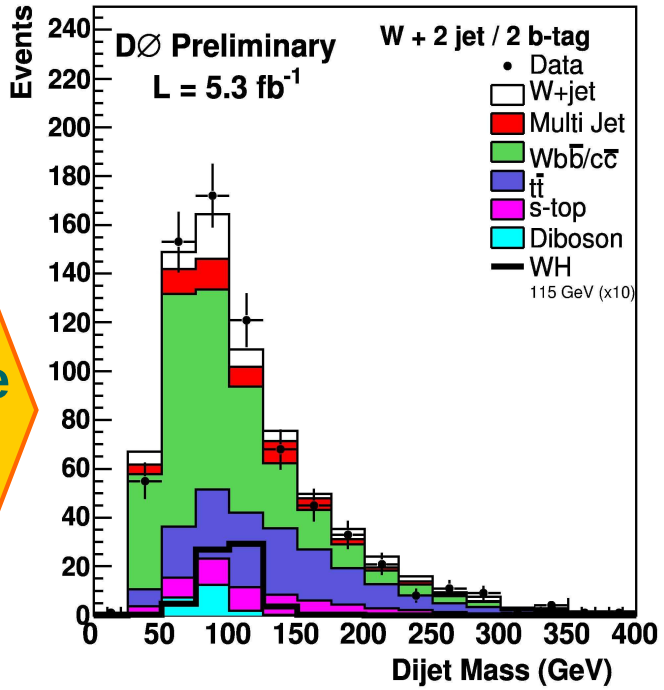


- One high p_T lepton (e/μ) with large missing E_T consistent with W decay
- Separate samples into 2 or 3 jet events and 1 (tight) tag or 2 (loose) tags to increase sensitivity





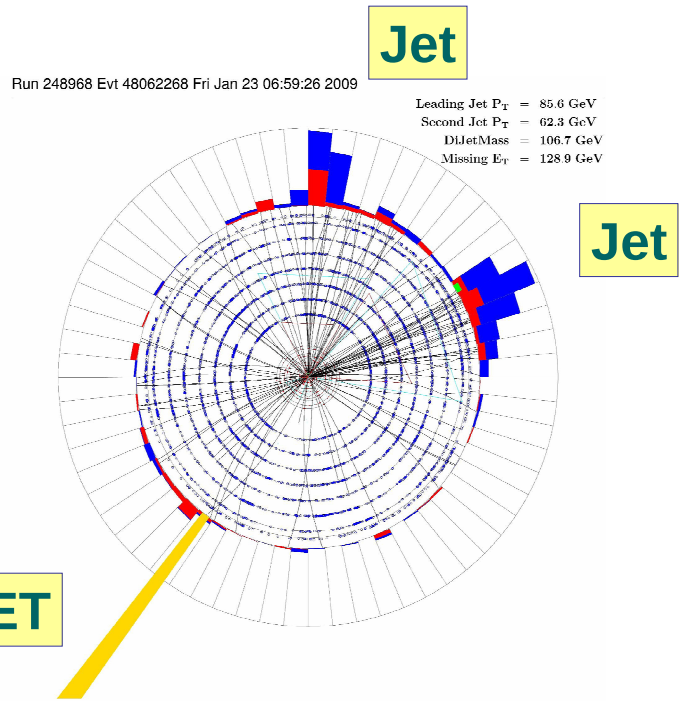
require b-tags

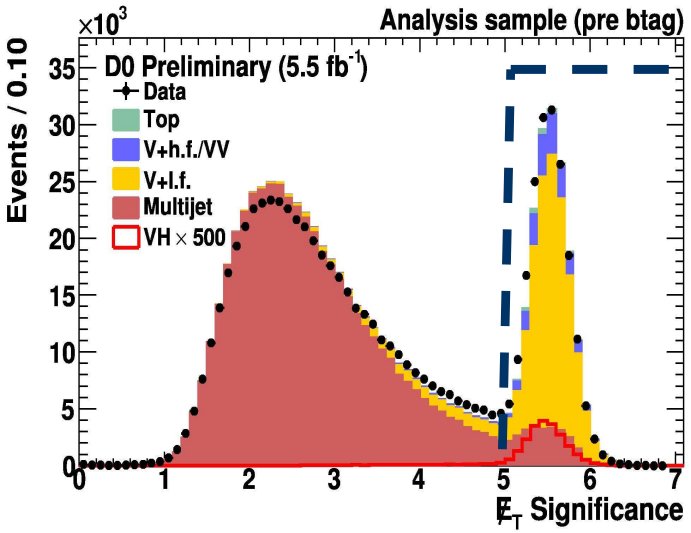


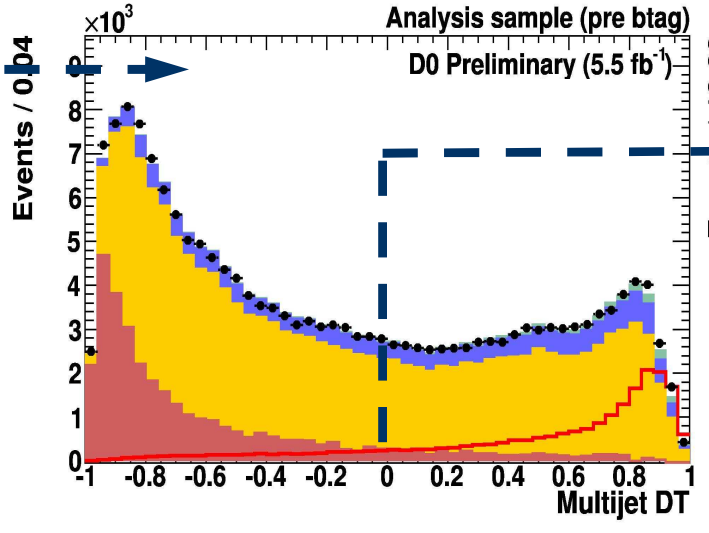
ZH→ννbb

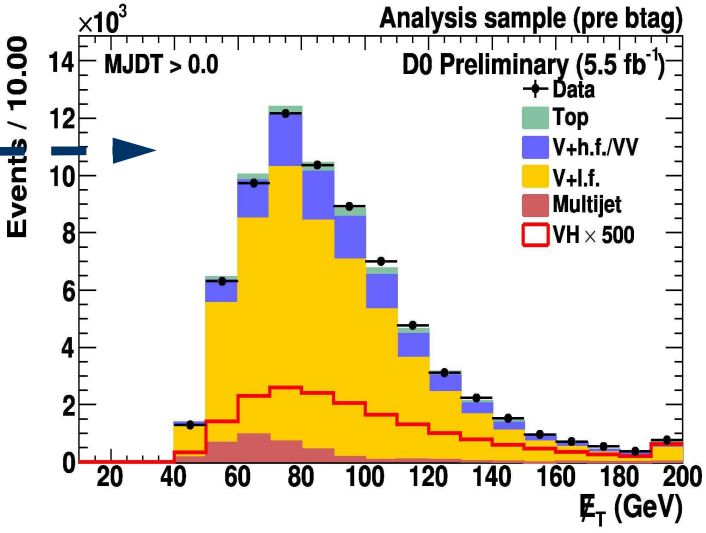
6.4 fb^{-1}

- Largest σ x B, with substantial multijet background
- Significant missing E_T for signal from the unidentified neutrinos
- Algorithm make use of correlations between MET and measured jets
- Specialized multivariate discriminant for multijet



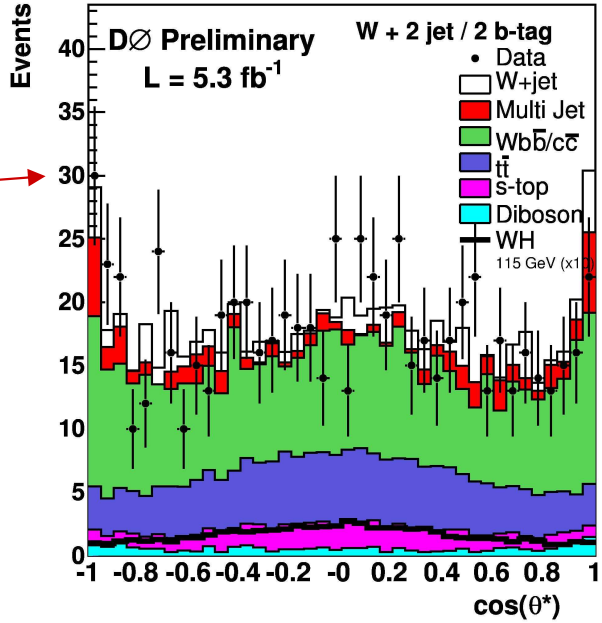




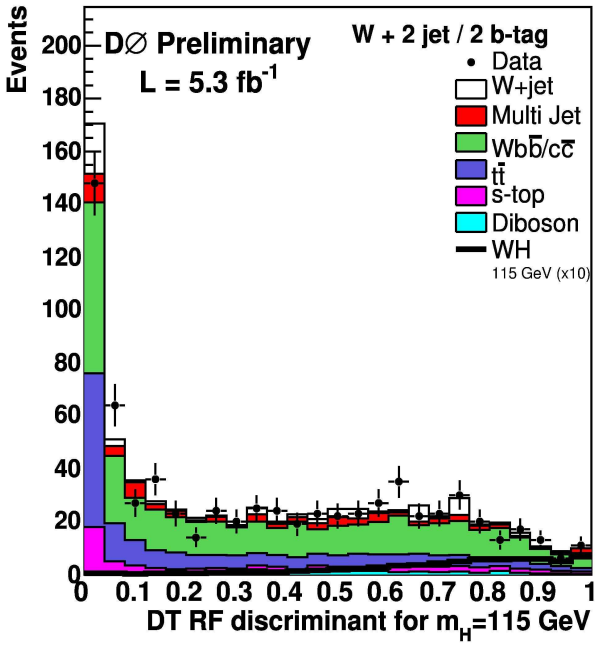


Multivariate Analysis

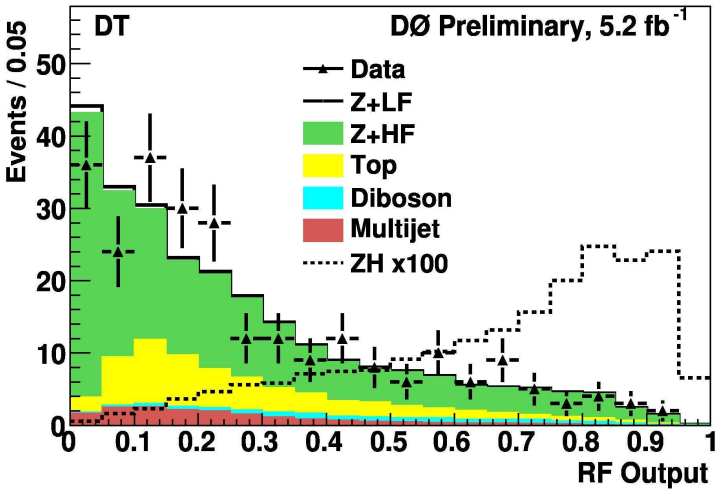
- All three analyses:
  - Decision Trees with many input variables
  - Includes spin correlation, neutrino direction and other kinematic information
  - 15-20% improvement in sensitivity comparing to dijet mass alone



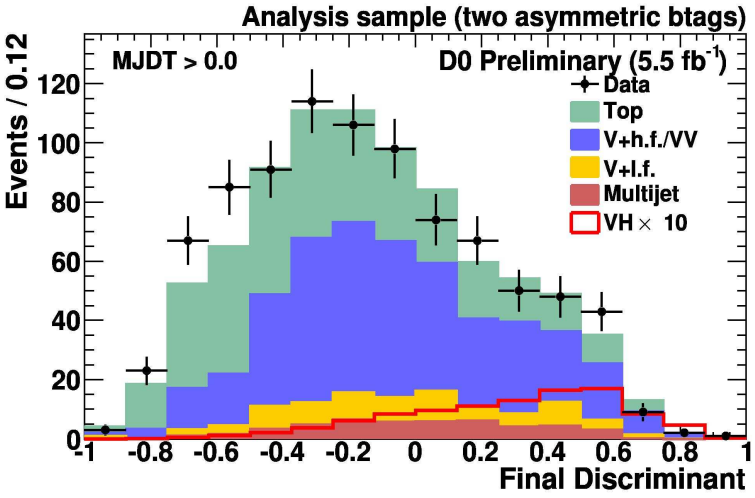
WH→lνbb



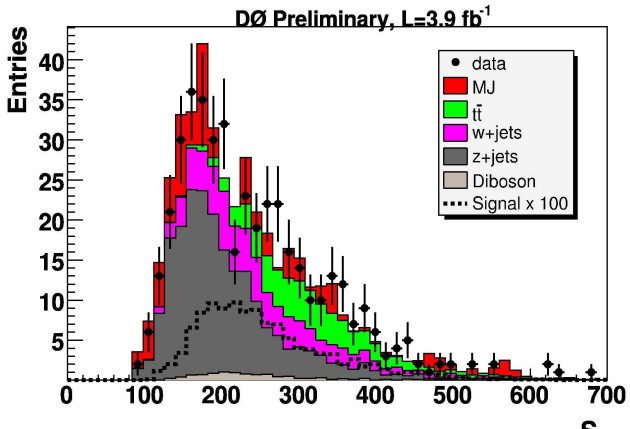
ZH→llbb

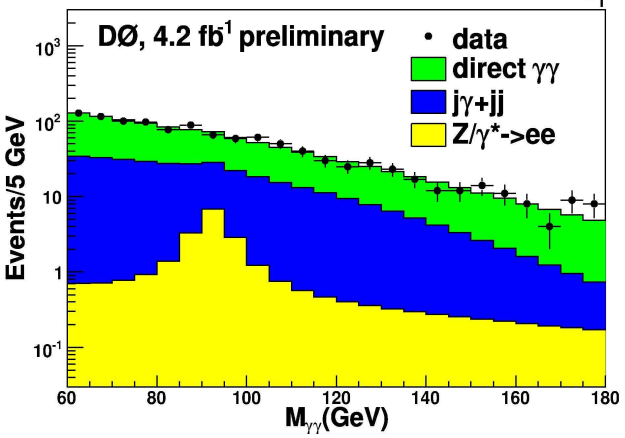


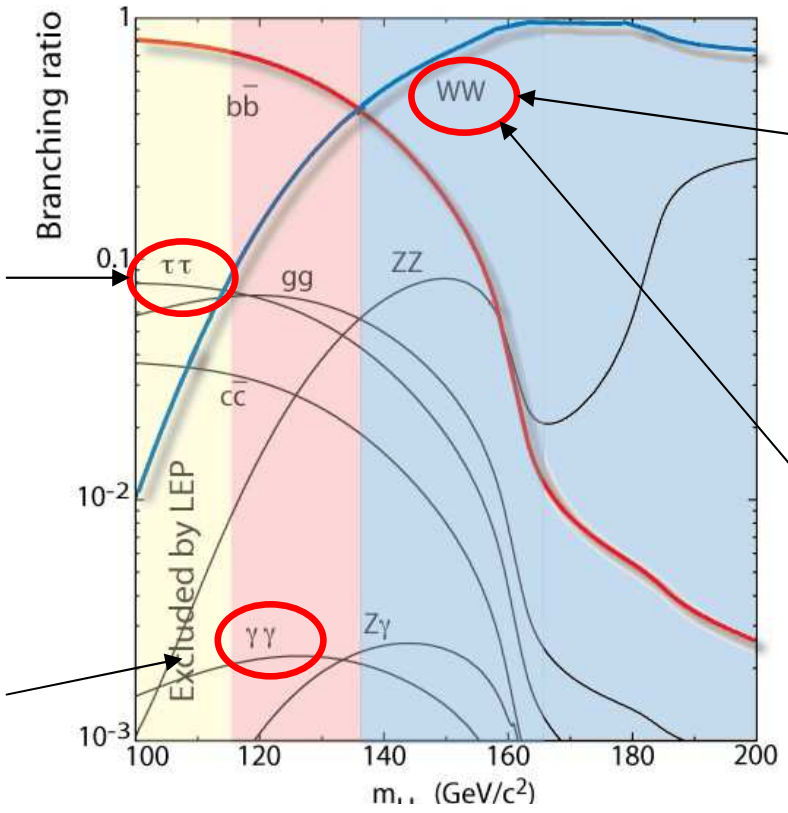
ZH→ννbb

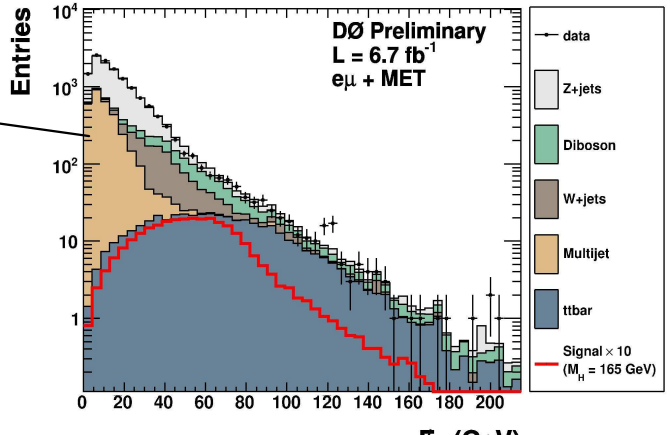


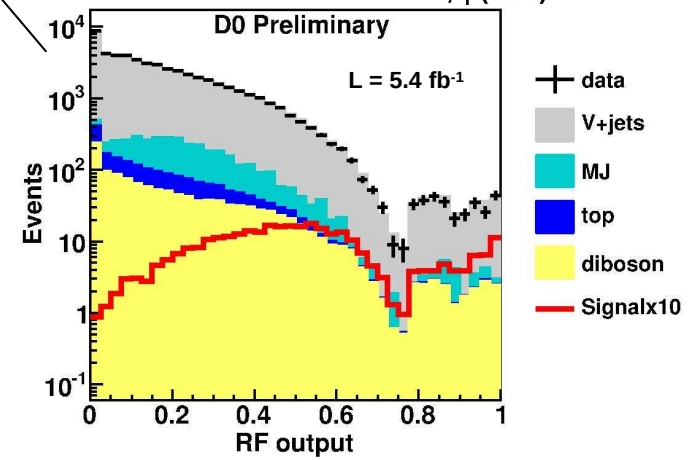
Other Low Mass SM Higgs Searches





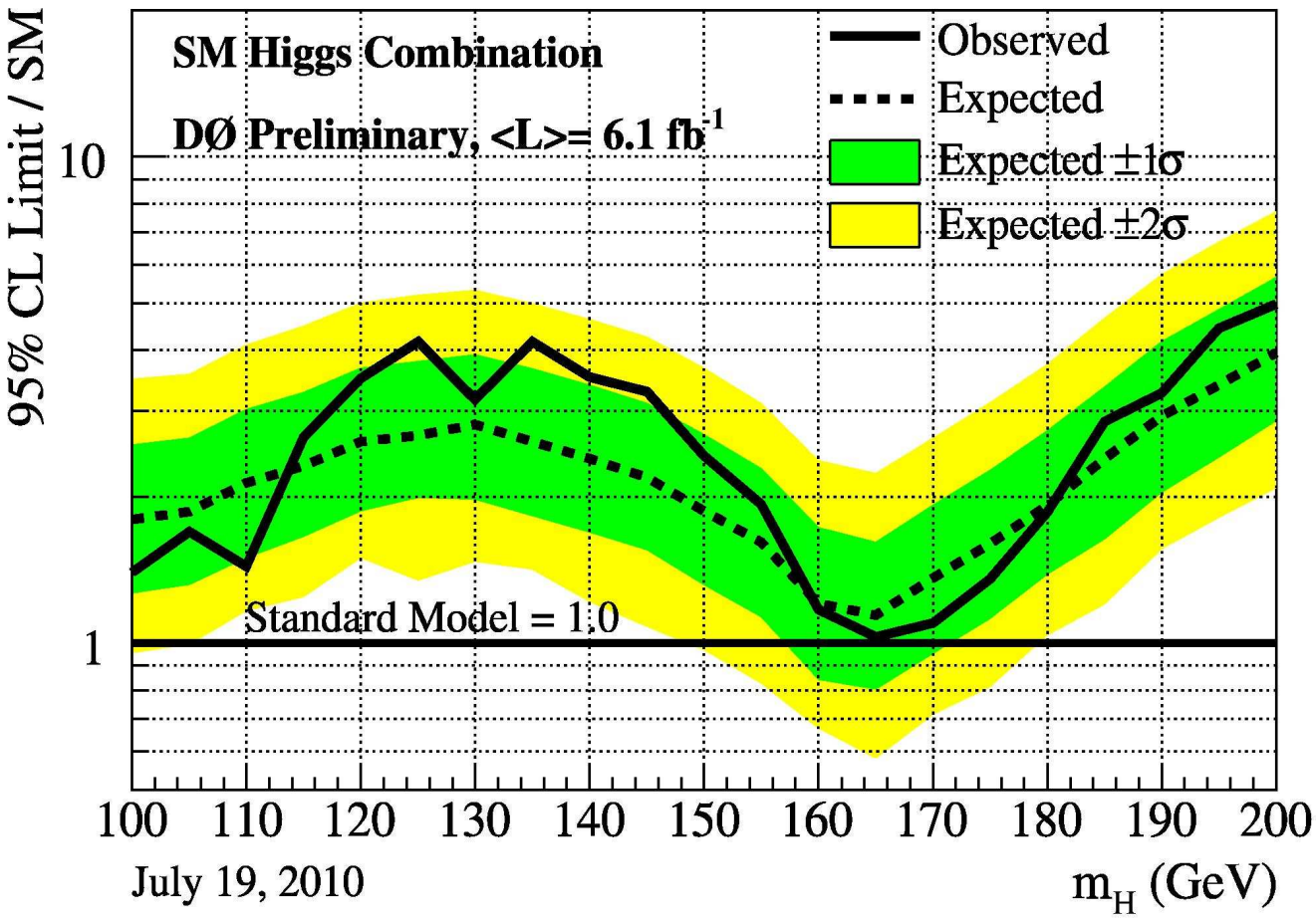






- Many more search channels, including those with τs or γs
- High-mass analyses generally extend to low-mass region
- Include all channels in a combined limit

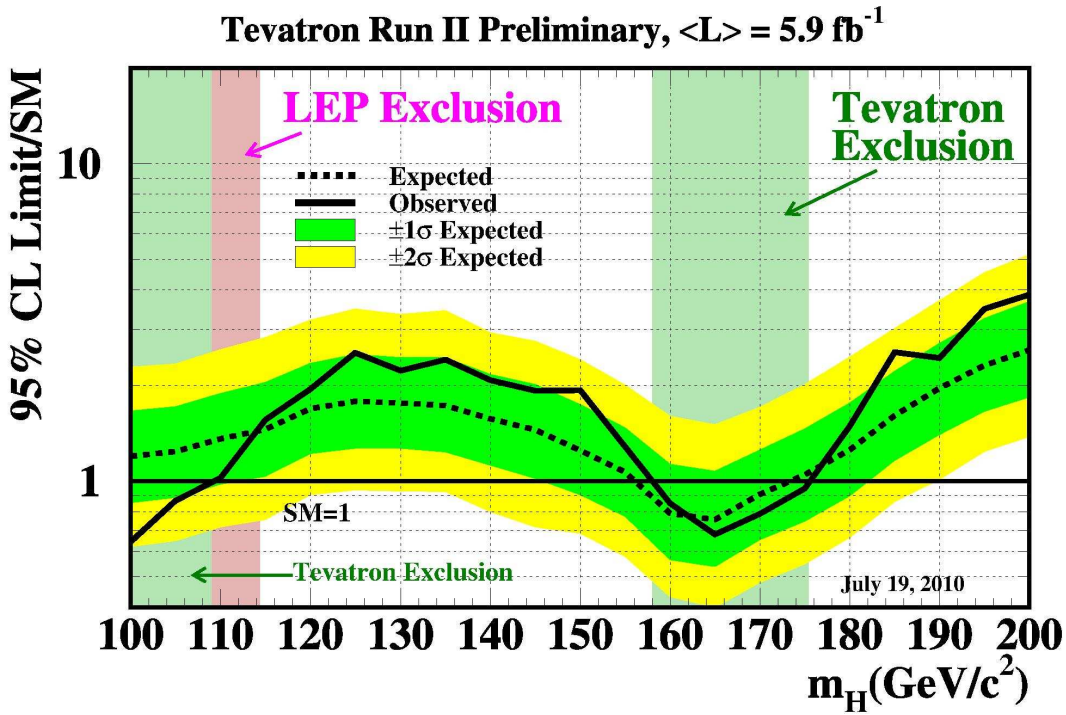
Combined Limits



- Upper limits reported as multiples of SM prediction
- At m_H = 115 GeV: 2.7 (2.3) observed (expected)

Summary and Outlook

- Combined DØ expected limits on Higgs cross section below 3 times σ_{SM} prediction in all low mass region
- Already 8.1 fb^{-1} of data recorded
- Tevatron and DØ are performing well and expected to run for at least another year to reach ~ 10 fb^{-1}
- Improvements to analyses are expected to continue, including lepton, b identification, jet measurements and multivariate techniques



Backup

Main Search Channel Limits