Search for the Higgs Boson in the H $\rightarrow$ WW $\rightarrow e\nu\mu\nu$ Channel at DØ

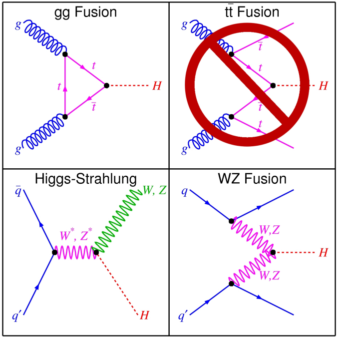
Jonas Weichert
(for the DØ collaboration)

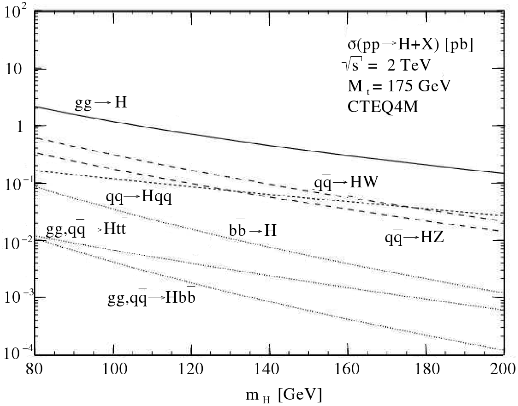
University of Mainz

Higgs Hunting 2011

Outline

1. Introduction
2. Analysis Strategy
3. Limits on the Higgs Cross Section
4. Summary

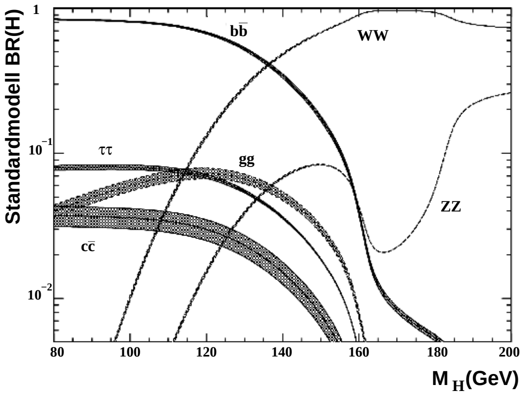




- The most important production process is gluon fusion with 0.1-2.0pb.
- The associated production and vector boson fusion are one order of magnitude smaller.

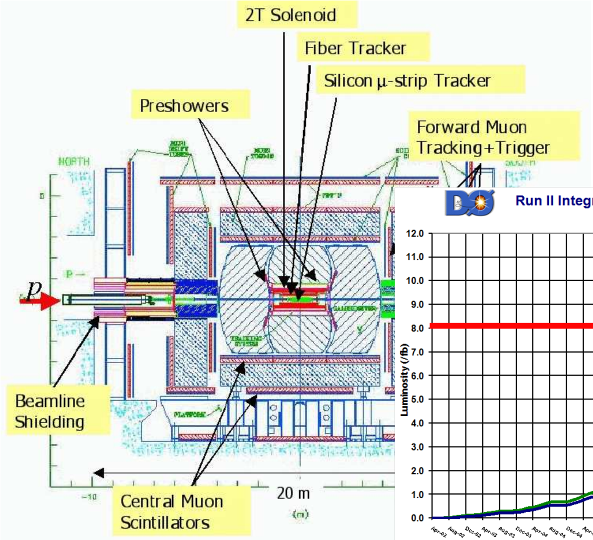
Higgs Decays

- For masses > 135GeV the decay into W^+W^- is dominant.
- The analysis covers a mass region from 115 to 200 GeV.



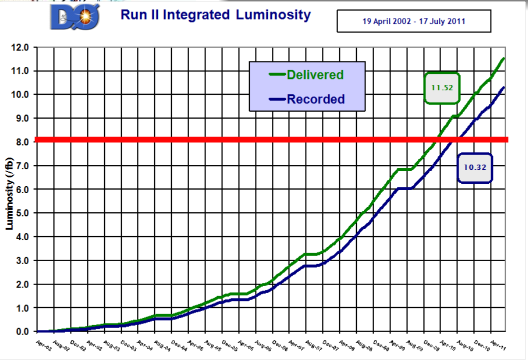
The $H \to WW \to e\nu\mu\nu$ Channel has the highest sensitivity for the high mass region > 135 GeV and has an impact for lower masses as well!

DØ Detector



$p\bar{p}$ collisions at $\sqrt{s} = 1.96$ TeV

8.1fb^{-1} are used in the current analysis

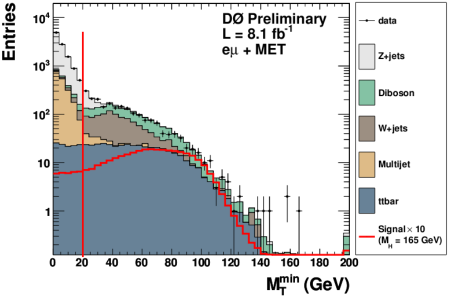


Signature of the $H \to WW \to e\nu\mu\nu$ Signal

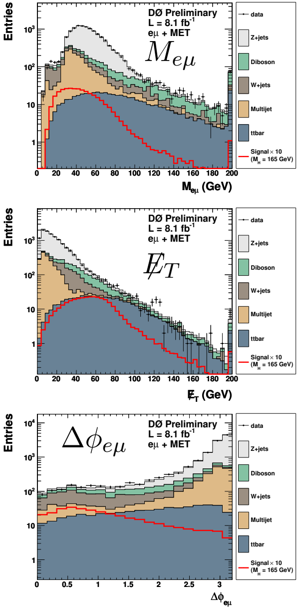
One isolated electron and one isolated muon with high transverse momenta and missing transverse energy (neutrinos).

Selection:

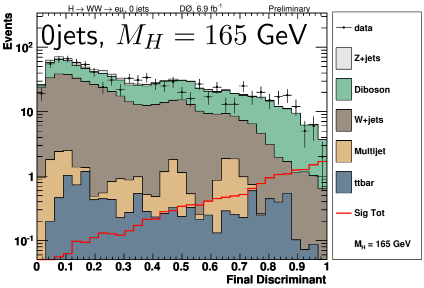
- One isolated electron and muon.
- $p_T^e > 15$ GeV
- $p_T^\mu > 10$ GeV
- $\Delta R(e,\mu) = \sqrt{\Delta\eta^2 + \Delta\phi^2} > 0.3$
- $M_T^{min} > 20$ GeV
- $M_T^2 > 15$ GeV
- Analysis split by number of jets.

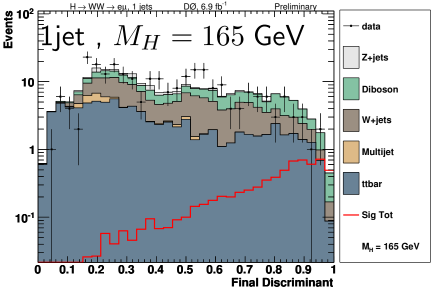


- discriminating variables:
  - object kinematics: p_T^l, p_T^{jet},...
  - event topology: $M_{e\mu}$, $\Delta\phi_{e\mu}$, ...
  - b identification
  - lepton quality
- As a final discriminant for signal and background *random forests (RF)* are used.
- For each mass point (115,120,125,...,200 GeV) 3 RF were trained.
  - 0, 1 and 2 or more jets



Final Selection

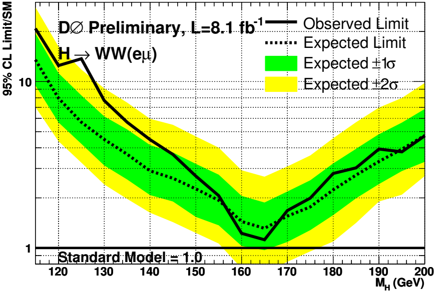


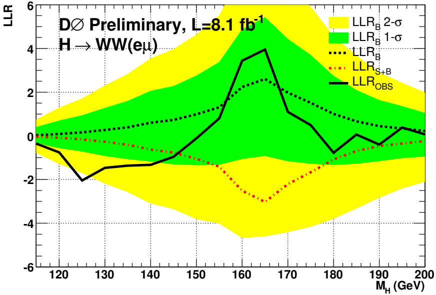


jets	data	sum bkgd	H_{165}	$t\bar{t}$	diboson	W+jets	Z+jets	QCD
0	881	949 ± 119	15.7	12.2	436	436	49.1	15.7
1	255	244 ± 38	6.8	86.7	55.6	76.6	13.0	12.6
2+	214	207 ± 30	3.0	174.5	7.7	21.0	3.6	0.1

Upper Limits on the SM Higgs Cross Section

- No signal is observed.
- A limit on the cross section is derived for each mass point using the modified frequentist method CL_S.

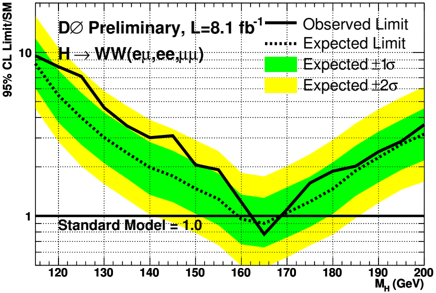


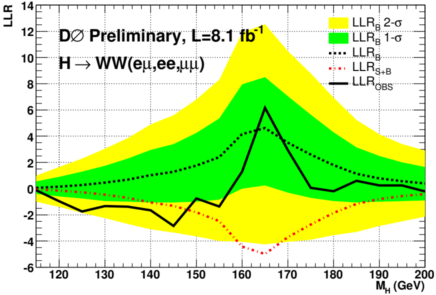


- Best sensitivity for a SM Higgs boson mass of 165 GeV.
- Exp. (Obs.): 1.31 (1.10) × SM

DØ ($H \to WW$) Combination: Upper Limits on the SM Higgs Cross Section

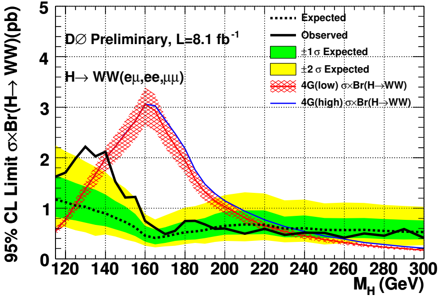
- When combining the three most sensitive "high mass" channels ($H \to WW \to e\nu e\nu/e\nu\mu\nu/\mu\nu\mu\nu$) we are able to exclude a mass region for the SM Higgs boson at 95% CL.





- Expected exclusion 159 to 169 GeV.
- Observed exclusion 162 to 170 GeV.

DØ ($H \to WW$) Combination: Upper Limits for the 4th Generation Model



4th Generation Model

- Taking into account a model with a 4th generation of quarks leads to a higher gluon fusion cross section due to additional loops.
- In this model the gluon fusion cross section is enhanced by a factor of 7 to 9.

- The multivariate technique is retrained on gluon fusion signal only.
- An exclusion of a Higgs boson in this model is obtained for masses between 140 GeV and 240 GeV at 95% CL.

Summary

- The current $H \to WW \to l\nu l\nu$ analyzes are based on 8.1 fb^{-1} of data.
- The final dataset of the DØ experiment will about 10 fb^{-1}.
- The additional data corresponds to 10-15% gain in sensitivity.
- We expect to perform better than scaling with luminosity due to further improvements in analysis techniques.
- The focus of our optimization is on the low Higgs masses.

These are very interesting times for Higgs searches. We may get an answer to an idea that has come up in the sixties soon.