Search for H→WW(*) at DØ

presented by

Per Jonsson

Imperial College London

On behalf of the DØ Collaboration

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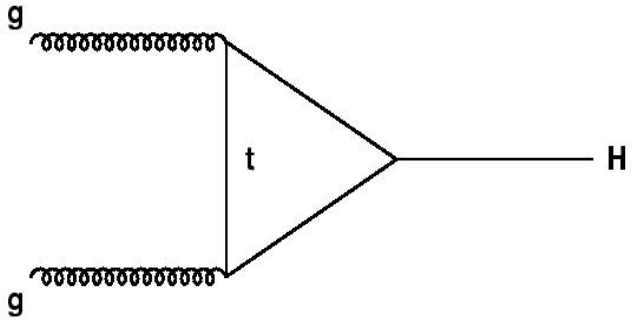
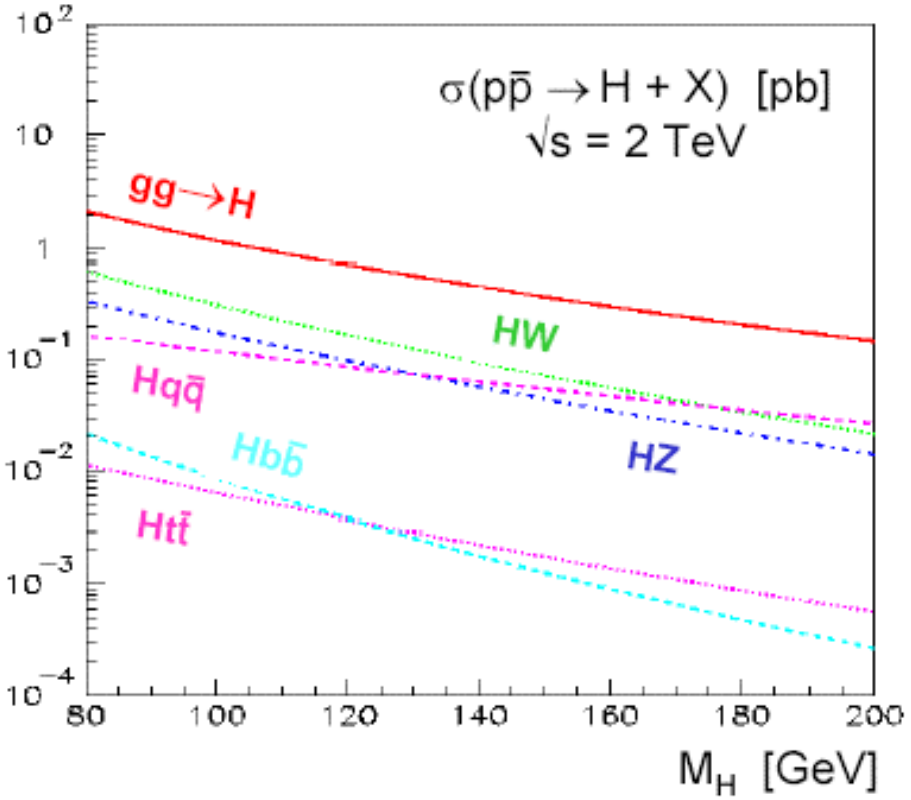
Standard Model Higgs Production @ the Tevatron

- Production cross sections are small 1 - 0.1 pb depending on M_H
- Gluon fusion, gg->H, dominates



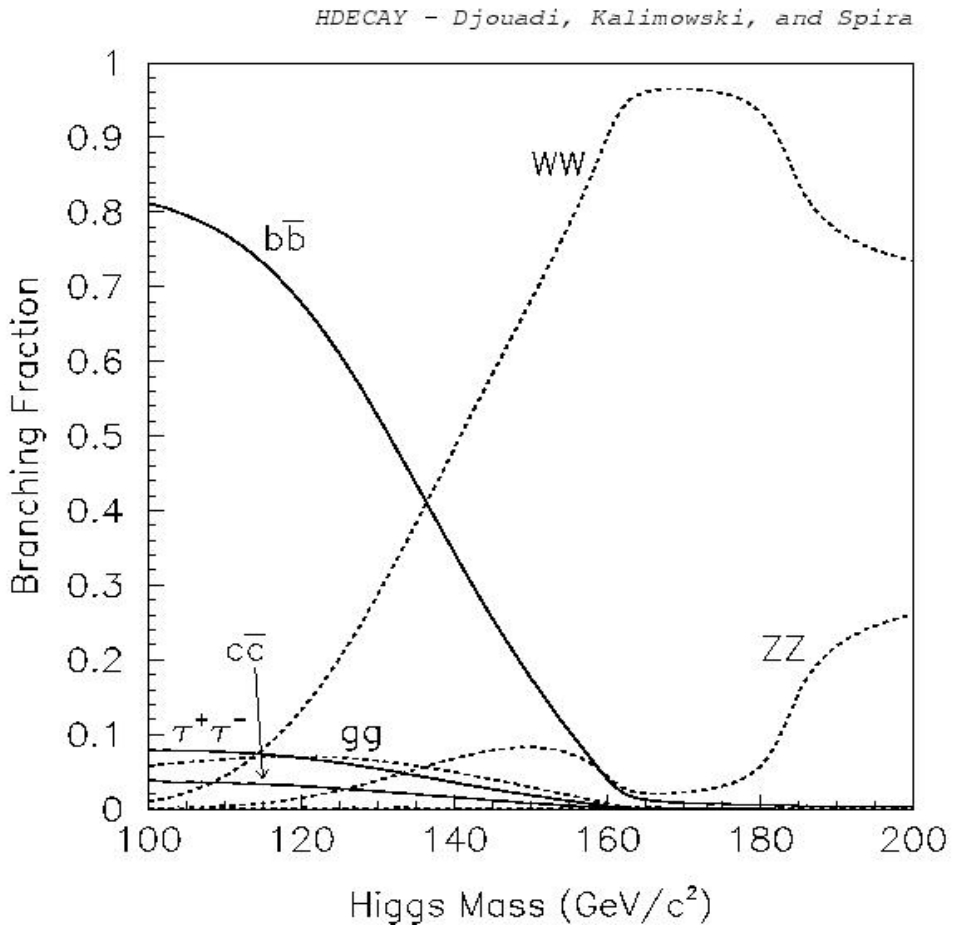
- Light Higgs preferred by global fit
  - M_H < 251 GeV at 95% C.L.
- LEP limit from direct searches
  - M_H > 114.4 GeV at 95% C.L.



Standard Model Higgs Decay Modes

Why look for H->WW(*)?

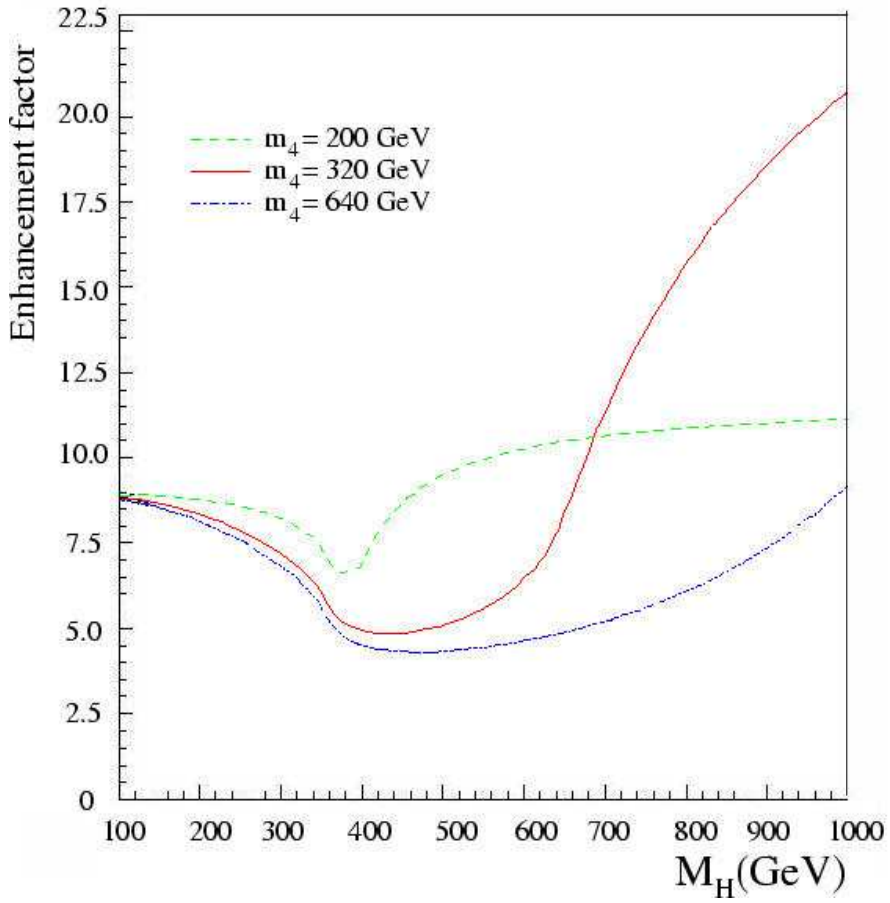
- H->bb is dominant for M_H < 135 GeV
- Strong interaction background overwhelm signatures with jets
- WW branching fraction ~5% for low mass
- Main search channel for M_H > 120 GeV
- Look for the "clean" final states:
  eμνν, eeνν and μμνν



Cross Section Enhancement from Extra Generations

- Extra quark generations could increase production cross section significantly,
- Enhancement factor depends on Higgs and quark masses,
- A factor of 8.5 is expected for a 4th generation, m_4=320 GeV.

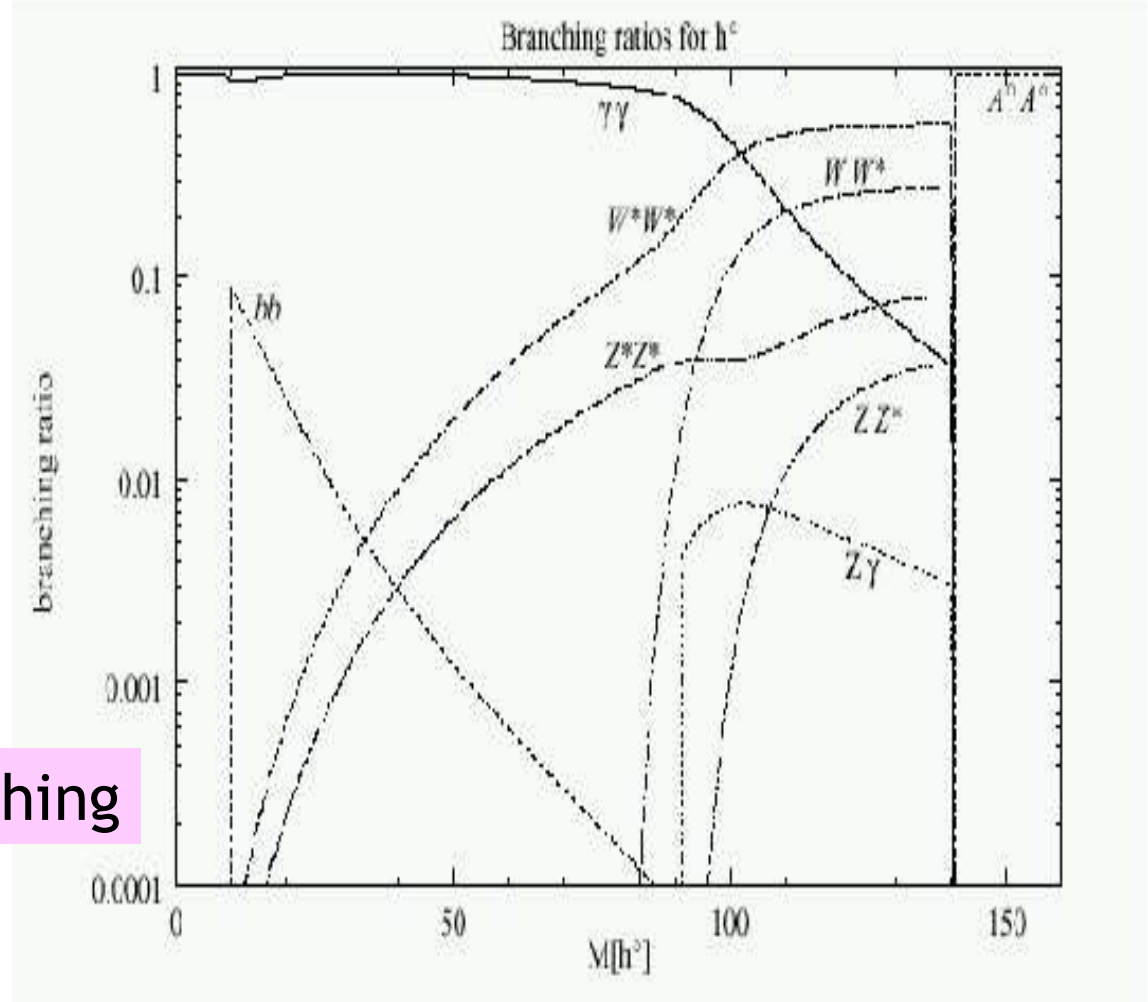
E. Arik et al, SN-ATLAS-2001-006



Suppressed Couplings to b, τ

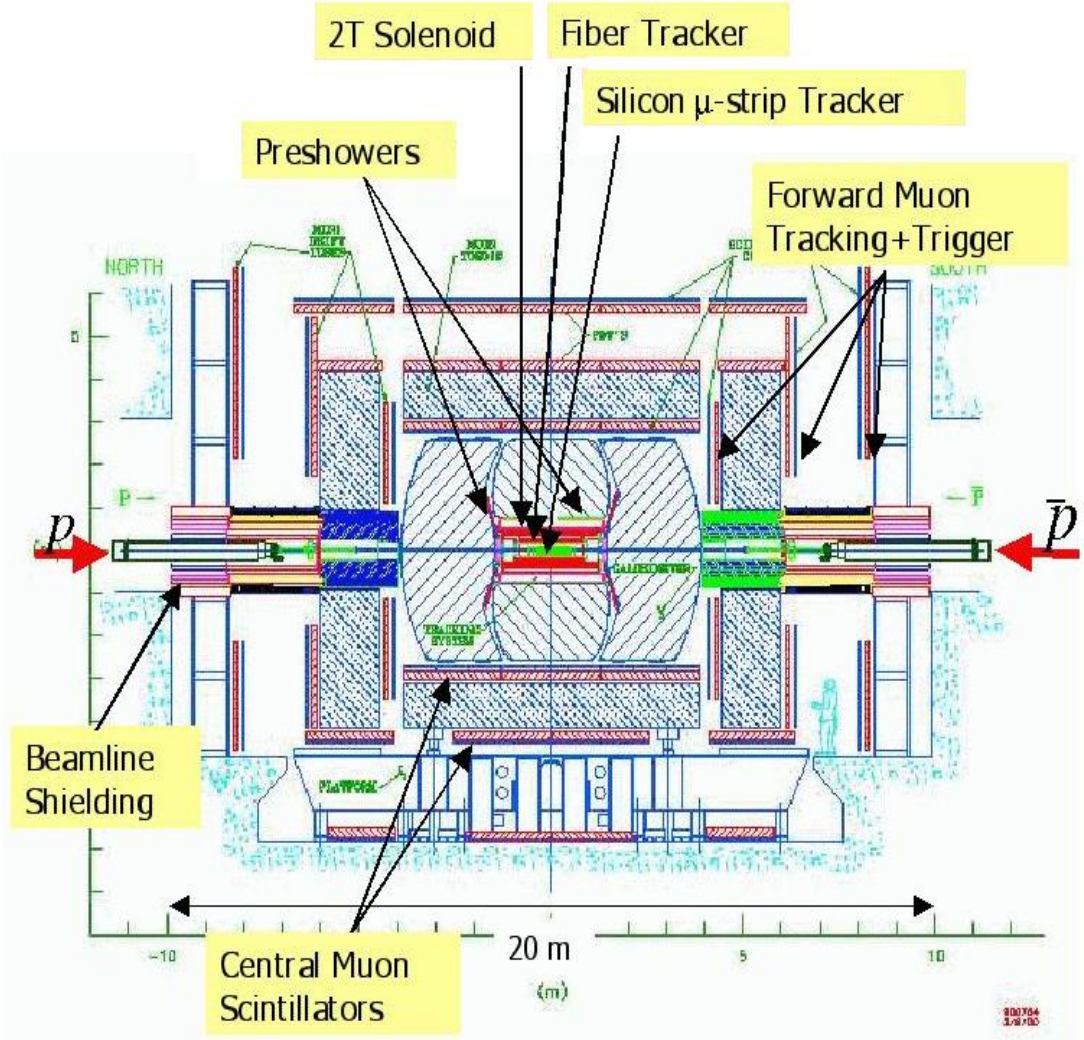
L. Brucher, R. Santos, hep-ph/9907434

Occurs Beyond the SM in Top Color or Fermiophobic Higgs models, see talk by A. Melnitchouk



Increased H->WW(*) branching

The Upgraded DØ Detector



- Completely new tracking system uses 2T magnetic field
- Inner Si vertex detector (SMT) provides b-tagging capability
- Excellent Run I calorimetry exploited in Run II
- Upgraded 3-tier trigger and data acquisition system

Data Samples

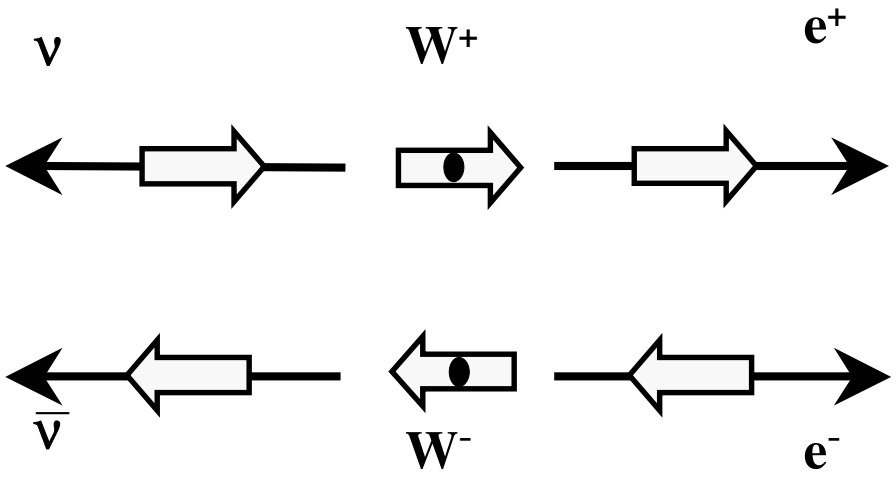
- Search for H->WW$^{(*)}$ in the 3 leptonic channels:
  eeνν, eμνν and μμνν
- Data investigated correspond to integrated lumi. of
  ~ 180 (ee), 160 (eμ) and 150 (μμ) pb^{-1}
  Collected between April 02 and September 03
- MC generated with Pythia passed through detailed detector simulation
  - Rates normalized to NLO cross section values

Event Signature- Spin Correlations

- Higgs Mass reconstruction not possible due to two neutrinos:

  Missing E_T

- Use spin correlations to suppress background.



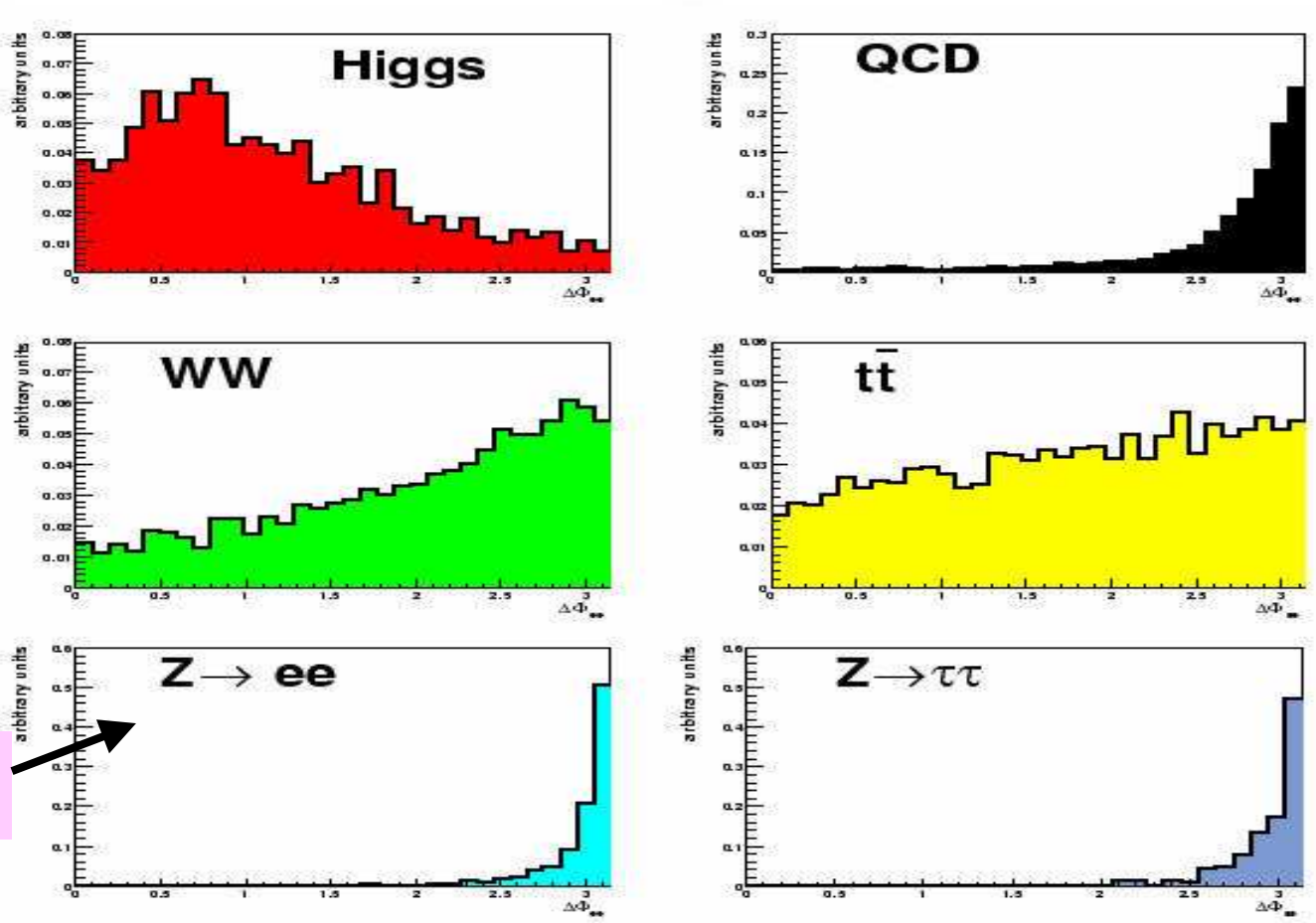
The charged leptons tend to be collinear:

Small opening angle

Experimental signature: high p_T l, small $\Delta\phi_{ll}$ and large Missing E_T

Azimuthal Opening Angle: $\Delta\phi_{ll}$

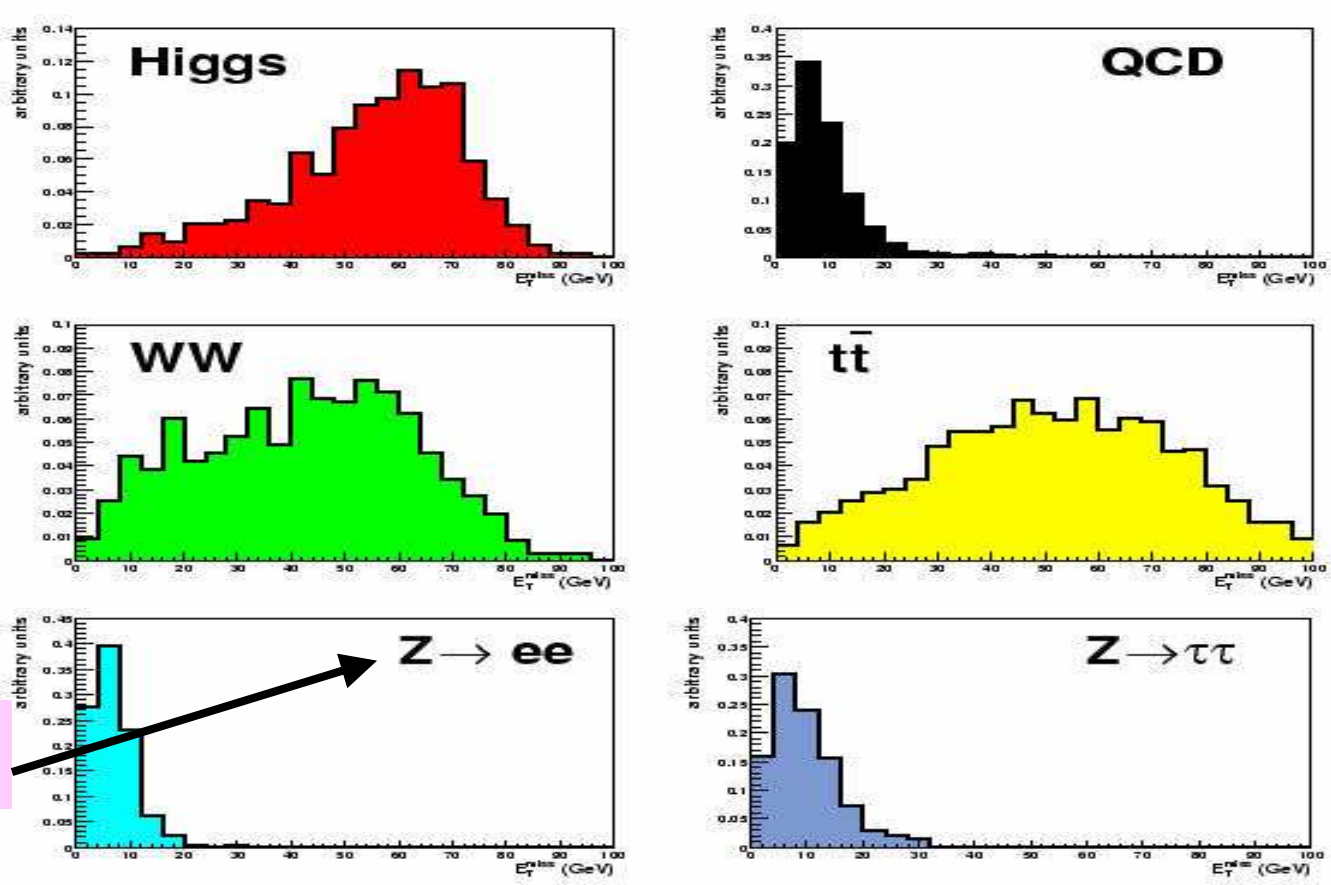
An example: e^+e^- final state MC



Main background

Missing E_T

An example: e^+e^- final state MC



Main background

Event Selection

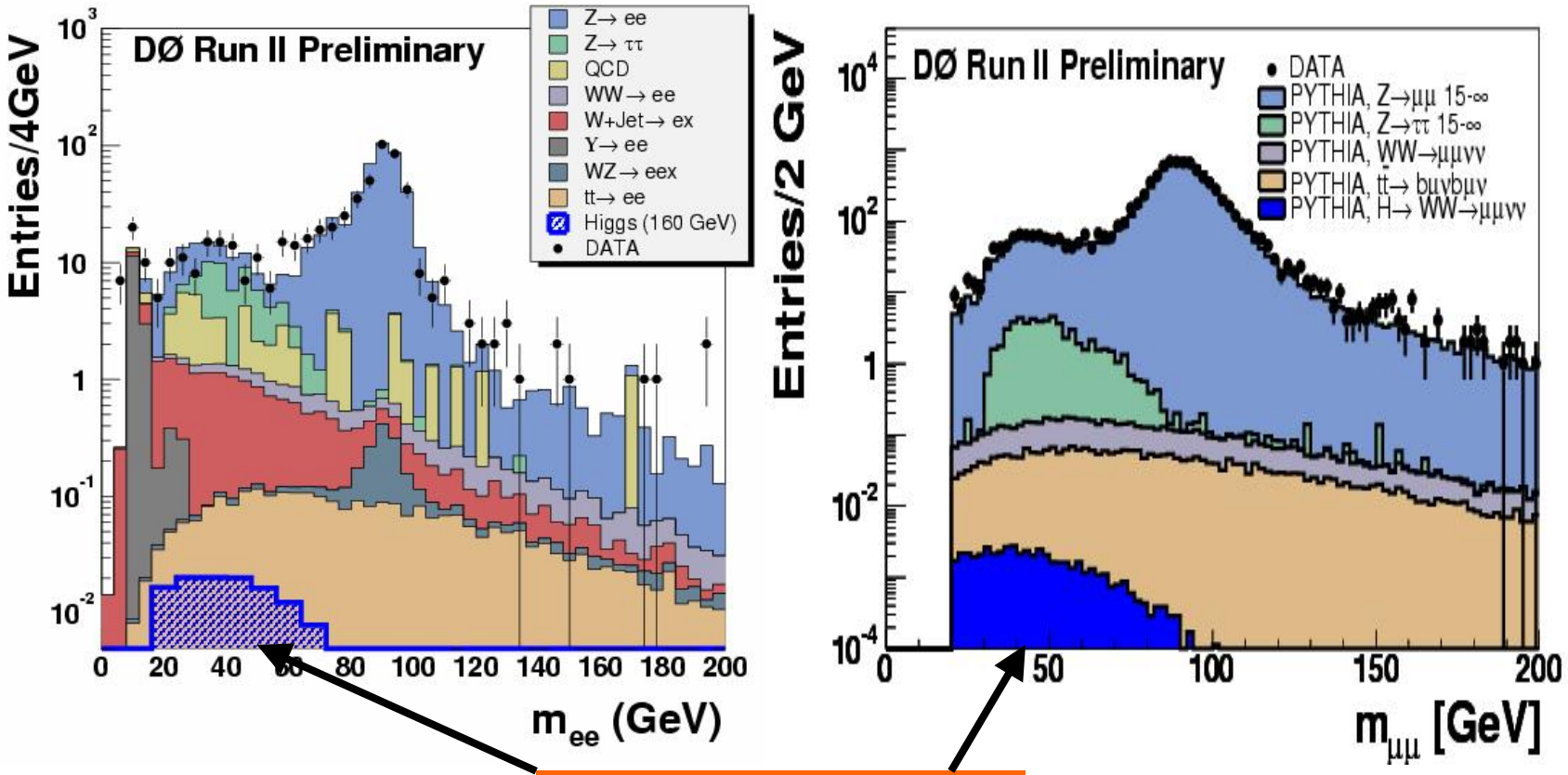
Event selection includes:

- Require two oppositely charged isolated leptons l = e, μ
  - ee: $p_T(e_1) > 12$ GeV, $p_T(e_2) > 8$ GeV
  - eμ: $p_T(e) > 12$ GeV, $p_T(\mu) > 8$ GeV
  - μμ: $p_T(\mu_1) > 20$ GeV, $p_T(\mu_2) > 10$ GeV
- Missing E_T greater than: 20 GeV (ee,eμ); 30 GeV (μμ)
- Removal of mass resonances:
  - 12 GeV < m(e,e) < 80 GeV
  - $m(\mu,\mu) > 20$ GeV and $|m(\mu,\mu) - m_Z| > 15$ GeV
- Azimuthal opening angle: $\Delta\phi(e,e) < 1.5$; $\Delta\phi(e/\mu,\mu) < 2.0$
- Rejection of energetic jets:
  - ee, eμ : $E_{T1} < 90$ GeV or $E_{T1} < 50$ GeV, $E_{T2} < 30$ GeV
  - μμ: $E_{T1} < 60$ GeV, $E_{T2} < 30$ GeV

Signal acceptance is ~ 0.02 – 0.2 depending on the Higgs mass/final state

Invariant mass: m_{ee} and $m_{\mu\mu}$

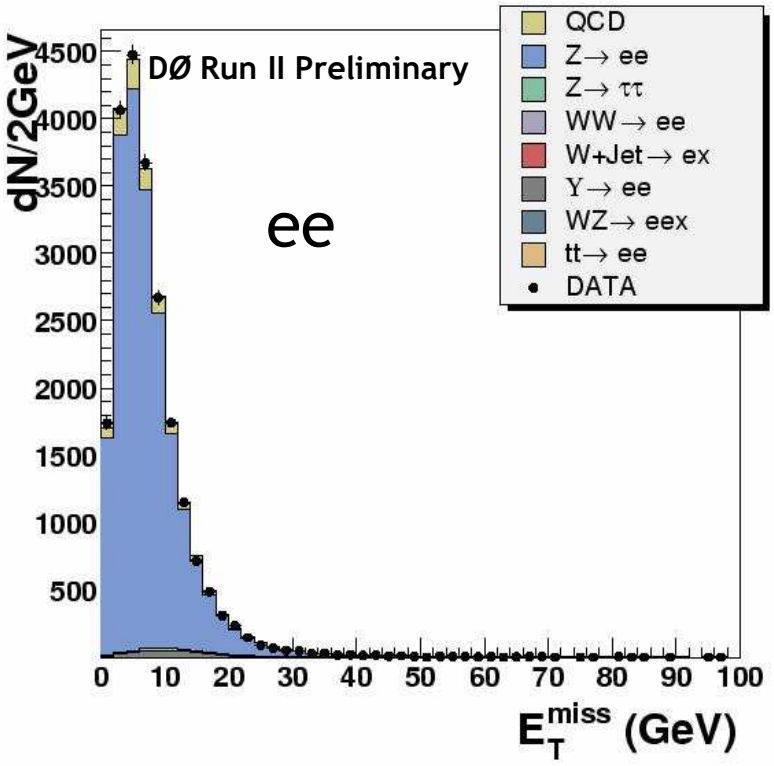
Data vs. MC after preselection

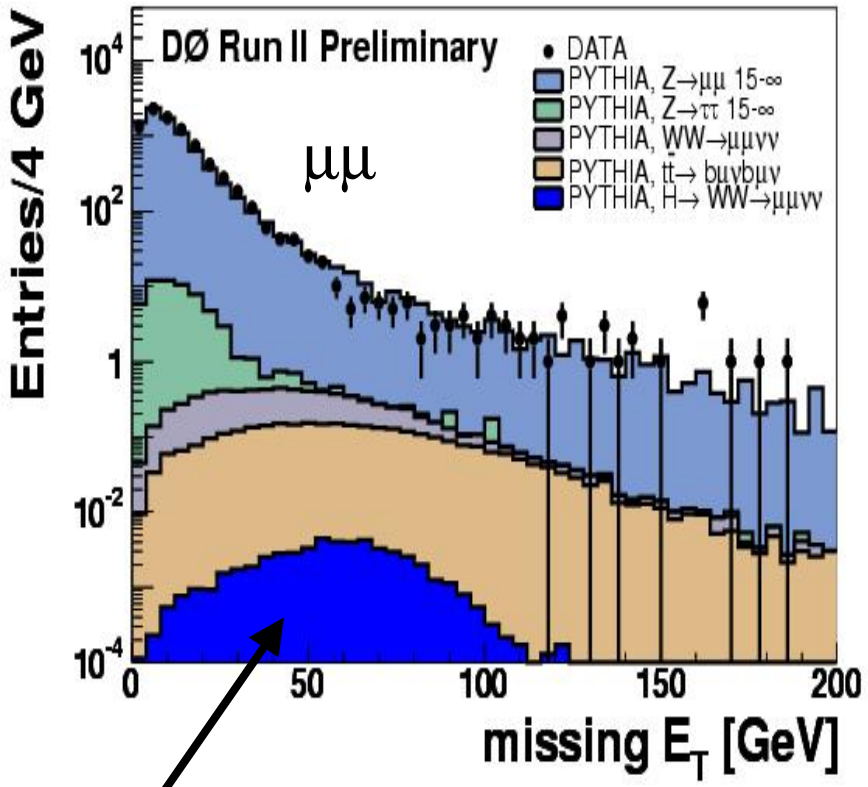


Higgs of 160 GeV

Missing E_T

Data vs. MC after preselection



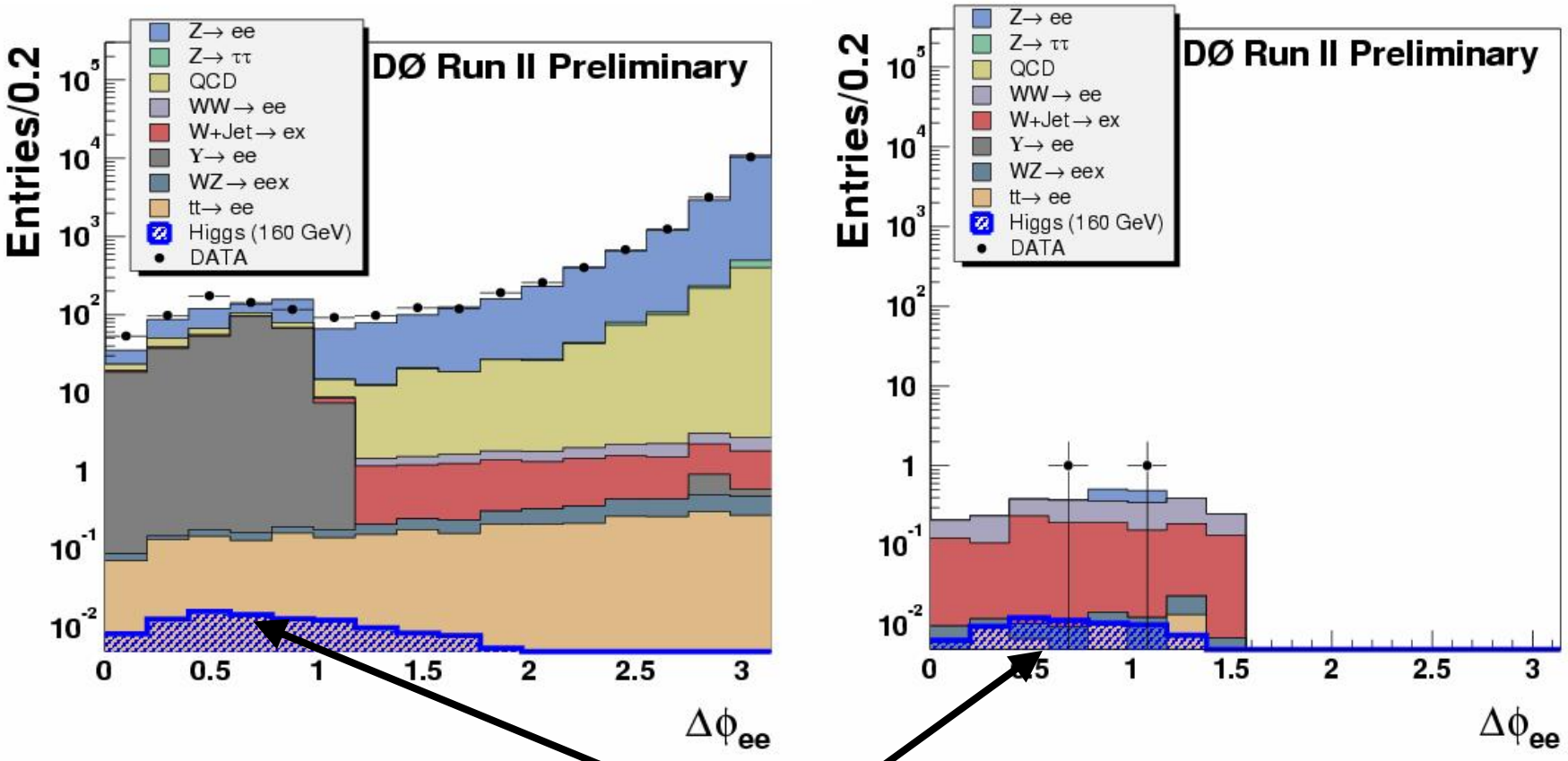


Higgs of 160 GeV

Opening Angle: $\Delta\phi(e,e)$

After preselection

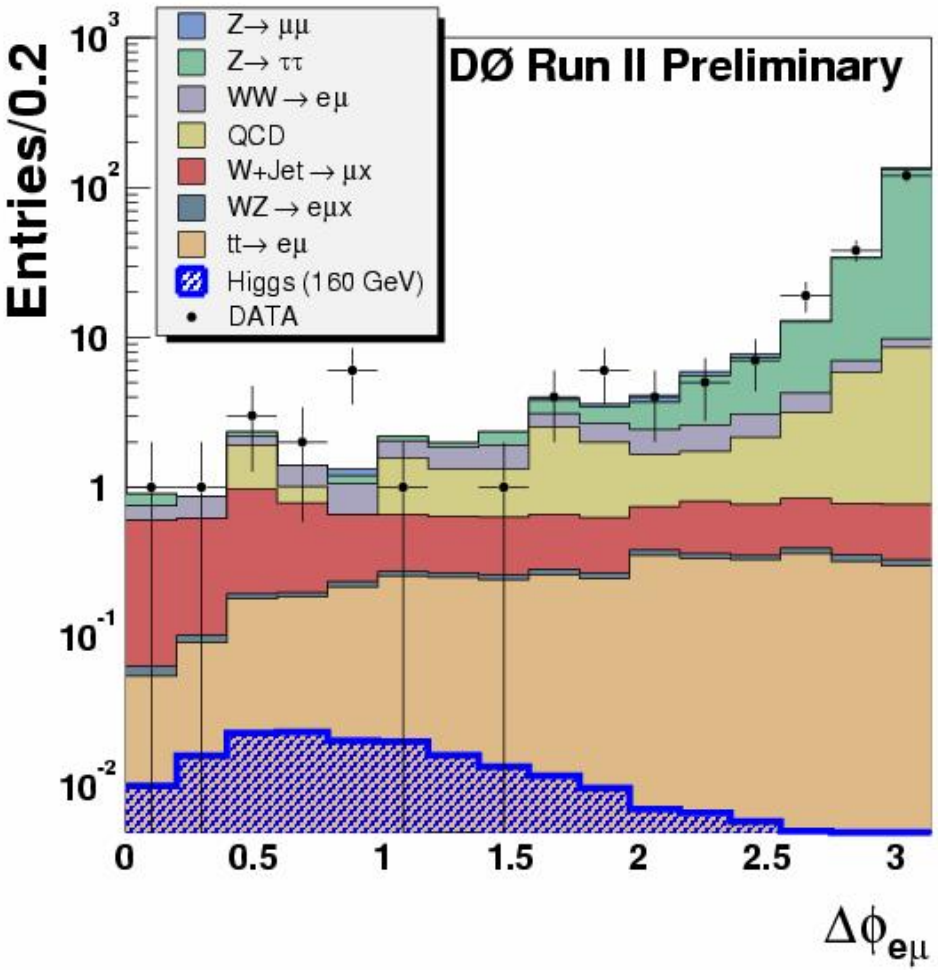
After final selection



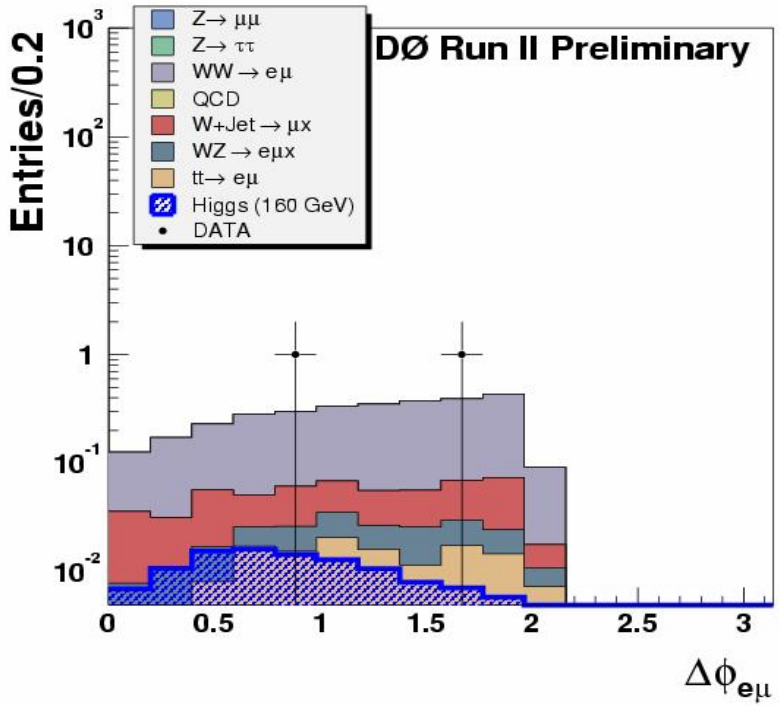
Higgs of 160 GeV

Opening Angle: $\Delta\phi(e,\mu)$

After preselection



After final cut



Good agreement between data and MC in all final states and variables examined

D0 Run II Preliminary

Event Counts

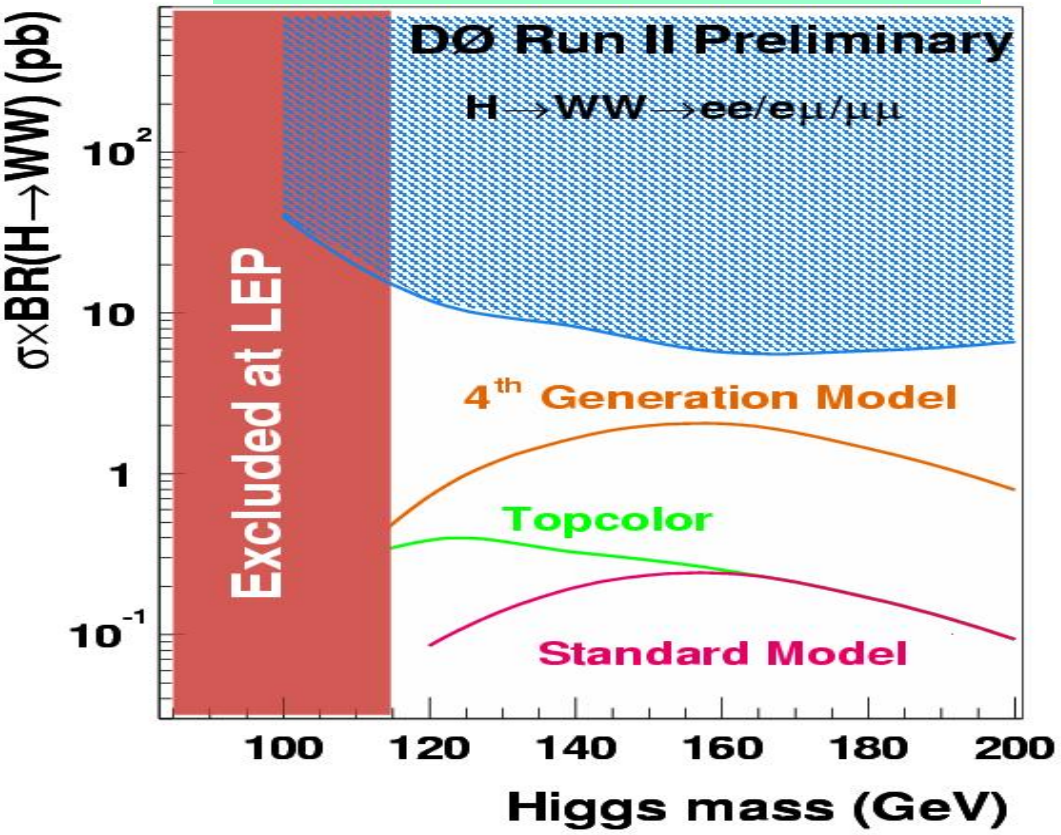
Source	ll'=ee L=180 pb^{-1}	ll'=eμ L=160 pb^{-1}	ll'=μμ L=150 pb^{-1}
tt->blνbl'ν	0.06 ±0.01	0.13 ±0.01	0.03 ±0.003
WZ->ll'+X	0.04 ±0.01	0.11 ±0.01	
Υ->ee	0.0 ±0.01		
QCD/W+jets	1.24 ±0.07	0.34 ±0.02	0.02 ±0.02
WW->lνl'ν	1.17 ±0.02	2.51 ±0.05	1.28 ±0.03
Z/γ*->ee	0.1 ±0.1		
Z/γ*->μμ		0.0 ±0.05	3.9 ±0.6
Z/γ*->ττ	0.0 ±0.1	0.0 ±0.1	0 ±0
Total Background	2.7 ±0.4	3.1 ±0.3	5.3 ±0.6
Data	2	2	5
Expected SM Signal M_H=160 GeV	0.073 ±0.002	0.111 ±0.004	0.085 ±0.001

Data in agreement with background expectations

Limits

Combined Upper Limits on σxBR between 6-40 pb

Excluded cross section times Branching Ratio at 95% C.L.

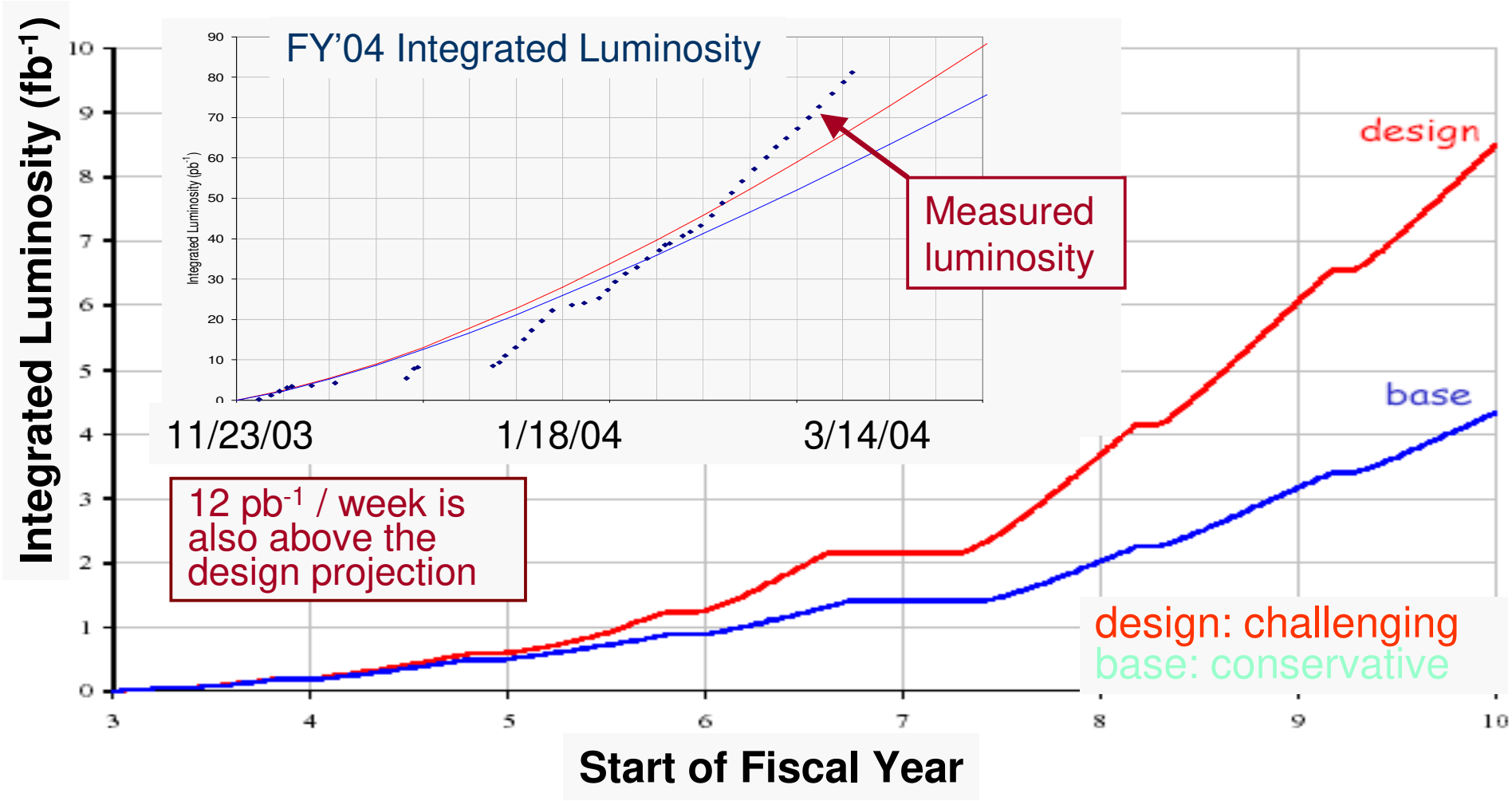


Summary

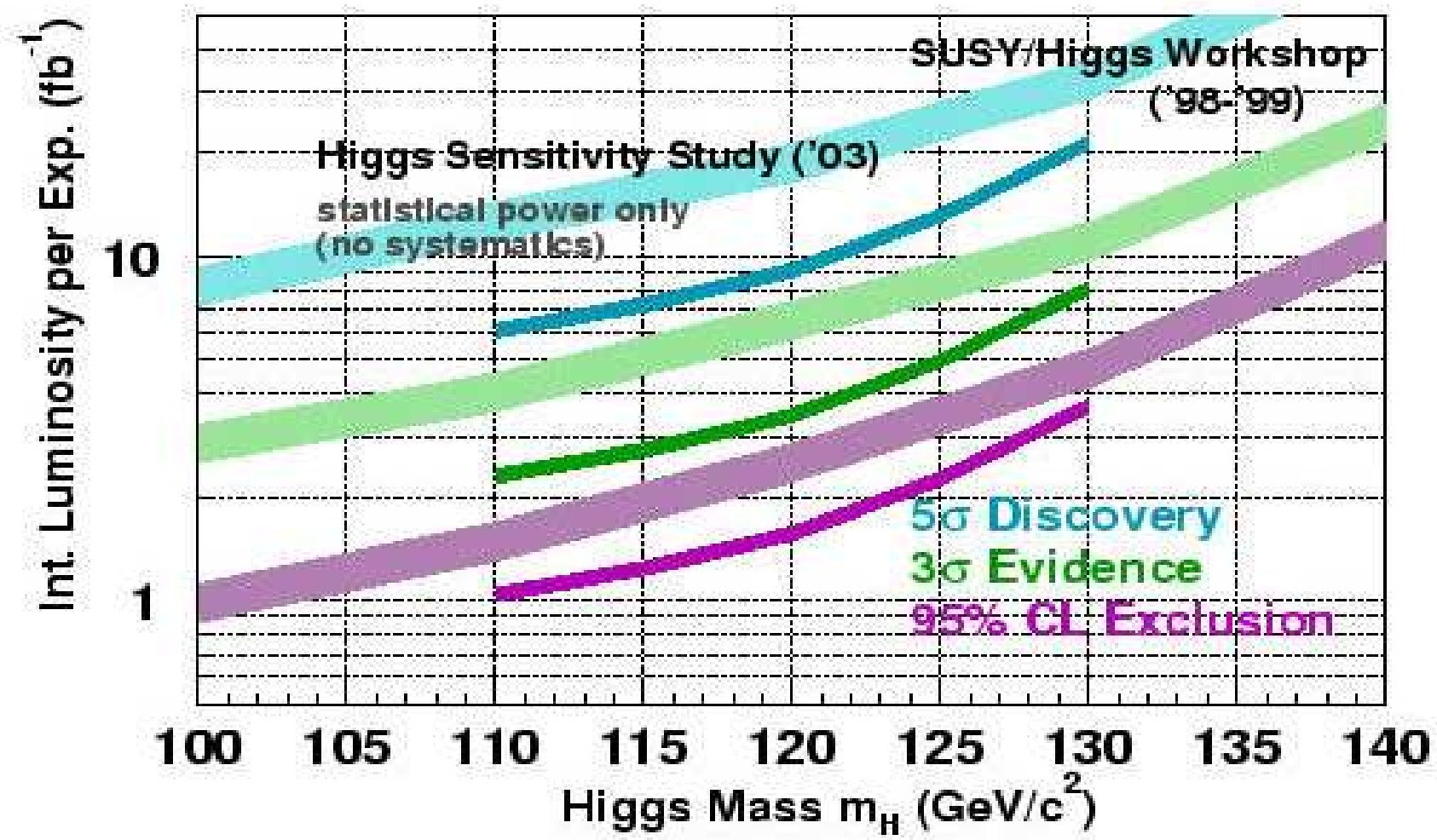
- DØ has searched for H->WW$^{(*)}$ with ee, eμ and μμ + MET signatures in 147-177 pb^{-1} of Run II data
- There are a total of 9 events with a background of 11.1
- Cross section limits for the combination of all channels have been calculated
- With L= ~1 fb^{-1} we will start to be sensitive to enhanced Higgs signals
- With L= ~ 10 fb^{-1} we will be sensitive to SM Higgs with M_H=160 GeV

Looking forward to more data!

Tevatron: Current and Projected Performance



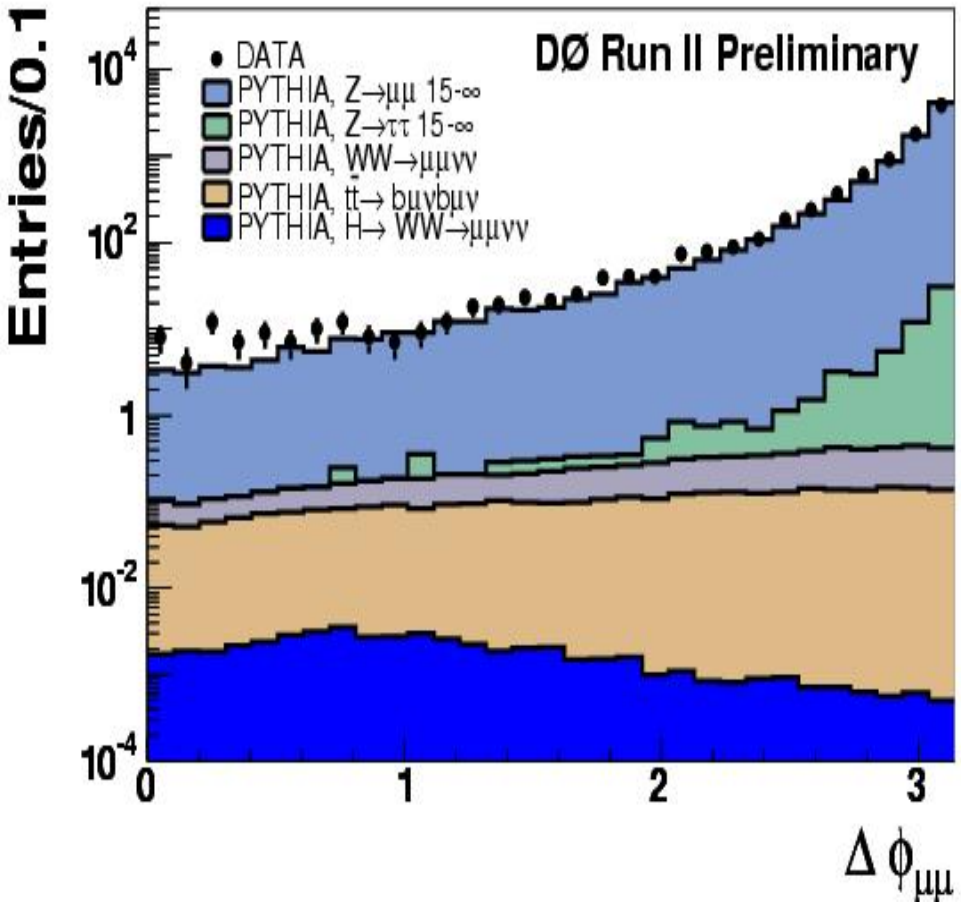
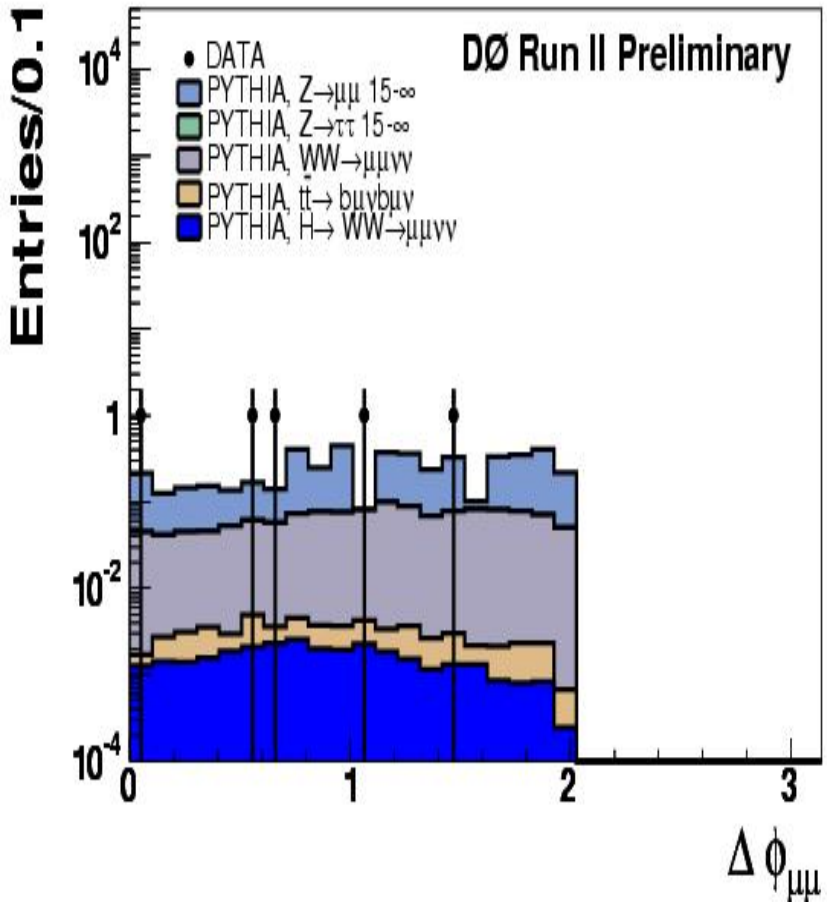
Higgs Sensitivity Reach



Back-up Slides

Opening Angle: $\Delta\phi(\mu,\mu)$

After preselection



After final cut