Search for $H \rightarrow WW$ at DØ

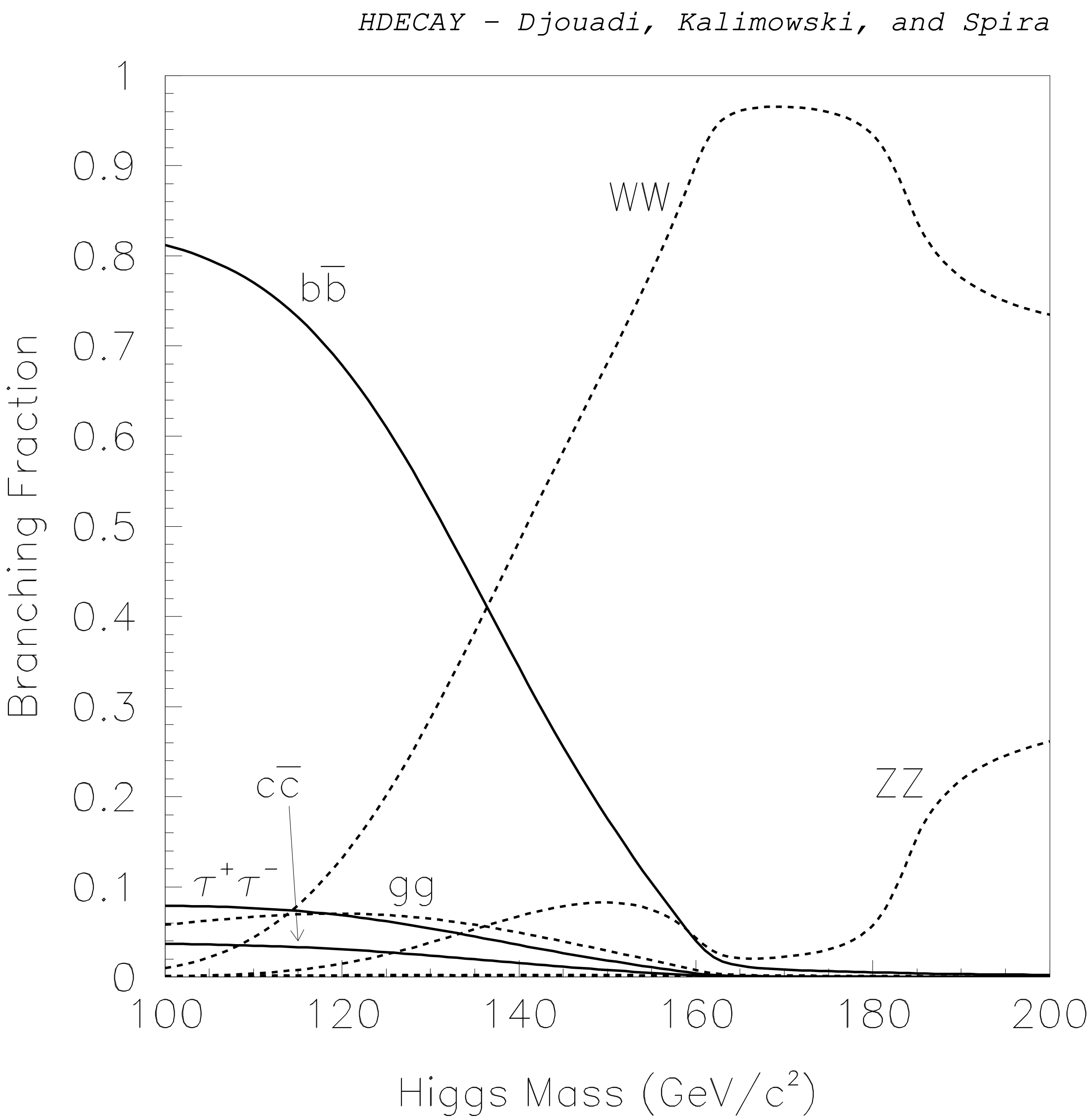
DPF 2003

P. Tamburello

University of Arizona

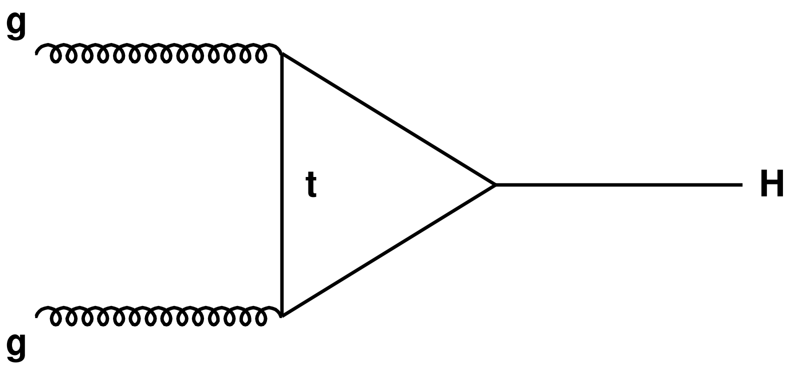
for the DØ Collaboration

Standard Model Higgs Decay Modes

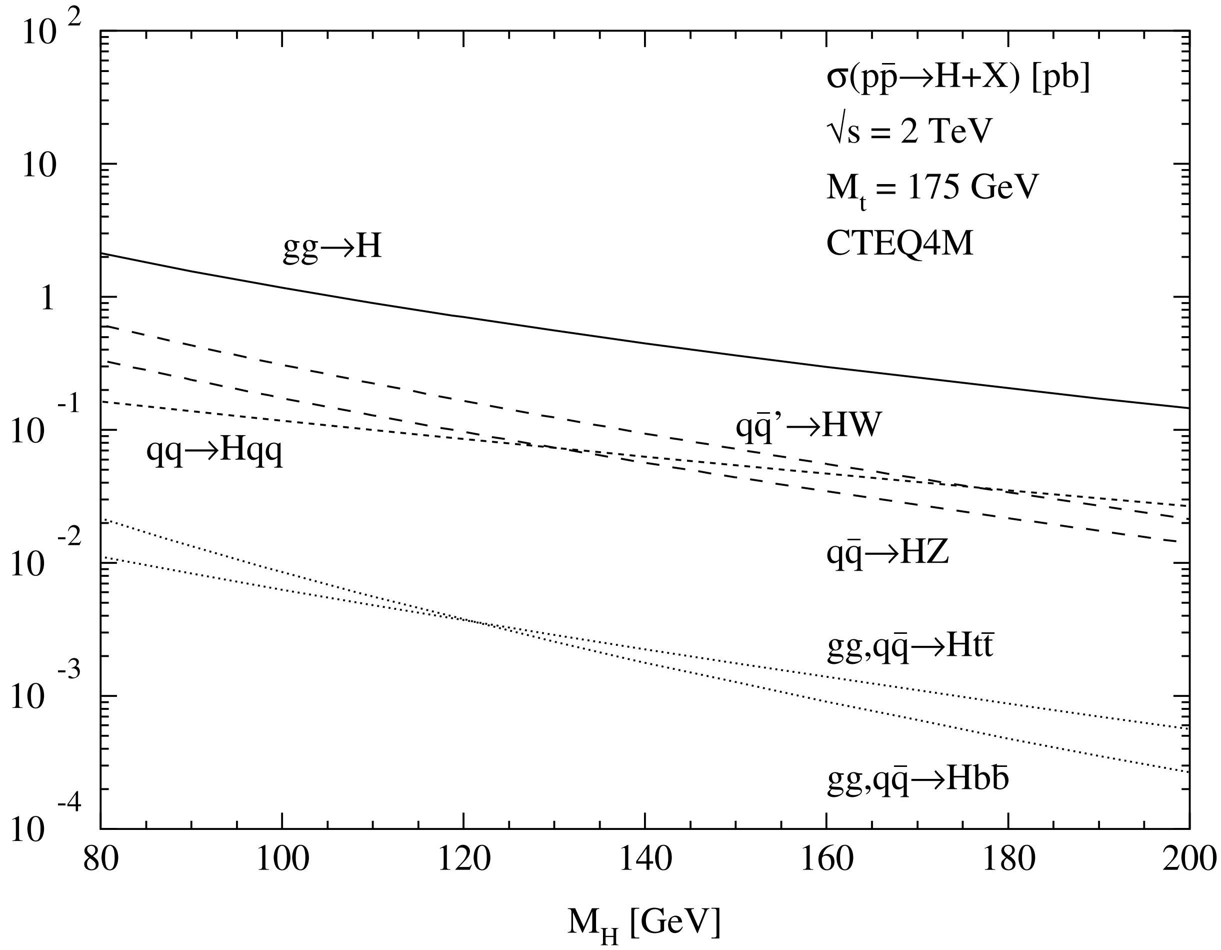


- Look for final states $e\mu\nu\nu$, $ee\nu\nu$, and $\mu\mu\nu\nu$ (new)
- Branching fraction only 5%, but strong interaction backgrounds overwhelm signatures with jets

Standard Model Higgs Production

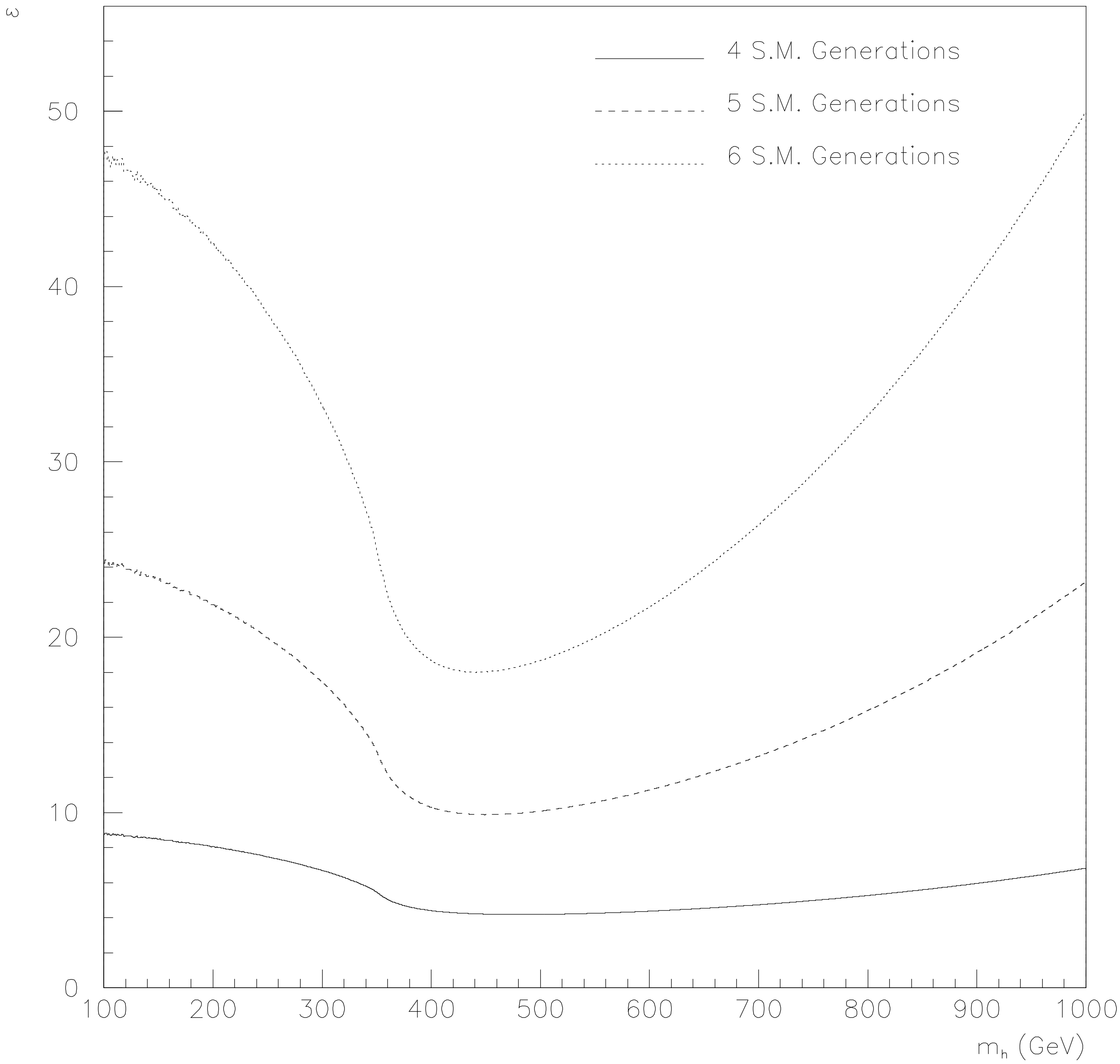


M. Spira, hep-ph/9810289



Cross Section Enhancement from Extra Generations

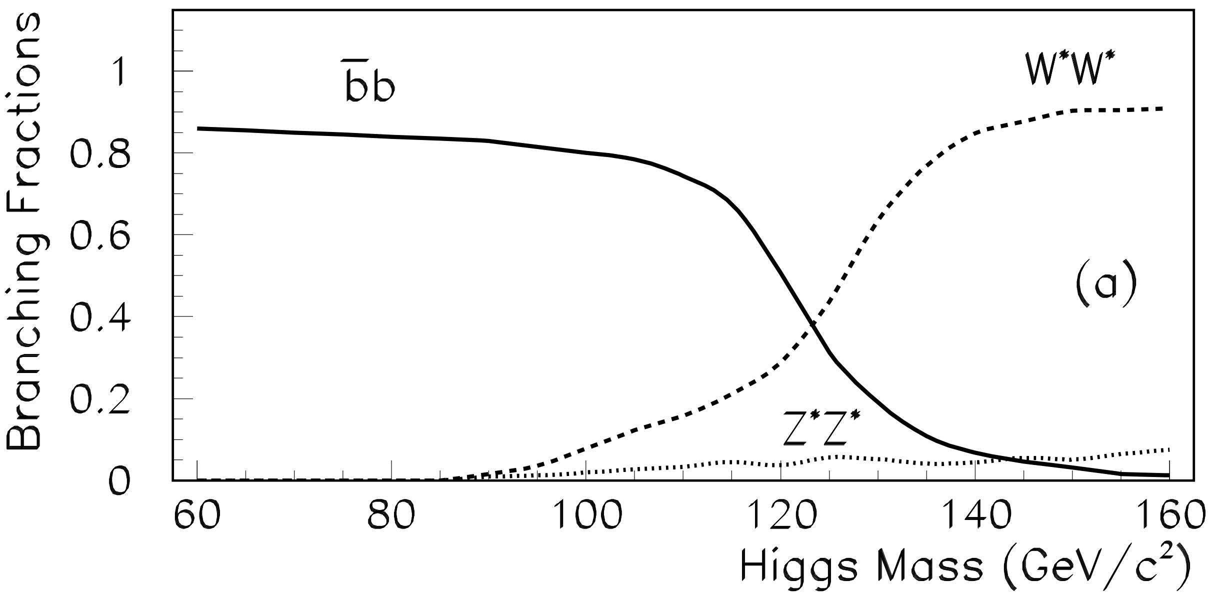
Arik, Cakir, Cetin, and Sultansoy, PRD 66 (2002) 033003

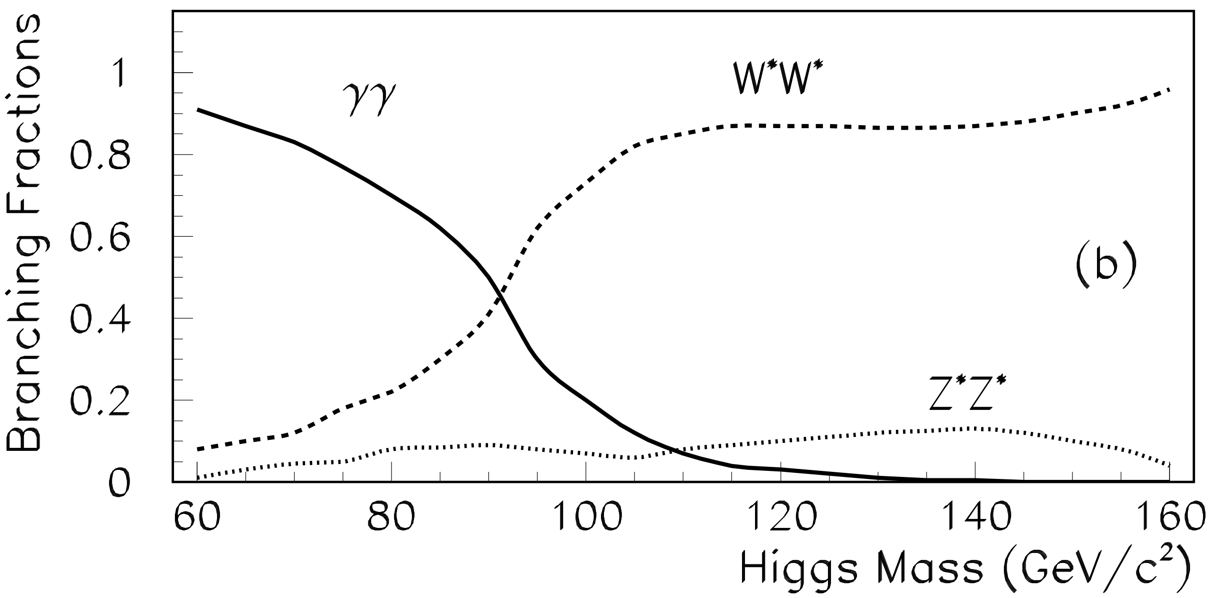


Suppressed Couplings to b, τ

This occurs in many models,
see A. Melnitchouk, P14.005

Abbott, et al. PRL 82 (1999) 2244



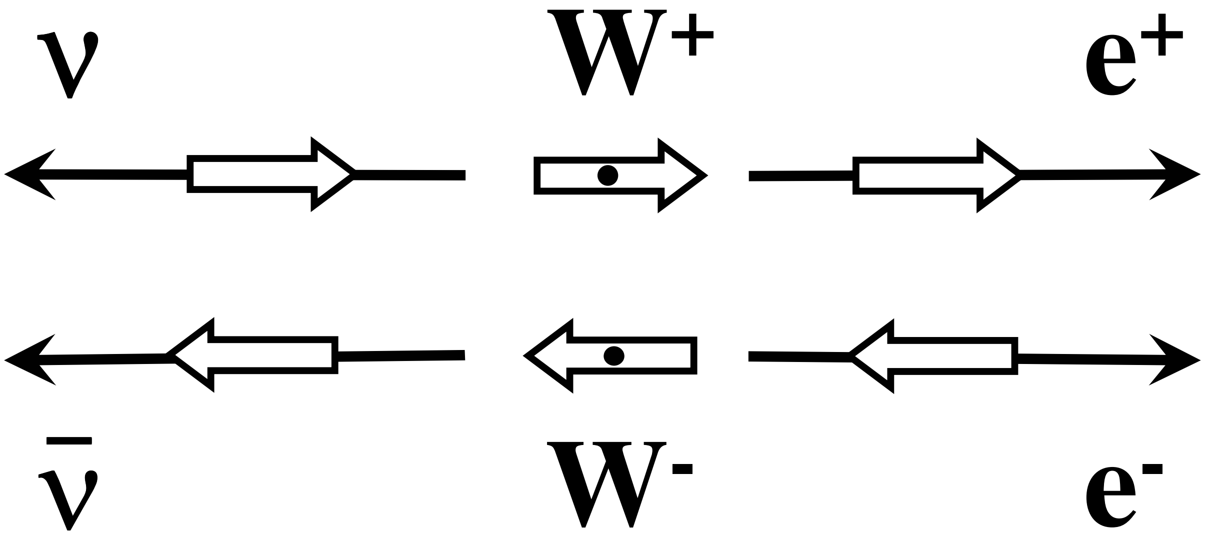


Spin Correlations

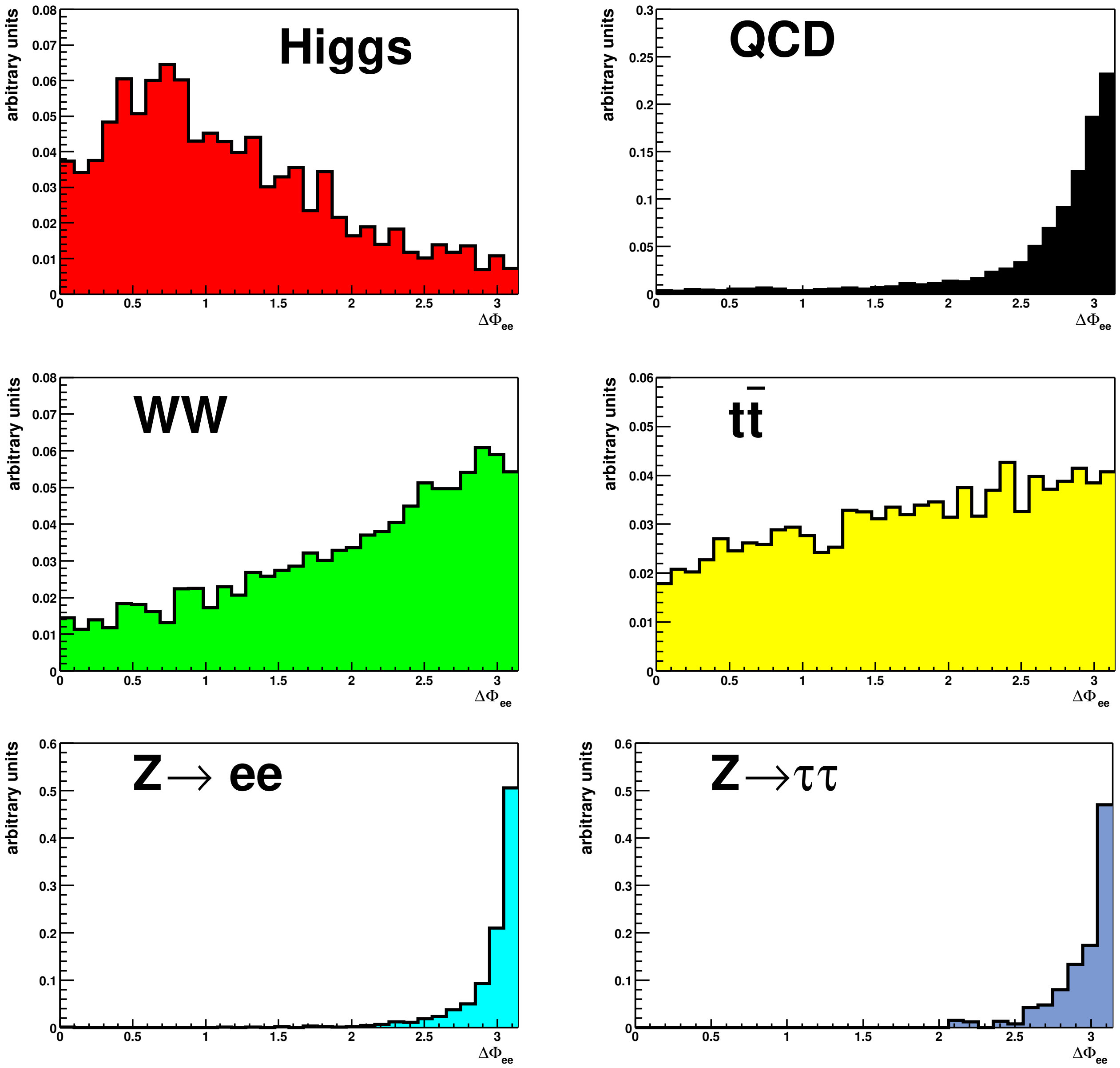
$W \to$ left-handed particle + right-handed antiparticle
(weak interaction is V-A)

$J = 0$

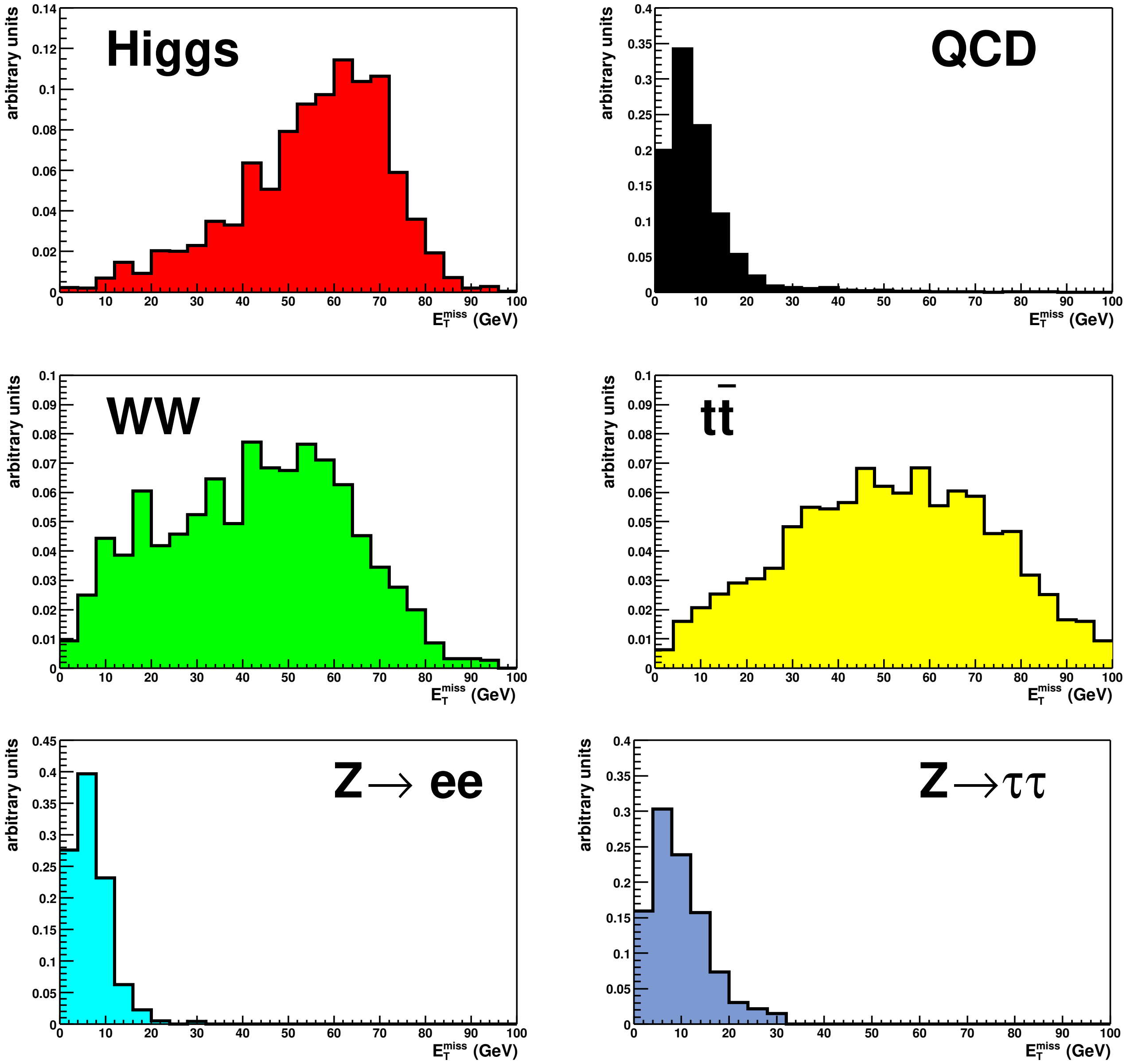
$\Rightarrow$ the charged leptons tend to be parallel to each other, likewise the neutrinos



$$\Delta\phi(l,l)$$



Missing E_T ($\not\!\!E_T$)



Dilepton Selection

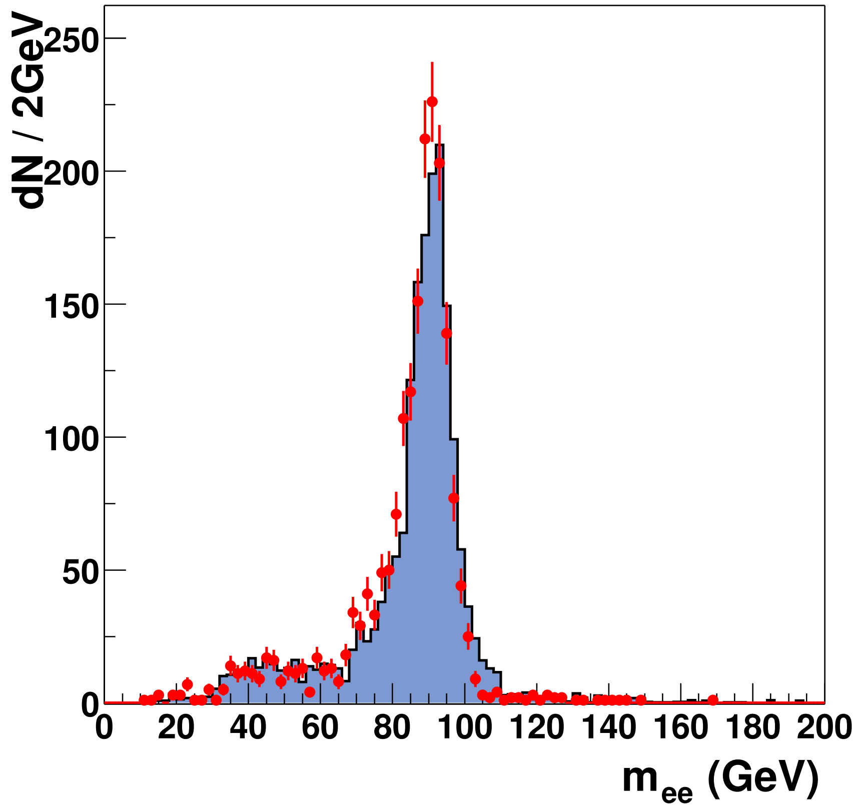
- Require two leptons $l = e, \mu$
  - ee: $p_T > 20$, 10 GeV
  - $\mu\mu$: $p_T > 15$ GeV
  - $e\mu$: $p_T^e > 20$, $p_T^\mu > 10$ GeV

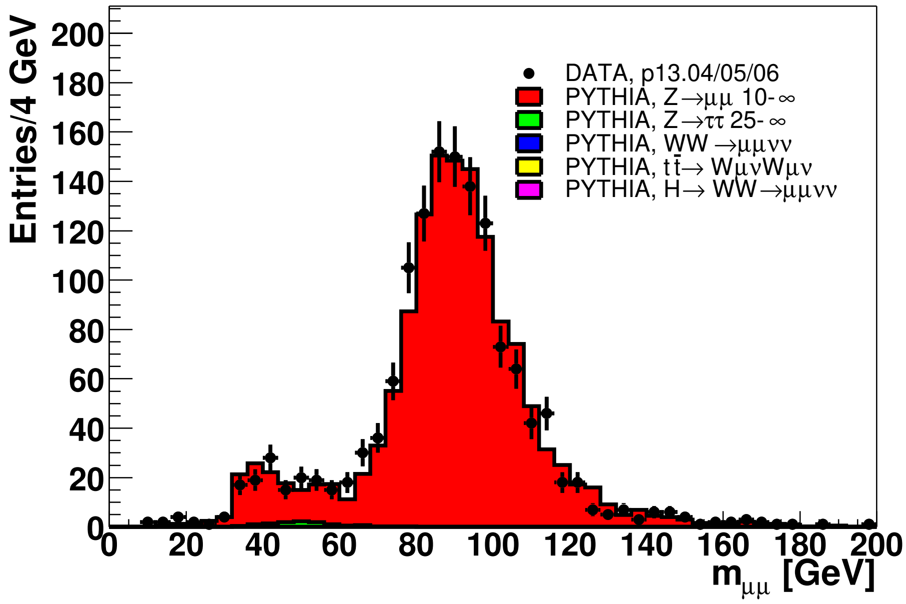
- The ee and $\mu\mu$ samples are mostly Z/γ

- Z removal. Require
  - ee: $m(e, e) < M_H/2$
  - $\mu\mu$: $20\,\mathrm{GeV} < m(\mu, \mu) < 75\,\mathrm{GeV}$

m_{ee} and $m_{\mu\mu}$

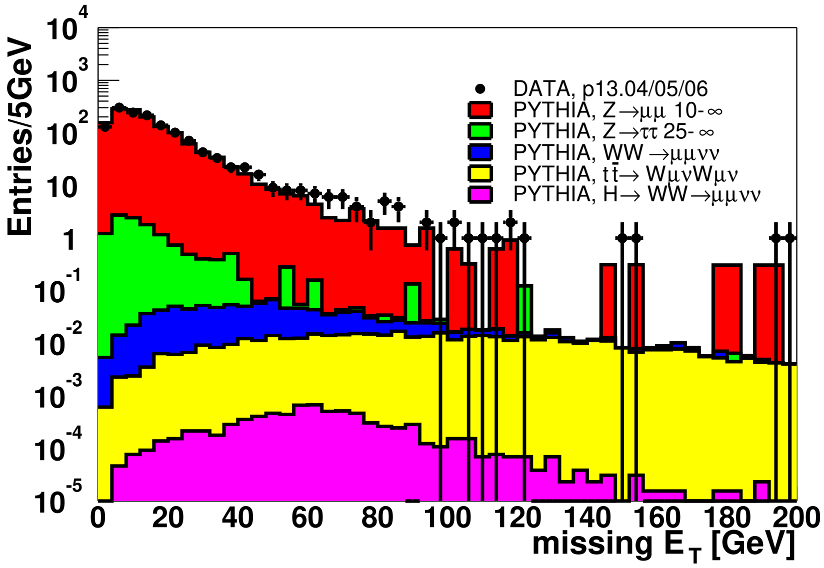
DØ Run II Preliminary

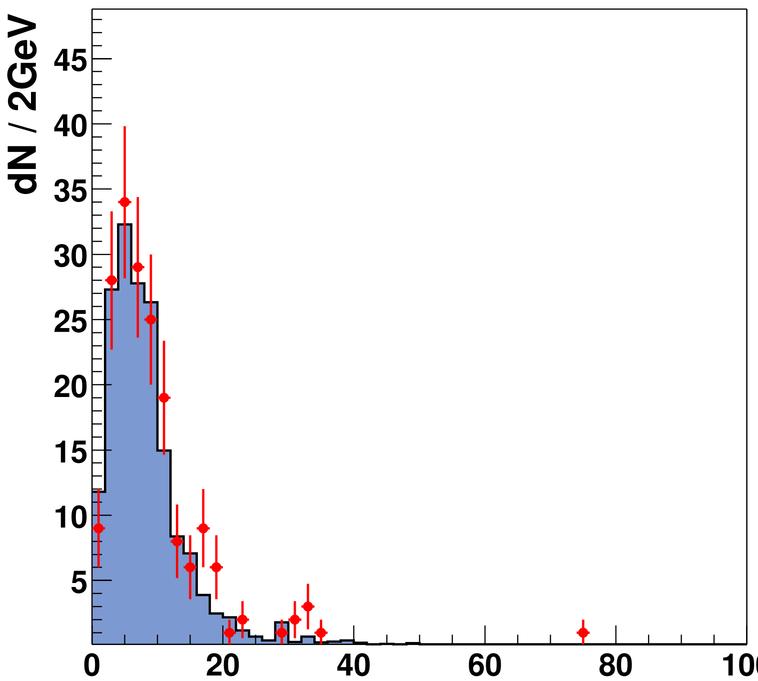




$\not{E}_T$

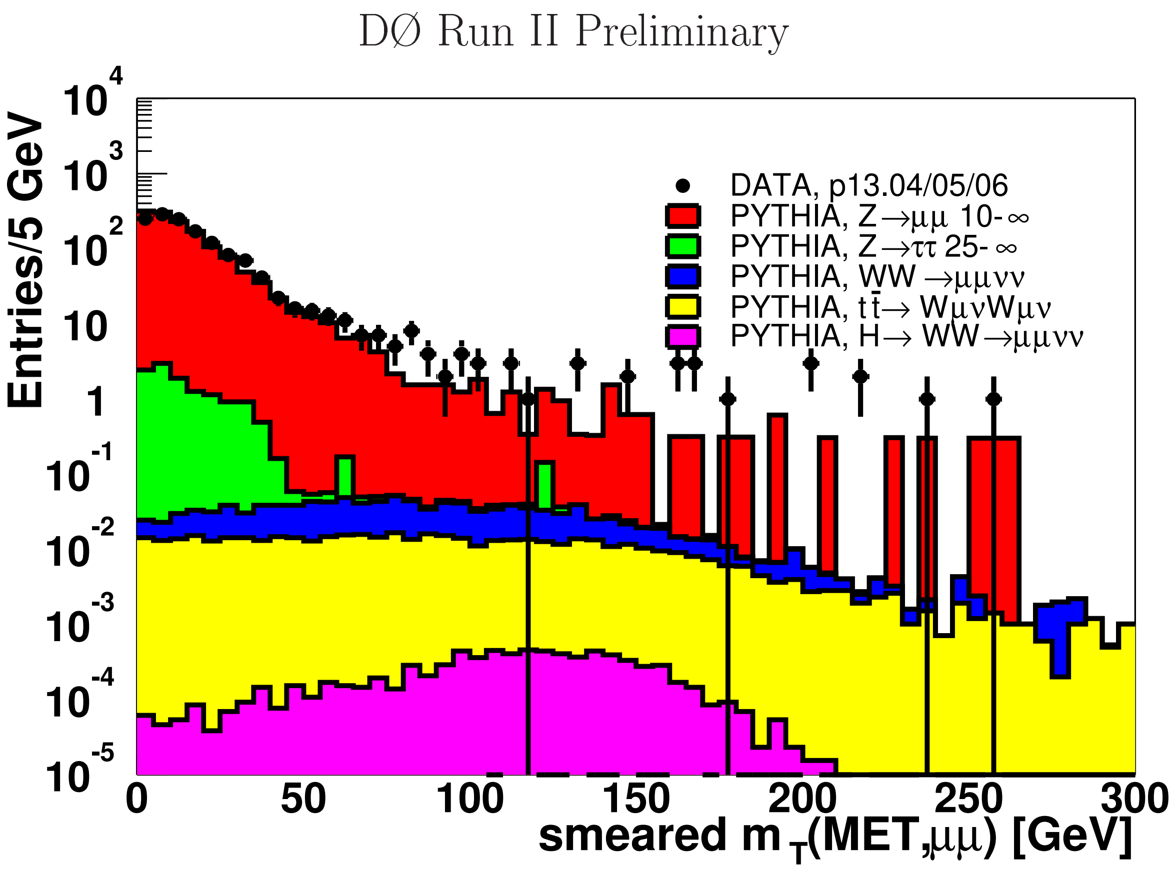
DØ Run II Preliminary





Require $\not{E}_T > 20$ GeV and $\Delta\phi(j, \not{E}_T) > 0.5$

$m_T(ll, \not{E}_T)$

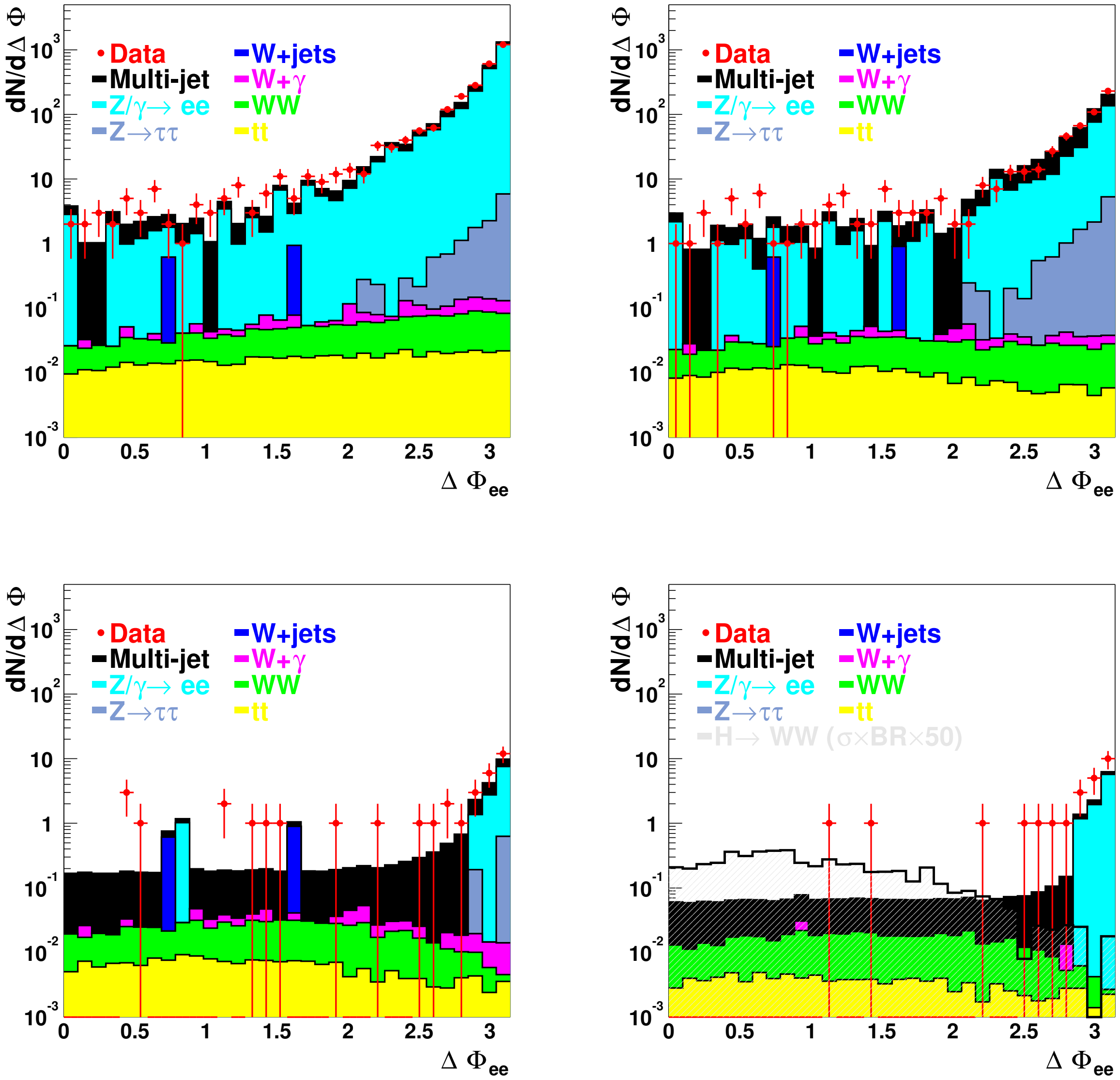


Require

- ee: $m_T(ee, \not{E}_T) < H_H + 20$ GeV,
  and 2nd e $p_T > 20$ GeV if $m_T(ee, \not{E}_T) < 80$ GeV
- $\mu\mu$: $50\,\mathrm{GeV} < m_T(\mu\mu, \not{E}_T) < 200$ GeV

$\Delta\phi(e, e)$

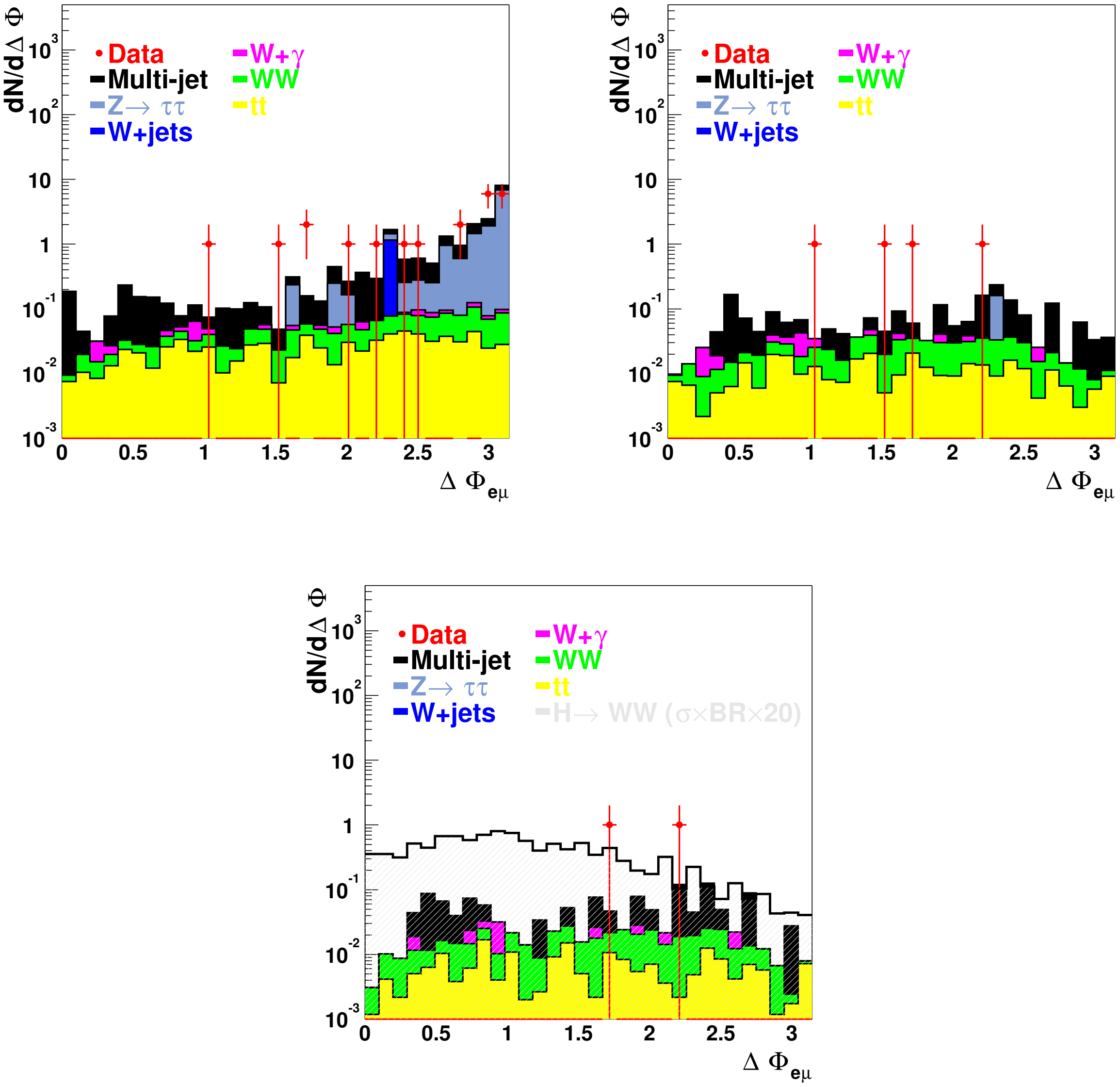
DØ Run II Preliminary



After ee selection (upper left), Z removal (upper right), $\not\!\!E_T$ (lower left), m_T (lower right)

$\Delta\phi(e,\mu)$

DØ Run II Preliminary



After $e\mu$ selection (upper left), Z removal (upper right), $\not\!\!E_T$ (bottom)

Event Counts

DØ Run II Preliminary

Source	ee	$\mu\mu$	$e\mu$
$Z/\gamma \to ee$	0.00 ± 0.03		
$Z/\gamma \to \mu\mu$			
$Z/\gamma \to \tau\tau$	0.0 ± 0.2		0.1 ± 0.1
WW	0.27 ± 0.01	0.20 ± 0.01	0.18 ± 0.01
$t\bar{t}$	0.070 ± 0.003	0.110 ± 0.003	0.13 ± 0.01
$W\gamma$	0.01 ± 0.01		0.06 ± 0.03
W + jets	0.0 ± 1.1		0.0 ± 1.5
multijet	0.7 ± 0.1		0.40 ± 0.04
Total Background	1.3 ± 1.4	0.3 ± 0.1	0.9 ± 1.5
Data	2	1	1
Expected Signal	0.13	0.18	0.21

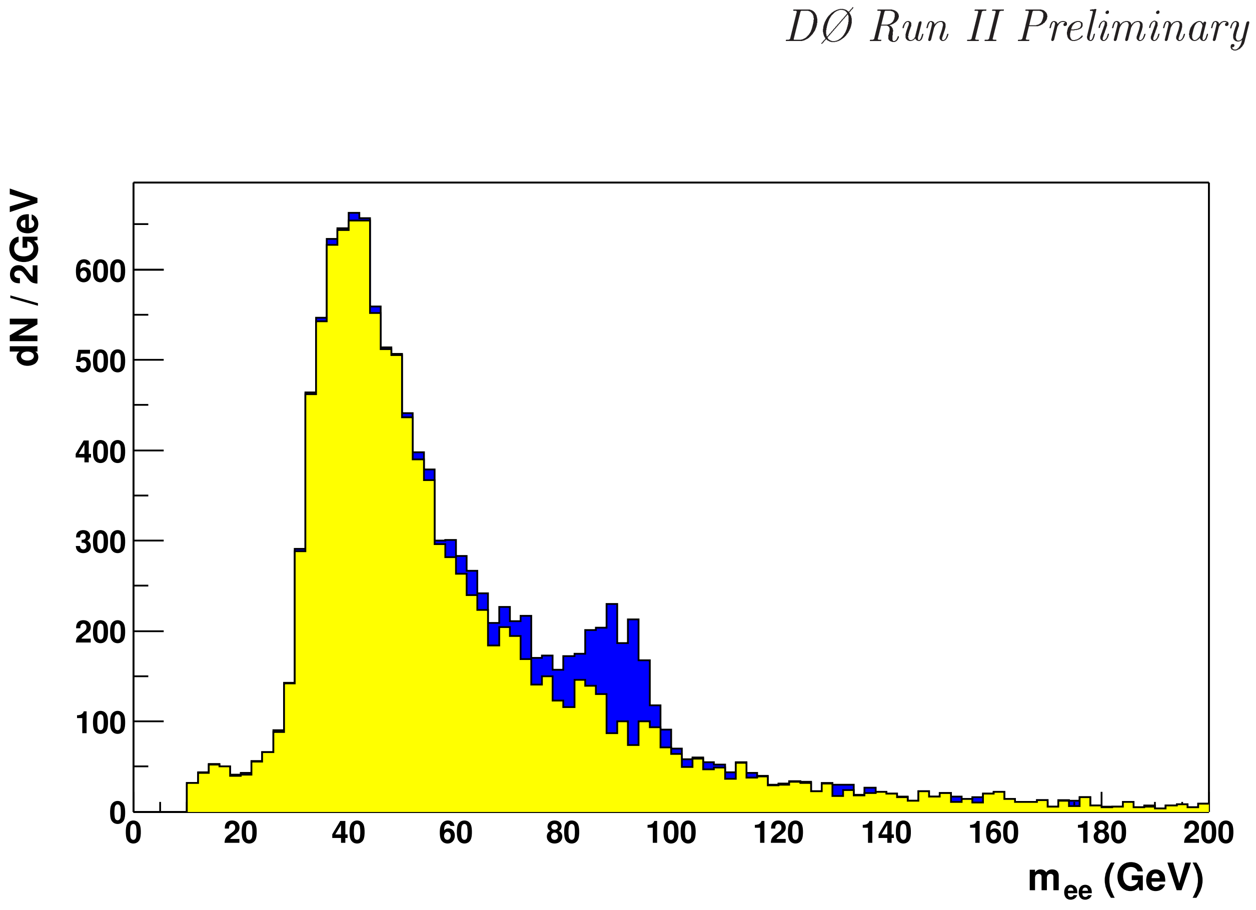
Results in ee channel are for cuts with $m_H = 160$ GeV$/c^2$

Expected signal assumes $m_H = 160$ GeV$/c^2$ and $\sigma = 8.5 \times \sigma_{\mathrm{SM}}$ due to 4th generation enhancement

QCD Background

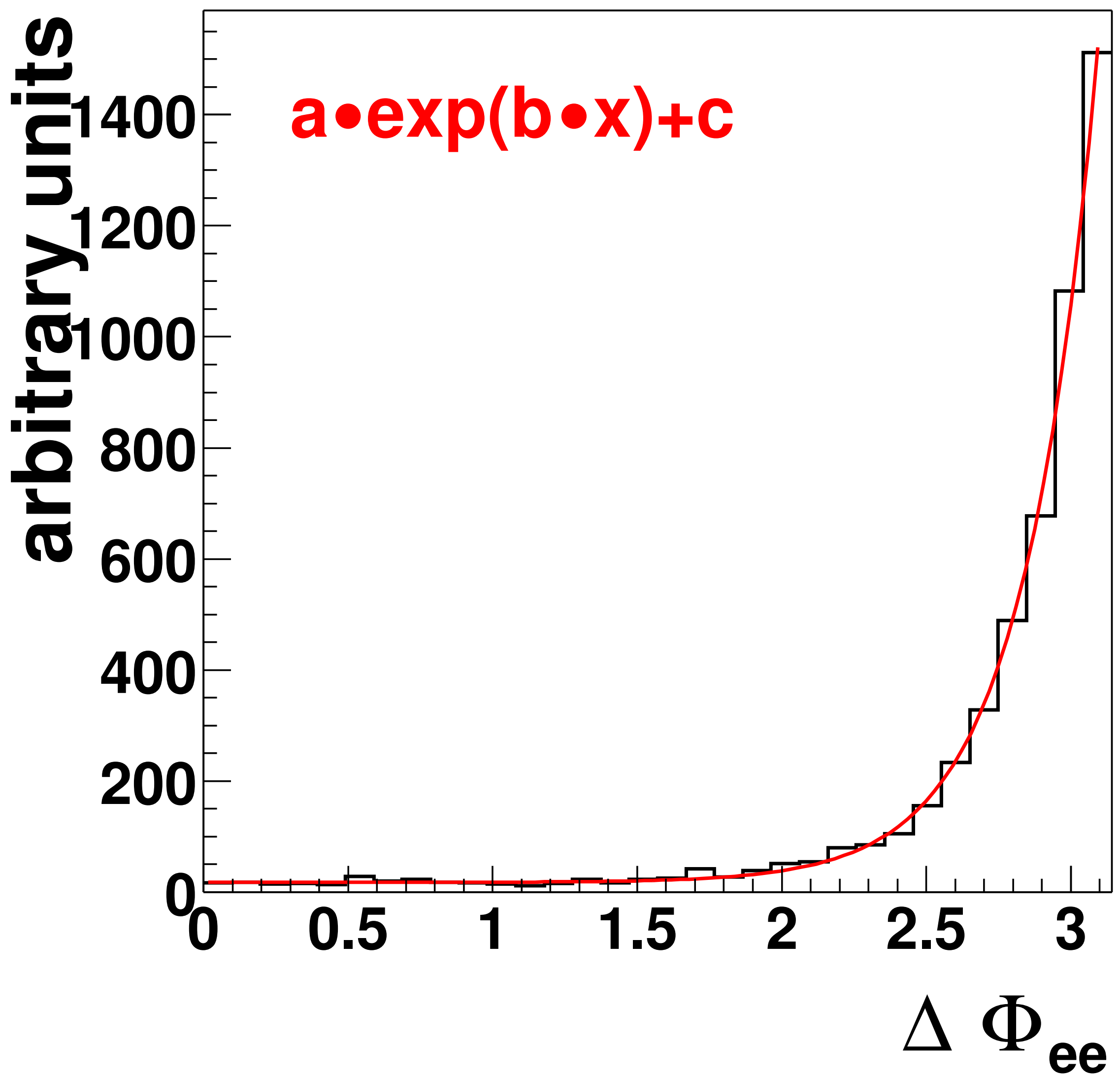
- Electron sources
  - jets that mimic an electron shower: $\pi^{\pm}$ contained in EM cal, π^0 + random track
  - direct photons that overlap with a random track
  - photon conversions
  - real electrons from heavy quark decays
- Backround is estimated using control data
- Method assumes $\not{E}_T$ + other cuts don't bias the proportions of sources, but it doesn't depend on modeling difficult and rare processes
- Control sample: events with an electron candidate that just fails the shower shape requirements for a good electron
- Similar strategy used for muons

QCD control sample before (blue) and after (yellow) subtracting contribution from real *ee* events



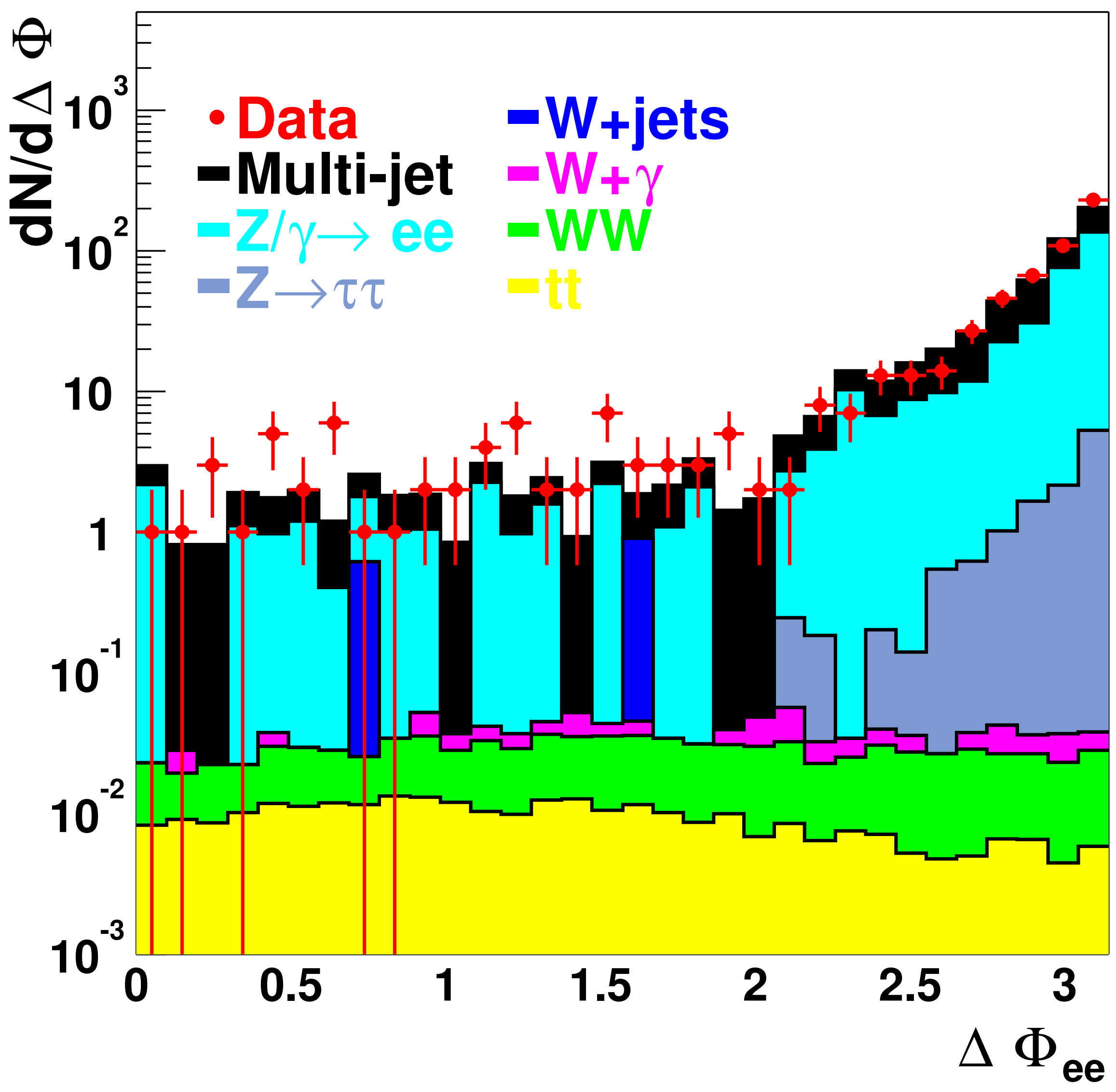
$\Delta\phi(e, e)$ distribution in QCD control sample

DØ Run II Preliminary



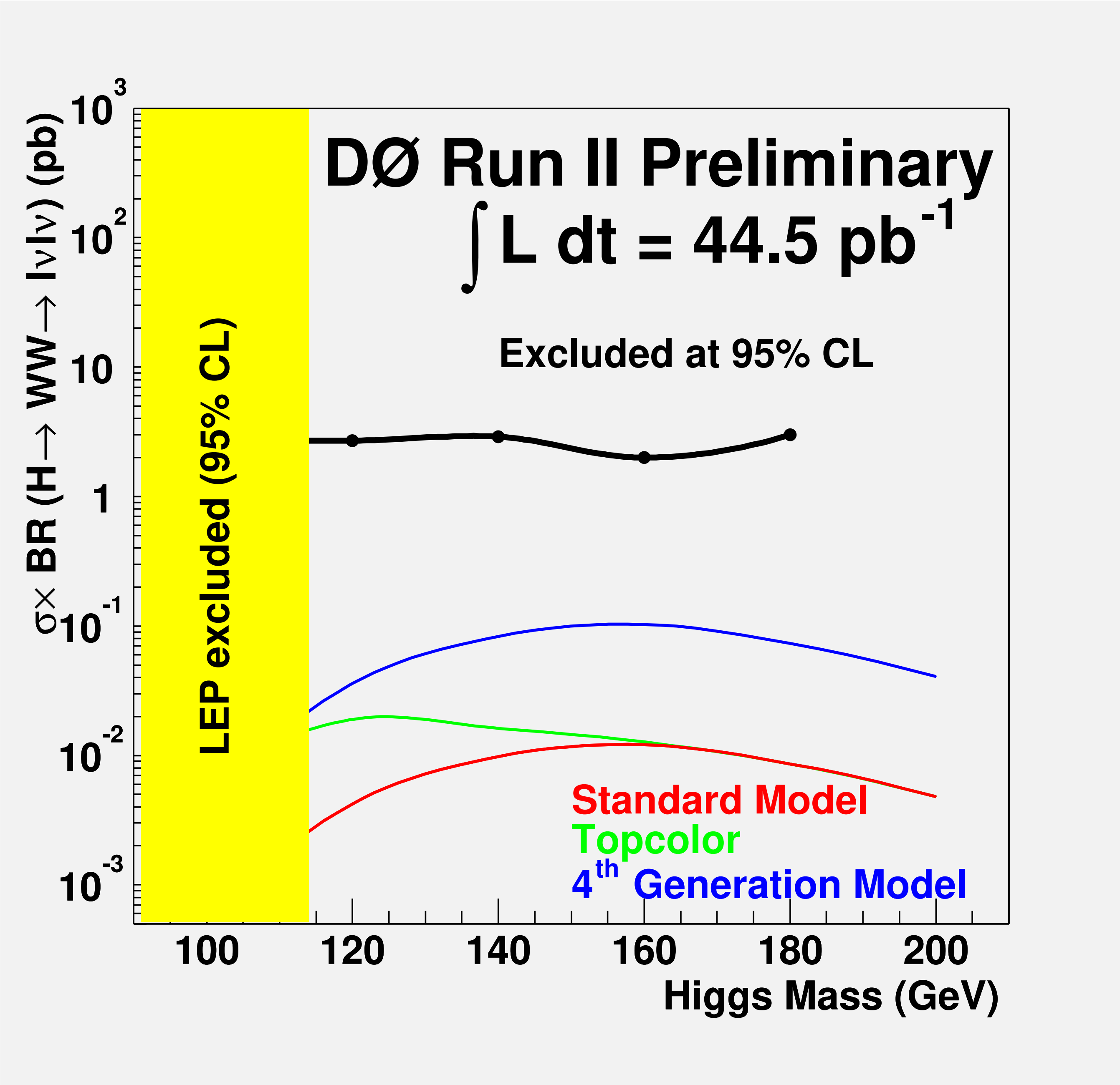
QCD background normalized to data in the background region $\Delta\phi > 2$

DØ Run II Preliminary



Limits

ee and $e\mu$ modes



Summary

- DØ has searched for $H \to WW$ with the $ee + \not\!\!E_T$, $\mu\mu + \not\!\!E_T$, and $e\mu + \not\!\!E_T$ signatures in the initial $\sim 40\ \mathrm{pb}^{-1}$ of DØ Run II data
- There are a total of 4 events with a background of about 2.5
- Improvements in electron ID and optimized event selection are expected
- With $\sim 1\ \mathrm{fb}^{-1}$, we will be sensitive to plausible enhanced Higgs signals
- With $\sim 10\ \mathrm{fb}^{-1}$ we hope to be sensitive to SM Higgs for m_H in the region around 160 GeV$/c^2$