Search for Higgs Bosons in H to WW Decays at the Tevatron

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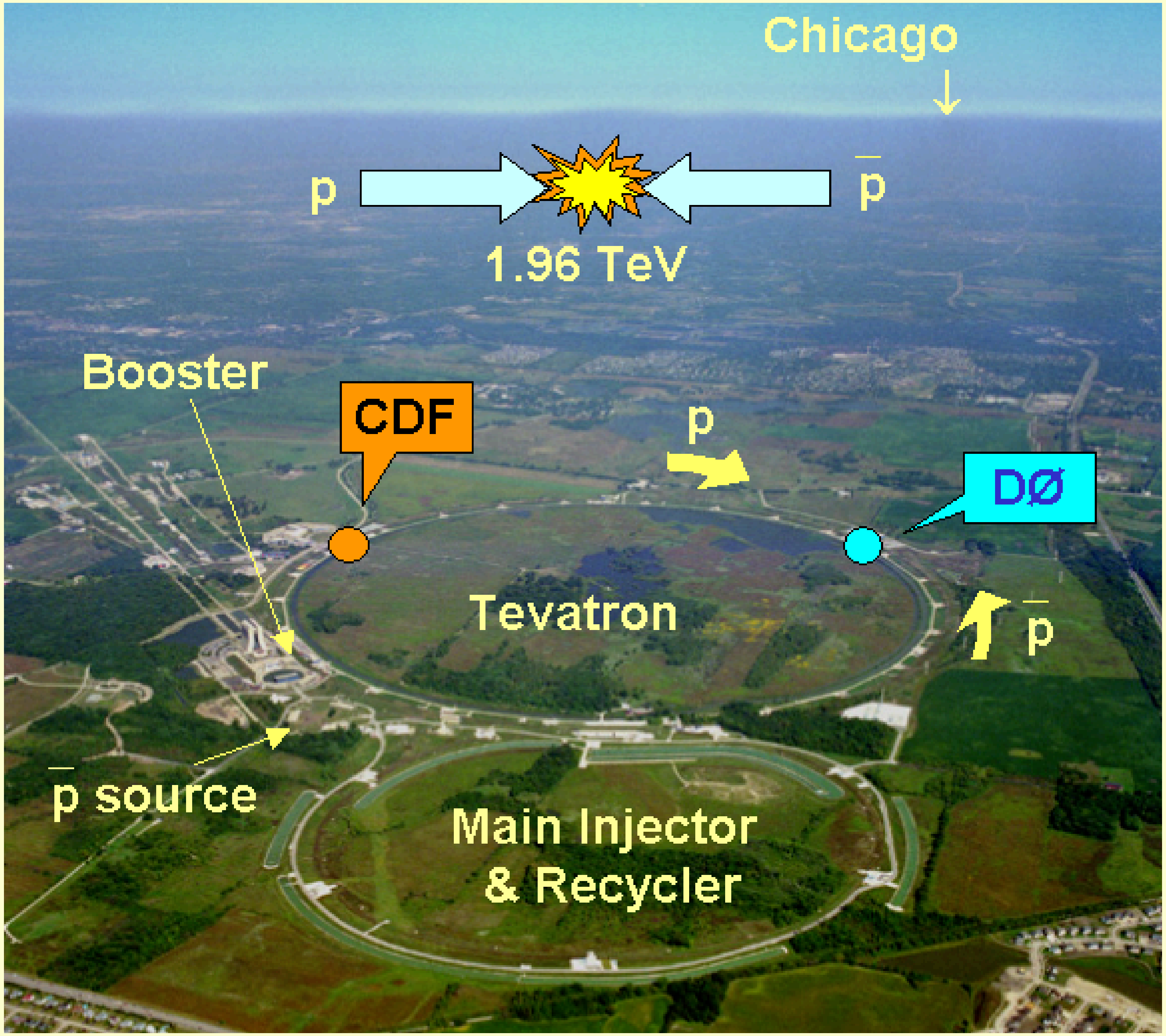
Outline

- introduction
- D0 results
- CDF results NN
- CDF results ME
- combined limit

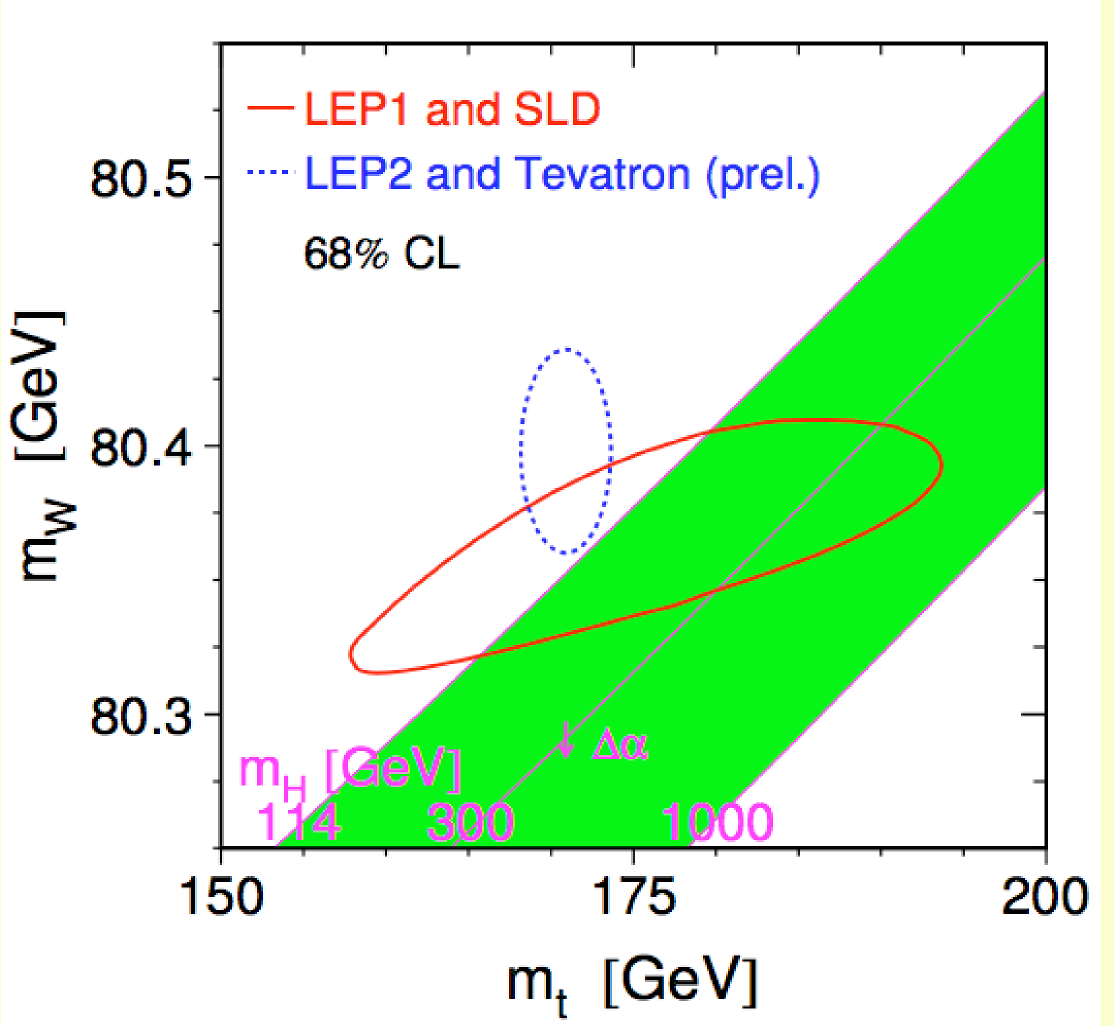


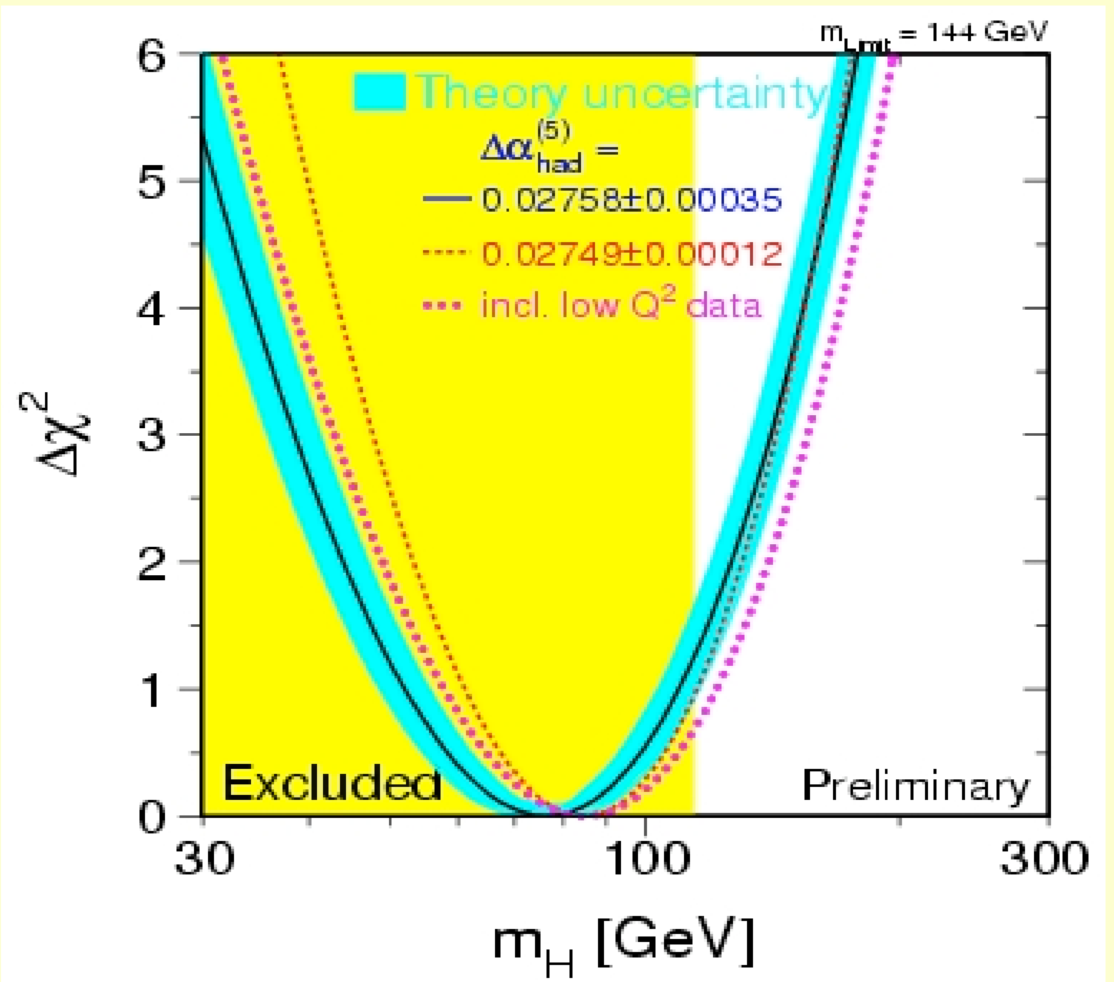
Higgs mass prediction

- Direct limits from LEP2:

  $m_H > 114.4$ GeV @ 95% CL

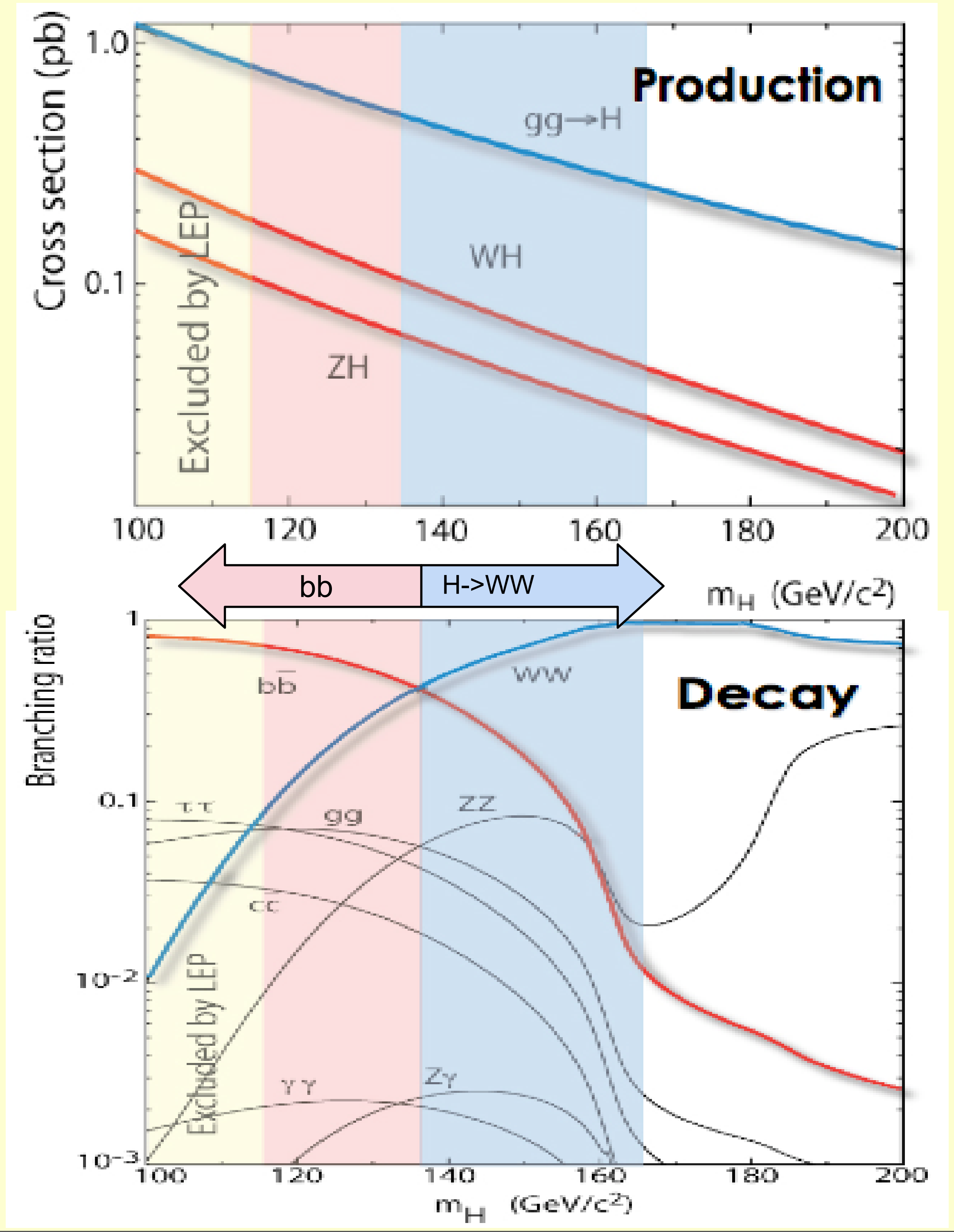
- fit to experimental data:
  - $m_H = 76^{+33}_{-24}$ GeV
  - $m_H < 144$ GeV @ 95% CL





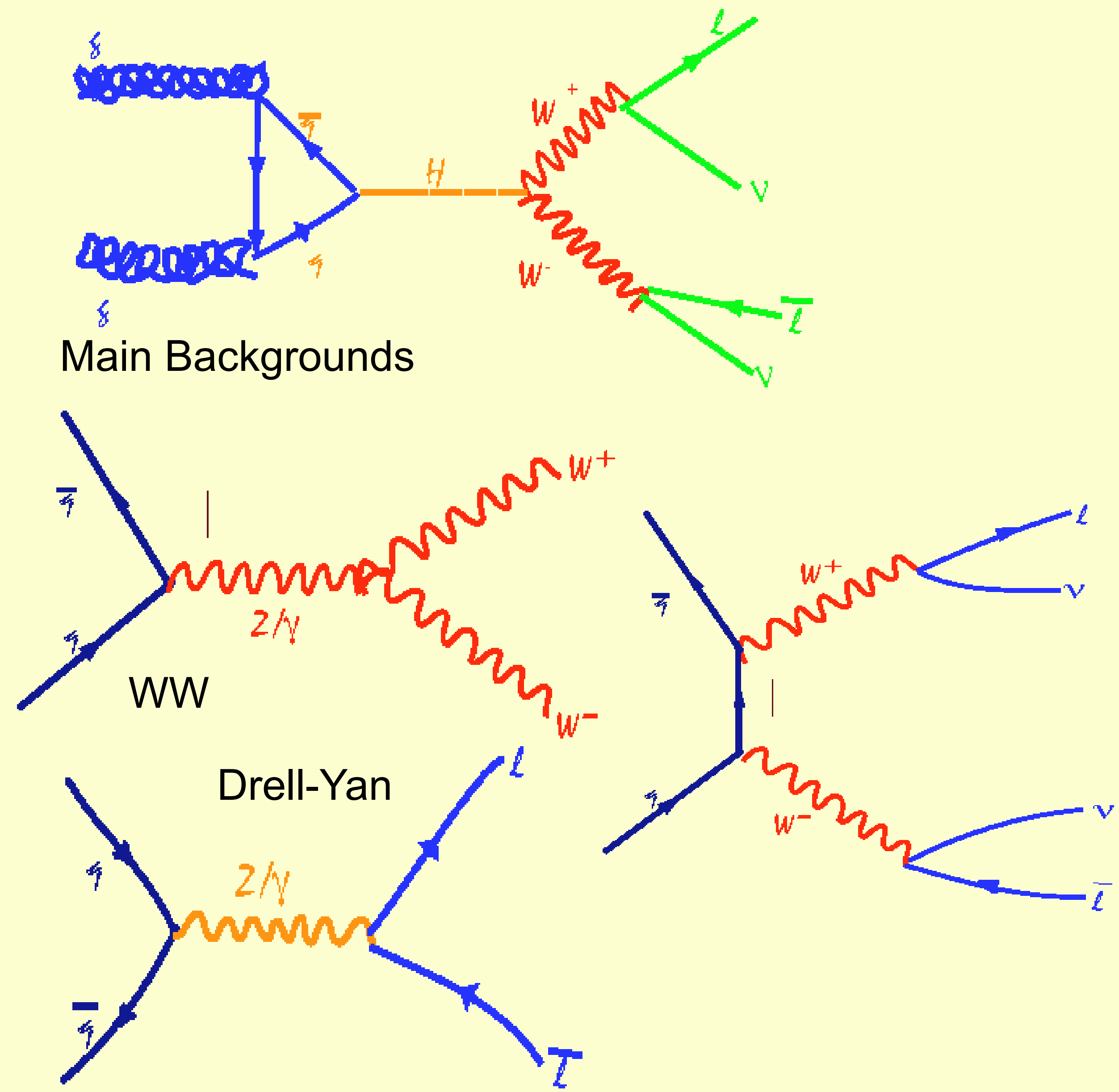
Higgs production at the Tevatron

- gluon fusion dominant production mechanism
- decay into WW predominant at high mass
- decay into $b\bar{b}$ predominant at low mass
- using associated production for $b\bar{b}$



H to WW overview

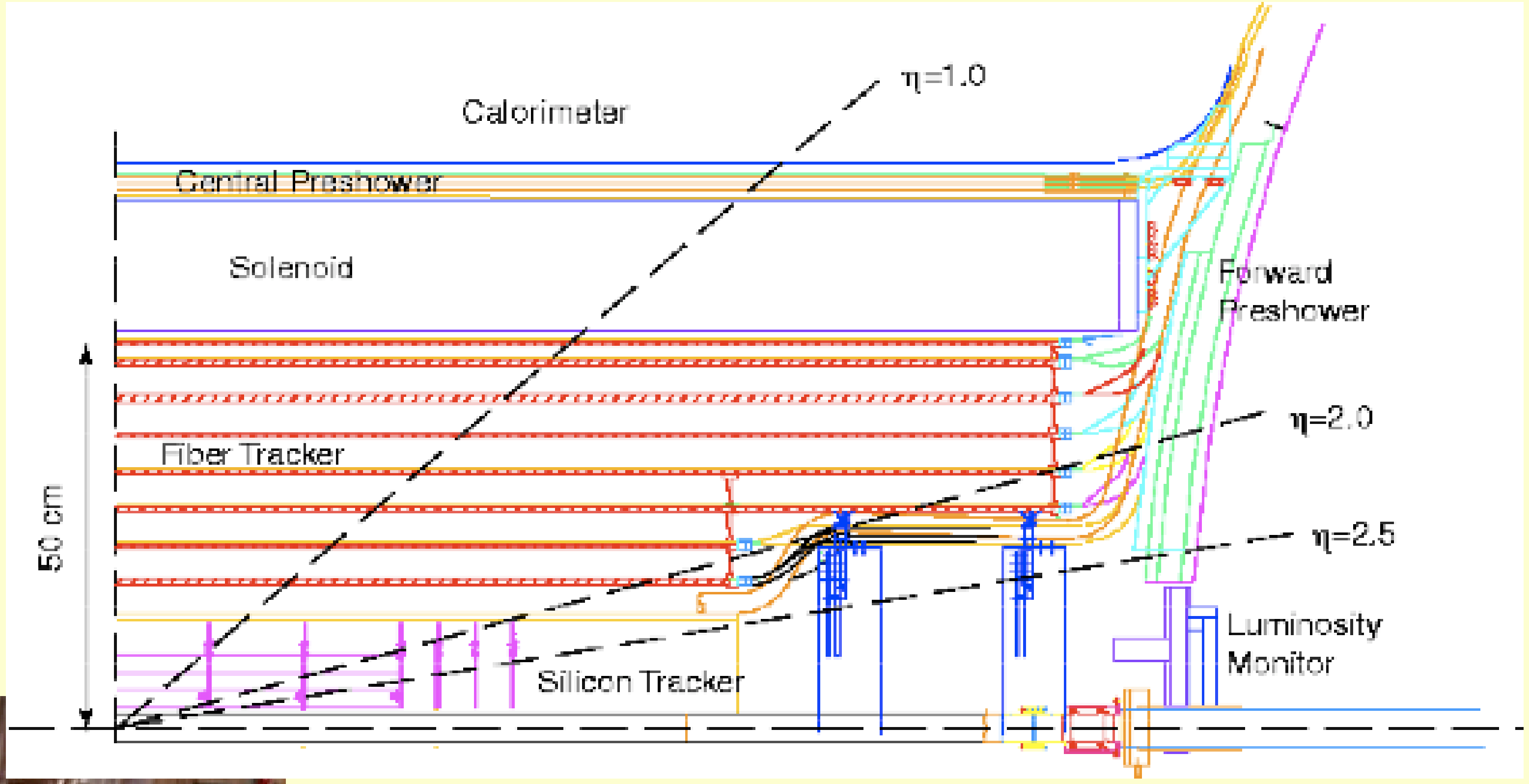
- H->WW predominant at high mass
- signature: two high p_T leptons and missing E_T
- leptons not back to back
- little jet activity in the event

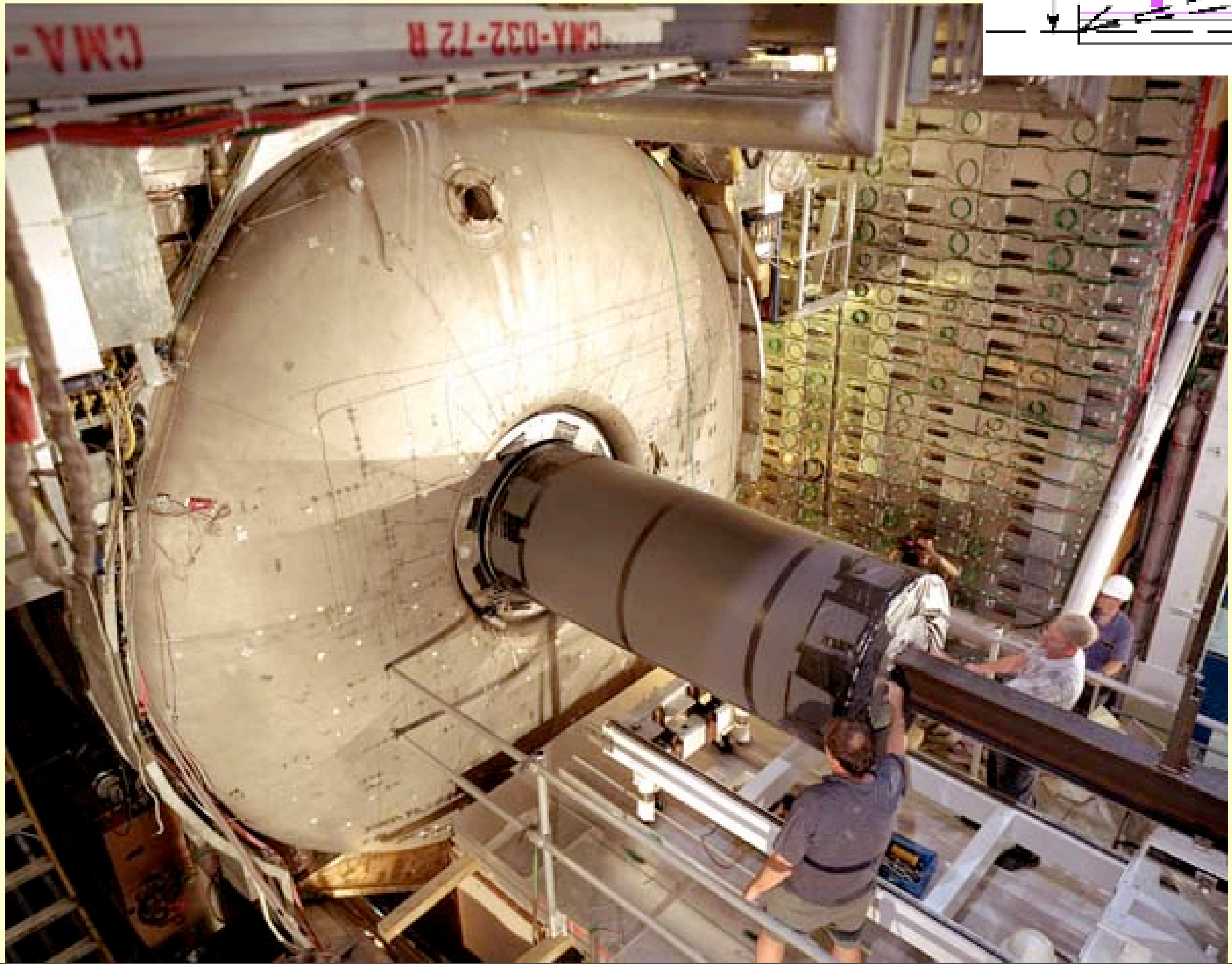


the D0 detector

LAr-U calorimeter

good muon coverage





magnetic field: 2 Tesla

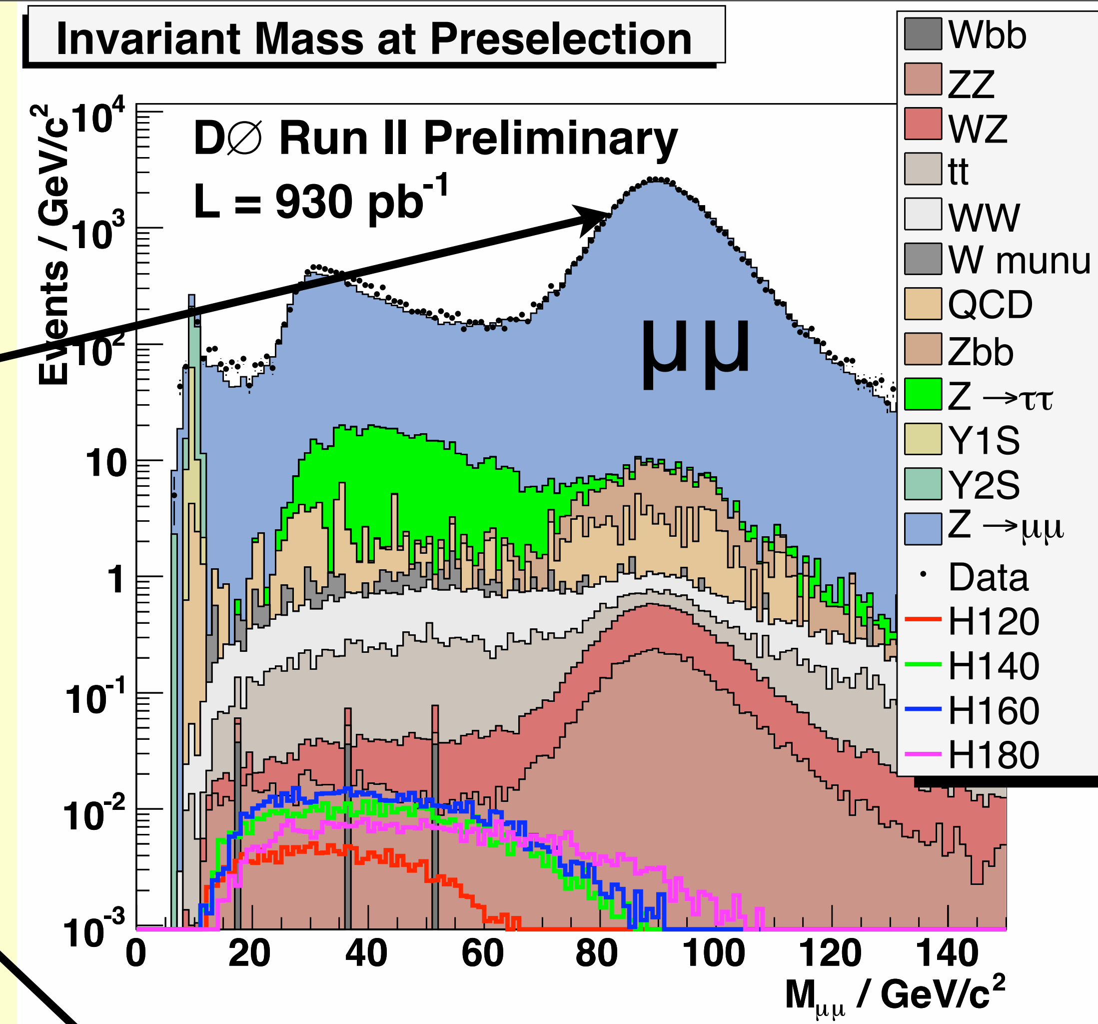
fiber tracker
silicon tracker

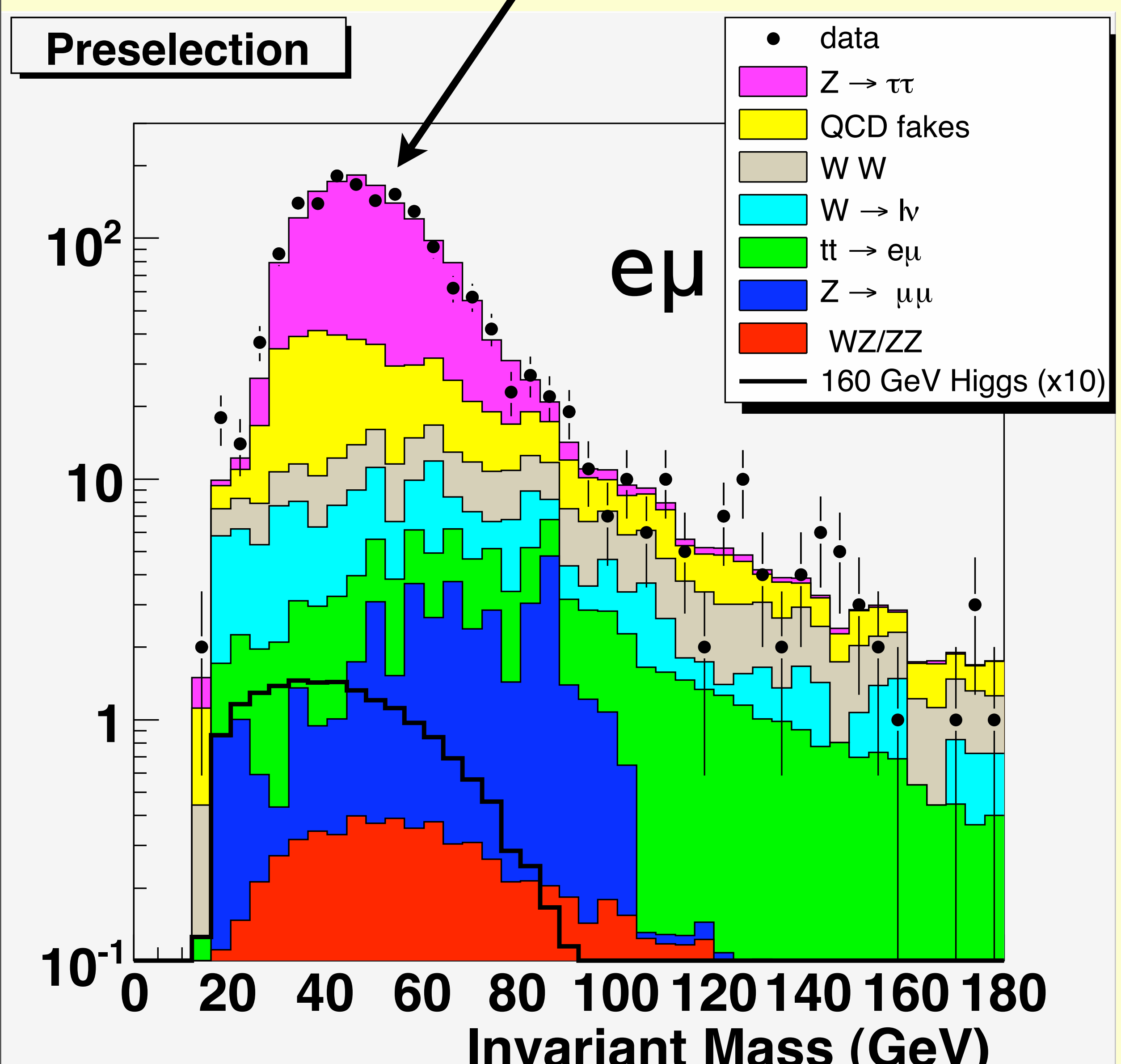
event selection

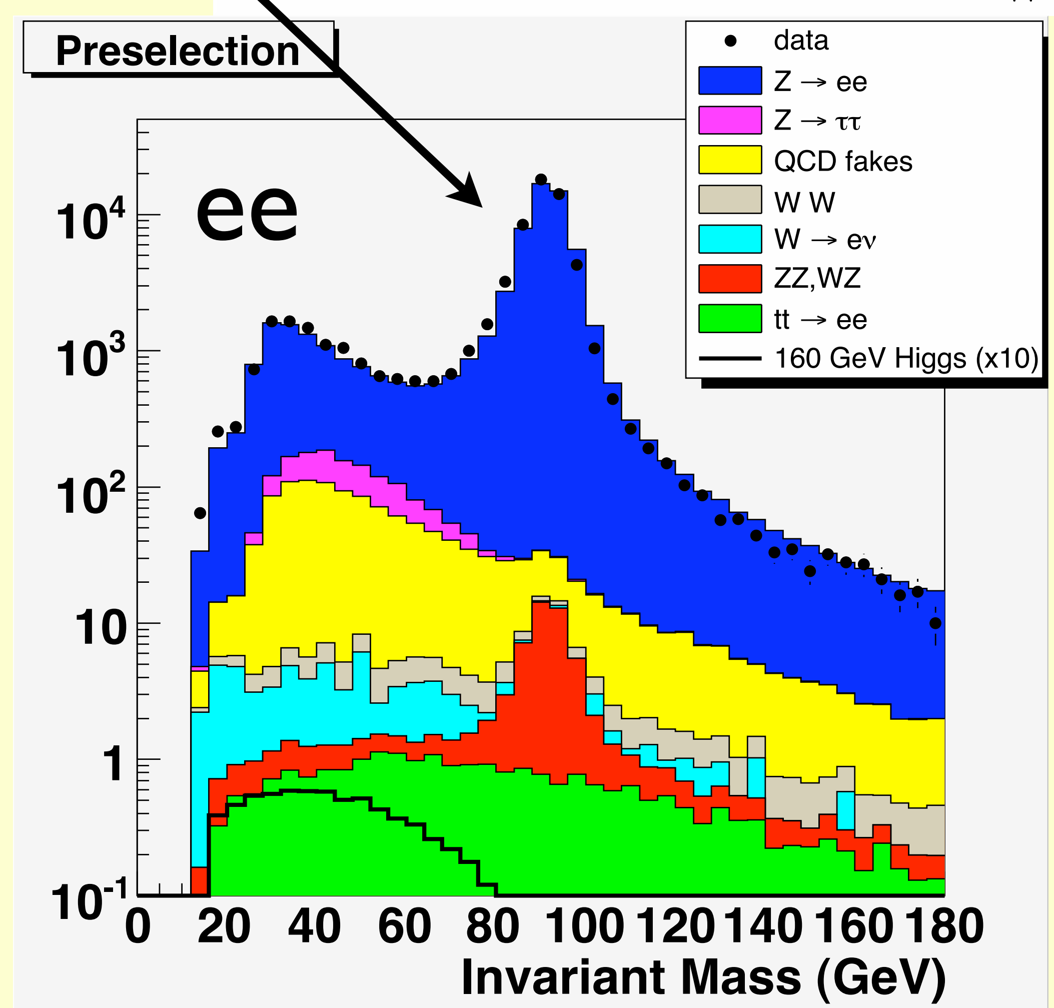
	ee	eμ	μμ
luminosity	$950\,\mathrm{pb}^{-1}$		$930\,\mathrm{pb}^{-1}$
lepton ID	$p_{T,1} > 15, p_{T,2} > 10, m_{ll} > 15$, isolation		
$\not{E}_T$	$\not{E}_T > 20$, significance$(\not{E}_T) > 7$		
$m_{ll} < x$	$\min(m_H/2, 80)$	$m_H/2$	80
$p_{T,1} + p_{T,2} + \not{E}_T$	$m_H/2 + 20 < x < m_H$		$100 < x < 160$
$m_{T,min}(l, \not{E}_T)$	$x > 15 + m_H/4$		$x > 55$
$H_T = \sum p_T^{\mathrm{jet}}$	$H_T < 100$		$H_T < 70$
$\Delta\varphi_{ll}$	$\Delta\varphi_{ll} < 2.0$		

control plots

normalized to
Z peak
(avoid luminosity uncertainty)

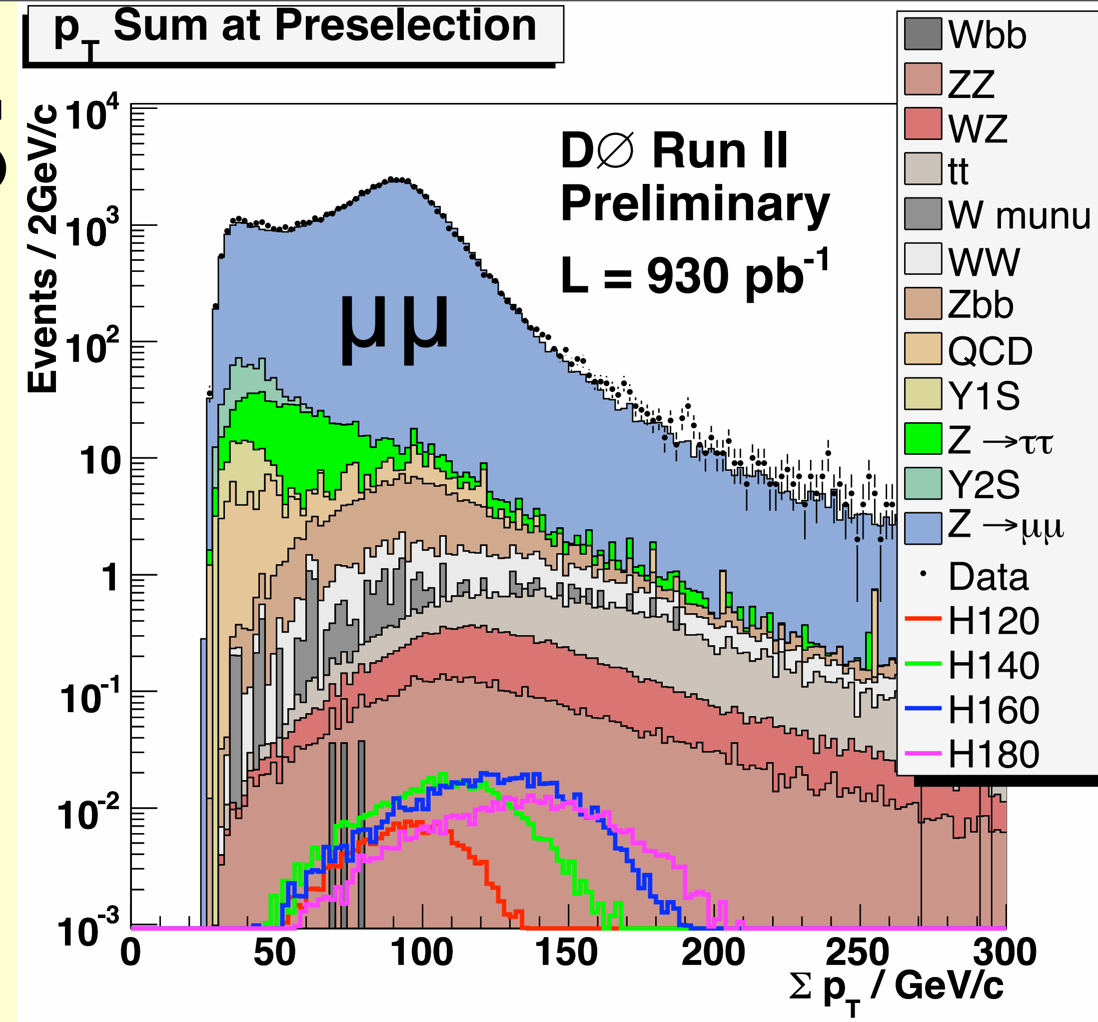


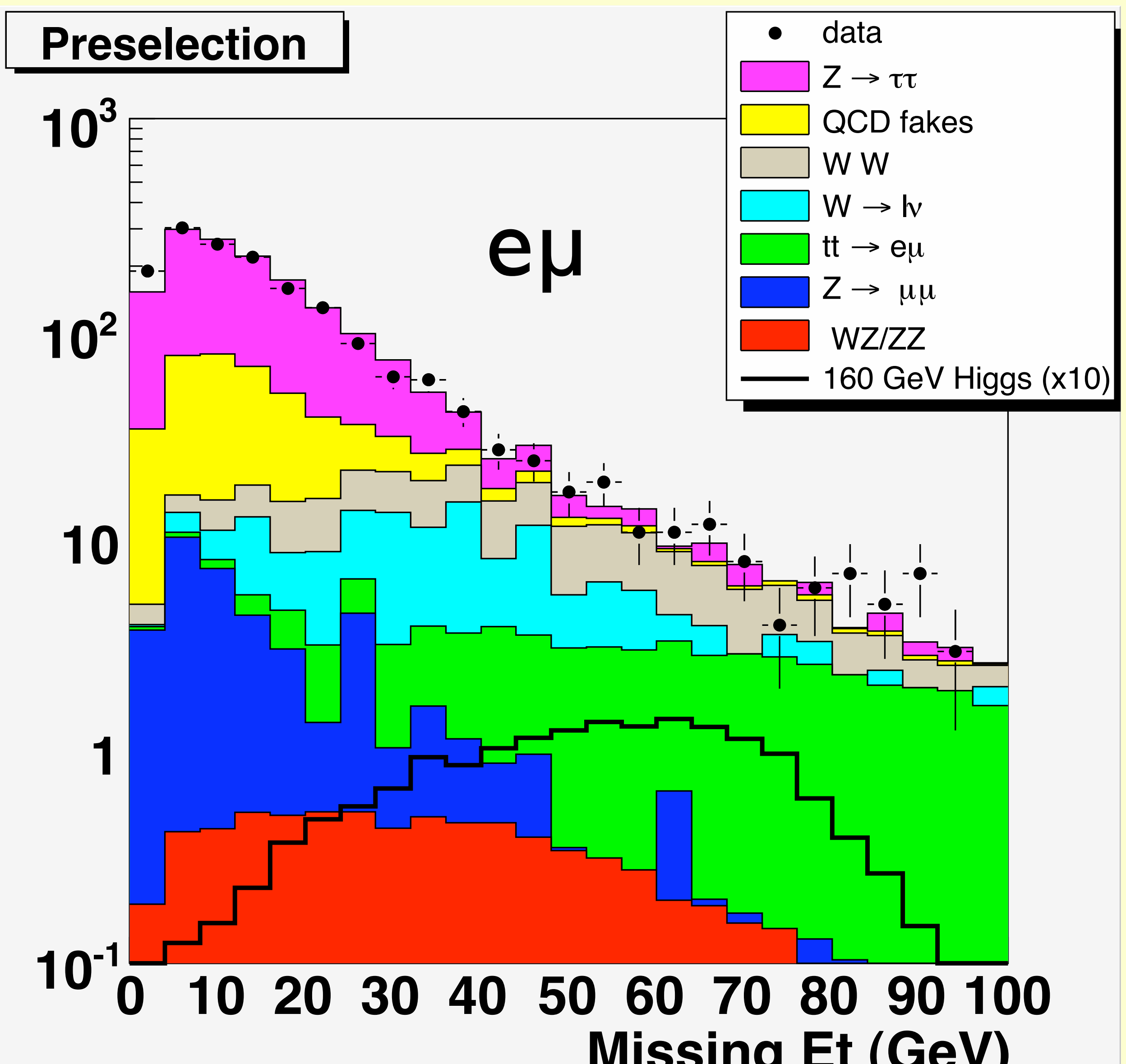


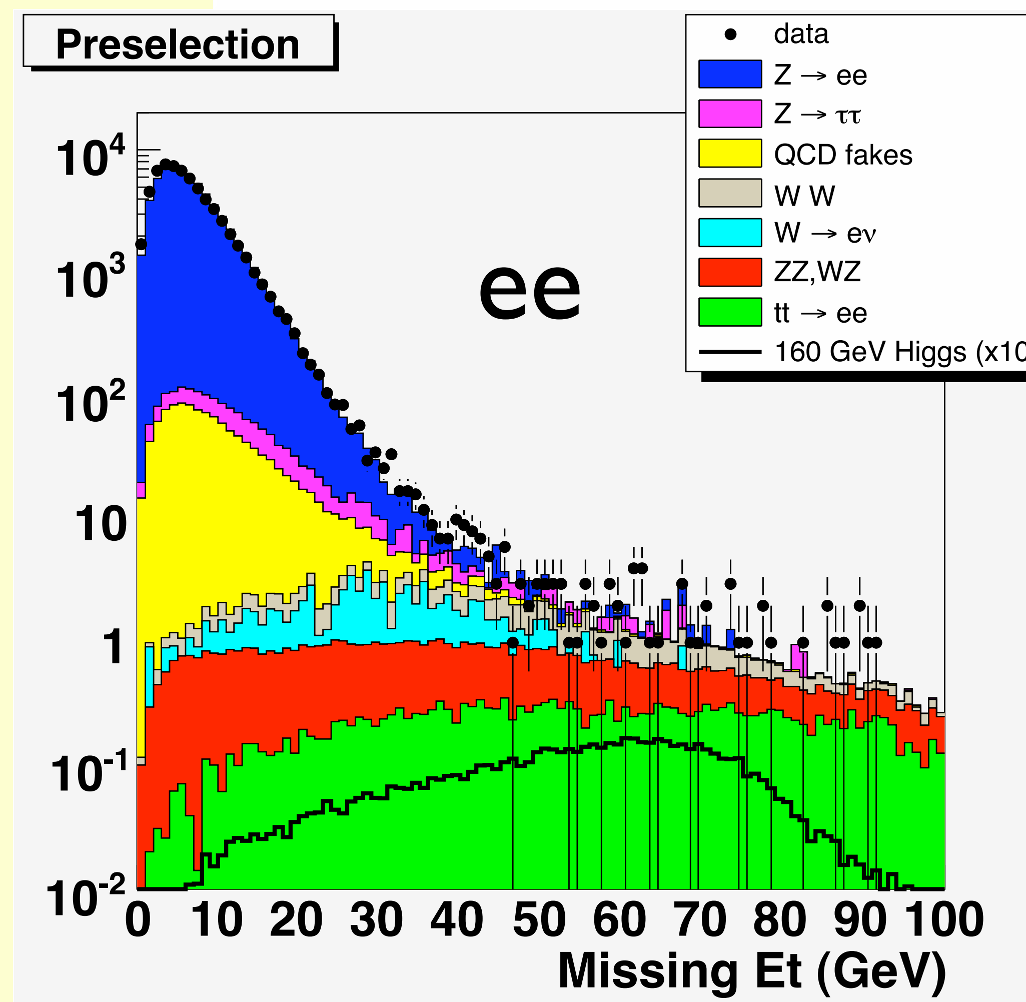


control plots

data well described by background simulation

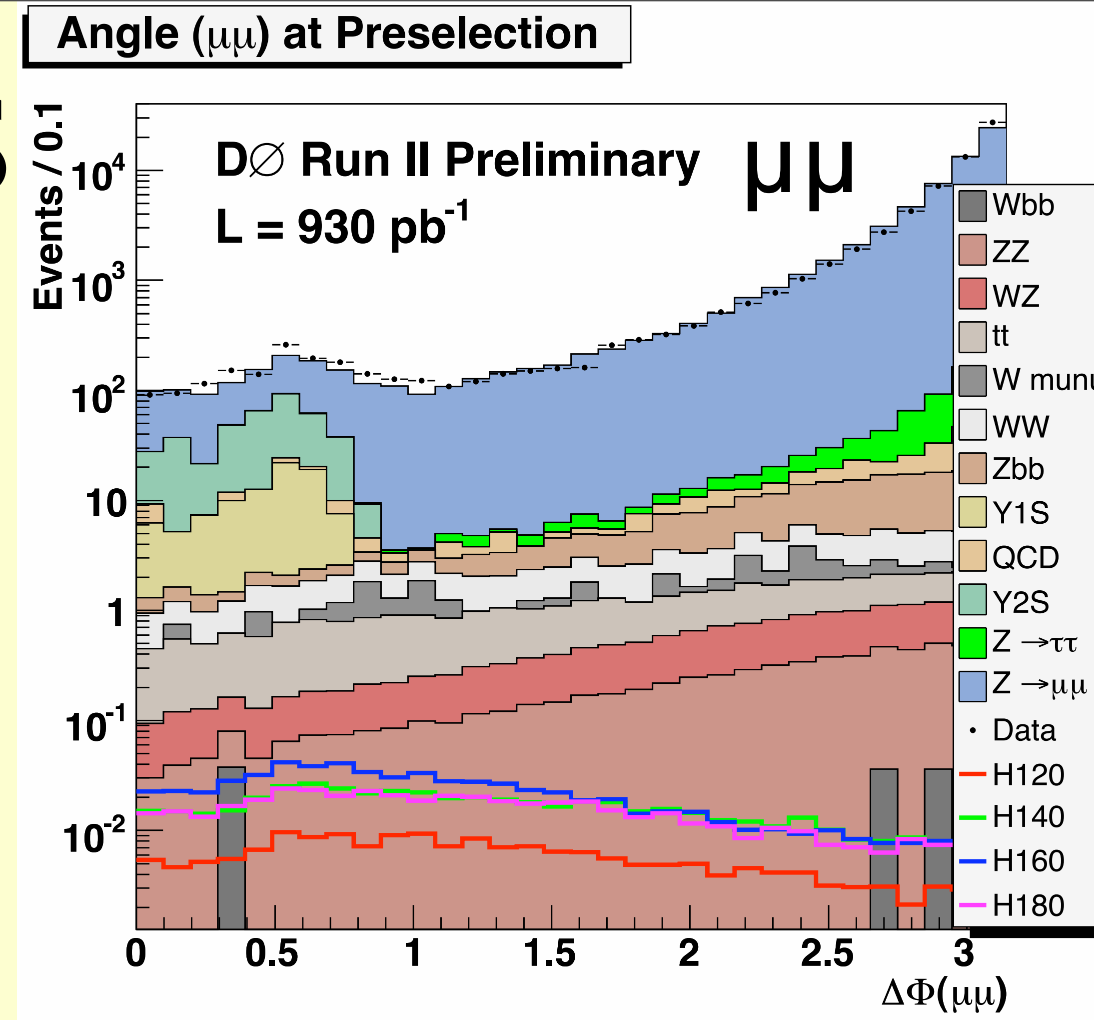


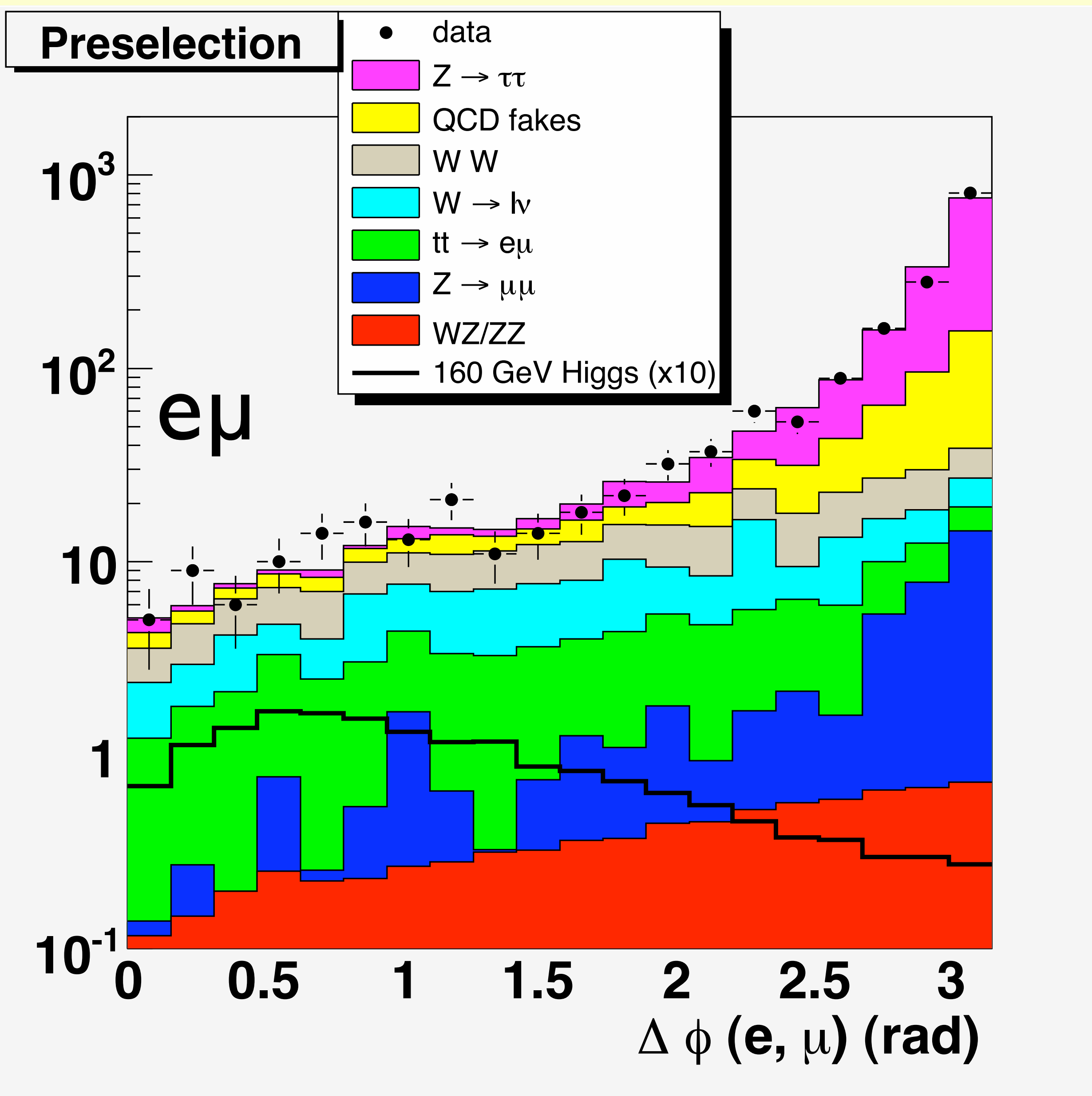


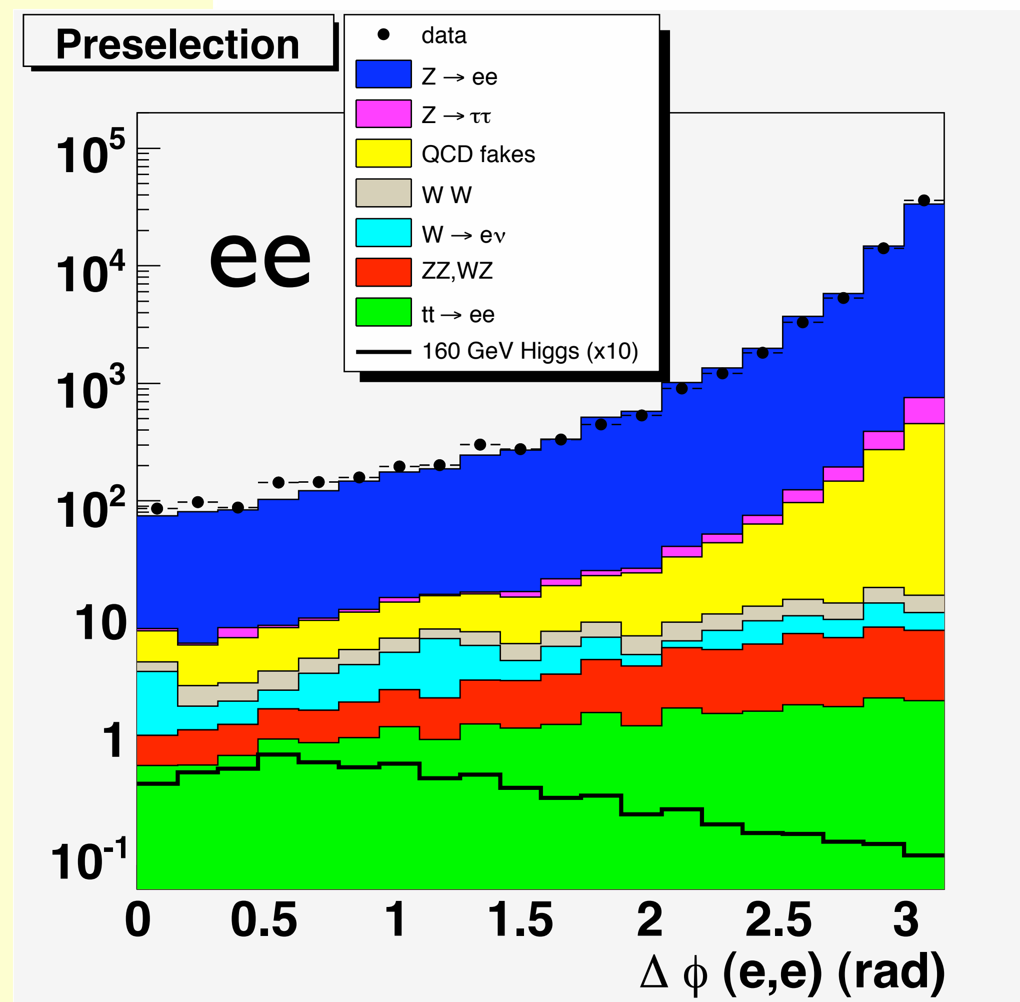


control plots

Δφ is the final selection variable good description in preselection sample



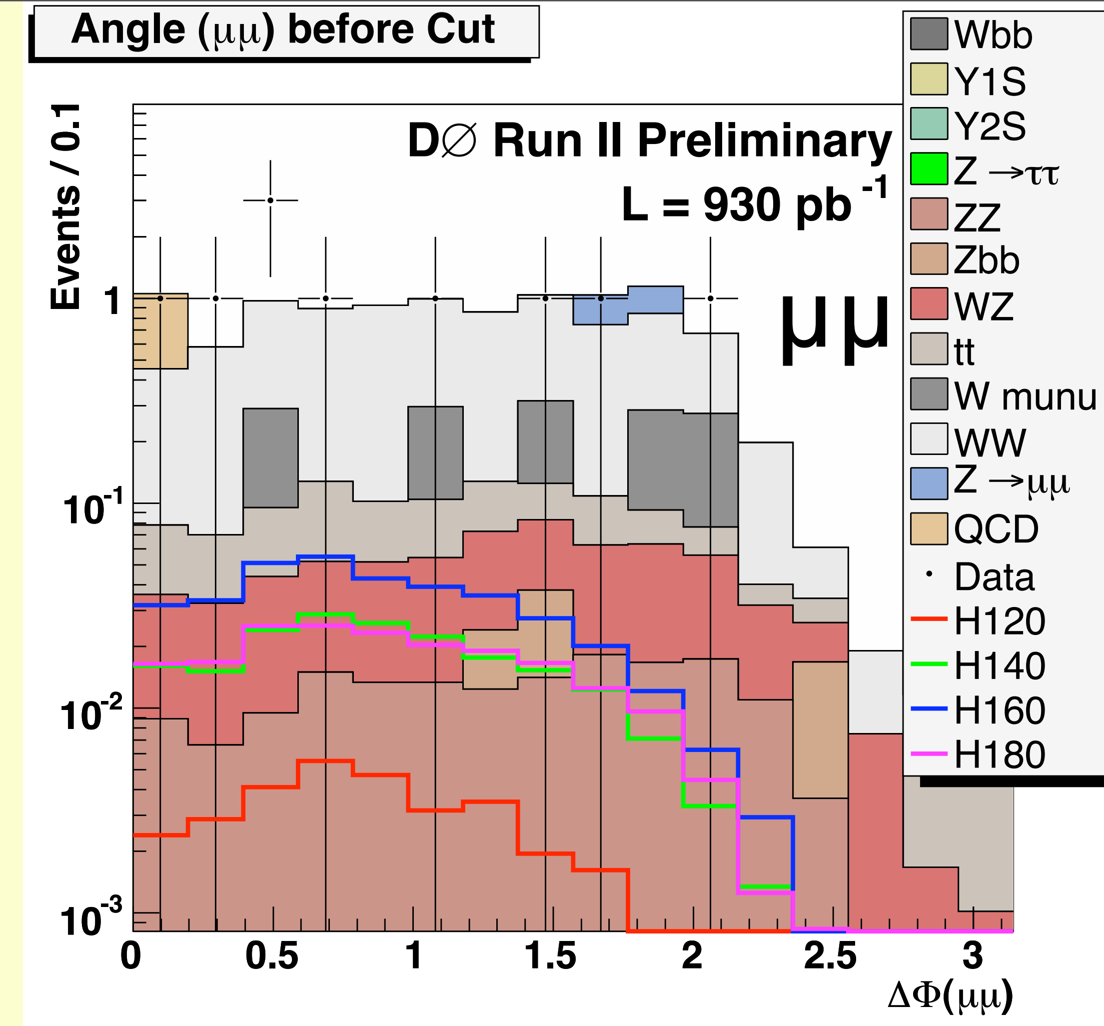


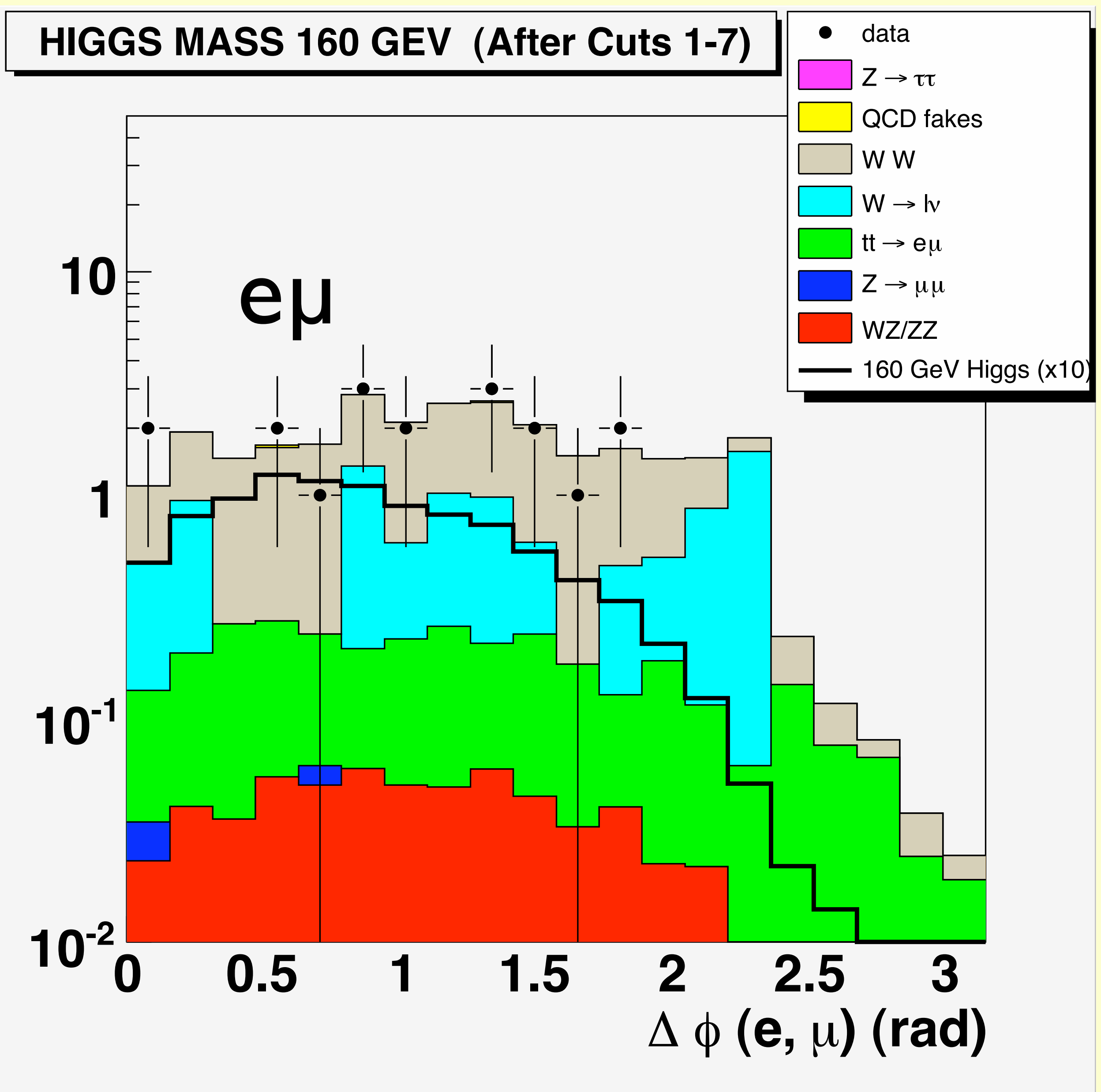


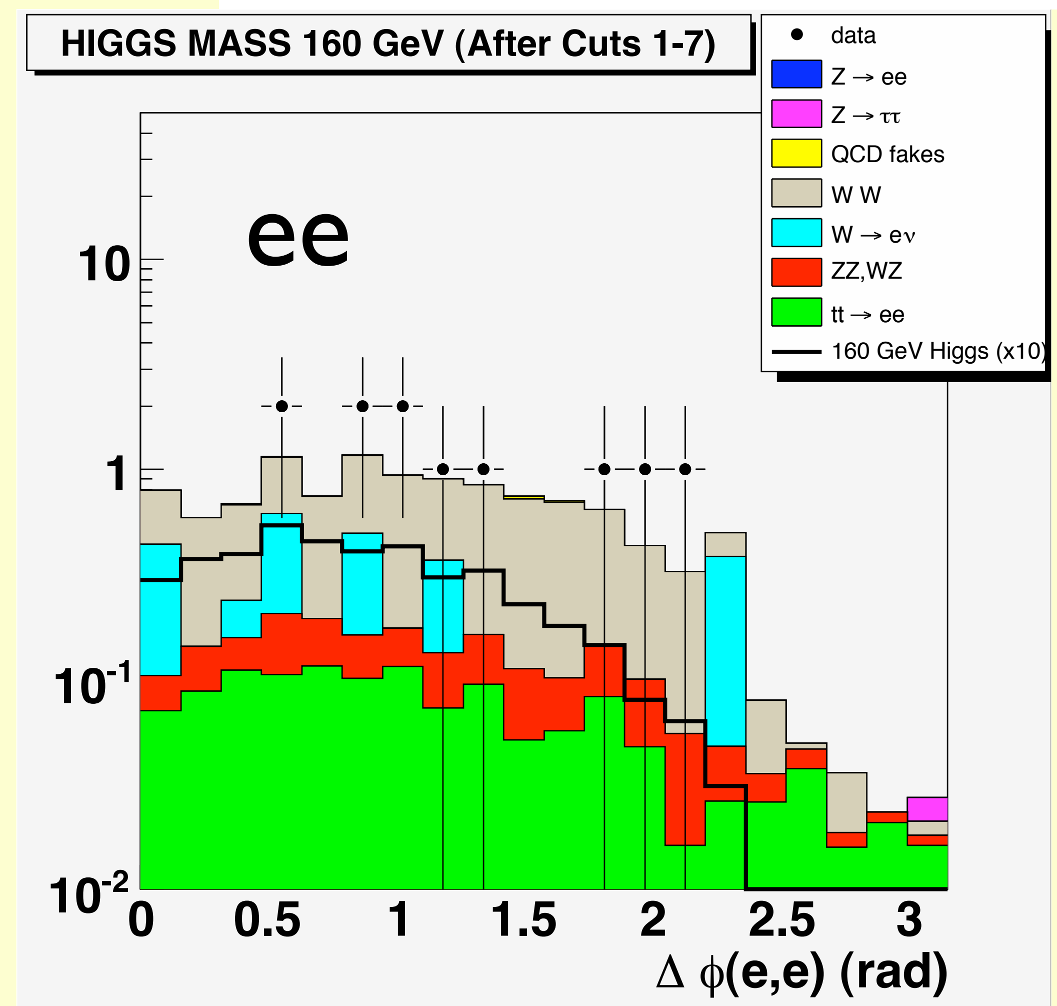
Δφ plots

using Δφ < 2

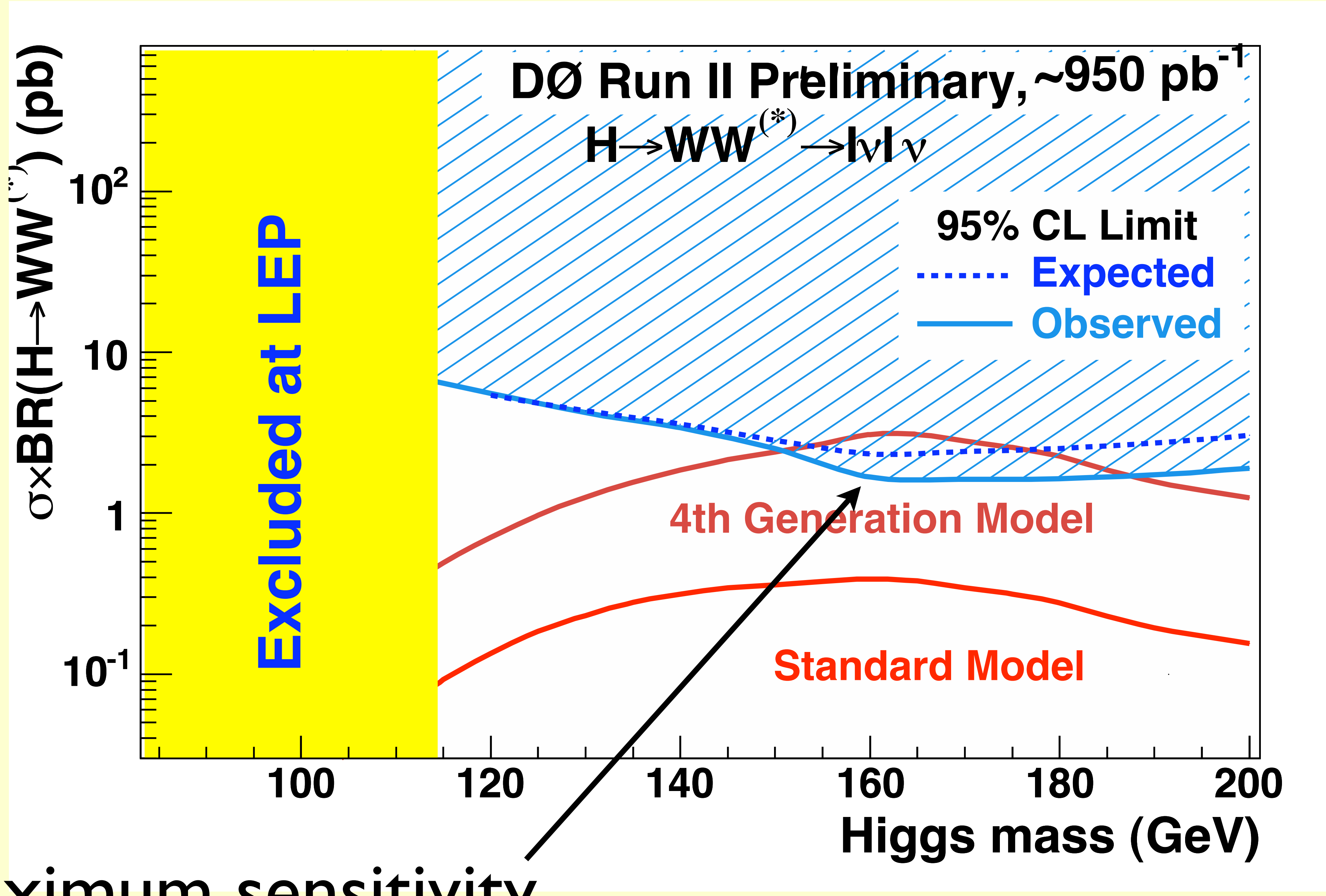
no significant excess







combined limit

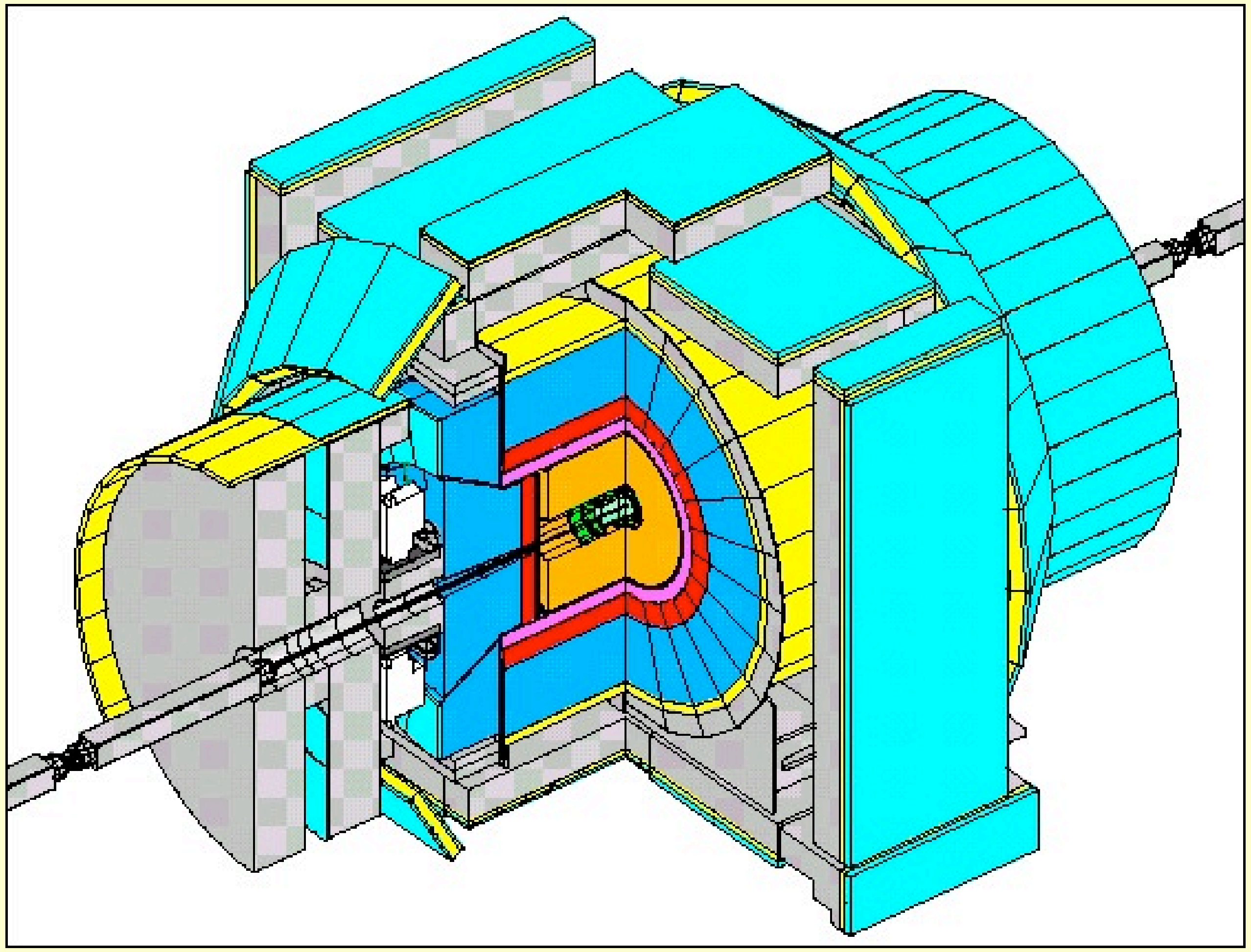


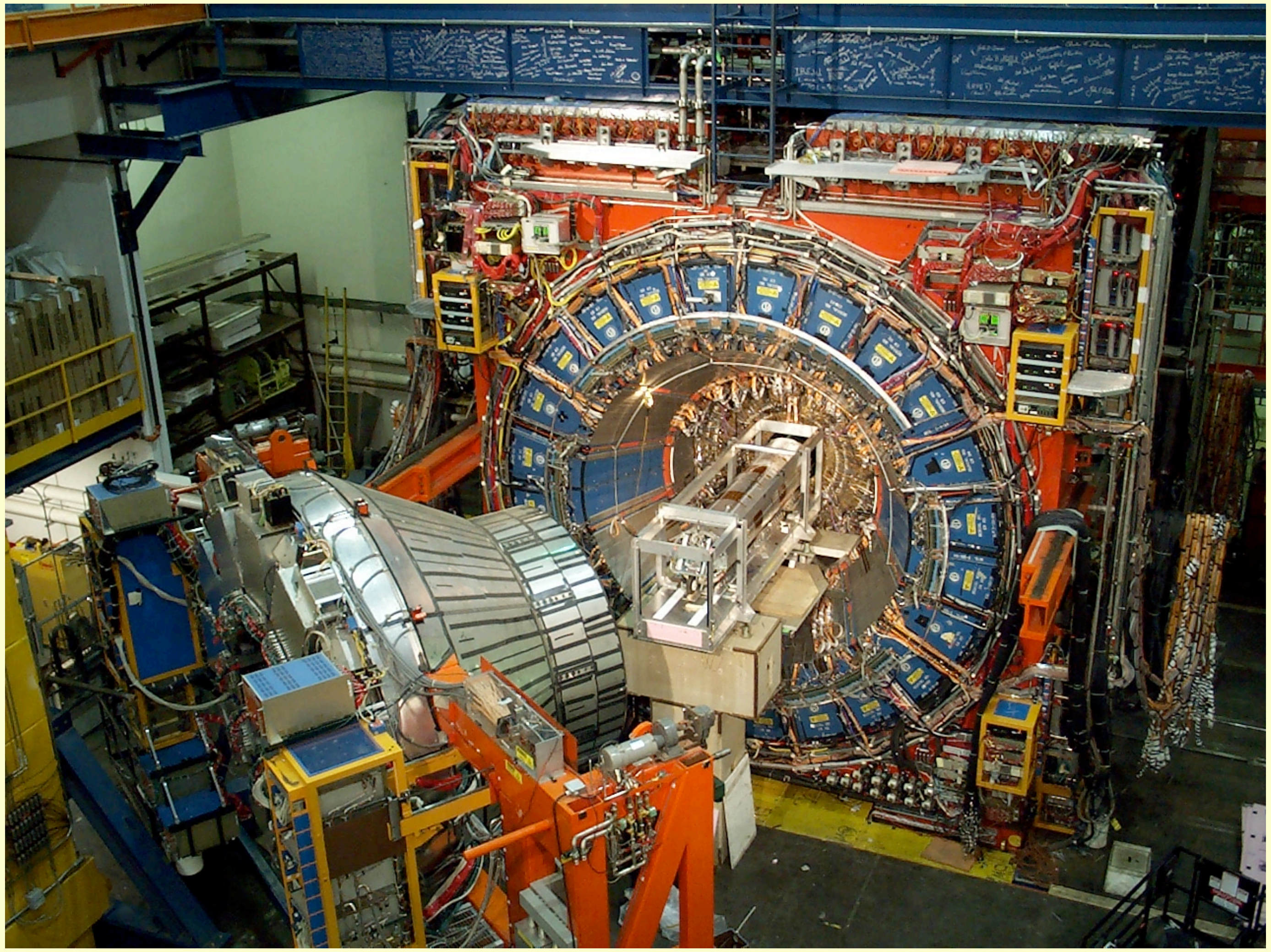
maximum sensitivity

within a factor 4 from standard model

The CDF detector

big tracking volume:
silicon tracker
+ drift chamber





calorimeter coverage:
$|\eta|<3.5$

muon coverage:
$|\eta| < 1.5$

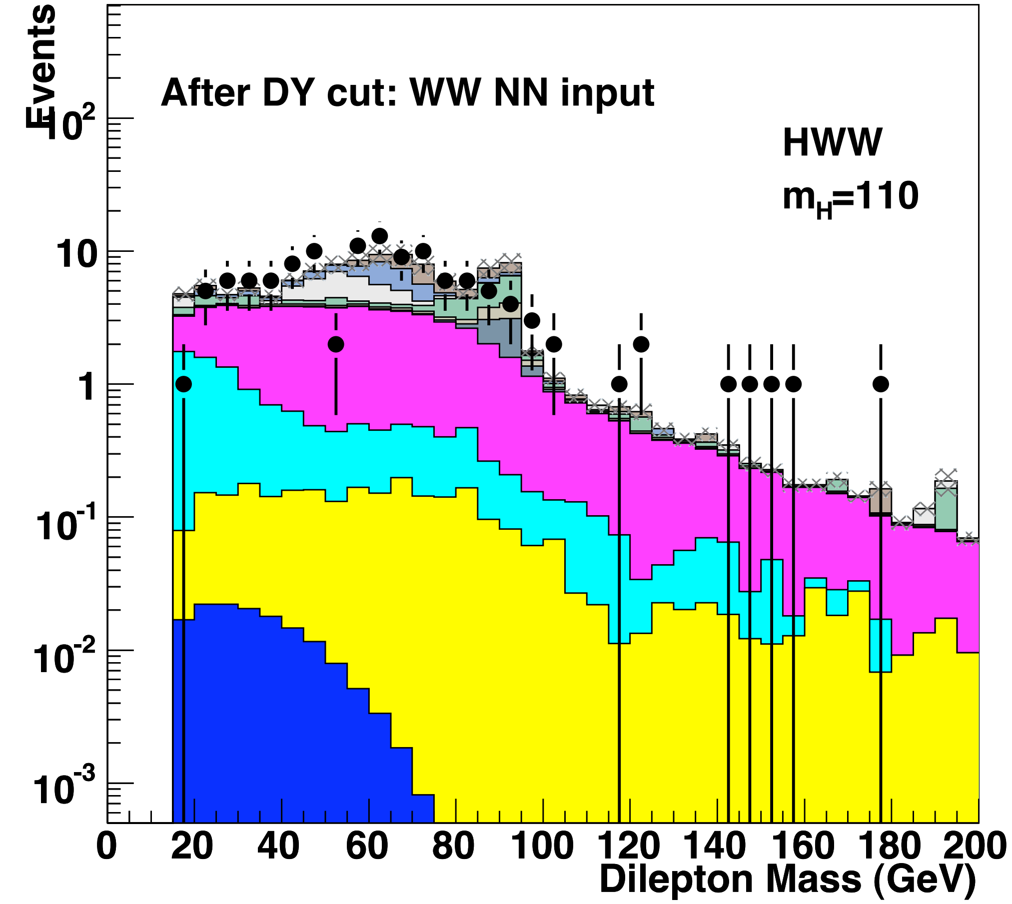
neural net analysis event selection

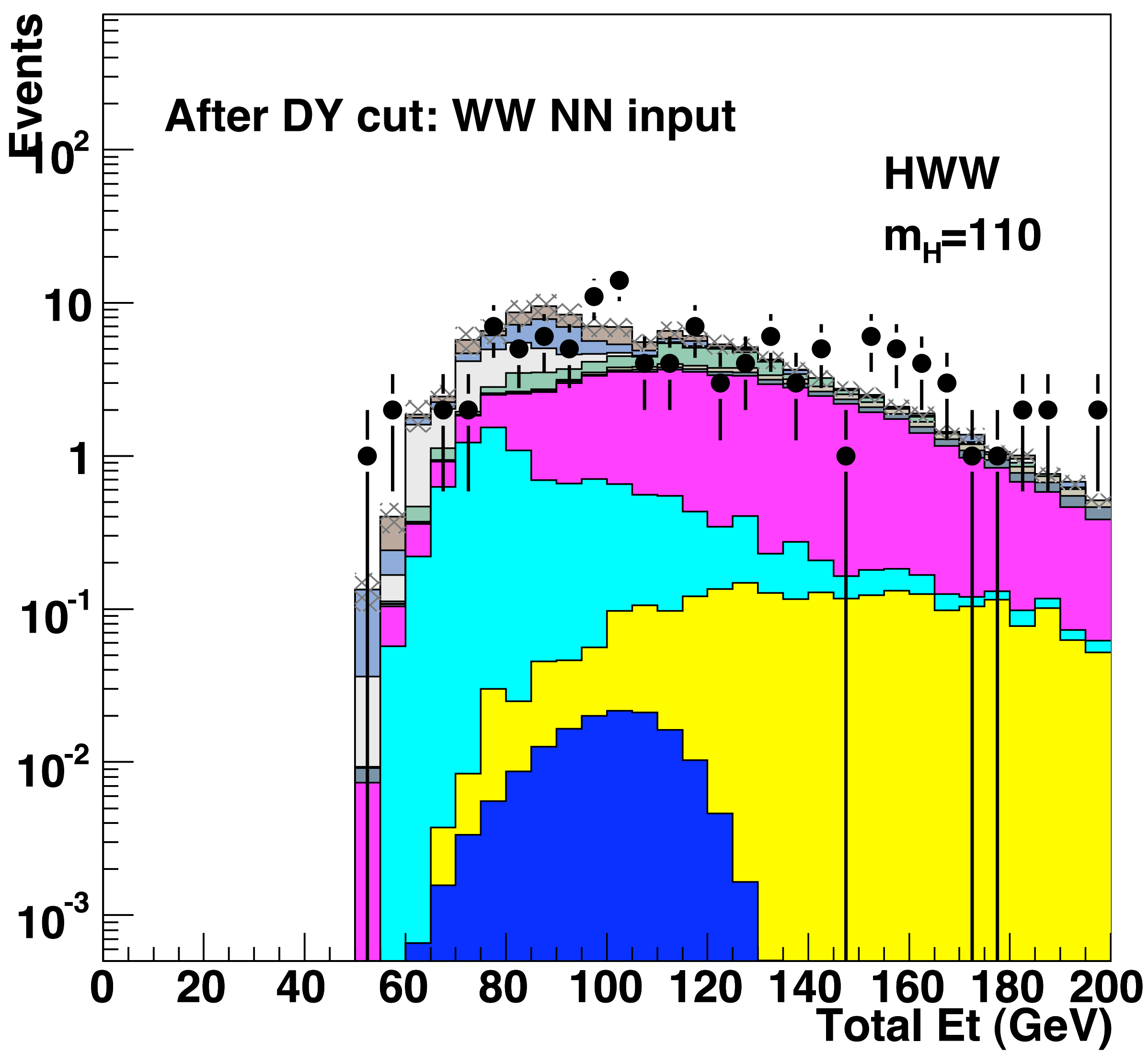
luminosity: $1\,\mathrm{fb}^{-1}$
$p_{T,1} > 20,\ p_{T,2} > 10$
lepton isolation
$m_{ll} > 16$
$n_{\mathrm{jet}} = 0$ or $n_{\mathrm{jet}} = 1, E_T^{\mathrm{jet}} < 55$ or $n_{\mathrm{jet}} = 2, E_T^{\mathrm{jet}} < 40$
opposite charge leptons
neural net for Drell – Yan suppression

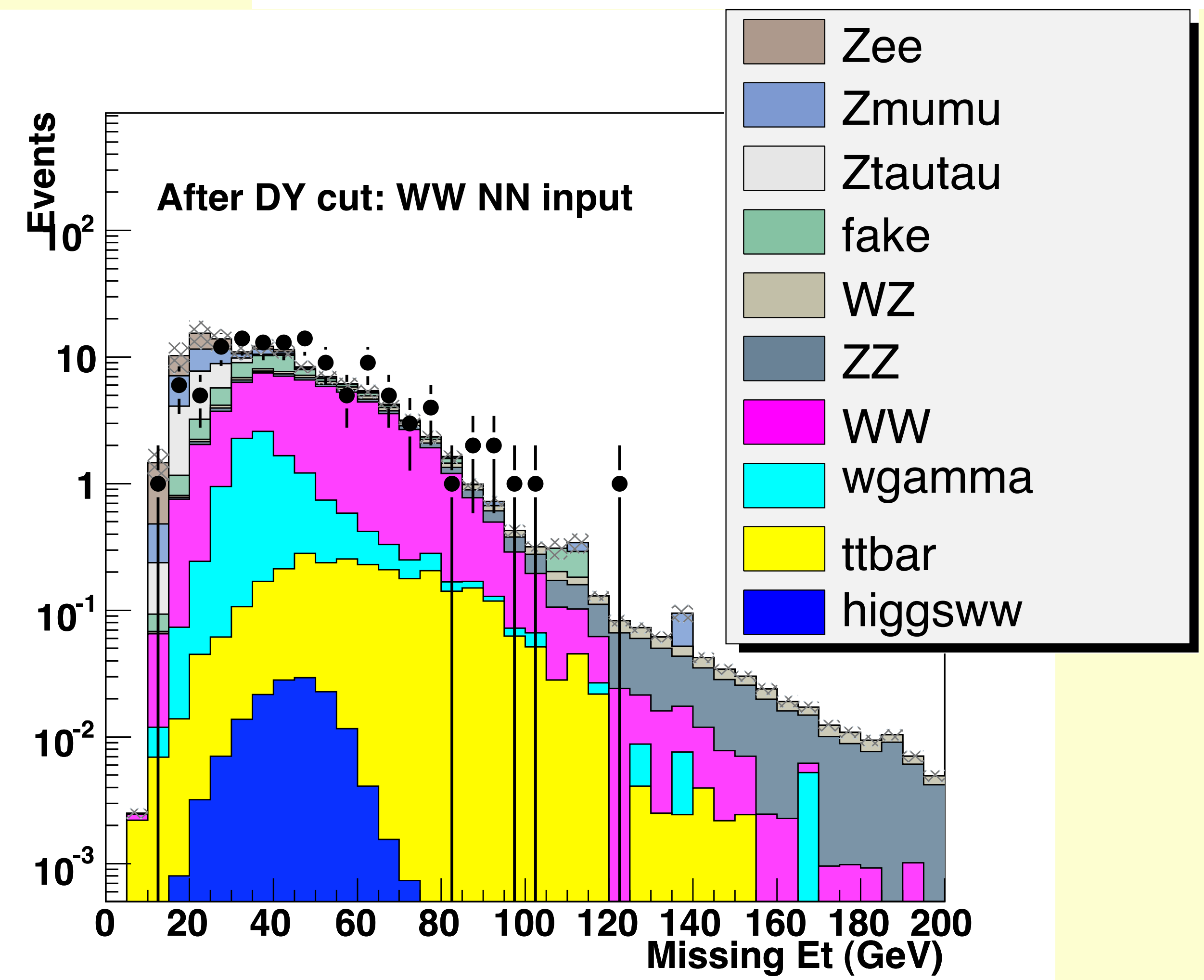
control plots

input variables well described by simulation

variables distinguish signal from background







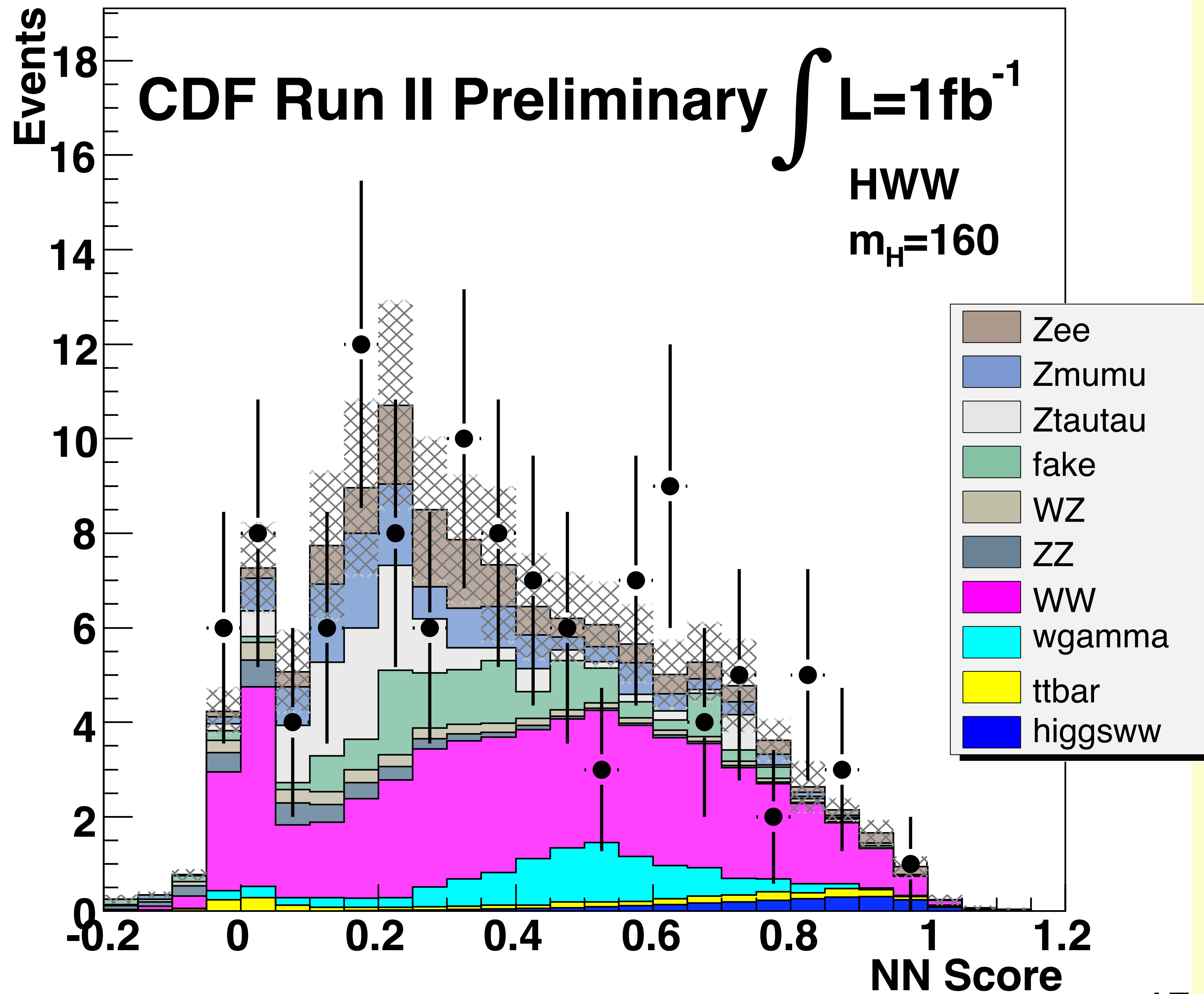
neural net input variables

$p_{T,1}$	$p_{T,1} + p_{T,2} + \not{E}_T$
$p_{T,2}$	m_{ll}
n_{jets}	$\Delta\varphi_{min}(\not{E}_T, \text{lepton or jet})$
$E_{T,1}^{\mathrm{jet}}$	$\Delta\varphi_{ll}$
$E_{T,2}^{\mathrm{jet}}$	$\sqrt{\Delta\eta_{ll}^2 + \Delta\varphi_{ll}^2}$
$\not{E}_T$	$\not{E}_T/(p_{T,1} + p_{T,2} + \not{E}_T)$

network discriminant

training separate networks for each mass

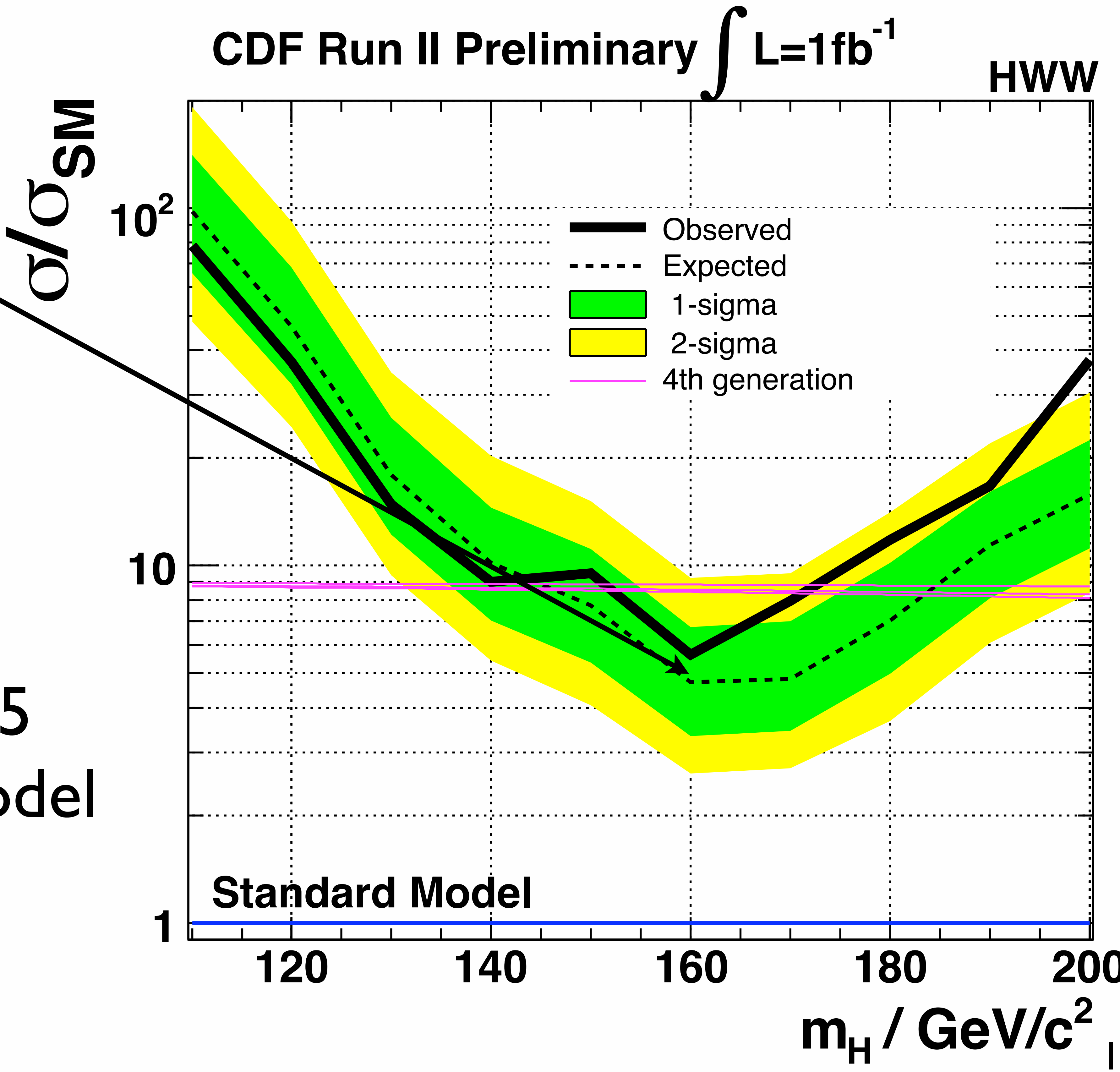
treating each bin as separate counting experiment



neural network limit

maximum sensitivity

within a factor 5 from standard model



matrix element method

- idea: use LO matrix elements to calculate event probabilities
- for each event and process integrate ME over phase space:

$$P_m(\vec{x}) = \int \frac{d\sigma_m(\vec{y})}{d\vec{y}} \varepsilon(\vec{y}) G(\vec{x}, \vec{y}) d\vec{y}$$

ME efficiency resolution

- calculate likelihood ratio for each event:

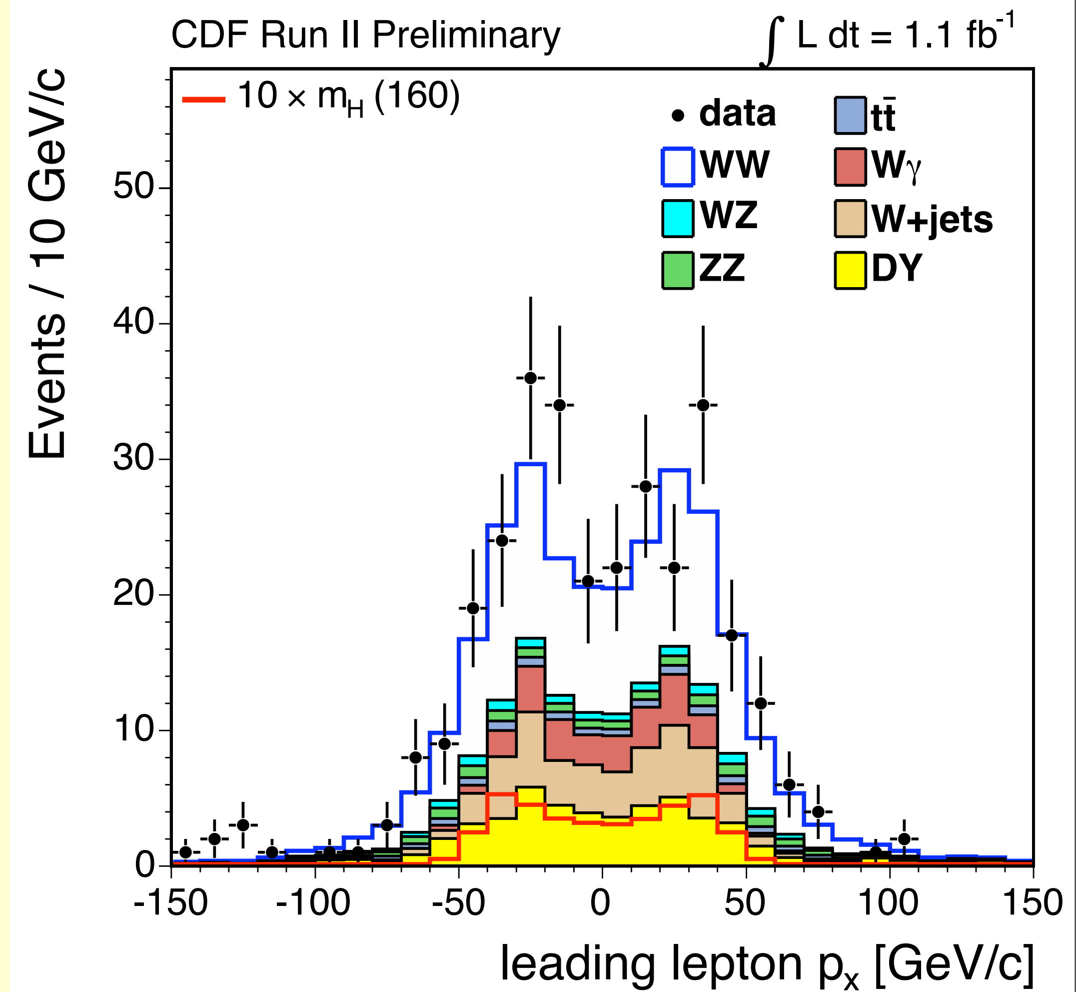
$$LR(\vec{x}) = \frac{P_H(\vec{x})}{P_H(\vec{x}) + \sum k_i \cdot P_{\text{back}}(\vec{x})}$$

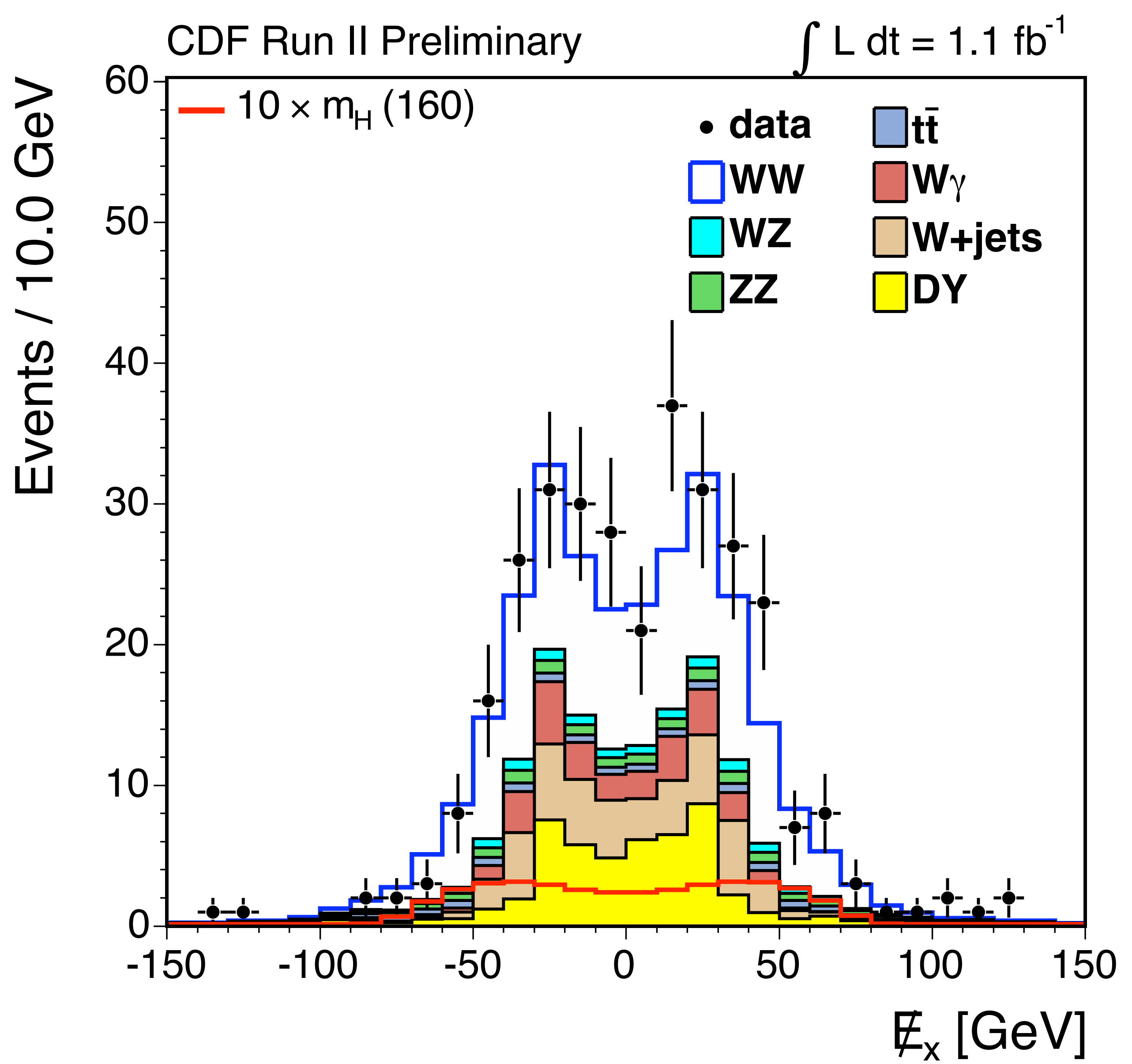
matrix element analysis event selection

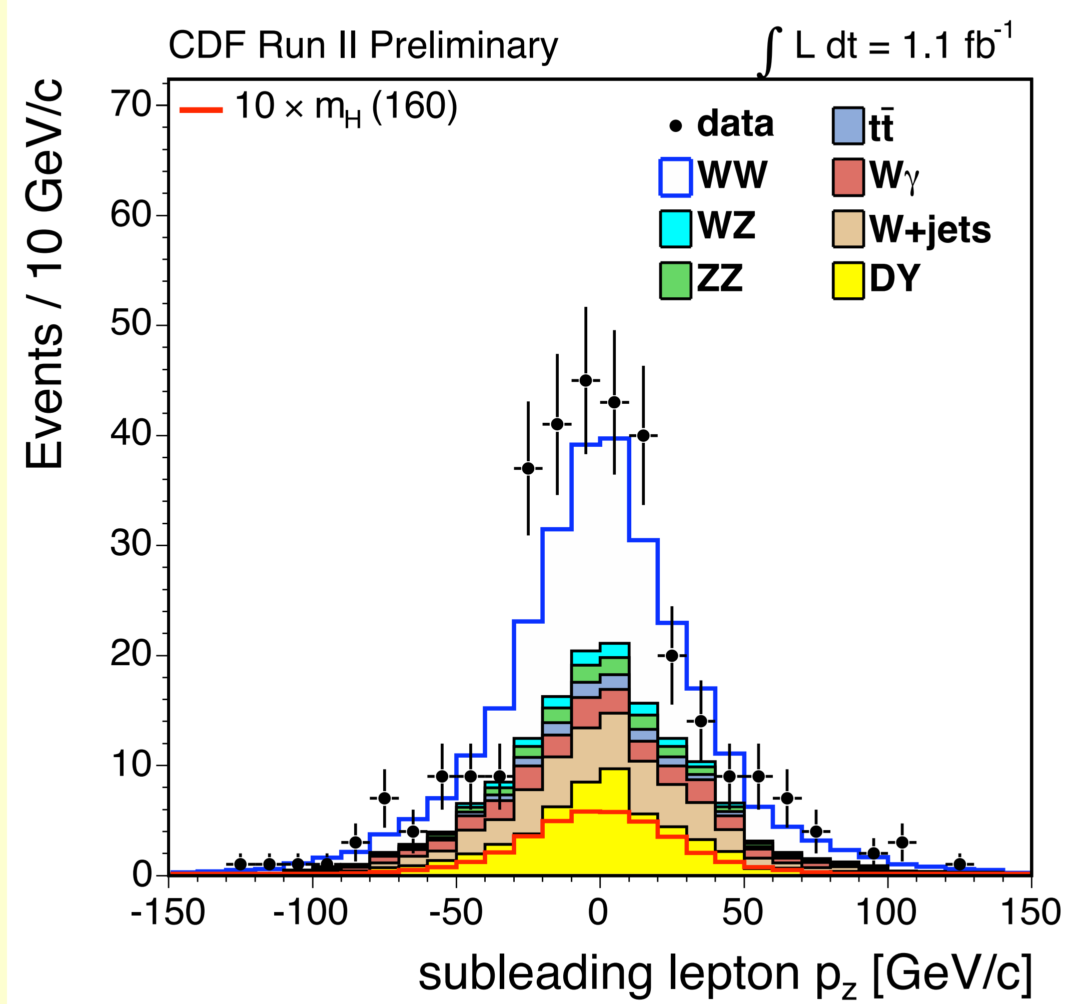
luminosity: $1.1\,\mathrm{fb}^{-1}$
$p_{T,1} > 20, p_{T,2} > 10$
$25 < \not\!\!E_{T,rel} = \not\!\!E_T \cdot \sin(\min(\pi/2, \Delta\varphi(\not\!\!E_T, \text{lepton or jet}))$
$\text{Sig}(\not\!\!E_T) = \not\!\!E_T \sqrt{\sum E_T} > 2.5$
$n_{\text{jets}} < 2$
$m_{ll} > 25$
trilepton veto

control plots

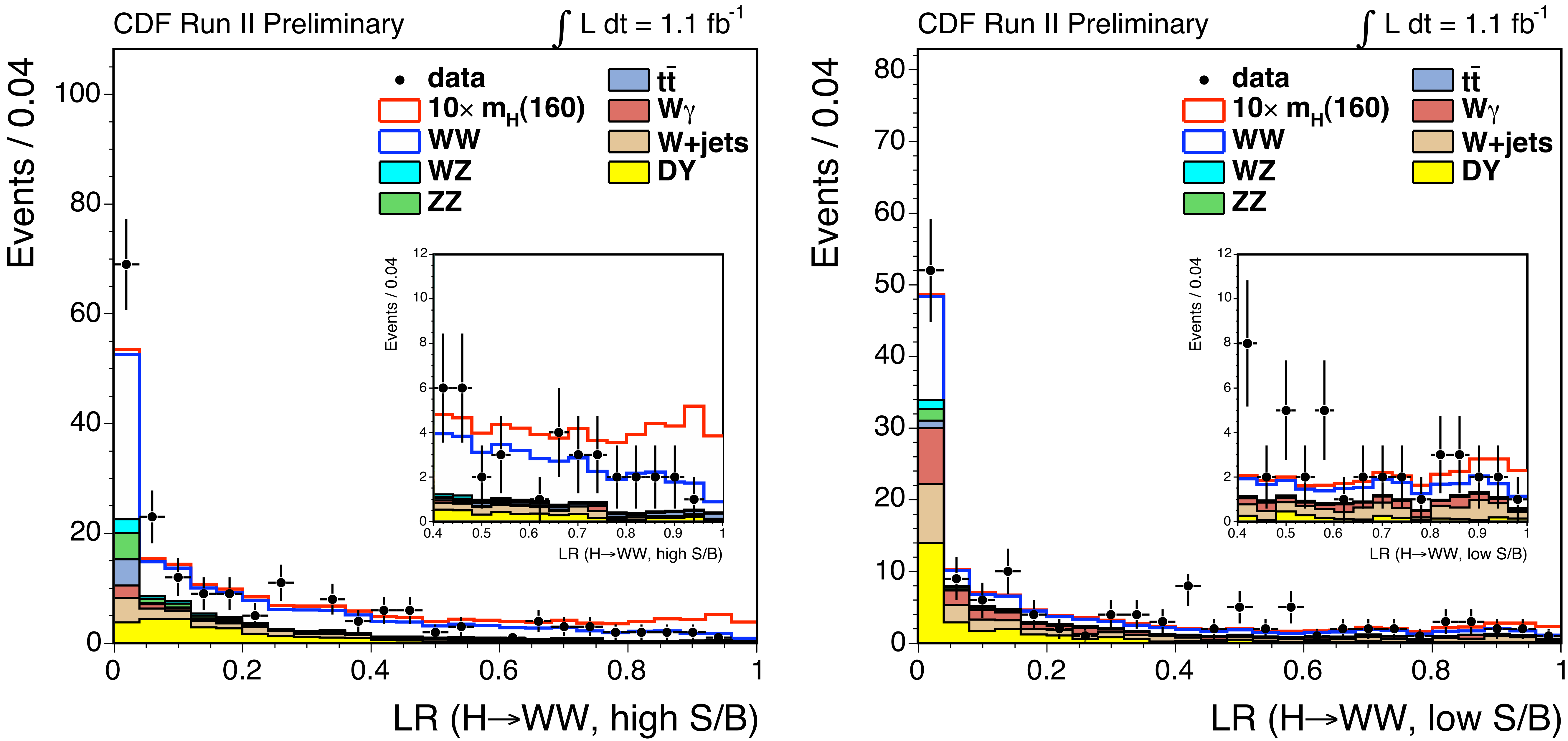
data well described by simulation







event discriminant

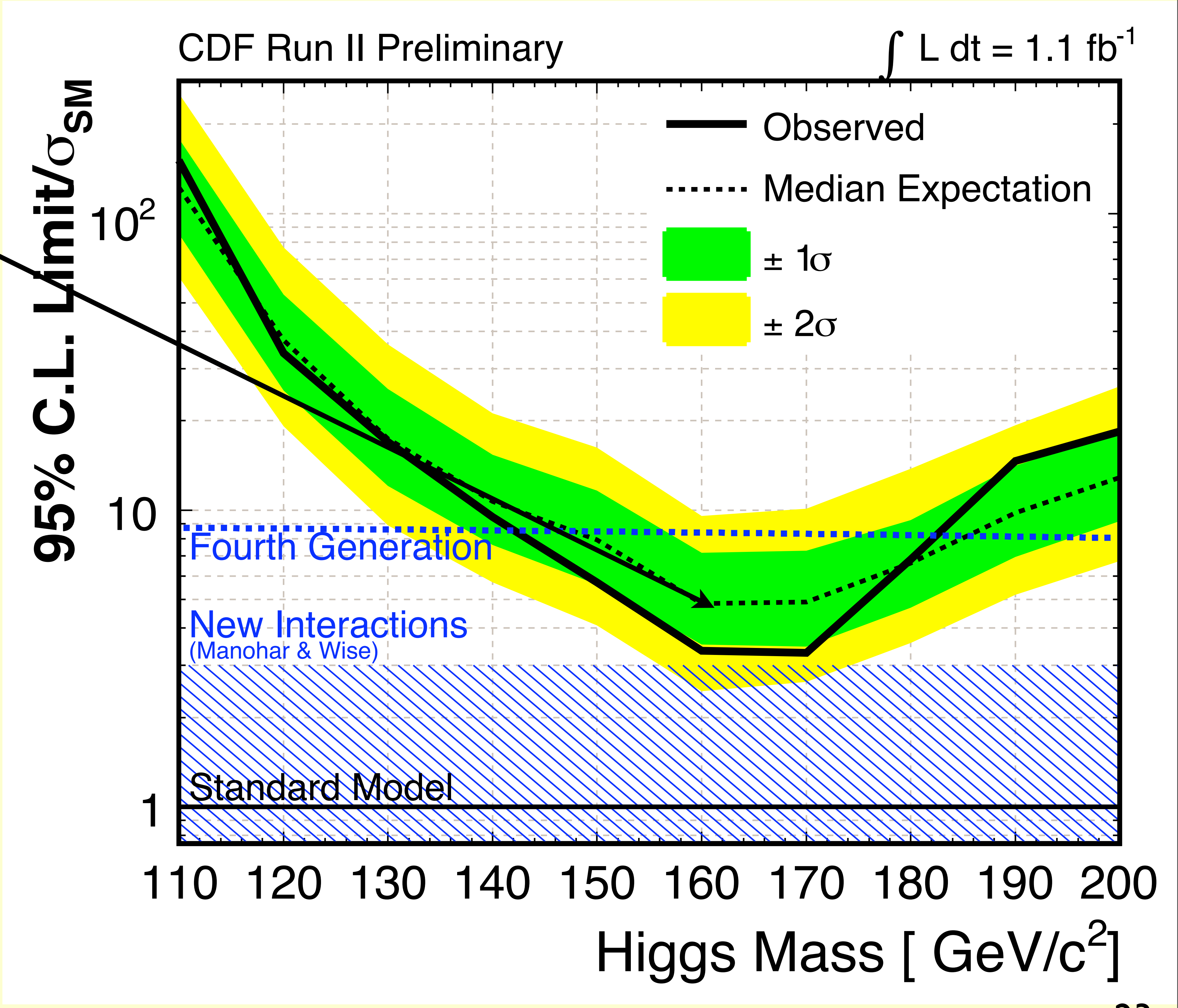


- dividing signal into high S/B and low S/B region
- treating each bin as separate experiment

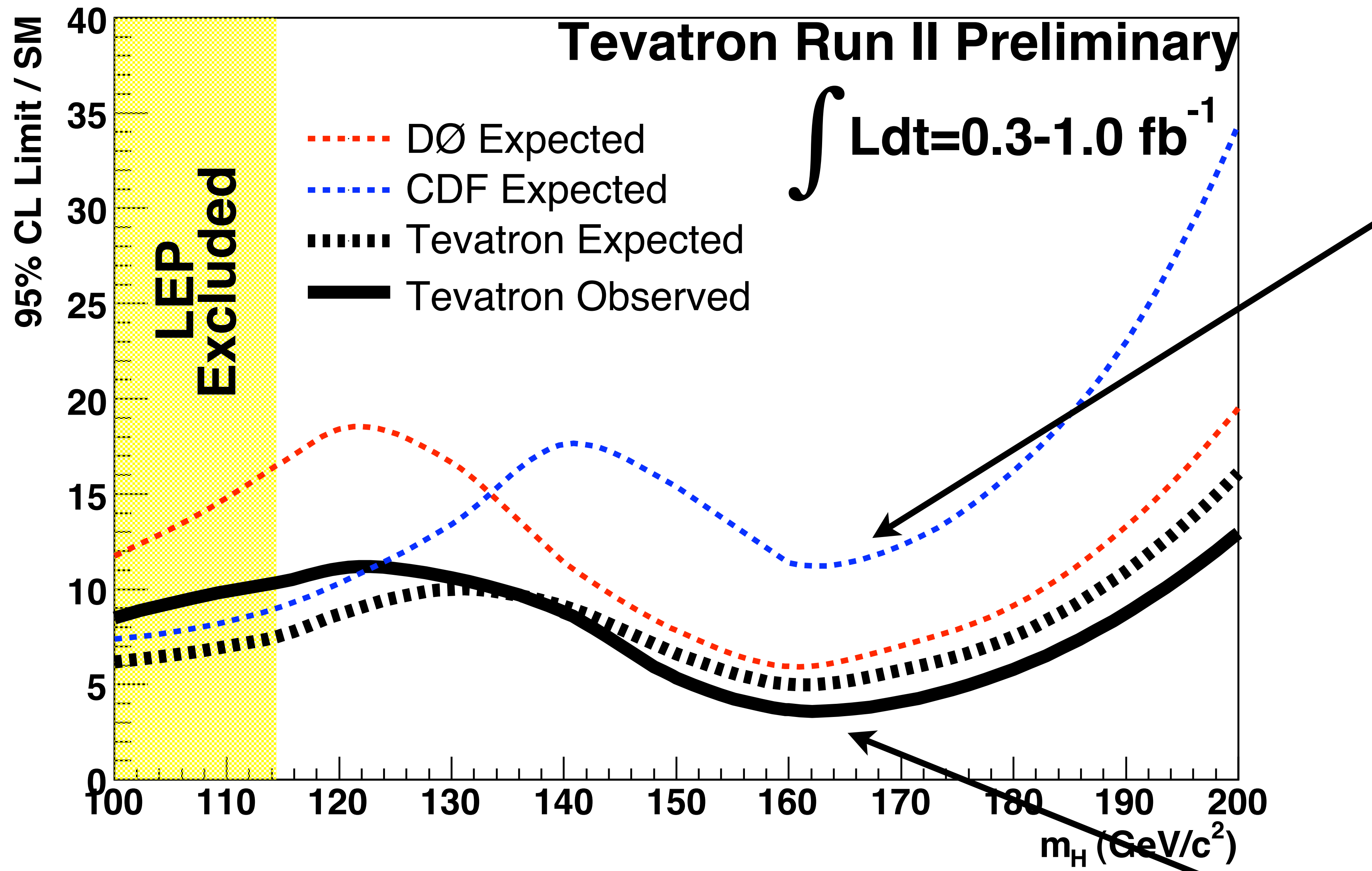
matrix element limit

maximum sensitivity

within a factor 5 from standard model



combined limit



CDF still using old 0.3 fb^{-1} H to WW

effect of WW analysis

- combining all tevatron results
- WW most sensitive at high mass
- getting close to standard model

summary & outlook

- presented limits on H to WW cross section at the Tevatron
- limit getting closer to excluding standard model at high mass
- working on combining both CDF results
- improved results with more data will soon be released
- working on new CDF and D0 combination