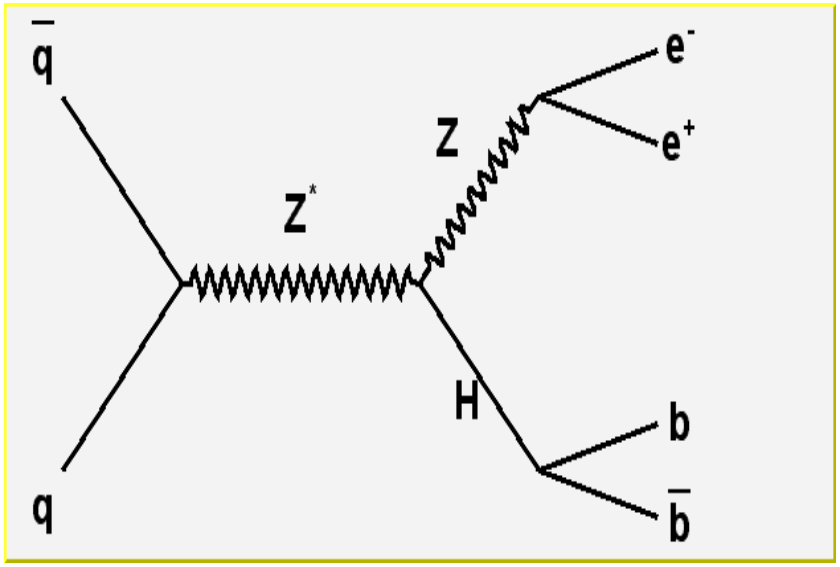
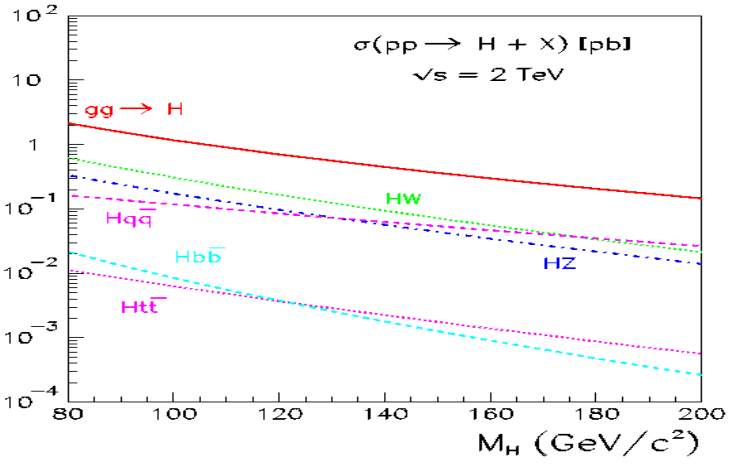
Search for the Higgs Boson in the Channel $ZH \rightarrow e^+e^-b\bar{b}$ with the DØ detector

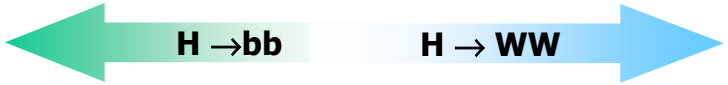


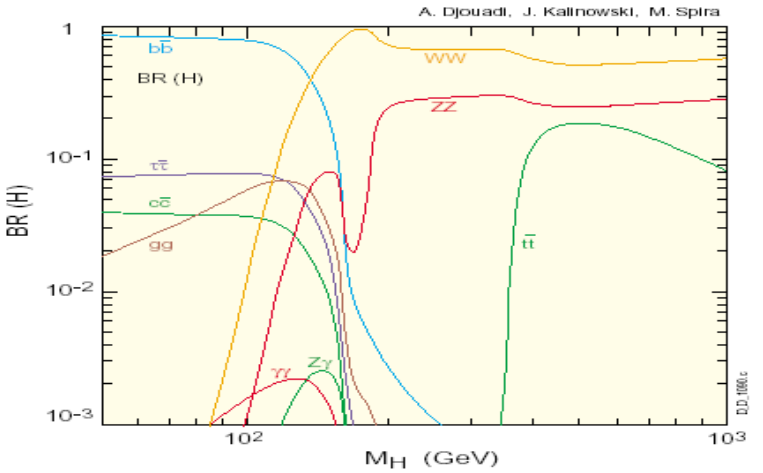
- Higgs Production and Decay Modes at the Tevatron
- Backgrounds
- Triggering
- Event Selection
- Z+jets studies

Higgs Production and Decay Modes at the Tevatron

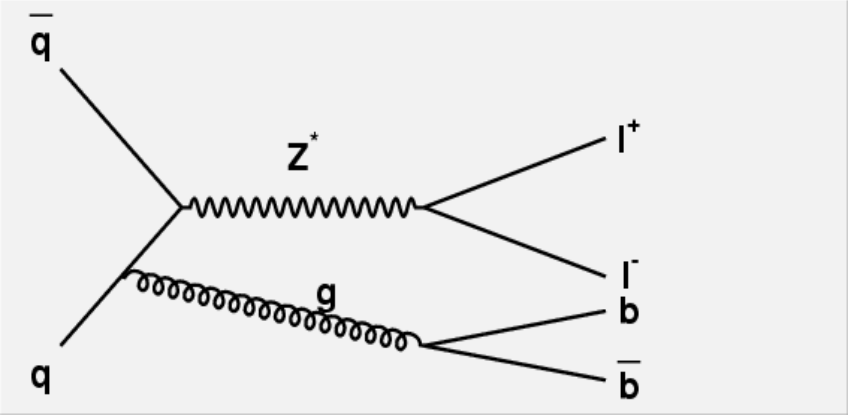
- **Inclusive Higgs cross section is quite high: ~ 1pb**
  - **for masses below ~ 140 GeV, the dominant decay mode $H \rightarrow b\bar{b}$ is swamped by QCD background**
  - **at higher masses, can use $H \rightarrow WW^{(*)}$ decay mode**
- **The best bet below ~ 140 GeV appears to be associated production of H plus a W or Z ("Higgsstrahlung")**
  - **leptonic decays of W/Z help reduce the background**

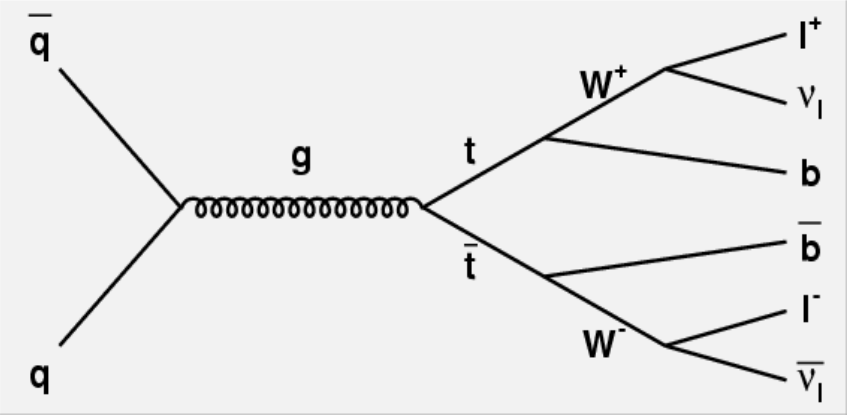


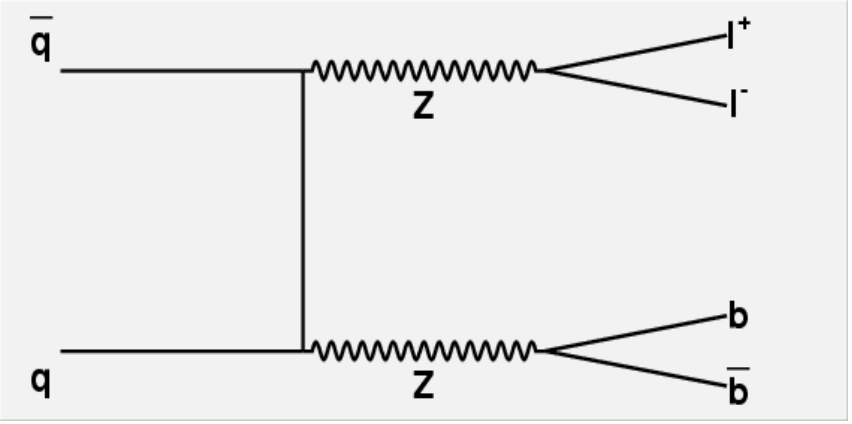




Backgrounds







Process	σ x branching ratio (fb)
ZH(115)	2.7
Zbb	150
tt	71
ZZ	13

DØ Trigger System

L1
4.2μs

5-10kHz

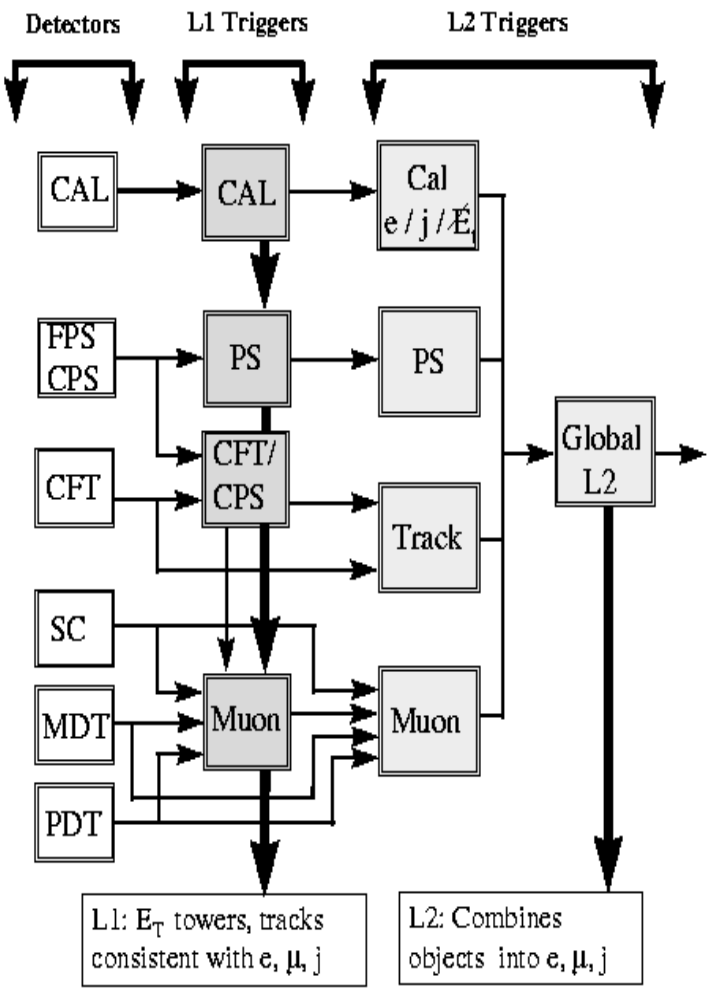
L2
100μs

1kHz

L3
25ms

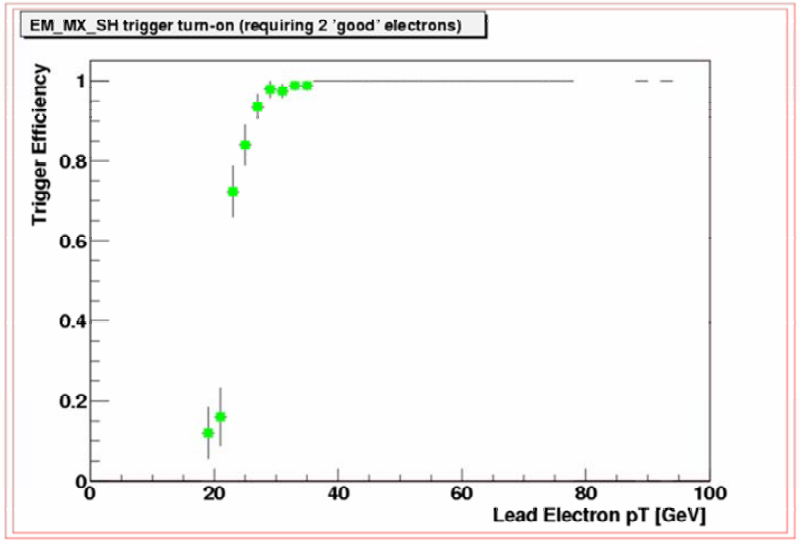
50Hz

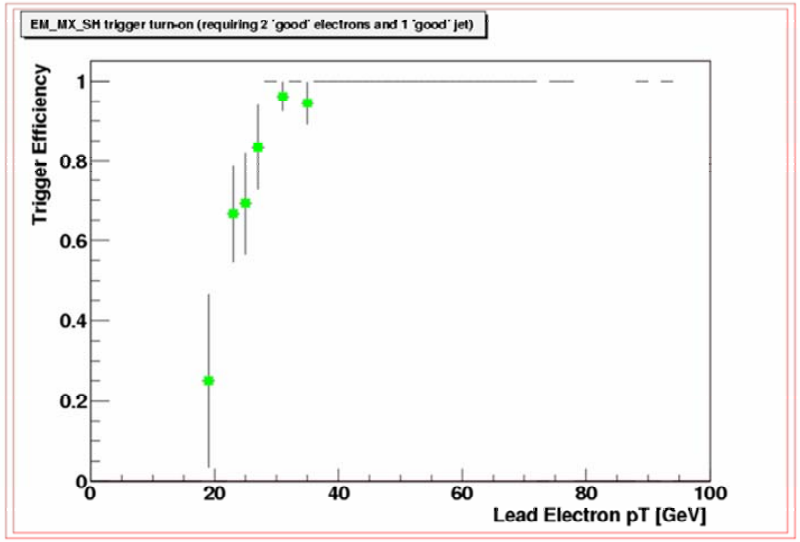
How to filter 5 million events/sec down to 50 events/sec ?



Triggering on $ZH \rightarrow e^+e^-b\bar{b}$

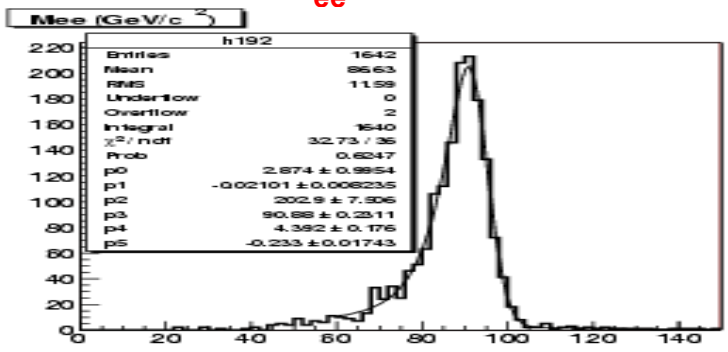
- **Single Electron Trigger (EM_MX_SH):**
  - L1: CEM(1,15), L3: EM(1,20,sh)
  - Efficiency ≈ 96.0 %
- **How does jet activity influence this trigger?**
  - Compare trigger turn-on for MC with and w/o requiring an additional reconstructed jet present: **EM_MX_SH has no jet bias!**





Event Selection

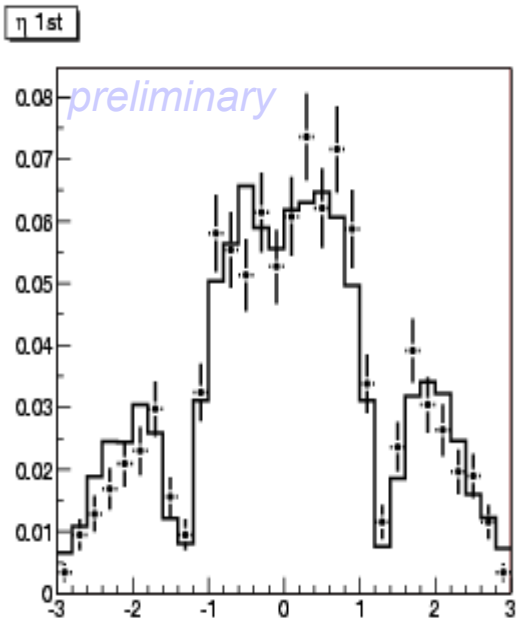
- Electrons:
  - **Quality cuts**
    - **EM fraction > 0.9**
    - **Isolation < 0.15**
    - **Shower shape cut**
    - **Track matching**
  - **Acceptance cuts**
    - **$|\eta| < 2.3$**
    - **$p_T > 20$ GeV/c**
  - **Mass window cut:**
    - **$80 < m_{ee} < 100$ GeV/c^2**

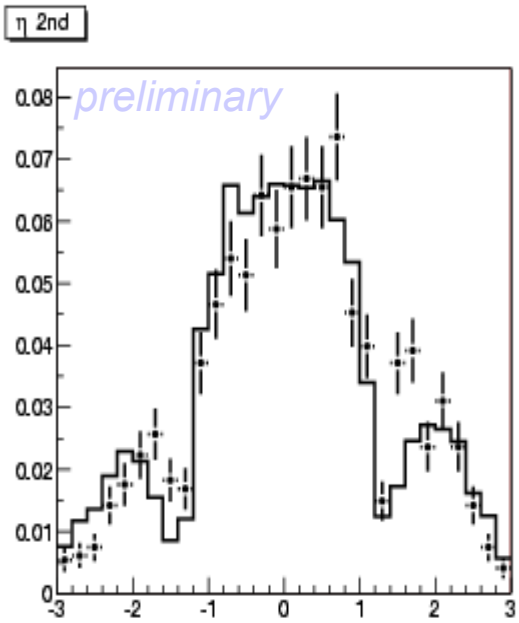


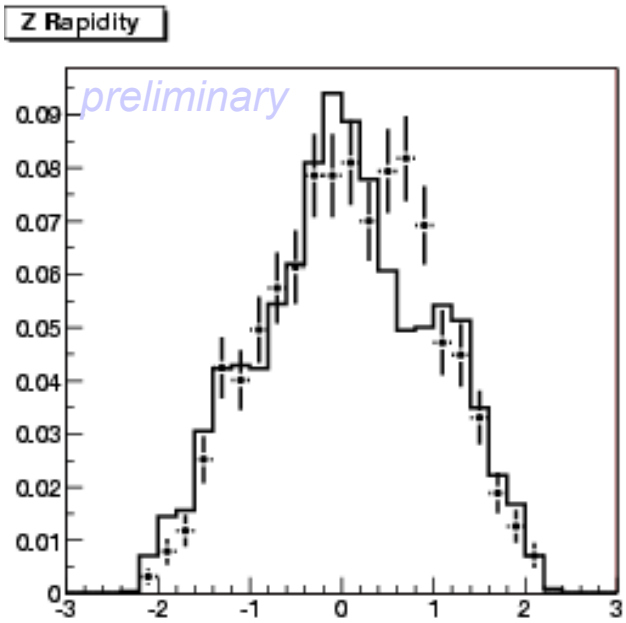
- Jets:
  - Quality cuts
    - **EM fraction**
    - **Hadronic fraction**
    - **Hotcell ratio**
    - **Number of towers containing 90% of jet energy > 1**
    - **Remove fake jets**
    - **Require separation between jets and electrons**
  - Acceptance cuts
    - **$|\eta| < 2.3$**
    - **$p_T > 20$ GeV/c**
  - Jet energy correction

Z+jets studies (1)

Data to MC comparisons





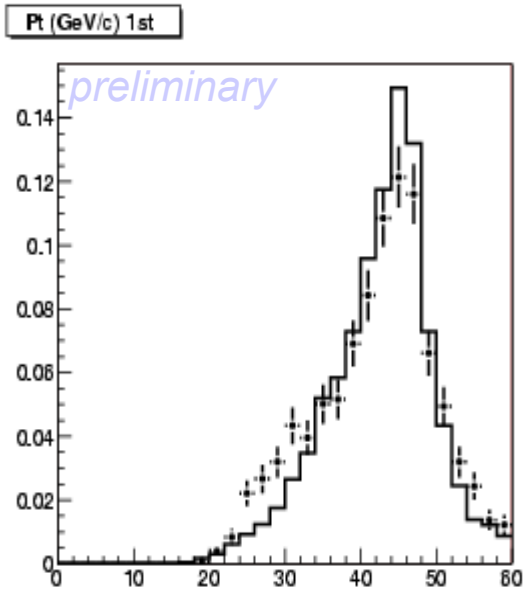


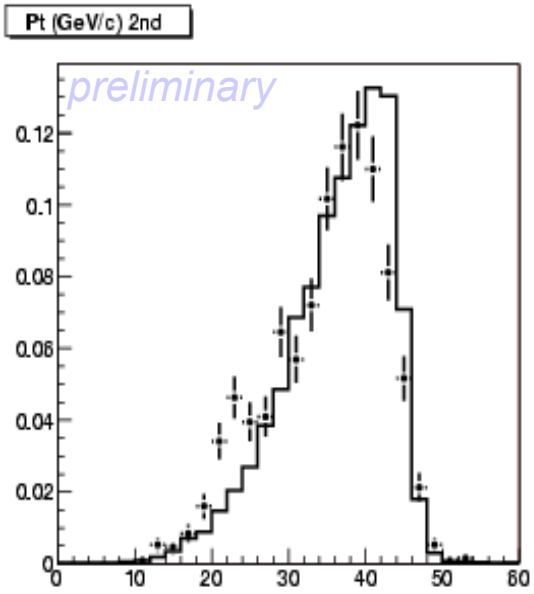
η distribution of leading p_T and second leading p_T electron in events with $80 < M_{ee} < 100$ GeV/c^2

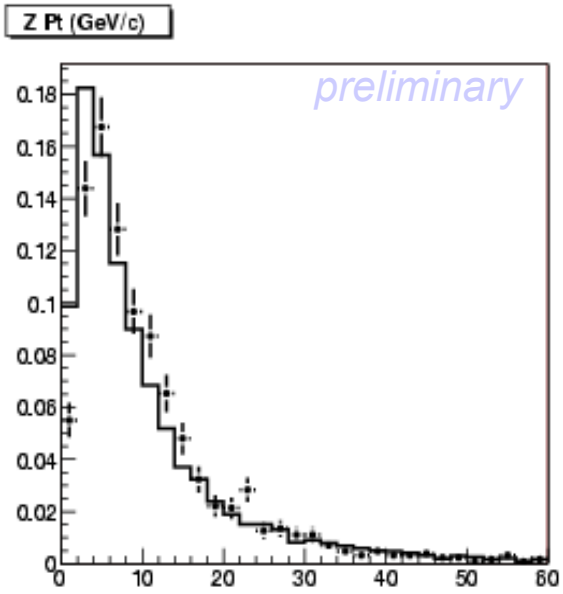
Rapidity distribution of the reconstructed Z

Dots represent data - histograms represent PYTHIA MC & GEANT detector simulation

Z+jets studies (2)







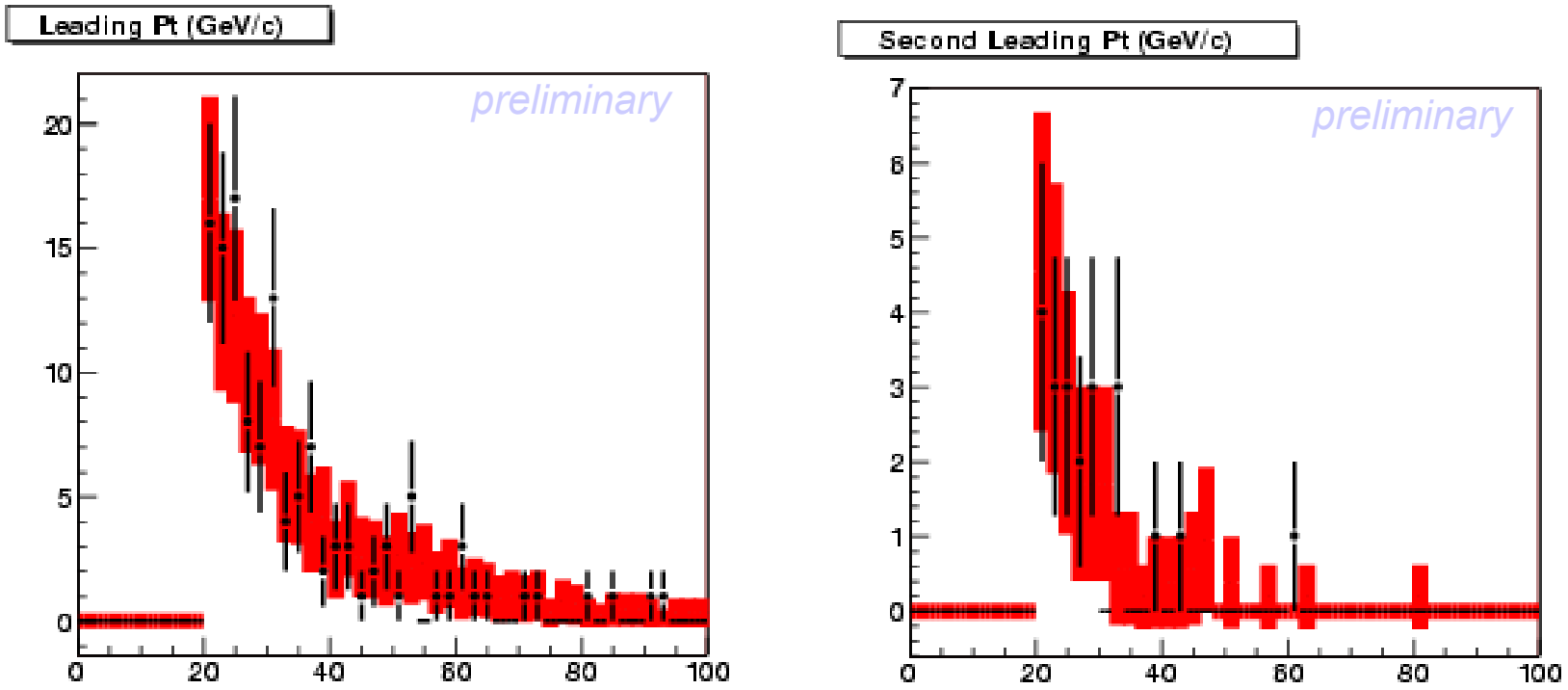
Transverse momentum distribution for leading p_T and second leading p_T electron in events with $80 < M_{ee} < 100$ GeV/c^2

Transverse momentum distribution of the reconstructed Z

Dots represent data - histograms represent PYTHIA MC & GEANT detector simulation

Z+jets studies (3)

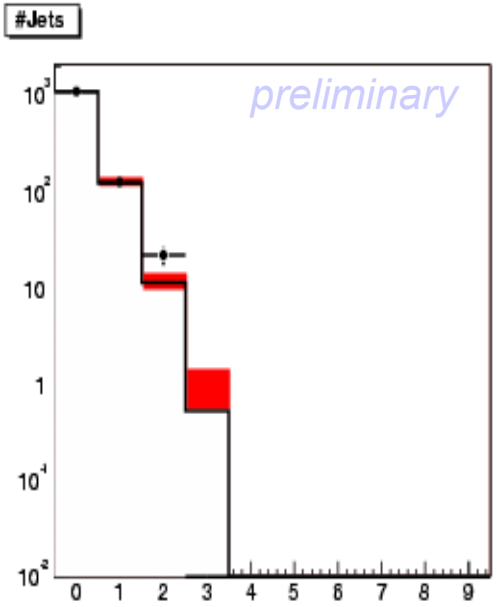
Study of jet properties in $Z \rightarrow e^+e^-$ events



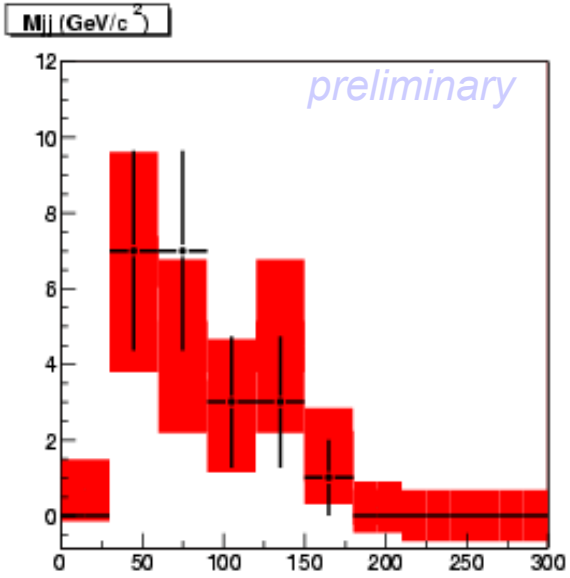
p_T distributions of leading and second leading jet

Dots represent data – red bands represent statistical and systematic errors (dominated by the jet energy scale correction) for MC

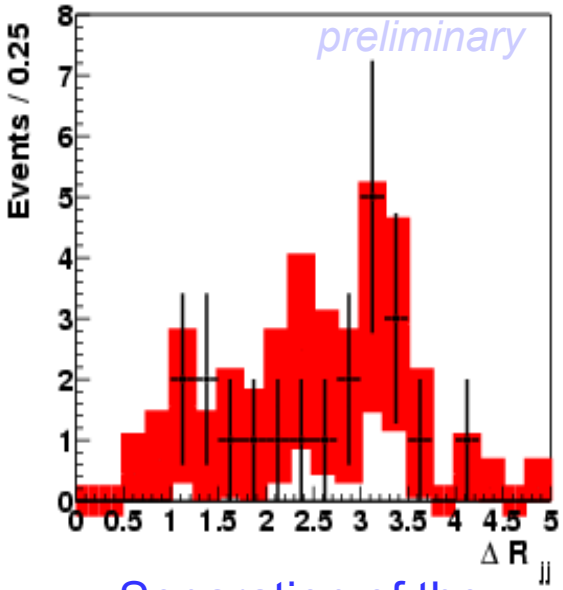
Z+jets studies (4)



Inclusive number of jets



Dijet invariant mass distribution

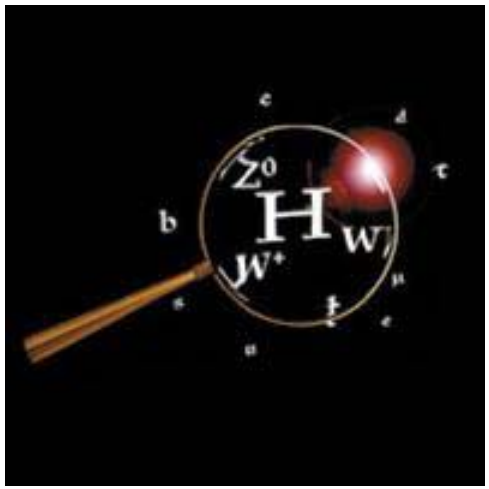


Separation of the two leading jets

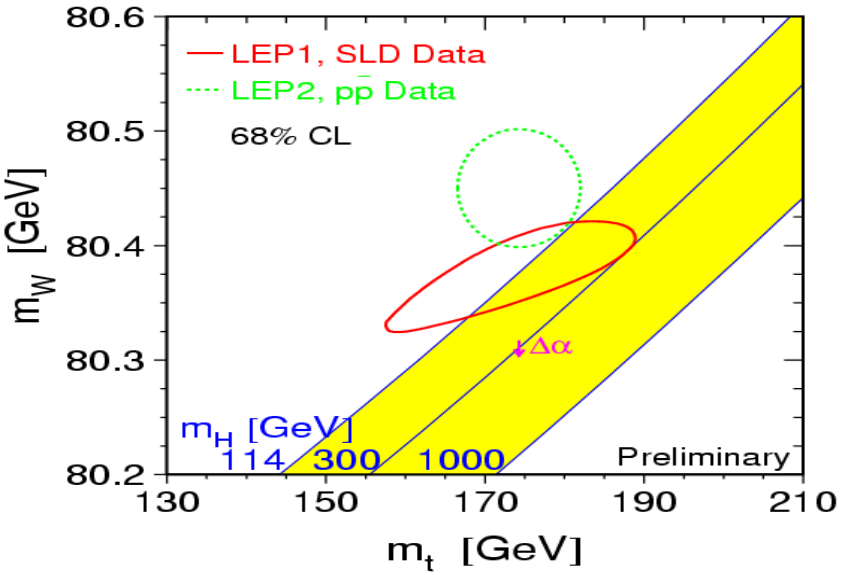
Dots represent data – red bands represent statistical and systematic errors (dominated by the jet energy scale correction) for MC

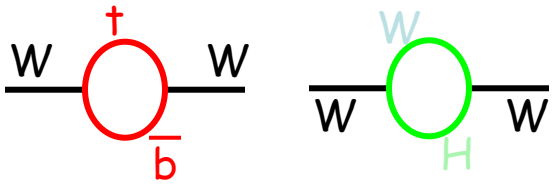
Summary & Outlook

- Properties of $Z(\rightarrow e^+e^-)$+jets events have been studied as a first step towards Higgs search in the $ZH \rightarrow e^+e^-b\bar{b}$ channel
- Kinematic properties of events have been compared to Monte Carlo simulations
- b-tagging studies are underway
- More data coming up soon

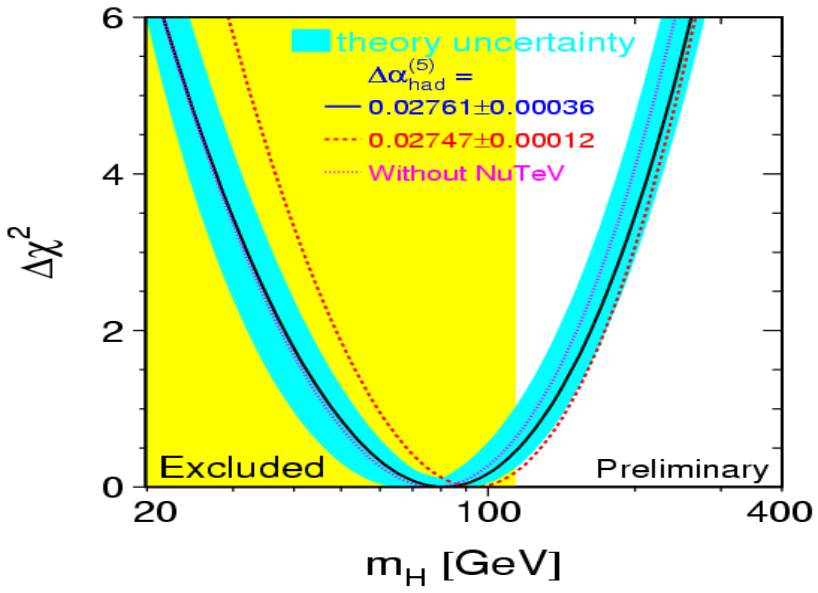


Current Limits on the Higgs Mass





Connection between Higgs and EW parameters via higher order loop corrections allow estimate of m_H.



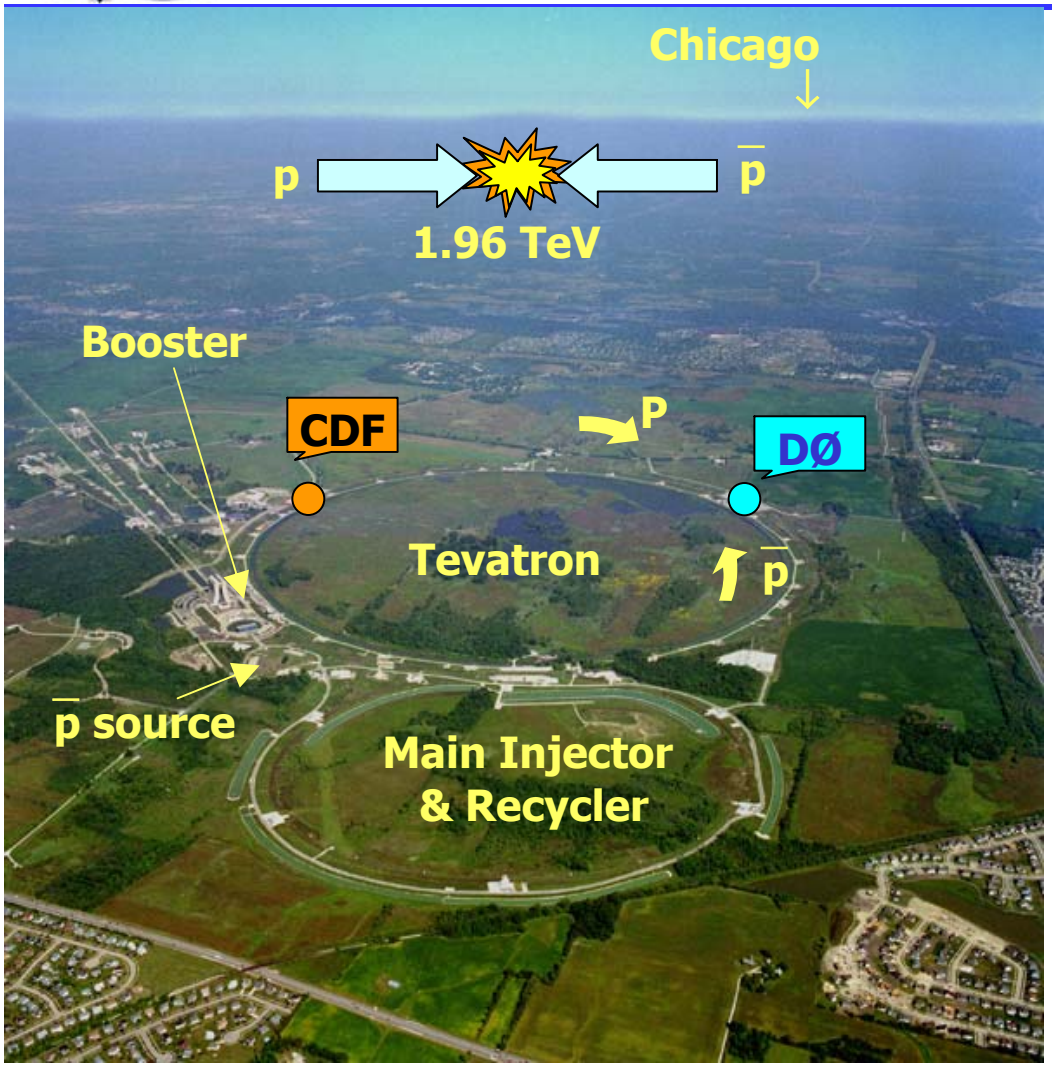
Global fit of EW data to m_H gives upper limit (95% CL):

$m_H < 193$ GeV/c^2

Direct LEP measurements give lower limit (95% CL):

$m_H > 114.3$ GeV/c^2

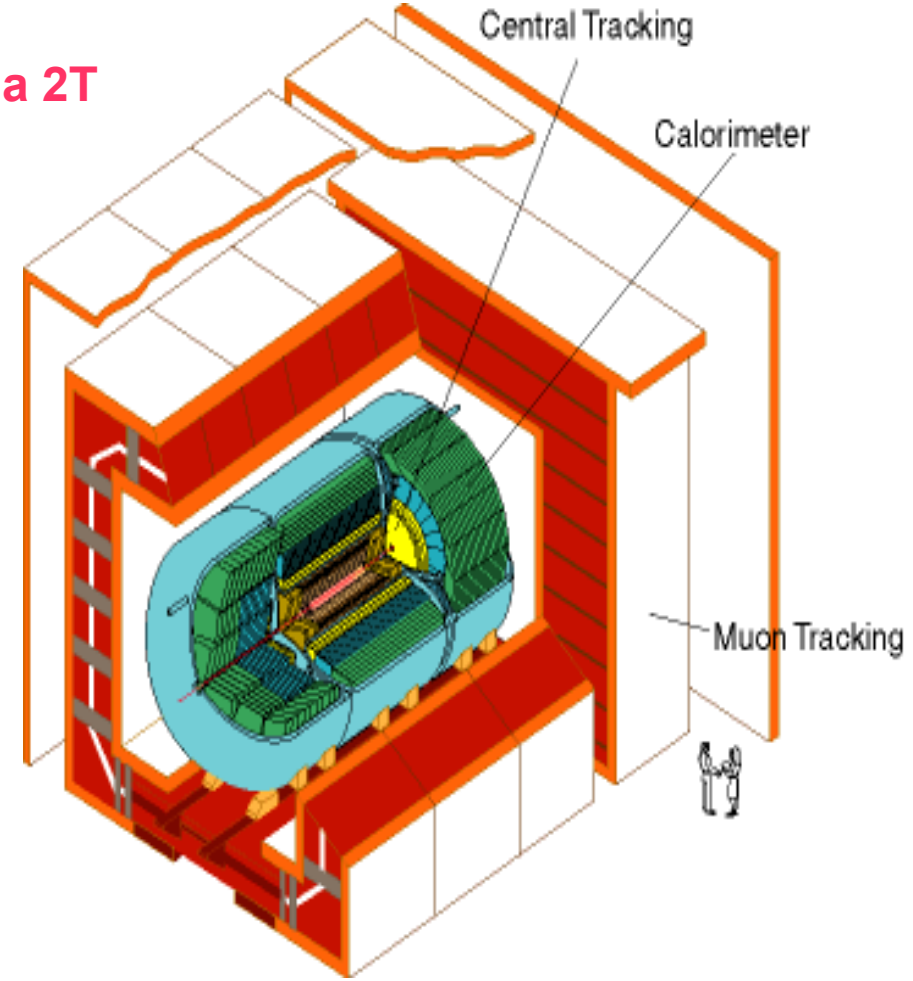
Tevatron Upgrade



- **Run 1: 1992 -1996**
  - Peak Luminosity: 2×10^{31} cm^{-2} s^{-1}
  - Integrated Luminosity: 100 pb^{-1}
- **Run 2: 2001-2007**
  - 1.8 TeV $\rightarrow$ 1.96 TeV
  - Peak Luminosity: $2 \times 10^{32} \rightarrow 5 \times 10^{32}$ cm^{-2} s^{-1}
  - Integrated Luminosity: 2 fb^{-1} $\rightarrow$ 11 fb^{-1}
  - New Main Injector

DØ Detector Upgrade

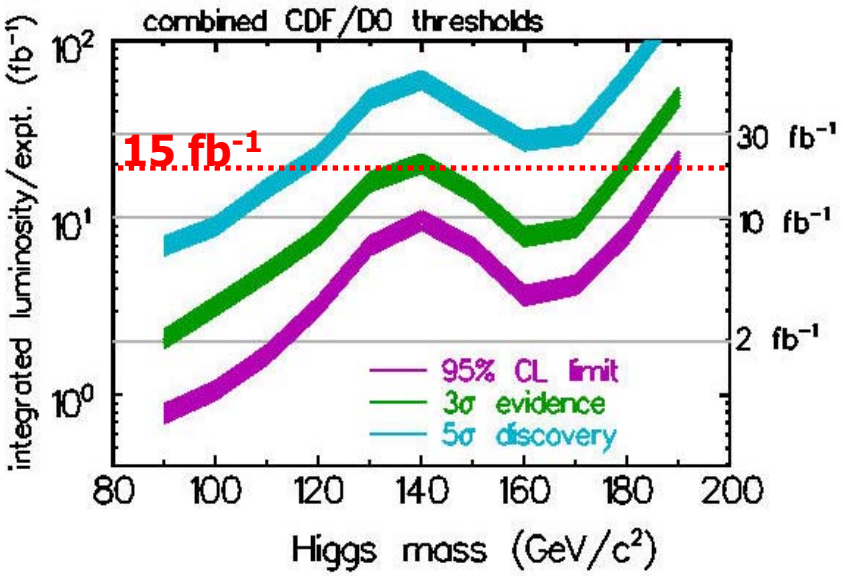
- **Significant upgrades for Run II:**
  - New silicon and fiber trackers in a 2T magnetic field
  - Preshower detectors in front of calorimeter
  - Improved muon system
  - New DAQ and trigger systems



- **Main commissioning efforts:**
  - Tracking Trigger
  - Forward Proton Detector (FPD)

Higgs Discovery Potential

- The Higgs discovery potential for the Run II Tevatron has been evaluated (hep-ph/0010338).
- A joint effort of theorists and both Tevatron experiments, using a parametrized detector simulation.
- Main conclusions:
  - Discovery cannot be made in a single channel alone; data from all channels must be combined.
  - Must also combine the data from both experiments.
  - Must improve understanding of the background and signal processes and detector characteristics.
  - Advanced multivariate analysis techniques are vital



Need fb^{-1} datasets for Higgs studies !