Prospects for Higgs Search at DØ

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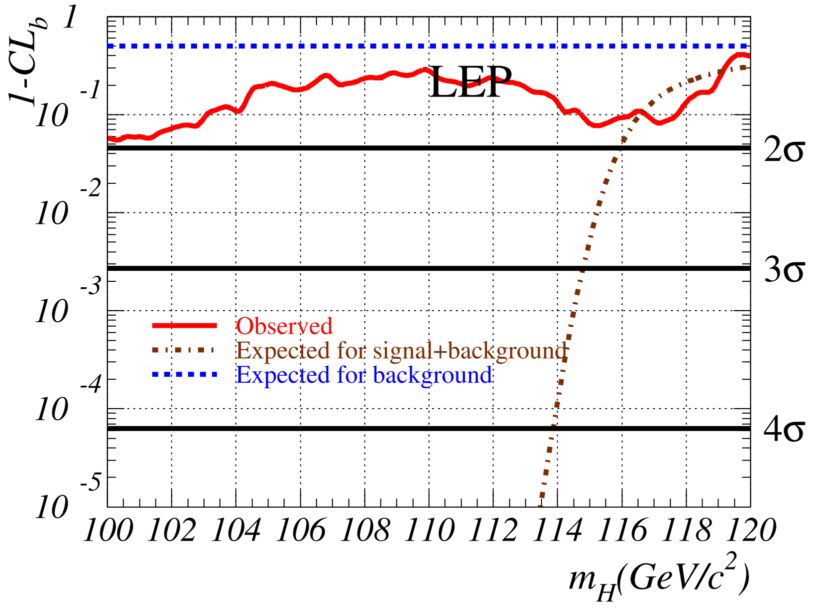
Outline:

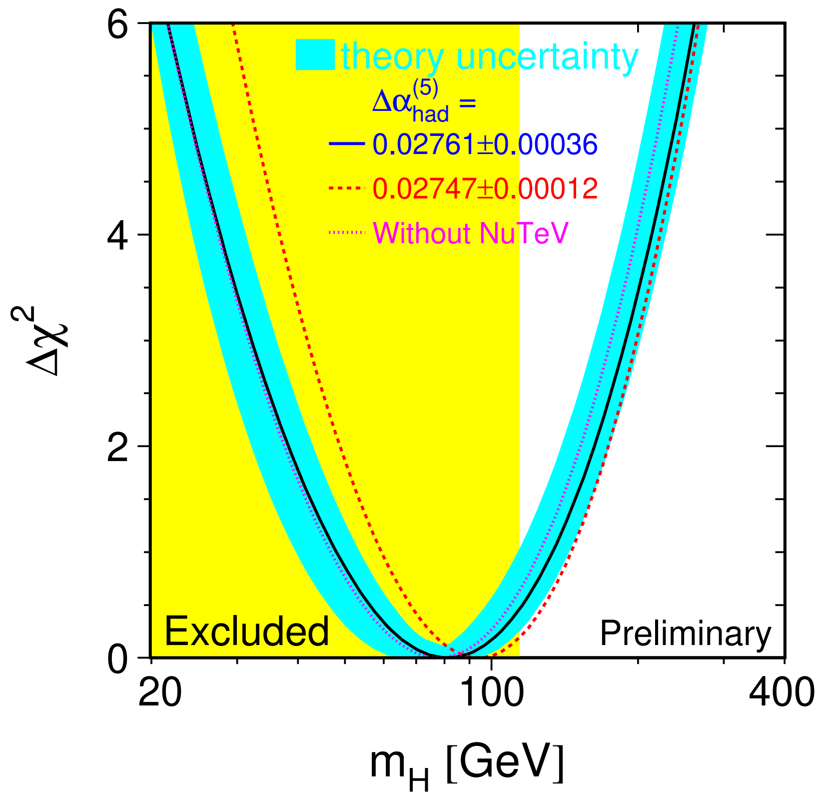
- Introduction.
- Tevatron Run II.
- Higgs channels.
- Summary.

Introduction

- A major goal of the current Tevatron run is the search for Higgs bosons.
- Searches at LEP exclude a SM Higgs < 114.4 GeV at 95% C.L., with a hint of an excess just above that.

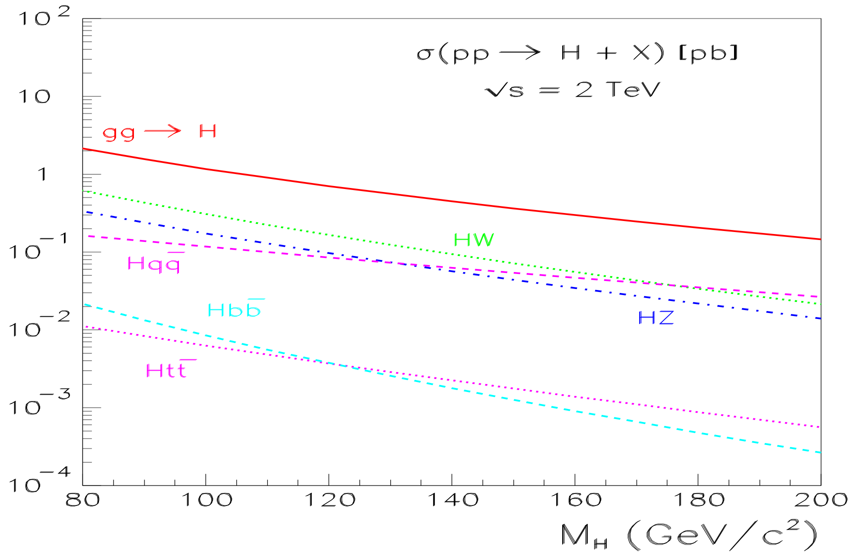


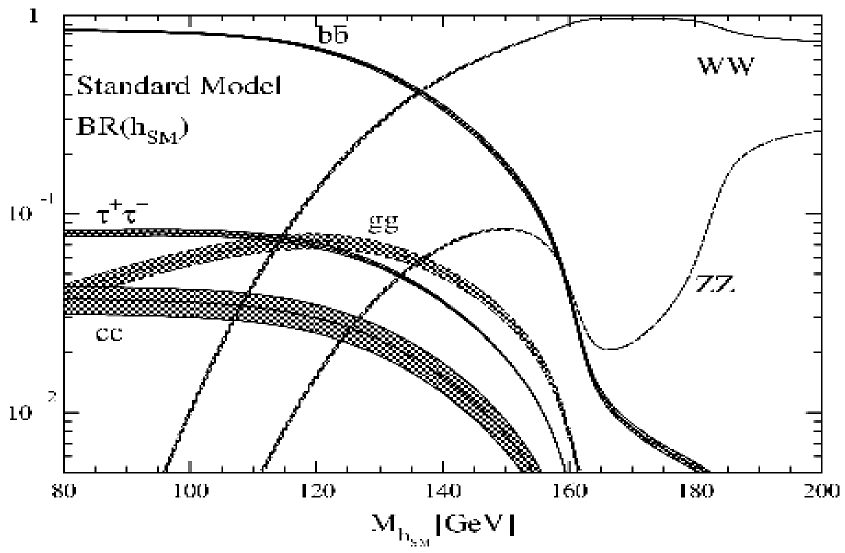
- Global SM fit gives an indirect limit of < 193 GeV, at 95% C.L. Low masses are preferred — fit minimum is at 81 GeV.



Standard Model Higgs

- For $m_H \lesssim 140$ GeV:
  - $H \to b\bar{b}$ dominates.
  - $gg \to H$ hopeless due to QCD background.
  - Look for associated W/Z production.
- For higher masses:
  - $H \to WW$ dominates.
  - Can look for $gg \to H \to WW$.
- Cross section ~ 0.1 pb.
- Other channels:
  - $Hb\bar{b}$, $Ht\bar{t}$ have spectacular signatures, but $\sigma \sim 5$ fb.
- SM extensions may enhance $hb\bar{b}$, $H \to \gamma\gamma$.

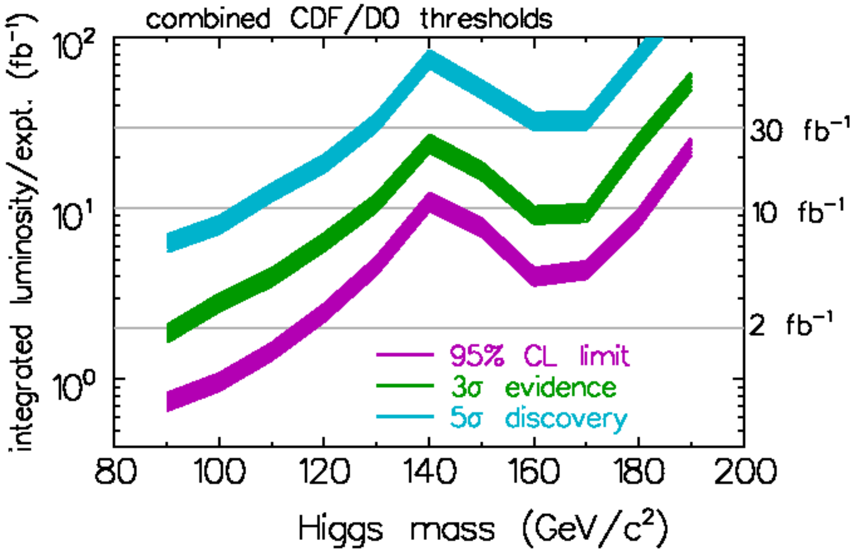




Higgs Working Group Studies

- 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 parameterized 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.

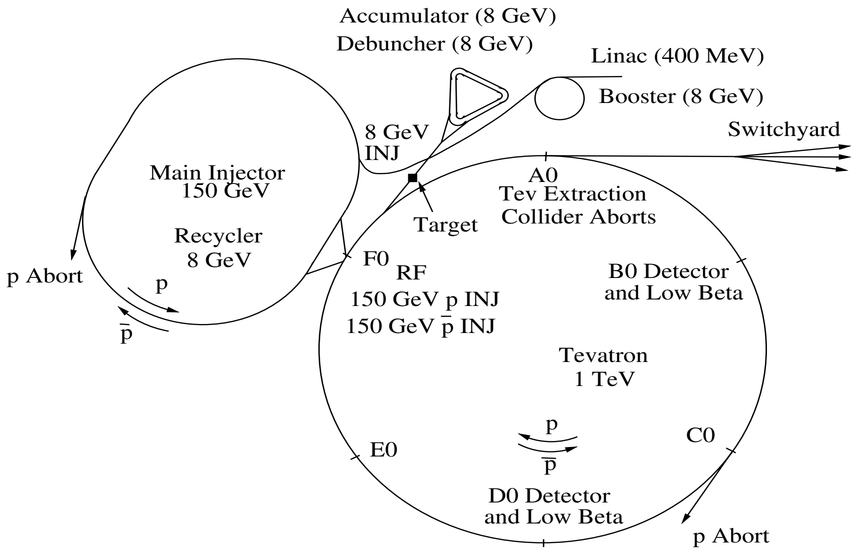
- Integrated luminosity per experiment for a 95% CL exclusion of a SM Higgs or a 3σ or 5σ discovery:

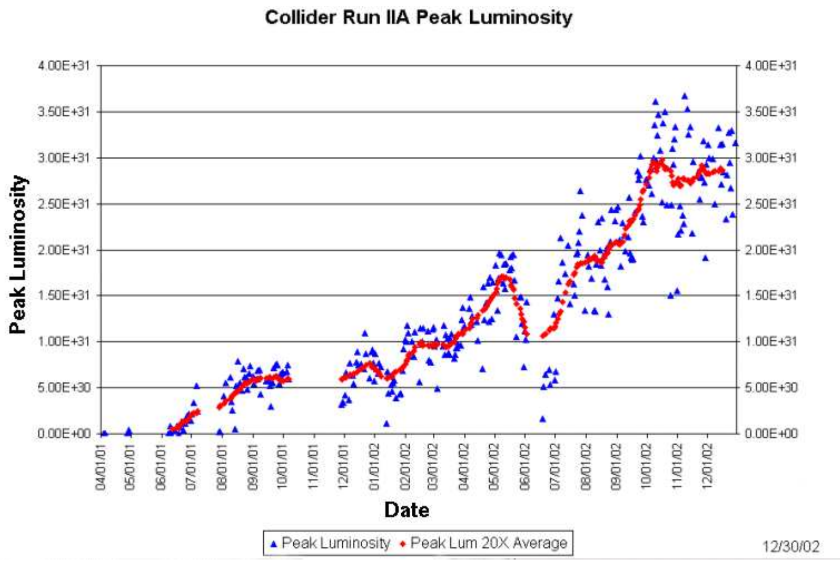


- Results of studies with more detailed detector simulations are consistent with HWG expectations.

Tevatron Run II

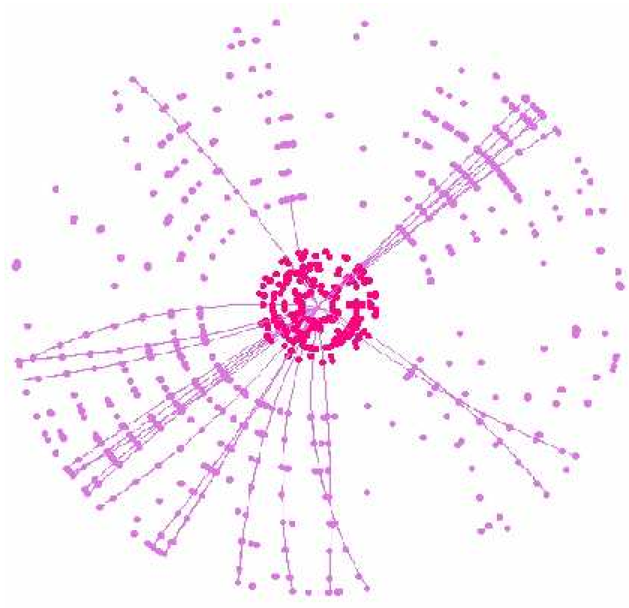
- Run I yielded $\sim 0.1\,\text{fb}^{-1}$ per experiment.
- Collider upgrades:
  - Collision energy increased: $1.8 \to 1.96$ TeV.
  - New Main Injector.
  - Recycler being comissioned.
- Run II in progress with a goal of 10–$15\,\text{fb}^{-1}$.
- Detector upgrades after $\sim 2\,\text{fb}^{-1}$.
- DØ has recorded $\sim 50\,\text{pb}^{-1}$. (Currently, $\sim 1\,\text{pb}^{-1}/\text{day}$.)
- Accelerator performance has been steadily improving.
  - Now doing better than Run I.
  - Peak $\mathcal{L} > $ 3E31.

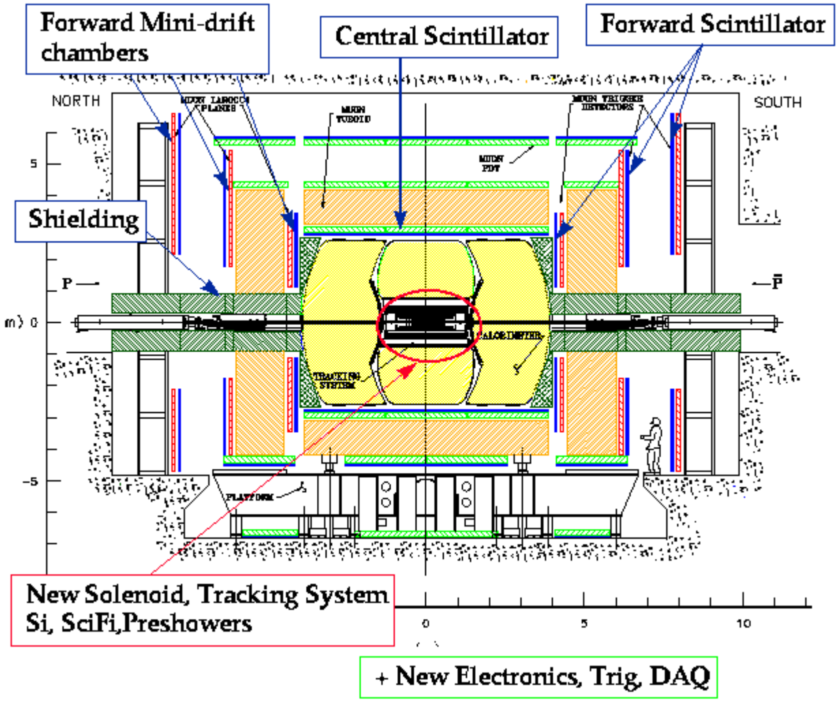




DØ Run II detector

- DØ has been upgraded for Run II:
  - New silicon and fiber trackers in a 2 T magnetic field.
  - Preshower detectors in front of calorimeters.
  - Improved muon system.
  - New DAQ and trigger systems.
- Global tracks:

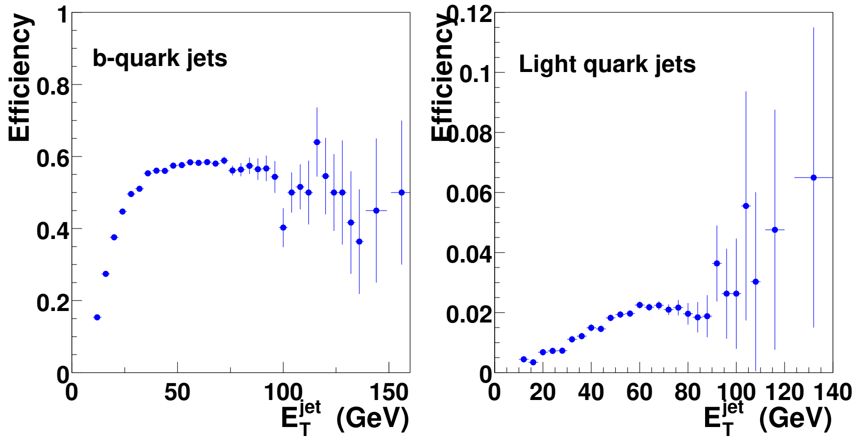




- All detector components functioning.
  - Some trigger systems still to be commissioned.
- Additional scheduled upgrades:
  - New silicon tracker.
  - Trigger upgrades.

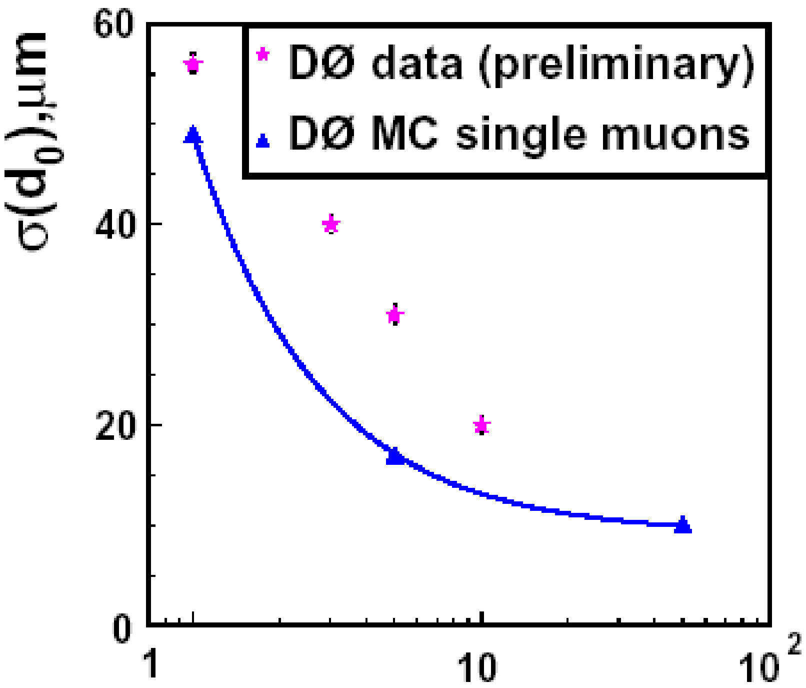
B-tagging

- Good b-tagging is crucial for the $H \to b\bar{b}$ channels.
- Tagging rate from Monte Carlo, using full simulation at high luminosity:



- b-tagging efficiency is $\sim 60\%$ for high-E_T jets; fake rate from light quarks is a few percent. ($\sim 20\%$ for c jets.)
- Efficiency and fake rates determined by impact parameter resolution.

- Measured resolution $\sim 20\ \mu$m, compared to MC expectations:

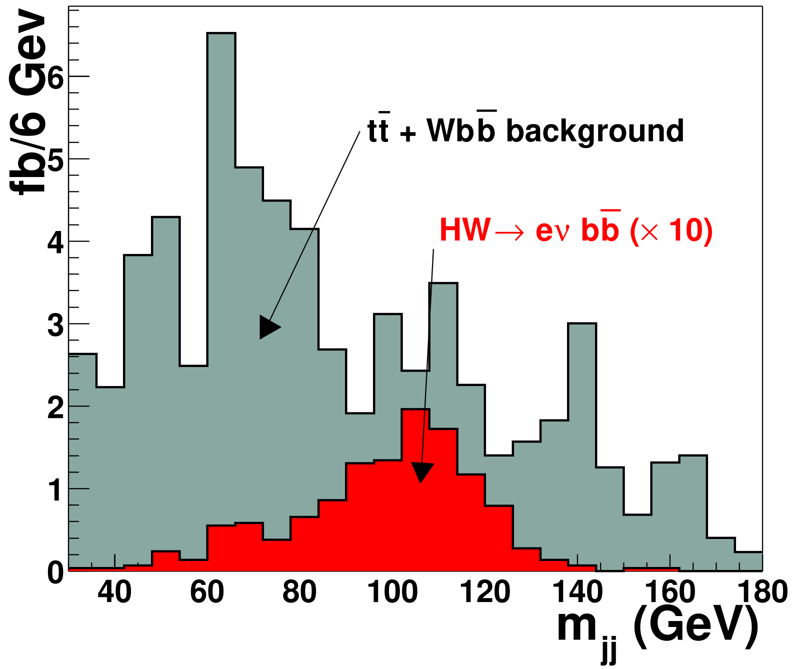


- Approaching expectations. Silicon alignment and calibration work is in progress, so this will improve.

$W(\to e\nu/\mu\nu)H(\to b\bar{b})$

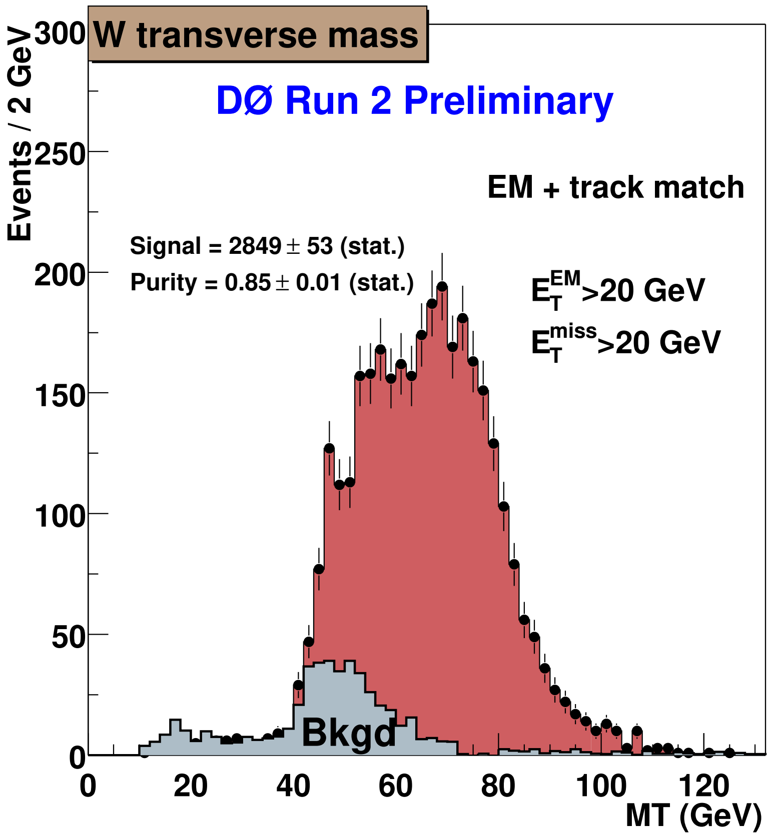
- Final states contain:
  - Isolated lepton, e or μ.
  - Large $\not{E}_T$.
  - Two b-jets.
- Major physics background is $Wb\bar{b}$.
  - Difficult to calculate accurately.
  - Detailed studies in progress.
- Other significant backgrounds include $t\bar{t}$ and WZ.
- Simple kinematic selection:
  - $E_T(e/\mu) > 20$ GeV.
  - $\not{E}_T > 20$ GeV.
  - 2 b-tagged jets with $E_T > 15$ GeV.

- Example for electron channel.
- Require $E_T(j_3) < 25$ GeV (rejects $t\bar{t}$).
- Plot $m_{b\bar{b}}$ for signal and dominant backgrounds.

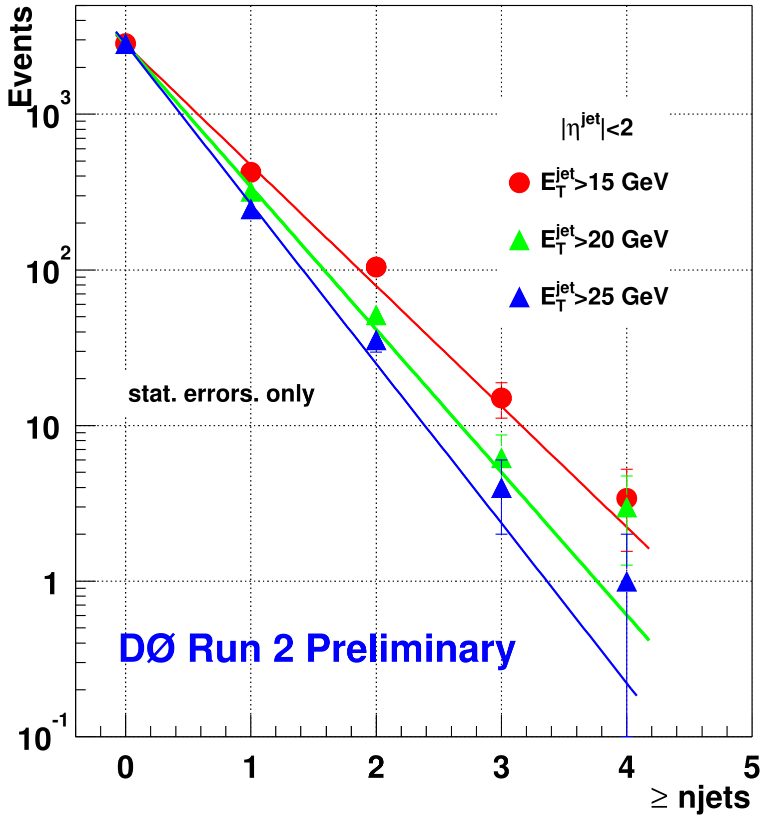


W bosons in data

- W transverse mass in $e + \not{E}_T$ data.
- Preliminary, from several pb^{-1}.
- More data being analyzed.

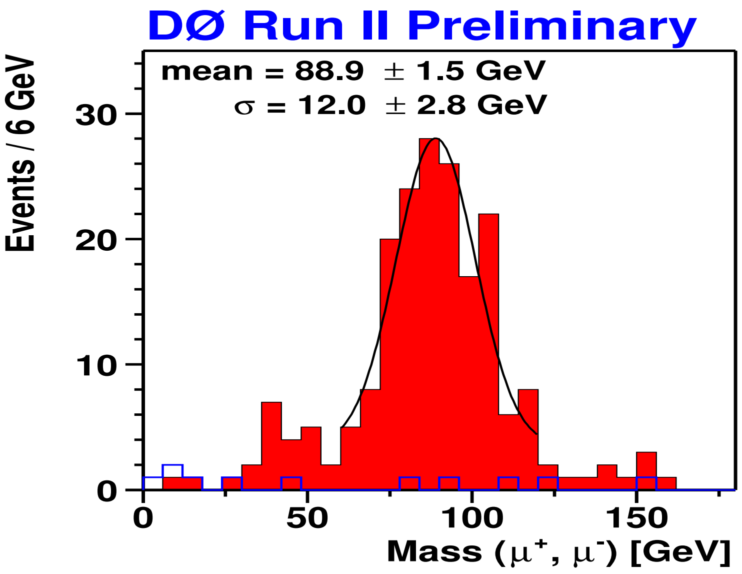


- Inclusive number of jets in $W \rightarrow e\nu$ events.

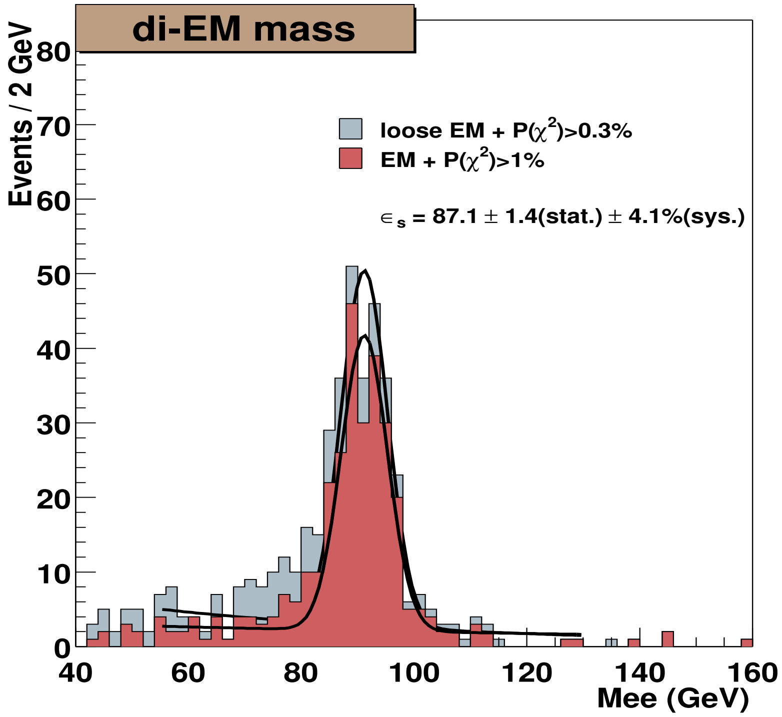


$Z(\to ee/\mu\mu/\nu\nu)H(\to b\bar{b})$

- $Z(\to ee/\mu\mu)H(\to b\bar{b})$. Final state:
  - Two isolated leptons, e or μ.
  - $m(\ell\ell)$ consistent with m_Z.
  - Two b-jets.
- $Z(\to \nu\nu)H(\to b\bar{b})$. Final state:
  - Large $\not{E}_T$.
  - Two b-jets.

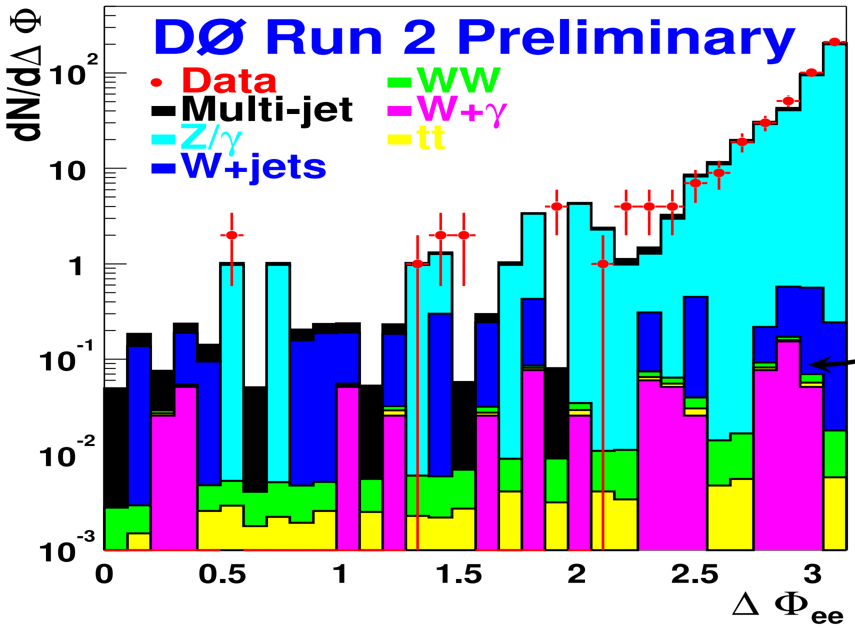


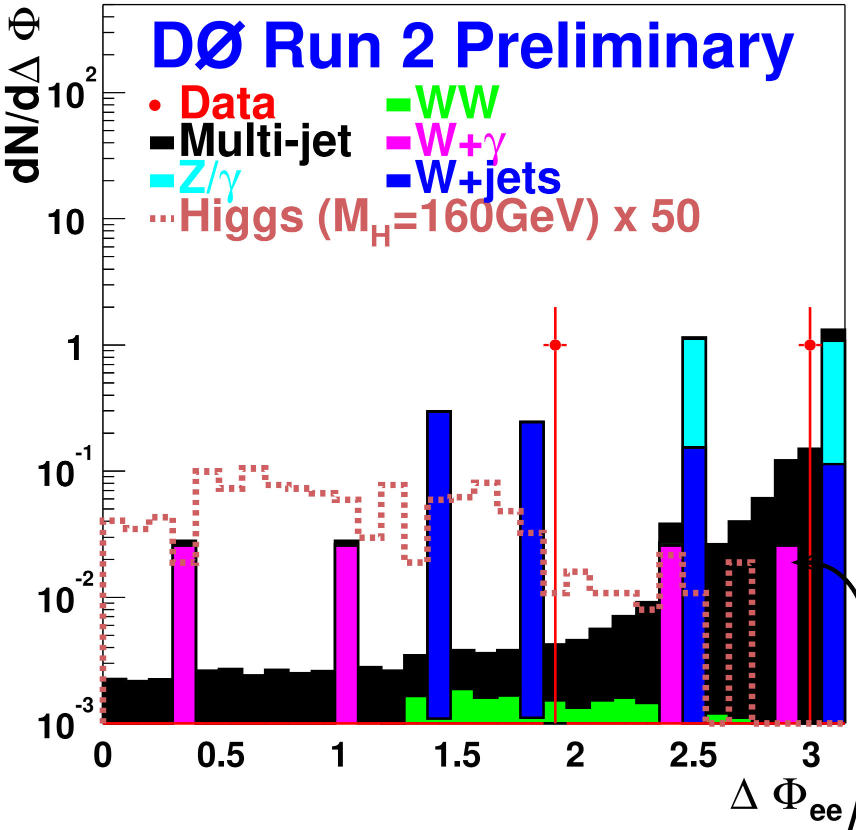
- Backgrounds include $Zb\bar{b}$, Zjj, ZZ, $t\bar{t}$, QCD.
- Detailed studies in progress.
- Estimate yield of ≈ 4.7 events/fb^{-1}.



$H \to WW^* \to \ell\ell\nu\nu$

- Useful for higher mass Higgs.
- Cannot directly reconstruct mass.
- Backgrounds include WW, $t\bar{t}$, $W/Z + \mathrm{jets}$, QCD.
- WW pair comes from a spin 0 particle, so spin correlation variables, like $\Delta\phi(\ell\ell)$, are useful.

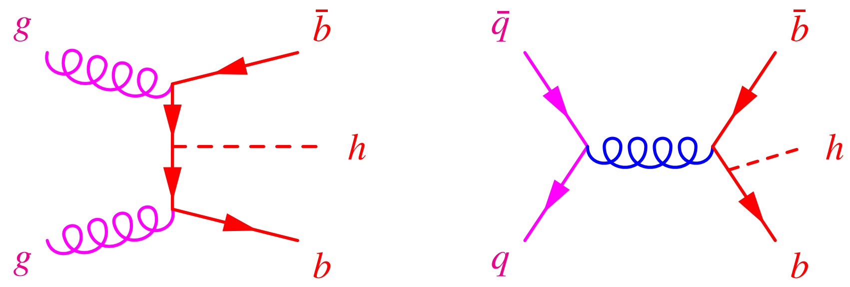




- Require 2 e with $p_T > 20\,\mathrm{GeV}$.
- Require $m(ee) < 78\,\mathrm{GeV}$, $\not{E}_T > 20\,\mathrm{GeV}$, and no jets with $E_T > 20\,\mathrm{GeV}$.

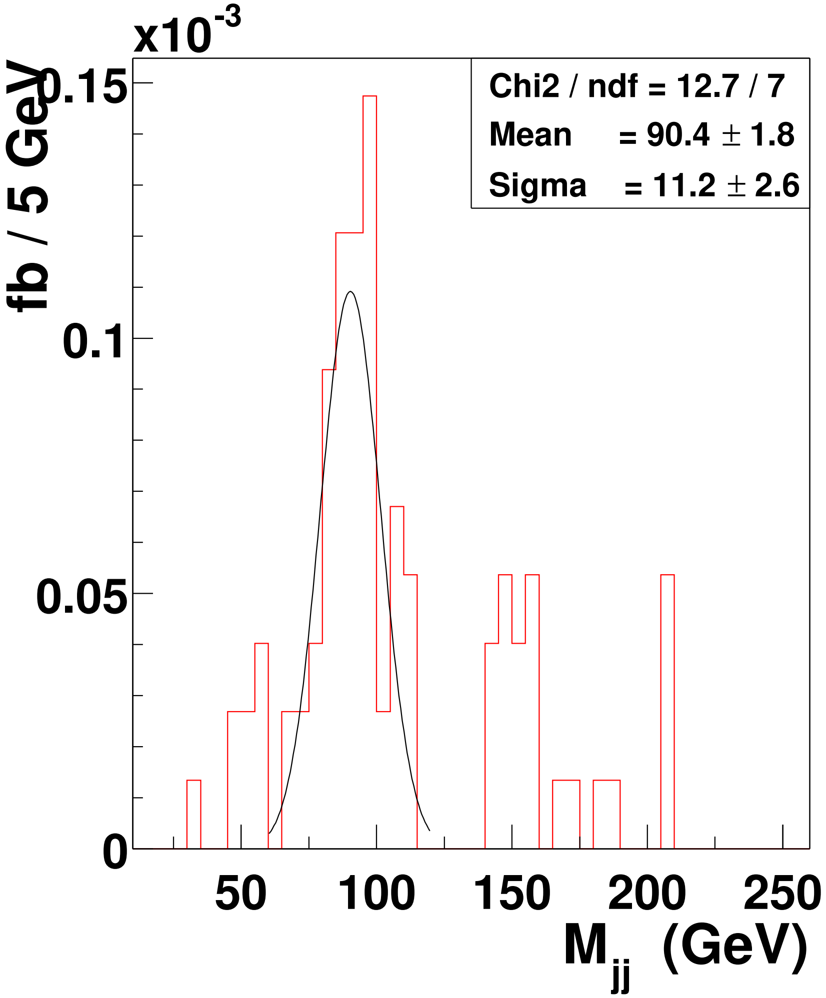
hbb

- In SUSY models, bH couplings are enhanced by $\tan\beta$.
- Search for Higgs in $4b$ final states.



- Backgrounds include QCD, $t\bar{t}$, $Wb\bar{b}$, $Zb\bar{b}$.
- For $m_H = 120$ GeV, require:
  - $E_T(j_1) > 55$ GeV;
    $E_T(j_2) > 40$ GeV.
  - $E_T(j_3, j_4) > 30$ GeV.
  - At least 3 b-tags.

- Consider all jet permutations.
- Get 12% relative mass resolution.



Summary

- We are recording physics data. Both the accelerator and detector performance are continually improving.
- Analysis of recent data is in progress.
- Work is ongoing on detailed studies of the detector performance in areas such as:
  - bb mass resolution.
  - b-tagging efficiency.
  - Missing E_T resolution.
- Backgrounds to Higgs processes are being studied.
- Looking forward to exciting results!