Physics Potential and the Status of DØ Upgrade at Fermilab

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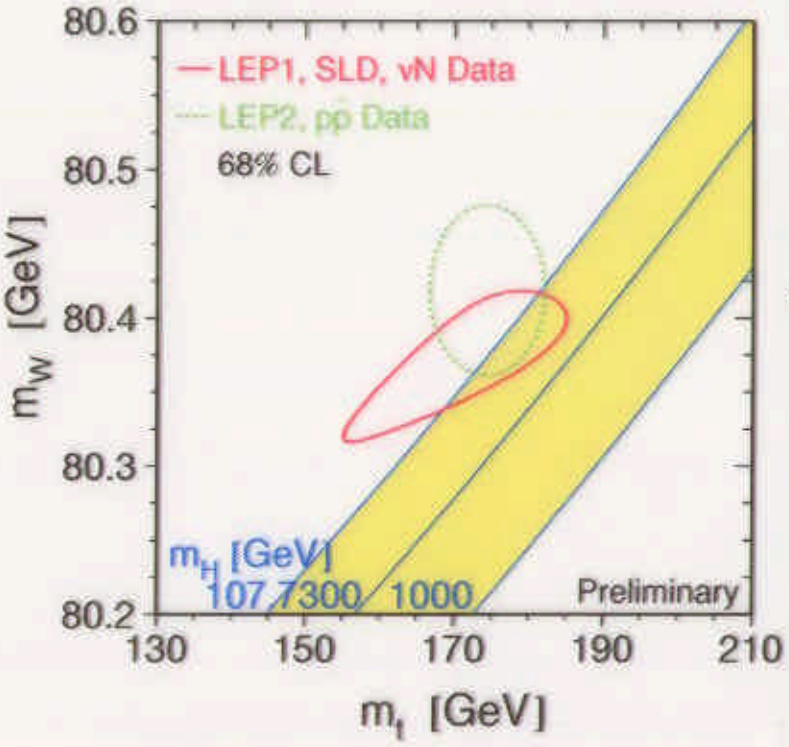
- Introduction
- Physics at TeVatron Run II
- TeVatron and DØ Upgrade
- Current Status
- Conclusions

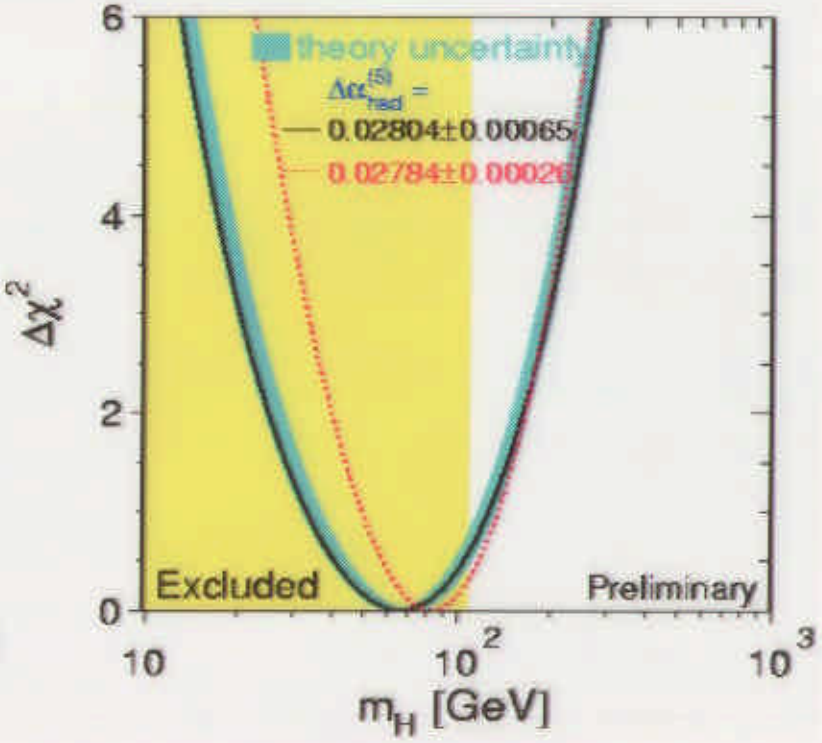
Introduction

- Standard Model has been extremely successful under scrutinization
- Yet, there are outstanding issues left over
  - Neutrino masses ← Neutrino oscillations
  - Electroweak symmetry breaking → Origin of masses
  - CP violations ← kTeV and other experiments
- Is there any other model that describes nature better?
- TeVatron collider Run II can provide clues for two of the three issues in SM as well as clues for beyond SM

Where do we stand, circa 2000?

- The Standard Model works at the 10^{-3} level





- All observations are consistent with a single light SM Higgs, though no such beast has yet been observed
  - $m_H > 113$ GeV (LEP) and $m_H < 175$ GeV (Global SM fit)

Beyond the Standard Model

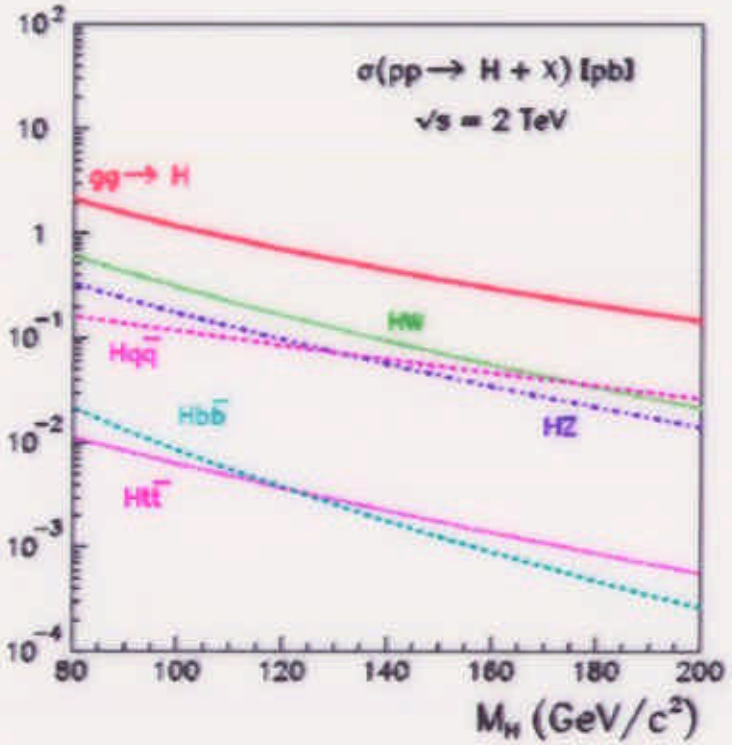
- General arguments for new physics at the EW scale (250 GeV)
- Standard Model fits suggest the new physics is weakly coupled
- Indirect pointers to supersymmetry?

Direct searches all negative so far

- LEP2
  - squarks (stop, sbottom) > 80-90 GeV
  - sleptons (selectron, smuon, stau) > 70-90 GeV
  - charginos > 70-90 GeV
  - lightest neutralino > 36 GeV

- Tevatron Run I
  - squarks and gluinos
  - stop, sbottom
  - charginos and neutralinos

Higgs Production at the Tevatron



- $gg \rightarrow H$ dominates, but huge QCD background
- WH and ZH seem to offer the best potential
- SUSY enhances associated b production

SM Higgs Channels

m_H < 130-140 GeV

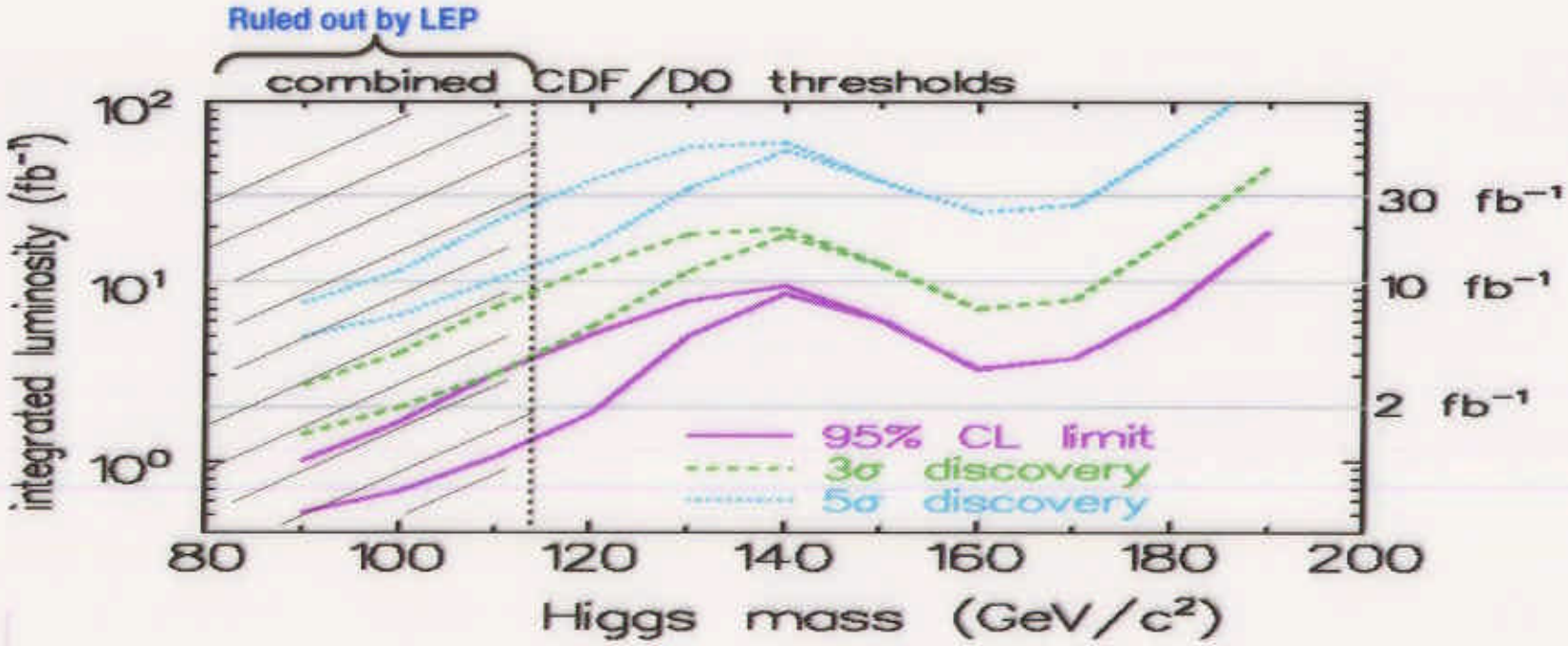
- $WH \rightarrow l\nu\, b\bar{b}$ backgrounds Wbb, WZ, tt, single top
  - factor ~ 1.3 improvement in S/B with neural network
  - possibility to exploit angular distributions (WH vs. Wbb) Parke and Veseli, hep-ph/9903231
- $WH \rightarrow q\bar{q}\, b\bar{b}$ overwhelmed by QCD background
- $ZH \rightarrow l^+l^-\, b\bar{b}$ backgrounds Zbb, ZZ, tt
- $ZH \rightarrow \nu\bar{\nu}\, b\bar{b}$ backgrounds QCD, Zbb, ZZ, tt
  - requires relatively soft missing E_T trigger (35 GeV?)

m_H > 130-140 GeV

- $gg \rightarrow H \rightarrow WW^*$ backgrounds Drell-Yan, WW, WZ, ZZ, tt, tW, $\tau\tau$
  signal:background ratio ~ 7×10^{-3}!
  - Angular cuts to separate signal from "irreducible" WW background

Run II "Results"

- LEP limit M_H>113.3 GeV already
- 2 fb^{-1} per DØ/CDF not enough
- Need 10-15 fb^{-1}/exp for discovery **before** LHC turns on



Run I, II TeVatron Benchmarks

Parameters	Run I	RunIIa/b
$\mathcal{L}_{inst}$ (cm^{-2} sec^{-1})	~10^{31}	~10^{32} / ➔10^{33}
Bunch Spacing	3.5 μsec	396 / 132 nsec
Beam Energy (TeV)	1.8	2.0
$\mathcal{L}_{int}$	~120pb-1	2fb^{-1} / >15fb^{-1}

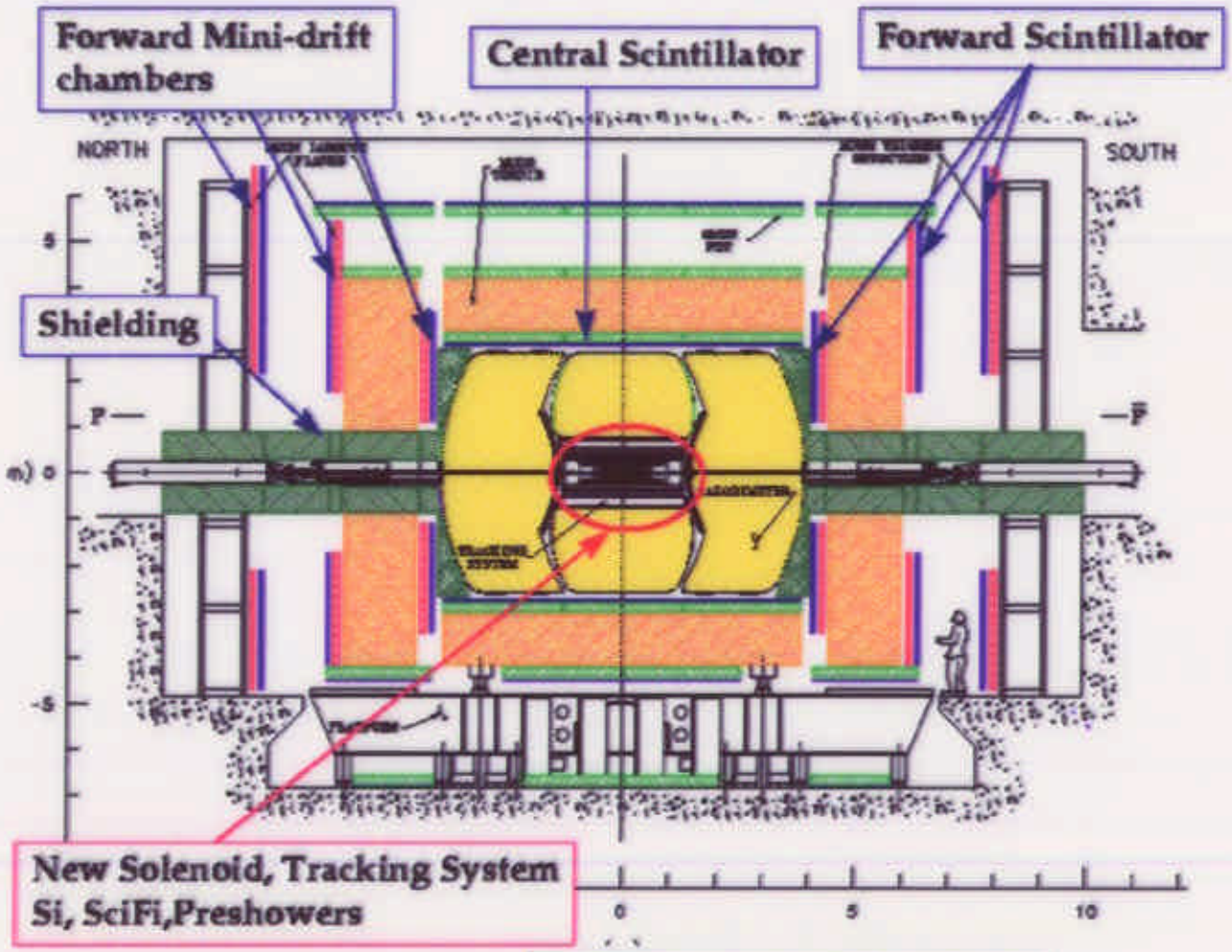
- $\sigma(t\bar{t})$ ~ 40% higher at 2 TeV
- dM_H ~ 40% per experiment

- Increase in rates
- Decrease in bunch spacing
- Physics goals (i.e., emphasis on b-tagging) ➔Significant detector upgrade

The DØ Upgrade

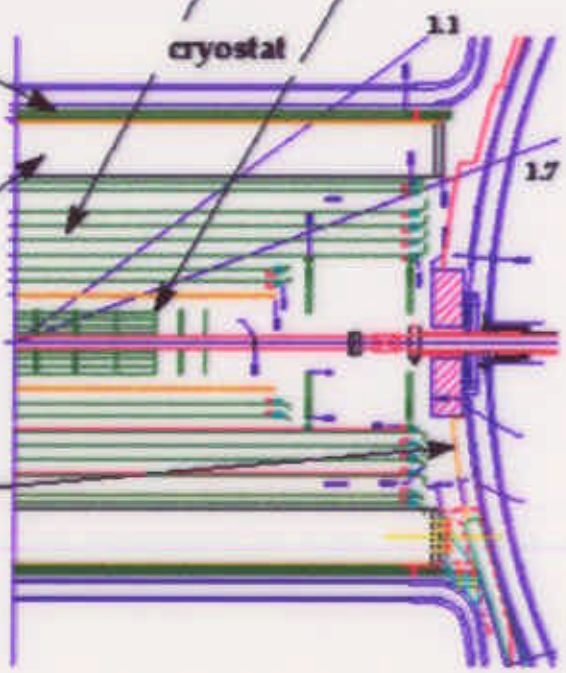
- Retain the excellent performance of the Run I detector, especially the calorimetry
  - electrons, jets and missing transverse energy
- Add magnetic tracking and b-tagging capabilities
  - silicon vertex detector (800,000 channels, barrels, disks)
  - scintillating fibre tracker (fast track trigger)
  - 2T superconducting solenoid with preshower detectors
- Strengthen the muon system
  - new forward chambers (mini-drift tubes)
  - new shielding around beamline elements
- Strengthen triggering on low-p_T leptons
  - new muon scintillator for 1.5 GeV/c dimuon threshold
  - preshower detectors for low-p_T electron triggers
- . . . and operate at ten times the luminosity of run I

The DØ Upgrade



The DØ Upgrade Tracking System

- **Silicon Tracker**
  - Four layer barrels (double/single sided)
  - Interspersed double sided disks
  - 840,00 channels
- **Fiber Tracker**
  - Eight layers sci-fi ribbon doublets (z-u-v, or z
  - 74,000 830um fibers w/ VLPC readout
- **Central Preshower**
  - Scintillator strips, WLS fiber readout
  - 6,000 channels
- **Solenoid**
  - 2T superconducting
- **Forward Preshower**
  - Scintillator strips, stereo, WLS readout
  - 16,000 channels

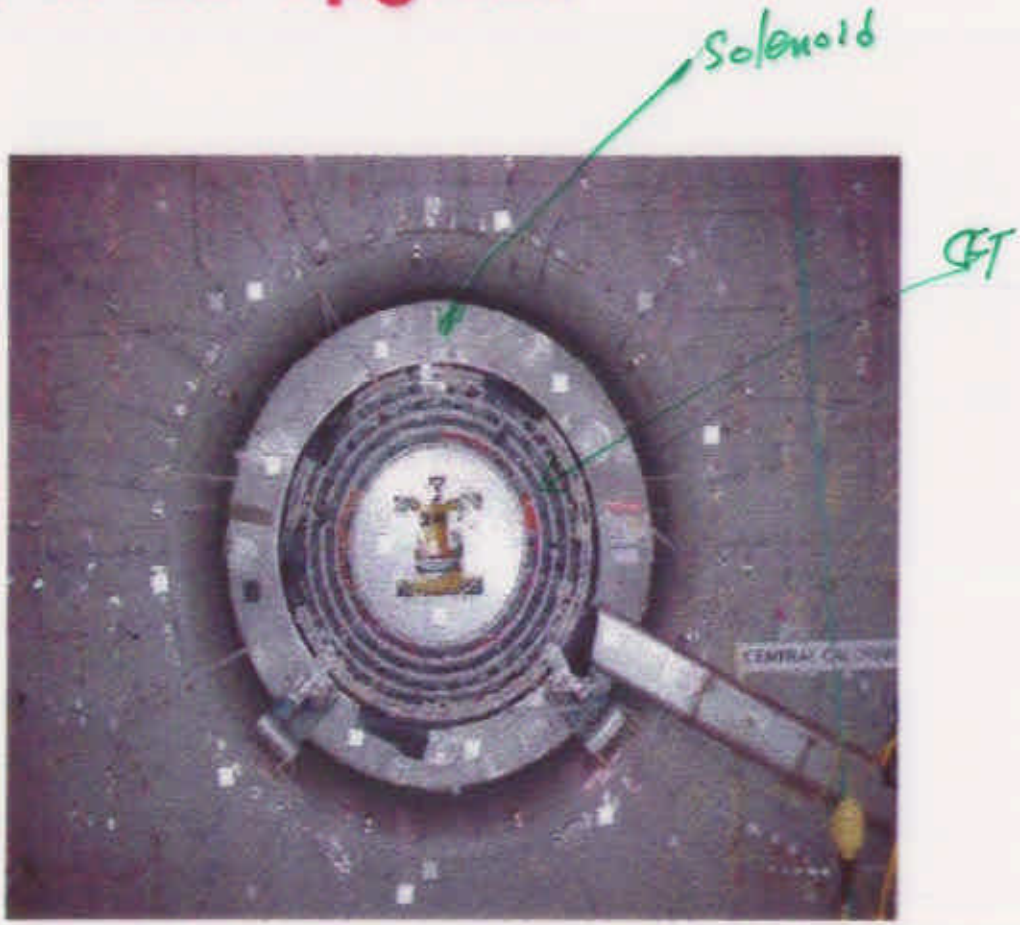


Charged Particle Momentum Resolution
$\Delta p_T/p_T \sim 5\%$ @ $p_T = 10$ GeV/c

see P. Rapidis' talk @ 4:00 am tomorrow in session PA-12b For SMT

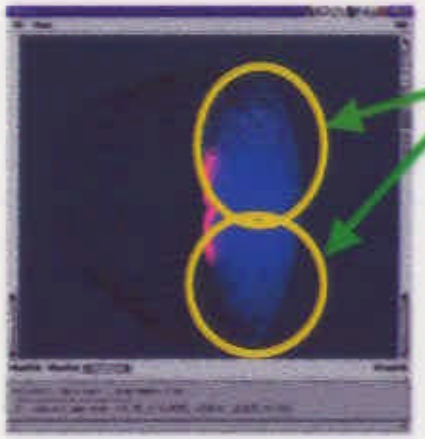
Current Status of DØ Upgrade

- Fixed end date forced us to find a better solution to complete the detectors ➔ Split SMT
- Detector components being installed
  - Recently CFT installation complete
  - CFT Wave Guide installation to being shortly (if not already)
  - Half cylinder of SMT to be installed in Sept.
  - Preparation for forward muon system installation in progress
- Target for Detector roll-in in January



Current Status of DØ Upgrade cont'd

- Commissioning of the various components in experiment in progress, vigorously
  - Mostly concentrated in DAQ and infrastructure establishment
  - Exercise full DAQ chain every day
  - Cosmic ray run to begin in December.
  - Maximally utilize remote facilities:
    - Si detector facility
    - CFT assembly facility
  - Expect to exercise full bandwidth read out before December cosmic ray run
- Eye on preparing as much as possible before the roll-in



2 calorimeter crates

Offline
Data
Storage
WEB
Catalogue

Conclusions

- TeVatron Run II will provide an order magnitude higher luminosity at 2TeV ➔ Extended physics reach
- Expanded physics reach also enables extended search for beyond the SM
- TeVatron accelerator upgrade making good progress ➔ Components are being commissioned
- DØ Upgrade detector is taking its shape fast ➔ Will be ready for beam in March 1, 2001
- Beyond Run IIa ($2fb^{-1}$) preparation begun
- TeVatron still the highest energy accelerator ➔ Best place to do frontier physics before LHC's trun-on