Higgs Searches at Hadron Colliders

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- Introduction
  - The Higgs Boson
  - The LHC and the Tevatron
- Standard Model Higgs Boson
  - Searches at Tevatron
  - Prospects for LHC
- MSSM Higgs Bosons
  - Charged and Neutral Higgs bosons
- Summary and Outlook

THE ROYAL SOCIETY

IoP, Warwick, April 12th 2006

The Standard Model

- Matter is made out of fermions:
  - quarks and leptons
  - 3 generations
- Forces are carried by Bosons:
  - Electroweak: γ,W,Z
  - Strong: gluons
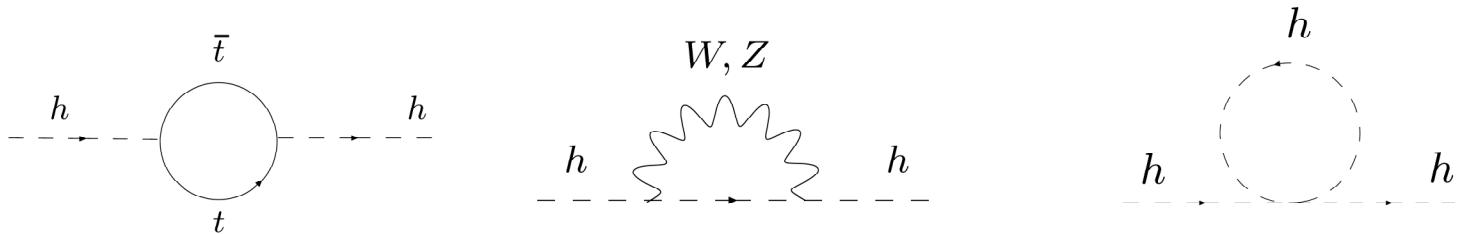- Higgs boson:
  - Gives mass to particles
  - Not found yet

Three Generations of Matter

What We Know about the Higgs

- Large radiative corrections:

$$m^2{}_H \approx (200\ GeV)^2 = m^2{}_H{}^{tree} + \delta\ m^2{}_H{}^{top} + \delta\ m^2{}_H{}^{gauge} + \delta\ m^2{}_H{}^{higgs}$$
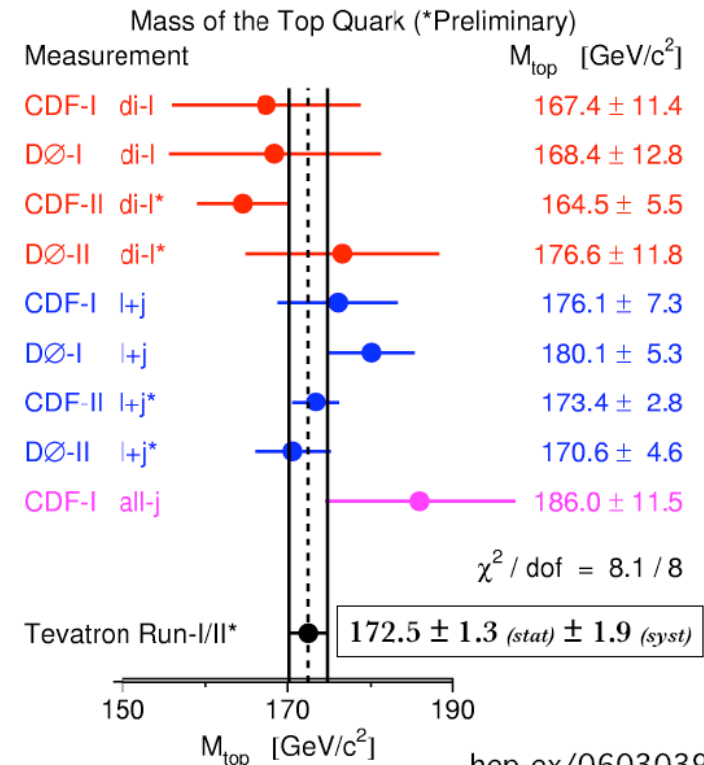

- Precision measurements of W and top mass constrain Higgs mass
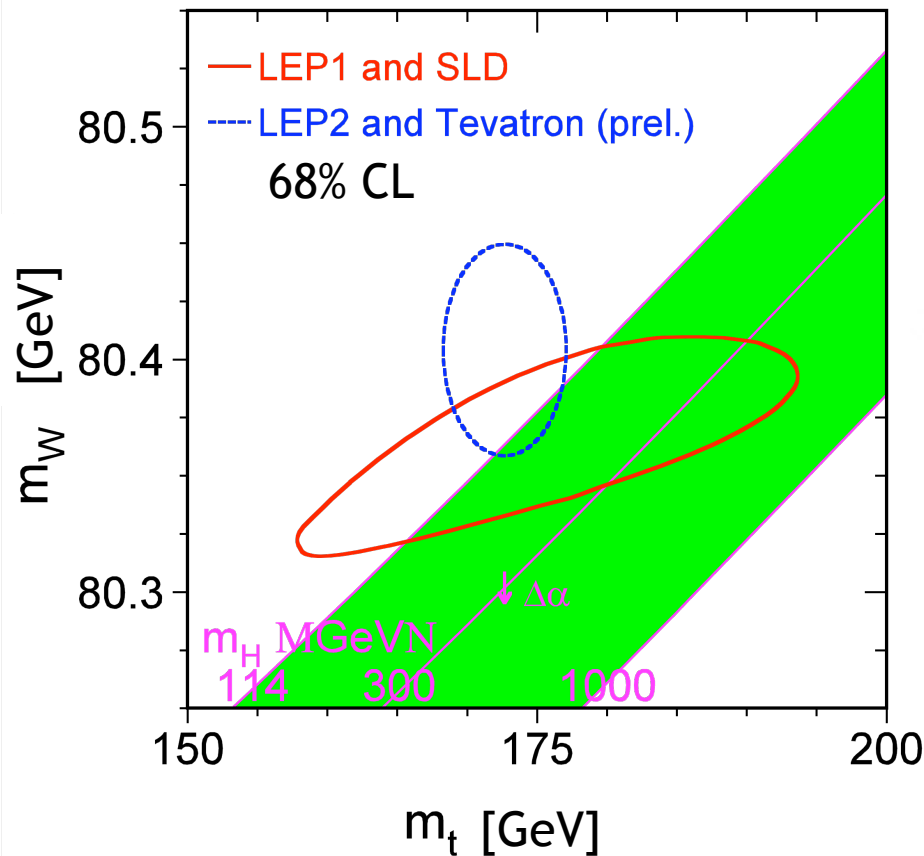 - Dependence is only logarithmic:
    - $M_W \propto \log(M_H)$
- Current world averages:
 - $M_W = 80.410 \pm 0.032\ GeV/c^2$
  - $m_{top} = 172.5 \pm 2.3\ GeV/c^2$

Mass of the Top Quark (*Preliminary)

Measurement		M_{top} [GeV/c^2]
CDF-I	di-l	167.4 ± 11.4
DØ-I	di-l	168.4 ± 12.8
CDF-II	di-l*	164.5 ± 5.5
DØ-II	di-l*	176.6 ± 11.8
CDF-I	l+j	176.1 ± 7.3
DØ-I	l+j	180.1 ± 5.3
CDF-II	l+j*	173.4 ± 2.8
DØ-II	l+j*	170.6 ± 4.6
CDF-I	all-j	186.0 ± 11.5

$\chi^2 / dof = 8.1 / 8$

Tevatron Run-I/II* 172.5 ± 1.3 *(stat)* ± 1.9 *(syst)*

M_{top} [GeV/c^2]

EW constraints on Higgs

m_H constrained in the Standard Model

Direct searches at LEP2:
$m_H > 114.4$ GeV @95%CL
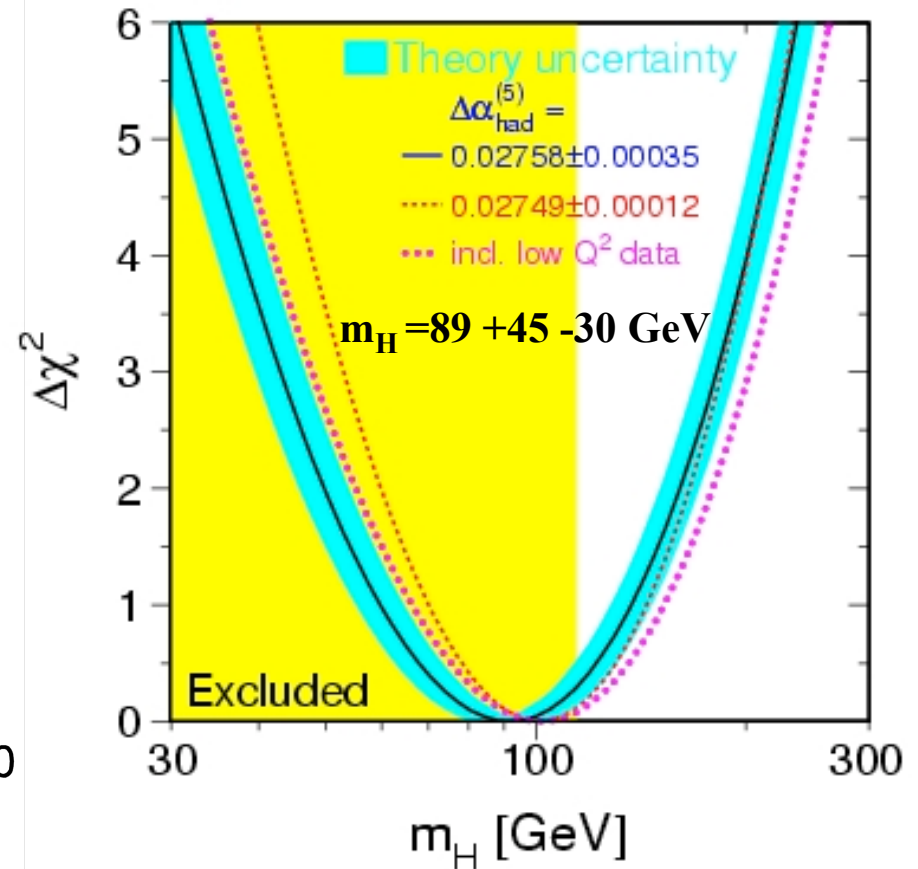
$m_H < 175$ GeV @95%CL
(< 207 GeV if LEP2 limit incl.)

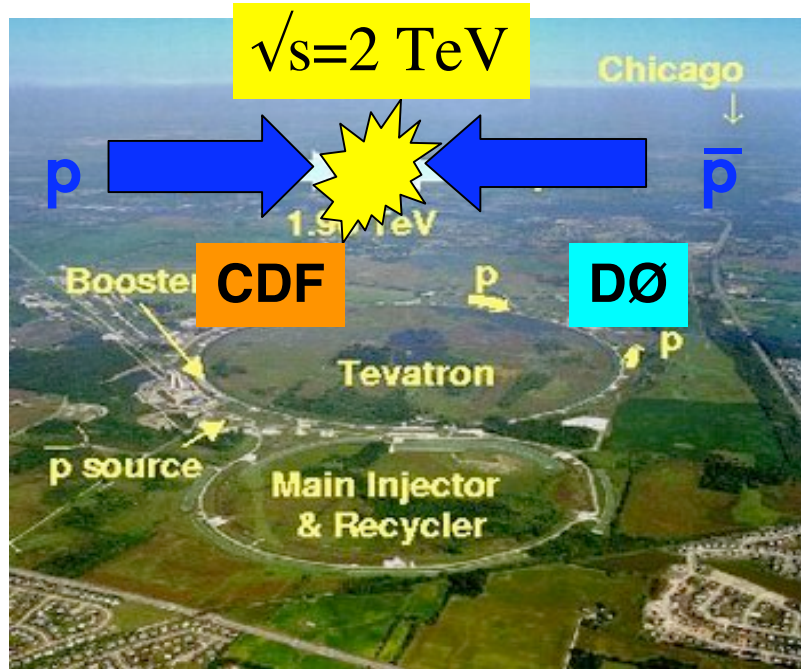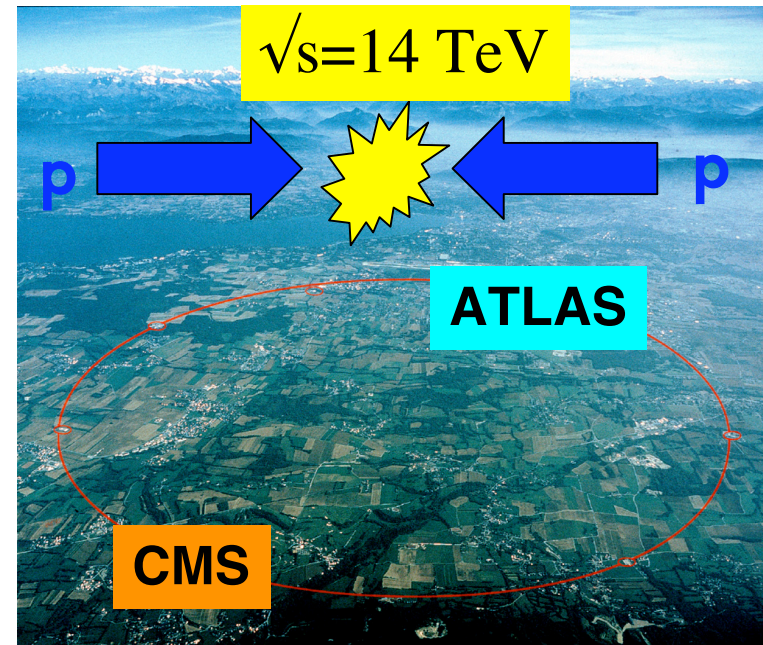A light Higgs is favored => focus on this in this talk

Searching for the Higgs

Now: Tevatron (<2009)

$\sqrt{s}=2$ TeV

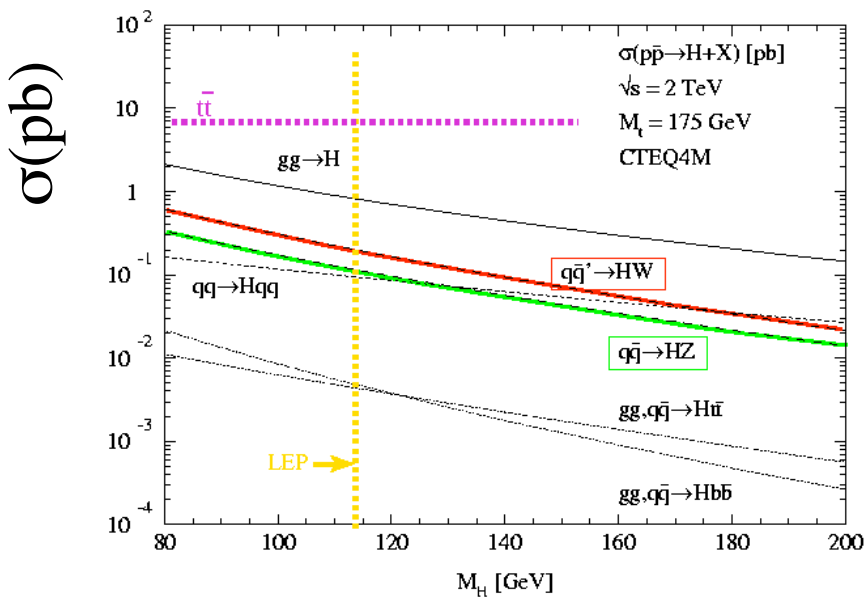p → ← $\bar{p}$

CDF   **DØ**

Future: LHC (>2007)

$\sqrt{s}=14$ TeV
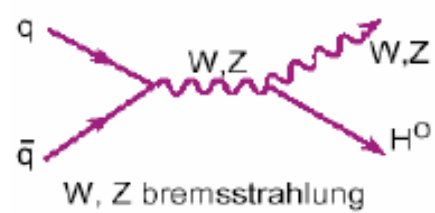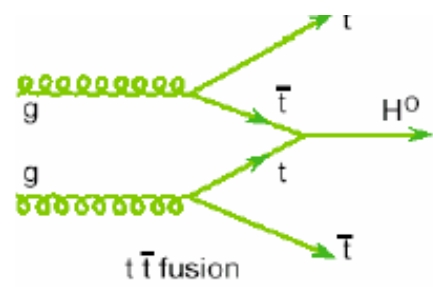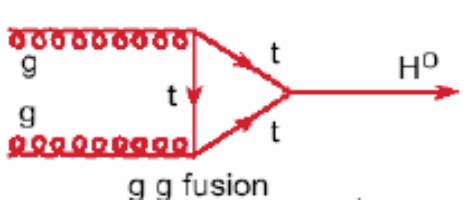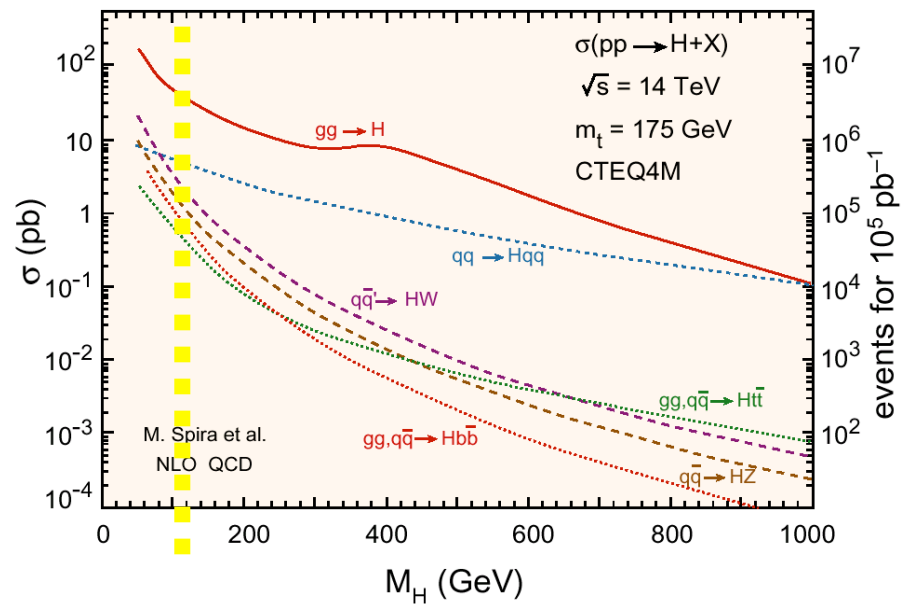
p → ← p

ATLAS

CMS

- Tevatron proton-antiproton collider at $\sqrt{s}=2$ TeV:
  - 1 fb^{-1} of data taken, 7 fb^{-1} more to come
- LHC proton proton collider at $\sqrt{s}=14$ TeV:
  - will take 10 fb^{-1}/year starting in 2008, 100 fb^{-1}/year after 2010
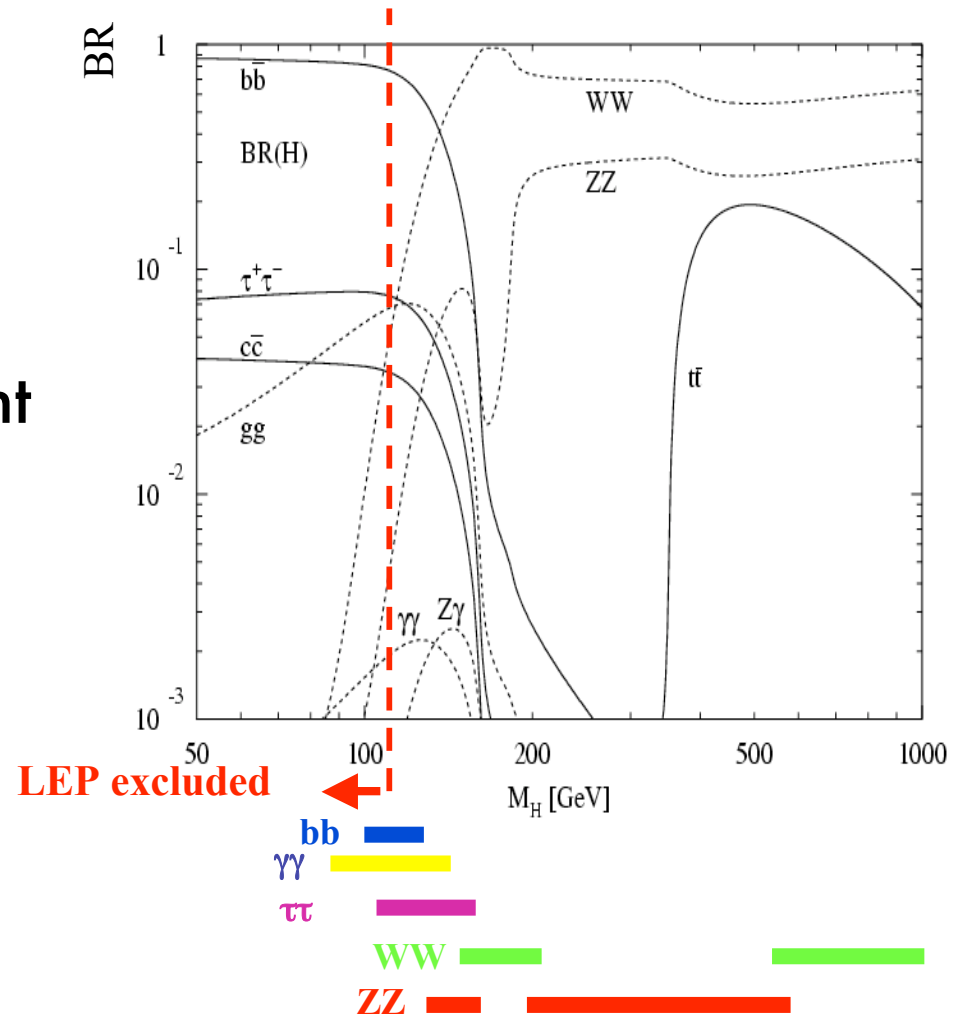 - Pilot run in 2007

Higgs Production: Tevatron and LHC

Tevatron

LHC
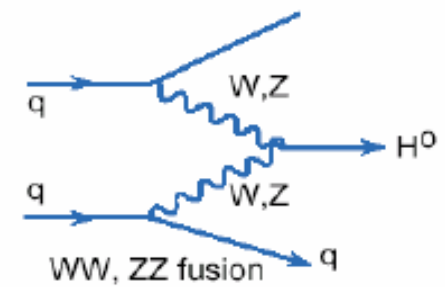
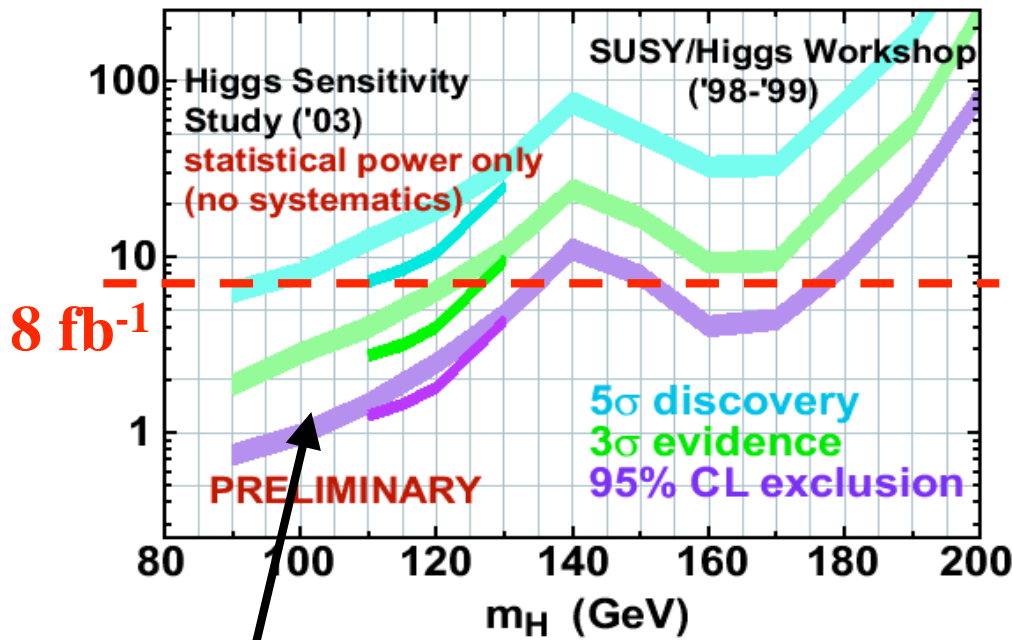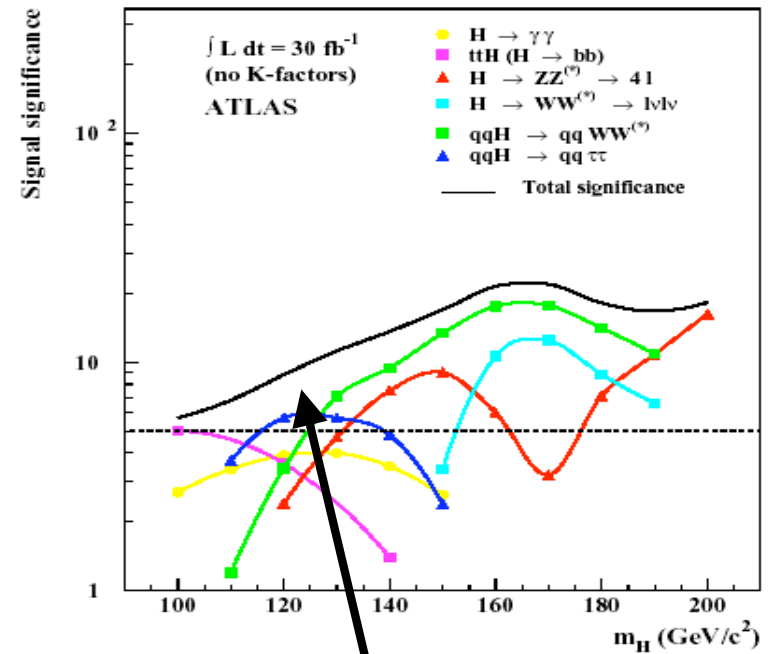**dominant: gg→ H, subdominant: HW, HZ, Hqq**

Higgs boson Decay

- **Depends on Mass**
- $M_H < 130$ **GeV/c²:**
  - bb dominant
  - $\tau\tau$ and WW subdominant
  - $\gamma\gamma$ small but useful
- $M_H > 130$ **GeV/c²:**
  - WW dominant
  - ZZ cleanest

Discovery at M_H<200 GeV/c^2
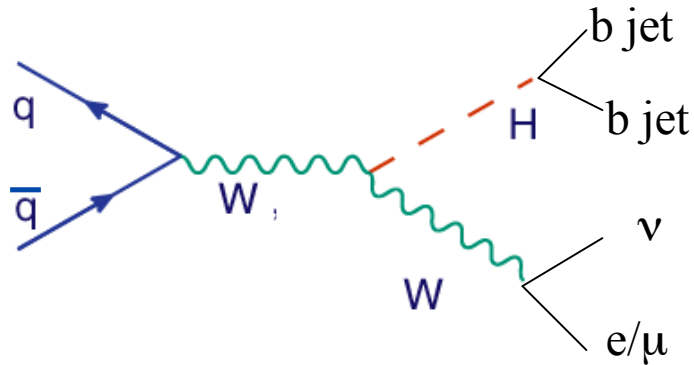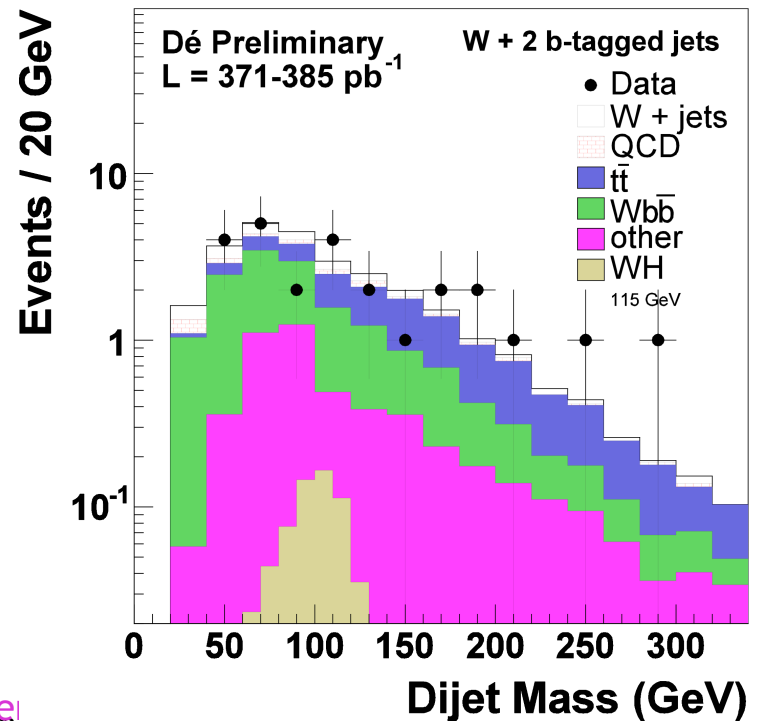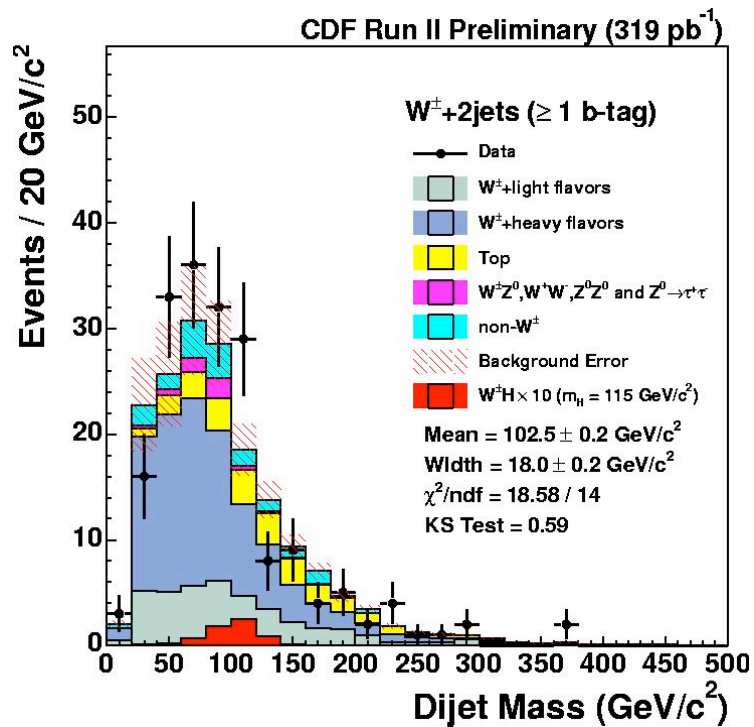

Uses WH, ZH with H->bb

Uses three production and decay modes

Many different final states and production modes at two colliders

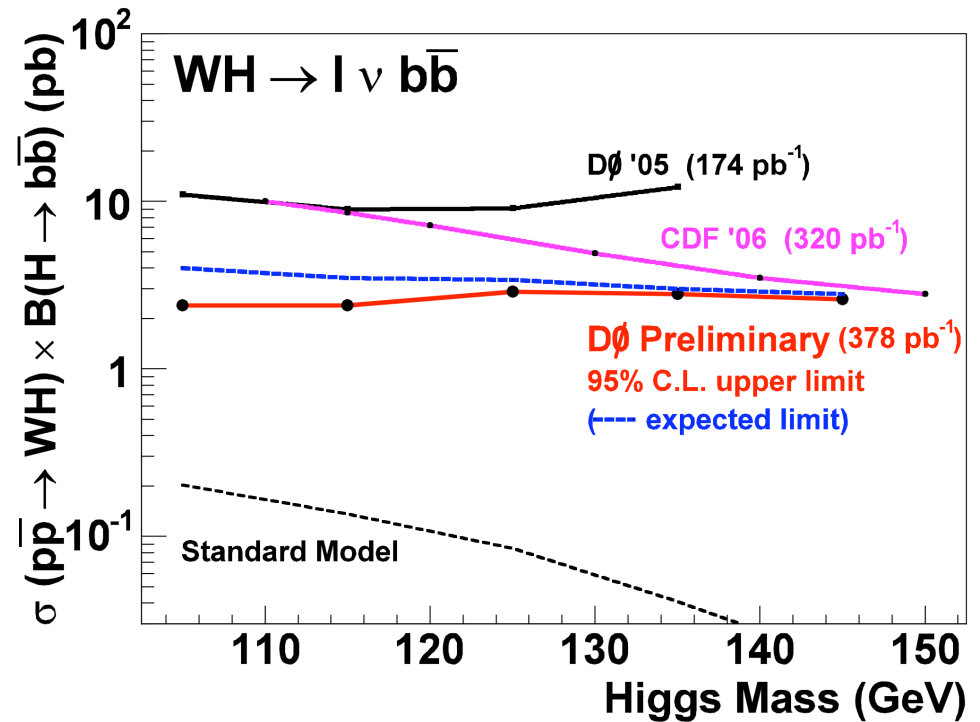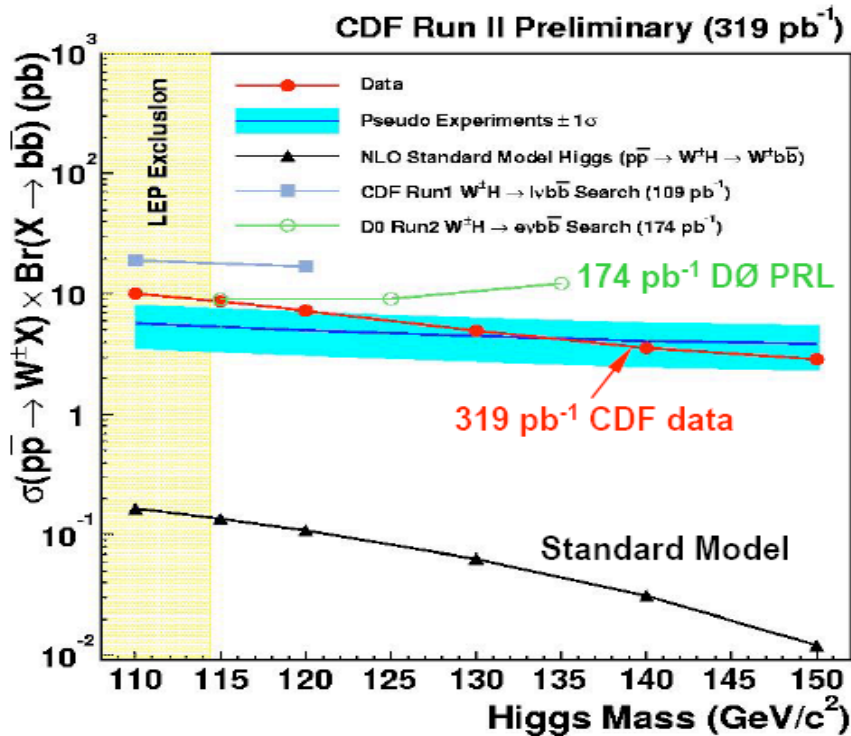# Tevatron: WH→lνbb (l=e,μ)

b jet

b jet

ν

e/μ

- **Muon and electron channel combined:**
  - 1 or 2 tagged b-jets
  - electron or muon with p_T > 20 GeV
  - E_T^{miss} > 20 GeV

CDF Run II Preliminary (319 pb^{-1})

W$^\pm$+2jets ($\geq$ 1 b-tag)

- Data
- W$^\pm$+light flavors
- W$^\pm$+heavy flavors
- Top
- W$^\pm$Z^0,W$^+$W$^-$,Z^{0}Z^0 and Z^0→τ$^+$τ$^-$
- non-W$^\pm$
- Background Error
- W$^\pm$H×10 (m$_H$ = 115 GeV/c^2)

Mean = 102.5 ± 0.2 GeV/c^2
Width = 18.0 ± 0.2 GeV/c^2
χ^2/ndf = 18.58 / 14
KS Test = 0.59

Events / 20 GeV/c^2

Dijet Mass (GeV/c^2)

Dé Preliminary
L = 371-385 pb^{-1}

W + 2 b-tagged jets

- Data
- W + jets
- QCD
- tt̄
- Wbb̄
- other
- WH

115 GeV

Events / 20 GeV

Dijet Mass (GeV)

WH→lνbb, (l=e,μ)

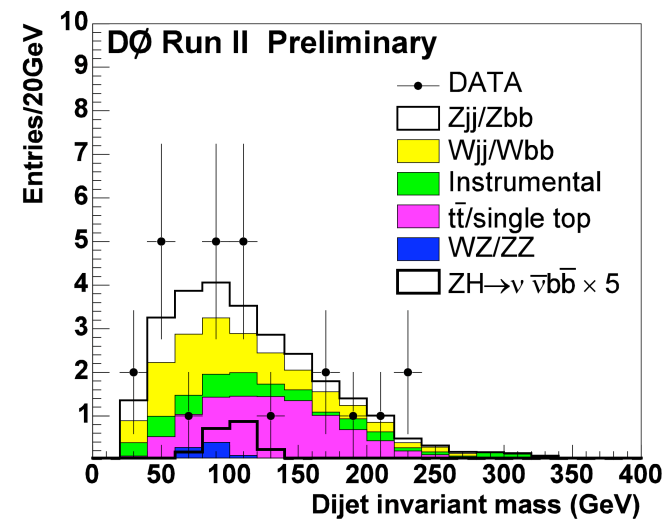
- **Cross section limit about 20 times larger than SM cross section prediction**
 - Expected limit similar between CDF and DØ

Tevatron: ZH→ννbb

$E\!\!\!/_T = 145$ GeV

$E_T = 55$ GeV

$E_T = 100$ GeV

ZH→ν̄νb̄b̄ Search, Signal Region

CDF Run II Preliminary
289 pb^{-1}

- ZH *10
  $M_h = 120$ GeV/c^2
- Data
- QCD+Mistag
- Top
- W/Z/Di-boson

Events/15 GeV

Di-Jet Mass (GeV/c^2)
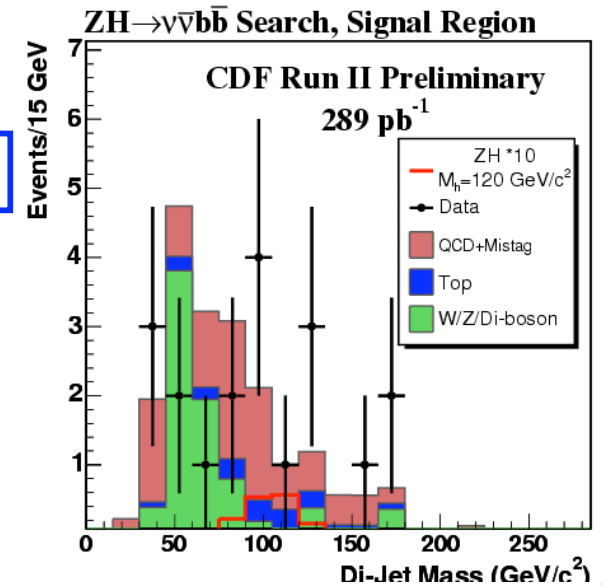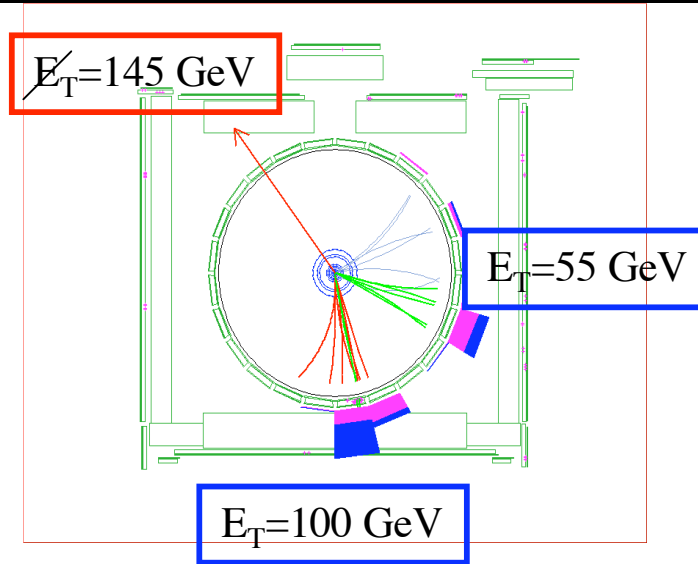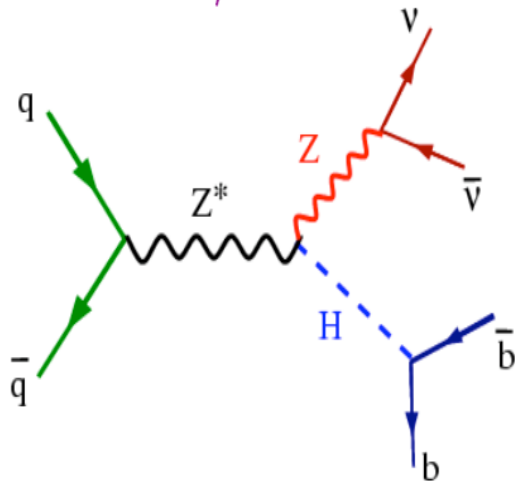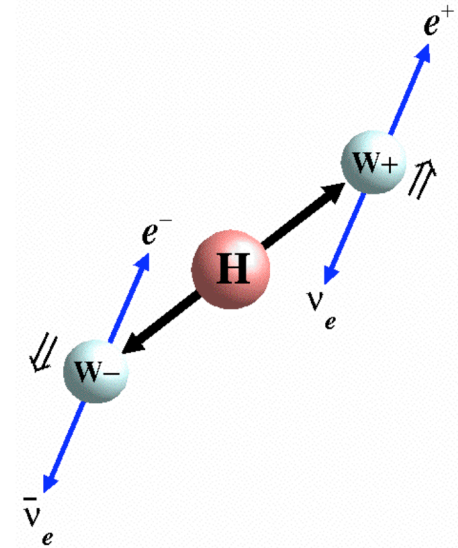
- **Event selection:**
  - ≥ 1 tagged b-jets
  - Two jets with E_T > 60/25 GeV
  - E_T^{miss} > 70 GeV
  - Lepton veto
- **Key discriminating variable:**
  - Invariant mass of two jets
  - Expect peak from H->bb decay

DØ Run II Preliminary

Entries/20GeV

- DATA
- Zjj/Zbb
- Wjj/Wbb
- Instrumental
- tt̄/single top
- WZ/ZZ
- ZH→ν ν̄b̄b × 5

Dijet invariant mass (GeV)

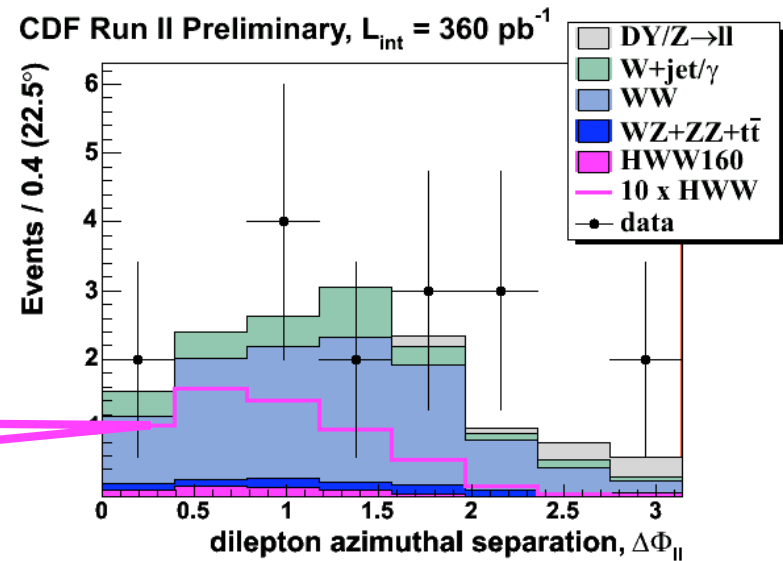# H → WW$^{(*)}$ → l$^+$l$^-\nu\bar{\nu}$

- **Higgs mass reconstruction impossible due to two neutrinos in final state**

- **Make use of spin correlations to suppress WW background:**
  - **Higgs has spin=0**
  - **leptons in H → WW$^{(*)}$ → l$^+$l$^-\nu\nu$ are collinear**

- **Main background: WW production**
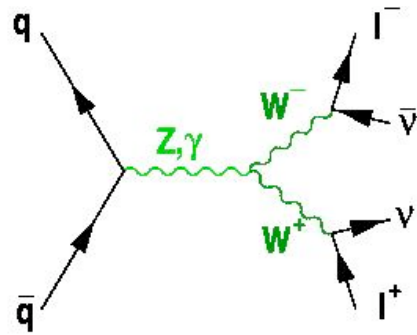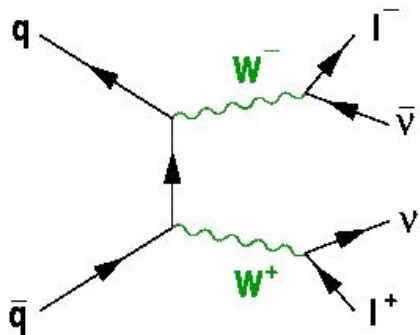
10x 160 GeV Higgs

H→WW(*)→l+l−νν (l=e,μ)

- D∅ analysis: L= 950 pb⁻¹

- ee and eμ channels

- Event selection:
  - Isolated e/μ :
    - p_T > 15, 10 GeV
  - Missing E_T >20 GeV
  - Veto on
    - Z resonance
    - Energetic jets
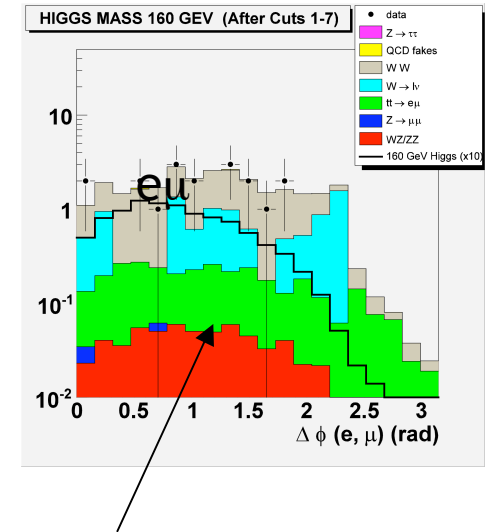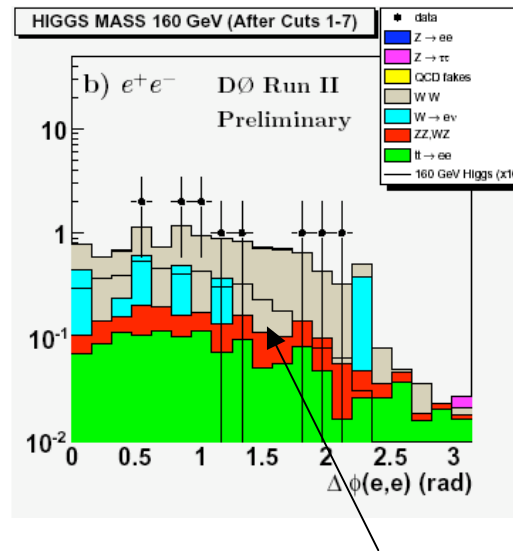
- E.g. for M_H = 120 GeV:
  - 31 events observed
  - 32.7 +/- 2.3 (stat) predicted
  - Bkg systematic uncertainty: 15%
  - σ_{95} = 6.3 pb

160 GeV Higgs (x 10)
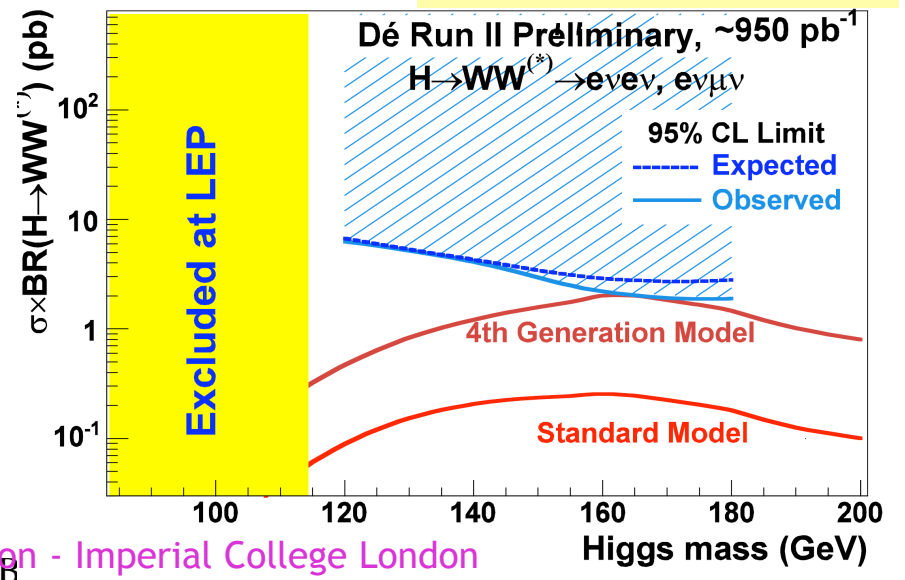
Limits

Tevatron Run II Preliminary

95% CL Limit/SM vs m_H (GeV)

ZH5$\nu\bar{\nu}b\bar{b}$ CDF 289 pb^{-1}

ZH5$\nu\bar{\nu}b\bar{b}$ D0: 261 pb^{-1}

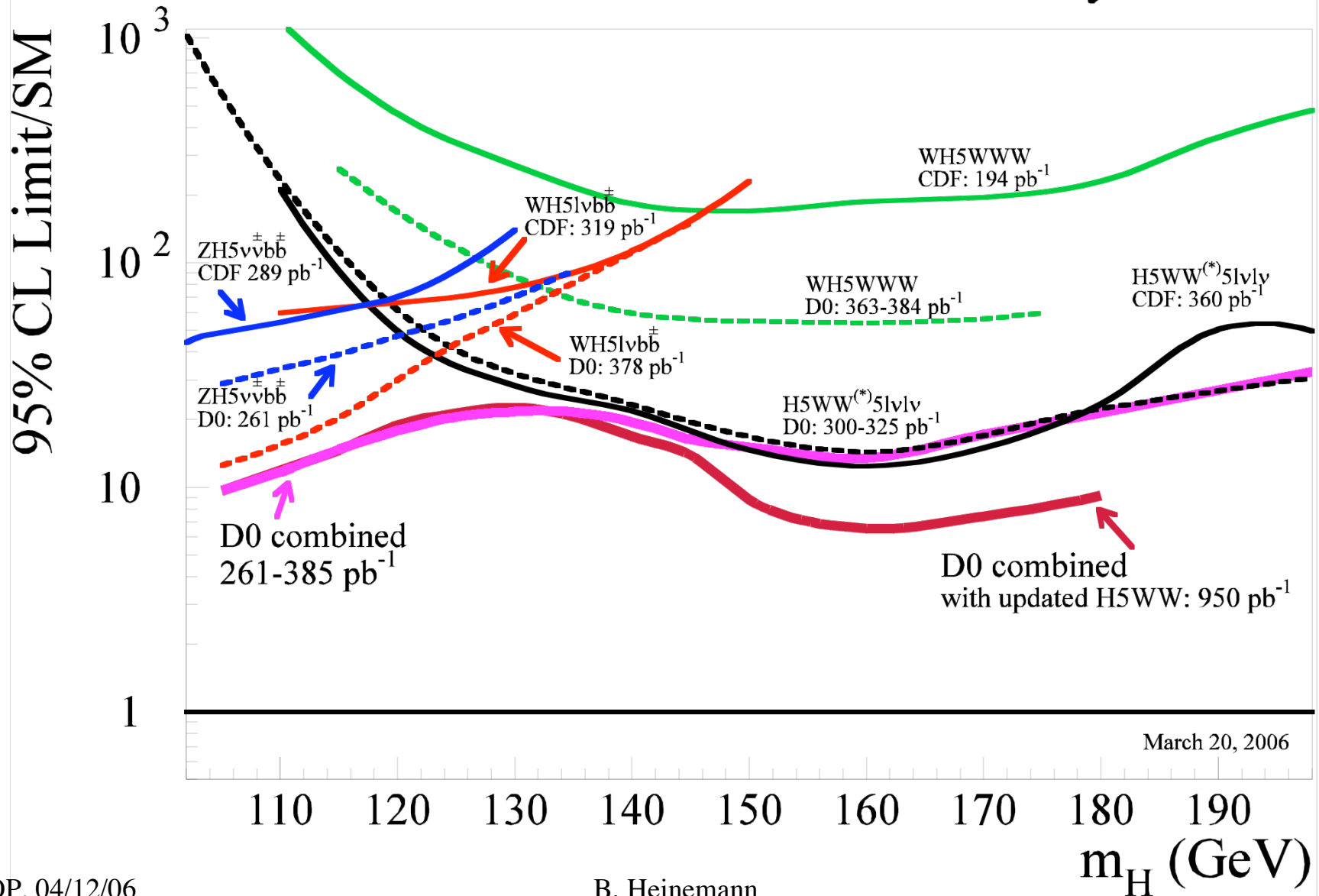WH5$l\nu b\bar{b}$ CDF: 319 pb^{-1}

WH5$l\nu b\bar{b}$ D0: 378 pb^{-1}

WH5WWW CDF: 194 pb^{-1}

WH5WWW D0: 363-384 pb^{-1}

H5WW$^{(*)}$5$l\nu l\nu$ CDF: 360 pb^{-1}

H5WW$^{(*)}$5$l\nu l\nu$ D0: 300-325 pb^{-1}

D0 combined 261-385 pb^{-1}

D0 combined with updated H5WW: 950 pb^{-1}

March 20, 2006

Can we close the Gap?

- Assume current analyses as starting point
  - Scale current systematic uncertainties by $1/\sqrt{L}$
- Reevaluated all improvements using latest knowledge

Improvement	Luminosity equivalent=$(S/\sqrt{B})^2$		
	WH->lvbb	ZH->vvbb	ZH->llbb
mass resolution	1.7	1.7	1.7
Continuous b-tag (NN)	1.5	1.5	1.5
Forward b-tag	1.1	1.1	1.1
Forward leptons	1.3	1.0	1.6
Track-only leptons	1.4	1.0	1.6
NN selection	1.75	1.75	1.0
WH signal in ZH	1.0	2.7	1.0
Product of above	8.9	13.3	7.2
CDF+DØ combination	2.0	2.0	2.0
All combined	17.8	26.6	14.4

Expect factor ~10 improvements and CDF+DØ combination:
**=> Need 2.5 fb^{-1} for 95%C.L. exclusion of 115 GeV Higgs**

"God Does Not Play Dice" (with the Physicist)?

- All numbers given so far were
  - a 50% probability of an experiment achieving discovery or exclusion
  - We perform 1 experiment
- Could get statistically lucky or unlucky (m_H=115 GeV/c^2):
  - with L=1 fb^{-1}:
    - 5% chance for 3σ evidence
    - 0% chance for 5σ discovery
  - with L=4 fb^{-1}:
    - 35% chance for 3σ evidence
    - 2% chance for 5σ discovery
  - with L=8 fb^{-1}:
    - 75% chance for 3σ evidence
    - 10% chance for 5σ discovery
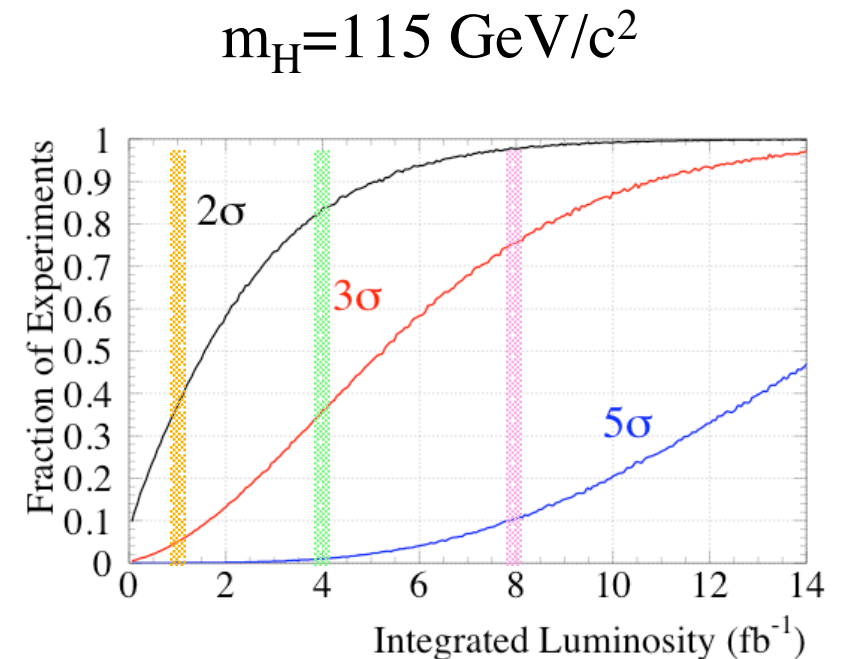
$$m_H = 115 \text{ GeV/c}^2$$

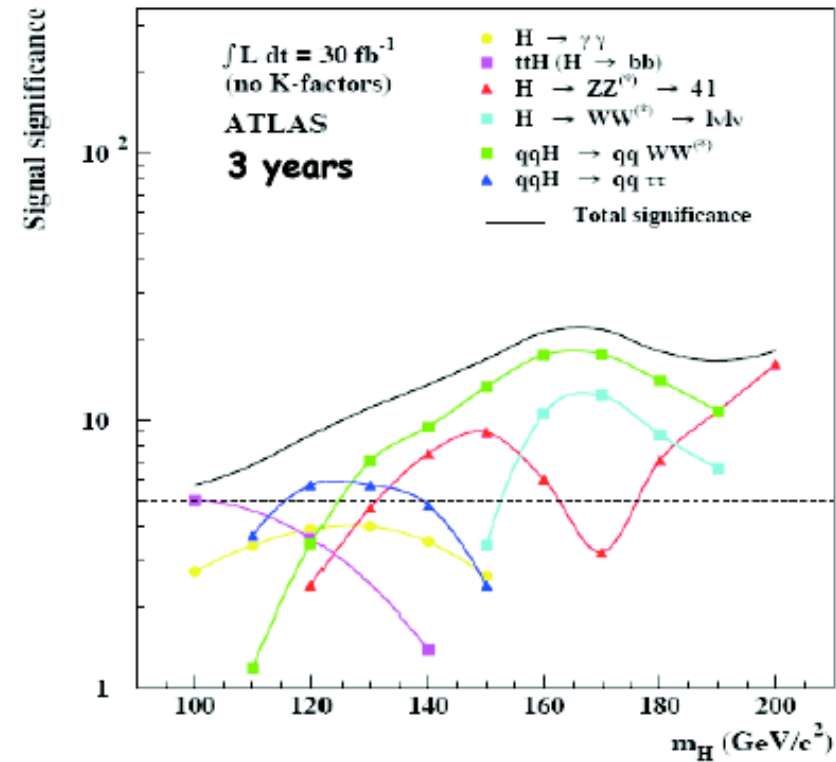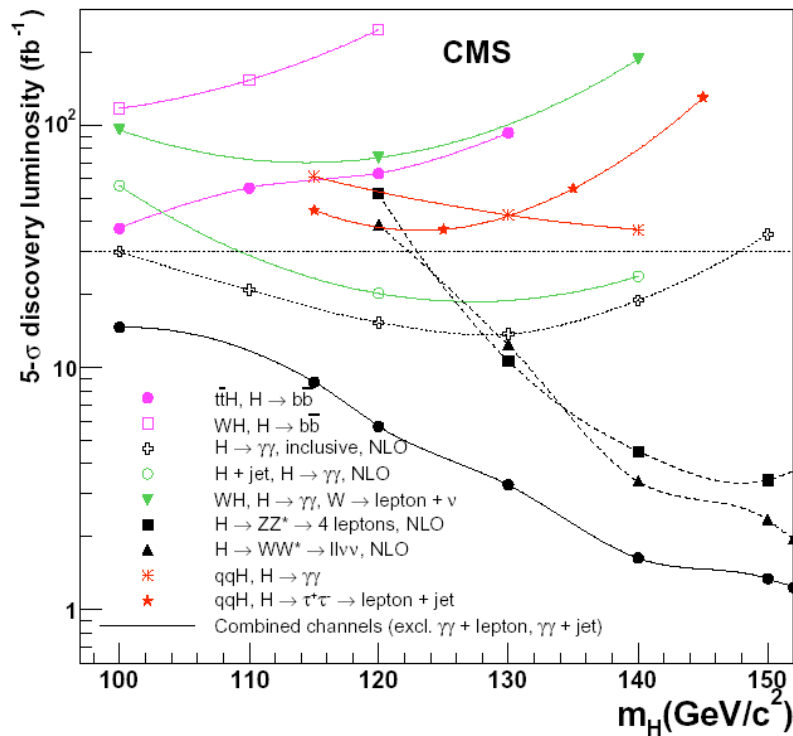5σ discovery unlikely
=> Need LHC

LHC SM Higgs Discovery Potential
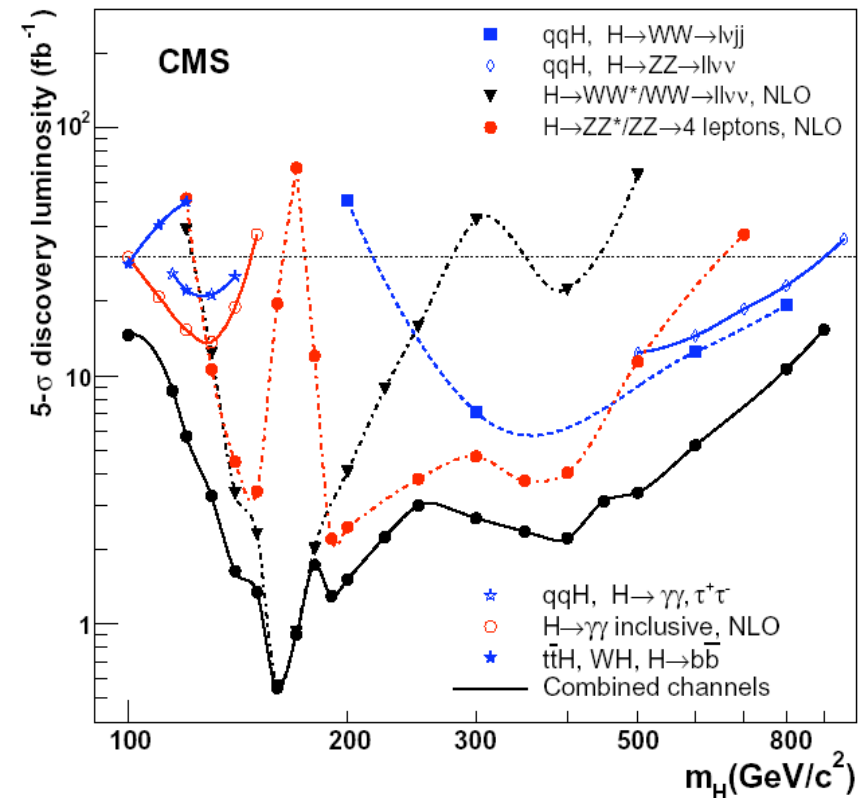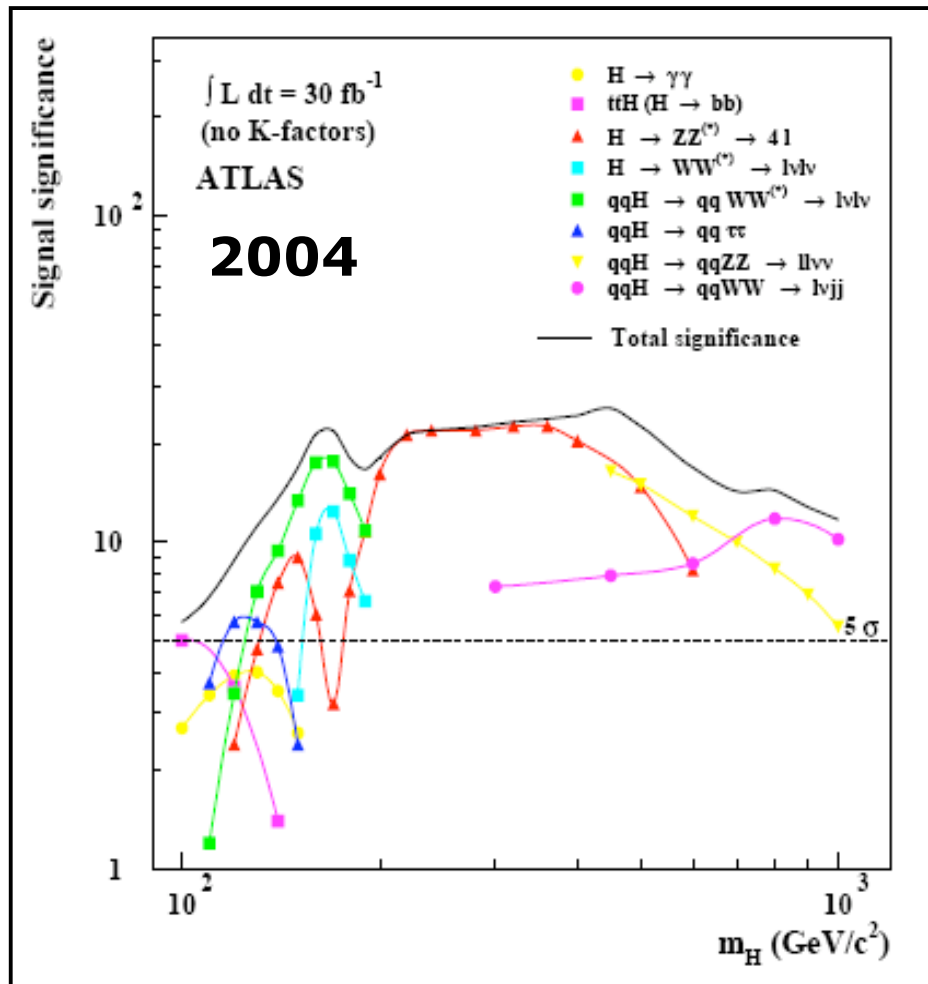
- Fast discovery for high mass, e.g. $m_H > 150$ GeV/c^2
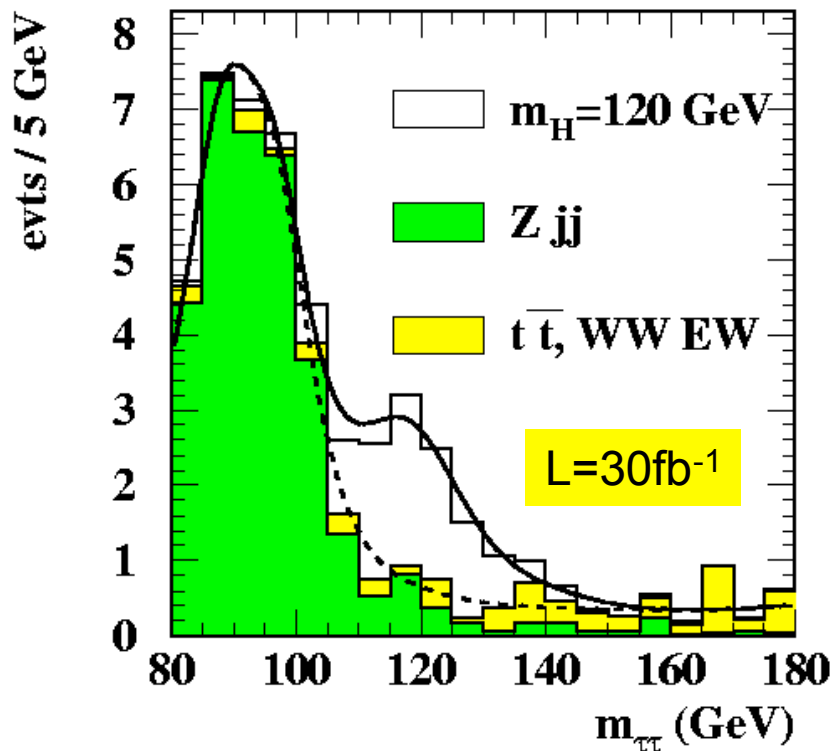- Harder at low mass => zoom into low mass region

LHC: Low Mass Region

- **LHC for m$_H$=115 GeV/c^2**
  - L≈10 fb^{-1} for 5σ discovery for single experiment
    - CMS mostly sensitive to $\gamma\gamma$ decay
    - ATLAS more sensitive to ttH->ttbb and qqH->qq$\tau\tau$

115 GeV Higgs: LHC with 10fb⁻¹

ATLAS

	H->$\gamma\gamma$	ttH->ttbb	qqH->qq$\tau\tau$
S	150	15	~10
B	3900	45	~10
S/$\sqrt{}$B	2.4	2.2	~2.7

Large K-factor~2 not included

- **Total S/$\sqrt{}$B=4.2**
  - First evidence possible
- **Difficult to know whether it is the Higgs boson**
  - Important to see signal in each channel
    - Gives first idea about branching ratios
  - Diphoton channel will have nice peak, others not

130GeV Higgs: first year (10fb⁻¹)

130 GeV Higgs
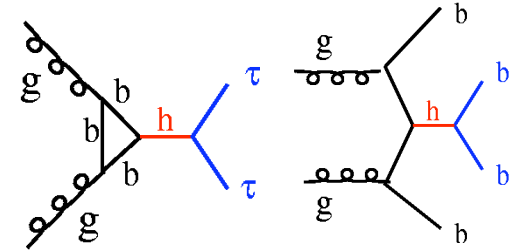L = 100 fb⁻¹
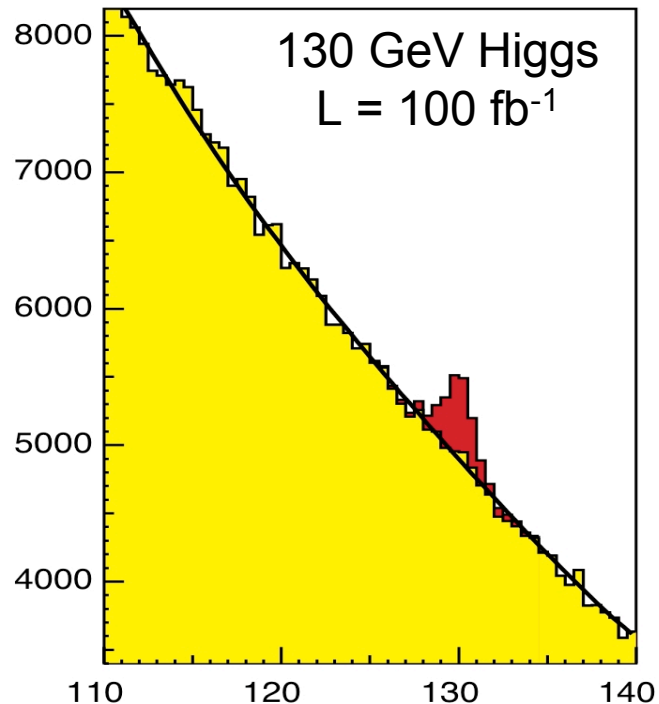
complete detector

	H->$\gamma\gamma$	H->ZZ	qqH-> qqWW	qqH-> qq$\tau\tau$
S	120	5	18	~8
B	2500	<1	15	~6
S/$\sqrt{}$B	2.4	2.8	3.9	2.6

- Total S/$\sqrt{}$B=6
  - This is good!
- Now qqWW and ZZ channels contribute a lot
  - ttH channel really difficult now => cannot measure branching into b's
  - Nice peaks expected in $\gamma\gamma$ and ZZ

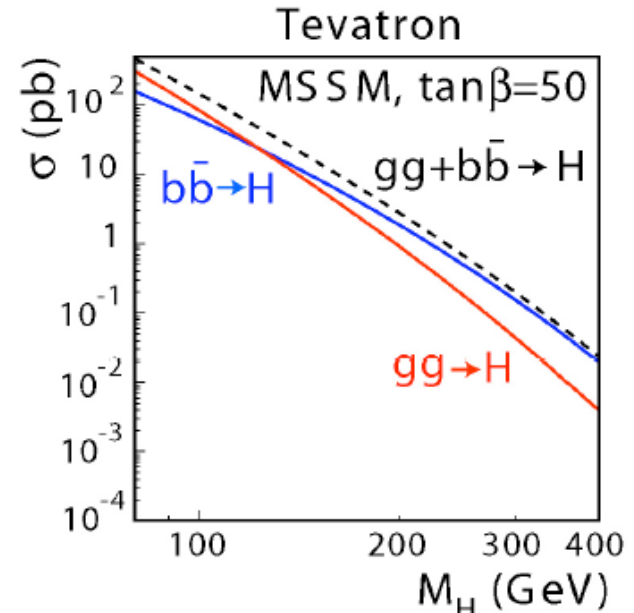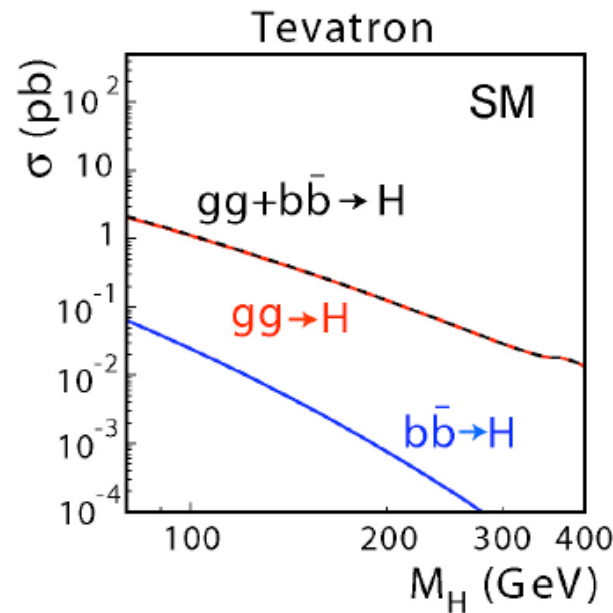# Higgs in the MSSM

- **M**inimal **S**upersymmetric **S**tandard **M**odel:
  - 2 Higgs-Fields: Parameter $\tan\beta = <H_u>/<H_d>$
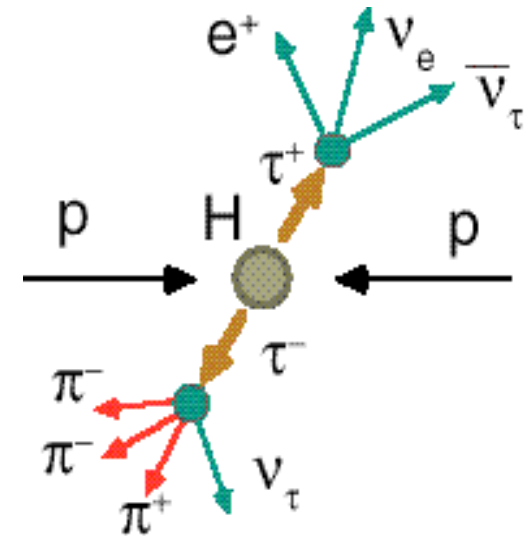 - 5 Higgs bosons: h, H, A, H$^\pm$
- Neutral Higgs Boson:
  - Pseudoscalar A
  - Scalar H, h
    - Lightest Higgs (h) very similar to SM

$$\sigma \times BR_{SUSY} = 2 \times \sigma_{SM} \times \frac{\tan\beta^2}{(1+\Delta_b)^2} \times \frac{9}{[9+(1+\Delta_b)^2]}$$
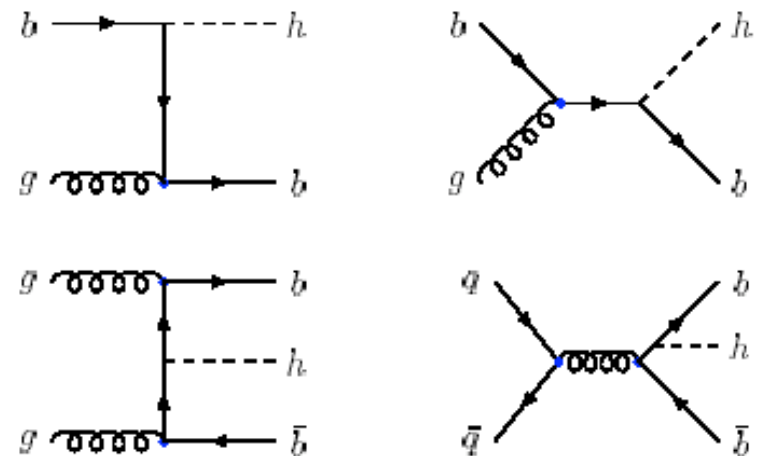
MSSM Higgs Selection

- **pp → Φ+X → ττ +X :**

  - One τ decays to e or μ
  - One τ decays to hadrons or e/μ
  - Use "visible mass", m($\not{E}_T$,l$_1$,l$_2$) for discrimination against background

- **pp → Φb+X → bbb+X :**

  - Three b-tagged jets
    - E_T >35, 20 and 15 GeV
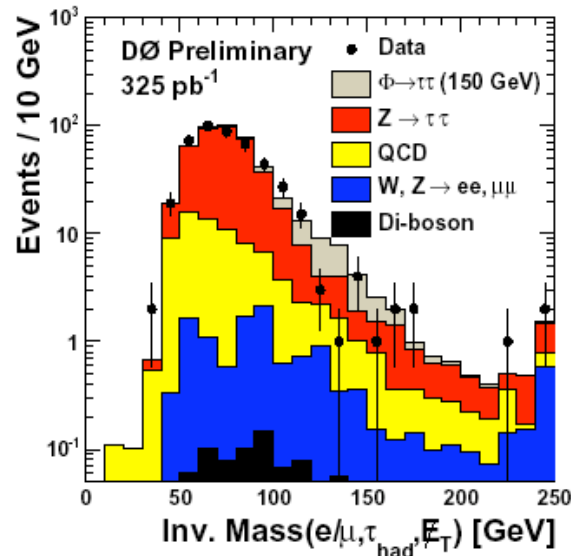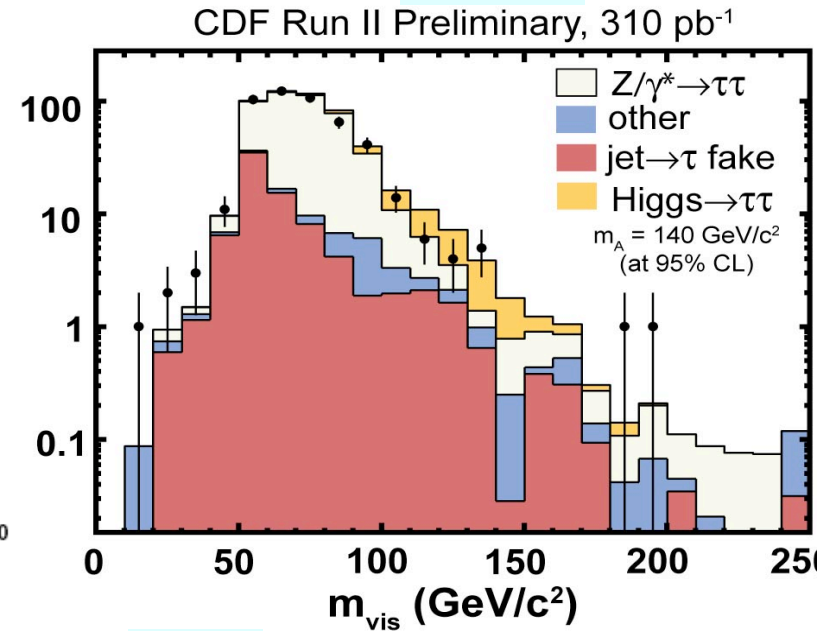 - Use invariant mass of leading two jets to discriminate against background

  Φ =h/H/A
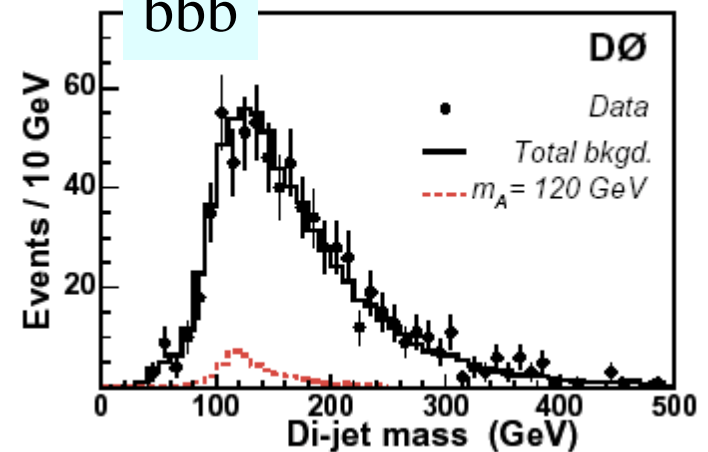
Mass Distributions

$e+\mu$
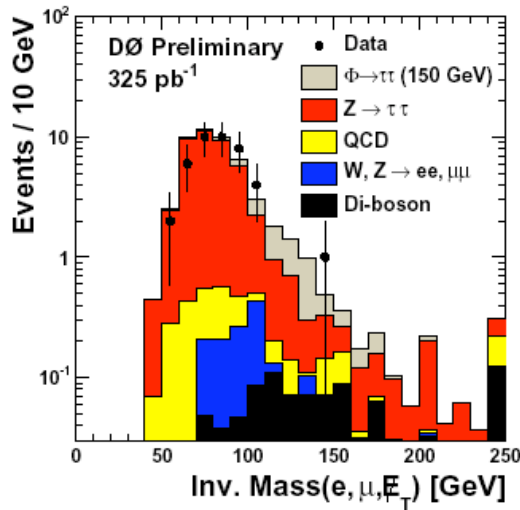
$e/\mu+\tau$

$e/\mu+\tau$

- Good agreement between data and background in all analyses
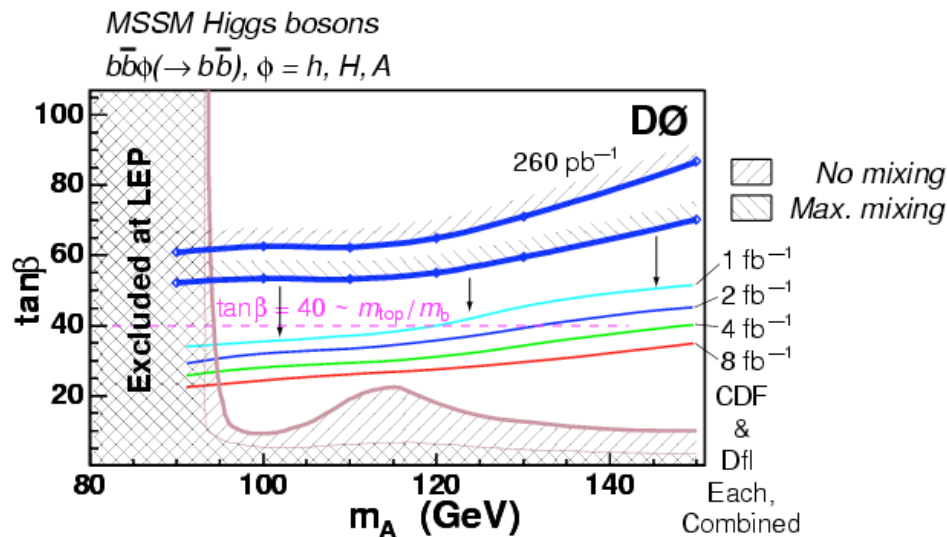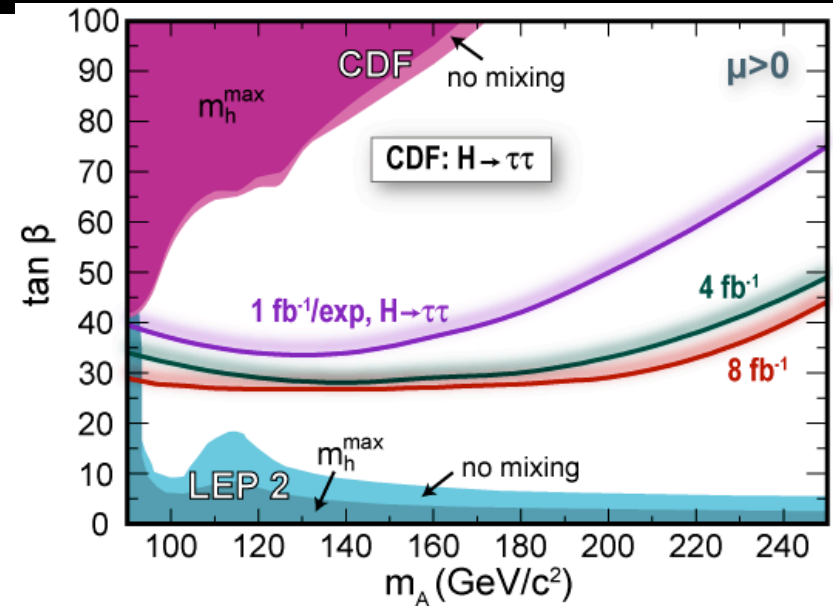- No sign of deviation

bbb

MSSM Higgs: Results

- ## $p\bar{p} \rightarrow A+X \rightarrow \tau\tau+X$
  - Sensitivity at high $\tan\beta$
  - Exploting regime beyond LEP

- ## $p\bar{p} \rightarrow Ab+X \rightarrow bbb+X$
  - Probes high $\tan\beta$ if $\mu<0$
  - Combined with $\tau\tau$ channel by D0

- ## Future (L=8 fb^{-1}):
  - Probe values down to 25-30!
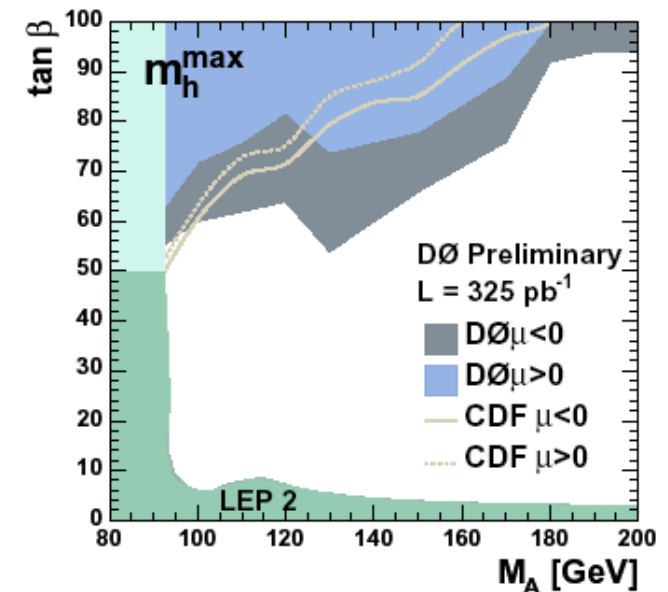
Charged Higgs: H±

- **SM Top decay:**
  - BR(t->Wb)≈100%
- **If m(H±)<m(top):**
  - Top decays to H±b
  - H± decays different to W±
- **top cross section** analyses sensitive to H± production:
  - Dilepton+jj+X
  - Lepton+τ+jj+X
  - Lepton+1b+jjj+X
  - Lepton+2b+jj+X
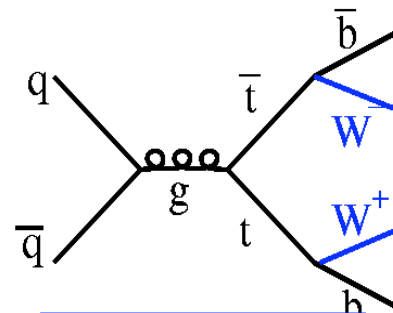
SM top decay
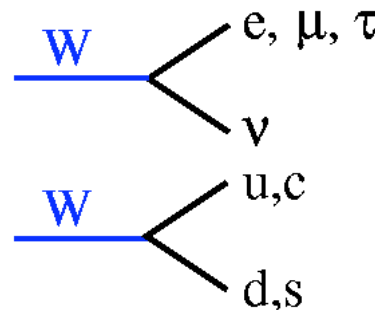
top decay to H±
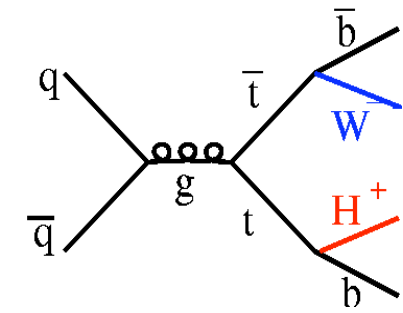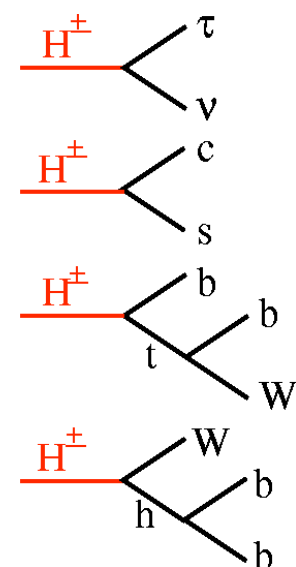
W± decay

H± decay

H± Branching Ratios

- ## BR(t → H±b):
  - Large at low and high tanβ
- ## H± Decay:
  - H± →τν
  - H± →cs
  - H± → t*b→ Wbb
  - H±→ Wh→ Wbb

- ## Constrain BR of t->bH±:
  - Use top production measurements
  - Assume BR(H± →τν)=100%
  - Result: BR(t → bH±) <40%
- ## More complicated model dependent limts also available

$M_{H^\pm}$=100 GeV

H± decays to
- τν̄
- cs̄
- t b̄
- W⁺h⁰
- W⁺A⁰

BR(t→ H⁺b)

Tauonic Higgs Model **CDF Run II Preliminary**
Excluded 95 %CL m_t= 175 GeV/c²   ∫L dt = 192 pb⁻¹
BR(H → τ ν) ≡ 1 ; BR(H → c s̄) = BR(H → t⁺ b̄) = BR(H → W⁺ h⁰) = 0

- SM Expected
- SM ± 1 σ Expected
- CDF Run II Excluded

MSSM Higgs Bosons at LHC

300 fb⁻¹

MHMAX scenario

only h

H and/or A

H⁺⁻

excluded by LEP (prel.)

$\tan\beta$

M_A (GeV)
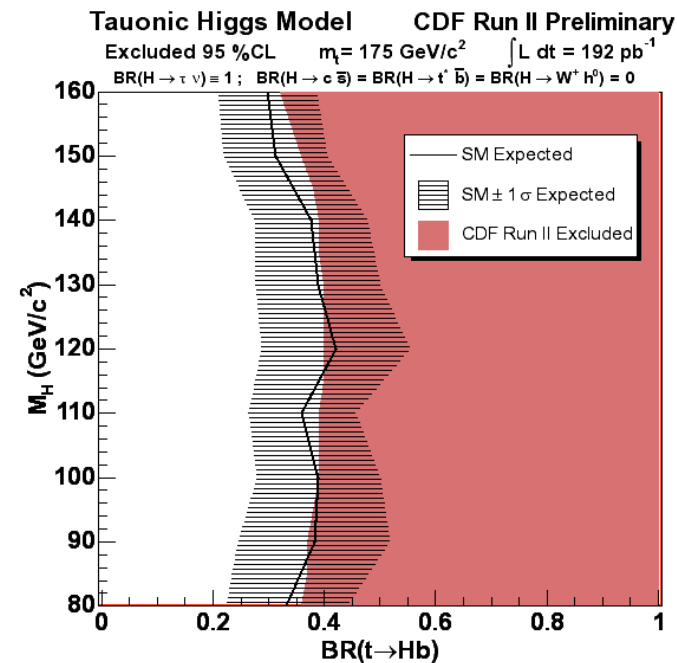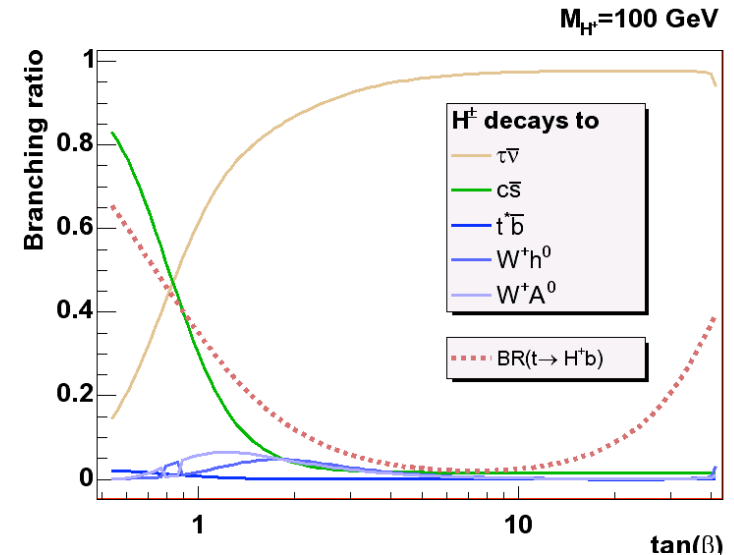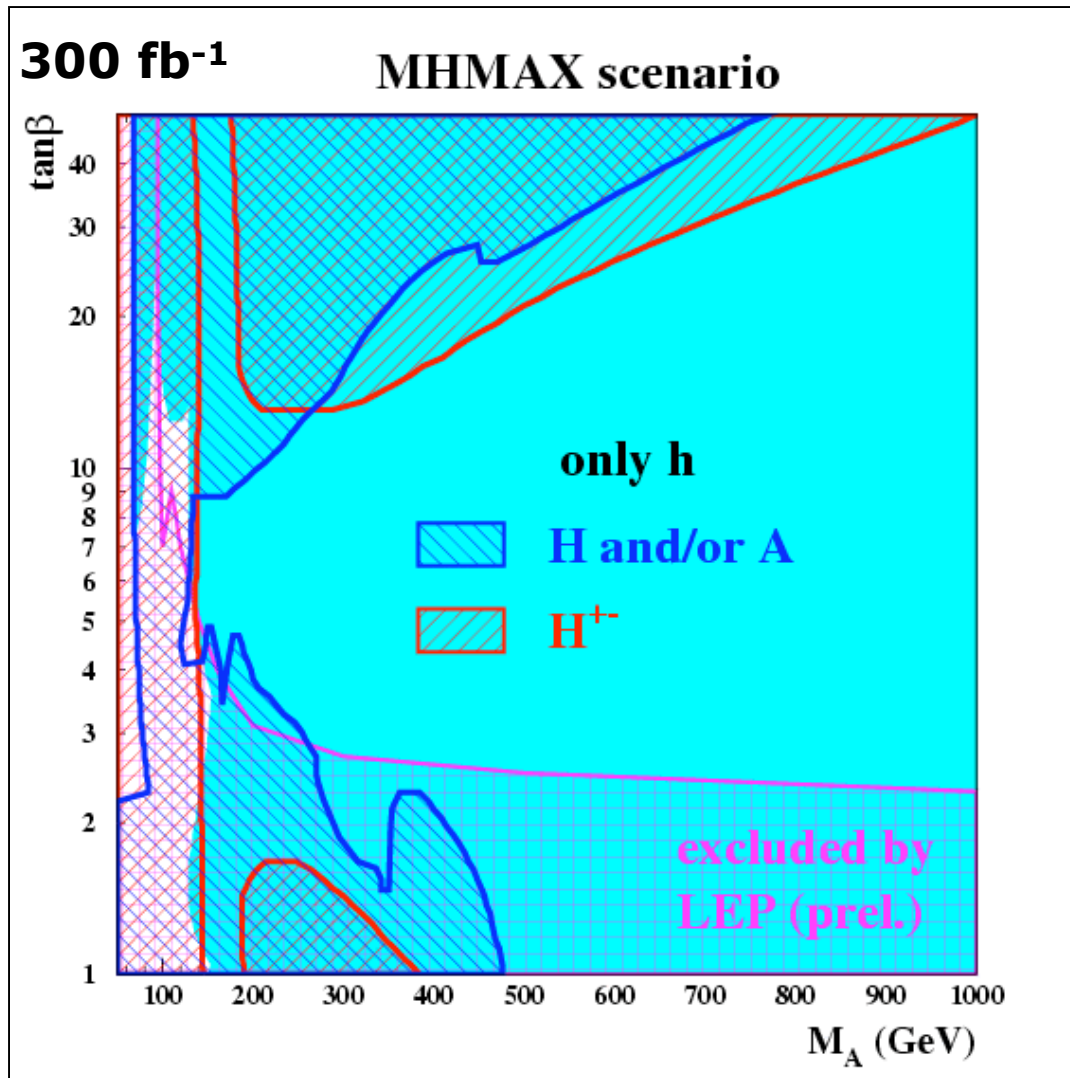
- **At least one Higgs boson observable in all models**
- **Often only one Higgs Boson observable**
- Could also be produced in SUSY cascades:
  - Depends on model how well this can be exploited

How do we know what we have found?

- After discovery we need to measure:
  - The mass
  - The spin
  - The branching ratio into all fermions
    - Verify coupling to mass
  - The total width
    - Are there invisible decays?

Mass
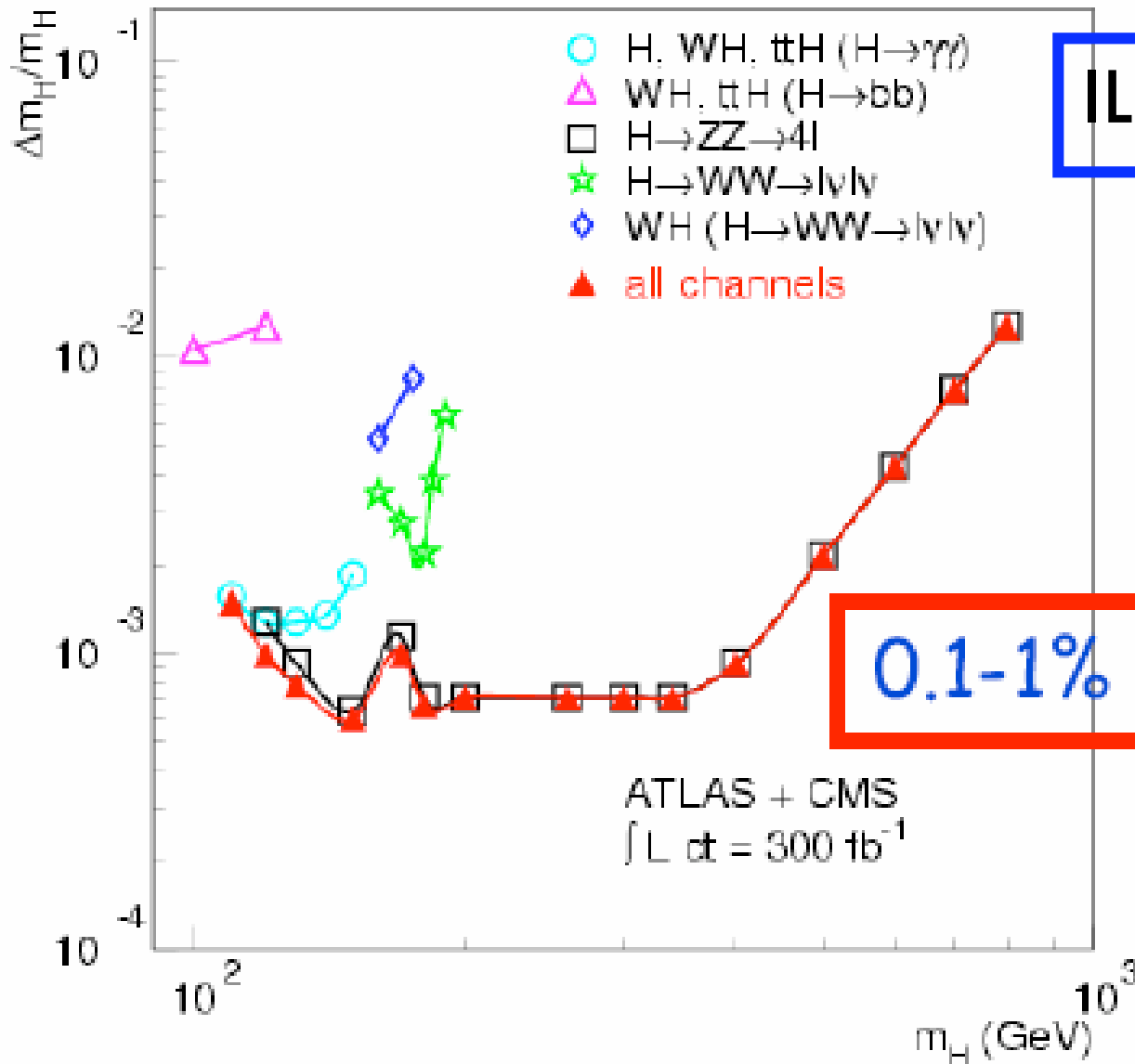
ILC: $\Delta m_H = 40$ MeV

0.1-1%

Couplings at LHC
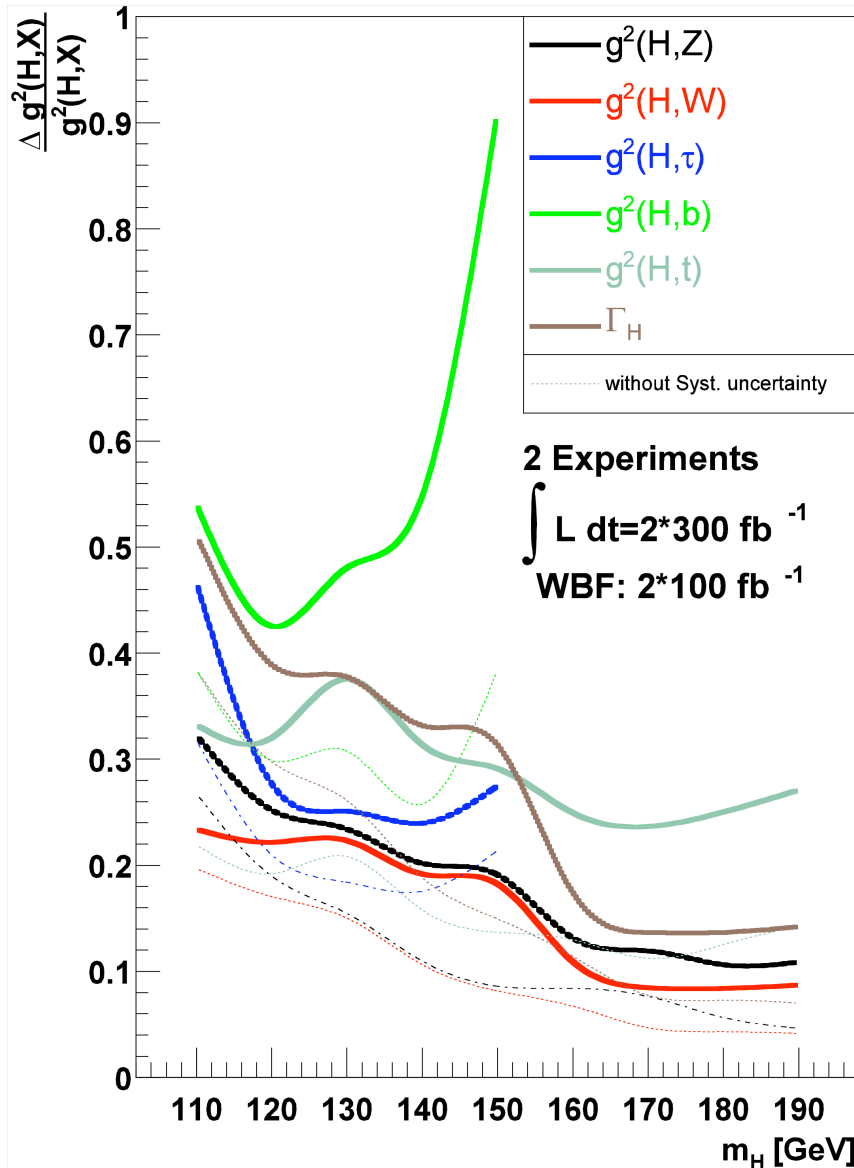
- **Measure the couplings of the Higgs to as many particles as possible:**
  - H->ZZ
  - H->$\gamma\gamma$
  - H->WW
  - H->$\tau\tau$
  - H->bb
- **And in different production modes:**
  - gg->H, ttH (tH coupling)
  - WW->H (WH coupling)

Couplings at the ILC

- **Measure branching ratios very precisely**
  - LHC can measure some decays to 20-40% precision
  - ILC can measure them to better than 5%
- **Precision necessary to tell us about the underlying model**
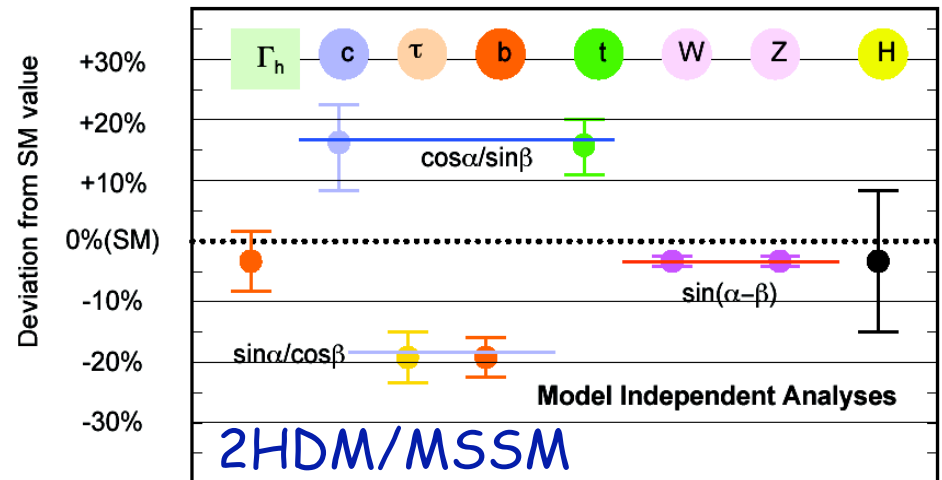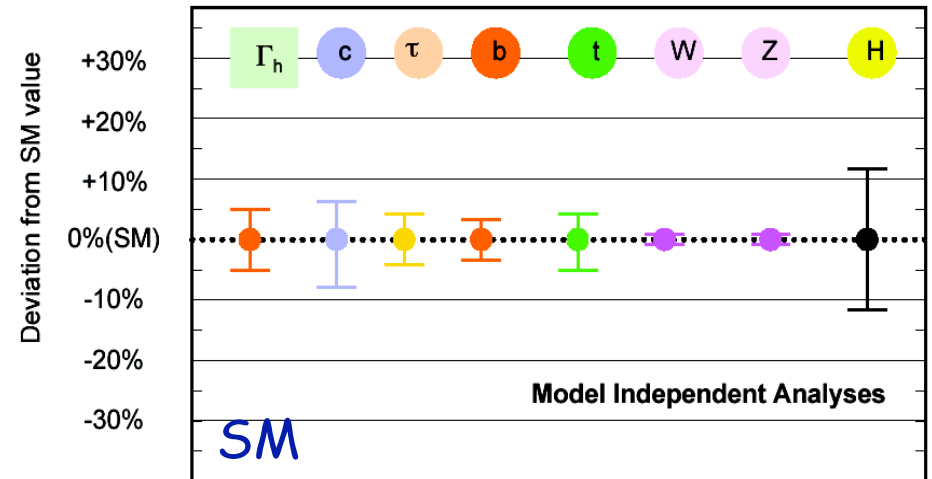
Exclusive Higgs Production

- State of the art calculation (V. Khoze, A. Martin, M. Ryskin)
  - Cross section: 3-10 fb
  - Other calculation:
    - 0.01-100 times different
- Advantages:
  - Can only make particles with quantum number of vacuum (0++)
    - Will know the spin and parity!
  - Excellent Mass resolution:
    - 2 GeV (by tagging protons with Roman Pots)
  - Background suppression:
    - $J_z=0$ selection rule

SM Higgs: (30fb⁻¹)
11 signal vs 12 bkg events

$$M_H^2 = (p + \bar{p} - p' - \bar{p}')^2$$

b -jet

gap   gap

p   H   p

$\bar{b}$ -jet

See: www.fp420.com

Good Potential in MSSM

5 σ discovery, H→ b̄b, mhmax scenario, μ=-200 GeV
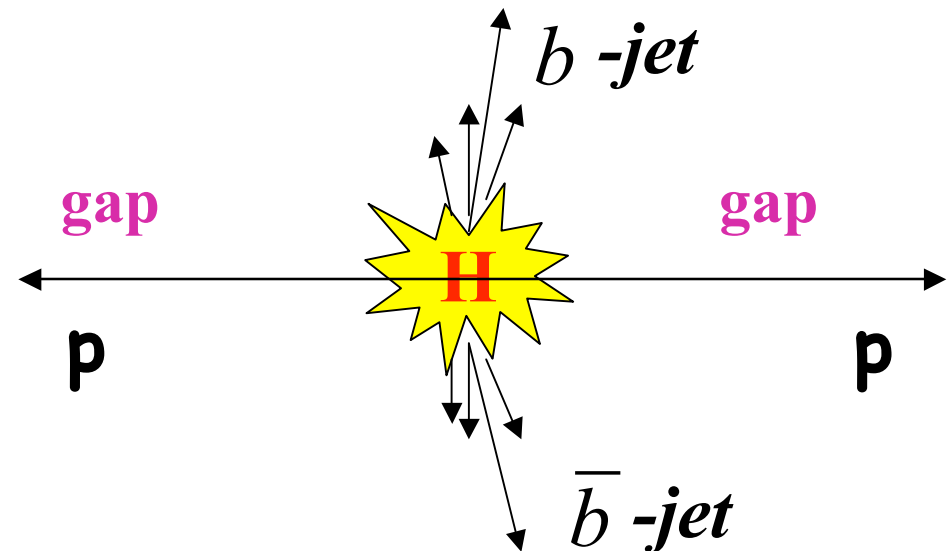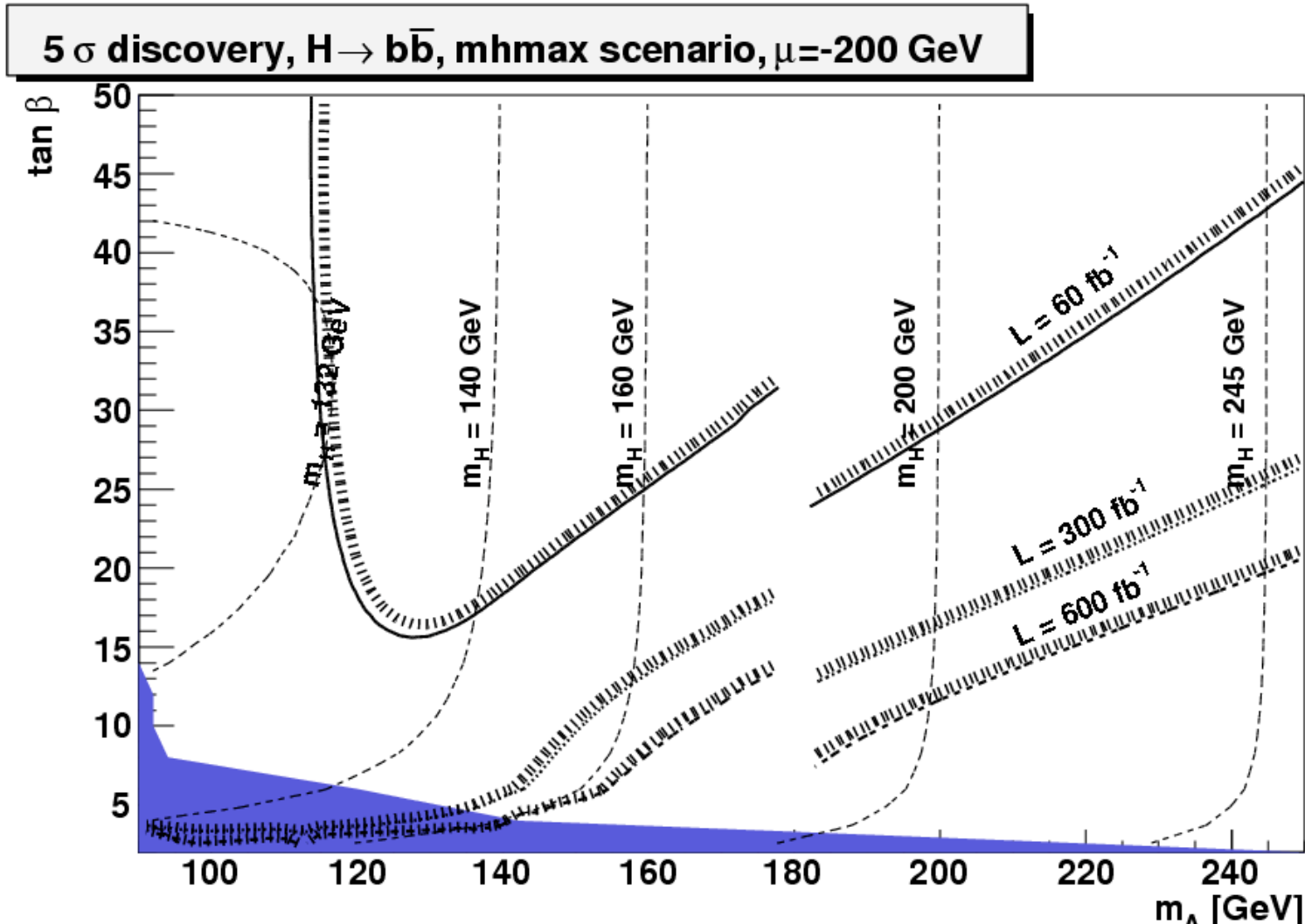
V.A.Khoze, S.Heinemeyer, W.J.Stirling, M.Ryskin M. Tesevsky and G. Weiglein in progress

Other Exclusive Processes

- Test theory at the Tevatron:
  - Exclusive diphoton
  - Exclusive dielectron (luminosity monitor)
- Theoretical predictions:
  - Diphoton calculated by KMR
  - Dielectron precisely known

Observation of pp–>eepp (!)

- Observed 16 events
- Probability of background fluctuation:
  - 5×10^{-8} (=5.4σ)
- First observation at hadron collider:
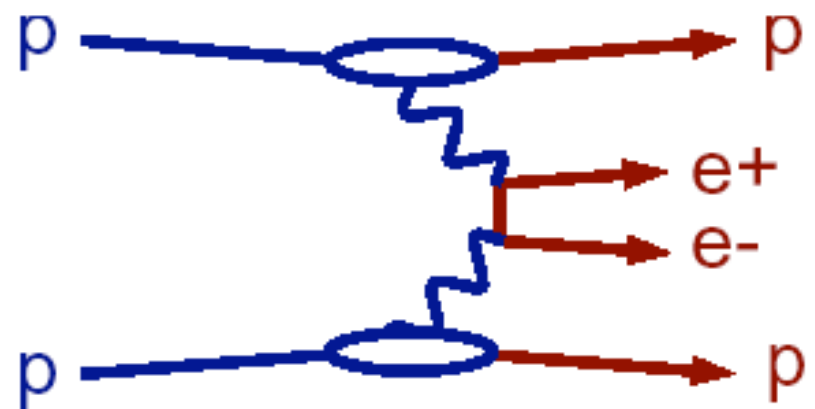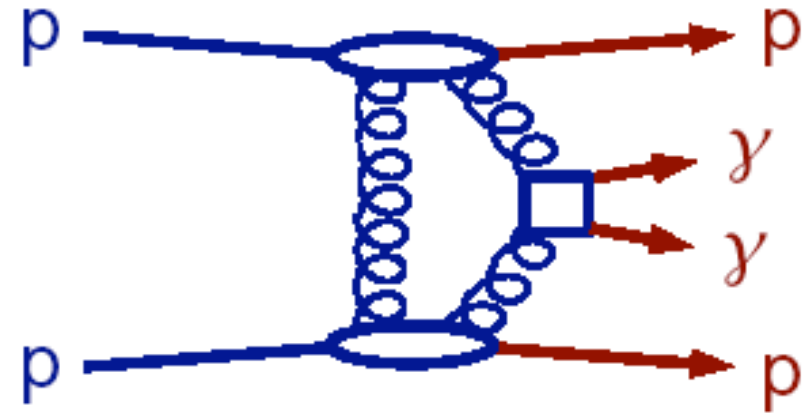 - Agrees with prediction

$$\sigma_{MEASURED} = 1.6 \, {}^{+0.5}_{-0.3} \, (stat) \pm 0.3 \, (sys) \, pb$$

Theory: $\sigma_{LPAIR} = 1.711 \pm 0.008 \, pb$

Fakes:	$0.0 \, {}^{+0.1}_{-0.0}$ events
Cosmic:	negligible
Exclusive:	$0.0 \, {}^{+0.3}_{-0.0}$ events
Dissociation:	2.1 ± 0.3 events
Total:	$2.1 \, {}^{+0.7}_{-0.3}$ events

CDF Run II Preliminary

- Data
- LPAIR MC
- Z → ee Data

Number of Events vs Number of Additional Clusters
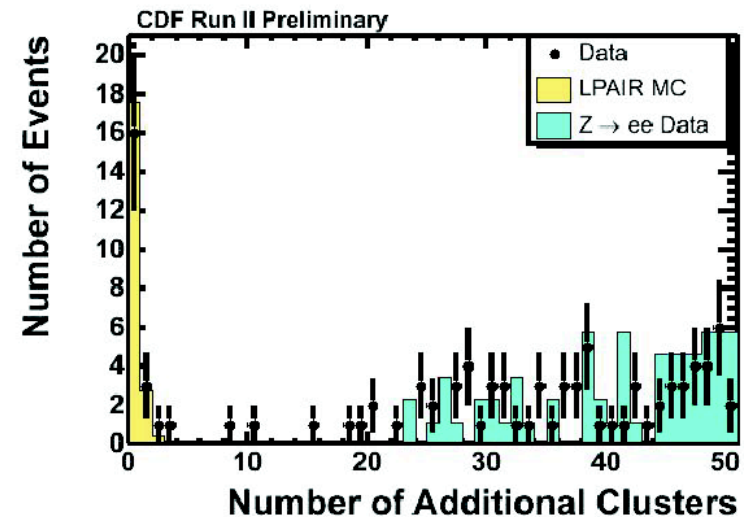
Evidence for pp->$\gamma\gamma$pp !

- **Observed 3 events**
- **Probability of background fluctuation:**
  - 1.1×10^{-3} (=3.3σ)
- **First evidence for this process:**
  - Agrees with KMR prediction!

Fakes: $0.0^{+0.1}_{-0.0}$ events

Cosmic: negligible

Exclusive: $0.0^{+0.05}_{-0.00}$ events

Dissociation: $0.0^{+0.05}_{-0.00}$ events

Total: $0.0^{+0.2}_{-0.0}$ events

$$\sigma_{MEASURED} = 0.14^{+0.14}_{-0.04} \text{ (stat)} \pm 0.03 \text{ (sys) pb}$$

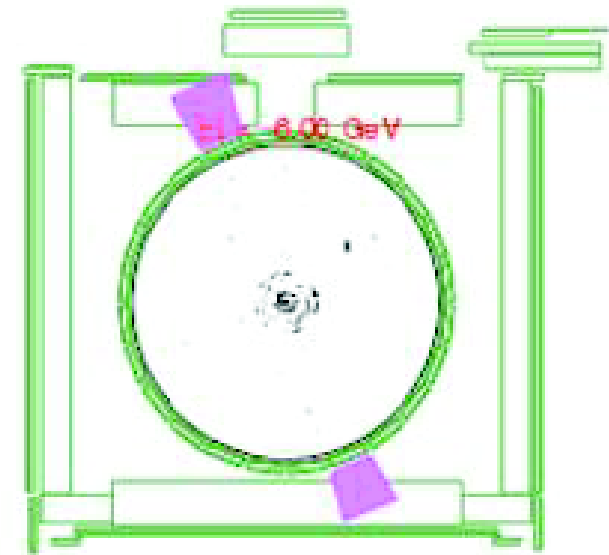**Theory:** $\sigma_{KRM} = 0.04 \pm (\times 3-5) \text{ pb}$

Conclusions

- **The Higgs boson is a major target of current and future colliders**
  - Tevatron can find evidence
  - LHC will discover at least one Higgs boson
  - Most likely require ILC to probe Higgs sector sufficiently well
- **Precision tests of Higgs sector:**
  - Consistency with indirect constraints from m_{top}, m_W?
  - Mass, width and couplings
  - Is there more than one Higgs boson?
- **It is the most wanted particle ever => let's find it!**

experimental errors 68% CL:

— LEP2/Tevatron (today)
— Tevatron/LHC
— ILC/GigaZ

light SUSY
MSSM
heavy SUSY

$M_H = 113$ GeV

$M_H = 400$ GeV

SM

SM
MSSM
both models

Heinemeyer, Weiglein '06

M_W [GeV]

m_t [GeV]
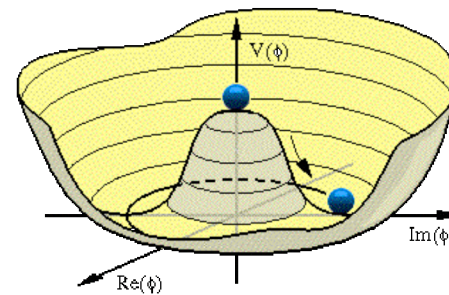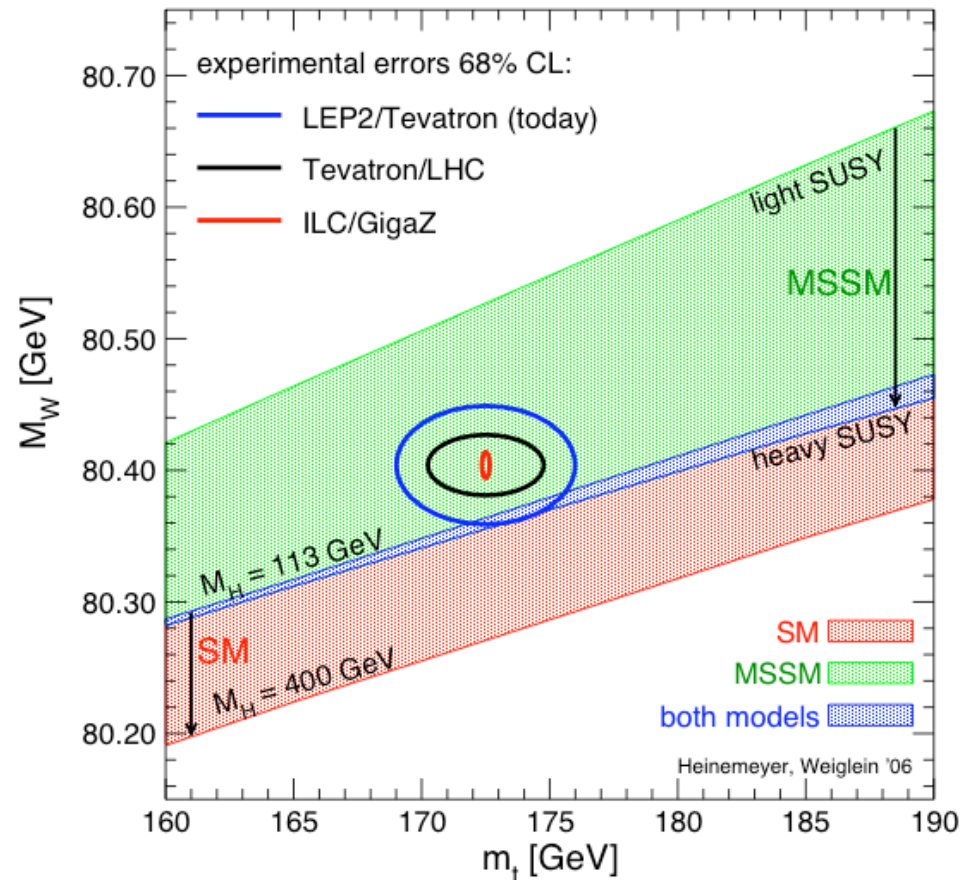
Higgs found by Google

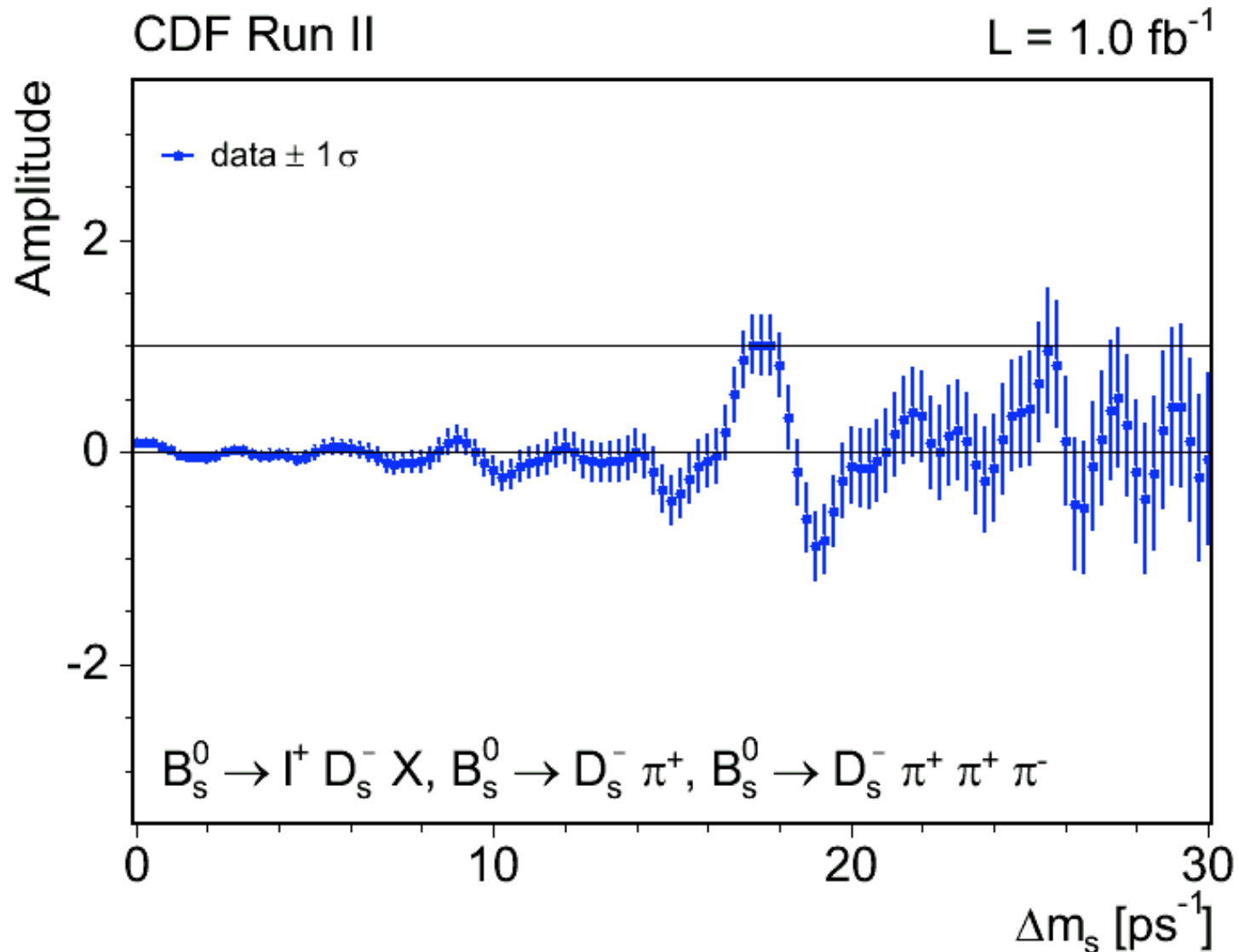Popular search method: (Google Image Search)
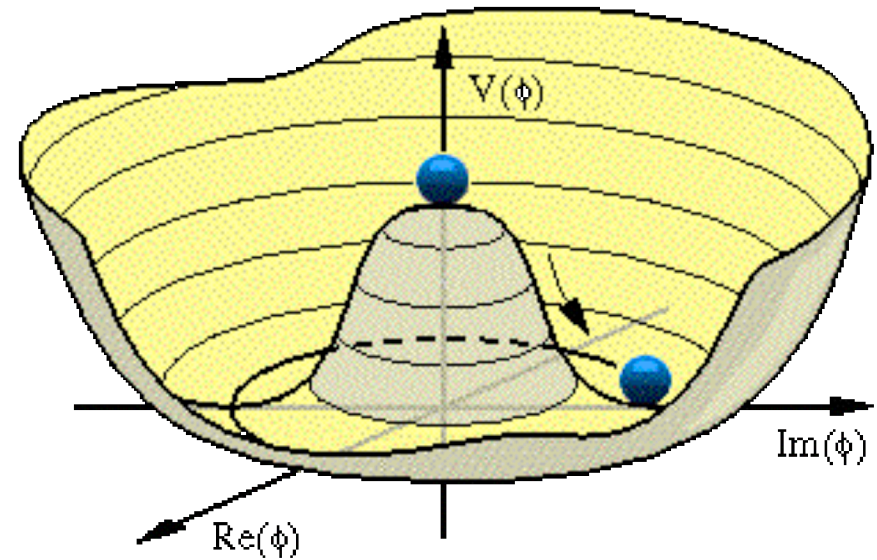

Paintings by artist called
Warwick Higgs

CDF B$_s$ Mixing Result

The Higgs Boson

- Symmetry breaking caused by scalar Higgs field

- vacuum expectation value of the Higgs field $\langle\phi\rangle = 246$ GeV/c^2

  - gives mass to the W and Z gauge bosons, $M_W \propto g_W \langle\phi\rangle$

  - fermions gain a mass by Yukawa interactions with the Higgs field, $m_f \propto g_f \langle\phi\rangle$

  - Higgs boson couplings are proportional to mass

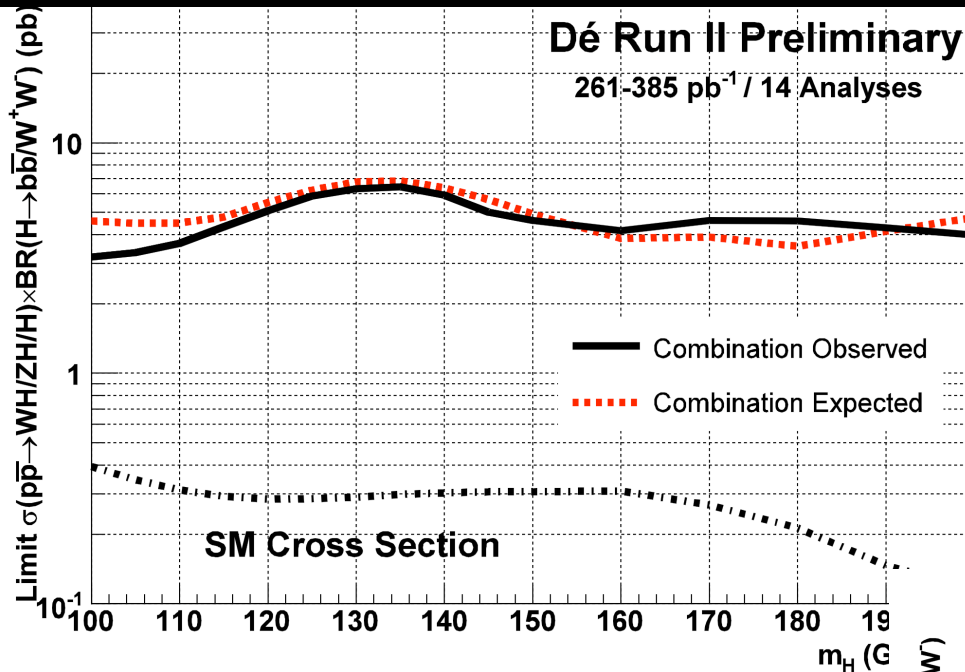- Higgs boson prevents unitarity volation of WW cross section
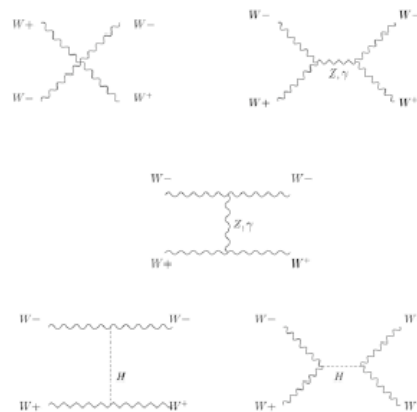
$$A \approx g^2 \frac{E^2}{M_W^2}$$

Terms which grow with energy cancel for $E \gg M_H$

$$A \approx -g^2 \frac{E^2}{M_W^2}$$

This cancellation requires $M_H < 800$ GeV

Combined limit

Dé Run II Preliminary

261-385 pb⁻¹ / 14 Analyses

Limit $\sigma(p\bar{p} \rightarrow WH/ZH/H) \times BR(H \rightarrow b\bar{b}/W^+W^-)$ (pb)

—— Combination Observed

······ Combination Expected

SM Cross Section

m_H (G

- New combined limit from all SM Higgs search channels!

- 14 orthogonal search channels (incl. single and double-tag analyses and WHγ lνbb w. missed lepton)
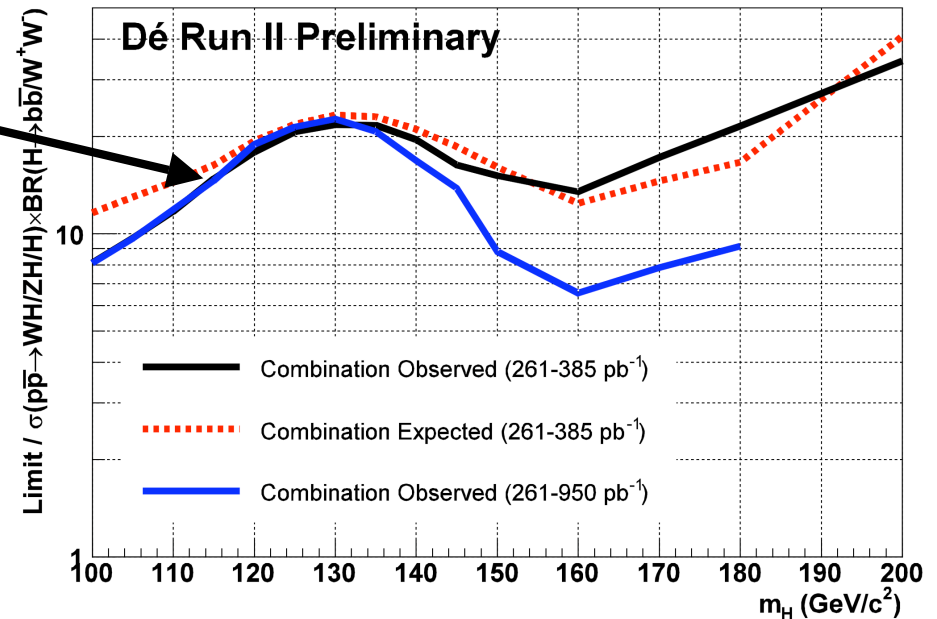
- Full account taken of systematic uncertainties

- High mass region benefits from HγWW analyses
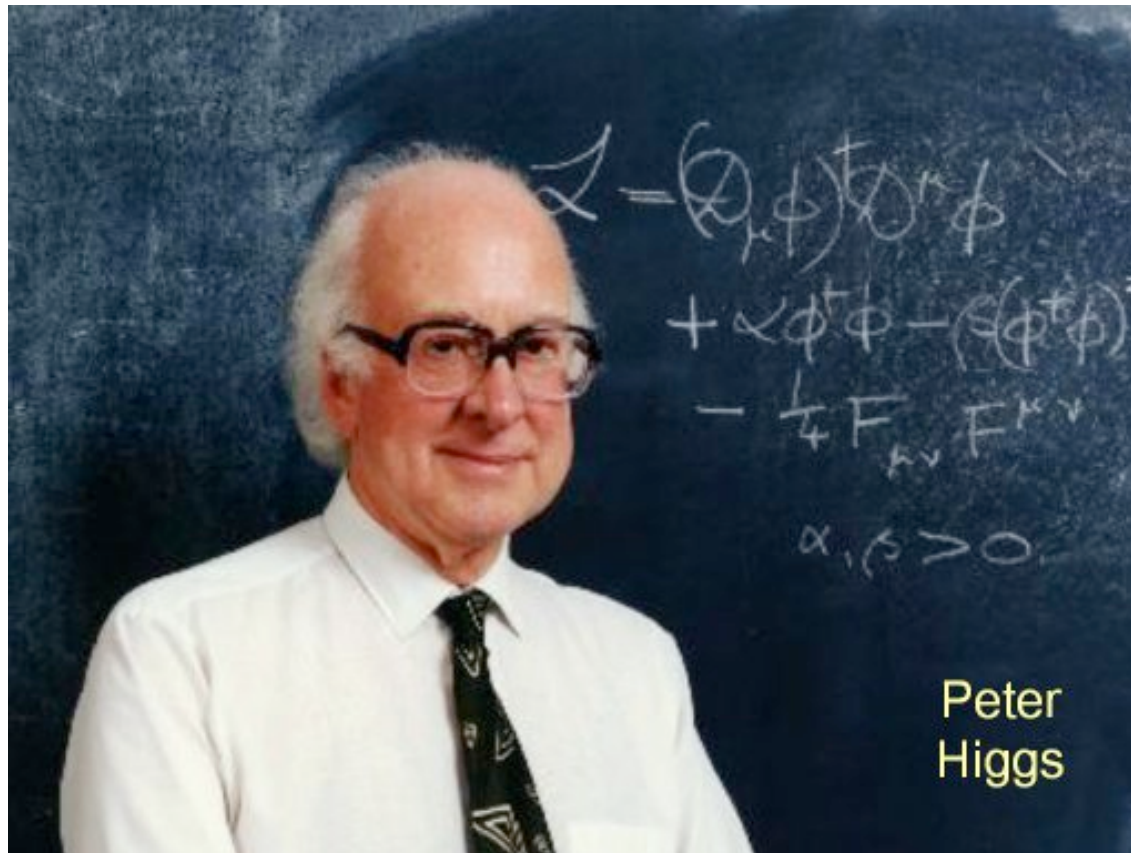
Currently **a factor 15** away from
m_H =115 GeV

- With L= 2 fb⁻¹, both experiments, NN b-tagging, NN analyses, track-cal jets, increased acceptance, new channels, full cross efficiency, and reduced systematics:
  - **Cross section factor = 1.2**

Dé Run II Preliminary

Limit / $\sigma(p\bar{p} \rightarrow WH/ZH/H) \times BR(H \rightarrow b\bar{b}/W^+W^-)$

—— Combination Observed (261-385 pb⁻¹)

······ Combination Expected (261-385 pb⁻¹)

—— Combination Observed (261-950 pb⁻¹)

m_H (GeV/c²)

Searching for the Higgs

Peter Higgs in Edinburgh

Peter Higgs

Is at least 1 Higgs boson observable in the entire parameter space?

How many Higgs bosons can be observed?

Can the SM be discriminated from extended Higgs sectors?

MHMAX scenario
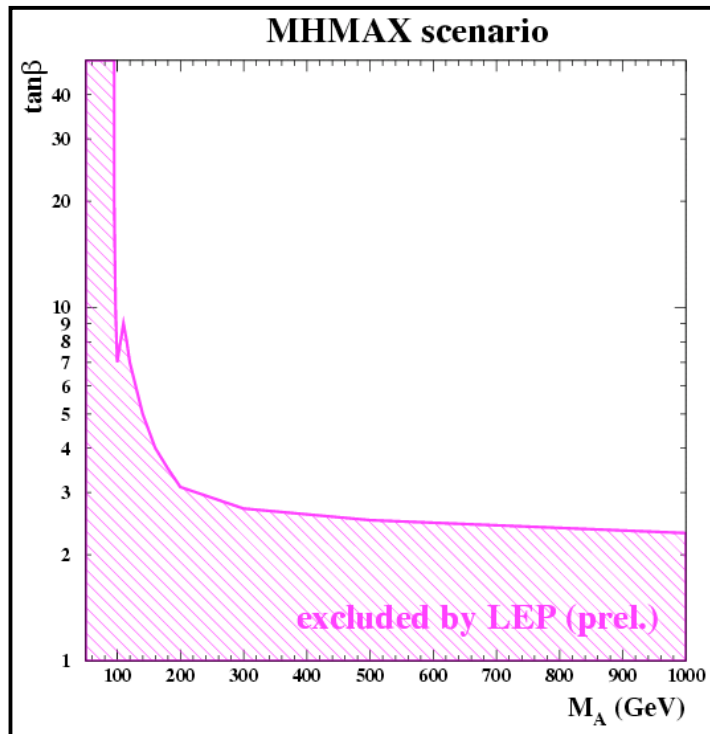
❖ two expected data volumes

30 fb^{-1} @ low lumi

300 fb^{-1} = 30 fb^{-1}@ low lumi.

+ 270fb^{-1} @high lumi

❖ discovery = 5 sigma excess

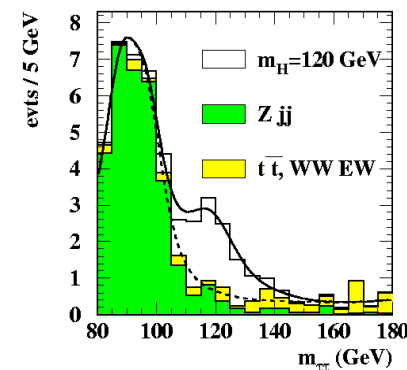using Poissonian statistics

❖ no systematic uncertainties yet

LEP tanβ exclusion: no exclusion for m$_t$ larger ~183 GeV !

H,h Discovery Potential 30fb⁻¹

MHMAX scenario

VBF: h → WW

VBF: h → ττ

excluded by LEP (prel.)

VBF: H → WW

VBF: H → ττ
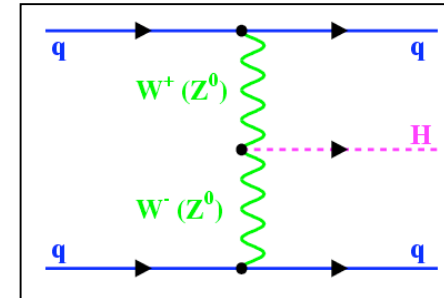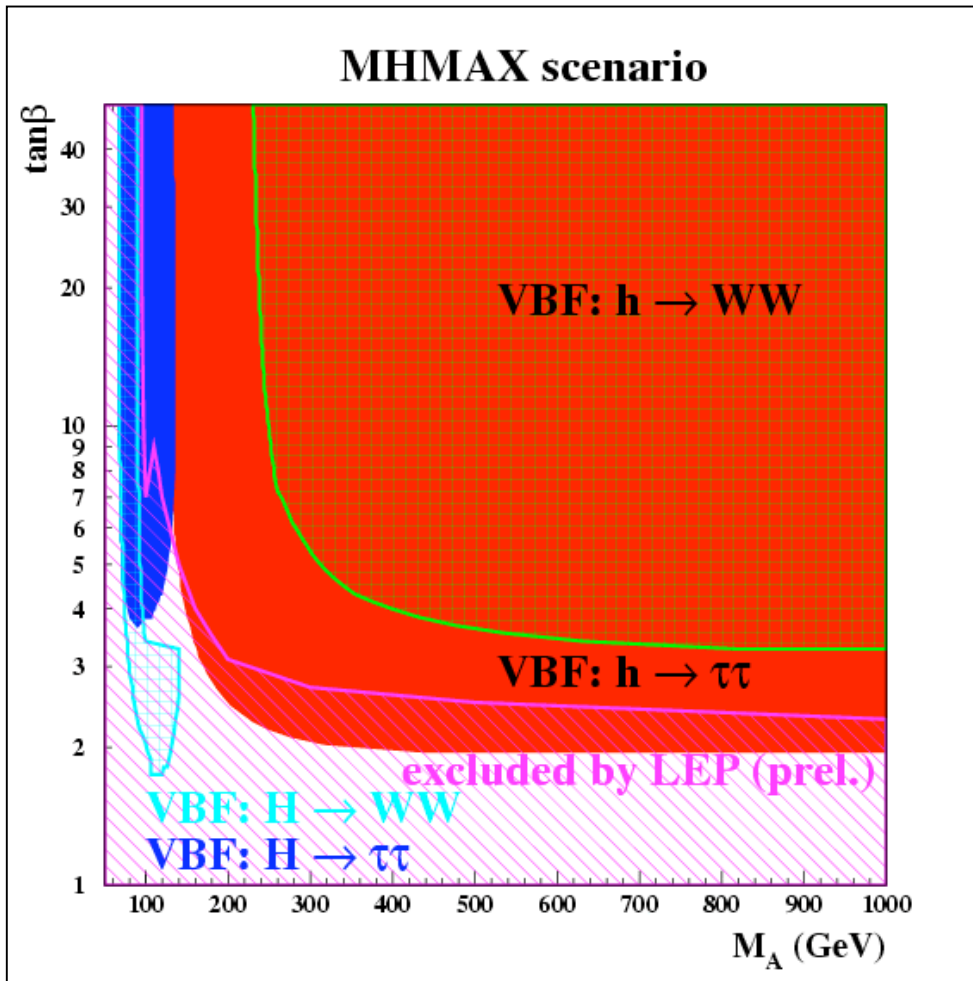
studied for $M_H > 110$GeV
at low lumi running

almost gurantees

discovery of at least one

h or H with 30 fb⁻¹

$m_H = 120$ GeV

Z jj

$t\bar{t}$, WW EW

SM like h
with 30 fb⁻¹

ττ→ll4 ν

Backup Slides

h Discovery Potential 30fb⁻¹

MHMAX scenario

VBF: $h \to WW$

VBF: $h \to \tau\tau$

bbh: $h \to \mu\mu$

excluded by LEP (prel.)

$\tan\beta$ vs M_A (GeV)
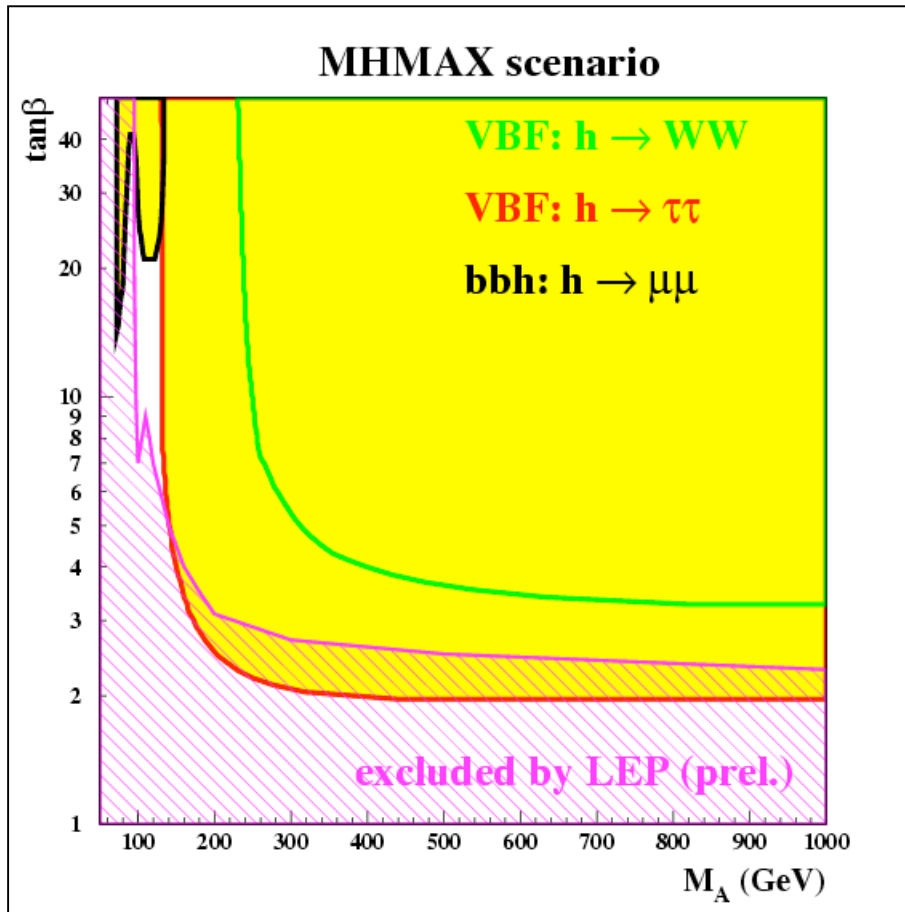
In Maximal Mixing Scenario:
VBF h→ττ covers most of the MSSM plane with 30fb⁻¹

The VBF h→ττ channel is also important for other MSSM scenarios
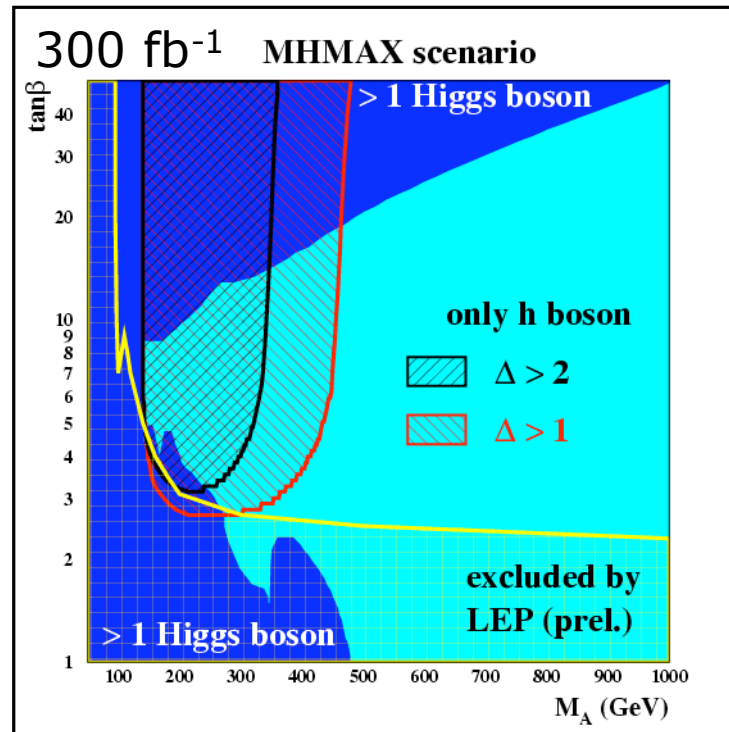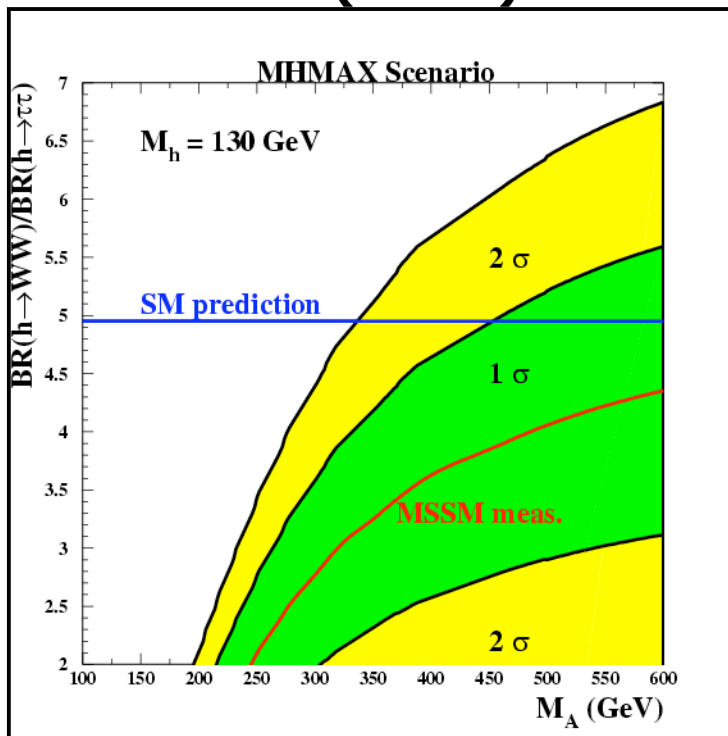
VBF h→ττ

Experimental Challenge:

Missing E_t Reconstruction

SM vs MSSM Higgs discrimination

❖ estimate of sensitivity from rate measurements in VBF channels (30fb^{-1})

❖ compare expected measurement of R in MSSM with prediction from SM

$$R = \frac{BR(h \to WW)}{BR(h \to \tau\tau)}$$

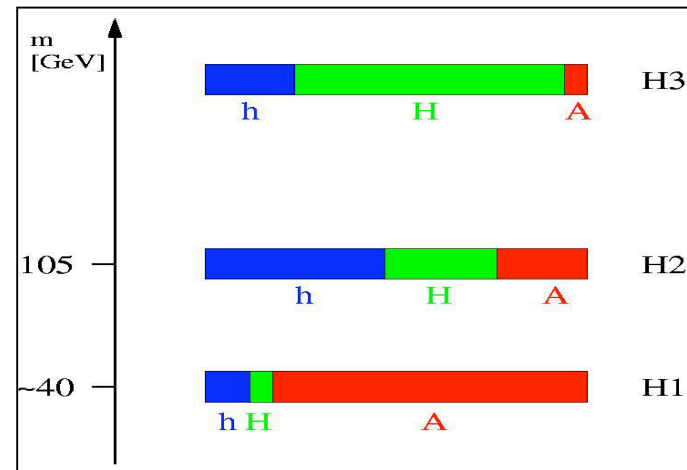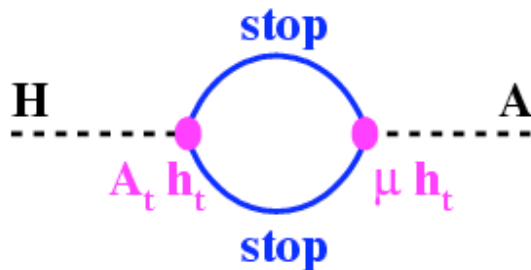$$\Delta = |R_{MSSM} - R_{SM}|/\sigma_{exp}$$

- only statistical errors

- assume M_h exactly known

needs further study incl. sys. errors

The CP violating CPX scenario

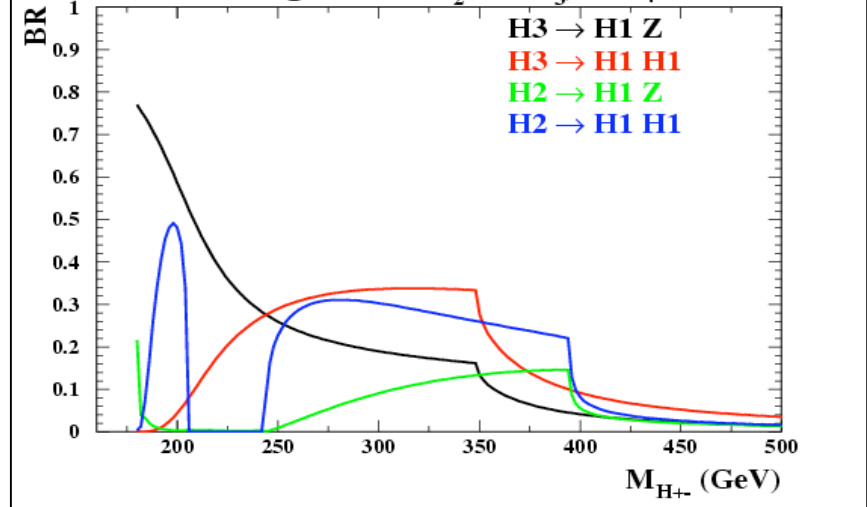➢ CP conserving at Born level,   but CP violation via complex A_t, A_b M_{gl}

➢ CP eigenstates h, A, H mix to mass eigenstates H_1, H_2, H_3

➢ maximise effect → CPX scenario   (Carena et al., Phys.Lett B495 155(2000))
  $arg(A_t)=arg(A_b)=arg(M_{gluino})=90$ degree

➢ scan of Born level parameters: $tan\beta$ and M_{H+-}

CPX Phenomenology

H_1, H_2, H_3 coupling to W,Z

H1
H2
H3

sum rule:
$\Sigma_i \, g_i^2 (ZZH_i)$
$= g_{SM}^2$
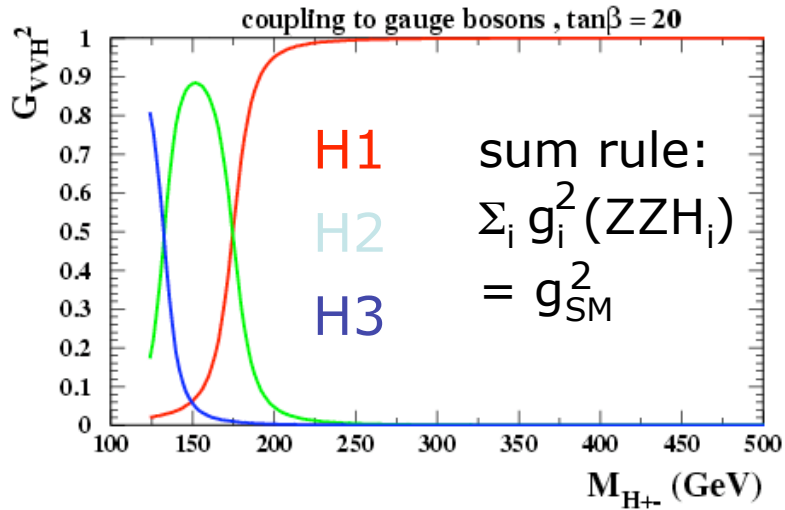
$H_2, H_3 \rightarrow H_1 H_1$, ZH_1 WW, ZZ decays

❖ no absolute limit on mass of H_1 from LEP

❖ strong dependence of excluded region

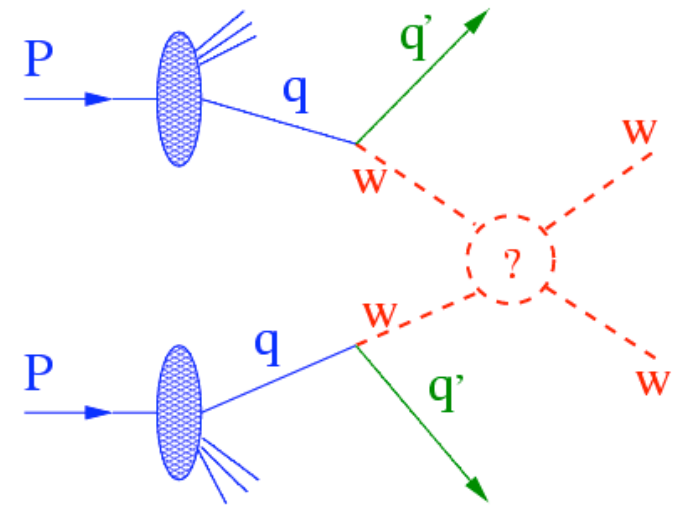on value for m_{top}

on calculation used FeynHiggs vs CPH
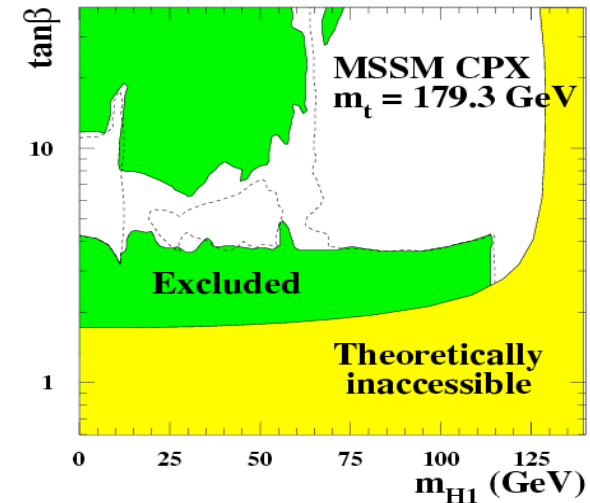
What if there is no Higgs?

-$W_L W_L$ cross section would violate unitarity since amplitude perturbative expansion in energy (s): $\sigma \sim s^2/v^2 + s^4/v^4 ...$

-Need either a Higgs boson with m_h<1 TeV or some new physics (e.g. SUSY, Technicolor)

-Tevatron and LHC probe relevant scale of 100 GeV - 1 TeV!

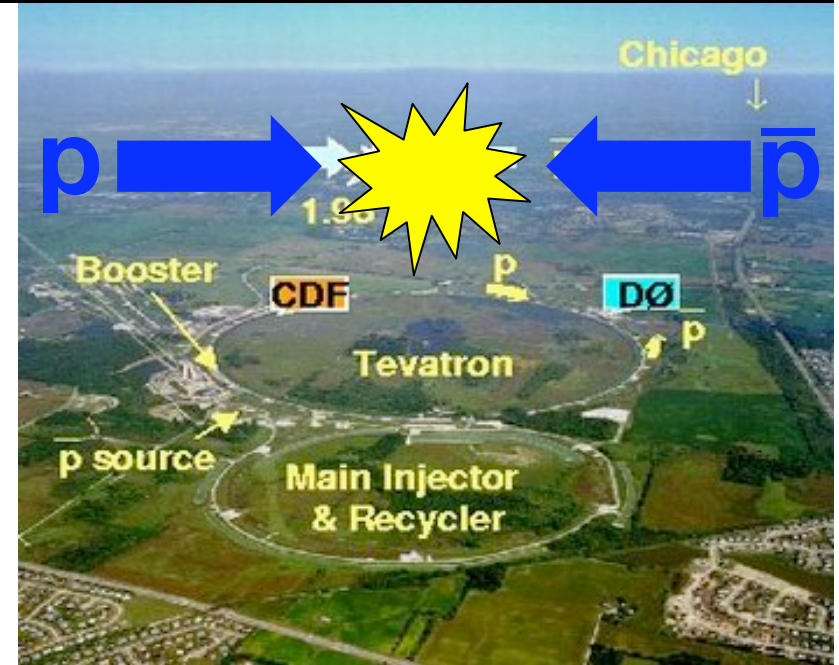=> We will find something (higgs or more extraodinary) in the next 10 years!
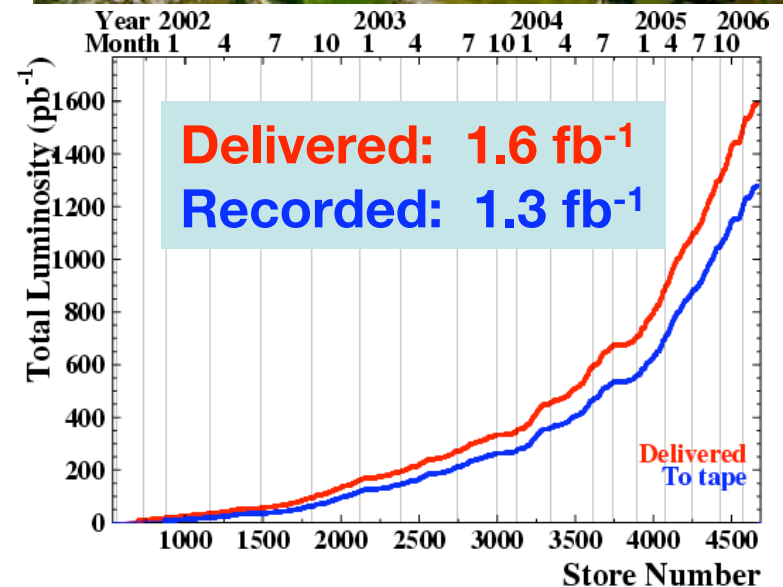
CDF and the Tevatron

Tevatron Run II

- World's highest energy collider
- Tevatron Accelerator:

|	$\sqrt{s}$(TeV)	Δt(ns)	L(cm^{-2} s^{-1})
Run II	1.96	396	1.7×10^{32}

Key parameter: $N=\sigma\cdot\int L dt$

- **Integrated luminosity >1.5 fb^{-1} by now:**
  - CDF data taking efficiency about 83%
- **Integrate $\int L dt$=4-8 fb^{-1} by 2009**

Delivered: 1.6 fb^{-1}
Recorded: 1.3 fb^{-1}

Tevatron Luminosity

Congratulations Fermilab!

Fermilab has set a world record for peak luminosity of a hadron collider! Operations established store 4431 at 9:11 a.m. yesterday, October 4, with an initial luminosity, or brightness, of $141E30$ cm^{-2}sec^{-1}. This record exceeds the previous Tevatron record by almost 8 percent, and it exceeds the world record for peak luminosity of a hadron collider achieved 23 years ago by the ISR proton-proton collider at CERN. The ISR achieved a peak luminosity of $140E30$ cm^{-2}sec^{-1} at a collision energy of 62 GeV. The Tevatron produces collisions between protons and antiprotons at a collision energy of 1960 GeV. The peak luminosity of the Tevatron has greatly increased since Fermilab began Run II in March 2001, and Fermilab expects to improve the Tevatron peak luminosity even further.
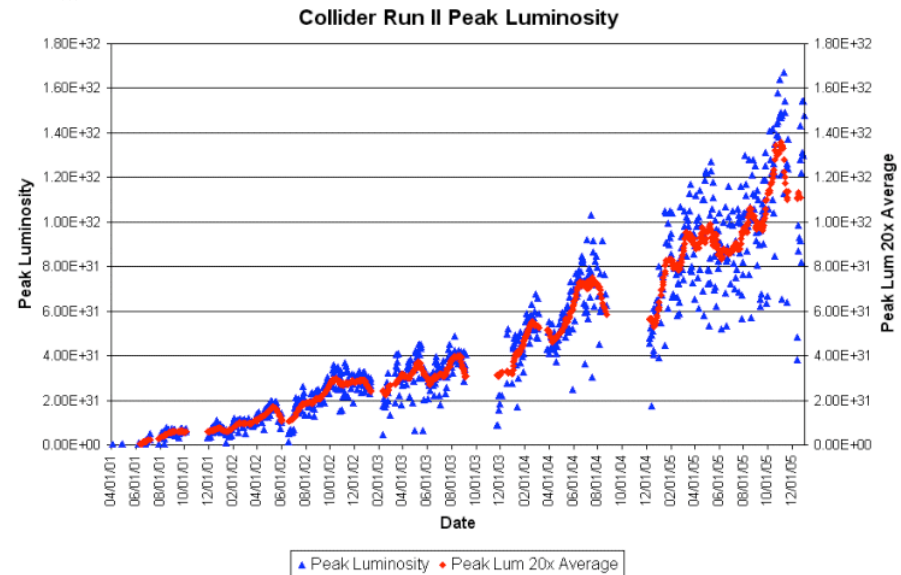

Tevatron Has Another Peak Luminosity Record in 2006

The Tevatron collider set a new peak luminosity record at 3:28 this morning, January 6. Store 4581 reached $171E30$ cm^{-2} sec^{-1}. Congratulations.

CPConserving Benchmark Scenarios

At $M_A \gg M_Z$ or $M_A \sim M_{h,max}$ and $\tan\beta \gg 1$, the heavy bosons degenerate in mass while the h decouples at $M_h \sim 130$ GeV (decoupling regime of MSSM)

Maximum M_h depends on stop mixing Xt
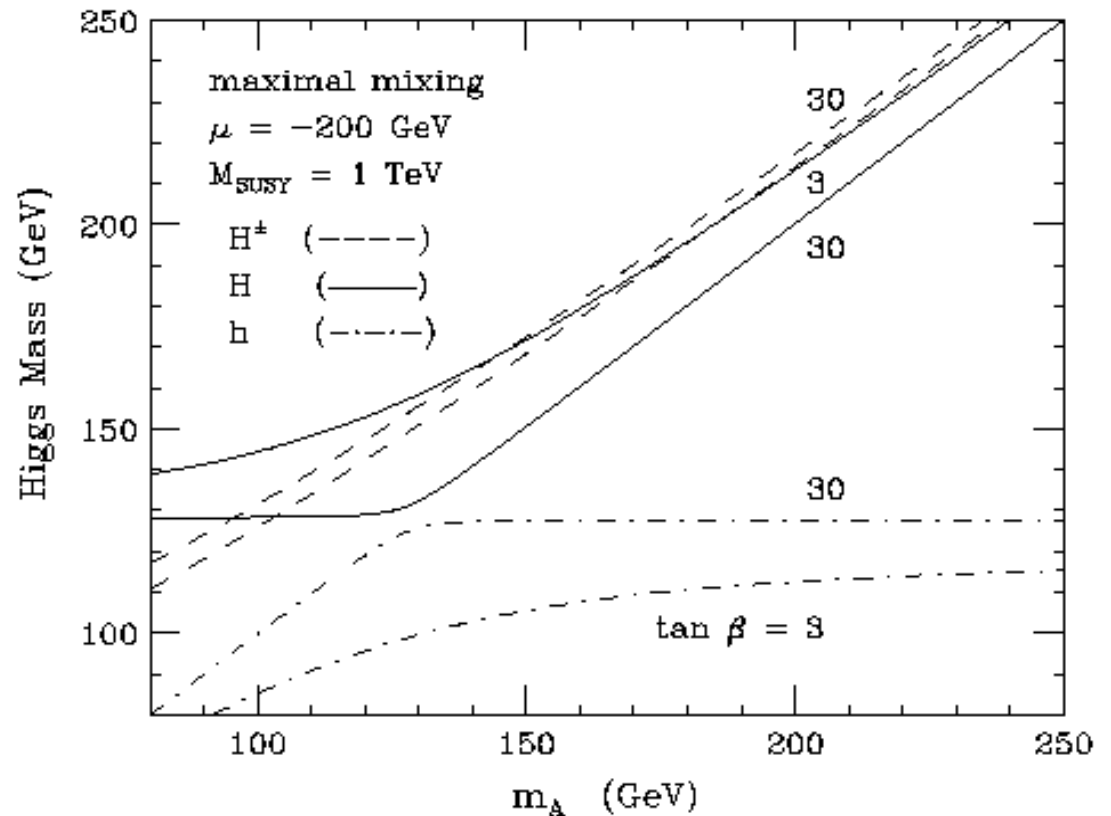
Examples:

❖ MHMAX scenario   maximal m_h < 135 GeV ($X_t \sim$ sqrt(6)*M_S)

❖ Nomixing scenario   small m_h < 116 GeV ($X_t = 0$)