# Recherches du boson de Higgs au TeVatron


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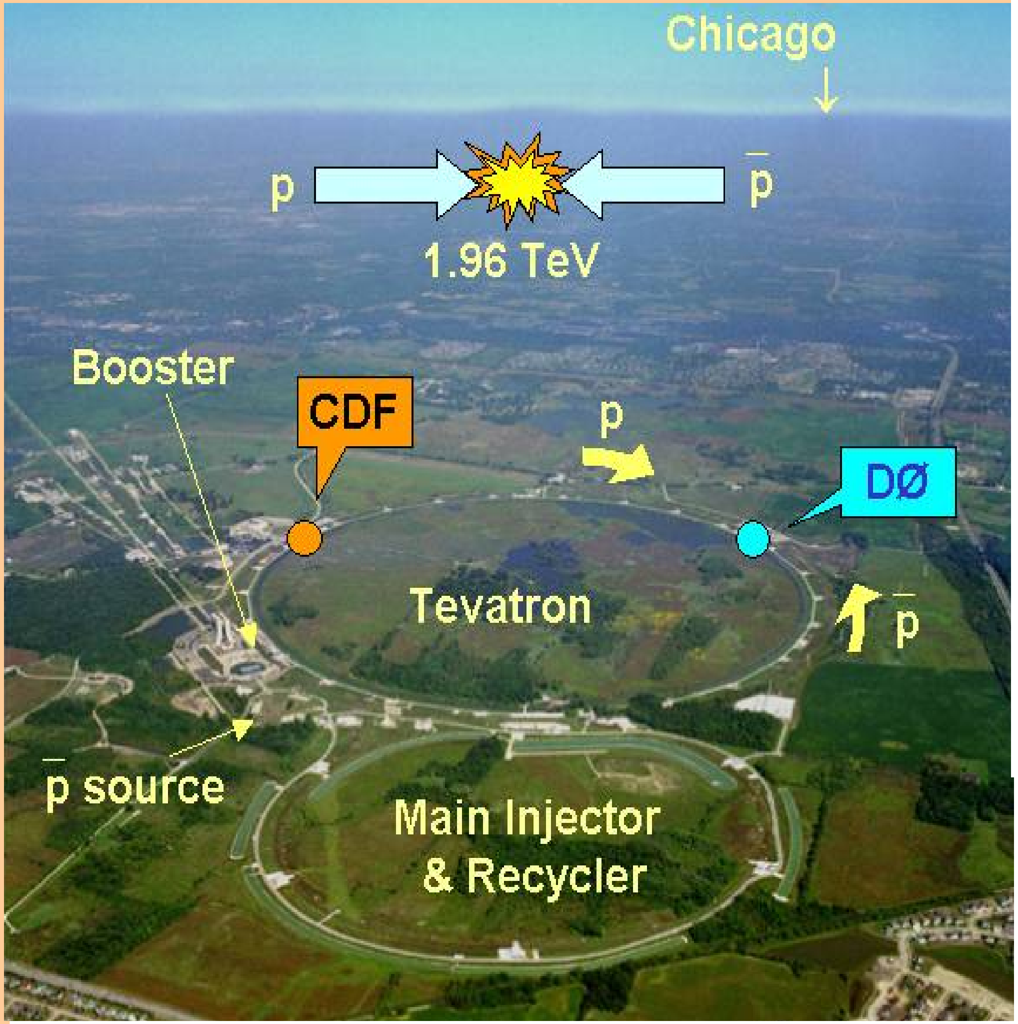
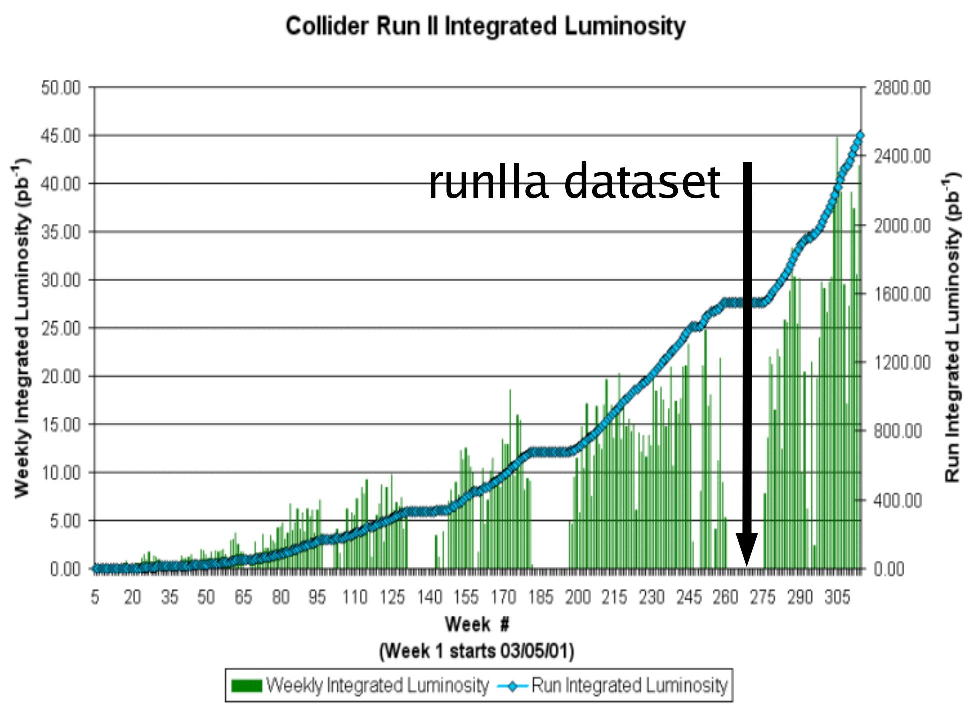
# Plan

- Le TeVatron, CDF & DØ
- Recherche du boson de Higgs du modèle standard
- Les bosons de Higgs du Modèle Standard Supersymétrique Minimal (MSSM)
- Conclusions

# The TeVatron




Efficacité de collection: 85-90%

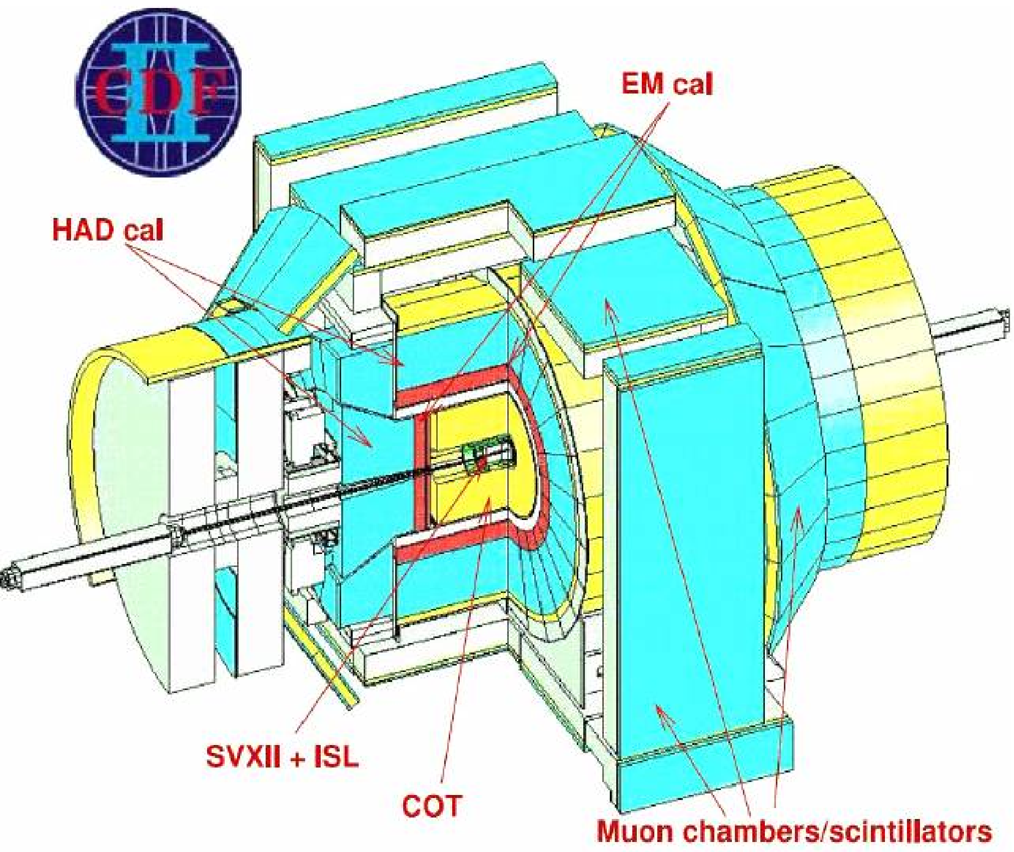
Analysées : 1.2 fb$^{-1}$

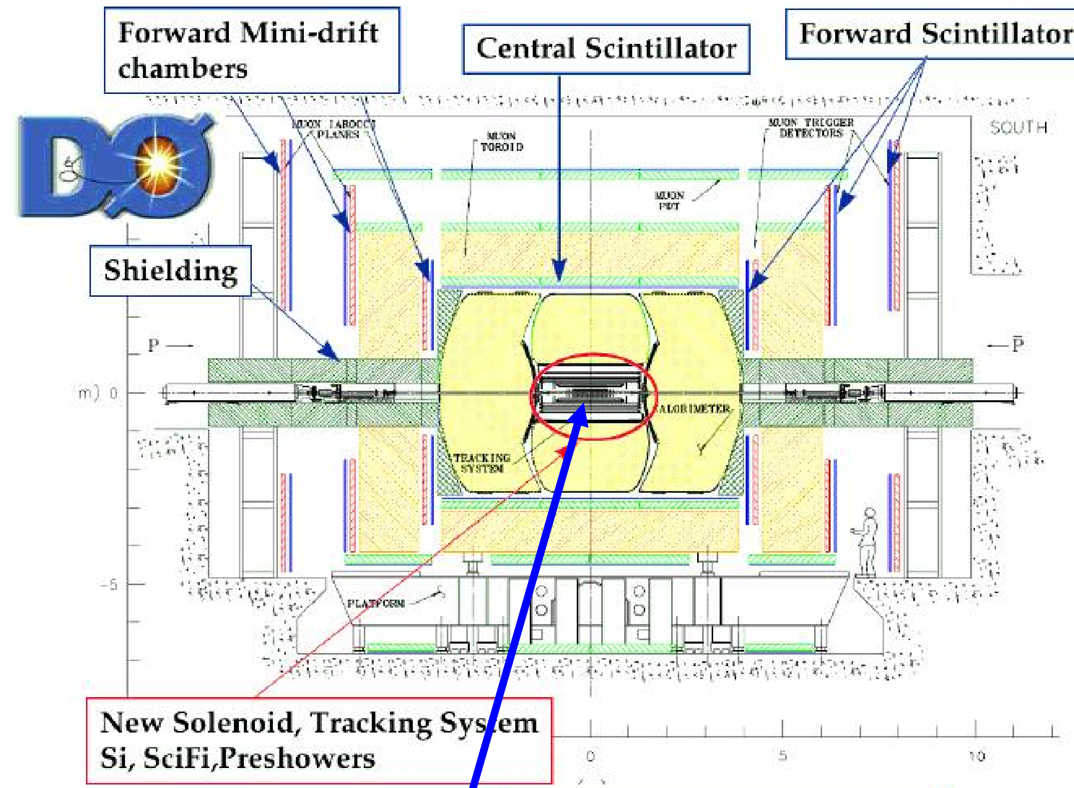
Enregistrées : 2.2 fb$^{-1}$

Record de lumi instantanée

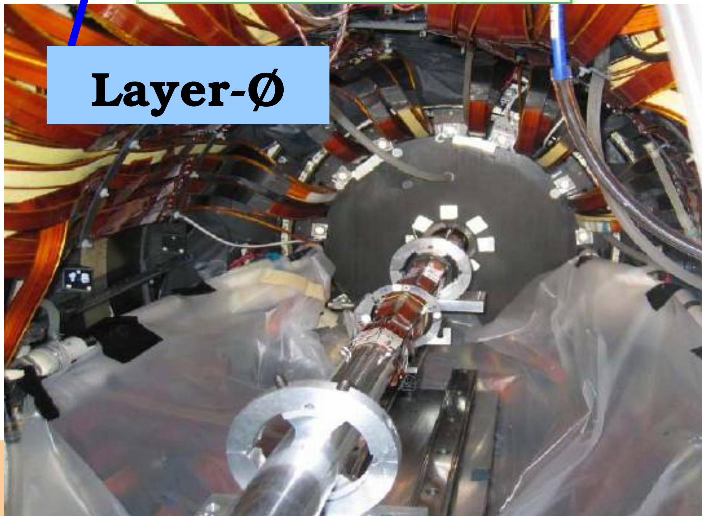
285E30 cm$^{-2}$/s$^{-1}$ (02/2007)

# DØ and CDF detectors




+ New Electronics, Trig, DAQ




Détecteurs généralistes

- détecteurs silicium au centre
- central tracker
- Calorimètres (EM/ HAD)
- Système à muon

# Le boson de Higgs du Modèle Standard

# Mécanisme de Higgs

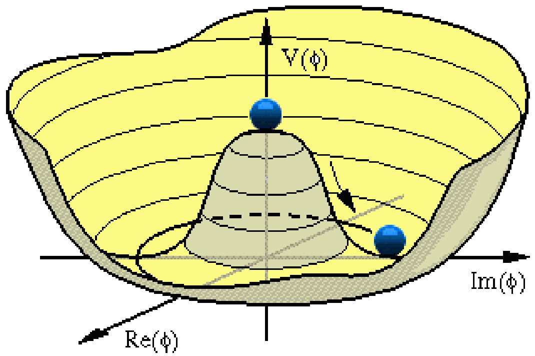
☺ Fin du dernier millénaire, triomphe de la Théorie électrofaible et de SU(2)xU(1)

☹ MAIS, terme de masse non invariant de jauge

$\Rightarrow$ Particules sans masse!

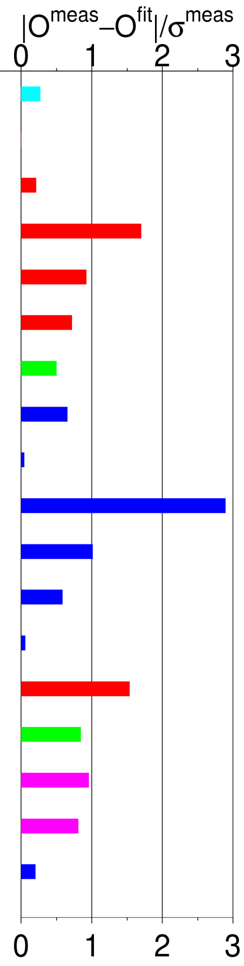
Mécanisme de Higgs: ajouté un champ scalaire (doublet de SU(2)) avec le bon potentiel

☺




- symétrie de jauge se brise
- bosons de jauges $\rightarrow$ massiques
- couplages de Yukawa
  $\rightarrow$ fermions massiques

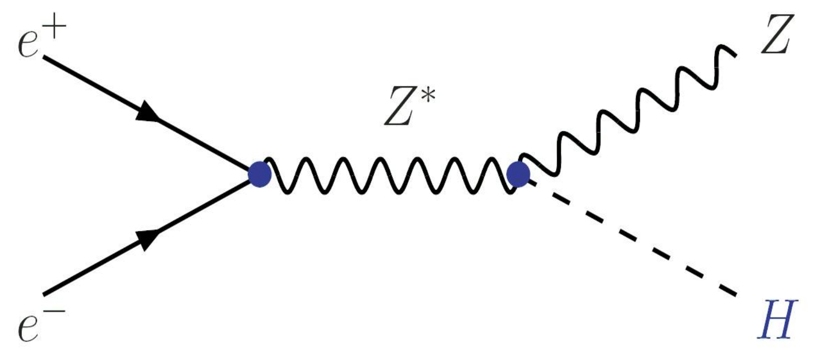
| | Measurement | Fit |
|---|---|---|
| $\Delta\alpha^{(5)}_{had}(m_Z)$ | $0.02758 \pm 0.00035$ | 0.02768 |
| $m_Z$ [GeV] | $91.1875 \pm 0.0021$ | 91.1875 |
| $\Gamma_Z$ [GeV] | $2.4952 \pm 0.0023$ | 2.4957 |
| $\sigma^0_{had}$ [nb] | $41.540 \pm 0.037$ | 41.477 |
| $R_l$ | $20.767 \pm 0.025$ | 20.744 |
| $A^{0,l}_{fb}$ | $0.01714 \pm 0.00095$ | 0.01645 |
| $A_l(P_\tau)$ | $0.1465 \pm 0.0032$ | 0.1481 |
| $R_b$ | $0.21629 \pm 0.00066$ | 0.21586 |
| $R_c$ | $0.1721 \pm 0.0030$ | 0.1722 |
| $A^{0,b}_{fb}$ | $0.0992 \pm 0.0016$ | 0.1038 |
| $A^{0,c}_{fb}$ | $0.0707 \pm 0.0035$ | 0.0742 |
| $A_b$ | $0.923 \pm 0.020$ | 0.935 |
| $A_c$ | $0.670 \pm 0.027$ | 0.668 |
| $A_l$(SLD) | $0.1513 \pm 0.0021$ | 0.1481 |
| $\sin^2\theta^{lept}_{eff}(Q_{fb})$ | $0.2324 \pm 0.0012$ | 0.2314 |
| $m_W$ [GeV] | $80.398 \pm 0.025$ | 80.374 |
| $\Gamma_W$ [GeV] | $2.140 \pm 0.060$ | 2.091 |
| $m_t$ [GeV] | $170.9 \pm 1.8$ | 171.3 |

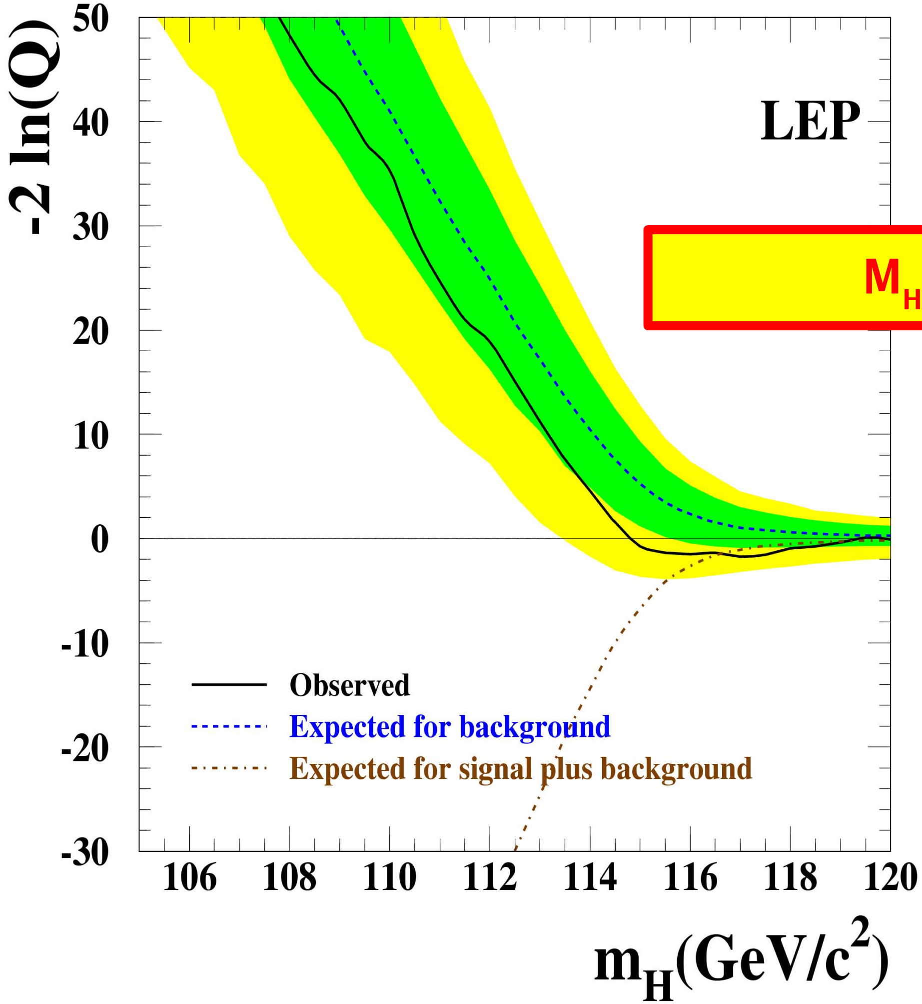



☹ relicat: le boson de Higgs, mais $m_H$ non prédit

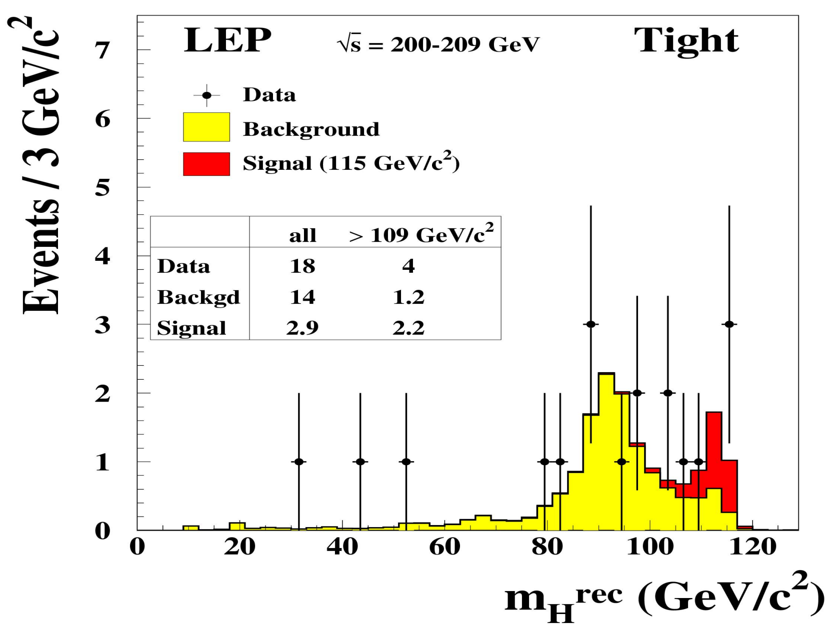
# Contraintes directes

## Recherche directe du boson de Higgs à LEP

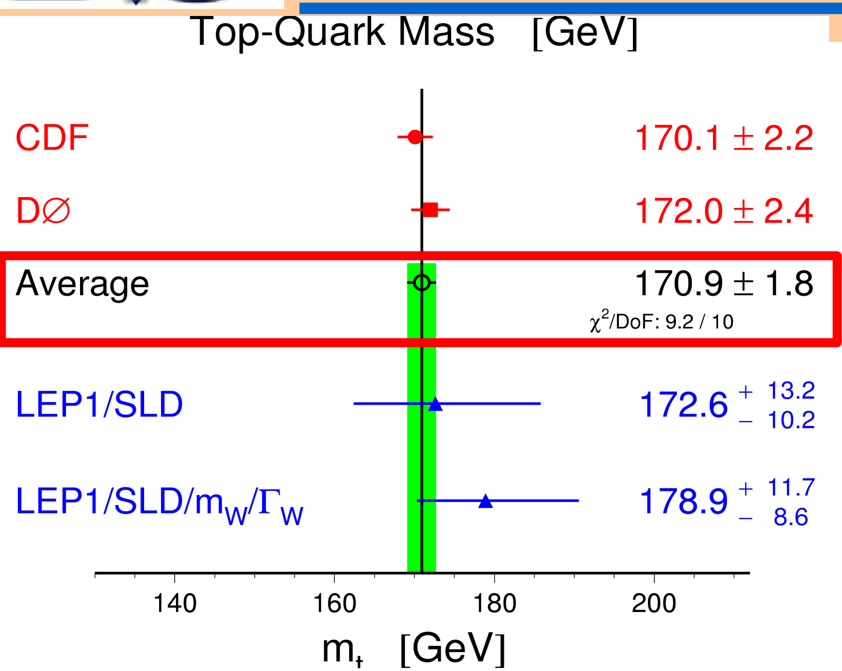


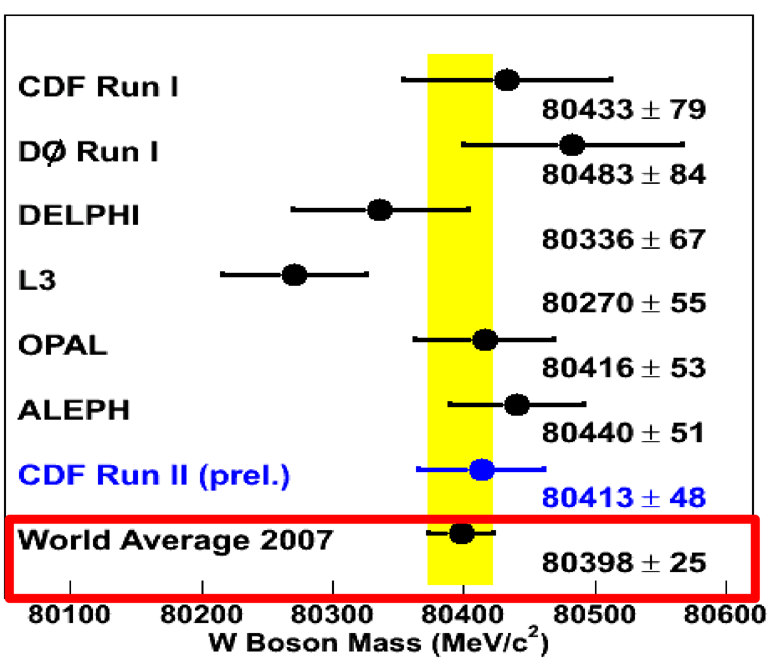

**$M_H$ > 114.4 GeV @ 95%**



# Contraintes indirectes



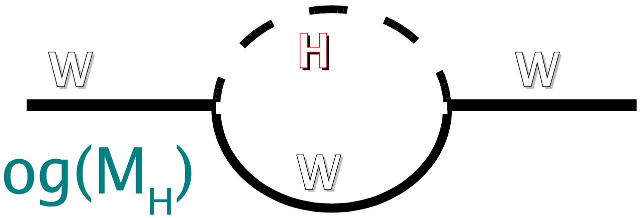

## Combinaisons **Mars 2007**

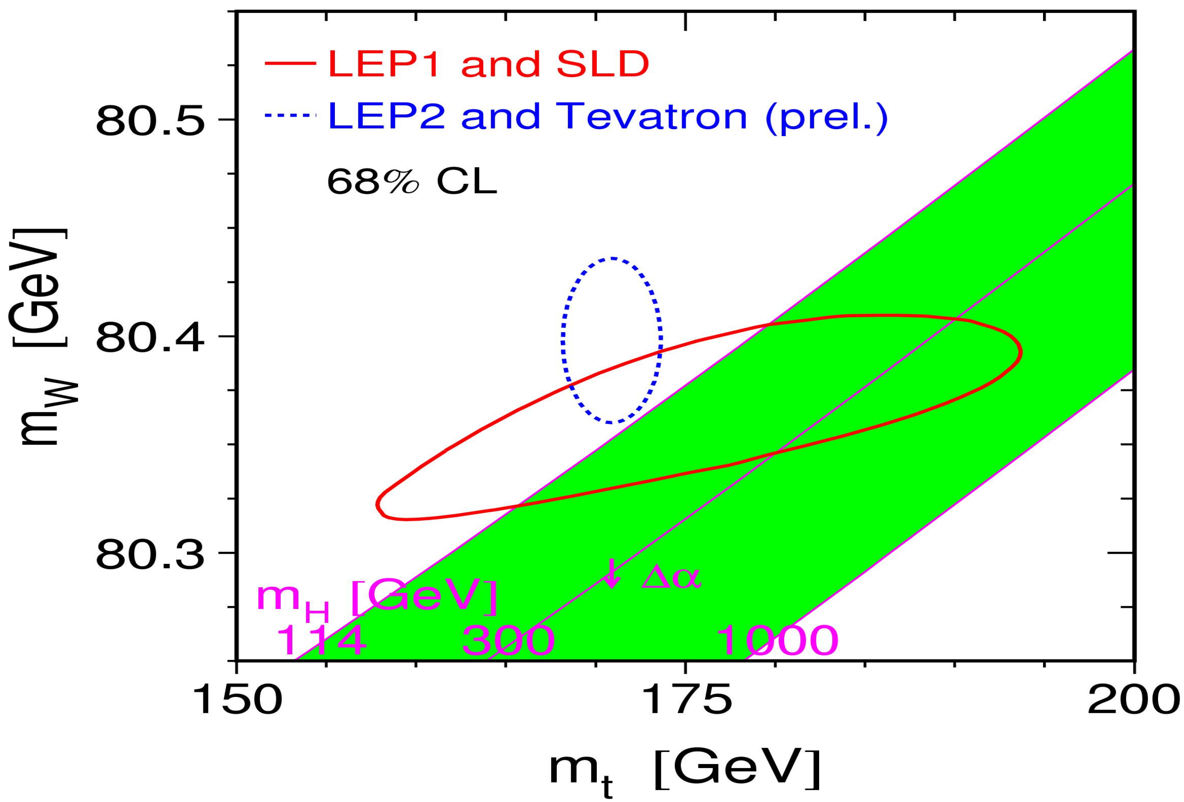



## Nouveaux résultats au Tevatron

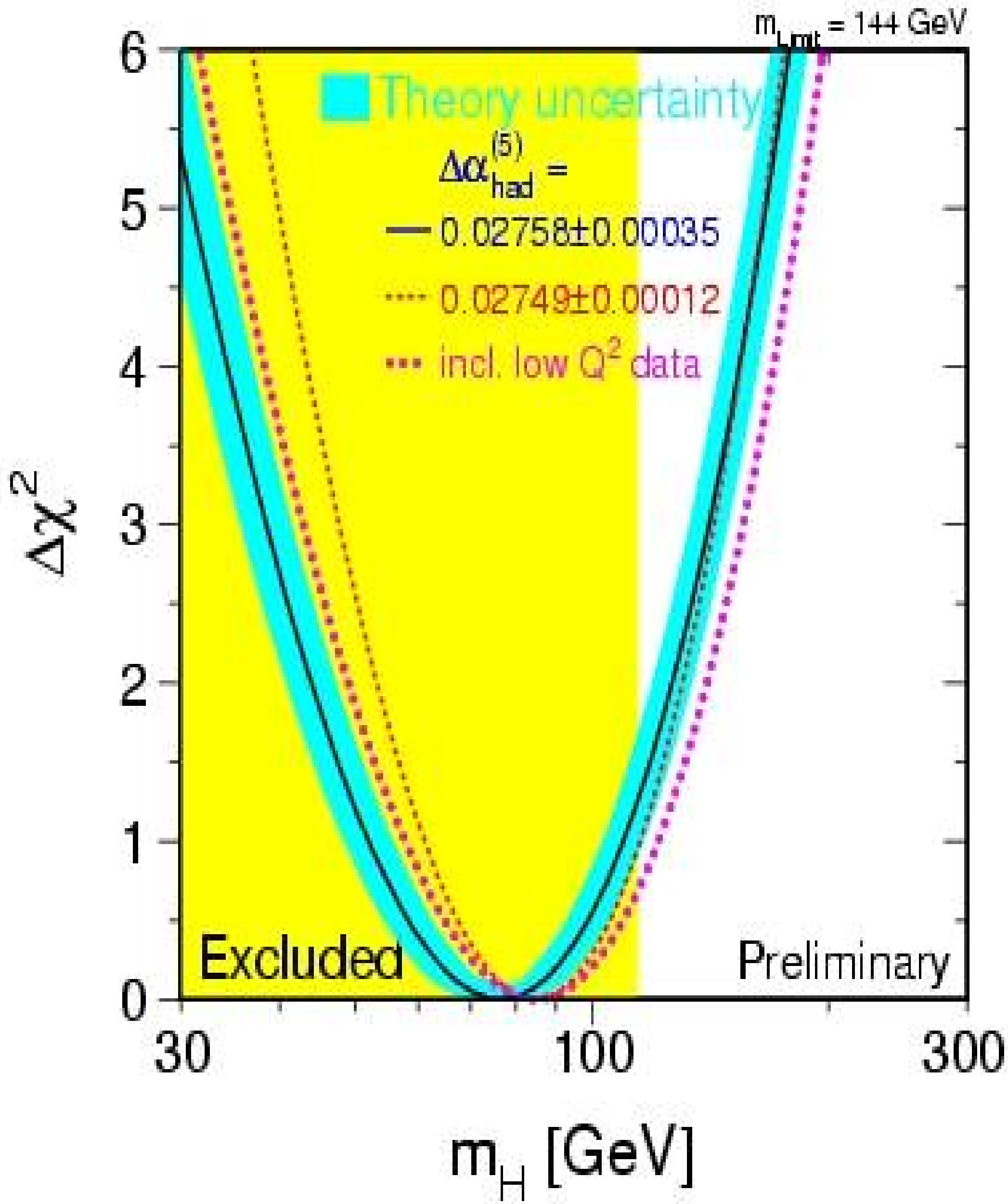
## Masses du top ET du W (CDF)

$\Delta M_W \alpha \log(M_H)$



# Fit Global




LEP EWG: Winter07

$M_H = 76^{+33}_{-24}$ GeV/c²

Upper limits @ 95 % CL

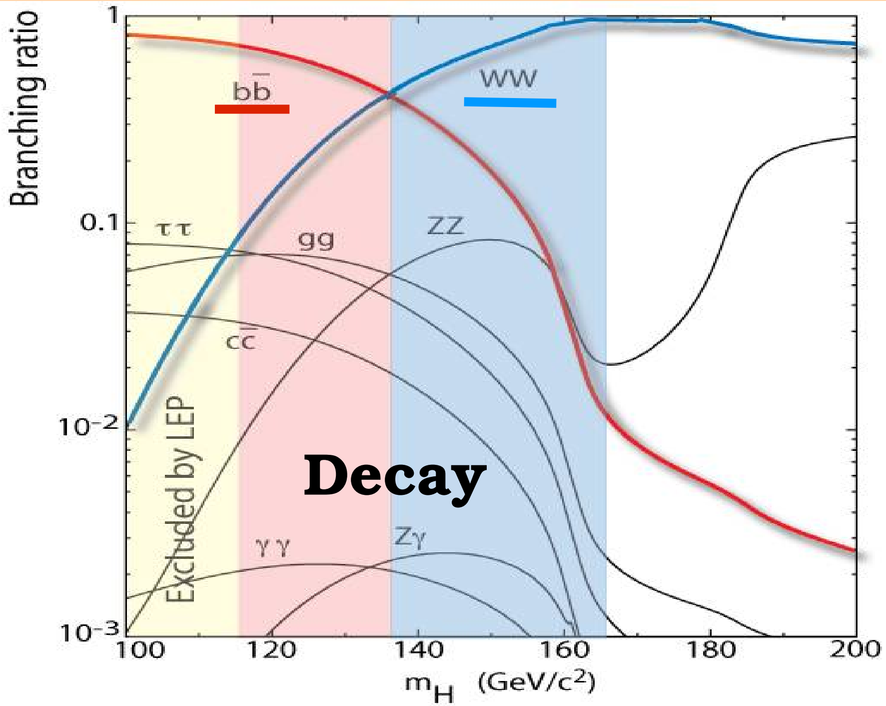
No direct search

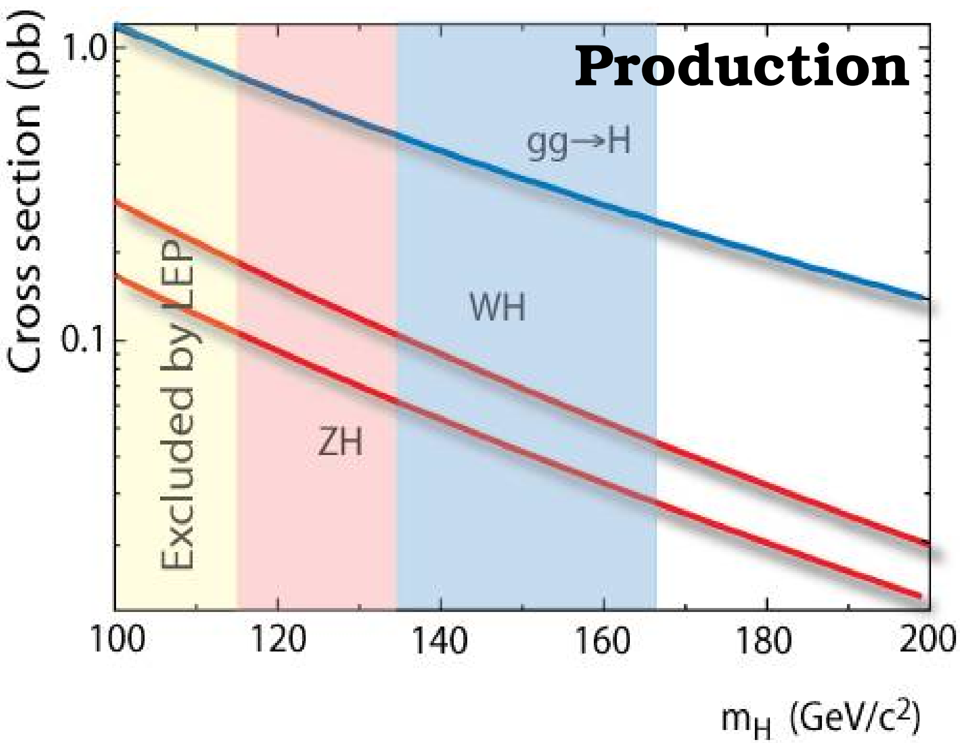
$M_H$ < 144 GeV/c²

Including LEP

$M_H$ < 182 GeV/c²

# Stratégie de recherche




☛ **Higgs de basse masse** ($m_H$ < 135 GeV/$c^2$)

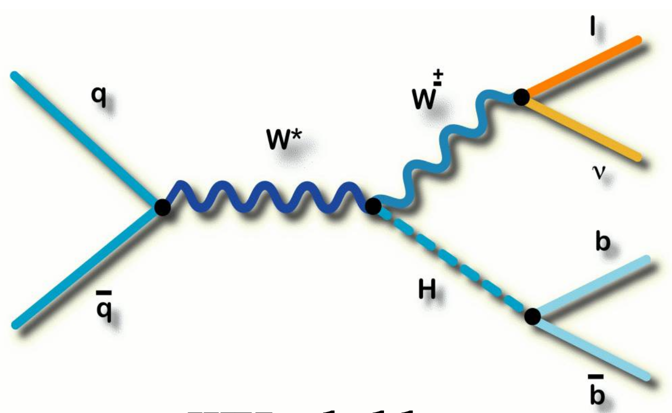
Au Tevatron, seule chance H→bb. Mais trop de <u>bruit de fond QCD</u> pour production inclusive ⇒ production associée WH, ZH (étiquetage avec leptons de haut $p_T$)

☛ **Higgs de haute masse** ($m_H$ > 135 GeV/$c^2$)

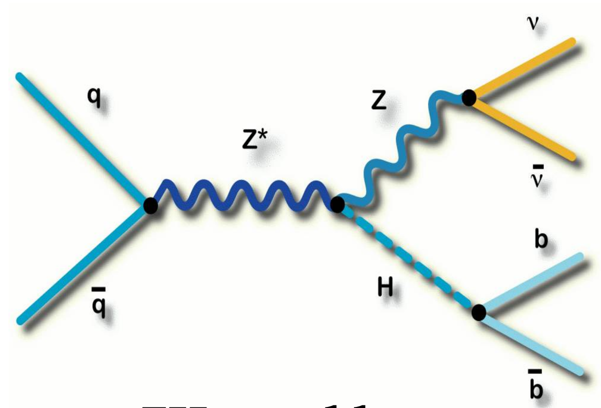
H→WW* grand taux d'embranchement, “seulement” bruits de fond électrofaibles (di-boson): recherche de gg → H(X)

# États finaux étudiés

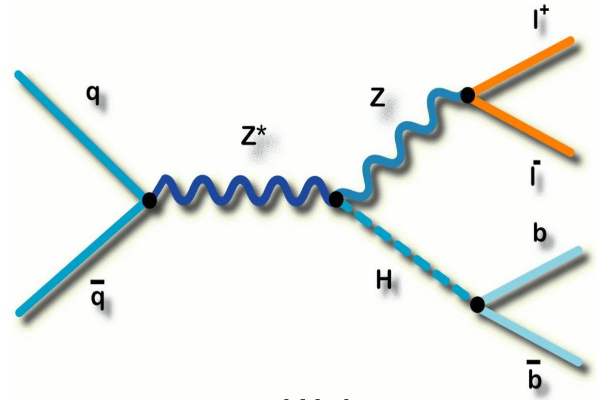
**Production associée:** basses masses, 3 états finals




**WH→lνbb**



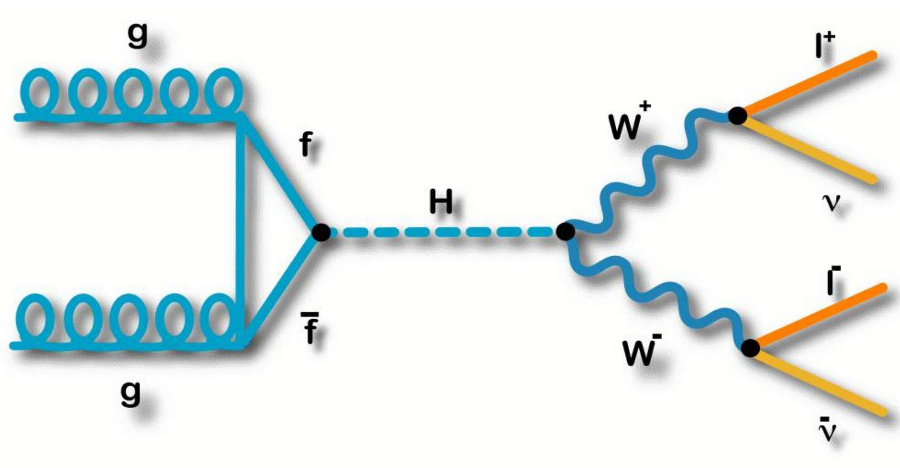

**ZH→ννbb**




**ZH→llbb**

**Gluon Fusion Production:**
hautes masses,
utile aussi à basses masses

**H→WW*→lνlν**

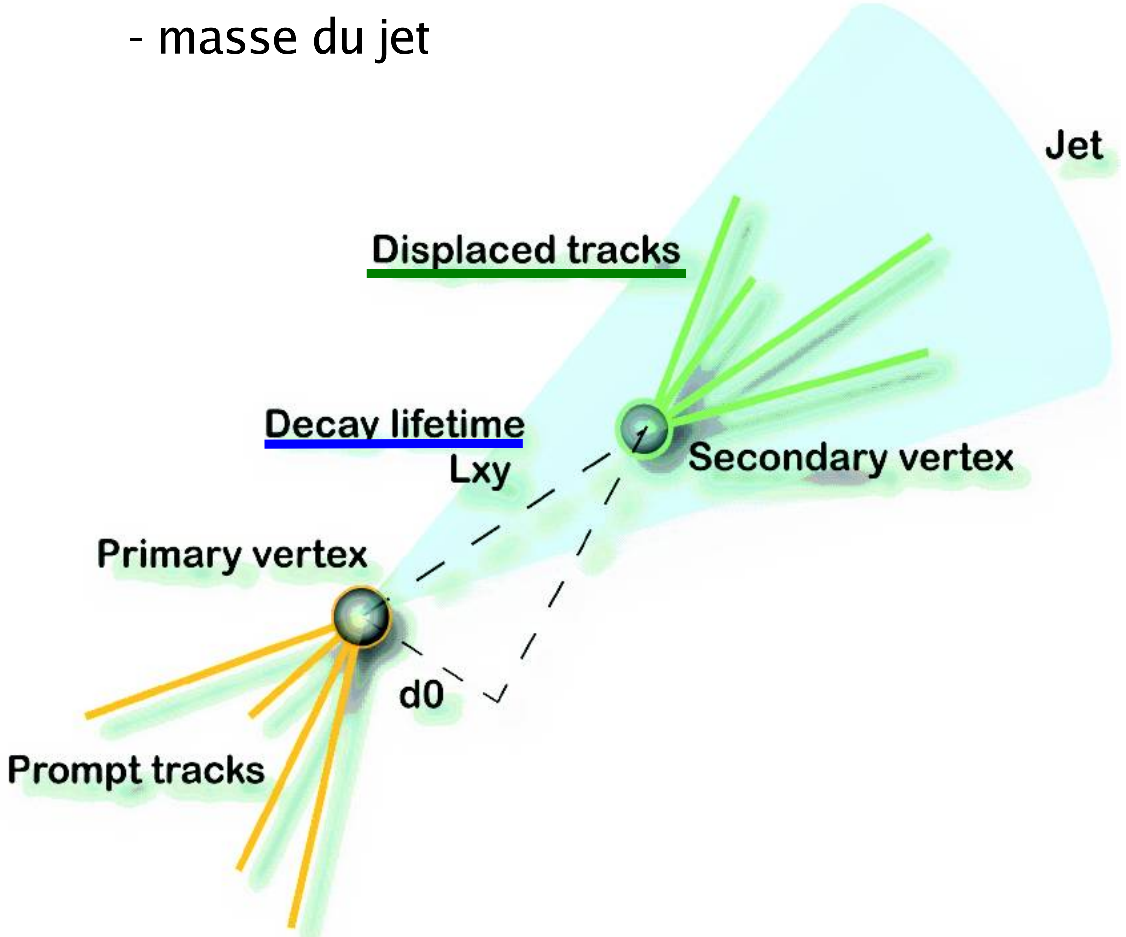


# Un outil indispensable

## Identitier les jets de b

Hadrons b: grands temps de vie + lourd

- vertex secondaires
- traces à grand paramètre d'impact
- masse du jet




CDF:

- vertex secondaires puis NN

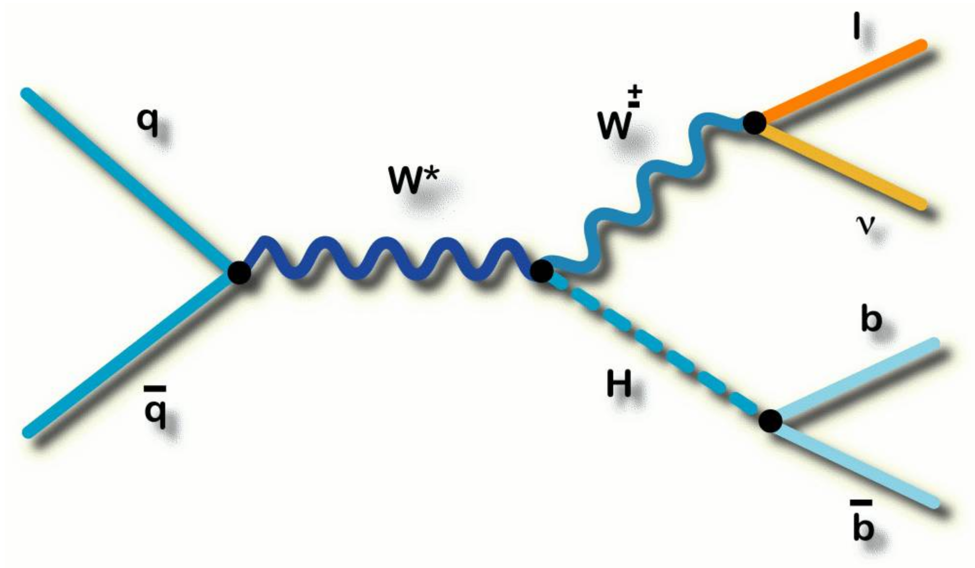
↳ efficacité (b): 40 / 50 %
↳ Réjection (j) : 0.5 / 1.5 %

DØ:

- informations cinématiques combinées dans un NN

↳ efficacité (b): 50 / 70 %
↳ Réjection (j) : 0.5 / 4.5 %

# WH → lυ bb




ICHEP 06
955 $pb^{-1}$

Moriond EW 07
1 $fb^{-1}$

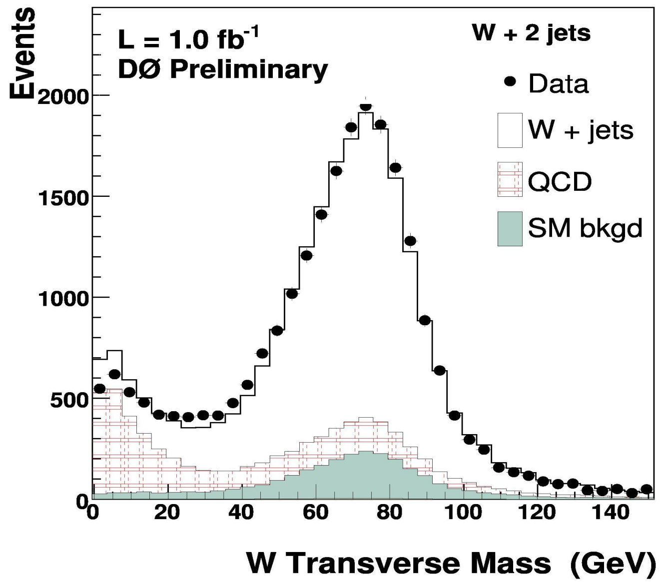
## Signature expérimentale:

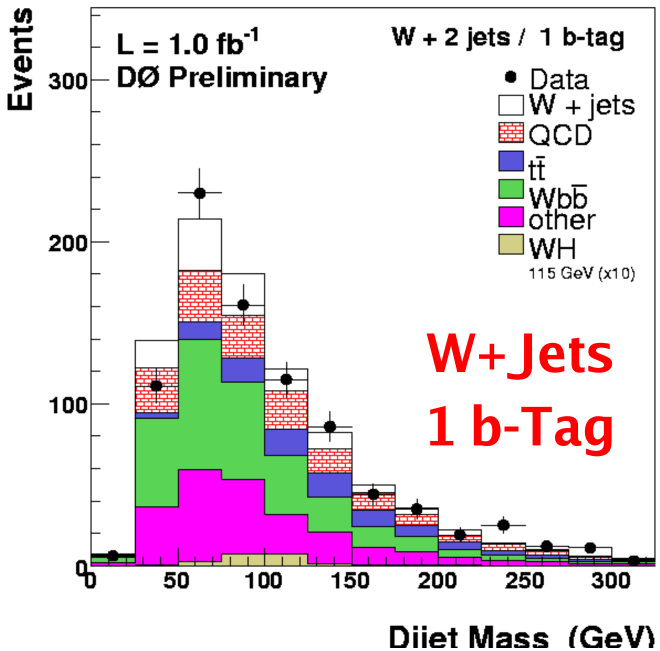
- 1 lepton e,μ dur isolé; $p_T$ [$\ell$]> 20 GeV/c
- Énergie transverse manquante (neutrino)
  $m_{ET}$ > 20 GeV
- au moins 2 jets de haut $p_T$
  $p_T$ > 20 (15) GeV/c à Dzero (CDF)
- Identification des jets de b (1 seul ou les 2)

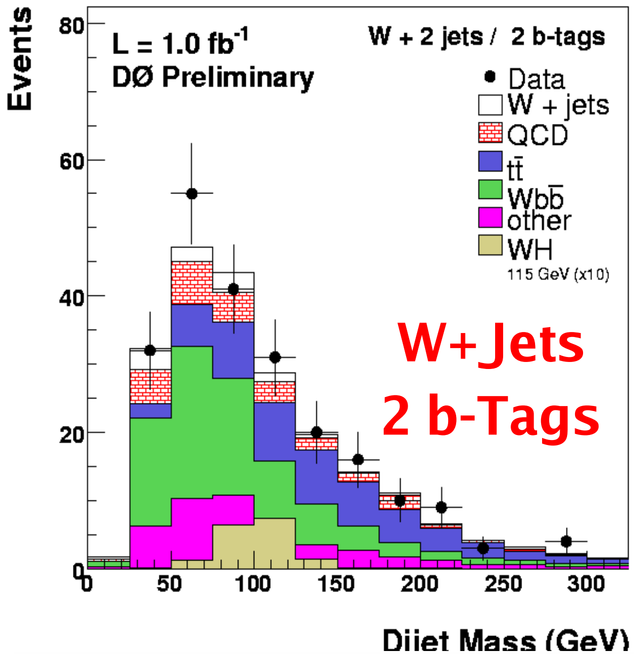
## Bruits de fond:

- **W + jets**
- QCD (B semi-leptonique)
- t tbar + single top
- diboson ZW

# Distributions avant/après tagging



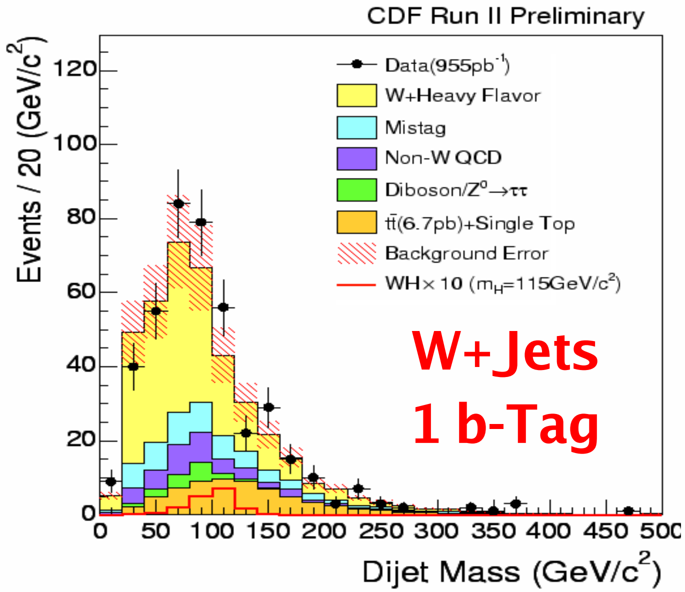



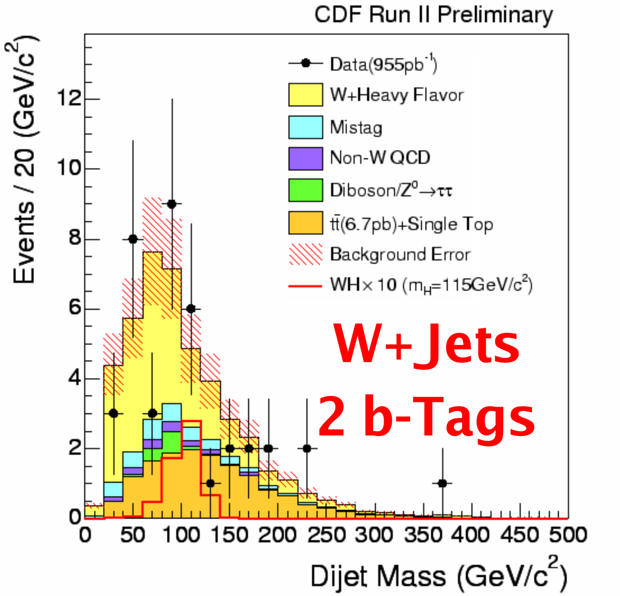




## Avant tagging

**Bruit de fond W+jets**

Normalisation du MC au données avant tagging en prenant en compte les autres bruits de fond



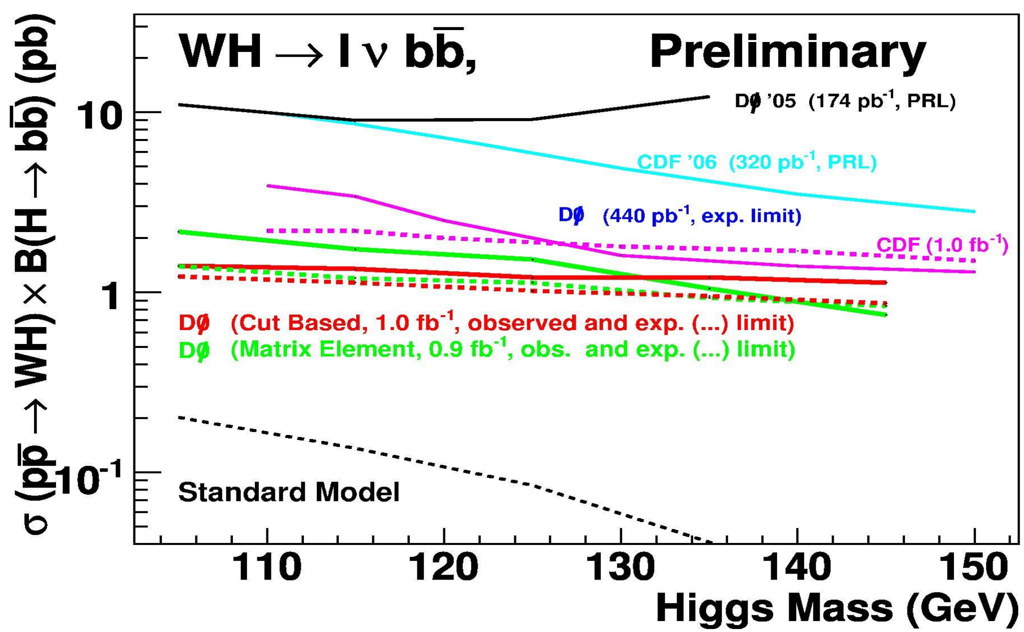



# Résultats WH

## Limites à 95 % CL ($m_H$ = 115 GeV/c2)

| 1 fb-1 | DØ | CDF |
|---|---|---|
| σ (×SM) exp | 1.1 pb (9×SM) | 2.2 pb (17×SM) |
| σ (×SM) obs | 1.3 pb (10×SM) | 3.4 pb (26×SM) |

Dzero utilise tous les triggers muons: +50% de signal !

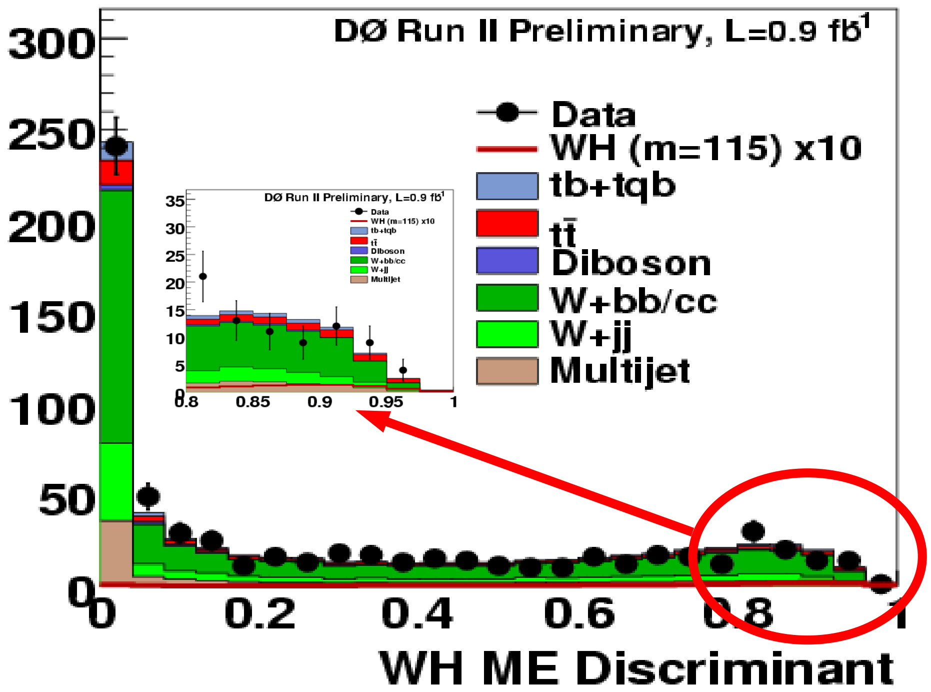


# L'avenir, un exemple

WH ou ZH systèmes complexes, contiennent plus d'informations que la seule masse invariante dijet: bénéfices des techniques multivariables pour discriminer signal/bruit de fond!

**Un exemple: la méthode des élèments de matrice appliquée à WH**

Rapport de Likelihood avec la méthode des élèments de matrices (cf plus loin)




Dzero: "1e cycle" analyse de recherche du single top pour la recherche du Higgs.

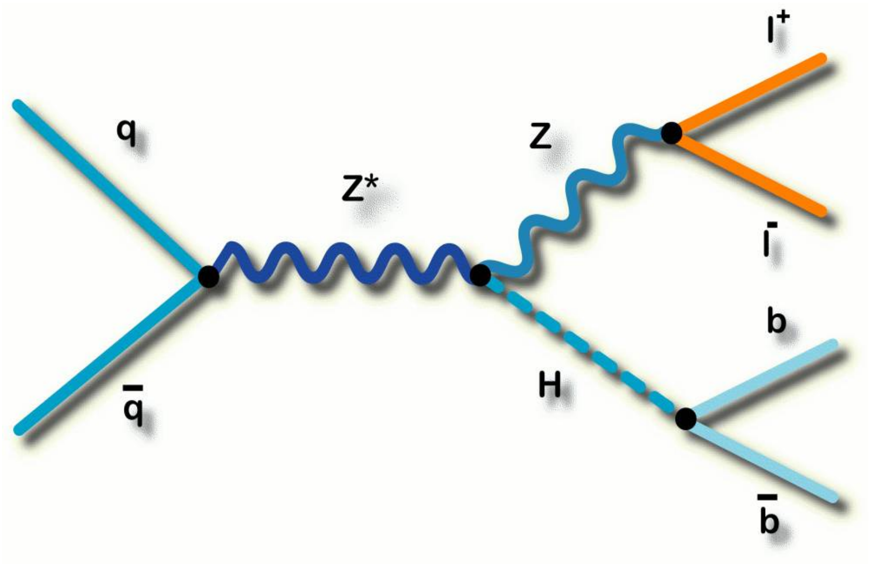
**Comparaison avec l'analyse "coupures"**

- pas d'optimisation, 30% moins efficace
- luminosité moins élevée
- pourtant **quasi aussi sensible** !

ME: $\sigma$ < 1.7 (1.2) pb, obs (exp)

cut : $\sigma$ < 1.3 (1.1) pb, obs (exp)

# $ZH \rightarrow ll\ bb$




Moriond QCD 07
~ 1 $fb^{-1}$

Novembre 06
840-920 $pb^{-1}$

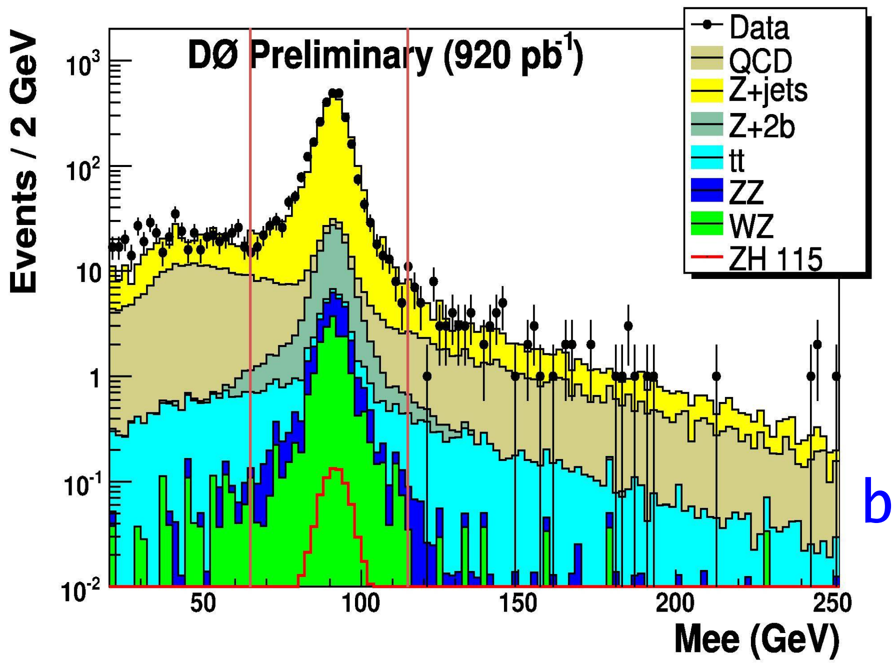
## Signature expérimentale:

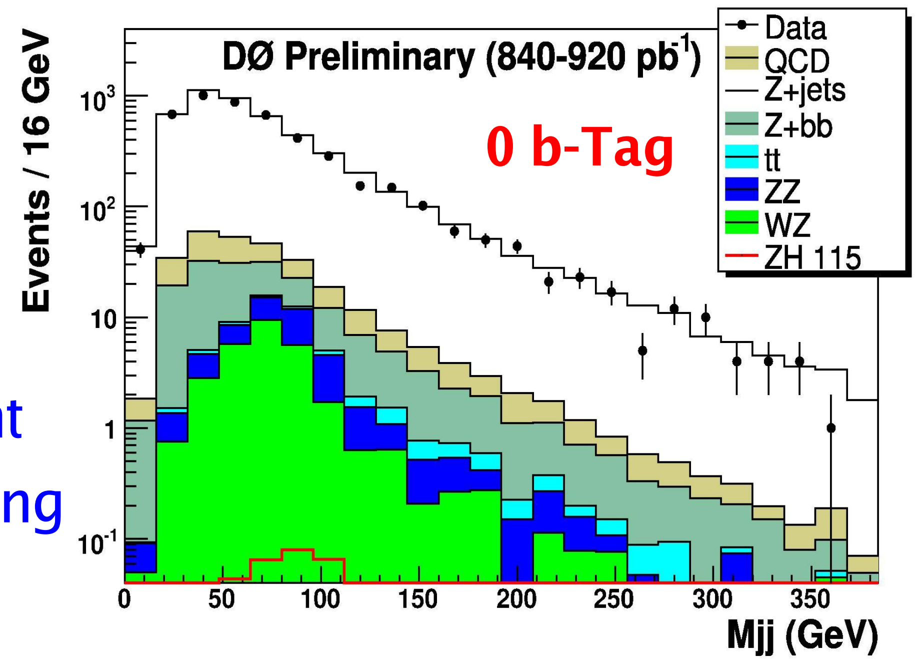
- 2 leptons (2e ou 2μ) durs, masse invariante compatible avec Z
- au moins 2 jets de haut $p_T$
- Identification des jets de b (1 seul ou les 2)

## Bruits de fond:

- **Z + jets**
- t tbar
- diboson ZZ

# ZH → ll bb à Dzero



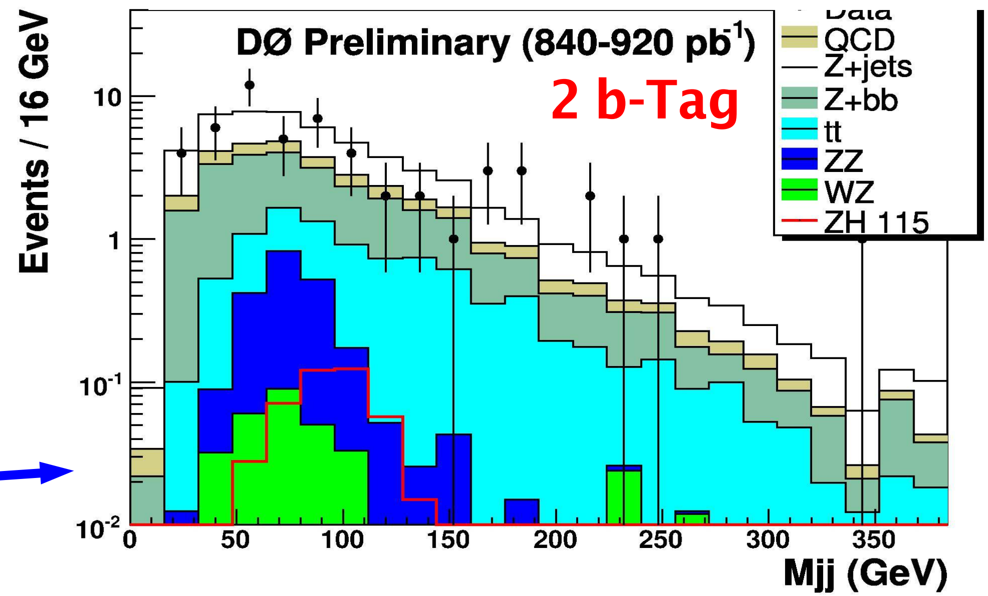

avant

b-tagging

- 2 jets $p_T > 15$ GeV/c
- 2 leptons $p_T > 15$ GeV/c

  coupure sur $m_{ll}$
- 2 b-Tag

Limite sur la masse invariante di-jet

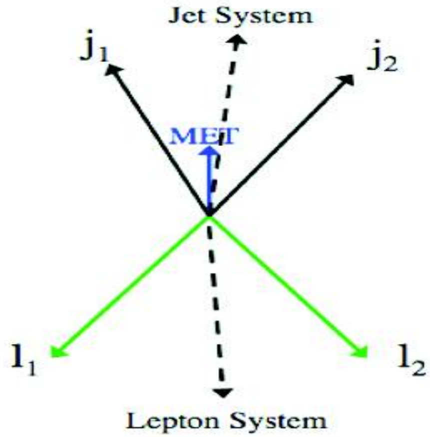


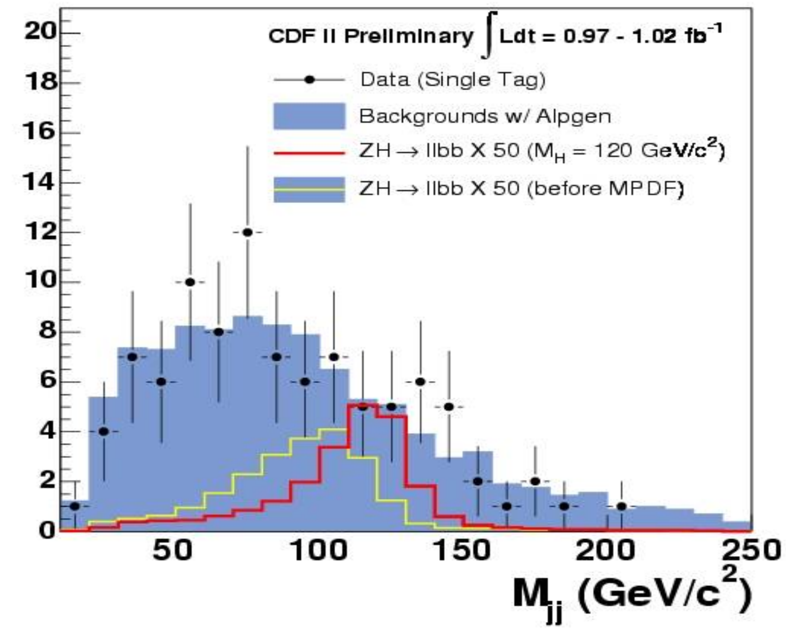
# ZH → ll bb à CDF

**Analyse sophistiquée à CDF. Deux points clefs:**

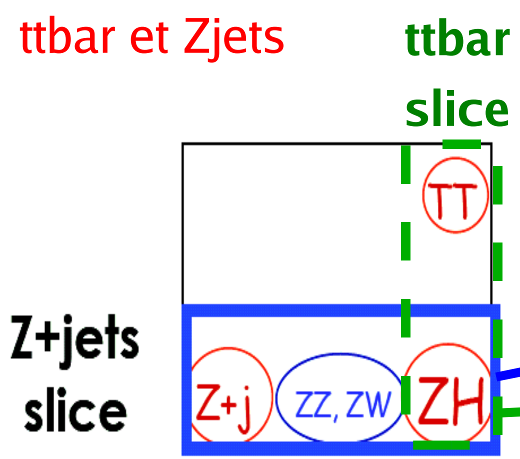
-

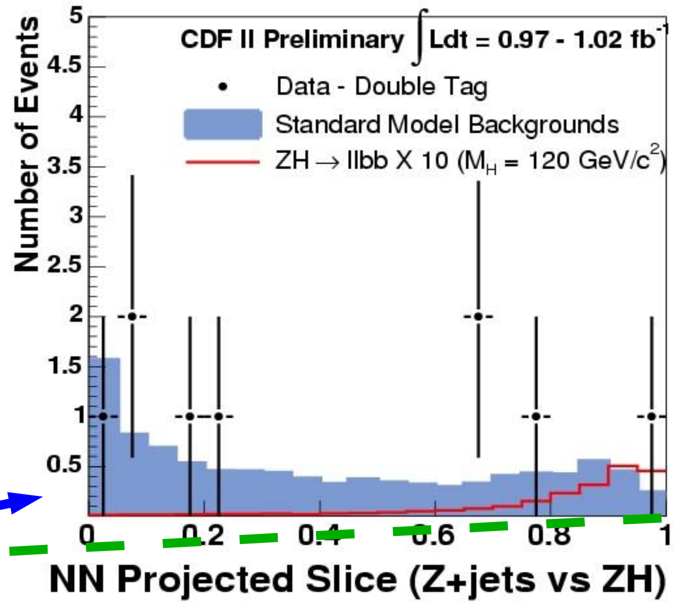
**1.** calcul des jets $p_T$ en imposant $m_{ET} = 0$
améliore résolution en masse dijet (15 %)
équivaut à lumi × 1.3

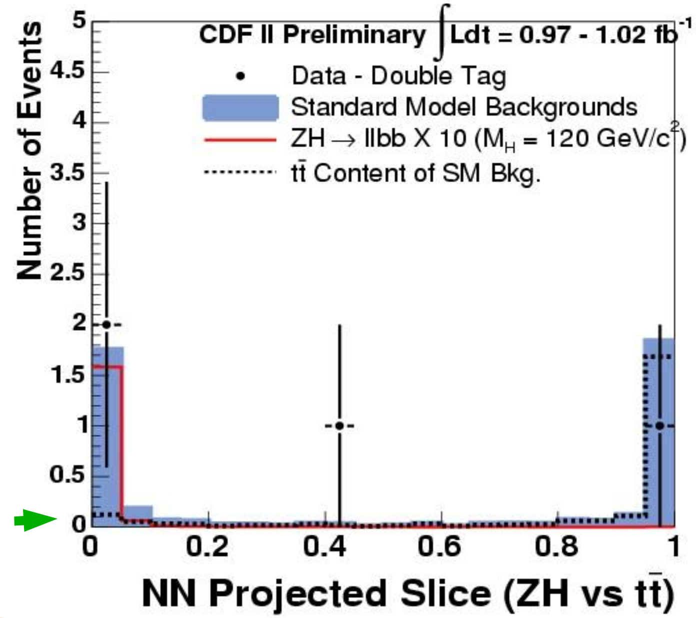



**2.** NN 2D pour lutter séparément contre ttbar et Zjets



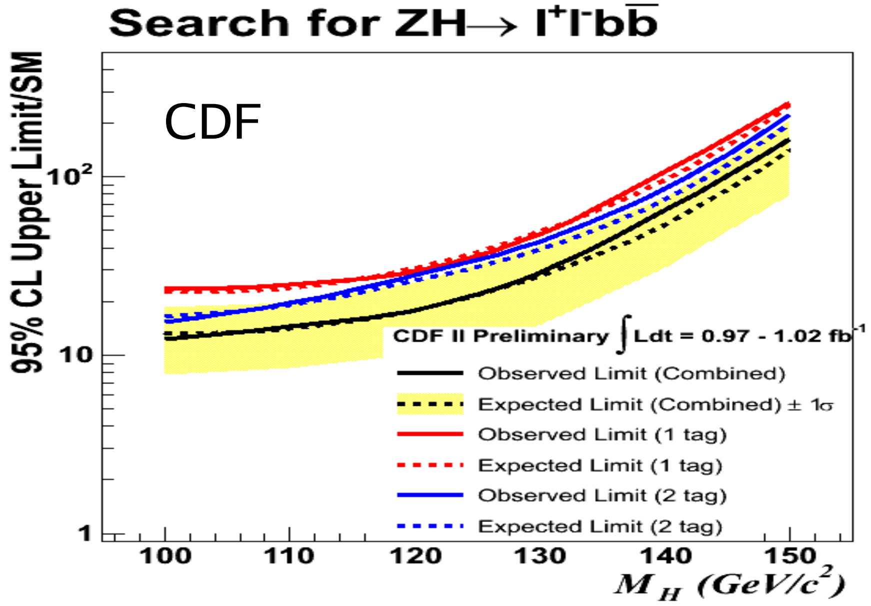



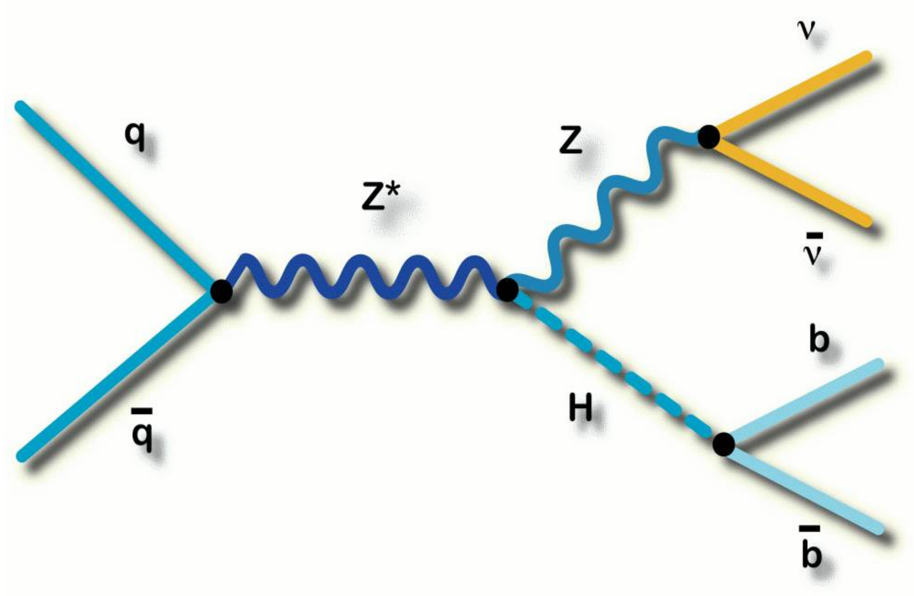
# Résultats ZH → ll bb

**Limites à 95 % CL ($m_H$ = 115 GeV/c2)**

| 1 fb-1 | DØ | CDF |
|---|---|---|
| σ (×SM) exp | 2.8 pb (34×SM) | 1.3 pb (16×SM) |
| σ (×SM) obs | 2.7 pb (33×SM) | 1.7 pb (21×SM) |



# ZH → υυ bb




ICHEP 06
970 $pb^{-1}$

avril 2007
930 $pb^{-1}$

## Signature expérimentale:

- au moins 2 jets de haut $p_T$
- large $m_{ET}$ (2 neutrinos)
- pas de traces chargées isolées
- Identification des jets de b (1 seul ou les 2)

## Bruits de fond:

- **W/Z + jets**
- **QCD saveurs lourdes**
- top

## Bonus:

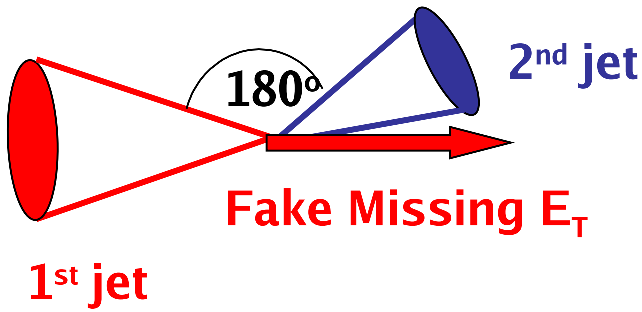
- WH → lυbb où l n'est pas détecté

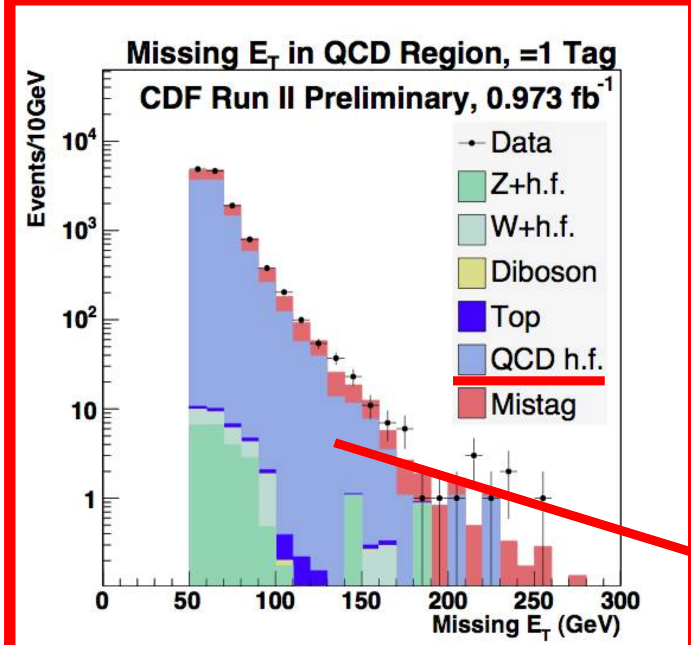
# Un bruit de fond complexe

***Bruit de fond : QCD bb***

Variables cinématiques: MC ?

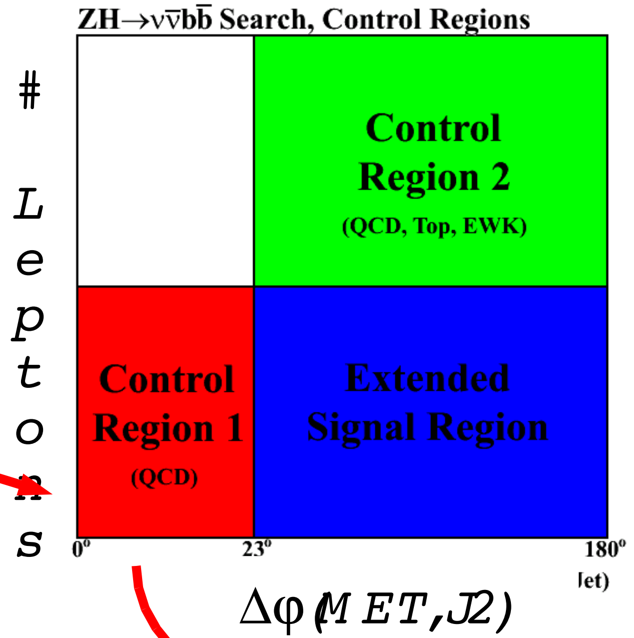
Normalisation : seulement données




MET in QCD control region:

- no leptons
- met close to second jet




Distributions : MC

Normalisation : Data

# Un bruit de fond complexe

## Différentes définitions de l'énergie transverse manquante

<u>Missing ET (mET)</u>: avec cellules du calorimètre

<u>Missing HT (mHT)</u>: avec impulsions des jets

<u>Missing Trk pT (mTrk):</u> avec traces chargées

Signal: pointent toutes dans la même direction

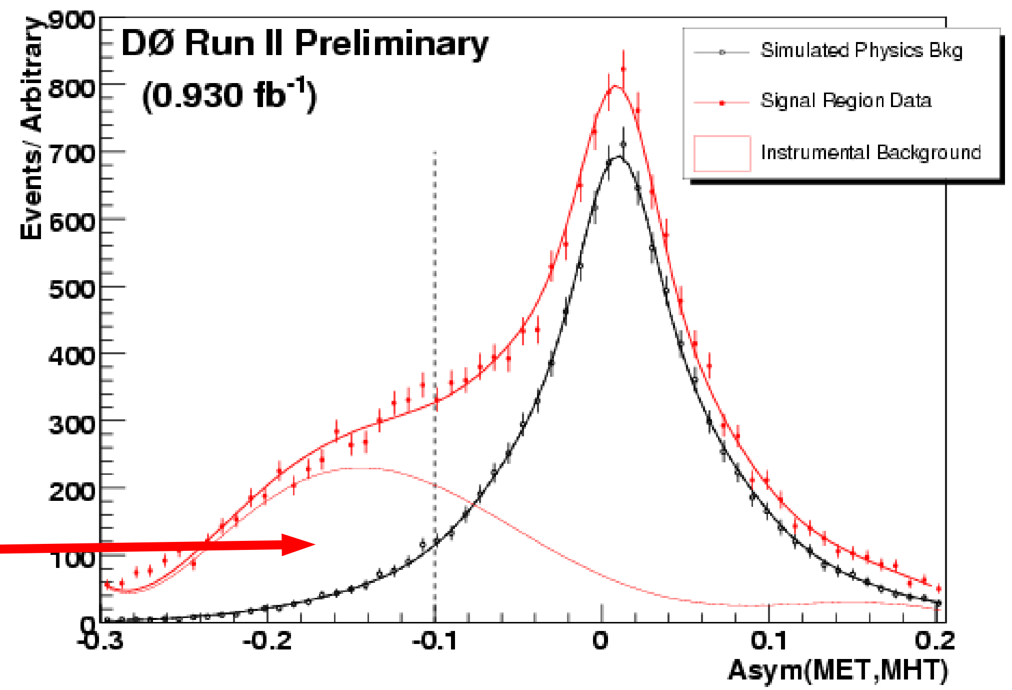
di-jet : mET créée par jets malmesurés

## Fenêtre Signal:

- ✗ Asym(MET,MHT) = (MET-MHT)/(MET+MHT) > -0.1
- ✗ $\Delta\phi$(MET,MTrkPt) < $\pi$π/2

✗ Région de control:

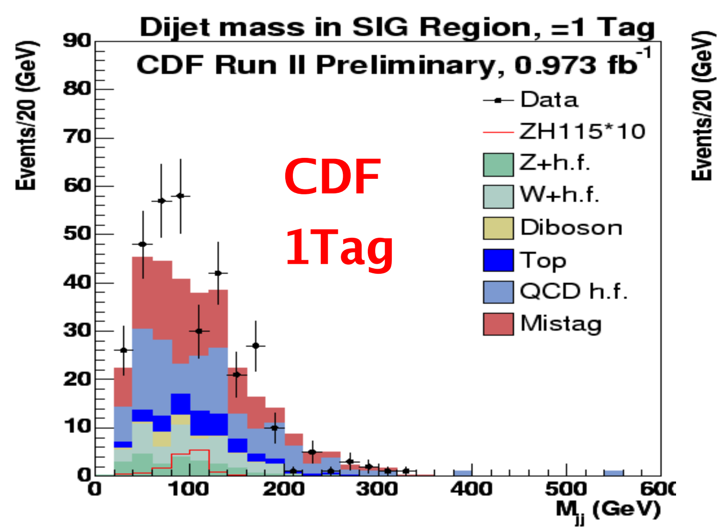
- ✗ $\Delta\phi$(MET,MTrkPt) > $\pi$/2

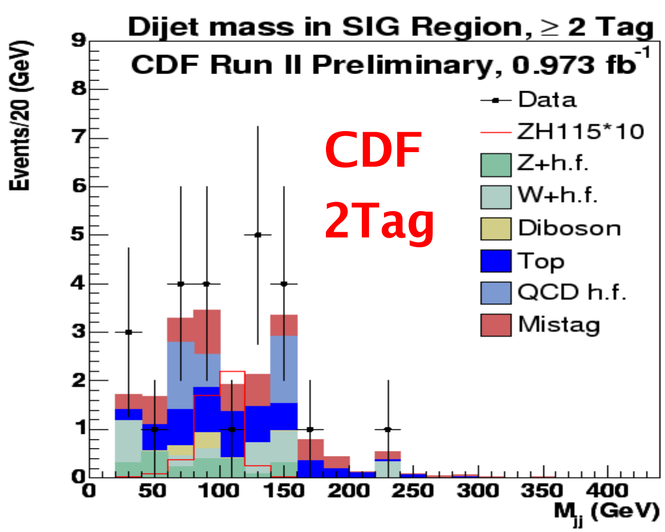


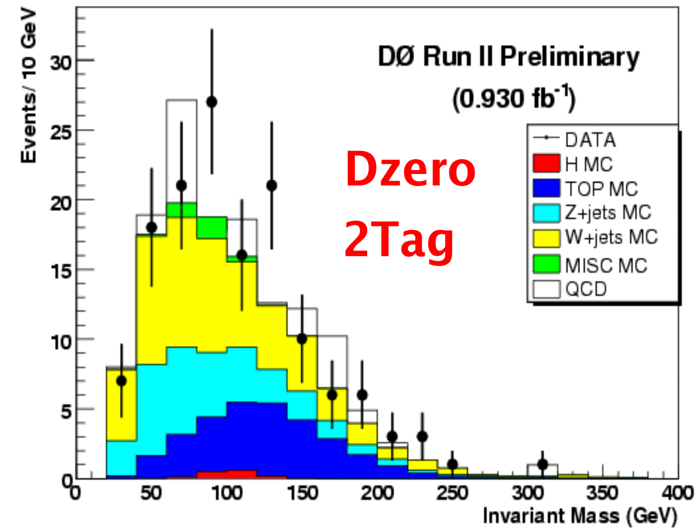
# Résultats ZH → νν bb

## Limites à 95 % CL ($m_H$ = 115 GeV/c2)

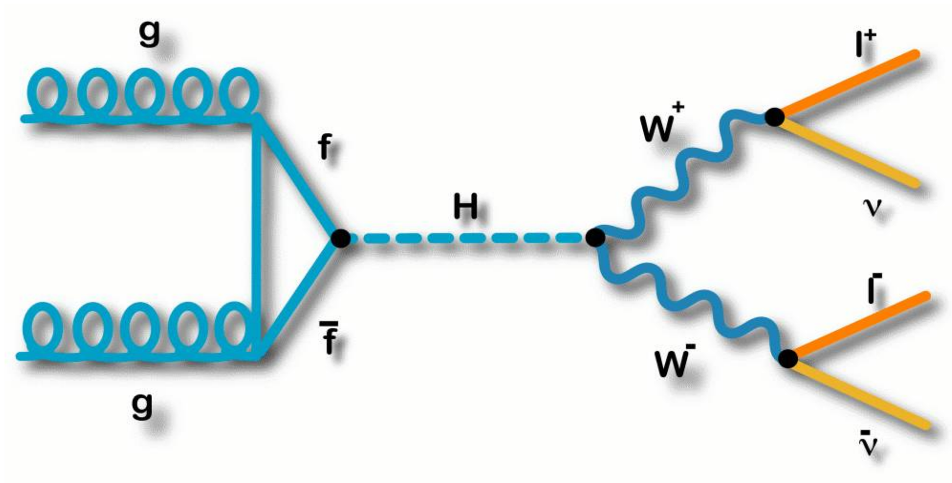
| 1 fb-1 | DØ | CDF |
|---|---|---|
| xSM exp : ZH/WH/comb | 25 / 38 / ?? | 28 / 34 / 16 |
| xSM obs : comb | 33 / 50 / ?? | 16 |



# $H \rightarrow WW^* \rightarrow l\nu \, l\nu$




Moriond QCD 07
1.1 $fb^{-1}$

ICHEP 06
930-950 $pb^{-1}$

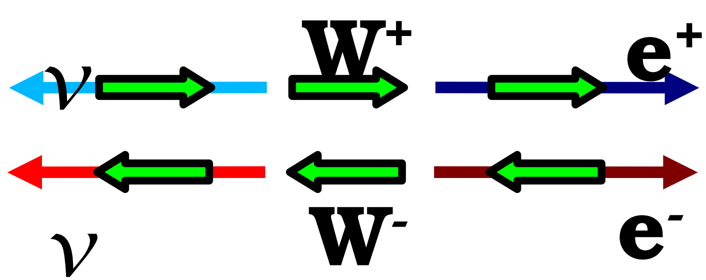
## Signature expérimentale:

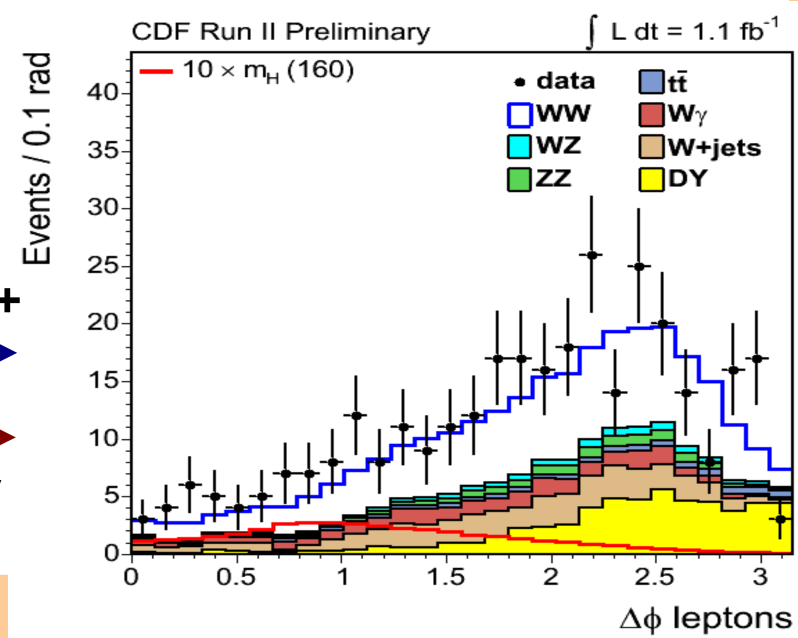
- 2 leptons de haut $p_T$ (e ou $\mu$)
- large $m_{ET}$ (2 neutrinos)

## Bruits de fond:

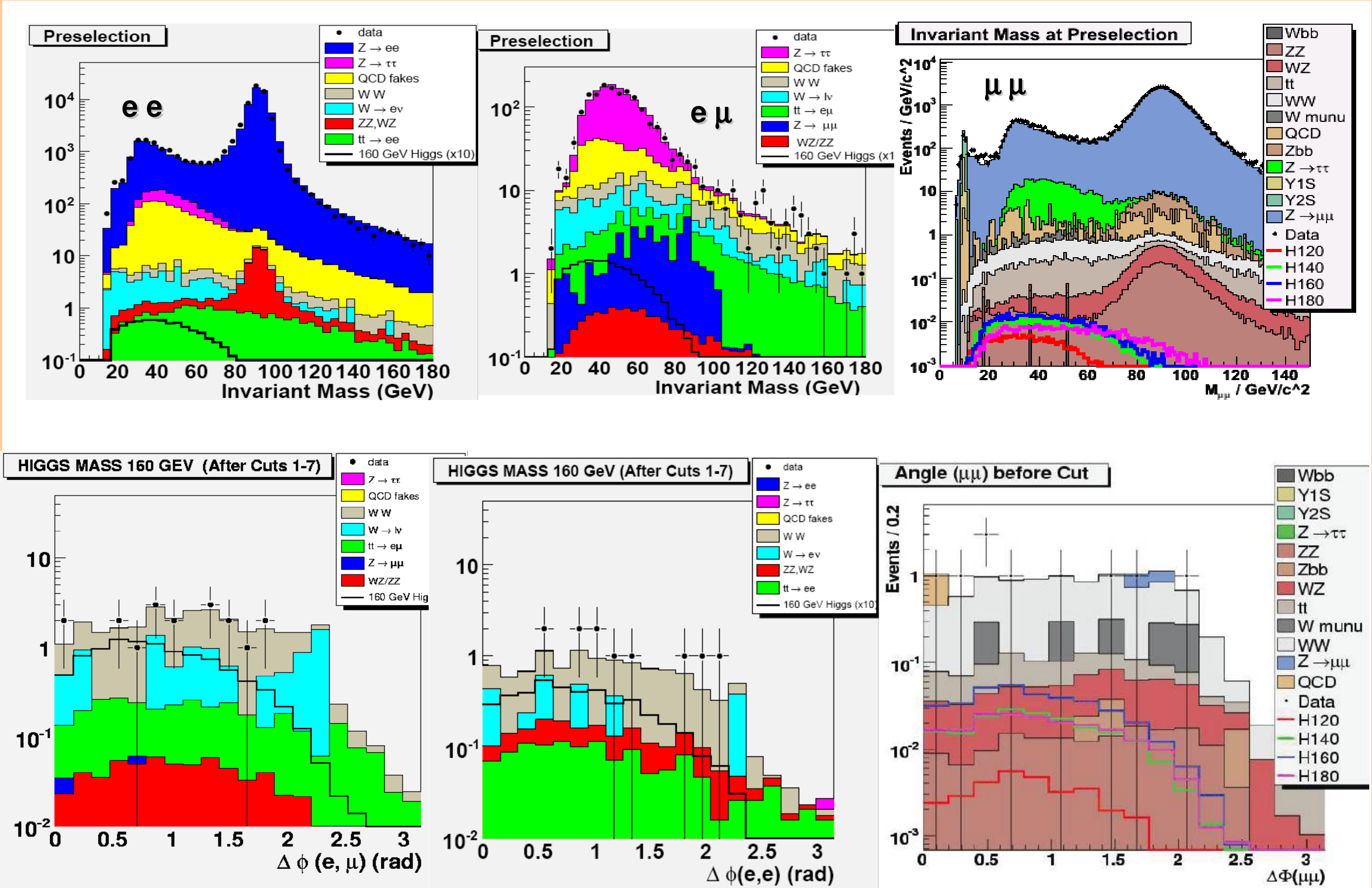
- WW / WZ
- $Z \rightarrow \tau\tau$
- Drell yan

**Higgs scalaire:**
les 2 leptons sont
"c olinéaires"



# H → WW* à Dzero


Preselection
e e
data
Z → ee
Z → ττ
QCD fakes
W W
W → eν
ZZ,WZ
tt → ee
160 GeV Higgs (x10)
Invariant Mass (GeV)
Preselection
e μ
data
Z → ττ
QCD fakes
W W
W → lν
tt → eμ
Z → μμ
WZ/ZZ
Invariant Mass (GeV)
Invariant Mass at Preselection
μ μ
Events / GeV/c^2
Wbb
ZZ
WZ
tt
WW
W munu
QCD
Zbb
Z →ττ
Y1S
Y2S
Z →μμ
Data
H120
H140
H160
H180
HIGGS MASS 160 GEV (After Cuts 1-7)
data
Z → ττ
QCD fakes
W W
W → lν
tt → eμ
Z → μμ
WZ/ZZ
Δ φ (e, μ) (rad)
HIGGS MASS 160 GeV (After Cuts 1-7)
data
Z → ee
Z → ττ
QCD fakes
W W
W → eν
ZZ,WZ
tt → ee
Δ φ(e,e) (rad)
Angle (μμ) before Cut
Events / 0.2
Wbb
Y1S
Y2S
Z →ττ
ZZ
Zbb
WZ
tt
W munu
WW
Z →μμ
QCD
Data
H120
H140
H160
H180
ΔΦ(μμ)

# $H \to WW^*$ à CDF

Probabilité d'observer la configuration cinématique “ob s” en supposant l'évt issu du processus m.

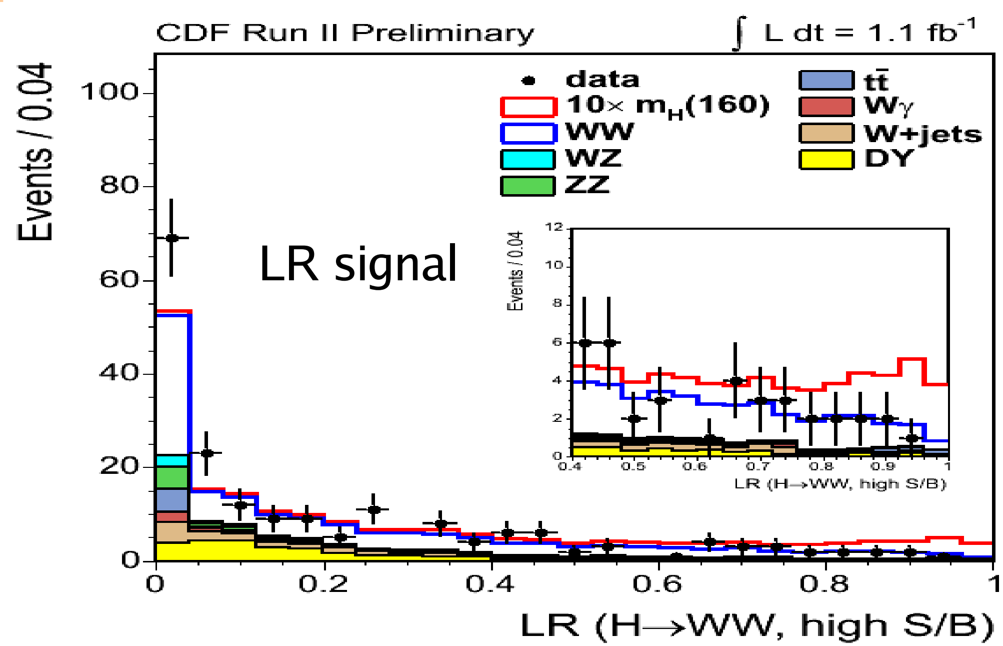
$$P_m(x_{obs}) = \frac{1}{<\sigma_m>} \int \frac{d\sigma_m^{th}(y)}{dy} \epsilon(y) G(x_{obs}, y) dy$$

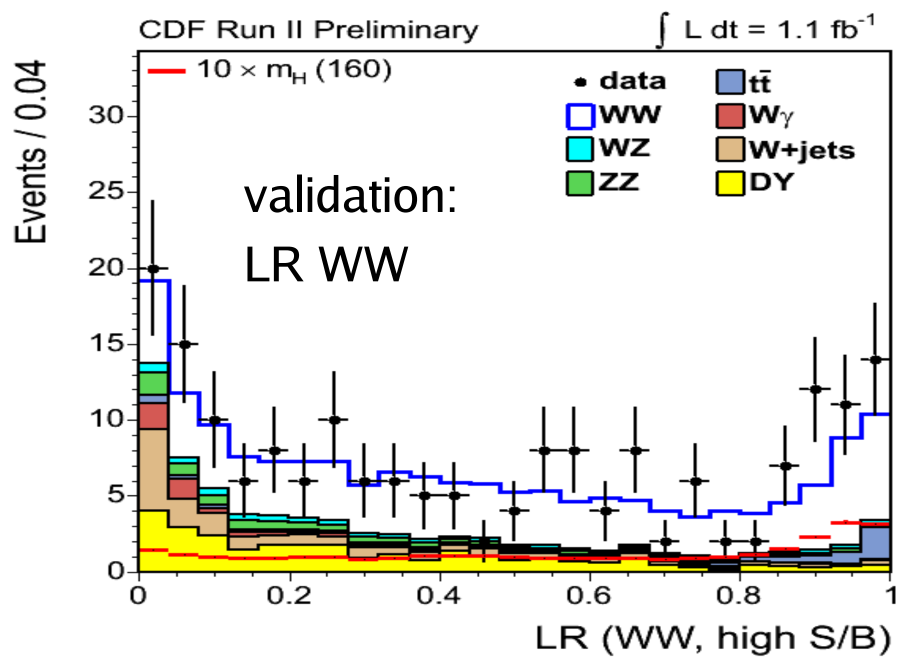
ME de m + PDFs

Fonction de transfert

Calcul du rapport de Likelihood:

$$LR(x_{obs}) \equiv \frac{P_H(x_{obs})}{P_H(x_{obs}) + \Sigma_i k_i P_i(x_{obs})}$$

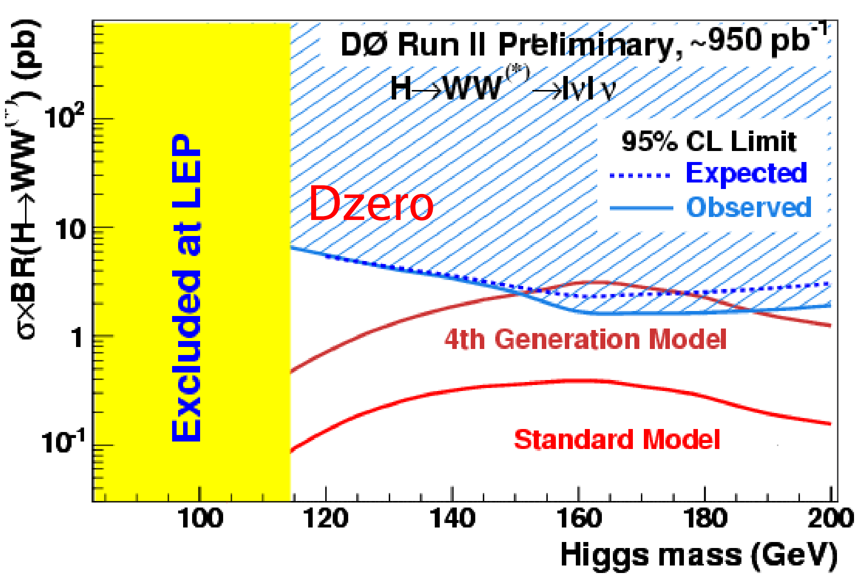


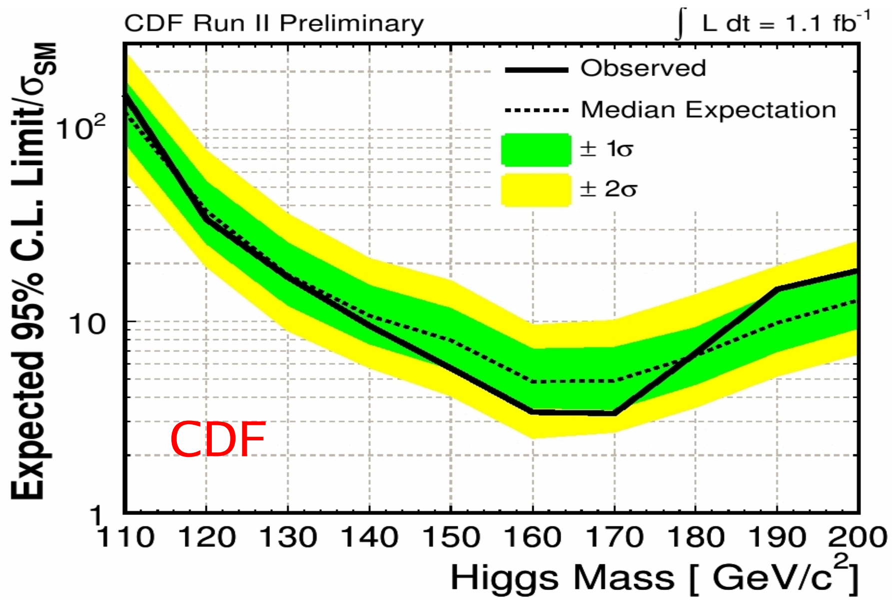



# Résultats H → WW*

**Limites à 95 % CL ($m_H$ = 160 GeV/$c^2$)**

| 1 fb-1 | DØ | CDF |
|---|---|---|
| σ (×SM) exp | 2.4 pb (6.0×SM) | 1.8 pb (5.0×SM) |
| σ (×SM) obs | 1.7 pb (4.5×SM) | 1.3 pb (3.5×SM) |



# Apercu des systématiques

## Exemple: CDF

## Systématiques utilisées dans la combinaison des résultats

TABLE V: The breakdown of systematic uncertainties for each individual CDF analysis. All positive-signed uncertainties within a group are considered 100% correlated across channels. Values with negative signs are considered uncorrelated.

| Source | $WH \to \ell\nu b\bar{b}$ ST | $WH \to \ell\nu b\bar{b}$ DT | $ZH \to \nu\bar{\nu}b\bar{b}$ ST | $ZH \to \nu\bar{\nu}b\bar{b}$ DT | $ZH \to \ell^+\ell^- b\bar{b}$ | $H \to W^+W^-$ |
|---|---|---|---|---|---|---|
| Luminosity (%) | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| $b$-Tag Scale Factor (%) | 5.3 | 16.0 | 8.0 | 16.0 | 8.0 | n/a |
| Lepton Identification (%) | 2.0 | 2.0 | 2.0 | 2.0 | 1.4 | 3.0 |
| Jet Energy Scale (%) | 3.0 | 3.0 | 6.0 | (1.0-20.0) | (1.6-20.0) | 1.0 |
| I(S)R+PDF (%) | 4.0 | 10.0 | 4.0 | 5.0 | 2.0 | 5.0 |
| Trigger (%) | 0.0 | 0.0 | 3.0 | 3.0 | 0.0 | 0.0 |
| $Z + h.f.$ Shape (%) | n/a | n/a | n/a | n/a | -20 | n/a |
| **Backgrounds** | | | | | | |
| W/Z+HF(I) (%) | 33.0 | 34.0 | 12.0 | 12.0 | 40.0 | n/a |
| W+HF(II) (%) | 0 | 0 | -10.0 | -42.0 | 0 | n/a |
| Z+HF(II) (%) | 0 | 0 | -6.0 | -19.0 | 0 | n/a |
| Mistag (%) | 22.0 | 15.0 | 17.0 | 17.0 | 17.0 | n/a |
| Top I (%) | 13.5 | 20.0 | 12.0 | 12.0 | 20.0 | n/a |
| Top II (%) | n/a | n/a | -2.0 | -3.0 | n/a | n/a |
| QCD (%) | 17.0 | 20.0 | -10.0 | -44.0 | -50.0 | n/a |
| Diboson I (%) | 16.0 | 25.0 | 12.0 | 12.0 | 20.0 | 11.0 |
| Diboson I (%) | n/a | n/a | -5.0 | -10.0 | n/a | n/a |
| Others (%) | n/a | n/a | n/a | n/a | n/a | -(12.0-18.0) |

Acceptance syst

Background syst

# Une idée du challenge

Nombres d'événements de signal et de bruit de fond attendus avec les coupures utilisées à Dzero pour les modes sensibles à un bosons de Higgs de 115 GeV/$c^2$

**Expected/Observed Events in 1.0$fb^{-1}$**

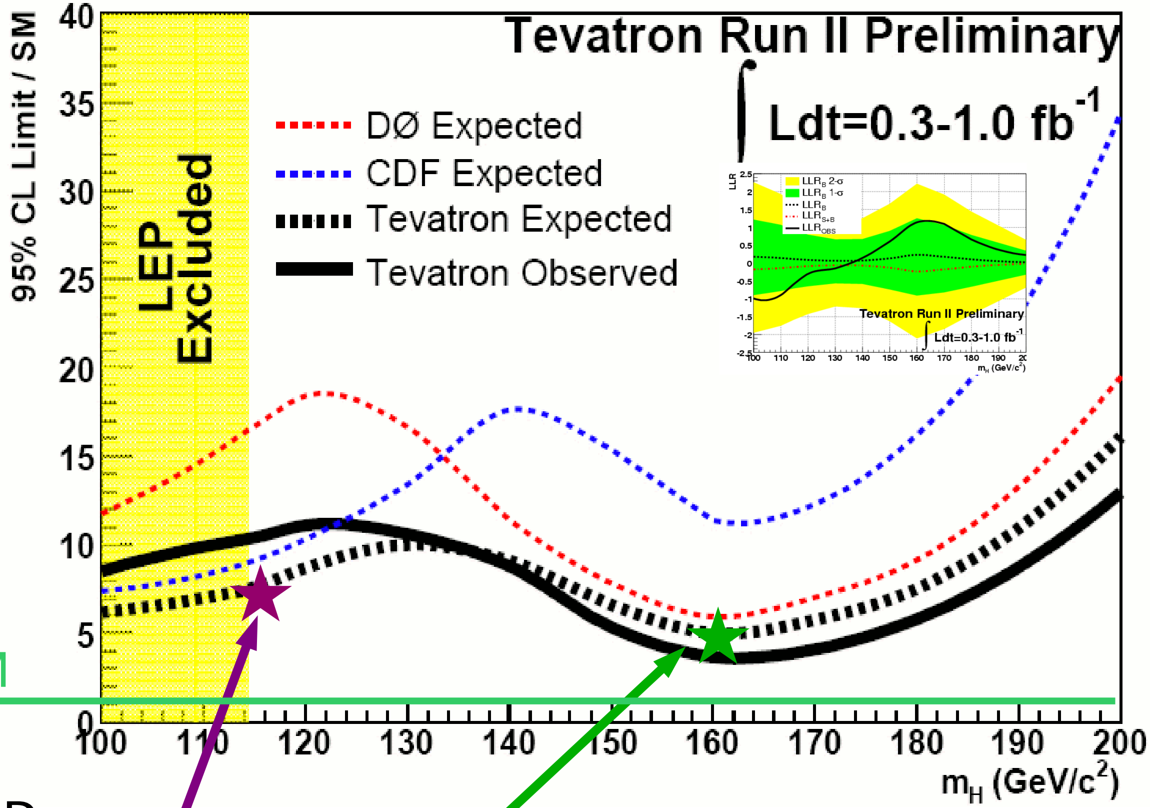
**mH=115 GeV$c^2$, 70<dijetMass<130 GeV/$c^2$**

| Channel | Signal | Bkgd | Data | S/sqrt(B) |
|---|---|---|---|---|
| WH→l$\nu$bb, 2Tag | 1,45 | 86,6 | 91 | 0,156 |
| WH→l$\nu$bb, 1Tag | 1,48 | 365,2 | 339 | 0,077 |
| ZH/WH→ MET+bb | 0.83/0.54 | 55,3 | 63 | 0,184 |
| ZH→llbb | 0,37 | 19,8 | 17 | 0,083 |

# Combinaison CDF/Dzero

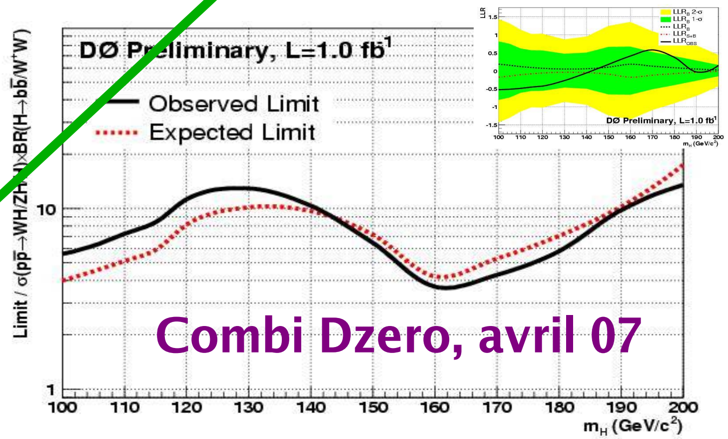
Première combinaison Dzero/CDF des ×SM pour ICHEP 06. Mais:

- Dzero: basses masses slt 300pb$^{-1}$
- CDF : hautes masses slt 300 pb$^{-1}$




Manque donc:

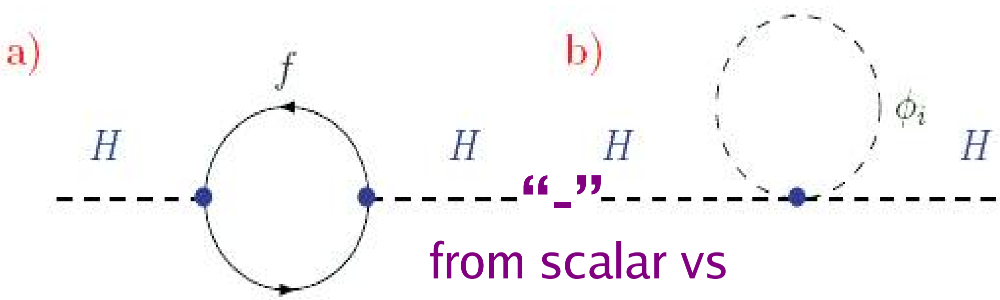
- Nouvelle combinaison des analyses Dzero
  - ☛ **115 GeV/c² : xSM obs (exp) < 8.4 (5.9)**
  - ☛ 160 Gev/c² : xSM obs (exp)< 3.7 (4.2)
- **CDF: H→WW**
  - ☛ **160 Gev/c² : xSM obs (exp)< 3.5 (5.0)**



# Le boson de Higgs du Modèle Standard Supersymétrique Minimal (MSSM)

# SUSY in a nutshell

- SUSY relates bosons to fermions. But it requires a complete set of new particles (“s”-particles): can not “only” relate known bosons to known fermions
- One of the main appeals: it solves naturally the hierarchy problem provided that $m_{Fermion}$ close to $m_{Scalar}$




$$= \Delta M_H^2 = \frac{\lambda_f^2 N_f}{4\pi^2}\left[(m_f^2 - m_S^2)\log\left(\frac{\Lambda}{m_S}\right)\right]$$

Quadratic divergences cancel out, only logarithmic ones remain !

⇒ New particles masses should not be much higher than TeV

⇒ Can be produced “o n-shell”at  the Tevatron/LHC! (direct searches)

# The MSSM Higgs sector

- **SUSY requires at least 2 Higgs doublets** (to cancel higgsino contribution to triangle anomalies, structure of superpotential)

MSSM: exactly 2 doublets

⇒ 1 couples to down (up) quarks with vev $v_d$ ($v_u$): $\tan\beta = v_d/v_u$ .

NB: if $\tan\beta \approx 40 \Rightarrow \lambda_{top} \approx \lambda_{bottom}$... large $\tan\beta$ regime appealing

⇒ After EW breaking: 5 Higgs bosons remain:

- 3 neutral : h/H (CP-even) and A (CP-odd) (convention: $m_H > m_h$)
- 2 charged : $H^+$, $H^-$

- In susy models, Higgs sector has only 2 parameters, usually $M_A$ and $\tan\beta$ , at tree level

⇒ $M_h$, $M_H$ and $M_{H\pm}$ are function of $M_A$ and $\tan\beta$ at tree level, more model dependent after radiative corrections

⇒ ∀ MSSM parameters, $M_h < 135$ (150) GeV/$c^2$. A light Higgs boson must exist if MSSM is realized!

# MSSM benchmarks scenarii

- Results at Tevatron are usually interpreted in 2 benchmark scenarii called $m_h^{max}$ and no-mixing.

Common set of parameters

$$
\begin{aligned}
m_t &= 174.3 \text{ GeV}, \\
M_{\text{SUSY}} &= 1000 \text{ GeV}, \\
\mu &= -200 \text{ GeV}, \\
M_2 &= 200 \text{ GeV}, \\
A_b &= A_t, \\
m_{\tilde{g}} &= 0.8\, M_{\text{SUSY}} .
\end{aligned}
$$

Sign of $\mu$ is usually varied

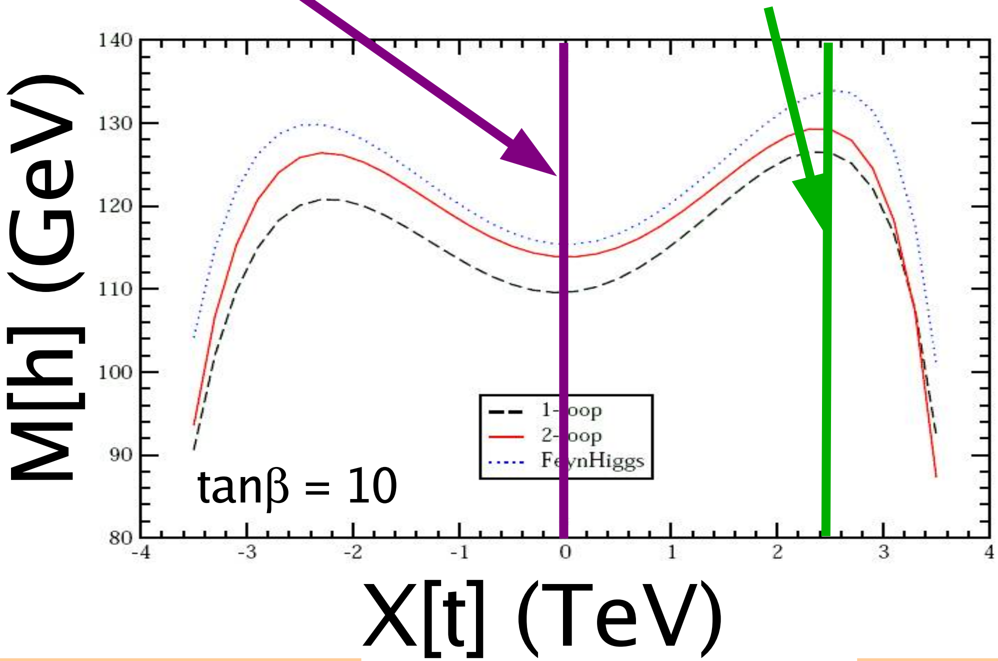
Differences in the stop mixing parameter $X_t$

No-mixing scenario

$X_t = 0$, ($M_S = 2$ TeV)

Maximal mixing scenario

$X_t = 2.45\times M_{SUSY}$



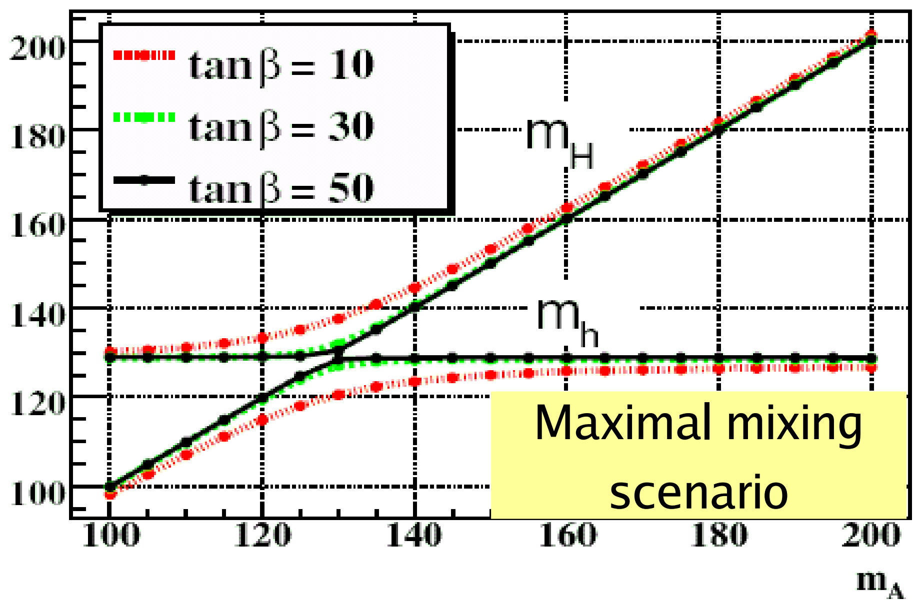
# The large tanβ regime

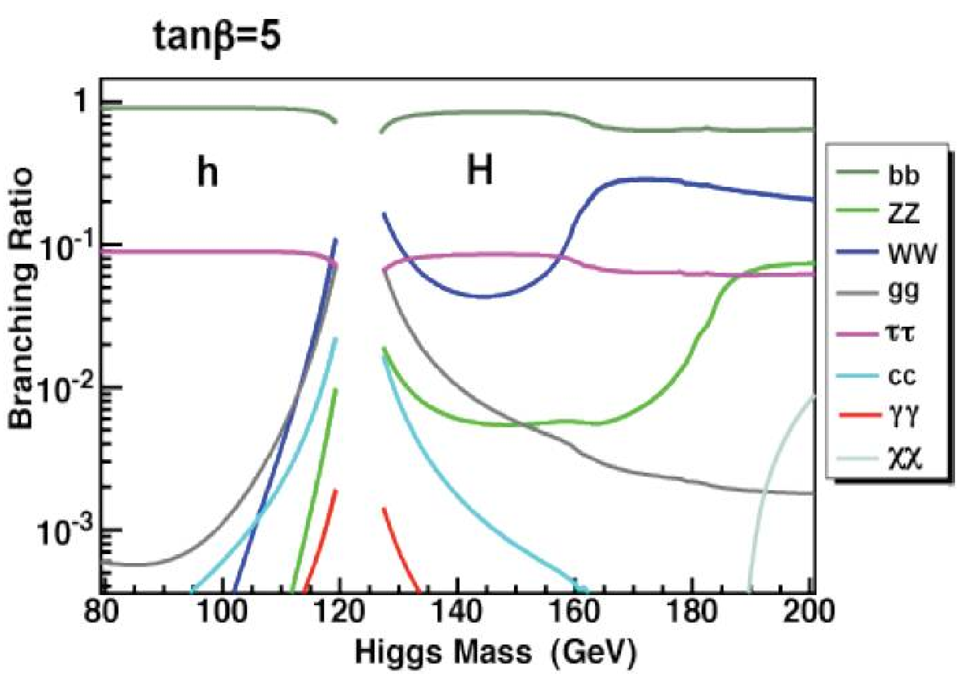
- A (+ h or H) coupling to down quark enhanced by tanβ
- A (+ h or H) coupling to up quark suppressed by cotanβ

$\Rightarrow \mathcal{B}(\Phi \to bb) \approx 90\%$ ; $\mathcal{B}(\Phi \to \tau\tau) \approx 10\%$ where $\Phi \equiv h/H/A$

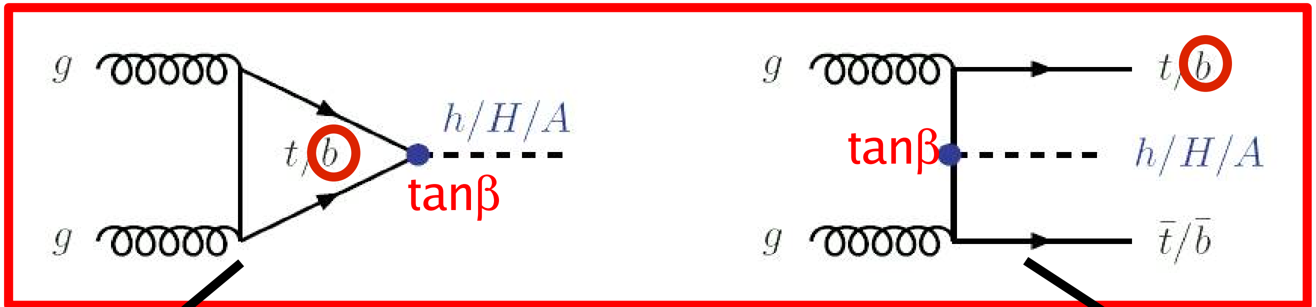
$\Rightarrow$ If $m_{H+} < m_{top}$, $\mathcal{B}(H^+ \to \tau\upsilon) \approx 1$ otherwise

- h/A or H/A or h/H/A are degenerated in mass



# Production h/H/A



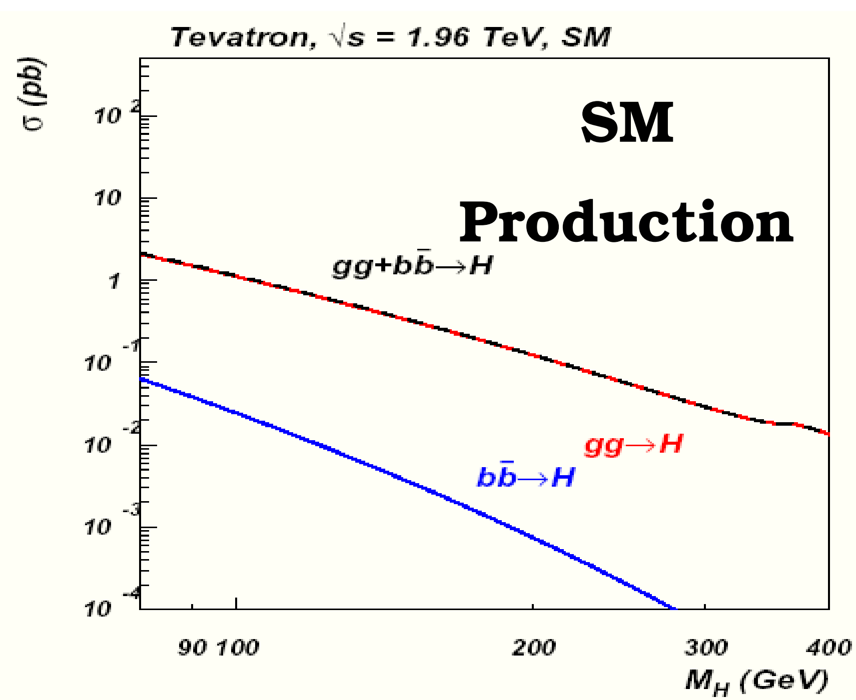

If tanβ >> 1
$\mathcal{B}(\Phi \to bb) \approx 90\%$
$\mathcal{B}(\Phi \to \tau\tau) \approx 10\%$
where $\Phi \equiv$ h/H/A

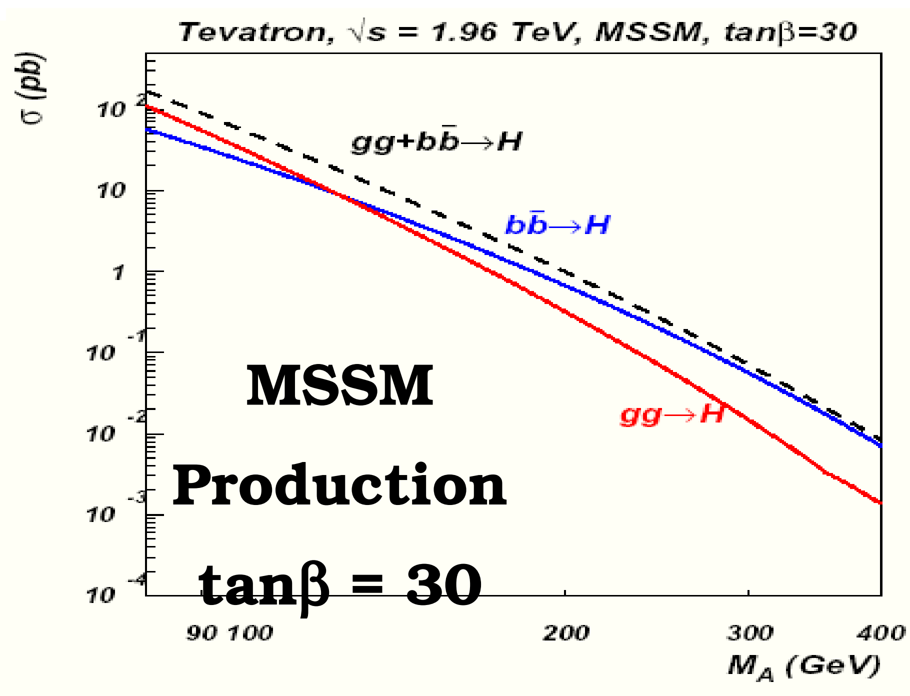
Susy : h/H/A $\to \tau\, \tau$
bb out of reach
(QCD background)

At LO

enhancement in $\tan^2\beta$ $\underline{\times 2}$

Both h/H/A $\to$bb and
h/H/A $\to \tau\, \tau$ possible
---> 1 jet de b

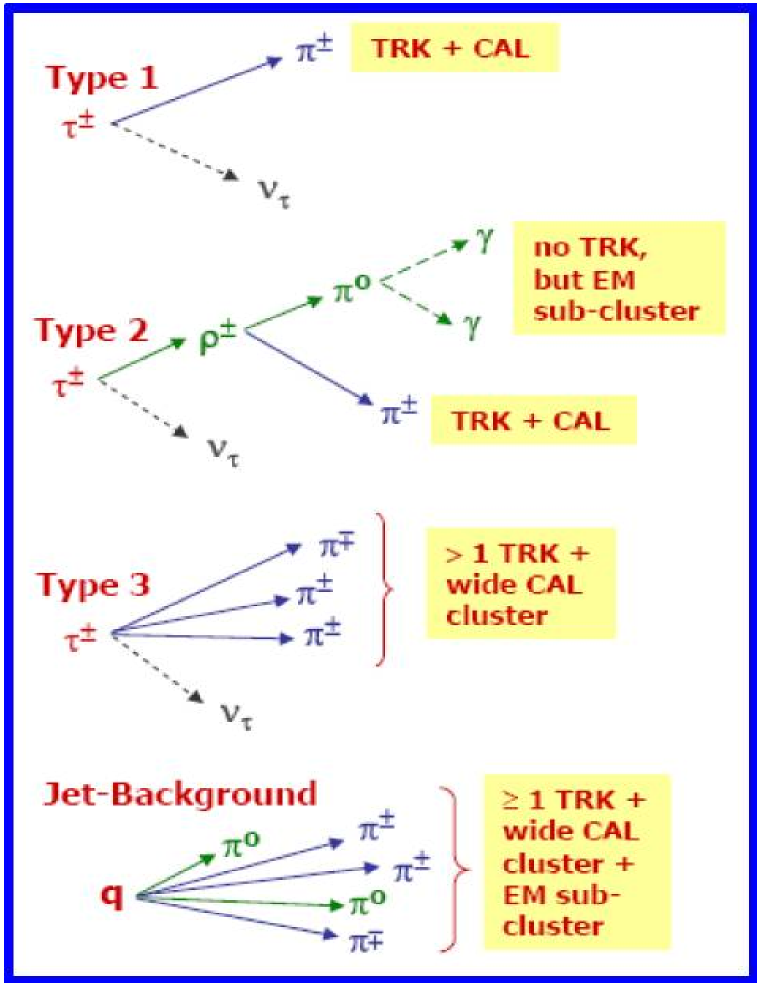


# Un nouvel outil: $\tau$ ID

## Neural network ID

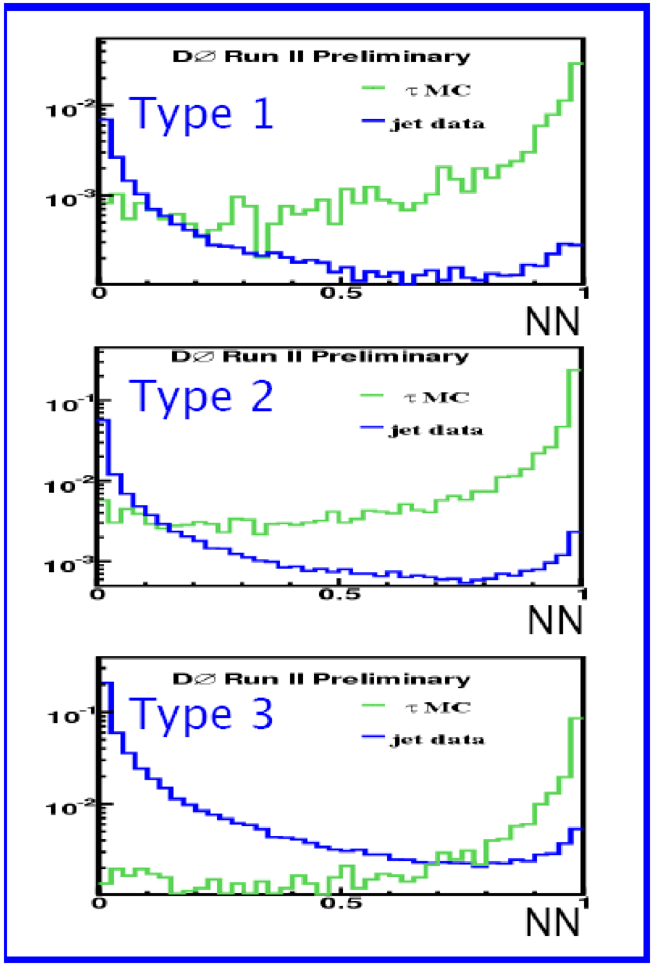
3 types distincts de Taus




Performence pour $p_T$ [$\tau$]>15 GeV :

Facteur de réduction du bruit de fond ~40 pour 70% d'efficacité au $\tau$

| Tau Type | 1 | 2 | 3 |
|---|---|---|---|
| Reconstruction | | | |
| Jets | 1.5 | 10 | 38 |
| Taus | 9.1 | 50 | 20 |
| NN > 0.9 | | | |
| Jets | 0.04 | 0.2 | 0.8 |
| Taus | 5.8 | 37 | 13 |



# Searches for h/H/A→ττ

## New result, both CDF and D∅, with 1 $fb^{-1}$

### Final State ττ(j) with

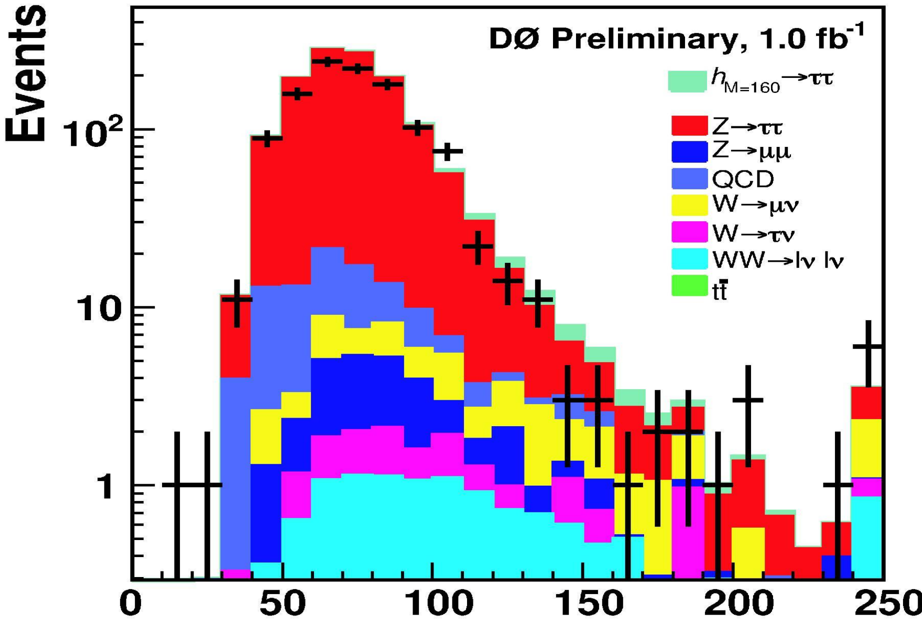
- CDF: $\tau_e\tau_\mu + \tau_e\tau_{had} + \tau_\mu\tau_{had}$
- D∅ : only $\tau_\mu\tau_{had}$ but use a NN to discriminate signal from background

### Selection

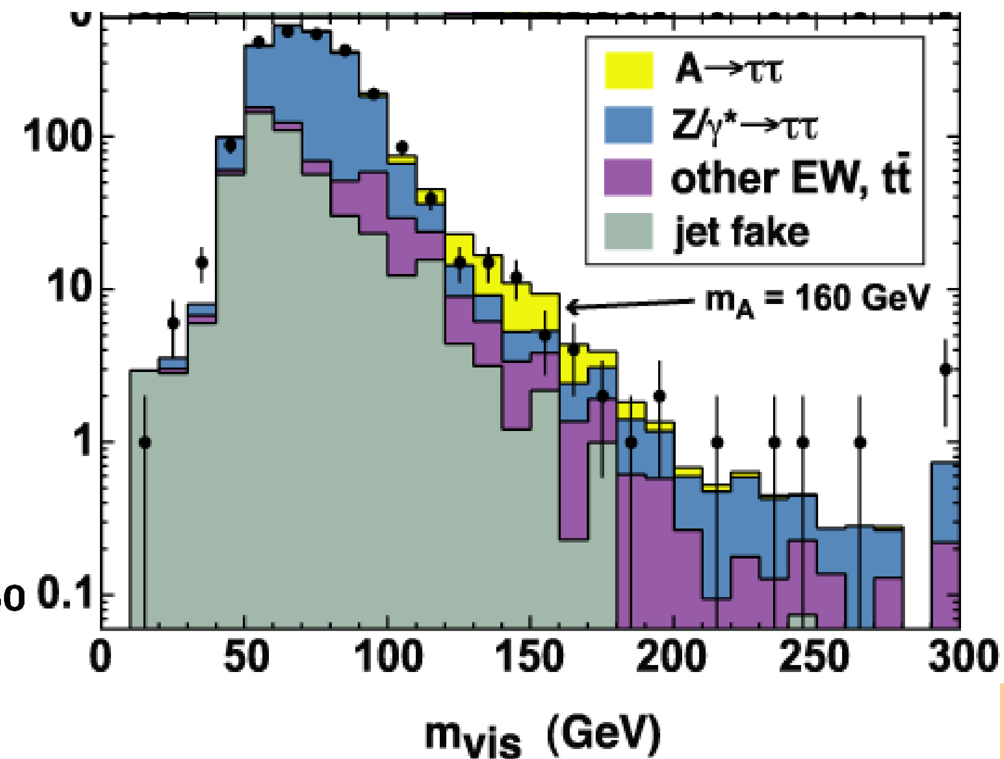
1 (2 for eμ) isolated hard lepton + one hadronic tau (apply NN tau id) with opposite sign. W(j) removed with $\vec{\not{E}}_T$

### Backgrounds

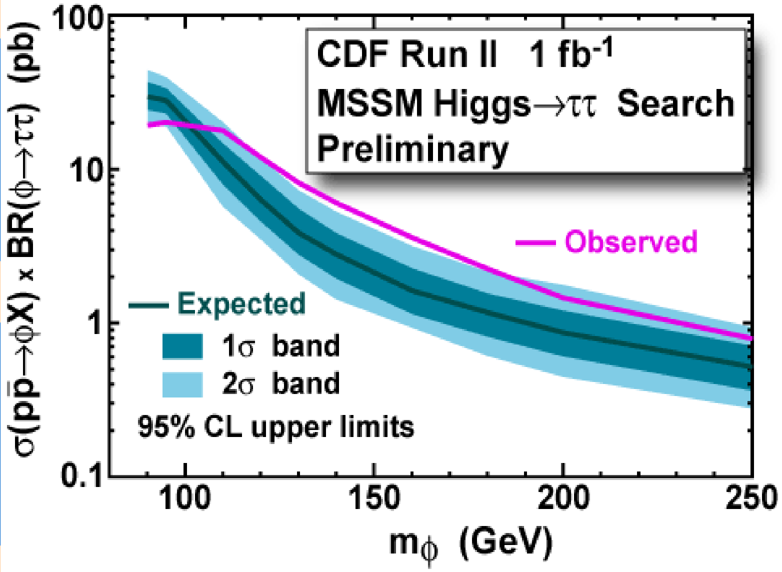
main Z→ττ, QCD, Z→ee, Z→μμ, di boson

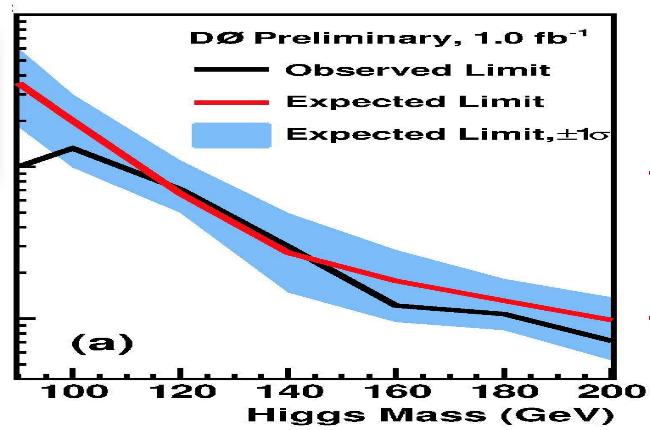



$$m_{vis} = |P^{vis}_{\tau_1} + P^{vis}_{\tau_2} + \not{P}_t|$$



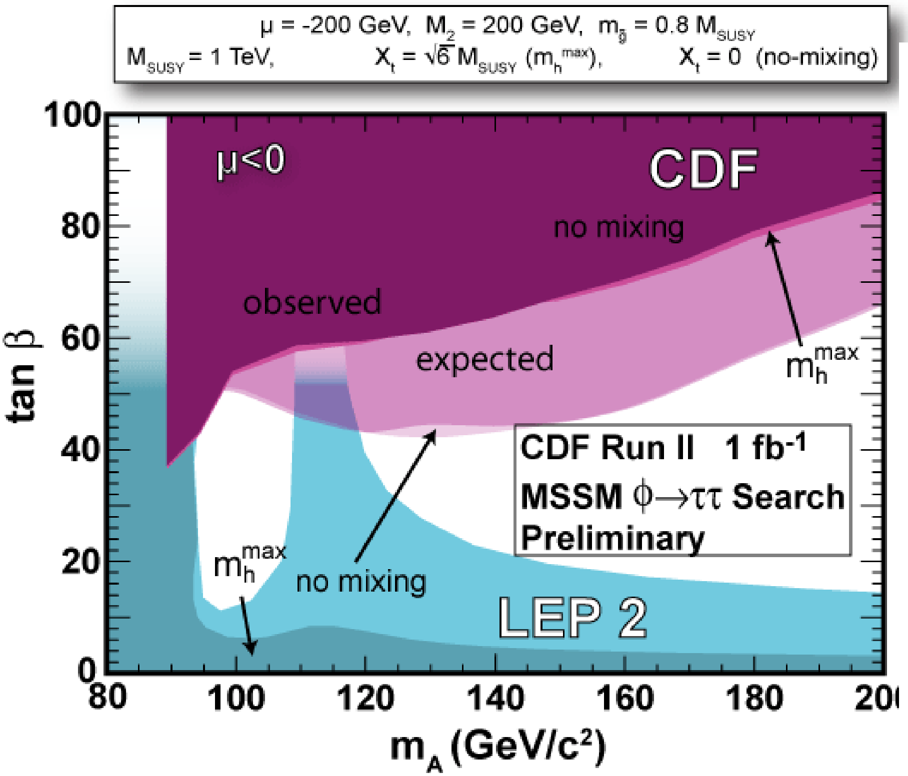
# Searches for h/H/A→ττ

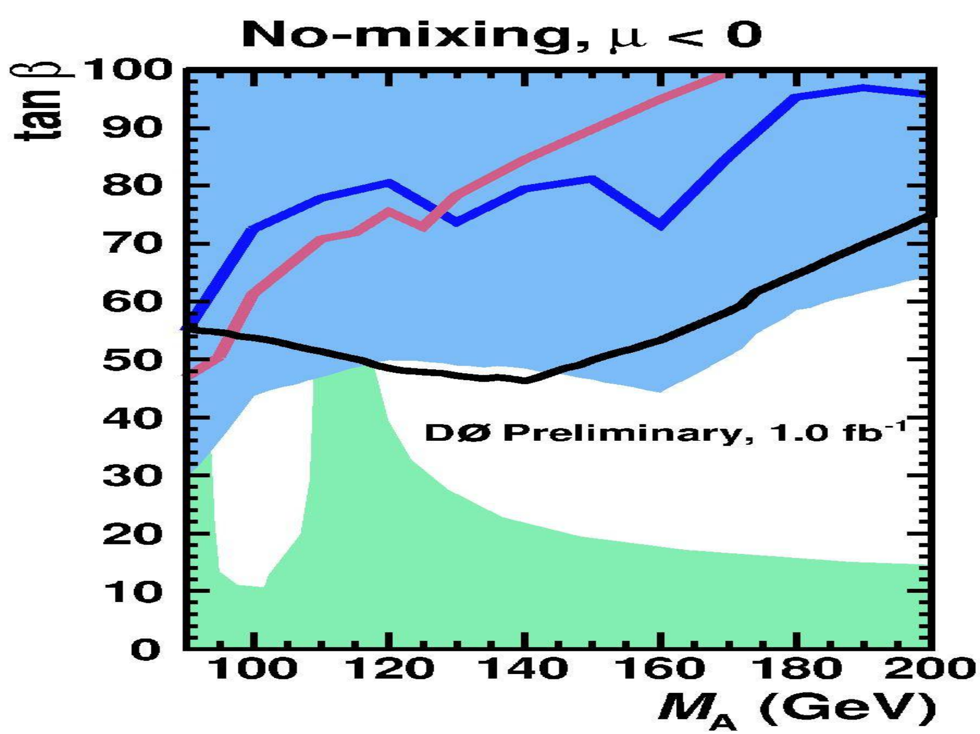



- CDF: 2 σ excess at high masses
- D∅ : no excess

CDF&D∅ have comparable sensitivities



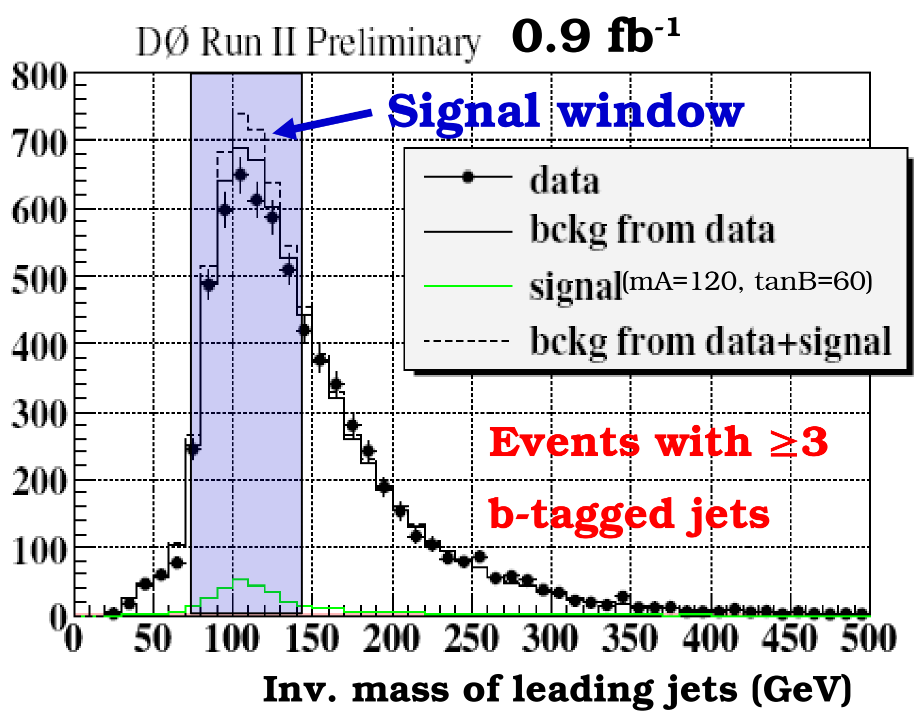



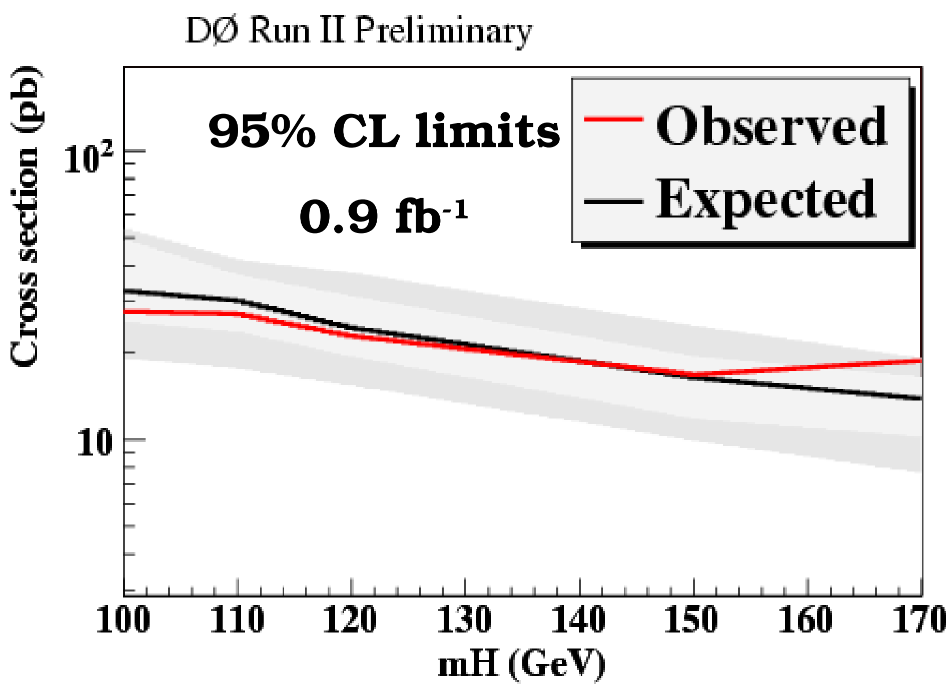
# Production in association with b

## Production associée hb: état final bbb

- bruit de fond QCD multijets : jjj, cjj, bjj, ccj, bbj, bbc, bbb...
    → pas de prédiction théorique fiable

- en cours de réoptimisation à Dzero, résultat attendu pour CDF. Été 2007 ?



# Searches of h/H/Ab→ττ b

DØ only, 344 $pb^{-1}$

Final State ττb(j) with $\tau_\mu \tau_{had}$ b

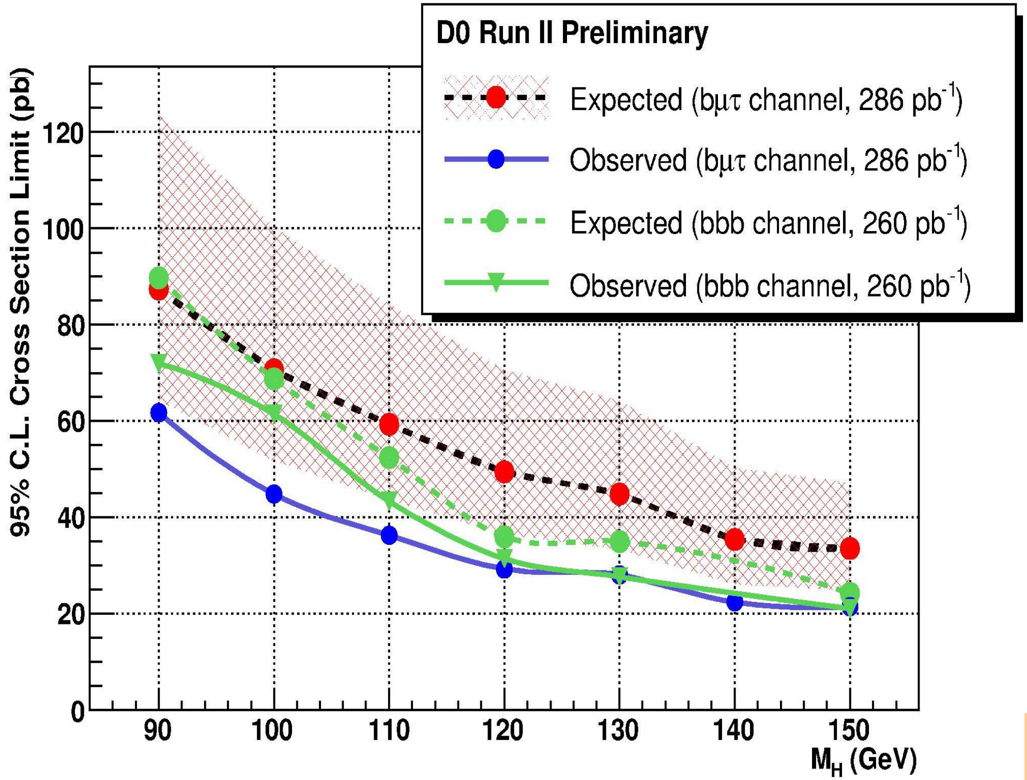
## Selection

1 isolated hard muon + one hadronic tau (apply NN tau id) with opposite sign + 1 tagged b jet.
ttbar events are discriminate with the help of an NN

## Backgrounds

Z(j), QCD, ttbar

Exp: 6.8 bkg evts ; Obs: 3




Less sensitive than previous slide but some lessons can be drawn:

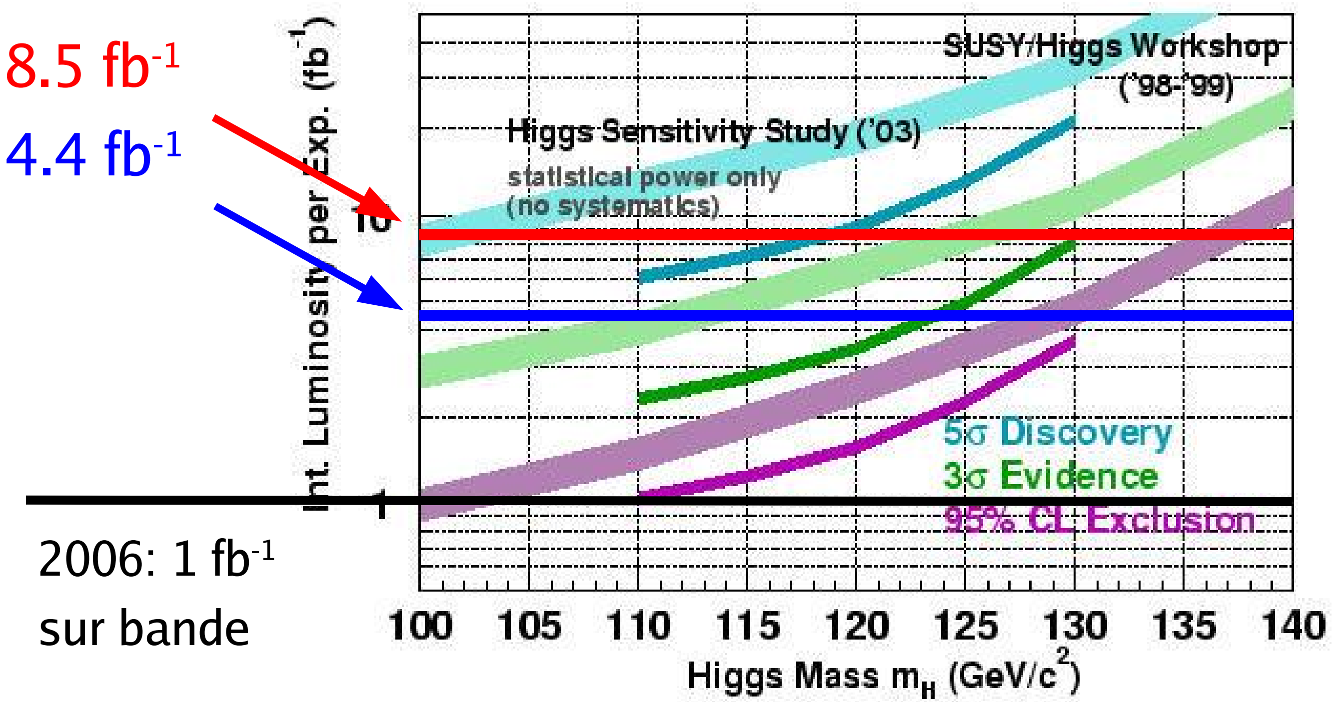
- nearly as sensitive as hb→bbb with 300 $pb^{-1}$ though the BR is 9 times smaller
- hb→bbb suffer froms a large QCD multijet production difficult to predict. With higher statistics, ττb will probably be more sensitive than hbb!

# Perspectives

# Le boson de Higgs SM

Prédictions datant de 2003 pour les possibilités de:

- **découverte**
- **évidence**
- **exclusion**




Où en est le Tevatron avec 1 fb$^{-1}$ ?

- à 110 GeV/$c^2$ CDF + Dzero devraient exclure 1 x SM

- à 110 GeV/$c^2$ CDF + Dzero exclude 3.5 x SM

Moyenne personnelle grossière

Requière au moins 12 fb$^{-1}$

Le Tevatron pourra-t-il tenir ses promesses ?

# Difficile mais pas impossible

Prévisions à Dzero:

- plus de canaux: les leptons τ ne sont pas utilisées
- les analyses multivariables commencent seulement
- amélioration des systématiques indispensables (Z/W + jets)

| **Ingredient** | **Equiv Lumi Gain** | **Xsec Factor MH=115 GeV** | **Xsec Factor MH=160 GeV** |
|---|---|---|---|
| Today with $1 fb^{-1}$ | - | 5,9 | 4,2 |
| Lumi = $2\ fb^{-1}$ | 2 | 4,2 | 3,0 |
| b-Tag (Shape + LayerØ) | 2 | 3,0 | 3,0 |
| Multivariate Techniques | 1,7 | 2,3 | 2,3 |
| Improved mass resolution | 1,5 | 1,8 | 2,3 |
| New Channels | 1.3/1.5 | 1,6 | 1,9 |
| Reduced systematics | 1,2 | 1,5 | 1,7 |
| Two Experiments | 2 | 1,1 | 1,2 |

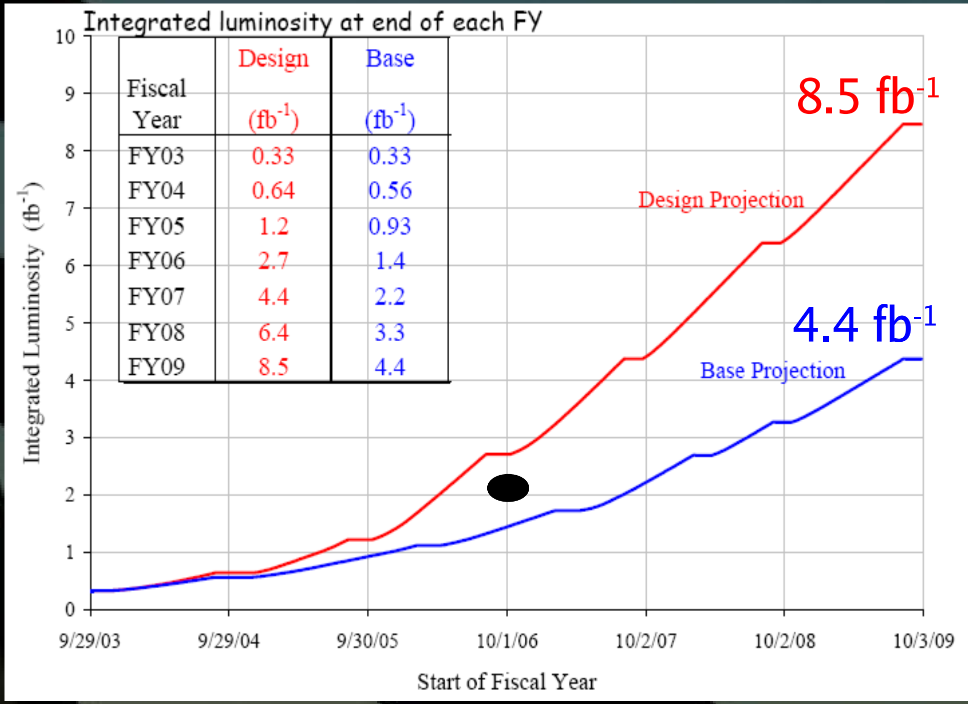
➔ **At 115 GeV need ~2.5 $fb^{-}$** **At 160 GeV need ~3 $fb^{-1}$**

# Conclusion

## Le TeVatron et son premier $1 fb^{-1}$:

- 2006 : $B_s$ mixing à CDF (et Dzero)
- 2007 : single top à Dzero

## et avec un $6/8\ fb^{-1}$ ?




## La quête du boson de Higgs commence seulement au TeVatron:

- tous les canaux sont analysés
- les outils de combinaisons sont en place
- des améliorations manquent encore mais sont prévues: addition des $\tau$, b-Tagging (Layer ∅ à D∅), améliorations des analyses (ME, NN), augmentation de l'acceptance des leptons à CDF....

## Higgs MSSM:

Dores et déjà atteint le domaine "intéressant" $\tan\beta \sim 40$

Une surprise est toujours possible !

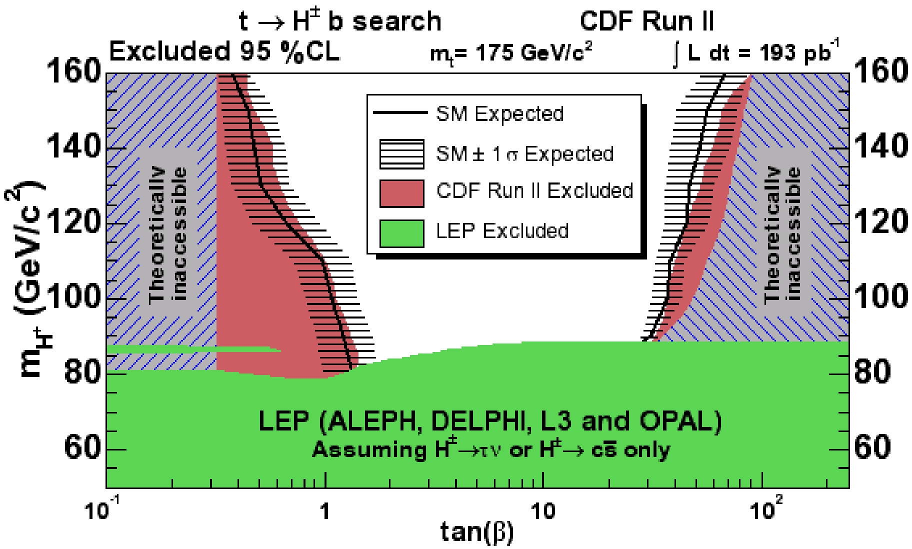
"Difficile de trouver un chat noir dans une pièce sombre, surtout s'il n'y est pas !"

# Backup slides

# CDF $H^+$ searches

If $m_{H+} < m_{top}$ then the decay $t \to b\ H^+$ compete with the SM $t \to b\ W^+$

Use the top samples. Look for excess of events over SM predictions

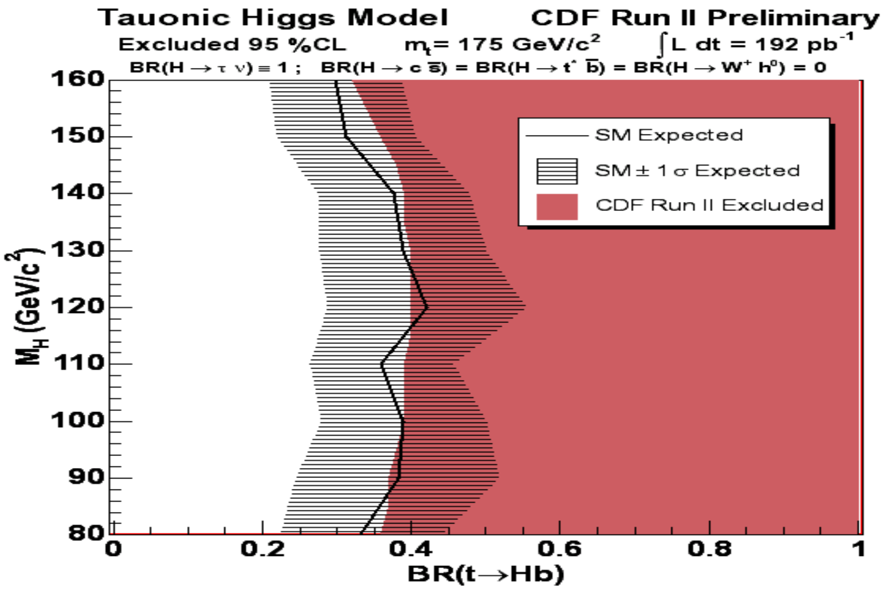



Limits in several scenarii, cover different $H^+$ decays. Left plot:

Maximal mixing scenario

200 $pb^{-1}$

Phys. Rev. Lett. 96, 042003 (2006)




large $\tan\beta$ case :

$Br(H^+ \to \tau\nu) = 100\ \%$ and one can put a limit on the $Br(t \to b\ H^+)$