

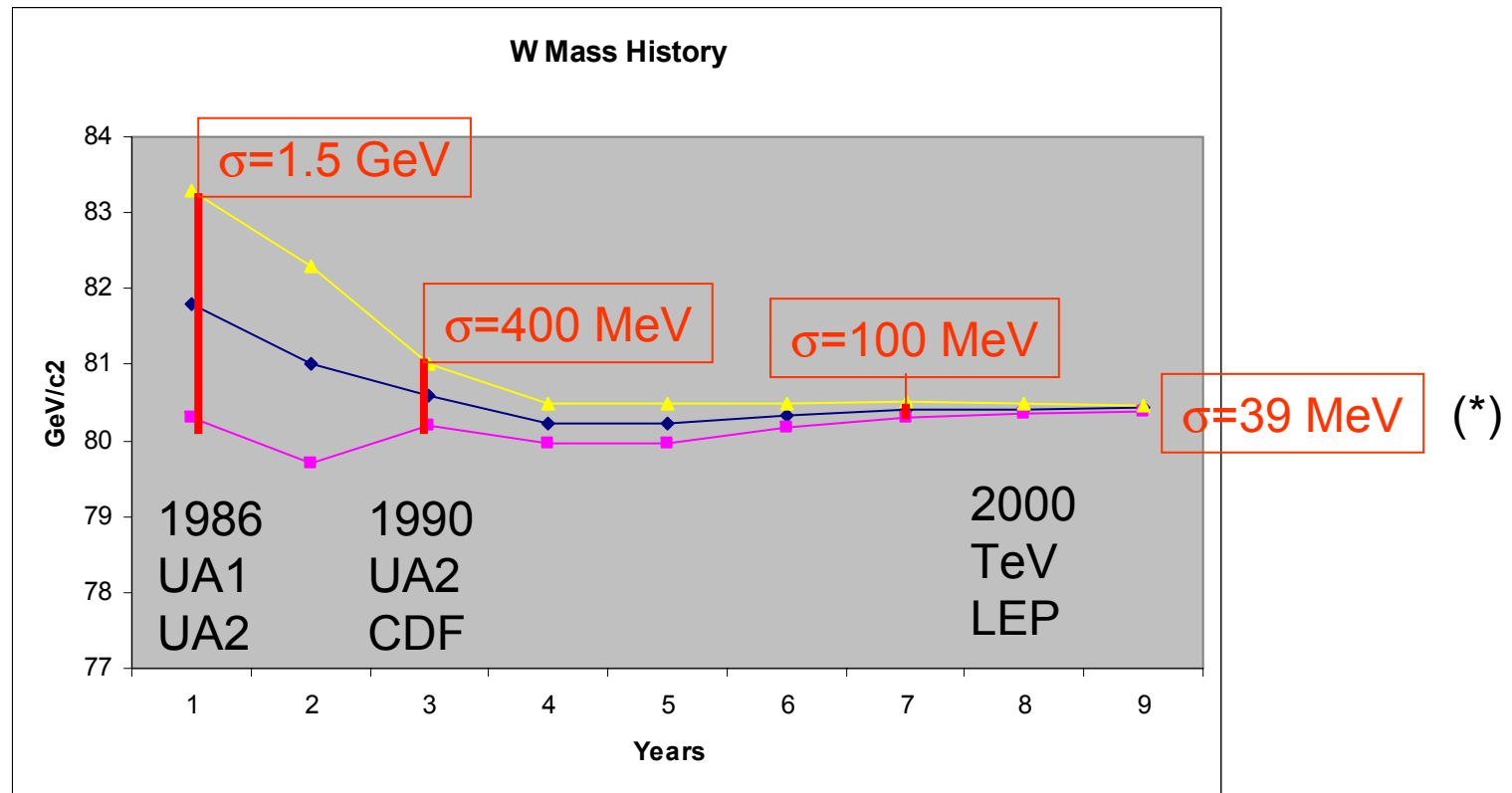
**Catania, 1 Aprile 2005**

Roberto Tenchini  
INFN-Pisa



**Misure di Precisione Elettrodeboli :  
stato attuale e prospettive per LHC**

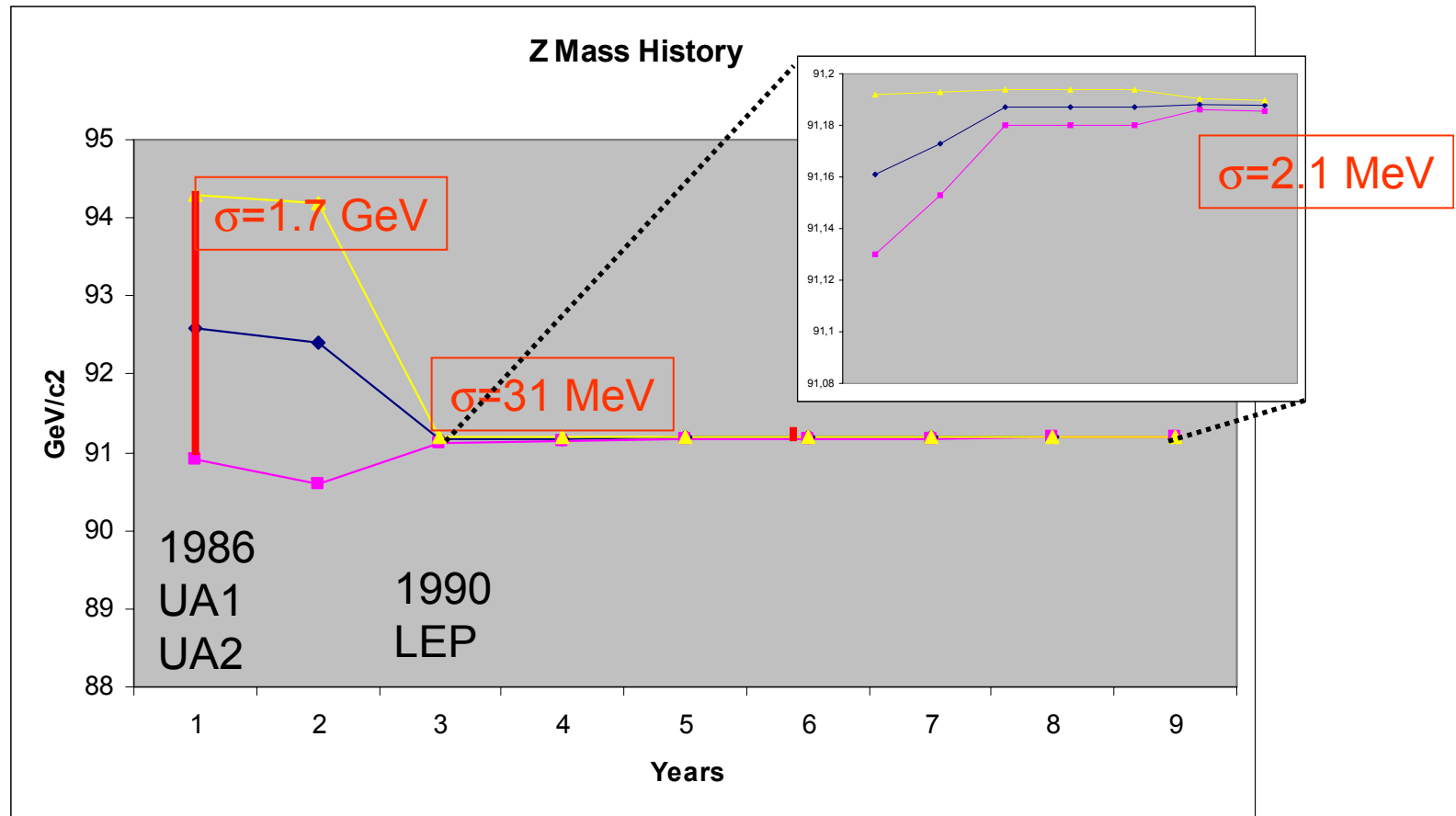
# 22 Anni di Fisica del W e della Z



*Solo risultati pubblicati*

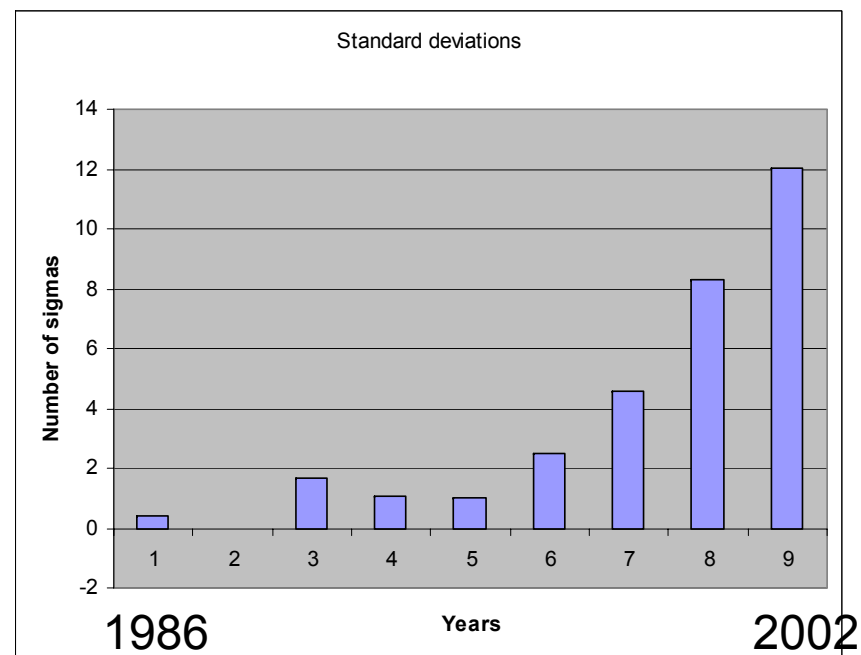
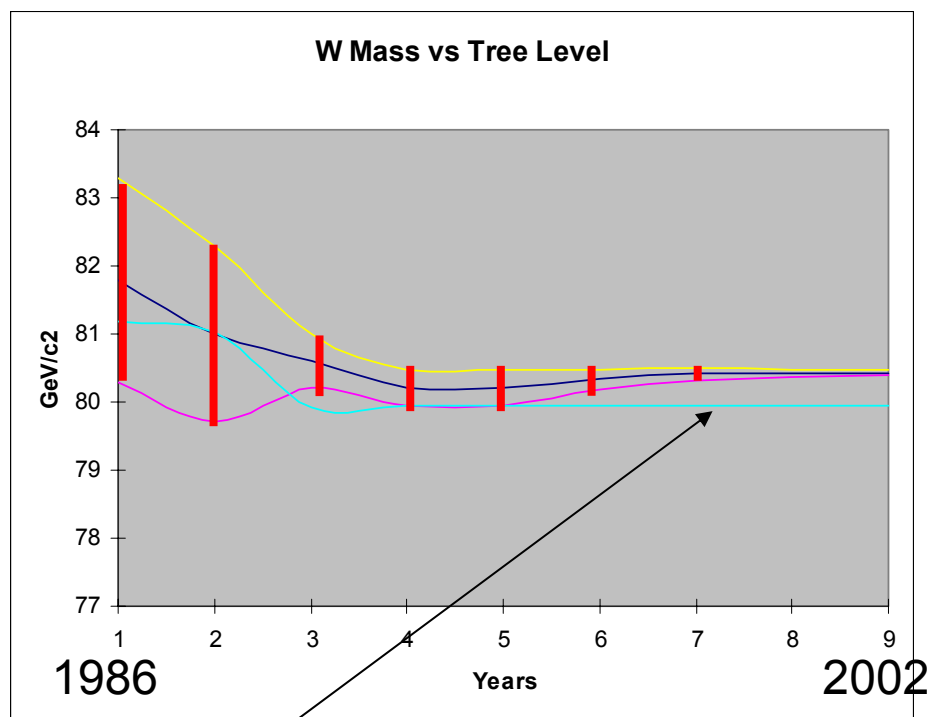
(\*) Media preliminare 2004 :  $\sigma=34$  MeV, peso di LEP 2/3, Tevatron 1/3

# 22 Anni di Fisica del W e della Z



*Solo risultati pubblicati*

# 22 Anni di Fisica del W e della Z



Forte evidenza di correzioni radiative elettrodeboli

Standard Model a livello di albero

(con  $\alpha$  QED running )

$$M_W^2 \left( 1 - \frac{M_W^2}{M_Z^2} \right) = \frac{\pi \alpha(M_Z)}{\sqrt{2}} \frac{1}{G_F}$$

$$\alpha(\sqrt{s} = M_Z) = \frac{1}{128.936 \pm 0.046}$$

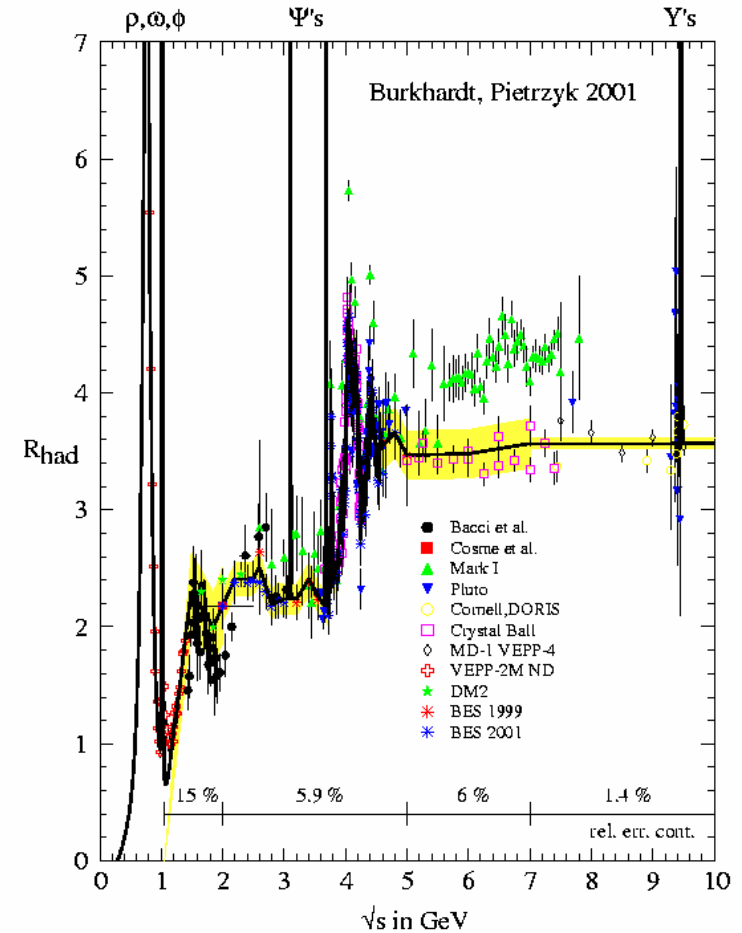
# Running of $\alpha$ QED: $\alpha(M_Z)$

$$\alpha^{-1}(0) = 137.0359895(61)$$

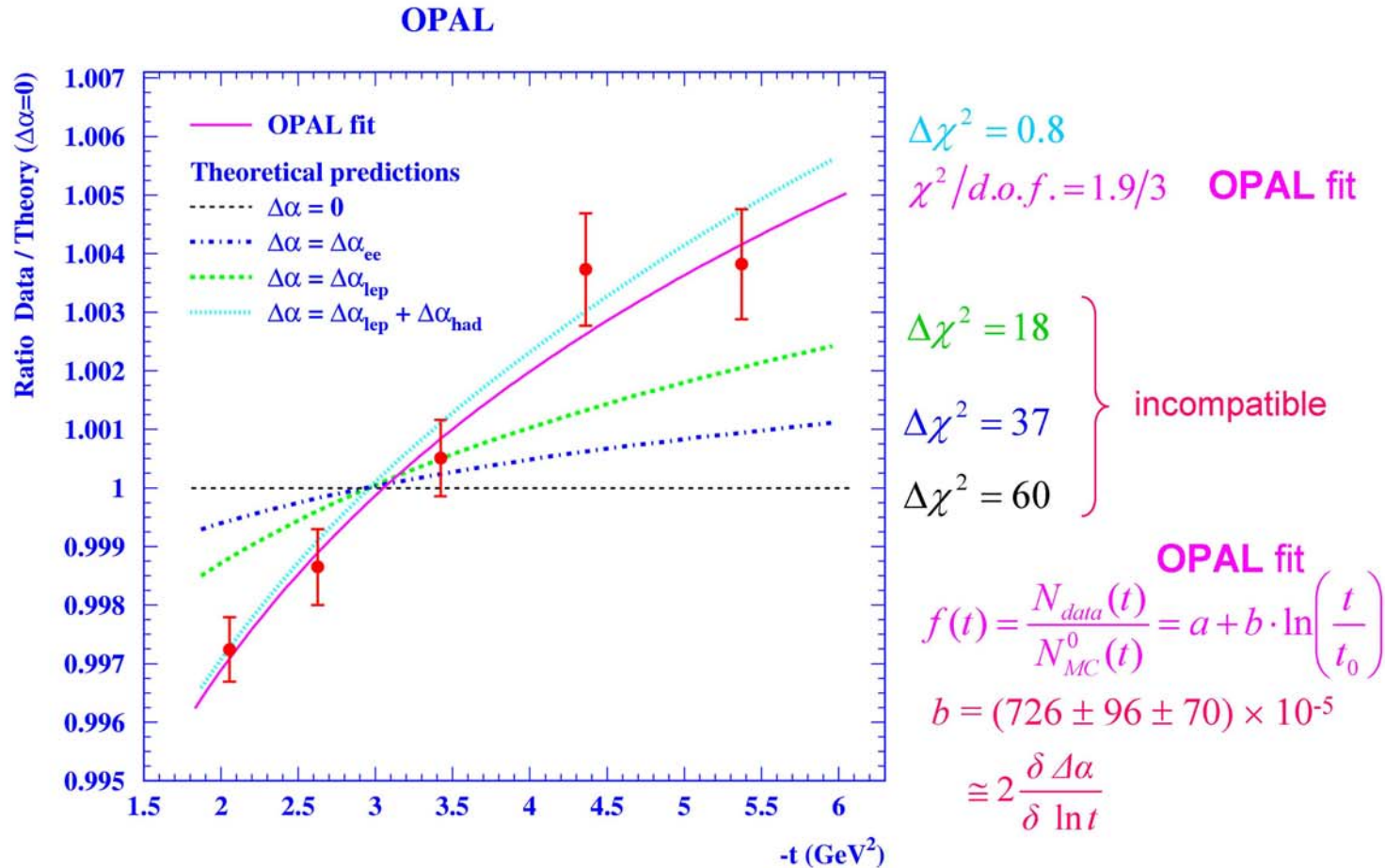
$$\alpha(s) = \frac{\alpha(0)}{1 - \Delta\alpha_l(s) - \Delta\alpha_{had}^{(5)}(s) - \Delta\alpha_{top}(s)}$$

$$\Delta\alpha_{had}^{(5)}(s) = -\frac{\alpha s}{3\pi} \int_{4m_\pi^2}^{\infty} \frac{R_{had}(s')}{s'(s'-s)} ds'$$

$$\alpha(s = M_Z) = \frac{1}{128.936 \pm 0.046}$$



# Diffusione Bhabha a piccolo angolo : Evidenza del running di $\alpha$ e di contributo adronico



# SM a livello di albero non sufficiente : correzioni a un loop

- Introduzione di tre parametri aggiuntivi:  
 $M_{\text{top}}$ ,  $M_{\text{higgs}}$ ,  $\alpha_s$
- Scrivere un Osservabile come:

$$O_i = f_i[\alpha(M_Z), G_F, M_Z, m_{\text{top}}, M_{\text{Higgs}}, \alpha_s]$$

Esempio :

$$M_W^2 \left( 1 - \frac{M_W^2}{M_Z^2} \right) = \frac{\pi\alpha}{\sqrt{2}} \frac{1}{G_F} (1 + \Delta r)$$

one loop  
radiative  
corrections

# Sommario per oggi

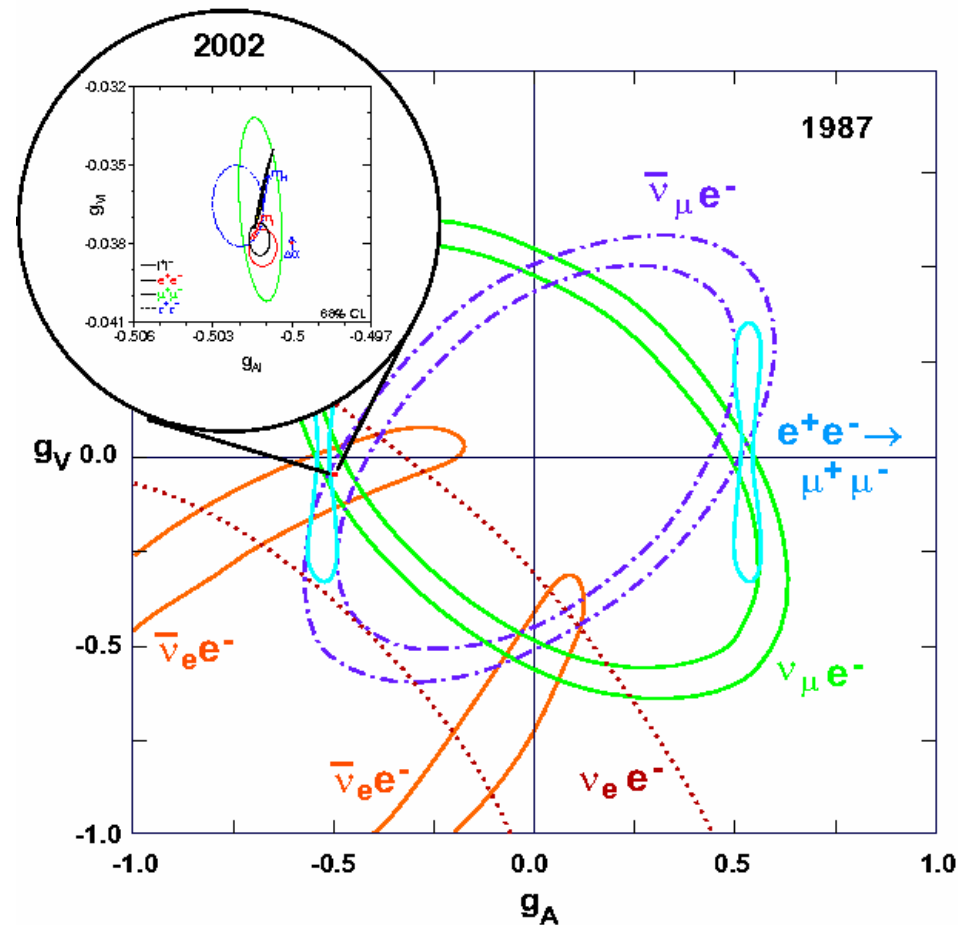
- **Accoppiamenti alla Z** : asimmetrie e  $\sin^2(\theta)_W$ 
  - (così e' se vi piace)
- **Accoppiamenti al W**: **W Branching Ratios**
  - (cosa succede al tau ?)
- **Misura della massa del W**
  - (qualche punto caldo)
- **Limiti sulla massa dell' Higgs SM**  
(Inverno 2005)
- **LHC come Top factory**
- **Accoppiamenti Trilineari**

Commenti per  
LHC





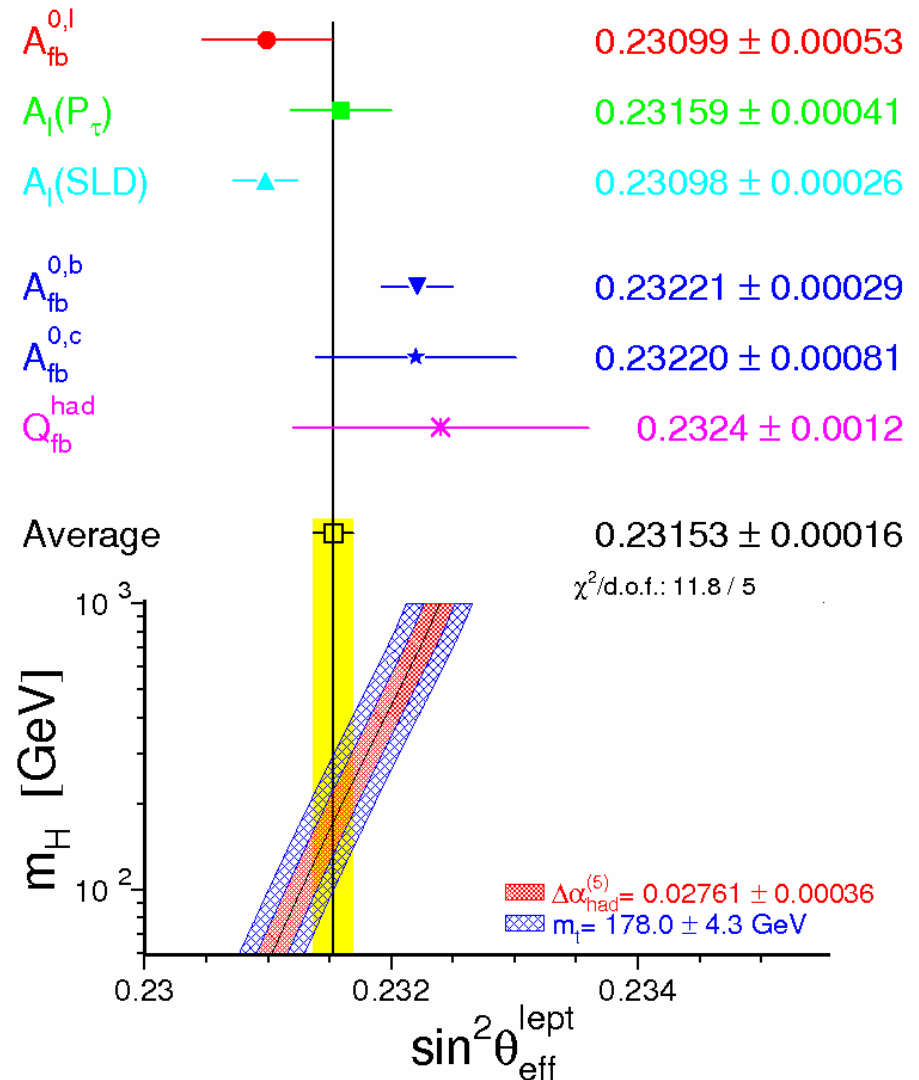
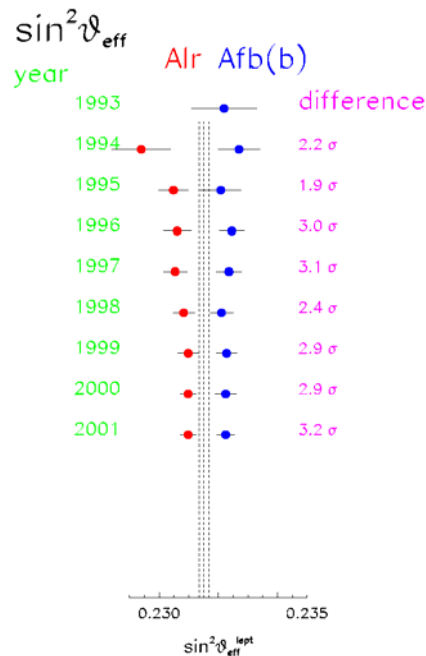
# Accoppiamenti Elettrodeboli : Dal deep inelastic scattering a LEP-SLC enorme aumento di precisione



# Asimmetrie alla Z e $\sin^2 \theta_{eff}^l$

- Consistenza al 3.7%
- Differenza storica tra  $A_{LR}$  and  $A_{FB}(b)$

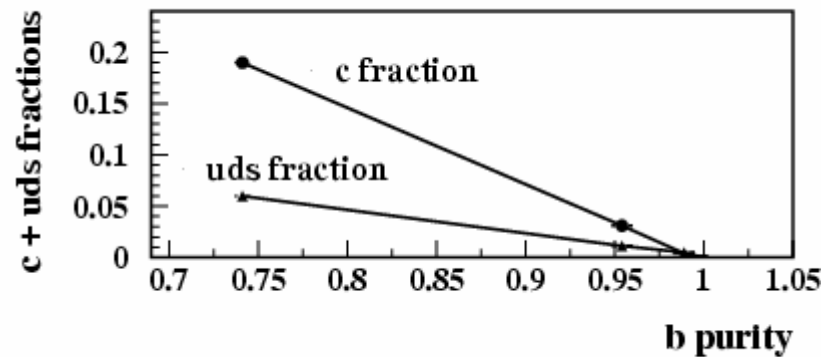
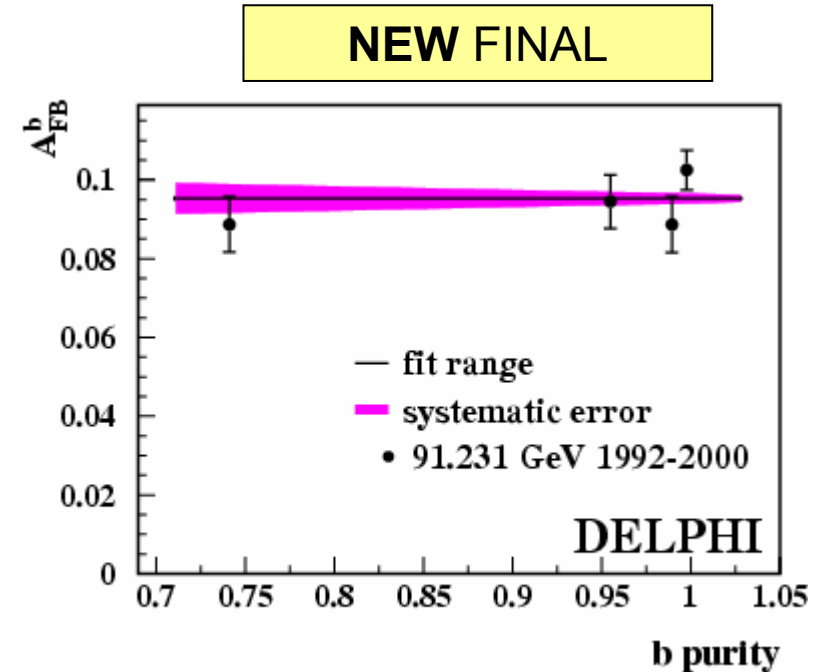
**NEW FINAL**



# Asimmetria forward-backward del b

- Due tecniche sperimentali
  - decadimenti semileptonici del b
  - **inclusiva basata sulla jet charge**
- Sistematici molto diversi
- Media LEP dominata dalla statistica

	$\Delta A_{FB}(b)$	
STATISTICS	0.00156	
UNCORRELATED SYSTEMATIC	0.00061	
QCD CORRECTION	0.00030	
LIGHT QUARK FRAGMENTATION	0.00013	
SEMILEPTONIC DECAYS MODELLING	0.00013	
CHARM FRAGMENTATION	0.00006	
BOTTOM FRAGMENTATION	0.00003	
TOTAL SYSTEMATIC ERROR	0.00073	



**Esempio: Stabilita' del risultato  
in funzione della purezza**

# Asimmetria del b: risultati

Media LEP

$$A_{FB}^0(b) = 0.0992 \pm 0.0016$$

Leptoni

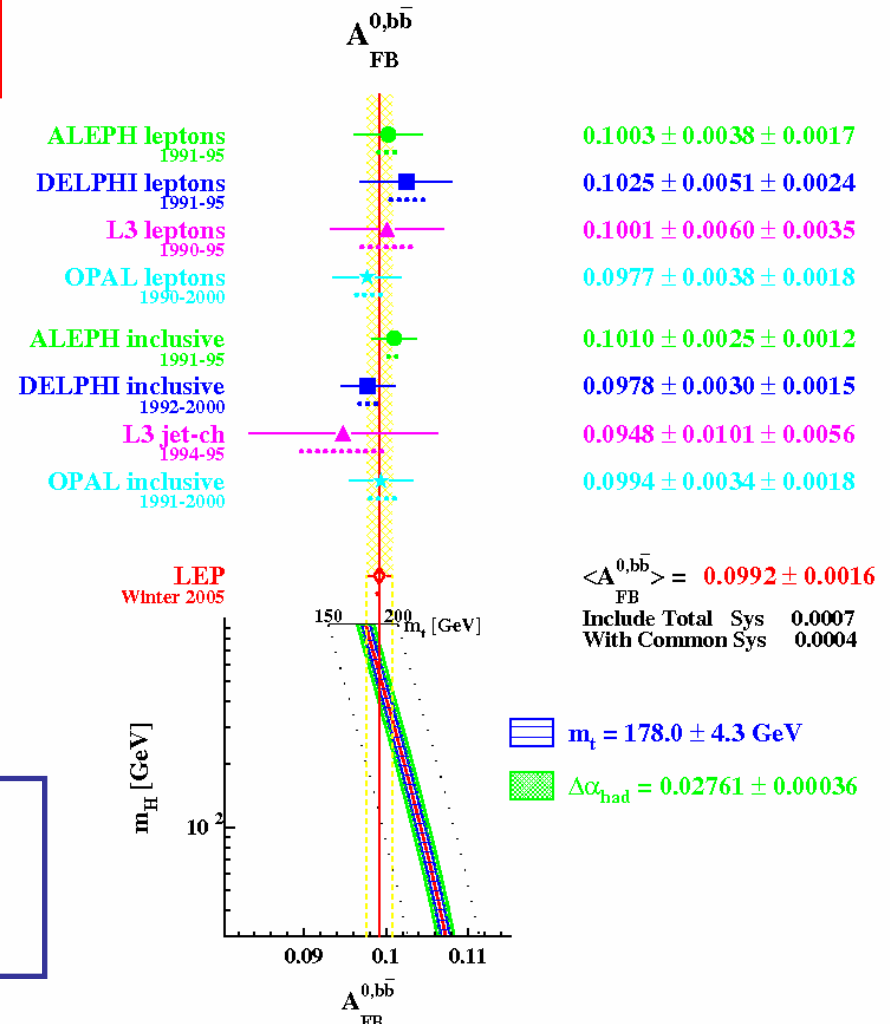
$$A_{FB}^0(b) = 0.0990 \pm 0.0025$$

Inclusiva

$$A_{FB}^0(b) = 0.0994 \pm 0.0019$$

Attenzione : Zfitter e' stato recentemente aggiornato per curare inconsistenze nel trattamento delle correzioni QED ai quark

**NEW FINAL**

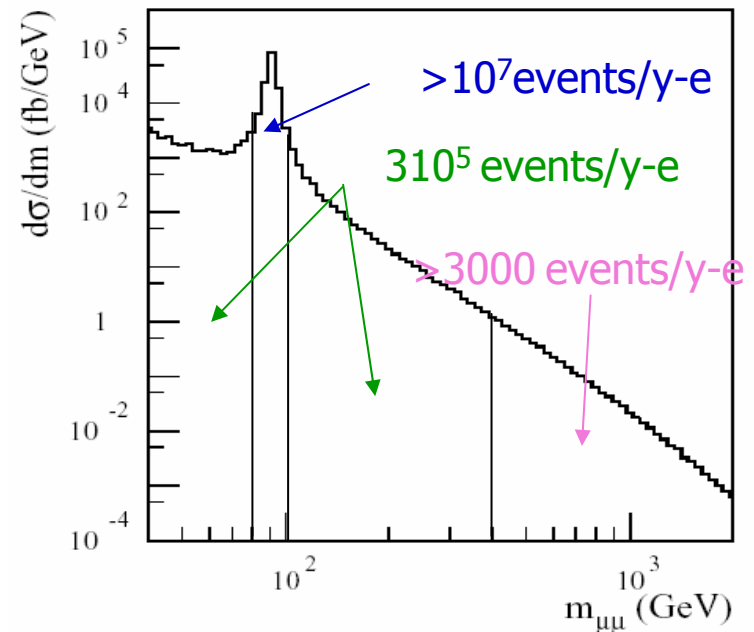
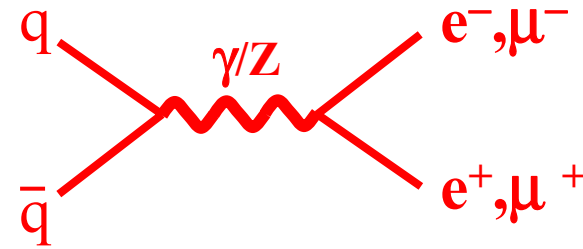


# Commenti sulle misure di $\sin^2(\theta)$

- Risolveremo la questione  $A_{LR}$ - asimmetria del b solo coi futuri collider lineari se
  - La polarizzazione di entrambi i fasci sarà disponibile
  - Ci sarà un run alla Z ad altissima statistica
- Intanto che fare a LHC ?

# Controllo importante a LHC : asimmetrie dagli eventi di Drell-Yan

- Chiara segnatura: una coppia di leptoni isolati di carica opposta
- Per misurare l'asimmetria forward-backward bisogna conoscere la direzione del quark
- Al Tevatron e' ovvia (p – pbar)
- A LHC la sezione d'urto DY va studiata in funzione della massa invariante e della rapidita'.
- Siccome alta rapidita' e' una segnatura dei quark di valenza (e a LHC solo q e' di valenza) la direzione del boost da la direzione del quark



# Asimmetrie dagli eventi Drell-Yan : necessario conoscere le PDF

Dalla presentazione di Giammanco:

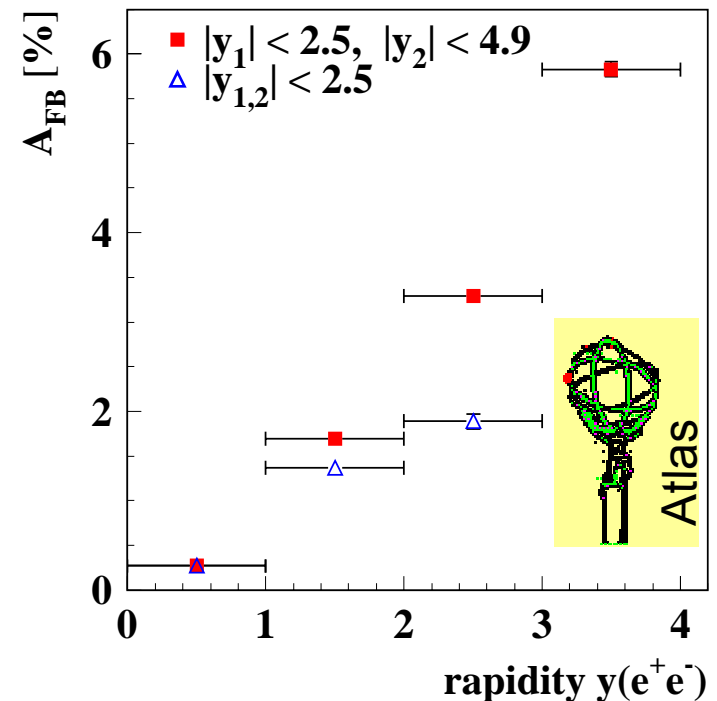
## $A_{\text{FB}}$ attorno al picco della Z

- grande sezione d'urto a LHC:

$$\sigma(Z \rightarrow e^+e^-) \approx 1.5 \text{ nb}$$

- errore statistico con  $100 \text{ fb}^{-1}$ :

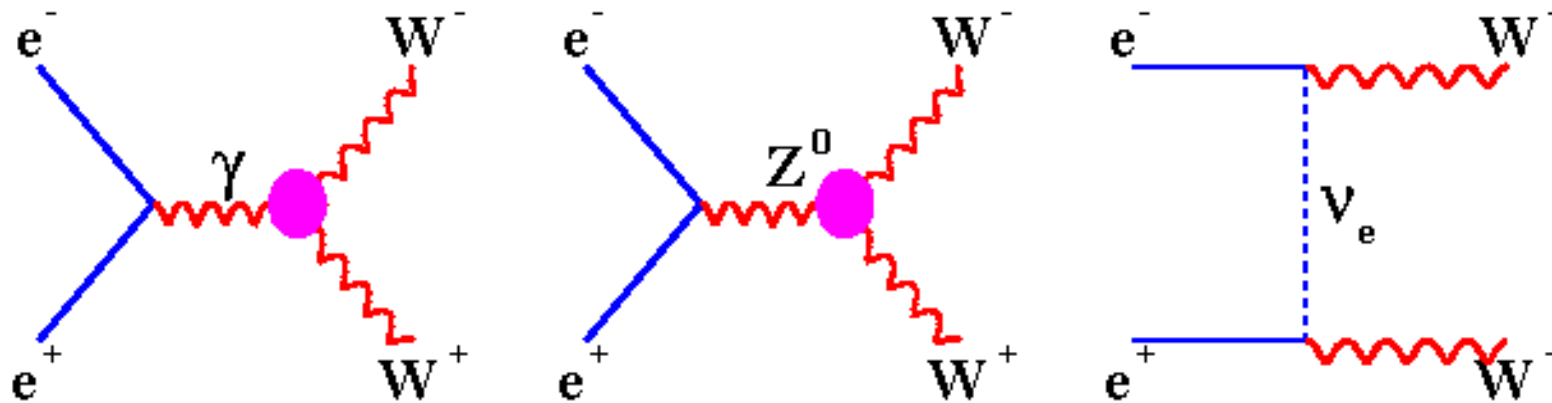
$$\Delta \sin^2 \vartheta_W \approx 0.00014$$



(Grandi errori sistematici - ancora da valutare ma probabilmente dominanti sullo statistico - da PDF, accettazione dei leptoni, corr. radiative.)  
**Fit simultaneo per estrarre PDF e angolo di Weinberg?**

# Risultati dalle coppie WW a LEP2

Tre diagrammi a livello di Born ( diagrammi CC03) :



In realta' si rivela il decadimento successivo del W in leptone-(anti) neutrino e quark<sub>1</sub>- (anti) quark<sub>2</sub>.

Processo reale

$$e^+e^- \rightarrow W^+W^- \rightarrow f_1\bar{f}_2f_3\bar{f}_4 \text{ definito da tagli sper.}$$



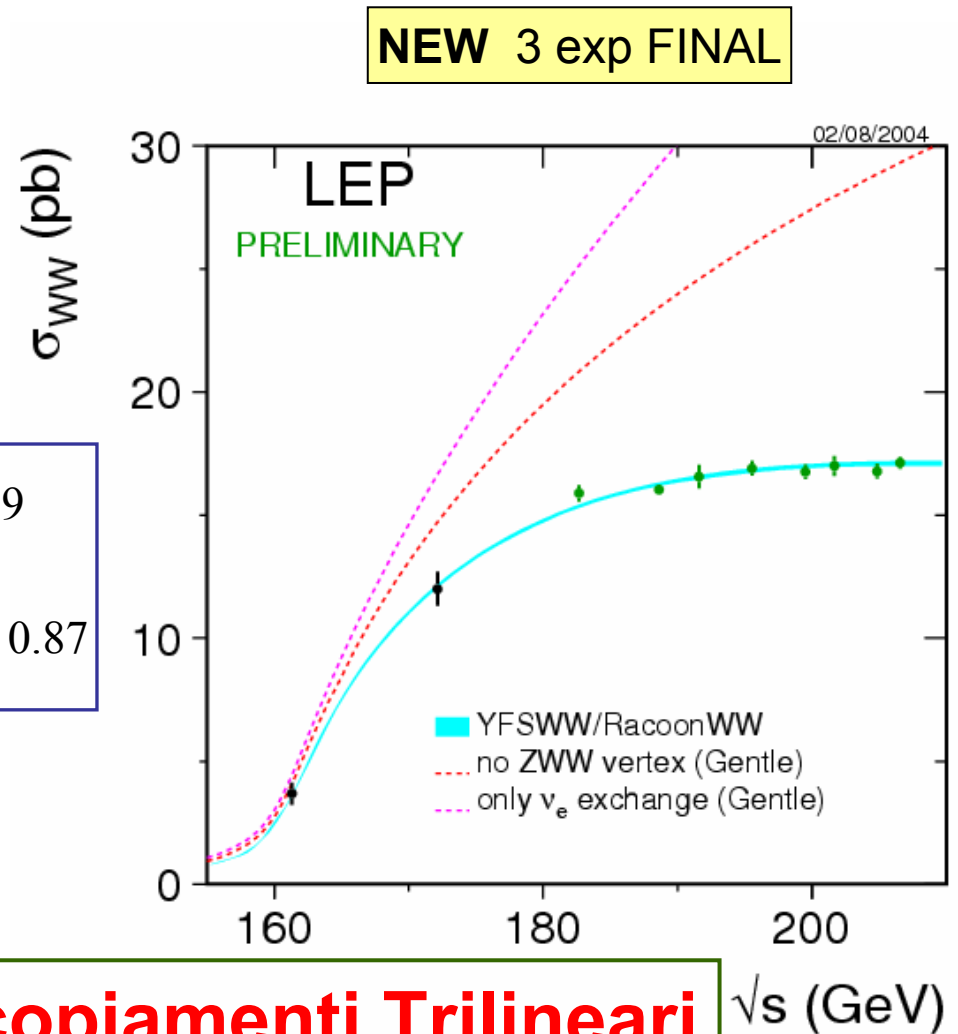
# Sezione d'urto WW totale

- La precisione raggiunta da LEP ha motivato nuove predizioni (post-dizioni ?)

- Predizioni con correzioni radiative  $O(\alpha)$  migliorate !

$$R_{\text{with } O(\alpha)} = \frac{\sigma(\text{LEP})}{\sigma(\text{Theory : YFSWW})} = 99.32 \pm 0.89$$

$$R_{\text{without } O(\alpha)} = \frac{\sigma(\text{LEP})}{\sigma(\text{Theory : KORALW})} = 97.42 \pm 0.87$$



**Chiara evidenza di Accoppiamenti Trilineari**

$\sqrt{s}$  (GeV)

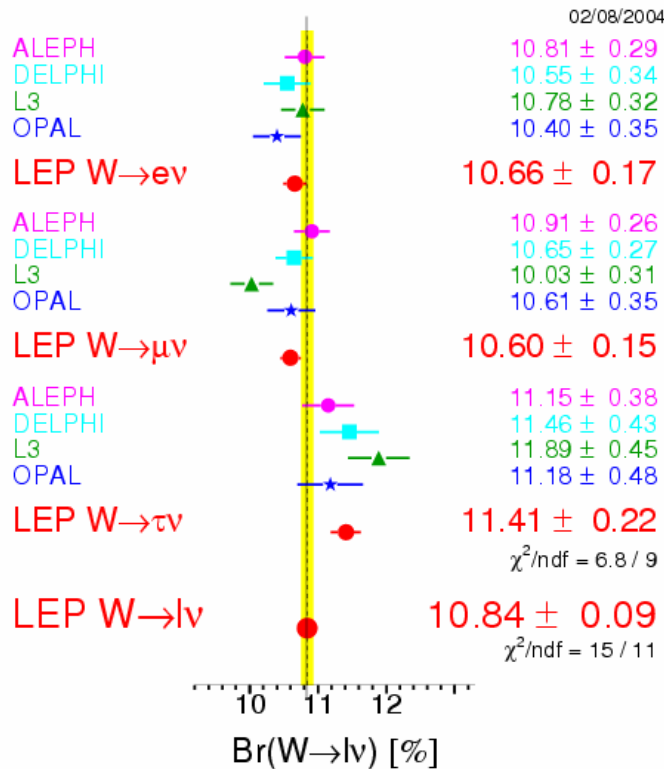
# Decadimenti del W : Branching Ratios

Summer 2004 - LEP Preliminary

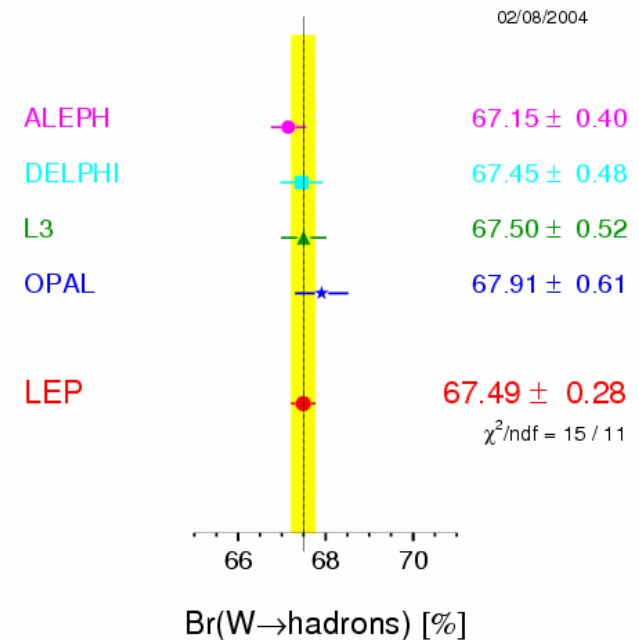
**NEW ADL FINAL**

Summer 2004 - LEP Preliminary

## W Leptonic Branching Ratios



## W Hadronic Branching Ratio



**Standard Model : 10.8%**

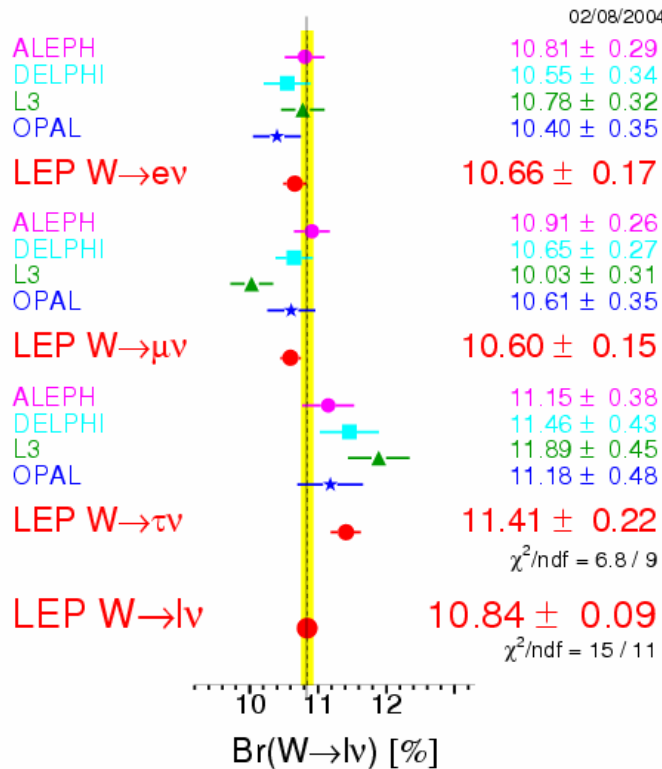
**Standard Model : 67.5%**

Test dell'universalita' leptonica:  
risultato per il  $\tau$  piu' alto di  $e+\mu$

# Accoppiamenti leptonici del W

Summer 2004 - LEP Preliminary

## W Leptonic Branching Ratios



**NEW ADL FINAL**

$$\frac{g(\mu)}{g(e)} = 0.997 \pm 0.010$$

$$\frac{g(\tau)}{g(e)} = 1.034 \pm 0.015$$

$$\frac{g(\tau)}{g(\mu)} = 1.037 \pm 0.014$$

- Se si assume lo stesso accoppiamento per **elettroni** e **mu** ed i due risultati sono combinati e confrontati a **tau** la differenza e' di **3σ**

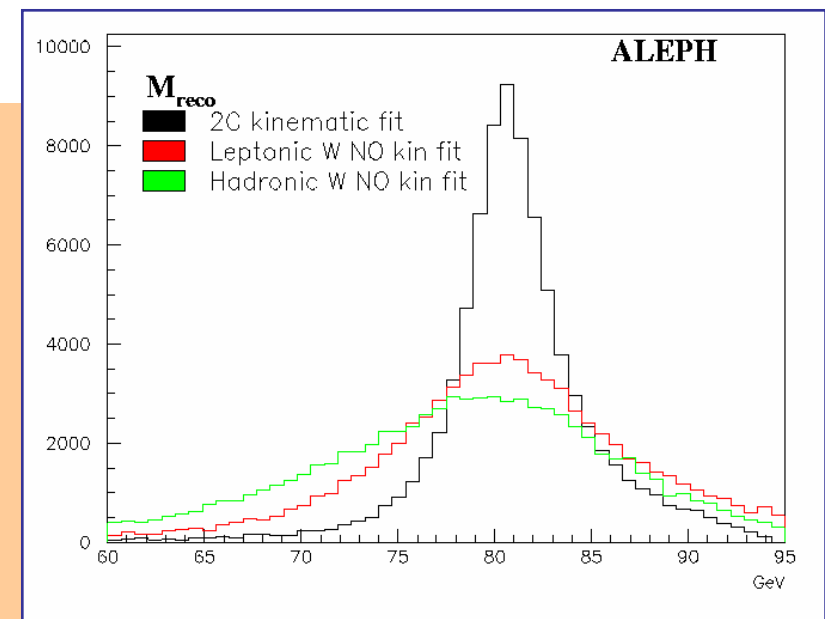
- erano **2.3σ** un anno fa
- sono **2.6σ** se si usano solo risultati finali

LHC: si potra' fare un controllo se i sistematici di identificazione dei tau lo permetteranno

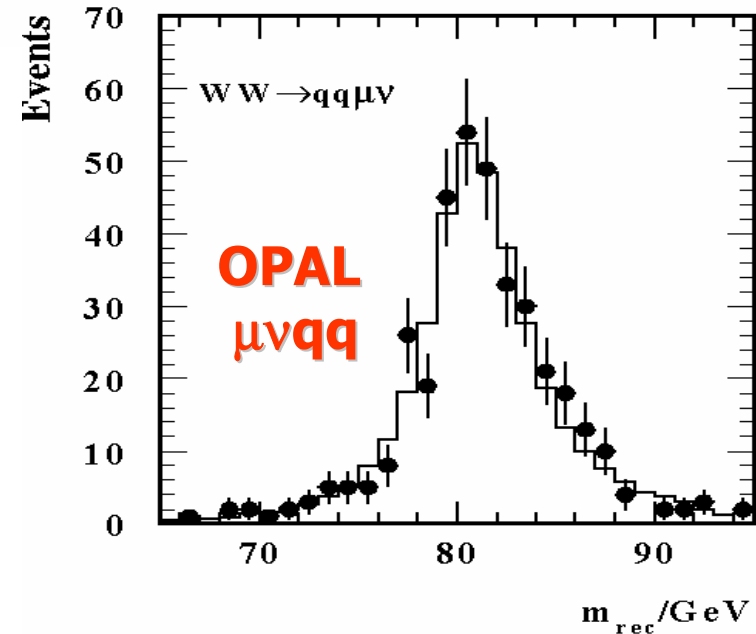
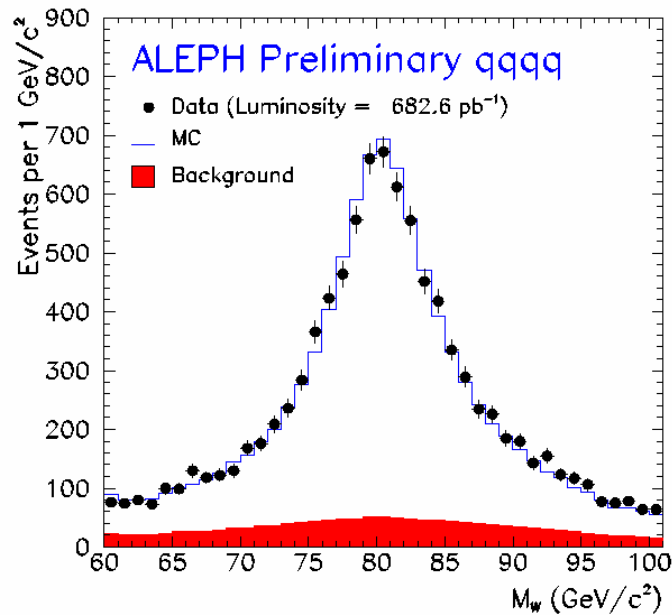
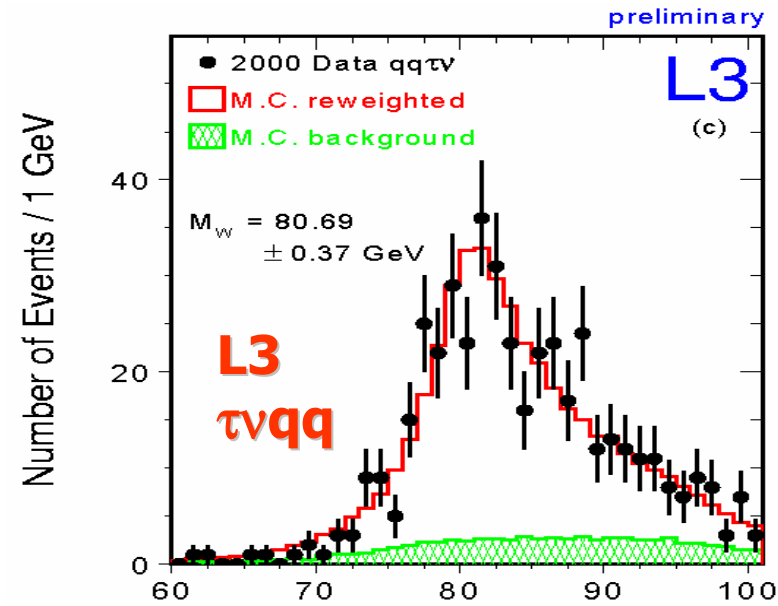
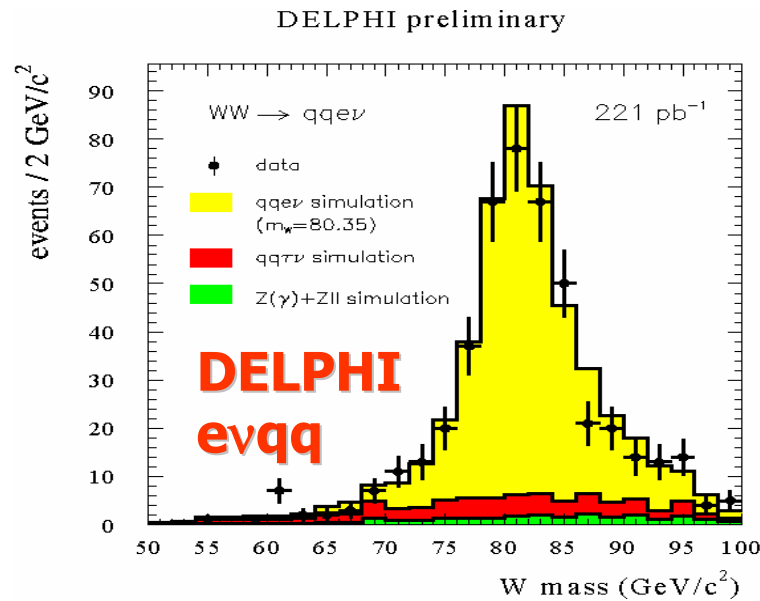
# LEP: Massa del W da ricostruzione diretta

- Al di là della soglia WW la massa del W si misura dalla massa invariante jet-jet nei canali totalmente adronico e semileptonico
  - Eventi ricostruiti in 2 (semileptonico) or 4 (adronico) jet
  - Fit cinematico per migliorare i quadrimpulsi dei jet.
- Bisogna conoscere l'energia del fascio

- Coppie WW a LEP
  - energia nel centro di massa 161 GeV – 209 GeV
  - $\sim 700 \text{ pb}^{-1}$  per esperimento
  - $\sim 4500$  qqqq ,  $\sim 4000$  lvqq per esperimento



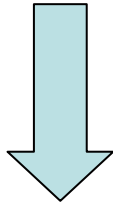
# $M_W$ ricostruita



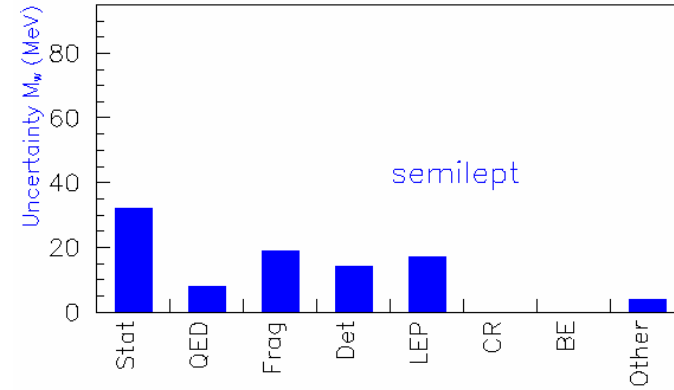
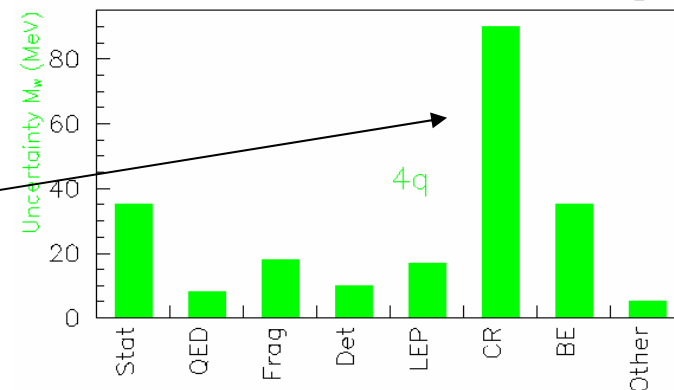
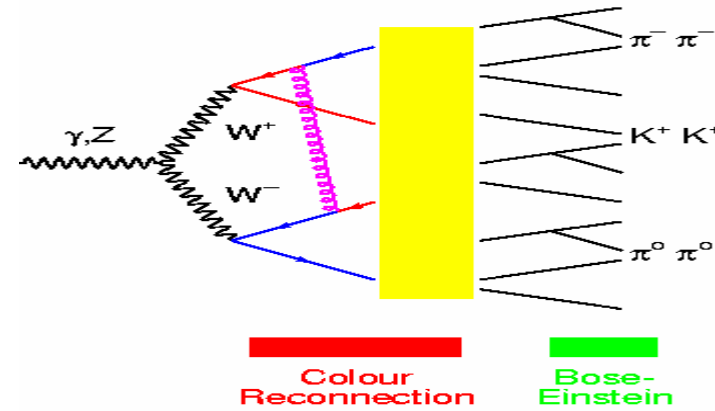
# LEP: Incertezze sistematiche su $M_W$

- Effetti QED (ISR, FSR, etc.)
- Frammentazione
- Effetti di Detector
- Incertezza sull'energia del fascio
- Colour Reconnection
- Bose-Einstein correlations

(Peso dei 4q nella combinazione LEP: 0.09%)



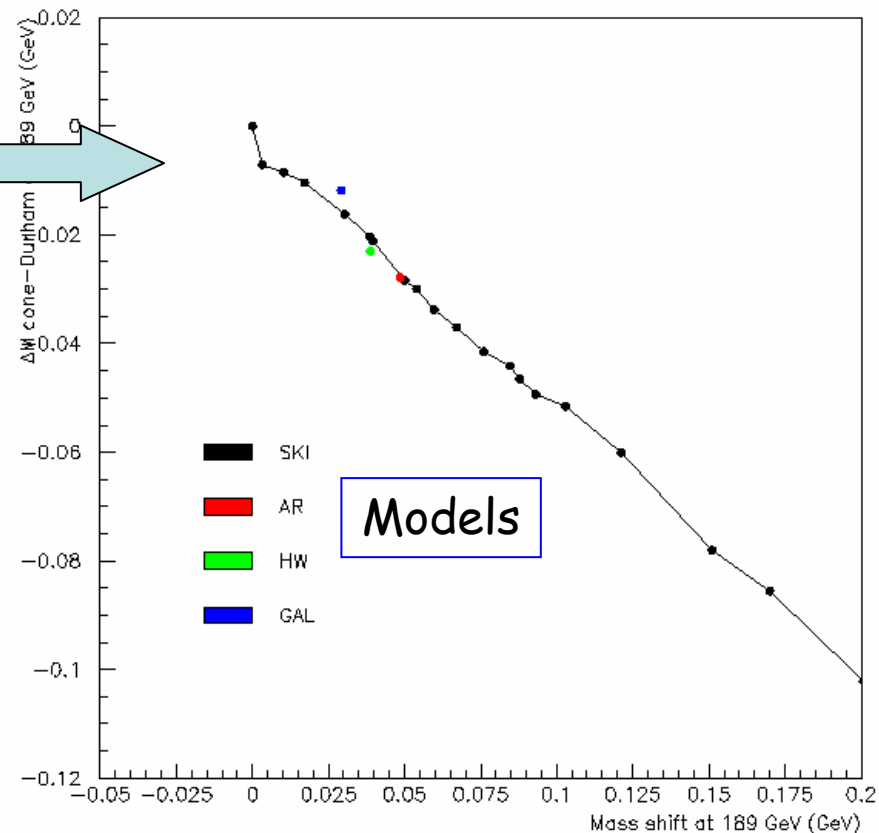
Sforzo per ridurre questo errore con analisi 4q poco sensibili alla Colour Reconnection



# Risultato **LEP** finale: **Colour** Reconnection misurata dai dati (o meglio modelli limitati dai dati)

Esempio:  $\Delta M$ , differenza tra  
**Massa misurata nella analisi standard**  
e  
**Massa misurate usando solo  
particelle nel core del jet**

- Correlazione tra  $\Delta M$  e shift predetto caratteristica generale dei modelli : CR influenza
  - Particelle soft
  - Particelle fuori dal core del jet



**Mass Shift predicted by model**

- Con tecniche di questo tipo il sistematico da **CR dovrebbe passare da 90 MeV a ~ 50 MeV**

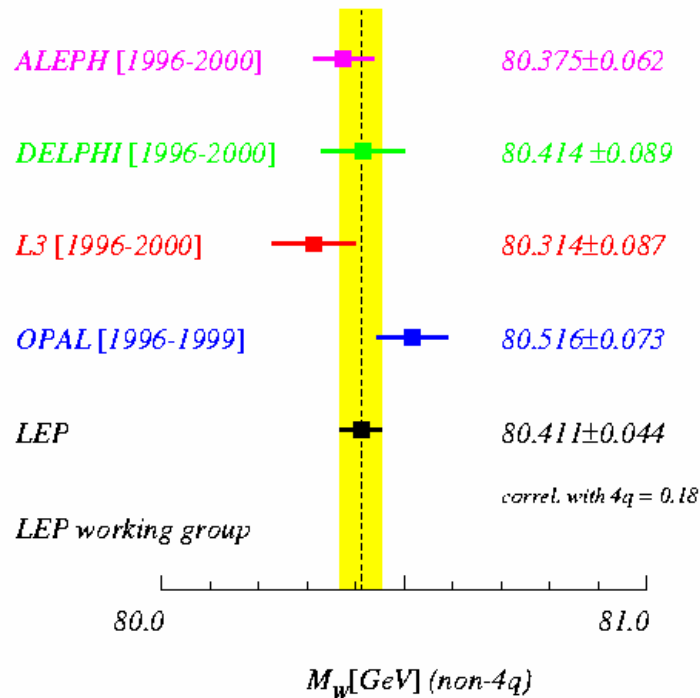
# $M_W$ a LEP : 4q e lvqq

$80.411 \pm 0.032(\text{stat})$   
 $\pm 0.030(\text{syst}) \text{ GeV}/c^2$

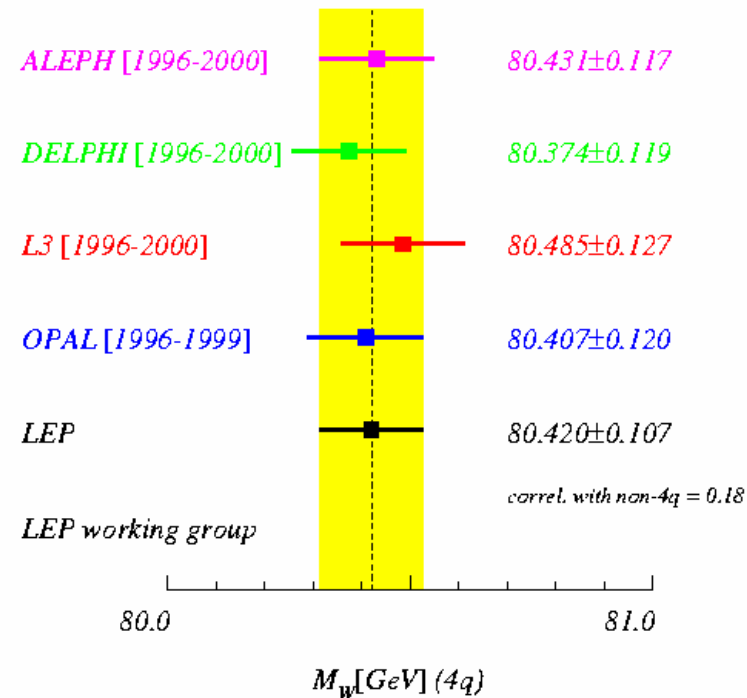
$80.420 \pm 0.035(\text{stat})$   
 $\pm 0.101(\text{syst}) \text{ GeV}/c^2$

Differenza tra i due canali (senza FSI syst)  
 $\Delta M_W(\text{qqqq}-\text{lvqq}) = +22 \pm 43 \text{ MeV}$

Winter 2003 - LEP Preliminary



Winter 2003 - LEP Preliminary

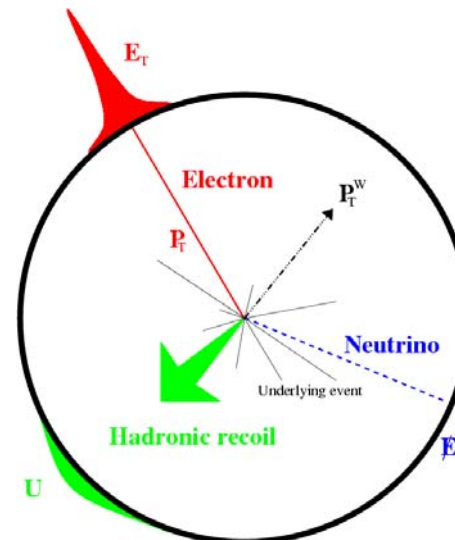
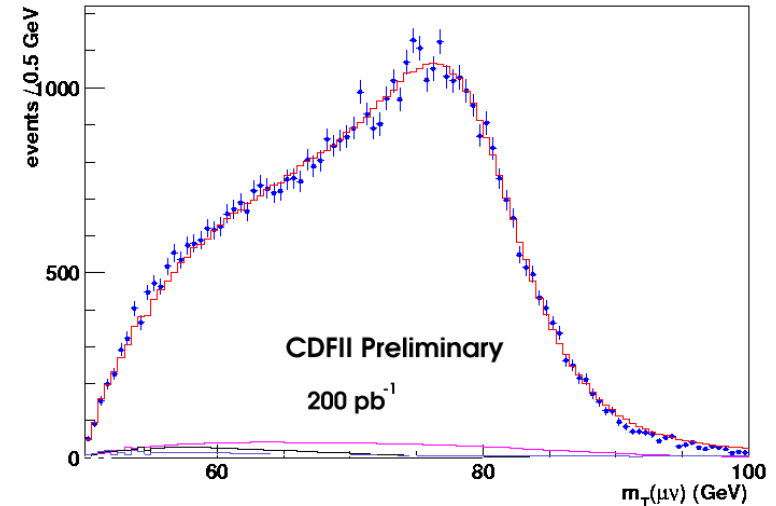




# Massa del W ai collider adronici: il passato e il futuro

- Prima di LEP: collider adronici (SpS, Tevatron Run I)
- Dopo LEP : collider adronici (Tevatron Run II, LHC)
- Produzione di **W singoli** da Drell-Yan (annichilazione quark-antiquark)
- Decadimento W in leptone (e or  $\mu$ ) + neutrino
- Fit a  $M_W^T$ , la distribuzione in massa trasversa

$$M_W^T = \sqrt{2 p_T^{\text{leptone}} p_T^{\nu} (1 - \cos \varphi)}$$



# Incertezze sulla massa del W al Tevatron (Run I)

	CDF e	CDF $\mu$	DØ e
<b>Uncorrelated uncertainties</b>			
W statistics	100	65	60
Lepton scale	85	75	56
Lepton resolution	20	25	19
$p_T(W)$	20	15	15
Recoil model	35	37	35
Selection bias	18		12
Backgrounds	25	5	9
<b>Correlated uncertainties</b>			
PDF	15		$7 \oplus 4$
Radiative corrections	11		12
$\Gamma_W$	10		10

These errors are determined using CDF/DØ data, scale with luminosity

Detector improvements for Run II will also help

Theory improvements  
Improve PDF constraints with measurements (W charge asymmetry, Z rapidity distribution)



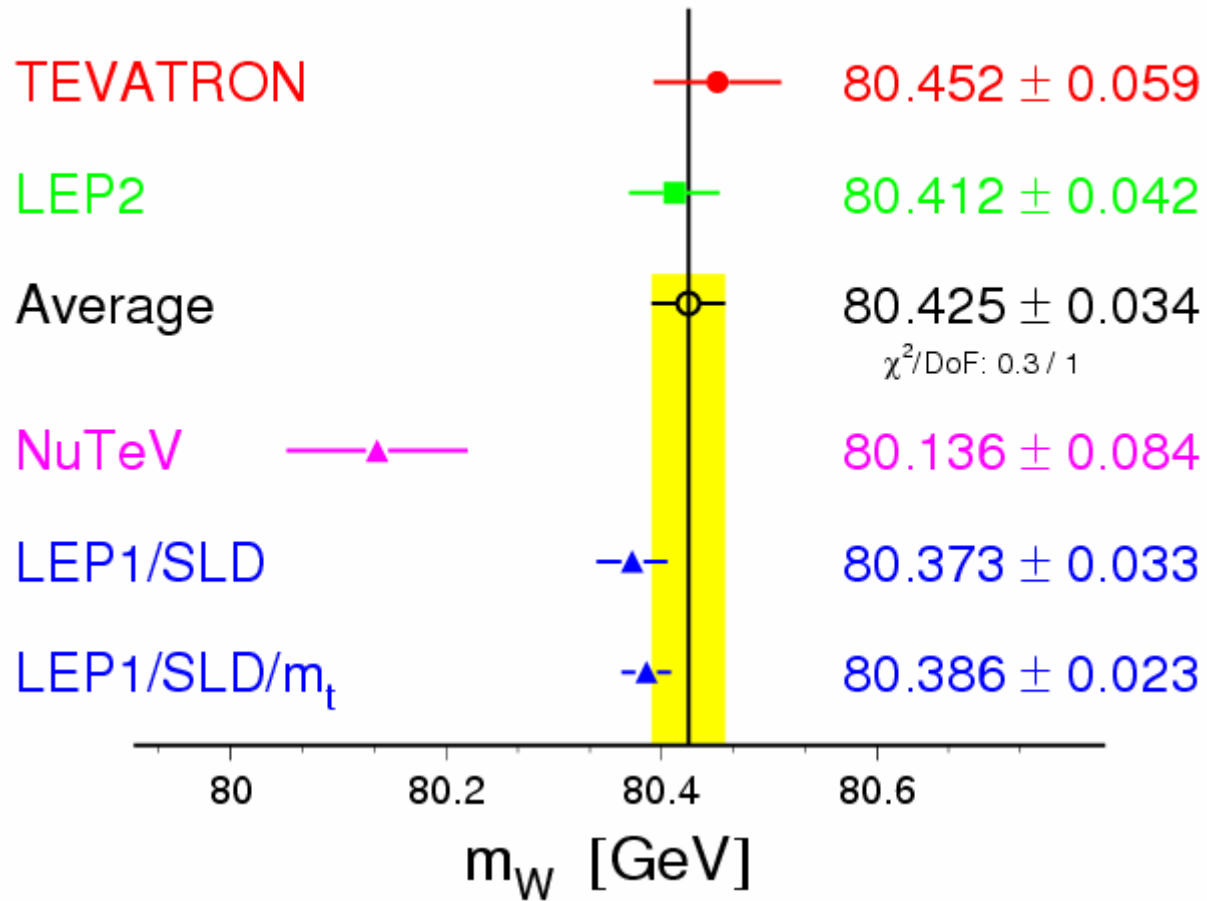
*40 MeV per experiment with  $2 \text{ fb}^{-1}$  feasible*

**RUN II**

**A LHC e' necessario raggiungere i 15 MeV**

# $M_W$ a LEP e TeVatron

W-Boson Mass [GeV]



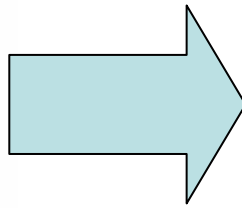
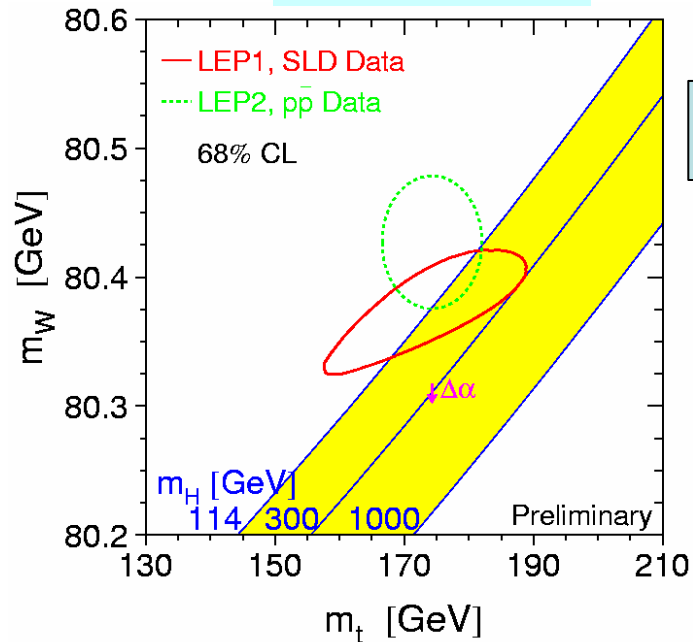
# Massa dell' Higgs dai fit Elettrodeboli

- Teoria Elettrodebole verificata a un loop
- Indicazioni per un Higgs leggero

$$M_{\text{top}} = 174.3 \pm 5.1 \text{ GeV}/c^2$$

$$M_{\text{Higgs}} \leq 219 \text{ GeV}/c^2$$

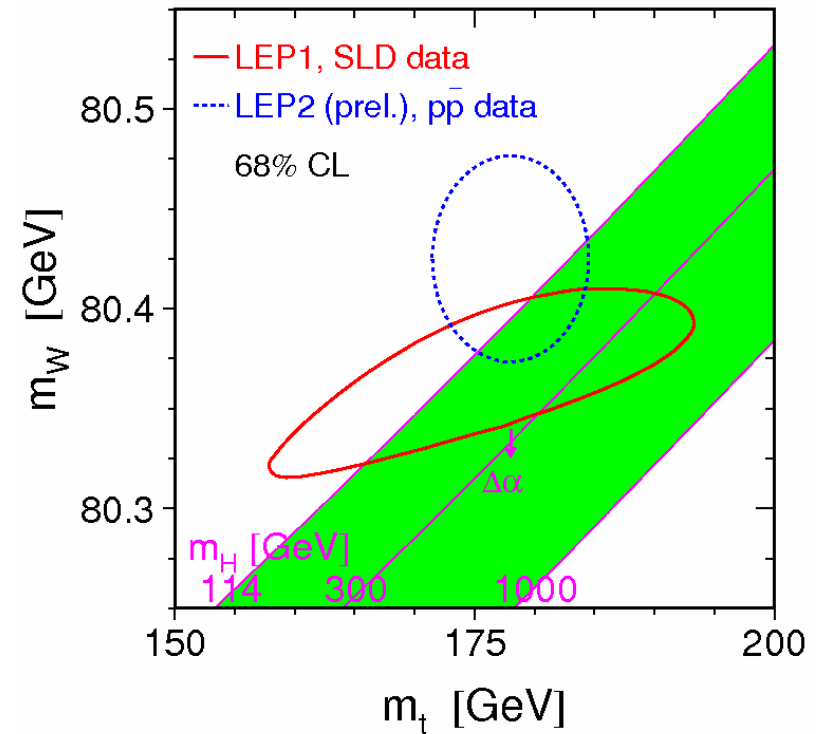
Summer 2003



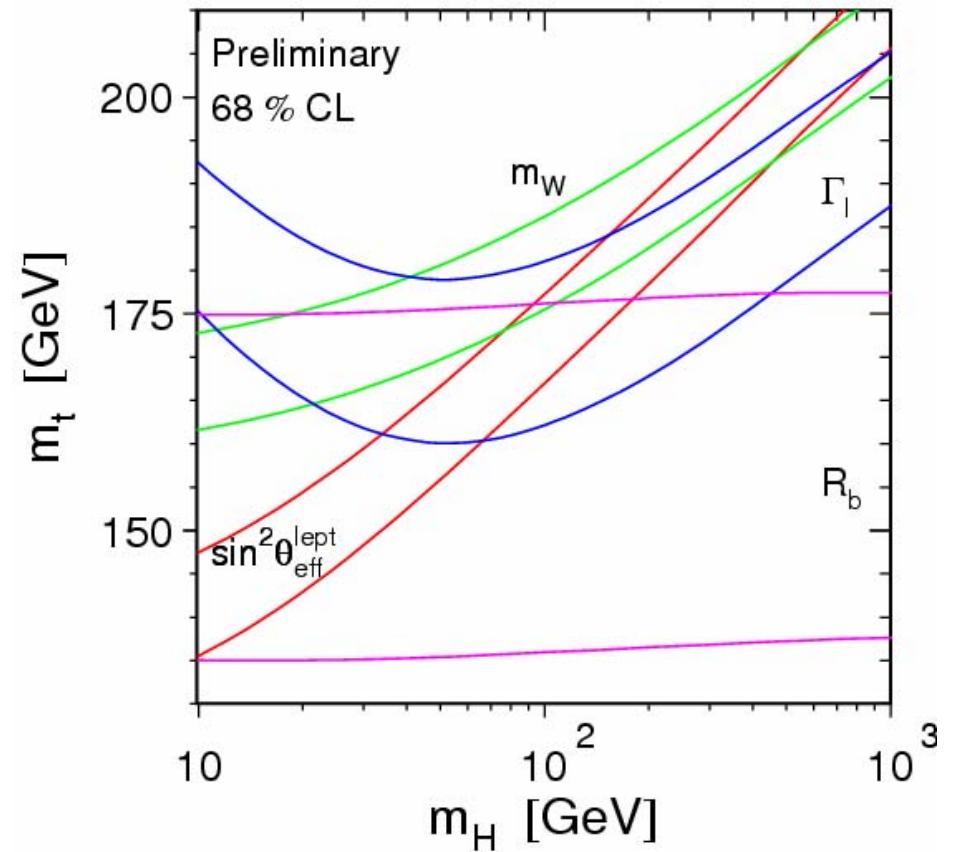
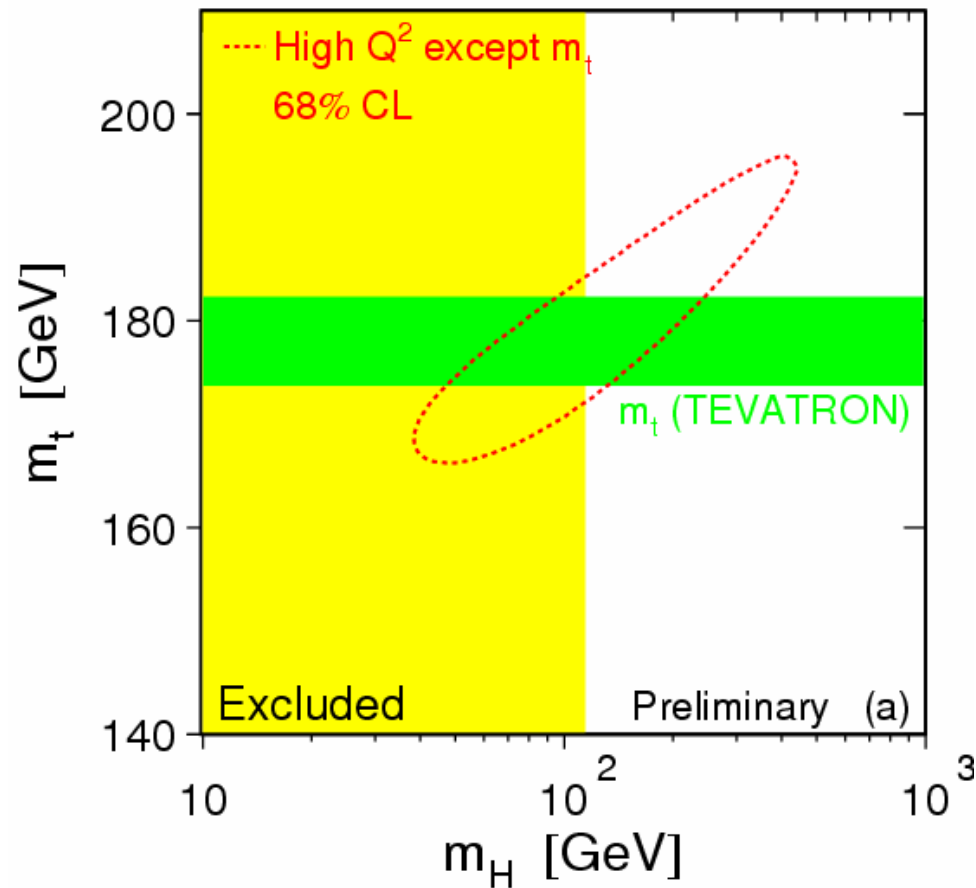
Winter 2005

$$M_{\text{top}} = 178.0 \pm 4.3 \text{ GeV}/c^2$$

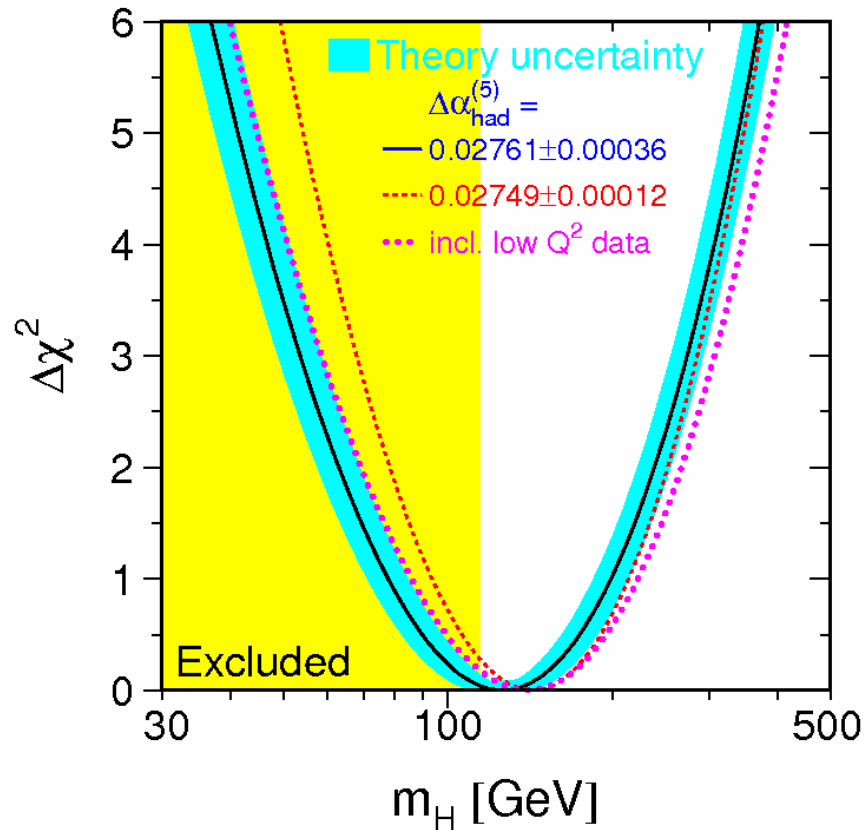
$$M_{\text{Higgs}} \leq 280 \text{ GeV}/c^2$$



# Risultato del fit nel piano ( $m_{\text{top}}$ , $m_{\text{higgs}}$ )

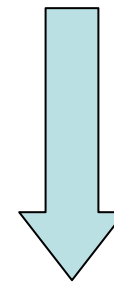


# Blue band plot Winter 2005



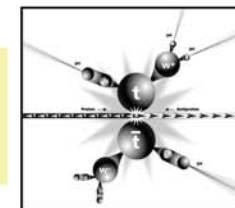
$$M_{\text{Higgs}} = (126_{-48}^{+76}) \text{ GeV}/c^2$$

..... Ma scendera' di nuovo,  
vedi sotto.....





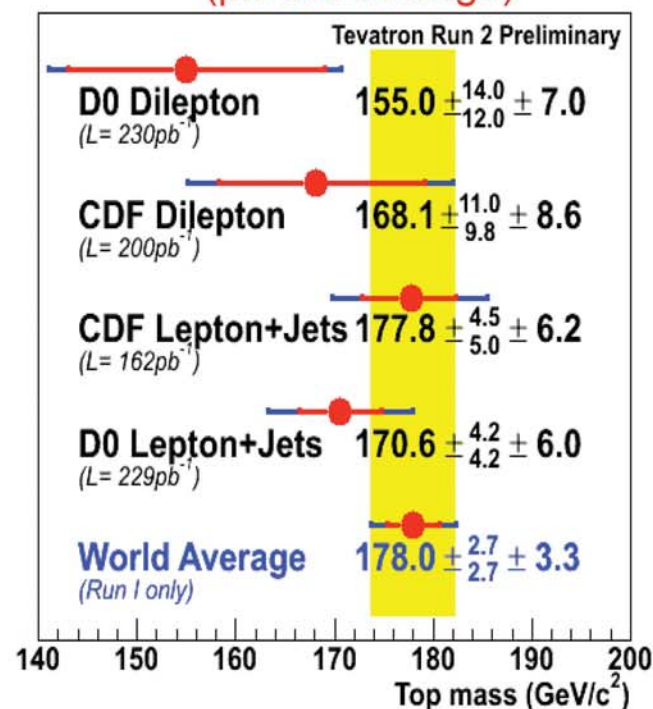
# Summary



- Several new top mass measurements available in different decay channels:
  - CDF Run II preliminary results
    - ➔ DLM: most precise measurement from run II
    - ➔ CDF average
  - **$176.7 \pm 7.6 \text{ GeV}/c^2$**  (private average)
  - Best Run II DØ results from l+jet channel:
    - ➔  **$170.6 \pm 7.3 \text{ GeV}/c^2$**  (from 2 days ago)
  - new techniques have being developed
  
- Tevatron is performing very well
  - Delivered luminosity approaches  $800 \text{ pb}^{-1}$
  - Top mass updates from the higher statistic ( $\sim 325 \text{ pb}^{-1}$ ) will be available soon (next months)
  - A lot of work is done to the reduce systematics –especially the jet-energy scale systematic uncertainty
  - Precision will be limited by systematic uncertainties

CDF& DØ Run2

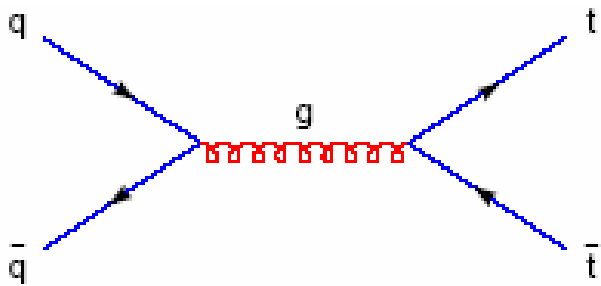
$M_{\text{top}} = 173.6 \pm 5.4 \text{ GeV}/c^2$   
(private average)



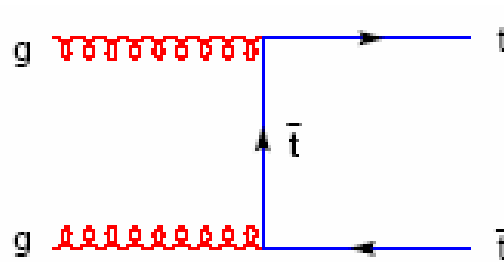
# LHC e' una top factory !

$$\sigma_{tt}(\text{th}) = 825 \pm 150 \text{ pb} \quad (\sim 100 \text{ volte Tevatron})$$

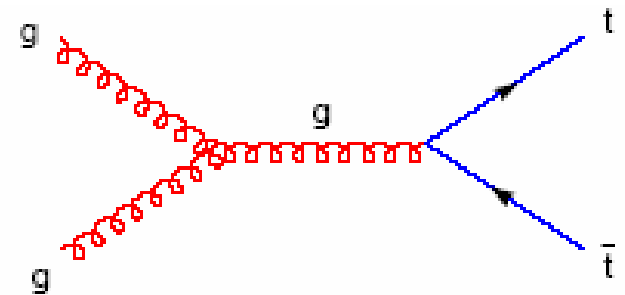
8 milioni di coppie  $t\bar{t}$  in un anno  
a **bassa luminosita'** (1 Hz)



$qq \rightarrow t\bar{t}$ : 13%



$gg \rightarrow t\bar{t}$ : 87%



Fondi principali: W/Z + jets



# Esempio : massa del top nel canale semileptonico

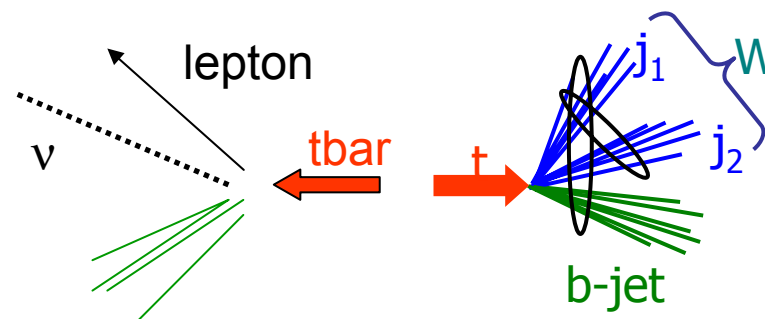
Electron/muon + jets:

Tre vincoli  
Piu' due (total pt=0)



- $M_{lv} = M_W$
- $M_{jj} = M_W$
- $M_{lvb} = M_{jjb}$

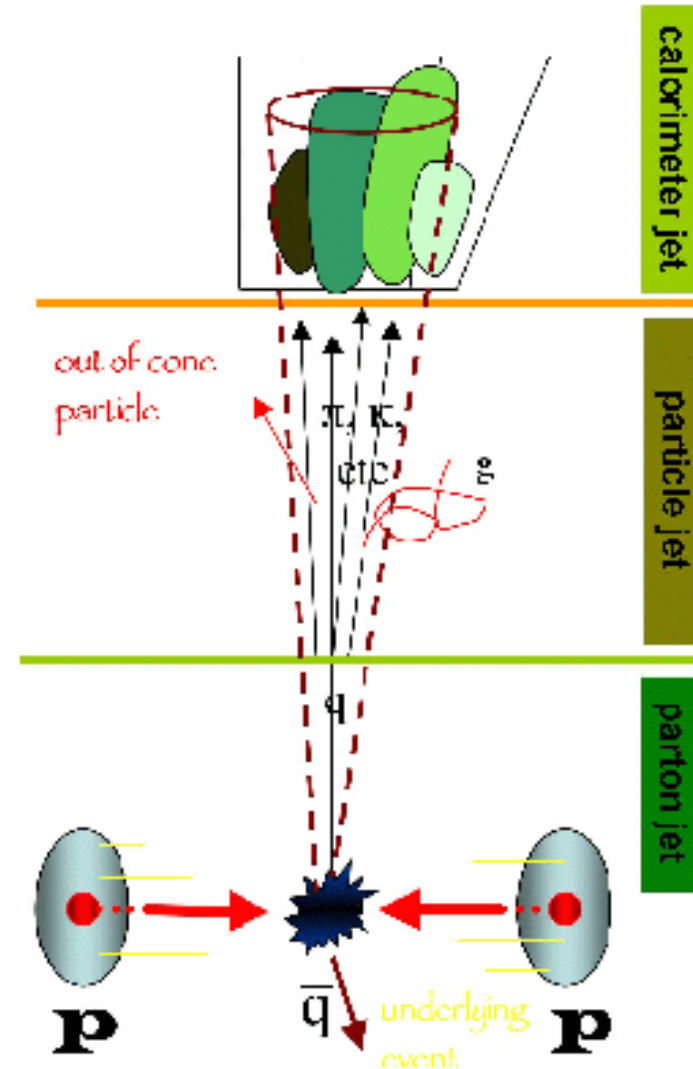
- Necessaria buona misura di  $E_T(\text{miss})$  per il neutrino
- Necessario calibrare i jet
- B-tagging importante per la selezione e abbassare il combinatorio



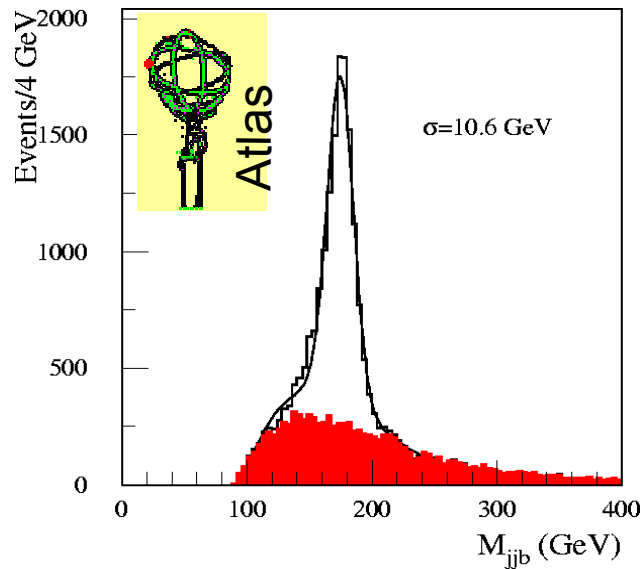
# Jet Energy Corrections

Determine true "particle", "parton"  
jet E from measured jet E

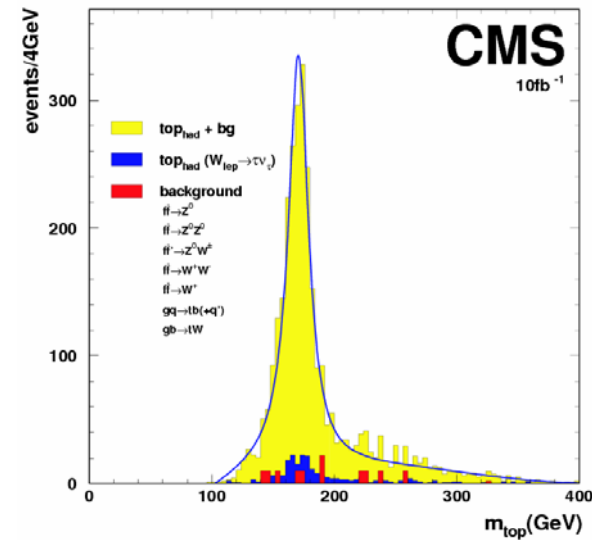
- Non-linear response
- Uninstrumented regions
- Response to different particles
- Out of cone E loss
- Spectator interactions
- Underlying event



# top mass at LHC (semilept.)

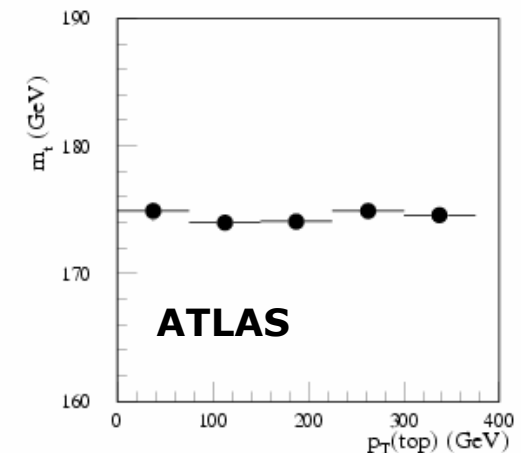
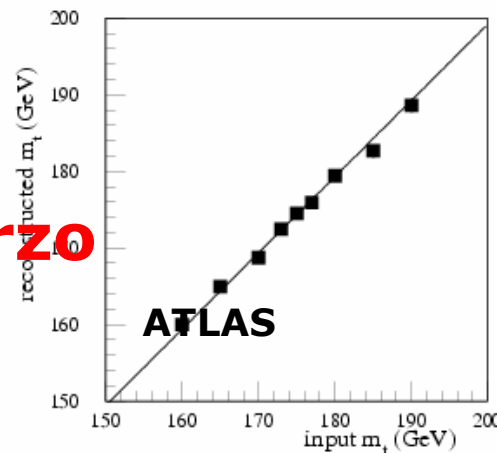


M(reco) vs M(true)

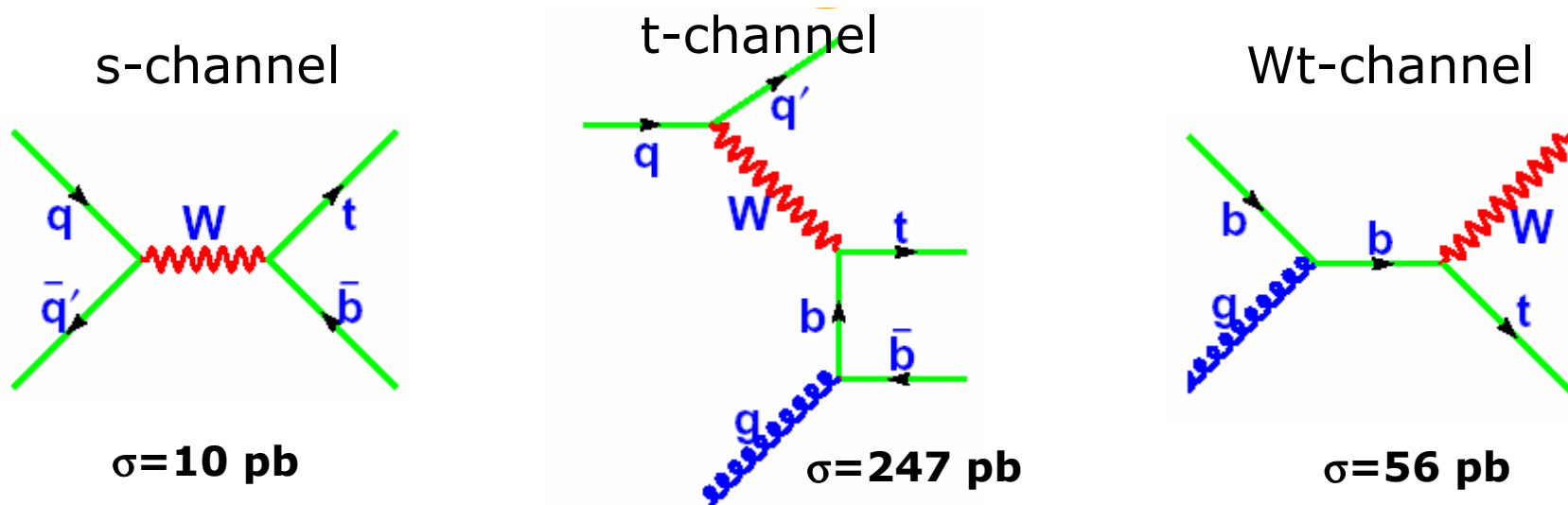


M(reco) vs P<sub>T</sub>(top)

$\Delta m_t \approx \pm 1-2 \text{ GeV}$   
 Ma, con grande sforzo  
 Sui sistematici !



# Top singolo a LHC



- Fino ad ora solo limiti superiori dal Tevatron
- Dal canale s misura precisa di  $|V_{tb}|$
- Sensitivita' a nuova fisica: FCNC (t-ch.), nuovi bosoni di gauge...
- Dal canale t studi precisi di polarizzazione, predetta dallo SM (processo elettrodebole !)

# Accoppiamenti Trilineari (TGC)

- I vertici trilineari ( $WW\gamma$ ,  $WWZ$ ) verificano la struttura **non-Abeliana** dello Standard Model. Limite ad **accoppiamenti anomali**.
- La lagrangiana piu' generale invariante di Lorentz presenta 14 costanti di accoppiamento (7 per  $WW\gamma$  e 7 per  $WWZ$ )
- Assumendo invarianza di gauge elettromagnetica, conservazione di C e P, relazioni  $SU(2) \times U(1)$ , rimangono 3 parametri

$$\{g_1^z, \kappa_\gamma, \lambda_\gamma\}$$

Momento magnetico anomalo del W

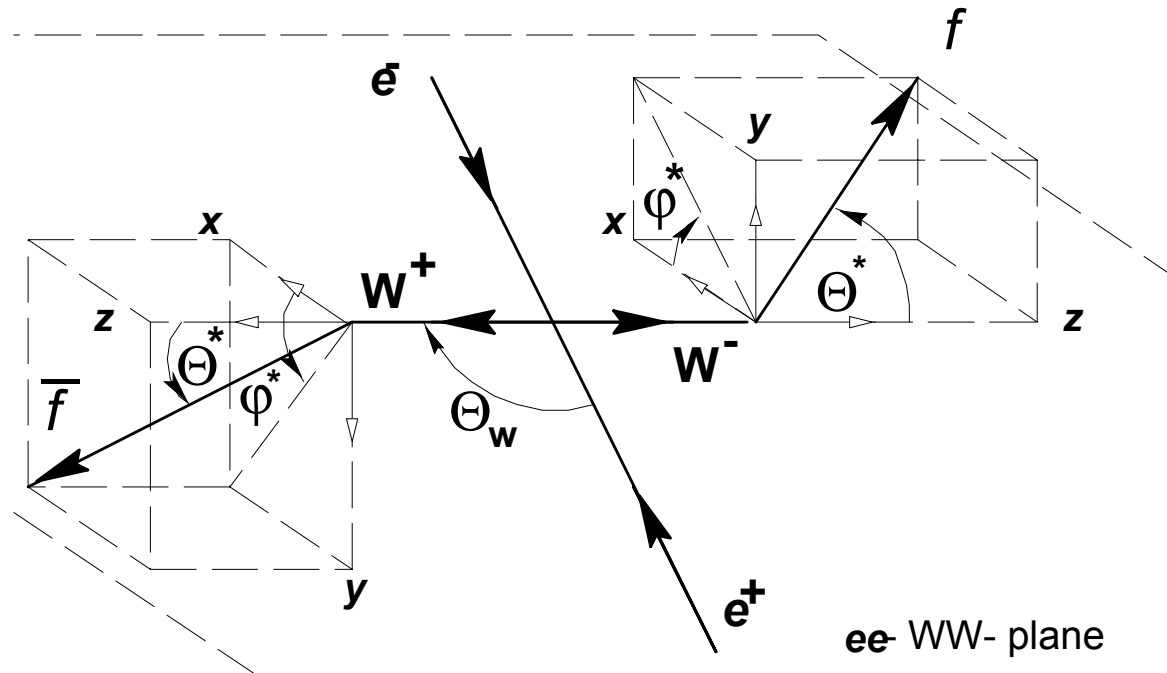
$$\mu_w = \frac{e}{2m_W} (1 + \kappa_\gamma + \lambda_\gamma)$$

Momento di quadrupolo elettrico del W

$$Q_w = -\frac{e}{m_W^2} (\kappa_\gamma - \lambda_\gamma)$$

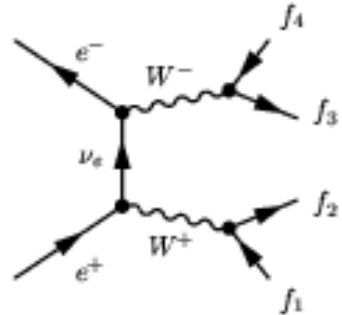
# Triple Gauge Couplings a LEP (e ILC)

- Gli accoppiamenti anomali influenzano gli **stati di elicità** del  $W$
- Modificano la sezione d'urto **totale** e le **distribuzioni angolari**
- Trascurando la larghezza e la radiazione di stato iniziale la produzione e il decadimento del  $W$  sono descritti da **5 angoli**



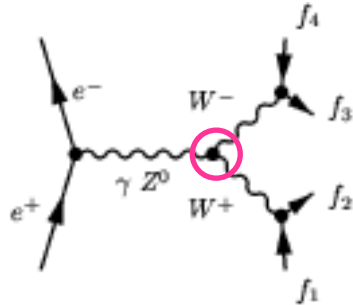
# Processi utilizzati a LEP

- $e^+e^- \rightarrow W^+W^-$  (CC03)



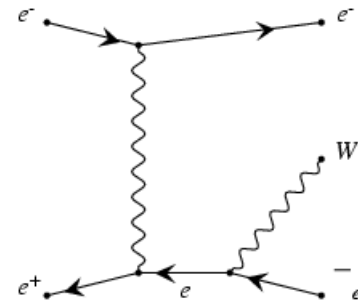
188.6 GeV

$\sigma = 15.98 \pm 0.23$  pb



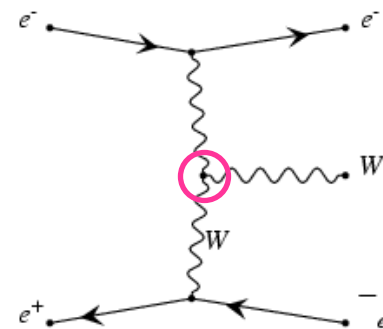
$g_1^Z, \kappa_\gamma$  and  $\lambda_\gamma$

- $e^+e^- \rightarrow We\nu_e$



188.6 GeV

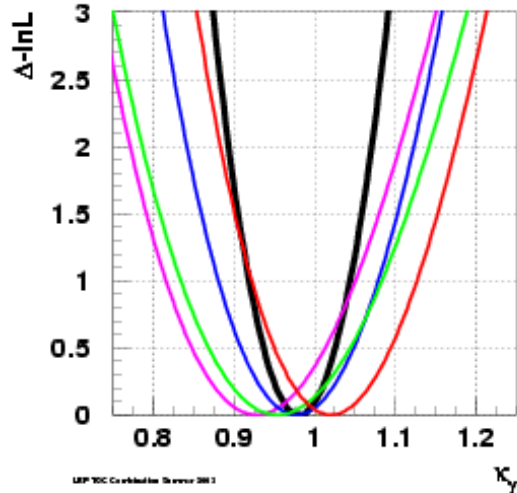
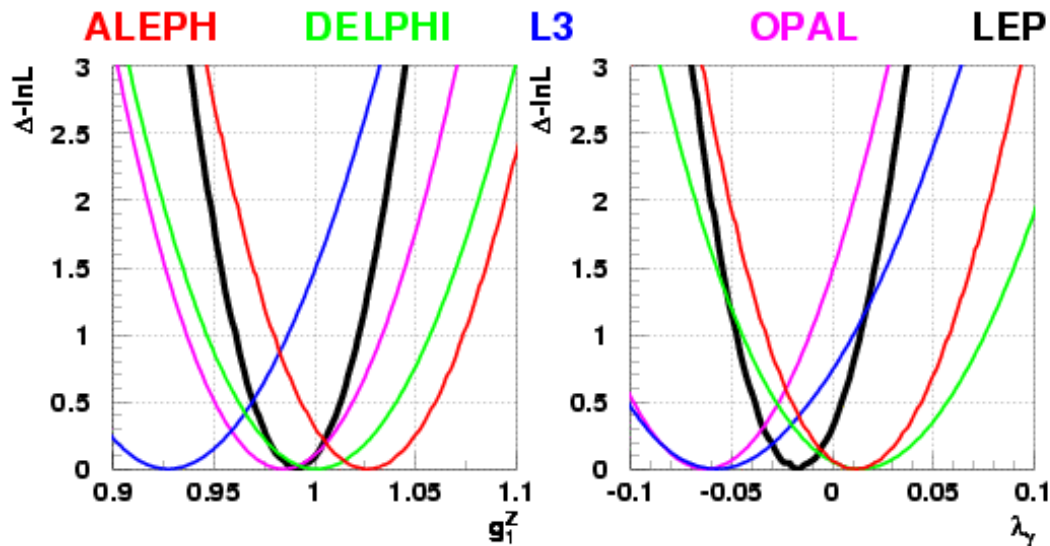
$\sigma = 0.60 \pm 0.09$  pb



$\kappa_\gamma$  and  $\lambda_\gamma$

- $e^+e^- \rightarrow \gamma W_e^- \bar{\nu}_e$

# Risultati: TGC a LEP



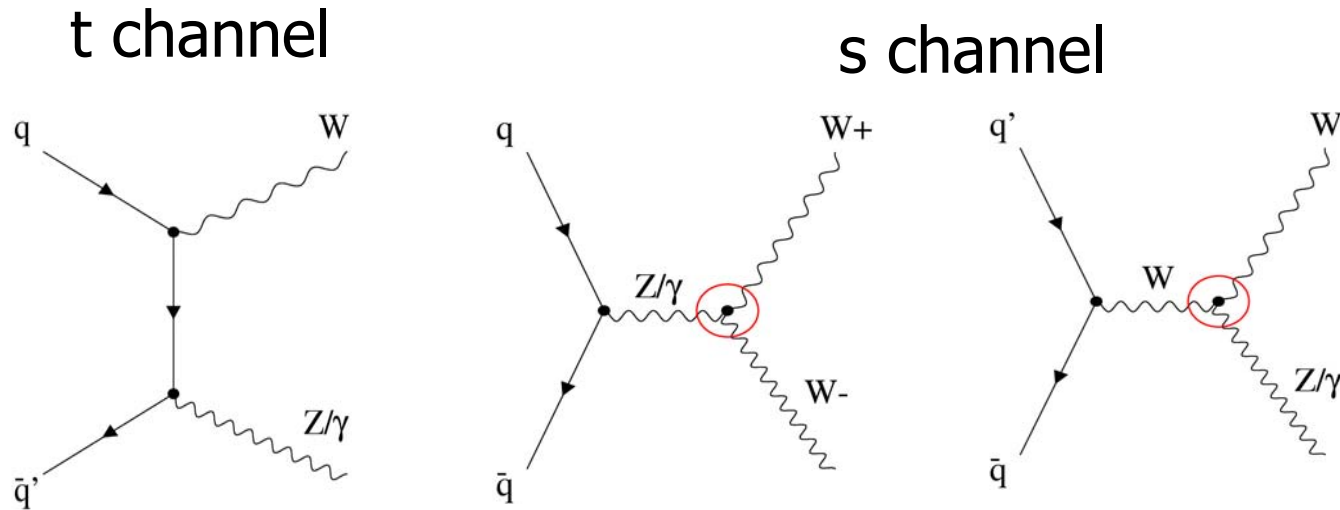
LEP preliminary

$\kappa_\gamma$	$= 0.984$	$+0.042$	$-0.047$	SM
$\lambda_\gamma$	$= -0.016$	$+0.021$	$-0.023$	1
$g_1^Z$	$= 0.991$	$+0.022$	$-0.021$	0
				1

- Prova dell'esistenza dei TGC
- Compatibili con lo Standard Model a livello di albero
- Correzioni radiative SM ( $\approx 10^{-3}$ ) sotto la sensitività raggiunta



# Accoppiamenti trilineari: macchine adroniche



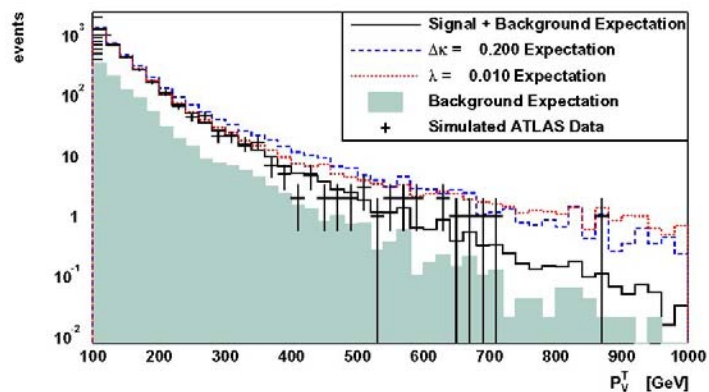
Tevatron (SU(2)xU(1)) :  $\kappa_\gamma, \lambda_\gamma$

LHC : Large statistics +  $\uparrow\sqrt{s} \Rightarrow g_{Z'}^1, \kappa_\gamma, \kappa_Z, \lambda_\gamma, \lambda_Z$

# Couplings a LHC

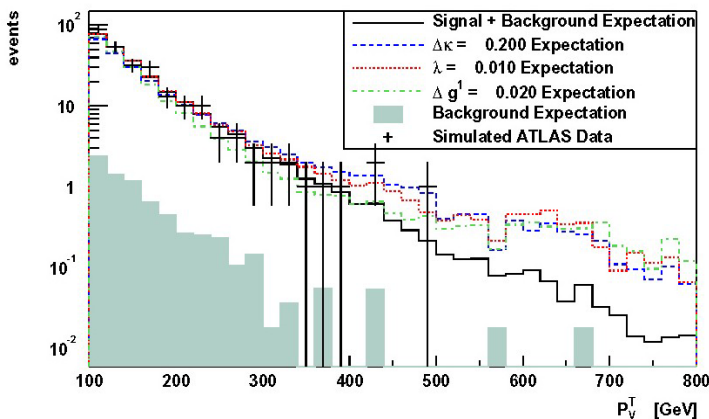
Effetto degli accoppiamenti anomali :

– Eccesso a grande  $P_T(\gamma/Z)$



Stato finale

$$\gamma W \rightarrow \nu$$



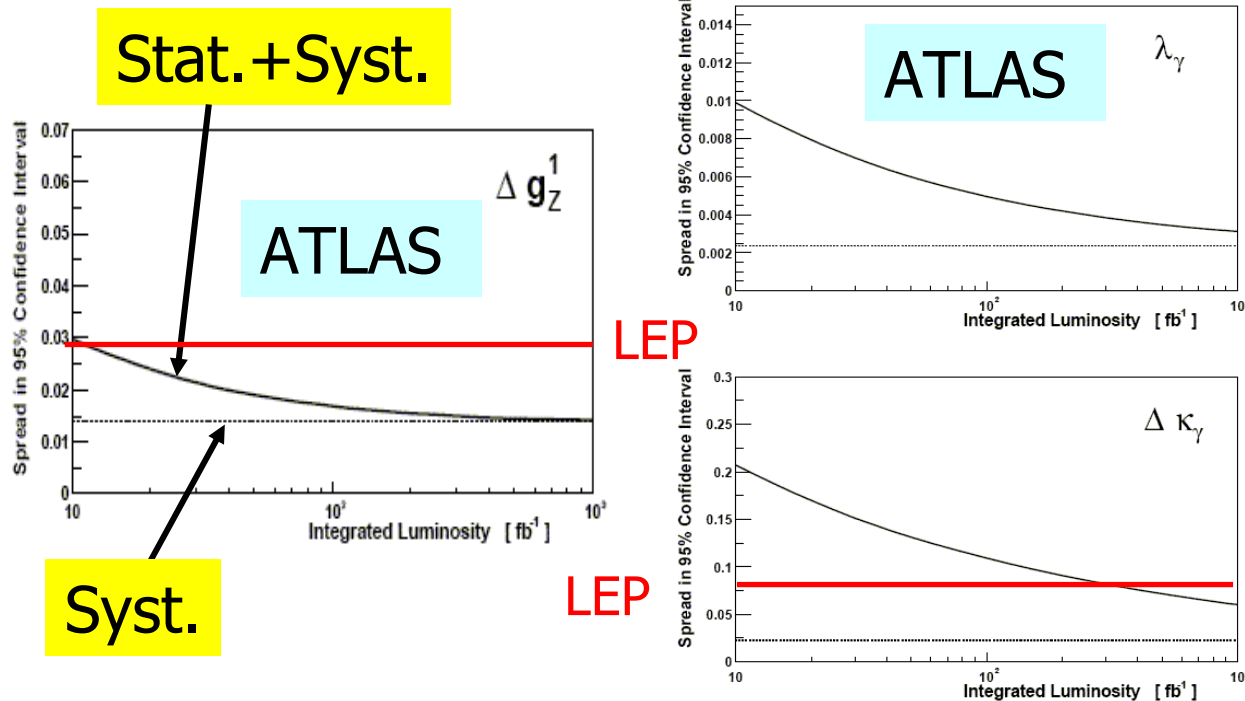
Stato finale

$$Z W \rightarrow \nu \bar{\nu}$$

Gli accoppiamenti gamma and Z possono essere misurati separatamente

# Couplings a LHC: incertezza prevista

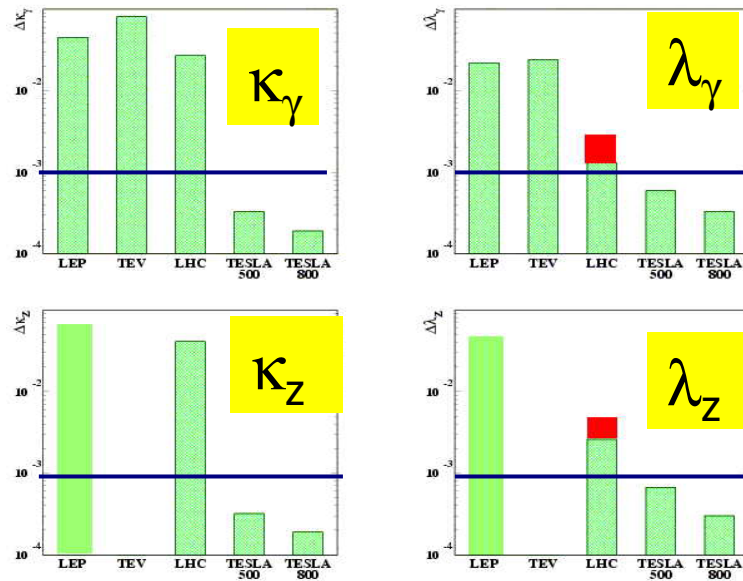
Errore sistematico dominante:  
calcoli QCD solo a NLO



Total Error  
avec  $L=300 \text{ fb}^{-1}$   
(ATLAS+CMS)

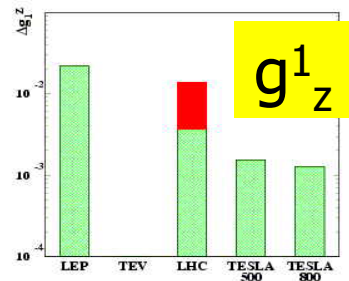
- $g_Z^1 : \sim 0,015$
- $\lambda_\gamma : \sim 0,003$
- $\lambda_Z : \sim 0,007$
- $\kappa_\gamma : \sim 0,08$
- $\kappa_Z : \sim 0,18$

# Prospettive a Futuri Collideri



- ## Loop Contributions
- MS :  $O(10^{-3})$
  - SUSY:  $O(10^{-3})$

■ Syst.



Tevatron:  $1 \text{ fb}^{-1}$   
 LHC:  $300 \text{ fb}^{-1}$   
 Tesla:  $500\text{-}1000 \text{ fb}^{-1}$

# Conclusioni (1)

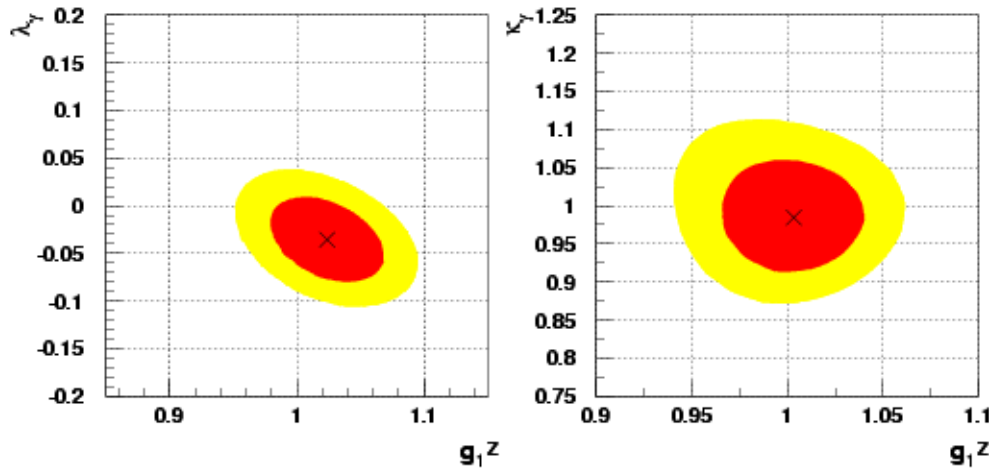
- **LEP-SLD**: Le asimmetrie alla Z sono finali (inclusi i quark)
- **Compito per LHC** : misurare le asimmetrie dai DY
- **Sezioni d'urto W a LEP** sostanzialmente finali
- **La misura della massa del W a LEP e' ancora PRELIMINARE**
  - L'incertezza dovuta agli effetti di Color Reconnection sara' ridotta e si sfruttera' meglio il canale a 4q
- **Ridurre l'errore finale di LEP su  $M_W$  ( $\sim 35$  MeV ) sara' il compito di Tevatron Run II e LHC**
- **Fit Elettrodeboli: nonostante tutto c'e' ancora evidenza per un Higgs leggero**

# Conclusions (2)

- TGC's misurati a LEP con precisione  $\sim 1\%$  , chiara evidenza dell'esistenza di accoppiamenti trilineari
- i TGC saranno misurato con precisione crescente a LHC, ma la vera macchina per i TGC e' il Linear Collider
- Con una sezione d'urto  $t\bar{t}$  di 800 pb e single top di 320 pb LHC sara' una top factory

# Backup Slides

# TGC 2D results



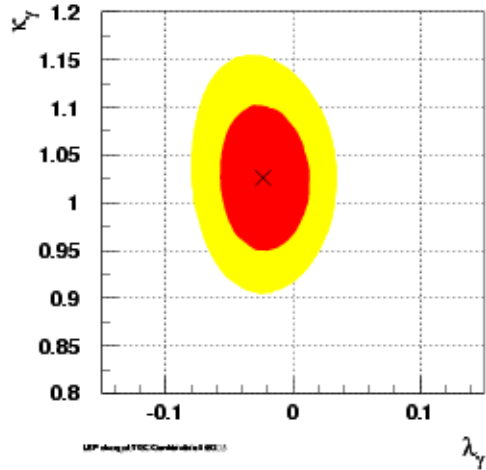
$$-\Delta\ln(L) = 0.5$$

$$g_1^Z = 1.024^{+0.029}_{-0.029}$$

$$\lambda_\gamma = -0.036^{+0.029}_{-0.029}$$

$$g_1^Z = 1.004^{+0.024}_{-0.025}$$

$$\kappa_\gamma = 0.984^{+0.049}_{-0.049}$$



LEP Preliminary

- 95% c.l.
- 68% c.l.
- × 2d fit result

$$\lambda_\gamma = -0.024^{+0.025}_{-0.021}$$

$$\kappa_\gamma = 1.026^{+0.048}_{-0.051}$$

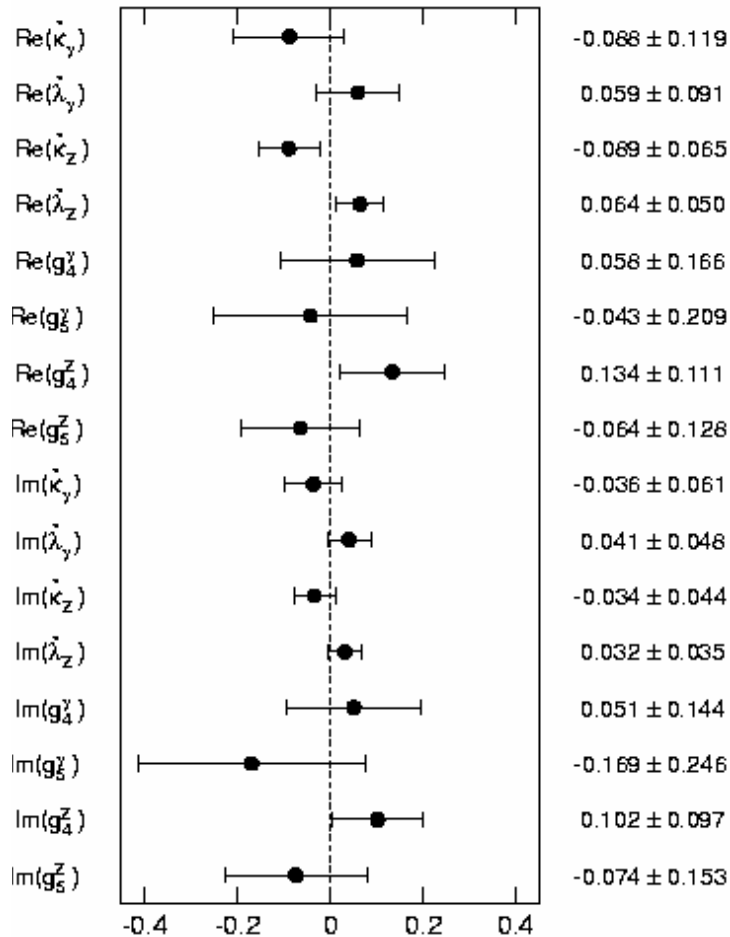
► 3D results available as well



# CP violating couplings

C, P Violating TGCs

183-207 GeV Data (684.0 pb<sup>-1</sup>)



- Measurement of all CP-violating trilinear couplings separately.

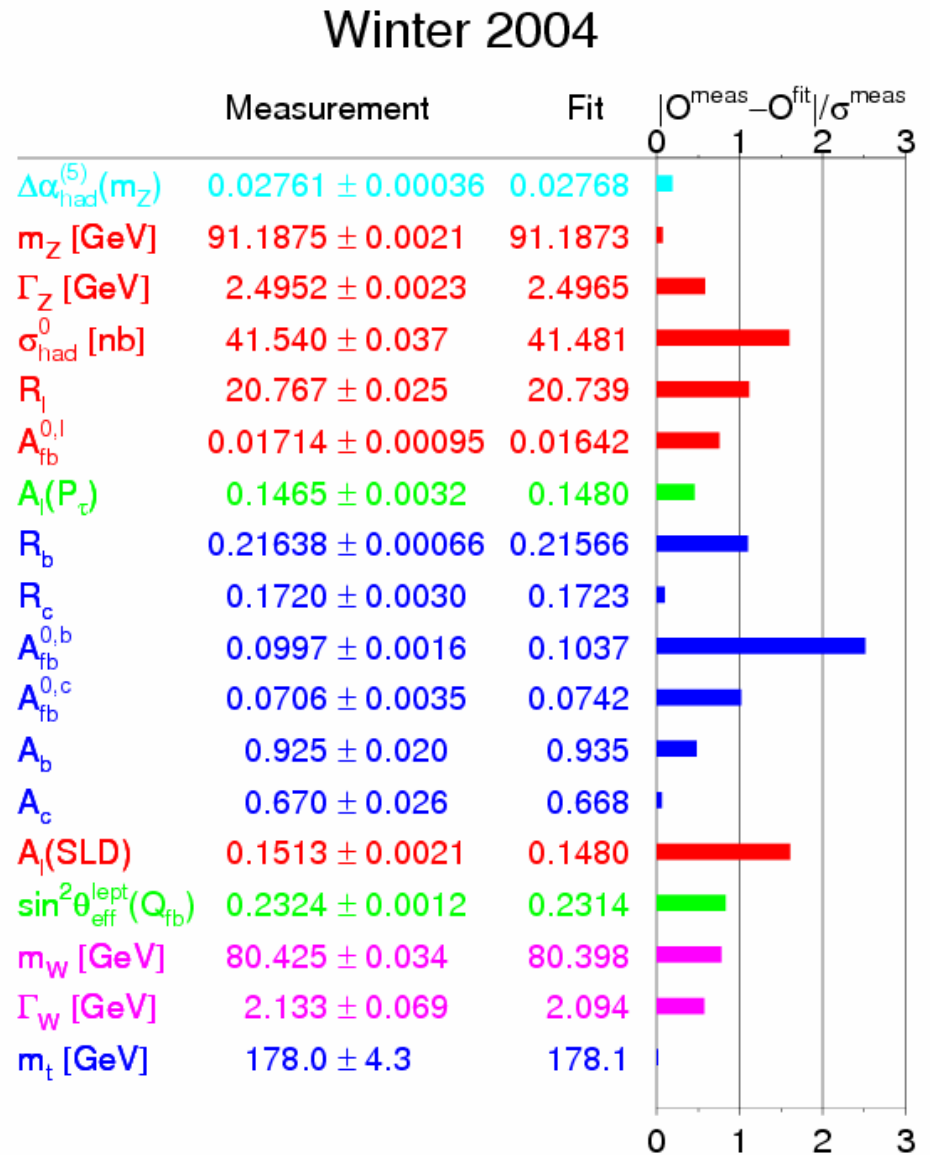
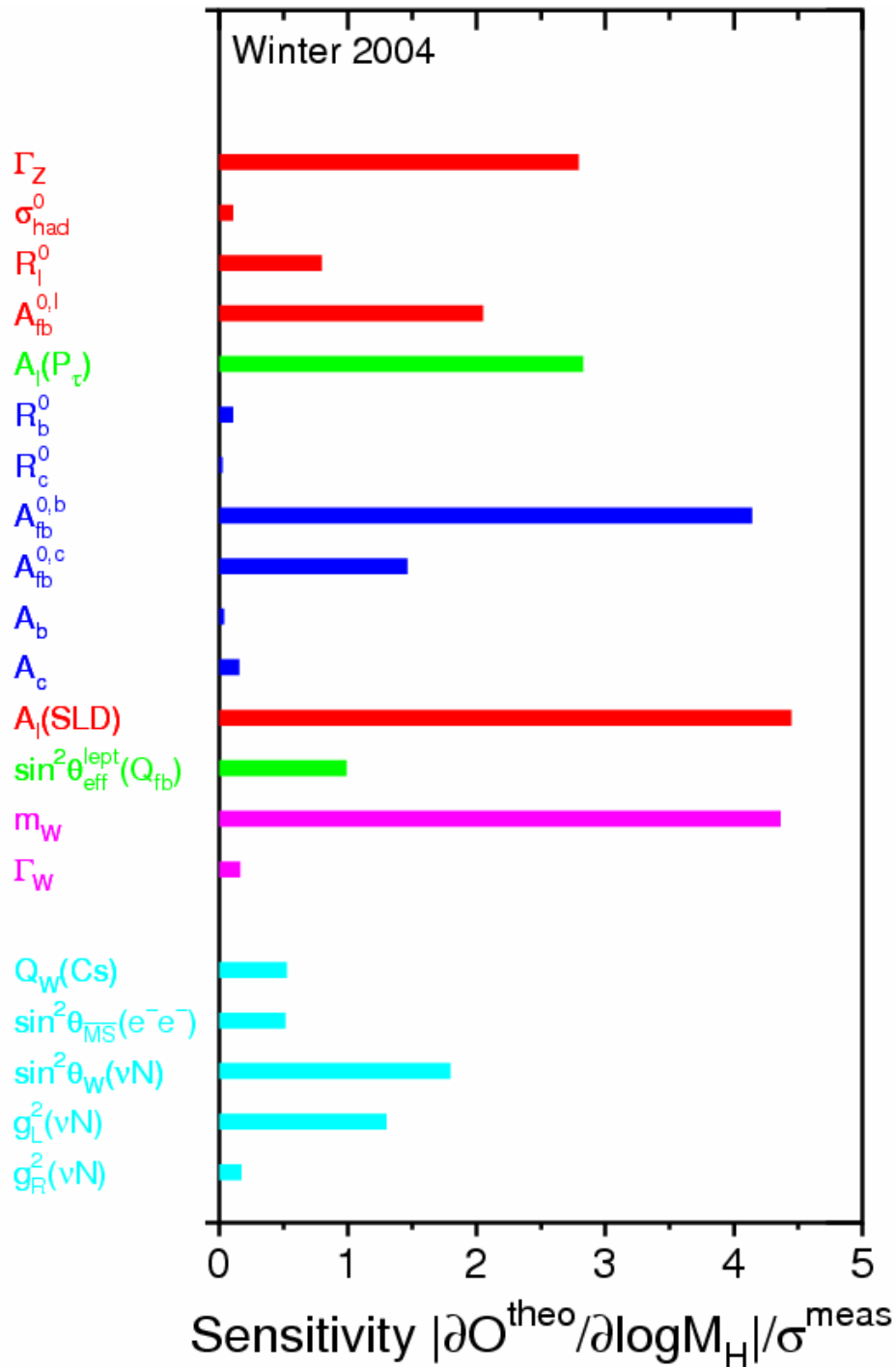
➔ Good agreement with SM expectations

- Analysis done with WW pairs (183 → 207 GeV) - ALEPH data only.

- For CP-conserving couplings, see

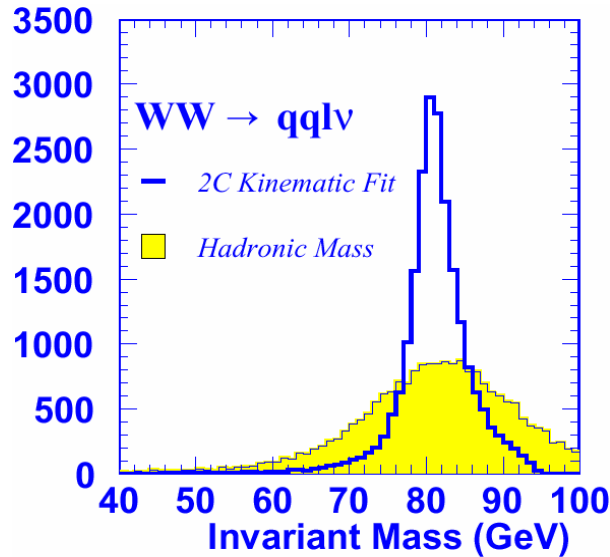
ALEPH 2003-035

- Alternative approach : spin density method



# Energia del fascio a LEP2

FINALE



- Conservazione energia-impulso imposta nel fit cinematico  $\Rightarrow$

$$\frac{\delta M_W}{M_W} \approx \frac{\delta E_{Beam}}{E_{Beam}}$$

*Depolarizzazione risonante:*

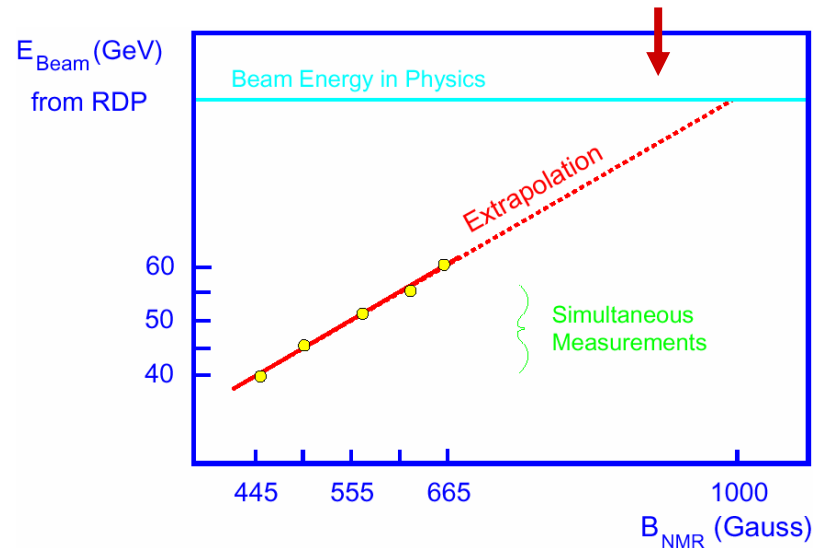
- Funziona solo fino a 60GeV  $\Rightarrow$  estrapolazione

- A LEP2:

- $\delta E_{beam} \sim 20\text{MeV}$  ( $\delta E/E \sim 10^{-4}$ )  $\Rightarrow$

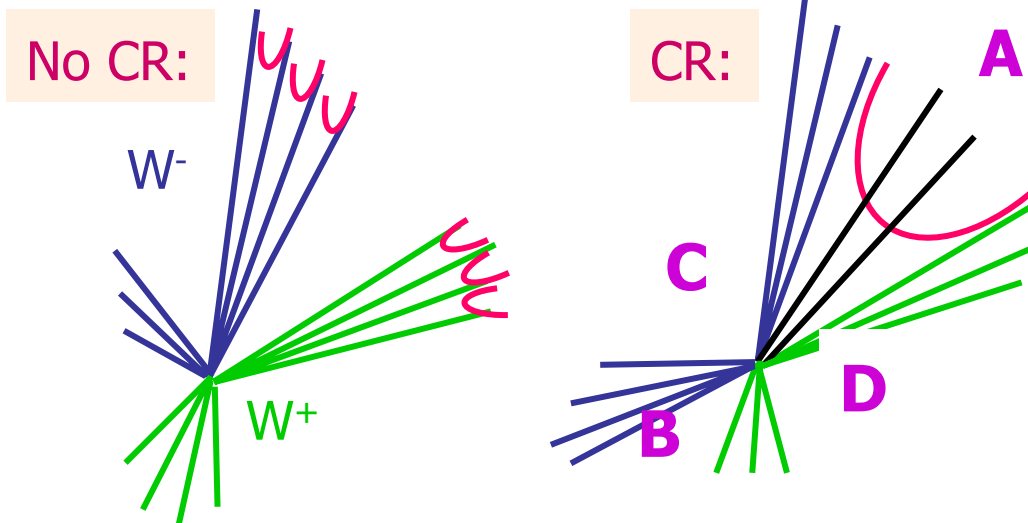
$$\delta m_W \sim 17\text{MeV}$$

- Errore dominato dall'extrapolazione.



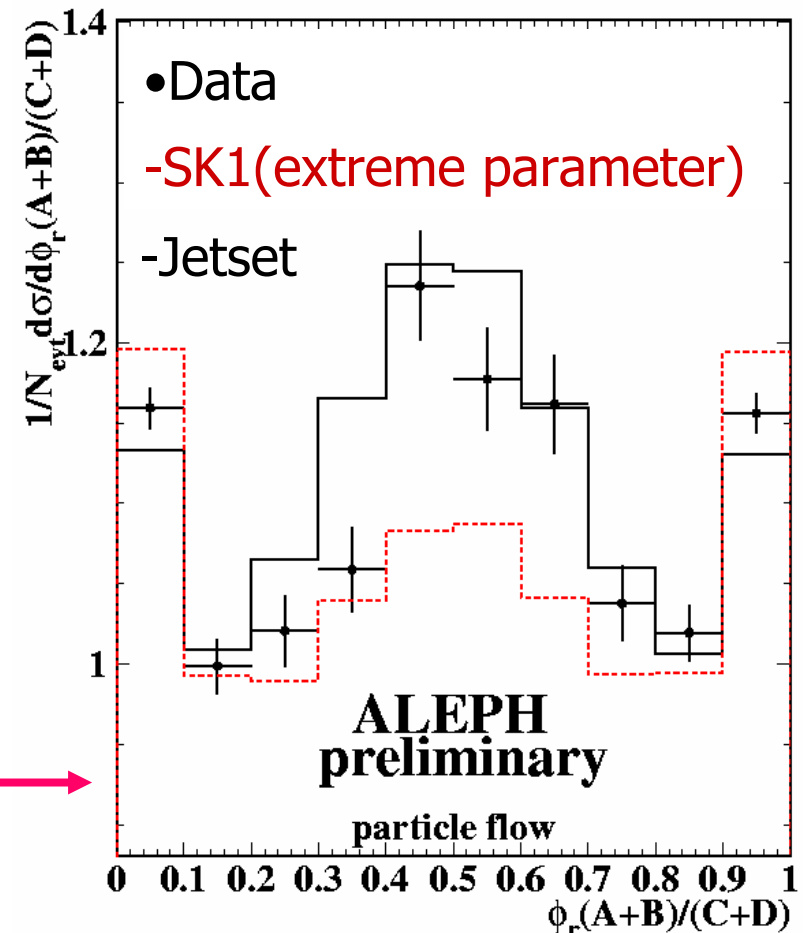
# Present LEP result: Colour Reconnection constrained by the particle flow analysis

- Most CR models predict a modified particle flow in  $W^+W^-$  events:



- The ratio of particle flow between the inter and intra- $W$  regions is built:

$$(A + B) / (C + D)$$



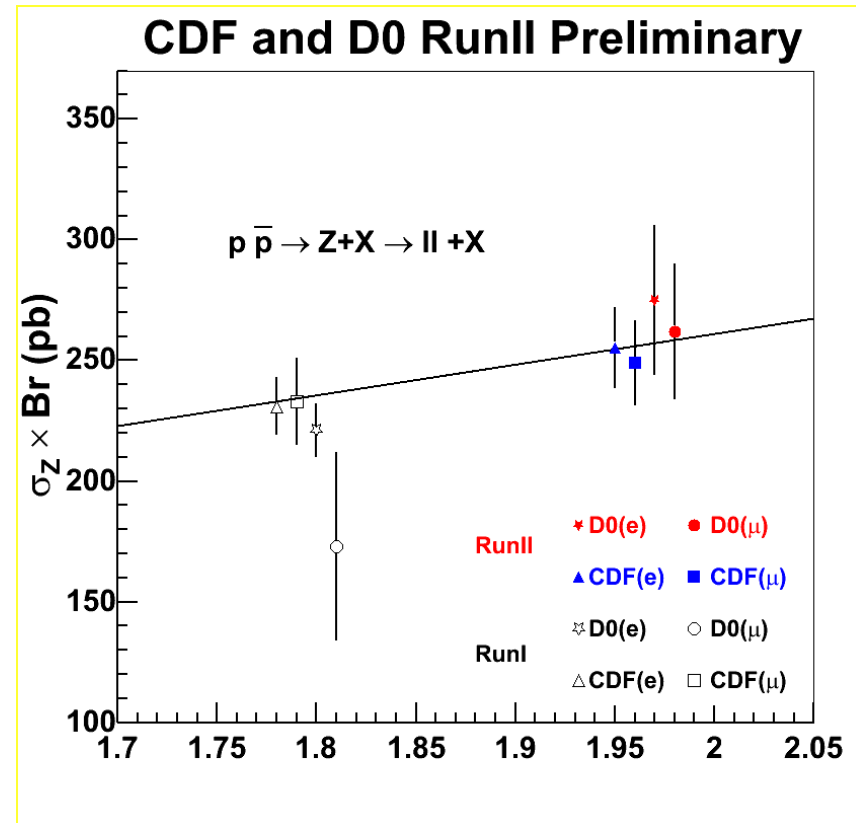
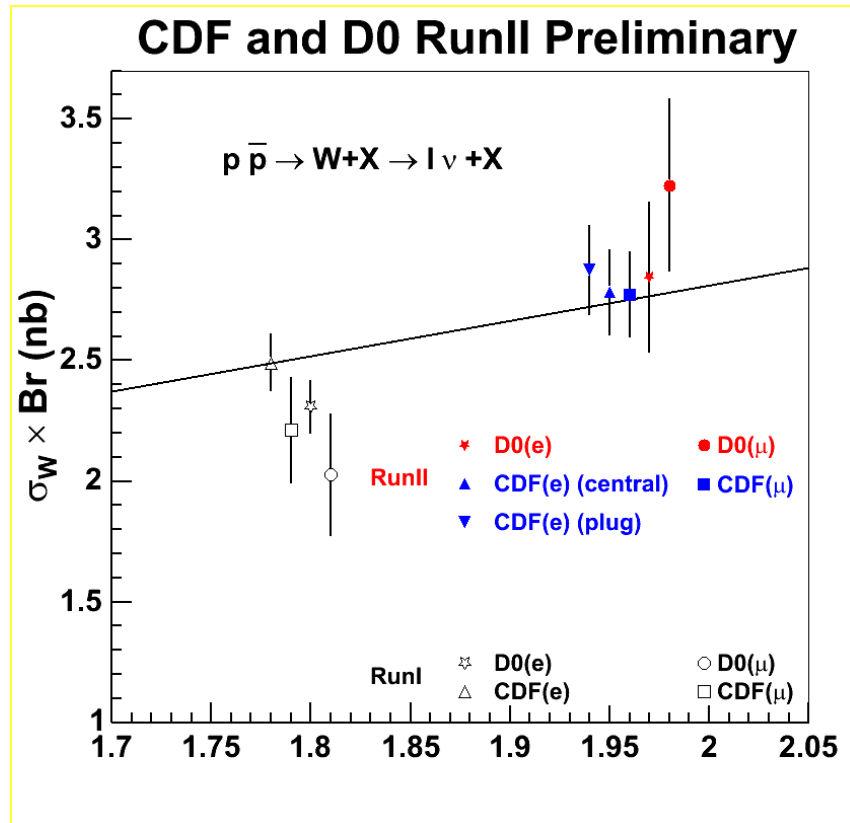
- Measurement sensitive only to extreme scenarios,



**Colour Reconnection Systematic error ~ 90 MeV**

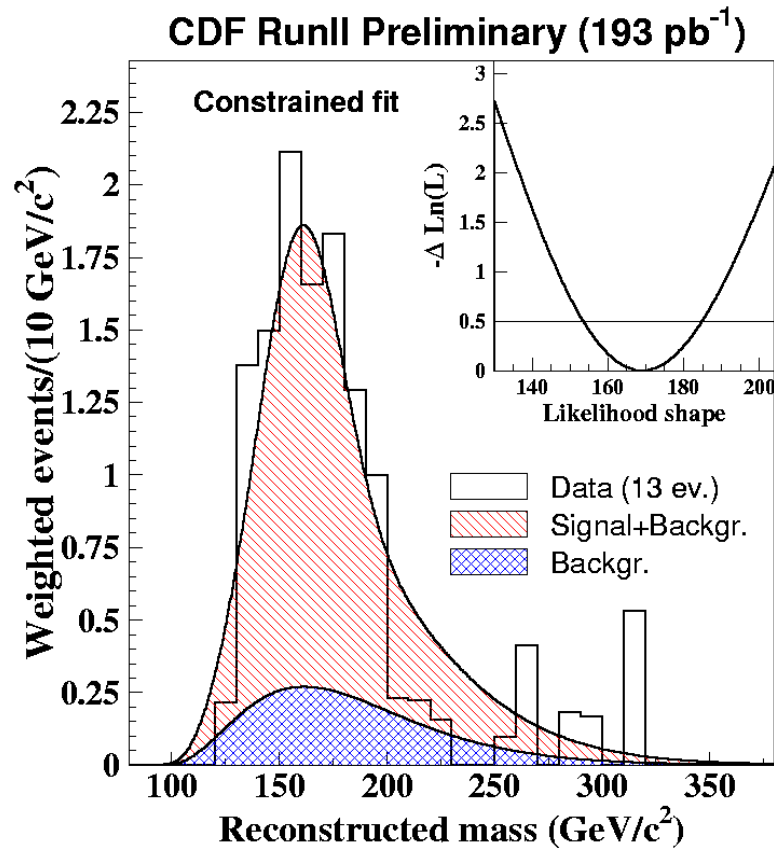
# TeVatron RUN II

## W and Z cross sections

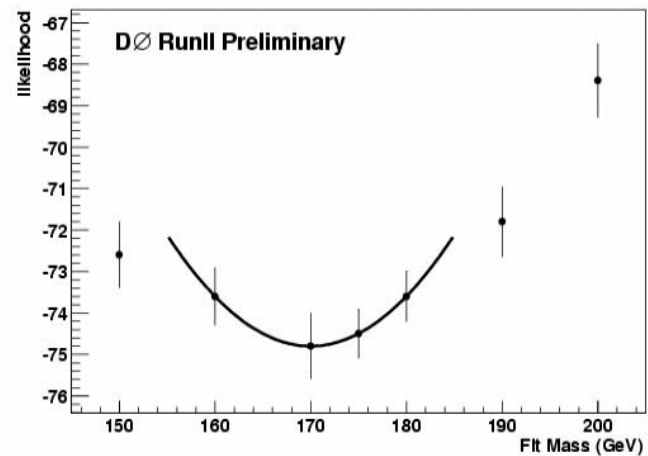
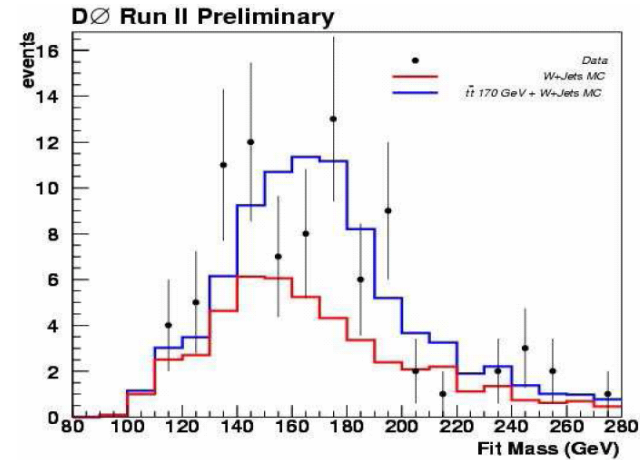


# Massa del top : risultati preliminari dal Run II

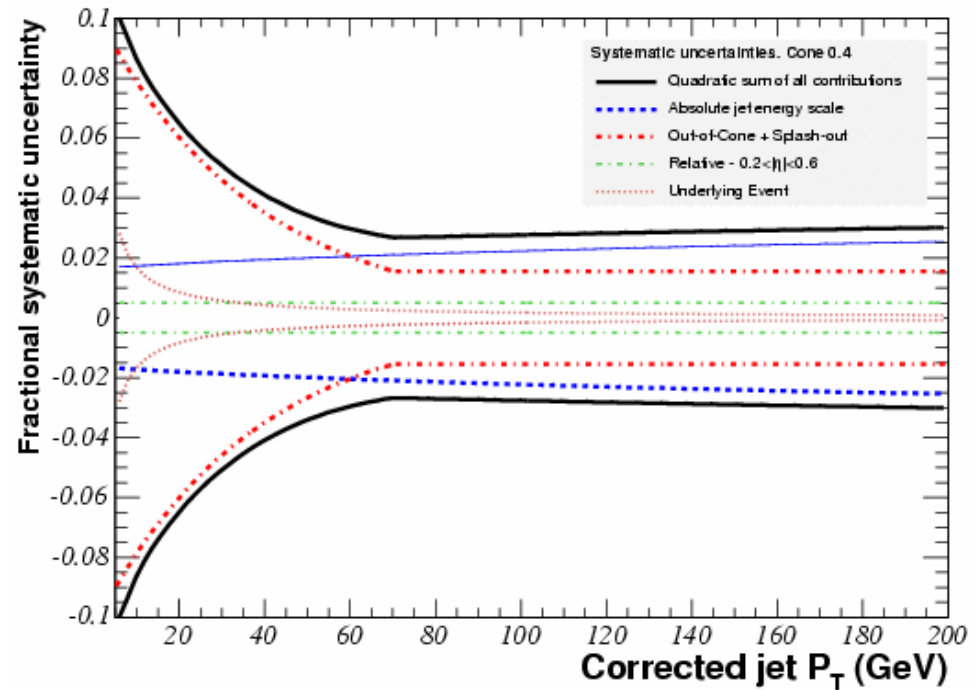
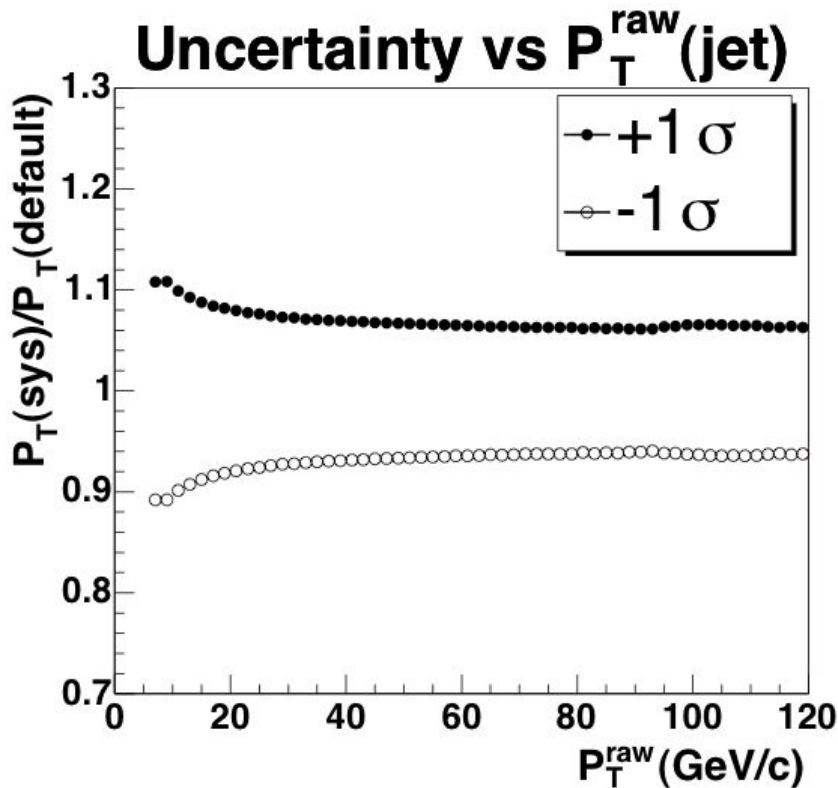
dileptons



Jets+lepton



# Incertezza sui jet da CDF



- Old systematic uncertainty
- Used for all mass results shown here
- Dominant systematic uncertainty

- New Systematic Uncertainty
- Significant Improvement
- Redoing mass analyses
- Improved results soon

# TGCs : Diboson production at Tevatron

Limited to leptonic decays, backgrounds in W/Z+jets too large

