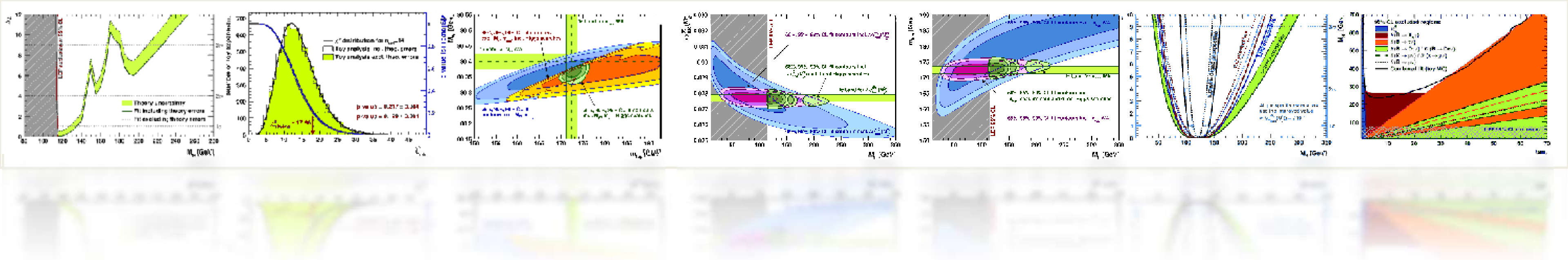

XLIV^th Rencontres de Moriond on QCD and High Energy Interactions
March 14^th – March 21^st 2009, La Thuile, Italy

Gfitter

The global Standard Model fit to electroweak precision data

http://cern.ch/Gfitter

Paper accepted for publication in EPJ C (arXiv:0811.0009)

*For the Gfitter Group**)*
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The Gfitter Project

G fitter

- Gfitter: A Generic Fitter Project for HEP Model Testing
  - provide a flexible framework for involved fitting problems in the LHC era
    - Based on the ROOT framework (math lib, drawing)

- Physics: plug-in packages
  - **GSM**: Standard Model fit to the electroweak precision data
  - **G2HDM**: Two Higgs Doublet Model extension of the SM
  - **GOBLIQUE**: Oblique parameters S,T, U in the global EW fit
    - presented by M. Goebel at Moriond EW

- Advanced statistical analyses methods:
  - *e.g.* parameter scans, MC toy analyses, p-value, goodness-of-fit, etc.
  - follows frequentist approach

- Consistent treatment of statistical, systematic and theoretical errors, correlations, and inter-parameter dependencies

  [CKM fitter, EPJ C21, 225 (2002)]
  - theoretical uncertainties: R*fit* prescription
    - theory uncertainties included in χ^2 estimator with flat likelihood in allowed ranges

The Electroweak Fit

Gfitter SM

- SM predictions of electroweak precision observables

- Complete re-implementation of electroweak theory
  - Excellent agreement with Zfitter

- State-of the art calculations in the OMS scheme
  - M_W and $\sin^2\theta^f_{eff}$: two-loop and leading beyond-two-loop correction

    [M. Awramik et al., Phys. Rev D69, 053006 (2004 and ref.][M. Awramik et al., JHEP 11, 048 (2006) and refs.]
  - Radiator functions: N^3LO of the massless QCD Adler function

    [P.A. Baikov et al., Phys. Rev. Lett. 101 (2008) 012022]

- Two versions of fits
  - ‘*Standard fit*’: all data except results from the direct Higgs searches
  - ‘*Complete fit*’: all data including results from direct Higgs searches at LEP and Tevatron [ADLO Phys.Lett. B565, 61 (2003)] [CDF+D0: arXiv:0804.3423] [CDF+D0: arXiv:0808.0534]

The Electroweak Fit – Experimental Input

Gfitter SM

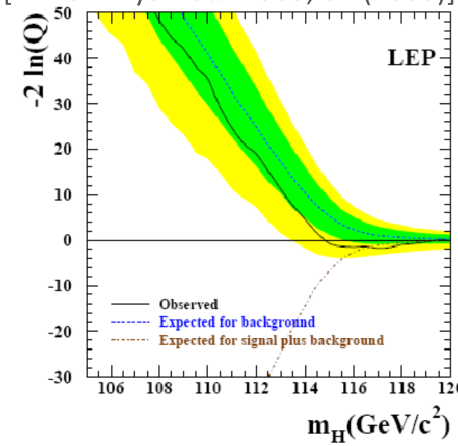
- Z-pole precision cross-section and asymmetry measurements from LEP/SLC:
  - M_Z, Γ_Z [ADLO +SLD, Phys. Rept. 427, 257 (2006)]
  - hadronic pole x-section σ^0_{had}
  - leptonic ratio R^0_l
  - the hadronic ratios R^0_c, R^0_b
    - includes SLD measurements
  - FB asymmetries l,b,c (final state angular distribution)
  - LR asymmetries
    - SLC A_l,A_b,A_c (IS polarization), LEP A_l(τ polarization)
- M_W and Γ_W from LEP/Tevatron [ADLO,CDF+D0: arXiv:0811.4682]
- m_c, m_b world averages [PDG, J. Phys. G33,1 (2006)]
- m_t latest Tevatron average [arXivx:0808.1089 [hep-ex]]
- $\Delta\alpha_{had}^{(5)}(M_Z^2)$ including α_s dependency [arXivx:0808.1089 [hep-ex]]
- M_H in complete fit: likelihood ratios from Tevatron

Parameter	Input value
M_Z [GeV]	91.1875 ± 0.0021
Γ_Z [GeV]	2.4952 ± 0.0023
$\sigma^0_{\rm had}$ [nb]	41.540 ± 0.037
R^0_ℓ	20.767 ± 0.025
$A^{0,\ell}_{\rm FB}$	0.0171 ± 0.0010
A_ℓ $^{(\star)}$	0.1499 ± 0.0018
A_c	0.670 ± 0.027
A_b	0.923 ± 0.020
$A^{0,c}_{\rm FB}$	0.0707 ± 0.0035
$A^{0,b}_{\rm FB}$	0.0992 ± 0.0016
R^0_c	0.1721 ± 0.0030
R^0_b	0.21629 ± 0.00066
$\sin^2\theta^\ell_{\rm eff}(Q_{\rm FB})$	0.2324 ± 0.0012
M_H [GeV] $^{(\circ)}$	Likelihood ratios
M_W [GeV]	80.399 ± 0.025
Γ_W [GeV]	2.098 ± 0.048
$\overline{m}_c$ [GeV]	1.25 ± 0.09
$\overline{m}_b$ [GeV]	4.20 ± 0.07
m_t [GeV]	172.4 ± 1.2
$\Delta\alpha^{(5)}_{\rm had}(M_Z^2)$ $^{(\dagger\triangle)}$	2768 ± 22

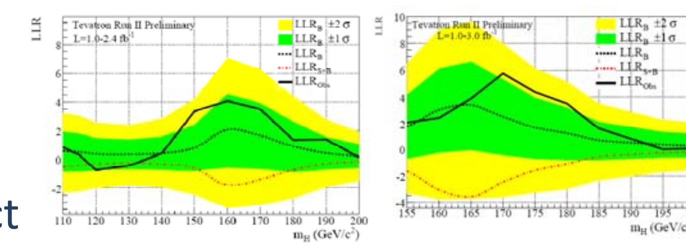
SM Fit

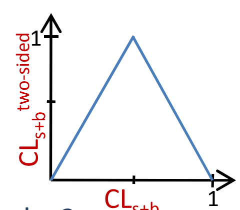
- Free fit parameters:
  - M_Z, M_H, m_t, $\Delta\alpha_{had}^{(5)}(M_Z^2)$, $\alpha_S(M_Z^2)$, $\overline{m}_c$, $\overline{m}_b$
  - $\Delta\alpha_{had}^{(5)}(M_Z^2)$ floating instead of α
    - Other contributions: leptonic and t-quark (well known)
- Fixed (world average): G_F and masses of leptons and light quarks
  - Well known and/or negligible effect
- Parameters for theoretical uncertainties
  - M_W: δM_W=4GeV; $\sin^2\theta^l_{eff}$: $\delta\sin^2\theta^l_{eff}$ = $4.7\cdot10^{-5}$
  - electroweak form factors ρ^f_Z, κ^f_Z: negligible effect
- LEP/Tevatron direct SM Higgs searches
  - interpret $-2\ln Q(M_H)$ as measurement
  - transform 1-sided into 2-sided CL
  - fit contribution $\delta\chi^2=2[\mathrm{Erf}^{-1}(1-CL_{s+b}^{\text{two-sided}})]^2$

[ADLO: Phys. Lett. B565, 61 (2003)]

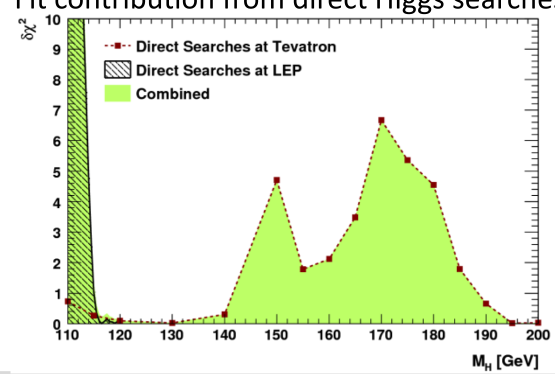


[CDF+D0: arXiv:0804.3423]



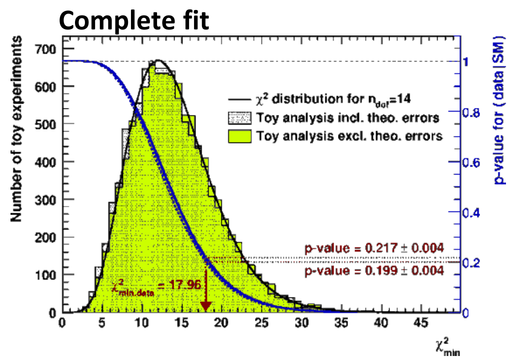


Fit contribution from direct Higgs searches

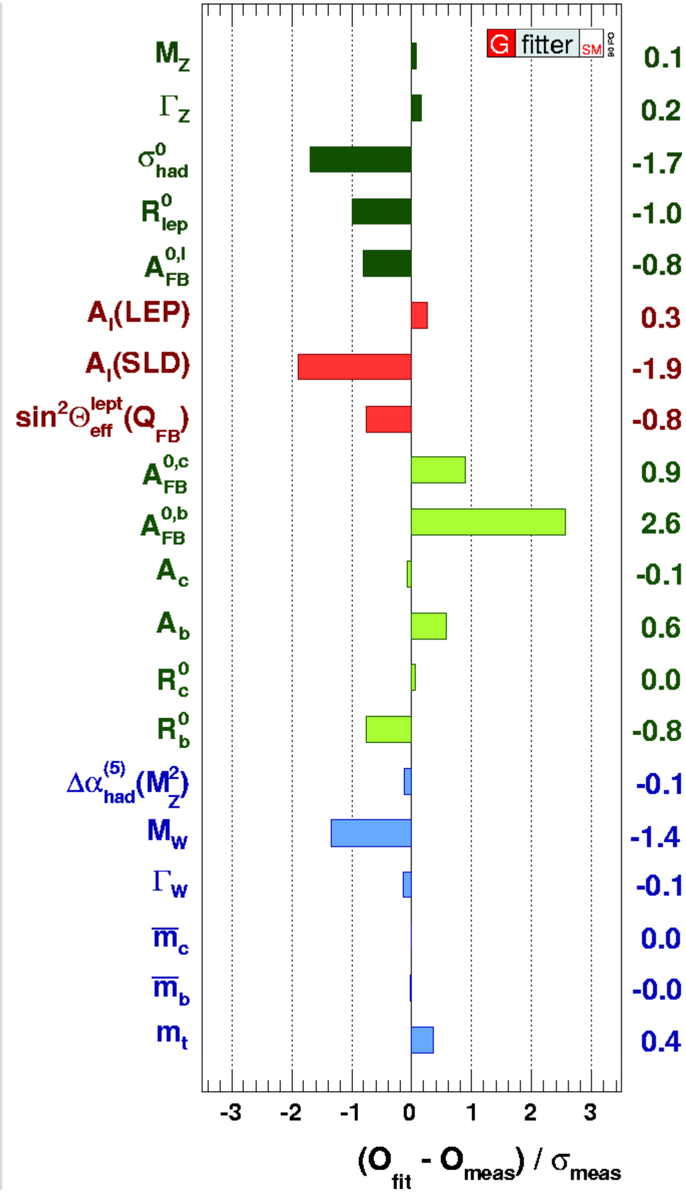


SM Fit Results – Model Test

- Goodness of fit:
  - standard fit: $\chi^2_{min}/n_{dof} = 16.4/13$
  - complete fit: $\chi^2_{min}/n_{dof} = 18.0/14$
- p-value evaluated using toy-MC



- Probability for wrongly rejecting SM: (21.7±0.4)%
  - No indication of new physics
- Pull values of complete fit:
  - largest χ^2_{min} contribution from A_{FB} of b-quark 2.6σ
  - Small contributions from M_Z, $\Delta\alpha^{had}(M_Z)$, m_c, m_b indicate that their input accuracies exceed fit requirements
- Complete fit results in backup slides



Checking α_s in N^{3}LO

<u>α_S from complete fit</u>

$$\alpha_S\left(M_Z^2\right) = 0.1193^{+0.0028}_{-0.0027} \pm 0.0001$$

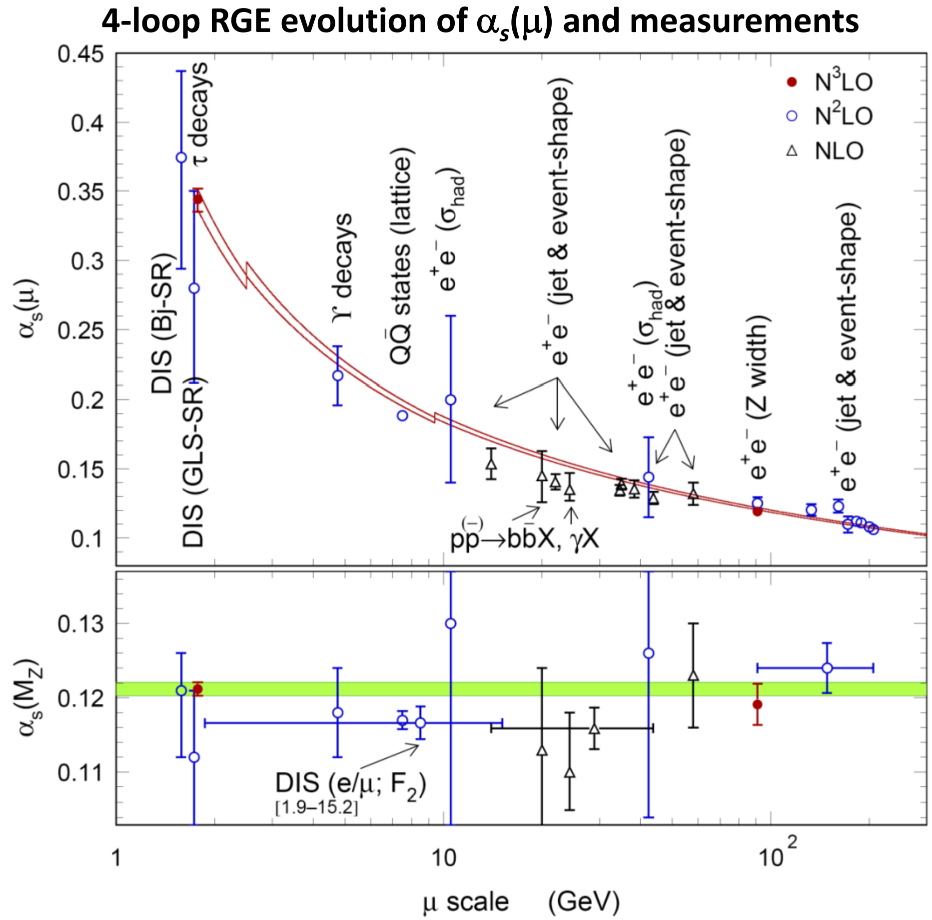
- first error is experimental fit error
- second error due to truncated pQCD expansion:
  - incl. variation of renorm. scale from $M_Z/2$ to $2M_Z$ and mass-less terms of order/beyond $\alpha_S^5(M_Z)$ and massive terms of order/beyond $\alpha_S^4(M_Z)$

- excellent agreement with recent N^{3}LO result from τ-decay

$$\alpha_S(M_Z^2) = 0.1212 \pm 0.0011$$

  - Sensitive test to RGE evolution over two orders of magnitude

[M. Davier et al., arXiv:0803.0979]

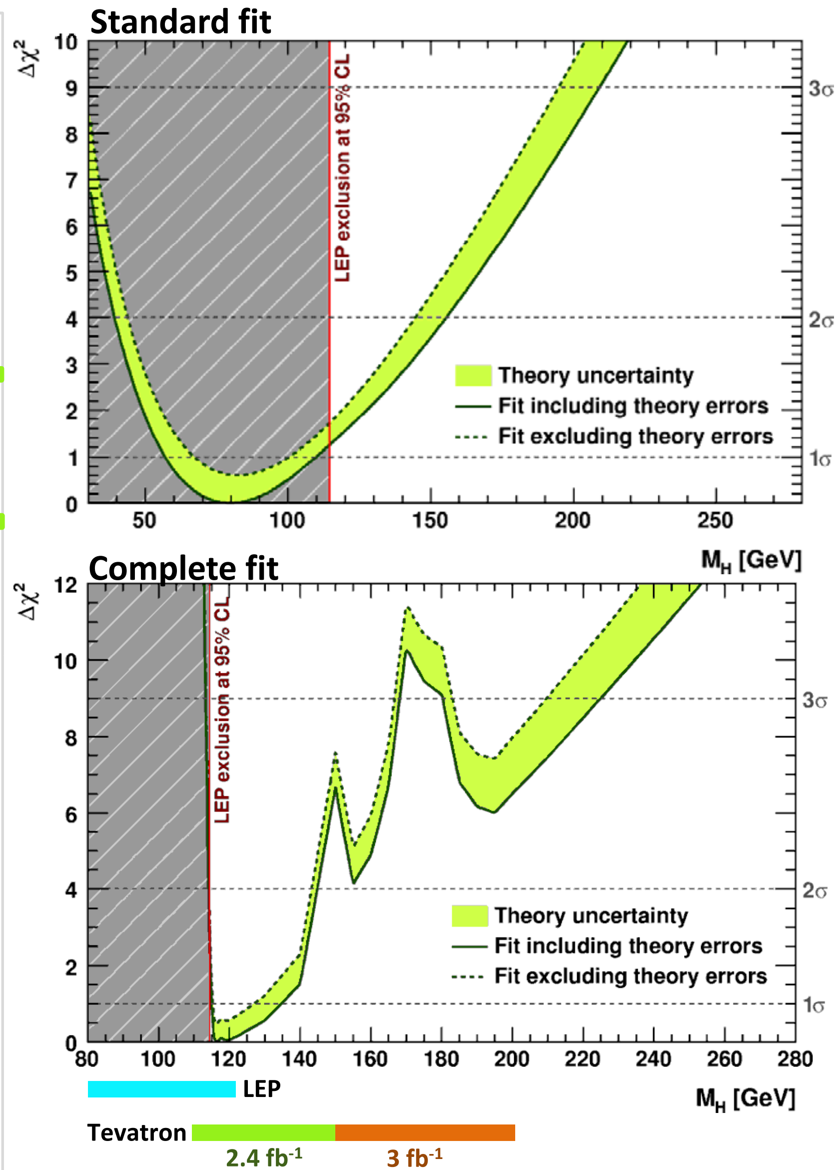


Higgs Mass Constraint

- M_H from standard fit:
  - Central value ±1σ: $M_H = 80^{+30}_{-23}$ GeV
  - 2σ interval: [39, 155] GeV
  - 3σ interval: [26, 209] GeV

- Green band due to R*fit* treatment, fixed theory errors lead to larger χ^2

- M_H from complete fit:
  - Central value ±1σ: $M_H = 116.4^{+18.3}_{-1.3}$ GeV
  - 2σ interval: [114, 145] GeV
  - 3σ interval: [113, 168] and [180, 225] GeV



Higgs Mass Constraint

Gfitter SM

Parameter	$\ln M_H$	$\Delta\alpha_{\rm had}^{(5)}(M_Z^2)$	M_Z	$\alpha_S(M_Z^2)$	m_t	$\overline{m}_c$	$\overline{m}_b$
$\ln M_H$	1	−0.395	0.113	0.041	0.309	−0.001	−0.006
$\Delta\alpha_{\rm had}^{(5)}(M_Z^2)$		1	−0.006	0.101	−0.007	0.001	0.003
M_Z			1	−0.019	−0.015	−0.000	0.000
$\alpha_S(M_Z^2)$				1	0.021	0.011	0.043
m_t					1	0.000	−0.003
$\overline{m}_c$						1	0.000

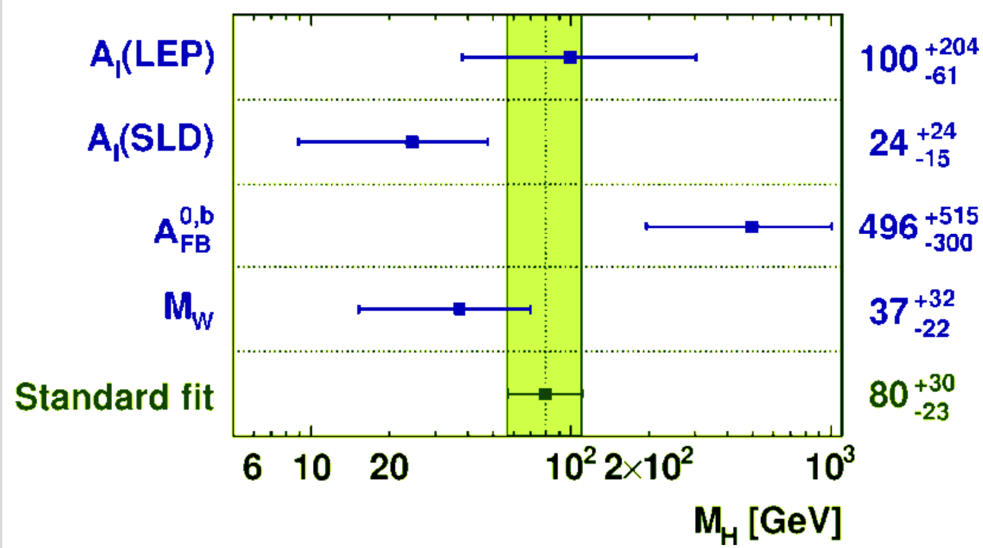
Correlation coefficients between the free fit parameters in the standard fit.

- Known tension between A_l(SLD) and $A^{0,b}_{FB}$

<u>Compatibility test (toy analysis):</u>

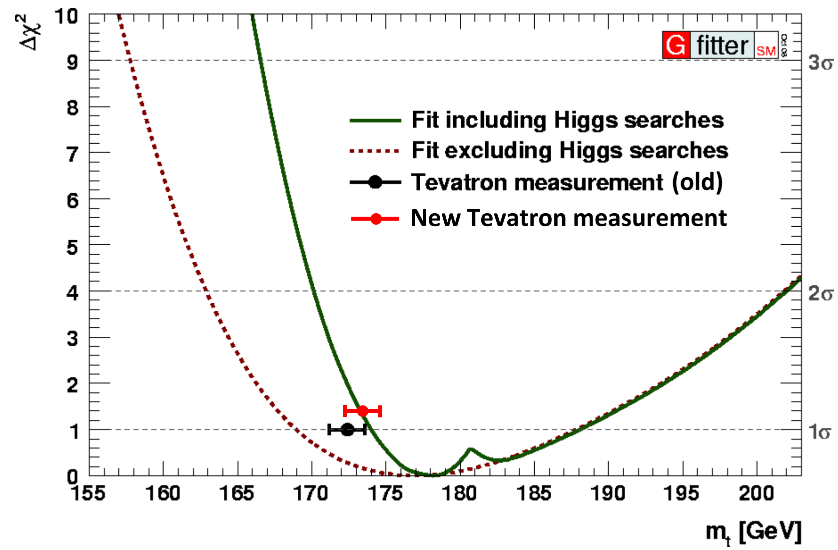
- Shift in χ^2_{min} when least compatible measurement (here $A_{FB}^{0,b}$) removed: $\Delta\chi^2_{min} = 8.0$
- Generate toy around fitted values, and repeat procedure -> $\Delta\chi^2_{min}$ *distribution*
- (1.4±0.1)% of toy experiments exceed $\Delta\chi^2_{min} = 8.0$ ("2.5σ")

Fitted value for M_H when removing all but the indicated observable from the fit



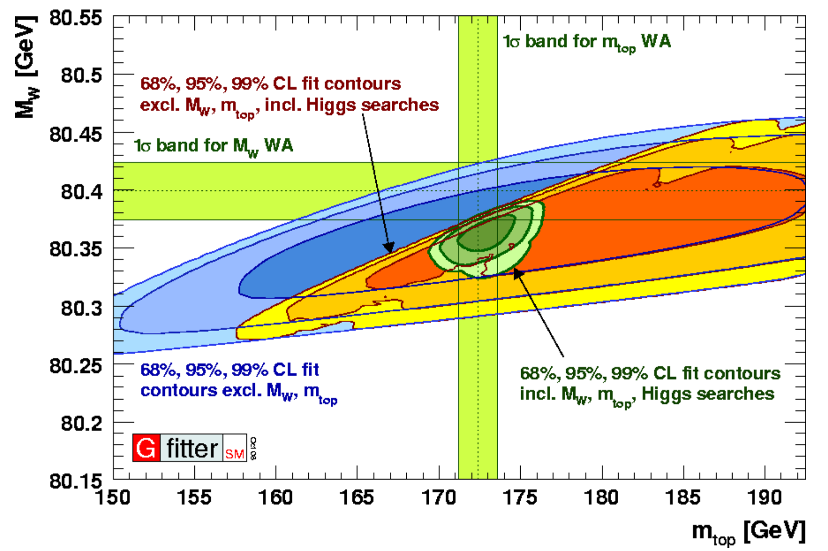
Top Quark Mass

- Top mass comparison:
  - Standard fit: $m_t = 177.0^{+10.8}_{-8.0} GeV$
  - Complete fit: $m_t = 178.2^{+9.8}_{-4.2} GeV$
  - Tevatron measurement: $m_t = 172.4 \pm 1.2 GeV$



<u>2-D scans:</u>

- Standard fit (excluding M_W and m_t) agrees with experimental values
- Results from Higgs searches reduce allowed parameter space significantly



- Good probe of SM if M_H is measured at LHC/ILC

Prospects for LHC and ILC

- Fit prediction of M_H and $\alpha_S(M_Z^2)$ in light of LHC, ILC (GigaZ option)
  - Conservative estimates on improvement on $\sigma(M_W)$, $\sigma(m_t)$, $\sigma(\sin^2\theta^l_{eff})$, and $\sigma(R_l^0)$
  - Anticipate improved calculation of $\Delta\alpha_{had}^{(5)}(M_Z^2)$
    - Requires $\sigma(\sigma_{had}) \leq 1\%$ below J/ψ

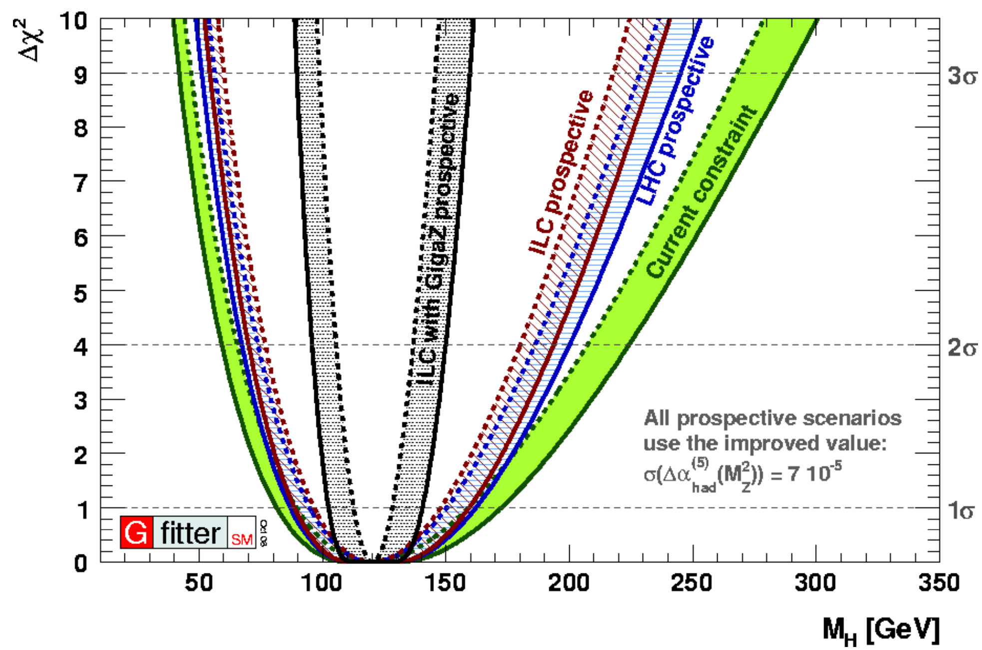
      [F. Jegerlehner, hep-ph/0105283]
  - Cross-section measurements by BABAR (ISR-based) and BESIII should improve $\Delta\alpha^{had}(M_Z)$
- Improvement of M_H prediction
  - Assume M_H=120GeV by adjusting central values of all observables
    - Broad minima: Rfit treatment of theoretical uncertainties
  - Confront with direct measurement
- GigaZ: significant improvement for $\alpha_S(M_Z^2)$ and M_H owing to smaller $\sigma(R_l^0)$

Quantity	Expected uncertainty: Present	LHC	ILC	GigaZ (ILC)
M_W [MeV]	25	15	15	6
m_t [GeV]	1.2	1.0	0.2	0.1
$\sin^2\theta^\ell_{\rm eff}$ [10^{-5}]	17	17	17	1.3
R^0_ℓ [10^{-2}]	2.5	2.5	2.5	0.4
$\Delta\alpha^{(5)}_{\rm had}(M_Z^2)$ [10^{-5}]	22 (7)	22 (7)	22 (7)	22 (7)
$M_H(= 120$ GeV) [GeV]	${}^{+56}_{-40}$ $({}^{+52}_{-39})$ $[{}^{+39}_{-31}]$	${}^{+45}_{-35}$ $({}^{+42}_{-33})$ $[{}^{+30}_{-25}]$	${}^{+42}_{-33}$ $({}^{+39}_{-31})$ $[{}^{+28}_{-23}]$	${}^{+27}_{-23}$ $({}^{+20}_{[illegible]})$ $[{}^{+8}_{-7}]$
$\alpha_s(M_Z^2)$ [10^{-4}]	28	28	27	6

input

Input values taken from:

[CMS, Physics TDR (2006)][A. Djouadi et al., arXiv:0709.1893]
[I. Borjanovic, EPJ C39S2, 63 (2005)][S. Haywood et al., hep-ph/0003275]
[ATLAS, Physics TDR (1999)][R. Hawkings, K. Mönig, EPJ direct C1, 8 (1999)]
[A. H. Hoang et al., EPJ direct C2, 1 (2000)] [M. Winter, LC-PHSM-2001-016]



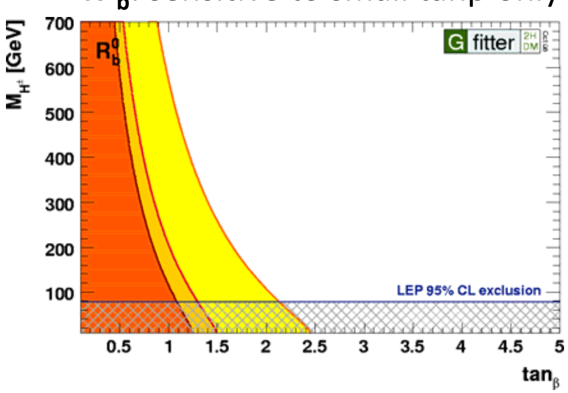
SM Extension – Two-Higgs-Doublet-Model

- Type-II Model:
  - Higgs-fermion coupling: up- and down-type fermions couple to different doublets
  - 6 free parameters: $M_{H\pm}$, M_{A0}, M_{H0}, M_h, tanβ, |α|

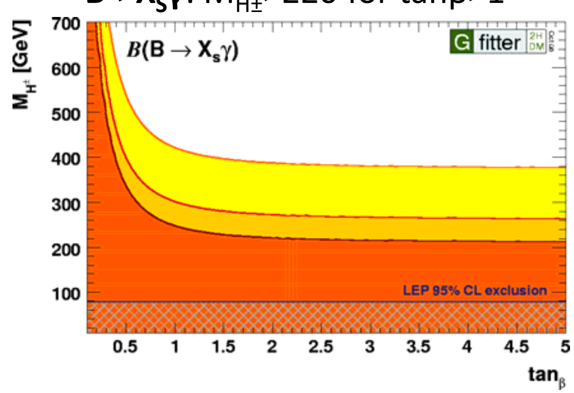
observable	input value
R_b^0	0.21629 ± 0.00066
BR (B->X_sγ)	(3.52±0.23±0.09)·10^{-4}
BR (B->τν)	(1.51±0.33)·10^{-4}
BR (B->μν)	<1.3·10^{-6} at 90% CL
BR (K->μν)/ BR(p->μν)	1.004±0.007
BR(B->Dτν)/ BR(B->Deν)	0.416±0.117±0.052

- So far: observables sensitive to $H^\pm$ → $M_{H\pm}$, tanβ
  - Hadronic *Z* width ratio: R^0_b
  - Semileptonic B decay: $B \to D\tau\nu \,/\, De\nu$
  - Radiative B and leptonic meson decays: $B \to X_s\gamma$, $B \to \mu\nu \,/\, \tau\nu$, $K \to \mu\nu \,/\, \pi \to \mu\nu$

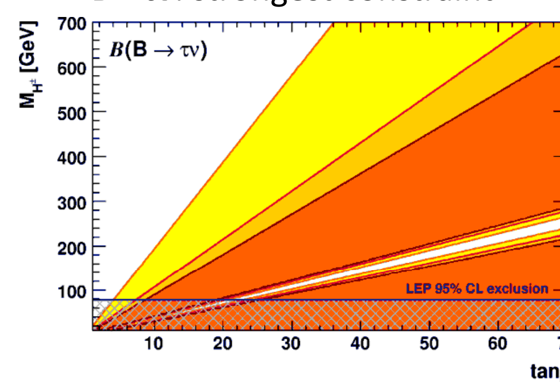
R^0_b: sensitive to small tanβ only



B->X_sγ: $M_{H\pm}$>220 for tanβ>1

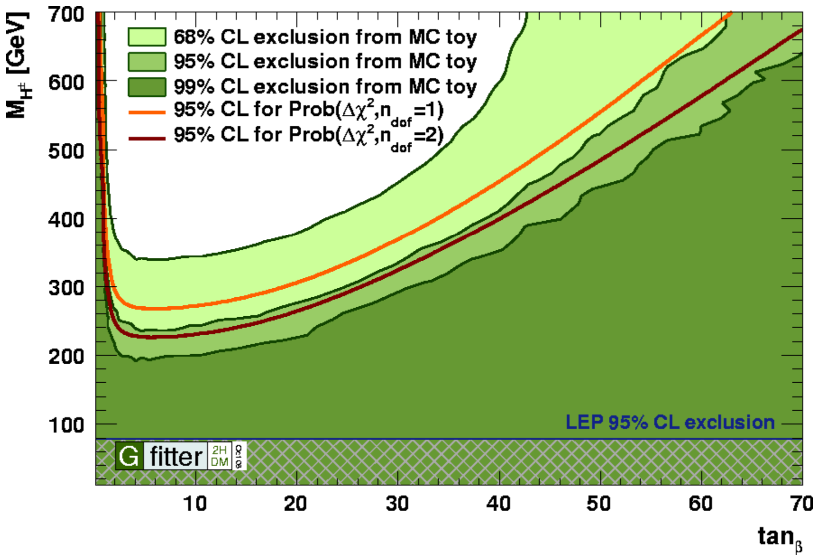


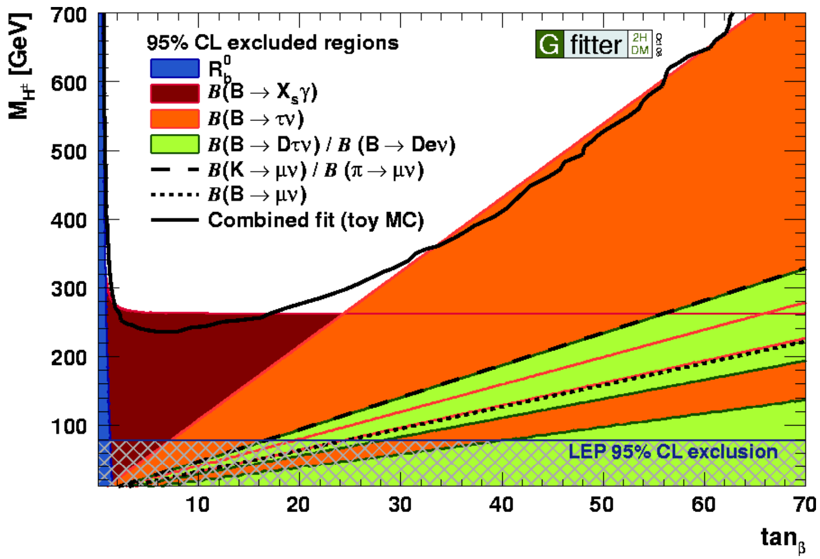
B->τν: strongest constraint



2HDM – Combined Fit

- Combined fit:
  - Exclusion area depends on assumption on number of degrees of freedom
    - n_{dof}=1 where single constraint dominates
    - n_{dof}=2 where several observable contribute
  - MC toy study to determine exclusion area
- Exclude at 95% CL
  - Small tanβ
  - $M_{H\pm}$ < 240 GeV for all tanβ
  - $M_{H\pm}$ < 780 GeV for tanβ=70
- Combined limit not necessarily stronger than single constraint due to increasing n_{dof}





Fitting with the New Tevatron Results

G fitter SM

- New M_W mass by D0:

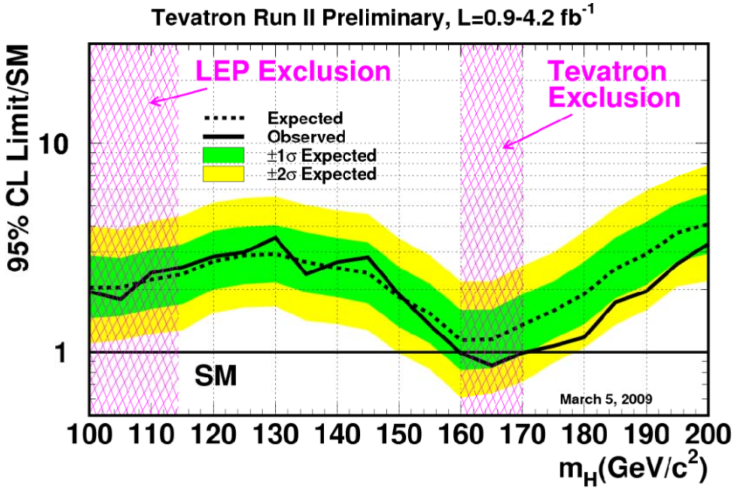
$$M_W = 80.401 \pm 0.025_{\text{stat}} \pm 0.035_{\text{exp}} \pm 0.037_{\text{corr}} \text{ GeV}/c^2$$

  - Tevatron average not yet released, use preliminary world average: M_W=80.399 ± 0.023 GeV/c^2 (error was 0.025 GeV/c^2 before)

- New top mass from Tevatron (previous 172.4±1.2 GeV/c^2)

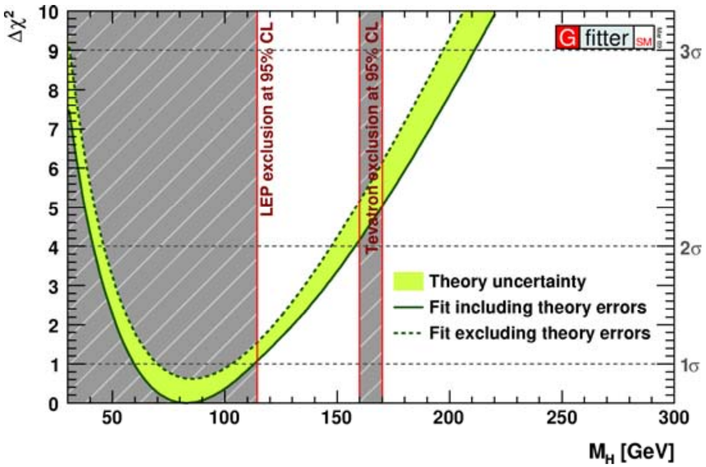
$$m_t = 173.1 \pm 0.6_{\text{stat}} \pm 1.1_{\text{sys}} \text{ GeV}/c^2$$

- New Higgs search limits: exclusion between 160 and 170 GeV/c^2



New Higgs Mass Constraints

- M_H from standard fit:
  - Fit input for M_W is our preliminary average!
  - Central value ±1σ: $M_H = 82.8^{+30}_{-23}\,\text{GeV}$
  - 2σ and 3σ interval: [41, 158] and [28, 211] GeV
  - (Previously: $M_H = 80^{+30}_{-23}\,\text{GeV}$)

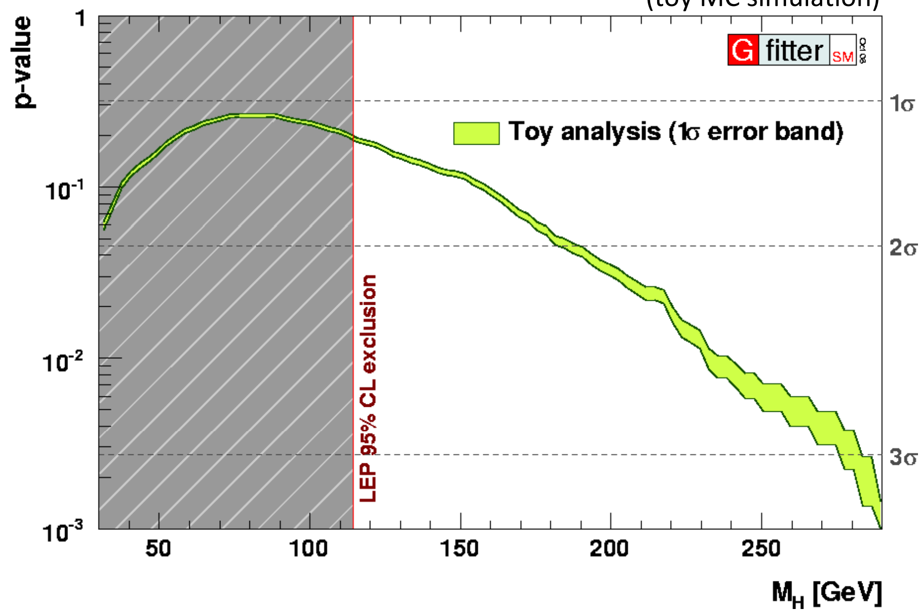


- Shift of mean and intervals up by about 3GeV
  - Positive correlation between M_H and m_t

- Complete fit: input from direct searches
  - Fit needs CL_{s+b} as input (we look for agreement with SM), Higgs searches use CL_s (for exclusion limits) which is more conservative
  - We are in contact with the Tevatron New Phenomena and Higgs WG (TEVNPHWG) for these numbers
  - Expect significantly tighter limits on M_H

Conclusions and Prospects

(toy MC simulation)



p-value of the standard fit versus true M_H

(not with the latest Tevatron results)

- Continue to update Gfitter for SM and 2HDM fits
  - http://cern.ch/Gfitter
- Next steps: Look further beyond the SM
  - Implementation of oblique parameters and Littlest-Higgs-Model
    - presented at Moriond EW

NUMERICAL RESULTS

Fit results (I) without New Tevatron Results

Parameter	Input value	Free in fit	Results from global EW fits: *Standard fit*	*Complete fit*	*Complete fit w/o exp. input in line*
M_Z [GeV]	91.1875 ± 0.0021	yes	91.1874 ± 0.0021	91.1877 ± 0.0021	$91.2001\,^{+0.0174}_{-0.0178}$
Γ_Z [GeV]	2.4952 ± 0.0023	–	2.4959 ± 0.0015	2.4955 ± 0.0015	2.4950 ± 0.0017
$\sigma^0_{\rm had}$ [nb]	41.540 ± 0.037	–	41.477 ± 0.014	41.477 ± 0.014	41.468 ± 0.015
R^0_ℓ	20.767 ± 0.025	–	20.743 ± 0.018	20.742 ± 0.018	$20.717\,^{+0.029}_{-0.025}$
$A^{0,\ell}_{\rm FB}$	0.0171 ± 0.0010	–	0.01638 ± 0.0002	0.01610 ± 0.9839	0.01616 ± 0.0002
A_ℓ $^{(\star)}$	0.1499 ± 0.0018	–	$0.1478^{+0.0011}_{-0.0010}$	$0.1471^{+0.0008}_{-0.0009}$	–
A_c	0.670 ± 0.027	–	$0.6682\,^{+0.00046}_{-0.00045}$	$0.6680\,^{+0.00032}_{-0.00046}$	$0.6680\,^{+0.00032}_{-0.00047}$
A_b	0.923 ± 0.020	–	$0.93470\,^{+0.00011}_{-0.00012}$	$0.93464\,^{+0.00008}_{-0.00013}$	$0.93464\,^{+0.00008}_{-0.00011}$
$A^{0,c}_{\rm FB}$	0.0707 ± 0.0035	–	0.0741 ± 0.0006	$0.0737\,^{+0.0004}_{-0.0005}$	$0.0737\,^{+0.0004}_{-0.0005}$
$A^{0,b}_{\rm FB}$	0.0992 ± 0.0016	–	0.1036 ± 0.0007	$0.1031\,^{+0.0007}_{-0.0006}$	0.1036 ± 0.0005
R^0_c	0.1721 ± 0.0030	–	0.17224 ± 0.00006	0.17224 ± 0.00006	0.17225 ± 0.00006
R^0_b	0.21629 ± 0.00066	–	$0.21581\,^{+0.00005}_{-0.00007}$	0.21580 ± 0.00006	0.21580 ± 0.00006
$\sin^2\theta^\ell_{\rm eff}(Q_{\rm FB})$	0.2324 ± 0.0012	–	0.23143 ± 0.00013	$0.23151\,^{+0.00012}_{-0.00010}$	$0.23149\,^{+0.00013}_{-0.00009}$
M_H [GeV] $^{(\circ)}$	Likelihood ratios	yes	$80^{+30[+75]}_{-23[-41]}$	$116.4^{+18.3[+28.4]}_{-\ 1.3[-\ 2.2]}$	$80^{+30[+75]}_{-23[-41]}$
M_W [GeV]	80.399 ± 0.025	–	$80.382\,^{+0.014}_{-0.016}$	80.364 ± 0.010	$80.359\,^{+0.010}_{-0.021}$
Γ_W [GeV]	2.098 ± 0.048	–	$2.092\,^{+0.001}_{-0.002}$	2.091 ± 0.001	$2.091\,^{+0.001}_{-0.002}$

Fit results (II) without New Tevatron Results

Parameter	Input value	Free in fit	Results from global EW fits: *Standard fit*	*Complete fit*	*Complete fit w/o exp. input in line*
$\overline{m}_c$ [GeV]	1.25 ± 0.09	yes	1.25 ± 0.09	1.25 ± 0.09	–
$\overline{m}_b$ [GeV]	4.20 ± 0.07	yes	4.20 ± 0.07	4.20 ± 0.07	–
m_t [GeV]	172.4 ± 1.2	yes	172.5 ± 1.2	172.9 ± 1.2	$178.2\,^{+9.8}_{-4.2}$
$\Delta\alpha_{\rm had}^{(5)}(M_Z^2)$ $^{(\dagger\triangle)}$	2768 ± 22	yes	2772 ± 22	2767^{+19}_{-24}	2722^{+62}_{-53}
$\alpha_s(M_Z^2)$	–	yes	$0.1192\,^{+0.0028}_{-0.0027}$	$0.1193\,^{+0.0028}_{-0.0027}$	$0.1193\,^{+0.0028}_{-0.0027}$
$\delta_{\rm th} M_W$ [MeV]	$[-4, 4]_{\rm theo}$	yes	4	4	–
$\delta_{\rm th} \sin^2\theta^{\ell}_{\rm eff}$ $^{(\dagger)}$	$[-4.7, 4.7]_{\rm theo}$	yes	4.7	−1.3	–
$\delta_{\rm th} \rho^f_Z$ $^{(\dagger)}$	$[-2, 2]_{\rm theo}$	yes	2	2	–
$\delta_{\rm th} \kappa^f_Z$ $^{(\dagger)}$	$[-2, 2]_{\rm theo}$	yes	2	2	–

$^{(\star)}$Average of LEP ($A_\ell = 0.1465 \pm 0.0033$) and SLD ($A_\ell = 0.1513 \pm 0.0021$) measurements. The *complete fit* w/o the LEP (SLD) measurement gives $A_\ell = 0.1472\,^{+0.0008}_{-0.0011}$ ($A_\ell = 0.1463 \pm 0.0008$). $^{(\circ)}$In brackets the 2σ errors. $^{(\dagger)}$In units of 10^{-5}. $^{(\triangle)}$Rescaled due to α_s dependency.

Fit results (I) with New Tevatron W and Top Mass

Parameter	Input value	Free in fit	Results from global EW fits: *Standard fit*	*Complete fit*	*Complete fit w/o exp. input in line*
M_Z [GeV]	91.1875 ± 0.0021	yes	91.1874 ± 0.0021	91.1877 ± 0.0021	$91.1978\,^{+0.0176}_{-0.0163}$
Γ_Z [GeV]	2.4952 ± 0.0023	–	2.4960 ± 0.0015	2.4956 ± 0.0015	$2.4953\,^{+0.0016}_{-0.0018}$
$\sigma^0_{\rm had}$ [nb]	41.540 ± 0.037	–	41.478 ± 0.014	41.478 ± 0.014	41.469 ± 0.015
R^0_ℓ	20.767 ± 0.025	–	20.742 ± 0.018	20.741 ± 0.018	20.717 ± 0.027
$A^{0,\ell}_{\rm FB}$	0.0171 ± 0.0010	–	0.01638 ± 0.0002	0.01624 ± 0.0002	$0.01617\,^{+0.0002}_{-0.0001}$
A_ℓ $^{(\star)}$	0.1499 ± 0.0018	–	0.1478 ± 0.0010	0.1472 ± 0.0009	–
A_c	0.670 ± 0.027	–	$0.6682\,^{+0.00045}_{-0.00044}$	$0.6679\,^{+0.00041}_{-0.00038}$	$0.6679\,^{+0.00045}_{-0.00032}$
A_b	0.923 ± 0.020	–	0.93469 ± 0.00010	0.93464 ± 0.00007	0.93464 ± 0.00007
$A^{0,c}_{\rm FB}$	0.0707 ± 0.0035	–	$0.0741\,^{+0.0006}_{-0.0005}$	0.0737 ± 0.0005	$0.0738\,^{+0.0004}_{-0.0006}$
$A^{0,b}_{\rm FB}$	0.0992 ± 0.0016	–	0.1036 ± 0.0007	$0.1032\,^{+0.0007}_{-0.0006}$	$0.1037\,^{+0.0004}_{-0.0005}$
R^0_c	0.1721 ± 0.0030	–	0.17225 ± 0.00006	0.17225 ± 0.00006	0.17225 ± 0.00006
R^0_b	0.21629 ± 0.00066	–	0.21578 ± 0.00005	0.21577 ± 0.00005	0.21577 ± 0.00005
$\sin^2\theta^\ell_{\rm eff}(Q_{\rm FB})$	0.2324 ± 0.0012	–	0.23142 ± 0.00013	$0.23148\,^{+0.00013}_{-0.00010}$	$0.23149\,^{+0.00012}_{-0.00011}$
M_H [GeV] $^{(\circ)}$	Likelihood ratios	yes	$83^{+30[+75]}_{-23[-41]}$	$116.4^{+18.4[+28.5]}_{-1.3[-2.2]}$	$83^{+30[+75]}_{-23[-41]}$
M_W [GeV]	80.399 ± 0.023	–	$80.384\,^{+0.014}_{-0.015}$	$80.370\,^{+0.008}_{-0.010}$	$80.360\,^{+0.013}_{-0.019}$
Γ_W [GeV]	2.098 ± 0.048	–	$2.092\,^{+0.001}_{-0.002}$	2.091 ± 0.001	2.091 ± 0.001

Fit results (II) with New Tevatron W and Top Mass

Parameter	Input value	Free in fit	Results from global EW fits: *Standard fit*	*Complete fit*	*Complete fit w/o exp. input in line*
$\overline{m}_c$ [GeV]	1.25 ± 0.09	yes	1.25 ± 0.09	1.25 ± 0.09	–
$\overline{m}_b$ [GeV]	4.20 ± 0.07	yes	4.20 ± 0.07	4.20 ± 0.07	–
m_t [GeV]	173.1 ± 1.3	yes	173.2 ± 1.2	173.6 ± 1.2	$178.4\,^{+9.7}_{-4.1}$
$\Delta\alpha^{(5)}_{\rm had}(M_Z^2)$ $^{(\dagger\triangle)}$	2768 ± 22	yes	2772 ± 22	2763^{+24}_{-20}	2728^{+62}_{-53}
$\alpha_s(M_Z^2)$	–	yes	$0.1192\,^{+0.0028}_{-0.0027}$	0.1193 ± 0.0028	0.1193 ± 0.0028
$\delta_{\rm th} M_W$ [MeV]	$[-4, 4]_{\rm theo}$	yes	4	4	–
$\delta_{\rm th} \sin^2\theta^{\ell}_{\rm eff}$ $^{(\dagger)}$	$[-4.7, 4.7]_{\rm theo}$	yes	4.7	0.8	–
$\delta_{\rm th}\rho^f_Z$ $^{(\dagger)}$	$[-2, 2]_{\rm theo}$	yes	2	2	–
$\delta_{\rm th}\kappa^f_Z$ $^{(\dagger)}$	$[-2, 2]_{\rm theo}$	yes	2	2	–

$^{(\star)}$Average of LEP ($A_\ell = 0.1465 \pm 0.0033$) and SLD ($A_\ell = 0.1513 \pm 0.0021$) measurements. The *complete fit* w/o the LEP (SLD) measurement gives $A_\ell = 0.1473 \pm 0.0009$ ($A_\ell = 0.1464 \pm 0.0008$). $^{(\circ)}$In brackets the 2σ. $^{(\dagger)}$In units of 10^{-5}. $^{(\triangle)}$Rescaled due to α_s dependency.