Electroweak Analyses

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On behalf of the ALEPH, DELPHI, L3, OPAL and SLD Collaborations, and the Electroweak Working Group

http://www.cern.ch/LEPEWWG

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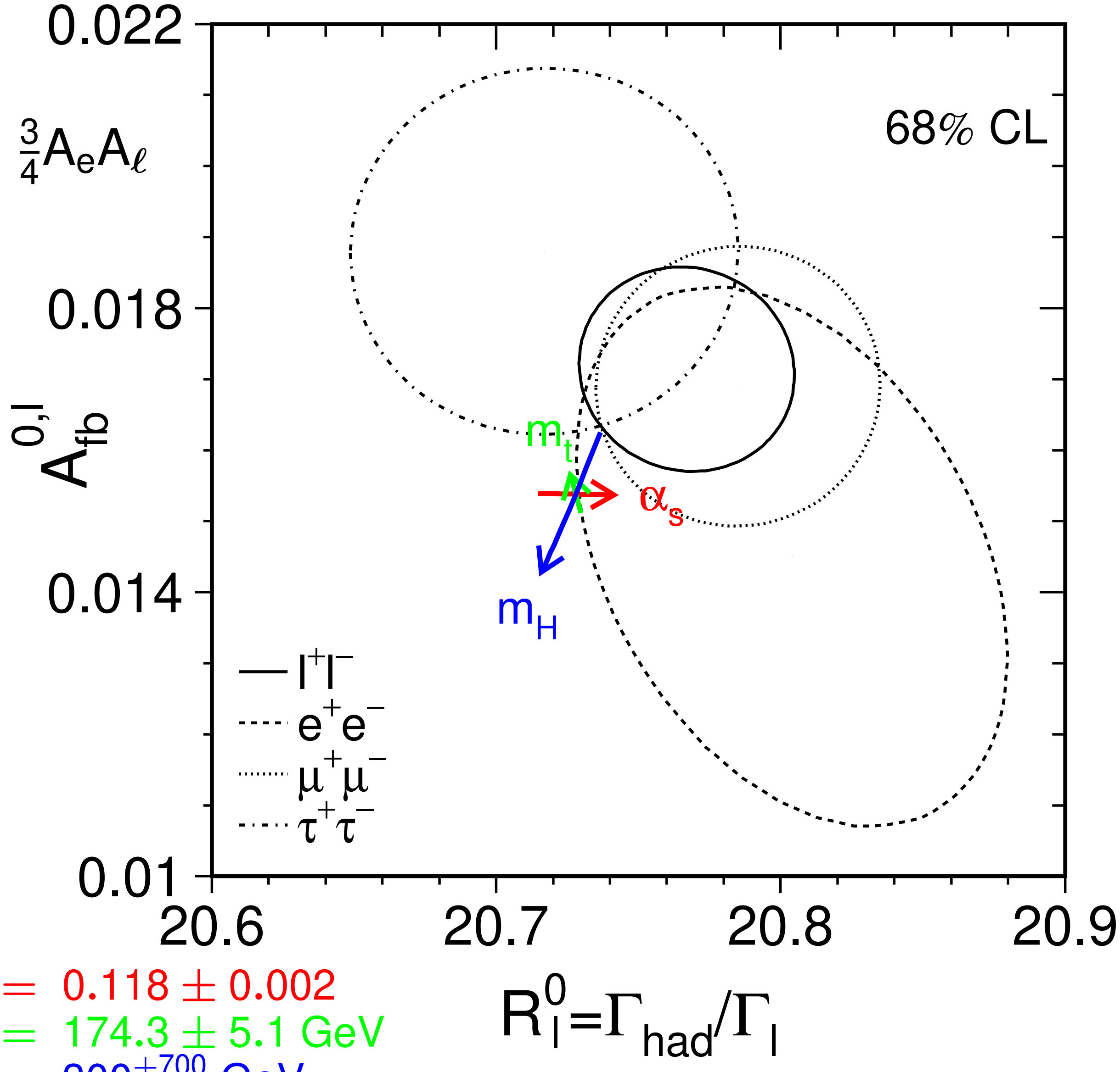
LEP-1 Z Lineshape and Asymmetries

Final LEP-1 results:

$$M_Z = 91.1875 \pm 0.0021 \text{ GeV}$$
$$\Gamma_Z = 2.4952 \pm 0.0023 \text{ GeV}$$
$$N_\nu = 2.9841 \pm 0.0083$$

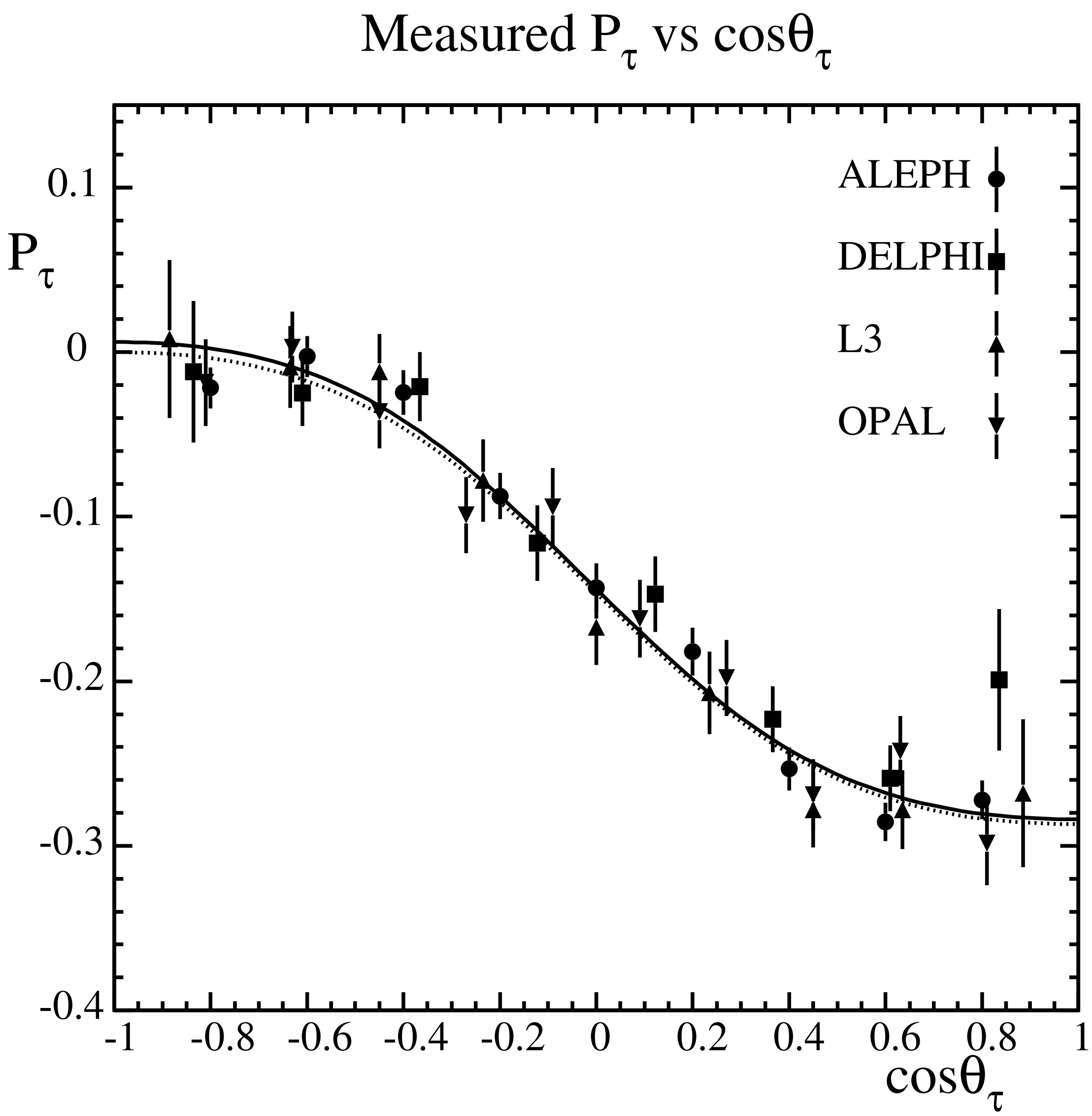
$$A_{fb}^{0,\ell} = \frac{3}{4} A_e A_\ell$$



$$\alpha_S = 0.118 \pm 0.002$$
$$M_t = 174.3 \pm 5.1 \text{ GeV}$$
$$M_H = 300^{+700}_{-186} \text{ GeV}$$

Low Higgs mass preferred!

SLD+LEP-1 Polarisation Asymmetries



Combination of final LEP-1 results:

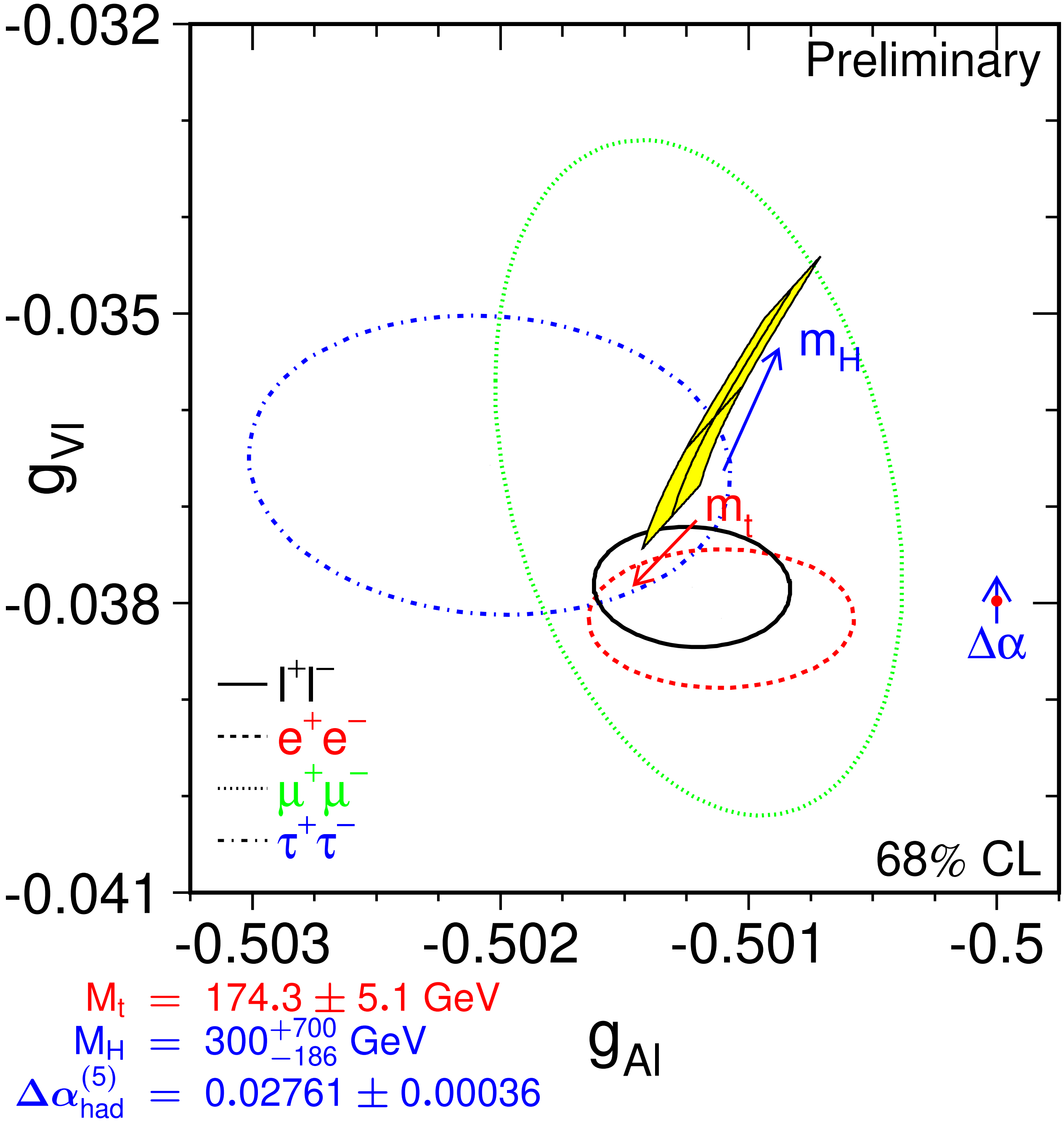
$$A_\ell = 2\frac{g_{V\ell}/g_{A\ell}}{1+(g^2_{V\ell}/g^2_{A\ell})} = 0.1465 \pm 0.0033$$

Correlations between ADLO small, under study

Final SLD result:

$$A_\ell = 0.1513 \pm 0.0021$$

Effective Leptonic Coupling Constants



$$g_{V\ell} = -0.03783 \pm 0.00041$$
$$g_{A\ell} = -0.50123 \pm 0.00026$$

Low Higgs mass preferred!

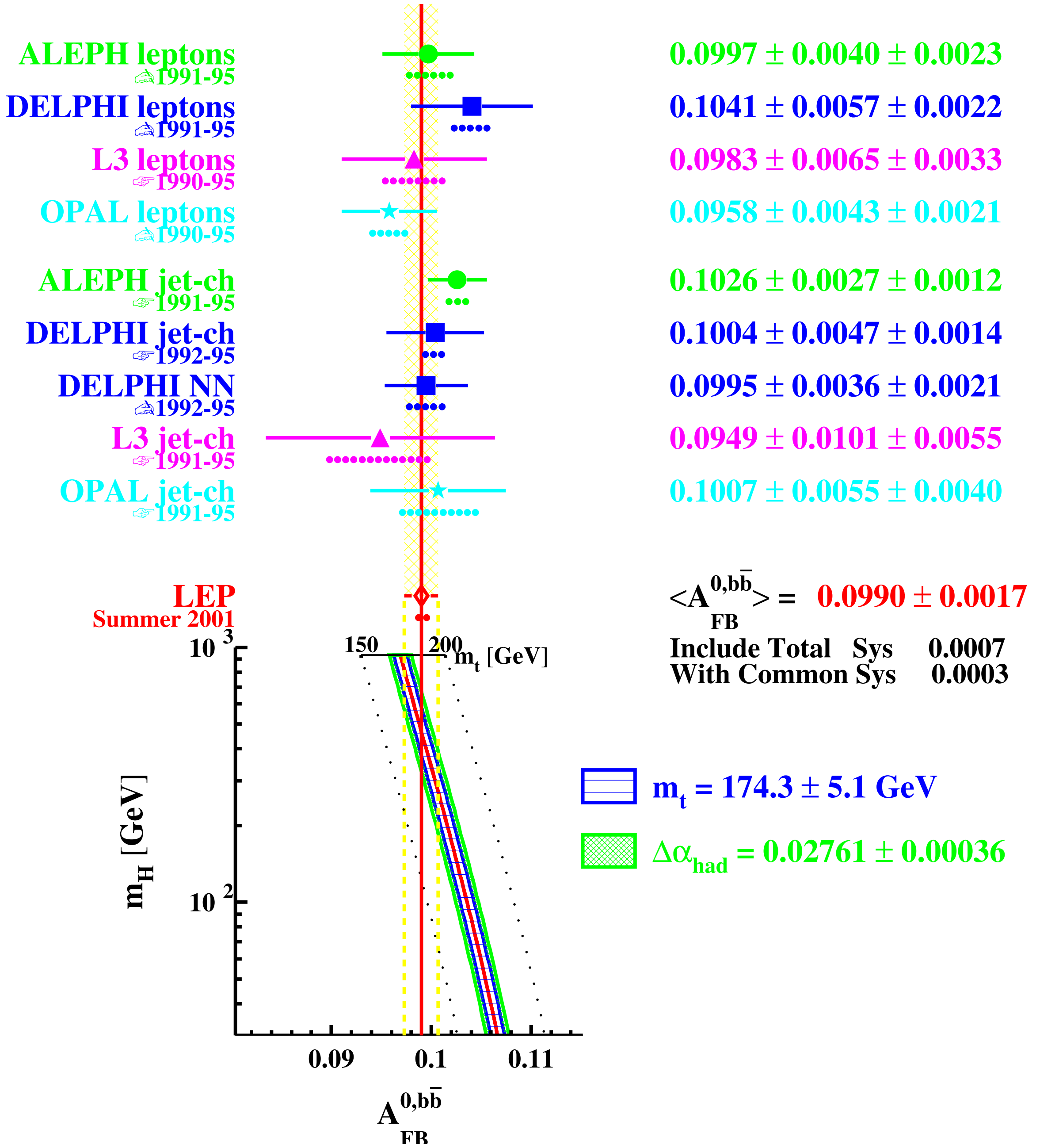
Most significant change in $A_{fb}^{0,b}$(LEP-1):

$0.0982 \pm 0.0017 \rightarrow 0.0990 \pm 0.0017$:

1/4 due to ALEPH, 3/4 due to DELPHI

Measurements consistent

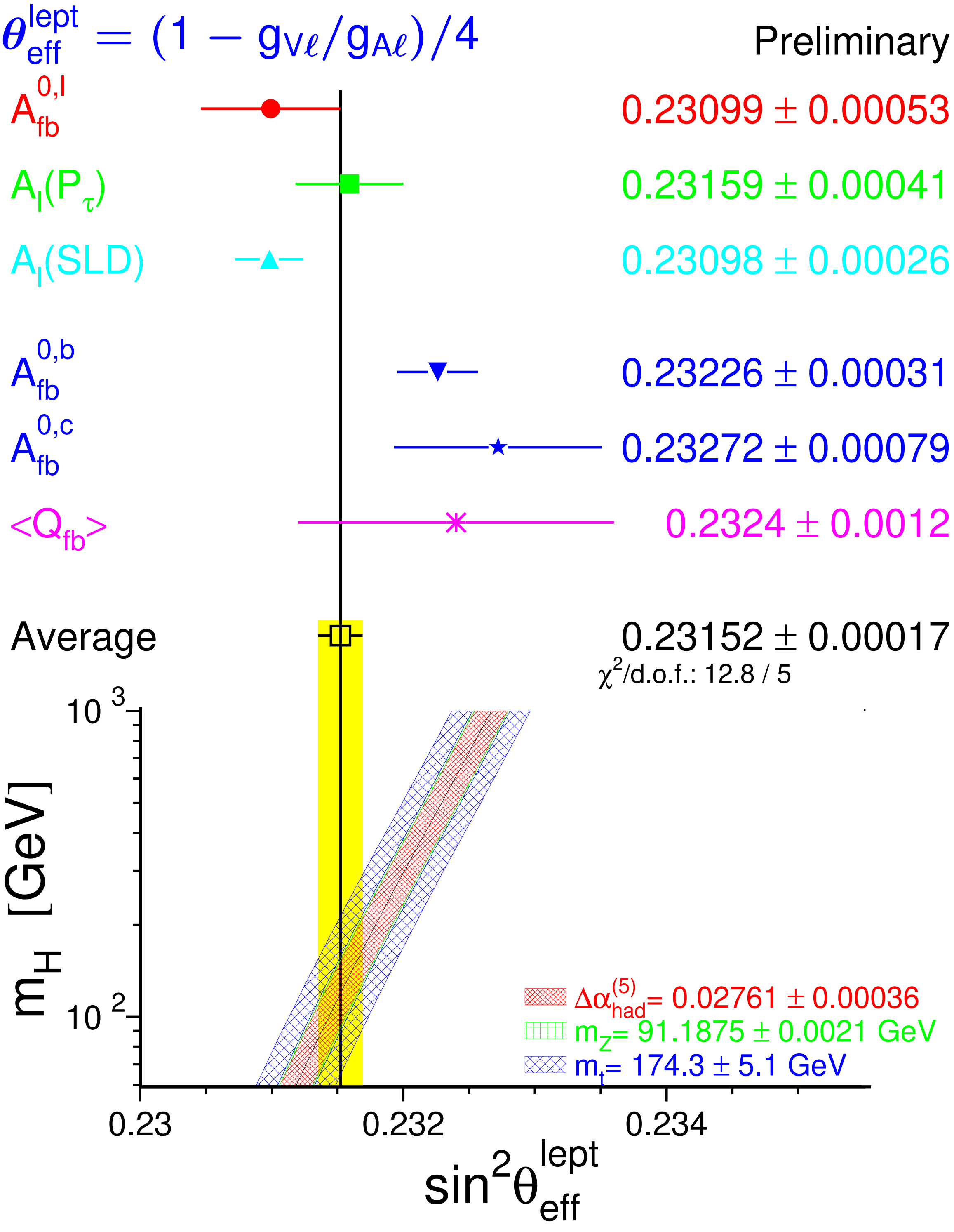
Preliminary



High Higgs mass preferred!

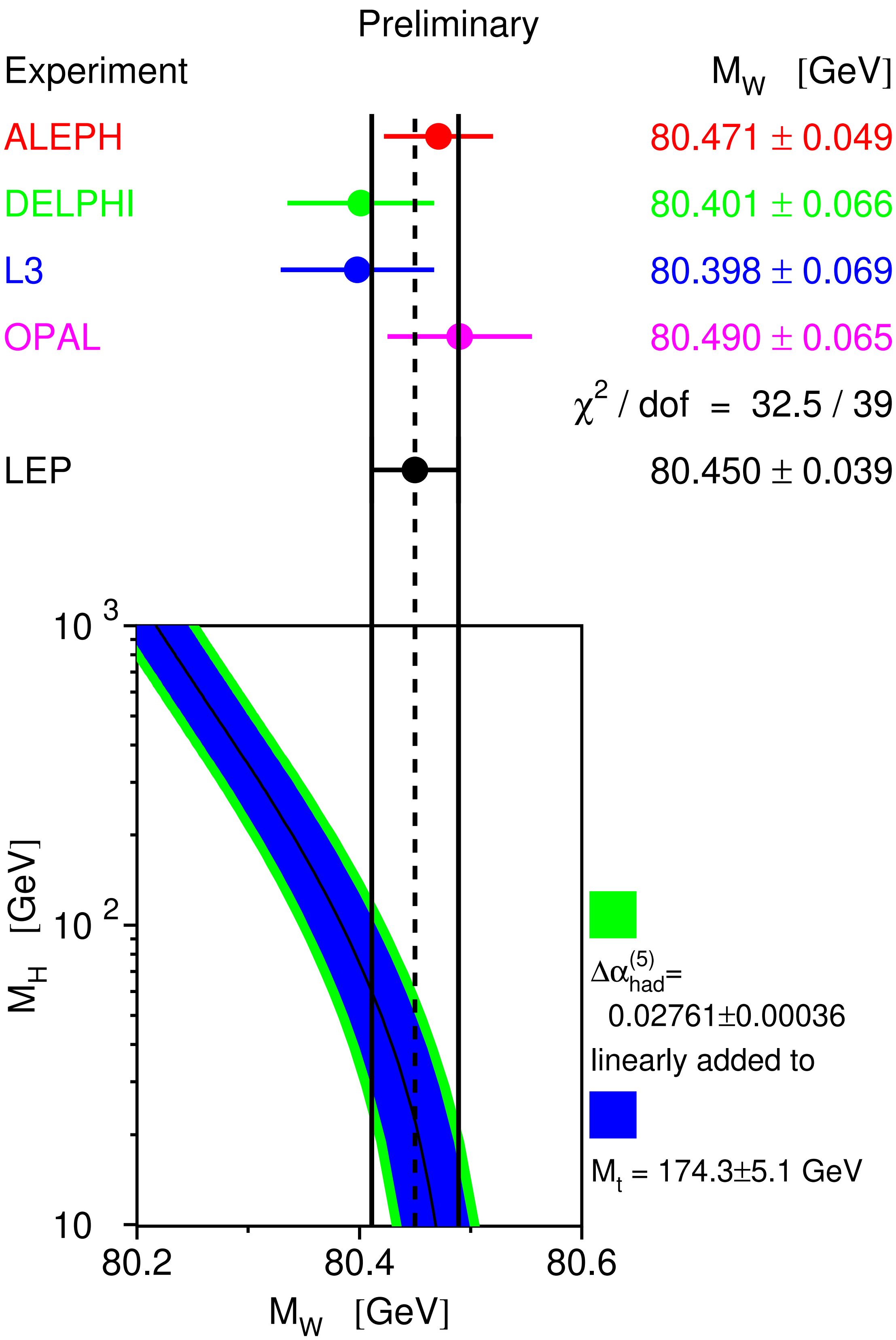
Effective Leptonic Electroweak Mixing Angle

$\sin^2\theta_{\mathrm{eff}}^{\mathrm{lept}} = (1 - g_{V\ell}/g_{A\ell})/4$



Leptons	0.23113 ± 0.00021	χ^2/d.o.f. : 1.6/2
Hadrons	0.23230 ± 0.00029	χ^2/d.o.f. : 0.3/2
Difference	3.3 sigma	

LEP-2 W-Boson Mass

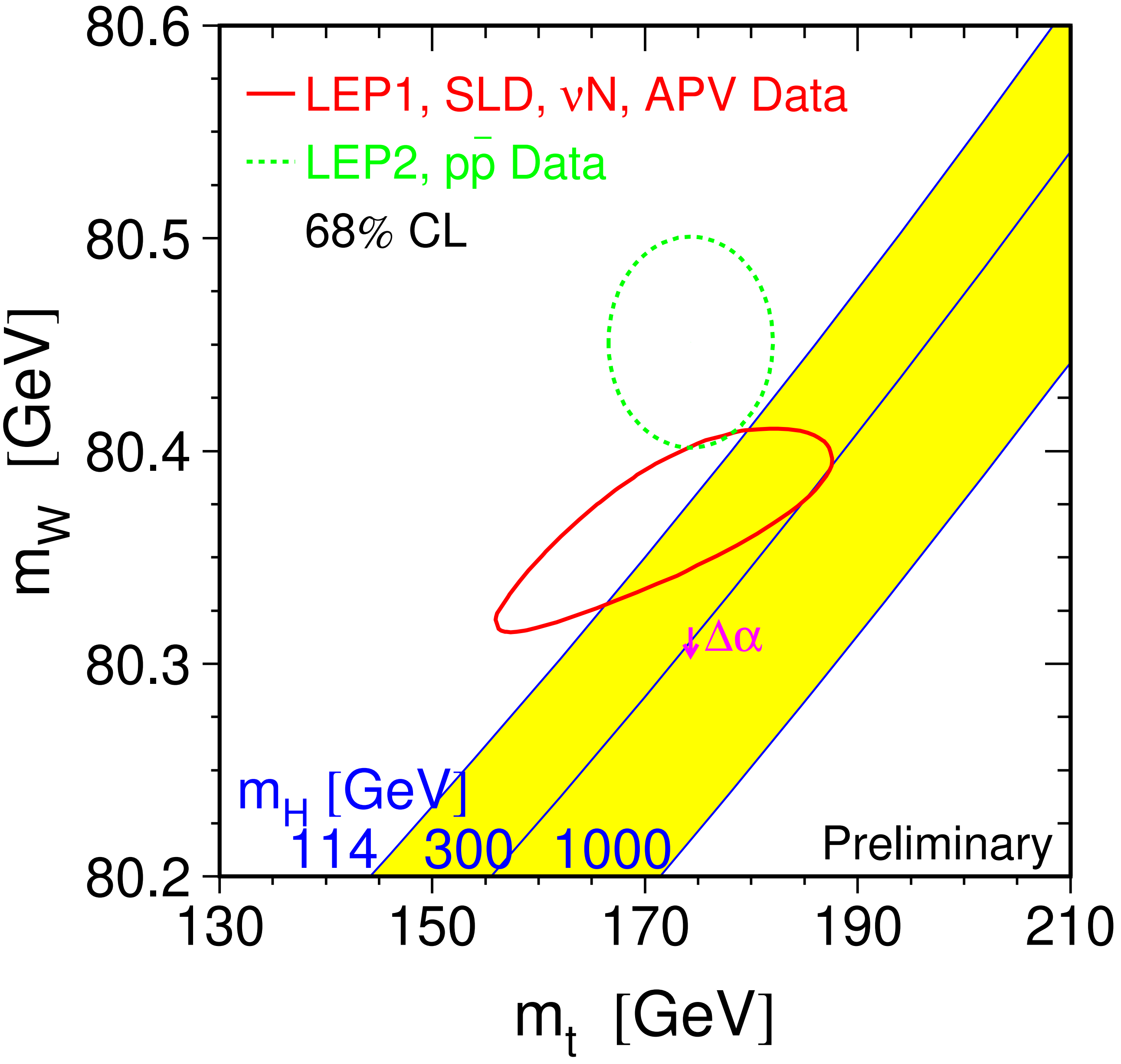


Low Higgs mass preferred!

W-Boson and Top-Quark Mass

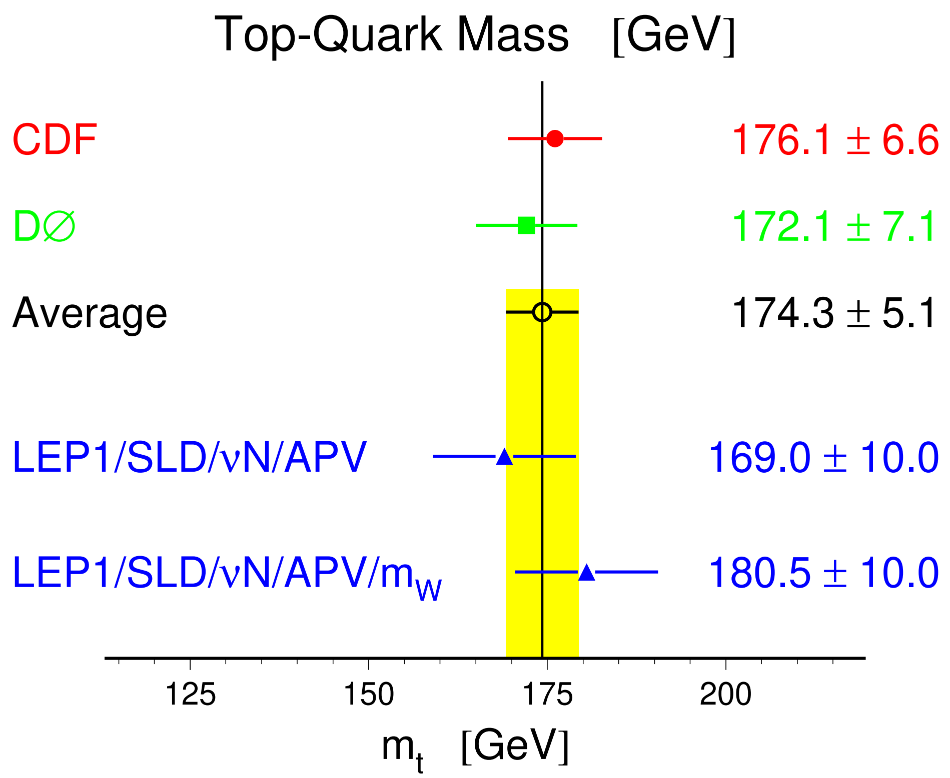
Many other results:

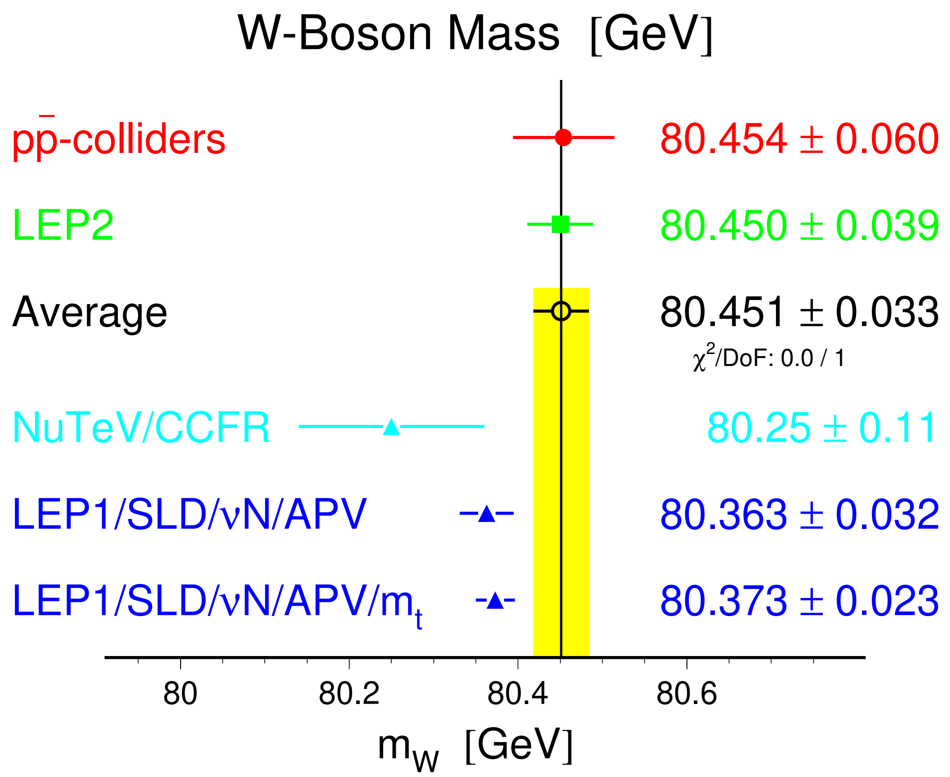
R_b, R_c, A_b, A_c, $\sin^2\theta_W(\nu\mathcal{N})$, $Q_W(Cs)$, $\Delta\alpha^{(5)}_{had}$ and $M_t(p\bar{p})$, $M_W(p\bar{p})$



Low Higgs mass preferred!

W-Boson and Top-Quark Mass

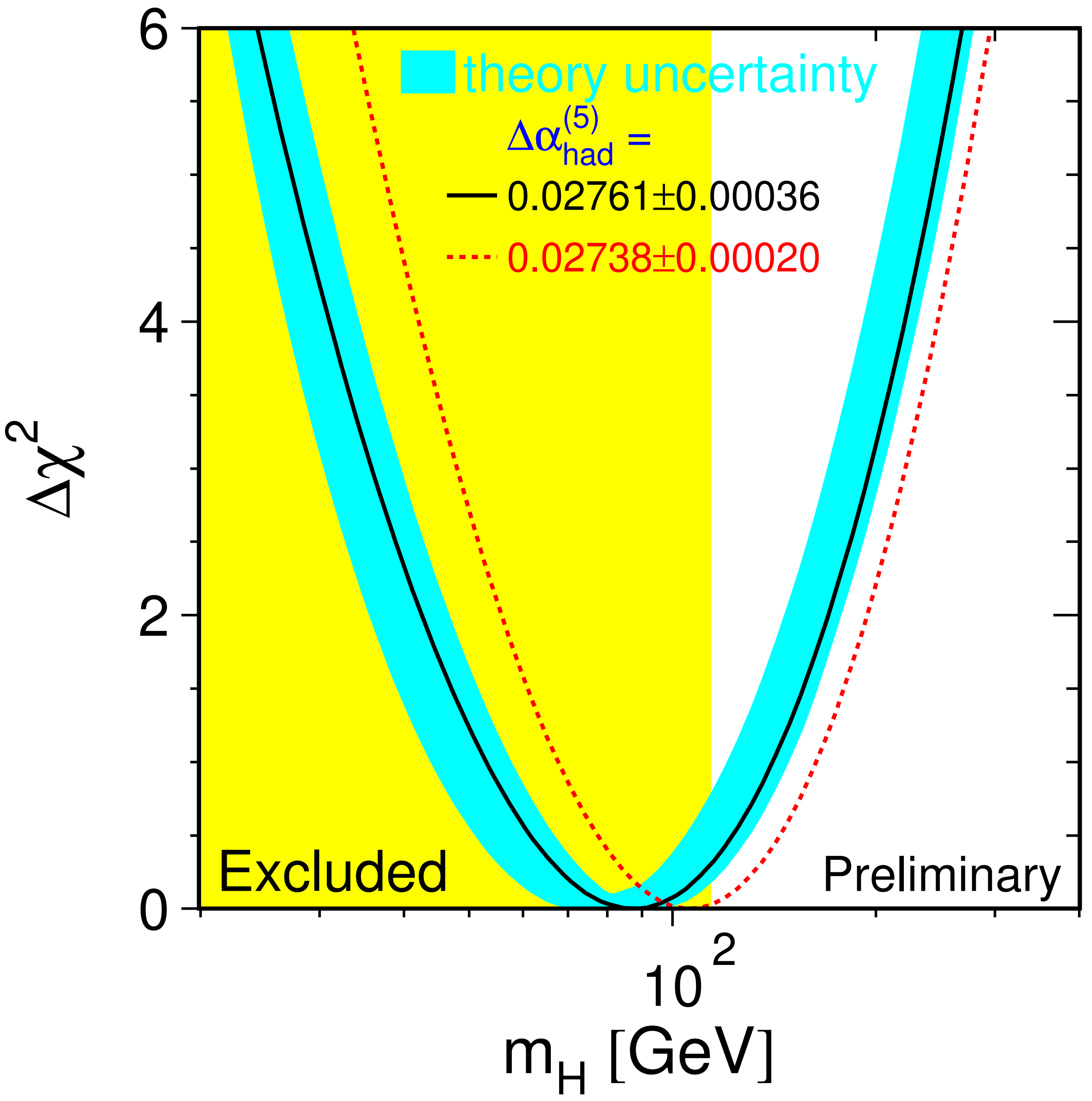




Successful predictions of heavy masses

Higgs-Boson Mass

$M_H = 88^{+53}_{-35}$ GeV



$M_H < 196$ GeV (95% CL) $M_H < 222$ GeV (95% CL)

Theory uncertainty enlarged towards low M_H

Upper limits are safe

Theory and its Uncertainty

Calculated with:

TOPAZ0 4.4 (2001-02-22): G.Passarino et al.

ZFITTER 6.36 (2001-06-21): D.Bardin et al.

Atomic parity violation calculations added

Bardin, Christova, Kalinovskaya, Passarino, hep-ph/0102233

Neglected non-leading QCD corrections added:

Chetyrkin, Kühn, Steinhauser, PRL 75 (1995) 3394

No additional uncertainty

Complete fermionic two-loop M_W:

Freitas, Hollik, Walter, Weiglein, PLB 495 (2000) 338

Full shift taken as new uncertainty

Uncritical for M_W but controversial problem for:

$$\sin^2\theta_{\mathrm{eff}}^{\mathrm{lept}} = \kappa_W \cdot \left(1 - \frac{M_W^2}{M_Z^2}\right)$$

Expect partial cancellation in $\sin^2\theta_{\mathrm{eff}}^{\mathrm{lept}}$

Need equivalent calculations for:

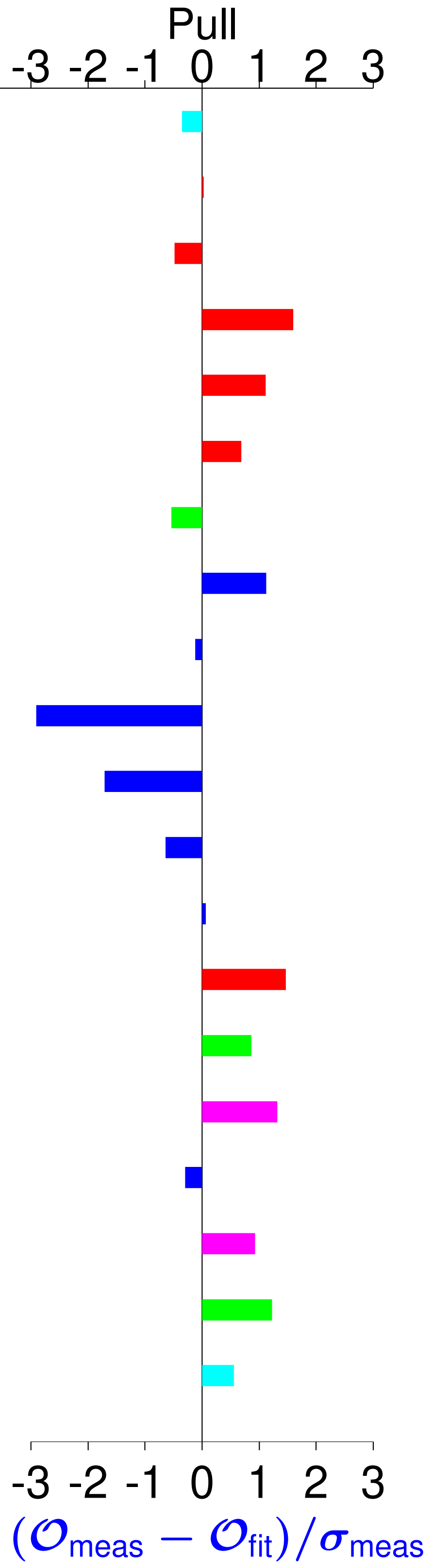
Partial Z decay widths

Effective electroweak mixing angle

Test of the MSM

Summer 2001

	Measurement	Pull
$\Delta\alpha^{(5)}_{had}(m_Z)$	0.02761 ± 0.00036	-.35
m_Z [GeV]	91.1875 ± 0.0021	.03
Γ_Z [GeV]	2.4952 ± 0.0023	-.48
σ^0_{had} [nb]	41.540 ± 0.037	1.60
R_l	20.767 ± 0.025	1.11
$A^{0,l}_{fb}$	0.01714 ± 0.00095	.69
$A_l(P_\tau)$	0.1465 ± 0.0033	-.54
R_b	0.21646 ± 0.00065	1.12
R_c	0.1719 ± 0.0031	-.12
$A^{0,b}_{fb}$	0.0990 ± 0.0017	-2.90
$A^{0,c}_{fb}$	0.0685 ± 0.0034	-1.71
A_b	0.922 ± 0.020	-.64
A_c	0.670 ± 0.026	.06
A_l(SLD)	0.1513 ± 0.0021	1.47
$\sin^2\theta^{lept}_{eff}(Q_{fb})$	0.2324 ± 0.0012	.86
$m_W^{(LEP)}$ [GeV]	80.450 ± 0.039	1.32
m_t [GeV]	174.3 ± 5.1	-.30
$m_W^{(TEV)}$ [GeV]	80.454 ± 0.060	.93
$\sin^2\theta_W(\nu N)$	0.2255 ± 0.0021	1.22
$Q_W(Cs)$	-72.50 ± 0.70	.56



$$\chi^2/\mathrm{dof} = 22.9/15 \ (8.6\%)$$

Conclusion

LEP, SLD, Tevatron, . . . :

Wealth of high-precision measurements

High sensitivity to radiative corrections

Most measurements agree with expectations:

MSM fit probability: 8.6%

Large spread in $\sin^2\theta^{\mathrm{lept}}_{\mathrm{eff}}$: Prob.: 2.5%

Largest deviation in $A^{0,b}_{fb}$: 2.9 sigma

Need final LEP results of highest precision!

Successful tests of the MSM:

Electroweak radiative corrections verified

Successful M_t and M_W prediction

Higgs-mass prediction from measurements:

$M_H < 196$ GeV at 95% CL

Need improved results on M_W, M_t, $\Delta\alpha^{(5)}_{\mathrm{had}}$

Need improved theoretical calculations

M_H prediction successful? Wait and see!