Fisica Nucleare e Subnucleare III

Interpretazioni dei risultati nell'ambito del Modello Standard

Analisi SM dei dati di LEP-SLC

Un fit globale di SM al set di misure di LEP e SLC precedentemente descritto, permette di determinare i seguenti parametri:

$\alpha_S(m_Z^2)$	0.1190 ± 0.0027
m_Z [GeV]	91.1874 ± 0.0021
m_t [GeV]	$173 \pm^{13}_{10}$
$\log_{10}(m_H/\mathrm{GeV})$	$2.05 \pm^{0.43}_{0.34}$

Notiamo che l'ottima determinazione di α_s si ricava essenzialmente da $\sigma^0_{\mathrm{lep}} = \sigma^0_{\mathrm{had}}/R^0_\ell$ che pur essendo in teoria una quantità puramente leptonica, per come è determinata dipende fortemente da α_s.

Le masse del top e dell'Higgs sono invece legate alle correzioni radiative.

memorandum delle correzioni radiative

$$\begin{aligned}\sin^2\theta_{\rm eff}^{\rm f} &\equiv \kappa_{\rm f}\sin^2\theta_{\rm W}\\ g_{\rm Vf} &\equiv \sqrt{\rho_{\rm f}}\,(T_3^{\rm f}-2Q_{\rm f}\sin^2\theta_{\rm eff}^{\rm f})\\ g_{\rm Af} &\equiv \sqrt{\rho_{\rm f}}\,T_3^{\rm f}\,,\end{aligned}$$

$$\begin{aligned}\cos^2\theta_{\rm W}\sin^2\theta_{\rm W} &= \frac{\pi\alpha(0)}{\sqrt{2}m_{\rm Z}^2G_{\rm F}}\frac{1}{1-\Delta r}\\ \cos^2\theta_{\rm eff}^{\rm f}\sin^2\theta_{\rm eff}^{\rm f} &= \frac{\pi\alpha(0)}{\sqrt{2}m_{\rm Z}^2G_{\rm F}}\frac{1}{1-\Delta r^{\rm f}}\end{aligned}$$

$$\begin{aligned}\rho_{\rm f} &\equiv \Re(\mathcal{R}_{\rm f}) = 1+\Delta\rho_{\rm se}+\Delta\rho_{\rm f}\\ \kappa_{\rm f} &\equiv \Re(\mathcal{K}_{\rm f}) = 1+\Delta\kappa_{\rm se}+\Delta\kappa_{\rm f}\end{aligned}$$

$$\begin{aligned}\Delta r &= \Delta\alpha+\Delta r_{\rm w}\\ \Delta r^{\rm f} &= \Delta\alpha+\Delta r_{\rm w}^{\rm f}\end{aligned}$$

$$\begin{aligned}\Delta\rho_{\rm se} &= \frac{3G_{\rm F}m_{\rm W}^2}{8\sqrt{2}\pi^2}\left[\frac{m_{\rm t}^2}{m_{\rm W}^2}-\frac{\sin^2\theta_{\rm W}}{\cos^2\theta_{\rm W}}\left(\ln\frac{m_{\rm H}^2}{m_{\rm W}^2}-\frac{5}{6}\right)+\cdots\right]\\ \Delta\kappa_{\rm se} &= \frac{3G_{\rm F}m_{\rm W}^2}{8\sqrt{2}\pi^2}\left[\frac{m_{\rm t}^2}{m_{\rm W}^2}\frac{\cos^2\theta_{\rm W}}{\sin^2\theta_{\rm W}}-\frac{10}{9}\left(\ln\frac{m_{\rm H}^2}{m_{\rm W}^2}-\frac{5}{6}\right)+\cdots\right]\end{aligned}$$

$$\begin{aligned}\Delta r_{\rm w} &= -\frac{\cos^2\theta_{\rm W}}{\sin^2\theta_{\rm W}}\Delta\rho+\cdots\\ \Delta r_{\rm w}^{\rm f} &= -\Delta\rho+\cdots.\end{aligned}$$

$$\begin{aligned}\Delta\kappa_{\rm b} &= \frac{G_{\rm F}m_{\rm t}^2}{4\sqrt{2}\pi^2}+\cdots,\\ \Delta\rho_{\rm b} &= -2\Delta\kappa_{\rm b}+\cdots.\end{aligned}$$

$$\Delta\rho \approx \frac{3G_F m_t^2}{8\sqrt{2}\pi^2}$$

I parametri effettivi dello SM

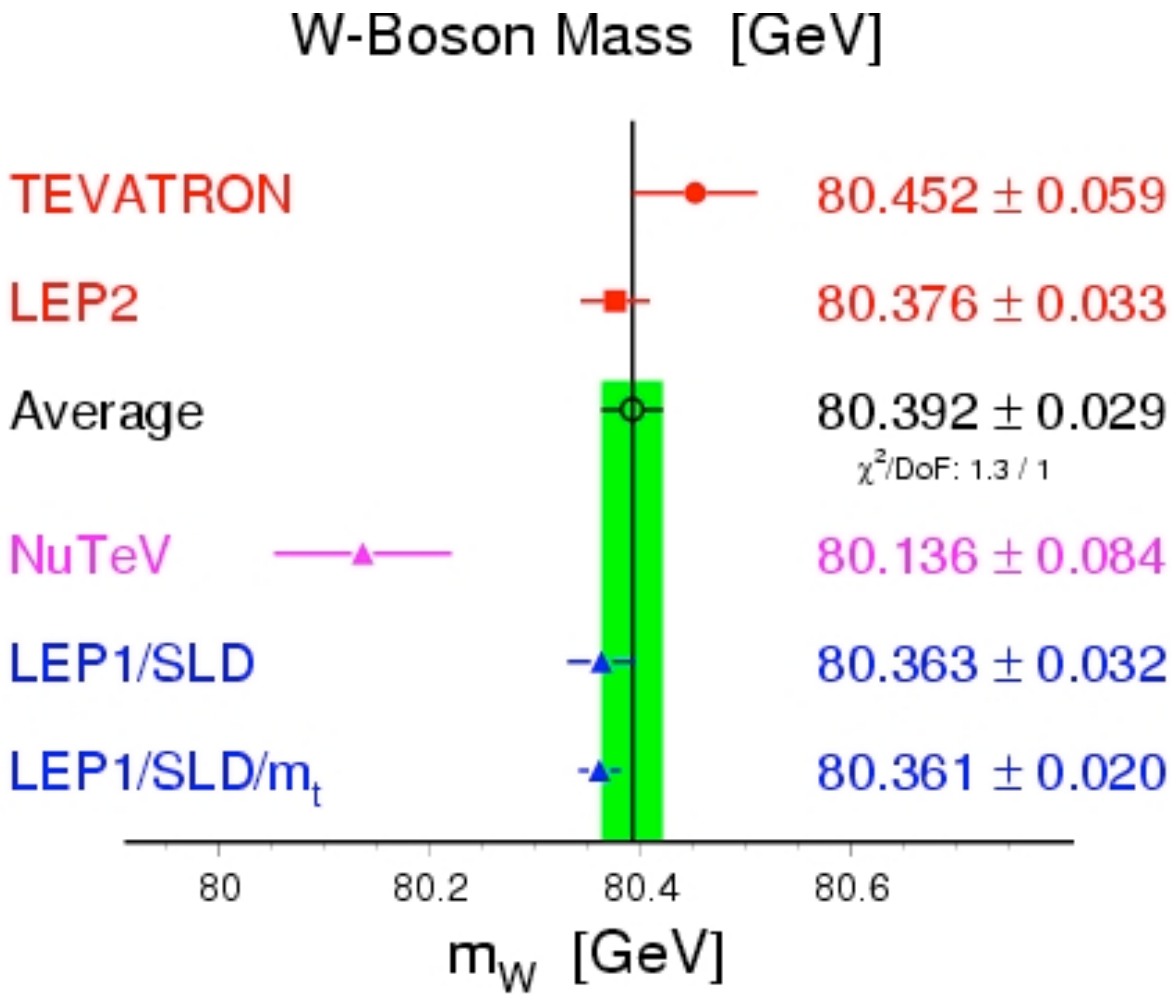
Utilizzando i valori di input del fit, si possono ricalcolare tutti i parametri introdotti attraverso le correzioni radiative, che permettono di determinare qualunque grandezza nell'ambito dello SM:

$$\begin{aligned}
\sin^2\theta_{\mathrm{W}} &= 0.22331 \pm 0.00062 \\
\sin^2\theta_{\mathrm{eff}}^{\mathrm{lept}} &= 0.23149 \pm 0.00016 \\
\sin^2\theta_{\mathrm{eff}}^{\mathrm{b}} &= 0.23293 \pm^{0.00031}_{0.00025} \\
\rho_\ell &= 1.00509 \pm^{0.00067}_{0.00081} \\
\rho_{\mathrm{b}} &= 0.99426 \pm^{0.00079}_{0.00164} \\
\kappa_\ell &= 1.0366 \pm 0.0025 \\
\kappa_{\mathrm{b}} &= 1.0431 \pm 0.0036
\end{aligned}$$

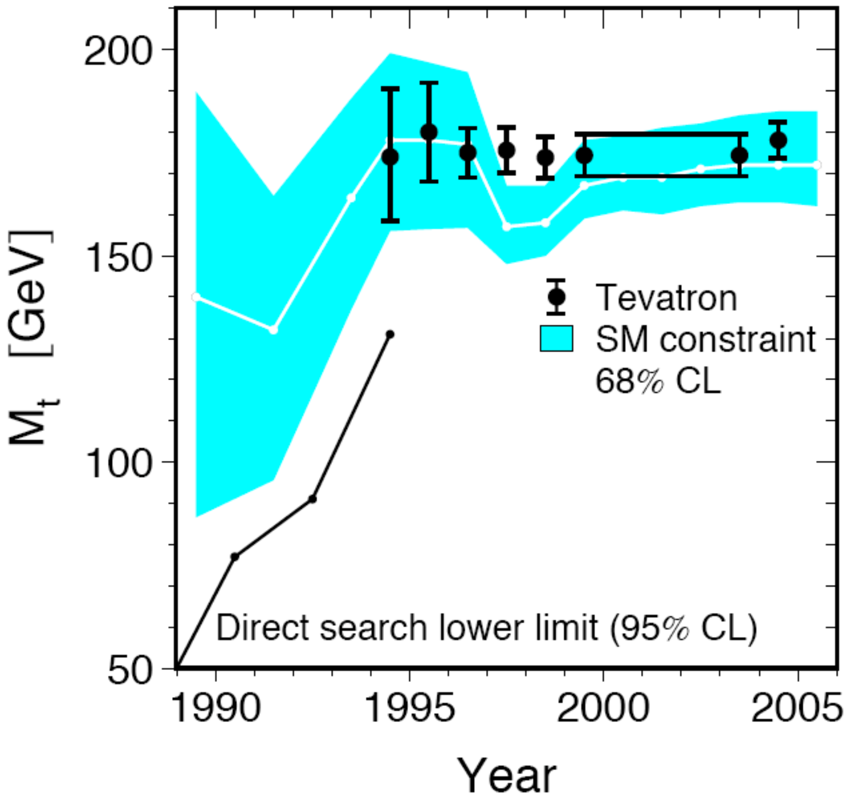
on-shell: $\frac{m_W^2}{m_Z^2 \cos^2\theta_W} = \rho_0 = 1$

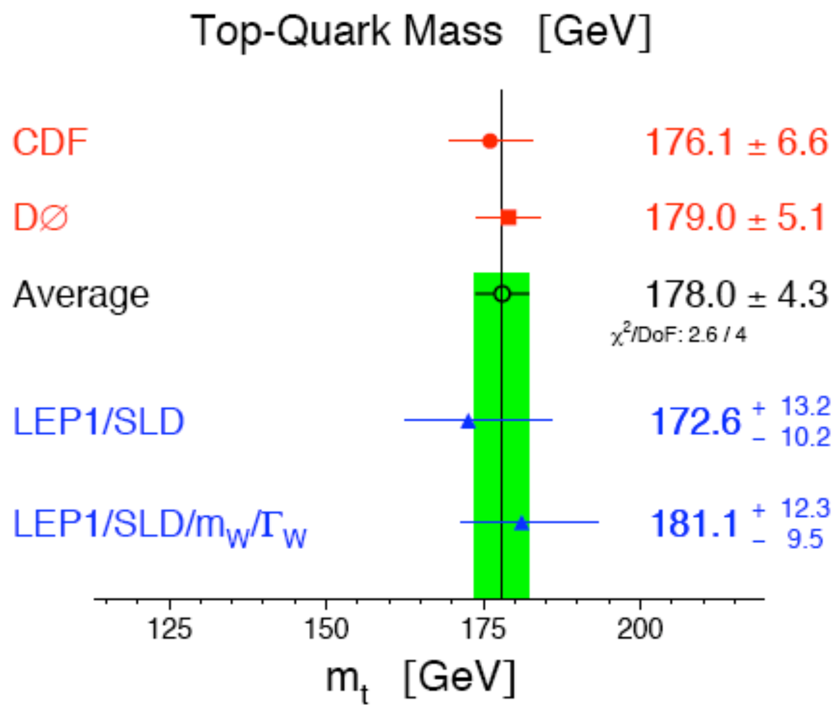
$$\begin{aligned}
-\Delta r_{\mathrm{w}} &= 0.0242 \pm 0.0021 \\
\Delta r &= 0.0363 \pm 0.0019
\end{aligned}$$

la massa del W



la massa del top

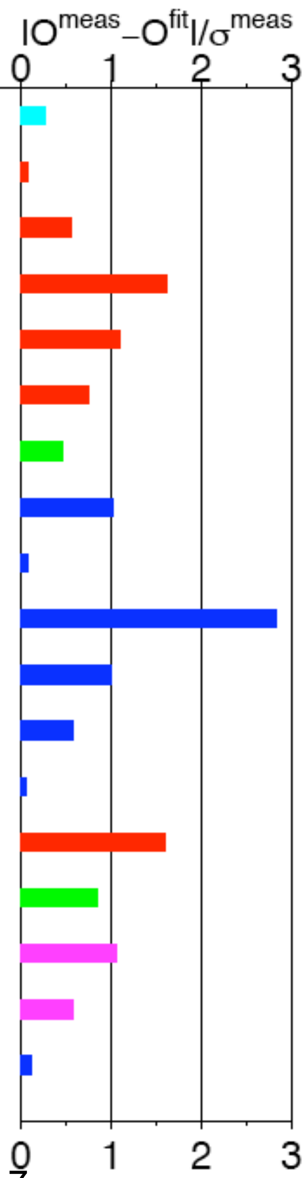




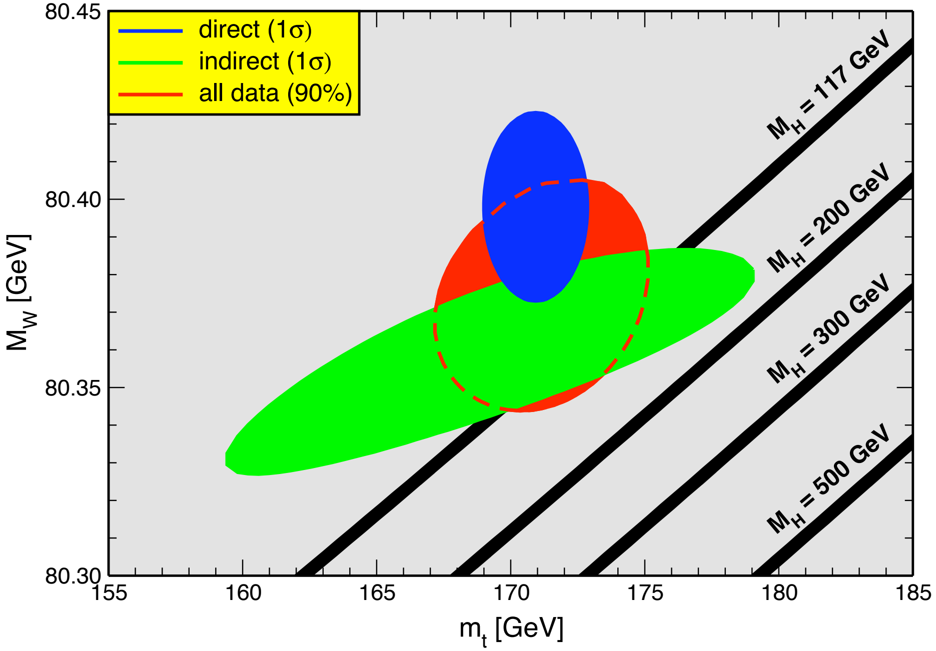
un fit globale

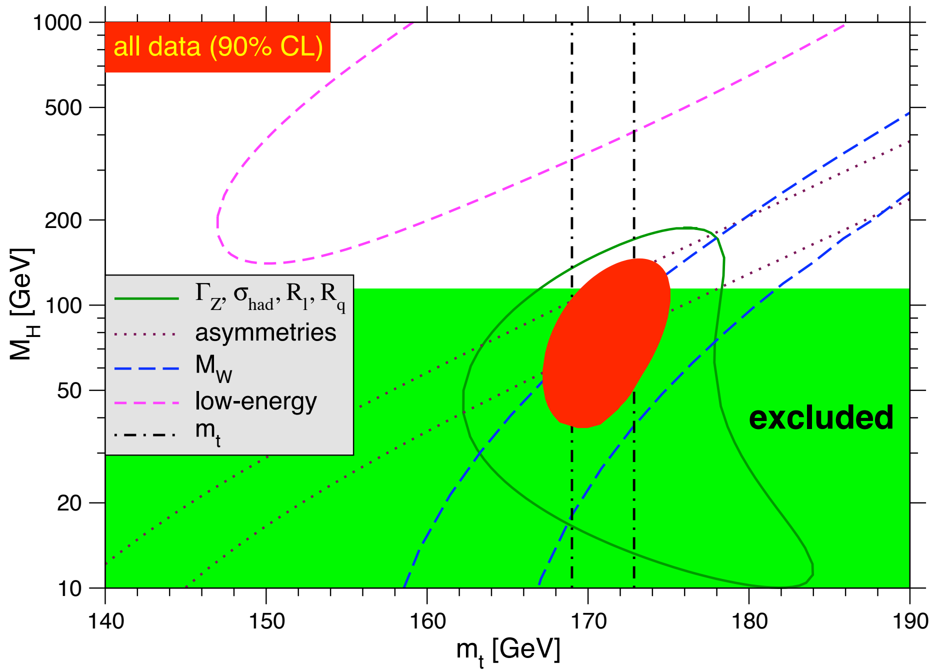
Includendo nel fit anche i valori misurati del top e del W si ottengono i seguenti risultati:

	Measurement	Fit
$\Delta\alpha_{had}^{(5)}(m_Z)$	0.02758 ± 0.00035	0.02767
m_Z [GeV]	91.1875 ± 0.0021	91.1874
Γ_Z [GeV]	2.4952 ± 0.0023	2.4965
σ_{had}^{0} [nb]	41.540 ± 0.037	41.481
R_l	20.767 ± 0.025	20.739
$A_{fb}^{0,l}$	0.01714 ± 0.00095	0.01642
$A_l(P_\tau)$	0.1465 ± 0.0032	0.1480
R_b	0.21629 ± 0.00066	0.21562
R_c	0.1721 ± 0.0030	0.1723
$A_{fb}^{0,b}$	0.0992 ± 0.0016	0.1037
$A_{fb}^{0,c}$	0.0707 ± 0.0035	0.0742
A_b	0.923 ± 0.020	0.935
A_c	0.670 ± 0.027	0.668
A_l(SLD)	0.1513 ± 0.0021	0.1480
$\sin^2\theta_{eff}^{lept}(Q_{fb})$	0.2324 ± 0.0012	0.2314
m_W [GeV]	80.425 ± 0.034	80.389
Γ_W [GeV]	2.133 ± 0.069	2.093
m_t [GeV]	178.0 ± 4.3	178.5

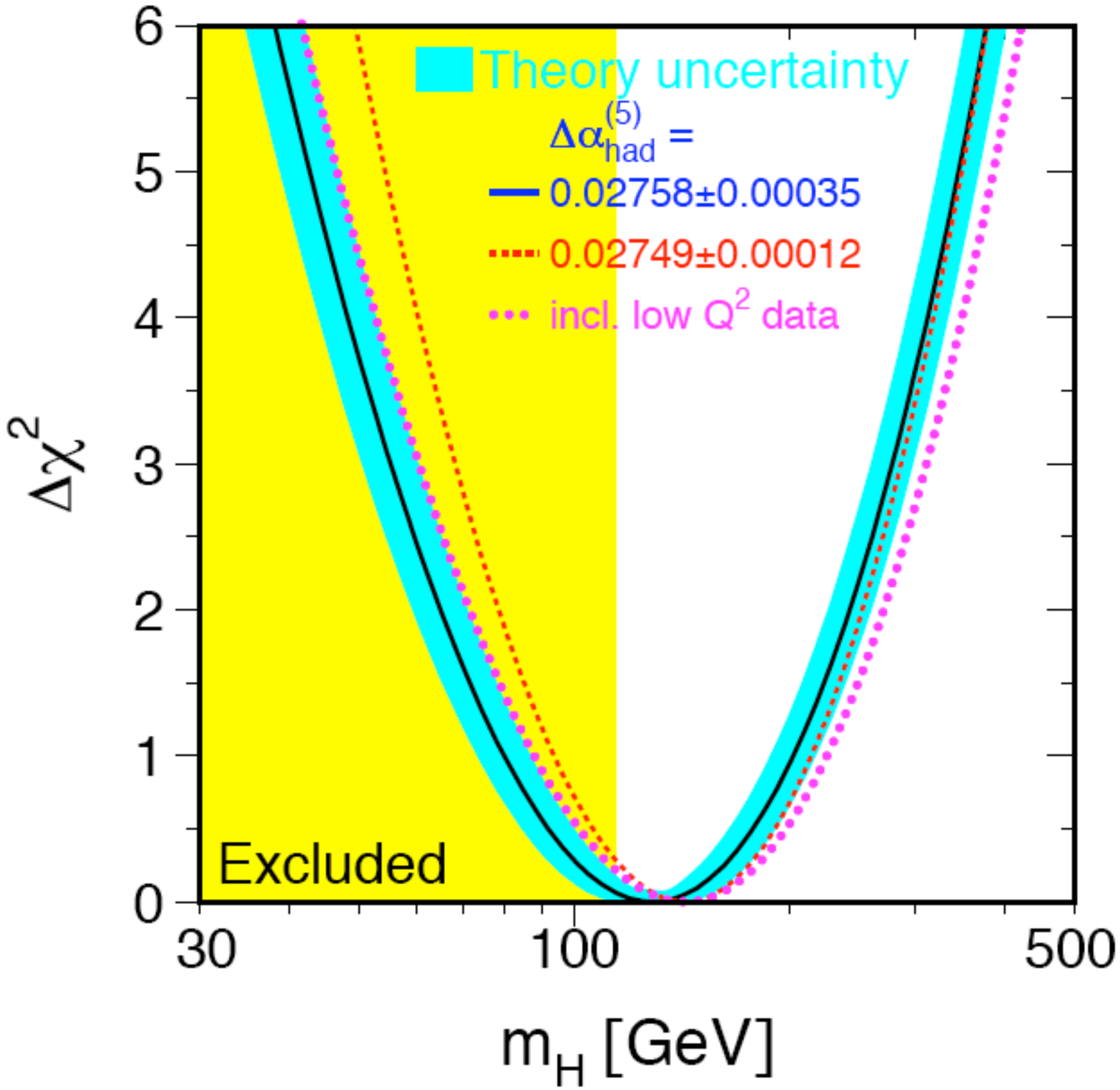


la massa dell’Higgs





la massa dell'Higgs



- excluding $\mathcal{A}_\ell$(SLD):

$$m_H = 175^{+99}_{-66}\ \text{GeV}$$

- excluding $A^{0,b}_{FB}$(LEP):

$$m_H = 76^{+54}_{-33}\ \text{GeV}$$