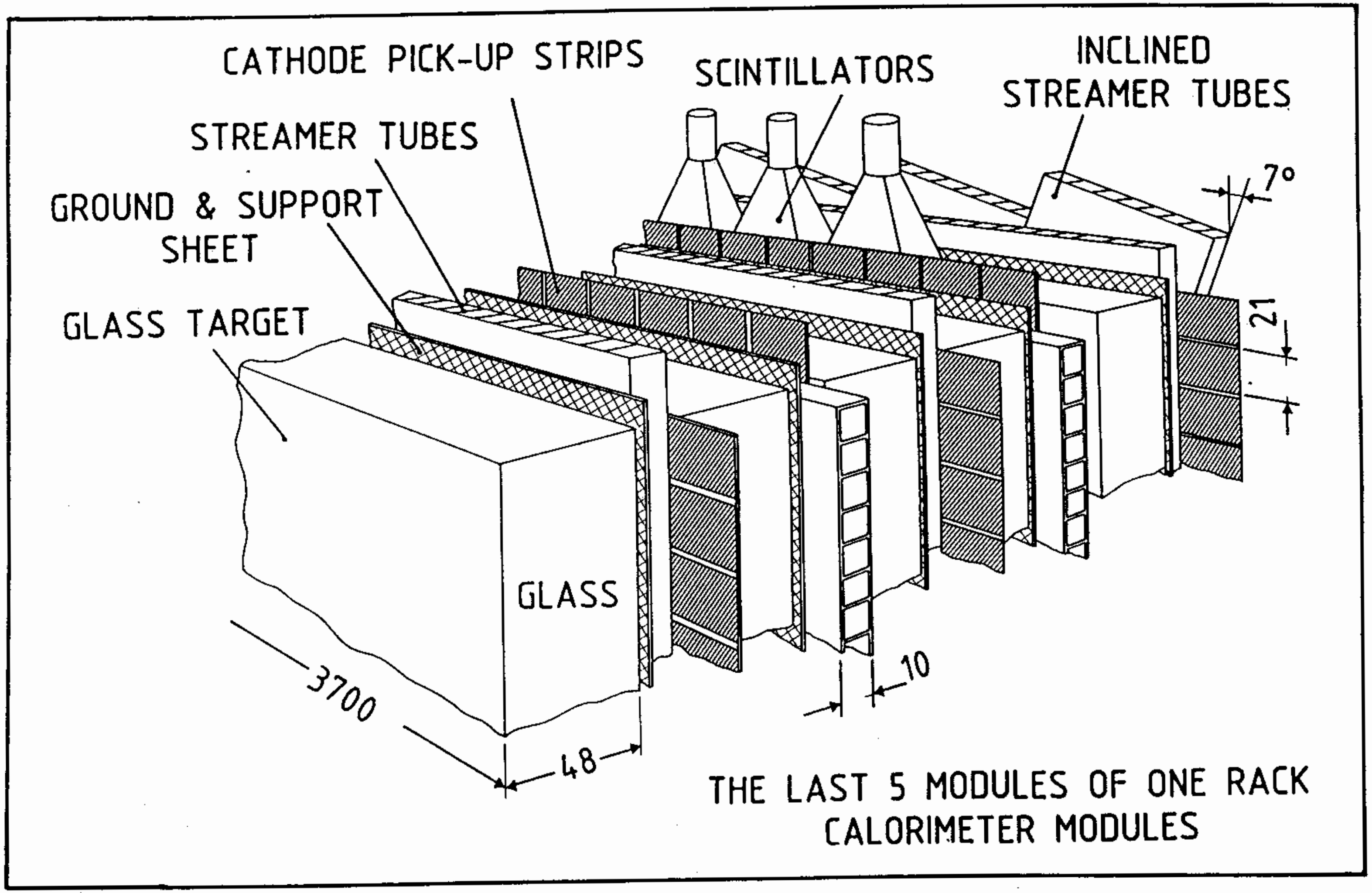
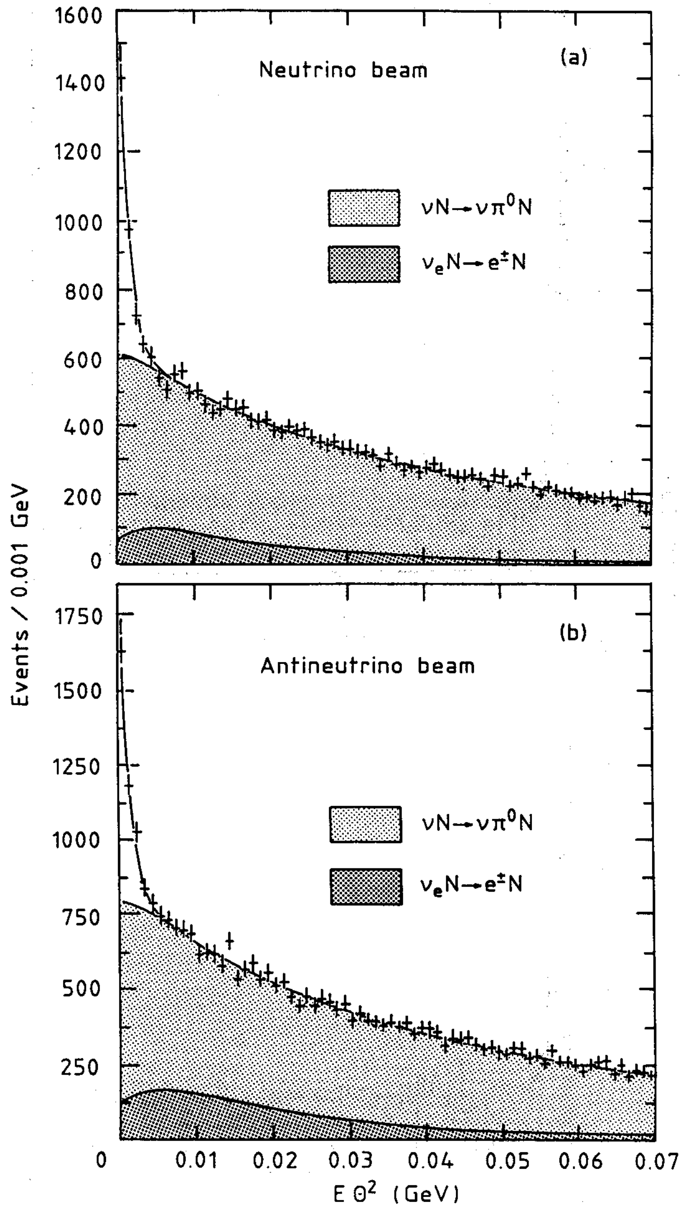
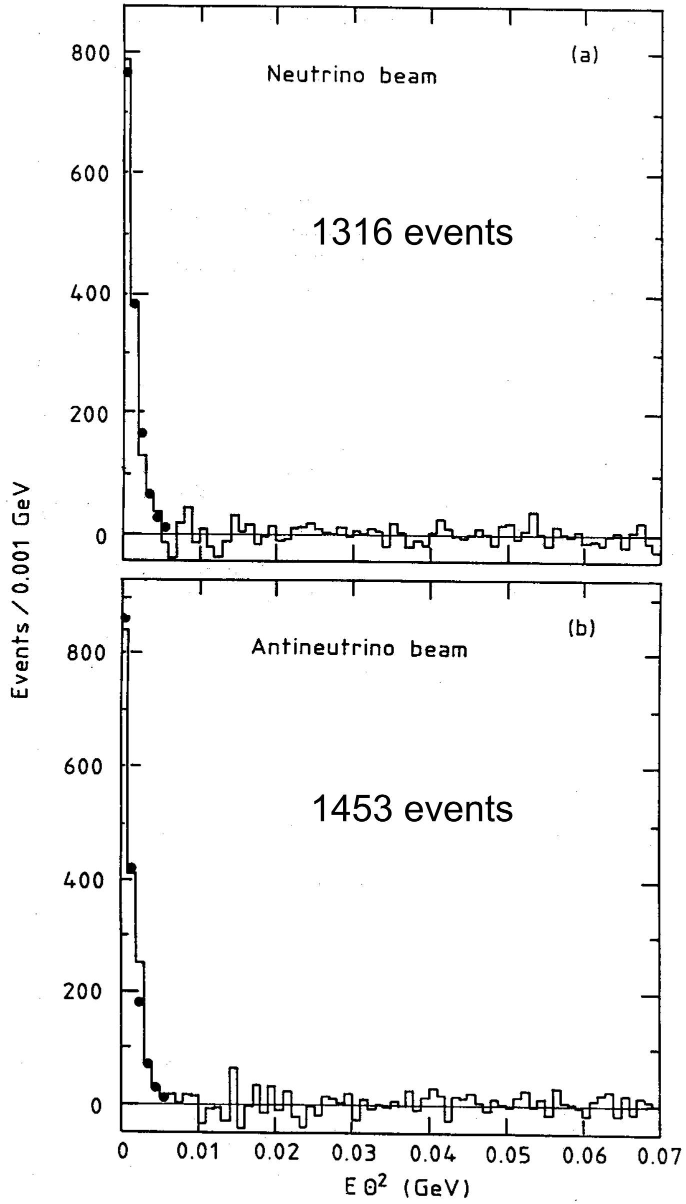
CHARM II


CATHODE PICK-UP STRIPS
SCINTILLATORS
INCLINED STREAMER TUBES
STREAMER TUBES
GROUND & SUPPORT SHEET
GLASS TARGET
7°
21
GLASS
10
3700
48
THE LAST 5 MODULES OF ONE RACK
CALORIMETER MODULES

Risultati di CHARM II





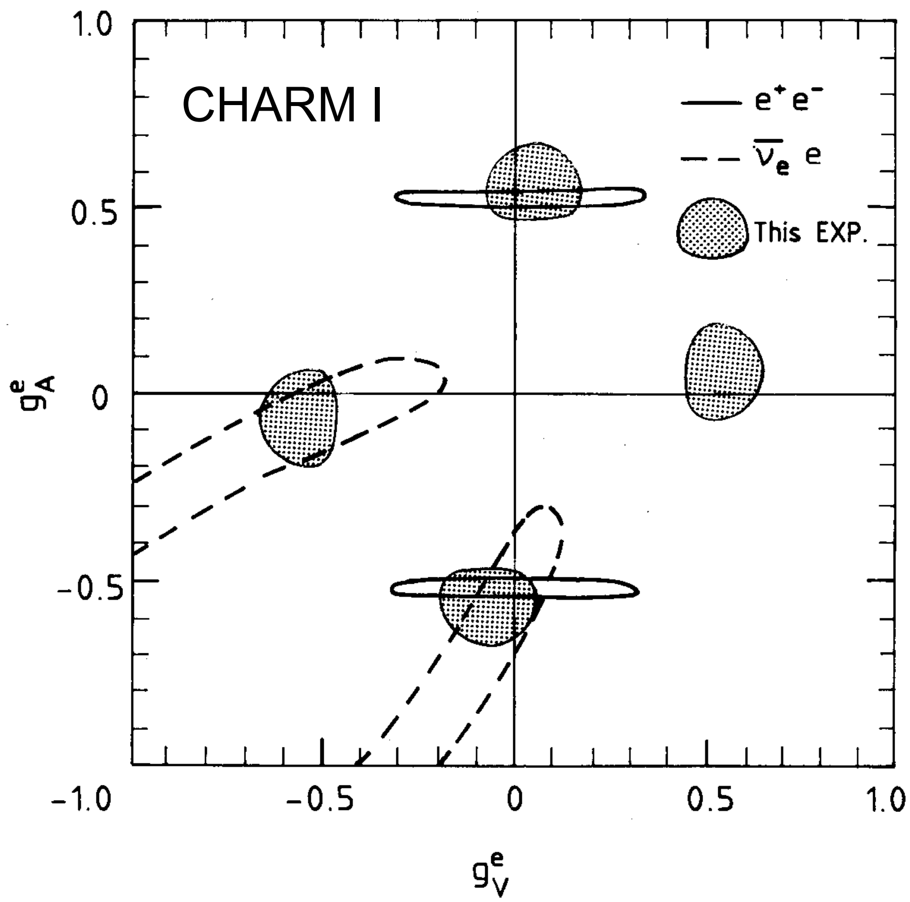
CHARM II, dall'intersezione delle ellissi:

$g_V = -0.035 \pm 0.017$

$g_A = -0.503 \pm 0.017$

$$g_V = I_3 - 2Q\sin^2\vartheta_W$$

$$g_A = I_3$$



$$\sigma_{\nu_\mu e} = \frac{G_F s}{\pi}\left(C_L^2 + \frac{1}{3}C_R^2\right) = \frac{G_F s}{\pi}\left[\left(\sin^2\vartheta_W - \frac{1}{2}\right)^2 + \frac{1}{3}\sin^4\vartheta_W\right]$$

$$\sigma_{\bar{\nu}_\mu e} = \frac{G_F s}{\pi}\left(\frac{1}{3}C_L^2 + C_R^2\right) = \frac{G_F s}{\pi}\left[\frac{1}{3}\left(\sin^2\vartheta_W - \frac{1}{2}\right)^2 + \sin^4\vartheta_W\right]$$

Il parametro ρ $\qquad \frac{m_W^2}{m_Z^2\cos^2\vartheta_W} = \rho$

$$\frac{\sigma_0^{NC}}{\sigma_0^{CC}} = \rho$$

al tree level:

un doppietto di Higgs, $\rho = 1$

più doppietti di Higgs, $\rho > 1$

ma le correzioni radiative
introducono piccole correzioni tali che $\rho = 1 + \Delta\rho$

$$\Delta\rho \simeq 0.005 - 0.01$$

$$\sigma_{\nu_\mu e} = \rho \frac{G_F s}{\pi}\left(C_L^2 + \frac{1}{3} C_R^2 \right) = \rho \frac{G_F s}{\pi}\left[\left(\sin^2 \vartheta_W - \frac{1}{2} \right)^2 + \frac{1}{3} \sin^4 \vartheta_W \right]$$

$$\sigma_{\bar{\nu}_\mu e} = \rho \frac{G_F s}{\pi}\left(\frac{1}{3} C_L^2 + C_R^2 \right) = \rho \frac{G_F s}{\pi}\left[\frac{1}{3}\left(\sin^2 \vartheta_W - \frac{1}{2} \right)^2 + \sin^4 \vartheta_W \right]$$

$$\frac{\sigma_{\nu_\mu e}}{\sigma_{\bar{\nu}_\mu e}} = \frac{16 \sin^4 \vartheta_W - 12 \sin^2 \vartheta_W + 3}{16 \sin^4 \vartheta_W - 4 \sin^2 \vartheta_W + 1}$$

La dipendenza da ρ è praticamente cancellata in $\sin^2\theta_W$
se viene determinato dal rapporto tra
σ neutrino e σ antineutrino
(che cancella anche molte altre sistematiche sperimentali)

$$\sin^2\theta_W = 0.2324 \pm 0.0058 \pm 0.0059$$

correnti neutre ν-nucleone

Anche in questo caso, le misure più significative vengono dai rapporti tra sezioni d'urto. Nell'ipotesi di bersaglio isoscalare, e trascurando i quark pesanti, indicando con d e u le frazioni di momento associate ai relativi partoni, possiamo scrivere (Llewellins Smith):

$$\frac{d}{dy}\sigma_\nu^{CC} = \frac{G^2 s}{\pi}\left(d_L + \bar{u}_R(1-y)^2\right)$$

$$\frac{d}{dy}\sigma_{\bar{\nu}}^{CC} = \frac{G^2 s}{\pi}\left(u_L(1-y)^2 + \bar{d}_R\right)$$

$$\frac{d}{dy}\sigma_\nu^{NC} = \frac{G^2 s}{\pi}\Big(d_L g_{dL}^2 + d_R g_{dR}^2(1-y)^2 + u_L g_{uL}^2 + u_R g_{uR}^2(1-y)^2 +$$

$$+\bar{d}_L g_{dR}^2 + \bar{d}_R g_{dL}^2(1-y)^2 + \bar{u}_L g_{uR}^2 + \bar{u}_R g_{uL}^2(1-y)^2\Big) =$$

$$= \frac{G^2 s}{\pi}\left(\left(d_L + \bar{u}_R(1-y)^2\right)\left(g_{uL}^2 + g_{dL}^2\right) + \left(u_R(1-y)^2 + \bar{d}_L\right)\left(g_{uR}^2 + g_{dR}^2\right)\right) =$$

$$= \frac{d}{dy}\sigma_\nu^{CC} g_L^2 + \frac{d}{dy}\sigma_{\bar{\nu}}^{CC} g_R^2$$

assumendo

$$u_L = d_L = u_R = d_R$$

$$\bar{u}_L = \bar{d}_L = \bar{u}_R = \bar{d}_R$$

con

$$(g_{uL})^2 = (g_{\bar{u}R})^2 = \left(\frac{1}{2} - \frac{2}{3}\sin^2\vartheta_W\right)^2$$

$$(g_{dL})^2 = (g_{\bar{d}R})^2 = \left(-\frac{1}{2} + \frac{1}{3}\sin^2\vartheta_W\right)^2$$

$$(g_{uR})^2 = (g_{\bar{u}L})^2 = \left(-\frac{2}{3}\sin^2\vartheta_W\right)^2$$

$$(g_{dR})^2 = (g_{\bar{d}L})^2 = \left(\frac{1}{3}\sin^2\vartheta_W\right)^2$$

$$g_L^2 = g_{dL}^2 + g_{uL}^2 = \frac{1}{2} - \sin^2\vartheta_W + \frac{5}{9}\sin^4\vartheta_W$$

$$g_R^2 = g_{dR}^2 + g_{uR}^2 = \frac{5}{9}\sin^4\vartheta_W$$

e analogamente per antineutrino, $\frac{d}{dy}\sigma_{\bar{\nu}}^{NC} = \frac{d}{dy}\sigma_{\bar{\nu}}^{CC} g_L^2 + \frac{d}{dy}\sigma_\nu^{CC} g_R^2$

integrando in y, dividendo per $\sigma^{CC}_{\nu,\bar{\nu}}$ e introducendo

$$r = \frac{\sigma^{CC}_{\bar{\nu}}}{\sigma^{CC}_{\nu}} = \frac{\frac{1}{3}q + \bar{q}}{q + \frac{1}{3}\bar{q}} = \frac{\frac{1}{3} + \varepsilon}{1 + \frac{1}{3}\varepsilon} \approx 0.44$$

per $\varepsilon \approx 0.125$, ma che può essere misurato direttamente,

si ottiene

$$R_{\nu} = \frac{\sigma^{NC}_{\nu}}{\sigma^{CC}_{\nu}} = g_L^2 + g_R^2 r \quad \text{e} \quad R_{\bar{\nu}} = \frac{\sigma^{NC}_{\bar{\nu}}}{\sigma^{CC}_{\bar{\nu}}} = g_L^2 + g_R^2 / r$$

Queste relazioni vanno però corrette per

gli altri quark del mare,
soprattutto c che ha una soglia, dove entra la massa effettiva del c
la non isoscalarità (ma CHARM era esattamente isoscalare)
altre correzioni radiative

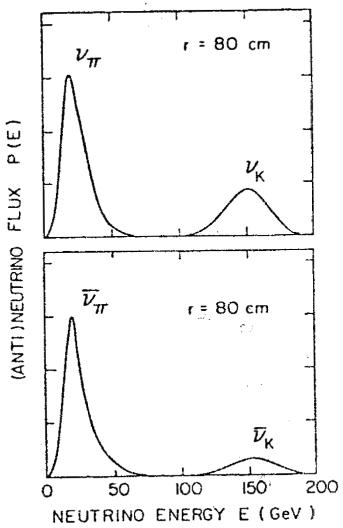
Il contributo maggiore alle incertezze viene dalla massa del c
Questo contributo praticamente scompare nel rapporto (Paschos-Wolfenstein)

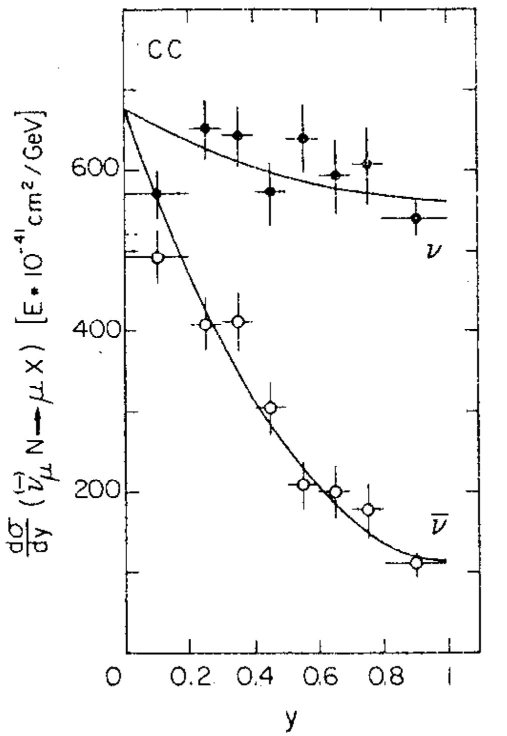
$$R^{-} = \frac{\sigma^{NC}_{\nu} - \sigma^{NC}_{\bar{\nu}}}{\sigma^{CC}_{\nu} - \sigma^{CC}_{\bar{\nu}}} = \frac{\sigma^{CC}_{\nu} g_L^2 + \sigma^{CC}_{\bar{\nu}} g_R^2 - \left(\sigma^{CC}_{\bar{\nu}} g_L^2 + \sigma^{CC}_{\nu} g_R^2\right)}{\sigma^{CC}_{\nu} - \sigma^{CC}_{\bar{\nu}}} = g_L^2 - g_R^2$$

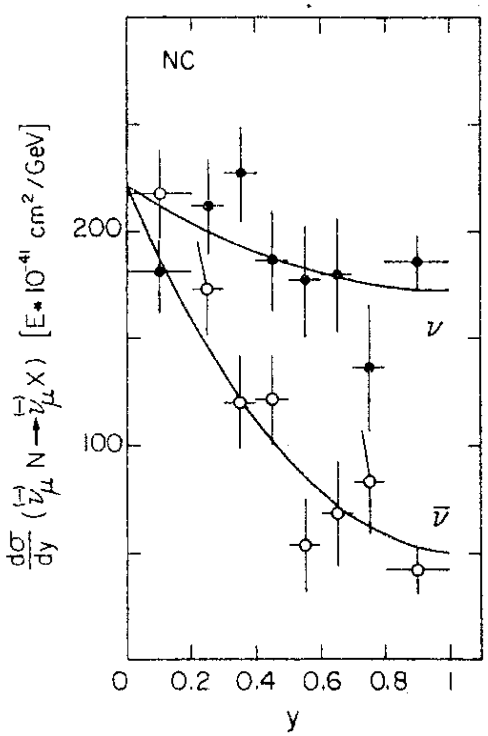
La massima sensibilità si può però avere misurando le distribuzioni in y

Risultati di CHARM

Fascio dicromatico (narrow band)
y determinata per le correnti cariche ma non per le correnti neutre
Unfolding con b-spline functions sia per CC che per NC







risultati di CHARM ('87)

dal fit alle distribuzioni differenziali in y

$$g_L^2 = 0.287 \pm 0.008$$

$$g_R^2 = 0.042 \pm 0.010$$

da $R_{\nu:}$ $\sin^2\theta_W = 0.2330 \pm 0.0111(m_c(\text{GeV})-1.46) \pm 0.0056$

NuTeV ('02)

da R^-

$$g_L^2 = 0.3000 \pm 0.0014$$

$$g_R^2 = 0.0308 \pm 0.0011$$

$$\sin^2 \vartheta_W = 0.2277 \pm 0.0016$$