$Formfactor\ splitting\ in\ \pi N\Delta\ interaction$

Abaev   Gridnev

ABAEV **GRIDNEV**

$$M_{\Delta}^{++}(uuu) = 1230.5 \pm 0.3 \qquad 1230.55 \pm 0.20 \ MeV$$

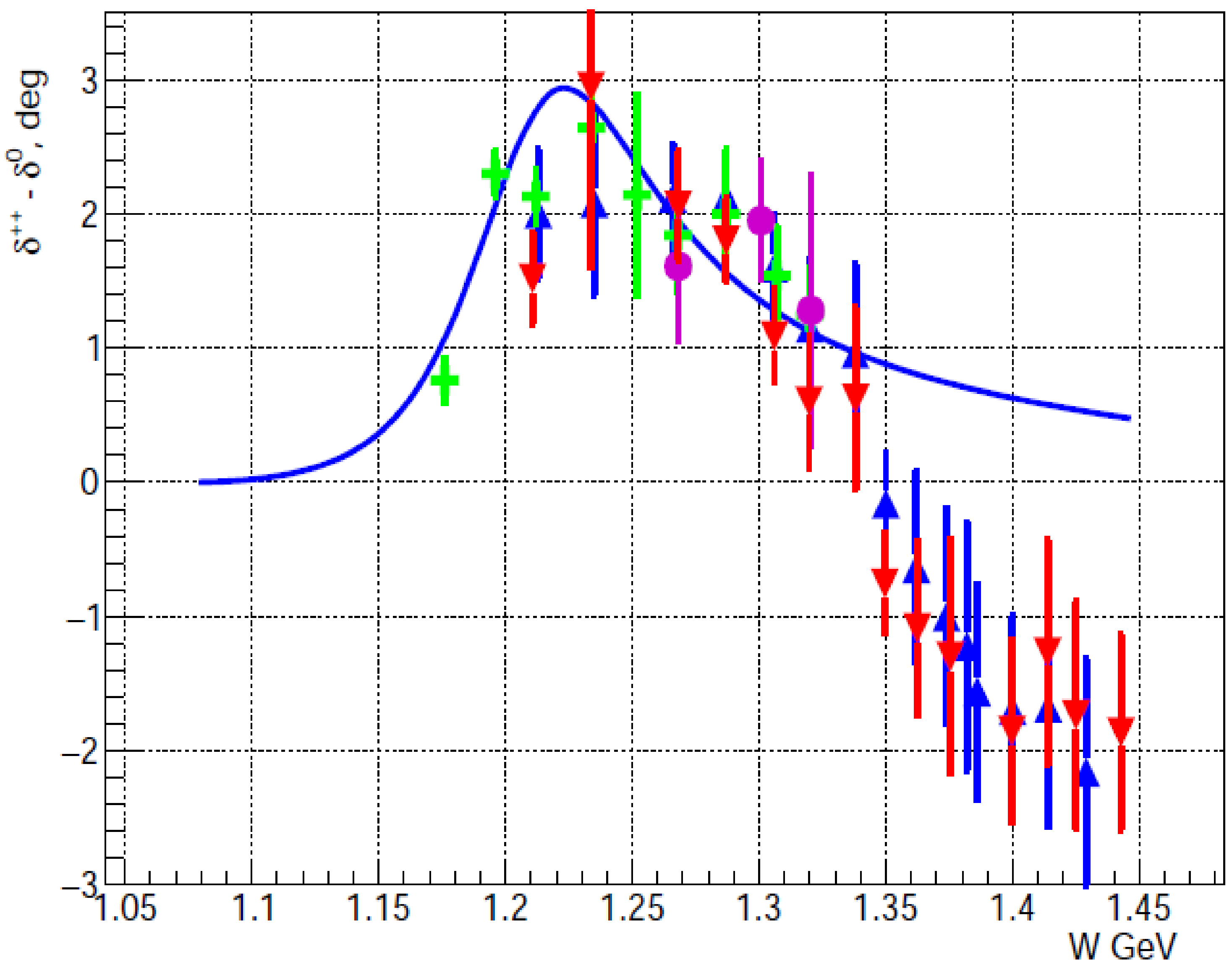
$$M_{\Delta}^{0}(udd) = \quad 1233.1 \pm 0.3 \qquad 1233.40 \pm 0.22 \ MeV$$

$$m_u = 2.2 \pm 0.5 \ MeV \qquad m_d = 4.7 \pm 0.5 \ MeV$$

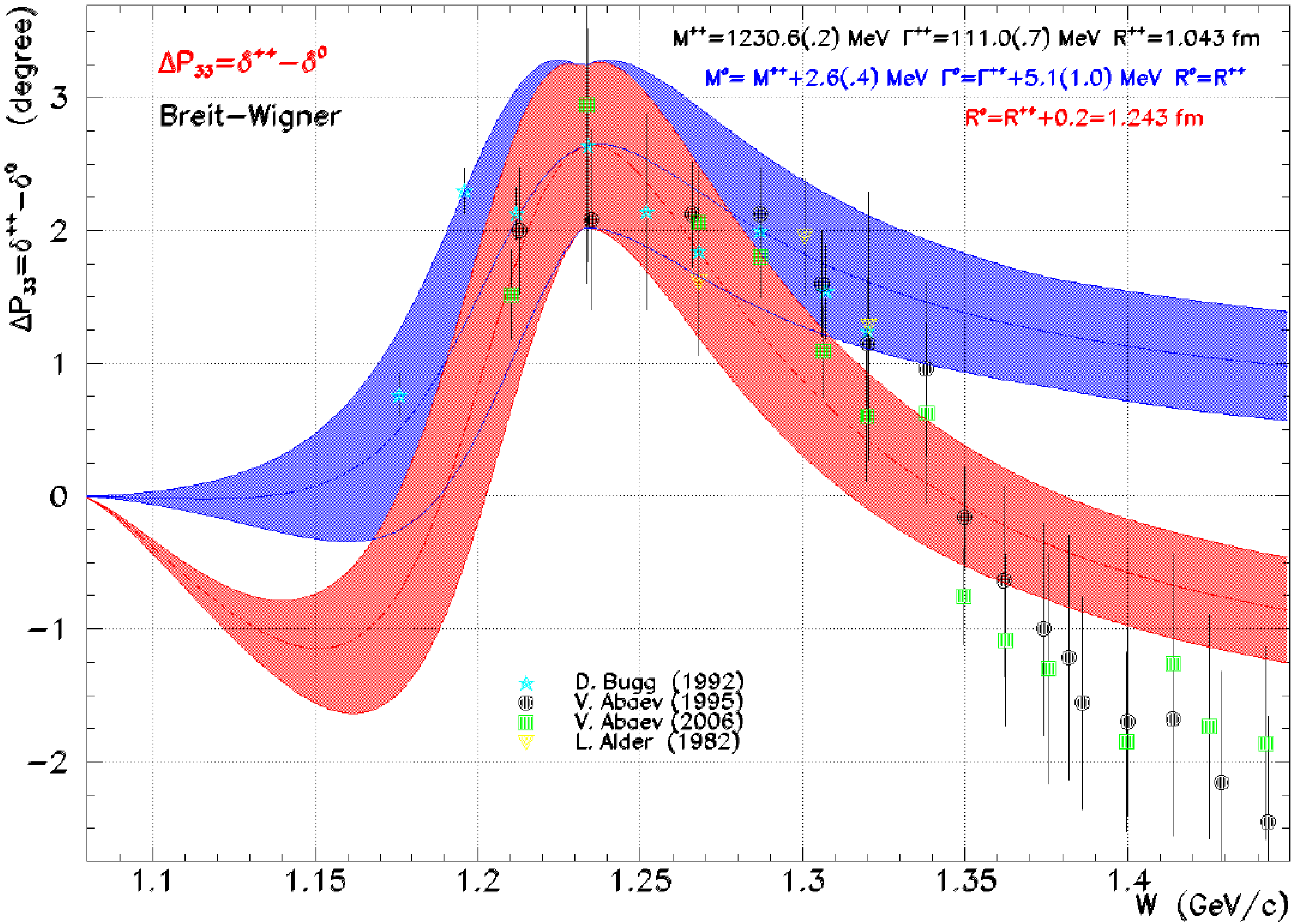
$$\Gamma_{\Delta}^{0} - \Gamma_{\Delta}^{++} = 5.1 \pm 1.0 \qquad 4.7 \pm 1.0 \ MeV$$

$$\Gamma_{\Delta}^{++} = 112.2 \pm 0.7 \ MeV \quad \Gamma_{\Delta}^{0} = 116.9 \pm 0.7 \ MeV$$

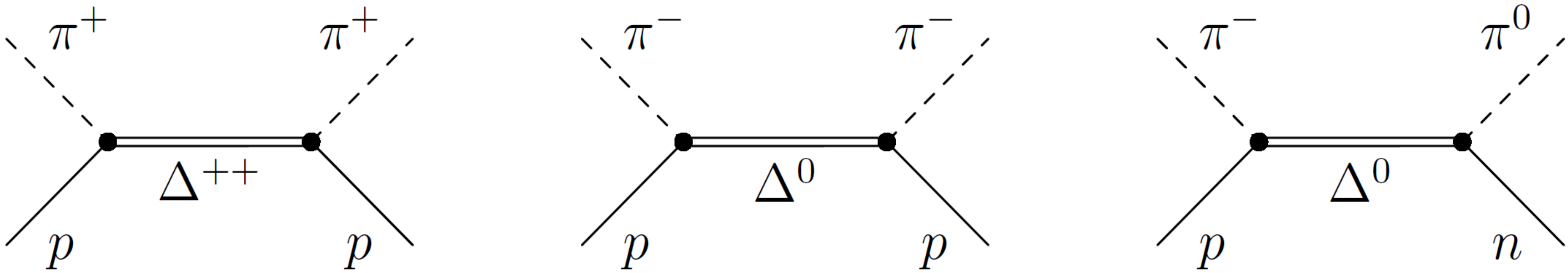
$$\frac{\Delta M}{M} = 0.2 \ \%$$



$\delta^{++} - \delta^{0}$, deg
3
2
1
0
−1
−2
−3
1.05
1.1
1.15
1.2
1.25
1.3
1.35
1.4
1.45
W GeV



ΔP33=δ++−δ0
Breit−Wigner
M++=1230.6(.2) MeV Γ++=111.0(.7) MeV R++=1.043 fm
M0= M+++2.6(.4) MeV Γ0=Γ+++5.1(1.0) MeV R0=R++
R0=R+++0.2=1.243 fm
ΔP33=δ++−δ0 (degree)
D. Bugg (1992)
V. Abaev (1995)
V. Abaev (2006)
L. Alder (1982)
W (GeV/c)
1.1
1.15
1.2
1.25
1.3
1.35
1.4
3
2
1
0
−1
−2



$$G_{\mu\nu} = \frac{\hat{P}+M}{P^2-M^2}\left(g_{\mu\nu} - \frac{2}{3}\frac{P_\mu P_\nu}{M^2}\right) + \frac{1}{3}\frac{P_\mu}{M}\gamma_\nu - \frac{1}{3}\frac{P_\nu}{M}\gamma_\mu - \frac{1}{3}\gamma_\mu\gamma_\nu)$$

$$\gamma_\mu G_{\mu\nu} = 0; \quad for \quad P^2 = M^2 \; only$$

$$L_{\pi n \Delta} = \frac{g_{\pi n \Delta}}{2m}\bar{\Delta}_\mu[g_{\mu\nu} - z\gamma_\mu\gamma_\nu]\vec{T}\partial_\nu\vec{\pi}\Psi$$

$$K = \frac{g^2 f(w)}{w - M} = \tan(\delta)$$

$$F = \frac{K}{1 - iK} = \frac{g^2 f(w)}{w - M - i g^2 f(w)}$$

$$g^2 f(w) = \frac{\Gamma}{2}$$

$$w \approx M$$

$$\frac{w - M_{++}}{g^2 f(w)} - \frac{w - M_0}{g^2 f(w)} = \frac{M_0 - M_{++}}{g^2 f(w)} = \cot(\delta^{++}) - \cot(\delta^0) \approx \delta^{++} - \delta^0$$

$$M_0 - M_{++} \approx 2.5 \ MeV \quad \Gamma \approx 100 \ MeV \quad \delta^{++} - \delta^0 \approx 3^\circ$$

$$\cot(\delta^0) - \cot(\delta^{++}) = \frac{M_0 - M_{++}}{g^2 f(w)} \neq 0$$

$$G_{\mu\nu} = \frac{\hat{P}+M}{P^2-M^2}\left(g_{\mu\nu} - \frac{2}{3}\frac{P_\mu P_\nu}{P^2}\right) + \frac{1}{3}\frac{P_\mu \hat{P}}{P^2}\gamma_\nu - \frac{1}{3}\frac{P_\nu \hat{P}}{P^2}\gamma_\mu - \frac{1}{3}\gamma_\mu\gamma_\nu)$$

$$\gamma_\mu G_{\mu\nu} = 0; \quad for \quad all \;\; P^2$$

$$\frac{\partial\sigma}{\partial\Omega} = \frac{\partial\sigma}{\partial\Omega}_{point} F(q^2)$$

$$F(q^2) = \int e^{\vec{q}\,\vec{r}} \rho(\vec{r}) d\vec{r}$$

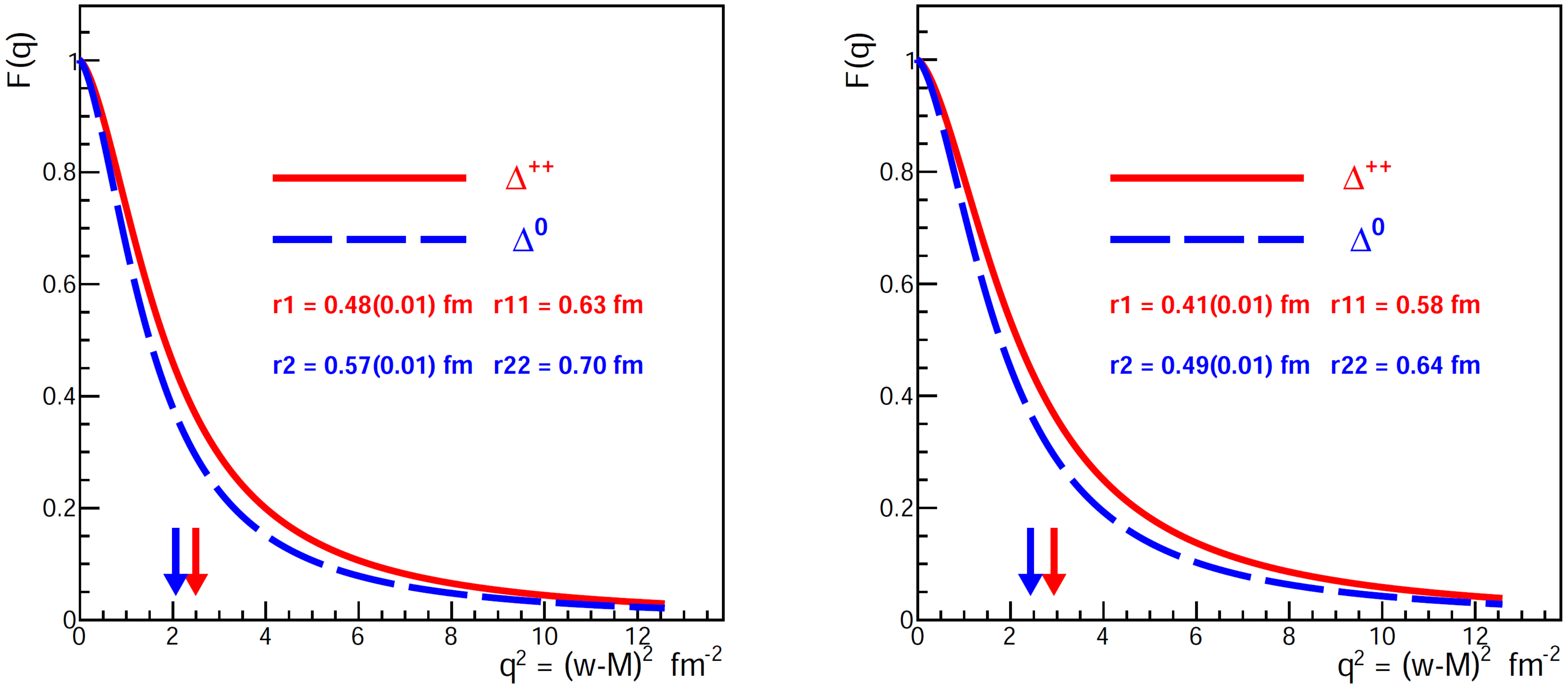
$$F(q^2) = 1 - \tfrac{1}{6} < r^2 > q^2 + \ldots$$

$$< r^2 > = -6 \frac{\partial F(q^2)}{\partial q^2} \Big|_{q^2=0}$$

$$F(P^2) = \frac{\Lambda^4}{\Lambda^4 + (P^2 - M_\Delta^2)^2}$$

$$\Lambda^4 = 8.15 \pm 0.16 \; for \; \Delta^{++}$$

$$\Lambda^4 = 5.77 \pm \; 0.12 \; for \; \Delta^0$$

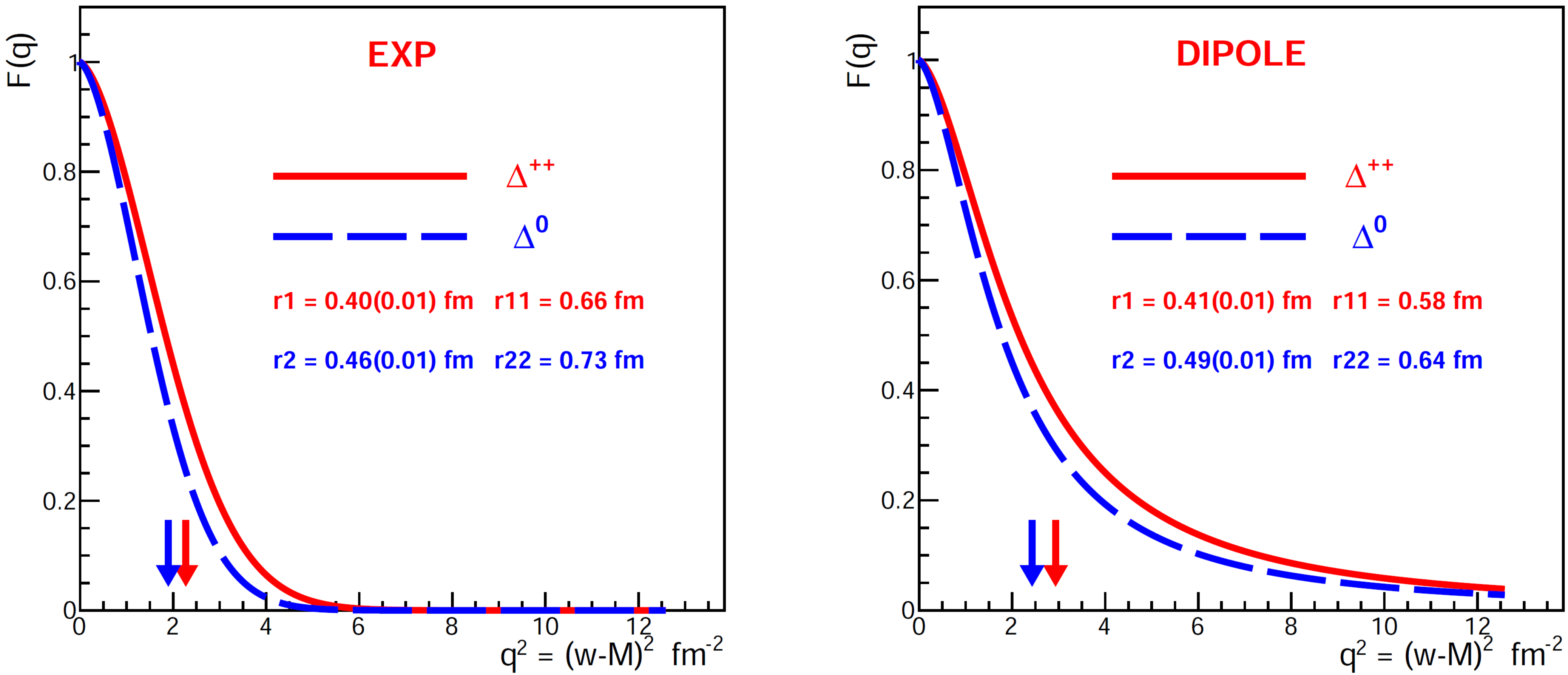


F(q)
1
0.8
0.6
0.4
0.2
0
0
2
4
6
8
10
12
q² = (w-M)² fm⁻²
Δ++
Δ0
r1 = 0.48(0.01) fm r11 = 0.63 fm
r2 = 0.57(0.01) fm r22 = 0.70 fm
F(q)
1
0.8
0.6
0.4
0.2
0
0
2
4
6
8
10
12
q² = (w-M)² fm⁻²
Δ++
Δ0
r1 = 0.41(0.01) fm r11 = 0.58 fm
r2 = 0.49(0.01) fm r22 = 0.64 fm

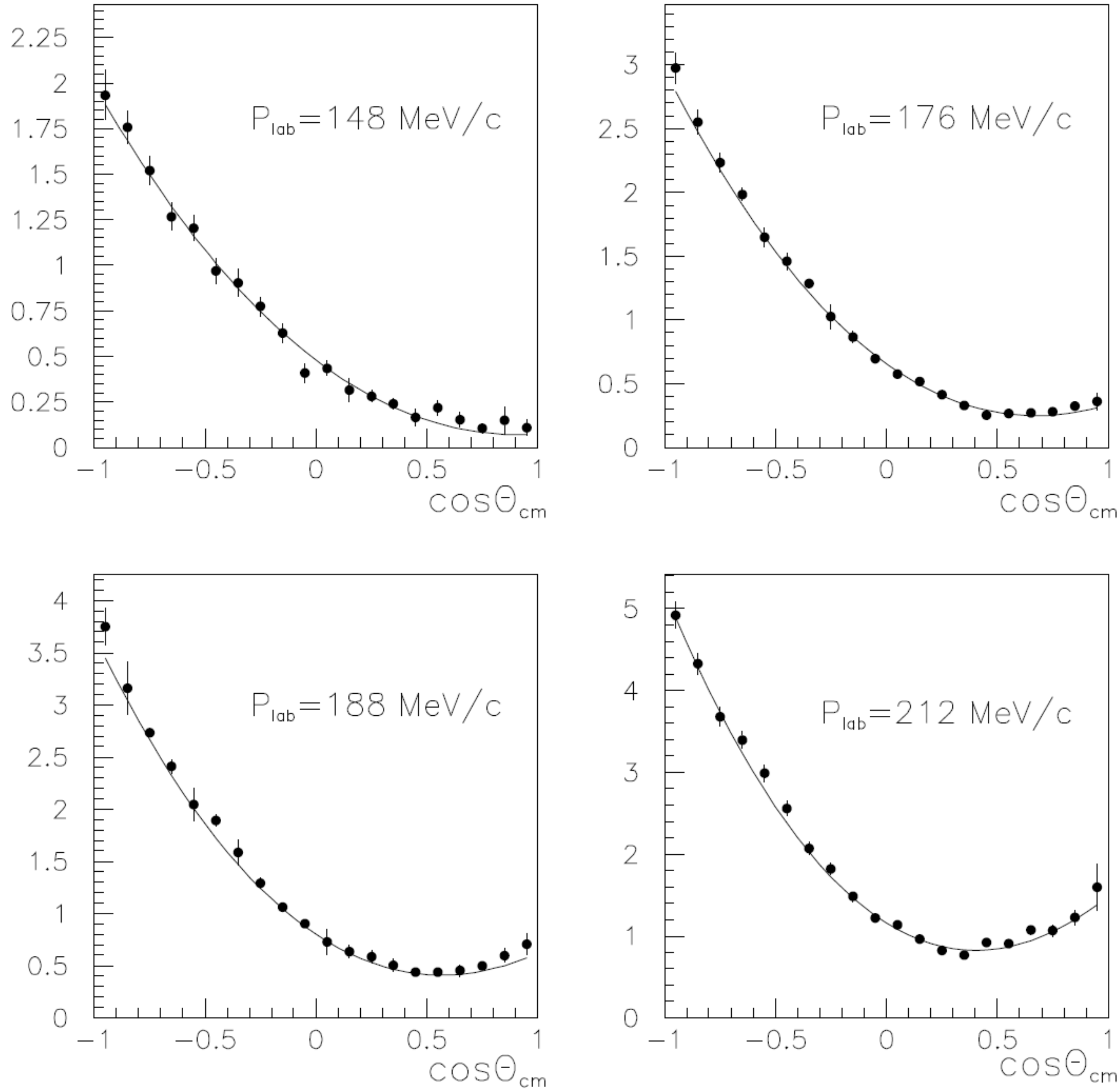
$$F(q^2) = EXP(-(\frac{q^2 - M_\Delta^2}{\Lambda}^2))$$

$$\Lambda = 3.00 \pm 0.06 \ for \ \Delta^{++}$$

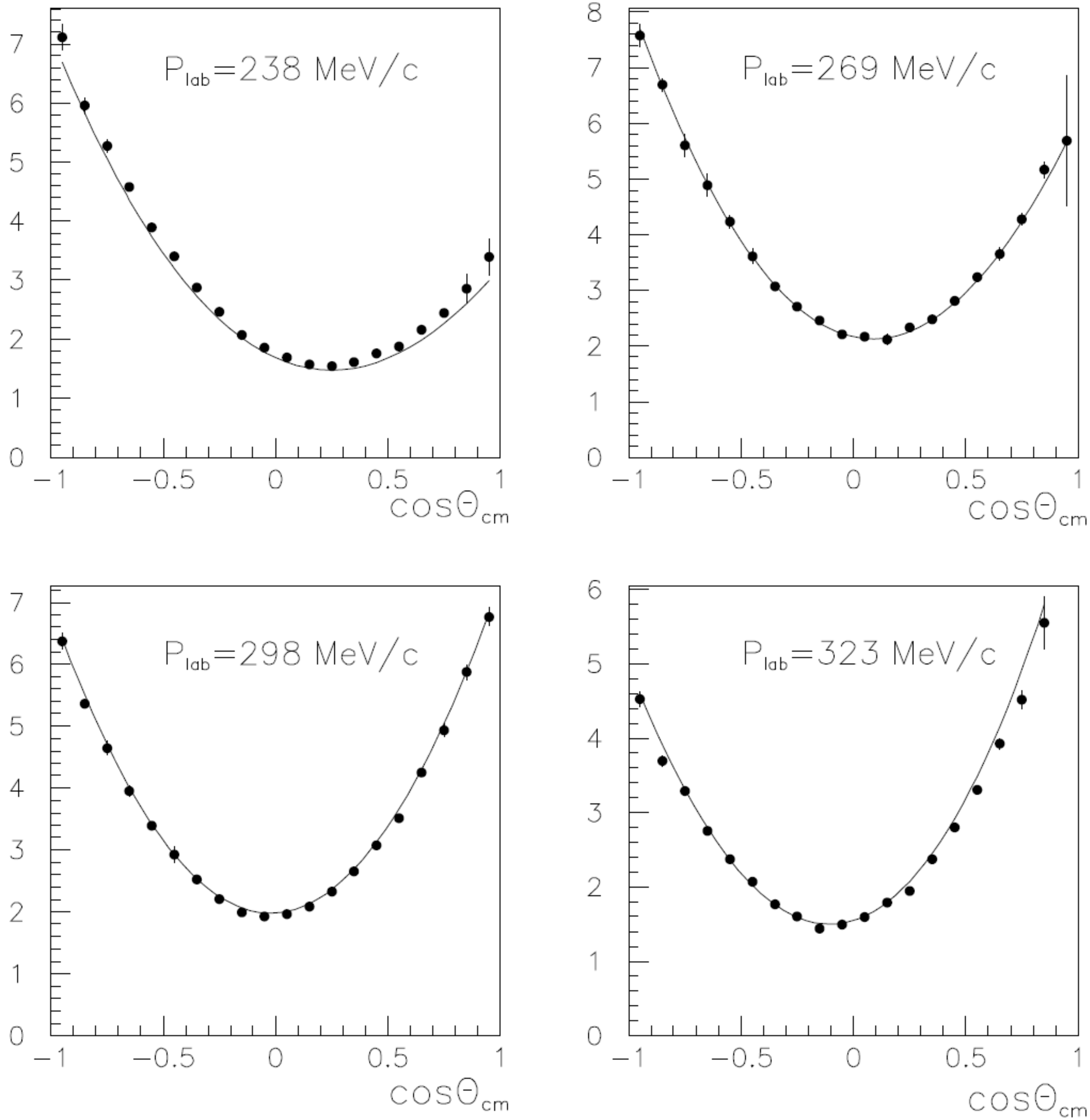
$$\Lambda = 2.55 \pm 0.06 \ for \ \Delta^0$$



EXP
F(q)
1
0.8
0.6
0.4
0.2
0
0
2
4
6
8
10
12
Δ++
Δ0
r1 = 0.40(0.01) fm r11 = 0.66 fm
r2 = 0.46(0.01) fm r22 = 0.73 fm
q2 = (w-M)2 fm-2
DIPOLE
F(q)
1
0.8
0.6
0.4
0.2
0
0
2
4
6
8
10
12
Δ++
Δ0
r1 = 0.41(0.01) fm r11 = 0.58 fm
r2 = 0.49(0.01) fm r22 = 0.64 fm
q2 = (w-M)2 fm-2



Plab=148 MeV/c
Plab=176 MeV/c
Plab=188 MeV/c
Plab=212 MeV/c
cosΘcm
cosΘcm
cosΘcm
cosΘcm



P$_{lab}$=238 MeV/c
P$_{lab}$=269 MeV/c
P$_{lab}$=298 MeV/c
P$_{lab}$=323 MeV/c
cosΘ$_{cm}$