Table 46.2: Total hadronic cross section. Analytic S-matrix and Regge theory suggest a variety of parameterizations of total cross sections at high energies with different areas of applicability and fits quality.

A ranking procedure, based on measures of different aspects of the quality of the fits to the current evaluated experimental database, allows one to single out the following parameterization of highest rank [1]

$$\sigma^{ab} = Z^{ab} + B^{ab}\log^2(s/s_M) + Y_1^{ab}(s_M/s)^{\eta_1} - Y_2^{ab}(s_M/s)^{\eta_2} \qquad \sigma^{\overline{a}b} = Z^{ab} + B^{ab}\log^2(s/s_M) + Y_1^{ab}(s_M/s)^{\eta_1} + Y_2^{ab}(s_M/s)^{\eta_2}\ ,$$

where Z^{ab}, $B^{a(p,n,\gamma*)} = \pi\frac{(\hbar c)^2}{M^2}$, $B^{ad} = \lambda\pi\frac{(\hbar c)^2}{M^2}$ (dimensionless factor λ introduced to test the universality for nuclei targets), Y_i^{ab} are in mb; s, $s_M = (m_a + m_b + M)^2$ are in GeV^2 ; m_a, m_b, $[m_{\gamma^*} = m_{\rho(770)}]$ are the masses of initial state particles, and M – the mass parameter defining the rate of universal rise of the cross sections are all in GeV. Parameters M, η_1 and η_2 are universal for all collisions considered. Terms $Z^{ab} + B^{ab}\log^2(s/s_M)$ represent the pomerons. The exponents η_1 and η_2 represent lower-lying C-even and C-odd exchanges, respectively. In addition to total cross sections σ, the measured ratios of the real-to-imaginary parts of the forward scattering amplitudes $\rho = Re(T)/Im(T)$ are included in the fits by using s to u crossing symmetry and differential dispersion relations.

Exact factorization hypothesis was used for both Z^{ab} and $B^{ab}\log^2(s/s_M)$ to extend the universal rise of the total hadronic cross sections to the $\gamma p \to hadrons$ and $\gamma\gamma \to hadrons$ collisions. This results in substitutions: $Z^{\gamma p} + \pi\frac{(\hbar c)^2}{M^2}\log^2(s/s_M) \Rightarrow \delta[Z^{pp} + \pi\frac{(\hbar c)^2}{M^2}\log^2(s/s_M)]$, and $Z^{\gamma\gamma} + \pi\frac{(\hbar c)^2}{M^2}\log^2(s/s_M) \Rightarrow \delta^2[Z^{pp} + \pi\frac{(\hbar c)^2}{M^2}\log^2(s/s_M)]$, with the additional parameter δ. Simultaneous fit was made to the 2011-updated data for all collisions listed in the central column of the table. The total number of adjusted parameters is **34**. Asymptotic parameters (Z, M, λ, δ, η_1, η_2) thus obtained were then fixed and used as inputs to fits by groups to check a stability of the whole situation with description of the high energy data. Results are shown in the right hand part of the table. All fits included data above $\sqrt{s_{\min}} = 5$ GeV with overall $\chi^2/\mathrm{dof} = 0.96$.

M=**2.15(2)**, η_1=**0.462(2)**, η_2=**0.550(5)**			Beam/	δ=**0.003056(15)**, λ=**1.630(35)**			χ^2/dof
Z	Y_1	Y_2	Target	Z	Y_1	Y_2	by groups
34.71(15)	12.72(19)	7.35(8)	$\overline{p}(p)/p$	34.71(15)	12.72(6)	7.35(7)	
35.00(18)	12.19(34)	6.62(16)	$\overline{p}(p)n$	35.00(16)	12.19(45)	6.6(2)	1.051
34.9(1.4)	−55(23)	−57(24)	Σ^-/p	34.9(1.4)	−55(6)	−57(8)	0.558
19.02(13)	9.22(16)	1.75(3)	$\pi^\pm/p$	19.02(13)	9.22(3)	1.75(3)	1.020
16.55(9)	4.02(14)	3.39(4)	$K^\pm/p$	16.55(9)	4.02(3)	3.39(3)	
16.49(10)	3.44(19)	1.82(7)	$K^\pm/n$	16.49(6)	3.44(16)	1.82(7)	0.737
	0.0128(12)		γ/p		0.00128(4)		
	$-0.034(0.183)\cdot10^{-4}$		γ/γ		$-0.034(166)\cdot10^{-4}$		0.722
65.02(38)	29.04(44)	14.9(2)	$\overline{p}(p)/d$	65.02(16)	29.04(39)	14.9(2)	1.524
37.06(30)	18.28(41)	0.34(9)	$\pi^\pm/d$	37.06(7)	18.28(19)	0.34(9)	0.747
32.34(22)	7.33(34)	5.59(9)	$K^\pm/d$	32.34(6)	7.33(16)	5.59(7)	0.819

The fitted functions are shown in the following figures, along with one-standard-deviation error bands. Whenever the reduced χ^2 is greater than one, a scale factor has been included to evaluate the parameter values and to draw the error bands. Where appropriate, statistical and systematic errors were combined quadratically in constructing weights for all fits. Only statistical error bars are shown on the plots. Vertical arrows indicate lower limits on the $p_{\rm lab}$ or $\sqrt{s}$ range used in the fits. Database used in the fits now includes pp data from TOTEM experiment [2] and new data in the RHIC energy range from ARGO-YBJ cosmic ray experiment [3]. The modifications of the universal asymptotic term are motivated by ideas, suggestions and results from the old and recent papers [4-14]. Computer-readable data files are available at `http://pdg.lbl.gov/current/xsect/`. (Courtesy of the COMPAS group, IHEP, Protvino, April 2012)

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