Table 40.2: Total hadronic cross section. Analytic $\boldsymbol{S}$-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 expremental database allows one to single out the following parameterization of highest rank [1].

$$\sigma^{ab} = Z^{ab} + B\log^2\left(\frac{s}{s_0}\right) + Y_1^{ab}\left(\frac{s_1}{s}\right)^{\eta_1} - Y_2^{ab}\left(\frac{s_1}{s}\right)^{\eta_2}, \quad \sigma^{\overline{a}b} = Z^{ab} + B\log^2\left(\frac{s}{s_0}\right) + Y_1^{ab}\left(\frac{s_1}{s}\right)^{\eta_1} + Y_2^{ab}\left(\frac{s_1}{s}\right)^{\eta_2}$$

where $\boldsymbol{Z^{ab}, B, Y_i^{ab}}$ are in mb, $\boldsymbol{s}$, $\boldsymbol{s_1}$, and $\boldsymbol{s_0}$ are in GeV$^{\boldsymbol{2}}$. The scales $\boldsymbol{s_0}$, $\boldsymbol{s_1}$, the rate of universal rise of the cross sections $\boldsymbol{B}$, and exponents $\boldsymbol{\eta_1}$, and $\boldsymbol{\eta_2}$ are independent of the colliding particles. The scale $\boldsymbol{s_1}$ is fixed at **1** GeV$^{\boldsymbol{2}}$. Terms $\boldsymbol{Z^{ab} + B\log^2(s/s_0)}$ represent the pomerons. The exponents $\boldsymbol{\eta_1}$, and $\boldsymbol{\eta_2}$ represent lower-lying C-even and C-odd exchanges, respectively. Requiring $\boldsymbol{\eta_1 = \eta_2}$ results in somewhat poorer fits. In addition to total cross sections $\boldsymbol{\sigma}$, the measured ratios of the real-to-imaginary parts of the forward scattering amplitudes $\boldsymbol{\rho = Re(T)/Im(T)}$ were included in the fits by using $\boldsymbol{s}$ to $\boldsymbol{u}$ crossing symmetry and differential dispersion relations. Global fits were made to the 2003-updated data for $\boldsymbol{{}^{(}\overline{p}{}^{)}p}$, $\boldsymbol{\Sigma^- p}$, $\boldsymbol{\pi^\pm p}$, $\boldsymbol{K^\pm p}$, $\boldsymbol{\gamma p}$, and $\boldsymbol{\gamma\gamma}$ collisions. Exact factorisation hypothesis was used for both $\boldsymbol{Z^{ab}}$ and $\boldsymbol{\log^2(s/s_0)}$ to extend the universal rise of the total hadronic cross sections to the $\boldsymbol{\gamma p \to hadrons}$ and $\boldsymbol{\gamma\gamma \to hadrons}$ collisions. This resulted in reducing the number of adjusted parameters from 21 used for 2002 edition to 19 and in the higher quality rank of the parameterization. The asymptotic parameters thus obtained were then fixed and used as inputs to a fit to a larger data sample that included cross sections on deuterons $\boldsymbol{(d)}$ and neutrons $\boldsymbol{(n)}$. All fits were produced to data above $\boldsymbol{\sqrt{s_{\min}} = 5}$ **GeV**.

Fits to $\overline{p}(p)\,p$, $\Sigma^- p$, $\pi^\pm p$, $K^\pm p$, γp, $\gamma\gamma$			Beam/	Fits to groups				$\frac{\chi^2}{dof}$ by
Z	Y_1	Y_2	Target	Z	Y_1	Y_2	B	groups
35.45(48)	42.53(1.35)	33.34(1.04)	$\overline{p}(p)/p$	35.45(48)	42.53(23)	33.34(33)	0.308(10)	
			$\overline{p}(p)/n$	35.80(16)	40.15(1.59)	30.00(96)	0.308(10)	1.029
35.20(1.46)	−199(102)	-264(126)	Σ^-/p	35.20(1.41)	−199(86)	-264(112)	0.308(10)	0.565
20.86(40)	19.24(1.22)	6.03(19)	$\pi^\pm/p$	20.86(3)	19.24(18)	6.03(9)	0.308(10)	0.955
17.91(36)	7.1(1.5)	13.45(40)	$K^\pm/p$	17.91(3)	7.14(25)	13.45(13)	0.308(10)	
			$K^\pm/n$	17.87(6)	5.17(50)	7.23(28)	0.308(10)	0.669
	0.0317(6)		γ/p		0.0320(40)		0.308(10)	
	-0.61(62)E-3		γ/γ		-0.58(61)E-3		0.308(10)	0.766
$\boxed{\chi^2/dof = 0.971}$	$B = 0.308(10)$ mb,		$\overline{p}(p)/d$	64.35(38)	130(3)	85.5(1.3)	0.537(31)	1.432
$\eta_1 = 0.458(17)$,	$\eta_2 = 0.545(7)$		$\pi^\pm/d$	38.62(21)	59.62(1.53)	1.60(41)	0.461(14)	0.735
$\delta = 0.00308(2)$,	$\sqrt{s_0} = 5.38(50)$ GeV		$K^\pm/d$	33.41(20)	23.66(1.45)	28.70(37)	0.449(14)	0.814

The fitted functions are shown in the following figures, along with one-standard-deviation error bands. When 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. On the plots only statistical error bars are shown. Vertical arrows indicate lower limits on the $p_{\rm lab}$ or $E_{\rm cm}$ range used in the fits.

One can find the details of the global fits (all data on proton target and $\gamma\gamma$ fitted simultaneously) and ranking procedure as well as the exact parameterizations of the total cross sections and corresponding ratios of the real to imaginary parts of the forward scattering amplitudes in the recent paper of COMPETE Collab[1]. Database used in the fits now includes the recent OPAL and L3 (LEP) $\gamma\gamma$ data, highest energy data for $\pi^- p$ and $\Sigma^- p$ from SELEX(FNAL) experiment,$\gamma\,p$ from ZEUS(DESY), cosmic ray $p\,p$ data from the Fly's Eye and AKENO(Agasa), and $\gamma\,p$ data from Baksan experiments. The numerical experimental data were extracted from the PPDS accessible at `http://wwwppds.ihep.su:8001/ppds.html` Computer-readable data files are also available at `http://pdg.lbl.gov`. (Courtesy of the COMPAS group, IHEP, Protvino, August 2003.) On-line "Predictor" to calculate σ and ρ for any energy from five high rank models is also available at http://nuclth02.phys.ulg.ac.be/compete/predictor.html/

References

[1] J. R. Cudell *et al.* (COMPETE Collab.) Phys. Rev. D **65**, 074024 (2002). [arXiv:hep-ph/0107219].

[2] G. Abbiendi *et al.* (OPAL Collab.), Eur. Phys. J. **C14**, 199 (2000). [hep-ex/9906039].

[3] M. Acciarri *et al.* (L3 Collab.), Phys. Lett. B **519**, 33 (2001). [arXiv:hep-ex/0102025].

[4] U. Dersch *et al.* (SELEX Collab.), Nucl. Phys. **B579**, 277 (2000). [hep-ex/9910052].

[5] S. Chekanov *et al.* (ZEUS Collab.), Nucl. Phys. B **627**, 3 (2002) [arXiv:hep-ex/0202034].

[6] R. M. Baltrusaitis *et al.* (Fly's Eye Collab.), Phys. Rev. Lett. **52**, 1380 (1984).

[7] M. Honda *et al.* (Akeno Collab.), Phys. Rev. Lett. **70**, 525 (1993).

[8] G. M. Vereshkov*et al.* (Baksan Collab.), Phys. Atom. Nucl. **66**, 565 (2003) [Yad. Fiz. **66**, 591 (2003)].