Table 49.2D: Total hadronic cross section. For data descriptions the HPR_1R_2 model of highest COMPETE–rank[1] is used. As in RPP-2012 it is modified to save the universality of the rising part in new form that explicitly includes dependence of the s_M and H on the initial state mass parameters and the new scale parameter M.

$$\sigma^{a\mp b} = H\log^2\left(s/s_M^{ab}\right) + P^{ab} + R_1^{ab}\left(s/s_M^{ab}\right)^{-\eta_1} \pm R_2^{ab}\left(s/s_M^{ab}\right)^{-\eta_2}$$

$$\rho^{a\mp b} = \frac{1}{\sigma^{a\mp b}}\left[\pi H\log\left(s/s_M^{ab}\right) - R_1^{ab}\left(s/s_M^{ab}\right)^{-\eta_1}\tan\left(\frac{\eta_1\pi}{2}\right) \pm R_2^{ab}\left(s/s_M^{ab}\right)^{-\eta_2}\cot\left(\frac{\eta_2\pi}{2}\right)\right]$$

where upper signs in formulas are for particles and lower signs for antiparticles. Adjustable parameters are as follows:

$H = \pi\frac{(\hbar c)^2}{M^2}$ in mb, where notation H[2] is after Heisenberg(1952,1975);

P^{ab} in mb, are Pomeranchuk's(1958) constant terms;

R_i^{ab} in mb are the intensities of the effective secondary Regge pole contributions named after Regge-Gribov(1961);

s, $s_M^{ab} = (m_a + m_b + M)^2$ 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. In addition to total cross sections σ, the measured ratios of the real-to-imaginary parts of the forward scattering amplitudes $\rho = \mathrm{Re}(T)/\mathrm{Im}(T)$ are included in the fits by using s to u crossing symmetry and differential dispersion relations.

Exact factorization hypothesis was used for both $H\log^2(s/s_M^{ab})$ and P^{ab} to extend the universal rise of the total hadronic cross sections to the $\gamma\ (p,d) \to hadrons$ and $\gamma\gamma \to hadrons$ collisions. This results in one additional adjustable parameter δ with substitutions:

$$\pi H\log^2\left(s/s_M^{\gamma(p,d)}\right) + P^{\gamma(p,d)} \Rightarrow \delta\left[\pi(1,\lambda)H\log^2\left(s/s_M^{\gamma(p,d)}\right) + P^{p(p,d)}\right],$$

$$\pi H\log^2\left(s/s_M^{\gamma\gamma}\right) + P^{\gamma\gamma} \Rightarrow \delta^2\left[\pi H\log^2\left(s/s_M^{\gamma\gamma}\right) + P^{pp}\right].$$

Three fits were made to the 2013-updated data above $\sqrt{s_{min}} = 5,\ 6,\ 7$ GeV for all collisions, listed in the "Beam/Target" column of the table . Fit results are shown only for fit above 7 GeV with the best fit quality $FQ = \chi^2/NDF$ and uniformity of data descriptions by groups (last column). The total number of adjusted parameters is **35**.

HPR_1R_2 at $\sqrt{s} \geq 7$ GeV	$M = 2076 \pm 0.016$ [GeV]; $\eta_1 = 0.412 \pm 0.017$; $\delta = (3.112 \pm 0.027) \times 10^{-3}$		$H = 0.2838 \pm 0.0045$ [mb]; $\eta_2 = 0.5626 \pm 0.0092$; $\lambda = 1.456 \pm 0.058$		$FQ_{Int} = 0.86$; $FQ_{Ext} = 0.87$
P **[mb]**	R_1 **[mb]**	R_2 **[mb]**	**Beam/Target**	**Npt=836 npt**	χ^2**/npt by groups**
33.73±0.33	**13.67±0.33**	**7.77±0.18**	$(\bar{p})p\ /\ p$	**219**	**1.09**
33.77±0.38	**14.05±0.63**	**6.93±0.29**	$(\bar{p})p\ /\ n$	**48**	**0.39**
33.20±3.90	**-14.±47.**	**-15.±52.**	$\Sigma^-\ /\ n$	**8**	**0.41**
18.08±0.29	**10.44±0.32**	**1.977±0.078**	$\pi^\mp\ /\ p$	**137**	**0.91**
15.84±0.20	**5.12±0.28**	**3.538±0.095**	$K^\mp\ /\ p$	**85**	**0.76**
15.73±0.22	**4.81±0.40**	**1.86±0.13**	$K^\mp\ /\ n$	**48**	**0.56**
	0.0132±0.0023		$\gamma\ /\ p$	**34**	**0.56**
	(-6.0±3.3)×10^{-5}		$\gamma\ /\ \gamma$	**31**	**0.68**
	0.0256±0.0044		$\gamma\ /\ d$	**3**	**0.31**
64.79±0.75	**27.06±0.85**	**15.46±0.37**	$(\bar{p})p\ /\ d$	**75**	**0.97**
36.66±0.62	**17.89±0.82**	**0.38±0.14**	$\pi^\mp\ /\ d$	**81**	**0.71**
32.28±0.46	**7.02±0.71**	**5.74±0.16**	$K^\mp\ /\ d$	**67**	**0.67**

All fits are stable: in all cases the $FQ < 1.0$, Hessian matrices are positive definite. Quoted parameter uncertainties are obtained by direct MC-propagation of the uncertainties in each input experimental data point assuming independent normal distributions. Computer-readable data files are available at http://pdg.lbl.gov/current/xsect/. (Courtesy of the COMPAS group, IHEP, Protvino, September 2013)

[1] Physical motivations for the model and related references see in mini-review. All plots give details for Figures 49.8 and 49.9 of the mini-review.

[2] For collisions with deuteron target $H_d = \lambda H$ where dimensionless parameter λ is introduced to test the universality of the Heisenberg rise for particle–nuclear and nuclear–nuclear collisions