Block - Kang

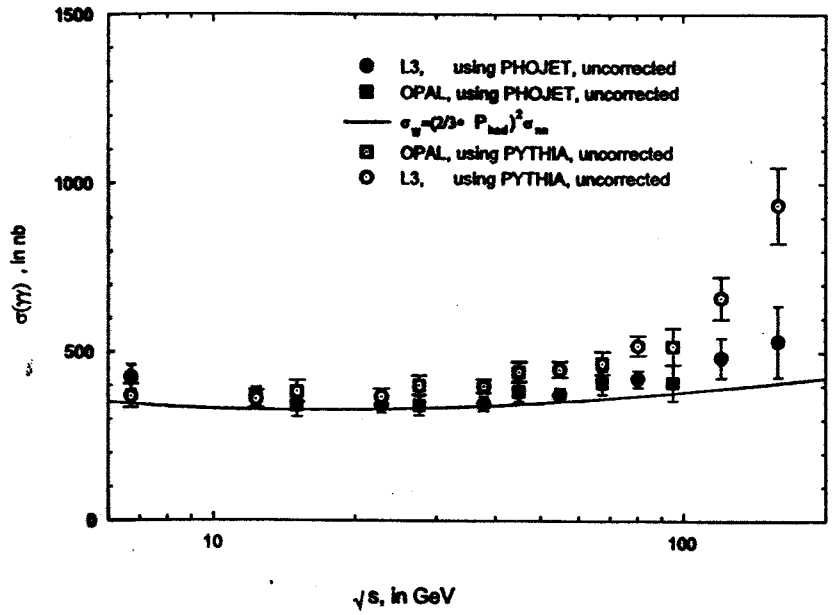
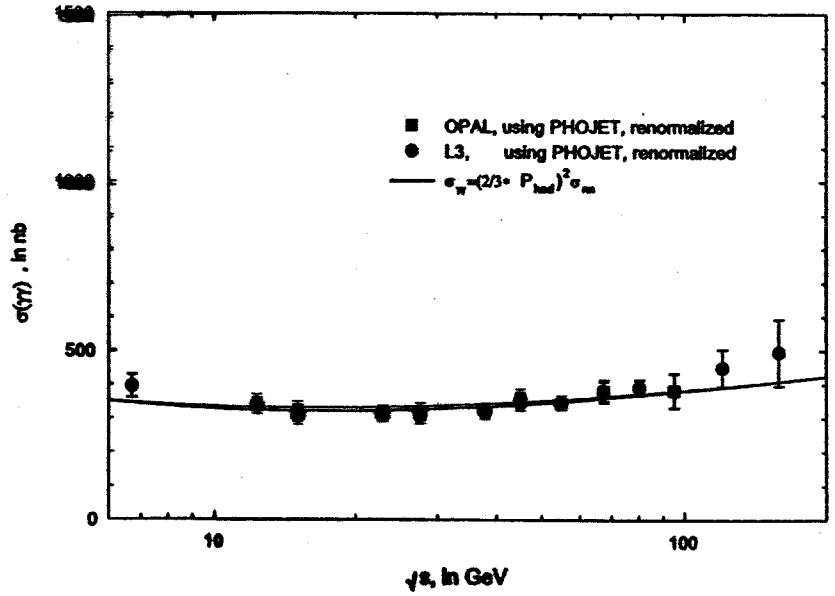


Figure 5: The curve is $\sigma_{\gamma\gamma} = (\frac{2}{3}P^{\gamma}_{had})^2\sigma_{nn}$, the predicted total cross section for $\gamma\gamma$ reactions, in nb, *vs.* $\sqrt{s}$, the cms energy, in GeV. The open squares and circles are the experimental total cross sections for OPAL and L3, respectively, unfolded using PYTHIA. The solid squares and circles are the experimental total cross sections for OPAL and L3, respectively, unfolded using PHOJET.



$\alpha_p = \alpha_{\bar{p}} = 0.5$

$\delta = 0.003985$

(Phojet OPAL, L3)

$B = 0.304$

Figure 6: The curve is $\sigma_{\gamma\gamma} = (\frac{2}{3}P^{\gamma}_{had})^2\sigma_{nn}$, the predicted total cross section for $\gamma\gamma$ reactions, in nb, *vs.* $\sqrt{s}$, the cms energy, in GeV. The squares and circles are the total cross sections for OPAL and L3, respectively, unfolded using PHOJET, *after* they have been renormalized by the factors $N_{\rm OPAL} = 0.929$ and $N_{\rm L3} = 0.929$ found in Fit 2 of Table 1.

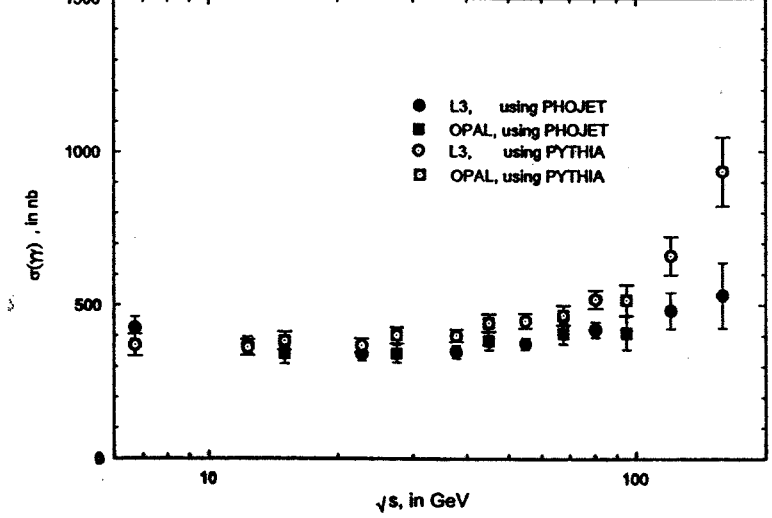


Figure 1: OPAL and L3 total cross sections for $\gamma\gamma$ scattering, in nb *vs.* $\sqrt{s}$, the cms energy, in GeV. The data have been unfolded according to the Monte Carlo used. The solid circles are the L3 data, unfolded using PHOJET and the open circles are the L3 data, unfolded using PYTHIA. The solid squares are the OPAL data, unfolded using PHOJET and the open squares are the OPAL data unfolded using PYTHIA.

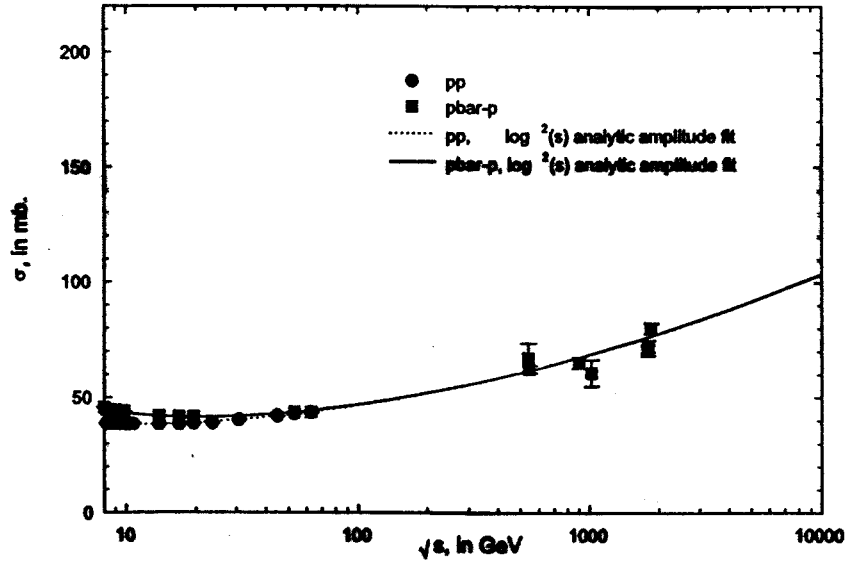


Figure 2: The dotted curve is σ_{pp}, the predicted total cross section for pp reactions, in mb, and the solid curve is $\sigma_{\bar{p}p}$, the predicted cross section for $\bar{p}p$ reactions, in mb *vs.* $\sqrt{s}$, the cms energy, in GeV. The circles are the experimental data for pp reactions and the squares are the experimental $\bar{p}p$ data.

Table 6. Cosmic rays data tests.

Highly Ranked Model Code	Experiment		Nikolaev et al. [7], [8]		Block et al. [10]	
	χ^2	χ^2/N_{dp}	χ^2	χ^2/N_{dp}	χ^2	χ^2/N_{dp}
$RRPL2_u(19)$	1.63	**0.23**	14.28	2.04	3.31	**0.47**
$RRPL2_u(21)$	1.62	**0.23**	14.31	2.04	3.30	**0.47**
*** $RRL_{nf}(19)$**	2.52	**0.36**	24.25	3.46	2.19	**0.31**
$(RR_c)^dPL2_u(15)$	1.43	**0.20**	15.39	2.20	2.98	**0.43**
$(RR)^dPL2_u(19)$	1.73	**0.25**	13.96	1.99	3.45	**0.49**
$RRL_{nf}(19)$	2.52	**0.36**	24.25	3.46	2.19	**0.31**
$R^{qc}R_cL^{qc}(12)$	2.43	**0.35**	23.98	3.43	2.16	**0.31**
$RRPL(21)$	2.93	**0.42**	25.48	3.64	2.34	**0.33**
$RR_cL2^{qc}(15)$	1.44	**0.21**	20.21	1.99	2.89	**0.30**
$RRL^{qc}(17)$	2.54	**0.36**	24.66	1.99	3.52	**0.31**

The Tevatron data

χ^2/dof using the database of the 2002 Review of Particle Physics +new ZEUS data + best model RRPL2$_u$.

Data with a change in χ^2	all	E710/E811 only	CDF only
total	0.966	0.964	0.951
total cross sections			
$\overline{p}p$	1.15	1.12	1.05
K^-p	0.62	0.62	0.61
$\gamma\gamma$	0.64	0.64	0.63
elastic forward Re/Im			
$\overline{p}p$	0.52	0.52	0.53
pp	1.83	1.83	1.80
π^-p	1.10	1.09	1.14
π^+p	1.50	1.52	1.46
K^-p	0.99	1.01	0.96
K^+p	1.07	1.10	0.98
values of the parameter B			
	0.307(10)	0.301(10)	0.327(10)

$\Rightarrow$ Preference for the CDF data. *Similar conclusion in the case of simple poles.*

Adjustable parameters naming. In total 20 parameters used:

(RR)^d PL2(20)

η, δ – dimensionless

s_0 – [GeV^2]

$Z_{pp}, Z_{\pi p}, Z_{Kp}, Z_{\Sigma p}, B_{pp}, B_{\pi p}, B_{Kp}, B_{\Sigma p}$ – [mb]

$Y^{pp}_{1,2}, Y^{\pi p}_{1,2}, Y^{Kp}_{1,2}, Y^{\Sigma p}_{1}, Y^{\gamma p}_{1}, Y^{\gamma\gamma}_{1}$ – [mb]

Scan-fits summary. 2000 database. Without cosmic data points.

$E^{\min}_{cm}$ [GeV]	3	4	5	6	7	8	9	10
N_{dof}: ρ excluded	706	561	487	414	349	311	265	210
N_{dof}: ρ included	884	722	628	549	478	433	377	309
χ^2/dof: ρ excluded	1.24	0.99	0.82	0.79	0.83	0.84	0.83	0.73
χ^2/dof: ρ included	1.92	1.23	1.00$^-$	1.00$^-$	0.99	0.94	0.93	0.92

Details of the fit to the data in the whole domain of applicability

	$\sqrt{s}$ of the starting point in [GeV]	Number of data points
Breakdown of the CS data sample		
pp:	5.00963	112
$\bar{p}p$:	5.1569	59
π^+p:	5.21275	50
π^-p:	5.02954	106
K^+p:	5.12707	40
K^-p:	5.10875	63
Σ^-p:	6.12189	9
γp:	5.01008	38
$\gamma\gamma$:	5.	30
Breakdown of the ρ data sample		
pp:	5.30542	74
$\bar{p}p$:	11.5382	11
π^+p:	8.98072	8
π^-p:	7.56285	30
K^+p:	5.21771	10
K^-p:	5.23565	8

χ^2/dof	=	0.9986
CL[%]	=	50.41
Name of value	Numerical value	Error value
s_0	55.768319	8.6418541
η	0.53323572	0.0086874031
Z_{pp}	37.276058	0.25450475
$Z_{\pi p}$	22.251442	0.22217687
Z_{Kp}	19.065862	0.21545386
$Z_{\Sigma p}$	31.78409	1.0756619
δ	0.003026178	0.000017802925
B_{pp}	0.33436876	0.012366471
$B_{\pi p}$	0.34645775	0.019965662
B_{Kp}	0.3523685	0.025765461
$B_{\Sigma p}$	0.55517805	0.1256545
Y_{pp1}	42.915501	2.0356375
Y_{pp2}	31.143403	1.2267345
$Y_{\pi p1}$	15.167946	1.685057
$Y_{\pi p2}$	5.5664443	0.2126837
Y_{Kp1}	1.0243323	1.8182457
Y_{Kp2}	12.744863	0.4981438
$Y_{\Sigma p1}$	12.399963	13.885885
$Y_{\gamma p1}$	0.014918353	0.0092437957
$Y_{\gamma\gamma 1}$	-0.00019815563	0.00012764446

Model quality indicators:

	A^M	C^M_1	C^M_2	U^M	R^M_1	R^M_2	S^M_1	S^M_2
RR^{d}PL2(20)	2.185	50.41	81.74	18.21	30.86	1.334E-4	0.265	0.407

Repository:

computer - **NPT**

`directory - d:\MathemD\Kolja\Evela\Gauron\(RR)dPL2(20)`

Adjustable parameters naming. In total 19 parameters used:

$(RR)^d PL2_u(19)$

$$\eta, \delta \; - \; \text{dimensionless}$$
$$Z_{pp}, Z_{\pi p}, Z_{Kp}, Z_{\Sigma p}, Z_{\gamma p}, Z_{\gamma\gamma}, B \; - \; \text{[mb]}$$
$$s_0 \; - \; \text{[GeV}^2\text{]}$$
$$Y_{1,2}^{pp}, Y_{1,2}^{\pi p}, Y_{1,2}^{Kp}, Y_1^{\Sigma p}, Y_1^{\gamma p}, Y_1^{\gamma\gamma} \; - \; \text{[mb]}$$

Scan-fits summary. 2000 database. Without cosmic data points.

E_{cm}^{min} [GeV]	3	4	5	6	7	8	9	10
N_{dof}: ρ excluded	707	562	488	415	350	312	266	211
N_{dof}: ρ included	885	723	629	560	479	434	378	310
χ^2/dof: ρ excluded	1.27	0.99	0.82	0.80	0.83	0.83	0.82	0.75
χ^2/dof: ρ included	1.96	1.26	0.99	0.99	0.98	0.93	0.93	0.93

Details of the fit to the data in the whole domain of applicability

	$\sqrt{s}$ of the starting point in [GeV]	Number of data points
Breakdown of the CS data sample		
pp:	5.00963	112
$\bar{p}p$:	5.1569	59
π^+p:	5.21275	50
π^-p:	5.02954	106
K^+p:	5.12707	40
K^-p:	5.10875	63
Σ^-p:	6.12189	9
γp:	5.01008	38
$\gamma\gamma$:	5.	30
Breakdown of the ρ data sample		
pp:	5.30542	74
$\bar{p}p$:	11.5382	11
π^+p:	8.98072	8
π^-p:	7.56285	30
K^+p:	5.21771	10
K^-p:	5.23565	8

χ^2/dof	=	0.995
CL[%]	=	53.15
Name of value	Numerical value	Error value
s_0	49.050427	4.6172475
η	0.53076334	0.0059203784
Z_{pp}	37.046665	0.14820915
$Z_{\pi p}$	22.094486	0.14102222
Z_{Kp}	18.941502	0.13998954
$Z_{\Sigma p}$	33.0569	0.43528134
$Z_{\gamma p}$	29.28947	2.8563214
$Z_{\gamma\gamma}$	19.937208	4.5590042
δ	0.0038096263	0.00035563171
B	0.32765691	0.0081457393
Y_{pp1}	44.317753	1.2312145
Y_{pp2}	30.819292	0.8311592
$Y_{\pi p1}$	16.299311	0.99512835
$Y_{\pi p2}$	5.514108	0.14527497
Y_{Kp1}	2.0106621	1.1025517
Y_{Kp2}	12.600861	0.33474977
$Y_{\Sigma p1}$	-3.4486615	6.6047133
$Y_{\gamma p1}$	0.024180593	0.007669911
$Y_{\gamma\gamma 1}$	0.00028571116	0.0001666682

Model quality indicators:

	A^M	C_1^M	C_2^M	U^M	R_1^M	R_2^M	S_1^M	S_2^M
$(RR)^dPL2_u(19)$	2.188	53.15	83.81	16.49	32.40	1.284E-5	0.286	0.690

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RRP$_{nf}$L2$_u$(21)

$Z_{pp}, Z_{\pi p}, Z_{Kp}, Z_{\Sigma p}, Z_{\gamma p}, Z_{\gamma\gamma}, B$ – [mb]

s_0 – [GeV^2]

$Y^{pp}_{1,2}, Y^{\pi p}_{1,2}, Y^{Kp}_{1,2}, Y^{\Sigma p}_{1,2}, Y^{\gamma p}_{1}, Y^{\gamma\gamma}_{1}$ – [mb]

Scan-fits summary. 2000 database. Without cosmic data points.

$E^{\min}_{cm}$ [GeV]	3	4	5	6	7	8	9	10
N_{dof}: ρ excluded	705	560	486	413	348	310	264	209
N_{dof}: ρ included	883	721	627	548	477	432	376	308
χ^2/dof: ρ excluded	1.26	0.97	0.81	0.79	0.82	0.83	0.82	0.75
χ^2/dof: ρ included	1.75	1.14	0.97	0.97	0.97	0.92	0.93	0.92

Details of the fit to the data in the whole domain of applicability

	$\sqrt{s}$ of the starting point in [GeV]	Number of data points
Breakdown of the CS data sample		
pp:	5.00963	112
$\bar{p}p$:	5.1569	59
π^+p:	5.21275	50
π^-p:	5.02954	106
K^+p:	5.12707	40
K^-p:	5.10875	63
Σ^-p:	6.12189	9
γp:	5.01008	38
$\gamma\gamma$:	5.	30
Breakdown of the ρ data sample		
pp:	5.30542	74
$\bar{p}p$:	11.5382	11
π^+p:	8.98072	8
π^-p:	7.56285	30
K^+p:	5.21771	10
K^-p:	5.23565	8

χ^2/dof	=	**0.973**
CL[%]	=	67.98
Name of value	Numerical value	Error value
s_0	34.035155	5.4366248
η_1	0.46727788	0.01520891
η_2	0.53981477	0.0064282823
Z_{pp}	35.833645	0.3977075
$Z_{\pi p}$	21.232133	0.32718381
Z_{Kp}	18.229063	0.29864369
$Z_{\Sigma p}$	35.573148	1.4312161
$Z_{\gamma p}$	29.408195	3.0017355
$Z_{\gamma\gamma}$	20.355095	4.953631
δ	0.0037064765	0.00035319514
B	0.31521331	0.0094831914
Y_{pp1}	42.105024	1.2691665
Y_{pp2}	32.193706	0.94360681
$Y_{\pi p1}$	17.775823	1.1211188
$Y_{\pi p2}$	5.7195415	0.1608047
Y_{Kp1}	5.7197982	1.4045873
Y_{Kp2}	13.133618	0.3766743
$Y_{\Sigma p1}$	-254.7914	128.23174
$Y_{\Sigma p2}$	-319.55667	151.59602
$Y_{\gamma p1}$	0.033850924	0.0079395328
$Y_{\gamma\gamma 1}$	0.00027798502	0.00014534096

Model quality indicators:

	A^M	C^M_1	C^M_2	U^M	R^M_1	R^M_2	S^M_1	S^M_2
RRPL2u(21)	2.207	67.98	84.74	22.88	29.45	6.908E-6	0.224	0.101

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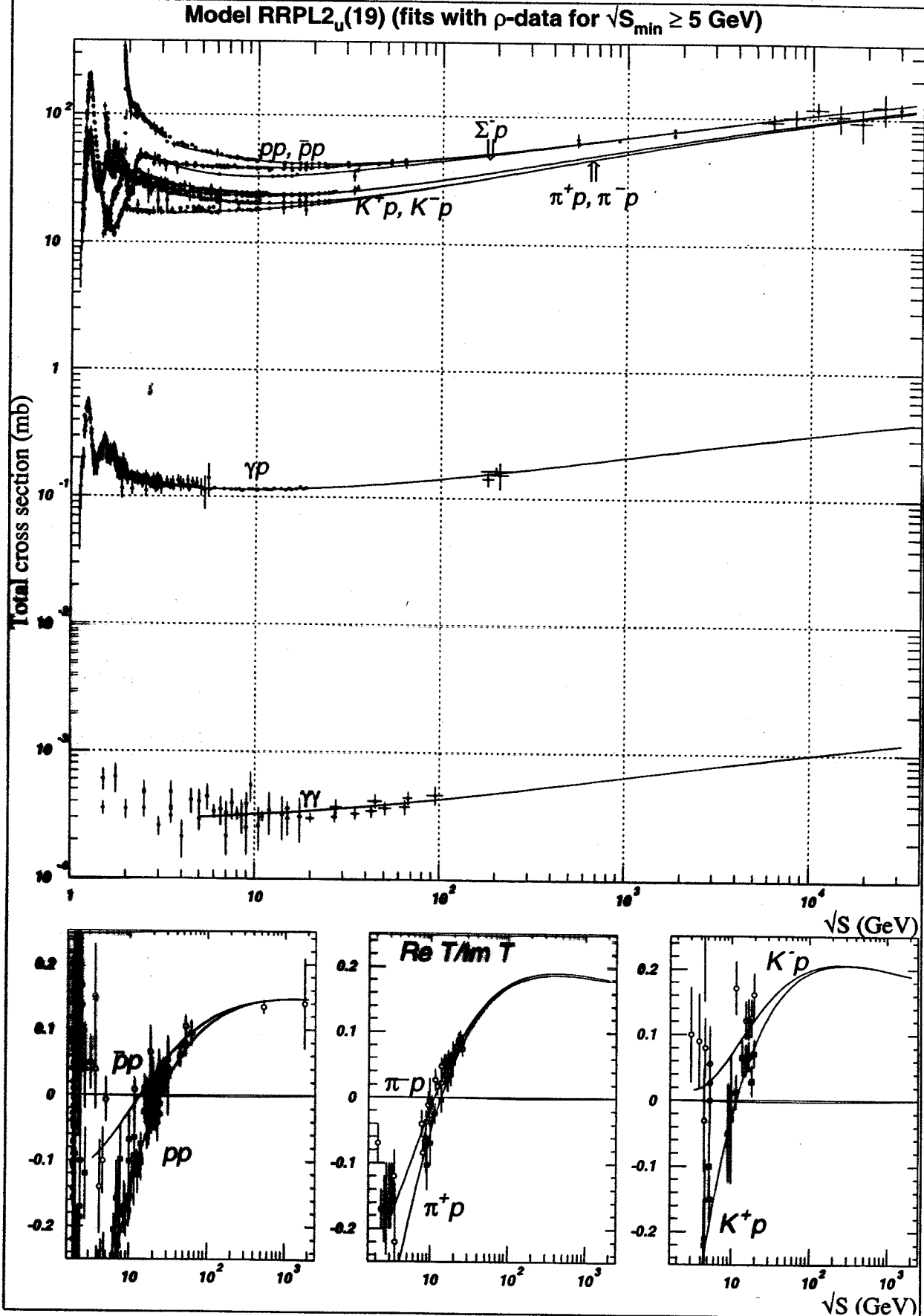
Model RRPL2u(19) (fits with ρ-data for √Smin ≥ 5 GeV)
Total cross section (mb)
pp, p̄p
Σ⁻p
K⁺p, K⁻p
π⁺p, π⁻p
γp
γγ
√S (GeV)
Re T/Im T
p̄p
pp
π⁻p
π⁺p
K⁻p
K⁺p
√S (GeV)

RRPL2u(19)

Adjustable parameters naming. In total 19 parameters used:

$$\eta_1, \eta_2, \delta \quad - \quad \text{dimensionless}$$
$$B, Z_{pp}, Z_{\pi p}, Z_{Kp}, Z_{\Sigma p} \quad - \quad \text{[mb]}$$
$$s_0 \quad - \quad \text{[GeV}^2\text{]}$$
$$Y_{1,2}^{pp}, Y_{1,2}^{\pi p}, Y_{1,2}^{Kp}, Y_{1,2}^{\Sigma p}, Y_1^{\gamma p}, Y_1^{\gamma\gamma} \quad - \quad \text{[mb]}$$

Scan-fits summary. 2003 database. Without cosmic data points.

E_{cm}^{min} [GeV]	3	4	5	6	7	8	9	10
N_{dof}: ρ excluded	707	562	488	415	350	312	266	211
N_{dof}: ρ included	885	723	629	550	479	434	378	310
χ^2/dof: ρ excluded	1.27	0.98	0.82	0.80	0.84	0.84	0.83	0.76
χ^2/dof: ρ included	1.75	1.15	0.98	0.98	0.97	0.93	0.93	0.92

Details of the fit to the data in the whole domain of applicability

	$\sqrt{s}$ of the starting point in [GeV]	Number of data points
Breakdown of the CS data sample		
pp:	5.00963	112
$\bar{p}p$:	5.1569	59
π^+p:	5.21275	50
π^-p:	5.02954	106
K^+p:	5.12707	40
K^-p:	5.10875	63
Σ^-p:	6.12189	9
γp:	5.01008	38
$\gamma\gamma$:	5.	30
Breakdown of the ρ data sample		
pp:	5.30542	74
$\bar{p}p$:	11.5382	11
π^+p:	8.98072	8
π^-p:	7.56285	30
K^+p:	5.21771	10
K^-p:	5.23565	8

χ^2/dof	=	0.98
CL[%]	=	63.46
Name of value	Numerical value	Error value
s_0	34.409806	5.442838
η_1	0.46822531	0.015111598
η_2	0.53956628	0.0064264992
Z_{pp}	35.865711	0.39194465
$Z_{\pi p}$	21.255573	0.32258531
Z_{Kp}	18.250196	0.29450647
$Z_{\Sigma p}$	35.595465	1.4285867
δ	0.0030641085	0.000016709173
B	0.31573	0.0094672397
Y_{pp1}	42.069653	1.2708388
Y_{pp2}	32.155544	0.94228883
$Y_{\pi p1}$	17.712148	1.1184374
$Y_{\pi p2}$	5.7136141	0.16061349
Y_{Kp1}	5.6248192	1.3995889
Y_{Kp2}	13.119015	0.37618197
$Y_{\Sigma p1}$	-260.39972	131.02776
$Y_{\Sigma p2}$	-325.24522	154.3704
$Y_{\gamma p1}$	0.029185027	0.0058494249
$Y_{\gamma\gamma 1}$	-0.00014738702	0.000071036228

Model quality indicators:

	A^M	C_1^M	C_2^M	U^M	R_1^M	R_2^M	S_1^M	S_2^M
RRPL2u(19)	2.206	63.46	84.13	24.14	32.40	6.942E-6	0.226	0.190

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$$
\begin{cases}
\sigma_{pp} &= Z_{pp} + B\ln^2\left(\dfrac{s}{s_0}\right) + Y_1^{pp}s^{-\eta_1} - Y_2^{pp}s^{-\eta_2},\\
\sigma_{\bar{p}p} &= Z_{pp} + B\ln^2\left(\dfrac{s}{s_0}\right) + Y_1^{pp}s^{-\eta_1} + Y_2^{pp}s^{-\eta_2},\\
\sigma_{\pi^+p} &= Z_{\pi p} + B\ln^2\left(\dfrac{s}{s_0}\right) + Y_1^{\pi p}s^{-\eta_1} - Y_2^{\pi p}s^{-\eta_2},\\
\sigma_{\pi^-p} &= Z_{\pi p} + B\ln^2\left(\dfrac{s}{s_0}\right) + Y_1^{\pi p}s^{-\eta_1} + Y_2^{\pi p}s^{-\eta_2},\\
\sigma_{K^+p} &= Z_{Kp} + B\ln^2\left(\dfrac{s}{s_0}\right) + Y_1^{Kp}s^{-\eta_1} - Y_2^{Kp}s^{-\eta_2},\\
\sigma_{K^-p} &= Z_{Kp} + B\ln^2\left(\dfrac{s}{s_0}\right) + Y_1^{Kp}s^{-\eta_1} + Y_2^{Kp}s^{-\eta_2},\\
\sigma_{\gamma p} &= \delta\left[Z_{pp} + B\ln^2\left(\dfrac{s}{s_0}\right)\right] + Y_1^{\gamma p}s^{-\eta_1},\\
\sigma_{\gamma\gamma} &= \delta^2\left[Z_{pp} + B\ln^2\left(\dfrac{s}{s_0}\right)\right] + Y_1^{\gamma\gamma}s^{-\eta_1},\\
\sigma_{\Sigma^-p} &= Z_{\Sigma p} + B\ln^2\left(\dfrac{s}{s_0}\right) + Y_1^{\Sigma p}s^{-\eta_1} - Y_2^{\Sigma p}s^{-\eta_2}.
\end{cases}
$$

$$
\begin{cases}
\rho_{pp}\sigma_{pp} &= \pi B\ln\left(\dfrac{s}{s_0}\right) - \dfrac{Y_1^{pp}s^{-\eta_1}}{\tan\left[\dfrac{1-\eta_1}{2}\pi\right]} - \dfrac{Y_2^{pp}s^{-\eta_2}}{\cot\left[\dfrac{1-\eta_2}{2}\pi\right]},\\
\rho_{\bar{p}p}\sigma_{\bar{p}p} &= \pi B\ln\left(\dfrac{s}{s_0}\right) - \dfrac{Y_1^{pp}s^{-\eta_1}}{\tan\left[\dfrac{1-\eta_1}{2}\pi\right]} + \dfrac{Y_2^{pp}s^{-\eta_2}}{\cot\left[\dfrac{1-\eta_2}{2}\pi\right]},\\
\rho_{\pi^+p}\sigma_{\pi^+p} &= \pi B\ln\left(\dfrac{s}{s_0}\right) - \dfrac{Y_1^{\pi p}s^{-\eta_1}}{\tan\left[\dfrac{1-\eta_1}{2}\pi\right]} - \dfrac{Y_2^{\pi p}s^{-\eta_2}}{\cot\left[\dfrac{1-\eta_2}{2}\pi\right]},\\
\rho_{\pi^-p}\sigma_{\pi^-p} &= \pi B\ln\left(\dfrac{s}{s_0}\right) - \dfrac{Y_1^{\pi p}s^{-\eta_1}}{\tan\left[\dfrac{1-\eta_1}{2}\pi\right]} + \dfrac{Y_2^{\pi p}s^{-\eta_2}}{\cot\left[\dfrac{1-\eta_2}{2}\pi\right]},\\
\rho_{K^+p}\sigma_{K^+p} &= \pi B\ln\left(\dfrac{s}{s_0}\right) - \dfrac{Y_1^{Kp}s^{-\eta_1}}{\tan\left[\dfrac{1-\eta_1}{2}\pi\right]} - \dfrac{Y_2^{Kp}s^{-\eta_2}}{\cot\left[\dfrac{1-\eta_2}{2}\pi\right]},\\
\rho_{K^-p}\sigma_{K^-p} &= \pi B\ln\left(\dfrac{s}{s_0}\right) - \dfrac{Y_1^{Kp}s^{-\eta_1}}{\tan\left[\dfrac{1-\eta_1}{2}\pi\right]} + \dfrac{Y_2^{Kp}s^{-\eta_2}}{\cot\left[\dfrac{1-\eta_2}{2}\pi\right]},
\end{cases}
$$

Variable s is in the units $[GeV^2]$. The additional scale $s_1 = 1\ [GeV^2]$ in terms with $(s/s_1)^{-\eta_{1,2}}$ is omitted for brevity.

BENCHMARKS FOR THE FORWARD OBSERVABLES AT RHIC, THE TEVATRON RUN II AND THE LHC

COMPETE collaboration

J.R. Cudell
Institut de Physique, Bât. B5, Université de Liège, Sart Tilman, B4000 Liège, Belgium

V.V. Ezhela, Yu.V. Kuyanov, S.B. Lugovsky, E.A.Razuvaev and N.P. Tkachenko
COMPAS group, IHEP, Protvino, Russia

K. Kang
Physics Department, Brown University, Providence, RI, U.S.A. and Korea Institute for Advanced Study (KIAS), Seoul

P. Gauron and B. Nicolescu
LPNHE-LPTPE, Université Pierre et Marie Curie, Tour 12 E3, 4 Place Jussieu, 75252 Paris Cedex 05, France

E. Martynov
Bogolyubov Institute for Theoretical Physics, Kiev

The details of the Parameterizations

$RRPL2_u(19)$	$RRPL2_u(21)$	$RRL_{nf}(19)$	$(RR_c)^dPL2_u(15)$
$(RR)^dPL2_u(19)$	$R^{qc}R_cL^{qc}(12)$	$(RR_c)^dP^{qc}L2_u(14)$	$(RR)^dP^{qc}L2_u(16)$
$RR_cL2^{qc}(15)$	$(RR)^dPL2(20)$	$(RR)^dPL2_u(17)$	$RRPL(21)$
$RR_cL^{qc}(15)$	$RRL2^{qc}(17)$	$R^{qc}R_cL2^{qc}(12)$	$RRL^{qc}(17)$
$RR(PL2)^{qc}(18)$	$RRPE_u(19)$	$R^{qc}RL^{qc}(14)$	$RR(PL2)(20)$
$RRL2(18)$	$RR_cPL(19)$	$RRL(18)$	

http://nucl-th02.phys.ulg.ac.be/compete/publications/predictor.html