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COMPARATIVE STUDY OF THE COMPETITIVE MODELS FOR THE FORWARD SCATTERING DATA AT HIGH ENERGIES

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This presentation is based on our comparative study[1] of the three popular analytic parametrizations of the total cross sections and ρ parameter on all available data accumulated in the PPDS databases[2]. The main goal of this presentation is to try to find answers to the following questions: where the parametrization with simple pole pomeron asymptitics start to be noticeably different from the others based on the unitarized pomeron asymptotics; where the asymptopia starts; what are the best model for extrapolations to higher energies.

1. Analytic Models. The proposals to use of the simple analytic models for the forward scattering amplitudes traced back to the end of 1960's (V.N.Gribov, A.A.Migdal, A. Martin, A. A. Logunov) and firstly tested on the available at that time experimental data on pp and $p\bar{p}$ by Bourelli and Fisher[3]. We perform analogous scan-fits of each model to the $p^{\pm}p, \pi^{\pm}p, K^{\pm}p, \gamma p$, and $\gamma\gamma$ total hadronic cross section data and ρ parameter for $p^{\pm}p, \pi^{\pm}p, K^{\pm}p$. All data fitted simultaneously to the following parametrizations.

RRP

$$\sigma_{\mp} = X \cdot s^{\epsilon} + Y_1 \cdot s^{-\eta_1} \pm Y_2 \cdot s^{-\eta_2}$$

$$\rho_{\mp} = \frac{1}{\sigma_{\mp}} \cdot \left[-\frac{X \cdot s^{\epsilon}}{\tan\left(\frac{(\epsilon+1)\pi}{2}\right)} - \frac{Y_1 \cdot s^{-\eta_1}}{\tan\left(\frac{(1-\eta_1)\pi}{2}\right)} \pm \frac{Y_2 \cdot s^{-\eta_2}}{\cot\left(\frac{(1-\eta_2)\pi}{2}\right)} \right]$$

RRL2

$$\sigma_{\mp} = \lambda\left(A + B \cdot \ln^2 s\right) + Y_1 \cdot s^{-\eta_1} \pm Y_2 \cdot s^{-\eta_2}$$

$$\rho_{\mp} = \frac{1}{\sigma_{\mp}} \cdot \left[\lambda \cdot B \cdot \pi \cdot \ln s - \frac{Y_1 \cdot s^{-\eta_1}}{\tan\left(\frac{(1-\eta_1)\pi}{2}\right)} \pm \frac{Y_2 \cdot s^{-\eta_2}}{\cot\left(\frac{(1-\eta_2)\pi}{2}\right)} \right]$$

RRL1

$$\sigma_{\mp} = \lambda \cdot (A + B \cdot \ln s) + Y_1 \cdot s^{-\eta_1} \pm Y_2 \cdot s^{-\eta_2}$$

$$\rho_{\mp} = \frac{1}{\sigma_{\mp}} \cdot \left[\frac{\lambda \cdot B \cdot \pi}{2} - \frac{Y_1 \cdot s^{-\eta_1}}{\tan\left(\frac{(1-\eta_1)\pi}{2}\right)} \pm \frac{Y_2 \cdot s^{-\eta_2}}{\cot\left(\frac{(1-\eta_2)\pi}{2}\right)} \right]$$

In constructing these parametrizations we use the "derivative dispersion relations" of K. Kang and B.Nicolescu [4] (see also prescriptions of Ref.[5]). To make number of parameters as low as possible we require the universality of the rising part of the cross sections and Pomeranchuk theorem in all cases as it is in the simple regge-pole motivated parametrizations as well as universality of the effective secondary regge-pole contributions. All models has the same total number of adjustable parameters, namely 16 parameters to fit 8 cross sections and 6 ρ data samples.

2. Experimental Data. Experimental data used were extracted from the Particle Physics Data System (PPDS)[2] maintained by the COMPAS Group at IHEP. Originally PPDS databases were created (1975-1980) by merging CERN-HERA cross sections data compilation, old LRL and LBL bibliographic and numerical data compilations. New data now gathered by collaborative efforts of COMPAS(IHEP), BPDG(LBNL), PDG(Durham,UK), ITEP(Moscow), and JINR(Dubna).

Data used for these studies were repeatedly checked with original publications, all preliminary data were removed, all known published errata fixed in the databases. Computer readable data files posted on the WEB [6]. It is our hope that this dataset will eventually become the standard reference when studying the validity of models for the forward quantities.

3. Scan-fits. We produce scan fits of each model to the data in the intervals from E^{cm}_{min} to the maximal evailable cm energies for each collisions and vary E^{cm}_{min} starting from 3-GeV in 1-GeV steps up to $E^{cm}_{min} = 13$-GeV, to be able to establish the area of applicability of each model (demanding $\chi^2/DoF \leq 1.$) and to see if the model parameters have weak dependence upon E^{cm}_{min}. The stability pattern presented on the plots in the Professor Kang report, here we give only figures for comparison of different models and to show their areas of applicability.

4. Summary. From the Figs 1.-3. we see that our three models reproduce the data sufficiently well and give practically the same fit qualities starting from $E^{cm}_{min} = 9$-GeV. However, the factorization of the coupligs in RRP model and reproduction of the quark counting rules[1] (discussed in details in the Professor

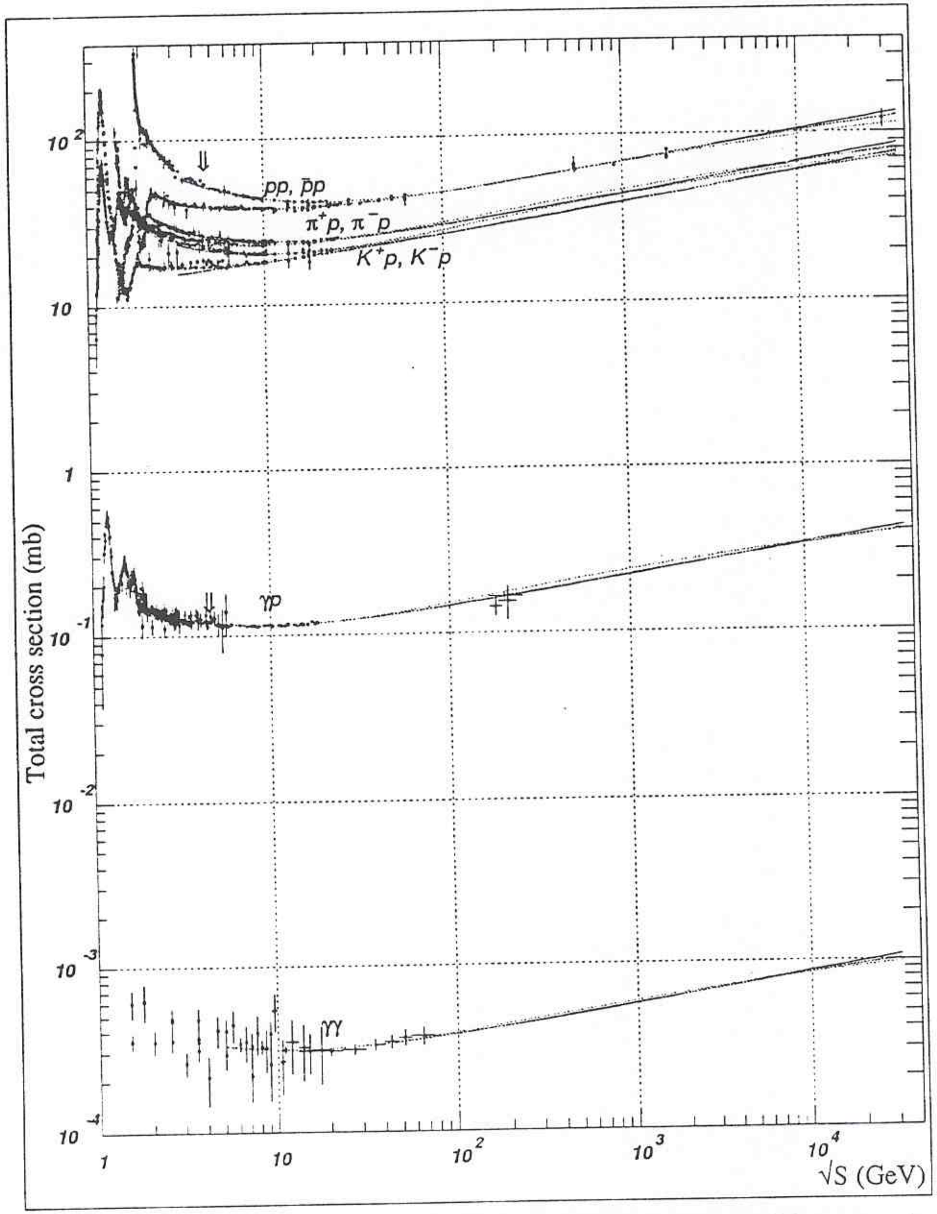

Figure 1: Three models global comparison. Curves are drawn with parameters obtained at the beginning of the parameters stability regions: for the RRP and RRL2 it is $E^{cm}_{min} = 9$-GeV and for the RRL1 it is $E^{cm}_{min} = 5$-GeV.

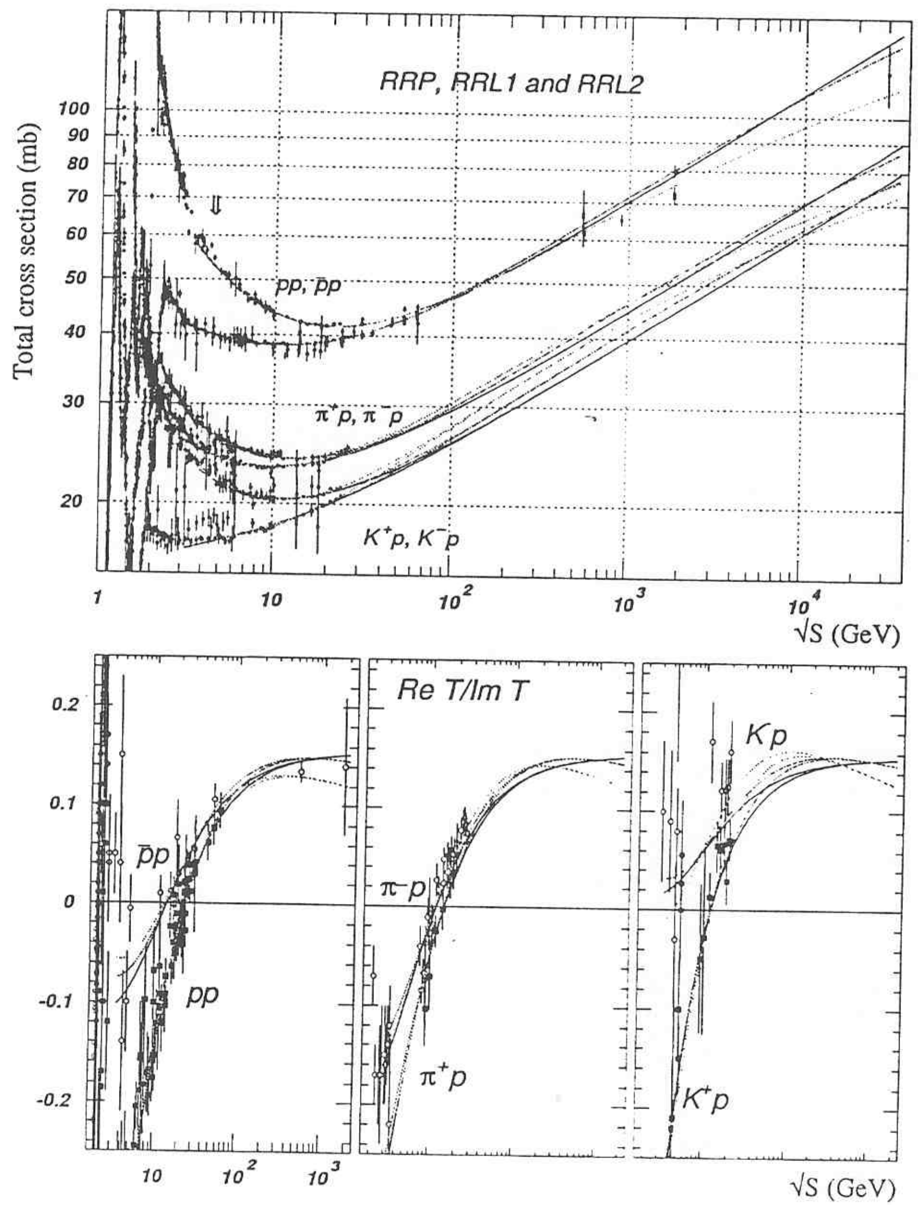

Figure 2: Hadronic collisions only. Curves are drawn with parameters obtained at the beginning of the parameters stability regions: for the RRP and RRL2 it is $E^{cm}_{min} = 9$-GeV and for the RRL1 it is $E^{cm}_{min} = 5$-GeV.

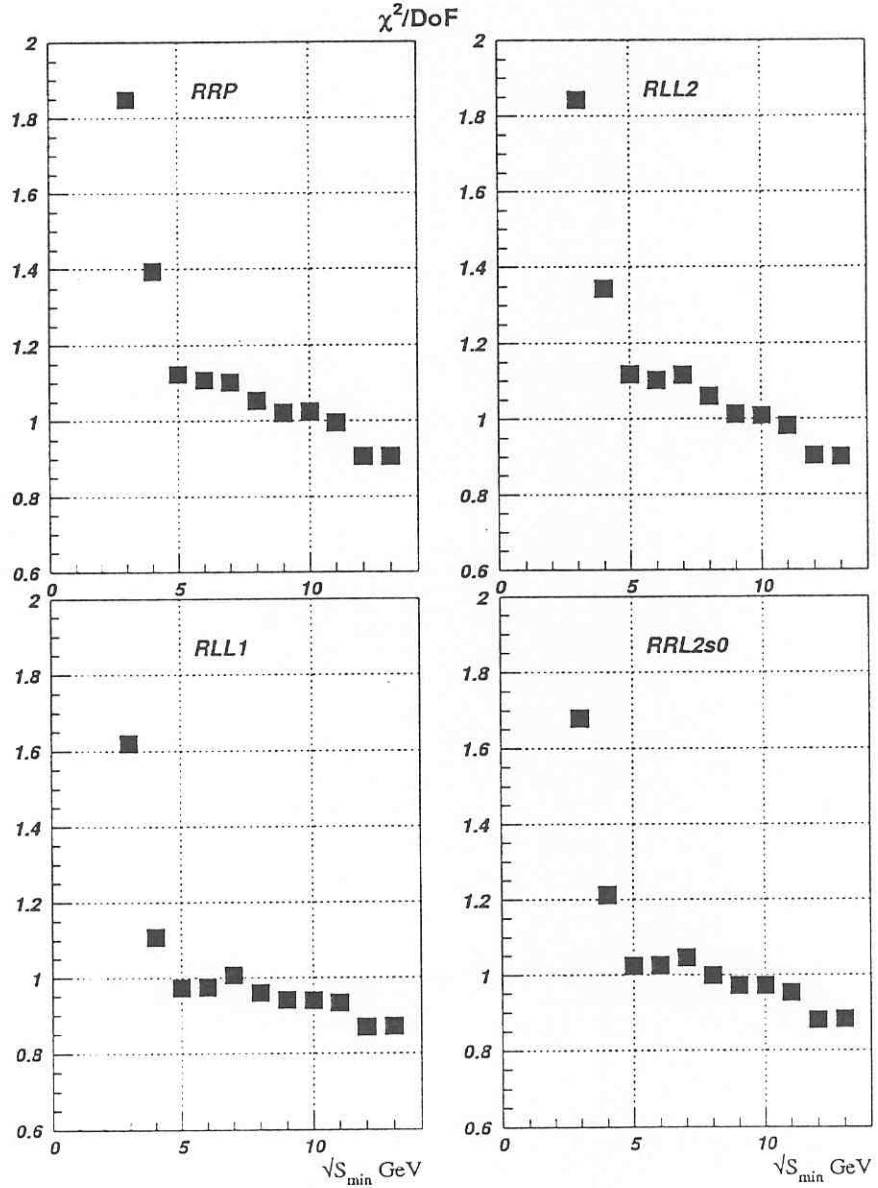

Figure 3: χ^2/Dof dependencies upon E^{cm}_{min}.

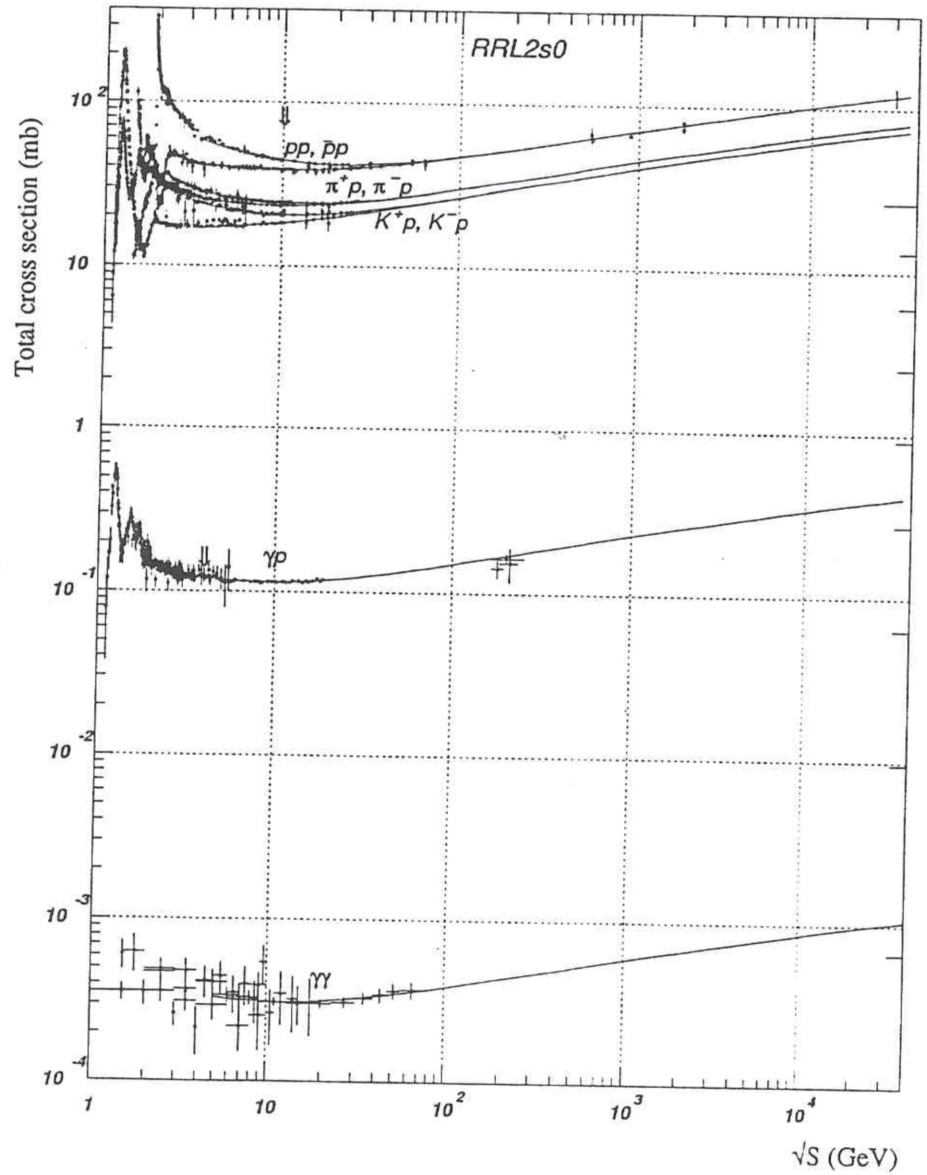

Figure 4: Data description by RRL2s0 model

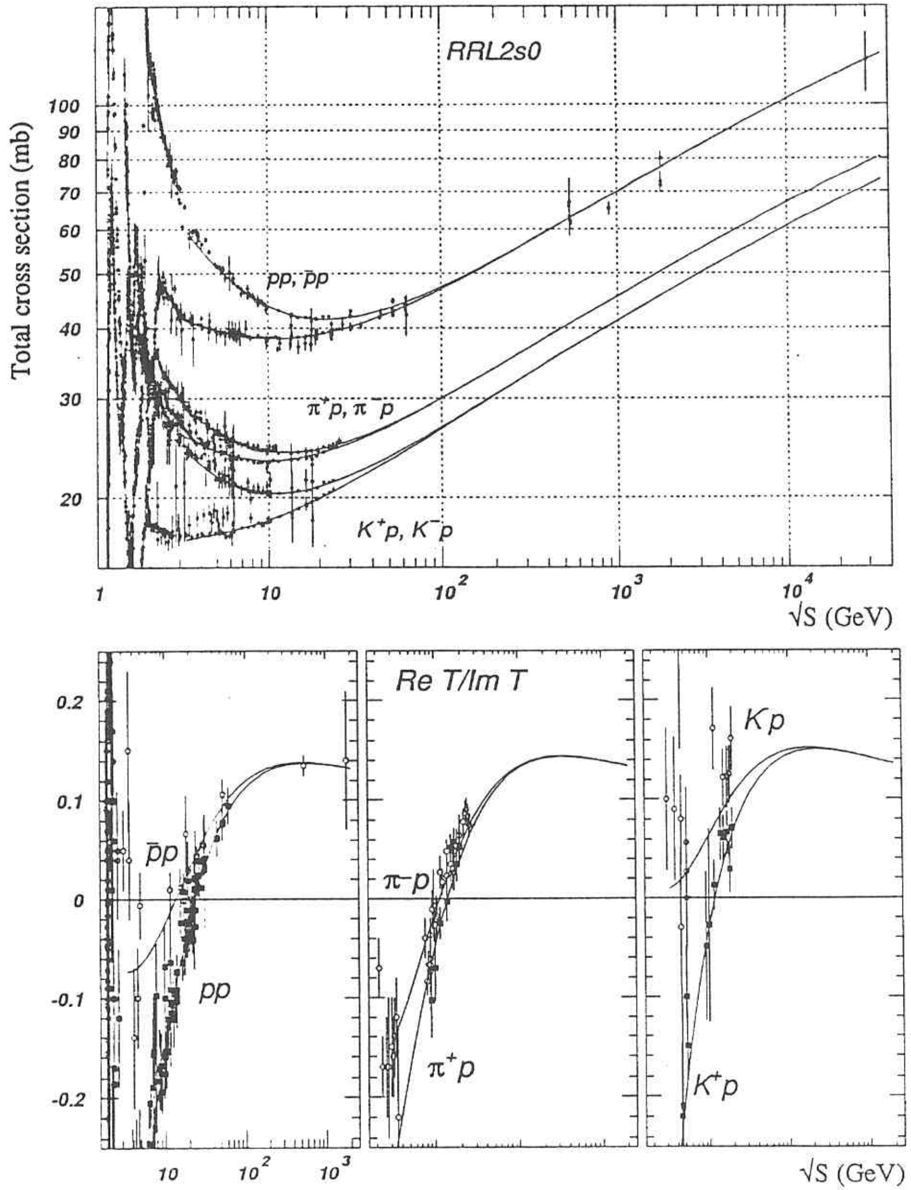

Figure 5: Data description by RRL2s0 model. Hadronic part only

Kang talk) make it more attractive for quick calculations. From the other side some kind of "ranking tendency" is revealed: models with unitarized (logarithmic) pomeron are preferable: RRL2 and RRL1 give slightly better $\chi 2/Dof$ values, more extended intervals of applicability, and more slow variation of parameters with E^{cm}_{min}.

5. Afterwords. After discussions at the conference around the scale parameter s_0, that was fixed in our fits at $s_0 = 1\text{-GeV}^2$ for the sake of reduction the number of parameters and correlations, we found a possibility to modify RRL2 parametrization in such a way that it still have 16 adjustable parameters. We remove parameters A and λ_{ab}, and introduced parameters B_{ab} and s_0.

RRL2s0

$$\sigma_{\mp} = \lambda\left(B \cdot \ln^2(s/s_0)\right) + Y_1 \cdot (s/s_0)^{-\eta_1} \pm Y_2 \cdot (s/s_0)^{-\eta_2}$$

$$\rho_{\mp} = \frac{1}{\sigma_{\mp}} \cdot \left[B \cdot \pi \cdot \ln(s/s_0) - \frac{Y_1 \cdot (s/s_0)^{-\eta_1}}{\tan\left(\frac{(1-\eta_1)\pi}{2}\right)} \pm \frac{Y_2 \cdot (s/s_0)^{-\eta_2}}{\cot\left(\frac{(1-\eta_2)\pi}{2}\right)}\right]$$

The obtained picture of the scan-fit is much better than in the RRL2 case and is quite similar to that of RRL1 (see Figs 3-5).

As it was expected[1] the value of $\sqrt{s_0}$ turned to be very small, approximately 20-MeV.

References

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