hep-ph/0412189

Total cross-sections: Cross-talk between HERA, LHC and LC[a]

G. Pancheri[1], A. De Roeck[2] R.M. Godbole[3] A. Grau[4] and Y. N. Srivastava [5]

[1]INFN, Frascati National Laboratories, I00044, Frascati, Italy

[2]CERN, EP-Division, Geneva, Switzerland.

[3]Centre for High Energy Physics, Indian Institute of Science, Bangalore, 560012, India.

[4]Departamento de Física Teórica y del Cosmos, Universidad de Granada, Spain.

[5]Dipartimento di Fisica & INFN, University of Perugia, Perugia, Italy.

Abstract

We discuss the need to compare total cross-section measurements at LHC and HERA with each other and with available models in order to obtain a more precise prediction of the total hadronic cross-section at the future Linear Collider, thus leading to a better estimate of the hadronic background.

[a]Presented by G. Pancheri at the International Linear Collider Workshop, April 2004, Paris.

TOTAL CROSS-SECTIONS : CROSS-TALK BETWEEN HERA, LHC AND LC

G. PANCHERI
INFN, Frascati National Laboratories, I00044Frascati, Italy

A. DE ROECK
CERN, Geneva, Switzerland

R.M. GODBOLE
Centre for High Energy Physics, Indian Institute of Science, Bangalore, 560 012, India

A. GRAU
Departamento de Física Teórica y del Cosmos, Universidad de Granada, Spain

Y.N. SRIVASTAVA
Dipartimento di Fisica & INFN, University of Perugia, Perugia, Italy

We discuss the need to compare total cross-section measurements at LHC and HERA with each other and with available models in order to obtain a more precise prediction of the total hadronic cross-section at the future Linear Collider, thus leading to a better estimate of the hadronic background.

1 Introduction

In order to make realistic predictions for $e^+e^- \to hadrons$ at the Linear Collider (LC), one needs to understand the role played by QCD in the energy dependence of total cross-sections. This will allow to reduce the large errors coming from the present large uncertainties in the $\gamma\gamma \to hadrons$ and which affect present predictions at the LC.

2 Hadronic Total Cross-sections

It must be noticed that presently all total cross-sections exhibit the same general features, namely an initial decrease followed by a more or less gentle rise[1], as shown in Fig.(1). We however lack a complete theoretical model and while we might be able to do a good parametrization of the proton-proton data, we do not know how to gauge the inherent theoretical uncertainties. This results in further uncertainties in the photoproduction cross-section and in an even larger uncertainty in predictions at LC. Thus we should study in detail the cross-talk between future measurements of total proton-proton cross-section at

the LHC and a similar HERA measurement, to develop and fully understand what to expect at LC in terms of the hadronic background.

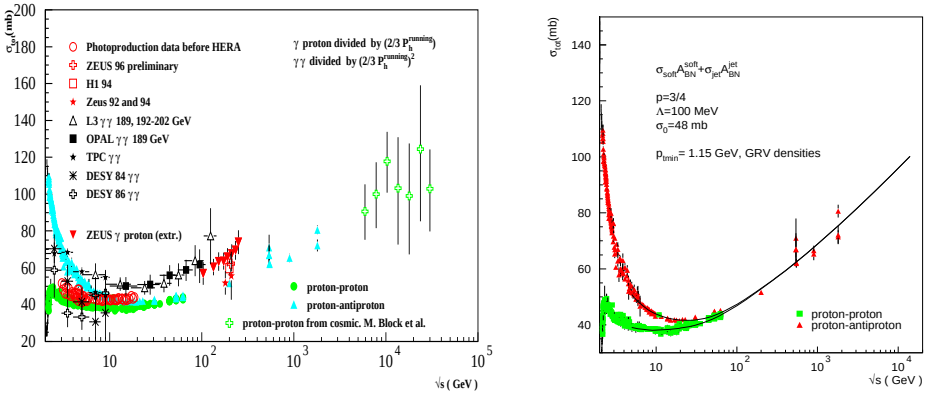

Figure 1: At left, proton and photon total cross-sections; those for photons scaled by a quark counting factor $\frac{2}{3}$ and a VMD factor. At right the total pp and $p\bar{p}$ cross-section compared to a QCD model with minijets in the eikonal formulation and soft gluons to soften the rise.

The curve shown in Fig.(1) is obtained by embedding the QCD mini-jet cross-section in an eikonal formulation [2]

$$\sigma_{tot} = 2 \int d^2\vec{b}[1 - e^{i\chi(b,s)}] \tag{1}$$

where we put $\chi_R \approx 0$, and

$$2\chi_I = n(b,s) = A_{BN}^{soft}\sigma_{soft} + A_{BN}^{jet}\sigma_{jet} \tag{2}$$

In this Eikonal Minijet Model (EMM), the rise is driven by the jet cross-section, which is calculated using current parton densities down to a minimum jet transverse momentum, $p_{tmin} \approx 1 \div 2\ GeV$. The impact parameter distribution is the (normalized to unity) Fourier transform of the initial transverse momentum of the colliding partons, in leading order the valence quarks, obtained through the Bloch Nordsieck soft gluon summation[2]. This model can also be applied to the photo-production and $\gamma\gamma$ data. The results, for a set of p_{tmin} values, are shown in Fig. (2), with CJKL [3] parton densities.

The EMM model with soft gluons has the virtue of reproducing the gentle rise with energy which characterizes the proton-proton data and is also compatible with the photon data. This is not true for other models, as we show in

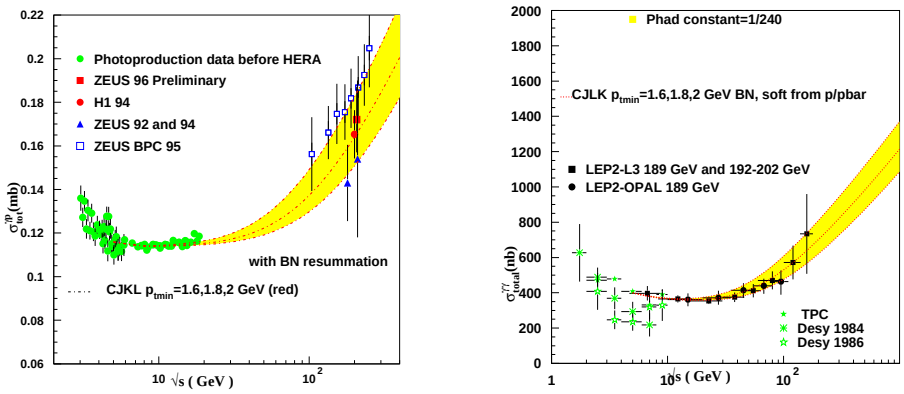

Figure 2: At left we show photoproduction data compared with the soft gluon improved EMM, at right the same for $\gamma\gamma$, using the same photon densities and set of p_{tmin} values.

Fig.(3), where a fit [4] of the $\gamma\gamma$ data with a Regge-Pomeron type parametrization, indicates a harder rise with energy than what is present in the proton-proton data. We also show the photoproduction data and compare it with the (i) EMM model without soft gluons [5] and with the (ii) Aspen model [6].

3 Conclusion

Present Tevatron data for total cross-section lead to uncertainties when extrapolated to the LHC energies. Such uncertainties are also found in predictions for LC hadronic cross-sections which suffer from uncertainties in the $\gamma\gamma$ cross-sections. We have emphasized that to obtain realistic estimates for the hadronic background at LC, we need combined model predictions for LHC as well as the HERA data. An example has been provided through our soft gluon formula for the purely hadronic as well as the $\gamma\gamma$ data.

Acknowledgments

This work was supported in part by EU Contract HPRN-CT2002-00311. RG wishes to acknowledge the partial support of the Department of Science and Technology, India, under project number SP/S2/K-01/2000-II. AG acknowledges support from MCYT under project number FPA2003-09298-c02-01.

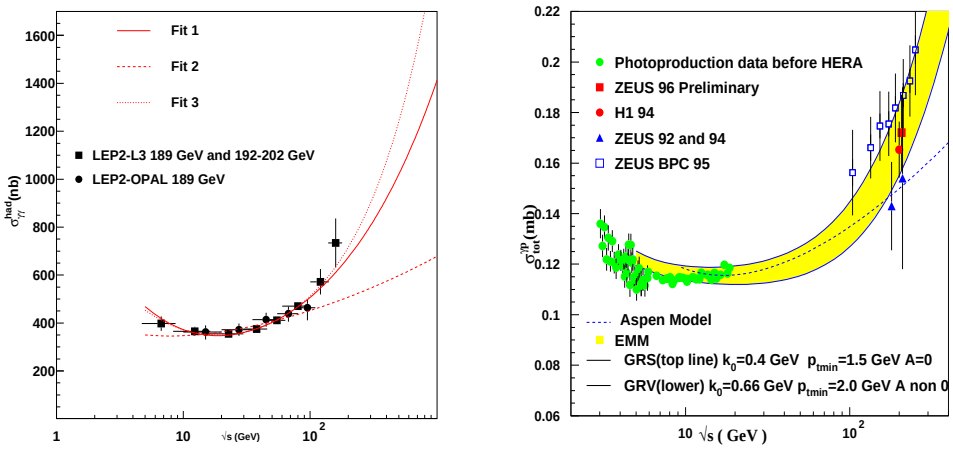

Figure 3: At left we show how different power laws can be used to parametrize $\gamma\gamma \to hadrons$ with fit 2 corresponding to the same slope parameters as in proton-proton, fit 1 to a rising power characterized by $\epsilon = 0.250$ and fit 3 includes two rising powers, one as in proton-proton, and a second one with $\epsilon' = 0.418$. At right we show photoproduction data fitted through the Aspen model (with same gentle rise as proton-proton) or through the EMM with Form Factors for the impact-parameter distribution.

References

1. A. Donnachie and P.V. Landshoff, *Phys. Lett.* B**296** (1992) 227.

2. R.M. Godbole, A. Grau, G. Pancheri and Y.N. Srivastava, hep-ph/0408355, and references therein.

3. F. Cornet, P. Jankowski, M. Krawczyk and A. Lorca, *Phys. Rev.* D**68** (2003) 014010, hep-ph/0212160.

4. R.M. Godbole, A. de Roeck, A. Grau and G. Pancheri, *JHEP* 0306:061,2003, hep-ph/0305071.

5. R. M. Godbole, G. Pancheri, *Eur. Phys. J.* C **19** (2001) 129, hep-ph/0010104.

6. M.M. Block, E.M. Gregores, F. Halzen and G. Pancheri, *Phys. Rev.* D**58** (1998) 17503; M. Block, E.M. Gregores, F. Halzen and G. Pancheri, *Phys. Rev.* D**60** (1999) 54024.