Coplanar Events and Multiproduction Event Generators in the Knee Region

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Abstract

The adjustment of multiproduction events generators to the pseudo-rapidity distributions recently observed indicates an increase of the total inelasticity near 200 TeV in laboratory system and a more important violation than usually expected for Feyman's scaling in forward region. The energy distribution of aligned events observed in coplanar events is commonly observed in the random superposition of successive collisions (even in low stratospheric densities)

1 Inclusive data and HDPM (Hybrid Dual Parton Model)

1.1 p_t distribution In the collision generator HDPM (Capdevielle 89), the hadrons coming from the fragmentations of the chains stretched between valence quarks and diquarks of projectile and target are represented mainly by one pair of normal distributions (symetric around CMS for p-p collisions) in rapidity . The sum restores the traditional plateau with gaussian wings. The center and width of those gaussian functions are first adjusted to the pseudo-rapidity distributions of NSD inclusive data as follows ; couples (p_{t_i}, y_i) are generated for each secondary. The p_t distribution is the QCD functional form taking into account the new correlation between central rapidity density and $\langle p_t \rangle$ observed in UA1-Mimi (minimum bias experiment (Bocquet96)):

$$\frac{d\sigma}{dp_t^2} = \frac{Ap_0^n}{(p_t + p_0)^n} \tag{1}$$

corresponding to $\langle p_t \rangle = 2p_0/(n-3)$ (used to fit the p_t spectrum up to $p_t = 25$ GeV/c). The set obtained $n = 8.91 \pm 0.13$, $p_0 = 1.32 \pm 0.05$, is consistent with $\langle p_t \rangle = 0.447$ GeV/c. A dichotomic Monte Carlo generator of transverse momenta was developed to reproduce this new situation and we observed a consequent rise of the total inelasticity of about 10% at $\sqrt{s} = 630 GeV$ (Capdevielle et al.,97)

1.2 New pseudo-rapidity distributions at $\sqrt{s} = 630GeV$ The guidelines of the rapidity generation mechanism in HDPM were adjusted in order to reproduce the inclusive and also semi-inclusive measurements of UA5 experiment(Alner et al.,87) on charged pseudo-rapidity distributions. Recently, at the occasion of tests for hadronic B-physics experiment, new and precise measurements with micro-strips silicon detectors have been performed allowing pseudo-rapidity estimation for $1 \leq \eta \leq 6$. The results obtained by Harr et al.(1997) are plotted (open circles) together with the previous results of UA5 (diamonds) on fig.1 . The important discrepancy in the distribution profile for $\eta \geq 3.6$ can be observed. We have superimposed the histograms derived from the simulation of 2000 collisions generated with HDPM modified (it was inserted in CORSIKA from the adjustment to UA5 data) on fig.1 (for NSD component) after tuning the rapidity generator to reproduce the most recent observation. In this last case, the center of gravity of the partonic strings have been shifted to $\eta = 1.88$ and the width of the chains after fragmentation have been enlarged to 1.17.

2 Enhanced inelasticity

2.1 Calculation of transverse mass and secondary momentum One simple kinematic treatment by summing up the energies carried by the different secondaries gives (from the average on one sample of 2000 collisions) the inelasticities in Laboratory system related to the total incoming energy.The inelastic enhancement resulting from fig.1 comes from the increase of the transverse mass of each secondary and even more from y_i

$E_i = m_{t_i} \cosh(y_i + y_0)$, with $m_{t_i}^2 = m_i^2 + p_{t_i}^2$,

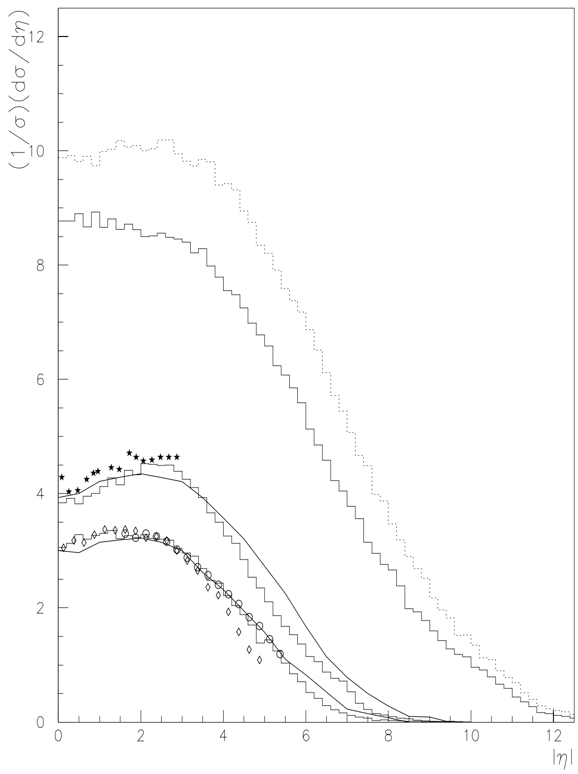

Figure 1: Pseudo-rapidity distribution with QGSJET (solid line) and improved HDPM (histogram) compared to Fermi-lab and CERN data . Two extrapolations at $E_0 = 10EeV$ carried with HDPM are plotted assuming different parton distributions functions.

(y_0 is the rapidity of the incoming particle). The total inelasticity rises from 0.54 (our previous agreement with UA5 data to 0.73 (0.47 for charged). The constrainct of the new trajectory (one rapidity or pseudo-rapidity of 6 corresponds to one value Feymann's x of 0.3) is more efficient. Unfortunately at $\sqrt{s} = 1800GeV$ (fig.1), we have no constrainct to indicate the tendancy near fragmentation region ; there are no values of pseudo-rapidity density measured for $\eta \geq 3.0$. We note that if we conserve the same generation procedure than at $\sqrt{s} = 630GeV$, we obtain herealso a total inelasticity of 0.7. Such values are very close of one previous estimation of total inelasticity in p-Air collisions derived from the interpretation of Gamma ray families measurement with X-ray film emulsion chambers (Capdevielle et al.1994) in the energy range 1000-10000 TeV.

2.2 Scaling violation in fragmentation region It has been in fashion to plot in the mirror system , all the distributions of pseudo-rapidity density (fig.2) to support the validity of Feymann's scaling in fragmentation region. One violation by less than10% was tolerated in Dual Parton Model (Capella et al.1994). This tendancy looks artificially plausible on fig.2 (right) as far as we don't consider the points of Harr et al.. This new data plotted again on fig.2 (left) , where we have isolated with the same scale the measurements at collider energy, exhibits, as our inelasticity balance, one significant tendancy to scaling violation in fragmentation region. It could be very interesting to know, as it was done for UA5, the behaviour of the semi-inclusive data corresponding to the recent inclusive measurements of Harr et al.. Several questions happen about the extrapolations at energies above LHC ; the summation of the transverse energy gives for some collisions at

100 EeV, energy densities exceeding 100 GeV/Fm^3.

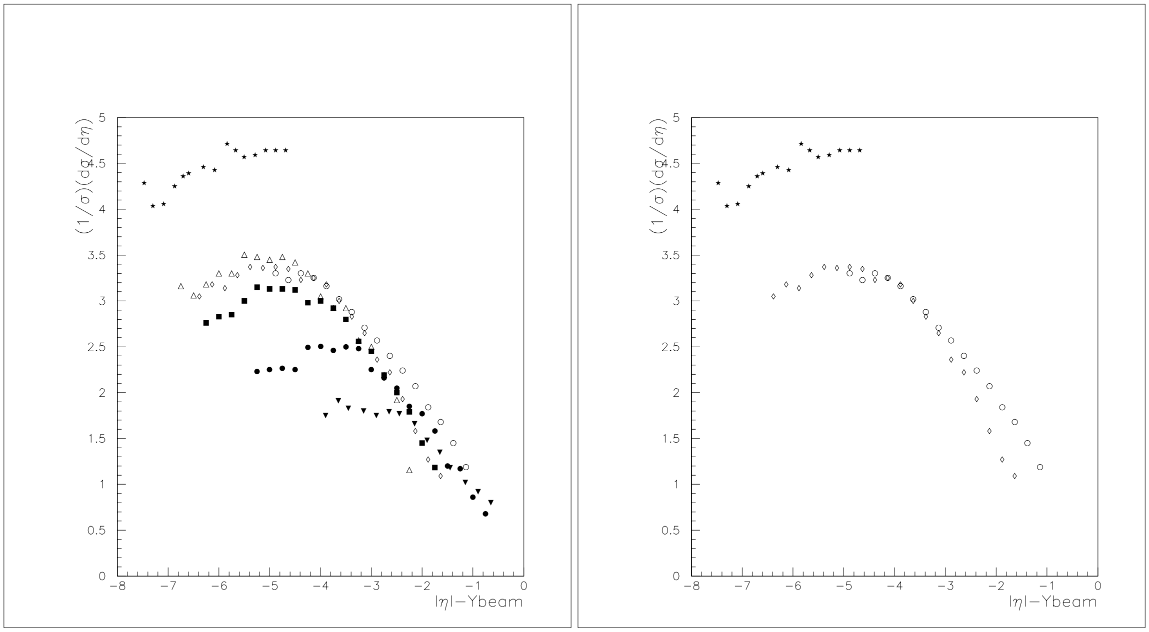

Figure 2: η distributions in mirror system for ISR and colliders

3 Coplanar events

Using the combination of some rare fluctuations (diffractive component, KNO fluctuations to high multiplicity for small diffractive mass, fluctuations of n_{ch} versus n_γ such that the γ's have individual energies under the threshold of the emulsion chamber, we have simulated events similar to the Centauro (Wlodarczyk,93). The inelasticity increase is not expected to produce some geometrical alignement of secondary particles as clear as the Concorde event registrated near $10^7 GeV$; however we have started some simulations with CORSIKA (Capdevielle et al.92, Heck et al.98) to explore the consequences of some special circumstances implied by the semi-inclusive data. At least, we obtained the evidence that the energy distribution of the 211 γ's can be easily reproduced with a small cascading in the atmosphere ; for instance, the superposition of 3 proton collisions, a quite banal configuration for an atmospheric depth of 105 $g - cm^{-2}$ and a proton mean free path of about 60 $g - cm^{-2}$ reproduces quite well the multiplicity and the energy distribution observed. Simulations are in progress to understand further geometric consequences of the semi-inclusive data in the stratospheric environment.

4 Conclusion

Those new elements support a significant increase of the total inelasticity in the Knee energy region/around 0.65 - 0.7 if we take into account single diffraction and nucleon-Air effects/. This implies a more important absorption of the electromagnetic component of Extensive Air Shower and a relative more important muon-electron abundance, as well as one maximum depth at higher altitude. The average mass required in the primary component in current interpretations of EAS data could then have been overestimated in calculations made with inelasticies values around 0.5. From the point of view of microscopic physics, this can be connected with the modified distribution at high x (Huston 1998) for the valence d quark or with di-quark breaking circumstance. The explanation of geometrical alignements of secondaries is not yet elucidated : however, multiplicities and momenta distributions of those special events can be reproduced with normal Ln(s) Physics and expected cascading in the atmosphere.

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