EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

CERN/SPSC/I 73-55
30.10.1973

LETTER OF INTENT TO THE SPS COMMITTEE

STUDY OF HADRON FRAGMENTATION IN THE MOMENTUM REGION (30-70 GeV/c)WHERE CORRELATIONS ARE NEARLY ABSENT.

P. Antich, A. Borghesi, E. Calligarich, M. Cavalli Sforza, C. Conta, R. Dolfini, F. Impellizzeri, G. Goggi, G.C. Mantovani, F. Pastore, A. Piazzoli, S. Ratti, R. Rivosecchi, B. Rossini, D. Scannicchio.

Istituto di Fisica dell'Università - Pavia.
Istituto Nazionale di Fisica Nucleare - Sezione di Pavia.

G.C. Bonazzola, G. Borreani, T. Bressani, D. Gamba, G. Rinaudo

Istituto di Fisica dell'Università - Torino.
Istituto Nazionale di Fisica Nucleare - Sezione di Torino.

Contact man: S. Ratti

1. During the past few years the study of inclusive collisions has been the subject of a major effort in the investigation on high energy hadron-hadron, lepton-hadron and lepton-lepton collisions.

The proof of a generalized optical theorem by A.M. Mueller[1] in 1969 has provided a new tool to investigate the nature of high energy reactions.

Scaling[1-7] and other connected properties [1,8-10] have been tested on available data up at Serpukhov[11,12], NAL [13-15] and ISR energies [16].

In particular, scaling has been tested both in the sense of Feynman or Yang [,17,18] and in the sense of Koba, Nielsen, Olesen or Wroblewski [6,17, 19].

Furthermore, recent work has pointed out the validity of local scaling properties in semi-inclusive and exclusive processes [19-22].

Another field of intense investigation has been the study of correlation functions in multiparticle production [9,17,21].

The most relevant experimental information on the correlation functions is found, in the measured value of f_n, where f_n is the integral of the n-particle correlation function $\rho_n(y_1, y_2, \ldots y_n)$ over the rapidity variables y (or equivalently over the Feynmann variables $x_1, x_2, \ldots, x_3$)

$$f_1 = \int_0^y dy_1 \; \rho_1(y_1) = \langle n \rangle$$

$$f_2 = \iint_0^y dy_1 \, dy_2 \; \rho_2(y_1, y_2) = \langle n(n-1) \rangle - \langle n \rangle^2$$

a.s.o.

Our experimental knowledge clearly indicates that the f_n's go to zero somewhere above 30 GeV/c and below 70 GeV/c

Fig. 1 (from ref. 9) shows the behaviour as a function of p_{Lab} of the measured values of f_2, f_3, f_4, f_5 for pp collisions.

It is therefore particularly interesting to investigate systematically multiparticle production in the region 30-70 GeV/c using possibly different beam particles.

Some preliminary comments are relevant at this point in order to clarify the aim of this proposal.

1) We assume that the change in sign of the correlation terms f_n is not accidental but due to the different role played by different mechanisms at work as p_{Lab} increases. Hence we propose to scan the indicated momentum region as regularly as possible looking for effects observable in different state channels.

2) Any inclusive function (the scaling functions, say, or the n-particle inclusive correlation functions) is the result of an incoherent sum over all final channels [19,23].

$$(1) \qquad \varphi_{inclusive} = \sum \varphi_{topological} = \sum \varphi_{exclusive}$$

where obviously the possibility of interferences between different final channels is forbidden.

The general logical statement (1) has been already made explicitly by Shei and Yan [23] for exclusive and inclusive particle distributions and by Antich at al [19] for the scaling functions of the Koba, Nielsen, Olesen type.

Statement (1) implies that <u>any regularity</u> shown by inclusive functions is a consequence of regularities shown by the single

exclusive (or seminclusive, or topological) contributions to them.

Therefore, we would like to measure with adeguate accuracy inclusive functions (typically ρ_2's) for various topologies and various well defined exclusive channels.

3) An anomalous region seems to be the region of large $p_\perp$'s since [16] "triggering on a large $p_\perp$ secondary is a bias in favour of large multiplicity reactions". Experimental data (different from single particle distributions), are particularly scanty in this region. For this reasons we are interested in comparing the measured values of the inclusive functions (typically the ρ_2's) for different $p_\perp$ of a given final particle (typically the target proton).

2. The main features of the experimental investigation can then be summarized as follows.

1) study of exclusive reactions like

(1) $$a + p \rightarrow r + X$$

where

a = $\pi^\pm, p, \bar{p}, K^\pm$

r = recoil proton

x = detectable (exclusive 1(2), 3 (4), 5(6)) charged particle final state (in parenthesis the total downstream particles).

Requirements: good detection of the recoil r and good measurement of t (or its $p_\perp$); angle and momentum measurement of the particles giving x(Trigger on r if possible to select defined t regions or $p_\perp$ intervals).

2) study of seminclusive reactions like

(2) $$a + p \rightarrow X_p + X_a$$

where x_p = set of detected target-like particles
x_a = set of detected beam-like particles

Requirements: good angle and momentum measurement of the two sub-sets of particles

3) for both reactions (1) and (2) high aquisition rate, at least in the forward solid angle.

4) seminclusive trigger giving particular multiplicities or topologies.

5) if possible, identification of the detected particles

6) detection of neutral particles.

The most convenient experimental apparatus seems to be the magnetic-spectrometer in the West Hall, where low energy RF separated beams are extracted from the SPS.

In line with the physical interest mentioned above we strongly recommend that the maximum momentum in beam S1 be increased to at least 70 GeV/c if possible.

As an example fig. 2 shows the energy dependence of the correlation parameter

$$g^2 = \frac{f_2}{\langle n \rangle^2}$$

for pp collisions [24]. It is clearly seen that $-0.02 \lesssim g^2 \lesssim 0.07$ between 30 GeV/c and 70 GeV/c.

In the same figure the energy behaviour for the 4-prong topological cross section is also shown, a typical seminclusive channel suitable to begin a systematic investigation.

R E F E R E N C E S

1) A.M. Mueller , Phys. Rev. D4, 150, 1971 and Phys. Rev. D2, 2963, 1970.

2) J. Benecke, T.T. Chan, C.N. Yang and E. Yen; Phys. Rev. 188, 2159, 1969.

3) R.P. Feynmann, Phys. Rev. Letters 23, 1415, 1969.

4) K. Wilson, Alta Physica Austriaca 17, 37 (1963.

5) Z. Koba, H.R. Nielsen and P. Olesen, Nuclear Phys. B40, 317 1972.

6) P. Slattery, Phys. Rev. Letters 29, 1627, 1972.

7) A. Wroblewski, preprint IFD/72/2, August 1972, Warszawa.

8) K. Paler et al. Phys. Letters B 43, 437 (1973)

9) W.R. Frazer, R.D. Peccei, S.S. Pinsky, Cheng-I Tan, preprint UCSD-10P10-113.

10) Experimental NAL data on Triple-Regge-Region, S.D. Ellis and A. I. Sanda, Phys. Rev. D6, 1347, 1972.

11) V.V. Ammosov et al. Nuclear Phys. B58, 77, 1973 Phys. Letters 42B, 519, 1972.

12) O. Balea et al. Nucl. Phys. B52, 414, 1973.

13) J.W. Chapman et al. Phys. Rev. Letters 29, 1696, 1972.

14) G. Charlton et al. Phys. Rev. Letters 29, 515, 1972.

15) F.T. Dao et al. Phys. Rev. Letters, 29, 1627, 1972.

16) M. Jacob TH. 1683-CERN (June 1973) pag. 80

17) References in IV Symposium on Multiparticle Hadrodynamics, Pavia, 1973.

18) G. Cecchet, R. Dolfini, F. Impellizzeri, S. Ratti, Lettere al Nuovo Cimento 6, 427, 1973.

19) P. Antich, E. Calligarich, G. Cecchet, R. Dolfini, F. Impellizzeri, L. Liotta and S. Ratti, IFNUP/AE 73/12, to be published Lettere al Nuovo Cimento.

20) Weingarten, Preprint NBI-HE-73-15.

21) P. Borzatta, E. Chiaveri, A. Daudin, L. Liotta, S. Ratti

communication at the IV International Symposium on Multiparticle Hadrodynamics (Pavia - 1973)

22) A. Giovannini, H.B. Nielsen (Torino University preprint IFTT.106 and NBI-HE-73-17)

23) Chan Hong-Mo, Proceedings of the 1972 CERN School of Physics, CERN 72-17 (1972)
S.S. Shei and T.M. Yan Phys. Rev. D6, 1744 (1972).

24) M. Garetto and A. Giovannini, Lettere al Nuovo Cimento 7, 35 (1973).

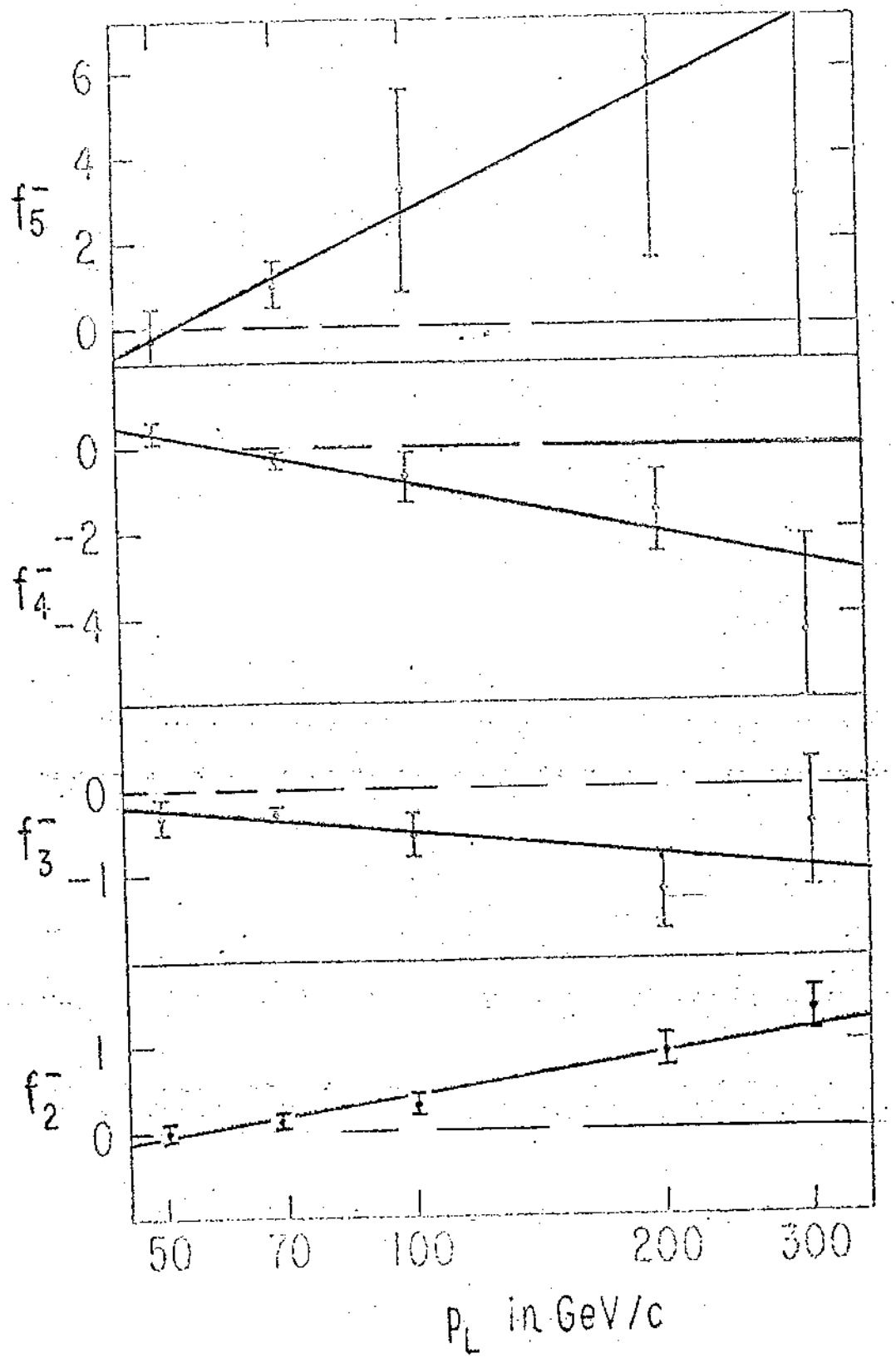

Fig. 1

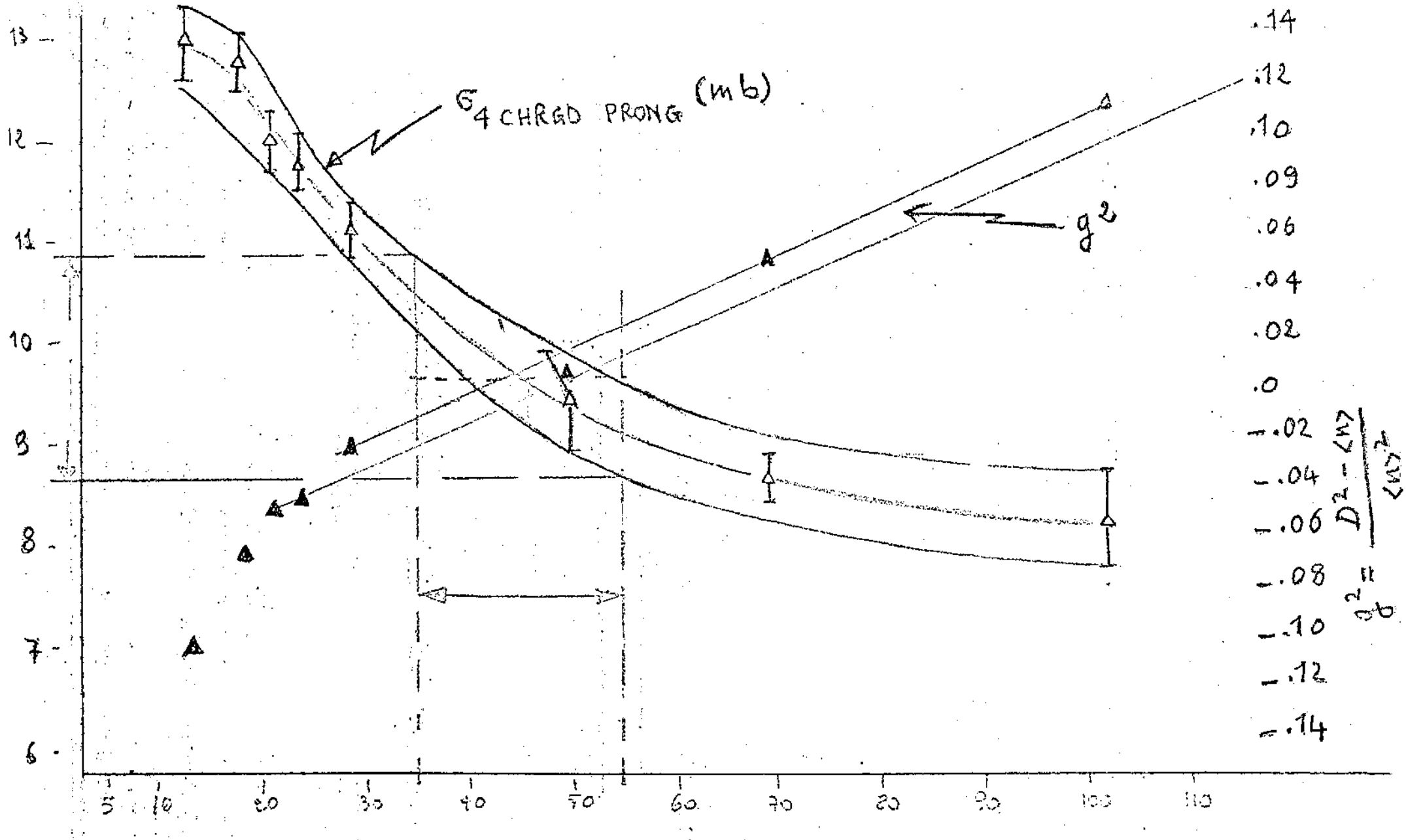
$\sigma_{4\,CHRGD\ PRONG}$ (mb)
g^2
$\frac{D^2 - \langle n \rangle}{\langle n \rangle^2} = \frac{g^2}{8}$
13
12
11
10
9
8
7
6
.14
.12
.10
.09
.06
.04
.02
.0
-.02
-.04
-.06
-.08
-.10
-.12
-.14
5
10
20
30
40
50
60
70
80
90
100
110

fig. 2