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LETTER OF INTENT

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PROPOSAL TO STUDY K^+p AND K^-p INTERACTIONS AT
70 GEV/C IN BEBC

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I. INTRODUCTION.

During the last years our laboratories in collaboration with other European laboratories are studying the K^+p and $\bar{p}p$ interactions at the highest available energy in Mirabelle bubble chamber experiments at Serpukhov. More than 100,000 pictures from K^+p experiments at 32 GeV/c have already been measured and it is hoped that the total will reach 400,000 for each experiment by the end of 1976. The preliminary results of these studies have already been published and presented at the international conferences. The present proposal is an extension of study of K^+p interactions to a still higher energy near 70 GeV at the CERN SPS with the Big European Bubble Chamber (BEBC). The RF separated beam^{/1/} and External Charged Particle Identifier (EPI)^{/2/} provide opportunity to get 70 GeV/c beam momentum, as the highest common available momentum for K^+ and K^- and when the EPI is still able to work.

A large hydrogen bubble chamber like BEBC is, in fact, one of the best available detectors for tackling a systematic and unbiased study of the many-body final states at high energy. The EPI behind the BEBC will help to solve K^+/π^+ , K^-/π^- , \bar{p}/π^- ambiguities in 4C-fitted channels. The identification of the majority of the fast forward particles will also facilitate some aspects of the inclusive studies.

A number of laboratories have proposed to study K^+p interactions in the BEBC. We are interested to participate in collaboration with other laboratories in order to be able to perform the proposed experiments in reasonably short time. Obviously many features of this proposal have already been covered in other letters of intent and proposals sent to SPSC. New forthcoming experimental and theoretical results may, of course, modify some

aspects of the proposed studies.

II. STATISTICAL SAMPLE.

Medium statistics exposure (10-25 $\text{ev}/\mu\text{b}$) to detect the channels with cross sections of the order of a few microbaras seems to be reasonable for first experiments at BEBS. It is undesirable to have more than 2 interactions per picture. Therefore we propose to run with no more than 10 beam tracks per photograph and to take 300,000 pictures for each of K^+ and K^- exposures. Using a 2.5 m long fiducial volume and the total cross sections $\sigma_{\text{tot}}(K^+p)=18.4 \text{ mb}$, $\sigma_{\text{tot}}(K^-p)=20.2 \text{ mb}$ at 70 GeV/c from ref.^{/3/} we shall have about 450,000 and 500,000 events of K^+p and K^-p interactions, respectively, roughly half of them elastic.

In order to get some experience in tuning the RF beams and in handling BEBC pictures we propose to start experiments with small exposures of 50,000 pictures for each of K^+ and K^- beams as soon as the SPS starts to operate.

Estimated topological cross sections for $K^{\pm}p$ interactions at 70 GeV/c can be found in another proposal^{/4/}, where the lower energy data, including Mirabelle experiments at 32 GeV/c^{/5/}, have been extrapolated up to 70 GeV/c.

The interesting feature of $K^{\pm}p$ interactions is the high percentage of events which gives rise to a visible K_S^0 decay in the chamber. The fraction of the inelastic cross section associated with K^0 production $\sigma_{K^0}/\sigma_{\text{inel}}$ is close to 40% for both K^+ and K^- reactions^{/6/} and practically independent of energy, although one can not exclude a possible small increase with s ^{/7/} (see fig.1). Extrapolation to 70 GeV/c shows^{/4/} that the total numbers of $K^0 \rightarrow \pi^+\pi^-$ decays are equal to about 26,000 and 30,000 in

K^+p and K^-p interactions, respectively.

An interesting result of 32 GeV/c $K^\pm p$ experiments at Mira-
belle¹⁷⁷ is unexpectedly high production cross section of Λ^0 's
(fig.1). Extrapolation to 70 GeV/c gives $\sigma(\Lambda^0) \approx 2$ mb for both
 K^+p and K^-p reactions with total number of seen Λ^0 decays on
the level of 15,000 events. Cross sections of $\bar{\Lambda}^0$ production in
 K^+p interactions and of multi V^0 production in $K^\pm p$ reactions also
go up to the values between 0,5 and 2 mb at 70 GeV/c. This, ta-
king into account a very small Λ^0/K^0 , K^0/γ , Λ^0/γ ambiguities as
found in 32 GeV/c $K^\pm p$ and 69 GeV/c pp experiments at Serpukhov,
gives a unique opportunity to an unbiased study of many aspects
of V^0 production in $K^\pm p$ interactions at BEBC with reasonable ac-
curacy.

III. PHYSICS INTERESTS.

1°) Multiplicity Distributions

Some very important general features of the $K^\pm p$ interactions
may be extracted rather easily from the scanning of the pictures.
Topological cross sections, multiplicity distributions, average
charged multiplicity $\langle n_c \rangle$, the dispersion $D = (\langle n_c^2 \rangle - \langle n_c \rangle^2)^{1/2}$,
the ratio $\langle n_c \rangle / D$, the integrated correlation function
 $f_2 = \langle n_c(n_c - 1) \rangle - \langle n_c \rangle^2$ and the normalized moments $C_q = \langle n_c^q \rangle / \langle n_c \rangle^q$
are interesting from the point of view of their energy dependen-
ces and particle-antiparticle comparison. For these multiplicity
studies first exposures of 50,000 pictures will give adequate
information.

2°) Inclusive Reactions

Our main interest lies in the study of many-body and, in
particular, of inclusive reactions. We would like to investi-

gate inclusive and semi-inclusive reactions for different kinds of particles like π^+ , K^0 , $\Sigma^0(\Lambda^0)$, $\bar{\Lambda}^0$ and resonances like $K^*(890)$, $Y^*(1385)$, $\Delta^{++}(1236)$. The EPI will allow to identify fast forward particles and consequently to study the reactions with fast inclusive K^+ , π^+ and p. This makes possible to extend the study of an approach to scaling in the projectile fragmentation region to a many new inclusive reactions, to test an exoticity rules in the Muller-Regge framework.

Among the most interesting subjects of inclusive studies is an approach to scaling in the central region for reactions with strong leading particle effect like $K^+p \rightarrow K^+X$, $K^+p \rightarrow K_S^0X$. The results for reaction $K^+p \rightarrow K_S^0X$ at 5, 8.2 and 16 GeV/c found by Birmingham-Brussels-CERN-Mons-Paris-Saclay-Serpukhov (BBCMSS) Collaboration indicate that the falling cross section for this reaction starts turning up with increase of energy and approaches the asymptotic value from below and close to the asymptotic limit for reactions $pp \rightarrow K_S^0X$, $\pi^+p \rightarrow K_S^0X$ (see fig.2). It is clear that an extension of this analysis to higher energy is crucial for direct experimental test of these interesting phenomena and for more accurate determination of the asymptotic limit.

Another interesting example of inclusive studies at the BEBC will be the determination of the total and topological $K^+\pi^-$ and $K^-\pi^+$ cross sections by a Chew-Low extrapolation applied to reactions $K^+p \rightarrow \Delta^{++}(1236) + X(m)$. The results of studies at present energies^{/8,9/} revealed the dominance of one pion exchange in these reactions, allowed to find the energy dependence of the total $K^+\pi^-$ cross sections. It would be of great advantage to study these reactions at appreciably higher energies than presently available. Besides the significant increase in the energy of $K^+\pi^-$

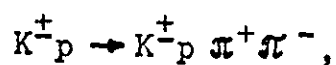
of extrapolation methods due to smaller values of $|t_{p, \Delta^{++}}|_{\min}$, i.e. closer to pion pole. This is important for understanding whether the structures seen in $K^+\pi^-$ -cross section by BBMPSS collaboration (fig.3) are meaningful or mere statistical fluctuations.

Among other topics in the field of inclusive reactions we may mention the study of two-particle correlations in the fragmentation and central regions and especially the separation of short-range correlations from dominant long-range effects. Analysis of inclusive resonance production in $K^0\pi^+$, $K^0\pi^-$, $K^+\pi^-$, $K^-\pi^+$ systems is of great importance for this.

Of course we are eager to look at the charge and strangeness transfer distributions, the reactions which require baryon exchange and are particularly useful for testing multiperipheral models. The study of diffraction mechanism in some inclusive reactions like $K^\pm p \rightarrow K^\pm X$, $K^\pm p \rightarrow pX$ as well as double diffractive dissociation in the reactions $K^\pm p \rightarrow (K\pi\pi)^\pm + X^\pm$, $K^\pm p \rightarrow (p\pi\pi)^\pm + X^\pm$ is also on the list of priorities. The use of the EPI is of great value here.

3°) Exclusive Reactions

A reaction particularly suitable for a conventional bubble chamber studies is the following



especially when slow proton can be identified by ionization and K^\pm/π^\pm ambiguity is resolved by the EPI. The investigation of $(K\pi\pi)$ states, Q, L and other possible resonances of higher mass will be pursued. Since all non-diffractive backgrounds are expected to be lower with increase of energy one may expect that a high energy

and L mesons are really resonances or mass enhancements of non-resonance origin. With expected statistics of the order of 2000 events one can hope to determine the quantum numbers and decay branching ratios of Q and L mesons and to establish production mechanism.

Non-diffractive quasi two-body reactions like $K^{\pm}p \rightarrow K^{*\pm}p$ or $K^{\pm}p \rightarrow K^{*}N^{*}$ have very much contributed to our understanding of few-body dynamics. At 70 GeV/c according to power law $G \sim p_{LAB}^{-n}$ the expected cross-sections are of the order of a few microbarns only. But still the investigation of quasi two-body reactions would give a very useful information.

In the course of the picture analysis several another reactions with small cross sections may be studied, among them are reactions with rare hyperons and excited hyperon states. It is hoped that at higher energies some of them are produced with sufficient cross sections. New forthcoming results from Mirabelle $K^{\pm}p$ experiments at 32 GeV/c will give more information for an extrapolation to 70 GeV/c.

IV. EQUIPMENT AND MANPOWER

Our equipment available for the analysis of the film from the BEBC will include about 6 film plane digitizers "Adam + Eva"^{/10/} (of the same type that we use now for treatment of Mirabelle film) and one CRT device^{/11/} or HPD.

A measuring power of 6 film plane digitizers "Adam + Eva" for scanning and measurement of the BEBC pictures together with one of the listed above automatic devices is of the order of 50.000 events per year. This power can be increased up to 100.000 events

As was stated in introduction we propose to share our efforts with other laboratories that are going to perform K^+ and K^- experiments. On our part about 10 physicists will participate in these experiments.

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FIGURE CAPTIONS

Fig. 1. Inclusive K^0 , Λ^0 , $\bar{\Lambda}^0$, $\Lambda^0 K^0$ and $K^0 K^0$ cross sections in K^-p (a) and K^+p (b) interactions versus the center of mass energy \sqrt{s} .

Fig. 2. The energy dependence of inclusive cross sections for K_S^0 producing reactions in the central region (at $p_{Tj}^* = 0$). The dashed curve is prediction of the double-Regge formula with parameters found from analysis of inclusive spectra at 5, 8.2 and 16 GeV/c.

Fig. 3. Total and topological cross sections as functions of the c.m. energy of $K^+\pi^-$ a) with different cutoffs $|t|_{\max}$ for different intervals of m_X , b) for $|t|_{\max} = 1.0 \text{ (GeV/c)}^2$ for all values of m_X .

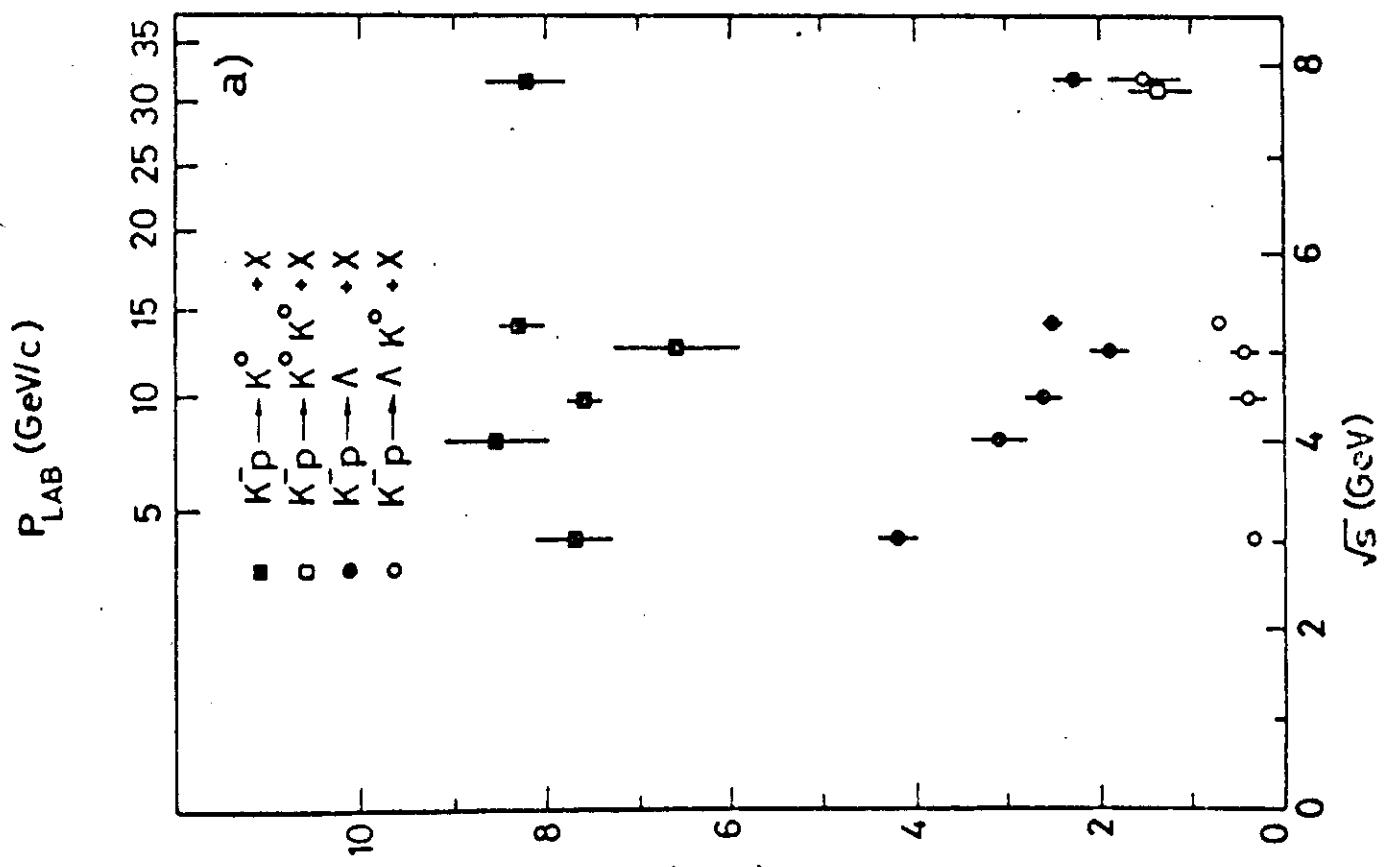
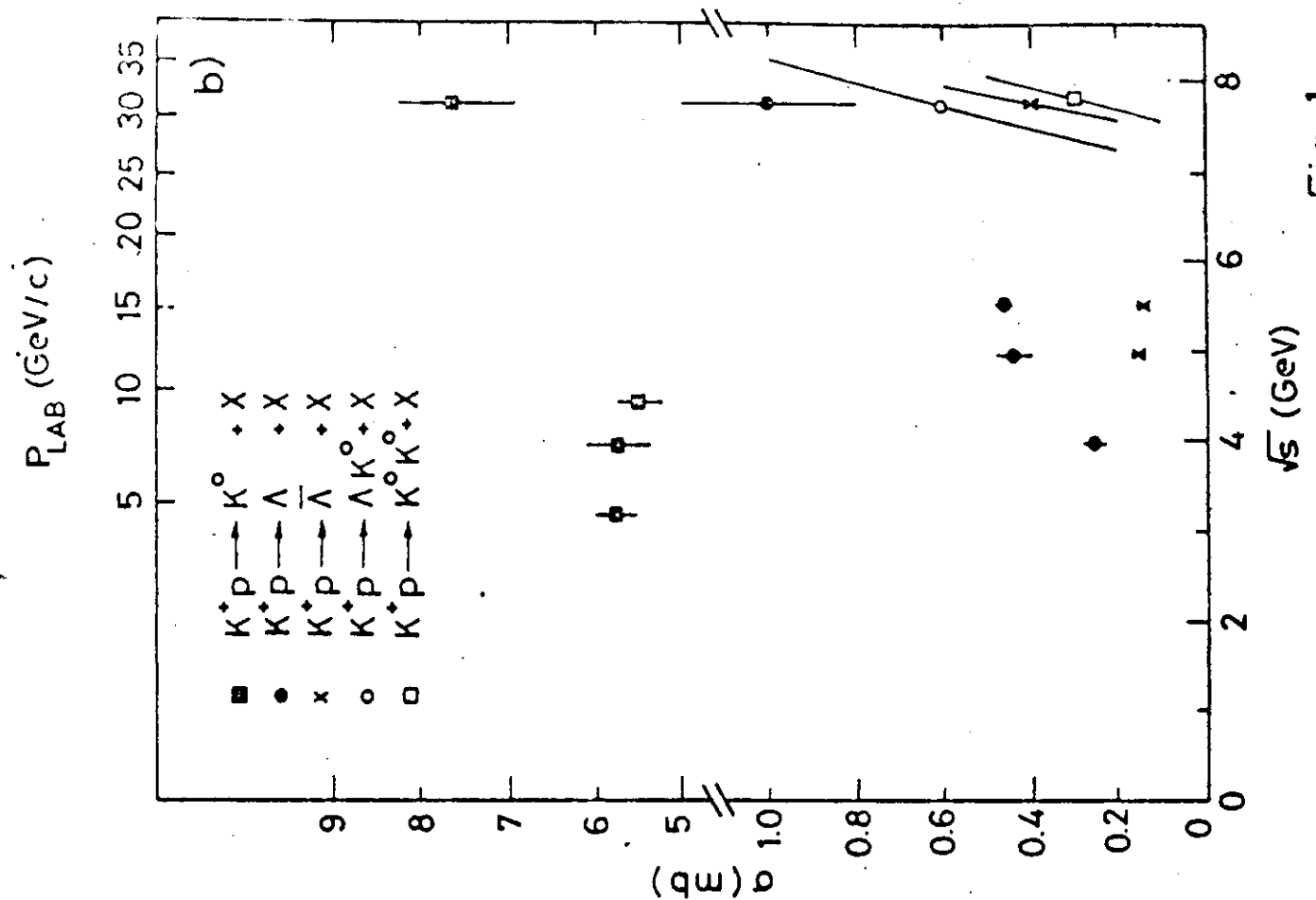


Fig. 1

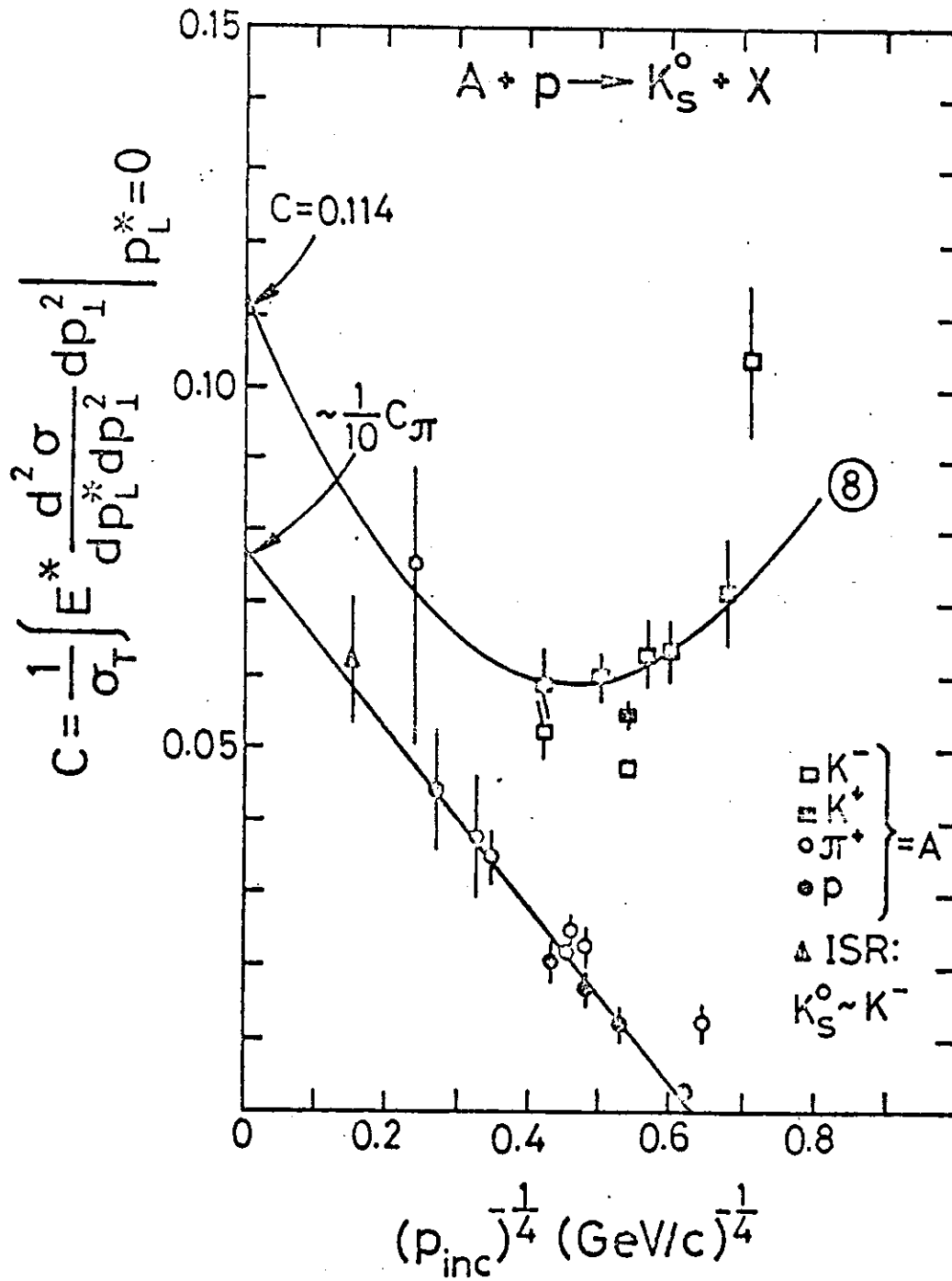


Fig. 2

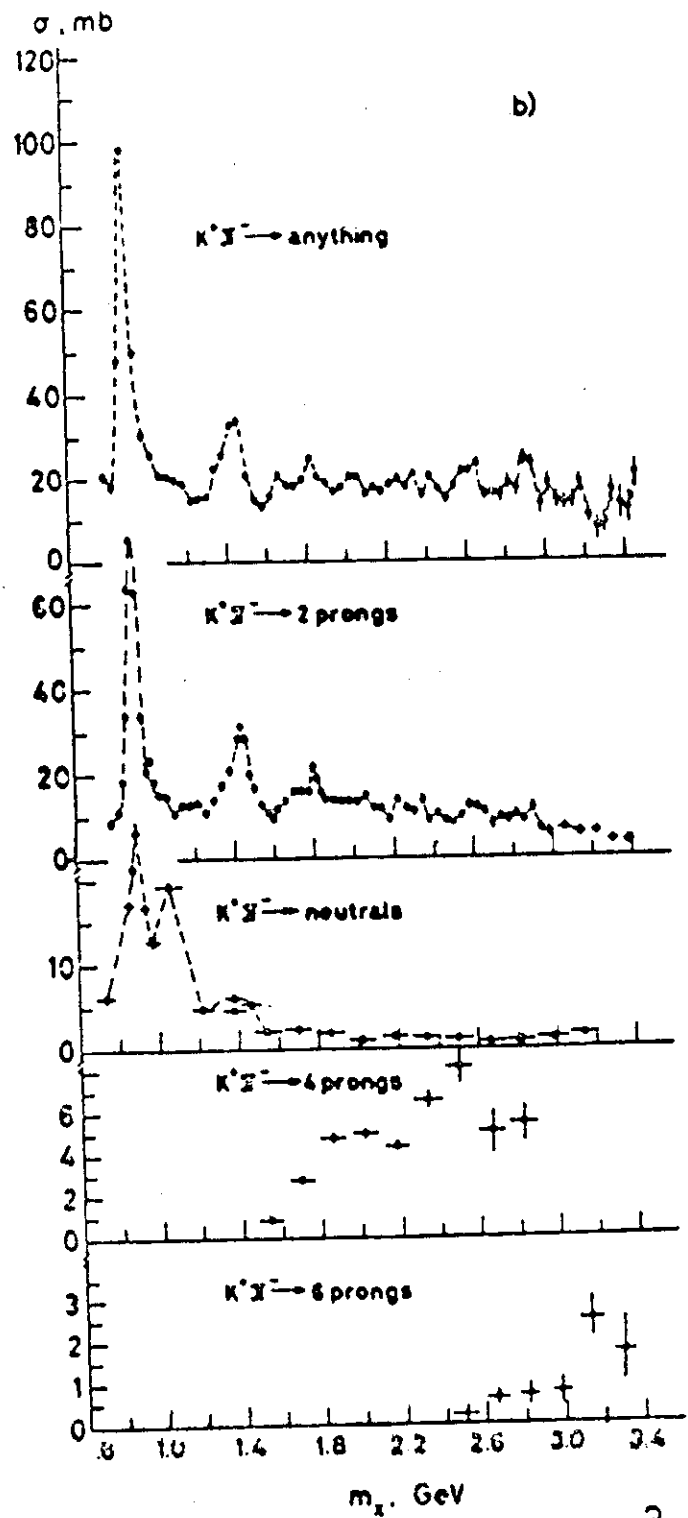
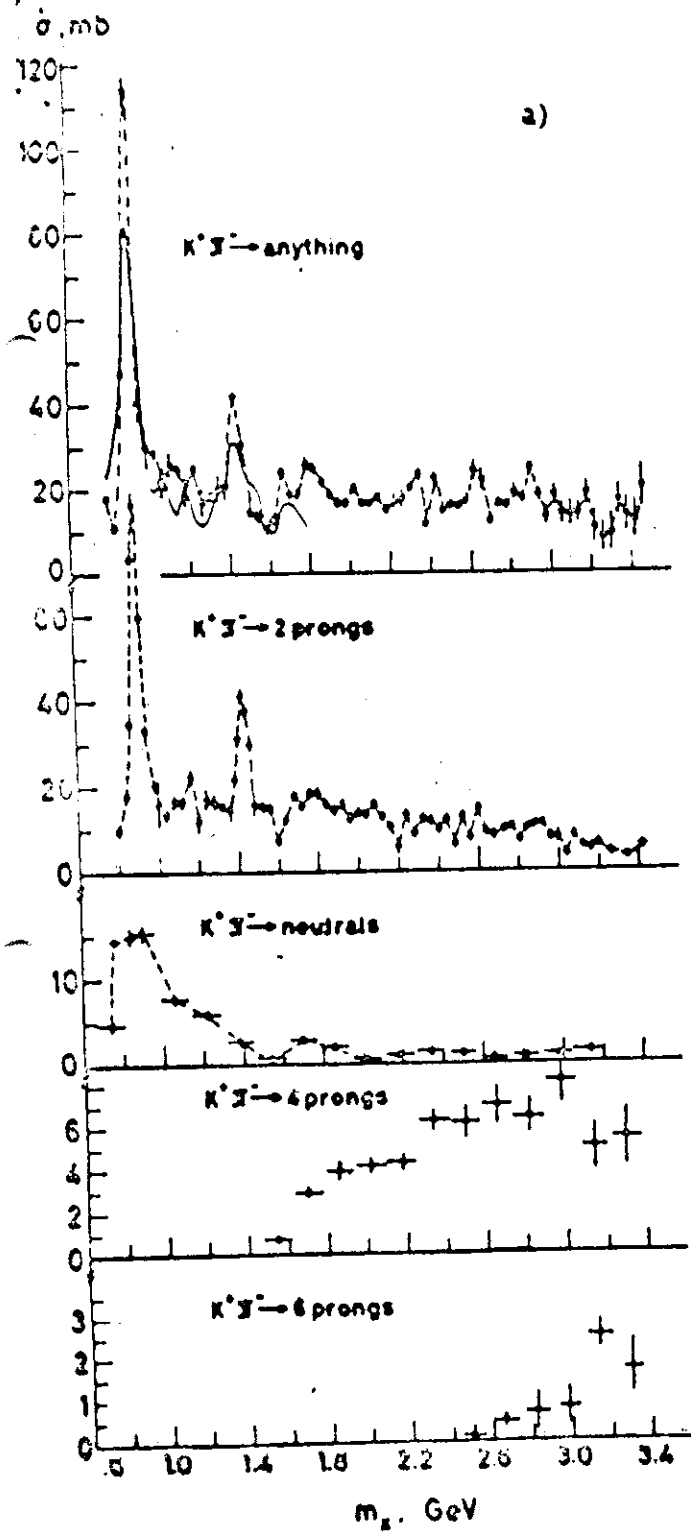


Fig. 3