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LETTER OF INTENT TO STUDY $\bar{p}p$ INTERACTIONS IN BEBC AT $\sim$ 10 GeV/c

B. Tallini

TC CERN

1. We propose to study $\bar{p}p$ interactions in BEBC at about 10 GeV/c with as large statistics as possible, in order to search for the possible production, in the $\bar{p}p$ annihilations, of narrow-width resonances which could be associated with "charmed quarks" mesons.

These could be produced either as single particles $(c\bar{c})$ i.e.

$$\bar{p}p \to \phi_c \; m\pi\text{'s} \quad ; \quad \phi_c' \; m\pi\text{'s}$$
$$\to \eta_c \; m\pi\text{'s} \quad ; \quad \eta_c' \; m\pi\text{'s}$$

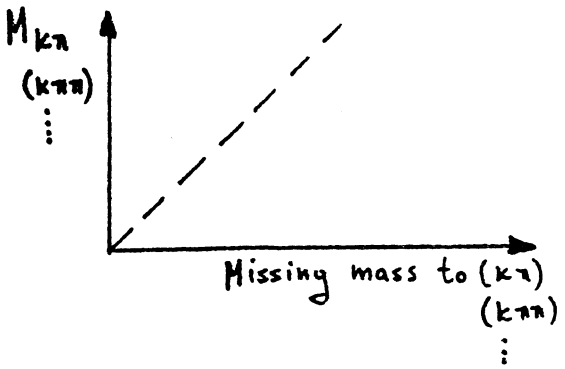
or in pairs $(c\bar{q})$ i.e.

$$\bar{p}p \to D_o \bar{D}_o$$
$$\to D^+ D^- \qquad D, \bar{D} \to \text{hadrons}$$
$$\to D \bar{D} \; m\pi\text{'s}$$

possible hadronic decays (with up to $\sim$ 30 % branching fractions):

$D_o \to K^- \pi^+$	$D^+ \to \bar{K}^o \pi^+$
$\to \bar{K}_o \pi^+ \pi^-$	$\to K^- \pi^+ \pi^+$
$\to \bar{K}^o \pi^o$	$\bar{K}^o \pi^+ \pi^o$
$\to K^- \pi^+ \pi^o$	$\bar{K}^o \pi^+ \eta$
'	'
'	'
'	'

In the case of quasi-two-body production, one could get all decays $D\,k\pi\,.\,\bar{D}_{all}$ or $D_{k\pi\pi}\,.D_{all}$ by studying the events on the 45° line in the scatter diagram of $M_{k\pi(k\pi\pi)}$ vs. the missing mass to the system $k\pi$ or $k\pi\pi$ ...(Fig. 1).
In this way all events can be used independently of their constraint type o-c, 1c, 4c, with resolutions on effective masses and missing masses given in the appendix.



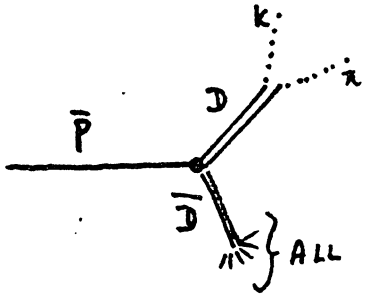


Fig 1

2. Physics justifications:

a) $\bar{p}p$ annihilations represent a large source of high $P_{\perp}$ events (accessible to HBC); the most promising region to look for production of large mass objects (Fig. 2).

b) ϕ_c: existing $\bar{p}n$ data show sharp enhancement at $\sim$ 3.1 GeV/c (Fig. 3).

c) $\eta_c^?$: existing $\bar{p}p$ data show sharp enhancements at 2.37 and 2.61 GeV/c (Fig.4)

3. Advantages of using BEBC

a) good resolution (ϵ = 250 μ, H = 35 kGauss) 2 ./. 3 times better than the 200 HBC (ECFA studies).

b) good γ-ray detection efficiency (15$\sim$20%).

c) good strange particle (V^o) detection efficiency.

d) reasonable particle identification (I.D., dE/dx over a long length and high field, trapping, secondary interactions ...)

4. Number of events

12 ½ weeks running time could give 200 ./. 500 kpictures corresponding to 20 to 50 events/μb respectively with 10 $\bar{p}$ per pulse (250 cm Invol.)

σ_{TOT} $\sim$ 50 mb	50 evts/μb	→	2.5 10^6	events
$\sigma_{ANNIHIL.}$ $\sim$ 15 mb.	" " "	→	.75 10^6	events } at 5.7 GeV/c
$\sigma_{k^o\ SEEN}$ $\sim$ 1 mb	" " "	→	50.000	events }

We propose to measure in the first place all events with associated V^o's. These are mainly k^o annihilations although Λ's and $\bar{\Lambda}$'s will also be present and will be measured at the same time. Subsequently the other annihilations will be scanned for and measured (with some selection criteria to eliminate small $P_\perp$ secondary protons or antiprotons).

5. Independently of the outcome of the charmed mesons search, a $\bar{p}$ run in BEBC in the 10 GeV/c region would represent a good complement to the $\bar{p}$ experiments now in progress in the 200 HBC at 12 GeV/c (CERN TCC 72-39) or proposed in the same chamber by the "Working party on $\bar{p}$ interactions" (CERN-TCC 74-25).

APPENDIX

Preliminary results of a study of event simulation comparing resolutions in the 200 HBC and BEBC are shown in Table I.

The reaction generated is

$$\bar{p}p \rightarrow D_o\bar{D}_o \; ; \quad D_o \rightarrow k^{\pm}\pi^{\mp} \; ; \quad \bar{D}_o \rightarrow \text{all}$$

The D_o is detected by the effective mass of the ($k\pi$) system, the $\bar{D}_o$ by the missing mass to the $k\pi$ system.

The widths of the D's were taken $\Gamma_{D=o}$; the angular distributions were assumed isotropic both for the production and decay of the D's.

The parameters $^1/p$, λ, ϕ were given spreads within their errors (Coulomb + distortions) in the usual way. The incident $\bar{p}$ momentum was assumed to be known from the beam optics to $\pm$ 0.2%, the λ and ϕ are measured in the chamber (10 cm track length in the case of the 200 HBC, 15 cm in BEBC). No secondary interactions nor decays were introduced and the tracks were taken as straight. The errors on the masses given in Table I correspond to ΔM measured of the type one could use for all events 0c, 1c, 4c.

TABLE I : $pp \rightarrow D_o \bar{D}_o$; $D_o \rightarrow K^{\pm}\pi^{\mp}$; $\bar{D}_o \rightarrow$ all ; M_D = 2,15 GeV; Γ_D = 0

Pinc.	200 HBC H=17.5 kgauss ε=70μ	BEBC H=35 kgauss ε=250μ	BEBC H=25 kgauss ε=250μ	BEBC H=20 kgauss ε=250μ
10 GeV/c	$\Delta M_{k\pi}$ = ±22 Mev ΔMM = ±30 Mev	±8 Mev ±10 "	±9 Mev ±13 "	±11 Mev ±15 "
12 GeV/c	ΔM ±24 Mev ΔMM ±43 "	±9 Mev ±16 "	±10 Mev ±20 "	±12 Mev ±22 "

ΔMM = error on missing mass to the $(k\pi)$ system

INVOL 200 HBC : ΔX = 100 cm ; Δy = 15 cm ; ΔZ = 2 cm

INVOL BEBC : ΔX = 250 cm ; Δy = 80 cm ; ΔZ = 4 cm

$\langle P_T \rangle$ versus $\langle |P_L| \rangle$ CORRELATIONS IN ANNIHILATION AND NON-ANNIHILATION PROCESSES

$\bar{p}p \rightarrow$ pions ○

$pp \rightarrow NN +$ pions } ▫ pions

$\bar{p}p \rightarrow \bar{N}N +$ pions } ▫ nucleons

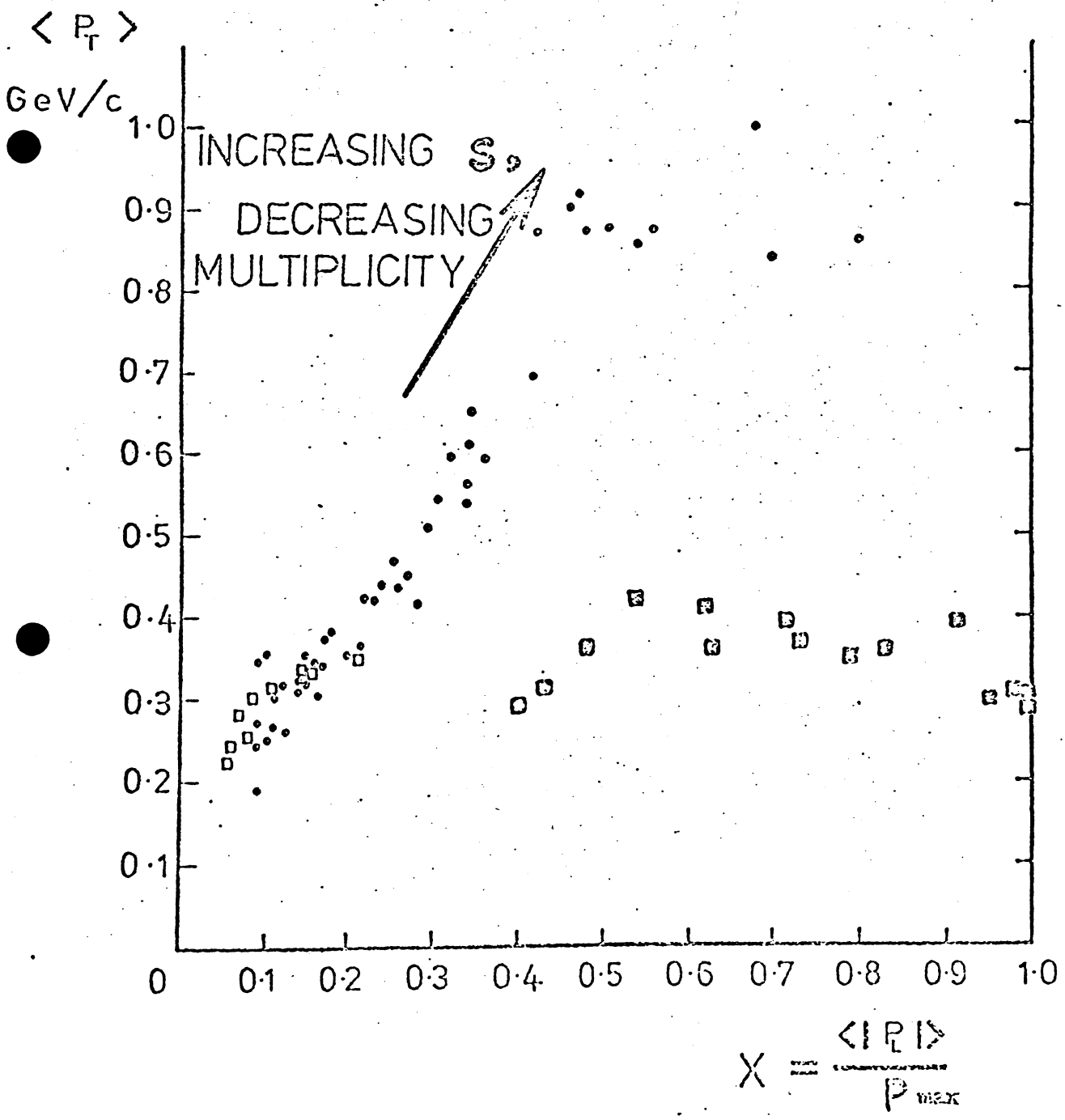


FIGURE 2. from Ref. CERN-TCC/74-25

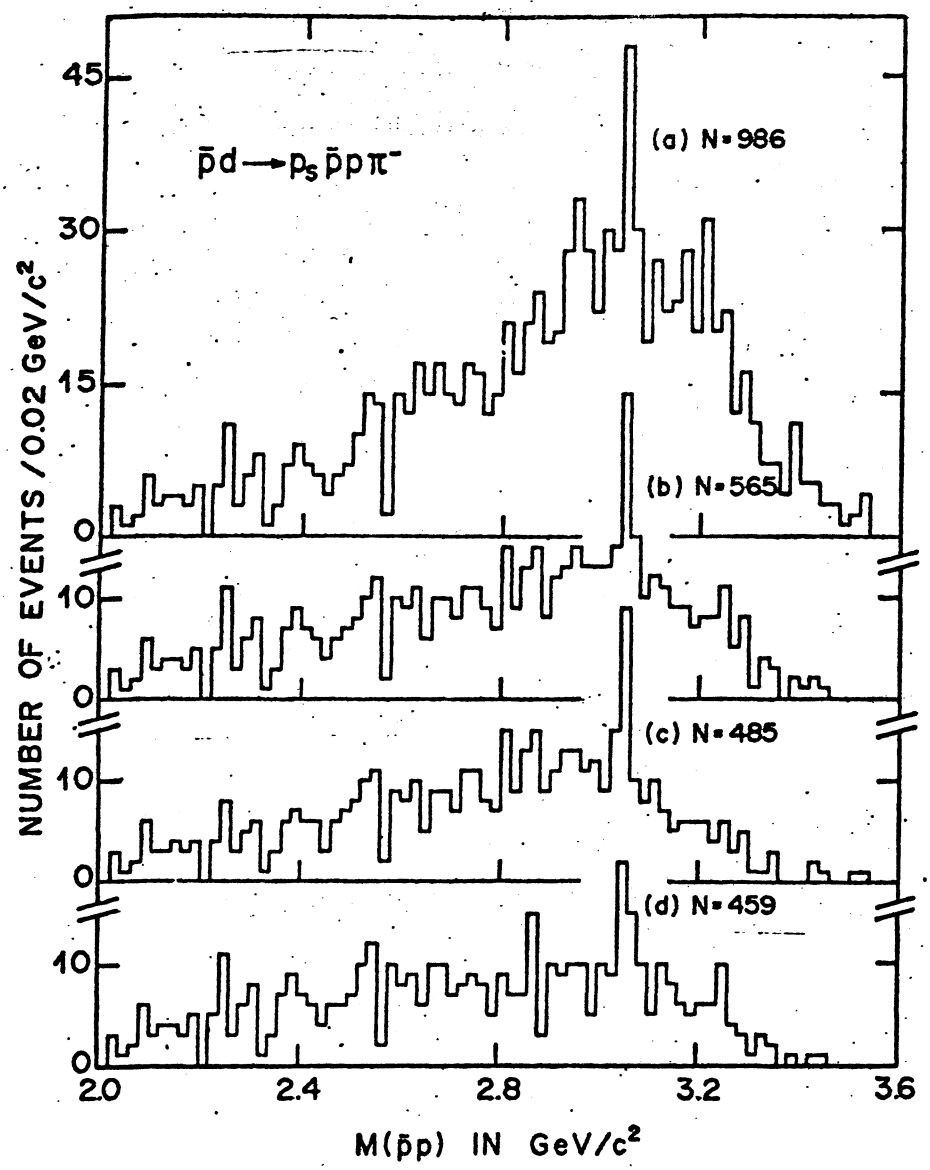


Figure 3 from H. BRAUN et al { Strasbourg CBH-71-3 Report to Amsterdam Conference 1°

The $M_{\bar{p}p}$ distributions

a) All the $\bar{p}d \rightarrow p_s \bar{p}p\pi^-$ events.

b) Excluding the events in the $\bar{\Delta}^{--}$ band defined by $1.16 < M_{\bar{p}\pi^-} < 1.32$ GeV/c².

c) Excluding the events in the $\bar{\Delta}^{--}$ band and also those for which the faster proton has a laboratory momentum less than 0.28 GeV/c.

d) Excluding the events in the $\bar{\Delta}^{--}$ and Δ^0 bands i.e. : $1.16 < M_{\bar{p}\pi^-}$, $M_{p\pi^-} < 1.32$ GeV/c².

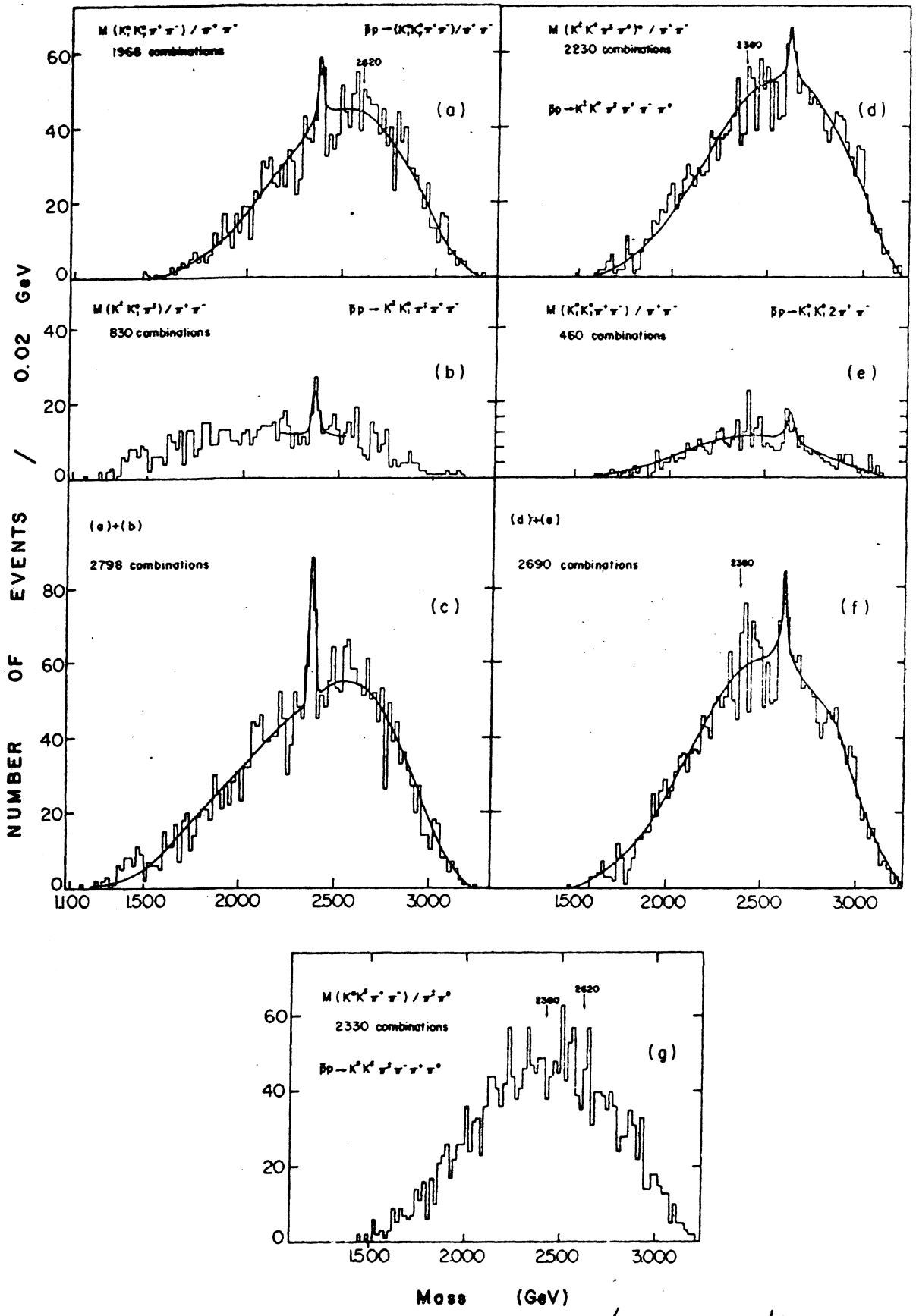


Fig. 4 Reference H.W. Atherton et al CERN/D-Ph II/Phys. 71-18