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LETTER OF INTENTION

To : Members of the EEC

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Subject : Systematic study of γ's and electrons produced in $\bar{p}p$ annihilation at rest.

We propose to study the production of γ-rays and electrons originating from $\bar{p}p$ annihilation at rest. Our attention is mainly focused on the following reactions.

1.1 E $\to 2\gamma$, using E produced in the $\bar{p}p \to E\pi\pi$ annihilation process.

The 2γ-decay is of importance in view of the determination of the pseudoscalar nature of the E-meson.

Presently, the two available candidates as ninth member of the pseudoscalar noneth are[1]:

the X^0	M = 958 MeV	$J^P = 0^-$ or 2^-
the E	M = 1420 MeV	$J^P = 0^-$ or 1^+ .

Many theoretical models[2] predict for such particle a mass in the region 1400-1500 MeV, thus favouring the choice of the E . The detection of the E $\to 2\gamma$ decay would give additional weight to this choice and the measure of its width would help to select a model in the frame of an SU(6) breaking theory[3].

1.2 A systematic survey of the channels $\bar{p}p \to \pi^0\omega$; $\to \pi^0\phi$; $\to \eta\omega$; $\to \eta\phi$, leading to 5γ-decay modes.

The measurements of the rates of these modes can be discussed in terms of vector meson dominance models and used to solve ambiguities presently existing in quantitative descriptions of meson decay[4], (in particular, to test the predictions of SU(3), SU(6) and quark models).

1.3 A search for the mode $\bar{p}p \to \bar{e}e$ at rest

A measurement of the cross-section for this reaction in flight was proposed in 1962 by Zichichi, Berman, Cabibbo and Gatto[5]; it was attempted at CERN[6] at $q^2 = 6.8$ (GeV/c)^2 and at Brookhaven[7] at $q^2 = 5.1$ (GeV/c)^2.

In both cases only upper limits for the cross-section were obtained ($\sigma \leqslant$ one nanobarn).

Recent measurements[8], carried out at Frascati intersecting storage rings, on the invers reaction $e\bar{e} \to \bar{p}p$ at $q^2=4.3$ (GeV/c)^2 have yielded a value of the cross-section which is much higher that it could be deduced from the above quoted upper limits.

Model independent comparison of all these results is difficult since they were carried out at different q^2's. Thus a new experiment carried out with $\bar{p}$ at rest $[q^2 = 3.53$ (GeV/c)$^2]$ is needed to clarify this question.

2. EXPERIMENTAL SET-UP

Figure 1 shows a schematic view of the experimental set-up. The beam of $\bar{p}$ is defined by three counters (# 1, 2, and 3). It is slowed down in a moderator M and brought to rest in a liquid hydrogen target (10 cm ∅ and 15 cm long).

A set of counters (# V) surrounds the targets and discriminates γ's from electrons or other charged particles. Counter # 4 is an anti-coincidence counter placed there to eliminate the background produced by particles non stopping in the target.

The energy and direction of the γ's and/or electrons are determined by the system (A,B,C,D) of optical spark chambers, absorbers and scintillators, arranged as sketched in Fig. 1. The particular geometry varies with the various problems mentioned in Section 1.

Previous experience[9] indicates that with such an apparatus a resolution in energy of ±15% and an angular resolution of 1° are obtainable for gamma rays and electrons of an energy ≥ 200 MeV. The rejection factor against pion of ≥ 400 MeV was of 5×10^{-4}.

3. PRELIMINARY ESTIMATES OF EVENT RATES AND BACKGROUNDS

A simple Monte Carlo calculation has been carried out for a preliminary estimate of production rates and backgrounds. Assuming:

a) a circulating proton beam of 8×10^{11} protons per burst;

b) the use of the k_{12} beam and

c) 300 stopping $\bar{p}$ per burst in our target[10];

the following event rates, per day, are expected:

a) $\bar{p}p \to E\,\pi^0\pi^0$ $(E \to 2\gamma)$ 60 ± 30 events per day detecting only the two γ's from E decay, with an energy cut at 500 MeV for each γ [11];

b) assuming a relative abundance of production*) of 5×10^{-3} and considering γ's of an energy $E_\gamma \geq 200$ MeV only,

$\bar{p}p \to \pi^0\,\omega$ ($\omega \to \pi^0\gamma$) 160 events per day

$\to \pi^0\,\phi$ ($\phi \to \eta\gamma$) 50 events per day

$\to \omega\eta$ ($\omega \to 2\gamma$, $\omega \to \pi^0\gamma$) 60 events per day

$\to \phi\,\eta$ ($\phi \to 2\gamma$, $\phi \to \eta\gamma$) 20 events per day

c) For the $\bar{p}p \to \bar{e}e$ channel, the proposed apparatus with the presently existing k_{12} beam[10] (i.e. 8×10^{11} proton per pulse) would reach the upper limit already obtained by Conversi et al.[6] in 20 days.

If the booster was operated to produce 8×10^{12} protons per pulse the same limit would be reached in two days; a 20 day run would allow us to detect it or to push the upper limit of the relative branching ratio to 10^{-9}.

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*) Notice that the measurement of the process $\bar{p} + d \to \pi^- + \omega^0 + p_{sp}$ gives in fact a rate of $\sim 5\times10^{-3}$.

4. REQUIREMENTS

All these experiments can be carried out in the existing k_{12} beam[10]. Beam m_{11}[12], although not as convenient, should not be excluded *a priori*.

We are also considering the possibility of building another enriched $\bar{p}$ beam at low energy.

As implied in Section 3.4, it would be of great help to have the use of the booster in connection with the study of the $p\bar{p} \to e\bar{e}$ channel.

5. PERIODS OF EXPERIMENTATION

It is proposed that the experiment be carried out in two periods. Using the k_{12} beam a first period of six weeks is required to carry out the program outlined in Sections 1.1 and 1.2.

In a second period - also of six weeks - the $e\bar{e}$ annihilation mode would be studied.

An interval of 3 to 6 months is required between the two periods and a test run of two weeks before each period.

We intend to be ready for data taking in the Autumn 1973.

4. COLLABORATORS

Preliminary approaches have taken place between the Turin Group and other groups which may lead to establishing a collaboration. It is in fact our intention to do so.

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Figure captions

Fig. 1 : Geometry of the recording apparatus. (ABCD) = optical spark chambers imbedded with scintillation counters and absorbers (not drawn). The planes of the chambers, counters and absorbers are parallel to the dotted lines.
"L" are the cylindrical lenses for the photographic recording system.
"M" is the moderator.
"H_2" is the hydrogen target.
#1, 2, 3, 4 and V are plastic scintillators.

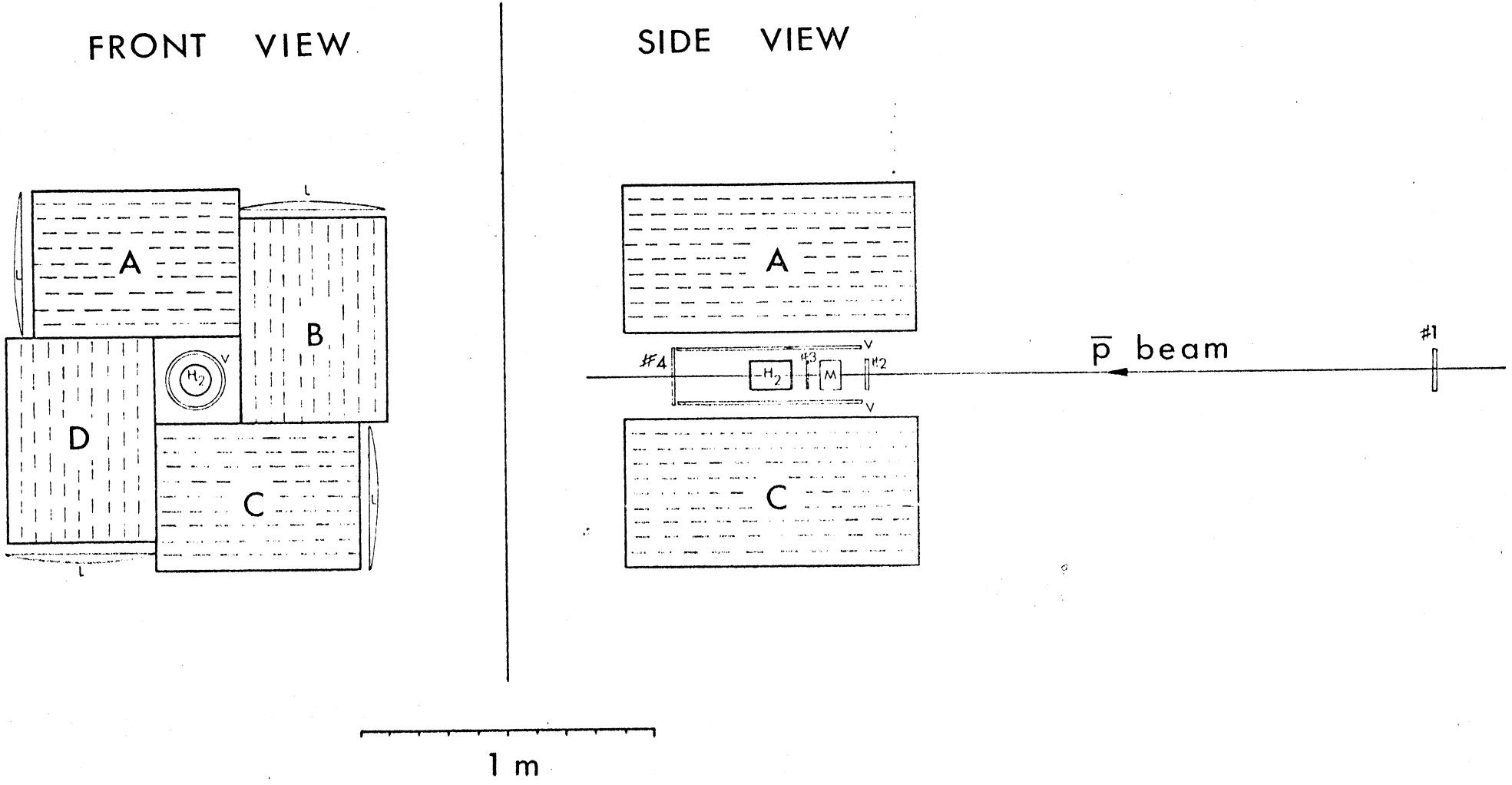

FIG. 1