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EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

$\pi^- + P \rightarrow \pi^0 + N$

EXPERIMENTAL ARRANGEMENT

Figure 1 shows the experimental arrangement.

Characteristic Events

A characteristic event will show one γ ray converted in S_6 and another γ ray producing a shower in S_5 or S_7 or S_{10} .

Triggering System

The chambers will be triggered on a coincidence $\bar{A}$, $\bar{C}_1 C_2$ (C_3 suitable twofold).

This demands that

1) no neutral particles leave the hydrogen target
2) no large angle π^0 are produced
3) charged particles are produced in the convertor chamber
4) the charged particles have momenta $P_1 + P_2 = P_T$ adding to $8 < P_{total} < 10$ Gev.

RATE OF TRIGGERS

We expect to work with a flux of $\emptyset\ 10^5\ \pi^-$ per pulse, where $2 < \emptyset < 6$.

We know that the total cross section for producing γ rays with $8 < E_\gamma < 10$ is $0{\cdot}50\ 10^{-26}$ cm^2 ster^{-1}, and falls off at $\sim 2^0$ from our survey measurements (to be published in Nuovo Cimento). With an 8% convertor thickness we will record a total number of $\emptyset/20$ counts per burst. Very possibly most of these are charge exchange events.

If we take a "theoretical" lower limit from the $\pi^+ P$, $\pi^- P$ total cross sections and assume all the π^0 channel amplitude is the imaginary amplitude given by the optical theorem, then we get about $\emptyset/30$ charge exchange events per machine pulse.

Thus our trigger rate will not exceed one in three pulses (if $\phi = 6$), and our rate of charge exchange events should be at least of the order of 1 in 15 pulses (for a pessimistic $\phi = 2$).

Determination of Charge Exchange above Background

Each event is over-determined in that the shower producing γ ray must lie on a well determined cone, and therefore the presence of one π^0 cannot be confused with 2 γ rays arising from another process. The energy distribution of the π^0 from the reconstruction of the event should be good to about m_π in about 50% of the events and therefore inelastic processes such as $\pi^- + P \rightarrow N + \pi^0 + \pi^0$ should not only trigger the anticoincidence but also fail in the kinematic fit. Processes such as $\pi^- + P \rightarrow \Lambda + K^0$ should fail the kinematic fit even if only one π^0 enters the system.

PRECISION OF MEASUREMENT

The measurement of the angle and momentum of one γ ray are sufficient to determine the angle of the π^0 to $\pm$ 10 mr. Using the orientation of the second γ and the energy of the first γ we estimate an error of $\lesssim$ 2 mr in the π^0 emission angle.

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COMMENTS COMPARING THIS ARRANGEMENT WITH THE SACLAY PROPOSAL

The two experiments are very different. The major differences are:-

		CERN	Saclay
1)	Triggering	selective counter system demands high energy γ	all neutral events accepted
2)	Geometry	spark chamber cover $\Omega = 2\pi$ around H_2 target, and all beam path	spark chambers cover small solid angle, not all beam path
3)	Information	measures angle and energy of 1 γ, point of conversion of other	measures point of conversion of 2 γ's
4)	Material in beams.	Thin convertor ~ 2% of nuclear interaction upstream, Pb at end of layout.	Beam particles interact in convertor chamber.

As a consequence of these differences the CERN arrangement has the following advantages:-

1) With a background of ~ 100 neutral reactions $\left(\begin{array}{c} \pi^- + P \to \text{all neutral} \\ \sigma = \sim 600\ \mu b \end{array} \right)$ per charge exchange ($\sigma = \sim 8\ \mu b$) the additional information to overdetermine the events may be very useful.

2) The compact geometra does not allow an event like

$$\pi^- + P \to \Lambda + K_2^0 \searrow \pi^0 + (\text{others})$$

to give rise to a π^0 outside the anticoincidence system.

3) The accuracy in angular resolution may yield something interesting. For example the $\pi^- p$ elastic scattering data of S. Brandt, V. Cocconi et al hint at an anomaly at small angles.

<u>The disadvantages are</u>

1) The complexity of the apparatus.

2) The high beam intensity required. - (With the high beam intensity and the trigger system the rate of collecting charge exchange events is about the same in both experiments. This arises because without a trigger system most of the events recorded will not be charge exchange).

FIGURE CAPTION

Figure 1 :

H_2	30 cm long hydrogen target
A	Anti-counter (scintillation and Pb)
A'	Anti-counter (scintillation only)
$S_{1,2,3,4}$	Thin plate spark chambers define beam momentum and angle of incidence on target
$S_{5,7,10}$	Spark chambers cover all solid angles not covered by A in forward direction, they contain 6 to 10 rad lengths of Pb
$S_{6,8,9}$	Thin plate spark chambers for γ ray conversion and momentum measurement
C_3	An array of 24 scintillation counters.
C_1 C_2	Scintillation counters

S_5 LAYOUT 27/11/62

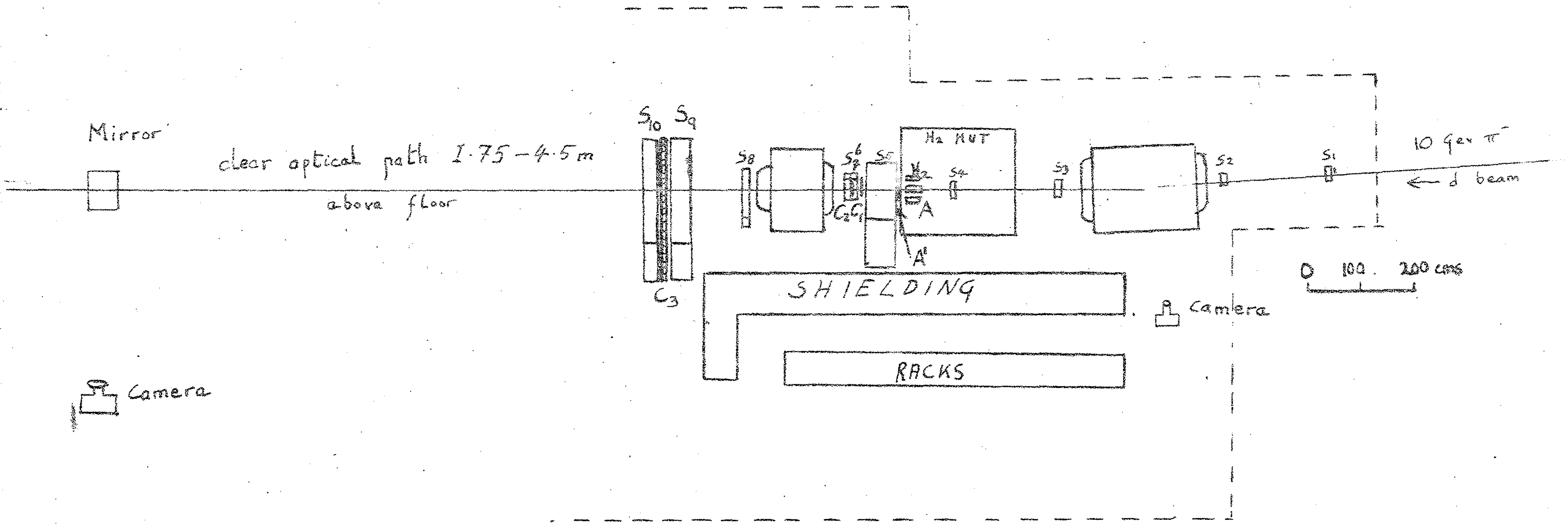

Fig. 1

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MACHINE TIME NEEDED FOR $\pi^- + P \rightarrow \pi^0 + N$

a) **SETTING UP**

The only change in the apparatus from recording $\pi^- + P \rightarrow \gamma$ + anything is to insert the anti-counter around the H_2 target. This should not take more than 2 shifts additional machine time.

b) **DATA COLLECTION**

At one good event in 30 pulses we should collect about 1000 charge exchange events a day. We consider 2000 events a sensible guess at the number to record, (until the analysis of angular distribution is completed we can only guess) and consider that 10 shifts of machine time should cover this with a small safety margin.