CERN/ISRC-74/42
3 September 1974

Install Jan. 75 ?
withdrawn

INTERSECTING STORAGE RINGS COMMITTEE

Proposal to study neutral meson decays and π^0-π^0 correlations in I7 in 1975

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G E N E V A
1974

We propose to study neutral meson decays and $\pi^0\pi^0$ correlations in I7 in 1975, using existing lead-glass detectors.

1. PHYSICS MOTIVATION

i) Several recent measurements at NAL and ISR are suggestive of abundant meson resonance production:

- In the low transverse momentum region the presence of a ρ^0 peak in $\pi^- p$ and pp collisions.
- The weakness of $\pi^+\pi^+$ and $\pi^-\pi^-$ correlations.
- The azimuthal dependence of the charged-charged correlation function.
- In the large transverse momentum region the lepton spectra which are observed to be four orders of magnitude below pion production.

Even if meson resonance production is not a dominant process it is likely to be important enough to obscure whatever other dynamical effect we hope to observe. We propose to search for neutral resonances through decay modes such as

$$\eta \to \gamma\gamma \quad \text{(B.R. 38\%)}$$
$$\omega \to \pi^0\gamma \quad \text{(B.R. 9\%)}$$
$$\text{etc.}$$

ii) The CERN-Columbia-Rockefeller Collaboration was first to report on correlations between large transverse momentum π^0's produced at 90° either alongside or back to back. Strong correlations were found, in both configurations. In the "alongside" configuration the invariant cross-section for dipion production is comparable to the one for inclusive production of a single pion. In the "back to back" configuration the mean transverse momentum between the pions is as high as 1.3 GeV/c. These data are essential in understanding the production mechanism and give some insight into the validity of the parton picture. We propose to extend these measurements of the momentum correlation function to a new domain of azimuthal difference $\Delta\phi$ and rapidity difference Δy between the pions.

2. EXPERIMENTAL SET-UP

Two lead-glass arrays will be used. The first (Aachen-CERN-Torino) consists of a honeycomb pattern of 61 hexagonal cells and covers $\sim 1\ m^2$. The other (CERN-Heidelberg) is made of 84 square blocks, which can be assembled at will in any configuration and cover a total of $\sim 2\ m^2$. Both detectors have very similar properties: an energy resolution of $\sim 12\%$ FWHM at 1 GeV and a spatial resolution of $\sim \pm 3$ cm. The cell depth of 15 radiation lengths ensures an excellent linearity over the explored energy range and the cell cross-section of $\sim 200\ cm^2$ is such that a shower is fully contained in a triplet.

From past experience in I7, we have learned that such detectors can be operated at large angles without any background contamination when properly shielded from the incoming beams. In particular, the requirement of a coincidence between two arrays with a minimum of 500 MeV deposited in each is sufficient to select beam-beam interactions. The thick walls (0.3 radiation lengths) of the central section of the vacuum chamber in I7 do not substantially affect the resolution; it is however important to keep the intersection region as free as possible from heavy material in order to minimize secondary interactions induced by background primaries.

Two schematic arrangements of the lead-glass arrays are shown in Fig. 1. They take into account the specific geometry of the vacuum chamber and of the intersection region.

Acceptances for $\eta \to \gamma\gamma$ and $\omega \to \pi^0\gamma$ detection are shown in Fig. 2. They are calculated in the geometry of Fig. 1a under the assumption that two well-separated energy clusters with energies larger than 0.5 GeV are observed in the lead-glass arrays. Also shown is the acceptance for two independent pions with the same requirement. The signal-to-background ratio depends very much on the strength of the two-particle correlation function. In particular if the results of the CCR Collaboration are still valid at larger rapidity differences, and if η's and ω's were produced with the same $p_\perp$ dependence as single pions, this ratio would not depend substantially on $p_\perp$ and could be directly obtained from the acceptances in Fig. 2, the resolution in invariant mass (of the order of $\pm 15\%$), and the branching ratios.

3. TIMETABLE

We want to remind the committee briefly of the status of experiment R412, in which the same group is involved.

The approved SFM experiment R412 aims at observing proton-proton collisions where a high transverse momentum π^0 has been produced. With the addition of momentum measurement in the SFM field it is a natural extension of the streamer chamber experiment R701, which is now being dismantled.

Experiment R412 is scheduled for a first short run in November 1974. The trigger will be provided by a single array of lead-glass counters at 90° and the main objective will be to momentum-analyse the particle excess in the hemisphere opposite to the high transverse momentum π^0. In 1975 a second run, approved but as yet not scheduled, will take place. We will then have two lead-glass arrays which can be used either singly or in coincidence to trigger the SFM detector.

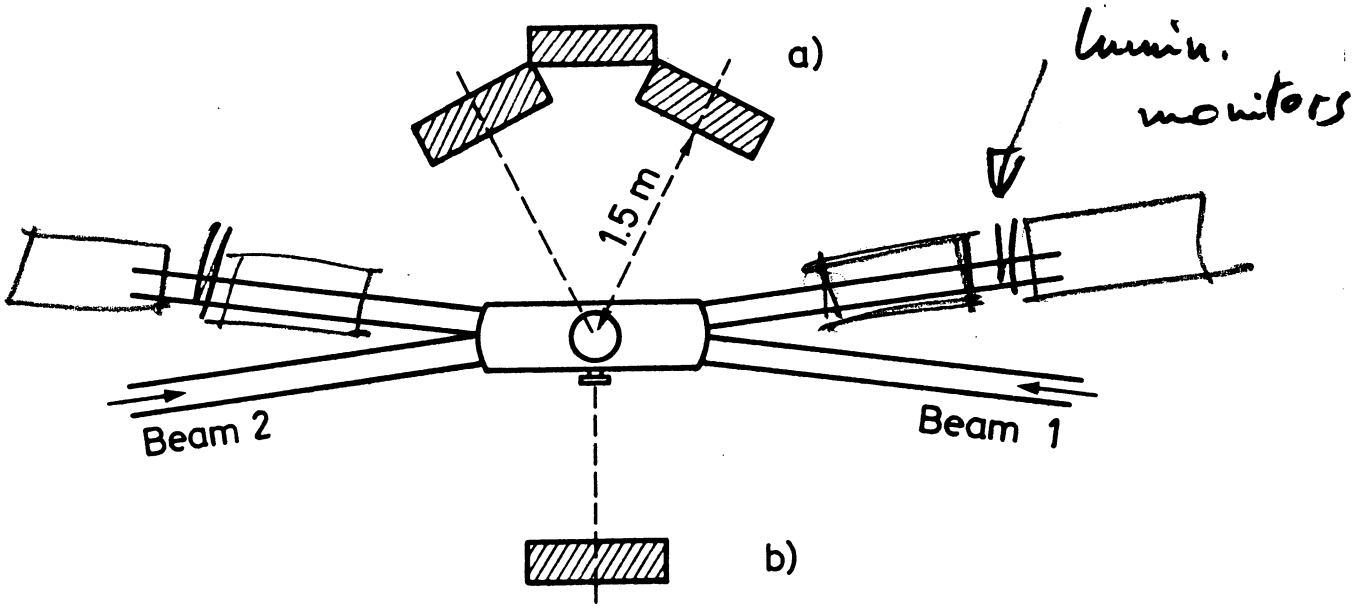
We propose to install both lead-glass arrays in I7 during the time interval between the first and second runs of experiment R412. We understand that our request is compatible with the programme of low beta studies undertaken by the ISR Division in this intersect. Apart from the obvious advantage of providing an understanding of the future SFM two-fold trigger, this would permit us to perform the very interesting measurements described above.

In addition to the lead-glass arrays we ask for the permission to keep the small R701 hodoscopes on the downstream arms for luminosity measurements. The R701 counting room and cables and the R412 computer and electronics can be used without modification.

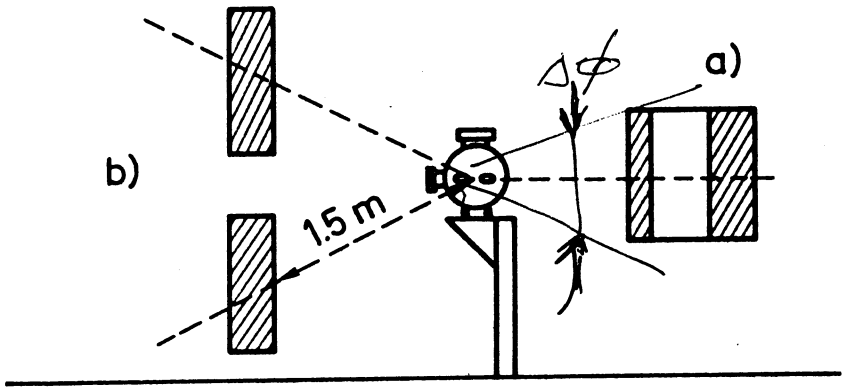
Figure captions

Fig. 1 : Two alternative layouts, shown in the same figure:
a) $\Delta\phi \lesssim 30^\circ$, $\Delta y \lesssim 1.5$
b) $\Delta\phi \lesssim 90^\circ$, $\Delta y \lesssim 0.5$

Fig. 2 : Acceptance curves. Fraction of detected $\eta \to \gamma\gamma$ and $\omega \to \pi^0\gamma$ decays versus the transverse momentum of the decaying particle. Also shown is the acceptance for two independent π^0's. The rapidity interval considered is $-1 \simeq y \simeq 1$.



Top view



Front view

FIG.1

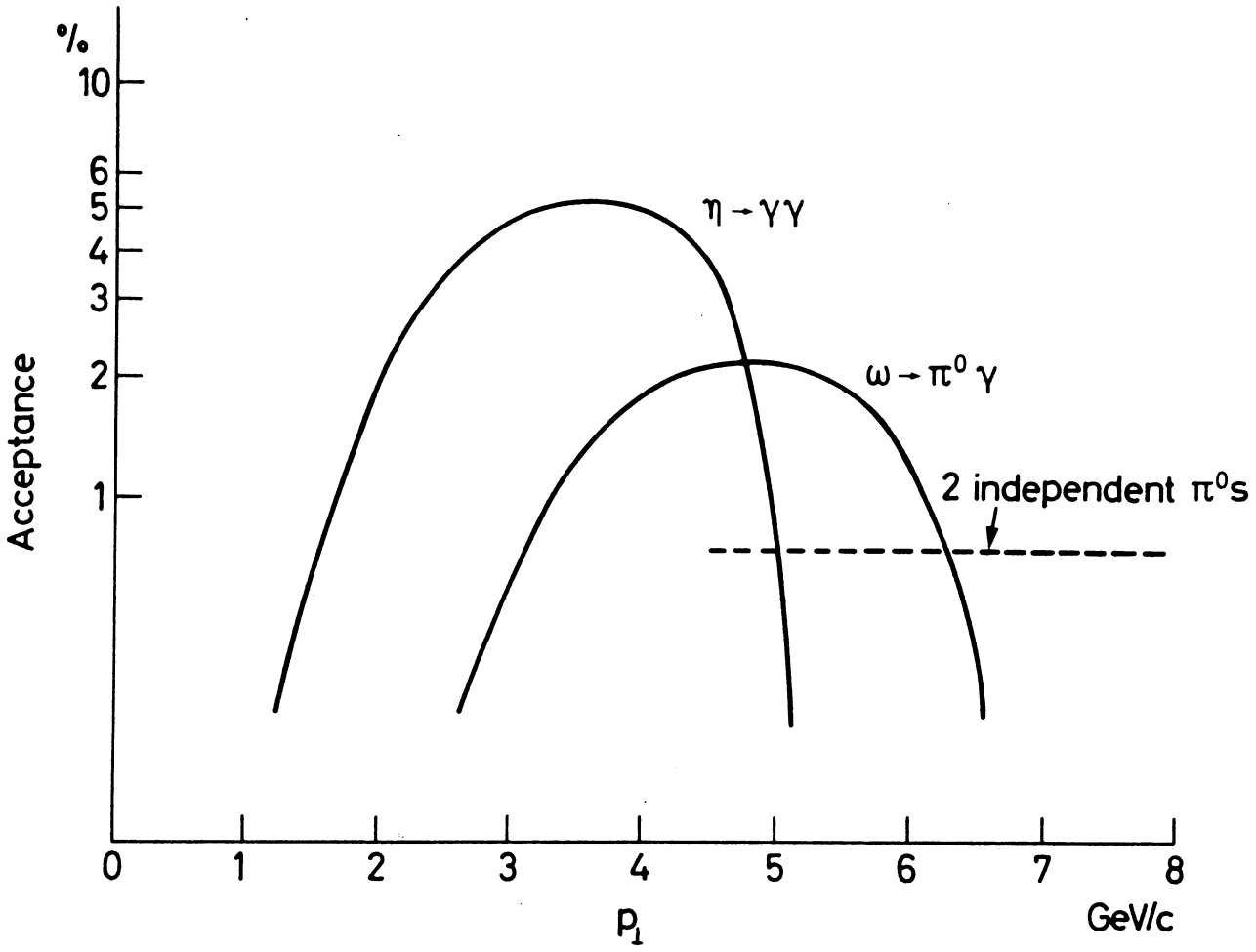

%
10
6
5
4
3
2
1
Acceptance
η → γγ
ω → π⁰ γ
2 independent π⁰s
0
1
2
3
4
5
6
7
8
P1
GeV/c

FIG. 2