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PROPOSAL FOR AN EXPERIMENT

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To : Electronics Experiments Committee

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Subject : Experiment to determine spin and parity of the A_2 meson

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We propose an experiment to determine the spin-parity assignment for the A_2 (1290) meson, believed to be either 2^+ or 2^-. At the same time, the experiment would yield new information on the following controversial questions:

a) the existence of an A_1 (1080) meson

b) the existence of the structure within the A_2(1290) meson.

It is hoped to obtain the spin-parity of A_2 from the analysis of its decay products with a system of wire chambers and counter hodoscopes, without magnetic field. This system has to be used in parallel with our boson missing-mass spectrometer, as shown in Fig. 1.

The instrument proposed consists of:

i) Two wide gap wire chambers, size 150 cm × 150 cm, wire spacing 1 mm, magnetostrictive read-out.

ii) A counter matrix made of 72 elements, over-all size 160 cm × 160 cm.

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The read-out is done whenever the missing-mass logics give a trigger. Most of the equipment is available or in the final testing stage.

We have observed the A_2 meson previously with the missing-mass spectrometer in the reaction:

$$\pi^- + p \rightarrow p + A_2^-$$

at 6 and 7 GeV/c with a signal-to-noise ratio 1 : 1 or better [Physics Letters 19, 434 (1965); 22, 714 (1966)]. In the cases where the A_2^- decays into three charged pions:

$$A_2^- \rightarrow \rho^0 + \pi^-$$
$$\hookrightarrow \pi^+ + \pi^-$$

the wire chambers would measure the directions of the decay pions which allows a reconstruction of the effective mass of A_2^- as well.

If (i) the decay particles are pions, (ii) the three-momentum of the A_2^- is known (given by the recoil proton analysis), (iii) the direction of all decay products are measured, then the only unknowns are the magnitudes of the momenta of the pions. These can be computed on the assumption that there are no missing π^0; the absence of the missing π^0 can be verified by requiring that the effective mass of 3π be, allowing for errors, equal to the missing mass of the proton. It is this procedure, essentially a one-constraint fit, (1c fit), that makes it possible to have a Dalitz plot of the A_2 decay without the magnetic field. Additional information on the absence of π^0 can be obtained from the absence of converted photons from π^0 decay in the counter matrix with a lead plate in front of it.

The normal to the decay plane in the c.m. can be determined unambiguously. A Dalitz plot can be made with six-fold ambiguities.

The two possible Dalitz-plot distributions for 2^+ and 2^- are seen in Fig. 3.

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A Monte Carlo calculation for the 3π decay gives the following performance:

a) Effective mass resolution: ± 25 MeV.

b) Rejection level against $\pi^- + \pi^- + \pi^+ + \pi^0$ decay: 93%.

c) Acceptance of 3π events: 50% (see Fig. 2).

We propose to run the experiment in the d_{25} beam with pions of 6 GeV/c. We need 10^6 triggers, in order to obtain a mass histogram of 250,000 events in the mass region 900 - 1800 MeV which will yield <u>18,000 events in the A_2 region</u> (150 MeV wide).

The estimated PS machine time is:

<u>2 weeks of running-time preceded by 2 good weeks of parasiting.</u>

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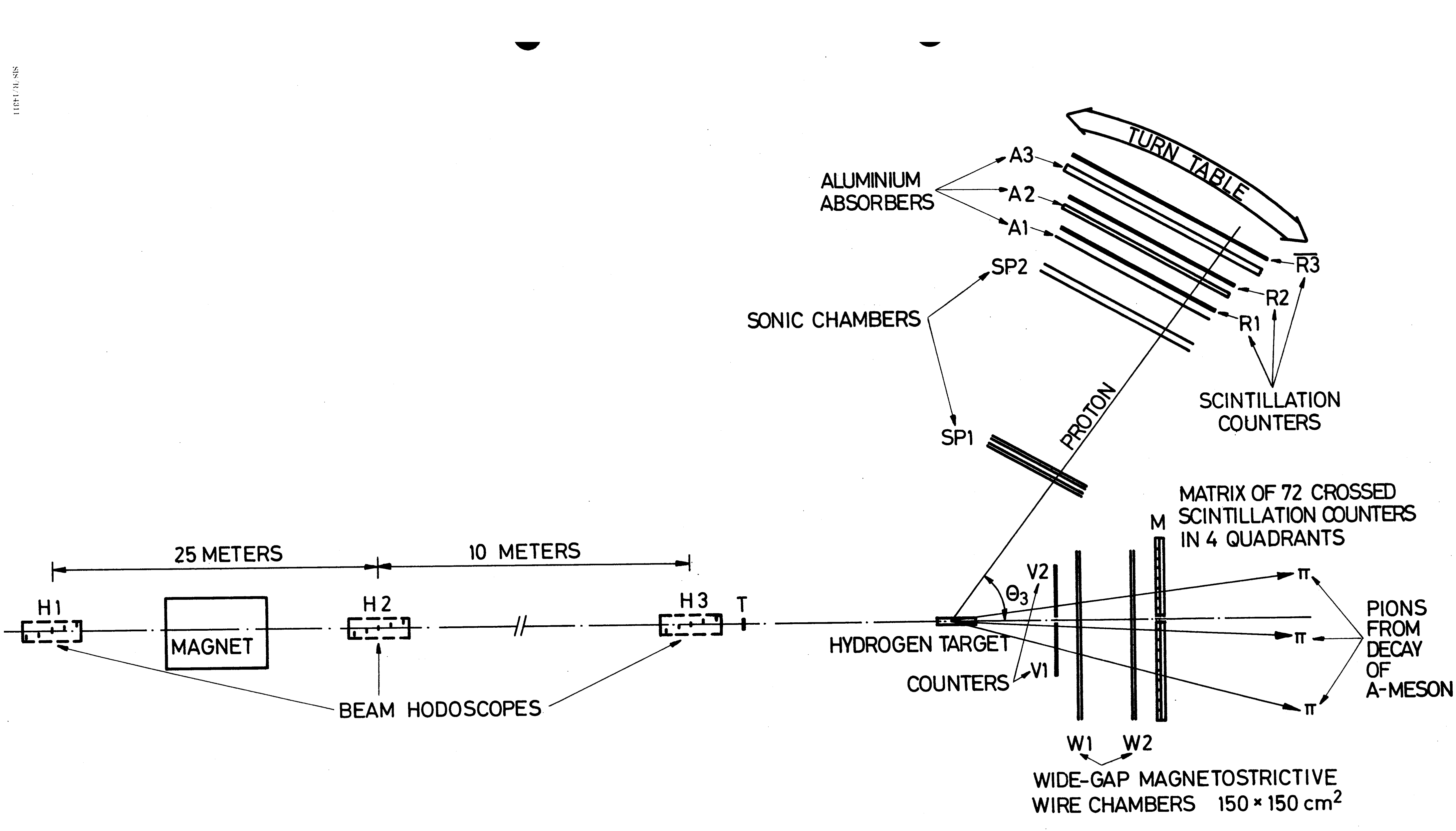

FIG. 1

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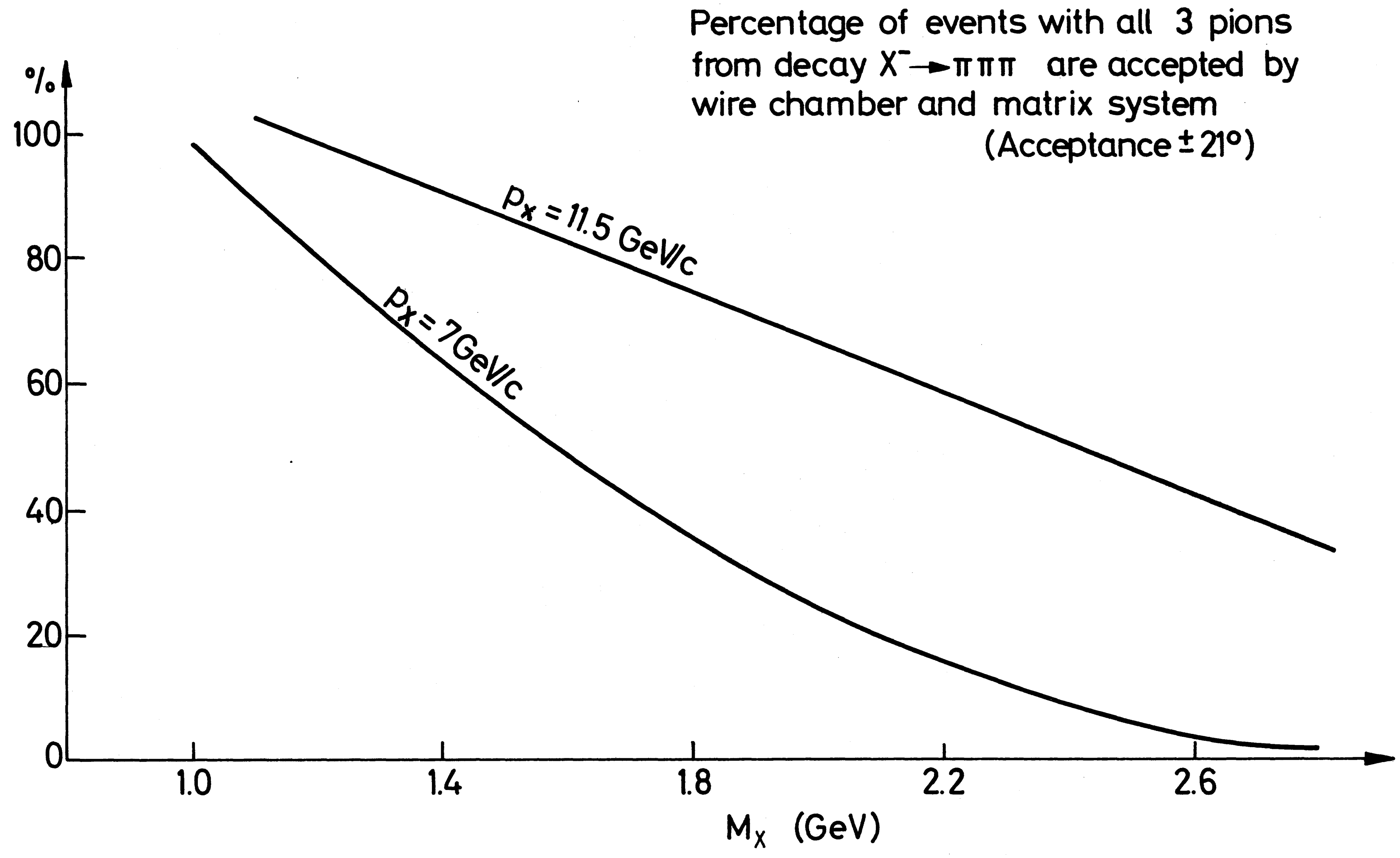
%
100
80
60
40
20
0
1.0
1.4
1.8
2.2
2.6
Mx (GeV)
px = 11.5 GeV/c
px = 7GeV/c
Percentage of events with all 3 pions from decay X⁻→πππ are accepted by wire chamber and matrix system
(Acceptance ± 21°)

FIG. 2

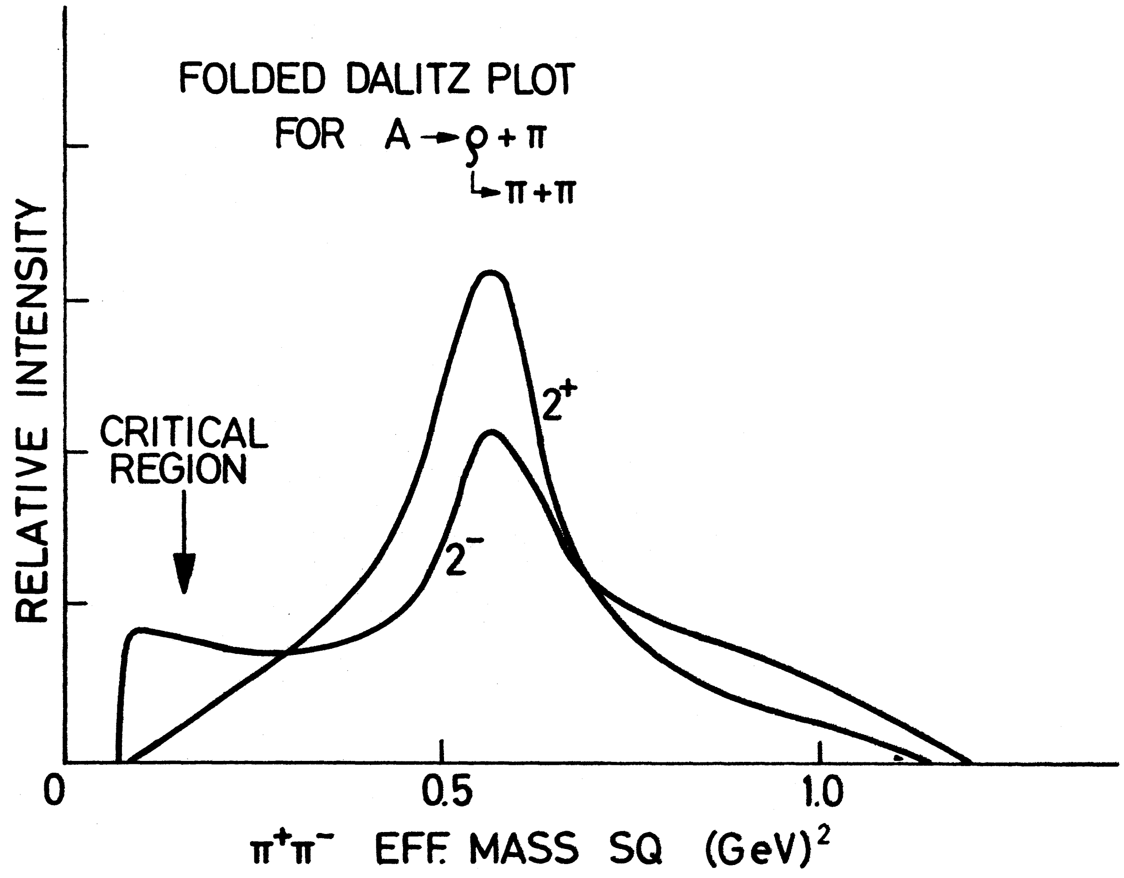
FOLDED DALITZ PLOT
FOR A → ρ + π
→ π + π
RELATIVE INTENSITY
CRITICAL
REGION
2+
2−
0
0.5
1.0
π+π− EFF. MASS SQ (GeV)²

FIG. 3