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LETTER OF INTENTION

To : The Members of the SPSC

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Subject: A SIMPLE MULTIPARTICLE SPECTROMETER FOR THE STUDY OF HIGH p_t EVENTS AND RESONANCE PHYSICS AT THE SPS.

Laboratories: Bari(*), Caen, CERN (NP/TC), Liverpool, Milan.

Requirements:
- 2 MORPURGO-type standard SPS magnets of 2 x 2 x 1 m^3 aperture and 50 KG x m.
- 200 GeV proton beam ($\sim 10^9$/burst) and a 150 GeV proton π^-, K^- beam ($\gtrsim 10^7$/burst) in the West area for end 1976.

1. INTRODUCTION AND APPARATUS

We would like to propose to build a simple (and thus reasonably flexible) multiparticle spectrometer for use at the SPS to study, in the first instance, the properties of high p_t events (with emphasis on πp and Kp interactions) and secondly to study resonance spectroscopy.

We wish the apparatus to be ready for use in the West area in the highest momentum beam available at SPS turn on (end 1976). In this way we have more than 2 years to build the equipment and modify the proposal so that it will be competitive with NAL experiments which are on the floor at that time.

The apparatus (fig. 1) is designed to utilise two Morpurgo standard type SPS magnets(1) of 2m x 2m x 1m aperture and 50 KG x m bending power. The first magnet, having inside it a hydrogen target and MWPC planes, acts as a vertex detector (see Appendix) analysing wide angle particles

(*) Subject to approval by INFN.

of $P < 10$ GeV/c with a $\delta p/p \lesssim 2\%$. The second magnet, placed close behind the first measures the higher momentum particles (e.g. $\delta p/p \sim 2\%$ at 100 GeV/c). The distance between the magnets can be varied to give different acceptances.

2. PHYSICS PROGRAM

In the following we describe a physics program which can be adapted according to new developments in the field.

2.1 The study of high-p_t events

The presence of an excess of events containing particles of high transverse momentum over what might be expected by a simple exponential extrapolation of the lower transverse momentum behaviour as seen at the ISR(2) and NAL(3) experiments is clearly of great interest as regards the possible point-like structure of the nucleon.

To us the next stage is to study the correlations of the other particles produced in the same interaction to see if, for example, jet-like structures are present which could be symptomatic of parton-parton local scatterings. One possible way of triggering on high-p_t events is to use a scintillation counter hodoscope M1 to M4 of fig. 1. Each magnet of 50 KG x m gives a transverse momentum kick of 1.5 GeV/c and thus positive (negative) particles of $p_t = 3$ GeV/c above (below) the symmetry axis emerge parallel to the axis. We can then trigger on

a) Positive particles of $p_t > 3$ GeV/c ($-0.5 < x = P_L/P^*_{max} < 0.5$)
b) Negative particles of $p_t > 3$ GeV/c (" " ")
c) A positive and a negative, both of $p_t > 3$ GeV/c (")

and study the correlations of the other associated charged particles. Since the ISR has an interaction rate equivalent to 10^7 protons on a 30 cm target it will be important to try to make use of the higher beam intensities which the SPS can provide. For example, 10^8 protons on a 30 cm H_2 target will give 10 times the ISR rate with 250 nsec between interactions. In this case a hole is provided for the beam in the MWPC system. Comparison of π^-, K^- and p initiated interactions will be possible.

It is clear that there are several other ways that can be envisaged to trigger the equipment e.g. lead glass shower counters may be placed around the axis at an angle corresponding to $\theta^* = 90^\circ \pm \Delta\alpha$, (that is at $\tan\theta_{lab} = 0.1$ for protons of 200 GeV/c) the energy of the γ being given by pulse height and p_t by $p\,\theta_{lab}$. For $p > 30$ GeV/c and $\tan\theta_{lab} = 0.1$, $p_t > 3$ GeV/c is selected.

2.2 The study of resonance spectroscopy at high energies

2.2.1 2-body decays

The CIBS experiment[4] has shown that the $J^P = 2^+$ $A_2(1300)$ and $K^*(1420)$ are produced with surprisingly high cross sections at 40 GeV/c. It is thus interesting to perform a precision measurement of these cross sections up to the highest possible momentum using the reactions

$$\pi^\pm p \rightarrow A_2\, p \quad (A_2 \rightarrow K_1^0 K^\pm) \qquad \text{and} \qquad K^\pm p \rightarrow K^*_{1420}\, p \quad (K^*_{1420} \rightarrow K_1^0 \pi^\pm)$$

Both channels are produced with little physical background and are experimentally clean, thus a good knowledge of their production mechanism can be obtained.

2.2.2 3-body decays

The reactions $\pi p \rightarrow \pi\pi\pi p$ and $Kp \rightarrow K\pi\pi p$ being 4C fits and having a large cross section are well suited for a complete analysis[4]. We would aim at $\sim$ 1000 events per bin of one experimental resolution (of $\sim$ 10 MeV) in the 3π mass range 1-2 GeV.

In the study of resonance phenomena the distance between the two magnets will be increased to get a better accuracy on the high momentum tracks. This is possible since with the lower average p_t values the energy us concentrated in a narrower forward cone.

APPENDIX

THE APPARATUS

1) Layout

The general layout is shown in fig. 1. The system consists of two parts, (i) a vertex detector (for details see fig. 2) and (ii) a forward spectrometer for the analysis of fast particles. We would like to use two standard SPS spectrometer magnets (design of M. Morpurgo). Large area multiwire proportional chambers (2×1 m^2) are foreseen as particle detectors.

2) Trigger

The trigger requires at least one high p_t charged particle. This is done in a fast coincidence (< 10 ns) between 4 sets of scintillation hodoscopes overlapping the downstream wire chambers. The selectivity of the fast logics is on the level of $\sim 10^{-5}$, leading to $\sim$ 100 triggers per SPS burst. Beam intensities up to 10^8 particles/burst can be accepted.

3) Proportional chambers

We originally intended to use "drift chambers" for particle detection in the present spectrometer system. However, in view of the high reaction rate and the expected high average particle multiplicity as well as the technical problems of operation in a magnetic field,we are now decided to use ordinary multiwire proportional chambers instead. At the same cost we will be able to achieve a resolution of ± 250μ (r.m.s.) per chamber unit, independent of the angle of incidence, by using groups of 3 wire planes displaced by 1/3 of the wire spacing (d = 2 mm). With a time resolution of 100 nsec per wire we expect to handle a beam intensity of 10^8 incident particles per second (in this case there is a "double event" accepted in 40% of the triggers).

4) The vertex detector

A detailed study of a magnetic vertex detector with multiwire proportional chambers has been carried out. The present status of our design is shown in fig. 2. The whole detector, containing 30,000 wires arranged in modular units, is constructed as one self-contained unit which fits into the gap of a standard SPS spectrometer magnet (*).

The lateral chambers (Nr. 1-5 in fig. 2) contain orthogonal wires, each chamber with 3 vertical and 3 horizontal wire planes. For solving the geometrical ambiguity in track reconstruction there is on each side of the target one chamber (W) with two planes of inclined wires ($\pm 10^{\circ}$).

The forward chambers (Nr. 6-10) contain crossed wire planes (3 series at $\pm 25^{\circ}$ in each chamber unit); in addition there are 2 chambers (W) with vertical and horizontal wires for resolving the geometrical ambiguity.

The mean multiple scattering in the vertex detector corresponds to $\sim$ 70 m radiation length. The mass resolution of K^{0} with 3 GeV/c momentum is $\Delta M = \pm 3.5$ MeV as obtained from a Monte Carlo calculation.

5) The forward spectrometer

The forward chambers (2×1 m^{2}) each contain 3 planes of vertical wires, wire spacing as above d = 2 mm, with consecutive planes shifted by d/3. In addition there are two inclined planes ($\pm 15^{\circ}$) for obtaining the vertical coordinates. The total number of wires in the forward system is 25,000. The resolution is $\delta p/p = 2\%$ at 100 GeV/c.

6) The cost

An estimated 5 M.SFr. are needed for the present spectrometer system i.e. 4.5 M.SFr. for the MWPC and associated electronics, plus 0.5 M.SFr. for the trigger system.

(*) Although the above apparatus has been designed arount the standard SPS magnets as envisaged by Morpurgo we strongly suggest that a second standard type of magnet be built having in mind specifically the problems of vertex detection. This could be, for example, of the type of the Saclay GOLIATH (2m diameter x 1.2 m height, open at the sides) which would cost 2 MS.Fr.

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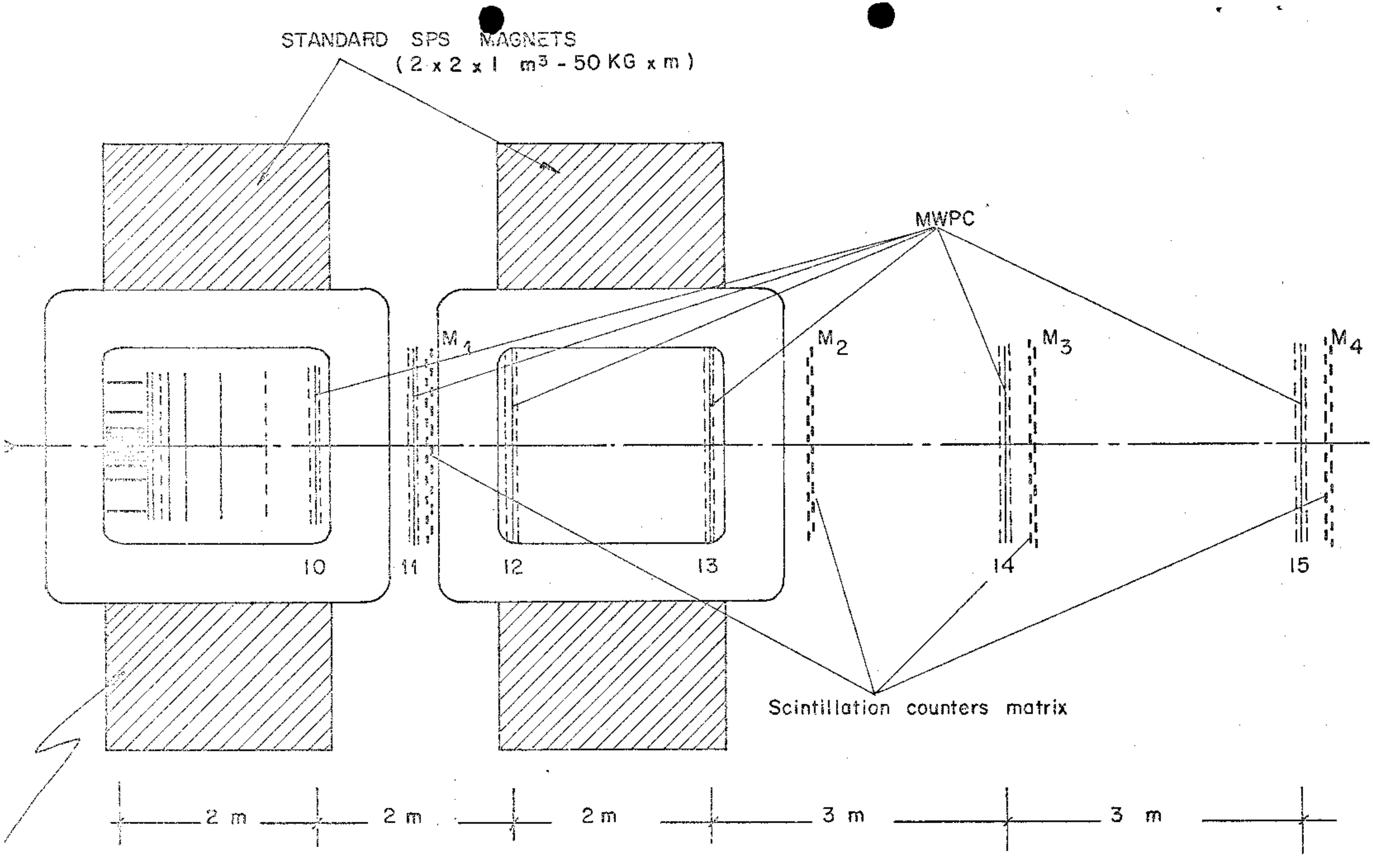

FIG. 1 - General layout (horizontal plane)

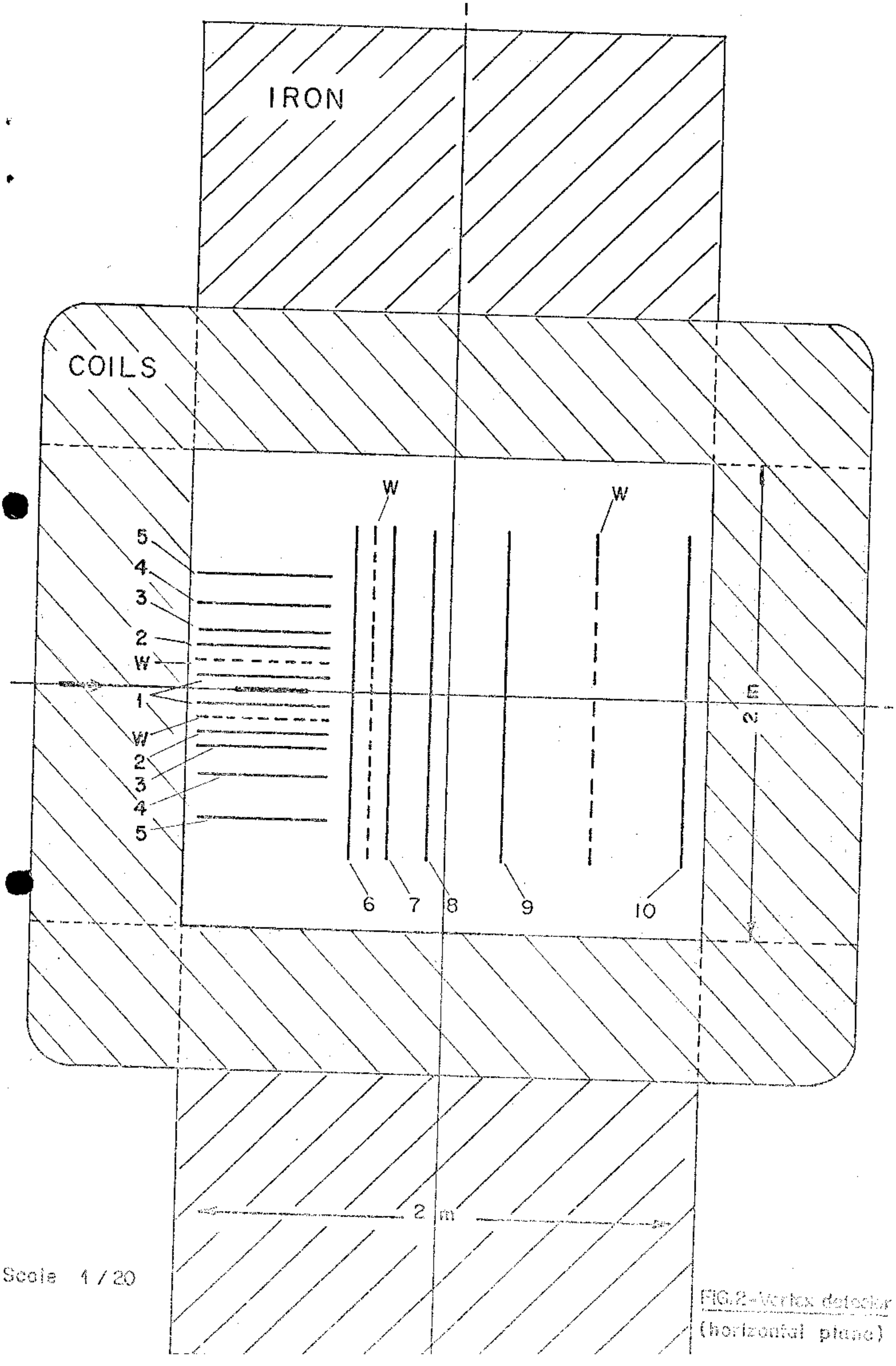

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FIG.2 - Vertex detector
(horizontal plane)