W. W. HANSEN LABORATORIES OF PHYSICS
STANFORD UNIVERSITY
STANFORD, CALIFORNIA 94305

Microwave Laboratory
High Energy Physics Laboratory

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Telephone: (415) 327-7530

CERN/SPSC/I 73-4
1.5.1973

Professor Willibald Jentschke
Director, CERN
Geneva, Switzerland

Dear Willi:

I have been travelling a lot in recent days, and have even given testimony to a Congressional Committee on the NASA budget very recently, so that I have not had time to prepare the spectrometer letter that I promised you. Here it is, however, and I apologize for the delay.

I have been interested for a very long time in high resolution work in elementary particle physics. The spectrometer program described below is an extension of such an interest, and indeed, I hope a very fine one because it involves a figure of resolution of 10^{-4}. Such high resolution might be very valuable at the SPS at CERN for one notes that a pion mass, relative to the main proton energy of 300 BeV corresponds to about 2.3×10^{-4} resolution.

The spectrometer construction is now being funded by the NSF, and has been in the building process for over two years. The work is now going on at a relatively slow pace (due to the budget problem in the U.S.) so that the spectrometer will be finished by early 1974. After a testing procedure I would think that 1975 would be an appropriate time in which installation might begin.

The properties of the spectrometer are listed in the enclosed table labeled "Characteristics of the 168" HEPL 2.5 GeV/c High Resolution Large Acceptance Spectrometer." The power requirements are also shown in an attached graph.

One layout of the supporting structure is shown on Sheet A. This employs a bridge construction which holds the shield over the detector. A second scheme is now being investigated in which the bridge would not be used. In the latter case the detector and shield would be supported on the magnet itself in much the same way we have supported shields on smaller, but exactly similar, spectrometers.

We are negotiating to see where we could make the best use of this spectrometer. There are at least three possibilities: SLAC, NAL and CERN. I have approached SLAC and our proposal is presently being considered. Apparently NAL cannot make a commitment soon enough to satisfy our program. I am, therefore, letting you study the system to find out whether CERN is interested.

Some of the major pieces of physics that could be done at CERN with the instrument would be:

(1) Investigation of all backward inelastic inclusive processes. For example: (including the elastic channel)

$$p + p \rightarrow p + p$$
$$p + p \rightarrow p + X$$
$$p + p \rightarrow \pi^{+} + X \qquad (X = \text{anything})$$
$$p + p \rightarrow \pi^{-} + X$$
$$p + p \rightarrow K^{+} + X$$
$$p + p \rightarrow K^{-} + X \quad , \text{ etc., etc.}$$

and many other similar reactions. The second reaction ($p + p \rightarrow p + X$) with very high resolution provides a single arm missing mass type of experiment which has, itself, very wide physical interest.

(2) Coincidence studies using the high resolution spectrometer as one arm and a TANC detector or any other type of particle or photon detector in the other arm. Some examples might be the following:

$$p + p \rightarrow p + p$$
$$p + p \rightarrow p + p + X$$
$$\pi^{-} + p \rightarrow \pi^{-} + p$$
$$\pi^{-} + p \rightarrow \pi^{\mp} + p + X \quad , \text{ etc., etc.}$$

(3) Inelastic inclusive processes using incident pion, kaon, or electron, etc., beams. Such incident beams would of course be the secondary beams generated by the main proton beam. I know that you will have plenty of ideas on how to make very good secondary beams and these will provide a good match to the spectrometer characteristics.

(4) Investigation of inelastic inclusive processes similar to those in category (1) using heavier targets such as deuterons or helium or heavier nuclei.

While these examples offer a considerable ensemble of possible experiments, others will surely suggest themselves to you.

My experience in high energy physics shows that one makes the greatest progress with a program employing (1) high resolution, (2) an experimental facility standing in one place for a long time so that (a) all the apparatus errors are removed and (b) more exact and careful studies are made seriatim.

I would be greatly interested in establishing such a program at CERN and would look forward to CERN's having a very productive period of research with this spectrometer system for many years. In fact I would personally be willing to put in as much time on the project as is required to make it a success.

I expect to be in Europe in July at Lindau and maybe earlier, in May. I should like to visit you at one of these times to discuss the matter further.

Best regards.

Sincerely yours,

Bob

Robert Hofstadter

RH/i

cc: Dr. A. Abashian, NSF
Dr. W. K. H. Panofsky, SLAC
Dr. R. R. Wilson, NAL

CHARACTERISTICS OF THE 168" HEPL 2.5 GeV/c HIGH RESOLUTION LARGE ACCEPTANCE SPECTROMETER

Optics	point-to point double focussing, $n = 1/2$ magnet, unit magnification
Target length	13 cm target acceptance (flat-top of distribution); 39 cm acceptance full length (at base of distribution).
Maximum momentum	2.5 GeV/c
Solid angle acceptance	11.6×10^{-3} strad.
Horizontal angular acceptance	44 mrad.
Vertical angular acceptance	264 mrad.
Momentum acceptance	11.12% (FW)
Momentum resolution	10^{-4}
MWPC spatial resolution required to match momentum resolution	$\pm$ 1.7 mm
MWPC spatial resolution actually available	$\pm$ 0.2 mm
Production angular resolution	$\pm$ 0.1 mrad
Power requirement (See graph)	2 MW at p_{max} = 2 GeV/c 3.7 MW at p_{max} = 2.5 GeV/c
Total spectrometer turning radius	33 ft; 10.1 m
Beam line height from supporting floor	7.845 ft; 2.28 m
Total spectrometer height from supporting floor	41.33 ft; 12.6 m
Magnet weight	1100 tons; 1010 metric tons
Magnet superstructure weight	300 tons; 272 metric tons

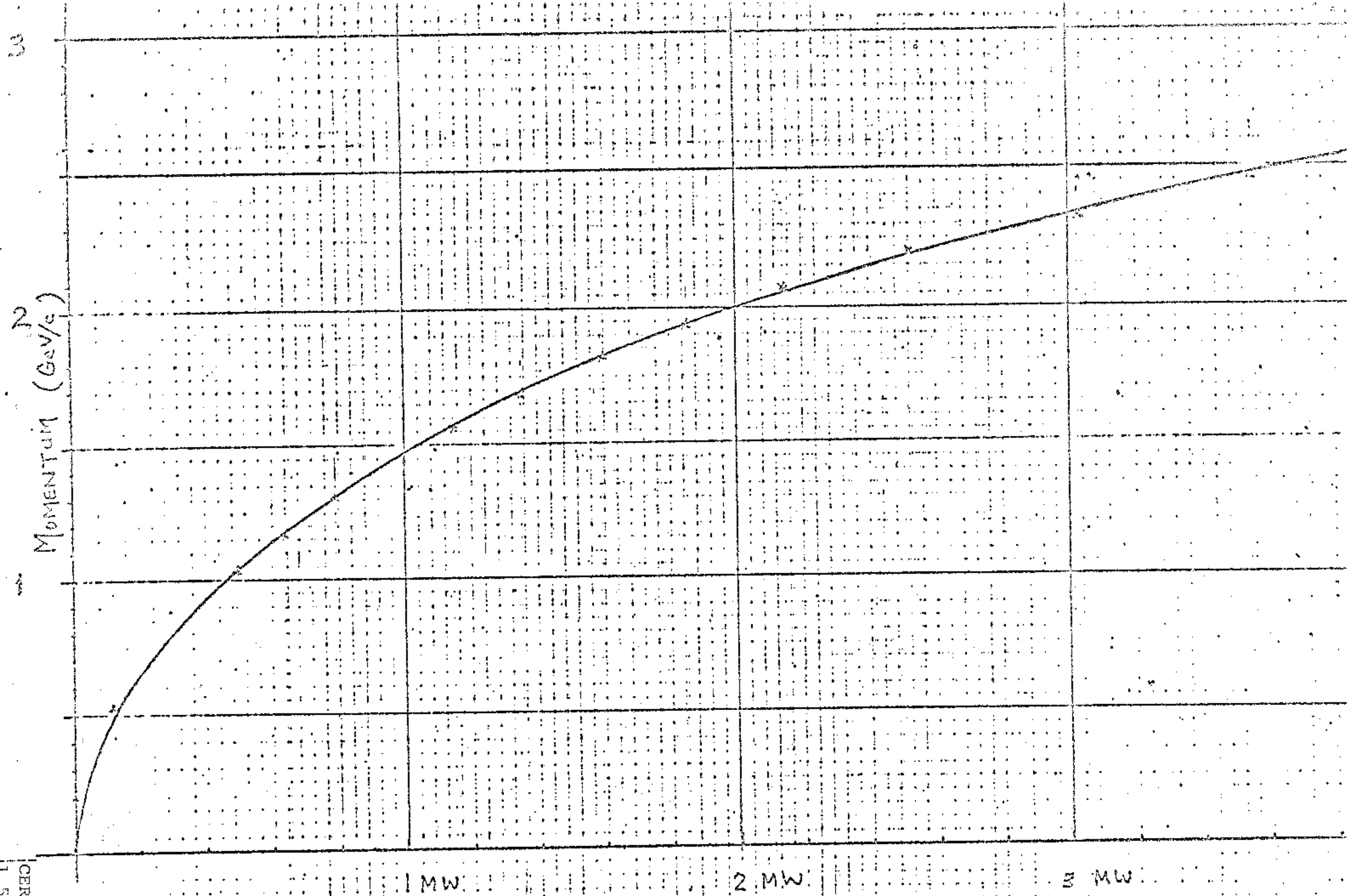
SPECTROMETER MOMENTUM RESOLUTION REQUIRED TO SEPARATE ELASTIC EVENTS

$$\Delta p/p = m_{\pi^0}/(2p_{beam}) = 1.35 \times 10^{-4} \text{ at 500 GeV}$$

A typical external proton beam might have the following properties, which compare favorably with the specifications of the spectrometer.

$$\Delta p/p = \begin{cases} 5 \times 10^{-4} \text{ without momentum slit} \\ 1 \times 10^{-4} \text{ with momentum slit} \end{cases}$$

$$\Delta\theta = \pm 0.1 \text{ mrad}$$



168" SPECTROMETER

POWER

A

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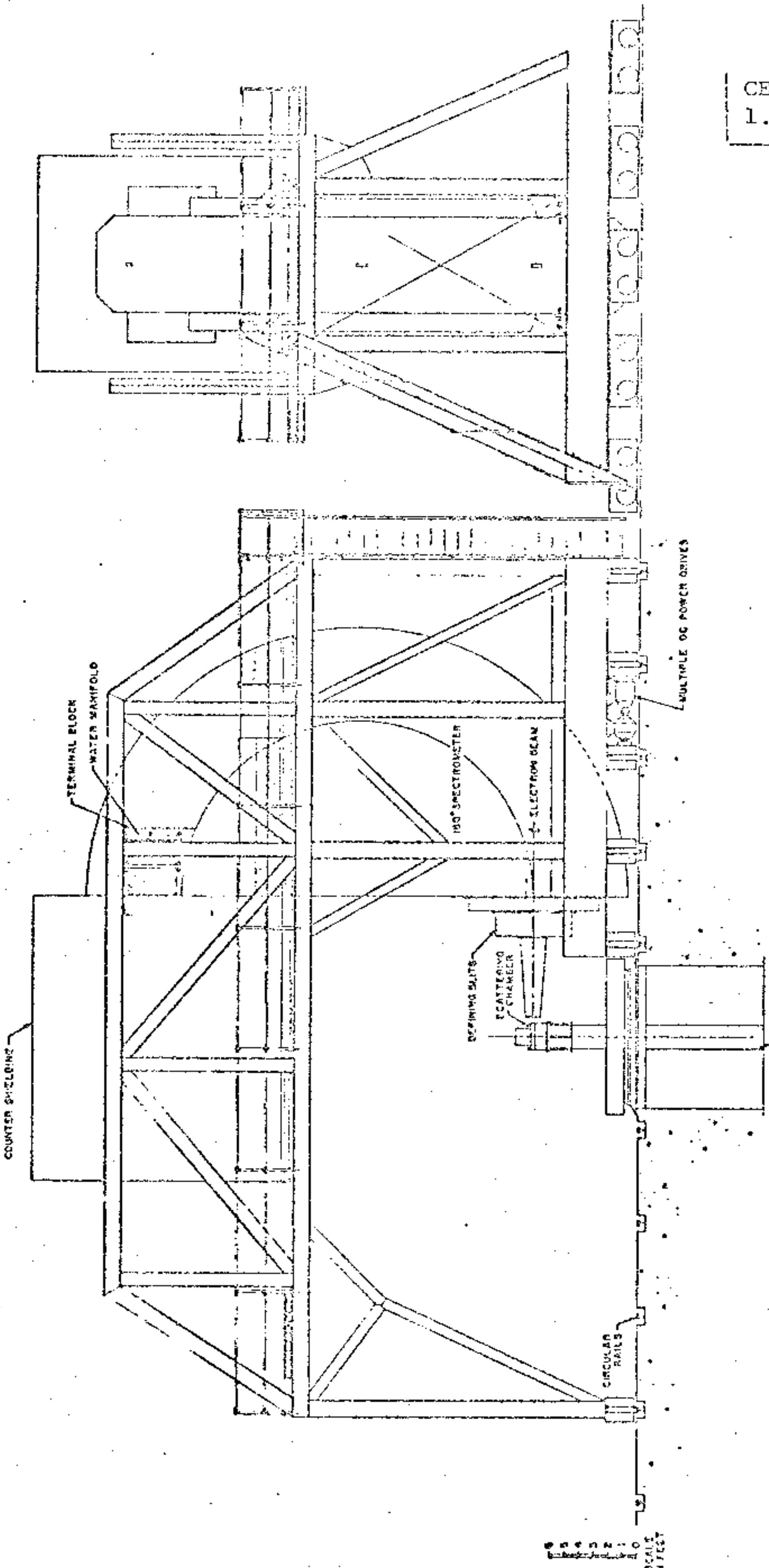

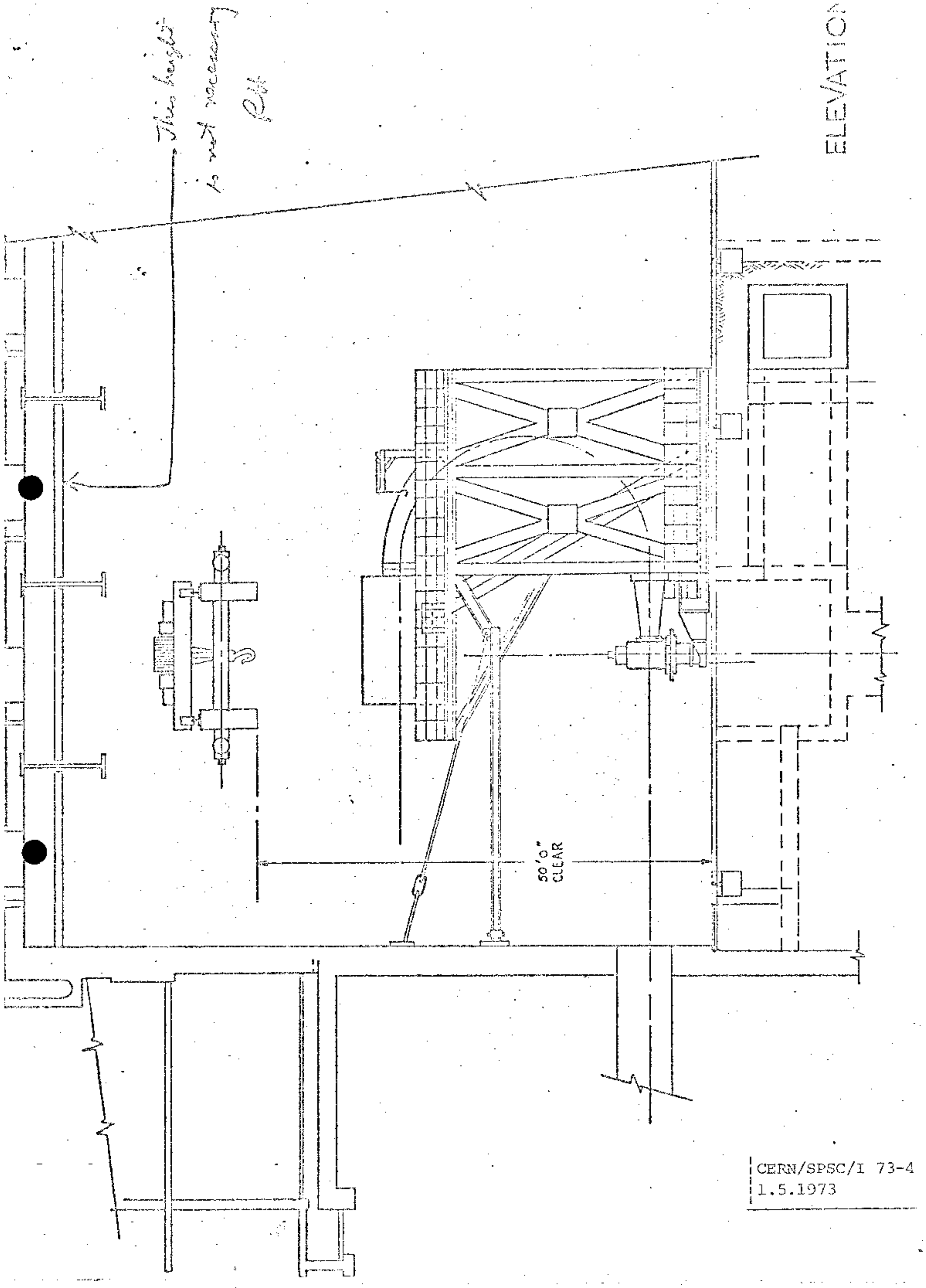

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