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THIN TARGET STATIONS
WITH EARTH SHIELDING AND STEERING MAGNETS

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This report is a proposal to have several thin target stations placed in a row along one of the branches of the EPB at NAL.

Employing earth shielding rather than movable concrete shielding drastically reduces the cost of each station. This may allow the construction of two or three such stations for the cost of one conventional thin station.

By using septum magnets as steering magnets, it will be possible to steer particles of most angles and momenta down one of the (perhaps 6 or 7) beam holes permanently placed in each station. Thus, we maintain that this reduction in cost will not significantly reduce the flexibility of each station.

Moreover, these steering magnets will make it possible to change production angles and momenta over a considerable range without moving any magnets, by simply changing the currents of the magnets. This is very important operationally, since it allows beam changes without shutting down the entire EPB for rigging.

Of course, someone can design a beam that will not fit into this fixed-shielding station. However, I believe that with a little more thought most beams can be replaced with a beam performing a similar function that can be placed in this station. The high cost of NAL dictates that this extra period of thought is justified even for our most valuable minds.

The need for thin-target stations of any type has been discussed in NAL reports by Frauenfelder and Wenzel (B. 7-68-108), Krisch and Meyer (C. 2-68-94), and Elioff and Sanford (D. 1-68-55). We will summarize these needs below.

1. Measurement of proton-proton elastic and inelastic interactions at high $p_\perp$. These cross sections are very small and can only be studied with the high intensity (10^{13}) main proton beam itself. Moreover, a thin target (~ 1%) is necessary to reduce scattering and nuclear interactions of secondaries. There is no other place to do these experiments except for the internal target area which is unsatisfactory for several reasons.
2. Low-intensity (10^5 ~ 10^7) secondary beams of low to intermediate energies (10 - 70 GeV) each station can probably give about four beams of this type.

I believe that these earth-shielding thin-target stations are an excellent way to buy many additional beams at a very low cost. Clearly very high-momentum high-intensity secondary beams do not belong here, but many of the important experiments can be very well done here at reduced cost.

1. $\pi^{\pm}$, $k^{\pm}$, $p^{\pm}$ total cross sections

2. Small angle elastic scattering

3. p-p backward scattering up to 50 GeV

Another important advantage of these less expensive stations will be the reduction in competition between groups. Excessive competition will make it difficult to run very precise experiments requiring detailed and lengthy studies of background. It will also make it difficult for new young groups to get started.

The basic idea of using steering magnets is shown below in Fig. 1. When looking at particles at the central angle (A) the septum magnet is turned off and the particles go down the center.

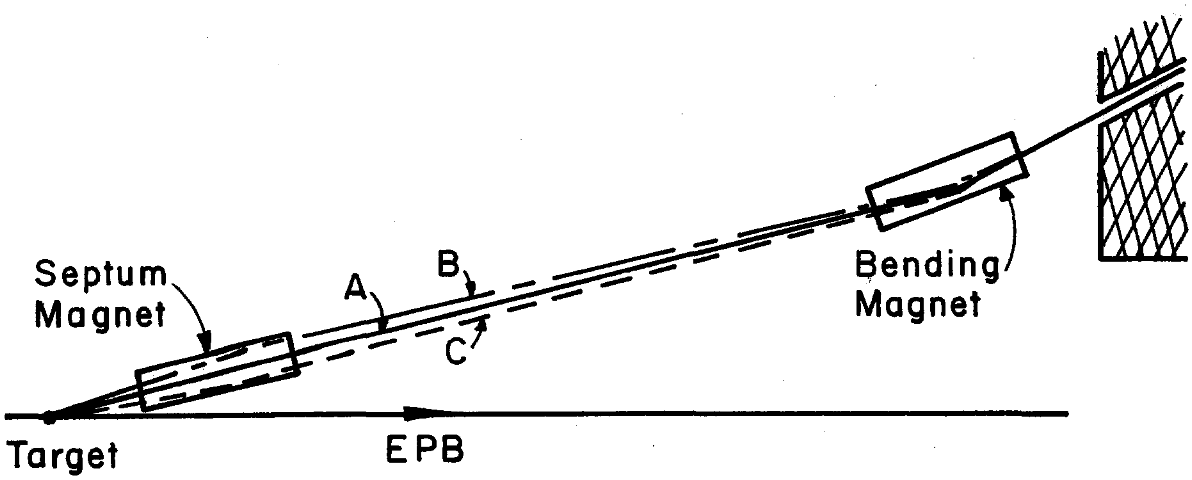

Fig. 1.

When looking at particles at larger angles (B) the septum bends them in and when looking at particles at smaller angles (C) the septum bends out. The next bending magnet is adjusted so that when the particles emerge from it they are exactly on axis. Thus, particles produced over a wide range of angles and momenta are sent down a single beam port.

Typical layouts of these fixed shielding stations are shown in Figs. 2-4. Figure 2 shows a station for low-intensity beams. Figure 3 shows a station for p-p interactions, and Fig. 4 shows both stations on a smaller scale.

I would recommend that three of these stations be built on the EPB line that ends in station A. I think that they should be separated by about 500 feet and that two of the stations should be planned for low-intensity secondary beams with about 5MW of power. The other station should be primarily for proton-proton interactions with about 1MW. I believe that the construction cost for the low-intensity and proton stations could respectively be held to \$2/3 million and \$1/3 million. This money would not provide for full utilization of the low-intensity stations, but additional facilities could be added later while the machine continued to run.

I believe that about \$1/3 million would provide a fully utilizable station for proton-proton interactions.

In making these estimates, I have not included magnets, which I regard as equipment not construction. I must also state that I am not expert in cost accounting but believe that the costs can be held close to these estimates if excessive flexibility is not added.

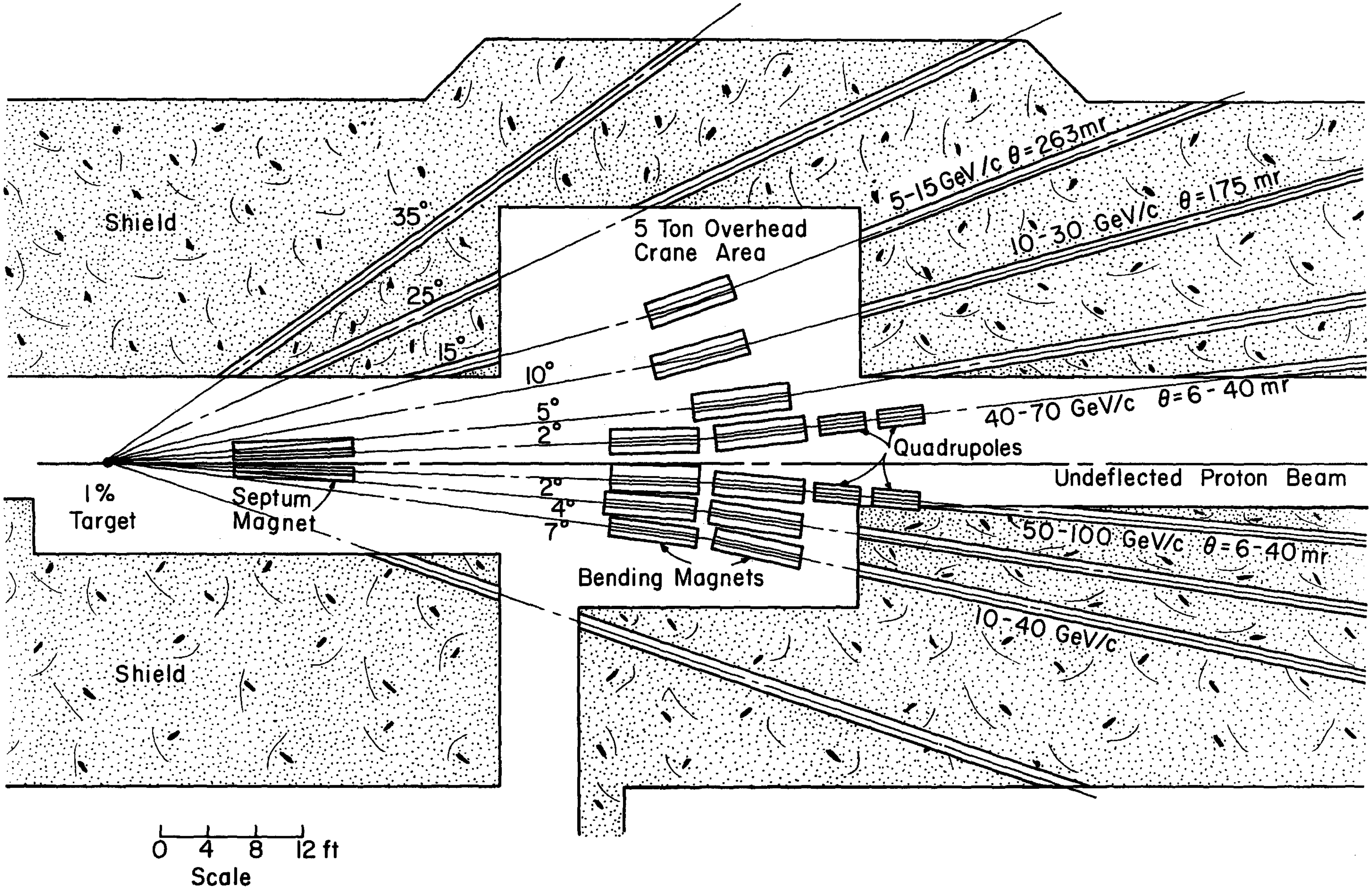

Fig. 2. Low-intensity secondary beam target station.

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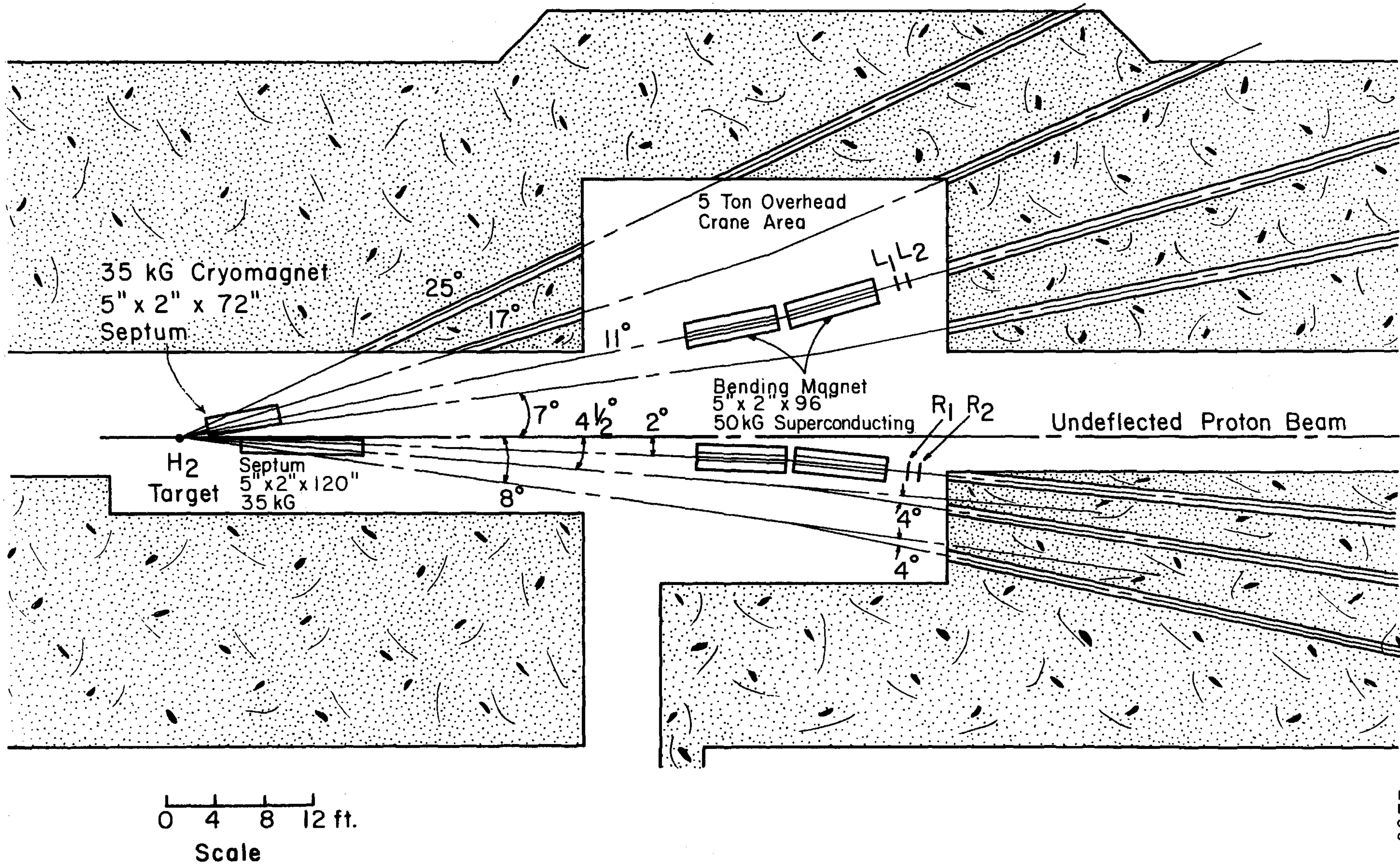

Fig. 3. Target station for proton-proton interaction studies, showing double-arm spectrometer.

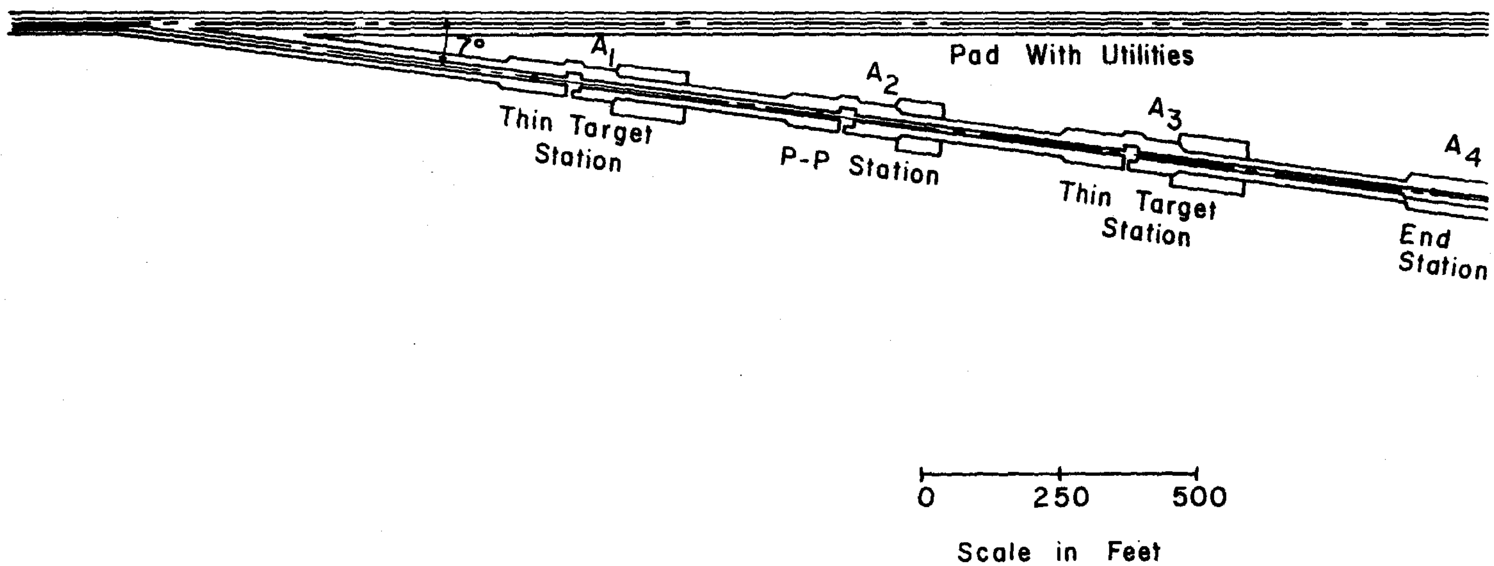

Fig. 4. Layout for cascaded low-intensity target stations in the same proton branch.

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