A FLEXIBLE TARGET STATION IN AREA 1

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ABSTRACT

A target station is described which allows the production in experimental-area 1 of not only a wide-band neutrino beam but also a muon/tagged neutrino beam and a rf-separated bubble-chamber beam of low to moderate energies.

INTRODUCTION

Target-area 1 has been designated as an area where neutrino experiments will be done.[1] In this note we discuss some other uses for this area. The neutrino beam facility, consisting of a decay channel straight ahead of the target followed by a shield, is easily shared among different experiments by placing one experiment after another in the neutrino beam line. It is thus imagined that there will be a series of spark chambers and a large bubble chamber appropriately spaced behind muon shielding. Depending upon the duty cycle requirements, they operate either together on the same pulse or alternately on a long-time basis (like monthly or bimonthly). These experiments require a large part of the proton intensity, and when they operate a small fraction of the accelerated protons remain for other experiments. The long proton target and large flux-gathering lenses of the neutrino beam preclude most other experiments from utilizing the secondary particles emanating from its target.

Proton-sharing with series targets is another way of increasing the utility of the accelerator. A natural experiment for a target upstream of the neutrino target is a muon experiment. It is desirable that a muon beam subtend a large solid angle at its target. A muon beam can only share its target with very large angle beams. It is therefore incompatible with area 2 where many beams view the same target at small angles. The length of the muon beam is several hundred meters and it can use many of the services already provided for the neutrino experiment.

Viewing the same target as the muon beam, an rf-separated hadron beam can also supply particles to a small bubble chamber (see Fig. 1). At a later date there is the possibility of constructing a high-energy rf beam to the large bubble chamber from the upstream target.

A sketch of such a target area is shown in Fig. 2. The requirements of each beam will now be examined separately. The compatibility of operating experiments simultaneously will then be discussed. More detailed descriptions of these beams may be found in other Group C reports, including a summary report of Hand and Mann,[4] and this report is intended to complement them. The design of this area is based upon targeting with 200-GeV protons and the inter-target distance may have to be modified for 400-GeV protons.

NEUTRINO EXPERIMENTS

The bubble chamber requires the protons to be delivered on target in about 100 μsec. Some spark-chamber experiments can tolerate this small duty cycle. At the time of writing this report, neither the neutrino flux nor the shielding (particularly thin magnetic shields) are understood , so the questions of duty cycle cannot be properly answered. Presumably, some spark-chamber experiments will require a long duty cycle. In that case, it will probably be desirable for short duty cycle experiments to focus with a pulsed horn, and for long duty cycle experiments to focus with a dc focusing device. Since all of these experiments requires most of the proton beam and they share the same hadron decay tunnel, the long and short duty cycle experiments should not be designed to operate on the same accelerator pulse. Provision should be made for rapid changeover from pulsed focusing device to dc focusing device. Nezrick's idea of lowering magnets onto a shelf from an upper gallery seems suitable for this application as illustrated in Fig. 3. Repositioning uncertainties less than 0.1 mm can be met with appropriate design precautions.

MUON/TAGGED NEUTRINO BEAM[2,3]

Many muon or tagged neutrino experiments will require a small fraction of the accelerated beam. Nevertheless, some experiments require the full intensity, and it is desirable to investigate the possibility of using the full beam for them. A slow proton beam spill (long duty cycle) is required. This beam can always operate on the same accelerator pulse as the neutrino experiments by appropriately regulating the time structure of the proton beam intensity and the target insertion into the beam.

RF SEPARATED BEAM

A low-energy rf-separted beam at 20 milliradians to the proton beam can operate on the same accelerator pulse as the muon/tagged neutrino and neutrino beams. In this way 15 - 40 GeV/c $K^{\pm}$, and p, $\pi^{\pm}$ up to 80 GeV/c can operate. If higher energy p or $\pi^{\pm}$ are desired, the production angle must be reduced. This is accomplished by magnetic deflection near the target and requires that part of the muon beam be removed. Again, as for the downstream neutrino area, proper design is needed to rapidly change active elements close to the target. In the high-energy mode the bubble-chamber hadron beam cannot operate with the muon/tagged neutrino facility.

COMPATIBILITY OF OPERATION

The target area described allows a bubble chamber to operate every accelerator pulse, a muon or tagged neutrino beam to run whenever very high energy hadrons are not being used in the bubble chamber and the neutrino experiments to operate as is consistent with scheduling the full proton intensity for the production of neutrinos.

A Target Area With A Single Target

In order to use the decay channel of the straight-ahead neutrino facility more effectively, it was proposed that the same decay channel also be used for muon experiments. In order to change from neutrino experiments to the muon experiment, a muon beam pipe, say 17 in. in diameter, could be placed in the 600 m hadron decay tunnel and surrounded with shielding. The shielding might be water. Conceivably, neutrino tagging counters could also be placed in this tunnel. When the neutrino experiments requiring high proton beam intensity are off, both the hadron bubble chamber and muon/tagged neutrino experiments can operate.

A sketch of the muon beam[2] in the straight ahead beam is shown in Fig. 4.

REFERENCES

[1] See, for example, Y. W. Kang and F. A. Nezrick, Neutrino Beam Design, National Accelerator Laboratory 1969 Summer Study Report SS-146, Vol. I.

[2] T. Kirk, Long Spill Muon and Neutrino Beams in Area 1, National Accelerator Laboratory 1969 Summer Study Report SS-43, Vol. I.

[3] D. Berley and L. Hand, Secondary Beam for Muons and Neutrinos for Area 1, National Accelerator Laboratory 1969 Summer Study Report SS-51, Vol. I.

[4] L. N. Hand and A. K. Mann, Neutrinos and Muons in Area 1, National Accelerator Laboratory 1969 Summer Study Report SS-50, Vol. I.

[5] D. Frisch, Notes on Neutrino Beam Design, National Accelerator Laboratory 1969 Summer Study Report SS-152, Vol. I.

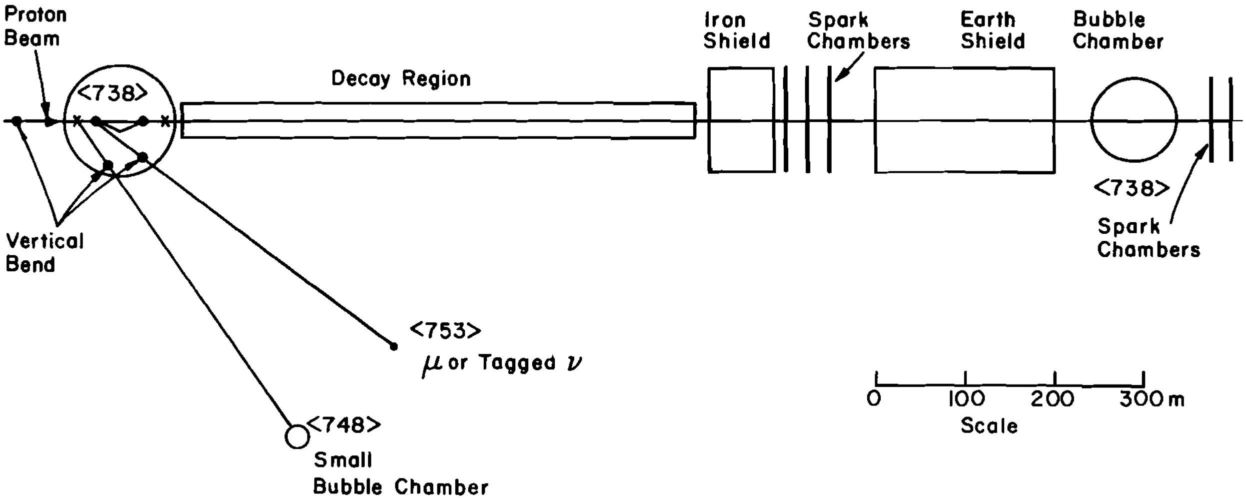

Fig. 1. Proposed neutrino area layout. Numbers in brackets are elevations above sea level, in feet.

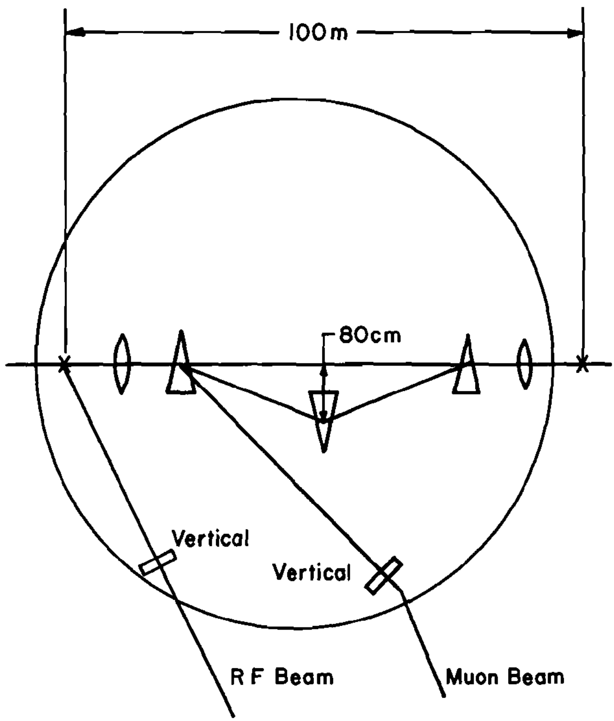

Fig. 2. Detail of target area.

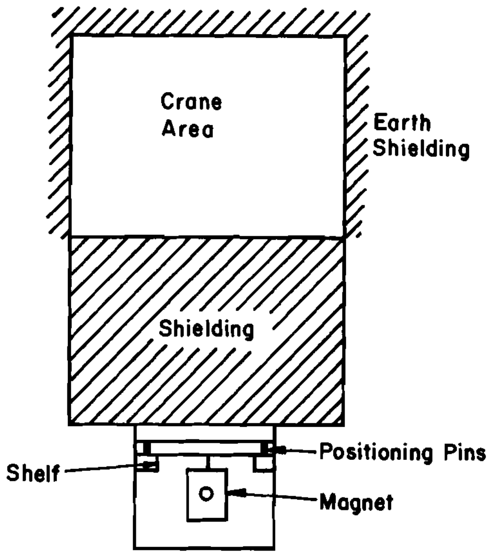

Fig. 3. Cross section of tunnel, showing magnet positioning and shielding.

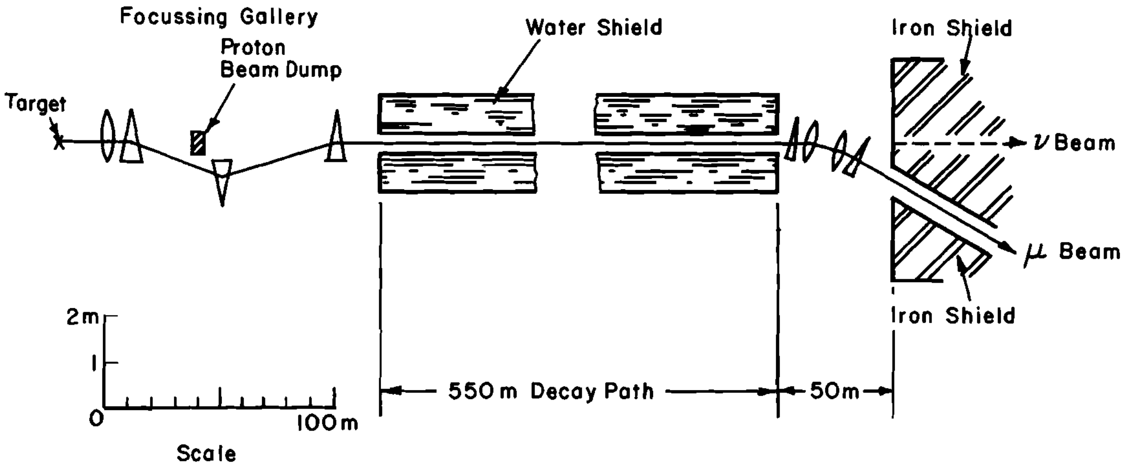

Fig. 4. Combined muon and neutrino beams.