THE EXTERNAL PROTON BEAM

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ABSTRACT

Some considerations on the external beam line are given which are pertinent to targeting for secondary beams.

I. ALTERNATIVE DESIGNS

A layout of the external proton beam by A. Garren and the author is given in Appendix II of the Research Facilities Design Concepts report.[1] In this design, each superperiod of the transport tunnel serves one target area. Each superperiod bends the beam by 7-1/2° using main-ring dipoles and quads, and having a phase advance of 2π. The beam will be split vertically and sent up to the target areas. The bending magnets are distributed so that the superperiods give achromatic transport. An alternative design suggested by Al Maschke using 4 FODO cells 325 ft long also has all of the above properties. The advantages of the Garren design are that the vertical β function is large at the septum ($\beta_y \sim 600$ m) and a longer straight section is available for beam division. The chief advantage of the Maschke design is that the quads and dipoles need only two current controls.

II. THE ADVANTAGE OF ACHROMATIC TRANSPORT

The momentum width of the 200 BeV beam of $\pm 10^{-3}$ is a small contribution to the beam size. One might then argue that since achromatic transport imposes requirements on the phase advance and thus the superperiod length and number of quads, that one might eschew the achromatic property and maximize some other desirable property or minimize cost.

The best argument seems to be that with total achromatic transfer from one superperiod to the next, the beam is centered at the entrance to all superperiods independent of magnet ripple to first order, if the bending magnets are powered in series. This gives a head start on the steering and control problem. Achromaticity will be used in the transport sections to the target stations. This will allow greater stability of spot position at the target. If a 1-2 mm spot size is used, we would expect to regulate this position to 0.1-0.2 mm or better.

III. TRACKING, FRONT PORCHING, AND BEAM SHARING

It has been decided that "front porching" (i.e., slow spilling part of the beam at a settable low energy and the rest at the flattop) is desirable. This immediately suggests that the external transport system should have the capacity to track as the main-ring elements do. The mechanical, electrical, and cooling requirements will then be nearly identical to the main ring, and I can see no mismatch which would make it desirable to undertake a separate design and engineering effort.

The beam sharing to the target areas will be monitored and servo-controlled to supply a steady fraction of the beam (say to 1%) down a given target line. One splitting septum is focused on the next due to the 2π phase advance. This is an advantage in reducing the halo at downstream septa, but tends to couple strongly the intensities at different stations even when small fractions of the total beam are targeted. Of course, when most of the beam is targeted, the coupling is strong in any case.

REFERENCE

[1] R. Carrigan, E. J. Bleser, F. A. Nezrick, and A. L. Read, Research Facilities Design Concepts -Summer 1969, National Accelerator Laboratory Internal Report TM-181, May-June, 1969.