THE YALE DESIGN STUDY OF LINEAR ACCELERATORS*

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At Yale University the interest exists in the proton linear accelerator as a research tool in the energy range of 600 Mev to 1000 Mev; the final energy has not as yet been decided.

The principal variable one would like to improve upon, as compared with existing synchrocyclotrons, would be the beam intensity. The parameters for the linear accelerator under consideration in this design study are listed in Table 1. As indicated the beam energy would be of the order of 0.5 to 1 Bev, with an average intensity of 1 ma and duty cycle of 5%. This will be a variable energy machine, a very favorable feature when compared to synchrocyclotrons. The variable energy interval of the beam will be something of the order of the gain in one tank, 20 Mev or so. The peak current for a two millisecond pulse length is about 20 milliamperes. The beam power is very large.

The rf fine structure in the beam might be useful in some applications; on the other hand, one might wish to spread it out in other applications.

Considerable time has been devoted to considering the type of experiments that can be done. This is the primary motivation for the machine. The primary beam, when it is a polarized proton beam, would be most useful. For the most part, one does not consider using the primary beam directly. Rather, protons would be used indirectly for producing secondary particles.

*Introductory Remarks

In the following three reports, by W.A. Blanpied, H.B. Knowles and R.L. Gluckstern, respectively, the results of some work done, as part of the Yale Design Study of Linear Accelerators, will be discussed. This will deal with the secondary beams one can get assuming the primary beam indicated in Table 1, shielding problems and experimental area layout and, a more futuristic consideration, the possible use of this machine as an injector for a secondary pion accelerator.

Yale Study on High Intensity Proton Accelerators

Tentative Characteristics of a High Intensity Proton Linear Accelerator

I. Beam Energy

a) Maximum energy between 500 Mev and 1 Bev.

b) Energy variable in discrete steps (of about 20 Mev) below the maximum value.

c) Energy spread approximately 0.1%.

d) Beam spot size, 1 cm diameter or less.

II. Beam Intensity

a) Time average, 1 ma (6×10^{15} protons/sec).

b) Peak pulse current, 20 ma.

c) Pulse length, 2 ms.

d) Duty cycle, 5% (repetition rate, 25 pps).

e) Beam power, 500 kw for 500 Mev.

III. Fine Structure of Beam

Each 2 ms beam pulse will have the following beam structure due to the rf accelerating voltage:

a) If the drift tube section operates at 200 Mc/s, each pulse will contain 4×10^5 "buckets" of approximately 0.02 n sec duration.

b) If the drift tube section operates at 400 Mc/s, each pulse will contain 8×10^5 "buckets" of approximately 0.02 n sec duration.

c) A debuncher could be employed to smooth this structure partially.