

VI. THE LINEAR-ACCELERATOR PROGRAM

Prof. J. C. Slater	P. T. Demos
Prof. A. F. Kip	M. Labitt
Dr. W. H. Bostick	L. Maier
R. J. Debs	I. Polk

J. R. Terrall

During the last three months, various parts of the accelerator system have been undergoing tests for methods by which operation can be improved. These tests include studies of the operation of the Van de Graaff generator, of various methods of tuning, and of methods for coupling a larger fraction of the power into the cavities. In addition, various exploratory tests have been made of the characteristics of the machine related to its use in nuclear experiments. Finally, an 18-inch-thick concrete house, to be used for radiation protection, is nearing completion. As soon as it is finished, the accelerator will be moved into it. Some details of the work outlined above will be given below.

Experience with the Van de Graaff generator during the last few months has indicated that, although most of the requirements for a stable machine to deliver 2-Mev electrons have now been met, the vacuum column of the machine will not now allow operation above about 1.5 Mev. A possible (though unverified) cause of deterioration of the vacuum column lies in materials which may collect on the glass surface of the column when microwave discharge occurs in the linear accelerator. Modifications of the geometry and vacuum system, which will minimize all such possible deposition of materials, are now being made, after which a new vacuum column will be installed.

The original method of tuning proving unsatisfactory, we have investigated other tuning methods. Using the frequency-perturbation method described in an earlier progress report (1), the field strength along the axis of a four-foot section was measured. It was found that any type of tuning mechanism which acts at only one position along the section causes marked variation in excitation along the tube, unless the tuner is set to a nontuning position. This is a very bad situation for two reasons. In the first place, given a certain power input to the cavities, uneven excitation reduces the acceleration obtained. In the second place, uneven excitation will change the coupling from the waveguide feeds to the cavity, resulting in reflection of a considerable fraction of power back into the water loads. A simple solution to this situation is obtained if one tuner is placed in each foot of the accelerator. With proper choice of the positions

(VI. THE LINEAR-ACCELERATOR PROGRAM)

of the tuners with respect to the feed holes, variations in coupling with tuning are negligible, and excitation is constant along the section. The new tuners are T-shaped, and tuning is obtained by their rotation. In the final assembly, all tuners in a section will be gauged and remotely controlled.

It turns out that another cause of difficulties lies in the existence of excited TE modes at frequencies close to the frequency of the desired TM mode. These TE modes seriously alter the shape and excitation of the desired TM mode. We have plotted the wave numbers versus frequencies of a number of TE modes, for various lengths of microwave-cavity sections, and now understand quite well the difficulties which occur. Since the mode spacing decreases as the length of section increases, it is more difficult to operate far from a TE mode when using longer sections. For this reason, we shall have to reduce the length of each independent section to less than the original four feet. The excitation of the TE mode is due to asymmetries in the cavities, such as the feed, but the fact that the TE-mode frequency lies close enough to the desired TM mode to affect it is apparently a chance result of the particular cavity geometry which we chose. In any case, tests which have been made indicate that the efficiency of the accelerator will be greatly improved, perhaps by a factor of at least two, in acceleration voltage per foot when the TE mode has been removed. It has been determined that the problem can be solved by shortening our sections from four to three feet. It is expected that before we have finished moving the accelerator into its new shield all of the necessary modifications will be finished.

The most important result of the tests on using the high-energy electron beam for nuclear studies is the demonstration that an increase by a factor of 100 of the electron-beam pulse current will allow many types of electron scattering and γ -ray studies which at present are at least marginal. It appears perfectly practical to make such an increase in the current, and details are now being studied. Present peak currents are of the order of 0.1 milliamperes, and we plan to increase this by a factor of somewhat more than 100. This work also should be finished by the time we are ready to operate in the concrete shield.

Reference

- (1) Quarterly Progress Report, July 15, 1947.