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Technology - Materials
Testing Accelerator

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RADIATION LABORATORY
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MINUTES OF MEETING OF MTA REVIEW COMMITTEE HELD AUGUST 8, 1951

Russell H. Ball

Berkeley, California

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MINUTES OF MEETING OF MTA REVIEW COMMITTEE
HELD AUGUST 8, 1951

Present: UCRL: Brobeck, Cooksey, Farly, Judd, Lawrence, Lofgren, Martin, Reynolds, Sewell, Thornton, Van Atta

CR&D: Cope, Crandall, Davis, Hildebrand, Kent, Powell

AEC: Ball, Fidler

Martin said that it will be necessary to produce approximately 700 ma of 300 Mev cyclotron beam in order to obtain the same neutron production which can be realized from a 500 ma 350 Mev linear accelerator. He said CR&D is preparing a cost estimate of a production cyclotron in terms of beam current and beam energy. The cost estimates are being prepared for a single machine to produce 700 ma of beam and also for seven individual cyclotrons each producing 100 ma beam.

Hildebrand said the first part of the J-16 report, which comprises a description of the test machine to be built at Livermore, is now essentially complete. The second section, dealing with a production model presumably to be built at Weldon Spring, is nearing completion. Present cost estimates for the cyclotron and the linear accelerator machines indicate that the cyclotron method will be less expensive by approximately 50 megabucks. (Note: This was later changed by revision of target and beam loss figures) He read a suggested draft of the third section which presents the pros and cons of the cyclotron and linear accelerator approaches. The draft met with tentative approval. Davis and Hildebrand have prepared estimates of plant cost and product cost as a function of beam energy for various beam currents.

Hildebrand said that the reduced rf losses in the cyclotron as compared with a linear accelerator will result in a power saving of approximately three megabucks per year per machine. He added that the ratio of peak to average intensity in the ion beam should be distinctly more favorable for the cyclotron than for the linear accelerator. Also it is thought that there may be less operating time lost due to sparking with the cyclotron. The linear accelerator, however, has the advantage of being capable of extension to higher beam energies and can therefore presumably be made more economical to operate.

Lawrence said that the comparison between a 500 ma linear accelerator and seven 100 ma cyclotrons should be made on the basis of having all seven cyclotrons in the same area and provided with common facilities. He said the expense involved in taking advantage of the dispersal possible with the multiple cyclotron approach should not enter the fundamental comparison of the two methods.

Martin said that the Radiation Laboratory has estimated the cost of a J-16 unit for Livermore at approximately 20 megabucks, while CR&D has estimated the cost at about 25 megabucks. Martin said that the magnitude of the target cost

for the cyclotron will be determined by the fraction of the circulating beam which it proves possible to deflect, the fraction of the deflected beam it proves possible to conduct to the target, the aperture of the deflected beam, ratio of peak to average intensity within the beam at the point of the primary target, and upon the neutron economy attainable within the target lattice.

Sewell discussed removal of the circulating beam. He said they have visually observed the deflected electron beam from the electron model external to the magnet pole. It has been observed that while the beam is being deflected none of the beam hits fluorescent clippers placed inside the machine. With the electron model it is not possible to obtain accurate measurements of the circulating beam. He said however that on the basis of visual observation it is estimated that approximately 90 percent of the circulating beam can be deflected and that of this deflected beam approximately 90 percent can be focused on a target. This latter factor of approximately 90 percent has been verified experimentally.

Sewell said it was possible in one experiment, by the addition of iron to the pole faces, to reduce the horizontal divergence of the external beam from 45° to between 10° and 15°. It was found possible in this experiment to concentrate 50 percent of this focussed beam upon an area 1/8" x 1-1/2" at a distance one pole radius away from the cyclotron. He said it should be possible to do better than this with a full scale machine, and suggested a target aperture of 2' x 6' as adequate for a full scale machine. Lawrence said that the aperture required should be independent of beam current.

In a discussion initiated by Lawrence it was decided to include in the J-16 report both a single 700 ma cyclotron and seven 100 ma cyclotrons as alternate approaches in order to permit an illustration of the expected savings in lattice costs realizable with such high currents and to illustrate the advantages of such possible future developments. Thornton said that it may prove desirable to build ten machines each producing 70 ma, or perhaps five producing 150 ma each. The construction of J-16 will answer just such critical questions as this.

Lofgren presented experimental data obtained with the 20" injector cyclotron for the quarter-scale bevatron. His conclusion was that a low ratio of peak to average intensity within the deflected beam is a characteristic of cyclotrons. Lawrence stated that the high dee voltages and the consequent large spread in radial velocity in the beam, together with the large (5-10 percent) angle with which the circulating beam entered the electro-static deflector rendered meaningless any comparison of the profiles of deflected beams of this injector cyclotron and J-16. Lawrence said the ability to focus the beam from the electron cyclotron to a small area is extremely encouraging and should permit the construction of a production target for J-16 having a beam aperture small enough to insure the attainment of excellent neutron economy within the lattice.

Davis said the advantage inherent in introducing the beam to the target through a small aperture could be realized either by reducing the size of the target or by increasing the production from the lattice. A discussion followed, the consensus of which was that the improved focus of the cyclotron beam would result in a reduction in investment cost of about 10 percent in favor of the cyclotron. Cope said a more important consideration would be the approximately 10 percent improvement in production for the cyclotron.

It was concluded that the ratio of peak to average intensity for the cyclotron beam would be no greater than 2/1, compared to 50/1 for the unprecessed and 4/1 for the precessed beam from the linear accelerator.

Davis presented some calculations on product cost which showed a slight economic advantage to the use of intermediate beam energies and high beam currents when a specified rather than an unlimited production is required. He added however, that in the energy range of 300 to 450 Mev the cost of the product is fairly constant. Cope said that the important conclusion to be drawn from Davis' calculations is that for any given machine one will eventually reach its ultimate beam current and if at that time it is possible to improve the voltage gradient (in the case of the linear accelerator) one could significantly improve production.

On the basis of the foregoing discussions it was the consensus of the meeting that the characteristic of a production cyclotron would be that 80 percent of the circulating beam would be available on the target and that the attainable ratio of peak to average intensity in the beam would be 2/1. Thornton said the figure of 80 percent is somewhat in doubt since with the electron model it is not possible to obtain an accurate measurement of the fraction of the circulating beam which is being removed.

Sewell said that the visual observation indicates that the cyclotron beam fills the dee at the hill from which it is removed, and it is possible that some of the beam is being lost unobserved to the tank in the region of this hill. Judd said that should this prove to be the case it will be possible by proper shimming of the magnet to correct such a defect.

Martin said that the 10 to 20 percent of the circulating beam which is lost will be collected on a tube bank near the deflector. It is not expected that there will be other regions of high heat flux due to stray beam.

The deadline of transmitting the J-16 to Washington was set at August 31, 1951.