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UCRL-993
Technology - Materials
Testing Accelerator

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UNIVERSITY OF CALIFORNIA
RADIATION LABORATORY

Contract No. W-7405-eng-48

CALIFORNIA RESEARCH & DEVELOPMENT COMPANY
Contract No. AT(11-1)-74

MINUTES OF MTA PROGRESS MEETING
HELD NOVEMBER 7, 1950

Russell H. Ball

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RESEARCH SERVICE BRANCH
Atomic Energy Commission
Berkeley Area
Berkeley, California

MINUTES OF MTA PROGRESS MEETING
HELD NOVEMBER 7, 1950

Present: UCRL: Alvarez, Brobeck, Brown, Cooksey, Farly, Gow, Hanson, Judd, Kilpatric, Latimer, Lawrence, Lofgren, Longacre, Martin, McKissen, McMillan, Norton, Panofsky, Reynolds, Serber, Chupp, Sewell, Street, Thornton, Twitchell, Van Atta, Wallace

CRDC: Chaffe, Cope, Crandall, Davis, Gleason, Hansen, Hildebrand, Powell

AEC: Ball, Fidler

G.E.: Fraenckel, Lausen, Webster

Westinghouse: Hulse, Kresser

Brobeck said that in preliminary discussions it was suggested that the major design parameters of Mark II should be set by February 1, 1951 or at least by that time to have reduced the designs considered to two alternatives. Should two alternatives remain for consideration by that date, design studies will be conducted in parallel on both of them until such time as sufficient data is at hand to allow a choice to be made between them. Panofsky noted that the field gradient which determines the length of the accelerator does not need to be chosen as early as does the frequency.

Alvarez asked how soon it was planned to have voltage in the Mark I tank. Hildebrand said this is expected about May 1951.

Panofsky said that there is still considerable uncertainty as regards the seriousness of the electron loading which may be encountered in Mark I and that in view of the fact that the L-1 test cavity will not be completed in time to be of use in Mark I design there remains the question of whether it is advisable at the present time to attempt to engineer remedies for discharge problems which we are not now certain will occur. He said that as a result of Baker's recent experiments on the XC equipment Baker is of the opinion that biasing voltages as high as 150 KV may be required in order to suppress electron emission from the drift tubes. Panofsky said that he felt this figure was too high. He said that the electron loading can probably be controlled by placing loops every 5 or 10 feet throughout the length of the Mark I cavity or by the placement of loops at the midpoints of each gap which loops would have a diameter somewhat greater than that of the outside diameter of the drift tubes. He said the placement of this latter type of loop near the drift tube gaps might eliminate the necessity of biasing individual drift tubes in future designs.

Panofsky asked what was the main hold-up in the construction schedule of the

L-1 cavity. Hildebrand said that the power supply and the copper clad steel were the two major items, of which the power supply was the controlling one. Brobeck said there is the possibility of using the Mark I power supply for the L-1 cavity. Panofsky said this would be desirable if the L-1 cavity is to be completed several months after Mark I but that it would not be a desirable thing to plan on if schedules of Mark I and L-1 are close together. Panofsky said that it would be desirable to include in the design of the Mark I cavity a number of bushings for the support of biasing rings which may prove to be required. This would eliminate extensive reworking of the liner at a later date should their use be required. Alvarez pointed out that there will be extra oscillator holes available for the purpose of supplying voltage to these biased hoops but Panofsky felt it would not be desirable to plan on using these oscillator ports for this purpose.

Lawrence asked if all of the drift tubes on Mark I were insulated. Brobeck said that only alternate drift tubes are being insulated, although the remainder are so designed that they may be insulated if required. He said the only difficulty encountered in individual biasing of the drift tubes will be insulating the motor generator sets which will supply power to the drift tube magnets. Alvarez pointed out that the insulation of these motor generator sets need not be required during the experimental phase of Mark I operation since the biasing will be required only if it is not possible to obtain a beam with Mark I and if there is no beam the focusing effect of the magnets will not be required. Hence, in order to determine the effectiveness of individual biasing of the drift tubes upon electron loading it would be possible to disconnect the motor generator sets.

Panofsky said that calculations have begun at RAND in order to determine the advisability of using larger entrance apertures and a higher injection voltage on Mark II. The results of these calculations will not be available for about 2 months. He said that he felt it desirable, however, to proceed immediately with the procurement of a 300 KV power supply which would enable Lofgren to begin the development of a high-voltage DC injector.

Sewell said his group is still investigating the discrepancies between measured and calculated values of Q on the 1/10 scale Mark I model. The difference between these two values is about 15%, with the calculated Q being the higher. He said that if the surface conductivity of the silver plating on the drift tubes is taken at half the conductivity of pure silver this 15% discrepancy can be accounted for. The drift tubes and stems are being re-plated under more carefully controlled conditions in order to study this possibility.

Lofgren reported that total ion currents of 2 amperes have been obtained by grounding the first two accelerating electrodes of the ion source in the manner described last week.

Longacre said that a higher power oscillator is being installed to drive the

electron accelerating model of Mark I in an effort to overcome the gas loading problems peculiar to this model.

Thornton outlined the present status of the electron accelerating cyclotron. He said the cyclotron utilizes the Thomas principle to obtain relativistic phase correction as worked out by Thomas theoretically in 1938. It employs a tri-foil system in which the magnet pole faces are so contoured as to present 3 maxima of the magnetic field symmetrically spaced 120° apart. An operating model to test this principle has been studied during the past 3 months. It accelerates electrons to about 70 Kev and models the relativistic behavior of deuterons up to an energy of 250 Mev. This model is a single dee cyclotron with a pole radius of 16½ inches and a maximum magnetic field of 27 gauss. The oscillator frequency is 60 megacycles. The electrons are accelerated satisfactorily to the periphery of the magnet. The operating parameters which are of particular interest are the dee voltage required and methods of getting the beam clear of the magnetic field. No difficulties have been experienced on the latter problem. No effort has been made to tailor the shape of the magnetic field near the edges and the application of a sufficiently high rf potential has sufficed to deflect a substantial portion of the circulating beam. The electrons appear to peel off just before reaching the peaks of the magnetic field. It is not possible to determine accurately the magnitude of either the circulating current as it varies with radius or the total deflected current. It is believed possible to tailor the contour of the field near the periphery of the magnet so that the beam will peel off preferentially at one or more selected points.

Thornton said that to get the electrons out to a 13-inch radius required a dee voltage of about 500 volts. This corresponds to an electron energy of 60 Kev. There was no reason that this figure should be the minimum obtainable since no great care was taken in shaping the magnetic field and since the contour of the pole faces was based upon rather crude calculations. In order to study the effects of modifying the field shape, circular wires were placed on the upper and lower pole faces at 2-inch radial intervals from the center out, with provision for controlling independently the current through each loop. By careful adjustment of the currents in these windings the minimum dee voltage required was reduced to somewhat less than 200 volts. To get deuterons up 250 Mev, using a full-sized cyclotron of this design would require these voltages to be multiplied by 2000 (that is, by one-half the ratio of the masses, the factor of 1/2 being introduced by the use of a second dee). Thus a two-dee machine would require voltages of between 1/2 and 1 million volts. A cyclotron of this design to produce 1/4 gram of neutrons per day would require a magnet weighing approximately 10,000 tons. The magnet excitation to about 10,000 gauss maximum would require about one megawatt. A large gap would be required in order to accommodate the ion currents of approximately 100 ma which are expected. With 250 Mev deuterons, 60 to 65 milliamps average beam would be required to produce 1/4 grams of neutrons per day. The present electron accelerating model has a circulating beam of the order of 20 μa.

Thornton said that in order to continue the studies of this type of machine

it is planned to convert the XC magnet into a proton cyclotron of the Thomas design to produce protons of 20 to 25 Mev. Its operation would be pulsed in order to minimize the power requirement, radiation, and induced radioactivity. Such a model would allow a determination of the beam currents which could be expected from a full-scale machine and would also allow for a convenient study of the beam orbits in the central region of the machine which cannot be done on the electron model.

It is also important to determine the beam loss between the energies of 20 and 200 Mev. On the electron model the beam loss between radii of 8 and 20 inches does not appear to be appreciable although it is not possible to measure it accurately. Panofsky asked why it would not be possible to obtain much higher electron currents in this model. Thornton said one of the main reasons is that the space charge effect is much more severe for electrons than for protons. Lawrence added that protons ionize a much larger fraction of the residual gas than do electrons and there is consequently a much different space charge neutralization with protons than with electrons.

Hansen said that all 5 of the manifolds are in place at Livermore and the welding of the fifth one is now underway. Six of the large sheets have been welded to the manifolds. Work has been completed on the north and west tunnels. Concrete will be poured tomorrow in the basement on the west side. The foundations for the building on all but the east side have been completed. Fabrication has been underway for two weeks on the vacuum piping and the electrical work. Foundations for the transformers are being installed. P.G. & E. is now setting poles on which the power lines to the site will be strung. Seven of the 14 supporting ribs for the vacuum vessel have been erected and the tank is now approximately 20% complete.

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