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SPECIAL REREVIEW

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REPORT PROPERLY DECLASSIFIED

J. N. GREEN 4-7-80

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J N Green 4-7-80

By Date

UNIVERSITY OF CALIFORNIA — BERKELEY

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SECURITY INFORMATION

MINUTES OF MTA PROGRESS MEETING
TUESDAY, SEPTEMBER 26, 1950

Present: UCRL: Alvarez, Baker, Brobeck, Brown, Cooksey, Dexter, Farly, Hansen, Latimer, Lawrence, Lofgren, Longacre, Martin, McMillan, Norton, Panofsky, Powell, Reynolds, Serber, Sewell, Street, Twitchell, Van Atta

CRDC: Cope, Crandall, Fossati, Gleason, Hansen, Hildebrand, Kent, Maker

AEC: Ball, Fidler, Fleckenstein

Professor Lawrence announced that the Commission has given approval to the Mark II program. The schedule selected by the Commission is believed to be for construction within 36 months and at a site other than Livermore.

Brobeck said that during the week the AEC requested that the Mark I unit be designed to allow for CW operation. The only item which is greatly affected by this change is the cooling of the liner where the change to CW operation will increase by a factor of 3.5 the heat which must be removed. This figure is based upon an effective duty factor of 28% for the former design. For the presently designed Mark I this change will require the addition of twice as much water tubing. In addition to this, some marginal locations such as joints might have to be supplied with still additional cooling. These figures are based upon a decay constant of 10 milliseconds for the cavity. The inlet water temperature will be 21° C and there will be a temperature rise of 15° in the water and 10° in the copper sheet, thus giving a maximum liner temperature at the far end of the cooling system of 46° C. Alvarez and McMillan questioned the advisability of having the cooling tubes run the length of the tank since this will introduce a temperature gradient along the tank which will give rise to a taper of the tank due to differential expansion. It was pointed out that this would not be a significant effect in the Mark I accelerator but that the cooling water circuit for Mark II cannot be of this type.

McMillan said that the spreading of the beam after leaving the accelerator does not help very much in eliminating the high intensity central spike. Brown said that present calculations indicate that the central spike which will be approximately 1 inch in diameter will have an intensity at least 50 times the average intensity of the beam. The intensity is expected to fall off from the central spot inversely as the radius. He said the distance from the center beyond which this 1/r law holds is dependent upon the nature of the injected beam. Panofsky said that he has discussed this problem with Henrich and they concluded that there are three phenomena which will affect the intensity distribution of the beam. One of these is space charge, the second is angular momentum, and the third is lack

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of alignment of the components of the accelerator. The first two of these phenomena have been studied and space charge has been found to have a minor effect. Under presently-planned operating conditions the angular momentum of the beam will limit the central spike of the beam to approximately 1 inch in diameter. He said this leaves the possibility that this central spike of the beam might be spread out by intentionally misaligning the drift tubes. McMillan said he was quite sure there would prove to be enough astigmatism in the accelerator to spread out the central spike appreciably. He felt that this astigmatism would be pronounced enough to mask any effects due to dimensions of the injector. It was the consensus that the central peak of the beam would not exceed the average intensity by more than a factor of 50 and that this figure would be satisfactory for design studies. Following considerable discussion, Panofsky said that since the focusing effects of magnetic fields within the drift tubes are second order it may not prove possible to greatly affect the beam by misalignment of the drift tubes.

Sewell said that on the 10th-scale model of Mark I they have almost finished making measurements of the magnetic field and the Q; they expect within a week to have final results on the shunt impedence and power losses in the various components such as drift tubes and stems. The drift tube magnets have all been designed and almost all measurements on them have been completed. They all appear to be satisfactory. These measurements should be completed by next week. The measurements to give the magnetic force between drift tubes as a function of drift tube position are nearly complete. The maximum force between drift tubes is being determined at minimum separation. This is on the safe side since adjacent magnets will be run at opposite polarity so as to repel each other.

Panofsky said that about three weeks would be required to compile an accurate table of dimensions for the proton drift tubes. He said this work has not yet begun. Lawrence stated that the Mark II design should be taken up after completion of the Mark I deuteron drift tube design and tests. Panofsky said that on the electron model of Mark I the discharge problem was found to be entirely due to multipactoring and that this difficulty has been entirely overcome by applying bias potentials to the drift tubes. The electron beam cannot be accelerated with this biasing in a manner which can be scaled for use in the MTA machine, so installation of rings in the gaps in underway to sweep out the electrons from between the drift tubes. Panofsky said that the magnetic fields of the drift tubes do not appreciably affect the multipactoring since the field strengths are so low. He said it has been observed that in reversing the magnetic fields the beam shifts sideways. This is believed to be due to a lack of symmetry in the magnetic fields which is in turn due to the low excitation of the magnets. Panofsky said that the most important thing to determine now with this model is the phase acceptance angle because the requirements of the injector are dependent on this. He said they would also measure the in-put and out-put phases of the beam in order to determine the bunching effect of the accelerator. Lawrence asked if this could not be accomplished by placing a control grid in the injector which would be tied to the rf field in the tank so that by phase shifting one could explore the entire phase region. Alvarez and Panofsky said that in theory this would work but that it would prove difficult in practice due to the high frequency being used.

Baker said that in testing the 1-megawatt RCA 5831 tube in Building 52 they have loaded it to ½-megawatt with a plate voltage of 14 KV. He said that the joint between the stem and liner in the resonant load has been burned out three times by this heavy loading due to the breakdown of soft solder at current densities of about 100 amperes per inch. He noted that Mark I will have liner currents of 92 amp./in. Alvarez asked if they intended to use the copper spray method to improve conduction at joints. Baker said they did not plan to use this method because they have had poor success with it. Brobeck said General Electric has reported R.F. conductivities of 80% of pure copper by using this method. Baker said that our difficulty with using copper spray probably lies entirely in our poor technique of applying it.

Lofgren reported that they have been testing the Phillips-type low-temperature cathode in the ion source. They let it run all last night and part of this morning and then removed it for examination. Apparently the high energy positive ions do not rapidly damage this type of cathode, due to the low temperature of about 1000° at which it operates. With this cathode the tank is much darker than previously and allows better observation of the ion beam. He said it is now possible to actually see the beam holding together as far as 28 inches from the source. The beam at this point has a diameter of approximately one inch. The beam can also be seen leaving the ion source. It appears as a white beam which is quite parallel. The beam obtained in this test has been limited to 500 ma due to the small size of the cathode. Upon examining the cathode after the above run it was observed that the image of the anode was fused on its surface. There was a fused circular area on the cathode corresponding to each of the 1/16-inch holes in the anode through which the protons are extracted. It was observed, however, that the tungsten surface between these fused spots still remained porous. A duty cycle of 1/1000 was used in the above test.

Thornton reported on the electron model of the cyclotron. He said the dee voltage has been reduced to 400 volts and that the accelerated electrons have the energy that is expected from their radius and the magnetic field. The electron beam has a magnitude of about 10^{-8} amperes. They are now trying to determine the factors which are limiting the electron beam.

Hildebrand said they have been having discussions with Westinghouse and General Electric in connection with Norton's group to insure that they are not overlooking any solution to the problem of precessing the beam with a rotating magnetic field. There appears to be general agreement on our present approach to the problem. He said they are now assembling final specifications for the precessing magnet which will be ready about the end of the week. There is a question at the moment of how to obtain the 4-foot diameter non-conducting vacuum tight cylindrical segment to fit inside the magnet. He said that they have been considering a segmented structure but this does not appear too feasible. If the procurement of this member is too difficult it might be possible to place the precessing magnet inside the vacuum chamber. The bidders will be allowed to submit bids on either procedure. Brobeck said that out-gassing of 10 micron-liters per second from the precessing magnet would raise the pressure at the far end of the tank to 10^{-7} millimeters. Professor Lawrence said that if it becomes necessary to place the precessing magnet in the vacuum chamber the

out-gassing problem can be reduced to a satisfactory value by enclosing the magnet within a thin-wall metal case with small openings.

Panofsky said he has made some calculations regarding Lofgren's suggestion of dissipating the high energy spike of the beam with a rotating tungsten target. He said the central intensity of the beam is such as to exceed by a factor of 200 the heat which can be removed by radiation from a stationary target without melting such a target and that consequently the physical size of a rotating target would probably be excessive. Lofgren said that the area of the central spike of the beam could be increased by this factor of 200 by oscillating as well as rotating the target so that this solution to the problem might still be feasible. Hildebrand said that the use of a precessing magnet appears to be the cheapest and most probably successful means of equalizing the intensity of the beam. Brobeck pointed out that a rotating tungsten target would be suitable only for the current measuring target only but not for Po production and thus does not deserve too much emphasis. Cope said that two vacuum manifolds have been delivered to the Livermore site but that there is as yet no structural steel on the site. delete.

Van Atta said that Livingston at ORNL had been studying the effects of thermal cycling on uranium. He said the results are not very encouraging, although it remains to be determined how applicable this work will be to the Mark II target.

Powell reported on calculations he has made regarding the weight of the magnets required for a high current cyclotron for neutron production. He said that for a 375-Mev deuteron accelerating cyclotron having a 2-foot minimum gap the weight of the magnet would be approximately 15,000 to 16,000 tons. If the deuteron energy is 250 Mev the weight of the magnet can be reduced to about 10,000 tons.

Russell H. Ball

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