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University of California, Davis

INITIAL INTERNAL BEAM STUDIES WITH THE **DAVIS 76-INCH CYCLOTRON**

Davis, California

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Initial Internal Beam Studies With The
Davis 76-Inch Cyclotron

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The first particle beam of H_2^+ ions was accelerated in the Davis 76-inch cyclotron on April 8, 1966 on the same day that the RF was on for the first time. Since only four trim coils were then operating, isochronism was lost at 20 inches. At this point 10 microamperes of beam were recorded with accompanying radioactivity and neutrons. Subsequently 8 trim coils became operative and 3 microamperes were obtained at 30 inch radius, which is the radius for extraction. Larger beam currents could have been obtained but beam intensities were kept down to save probes and to decrease radiation levels as the roof shielding has not yet been installed. All beams were obtained at linear program settings except for the necessity to retune the main coil. Visual observations of fluorescence indicates that the beam is approximately centered in the median plane with about a 1/2 inch axial spread beyond 10 inch radius. A radio-autograph taken at 30 inches indicates a 3/16 inch to 1/4 inch radial depth of the beam spot which was about 3/8 inch in axial dimension.

Since the vacuum in the acceleration region was 1.3×10^{-5} mm it was elected to run with a reduced beam intensity of 42 MeV alpha particles to make it unnecessary to correct for beam attenuation due to gas loss. The beam was obtained immediately on the settings as H_2^+ . It was centered to 1/4 of an inch using ion source position and puller position and dee voltage. Unfortunately the harmonic coil supplies proved to be inoperable. The dee voltage was fixed at 46 kilovolts (known to $\pm 30\%$) for most runs using alpha particles. A resonance curve was taken at the 30 inch extraction radius. It correlates with neutron production and has a full width at half maximum of 0.14% in magnetic field.

A three element axial probe measurement was made. The elements are 1/2 inch in axial dimension. The results show that over 90% of the beam is confined to $\pm 1/4$ inch of the median plane from 10 to 30 inches in radius. Figure 1 shows a copy of two x-y recordings from this probe. Between 5 and 10 inches the lower axial element begins to collect beam current and it has a current equal to the central element at 5 inches. This indicates that the plane of the initial beam is approximately 1/4 of an inch below the geometric median plane. Since the RF plate voltage is at present unregulated, the above measurements as well as the radial ones are to be regarded as preliminary.

When we were on resonance, a series of radial profiles were taken with an x-y recorder for several dee voltages starting at 15 kilovolts threshold. They are shown in figure 2. For this measurement current from all three elements was metered together.

A three element radial probe was also used to measure the radial current distribution versus radius as shown in figure 3. This probe has 3/16 inch radial steps for the first two elements and a one inch step from element 3. Spurious has been subtracted from the current shown by shadowing the main probe with the 150° probe which is 120° upstream. It can be seen that over 85% of the beam is on the first 3/16 inch element at extraction radius. Measurements using the 150° probe to shadow the main probe indicates a radial motion of 0.6 inches is required to reduce the beam to one half value. This result was taken at 46 kilovolts dee voltage and 30 inch radius.

The work which has been described is the result of the effort of the entire staff of the Crocker Nuclear Laboratory. I would like to mention Dr. N. F. Peek, assistant director; C. F. Hanson, chief engineer; H. L. Thibau and H. H. Whiting, senior engineers; R. L. Hickerson and J. W. Cline, electronics; G. D. Anderson, chief mechanic; R. W. Rothrock, chief designer; J. L. Wood, principal accelerator operator; L. J. Kibbe, computer programs, and Professor J. E. Draper, external beam optics.

Splendid cooperation has existed between the Crocker Nuclear Laboratory and the Oak Ridge National Laboratory and this made it possible to benefit greatly from the second generation aspects of this machine. William M. Brobeck and Associates performed the engineering. We are also grateful for the many suggestions from the Naval Research Laboratory group with whom we have procured

many components of the Davis cyclotron in joint venture. Finally our thanks are certainly due to the Atomic Energy Commission and the National Science Foundation for the financial assistance which has made the construction of this accelerator possible.

Fig 1 Axial Current Distribution

42 MAR 2

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142.72 m.s.

Fig 2

Current to 1, 2 + 3 radial
fingered probe

Figure 3 Radial Current Distribution