

CYCLOTRON PANEL
OF
NUCLEAR PHYSICS SUB COMMITTEE

7th.
MINUTES OF THE MEETING OF THE CYCLOTRON PANEL
HELD IN CONFERENCE ROOM "C" CABINET OFFICE,
GREAT GEORGE STREET, LONDON S.W.1
ON THURSDAY, 13TH FEBRUARY, 1947. AT 2.0 P.M.

Present: Mr. J.E. Adams (A.E.R.E. Harwell)
Mr. J. Boag (M.R.C.)
Mr. M.E. Boston (Cavendish Lab. Cambridge)
Dr. B.V. Bowden
Mr. J. Cassels (Cavendish Lab. Cambridge)
Dr. L.H. Gray (M.R.C.)
Dr. J.R. Holt (Liverpool University)
Mr. M.J. Moore (" ")
Dr. T.G. Pickavance (A.E.R.E. Harwell)
Dr. J. Rotblat (Liverpool University) (Chairman)
Dr. H.V.B. Skinner (A.E.R.E. Harwell)
Mr. M. Snowden (" ")

1. HARWELL CYCLOTRON

Dr. Pickavance reported on the progress made in the design and construction of the Harwell cyclotron. The excavation for the magnet is proceeding and the magnet itself is under construction at Parsons' and should be installed at the beginning of next year. The H.T. set, R.F. system, deflector H.T. supply and magnet generator, should also be ready about this time. The vacuum chamber and dees are being designed. The vacuum pumps are to be obtained from Metro Vicks.

Using a one tenth scale model of the magnet, the correct taper of the pole pieces has been worked out. Experiments on this model have also shown that with the reduced pole gap - which is now 12" - the maximum R.F. frequency can be increased from 25 Mcs to 30 Mcs. At this frequency, and with the magnetic field available, the energy of the proton beam is expected to be 150 MeV.

It is hoped to be able to vary the mean frequency without letting air into the tank, by using a hydraulic piston system for operating the shorting bars.

It is proposed to use a single dee with the F.M. condenser joined to the end of a stub line. This will enable the capacity to be reduced and also to eliminate serious difficulties in removing the heat produced by eddy currents when the rotating condenser is in the stray magnetic field near the tank. The condenser chamber will be pumped independently. The method of altering the length of the stub line for tuning purposes has not yet been worked out.

The Harwell cyclotron will be designed for frequency modulation working only.

In the discussion it was pointed out that the variation of the mean frequency might present serious difficulties, particularly with regard to extracting the beam, since the necessary change in the magnetic field will alter the radius at which the rapid falling off in field strength occurs. At Harvard it has apparently been decided to work at a fixed mean frequency and to vary the energy of the particles by means of absorbing foils or by the use of probes. The Harwell people, however, thought it advisable to be able to change the frequency and the intention was to investigate the possibilities of achieving this.

2. LIVERPOOL CYCLOTRON

Mr. Moore reported on changes in the plans for the Liverpool cyclotron. It has now been decided that this should be of the frequency modulated type, and of a much larger size. The Nuclear Physics Sub Committee have agreed to this change and recommended that, if possible, the magnet should be larger than 120". Plans have been worked out for a 120" magnet, which is about the maximum size Metro-Vicks are able to make, but the possibility of increasing the diameter of the magnet poles to 150" is being investigated. Metro-Vicks have quoted £80,000 for a 120" magnet, weighing 1200 tons, and a total sum of £117,000 for the full cyclotron (excluding screening). It is thought that this was a very reasonable sum.

The main bottle neck at the moment is the supply of steel. A 150" magnet would require 1500 tons of steel, which is a considerable proportion of the annual steel allocation to Metro Vicks. The possibility of obtaining the steel from the U.S.A. is being investigated.

No definite plans have yet been made with regard to the R.F. system. It was thought that before deciding on this, a careful study should be made of the methods used or proposed to be used in the F.M. cyclotrons being built in the United States.

3. M.R.C. CYCLOTRON

Dr. Gray reported that a plan for the M.R.C. 65" cyclotron had been drawn up on the basis of recommendations of the Panel, but in view of the changed plans for the other cyclotrons, it might be worth while to reconsider the requirements for the M.R.C. machine, and in particular whether this too should be a F.M. cyclotron. Dr. Gray pointed out that a proton beam of 130 MeV would have a penetration in tissue of 10-20 cm., which might be of great value for therapy.

It was generally felt that a F.M. cyclotron would not provide the neutron flux (10^{13}) that was required for neutron therapy, and moreover the reliability of operation - which is of particular importance for medical applications - is not as good as in a constant frequency cyclotron. In view of the fact that neutron therapy and the production of tracer elements will still be the main object of the M.R.C. cyclotron it was agreed that the Medical Research Council could either follow the design of the Birmingham 61" cyclotron, or make use of Metro Vicks' quotation for the 65" cyclotron for Liverpool.

4. CYCLOTRON WORK IN U.S.A.

Dr. Bowden reported on recent developments in F.M. cyclotron work in the U.S.A. His observations had already been circulated to some members, and it was agreed that the complete report should be made available to all members of the Panel.

Dr. Bowden thought that the main difficulty at the present stage lies in the R.F. system. The system being used at Harvard (and Harwell) is feasible only for relatively small cyclotrons, not much greater than 90", but it will probably be impossible to use this method in the larger cyclotrons for work at the high frequencies required for protons. The whole problem of the R.F. system will have to be tackled on an entirely different basis, and a completely new type of dee circuit; probably on the lines of cavity resonators, might have to be developed. This job is going to be undertaken by Livingston at Brookhaven and Dr. Bowden thought that the construction of the R.F. systems for the other large cyclotrons, which are being built in the United States, will probably be delayed pending the results of Livingston's work.

In the discussion, various difficulties with frequency modulation were mentioned and some ways of removing them suggested. It was felt that the best policy at the moment would be to wait for developments in the U.S.A. and that fundamental work on design of R.F. systems should be undertaken here only if the results from the U.S.A. were not satisfactory.

It was reported that blue prints of the Harvard cyclotron have been received in Harwell. It was agreed that these should be duplicated and circulated among members of the Panel.

It was agreed that more information about work in the U.S.A. and particularly at Berkeley was required and that the visit to Berkeley of several members of the Panel, which had been planned for some time past, would be of very great value and should be supported by the Panel.

5. RADIATION SHIELDING

This problem is of particular importance for the Liverpool cyclotron where a decision has to be made soon, whether to excavate for the cyclotron or to build it above ground level using wall screens. Information available is very conflicting; according to Harvard even a fraction of the scattered proton beam would be dangerous, but this is in direct contradiction to calculations made at Harwell. Some information from Berkeley indicated that the radiation hazards are the main limitation for the beam obtainable, but on the other hand it has been reported that the 180 MeV neutron beam is so harmless that one could stand in it for many hours without ill effects.

It is very difficult to calculate the effects of a beam of very high energy particles, owing to the various competing reactions which may take place. It was felt that here too more detailed information about the experience at Berkeley would be of great value.

6. FUTURE MEETINGS

It was agreed to recommend that the Panel should continue in existence but that it should meet at fairly long intervals to discuss progress made, unless there is special business to consider.