

MINUTES OF MEETING OF

ACCELERATION PANEL OF NUCLEAR PHYSICS

SUB COMMITTEE A.E.R.E. HARWELL, OCTOBER 9TH, 1946

Present:

Professor J.D. Cockcroft	A.E.R.E. Harwell - <u>Chairman</u>
Mr. M.J. Moore	Liverpool University
Mr. T.E. Calverly	Cambridge University
Mr. D. Roaf	Oxford University
Mr. T.L. Michiels	Royal College of Science
Dr. L.H. Gray	Medical Research Council
Dr. J.W. Boag	" " "
Mr. F.R. Perry	Metropolitan Vickers Engineering Co.,
Mr. J.F. Smee	" " " "
Mr. J.D. Craggs	" " " "
Mr. D.R. Chick	Associated Electrical Industries
Mr. J.K. Brown	English Electric Co.
Mr. J.M. Ferguson	" " "
Mr. L.W. Brown	British Thomson Houston Co.
Mr. R.W. Wilkinson	" " "
Mr. G. King	Standard Telephones & Cables.
Mr. L. Lewin	" " " "
Mr. R. Rossignol	General Electric Co.,
Mr. W.E. Willshaw	" " "
Mr. D.W. Fry	T.R.E. Malvern
Mr. T.G. Pickavance	A.E.R.E. Harwell
Mr. P.D. Hall	" "
Mr. R. Cockburn	" "
Mr. H. Snowden	" "
Mr. O.R. Frisch	" "
Mr. J.B. Adams	" "
Dr. H.W.B. Skinner	" "
Mr. R.L. Fortescue	" " <u>Secretary</u>

1. The Chairman conveyed Professor Oliphant's apologies to the Meeting for his absence on account of sickness.

Describing the object of the Panel as being exchange of information between the various parties interested in accelerating machines, he proposed that the first part of this meeting should consist of a short review of the position on the various types of accelerator, in order to give a more general picture of this than was obtained at the various specialist meetings which dealt with individual types of machines. After this it would be possible to discuss the future work of the Panel.

2. In reply to the Chairman, Mr. Fry told the meeting that work was proceeding on the corrugated first section of the linear accelerator to cover energies from 50 KEV to $\frac{1}{2}$ MEV at T.R.E. Work was also proceeding on the use of magnetrons in parallel. The aim was still an energy of 20 MEV, using 2 mega-watts peak power. No electrons, had so far been accelerated. Mr. Lewin asked whether the system was broken in the high velocity region. Standard Telephones were using a 2 metre length to accelerate to 0.95C. This was followed by a velocity control section every metre. He asked how Mr. Fry was terminating his accelerator. Mr. Fry replied that he was using a concentric feed-off to a 'dummy' load. Some trouble had been experienced with matching, but it was now better than 0.9 on C.W. Mr. Lewin said that it appeared that Standard Telephones and T.R.E. were working along very similar lines. Standards' had made a gun for production of high currents but were having trouble with the tungsten cathode. 4-5 metres of corrugated tube would be available by the end of the month. The control section was almost finished, the drive section was satisfactory, and the termination probably satisfactory.

3. The Chairman remarked that at the T.R.E. Meeting on this subject recently, it was pointed out that it was desirable to get some experiments started as soon as possible on the Radiation properties to be expected from these devices. The Medical Research Council were not interested in lengths of this sort. Mr. Fry replied that a short length should be sufficient with 10-12 mego-watts of power. Under such circumstances, however, the resonant cavity system might be better. Mr. Willshaw said that the General Electric Company were working for the Medical Research Council on the 10-20 MEV short-length project; they were, however, short of staff. They were considering a design with 3 cavities, using 2 megawatt valves, to give 2-3 MEV and a plan had also been made for obtaining 10 MEV with cavities on existing valves. Work was, however, proceeding on high power valves. Some work appeared to be needed for modulators for such valves; which might be expected to give a reduction in length of the order of 5. In such circumstances the limit would be vacuum break down inside the accelerator which might prevent the realization of the whole of this advantage. Mr. Lewin said that with special designs of accelerator tube it should be possible to obtain 5 MEV per metre without very large powers. The Chairman said that the requirements for medical purposes were fairly definite; but the use of linear accelerators in physics, particularly with electrons, was doubtful. A.E.R.E. should clarify this position. Dr. Gray confirmed that the British Medical Research Council's requirements were something of the order of 20 MEV. in 2 metres length. Mr. Wilkinson said that British Thomson Houston were working at a single resonant cavity, 70 centimetre project which might give of the order of 1 MEV using 1 MW at about 15 pulses per second and 5 micro-second pulse width. A 2 milliamp D.C. 5 KV gun was used with this cavity. Some output was already being obtained. Mr. Fry agreed that resonant cavity systems were quite likely to help in providing accelerators in short lengths. T.R.E. felt that more work was needed on the powers required by such cavities and hoped that some firm would investigate this. Mr. Willshaw said that the General Electric Company were already examining this question. Judging from American information some attenuation and some detuning were necessary before magnetrons could work into such loads. Mr. Wilkinson said that this was why they were using a 70 centimetre frequency.

4. In reply to the Chairman, Mr. Perry said that the Metropolitan Vickers were having some trouble in obtaining the beam from their betatron. They were not yet decided as to whether they would introduce a biasing system to this betatron or whether they would convert it to a synchrotron. It might be described as a 20-40 MEV Project, but probably a new one would be made at the Christie Hospital. Mr. Wilkinson said that British Thomson Houston were proceeding with their model for economical use of KV's; they were designing for 10 MEV without bias, with a weight of the order of 1800 lbs. Mr. Roaf said that it appeared that the beams from the American betatrons gave of the order of 100 r at 1 metre. He thought that the work on flux biasing should be continued. Mr. Wilkinson said that they were now doubtful of the advantage of bias, it must depend upon the particular design considered. Dr. Gray said that the Medical Research Council were still interested in betatrons, mobility, however, was vital. They could obtain a 20 MEV, Kerst machine quite quickly. Mr. Perry said he thought Professor Dee was now more interested in obtaining a synchrotron. Mr. Roaf said, however, that a betatron which could be available considerably sooner would probably also be of interest to Professor Dee. The Clarendon Laboratory were interested in the British Thomson Houston betatron. He thought that Kersts' big 500 MEV Machine, which was being made at Illinois would take two to three years. Other American betatrons gave energies up to 50 MEV but synchrotrons were giving more than this. Mr. Smee said that the American General Electric Company's betatron was being increased from the 100-160 MEV by biasing.

5. In reply to the Chairman, Mr. Adams said that the present plans for the Harwell cyclotron involved a root diameter of 110" and pole diameter of 90". With frequency modulation that might give protons of 100-120 MEV energy. A mechanical rotating condenser system would be used for the frequency modulation and the single dee would be fed by one Cat. 17 valves, for which it would form the tuned circuit. This should give 100 KV maximum across the dee. The machine was being put in a pit in the interests of screening. The present target date for complete construction was March 1948 and operation might be expected somewhere around the middle of 1948. Dr. Gray said, Medical Research Council were interested in a cyclotron with 65 pole diameter which might be frequency modulated.

Mr. Moore said that the plans at Liverpool were still uncertain but might involve sizes of 120" pole diameter. Mr. Calverley said that he thought that the Cavendish cyclotron plan would be similar to that described by Dr. Gray for Medical Research Council.

6. Mr. Fry said that T.R.E. were working in conjunction with the English Electric Company on a 30 MEV synchrotron project. This used a radio frequency of 50 cm on a 10 cm radius. They had also been working with Woolwich on conversion of the 4 MEV betatron to an 8 MEV synchrotron which might later be increased up to 16 MEV. The 30 MEV machine was a model but was of direct interest to Medical Research Council. The components for this were expected early in the new year. In conjunction with Professor Dee and Metropolitan Vickers, they were considering a 300 MEV project. Mr. Le Rossignol said that it should be possible to make the donut from glass and in fact, a small one was being made for Woolwich. Mr. Roaf said that he thought the ceramic tubes were made at Illinois University for Kerst's project. Kerst had promised all information on this but he thought the porcelain practise was quite standard. Mr. Perry said that the design of the machine for Professor Dee would be considered at a meeting shortly. In conjunction with British Thomson Houston, they were examining the possibility of glass donuts. Mr. Craggs said that the ceramic firms were at present too busy to take on any special jobs. Mr. Roaf said that special shapes might be easier in porcelain, glass, was, however, being used in the General Electric Company's machine in America. Mr. Wilkinson confirmed that glass was likely to be cheaper for individual items. Mr. Perry said that the Berkeley drawings were being considered. The weight might be of the order of 140 tons. Mr. Fry said that the main differences would probably be in the resonators and vacuum chambers. The Chairman said that Prof. Dee was interested in this machine and possibly also Oxford. Medical Research Council were interested in the 20-50 MEV range. Mr. Roaf said that the General Electric Company of America were starting work on air-cored synchrotron. With say 1-2 pulses per minute and a field of 20-30 kilo-gauss, the orbit radius was 10 cm with about 2 sq. cm. cross section. The current would be of the order of 80,000 amps. They were now plotting field distribution on this project, which was expected to give of the order of 100 MEV. Mr. Brown said that Professor Oliphant's project might now use D.C. machinery of special design to avoid the use of condensers.

7. Mr. Frisch described the principles of the 'Wirbelrohr' emphasizing the peculiar properties of the field from the gas discharge. He said that Herr Wasserab had reported that so far only design work had been done apart from the manufacture of a single ceramic tube. This tube was believed now to be in England. The Chairman asked the secretary to find out where it was located. *

Mr. Brown said that the question of the removal of the beam appeared not to have been considered by Wasserab. After some discussion it was agreed that this project did not appear to have any particular advantages, but could not be ruled out as a possible accelerating machine.

8. In reply to the Chairman, the secretary said that the Harwell Van de Graaff machine was at present 90% complete, as far as supply of components was concerned, and was being assembled at T.R.E., Melvern. It was expected that it would be moved to Harwell in about a month. Mr. Brown said that the Cavendish machine on a similar basis might be said to be 60% complete. It was expected that it would be assembled around Christmas. The Secretary said that the prototype of these two machines was expected to be doing tests on a beam during the beginning of November at M.I.T. Mr. Michiels said that the R.C.S. machine was now complete as a generator but the tube and vacuum system were, at present, held up. Dr. Boag said that the M.R.C. machine was in a similar state but they hoped to have the vacuum system tested in the next few months, and to obtain electrons by Christmas. Mr. Rossignol said that G.E.C., had started work on a copper-glass accelerating tube for the Van de Graaff generator with a 4" inside diameter. Preliminary electrical tests at about the working voltage gradient had been satisfactory. The sample had been pressure tested to 750 lbs per sq. in. and a satisfactory vacuum of 10^{-5} millimetres had been maintained. They were about to start on a full sized section. The Chairman said, that the radiation chemists were now potential users of electro-static generators.

* The tube is at present in the hands of the War Office - R.L.F.

9. The Chairman asked what the views of the members of the Panel were on the value of these meetings in view of the fact that there were now specialist meetings dealing with the various individual machines and that the programme appeared to be settling down. Mr. Brown suggested that from the point of view of a general review some form of report which was circulated might be of value. Mr. Wilkinson said that he thought that provided the meetings were at fairly wide intervals, they served a useful purpose in the transmission of information. He asked whether, for instance, some detailed recommendations on protection might not be drawn up and circulated in view of the fact that a considerable number of users were now to be confronted with this problem. The Chairman agreed with this and said A.E.R.E. would draw up a memorandum on the subject. Dr. Fry said that a preliminary note on this was already available and might be of value in the mean time. Dr. Gray said he thought that the M.R.C. Protection Subcommittee ought to deal with this question. Mr. Lewin said that he agreed with the proposal to hold these Panel meetings once or twice per year as they did provide information of common interest. Dr. Gray agreed to this from the point of view of M. R. C.. The Chairman asked whether members of the Panel obtained reports from America which were available to the Parent Committee. It was agreed that members of the Panel did not have access to such reports and their circulation should be arranged. Mr. Wilkinson asked whether the meetings could not be held in London in view of the long distances which members had to travel. Summarizing, the chairman said that the balance of the opinion seemed to be that the Panel should be continued, but should not meet more often than every six months. He thought that the composition of the specialist panels on individual machines should be reviewed and steps should be taken to circulate more information from the Parent Committee to members of the Panel.

R. FORTESCUE
Secretary.

A.E.R.E. H. R. WELL
25th October, 1946.
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