Cleveland, Ohio
February 4, 1955

MEMORANDUM for Chief, Materials & Thermodynamics Division

Subject: Possible Utilization of a 60-Inch Cyclotron

I - SUMMARY OF FIELDS OF APPLICATION

1. A cyclotron capable of accelerating lighter nuclei to energies in the range of 10-30 mev is of the greatest value in carrying out research in fundamental and applied physics, chemistry, and metallurgy. The versatility of such an instrument and the fact that new uses for it are constantly being discovered makes it difficult to present a detailed list of the applications but an enumeration according to general functions will indicate the flexibility and utility of the cyclotron.

2. In the first place, it can be employed in nuclear physics to study the interactions between neutrons, protons, deuterons, or alpha particles and any target nuclei. With regard to the charged particles it is very advantageous for such studies that a moderately well collimated monoenergetic beam is available from a cyclotron. Insofar as neutrons are concerned the conditions are much more favorable for doing experiments with monoenergetic fast neutrons than in a pile since there are two very effective methods available for doing experiments with fast monoenergetic neutron with the aid of a cyclotron. First one can make use of a nuclear reaction (e.g. deuterons on a tritium target) producing neutrons of essentially a single energy. Secondly one can make use of the fact that the cyclotron output consists of pulses of particles with a pulse width of about .01 - .1 μ second to employ time of flight methods using fast amplifiers and coincidence circuits to make studies of relatively high energy neutron cross sections. This is of considerable interest in view of the practical and theoretical importance of cross sections for reactions with high energy neutrons.

3. Secondly, one may use the beam of charged particles from the cyclotron to investigate the chemical and physical effect of nuclear particle irradiation. For the production of radiation damage in small samples of material (e.g. wires or thin sheets) such a bombardment by charged particles is considerably more efficient than the use of neutrons from a pile. For many fundamental investigations of radiation damage small samples, in which fairly uniform damage can be produced by charged particles emerging from a cyclotron, are satisfactory. Cyclotrons are currently being employed for such studies by at least six laboratories, many of them using cyclotrons of smaller energy and beam intensity than the NACA cyclotron. Several samples are usually exposed simultaneously intercepting a total beam emerging from the cyclotron of 10 to 20 micro amperes. Exposures resulting in an integrated beam of 50 to 100 micro-ampere-hours are customary. (See e.g. "Cyclotron Techniques for Radiation Damage Studies", M. P. Yockey et al., North American Aviation Inc., Rev. Sc. Instr. 25, 1011, 1954.)

Employing the device conceived by P. Schwed and G. Groetzinger (J. of Applied Physics 23, 234, 1952) the same amount of uniform radiation damage can be produced by deuterons emerging from a 60 inch cyclotron with 1/40 the amount of integrated beam than without this device.

4. Third, study of the energy levels of the (unstable) product nuclei produced by the bombardment of the target nuclei with a cyclotron beam is the best method available for the elucidation of nuclear structure.

5. Finally, the cyclotron can by effectively used to produce isotopes. The number of isotopes obtainable is about twice as great as from a pile, and one may use isotopes with half lives so short that they could not survive transportation from the pile to the location where they are used. These isotopes can be used, of course, in tracer experiments in solid state physics, chemistry and metallurgy and as sources of gamma rays electrons etc.

II - PLANS FOR USE BY RADIATION PHYSICS SECTION IN IMMEDIATE FUTURE

1. At the present time the main emphasis would be on the study of irradiation effects in solids making use of the method described above for producing an effect uniform throughout the bulk of the material investigated without too much heating. The substances initially investigated would include copper-gold alloys which are quite sensitive to irradiation effects and have been extensively studied in this laboratory, copper, and NaCl which are also quite sensitive to irradiation and have been extensively studied here. In addition isotopes would be produced to be used as sources in studies of the scattering and slowing down of fast charged particles. Some isotopes would also be utilized as tracers in diffusion measurements.

G. Groetzinger
Head, Radiation Physics Section

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NACA - Lewis

Cleveland, Ohio
February 20, 1956

MEMORANDUM for J. R. Braig

Subject: Utilization of the 60 inch Cyclotron

1. The memorandum on this subject prepared February 4, 1955 by Dr. G. K. Groetzinger continues to represent a complete and accurate account of the uses to which the Cyclotron will be put according to present plans.

Philip Schwed

Philip Schwed, Head
Radiation Physics Section

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PS:pjk

Cleveland, Ohio
February 4, 1955

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