Rutherford Laboratory

Technical Leaflet

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THE NUCLEAR AND RADIOCHEMISTRY WING

The Nuclear and Radiochemistry Wing (N.R.C.W.) was built so that radiochemists from universities and other organisations would be able to enjoy the same kind of benefits which the National Institute confers on physicists.

The term "radiochemist" simply implies that the scientist concerned is a chemist who works with radioactive materials. Radiochemists use these materials in a variety of ways, but the two main ones are, first, where the object of the work is to investigate problems related to the atomic nucleus, using chemical techniques to separate the different atomic species involved; this is "nuclear chemistry". Secondly, where the object is to investiage chemical or other problems which are not concerned with nuclear reactions, and in which use is made of the radioactivity as a convenient label to help in the analysis; "tracer chemistry" and "radioactivation analysis" both come into this category.

The N.R.C.W. is designed for 12-16 radiochemists. It is a necessary condition that the work involves either:-

i) The investigation of radioactivities which the scientist concerned has produced by irradiation of his target in one of the accelerators or reactors of the Rutherford Laboratory or of A.E.R.E. and which are too short-lived for him to transport to his own laboratory.

ii) Facilities which the scientist cannot reasonably be expected to have in his own laboratory.

FACILITIES AVAILABLE IN THE N.R.C.W.

The Wing is broadly divided into four laboratory suites, each consisting of a radiochemistry laboratory, an office, vestibule, and counting room. Each suite is designed for 3-4 chemists working full-time. In addition to these, there is a balance-room, cave-room, and changing and utility rooms.

The radiochemistry laboratories:

Each laboratory is equipped with five fume-hoods which are designed for general radiochemical work. The hoods are built on a massive plinth which is strong enough to allow the erection of a 2" thick lead wall all round them. The minimum air-flow velocity into the hoods is 200 linear ft/min. with the window half-open - high enough for all normal radiochemical work. The hoods have armour glass windows and the usual services.

Each laboratory has an analytical bench equipped with services, and with a sink unit. There is also a 4" thick, vented, lead safe for storage of radioactive materials, and a special built-in cupboard for contaminated glassware.

The centre part of the laboratories has been left clear. Electrical and other services are terminated in the ceiling above this space and there are drains in the floor. The idea of this is that any sort of equipment, such as for example, a glove-box for handling α-emitting radioactive sources, or a vacuum line, may be installed for a period, and the arrangement changed as required.

The vestibules

The vestibules act as buffer areas to help in controlling the possible spread of radioactive contamination from the active laboratories. Controls for shutting off the ventilation in the laboratory, emergency fresh air hoods, an emergency shower and, in two of the four, a hand and clothing monitor, are available.

The counting rooms

The counting rooms each have two massive benches, on and under which castles and electronic gear can be placed. Various types of electrical supply points are distributed along the benches, and a 50-way cable with four outlets runs along the back of each.

Almost any type of electronic counting equipment can be provided as required. A special data-handling system is fitted which operates as follows. A source of data such as, for example, a β-counter, is connected to one of the data-handling "modules". The module is plugged in to the 50-way cable and set in operation. Computer cards are then punched automatically with the data coming from the β-counter, together with the time at which each observation occurs, and all other relevant parameters needed for computation. If required, the module can be connected to an individual recording device in the counting room, instead of to the central card punch.

Besides standard equipment and the data-handling system, the N.R.C.W. has two pulse-height analysers, one 512-channel and one 100-channel. These are both equipped with fully automatic recording on the computer cards or printed tape.

The balance room

This has three analytical balances and a semi-micro balance, an ultra-violet spectrophotometer, microcard reader, typewriter, and dictating machine. In addition, it contains a small library of scientific journals.

The cave-room

The card punch and absolute time clock of the automatic data handling system are located in the cave room. Its main object, however, is to provide space for a cave for the handling of highly radioactive sources.

The cave has 4" lead walls and is intended for γ-emitting sources of up to about 10 MeV-curies. In addition to this, it has an inner sealed box, and so it can be used for α-emitting sources as well. It has a 10" thick lead-glass window, which gives full vision over the interior, and is equipped with type 7 manipulators.

The plant room

The first floor of the N.R.C.W. is occupied by the ventilating plant and by the building services. The input air is filtered and heated before being forced into the Wing by the plenum fan. It is extracted through the 20 fume-hoods by the extract fan, and is again filtered before being discharged to the atmosphere.

This floor also contains an equipment store, together with a small glass blowing area and a work bench.

SCIENTIFIC WORK IN THE N.R.C.W.

The Wing has only been open for 15 months, and consequently not much of the work has yet reached completion. The following is a summary of both completed and current experiments:-

Studies of (p,γ) reactions by activation methods

(P. J. Daly, P. F. D. Shaw, B. M. Seppelt, P. E. Hodgson, J. R. Rook: Oxford University Nuclear Physics Dept.)

The reaction mechanism for the (p,γ) reaction was investigated by determination of excitation functions for the Te^{130} (p,γ) I^{131} and Mo^{100} (p,γ) Te^{101} reactions, using radiochemical techniques. The results show that a particular type of direct capture mechanism accounts well for the results above 20 MeV incident proton energy, but refinement of the theoretical treatment will be needed to account for results below this energy.

Szilard-Chalmers reactions in sulphur compounds

(A. G. Maddock and R. Pearson: Cambridge University Chemistry Dept.)

An investigation into the effect of temperature in Szilard-Chalmers reactions in these compounds.

Trace elements in minerals

(K. Brooks and E. Hamilton: Oxford University Geological Dept.)

A study of the abundance of zirconium and hafnium in certain minerals, by radioactivation methods.

Correlation of certain physical properties of diamond with its nitrogen content

(E. C. Lightowlers: Kings College, London).

The effects of trace nitrogen on the U.V. and I.R. absorption and spin resonance of diamonds are examined, the amount of nitrogen present being determined by means of the N^{14} $(\gamma, n)N^{13}$ reaction.

The use of mass separators in nuclear chemical research

(B. J. Dropesky: Los Alamos Scientific Laboratory, U.S.A.)

An examination of the characteristics of laboratory-type isotope separators, and their application, to the separation of radioactive isotopes of some fission product elements, with particular emphasis on tin. Such methods greatly improve the selectivity of radiochemical methods since, to the perfect resolution in atomic number achieved by chemical separation, they add perfect resolution in mass number.

Fission of Bi^{209}

(A. W. Fairhall: Washington University, U.S.A.)

The fission reaction as it occurs in the lighter elements has some particularly interesting features. This work examines the mass and kinetic energy distributions of the fission fragments from Bi^{209} fissioned by 50 MeV protons from the proton linear accelerator, making use of solid state detectors rather than pure radiochemical analysis.

Fission studies of the heavy elements

(J. G. Cuninghame, J. A. B. Goodall, C. Webster: A.E.R.E.)

A variety of experiments, all of which are concerned with finding out more about the mechanism of low energy fission. The three basic experiments are, p-wave neutron fission of U^{235}, p-wave neutron fission of Pu^{239}, and an examination of the effect of increasing neutron energy on the mass-yield fine structure in neutron fission of U^{238}.