COMMENTARY

A SOLUTION TO THE CURRENT SHORTAGE OF CLINICAL AND EXPERIMENTAL RADIOISOTOPES ALREADY EXISTS

In a recent commentary (*1*), Dr. Richard Lambrecht identified the need for a dedicated medium energy linear accelerator to produce isotopes for biological and medical uses. New developments in the field of cyclotron accelerators, however, have already made the production of radioisotopes both technically and economically feasible with these instruments.

Karl L. Erdman, PhD

This has occurred in the main through the development of new targetry techniques (*2*) involving the use of separated isotopes and the development of high intensity ion sources (*3,4*) and accelerators with totally automated control systems (*5,6*). High current cyclotrons having an energy of 30 MeV are capable of generating most of the radioisotopes required for current radiopharmaceutical production and are being manufactured.

An extension of the design of these machines makes possible construction of 70 MeV cyclotrons with beam currents of 500 microamps.

Since these machines are negative ion cyclotrons which have very good beam quality and use external ion sources, the major problems encountered in the more traditional cyclotrons have largely disappeared. Automated control systems simplify their operation to the extent that operational costs have been greatly reduced.

Research into targetry at the TRIUMF facility in Canada has essentially solved the problem of the production of isotopically pure iodine-123 by the proton irradiation of the separated isotope xenon-124 at energies below 30 MeV. This is now the preferred method of production of radioiodine; gaseous xenon targets are being used by a number of the commercial radioiodine producers.

Measurements done at TRIUMF and elsewhere (*7*) have also shown that strontium-82 can be produced by the 70 MeV irradiation of rubidium-85 with protons. When the total beam current is 250 microamps and suitable targets are used, the production rate is 45 mCi per hour. Thus a 500 microamp cyclotron with an energy of 70 MeV is capable of producing one Sr/Rb generator every couple of hours or a conservative 10 per day. Such a single facility is thus capable of supplying all of these generators required (*8*) in the near future with one week of operation per month.

The rate of production of copper-67 has also been determined at 40 MeV. A 500 microamp accelerator could produce 10 mCi per hour or 1.5 Ci per week. Since the present demand of this isotope is 500 mCi per month, such an accelerator could also satisfy the demand for this isotope.

The designs for the 70 MeV high current machines are well advanced (such an accelerator is one of a series under development at EBCO Technologies in Vancouver, BC, Canada), and such machines could be built with little difficulty as the design features of the 30 MeV accelerators need little alteration to increase the energy, excepting size adjustments.

When one considers that the cost of such a high current cyclotron is about one-fifth of the cost of the high current linac proposed for isotope production and that the costs of operation are much lower, the advantages of the cyclotron sources are obvious. Construction could begin almost immediately if the decision were taken to build a machine of this type, with the expectation that it could be in operation in the next few years.

Hospital Based Machines

With external negative ion sources producing beams of both protons and deuterons, a further exciting possibility for clinical isotope production facilities arises. An accelerator capable of producing beams of both types of particles at energies of 13 and 8 MeV, respectively, becomes both feasible and inexpensive.

It is no longer difficult to foresee the installation of a

small cyclotron capable of this type of operation in any clinical facility that possesses a PET or SPECT system. Microprocessor control makes the operation by a trained nuclear medicine technician a possibility, and the reliability of the system makes it feasible.

Such a facility should be able to be installed at a site for a cost comparable to the PET or SPECT facility itself. Since all of the low atomic number short-lived positron emitters could be produced by such a dual particle accelerator, the use of fluorine-18, oxygen-15, and carbon-11 in biologically active materials at facilities other than research institutions becomes practicable.

Advantages of a Cyclotron

Modern cyclotrons with external ion sources are reliable, well-developed machines. When interfaced with industrial microprocessor systems they are inexpensive sources of high energy, high flux particle beams. The production of radioactivity in the cyclotron due to the spilled beam and the consequent high doses acquired by personnel servicing these machines is no longer a major consideration. Extraction by stripping the electron from the negative ions by passing them through a thin foil at the requisite energy is 100% efficient. Furthermore, the extracted beams are of high quality. Consequently, there is little spillage in the beam lines between the accelerator and the target stations.

The technique of using accelerated high current negative ion beams has thus removed the last obstacle to cyclotrons being the preferred sources for the production of radioisotopes. Since the activation problem has been solved, the main argument for the use of a linear accelerator for isotope production has disappeared. The parameters governing the choice of the accelerator now change to the more conventional ones of cost and ease of operation. It is here that the high current negative ion cyclotron has an enormous advantage.

A modern 500 microamp 30 MeV cyclotron requires less than 100 kW of power. It occupies an area which is only 8 feet square and 10 feet high with an equivalent space for the power supplies that are required to run it. The control is done by an industrial PC/AT computer system using industrial programmable logic units to do the control functions and simplify the maintenance. Such machines are already in operation.

Little development work is needed to extend the energy to 70 MeV. At this energy and with a beam current of 500 microamps, almost all of the isotopes currently required by the nuclear medicine clinician or the radiobiological researcher can be produced. Moreover, the operating costs of that production can be supported by the majority of users. There is no longer a reason to look for any other solution to the needs of the nuclear medicine community, and the production of the radioisotopes need not be tied to the operation of the large research accelerators or be disrupted by research programs at those institutions.

Karl L. Erdman, PhD
TRIUMF/EBCO Technologies Ltd.
Vancouver, BC, Canada

References

1. Lambrecht RM. The need for radioisotope production LINAC. *J Nucl Med* 1988;29:1758-1759.
2. See various articles by T.J. Ruth and coworkers in Journal Label. Compds. *Radiopharm* 1986;23.
3. Kendall et al. Measurements on a DC volume H^- multicusp ion source for TRIUMF. *Rev Sci Inst* 1986;57(7):1277.
4. Yuan DH et al. Extraction of H^- ions from a DC cusp source. Fourth International Symposium on Production and Neutralization of Negative Ions and Beams, Brookhaven, Oct., 1986.
5. Schneider HR. Small H^- cyclotron design status at TRIUMF. Invited talk at 25th European Cyclotron Progress Meeting, Uppsala, Sweden, Sept. 21-24, 1988.
6. Schneider H et al. A 400 μA, 30 MeV H^- Cyclotron for Isotope Production. Prog. of the Tenth Conference on the Application of Accelerators in Research and Industry. *Bull Am Phys Soc* Vol. 33, No. 8, 1988, 1739.
7. Mausna LF, Prach T, Srivastava SC. Production of ^{82}Sr by Proton Irradiation of RbCl. *Appl Radiat Isot* 1987;38:181-184.
8. Harby K: DOE convenes workshop to explore improved availability of research isotopes. *J Nucl Med (Newsline)* 1988;29:1611-1617.

Nuclear Medicine Week Update

The fourth annual Nuclear Medicine Week (NMW) celebrations will be held July 30–August 5, 1989. Efforts have begun to make the week's activities more widely recognized and successful than ever. General Electric is again sponsoring the Media Stars contest, in which nuclear medicine departments compete on the basis of their NMW activities, such as media coverage, open houses, and slide and video shows. Posters and buttons will be available for order beginning this month. For further information or to obtain a guidelines packet contact: Virginia Pappas, CAE, The SNM, 136 Madison Ave., New York, NY 10016-6760, (212)889-0717. An article in the May 1989 *Newsline* will preview this year's NMW poster. ■