

PRODUCTION OF HIGH PURITY ^{123}I FOR CLINICAL AND RESEARCH PURPOSES

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The advantages of the use of ^{123}I over other radio-isotopes for clinical diagnostic procedures in nuclear medicine, its short half-life (13.1 hours) and the suitability of its only emitted radiation (159 keV γ ray) to existing detection methods, have been known for many years.^{1,2,3)} In spite of these ideal properties, however, it has not come into general clinical use because of the complexity of its production via particle accelerators and resulting high cost. A review of the various reaction mechanisms used to produce ^{123}I is provided by Sodd et al.^{4,5)} Most commercial suppliers of ^{123}I use low energy reactions (≤ 35 MeV) on expensive, isotopically enriched ^{122}Te or ^{124}Te targets. The purity of the resulting ^{123}I depends on the purity of the Te target, the primary contaminant being ^{124}I , a beta emitter with a 4.2 day half-life.

A program to develop an on-line facility

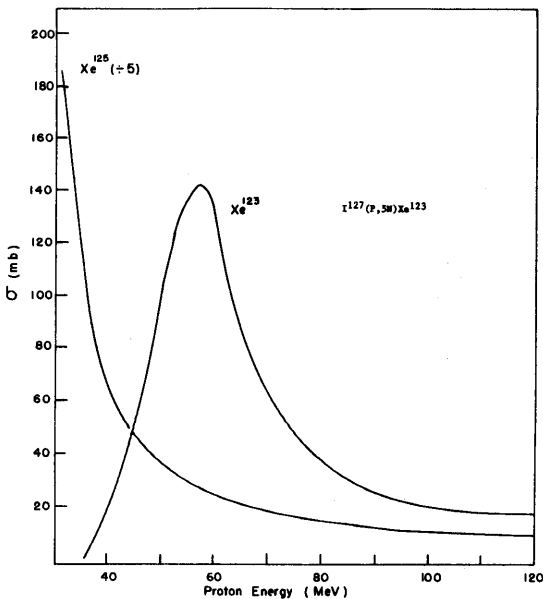


Figure 1.

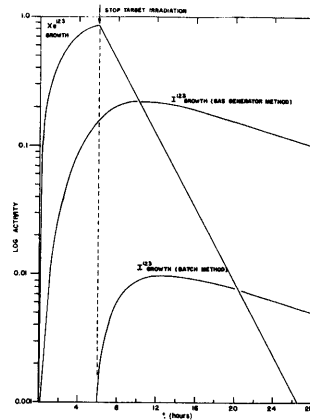


Figure 2.

for the production of an ^{123}I isotope free of any other radioactive contaminants via the $^{127}\text{I}(p,5n)^{123}\text{Xe} \beta^+ \rightarrow ^{123}\text{I}$ has begun using the proton beam from the Indiana Isochronous Cyclotron. The objective is to demonstrate that a pure ^{127}I "Liquid-Vapor" target assembly utilizing a continuous helium gas flow generator is not only feasible, but has a higher production rate than other targets using this reaction, while yielding a contaminant-free isotope. In addition, it is required that the target assembly be usable for many irradiations with no maintenance or re-charging, while being quickly and easily placed into or out of service on the beam line in the isotope production room.

The cross section for the $^{127}\text{I}(p,5n)^{123}\text{Xe}$ reaction has been measured by several groups⁶⁾ and is found to peak at about 57 MeV, as illustrated in Figure 1. The $^{127}\text{I}(p,3n)$ reaction cross section is also shown and is a possible contaminant source, i.e., ^{125}I . From these data, the calculated yield of

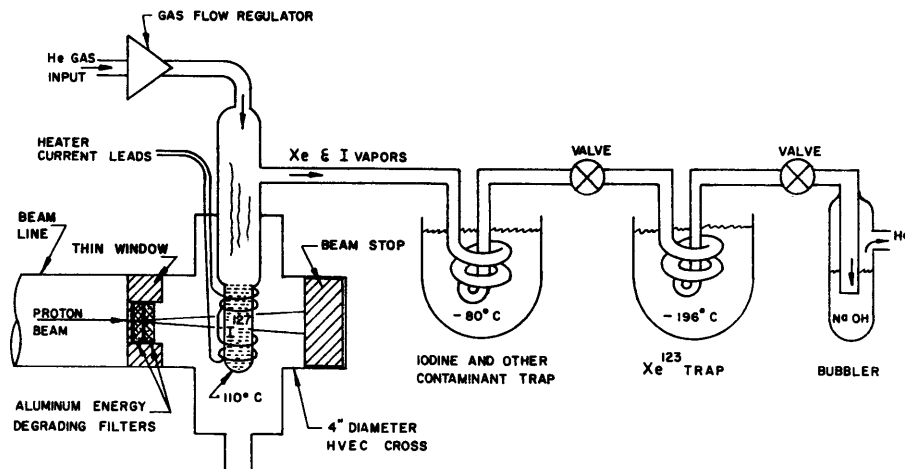


Figure 3.

^{123}I using the helium gas generator method for collection of the Xe isotopes is given in Fig. 2. The rate of ^{123}Xe growth during irradiation and ensuing decay, as well as those for ^{123}I are shown for a typical 6 hour irradiation period. For comparison purposes, the yield of ^{123}I for a 6 hour batch irradiation of ^{127}I followed by the separation of the Xe isotopes is shown. Using our gas generator system, described below, a production rate of 16 mCi/ μA hr has been achieved, which is slightly better than the rate experienced by other groups who made ^{123}I using the (p,5n) reaction.^{3,7)}

A ^{127}I self-vapor cooled target, as described by Blue et al.,⁸⁾ was built and modified for our tests. A schematic of the target and cold trap system is shown in Figure 3. Pure iodine is kept in the liquid state in the target by heating the walls of the vapor tube to 110°C. The walls above the target volume are water cooled to prevent the iodine from condensing out of the target volume. Helium gas is injected at a slow rate (4.5 cfm) at the top of the tube to trans-

port the iodine and Xe 123 vapors through a low temperature purification trap (-80°C) to remove the radioiodines, and on to a collection trap operated at liquid nitrogen temperatures. The target contains 100 grams of ^{127}I initially. In its stable operating mode, the vapors escaping from the target volume, condense on the cooled walls of the vapor-tube about one inch above the target and drips back down into the target volume. Thus, during irradiation, the amount of iodine at the location of the beam remains constant.

With a target thickness of 2.2 cm, 100 MeV protons lose 55 MeV in the target. Beam exiting from the target is collected on a current reading beam stop for monitoring purposes. Incident protons of energy higher than 100 MeV are used by the placement of energy reducing foils in front of the target assembly. Beam energies as low as 80 MeV may be used with no appreciable contribution of the (p,3n) reaction.

The target apparatus described above was used to make ^{123}I in various amounts up to 16mCi in a 6 hr. shift with a production rate of 16 mCi/ μA -hr. The

purity of the isotope was verified by analysis of the γ -ray spectra, which showed only one γ -ray at 159 keV. The most likely contaminant would be ^{125}I , which is produced by a (p,3n) reaction on ^{127}I , and has a 35 keV γ ray. Background in the observed spectra would obscure a contamination of $\leq 0.01\%$ ^{125}I , if present. No 35 keV γ ray was observed in the isotope produced using either 80 MeV or 100 MeV protons.

Efforts are continuing to improve the ruggedness and reusability of the target assembly, and to automate the extraction of the iodine from the collection trap. In addition, efforts are being made to improve the efficiency of the extraction procedure, which now stands at about 75%. The production rate quoted above is for the amount of ^{123}I extracted from the trap after a given irradiation period.

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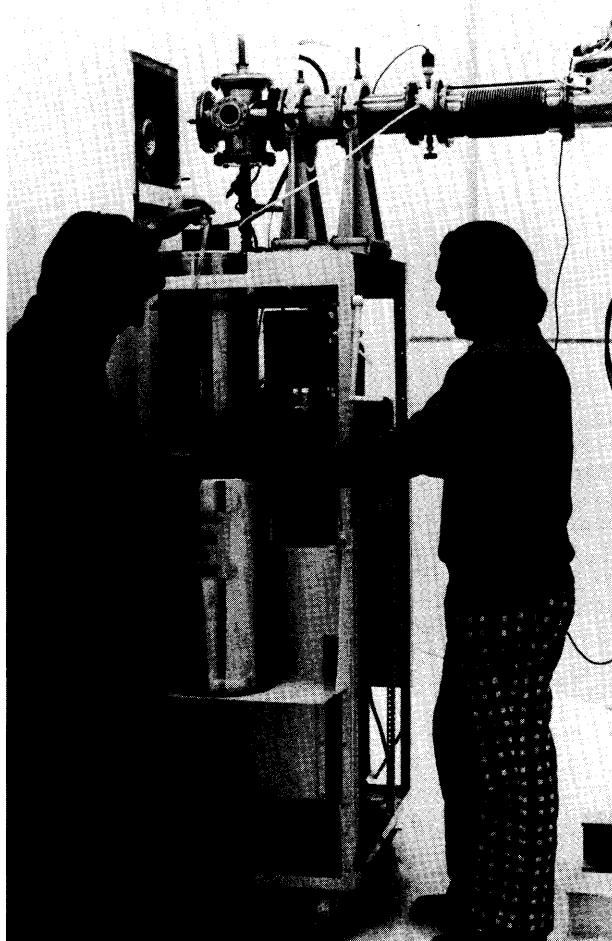


Figure 4. ^{123}I production station in place in the isotope production room. The ^{127}I target is mounted in the HVEC cross at the end of the beamline. Target, He gas generator, and cold trap for impurity and Xe isotope collection are visible. The entire assembly is mounted on a rollaway cart for easy installation and removal from the beamline. When the target station is removed, a section of beamline is installed and connected to the beam dump whose opening is visible at the upper left.