

EXCITATION FUNCTION MEASUREMENTS OF PROTON INDUCED REACTIONS ON RHODIUM AND
INDIUM: YIELDS OF ^{97}Ru , ^{96}Tc , ^{109}Cd , AND ^{113}Sn

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The excitation functions of proton-induced nuclear reactions for four radionuclides of value in nuclear medicine have been measured. Cross sections of ^{97}Ru and ^{96}Tc formed in rhodium targets as well as ^{109}Cd and ^{113}Sn formed in indium targets have been determined for proton energies from 60 to 200 MeV. These data will provide a basis for selecting optimal irradiation conditions and calculating thick-target yields for large-scale preparations at the Brookhaven Linac Isotope Producer (BLIP).

The cross sections have been determined by activation of targets followed by Ge(Li) gamma-ray counting of the activities. No chemical separations were performed. Irradiations were carried out in the isotope production facility at IUCF. The beam currents were monitored with a Faraday cup. After irradiation the samples were shipped to BNL for counting. Several of these results are shown in Figs. 1a-1b along with Alice Hybrid calculations performed by Dr. H. Karwowski. Aside from some discrepancy at lower energies, the overall shapes of the excitation functions and general magnitude are reproduced.

The elements, ^{97}Ru , ^{96}Tc , ^{109}Cd , and ^{113}Sn , are of considerable interest for biomedical and other applications. Because of its desirable physical characteristics ($t_{1/2} = 2.9$ d, 86% 216 keV gammas) and high chemical reactivity, ^{97}Ru is a potential radionuclide for nuclear medicine applications to nuclear oncology.

In addition, a number of ruthenium compounds have shown promise as useful agents in cancer chemotherapy.¹ The convenient half-life of ^{96}Tc (4.3 d) makes it a valuable tracer for developing new radiopharmaceuticals for the short-lived isotope, $^{99\text{m}}\text{Tc}$ (6.02 h), which has found extensive application in nuclear medicine.²

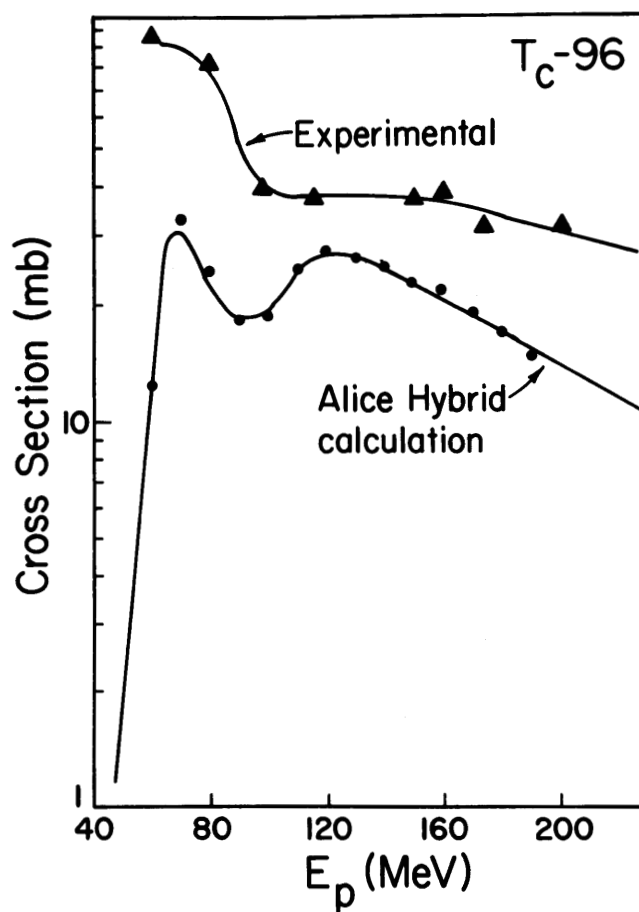


Figure 1a. Total cross section for the production of ^{96}Tc by proton bombardment of rhodium. A comparison to Alice Hybrid calculations is shown. The curves are a guide to the eye.

The element, ^{109}Cd ($t_{1/2} = 453$ d), is in equilibrium with its daughter, $^{109\text{m}}\text{Ag}$ ($t_{1/2} = 40$ s), which emits a single 88 keV gamma-ray (3.92% abundant). It is useful as an X-ray fluorescence or radiography source. The nuclear properties of the ^{109}Cd - $^{109\text{m}}\text{Ag}$ pair also satisfy the requirements for a generator system which would provide a continuous source of ultrashort-lived medical nuclide for repeated dynamic studies.³ The parent nuclide for the important $^{113\text{m}}\text{In}$ generator system is ^{113}Sn ($t_{1/2} = 114.9$ d). The $^{113\text{m}}\text{In}$ generator has been shown to be of value in many nuclear imaging applications.⁴ The desirable characteristics of $^{113\text{m}}\text{In}$ include a short half-life of 1.658 h, a monoenergetic gamma emission of 392 keV (65% abundant), and no beta emissions to contribute to the radiation dosage.

The Brookhaven Linac Isotope Producer (BLIP)^{5,6} has been in active use for the past few years for preparing large quantities of radionuclides of medical interest. It utilizes the excess beam capacity of a 200-MeV proton Linac that injects protons into the Alternating Gradient Synchrotron, a 33-GeV accelerator used in high-energy physics research. The Linac can generate up to 10 pulses of 200-MeV protons per second, providing beam currents of 70 to 100 microamperes for radionuclide production. Preparations of clinically useful quantities of ^{97}Ru and ^{96}Tc from a rhodium target, and ^{109}Cd and ^{113}Sn from an indium target at the BLIP have been demonstrated to be feasible.

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national Congress of World Federation of Nuclear Medicine and Biology, Washington, D.C., September 1978.

- 2) P. Richards, et al., in Radiopharmaceuticals, ed. G. Subramanian et al., Part Two (Society of Nuclear Medicine, Inc., New York, 1975).
- 3) P. Richards, Division of Isotopes Development, Research and Development Projects, Atomic Energy Commission, Washington, DC, TID Report #25372 (1969).
- 4) J. Alvarez, in Radiopharmaceuticals, ed. G. Subramanian et al., Chapter 10 (Society of Nuclear Medicine, Inc., New York, 1975).
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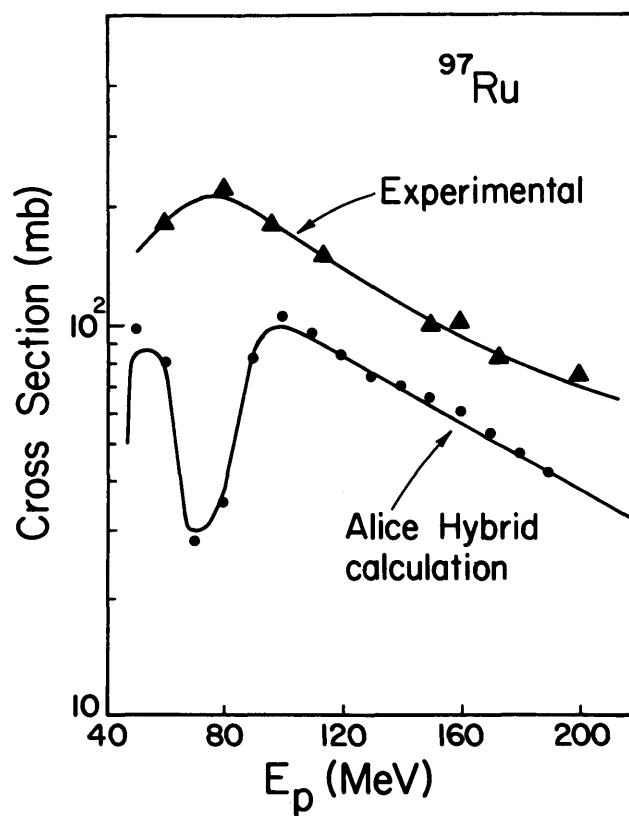


Figure 1b. Total cross section for the production of ^{97}Ru by proton bombardment of rhodium. The curves are explained in Fig. 1a.