

Idaho Incubation Fund Program

Final Report August 31, 2016

Proposal No. AHRC-33
Name: IGEMs funded Development of a commercial process for I-123
Name of Institution: Idaho State University
Project Title: Development of a commercial process for I-123
Reporting Period: 7-1-2015 to 6-30-2016

1. Summary of project accomplishments:

The goal of this project is to investigate a commercially viable process for producing an "in demand" medical isotope, iodine-123. The initial work has shown feasibility of the nuclear reactions $^{124}\text{Xe}(\gamma, p)^{123}\text{I}$ and $^{124}\text{Xe}(\gamma, n)^{123}\text{Xe}(\beta^+)^{123}\text{I}$. Over the last year we have completed activation studies with small vials of 10% enriched ^{124}Xe with very encouraging results ($> 1\text{mCi/gm/kw}\cdot\text{hr}$) and constructed a target system for large scale studies. We determined a method to separate the product. INL donated two liters of natural Xe for full scale studies. The final work tested the target system with natural Xe, extracted the ^{123}I and purified it using our process. From this work the final yields were determined. We are working on invention disclosures for the inventive part of our process and hoping to attract further interest from commercial partners.

See attachment for detail.

2. Summary of budget expenditures (include project burn rate):

We received \$61,700 and all funds were expended.

	Budget	Spent	Balance
Labor	\$ 45,260	\$ 45,260	\$ -
Materials	\$ 8,815	\$ 8,815	\$ -
Beamtime	\$ 7,625	\$ 7,625	\$ -
Total	\$ 61,700	\$ 61,700	\$ -

3. Numbers of faculty and student participation resulting from the funding, including internships:

The project involved 5 including the PI, composed of faculty, staff and students.

4. List patents, copyrights, plant variety protection certificates received or pending:

We are investigating an invention disclosure for a process to manufacture I-123. No applications have been files as of this date.

5. List technology licenses signed and start-up businesses created:
No businesses have started up. The technology is not mature enough for a licensee.
6. Status of private/industry partnerships (include enough information to judge level of engagement): Our partnership with INIS is continuing.
7. Any other pertinent information that will indicate to the council that the project is meeting satisfactory progress.
Please see detailed attachment.



IGEMs/HERC Project Status Report
Idaho Incubation Fund Program
Detailed Attachment
Final Progress Report
August, 31th 2016

Proposal No.	<u>AHRC33</u>
P.I. Name:	<u>Jon Stoner</u>
Name of Institution:	<u>Idaho State University/ Idaho Accelerator Center</u>
Project Title:	<u>Development of a commercial process for I-123</u>

Proprietary Information – not for public review

(1)Executive Summary:

The goal of this project is to investigate a commercially viable process for producing an “in demand” medical isotope, iodine-123. The initial work has shown feasibility of the nuclear reactions $^{124}\text{Xe}(\gamma,p)^{123}\text{I}$ and $^{124}\text{Xe}(\gamma,n)^{123}\text{Xe}(\beta^+)^{123}\text{I}$. Over the last year we have completed activation studies with small vials of 10% enriched ^{124}Xe with very encouraging results (> 1mCi/gm/kw*hr) and constructed a target system for large scale studies. We determined a method to separate the product. INL donated two liters of natural Xe for full scale studies. The final work tested the target system with natural Xe, extracted the ^{123}I and purified it using our process. From this work the final yields were determined. We are working on invention disclosures for the inventive part of our process and hoping to attract further interest from commercial partners.

(2)Financial Summary:

We received \$61,700 and spent all of the funds.

	Budget	Spent	Balance
Labor	\$ 45,260	\$ 45,260	\$ -
Materials	\$ 8,815	\$ 8,815	\$ -
Beamtime	\$ 7,625	\$ 7,625	\$ -
Total	\$ 61,700	\$ 61,700	\$ -

(3)Participation:

The project involved 5 including the PI, composed of faculty, staff and students.

(4,5,6) IP, Businesses, Partnerships

We are working on one invention disclosure. No businesses have started up, however, our partnership with INIS is continuing. We have successfully started a partnership with INL for further isotope development work. This has led to two additional Federal grants.



Initial Experimental results

The initial work reported previously showed the feasibility of our plan to irradiate Xe-124, converting a portion of the target into I-123 through the reaction Xe-124 (γ, n) Xe-123 (B+ decay) I-123. Our experimental results showed that we can achieve ~ 1.4 mCi/g/kw*hr of ^{123}I from a ^{124}Xe target at 40 MeV. This equates to a potential 525 mCi of activity/one liter enriched target per 10 hour day.

Target Development

To show commercial feasibility, we constructed a target allowing us to irradiate larger quantities of gas. See following pictures.



Figure 1 target system with pump out piping as drawn in Solidworks

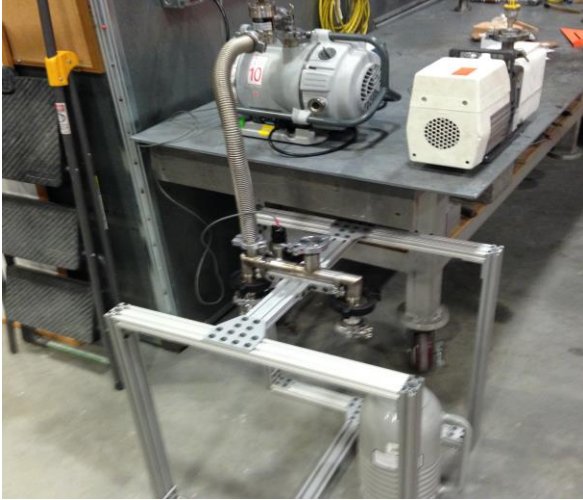


Figure 2 Pump out system for target. Required to evacuate target and transfer remaining Xe after production of I.



Figure 3 Target after use in the system. The large aluminum cylinder held the Xe for activation by the accelerator. The green valve is for transferring the gas.



Figure 4 Evacuation tank. The Xe gas is very expensive and after production most of the Xe remains for future use. The tank holds the Xe after use.

We received two liters of Xe gas donated by Idaho National Labs for our full scale experimental irradiation in June, 2016. The value of the donated gas was several thousand dollars.

Separation

During the second half year of this grant we spent several hundred man-hours trying to determine a method to separate the I-123 and purify it. No commercially available anion exchange resin was satisfactory for the process because of quaternary amine groups which refused to release the I-123. We developed a process to modify the commercially available resins using the Hoffman reaction. After considerable experimental testing and thanks to the donation of an iodine tracer by International Isotopes Inc. (INIS) we showed excellent recovery using our modified resin. However, additional work must be done to improve the reproducibility for commercial effort.

Final Testing

In June of 2016, we ran final tests of the target filled with pressurized Xe gas. The total amount of Xe gas at 11psi gauge pressure was .975 grams corresponding to \sim .97 mg of Xe-124. This is a very small amount, however, the feasibility of the reaction allow calculations for commercial viability.

After a 3 hour irradiation at 7 kW and 40 MeV, the target was allowed to decay to build up I-123 then the separation process was run. The total yield of I-123 was 3.07 micro Curies of which approximately 78% was collected on the column. The

yield per gram kw hour however was only approximately 10% (118 micro Curies) of the yield per gram kw hour we achieved in our early tests with a glass vial (1.4 milli Curies). We believe the lower yield was due to difficulties in extracting the ¹²³I from the target. We found that our simple process of flushing the target was insufficient and a more elaborate recovery system is needed.

Commercial evaluation

Our initial results of 1.4 mCi per gram kw hour were very interesting for commercialization. The following table computes our estimated cost/500 uCi dose (a standard dose for ¹²³I).

Cost to produce one 500 uCi dose of I-123	
Activation costs	\$ 4,000.00
Starting material costs	\$ 250.00
Purification costs	\$ 100.00
Total	\$ 4,350.00
Yield (mCi)	578
Decay losses	0.5
Cost/mCi	\$ 7.53

This cost is competitive with cyclotron produced material with the potential to drop significantly below. Unfortunately, at the yields we achieved with our large target, the costs would be non-competitive. We have explored interest with our private sector partner and others. The general comment was that we needed to further refine the process to solve the final transfer problem. We are actively researching an approach for this and will try to find funding for the development.

Intellectual Property

We are working on an invention disclosure for the activation process. We will file a patent application if we find sufficient commercial interest and funding to cover the patent application.

Follow on grants

So far this program has been exceedingly successful in attracting donated materials and follow-on grants. The PI has received two grants from INL as a result of the knowledge gained from this work and one from DTRA. In addition, INL and the PI are working on a follow-on grant to DOE using experience gained from this work. Our private sector partner, International Isotopes remains very interested in the final commercial viability of this process.

FINANCIAL Summary FY 2016 to June 30th, 2016 (anticipated spend)

	<u>Original Budget</u>	<u>Revised Budget</u>	<u>Final Balance</u>
Total Personnel Costs	35,260.00	45,260	0
Materials and Supplies	2,440.00	8,815	0
Beam Time	10,000.00	7625	0
Capital	14,000.00	0	0
Totals	61,700.00	61,7000	0

We spent all of the funds.

Prepared by Jon Stoner (P.I.)
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