COVER SHEET FOR GRANT PROPOSALS

State Board of Education

SBOE PROPOSAL NUMBER: (to be assigned by SBOE)	AMOUNT REQUESTED: $50,000

TITLE OF PROPOSED PROJECT: Commercialization of Electron Linear Accelerator Manufactured Isotopes

SPECIFIC PROJECT FOCUS: Commercialization of medically important, high demand isotopes for nuclear medicine. Especially copper-67.

PROJECT START DATE: July 1, 2011	PROJECT END DATE: June 30, 2012	
NAME OF INSTITUTION: Idaho State University	DEPARTMENT: Idaho Accelerator Center	
ADDRESS:		
Idaho State University 921 South 8TH Avenue, Stop 8263 Pocatello, ID 83209-8263	E-MAIL ADDRESS: wells@iac.isu.edu	PI PHONE NUMBER: 208-282-3986

	NAME:	TITLE:	SIGNATURE:
PROJECT DIRECTOR	Doug Wells	Professor and Director	[signature]
CO-PRINCIPAL INVESTIGATOR			
CO-PRINCIPAL INVESTIGATOR			
CO-PRINCIPAL INVESTIGATOR			

	NAME:	SIGNATURE:
Authorized Organizational Representative	**Dianne K. Horrocks**	Dianne K. Horrocks

SUMMARY PROPOSAL BUDGET

Name of Institution:

Name of Project Director:

A. FACULTY AND STAFF

Name/ Title	Rate of Pay	No. of Months CAL	ACA	SUM	Dollar Amount Requested
Douglas P. Wells	68.88/hr	.29			$3,444
Dr. Frank Harmon	81.00/hr	.14			$2,025
Dr. Valeriia Starovoitova	25.00/hr	.29			$1,250
Dr. Lisa Goss	40.74/hr	.29			$2,037
% OF TOTAL BUDGET:	17%			SUBTOTAL:	$8,756

B. VISITING PROFESSORS

Name/ Title	Rate of Pay	No. of Months CAL	ACA	SUM	Dollar Amount Requested
% OF TOTAL BUDGET:	0%			SUBTOTAL:	$0

C. POST DOCTORAL ASSOCIATES / OTHER PROFESSIONALS

Name/ Title	Rate of Pay	No. of Months CAL	ACA	SUM	Dollar Amount Requested
K.Folkman	$37.66/hr	.25			$1,632
C.O'Neill	$30.47/hr	.25			$1,320
M. Balzer	$29.18	.27			$1,264
% OF TOTAL BUDGET:	8%			SUBTOTAL:	$4,216

D. GRADUATE / UNDERGRADUATE STUDENTS

Name/ Title	Rate of Pay	No. of Months CAL	ACA	SUM	Dollar Amount Requested
% OF TOTAL BUDGET:	0%			SUBTOTAL:	$0

E. FRINGE BENEFITS Rate of Pay (%)	Salary Base	Dollar Amount Requested
12 month and AY employees and faculty (21%)	$10.948	$2,299
Health Insurance for Faculty/Staff	NA	$1,185
Part Time Employees (8.9%)	$2,025	$180
	SUBTOTAL:	$3,664

F. EQUIPMENT: (List each item with a cost in excess of $1000.00.) Item/Description	Dollar Amount Requested
NA	$0
SUBTOTAL:	$0

G. TRAVEL: Dates of Travel (from/to)	No. of Persons	Total Days	Transportation	Lodging	Per Diem	Dollar Amount Requested
July, Argonne NL, Chicago, IL	2	3	$475/person	$225/person	$150/person	$1,700
August, PNNL, Richland, WA	2	3	$475/person	$200/person	$150/person	$1,650
					SUBTOTAL:	$3,350

H. Participant Support Costs:	Dollar Amount Requested
1. Stipends	
2. Travel (other than listed in section G)	
3. Subsistence	
4. Other	
SUBTOTAL:	$0

I. Other Direct Costs:	Dollar Amount Requested
1. Materials and Supplies	
2. Publication Costs/Page Charges	
3. Consultant Services (Include Travel Expenses)	
4. Computer Services	
5. Subcontracts	$30,000
6. Other (specify nature & breakdown if over $1000)	
SUBTOTAL:	$30,000
J. Total Costs: (Add subtotals, sections A through I) **TOTAL:**	$49,987
K. Amount Requested: **TOTAL:**	$50,000
Project Director's Signature: Doug Wells	Date: 5-31-11

INSTITUTIONAL AND OTHER SECTOR SUPPORT
(add additional pages as necessary)

A. INSTITUTIONAL / OTHER SECTOR DOLLARS

Source / Description	Amount

B. FACULTY / STAFF POSITIONS

Description

C. CAPITAL EQUIPMENT

Description

D. FACILITIES & INSTRUMENTATION

Description

1. **Project Director:** Dr. Douglas Wells, Director, Idaho Accelerator Center

2. **Public Institution:** Idaho State University

3. **Objective:** This project has multiple objectives: 1) Support the continued development for commercialization of the ^{67}Cu process at the IAC by testing the complete production flow. 2) Develop the accelerator produced medical isotope market by providing trial samples of ^{67}Cu to researchers, 3) Complete a ^{67}Cu production partnership and transfer agreement with a private sector company . Finally, an expectation of the project is to build expertise within the University regarding commercialization of University Intellectual Property and foster a culture of entrepreneurship and innovation with commercialization as a goal. The requested funding is $49,900.

4. **Commitments and Priorities:** ISU's Research priorities are to advance the state of knowledge in medical and related sciences, invent novel intellectual properties (IP), and create economically viable licensing and commercial spin-offs. ISU is one of only a handful of Universities operating an accelerator center in the US and has the largest operating number of accelerators of all Universities. The IAC has been very successful in developing a strong nucleus of accelerator expertise while attracting over $8M/year in funding from private industry and government sources. As a result, the IAC is very well positioned to significantly expand its IP portfolio while broadening its economic impact by commercializing developed expertise. Moreover, this project directly ties ISU's nuclear science research with the medical mission of the university.

5. Economic Impact: This proposal will provide a portion of the support necessary to prepare IAC technology for license and transfer to a new company and produce sample quantities of ^{67}Cu material to develop the nascent market. ^{67}Cu will be used in cancer therapy drugs (please see discussion in item 6.4 below). Therapy drugs are known to take some time for FDA approval, therefore, we have built our business model around a partnership with a private company and production using capital infrastructure at the IAC. This allows the market to develop at low initial investment by the private company, yet provides a healthy revenue stream to support future growth. In addition, the business model we envision will provide continued opportunities to train and utilized ISU students and assets. With successful completion of current negotiations, a commercial company will invest approximately $1M initially in capital infrastructure and operating capital. Invested capital combined with the IAC accelerators and facilities will allow potential for shipments throughout North America of up to several hundred human doses per year by the IAC and commercial company. We believe that Idaho is the ideal location for commercialization of ^{67}Cu production because of the nucleus of expertise and accelerator capital infrastructure residing at the IAC. We expect that business ramp-up will continue at the IAC site or in a nearby location. The close proximity of the INL, and a positive business environment for production of radioisotopes further enhance the attractiveness of this area. We believe that commercialization of accelerator produced radio-isotopes will create significant future employment and capital investment in Idaho. The commercialization project will support approximately 5 full and part-time employees in Pocatello at start-up, with the potential to grow significantly to over 20 highly skilled employees over the next 3-5 years. The following table presents our view of the potential jobs that will be supported by commercialization of only ^{67}Cu:

Job Type	Salary range	Required at initial commercialization	Required 3-6 years after commercialization
Engineers	70-100K	2	10
Scientists	60-100K	1	6
Operations	40-70K	1	16
Management	80-140K	1	4

6. Project Plan: Commercialization of Electron Linear Accelerator Manufactured Isotopes:

6.1 Executive summary: The Idaho Accelerator Center (IAC) has developed a potentially commercially viable method of manufacturing radioactive medical isotopes using electron linear accelerators (LINACs) and photo-nuclear activation. This proposal is to partially fund required resources to move the IAC's method into production (the Project).

Radioactive isotopes for Medical therapy and diagnostics are an established multi-billion dollar market, but, some isotopes are unavailable or in very short supply. Current methods of manufacturing most medical isotopes rely principally on aging nuclear reactors located outside of the United States leaving very few domestic sources. Some isotopes are not economically viable using reactor methods. LINAC technology can provide a new source of some of these needed isotopes with important implementation advantages over reactors. High power LINACs of the optimum beam energy of ~ 50 MeV are available, relatively simple to operate, reliable, have relatively low initial and operational costs when compared to reactors, much lower waste streams than nuclear reactors, and much lower decommissioning costs. Photo-production of radio-isotopes using LINACs will help to provide the U.S. a more diverse and reliable domestic supply of short-lived isotopes. Accelerators would also provide a much lower capital investment compared to nuclear reactors with a far quicker ROI.

The IAC has focused on methods to commercially produce ^{67}Cu, an emerging medical isotope useful for treating and imaging many cancers. No commercial source exists for this isotope and the research community is very interested in progressing with human trials. The IAC's process to produce ^{67}Cu uses an electron linear accelerator combined with an enriched target isotope and chemical separation processes. This proposal will partially fund the required testing of the complete production flow necessary to commercialize the entire process and initial deliveries of sample quantities to researchers.

6.2 Project Director: will be Dr. Douglas Wells. In addition, a former private sector executive, Jon Stoner, will assist in program management and direction of the commercialization efforts, investor presentations, and investor and partner meetings.

6.3 Commercialization Partners: The IAC has developed this project through its research into accelerator produced isotopes. Based on the IAC's research, we have attracted a private company and two national labs, Argonne National Lab and Pacific Northwest National Lab to collaborate with us on commercialization. ISU at the present time is negotiating an LOI with a private sector company regarding technology transfer and business support to produce ^{67}Cu, the details of which are confidential. The IAC has worked with this company for approximately 2 years with joint proposals for development of medical isotopes. The company has created a

US subsidiary with a Pocatello, ID address, therefore, we have strong belief that the company will wish to become a transferee of the ISU/IAC technology and that they will subcontract to produce ^{67}Cu at the IAC facility. We anticipate the signing of an LOI in the near future with the goal of beginning production in 2012. Funding this proposal will allow us to keep efforts intact on the technology development needed to reach this goal. While we have a great deal of confidence that our current partner will move forward to commercialization, even if they choose not to, funding this proposal will further mature the technology which will entice alternative partners and investors. We also have reviewed the commercialization opportunities with other businesses and economic development agencies and find strong interest. The IAC has collected letters of support (attached). The positive feedback on the business prospects of the ^{57}Cu project using IAC technology convinced us that even if the current negotiations are not successful, other companies are very interested in the prospects.

6.4 Market opportunity: ^{67}Cu is a specific isotope of Cu with unique characteristics. As it decays (with a half-life of approximately 2.5 days) it gives off a beta particle and a gamma ray. The energy of the beta particle is such that if the radio-isotope is close to a cancer cell, the beta will likely kill the cancer cell. However, the range of the beta particle is not so great that it will travel far through the body killing healthy cells. Another unique characteristic of ^{67}Cu is that the gamma ray emitted is at an ideal energy to be seen by most hospital's common imaging equipment (SPECT cameras). These two characteristics make ^{67}Cu an ideal candidate for cancer therapy when combined with a Monoclonal Antibody (mAb). An mAb is an antibody that is created to bind to the tumor of interest. If an appropriate mAb is created that can bond to the cancer tumor of interest and ^{67}Cu is attached to that mAb, the mAb will deliver a specific radioactive dose directly to the tumor. Thanks to the imaging properties (using SPECT scans) of ^{67}Cu, therapists can observe the location of the target tumor and estimate the dose delivered. Because of these properties, ^{67}Cu has been studied for over 30 years and has been a high priority radio-isotope for the nation [NSAC 2008]. Researchers have been attempting to complete comprehensive clinical trials, unfortunately, no reliable source, including national labs Brookhaven and Los Alamos, has supplied the necessary quantities of ^{67}Cu to the researchers developing therapies. One private company supplier, Trace Life Sciences, has undergone restructuring for unrelated reasons and is not producing material. As a result, drugs containing ^{67}Cu have not been commercialized. Work done to date, however, has shown that ^{67}Cu is a very effective radioisotope for treatment of Non-Hodgkins Lymphoma (NHL), ovarian cancer, colorectal cancer and bladder cancer. We believe that if reliable supplies of ^{67}Cu are made available to researchers, several new therapies will be released within a few years.

An analog to ^{67}Cu is the radioimmunotherapy (RIT) drug Zevalin which is used to treat some cases of NHL. Zevalin is a drug that combines an antibody called ibritumomab with a chelator (the chemical which helps bind the radio-isotope) called tiuxetan. To treat a patient with Zevalin, the patient receives a dose of drug for imaging using a radio-isotope (^{111}In) combined with the mAb and a treatment dose of the drug combined with ^{90}Y. Zevalin is one of the most expensive drugs on the market with a typical treatment reimbursed by Medicare at approximately $30,000. The pharmaceutical company providing Zevalin to the market reported revenues of $15M on Zevalin in 2009 and $26M on Zevalin in 2010 which we believe equates to approximately 1000-2000 treatments annually of the roughly 65,000 case of NHL in the US per year. We believe that ^{67}Cu based drugs will provide improved procedures for treatment of NHL and other cancers because it combines both therapy and imaging at the same time giving the potential for thousands of ^{67}Cu doses per year.

As with most therapy drugs, the initial market is small, tens to hundreds of doses per year, essentially research quantities until trials are completed. We recognize that the slow market ramp is a deterrent to large initial investment, therefore, we have structured our business plan around a collaboration with a private company where the IAC resources are used to jump start the market. Initially, the commercial partner and the IAC will produce ^{67}Cu for researchers at a few hundred doses per year. We anticipate that the material produced will be reimbursed by the NIH and researchers at an attractive rate ($3K-$5K/dose estimated based on reimbursement for ^{90}Y during development of Zevalin). Based on our modeling, we believe that ^{67}Cu has potential as a good revenue product for an Idaho radioisotope company and a potential total market (assuming 10,000 treatments/year) of greater than $30M dollars.

Among the potential customers for the isotope are large pharmaceutical companies such as Nordion, Covidien, Lantheus, and GE as well as the current licensor of Zevalin, Spectrum Pharmaceutical. We anticipate sample deliveries to medical complexes conducting research and clinical trials such as City of Hope Research Institute, CA.

6.5 Technology: The technology involves the irradiation of specific isotopically enriched targets with gamma rays created from a multi-Mev electron accelerator. During this irradiation, a photo-nuclear reaction occurs resulting in the ejection of a particle, typically a neutron or proton. Our production method for ^{67}Cu, takes advantage of the ejection of a proton from our target, enriched ^{68}Zn, to form ^{67}Cu. This is known as a ^{68}Zn (γ,p) ^{67}Cu reaction. Accelerator technology is very mature, having been utilized domestically for over 50 years in a variety of applications. Cyclotron accelerators are currently utilized for producing low atomic mass isotopes for PET scans (^{18}F) for instance. However, Cyclotrons lack the energy and power to make significant quantities of heavier isotopes. Applications of electron linear accelerator technology for medical isotopes, while discussed in the past (patent #'s 5784423, 5949836, 5802438, 5802439), have not been reduced to commercial practice by any known entity. Several significant technical challenges must be overcome including designing targets and converters to handle high power density, developing methods to recover expensive enriched isotope targets and improving separation to provide high radio active purity (Specific Activity). We at the IAC and our collaborators believe we have addressed these challenges

The fully integrated ^{67}Cu process involves irradiating a prepared target of enriched ^{68}Zn with an electron accelerator produced gamma ray flux produced by 10kW of power at an energy greater than 30 MeV. The target is designed to dissipate the high energy it receives so it doesn't melt or degrade. After irradiation, two separations are completed. One separation recovers the expensive ^{68}Zn target material and another separation refines the ^{67}Cu sufficiently for use in therapy drugs. The IAC has been investigating the requirements of and developing technology for the target isotope, the target holder, the accelerator conditions, and the separation methods to meet or surpass commercial requirements. In addition, the IAC is collaborating with Argonne National Labs on methods to recover very expensive enriched ^{68}Zn target material. The IAC has filed one patent application on the methods of making high specific activity radioisotopes and we expect current development work will lead to further patents for economical manufacture and separation of accelerator produced isotopes.

The IAC developed the technology over the last 3 years with funding from Congressional funds and the DOE. Small quantities of various isotopes in the micro Curie range have already been created by the IAC. During this Project we will investigate scaling the methods to activities of 200 miliCuries. The major components of the Project (accelerator technology and operation, chemical separation and refining) are sufficiently understood and with the collaboration of our national lab partners, ANL and PNNL, we believe technology integration risk is low. The Project will also study the specification requirements and capital investment for large scale production, up to 10,000 doses per year.

6.6 Detailed Project Plan: Funding will be used directly to support the IAC researchers and the consultant on the commercialization of ^{67}Cu production. Steps for commercialization include testing all the steps for producing the radio-isotope from a commercial provider perspective and then producing laboratory, animal and human trial samples of ^{67}Cu for our research collaborators at City of Hope Research Institute in California. In addition, the Project will use the funding to continue supporting the collaboration between the IAC, ANL, PNNL and the private company, transferring needed target and separation technologies as necessary. The verification and scaling of technology processes and refinement of method tasks will be assigned to specific researchers in the IAC with direction by the Director of the IAC and the consultant. A continuous interplay between our developers and collaborators will be necessary to remain focused on the objectives as well as communicate requirements and opportunities during commercialization. As the tasks are completed, it is our expectation that the private sector partner will invest and assume responsibilities for future capital spending and business growth.

The major Project milestones are: 1) Completion of internal infrastructure, 2) Testing of all discrete production steps followed by production of trial samples 3) Approval of tissue, animal and human trial samples, 4) Delivery of approved quantities to researchers for human trials. We anticipate that our commercial partner will make initial investments late in 2011 with the goal of human dose shipments during the Spring and Summer of 2012.

7. **Education and Outreach:** A critical goal of the Project is the engagement and education of IAC management, graduate students and post doctoral researchers in the commercialization process. We hope to dramatically increase the number of entrepreneurs within the Idaho University System and influence faculty, future researches and graduate students with the potential rewards of a commercialization effort. In addition, the act of publicizing the expertise of the IAC to investors and potential partners will raise overall awareness of the strength and capabilities of the Idaho University System. Marketing of the skills of the IAC, ISU Chemistry and other departments can lead to further investments from the private sector in other worthwhile research and commercialization opportunities. Finally, we anticipate an increase in interest among Faculty and Staff at ISU to create novel and patentable technologies furthering the Intellectual Property of Idaho Universities.

8. **Institutional Support:** We believe that ISU and the IAC will have the facilities necessary to complete the Project. We anticipate strong commitment from the Office of Research, the College of Science and Engineering and the Business School.

Appendix A – Facilities and Equipment Resources

Introduction

The Idaho Accelerator Center (IAC) was created by the Idaho State Board of Education in 1994; the IAC is charged with undergraduate and graduate education, conducting applied physics research, creating new applications of accelerator physics and supporting the economic development of Idaho. The IAC has 10 operating accelerators in 5 research facilities with over 30,000 sq. ft. of laboratory space; we believe this is the most operating accelerators of any university in North America. This includes the IAC-Inspection Technology Research and Development Laboratory (IAC-ITRDL), which has a 20,000 sq. ft. high-bay space for large scale systems testing and 15 acres of open area for field testing. The operation personnel at these facilities consists of 12 scientists (many of whom are PIs, Co-PIs or senior personnel on this project), 10 engineers and 3 administrative assistants.

Main IAC "Campus"-Accelerator Laboratory #1:

The main IAC campus, which is shown is shown in Figure 1, was constructed in 1999 and initially consisted of office space and Accelerator Laboratory #1. This accelerator lab was built into the hills that surround Pocatello Idaho and the 2,010 sq. ft. hall is 20 feet underground providing ample radiation shielding. This accelerator hall houses a 44 MeV Short Pulsed LINAC and a 25 MeV LINAC. In addition, this accelerator hall has a well shielded experimental cell that is separated by a six foot wall from the accelerator hall. This wall has four penetrations allowing collimated bremsstrahlung beams to be delivered to a “low” radiation environment, which is critical for precise photonuclear measurements.

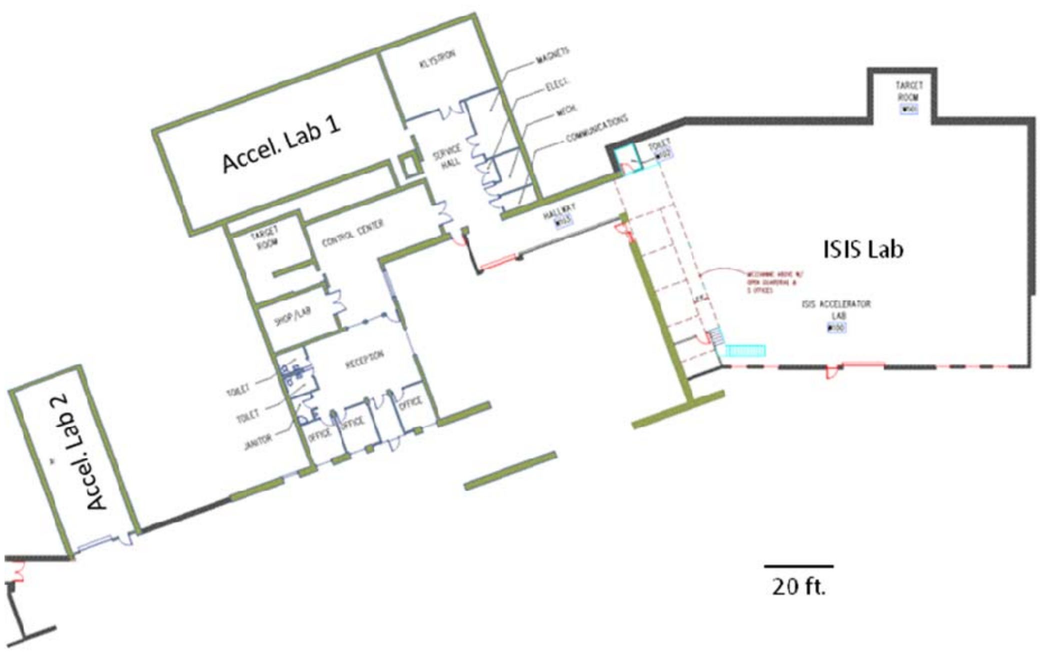

Figure 1 Schematic diagram of the main IAC campus located in the hills that surround Pocatello Idaho.

The 44 MeV Short Pulsed LINAC, is an L-band traveling wave radio frequency accelerator operating at ~1.3 GHz. It is capable of delivering electron pulses with operator selectable widths between 50 ps to 4 μs at a repetition rate up to 120 Hz. The maximum charge per pulse ranges from 5 nC for 50 ps pulses to 2 μC for 4 μs pulses. The electron energy can be varied from ~4 to 44 MeV with an energy resolution of 0.5% to 4%, which can be controlled by a set of retractable slits. This accelerator excels when short bremsstrahlung pulses are required for photonuclear experiments where timing is critical such as neutron time of flight spectrometry. More importantly for this project, this accelerator has been upgraded to 5 kW average beam power, which makes it ideal for support research in medical isotope production.

The 25 MeV LINAC in Accelerator Laboratory #1, is an S-band standing wave radio frequency accelerator operating at ~2.8 GHz. It is capable of delivering electron pulses with operator selectable widths between 0.5 μs to 4 μs at a repetition rate up to 600 Hz. The maximum charge per pulse ranges from 40 nC for 0.5 μs pulses to 350 nC for 4 μs pulses. The electron energy can be varied from ~5 to 25 MeV with an energy resolution of 5%, which can be reduced using collimators or slits. This accelerator has a broad parameter space, is easy to operate and when short pulses are not required this is often the accelerator of choice.

Main IAC "Campus"-Accelerator Laboratory #2

Accelerator Laboratory #2 is shown in Figure 1 and is approximately 1000 sq. ft. accelerator hall, which is primarily used for initial construction and testing of accelerator systems and components. This accelerator hall is built into the hill and is approximately 10 feet underground for radiation shielding. It just underwent a major upgrade for high-power accelerator operations in support of isotope production. The IAC is currently planning installation of a 10 kW, 50 MeV accelerator in this hall to specifically support isotope research and production.

Main IAC "Campus"-ISIS Laboratory

The ISIS Laboratory is shown in Figure 1 and is a 7,659 sq. ft. high-bay accelerator laboratory, which houses the Idaho State Induction Accelerator System (ISIS). The ISIS accelerator system, is a pulsed-power accelerator that provides an extraordinary high power accelerator capability at the IAC. It consists of a ~3 MeV injection accelerator that generates an electron beam for a ten cell induction accelerator. Due to the spiral lines, the electrons make two passes through each induction cell. At full power ISIS can deliver a 35 ns, 9.5 MeV electron pulse with 10 kA of current for ~0.1 TW of peak power. Due to the capacitor charging times, ISIS can fire about once every two minutes. This accelerator has been used for radiation effects research in electronic and biological systems. At a beam energy of 9.5 MeV, ISIS can be used for initial research into fissionable material detection using a single bremsstrahlung pulse.

Physical Building-HRRL Laboratory

The HRRL Laboratory is located in the basement of the physical sciences building and is a 400 sq. ft. accelerator hall with an adjoining 700 sq. ft. well shielded experimental cell. This laboratory houses the High-Repetition Rate LINAC (HRRL). The HRRL is a 20 MeV S-band standing wave radio frequency accelerator operating at ~2.8 GHz. It is capable of delivering electron pulses with a width 70 ns at a repetition rate up to 1,200 Hz. The maximum charge per pulse is 8.4 nC. The electron energy can be varied from ~12 to 20 MeV with an energy resolution of 8%. Due to its high-repetition rate this accelerator will be utilized for prompt γ-ray signatures from fissionable materials.

IAC-Inspection Technology Research and Development Laboratory (IAC-ITRDL)

The IAC-ITRDL is located near the Pocatello Regional Airport and has a 20,000 sq. ft. high-bay space for large scale systems testing and 15 acres of open area for field testing. Currently at the IAC-ITRDL, is a 25 MeV accelerator similar to the ones located at the IAC Main "Campus", which is being used by Co-PI Brandon Blackburn for investigating the detection of fissionable materials at large distances. In addition, there is a 10 MeV LINAC, which is part of the cargo container scanning test bed. This 10 MeV LINAC is an S-band standing wave radio frequency accelerator operating at ~2.8 GHz. It is capable of delivering electron pulses with operator selectable widths between 1 μs to 4 μs at a repetition rate up to120 Hz. The maximum charge per pulse ranges from 100 nC for 1 μs pulses to 400 nC for 4 μs pulses. The electron energy can be varied from ~8 to 10 MeV with an energy resolution of 10%. A full size 40 ft. cargo container can be pulled past the 10 MeV accelerator in as little as 20 sec. This system includes ample room for placing detectors and associated hardware for realistic scanning tests. This system is also an excellent test bed for investigating radiation safety issues associated with cargo scanning systems. Furthermore, a variety of shielding pallets are available though Dr. Blackburn for investigating the effects of various fissionable material shielding scenarios.

Detectors and Data Acquisition

Detector and data acquisition equipment to support research is abundant. The IAC currently possesses over five HPGe detectors that can be utilize for prompt and delayed γ-ray signature research. There are a large number of various photomultiplier tubes with a large array of different scintillators ranging from fast plastics to NaI. For neutron detection, the IAC has over 12 ^{3}He detectors currently configured for fast neutron detection by using neutron absorbers and moderators. These detectors work exceptionally well for delayed neutron detection. Furthermore there are BF_3 and fission chambers for neutron detection. The data from these detectors can be acquired, by three different multiparameter data acquisition systems that can handle up to 16 channels of data each. There is also two VME systems that are very flexible and modules for these systems, include a 16 channel multihit time to digital converter, 16 charge to digital converters, a 16 channel pulse height analog to digital converter and 16 channel scalars. Finally, the IAC has over 100 nuclear instrument modules that can be employed for various pulse shaping functions and logic control.

New detector and data acquisition development such as the GEMS and LPMWPC will take place in the Detector Science Laboratory, which is a 1,100 sq. ft. lab specifically for the construction and testing of new detectors. This lab includes a dark room for photomultiplier work, chemical hoods for potential hazardous vent gasses and optical tables for precision wire placement. One of the two VME data acquisition system in normally located in the DSL for development work.

Radiation Transport Simulation Capabilities

The Department of Physics and the IAC maintain a Beowulf cluster in the Physical Sciences Building, which is the most powerful computation engine on the Idaho State University. The cluster consists of a 12-node dual-core processor AMD Opteron 246 with 1MB Cache and 9-node double dual-core processor AMD Opteron 246 with 1MB Cache for a total of 60 processors. Each unit has 2 GB DDR 400 MHz ECC/Registered Memory. In addition 1.75 TByte of RAID5 storage, a PCI Workstation, a Pioneer DVR-S606 External Firewire and a 24-port 10/100/1000 switch are also available. The cluster has the standard compilers (C, C++, Fortran etc…) and has Monte Carlo programs MCNPX and GEANT installed. Extensive and complex data analysis can be performed using the data analysis program ROOT.

Engineering and Technical Support at the IAC

As stated in the introduction, the IAC has 10 personnel on its engineering and technical staff. This includes 3 accelerator engineers, 3 pulsed-power engineers and an electronics engineer. These engineers are responsible for construction of the various accelerator systems, accelerator operations and care of the overall facilities. In addition, the IAC has an instrumentation physicist and a radiation engineer. The former's responsibilities include care and setup of the various detectors and data acquisition systems. The latter's responsibility is all aspects of safety with an emphasis on radiation safety. Support facilities heavily used by the technical staff include, the IAC machine shop, the IAC electronics shop and the IAC radiation dosimetry laboratory.

Summary - IAC has many accelerators among 3 Labs:

<u>Electrons:</u>

– A 1.2 MeV DC Accelerator

– A 4 MeV LINAC

– A ~ 10 MeV Pulsed-power Induction Accelerator (~10 kA)

– A 18 MeV High-Repetition (1kHz) LINAC

– (4) 25 MeV LINAC

– 44 MeV Short-Pulse (10 ps) 5 kW LINAC

Gammas from bremsstrahlung plus X-Rays from above electron Linacs plus:

– X-Ray Tubes: ~450 keV

– Monoenergetic LCS: Energy ~ 5-100 keV

– 137Cs Sheppard Source: 13 Ci

Positive Ions:

– 2 MeV Van de Graff

Neutrons:

– LINAC (gamma, n) sources, variety of radioactive sources

General Infrastructure includes three major laboratories, ~35,000 sq. feet of lab space, a well-equipped machine shop and an electronics shop. ISU also has chemistry labs ('hot' and 'cold') to support the radiochemical separations.

Biographical Sketches:

Douglas P. Wells, Ph.D.
Idaho Accelerator Center
Idaho State University
Pocatello, ID, 83209-8236

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(208) 282-3986
(208) 282-5878 (fax)

Professional Preparation

Rutgers University	Physics,	B.S. 1982
University of Virginia	Mathematics,	M.S. 1984
University of Illinois	Physics,	M.S. 1985
University of Illinois	Physics,	Ph.D. 1990

Appointments

2006-present	Director, Idaho Accelerator Center at Idaho State University
2003-2006	Chair of the Department of Physics at Idaho State University
2003-present	Associate Professor of Physics at Idaho State University
1997-2003	Assistant Professor of Physics at Idaho State University
1996-1997	Associate Professor of Health Physics at Idaho State University
1993-1996	Radiation Health Physicist for Washington State Department of Health

Recent Publications (over 100 peer-reviewed publications in all)

S. F. Naeem, D.P. Wells, T. White and T. Roney, Activation Analysis for Transuranic (TRU) Waste Assay and Imaging, Nuclear Instruments & Methods in Physics Research A (in press).

Mestari, M.A., D. P. Wells, L.C .DeVeaux, and S. F. Naeem, *Real-Time Dosimetry System for Radiobiology Experiments Using a 25 MeV LINAC*, Proceedings of 20th International Conference on the Application of Accelerators in Research & Industry, AIP press, Vol. 1099, pgs. 3-6, (2009).

J. Green, D. P. Wells, B. Benson, Z. J. Sun, and H. D. G. Maschner, *A Priori Method of Using Photon Activation Analysis to Determine Unknown Trace Element Concentrations in NIST standards*, Proceedings of 20th International Conference on the Application of Accelerators in Research & Industry, AIP press, Vol. 1099, pgs. 919-924 (2009).

G. Kharashvili, V. Makarashvili, M. Mitchell, W. Beezhold, R. Spaulding, D. P. Wells, T. F. Gesell, W. Wingert, *Development and Testing of Gallium Arsenide Photoconductive Detectors for Ultra Fast, High Dose Rate Pulsed Electron and Bremsstrahlung Radiation Measurements,* Proceedings of 20th International Conference on the Application of Accelerators in Research & Industry, AIP press, Vol. 1099, pgs. 55-58 (2009).

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A. K. Roy, S. Chanda, D. P. Wells, A. Ghosh, C. K. Mukhopadhyay, Residual Stress Characterization of Welded Specimens by Nondestructive Activation Technique, Materials Science and Engineering A **464** (1-2), 281 (2007).

L.C. DeVeaux,, J.A. Müller, J.R. Smith, D.P. Wells, J.E. Petrisko, S. DasSarma, Extremely radiation-resistant mutants of a halophilic archaeon with increased single-stranded DNA binding protein (RPA) gene expression, Radiation Research **168** (4), 507 (2007). (Note: This paper was selected as the featured article from the October issue for open access on BioOne)

V. Makarashvili, D. P. Wells, MCNPX Simulations for Positron Production Mechanisms to Generate Defect Density Images using Positron Annihilation Energy Spectroscopy, Proceedings of the Eighth International Topical Meeting on Nuclear Applications and Utilization of Accelerators, (2007).

Synergistic Activities

My work at ISU, as an educator, researcher, and administrator has been focused on applied nuclear science. This includes collaborations with engineers and material scientists (novel positron annihilation spectroscopy techniques for defect and stress analysis), biologists (accelerator-based irradiation schemes for extremophile research), homeland security researchers (accelerator-based inspection methods for detecting fissile and explosive materials in a variety of challenging environments), and medical/imaging scientists (novel x-ray beams for imaging). All of these projects have produced peer-reviewed publications and completed graduate degrees for students that went on to careers in industry, national labs or additional graduate studies. Several of them have led to patents or patent disclosures. In my nine years at ISU I have been the major advisor of 27 graduate students, of which 11 have been female or minority, and 16 have completed their degrees. As an administrator I served as Chair of the Department of Physics and am currently serving as Director of the IAC.

Collaborators and Other Affiliations

B. Blackburn, Idaho National Laboratory (INL); S. DasSarma University of Maryland Baltimore; J. L. Jones, INL; S. Maloy, Los Alamos National Laboratory (LANL); T. Roney, INL; T. White, INL; M. Espy (LANL); F. Merrill (LANL); K. Pitts (PNNL).

Graduate and Postdoctoral Advisors

Ph.D. Advisors: A. Nathan, B. Eisentein, (retired) University of Illinois.
Postdoctoral Advisor: K. Snover, E. Adelberger, University of Washington.

Thesis Advisor and Postgraduate-Scholar Sponsor

Greg Gibbons, Doug Walker, Liu Jiwen, Tobin Mott, John Kwofie, Dr. Wade Scates, Jason Williams, Yoshi Toyoda, Vakhtang Makarashvili, Lali Tchelidze, Scott Thompson, Syed Naeem, Nino Tchelidze, Dr. Cecilia Hoffman, Amine Mestari, John Ralph, Ee Lin Roethlisberg, Kristin Smith, Jonathon Case, Jonathon Walker, Jay Kumar, Kiran Billa, Dr. Farida Selim, Dr. Khalid Choffani, Dr. Marc Mitchell, Charles Taylor.

Jon L. Stoner
209 Stanford Ave.
Pocatello, ID
208-760-0692

SUMMARY

Technology professional with extensive experience as a CTO, Business Unit General Manager managing large technical organizations, running mergers and acquisition, and managing and creating intellectual property

EXPERIENCE

CJ Tech Consulting LLC

CEO/ Founder **Date: April 2008 - present**

Work with clients in Corporations, Private Equity and Venture Capital firms to analyze businesses product lines, technology, intellectual property and facilities. Support product planning, business reengineering, start up business plans, and mergers. Example Projects include:

1). Analyze patent position and product position for Medical Imaging company for Private Equity Investors

2). Technical and product diligence of a large European Technology company for acquisition by a Private Equity firm. Involved evaluations of products, intellectual property, Research and Development projects and plans, financial metrics for product and technical success, and interviews of key management and technical personnel.

3). Facility, product and technical diligence of a large Japanese technology company for acquisition by Private Equity firm. Involved site visits, interviews, and meetings with executives.

4). Numerous evaluations of small technology companies for appraisal by principal investors and venture capitalists.

5). Extensive pro-bono support of University Accelerator Center. Develop Project Plans, evaluation of Intellectual Property, financial analysis of technical approaches, market analysis, and presentations to support collaborations with private sector investors.

AMI Semiconductor **Date: 2005- March 2008**

Sr. Vice President, General Manager of Image Sensor Products

Job Functions & Responsibilities

Complete P&L responsibilities for Image Sensor Product division of AMIS. Drive profitability, relocate organization, integrate systems, cut costs, change and implement new product strategy.

Accomplishments

- Grew revenue 20%, achieving $38M in revenues in 2006 at OI of 20%
- Achieved $31M in revenues in 2007 at OI of 27%
- Improved product gross margins from 27% to 42%
- Brought on new key Japanese customer and grew revenues to >$10M annually
- Introduced four new products while decreasing OP EX
- Managed 18 employees in CA, three in Idaho, one in Europe
- Engaged bank to evaluate sale of the business, provided sale packaged and reviewed with multiple potential buyers
- AMIS decided to keep the business due to improvements I made in performance

AMI Semiconductor **Date: 2002- March 2008**

Sr. Vice President, CTO, Acquisitions, Strategy

Job Functions & Responsibilities

Present AMIS story to analysts, investors and Board of Directors, analyze AMIS Businesses, find, analyze and execute strategic acquisitions, prepare and present product strategies, evaluate and meet with potential buyers of AMIS, prepare diligence. Meet with and improve sales at AMIS Key customers. Negotiate partnerships and license agreements. Manage AMIS Intellectual Property and IP technical organization.

Accomplishments

- Significant role in growing AMIS revenue from $280M to $600M annual sales.

- Managed various teams of 3-10 people for strategic activities.
- Sale of AMIS to ON Semiconductor
- Acquisition of Flextronics Semiconductor
- Acquisition of DSP factory
- Acquisition of Alcatel Micro Electronics
- Acquisition of Microsemi ASICs
- Acquisition of Focus Semiconductor
- Presented at numerous analyst and investor meetings and rating agencies including S&P and Moodys Represented AMIS at many major bank conferences
- Worked as consultant to well known PE Group for major semiconductor acquisition
- Drove strategic activities at Blue Chip companies such as GE, Medtronic, Boston Scientific, HP, Symbol, Honeywell and others
- Analyzed and presented new operational strategies to AMIS BOD
- Analyzed and met with principals and banks on approximately 30 potential acquisition candidates
- Negotiated IBM and Agere license agreements

AMI Semiconductor **Date: 2001-2005**

Vice President Technology, CTO, Acquisitions, Strategy

Job Functions & Responsibilities

Managed Design, Development and R&D Engineers. Created new product platforms for AMIS Mixed Signal Business and new Array platforms for AMIS Digital Business. Drove new product strategies. Managed IP and licensing.

Accomplishments

- Managed multiple departments of designers, technologists, software developers and IP architects
- Total managed headcount - 100
- Developed and released Digital Array based product platform generating $20M in sales in first year
- Developed and released IP and technology supporting 20% growth in Mixed Signal sales
- Negotiated outsource fabrication agreements with TSMC and others
- Evaluated and drove operational consolidations including Fab equipment and test
- Responsible for reviewing and approving annual capital expenditures - $30M

AMI Semiconductor **Date: 1997-2000**

Director Business Development, Director Standard Product BU

Job Functions & Responsibilities

Prepare analysis and diligence supporting IPO by Japanese owners or sale of AMI to PE.

Meet with BU and customers to increase sales penetration. Direct company strategy. Manage the Timing Products BU, Start up and hire Director of Wireless BU.

Accomplishments

- With CEO, CFO, various consultants and banks, prepared analysis of AMIS businesses and strategy Evaluated possibility of IPO and supported diligence and story presentation with banks for final PE buyout in December, 2000
- Managed AMIS's Timing products BU (16 people in Philadelphia) driving from 0 to >5M annual sales in 2 years, started up AMIS Wireless Products BU (6 people in Idaho increased to 15 people in San Diego, CA)

AMI Semiconductor **Date: 1994-1997**

Director R&D, Project Manager, Fab 10

Job Functions & Responsibilities

Working directly for CEO, plan, budget, gain approval, manage construction and completion of new lowest cost, deep submicron 8 inch Fabrication for AMIS.

Accomplishments

- Analyzed AMIS business, growth and demand, created Business Plan, Business Models and made multiple presentations to Japan Energy BOD to gain approval of $150M investment in new 8 inch Fab. Planned, developed and managed construction of 8 inch Fab. Completed world wide visits and assessments of more than 20 new, operating and underdevelopment Fabs. Negotiated with all equipment and construction vendors. Completed state of art Fabrication facility at <40% of the cost/square foot of equivalent sites.

AMI Semiconductor **Date: 1988-1997**

Director R&D, Director Operations Engineering, Director Foundry Engineering

Job Functions & Responsibilities

Managed 60-70 engineers and technicians to develop technology platforms for AMIS businesses. Meet with customers, plan and develop technology for Foundry business. Manage AMIS IP.

Accomplishments

Managed development of technology platforms and operations groups supporting Revenue growth from $80M to >$220M. Responsible for operational budget of ~$8M and capital budget of ~$20M annually.

AMI Semiconductor **Date: 1985-1988**

Senior Engineer, Project Manager EEDMA

Job Functions & Responsibilities

Working with Marketing, conceived, developed and released most successful process/product technology platform in AMIS. To date has achieved >$1.0B in accumulated sales.

AMI Semiconductor **Date: 1980-1985**

Various roles in engineering in Operations, R&D, Product Engineering and Development

EDUCATION & TRAINING

- MS Physics – Idaho State University with Honors
- BA Chemistry – University of Montana with Honors
- Accepted to and attended University of Minnesota School of Dentistry 1979-1980
- Numerous short courses in management, product development, and marketing

OTHER

- Member of Advisory Committee to Idaho State Board of Education on Engineering education – 6 years
- Member Advisory Board for BSU school of Engineering
- Governor appointed member EPSCORE (Experimental Program for Competitive Research) committee for State of Idaho – advises and reviews projects to be submitted for Grants and Funding to various Federal agencies
- Member of multiple societies of IEEE

REFERENCES

Available on request

Biographical Sketch for Lisa M. Goss

Professional Preparation

Willamette University	Chemistry, B.S., 1992
University of Colorado at Boulder	Chemistry, Ph.D., 1998

Academic and Professional Appointments

Associate Professor, Idaho State University	Aug 2004 to present
Assistant Professor, Idaho State University	Aug 1999 to Aug 2004
Visiting Assistant Professor, Whitman College	Aug 1998 to May 1999

Publications

Lisa M. Goss, Whitney R Hess, Thomas A Blake, Robert L Sams, "The high-resolution, jet-cooled infrared spectrum of pentafluoroethane", Journal of Molecular Spectroscopy, in press.

Lisa M. Goss, Clay D. Mortensen, Thomas A. Blake, "Rotationally Resolved Spectroscopy of the ν_8 Band of *cis*-Methyl Nitrite", Journal of Molecular Spectroscopy, 225(2), 182-188 (2004).

Lisa M. Goss, "A Demonstration of Acid Rain and Lake Acidification: Wet Deposition of Sulfur Dioxide," Journal of Chemical Education, 80, 39-40 (2003).

Veronica Vaida, John S. Daniel, H. G. Kjaergaard, Lisa M. Goss, Adrian Tuck, "Atmospheric absorption of near infrared and visible solar radiation by the hydrogen bonded water dimer," Quarterly Journal - Royal Meteorological Society, 127(575), 1627-1644 (2001).

Lisa M. Goss, Veronica Vaida, James W. Brault, and Rex T. Skodje, "Sequential Two-Photon Dissociation of Atmospheric Water," Journal of Physical Chemistry A, 105(1), 70 (2001).

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Veronica Vaida, Gregory J. Frost, and Lisa M. Goss, "Spectroscopic Characterization of Supersonic Molecular Beams," Israeli Journal of Chemistry, 37, 387-393 (1997).

Gregory J. Frost, Lisa M. Goss, and Veronica Vaida, "Measurements of High Resolution Ultraviolet-Visible Absorption Cross Sections at Stratospheric Temperatures: 1. Nitrogen Dioxide", Journal of Geophysical Research, 101, 3869-3877 (1996).

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Bo Albinsson, Hiroyuki Teramae, Harald S. Plitt, Lisa M. Goss, Hubert Schmidbaur, and Josef Michl, "The Matrix Isolation IR and UV Spectra of Conformers and Isomers of Oligo-Silanes", Journal of Physical Chemistry, 100, 8681-8691 (1996).

Lisa M. Goss, Gregory J. Frost, D. J. Donaldson, and Veronica Vaida, "Photooxidation of CS_2 in the near-ultraviolet and its atmospheric implications", Geophysical Research Letters, 22, 2609-2612 (1995).

Synergistic Activities

Mentor Participant in Forays Into The Field, July 2008.
Mentor Participant in ScienceTrek, April 2007, April 2008, April 2009, April 2010.
Reviewer for Journal of Chemical Education

Reviews for NSF, NASA, ACS PRF

Collaborators & Other Affiliations

Collaborators: Thomas A. Blake, Pacific Northwest National Lab; Robert L. Sams, Pacific Northwest National Lab; Joshua J. Pak, Idaho State University

Graduate Advisors & Postdoctoral Sponsors: Veronica Vaida, University of Colorado at Boulder

Thesis Advisor and Postgraduate-Scholar Sponsor: Clay D. Mortensen, University of Oregon, Whitney Hess, Idaho State University, Samuel J Plesner, Idaho State University

Additional Resource Commitments

jstoner

CJ Tech Consulting LLC

Dr. Douglas Wells

IAC

To whom it may concern:

This letter is to show support and commitment to the IAC submitted proposal to HERC RFP . I have worked with Dr. Wells and the ISU/IAC staff since February, 2009 to provide my Private Sector expertise to aid research and potentially commercialize ISU/IAC Medical Isotope Technology. On receipt of funding from this proposal, I will commit to continued support of Dr. Wells in the commercialization efforts.

Sincerely

jstoner
Managing Partner

BANNOCK
DEVELOPMENT CORPORATION

May 9, 2011

Dr. Douglas Wells
Director, IAC
Idaho State University
921 So. 8th Avenue, Stop 8263
Pocatello, ID 83209-8263
RE: *Idaho Accelerator Center radio-isotope technology*

Dear Dr. Douglas Wells,

I am writing on behalf of Bannock Development Corporation (BDC) to offer our support for efforts by ISU and the IAC to develop and commercialize technology to produce radio-isotopes for medical and other uses.

BDC is an Idaho non-profit corporation whose purpose is to create a healthy economy for Eastern Idaho, focusing primarily in Bannock County. BDC's key goal is to create jobs – that offer good salaries and benefits—and promote workforce development by attracting new industry and businesses and helping local businesses grow or continue to operate.

In recent years BDC and other organizations have worked hard to grow and diversify the economy of eastern Idaho. We have had considerable success in our efforts due in large part to our ability to create partnerships with public and private entities that lead to clean and productive economic development. Bannock Development supports efforts by ISU and the IAC to develop and commercialize technology to produce radio-isotopes for medical and other uses.

As you know, we have been working with the IAC on a proposal to the Economic Development Agency to expand the IAC facility to support business growth. Production of medical isotopes at this location is in line with our strategic priorities for job creation and economic growth and we stand fully ready to provide our support to this endeavor.

Thank you,

Ms. Gynii A Gilliam
Executive Director
Bannock Development Corporation

Bannock Development Corporation
1651 Alvin Ricken Drive ~ Pocatello, Idaho 83201
1.208.233.3500 ~ www.bannockdevelopment.org

IOTRON
Industries Canada Inc.

May 6, 2011

Idaho State University
921 So. 8th Avenue, Stop 8263
Pocatello, Idaho 83209 – 8263
Attn: Dr. Douglas P. Wells, Ph.D.
Director, Idaho Accelerator Center
Professor, Department of Physics

Dear Dr. Douglas Wells,

Iotron Industries supports your project to commercialize photo-nuclear production of radio-isotopes. As you are aware, we have been working closely with the IAC to outline the business case for production with the goal of moving to full commercialization. We are pleased to continue our efforts in this regard and support your project.

Yours Very Truly,

IOTRON INDUSTRIES CANADA INC.

Lloyd Scott
Chairman

LS:kb

Fax: (208) 782-9005

April 29, 2010

Idaho Accelerator Center
ATTN: Dr. Douglas Wells
1500 Alvin Ricken Drive
Pocatello, ID 83201

Dear Dr. Wells,

Thank you for the thorough briefing on the technical and business value that can be realized by your efforts to commercialize 67Cu for cancer treatment.

Premier Technology supports and endorses the efforts of Idaho State University and the Idaho Accelerator Center to develop and commercialize 67Cu for cancer treatment. Clearly this technology brings a new and valuable weapon to the fight in the diagnosis and treatment of various cancers. The market opportunity is equally clear. This top priority isotope is not produced in sufficient quantities to perform the critical research that will allow it to be introduced in the market. The IAC effort provides capacity for the necessary research and will lead to a regional means of providing this isotope at a competitive price.

The IAC, a research center of ISU, is working to commercialize 67Cu for use in medical therapy for diseases such as NHL (Non-Hodgkins Lymphoma), bladder and colorectal cancers. 67Cu production will utilize the IAC's equipment and capability in Linear Accelerators (LINACs) and research work in photo-nuclear reactions. Commercializing this technology will bring a needed radio-isotope to the market as well as be a potential additional industry in Idaho that plays off regional strength in designing and working with unique nuclear processes. Growth of medical isotope production will require specialized facilities including equipment to work with radioactive materials, accelerators, separation processes and analytical equipment and a trained, technical workforce.

Commercialization of medical isotope technology at the IAC would also promote economic development in the region and is a great opportunity for Idaho to get into a niche market that will eventually be essential in the medical industry. We support the IAC's effort to commercialize this technology.

Best Regards,

Mike Scott
Director, National Security & Special Programs
Premier Technology, Inc.

ON Semiconductor
2300 Buckskin Road
Pocatello, ID 83201
Phone: 208-234-6696

Dr. Douglas Wells

Idaho Accelerator Center

Dear Dr. Douglas Wells,

ON Semiconductor ***supports efforts by ISU and the IAC to develop and commercialize technology to produce radio-isotopes for medical and other uses. We believe that the IAC's commercialization efforts not only provide potential economic development in our region, but also develop ISU's strengths in applied technology and business requirements. These strengths will enhance collaboration with businesses such as ours in the future and enhance ISU's outreach to the private sector. We support these efforts at ISU and the IAC and encourage the local economic development.***

I wish you continued success and best wishes.

Sincerely,

John Spicer
Senior Director Operations and Pocatello Site Manager
ON Semiconductor
5/9/2011