International Seminar on Development of Radiochemistry and Medical Isotopes Institute for Nuclear Research Russian Academy of Sciences Dedicated to 70th Anniversary of Dr. Sci. Boris L. Zhuikov January 14, 2022

A Providential Partnership Between Institute for Nuclear Research and the DOE Isotope Program

Dr. Dennis R. Phillips

USA Department of Energy Isotope Program

Los Alamos National Laboratory

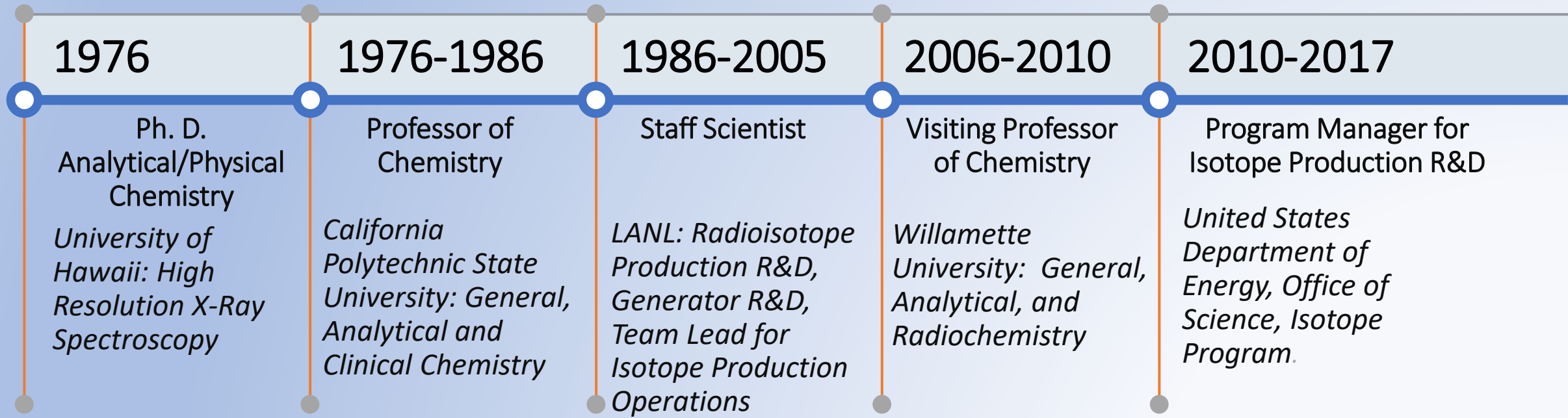
Провиденциальное партнерство между Институтом ядерных исследований и Изотопной программой Министерства энергетики США

Д-р Деннис Р. Филлипс

Изотопная программа Департамента энергетики США Лос-Аламосская национальная лаборатория

My Professional Background

Professor of Chemistry, Research Scientist, Research/Manager, Consultant



Collaboration Timeline

Collaboration Funding Timeline

*DOE/NNSA Initiatives for Proliferation Prevention IPP Grants**

1995

LANL-T1-024-RU
LANL-T2-0164-RU
Commercialize electrochemical Se-72/As-72 generator help develop production of Se-72 at INR

1996

LANL-T2-0193-RU

Develop Capability to produce Sr-82for use in the Cardiogen Sr-82/Rb-82 Generator using Rb metal targets Irradiated at INR

1997

LANL-T3 -0400-RU

Establish the technical and logistical capabilities to ship Rb metal targets irradiated at INR and process them at LANL to commercially supply Sr-82

1998

BNL-T2-0306-RU

Three way collaboration among BNL, LANL, and INR to develop co-production of Sr-82, Pd-103, and Ge-68; develop Pd-103 seed fabrication and a Sr-82/Rb-82 generator in Russia

1998 -

A successful and cordial technical and business collaboration between the DOE Isotope Program and the Institute for Nuclear Research

**US Corporate Sponsor for all grants was Technology Commercialization International (TCI), Albuquerque, New Mexico, USA*

Why Strontium-82

Radiochimica Acta **88,** 149-155 (2000).

Radiochim. Acta **88**, 149–155 (2000)

Production of strontium-82 for the Cardiogen® PET generator: a project of the Department of Energy Virtual Isotope Center†

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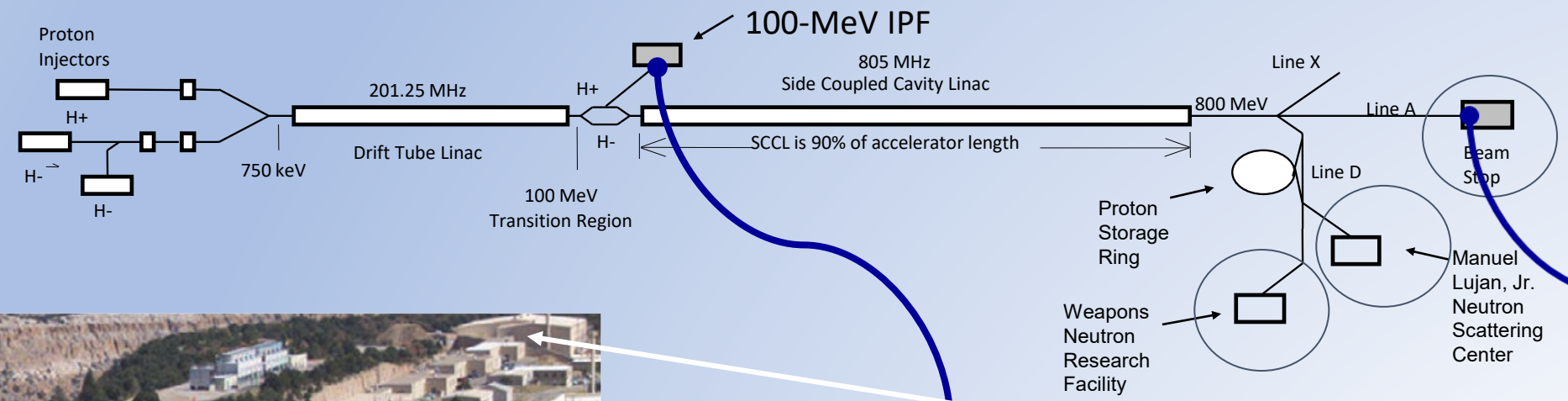
Strontium-82 / Rubidium-82 / Isotope production / PET / Generator / Cardiogen®

Summary. In December of 1989, the United States Food and Drug Administration approved ^{82}Rb chloride in saline solution for cardiological perfusion imaging by positron emission tomography (PET). The solution is derived from a ^{82}Sr generator system that is presently manufactured by Bristol Myers Squibb and distributed for clinical application in the United States by Bracco Diagnostics, Inc. Many years of research and development by people in several institutions led up to the approval for clinical use. Currently, there are about 15 sites in the U.S. that perform clinical myocardial perfusion imaging by PET using ^{82}Rb chloride from the generator. In order to manufacture the generators, Bristol Myers Squibb requires about 1600 mCi of ^{82}Sr every 30 days. The United States Department of Energy and MDS Nordion, Canada are the current suppliers with qualified Drug Master Files for the production and distribution of this nuclide for the Cardiogen® generator. These two entities have worked together over the years to assure the regular, reliable supply of the ^{82}Sr. Here we describe the facilities and methods used by the Department of Energy in its Virtual Isotope Center to make and distribute the nuclide.

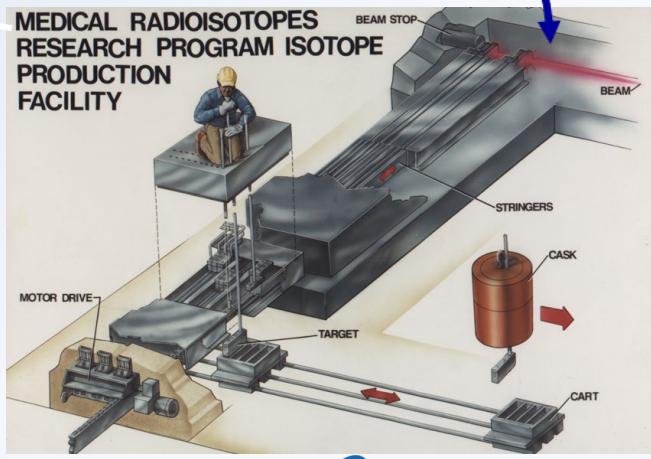
https://imaging.bracco.com/us-en/products/nuclear-medicine-radiopharmaceuticals/cardiogen-82

Exchange of Visits

LANL Irradiation Facilities—Past and Present



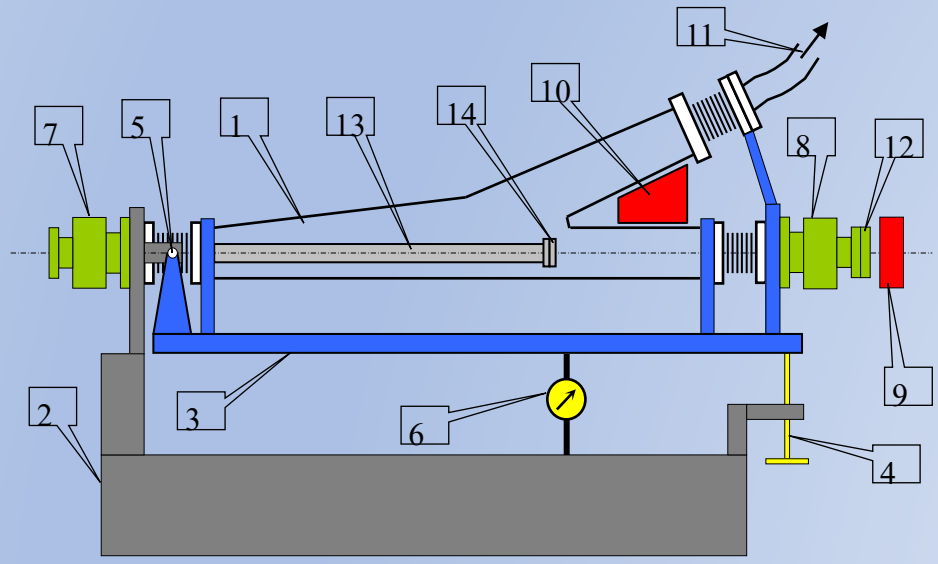
IPF at LANSCE

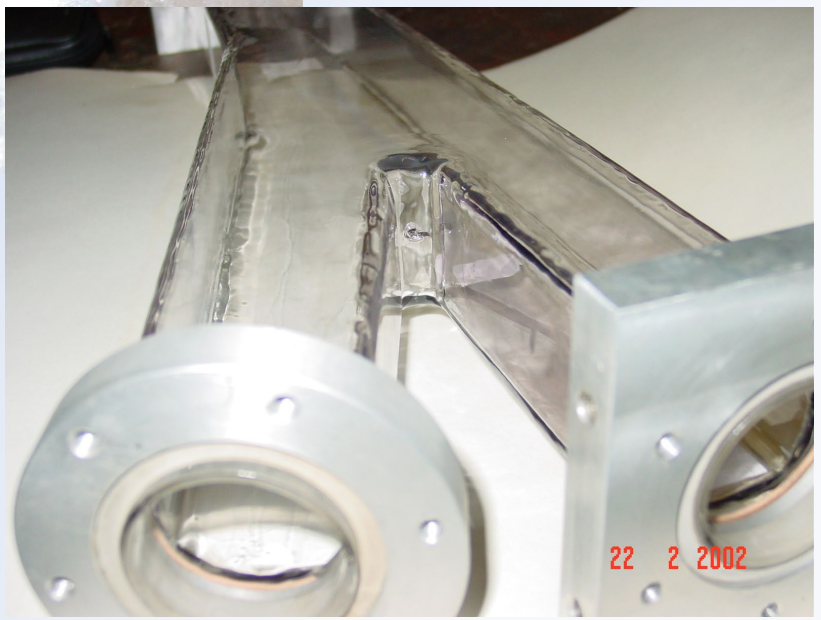


- Deflection of 100 MeV proton beam to target station
- Irradiates targets while LANSCE operates for NNSA/BES
- Commissioned in 2004.

Los Alamos NATIONAL LABORATORY EST.1943

IPF Beamline Development Experiment at INR



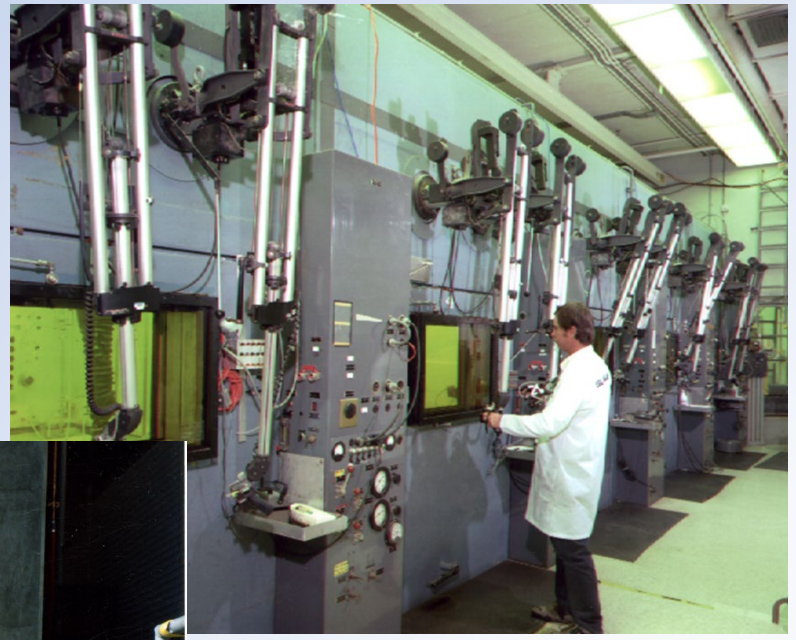


Y-tube experimental work performed by A.V.Feschenko, Yu.G.Kalinin, V.L.Serov, A.N.Mirzojan, A.N.Drugakov, Yu.V.Kisselev, S.K.Esin, E.S.Nikulin, Russian Academy of Sciences, Institute for Nuclear Research.

Several Visits to LANL by INR Team

1997

1995



Hot cells Circa 1987

Albuquerque Journal, April 30, 1997

ALBUQUERQUE JOURNAL
WEDNESDAY
April 30, 1997
North EDITION
WEATHERLINE FROM KVSF-AM 988-5151
SANTA FE • ESPAÑOLA • LOS ALAMOS • LAS VEGAS • TAOS

Chinese Food Pro Takes Wok On Wild Side
PAGE B1

Hoping for Surrender
Armored Carriers Join Barricade in Texas Standoff
PAGE A1

NEW MEXICO
Weather Delays Retrieval Of Pilot's Body Near Chama
PAGE C1

Russians, Lab Team Up For Nuke Project

Heart Disease, Black Market Targeted

BY IAN HOFFMAN
Journal Staff Writer

A plain-looking steel drum made its way through customs in Albuquerque on Tuesday, then traveled the final leg of its 7,010-mile journey by Aeroflot and cargo truck from Russia's Institute of Nuclear Research to Los Alamos National Laboratory.

Nestled at the core of the drum's more than 700 pounds of lead and steel shielding is a shiny, two-ounce ingot of rubidium and strontium — highly radioactive yet potentially full of promise for U.S. heart-disease patients and for Russian nuclear scientists.

It also could lead indirectly to new tools for U.S. physicians to diagnose and treat breast and prostate cancer, all using rare elements created at the end of a beam of protons at the Russian institute.

LANL chemists, operating mechanical arms by remote from behind 18 inches of leaded glass, will drill a hole in the ingot's candy bar-sized frame this morning and drain out the mercurial metal, beginning three intense days of chemical separation and purification. The result: a vial of roughly 10 drops of strontium chloride, containing 13 millionths of a gram of strontium-82.

The rare isotope decays to an even rarer rubidium-82. The rubidium's brief half-life of 68 seconds and ability to mimic nutrients used by the human heart let cardiologists peer into patients' hearts in three dimensions or by slices, using positron emission tomography.

The unstable rubidium nuclei, carried by saline into patients during the 30-sec-

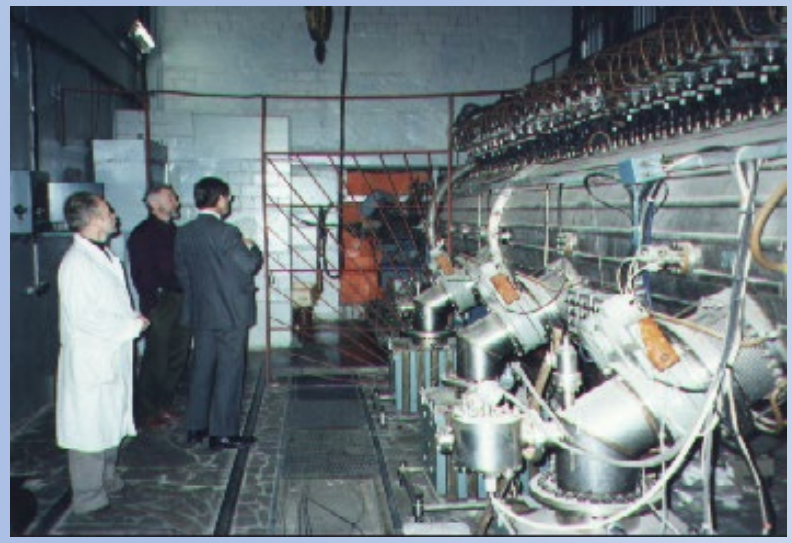
See RUSSIANS on PAGE 3

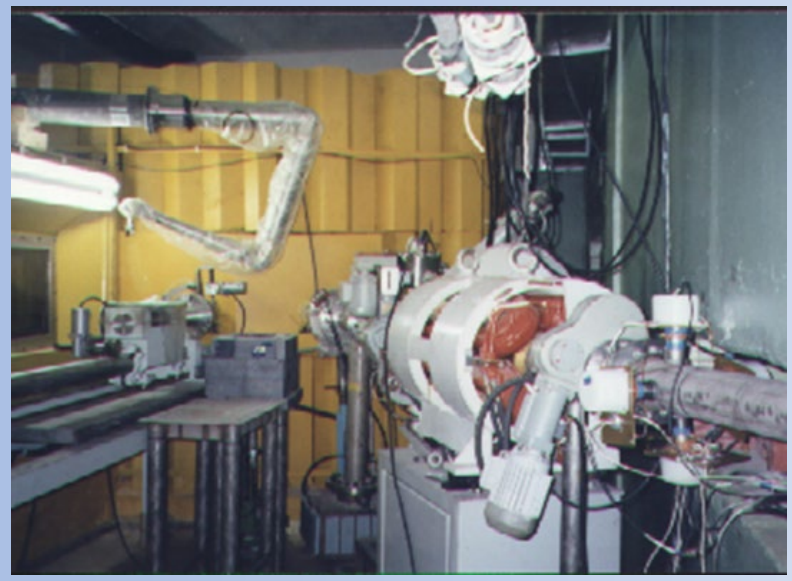
COURTESY OF LOS ALAMOS NATIONAL LABORATORY

HOT PROJECT: Dennis Phillips, a radiochemist at Los Alamos National Laboratory, practices chemical processing on a mock ingot of rubidium from the Institute of Nuclear Research in Troitsk, Russia. Chemist Boris Zhuikov, right, led a team of Russian scientists who have irradiated three such ingots with a proton beam in hopes of getting certified to supply strontium-82 for U.S. nuclear medicine.

Several Visits by INR Team to LANL

INR Irradiation Capabilities





- 600 MeV linear proton accelerator
- 100 microamp beam current
- Irradiation facility at 160 MeV segment for isotope production

Accomplishments

Essential Accomplishments
Sr-82 Supply

- 1998 (January 13): Squibb manufactures first CardioGen generators from Sr-82 produced by irradiations at INR; Money began to flow through TCI into the Institute per negotiated agreements
- 1998: Repeated each month from January through June
- Assured availability of Sr-82 for generators when no other approved source was operating
- In January 1998 began true commercial supply of Sr-82
- From 1998 through October 2003 $1233.4 K went to INR (accounted 30% of the Sr-82 supply for Cardiogen)
- INR ultimately shipped 150 Rb metal targets; the last one shipped in December, 2017

Successful IPP Projects per GAO Report 2007

Appendix IV: IPP Projects DOE Reported to Be Commercially Successful

Table 3 provides information on the 50 IPP projects DOE indicated as contributing to commercial successes in its *Fiscal Year 2005 IPP Program Annual Report*.

Table 3: DOE Projects Listed as Contributing to Commercial Successes in DOE's *Fiscal Year 2005 IPP Program Annual Report*

Project title	Project number(s)	U.S. companies	Lead DOE national laboratory	Lead foreign institute(s)
Nanophase Powders	LANL-T2-0148-RU LANL-T2-0190-RU	Argonide Corporation	Los Alamos	Institute of Petroleum Chemistry and Institute of Strength Physics and Materials Science, Russia
Ceramic Nanofibers	NREL-T2-0200-RU NREL-T2-0200a-RU	Argonide Corporation	National Renewable Energy	Institute of Strength Physics and Materials Science, and State Research Center of Virology and Biotechnology, Russia
Positron Emission Tomography	LANL-T2-0164-RU LANL-T2-0193-RU LANL-T3-0400-RU	Technology Commercialization International	Los Alamos	Institute of Nuclear Research, Russia
Positron Emission Tomography	BNL-T2-0306-RU	Technology Commercialization International	Brookhaven	Institute of Nuclear Research, Russia

Prototype Target Assembly Co-production Pd-103, Sr-82, Ge-68

- IPP funded R&D for co-production of Sr-82, Pd-103, and Ge-68 as development of a Sr-82/Rb-82 generator production in Russia This work continued for several years after 2003 under on-going IPP awards for collaborations among INR, LANL, and BNL .
- INR shipped four gallium targets and three silver targets to LANL

Photo Montage

Boris and Friends in New Mexico

Boris/Elena At Albuquerque Dukes (1997)

(In 2003, the team name was changed to the “Isotopes”--https://en.wikipedia.org/wiki/Albuquerque_Isotopes)

A Birthday Party 27 Years Ago

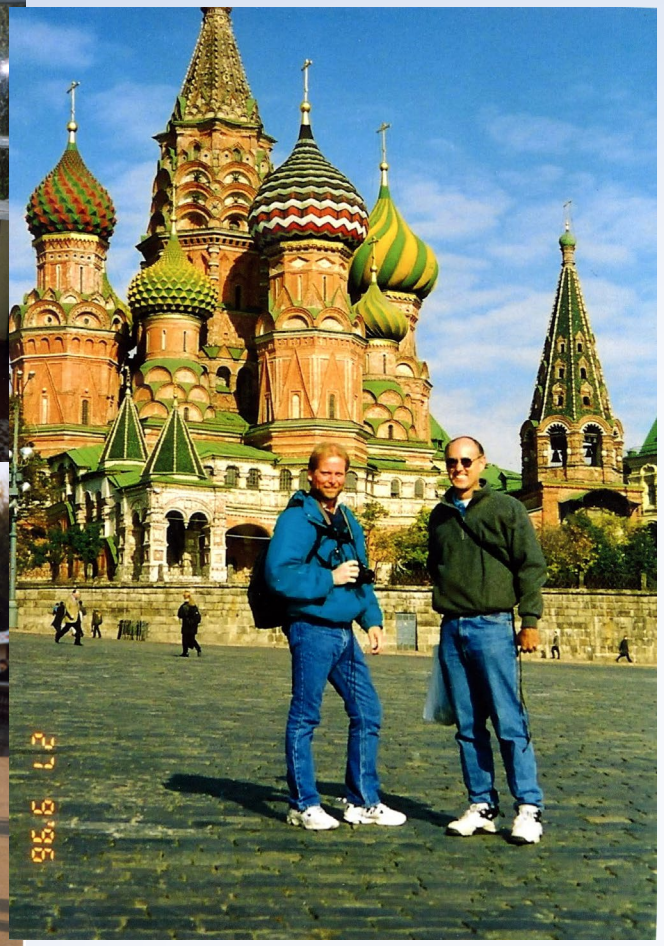
Boris Zhuikov

Nikolai Konyakhin

Vladimir Kokahnyuk

International Conferences

Moscow 1995-1997



LANL Radioisotope Team--2003

Conclusion

- The collaboration was a great success
- Accomplished the goal of the NNSA IPP Program to promote commercialization of some activities in the Nuclear Science Laboratory systems of the Former Soviet Union
- Significantly benefitted both INR and DOE
- And above all for me it was a great pleasure professionally and personally to know Dr. Boris Zhuikov. He is truly my friend
- I believe this collaboration was very providential

PROVIDENTIAL: ”Happening as if through divine purpose.”

Thank You

Большое спасибо