

The Western Nuclear Science Alliance

Authors: Stephen E. Binney, Wade J. Richards, Walter D. Loveland, Steven R. Reese, Kathryn A. Higley, James T. Elliston, Sue B. Clark, Edward C. Morse, John Bennion

Oregon State University/University of California Davis/Oregon State University/
Oregon State University/Oregon State University/Washington State
University/Washington State University/University of California Berkeley/Idaho
State University

Introduction

The Western Nuclear Science Alliance (WNSA) came into existence in September 2002 when Oregon State University (OSU) as the lead institution teamed with University of California Davis (UCD) and other organizations to receive one of the four five-year awards under DOE's Innovations in Nuclear Infrastructure and Education (INIE) program. The objective of these INIE awards was "to strengthen U.S. university nuclear engineering education programs through innovative use of the university research and training reactors and encouraging strategic partnerships between the universities, the DOE national laboratories, and U.S. industry." The method whereby WNSA addresses this objective is discussed below.

Structure of WNSA

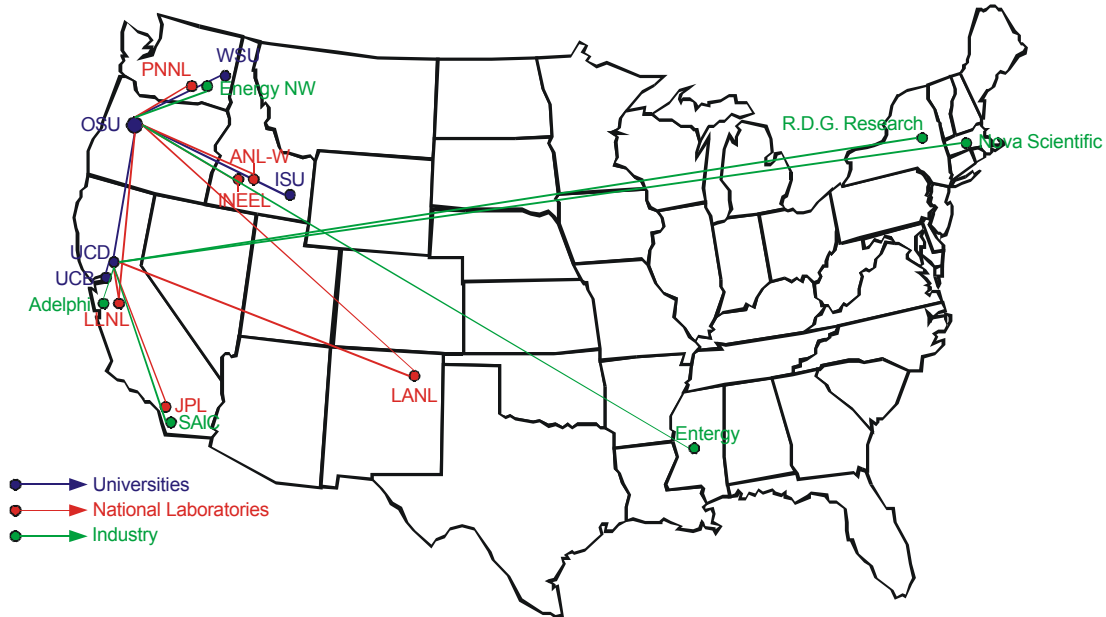
WNSA is initially composed of five western universities (OSU, UCD, Washington State University (WSU), University of California Berkeley (UCB), and Idaho State University (ISU)). Together these universities operate four research reactors and have three nuclear engineering programs and two radiochemistry programs. In addition, six western national Department of Energy and NASA laboratories (Argonne National Laboratory-West, Idaho National Engineering and Environmental Laboratory, Jet Propulsion Laboratory, Lawrence Livermore National Laboratory, Los Alamos National Laboratory, and Pacific Northwest National Laboratory), and several nuclear industrial organizations from around the country (Adelphi Technology, Energy Northwest, Entergy, Nova Scientific, and SAIC) are initial members of WNSA (see Figure 1).

WNSA program progress is monitored by a Management Council. The Management Council is responsible for providing management and decision-making capabilities for WNSA, coordinating all activities of WNSA, including the preparation of annual reports and renewal proposals, and providing vision for expansion of programs under WNSA.

The Management Council is composed of six members, including the Chair, with an equal number from OSU and UCD. The Management Council is initially chaired by an OSU member with the Chair alternating between OSU and UCD each September. A Vice-Chair of the Management Council is selected from the other university. Replacement of Management Council members is at the discretion of the Management Council membership. Members may serve

consecutive terms. The Chair and Vice-Chair are chosen by the members of the Management Council.

Each WNSA partner (in all three categories—university, national laboratory, and industry) has one member on the WNSA Advisory Committee. The Advisory Committee’s purpose is to provide advice and expert opinion on WNSA matters to the Management Council. The Advisory Committee is authorized to report separately and directly to USDOE about the significance and



performance of WNSA. Additional organizational members may be admitted to WNSA at the discretion of the Management Council in consultation with the Advisory Committee.

Figure 1. WNSA member organizations

Funding of WNSA

Because of limited funds in the INIE program, first year funding for WNSA programs was reduced from that requested in the proposal. The first year grant for WNSA was \$1.30 million, which covered only 77% of the proposed scope of work. Three smaller subawards went to WSU, UCB, and ISU, with the remainder roughly split evenly between OSU and UCD.

WNSA Programs

Several programs, involving real-time neutron radiography (OSU), neutron microscopy (UCD), production of radioisotopes (OSU), and pre-college training (OSU), were postponed to the second year of the grant because of incomplete first year funding.

Major first year programs under WNSA fall into four categories: research, infrastructure improvements, educational, and outreach. These programs are distributed among the WNSA universities and include some level of cooperation and collaboration between the various universities and with the national laboratories and industry. Details of the first year WNSA funded programs are included below.

Neutron computed tomography (UCD)

The UCD McClellan Nuclear Radiation Center (MNRC) neutron tomography system has been in operation for the last eight years. The system has been used to find low levels of hydrogen in aircraft engine inspections of titanium compressor blades, high pressure valves looking for correct "O-ring" placement, and geology specimens (see Figure 2).

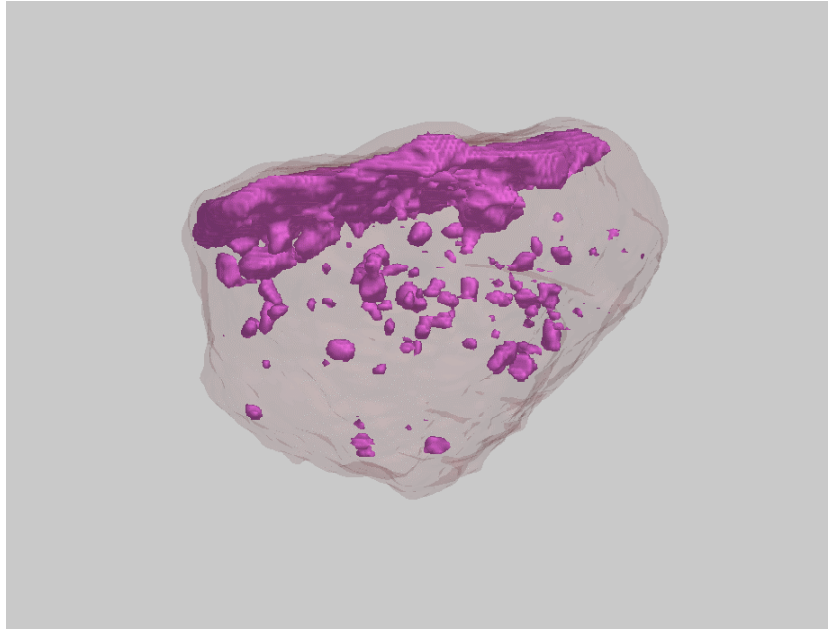


Figure 2. Astrobiology and the search for early life: Endolithic Bacteria

The present system consists of an object turntable, a scintillator screen, a mirror, a cooled CCD camera, and computer support. The neutron source is the 2 MW research reactor. The neutron beam is approximately 35 cm in diameter at the screen, resulting in a radiographic L/D of 140. The object turntable is approximately 10 cm in front of the scintillator screen. The photons generated in the screen are reflected from the mirror and then pass through a 50 mm lens into the CCD camera. The CCD camera consists of a rectangular array of 1024 x 1024 pixels (24 μm x 24 μm). The image data are collected in a 16-bit format. Image acquisition and reconstruction is controlled with two workstations. One provides control to the CCD camera and sample turntable as well as image data capture functions; the other provides tomographic reconstruction and image analysis.

The WNSA program will allow the tomography system to be upgraded. A new CCD camera with an array of 3028 x 2048 pixels and 9 μm pixels will allow a resolution of approximately 50 μm as compared to the present 250 μm . Also new faster computers are being purchased to handle the larger image files. These computers will also allow 32-bit reconstructions.

Nuclear analytical techniques (OSU)

As intended, WNSA funding will greatly increase the irradiation capabilities of the Oregon State TRIGA[®] Reactor (OSTR). Most notably, funding will be dedicated toward revitalization of inactive irradiation facilities. This will allow the OSTR to expand without interfering with already well-utilized facilities.

The OSTR is a General Atomics TRIGA[®] Mark II pool-type research reactor. It is licensed by the U. S. Nuclear Regulatory Commission to operate at a maximum steady state power of 1.1 MW and can also be pulsed up to a peak power of approximately 2500 MW over 8 ms. The OSTR has a number of irradiation facilities providing a wide range of neutron flux levels and qualities which are sufficient to meet the needs of most researchers. However, in recent years the four available beam ports have been underutilized. To correct this, investments in beam port facility improvements are a high priority for reactor-related WNSA funding.

The OSTR facility has four beam ports which permit controlled emission of both photon and neutron radiation from regions near the core. Beam Port #4 is dedicated to production of highly purified argon-41. Beam Port #3 is configured to stream radiation tangentially from the reflector region around the core. Proof of concept testing indicates that the level and quality of the Beam Port #3 neutron flux is sufficient for neutron radiography examination of neutronically thin targets or long duration target exposures.

Beam Ports #1 and #2 are configured such that radiation streams directly from the core as opposed to the Beam Port #3 tangential orientation. As a result achievable flux levels in these ports will be at least an order of magnitude higher than the level attained in Beam Port #3. Ultimately it is hoped that both Beam Ports #1 and #2 will be available for real-time radiography studies.

Real-time neutron radiography using the OSTR will be used to measure and characterize multi-phase flow in high-pressure systems. This is important in power plants where it is necessary to understand the thermal hydraulic behavior of steam and water in a mixed phase system. The higher flux will also allow shorter exposure times with thicker targets.

The beam hall that will house the radiography facility using Beam Port #3 has been designed. Fabrication and erection of the facility should take place by this June. Additionally, the collimator and shutter system will be fabricated and placed in the beam port shortly after construction of the beam hall has been completed. Other equipment purchases (i.e., crane control upgrades, facility power modifications, reactor control modifications, etc.) will take up the remainder of the funds budgeted for reactor equipment this fiscal year. Construction of irradiation facilities for Beam Ports #1 and #2 is planned over the next three years.

WNSA funds will also be used to upgrade and refurbish nuclear instrumentation used in undergraduate and graduate teaching laboratories at the OSU Radiation Center. To facilitate this process, Nuclear Engineering and Radiation Health Physics, Chemistry, and Radiation Center staff have reviewed the operational status of existing equipment and discussed equipment requirements for new course offerings planned for future years. What students need to learn at the undergraduate and graduate levels with regard to nuclear equipment design and function was taken into consideration. Nuclear equipment vendors were invited to present bids on replacement

and upgrade equipment. Bid packages are currently being reviewed with plans to purchase equipment for use in the spring quarter.

Nuclear engineering/health physics education (OSU)

The OSU Department of Nuclear Engineering and Radiation Health Physics typically offers 17 undergraduate and 18 to 20 graduate courses over the three academic quarters each year (typically 10 of these courses are cross-listed as undergraduate/graduate). Under WNSA this course offering will be expanded by extending graduate level courses in these two majors to off-site locations. The first sites will be set up for personnel from WNSA national laboratory and industry members. To the extent possible on-campus and off-site courses will be taught concurrently.

The goal when in "steady state" in the second year of the WNSA grant will be to offer one Nuclear Engineering and one Radiation Health Physics graduate level course each quarter to off-campus students.

Current year one efforts have been centered around equipping the main OSU Radiation Center classroom with distance education technology and with establishing the administrative aspects of the program.

Nuclear engineering education (UCB)

As a part of the activity supported by the WNSA, a field trip to the MNRC was arranged for UCB Nuclear Instrumentation Laboratory students. The twelve students who participated included nine seniors and three graduate students. For most of the students this was their first opportunity to see a real reactor. The reactor tour included a demonstration of a reactivity pulse and Cerenkov radiation and an explanation of negative temperature coefficients of reactivity. The tour also included an overview of some of the applications of the reactor, including neutron radiography of the wing joints for F-22 Raptor aircraft and a production facility for iodine-125.

The students performed an experiment involving irradiation of a set of samples and gamma ray analysis of the activation products. This experiment was performed twice during the day, with half of the group in the control room and the other half involved with the sample handling near the reactor. The control-room demonstration also included a rod-drop experiment to determine reactivity worth of a control rod. The field trip was successful from an educational standpoint as well as a useful tool for recruiting and retention of undergraduate and graduate students in nuclear engineering.

Nuclear engineering education (ISU)

ISU will provide undergraduate- and graduate-level distance-learning opportunities and degree programs to place-bound national laboratory employees in the areas of radiation transport, reactor physics, criticality safety, thermal hydraulics, nuclear waste treatment, radiological engineering, and health physics. Multiple technologies allow ISU to host an active distance-learning program to provide high-quality educational programs statewide.

Research and training opportunities for ISU graduate students and faculty will be provided on

WNSA reactor facilities to augment on-campus facilities. This will expand and enhance the students' educational experience and promote collaborations between participating institutions. In addition, ISU students and faculty will use Energy Northwest's Columbia Generating Station to train students in nuclear power plant construction and operations by touring the facility and using the plant's reactor simulator.

Radiochemistry education (OSU)

One of the most critical national needs for trained personnel is in the area of radiochemistry. There is an imbalance of a factor of ten between demand and supply with the promise/threat of increasing demand to replace retiring radiochemists at the national laboratories in the next five years. Through the WNSA program OSU has embarked on an effort to re-vitalize radiochemistry education and research in response to this demand. OSU will continue to provide graduate education in radiochemistry (as has been done since the late 1940s) and is launching a new initiative with the national laboratories to allow them to "grow their own" graduate level radiochemists from their present employees. The long-term plan for graduate radiochemistry instruction will focus on providing on-site instruction along with web-based/distance education programs for students at national laboratories and in the nuclear industry.

This effort has begun by adding a new multidisciplinary (two college, four department) radiochemistry class to be offered for the first time in Spring 2003. A Research Assistant Professor of Radiochemistry is being hired to assist in teaching this class and to carry out the development of OSU's "outreach curriculum" in radiochemistry. He/she will be expected to initiate and maintain a radiochemistry research program as well. New radiochemistry instrumentation is being purchased to replace aging equipment along with the development of new radiochemical separation capabilities.

Radiochemistry education (WSU)

WSU plans to provide summer training opportunities in radiochemistry for five regional university faculty members and five regional high school teachers each year of the INIE grant. The WSU Nuclear Radiation Center houses a 1 MW TRIGA III research reactor as a neutron source, radiochemistry laboratories where work with tracers can be done, and counting laboratories for radiometric measurements.

The goals of WSU's efforts are (1) to educate regional college science faculty on applications of neutrons to enhance their own research and educational activities at their home institutions and (2) to provide the college faculty and high school science teachers with training materials in the nuclear sciences that they can use in their courses and classrooms at their home institutions. Success for the WSU program will be determined by the numbers of regional college faculty and high school teachers who complete the summer experiences, their subsequent usage of training materials, an increase in the number of non-WSU users of the WSU reactor facilities in either research or training, and an increase in the numbers of undergraduate and graduate students interested in pursuing educational opportunities in WSU's nuclear science programs.

Initially, the focus for the training opportunities will be on neutron activation analysis for trace element determination, environmental radiochemistry and natural radioactivity, radiochemical separations in radioanalytical chemistry and radioactive waste management, radiopharmaceuticals

and nuclear medicine, and applications of radiotracers in biological and environmental research and technology. Applications for participants for the first summer experience, which will be offered during the 2003 summer session, are currently being requested.

Minority scholarships (OSU)

To increase the number of minority students in the academic majors of Nuclear Engineering (NE) and Radiation Health Physics (RHP) and, in turn, to increase the number of minority graduates entering these technical disciplines, OSU under WNSA has begun a Nuclear Science and Engineering (NSE) minority scholarship program for undergraduate students majoring in NE or RHP. The program is administered through the OSU Native Americans in Marine and Space Sciences program. To be eligible for selection and retention of a scholarship, the student must (1) be enrolled in the NE or RHP major at OSU, (2) be enrolled in NE and/or RHP course(s) each quarter, (3) be making satisfactory progress toward a B.S. in NE or RHP, and (4) have minority status, as defined by OSU. Scholarship awards increase as the student progresses through the NE or RHP program. A maximum of \$14,000 may be received by any individual under the NSE program. In addition to the NSE scholarship, students will be assisted in securing summer internship appointments in the nuclear field.

Minority scholarships (UCD)

At UCD undergraduates, graduate students, and faculty will be engaged in the use of neutrons for scientific studies and engineering applications to create opportunities for science, learning, and exploration for underrepresented groups.

Conclusions

All of the contracts and subcontracts involved were not finalized until one to three months after the official start of the WNSA grant. At the time of this writing (January 2003) most of the WNSA programs are just getting under way. By the end of the first year all of the programs will have begun and some will be fully functional.

The WNSA program is energetic and innovative with the promise of further strengthening already strong nuclear science and engineering programs in western universities. New educational opportunities, from pre-college to graduate level, are being pursued both within and external to the universities. New university research reactor and nuclear laboratory infrastructure improvements will lead to advanced state-of-the-art research and new collaborations with national laboratories and industry.

Acknowledgments

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Biographical Information

STEPHEN E. BINNEY is Professor Emeritus of Nuclear Engineering and Radiation Health Physics and Director Emeritus of the Radiation Center at Oregon State University. He is also the Administrator of the Western Nuclear Science Alliance.

WADE J. RICHARDS is Director of the McClellan Nuclear Radiation Center at University of California Davis.

WALTER D. LOVELAND is Professor of Chemistry at Oregon State University.

STEVEN R. REESE is Reactor Administrator of the Oregon State University TRIGA Reactor.

KATHRYN A. HIGLEY is Associate Professor of Nuclear Engineering and Radiation Health Physics at Oregon State University.

JAMES T. ELLISTON is Project Associate at the Washington State University Nuclear Radiation Center.

SUE B. CLARK is Professor of Chemistry at Washington State University.

EDWARD C. MORSE is Professor of Nuclear Engineering at University of California Berkeley.

JOHN BENNION, is Associate Profession of Nuclear and Mechanical Engineering at Idaho State University.