

Radiochemistry Research at the University of Nevada, Las Vegas: Towards a Center of Excellence

**Professors: Patricia Paviet-Hartmann, Ralf Sudowe, Gary
Cerefice, Kenneth R. Czerwinski**

**Research Professors: Thomas Hartmann, Frederic Poineau,
Phil Weck**

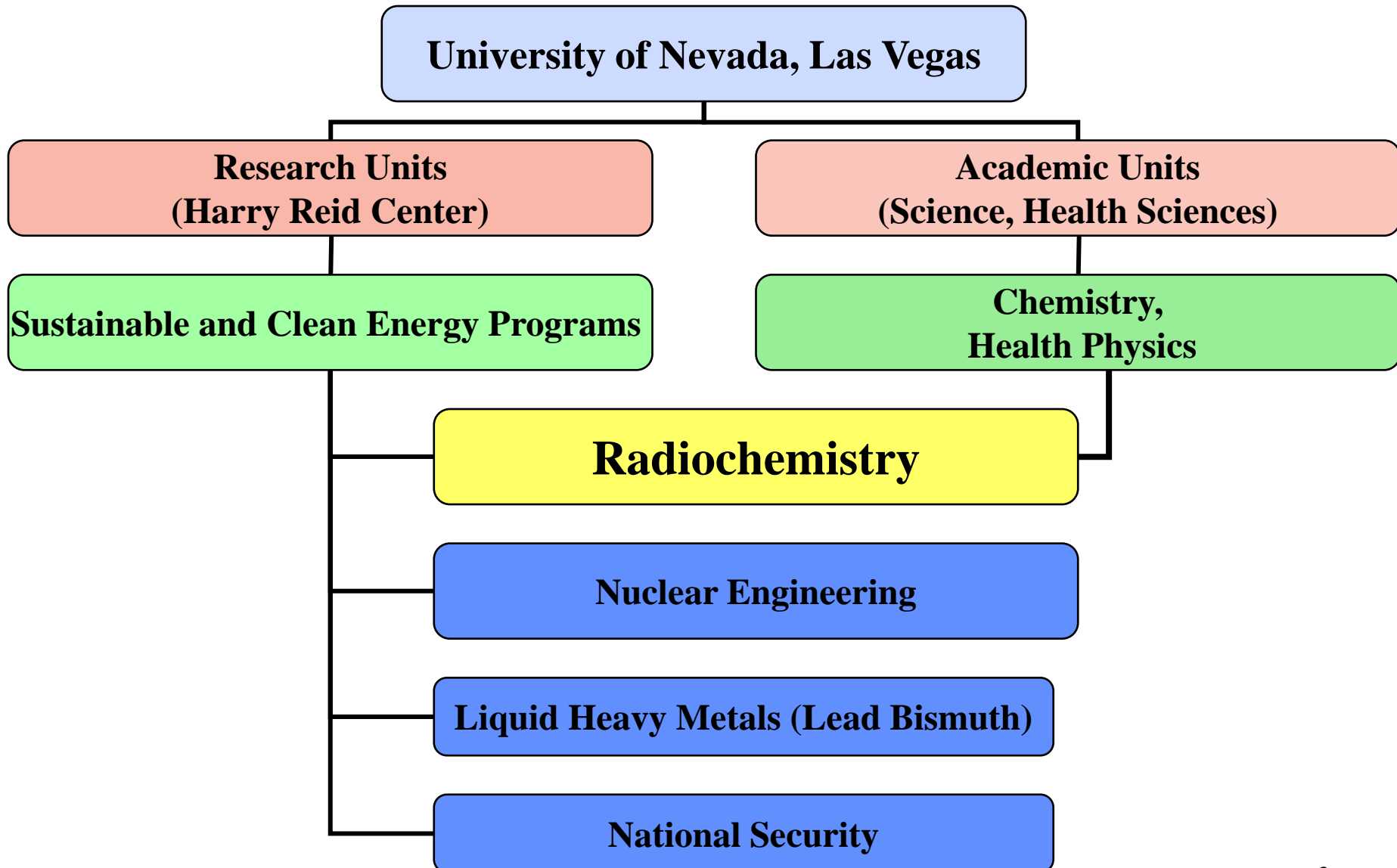
**Radiochemistry Program, University of Nevada Las Vegas,
Las Vegas, NV 89154**



Outline

- **Radiochemistry in UNLV**
 - **Research and academic activities**
- **Research Team**
 - **Professors, Post-doctoral researchers, students, outside collaborators**
- **Program Concepts**
 - **Basic to applied research**
- **Experimental Facilities**
- **Funding and Publications**
- **Research**
 - **Environmental**
 - **Separations**
 - **proposed**
 - **Discussed with DOE-EM 1 June 2009**

Organization



UNLV Research Team

- **Radiochemistry Faculty**
 - **Ken Czerwinski (Chemistry), Ralf Sudowe (Health Physics), Patricia Paviet Hartmann (Chemistry)**
- **Associate Faculty**
 - **David Hatchett (Chemistry): Electrochemistry**
 - **Paul Forster (Chemistry): Inorganic synthesis**
- **Research Professors**
 - **Thomas Hartmann (Solid phase analysis), Frederic Poineau (Tc chemistry), Phil Weck (Computational), Gary Cerefice (Waste Forms)**
- **Post-Doctoral Researcher**
 - **Dan Rego (Synthesis)**
 - **Chinthaka Silva (Synthesis)**
- **Graduate Students**
 - **20 graduate students**



US DOE Collaborators

- **Nevada Site Office (Nevada Test Site, NSTec, Special Technologies Laboratory)**
 - **Environmental Pu chemistry and Nuclear Forensics**
- **Argonne National Laboratory (Alfred Sattelberger, Associate Laboratory Director)**
 - **Tc coordination chemistry, GNEP actinide nitride synthesis**
- **Los Alamos National Laboratory (Gordon Jarvinen, Kurt Sickafus)**
 - **GNEP Fuel Cycle Separations and Waste Forms**
 - **Tc and actinide oxide material synthesis and irradiation**
- **Oak Ridge National Laboratory (Robert Jubin)**
 - **GNEP CETE (complete-end-to-end) demonstration,**
 - Tc separation and waste form
 - Characterization of undissolved solids



US DOE Collaborators

- **Idaho National Laboratory (Jack Law, Rory Kennedy)**
 - **AFCI separations and Inert Fuels**
- **Pacific Northwest National Laboratory (Edgar Buck, Herman Cho, Sam Bryan)**
 - **Microscopy of tank waste solids and Tc waste forms**
 - **NMR of Tc**
 - **Actinide separations and spectroscopy**
- **Lawrence Berkeley National Laboratory (Wayne Lukens)**
 - **Characterization of Tc compounds**
- **Livermore National Laboratory**
 - **Novel actinide fuels and separations**
 - **Nuclear forensics**
- **Use of synchrotron and neutron diffraction facilities at Argonne, Berkeley, Los Alamos, Stanford, and Brookhaven**



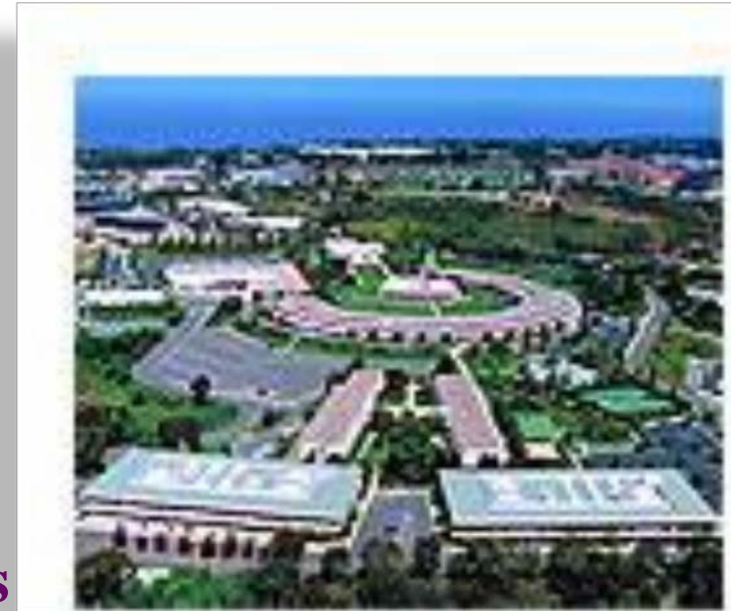
Visiting Students

- **Massachusetts Institute of Technology**
 - **Interaction of bacteria with actinides (Ph.D. thesis)**
- **University of California, Berkeley**
 - **Fluorination reactions of uranium dioxide (Ph.D. thesis)**
- **University of California, Santa Barbara**
 - **Tc oxide synthesis and characterization (Ph.D. thesis)**
- **ENSCP**
 - **Multiple student projects on the nuclear fuel cycle (5 students at UNLV)**
- **CIEMAT**
 - **Tc separations**
- **Other university collaborations**
 - **Cambridge University, University of Florida, Boise State University, Oregon State University, Idaho State University, University of Idaho, University New Mexico, Georgia Tech, University of Iowa, University of Nantes, Universite de Savoie, Oxford University**



Industrial Collaborations

- **AREVA**
 - Nuclear fuel cycle
- **TerraPower**
 - Nuclear fuel and materials
 - <http://seekingalpha.com/article/149043-bill-gates-speaks-on-physics-terrapower-and-google-chrome>
- **Canberra and ORTEC**
 - Detector courses
- **Varian**
 - Nuclear material detection
- **Creare**
 - Portable mass spectroscopy for nuclear forensics
- **General Atomics**
 - Fuel cycle and advanced reactors



Researchers September 2009



Research Program Concepts

- **Research areas**
 - **Radiochemical materials synthesis and characterization**
 - **Fuel cycle separations**
 - **Radioanalytical separations**
- **Chemistry based analysis of actinides and technetium**
 - **Interested in chemical species and coordination**
- **Research with radionuclides**
 - **Kg quantity of Th and U**
 - **Gram amount of Tc, Np, Pu**
 - **Milligram quantity of Am and Cm**
- **Research coupled with education program**
 - **Provide undergraduate and graduate students with actinide research opportunities**
- **Develop a center of excellence in radiochemistry**
 - **Noted researcher, strong collaborations**



DOE Separations Research

Discovery Research

Use-inspired Basic Research

Applied Research

Technology Maturation & Deployment

- Molecular f-element chemistry: structure and bonding
- Response of molecules or ensembles of molecules to harsh environments
- Mesoscale phenomena in multiphase systems
- Chemistry and speciation in new media
- Approaches to deconvoluting physical behavior in complex systems (semi-ordered, non-ordered)
- Controlling An and FP chemistry
- Creating selective receptor systems
- Developing real-time sensing mechanisms
- Controlling behavior of micellar systems

Office of Science
BES

Goal: new knowledge/understanding
Mandate: open ended
Focus: phenomena
Metric: knowledge generation

- Modifying separation materials for durability in harsh environments
- Prototype sensors
- Demonstrating new separation systems at bench scale
- Incorporating fundamental data to improve process models (AMUSE++)

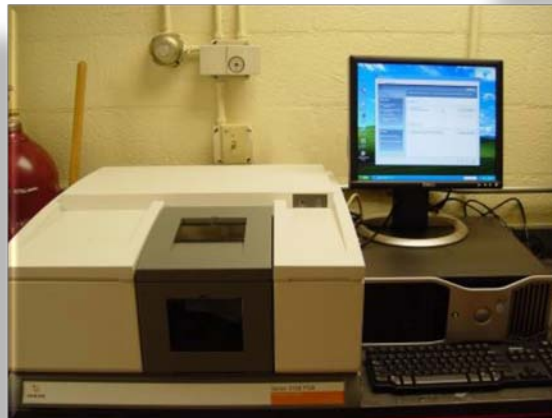
Applied Energy Offices
EERE, NE, FE, TD, EM, RW, ...

Goal: practical targets
Mandate: restricted to target
Focus: performance
Metric: milestone achievement

- Codevelopment
- Scale-up research
- At-scale demonstration
- Cost reduction
- Prototyping
- Manufacturing R&D
- Deployment support

Experimental Facilities

- **Spectroscopy**
 - **XAFS, UV-Visible, Laser, NMR, IR, EELS**
- **Radiochemical separation and detection**
 - **Gross alpha/beta counting**
 - **α -spectroscopy**
 - **γ -spectroscopy**
 - **Scintillation Counting**
- **Thermal methods**
 - **TGA, DSC**



Experimental Facilities

- **Scattering**
 - **Powder XRD**
 - **Single crystal XRD**
- **Analytical**
 - **ICP-AES, ICP-MS, Electrospray-MS**
→ Includes laser ablation
- **Microscopy**
 - **SEM, TEM**



Modern research facilities at UNLV

- 6 laboratories and counting room
 - Can work with macro amounts of radionuclides
- Adding four more laboratories
 - 3 Low level
 - Instrumental



Funding

- **US-DOE Nuclear Energy**
- **US-DOE Basic Energy Science**
- **US-DOE Environmental Management**
- **National Nuclear Security Agency**
- **Department of Homeland Security**
- **Nuclear Regulatory Commission**
- **Defense Advanced Research Projects Agency**
- **Industrial**
 - **AREVA**
 - **TerraPower**



2008 Publications

- **Preparation of the Binary Technetium Bromides: TcBr_3 and TcBr_4 , *Journal of the American Chemical Society***
- **Preparation of technetium metal by thermal treatment under Argon/ H_2O , *Journal of Radioanalytical and Nuclear Chemistry***
- **Investigation of Nanostructure and Thermal Behavior of Zinc-Substituted Fluorapatite. *Inorganic Chemistry***
- **Reduction of pertechnetate by acetohydroxamic acid: Formation of $[\text{TcNO}(\text{AHA})_2(\text{H}_2\text{O})]^+$ and implications for the UREX process. *Inorganic Chemistry***
- **Preparation and Crystal Structures of Bismuth Technetates: A New Metal Oxide System, *Inorganic Chemistry***
- **Microscopic Characterization of Uranium Nitrides Synthesized by Oxidative Ammonolysis of Uranium Tetrafluoride, *Chemistry of Materials***
- **XAFS spectroscopic study of $\text{Tc}_2(\text{O}_2\text{CCH}_3)_4\text{X}_2$ ($\text{X} = \text{Cl}, \text{Br}$), *Journal of Coordination Chemistry***
- **Octachloro- and Octabromoditechnetate(III) and Their Rhenium(III) Congeners. *Inorganic Chemistry***
- **Oxidative Ammonolysis of Uranium(IV) Fluorides to Uranium(VI) Nitride, *Journal of Nuclear Materials***