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Synchrotron Studies for Nuclear Security

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For over 25 years, Los Alamos National Laboratory has been using synchrotron-produced x-rays at Stanford Synchrotron Radiation Lightsource (SSRL) in support of nuclear security research. Currently, electronic structure studies in the Tender X-ray region are giving insights on closing the nuclear fuel cycle, and hard x-ray micro-spectroscopy on single particles is of growing interest for nuclear forensics and environmental science applications. Over the last decade, x-ray absorption spectroscopy studies helped guide cleanup decisions of contaminated Superfund Sites; and helped table plans for a new US nuclear weapon's production facility. I will give highlights of these studies and offer my perspective on future opportunities for synchrotron x-ray spectroscopy to contribute new science in support of nuclear security.

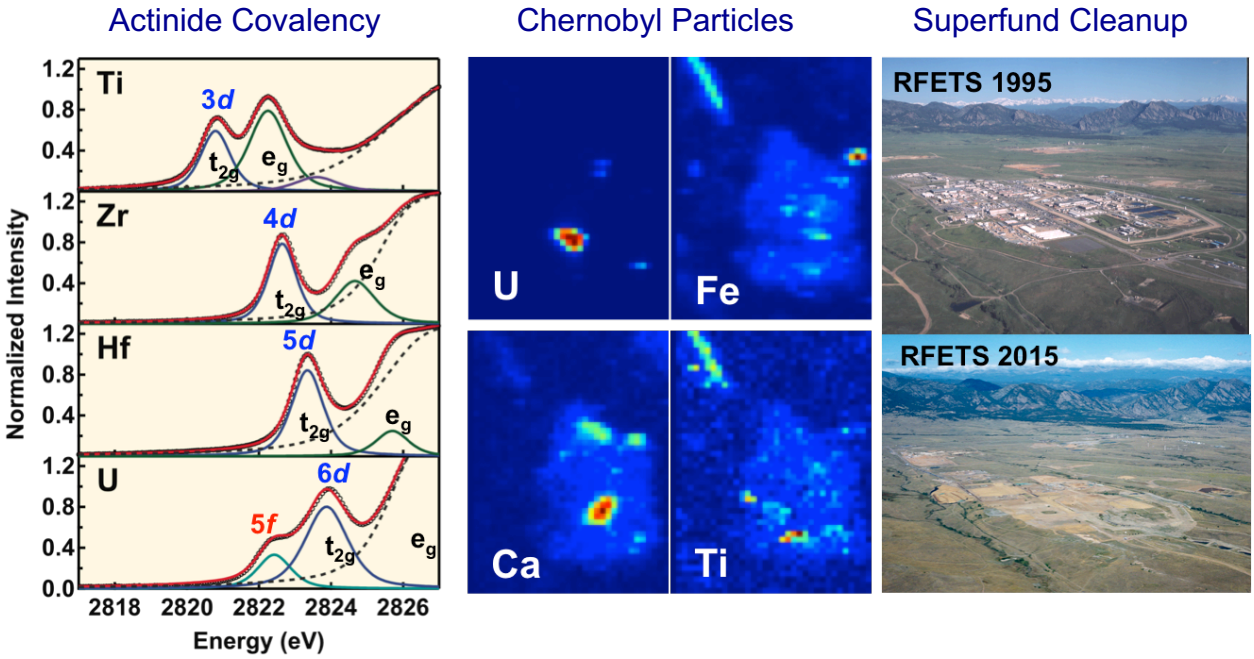

Figure. (Left), Chlorine K-edge x-ray absorption spectroscopy has been used to probe covalent mixing in the metal-ligand bond of octahedral MCl_6^{2-} complexes, providing spectroscopic evidence for involvement of both 5f and 6d orbitals in actinide metal-ligand bonds. (Center), Microfocused x-ray beams can image small particles through the use of element specific x-ray fluorescence, giving rise to element maps that show the concentrations of contaminants, (Right) Aerial photos of the Rocky Flats nuclear weapons production facility in 1995 and after remediation and cleanup, guided by x-ray absorption studies of plutonium in soil, groundwater and concrete.