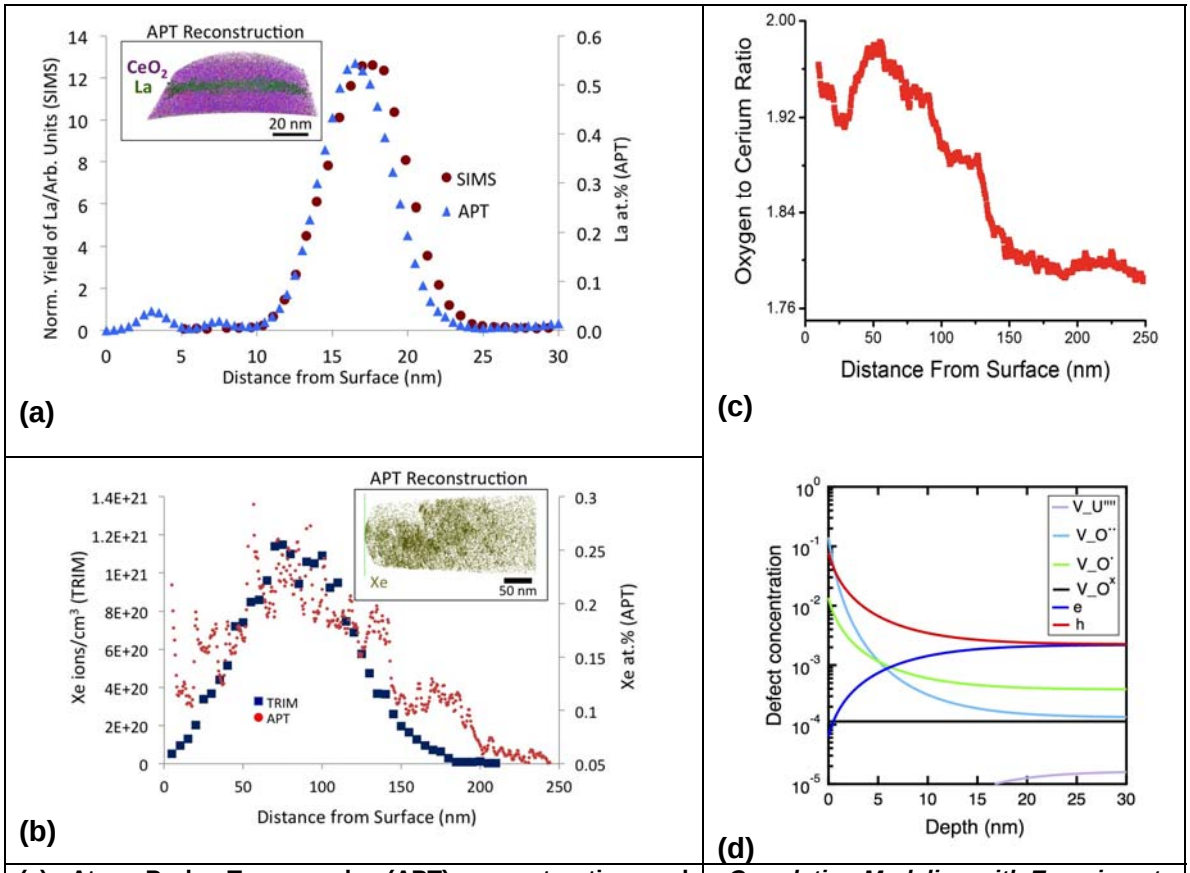
Highlight: Atom Probe Analysis of Nanoscale Processes in Nuclear Fuel



(a): Atom Probe Tomography (APT) reconstruction and corresponding La concentration profile of a La-doped CeO_2 single crystal as measured by APT and Secondary Ion Mass Spectroscopy (SIMS). (b): APT measurement and Transport of Ions in Matter (TRIM) prediction of Xe implantation profile in Xe-doped CeO_2.

Correlating Modeling with Experiment
(c): Stoichiometry variation away from surface in CeO_2 as measured by APT and the corresponding (d): phase field prediction of defect concentration from a free surface in UO_2.

Researchers **Michele Manuel** (PI), **Hunter Henderson** (Ph.D. student), and **Billy Valderrama** (Ph.D. student) have been employing Atom Probe Tomography (APT) to improve the understanding of microstructural processes in irradiated nuclear fuel. Shown in **(a)** is an APT reconstruction and La concentration profiles (measured by APT and SIMS) of a La-doped CeO_2 thin film (a UO_2 surrogate). This study, performed with Brent Heuser, provides insight into radiation-enhanced diffusion of dopants, a key process in nuclear fuel. In **(b)** the measured (APT) was correlated to the predicted (TRIM) calculations produced by Clarissa Yablinsky. These experimentally-validated models provide insight into the microstructural evolution of fuel. Additionally, it has been shown that the stoichiometry and defect characteristics of oxide fuel have critical implications on thermal conductivity. APT is being used to measure local stoichiometry changes. An example is shown in **(c)**, where Ce to O ratio changes away from the free surface. These studies are in conjunction with collaborators performing transmission electron microscopy (Todd Allen) and thermal diffusivity measurements (David Hurley/Marat Khafizov). Phase field simulations of the underlying defect mechanisms by Anter El-Azab are shown in (d).