Physics Colloquium

Laser-driven Pulsed Neutron Sources as a Potential Pool-side Characterization Tool for Nuclear Fuels

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Abstract:

The unique advantages of neutrons for characterization of nuclear fuel materials [1] are applied at the pulsed spallation neutron source at LANSCE to accelerate the development and ultimately licensing of new nuclear fuel forms. Neutrons allow to characterize the crystallography of phases consisting of heavy elements (e.g. uranium) and light elements (e.g. oxygen, nitrogen, or silicon) [2]. The penetration ability in combination with comparably large (e.g. cm sized) beam spots provide microstructural characterization of typical fuel geometries for phase composition, strains, and textures from neutron diffraction.

In parallel, we are developing energy-resolved neutron imaging and tomography with which we can complement diffraction characterization. This unique approach not only allows to visualize cracks, arrangement of fuel pellets in rodlets etc., but also characterization of isotope or element densities by means of neutron absorption resonance analysis [3].

Laser-driven pulsed neutron sources [4] have the potential to provide these capabilities “pool-side”, e.g. at the Advanced Test Reactor at Idaho National Laboratory. Compared to proton accelerator driven spallation sources, requiring investments exceeding $1B, the investment cost for a laser-driven neutron source would be of the order of several $10M with the potential of similar flux to that of a smaller, earlier generation spallation neutron source. Compared to electron accelerator-driven neutron sources, the flux of a laser-driven source would be at least one order of magnitude higher. Compared to reactor neutron sources, the pulse structure of the laser-driven neutron source would enable unique characterization not possible with steady-state reactor neutrons.

In this presentation, we provide an overview of our recent accomplishments in fuel characterization for accident-tolerant fuel consisting of uranium nitride/uranium silicide composite fuels as well as metallic fuels. We will further discuss recent results demonstrating the use of laser-driven neutron sources for these efforts.

Monday, November 21st, 2016
1:00-2:00 pm
Goudsmit Conference Room, LP 208