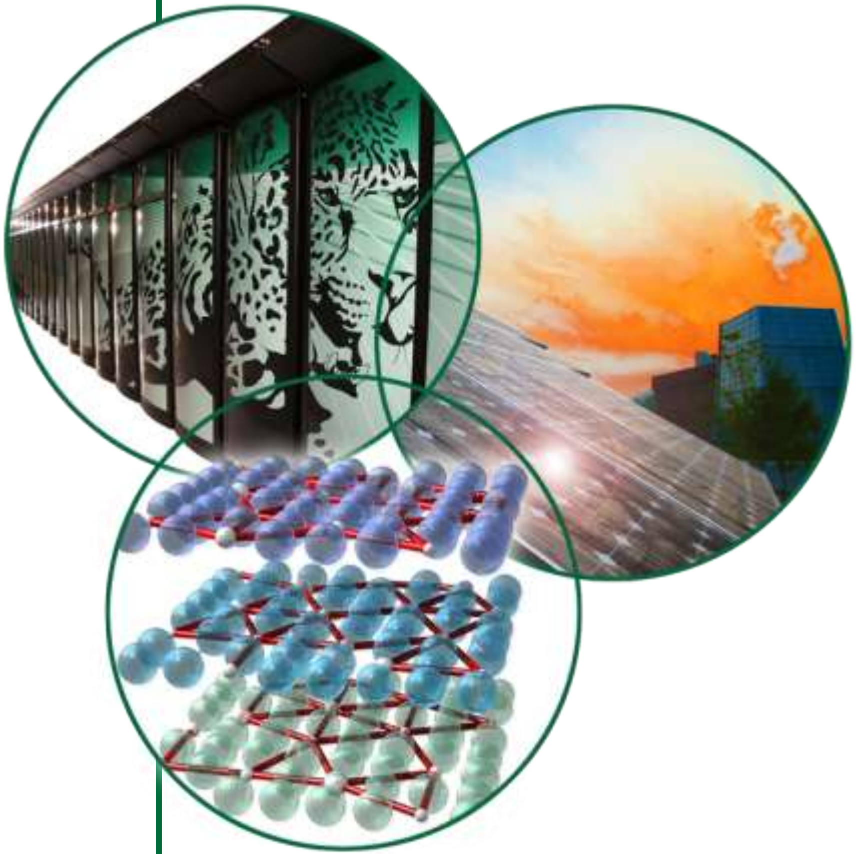
Neutron Sciences Directorate User Week Meeting



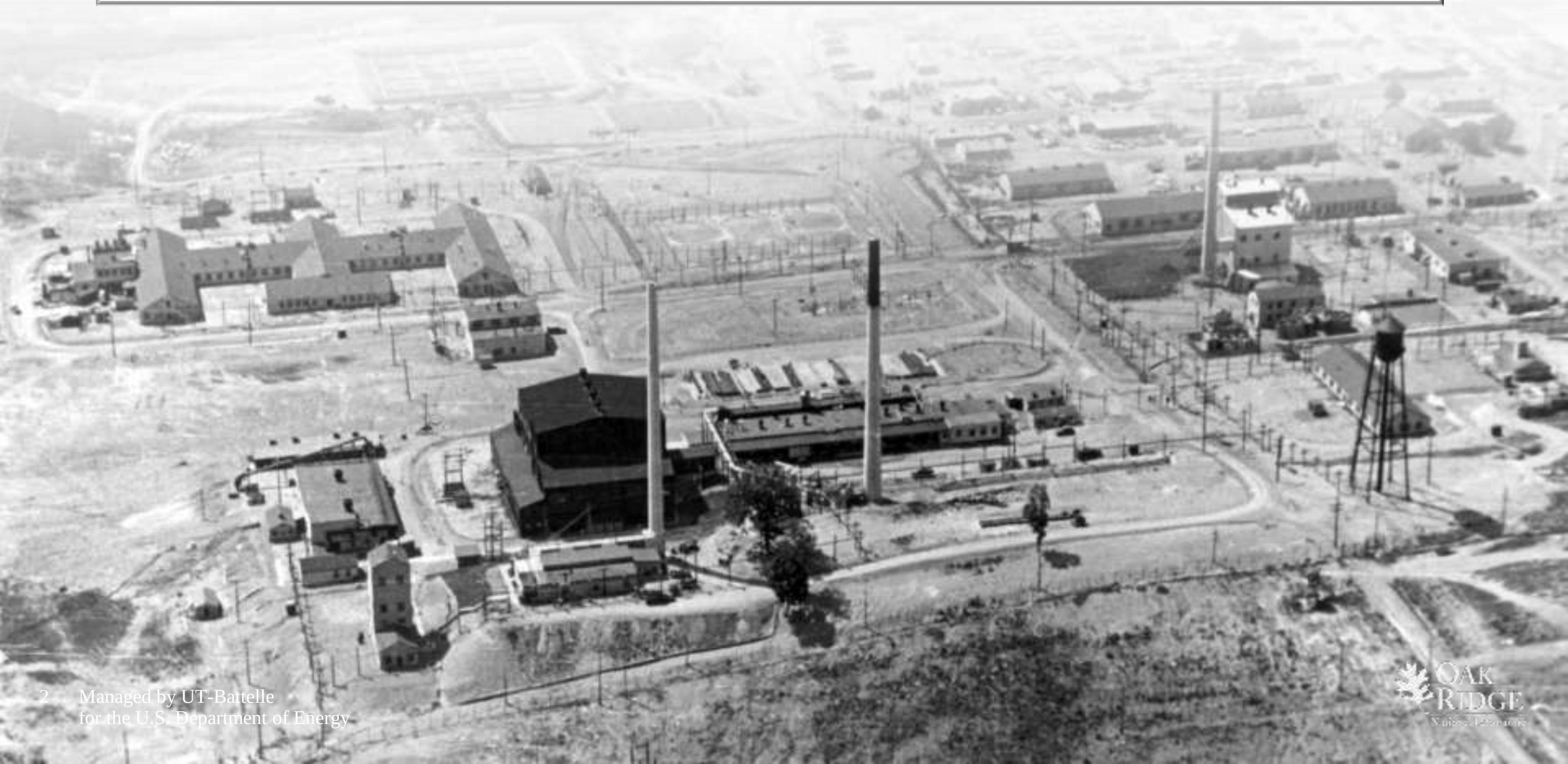
Ian Anderson
Associate Laboratory Director

September 13, 2010

Welcome to Oak Ridge National Laboratory

ORNL in 1943

The Clinton Pile was the world's first continuously operated nuclear reactor



Welcome to the new Oak Ridge National Laboratory

East Campus

Chestnut Ridge Campus

Science and Technology Park

West Campus

A clean energy future: The President's goals

- Reduce greenhouse gas emissions 80% by 2050
- Increase electricity from renewable sources
  - To 10% by 2012
  - To 25% by 2025
- Put 1 million plug-in hybrid cars on the road by 2015
- Within 10 years, reduce oil consumption by the amount that we currently import from the Middle East and Venezuela

DOE has a key role in delivering on these goals

U.S. Department of Energy strategic priorities

Innovation

Investing in science, discovery, and innovation to provide solutions to pressing energy challenges

Energy

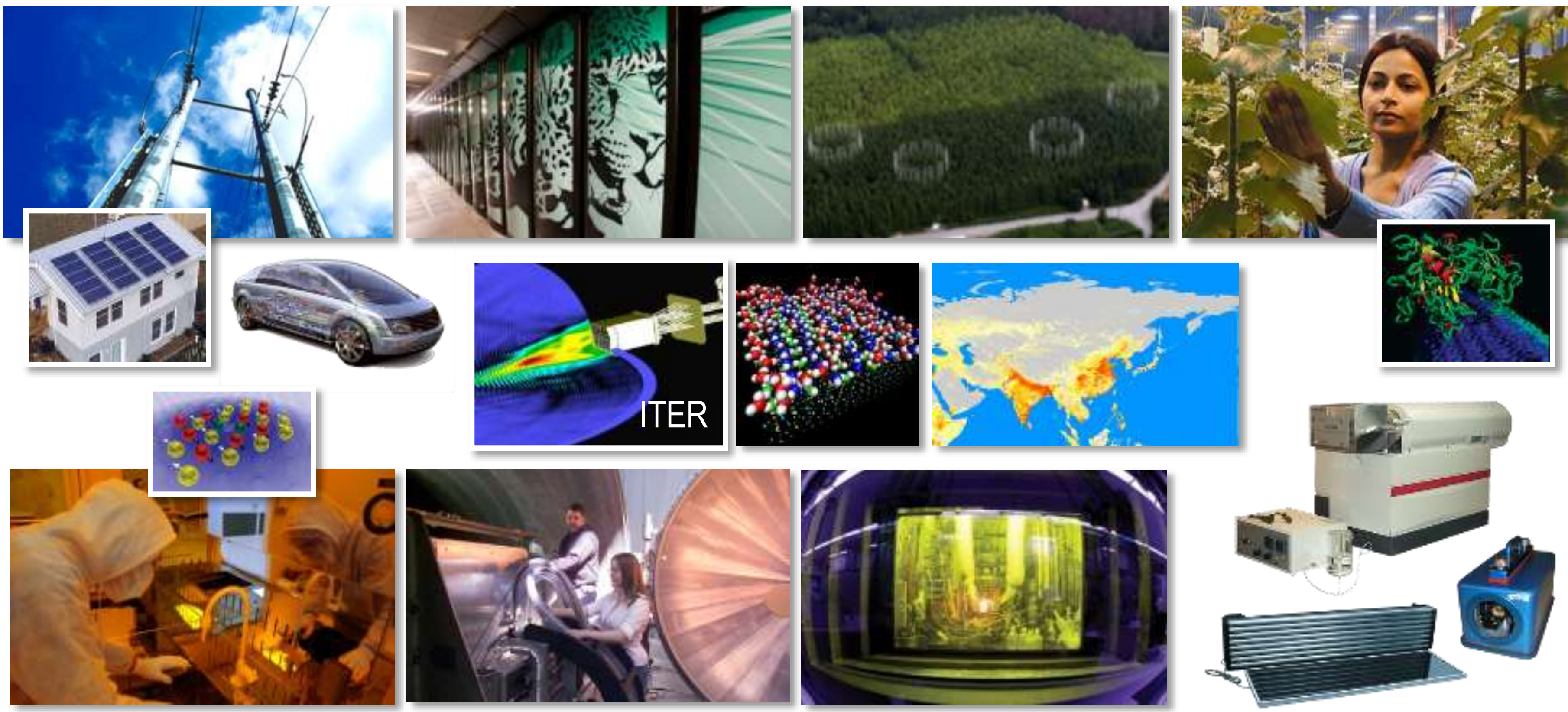
Providing clean, secure energy and promoting economic prosperity through energy efficiency and domestic forms of energy

Security

Safeguarding nuclear and radiological materials, advancing responsible legacy cleanup, and maintaining nuclear deterrence

Delivering science and technology:
We lead major R&D programs for DOE and other customers

Energy technologies | Ultrascale computing | Climate | Bioenergy



Materials at the nanoscale | Neutron sciences | Nuclear energy | National security

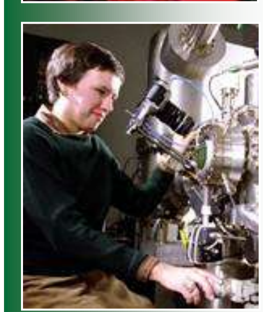
ORNL is DOE’s largest science and energy laboratory

- $1.55B budget
- 4,750 employees
- 4,000 research guests annually
- $500 million invested in modernization

- Nation’s largest concentration of open source materials research
- World’s most intense pulsed neutron source and a world-class research reactor

- World’s most powerful open scientific computing facility
- Nation’s most diverse energy portfolio
- Managing the billion-dollar U.S. ITER project

National user facilities at ORNL



- Buildings Technology Research and Integration Center
- Center for Nanophase Materials Sciences
- Center for Structural Molecular BiIology
- High Flux Isotope Reactor
- High Temperature Materials Laboratory
- Holifield Radioactive Ion Beam Facility
- National Center for Computational Sciences
- National Transportation Research Center
- Safeguards Laboratory
- Shared Research Equipment Collaborative Research Center
- Spallation Neutron Source

Putting two of the world's best tools for neutron scattering to work

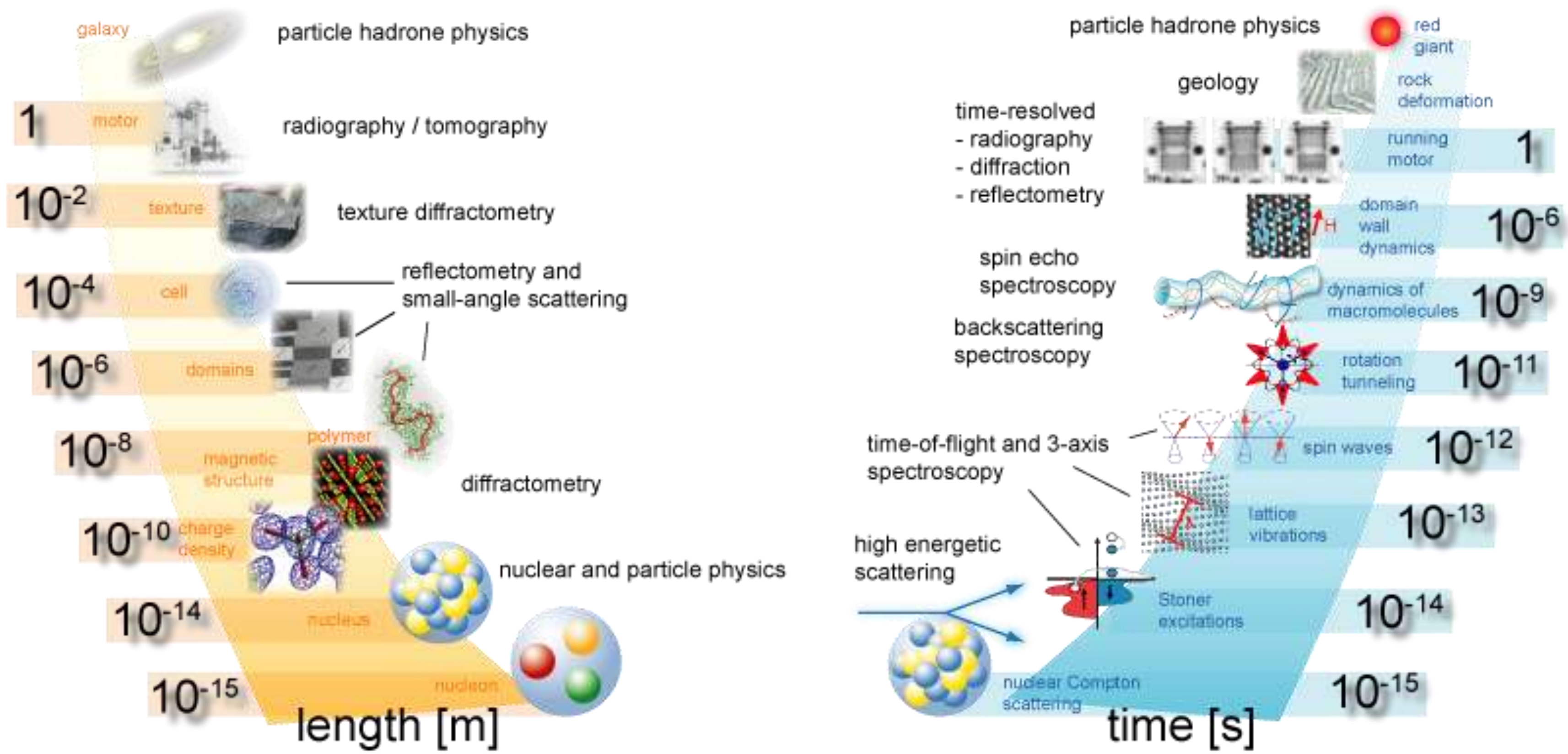
High Flux Isotope Reactor:
Intense steady-state neutron flux and a high-brightness cold neutron source

Spallation Neutron Source:
World's most powerful accelerator-based neutron source

UT-ORNL Joint Institute for Neutron Sciences:
User gateway for SNS and HFIR

Delivering neutrons to a growing user community

Neutrons measure structure and dynamics

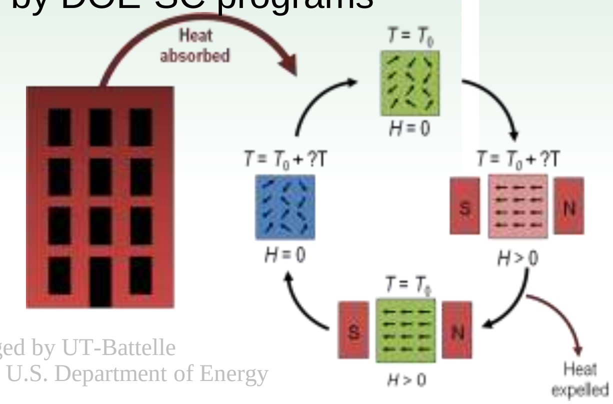


Magnetic field processing
2009 R&D 100 Award; 2009 Gordon Bell Prize

DOE-SC → DOE-EERE: ITP → Industry

DOE-SC

- Discovery: Magnetic fields can increase strength and fracture resistance of steel and other ferromagnetic alloys
  - Predicted by first-principles theoretical modeling
  - Neutron scattering key for validation and quantification
  - Key capabilities advanced by DOE-SC programs



DOE-EERE: ITP

- Structural materials with reduced residual stress, containing phases that cannot be achieved by conventional thermo-mechanical processing
  - Reduced processing cost and energy
  - Higher performance materials

Industry

- Support from strong industry partners
  - American Magnetics Inc., Toyota, Eaton, others
  - DOE-EERE ITP enables partnerships

- Magnetic processing of materials is now reconnecting with basic science questions

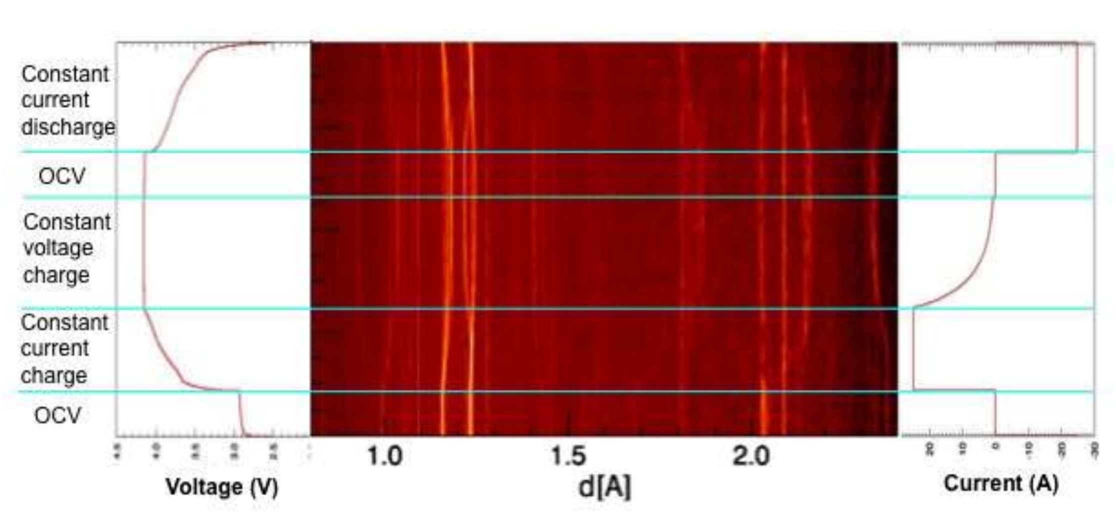
Increasing energy efficiency:
Reducing the weight of heavy trucks

- **Heavy-duty vehicles:**
  - **4% of U.S. vehicles**
  - **20% of U.S. fuel consumption**
- **Second Generation Neutron Residual Stress Facility (NRSF2) at HFIR: Experimental correlation of hole-cutting manufacturing processes and material choice with magnitude of residual stress and fatigue life**
- **Outcome: Weight of frame rails for heavy trucks can be reduced by up to 200 lb**
  - **Steel savings: Up to 30M lb per year**
  - **Fuel savings: 3.8M gal for 150,000 trucks driven 100,000 miles**

Mounting a plate test specimen
for through thickness strain mapping at NRSF2

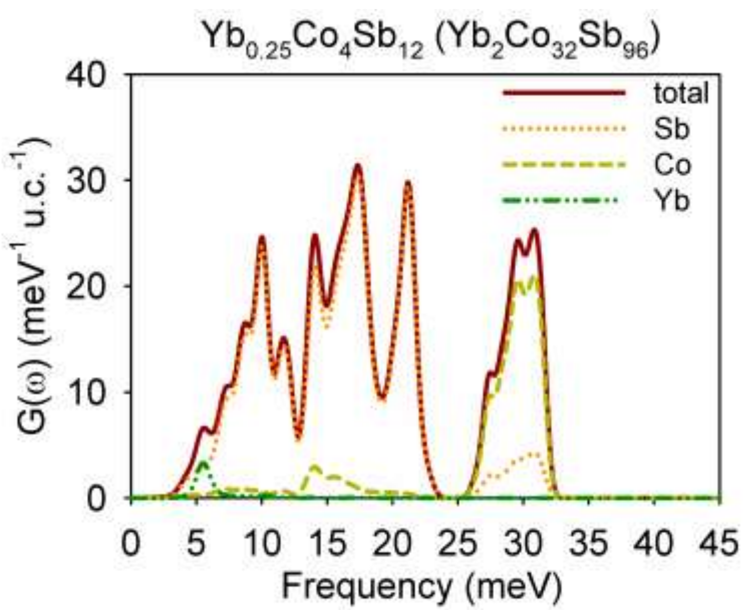
Enhancing energy storage:
In situ study of structure evolution during battery charge-discharge

- Investigating atomic- and nanoscale structural features in energy storage materials at SNS:
  - In situ neutron diffraction measurements
  - Event-based data acquisition
- Outcome: Knowledge applicable to design of next-generation batteries with dramatically improved capacity and long lifetime

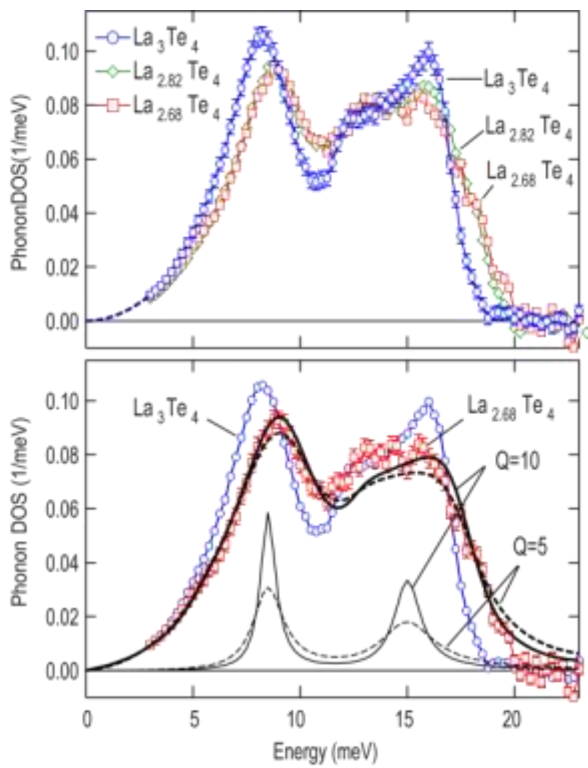


Increasing energy efficiency: Realizing the promise of thermoelectric materials

- **Cold Neutron Chopper Spectrometer at SNS: Studies of cerium- and ytterbium-filled ternary skutterudites**
  - High thermoelectric figure of merit ZT
  - Promise for applications at 400–800 K

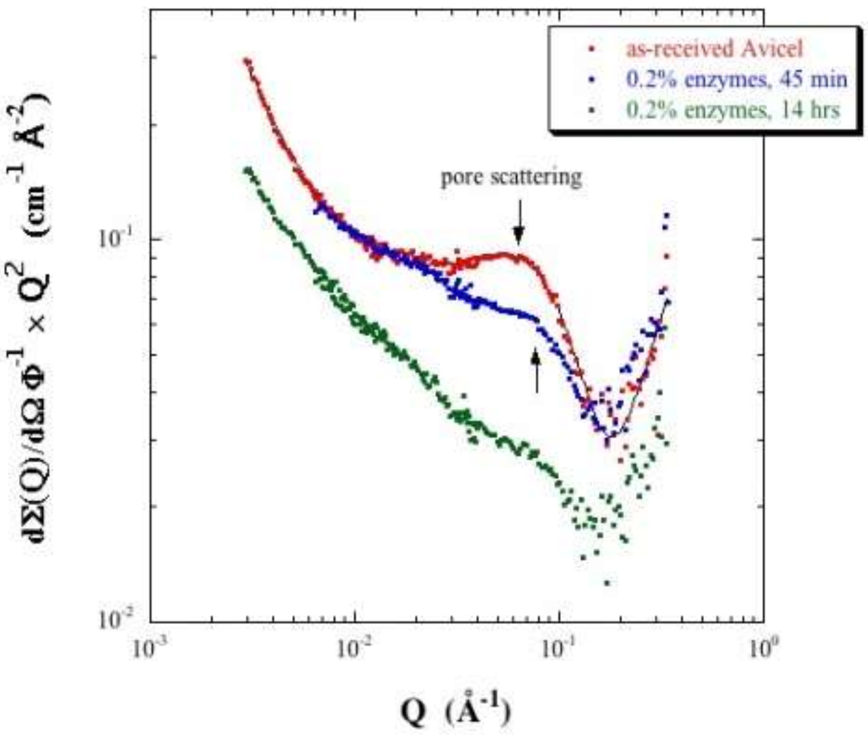


- **Wide Angular-Range Chopper Spectrometer (ARCS) at SNS: Measurement of phonon density of states (DOS) in lanthanum telluride by inelastic neutron scattering**



Biomass to biofuels:
Probing cellulose digestion

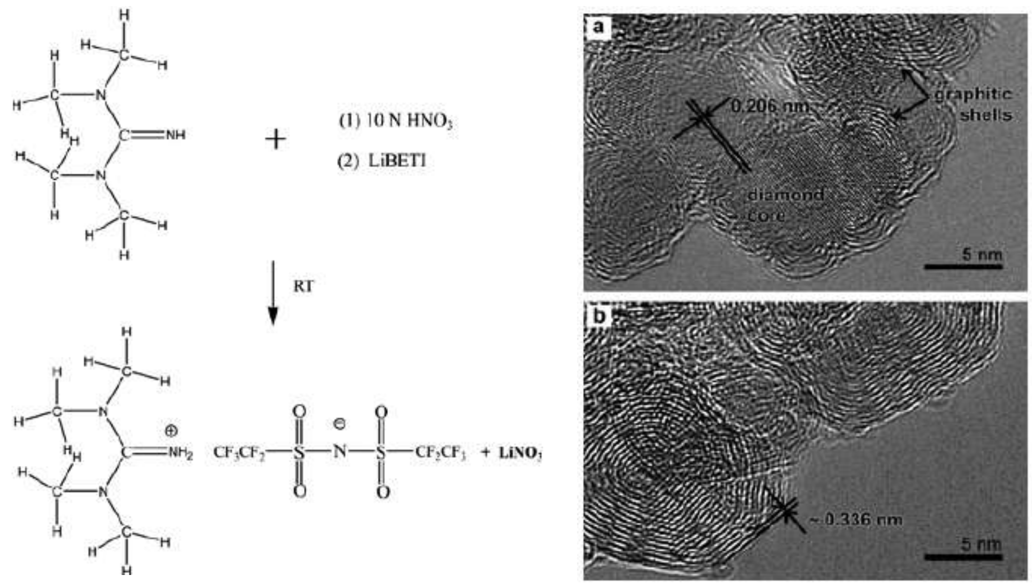
- Improving the efficiency of enzymatic digestion of cellulose biomass would reduce the cost of producing fermentable sugars
- Bio-SANS at HFIR: First neutron scattering study of the structure of Avicel (FD100) microcrystalline cellulose during enzymatic digestion
- Outcome: Significant agitation is required in order for enzyme digestion to affect nanopore structure



Bio-SANS data obtained during dynamic digestion: Roll-off in intensity decreases rapidly after introducing enzymes, indicating that rapid digestion occurs in or around water-filled pores

Enhancing energy storage:
Studying the mobility of ions in room-temperature ionic liquids

- **Backscattering Spectrometer (BASIS) at SNS:**
  QENS used to identify several distinct dynamic components in RTILs in bulk form
- **Current work at ORNL Fluid Interface Reactions, Structures, and Transport Center (a DOE EFRC): Studies of RTILs confined in carbon-based nanomaterials, such as nano-onions, and other mesoporous media**
- **Potential for ionic charge-carrying media for advanced batteries and supercapacitors**



Structure of RTIL confined in carbon nano-onions

Purpose and goals for this week

- Highlight opportunities for collaboration with ORNL researchers in the areas of Solar Energy and Energy Storage
- Assist you in identifying ORNL staff and facilities that can support research in these areas
- Get feed back from users on new experimental capabilities required to support future research needs