Technologist in Residence Pilot Overview and An Introduction to Argonne National Laboratory

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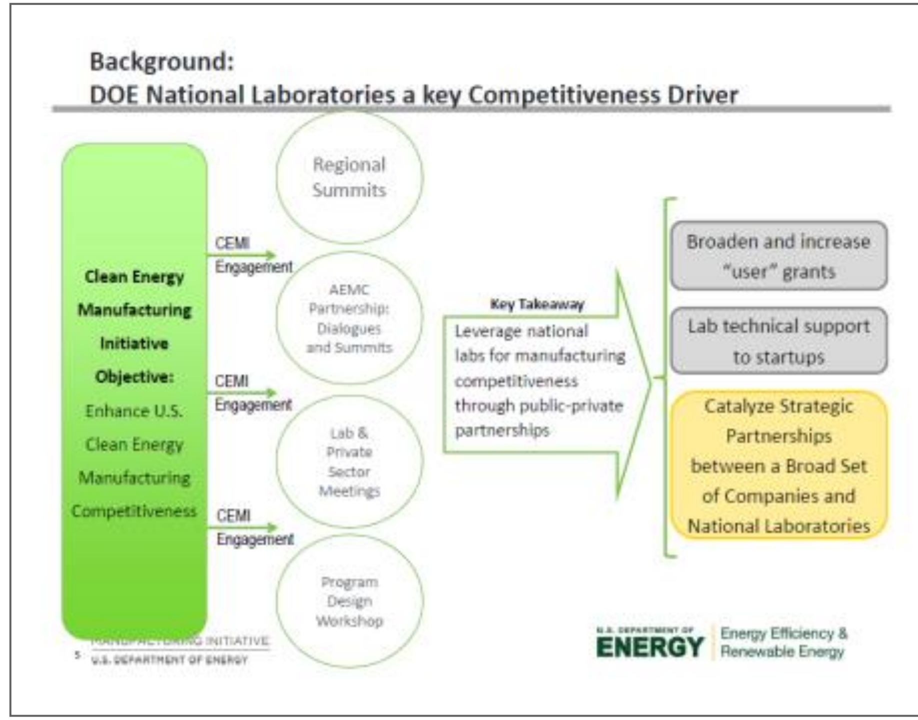
Agenda

- Technologist in Residence (TIR) Pilot
  - Background
  - Summary
  - Programmatic Details and Cost Share Information
- A Brief Introduction to Argonne National Laboratory
  - Capabilities
  - Initiatives
  - Selected Topics: Advanced Photon Source, Connected and Automated Vehicles, Batteries, Nanomanufacturing
- Next Steps and Contact Details

EERE Technologist in Residence Pilot Background



http://energy.gov/eere/cemi/technologist-residence-pilot

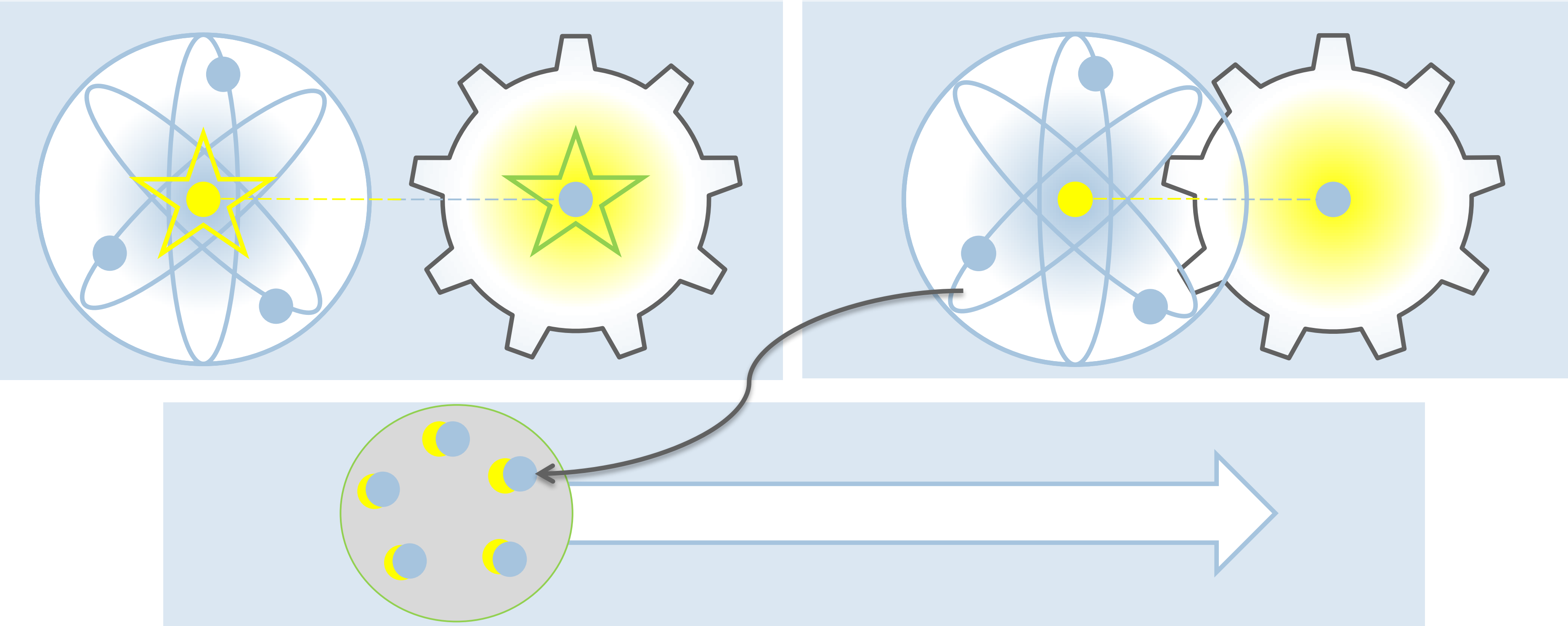
EERE Technologist in Residence Pilot Overview

- ***TIR Vision:*** Catalyze strong Lab-Industry relationships that result in the significant growth of high impact collaborative research and development
- ***Pilot Goals:***
  - Increase collaborative research and development between national laboratories and private sector companies
  - Develop a streamlined method for companies to establish long term relationships with laboratories that result in collaborative research and development

Technologist in Residence Pilot Summary: Model

Senior Technologists are identified within a National Lab and a manufacturing company. The Technologists work together…

…… to identify new areas of collaborative research between the company and the Lab, and formulate an agreement and specific scopes of work



Through the Council of Technologists, pilot participants will work together to provide insight into all of the participating laboratories, and to provide feedback to DOE about the most effective process

Technologist in Residence Pilot Summary: Progression

1. Pair Formation
2. Participant Selection
3. Priority & Capability Exchange
4. Agreement and Scopes of Work Development
5. Feedback and Development of Standard Procedure

Council of Technologists:
Multi-lab platform for supporting the development of the pilot

- Lab members serve as designated points of contact to provide access across labs
- All council members are convened on a semi-annual basis to provide feedback and share best practices

Programmatic Details and Cost Share Information

- Milestones for technologist pairs include:
  - Development of a framework partnership agreement that can be modified with statements of work as they are identified
  - Creation of Statements of Work to be added to the agreement by the end of the pairs' participation in the Pilot
- The private sector partner must commit to match (equal to or greater than) the anticipated Federal share (up to $400,000)
  - Cost match to support salary and travel of Lab Technologist(s)
  - Industry partner to cover 100% of Industry Technologist's salary and expenses over the duration of the Pilot.

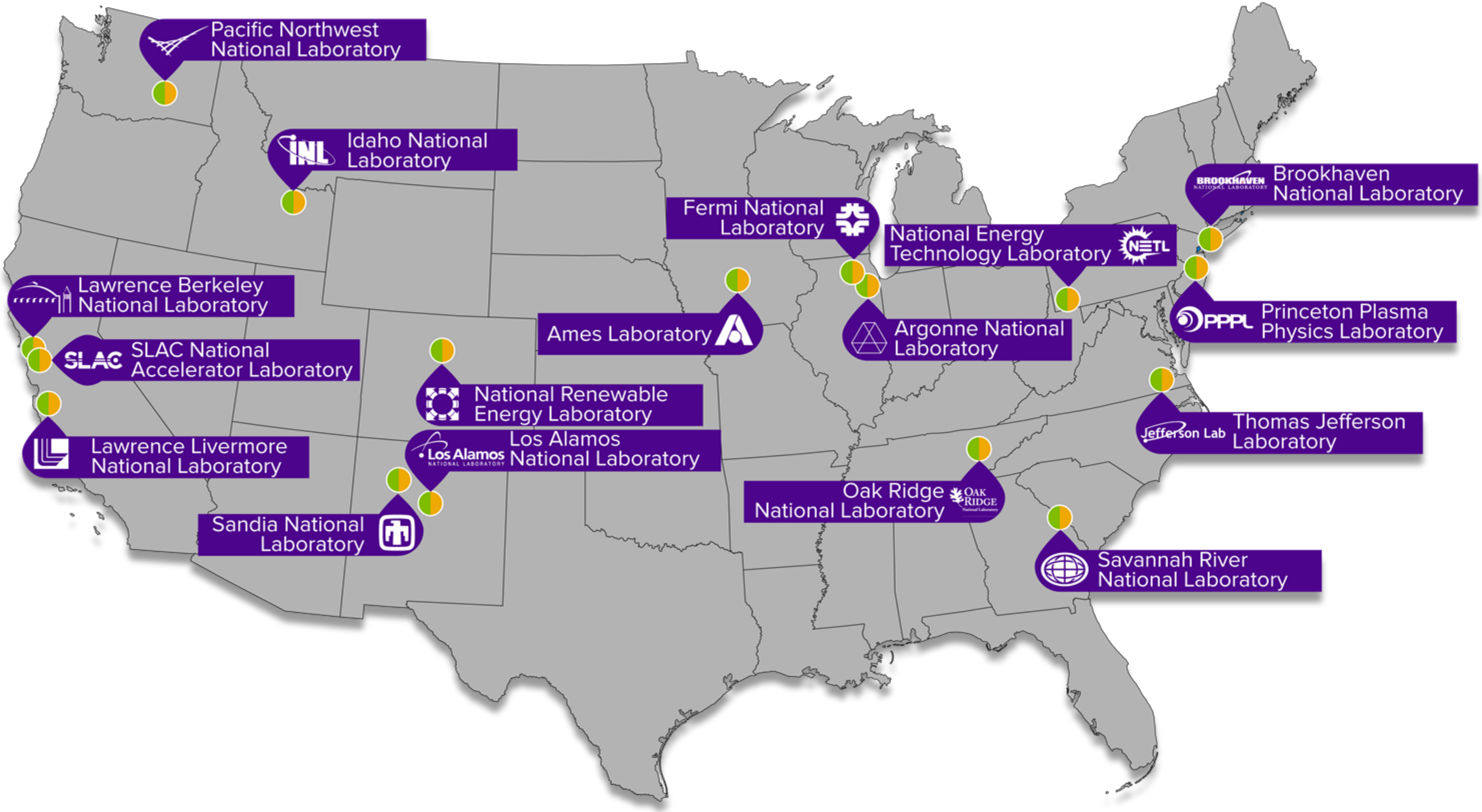
Timeline and Contact Details

- Proposals must be submitted before **5:00 p.m. (ET) on June 21, 2015**.
- Proposals must not exceed 10 pages single spaced, 12 point font with standard margins.
- Argonne invites Industry Participants that may be interested in participating in this Pilot to a dialog on interests and fit
  - Please contact Suresh Sunderrajan
  - ssunderrajan@anl.gov; +1-630-252-8111

Argonne at a glance

- Chartered July 1, 1946 with nuclear energy mission – now multi-purpose S&T
- Owned by the U.S Department of Energy
- Operated ever since by The University of Chicago, now via UChicago Argonne, LLC
- $730M+ annual budget
- 3400+ employees including 1700+ scientists and engineers
- 7300+ external users of our research facilities every year

Argonne – a vital part of DOE National Laboratory System



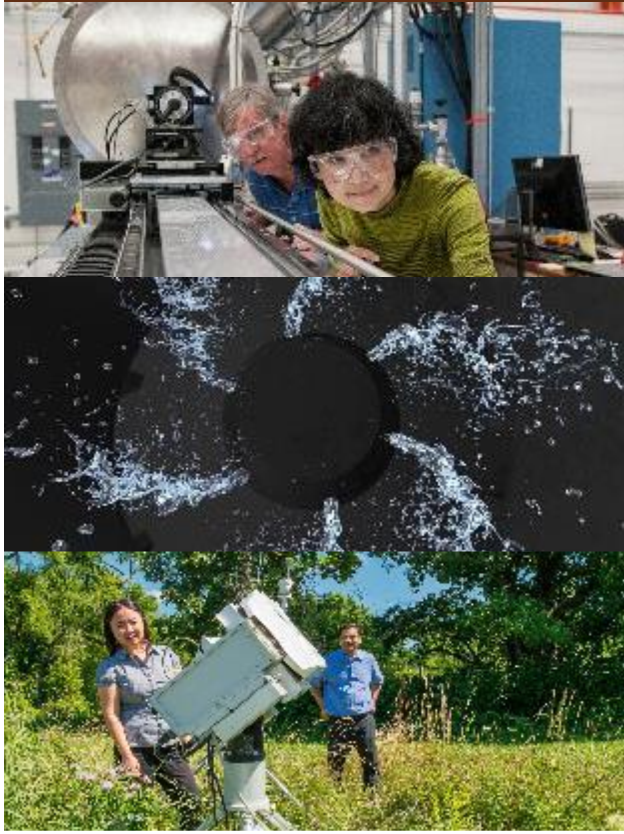
Our Strategic Initiatives

Leadership in discovery science & engineering

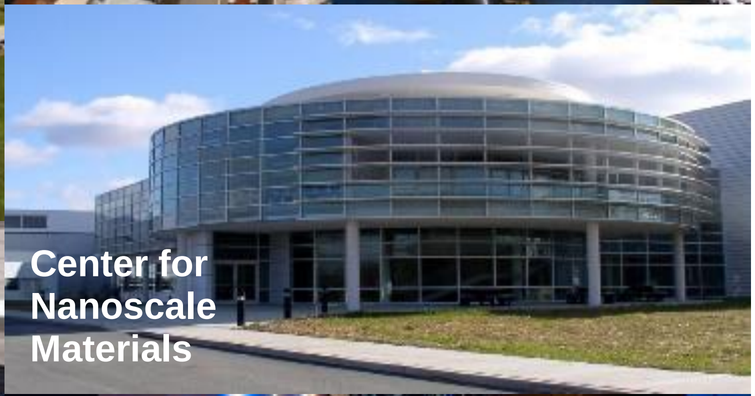
Innovation in energy and technology

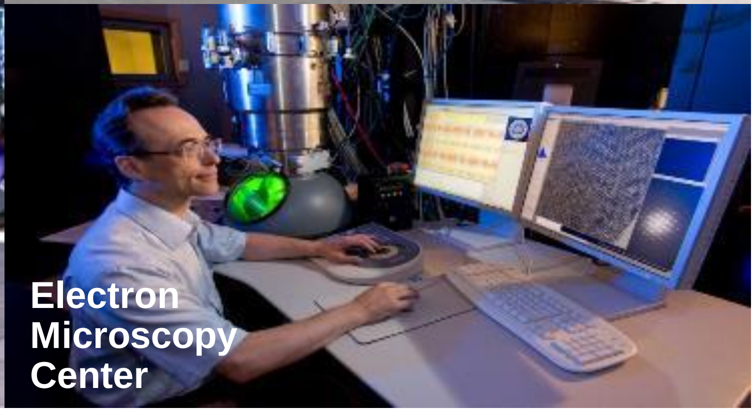
Security for the nation

World-class facilities to enable science



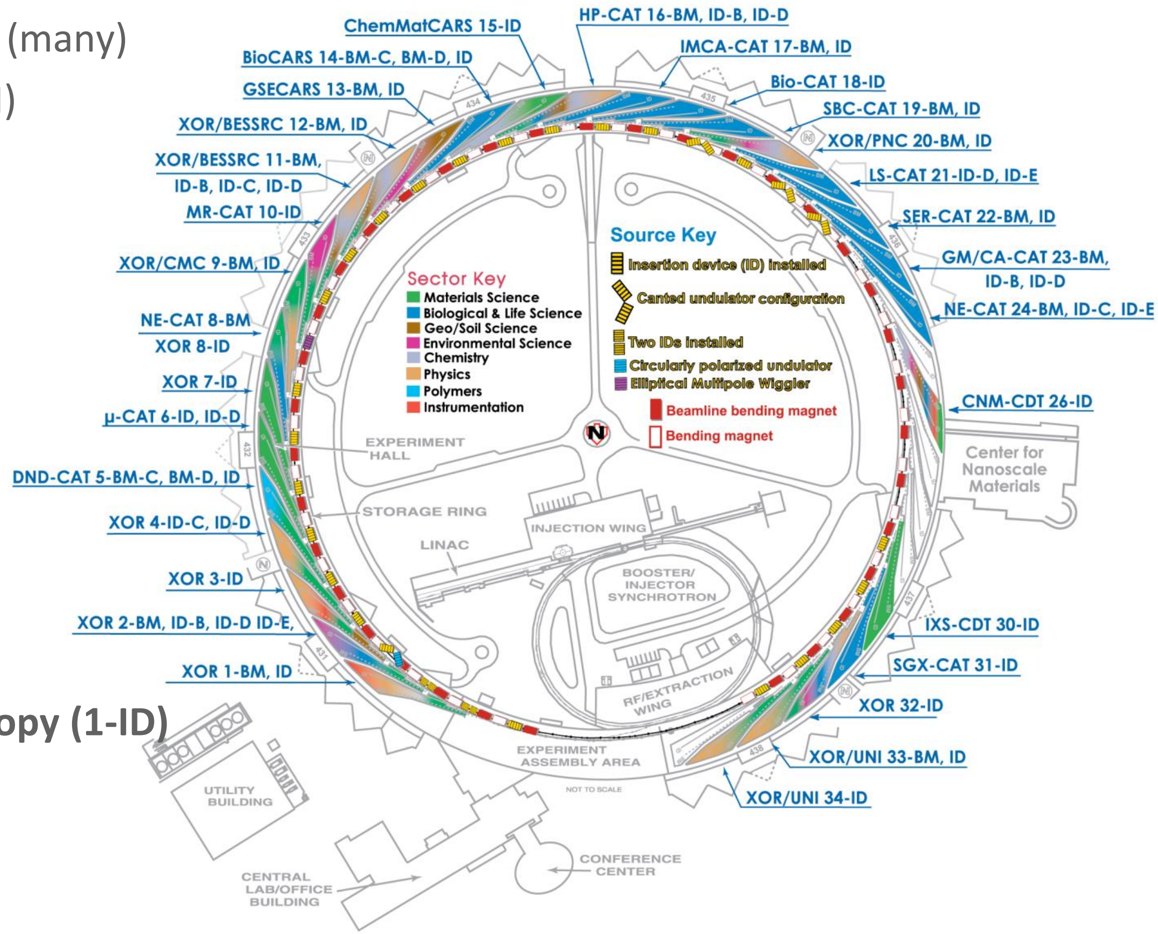
Argonne's Suite of World-class User Facilities



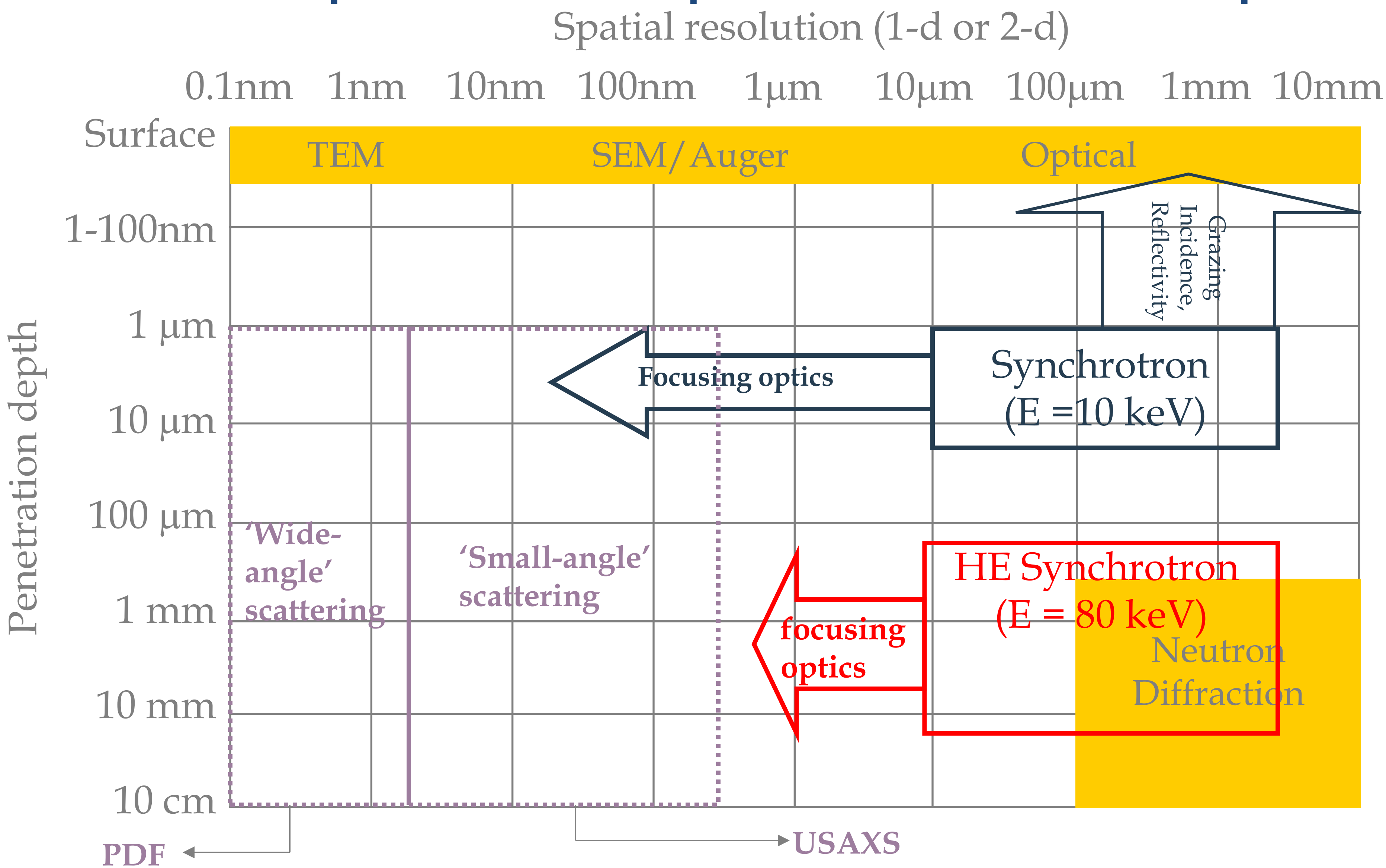


Advanced Photon Source – ‘industrial’ techniques

- Core
  - Macromolecular crystallography (many)
  - Powder diffraction (1-BM,11-BM)
  - XAFS (S20)
  - **Tomography (2-BM, 1-ID)**
  - SAXS (various)
  - **Strain scanning** (1-ID)
- Specialized / in development
  - Nano-diffraction (24-ID,34-ID)
  - PDF (11-ID)
  - Fluorescence microscopy (2-ID)
  - **High-energy diffraction microscopy (1-ID)**
  - Time resolved scattering (7-ID)
  - Time resolved imaging (32-ID)
  - **Combined techniques**
    - **EXAFS/SAXS/PDF**
    - **SAXS/WAXS (1-ID)**
    - **WAXS/Imaging (1-ID)**

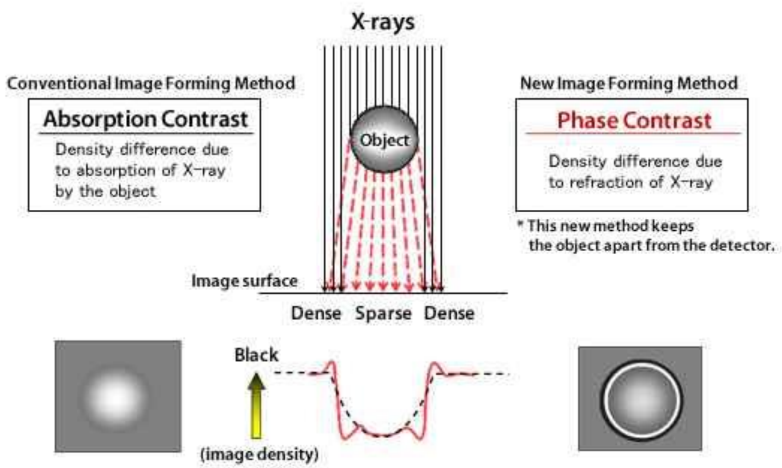


Resolution & penetration depth of selected techniques

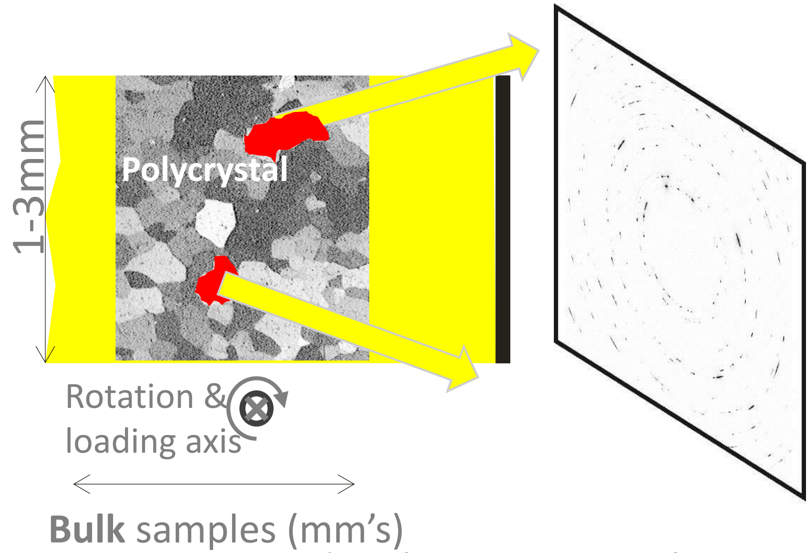


Techniques for microstructural mapping

- Absorption or phase tomography
  - Full field 2D image (mm^2) of direct beam
  - Absorption contrast (near) to phase contrast (far) by changing sample-detector
  - Take image and rotate M times (M images)
  - Reconstruct ->3D volume



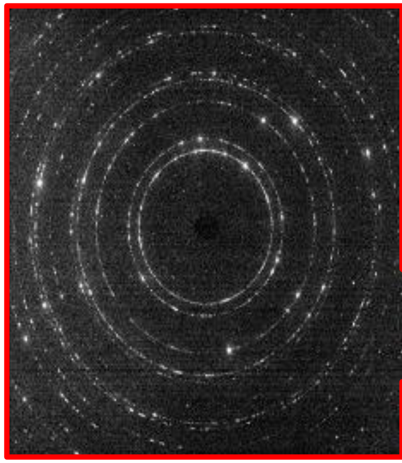
- Diffraction tomography (High Energy Diffraction Microscopy- HEDM)
  - Thin beam (~ 1mm x 5um)
  - Take image at N different distances and rotate M times (NxM images)
  - Reconstruct distinct spots on detector - >2D diffraction contrast
  - Move sample vertically to build up 3D sample volume
  - Semi-transparent beamstop for simultaneous AT



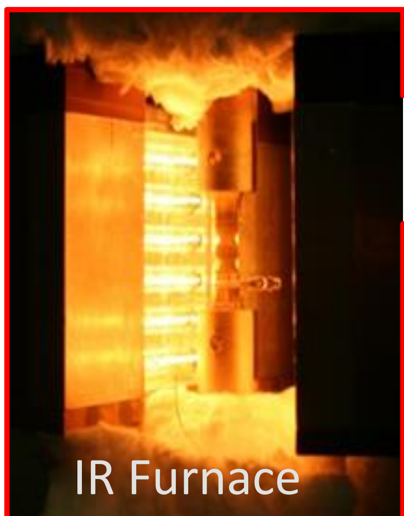
Incident beam E= 50-80 keV
Scattering angles <10 deg

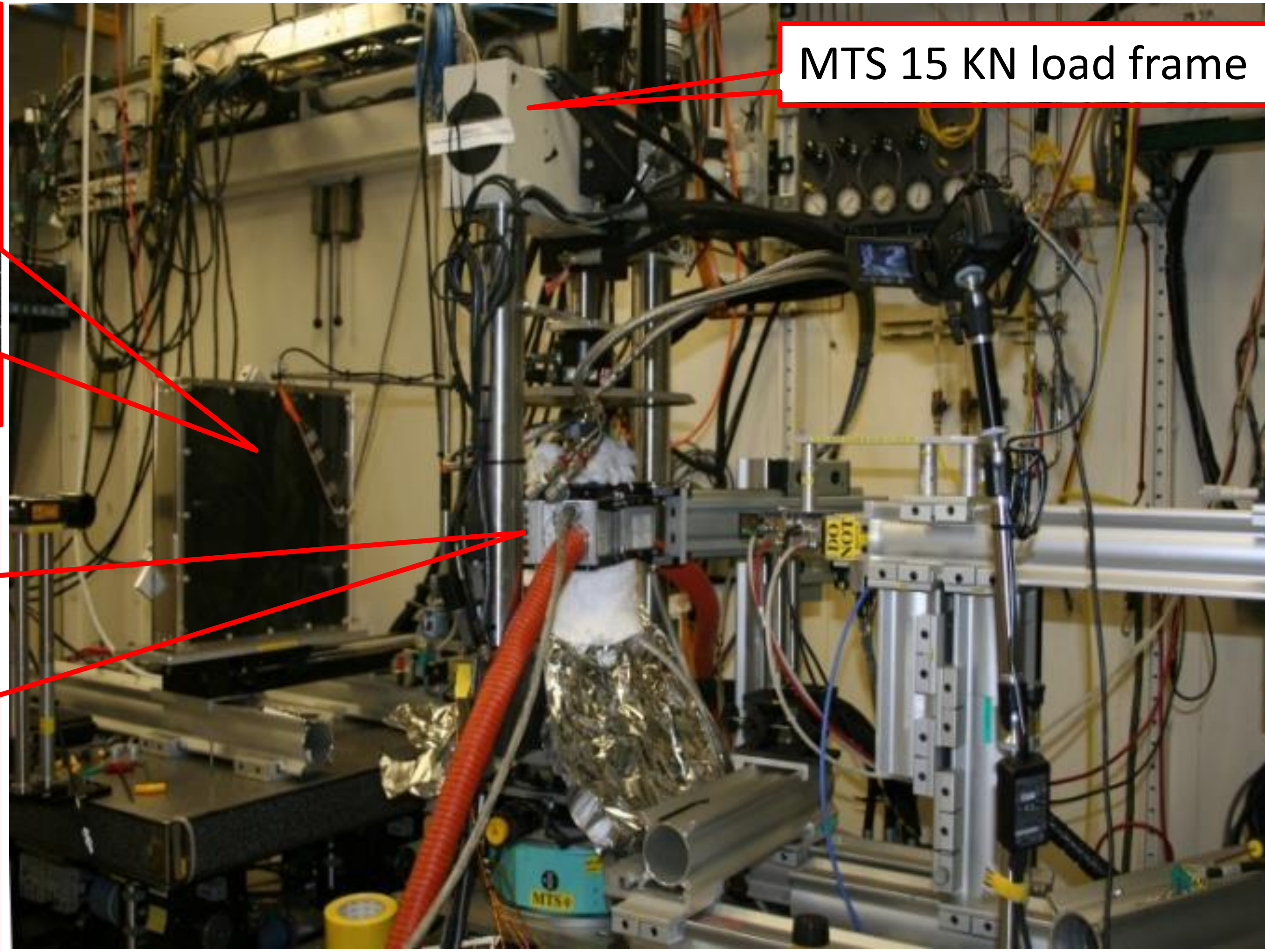
Example 1 - High-Energy X-ray Strain Mapping

Strain mapping under thermal-mechanical loading



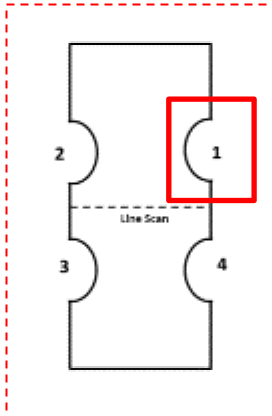
2D diffraction pattern

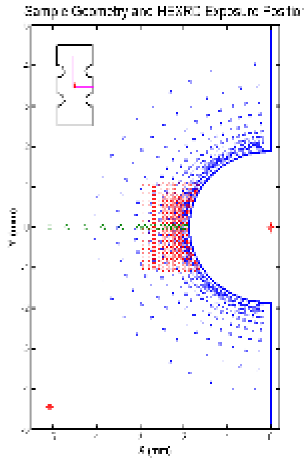




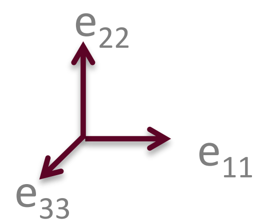
In-situ high-temperature diffraction setup at 1-ID

Example 1 - High-Energy X-ray Strain Mapping

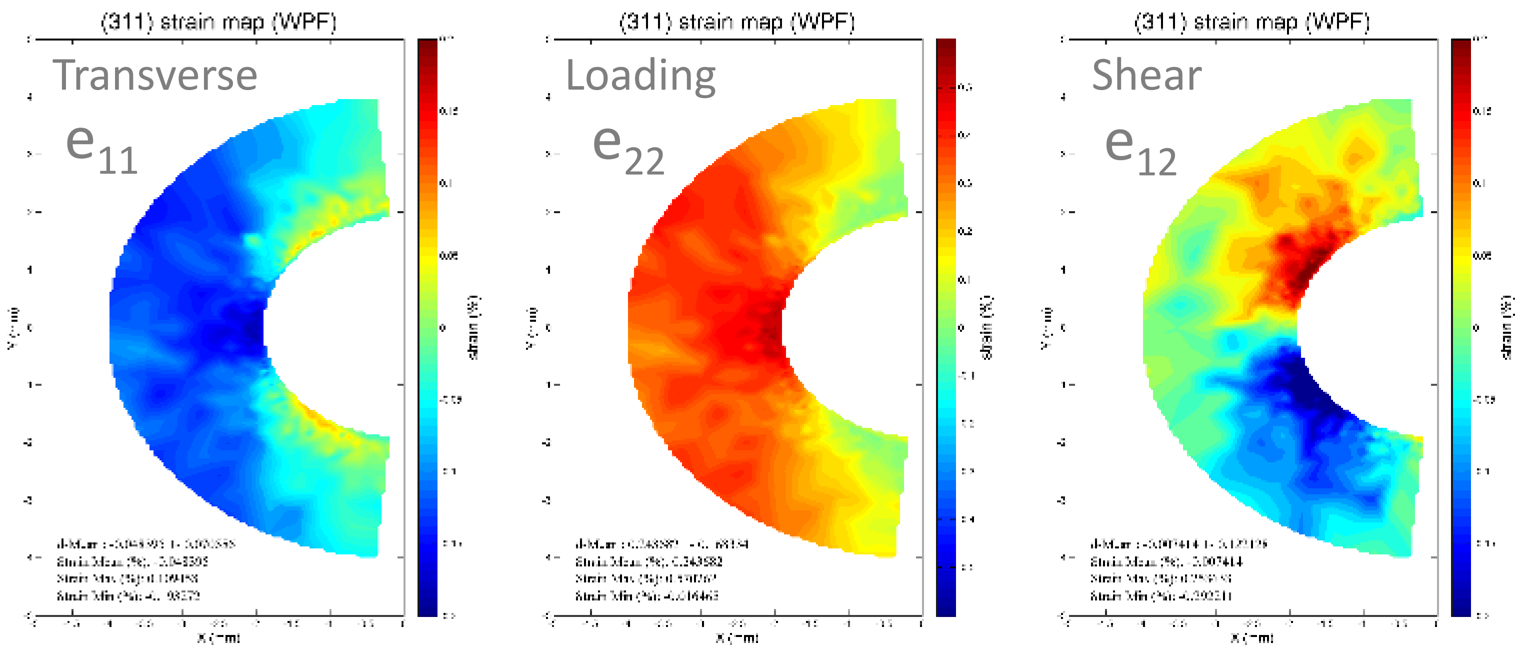




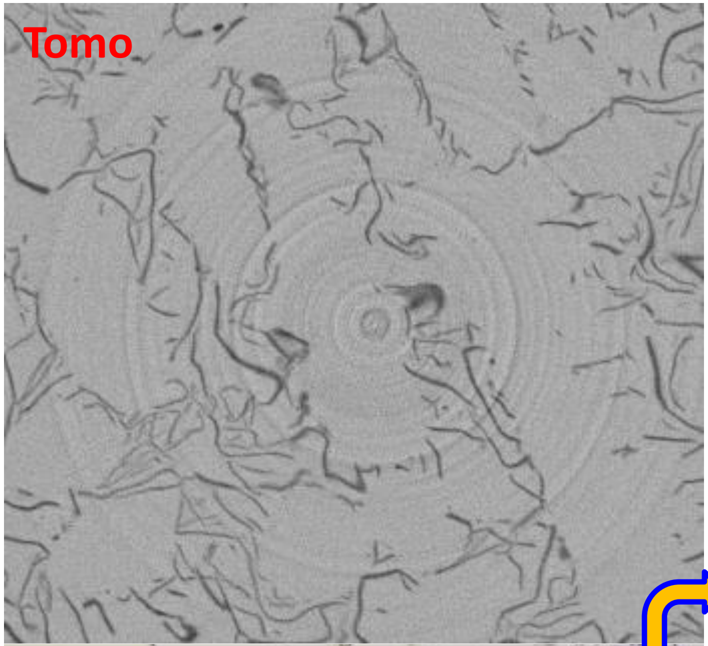
Distribution of residual lattice strain (both normal and shear) near notch can be measured accurately.

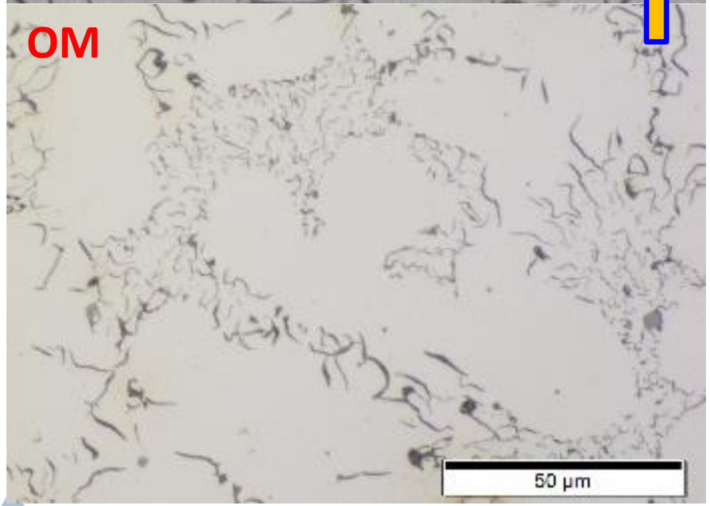


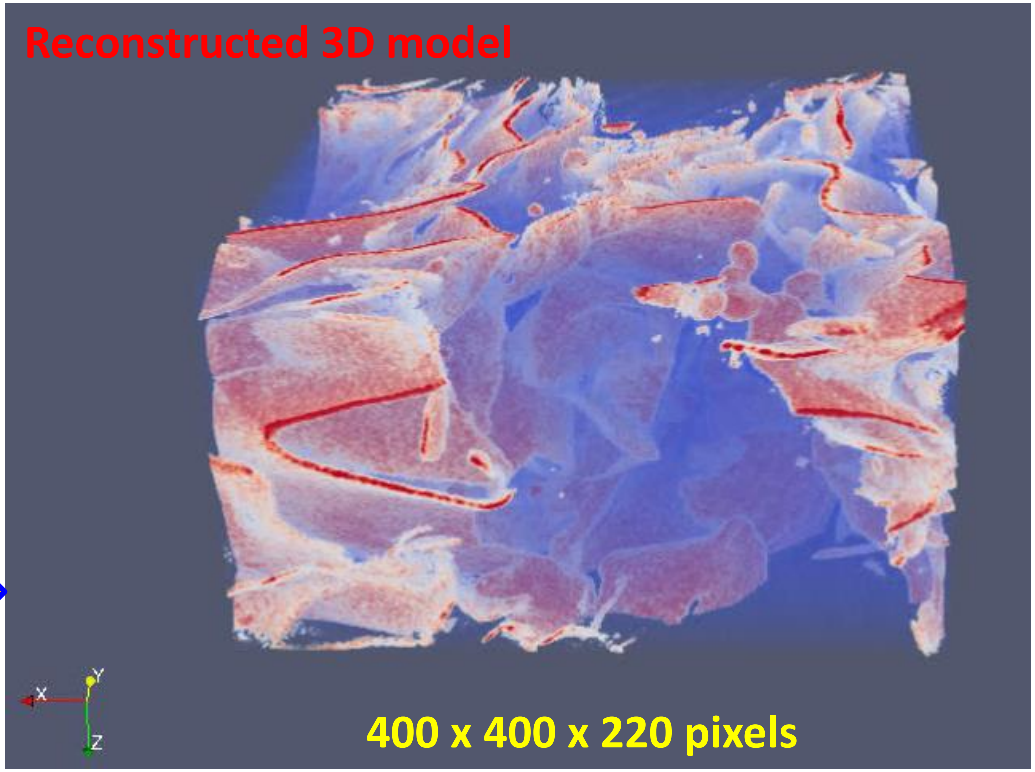
Beam Size:
25 x 25 µm



Example 2 – X-ray Tomography of Gray Cast Iron



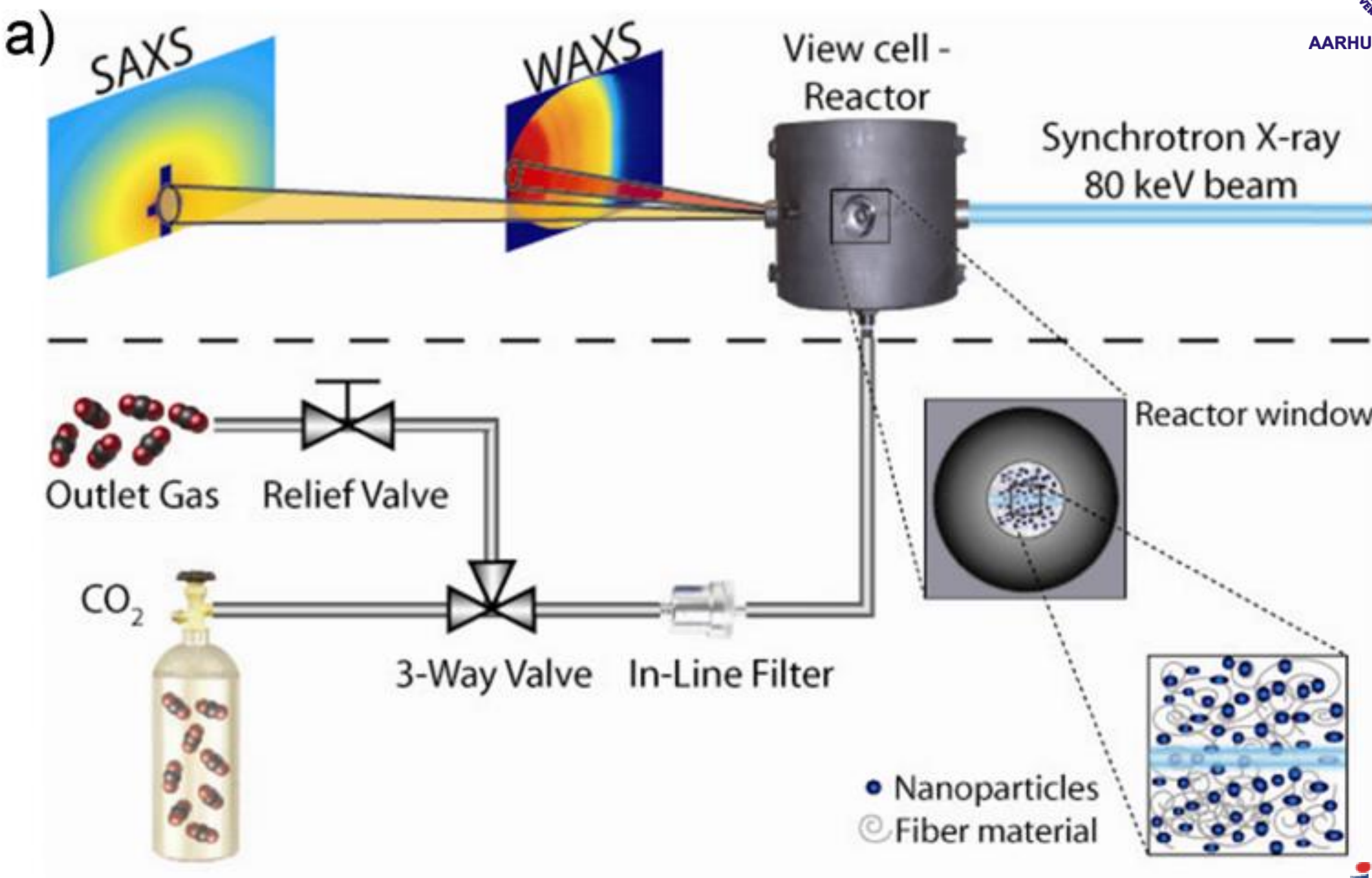




Tomography provide 3D morphology of flake graphite and enable precise volumetric analysis

Commercial gray cast iron, form type-I, distribution type-E (ISO-945)

Example 3 - In-situ synthesis of nano-particles for Li-ion batteries



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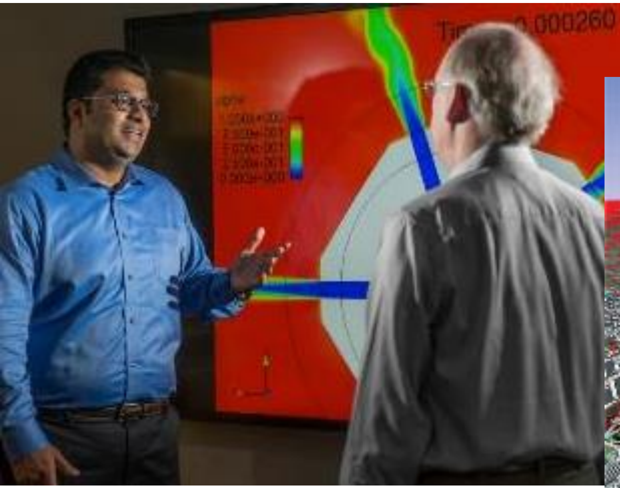
SCF Technologies

Summary

- High-energy x-ray techniques provide new insights into complex systems of industrial relevance, with particular impact on energy research:
  - Irradiated materials
  - Batteries/fuel cells
  - Structural materials and coatings
- Trend is to combine techniques: High-energy SAXS/WAXS/Imaging
  - Access a range of length scales (sub-nm to mm) using the same probe, msec resolution
  - Non-destructive
  - Microstructural evolution in extreme environments

Argonne's Center for Transportation Research



Ford USCAR DaimlerChrysler GM HONDA

Full Capabilities for CAVS (Connected & Automated Vehicles)

Eco-Driving

Eco-Routing

Route Based Control

AUTONOMIE

Single Vehicle

Eco-Approach & Departure at Signalized Intersections

Eco-Traffic Signal Timing

Eco-Traffic Signal Priority

Small Network of CAVs and ITS

Eco-Lanes

Low Emission Zones

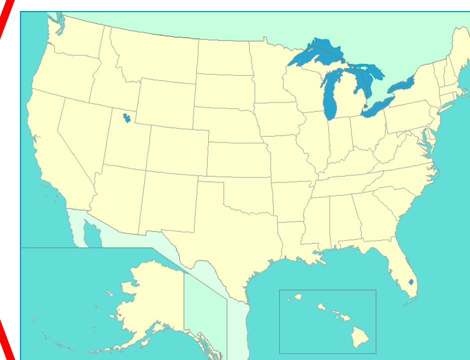
Platooning

Increase VMT

POLARIS

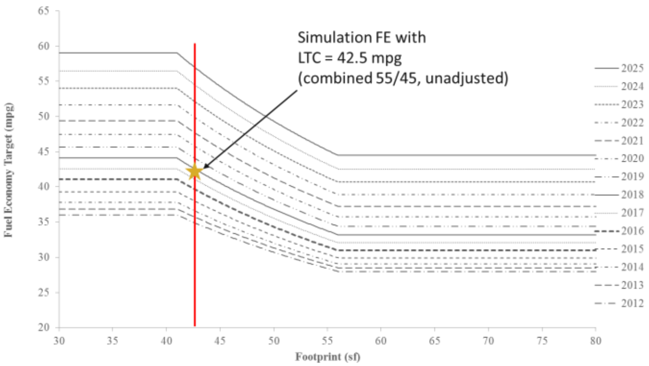
Regional Area

Energy impact at the national level



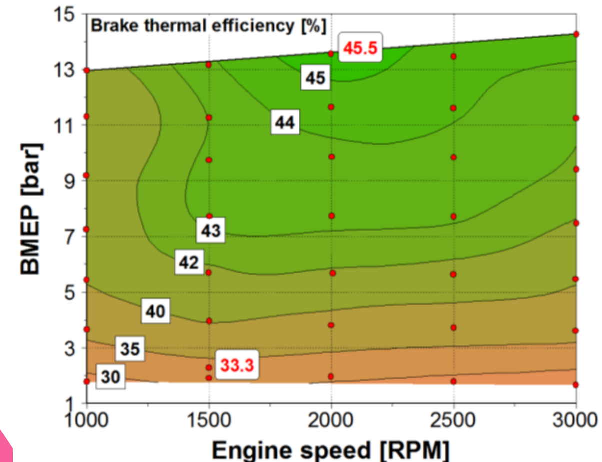
National Level

Single Vehicle High-Efficiency Powertrain R&D Portfolio



Demonstrating Gasoline Compression Ignition (GCI) with 30% drive-cycle fuel economy benefits over conventional baseline

45% Brake Thermal Efficiency (BTE) Automotive Hydrogen Spark Ignition Engine with near-zero engine out emissions



Develop Best-In-Class Efficiency Concepts

Co-Optimize Engine-Fuel System

VERIFI

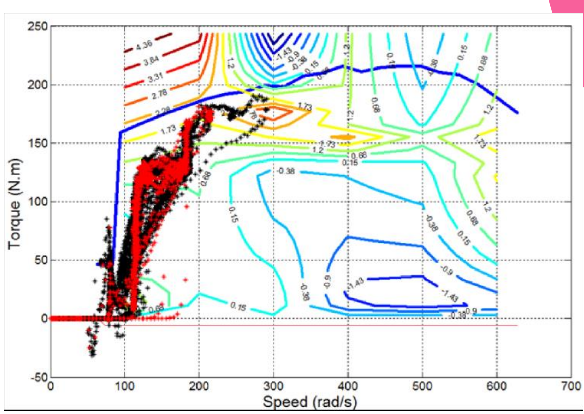
Engine & System Simulations

AUTONOMIE

POLARIS

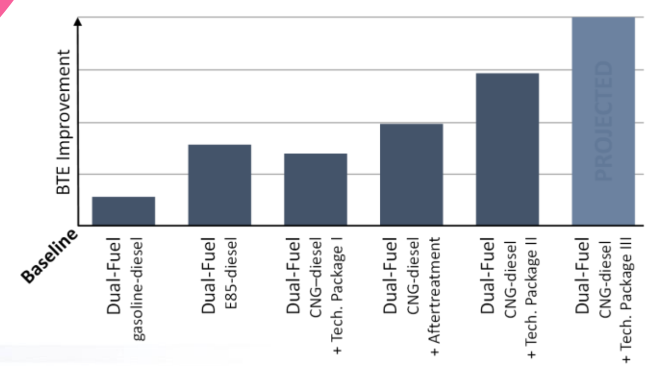
Understand Engine- Controls Interactions

55% BTE Class 8 Truck Engine Concept with VVA and Dual-Fuel Reactivity Controlled Compression Ignition (RCCI)



Maximize Real-World Efficiency Benefits

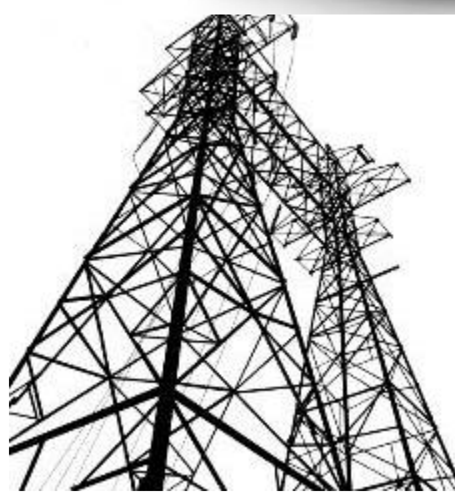
Translating E85 engine efficiency gains over gasoline into drive-cycle results using Hardware-in-the-Loop Operation

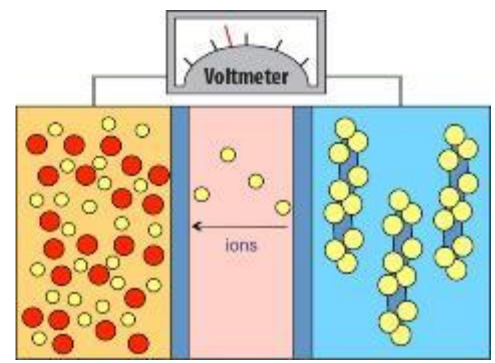


Joint Center for Energy Storage Research

DOE Energy Innovation Hub—

- Basic research to enable next-generation energy storage technologies for transportation and the grid
- Goal: “5-5-5”
  - Store 5 times the energy
  - Cost 5 times less
  - Accomplish in 5 years
- JCESR Team
  - Five DOE national laboratories
  - Five universities
  - Three battery manufacturers





Advanced Battery Materials Manufacturing R&D

New Materials Engineering Research Facility

- Advanced Battery Materials Synthesis and Manufacturing R&D capability provides unique resource to support development of "production ready" processes for industry---

- Leverages Argonne's capabilities in battery chemistry and materials development:
  - ✓ Experimental materials---10-100g batches
  - ✓ Material validation---~10kg
  - ✓ Process validation---~100kg

- Related facilities include a Cell Fab Lab and a Battery Post-test Diagnostic Lab.

View of pilot-labs in the Materials Engineering Research Facility. Cell fab line.

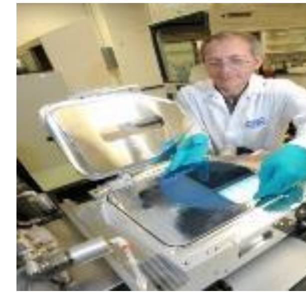
Chevy Volt Battery

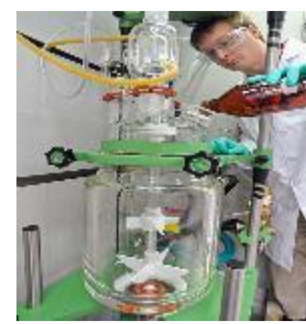
Argonne-developed cathode technology offers the longest-lasting energy available in the smallest, lightest package:

- 50—100 percent increase in energy storage capacity over conventional cathode material
- Lithium and manganese mixed-metal oxide
- Extends the operating time between charges
- Increases the calendar life
- Improves safety

Clean Energy Manufacturing R&D

Transformational technology for traditional and emerging industries





- Ultra-fast boriding in high-temperature heat-treating industries
- Hydrogen transport membranes for ethylene production
- Ultrananocrystalline diamond coating for pump seals
- Magnetron sputtering for automotive wear parts
- Atomic layer deposition for manufacture of nanostructured solar cells and synthesis of catalysts
- Resin-wafer technology for water management and biorefinery separations
- Manufacture of nanocomposite exchange-spring magnets
- Manufacture of ceramic film capacitors for power electronics
- Next-generation superconducting wind turbine drive train
- Surface treatment technology for wind system drive components

Development and Scale-up of Ultrafast Boriding—Case Study of a CRADA

- Argonne and Bodycote Americas partner and submit proposal in response to DOE solicitation
- Argonne proposes development of an novel Electrochemical Surface Treatment Technology
- Technology offers significant energy savings and cost reductions
- Process developed over 3 years from bench-scale to full scale

Ultrafast Boriding Scale-up

2700kg melt, 8000 Amp Pilot Refractory lined furnace

22", 130kg melt, 200 Amp Pilot

5", 6kg melt, 15 Amp Experimental Furnaces

2", 250g melt, 1.5 Amp

Nanomanufacturing for Energy Efficiency

- Goal: Develop scalable process technology for the production of nanotechnologies
- Research includes “Process Concept” studies and industrial cost-shared “Process Development” projects
  - High-Power Impulse Magnetron Sputtering of Ultra-hard and Low-friction Nanocomposite Coatings
  - Nanoscale Electrodeposition Process for Manufacturing High Selectivity Catalysts
  - Process Development Methods for Nanostructured Photovoltaics
  - Large-Scale Manufacturing of Nano-Particulate-Based Lubrication Additives for Improved Energy Efficiency and Reduced Emissions
  - Development, Characterization, Production, and Demonstration of Nanofluids for Industrial Cooling Applications

HiPMS Sputtering Chamber for production performance and cost Studies

Sample preparation for QC evaluation of thermal nanofluids

Summary -- Clean Energy Manufacturing at Argonne

Lead the development, engineering, and application of ***scalable*** production technologies for materials that will advance energy production, storage, distribution, and use:

- Materials: advanced cathode and anode materials, electrolytes, ultracapacitors, nanocomposites, coatings, membranes
- Processes: Demonstration of scalable production working with DOE and industry
- Nanomanufacturing: Manufacturing R&D of nanoscale materials for industrial technologies

New Materials Engineering Research Facility

Process development from bench-scale through commercial demonstration

Solutions through the integration of basic materials research with technology development

Summary and Contact Details

- Selected topics covered:
  - Advanced Photon Source: Materials characterization techniques
  - Simulation and modeling: Connected and Automated Vehicles
  - Battery Materials: from concept to Chevy Volt
  - Nanomanufacturing: Scalable processes for nanoscale materials in clean energy applications
- Many others topics areas available for TIR Pilot
- Argonne invites Industry Participants that may be interested in participating in this Pilot to a dialog on interests and fit
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