

# SSRL Update and Planning



Chi-Chang Kao

# Worldwide Synchrotron Facilities

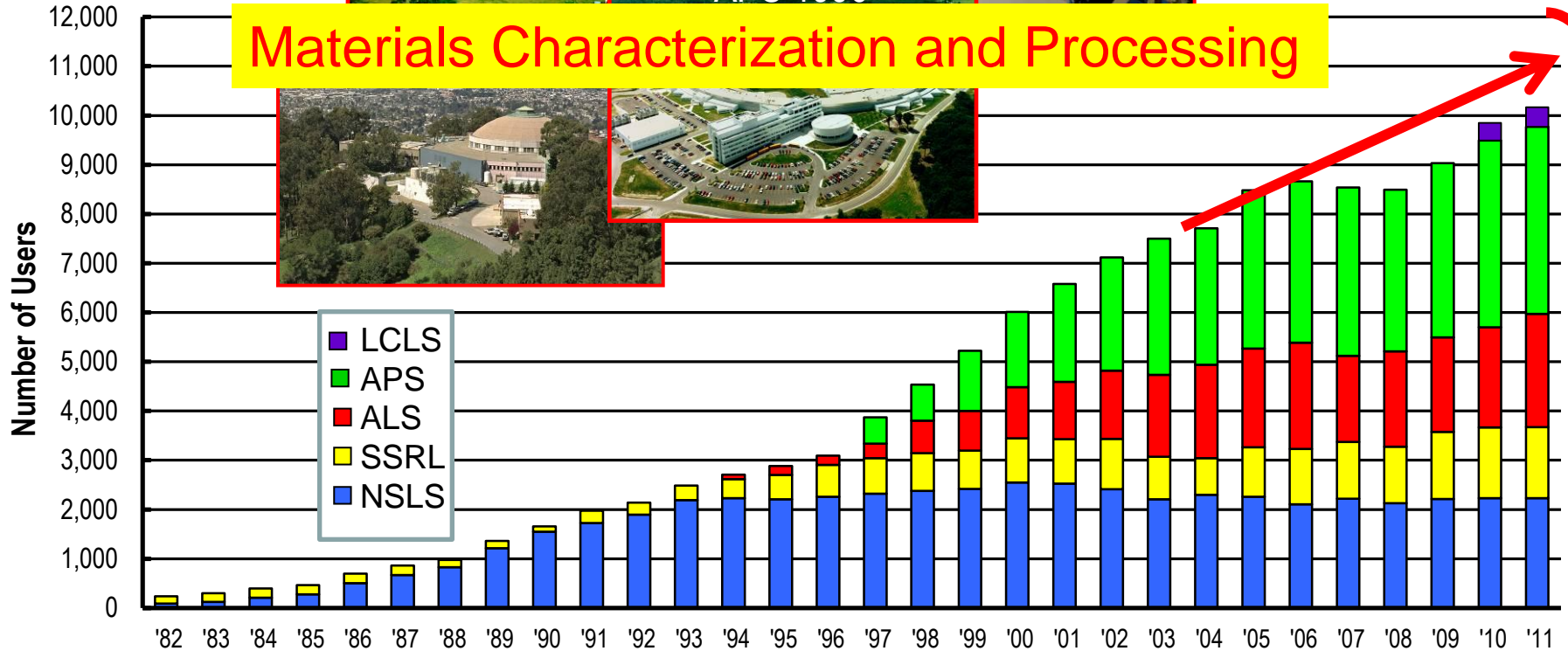


11-2011  
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# Support more users at SSRL



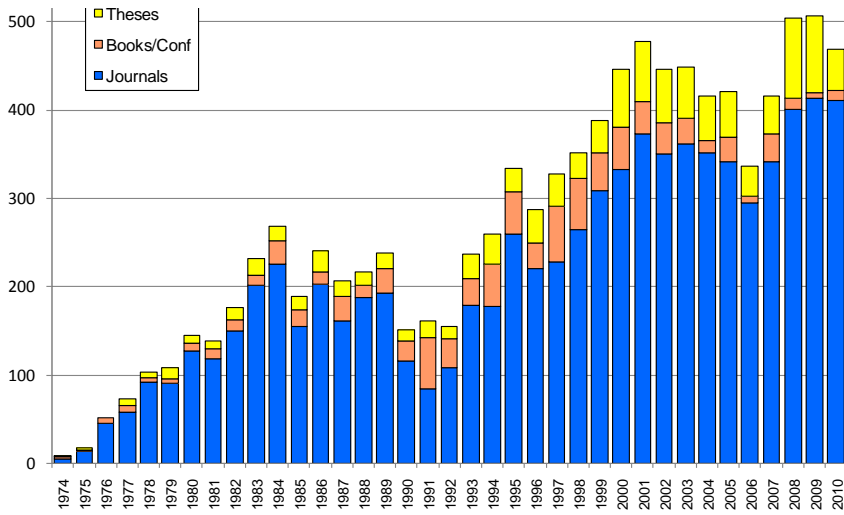
## Materials Characterization and Processing



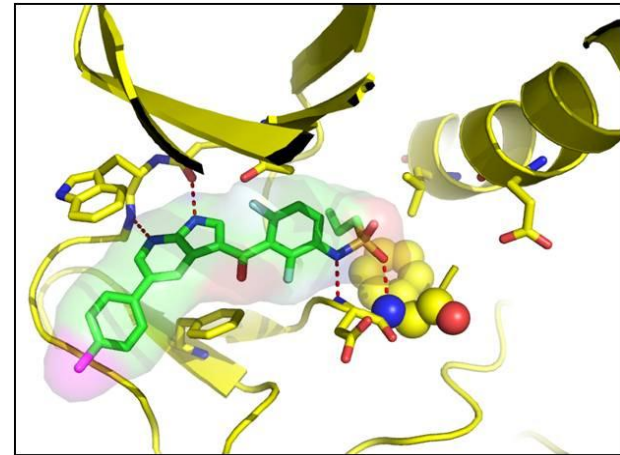
SSRL – 1500 user to > 2000 user

# Increase Productivity and Impact at SSRL

**~9,879 publications to date**



X-ray crystallography at SSRL, ALS, and APS has enabled Plexxikon Inc. to develop new drug against malignant melanoma.



Year	Total Journals	PRL	Science	Nature	Cell	Total High Impact	Nature other	PNAS	JACS	EST	Total High Impact*
2008	401	9	5	6	4	20	7	21	27	14	89
2009	413	5	6	9	1	20	16	16	22	14	88
2010	411	4	6	5	1	15	8	19	33	20	95

\* Includes additional high impact journals

# SSRL Beamline and Accelerator Plan



9 insertion devices

- 1 IVUN
- 1 EPU
- 1 ppm undulator
- 6 wigglers

3 undulator BL (11%)

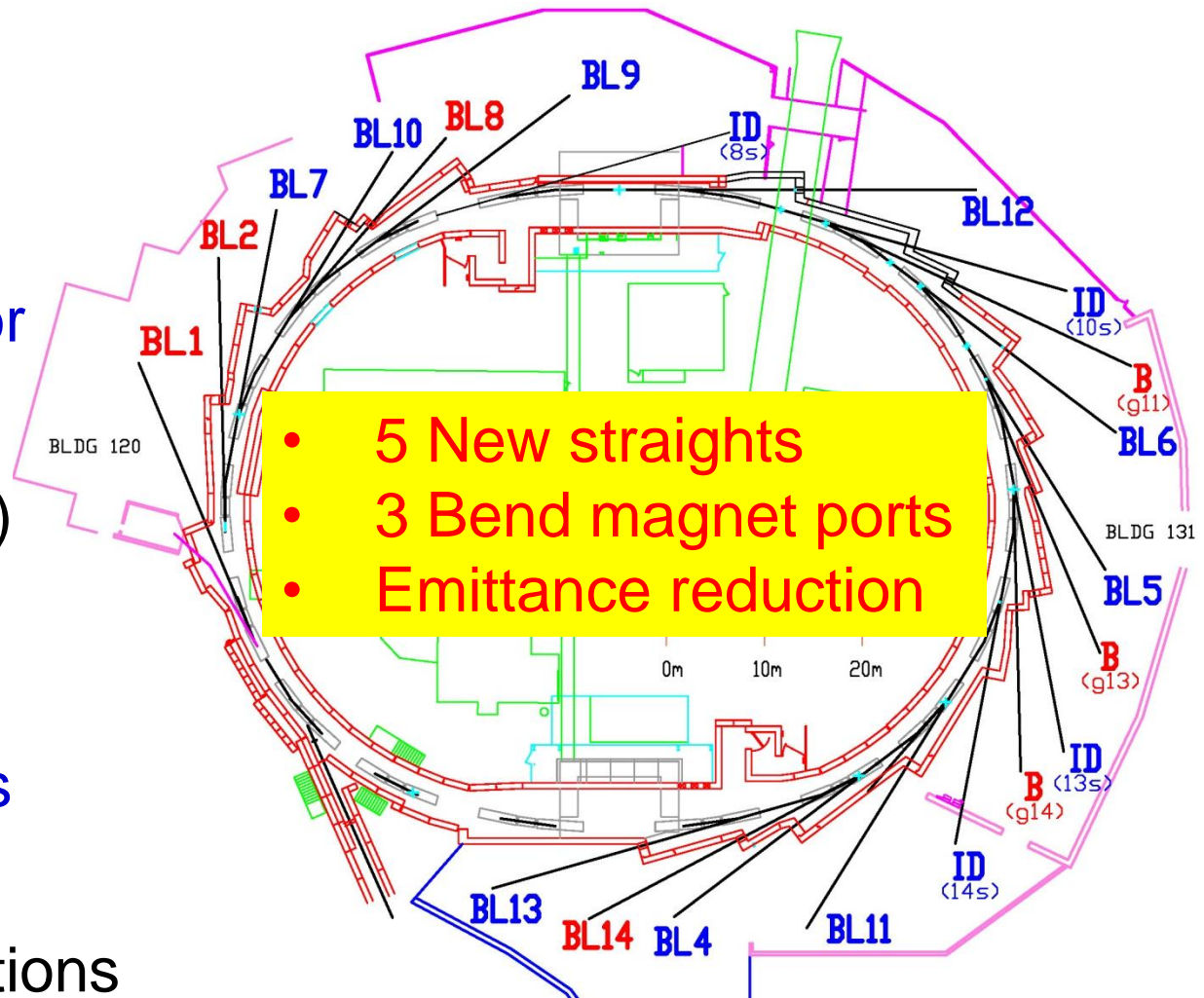
- 5 exp. stations

15 wiggler BL (56%)

- 18 exp. stations

9 bend BL (33%)

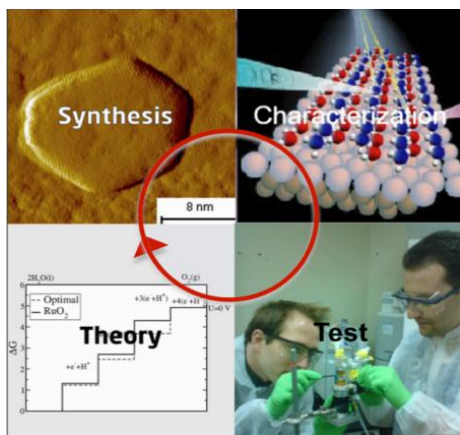
27 BL w/ 32 exp. stations



- 5 New straights
- 3 Bend magnet ports
- Emittance reduction

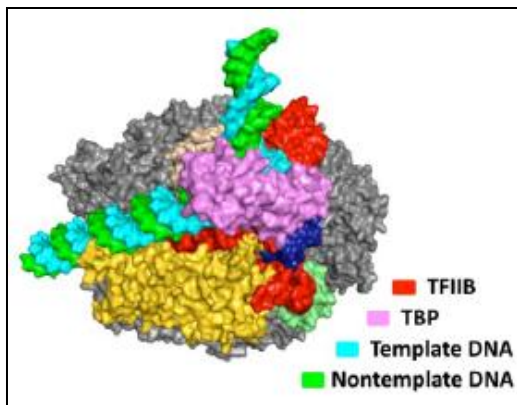
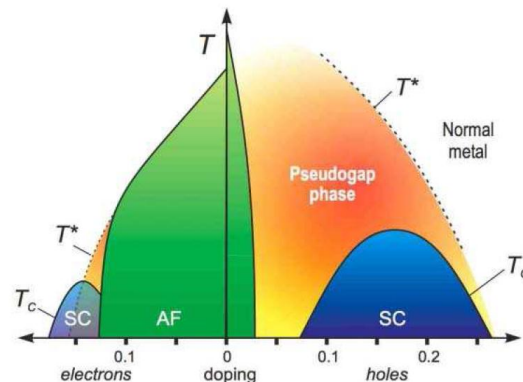
**~100M capital + ~10M operating increase**

# Scientific Opportunities



## Materials by Design

## Emergent Behaviors

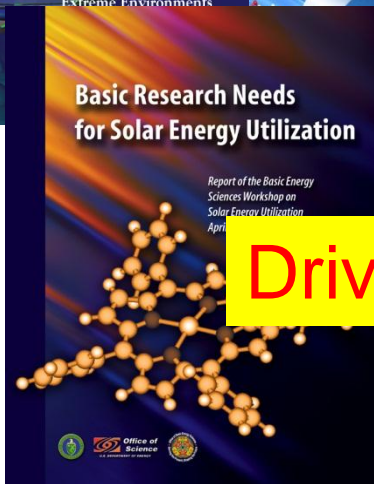
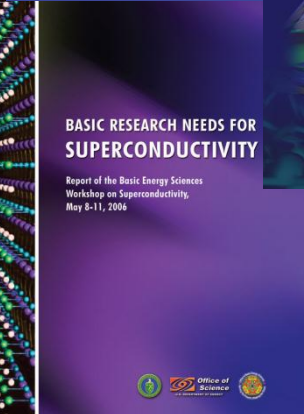
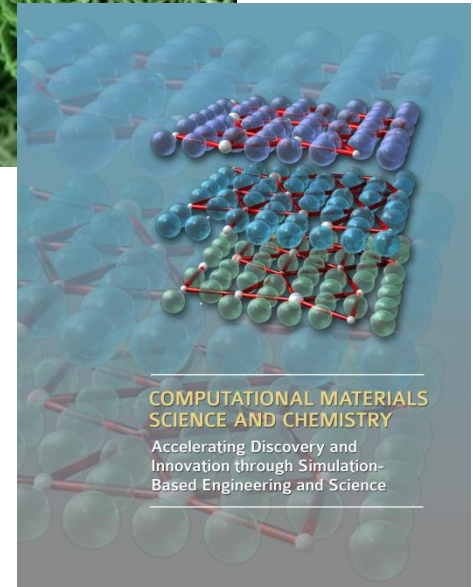
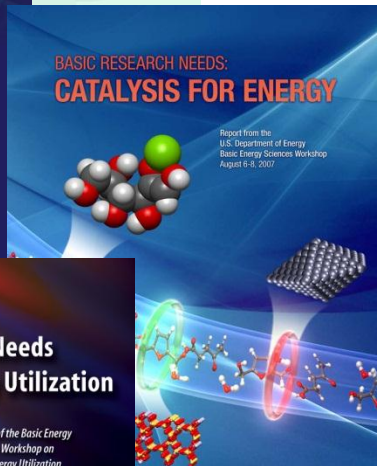
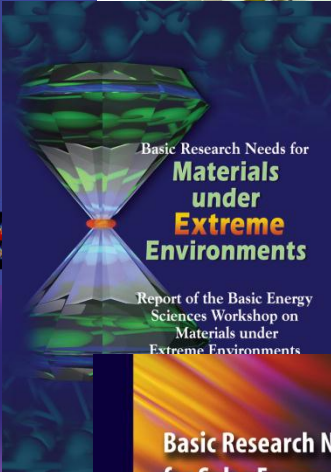
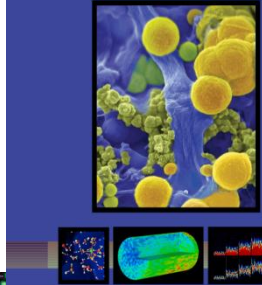
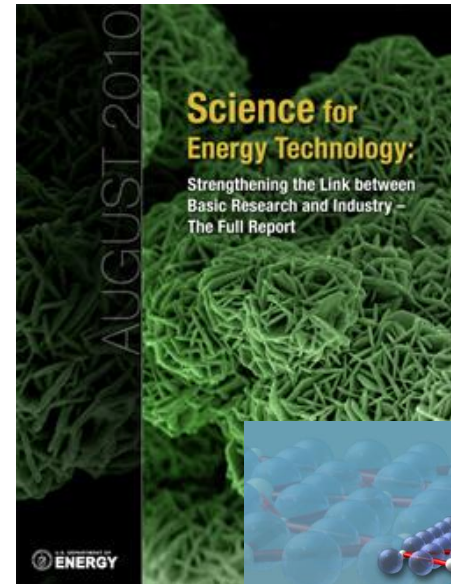
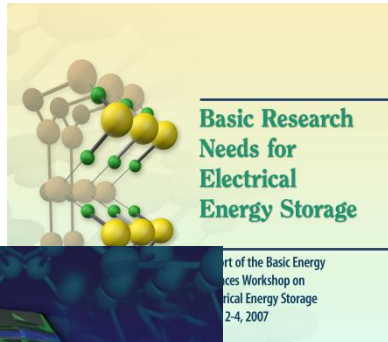
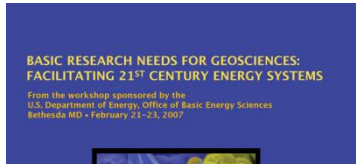


## Complex Bio-processes

# Strategy: Focus on Targeted Areas in Energy Research



## BES - Basis Research Needs Workshops



Drive new directions



Office of Science



# Basic - Applied Research Integration

## Grand Challenges

*How nature works*

- Controlling materials processes at the level of quantum behavior of electrons
- Atom- and energy-efficient syntheses of new forms of matter with tailored properties
- Emergent properties from complex correlations of atoms

## Discovery and Use-Inspired Basic Research

*Materials properties and chemical functionalities by design*

- Basic research for fundamental new understanding on materials or systems that may revolutionize or transform today's energy technologies
- Development of new tools, techniques, and facilities, including those

## Applied Research

- Basic research, often with the goal of addressing showstoppers on real-world applications in the energy technologies

## Technology Maturation & Deployment

- Scale-up research
- At-scale demonstration
- Cost reduction
- Prototyping
- Manufacturing R&D
- Deployment support

**Synchrotron Covers the Whole Range of Research**

- Manipulating matter with capabilities rivaling those of living things

- Controlling matter very far away from equilibrium

BESAC & BES Basic Research Needs Workshops

BESAC Grand Challenges Panel

DOE Technology Office/Industry Roadmaps

EFRC



**Kung, BESAC, July 2009**



# SLAC WORKSHOP ON THE APPLICATION OF X-RAY IN ENERGY RESEARCH



Define the focus and relevant energy problems that can be impacted by x-ray tools and then to identify a key set of energy problems where SLAC can play an important role.

- Assess national needs
- Define unique opportunities and problems to SLAC.
- How to exploit x-ray for the three topic areas identified by SLAC/SU (catalysis, solar, and battery).
- How to nurture leadership in this general area.



## Bay Area Photovoltaic Consortium



The Northeastern Center for Chemical Energy Storage  
A U.S. Department of Energy, Office of Science funded Energy Frontier Research Center



# SSRL Mission and Strategy



Provide *unique* photon science capabilities and facilities to researchers from around the world to address important problems from *discovery to deployment*

- Leveraging and enabling the growth of Photon Sciences at SLAC (and Stanford)
- Exploring the properties of SPEAR3 and synergy between SSRL and LCLS
- Establishing a new paradigm of utilization of major national facilities

**Problem**



**Tools**



**Empower  
users**

# Materials by Design: Catalysis



Grand Challenges

*How nature works*

Discovery and Use-Inspired Basic Research

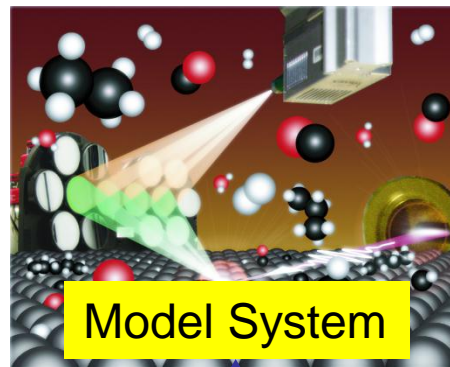
*Materials properties and chemical functionalities by design*

Applied Research

Technology Maturation & Deployment

SUNCAT

Develop new technique with LDRD

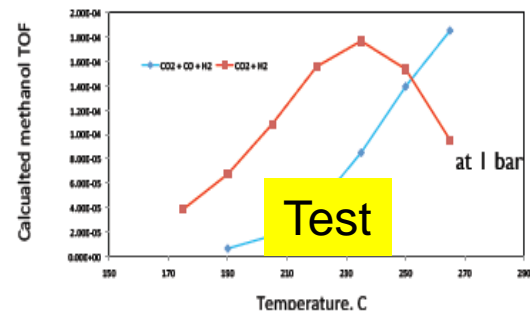


Model System

SUNCAT

Characterization Challenges:

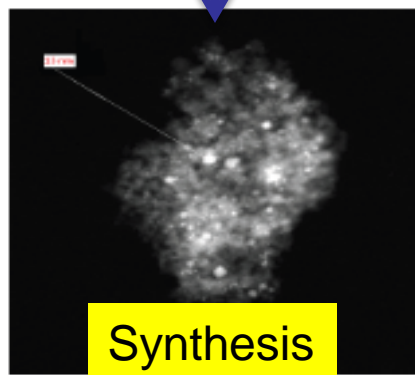
- Surface & Bonding
- Experimental descriptors
- High throughput screening



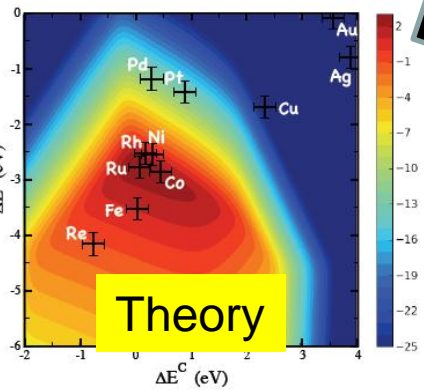
Test

SUNCAT

Engage PNNL, LBNL, Industry



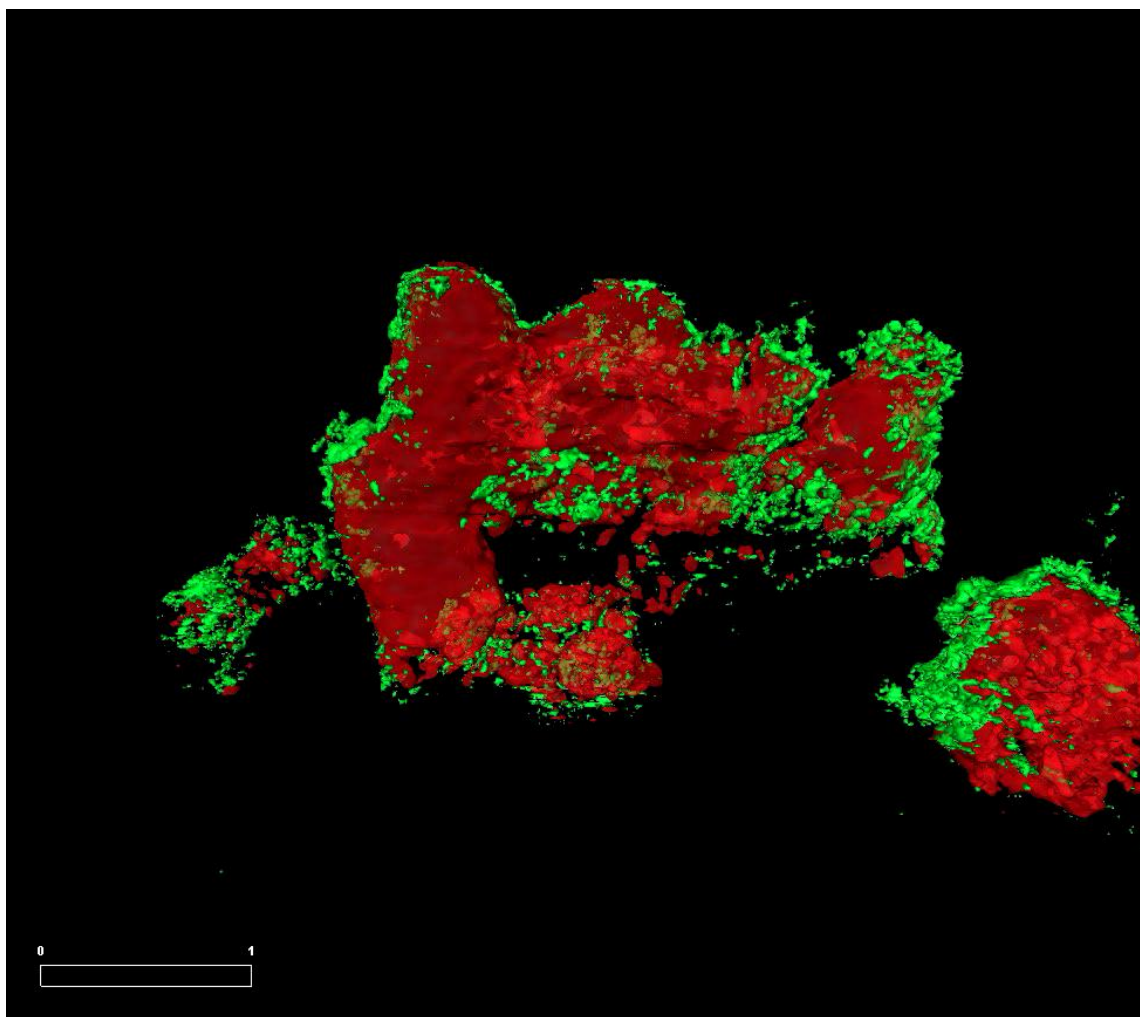
Synthesis



Theory



# 3D in-situ Chemical Mapping of Electrode



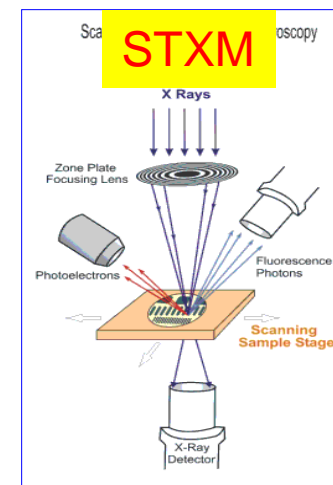
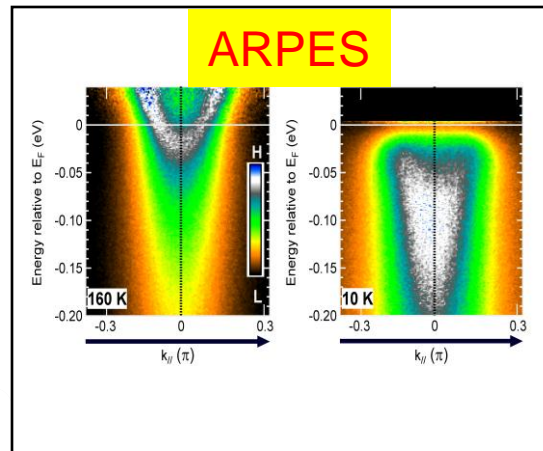
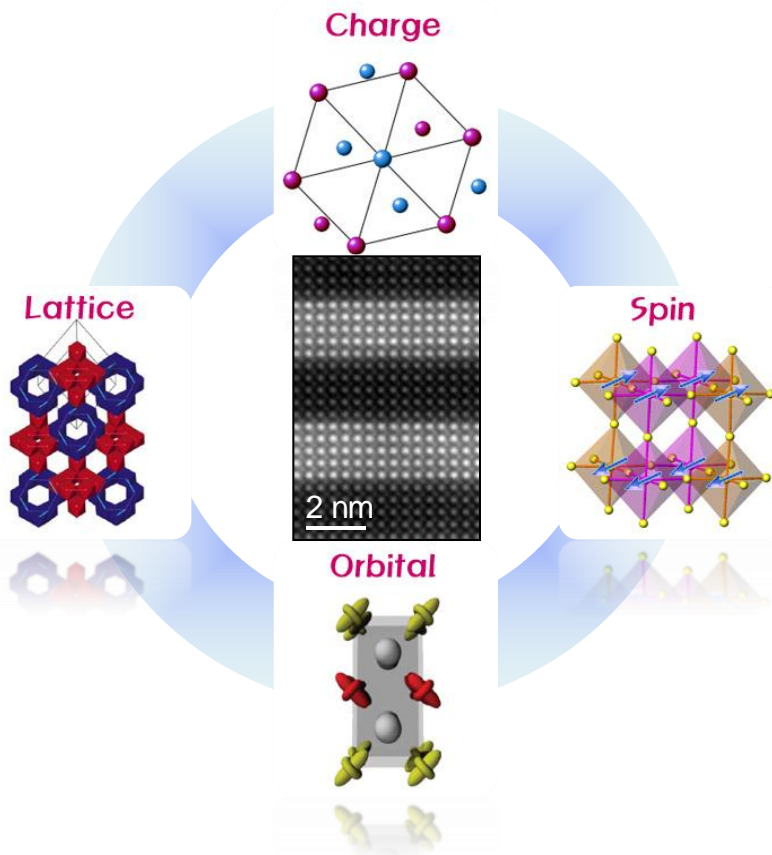
- One major barrier to the increased prevalence of electric vehicles is their batteries; today's lithium-ion technology has yet to meet energy density, cost, life cycle or safety goals
- Studies conducted at SSRL BL6-2, combining full-field transmission x-ray microscopy (TXM) with XANES to follow morphological & chemical changes, at 10's of nm scale
- Provided 2D and 3D chemical information about the changes taking place in lithium-ion battery electrodes with applied charge, revealing the location of nickel and nickel oxide

Meirer, *et al.*, *J. Synchrotron Rad.* **18**, 773 (2011);  
Nelson, *et al.*, *Appl. Phys. Lett.* **98**, 173109 (2011)

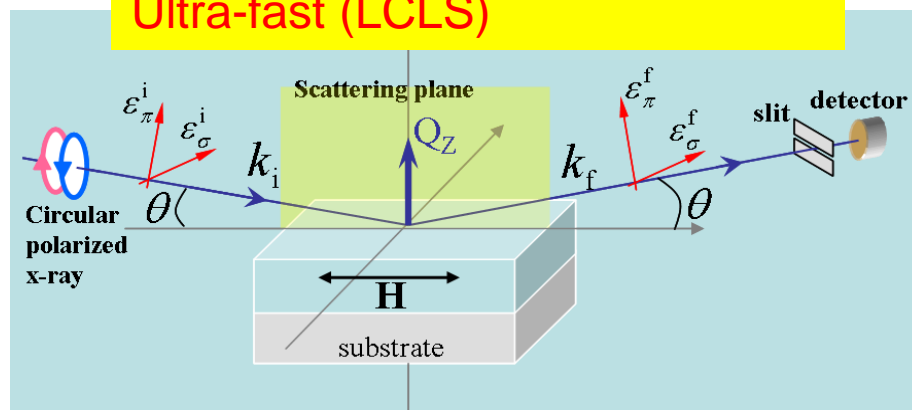
# Emergent Behaviors: Strongly Correlated Electrons



SIMES



**Soft X-ray Resonant Scattering:  
High Magnetic field (SSRL)  
Ultra-fast (LCLS)**



# Empower user community to improve overall scientific productivity



Publications & Presentations

New Researcher Outreach

Workshops & Training

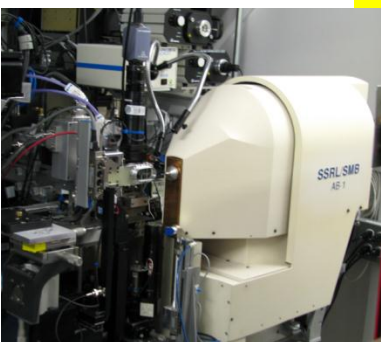
## User Experiment Life Cycle

Post-experiment Data Analysis Management

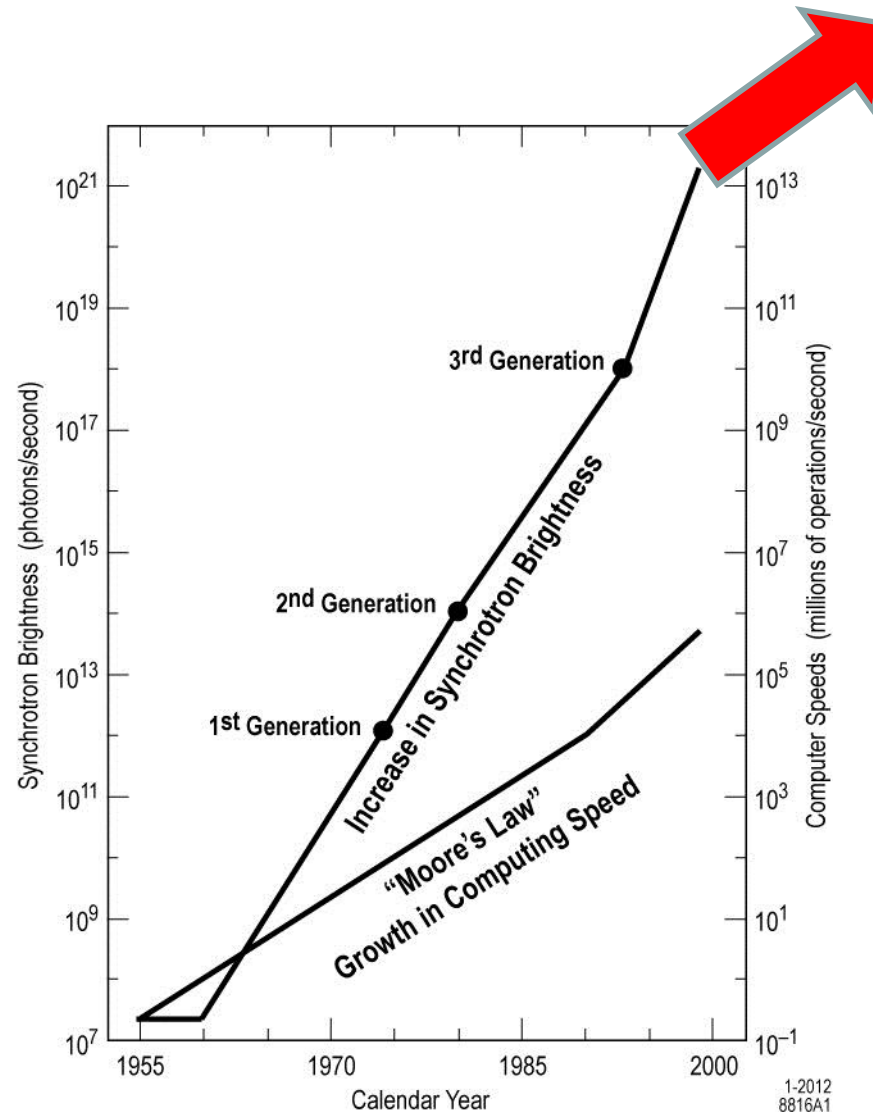
Online analysis visualization

Tools to better design experiments

- ASCR-BES Workshop
- Theory Institute for Photon Science

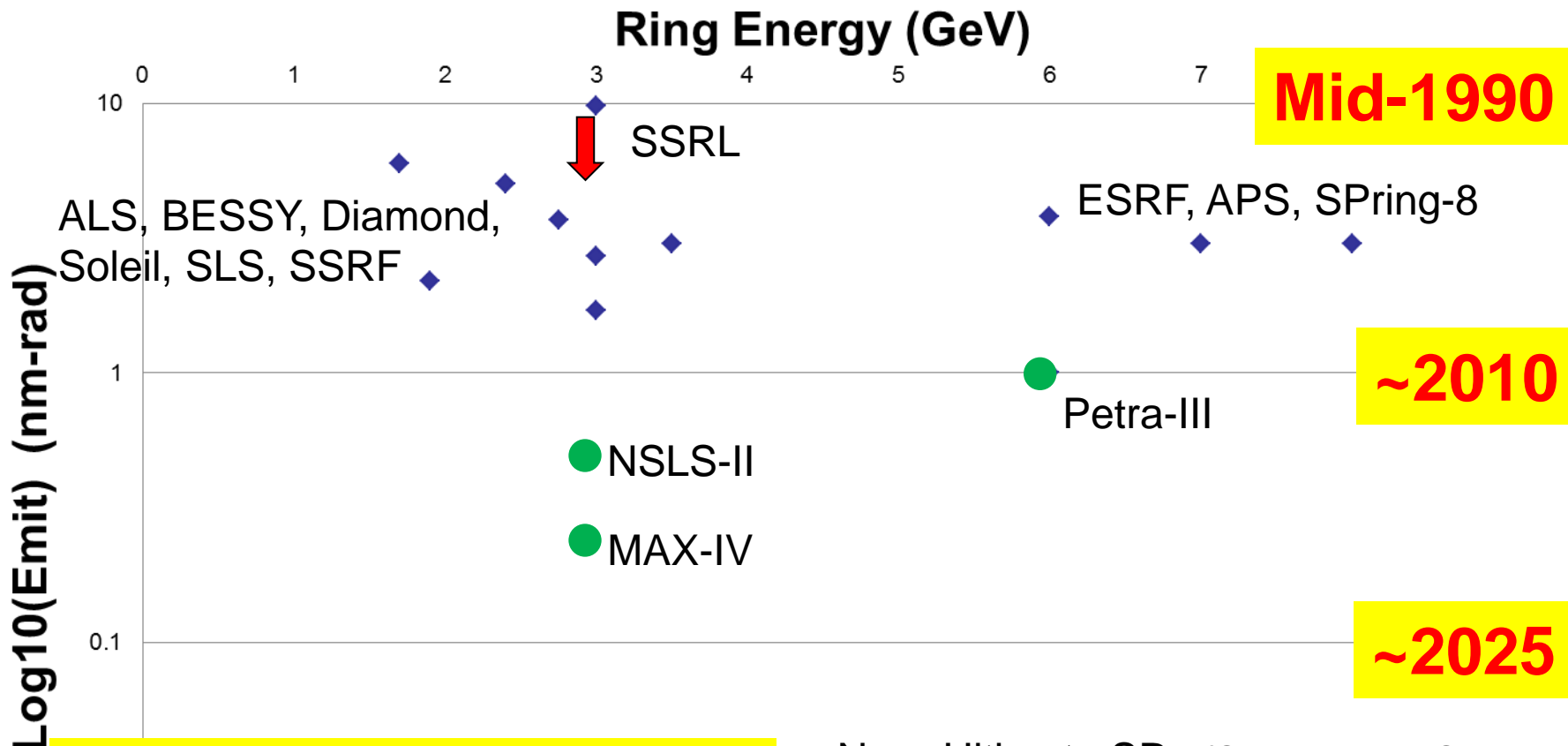


# Long Term SSRL Future: PEP-X



**100-1000 X**

# Development of Storage Rings



**Mid-1990**

**~2010**

**~2025**

- **Diffraction limit CW source for ~1 Å**
- **Round beam**

- Near-Ultimate SRs (SPring-8, DESY, China) **PEP-X**
- APS USR7 – 3 km
- ERLs (Cornell, KEK)