

# Advanced Photon Source

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# ADVANCED PHOTON SOURCE

72

X-ray  
beamlines

6,000  
Experiments  
*per year*

2,000  
Publications  
*per year*

5,500  
Unique users  
*in a typical year*  
*~2000 grad students*  
*~1000 postdocs*

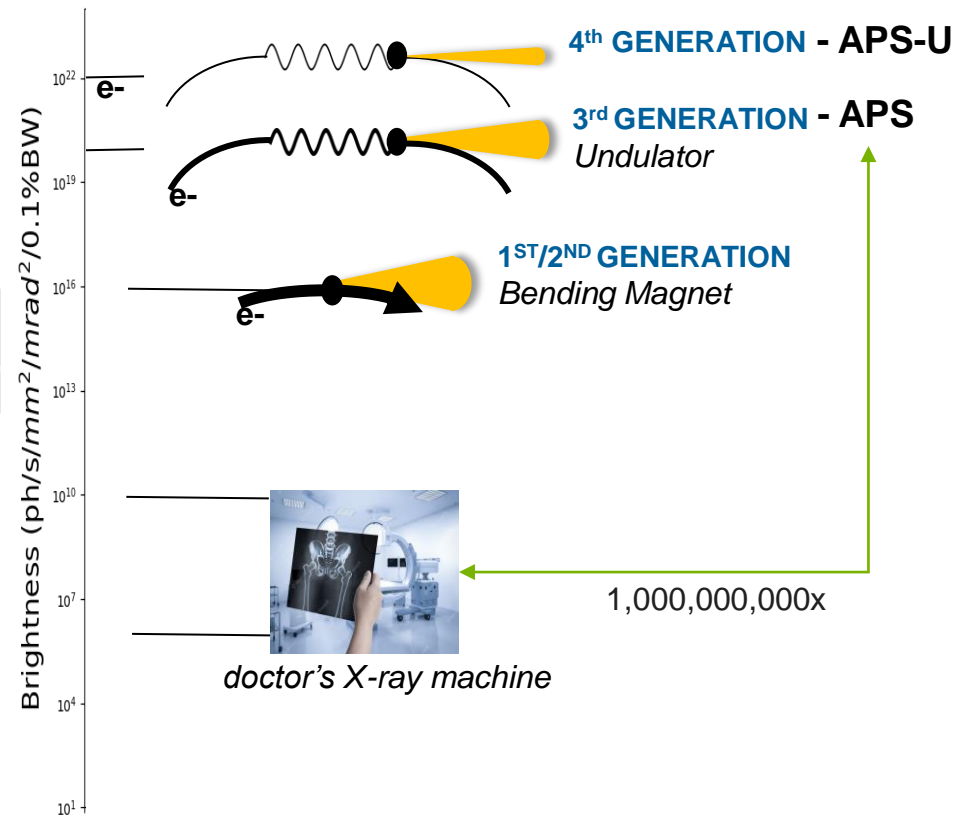
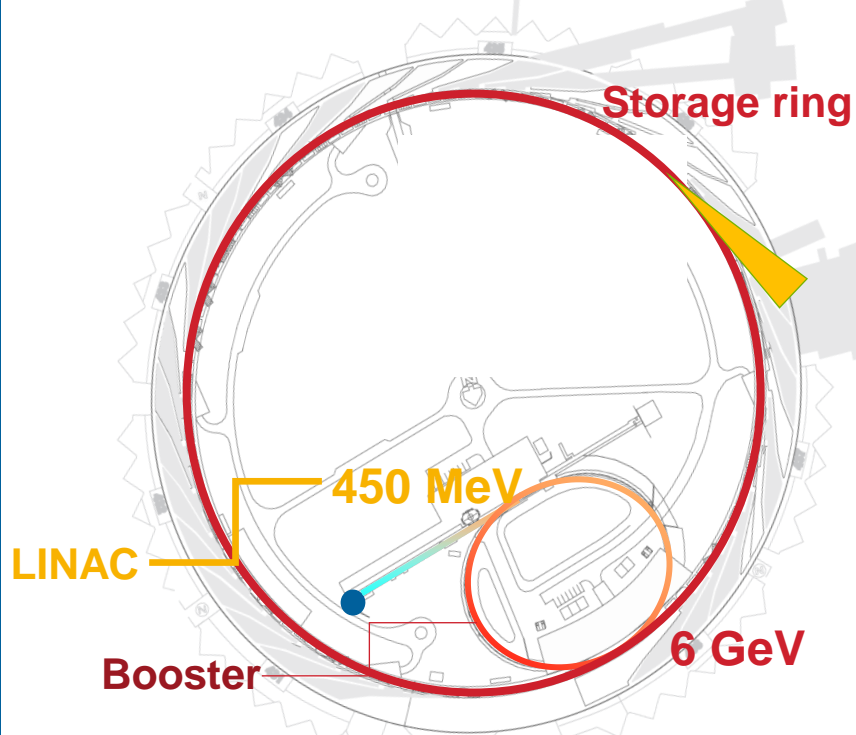
Countless  
Societal impacts



An illustration of the gradient descent method  
producing a structure for CAPRI target T1000



# SYNCHROTRON: AN EXTREMELY BRIGHT X-RAY SOURCE



# THE POWER OF HARD AND HIGH-ENERGY X-RAYS

Hard and high-energy X-rays

- Deep penetration

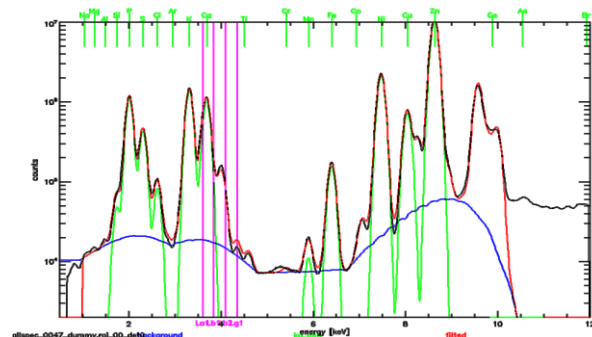
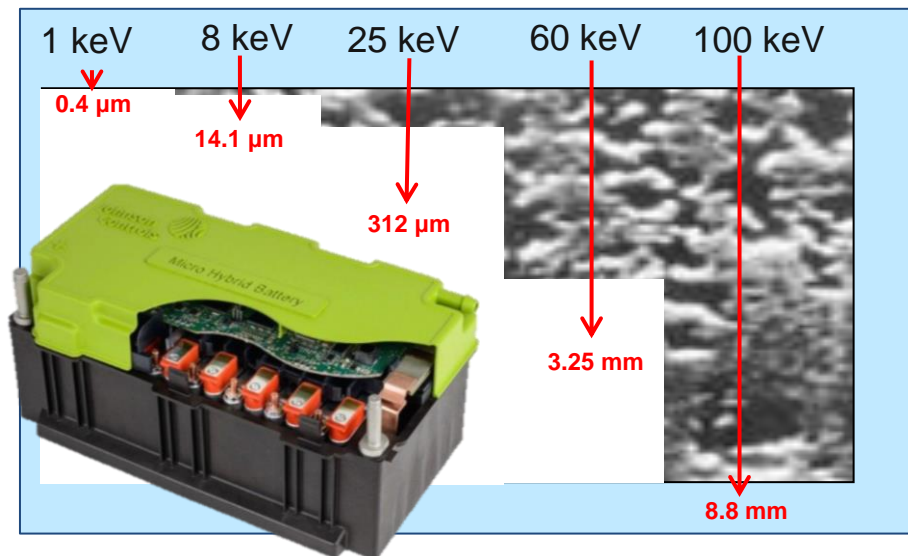


- X-ray Diffraction:

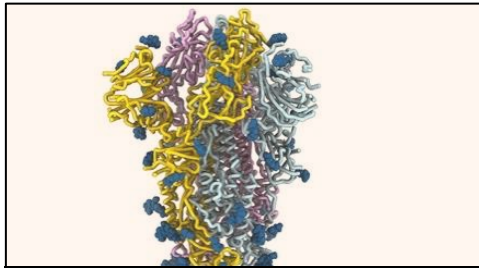
Comprehensive reciprocal space information

- X-ray Fluorescence & Spectroscopy:

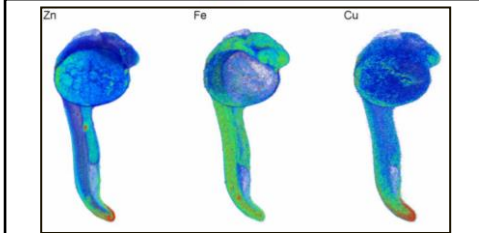
Chemical information, with trace sensitivity



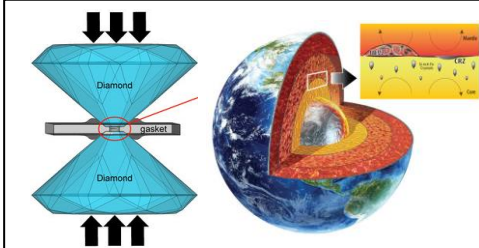
# A WIDE RANGE OF SCIENCE



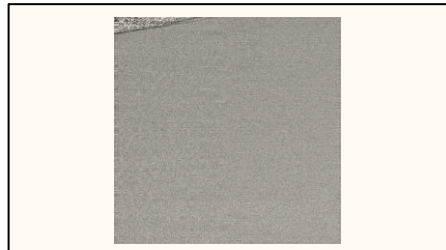
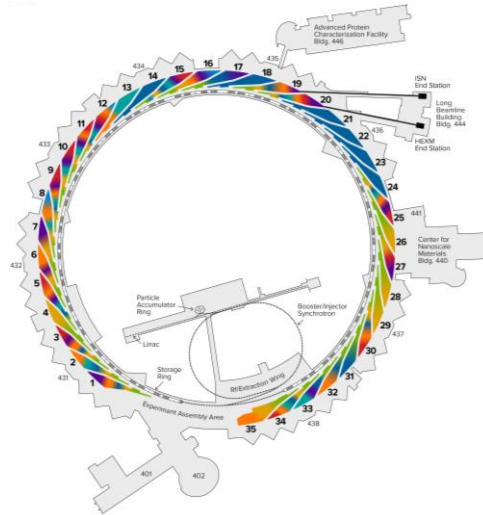
Structural biology



Developmental biology



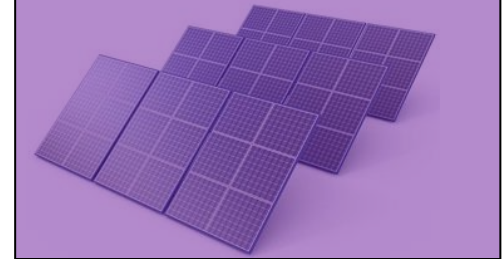
Earth science



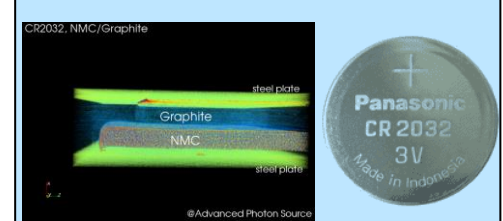
Fuel science



Shock compression

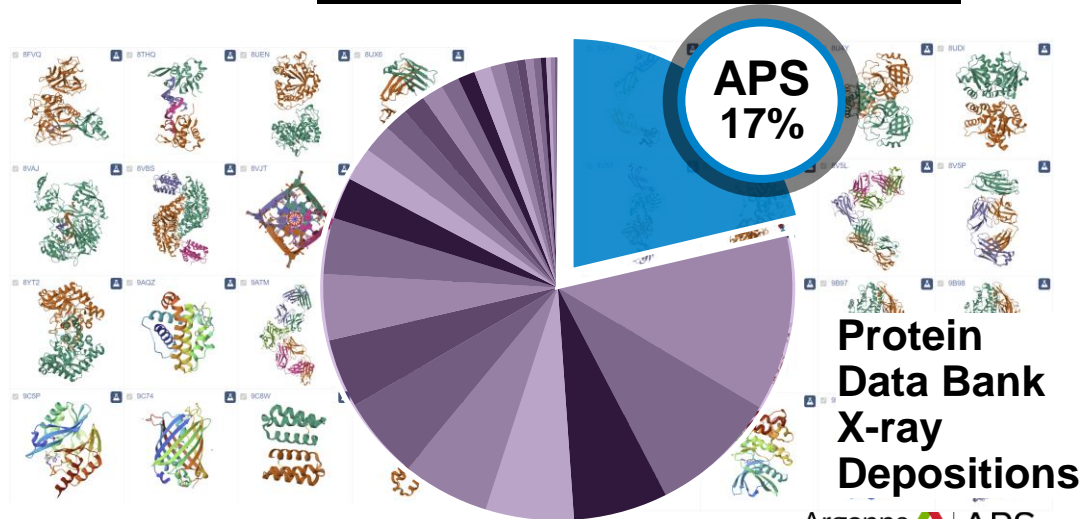
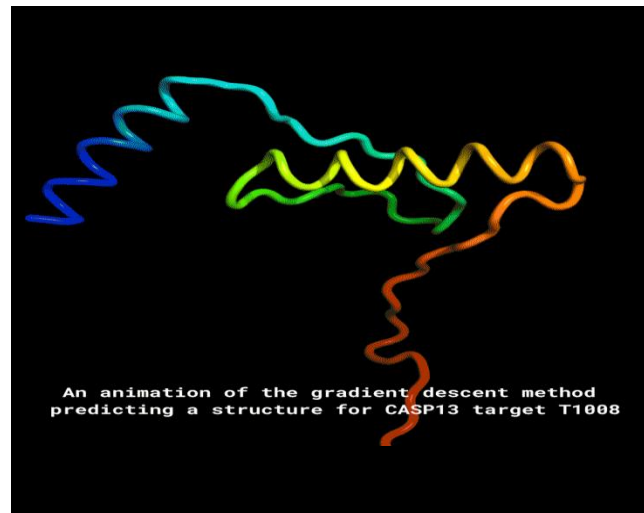


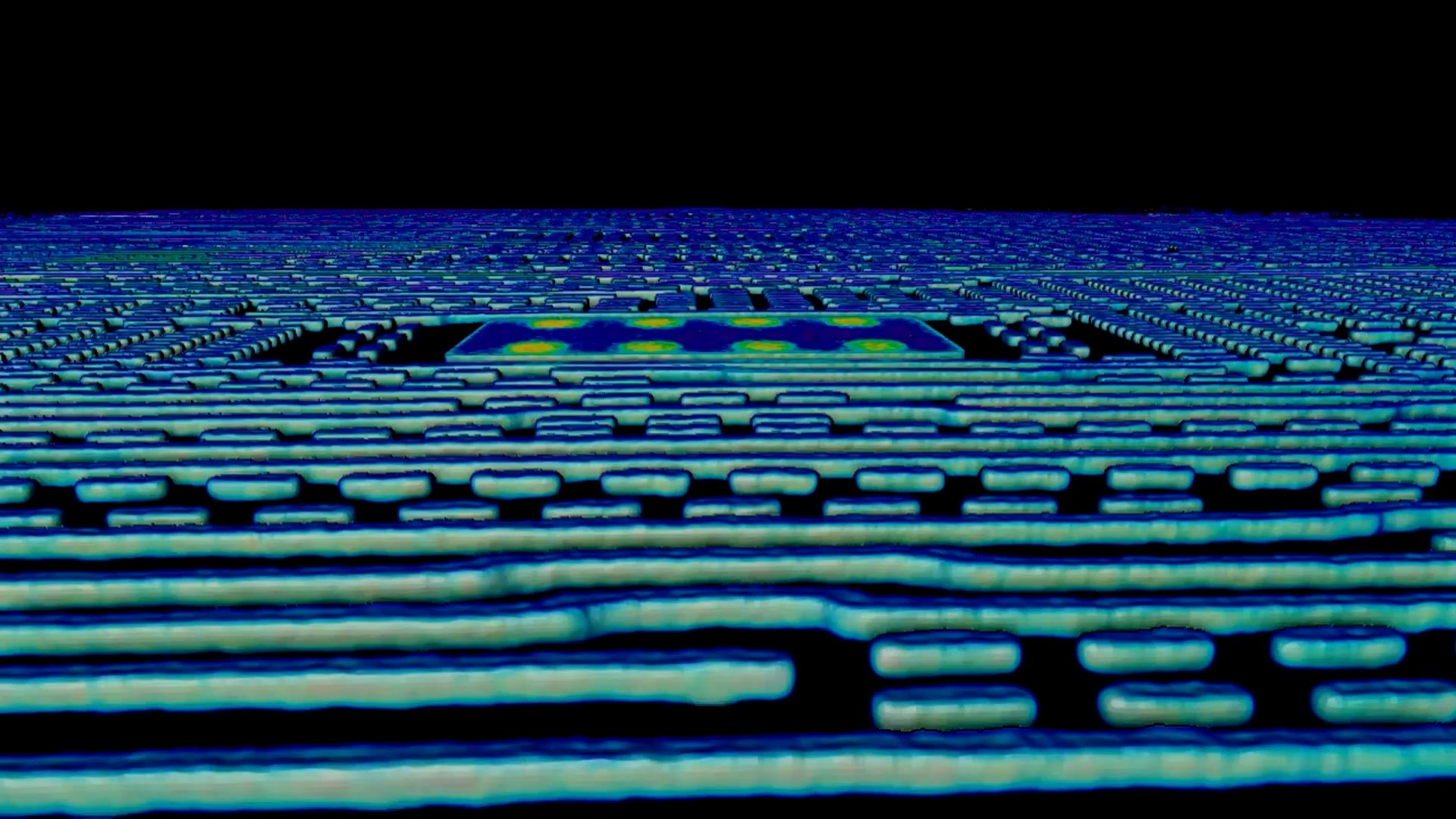
New photovoltaics



Batteries

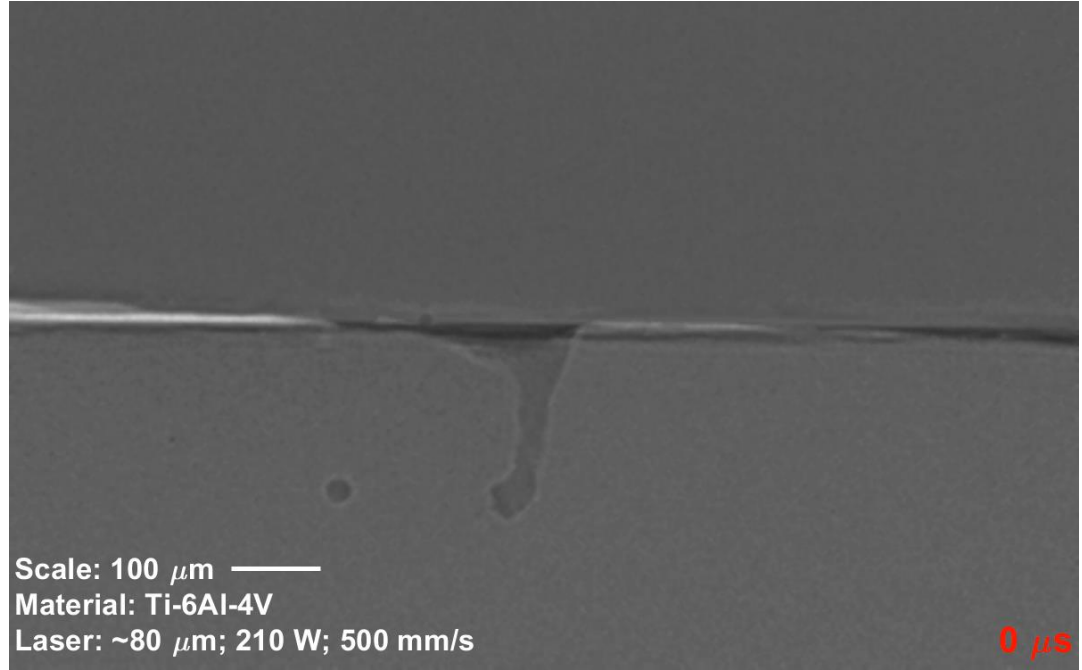
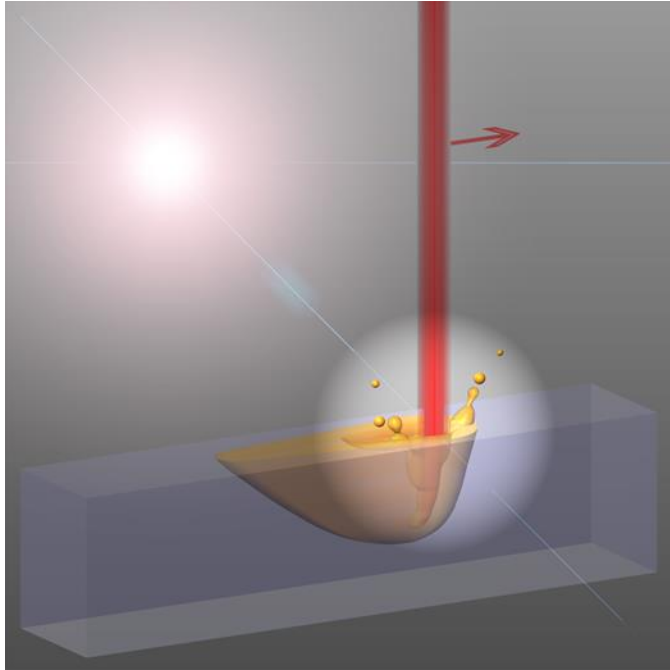
# STRUCTURAL BIOLOGY





# ADDITIVE MANUFACTURING

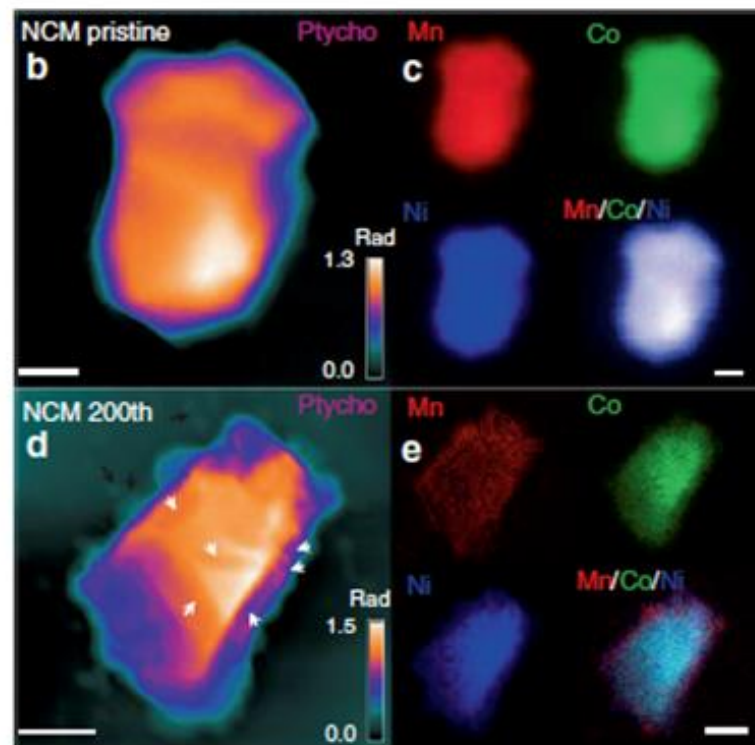
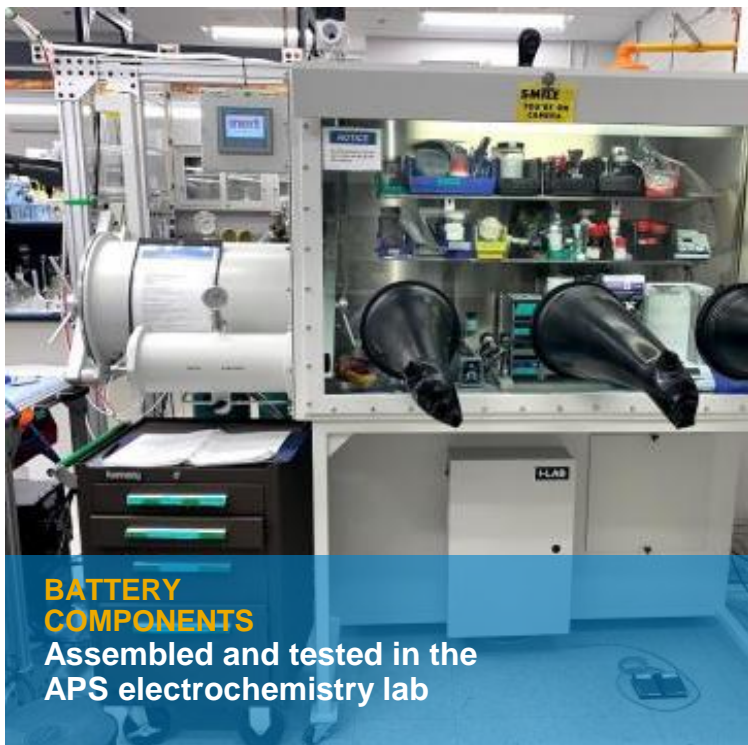
## X-ray imaging of metal 3D printing process



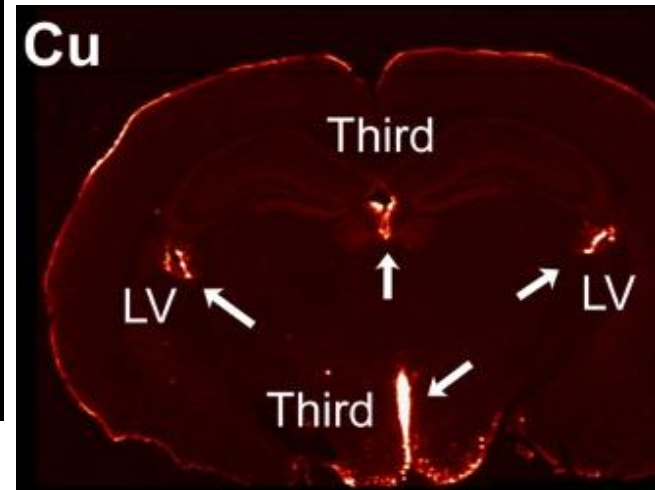
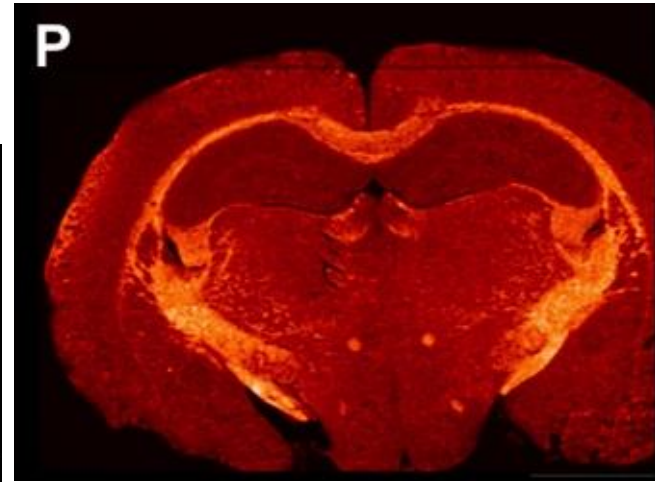
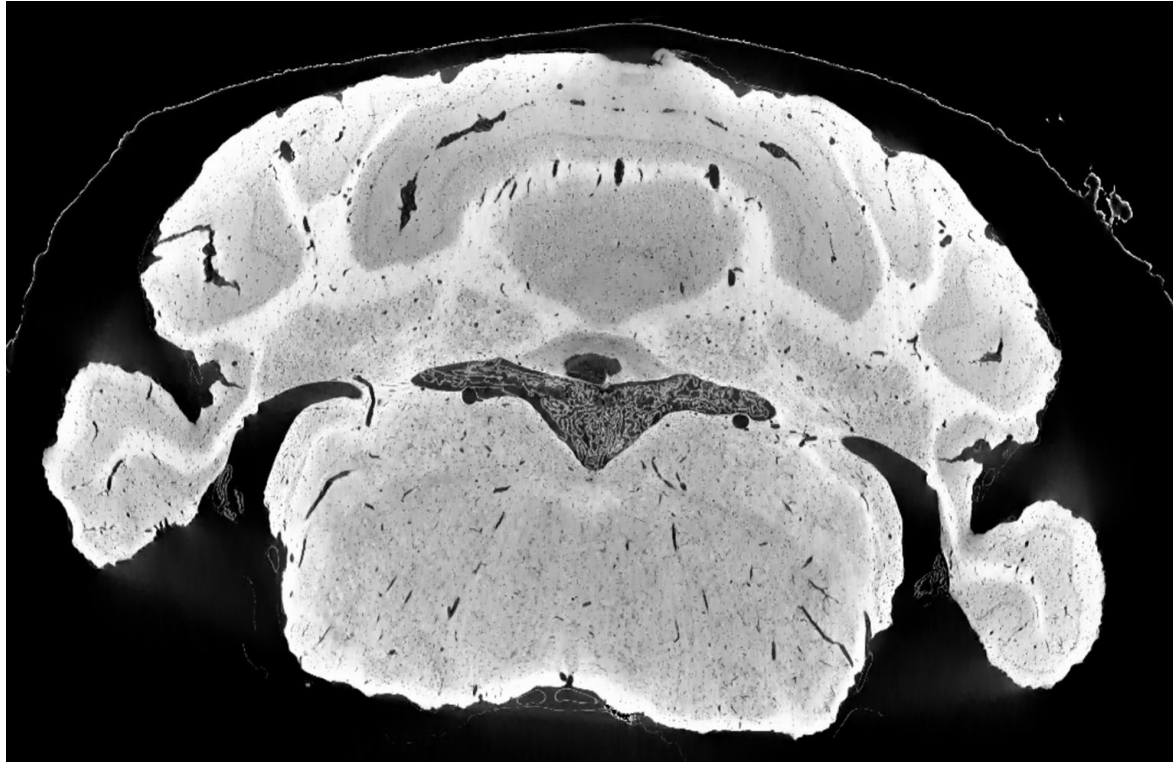


# BATTERY MATERIALS

## Understanding the degradation process with X-ray beams

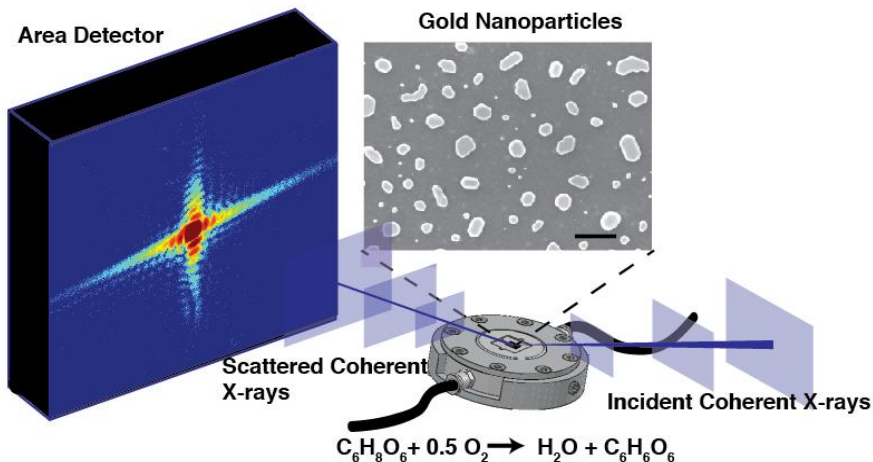


# BETTER UNDERSTANDING THE BRAIN



# BRAGG CDI SCIENCE

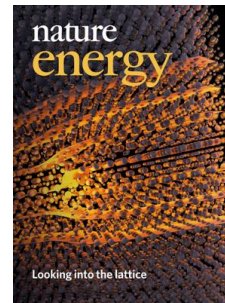
## Operando Nanoscale Imaging



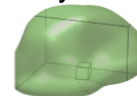
### Increased coherent flux enables

- Increase in both temporal and spatial resolution.
  - Rapid charging battery.
  - Catalysis with more realistic reagents.
  - Phase transformation for energy storage.
  - Multi-Bragg peak full strain tensor imaging.

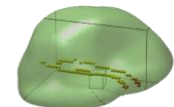
### Dislocation in Li-Ion battery



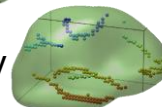
4.0V



4.3V

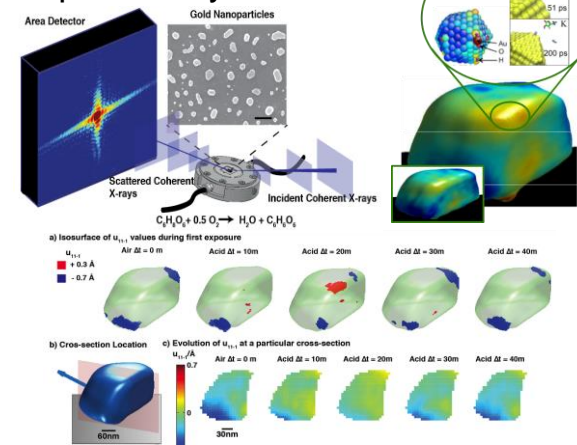


4.4V



Singer, A., et al. *Nature Energy*, 3(8), 641–647. Aug. 2018

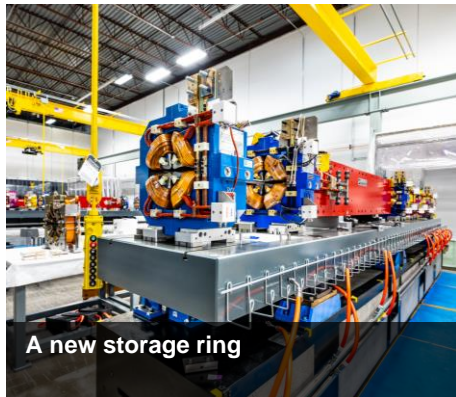
### Liquid Catalysis



A. Ulvestad, et al. *J. Phys. Chem. Lett.*, vol. 7, no. 15, pp. 3008, Aug. 2016.



x500



A new storage ring



New experimental facilities



\$815M



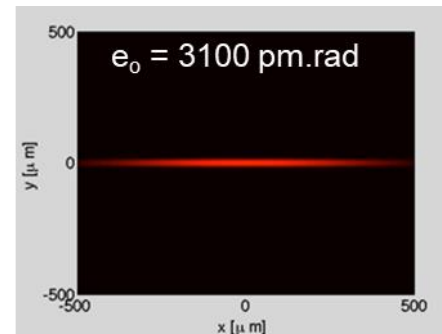
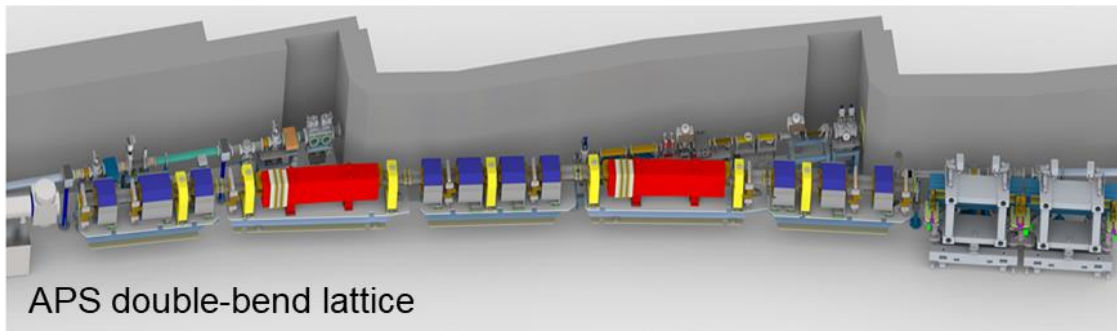
New infrastructure, which will house two feature beamlines



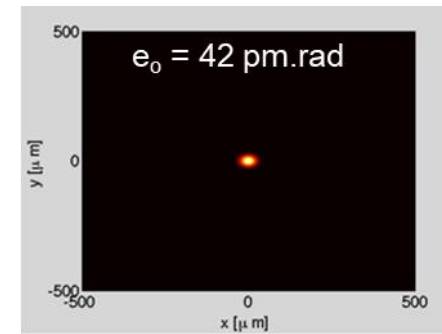
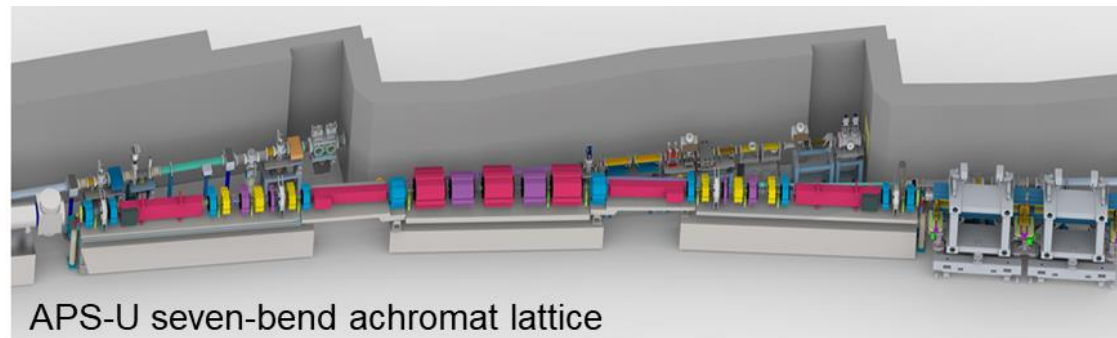
\$1.5B

# The APS upgrade opened the door to ultra-low emittance

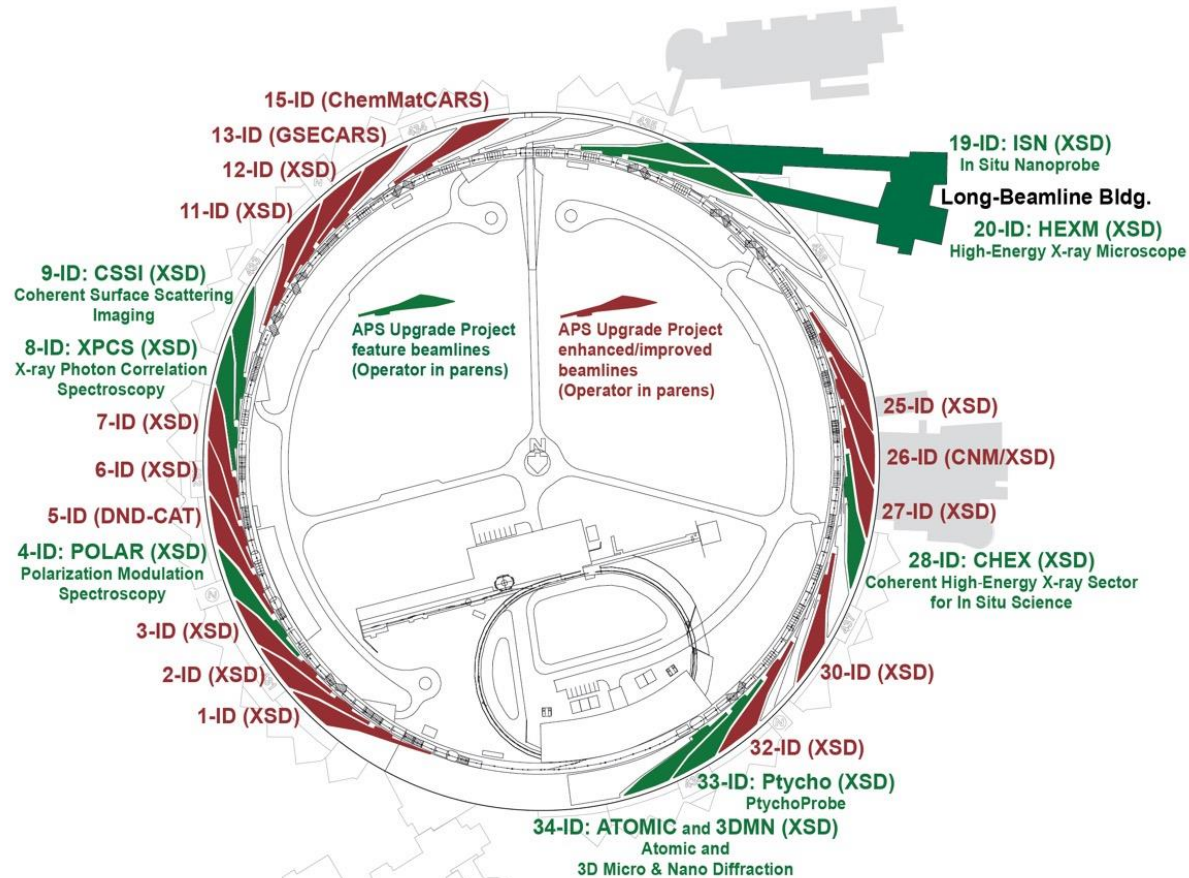
## ORIGINAL APS



## UPGRADED APS



# APS UPGRADE PROJECT - BEAMLINES



- New and updated insertion devices for optimum spectral performance.
- 9 new feature beamlines + Long Beamline Building (green)
- 14 enhanced and improved beamlines
- 18 bending magnet beamline relocations
- CAT beamline upgrades (off-project)
- Other XSD BL upgrades (off-project)

# BEAMLINE COMMISSIONING PROGRESS

MARCH 3, 2025

KEY 1 Installation Ongoing 2 Installation Complete 3 Ops Commissioning 4 Technical Commissioning 5 Scientific Commissioning and Early Experiments 6 Restart of General User Program

Beamline	Restart Status	Beamline	Restart Status	Beamline	Restart Status	Beamline	Restart Status
1-BM-B,C XSD	1 2 3 4 5 6	10-BM-B MR-CAT	1 2 3 4 5 6	16-ID-D,E HPCAT-XSD	1 2 3 4 5 6	25-ID-D,E:ASL XSD	1 2 3 4 5 6
1-ID-B,C,E XSD	1 2 3 4 5 6	10-ID-B MR-CAT	1 2 3 4 5 6	17-BM-B XSD	1 2 3 4 5 6	26-ID-C CNM/XSD	1 2 3 4 5 6
2-BM-A,B XSD	1 2 3 4 5 6	11-BM-B XSD	1 2 3 4 5 6	17-ID-B IMCA-CAT	1 2 3 4 5 6	27-ID-B XSD	1 2 3 4 5 6
2-ID-D XSD	1 2 3 4 5 6	11-ID-B XSD	1 2 3 4 5 6	18-ID-D Bio-CAT	1 2 3 4 5 6	28-ID-B,C XSD	1 2 3 4 5 6
2-ID-E XSD	1 2 3 4 5 6	11-ID-C XSD	1 2 3 4 5 6	19-BM-D XSD	1 2 3 4 5 6	28-ID-D,E XSD	1 2 3 4 5 6
3-ID-B,C,D XSD	1 2 3 4 5 6	11-ID-D XSD	1 2 3 4 5 6	19-ID-E:ISN XSD	1 2 3 4 5 6	28-ID-F XSD	1 2 3 4 5 6
4-ID-B,G,H:POLAR XSD	1 2 3 4 5 6	12-BM-B XSD	1 2 3 4 5 6	20-BM-B XSD	1 2 3 4 5 6	28-ID-G:CHEX XSD	1 2 3 4 5 6
5-BM-B DND-CAT	1 2 3 4 5 6	12-ID-B XSD	1 2 3 4 5 6	20-ID-D,E:HEXM XSD	1 2 3 4 5 6	29-ID-C,D XSD	1 2 3 4 5 6
5-ID-B,C,D DND-CAT	1 2 3 4 5 6	12-ID-E XSD	1 2 3 4 5 6	21-ID-D LS-CAT	1 2 3 4 5 6	30-ID-B,C XSD	1 2 3 4 5 6
6-BM-A,B COMPRES/XSD	1 2 3 4 5 6	13-BM-C GSECARS	1 2 3 4 5 6	21-ID-F LS-CAT	1 2 3 4 5 6	31-ID-D LRL-CAT	1 2 3 4 5 6
6-ID-B,C XSD	1 2 3 4 5 6	13-BM-D GSECARS	1 2 3 4 5 6	21-ID-G LS-CAT	1 2 3 4 5 6	31-ID-E XSD	1 2 3 4 5 6
6-ID-D XSD	1 2 3 4 5 6	13-ID-C,D GSECARS	1 2 3 4 5 6	22-ID-D SER-CAT	1 2 3 4 5 6	32-ID-B,C XSD	1 2 3 4 5 6
7-BM-B XSD	1 2 3 4 5 6	13-ID-E GSECARS	1 2 3 4 5 6	22-ID-E SER-CAT	1 2 3 4 5 6	33-BM-C XSD	1 2 3 4 5 6
7-ID-B,C,D XSD	1 2 3 4 5 6	14-ID-B BioCARS	1 2 3 4 5 6	23-ID-B GM/CA-XSD	1 2 3 4 5 6	33-ID-C:PTYCHO XSD	1 2 3 4 5 6
8-ID-E,I:XPCS XSD	1 2 3 4 5 6	15-ID-B,E ChemMatCARS	1 2 3 4 5 6	23-ID-D GM/CA-XSD	1 2 3 4 5 6	34-ID-F:ATOMIC XSD	1 2 3 4 5 6
8-BM-B XSD	1 2 3 4 5 6	15-ID-C,D ChemMatCARS	1 2 3 4 5 6	24-ID-C NE-CAT	1 2 3 4 5 6	34-ID-E:3DMN XSD	1 2 3 4 5 6
9-ID-D: CSSI XSD	1 2 3 4 5 6	16-BM-B,D HPCAT-XSD	1 2 3 4 5 6	24-ID-E NE-CAT	1 2 3 4 5 6	35-ID-B,C,D,E DCS	1 2 3 4 5 6
9-BM-B,C XSD	1 2 3 4 5 6	16-ID-B HPCAT-XSD	1 2 3 4 5 6	25-ID-C XSD	1 2 3 4 5 6		

# BIG DATA FOR THE FUTURE OF SCIENCE

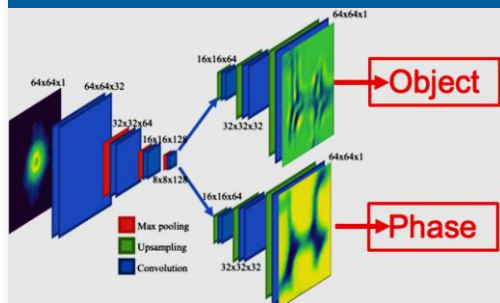
Unique co-location of brightest synchrotron and leadership computing





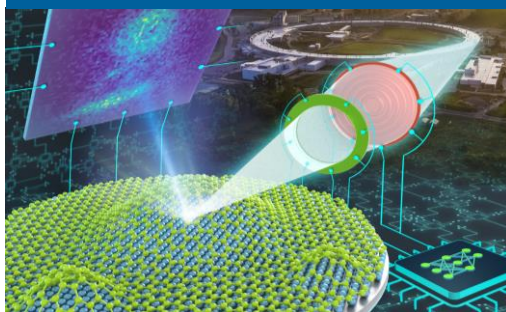
# VISION: AI-POWERED X-RAY SCIENCE

## AI4Analysis



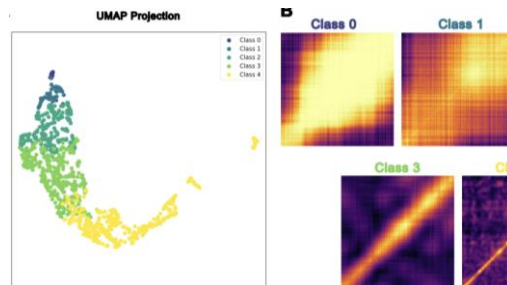
- AI@Edge: >100X faster & (sometimes) more accurate analysis
- Enables real-time analysis on Gb/s data streams

## AI4Steering



- AI@Edge: Self-driving experiments and instruments: maximize info gain in minimal time

## AI4Knowledge



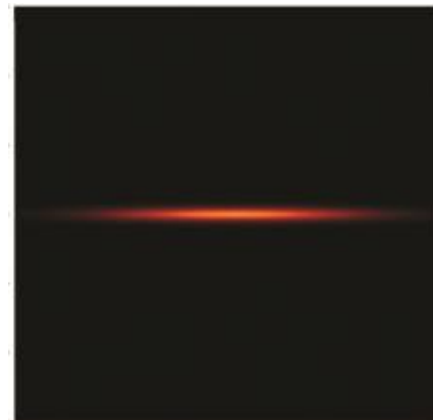
- Learn material physics directly from measurements

# HOW CAN YOU MAKE USE OF THESE RESOURCES ?

- Beamtime is available to users through a competitive proposal process.
- Proposal submission deadlines 3 times a year.
- General User Proposals
  - Open to anyone, just have to write a good proposal. Proposals get reviewed by committee, assigned based on scores. Users typically come for experiments 3-4 days (9-12 shifts), carry out experiments with help of beamline scientist
  - No cost for beamtime, the expectation is that results will be published.
- Most importantly: try to identify possible beamlines in advance, and **contact the beamline scientist** well **before writing the proposal**.
  - **Often possibility to do feasibility studies before actual experiment, to acquire preliminary data for proposals (beamtime, funding)**
- **Please contact me with any questions: [svogt@anl.gov](mailto:svogt@anl.gov)**

# THE FUTURE IS BRIGHT

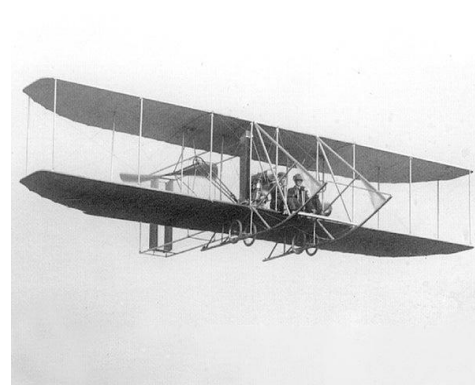
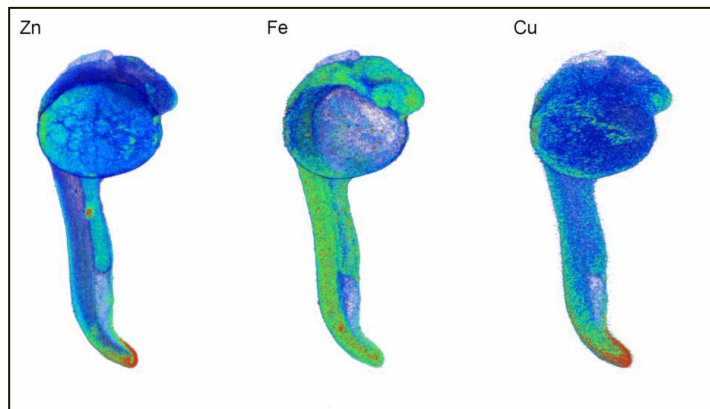
- ⇒ Up to 500x higher brightness
- ⇒ Micro/nanoprobe: increased flux
- ⇒ smaller spot sizes
- ⇒ increased contrast, better SNR
- ⇒ higher speed



Old APS beam



Upgraded APS beam



500x





Thank you!



Argonne  
NATIONAL LABORATORY



# ADDITIONAL RESOURCES

- APS user information (including how to register as a user):

<https://www.aps.anl.gov/Users-Information>

- Proposals and proposal deadlines (next one is June 2025 for beamtime in the fall):

<https://www.aps.anl.gov/Users-Information/About-Proposals/Proposal-Deadlines-and-Meetings>