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U.S. Department of Energy

UChicago ▶ Argonne LLC

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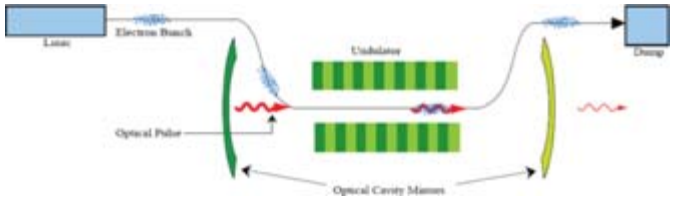
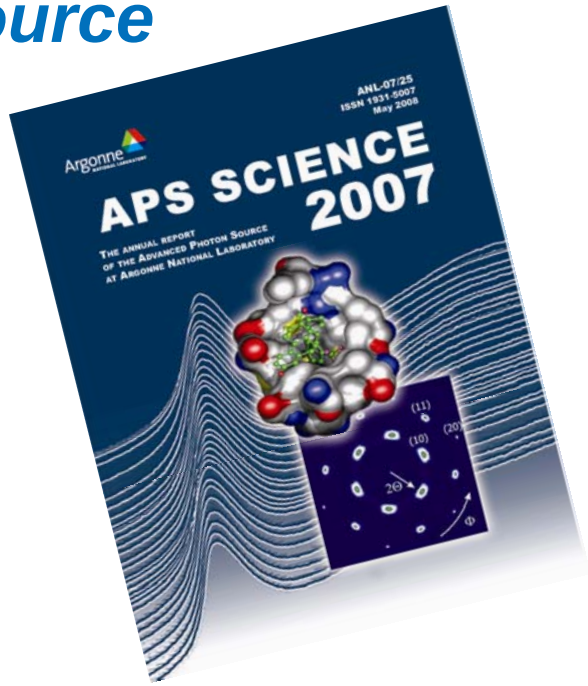
Update on the Advanced Photon Source





J. Murray Gibson
Director, Advanced Photon Source

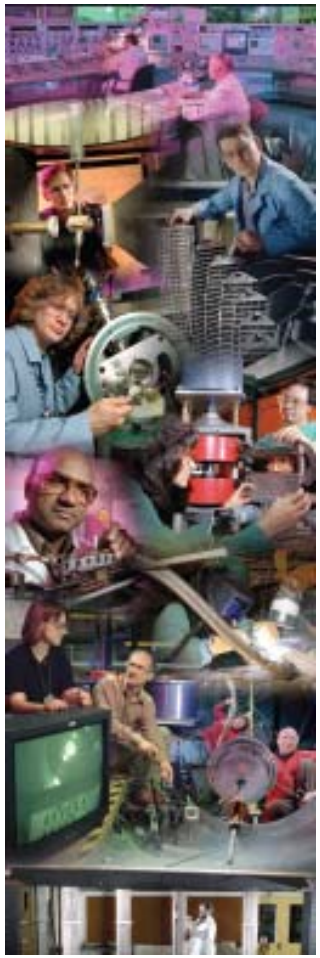
Associate Laboratory Director for Scientific User Facilities

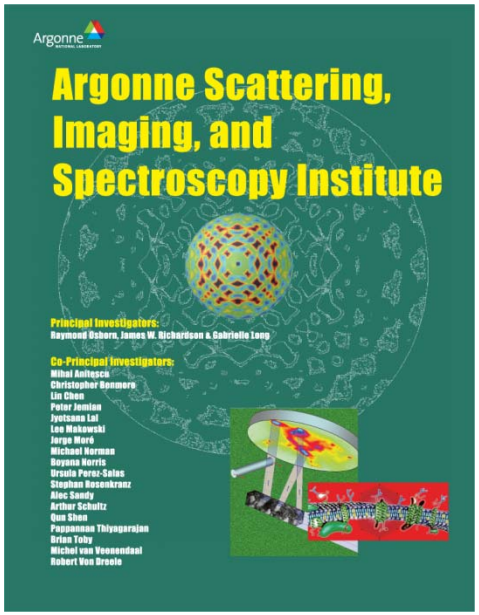
Argonne National Laboratory

Users Week

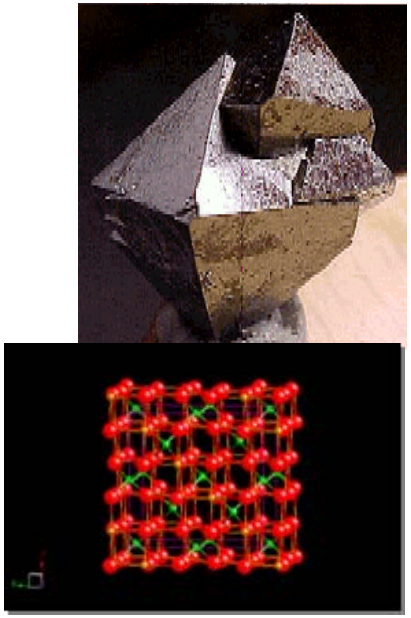
May 5th 2008

The Intense Pulsed Neutron Source – an era ends, another begins…





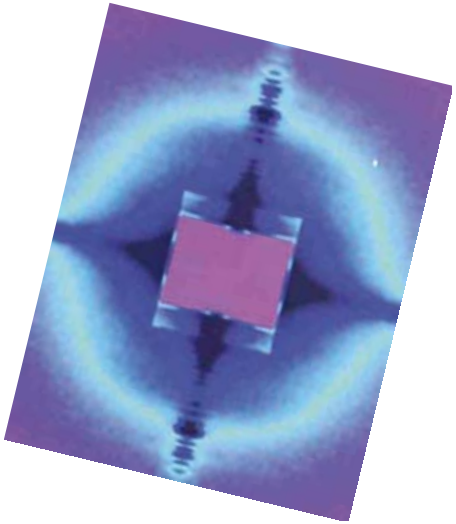
Exciting new science from APS published recently



Lodestone holds surprises under high pressure

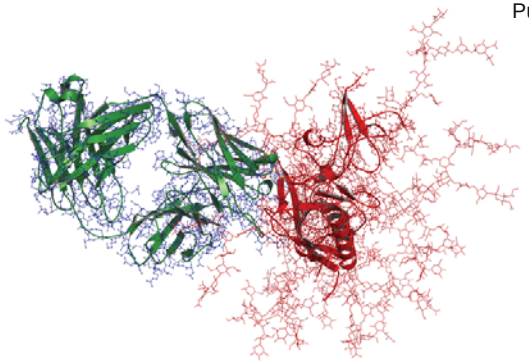
DNA guides nanoparticle assembly

Cover article: *Nature* **451**, 553 (2008)



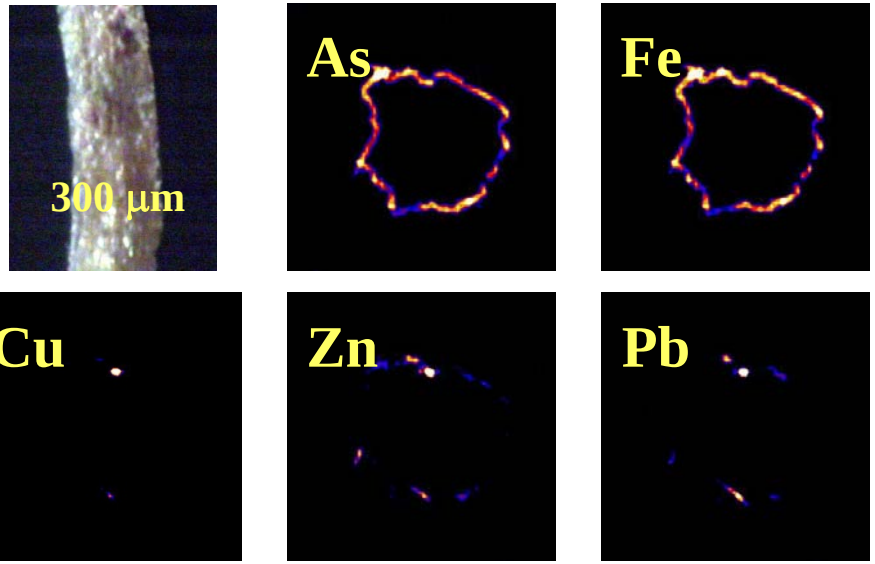
How muscle works under stress

Cover article: *Cell*, 131(4), 784 (2007)



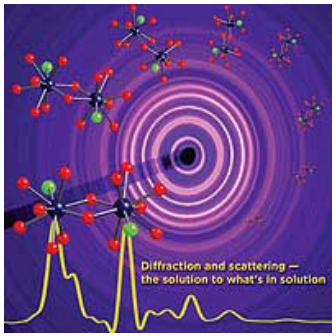
AIDS virus vulnerability

APS research addresses key environmental problems



How do cattails clean up As at a superfund site?

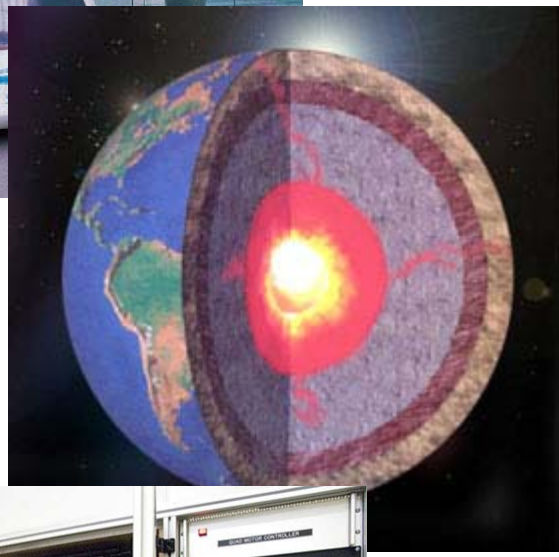
Blute, N. K. et al. (2004) Environ. Sci. & Technol. **38**, 6074 -7.
GSECARS

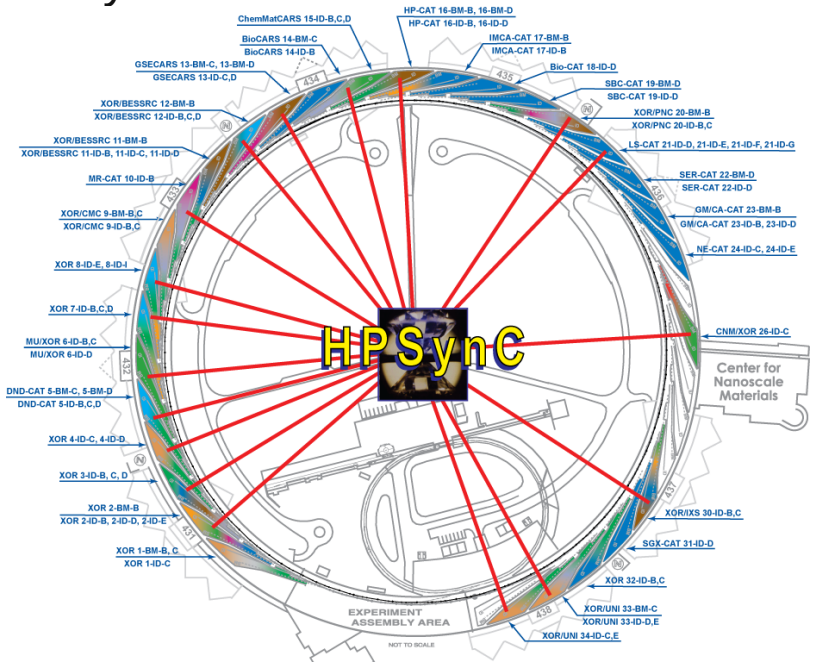


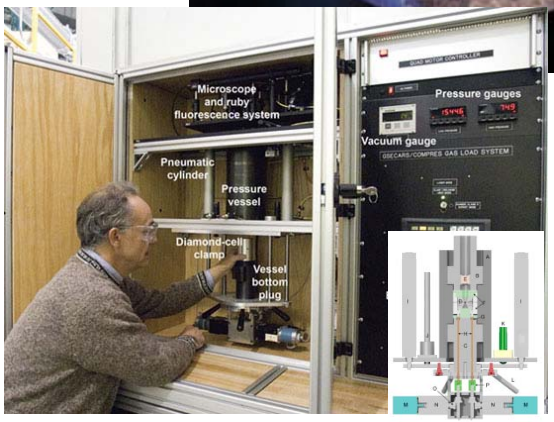
Caged metal ions in solution
Wilson et al., Inorg. Chem. **46**, 2368 (2007)

APS research illuminates extreme conditions as a foundry for new materials

- High-pressure science
- Planetary science
- *In situ* science, e.g., surface/interface
- HPSynC

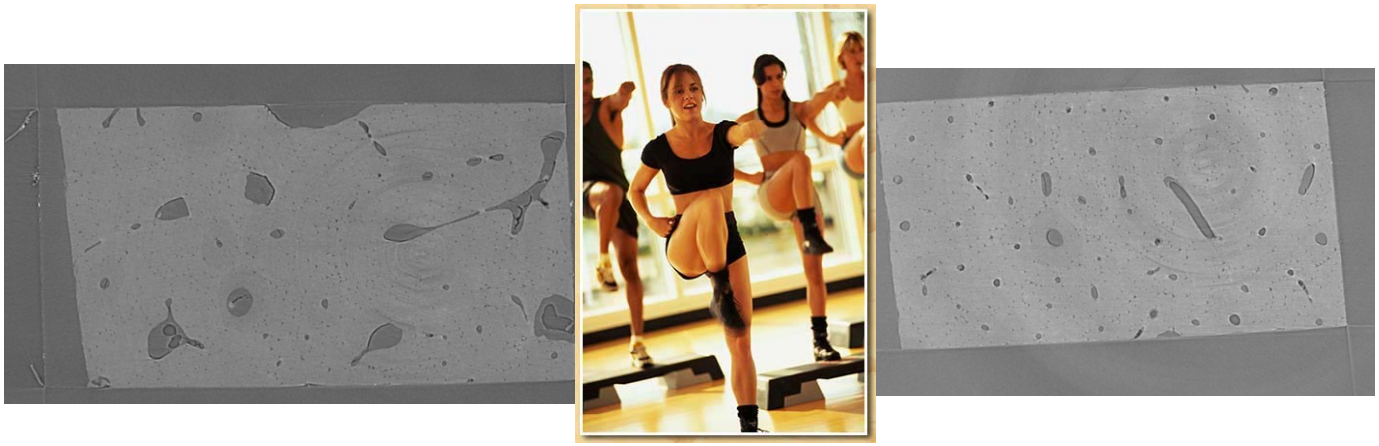






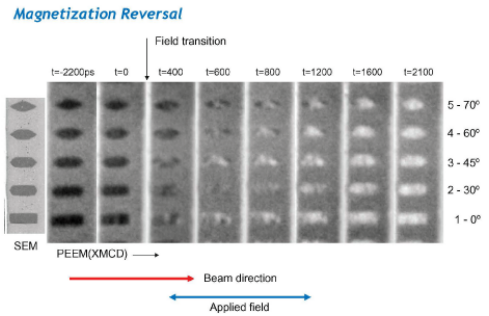
75 papers in *Nature*, *Science*, *PRL,* and *PNAS* from APS high-pressure science in 2003-2007

Advanced x-ray imaging reveals hierarchical structure

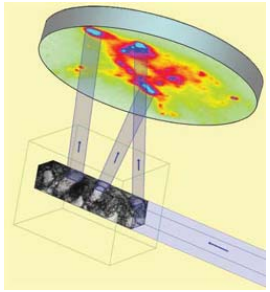


The effect of different exercise regimens on bone – S. Stock, NWU 2-BM

Big bugs, Socha et al.,
PNAS **104**, 13198, (2007)

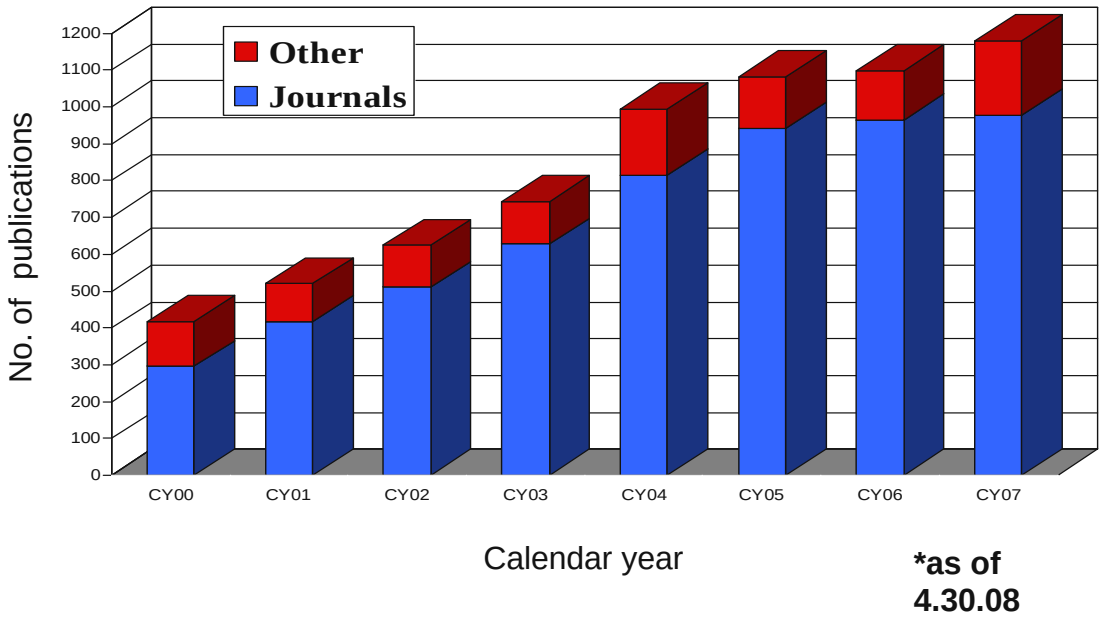


Magnetic instability regions in patterned structures,
Han et al., Phys. Rev. Lett. **98**, 147202 (2007)



Dislocation walls are lumpy,
Levine et al., Nat. Mater. **5**, 619 (2006)

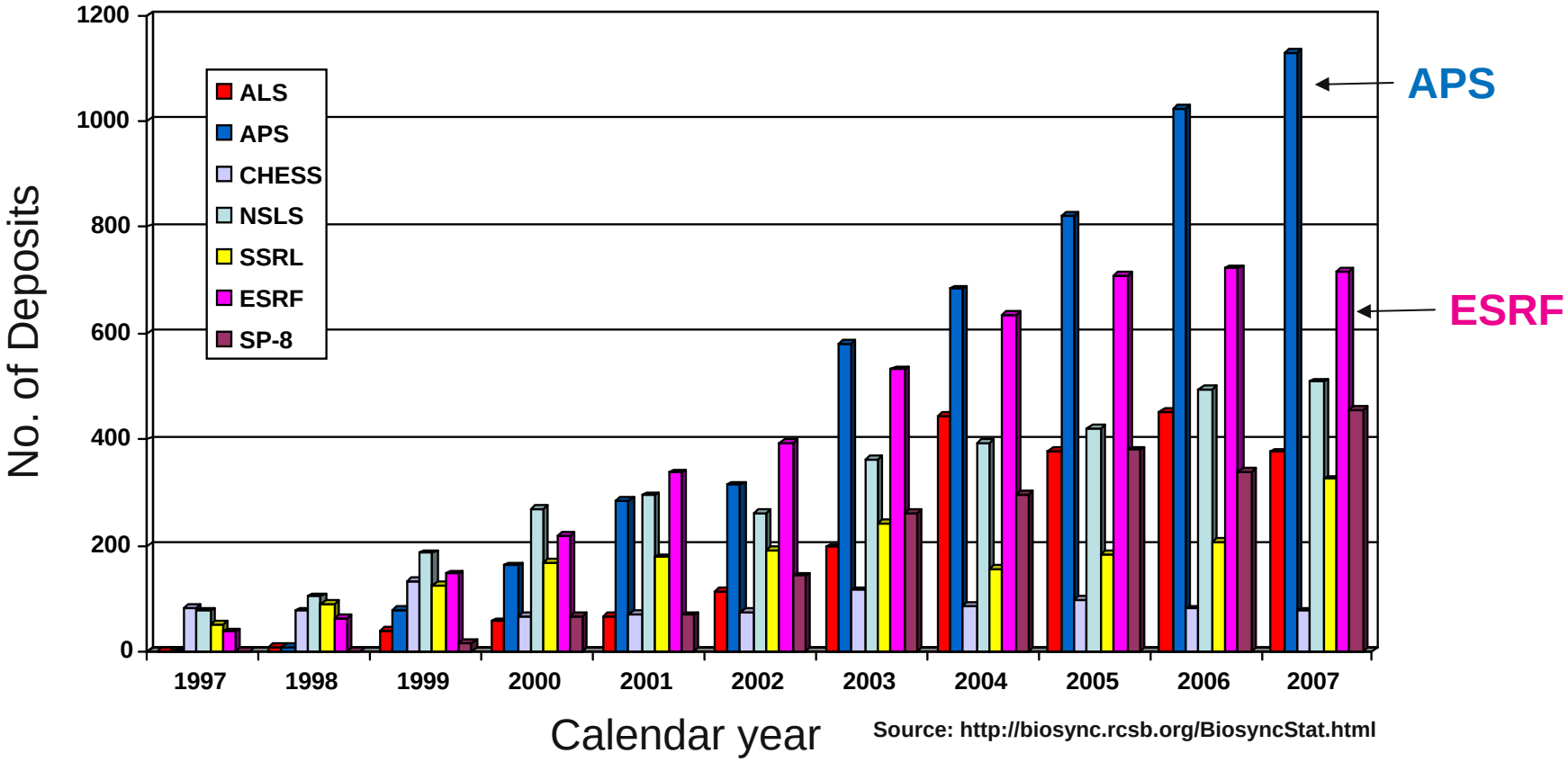
APS refereed publications



151 papers in *Cell*, *Nature*, *Science*, *PNAS*, *PRL* in 2006

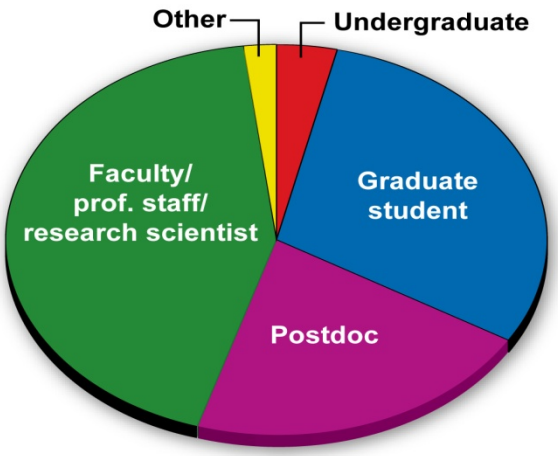
60% of 2007 APS journal papers had impact factor >3.5 (c.f., 53% in 2001)

Deposits in Protein Data Bank (synchrotron light sources)

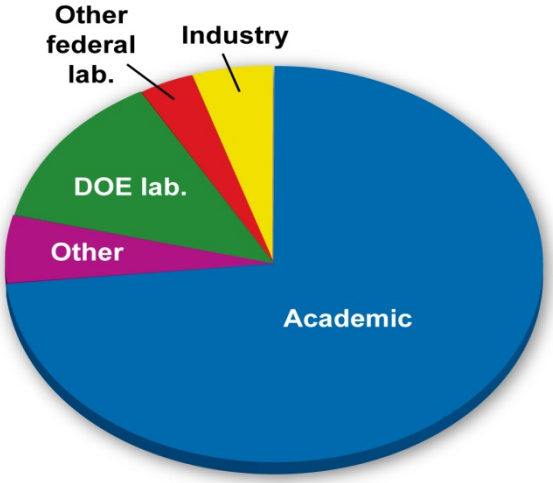


17 APS beamlines dedicated to protein crystallography

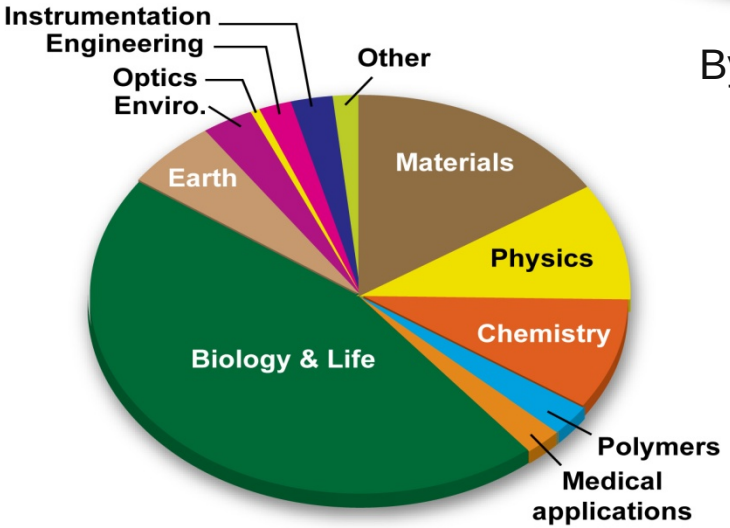
APS user population



By employment

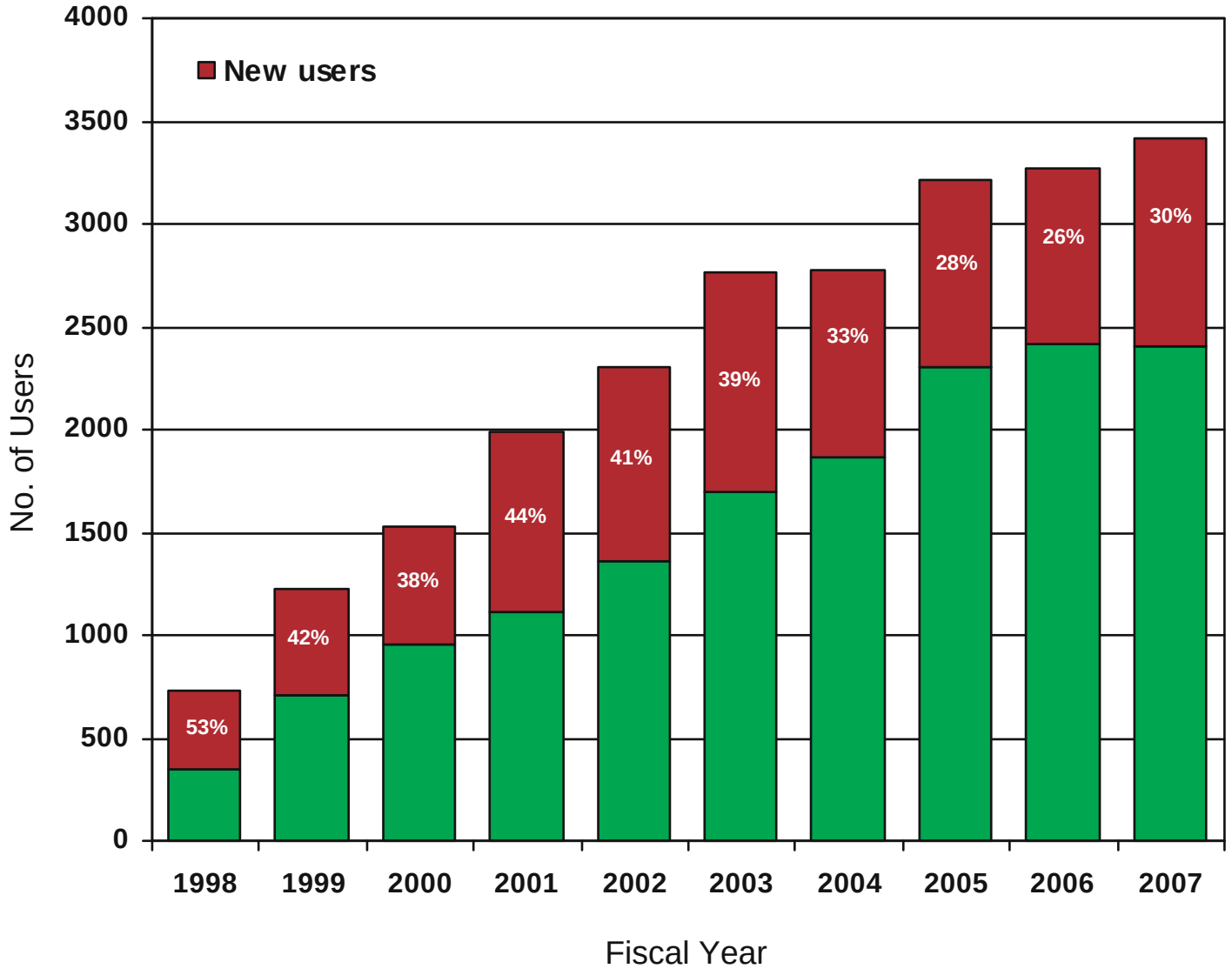


By institution



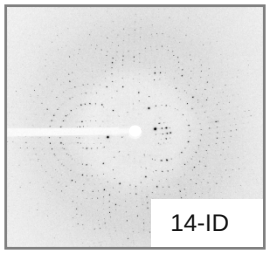
By interest

Our growing unique user population isn't static – many first time users come each year

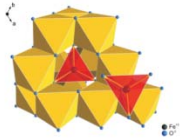


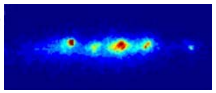
New capabilities and beamlines

FY '08: 54 operating beamlines
30 operated by APS (XOR)

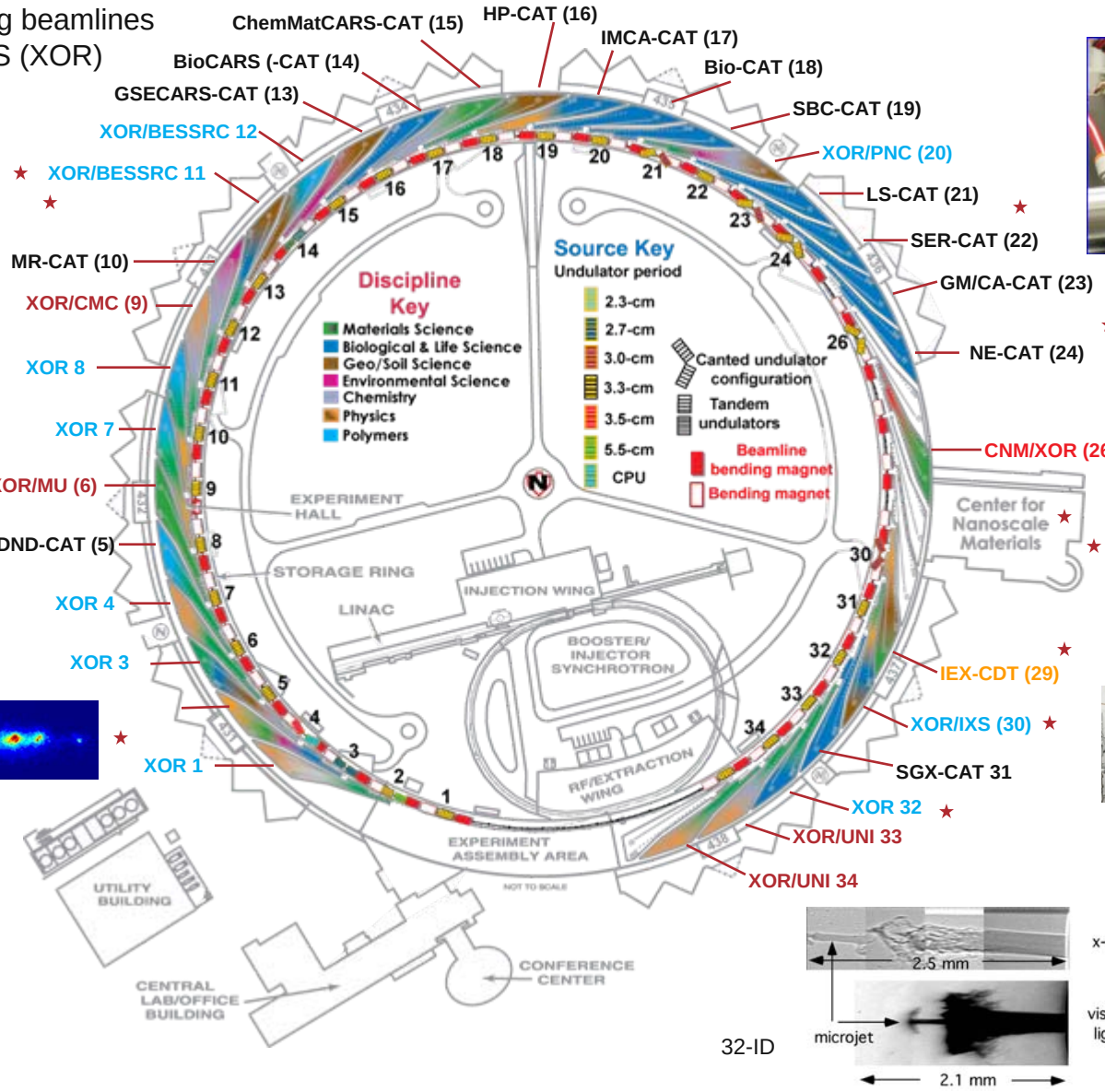

14-ID

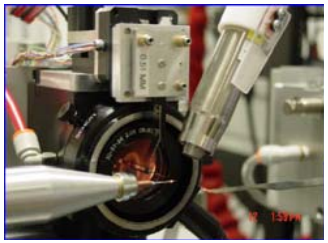

11-BM


11-ID

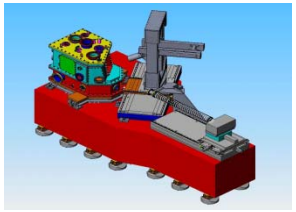

1-ID


29-ID




23-ID

21-ID
24-ID


26-ID


30-ID

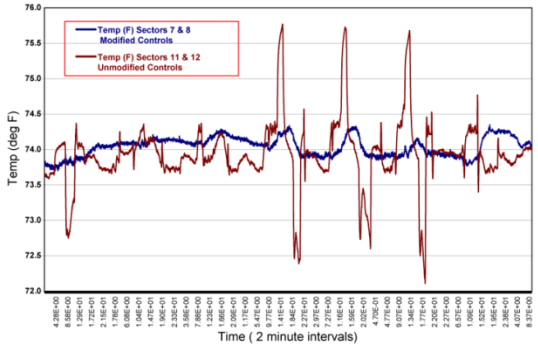
32-ID

Key

CAT sectors
Current XOR sectors
Transitioning to XOR sector
CDT sector
Operated jointly (APS, CNM)

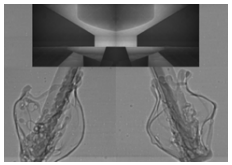
Some examples of machine innovation in last few years…

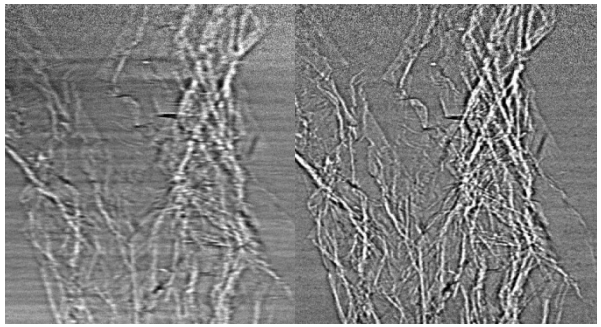
a. Improved beam stability



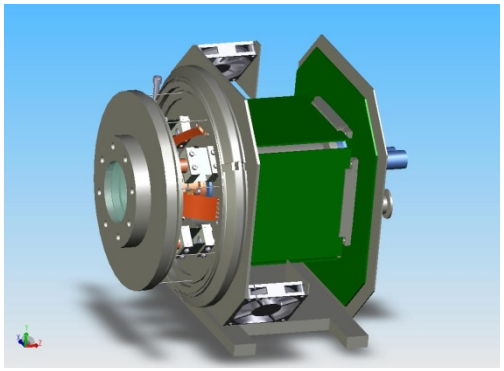
b. Local beta functions

Pays off for a dedicated imaging sector (32-ID)





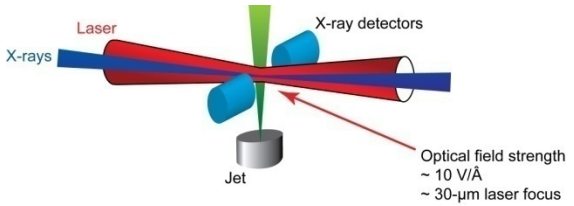
d. Improved detectors



Conceptual model of the quasi-column parallel CCD x-ray detector (XSD-BTS collaboration with LBNL – XSD-BTS lead: J. Weizeorick)

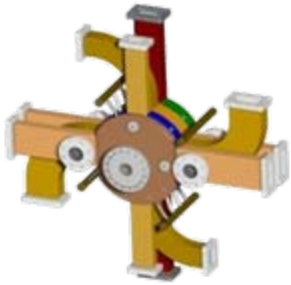
c. Single-bunch charge increased by ~2 times to 16 mA

L. Young et al., “X-Ray Microprobe of Orbital Alignment in Strong-Field Ionized Atoms,” Phys. Rev. Lett **97**, 083601 (2006).

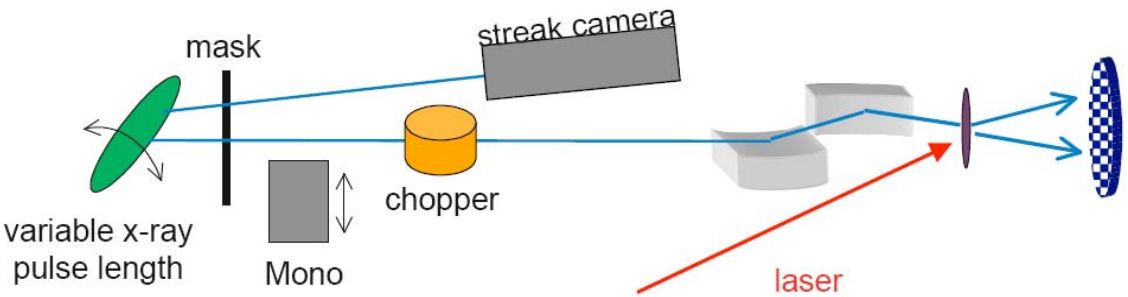


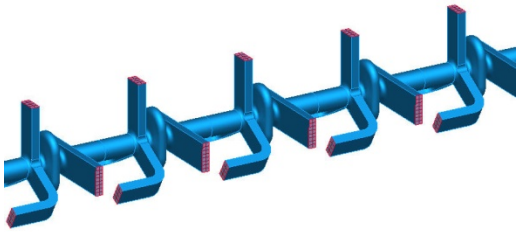
…driven by x-ray science

Major source innovations



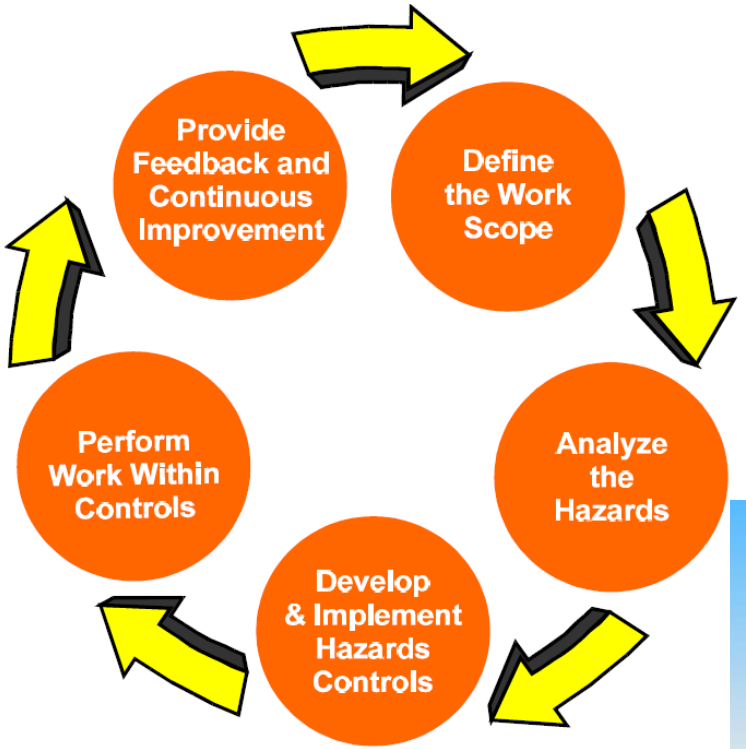
- R&D for short-pulse x-rays (see satellite workshop Friday)

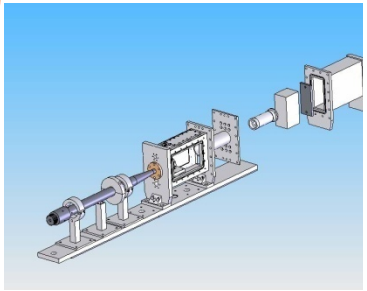




- Delivering the undulator system for the world's first x-ray laser at LCLS

Integrated safety management – key to what we do





APS User Experiment Safety & Integrated Safety Management

User Submits Proposal and ESAF Defining Hazards of Experiment

Define Sope of Work

User Analyzes Hazards and Proposes Controls during ESAF Completion

Analyze Hazards

Beamline and APS Analyze Hazards and Recommend Controls during Review

Develop/Implement Controls

User, Beamline, & APS Implement Required Controls and Procedures

ESAF MUST be Approved by Beamline & APS

Perform Work within Controls

User Operates System Within Controls

ESAF, Controls, & Training Verified by User, Beamline, & APS at Start of Experiment

Feedback & Improvement

Interactions Between Users, Beamline, & APS during Review

User Completes End-of-Experiment Form

General | Experimenters | Description | Materials | Equipment | Electrical Inspection | Lab Use | Requirements | Comme Summa

Status : Approved (Gupta) | PEN : 16-IDD-2007-022

NOTE : No experiment will be allowed to run until a properly completed and approved experiment safety assessment form has been posted by an APS Floor Coordinator

Sector: 16 - HP-CAT | Date Submitted: 07/16/2007 | U.S. government classified

Experiment Title: Single Bunch X-ray Diffraction Measurements on Shock Compressed Single Crystals

GUP Id :

ESAF TYPE: CAT

But we must always strive to improve:

Disturbing near-miss electrical incident while "swapping out" a cryopump control unit on an APS CAT sector

- Person on beamline staff planned to swap out unit – no electrical work should have been required – found unidentified 2nd power source to relays - went ahead to do unauthorized electrical work to remove wires – assumed 24V – found 208V after disconnecting wires with a screwdriver

Among the lessons learned…

- Don't make assumptions – ask questions and stop when work goes outside scope
- Electrical equipment inspections will provide a further barrier
  - specific equipment already being addressed

Reliability is outstanding…

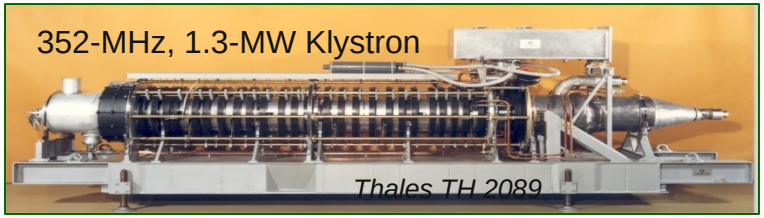
The last run (2008-01) had a record MTBF of >130 hours

- Five and a half days is long enough
  - for Australia to beat England in a Cricket Test Match
  - or to sail the Atlantic in an ocean liner

But clouds are on the horizon…

Components (on accelerator and beamlines) are becoming obsolete

- An rf coupler to the booster failed this winter and led to a 40-hour downtime – this component had never failed in 11 years of operation
- We plan for obsolescence, but our resources to cope with it are inadequate
- Take nothing for granted – e.g., water brought down the Roman Empire (Gibbons)



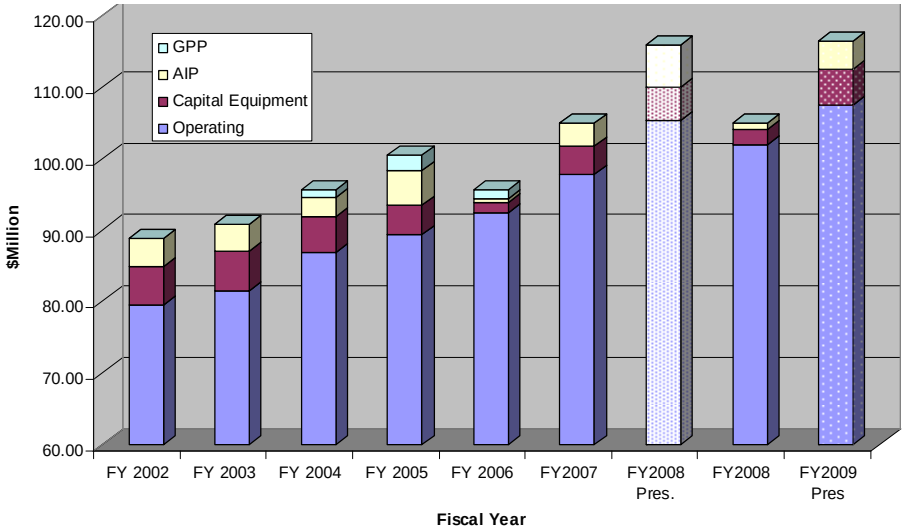
Recent review by DOE expressed praise and concerns

- Positive feedback (consistent with the UC reviews of 2007)
  - World-class accelerator performance, R&D
  - Scientific output of APS excellent and growing
  - Excellent staff on beamline and accelerator/engineering side
  - CAT->XOR transitions going well
    - *challenges include limited resources and damaged partnerships*
- Recommendations
  - Develop a five-year plan, with users, for essential needs re: accelerator and beamlines
  - Reduce workload on beamline scientists and accelerator staff, leaving more time for research. Until budget increases, this requires reducing scope.
  - Develop a bottoms-up budget exercise within APS
  - Increase engagement of the SAC in strategic planning

Issue - need to improve internal and user communications and strengthen user involvement in strategic planning

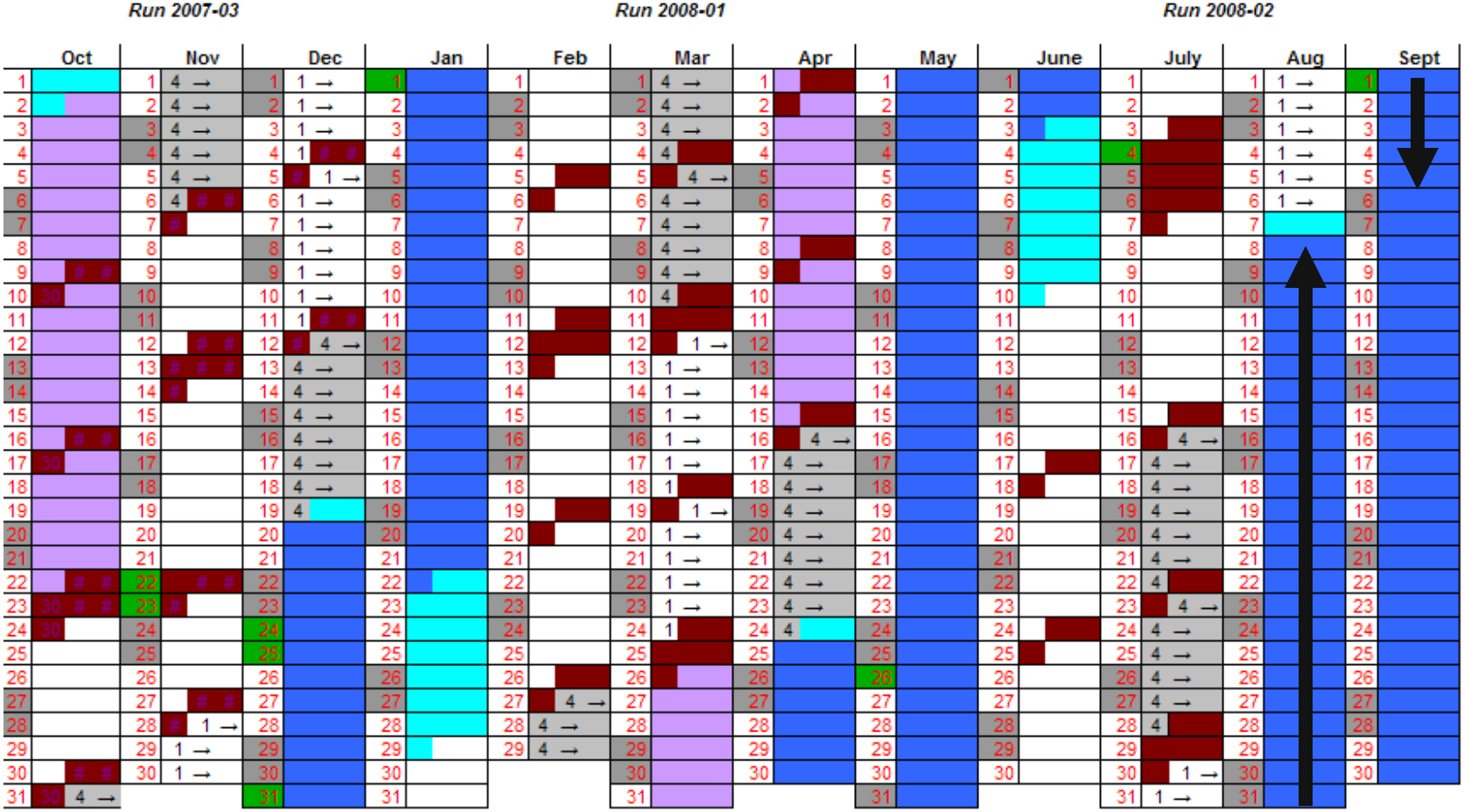
"A pessimist sees the difficulty in every opportunity; an optimist sees the opportunity in every difficulty"

– Winston Churchill



Challenges: The crisis created by the 2008 U.S. Congress Omnibus Funding Bill

APS FY 2008
Long Range Operations Schedule



~1 Month Reduced Operating Time

User Operation in standard lattice
User Operation in Reduced Horizontal Beam Lattice (RHB)

SOM Periods
1 Hybrid Fill - (singlet)
4 324 Singlets - Non Top-Up

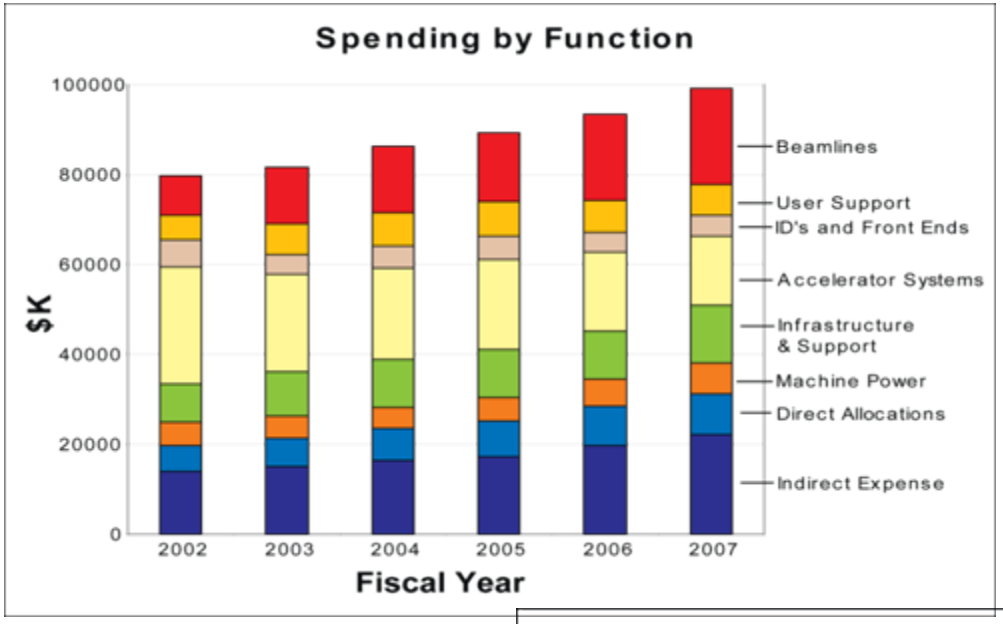
Machine Studies
Maintenance
Shifts set aside for Studies/ Machine Intervention as Needed

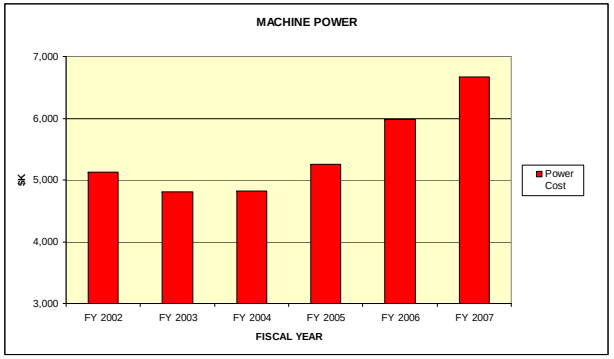
Weekends
Lab Holidays

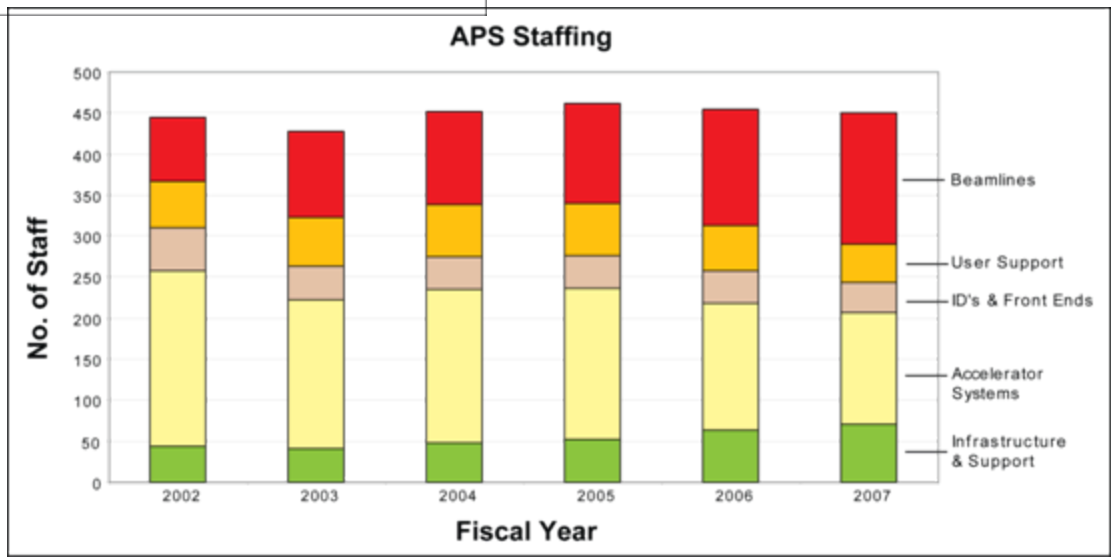
Top-Up Operations is standard unless indicated in fill pattern

Fill pattern is 24 singlets unless otherwise indicated by number

Functional analysis of APS DOE operating budget and staffing







Planning for the worst

- We cannot continue to defer essential maintenance of beamlines and accelerator (only 4% went to capital improvements the last 3 years)

- If we do not see a funding increase in FY 2009
  - We would need to reduce our staffing by ~10%
  - We would not plan to reduce the number of beamline staff or key accelerator/engineering expertise
    - *We must reduce the scope of beamline operations to ensure adequate user support*
    - *We must reduce operating hours to save on maintenance effort costs*

- Scenario planning is occurring now

- But our users are working to advocate for our increased budget needs…

Chicago Business News, Analysis & Articles | Durbin seeks more money for Fermilab, Argonne | Crain's - Mozilla Firefox

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Durbin seeks more money for Fermilab, Argonne

By: Lorene Yue March 17, 2008

(Crain's) — U.S. Sen. Dick Durbin (D-Ill.) has rounded up bipartisan support in his quest to obtain additional federal funds for Fermilab and Argonne national laboratories.

Mr. Durbin's letter, supported by seven other U.S. senators, specifically asks for $350 million in additional funding for science programs administered by the Department of Energy and the National Science Foundation. It was sent to the Senate Appropriations Committee and dated Wednesday.

The money, he wrote, would help the nation's laboratories continue neutrino and particle astrophysics research. Those programs are in jeopardy thanks to a 2008 funding shortfall. As a result, Fermilab and Argonne have been forced to shutter certain programs, place employees on unpaid leave and cut staff when federal government allocations for 2008 were less than

CRAIN'S LIVE SEARCH Search

TODAY'S FEATURES « 4 of 5 »

VIDEO: Check, Please! lunches at Lucky Platter

Brent Brotine likes to have his business meals at a place where there's more to look at than just the menu. That's what takes him to Lucky Platter, the funky Evanston...

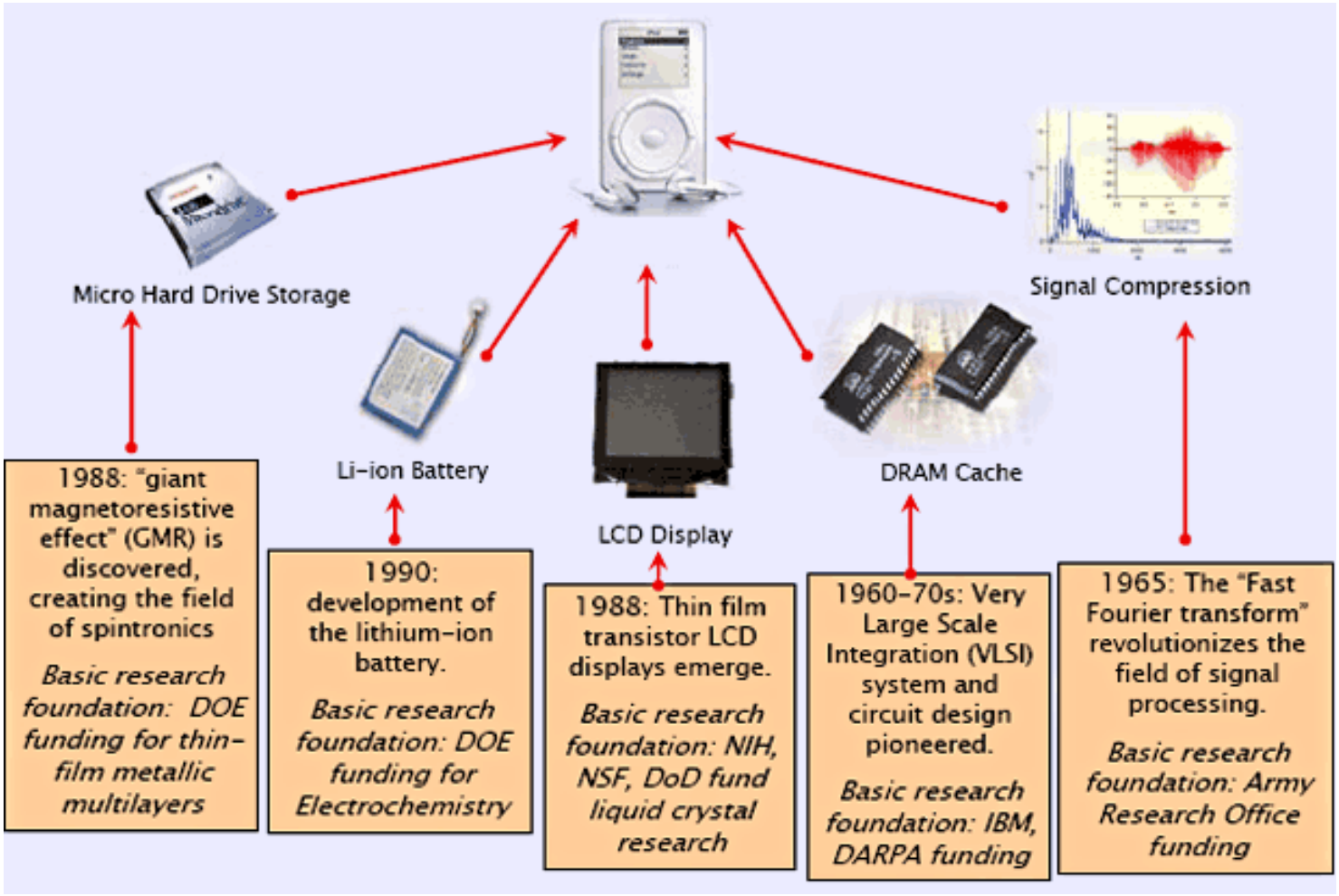
See More

Done

start | Chicago Business Ne... | Inbox for jmgibson@... | jmgibson$ on 'Cluste... | Microsoft PowerPoint... | 8:47 AM

Argonne NATIONAL LABORATORY

Science drives the economy, but it takes a while!



Where APS should make societal and economic impact…

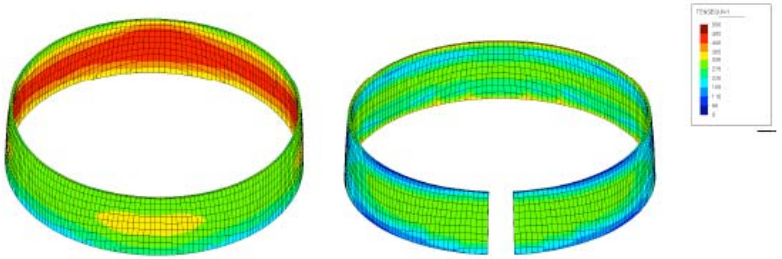
Curing cancer

Sustainable energy

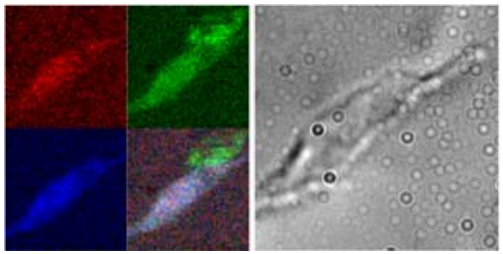
“I’ve got the whole world in my hands”

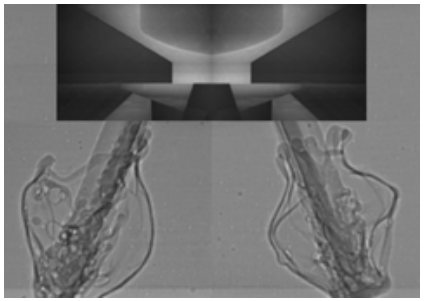
Through today's research…

Lightweight, efficient autos

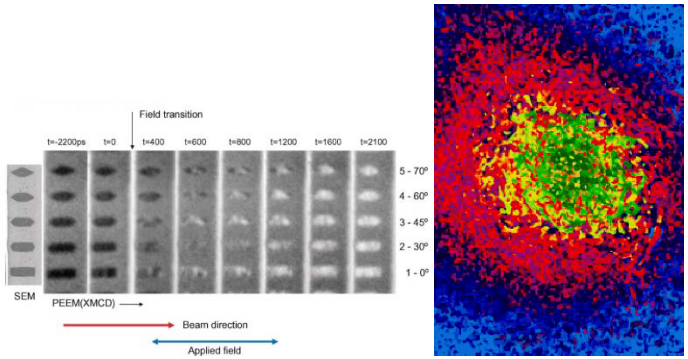


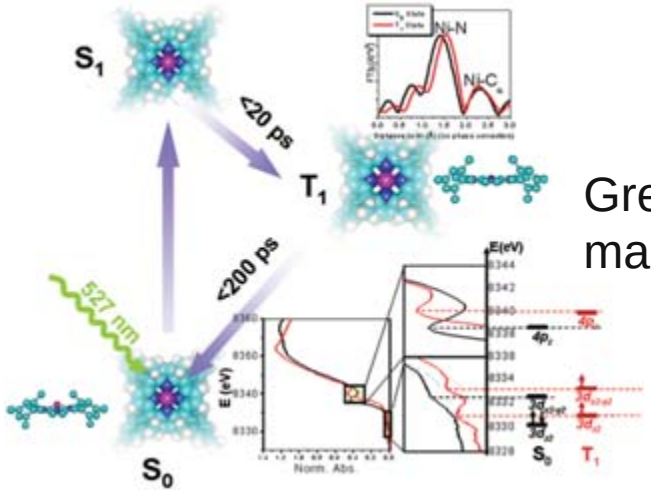
Starving cancer of blood





Nanomagnetic memory

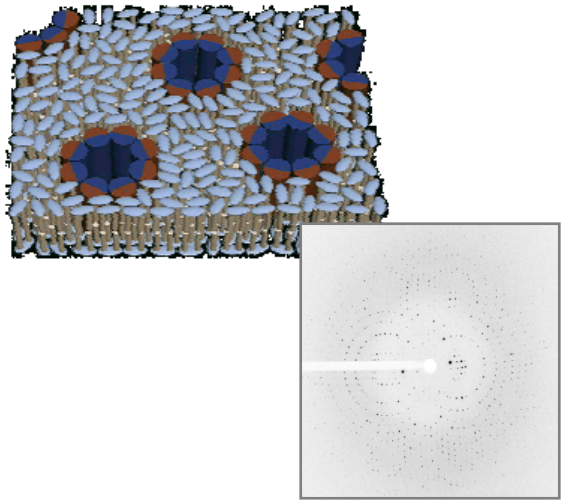




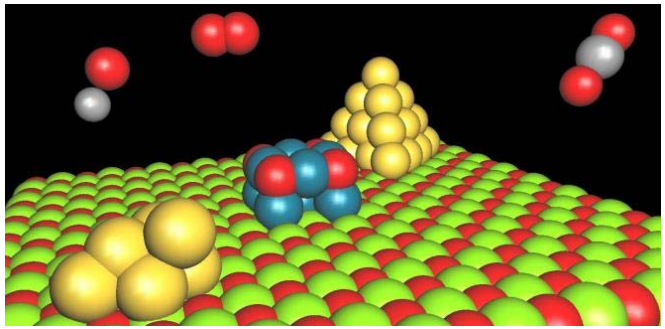
Green machines

Where is APS science impact growing most rapidly?

- Protein crystallography
- Science under extreme conditions
- Biological applications of imaging
- Nanoscience
- Catalysis
- …..



The future will be



ultrasmall

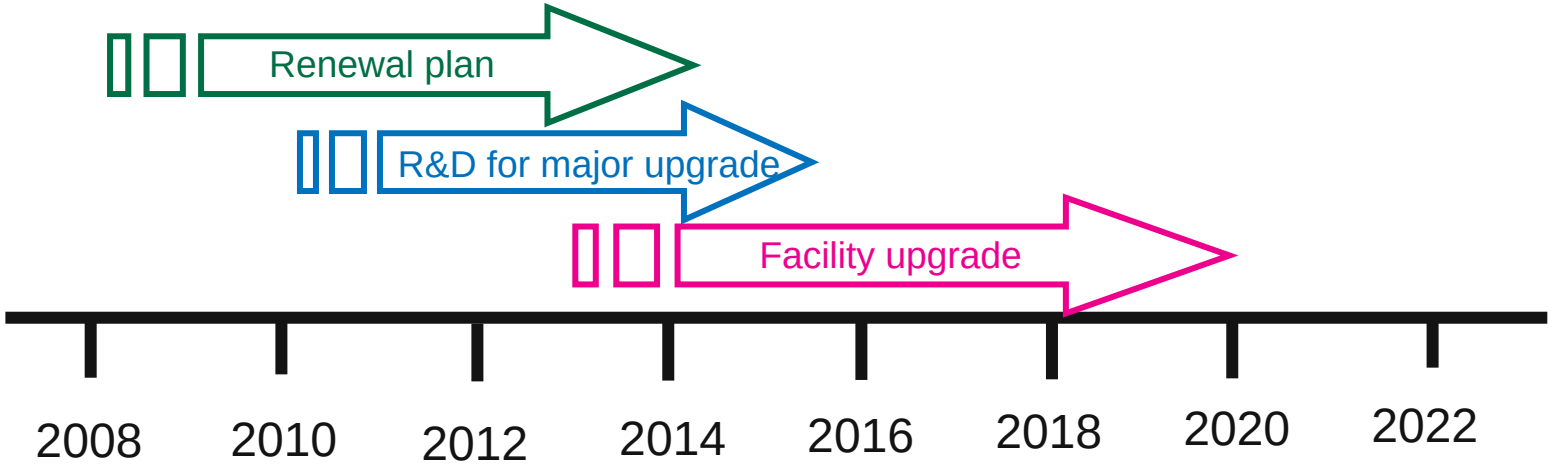
ultrafast

Components of the developing APS 2020 strategic plan

- The APS 2020 plan is a high-priority component of the ANL 2020 Plan, recently submitted to DOE, that (among other things) describes the Laboratory's major activities over the next decade and beyond.

> "All that is human must retrograde if it does not advance."
> Edward Gibbon, *The History of the Decline and Fall of the Roman Empire*

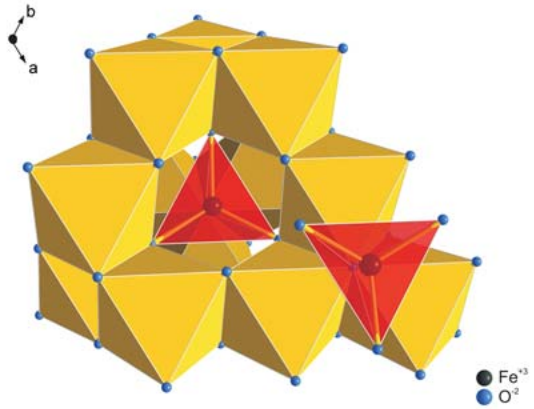
- The APS 2020 plan aims to revolutionize the scientific impact of APS and has several components:
  - APS renewal plan - a 5-year science-driven investment plan that will focus on beamlines, optics, detectors, and source improvements (includes new beamline proposals)
  - R&D for major upgrade - a plan that focused on the R&D required for a major facility upgrade that will build on the renewal plan that will take SR sources to the next level
  - Facility upgrade - a project that, once defined and approved by funding agencies, would keep the synchrotron radiation facilities at ANL at the state of the art to 2020 and beyond.

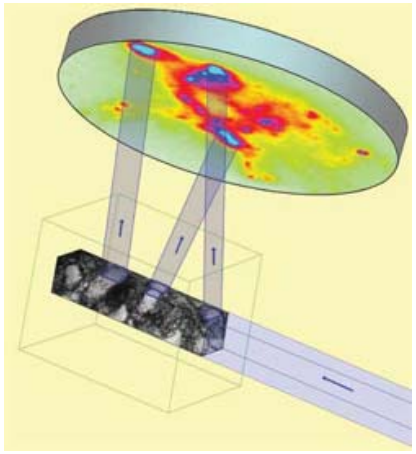


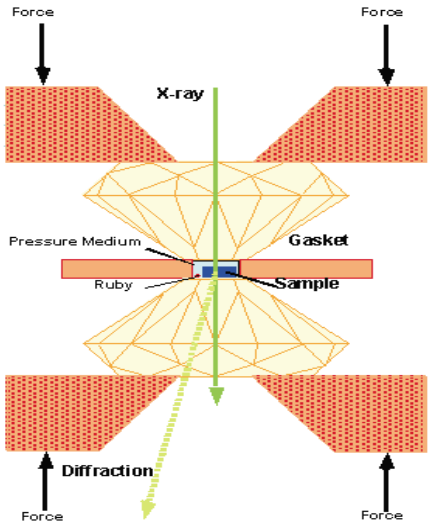
The future for high-energy machines such as APS, ESRF, and SPring-8 is secure

even with growing beamports at "3½-generation" sources nearby

- They will be uniquely suited for applications needing ~15 keV or higher

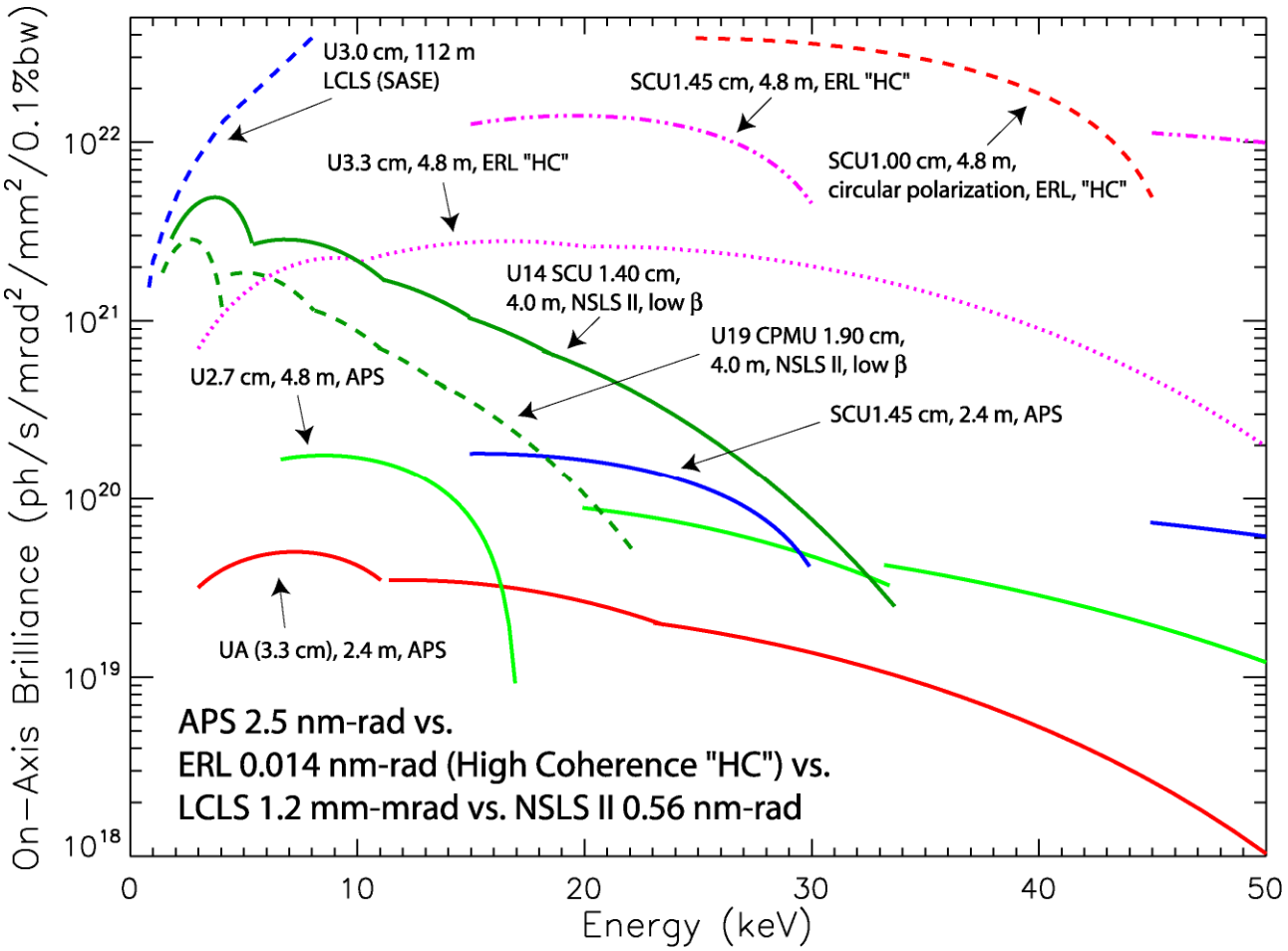


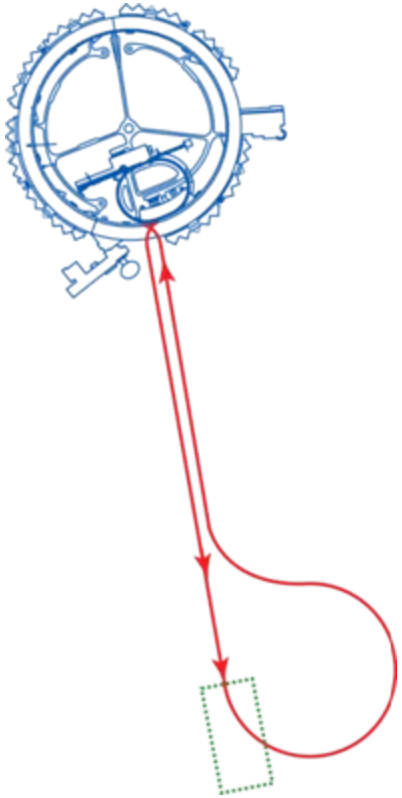




Each facility is planning for upgrade and renewal

Long-term accelerator upgrades for APS? ERL is one option…

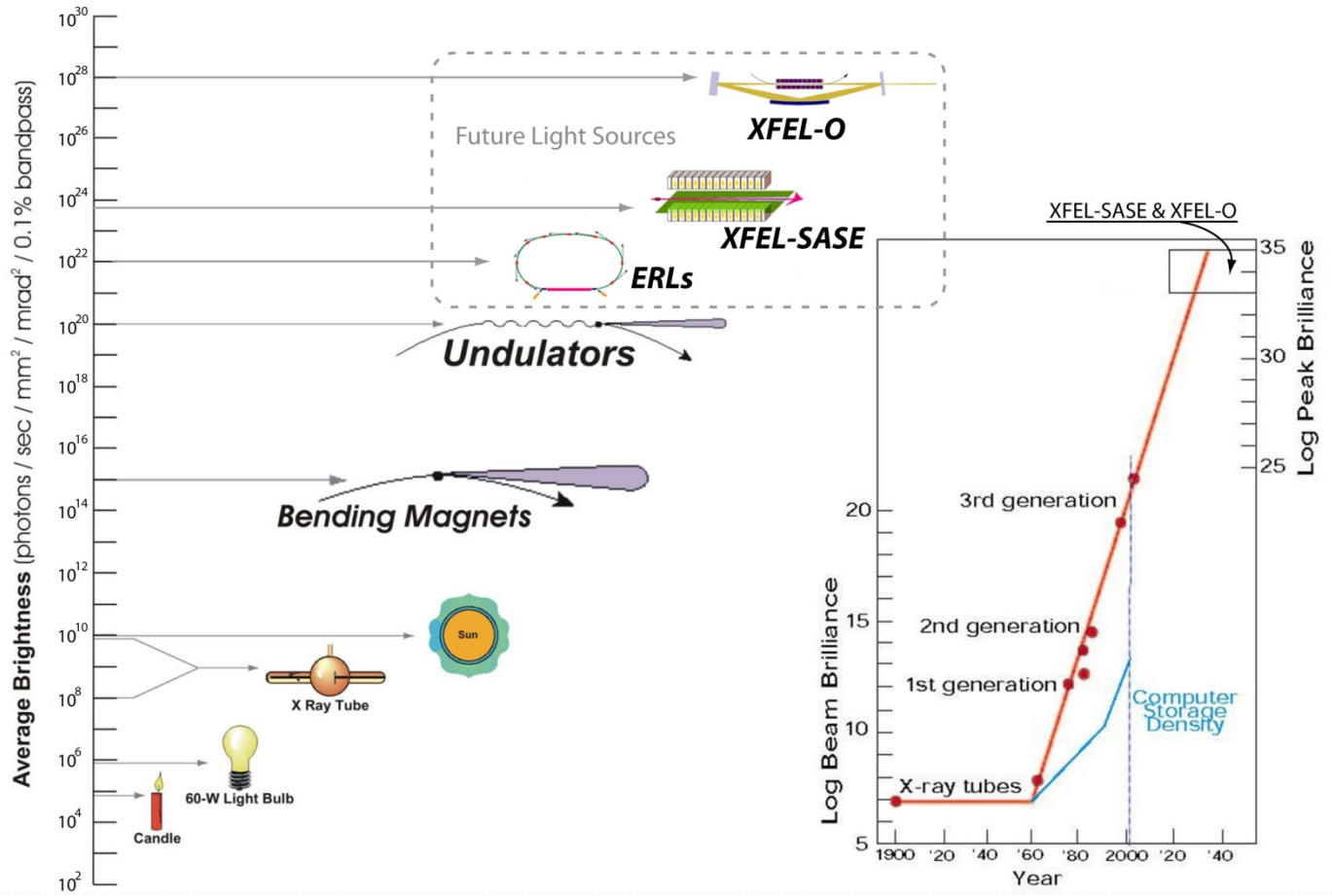




- We are doing R&D supported by laboratory LDRD, and have submitted an R&D proposal to DOE

Among other options to consider: X-ray Laser-Oscillator (XFEL-O)?

K.J. Kim and Y. Shvydko, PRL in press



Menu of options to be explored with users at October 20-21 retreat

Ab initio *user involvement is key for strategic planning –* *together I believe we can make a compelling case for renewal based on the science impact*

- Science-driven plan for improvements to beamlines and accelerator needed
- Oct 20-21st workshop (NIU) will prioritize 5-year plan and consider path towards future upgrades to APS
- Scientific advisory committee will attend workshop and advise on priorities

The renewal of APS

- With our users we must craft a compelling 5-year plan for investments which will increase dramatically the impact of APS in important scientific areas

- Denny Mills will describe the process that we are proposing to use to put this plan together with *ab initio* user involvement

- The final product at the end of this year will be a document that lays out a prioritized 5-year plan focusing on a few key scientific themes

On the next slides are some examples
– the challenge to the APS community is to work together
to identify these key themes and tailor our proposed capabilities
to address them

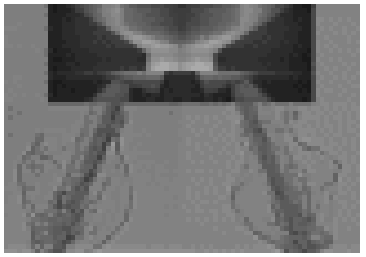
Five Grand Challenges for Science and the Imagination – *how APS makes an impact*

- **How do we control materials and processes at the level of electrons?**
  - *e.g., imaging spins at interfaces (XMCD)*
- **How do we design and perfect atom- and energy-efficient synthesis of new forms of matter with tailored properties?**
  - *e.g., catalysis (NEXAFS), photosynthesis (time resolved)*
- **How do remarkable properties of matter emerge from complex correlations of atomic and electronic constituents and how can we control these properties?**
  - *Colossal magnetoresistance, quantum phase transitions*
- **Can we master energy and information on the nanoscale to create new technologies with capabilities rivaling those of living systems?**
  - *Self-assembly (SAXS), imaging for hierarchical systems*
- **How do we characterize and control matter away—especially very far away—from equilibrium?**
  - In situ *studies (surface/interface, extreme conditions), suited to hard X-rays*

From the BESAC draft report on "Controlling Matter and Energy: Five Challenges for Science and the Imagination," Fleming and Ratner (9/2007)

Key science themes demand APS renewal

- *Sustainable energy*
  - That includes environmental science, transportation, solar energy, etc. …
- *New materials forged under extreme conditions*
  - *matter far from equilibrium (BESAC grand challenge)*
  - *geosciences, high-pressure science,* in situ *studies of material*
  - *growth and processing*
- *Hierarchical structure (multiscale materials?)*
  - from proteins to organisms
  - self-assembly of nanostructures and nanostructured materials
  - nano-manufacturing
  - materials properties from macro- to meso- to nano-scale
- *Fighting the scourge of disease*
- *Energy and information on the nanoscale*
- *The next information technology revolution*
- *…*



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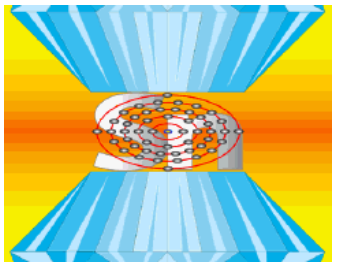

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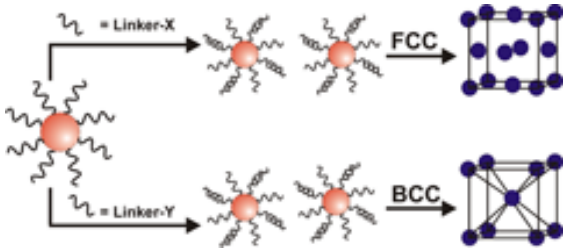

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