Background on APS Upgrade

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Biology and Life Sciences Planning Meeting

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Past Planning for Possible APS Upgrades

- Planning for the APS Upgrade began with the Office of Science 20-year plan several years ago (2003).

- Need for beamline and ID upgrade had a high priority but was not considered a major project and was not funded.

Facility Summaries

Near-Term Priorities

Priority: 1	ITER
Priority: 2	UltraScale Scientific Computing Capability (USSCC)
Priority: Tie for 3	Joint Dark Energy Mission (JDEM)
	Linac Coherent Light Source (LCLS)
	Protein Production and Tags
	Rare Isotope Accelerator (RIA)
Priority: Tie for 7	Characterization and Imaging of Molecular Machines
	Continuous Electron Beam Accelerator Facility (CEBAF) 12 GeV Upgrade
	Energy Sciences Network (ESnet) Upgrade
	National Energy Research Scientific Computing Center (NERSC) Upgrade
	Transmission Electron Achromatic Microscope (TEAM)
Priority: 12	BTeV

Mid-Term Priorities

Priority: 13	Linear Collider
Priority: Tie for 14	Analysis and Modeling of Cellular Systems
	Spallation Neutron Source (SNS) 2-4MW Upgrade
	Spallation Neutron Source (SNS) Second Target Station
	Whole Proteome Analysis
Priority: Tie for 18	Double Beta Decay Underground Detector
	Next-Step Spherical Torus (NSST) Experiment
	Relativistic Heavy Ion Collider (RHIC) II

Far-Term Priorities

Priority: Tie for 21	National Synchrotron Light Source (NSLS) Upgrade
	Super Neutrino Beam
Priority: Tie for 23	Advanced Light Source (ALS) Upgrade
	Advanced Photon Source (APS) Upgrade
	eRHIC
	Fusion Energy Contingency
	High-Flux Isotope Reactor (HFIR) Second Cold Source and Guide Hall
	Integrated Beam Experiment (IBX)

- Accelerator upgrade rated as a "Far-Term Priority".

Presentation to DOE in April 2006

- Nonetheless, we continued exploring a variety of possible upgrades to the APS, including an improved storage ring, energy recovery linac (ERL) and free electron laser (FEL) options.

- In 2005 we began to develop a short term (5 year) plan - ***APS 2010*** - but due to very tight Federal budgets in FY05 and FY06, that was put on hold.

- In April 2006 (after the Administration announcement of the American Competitiveness Initiative) we presented to DOE an upgrade plan - ***APS 2010 and Beyond - A World Class Upgrade.***

- DOE was supportive of an upgrade for the APS and provided some guidance.

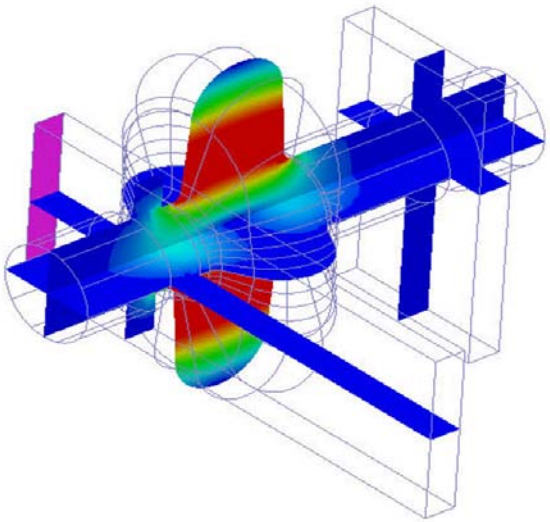
Guidance from DOE

- The project should be integrated (not a laundry list of things we would like to do) and emphasize the new scientific capabilities that would be enabled. The Upgrade should include:
  - Accelerator enhancements
  - Beamline improvements
  - Optics, detectors, etc.

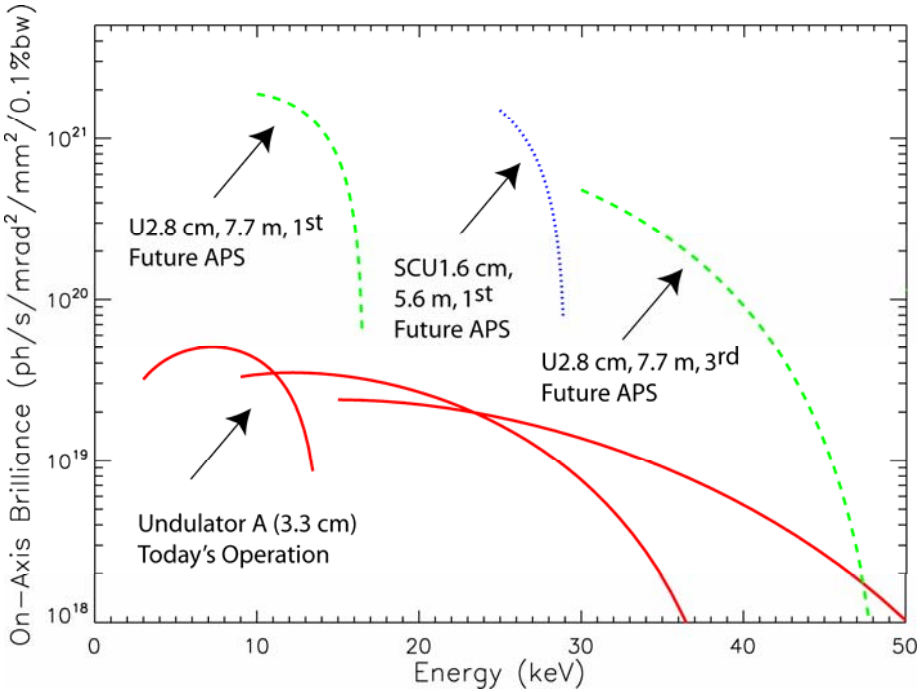
- Keep the project under $500M
  - This should include all of the items in the above bullet
  - Makes an ERL/FEL option financially challenging (not to mention the technical challenges)

APS Upgrade

- Based on this guidance, we feel we have a unique opportunity to develop an upgrade plan to bring APS to world-leading level in the next decade.
  - Reduce lattice emittance to ~1 nm
  - Most straight sections longer (8m), special undulators
  - Low/high beta straights to tailor x-ray beams to user's needs
  - "Crab" cavities for ps pulses and controlled coherence
  - Optimized and upgraded beamlines



Transverse deflecting RF cavity design for ps pulse production at APS

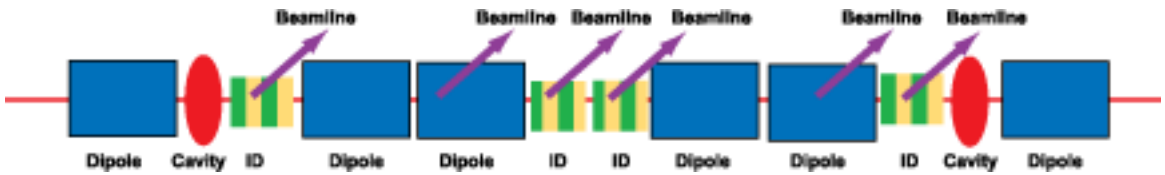


Some Ideas for Revolutionary Science from an Upgraded APS

- Chemical excited states give insight into photosynthesis for efficient and cheaper solar energy
- Ultrafast dynamics of magnetic and ferroelectric domains for information storage and computing
- Detecting sub zeptogram (10^{-21}g) quantities of metals in cells and soils – health and environment
- In-situ study of nucleation in liquids – leading to better controlled chemical synthesis and catalysis
- Materials under extreme magnetic fields – routes to quantum computing
- …

APS-imposed "Boundary Conditions" for an Upgrade

- Bring many (most) beamlines capabilities beyond the current state-of-the-art level along with upgraded accelerator - an integrated approach.
- Utilize the existing APS storage ring tunnel
- Keep beam energy at least 6 GeV, but with a goal of 7 GeV
- Preserve all existing insertion device beamlines
- Preserve existing bending magnet ports (but may require beamline realignment)
- Allow beamlines to continue operation with no changes to equipment (if that is desired) with no reduction in performance.
- Preserve existing capabilities for bunch patterns, including single bunch current of up to 16 mA in hybrid mode.



New Immediacy in Developing an Upgrade Plan

- Now APS upgrade is being seriously considered
  - Great opportunity given strong U.S. administration support for physical sciences
  - We were asked to develop a scientific proposal for outside review – to be submitted to DOE/BES by October 31, 2006

- We are now engaging our users in planning a proposed upgrade and are running a series of Planning Meetings (such as this one) to:
  - share ideas on the upgrade,
  - explore novel science that would be enabled by such an upgrade,
  - get feedback on our plans and
  - gather new ideas for beamline enhancements.

- A final Workshop will be held Aug 10-11, 2006 at APS to summarize the planning meetings and to continue a dialog with the users.

Why Now?

- As stated previously the time is right from a budgetary point of view.
- An opportunity for a “soup-to-nuts” upgrade of the facility.
- By the time of the planned shutdown for the upgrade in 2013:
  - the APS will have been operating for over 15 years and
  - 20 years will have passed since some of the original beamlines were designed.
- The APS is the DOE’s premier 3rd generation hard x-ray source. To remain at the cutting edge of 3rd generation capabilities, we must continually plan for improvements otherwise we will be left behind when compared to other hard x-ray facilities (ESRF, Petra III, SPring-8) around the world.

Planning Meetings

- We have held meetings to discuss:
  - Ultrafast SAXS
  - Science with High Magnetic Fields
  - Intermediate Energy (0.2- 2 keV) X-rays
  - Coherence/Imaging
  - Interfacial and Surface Science
  - Novel Science with Polarized X-rays
  - Pico-second Science

- And we are scheduling meetings to discuss:
  - Biology and Life Sciences (July 14)
  - Microscopy (July 17)
  - Sub-meV Energy Resolution (July 20)
  - Detectors (July 21)
  - New Applied Materials Research from High Energy X-ray Sources (July 28)

Summary Workshop

- A special summary workshop will be held at APS on August 10 and 11 which will include:
  - Summary of planning meetings
  - An opportunity for APS staff and users to provide input on ideas associated with the upgrade
  - A solicitation from the audience so that in the proposal we can emphasize revolutionary new capabilities that would be impossible without the upgrade.

Remember the submission date for the full proposal to DoE is October 31, 2006.

Today's Agenda

9:00-9:45	Anticipated Capabilities of the Upgraded Storage Ring Kathy Harkay
9:45-10:00	Q&A on Accelerator Upgrade
10:00-10:30	Coffee
10:30-11:00	Physical Science Drivers for the APS Upgrade Qun Shen
11:00-11:30	Biology/Life Science Drivers for APS Upgrade John Helliwell (University of Manchester)
11:30-12:00	Scanning X-ray Fluorescence Microscopy in Biology and the Life Sciences: Applications, Opportunities, Impact and Future Stefan Vogt
12:00-1:00	Lunch
1:00-1:30	Time-resolved Macromolecular Crystallography V. Srajer (U of C)
1:30-2:00	Optimal Source Characteristics for Micro-Beams for Macromolecular Crystallography Gerd Rosenbaum
2:00-3:00	Discussion (D. Mills and J. Helliwell – moderators)
3:00	Adjourn

What Do We Need From You?

- Input on what upgrades to the accelerator, insertion devices, beamlines you feel are needed to advance the biological and life sciences.
- Input on what exciting new science could be achieved with the proposed upgrades.
- Creative thinking on what beamline enhancements should be included in the proposal.
- Anything else you can provide to make the APS Upgrade plan a reality.