Argonne NATIONAL LABORATORY

… for a brighter future

U.S. Department of Energy

UChicago ▶ Argonne LLC

A U.S. Department of Energy laboratory managed by UChicago Argonne, LLC

# Technical Support

- ***Optics***
- ***Detectors***
- ***Software***
- ***Computing and Networks***
- ***Conventional Facilities Infrastructure***

*-- then --*

- ***Discussion***

*Patricia Fernandez, John Maclean*

*APS Renewal Instrumentation Open Forum*

*APS, Bldg. 401/A1100*

*Friday, 2009-January-9*

# *Tech Support - Optics*

- Al Macrander

## *Introduction*

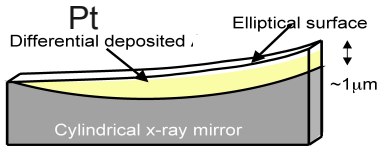
### *There is a need for nanofocusing to carry out R&D in nanotechnology*

**Focusing to below 30 nm is specifically mentioned in eight science case reports, one LOI, and three beamline proposals as an objective. Focusing below 100 nm is mentioned in four other beamline proposals, and submicron focusing is mentioned in two others. (18 total times for submicron focusing).**

*"Past progress at the APS has resulted in promising x-ray optics with demonstrations of a record smallest one-dimensional hard x-ray focusing device - a Laue Zone plate lens with 16 nm FWHM- and demonstration of the world's smallest polychromatic probe, a Kirkpatrick-Baez total-external-reflection mirror system with 80 nm-D probe size. Yet these optics are not widely available at the APS* ***and a major effort is needed to approach these performance numbers routinely and for x-rays above 40 keV****."* – case report on *Engineering Applications & Applied Science*

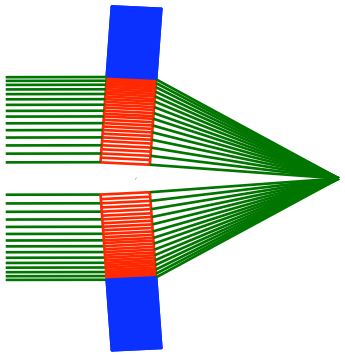
High energy x-rays penetrate into extreme environments.
The APS needs to develop focusing optics that work **above 40 keV**.

K-B:




Partnership: SNS, AAI

MLL:



Partnerships: NSLS-II, XRadia

### *There is a need for optics that do not reduce the lateral coherence length*

(These are needed to fill apertures for nanofocusing, imaging , and photon correlation spectroscopy.)

- Windows (+1 FTE)
- Monochromators (+1 FTE)
- Beam splitters



Acknowledgements: OFM group
With input from: M. Beno, P. Fernandez, P. Jemian, Y. Ding (HP Sync)

## List of specific requests

### New Metrology Beamline (BM)

- At-wavelength metrology of mirrors with Talbot effect.
- Talbot effect as coherence meter.
- Stable set-up for testing of nanofocusing optics.
- Topography of crystals:
  - Si & Ge monochromators and analyzers
  - Diamond monochromators and beamsplitters
- Testing of new optics manipulators (with mechanical engineering group)
- Testing of new detectors (with detector group)
- Test bed for controls (with BCDA group)
- Two beamline staff ( +2 FTE)
- LOM lab space

*(At the time of the last user meeting there were **18** unused BM beamlines – D. Mills in "APS Renewal and Beyond: Plotting Out a Course of Action, May 2008)*

### New Laboratory-based metrology instruments

•New Fizeau interferometer with sample stage capable of measuring large mirrors (+ 1 FTE)
•New Atomic Force Microscope.

### New sputtering chamber and coating characterization instruments

(for differential deposition of KB mirrors larger than 100 mm).
•A high precision substrate transport system.
•New ellipsometer for larger samples (>100 mm).
•Steady supply of substrates with state-of-art roughness

### New precise crystal cutting machines for low strain

•Modern dicing saw with vibration isolated spindle.
•Laser ablation dicer (partnership with HP Sync) (new lab space +1 FTE)

# *Tech Support - Detectors*

- Patricia Fernandez

# *Detectors – Why and What*

- APS Renewal: Why expand detector support and R&D at the APS?
  - **33 out of 42 APS Beamline Renewal proposals** request additional **commercial detectors** and/or the **development of novel detectors** → additional support needed for detector R&D, characterization, testing, sensor and ASIC modeling, etc.
  - Perhaps the **only path to cutting-edge detectors** specifically suited to APS science needs and available **in a timely manner** (detectors developed by other facilities will serve *their* needs and will be available to APS users with ~5 years time lag).
  - Nurture the APS detector effort into a **mature detector R&D program** able to play a leading role in national and international projects, with commensurate benefits to the APS community.
- APS Renewal: What detectors to procure or develop
  - **Commercial detectors**, e.g. Pilatus PAD; a-Si detectors; various CCD detectors; silicon strip detectors; single and few-element SDDs; multi-element Ge detector; etc.
  - R&D efforts on:
    - ***fast-framing area detectors*** → *study systems and materials in real time*
    - ***spectroscopy arrays*** → *probe hierarchical structures through imaging*
    - ***sensors for high-energy x rays*** *(E > 40 keV)* → *study real materials under real conditions*
  - Leading-edge ideas, e.g. pico-second detectors/electronics and superconducting sensors.

# Detectors – How (5-7 year plan)

- Buy commercial detectors: $10-13M
- Support R&D efforts: $12-15M
  - **Collaborate with groups that develop novel sensors/ASICs**: ongoing collaboration with LBNL /ALS on multi-port CCD cameras, and with MSD and NIST/UCSB on superconducting sensors (TES, MKID); explore collaboration with Cornell on analog PADs, with BNL on Ge strip detectors, and with SPring-8, ESRF, DESY, Hamburg on APD arrays.
  - **Contract with companies**, e.g. development of large solid angle SDD arrays.
  - **SBIR/STTR process**, e.g. Voxtel Inc. photodiode array (phase 2 funded); HD Technologies multilayer analyzer fluorescence detector (phase 2 funded); Voxtel Inc. XPCS detector (phase 1 funded).
  - **Work at the sensor/ASIC level**, e.g. collaboration with FNAL; NIU/ANL ASIC readout amplifier development and sensor prototyping; nano- and micro-structure fabrication at CNM.
- Strengthen the detector R&D effort in the XSD Beamline Technical Support group.
  - **Add 3 FTEs** in XSD-BTS to pursue and coordinate detector development projects with other national laboratories, universities, industry: sensor and IC expertise, knowledge of contract management.
  - **Expand capabilities for detector characterization and modeling**: improve/expand test stands; acquire software for sensor and IC modeling; new shared beamline for detector R&D/testing.

PLEASE CONTACT US WITH YOUR IDEAS, ISSUES, CONCERNS

P. Fernandez (fernandz@aps.anl.gov)

# *Tech Support - Software*

- Pete Jemian

# *Enabling Partnerships through Software*

- ***Introduction***
  - Many new detectors (the most common theme)
  - "*Data handling and analysis are increasingly a bottleneck for producing science from synchrotron experiments*"
  - *"Develop user-friendly "expert" software for all engineering stations…"*
  - Reduce the learning effort to using the facility
  - Improve visualization
  - Remote collaboration: Control data analysis from offsite
  - Maintain library of analysis routines
  - Integrate control and acquisition with analysis
  - Portable controls (move between beam lines)
- ***To fulfill proposed beamline science objectives***
  - Dedicate support staff to integrate new detectors with beamline controls
  - Expand existing support staff and work more closely with beamlines
  - EPICS core software must be maintained
  - Computing infrastructure must support remote collaboration

# Enabling Partnerships through Software

- **Specific Requests**
  - **Direct Beamline Support**
    - *Expanded Beamline Software Support: expand to 12 FTE (7 new)*
    - *Detector Software Support: dedicate 1 FTE*
  - **Additional Support**
    - *Scientific Software Group: expand to 8 FTE (7 new)*
    - *Core support for control software (EPICS): expand to 5 FTE (3 new)*
    - *Computing infrastructure: high-speed, storage, computations, security*
    - *Test beamline for controls (partner with Optics)*
  - **Partnerships**
    - *ANL-MCS, Other facilities, DANSE, NeXus, APS User Community*
- **Summary**
  - Benefits all APS user community (both on- and off-site)
  - "software is the key to widening the experimental community and is a ***deciding factor in facility productivity***"
  - Automation of processing, Information Security, Standards-based

# *Tech Support – Computing and Networks*

- Kenneth Sidorowicz

## *Introduction: Upgrades to XOR Beamline Computing and Networks and CAT Networks*

- ***Beamline proposals and the march of technology:*** Detector technology increases in resolution and acquisition rates every year. Most importantly, APS is engaged in leading edge science, and APS scientists are constantly pushing the envelope of available and upcoming technologies. This creates a huge challenge for APS IT Support to keep the APS technological infrastructure up to date and able to meet the ever-changing needs of beamline users.

- ***Growth of APS beamlines:*** Over the past three years, APS has been implementing a transition plan to manage the technical support of Department of Energy Basic Engineering Sciences-funded beamlines. During that process, the number of sectors supported by APS IT Support has grown from four sectors to 16 sectors. This has come with a proportionate increase in the number of computers, APS users, and visiting scientists.

- ***Future Growth of APS beamlines:*** Letters of Intent propose new CAT and XOR beamlines that will require additional support from APS IT.

## *Specific Requests: Upgrades to XOR Beamline Computing and Networks and CAT Networks*

- **High Availability (HA) Computing**
  - Upgrade and Expand XOR Clusters and add additional storage
  - Add additional XOR clusters with new storage
  - Add new beamline co-located servers/storage for spooling real-time data and to provide beamline-critical network services
- **Real Time High Performance Computing (HPC)**
  - Add additional nodes and disk storage to XOR Orthros HPC Cluster
  - Upgrade HPC Cluster internal Infiniband switch to support expansion and integration of existing XOR beamline clusters
- **HA,HPC, and Beamline Storage Backups**
  - Increase backup storage capacity to support both the HA and HPC computing
  - Add 2-stage backup capability to the XOR backup servers
- **High Performance and High Availability Networking**
  - Upgrade XOR backbone network and LOM switches to 10 GigE. The current 4 GigE backbone is running at full capacity.
  - Upgrade CAT backbone network and LOM switches to 10 GigE.

## *Summary: Upgrade to XOR Beamline Computing and Networks and CAT Networks*

- Beamline upgrades increase the demand for high performance and high availability networking and computing in order to handle the data acquisition, analysis, storage and movement of data both within the APS and to remote users' home institutions.

- The result is that all areas of IT Support - HA Computing, HPC Computing, Storage, Backup, and Networking must be able to meet the challenge of the ever-changing needs of beamline users.

# *Tech Support – Conventional Facilities Infrastructure*

- Rick Janik

# Conventional Facilities Infrastructure

## INTRODUCTION

- The existing AES Site Operations Group is responsible for new and existing APS Conventional Facilities infrastructure modifications and site infrastructure operations. The group provides APS with engineering, construction management, construction safety oversight, and building management services
- The Site Operations Group currently operates a minimum engineering staff to support small and medium size projects. In order to support beamline science it will be necessary to increase staff

## SPECIFIC REQUESTS

- ADDITIONAL MANPOWER SUPPORT
  - After review of 42 beamline projects and 5 letters of intent, it was estimated that an addition of 13 temporary FTEs at the project's peak is needed in order to support the beamline science renewal projects. Most of these FTEs will be phased out once the project winds down
- ADDITIONAL FACILITY INFRASTRUCTURE
  - Storage Facility – act as staging and assembly area during project construction and later used as APS storage building
  - Computer Room Expansion – current server room is full. Additional space is required for support of new renewal project requirements
  - Utility System Expansion – Evaluate cumulative utility system requirements generated from all renewal projects. Each proposal should identify its impact to the existing physical infrastructure
  - Project Office – Determine where and how to house the project team; i.e., job trailers, new office building, etc.

# Conventional Facilities Infrastructure

- CONSIDERATIONS/DECISION POINTS
  - Renewal Program Organizational Structure
    - *Set up separate Project Team to work exclusively on project vs. in-house*
    - *Determine project delivery system*
      - Traditional architect/engineer contract
      - Design/construction manager contract
      - Professional construction manager contract
      - Design build contract
  - Research and comply with DOE orders for major projects
  - Research and comply with DOE mandates to meet energy efficiency requirements
  - Develop APS design standards to be used for all projects
  - Update and organize APS as built drawings
  - Acquire consulting help as needed for cost estimating, engineering services and project management services
  - Determine utility needs, beamline stability requirements, noise abatement, temperature requirements, humidity requirements, etc., in order to determine infrastructure expansion

## *SUMMARY*

- A better estimate can be made to evaluate the APS Conventional Facility manpower and infrastructure needs once beamline and letter of intent projects, facility infrastructure support buildings and project consideration/decision points are further defined