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U.S. Department
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THE UNIVERSITY OF
CHICAGO



**Office of
Science**

U.S. DEPARTMENT OF ENERGY

A U.S. Department of Energy laboratory
managed by The University of Chicago

Safety at the Advanced Photon Source

Over 30,000 user visits
since 1996, with no serious incidents . . .

Its no accident!

But vigilance
and improvement
are essential



Presented to Accelerator Safety Workshop

August 7th, 2007

By J. Murray Gibson

Director, Advanced Photon Source

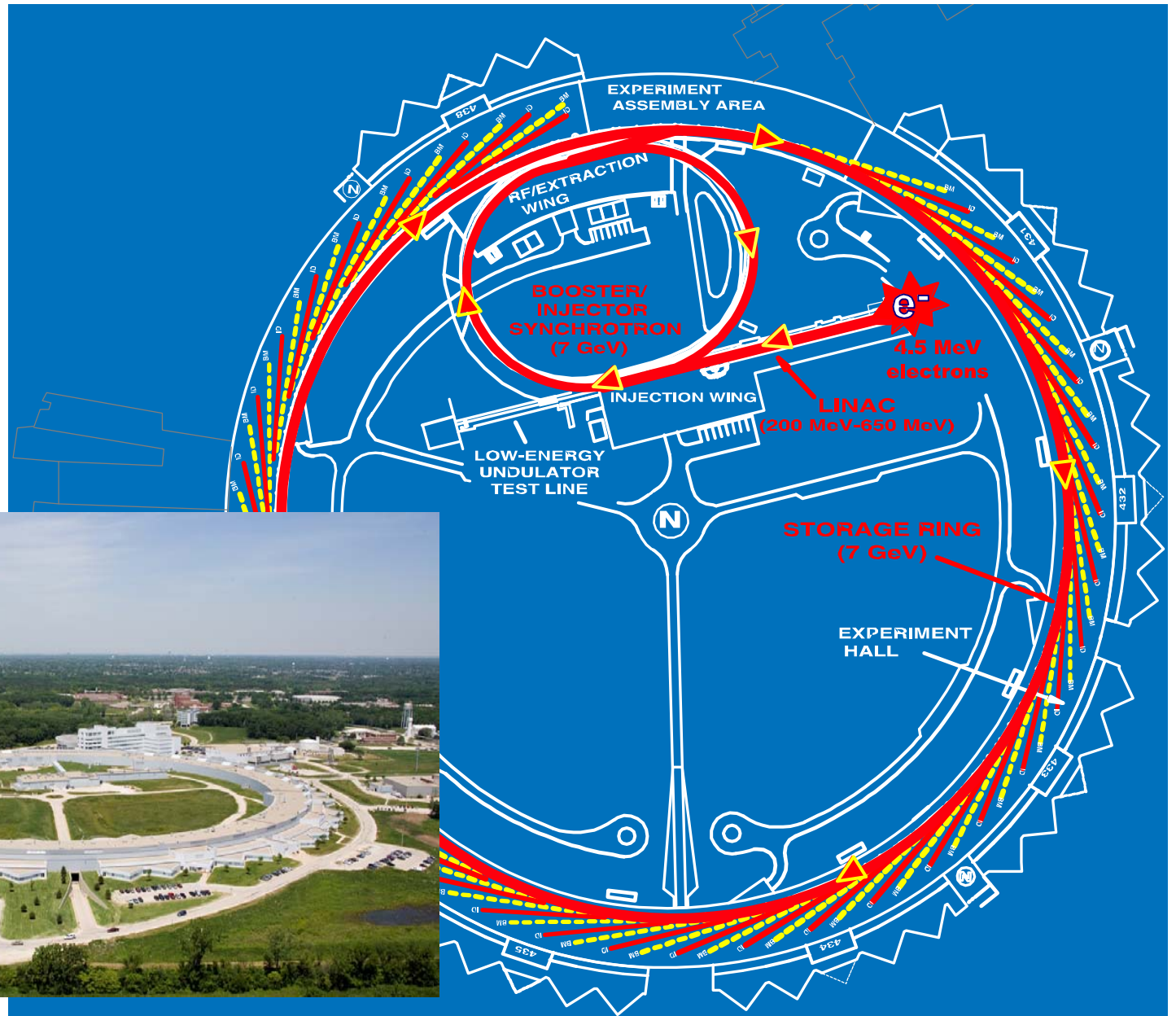
*Associate Laboratory Director for Scientific User
Facilities*

Argonne National Laboratory

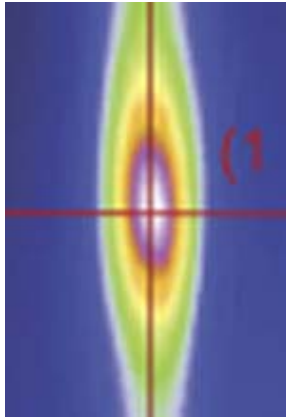
Outline

- What is APS?
- Key areas of concern for safety
 - Processes
 - Improvements
- Key challenges
 - Small science culture meets big science culture
 - Innovation and the work control envelope in ISM
 - *Helping mark the boundaries for work control in research*
 - *Protecting the innocent user*
 - Safety and reliability
 - *Avoiding a conflict by keeping safety first*
 - Crying wolf
 - *Is focus on DART/TRC misguided?*

APS x-ray beams are emitted from 34 undulator and bending magnet ports to users

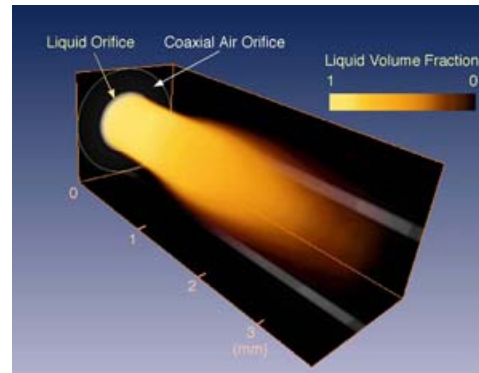
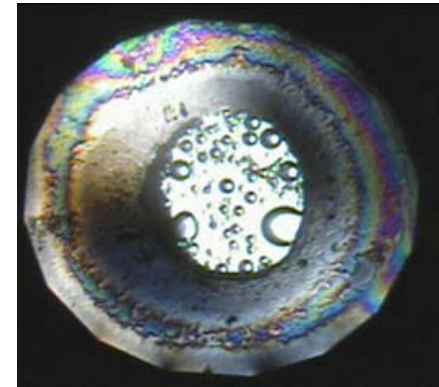


A very diverse user community

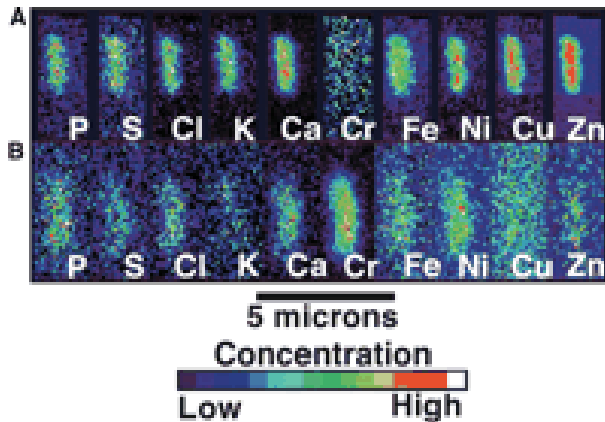
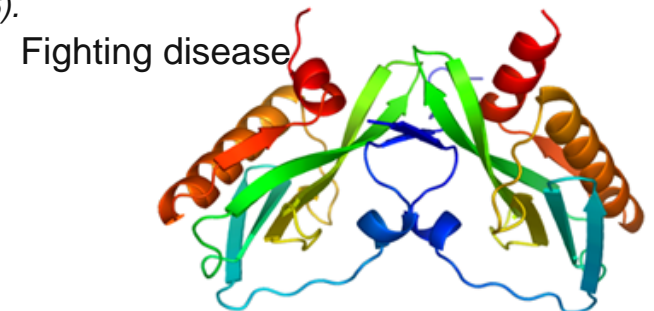
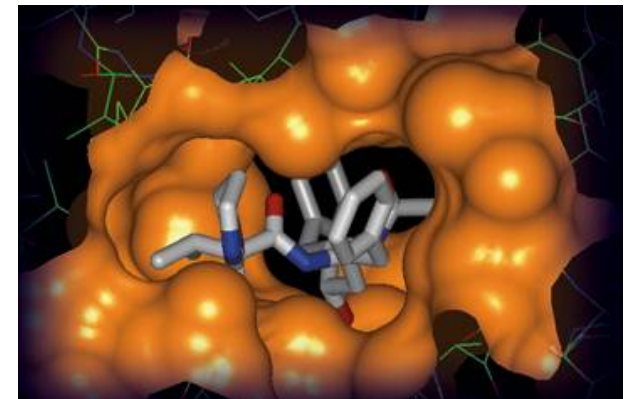


WSe₂ - a material with lowest κ due to deliberate random layer stacking *Chiritescu et. al. Science, January 2007*

New H₂:O₂ alloy at high P-T
Mao et al., Science 314, 636 (2006).

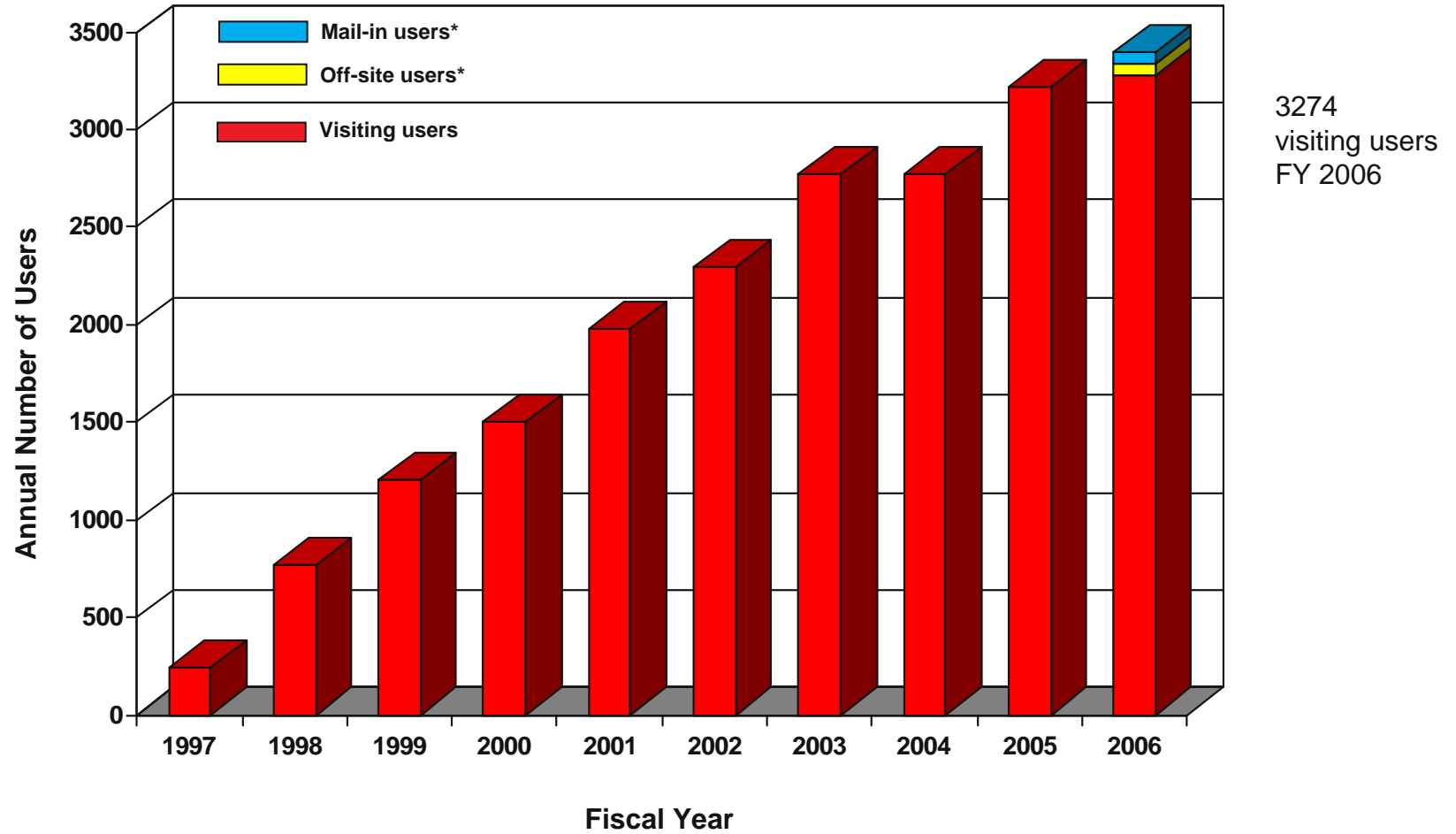


Inside a paint-spray *Wang et. al. Appl. Phys. Lett. 89, 151913 (2006).*



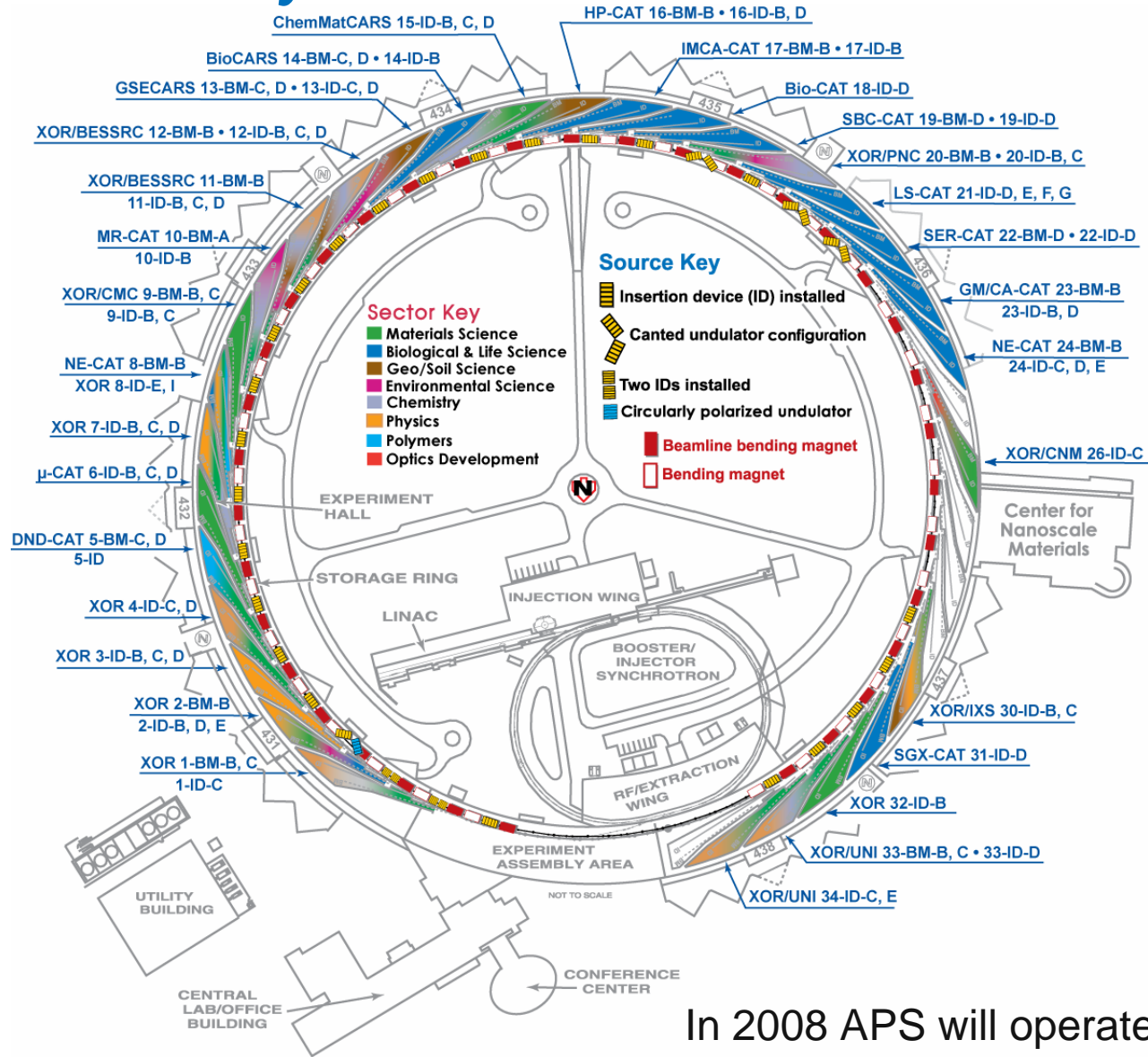
Cr contamination in cells (Kemner et. al.)

Very large and growing in size...



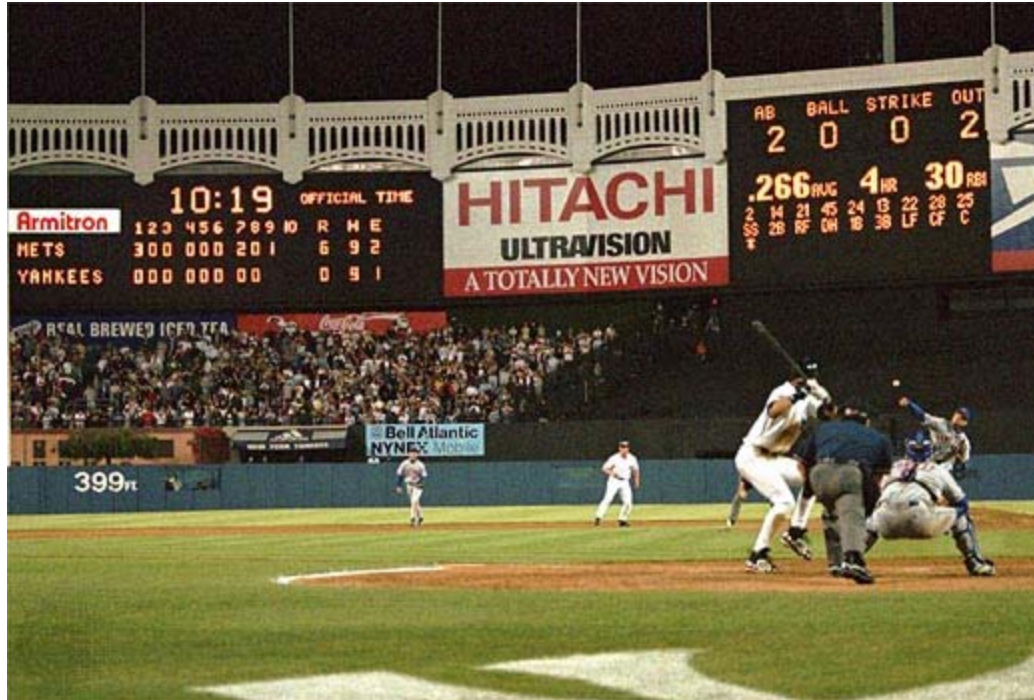
*Partial year

Sectors almost fully built-out



In 2008 APS will operate 16 sectors

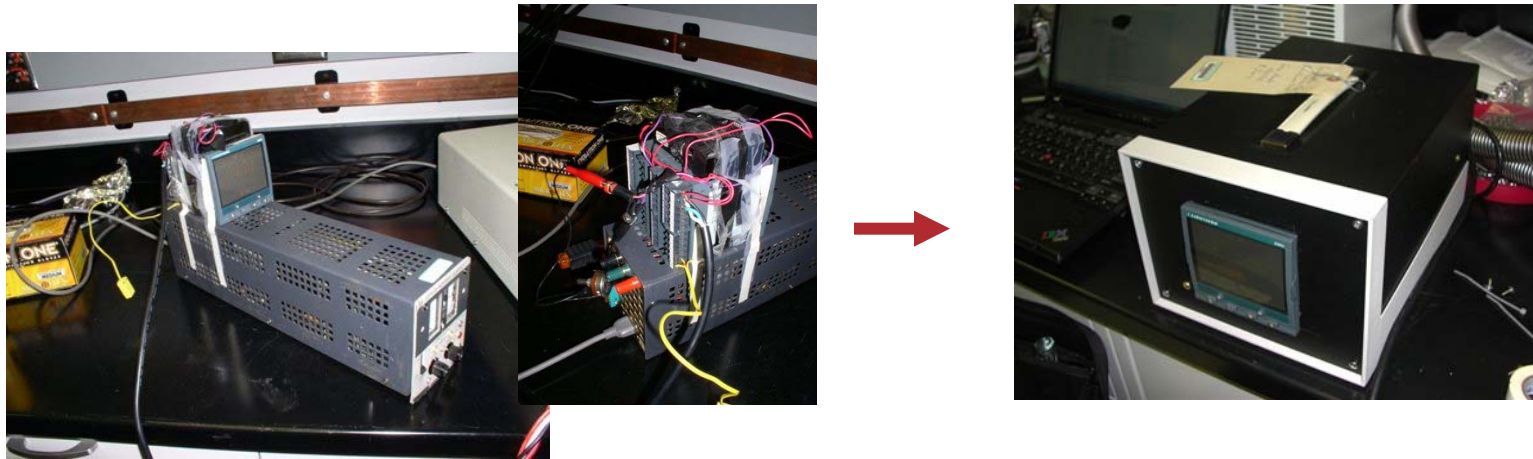
Running a major national accelerator-based user facility



is like running a baseball team. The game is not the biggest safety issue, it's the crowds who come to it ..

Protecting users is always on our minds ..

- We now inspect all non-NRTL-approved user electrical equipment for improved safety



*H*rv*rd University Temperature Controller*

Radiological risks to users are minimal
in comparison with other dangers

User removed a “stuck” plug with a pair of pliers from an energized 208V receptacle - unauthorized electrical work in anybody’s book!

Could have caused serious injury ..

ORPS incident filed, affects ANL contract performance ..

New policy on serious user procedure violations:

User institution asked to follow-up on avoiding future violations

.. Proving effective



Laser engineering controls protect users



Replaced previous administrative controls
- resulted from lessons learned in a
2004 laser injury at APS, and complex-wide problems

USER-FRIENDLY Experiment Safety Approval System

New process updated – web based

ESAF = Experiment Safety Assessment Form

- ESAF completed by experimenter
- Before experiment begins:
 - *Beamline and the APS approve the experiment*
 - *All implemented safeguards are verified*
 - *APS floor coordinator posts ESAF form at beamline*

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General	Experimenters	Description	Materials	Equipment	Lab Use	Requirements	Beamline Admin	APS Admin	
Status : Pending (Rosenfeld)		PEN : 05-BMD-2003-			Role : Floor Coordinator				
NOTE : No experiment will be allowed to run until a properly completed and approved experiment safety analysis form has been posted by an APS Floor Coordinator									
Sector	05 - DND-CAT	Date Submitted	07/09/2003	U.S. government classified work will be performed					No
Does this research involve macromolecular crystallography ? Yes <input type="radio"/> No <input checked="" type="radio"/>									
Experiment Title	In-situ Rubidium/Iron EXAFS Tantalum Electrochemistry								
Subject Area(s)	<input checked="" type="checkbox"/> Materials sciences <input type="checkbox"/> Physics <input type="checkbox"/> Chemistry <input type="checkbox"/> Polymers <input type="checkbox"/> Medical applications <input type="checkbox"/> Biological and life sciences <input type="checkbox"/> Earth sciences <input type="checkbox"/> Environmental sciences <input type="checkbox"/> Optics (excluding x-ray optics) <input type="checkbox"/> Engineering <input type="checkbox"/> Instrumentation related to user facilities <input type="checkbox"/> Purchase of specialty service or materials <input type="checkbox"/> Other (specify) _____ Specify Other _____								
Funding Source(s)	<input type="checkbox"/> DOE, Office of Basic Energy Science <input type="checkbox"/> DOE, Office of Biological and Environmental Research <input type="checkbox"/> DOE, Other (specify) _____ <input type="checkbox"/> DOD, (specify) _____ <input type="checkbox"/> NSF <input type="checkbox"/> NIH <input type="checkbox"/> NASA <input type="checkbox"/> USDA <input type="checkbox"/> Other U.S. Government <input checked="" type="checkbox"/> Industry <input type="checkbox"/> Foreign (specify) _____ <input type="checkbox"/> Other (specify) _____ <input type="checkbox"/> HHHH <input type="checkbox"/> Howard Hughes Medical Institute (HHMI) Specify Other _____								
Generate Report							Next		

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User – APS Staff Communication

- CAT Chat
 - Weekly meeting with CAT personnel on a variety of issues
 - Minutes taken, posted on web
 - Questions answered the following week in writing
- CATNet
 - E-mail distribution of operations items (as needed)
- TWG (Technical Working Group)
 - Monthly user meeting with operations status reports
- Monthly Sector – User – APS Meeting
 - Meeting agenda decided on by APS-PUC-APSUO

CAT – Collaborative Access Team

PUC – Partner User Council

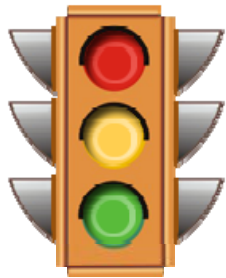
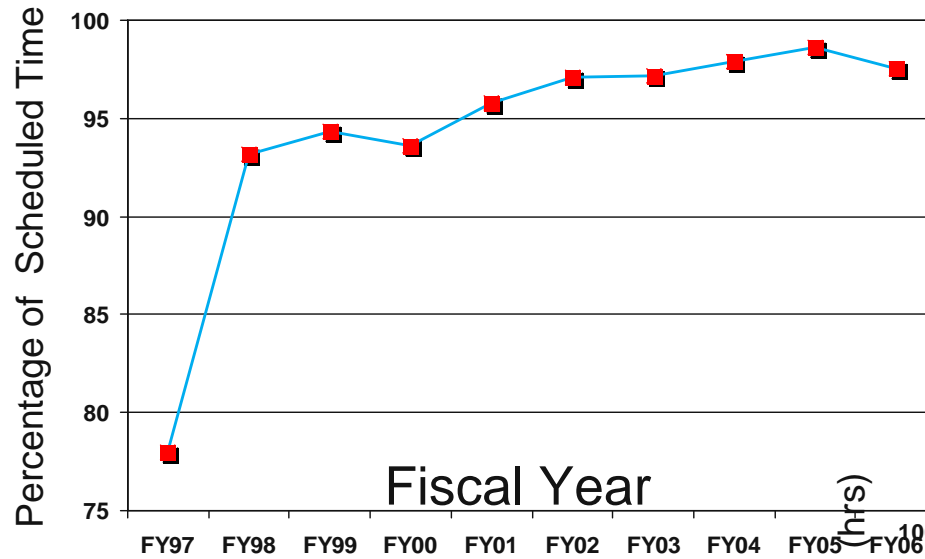
APSUO – APS User's Organization



formal and informal

Accelerator safety

High APS x-ray availability...



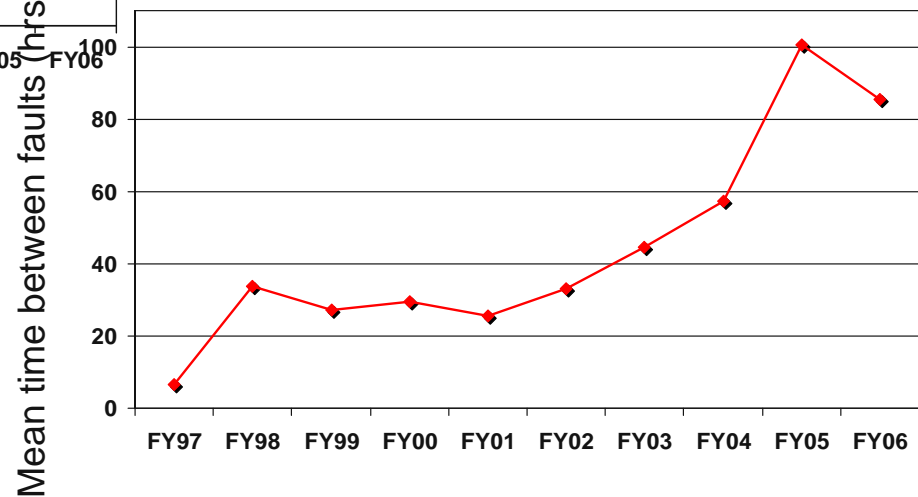
Analogous to work on a system like traffic lights..

There is danger in the work but much more process danger if you don't leave them in a safe state

For a facility like ours, maintenance is the major challenge

Design also remains an issue as instrument improvements and innovations are continual

...and reliability



Human factors in serious accidents

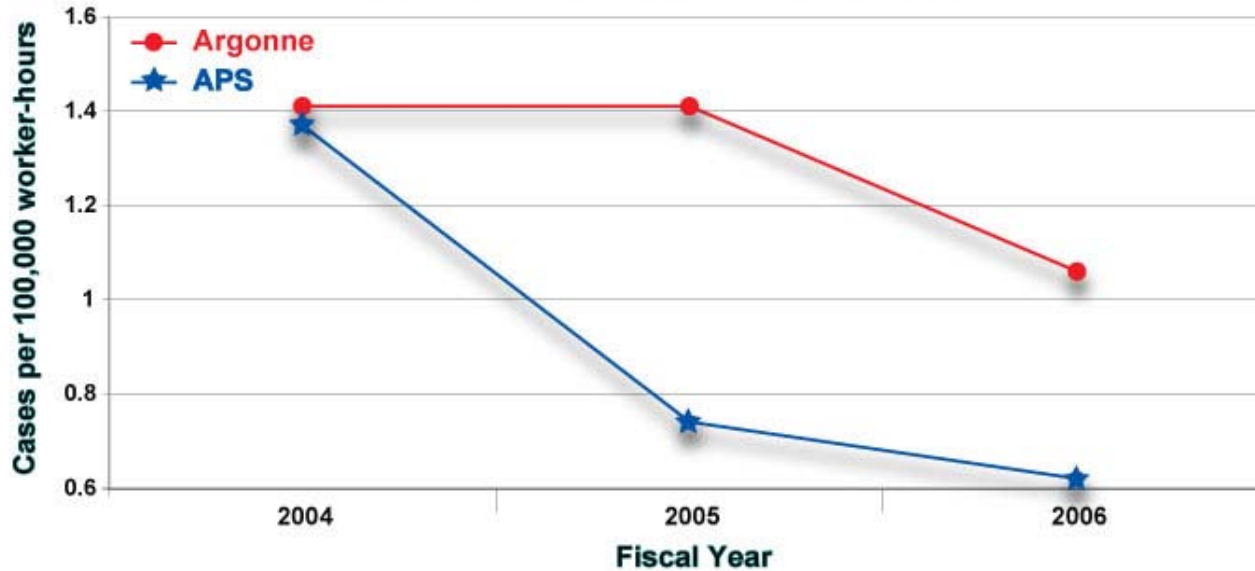


World's worst air collision in Tenerife (1977) killed 583. Misunderstanding of takeoff clearance compounded by fog, and tired captain eager to get going who ignored softly spoken reservations of his first officer ("stop work")

What do a professor from MIT and a veteran KLM captain have in common?

Individual safety is very important - but is too much attention paid to these metrics?

Total Recordable Cases Rate



- BP Texas City disaster killed 15 in 2005
- Individual safety metrics were great
- Process safety was weak

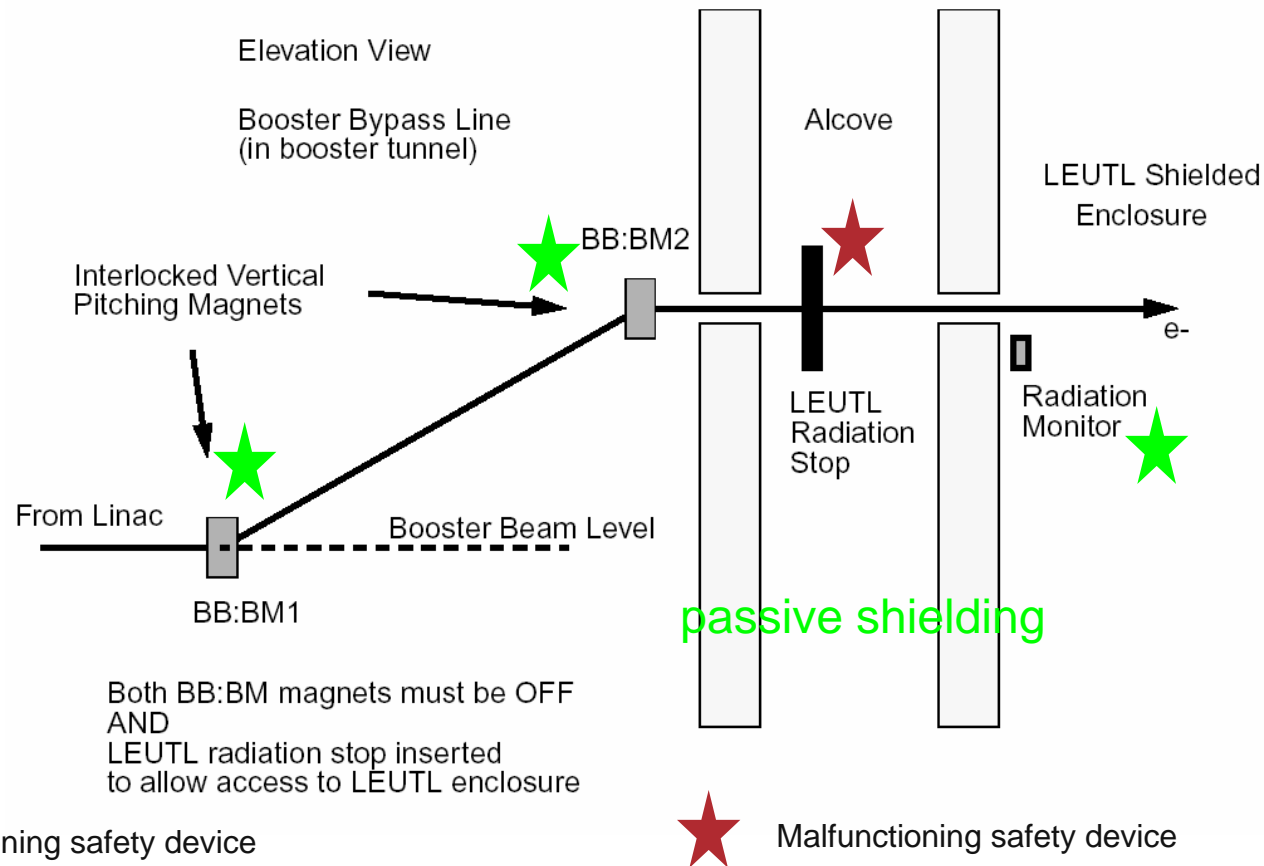
Radiation Safety Systems Work Process



ISO 6062 – No access for Unauthorized Persons

Incident with LEUTL Radiation Stop in 2003 was a LESSON

- On 7/9 it was discovered that the LEUTL radiation stop was reversed (pneumatic actuator inverted so that open and closed positions were reversed)



What happened?

- Work performed on rad stop in May shutdown, first since 1998 installation
- Wrong part ordered for pneumatic plate, could only be installed in reverse (LEUTL is the only one of 5 rad. stops in accel. area which is “upside down”)
- Following reverse pneumatic actuator installation, ACIS wiring was reversed, operation “appeared” normal
- “*Independent*” validation (procedure) failed to correctly detect “open” and “closed” position
- i.e. cascade of 3 failures, 2 should have been **independent**
 - Previous event on 2BM shutter was eerily similar
- **Fortunately**, failure in this device leaves two levels of active protection (and passive shielding protection)
- But **serious** management concern (ORPS filed, cat 4 “management concern”)

Led to redesign of our radiation safety systems maintenance process from the ground up, using a graded approach, a responsible person for all work, and an independent validation step

New bar-coded radiation safety component signs

Accelerator



SR Girder Shield

Beamlines



Labyrinth



PAR RF ACIS Interlock



Photon Safety Stop

Configuration control work permit modified and extended

- Step 1 - Identification of the work
- Step 2 - Determine the approval and validation requirements
- Step 3 - **Authorization to start**
 - Identify a responsible engineer / Beamline Representative
- Step 4 - Approvals to start
 - Design Review / BCRRT (if needed)
 - CCSM
 - Floor Coordinator
- **Work is performed**
- Step 5 - **Validations**
- Step 6 - Close out and return to service
 - Responsible engineer/ beamline representative
 - CCSM
 - Floor coordinator

Configuration Control Work Permit 19321 Beamline Front end UNAC Beamline PAP SB

STEP 1 - Work Description (to be completed by the requestor)
 Requestor : Wiemerslage, Greg E. Date : 11/28/2005 Phone No 0142 Organization XFD-XFE

***Validator signature indicates:**
 My groups work
 - has been completed and validated
 - all safety concerns have been resolved, and
 - appropriate records have been updated

Step - 3 - Authorization to start
 1. Information (Specs, drawings, procedures, task, description, etc) is adequate to safely complete the work.
 2. The requested work is consistent with an approved design, and,
 3. I concur with the approval / validation checklist requirements.

Greg E. Wiemerslage 12/20/05
 Responsible Engineer or Beamline Rep. Approval Date

<input type="checkbox"/>	Vacuum	
<input checked="" type="checkbox"/>	Other AD/DPP	
<input checked="" type="checkbox"/>	MCR Ops.	
<input type="checkbox"/>	Beamline Rep.	
<input checked="" type="checkbox"/>	HP	
<input checked="" type="checkbox"/>	Radiation Scientist	

Step - 3 - Authorization to start
 1. Information (Specs, drawings, procedures, task, description, etc) is adequate to safely complete the work.
 2. The requested work is consistent with an approved design, and,
 3. I concur with the approval / validation checklist requirements.

Greg E. Wiemerslage 12/20/05
 Responsible Engineer or Beamline Rep. Approval Date

***Validator signature indicates:**
 My groups work
 - has been completed and validated
 - all safety concerns have been resolved, and
 - appropriate records have been updated

Step - 6 - Close out complete/Return to service Signature and date.

Validations are complete and the device/system is ready to return to service	Responsible Engineer or Beamline Rep.	
Approvals complete	CCSM or designee	
Ready for service, on-line status restored	Floor Coordinator	

Comments: _____

UO-29 (Rev 12/21/04)

APS Design Review Procedure Improved

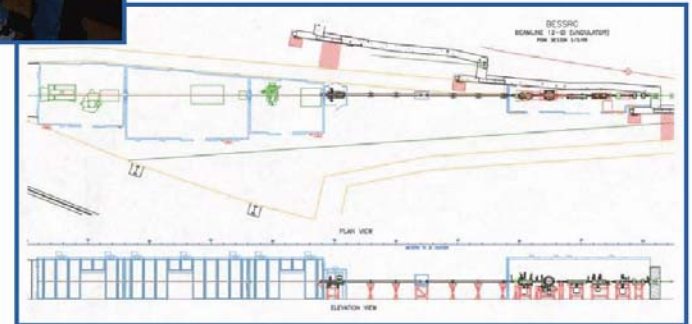
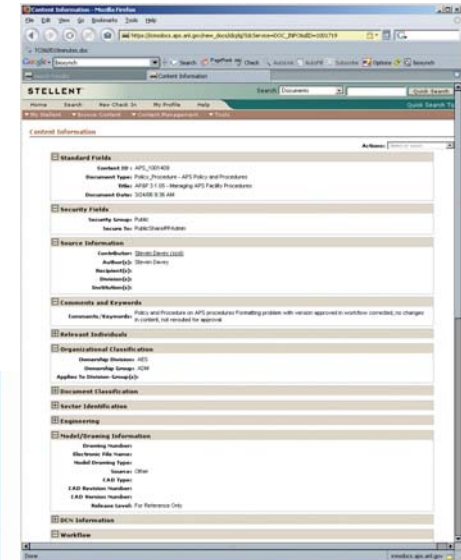
ICMS

Advanced Photon Source	PROCEDURE	Page 1 of 14
	Procedure #:	x.3.1.1
	Revision:	0
	Issue Date:	13 Sept. 2004
	Supersedes:	na

APS Design Review Procedure

Prepared by:	Date
_____ R. Gerig/S. Davey Preparer's Name, Title/Group	_____ 9/14/04
Approved by:	
_____ W. Ruzicka, AOD Division Director	_____ 9/14/04
_____ E. Gluskin, XFD Division Director	_____ 9/14/04
_____ R. Gerig, ASD Division Director	_____ 9/14/04
_____ D. Mills, Deputy APS Associate Laboratory Director	_____ 9/14/04
_____ J. Murray Gibson, APS Associate Laboratory Director	_____ 9/14/04

Sector Candidate



Safety and quality control

Safety comes first before availability/reliability



J. Murray Gibson
SUF Assoc. Lab. Dir.

Noel Rivera
ASD
Powr. Sysys. Grp.
Tech. Sr.

Tony Puttkammer
ASD
Powr. Sysys. Grp.
Chief Tech. II

Jeff Goetzen
ASD
Powr. Sysys. Grp.
Tech. Sr.

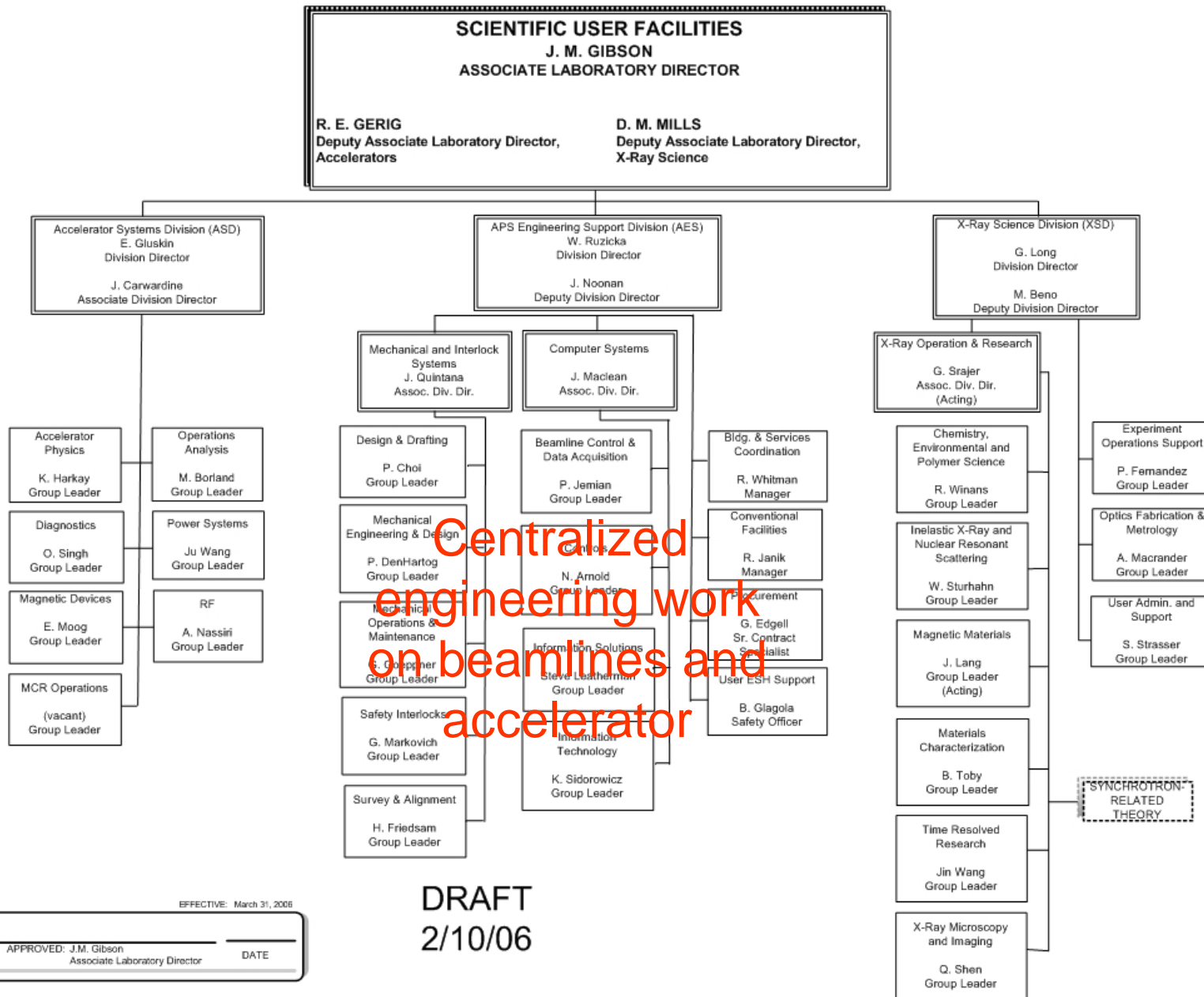
David Donkers
ASD
Powr. Sysys. Grp.
Tech. Sr.

Ju Wang
ASD
Powr. Sysys. Grp. Leader

For diligence in troubleshooting a difficult and subtle problem, and for rigorous application of safe work practices in the troubleshooting of the booster main dipole power supply.



APS Reorganization – Effective March 31, 2006



Teamwork and continuous improvement:

Do employees feel reluctant to give feedback?

360 Feedback Average Scores for SUF Supervisors

■ **Top 5**

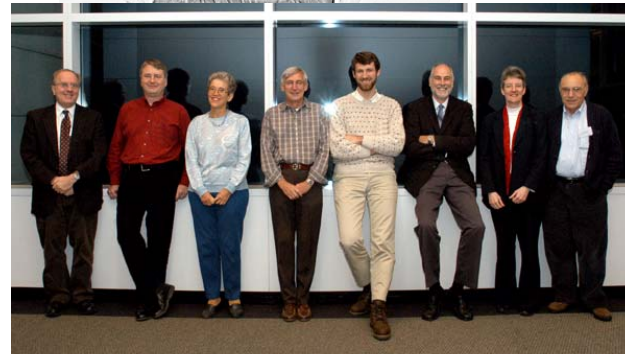
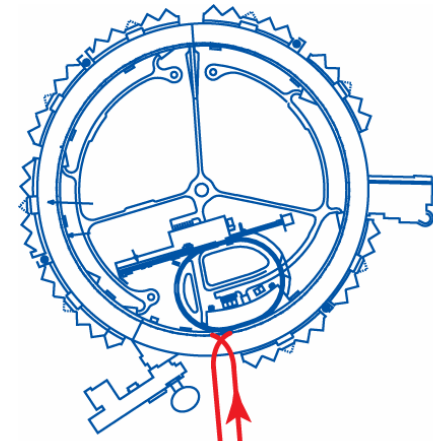
- Acts in an honest and upfront manner
- Ensures that safety is integrated into work planning, execution and review
- Creates and maintains safe, secure and environmentally sound working conditions
- Treats people of all backgrounds fairly
- Promotes safety as a personal value for colleagues and staff

■ **Bottom 4**

- Delegates important work to build the skills of others
- Takes reasonable risks
- Negotiates outcomes without alienating people
- Effectively manages resistance to change

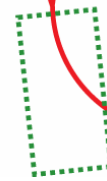
The future is coming into focus...

- APS is the largest user facility in U.S. and growing in scientific impact
- We are developing existing and new sectors and capabilities
- We are exploring options for an upgrade to APS in the next decade, and favor an ERL at this point
- We will continue to explore the scientific case for an upgrade, and technical options with our user community



Sam Krinsky (NLSL) Klaus Baleski (DESY) Annick Robert (ESRF) Vic Siller (Chair) (CAMD) Georg Hoffstetter (Cornell U.) Andrew Hutton (JLab) Elaine Seddon (Daresbury) Max Cornacchia (SLAC, retired)
Not pictured: John Galayda (SLAC)

*Advanced Photon Source Machine Advisory Committee
Argonne National Laboratory
November 15-16, 2006*



Conclusion

- APS is a well-built and designed facility which operates very safely
- Key areas of concern for safety
 - Processes which have been improved in last few years
 - *ESAF*
 - *Radiation Systems*
- Key challenges
 - Small science culture meets big science culture
 - Innovation and the work control envelope in ISM
 - *Helping mark the boundaries for work control in research*
 - *Protecting the innocent user with engineered controls*
 - Safety and reliability
 - *Avoiding a conflict by keeping safety first*
 - Crying wolf
 - *Is focus on DART/TRC misguided?*