APS Update

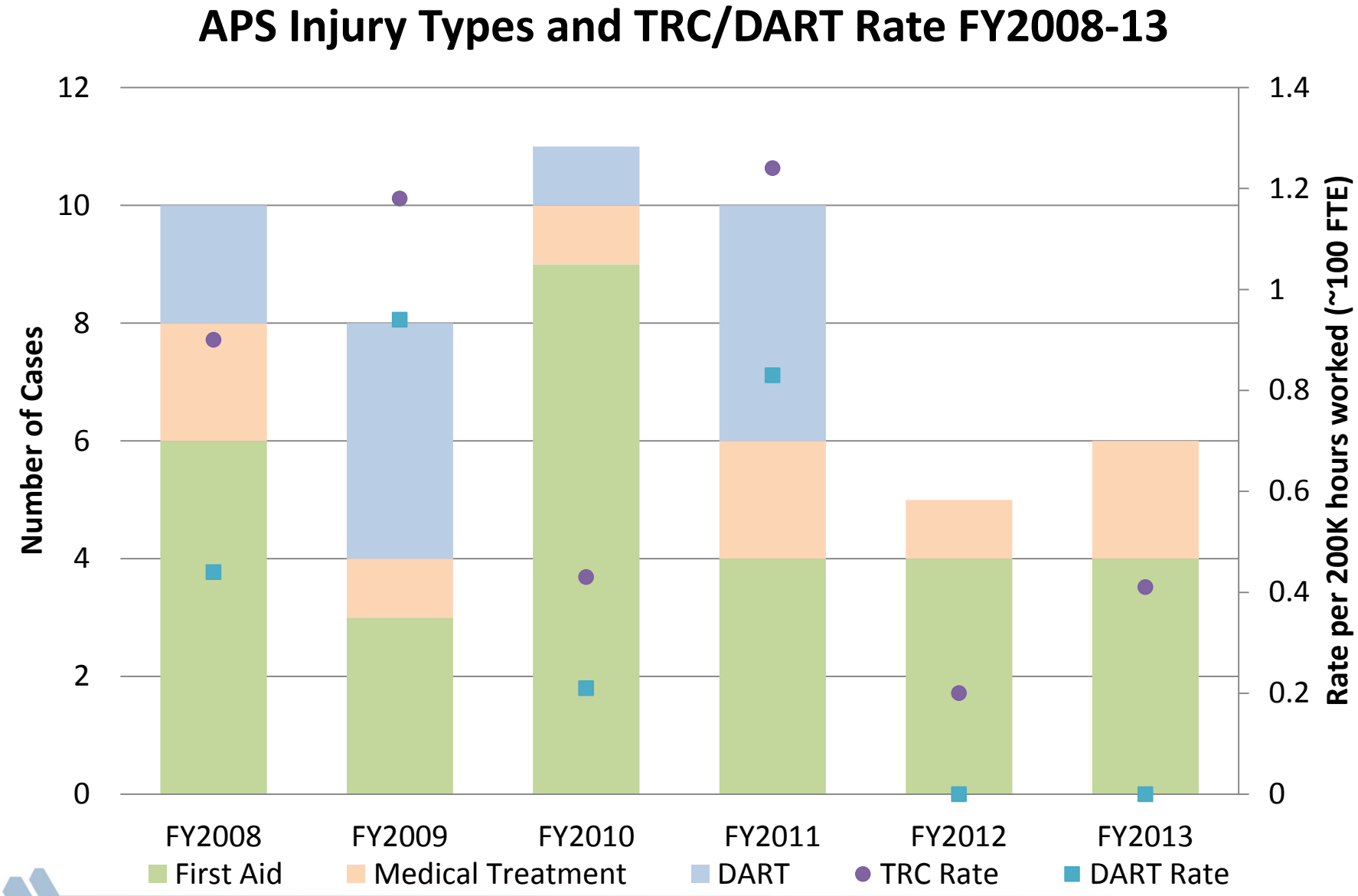
Brian Stephenson
Associate Laboratory Director, Photon Sciences
Argonne National Laboratory

APS Users Org Steering Committee and Partner User Council
September 18, 2013

Outline of Overview Talk

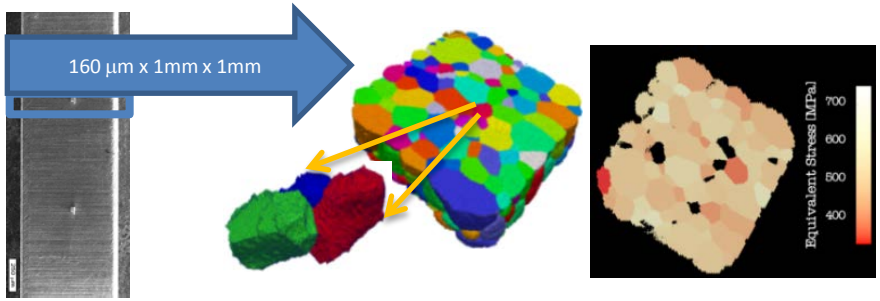
- Safety
- Science Highlights
- Radioactive samples
- Liquid Nitrogen
- FY14 Budget
- Construction Photos

Excellent and Improving APS Safety Record



HEDM: A New Paradigm for Engineering Design

- Researchers from AFRL, APS, LLNL, DESY, CMU, PulseRay working at XSD 1-ID (as well as CHESS and PETRA) developed a novel capability to concurrently map material substructure and the evolving stress in 3D during mechanical testing
- Data form an essential basis for the development of microstructure-based design tools, enabling adoption of location-specific processing where properties are optimized spatially within components to improve capabilities, safety, and savings
- Integrated three high-energy synchrotron x-ray techniques to:
  - quantify the average elastic strain and stress tensor for each grain using far-field high-energy diffraction microscopy (HEDM);
  - map the grain shape and local crystallographic orientation within and between grains using near-field HEDM; and,
  - track the formation and spread of voids and cracks using micro-contrast tomography during mechanical testing

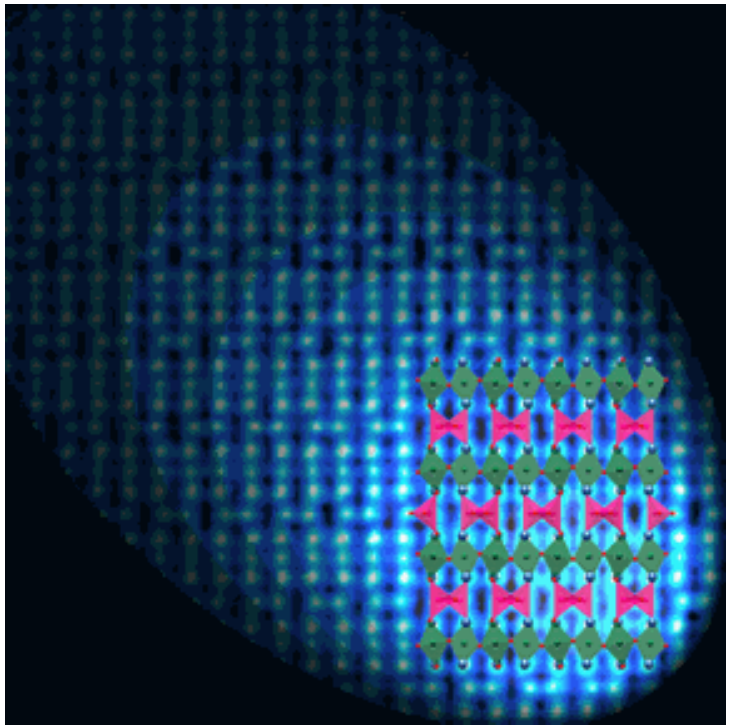


A titanium test specimen shown with a sub-volume selected to demonstrate how the internal grain structure can be mapped nondestructively. The equivalent stress is also shown for each grain in a 2D cross-section. This information pushes far below surface measurements on bulk samples to allow for each grain to be used as a test bed for model development.

J.C. Schuren, P.A. Shade, T.J. Turner (AFRL/RXCM) J. Almer, P. Kenesei, A. Mashayekhi, E. Benda, K. Goetze (ANL/APS) U. Lienert (DESY) J. Bernier, S.F. Li (LLNL) R. Suter, J. Lind (Carnegie Mellon Univ.) Basil Blank (PulseRay)

A “Sponge” Path to Better Catalysts & Energy Materials

- XAS and XMCD at XSD beamline 4-ID-C aided development of new oxygen “sponge” that can easily absorb or shed oxygen atoms at low temperatures
- Materials with these novel characteristics would be useful in devices such as rechargeable batteries, sensors, gas converters, and fuel cells
- Material consists of strontium cobaltite $SrCoO_x$, known to occur in a preferred crystalline form called brownmillerite ($SrCoO_{2.5}$)
- Through epitaxial stabilization process team discovered way to synthesize material in a more desirable perovskite phase ($SrCoO_{3-\delta}$)
- Researchers have filed an invention disclosure on their findings



Schematic of new ORNL material that can easily absorb or shed oxygen atoms

H. Jeen, W.S. Choi, M.D. Biegalski, C.M. Folkman, I-C. Tung, D.D. Fong, J.W. Freeland, D. Shin, H. Ohta, M.F. Chisholm, H.N. Lee, “Reversible redox reactions in an epitaxially stabilized $SrCoO_x$ oxygen sponge,” Nat. Mater., published online (2013). DOI: 10.1038/NMAT3736

H. Jeen, W.S. Choi, M.D. Biegalski, D. Shin, M.F. Chisholm, H.N. Lee (ORNL) C.M. Folkman, D.D. Fong, J.W. Freeland (ANL) I-C. Tung (ANL, NWU) H. Ohta (Hokkaido U.)

A New Family of Quasicrystals

- High-energy x-ray single-grain diffraction utilizing XSD beamline 6-ID-D reveals new family of rare-earth quasi-crystals, candidates for hydrogen storage; cylinder liners, piston coatings that could reduce air pollution and increase engine lifetimes; coatings on metallic parts for bone repair and prostheses
- Only known magnetic rare-earth icosahedral binary quasicrystals; a "matched set" of magnetic quasicrystals and their closely related periodic cousins provide a means for cleaner comparison of structural and magnetic properties between a quasicrystal and its periodic approximant

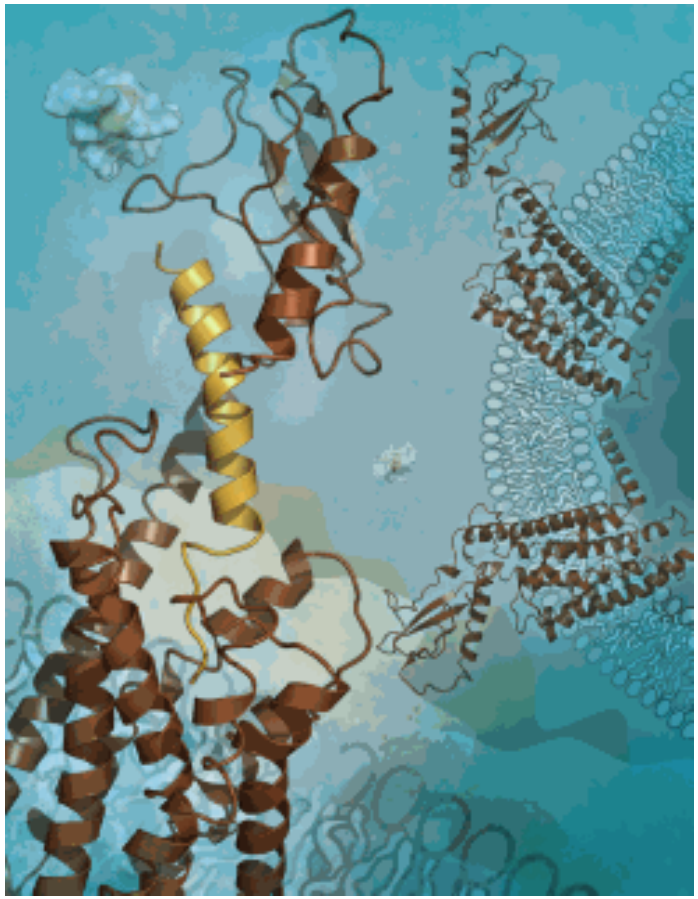
Diffraction pattern from an icosahedral Gd-Cd quasicrystal showing 10-fold rotational symmetry. High-energy diffraction with x-rays from the new Advanced Photon Source superconducting undulator was used to create this diffraction pattern. *A. Kreyssig and A. Goldman (Iowa State University and Ames Lab)*

A.I. Goldman, T. Kong, A. Kreyssig, A. Jesche, M. Ramazanoglu, K.W. Dennis, S.L. Bud'ko, and P.C. Canfield, "A family of binary magnetic icosahedral quasicrystals based on rare earths and cadmium," Nat. Mater. **12**, 714 (2013). DOI:10.1038/nmat3672

A.I. Goldman, T. Kong, A. Kreyssig, A. Jesche, M. Ramazanoglu, S.L. Bud'ko, P.C. Canfield (Ames Lab, ISU), K.W. Dennis (Ames Lab)

A Key Target for Diabetes Drugs

- 3-D atomic structure of the human glucagon receptor was identified by an international team of researchers at the GM/CA-XSD 23-ID-D beamline
- The receptor, found mainly on liver and kidney cells, helps regulate glucose levels in the bloodstream and is the target of potential therapeutic agents for type 2 diabetes
- This and related GLP1 and GIP receptors are high on list of desired class B GPCR structures due to potential as diabetes drug target and similarity to other receptors involved in endocrine and metabolic disorders



The structure of the human glucagon receptor. (Image courtesy of Katya Kadyshevskaya, The Scripps Research Institute)

F.Y. Siu, GW. Han, D.Wacker, J.S. Joseph, W. Liu, V. Cherezov, V. Katritch, R.C. Stevens (Scripps) M. He, D.Yang, Z. Zhang, C. Zhou, M.-W. Wang (Shanghai Inst. Materia Medica) C. de Graaf, (U. Amsterdam) Q. Xu (SLAC) J. Lau (Novo Nordisk)

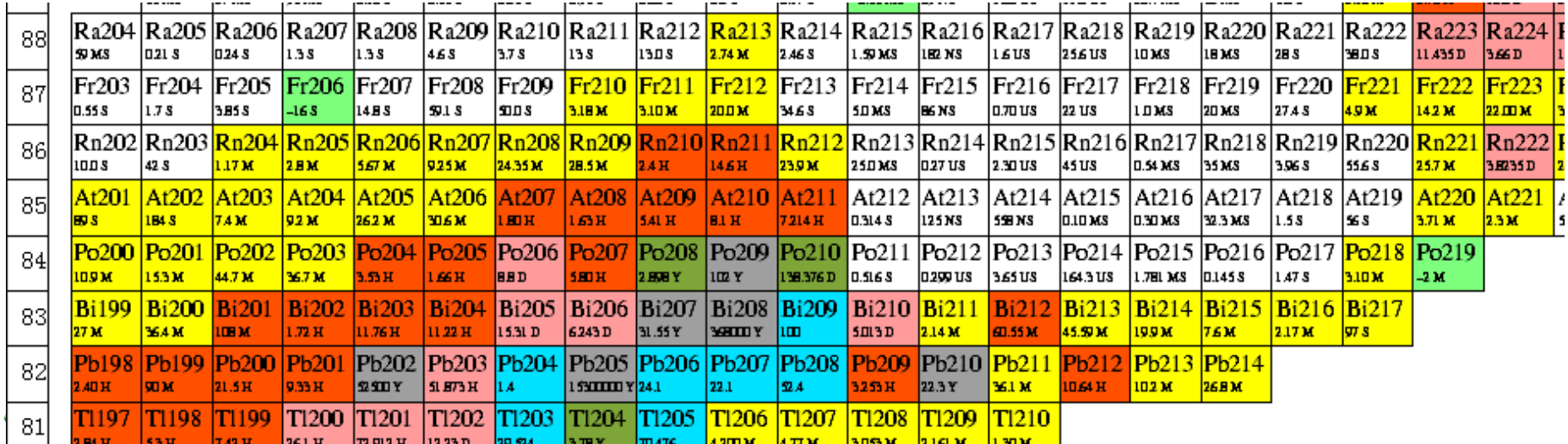
F.Y. Siu, M. He, C. de Graaf, GW. Han, D.Yang, Z. Zhang, C. Zhou, Q. Xu, D.Wacker, J.S. Joseph, W. Liu, J. Lau, V. Cherezov, V. Katritch, M.-W. Wang, R.C. Stevens[1]*, "Structure of the human glucagon class B G-protein-coupled receptor," *Nature*, published online 17 July 2013. DOI:10.1038/nature12393

“Natural” Radioactivity & APS Samples

- The Department of Energy (DOE) requires radiation exposure to employees, visitors, the general public and facility users to be maintained as low as reasonably achievable (ALARA).
- The DOE includes consideration of background radiation in this requirement. Background radiation has several sources including *naturally occurring radioactive materials* and global fallout as it exists in the environment (such as from testing of nuclear explosive devices.)
- The DOE explicitly requires controlling potential exposure *beyond that solely due to background radiation.*
- One means by which APS implements these controls is through the requirements defined under APS Experiment Hazard Class 8.1 which includes radioactive material samples. These controls include shipping and handling requirements for radioactive material samples. Also considered is potential radioactive contamination of APS facilities and equipment.

Proposed "Natural" Radioactivity Exemption

- At APS, the first step in managing radioactivity is to have users declare on the ESAF that their experiment involves a “radioactive sample”
- We need to provide clear guidance as to what constitutes a radioactive sample, e.g.
  - For radioactive elements with no stable isotopes (e.g. Tc, Pm, and Po or higher, Z = 43, 61, or >=84), samples in which they are chemically enriched beyond naturally occurring background levels
  - For other elements, samples in which radioactive isotopes are present in concentrations above their natural abundance
- Samples not falling into the above categories would be exempt because their radioactivity is part of background radiation



Proposed "Natural" Radioactivity Exemption

- Natural samples that have not been processed (beyond e.g. sterilization) are part of background radiation and as such are not considered to be radioactive for application of radioactive sources requirements.
- However, samples must be treated as radioactive material at APS if radioactive elements or isotopes occur at levels above their natural abundance. Examples include:
  - Rocks, ores, mineral deposits, mining tailings, or similar items with naturally occurring radioactive elements known to contain higher concentrations than typically encountered
  - Any manmade chemical in which radioactive elements are concentrated (such as biological staining chemicals containing uranium) or samples treated by such chemicals
  - Samples that have been activated by exposure to high energy radiation or neutrons
  - Soil samples from the Chernobyl or Fukushima exclusion areas or similar areas affected by known or suspected airborne effluent discharge points
  - Sediments taken from downstream of known or suspected radioactive effluent discharge points
- **Are any loopholes created by this language that could result in exemption of material that could contaminate a beamline station?**

“Natural” Radioactivity & APS Samples *(cont’d)*

- In addition while radioactive material samples containing minute quantities of radioactive isotopes may not require special packaging under Department of Transportation regulations in transit to Argonne, these samples do require radioactive postings and handling once they arrive at the Laboratory. These materials must be shipped via the Argonne Materials Controls & Accountability (MC&A) Group.

- Any questions regarding the proposed use of naturally occurring radioactive materials must be brought to the attention of your Beamline and/or the APS (Bruce Glagola) as early as possible to assure that the materials are handled according to the required regulations. See APS Experiment Hazard Class 8.1 for details on shipping and other requirements for radioactive materials.

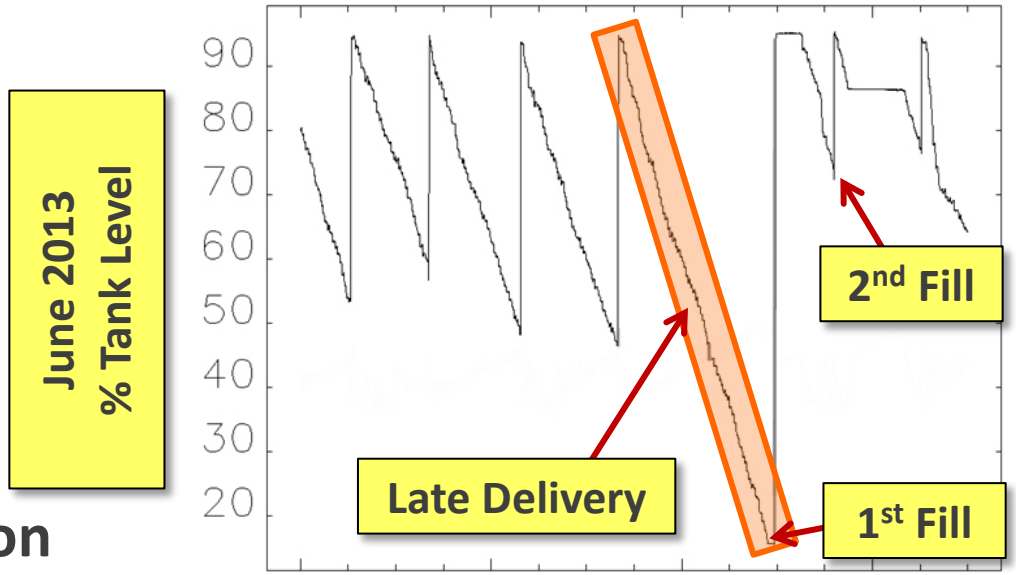
- **Is this direction clear? What else may need to be said?**

Liquid Nitrogen Issues

June and August Low Tank Levels

June 2013

1. In June, the LN2 Airgas delivery truck broke down. The delivery was delayed by 16 hours. Dewar C in truck lock 435 dropped to 15 inches.
2. C-D interconnect valve opened.
3. Five beamline sectors affected.



June Action

A. Airgas was contacted. They gave us assurance that this would not happen again.
B. The APS formed a LN2 Task Force to study the issues with the LN2 system and provide recommendations.

July Action

July 11, 2013

TO: Jeff Toeller — Electrical Engineer

FROM: William G. Ruzicka — AES Division Director

SUBJECT: **APS Liquid Nitrogen Distribution System Task Force**

Jeff, you have been assigned to chair a task force to study the current status of the APS Liquid Nitrogen System and recommend upgrades as appropriate. A mid-June 2013 problem with a late LN2 delivery caused beamline cooling problems. This event was the driver behind forming this task force.

Charge: The ad hoc task force will review the APS Liquid Nitrogen Distribution System (LNDS) for the specific purpose of determining system characteristics or processes that can be improved or modified in order to increase the reliability of the system. The task force will propose recommended changes to the AES Division Director. The proposals will include estimates for cost and manpower as well as the approximate time it will take to implement the upgrades. Implementation of task force recommendations is not within the charge of this task force.

The following LNDS constituents will be reviewed:

- Vendor delivery
- LN2 optimized tank capacities
- Hardware
- Controls
- Procedures
- Surveillances
- Notifications
- Training

Meetings: Meetings will be held twice a month until final recommendations are delivered to the AES Division Director. Meeting minutes will be taken and distributed to committee members and the AES Division Director. Members may need to meet more frequently during the review process.

Task Force Members:

- J. Toeller (Chair)
- K. Brister
- G. Doktorczyk
- M. Kirshenbaum
- G. Moonier
- A. Stevens

Time Frame: It is expected that the review and recommendation process will take approximately 6 months. Final **Recommendations will be delivered on or before December 20, 2013**. The task force will be dissolved upon acceptance of the final recommendations by the AES Division Director.

LN2 Issues to be reviewed:

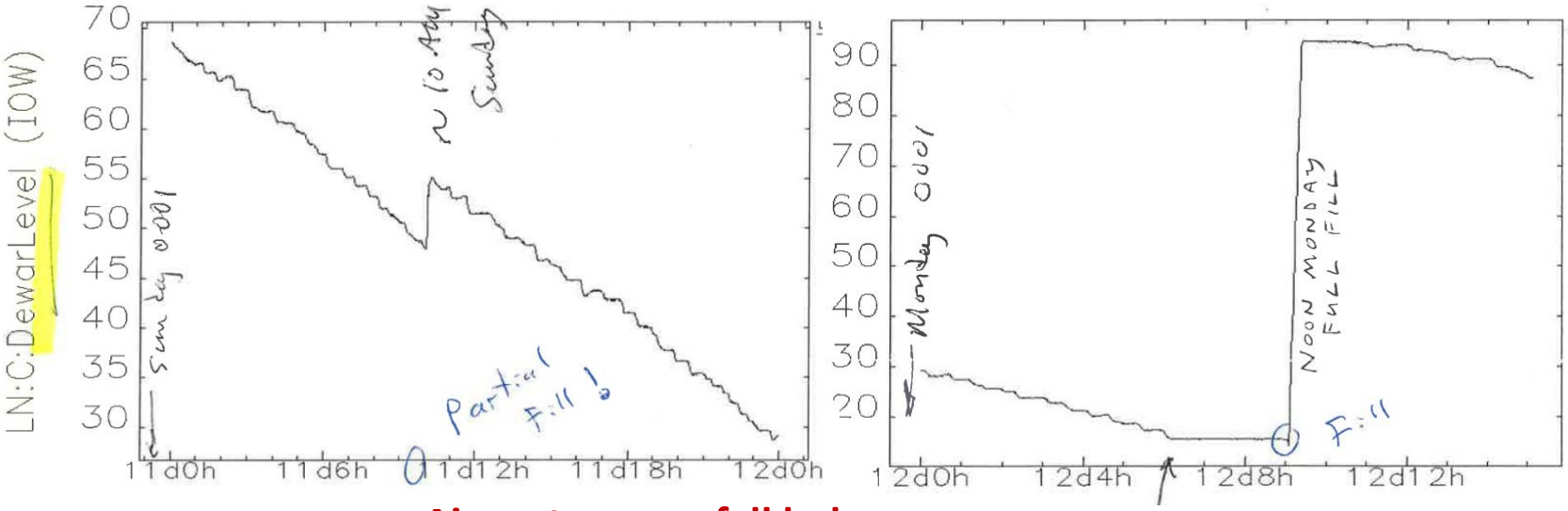
- Vendor delivery
- LN2 optimized tank capacities
- Hardware
- Controls
- Procedures
- Surveillances
- Notifications
- Training

Task Force Members:

- J. Toeller (Chair)
- K. Brister
- G. Doktorcyzk
- M. Kirshenbaum
- G. Moonier
- A. Stevens

August 2013

A. In August, Airgas delivered LN2 to the APS Dewars. Dewar C was filled from 47” to 55”. The truck delivery tank was then empty and the truck exited Argonne.
B. Dewar C, later went into low alarm status (15.8”). MCR operations, per standing order, opened the B-C interconnect valve. LN2 System Engineers (Stevens & Doktorczyk) were called. The C-D interconnect valve was opened. Airgas was called and told to immediately fill Dewar C.



Airgas to never fall below
3/8 = .375 = 37.5”

APS Reviewed The Contract Specifications for Bulk Liquid Nitrogen

Appendix G

ARGONNE NATIONAL LABORATORY
9700 South Cass Avenue
Argonne, Illinois 60439

SPECIFICATION FOR
BULK LIQUID NITROGEN
ANL PART No. 03-3780-00

February 28, 2005

2.1.1: Bulk Liquid Nitrogen Purity – **99.99% pure**

2.1.2: Maximum impurities:

C. Moisture – **Not over 2 grains per 1,000 cubic feet**

r Technique –

.5.1: Drivers shall be properly trained.

Vendor Requirement

4.5.3: The LN2 **tanks shall not be allowed to fall below a min. level equivalent to 3/8 (37.5”)** of the unit’s capacity to insure an uninterrupted supply.

Airgas

August 23, 2013

Kevin Spellman
Area Vice President
Airgas North USA LLC, - North Central
621 East 131st Street
Hammond, IN 46327
(219) 989-9030 Fax (219) 989-0681
kevin.spellman@airgas.com

William G Ruzicka P.E
Division Director
APS Engineering Support Division
Advance Photon Source
Argonne National Laboratory
9700 South Cass Avenue, Bldg 401
Argonne, IL 60439-4800

Dear Bill,

Thank you for your time this past Tuesday to discuss your team's bulk nitrogen requirements specific to the APS ring. The recent issues we have experienced have certainly gained our attention as we take these matters very serious not only for your area but for all of Argonne Labs requirements.

August Action

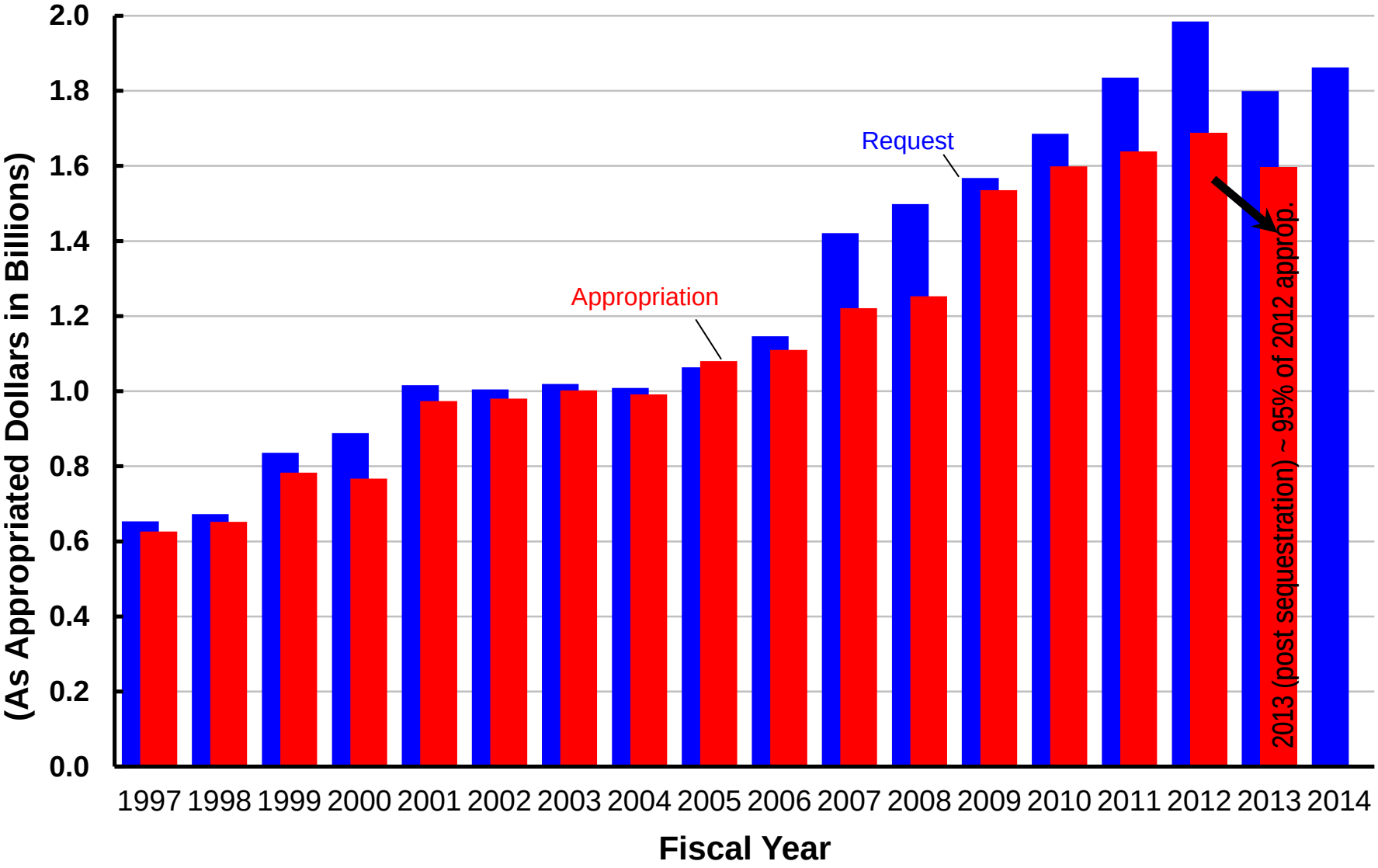
Facts:

- APS spends $420,000/year with Airgas for LN2.
- Airgas contract statements:
  - Dewar's never to go below 37.5" (3/8 full).
  - Drivers properly trained.

APS/ANL – Airgas Contract Changes

- Implemented process to begin utilizing tank readings from APS Telemetry.
- Implemented reorder level of 53.6".
  - Allows approximately 8 hours to complete delivery before hitting the required 3/8 (37.5%) fill point.
- At the Argonne Site the APS tanks will be filled first each day and the driver will call in readings to Airgas headquarters.
  - Tank #35 will be filled first on the ring prior to all other tanks.
- In the event the driver does not have enough LN2for the total fill of scheduled tanks, the driver will call the Airgas headquarters before leaving ANL to ensure back up supply is scheduled so that the tank level does not fall below 3/8 (37.5%).

BES Budget Request vs. Appropriation (1997 – 2013)



FY14 BES HEWD Mark

- The Committee recommends $1,583,099,000 for Basic Energy Sciences, $106,396,000 below fiscal year 2013 and $279,312,000 below the request.
- The Committee recognizes the critical contribution that the program's light sources, neutron sources, and other user facilities make to scientific discovery and American industry. The United States is currently host to the world's most advanced and productive basic energy science user facilities, and the Department is urged to develop a plan for the next generation of light sources and other user facilities in order to maintain American leadership through the next decade.
- $1,509,299,000 for Research within Basic Energy Sciences, $29,199,000 below fiscal year 2013 and $231,812,000 below the request. The recommendation includes $24,237,000 for the fifth year of the Fuels from Sunlight Energy Innovation Hub and $24,237,000 for the second year of the Batteries and Energy Storage Energy Innovation Hub, the same as the request; and $60,000,000 for Energy Frontier Research Centers (EFRC's), $40,000,000 below the request. The recommendation does not provide $68,729,000 for the requested one-time funding for additional EFRCs. The Committee provides no funds, $8,520,000 below fiscal year 2013 and the request, for the Experimental Program to Stimulate Competitive Research.
- MIE: $64,200,000 for two major items of equipment, the same as the request: $39,200,000 for the Advanced Photon Source Upgrade and $25,000,000 for NSLS-II Experimental Tools.
- Facilities: $775,003,000 for facility operations, which includes funding for individual scientific user facilities at their finalized fiscal year 2013 operating levels and $50,000,000 for NSLS-II early operations, $29,053,000 above fiscal year 2013 and $19,000,000 below the budget request.
- Construction.—$73,800,000 for Basic Energy Sciences construction projects, $77,197,000 below fiscal year 2013 and $47,500,000 below the request. The recommendation includes the first year of construction funding for the LINAC Coherent Light Source II two-tunnel upgrade project.
- The bill includes a provision prohibiting the Office of Science from entering into multi-year funding agreements with a value of less than $1,500,000.

FY14 BES SEWD Mark

- The Committee recommends $1,805,162,000, a decrease of $57,249,000 below the budget request, for Basic Energy Sciences.
- Of these funds, the Committee recommends up to $100,000,000 for Energy Frontier Research Centers and $24,237,000 each for the Fuels from Sunlight and Batteries and Energy Storage Hubs.
- Within these funds, the Committee also recommends $20,000,000 for the Experimental Program to Stimulate Competitive Research [EPSCoR] program, which was created by Congress over concerns about the uneven distribution of Federal research and development grants.
- MIE: $64,200,000 for two major items of equipment, the same as the request: $39,200,000 for the Advanced Photon Source Upgrade and $25,000,000 for NSLS-II Experimental Tools.
- Construction—$121,300,000 is provided for construction activities as requested, which includes $26,300,000 for the National Synchrotron Light Source-II at Brookhaven National Laboratory and $95,000,000 for the Linac Coherent Light Source-II at SLAC.

FY14 BES Appropriations: HEWD vs. SEWD

HEWD Mark

	FY 13 Approp.	FY 14 Request	FY 14 House	FY 14 House vs. FY 13 Approp.		FY 14 House vs. FY 14 Request	
BES Total	1,596,166	1,862,411	1,583,099	-13,067	-0.8%	-279,312	-15.0%
MSE & CSGB	676,248	750,921	610,342	-65,905	-9.7%	-140,579	-18.7%
SUFD	872,715	990,190	898,957	+26,242	+3.0%	-91,233	-9.2%
Construction	47,203	121,300	73,800	+26,597	56.3%	-47,500	-39.2%

- The House EWD FY 2014 mark for BES continues most of the activities that are funded in FY 2013, including support of the EFRCs—but at a 60% reduced level from the FY 2013 level, two Energy Innovation Hubs, NSLS-II construction, and the operations of BES user facilities below the FY 2013 funding levels, reducing their operations to below optimum.
- The House mark allows for the continuation of the APS upgrade and NSLS-II instruments MIEs per planned schedules.
- The House mark reduces the core research by $17 million from the FY 2013 level, the support for LCLS-II construction below the request, NSLS-II early operations below the request, and eliminates funding for the DOE EPSCoR program.

SEWD Mark

	FY 13 Approp.	FY 14 Request	FY 14 Senate	FY 14 Senate vs. FY 13 Approp.		FY 14 Senate vs. FY 14 Request	
BES Total	1,596,166	1,862,411	1,805,162	+208,996	+13.1%	-57,249	-3.1%
MSE & CSGB	676,248	750,921	693,673	+17,424	+2.6%	-57,249	-7.6 %
SUFD	872,715	990,190	990,190	+117,475	+13.5%	—	—
Construction	47,203	121,300	121,300	+74,097	+157%	—	—

- The Senate EWD FY 2014 mark for BES provides funding for all of the activities requested in FY 2014, except for the $68,729,000 requested one-time funding for additional EFRCs.
- The Senate mark will permit the facilities to perform needed maintenance and upgrades—much of which has been deferred— and will improve support to users in order to return facilities operations to optimum levels in FY 2014.
- All construction and MIE projects are funded at the requested levels.
- The Senate mark funds the Experimental Program to Stimulate Competitive Research [EPSCoR] program at $20,000,000, which is $11,480,000 above the FY 2014 request.

LOM 437 Build-out

- Funded by lab
- Occupancy October 1
- Provides 40 offices, some needed for nearby beamlines

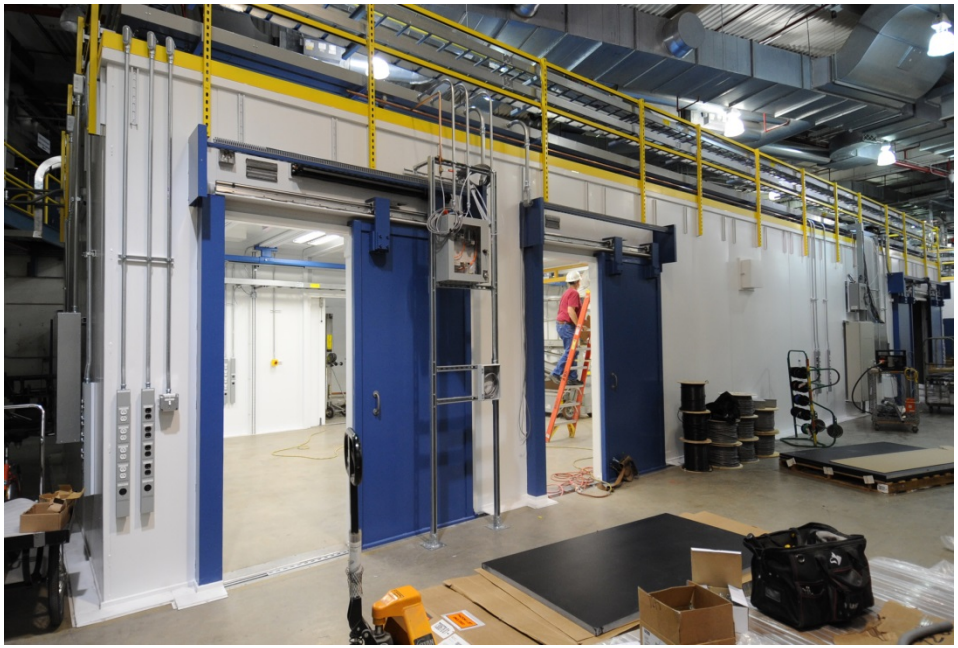
Dynamic Compression Sector (35) Hutches

- Hutches going up

9.12.2013

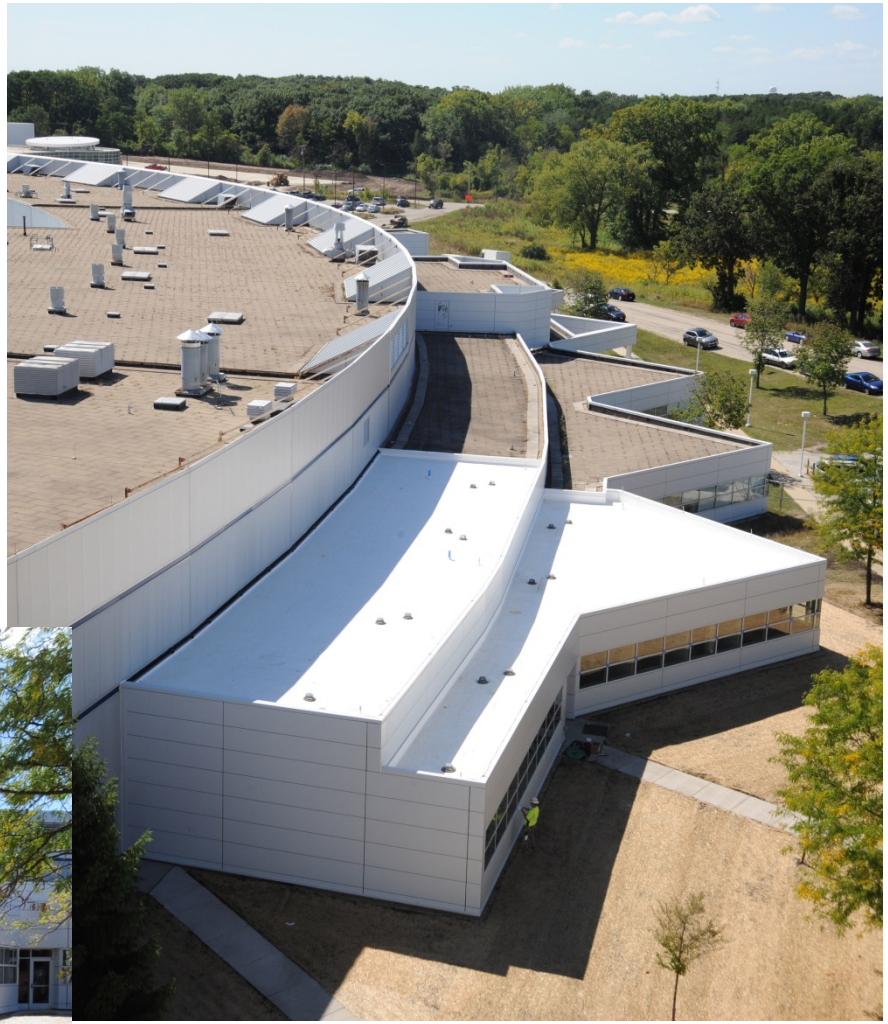
Dynamic Compression Sector (35) Hutches

- Hutches going up



LOM 438F Construction

- Funded by NNSA, will provide space for DCS



LOM 438F Construction

- Funded by NNSA, will provide space for DCS

9.12.2013

Advanced Protein Crystallization Facility Construction

- Funded by State of Illinois
- Space for ANL Biosciences programs
- Completion scheduled for Fall

New Parking Lot in 437 / CNM Area

- Funded by lab
- Ready for use October 1

New Parking Lot in 437 / CNM Area

- Funded by lab
- Ready for use October 1