APS-U Forum Update

Dean Haeffner

APS-U Forum
January 29, 2015

APS-U Forum

- New meeting designed to foster communication about the APS-U amongst:
  - Resident user community
  - People working directly on the project
  - People working on R&D topics related to the project
  - APS-U management

- 2nd and 4th Thursday of every month @ 10 am in 401-A1100

- Hosted by Dean Haeffner & Stefan Vogt
  - Comments, suggestions for topics are most welcome

- This week
  - APS-U Update – Dean Haeffner
  - RIXS – Thomas Gog

General Update

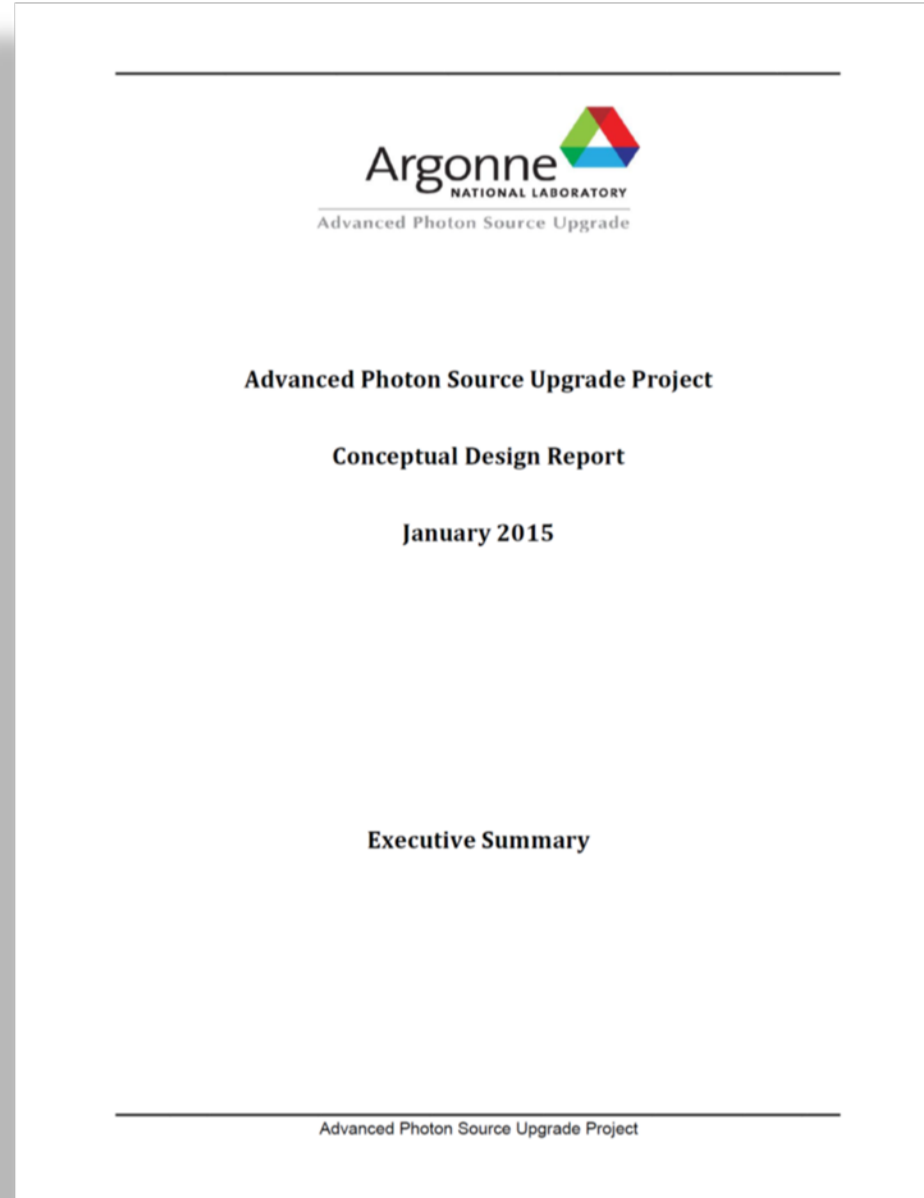
- Project Status
  - Waiting for revised CD-0 signing
  - In DOE’s hands
  - No indications of major problems
  - Continued requests for refinement and improvement of the Science Case
  - Meeting of APS/APS-U management with DOE March 5, 2015 may clarify

  - CDR draft complete
    - Beamlines as placeholders

APS Upgrade Conceptual Design Report

- The Conceptual Design Report (CDR) has been developed over the last year
- It describes a complete, coherent technical concept to meet the APS Upgrade Mission
- A series of technical reviews in Spring 2014 informed the technical design
- The CDR incorporates all technical aspects of the project
  - Accelerator
  - Front-ends and Insertion Devices
  - Beamlines
  - Storage Ring removal/installation
  - Utilities
  - ESH&Q

- ~440 pages



Argonne NATIONAL LABORATORY

Advanced Photon Source Upgrade

Advanced Photon Source Upgrade Project

Conceptual Design Report

January 2015

Executive Summary

Advanced Photon Source Upgrade Project

General Update

- Project Status
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  - In DOE's hands
  - No indications of major problems
  - Continued requests for refinement and improvement of the Science Case
  - Meeting of APS/APS-U management with DOE March 5, 2015 may clarify
  - CDR draft complete
    - Beamlines as placeholders
- Reviews
  - Some indications a CD-1 (CDR) review could be late summer
  - Machine Advisory Review (MAC)
    - February 2-4, 2015
    - Serves as technical review for the accelerator systems for CD-1 DOE review

APS Machine Advisory Committee Meeting
February, 2-4, 2015
Building 401/Room A5000
Agenda

Monday, February 2, 2015

8:30 AM	Executive Session	
9:00 AM	Welcome and Introduction to APS	Stephen Streiffer
9:25 AM	Introduction to APS Upgrade Project	Stuart Henderson
9:55 AM	Discussion	
10:10 AM	Break	
10:30 AM	APS Accelerator Operations Overview and Future Plans	Alexander Zholents
11:15 AM	Insertion Device Development - Revolver, SCU and HGVPU Undulators	Efim Gluskin
11:45 AM	Discussion	
12:00 PM	Working Lunch - Overview of Morning Talks and Discussion	Stuart Henderson
12:45 PM	Overview of APS Upgrade Conceptual Design	Glenn Decker
1:20 PM	APS Upgrade Lattice Design and Evaluation	Michael Borland
2:00 PM	Tolerances, Correction and Stability	Vadim Sajaev
2:25 PM	Collective Effects	Ryan Lindberg
2:50 PM	Discussion	
3:05 PM	Break	
3:30 PM	Storage Ring Injection	Aimin Xiao
3:55 PM	Injector Requirements and Plans	Chih-Yuan Yao
4:20 PM	Alternative Lattice Design and Evaluation	Yipeng Sun
4:45 PM	Executive Session	
6:15 PM	Depart APS for Capri Restaurant	
7:00 PM	Dinner - Capri Restaurant 324 Burr Ridge Park, Burr Ridge, IL 60527	

Tuesday, February 3, 2015

8:30 AM	Executive Session/Follow-up on Previous Day's Material	
9:00 AM	Mechanical Systems Technical Breakout	Room 401/A5000
9:00 AM	Electrical Systems Technical Breakout	Room 401/B5100
12:15 PM	Working Lunch - Overview of Morning Talks and Discussion	Stuart Henderson
1:00 PM	Front Ends and Insertion Devices	Mohan Ramanathan
1:25 PM	Beam Stability R&D for the Upgrade	Nick Sereno
1:50 PM	Radiation Shielding Strategy and Engineered Safety Systems	Brad Micklich
2:15 PM	Storage Ring Removal and Installation Commissioning	Tom Fornek
2:45 PM	Discussion	
3:15 PM	Executive Session	
5:15 PM	Adjourn	

Wednesday, February 4, 2015

8:30 AM	Follow-up with Committee and/or Executive Session	
9:30 AM	Executive Session	
11:30 AM	Close-out	
12:30 PM	Working Lunch for Committee - Discussion TBD	TBD

MAC Review Committee

Committee Members

Name	Inst.
John Byrd	LBNL
Yunhai Cai	SLAC
Mark Champion	ORNL
George Ganetis	BNL
Bob Hettel (Chair)	SLAC
Yulin Li	Cornell Univ.
Guenther Rehm	Diamond Light Source
Ross Schlueter	LBNL
Timur Shaftan	BNL
Sushil Sharma	BNL
Christoph Steier	LBNL
Karen White	ORNL

Science Case

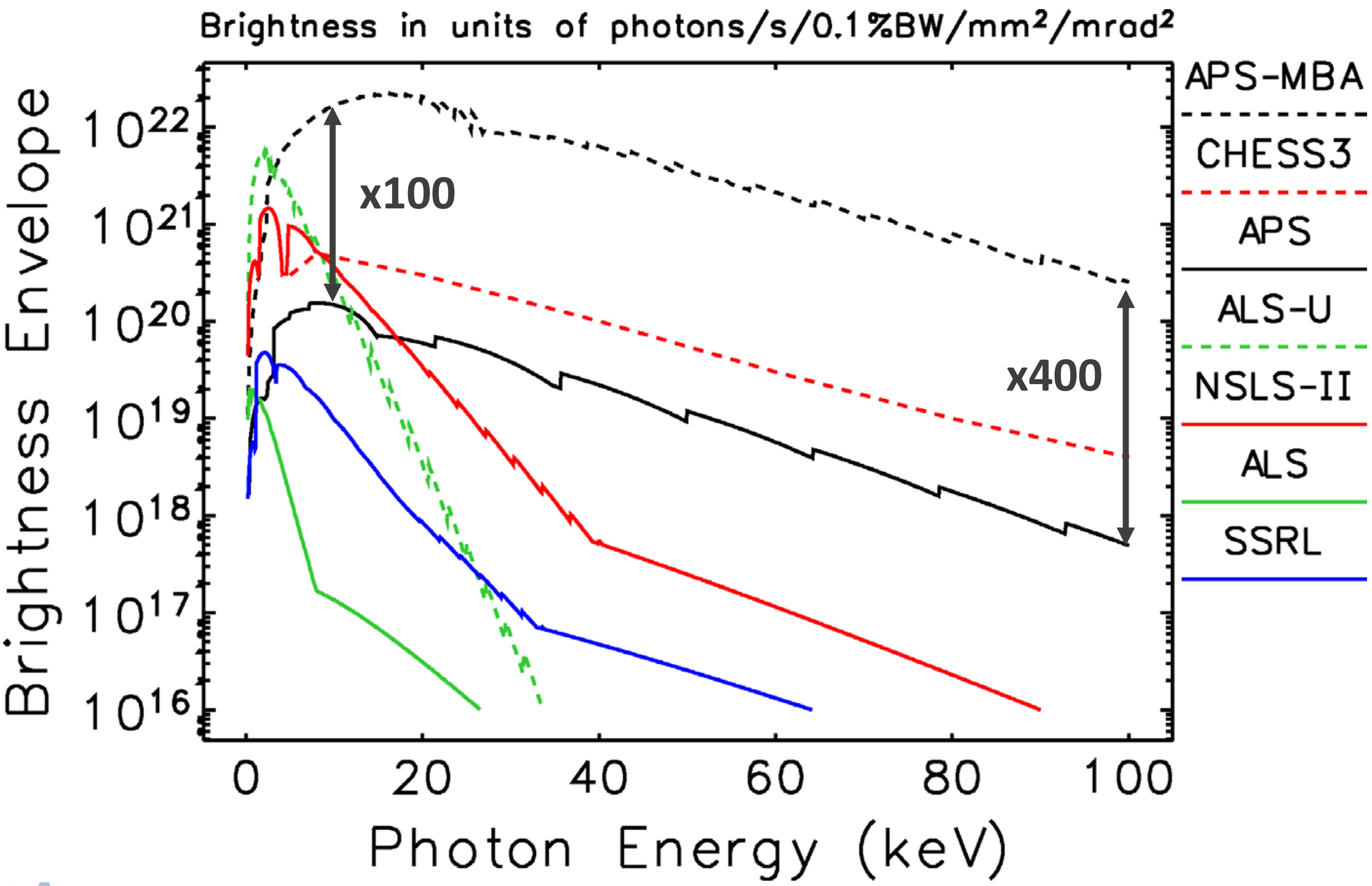
- Development Continue
  - This likely to be the case for some time
- Elizabeth Austin working with the project on this
- Stefan Vogt working as a science advisor to the project
- Paul Evans is consulting to the project
  - Visiting the APS once or twice a month

- Always looking for ideas

APS MBA Parameters – V6 Lattice

Quantity	APS Now	APS MBA Timing Mode	APS MBA Brightness Mode	Units
Beam Energy	7	6	6	GeV
Beam Current	100	200	200	mA
Number of Bunches	24	48	324	
Bunch Duration (rms)	34	67	55	ps
Bunch Spacing	153	77	11	ns
Emittance Ratio	0.013	0.98	0.1	
Horizontal Emittance	3100	47	68	pm-rad
Horizontal Beam Size (rms)	275	18	22	μm
Horizontal Divergence (rms)	11	2.6	3.1	μrad
Vertical Emittance	40	46	6.8	pm-rad
Vertical Beam Size (rms)	10	10.6	4.1	μm
Vertical Divergence (rms)	3.5	4.3	1.7	μrad

APS-U within the present and future domestic context



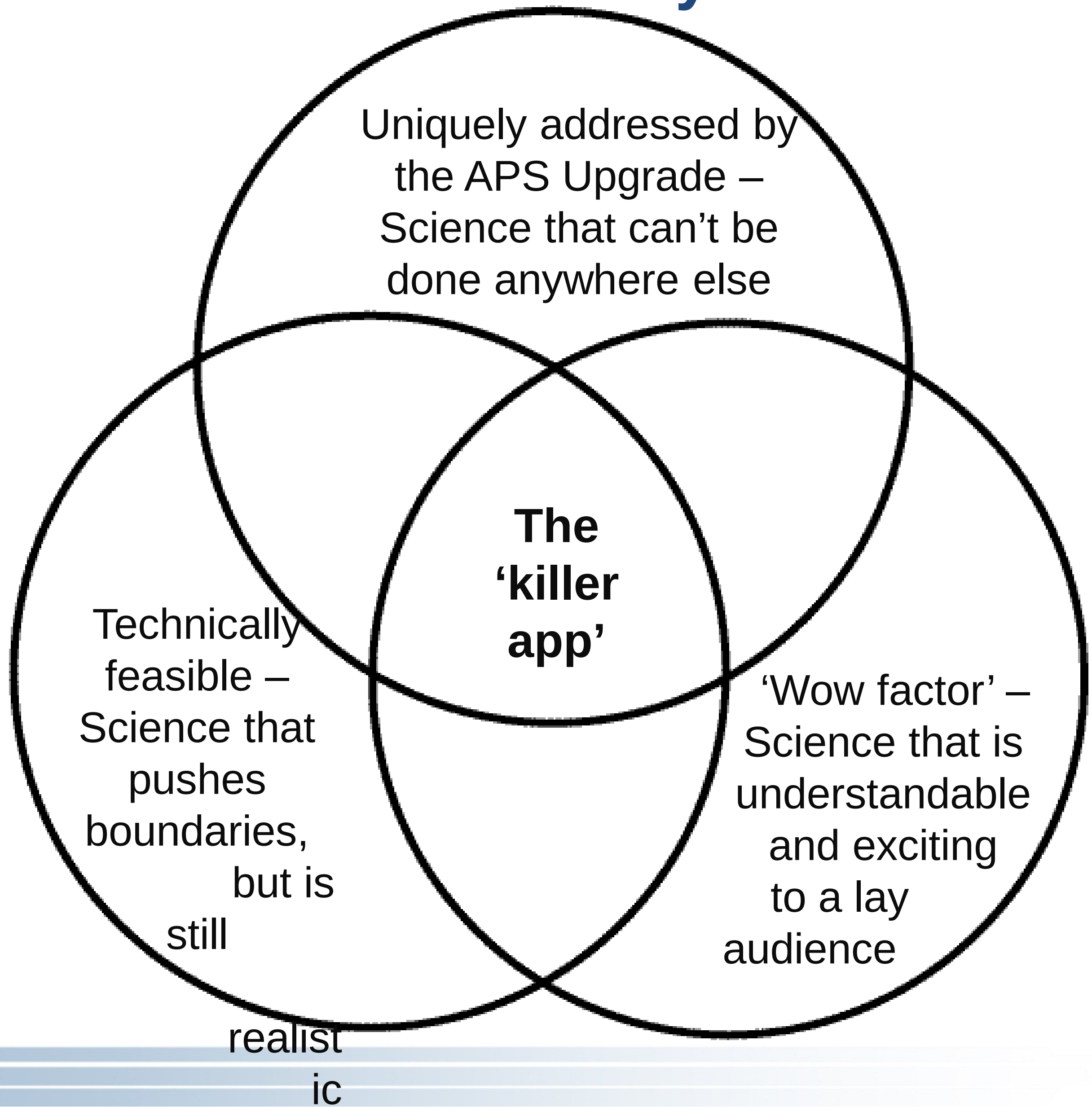
APS-U Comparison Specs

Parameter		APS Present	APS Upgrade Hi-Bright	APS Upgrade 48 Bunch	ESRF-II	SPring8-II	Petra-III	NSLS-II	MAX-IV	Sirius
Energy [GeV]		7	6	6	6	6	6	3	3	3
Current [mA]		102	200	200	200	100	100	500	500	500
Emittance, Horizontal [pm]		3113	67	48	142	99	1000	800	302	275
Brightness (*)	8 keV	1	88	51	61	43	4.1	3.7	13.9	22.7
	20 keV	1	336	144	164	137	2.9	0.8	5.2	8.1
	80 keV	1	382	152	154	127	1.0	0.01	0.4	0.3
Flux Density (*) (#)	8 keV	1	4.6	4.1	3.9	1.8	1.8	0.4	2.0	1.7
	20 keV	1	10.4	9.1	7.7	4.1	1.4	0.1	0.6	0.5
	80 keV	1	10.4	9.0	7.5	3.9	0.1	0.0	0.0	0.0
Coherent Flux (10^{11} ph/s)	8 keV	9.3	813	472	562	398	38	34	129	211
	20 keV	0.6	198	85	97	81	2	0	3	5
Single Bunch Brightness @ 8 keV (*)		1	6.5	25.5	1.5	5.1	0.3	0.1	1.9	3.1
Flux for 10 nm focus @ 20 keV (*)		1	336	144	164	137	2.9	0.8	5.2	8.1

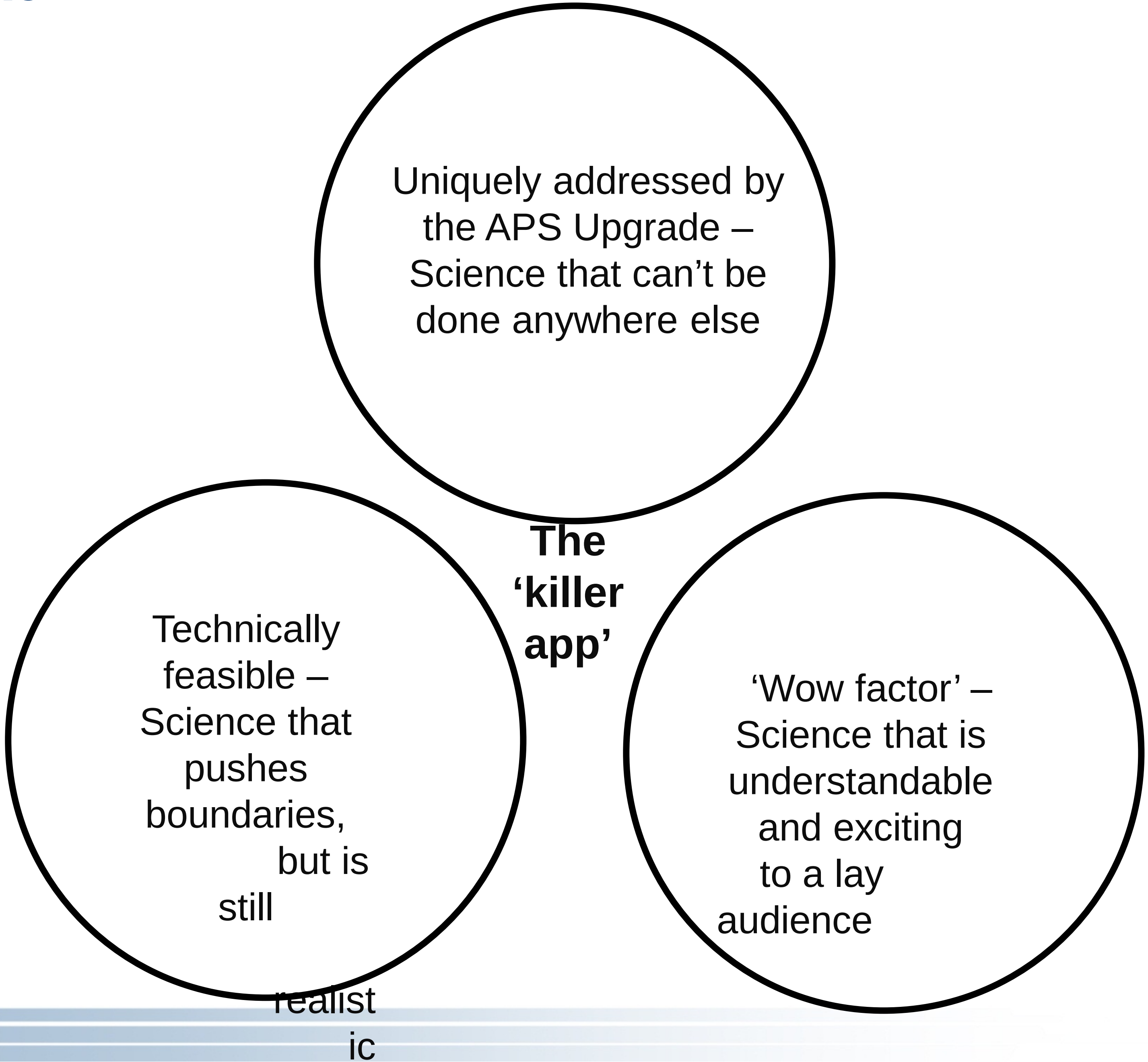
(*) Relative to present APS performance

(#) Flux Density is through a 0.5 x 0.5 mm aperture at 30 m

Science case challenge: What are the best examples that ‘tick every box’?



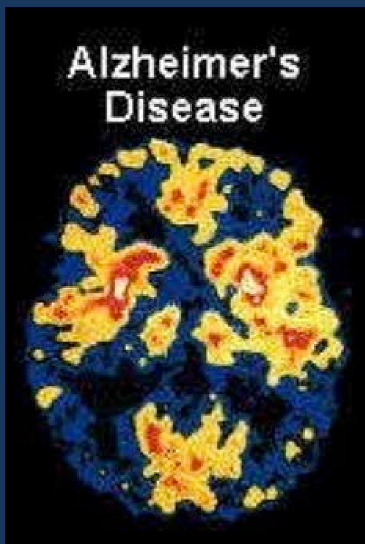
Not This



Uniquely addressed by the APS Upgrade – Science that can't be done anywhere else
The 'killer app'
Technically feasible – Science that pushes boundaries, but is still realistic
'Wow factor' – Science that is understandable and exciting to a lay audience

Life Sciences: Identifying triggers and pathways of fatal diseases

The Challenge



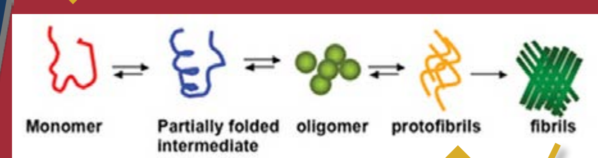
Alzheimer's disease, the nation's sixth-leading cause of death, affects 5.2 million Americans; medical and long-term care costs average $150 billion every year.

The Science Problem

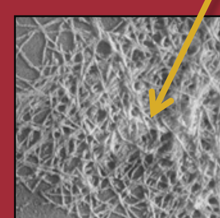
Neurological damage is tied to transformation of healthy neuropeptides into amyloid fibrils and other toxins.

Peptides transform in complex processes at the nanoscale – too small and too quickly for current techniques to capture.

Nucleation begins at nanoscale



… but current imaging can show fibrils only after they begin to form



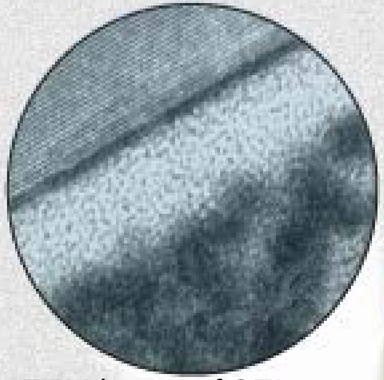
APS Upgrade will:

- Make it possible to study assembly/function of sub-micron proteins
  - Real environments
  - Sub-millisecond time resolution
  - Extremely small-volume samples
  - Entire pathway – pre-nucleation to plaque formation

Understanding nucleation is a critical first step toward interrupting – or preventing – the disease process.

APS-U: To expand the limits of energy storage

Next-gen batteries hold key to long-range electric cars, renewable energy expansion



TEM image of SEI structure, composition

- Formation of the solid-electrolyte interphase (SEI), where electrolyte meets electrode, is the miracle of the modern lithium ion battery
  - SEI forms spontaneously – creating an unpredictable "black box"
  - SEI is only a few nanometers thick
  - SEI controls many aspects of battery efficiency, safety and working life – but we do not understand it
- Today: Impossible to observe SEI reactions in working cells

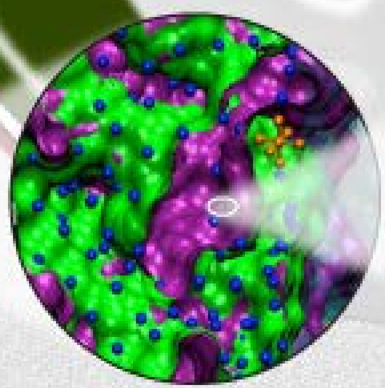
Only APS-U's high energy, coherence and brightness will enable:
  - High-res images/movies of SEIs
  - Inside working batteries
  - Across multiple length/time scales
  - In unprecedented detail

Today:

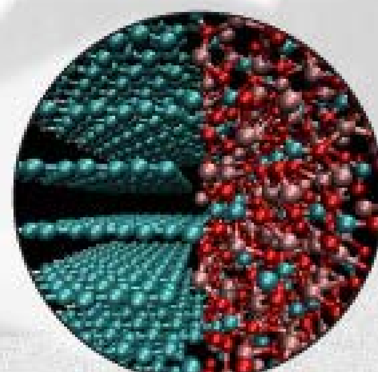
Critical nanoscale SEI visible only via electron microscope *post mortem*

Challenge	Solution
In action	High energy
Spatial resolution	Coherence
Time resolution	Brightness

Electrode surface undergoing SEI coating



Simulated SEI



Li_2CO_3-based SEI on graphite anode

With APS-U:

Detailed *real-time* observation of time/space evolution of SEI electrochemistry through CDI, XPCS, spectroscopy

APS-U – Making it possible to observe and control electrochemistry at atomic and molecular levels

APS-U: To create greener, better nanocatalysts

Replacing precious metal catalysts – key for manufacturing, energy and environment

Challenge	Solution
Penetration	High energy
Sensitivity	Brightness
Spatial resolution	Coherence

- U.S market for petrochemical catalysts: $4.6 billion
  - Today's rare-earth catalysts are expensive, inefficient
- New, efficient green nanocatalysts can use lower temperatures to achieve more efficient reactions
  - But today's X-ray facilities lack the flux, brightness and coherence at high energies to observe nanoscale catalytic particles in chemical reactions under realistic conditions
- ***Only APS-U*** will enable 10-atom resolution of nanocatalysts in action, with time resolution at high pressures and temperatures
- ***Only APS-U*** will provide hard x-ray beams with the power to penetrate containers to visualize catalytic reactions inside them

APS-U – Enabling a revolution in 21st century catalysis– in action, at the nanoscale

Next Meeting

- February 12, 2015
- Agenda
  - APS-U Update – TBD
  - Storage Ring Removal & Installation – Tom Fornek
- Questions?