25 APRIL 2018

APS ALL-HANDS MEETING

APS UPGRADE UPDATE

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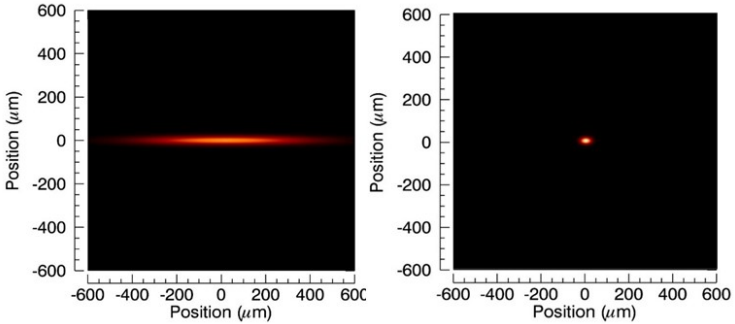
PROJECT MANAGER, APS UPGRADE

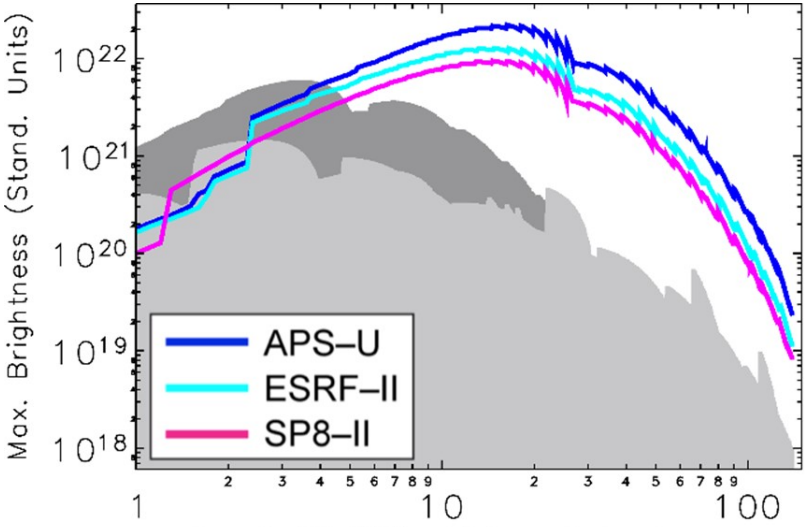
Argonne NATIONAL LABORATORY

APS-U – WHY?

Electron emittance reduced from 3000 pm-rad to 42 pm-rad, approaching diffraction-limited photon emittance for mid-keV X-rays

- ⇒ **2 orders of magnitude higher brightness and transverse coherence**
- ⇒ **smaller spot size for microprobes**
- ⇒ **round beams**

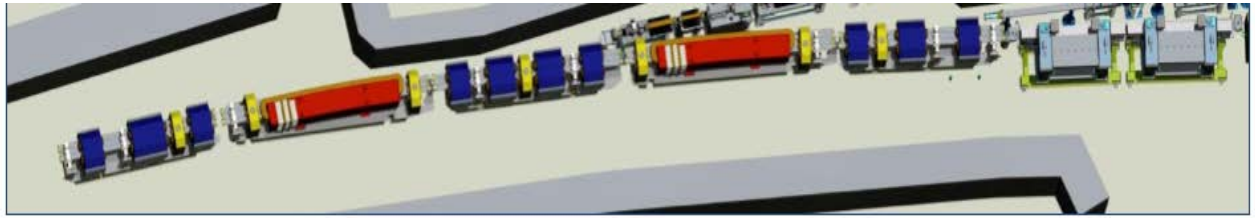


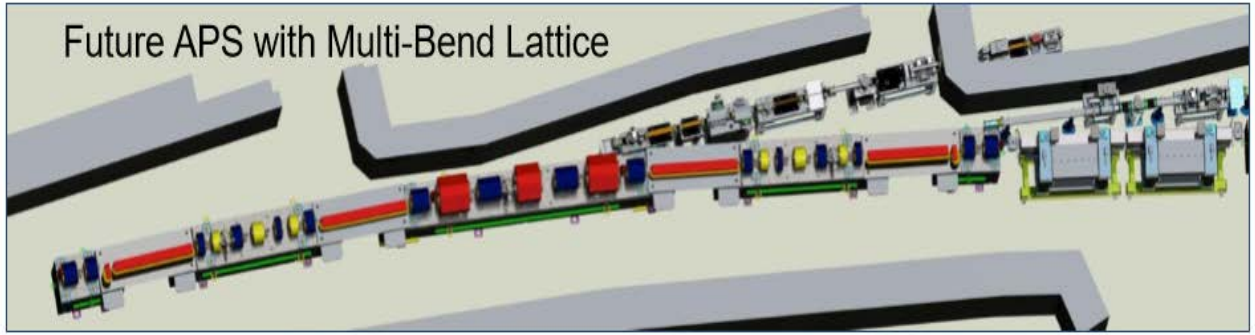


Curves for APS, ESRF, and SP8 upgrades based on present designs, assuming identical undulators

APS-U – HOW?

~70-fold reduction in horizontal emittance





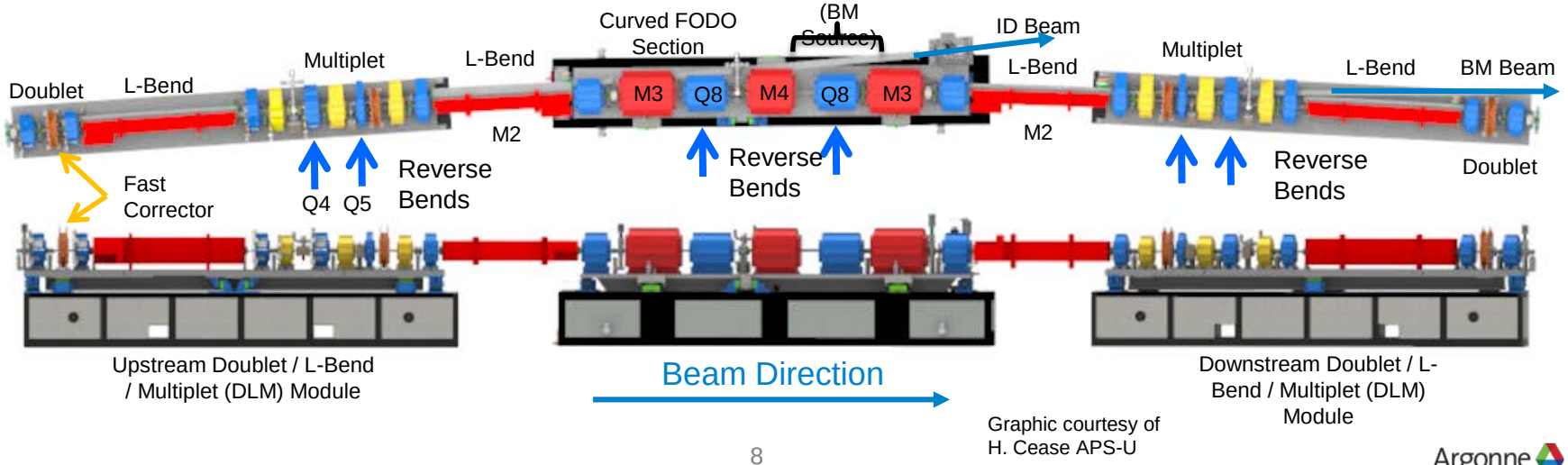
$$\varepsilon_x = C_L \frac{E^2}{N_d^3}$$

E = Beam energy (E = 6 GeV for APS MBA)

N_d = Number of dipoles per sector (N_d = 7 for APS MBA)

APS-U LATTICE

- Storage ring consists of 40 Sectors. Each with 33 arc magnets; 27.6 meters / sector
- Sector arcs consist of nine modules, mounted upon three large support structures:
- Vacuum systems integrated with magnets, supports, insertion devices, front ends.
- 5 Straight sections in Zone F
  - Injection/extraction hardware, RF accelerating cavities and bunch lengthening system
- Assembly and installation readiness:
  - Each module pre-assembled, components aligned, full system tests prior to installation



Graphic courtesy of H. Cease APS-U

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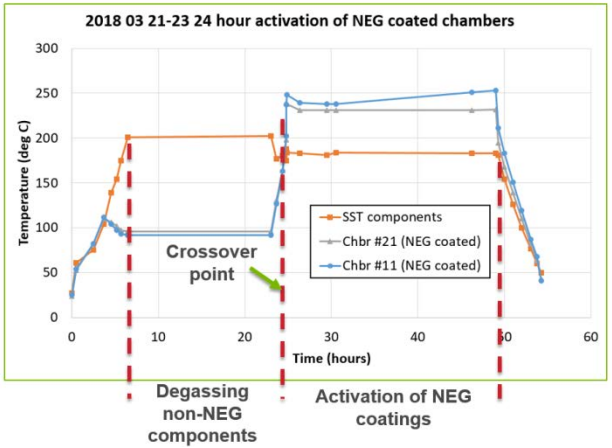
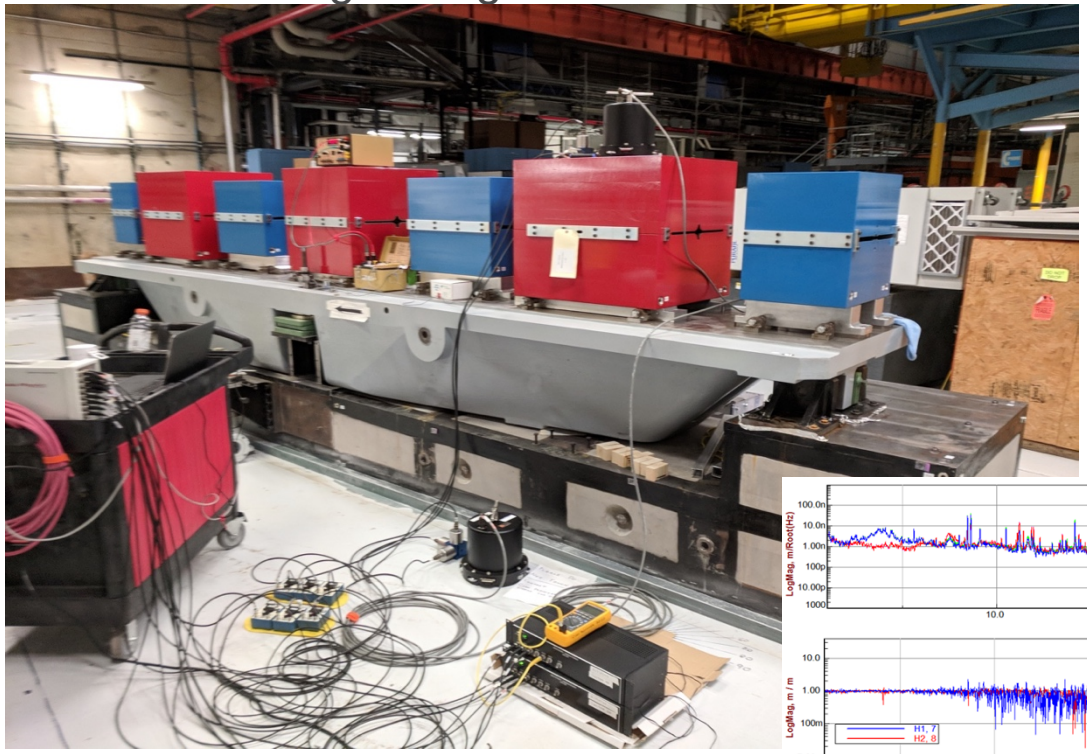
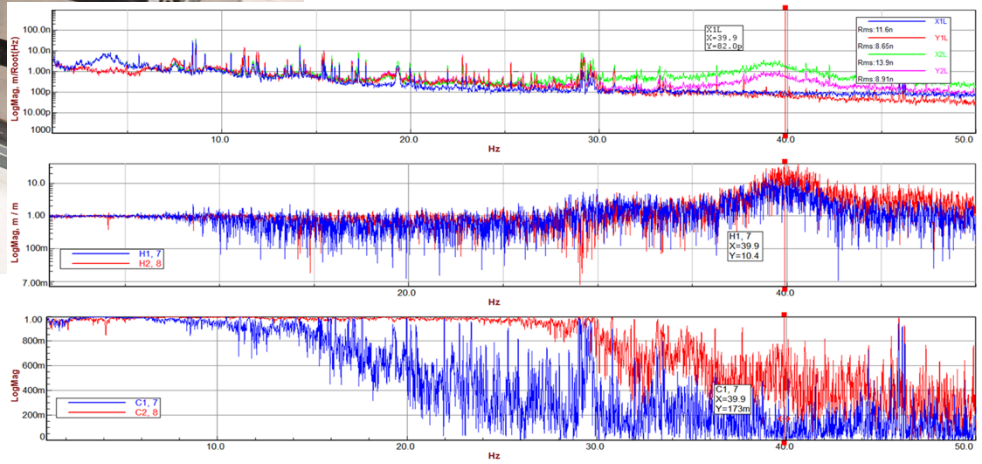
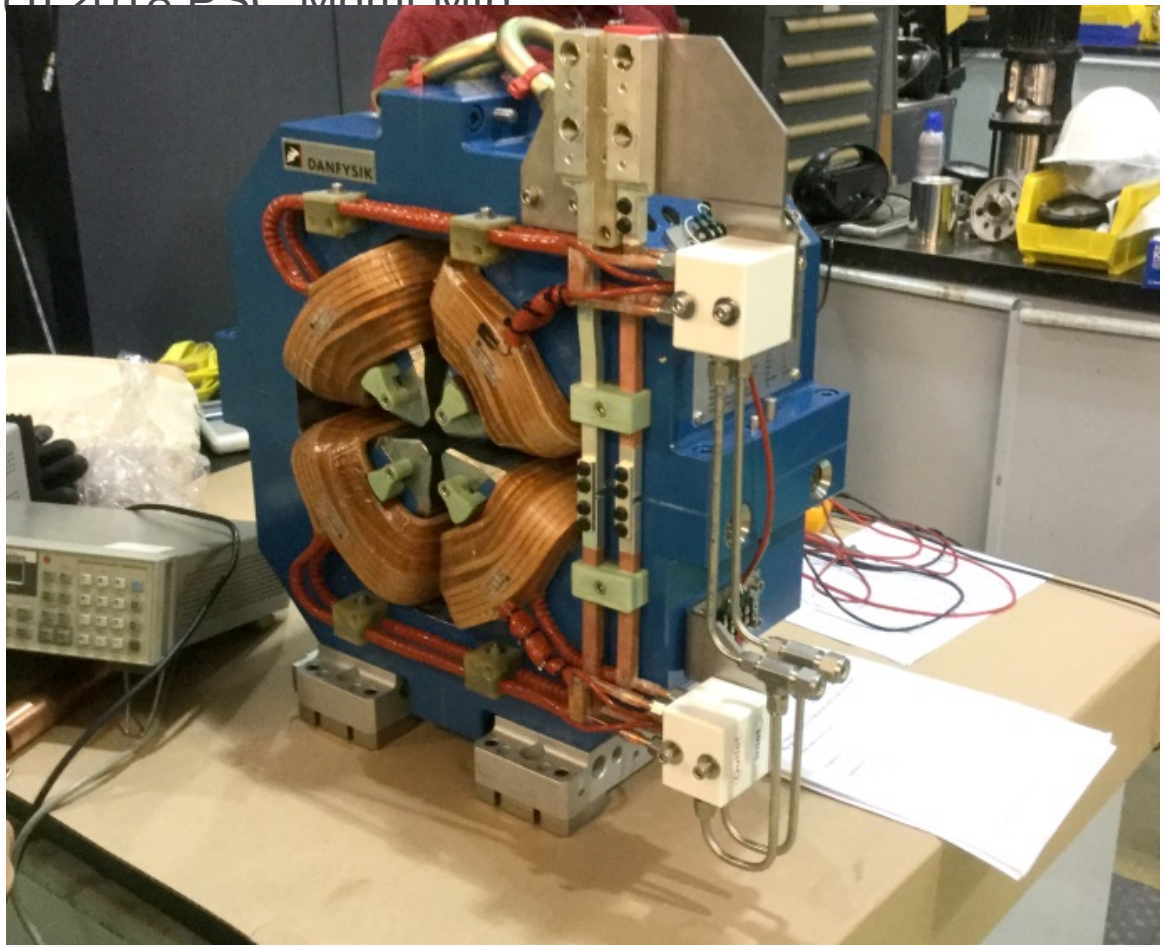
Vacuum Section undergoing bakeout testing





Vibration measurements in 375

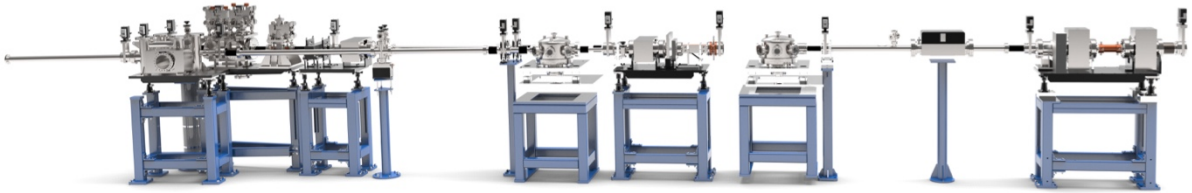




First APS-U Production Magnet – Q1 from Danfysik

HOW? – PROPOSED FEATURE BEAMLINES

Location	Name	Title	Science Lead	Technique
28-ID	CHEX	Coherent High-Energy X-ray Sector for In Situ Science	Robert Winarski Brian Stephenson	*In situ*, surface high-energy coherent scattering
4-ID	Polar	Polarization modulation spectroscopy	Daniel Haskel	Magnetic spectroscopy
20-ID	HEXM	A High-Energy X-ray Microscope	Sarvjit Shastri Jon Almer	High-energy microscopies & CDI
8-ID	XPCS	Development of a Small-Angle X-ray Photon Correlation Spectroscopy Beamline for Studying Dynamics in Soft Matter Wide-Angle X-Ray Photon Correlation Spectroscopy and Time-Resolved Coherent X-Ray Scattering Beamline	Suresh Narayanan Alec Sandy	Small-angle XPCS Wide-angle XPCS
33-ID	Ptycho	PtychoProbe	Volker Rose	Ultimate resolution, forward scattering ptychography/spectromicroscopy
19-ID	ISN	InSitu Nanoprobe Beamline	Jörg Maser	*In-situ*, forward scattering ptychography/spectromicroscopy Long working distances
9-ID	CSSI	Coherent Surface Scattering Imaging Beamline for Unraveling Mesoscopic Spatial-Temporal Correlations	Jin Wang Jiang Zhang	Coherent GISAXS, XPCS
34-ID	ATOMIC	Atomic – A beamline for extremely high resolution coherent imaging of atomistic structures	Ross Harder	Diffraction microscopy & CDI Bragg CDI
	3DMN	3D Micro & Nano Diffraction	Jon Tischler	Upgrade of current 34-ID



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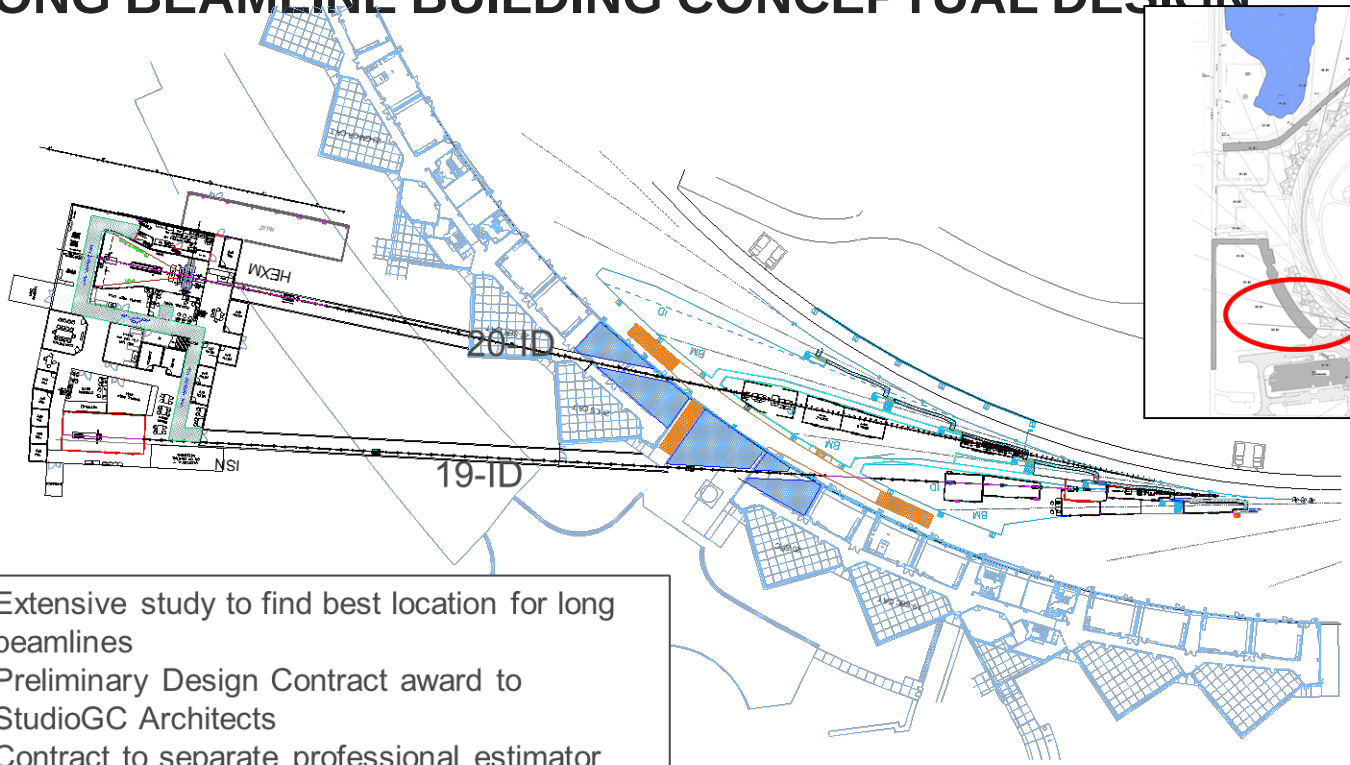
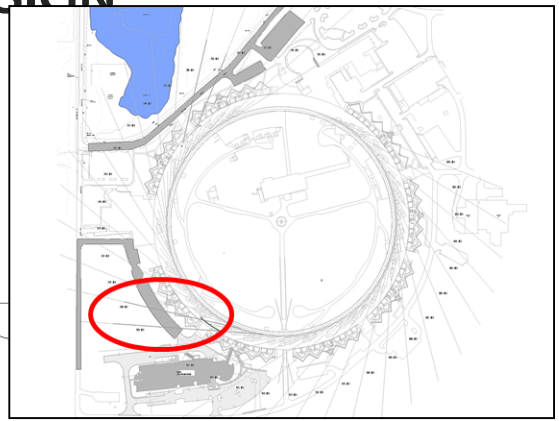
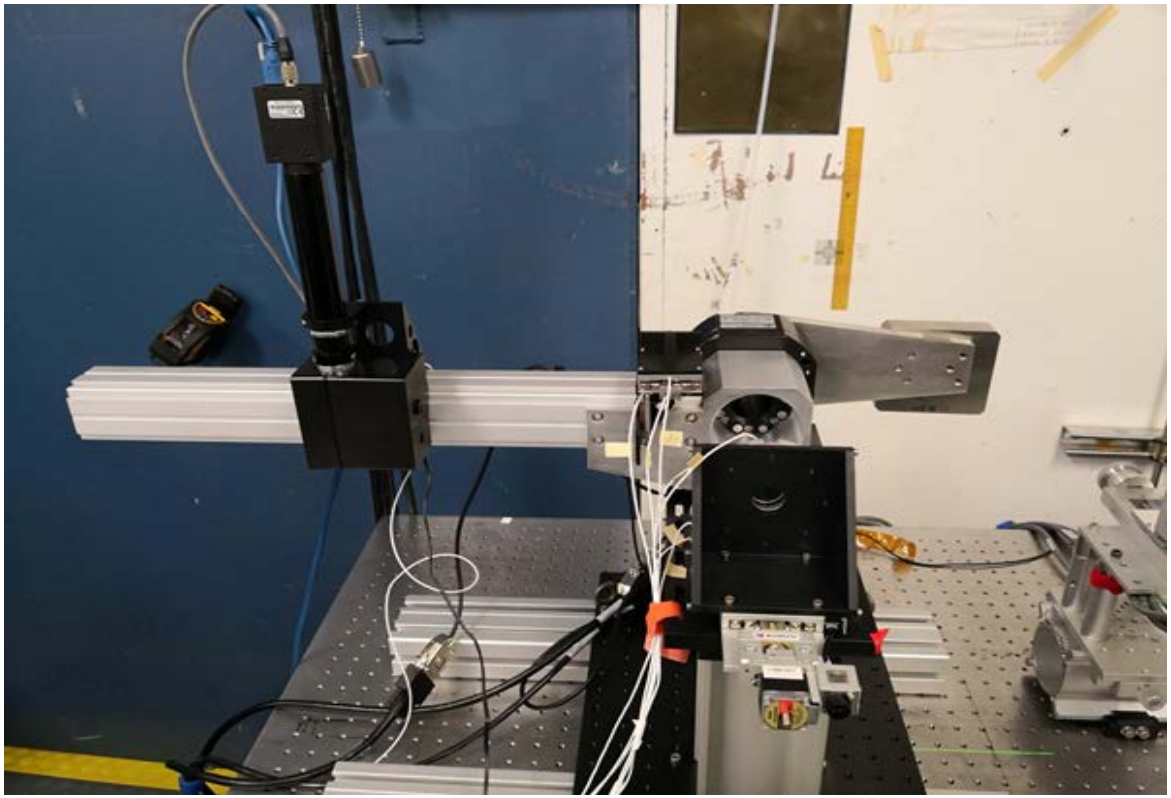
LONG BEAMLINE BUILDING CONCEPTUAL DESIGN





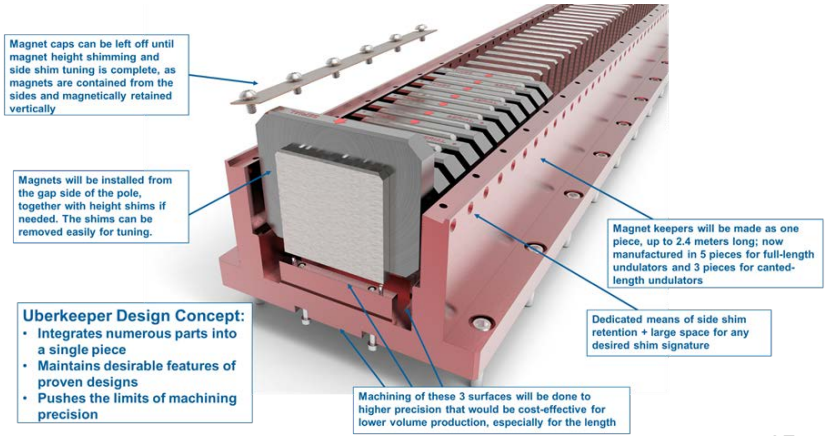
- Extensive study to find best location for long beamlines
- Preliminary Design Contract award to StudioGC Architects
- Contract to separate professional estimator will be awarded soon

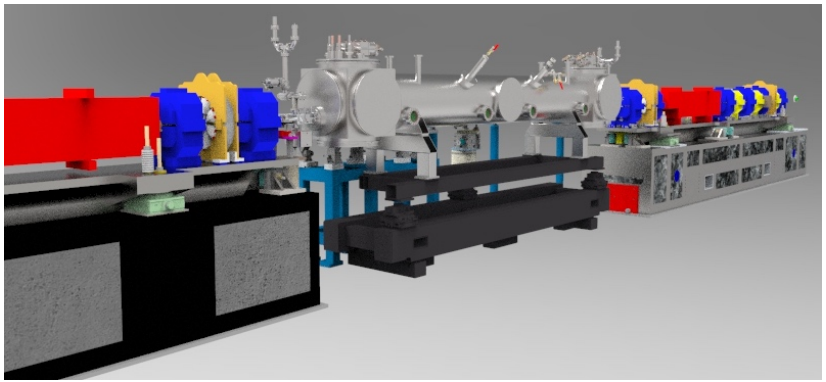


First X-ray test of a prototype compact wavefront sensor for *in situ* measurement and monitoring of beamline wavefront

HOW? - INSERTION DEVICES SCOPE

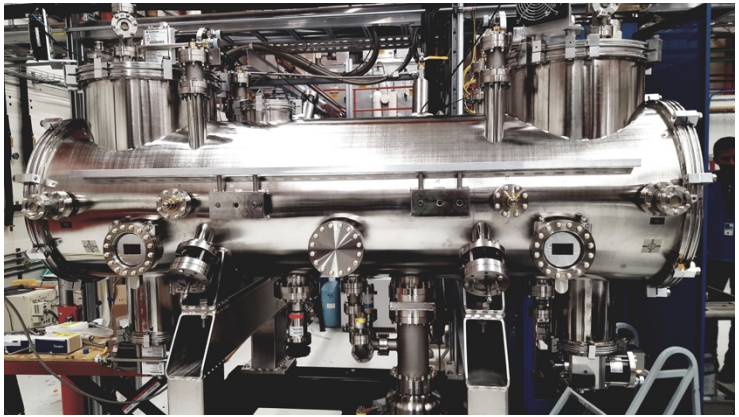
- A total of about 70 insertion devices are expected to be operational at the start of the APSU operations
- Majority of the IDs are based on hybrid permanent magnet undulators, optimizied for need
- Existing experience in building and operating planar and superconducting undulators at APS will be capitalized to the maximum extent
- All straight section vacuum chambers have been designed with full integration of the IDs

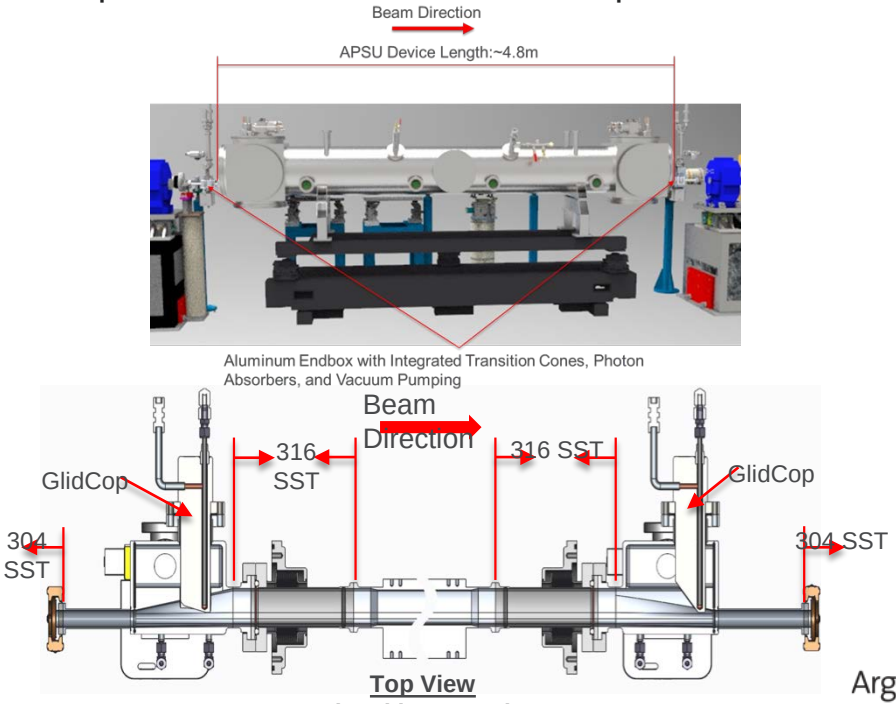


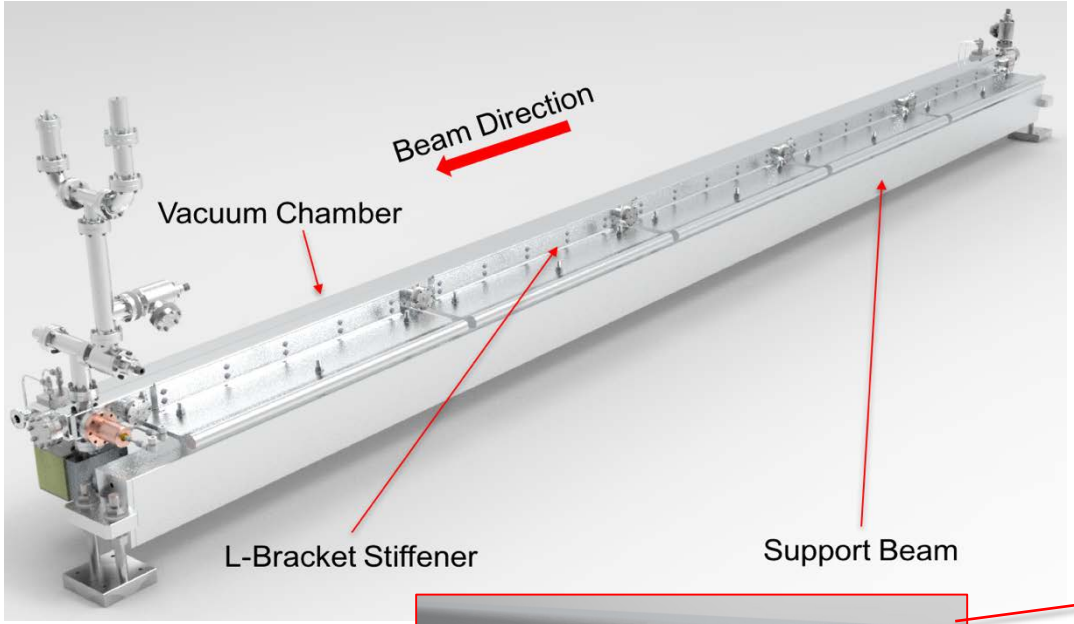


SCUS

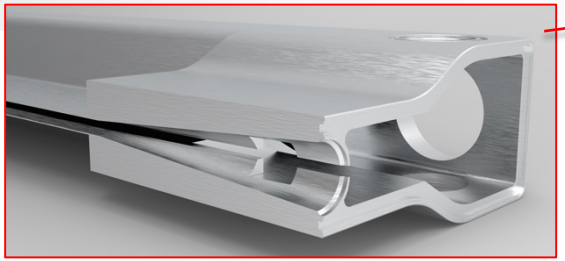
- Full magnetic modelling of the SCU of period 1.65cm confirms assumption of possible maximum fields.
- Conceptual design review of a long cryostats completed for March 2018; builds on Helical SCU
- SCAPE device, if successful, will provide a unique source and build on APS expertise

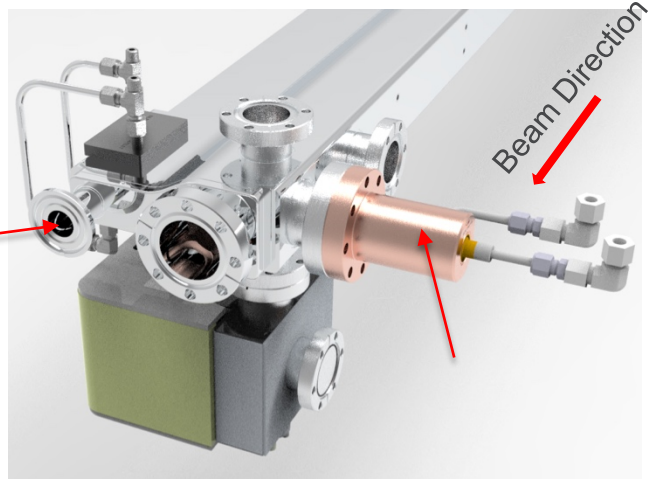






Planar insertion device vacuum chamber design reviewed





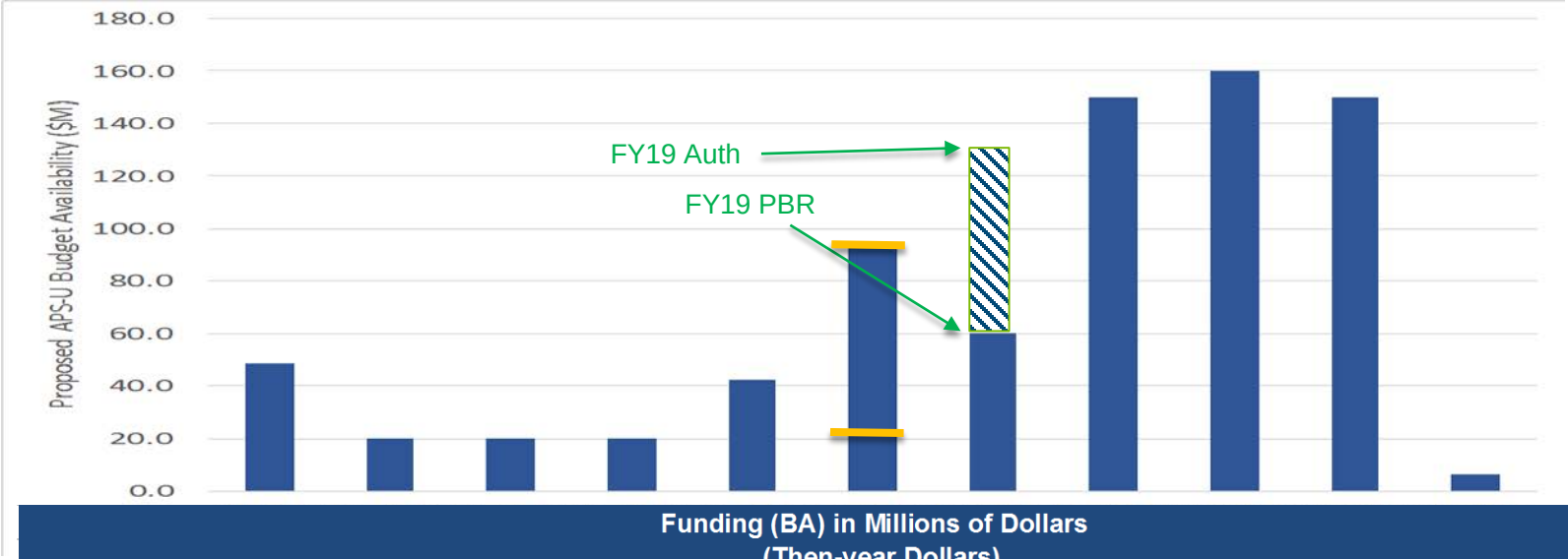
APS-U REVITALIZES OUR FACILITY AS A WHOLE

We have successfully modeled and measured many components and systems, and completed an exceptional Preliminary Design Report

- Nearly all components of the storage ring have been prototyped
- Construction contracts on magnets, beamlines, and optics have started
- Key staff have been added
- Engineering models have been created to assist in the continued best engineering of the accelerator, front ends, and beamlines
- …

We are well positioned to move into the next phase of the Project thanks to your sustained efforts … so far.

APS-U FUNDING PROFILE – APPROXIMATE



Funding (BA) in Millions of Dollars (Then-year Dollars)												
	All Prior Years	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	Total
OPC	8.5										4.4	12.9
TEC	40.0	20.0	20.0	20.0	42.5	93.0	60.0	150.0	159.8	150.0	1.8	757.1
Total	48.5	20.0	20.0	20.0	42.5	93.0	60.0	150.0	159.8	150.0	6.2	770.0

DRAFT FY18 LLP UPDATED REQUEST

Previously approved FY18 LLP in green

Including 10% contingency on FY17, 35% on remainder keeps total within $89.5M limit set of LLP procurements

“Potential FY19 add” should procurements be favorable under development

- M1, M2, M4 magnets
- Bipolar power supplies
- Libera BPM equipment
- ASL Technical equipment
- Septum magnet production
- DLM B Plinth and associated
- Long Beamline Civil Construction

Control Account / CD-3B Package	FY17	FY18	FY19	Grand Total
U.U2.03.03.01 - Magnets	$3,057,901	$17,851,690	$3,260,877	$24,170,468
Q1/Q2 Quadrupole Magnets	$3,057,901			$3,057,901
8-pole Corrector Magnets		$2,148,129		$2,148,129
Q3, Q6 Quadrupole Magnets		$4,063,587		$4,063,587
Q4, Q5 Quadrupole Magnets		$4,063,587		$4,063,587
Sextupole Magnets		$7,576,387		$7,576,387
M1 Dipole Magnet				$0
M3 Dipole Magnet			$3,260,877	$3,260,877
U.U2.03.03.02 - Support Structures and Alignment Systems		$0	$4,437,260	$4,437,260
DLM A Plinth and associated			$4,437,260	$4,437,260
U.U2.03.03.03 - Magnet Power Supply Systems		$9,173,180	$0	$0
Unipolar Power Supply Components		$9,173,180		$9,173,180
U.U2.03.03.04 - Vacuum System		$0	$3,746,526	$3,746,526
Multiplet/Doublet vacuum chambers			$1,722,362	$1,722,362
L-bend chamber components			$936,342	$936,342
Fast Corrector chambers			$1,087,823	$1,087,823
U.U2.03.03.05.02 - Bunch Lengthening System	$251,405	$347,726	$2,822,850	$3,421,981
Bunch lengthening Cavity and Cryomodule	$251,405	$347,726	$277,576	$876,707
Bunch lengthening System Cryoplant			$1,354,112	$1,354,112
Bunch lengthening System Cryogenic Distribution System			$1,191,162	$1,191,162
U.U2.03.03.06 - Injection / Extraction Systems		$0	$1,414,270	$1,414,270
High Voltage Pulsers			$1,414,270	$1,414,270
U.U2.03.03.07 - Diagnostics		$374,212	$0	$374,212
RF BPM Components (Relay Racks)		$374,212		$374,212
U.U2.04.02 - Global Beamline Support	$354,990	$588,481	$887,102	$1,830,572
Optics, Stability Components	$354,990	$588,481	$887,102	$1,830,572
U.U2.04.04 - Beamlines		$4,579,000	$0	$0
ASL Hutch Procurement		$2,269,000		$2,269,000
ASL Beamline Critical Components		$2,310,000		$2,310,000
U.U2.05.02 - Front Ends		$3,907,200	$2,150,017	$6,057,217
High head load front end components (all FE GlidCop)		$1,053,163	$1,130,985	$2,184,148
Canted front end components (all FE GlidCop)		$663,911	$423,488	$1,087,399
X-ray Beam Position Monitor Components (GlidCop)		$791,593		$791,593
FE Equipment Protection Systems & Pneumatics		$1,165,441		$1,165,441
ASL CUFE		$233,092	$595,544	$828,636
U.U2.05.03 - Insertion Devices		$4,267,084	$4,502,995	$8,770,079
Magnetic Structures		$1,840,199	$4,502,995	$6,343,194
Insertion Device Vacuum Chamber Components		$2,426,885		$2,426,885
Grand Total	$3,664,296	$41,088,572	$21,807,628	$66,560,496
Contingency @35%	$366,430	$14,381,000	$7,632,670	$23,296,174
Grant Total Including Contingency	$4,030,726	$55,469,572	$29,440,297	$88,940,595

RECENT AND UPCOMING REVIEWS

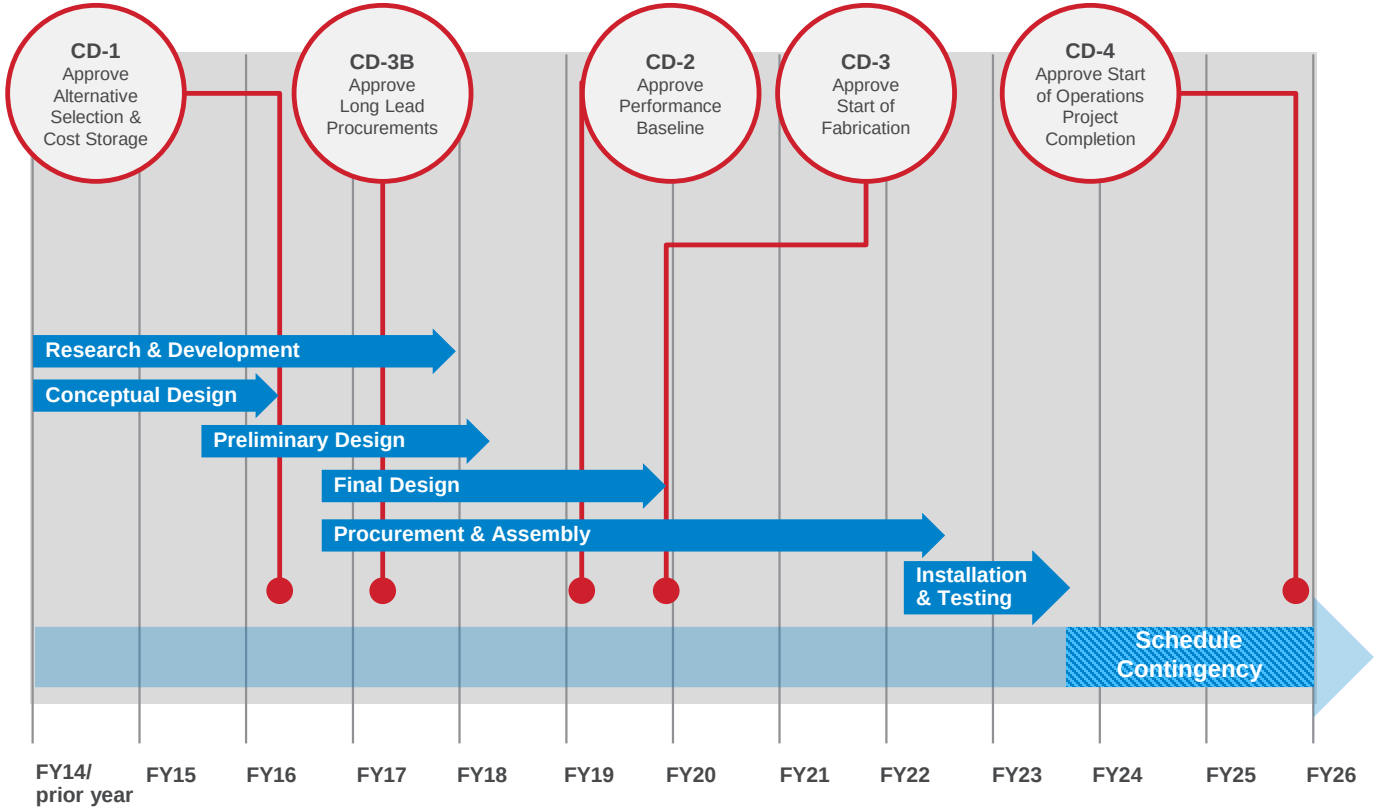
Review	Date Planned
Procurement readiness review – HHLFE Masks and Shutter - LLP	May 2018
APS-U Injector Plan Preliminary Design Review	May 15, 2018
Lattice Review	May 16-17, 2018
Final Design Review Insertion Device Vacuum Chamber	May 2018
Procurement Readiness Review - EMI Cabinets - LLP	May 2018
S1, S2 and S3 Procurement Readiness Review	May 2018
Procurement readiness review – Planar ID Magnet - LLP	June 2018
Procurement readiness review – Canted Undulator Front Ends Masks and Shutter - LLP	June 2018
Procurement readiness review – Fast Corrector Chambers	July 2018
Procurement readiness review – IDVC system - LLP	July 2018
Final Design Review - Longitudinal Feedback System	Aug 2018
Procurement Readiness Review – DLM A Plinth and Associated Equipment	Aug 2018

Risk workshop is May 1-2 at ANL

Reviews conducted in the last month

- ID vacuum chamber extrusions FDR and PRR held 3/1/2018 – Report Received, Recommendations being addressed
- APS-U SCU Cryostat Preliminary Design Review held March 21, 2018 – Report Received, Recommendations to address
- APS-U Q3-Q6 Procurement Readiness Review held March 23, 2018 – Report Received, Recommendations to address
- APS-U Insertion Device Magnet Final Design Review held March 27-28, 2018 - Report Received, Recommendations to address

APS-U PROJECT SCHEDULE



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PROJECT CHALLENGES

- How to we maximize the science of the facility in the APS-U era?
- How do we take best advantage of the existing APS infrastructure and equipment and apply our limited resources to the most critical and challenging needs?
- How do we best utilize collaborating laboratories and industry such that they can help us succeed?
- How do we shift from creation and handling of single items / components to those of tens, hundreds, or thousands?
- How do we best design, build, and install equipment such that the resulting facility can be efficiently operated to best advantage?
- How do we maintain our sponsors trust in our ability?
- How do we do this all safely?

While not complete (yet), I believe we can and will answer these questions

MOVING FORWARD – A STARTER LIST

- APS-U, PSC, and ANL Leadership are working extremely hard with our sponsors to deliver the best APS-U possible
- We (you!) and our partners are working to deliver technical solutions, delivering the most ‘bang for the buck’
- We are developing new processes in planning, procurement, and acceptance to handle the quantities involved
- We communicate regularly and transparently
- We learn from our mistakes and those of others
- We are aware of our work area, and that of our colleagues

Any Project brings challenges – the payoff is a once (or twice) in a lifetime opportunity

SAFETY

Taking the last item, and making it first…

- Focus on the task at hand, being aware of our work, and the environment around that work is the only way we will safely succeed.
- This is critical.
- The weekly ORPS reports (safety incidents from the National Lab system) consistently include accidents involving poor planning; poor work area preparation; poor de-energization practices; and scope creep.
- PLEASE…for your sake…do not become a statistic.

https://www.youtube.com/watch?v=lRYv_2JRCT0&feature=youtu.be