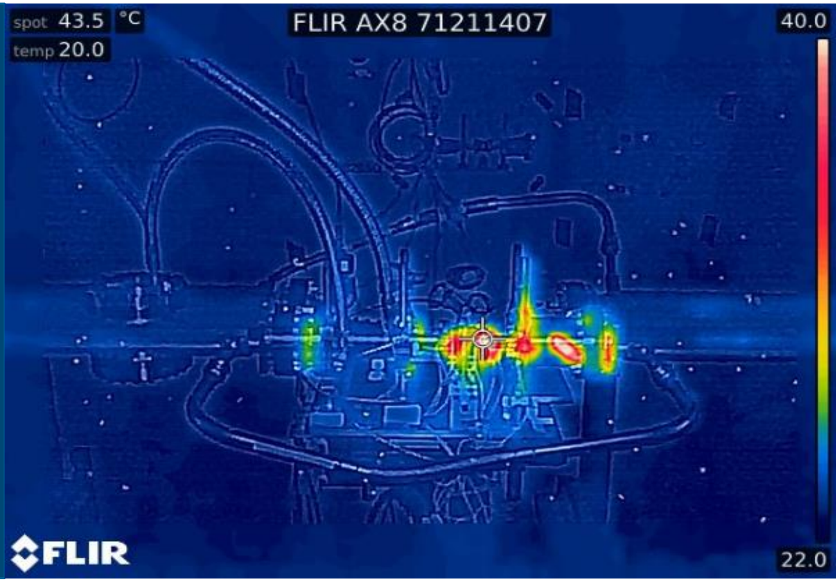
Status of the APS Upgrade Project



Jim Kerby
for the APS-U team

PSC All Hands Meeting
30 October 2019

Since last meeting….

The APS-U (officially!) received CD-3!

Advanced Photon Source Upgrade Project at
Argonne National Laboratory
CD-3, Approve Start of Construction

Recommendations:

The undersigned "Do Recommend" (Yes) or "Do Not Recommend" (No) approval of CD-3, for the Advance Photon Source Upgrade at Argonne National Laboratory as noted below.

_______________ 7/25/2019 Yes X No___
ESAAB Secretariat, Office of Project Assessment Date

_______________ Yes___ No___
Representative, Office of Budget Date

_______________ Yes___ No___
Representative, Environment, Safety and Health Date

_______________ 7/25/19 Yes ✓ No___
Representative, Infrastructure (Field Safety, Security and Infrastructure) Date

_______________ 7/25/19 Yes ✓ No___
Representative, Security (Field Safety, Security and Infrastructure) Date

_______________ Yes ✓ No___
Representative, Non-Proponent SC Program Office Date

_______________ 7/25/19 Yes ✓ No___
Representative, Non-Proponent Federal Project Director Date

Concurrence:

_______________ 7/25/19
J. Stephen Binkley Date
Deputy Director for Science Programs
Office of Science, DOE

Approval:

Based on the information presented above and at this review, Critical Decision-3, Approve Start of Construction, is approved for APS-U.

_______________ 7/25/19
Chris Fall, Project Management Executive Date
Director
Office of Science, DOE

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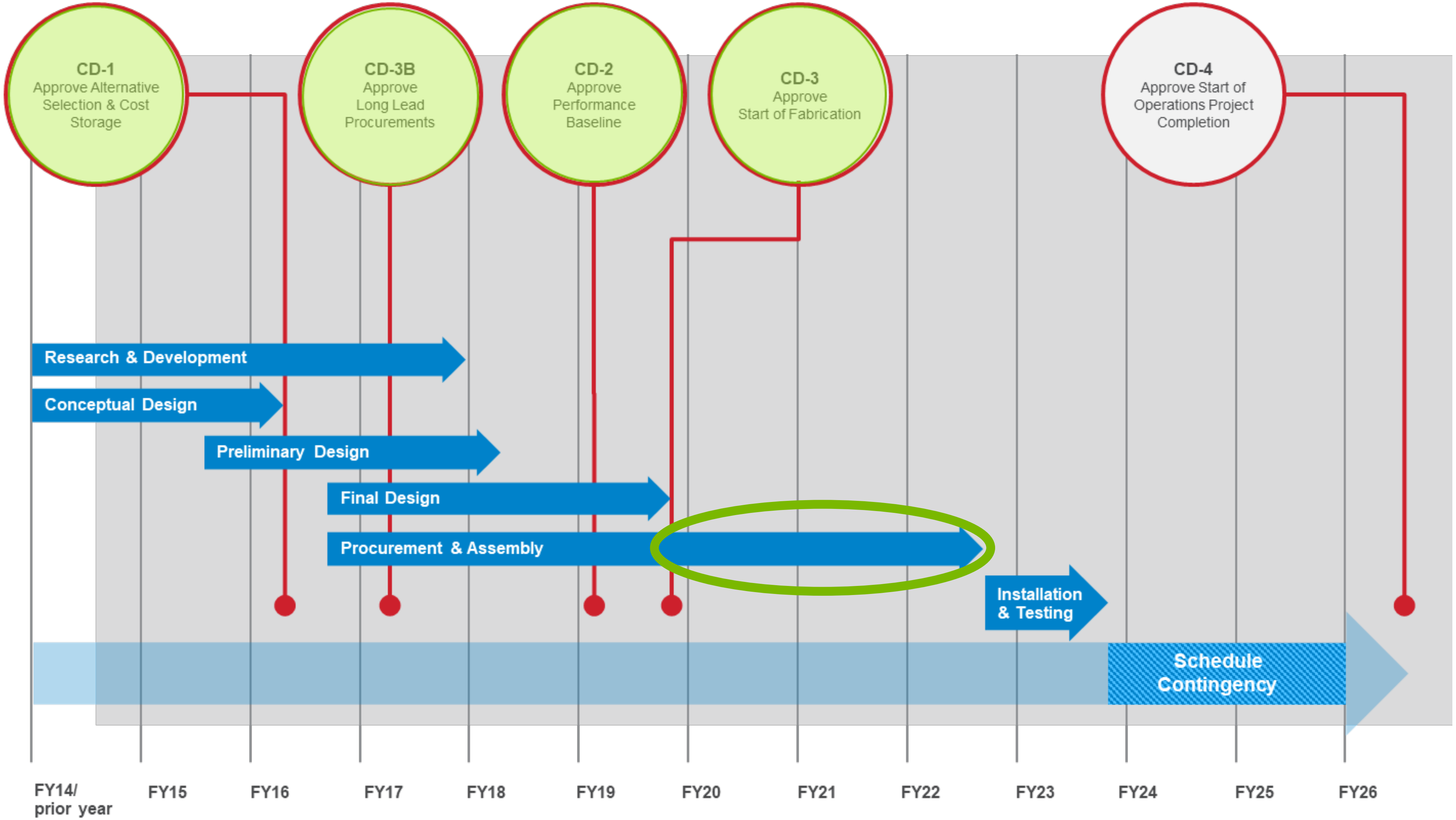
Key Performance Parameters

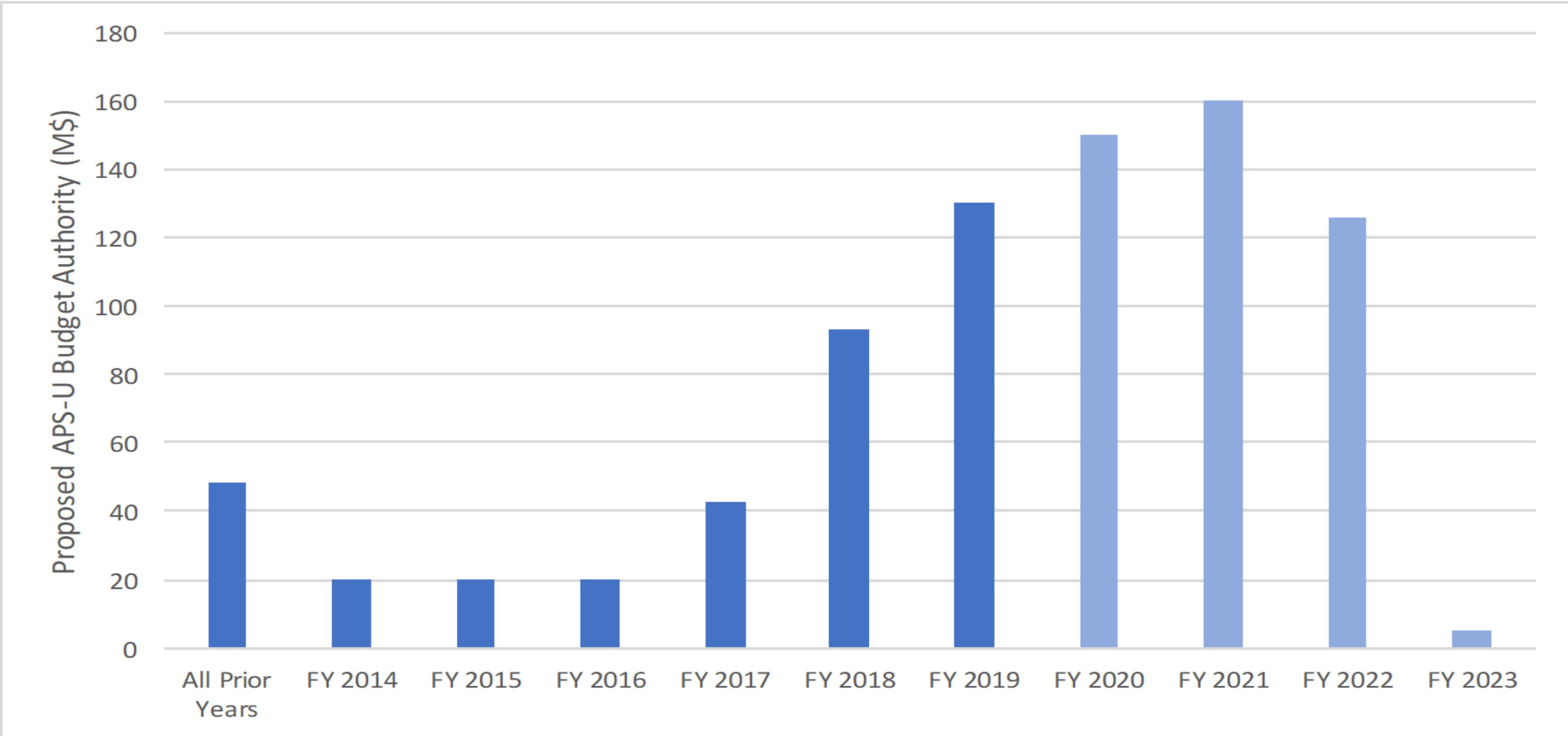
Key Performance Parameter	Thresholds (Performance Deliverable)	Objectives
Storage Ring Energy	> 5.7 GeV, with systems installed for 6 GeV operation	6 GeV
Beam Current	$\geq$ 25 mA in top-up injection mode with systems installed for 200 mA operation	200 mA in top-up injection mode
Horizontal Emittance	< 130 pm-rad at 25mA	$\leq$ 42 pm-rad at 200mA
Brightness @ 20 keV[1]	> 1 x 10^{20}	> 1 x 10^{22}
Brightness @ 60 keV[1]	> 1 x 10^{19}	> 1 x 10^{21}
New APS-U Beamlines Transitioned to Operations	7	$\geq$ 9

[1]photons/sec/mm^2/mrad^2/0.1%BW

APS-U Project Schedule



APS-U baseline funding profile



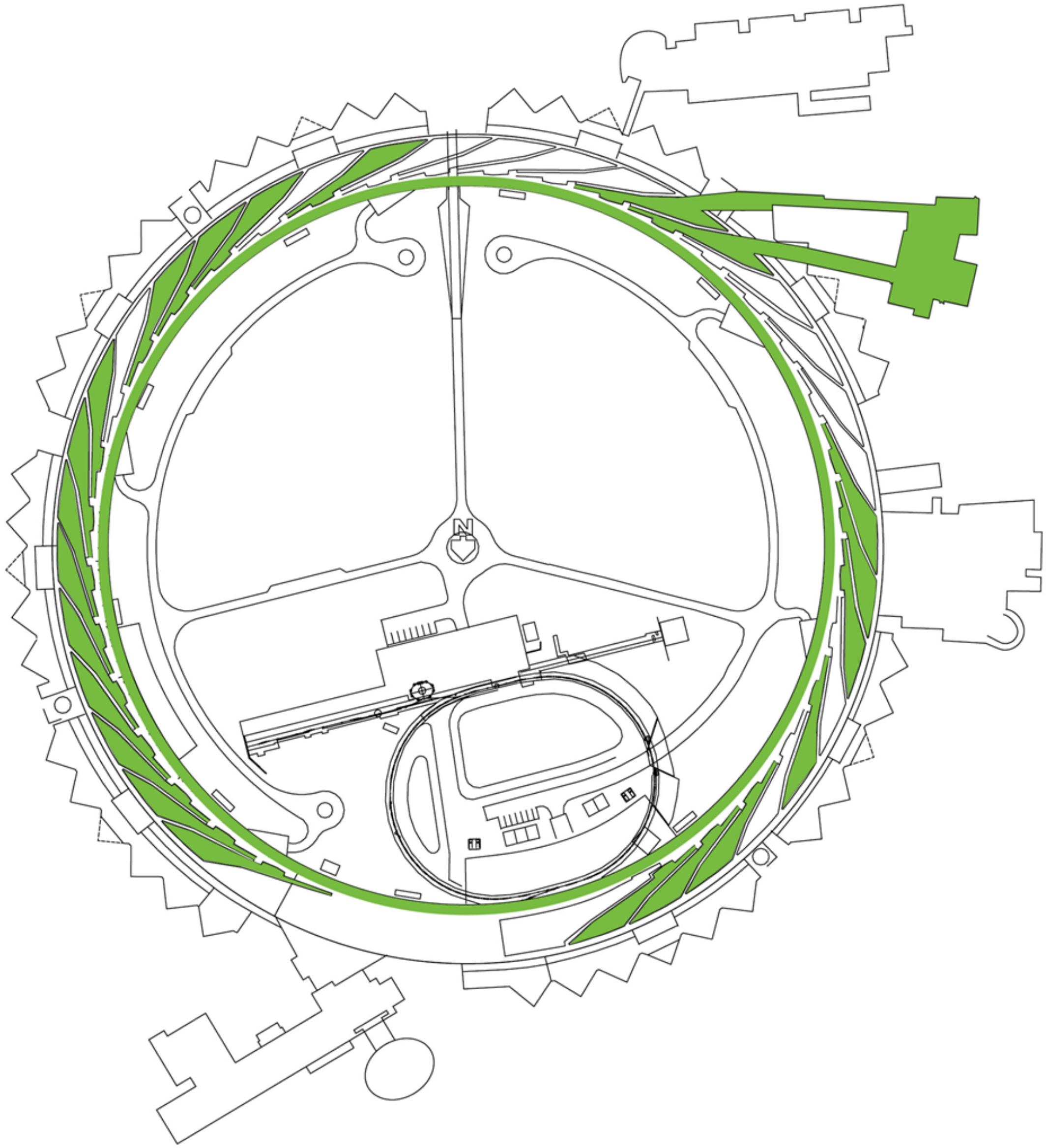
Funding (BA) in Millions of Dollars (Then-year Dollars)												
	All Prior Years	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	Total
OPC	8.5									5.0	5.0	18.5
TEC	40.0	20.0	20.0	20.0	42.5	93.0	130.0	150.0	159.8	121.2		796.5
Total	48.5	20.0	20.0	20.0	42.5	93.0	130.0	150.0	159.8	126.2	5.0	815.0

- FY17 – FY19 Funding came in at the high end of planning ranges; APS-U taking full advantage.
- FY20 funding in President's budget request of $150M; House and Senate markups are higher (no increase in TPC).
- Committed $63.3M of the $89.5M LLP funding and will commit the remainder in the next couple of months.
- The APS-U is well on it's way- It's critical to keep the momentum going!

APS-U Scope

$815M Project to update and renew the facility

Re-uses $1.5B in existing infrastructure



- Completely new storage ring, **42 pm** emittance @ 6 GeV, 200 mA
- New and updated insertion devices
- Combined result in brightness increases of up to 500x
- 9 new feature beamlines
- 15 enhanced and improved beamlines

September EVMS

			a. NAME							a. FROM (YYYYMMDD)		b. TO (YYYYMMD			Dollars
			U2-S - APS-U2 September Status							2019 / 08 / 26		2019 / 09 / 30			
WBS-CA (1)	CURRENT PERIOD							CUMULATIVE TO DATE							AT
Level 2	BUDGETED COST		ACTUAL	VARIANCE				BUDGETED COST		ACTUAL	VARIANCE				BUDGETED
ITEM	WORK SCHEDULED	WORK PERFORMED	COST WORK PERFORMED	SCHEDULE	COST	SPI	CPI	WORK SCHEDULED	WORK PERFORMED	COST WORK PERFORMED	SCHEDULE	COST	SPI	CPI	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
U1-CCID - APS Upgrade - CM to Cobra (	**0**	**0**	**0**	**0**	**0**	**0.00**	**0.00**	**43,917,640**	**43,917,640**	**43,917,640**	**0**	**0**	**1.00**	**1.00**	**43,917,640**
U2-S - APS-U2 September Status	**6,719,427**	**5,970,047**	**2,858,862**	**-749,380**	**3,111,185**	**0.89**	**2.09**	**167,016,276**	**159,870,199**	**157,983,664**	**-7,146,077**	**1,886,535**	**0.96**	**1.01**	**627,999,900**
U2.01 - PROJECT MANAGEMENT, PLAN	1,661,432	981,170	808,727	-680,261	172,444	0.59	1.21	37,179,574	36,034,768	35,954,967	-1,144,806	79,802	0.97	1.00	70,266,945
U2.02 - CONCEPTUAL DESIGN & DEVEL	59,692	341,208	102,779	281,516	238,429	5.72	3.32	48,383,911	47,832,577	48,251,705	-551,335	-419,128	0.99	0.99	49,827,007
U2.03 - ACCELERATOR	3,453,945	3,640,016	1,417,517	186,071	2,222,499	1.05	2.57	51,361,638	48,520,376	47,943,573	-2,841,263	576,802	0.94	1.01	248,696,077
U2.04 - EXPERIMENTAL FACILITIES	992,110	812,169	749,180	-179,941	62,989	0.82	1.08	19,079,335	17,763,001	15,151,107	-1,316,334	2,611,894	0.93	1.17	193,934,638
U2.05 - FRONT ENDS & INSERTION DEV	552,248	195,483	-219,342	-356,765	414,825	0.35	-0.89	11,011,817	9,719,478	10,682,312	-1,292,339	-962,834	0.88	0.91	65,275,232
a. UNDISTRIBUTED BUDGET															0
b. SUBTOTAL	6,719,427	5,970,047	2,858,862	-749,380	3,111,185	0.89	2.09	210,933,916	203,787,839	201,901,304	-7,146,077	1,886,535	0.97	1.01	671,917,540
c. CONTINGENCY															143,082,460
d. TOTAL	6,719,427	5,970,047	2,858,862	-749,380	3,111,185	0.89	2.09	210,933,916	203,787,839	201,901,304	-7,146,077	1,886,535	0.97	1.01	815,000,000
TOTAL CONTRACT VARIANCE											-7,146,077	1,886,535	0.97	1.01	815,000,000

- SV driven by delays in finalizing contracts for the off-site space and 28-ID: CHEX utilities, submitting procurement packages for beamlines, and final designs for several accelerator components.
- CV driven by design efficiencies gained by the beamline team and procurements to date.

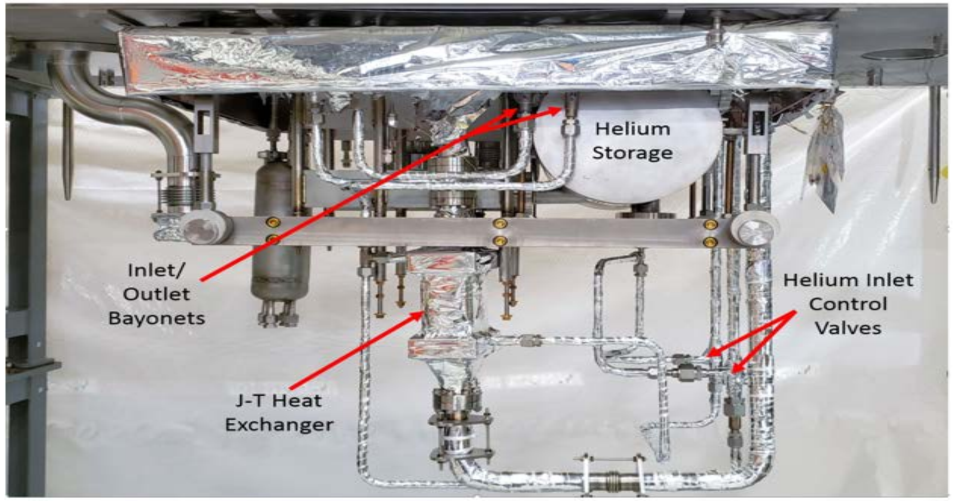
Since last meeting….

- With a performance baseline funding of 672 M$ (+ 143 M$ contingency = 815 M$ TPC), have costed 202 M$ and awarded another 53 M$ (30% complete on costs; 38% on cost+obligation)
- Plan to spend ~10 M$/month over next year – we accomplished this in August and September!
- 1067 of 1321 storage ring magnets ordered; 82 Q1, 62 Q2 accepted in addition to first articles for Q4, Q5, Q6, S2, S1/3, and the 8 pole corrector
- 2300 unipolar and bipolar power supplies ordered (first articles of each exist!)
- 3 shielded enclosures installed on 28-ID; 5 shielded enclosures for 25-ID ordered and construction will start in Jan 2020; notional enclosure installation schedule has been developed
- Next DOE/OPA status review will happen around June 2020

Magnets and Measurement

Magnet measurements in Bldg 369

1st unipolar power supply inspection at vendor



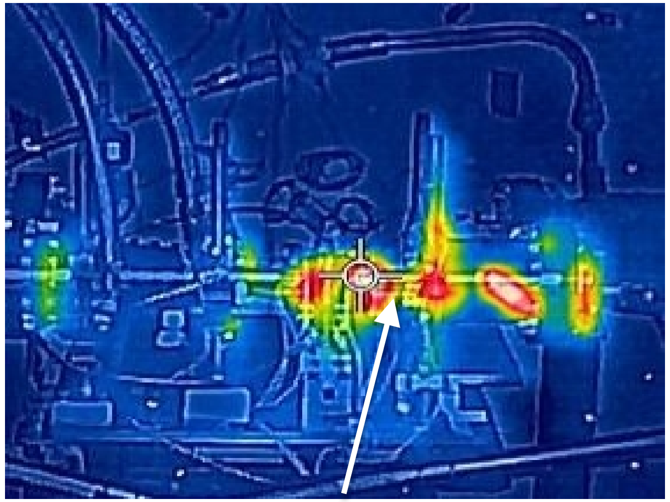
Internal Helium Circuit for the BLS Cryomodule

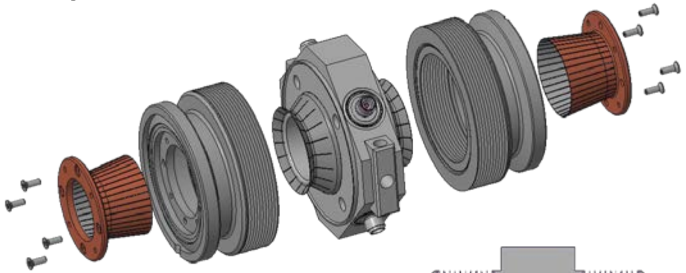
1st bipolar power supply from vendor

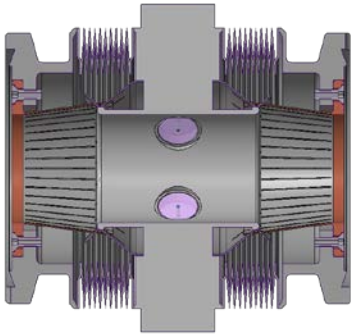
Beam Position Monitors

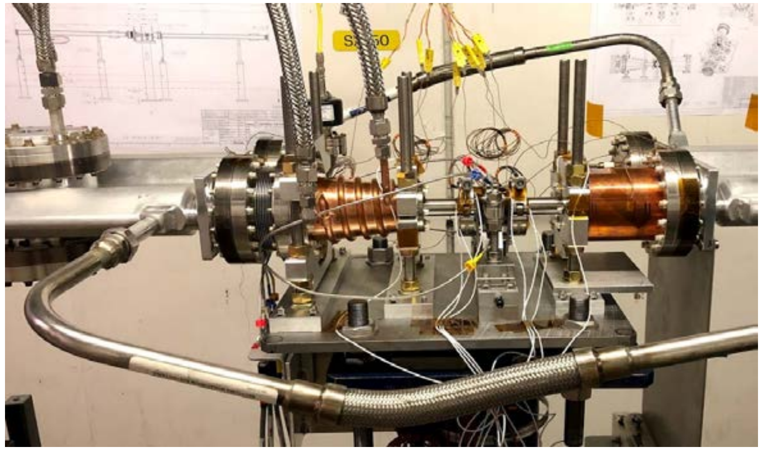
- This BPM pickup electrode unit tested last month at BNL has been refurbished (new rf fingers, added bellows restraints) and installed in APS sector 25.

- The BPM runs cool, however a downstream flange is running warmer than expected at 72 deg. C, at 108 mA.
- Studies show heating is caused by wakefields and not synchrotron radiation.

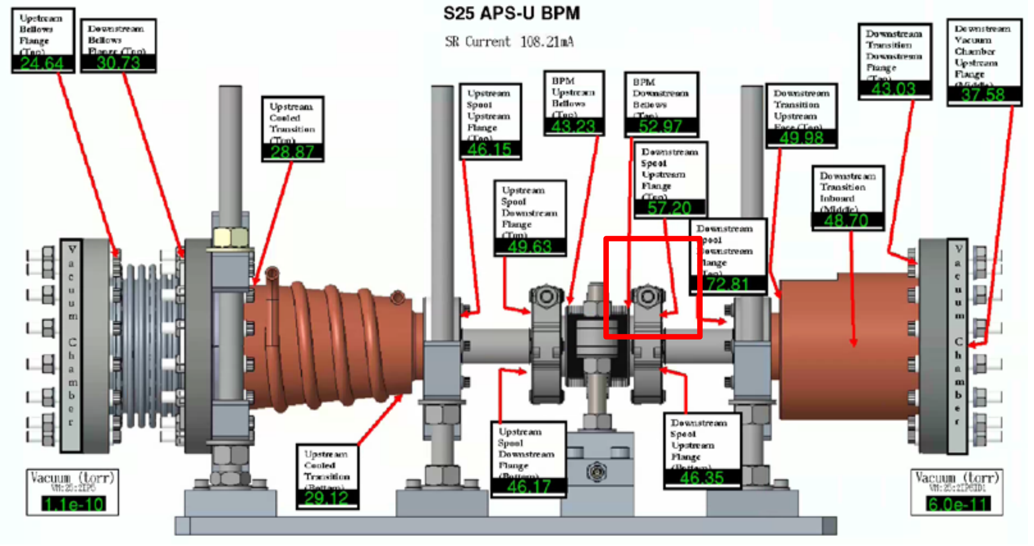








APS-U BPM prototype installation at APS.



Insertion Devices

SCU Vacuum Vessel

SCU Copper thermal shield assembly

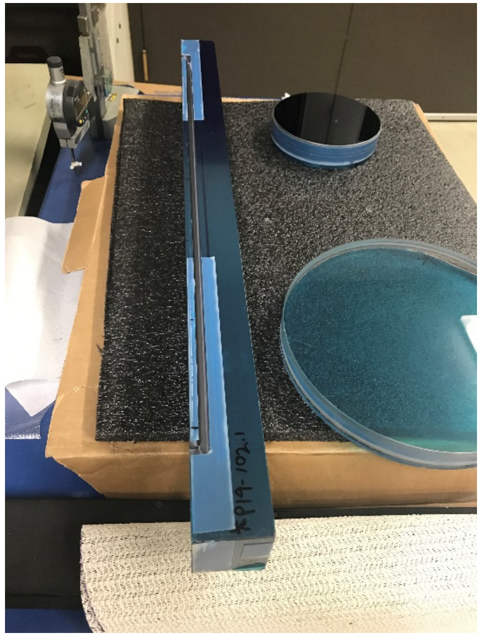
28mm HPMU and monokeeper

ID vacuum chambers extrusions

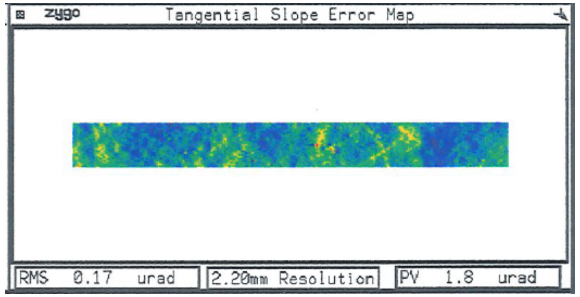
Experimental Systems

2-ID monochromator after arrival at APS

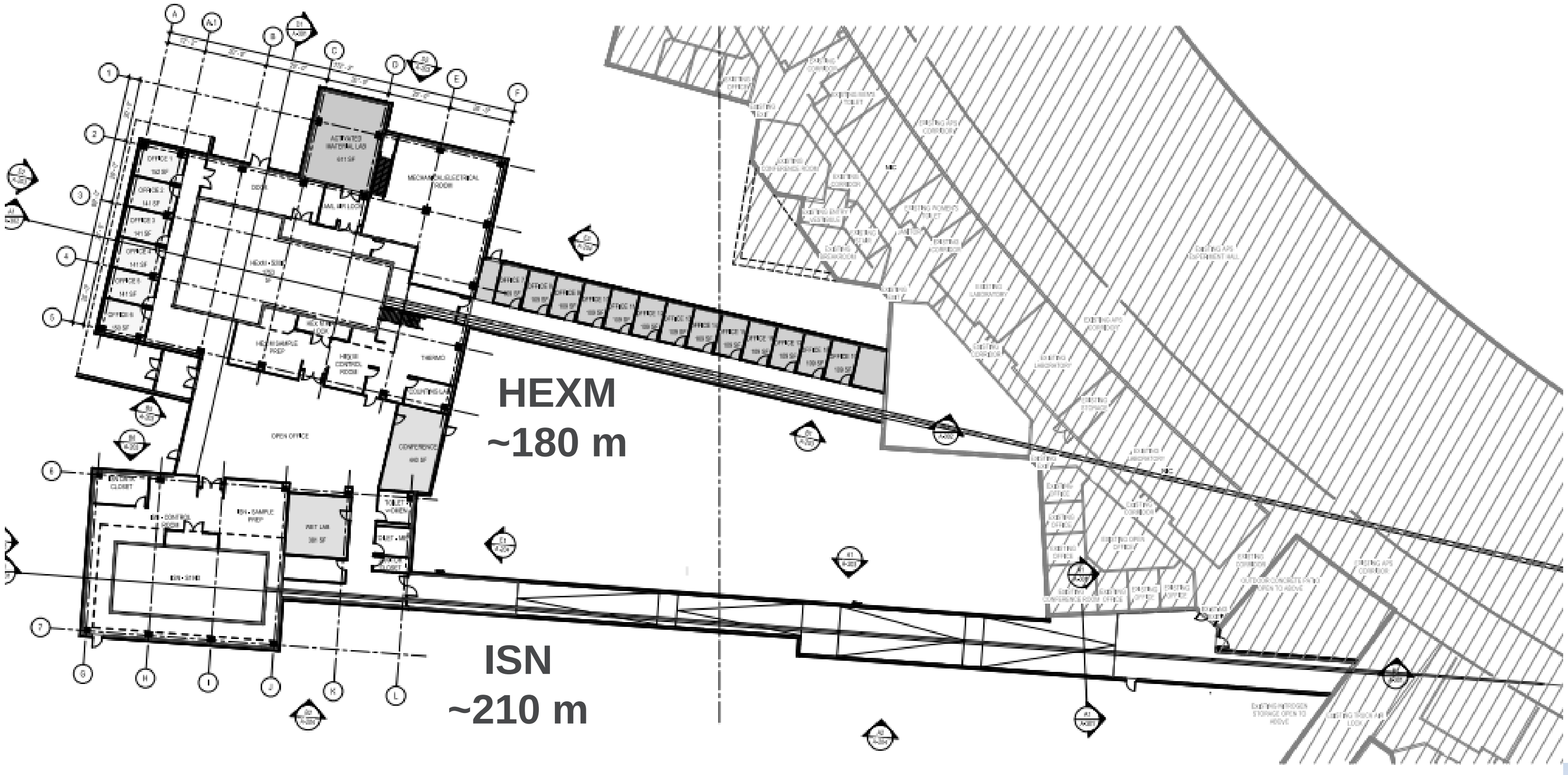
Picture of parts for the bases of the ASL mirrors at vendor, and solid model of what the assembled bases will look like.



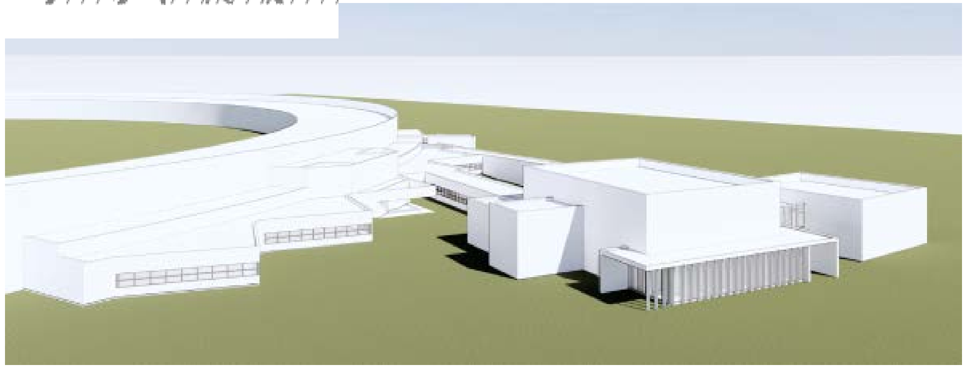
The ASL ORM1 mirror after manufacture, and measured slope error



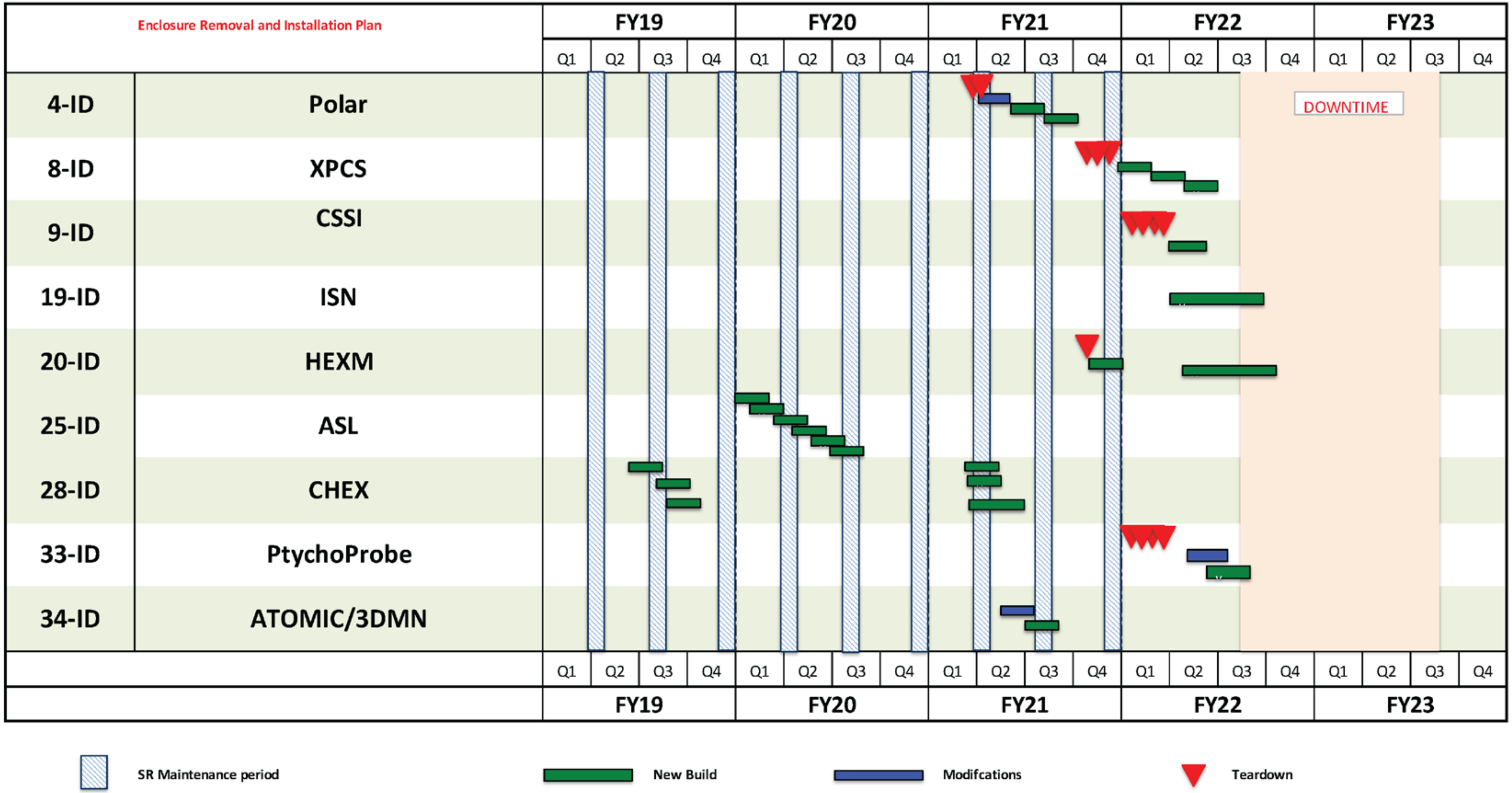
Long Beamline Building



30% Design Review underway



Notional Enclosure Installation Schedule



Beamline Transition to Operations Parameters

- Brightness measurement required for each new beamline.
- For completion of beamline transfer to operations: Threshold TTOP must be met or exceeded; key equipment is verified to be in place and working.

Beamline	TTOP Thresholds (Performance Deliverable)	Energy Range (keV)	Description
Polar	Brightness @ 9 keV > 4.9 x 10^{19}	2.75 – 27	Magnetic spectroscopy beamline designed to take advantage of novel undulators developed for the APS-U storage ring. Nanofocused, polarized beams will be used to study materials in extreme conditions.
XPCS	Brightness[1] @ 20 keV > 4.2 x 10^{19}	8 – 25	X-ray photon correlation spectroscopy beamline with instruments for small- and wide-angle scattering, designed for maximum coherent flux.
CSSI	Brightness[1] @ 20 keV > 4.2 x 10^{19}	6 – 30	Coherent surface scattering imaging beamline to explore the structure and dynamics of low dimensional, mesoscale, heterogeneous systems.
ISN	Brightness[1] @ 20 keV > 4.2 x 10^{19} Focused beam < 50 nm (FWHM)	4.8 – 30	A scanning nanoprobe optimized for large working distances and in situ experiments
HEXM	Brightness[1] @ 60 keV > 5.1x10^{18}	35 – 120	High-energy x-ray microscope for experiments on in situ environments for materials science and engineering applications.
CHEX	Brightness[1] @ 20 keV > 3.9 x 10^{19}	5 – 60	One tunable and three fixed-energy beamlines designed for coherent, high-energy x-ray in-situ diffraction studies of materials synthesis and chemical transformations.
Ptycho	Brightness[1] @ 10 keV > 1.3 x 10^{20}	5 – 30	Ultimate spatial resolution, ultra-fast scanning nanoprobe with ptychography for extremely high-resolution structural measurements.
ATOMIC	Brightness[1] @ 20 keV > 3.8 x 10^{19}	5 – 30	Bragg coherent diffraction imaging to study materials with spatial resolution of one nm or better. Zoom optics allow variable spot sizes so that the x-ray probe can be matched to the needs of individual experiments.
3DMN	Brightness[1] @ 20 keV > 2.5 x 10^{19}	5.3 – 30	3D diffraction nanoscope using both pink and monochromatic x-rays to study materials structure and mechanical behavior.

[1] Brightness = photons/sec/0.1% BW/mm^2/mrad^2 @ > 5.7 GeV, ≥25 mA, <130 H/65 V pm-rad, 20% high β_x (6.24 m) and β_y (2.88 m) with 8-mm η_x and 4-mm η_y leakage at source ; brightness measurements inferred by measurements of central cone spectral flux, β_x, β_y, η_x, η_y at source point.

Schedule to reach KPPs (estimated)

Begin dark time (accelerator removal, install new systems)	T_0-12 months
Begin ring tests with beam	T_0 - 3 months
Initial ring operation (threshold KPPs: 25 mA, >5.7 GeV, <130 pm)	T_0
Initial feature beamline operation (25 mA, 6 GeV, threshold TTOPs)	T_0 + 6 months
100 mA, 6 GeV, 42 pm (Run 3)	T_0 + 8 months
200 mA, 6 GeV, 42 pm (ring objective KPPs, Run 4)	T_0 + 12 months
Feature beamline brightness (objective KPPs, TTOPs, Run 5)	T_0 + 16 months

- ISN and Ptycho are most difficult feature beamlines. Reaching full operational capability (involving a combination of flux density on the sample and spot size) depends on optics and operational development extending to T_0 + ~3-5 years.
- Within the T_0 + 6-month period, various operational bunch patterns will be developed, including 25 mA in 48 bunches. Most challenging pattern for higher current is 48 bunches when operating with more than 150 mA. This requires operating the injector chain with higher bunch charge than presently possible. APS Operations has an investment plan to develop this capability with a targeted completion before the ring shut-down dark period (T_0 – 12 months).

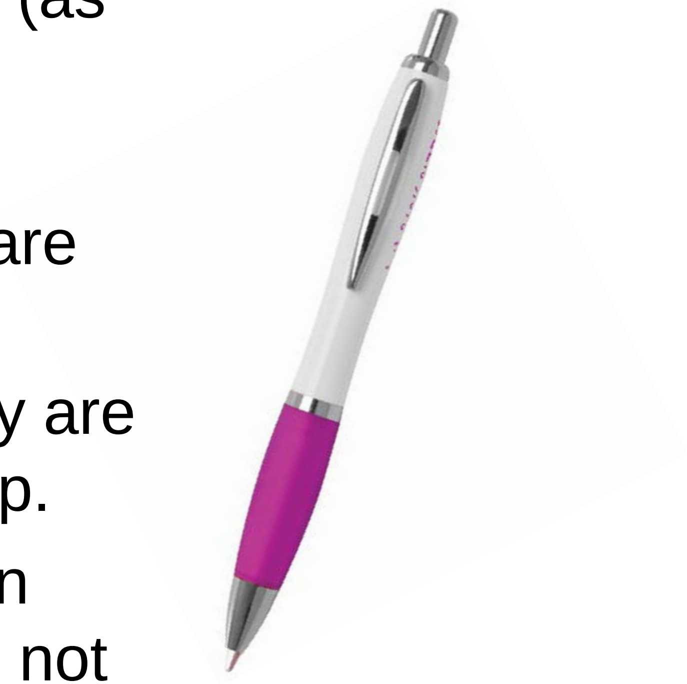
CDB and APS-U Work Planning

- Components are to be added to the CDB at Procurement
  - Properties capture statements of work, technical specifications, and drawings
  - System interfaces with other tools, such as ICMS, PDMLink, DMS, and PARIS
  - CDB aims to organize information, as a relational database
- Work Control Documents bound the work activities
  - WCDs document scope, high level work instructions, and scope limits
  - Hazards are identified and analyzed
  - SMEs are involved where appropriate
  - Approval and authorization is required before work can proceed
- eTravelers support work execution
  - Travelers help us record critical measurements and activities
  - Travelers support activity sequencing
  - Travelers document discovered nonconformances and their associated actions
  - Important hazard mitigation controls are integrated directly into work steps

Contact Betsy Dunn (x 8274) and Diane Wilkinson (x 7810) for support

SAFE Training Comment

- I attended SAFE Training October 10 and 11 here at Argonne (as an “Observer”…though I did participate in the role playing)
- An interesting side discussion came up on ‘pauses’ in conversations…letting someone else in the room know ‘you’ are uncomfortable
- Among the many problems, if someone is uncomfortable, they are already feeling on the defensive. It is even harder to speak up.
- I have asked the APS-U leaders…to lead…we will speak up in meetings to stop badgering, bullying, or other behavior that is not respectful. We may ‘pass a pen’, for instance.
- While we will not be perfect, we will work to creating an environment where it is accepted to speak up, and be heard.
- This will take time. But we must start. And so we will.



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Summary

- The APS-U Project becomes the BES top priority as the LCLS-II project winds down
- The Project now has full CD-3 spending authority and has moved into full speed execution mode
- Accelerator and beamline designs are proceeding well
- Dark time and beamline implementation plans are progressing
- We have accelerated our obligations…keep it up!
- Thanks for your support!