

25 JULY 2018

# APS All-Hands Meeting

## APS UPGRADE UPDATE

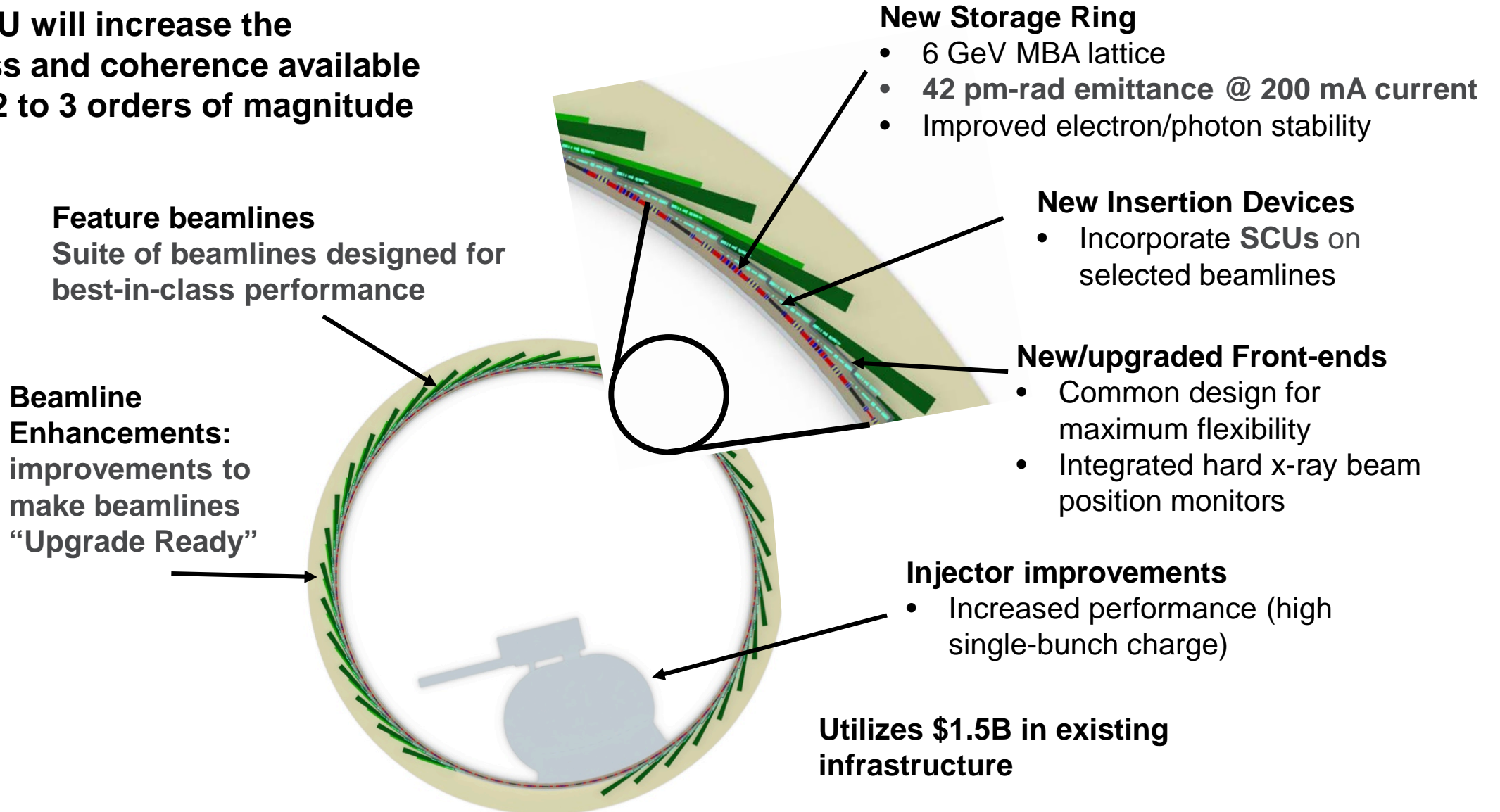
**JIM KERBY**

**PROJECT MANAGER, APS UPGRADE**

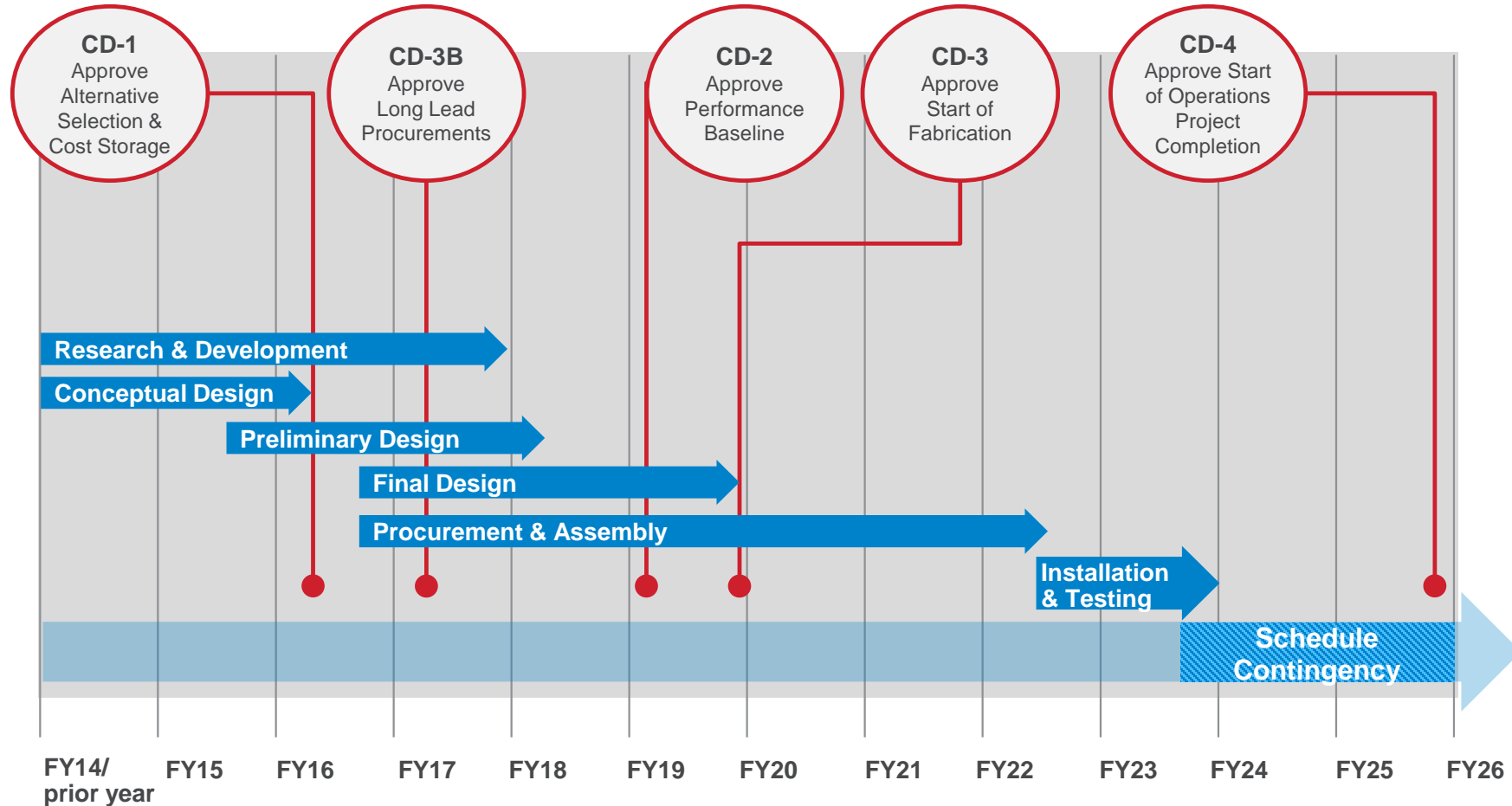


# APS-U PROJECT

The APS-U will increase the brightness and coherence available by up to 2 to 3 orders of magnitude



# PROJECT SCHEDULE



Director’s Review August 21-23

DOE ICE/ICR on site week of October 1<sup>st</sup>

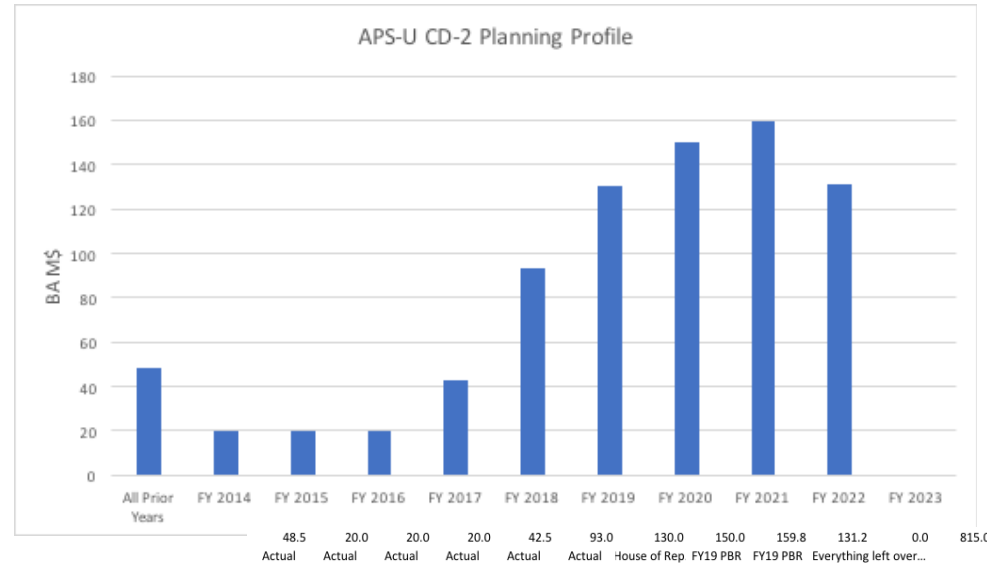
CD-2 Review October 10-12



These reviews confirm the baseline scope, cost and schedule of the APS-U

# APS-U TPC AND KEY PERFORMANCE PARAMETERS

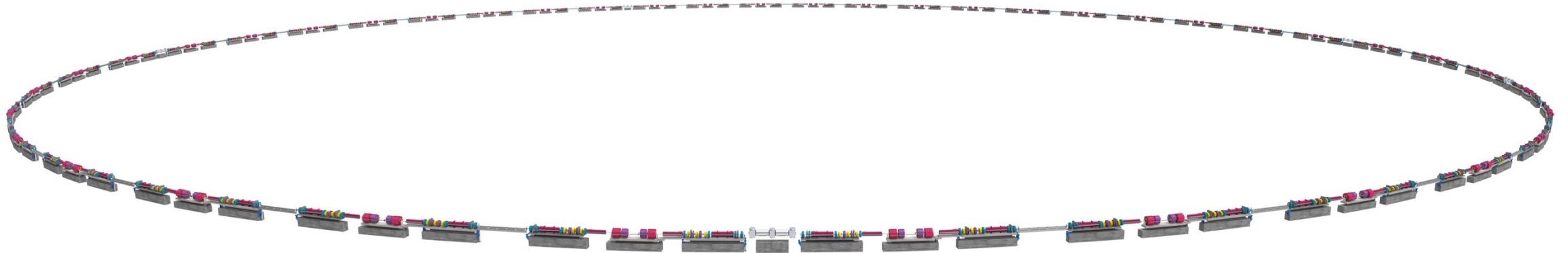
- Total Project Cost increased to \$815M to more fully enhance the scientific capabilities of the facility after the APS-U is complete
- Key Performance Parameters modified to reflect the change in TPC



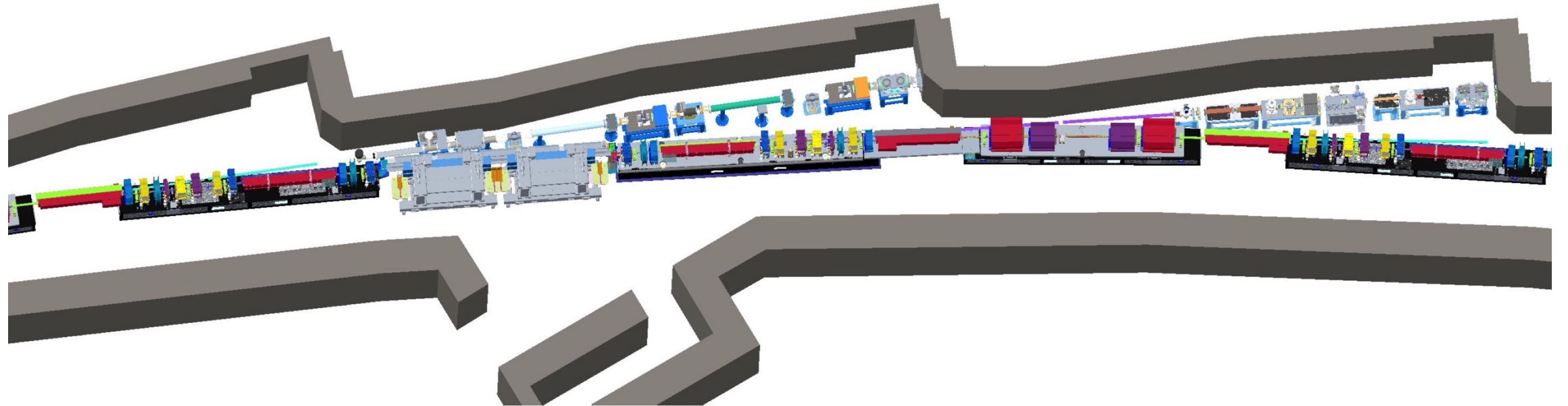
Key Performance Parameter	Thresholds (Performance Deliverable)	Objectives
Storage Ring Energy	> 5.7 GeV, with systems installed for 6 GeV operation	6 GeV
Beam Current	≥ 25 mA in top-up with systems installed for 200 mA operation	200 mA
Horizontal Emittance	< 130 pm-rad at 25 mA	< 42 pm-rad at 200 mA
Brightness <sup>1</sup> @ 20 keV	> 1 x 10 <sup>20</sup>	> 1 x 10 <sup>22</sup>
Brightness <sup>1</sup> @ 60 keV	> 1 x 10 <sup>19</sup>	> 1 x 10 <sup>21</sup>
APS-U Beamlines Transitioned to Operations	7	≥ 9

<sup>1</sup> photons/sec/0.1% BW/mm<sup>2</sup>/mrad<sup>2</sup>

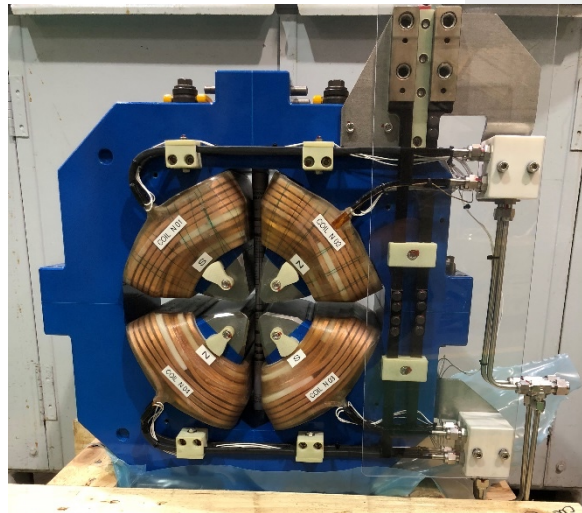
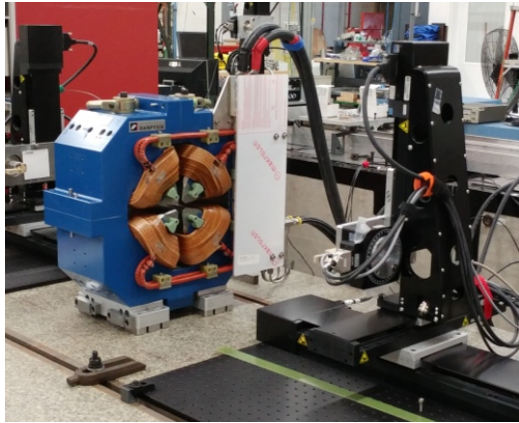
# ACCELERATOR WHOLE-RING MODEL



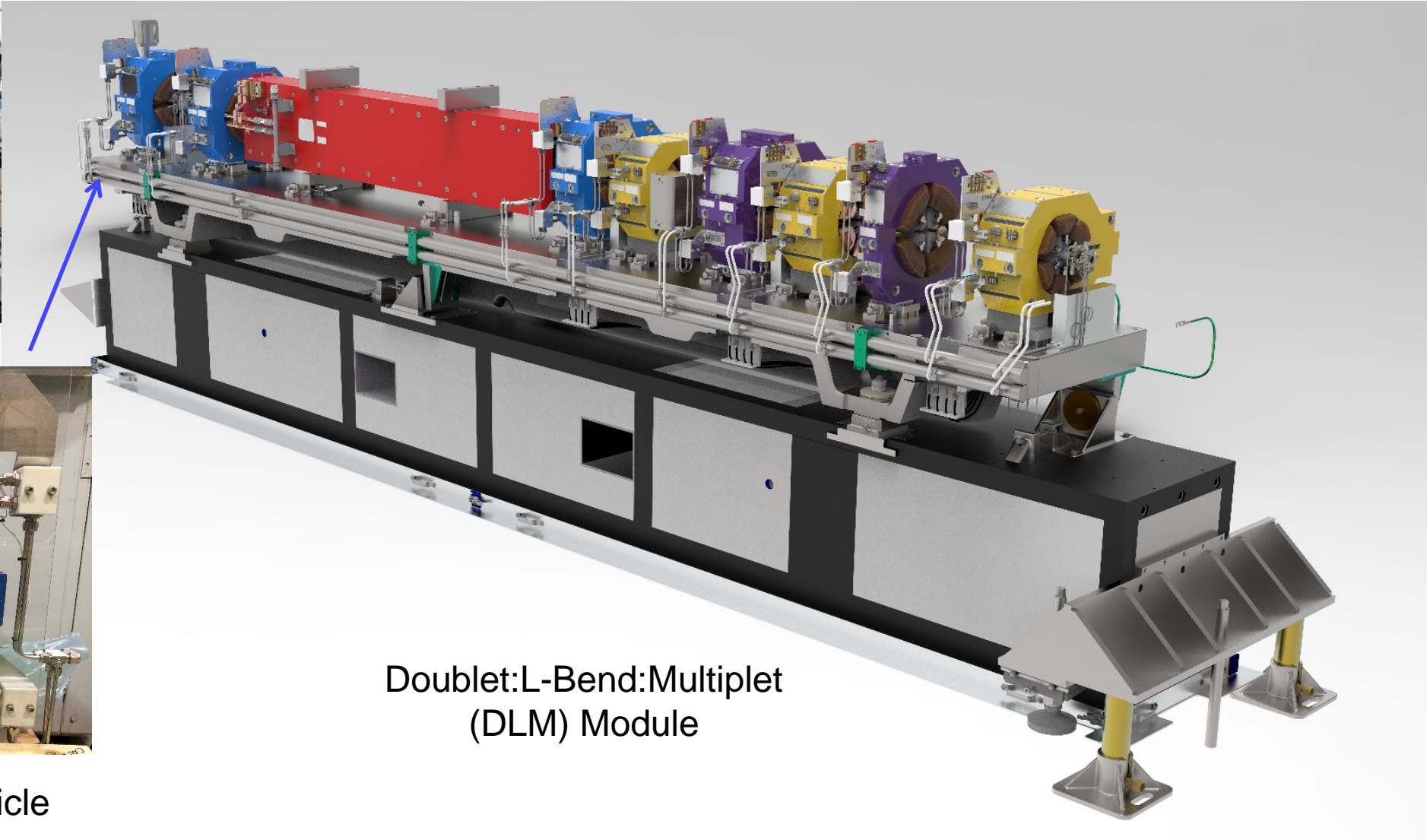
# MODEL OF STORAGE RING, INSERTION DEVICES, AND FRONT ENDS



# ACCELERATOR MECHANICAL INTEGRATION

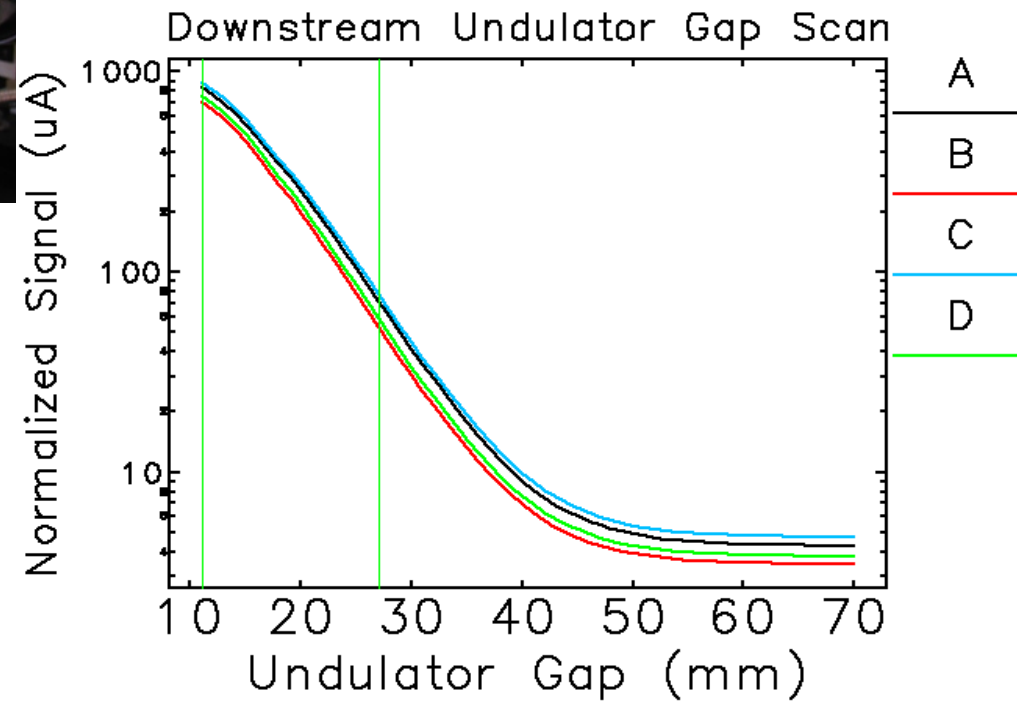
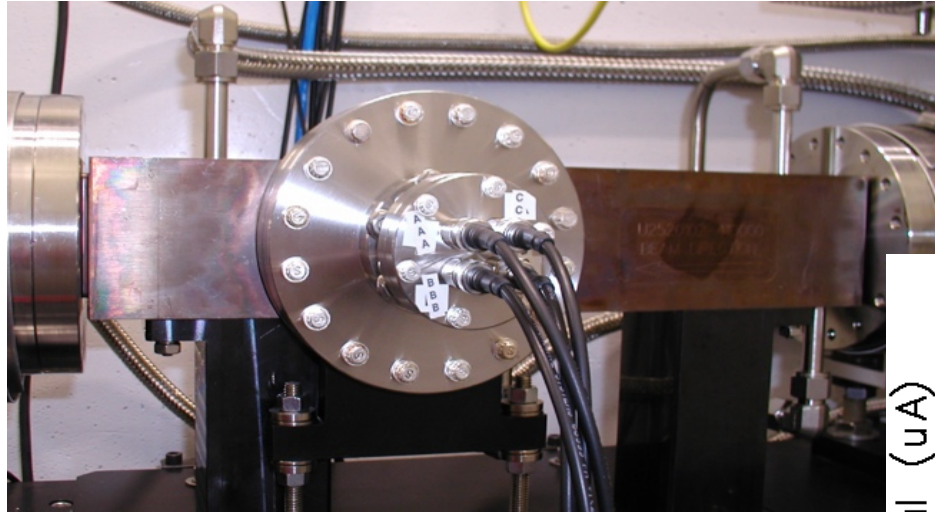


First Production Article  
Quadrupoles



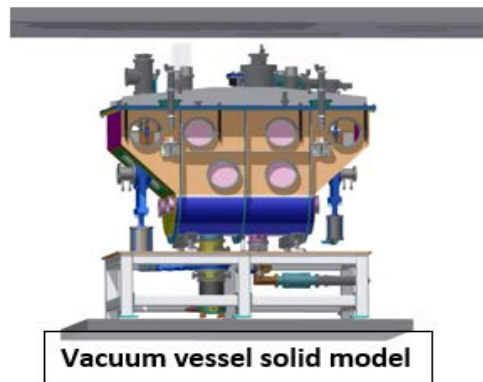
Doublet:L-Bend:Multiplet  
(DLM) Module

# X-RAY BEAM POSITION MONITOR DEVELOPMENT





# BUNCH LENGTHENING SYSTEM HARMONIC CAVITY CRYOMODULE



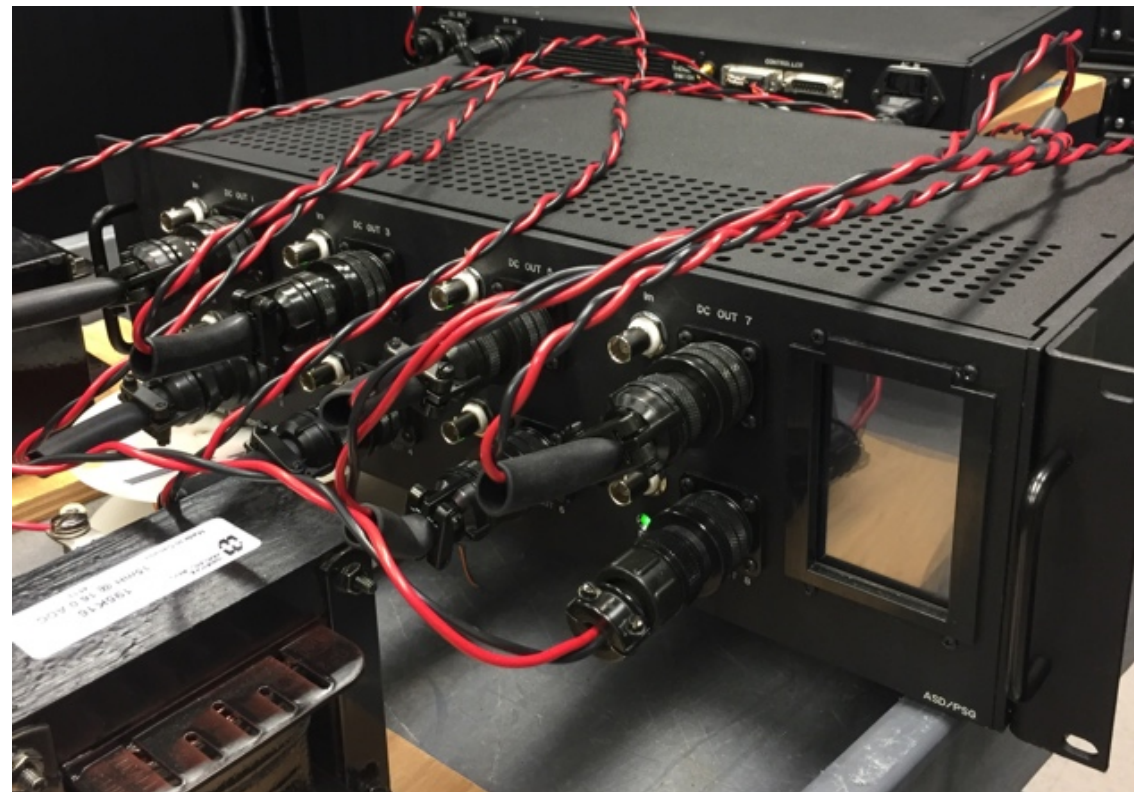
# POWER SUPPLY CALIBRATION AND CONTROL



Power Supply Controller



Bipolar Power Supply  
In-house design



Bipolar Power Supply  
Calibration Hardware

# GREAT TECHNICAL PROGRESS

23 design reviews completed since April →  
Advancing and completing our designs

Leading to...

APS-U Coherent High-Energy X-ray (CHEX) Technical Review	July 24, 2018
APS-U ATOMIC Beamline Technical Review	July 25, 2018
APS-U In-Situ Nanoprobe (ISN) Technical Review	August 1, 2018
APS-U Ptychoprobe (Ptycho) Technical Review	August 2, 2018
APS-U Polar Beamline Technical Review	August 15, 2018
ANL Director's DOE CD-2 Review of the APS Upgrade Project	August 21-23, 2018

## Previous APS-U Project Reviews

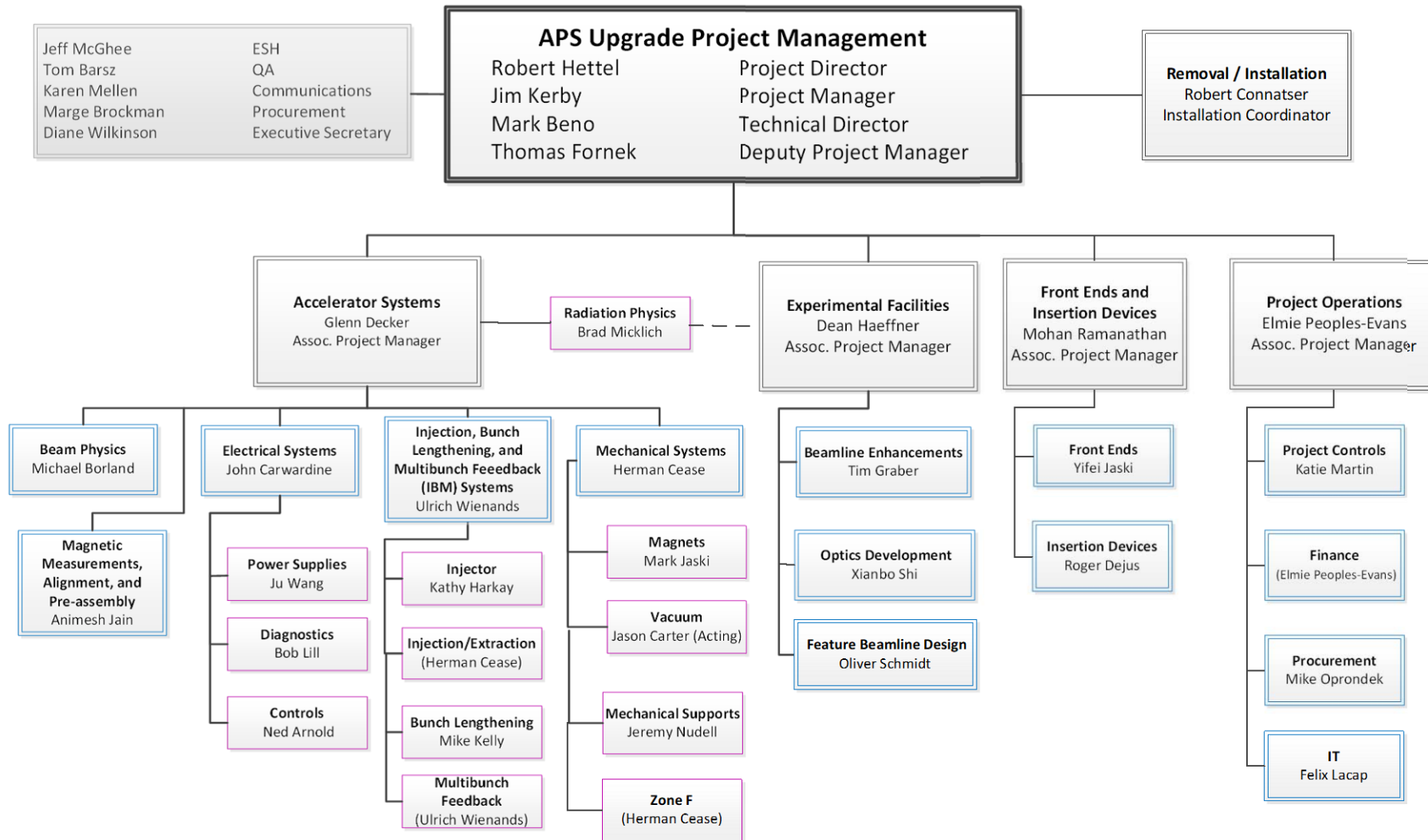
All	DOE	CDR	PDR	FDR	Install	Production	Safety	R&D	Other
APS-U 3D Micro and Nano Diffraction (3DMN) Technical Review									
APS-U High Energy X-Ray Microscope (HEXM) Technical Review									
APS-U X-Ray Photon Correlation Spectroscopy (XPCS) Technical Review									
APS-U Coherent Surface Scattering Imaging (CSSI) Technical Review									
APS-U 25-ID High Heat Load Mirror System Procurement Readiness Review									
APS-U Insertion Device Vacuum Chamber Support Extrusion Procurement Readiness Review									
APS-U Planar Insertion Device 2.8cm period Procurement Readiness Review									
APS-U Canted Undulator Front End Technical Review									
APS-U Bunch Lengthening System Cryoplant Final Design and Procurement Readiness Review									
APS-U Longitudinal Feedback Kicker Preliminary Design Review									
APS-U S1, S2, S3 Sextupole Final Design and Procurement Readiness Review									
APS-U Magnet Measurement Space Layout Design Review									
APS-U Front End Pneumatics Procurement Readiness Review									
APS-U ID Front End Equipment Protection System Procurement Readiness Review									
APS-U Storage Ring Vacuum Technical Status Review									
APS-U Insertion Device Vacuum Chamber Final Design Review									
APS-U High Heat Load Front Ends Masks/Photon Shutters Production Readiness Review									
APS-U Lattice and Beam Physics Final Design Review									
APS-U Injector Plan Preliminary Design Review									
APS-U Advanced Spectroscopy/LERIX (ASL) Technical Review									
APS Upgrade CD-2 Risk Management Workshop									
APS-U Magnet Supports Technical Review									
APS-U Shielded EMI Cabinets for Dignostics Procurement Readiness Review									

# LONG LEAD PROCUREMENTS

Since our April meeting APSU has put more than \$30M of magnets, power supplies, optics, vacuum chambers and front end components out for bid

Control Account / CD-3B Package	FY17	FY18	FY19	Grand Total
<b>U.U2.03.03.01 - Magnets</b>	<b>\$3,057,901</b>	<b>\$17,851,690</b>	<b>\$1,721,917</b>	<b>\$22,631,508</b>
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			\$1,721,917	\$1,721,917
M3 Dipole Magnet				\$0
<b>U.U2.03.03.02 - Support Structures and Alignment Systems</b>		<b>\$0</b>	<b>\$4,437,260</b>	<b>\$4,437,260</b>
DLM A Plinth and associated			\$4,437,260	\$4,437,260
<b>U.U2.03.03.03 - Magnet Power Supply Systems</b>		<b>\$9,173,180</b>	<b>\$0</b>	<b>\$0</b>
Unipolar Power Supply Components		\$9,173,180		\$9,173,180
<b>U.U2.03.03.04 - Vacuum System</b>		<b>\$0</b>	<b>\$3,746,526</b>	<b>\$3,746,526</b>
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
<b>U.U2.03.03.05.02 - Bunch Lengthening System</b>	<b>\$251,405</b>	<b>\$347,726</b>	<b>\$2,822,850</b>	<b>\$3,421,981</b>
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
<b>U.U2.03.03.06 - Injection / Extraction Systems</b>		<b>\$0</b>	<b>\$1,414,270</b>	<b>\$1,414,270</b>
High Voltage Pulsers			\$1,414,270	\$1,414,270
<b>U.U2.03.03.07 - Diagnostics</b>		<b>\$374,212</b>	<b>\$0</b>	<b>\$374,212</b>
RF BPM Components (Relay Racks)		\$374,212		\$374,212
<b>U.U2.04.02 - Global Beamline Support</b>	<b>\$354,990</b>	<b>\$588,481</b>	<b>\$887,102</b>	<b>\$1,830,572</b>
Optics, Stability Components	\$354,990	\$588,481	\$887,102	\$1,830,572
<b>U.U2.04.04 - Beamlines</b>		<b>\$4,579,000</b>	<b>\$1,850,655</b>	<b>\$0</b>
ASL Hutch Procurement		\$2,269,000		\$2,269,000
ASL Beamline Critical Components		\$2,310,000	\$1,850,655	\$4,160,655
<b>U.U2.05.02 - Front Ends</b>		<b>\$3,907,200</b>	<b>\$2,150,017</b>	<b>\$6,057,217</b>
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 & Phnumatics		\$1,165,441		\$1,165,441
ASL CUFE		\$233,092	\$595,544	\$828,636
<b>U.U2.05.03 - Insertion Devices</b>		<b>\$2,085,379</b>	<b>\$6,696,016</b>	<b>\$6,588,374</b>
Magnetic Structures		\$1,840,199	\$4,502,995	\$6,343,194
Insertion Device Vacuum Chamber Components		\$245,180	\$2,193,021	\$2,438,201
<b>Grand Total</b>	<b>\$3,664,296</b>	<b>\$38,906,868</b>	<b>\$24,312,343</b>	<b>\$66,883,506</b>
Contingency @35%	\$366,430	\$13,617,404	\$8,509,320	\$23,493,154
<b>Grant Total Including Contingency</b>	<b>\$4,030,726</b>	<b>\$52,524,271</b>	<b>\$32,821,663</b>	<b>\$89,376,660</b>

# APS-U PROJECT TEAM



A project is scope, cost and schedule....but is only as good as it's people.

APSU has >100 FTEs of the best --full time or matrixed from across Argonne, the National Lab System, and Industry

# CONCLUSION

The APS-U is coming!

- The project will be baselined this fall, with a
  - Scope
  - Cost
  - Schedule
  
- We are executing on the Long Lead Procurements

People (you!) make it happen.

It's hard and exciting work...please do it safely!