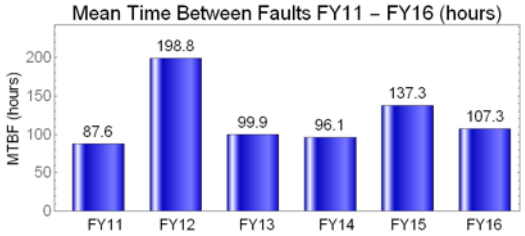
PSC ALL-HANDS MEETING: ACCELERATOR SYSTEMS DIVISION

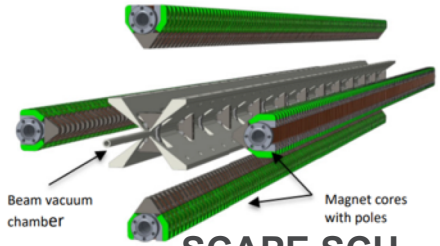
JOHN BYRD
ASD
Photon Sciences Directorate

3 August 2020

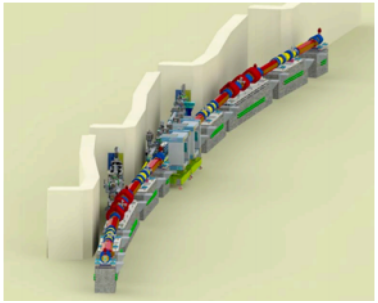
ASD SUPPORTS THE APS MISSION TO DELIVER WORLD-CLASS SCIENCE WITH HARD X-RAYS

- Provide reliable and high-quality beam for user operations
- Pursue accelerator physics and technology research to constantly enhance the scientific capabilities of the APS
- Research and develop concepts for new accelerator technologies and facilities to further enhance x-ray science





SCAPE SCU



APS-U MBA Lattice

IMPACT ARGONNE AWARD FOR MCR GROUP

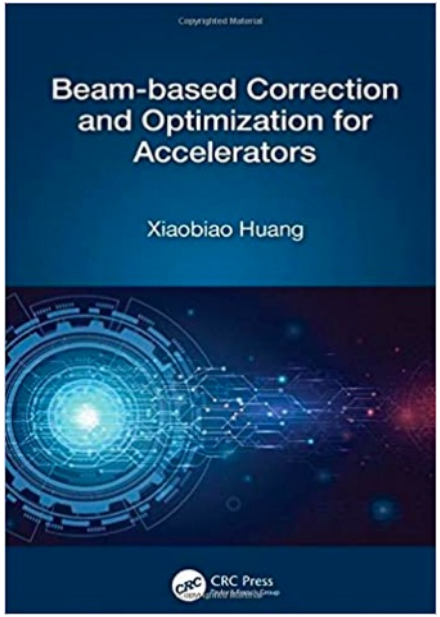
APS operators been on the job since lockdown…with superb beam availability

- Kyle Berg
- Lisa Berkland
- Ted Davis
- Randy Flood
- Greg Fystro
- Ted Grodecki
- Megan Kimbro
- Steve LaBuda
- Sean Orne
- Dmitriy Ronzhin
- Karen Schroeder
- Eric Smith
- Dee Weyer

…. To date, this is the longest run in the history of the APS and if the APS continues to achieve its high availability factor to an August shutdown start, it will have added a supplemental 500 hours to the FY2020 user run cycle, something never before achieved in its 24 year history….

NEW GROUP LEADER FOR ASD ACCELERATOR PHYSICS

Dr. Xiaobiao Huang, from SLAC (SPEAR3), starts 10 August after an international search.



His book is available on Amazon!

Xiaobiao brings an excellent record of research and operations experience. He is also one of the foremost experts in Machine Learning applications for accelerators.

USING APS TO PREPARE FOR APS-U OPERATION

Try to simulate conditions for APS-U today using APS at 200 mA and 6 GeV.

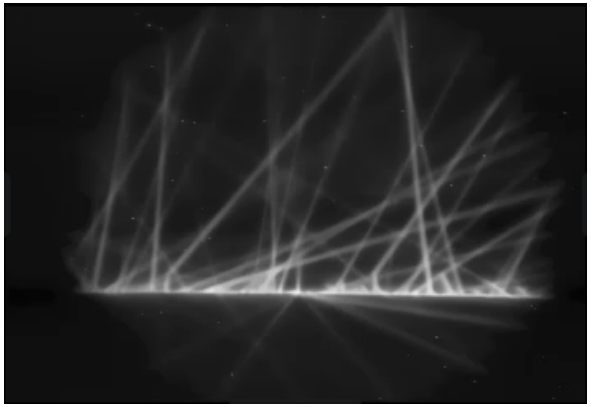
We can use APS to study and prepare for APS-U challenges. These include:

- Collimators: APS-U beam density is so large that it burns thru collimators.
- Beam-Ion Instabilities: Residual ionized gas can resonate in the beam potential and destabilize the beam and cause emittance growth.
- Cavity Instabilities: Higher order modes in the APS RF cavities can drive instabilities. At 6 GeV and 200 mA, the beam will be much more sensitive to these effects.

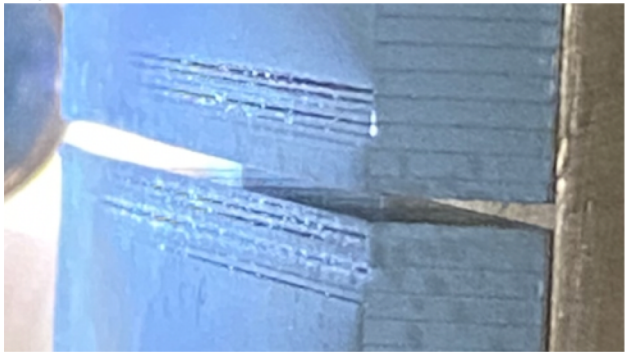
APS-U PREP: COLLIMATOR STUDIES

Use a scraper assembly in Sector 37 with special insert to simulate collimator.

- Low-beta optics and operation at 200 mA approximates APS-U beam energy density.
- The scraper is moved close the beam. We then move the beam onto the scraper using correctors and observe scraper image. Beam position can be moved to strike scraper at different positions.
- We were able to hit the scraper in multiple locations and multiple times in the same location. A number of interesting images.
- Scraper assembly has now been removed and collimator is under metallurgical study. More results to come in the near future.
- We are much more confident that we can find a solution for APS-U collimators.



Frame grab of video image during a strike showing ejecta.

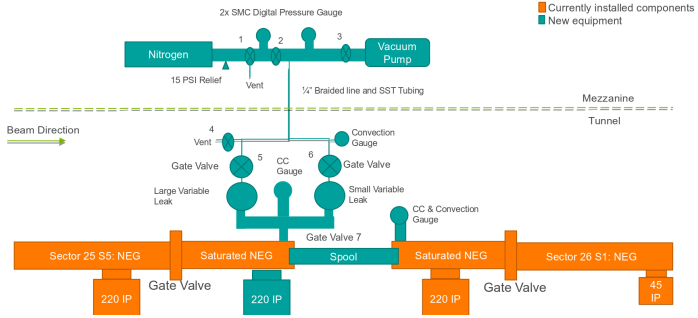


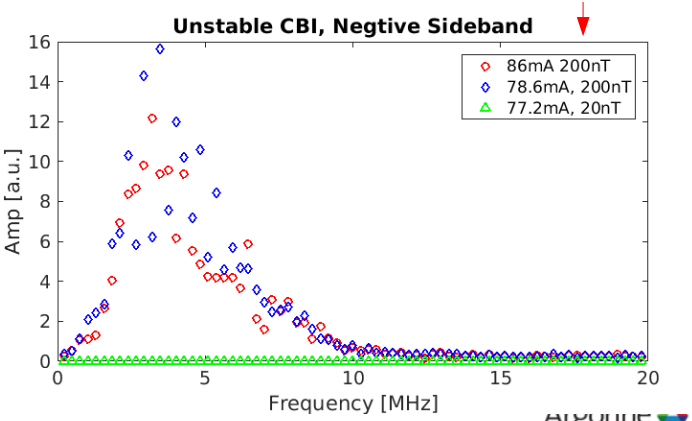
Collimator assembly after multiple full0beam strikes Under metallurgy tests now.

APS-U PREP: GAS INJECTION EXPERIMENT TO FULLY UNDERSTAND APS-U ION INSTABILITIES

Nominal APS-U beam filling pattern (324 bunch) shows ion instability problems. Remediation techniques have been tested in APS.

- Controlled gas leak installed in Sector 25 to create a pressure “bump” with a known beta function. Fully tested with no impact on storage ring pressure outside of the sector.
- Use existing suite of tools to characterize instability behavior as a function of pressure, current, filling patterns, etc.
- Latest machine studies on July show excellent results. Demonstrates ion instability goes away with APS-U fill pattern. Studies will continue over next year. Led by Joe Calvey.
- We plan for this to be the “definitive” study of ion effects for 4th gen storage rings.

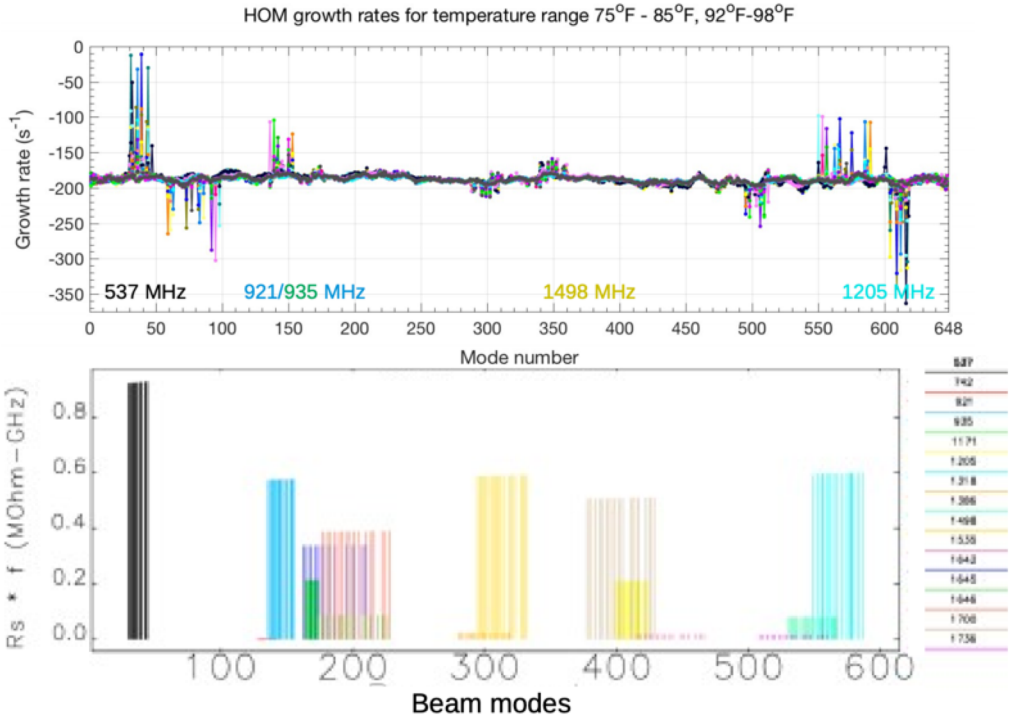




APS-U PREP: MAPPING RF CAVITY-DRIVEN BEAM INSTABILITIES

The APS RF cavities will be reused for APS-U. A new technique using the beam can map Higher-order Mode resonances that drive instabilities.

- HOM instabilities occur when a narrowband cavity mode overlaps with a beam mode.
- It is difficult to measure the precise frequency of the HOMs externally. Let's use the beam to do it!
- HOM frequencies are varied with cavity temperature and the beam is "tickled" to observe its response.
- This technique will be used to "park" HOMs for APS-U operations.

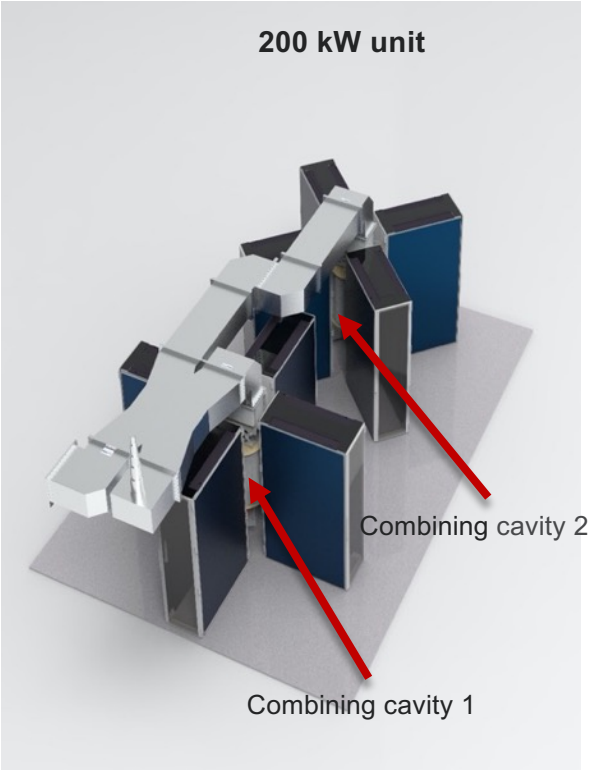


Argonne NATIONAL LABORATORY

UPDATE ON SOLID-STATE POWER AMPLIFIERS

LDRD-funded engineering development phase is complete. RFP issued for procurement of first 200 kW unit for APS test.

- All SSPA prototype testing is complete.
- Review of SSPA plan held on 12 Dec 2019 and chaired by Jim Sebek. Review committee endorsed our plan and recommended moving ahead to procurement.
- $25M RFP issued in early July. Two units will be purchased every year until storage ring system complete.
- First storage ring cavity test with 200 kW SSPA planned for mid-2021



STATUS OF APS LINAC REFURB

Linac RF system needs refurbishment to meet APS-U requirements

- Structures:
  - We are building a linac RF test stand that will allow the conditioning of structures/SLEDs without impacting operations.
- RF sources:
  - We have ordered two new Canon/Toshiba klystrons and two Scandinova k400 modulators. Cost of ~$2M.
- New Electron Guns
  - A redesigned electron gun will be installed over August shutdown, addressing many troublesome issues with current guns. If successful, we will replace all guns with the new design.
- Digital RF, Timing system upgrade, modern power supplies, etc.
- **Final system will allow us to run linac at peak energy of 530 MeV, allowing some overhead to operate 24/7 at 475 MeV.**

MAGNETIC DEVICES GROUP CONTINUES TO BE THE PARTNER OF CHOICE FOR NEW IDS

In addition to APS-U IDs, MD group continues to innovate.

- HGVPU undulators for LCLS-II HXR FEL
  - Just successfully lased two weeks ago
- XLEAP-II wigglers for attosecond pulse generation at LCLS.
- Proposal for TeraHertz Wiggler at LCLS-II now at DOE. Period of ~1 m for coherent THz pulses for pump/probe experiments.
- Nb3Sn DOE R&D program now testing 0.5 m prototype. If successful, 1.2 m device will be built and tested in APS before downtime.
- Potential SCU FEL at LCLS white paper being discussed at DOE.

The APS XLEAP team after completion of the project. Group and project leader Joe Xu is at far left.

ACCELERATOR R&D OPPORTUNITIES ABOUND

- Cavity-based XFEL
  - Work ongoing to build an “optical” cavity for x-rays using diamond mirrors for testing at LCLS. Potential for new capabilities for LCLS-II.
- Superconducting RF Gun
  - Argonne has inherited a high-brightness SRF gun that has yet to be commissioned. Potential applications as new LCLS-II gun or UED/UEM source.
- TESSA
  - Collaboration with UCLA to test a new seeded, tapered FEL in the visible as a means of higher energy extraction. Uses the Linac Extension Area driven by the APS linac