Accelerator Aspects of APS-U

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Outline

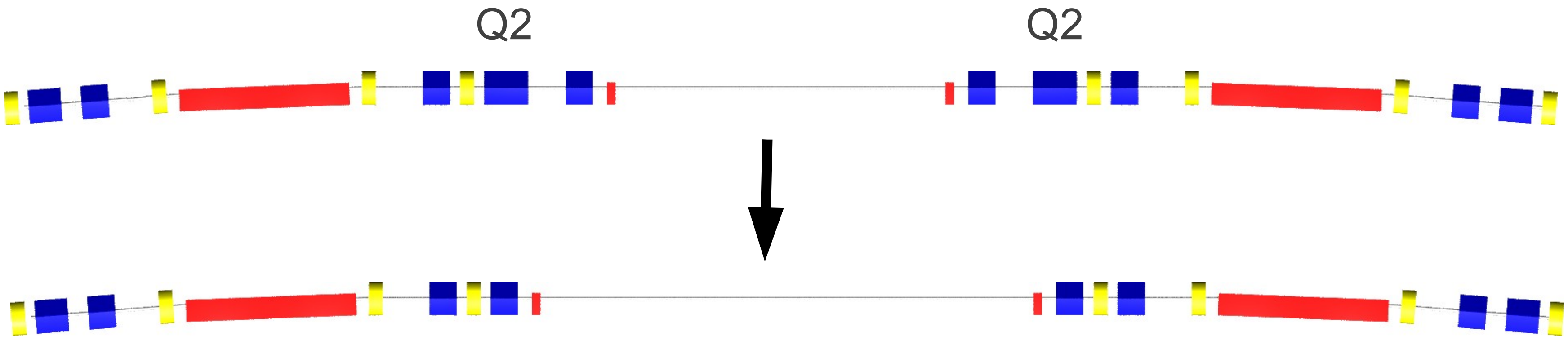
- Purpose:
  - Review plans for accelerator upgrades as part of APS-U
  - Nothing about SPX in this talk
- Lattice changes
- Higher current
- Beam stability
- Undulators

Present Performance and Goals for Upgrade

Parameter	Present	APS-U goal
Beam energy	7 GeV	≥ 7 GeV
Beam current	100 mA	150~200 mA
Effective emittance	3.15 nm	≤ 3.5 nm
Vertical emittance	35 pm	10~50 pm
Top-up interval	≥ 60 s	≥ 30 s
Fill patterns	24 & 324 bunch Hybrid mode	24 & 324 bunch Hybrid mode
Operational single bunch current limit	16 mA	16 mA
Straight section length	4.8 m	4.8~7.7 m

Long Straight Section (LSS) Scheme

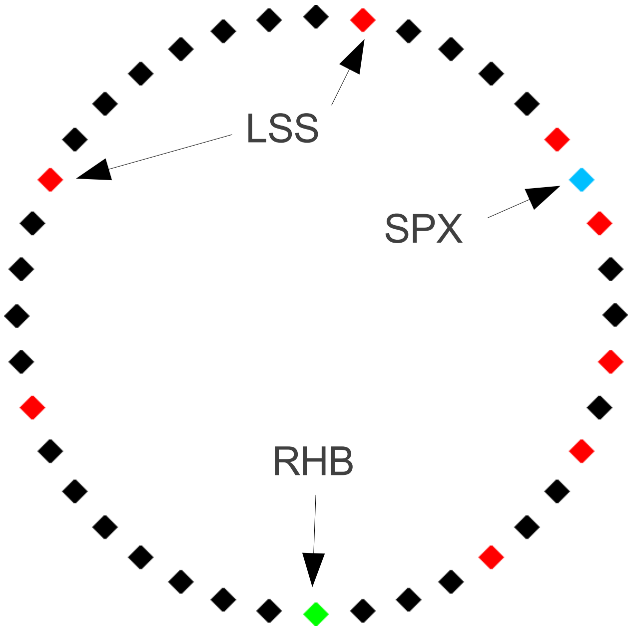
- LSS can be implemented at APS with a simple scheme
  - Remove the Q2 magnets on either side of SS
  - Remove the adjacent correctors
  - Remove the adjacent BPMs
  - Slide other components away from the ID



- Increases space available for ID from 4.8 to 7.7m
- Most cost-effective option for LSS
  - Still, hard to afford more than 8

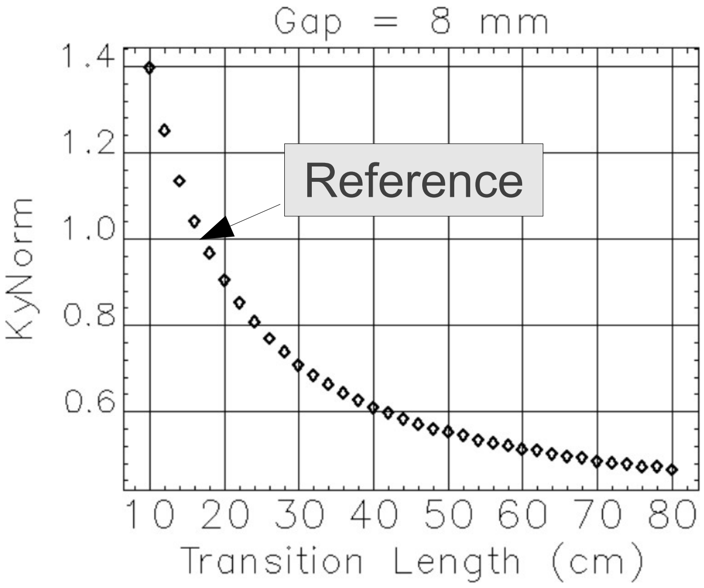
Lattice Considerations

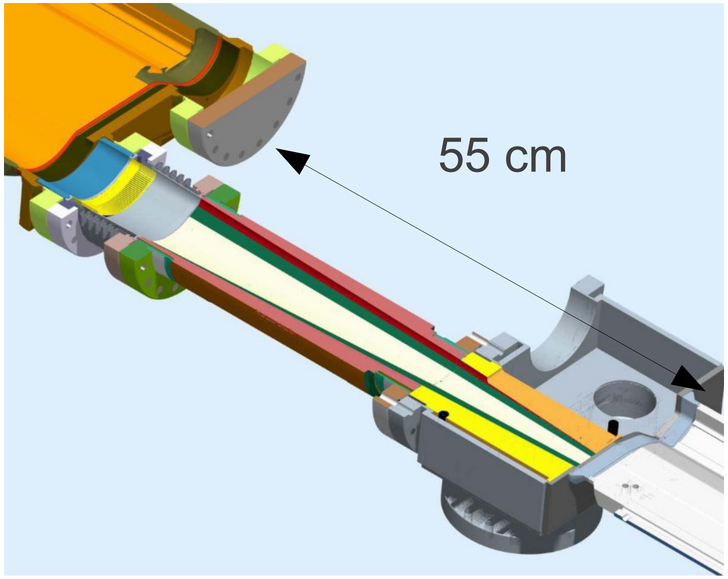
- Used parallel evolutionary algorithm to optimize injection aperture and lifetime in simulation
  - Use dozens of independent sextupole knobs
  - APS and ANL computing resources (Fusion, Intrepid) have been important resources
- Have developed three basic lattices:
  - 8 "random" LSS
  - 8RLSS + SPX in sector 7
  - 8RLSS + SPX + RHB in sector 20
- Tests of mock-up lattices are promising
  - Lifetime not as long as desired for most complex lattices



Long Taper for APS Upgrade

- Longer straight sections will increase effective vertical impedance
  - Single bunch limit 16 mA → 12 m A !
- Longer (linear) tapers will reduce impedance
- Design for 4ID, where the ID VC aperture (5mm) is smallest.





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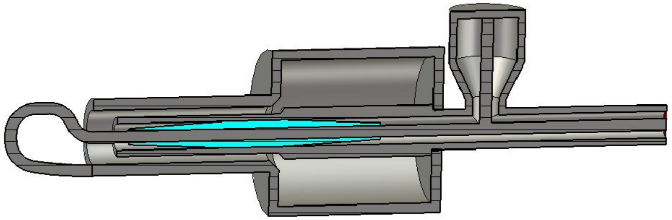
Higher Beam Current

- Presently operate at 100 mA
- Plan for upgrade
  - Increase brightness, flux by running at 150 to 200 mA
  - Upgrade all front ends and beamlines to handle 200 mA
  - Accelerator can run at 150 mA without modification
- If funds permit, upgrade accelerator to 200 mA
  - Replace a few components (e.g., scrapers) to resolve rf heating issues
  - Move to full-time operation with 4 rf systems
    - Reduced reliability
    - Increased electrical power consumption
  - Design/install improved cavity HOM dampers
  - Upgrade input power couplers for all cavities

Concept for improved HOM damper



Beam Stabilization

- Spurious storage ring vacuum chamber microwave mode dampers
- Real-time feedback system upgrade
- Improved tunnel temperature regulation
- Front-end hard x-ray beam position monitor developments

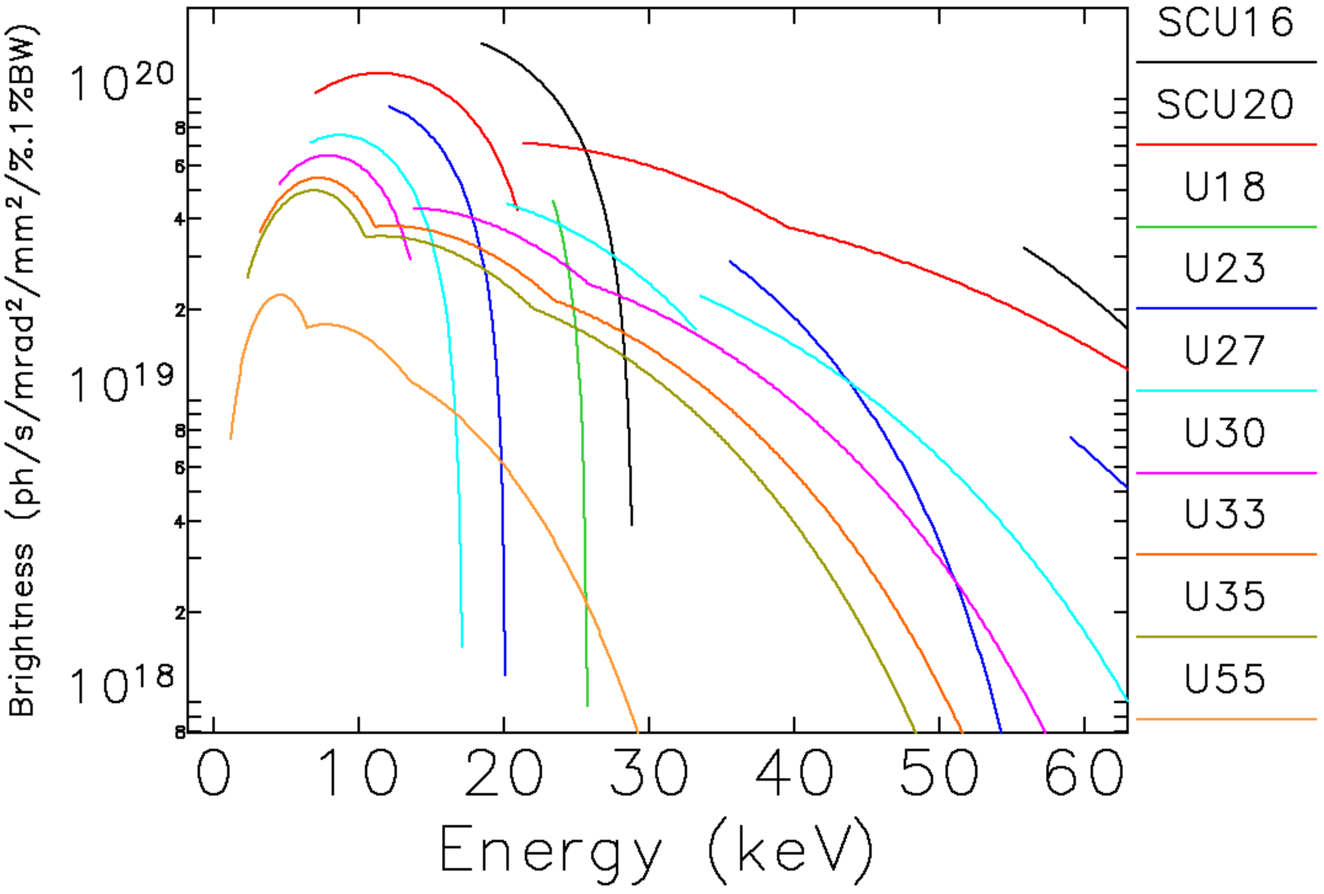
		AC Motion* (0.1-200 Hz)		Long term (1 week, pk-pk)	
Horizontal	Now	5.0 µm	0.85 µrad	7.0 µm	1.4 µrad
	Upgrade	3.0 µm	0.5 µrad	5.0 µm	1.0 µrad
Vertical	Now	1.6 µm	0.8 µrad	5.0 µm	2.5 µrad
	Upgrade	0.4 µm	0.2 µrad	1.0 µm	0.5 µrad

*0.1-200Hz BW

Undulator Developments

- Presently, most undulators are general-purpose UA
- We envision replacing many undulators with devices customized to experimental requirements
- Possible devices include
  - Customized period length planar undulators
  - Superconducting undulators
    - Provide wide tuning range with short period
    - Much more compatible with hybrid mode than in-vacuum devices
  - Revolver undulators
    - Several planar undulators on a common support
    - User can switch among them at will
    - Another approach to the tuning range dilemma
  - Polarization control (e.g., APPLE)

Undulator Brightness Performance



Present HPM devices with 2.4m length, 10.5mm gap

SCU with 2.0m length, 9.5 mm gap

100 mA, present lattice, 1% coupling

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