High Current Studies With User Participation

January 22, 2013

APSUO Steering Committee

Past Beamline Studies Above 100 mA

Accelerator Division Experiments Starting in 1996

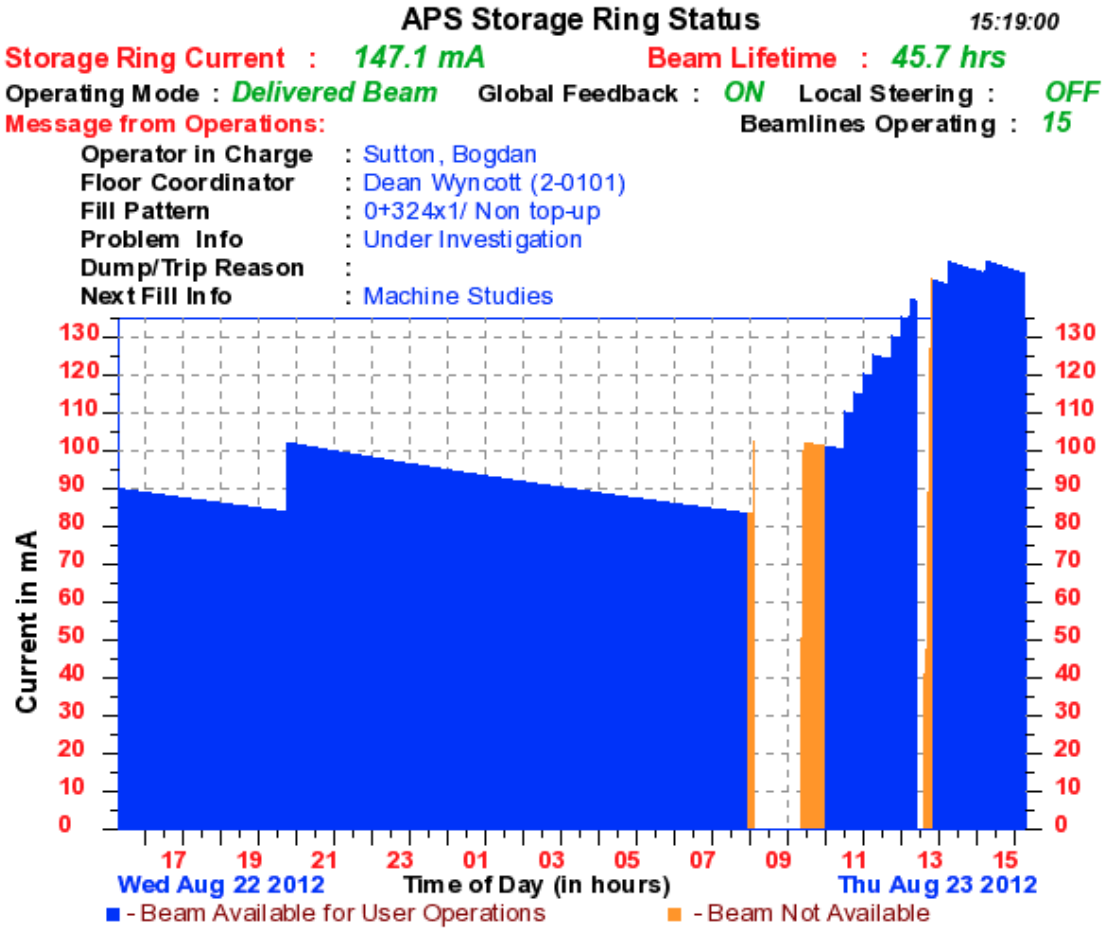
ID Shutters Enabled

- **2002 April**
  - 130 mA / 23 bunch
- **2002 June**
  - 130 mA / 23 bunch
- **2012 August**
  - 150 mA / 324 bunch

For complete history, see:

APS Higher-Current Operation Milestones (ICMS APS_1423957)
K. Harkay, J. Dooling, D. Horan, A. Nassiri, V. Sajaev, K. Schroeder, A. Xiao, C.-Y. Yao

August 23, 2012 — 150 mA Study



Motivation:

APS-U Key Performance Parameters include 150 mA operations

Objective:

Study the performance of **Beamline Optics** above 100 mA

30-ID High Heat Load Monochromator at 150 mA

Criteria for participation:

Front End ***and*** Beamline radiation safety system (RSS) components OK to operate at 150 mA without gap restrictions.

ID Beamlines Rated for 150 mA

August 23, 2012 — 150 mA Study

Sector	First High Heat Load Component		Cooling	Front End
13	Mono	Si	LN2	Canted
16	Mono	Diamond	Water	Canted
21	Mono	Diamond	Water	Canted
23	Mono	Si	LN2	Canted
24	Mono	Si	LN2	Canted
26	**Mirror**		Water	High Heat Load
30	Mono	Diamond	Water	High Heat Load
34	**Mirror**		LN2	Canted

Canted Undulator and High Heat Load Front Ends except:

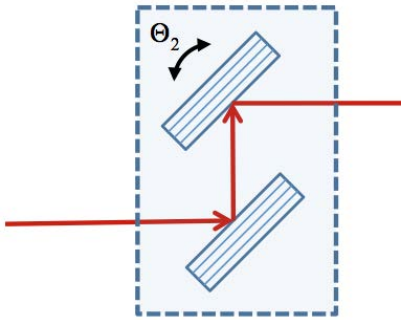
- 12-ID — Beamline RSS
- 29-ID — Construction

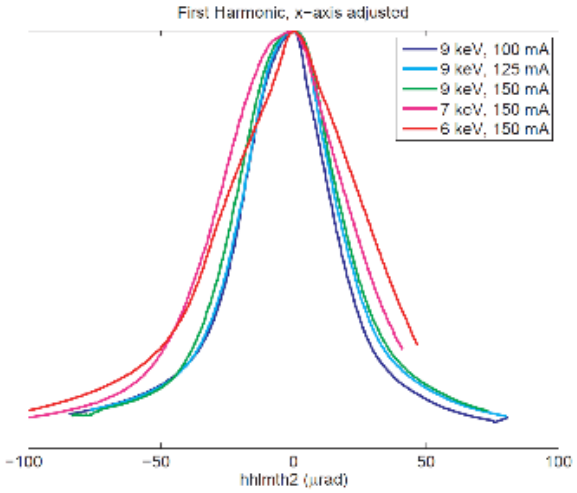
Good Diversity of first white beam optics:

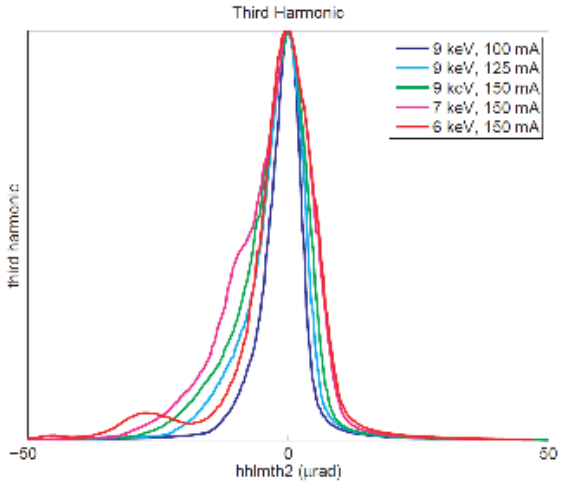
- (3) Diamond mono
- (3) Silicon mono
- (2) Mirror

Sector 30 High Heat Load Monochromator

August 23, 2012 — 150 mA Study







Diamond (111)

First harmonic broadens with increasing power.

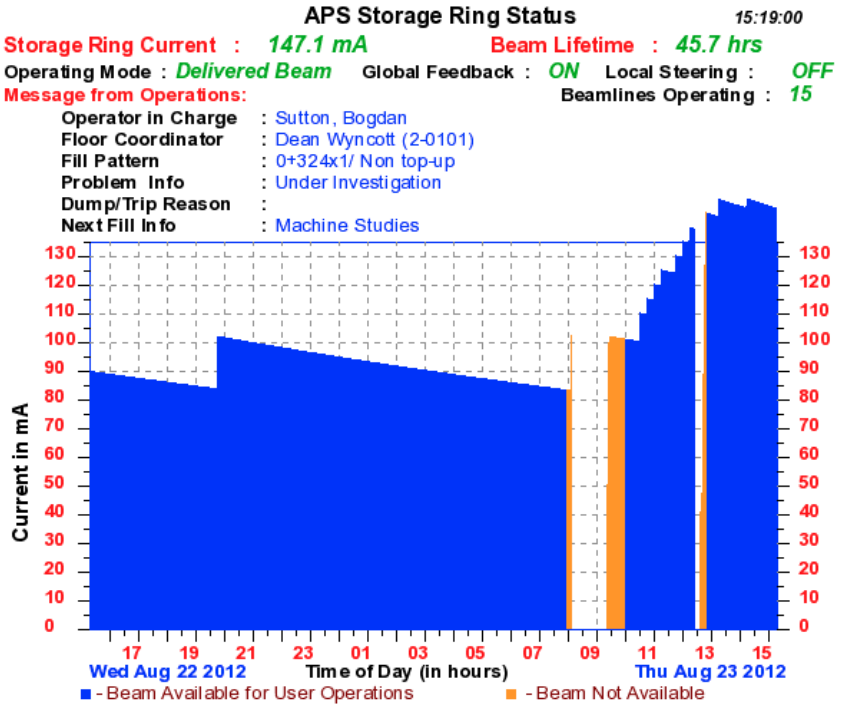
Diamond (333)

Third harmonic broadens until a satellite peak appears.

Behavior tentatively attributed to increasing lattice spacing gradient in the beam spot.

Findings from August 23, 2012 Study

1. Flux delivered through LN2 cooled monochromators found to be linear with current (13-ID, 21-ID, 34-ID)
2. Upgraded Beamlines are generally ready for 150 mA operations
3. More 150 mA time is needed to fully understand the behavior of the 30-ID high-heat-load diamond mono
4. More high-current studies are needed for all beamlines to characterize optics performance



Planning for 2013 High-Current Studies

SCU0 Installed December 2012

- SCU0 commissioning 2013-01
- No 150 mA studies until 2013-02

Study Time Requested for End of 2013-02

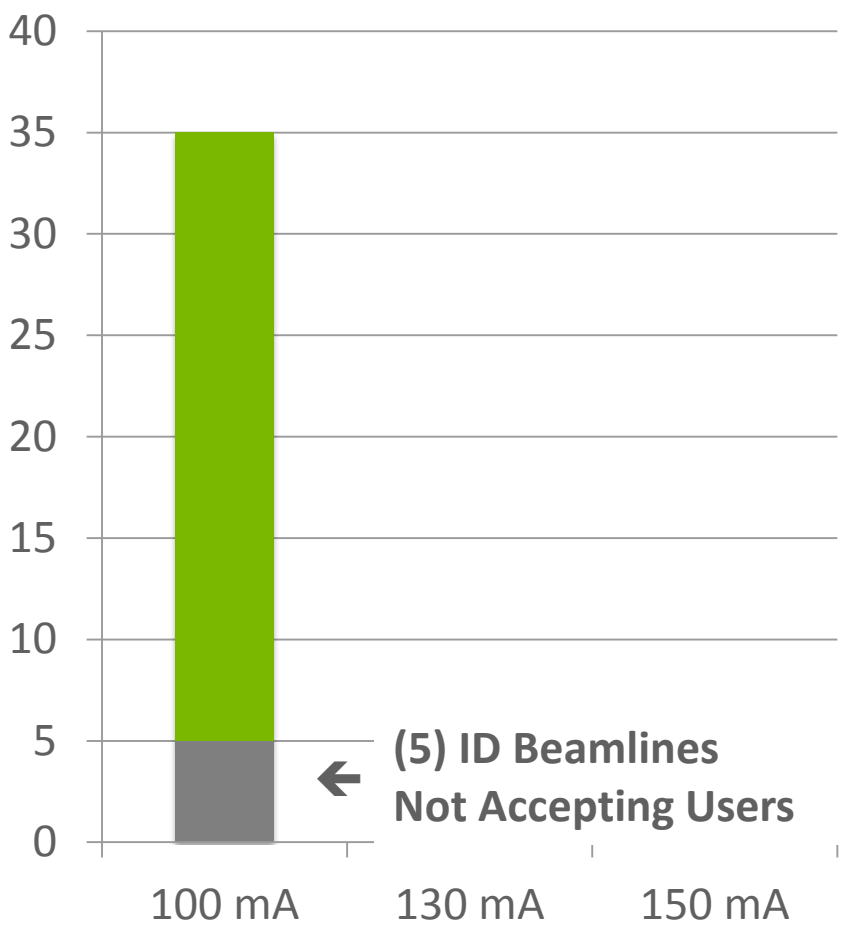
- Input from Users and APS-U Needed:
  - Ring Current Profile vs. time
  - Use of Administrative Restrictions (e.g., gap limits)
- Priorities
  - Value of 130 mA (increased participation) vs. 150 mA (valuable data)
  - Targeted experiments for APS-U
  - Accelerator research needs
  - Engineering support to re-evaluate thermal analysis

Include Bending Magnets

- BM Front Ends and Beamline RSS rated for 150 mA

Planning for 2013 High-Current Studies

(30) ID Lines Operating at 100 mA



≤ 100 mA

(30) Operating ≤ 100 mA

(5) Off-Line

25 Planned APS-U / Advanced Spectroscopy

27 Planned APS-U / RIXS

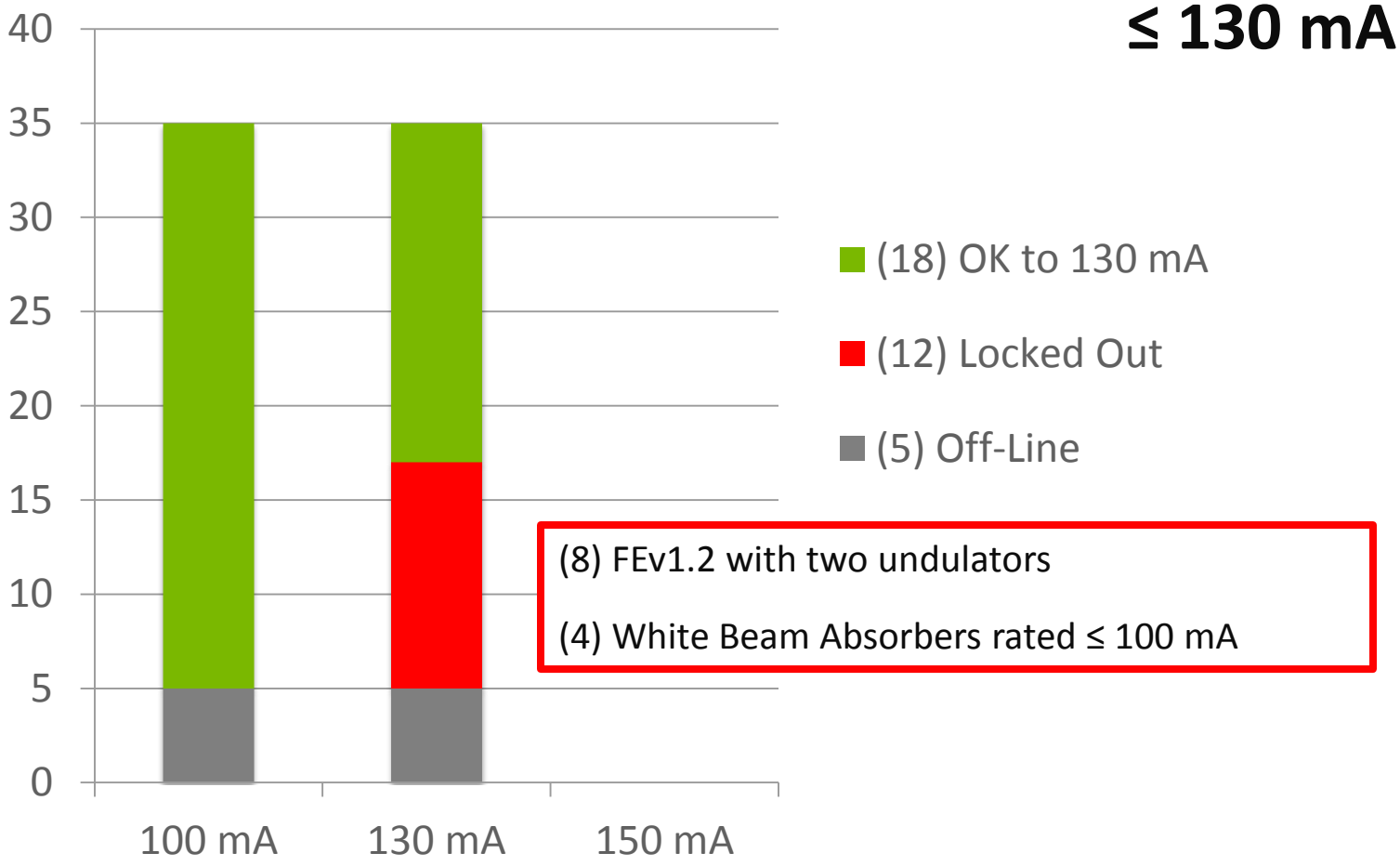
28 Planned APS-U / Interface Scattering

29 Commissioning / Intermediate Energy

35 Construction / Dynamic Compression

Planning for 2013 High-Current Studies

(18) ID Lines Rated for 130 mA Operations



≤ 130 mA

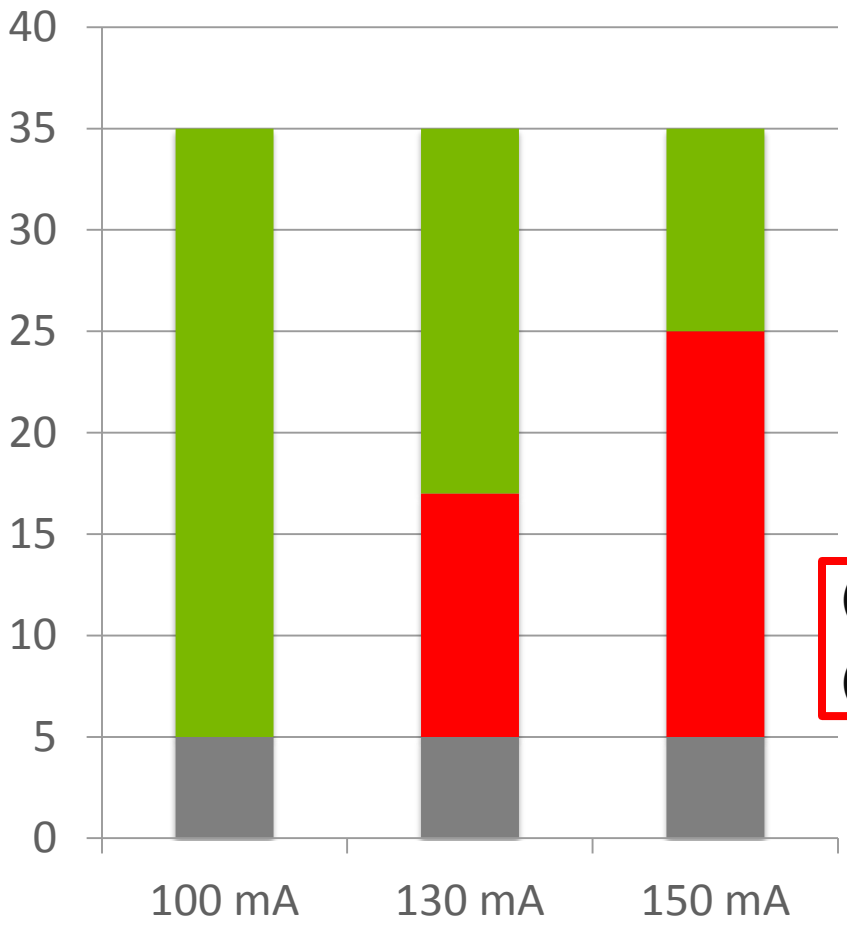
(8) FEv1.2 with two undulators

(4) White Beam Absorbers rated ≤ 100 mA

See Handouts for breakdown of thermal analysis by beamline

Planning for 2013 High-Current Studies

(10) ID Lines Rated for 150 mA Operations



≤ 150 mA

(18) FEv1.2 Front Ends

(2) White Beam Absorbers rated < 150 mA

See Handouts for breakdown of thermal analysis by beamline

Planning for 2013 High-Current Studies

Input is Needed from Users, ASD, APS-U, etc.

- **User Community**
  - Decide on an acceptable Ring Current Profile vs. Time
  - Are Administrative Restrictions (e.g., gap limits) acceptable for some beamlines
- **APS-U**
  - Design targeted experiments to answer APS-U engineering questions
- **Accelerator Division**
  - Readiness of SCU0 for high current studies
  - Acceptable fill patterns with SCU0
  - Scheduling

Questions?

Original Front Ends (FEv1.2)

	Sector	Front End	Beamline RSS	
➔	1	FEv1.2		U33 + U23
➔	2	FEv1.2		U33 + U55
➔	3	FEv1.2		U27 + U27
➔	4	FEv1.25		CPU+ U35
➔	5	FEv1.2		U33
➔	6	FEv1.2		U33
➔	7	FEv1.2		U33
➔	8	FEv1.2		U33 + U33
➔	9	FEv1.2		U33 + U33
➔	10	FEv1.2		U33
➔	11	FEv1.2		U33 + U23
	12			
	13			
➔	14	FEv1.2		U27 + U23
➔	15	FEv1.2		U33
	16			
➔	17	FEv1.2		U33
➔	18	FEv1.2		U33
➔	19	FEv1.2		U33
➔	20	FEv1.2		U33
	21			
	22			
	23			
	24			
	25			
	26			
	27			
	28			
	29			
	30			
	31			
	32			
➔	33	FEv1.2		U33
	34			
	35			

FEv1.2 rated ≤ 130 mA with a single U33

(18) Beamlines with the original APS Version 1.2 Front End

See Handouts for breakdown of thermal analysis by beamline

Addition of a Second ID on FEv1.2

	Sector	Front End	Beamline RSS	
➔	1	FEv1.2		U33 + U23
➔	2	FEv1.2		U33 + U55
➔	3	FEv1.2		U27 + U27
➔	4	FEv1.25		CPU+ U35
➔	5	FEv1.2		U33
➔	6	FEv1.2		U33
➔	7	FEv1.2		U33
➔	8	FEv1.2		U33 + U33
➔	9	FEv1.2		U33 + U33
➔	10	FEv1.2		U33
➔	11	FEv1.2		U33 + U23
	12			
	13			
➔	14	FEv1.2		U27 + U23
➔	15	FEv1.2		U33
	16			
➔	17	FEv1.2		U33
➔	18	FEv1.2		U33
➔	19	FEv1.2		U33
➔	20	FEv1.2		U33
	21			
	22			
	23			
	24			
	25			
	26			
	27			
	28			
	29			
	30			
	31			
	32			
➔	33	FEv1.2		U33
	34			
	35			

FEv1.2 rated ≤ 130 mA with a single U33

(8) Beamlines restricted to ≤ 100 mA because source power exceeds FEv1.2 capacity

See Handouts for breakdown of thermal analysis by beamline

Thermal Analysis of Beamline RSS Components

	Sector	Front End	Beamline RSS	
	1	FEv1.2		
→	2	FEv1.2	100 mA	Photon Shutter
→	3	FEv1.2	108 mA	Photon Shutter
→	4	FEv1.25	104 mA	Mask
	5	FEv1.2	134 mA	Photon Shutter
	6	FEv1.2	134 mA	Photon Shutter
	7	FEv1.2		
	8	FEv1.2		
→	9	FEv1.2	100 mA	Photon Shutter
	10	FEv1.2		
→	11	FEv1.2	100 mA	WBS
→	12		100 mA	Multiple Components
	13			
→	14	FEv1.2	100 mA	WBS
	15	FEv1.2		
	16			
	17	FEv1.2		
→	18	FEv1.2	100 mA	Mask, WBS
→	19	FEv1.2	100 mA	WBS
	20	FEv1.2	134 mA	Photon Shutter
	21			
	22		136 mA	WBS
	23			
	24			
	25			
	26			
	27			
	28			
	29			
	30			
	31			
	32			
→	33	FEv1.2	100 mA	Mask, WBS
	34			
	35			

(10) Beamlines restricted to 100 mA because power load on thermal components exceeds engineering limits

See Handouts for breakdown of thermal analysis by beamline

Total of (12) Beamlines Restricted to ≤ 100 mA

	Sector	Front End	Beamline RSS	
➔	1	FEv1.2		
➔	2	FEv1.2	100 mA	P9-30 Photon Shutter
➔	3	FEv1.2	108 mA	P5-23 Photon Shutter
➔	4	FEv1.25	104 mA	M7-40 Mask
	5	FEv1.2	134 mA	P5-23 Photon Shutter
	6	FEv1.2	134 mA	P5-23 Photon Shutter
	7	FEv1.2		
➔	8	FEv1.2		
➔	9	FEv1.2	100 mA	P5-23 Photon Shutter
	10	FEv1.2		
➔	11	FEv1.2	100 mA	White Beam Stop
➔	12		100 mA	Multiple Components
	13			
➔	14	FEv1.2	100 mA	White Beam Stop
	15	FEv1.2		
	16			
	17	FEv1.2		
➔	18	FEv1.2	100 mA	Fixed Mask, White Beam Stop
➔	19	FEv1.2	100 mA	White Beam Stop
	20	FEv1.2	134 mA	P5-23 Photon Shutter
	21			
	22		136 mA	White Beam Stop
	23			
	24			
	25			Planned APS-U/ASL Beamline
	26			
	27			2013 APS-U/RIXS Hutch Construction
	28			Planned APS-U/XIS Beamlines
	29			2013 ICX Commissioning
	30			
	31			
	32			
➔	33	FEv1.2	100 mA	M8-30 Mask, White Beam Stop
	34			
	35			2013 DCS Hutch Construction

Due to either Front End or Beamline RSS exceeding APS engineering limits for OFHC or GlidCop

Possible Mitigation

1. Restrict ID gaps
2. Upgrade front ends
3. Re-evaluate limits
4. Replace components
5. Reduce FE apertures
6. Etc…