

# NSLS-to-NSLS-II beamline transition planning



S. Hulbert  
Experimental Systems  
Division, NSLS

NSLS SAC Meeting  
December 13, 2007



# NSLS-to-NSLS-II beamline transition planning: **outline**

---

- **Introduction**

The NSLS-to-NSLS-II transition is unprecedented in its scale and requires detailed planning and close coordination between NSLS and NSLS-II project

- **Goals**

- Ensure a smooth transition
- Realize scientific opportunities offered by the transition
- Minimize potential negative impact

- **Transition elements (interconnected)**

- I. Transition of scientific programs
- II. Transition of beamline/endstation hardware
- III. Transition of user access model
- IV. Transition of staff

# I. Scientific Program Transition

---

## 1. Orienting the scientific program towards NSLS-II

- NSLS five-year strategic plan has identified several broad areas of science that will benefit most from NSLS-II : Nanoscience, Energy, and Imaging

<http://www.nsls.bnl.gov/newsroom/publications/manuals/5YearPlan.pdf>

- Work with existing user community and NSLS scientific advisory committee to develop specific scientific programs within the broad scientific areas, both at NSLS now and for transition to NSLS-II later
- Provide active outreach to the new user community

# I. Scientific Program Transition (cont.)

---

- Develop long range white papers in major program areas to translate the scientific challenges to an overall plan for beamline/endstation upgrades at NSLS, and new beamline/endstation proposals at NSLS-II
- Near-term activities
  - NSLS scientific strategic planning workshops in 2008
    - Hard Condensed Matter and Materials Physics
    - Materials Science and Engineering
    - Chemical and Energy Sciences
    - Soft Condensed Matter, Biophysics, and Liquids
    - Life Sciences
    - Earth and Environmental Sciences
  - NSLS DOE review in late April 2008
  - NSLS SAC meetings in December 2007 and spring 2008
  - Major revision of the NSLS strategic plan

# I. Scientific Program Transition (cont.)

---

## 2. Transition of Research Resources/consortia and PRTs

- Research Resources and PRTs are responsible for many scientific programs at the NSLS
- Work with research resources, such as PXRR, Case Center for Synchrotron Biosciences, COMPRES, Catalysis consortium, on their program renewals
  - evolution of their scientific programs and their role in operating beamlines
- Work with PRTs on their long term plans and transition plans
- Near-term activities
  - NSLS SAC beamline reviews in spring 2008
  - DOE review of NSLS in late April 2008

# Consortium example: COMPRES

---

- Consortium for Materials Properties Research in Earth Sciences (COMPRES), an organization that facilitates the operation of high-pressure beamlines for earth science research, including four beamlines at the NSLS, was renewed through the National Science Foundation
- The five-year, \$11.5 million cooperative agreement took effect on May 1, 2007. The funding total includes more than \$4 million for the operation of NSLS beamlines X17B2, X17B3, X17C, and U2A
- Partnership between NSLS and COMPRES
  - Leverage investment: NSLS on beamline, COMPRES on endstations; joint hire between Stony Brook mineral physics institute and NSLS
  - COMPRES played an important role in developing a white paper for high pressure research at NSLS-II and organizing a NSLS-II user workshop breakout session
- An area that will benefit from the properties of NSLS-II; plans for transition of beamlines/endstations/programs to NSLS-II

# II. Beamline/Endstation Transfer

---

## 1. Rationale

- Ensure significant capacity for NSLS-II at the commencement of operation to accommodate the large number of users from NSLS
- NSLS-II large gap dipoles (for far-IR), soft bends, and three-pole wigglers are world-class sources for many experimental techniques
- Many NSLS beamlines, with proper upgrades funded by DOE and other agencies, will be state-of-the-art for these sources
- Commissioning and use of the upgraded hardware at NSLS prior to transfer to NSLS-II will save valuable commissioning time
- Recommended by Lehman CD-1 review and NSLS-II Experimental Facility Advisory Committee (EFAC)
- Supported by DOE/BES

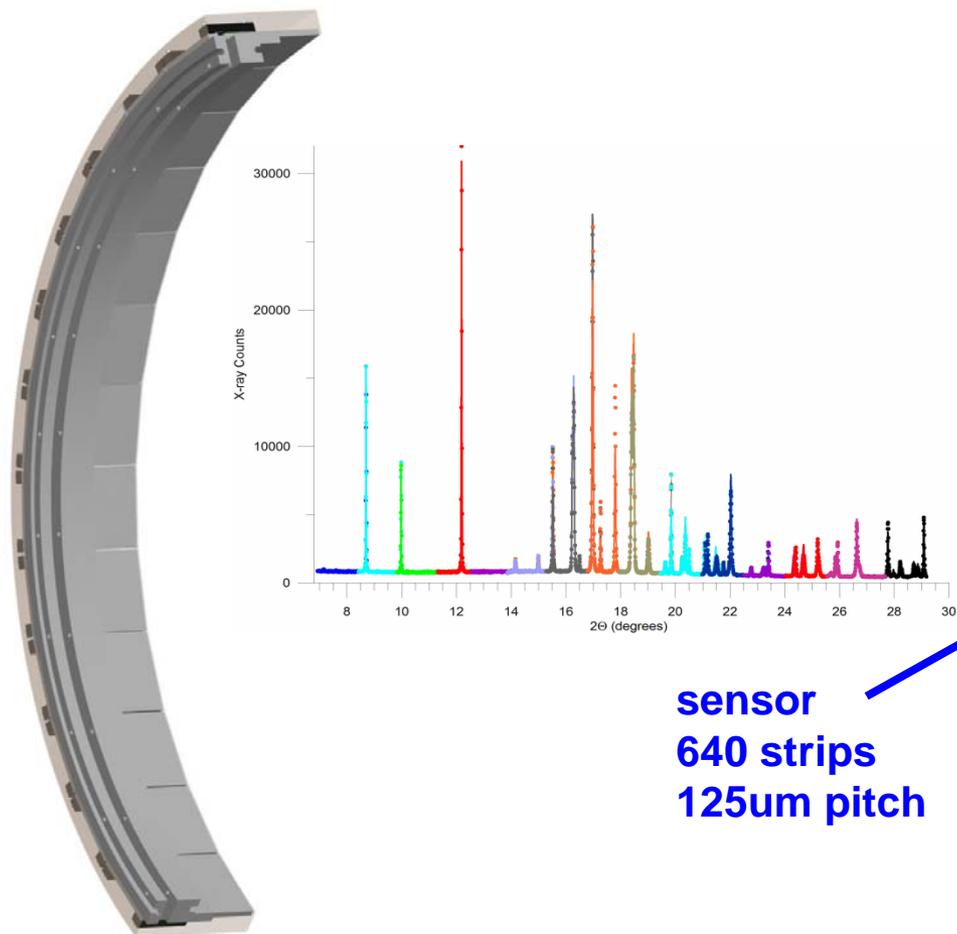
# II. Beamline/Endstation Transfer (cont.)

---

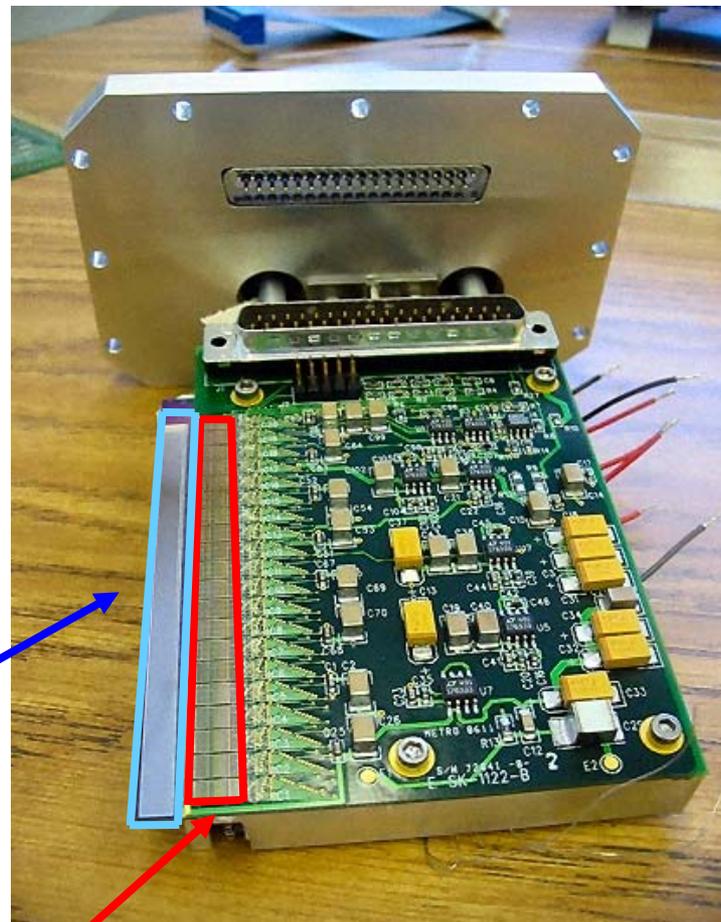
## 2. Examples

- IR beamlines: World-class at NSLS and NSLS-II
- High demand / high throughput materials characterization or screening beamlines, such as x-ray absorption spectroscopy, x-ray powder/single crystal diffraction
- State-of-art beamlines that do not require the brightness of insertion devices, such as full-field x-ray microscopy
- State-of-the-art endstations or beamline components that are suitable for insertion devices at NSLS-II

# Example: Powder Diffraction Beamline



sensor  
640 strips  
125um pitch



20 ASICs  
low-noise preamp  
+ discr. + counter

Courtesy of Siddons, Stephens,  
Kuczewski, Pjerov

# II. Beamline/Endstation Transfer (cont.)

---

## 3. Mechanism (proposed)

- A letter of interest (LoI) will be required for transfer of any PRT or facility beamline
  - Example 1: Full beamline and financial resources for the move (to form basis for Partner User access at NSLS-II)
  - Example 2: Endstation only (to form basis for Partner User access at NSLS-II, on a smaller scale than Example 1)
  - Example 3: Can express interest in a particular capability at NSLS-II, without hardware to transfer (GU access at NSLS-II)
- NSLS-II EFAC will perform review
- Upon EFAC approval, proceed with Beamline Advisory Team (BAT) and planning for beamline/endstation upgrades, including seeking funding

# II. Beamline/Endstation Transfer (cont.)

## 4. Beamline transfer working group (BTWG)

- The BTWG, led by S. Hulbert, has been established at NSLS
- Current (Feb. '08) membership: L. Berman, L. Carr, Z. Zhong, D. Fischer, J. Hill, A. Broadbent
  - Representation from NSLS, NSLS PRTs, NSLS UEC, and NSLS-II
- Involvement and communication: Work with NSLS Science Division, NSLS Management, PRTs, UEC, and NSLS-II on **evolution** and **transition** of beamline scientific programs and staff; open and frequent communication among all these stakeholders is crucial
- Scope of work:
  - **Identify** the types of beamlines and endstations which are most suitable to be transferred, and to which type of NSLS-II source (ID, bend, 3PW, IR)
  - **Perform** detailed analysis of the performance of these beamlines/endstations; **determine** necessary upgrades for these beamlines to match NSLS-II sources
  - **Coordinate** major NSLS facility beamline/endstation upgrades
  - **Perform** detailed analysis of cost and schedule for all beamline transfers, after EFAC approval
  - The BTWG meets weekly, has key short-term deliverables (e.g. the Strategic Planning Workshops, Jan.-Feb. 2008) and commitment to long-term effort until the transfer process is complete

# II. Beamline/Endstation Transfer (cont.)

---

## 4. Beamline transfer working group (BTWG) (con'd)

### Progress and conclusions to date:

- BTWG has discussed transition plans and issues with nearly all NSLS PRT spokespersons (and in many cases with their local staffs)
- Some PRTs, but not many, are interested in upgrading entire beamlines and endstations for transfer to NSLS-II
  - BUT, they have important access issues to discuss/overcome
- Most PRTs that expect to survive until 2014-5 are interested in upgrading their endstations and the associated techniques, software, scientific programs, and research groups for transfer to NSLS-II.

# II. Beamline/Endstation Transfer (cont.)

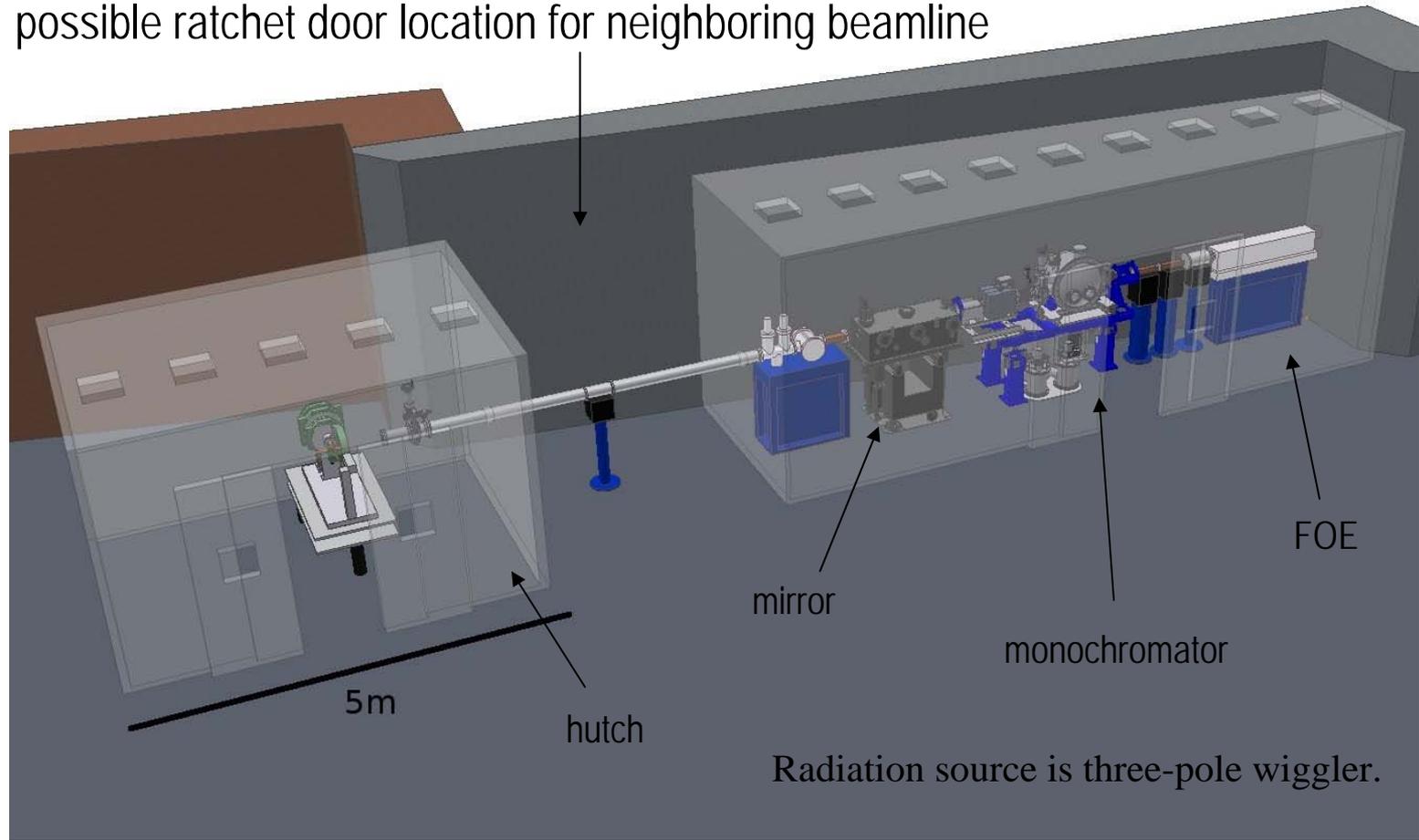
---

## 5. Transition of beamline optics : overview by photon energy

- **Far- and mid-IR** : specialized (new) extraction and relay optics; move FTIR benches/endstations (~half the cost)
- **UV**: specialized (new) extraction, relay optics, and monochromator; move endstations
- **VUV**: need VUV insertion device, new optics and monochromator; move endstations
- **Soft** (0.1 to 3 keV) and **tender** (2 to 6 keV) x-ray: use soft bends; requires new matching optics; move monochromators and endstations.
- **Hard x-ray**: use three-pole wigglers; move entire beamlines (maintain magnifications of focusing mirrors) and endstations
- **Very hard x-ray**: requires SCW (transition possible if planned correctly); move entire beamlines (sagittal focusing Laue optics have adjustable focal lengths) and endstations

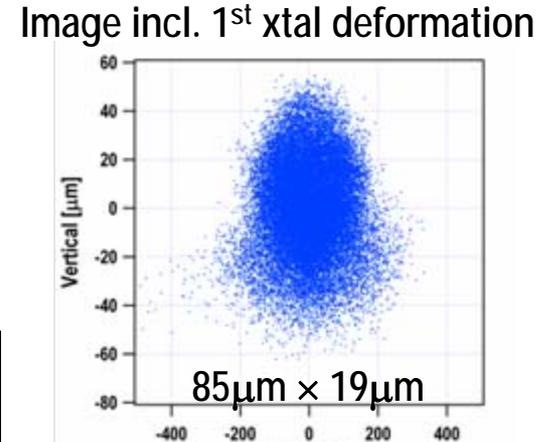
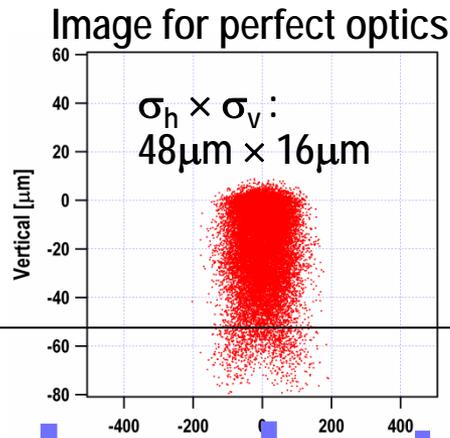
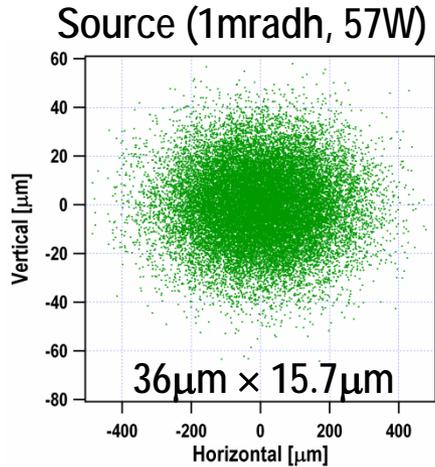
# Example: Layout of X25 moved to NSLS-II 3-pole wiggler

possible ratchet door location for neighboring beamline



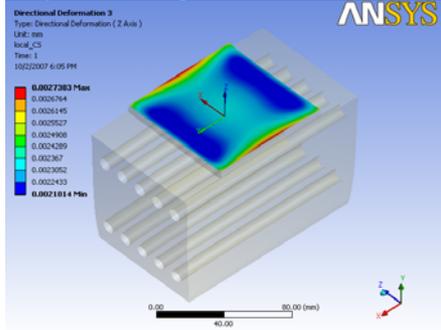
Courtesy of Mary Carlucci-Dayton and Scott Coburn

# Performance of X25 Beamline on NSLS-II 3-pole Wiggler

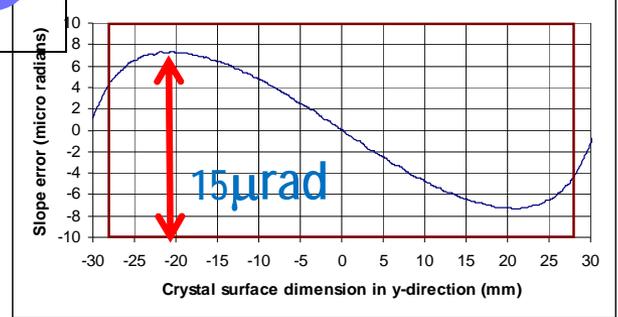
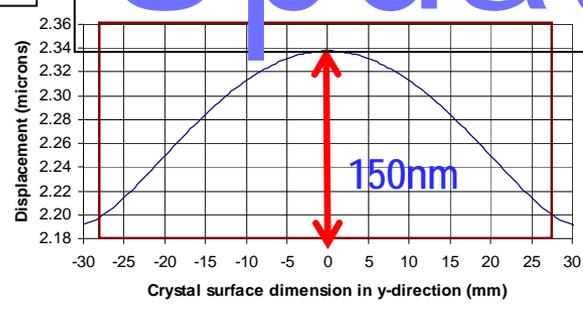


Update

1<sup>st</sup> crystal deformation



Optical layout: mono 30m mirror 34m, sample 39.1m (from source):  
sagittal demag. 3.5:1 mono, tangential demag. 6.6:1 (mirror)



**Conclusion:** existing X25 monochromator cooling is acceptable for NSLS-II 3PW source. **Mitigating measure:** re-design of the 1<sup>st</sup> crystal and its support.

# Performance of X25 Beamline on NSLS-II Damping Wiggler

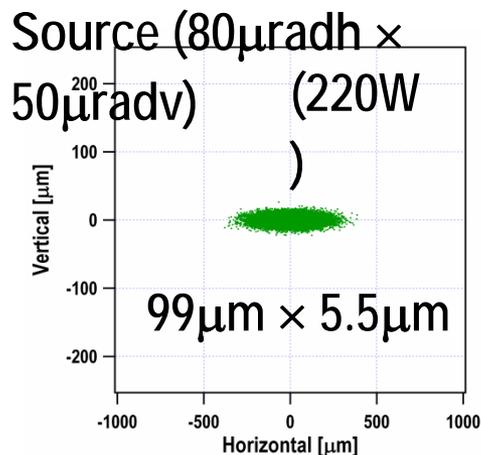


Image for perfect optics

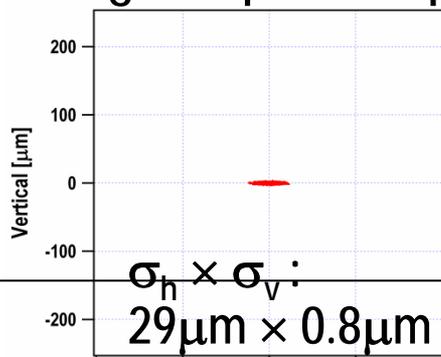
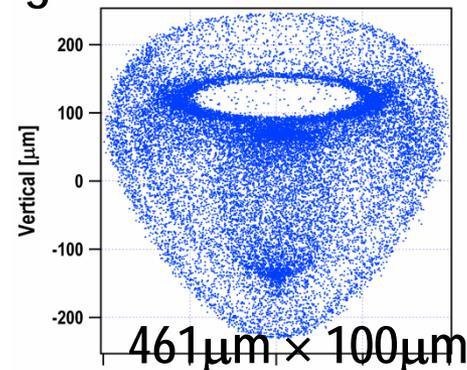
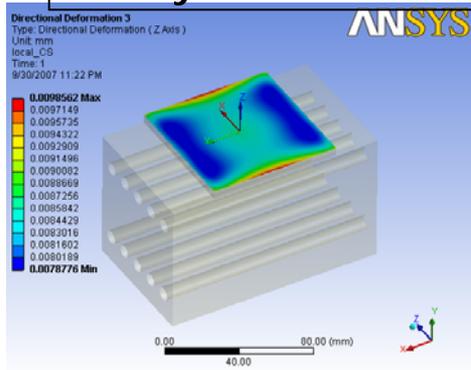


Image incl. 1<sup>st</sup> xtal deformation

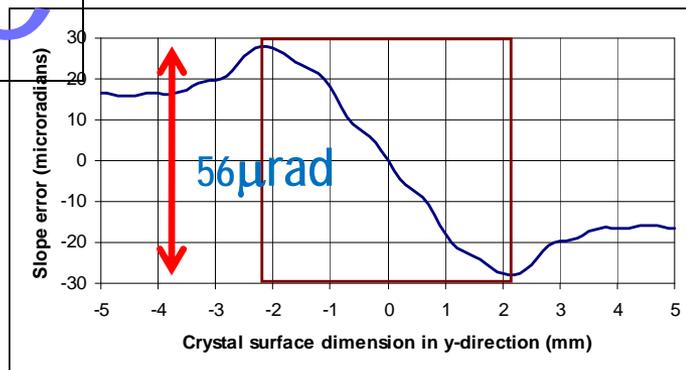
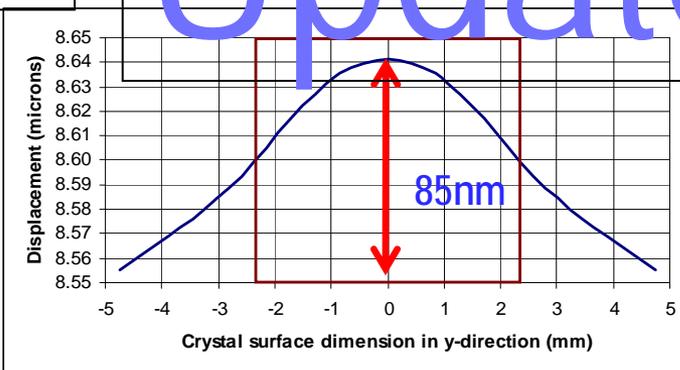


1<sup>st</sup> crystal deformation



Optical layout: mono 9m mirror 34m, sample 39.1m (from source): sagitta demag. 3.3:1 mono tangential demag. 6.6:1 (mirror)

Update



**Conclusion:** (i) existing X25 monochromator cooling is *not* desirable for NSLS-II DW source. **Mitigating measures:** (i) graphite, Be low-hv filters, (ii) direct cryogenic cooling of

# Beamline Transition Plan: strawman exercise

---

- 1) Each of the existing beamlines at the NSLS, grouped by technique, was evaluated in terms of technical suitability for moving to a soft bend, a 3-pole wiggler, or an insertion device at NSLS-II.
- 2) Moving costs and costs associated with upgrading equipment to be suitable for NSLS-II were estimated (under the assumption that beamlines planned to be moved would be maintained at close to state-of-the-art in the interim).
- 3) The productivity (number of publications and premier publications) and user demand (beamtime hours requested) of the existing NSLS beamlines were evaluated.
- 4) From this list, and the technical and cost considerations, a suite of bending magnet beamlines were identified that would support the largest number of users with the greatest scientific impact.

# Strawman list of beamlines for upgrading and moving, page 1

Beamline	Technique	Movability comments	Organization	NSLS-II Source	Upgrade cost (k\$) *	Std. cost (k\$) *	Notes
U2A	IR-spect. (hi-P)	yes	NSLS	large gap dipole	100	997.6	FTIR bench only; new controls
U2B	IR-imaging	yes	NSLS	soft bend	100	997.6	FTIR bench only; new controls
U4B	MCD	yes	NSLS	soft bend	600	1396	need new first KB mirrors
U7A	NEXAFS	no, but NIST upgrading	PRT-NIST	Bend	500	1396	new KB first mirrors; move X1B soft x-ray beamline
U10B	IR-imaging	yes	NSLS	soft bend	100	997.6	FTIR bench only; new controls
U12IR	far-IR spect	yes	NSLS	large gap dipole	100	997.6	FTIR bench only; new controls
X1A	soft x-ray imaging	endstation	PRT-SUNYSB	soft bend	400	1396	new first two mirrors
X6A	PX	yes	NSLS	3-pole wiggler	400	1427	new mirror
X7B	Powder/PDF	yes	PRT-BNL-chem	3-pole wiggler	800	1427	two new mirrors
X11A	EXAFS	yes	PRT-SB, NRL	3-pole wiggler	600	1427	new mono and new controls
X14A	Powder	yes	ORNL	3-pole wiggler	800	1427	two new mirrors
X15A	DEI, optics	endstation	NSLS	3-pole wiggler	300	1427	white beam hutch
X17B	high-E	yes	NSLS	SCW	100	2500	more expensive FOE for SCW; SCW cost not incl.; new controls
X17C	high-E	yes	NSLS	SCW	100	2500	more expensive FOE for SCW; SCW cost not incl.; new controls
X18B	hard -EXAFS	yes	NSLS	3-pole wiggler	440	1427	new mirror
X19A	tender- and hard-EXAFS	yes	NSLS	3-pole wiggler	740	1427	two new mirrors

red = Facility Beamline

\* Direct, unescalated FY07 dollars

# Strawman list of beamlines for upgrading and moving, page 2

Beamline	Technique	Movability comments	Organization	NSLS-II Source	Upgrade cost (k\$) *	Std. cost (k\$) *	Notes
X19C	white beam topography	endstation only	PRT-SUNYSB	3-pole wiggler	400	1427	new white beam transport, shutter, and white beam hutch
X20A/X13B	microdiffraction	endstations only	PRT-IBM/NSLS	3-pole wiggler	900	1427	KB + mono
X21	X-ray scattering, magnetic, in-situ growth	yes	NSLS	3-pole wiggler	350	1427	new mirror
X22C	hard x-ray scattering	yes	PRT-BNL physics	3-pole wiggler	400	1427	upgrade mono
X25	PX	yes	NSLS	3-pole wiggler	0	1427	rebuilt beamline is NSLS-II-ready
X26A	Microprobe	yes	PRT-Geo-Cars	3-pole wiggler	250	1427	move best hardware from X26A, X27A; new KB mirrors
X27C	SAXS	yes	PRT-SUNYSB	3-pole wiggler	250	1427	New KB mirrors
X29	PX	yes	PRT- BNL Biology	3-pole wiggler	400	1427	new mirror needed

Totals: 9130 34583.4 43713.4

red = Facility Beamline

\* Direct, unescalated FY07 dollars

# Estimated costs for moving beamlines (not incl. IR)

Item	Labor	\$k	Notes	Comments
Disassembly, moving and reassembly	4.1 FTEs	500	NLSL spreadsheet for X9-X3 move	
Engineer for above	0.5 FTE	70		
Scientist to supervise above	0.5 FTE	70		
FOE @NLSL-II		119	from CED for soft bend	3-pole wiggler FOE > soft bend FOE; estimate 150k\$ for 3-pole wiggler FOE
NLSL-II PSS		48	from CED	
NLSL-II EPS		59	from CED	
NLSL-II BM Front End		300	per Sushil Sharma	
Additional hardware (beampipes, pumps, valves, windows, cabling...)		200	Estimate based on past experience	incl. possible cleaning of UHV hardware for non-windowed beamlines
2nd (redundant) photon shutter (assuming required)		30	from CED	if existing primary shutters are not NLSL-II compatible, new ones will be needed
<b>Costs per beamline</b>	<b>Total</b>	<b>1396</b>		

red = Facility Beamline

\* Direct, unescalated FY07 dollars  
20

# Estimated costs for moving IR beamlines

Item	CDR section	\$k	Notes
Extraction	2.5.12	295.0	Does this include the 1st in-ring mirror?
PPS	2.5.X.7	3.5	
Extraction Commissioning	2.5.13	1.5	
IR Beamline, incl. relay optics	2.5.15	250.0	Estimate based on past experience
Front End (includes EPS)		210.7	
Hutch enclosures	2.5.X.1	30.6	
Beam transport	2.5.X.2	32.3	
Utilities	2.5.X.3	34.0	
Engineer for above	0.5 FTE	70	
Scientist to supervise above	0.5 FTE	70	
<b>Costs per beamline</b>	<b>Total</b>	<b>997.6</b>	

red = Facility Beamline

\* Direct, unescalated FY07 dollars  
21

# Possible distribution of beamlines to be moved from NSLS to NSLS-II

Technique	NSLS-II source	# at NSLS-	
		II	# at NSLS (FY2007)
Far-IR spectroscopy	large gap IR	2	2
Mid-IR spectromicroscopy	standard IR	2	2
Soft x-ray MCD	soft bend	1	2
Soft x-ray spectroscopy	soft bend	1	6
Soft x-ray imaging	soft bend	1	2
X-ray macromolecular crystallography	3-pole wiggler	3	8
Tender x-ray spectroscopy	soft bend	1	3
X-ray spectroscopy	3-pole wiggler	2	7
X-ray powder diffraction	3-pole wiggler	2	6
X-ray micro-diffraction	3-pole wiggler	1	1
X-ray scattering	3-pole wiggler	2	8
X-ray imaging	3-pole wiggler	2	4
X-ray microprobe	3-pole wiggler	1	3
SAXS	3-pole wiggler	1	3
Very hard x-ray	SCW	2	4
<b>Totals</b>		<b>24</b>	<b>61</b>

# Soft x-ray beamlines: possible distribution

## Candidate soft x-ray undulator beamlines at NSLS-II

Technique	NSLS-II source	# at NSLS-II	# at NSLS (FY2007)
Coherent soft x-ray	EPU45	1	0
STXM	EPU45	1	2
Soft x-ray scattering/RIXS	EPU45	1	1
High res'n soft x-ray spectroscopy/XPS	EPU45	1	0
<b>Totals</b>		<b>4</b>	<b>3</b>

## Transition to soft bending magnet beamlines

Technique	NSLS-II source	# at NSLS-II	# at NSLS (FY2007)
Soft x-ray MCD	soft bend	1, 2?	2
Soft x-ray spectroscopy	soft bend	1, 2?	6
Soft x-ray imaging (STXM, TXM)	soft bend	2	2
Tender x-ray spectroscopy	soft bend	1,2?	3
<b>Totals</b>		<b>5, 8?</b>	<b>13</b>

# NSLS Beamline Transition plan: summary

- 24 beamlines were identified, covering the following techniques
  - Far-IR spectroscopy; mid-IR spectromicroscopy; soft, tender, and hard x-ray spectroscopy; MCD; soft and hard x-ray imaging; microprobes, powder diffraction; microdiffraction; scattering; SAXS; macromolecular crystallography; and very hard x-ray scattering.
- Cost includes (no operating costs)
  - New optics req'd to match NSLS-II source and/or layout (mirrors, crystals, gratings)
  - Disassembly, moving and reassembly (based on recent X9-to-X3 move at NSLS)
  - Front end, First Optics Enclosure, PSS, and EPS at NSLS-II
  - Design support
  - Additional hardware (beampipes, cabling, windows and photon shutters).

Total transition cost = ~\$45M (direct, FY07 dollars)

# NSLS Beamline Transition plan: schedule

---

- Perform the beamline/endstation hardware upgrades prior to 2014. Ideally, the entire suite of beamlines/endstations to be transferred to NSLS-II is ready to go in 2014. This requires appropriate level of resources at NSLS.
- Based on the X9A/B-to-X3A/B move project, we estimate 4 FTEs req'd to move one beamline from NSLS to NSLS-II in 4-6 months (assume 0.5 year).
- For transfer of ~20 beamlines at the same time (schedule-ideal, resource-blind case), need  $20 \times 4 = 80$  FTEs / 0.5 year = 160 staff (!) for 0.5 years, or 80 staff for 1 year, 40 staff for 2 years, or 20 staff for 4 years.
- Existing NSLS technical (mech. and elect.) and engineering staff for this effort: ~16 staff. Solution is a combination of: increasing permanent staff (they'll be needed for beamline operations after the transition) and contract labor. Aim for a peak manpower resource of 40 staff = 2 year overall effort to transfer 20 beamlines.
- Begin as soon as beneficial occupancy is granted. Stagger the transfer of same-technique beamlines, to provide continuity through the transition period.

# III. Transition of User Access Mode

---

- Almost all beamlines at the NSLS were operated by PRTs until recently. PRTs have contributed significantly to the success of the NSLS
- Working closely with BES, the number of facility beamlines has increased over the last few years. Today, 17 out of 65 beamlines are facility beamlines
- Working under the new NSLS user access policy, a Contributing User (CU) program has been established to provide another mechanism to attract the investment, both intellectual and financial, from the scientific community at large. Today, 12 CU groups are working with the NSLS at our facility beamlines.

# III. Transition of User Access Mode (con'd)

---

- With increasing NSLS operating funding expected from American Competitive Initiative, we hope to increase the number of staff at the existing facility beamlines and to expand the number of facility beamlines
- We will work with PRTs to make the transition to either Contributing Users or General Users
- Discussions with individual PRTs on all aspects of this transition has begun

# IV. Staff Transition

---

- The dedication and talent of the NSLS staff are essential to the success of the NSLS and will be to the success of NSLS-II
- We have re-organized the department recently (April 2007) to better position the staff for the future. The organization will continue to evolve to meet changing needs
- Staff transfers between NSLS and NSLS-II are coordinated closely to ensure that both facilities can meet their short term goals
- NSLS is working with NSLS-II to develop a long term staff planning to address staff concerns
- NSLS will also work with PRTs on their staffing issues

# Summary

---

- Transition from NSLS to NSLS-II is an important and complex task that requires detailed planning and close coordination between NSLS and NSLS-II project
- We have identified the scope and begun to develop a comprehensive plan, including estimates of cost and schedule
- Steady increase of NSLS staff is essential to ensure the success of this transition