Informal Response to Jihua Chen's

Whitepaper: A proposal for establishing DAC experimental station at NSLS-II

Mark Rivers
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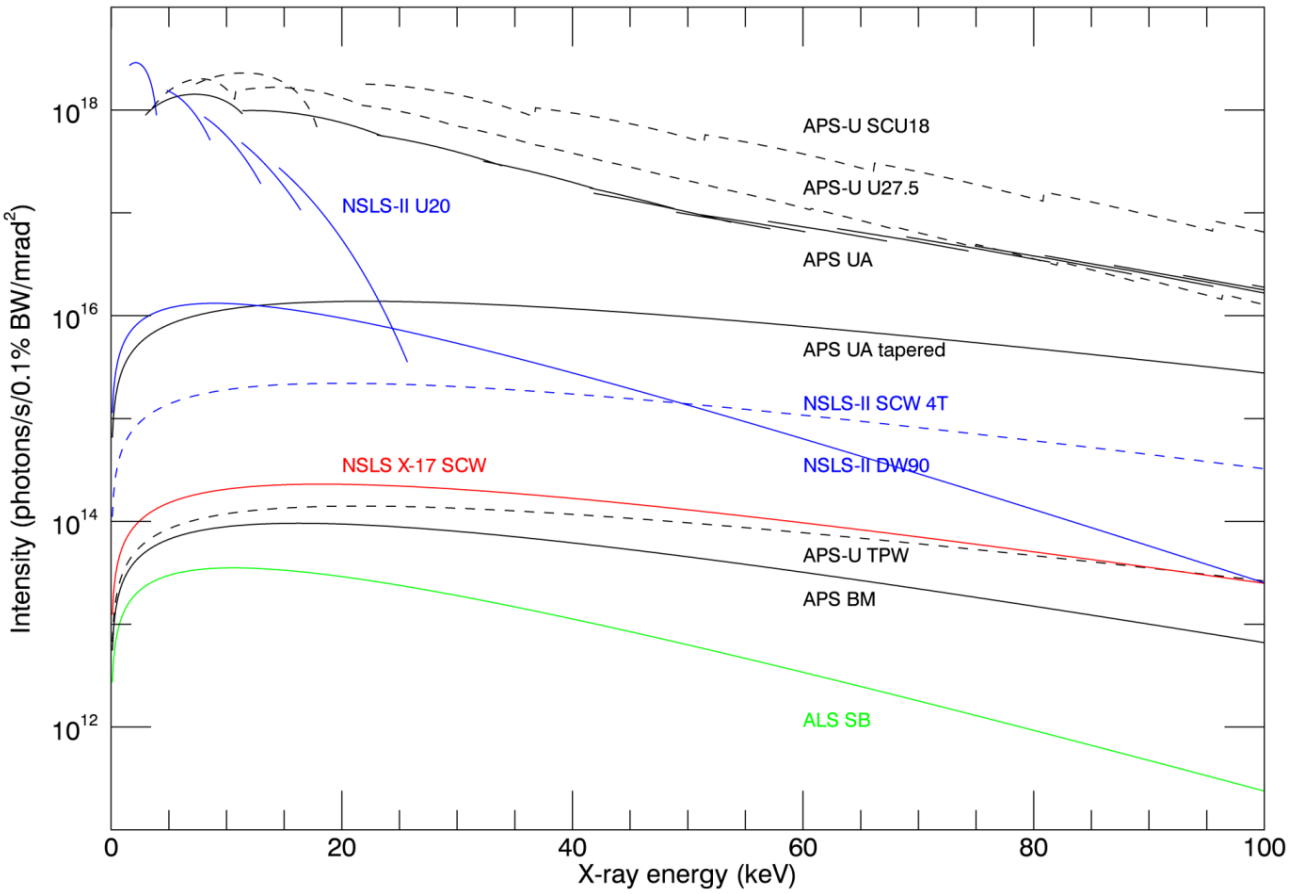
This document is my personal informal response to the whitepaper that Jihua Chen sent me on June 25, 2017. It does not necessarily reflect the opinions of the COMPRES Facilities or Executive Committees.

One of the strengths of this proposal is that it envisions support from HPSTAR and FIU in addition to COMPRES. This reduces the costs for COMPRES considerably. A second strength is that it envisions not just using XPD, but also other NSLS-II beamlines, including CHX, HXN, SRX and IXS. These other beamlines are developing unique capabilities that the diamond anvil cell community may want to exploit. Time on these beamlines would be allocated, at least initially, through the General User Program, not through a Partner User Proposal. The advantage of the proposed support is that there would be on-site staff to facilitate high-pressure experiments on beamlines that were not constructed with high-pressure experiments in mind.

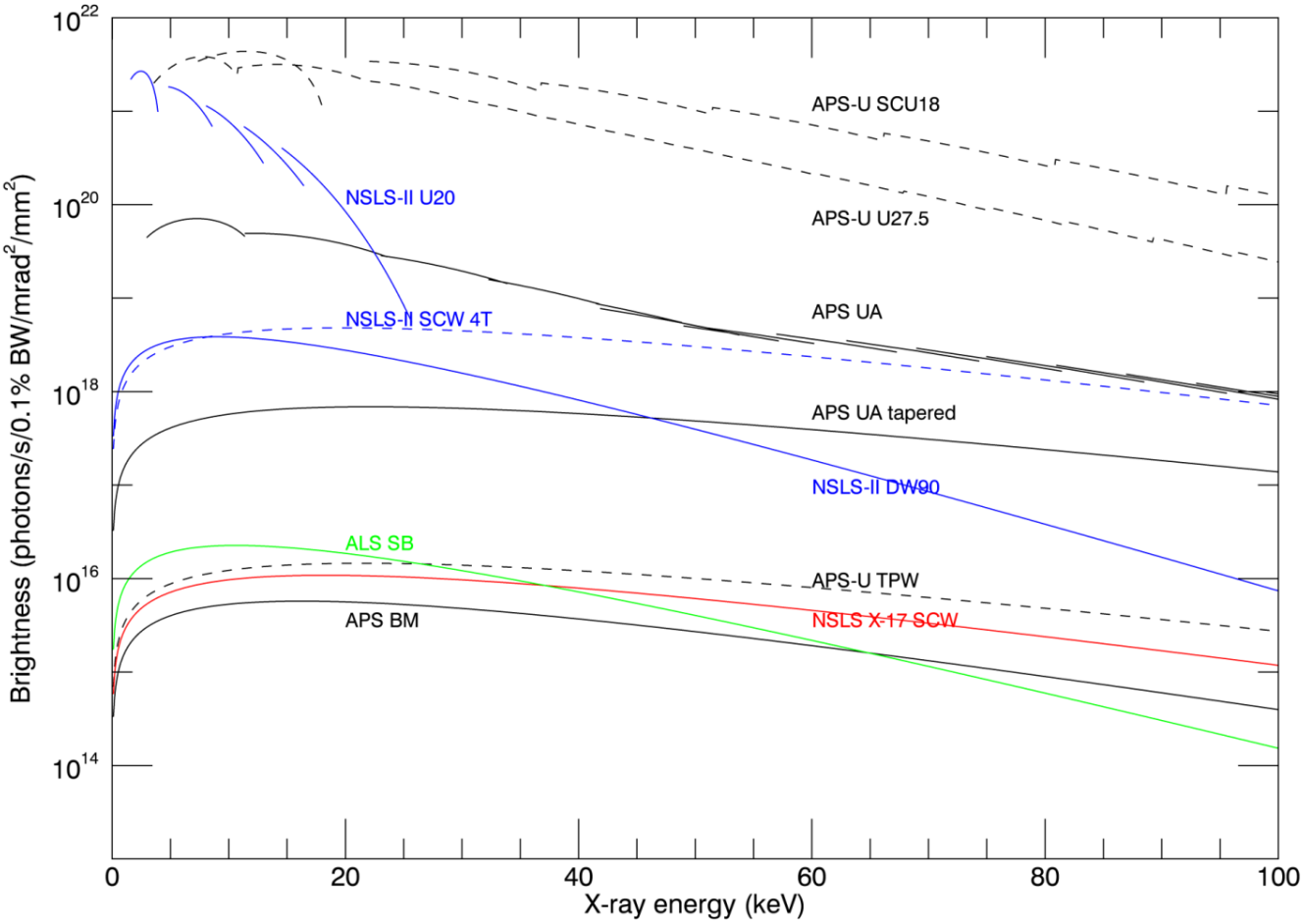
The following figures shows the intensity and brightness of a number of beamlines where DAC experiments have been conducted in the past, are conducted now, or may be conducted in the future. The following table lists the labels used in the plots and corresponding source descriptions.

Past sources	
NSLS X-17 SCW	NSLS-X17 superconducting wiggler
Current sources	
ALS SB	ALS superbend beamline 12.2.2
APS BM	APS bending magnet
APS UA	APS 33mm period undulator untapered
APS UA	APS 33 mm period undulator tapered
NSLS-II U20	NSLS-II 20mm period undulator at HXN
NSLS-II DW90	NSLS-II 90 mm period damping wiggler at XPD
Potential future sources	
NSLS-II SCW 4T	NSLS-II 4 tesla superconducting wiggler at HEX
APS-I U27.5	APS upgrade 27.5 mm period normal undulator
APS-U SCU18	APS upgrade 18 mm period superconducting undulator
APS-U TPW	APS upgrade three pole wiggler

Intensity is flux per solid angle, and is the appropriate figure of merit for beamlines without focusing, or where the focusing is far from preserving the source brightness. The important energy range for DAC experiments is generally between 20 and 80 keV. It can be seen that the NSLS-II XPD source is ~10-100 times higher intensity than the ALS superbend, APS bending magnet, and X-17 superconducting wiggler. It is ~100 times lower intensity than the APS undulators.



The following figure shows the brightness of the same beamlines shown in the previous figure. Brightness is flux per solid angle per source size, and is the appropriate figure of merit for beamlines with focusing. It can be seen that the NSLS-II XPD source is ~100 times brighter than the ALS superbend, APS bending magnet, and X-17 superconducting wiggler. It is ~10-100 times less bright than the APS undulators today, and 1000 times less bright than APS undulators after the upgrade.



The following table compares the beamlines in the U.S. where DAC experiments are run for a significant fraction of the time. I have estimated the fraction of time that COMPRES users would be able to compete for on each beamline. In the case of APS sector 16 (HP-CAT) the remaining 75% of the time is for the HP-CAT members. In the case of APS sector 13 (GSECARS) the remaining time is used for running other techniques.

Beamline	% of time available for COMPRES DAC	Laser heating	Specialty Techniques
APS 3-ID	50%	Yes	Nuclear resonance; inelastic scattering
APS 13-BM-D	50%	No	Brillouin
APS 13-BM-C	75%	In commissioning	Single crystal
APS 13-ID-D	50%	Yes	X-ray emission
APS 16-ID-B	25%	Yes	Cryostats
APS 16-ID-D	25%	No	Nuclear resonance; inelastic scattering
APS 16-BM-D	25%	No	Cryostats
ALS 12.2.2	80%	Yes	Radial diffraction; single-crystal

Here are some questions that I think would need to be answered in proposal to COMPRES to develop a DAC station at NSLS-II XPD.

1. The table above shows that most DAC beamlines offer one or more specialty techniques. What would be the specialty techniques at XPD? I guess they would probably include total scattering (PDF) since that is something that Lars Ehm is very interested in. Would there be others?

2. Would it include online laser heating? If so, who would be in charge of getting that working? In the past COMPRES purchased equipment for laser heating to be installed at NSLS X-17B3. This included a fiber laser, spectrometer, and optics. Where is this equipment, and is it available for use at NSLS-II?

3. Who are the major potential users of the facility? It is important to identify a core set of users who view the NSLS-II facility as critical to their research. These would need to be members of the COMPRES community, i.e. users from US whose research is focused on earth science problems.

4. What is the management plan? Who will be local to the NSLS-II to keep the project on track? Who will provide the scientific driving force?

5. What capital equipment expenditures will be required to produce a competitive DAC station? The K/B mirrors from NSLS are old, and not well suited to producing a good focus from the NSLS-II source. What detectors will be used, and do they need to be purchased? If laser heating is to be offered then the cost of any missing items (see question 2) needs to be considered. What exists and what needs to be purchased for the sample translation system, optical viewing system, etc.?

6. What fraction of time can COMPRES DAC users be guaranteed, and what is the maximum amount of time they might realistically be expected to receive if they write excellent General User Proposals?