NSLS-II Site Visit Report

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COMPRES held a site visit of the COMPRES-supported user facilities at NSLS-II on August 24-25, 2015. The review included both the multi-anvil cell and diamond anvil cell X-ray programs at XPD (Weidner and Ehm, PIs) and the diamond anvil cell infrared program at FIS (Hemley and Liu, PIs). COMPRES President-elect Carl Agee also attended the site visit. The review was initiated following a request from a subset of the PIs for a site visit following a COMPRES committee recommendation to defund personnel support for the diamond anvil X-ray program. The charge for the site visit (Appendix 1) included a comprehensive review of beamline capabilities and management, with the aim of ensuring that COMPRES continues to best serve the research interests of its constituent members following the transition from NSLS to NSLS-II. The site visit agenda (Appendix 2) consisted of presentations from NSLS-II management and COMPRES PIs, as well as representatives of several other beamlines and BNL facilities representing activities of a potential 'High Pressure Village' centered at NSLS-II.

This report describes the outcome of our site review, with additional feedback solicited from users of the COMPRES-supported NSLS facilities by XPD management (Appendix 3) and by the Site Visit Team (Appendix 4). The three COMPRES user facilities are considered separately: the diamond anvil cell infrared program at FIS, the multianvil cell program at XPD, and the diamond anvil cell program at XPD. Each section addresses the items listed in the charge (Appendix 1), and is summarized by a prioritized list of recommendations.

FIS

The Frontier Infrared Spectroscopy (FIS) program, led by PIs Rus Hemley and Zhenxian Liu, is a continuation of the long-running high-pressure infrared spectroscopy program at beamline U2A of the NSLS. U2A, like the rest of NSLS, ceased operations in September 2014. FIS will share the sole infrared beamline at NSLS-II with the MET program, each running 50% of the time. This is a reduction from the 100% beamtime share enjoyed by U2A, but the FIS source promises greater intensity (up to an order of magnitude, depending on wavelength) and much greater stability (100x). There is a possibility of upgrading the IR sector at FIS/MET by adding an additional extraction from the storage ring, allowing both beamlines to operate simultaneously 100% of the time. The estimated cost for this upgrade is $1.2M.

FIS promises performance and usefulness to the COMPRES community that should exceed that of U2A; it is highly desirable to maintain this facility within COMPRES. However, as part of the NxtGen set of NSLS-II beamlines, FIS will not be available for users until at least 2018 by the current schedule. Its construction could be accelerated if money targeting its completion becomes available sooner. This date for beam availability slipped sporadically during the run-up to NSLS-II (this slippage is not specific to the FIS beamline). The challenges facing COMPRES at this stage are (1) how to continue to meet user demand for a high-pressure IR program during the IR dark period between U2A and FIS; (2) failing that, how Zhenxian Liu should be deployed to justify his COMPRES support; and (3) failing that, how to reduce or eliminate support to Liu and still maintain community access to FIS after the IR dark period.

The high-pressure infrared program at U2A was a world-class facility, with no competition among U.S. synchrotrons. Its spectroscopic capabilities spanned the near- to far-infrared, and also included user facilities for visible-NIR spectroscopy and Raman spectroscopy. Zhenxian Liu highlighted in his presentation the many scientific and technical 'firsts' that were achieved at U2A over its lifetime. Although there was a heavy materials science and solid-state physics component to its output, U2A publications also included a strong component of Earth and planetary science, consistent with COMPRES' mission. Users have praised the helpfulness and experience of beamline scientist Liu.

Liu and Hemley plan to continue operating the IR facility as an offline user facility at NSLS-II during the IR dark period. Currently, the equipment from U2A is located in lab space at NSLS-II, and can be operated using a conventional (globar) source even in the absence of a synchrotron source. This will cause a reduction in intensity by 2-3 orders of magnitude, and far-IR will not be obtainable. This plan of operating the IR facility may be a suitable stopgap measure during the IR dark period, although it is difficult to predict the amount of COMPRES user demand for such a facility. Logistical barriers at NSLS-II remain, in that the IR laboratory needs to be identified as a user facility by NSLS-II management before outside users can have access. It is anticipated that this hurdle might soon be overcome; apparently stimulated by the COMPRES Site Visit, Paul Zschack was scheduled to visit the IR laboratory and meet with Zhenxian Liu on Aug. 27, with the expectation that the IR lab would obtain user facility status soon afterward. Currently this access is still on hold, pending further review at BNL/NSLS-II. If, for management reasons, development of the offline IR lab does not occur, then it will be necessary to reassess the COMPRES NSLS-II-IR enterprise.

A second measure initiated by Liu and Hemley to maintain high pressure IR capability during the IR dark period is an Approved Program (AP) proposal that has successfully obtained beam time at ALS beamline 1.4.2 (which otherwise does not support diamond anvil cell users). This AP was written mainly to support Liu, Hemley and their collaborators' research, and not to serve the COMPRES user base (indeed, their AP proposal does not mention COMPRES). However, with the high pressure capability established at ALS 1.4.2, COMPRES users could also request General User (GU) time at 1.4.2, and Liu has agreed to coordinate with beamline management to ensure his presence to support GU COMPRES users in their high pressure experiments. The ALS 1.4 source has similar brightness, although greater noise, compared to U2A in the mid-IR, but is ~10x less bright in the far IR. This program does offer another opportunity for COMPRES users to obtain synchrotron IR during the NSLS/NSLS-II IR dark period, but again it is difficult to anticipate the user demand. Additionally, it requires travel funding for Liu to be present to support COMPRES users, and currently there is insufficient budget for that.

Given the circumstances, the FIS management (Hemley and Liu) have put forward a reasonable plan to try to provide high pressure IR capability during the synchrotron dark period. It remains to be seen how their COMPRES user base will respond. The Site Visit Team emphasized the need to publicize both the offline IR facility and the ALS 1.4.2 program to encourage COMPRES users to take advantage of them.

User experience at U2A was positive overall. Liu is praised for his helpfulness, his experience, and his hard work in support of user experiments.

Summary following Charge

1. The IR beamline at the NSLS was highly valued by the COMPRES user community, generating a number of high profile publications. The closing of NSLS was a huge loss of the nation's capacity for synchrotron IR sources, relative to the smaller fractional loss of X-ray beamlines. The planned FIS facility appears to be a suitable continuation of the previous U2A beamline, offering greater performance in stability and intensity. The available beamtime will be reduced by 50%, but this is an acceptable tradeoff for greater performance, and there is a possibility of upgrading to 100% beam time for FIS in the future.

2. a) The near-term plan for the IR program is critical, because there will be no synchrotron beam until at least 2018. The intention is to develop two other capabilities for users: an offline system at NSLS-II, and the existing IR beamline at ALS. Interim support is dependent on work plan.
b) In the mid-term, FIS will have a 50% share of the infrared beamline at NSLS-II (with MET).
c) In the long-term, there is a possibility of upgrading the IR sector at FIS/MET by adding an additional extraction from the storage ring to allow both beamlines to operate simultaneously (estimated cost: $1.2M)

3. A detailed work plan for Zhenxian Liu for the dark period is required to evaluate the adequacy of staffing, and the adequacy of the interim support. This must be an adaptive plan that responds to user demand for off-line/ALS capabilities: as such, quarterly plans and updates must be generated by Liu on how he plans to spend each quarter. An additional possibility that would lessen the burden on COMPRES of funding facility-less personnel is to request matching funds from Carnegie, or generation of additional salary funding for Liu by Liu/Hemley for their scientific agenda during the dark time.

4. When up and running, the FIS beamline will be a significant upgrade from the older NSLS IR

beamline, with ~10x greater intensity and ~100x greater stability.

5. Future plans for facility: mid-term plan are reasonable. However, there needs to be a clear work plan for the short term.

6. Facility commitment: Unclear. Substantial investments have been made toward the FIS infrastructure, but the date-of-availability for this and other NxtGen beamlines has been slipping further into the future. While recognizing the difficulties associated with establishing a new facility, the Site Visit Team is not confident in the date-of-availability projected by NSLS-II management for the FIS beamline.
Second, there have been significant delays in bringing the offline IR system to users. NSLS-II management said during the site visit that they would perform the offline IR inspection and find a way for users to request access. This has not occurred: currently, user access to the offline IR system is on hold indefinitely while being reviewed by the legal department. The committee is disturbed that NSLS-II management has not found a solution for user access. If such an offline user facility cannot be instituted at NSLS-II during the very extended dark period, COMPRES will need to find alternate solutions, possibly at other facilities.

7. Prioritized recommendations

High priority: A reactive, quarterly work plan is needed for Zhenxian Liu. Because of uncertainties about COMPRES IR usage during the dark period, a detailed and evolving work plan will need to be developed during the offline period.

High priority: COMPRES leadership will follow-up and, as necessary, work with NSLS-II leadership to find a path forward for user access to an offline IR system as soon as possible.

Priority: Partner with Carnegie/Geophysical Lab for cost sharing during the interim period.

Priority: Advertise offline system and CO_2 laser heating system for users during dark time.

Priority: User interest should be monitored each year to confirm that COMPRES community members are using the high pressure IR facilities, both offline at NSLS-II and at ALS 1.4.2. It is hoped that community demand will remain strong, but if it is not then alternate staff deployments should be considered.

Suggestion: Perhaps establish a mail-in service to enhance use of the COMPRES IR facilities.

Introduction to XPD—diamond cell and multianvil program

The X17 beamlines comprised most of COMPRES' investments at NSLS, including X-ray experiments with both MAP and DAC apparatus. At NSLS-X17, COMPRES was able to run DAC experiments 100% of the time at X17C and 67% at X17B3, and MAP experiments 67% time at X17B2 plus a monochromatic side station that could be run simultaneously. These stations were productive and important facilities since COMPRES was formed, and produced (particularly in their earlier history) high profile, flagship-type scientific contributions for the NSLS.

All of COMPRES' X-ray activities at NSLS-II are at XPD (Weidner and Ehm, PIs). Weidner and Ehm have a Partner User agreement with NSLS-II at the XPD beamline. In exchange for personnel and equipment contributions from the PIs (who in turn are backed by the MPI at SBU and by COMPRES), the PIs negotiated an agreement for 20% of the beamtime at XPD-1 for high pressure studies (shared by MAP and DAC), plus any GU time that is assigned to high pressure work based on GU proposal ratings. The agreement as written specified that the highest-scoring GU proposals for high-pressure studies would be assigned to the 20% PU time, leaving lower-rated COMPRES-related proposals to compete with the broader GUP pool. Notably, COMPRES was not a signatory on this agreement; it is an agreement solely with the Stony Brook PIs. This policy was disadvantageous to the COMPRES user community, and after discussions between members of the Site Visit Team and NSLS-II management (Hill, Zschack, and Shen) it was decided that the policy needed to be revisited and a new agreement put in place. NSLS-II management was agreeable to change the wording to be consistent with former NSLS practice -- namely that the highest-scoring COMPRES proposals compete for GU time first, and only those proposals not receiving GU time would normally be assigned to the PU beam time.

A revised beam time allocation policy in the PUA will ensure that the stated 20% beam time is a minimum for COMPRES activities at XPD. However, this is still far below the sum of beam time that COMPRES users had access to at NSLS X17. The split between MAP and DAC operations at XPD will be driven by user demand and proposal competitiveness, so it is important to compare the relative strengths of the MAP and DAC programs at XPD.

It is not yet clear what the exact specifications of the X-ray beam will be for the high pressure applications at XPD. XPD uses upstream optics to make a secondary source. The fundamental limit is the quality of the upstream mirror and focusing monochromator. While the spot size can be slitted down (for example, to ~5x5 µm) by closing the upstream slit, the tradeoff in how many photons they can deliver depends not only on the brightness of the NSLS-II beam (a known quantity) but also the quality of upstream optics (not known yet).

Multianvil Press Program

The MAP program at X17B2 has been one of the world-leaders of its type. A number of high profile scientific papers and innovative technical advances have distinguished this program. X17B2 has had a strong and productive user community that is predominantly Earth science based, and notably COMPRES-based. Most of this productivity came from white beam applications, but there was a monochromatic side station that also was developed over the last several years of X17 operation. Some users are expected to migrate to the 6-BM-B beamline at APS, which was established to continue white beam applications for the COMPRES MAP community. Early reports from users (e.g. Appendix 4) indicate that the beam intensity at 6-BM-B is significantly lower than at X17B2, making measurements more difficult and/or time consuming than previously, but nonetheless standard white-beam applications can continue there. Other users are expected to pursue beamtime at XPD instead of, or in addition to, 6-BM-B because of the greater intensity, despite needing to change their methodology from white to mono beam. Some users specifically look forward to the mono beam applications at XPD (Appendix 3, 4); for example, texture measurements should be facilitated by angle dispersive experiments. In general there is strong support from the COMPRES community to continue COMPRES-related MAP operations at NSLS-II (Appendix 3). The user base that PI Weidner has built is an important part of the COMPRES community, and their appreciation of his efforts developing the MAP programs at NSLS and NSLS-II are evident in the user feedback (Appendices 3, 4).

Summary following Charge (for Multi-anvil program)

1. A supportive user community exists for the multianvil program. (See Appendix)

2. a) Near term vision—use of APS beamline BM-6 for existing white beam-based Multianvil program. Presently staffed by Haiyan Chen, and presumably through the near-/mid-term. The vision is that this beamline will exist near term and mid-term.
b) In the mid-term—establishing a monochromatic multianvil program at XPD.
c) In the long-term/mid-term: establishing high-pressure outpost with XPD.

3. The current workplan for the staff located at NSLS-II is not clear to the Site Visit Team.

4. The XPD beamline will provide a monochromatic beam, not a white beam, as was previously used. This will require some adaptations of experiments and protocols. The Weidner MRI proposal to fund infrastructure at XPD was not funded, but NSLS-II has apparently agreed to fund the mirrors and motors/motion control.

5. The PI and staff anticipated the transition to mono beam operations at NSLS-II and developed mono beam applications while still at X17B2. Continuous development of X-ray applications to multianvil experiments has been a hallmark of the facility and is expected to continue at XPD.

6. Facility commitment: The engagement between COMPRES and NSLS-II scientific management could be improved. In some aspects the partner user agreement was not especially favorable for the COMPRES community. Facility agreements that involve COMPRES resources must be made in negotiation with the President of COMPRES.

7. Prioritized recommendations

Highest Priority: A superb level of communication should be expected between the PIs of COMPRES-supported diffraction programs at NSLS-II and COMPRES Central; this is an area where improvement needs to be made. This should include an integrated work plan for staff deployed both at NSLS-II and at APS.

Priority: Renegotiate a more advantageous partner user proposal with COMPRES as a co-signatory.

Recommendation: The XPD-MAP program should continue to be supported by COMPRES. Even at a reduced PU time of 20% plus uncertain GU time, it will be important that highly competitive

COMPRES-related MAP projects can be performed at COMPRES facilities. The user support for continued operation of a monochromatic X-ray MAP facility at NSLS-II is well established (Appendices 3, 4).

Diamond Anvil Cell program

COMPRES user support for DAC operations at XPD is significantly lower than for the MAP. Earth science applications did continue at X17C/B3 over the last several years, but a substantial fraction of productivity from those NSLS beamlines derived from materials science / solid state physics studies. User feedback (Appendix 3,4) was less positive for DAC experiments. During the site visit, Lars Ehm acknowledged that a COMPRES user base has not been established for the proposed XPD DAC facility, and stated that improvement is needed. The PIs for this facility have not done the community building that is needed to grow and support a DAC user base.

The DAC applications promoted by Ehm at NSLS II XPD during the review were imaging, multigrain diffraction, and total scattering at high pressures and temperatures. The total scattering method aligns with the research interests Ehm pursued at X17C/B3. Extending this method to high PT conditions will require significant development effort on a scale that was not achieved at X17C/B3. Multigrain diffraction applications are underway also at several other high pressure beamlines (e.g. GSECARS, HPCAT, ALS), and no case was made that XPD will offer significant advantages over existing beamlines for multigrain diffraction. High X-ray energy applications were cited by Ehm as an advantage of XPD at NSLS-II. Total scattering methods in particular will benefit from a bright high energy X-ray source. (In fact, there are APS beamlines dedicated to this technique that offer greater brightness than XPD.) Total scattering studies of silicate and metallic liquids, rather than amorphous solids, would find greater application within the Earth sciences, and this requires in situ high-PT measurement -- hence a laser heating system and appropriate X-ray beam characteristics, namely small focused spot size (<10 microns, and preferably 5 or less based on experience at other beamlines). Ehm reports that currently a 10 x 10 micron beam size is predicted, and NSLS-II staff are working on ray tracing calculations to explore reducing that to approximately 5 x 5 microns.

The case for a DAC program at XPD is weakened by the lack of COMPRES user enthusiasm. The site review produced no evidence that the proposal for XPD-DAC has sparked much interest in the COMPRES community, nor have there been recent workshops or sessions held specifically to stimulate interest in XPD-DAC or to obtain community input on its capabilities. Furthermore, the online laser heating system at X17B3 never became operational. That system could have provided Ehm with a track record in laser heating applications that could inspire potential COMPRES users of XPD-DAC; not having it handicaps pursuit of simultaneous high T/high P experiments of primary Earth Sciences interest.

The contributions of Xinguo Hong, the current XPD-DAC beamline scientist, were highlighted at the site visit. As former X17C/B3 PI Duffy mentioned, Hong has been effective not only at user support but also, in contrast to other X17-DAC beamline scientists, has developed independent research activities of his own. Moreover, Hong has taken the initiative to write a successful general user proposal at the IXS beamline to develop high-pressure applications there. These contributions are useful to COMPRES users.

Finally, for COMPRES users the beamlines at X17 played an important role not only for research but also for student development. Although the X-ray source was weaker than at APS, the beamtime was more plentiful for high-pressure research, so students gained more experience than they would at a beamline with greater time pressure. The longer beamtimes are important for student training. With a brighter source at NSLS-II, it is expected that for some experiments, more science might be able to be done with less beamtime. However, as noted in both the committee discussion and external user feedback, this critical training role that NSLS played is lost to the community.

Summary following Charge for diamond cell program

1. The user community for the diamond cell program at NSLS-II is limited, especially for domestic users who have mostly based their X-ray DAC diffraction research programs at APS and ALS. The PIs have not built a substantial user community or potential user community at the NSLS-II. The solicited feedback from users is not indicative of strong support for the diamond cell program at NSLS-II.

2. A vision for an integrated “high pressure village”(see next section) in which high pressure capabilities are developed at other beamlines and related user facilities at NSLS-II was articulated. Scientific vision for the diamond cell program was not as well articulated independently within XPD or as a part of the high-pressure village.

3. Staff: the diamond cell program is staffed by Xinguo Hong. Hong has provided good support for users, and has written a successful general user proposal to spearhead diamond cell developments at the IXS beamline. Concerns were raised by the Site Visit Team about the current mentorship and supervision, with a concern about lack of professional development opportunities and clear guidance, especially in light of program uncertainties that have existed for many months.

4. The tradeoff between spot size of the X-ray beam and intensity at the sample is still not known. Only limited information has been provided on the design and quality of the upstream optics, which determines the tradeoff between spot size and photons at the source. The COMPRES PIs' MRI proposal to help fund the optics was not funded. The Site Visit Team is under the impression that NSLS-II has offered to pay for optics; however to our knowledge, there is no formal agreement.

5. Mid-term/long-term: the question of engagement with the HEX beamline remains unclear, but potentially offers opportunities for COMPRES.

6. Facility commitment: Prior to the site visit there was a lack of engagement between NSLS-II scientific management and COMPRES management. Consequently, aspects of the XPD high pressure partner user proposal were not especially favorable for the COMPRES community.

7. Recommendations for DAC:

The XPD-DAC program is the least well developed of the COMPRES facilities at NSLS-II, and is the one with the least COMPRES user endorsement. A more compelling scientific rationale for the DAC program at XPD is needed. At this stage it appears unlikely that beam time proposals for the XPD-DAC program will be highly competitive for either GUP or PUA time. The science objectives articulated for the XPD-DAC program can be met at existing beamlines elsewhere, at which greater beam time commitments have been made toward high pressure research. Hence, the Site Visit Team did not find cause to recommend overturning the Executive Committee's earlier decision to withdraw support for the DAC program at XPD.

The following minimum elements that would provide justification for COMPRES to support a diamond cell X-ray program at NSLS-II are:

1. A PI experienced with and committed to nurturing an Earth science user community who will invest effort establishing a user-based, science-driven DAC program in high-pressure Earth sciences at NSLS-II.
2. A strong endorsement of a substantial number of COMPRES DAC users that NSLS-II will represent a significant part of their research planning/infrastructure moving forward.
3. A strong indication of commitment/support from NSLS-II leadership for the high pressure Earth science community at NSLS-II, and the DAC effort in particular.
4. Clarity on beam characteristics.
5. Clarity on partner user agreement.

6. A clear pathway for development and approval of online laser heating, including ensuring that the capability to establish a state-of-the-art laser heating facility exists at NSLS-II.

High Pressure Village

A substantial part of the site visit agenda was used to highlight other beamlines and facilities at NSLS-II and BNL, that are not supported by COMPRES but may be useful to COMPRES users either alone or in conjunction with COMPRES beamline activities. Most of these were impressive presentations, and it is likely that COMPRES users will take advantage of these facilities regardless of COMPRES' investment at NSLS-II. For example, the CFN is already used by COMPRES members at Yale, and as mentioned above X. Hong has had beamtime at IXS awarded from a GU proposal for high pressure work. D. Weidner has a PU agreement at TES to provide partner user access for high-pressure users, with SBU providing beamline optics and other equipment to the endstation in exchange.

The HEX beamline might provide more opportunity for high-pressure work in the future. As Z. Zhong described in his presentation, the HEX facility could have three hutches running simultaneously: a 80 keV branch; a 25-150 keV branch; and a white beam branch. Construction of the HEX facility is stimulated by $25 million from New York State over the next 4 years, committed to promote research into batteries and other energy storage methods. The project also aims to reach out to other user communities with similar experimental needs, for example high-pressure research. Zhong described that with 3 hutches, even a small proportion of the total time could be a significant amount of beamtime for Partner Users, such as perhaps COMPRES.

Recommendations:
It is recommended that COMPRES should consider HEX as a possible location for MAP and possible future DAC operations as the facility develops further. Meanwhile, the existing High Pressure Village facilities offer resources that may appeal to COMPRES users. The COMPRES PIs at NSLS-II should be encouraged to promote these opportunities to the broader COMPRES community, perhaps by holding workshops. In turn, this might stimulate more PU proposals to facilitate more use of the High Pressure Village capabilities by COMPRES users.

APPENDIX 1

Charge for 2015 Review of COMPRES Facilities at NSLS-II

COMPRES will perform a site visit of its XPD and FIS facilities at NSLS-II on August 24-25 2015. The expected COMPRES participants, in addition to the PIs and staff at the NSLS-II COMPRES facilities, include: President, President-Elect, Executive Committee Chair, Facilities Committee Chair, and other Members of the Facilities Committee. This review is intended to determine, for each COMPRES-funded facility:

1) Identification of stakeholders and their expectations from the facility
   a) through solicited feedback from continuing or anticipated users
   b) through solicited feedback from one-time or non-continuing users
   c) through discussion with the PIs
2) What is the vision of each facility for the near term, and in the long term?
3) The adequacy of staffing, from both the perspective of whether it is sufficient for users to conduct their experiments, and whether the staff can achieve the level of professional development commensurate with their job description
   a) through interviews with the staff and PIs
   b) through user feedback
4) Excellence of the experimental infrastructure: Does the facility now have (or will it have in the future) special capabilities not available from other COMPRES facilities, or of higher quality? What will the various sources of infrastructure be? Who will provide the infrastructure? What will be the expected costs to COMPRES? Are the expected outcomes from this facility commensurate with its cost, relative to other COMPRES facilities? To be determined:
   a) through discussions with the staff and PIs
   b) from the Site Visit Team perspective
   c) from the user perspective
5) Future plans for the facility: Are they reasonable, clearly oriented towards user needs, and consonant with those of other facilities available to high-pressure users, including those funded by COMPRES?
   a) through discussions with the staff and PIs
   b) through user feedback
   c) through Site Visit Team assessment
6) Assessment of facility commitment: Is the facility committed to provide adequate space, expected level of institutional resources, and ongoing engagement associated with the COMPRES effort. This will be evaluated:
   a) through discussions with NSLS-II management
   b) through assessment of MOUs, etc. by the Site Visit Team
   c) through discussions with the staff and PIs
7) Are there specific improvements in user feedback, facilities management, planning or staff deployment that the Site Visit Team can recommend?
   a) From assessment by the Site Visit Team

APPENDIX 2

Agenda for the high pressure NSLS II site visit. August 24 & 25, 2015 Room 156 bldg. 745

Time	Theme	Speaker	Topic
8:00	Breakfast		
8:30	Introduction	Andy Campbell, Carl Agee	Purpose of site visit
8:45		John Hill	NSLS II
9:00	Overview & Management	Rich Reeder	Stony Brook - BNL
9:20		Qun Shen	strategic plan and partnerships
9:40		Paul Zschack	Beamlines status and development
10:00	Coffee Break		
10:30	The High-Pressure Village	Zhong Zhong	XPD and HEX
10:45	Review DAC program	Lars Ehm	
		Tom Duffy	
		Zhong Zhong	
		Don Weidner	
12:45	Closed Lunch		
1:45	Posters		
2:45	The High-Pressure Village	Larry Carr	FIS/MET
3:00	Review IR program	Rus Hemley	
		Zhenxian Liu	
		Larry Carr	
4:30	Review of MAC Program	Don Weidner	
		Zhong Zhong	
		Lars Ehm	
6:00	Tour Facilities		
7:00	Dinner		

	25-Aug		
8:00	Breakfast & Closed Session		
9:00	The High-Pressure Village	Alessandro Cunsolo	IXS
9:15		Yu-chen Karen Chen-Wiegart	SRX
9:30		Paul Northrup	TES
9:45		Eric Stach	CFN
10:00	Closed Session, Follow-up with PI's		
12:00	Lunch and depart		

APPENDIX 3

Letters from the User community

Frédéric Béjina
Cecilia S. N. Cheung
David Dobson
William Durham
Jennifer Gerard
Thomas Duffy
Shun-ichiro Karato
David Kohlstedt
Misha Bystricky
Pamela Burnley
Jiuhua Chen
Li Li
Baosheng Li / Robert Liebermann
Hanns-Peter Liermann
Shenghua Mei
Liping Want
Sean R. Shieh
Paul Raterron
Jack Simonson
Yusheng Zhao
Lowell Miyagi
Surendra K. Saxena
Oliver Tschauner
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Toulouse, August 13, 2015

Dear Madam, Sir,

I am pleased to write this letter as a mark of my strong support for the "High Pressure Village" project.

As a regular user of NSLS beamline X17B2 for experiments on rheology and equations of state of minerals, I have witnessed the many technical/technological developments made by Professor Weidner and his group over the years. His unflagging efforts to improve equipment and theory have made X17 not only a reference but also a milestone in the mineral physics community for rheology experiments at high pressure and temperature. Most importantly, his initiative created a community of scientists and technical staff members united around solving scientific and technical problems, and brought many newcomers to the synchrotron – achievements that are perfectly inline with the vision of COMPRES. As science has to move forward, the High Pressure Village is the logical and necessary next step, bringing more cutting-edge techniques and more people, together.

Working at X17, I had the privilege to be immersed in the scientific "buoyancy" generated by the many scientists and students coming there to do experiments. The spirit of knowledge sharing, of education and cooperation has been a true success and was just as important as the technological achievements realized at X17. It was a place where new ideas emerged constantly, where everyone learned new things and students acquired tremendous knowledge and experience. One of my personal interests being on the rheology of minerals, I believe developments at X17B2 have rejuvenated this field of research thereby allowing the determination of rheological laws at very high P and T and consequently lead to the development of new high pressure deformation equipment. As I am also a user of the ESRF beamline ID06 (large volume press), I can testify that X17 has had world-wide impact and several synchrotrons around the globe are still trying to catch up with it.

The High Pressure Village, will push forward all these ideas and areas of development (hence its name!), and will pave the way toward answers to fundamental questions and problems in Earth sciences. For our community which relies more and more on the use of synchrotron radiation, this new project will be a major step toward a deeper understanding of the physical and chemical properties of minerals, and therefore of the Earth and other planets, but also and most importantly, for the societal aspects related to geosciences. For my own work, sample preparation and post-experiment observations are crucial. Because my colleagues and I are conducting several experiments during a beamtime, being able to quickly check on the sample's chemistry, microstructure, etc. after an experiment will allow us to better decide on the next run conditions. The High Pressure Village promises to ease this process by making on-site or Stony-Brook University tools available and therefore will allow users to better optimize their beamtime. By creating the proposed partnerships included in the project, the High Pressure Village will create unique work conditions, therefore maintaining the scientific lead inherited from X17 and will be a driving force to attract more high pressure science.

The goals of the High Pressure Village to make synchrotron-based techniques more accessible, to couple different analysis techniques and to bring the latest technological developments in high pressure to more users are very exciting. I have no doubt that the outcomes of what will be quickly simply called "the Village" will be much greater that we can imagine today and that the benefits will extend much further than only the scientific world. I therefore reiterate my strong support for this proposal (and testify of my own eagerness and impatience to see it come to fruition).

Sincerely yours,

Frédéric Béjina

WISCONSIN
UNIVERSITY OF WISCONSIN–MADISON

August 15, 2015

To whom it may concern,

I am writing in support of National Synchrotron Light Source (NSLS) II program. My research interest is focused on understanding how stress and strain evolve at low pressure simulating the subsurface condition. I had 6 years of experience using in-house conventional rock mechanics equipment at Stony Brook University and University College London, before I had joined the high pressure village community and first explored the potential of multi-anvil cell system. My research in rock deformation has been highly benefitted since then, through experiments achieved at NSLS facilities X17B2 beamline, which is now relocated to Argonne National Laboratory 6-BMB beamline.

I still remember vividly how much I was amazed by the precise control of the equipment that the systems allowed, as well as how much assistance I was offered during my rookie synchrotron experiments. Honestly, before as a rock mechanics scientists, I had rarely used such fancy systems in my career. I must not forget to mention how helpful and supportive all my colleagues are. As an enthusiast experimentalist at heart, it is my ideal perfect environment for testing hypothesis. Scientifically, my stress and strain analysis was immensely enhanced by more information with respect to different orientation.

I can envision that my research to excel under the future direction of NSLS II, with the possibility of upgrading the X-ray diffraction to 3-dimension (3D-XRD). No current rock mechanics equipment can be able to map individual grains and trace how the grain movement evolve during compaction. Moreover, with proposed improved imaging capability (e.g. in-situ 3D X-ray microtomography) under NSLS II program, I would certainly foresee even more broad base user like myself would join the high pressure village. Therefore, I hope to conclude by looking forward to seeing my wonderful experience as a facility user under NSLS and NSLS II could be continued, and so as the future young scientist generation.

Sincerely yours,

Cecilia S. N. Cheung

Research Associate in Geological Engineering
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UCL DEPARTMENT OF EARTH SCIENCES
FACULTY OF MATHEMATICAL AND PHYSICAL SCIENCES

UCL

19 August 2015

Letter of support for NSLS2 'High-Pressure Village'

Dear Don,
I am writing to express my full support for the high-pressure village concept for NSLS2. It seems that the joined-up availability of a wide range of facilities, both beamlines and off-line preparation and characterisation facilities, is currently very rare for the high-pressure communities. In the UK, the Diamond light source/ISIS campus at Harwell is just beginning to think along these lines, with substantial buy-in from academic and industrial sectors. So you have hit the nail on the head strategically.

In terms of concrete benefit, a combined on- and off-line village provides several substantial advantages, here are a few from my experience:
First, an increased throughput for instances where there needs to be iteration of experimental design by allowing synthesis and cell preparation to be performed on site rather than remotely (and in many cases the preparation is currently very remote from the in situ facility).
Second, rapid turnaround between synthesis and analysis can be vital for investigating weakly metastable or environmentally sensitive materials
Thirdly multiferroic behaviour requires access to a wide range of facilities, ideally collocated.

Finally, I am very impressed with the beam specifications for the LVP beamline at NSLS2. The ability to use a large beamsize is vital for many imaging applications in the multi-anvil press: radiography and tomography, viscometry, microstrain measurements to name a few uses which I put large beam size to. This capability is becoming quite rare in third-generation synchrotrons with the current drive to ever smaller beamsizes, making the NSLS2 facility very timely for the survival of some of these techniques which still offer the possibility of major advances in our understanding ot the Deep Earth.

I wish you every success in seeing this project through to a successful conclusion.

Best regards,

D. Dobson

David Dobson
Professor of Earth Materials

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William Durham 5:40 PM (21 hours ago)

to me

Don --

I just wanted to add my voice to the collective opinion of a large number of our colleagues in the high-pressure research community who feel that our measurements at the NSLS X17 beam lines of a spectrum of physical, chemical, and transport properties of rocks at very high pressures have been critically important to progress in understanding the behavior of the deep earth. The utility of synchrotron research to earth science is evident in its proliferation around the globe. Over the years, and lately under the umbrella of the COMPRES organization, which serves to coordinate and facilitate high-pressure earth sciences research, our synchrotron measurements at X17 have developed as part of a coherent and coordinated effort in studies of the deep earth involving a spectrum of research methods. These methods range from high-pressure, high-temperature laboratory properties measurements such as ours, to electron microscopy of laboratory and natural samples, to high-resolution seismic imaging of the deep earth itself, to ab initio computer modeling of solids at pressures beyond our current reach. I wish you success in your efforts to map the vital operations at X17 to new beam lines at NSLS II so that we may continue to support our commitment to the community and to keep up with the exciting work in the studies of the deep earth.

Best regards,
Bill D.

****

William B. Durham
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Jennifer Girard
Yale University,
Geology and geophysics department
210 Whitney Ave,
New Haven, CT06511

August 18th,

To whom it may concern,

I feel very pleased to write this letter of recommendation and comments for the High pressure research that has been done at the NSLS and will be done at NSLS II. I have been a user of the large volume X-ray diffraction facility at NSLS, X17B2 beamline for the past 7 years (using D-DIA and RDA equipment), and I have as well used the infrared facility U2 beamline for sample analyses, in the field of high pressure deformation. These beamlines had amazing management and beamline scientists that where always keen on helping use get the best possible measurements and results. This allowed our research group to obtain ground breaking results and push the boundary of our knowledge in high pressure deformation science. At the end NSLS synchrotron limitation were obvious, but the beamline staffs were able to overcome these limitations and still provide us with amazing technology and accurate measurements in X-ray diffraction technic for stress estimation and X-ray radiography for strain measurement.

The new facilities at the NSLS II, that will become available to the High pressure community in the year to come, will really push the boundary of what is technically possible at the moment, and open the door to cutting edge research. After the shutting down of NSLS, this new facilities become indispensable for the whole high pressure community. Thanks to the high pressure village, the high pressure community will be able to access world class tools to study the rheology of Earth mineral at extreme conditions of pressure and temperature, as well recovered sample analyses usually really challenging, will be eased and of higher precision (e.g. using the Infrared facility as well as the CFN technology SEM, FIB).

One of the most important technics for our research using the RDA equipment is the large Intensity X-ray white beam that will become available at NSLS II beamline. This will allow the beamline staff to narrow the X-ray diffraction volume and still collect an intense diffraction signal that will allow us to perform for the first time stress gradient mapping across our RDA samples. This is a major technological advance, not only for high pressure, but for the whole mineral physics community. The white beam beamline at NSLS II will be the only place in the world that has the technical capability for us to perform these measurements using the RDA, which is here at Yale, one of our research group main focus. As a user, I can certify, this will greatly improve the quality and accuracy of our data, as well as greatly ease the X-ray data analyses and processing involved in RDA deformation experiments.

I support and I am very impatient to use the technics that will be offered at brookhaven by the high pressure village.

Sincerely,

Jennifer

Princeton University

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July 30, 2015

Prof. Donald Weidner
Mineral Physics Institute
Stony Brook University
Stony Brook, NY

Dear Don,

I am writing this letter in strong support for your proposal to develop a high-pressure Earth science research center at the NSLS II. This newly constructed state-of-the-art synchrotron facility represents an important step forward for the future of high-pressure science at Brookhaven National Laboratory. The new HEX beamline together with the capabilities of XPD and FIS offer exciting opportunities for high-pressure research with diamond anvil cells. Your plan to develop a high-pressure village will foster the growth of a community of scientists who are able to exploit high-pressure techniques across the range of beamlines and facilities at NSLS –II and CFN. The program you are developing promises to be a great asset for the COMPRES community in the coming years.

Very truly yours,

Thomas Duffy
Professor of Geosciences
Princeton University

Yale University

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August 13th, 2015

Don,

The purpose of this letter is to express my enthusiastic support for the plan "High Pressure Studies of Earth Materials at NSLS II".

The scope of high-pressure studies of Earth materials has expanded dramatically during the last decade or so partly due to the advancement in the study of Earth's deep interior from geophysical approach (e.g., probing the Earth's deep interior by seismic waves) but also due to the advancement in planetary sciences in particular the discovery of many exo-planets (planets around stars other than the Sun) that has provided a new data set on a rich variety of planets. For the first time in the history, we are now poised to understand Earth in comparison to 1000s of other planets so that we could hope to develop a model on the structure and evolution of planets as astrophysicists did in the past.

High-pressure studies at NSLS and elsewhere have contributed enormously to this development. These studies have shown that many materials properties undergo large changes under high-pressure (and temperature) conditions that affect the dynamics and evolution of Earth and other planets. For example, experimental studies on plastic deformation at high-pressure and temperature conditions pioneered by Don Weidner have provided key data set to understand how materials deep inside of Earth (and other planets) deform plastically, a key issue in understanding the dynamics and evolution of planets. Also a number of studies showed that a substantial amount of water (hydrogen) can be stored in minerals under the deep Earth conditions. The deep interior of Earth can store water more than 10 times of the ocean water. The FTIR studies at NSLS have contributed much to this progress. Water storage and its circulation are the key to understand the evolution of oceans and life on Earth. Importantly, this issue (water issue) is closely linked to plastic deformation because large-scale materials transport by plastic deformation is a very efficient way for water circulation in Earth, and water likely affects plastic properties. The experimental studies at NSLS have made critical contributions to these key issues in Earth science.

Having said this, studies in these areas (plastic deformation under high-pressure conditions and water solubility and transport) are still in their infancy. For instance, the influence of water on plastic properties of minerals in the very deep mantle is totally unconstrained. Physical mechanisms of dissolution of water (hydrogen) in the deep interior of Earth are unknown.

In both areas, understanding the nature of defects (point defects, line defects (dislocations) and planar defects (grain-boundaries)) is critical. High-resolution x-ray diffraction/scattering studies will provide rich information on these defect-related properties of minerals that play a critical role in the dynamics and evolution of Earth and other planets. These studies require advanced synchrotron facilities such as those provided by NSLS II.

During the past decade or so, I have enjoyed very fruitful collaborations with both Don Weidner (X17B) and Zhenxian Liu (U2A). With renewed capabilities, I expect much more exciting studies to come from NSLS II that will make NSLS II a world center of high pressure studies on Earth materials.

I wholeheartedly support the plan outlined in "High Pressure Studies of Earth Materials at NSLS II".

Sincerely,

S. Karato

Shun-ichiro Karato
Adolph Knopf Professor
Yale University
Department of Geology & Geophysics

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August 19, 2015

Prof. Donald Weidner
255 Earth and Space Sciences Building (ESS)
Stony Brook University
Stony Brook, NY 11794-2100

Dear Don,

I am writing in strong support of the high-pressure experimental facility at NSLS II. We have been fortunate to use NSLS in our research for the past ten years. For our program in particular, the deformation DIA at the NSLS beam line has been critical. It has allowed us to investigate rheological properties of mantle minerals and rocks at much higher pressures (factor of >10) than possible with conventional testing equipment. In the earth sciences, this capability is extremely important as it permits probing of the behavior of earth materials at conditions similar to those at great depths. The experimental capabilities and support staff at the Brookhaven beam line are truly unique, facilitating experiments that we only dreamed about ten years ago.

With the new facility at NSLS II, we will continue our studies of rock deformation at very high pressures and temperatures. In addition, we will now be able to expand our research in order to explore problems such as the role of small amounts of melt on the viscosity of partially molten rocks at mantle conditions. One area that we hope to investigate involves the use of a reactive melt, that is, a melt that reacts with one of the solid components of the rock. In such experiments, the reaction leads to the formation of channels of melt. We anticipate that deformation will localize on the resulting channels, enhancing the rate of melt segregation and rapid growth of the channels. In the Earth, such channels provide high-permeability paths that facilitate transport of melt from depths of ~100 km to Earth's surface. Quantitative measurements of the kinetics of this process are important in understanding extraction and eruption dynamics of melt at mid-ocean ridges, for example.

In summary, the NSLS II facility will be of enormous benefit for our research, allowing us to push into new research areas that were simply not possible in the past.

Sincerely,

David

David L. Kohlstedt
Gibson Professor of Earth and Planetary Sciences

Misha Bystricky, PhD
Université Paul Sabatier, Toulouse, France
Institut de Recherche en Astrophysique et Planétologie
Observatoire Midi-Pyrénées, 14 av. E. Belin, 31400 Toulouse, FR
micha.bystricky@irap.omp.eu
Tel. 05 61 33 26 34

Université
de Toulouse

Toulouse, August 19th, 2015

Dear Dr. D. Weidner,

I am writing this letter in support of the *High Pressure Studies of Earth Materials* program at NSLS II. Thanks to COMPRES funding, tremendous progress has been achieved in the last ten years or so in the field of high pressure mineral physics, in particular with the development of new high-pressure equipment and techniques to measure stress and strain *in situ* using a synchrotron light source. The program at NSLS has played a major role, providing technical support as well as a fruitful environment for the emergence of new scientific ideas and projects, many of which have lead to significant contributions in the field.

Our research group in Toulouse has greatly benefitted from this environment at NSLS. A graduate student, Arnaud Proietti, is currently finishing his PhD on the rheology of polyphase aggregates at upper mantle pressure and temperature conditions. His results have highlighted the importance of stress partitioning in polyphase materials. All of his key experiments have been performed at NSLS, and his project has been highly successful largely thanks to all the scientific interactions we have been able to develop during our stays at BNL.

I am very excited by the prospect of a new platform dedicated to the study of Earth materials at BNL. In particular, the availability of 3D-XRD imaging at NSLS II will make it possible to determine the spatial stress distribution in polycrystalline aggregates, giving us potentially a much better understanding of the physical processes taking place during deformation. This innovative approach is key in gaining new insights on the rheological properties of rocks at high PT and developing improved models of the dynamics of the Earth.

In summary, I am convinced that with continuing support from COMPRES, the scientific expertise and the technical know-how at BNL will consolidate the *High Pressure Village* as one of the world leading platforms in high pressure research, especially in the field of high pressure rock deformation. I strongly support this proposal and I am looking forward to exciting new projects and collaborations that it is bound to foster in our field.

Sincerely,

M. Bystricky

Misha Bystricky
Associate Professor
Toulouse, France

UNLV | Department of GEOSCIENCE
UNIVERSITY OF NEVADA, LAS VEGAS

Dr. Donald Weidner
Distinguished Professor
Director, Mineral Physics Institute
Department of Geosciences
Stony Brook University
Stony Brook, NY 11794-2100

August 20, 2015

Dear Don,

I am writing this letter in support of your efforts to develop high pressure capabilities at the NSLS II in general, as well as specifically at the XPD and HEX beamlines. NSLS II beamlines will offer a variety of new techniques that our community can exploit. Providing a framework to support high pressure work at these beamlines makes a lot of sense. For diamond anvil cell users the facility-wide high pressure village will greatly enhance access. For multi-anvil (LVP) users, unless there is 'real estate' on beam lines and a support –structure, access simply isn't possible. Therefore, the success of your operations, at the XPD and eventually HEX beamlines, are absolutely critical to the future of my LVP-based research.

Over the last decade those working in high pressure deformation have benefited from an unprecedented opportunity to conduct deformation experiments with macroscopic samples under well characterized stress conditions by using the D-DIA and RDA with synchrotron x-rays; an area of research that you pioneered. There have been many advances including improved estimates of the strength of earth materials at pressures above ~3GPa, the discovery of the change in the dominant slip system in olivine above ~7 GPa, new insights into anelastic behavior associated with phase transformations and, closest to my interest, the observation that the Reuss iso-stress assumption is incorrect in polycrystalline ceramics of geologic interest. It has been a very exciting decade for rock deformation. In addition to allowing us to greatly expand the pressure range over which quantitative deformation experiments can be conducted, synchrotron x-ray diffraction has provided us with an entirely new kind of data that allows us to

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interrogate the inner workings of polycrystals while they are deforming. Although we have already gained significant new insights, there are still aspects of the synchrontron diffraction signal that remain to be exploited. To do this science it is clear that we need a high photon flux and the ability to work with both small spot sizes and large spot sizes; there are both monochromatic and white light experiments to do as well as experiments where we scan the energy of the beam or use white beam with a tunable "notch". Additional advances will come with new imaging techniques such as phase contract tomography, diffraction enhanced imaging and 3DXRD imaging. The NSLS II XPD and new HEX beamlines have all the qualities we need to pioneer these experiments. The NSLS II team that is managing the XPD and new HEX beamlines and the scientific community developing around these beamlines are very interested in developing exactly the kinds of capabilities we need. So there is a strong potential for a lot of positive synergy between our community and the materials science and engineering community around these two beamlines.

In summary, I am very excited about the future at NSLS II. I think it will be important for COMPRES to support and thereby allow the high pressure earth science community to participate in and benefit from the significant advances in materials research that are bound to occur there.

Best Regards,

Pamela Burnley

Pamela Burnley

FLORIDA INTERNATIONAL UNIVERSITY
Miami's public research university

Jiuhua Chen, PhD
Deputy Director
Center for the Study of Matter at Extreme Conditions
Professor
Department of Mechanical and Materials Engineering
Florida International University
Email: chenj@fiu.edu

August 8, 2015

Professor Donald J Weidner
Mineral Physics Institute
Stony Brook University
Stony Brook, NY 11794-2100

Dear Don:

Thank you very much for sending me the visionary letter about high pressure research at NSLS-II. The proposed facilities are essential for the Earth science community to tackle most challenging problems of the field.

NSLS had been a testbed for pioneer high pressure synchrotron x-ray studies using large volume press (LVP) and diamond anvil cell (DAC) and a workhorse producing tremendous important data for understanding physics and chemistry of Earth's interior. Until its shutdown, NSLS had led the developments in many in-situ high pressure research areas, for example, rheological study with controlled strain rate using D-DIA and RDA, and total diffuse scattering using energy x-ray and DAC. While some of the experimental techniques have been replicated at many other synchrotron facilities, activities at the NSLS were still leading the scientific development in the direction at the time NSLS ramping down. It is essential for the Earth science community to keep investing at the NSLS-II so that a state-of-the-art facility and cutting-edge research can be continued.

From my personnel perspective, NSLS has been critical to my research. All my NSF-EAR funded projects including mineral's cation ordering, melts density, transformation kinetics, single crystal deformation etc had heavily relied on the high pressure facility at NSLS. I have published over 60 papers based on the research at NSLS. My current research on mantle minerals requires in situ experiments using LVP (D-DIA) / DAC and synchtroton x-rays. High pressure facility at NSLS-II is extremely important to the Earth science related faculty members of US universities, especially those on the east coast.

The concept of High Pressure Village at NSLS-II in your vision is even more exciting. The High Pressure Village will serve as an alliance center that links high-pressure mineral physics and synchrotron technology communities, and helps mineral physicists to access all kinds of state-of-the-art techniques to be developed at NSLS-II. Such a philosophy has yielded a very successful experience at APS through the establishment of HPsync. A difference between the proposed High Pressure village at NSLS-II and HPsync at APS is that the former primarily focus on Earth Science community whereas the latter serves to a broader multi-communities including physics, chemistry, materials science.

In short, as a frequent user of high pressure/synchrotron facilities, I enthusiastically support the proposal to establish high pressure facility and infrastructure at NSLS-II. I believe such a program is critical to promote the mineral physics research and to maintain such research in US being at the frontier of the world. Please don't hesitate to contact me at either chenj@fiu.edu or (305) 348-3140 if I can be any further help with regard to support of your proposed program.

Sincerely,

Jiuhua Chen

Stony Brook University

Mineral Physics MPI Institute

Li Li
Research Associate Professor

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Stony Brook, NY 11794-2100

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August 17, 2015

Dear COMPRES,

I am writing this letter to request the support from COMOPRES for the high pressure program in National synchrotron Light Source II.

COMPRES has brought together the mineral physics community and cradled many research programs otherwise not possible. NSLS II is the best resource for COMPRES to support the most frontier research program and to proceed in the future. NSLS II could provide mineral physics community unprecedented opportunities, with the support from COMPRES.

During the past 17 years, I have been conducting multi-anvil high pressure research in NSLS (supported by COMPRES). Many *in situ* experimental techniques have been developed and in use. Our understandings of mineral behavior have made a big leap, while we have also realized the limitation from the X-ray source. The brightness and spot size of the X-ray source limit our time-resolution and strain resolution. NSLS II will solve both issues, which means not only continuation but breakthroughs for the research program.

I strongly support the concept of "high pressure village" by integrating many resources in BNL. For my personal research, submicron resolution X-ray spectroscopy and the Tender Energy X-ray absorption Spectroscopy are particularly interesting.

Sincerely,

Li Li

Li Li

STONY BROOK

STATE UNIVERSITY OF NEW YORK

Department of Geosciences

7 August 2015

Professors Donald Weidner and Lars Ehm
Mineral Physics Institute
Stony Brook University
Stony Brook, NY 11790-2100

Dear Don and Lars:

This letter is written to offer our strong support for the High Pressure Village which you are proposing to develop at the NSLS II over the next few years.

As you are aware, over the past twenty years, our research team has developed novel techniques to perform ultrasonic interferometry experiments at high pressure and temperatures in conjunction with synchrotron X-radiation, leading to a number of important publications in Earth and materials sciences. Many of these experiments were conducted at the X17B2 beamline of the NSLS with the support of Michael Vaughan, Liping Wang and Don Weidner, These pioneering developments have now been emulated at synchrotron facilities throughout the world, including the APS, Spring-8, DESY and the ESRF. The technological progress over past twenty years is described in a series of papers: Li et al., 1996; Li et al., 2004; Li and Liebermann, 2007; and Li and Liebermann, 2014 [see references below].

We were very pleased to read in your proposal to establish at High Pressure Village at NSLS II that the DDIA and T-10 apparatus which we have used at X17B2 will be incorporated in the multi-anvil facilities, as well as the new DT-25. These apparatus will be well-suited to the ultrasonic experiments we are planning to conduct with our graduate students and postdoctoral colleagues over the next few years, with support from exisiting grants from the Geophysics Program of the Division of Earth Sciences at National Science Foundation and the Stewardship Science Academic Alliance program of the U. S. Department of Energy.

We look forward to working with you and your colleagues to take full advantage of the new capabilities of XPD and the High Pressure Village at NSLS II and offer our strong support to your efforts to secure funding for these new initiatives.

Best regards,

Baosheng Li Robt C. Liebermann

Baosheng Li and Robert C. Liebermann
Research Professors
Mineral Physics Institute and Department of Geosciences at Stony Brook University

STONY BROOK

STATE UNIVERSITY OF NEW YORK

Department of Geosciences

<u>References cited above:</u>

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10. August 2015
Support of HEX beamline for Extreme Condition Research

Dear Lars,
This letter is in strong support of your efforts to establish an Extreme Conditions (pressure and temperature) beamlines and infrastructure at NSLS II Brookhaven National Laboratory in from of a "High-Pressure Village". I am particularly excited about your plans to develop a HEX beamline at the NSLS II that has become one of the most brilliance light source. From my own experience in building and operating high-pressure beamlines in the US and Germany, it is very clear that the US is lacking beamline capabilities that offer a highly focused beam at high energies to be able to conducted effectively high-pressure powder and single crystal diffraction studies in the Diamond Anvil Cell. Thus, the added access in reciprocal space that we offer to the users at 43 and 60 keV make all the difference between a good and an excellent refinable crystal structure. In addition, PDF scattering studies on melts (and glasses as a proxy) encountered in the earth interior require as larger access to reciprocal space as possible and its success is hugely dependent on the availability of a high-energy beamline that is dedicated to high-pressure research. I am further applauding your plans to develop an all including village for high-pressure research that I have found to be enabling inter technical extreme conditions research, i.e. the combination of conducting spectroscopic and scattering studies under one umbral will be one of the most powerful tools in the next decades to advance high-pressure research in the US and worldwide.
In summary, the establishment and development of extreme conditions research in the form of a dedicated center/village for high-pressure research at NSLS II will be essential to accelerate high-pressure research at the BNL and in the US for the next decades.

Sincerely,

H. P. Liermann

Hanns-Peter Liermann

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Prof. Donald J. Weidner
Director, Mineral Physics Institute
Stony Brook University
Stony Brook, NY 11794

August 16, 2015

Dear Prof. Weidner,

I am writing to strongly support the establishment of a possible High Pressure Village (HPV) at NSLS II as proposed by a group of pioneering scientists who has greatly advanced the field of high-pressure mineral physics by developing new technologies including the integration of synchrotron x-ray analytical techniques with high-pressure apparatus over the past few decades.

High-pressure mineral physics provides an essential means to exploring the physical processes occurring within Earth's interior. Because the field focuses mainly on experimental studies, it is strongly driven by tech developments. In particular, the integration of synchrotron x-ray analytical techniques with testing systems has made many experimental researches possible in the field of high-pressure mineral physics; it provides not only precise measurements but also a distinct function of in-situ observation. Now, with the help of this new technology, the opportunity to investigate the rheological properties of mantle rocks in the laboratory at pressures applicable to Earth's entire mantle is within reach. As an example, in the past few years, our mineral physics group at University of Minnesota has carried out a series of experimental studies using synchrotron x-ray facility at NSLS (X-17B2), establishing flow laws of quite a few constituent minerals of Earth's mantle from olivine, enstatite to garnet. These results provide a robust database for modeling diverse geodynamic processes from mantle convection and melt migration to plate subduction.

Among others, one opportunity proposed for the HPV is to increase the breadth of deformation studies to include problems at lower pressures relevant to the crust. Such exciting new developments will draw great attention from scientists in geophysics and other fields. For example, stress distribution/evolution of cracks in rock materials, which can be probed with x-ray diffraction techniques, is of great interest for both seismologists and petroleum engineers. Such studies would provide better understanding of the development of cracks in the processes of both earthquakes and wellbore stability.

As the proposed HPV will have a great impact to the fields of geosciences and other related fields, I wholeheartedly support the proposed program and hope it soon becomes a reality.

Sincerely

Shenghua Mei, PhD
Senior Research Associate

UNLV
UNIVERSITY OF NEVADA LAS VEGAS

Prof. Donald Weidner, Director
Mineral Physics Institute
Stony Brook University
Stony Brook, NY 11794

August 18, 2015

Dear Prof. Weidner,

I strongly support your effort in establishing comprehensive experimental capabilities under extreme conditions at the National Synchrotron Light Source II (NSLS II). Nearly three decades of high-pressure research at NSLS I was remarkably successful and made great contributions to the field of study. I have no doubt the new high-pressure facilities at NSLS II will continue to be at the forefront of research and benefit the scientific communities for years to come. Indeed your vision of combining synchrotron-based core experimental stations with the Center for Functional Nanomaterials at Brookhaven Lab and the Mineral Physics Institute at Stony Brook University offers a great opportunity for "High Pressure Village" to be realized.

Of all experimental programs described in your proposal, I believe I am uniquely qualified to comment on the large-volume multi-anvil press (MAC) technique as a beamline-scientist turned user. The COMPRES-supported MAC program at NSLS I was a pioneering and world-leading facility in rheological and acoustic studies of the Earth materials at extreme conditions. While some of the capabilities have since been transferred to APS during the "dark period", with newly invented and built D-T25 and D-TCup, the new MAC program at NSLS II promises the exciting opportunity to shed light on rheological properties of the Earth's lower mantle. Again no other facilities on the planet offer such a capability.

Please do not hesitate to contact me if I could be of further help.

Sincerely

Liping Wang

Liping Wang

Associate Research Professor
HiPSEC/UNLV
liping.wang@unlv.edu

Western Science

Department of Earth Sciences

August 15 2015

Execute Committee
COMPRES

Dear Committee:

It is my understanding that COMPRES is evaluating the possibility of setting up high pressure facilities in one of the beamlines at NSLS II. In such a regard, I am writing to express my support on this project.

The Soochow University -Western University Center located in Western University, London, Ontario is dedicated to synchrotron-related research and is of great interest to use all synchrotron facilities nearby and to collaborate with their beamline scientists. In this center, we have at least two groups, Shieh and Yang's, using the high pressure synchrotron facilities (diamond-anvil cell) frequently at NSLS and APS. In addition, my group members (four graduate students and two undergraduate students) used and will use high pressure synchrotron facilities for their thesis projects. My colleagues (Drs. Tony Withers and Desmond Moser) are also interested in using the high pressure synchrotron facilities for our collaborative projects.

Therefore, the beamline with the capability to perform high pressure diamond anvil experiments within NSLS II would be strongly supported by my group.

Sincerely yours,

Sean R. Shieh
Associate Professor
Department of Earth Sciences
Western University

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Dr. Paul RATERRON *

UMET, Bât C6
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Sciences et Technologies
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Providence, August 14, 2015

Dear Don,

I read with great interest and excitement the document you sent me regarding the project of a high-pressure village at Brookhaven National Laboratory. The vision of a facility centered on multi-anvil cells (MAC) and diamond anvil cells (DAC) installed on several x-ray and IR beamlines at the NSLS II, with access to sample preparation and analytical facilities at the Centre for Functional Materials, is definitely the way to go. State-of-art devices are very costly, yet necessary to achieve scientific breakthrough. The proposed *one-stop* facility, where scientists would come and investigate the properties of Earth materials at extreme conditions, would give our community access to such equipment while sharing the maintenance cost with other communities. I had been for many years in charge of a SEM/TEM facility in Lille, France, which is shared between the Earth Sciences and Materials Science communities. Such geometry allows acquiring and maintaining state-of-the art electron microscopes which benefit numerous scientists, with a win-win outcome for both our institutions (less cost) and good science (>30 publications/year, http://umet.univ-lille1.fr/CCM/publications.php?lang=en).

This future facility will work. Indeed, the COMPRES team has an extensive and successful experience in dealing with high-pressure devices at synchrotron beamlines dedicated to the Earth Sciences community. I have benefited for more than a decade, as an international COMPRES member, from the MAC installed at the X17-B2 beamline of the NSLS. General user proposal procedures at synchrotron facilities worldwide (including at the NSLS) allow for temporary and often short access to beamline equipment. This is very suitable for short targeted studies, but not so well adapted to fundamental research which often implies technical or analytical developments, and requires long-time access to beamlines. In particular, the investigation of Earth materials rheology is time consuming, yet fundamental to constrain the plastic properties of the terrestrial planet deep interior. In this framework, COMPRES had been of invaluable help for me, recurrently supplying me with extra beamtime when the general user time was overbooked. This promoted consistency in the planning of my experiments - particularly important when training graduate students - and allowed obtaining critical data on the plasticity of mantle materials which stand today as reference data. This could not have happened without COMPRES.

This is why I would like to express here my strong and wholeheartedly support regarding the project of a high-pressure village at Brookhaven National Lab. Please let me know if I can be of any help to make this project become a reality. It would be my great pleasure.

Best regards,

* Presently at *Department of Earth, Environmental and Planetary Sciences*, Brown University, RI, USA

Farmingdale State College
State University of New York

Farmingdale State College
Department of Physics
Lupton Hall, Room 200C
2350 Broadhollow Rd.
Farmingdale, NY 11735

August 19, 2015

Dear Professor Weidner:

I am writing to express my strong support for the High Pressure Village at the National Synchrotron Light Source II.

The proposed facilities will be invaluable to the high pressure condensed matter physics community, particularly to those of us who are working in fields associated with advanced energy materials, such as superconductors. It is well known that the high pressure phase diagrams of Fe-based high temperature superconductors are rich with new phenomena, including higher critical superconducting transition temperatures T_c than have been observed at 1 bar. Moreover, it now appears that the limit to T_c with conventional doping of this class of materials has already been reached, emphasizing the need to explore high pressure alternatives. Along these lines, we note that we have previously observed striking differences in the properties of this family of compounds when subjected to uniaxial versus quasi-hydrostatic pressures, underscoring the need to have access to both techniques. Infrared spectroscopic capabilities at high pressures, such as those that you have proposed, will provide critical optical conductivity data on prospective superconducting compounds and are some of the few methods of obtaining direct evidence of electron delocalization transitions, proximity to which is thought to be critical for high T_c.

The two major families of high temperature superconductors are thought to be intimately tied to quantum criticality. High pressure is also a powerful parameter for exposing strange quantum critical states in clean magnetic materials without introducing atomic site disorder, the presence of which is likely to transform a desirable second order phase transition to first order, thereby spoiling quantum critical fluctuations.

We are particularly excited that the High Pressure Village will provide the capability to perform *in-situ* materials synthesis and structural characterization at high temperatures and pressures. There is a substantial push in the condensed matter physics community towards theory-assisted approaches to augment the synthesis of novel materials, in which cutting-edge dynamical mean field theory calculations are applied in concert with advanced sample growth techniques to accelerate the discovery of new compounds with transformational functional properties. Accurate electronic structure calculations, however, are strongly dependent on accurate crystallographic information, and the proposed *in-situ* capabilities will contribute dramatically to this effort.

While we invest the majority of our effort in these fields, our group has also spent a portion the last year studying high temperature coating materials for power generation applications. Increasing the operating temperatures of coal, shale gas, and biomass power plants would enhance the efficiency of power generation while reducing global CO_2 emissions. Key measures of the efficacy and robustness of prospective coating materials for these applications include their elastic properties at high temperatures, which are typically challenging to access. The capabilities proposed at the High Pressure Village, however, will provide us with the capability to measure these important quantities directly.

In addition to the above scientific goals, I also wish to stress that the broader impacts of the proposed facilities will be substantial. I am a faculty member at Farmingdale State College, which is designated both a Primarily Undergraduate Institution and a Minority Serving Institution. The opportunities inherent in the High Pressure Village will be instrumental in providing our young scientists with exposure to high pressure condensed matter physics, materials science, and earth science. Over the past two years, 16 students have participated in our research group. Of these, 13% are of African descent, 25% are Hispanic, 25% are women, and 6% suffer from a disability. The majority are from economically disadvantaged backgrounds – 75% qualify for Federal Student Work Study assistance. Outreach is an integral part of our research program, and some 19% of our group members are actually students at local high schools. Without the facilities proposed as part of the High Pressure Village, these students – in particular those who come from populations typically underrepresented in the scientific and engineering professions – would otherwise not have exposure to high pressure research.

In closing, thank you for your continued support of our research and our educational mission. I wish you every success with this exciting opportunity.

Sincerely,

Jack Simonson
Assistant Professor of Physics
Farmingdale State College

University of Nevada Las Vegas
High Pressure Science & Engineering Center
A DOE/NNSA Center of Excellence

UNLV HiPSEC

August 15, 2015

COMPRES Executive Committee / Facilities Committee

Subject: Support for High Pressure Village DAC/LVP Programs at NSLS-II

Dear Colleagues:

I am writing this letter to express my support to the High Pressure Village, led by Prof. Donald Weidner for high pressure Earth science research that is well operated under current and future capabilities at the NSLS-II. Prof. Weidner served as the director of Center for High Pressure Research (CHiPR), an NSF Science and Technology Center from 1990-2001. It was during this period that synchrotron studies at high pressure exploded on the research scene. The CHiPR focus then was to use high-pressure research to understand the Earth's interior. Don is also the founding director of Consortium for Materials Properties Research in Earth Sciences, COMPRES, a community-based consortium whose goal is to enable Earth Science researchers to conduct the next generation of high-pressure science on world-class equipment and facilities. It has served the community since 2002 and continues to be the nucleus for high pressure Earth science research at synchrotrons and neutrons. In particular, COMPRES has been supporting operations at several beamlines at national facilities. COMPRES operates for the community to encounter Grand Challenges since 2002 and continues to play key roles in expanding the role of synchrotron in high-pressure crystallography/deformation studies.

The High Pressure Village for NSLS-II envisions comprehensive investigation of Earth materials at extreme conditions employing frontier sample preparation techniques as well as in situ and ex situ experimental capabilities. It enables diffraction, spectroscopy, and imaging on samples at pressures from the subsurface to the center of the Earth. The combination of synchrotron x-ray and diamond anvil cell (DAC) techniques will enable world-class tools to define atom coordination, element distribution, and inelastic scattering with extremely high spatial and energy resolutions. It fits well with the COMPRES mission and goal. As the HiPSEC executive director, I can foresee HiP Village at NSLS-II further contribution to the COMPRES research and I will be happy to continue participate its developments.

Sincerely yours,

Yusheng Zhao, Ph.D.

Professor, Department of Physics and Astronomy

Executive Director, High Pressure Science and Engineering Center
HiPSEC : a DOE/NNSA Center of Excellence

University of Nevada Las Vegas, NV 89154, U.S.A

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THE UNIVERSITY OF UTAH

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Wednesday, August 19, 2015
Re: High Pressure program at NSLS II

To whom it may concern,

I am writing this letter to support the high pressure program at NSLS II. I am particularly interested in the use of large volume deformation apparatuses such as the D-DIA and DT-25 with angle dispersive x-ray diffraction. Previously much of my experience with NSLS was using large volume apparatuses and energy dispersive x-rays. Energy dispersive x-rays have limitations for synchrotron texture measurements which is my primary focus. Thus I am excited to see these techniques being combined with angle dispersive x-rays. Currently GSECARS at the APS is the only D-DIA with angle dispersive synchrotron x-rays in the United States. However the D-DIA program is limited to only 2 weeks per run and thus available time is quite limited. Furthermore the DT-25 can potentially allow in-situ texture measurement during controlled deformation at transition zone and lower mantle conditions. This will be a unique capability, and one that my group would be excited to use. In addition, radial diffraction texture measurements in the diamond anvil cell are a staple of my research group and we are always delighted to have another beamline available for use.

Sincerely,

Lowell Miyagi
Assistant Professor
University of Utah
Geology/Geophysics

FLORIDA INTERNATIONAL UNIVERSITY

Hope, Knowledge, and Opportunity

Aug. 10, 2015

CESMEC: Center for the Study of Matter at Extreme Conditions

Dear Lars and Don,

I am very pleased to see the progress you are making on the High Pressure Village at the NSLSII. We have used X17C for some decades and it heartening to see that the facility will continue with a revival.

I would like to pursue high pressure chemistry; it would involve study of industrial chemical reactions at moderate pressures and creation of metallurgical phase diagrams in the melting temperature range.

Your development plans are very impressive and I am convinced that their success will take our high pressure science to extreme heights.

I wish you the best in your efforts and we at CeSMEC/FIU will do whatever is needed to support your efforts.

SKSaxena

Surendra K. Saxena,
Professor and Director,
Center for the Study of Matter at Extreme Conditions,
College of Engineering & Computing,
Florida International University,
Miami, FL 33199,USA
Tel: 305-348-3030 Cell:305-338-0615

UNLV

High Pressure Science and
Engineering Center
A DOE/NNSA Academic Alliance
Center of Excellence

University of Nevada, Las Vegas

Las Vegas, August 19th, 2015

Dear Dr. Ehm,

this letter is written in strong support for the High Pressure Village, a platform for experimental research at the NSLS-II and BNL with high pressure as common nexus.

The High Pressure Village addresses the demand for a large volume press (LVP) facility at a high-energy high-flux beamline. Presently, within the U.S. there is only one such facility, which is highly oversubscribed. Many excellent research projects cannot be accomplished or suffer from delays. A new LVP facility at a high-energy high-flux beamline is much needed.

Similarly, the available facilities for synchrotron IR spectroscopy are insufficient for the rather large community of users who need high spatial resolution and/or far IR capabilities. Thus, an 'East-coast' IR microscopy beamline at NSLS-II is much welcome.

I also strongly support the plan to make high-energy high-resolution powder diffraction accessible to the high pressure community. There is a wealth of projects that require resolution beyond the present standard (area detectors, Q-range below 10 $Å^{-1}$). The NSLS-II high-energy high-resolution powder XRD beamline addresses this issue.

The outline of the High Pressure Village promises great synergy between different techniques, which the community will certainly profit from. For instance, the multi-crystal indexing approach, high resolution imaging of large polycrystalline samples – a particular strength of NSLS-II - will open paths for novel science beyond the present limits in examining polycrystalline aggregate deformation.

Sincerely yours,

Oliver Tschauner

Oliver Tschauner
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The University of Michigan

Department of Earth and Environmental Sciences
1100 North University Avenue, Ann Arbor, MI 48109

August 18, 2015

To: COMPRES—

The Consortium for Materials Properties Research in Earth Sciences

As an active user of the former NSLS-I, we have conducted synchrotron XRD experiments at beamline X17c for more than twenty times from 2005 to 2013. X17c has been becoming our major facility for our research: structral changes of materials (including earth materials) at extreme conditions, which is supported by several federal grant programs, such as NSF, DOE-BES, ESRF and SSAA. Up to now, we have published more than 40 papers in various peer-reviewed journals including Nature Materials, PRL, JACS etc. based on the data collected at X17c. The analysis of more data from X17c is still under way. X17c is definctely the indispensable tool for our research.

Since 2013, however, we have to reduce our experimental time because of the shutdown of NSLS-I. Though there are some related beamlines at APS which are suitable for our research, the beamtime at APS is very limitted because of too many users. The beamtime at APS is far from the requirement for the whole high-pressure community around the world.

We strongly support to build high-pressure beamlines at the new National Synchrotron Light Source (NSLS-II) at Brookhaven National Laboratory.

Sincerely

Fuxiang Zhang

Fuxiang Zhang, Ph.D.

Associate Research Scientist
Department of Earth and Environmental Sciences
University of Michigan, Ann Arbor
Tel: 734-647-5704
Email: zhangfx@umich.edu

Dr Simon Hunt
Department of Earth Sciences,
University College London,
Gower Street,
London
WC1E 6BT

20th August 2015

c/o Prof. Donald Weidner,
Mineral Physics Institiute
Stony Brook University,
New York.

To whom it may concern,

High Pressure Studies of Earth Materials at the NSLS-II

I have read with much interest the proposal for the high pressure village at the NSLS-II.

The demise of the NSLS has had a significant impact on my research programme because the facilities present there have not been fully replicated elsewhere. The DT-Cup which was on the side-station of the X17B2 beam-line at the NSLS was unique in the world. The high pressure village at the NSLS–II is proposing to build a larger, more capable, version of the facilities that were present at the NSLS. These facilities will be world leading and enable significant advances in the high-pressure Earth sciences.

I look forward with anticipation to these new facilities coming online in the next few years.

Yours Sincerely,

Simon Hunt

The University of Akron

19 August 2015

Dr. Donald Weidner
Department of Geosciences
Earth and Space Science Building
SUNY Stony Brook
Stony Brook, NY 11794

Dear Dr. Weidner:

I am writing in support of the development of the High Pressure Village at the National Synchrotron Light Source II at Brookhaven National Laboratory. I have worked with Drs. Paul Raterron, Jiuhua Chen and Jennifer Girard for approximately five years using the DDIA formerly located at beamline X17B2 on how water affects the strength of olivine and orthopyroxene. I have also worked with Drs. Andreas Kronenberg, Jay Thomas and Richard Law using the Bruker FTIR formerly located at beamline U2A to map water distributions in naturally deformed quartzites. These results have been published or are in the process of being published. I hope to continue these types of studies, all of which were funded by the National Science Foundation, at the new High Pressure Village at NSLS-II.

I am currently focused on the effects of water on the strength of silicate minerals, but am also working on new mechanisms for deep focus earthquakes (Holyoke et al. 2014, JGR). The proposed capabilities of the High Pressure Village are exactly the types of experimental devices that I will need to extend my work in these areas.

Our results from experiments performed at moderate (4-8 GPa) indicate that there may be a pressure at which the strength of wet olivine aggregates begins to increase dramatically, which may be due to a change in slip system. However, the upper limits of pressure for deformation experiments with significant (>10% strain) in the DDIA has meant that we are unable to explore this problem. The DT-25, which will be capable of deformation experiments at pressures up to 15 GPa, is the perfect tool to extend our study of the effect of pressure on the strength of wet olivine aggregates.

I was glad to see that the High Pressure Village was going to retain the DDIA, though. That device has the perfect pressure range and stress sensitivity to start our study on the pressure dependence of magnesite aggregates. Magnesite, which has similar strain rate and temperature sensitivity to calcite, is stable into the lower mantle and may be a cause for deep focus earthquakes. Unfortunately, very little is known about its pressure dependence. If its pressure dependence is similar to calcite, increasing pressure would result in weakening of the magnesite. This weakening could lead to strain localization into magnesite layers in subducting slabs, which could cause deep focus earthquakes.

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Finally, Jay Thomas, Richard Law, Andreas Kronenberg and I mapped water contents in quartzites using the Bruker FTIR just before the shutdown of NSLS. We observed many variations in the water contents in quartz grains that indicate that water is being progressively lost due to dislocation motion through porphyroclasts and that the recrystallized grains have significantly lower water contents. These results would not have been possible without the very small (<10 micron) spot sizes that cannot be achieved with normal FTIR light sources. We are very excited to continue this study when the new IR station has been established.

If you would like me to clarify or elaborate on any of the points I have made in this letter, please do not hesitate to contact me by email at cholyoke@uakron.edu or by phone at 330-972-7635.

Sincerely,

Submitted electronically

Dr. Caleb W. Holyoke, III
Assistant Professor

Department of Geosciences
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APPENDIX 4

User feedback for COMPRES NSLS-II site review (Aug 20 2015)

User 1:

I have used X17B2 at NSLS and now 6-BM-B at the APS. My experience has been positive at X17B2 & 6- BM-B. Since the D-DIA was first installed at X17B2 there has been a steady stream of improvements to the equipment, which have been aimed at improving performance. It is important to remember that this was the first D-DIA to be put permanently on a beam line so best practices have needed to be developed (the rheology grand challenge group ran the instrument once in Chicago - which was the first experiment ever done with a D-DIA and synchrotron x-rays). I think the first major improvement was a newly designed front-end slit system which made collecting spectra faster. Then there was the scanning program that allowed the press to move up and down while diffraction was being collected - which improves the quality of the data, especially if there is grain growth in the sample. There has also been a steady stream of new imaging capabilities, a newly designed conical slit system, a new detector that allowed us to go from collecting 4 to 10 diffraction patterns at once; which is important for improving stress measurements as well as our understanding of the inner workings of polycrystals. And last but not least the new blue press and the monochromatic side station. The data analysis software (plot85) is home-made and a bit quirky but it is always being updated (by Ken Baldwin) and one can (within reason) request changes and suggest bug fixes. As it true for many synchrotron techniques, the software capabilities are not up to the amount of data that needs to be processed; which is something that the community still needs to address. My only problems at X17B2 were with the wiggler - which was completely beyond the beamline's control. From what I could tell the beam line staff were very engaged with NSLS management regarding the performance of the wiggler. A number of work arounds were attempted including increasing the maintenance schedule at the expense of beam time in an attempt to guarantee beam time for users. It didn't always work out and I lost a lot of my beam time, but as I mentioned before, it was just bad luck which ended with the closure of NSLS.

Two weeks ago I worked for the first time at 6-BM-B. Since the site visit will occur in New York, the committee won't have the opportunity to see this beam line or appreciate what has been accomplished here over the last year. Thinking about the move, I had a very naïve expectation that it was just a matter of packing up all the equipment, shipping it to Chicago and plugging it all back together in the 6-BM-B hutch. Looking around me I recognized the vast majority of the equipment and computers, but they are assembled together differently. Similarly the software GUIs are familiar but the underlying variables that they are manipulating have new names – so this was not just a matter of unplugging and plugging things back together, everything has had to be reconfigured or reprogrammed or re-coded. We had a three day run of flawless operations; all the computer programs worked and the instrumentation was working; I couldn't have asked for more. 6BM-B is a new beamline built from recycled equipment, so it could have easily been different. Haiyan tells me that as of this week Chicago and Stony Brook accountants still have not managed to create a fiduciary relationship that will allow her to take advantage of the APS stock room. The fact that the beamline is up and working in advance of the paperwork, is a testament to the effort that the management team has put into getting this beamline together.

My only problem with 6BM-B is that the intensity from the bending magnet is dramatically less than the beam at NSLS X17B2. Due to a lot of work with the shielding and careful alignment of the detector slits the signal to noise ratio is decent, so for some detectors this is not much of an issue.

However, for diffraction from detectors that look through the sintered diamond anvil tip (on the side anvil), diffraction is particularly weak. I have not reduced my data yet, but I can tell that it is going to be a challenge to extract all the information we need from the side anvils. For the long term, we need to have the D-DIA at a more intense source in order to push the science forward.

In summary, I have worked at CHESS, the ESRF, APS (both GSECARS & HPCAT), and the ALS. X17B2 and 6BM-B compare favorably (as good or better) with my experiences elsewhere. Matt and Haiyan are among the most caring and responsive beamline scientists I have worked with. Matt is particularly brilliant with the equipment. Haiyan takes great pride in perfecting the quality of the diffraction on the beamline. Using the multi-anvil at the synchrotron is probably one of the more difficult types of experiments that one can do. Using a multi-anvil has its own set of challenges and is non-trivial all by itself. Add to this the challenges of doing good powder diffraction work; getting everything to work reliably takes a lot of effort for everyone involved. Stony Brook has always invested a great deal of time and effort to ensure the success of the beamline. Finally, I want to note that Don Weidner has always been very involved personally in the management and operation of the beam-line. Its clearly important to him that we get good data during our beamtime and that everything works smoothly. At the same time he is quite hands off when it comes to what we do with our data. I have been free to model and interpret my data the way I see fit, even when I have disagreed with others at Stony Brook about how the data should be handled. This has allowed me to pursue innovations in data interpretation that are valuable for everyone. So I have found my relationship with the Stony Brook beamline very fruitful on all fronts.

[notes from follow-up phone call]
6-BM-B seen as temporary. 3-year agreement, much lower intensity. (5x). Haiyan has been working on this (background reduction) but still poor. Now using 2x exposure times, and is aware of other users doing the same.
Texture, peak width: Not as feasible because of intensity loss.
Interested in trying angle dispersive diffraction. Might be helpful for user because of interest in texture.
Tunable mono beam? Sweep beam over energy range.
Pushing boundaries, new and innovating things not going to happen at 6-BM. Need photons.

HEX would also be helpful -- white beam there. Same crowd (Zhong, Doryhee) so they know the needs. Battery people main audience there, but they have similar needs (looking through batteries instead of looking into rocks). Exciting capabilities there for former X17B2 users.

User 2:

Thank you very much for requesting feedback regarding the operation of high pressure facility at Brookhaven National Laboratory. I have been thinking about suggestive comments since your first email. I know the site visit is coming up. As a matter of fact, I wrote a letter of support to Don upon his request for the site visit as well. In short, the proposed facilities at NSLS-II are essential for the Earth science community to tackle most challenging problems of the field.

NSLS had been a testbed for pioneer high pressure synchrotron x-ray studies using large volume press (LVP) and diamond anvil cell (DAC) and a workhorse producing tremendous important data for understanding physics and chemistry of Earth's interior. Until its shutdown, NSLS still led the developments in many in-situ high pressure research areas, for example, rheological study with controlled strain rate using D-DIA and RDA, and total diffuse scattering using energy x-ray and DAC.

Although some of the experimental techniques have been replicated at many other synchrotron facilities, activities at the NSLS were still leading the scientific development in the direction at the time NSLS ramping down. It is essential for the Earth science community to keep investing at the NSLS-II so that a state-of-the-art facility and cutting-edge research can be continued.

In the following, I will try to give my comments on the areas you have specifically highlighted in your message.

On-site staffing: The leading PI (Don Weidner) is a pioneer in LVP developments in conjunction with synchrotron radiation sources and is definitely capable to lead the program. The supporting staff for electronics and IT is highly experienced and capable. The beamline scientists are relative less satisfactory. Ideally, a good scientific agenda of the scientists' own greatly motivates them for technical development and scientific engagement to the community. I think there is big space for them to grow currently. This is true for both LVP and DAC area, and particularly more serious in its DAC area.

The anticipated capabilities of NSLS-II facilities: The facility has particular strength in its rheological research capability. While its D-DIA experimental capability might not significantly better than that at APS, the strength at NSLS-II is its scientific driven program on both D-DIA and RDA rheological apparatus. On the other hand, frankly speaking, the source merits at NSLS-II is more beneficial to DAC. Hope the proposed facility will put more emphasis of its DAC area on taking the advantage of NSLS-II sources, e.g. inelastic scattering and high resolution tomography.

Reliability of experimental infrastructure: The High Pressure Village (HPV) concept is similar to HPsync at APS, which has been proved to be very effective and productive. Such an infrastructure at NSLS-II will play a critical role in getting the most out of this new synchrotron light source for high pressure research, and should be definitely promoted. HPV will help the community to take the advantage of the unique characters of the light source (high resolution in energy and spatial dimension). Formation of HVP will also attract experienced users from the community to utilize the other related beamlines than the XPD beamline where a dedicated HP hutch is proposed. The current experimental infrastructure (transferred from NSLS) is very basic (i.e. microscopes, small part handling tools, oven, Ruby system, gasket drilling) and reliable. For improvement, some essential tools for LVP cell assembly (e.g. lathe) should be in place and accessible to users. If NSLS-II does not allow such equipment, the beamline scientists should be trained and qualified to use the centralized machine shop and be ready for help users for occasional demands. DAC gasloading system should be installed; especially COMPRES funded an infrastructure project for building such system and the cost for replicating such system under the COMPRES umbrella should be at no-profit level.

Other comments: For high pressure research, NSLS-II is a complementary x-ray source to APS. For example, smallness of beam size at APS no longer fulfills the demand of super high pressure experiments in DAC. In addition, all high pressure beamlines at APS are significantly oversubscribed, which means many projects in high pressure mineral physics are slowed down or impossible because of the inaccessibility of the facility. This hinders new scientific discoveries or progresses in the field. The mission of COMPRES is to solve such issue for the community as a whole to promote the scientific discoveries. Therefore, establishment of high pressure facility becomes a responsibility that COMPRS cannot relinquish. Certainly, it is always true that the completely satisfactory solution is very difficult to found when the funding is limited. Considering the fact that all high pressure beamlines at APS are funded by multiple funding sources (GSECARS) or partners (HPCAT), a similar funding/operation mode may be explored for the high pressure facilities at NSLS-II.

Hope this helps. I highly care about the program at NSLS-II as an individual of the community because much of my work has primarily come out of the facilities at NSLS. If is not confidential, I would like to learn about the outcome of the site visit, and am willing to help in any form.

User 3:

Sorry for the delay. My thoughts are probably a bit out-of-date, since I've been in Europe and haven't heard much about the progress with NSLS-II, except that we won't have a dedicated high pressure beamline. My understanding is that NSLS-II will be able to provide a nano-resolution focused X-ray beam. If this high spatial resolution is made available for high-pressure diffraction or tomography, I will be interested in using it in the future. Availability of laser heating is also important to me.

I went to X17B3 and X17C regularly for powder diffraction from 2006-2011. The availability of beamtime and travel support from COMPRES made it an appealing place for students like me to work. But we also went to APS, which made NSLS look pretty bad. NSLS broke down more often, beamline facilities like laser heating were often broken/unavailable, and staff were less competent and less available at late hours. During one run, we collected data that later appeared to be worthless due to a failure by the beamline scientists to calibrate the energy properly. We left another run early when the laser heating system broke down and the beamline scientist had no idea how to fix it. I did end up with 1 1/2 publications based on NSLS data (the 1/2 started at NSLS and was heavily supplemented with APS data).

User 4:

I just wanted to add my voice to the collective opinion of a large number of our colleagues in the high-pressure research community who feel that our measurements at the NSLS X17 beam lines of a spectrum of physical, chemical, and transport properties of rocks at very high pressures have been critically important to progress in understanding the behavior of the deep earth. The utility of synchrotron research to earth science is evident in its proliferation around the globe. Over the years, and lately under the umbrella of the COMPRES organization, which serves to coordinate and facilitate high-pressure earth sciences research, our synchrotron measurements at X17 have developed as part of a coherent and coordinated effort in studies of the deep earth involving a spectrum of research methods. These methods range from high-pressure, high-temperature laboratory properties measurements such as ours, to electron microscopy of laboratory and natural samples, to high-resolution seismic imaging of the deep earth itself, to ab initio computer modeling of solids at pressures beyond our current reach. I wish you success in your efforts to map the vital operations at X17 to new beam lines at NSLS II so that we may continue to support our commitment to the community and to keep up with the exciting work in the studies of the deep earth.

User 5:

Thanks for the request
I do not really have any recent experience at NSLS/NSLS-II.

User 6:

My first reaction about doing experiments at NSLS-U2A is what an asset Zhenxian Liu has been. He is one of the best people I've ever worked with at user facilities. He's been involved to the point that we have co-authored most everything I ever published coming from U2A. The one thing about Zhenxian is that he has been incredibly over-stretched in my opinion. He's not only running the beamline but doing the scheduling, writing grants, getting new instruments, developing new instrumentation, working with every single user, etc. My hope is that in the future at FIS Zhenxian might have administrative assistance or a post-doc level person helping him run the show.

As for equipment, U2A was in really good shape. The new interferometer and Hyperon microscope are ideal for the NextGn model (transfer of existing equipment), although it is also important that a separate/flexible optical beam path be re-built (previously serving transmission-geometry DAC Raman, IR, UV-VIS and cryostat). Most of the old optics in that path worked ok, but I'm sure there could be improvements in design, optics, and lasers. Maybe all the old gas lasers could be eventually replaced with SSDP lasers (blue+green+785) to save space and noise/water cooling.

My student Josh Townsend has been helping him put together a CO2 laser heating system, but that is currently indented to be off IR-line, which is fine for most things. In fact, since I work mostly in the near-mid-IR it would not make sense to incorporate it into the IR beampath, other than the ease of not transferring the cell. For us, the CO2 laser-heating setup is a synthesis tool, and a very important one.

I also really like the cryostat setup and we have used that extensively even for geophysical research (like reflectance of methane liquid-solid transition or trying to sharpen OH bands from bridgmanite after synthesis at Mbar pressures). The Raman system was adequate, but not excellent. I do like how it was interfaced with the transmission (DAC) mode of IR so one could flip back and forth. Because ruby, Raman, and potentially CO2 laser heating are integral to things we do with IR, I hope that early planning can be made for the hutch to allow safe but also easy access and laser use in the IR hutch, which I recognize will be shared. Design will be important in that respect. Non-users may tend to think of FIS as just an IR system, but as you well know Zhenxian had like 5 or 6 optical setups spanning wavelenghts from UV through the far IR.

Also, if one could have everything they want during IR time, it would be to have a place to collect quick XRD patterns. At U2A we often needed structural confirmation or a lattice parameter that could not be obtained by Raman. Fortunately, the people at X17 were often willing to accommodate a quick pattern now and again. That was very beneficial. So, another thing to consider is what XRD beamlines will run concurrently and how to schedule such that e.g. peak user time of IR and XRD have minimal overlap. Who knows, maybe XRD users may wish to collect an IR pattern now and again.

Finally, a gas-loading system should be built at NSLS to serve all high-pressure beamlines.

User 7:

I participated in some LVP experiments conducted at the NSLS X17B2 facility during the period of 2005-2008. At that time Liping Wang was the beamline scientist. He was one of the most helpful and hardworking beamline scientists I have worked with. The support provided by other support stuff like Michael T. Vaughan, Carey (forgot his last name), and others was also great. I enjoyed working with them. The multichannel solid state detector used at X17B2 was an important development to enable stress measurements using white beam with collimation. I did not have chance to use the later installed SAM2010 press.

I have not had any user experience after 2008, but I have a little concern about the current situation. I understand it is a very difficult transition period from NSLS to NSLS II and the COMPRES supported NSLS team has made enormous efforts to make this transition as smooth as possible. I think the collaboration with APS at Beamline 6-BM is critical to keep users of the former NSLS. But just based on my limited observation, there seems to be much less technical support at 6-BM of APS with only Haiyan Chen as the beamline scientist in residence. Although she has done a terrific job in setting up the beamline almost single handed, I think more support is required. Of course some support may be sought from APS, but such support would not be very timely and sustainable and it would be very difficult for further technical development customized to user needs.

As a user relying on synchrotron facilities, I always look for new technical developments, new capabilities, and new opportunities at beamlines. Compared to the GSECARS and HPCAT facilities, I feel NSLS is somewhat lagged behind. Of course, this may be due to this NSLS to NSLS II transition. I do not know how the funding structure works at COMPRES, but I think it would be beneficial for COMPRES to provide some support or seed money for new technical developments in addition to routine operations.

User 8:

We have been using NSLS I (X17B2 and U2A). At X17B, the subject of our studies is plastic deformation of minerals under the deep mantle conditions. We developed a unique apparatus called RDA (rotational Drickamer apparatus) by which we have conducted deformation experiments under the controlled strain rate, P and T up to P=28 GPa, T=2200 K (to the shear strain of ~100 %). Because of our complicated sample assembly design, the white beam x-ray diffraction facility where the location of diffraction volume is well-defned best serves to our purpose and the facilities developed by Don Weidner and his colleagues has been playing a crucial role in our studies. In NSLS II, the emphasis is on the monochromatic X-ray, but HEX supports white X-ray as I understand. In near future, we are planning a few directions to further improve experimental techniques for the studies of plastic deformation. One of them is to determine the stress exponent of a flow law in one experiment taking an advantage of the rotational geometry. In order to make such a development, a close collaboration with a beamline scientist, electronics technician and a machinist is very important.
At U2A, our study has been to characterize H in minerals. One of the fundamental issues in studying H in minerals under high P-T conditions is how well are the site of H at high P-T conditions quenched during "quenching"? In most of the experiments, we prepare a hydrated samples at high P-T and quench the sample, and study H on a "quenched" sample at ambient conditions. However, the ability of quenching is questionable particularly in samples where H solubility increases strong;y with T. The in-situ FTIR capability at U2A has provided a unique opportunity to address this question. However, the current capability of the in-situ FTIR is limited to relatively low P and T. I believe that this issue is critical particularly in the lower mantle minerals.

In both cases, close collaborations with the beamline scientists (+ technical support people both in machining and electronics) have been essential.

User 9:

Thanks Andy for asking my feedback.
I have not visited BNL for a while and have no feedback on the new beamline.
However, I wish to know the beamline and those feedbacks from others in the future.

User 10 [phone notes]:

no good signal at x17c. Not bright enough for radial diffraction.
White RDA stuff was good. RDA had high failure rate. Good beamline though. Prefers to do DAC stuff at ALS. 15 keV really helpful for DAC radial diffraction
NSLS getting too old; did DAC stuff elsewhere. White beam unique though.

Getting emails from Don and Lars about NSLS2. More interested, especially in Angle dispersive LVP. Stress measurement better w/ white beam maybe, but main application will be better at NSLS-II. (Texture better with angle disp.) Definitely going to use XPD! D-DIA sounds good, and so does diff. T-cup (DT25). D-DIA time too competitive at gsecars. Less likely to use DAC program there; ALS much better for his work.

User 11:

Sorry for late reply. I did not see your email till now. My comments are as follows.

Onsite staffing - There is a need that a user support staff with DAC experience on site for community. There is a case that supporting staff without DAC experience has the excuse that failed DAC users and caused unwanted complaints.

The anticipated capabilities of NSLSII facilities - Beamline equipped with high pressure and high temperature DAC facilities.

The adequacy and reliability of experimental infrastructure - Support for high pressure and temperature XRD experiment using DAC, gas loading system and user-friendly data collection system.

User 12:

I was a user at X17B2 from 2005 to 2010. I used X17B3 beamline as well but only for a couple of days. My experience at X17B2 has always been positive with reliable support from the beamline scientist and staff members at any time of the day or of the night. X17B2 leaders have continuously provided the mineral physics and rock deformation communities with development of new capabilities: a side station with monochromatic beam to increase the beamline allocated time, 10 elements detector to improve stress measurement resolution and development of deformation apparatus such as the D-tcup, to just mention a few. The beamline was always popular, productive and heavily booked.

Numerous efforts were made to increase the time available at X17B2. I, personally, never had down time due to malfunction of the equipment, electronic or shortage in consumable supplies. My only drawback was the data treatment. I wish it was more reliable and automatic then, but my understanding is that with the installation of the 10 elements detector came an upgraded data analysis software.

The XPD-D beamline at NSLSII shows promising and exciting resources to advance time resolve and 3D tomography rheological studies, for instance. I wish to see an effort into interesting and integrating the rock mechanics community in this venture with the incorporation of lower pressure and larger volume apparatus allowing the community to take full advantage of the beamline capability for the study of rock-fluid interaction, earthquake, faults and other lower pressure phenomenon.