Response to first CDI BAT report

We thank the BAT for their careful and thorough response. Below, we collect and respond to the points raised in the report delivered on 12 March 2018.

Optical Design:

(1) On the proposed beam size range of 1 to 10 microns in diameter and the inclusion of a DMM:
We appreciate the BAT's comments endorsing the inclusion of a double multilayer monochromator and the enlargement of the design focal spot size on the sample from 7 microns to 10 microns in the beamline scope. Our design efforts will proceed under this guidance. Initial calculations also show that it is feasible to include a DMM with minimal change to our optical design.

(2) On the required vertical displacement of the vertical focusing KB:
The BAT correctly identifies that the optical design for the beamline will result in a change of the beam elevation as the spot size is changed on the sample, i.e., as the vertical KB mirror is translated along the beam. We will limit the impact of this elevation change through minimizing the deflection of the first vertical mirror and careful design of the motion system for this mirror.

(3) On the acceptance of mirrors:
We thank the BAT for their advice and concur that 4-sigma acceptance of the coherent beam is good design parameter for the optical system.

(4) On engaging with DOE wave-front sensing diagnostics programs:
Mourad Idir is a member of both the DOE's wavefront sensing program and the CDI beamline development team. We agree that diagnostics will be vitally important to productivity of this beamline and will pursue collaboration with other Labs where appropriate.

(5) On beam pointing instabilities and long-term drift:
Following the BAT's recommendation, we will study the potential impact of long-term drift through engagement with NSLS-II engineering and survey staff and simulate the impact of angular instability using SRW.

(6) On the possible inclusion of an x-ray phase plate:
We thank the BAT for bringing this possibility to our attention and will study its feasibility and impact. We note that such a device will be commissioned at 4-ID of NSLS-II in the near future and we will engage with beamline staff there. In general, the current optical design provides ample opportunity for the inclusion of this device.

(7) On contingency plans for failures of the optical system:
We have considered a number of failure scenarios.

(a) The vertical and deflecting mirrors in the FOE cannot be dynamically bent.
In this case, the focal spot size at the sample would be fixed. If the mirrors were flat, the current design could create a round focal spot of approximately 4-micron diameter and a fluence of more than 10^{11} ph/sec. Simulations have confirmed that the beam size at the sample

can be controlled by closing the mirror entrance apertures (Our design calls for entrance apertures on each KB mirror and an exit aperture after the second mirror of the pair.); by closing the aperture, the spot on the sample can be made larger, with a concomitant decrease in fluence.

(b) The vertical deflecting mirror induces unacceptable beam motion.
It may be possible to operate the beamline without the vertical mirror. This would entail reducing the deflecting angle as much as possible, which is desirable for the optical design, but disfavored for the loss in harmonic rejection.

(c) One or both of the mirrors has an unacceptable figure or slope error.
This would be difficult to compensate. One could try to implement phase-correcting plates, which have been used with CRLs. Sufficient space will exist in the design for including these. We would, of course, seek remediation with the vendor.

Detection

(1) On the arc-style detector mover being preferred to a gantry-based solution:
We thank the BAT for its endorsement of this concept and will move forward with its design.

(2) On continued study of the preferred detector motion system:
We have made considerable progress toward a final concept for this motion system. It will be vetted during future reviews.

(3) On decreasing the sample-to-detector distance:
We have achieved the recommended reduction to 0.4 m in the current preliminary design.

(4) On increasing vertical range if possible:
We will monitor progress on the mechanical stability of the detector elevator to evaluate the feasibility to increase the travel range beyond 1.5 m.

(5) On encouraging the continued study detector options:
We will continue to monitor detector developments and not commit until the risk-benefit analysis of waiting for new technologies is no longer favorable.

Sample handling

(1) On encouraging a laser-ready hutch design and specification of the laser system:
We will proceed under the assumption that the desired laser is a class 4 system and we acknowledge that the BAT recognizes a rich science case in probing 10s-to-100s-of-picoseconds time-scale dynamics with the proposed instrument, and we will explore the additional needs of optical-laser pump experiments with the user community.

(2) On studying the diffraction geometry with an eye to simplifying the goniometer:
As the design progresses, we perform detailed studies and experiment simulations to establish the requirements on the sample positioning system.

(3) On concerns regarding the stability of the goniometer for scanning CDI:

We will discuss the projected stability of a new goniometer with vendors and the existing performance of such devices with colleagues at other facilities.

(4) On increasing the scanning range on sample holder within a 1 kg load limit:
We thank the BAT for their input on the required range of motion on the sample. As our requirement for the goniometer take shape, we will endeavor to meet the designed ranges of motion.

Interfacing with NSLS-II groups

(1) On collaborating with the Metrology group for wave-front sensing:
Mourad Idir is an active member of the CDI development team and we will further discuss wavefront sensing and other diagnostic needs of the beamline as we move toward a preliminary design.

(2) On collaborating with the Multi-modal Imaging task force:
The multimodal task force has strong input from the Imaging and Microscopy Program, of which CDI is a member, and we will continue to discuss needs and remain abreast of current developments at the facility.

R&D

(1) On studying the implementation of a pink beam Laue mapping capability:
The BAT raises an interest application for the fast mapping of polycrystalline materials. We are not aware of any current implementation of this idea, but will pursue it with colleagues at NSLS-II and, potentially, the APS.

(2) On the need for algorithms for strong-phase compensation in CDI:
We agree with the BAT that this remains an important question for the user community, especially with respect to BCDI. There have been proposals to pursue this within NSLS-II already. We will actively pursue this vein of research.

(3) On the required temporal coherence in BCDI:
The BAT correctly point out that the proposed reduction of temporal coherence through the use of a DMM will impact the maximum size of a crystal that can be imaged by such a beam via BCDI. We will study this problem through simulation and use the outcome as a bound on the bandpass of the multilayer in used in the DMM.

Support infrastructure

(1) On the recommended proximity of user labs to the instrument:
We thank the BAT for the recommendation. We will endeavor to remain aware of and contribute to NSLS-II's ongoing effort to provide user support facilities in LOBs around the ring.

(2) On the recommendation for a clean environment around the sample location:
We agree with the BAT and will plan to provide a "clean-tent" with a slight positive pressure of filtered air surrounding the sample location. Other solutions may become apparent as the design progresses.

(3) On implementing a procedure for maintaining hutch cleanliness:
We will study the measures undertaken at NSLS-II, e.g., in the HXN hutch, and adopt similar measures where feasible.

Other

(1) On the recommendation for more human resources, especially in the areas of scientific design, engineering, and user-support software programing.
We thank the BAT for the recommendation. A posting for a beamline scientist will soon be advertised. We will continue to work to clearly identify personnel needs.

(2) On the BAT preference for the longer beamline concept:
We acknowledge the recommendation and will proceed to study the choice of beamline location by considering the BAT's concerns

(a) The BAT recommends continued simulation of the longer concept and we will comply with this request. We acknowledge the BAT's assessment that the optical design is more favorable for the longer beamline concept.

(b) The BAT notes that the measurements on floor motion and correlation lengths at HXN are more favorable than those of the experimental floor. We will continue to make measurements of this kind on the experimental floor at 9-ID and 3-ID, as well as inside the HXN out-building; however, we agree that the instrument will need a highly stable floor over large distances.

(c) The BAT notes that the location of an out-building at 9-ID is closely compatible with the conceptual design of the experimental hutch. We acknowledge the BAT's concern about complications arising from potential interferences with existing and future instrumentation at the facility.

(d) The BAT notes that the placement of the instrument inside an out-building might lead to a later completion date for the BCDI endstation, but that a slightly longer time-line is acceptable. We thank the BAT for this assessment. We continue to work to provide the described capabilities to the user community as quickly as is feasible.