12-21-07

Report from the review committee of the Preliminary Instrument Design Review of the CXI Instrument for LCLS

December 4, 2007

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Committee: John Arthur (SLAC), Chris Jacobsen (Stony Brook), Stefano Marchesini (LLNL), and Michael Soltis (SLAC)

The committee wishes to convey its thanks to the principal presenter for his efforts in preparing and giving the presentation. The committee found the preliminary design well thought out, and the proposed design viable. The design appears to be appropriately flexible and applicable to a wide range of diffraction-imaging science. *Therefore, the committee recommends that the experimental team move forward with the design leading to a Final Design Review, taking into account the comments and recommendations enumerated below. These comments and recommendations are given in no special order.*

1. The instrument utility depends on the performance of the focusing system, which plans to utilize KB mirrors. At this point it is not certain whether the required focus efficiency and wavefront preservation can be achieved. *It is recommended that LUSI actively collaborate with one of the leading KB mirror development programs, so as to better understand the state of the art and minimize risk in this area.*

2. In addition to KB mirrors, this instrument plans to use Be lenses for focusing. At this time it appears that lenses with the desired focal length are not readily available. *The CXI team needs to pursue this issue with the lens vendor, to be certain that the desired lenses can be procured.*

3. The range of applicability of the Cornell detector is still being decided. This has the consequence that some detector specifications, such as the diameter of the central hole, are not yet determined. *The CXI team needs to finalize the application-driven specifications for the detector soon. The CXI team should investigate the possibility of a detector scaffold that would allow for a variable central hole.*

4. Analysis of the experimental data will be affected by the quality of the X-ray focal spot, so a reliable technique for determining X-ray wave shape at the focus needs to be developed. Two concepts were presented during the review, but it is not yet clear if either concept will work for CXI. *Since this is an issue common to other LCLS experiments and experiments at other XFELs, it is recommended that LUSI collaborate with other XFEL groups in R&D in this area.*

5. The current concept for an experimental chamber stresses flexibility, with lots of access ports and valves. The committee approves of this flexible approach, since it is not yet clear exactly which types of imaging experiments will prove most suited to

LCLS. After some experience is obtained, a more specialized second-generation chamber may be desired.

6. The committee feels that in the near term, a scientifically-productive use of the CXI station could be for performing crystallography using sub-micrometer-sized crystals. *The CXI team should examine the needs of such experiments, in particular detector and sample holder needs, and make sure that a proof-of-principal experiment could be accommodated by the near-term instrument design.*

7. It is likely that X-ray beam time for the CXI instrument will be very limited. Therefore, it is important for this instrument to support as much off-line setup, testing, and diagnostic work as possible. Off-line analysis of the sample delivery system and sample quality, for example, should be used to avoid unproductive beam time. Moreover, automation should be employed where possible (i.e. for changing micro-crystal samples). *The CXI team should decide which off-line diagnostics would be most effective for this instrument, and include them. In addition, the team should study the user interactions and data flow at synchrotron crystallography facilities, to better enhance the user-friendliness of the CXI instrument.*