LUSI-LCLS-XCS Preliminary Design Review, Friday, July 25, 2008
SLAC-KAVLI Building, Room: 222

Reviewers:
E. Alp (APS), B. Brajuskovic (APS), T. Rabedeau (SSRL)

Presenters:
Aymeric Robert
Eric Bong

Also present from LCLS/LUSI: R. Boyce, S. Butet, Y. Feng, T. Fornek, J. Hastings.

Our committee was presented with the technical and scientific aspects of the X-Ray Correlation Spectroscopy Instrument (XCS) as well as budget and WBS.

We were very positively impressed with the technical, budgetary, and scheduling details given at the meeting. It is clear that what was presented is commensurate with the time frame and financial aspects of such a large project. We commend the technical staff and LUSI management for the work they have done so far.

Our committee was charged to review the project from four perspectives as follows:

1. Scientific Goals
2. Technical Design
3. Value Engineering
4. Opportunities

1. Scientific Goals

i) A. Roberts has completed a comprehensive survey of the current worldwide literature to determine the exact energy and momentum transfer map to identify the target domain for the XCS instrument. This survey is the basis of some of the critical scientific decisions with respect to energy and momentum transfer range.

ii) In addition to XCS, the scientific scope has been widened to include small-angle x-ray scattering, SAXS, and wide-angle x-ray scattering, WAXS, over 8-24 keV. This expansion may be difficult to realize with tight budget allocation. It may be advisable to split the low energy part and simplify the high-energy effort. Particularly, the large energy range between 8-24 keV is a major cost-determining factor. The science team is advised to re-visit this issue.

iii) One of the innovative aspects of the scientific program is to extend the time-resolved studies to nanosecond regime by implementing a "split-and-delay" instrument. While this is an exciting prospect, and some early work in Europe proves the feasibility for a fixed-wavelength, it remains to be seen if such an instrument can be developed fully tunable over a large energy range. The committee feels that, if this is part of the scientific program, the "split-and-delay" instrument itself should be included in scope, cost and schedule.

iv) There is a concern that the LCLS electron-beam based source fluctuations may limit the scientific program for XCS.

2. Technical Design

i) The committee was surprised to see the length and the number of optical components needed to bring the beam into the experimental area. Because of the complexity of the LCSL machine, and the need for diagnostics over 450 m length of the beamline, the choice of 60 cm horizontal off-set between XCS and CXI beamlines might drive the cost up. This should be re-visited after the exact locations of the XCS upstream components are determined. In particular, the location of the monochromator at 200 m upstream of the sample position may prove to be too long of a level arm, in addition to creating a need for a separate beam pipe and additional diagnostics.

ii) The need for the horizontal deflecting monochromator to operate between 8-24 continuously should be revisited. A tunable monochromator operating in the larger energy half of this energy range significantly complicates the design of the large offset monochromator, raises the cost of the monochromator, and potentially compromises its stability yet it is not well justified. Instead a fixed energy monochromator operating at some appropriate energy inside this upper energy range should be considered in addition to a tunable large offset monochromator operating in the smaller energy half of the energy range. This approach is more consistent with likely beam split and delay systems that will eventually replace the 8.3keV fixed energy system.

iii) Photon shutters after each diagnostic element is not necessary, and should be replaced with simple commercial actuators with a steel block at the end.

iv) The monochromator is supposed to be a common element, and to be duplicated for the XPS beamline, following a contingency plan. Thus any change in scope or implementation is to be coordinated. It may be better to decouple the two instruments, and if in the end, they turn out to be the same, two instruments can be ordered at once.

v) Position sensitive detectors with 4-PIN diodes may not have the sensitivity at low photon flux. So the diagnostics detectors should be re-considered. APD based system may prove to be a better alternative.

vi) There seems to too many "coherence-reducing" optical elements in the way before the x-ray beam hits the sample. We have counted some 20-bounces or filter transmissions. While the reduction in coherence at each element may be tolerable, when there are so many, the net coherence degradation should be a concern. The team is advised to look at this issue, and reduce the number of elements in the beam to a minimum.

3. Value Engineering

i) The long-arm detector mount, LADM, based on the APS-HERIX design, may be overkill in terms of stability and resolution requirements, and therefore a design simplification is recommended for potential cost savings. Specifically, for the XCS application only the detector position need be carefully controlled while the upstream end of the flight arm can be designed with much coarser position control hence cost. The APS HERIX instrument had to line up five elements (sample, slits, detector array, collimator and the analyzer array), thus the requirements were much more stringent. LUSI_XCS team can relax the resolution and the repeatability requirements for the upstream set of stages, and potentially save money.

ii) For the LADM, pipe dimension should grow as the x-ray beam progresses towards the detector to minimize the total weight.

iii) The granite block to move the diffractometer should be either eliminated or replaced with a cheaper design

iv) It was difficult to get a clean break down between instrument and effort costs, since some of the XCS instruments are common with the other two LUSI beamlines. We advise to remove this uncertainty soon to keep the schedule and cost tractable.

v) 35 % financial contingency is considered appropriate and adequate. Enough floats in the schedule is provided to allow LCLS management to adjust the work load during the simultaneous construction of 3 beamlines assuming the orally presented figure of 100 working days

4. Opportunities

i) The main XCS detector is to be built by BNL. Our review team considers this a wise decision and considers it the right way to go.

ii) The scientific opportunity to implement "split-and-delay" instrument is considered to be very important by our committee, and therefore, every effort should be made to include the construction of this critical component in the main program. However, it is also possible to consider a fixed-wavelength version of the instrument as Phase I, and delay the tunable "split-and-delay" instrument to a later period, after the beamline is completed, and early science experiments are done.