

Closeout Report

on the Review Committee for the

LCLS Ultrafast Science Instruments (LUSI)

at the

Stanford Linear Accelerator Center

April 20-22, 2009

Daniel R. Lehman, Chair
DOE/SC Review Committee
Office of Science, U.S. Department of Energy
<http://www.science.doe.gov/opa/>

Review Committee Participants

Daniel R. Lehman, DOE/SC, Chairperson

SC-1

XPP Instrument (WBS 1.2)

*Robert Schoenlein, LBNL
Eckhart Foerster, U. of Jena

SC-2

CXI Instrument (WBS 1.3)

*Al Macrander, ANL
Zenghu Chang, KSU

SC-3

Diagnostics &

Common Optics (WBS 1.5)

*Mark Beno, ANL
Jorge Rocca, Colorado State
Peter Takacs, BNL

SC-4

Controls/Data Acquisition

Systems (WBS 1.6)

*Mohan Ramanathan, ANL
Deming Shu, ANL
Tony Warwick, LBNL

SC-5

XPCS Instrument (WBS 1.4)

*Simon Mochrie, Yale
Ali Khounsary, ANL

SC-6

Cost and Schedule

*Richard Stanton, LBNL
Ray Won, DOE/SC

SC-7

Project Management

*Erik Johnson, BNL
John Haines, ORNL
Steve Tkaczyk, DOE/SC

SC-8

ES&H

*Hans Vogel, PPPL

Observers

Pedro Montano, DOE/SC
Thomas Kiess, DOE/SC
Thomas Brown, DOE/SC
Tony Guadagni, BNL

Hannibal Joma, DOE/SSO
Hanley Lee, DOE/SSO
Brian Huizenga, OECM

LEGEND

*Chairperson

Count: 18 (excluding observers)

Charge Memorandum

Charge Questions

1. Technical Scope: Are accomplishments to date and planned future activities adequate to meet baseline objectives, including two remaining FY 2009 Level 2 milestones? Is it reasonably likely that the instruments will meet the CD-4 criteria (e.g., Key Performance Parameters and required hardware) that are specified in the PEP? Have appropriate plans been made for each instrument's procurements, integrated assembly, and transition to operations?
2. Project Management: Is the LUSI project being properly managed for its successful execution? Is the management approach, including interactions among the project team, Instrument Team members, and other stakeholders, effective? Are issues identified and resolved in a timely manner? Are there opportunities for improvement?
3. Resources and Risks: Are adequate resources being applied to effectively execute the remaining LUSI project scope? Have the most major risks been identified and addressed? How well are remaining risks and uncertainties being managed? Is the contingency (cost and schedule) being managed well to address the remaining risks?
4. ES&H: Are ES&H aspects being properly addressed? Are Integrated Safety Management Principles being followed?
5. Prior Reviews: Has the project responded appropriately to previous reviews?

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2.4 Diagnostics and Common Optics (WBS 1.5).....	Beno/SC-3
2.5 Controls/Data Acquisition System (WBS 1.6).....	Ramanathan/SC-4
3. Environment, Safety and Health (Charge Question #4, 5).....	Vogel/SC-8
4. Cost and Schedule (Charge Questions #3, 5).....	Stanton/SC-6
5. Project Management (Charge Questions #2, 5).....	Johnson/SC-7

2.1 X-ray Pump/Probe Instrument

Robert Schoenlein
Lawrence Berkeley National Lab

Eckhart Foerster
University of Jena

2.1.1 Findings

- **Clear presentation made of project organization and plans**
- **Technical scope consistent with budget and the needs for early science**
- **Project is being effectively managed to meet and/or accelerate schedule while mitigating risk**
- **Thorough FIDR (March 2009) – some advanced procurement approval**
- **Laser Amp and Optical Parametric Amp (OPA) – recommended for procurement approval for “early science” (FIDR March 2009), DOE authorization not received**
- **Critical path items: (1) goniometer, (2) detector, (3) common optics and diagnostics, (4) installation**
- **Considerable schedule float for CD4, larger issue - meeting early science goals**
- **Procurement issues – more than manpower problem – cumbersome system now complicated further with ARRA**

2.1.2 Comments

- Overall project in very good shape – commendation to Inst. Scientist, Engineer
- Not limited by CD3 – very effectively using ‘advanced procurement’ approval
- Strongly support re-scope to include large-offset monochromator
- Detector contingency appears to be too low, and not well justified
- Possible mis-communication on FIDR recommendation and DOE approval letter re: laser amplifier and OPA procurement approval
- Very encouraged to see project team looking beyond CD3/CD4 requirements and focusing on more ambitious “early-science” goals
- Effective back-up plans for goniometer and detector in place
goniometer back-up should be communicated to user community
- Strongly support accommodation of other sample environments (comment from previous review) – question of science priorities (enhanced capability at small cost), need to communicate details to user community

2.1.3 Recommendations

- **Secure DOE procurement approval for laser amplifier and OPA (May '09)**
- **Re-evaluate contingency on detector, provide better justification (June '09)**
- **Develop installation schedule to avoid delay of “early science” (June '09)**
- **Develop testing/commissioning plan to meet “early science” goals (Oct. '09)**
- **Secure ES&H approval *in advance* for novel components (robot, OPA) (Oct. '09)**
- **Implement other sample environments (vacuum chamber, cryo) – (Oct. '10)**

2.2 Coherent X-ray Imaging

Al Macrander, Zenghu Chang

2.2.1 CXI Findings

- **CXI is in good shape. The prospects are very exciting.**
- **Several bids were received for both 1 micron and 0.1 micron mirrors.**
- **Several bids were received for the mirror manipulator + the vacuum system.**
- **Detector plans look adequate.**
- **Collaboration with FLASH is very helpful.**

2.2.2 CXI Comments

- **The CXI particle injector is very far from optimum. R&D could be facilitated by adding staff to a lab for an “injector” specialist now at PULSE. This may possibly be facilitated in HR.**
- **Science users will be implementing algorithms to invert to real space, and an additional scientist on the CXI team that can concentrate on implementing algorithms should improve early and full productivity for the exciting CXI instrument.**
- **There is very long lead time for the mirrors, and there is not a good reason to delay procurement of either the 1 micron or the 0.1 micron KB mirror pairs .**

CXI Comments (contd.)

- **A vendor has been selected for 1 micron mirror manipulator , vacuum system , and stand. Vendor selection on the corresponding 0.1 micron system has not been made**
- **A successful speed-up in schedule for 0.1 micron system necessarily entails an additional mechanical designer .**
- **Contingency looks reasonable even if a damaged mirror needs to be replaced.**
- **An MOU between SLAC and LLNL is planned for mirror metrology (including test coupons) and for mirror coatings.**

2.1.3 Recommendations

- **Procure mirrors for 0.1 micron KB system.**
- **Have manipulator and vacuum system for 0.1 micron system evaluated by several experts as soon as possible.**
- **An additional mechanical designer should be added to implement both KB systems.**
- **Expedite the SLAC/LLNL MOU for metrology & coating.**
- **Facilitate R&D on the particle injector.**
- **Improve coupling to the science users on software with an additional CXI x-ray scientist.**

2.3 WBS 1.4

Simon Mochrie and Ali Khounsary

Findings:

▪ The confluence of (1) achieving laser action at 8 keV by LCLS, (2) ARRA funding, permitting schedule acceleration for XCS, (3) the success of the split-and-unit, and (4) the mature design of XCS has created an extraordinary opportunity to carry out innovative hard x-ray science, but there's a need to move in a timely fashion.

Comments:

The potential now exists for (1) through (4) to transform the paradigm of x-ray correlation spectroscopy (XCS) but also very high-resolution inelastic x-ray scattering, conceived in the time domain.

Recommendations:

- Laboratory, LCLS, and LUSI management should do their utmost to exploit this tremendous opportunity.
- Laboratory, LCLS, and LUSI management should initiate early planning for how to accommodate operations and General Users at XCS.

2.3 WBS 1.4

Findings:

- MOU with DESY recently signed for the critical split and delay unit (SD)
- SD is built and successfully tested and is to be at SLAC for an initial period of 3 years, starting in Summer 2009 or where agreed.
- The DESY SD operates at a single energy.
- After 3 years, there's the possibility/likelihood that the MOU may be renewed.

Comments:

Coherence degradation has been shown experimentally to be minor. This device at LCLS running at 8 keV will be transformative for XCS and sub-meV inelastic x-ray scattering in the time domain. Paper describing the SD is submitted for publication. SD data reduction methodology is demonstrated. DESY will provide a scientist on-site at SLAC.

Recommendations:

- Initiate design and procurement of a LUSI SD, incorporating the possibility of tuning the energy, and avoiding air attenuation.
- Evaluate what level environmental control is needed for the SD to maximize stability.

2.3 WBS 1.4

Findings:

- XCS detector design by BNL started recently.
- A possible change from 35 μm to 56 μm pixels is proposed that is expected to reduce the XCS contrast by a factor 2.5, but this will NOT adversely affect the XCS signal-to-noise ratio.
- A tremendous increase in scientific productivity is possible by employing detection via 10 or 100 chips, rather than 1 chip.

Comments: A detector with pixels of 56 μm is deemed acceptable, and overall the optimum compromise among pixel size, performance, and delivery date should be reached, with delivery date a primary consideration.

Using 10 or 100 detectors will permit data to be acquired 10 or 100 times faster.

The incremental cost of additional chips/detectors, once 1 has been built, is modest.

We note that gaps in continuous coverage of reciprocal space are acceptable in XCS experiments. The XCS detector is subject to detailed LDAC review twice per year.

Recommendations:

- Proceed to construct an XCS detector with 56 μm or smaller pixels as soon as possible.
- Plan to deploy multiple detectors (10 or 100) at XCS simultaneously (*i.e.* an effectively tiled detector) in order to correspondingly multiply the data acquisition

2.3 WBS 1.4

Findings:

- The XCS detector will not be ready in time for XCS commissioning
- Appropriate data reduction is extremely important for creating a user-friendly and therefore scientifically-productive facility.

Comments:

The XCS team proposes to acquire an additional XPP detector for initial commissioning, prior to availability of the XCS detector. Then, once the XCS detector is delivered, this XPP detector will be transferred to XPP.

The XCS detector will not be available until the end of fiscal 2011, so this proposal is a win-win for XCS and XPP, which desires a second detector. Appropriate data reduction is extremely important for creating a user-friendly and therefore scientifically-productive facility. Software to permit data reduction to intensity autocorrelation functions in near-real time is planned to be provided by LUSI to general users.

Recommendations:

- Follow the strategy proposed by XCS/XPP in order to expedite early XCS commissioning.
- Ensure that the planned user software is indeed available as soon as it's needed

2.3 WBS 1.4

Findings:

- Community involvement via XCS Team Leaders is meaningful and valuable for XCS staff.
- A successful scientific workshop on XCS science was held at SLAC last fall.
- Currently, there is a single scientist pursuing XCS at LCLS/LUSI and across the Stanford campus.
- A second XCS scientist position has been advertized.

Comments: Opening a second beamline scientist position is important and laudable. Nevertheless, we recommend that the level of scientific commitment to hard x-ray correlation spectroscopy from the laboratory/LCLS/LUSI should be further strengthened and developed.

Recommendations:

- Broaden further community participation and awareness of LUSI XCS (including to the inelastic x-ray scattering community).
- Increase outreach via further workshops, seminar series, visits off-site *etc.*
- Augment the experimental facilities scientific leadership within LUSI/LCLS.

2.3 WBS 1.4

Simon Mochrie and Ali Khounsary

Findings:

- Remaining design risk for XCS is generally low – on slits, focussing lenses, etc.
- There is an unusually protracted process for review and procurement at SLAC.

Comments:

Future procurement delays and delays caused by duplicative reviews of low risk items (post-monochromator from APS, diagnostics, *etc.* from XPP) are the principle risk associated with XCS schedule.

Recommendations:

- LUSI management must expedite the procurement cycle and manage the review process.
- LUSI management should exploit any procurement efficiencies (and savings) that may be possible by placing combined orders for items common to more than one beamline.
- Proceed to CD-3 as soon as possible, pending successful completion of final instrument design review.

2.4 Diagnostics and Common Optics

Mark Beno (ANL) Jorge Rocca (Colorado State Univ.) and
Peter Takacs (BNL)

2.4.1 Findings

The LUSI staff have made excellent progress in Diagnostics and Common Optics in a very short time.

2.4.2 Comments

- Diagnostic devices have reached the FDR stage in the planning process. Many components are in procurement or have been delivered. Cost, schedule and contingency for Diagnostic Devices are reasonable and timing of delivery for first articles should allow testing and refinement.
- Common Optical components - mirrors and large-offset mono designs are less mature pending completion of design reviews. Final design specs resulting from reviews will be used for final designs and resultant procurements.

2.4.3 Recommendations

- Mirror procurements have long lead times: Early procurement of D&CO mirrors is recommended.
- Vendor selection for DCO components should be carefully examined so that timely delivery for early science is assured.
- The rotation of the 2nd mirror is a complicated engineering solution. Replacement of this motion with a third mirror and translation system is recommended.
- Diagnostics and Common Optics is ready to proceed to CD-3.

2.5 Controls/Data Acquisition System

Mohan Ramanathan

Deming Shu

Tony Warwick

2.5.1 Findings

- A complete and clear presentation was made of the status of the LUSI Controls/Data Acquisition.
- Regular coordination meeting between Controls staff and LUSI scientific staff have been taking place.
- Experiment control is based on EPICS and are well developed.
- Plans for detector integration into LUSI DAQ systems are well developed.
- Plans for data manipulation and storage are based on past experience from HEP experiments.
- All ESD's and ICD's have been completed and most are released

2.5.2 Comments

- SLAC controls staff experience handling massive data is very impressive.
- Good progress on the Controls/Data Acquisition has been noted.
- Integration of 2D Detectors to LUSI controls is progressing very well.
- Staffing to handle the accelerated schedule seems to be under control.
- Controls/Data Acquisition is ready for the accelerated schedule.

2.5.3 Recommendations

- Suggest Controls/Data Acquisition staff to begin now to work with typical synchrotron users. LUSI systems should provide flexible interfacing for special equipment brought by general users.

ES&H

Section 3

Hans Vogel – PNNL

Charge Question #4:

- Are ES&H aspects being properly addressed?
- Are Integrated Safety Management Principles being followed?

Charge Question #5:

- Has the project responded appropriately to previous reviews?

Findings

- **Experienced Staff**
 - Benchmarking efforts with other accelerator facilities has been very helpful for LCLS / LUSI ES&H staff
 - Strong interface with LCLS Project
- **All required documents in place or properly planned**
 - LUSI HAR update DOE approved at CD-2 (ready for CD-3); LCLS SAD not impacted
- **Safety performance for LUSI**
 - ~72K hours without an incident
- **All recommendations from prior review have been addressed**

Comments

- **Construction support for LUSI end stations and hutches is appropriately considered**
 - Contractor selection will benefit from other LCLS Lessons Learned
- **System and process interfaces with LCLS (e.g. PPS, laser interlocks) planned for**
- **ES&H management support is accounted for in the LUSI WBS (1.1.1)**
 - Additional ES&H support is provided via LCLS and SLAC
- **Experimental Safety Review Process is in development**
 - Integration of safety into design and operations of proposed experiments

Recommendations

- Maintain strong ES&H interface within and external to the project, supporting timely achievement of project milestones and deliverables.



4.0 Cost and Schedule

Richard Stanton
Ray Won



4.0 Cost and Schedule

Findings

- Project is proceeding on schedule for a CD-4 date of August 2012 and on budget (\$60M TPC). Project is currently 24% complete.
- ARRA funding has removed the project funding constraints.
- A proposed ARRA schedule has been prepared which shows the Final Instrument Readiness Review approximately three months earlier than the current baseline.
- A plan to integrate the ARRA funding into the project has been developed. Plan provides for separate reporting on the use of these funds.
- Current baseline schedule includes 100 working days of float, this increases to 160 days in the proposed ARRA schedule.
- Current project cost contingency is \$12.3M which is 34% of ETC.



4.0 Cost and Schedule

Comments

- The management team is effectively managing the project budget, schedule and project risks.
- The proposed ARRA schedule is reasonable and should be adopted as the schedule performance baseline as soon as possible to maintain accurate project reporting and avoid unnecessary variances.
- The schedule includes one week for SLAC approval and one week for DOE approval on all procurements. This may be inadequate due to the large volume of procurements that need to be placed and additional time needed for review of ARRA funded procurements.
- Approval of early procurements has allowed work to proceed in a timely manner. Opportunities should be explored to request additional early procurement approval to allow for early completion of work activities, take advantage of the current favorable market conditions, and avoid a spike in procurement requests following approval of CD-3.



4.0 Cost and Schedule

Recommendations

1. A baseline change to establish the ARRA schedule as the new schedule performance baseline should be submitted by the end of May.
2. We support maintaining the current CD-4 date of August 2012. Project should be managed to the level-two early finish milestones for instrument readiness reviews.
3. Ensure adequate schedule time is provided for SLAC and DOE approvals on procurements, especially those over \$500k.
4. Project team should consider requesting early procurement approval for additional schedule critical items.
5. Project cost contingency appears more than adequate for this stage of the project. Continue to update the contingency to reflect project risks and perform additional planning for contingency use.

LCLS Ultrafast Science Instruments

5 - Project Management

DOE/SC Review

20-22 April 2009

**John Haines,
Erik Johnson,
Steve Tkaczyk**

- **Responsive to previous recommendations**
- **Staffing mostly in place, required additions achievable**
- **Risk registry updated and actively managed**
- **Have a prioritized contingency draw-down list**
- **Working schedule to deal with ARRA 'opportunities'**
- **ARRA allows schedule to benefit early science to varying degrees depending on instrument**
- **Accelerated funding may result in ~1.4 M\$ additional buying power due to reduced escalation**

- **Trying to understand impact of ARRA rules**
- **About 25 XPP WBS elements to be procured between now and beginning of June**
 - **worth ~ 730 k\$..**
 - **49 procurement actions**
- **~380K\$ in 3 foreign procurement actions**
- **Balance ~350 k\$ over 46 procurement actions**
 - **only 1 action is over 25 k\$**

■ Readiness for CD-3

- Technical work on track
- Project management tools and processes in place
- Get remaining staff on board to achieve required design maturity
- Use graded response to changes (technical and financial)

■ *Procurement is a concern across review team*

■ ARRA is tricky for LUSI

- Work in progress on exploiting ARRA funding evident
- Execution will be key to success
- Establish working process to handle procurements

- **Understand real scope of procurement problems**
- **Cooperatively identify and mitigate bottlenecks**
 - LUSI - SLAC - DOE all in uncharted territory
 - Unlikely that area office could review every procurement for duration of project
 - Level of DOE oversight required may determine rate
 - Balance level of oversight with objectives of ARRA funding
- **Work to establish 'normalcy' in the process**
 - Workflow management
 - Approval levels and authorities
- **Factor in actual performance in planning for CD-3**

1. Identify, introduce and manage the risks associated with ARRA into the risk registry by the **Middle of May 2009**
2. Establish a realistic date for CD-3 review by the **End of May 2009**
3. Assess schedule impacts of ARRA procurements for LUSI considering roles and responsibilities of LUSI, SLAC and DOE partners no later than the **Middle of June 2009**