DESIGN REVIEW REPORT	Report No. TR-391-003-23

The Design Review Report Shall include at a minimum:

- The title of the item or system;
- A description of the item;
- Design Review Report Number;
- The type of design review;
- The date of the review;
- The names of the presenters
- The names, institutions and department of the reviewers
- The names of all the attendees
- Findings/List of Action Items – these are items that require formal action and closure in writing for the review to be approved. See SLAC Document AP-391-000-59 for LUSI Design Review Guidelines.
- Concerns – these are comments that require action by the design/engineering team, but a response is not required to approve the review
- Observations – these are general comments and require no response

TYPE OF REVIEW: **Final Instrument Design Review**

WBS: 1.2 X-ray Pump Probe

Title of the Review	XPP Final Instrument Design Review	
Presented By:	David Fritz, J. Langton, Tom Fornek, Eliazar Ortiz, Gunther Haller, Niels Van Bakel, Michael Scharfenstein	
Report Prepared By:	Erik Johnson, BNL	**Date:** 2 March 2009
Reviewers/Lab :	Erik Johnson (BNL) Paul Fuoss (ANL) Patric Den Hartog (ANL) Mohan Ramanathan (ANL) Deming Shu (ANL)	
Distribution:		
Attachments:	☐ Review Slides ☐ Design Checklist ☐ Calculations ☒ Other	

Purpose/Goal of the Review:

This design review for the XPP Optical Table and Laser Enclosure is intended to OK completion of design, leading up to placing an order for shop fabrication table/enclosure. Only one design review is needed for this component.

Additional Attendees:

Hannibal Joma

Review Date:

February 24-25, 2009

X-ray Pump Probe (XPP) Instrument Review

Readiness to begin partial fabrication

February 2009

Executive Summary

An external committee review for the LUSI- XPP instrument was held on 24 and 25 February 2009 at SLAC. The purpose of the review was to evaluate the project technical scope, management, cost & schedule, ES&H posture, and overall readiness to proceed with partial fabrication of the XPP instrument to enable early science at the LCLS. The XPP team and LUSI management provided background information that was available to the committee prior to the review, and made presentations at the review with ample time for questions and discussions.

Based on this information, the committee believes that the technical scope described is concordant with the projected budget and the needs of the science community that will utilize the XPP instrument for early science at the LCLS. The project is being managed to assure that ES&H aspects are adequately addressed and that the agreed upon schedule and cost are respected.

Detailed findings, comments and recommendations are found within the report, but in summary the review committee believes that the XPP instrument is ready to proceed with fabrication to support the early science program at LCLS.

1 INTRODUCTION

The purpose of the LUSI project is to expand upon and utilize the unique scientific capability of the Linac Coherent Light Source (LCLS) by building instruments that use the LCLS ultrafast x-ray beam for research. X-ray Pump Probe (XPP) is the first of a suite of three instruments that will be fabricated and installed as part of the LUSI project. The LUSI project achieved its Critical Decision-2 (CD-2) milestone, Approval of performance Baseline, on October 28, 2008.

To enable early science at LCLS, the LUSI project is tailored to allow for expedited management decisions for its execution including the minimization of major technical risks by the authorization of advanced procurement of critical sub- systems and components requiring long lead time. In keeping with this strategy, advance procurement of the sample goniometer and the detector mover were approved for XPP in December 2008. Similarly the decision to authorize Partial Fabrication of XPP for early science was delegated for approval by the Federal Project Director as a Level 2 milestone. The purpose of this review was to evaluate the readiness of the project to attain this milestone.

To assist the Federal Project Director in making this determination, a review panel was constituted to evaluate the Instrument's readiness by examining the Technical Scope, Project Management, Cost and Schedule, ES&H posture and overall readiness to proceed. The methodology utilized was for the XPP team to post reference information in advance of the review to a web site accessible to the committee as well as interactively presenting elements of the project at the meeting held on February 24th. The review team assigned themselves to review particular aspects of the project corresponding to the elements of the charge. A closeout session was held on February 25th for the committee to present its findings, comments and recommendations. This report is largely patterned after the closeout presentation. The full charge to the committee, the committee membership, the review agenda and the closeout presentation can be found among the appendices to this report.

2 TECHNICAL SYSTEMS

The technical systems presented for the XPP instrument at this review included the major components of the instrument itself, the BNL detector and experimental controls that are unique to the XPP instrument as well as the XPP instrument versions of systems that are used elsewhere in LCLS or LUSI including the laser systems, common diagnostics and optics. The perspective of the review team for each of these areas follows with a total of 24 Findings, 20 Comments, and 9 Recommendations. There were no Action Items to be addressed before approval for procurement.

2.1 XPP Components

Findings

The XPP instrument Early Science deliverables include the Sample Goniometer, Detector Mover, Detector, Support Tables, Laser optics, optomechanics & diagnostics, X-ray Slits, X-ray Diagnostics/Pop-ins, X-ray Pulse Picker, Hutch Facilities, Vacuum System, and the Multipass Amplifier. The diffractive x-ray lenses and harmonic rejection mirrors are not included in the early science scope. The XPP instrument is designed to be readily "rolled" out from the beamline for easy beamline configuration changes. PSDs, ESDs, and ICDs have been written for major systems and components and all of the XPP component systems have passed PDR and many have completed FDR.

Comments

The XPP component design maturity is at the expected level for a project at this stage and is sufficient to begin procurements. There is little technical risk in proceeding with procurements now but there is schedule risk in delaying procurements. Sufficient attention has been paid to design interfaces to be confident that few surprises will be revealed. Some interfaces with XTOD have yet to be fully defined. Since the project was baselined, it has remained on schedule. The SPI was 0.99 and CPI was 0.97 as of Dec 31, 2008. This is an excellent result for the overall project, but it is important to keep all level 3 elements on track in the next year. The estimate of the cost and schedule appear to be reasonable and current. The cost estimate has not changed significantly over the last year.

Testing has been performed on a robot system that meets all of the design requirements and specifications for reproducibility and stability but absolute positioning accuracy, although not required for operation, is not as good as desired. This may impact system operational efficiency. Two methods for ensuring accuracy have been considered: establishing a baseline grid of known positions and use of an active metrology system. Early procurement of the robot will enable these strategies to be fully investigated. A preferred location for mounting has been determined to be directly overhead the sample. This position seems unlikely to present new problems as compared to floor mounting but early robot acquisition and testing would be appropriate. Robots are massive objects which are capable of translating with considerable momentum. The project seems to be well aware of the hazards this entails and are planning to develop a safety system that is consistent with ANSI standards.

The BNL detector schedule has been integrated into the LUSI schedule as recommended in a previous review. It is now apparent that the schedules mesh appropriately and that it is likely that a 1024 x 1024 detector with four 512 x 512 modules will be available for XPP commissioning.

Recommendations

1 - Expedite the acquisition of a robot for the detector mover and
2 - Proceed with additional testing in order to clarify operational and metrology requirements

2.2 XPP Laser Systems

Findings

The XPP laser system is designed to excite a sample with a high power, femtosecond optical pulse. The excited sample is then probed with the x-ray beam. The general laser systems for such experiments are very well developed, are used routinely in other research settings, and have been successfully used for very similar experiments at SLAC. There is very little risk associated with the purchase of the individual components of such a system and its assembly into a practical system.

For use within LCLS, the laser has the unusual requirement that it be operated by a large number of users, many of whom are not experts in laser technology. This requirement puts demands on the alignment and safety systems. The XPP instrument is designed to be remotely operated which should largely satisfy this unusual requirement. In addition, the XPP project has plans for suitable enclosures to isolate the users from the high power laser beams. Since this laser system is largely constructed from commercial components and builds on the design and infrastructure of the LCLS AMO laser system, there is very little uncertainty in the budget and low risk regarding the laser's performance.

Comments

The approach of making the laser remotely operable should greatly increase its utility within the user community anticipated for the XPP instrument. This approach should also result in much more reliable and predictable operation of the laser, and increase the overall utility and efficiency of LCLS operations.

The laser planned for the early operation of XPP satisfies the needs of the planned early experiments but it doesn't have the high power performance required for all of the currently anticipated XPP experiments. Improving the performance of laser would open up the envelope of experiments.

Recommendations

1 - LUSI should aggressively pursue the purchase of the additional optical components required to reach full laser performance as soon as funds become available. These components include the high power amplifier, the temporal pulse shaper and the optical parameteric amplifier.

2.3 Common Diagnostics and Optics

Findings

XPP is one of three instruments of the LUSI project. As the LCLS starts commissioning it is planned to have the XPP ready for early science. There are numerous diagnostic components like intensity monitor, profile monitor and position monitors, which are common to all three instruments. In addition the slits, attenuators, pulse kicker, monchromator and mirrors are also common in design to all three instruments. For early science the mirrors and monochromator are not needed and are not part of this review.

Due to the nature of the LCLS operation, each X-ray pulse has its own characteristics. Hence diagnostic hardware to measure and characterize by pulse-to-pulse is needed. The plans call for a profile monitor in hutch 2. In addition there are two combined profile-intensity monitors in hutch 3, which is the station for the XPP instrument. The design calls for 3 intensity –position monitors one: in hutch 2 and two hutch 3.

For beam definition there is one single slit is hutch 2 and 1 single and 1 double slit in hutch 3. An attenuator assembly will be installed in hutch 3 for beam attenuation as needed. To reduce the duty cycle of the LCLS to below 10 Hz a pulse picker is also located in hutch 3.

The Physics Requirements, Engineering Specifications, Interface Control Documents have all been completed for the above mentioned diagnostic and common optics components. Preliminary design reviews for these components have all been completed.

Comments

The support system for all the diagnostic monitors are the same. The interface document for the alignment of these devices have been defined. The support system is similar to existing supports used at LCLS. All the diagnostic monitors share the same design for the 6 degree of freedom alignment stands. In addition the translation stages and chambers are identical. The design of the translations are based on existing design used in LCLS.

LUSI team plans to procure commercially hardware for all the translations stages based on LUSI specifications. Some of the hardware for the diagnostic monitors is expected to be fabricated in SLAC shops. The assembly and testing of the devices is expected to be performed in-house.

The slits design is based on commercial designs built for other x-ray facilities. The LUSI team has determined a need for both Silicon Nitrate based blades to absorb the power from the LCLS beam and a final cleanup slit made of Tantalum or Tungsten for the higher energies. The LUSI team envisions using the two types of slits in tandem. Commercially available slits have knife edges for the blades while LUSI requires cylindrical edges to avoid scattering from the knife edges. Procurement specifications documents have been generated for the slits. LUSI plans to procure the slits commercially based on the LUSI specifications.

The filter assembly is designed to be combined with the pulse picker. The vacuum housing is common to both and the alignment stand is identical to those used in the diagnostic monitors. Detailed analysis has been performed on the filter material choice. Polished Si wafers of various thicknesses were chosen as the preferred filter material. These filter assemblies will be built in house.

The pulse picker employs a commercial mechanical teeter-totter. The design calls for installation of the pulse picker inside a vacuum environment and mounted on an external translation stage. The blade assembly is iron but coated with silicon nitrate to reduce damage from the LCLS beam. Testing of the pulse picker assembly is in progress. The solenoid coil is expected to be energized at all times and hence is likely to heat the device. Care has to be taken to provide a path for the heat dissipation.

Recommendations

1 - Accelerate the Design work to complete the Final Design Reviews to reduce schedule risk
2 - Advance first article procurements to expedite early component testing prior to production

2.4 BNL Detector

Findings

It was correctly recognized by the LCLS team early on that suitable x-ray detectors that could operate at the full repetition rate of LCLS were not available. LUSI responded to this lack by developing, through BNL, a high performance detector. The goal of this detector program was a 1024x1024 pixel detector with single photon sensitivity and a dynamic range of 10^4.

To date, this effort has been very successful and has met the agreed upon milestones. In particular, 1) a 64x64 sensor has been developed and tested, 2) readout circuitry has been developed and tested, 3) the conceptual design for a housing to stabilize the environment and enable mounting to the detector robot has been completed.

There has been difficulty in scaling the fabrication of the sensor from the initial 100 mm wafer substrate to the desired 150 mm diameter substrate. The practical impact of this difficulty is to make delivery of the full 1024x1024 sensor uncertain. The project has worked to reduce this risk by proposing a tiled detector consisting of four 512x512 elements. This approach should work but adds integration risks to the project. These risks are not judged to be significant.

In addition to the sensor and local readout electronics, the overall detector system requires a fast processing system to 1) quickly reject unsuitable x-ray image frames (e.g. the FEL pulse parameters were unsuitable) to reduce computation and storage requirements and 2) to tag the data with the appropriate metadata (e.g. pulse arrival time). This integration appears to be proceeding smoothly but is challenging. Given the successful testing of the smaller sensors, the budget appears to be adequate to successfully complete this subtask.

Comments

Given the successful operation of the small sensors, the primary challenge is integrating the four 512x512 modules into a useful detector. The committee was not presented with a detailed plan for achieving this integration but it doesn't appear to present difficulties. It does increase some mechanical limitations, slightly reduces the advantage of the monolithic detector, and introduces some additional risk.

The risk of the detector not being completed is mitigated by the presence of the prototype Cornell detector being developed for the single particle imaging instrument. While this detector is less suited to the XPP measurements than the BNL detector, it would enable early science experiments with the XPP instrument. However, it is important to note that not all risks are mitigated with this approach since both detectors appear to share higher level components associated with moving x-ray frames from the detector to the data store.

Recommendations

1 - Test a small sensor as soon as possible on LCLS to reduce risk by

- measuring detector performance with femtosecond x- ray pulses,
- determining radiation damage thresholds and
- testing the integration of sensor data with FEL metadata.

2.5 XPP Controls

Findings

LUSI presented a very good control and data system for XPP. Preliminary Design Review was completed in February 2009. Final Design Review is scheduled for May 2009. The interface to LCLS control infrastructure will provide machine timing, laser timing, and 120 Hz LCLS beam data at the XPP end-station. Information from LCLS machine protection system, hutch protection system and laser safety system will also be available at the XPP end-station. The risk is low particularly since many controls items are already used in other earlier photon sections, XTOD and AMO, both are past the Final Design Review stage and are being assembled.

Engineering Specification Documents (ESD) for detailed requirements regarding controls and data systems needs of instrument is released. Interface Control Documents (ICD) is also released for specifying where the interface is, who is responsible for what. The Data system concept and architecture are well developed. The test of interfaces between LUSI DAQ system and readout electronics for LUSI BNL detectors are at an advanced stage.

Comments

The control and data system design for XPP is technically sound. The project scope, attendant cost and schedule are all satisfactory to begin partial fabrication and installation for XPP early scientific experiments.

The committee is pleased to see the following:

- The LUSI control and data system design team is well organized and staffed to successfully achieve the milestone.
- The design team is taking advantage of established designs from existing XTOD and AMO tasks.
- ESD and ISD Documents are released and kept current.
- Regular interface meetings with XPP scientists will be scheduled.

Based on experience from other facilities, establishing safe and robust XPP detector-mover system will require significant software development effort.

Recommendations

1 - Proceed with implementation of the control and data system for XPP.

2 - Start regular coordination meetings between XPP and control teams immediately to assure a safe and robust XPP detector-mover system.

2.6 XPP Installation

Findings

XPP is the first of three instruments of the LUSI project to start early science. Towards this the XPP team has started working on planning for installation. The current plan calls for installation to start by 19 June 2009. LUSI has planned and budgeted their installation activities based on Davis–Bacon labor requirements. They have a baseline P3 installation schedule and budget.

Comments

The XPP team has an installation process in place. The budgeted costs are reasonable in comparison with recent LCLS activities. The installation activities will be conducted in coordination with LCLS and will employ the same teams used in LCLS installations. XPP team plans to implement improvement based on lessons learned during the LCLS installations. The XPP team has not yet assigned a person as the installation manager.

Recommendations

1 - The committee recommends that the project identify a Installation Manager as early as practical.

2 - A detailed installation plan that reflects the likely labor requirements should also be developed. It should include realistic distribution of labor types as well as a perspective on the availability of personnel where contract labor is not utilized.

3 PROJECT SYSTEMS

This section of the report groups together the 'soft' aspects of the project that are not of direct technical interest to the XPP scientific end user community, but form the foundation without which success in the project is not possible. This includes the project design and execution aspects of Environment Safety & Health (ES&H), Cost and Schedule performance, and Project Management. Each aspect of these project systems is described with a total of 8 Findings, 7 Comments and 4 Recommendations. There were no Action Items to be addressed before approval for procurement.

3.1 ES&H

Findings

A robust process for hazard assessment is in place and in use. Throughout the review an awareness of ES&H issues was in evidence and reflected in the material presented. Application of ISEM principles was evident through out the presentations and in discussions with the XPP team.

Comments

It was clear to the committee that a good ES&H experience base is in place from the LCLS project which is being used to inform decisions in the XPP project. There seems to be good stakeholder involvement in safety aspects of the project which is an indication of a strong safety program. In discussions during the presentations it was suggested that diversifying the participation on hazard analysis teams with 'fresh-eyes' during the design will add strength to the ISEM process. Examples might include participation by technicians, floor coordinators and other personnel who didn't design the system that may interact with the installed equipment. They may be more likely to notice things like pinch hazards that might be overlooked by staff who were involved in the development of the equipment design.

Recommendations

None other than to continue with the improvement process in evidence.

3.2 Risk and Contingency

Findings

The XPP instrument is included in a comprehensive and current risk registry for the LUSI project. There are 16 risks identified for XPP including 6 associated with the goiniometer, 5 for the detector mover, and 5 for the detector. The identified risks relate to schedule and technical issues. A systematic bottom-up methodology for estimation of contingency requirements was presented. In parallel, the risk registry includes estimates of potential cost impacts after handling for what are judged to be the Best, Most likely and Worst case outcomes. For the XPP instrument the risk based estimate of 'worst case' contingency draw down is 720 k$.

For the LUSI project as a whole the available contingency is 12,210 k$ while the sum of all of the 'worst case' outcomes is 10,724 k$ in the current plan. For the XPP instrument there is 4,211k$ work to go representing roughly 30% complete, with an estimated potential contingency draw of 875 k$ or roughly 21% on the remaining work.

Comments

Contingency for the project overall seems to be adequate for the defined project scope. The magnitude of the 'worst case' estimates derived from the bottoms up assessment is comparable to the management judgement outlined for the 'worst case' estimates in the risk registry. Coming to the same answer (within the precision of contingency estimates) from both directions is reassuring. The committee does note that some of the risks identified could be substantially mitigated by funding procurements and gaining some float to mitigate technical issues that might arise. An example would be procurement of the detector mover as early as possible to gain experience with it and make any adjustments required to assure that its performance meets the needs of the project.

Recommendations

1 - Continue with diligent update and management of the risk registry
2 - Advance procurements (if funds are available) that will retire schedule and technical risks

3.3 Management

Findings

As of January 2009 XPP is ~30% complete with an SPI of 1.0 and a CPI of 0.97 while Diagnostics and Common Optics (DCO) is ~12% complete with an SPI of 0.94 and a CPI of 0.93. The committee notes that there has been diligent follow-up on previous review recommendations. Overall management systems are mature, building on the experience gained from LCLS.

Comments

There is a good suite of EVMS tools in use that inform project management decisions. The schedule variance in DCO is recognized by management as a potential issue for XPP since it is the first customer of the products of the DCO element of the LUSI project. While DCO is regarded as presenting modest technical risk to the project as a whole, the 10% SV in DCO overall may represent a more significant impact to XPP.

Recommendations

1 - Allocate enhanced resources to DCO to 'catch-up' on schedule
2 - Proceed with final design and procurement

4 ASSESSMENT OF CHARGE

This section of the report presents the summary assessment of the technical and project systems with respect to the elements of the original charge to the committee.

4.1 Technical Scope

The XPP design is mature with well defined interfaces. Preliminary design reviews have been completed for all technical systems. The committee is confident that the requirements of the project will be met within the defined scope based upon the information provided.

4.2 Management

The XPP instrument team is in place, is well qualified and is well coordinated with the user defined science needs. An active risk management process is evident and an advanced procurement process is in place that is well organized..

4.3 Cost and Schedule

The costs presented seem reasonable and have remained relatively stable since CD-2. The cost and Schedule data are maintained and are kept current. The committee has confidence that the requirements of the project will be met within the defined scope of XPP for early science.

4.4 Environment Safety and Health

A solid ES&H program is in place and is being actively and continuously improved. The committee is of the opinion that the ES&H aspects of the XPP instrument are being appropriately addressed.

4.5 Overall readiness of XPP

The committee is of the opinion that XPP is ready to begin partial fabrication and installation at LCLS to begin conducting early scientific experiments.

X-ray Pump Probe (XPP) Instrument Review

Readiness to begin partial fabrication

February 2009

SECTION 5 APPENDICES

Charge memorandum

Review agenda

Review team

Review Points of Contact

Closeout presentation

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February 03, 2009

Mr. Erik Johnson
Brookhaven National Laboratory
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SUBJECT: LUSI Project X-ray Pump Probe Instrument Readiness to begin Partial Fabrication for Early Science at LCLS

Erik

Dear ~~Mr. Johnson~~:

Thank you for agreeing to lead the review of the X-ray Pump Probe (XPP) instrument at SLAC National Accelerator Laboratory in Menlo Park, California, during February 24-25, 2009.

The purpose of LUSI project is to expand upon and utilize the unique scientific capability of the Linac Coherent Light Source (LCLS) by building instruments that use the LCLS ultrafast x-ray beam for research. To this end, the objective of the LUSI project is to design, build, and install three instruments at LCLS. XPP is the first instrument that the LUSI project will fabricate and install at LCLS. The capability, technical performance parameters, and full description of XPP is described in project documents that will be available prior to review.

The LUSI project achieved its Critical Decision-2 (CD-2) milestone, Approval of Performance Baseline, on October 28, 2008. In order to enable early science at LCLS, this project is tailored such that to expedite the decision making process as well as minimize the major technical risks by authorizing advance procurement of critical sub-systems and components requiring long lead time. To this end, in December 2008, advance procurement of the Sample Goniometer and the detector mover were approved for XPP. Also, authorization to begin Partial Fabrication of XPP for early science, is a Level 2 milestone to be approved by the Federal Project Director.

The purpose of this review is to evaluate the XPP readiness to achieve the above milestone. To carry out this charge, the review committee should evaluate the Instrument's readiness by responding to the following questions:

1. Technical Scope: Is the design of the partial instrument mature and technically sound to enable early scientific experiments at LCLS? Have all the major interfaces been identified and incorporated in the design? Have design reviews been performed?
   Is the design likely to meet performance expectations?
2. Management: Is the Instrument Team organized and staffed to successfully achieve the milestone? Have all the major risks been identified and are being effectively managed? Are procurements appropriately planned for the partial fabrication of XPP?
3. Cost and Schedule: Are the XPP cost and schedule reasonable to achieve the planned scope? Have the XPP cost and schedule been recently updated? Is there sufficient cost and schedule contingency to ensure successful completion of the partial instrument in time for installation at LCLS?
4. ES&H: Are all related ES&H aspects being properly addressed?
5. Overall Readiness: Is XPP ready to begin partial fabrication and installation at LCLS to begin conducting early scientific experiments?

I would appreciate receiving the committee's findings and recommendations by the close of the review and the final report within 30 days of the review's conclusion.

Hannibal Joma
Federal Project Director
US DOE Stanford Site Office

cc:

Patric Den Hartog, ANL, Review Committee Member
Deming Shu, ANL, Review Committee Member
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Tom Kiess, DOE SC/BES, SC-22
Hanley Lee, DOE SSO

Time		Agenda Topic
Tuesday 24 February		
8:00 - 8:30	am	Executive Session
8:30 - 8:45	am	Breakfast
8:45 - 9:00	am	Introduction (Fornek)
9:00 - 9:15	am	Science Program and Team Leaders Update (Gaffney)
9:15 - 10:00	am	Instrument Goals and Requirements (Fritz)
10:00 - 10:15	am	Break
10:15 - 11:00	am	XPP Component Status, Cost & Schedule (Langton)
11:00 - 11:15	am	XPP Laser System Status, Cost & Schedule (Fritz)
11:15 - 12:00	pm	Common Diagnostics and Optics Status & Schedule (Ortiz)
12:00 - 1:00	pm	Lunch
1:00 - 1:30	pm	BNL Detector Status, Cost & Schedule (Van Bakel)
1:30 - 2:00	pm	XPP Controls Status & Schedule (Haller)
2:00 - 2:15	pm	Break
2:15 - 2:45	pm	Installation (Langton)
2:45 - 3:00	pm	Safety (Scharfenstein)
3:00 - 3:45	pm	Risks and Contingency (Fornek)
3:45 - 4:00	pm	Break
4:00 - 5:00	pm	Questions
6:00	pm	Dinner
Wednesday, February 25		
8:00 - 8:30	am	Breakfast
8:30 - 10:30	am	Report Writing
10:30 - 11:00	am	Closeout

LCLS Ultrafast Science Instruments (LUSI) Project
February 24-25, 2009

Erik Johnson - Chairperson

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X-ray Pump Probe (XPP) Instrument Review

Readiness to begin partial fabrication

February 24 and 25, 2009

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Mohan Ramanathan ANL

Controls & DAQ
Deming Shu ANL

Management and Safety
Erik Johnson BNL

Evaluate XPP readiness to begin fabrication for early science

Charge Elements and Questions		Terse element
1 Technical Scope		
Is the design of the partial instrument mature and technically sound to enable early scientific experiments at LCLS?	a	Design mature
Have all the major interfaces been identified and incorporated in the design?	b	Interfaces defined
Have design reviews been performed?	c	Reviews performed
Is the design likely to meet performance expectations?	d	Meet requirements
2 Management		
Is the Instrument Team organized and staffed to successfully achieve the milestone?	a	Team adequate
Have all the major risks been identified and are being effectively managed?	b	Risks managed
Are procurements appropriately planned for the partial fabrication of XPP?	c	Procurements planned
3 Cost and Schedule		
Are the XPP cost and schedule reasonable to achieve the planned scope?	a	C&S reasonable
Have the XPP cost and schedule been recently updated?	b	C&S Current
Is there sufficient cost and schedule contingency to ensure successful completion of the partial instrument in time for installation at LCLS?	c	Contingency adequate
4 ES&H		
Are all related ES&H aspects being properly addressed	4	ES&H addressed
5 Overall Readiness		
Is XPP ready to begin partial fabrication and installation at LCLS to begin conducting early scientific experiments?	5	Project ready

Reporting out

- Crosswalk between
  - Agenda
  - Committee members
  - Report assignments
  - Charge

Agenda Topic	*Engineering & Instrument Design* Patric Den Hartog	*Engineering & Instrument Design* Paul Fuoss	*Diagnostics & Common Optics* Mohan Ramanathan	*Controls & DAQ* Deming Shu	*Management & Safety* Erik Johnson
XPP Component Status, Cost & Schedule (Langton)	X				
XPP Laser System Status, Cost & Schedule (Fritz)		X			
Common Diagnostics and Optics Status & Schedule (Ortiz)			X		
BNL Detector Status, Cost & Schedule (Van Bakel)		X			
XPP Controls Status & Schedule (Haller)				X	
Installation (Langton)			X		
Safety (Scharfenstein)					X
Risks and Contingency (Fornek)					X

- Closeout and Report follow this basic outline
- Add summary assessment against committee charge

2.1 Component Findings

- The XPP instrument Early Science deliverables include the Sample Goniometer, Detector Mover, Detector, Support Tables, Laser optics, optomechanics & diagnostics, X-ray Slits, X-ray Diagnostics/Pop-ins, X-ray Pulse Picker, Hutch Facilities, Vacuum System, and the Multipass Amplifier
- The diffractive x-ray lenses, and harmonic rejection mirrors are not included in the early science scope.
- The procurement of the XPP goniometer was previously approved and the procurement process is well advanced.
- PSDs, ESDs, and ICDs have been written for major systems and components.
- All of the XPP component systems have passed PDR and many have completed FDR

2.1 Components Comments

- The XPP component design maturity is at the expected level for a project at this stage and is sufficient to begin procurements. There is little technical risk in proceeding with procurements now but there may be schedule risk in delaying procurements.

- Sufficient attention has been paid to design interfaces to be confident that few surprises will be revealed.
  - Some interfaces with XTOD have yet to be fully defined.

- Since the project was baselined, it has remained on schedule.
  - This is an excellent result for the overall project, but it will be a challenge to keep all level 3 elements on track in the next year.
  - Any one of them can become the critical path

- The estimate of the cost and schedule appear to be reasonable and current. The cost estimate has not changed significantly over the last year.

2.1 Components Comments

- Testing has been performed on a robot system that meets all of the design requirements specifications for reproducibility and stability but absolute positioning accuracy, although not required for operation, is not as good as desired.
  - This may impact system operational efficiency.
  - Two methods for ensuring accuracy have been considered: establishing a baseline grid of known positions and use of an active metrology system.
  - Early procurement of the robot will enable these strategies to be fully investigated.
- A preferred location for mounting has been determined to be directly overhead the sample.
  - This position seems unlikely to present new problems as compared to floor mounting but early robot acquisition and testing would be appropriate.
- Robots are massive objects which are capable of translating with considerable momentum.
  - The project seems to be well aware of the hazards this entails and are planning to develop a safety system that is consistent with ANSI standards.

2.1 Component Recommendations

1. Expedite the acquisition of a robot for the detector mover

2. Proceed with additional testing to clarify
   - Operation questions
   - Metrology requirements

2.2 Laser System

- Findings
  - The laser system for the XPP system largely builds upon and replicates capabilities already developed for the AMO instrument.
  - The laser system is largely constructed from commercial systems.
  - The laser system is designed to be remotely controlled to reduce laser training requirements.
  - The budget and contingencies are consistent with the system requirements.
- Comments
  - The approach of making the laser remotely operated should greatly increase its utility with users trained in x-ray but not laser techniques.
  - The use of commercial components is an excellent approach and reduces risk.
- Recommendations
  1. LUSI should aggressively pursue purchasing the power amplifier, temporal pulse shaper and optical parametric amplifier should funding become available.

2.3 DCO Findings

- The Diagnostics and Common Optics consists of
  - Profile Monitor
  - Profile-Intensity Monitor
  - Intensity-Position Monitor
  - Slits
  - Attenuator & Pulse Picker
- XPP is the first customer for DCO components that will be required across the LUSI project
- Preliminary Design Review of all the components have been completed
- Slits are to be procured and built to specification
  - Procurement specifications documentation have been prepared
- Testing of pulse picker is in progress
- Physics Requirements /Engineering Specifications/ Interface Control Documents have been completed

2.3 DCO Comments

- The support structure for all the diagnostics and common optics are standardized
- All the monitors share the same design for the chamber, alignment stand and translation stages
- The design of the translation stages are very similar to existing designs in place in LCLS
- The 6 degree of freedom alignment stands are identical to those in use at the LCLS
- The diagnostics monitor components are expected to be designed and procured commercially but assembled in-house
- The pulse picker is a commercial mechanical teeter-totter
  - Testing is in progress for the blade assembly
  - Thermal issues (heat from solenoid in vacuum) a concern

2.3 DCO Recommendations

1. Accelerate the Design work to complete the Final Design Reviews to reduce schedule risk

2. Advance first article procurements to expedite early component testing prior to production

2.4 BNL Detector Findings

- The BNL detector is a novel design with performance specifications tailored to XPP physics requirements
- Very good progress has been made on sensor chip
  - 64x64 chip has been tested
  - Readout circuitry has been tested, performed well and is being improved
  - Housing for the detector has been designed to work with the detector robot
- There has been difficulty scaling from 100 mm to 150 mm wafers and this puts delivery of the original 1024x1024 design in doubt
- The design and prototyping of the readout chain (sensor to data storage) is well advanced
  - Fast reject of bad data is used to reduce data processing and storage requirements
  - Data is tagged with FEL metadata
- The budget is consistent with the scope of work remaining

2.4 BNL Detector Comments

- Lack of 1024x1024 sensor requires integration of four 512x512 modules
  - Integration remains to be done
  - Introduces more mechanical design challenges
  - Slightly reduces advantage of detector sensor being a monolith
- The risk of the detector not being finished is mitigated by the presence of the Cornell detector
  - The Cornell detector will not have as high performance but should enable early physics
  - Both detectors appear to share higher level components (movement of x-ray images from detector to data storage) and thus some risks may not be mitigated by this strategy

2.4 BNL Detector Recommendations

1. Continue with the detector development plan since it has a high probability of success

2. Test a small sensor detector on the LCLS as soon as practical to:
   - Test detector performance with femtosecond pulses
   - Determine radiation damage thresholds
   - Test integration of sensor data with FEL metadata

2.5 Controls Findings

- LUSI presented a very good control and data system for XPP. Preliminary Design Review was completed in February 2009. Final Design Review is scheduled for May 2009.
- The risk is low particularly since many controls items are already used in other earlier photon sections, XTOD and AMO, both are past the Final Design Review stage and are being assembled.
- Engineering Specification Documents (ESD) and Interface Control Documents (ICD) are released.
- Data system concept and architecture are well developed. The test of interfaces between LUSI DAQ system and readout electronics for LUSI BNL detectors are at an advanced stage.

2.5 Controls Comments

- The control and data system design for XPP is technically sound. The project's scope, attendant cost and schedule are all satisfactory to begin partial fabrication and installation for XPP early scientific experiments.
- The committee is pleased to see the following:
  - The LUSI control and data system design team is well organized and staffed to successfully achieve the milestone.
  - The design team is taking advantage of established designs from existing XTOD and AMO tasks.
  - ESD and ISD Documents are released and kept current.
  - Regular interface meetings with XPP scientists will be scheduled.
- Based on experience from other facilities, establishing safe and robust XPP detector-mover system will require significant software development effort.

2.5 Controls Recommendations

1. Start regular coordination meetings between XPP and control teams immediately to assure a safe and robust XPP detector-mover system.

2. Proceed with implementation of the control and data system for XPP.

2.6 Installation

- Findings
  - XPP has P3 Installation Schedule
  - Predicated on Davis-Bacon labor requirements
  - Installation to start in June 2009
- Comments
  - Installation process is in place. Installation Manager has not been assigned.
  - Installation Planning is in coordination with LCLS.
  - LUSI will benefit from the LCLS installation experience
- Recommendations
  1. Identify a Installation Manager as early as practical.
  2. Develop detailed installation plan that reflects likely labor requirements

3.1 Safety

- Findings
  - Process for hazard assessment in place
  - Application of ISEM principles evident
- Comments
  - Good ES&H experience base from LCLS to inform process
  - Strong safety program with good stakeholder involvement
  - Diversifying the participation on hazard analysis teams with'fresh-eyes' strengthens the ISEM process
    - E.g. Technicians, floor coordinators, others who didn't design that may interact with the installed systems
    - May notice things overlooked by staff familiar with equipment
- Recommendations
  - None – keep up the good work!

3.2 Risk and Contingency

- Findings
  - XPP included in comprehensive and current risk registry for LUSI
    - 15 total, 6 for Goiniometer, 5 Detector mover, 5 Detector
    - Covers schedule, technical issues
  - 'Worst case' contingency draw within present project contingency
- Comments
  - Some of the risks can be substantially mitigated by funding procurements and gaining some float to mitigate technical issues that arise (e.g. Detector mover)
- Recommendations
  1. Continue diligent update and management of risk registry
  2. Advance procurements (if funds are available) that will retire schedule and technical risks

3.3 Project Management

- Findings
  - XPP ~ 30% complete SPI 1.0, CPI 0.97 as of January 2009
  - DCO ~12% complete SPI 0.94, CPI 0.93 as of January 2009
  - Diligent follow-up on previous review recommendations
  - Management systems are mature building on LCLS experience
- Comments
  - Good suite of EVMS tools informing project management
  - SV in DCO recognized by PM as potential issue
  - DCO presents modest technical risk, but could become schedule problem for XPP
- Recommendations
  1. Allocate enhanced resources to DCO to 'catch-up' on schedule
  2. Proceed with final design and procurement

Assessment of Charge -1

1- Technical Scope

- Design is mature with well defined interfaces
- Preliminary design reviews completed for all systems
- Confident that requirements of project will be met within defined scope

2- Management

- Instrument Team is in place, well qualified and well coordinated with user defined science needs
- Active risk management process evident
- Advanced procurement process well organized

3- Cost & Schedule

- Costs presented seem reasonable and have remained relatively stable since CD-2
- Cost and Schedule data are maintained and current
- Confident that requirements of project will be met within defined scope

January 2009 LUSI EVMS Data	BCWS	BCWP	ACWP	BAC	% CMP	SPI	CPI
XPP							
1.2.01 XPP System Integration & Design	509,571	509,571	479,171	1,210,157	42.1%	1.00	1.06
1.2.02 XPP X-ray Optics & Support Table	180,012	177,088	190,139	367,446	48.2%	0.98	0.93
1.2.03 XPP Laser System	43,380	45,195	44,958	1,131,791	4.0%	1.04	1.01
1.2.04 XPP Detector System (BNL)	774,707	774,227	838,697	1,411,689	54.8%	1.00	0.92
1.2.05 XPP Sample Environment & Diffractometer System	151,827	154,742	156,645	982,427	15.8%	1.02	0.99
1.2.06 XPP Facilities	0	7,015	1,796	82,725	8.5%	-	3.90
1.2.07 XPP Vacuum System	25,999	18,125	18,457	231,911	7.8%	0.70	0.98
1.2.08 XPP Installation	1,111	0	0	353,701	0.0%	0.00	-
	1,686,607	1,685,964	1,729,863	5,771,846	29.2%	**1.00**	**0.97**
Diagnostics and Common Optics							
1.5.01 Diagnostics & Common Optics System Integration &	438,082	438,082	418,231	1,263,607	34.7%	1.00	1.05
1.5.02 Diagnostics	140,761	136,116	202,513	1,553,723	8.8%	0.97	0.67
1.5.03 Common Optics	256,971	211,676	226,219	3,495,125	6.1%	0.82	0.94
	835,814	785,874	846,962	6,312,455	12.4%	**0.94**	**0.93**

Assessment of Charge -3

4- Environment Safety and Health

- Solid ES&H program in place and active
- ES&H aspects are appropriately addressed

5- Overall readiness of XPP

- ***XPP is ready to begin partial fabrication and installation at LCLS to begin conducting early scientific experiments***

LUSI Responses to the XPP Early Science Instrument Procurement Readiness Review and FIDR Committee Recommendations

March 4, 2009

2.1 XPP Components

1. Expedite the acquisition of a robot for the detector mover and

The XPP team is releasing the RFP to purchase the robot immediately.

2. Proceed with additional testing in order to clarify operational and metrology requirements

The robot will be installed and integrated into hutch 3 as soon as possible to begin testing.

2.2 XPP Laser System

1. LUSI should aggressively pursue the purchase of the additional optical components required to reach full laser performance as soon as funds become available. These components include the high power amplifier, the temporal pulse shaper and the optical parameteric amplifier.

We are seeking approval to include these components in the early science instrument if funds become available.

2.3 Common Diagnostics and Optics

1. Accelerate the Design work to complete the Final Design Reviews to reduce schedule risk

The DCO team is actively working and looking for ways to accelerate the design of the components. Based on current resources, the Final Design Reviews for the Monitors and attenuator/Pulse picker will be completed by early April and incorporated in the 2nd Advance Procurement package planned for approval in mid April. The RFP for the Slit systems is in work and will be released as soon as possible.

2. Advance first article procurements to expedite early component testing prior to production

The 2nd planned advance procurement package (Controlled as a DOE Level 2 decision) will be revised to include the DCO parts required for the first article. DCO has started the procurement process for the profile monitor, Intensity position monitor, Attenuator and pulse picker for first article testing.

2.4 BNL Detector

1. Test a small sensor as soon as possible on LCLS to reduce risk by

- Measuring detector performance with femtosecond x-ray pulses
- Determining radiation damage thresholds and
- Testing the integration of sensor data with FEL metadata

This test program will be pursued.

2.5 XPP Controls

1. Proceed with implementation of the control and data systems for XPP

No comment required.

2. Start regular coordination meetings between XPP and control teams immediately to assure a safe and robust XPP detector-mover system.

The first coordination meeting was scheduled for March 5th and will occur every Thursday. A robotics integrator will visit SLAC that day to begin discussions for a robot software statement of work.

2.6 XPP Installation

1. The committee recommends that the project identify an Installation Manager as early as practical.

This position will be filled as soon as possible. A request has already been sent to the LCLS Engineering Physics division.

2. A detailed installation plan that reflects the likely labor requirements should also be developed. It should include realistic distribution of labor types as well as a perspective on the availability of personnel where contract labor is not utilized.

This task will be started under the direction of the installation manager. A detailed installation plan will be developed that will coordinate/ incorporate the detailed labor and equipment requirements of all work to be completed in the NEH – XRT – FEH.

3.1 ES&H

1. None other than continue with the improvement process in evidence.

No comment required.

3.2 Risks and Contingency

1. Continue with diligent update and management of the risk registry

No comment required.

2. Advance procurements (if funds are available) that will retire schedule and technical risks

This will be actively pursued.

<u>3.3. Management</u>

1. Allocate enhanced resources to DCO to 'catch-up' on schedule

The project is actively pursuing an additional engineer.

2. Proceed with final design and procurement

No comment required.