PHOTON SCIENCE at STANFORD LINEAR ACCELERATOR CENTER

LUSI LCLS Ultrafast Science Instruments

DESIGN REVIEW REPORT	Report No. TR-391-003-19-0

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 (attach sign-in sheet)
- Completed Design Checklist.
- 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: Preliminary Design Review

WBS: 1.3 Coherent X-ray Imaging

Title of the Review	Reference Laser Preliminary Design Review	
Presented By:	Paul Montanez, Sébastien Boutet	
Report Prepared By:	Douglas Van Campen	**Date:10-March-2009**
Reviewers/Lab :	Douglas Van Campen, SSRL Engineering Physicist Greg Hays,. LCLS Laser Physicist Mike Woods, SLAC Laser Safety Officer	
Distribution:	Montanez, Boutet, Fox, Van Campen, Hays, Woods	
Attachments:	☐Review Slides ☐Design Checklist ☐Calculations XOther Attendance	

Purpose/Goal of the Review:

- Assess the completeness of the physics and engineering requirements for the CXI Reference Laser
- Review the preliminary design of the CXI Reference Laser and evaluate how well it meets the requirements
- Review the interfaces that have been identified and how well they have been communicated to the relevant parties (includes controls and software interfaces, safety review committees)
- Assess plans for fabrication, assembly, testing and inspection, and maintenance
- Review the cost estimate and schedule.
- Identify high-risk elements and evaluate plans to mitigate the risk.
- Identify safety issues

Comment on whether the component design is ready to proceed to final design

Introduction and outcome summary of the review:
A laser system for alignment of CXI instrumentation was reviewed. The system provides a means of checking the alignment of the CXI detector. The most demanding requirement is 5urad pointing repeatability (100um over 20m distance).

There were proper mechanical design considerations for this system in regards to stiffness and reproducibility. Note, the stage repeatability should be de-rated by 2X since the stability applies to a reflected beam.

Means of optical alignment with the LCLS beam seem appropriate. There will be limits in precision due to optical windows on valves and over-filling diffraction-limited KB optics. The goal is to help thread the LCLS beam through a 1-10mm aperture in the CXI detector.

The mechanical design can proceed forward.

The laser system specification needs changed and checked. For the system chosen, it is not stated if the laser/collimator system can meet the pointing repeatability and stability. No vendor data is indicated. The concern is that the pointing stability is less than 5% of the laser's divergence. Which ever laser is chosen, the expected performance needs to be stated and combined with the whole system requirements.

For safety reasons, the laser system should be reconsidered. The laser specification should be changed from a Class 3R to a Class 2 (< =1mW cw visible).

It is recommended to change from a red laser to a green laser to provide better visibility per same wattage laser.

Findings/Action Items:
1. The specifications are for use of a Class 3R laser system. There is no specific reason indicated for use of this class laser. The concerns are for safety. It unnecessarily elevates the level of training, overhead and safety systems needed to run such a laser safely.

Action Item: This specification should be lowered to a Class 2 laser or less (i.e. <=1mW cw visible laser). If it is determined that a Class 3R laser is needed, a specific safety plan and design must be reviewed. When selecting a laser and collimator, its specification with regards to pointing stability should be known and stated.

Related Safety comments and recommendations:
a. The purpose for the laser is to use the beam to physically see the path of the LCLS x-ray for aligning optics. Most of the time, it will be done remotely with YAG screens. However, there will be people working closely to the laser beam during initial alignment and special purposes. An example might be someone aligning components in the sample chamber. Such use should be is part of the safety consideration.
b. . Even at 1mW, there are some laser safety requirements.
- the laser and any laser transport system need appropriate labeling (CAUTION for Class 2, but DANGER for Class 3R; for non-laser personnel working in the area it would be better to be confronted with CAUTION signs rather than DANGER signs!); transport lines need labels at least every 3 meters.
- the area hazard analysis document needs to accurately describe the laser system and associated hazard (a separate SOP for the laser is not required). Personnel who work in the area must receive appropriate training to be knowledgeable about the laser and it's associated hazard. Personnel should be trained on how to determine whether the laser beam is on or enabled, and an appropriate status sign or indicator is recommended.
c. Potential for a startle hazard. Even though the laser is not considered a hazard for accidental viewing, it could still be a significant startle hazard and controls should be implemented to avoid accidental exposures. Administrative controls and personnel training may be adequate for this, but barriers to block access to the laser beam are also recommended.

Concerns/Design Comments:
1. There is a plan to add a machine protection system (MPS) to the translation stage such that the LCSL beam will not strike the apparatus during operation. This stage will need two sets of limit switches. One set, normally closed, is for motion control of the stepper motor. Not specified, there should be a second set of switches for MPS. For SSRL type devices, these switches are normally open: it is recommended to follow the same scheme.

2. Choice of wavelength. Current wavelength is 633nm, but consideration should be given to using a green HeNe or green laser diode. A lower power laser could be used in the green because the eye is more sensitive to green light than red.

Example: A 532 nm laser diode with 0.9mW part # 300-0088-00. (see attached link and datasheet)
http://www.laserglow.com/index.php?lrs532#

3. Don't change the power of the laser output during alignment. The beam should be attenuated external to the laser to maintain pointing stability.

4. It may be more advantageous to leave the laser on at all times. The alignment/pointing may drift for several days during warm-up. This will have to be evaluated.

5. Consider a shutter to gate the laser instead of an attenuator.
http://www.nmlaser.com/safety.htm

6. AR coated optics grade windows will reduce the back reflections of the alignment laser. For the initial input window, they may want to specify a high wedge angle to separate the two surface reflections.

7. New Focus products are specified. New Focus piezo motor drive has no support for EPICS system. Similar Newport system has support. Consider overhead for software support in the decision on what to use. SSRL has a piezo motor system drive that looks like a 'stepper motor' to the control system – might be another option.

General Observations:

1. The LCLS beam in this experiment will be ~ 0.5mm in width with 1urad divergence. The laser beam will be considerably larger 5.5mm with 100-200urad divergence. Also noted, the laser would be over-filling the KB optics and diffraction limited. But, the goal is to provide alignment to a 1-10mm hole in a detector.

2. The Vat valves separating systems will employ wedge windows to allow the laser beam to pass through the system. It is understood that this may cause a shift in this alignment beam.

3. Vacuum tank that is reusing a DCO design will have changes made for better functionality.

4. Various systems may be vented. This status will be part of the MPS system to ensure there will be no enable for LCLS beam.

5. A commissioning plan during initial start-up should be outlined. It was mentioned that a low-power LCLS beam will be used for initial alignment, maybe initially without a detector. An outline would be useful for planning purposes.

LUSI	LUSI Design Review Attendance Record	
System: CXI WBS 1.3 ~~Diagnostics and Common Optics~~	Review Title: REFERENCE LASER ~~IPM Preliminary Design Review~~	Date: 3/3/09 ~~01-09-09~~
Name	**Affiliation**	**Job Title**
PAUL MONTANEZ	LUSI	MECH ENG
Doug Van Campen	SSRL	Eng Phy.
Mike Woods	SLAC - LSO	Laser Safety Officer
Greg Haupt	LCLS - Laser group	Laser Group
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