PHYSICS REQUIREMENT DOCUMENT (PRD)	Doc. No. SP-391-000-08 R1	LUSI SUB-SYSTEM Diagnostics/Optics

Physics Requirements for the LUSI Intensity-Position Monitor

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Revision	Date	Description of Changes	Approved
R0	27Nov07	Initial release	
R1	1May08	Revision to update performance parameters	7/8/2008

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1. Overview

The LCLS FEL beam will exhibit intrinsic intensity, position, and pointing fluctuations. A diagnostic is required to measure the intensity, position, and to the extent possible the pointing of the X-ray beam (when two monitors are used in tandem), as well as aide in the alignment of X-ray optics and diagnostics. This document describes the physics requirements of this monitor.

The coordinate system is defined in Design Standards Supplement DS31100036.

2. Requirements

2.1. Performance Requirements

2.1.1. The intensity-position monitor shall be designed to measure the intensity of the X-ray beam with a 0.1% relative accuracy or permitted by counting statistics.

2.1.2. The intensity-position monitor shall be designed to measure the position of the X-ray beam in the XY plane to better than 5 μm in both X and Y directions.

2.1.3. The intensity-position monitor shall be designed to work for X-ray energies from 2 keV up to 25 keV.

2.1.4. The intensity-position monitor ideally should transmit greater than 95% of the incident flux for X-ray energies from 2-25 keV.

2.1.5. The intensity-position monitor shall be capable of measuring the intensity and position of the X-ray beam on a pulse-by-pulse basis.

2.1.6. The intensity-position monitor must withstand the full LCLS flux, which can be calculated from parameters listed in LCLS PRD# 1.1-014, when focused to an X-ray Gaussian spot size of 50 μm FWHM across the 8-25 keV spectral range without degradation to the monitor due to radiation damage. For energies lower than 8 keV, the focal spot size will be constrained to produce fluence equal to or less than that of an spot size of 50 μm FWHM at 8 kV.

2.1.7. The intensity-position monitor shall preserve the transverse coherence of the FEL radiation to the highest extent achievable.

2.2. Mechanical

2.2.1. Two nominal operating positions are required for the intensity-position monitor: 'In' and 'Out'.

2.2.2. Changing between nominal operating positions should occur in time interval less than 30 seconds.

2.2.3. The intensity-position monitor must have the ability to be translated in the X and Y direction with a 2 μm accuracy and repeatability.

2.2.4. When in the nominal 'In' position, the nominal LCLS beam shall impinge at the center of the sensor to within 10% of the sensor size and the surface normal of each sensor shall be aligned to the z-axis of the LCLS coordinate system to within ±1°. This can be achieved

manually.

2.2.5. A minimum stay clear radius of 0.5" will be maintained when the sensor is in the nominal 'Out' position.

2.2.6. The design of the intensity monitor should be compatible with the overall design of all instruments (XPP, CXI and XCS).

2.2.7. The design of the intensity-position monitor should permit replacement of the sensor in the field.

2.2.8. The operational range of the intensity-position monitor shall be greater than 2X2 mm^2.

2.3. Vacuum

2.3.1. The intensity-position monitor will reside in a 10^{-7} Torr pressure environment and the appropriate vacuum practice for the design, manufacturing, and installation of the system components shall be implemented.

2.4. Controls and Data Systems

2.4.1. The intensity-position monitor state, X and Y position, and intensity acquisition shall be controlled remotely.

2.4.2. There shall be the capability of measuring the beam intensity and position on a pulse-by-pulse basis.

2.4.3. There shall be rudimentary processing of the measured intensity to characterize the X-ray beam intensity and X and Y position including, but not limited to statistical quantities such as averages, standard deviations, histograms.

2.4.4. The intensity monitor must allow the capability of saving the result of the measurement and associated statistical description and the per-pulse data shall be embedded in the experimental data.

2.4.5. The operation of the monitor shall be constrained by the status of other optical components to prevent potential damages.

Appendix A – Revision 1 Primary Changes Affected Sections

2.1. Performance Requirements

2.1.1. (R0) The intensity-position monitor shall be designed to measure the intensity of the X-ray beam with a 0.1% relative accuracy.
2.1.2. (no change).
2.1.3. (R0) The intensity-position monitor shall be designed to work for X-ray energies from 6 keV up to 25 keV.
2.1.4. (R0) The intensity-position monitor ideally should transmit greater than 95% of the incident flux for X-ray energies from 6-25 keV.
2.1.5. (no change).
2.1.6. (R0) The intensity-position monitor must withstand the full LCLS flux when focused to a X-ray Gaussian spot size of 20 μm FWHM with a 1 mJ pulse energy across the 6-25 keV spectral range without degradation to the monitor due to radiation damage
2.1.7. (no change).

2.4. Controls and Data Systems

2.4.1. (no change).
2.4.2. (no change).
2.4.3. (no change).
2.4.4. (no change)
2.4.5. (added) The operation of the monitor shall be constrained by the status of other optical components to prevent potential damages.