PHYSICS REQUIREMENT DOCUMENT (PRD)	Doc. No. SP-391-000-09 R1	LUSI SUB-SYSTEM Diagnostics/Optics

Physics Requirements for the LUSI Pop-in Intensity Monitor

Yiping Feng
LUSI Scientist, Author — Signature — Date

David Fritz
LUSI Scientist — Signature — Date

Aymeric Robert
LUSI Scientist — Signature — Date

Sébastien Boutet
LUSI Scientist — Signature — Date

Niels van Bakel
LUSI Scientist — Signature — Date

Eliazar Ortiz
Diagnostics/Optics Lead Engineer — Signature — Date

Darren Marsh
LCLS Quality Assurance Manager — Signature — Date

Nadine Kurita
LUSI Chief Engineer — Signature — Date

Tom Fornek
LUSI System Manager — Signature — Date

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

1. Overview

The LCLS FEL beam exhibits intrinsic intensity fluctuations. A diagnostic is required to characterize the intensity of the X-ray beam, 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 monitor shall be designed to measure the intensity of the X-ray beam with a 1% relative accuracy or that limited by counting statistics.
2.1.2. The intensity monitor shall be designed to work for X-ray energies from 2 keV up to 25 keV.
2.1.3. The intensity monitor shall be capable of measuring the intensity of the X-ray beam on a pulse-by-pulse basis.
2.1.4. At high X-ray fluences, attenuation is acceptable to avoid saturation and potential permanent damage.

2.2. Mechanical

2.2.1. Two operating positions are required for the intensity monitor: 'In' and 'Out'.
2.2.2. The intensity monitor state should have the ability to be changed in ~ 1 second.
2.2.3. When in the '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.
2.2.4. A translational repeatability of 100 microns and a rotational repeatability (pitch and yaw) of 0.1° shall be maintained when the sensor is placed in the 'In' position.
2.2.5. A minimum stay clear radius of 0.5" will be maintained when the sensor is in the 'Out' position.
2.2.6. The sensor shall default to the 'Out' position in the event of a system fault if feasible.
2.2.7. The design of the intensity monitor should be compatible with the overall design of all instruments (XPP, CXI and XCS).
2.2.8. The design of the intensity monitor should permit replacement of the sensor in the field.
2.2.9. The size of the sensitive area of the intensity monitor shall be greater than 2 x 2 cm^2.

2.3. Vacuum

2.3.1. The intensity 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 monitor state and intensity acquisition shall be controlled remotely.

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

2.4.3. There shall be rudimentary processing of the measured intensity to characterize the X-ray beam 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 monitor shall be designed to measure the intensity of the X-ray beam with a 1% relative accuracy.
2.1.2. (no change).
2.1.3. (no change).
2.1.4. (no change).

2.2. Mechanical

2.2.1. (no change).
2.2.2. (no change).
2.2.3. (no change).
2.2.4. (no change).
2.2.5. (no change).
2.2.6. (R0) The sensor shall default to the 'Out' position in the event of a system fault.
2.2.7. (no change).
2.2.8. (no change).
2.2.9. (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.