

PHYSICS REQUIREMENT DOCUMENT (PRD)	Doc. No. SP-391-000-34 R1	LUSI SUB-SYSTEM XCS, XPP
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**Physics Specifications
for the LUSI Harmonic Rejection Mirror System**

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Revision	Date	Description of Changes	Approved
R0	28NOV07	Initial release	
R1	05MAY08	Updated performance requirements	7/8/2008

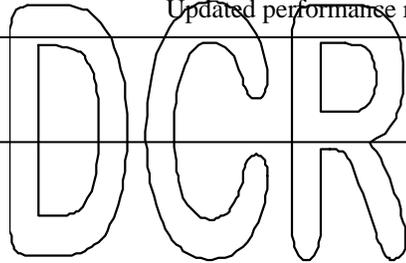


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1. Overview

A harmonic rejection mirror system will be used as a low pass filter to reject harmonics of the FEL fundamental. The system is based on the successive reflection of the x-ray beam by two x-ray mirrors in grazing incidence geometry. It also provides the capability to perform grazing incidence x-ray experiment. This document describes the requirements of this system.

The coordinate system is defined in Design Standards Supplement DS31100036.

2. Performance Specifications

- 2.1.** The mirror system shall have greater than 10^4 contrast between the fundamental and 3rd harmonic over a fundamental energy range of 6 - 8.5 keV.
- 2.2.** The mirror system shall preserve the transverse coherence of the FEL radiation to the highest extent achievable.
- 2.3.** The throughput of the mirror system shall be greater than 80%.
- 2.4.** The mirrors must not damage or degrade when exposed to the full unfocused LCLS FEL beam intensity in the NEH Hutch 3. The LCLS beam intensity can be calculated from parameters listed in LCLS PRD# 1.1-014.
- 2.5.** The clear aperture of the mirror system shall be greater than 1mm in the Y direction.
- 2.6.** The mirror shall not alter the beam divergence more than 50% of the natural FEL divergence.

3. Geometry Requirements

- 3.1.** The mirrors will deflect the X-ray beam in the vertical plane (YZ).
- 3.2.** The upstream mirror will deflect the beam down.
- 3.3.** The downstream mirror will have the capability to deflect the beam up so that the exit beam is parallel to the z-axis (normal operation) or deflect the beam down again (high grazing incidence angle operation). Breaking vacuum is acceptable when changing between these operation modes.

4. Positioning Requirements

- 4.1. Motorized translations (i.e in the X,Y directions) are required for each mirror. It should satisfy the position requirements 4.2, 4.3, 4.4, 4.5 4.7.
- 4.2. Each mirror should have the capability to be translated out of the x-ray beam path, allowing a stay clear of 0.5” whatever the operation mode (cf. 3.3)
- 4.3. The mirrors must be positioned such that the incident LCLS FEL beam is centered on the mirrors to within 10% of the mirror lengths in either direction.
- 4.4. The vertical motion along the Y axis of the downstream mirror should be compatible with the two modes of operation described in 3.3.
- 4.5. Horizontal translation (i.e in the X direction) is needed to adjust to location of the beam on the mirrors if damage is detected or if a multicoated mirror is used.
- 4.6. Motorized independent tilt adjustment of each mirrors is needed with a 5 mDegree accuracy and repeatability over a ± 2 degree range.
- 4.7. The roll of the mirror surface will be aligned to within 0.1 degree of the y-axis. Necessary capability to meet that requirement by the metrology group should be implemented in the design.
- 4.8. The mirrors should have the necessary stability, both long term and short term, such that the beam pointing is not altered by more than 10% of the spot size.

5. Vacuum Requirements

- 5.1. The harmonic rejection mirror system 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.
- 5.2. The mirror system should allow for direct viewing of the mirrors during operation.

6. Control Requirements

- 6.1. All motorized degrees of freedom of the harmonic rejection mirror system dedicated to each instrument (i.e. XPP and XCS) is required to be controlled remotely via the corresponding instrument control system.

Appendix A – Revision 1 Primary Changes Affected Sections

2. Revision 1 Performance Requirements

- 2.1. (no change)
- 2.2. (no change)
- 2.3. (was) The mirrors must not damage or degrade when exposed to the full LCLS FEL beam intensity calculated with the following assumption : full LCLS flux in the NEH Hutch 3, where the x-ray spot size is 220 μ m FWHM and energy per pulse is 1 mJ, across the 6-25 keV spectral range.
- 2.4. (was) The mirrors must not damage or degrade when exposed to the full unfocused LCLS FEL beam intensity in the NEH Hutch 3.
- 2.5. (no change)
- 2.6. (was) The mirror shall preserve the natural FEL beam divergence.