

PHYSICS REQUIREMENT DOCUMENT (PRD)	Doc. No. SP-391-000-14 R1	LUSI SUB-SYSTEM DCO, CXI, XCS, XPP
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Physics Requirements for the LUSI Slit System

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Revision	Date	Description of Changes	Approved
R0	28NOV07	Initial release	
R1	19JUN08	Deleted Obsolete Beam Parameters, added a requirement in section 2 , Added a section for size and interface requirements. Added a section about controls	7/8/2008

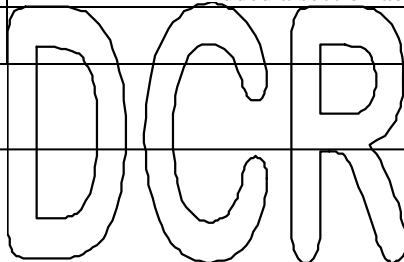


Table of Contents

Table of Contents	2
1. Overview.....	2
2. Performance Requirements.....	2
3. Positioning Requirements.....	3
4. Vacuum Requirements.....	3
5. Size and Interface Requirements	3
6. Controls Requirements	3
Appendix A – Revision 1 Primary Changes Affected Sections	4

1. Overview

Slits are required to define the x-ray beam dimensions for the X-ray Pump Probe (XPP) and X-ray Correlation Spectroscopy (XCS) experiments. Slits are also required to cleanup the edges of the beam in Coherent X-ray Imaging (CXI) experiments, as well as XPP and XCS. The x-ray beam dimension will be tailored to each experiment and thus a variable aperture is needed. Slits will be used in three different situations.

- I. To cut into the main white beam. These are called primary slits.
- II. To cut into the halo surrounding the main white beam. These are called guard slits.
- III. To cut into the monochromatic beam. These are called monochromatic slits.

Depending on the location of the slits, they will have different requirements on the positioning and gap size accuracy. We make the distinction between two types: precise and coarse slits. A common design with small modifications should be used to accommodate all 6 types of slits.

The coordinate system is defined in Mechanical Design Standards Supplement DS-391-000-36.

2. Performance Requirements

2.1. The x-ray transmission through a single slit blade is given in Table 2-1.

Name	Transmission at 25 keV	Transmission in 2-8.3 keV range	Positioning Accuracy and Repeatability (μm)	Radiation Protection
Precise Primary	$<10^{-8}$	$<10^{-11}$	0.5	White beam
Precise Guard	N/A	$<10^{-9}$	0.5	White beam
Precise Monochromatic	$<10^{-8}$	$<10^{-9}$	0.5	Monochromatic beam

Coarse Primary	<10 ⁻⁸	<10 ⁻¹¹	5	Full white beam
Coarse Guard	N/A	<10 ⁻⁹	5	White beam
Coarse Monochromatic	<10 ⁻⁸	<10 ⁻⁹	5	Monochromatic beam

Table 2-1: Transmission, resolution for the positioning and radiation protection requirements for the 6 types of slits required.

- 2.2. The primary and guard slit blades must withstand the full LCLS flux (white beam or monochromatic beam) at all locations downstream of and including NEH Hutch 2, across the 2-25 keV spectral range without degradation due to radiation damage. See Table 2-1. The beam parameters in Hutch 2 can be calculated from the parameters listed in LCLS PRD# 1.1-014.
- 2.3. The monochromatic slit blades must withstand the monochromatic beam produced by a Si(111) monochromator at all locations downstream of and including NEH Hutch 2, across the 6-25 keV spectral range without degradation due to radiation damage.
- 2.4. Parasitic scatter from the slit blades shall be minimized.
- 2.5. The transmission and radiation protection requirements for the primary slits may be met using a combination of the guard and monochromatic slits in series if desired.

3. Positioning Requirements

- 3.1. The horizontal and vertical gap widths shall be variable between -0.1 – 10 mm.
- 3.2. The gap centers shall translate over a 10 mm range.
- 3.3. The repeatability and accuracy of positioning of the gap widths and center locations are given in Table 2-1 for each type of slit.
- 3.4. The Y and X axis of the slits shall be parallel to the LCLS coordinate system to within 1 degree. This requirement only strictly applies to the roll angle of the blades with 1 degree being a design goal for the pitch and the yaw.

4. Vacuum Requirements

- 4.1. The slit assembly must be contained in a high vacuum environment (10⁻⁷ torr) and the appropriate vacuum practice for the design, manufacturing and installation of the system components shall be implemented.

5. Size and Interface Requirements

- 5.1. The z length of the slit assembly shall be minimized with a maximum length allowable of 6 inches.
- 5.2. The X and Y length of the slit assembly shall be minimized.
- 5.3. It shall be possible to attach two slit assemblies directly to each other in series.

6. Controls Requirements

- 6.1. All motorized degrees of freedom of the slit system dedicated to each instrument is required to be controlled remotely via the corresponding instrument control system.

Appendix A – Revision 1 Primary Changes Affected Sections

2. Performance Requirements

- 2.1 Updated the table, removed the transmission requirement for the guard slits at 25 keV.
- 2.2 (was) The primary and guard slit blades must withstand the full LCLS flux (white beam) in NEH Hutch 3, where the x-ray spot size is 220 μm FWHM and energy per pulse is 1 mJ, across the 2-25 keV spectral range without degradation due to radiation damage. See Table 2-1.
- 2.3 (was) The monochromatic slit blades must withstand the monochromatic beam in NEH Hutch 3, where the x-ray spot size is 220 μm FWHM and energy per pulse is $<40 \mu\text{J}$, across the 2-25 keV spectral range without degradation due to radiation damage. The value for the energy per pulse is obtained from the bandwidth of the Si(111) reflection and represents an upper bound. See Table 2-1.
- 2.4 No change
- 2.5 Added this requirement

3. Positioning Requirements

No change

3.2 No change

3.3 No change

3.4 (was) The Y and X axis of the slits should be parallel to the LCLS coordinate system to within 1 degree.

5. Control Requirements

5.1 Added this requirement