




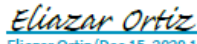


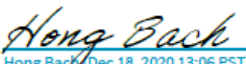

Physics Requirements Document

Document Title: LCLS-II-HE DXS Detectors PRD

Document Number: LCLSII-HE-1.4-PR-0280-R0

Page 1 of 6

Document Approval:

<p>Originator: Hasan Yavas, DXS Instrument Scientist</p> 
<p>• Content/Format • Req ID's/Source ID's • Verif. Planning • SME Input, as appl</p>
<p>Approver: Angelo Dragone, Detector Engineer</p>  <small>Angelo Dragone (Dec 15, 2020 14:18 PST)</small>
<p>• Complete/Accurate • SME Involvement • Actionable, as appl</p>
<p>Approver: Mark McKelvey, LCLS Detector Department Head</p>  <small>Mark McKelvey (Dec 15, 2020 12:23 PST)</small>
<p>• Complete/Accurate • SME Involvement • Actionable, as appl</p>
<p>Approver: Eliazar Ortiz, System Manager</p>  <small>Eliazar Ortiz (Dec 15, 2020 15:30 PST)</small>
<p>• Articulation • Meets Higher Level Expectations • Alt. CAM/SM Informed, as appl</p>
<p>Approver: Ted Price, Systems Engineer</p>  <small>Ted Price (Dec 17, 2020 08:52 PST)</small>
<p>• Clarity • Format • Req ID's/Traceability • Change Control, as appl</p>
<p>Approver: Ian Evans, ES&H Manager</p>  <small>Ian Evans (Dec 15, 2020 12:20 PST)</small>
<p>• ES&H Content, as appl</p>
<p>Approver: Hong Bach, Quality Assurance Manager</p>  <small>Hong Bach (Dec 18, 2020 13:06 PST)</small>
<p>• General QA Provisions • Req's Validation/Verification, as appl</p>
<p>Approver: David Fritz, Photon Systems Technical Director</p> 
<p>• Scope Alignment</p>

See [Document Review/Approval Matrix of Responsibilities](#)

Revision History

Revision	Date Released	Description of Change
R0	12/20/2020	Original Release



Table of Contents

1 Purpose	2
2 Scope	2
3 Acronyms	2
4 References	3
5 Roles and Responsibilities	3
6 Requirements Definition	4
6.1 Two line Detectors: One for IXS Spectrometer and one for HRM diagnostics	4
6.2 One area Detector for XPCS.....	5

1 Purpose

This Physics Requirements Document (PRD) identifies and outlines physics requirements that apply to the portion of the LCLS-II facility that is referenced in this document, and that must be addressed as part of the LCLS-II HE project. From this information, the engineering team will formulate engineering requirements that provide the basis for hardware and software design, development, and integration. Thus, the PRD primarily focuses on performance criteria that can be traced back to top-level system/facility performance parameters. However, PRD preparation and approval also ensure that requirements can be properly interpreted at lower levels of specification, for purposes of accurate system developmental definition.

2 Scope

This PRD details the requirements for the DXS Detectors. Three detectors are required in DXS: two line-detectors compatible with the requirements of the IXS spectrometer and the 4f-diagnostic spectrometer, and an area detector compatible with the requirements of XPCS experiments. All detectors need to have an architecture allowing future upgrades in energy and rate. The listed parameters represent what is required at first light.

3 Acronyms

Acronym	Definition
DXS	Dynamic X-ray Scattering Instrument
HRM	4f High-resolution Monochromator
IP	Interaction Point
IXS	Inelastic X-ray scattering
PRD	Physics Requirements Document
QE	Quantum Efficiency
RIXS	Resonant Inelastic X-ray scattering



Physics Requirements Document

Document Title: LCLS-II-HE DXS Detectors PRD

Document Number: LCLSII-HE-1.4-PR-0280-R0

Page 3 of 6

ROI	Region of Interest
XPCS	X-ray Photon Correlation Spectroscopy

4 References

LCLSII-HE-1.1-PP-0224	LCLS-II-HE Requirements Specification Preparatory Instruction
LCLSII-HE-1.4-PR-0211	LCLS-II-HE DXS Instrument PRD
LCLSII-HE-1.4-PR-0277	LCLS-II-HE DXS End Station PRD

5 Roles and Responsibilities

Hasan Yavas DXS Instrument Scientist	Defines requirements
Angelo Dragone Detector Engineer	Oversees the delivery of the requirements specified in this PRD
Mark McKelvey LCLS Detector Department	Approves verification method
Frank O'Dowd DXS Instrument Engineer	Oversees component integration and design



6 Requirements Definition

6.1 Two line Detectors: One for IXS Spectrometer and one for HRM diagnostics

Requirement #	Requirement	Comments	Verification Method	Parent Requirement
PRD0280.4101	DXS shall acquire two units of line detectors: IXS line detector and HRM line Detector	One line detector for IXS Spectrometer (IXS Detector) and one line detector for HRM diagnostics (HRM Detector).	Inspection	PRD0211.3322
PRD0280.4102	Both IXS and HRM line detectors shall be sensitive in the energy range of 4-12 keV	Goal: Sensitivity up to 20keV	Analysis/Test	PRD0211.3322
PRD0280.4103	Both IXS and HRM line detectors shall have a QE >70% @ 12 keV	Goal: >70% @ 20 keV	Analysis	PRD0211.3322
PRD0280.4104	Frame rate of both IXS and HRM line detectors shall be \geq 100 kHz	Goal: 1 MHz	Test	PRD0211.3322
PRD0280.4105	Strip full well of both IXS and HRM line detectors shall be \geq 100 ph @ 10 keV per pulse		Analysis/Test	PRD0211.3322
PRD0280.4106	Read-out noise of both IXS and HRM line detectors shall be \leq 75 e-		Test	PRD0211.3322
PRD0280.4107	Both IXS and HRM line detectors shall have a sensitive area \geq 15x4 mm ²		Inspection	PRD0211.3322
PRD0280.4108	Both IXS and HRM line detectors shall have a strip pitch \leq 50 μ m	Goal: \leq 25 μ m	Inspection	PRD0211.3322
PRD0280.4109	Both IXS and HRM line detectors shall have strip length \leq 1 mm		Inspection	PRD0211.3322



Physics Requirements Document

Document Title: LCLS-II-HE DXS Detectors PRD

Document Number: LCLSII-HE-1.4-PR-0280-R0

Page 5 of 6

Requirement #	Requirement	Comments	Verification Method	Parent Requirement
PRD0280.4110	For both IXS and HRM line detectors, the number of strips shall be ≥ 300 (15mm/50 μ m) (dispersive direction)	Goal: 600 (15mm/25 μ m)	Inspection	PRD0211.3322
PRD0280.4111	Both IXS and HRM line detectors shall have ≥ 4 strips (non-dispersive direction)	Goal: 8	Inspection	PRD0211.3322
PRD0280.4112	Maximum Power dissipated by each line detector individually shall be < 50 W		Analysis	PRD0211.3322
PRD0280.4113	Both IXS and HRM line detectors shall have cabling and cooling length ≥ 2 m		Inspection	PRD0211.3322
PRD0280.4114	IXS line detector shall be compatible with Level 4 per LCLS Vacuum Policy	Reference: SLAC-I-030-714-001-07	Inspection/ Analysis/Test	PRD0211.3404
PRD0280.4115	HRM line detector shall be compatible with Level 3 per LCLS Vacuum Policy	Reference: SLAC-I-030-714-001-06	Inspection/ Analysis/Test	PRD0211.3403

6.2 One area Detector for XPCS

Requirement #	Requirement	Comments	Verification Method	Parent Requirement
PRD0280.4201	DXS shall acquire one area detector for XPCS		Inspection	PRD0211.3322
PRD0280.4202	The XPCS detector shall be sensitive in the energy range of 4-12 keV	Goal: Sensitivity up to 20keV	Analysis/Test	PRD0211.3322
PRD0280.4203	The QE of the XPCS detector shall be $> 70\%$ @ 12 keV	Goal: $> 70\%$ @ 20 keV	Analysis	PRD0211.3322
PRD0280.4204	The frame rate of the XPCS detector shall be ≥ 5 kHz full frame mode		Test	PRD0211.3322



Physics Requirements Document

Document Title: LCLS-II-HE DXS Detectors PRD

Document Number: LCLSII-HE-1.4-PR-0280-R0

Page 6 of 6

Requirement #	Requirement	Comments	Verification Method	Parent Requirement
	≥ 1 MHz sparsified (>0.5% occupancy)			
PRD0280.4205	The XPCS detector pixel full well shall be ≥ 5ph @ 10keV per pulse		Analysis/Test	PRD0211.3322
PRD0280.4206	The XPCS detector read-out noise shall be < 60 e-	Goal: 30 e-	Test	PRD0211.3322
PRD0280.4207	The XPCS detector sensitive area shall be > 2MPix 80x80 mm ²		Inspection	PRD0211.3322
PRD0280.4208	The XPCS detector pixel size shall be ≤ 50 μm x 50 μm	Goal: 25 μm x 25 μm	Inspection	PRD0211.3322
PRD0280.4209	The XPCS detector Maximum Power dissipation shall be < 300 W		Analysis	PRD0211.3322
PRD0280.4210	The XPCS detector cabling and cooling length shall be ≥ 2 m		Inspection	PRD0211.3322
PRD0280.4211	The XPCS detector physical package envelope (WxLxD) shall be < 120 mm x 120 mm x 200mm		Inspection	PRD0211.3322
PRD0280.4212	The XPCS detector vacuum compatibility shall be Level 5 per LCLS Vacuum Policy	Reference: SLAC-I-030-714-001-08	Inspection/ Analysis/Test	PRD0211.3405