



Interface Requirements Document

Document Title: LCLS-II-HE XPP Detectors IRD

Document Number: LCLSII-HE-1.4-IR-0875-R0.1

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Articulation • Meets Higher-Level Expectations • Stakeholder/SME/Other System Manager(s) Engagement

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



Revision History

Revision	Date Released	Description of Change
R0.1	7/25/2023	Minor change, no new approvals. Changed circle diameter (shown in Fig. 5) for IRD0875.4002. Was 19.5", now 18" diameter.
R0	6/23/2023	Original Release

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1 Purpose

This Interface Requirements Document (IRD) identifies and outlines physical and functional engineering interface requirements that apply to the portions of the LCLS-II facility that are referenced in this document, and that must be addressed as part of the LCLS-II HE project. The IRD is intended to focus on detailed qualitative and quantitative engineering factors that supplement stand-alone product design requirements specified in related subsystem or component ESD's. However, the IRD outlines engineering design detail that is typically shared by two parties, in order to capture necessary physical or functional interactions across a defined subsystem-to-subsystem, or component-to-component boundary. An agreement or "handshake" of sorts. Along with complementary ESD's, this IRD captures design factors that can be traced back to FRS functional expectations, PRD physics requirements, and other performance criteria included in higher-level subsystem/system/facility requirements specifications. IRD's provide the balance of requirements detail that the engineering team will need to properly address hardware and software design, development, and integration.

2 Scope

This document provides interface requirements for the Large Format Area Detector (LFAD) and related equipment that will be used at XPP and delivered as part of the HE project scope. It is assumed that the LFAD will consist of 4 x 1Mpixel modules and will perform to requirements specified in the detector PRD (LCLS-II-HE XPP Detectors PRD). This document also provides interface requirements for Small Format Area Detectors (SFADs) that may be used at XPP in the future.

3 Acronyms

Acronym	Definition
XPP	X-ray Pump Probe Instrument
LFAD	Large Format Area Detector
SFAD	Small Format Area Detector
ID	Inner Diameter
SM	Single-Mode
MM	Multi-Mode

4 References

LCLSII-HE-PP-0224	Requirements Specification Preparatory Instruction
LCLSII-HE-1.4-PR-0212	LCLS-II-HE XPP Instrument PRD
LCLSII-HE-1.4-PR-0220	LCLS-II-HE XPP Detectors PRD



LCLSII-HE-1.4-ES-0423	LCLS-II-HE XPP Instrument ESD
LCLSII-HE-1.4-IC-0688	LCLS-II-HE Detectors ICD
LCLSII-HE-1.4-IR-0881	DXS Detectors IRD

5 Roles and Responsibilities

Title of Responsible Individual	Define what role the individual plays in identifying and delivering product(s) that meet the requirements of this specification
Diling Zhu XPP HE Lead Instrument Scientist	Ensures interface requirements are consistent with science needs of the instrument.
Rebecca Armenta XPP HE Lead Instrument Engineer	Defines mechanical interface requirements. Ensures that equipment interfacing with instrument systems are delivered per requirements.
Vincent Esposito XPP HE Controls Engineer	Defines control system interface requirements.
Angelo Dragone TID-DRDAM	Develops and delivers the detector unit(s) and required equipment per the ICD.
Conny Hansson LCLS Detectors	Reviews interface requirements. LCLS Detectors Dept is responsible for operation, deployment, and maintenance of delivered detector systems.



6 Requirements Definition

6.1 XPP LFAD Interface Requirements

Table 6.1

Requirement #	Requirement	Comments	Verification Method	Parent Requirement
IRD0875.4001	The environment of the LFAD detector in XPP shall be "in Air." Provisions shall be made to allow for operation in this environment.	Environmental expectations, including temperature/humidity detail, is available for XPP as noted in LCLSII-HE-1.4-ES-0423.	Analysis Inspection	RDS0345.3151 RDS0345.3152 RDS0345.3153
IRD0875.4002	The external dimensions of the LFAD shall not exceed 12" x 12.75" x 8.75" (Width x Height x Depth). For purposes of positioning the center of the LFAD on the beam centerline, all additional external features shall remain within a 18" diameter circle on detector center (see figure 5).	See Fig. 1, Fig 5.	Inspection	ESD0423.4010
IRD0875.4003	The LFAD shall include a repeatable mounting interface with the overhead detector robotic mover mounting bracket. The center of the LFAD shall be 6.63-6.75 inches below this interface (see Fig 1). The interface shall include threaded mounting hole pattern shown in Fig. 2. Depth of threaded holes shall be determined such that 4 screws can hold the load of the detector with a factor of safety of 2.	See Fig. 1, Fig. 2.	Inspection	PRD0220.4109
IRD0875.4004	The robotic mover shall be capable of providing LFAD position repeatability in all 3 axes that is <50 micron and angular orientation repeatability on all		Test	PRD0351.4308



Table 6.1

Requirement #	Requirement	Comments	Verification Method	Parent Requirement
	three axes that is better than 0.01 degrees.			
IRD0875.4005	The robot arm shall be capable of supporting an LFAD weight (including portion of cables routed along robot arm) that does not exceed 25 kg (55 lbs).		Analysis	PRD0220.4110
IRD0875.4006	The LFAD shall include an integrated beam pass through tube with a nominal ID of 5mm. The tube shall extend through the body of the detector and extend past the plane of the removable shield. The tube shall be constructed of tungsten or similar material to shield internal electronics from radiation. The internal diameter of the tube shall be toleranced to interface with a beam collimating tube that provides a sliding fit.	Interfacing Part: PF-391-574-19 (or similar) See Fig. 3.	Inspection	PRD0220.4112
IRD0875.4007A	The LFAD shall include a hole pattern for a removable debris/light shield.	See Fig 1. Shield will be designed in coordination with detector design. Appropriate hole patterns will be determined prior to final design review for detector.	Inspection	PRD0220.4111
IRD0875.4007B	A removable debris/light shield shall be designed and constructed to install on the front face of the LFAD. Mounting hole pattern shall match that added to the LFAD housing.	See Fig. 1. Hole pattern to be determined prior to detector FDR.	Inspection	PRD0220.4111
IRD0875.4009	The LFAD beam pass-through tube shall include a non-adhesive seal around the center hole of the	This may be achieved with a barbed feature on	Inspection	IRD0875.4006



Table 6.1

Requirement #	Requirement	Comments	Verification Method	Parent Requirement
	removable shield when installed. The sealing feature shall not block detector sensor pixels near the center hole.	the tube or with a separate sealing part/feature.		
IRD0875.4010	Features for cable mounting strain relief near the LFAD electrical connectors shall be provided on the rear side of the LFAD.	(e.g. support brackets)	Inspection	N/A
IRD0875.4011	Cables interfacing with the LFAD shall be long enough (approx. 23 feet) to be routed through the cable carrier on the XPP Overhead Robot.		Inspection	PRD0220.4108
IRD0875.4012	LFAD cables shall fit through the robot arm's cable carrier and shall be sufficiently flexible to avoid degradation of robot mover positioning performance.	Cable Carrier P/N: IGUS TRE.60 ¹ See Fig 4.	Inspection Test	PRD0220.4108 PRD0220.4110
IRD0875.4014	At least four alignment features shall be present on the exterior of the detector that are collectively visible from common XPP laser tracker locations.	Preferred alignment features are internal socket holes for mounting removable tooling balls. Internal diameter of socket holes should match the related feature in drawing PF-444-316-76 (See Figure 6). COTS laser tracker sphere mount retroreflectors are also acceptable:	Inspection	ESD0423.3142

¹ If it is determined that cables required will exceed the capacity of the existing carrier, parties will coordinate to upgrade cable carrier to appropriate size prior to procurement/installation.



Table 6.1

Requirement #	Requirement	Comments	Verification Method	Parent Requirement
		HUBBS (.500 SMT - .500" - 1/4-20) but when installed on LFAD, the complete assembly must fit inside a cylinder with radius as shown in Figure 5. For internal tooling ball socket reamed holes that will utilize a pin nest to SMR, suggested location is 1.5" in from the radial edges as shown in Figure 7 below.		
IRD0875.4015	Detector sensor features (such as sensor pixel alignment, sensor plane alignment, center hole position, etc) shall be fiducialized to LFAD alignment features.		Inspection	ESD0423.3143
IRD0875.4016	Indicator marks for detector plane location shall be visible on the LFAD housing.		Inspection	IRD0875.4015
IRD0875.4017	Threaded holes in the LFAD housing, used for attachment of removable interfacing parts, shall utilize threaded inserts (helicoil, etc).		Inspection	N/A
IRD0875.4018A	Power and data connector receptacles on the LFAD housing shall be sufficiently robust to accommodate many reconnect cycles over the LFAD's anticipated lifespan. Also, the connectors shall be selected to properly interface with plug		Inspection	ESD0477.4024



Table 6.1

Requirement #	Requirement	Comments	Verification Method	Parent Requirement
	connectors that terminate relevant power/data cables.			
IRD0875.4018B	Power and data connectors associated with LFAD power/data cables shall be robust and matching to power/data receptacles mounted on the LFAD.		Inspection	ESD0477.4024
IRD0875.4019A	CO ₂ cooling line connector receptacle attached to the LFAD shall be a high-pressure VCR type, shall include appropriate insulation, and shall properly interface with the connector plug that terminates the relevant CO ₂ hose.	Exact size will be determined during detector design.	Inspection	ESD0477.4024
IRD0875.4019B	CO ₂ cooling line connector plug that terminates the input CO ₂ hose shall be a high-pressure VCR type that includes appropriate insulation and that properly interfaces with the connector receptacle on the LFAD housing.		Inspection	ESD0477.4024
IRD0875.4021A	A cover shall be provided to protect the LFAD sensor. The cover shall interface with the debris/light shield and attach to the LFAD body. Cover shall also enclose the front facing end of beam tube. Cover shall utilize captured screws to prevent loss of hardware when removed.		Inspection	N/A
IRD0875.4021B	The LFAD body shall incorporate provisions to attach the detector sensor cover.		Inspection	N/A



Table 6.1

Requirement #	Requirement	Comments	Verification Method	Parent Requirement
IRD0875.4022	The LFAD power supply shall provide stability of at least 10mV peak-to-peak.		Test	IRD0875.4023
IRD0875.4023	2x 3U Wiener PL516 power supplies, each with two PF8F8 power boxes equipped with four MEH-12/30 power modules shall be used to power the LFAD. Power supplies shall be installed in the B950-100H3-R09 rack.	This will provide sixteen 24V channels, as per the 4 ch/Mpix requirement	Inspection	ESD0691.3152 RDS0345.4101
IRD0875.4024	PL516 power supply electrical input/output connections, including respective power ratings, shall adhere to the supplier's engineering documentation.	One 208V-30A outlet will be used to supply power per the RDS	Inspection	RDS0345.4311
IRD0875.4025	A Wiener MPOD micro-2 crate equipped with two EHS F010p modules (16 channels, 1kV, 8mA) shall be used to bias the LFAD sensors. The MPOD chassis shall be installed in the B950-100H3-R09 rack.		Inspection	ESD0477.4024 RDS0345.4101
IRD0875.4026	MPOD power module electrical input/output connections, including respective power ratings, shall adhere to the supplier's engineering documentation.	One 208V-30A outlet will be used to supply power per the RDS.	Inspection	RDS0345.4311
IRD0875.4027	Dry air receptacle connector(s) at the LFAD shall be a "quick disconnect" type.	Exact size will be determined during detector design.	Inspection	PRD0351.4201
IRD0875.4028	Power and HV receptacle connector(s) at the LFAD shall be a "quick disconnect" type.	The exact type of connector will be part of the detector design.	Inspection	PRD0351.4201



Table 6.1

Requirement #	Requirement	Comments	Verification Method	Parent Requirement
IRD0875.4029	The LFAD detector shall connect to two SM-MM conversion boxes via 8 MM 24 fiber trunks, with MPO-24 connectors at both ends. The fiber bundles shall be supplied as part of SM-MM conversion box deliverables and follow the length requirements defined in IRD0875.4011.	Can utilize the two SM-MM boxes installed in B950-100H3-R09 or the two SM-MM boxes installed in B950-100H3-R08, as appropriate. Fiber bundle connection details can be found in ID-391-701-55.	Inspection	IRD0875.4205B

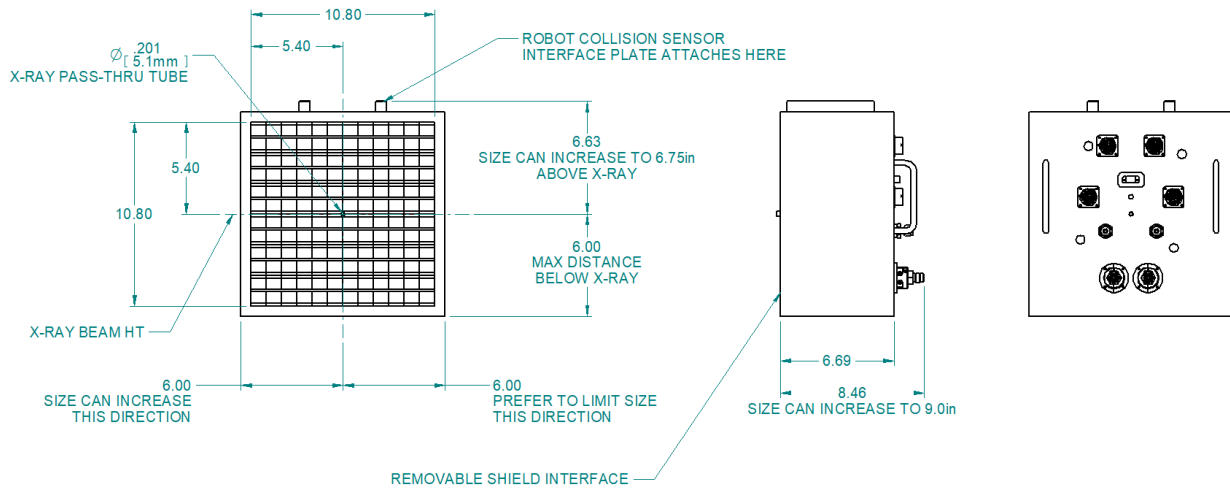


Figure 1: XPP LFAD envelope and features (connectors not necessarily shown in exact required position; unless otherwise specified, units are in inches).



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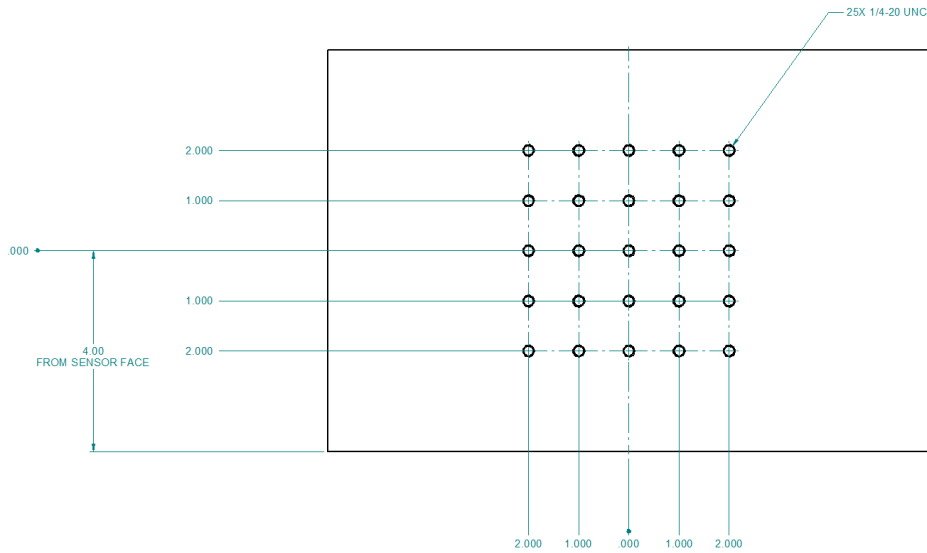


Figure 2: Interface Pattern (top surface of enclosure). Units are in inches.

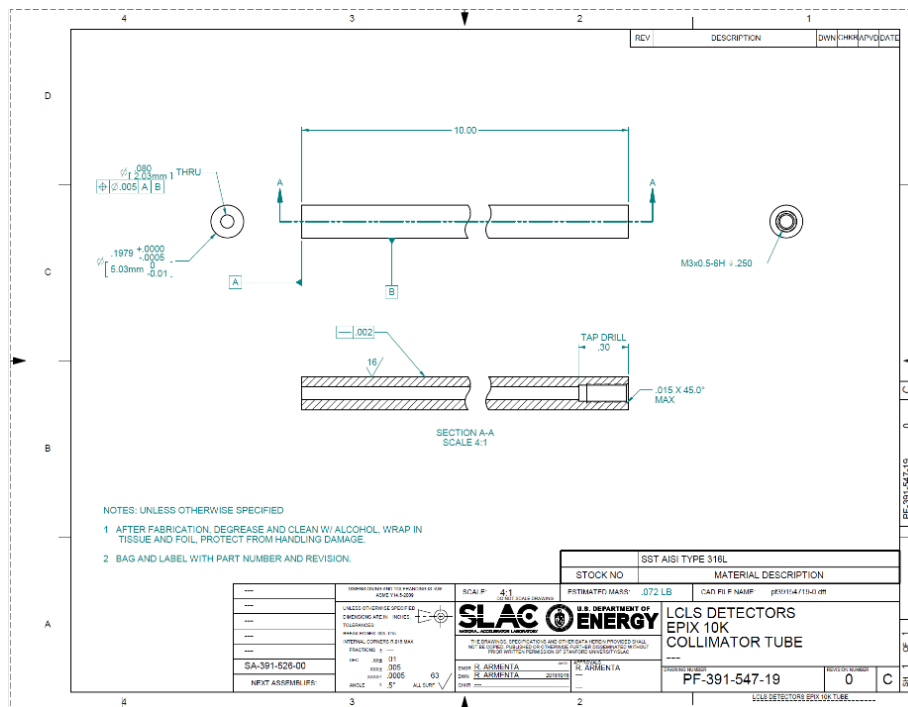


Figure 3: Collimator Tube interface.(Unless otherwise specified, units are in inches).

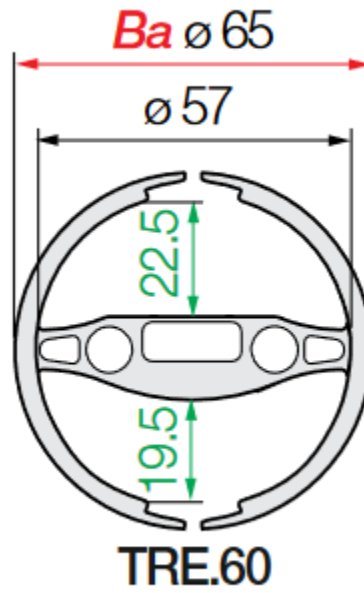


Figure 4: XPP Robot "Cable Carrier" dimensions (mm).

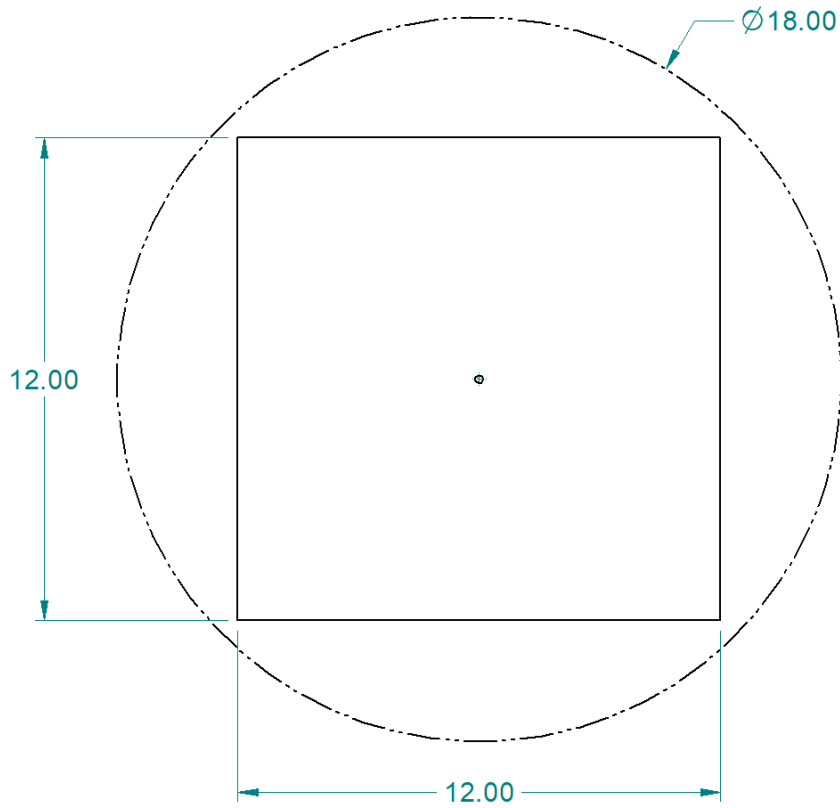


Figure 5: Maximum dimension circle. Dimensions are in inches.



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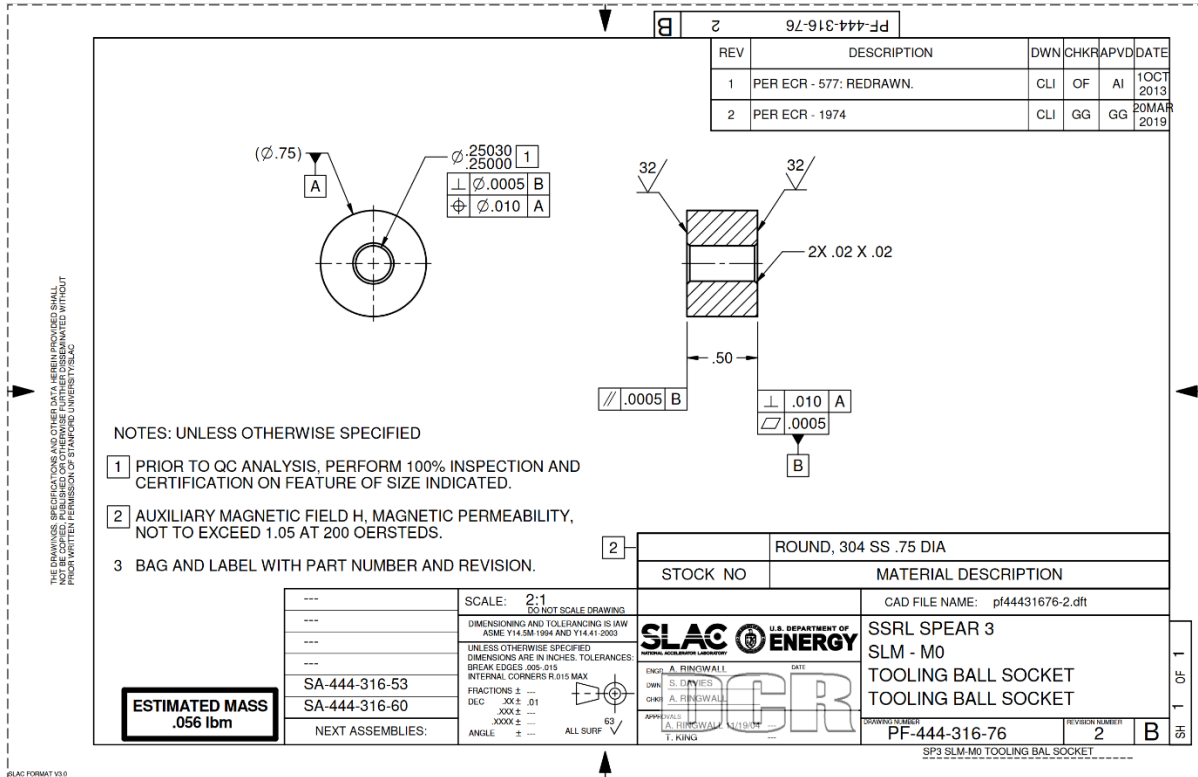


Figure 6: Tooling Ball Socket

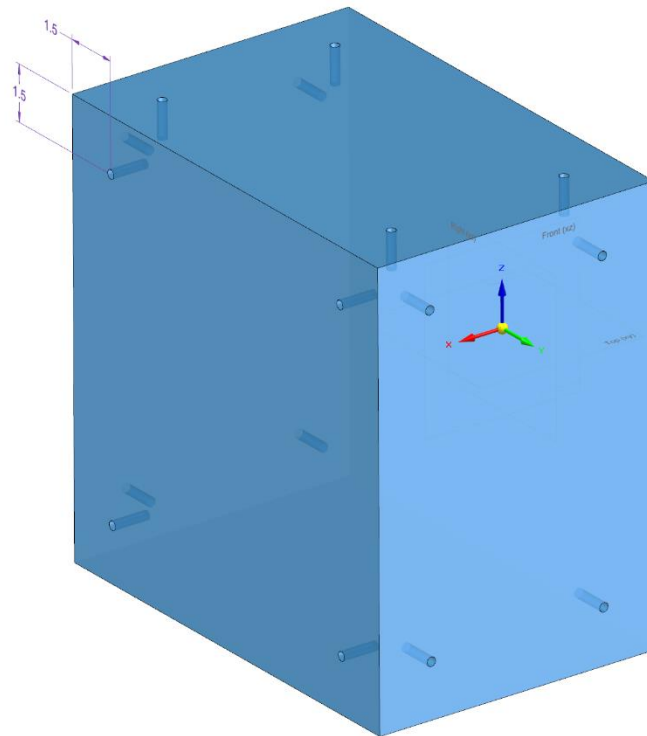


Figure 7. Suggested tooling ball socket locations, X = Beam, 1.5" in from edge typical

6.2 XPP SFAD Interface Requirements

XPP-specific interface requirements for the XPP Small Format Area Detector (SFAD) are listed in the table below. It is assumed that the XPP SFAD will be a SparkPix-S detector. All other general interface requirements for the SFAD are listed in the DXS Detectors IRD: LCLSII-HE-1.4-IR-0881.

Table 6.2				
Requirement #	Requirement	Comments	Verification Method	Parent Requirement
IRD0875.4100	The environment of the SFAD detector in XPP shall be "in Air." Provisions shall be made to allow for operation in this environment.	Environmental expectations, including temperature/humidity detail is available for XPP as noted in LCLSII-HE-1.4-ES-0423.	Analysis Inspection	RDS0345.3151 RDS0345.3152 RDS0345.3153
IRD0875.4101A	The SFAD shall include installation provisions for a removable sensor debris shield.	See DXS Detectors IRD: LCLSII-HE-1.4-IR-0881	Inspection	PRD0220.4206
IRD0875.4101B	A removable debris shield shall be designed and constructed to install on the front face of the SFAD. Mounting provisions shall complement those added to the SFAD housing for debris shield attachment.	See DXS Detectors IRD: LCLSII-HE-1.4-IR-0881	Inspection	PRD0220.4206
IRD0875.4102	The SFAD shall include mounting features that will allow it to interface with XPP endstation equipment mounting provisions.	See DXS Detectors IRD: LCLSII-HE-1.4-IR-0881	Inspection	ESD0477.4024
IRD0875.4103	Cabling/cooling lines for the SFAD shall be ~10m to allow placement of the detector near to the IP.	Longer would be desired if this does not impact detector performance.	Inspection	PRD0220.4208
IRD0875.4104	A single 3U Wiener PL516 power supply, including two PF8F8 power boxes equipped with four MEH-12/30 power modules shall be used to power the SFAD. The power supply		Inspection	ESD0477.4024 RDS0345.4101



Table 6.2

Requirement #	Requirement	Comments	Verification Method	Parent Requirement
	shall be installed in the B950-100H3-R06 rack and shall be patched to B950-100H3-PR01.			
IRD0875.4105	PL516 power supply electrical input/output connections, including respective power ratings, shall adhere to the supplier's engineering documentation.	One 208V-30A outlet will be used to supply power per the RDS.	Inspection	RDS0345.4406
IRD0875.4106	A Wiener MPOD micro-2 crate equipped with two EHS F010p modules (16 channels, 1kV, 8mA) shall be used to bias the SFAD sensors. The MPOD chassis shall be installed in the B950-100H3-R06 rack and shall be patched to B950-100H3-PR01.		Inspection	ESD0477.4024 RDS0345.4101
IRD0875.4107	MPOD power module electrical input/output connections, including respective power ratings, shall adhere to the supplier's engineering documentation.	One 208V-30A outlet will be used to supply power per the RDS.	Inspection	
IRD0875.4108	The SFAD detector shall connect to one SM-MM conversion box via 2 MM 24 fiber trunks, with MPO-24 connectors at both ends. The fiber bundles shall be supplied as part of SM-MM conversion box deliverables and follow the length requirements defined in IRD0875.4103.	Can utilize the SM-MM box installed in B950-100H3-PR01 or the additional SM-MM box installed in B950-100H3-R08, as appropriate. Fiber bundle connection details	Inspection	IRD0875.4205B

Table 6.2

Requirement #	Requirement	Comments	Verification Method	Parent Requirement
		can be found in ID-391-701-55.		
IRD0875.4109	Dry air receptacle connector(s) at the SFAD shall be a “quick disconnect” type.	Exact size will be determined during detector design.	Inspection	PRD0351.4201
IRD0875.4110	Power and HV receptacle connector(s) at the SFAD shall be a “quick disconnect” type.	The exact type of connector will be part of the detector design.	Inspection	PRD0351.4201

6.3 SM-MM Conversion Box Interface Requirements

The SM-MM conversion box is designed and built by TID-DRDAM.

Table 6.3

Requirement #	Requirement	Comments	Verification Method	Parent Requirement
IRD0875.4201	Space shall be provided in XPP equipment rack B950-100H3-R09 for the two XPP SM-MM boxes.	Each SM-MM conversion box is 2U x 19” x 19”. See Fig. 8. Two fully stacked SM-MM boxes will accommodate a 4M EpixHR detector.	Inspection	RDS0345.4101
IRD0875.4202	Space shall be provided in XPP equipment rack B950-100H3-R08 for two XPP SM-MM boxes.	Each SM-MM conversion box is 2U x 19” x 19”. See Fig. 8. These SM-MM boxes will provide the necessary conversion interface for LFAD detector in the alcove.		RDS0345.4101



Table 6.3

Requirement #	Requirement	Comments	Verification Method	Parent Requirement
IRD0875.4203	Space shall be provided in XPP equipment rack B950-100H3-PR01 for one XPP SM-MM box, next to the IP and under the laser table.	The single SM-MM box will accommodate a 2M Pix detector.		RDS0345.4101
IRD0875.4204	Space shall be provided in XPP equipment rack B950-100H3-R08 for one additional XPP SM-MM box.	This SM-MM conversion box will provide the necessary conversion interface for the SFAD detector in the alcove.		RDS0345.4101
IRD0875.4205A	Input/output connectors affixed to the SM-MM conversion box shall include: <ul style="list-style-type: none"> - 4x3 SM MPO-8 for data (3 for each LEAP group) - 4x1 MPO-24 for detector connection (LEAP groups) - 1x MM QSFP timing - 1x SM QSFP for generic use 	SM-MM conversion box electrical interfaces will adhere to supplier's engineering design documentation	Inspection	ESD0477.4024
IRD0875.4205B	Cable connectors that terminate input/output cables that serve the SM-MM conversion box shall correctly interface with complementary	SM-MM conversion box electrical interfaces will adhere to supplier's engineering design documentation	Inspection	ESD0477.4024

Table 6.3

Requirement #	Requirement	Comments	Verification Method	Parent Requirement
	connectors attached to the conversion box.			
IRD0875.4206	The SM-MM conversion box microcontroller shall communicate with external inputs/outputs via a standard cat5 (or better) ethernet cable.	Rogue over TCP/IP and DHCP support.	Inspection	PRD0351.4401 ESD0691.4305
IRD0875.4207	The SM-MM conversion box shall be powered with a power brick connected to a 120VAC outlet near the associated equipment rack.	120VAC	Inspection	PRD0351.4401

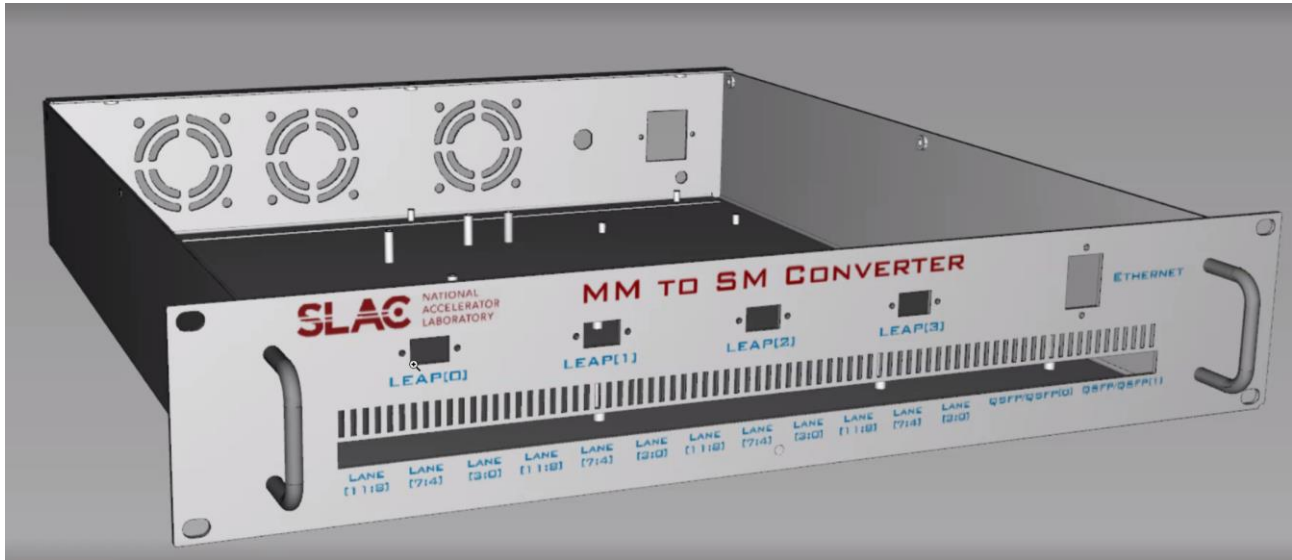


Figure 8: SM-MM Conversion Box (Original Version). 2U x 19" x 19"