Document Approval:

Originator: Dionisio Doering, TID Detectors — *Dionisio Doering* Dionisio Doering (Sep 18, 2023 19:39 PDT)

• Content/Format • Req ID's/Source ID's • Verif. Planning • SME Input, as appl

Reviewer: Diling Zhu, XPP HE Lead Scientist • Facts, Details, Concepts, Calculations, Analysis to meet Stakeholders, Policies, Standards, Best Practices, as appl	*signature not required*
Reviewer: Mengning Liang, CXI HE Instrument Lead Scientist • Facts, Details, Concepts, Calculations, Analysis to meet Stakeholders, Policies, Standards, Best Practices, as appl	*signature not required*
Reviewer: Hassan Yavas, DXS HE Lead Scientist • Facts, Details, Concepts, Calculations, Analysis to meet Stakeholders, Policies, Standards, Best Practices, as appl	*signature not required*
Reviewer: Alex Batyuk MFX HE Lead Scientist • Facts, Details, Concepts, Calculations, Analysis to meet Stakeholders, Policies, Standards, Best Practices, as appl	*signature not required*
Reviewer: Armin Busse, LCLS-II-HE Experimental Systems CAM • Complete/Accurate, SME Involvement, Actionable, Scope Alignment, as appl	*signature not required*
Reviewer: Conny Hansson, LCLS Detectors •General QA Provisions and Compliance, as appl	*signature not required*
Reviewer: Rebecca Armenta, XPP Instrument Lead Engineer • Req ID's/Source ID's • Verif. Planning • SME Input, as appl	*signature not required*
Reviewer: Marco Oriunno, TID Detectors Mechanical Engineer • Clear and Complete Installation Detail, as appl	*signature not required*
Reviewer: Marc Weibel, ES&H Manager • ES&H Content, as appl	*signature not required*
Reviewer: Serge Guillet, CXI Instrument Lead Engineer • Clear and Complete Installation Detail, as appl	*signature not required*
Reviewer: Frank O'Dowd, DXS Instrument Lead Engineer • Clear and Complete Installation Detail, as appl	*signature not required*
Reviewer: Vincent Esposito, Controls Engineer • Scope Alignment, Execution as appl	*signature not required*
Reviewer: Margaret Ghaly, HE Controls Lead • Scope Alignment, Execution as appl	*signature not required*
Reviewer: Ted Price, Systems Engineering Manager Clarity • Format • Req ID's/Traceability • Change Control	*signature not required*
Reviewer: Hong Bach, Quality Assurance Manager • General QA Provisions • Compliance • Req's Validation/Verification	*signature not required*
Reviewer: Scott DeBarger– Project Chief Engineer • Scope Alignment, Stakeholder/ SME Engagement	*signature not required*

Approver: Angelo Dragone, HE Detectors Lead • Complete/Accurate, Actionable	Angelo Dragone (Sep 18, 2023 10:05 PDT)
Approver: Eliazar Ortiz, HE Experimental Systems Manager • Articulation, Meets Higher-Level Expectations, Stakeholder/SME Engagement	*Eliazar Ortiz* Eliazar Ortiz (Sep 18, 2023 10:25 PDT)

See Document Review/Approval Matrix of Responsibilities

Revision History

Revision	Date Released	Description of Change
R0	9/16/2023	Original Release

Table of Contents

1 Purpose

This Interface Control Document (ICD) identifies the interfaces that must be defined and accepted by the parties to whom this ICD applies. It also outlines the responsibilities assigned to each party in developing, defining, and fulfilling interface technical requirements. Interface detail 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. Interface technical detail is disclosed in Interface Requirements Documents (IRDs), which are properly referenced in this ICD to complete the interface planning and documentation record. This ICD document describes the interface specifications between the TID DRDAM group and the DXS Instrument.

2 Scope

This document provides a general overview of the system interface content of the LCLS-II-HE detectors defined in the instrument detector PRDs. The two types of SFAD interfaces are defined based on the SparkPix-S detector technology and the LFAD interfaces are defined based on the ePixHR$_{25kfps}$ detector technology.

3 Acronyms

Acronym	Definition
SFAD	Small Format Area Detector
LFAD	Large Format Area Detector
SM	Single Mode
MM	Multi-Mode
XPP	X-ray Pump Probe Instrument
MFX	Macromolecular Femtosecond Crystallography Instrument

4 References

Reference No.	Title
LCLSII-HE-1.4-PR-0220	XPP Detectors PRD
LCLSII-HE-1.4-IR-0875	XPP Detectors IRD
LCLSII-HE-1.4-PR-0280	DXS Detectors PRD
LCLSII-HE-1.4-IR-0881	DXS Detectors IRD
LCLSII-HE-1.4-PR-0222	CXI Detectors PRD
LCLSII-HE-1.4-IR-0880	CXI Detectors IRD

LCLSII-HE-1.4-PR-0279	MFX Detectors PRD
LCLSII-HE-1.4-IR-0879	MFX Detectors IRD

5 Organizational Roles

Name of Responsible Organization	**Define what role the organization plays in identifying and delivering product(s) that meet the expectations of this control document**
TID-DRDAM	The TID-DRDAM is responsible for the development and delivery of the detector systems (detector unit including power cables to local power supply, fibers to the local multimode to single mode conversion box) and interfaces. POC is Angelo Dragone.
Diling Zhu XPP Lead Instrument Scientist	Ensures interface agreements are consistent with science needs of the instrument.
Rebecca Armenta XPP Lead Instrument Engineer	Ensures that XPP equipment interfacing with detector systems is delivered per requirements.
Hasan Yavas DXS Lead Instrument Scientist	Ensures interface requirements are consistent with science needs of the instrument.
Frank O'Dowd DXS Lead Instrument Engineer	Ensures that DXS equipment interfacing with detector systems is delivered per requirements.
Meng Liang CXI Lead Instrument Scientist	Ensures interface requirements are consistent with science needs of the instrument.
Serge Guillet CXI Lead Instrument Engineer	Ensures that CXI equipment interfacing with detector systems is delivered per requirements.
Alex Batyuk MFX Lead Instrument Scientist	Ensures interface requirements are consistent with science needs of the instrument.
Rebecca Armenta	Ensures that MFX equipment interfacing with detector systems is delivered per requirements.

MFX Lead Instrument Engineer	

6 Interface Identification and Responsibilities

This section identifies the interfaces that must be addressed by the parties referenced in this document. Responsibilities for interface definition and control are included. A reference to the IRD that outlines all technical detail related to the identified interface should be provided. And there is space to identify any additional notes that pertain to interface identification. Notes can be more fully conveyed after the table.

6.1 SparkPix-S 0.5MPIX SFAD Detector

SFADs for emission and spectroscopy experiments will utilize SparkPix-S technology. Form factor, environment, pixel count, and sensor orientation will vary by instrument.

Table 6.1 – SFAD detector (aka SparkPix-S 0.5 MPIX in vacuum)

Interface Identification	TID-DRDAM	Beamlines (DXS, XPP)	IRD	Applicable Notes
Detector fiber communication SFAD	a. Provide a multimode MPO 24 fiber to the MM to SM conversion box. This includes connection from the back of the detector to the vacuum feedthrough to the box. b. Number of fibers is one fiber bundle per detector.	a. Provide rack space (2U) to hold the MM to SM conversion box. b. Provide a port (CF DN 40 preferred) at the chamber for the vacuum feedthrough.	LCLSII-HE-1.4-IR-0881 LCLSII-HE-1.4-IR-0875	For detectors operated in air, there will be no feedthrough.
Environmental variables	a. Provide a unique serial number per board. b. Provide a minimum of one temperature sensor. a. Provide one temperature sensor at the power connector and can be used by the controls team to perform status monitoring and interlocks.	a. If needed provide temperature sensor reader (optional). b. If needed, provide interlocks.	LCLSII-HE-1.4-IR-0881 LCLSII-HE-1.4-IR-0875	
Timing and Trigger Interface	a. There will be only one timing and trigger interface via fiber optics.	a. LCLS-II timing interface port will be available at the hutch.	LCLSII-HE-1.4-IR-0881 LCLSII-HE-1.4-IR-0875	

Table 6.1 – SFAD detector (aka SparkPix-S 0.5 MPIX in vacuum)

Interface Identification	TID-DRDAM	Beamlines (DXS, XPP)	IRD	Applicable Notes
Detector Power cable SFAD[1]	b. Provide power cable to connect to the back of the detector to a vacuum feedthrough. c. Provide power cable from the vacuum feedthrough to the rack mount power supply. d. Provide power cable from the vacuum feedthrough to the power supply.	a. Provide a Wiener power supply PL516 (or equivalent) with two channels capable of 500 W each at 24V. b. Provide a port on the chamber for the vacuum feedthrough. c. Provide cable lengths from detector to feedthrough and feedthrough to power supply.	LCLSII-HE-1.4-IR-0881 LCLSII-HE-1.4-IR-0875	For detectors operated in air, there will be no feedthrough.
Sensor bias	a. Sensors are biased with low current (less than 5mA) and high voltage (up to $200V_{DC}$).	a. Provide a power supply (performance comparable with the Keithley 2400).		
Detector Cooling for SFAD	a. The detector is cooled based on CO_2 chillers. It will be provided a single inlet and single outlet vacuum feedthrough for the CO_2. b. Provide the internal cable to the feedthrough. c. Provide chiller requirements and operation settings. d. Specify dry air requirements (pressure, flow, fitting sizing) for detectors operating in air.	a. Provide cable length from the detector to the vacuum feedthrough. b. Provide all cooling lines from facilities to the air side of the vacuum feedthrough. c. Provide CO_2 Chiller d. Provide dry air supply and tubing from supply manifold to detector.	LCLSII-HE-1.4-IR-0881 LCLSII-HE-1.4-IR-0875	For detectors operated in air, there will be no feedthrough.
Detector interface to the support structure	a. Provide a set of mounting holes at the back and side of the detectors to be used to attached it to experimental chamber or equivalent support structure.	a. Provide the mechanical mount interface	LCLSII-HE-1.4-IR-0881	

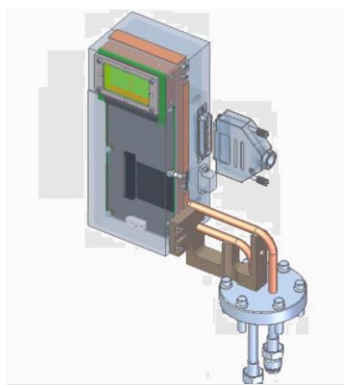
Table 6.1 – SFAD detector (aka SparkPix-S 0.5 MPIX in vacuum)

Interface Identification	TID-DRDAM	Beamlines (DXS, XPP)	IRD	Applicable Notes
Alignment features	a. Measure as-built sensor positions, which are used as part of data calibration parameters to reconstruct the images. b. Provide alignment features on exterior of detector which are fiducialized to internal sensor features.	a. Specify required locations and types of external fiducials.	LCLSII-HE-1.4-IR-0881	
Mass limit	a. Design detector package such that it meets mass limit requirements.	a. Specify mass limits.	LCLSII-HE-1.4-IR-0881 LCLSII-HE-1.4-IR-0875	
Vibration	a. Analyze and mitigate vibrations through design best practices. b. Provide validation/measurement report for as-built detectors.	a. Specify max allowable vibration amplitudes and frequencies.	LCLSII-HE-1.4-IR-0881	
Outgassing	a. Select materials compatible with vacuum level/load requirements. b. Manufacture parts in accordance with vacuum level specification	a. Specify max gas load in [Torr*L/s]. Indicate required LCLS vacuum level specification.	LCLSII-HE-1.4-IR-0881 LCLSII-HE-1.4-IR-0875	For detectors operated in air, there will be no outgassing requirements, but in-air environmental factors must be considered.
Focal plane shield interface	a. Provide interface to mount shields. b. Provide first article shields for transport protection.	a. Specify shield requirements.	LCLSII-HE-1.4-IR-0881	
Detector geometry	a. Provide desired detector geometry (side entrance detector is being considered as default orientation).	a. Specify desired orientation of sensor plane with respect to package geometry, if differs from the default geometry.	LCLSII-HE-1.4-IR-0881	

Table 6.1 – SFAD detector (aka SparkPix-S 0.5 MPIX in vacuum)				
Interface Identification	**TID-DRDAM**	**Beamlines (DXS, XPP)**	**IRD**	**Applicable Notes**
Cover shield	a. Provide cover shield that interfaces both with front face shield and with detector body (without shield)	a. Specify shield requirements	LCLSII-HE-1.4-IR-0881	

Notes:

1. The power supply and its internal modules will not be delivered by the TID DRDAM group and is considered existing infrastructure at the beamline. LCLS controls will provide the power supply. CO2 cooling chillers, from the detector's group point of view is part of the hutches infrastructure.
2. DXS is considered the primary design authority for the SparkPix-S-500kPix – Any other variants are not part of HE project.
3. Pre-concept design of the SFAD is based on the ePixHRM320k$_{5kfps}$ detector as shown below:



6.2 SparkPix-S 2 MPix SFAD Detector

Due to similarities of the two SFAD Table 6.2 presents only the items where the requirements are not the same (**Bold text**)**.** All shared requirements are presented in Table 6.1

Table 6.2 – SFAD detector (aka SparkPix-S 2 MPIX in vacuum)				
Interface Identification	**TID-DRDAM**	**Beamlines (DXS)**	**IRD**	**Applicable Notes**
Detector fiber communication SFAD	c. Provide a multimode MPO 24 fiber to the MM to SM conversion box. This includes connection from the back of the detector to	c. Provide rack space (2U) to hold the MM to SM conversion box. d. Provide a port (CF DN 40 preferred) at	LCLSII-HE-1.4-IR-0881 LCLSII-HE-1.4-IR-0875	**For detectors operated in air, there will be no feedthrough.**

Table 6.2 – SFAD detector (aka SparkPix-S 2 MPIX in vacuum)				
Interface Identification	**TID-DRDAM**	**Beamlines (DXS)**	**IRD**	**Applicable Notes**
	the vacuum feedthrough to the box. **d. Number of fibers is two fiber bundle per detector.**	the chamber for the vacuum feedthrough.		
Detector Power cable SFAD1	e. Power cable to connect to the back of the detector to a vacuum feedthrough. f. Power cable from the vacuum feedthrough to the rack mount power supply g. Power cable from the vacuum feedthrough to the power supply.	d. Provide a Wiener power supply PL516 (or equivalent) with **two** channels capable of 500 W each at 24V. e. Provide a port on the chamber for the vacuum feedthrough. f. Provide cable lengths from detector to feedthrough and feedthrough to power supply.	LCLSII-HE-1.4-IR-0881 LCLSII-HE-1.4-IR-0875	**For detectors operated in air, there will be no feedthrough.**
Detector geometry	b. Provide desired detector geometry. **Front entrance detector is being considered as default orientation.**	b. Specify desired orientation of sensor plane with respect to package geometry, if different from the default geometry.	LCLSII-HE-1.4-IR-0881	

6.3 ePixHR10k$_{25kfps}$ LFAD Detector

LFADs for scattering and diffraction experiments will utilize ePixHR10k$_{25fps}$ technology. Form factor, environment, and megapixel count will vary by instrument.

Table 6.3 – LFAD detector (aka 4MPix and 16MPix ePixHR10k$_{25kfps}$)				
Interface Identification	**TID-DRDAM**	**Beamline (XPP, MFX, CXI)**	**IRD**	**Applicable Notes**
Detector fiber communication LFAD	a. Provide two multimode MPO 24 fiber per megapixel (8 bundle total) to the MM to SM conversion box. This includes connection from the back of the detector to	a. Provide rack space for two (2U/card) to hold the MM to SM conversion box. b. Provide openings (CF DN 40) at the chamber for the vacuum feedthroughs	LCLSII-HE-1.4-IR-0875 LCLSII-HE-1.4-IR-0880	For detectors operated in air, there will be no feedthrough.

Table 6.3 – LFAD detector (aka 4MPix and 16MPix ePixHR10k$_{25kfps}$)

Interface Identification	TID-DRDAM	Beamline (XPP, MFX, CXI)	IRD	Applicable Notes
	the vacuum feedthrough to the box. b. Provide MM to SM conversion boxes. c. Number of fibers is two fiber bundles per 1MPix detector module. d. Provide 1 MTP/ MPO fiber feedthrough per fiber bundle.	(8 for the 4MPIx detector). c. Provide location of conversion box (distance to box). d. Provide connections beyond the MM-SM conversion box.		
Detector Envelope	a. Design detector to fit within maximum specified envelope.	a. Specify maximum envelope.	LCLSII-HE-1.4-IR-0875 LCLSII-HE-1.4-IR-0880	
Detector interface to the support structure	a. Provide structural components in order to package sensors and respective readout boards/electronics in 1M modular units. b. Structure provided shall support modular buildout of detectors over 4M (See note 3).	a. Provide Mpixel size requirements in units of 1M. b. Provide buildout plan for detector over 4M.	LCLSII-HE-1.4-IR-0875 LCLSII-HE-1.4-IR-0880	
Environmental variables	a. Detector team will provide a unique serial number per board. b. Provide a minimum of one temperature sensor per 1Mpix raft. c. Multiple megapixel detectors will have one sensor that is connected to the power connector and can be used by the controls team to perform status	a. If needed provide temperature sensor reader, with two electrical lines used for temperature measurement (optional). b. If needed, provide interlocks.	LCLSII-HE-1.4-IR-0875 LCLSII-HE-1.4-IR-0880	

Table 6.3 – LFAD detector (aka 4MPix and 16MPix ePixHR10k$_{25kfps}$)

Interface Identification	TID-DRDAM	Beamline (XPP, MFX, CXI)	IRD	Applicable Notes
	monitoring and interlocks.			
Timing and Trigger Interface	a. Provide one trigger interface via fiber.	a. Provide LCLS-II timing interface at the hutch	LCLSII-HE-1.4-IR-0875 LCLSII-HE-1.4-IR-0880	
Detector Power cable LFAD	a. Provide one power cable to connect to the back of the 1MPix detector module to a vacuum feedthrough. Total of four cables. b. Power cable from the vacuum feedthrough to the rack mount power supply. Total of four cables. c. Power cable from the vacuum feedthrough to the power supply. Total of four cables.	a. Provide a Wiener power supply PL516 (or equivalent) with four channels per 1MPix capable of 500 W each at 24V. b. Provide four openings on the chamber for the vacuum feedthrough (dimensions). c. Provide cable lengths from detector to feedthrough and feedthrough to power supply.		For detectors operated in air, there will be no feedthrough.
Sensor bias	a. Sensors are biased with low current (less than 5mA) and high voltage (up to 200V_{DC})	a. Provide a power supply (performance comparable with the Keithley 2400).		
Detector Cooling for LFAD	a. The detector is cooled by CO_2 chillers. It will be provided with a single inlet and single outlet vacuum feedthrough. The detector team will provide the internal manifold. b. Perform pressure drop calculations and specify cooling line size and recommended type based on length	a. Provide cooling lines length from the detector to the vacuum feedthrough. b. Provide all cooling lines from the plant to the air side of the vacuum feedthrough. c. Provide CO_2 Chillers. d. Provide dry air supply and tubing from supply manifold to detector.	LCLSII-HE-1.4-IR-0875 LCLSII-HE-1.4-IR-0880	For detectors operated in air, there will be no feedthrough.

Table 6.3 – LFAD detector (aka 4MPix and 16MPix ePixHR10k$_{25kfps}$)

Interface Identification	TID-DRDAM	Beamline (XPP, MFX, CXI)	IRD	Applicable Notes
	information provided by beamlines. c. Provide cooling line connectors at detector. d. Specify CO_2 chiller requirements and operation settings (flow rate, temperature set point, etc.) based on appropriate thermal analysis. e. Specify dry air requirements (pressure, flow, fitting sizing) for detectors operating in air.			
Alignment features	a. Provide as-built information of pixel/module alignment with alignment features. b. Provide alignment features on exterior of detector which are fiducialized to internal sensor features.	a. Specify required locations for external fiducials	LCLSII-HE-1.4-IR-0875 LCLSII-HE-1.4-IR-0880	
Mass limit	a. Design detector package such that it meets mass limit requirements.	a. Specify mass limits.	LCLSII-HE-1.4-IR-0875 LCLSII-HE-1.4-IR-0880	
Vibration	c. Analyze and mitigate vibrations through design best practices. d. Provide validation/measurement report for as-built detectors	a. Specify max allowable vibration amplitudes and frequencies	LCLSII-HE-1.4-IR-0875 LCLSII-HE-1.4-IR-0880	

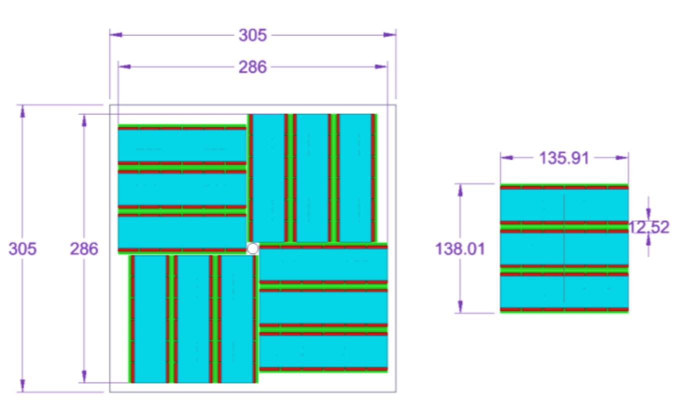
Table 6.3 – LFAD detector (aka 4MPix and 16MPix ePixHR10k$_{25kfps}$)

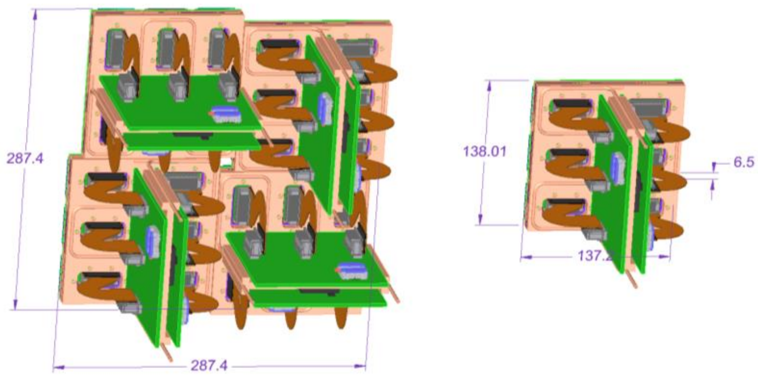
Interface Identification	TID-DRDAM	Beamline (XPP, MFX, CXI)	IRD	Applicable Notes
Outgassing	c. Select materials compatible with vacuum level/load requirements. d. Manufacture parts in accordance with vacuum level specification	a. Specify max gas load in [TorrL/s]. Indicate required LCLS vacuum level specification.	LCLSII-HE-1.4-IR-0875 LCLSII-HE-1.4-IR-0880	For detectors operated in air, there will be no outgassing requirements, but in-air environmental factors must be considered.
Installation interface	a. Integrate interface features within.	a. Specify interface hole patterns. b. Provide the mechanical mount interface.	LCLSII-HE-1.4-IR-0875 LCLSII-HE-1.4-IR-0880	
Front face shield interface	a. Provide interface with hole pattern. b. Provide first article shields for transportation protection.	a. Specify shield requirements.	LCLSII-HE-1.4-IR-0875 LCLSII-HE-1.4-IR-0880	This is a parameter that will be the same for all detectors. All users should agree with this parameter, and we will design to that.
Beam pipe interface	a. Provide internal tube/beampipe interface that is integrated into detector.	a. Provide the OD of the beam pipe and fit specifications. b. Provide beam pipe.	LCLSII-HE-1.4-IR-0875 LCLSII-HE-1.4-IR-0880	This is a parameter that will be the same for all detectors. All users should agree with this parameter, and we will design to that.
Cover shield	a. Provide cover shield that interfaces both with front face shield and with detector body (without shield)	a. Specify shield requirements	LCLSII-HE-1.4-IR-0875 LCLSII-HE-1.4-IR-0880	
Lift Points/Features	a. Provide lifting features and	a. Specify requirements for lifting features.	LCLSII-HE-1.4-IR-0875	

Table 6.3 – LFAD detector (aka 4MPix and 16MPix ePixHR10k$_{25kfps}$)				
Interface Identification	**TID-DRDAM**	**Beamline (XPP, MFX, CXI)**	**IRD**	**Applicable Notes**
	appropriate structural analysis. b. Provide interfacing lift equipment (e.g., handles, permanent external brackets)	b. Provide non-permanent lifting equipment.	LCLSII-HE-1.4-IR-0880	
External Markings/ Features	a. Provide external markings/features integrated into the casing design	a. Specify required external features (Such as engravings/markings, etc.)	LCLSII-HE-1.4-IR-0875 LCLSII-HE-1.4-IR-0880	

Notes:

1. The power supply and its internal modules will not be delivered by the TID DRDAM group and is considered existing infrastructure at the beamline. TID DRDAM will provide specifications and part numbers.
2. The expected number of detector board needed for the 1MPix module is two and that multiplicity expands linearly with the number of modules required for the complete focal plane. For reference, the picture below shows the concept
3. MFX 16Mpix LFAD will be populated in 4M increments.





The detector modularity is for reference only, since the models are a pre-concept sketch, and it should not be considered as final the dimensions are initial estimates.