

Development of CITIUS-20.2M for SACLA



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Abstract

A new X-ray imaging detector, CITIUS-20.2M, has been developed for Serial Femtosecond Crystallography (SFX) at SACLA. CITIUS-20.2M has a seven times higher peak signal, seven times smaller noise, and five times more pixels than the currently used detector MPCCD (Phase III). The total number of pixels will be the world's largest as a direct detector for XFEL. Our objective is to improve the spatial resolution of SFX with higher-Q measurements. The detector will be deployed in FY2024. Status of the development and the preparation for the deployment are presented in this poster.

CITIUS detector

A new charge-integrating X-ray imaging detector, CITIUS, has been developed for high photon fluxes onto samples with upgraded synchrotron radiation facilities. The

Specifications of CITIUS-20.2M and MPCCD (Phase-III) for SACLA

integration of CITIUS detectors into synchrotron radiation experiments are in progress at SPring-8.

In parallel, we are also developing another larger version, CITIUS-20.2M, with high spatial resolution for Serial Femtosecond Crystallography (SFX) at SACLA. CITIUS-20.2M will have the world's largest number of pixels as a direct X-ray detector for XFEL. In comparison with the current detector MPCCD (Phase-III) in operation, CITIUS-20.2M has a seven times higher peak signal, seven times smaller noise, and five times more pixels.

		Architecture [1-3]				
	Integrati	Integrating Pixel & High Frame Rate				
Features						
High Dynamic	Ultralow	Single Photon	Spectro-	High Spatial		
Range	Systematic	Sensitivity	Imaging	Resolution		
	Error					
			[1] SPring-8 II CDR (2 [2] T. Hatsui, present [3] T. Hatsui, AOSFRF	2014) with updated values. ed at iWorid (June. 2014). R (Nov. 2015)		

Parameters		Value		
		CITIUS for XFEL (SACLA)	MPCCD (Phase III)	unit
Sensor	Sensor Material	Silicon		N/A
	Thickness	650 🔨	300	μm
	Pixel Size	72.6 🔨 🔨	5 50	μm
	Pixel Number	0.28	6 0.5	Mpixels/Sensor module
	Peak Signal	17,000 🖊	2,400	phs/pixel@6 keV
	Typical noise	25	./7 250	e-rms
	Frame Rate	60*	60	Hz
	Data Rate	1.6**	0.06	GB/s @ digital out
System	Imaging area	325 × 363	100×100	mm ²
	Pixel Number	20.2	4	Mpixels
	Data Rate	116* × 24	0.48	GB/s @digital out

* The frame rate of CITIUS is 17.4 kHz (SR variant) and 5 kHz (XFEL variant).

** The data rate of CITIUS is the total raw data rate from the sensor. Each frame data has 16 multi- AD sampled data.

Timeline for deployment

- FY2022: Feasibility study with CITIUS-560k
- FY2023: 20.2M camera assembly and the installation of data acquisition system
- FY2024: Installation of CITIUS-20.2M at SACLA on BL2 EH3

Preparation of data acquisition system

CITIUS-20.2M generates orders of magnitude more data than the data rate of MPCCD. This amount requires dedicated computers for data acquisition and data processing. The new computing system will have an analysis environment similar to the one currently used for SFX



First (XFEL) light on CITIUS using CITIUS-560k Assembly of Sensor Sub System (SSS) consisting of 9 sensors \rightarrow in progress

CITIUS-20.2M (result of the assembly test using dummy sensors)

Feasibility Study with CITIUS-560k

The first beamtime at SACLA, using CITIUS-560k, has been conducted in December 2022 and the response of CITIUS to XFEL beam conditions has been measured. The successful DAQ integration to RunControl of SACLA, the lower noise, higher dynamic range, and linearity have been confirmed.



experiments with MPCCD environments for SACLA users, by reducing the huge amounts of data





Outline of CITIUS-20.2M data flow

Preparation Status

The data acquisition computers for CITIUS-20.2M have started running in the server room of SACLA since the winter shutdown period.

Data processing testing started by generating dummy data simulating the data rate of CITIUS-20.2M.

We will start integration testing early next FY when CITIUS-20.2M is installed at BL2EH3 of SACLA.

installed in the server room of SACLA

Summary

- CITIUS-20.2M is the world's largest direct X-ray detector developed with high spatial resolution of SFX at SACLA.
- The sensor of CITIUS detectors has been confirmed to work as expected for XFEL.
 CITIUS-20.2M is now under assembly and the data acquisition computers are in preparation.
- CITIUS-20.2M will be installed in FY2024. After the verification of CITIUS-20.2M through test experiments, the detector will be provided for users' experiments.

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