kai scientific CITIUS

CITIUS

(Charge Integration Type Imaging Unit with high-Speed extended-dynamic-range detector)

CITIUS X-ray detector system

The CITIUS X-ray detector system is a next-generation direct detection type, which employs an integral method to measure the signal charge converted from X-ray photons. Direct detection has become a standard in recent years and achieves high sensitivity and effective zero noise.

It also has a capable of detecting high-intensity X-rays. It performs a high counting rate that cannot be achieved with the current state-of-the-art photon-counting detectors and has the world's highest performance.

High Count Rate - 600 Mcps/pixel @ 12 keV

As a performance index, the maximum number of X-ray photons, called the saturation count rate, can be measured in one second. For CITIUS X-ray detector systems, the saturation count rate is inversely proportional to photon energy.

The CITIUS X-ray detector system achieves 600 Mcps at 12 keV. The high count rate makes it possible to upgrade existing experiments. It expects to use in new experimental methods for high-brightness light sources.

High Frame Rate - 17.4 kfps

The frame rate in an image sensor defines as the number of images per second. The higher the speed, the higher the time resolution, and the change in the object can be recorded.

The CITIUS, a CMOS image sensor is of the integration type (charge integration type) and can accurately record the amount of signal while operating at high speed.
Furthermore, the maximum amount of signal for each frame is as large as 1800 photons/frame, enabling a detailed analysis on a frame-by-frame basis at high speed.

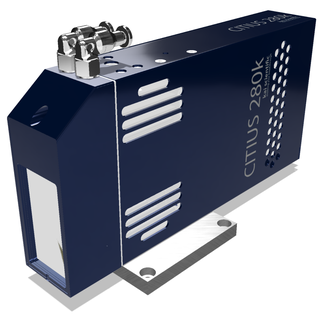
Electro-optical performance

Sensor material	Silicon(Si)
Archtecture	Interating pixel, fast frame readout
Sesor thickness	650 µm
Nominal Quantum Efficiency [1]	100 % @ 6 keV 94 % @ 12 keV 47 % @ 20 keV
Pixel size	72.6 µm x 72.6 µm
Format	384 x 728 = 279,552 pixels
Image area	27.88 mm x 52.85 mm
Noise	< 60 e-rms. (equivalent to 0.018 photons @12 keV)
Peak signal	1,800 photons/pixel/frame @ 12 keV
Saturation count rate	30 Mcps/pixel @ 12 keV – standard configuration 600 Mcps/pixel @ 12 keV – High Dynamic Range
Max frame rate	17.4 kHz – standard configuration
Supported energy range	1.5 - 40 keV [2]

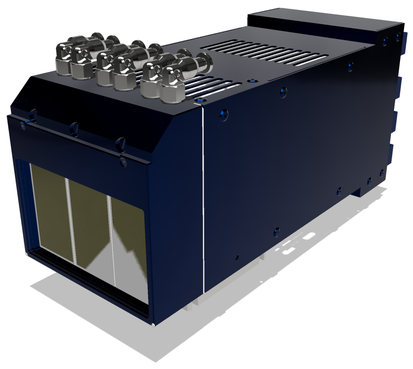
[1] B.L. Henke, et.al., Atomic Data and Nuclear Data Tables Vol. 54 (no.2), 181-342 (July 1993).

[2] For the operations in 1.5-5 keV and intense and continuous X-ray detection beyond 8 keV, please consult with us.

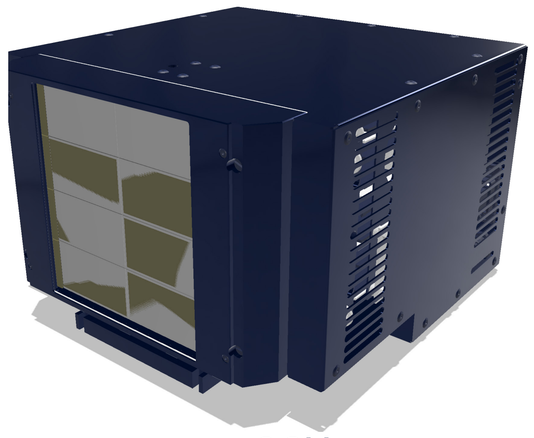
Camera Head Line-up



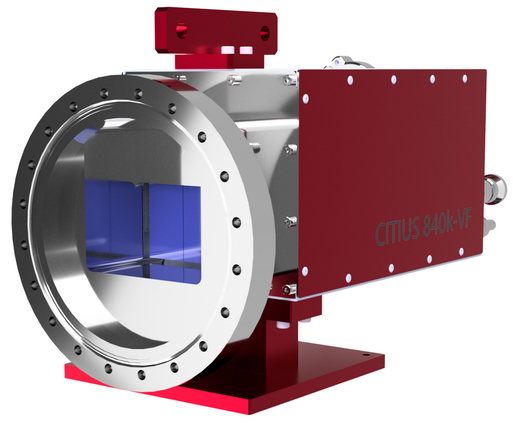
280k
1 sensor



840k
3 sensors



2.2M
8 sensors



840k with Vacuum Flange
3 sensors

Data Framing Board (DFB)

Another feature of the CITIUS X-ray detector is the data acquisition board, which was developed at the same time as the sensors. Three boards are used per sensor via PCI Express slots in the edge server, supporting up to 140 Gbps input data/board, with the following features.

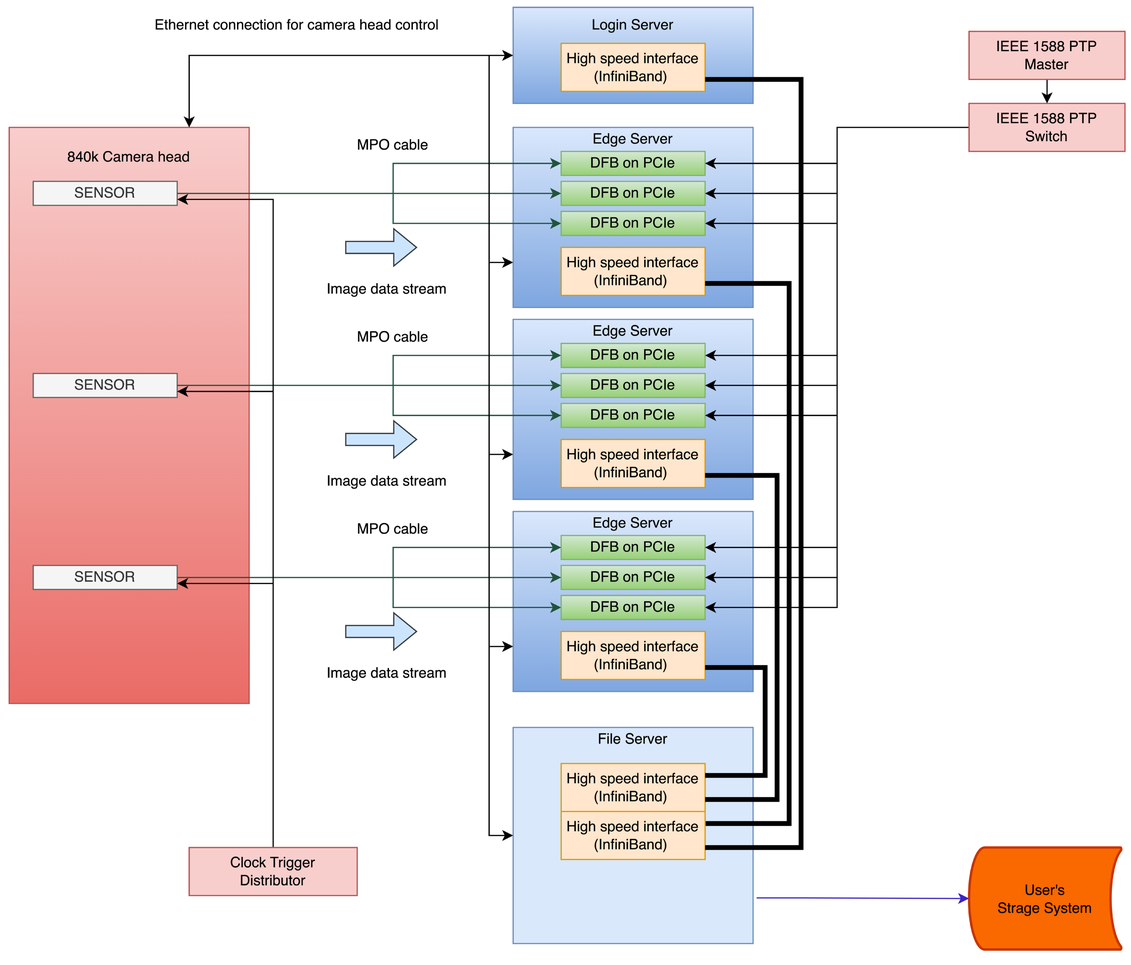
- Correction processing
- Compression processing - in some experiments compression ratios of over 1/1000 have been achieved
- Selective processing and addition of the required frames

Haruki Nishino, et.al., The false beat signal of a high-speed X-ray imaging detector for synchrotron radiation experiments and its elimination with a synchronized CITIUS detector, Nucl. Instrum. Methods Phys. Res. A, Vol.1057 (2023) , https://doi.org/10.1016/j.nima.2023.168710.

CITIUS Edge Server

The CITIUS Edge Server has multiple DFBs mounted in PCIe slots for data collection and data processing as required.

840k System Configuration Example



The above configuration is an example. Please consult with us as it will vary depending on the customer's environment. The vacuum pump and water cooling system are not shown in the diagram above, but are required together.