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Technical Specifications

Rayonix MX 170 HS

170 mm High Speed CCD Detector System for X-ray Science Applications

(2011/3/17 - Specifications subject to change)

1. MX170-HS CCD X-ray Detector System

1.1. 170 mm High Speed Mosaic Frame Transfer CCD Detector

- Four element mosaic CCD X-ray detector — optimized for highest possible speed consistent with full 16-bit dynamic range and uncompromised sensitivity, accuracy and stability.
- Frame rates as high as 140 frames/sec. Typical rate is 10 frames/sec for operation at standard resolution and speed.
- Deadtime between frames of 1 msec facilitates high duty cycle shutterless data collection.
- Four custom designed 2k x 2k (1920 x 1920 pixels) Split Frame Transfer Charge Coupled Device (SFT-CCD) image sensors with 16 readout channels per chip (64 channels total).
- Produces fully corrected, seamless images. Maximum physical gap (< 50 µm) between adjacent fiber optic taper elements is smaller than 1 binned pixel. Unbinned images will have a 2 pixel (89 µm) gap between modules.
- Active imaging surface : 170 mm x 170 mm square (28,900 mm^2).
- Software-selectable on-chip binning yields the following supported resolutions (standard mode is highlighted):

On-Chip Binning	Resolution	Pixel Size (µm)
1 x 1	3840 x 3840	44
2 x 2	**1920 x 1920**	**89**
3 x 3	1280 x 1280	133
4 x 4	960 x 960	177
5 x 5	768 x 768	221
6 x 6	640 x 640	266
8 x 8	480 x 480	354
10 x 10	384 x 384	443

- **Readout Modes** – Two software selectable readout modes: **Normal (High Speed)** and **Low Noise (Low Speed)**

Speed and Noise vs. Mode and Binning

	Normal (High Speed) Read Noise = 8 e^-/pixel		Low Noise (Low Speed) Read Noise = 4 e^-/pixel	
On-Chip Binning	**Max Frame Rate (sec^{-1})**	**Duty Cycle (%)**	**Max Frame Rate (sec^{-1})**	**Duty Cycle (%)**
1 x 1	3	> 99	1.5	> 99
2 x 2	**10**	**99**	6	99
3 x 3	20	98	12	99
4 x 4	35	96	20	98
5 x 5	50	95	30	97
6 x 6	70	93	40	96
8 x 8	100	90	65	93
10 x 10	140	86	90	91

- **Low Demagnification FOT** - Each CCD is coupled to the X-ray sensitive phosphor by 2.92:1 Fiber-Optic Taper
- **Electro-optical Gain** (electrons/X-ray photon) - 7 e^-/12keV X-ray photon
- **DQE** (Detective Quantum Efficiency) - DQE up to 0.8 for 8 keV - 12 keV
- **PSF** (Point Spread Function) - FWHM ~ 100µm *(with standard 40um thick phosphor)*
- **Dark current** (unbinned, at standard operating temperature of -75°C) - ~0.003 e^-/pixel /second or ~0.0005 12 keV photon /pixel /second
- **Full well capacity** - Depends on binning and gain.
  At 1920 x 1920 resolution, high speed, low gain : 400 ke^-/pixel = 57,000 12 keV photons/pixel
- **Dynamic Range** (~ Full Well / Noise) - 16 bits
  Depends on photon energy, binning, and readout rate, but in most cases the dynamic range will be limited by 16 bit A/D converters, 16 bit data format, and the choice of Readout Mode.
  For 1920 x 1920 resolution, High Speed, Low Gain Mode → 400 ke^-/8 e^- → 50,000
  Low Speed, High Gain Mode → 200 ke^-/4 e^- → 50,000
- **Phosphor** - Gd_2O_2S ~40µm thick
  Replaceable, but not routinely changeable. High accuracy data requires careful factory calibration after phosphor change. Other phosphor options are available, including thin phosphor for higher resolution or thick phosphor for higher X-ray energy.
- **Defects** - CCD sensors are selected for low noise and low number of cosmetic blemishes. All defects and spatial distortion are correctable and permanently mapped, and corrected by our factory calibration procedure. Fiber Optic tapers are low thorium glass with extra mural absorption (EMA) selected for minimal geometric and shear distortions.
- **Physical**

Detector Head	
Dimensions	H x W x D = 41 cm x 25 cm x 53 cm
Weight	approx. 30 kg
Power Supply/Cooling assembly	Rolling cabinet
Dimensions	H x W x D = 180 cm x 64 cm x 64 cm ea.
Weight	approx. 215 kg

Vacuum Pump

Dimensions	H x W x D = 36 cm x 33 cm x 30 cm
Weight	approx. 17 kg

- **Locations**

Between Detector Head and:

Computer	Standard = 3 meters Max 10 meters (Max 100 meters for fiber optic cable option)
PS/Cooling	Standard = 7.5 meters Max 30 meters
Vacuum Pump	Standard = 1.8 meters Max 5.5 meters

Non-standard distances require specification at time of order.

1.2. Control and Data Acquisition Hardware and Computer Workstation

- Dedicated data acquisition and processing hardware provides real-time correction and storage of frames.
- Computer Server/Frame Buffer/Frame Processor:
  - Rack-mounted Linux Server
  - Solid State Drive Frame Storage
  - 10 Gigabit Ethernet Network Interface
  - Dedicated GPU for frame corrections
  - Camera-Link data interface (Detector to Server) or optional Fiber Optic to PCI/PCIe interface
- TTL or optically isolated digital input for external trigger of readout
- TTL or optically isolated digital output as trigger for external shutter controller or other device synchronization

1.3. Control and Data Acquisition Software Package

- User control
  - Separate client computer connects to computer server over Ethernet TCP/IP connection
  - Rayonix function library DLL is installed on client computer for use by client application
  - Example menu-driven client application provided
  - Alternative control method with simple text commands over Ethernet TCP/IP also available
- Server performs dark current, flat-field and geometric distortion correction in real-time
- Graphical data display and inspection software included
- Function library includes “zinger"' removal routines
- Software selectable Stability mode to process overscan to reduce baseline drift
- Complete Documentation