

CheeTah

Medipix3

High-dynamic-range detector for electron diffraction

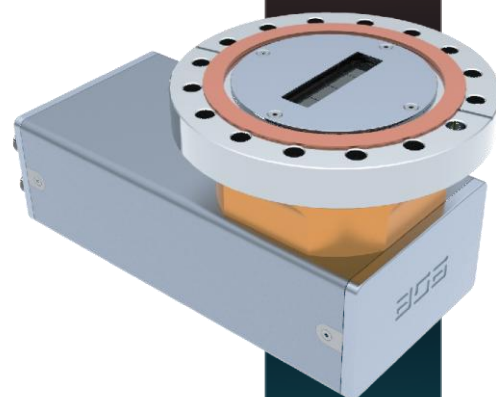
CheeTah Medipix3 is a frame-based, zero-noise electron-counting detector that records the intense direct beam and the faintest reflections in one saturation-free pattern — at up to 2,000 fps.

Technology

CheeTah Medipix3 is a hybrid-pixel, frame-based electron detector built on CERN's Medipix3 chip. Every $55\text{ }\mu\text{m}$ pixel counts individual electrons above an adjustable energy threshold, so every image has zero read-out noise. Its defining strength is dynamic range: a 24-bit counter stores more than 16 million counts per pixel, so an intense direct beam and the faintest high-order reflections are recorded in the same diffraction pattern without saturation or blooming. Charge-summing mode sharpens the point-spread function for crisp diffraction spots, while continuous read-write reaches 2,000 frames per second with zero dead time — up to 10,000 fps at 1-bit. With more than 90% electron detection efficiency and threshold-based background suppression, CheeTah Medipix3 is built for quantitative electron diffraction.

General Features

- * Zero read-out noise — pure electron counting
- * Single-electron sensitive; >90% electron detection efficiency
- * Exceptional dynamic range — 24-bit, >16 million counts per pixel
- * Up to 2,000 fps continuous with zero dead time (10,000 fps at 1-bit)
- * Charge-summing mode for a sharp point-spread function & crisp spots



Specification

	SINGLE	QUAD	LINEA	ULTRA
Interface	256 × 256	512 × 512	256 × 1024	512 × 1024
Active Area (mm ²)	14.08 × 14.08	28.16 × 28.16	14.08 × 56.32	28.16 × 56.32
Pixel Pitch	55 μm · Medipix3 · all configurations			

Medipix3	
Modes	Continuous (CRW) or Sequential Read/Write (SRW)
Data Output	Images (.tiff)
Effective Frame Rate	Sequential → 24 bits @ 700 Hz Continuous → 12 bits @ 2000 Hz

Bit Depth	Rate Range	Frame Rate	Mode & Dead Time
1 bit	1 count	10,000 fps	CRW, Zero
6 bit	64 counts	4,000 fps	CRW, Zero
12 bit	4,096 counts	2,000 fps	CRW, Zero
24 bit	16 Mcounts	800 fps	SRW, 1.1 ms

Applications in Electron Diffraction

* 3D Electron Diffraction (3DED / MicroED)

Continuous-rotation collection of diffraction volumes from nano- and microcrystals for ab-initio structure solution; zero dead time and high dynamic range preserve weak high-order reflections.

* Precession Electron Diffraction (PED)

Reduced dynamical effects and near-kinematic intensities; the 24-bit counter records strong and weak reflections in one pattern without saturation.

* Selected-Area & Nano-Beam Diffraction (SAED / NBD)

Sharp, high-dynamic-range spots and disks from a static probe, with a crisp point-spread function from charge-summing mode.

* Low-Dose Diffraction of Beam-Sensitive Materials

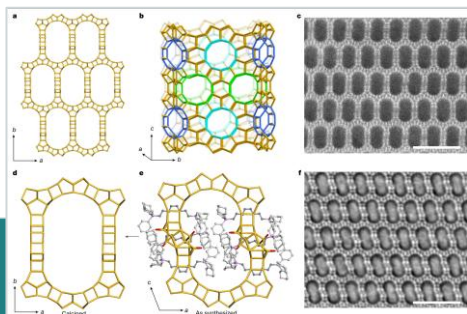
Single-electron counting lets MOFs, zeolites, pharmaceuticals, 2D materials, and hybrid perovskites be studied before beam damage.

* In-situ & Time-Resolved Diffraction

Fast frames capture structural phase transitions and non-equilibrium dynamics during heating, biasing, or environmental experiments.

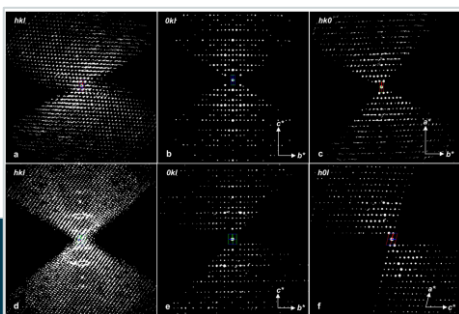
Mesoporous zeolite ZMQ-1

Lu et al., Nature 636, 368-373 (2024)



ZMQ-1 solved by 3D ED

Lu et al., Nature 636, 368-373 (2024)



Environmental 3D ED of MIL-53

Ling et al., Nat. Commun. 13, 6625 (2022)

