

Merlin

Merlin for EM

Technical Datasheet

The Merlin for EM Hybrid Pixel Detector (HPD) is an advanced detector development in the field of Electron Microscopy, combining direct detection of electrons and rapid readout in a pixelated format ideal for applications such as 4D STEM and TEM dynamic imaging. Each sensor pixel is individually bump-bonded to an intelligent chip which uses threshold discriminators to distinguish electrons from the background, effectively eliminating all readout noise. This allows for integral mode imaging where multiple short exposure images are acquired and summed together. Uniquely, neighbouring pixels can communicate to mitigate charge-sharing effects, and this, combined with the direct detection of electrons, yields enhanced performance. As beam energies decrease toward 60 keV, the Merlin for EM has been shown to provide near-ideal DQE and MTF detector response¹.

Key points

Direct detection

Noise-less detection of single electron events

Dynamic Range

Up to 24-bit counting depth enabling 1:16.7 million intensity range in a single image, ideal for recording diffraction patterns

Effectively noise-free

2 threshold discriminators in each pixel means zero read noise

Charge summing mode

Communication between pixels designed to mitigate charge sharing effects for maximising both DQE and MTF

Rapid readout

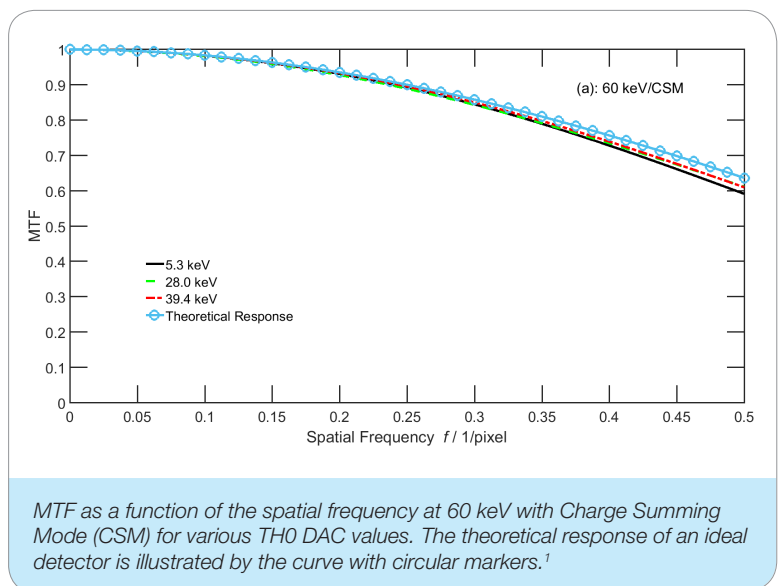
Kilohertz frame rates and zero deadtime in continuous mode offer more experimental flexibility than ever before, minimising effects such as sample drift, and enabling single shot and “pump and probe” dynamic experiments

Wide energy range and radiation tolerance

Minimum 30 keV threshold making low energy EM imaging possible

Mount

Static and retractable mounts available to fit many electron microscopes



1. J.A. Mir, R. Clough, R. MacInnes, C. Gough, R. Plackett, I. Shipsey, H. Sawada, I. MacLaren, R. Ballabriga, D. Maneuski, V. O'Shea, D. McGrourther, A.I. Kirkland: "Medipix3 Demonstration and understanding of near ideal detector performance for 60 & 80 keV electrons", arXiv:1608.07586 [physics.ins-det]

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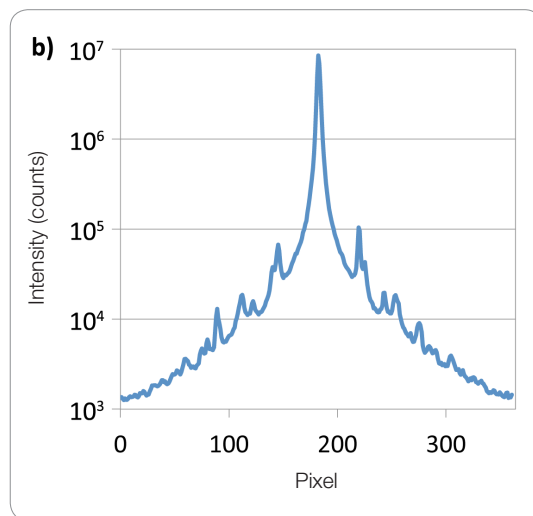
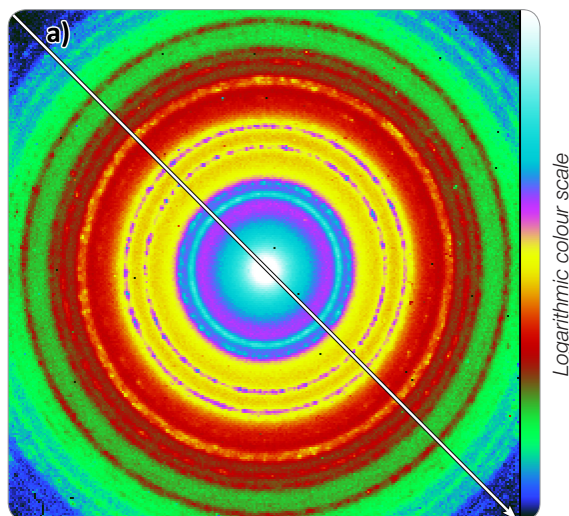


Figure illustrating Merlin's dynamic range capabilities - 24-bit depth acquisition of a diffraction pattern. (a) Acquired diffraction pattern with logarithmic colour scale making visible diffraction features across the full intensity range. (b) Single-line profile along the pattern diagonal highlighting the dynamic range of the information contained in the pattern.¹

Technical specifications

Sensor:	Silicon 500 μm
Sensor Type:	Reverse biased hybrid silicon diode array
Pixel size:	55 x 55 μm
Active area:	14 mm x 14 mm, or 28 mm x 28 mm
Pixels:	256 x 256 (single) or 512 x 512 (Quad)
Readout noise:	Zero with thresholds set
DQE at 60 keV:	1 at Zero frequency 0.45 at Nyquist ¹
MTF at 60 keV:	>0.62 at Nyquist (depends on mode) ¹
Max frame rate (continuous):	2400 Hz (6-bit)
Gap time (continuous):	0 μs
Maximum dynamic range:	24 bit - up to 16,777,216 counts per pixel.
Trigger:	3.3 / 5 V TTL pulse or within software
Communication:	up to 10 m VHDCI cable; TCP/IP protocol
Energy range:	30 keV – 300 keV
Software:	Labview and TCP/IP protocol
Mount:	Static and retractable available

About

Merlin, developed by Diamond Light Source, is a robust and versatile system built around the Medipix3 ASIC. It is designed with the high performance and reliability standards required by synchrotron beamlines and other industrial and large scale scientific applications.

Merlin for EM is an adaptation of the Merlin for electron microscopy use, developed in conjunction with the University of Glasgow.