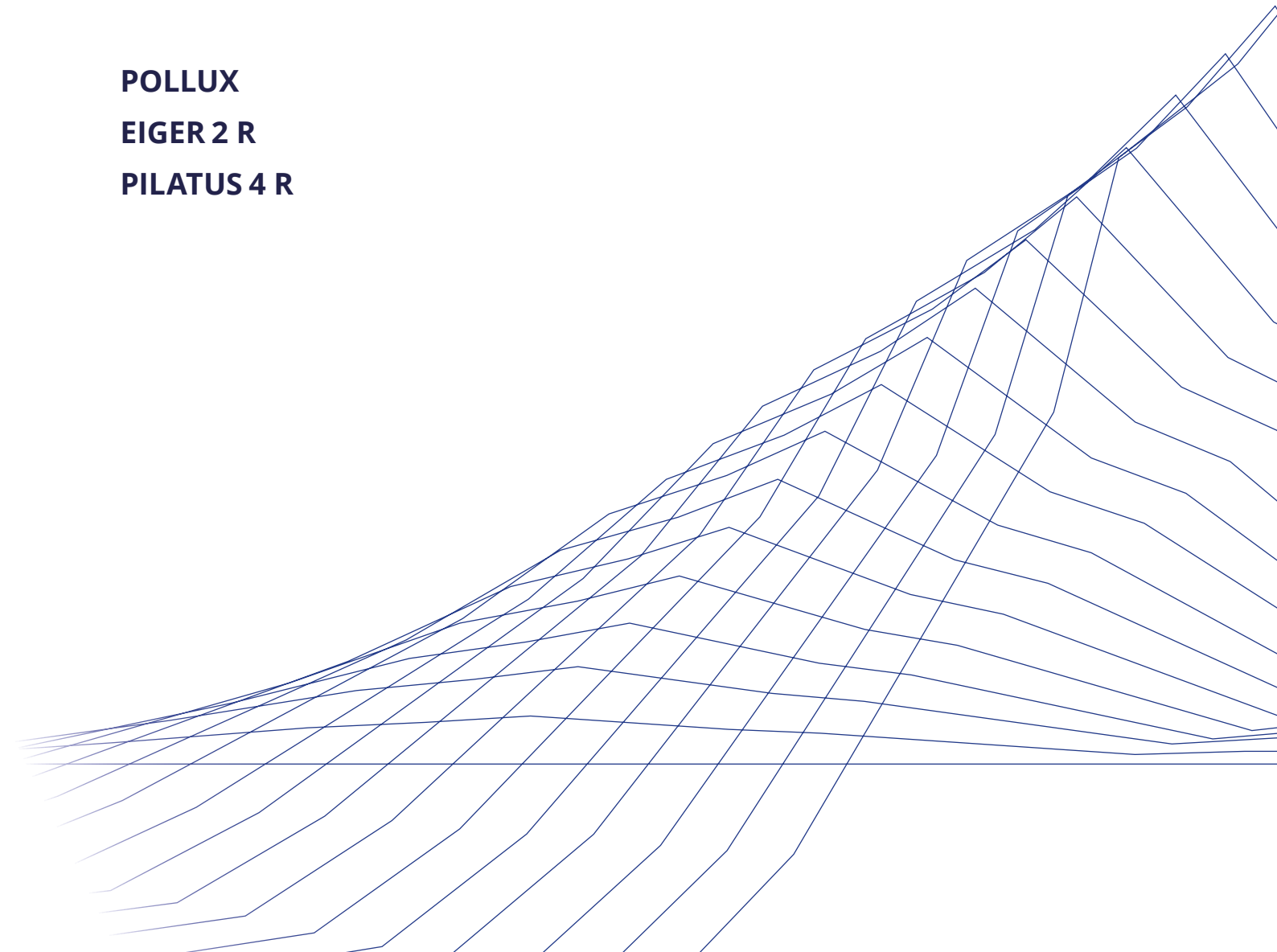
DECTRIS

Laboratory **Detectors**

POLLUX

EIGER 2 R

PILATUS 4 R



Bringing Synchrotron-Grade Performance to Your Laboratory

As a pioneer in high-performance Hybrid Photon Counting (HPC) detectors for synchrotrons, DECTRIS has set new standards in X-ray detection. Our state-of-the-art technology is available for X-ray analytics in laboratories and industry, empowering scientists and engineers with the accuracy, speed, and sensitivity that has transformed cutting-edge research at synchrotrons. Our advanced laboratory detectors enable synchrotron-quality experiments in a compact, user-friendly setup - delivering exceptional data quality without the need for beamtime. Explore our range of laboratory detectors and unlock new possibilities for your research.

POLLUX®

This family of 2D hybrid-pixel detectors features our most versatile XRD detectors yet. It achieves excellent peak-to-background ratios thanks to outstanding energy resolution and dual energy discrimination. Active areas of up to 57.9 by 14.4 mm allow for wide angular coverage and fast measurements. Head to pp. 3-4 to read more about POLLUX.

Are you looking for a larger active area? Then you will find what you need in our EIGER2 R and PILATUS4 R detectors series that we introduce on the next page.

POLLUX for Laboratories

EIGER 2 R and PILATUS 4 R

Which Detector Family Should You Choose?

EIGER2 R embodies DECTRIS' series of high-end detectors for in-house X-ray analytics. It features a small pixel size of 75 µm, superior count rates and all advanced features of HPC technology. Choose EIGER2 R if you want to benefit from high spatial resolution and the widest possible dynamic range.

PILATUS4 R is a cost-efficient option with a larger active area than most other HPC detectors. Its pixel size of 150 µm is a good match for many conventional in-house X-ray sources and optics. And except for EIGER2 R, there are hardly any HPC detectors that outperform PILATUS4 in count rates and dynamic range. Choose PILATUS4 R if a large active area is the most critical specification in your measurements.

EIGER2 for Laboratories

PILATUS4 for Laboratories

Which Sensor Material Should You Choose?

HPC detectors with **silicon sensors** provide high quantum efficiency and short measurement times for Ga, Cu, or longer-wavelength radiation and are the ideal companions for such X-ray sources. Thanks to the absence of detector background in HPC detectors, silicon sensors can also be used for Mo and Ag radiation when the longer measurement times are not critical. You will find EIGER2 R and PILATUS4 R detectors equipped with silicon sensors on pp. 3-4 and pp. 7-8, respectively.

DECTRIS HPC detectors with **CdTe sensors** achieve similar performance for Cu and Ga radiation compared to their silicon sensor counterparts. Thanks to the high-Z sensor material, quantum efficiency, sensitivity, and measurement speed are greatly improved when using high-energy radiation, compared to what is possible when using HPC detectors equipped with Si sensors. Choose a DECTRIS CdTe detector as the perfect match for any dual-wavelength setup or high-energy laboratory source. You will find EIGER2 R CdTe and PILATUS4 R CdTe detectors on pp. 5-6 and pp. 9-10, respectively.

POLLUX®

Versatility Meets Performance in X-Ray Detection

DECTRIS POLLUX® is the lab detector that redefines what you can expect from compact, energy-discriminating X-ray detection. Whether you're integrating it into a next-generation instrument or want to run fast measurements of high-quality data in the lab, POLLUX delivers exceptional results — consistently and effortlessly.

Designed to deliver the **optimal balance between energy resolution, count rate, and active area**, POLLUX sets a new benchmark for real-world performance. With dual energy discrimination and excellent resolution, POLLUX effectively suppresses fluorescence and high-energy background, providing clearer signals and better peak-to-background ratios. Its large active area captures more of the beam and covers a wider angular range, enabling faster measurements and improved data quality. Thanks to its superior count rate capabilities, POLLUX enables accurate measurement of high intensities and supports absorber-free reflectometry experiments.

Engineered for versatility, POLLUX is ready for everything from diffraction to spectroscopy. With its compact form factor and effortless integration, it's an easy fit for any instrument. And thanks to robust electronics and passive cooling, it offers best possible reliability.

Key Advantages

Excellent energy resolution and dual energy discrimination for effective background suppression.

Superior count rates for unparalleled dynamic range.

Pixel detector with 2D, 1D and 0D readout modes.

Up to 400 Hz frame rate for fast scanning.

Applications

- Powder X-ray diffraction
- Residual stress
- X-ray reflectometry
- Wavelength-dispersive X-ray spectroscopy
- Small- and wide-angle X-ray scattering

Technical Specifications

	POLLUX	POLLUX PANORAMA
Active area (W x H) [mm²]	19.2 × 14.4	57.9 × 14.4
Pixel array (W x H)	256 × 192	772 × 192
Pixel size (W x H) [µm²]	75 × 75	
Count rate per pixel (max., @8 keV) [ph/s]	1.0×10^6	
Energy resolution (FWHM @8 keV) [eV]	< 600	
Energy range [keV]	4.5 - 9.3	
Number of energy thresholds	2	
Readout modes	2D, 1D, 0D, each with ROI	
Frame rate (max. for 2D/1D/0D) [Hz]	100/100/400	
Readout time	Zero dead time continuous readout	
Sensor material	Silicon	
Sensor thickness [µm]	320	
Point-spread function (FWHM) [pixels]	1	
Vacuum compatibility	Optional	
Cooling	Passive air	
Dimensions (W x H x D) [mm³]	29 × 62 × 37	68 × 62 × 37
Weight [kg]	0.15	0.3

* Specifications are subject to change without prior notice.

EIGER 2 R

The High-End HPC Detectors for Your Laboratory

EIGER2 R incorporates every state-of-the-art feature of HPC technology. Small pixels, in combination with direct detection, enable a high spatial and angular resolution and give you the benefit of fine sampling of reciprocal space. A superior count-rate performance ensures accurate measurements of even the highest intensities. Take full advantage of this detector series' vast dynamic range, even during long exposures, using continuous readout. Dual-energy discrimination allows for extensive background suppression and improves the signal-to-noise ratio, in particular for weak signals and long exposure times. Eliminate absorption and scattering from air and windows, thanks to the optionally available removable detector window and vacuum compatibility. Choose from four different models to match your needs.

Key Advantages

DECTRIS Instant Retrigger for a virtually linear response and superior count rates.

Direct detection and a small pixel size for the best spot separation, minimal background overlap and better signal-to-noise ratio.

DR

The highest possible dynamic range thanks to zero detector background, superior count rates, continuous readout and high pixel density.

Dual-energy discrimination for suppression of low- and high-energy background.

Zero readout noise or dark current thanks to digital counting and readout, enabling the best signal-to-noise ratio.

Applications

- Single-crystal X-ray diffraction
- Powder X-ray diffraction
- SAXS/WAXS
- EXAFS, XANES

Technical Specifications

EIGER 2 R	4M	1M	500K	250K
Active area (W x H) [mm²]	155.1 x 162.2	77.1 x 79.7	77.1 x 38.4	38.4 x 38.4
Pixel array (W x H)	2,068 x 2,162	1,028 x 1,062	1,028 x 512	512 x 512
Pixel size (W x H) [µm²]	75 x 75			
Energy range [keV]	5.4 - 22.2			
Number of energy thresholds	2			
Threshold range [keV]	3.5 - 30			
Count rate per pixel (max., @8 keV) [ph/s]	3.8×10^6			
Count rate per area (max., @8 keV) [ph/s/mm²]	6.7×10^8			
Frame rate[1] (max.) [Hz]	20	100	50	50
Readout time[2]	Continuous			
Sensor material	Silicon (Si)			
Sensor thickness [µm]	450			
Point-spread function (FWHM) [pixels]	1			
Vacuum compatibility	Optional			
Cooling	Water	Water	Air	Air
Dimensions (W x H x D) [mm³]	235 x 237 x 372	114 x 133 x 240	100 x 140 x 93	100 x 140 x 93
Weight [kg]	15	4.7	1.8	1.8

All specifications are subject to change without notice.

[1] With optional calibration for an extended energy range.
[2] The effective dead time between exposures is < 100 ns (max. loss of 1 count/pixel).

EIGER 2 R CdTe

All the Advantages of HPC Technology for High-Energy Applications

EIGER2 R CdTe X-ray detectors combine the latest developments in HPC technology with the high quantum efficiency of cadmium-telluride sensors. This makes them indispensable for your laboratory when you are using high-energy sources or a dual-wavelength setup. Their unprecedentedly high count-rate capability, enabled through by DECTRIS' patented Instant Retrigger, allows for more accurate measurements of the highest intensities that can be achieved with laboratory sources. Equipped with two energy-discriminating thresholds, these detectors have lower dark counts from environmental background than their predecessors did. This significantly improves the signal-to-noise ratio for weak signals and long exposures, allowing for shorter measurement times and better data quality. Single-photon counting, in combination with continuous read/write, overcomes all saturation issues and the limited dynamic range of integrating detectors. In addition, direct detection and the small, 75-µm pixel size guarantee high spatial and angular resolution.

Key Advantages

Integrated **DECTRIS Instant Retrigger** technology for superior count rates.

Direct detection and a small pixel size for the best spot separation, minimal background overlap and better signal-to-noise ratio.

DR

The highest possible dynamic range thanks to zero detector background, superior count rates, continuous readout and high pixel density.

Zero readout noise or dark current thanks to digital counting and readout, enabling the best signal-to-noise ratio.

Dual-energy discrimination for suppression of low- and high-energy background.

Applications

- Single-crystal X-ray diffraction
- Powder X-ray diffraction
- SAXS/WAXS
- µCT

Technical Specifications

EIGER 2 R CdTe	CdTe 4M	CdTe 1M	CdTe 500K
Active area (W x H) [mm²]	155.1 x 162.2	77.1 x 79.7	77.1 x 38.4
Pixel array (W x H)	2,068 x 2,162	1,028 x 1,062	1,028 x 512
Pixel size (W x H) [µm²]	75 x 75		
Energy range [keV]	8 - 25 (8 - 100)[1]		
Number of energy thresholds	2		
Threshold range [keV]	4 - 30 (4 - 80)[1]		
Count rate per pixel (max., @22 keV) [ph/s]	5.5 x 10^6		
Count rate per area (max., @22 keV) [ph/s/mm²]	9.8 x 10^8		
Frame rate[1] (max.) [Hz]	20	100	100
Readout time[2]	Continuous		
Sensor material	Cadmium telluride (CdTe)		
Sensor thickness [µm]	750		
Point-spread function (FWHM) [pixels]	1		
Vacuum compatibility	Optional		
Cooling	Water		
Dimensions (W x H x D) [mm³]	235 x 237 x 372	114 x 133 x 242	114 x 92 x 242
Weight [kg]	15	4.7	3.7

All specifications are subject to change without notice.

[1] With optional calibration for an extended energy range.
[2] The effective dead time between exposures is < 100 ns (max. loss of 1 count/pixel).

PILATUS 4 R

Optimized for Performance and Value

Do you want to benefit from the advantages of DECTRIS' latest HPC technology, such as zero detector background, continuous readout and wide dynamic range? Do you want a large active area detector for your in-house measurements while you don't really need the highest spatial resolution and ultimate dynamic range of EIGER2 R? Then you will find the right detector in our PILATUS4 R series.

Key Advantages

Large & efficient: Active areas of up to 155 x 162 mm, with more than 95% quantum efficiency for Cu and Ga radiation.

Four energy discriminating thresholds for suppression of low- and high-energy background and new possibilities in polychromatic applications.

Wide dynamic range thanks to zero detector background, high count rates, and continuous readout.

Zero readout noise or dark current thanks to digital counting and readout, enabling the best signal-to-noise ratio.

Applications

- Single-crystal X-ray diffraction
- Small-angle X-ray scattering
- Spectral imaging

Technical Specifications

PILATUS 4 R	1M	260K
Active area (W x H) [mm²]	155.0 x 162.0	77.0 x 79.5
Pixel array (W x H)	1033 x 1080	513 x 530
Pixel size (W x H) [µm²]	150 x 150	
Energy range [keV]	6 - 40	
Number of energy thresholds	4	
Threshold range [keV]	4 - 30	
Count rate per pixel (max., @22 keV) [ph/s]	3.1×10^6	
Count rate per area (max., @22 keV) [ph/s/mm²]	1.4×10^8	
Frame rate (max.) [Hz]	10	100
Readout time[1]	Continuous	
Sensor material	Silicon	
Sensor thickness [µm]	450	
Point-spread function (FWHM) [pixels]	1	
Dimensions (W x H x D) [mm³]	235 x 237 x 372	114 x 133 x 242
Weight [kg]	15	4.7

All specifications are subject to change without notice.
[1] The effective dead time between exposures is < 100 ns (max. loss of 1 count/pixel).

PILATUS 4 R CdTe

High Quantum Efficiency and Large Area for Fast Data Collection

With their high quantum efficiency (greater than 95%) and their large active area of up to 155 x 162 mm, PILATUS4 R CdTe detectors enable fast data collection using any X-ray source from Cu to In. In particular, for Mo, Ag, and In radiation, PILATUS4 R CdTe outperforms any HPC detector with a Si sensor – even PILATUS3, which has the thickest Si sensor available.

A dynamic range spanning ten orders of magnitude is achieved through PILATUS4's superior count rates and the absence of any detector background. Internal frame rates of up to 200 Hz improve the count-rate correction and ensure highly accurate measurement of strong intensities. With four energy-discriminating thresholds, PILATUS4 offers new possibilities in Laue diffraction and spectral imaging.

Key Advantages

Large & efficient: active areas of up to 155 x 162 mm, with more than 95% quantum efficiency from 8 to 25 keV.

Four energy discriminating thresholds for suppression of low- and high-energy background and new possibilities in polychromatic applications.

Wide dynamic range thanks to zero detector background, high count rates, and continuous readout.

Zero readout noise or dark current thanks to digital counting and readout, enabling the best signal-to-noise ratio.

Applications

- Single-crystal X-ray diffraction
- Small-angle X-ray scattering
- Spectral imaging
- Laue diffraction

Technical Specifications

PILATUS 4 R CdTe	1M	260K	260K-W
Active area (W x H) [mm²]	155.0 x 162.0	77.0 x 79.5	155.0 x 38.3
Pixel array (W x H)	1,033 x 1,080	513 x 530	1,033 x 255
Pixel size (W x H) [µm²]	150 x 150		
Energy range [keV]	8 - 25 (8 - 100)[1]		
Number of energy thresholds	4		
Threshold range [keV]	4 - 30 (4 - 80)[1]		
Count rate per pixel (max., @22 keV) [ph/s]	5.0×10^6		
Count rate per area (max., @22 keV) [ph/s/mm²]	2.2×10^8		
Frame rate[1] (max.) [Hz]	10	100	100
Readout time[2]	Continuous		
Sensor material	Cadmium telluride (CdTe)		
Sensor thickness [µm]	1,000		
Point-spread function (FWHM) [pixels]	1		
Dimensions (W x H x D) [mm³]	235 x 237 x 372	114 x 133 x 242	192 x 92 x 277
Weight [kg]	15	4.7	5.8

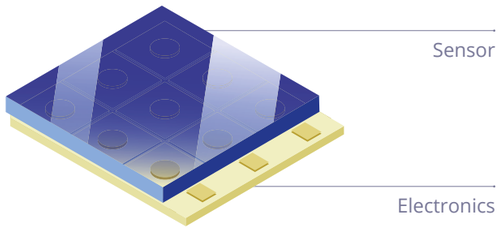
All specifications are subject to change without notice.

[1] With optional calibration for an extended energy range.
[2] The effective dead time between exposures is < 100 ns (max. loss of 1 count/pixel).

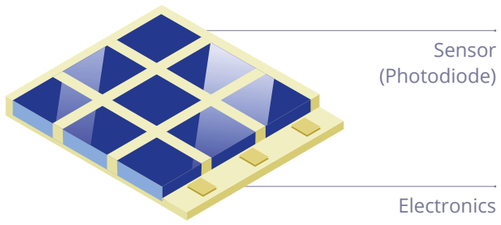
Hybrid Photon Counting

Direct Conversion In Hybrid-Pixel Technology

Characteristically, Hybrid Photon Counting (HPC) incorporates the method of single-photon counting as well as hybrid-pixel technology. This technology enables direct conversion of X-rays to electric charge and is the state of the art in X-ray detection because it offers several advantages over indirect detection. In the sensor layer of a hybrid pixel, the charge generated by X-ray absorption is captured in an electric field, along which it moves rapidly, going towards the electronics layer for processing and counting. Both loss and spreading of the signal are minimized. Therefore, hybrid-pixel detectors achieve a sharp point-spread function and quantum efficiencies that are close to the sensor's absorption efficiency. Hybrid-pixel technology also makes it unnecessary to use a large fraction of the electronics layer's pixel area for a photodiode because the electric signal is generated in a separate layer that covers the full pixel area. This way, thousands of transistors for advanced detector features can be implemented in every pixel without reducing the area that is available for signal detection or compromising quantum efficiency.



Hybrid-Pixel Detector



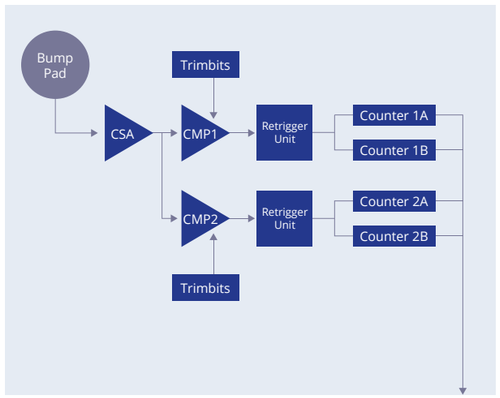
CMOS Active Pixel Sensor

Highly Advanced HPC Chip

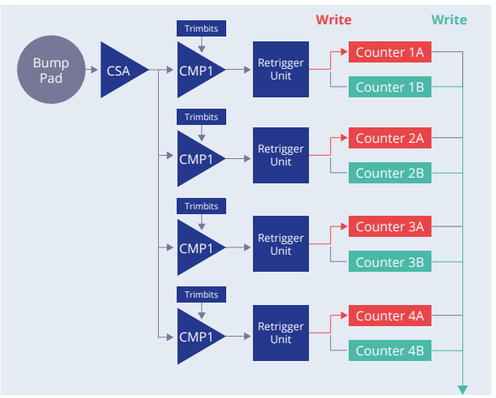
EIGER2 and PILATUS4 feature some of the most advanced Application-Specific Integrated Circuits (ASICs) for HPC, with more than 150 million transistors per chip and 1.2 billion transistors on a single detector module. As in a CPU or GPU, more transistors mean more features, and that means advantages over previous generations or competing products.

Every pixel in an EIGER2 detector features not one, but two comparators per charge-sensitive amplifier (CSA). This enables high-energy discrimination, in addition to low-energy discrimination of a single comparator (CMP). A retrigger unit for each of the comparators complements the fast CSA, further boosting the count-rate performance. This makes EIGER2 compatible with the requirements of latest-generation synchrotrons and provides a virtually linear response for count rates that can be achieved in typical laboratory experiments. At the same time, two digital counters for each comparator allow you to take advantage of both dual-energy discrimination and simultaneous read/write at the same time. Thanks to the combination of zero detector background, superior count rates, and simultaneous read/write, EIGER2 detectors achieve a dynamic range of more than 10 orders of magnitude.

The PILATUS4 ASIC is closely related to EIGER2. However, it features twice as many energy discriminating comparators, retrigger units, and digital counters. This allows for recording of up to four different X-ray energies in a single exposure and opens up new possibilities in polychromatic applications such as spectral imaging and Laue diffraction.



Schematics of a single pixel in an **EIGER2 ASIC.**



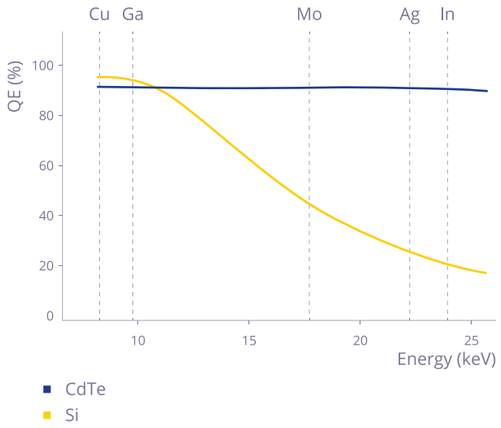
Schematics of a single pixel in a **PILATUS4 ASIC**

High Quantum Efficiency

Direct detection in HPC detectors enables high quantum efficiency that is close to the absorption efficiency of the sensor material. High quantum efficiency gives you better data in less time.

DECTRIS HPC detectors with CdTe sensors offer high quantum efficiency of more than 90% for any wavelength from Cu to In. Measurement times with short wavelengths can be reduced by a factor of 2 to 4, thanks to the efficiency advantage of cadmium telluride over silicon. The performance of EIGER2 R CdTe and PILATUS4 R CdTe detectors with Cu and Ga radiation is similar to that of their silicon counterparts. Choose DECTRIS HPC detectors with CdTe sensors for the shortest measurement times with high-energy sources or dual-wavelength setups.

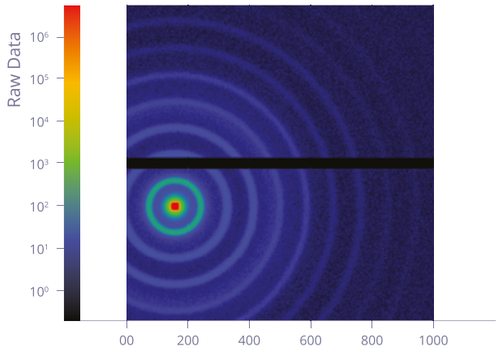
DECTRIS HPC detectors with silicon sensors achieve more than 90% quantum efficiency for Cu and Ga radiation. They are the perfect companion for any such laboratory source. The decreasing quantum efficiency for shorter wavelengths of this sensor material can be compensated for by increasing exposure times. Thanks to the absence of detector background, as well as the suppression of experimental background with EIGER2's and PILATUS4'S multi-energy discrimination, this strategy also enables excellent data quality for high X-ray energies.



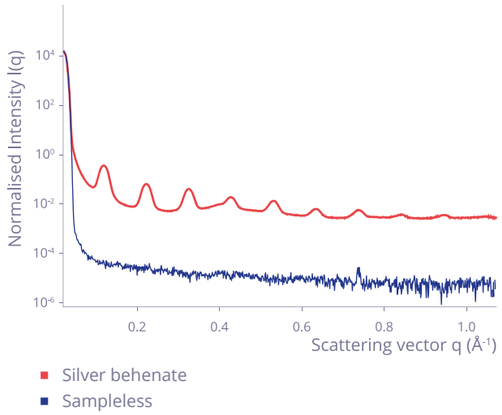
Quantum efficiency (QE) of EIGER2 R CdTe (blue) and EIGER2 R (yellow) with silicon sensors.

The Highest Dynamic Range

Thanks to zero detector background, superior count rates, and simultaneous read/write, EIGER2 and PILATUS4 detectors provide an extremely wide dynamic range. Determine the highest and lowest intensities accurately and in a single image, whether you are measuring strong and weak reflections or diffuse scattering, or facing a challenging SAXS/WAXS measurement.



The WAXS signal of Silver behenate (AgBH). The data were acquired with an EIGER2 R 1M in a Xeuss3.0 SAXS/WAXS instrument from Xenocs.

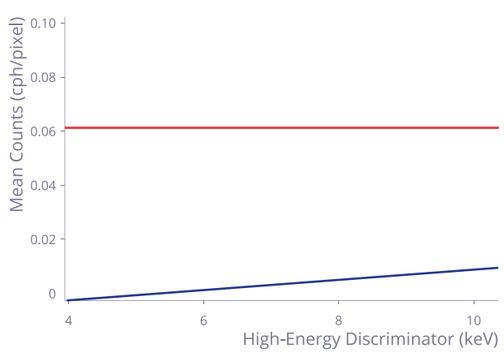


The WAXS signal of Silver behenate (AgBH). This dual plot of AgBH's signal and a negative control shows that the dynamic range of EIGER2 R detectors easily covers the more than ten orders of magnitude that are needed for weakly scattering samples.

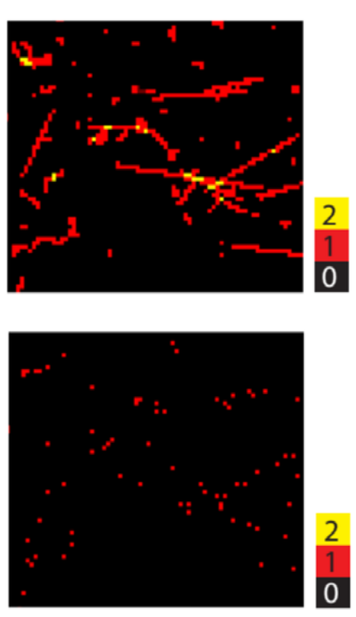
Background Suppression

The multi-energy discrimination of EIGER2 and PILATUS4 enables suppression of both low- and high-energy background. A single energy-discriminating threshold, as implemented in any HPC detector, allows for the suppression of low-energy background. This is a tremendous advantage when dealing with X-ray fluorescence from the sample, or low-energy contamination in the spectrum of the X-ray beam. However, with a second energy-discriminating threshold, as implemented in EIGER2 and PILATUS4, it is possible to suppress high-energy background as well.

Cosmic radiation is a source of high-energy background that compromises data quality when measuring very weak signals with long exposure times. EIGER2 R achieves a fivefold reduction of high-energy background from cosmic radiation, which ensures better data quality. If there is high-energy contamination of the X-ray beam, such as higher-order harmonics, dual-energy discrimination becomes even more critical. Thanks to their lack of detector background and their extensive capabilities for suppression of experimental background with dual-energy discrimination, EIGER2 and PILATUS4 detectors are your best choice for measuring weak intensities with high accuracy.



Background counts per pixel in 1-hour dark images. Red line: Dark counts for EIGER with a single energy discriminator set at 4 keV. Blue line: Dark counts for EIGER2 R with a low-energy discriminator at 4 keV as a function of a high-energy discriminator setting.

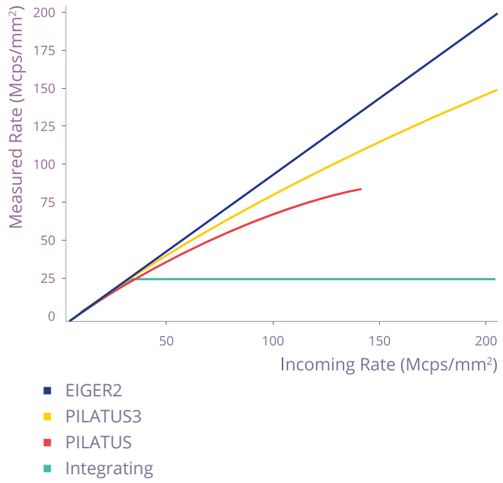


Identical regions obtained through a 1-hour dark exposure of an EIGER2 R detector. Top: Counts obtained with a low-energy discriminator at 4 keV. Bottom: The difference between the counts with a high-energy discriminator at 10 keV and the counts with a low-energy discriminator at 4 keV.

Superior Count-rate Performance

DECTRIS HPC detectors are designed to match the high count-rate requirements of synchrotron sources, but even the most advanced laboratory sources offer lower flux and brightness than a typical synchrotron beamline does. Therefore, DECTRIS HPC detectors far exceed the count-rate requirements of any laboratory set up and experiment. At the same time, HPC detectors overcome the saturation issues and limited dynamic range that are typical of integrating detectors, even modern ones.

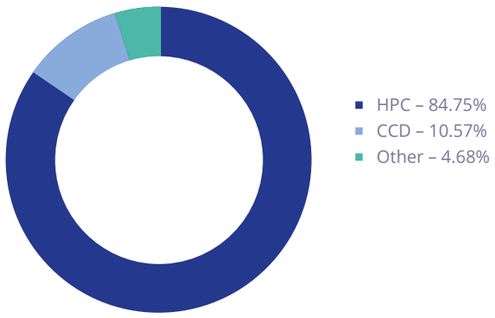
Thanks to its superior count-rate performance, EIGER2 R is the best match for state-of-the-art laboratory sources with high brilliance. It provides high accuracy for strong intensities, without saturation issues, and even allows for measurement of a direct beam.



DECTRIS HPC: The World's Most Successful Detector Technology

At synchrotrons and in laboratories, more and more indirectly detecting X-ray detectors, such as CCDs and image plates, are being replaced by hybrid-pixel technology. The use of indirectly detecting CMOS active-pixel sensor detectors in protein crystallography was first reported in 2009[1], but nowadays, the technology is not providing the field of protein structure determination. More than 84% of the X-ray-crystallographic structures released in the Protein Data Bank in 2024 are based on data that were acquired with DECTRIS HPC detectors.

The advantages of direct detection and single-photon counting are key to the success of HPC technology. And with DECTRIS detectors, you can easily benefit from these advantages in your laboratory.



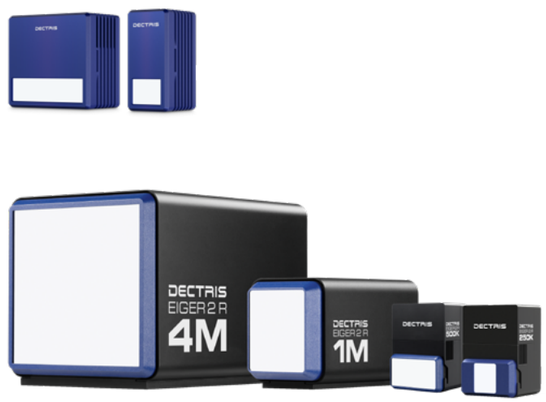
X-ray detector technologies used in PDB releases – 2024.

[1] K. Hasegawa *et al.*, "Development of a shutterless continuous rotation method using an X-ray CMOS detector for protein crystallography," Journal of Applied Crystallography, **vol. 42, no. 6**, pp. 1165–1175, Dec.

OEM Partners

DECTRIS HPC detectors are integrated in instruments made by the following manufacturers:

- Anton Paar
- Bruker AXS
- Forvis Technologies
- GNR
- HP Spectroscopy
- Huber Diffraktionstechnik
- LynXes Innovation Ltd.
- Malvern Panalytical
- marXperts
- PHOTRON-X
- Proto
- Rigaku
- STOE & Cie
- Xenocs
- XRD Eigenmann



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