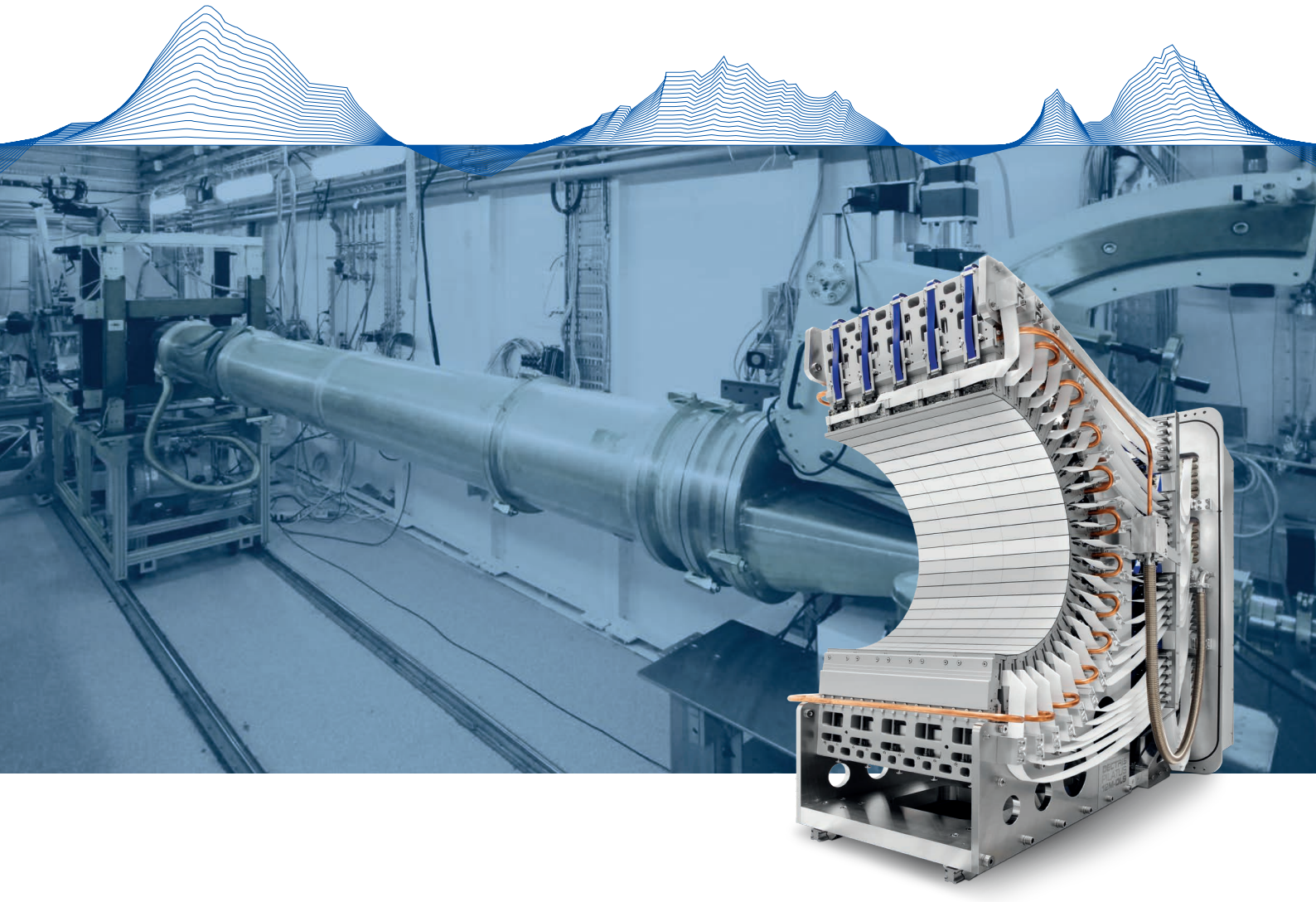
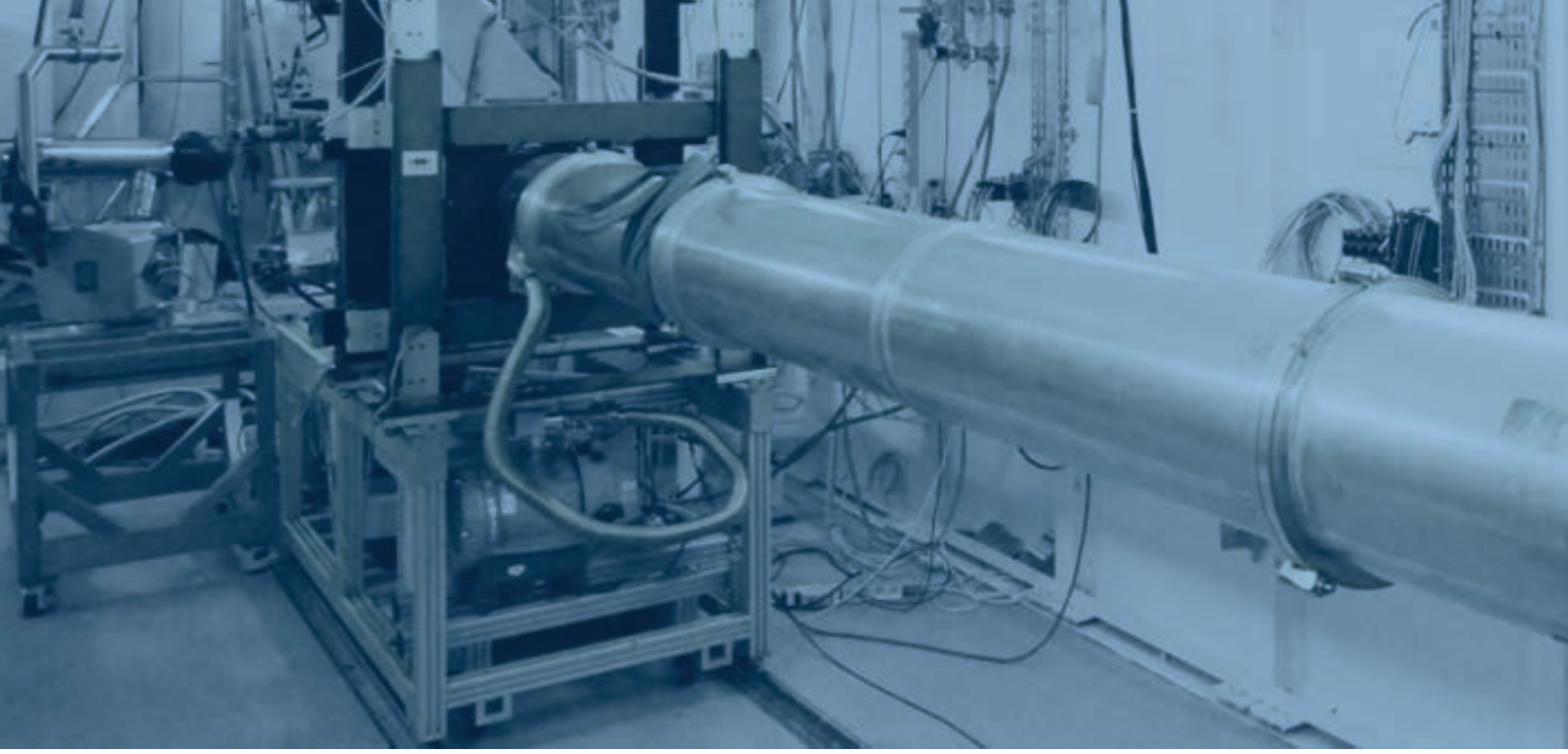
DECTRIS
detecting the future



SPECIFIC SOLUTIONS

X-ray detection without limits

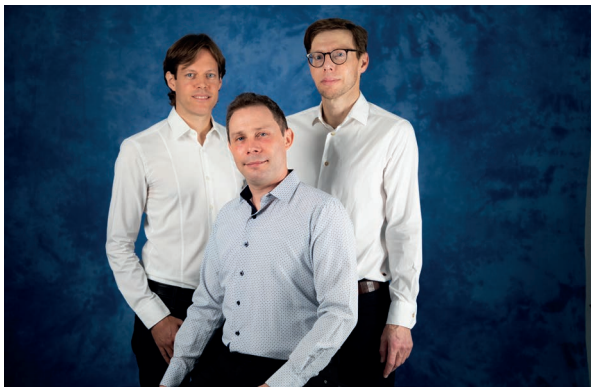


Could your experiments benefit from an X-ray detector that is designed for your needs? If so, unleash the full potential of your experiments with specific solutions: customized detector systems from DECTRIS! In close collaboration with our highly motivated team, you can realize your idea for a specific-solution detector based on the Hybrid Photon Counting PILATUS3 and EIGER2 pixel detectors or the MYTHEN2 strip detector. The detectors shown in this brochure are selected examples of solutions we have previously realized for our customers. If you need a similar - or even an entirely different - detector solution, please contact us to discuss how it can become reality.

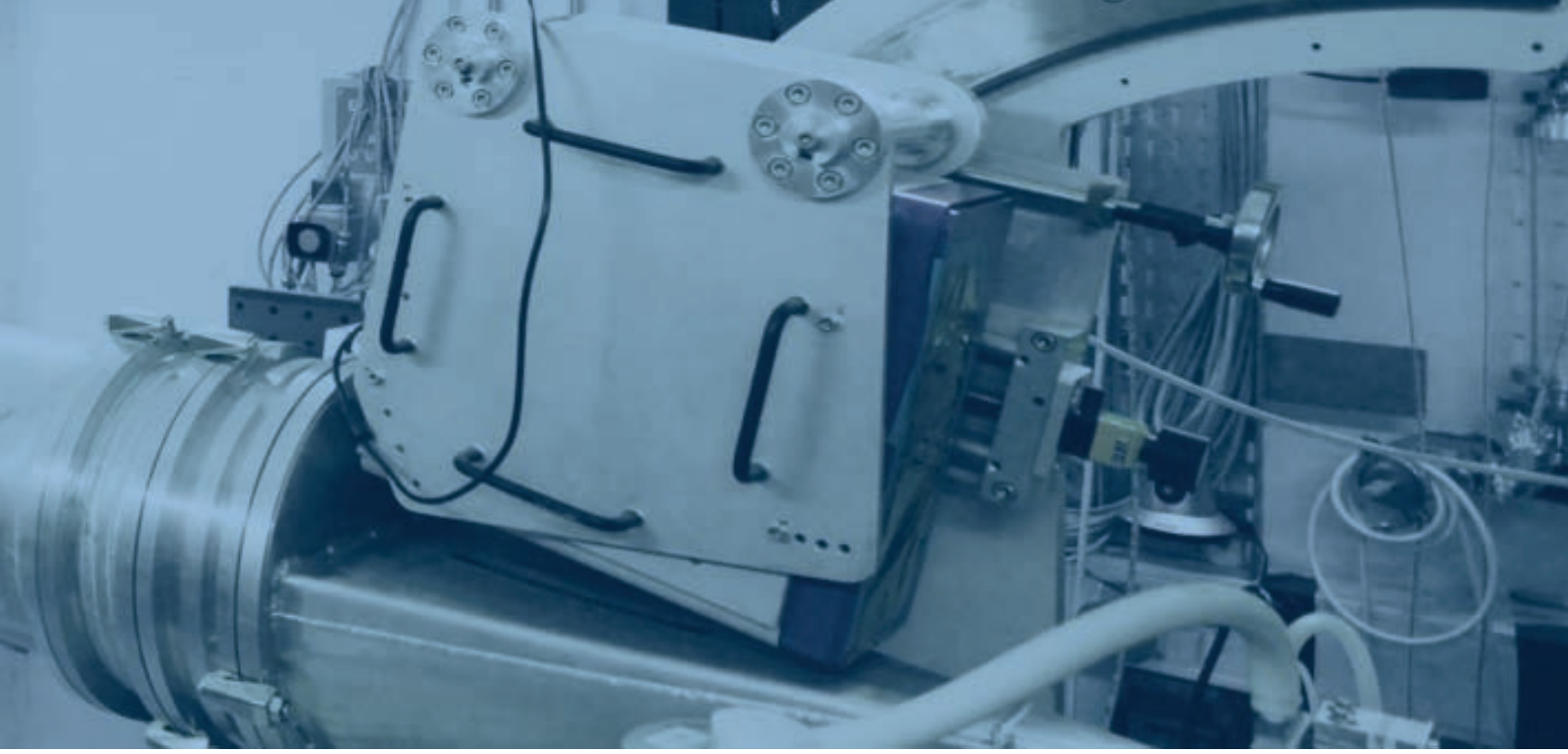
Take advantage of the extensive know-how that DECTRIS has gained throughout its more-than-ten-year history of designing and assembling a large variety of Hybrid Photon Counting detector systems.

Together with our development team, our specific solutions team can realize even the most challenging specific design!

– Custom geometries
– In-Vacuum detectors
– Removable window
– Special energy calibrations



Our specific solutions team

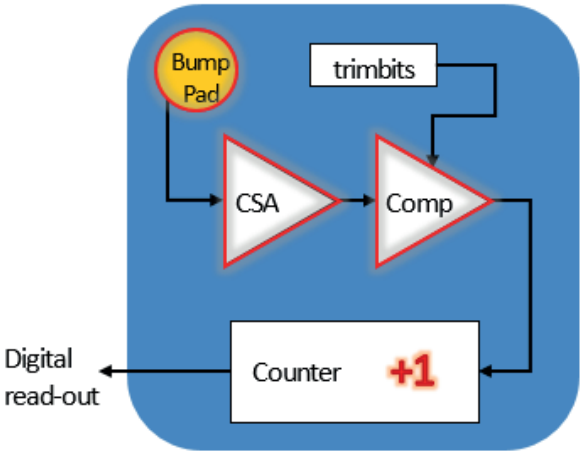


Technology

Specific solutions are based on DECTRIS Hybrid Photon Counting technology platforms: PILATUS3 and EIGER2 pixel detectors, as well as MYTHEN2 strip detectors. All X-ray detectors operate in single-photon counting mode and provide outstanding data quality. They feature a very high dynamic range, zero dark signals and no readout noise, thus achieving optimal signal-to-noise ratios even for short readout times and high frame rates. Large active areas with customer-specific geometry are built from multiple identical modules using a modular system concept.

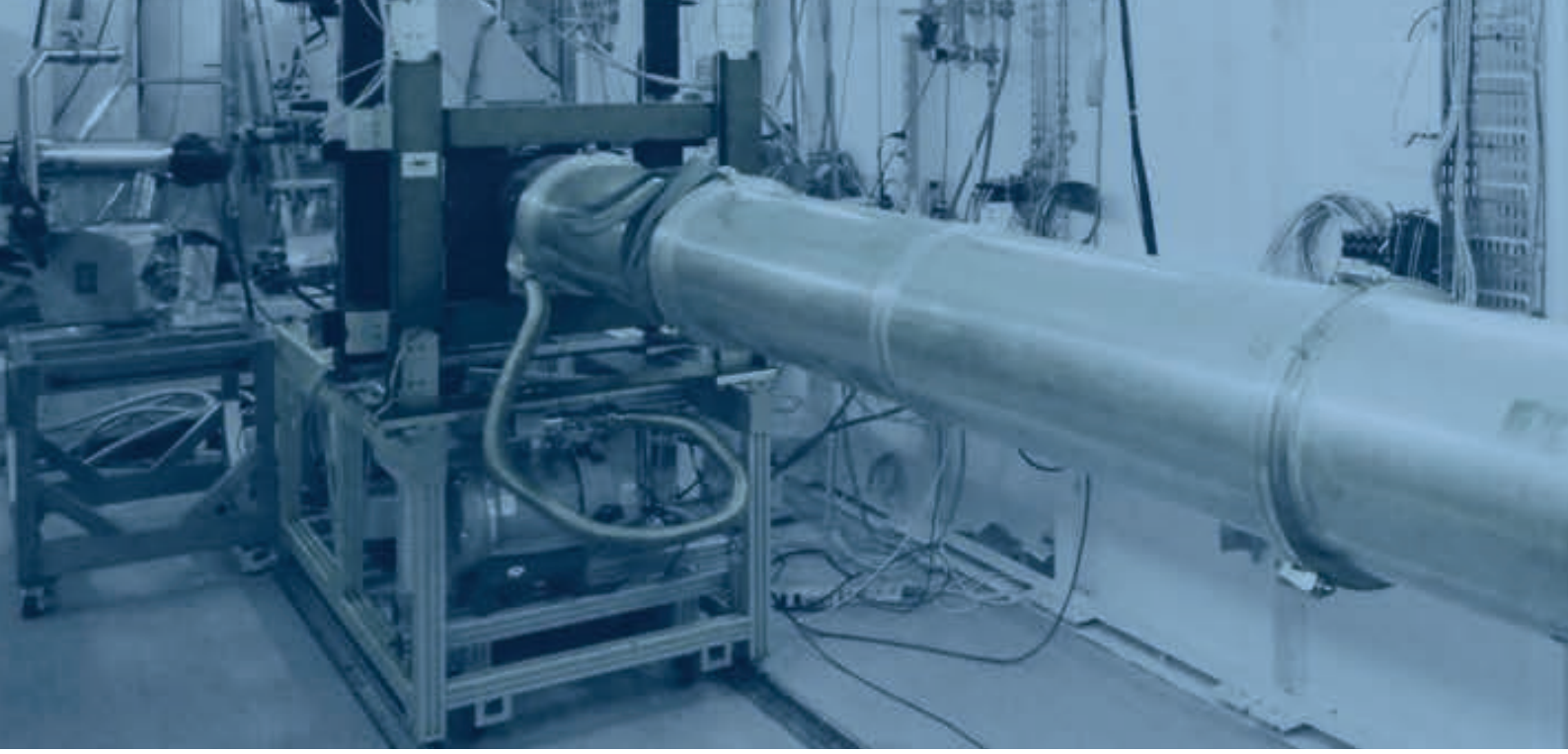


The PILATUS3 detector modular concept enables the construction of detectors in custom geometries and sizes.



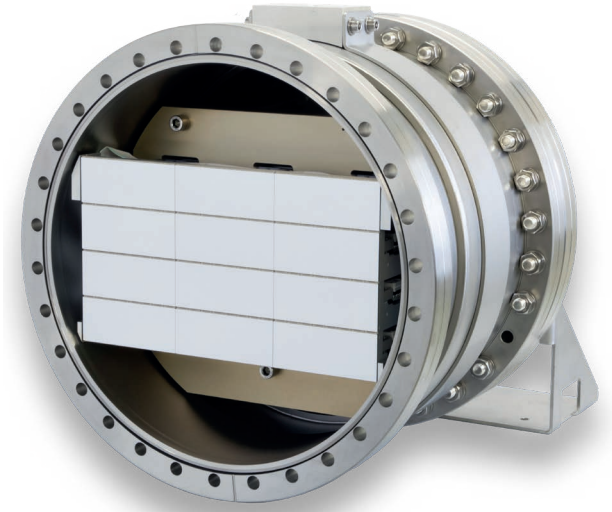
Key advantages

- No read-out noise
- Quantitative signal
- Optimised sensors for large energy range
- Very high dynamic range (from single photon to 10^7 photons/s/pixel)
- Optimal point-spread function
- Custom geometries thanks to modular design



In-vacuum detectors

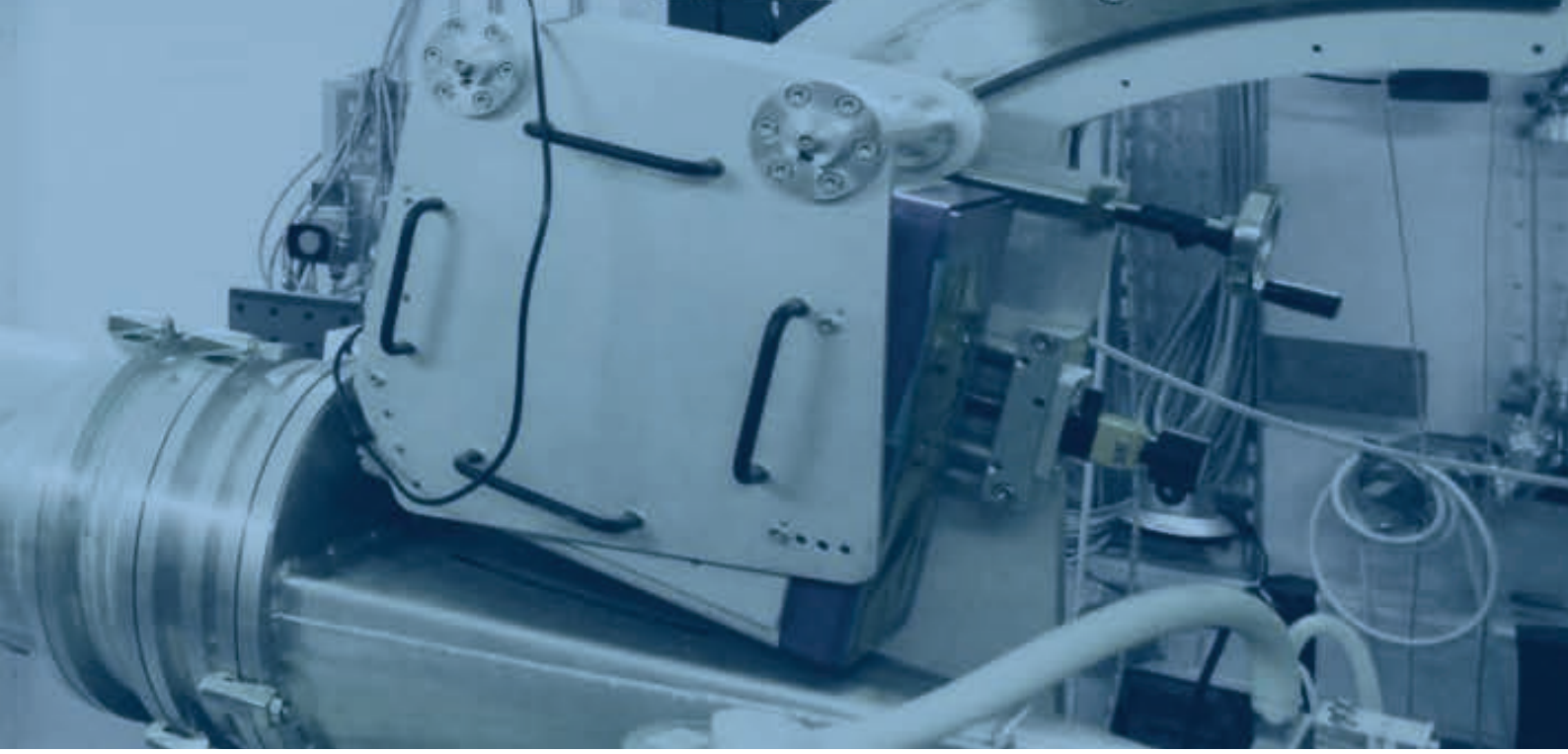
Do air-scattering or absorption effects limit your experiments? Do your samples need a vacuum environment? Many standard detectors from DECTRIS can be ordered in fully vacuum-compatible versions with water-cooled modules and electronics; these are the PILATUS3 300K(-W) and the EIGER(2) 500K, 1M and 4M. Almost all other detectors can be modified for in-vacuum usage as specific solutions to fit optimally into your setup. Vacuum compatibility to below 10^{-6} mbar can be achieved. The range of detectable X-ray energies can be extended below the specifications of the standard detectors using special, low-energy calibrations.



Custom geometries

Does your setup impose severe spatial constraints on the detector's geometry and dimensions? Do you need a detector that lets the beam through? The modular concept of DECTRIS detectors allows for various detector geometries, with a planar or even three-dimensional arrangement of the individual modules. Standard housings can be modified, or new housings can be designed from scratch, to meet your requirements on detector shape, sensitive areas and available space.

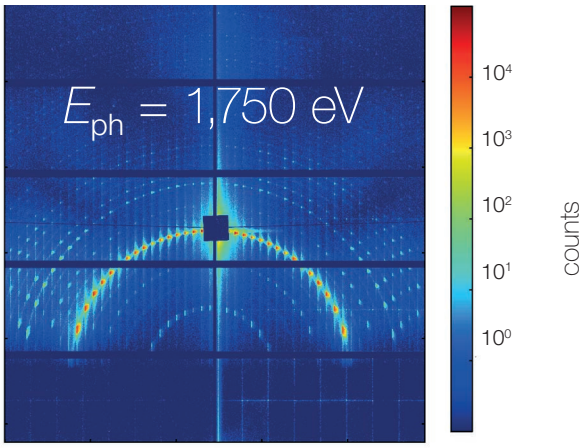




Special energy calibrations

Are you using soft X-rays? Low energy calibrations down to a minimum threshold energy of 1.6 keV allow to access biological relevant K-edges such as S, Cl, K and Ca.

Do you need more than an image and want to explore the energy dimensions as well? Each pixel has a low-energy threshold and starts counting at energies above the selected threshold value. Special energy calibrations with freely configurable energy threshold patterns can be realized to obtain selectable pixel-wise and/or module-wise energy thresholds for advanced spectroscopy experiments.

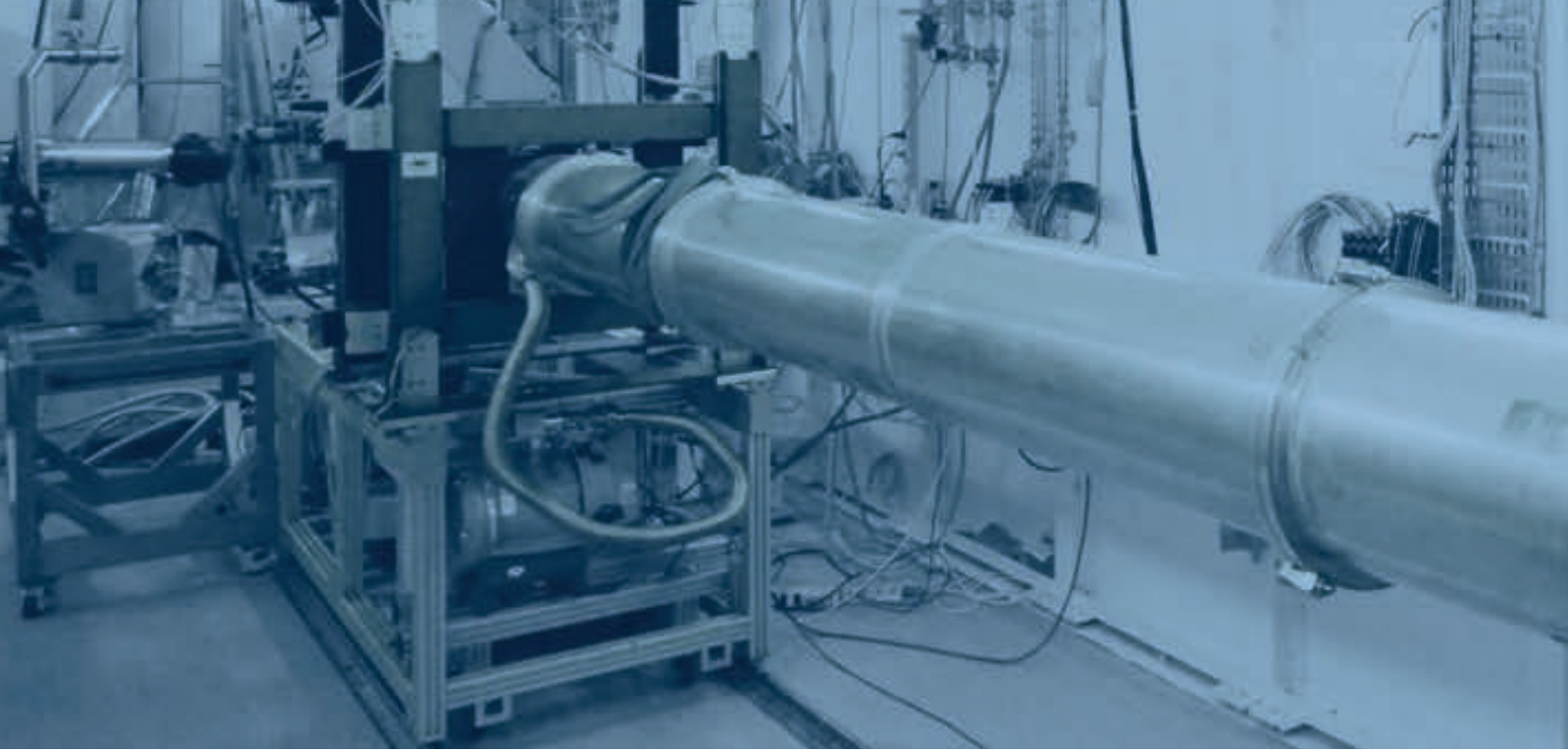


Grazing-Incidence SAXS pattern recorded with the in-vacuum PILATUS 1M detector at a photon energy of 1.75 keV.
Figure courtesy of Michael Krumrey, PTB.

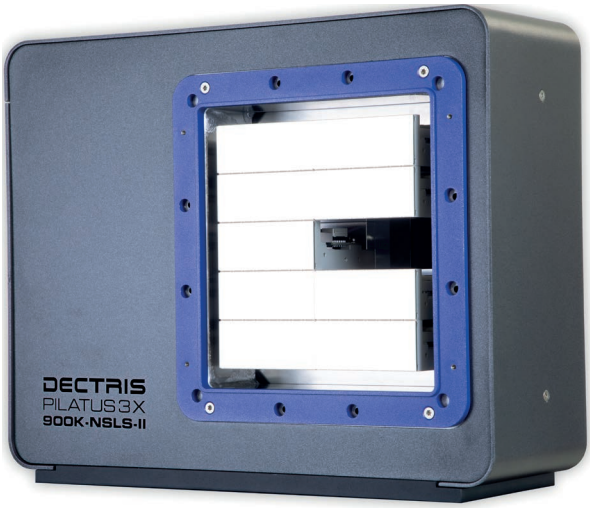
Key advantages

- No air scatter and absorption when the detector is operated in vacuum
- Highest possible data quality with windowless detector operation
- Measurements in the soft X-ray range with special low-energy calibrations
- Sensitive area optimally match your experiment and application
- Detectors can be built with custom geometries and vacuum chambers for smooth integration into your system
- Special energy calibrations for spectroscopy and spectroscopic imaging

„The in-vacuum PILATUS 1M detector has significantly improved our SAXS capabilities, especially for weakly scattering samples and for element-specific measurements at low energies."
Michael Krumrey, Physikalisch-Technische Bundesanstalt, Berlin (Germany)

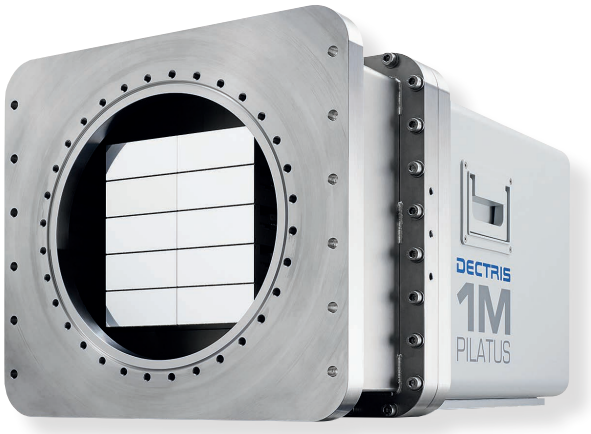


Examples of specific solutions



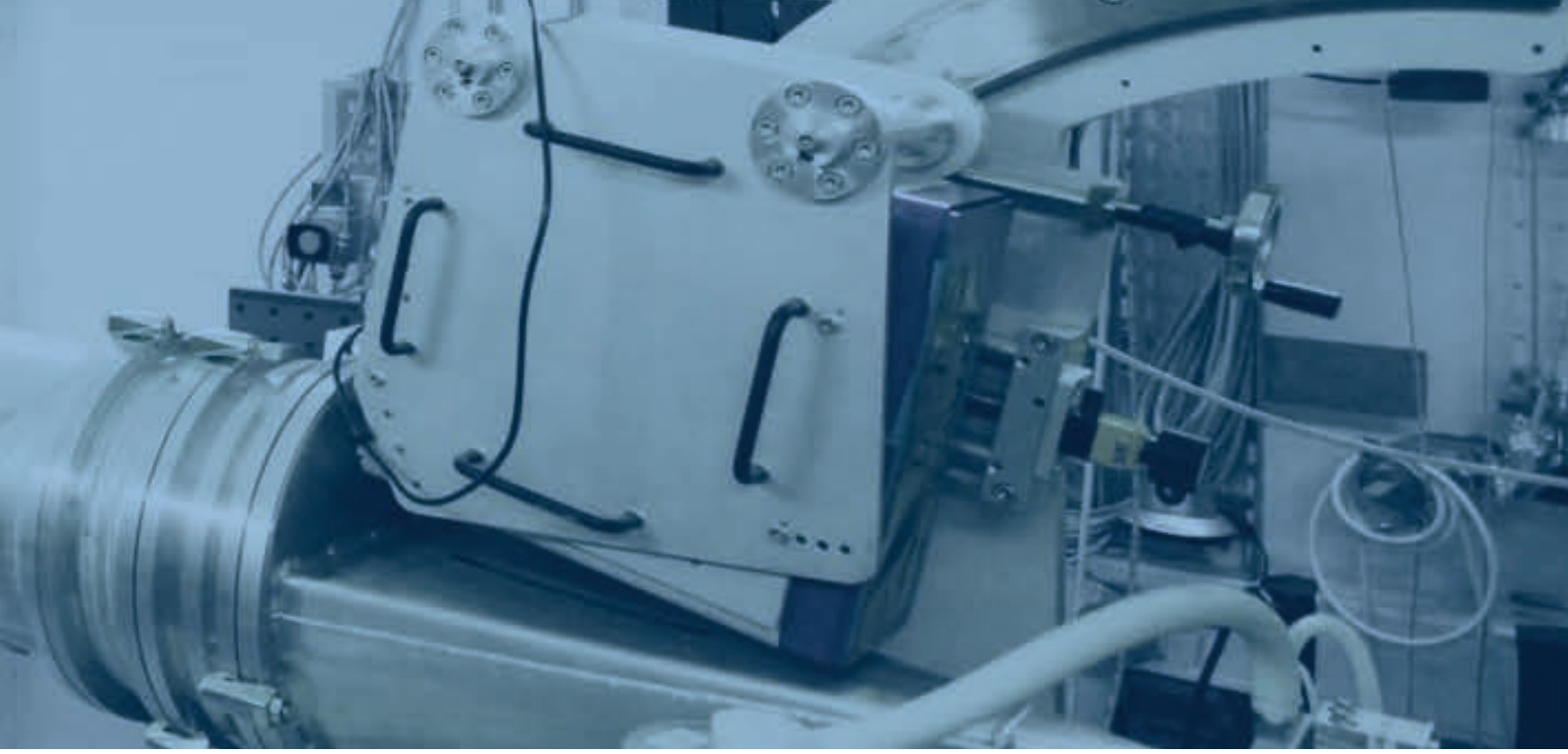
Customized WAXS detectors

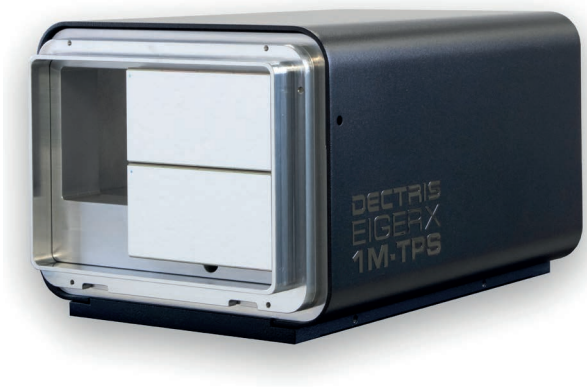
Dedicated geometries allow for the design of a perfect WAXS detector for simultaneous SAXS and WAXS measurement. Missing modules as in the PILATUS3 X 900K-NSLS II (National Synchrotron Light Source II, LiX) and the PILATUS3 X 2M-DLS-L (Diamond Light Source, I22), or ducts on the edge as in the EIGER X 1M-TPS (Taiwan Photon Source, 13A) and the PILATUS3 X 2M PETRA III (PETRAIII), will let the beam through for SAXS detection. The direct beam and small-angle scattering signal pass as close as 3 mm to the active area in a windowless vacuum detector and 5 mm in a detector with a Mylar window.



In-vacuum SAXS detector

DECTRIS has developed a vacuum-compatible version of most of its standard detectors. Complete detectors in vacuum, or remote detector heads used together with a detector electronics unit (DEU) in air, allow you to achieve the vacuum that you need for each experiment. A removable window option allows for complete prevention of parasitic scattering. The PILATUS3 100K-M detector has a very compact detector head design and a DEU in air, which allow you to reach 10^{-6} mbar easily with reasonable pumping power.



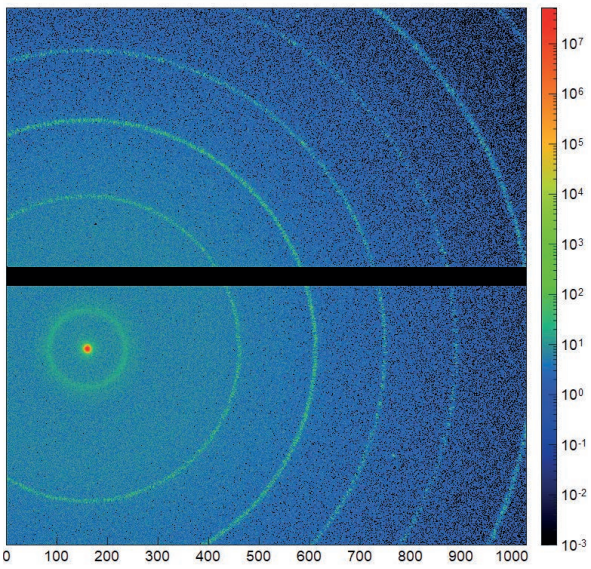


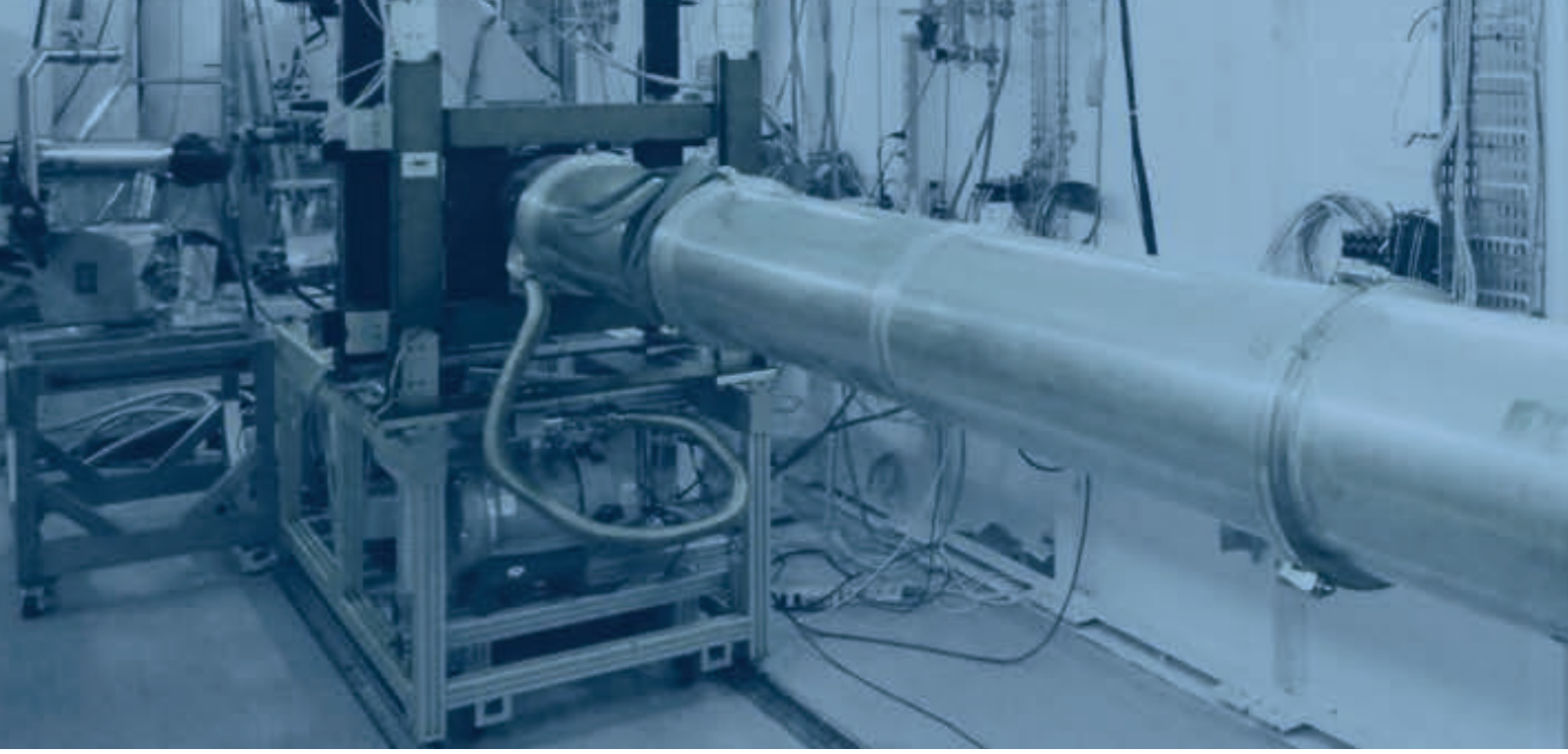
Lateral flight tube on WAXS detector

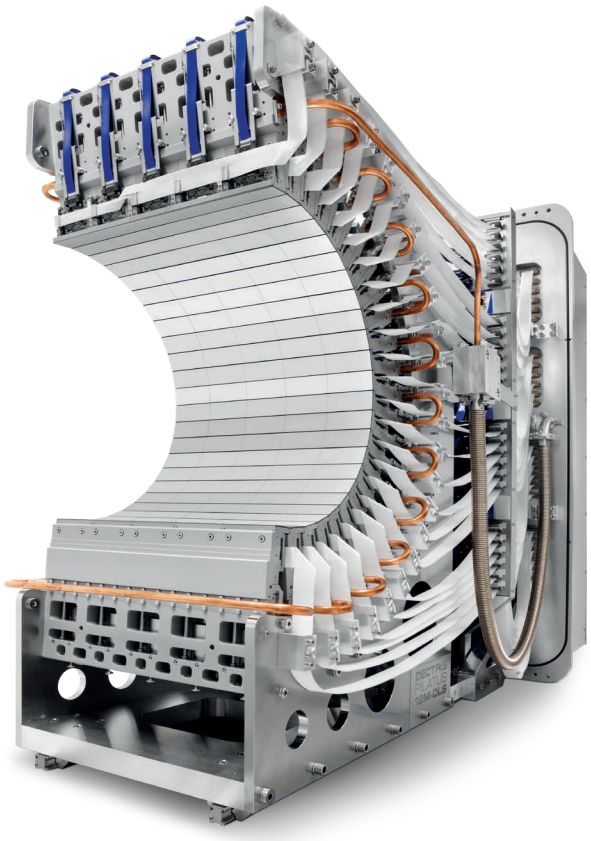
Dedicated geometries can also be based on the EIGER2 modules. Their 75 µm x 75 µm pixels enable high-resolution WAXS detection together with coverage of a large q-range. The removable window option and vacuum compatibility, when added to the flight tube of the EIGER X 1M-TPS, allow the straight beam to pass less than 3 mm from the active area to reach the SAXS detector upstream. The flight tube has been designed to fit the beamline geometry optimally. The upstream SAXS detector of this beamline is an EIGER X 9M specially adapted to vacuum, which extends the high resolution and large q-range to the SAXS regime.

EIGER2 R 1M without window, the ultimate WAXS detector

WAXS scattering of lanthanum hexaboride (LaB_6) measured in a Xeuss3.0 SAXS/WAXS instrument from Xenocs. Thanks to direct detection and a small pixel size, the sharp scattering rings are captured with high angular resolution. The large sensitive area of the EIGER2 R 1M enables the acquisition of multiple rings in a single image. Wide-angle scattering data acquisition benefits greatly from the unprecedented dynamic range of the EIGER2 series, that enables beamstopless operation in laboratory. This allows the direct beam intensity and the scattered signal to be measured by the same detector. The absence of a Mylar window prevents any parasitic scattering and enables sample scattering detection, down to very small angles.







Long-wavelength PX system

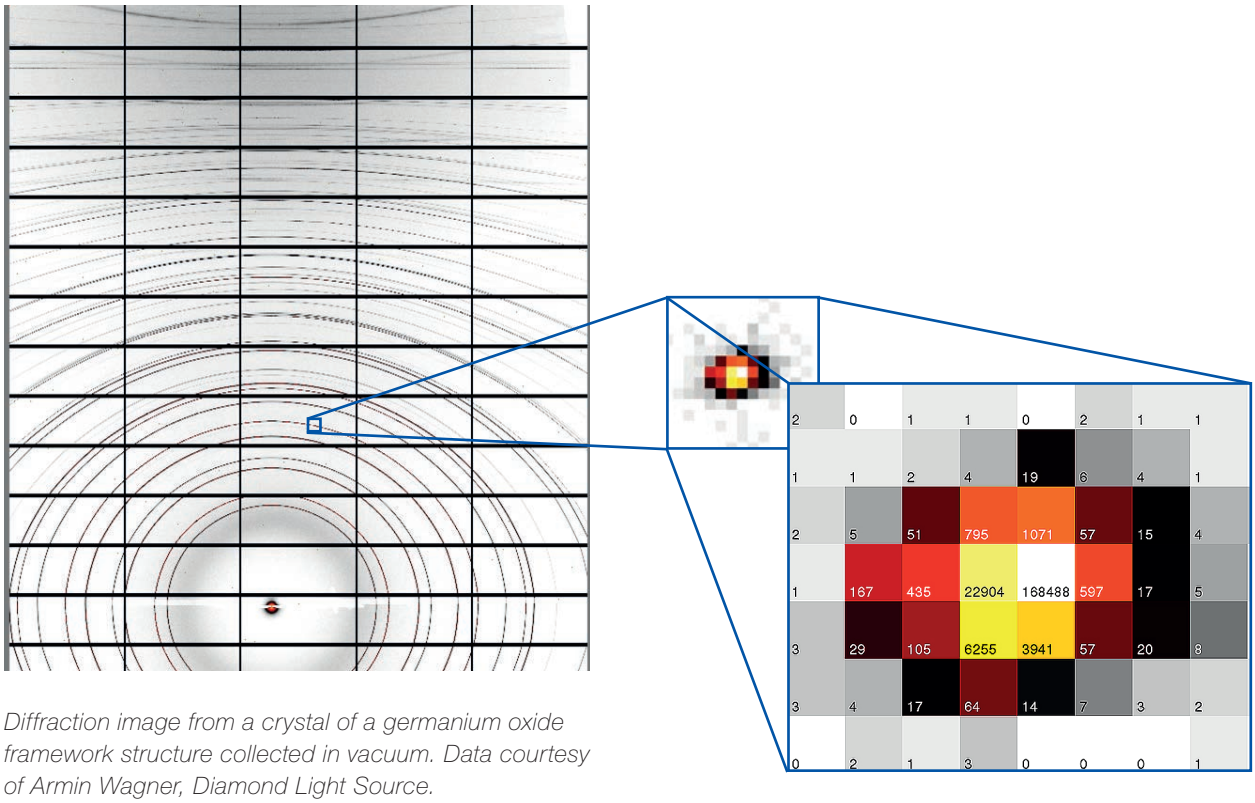
The use of long wavelengths for anomalous phasing has long been hampered by strong air absorption and large scattering angles, but a PILATUS 12M specific solution, built by DECTRIS in close collaboration with the I23 team of Diamond Light Source, successfully overcomes these limitations. Placing the sample and detector in vacuum eliminates air absorption and scattering. The semi-cylindrical shape of the detector covers a 2θ range of ± 100° and makes it possible to collect low- and high-resolution data simultaneously. [1], [2], [3]

The PILATUS 12M-DLS detector consists of 120 PILATUS detector modules mounted on a high-precision frame to form a semi-cylindrical shape. With an active area of 0.34 m^2, this is the largest PILATUS detector ever built. This iconic detector can detect X-rays with energies down to 2.3 keV, and it is vacuum-compatible down to a pressure of 10^{-6} mbar.

[1] A. Rozov *et al.* "Importance of Potassium Ions for Ribosome Structure and Function Revealed by Long-Wavelength X-Ray Diffraction." Nature Communications 10(1), 2519 (2019)

[2] P. S. Langan *et al.* "Anomalous X-Ray Diffraction Studies of Ion Transport in K+ Channels." Nature Communications 9(1), 4540 (2018).

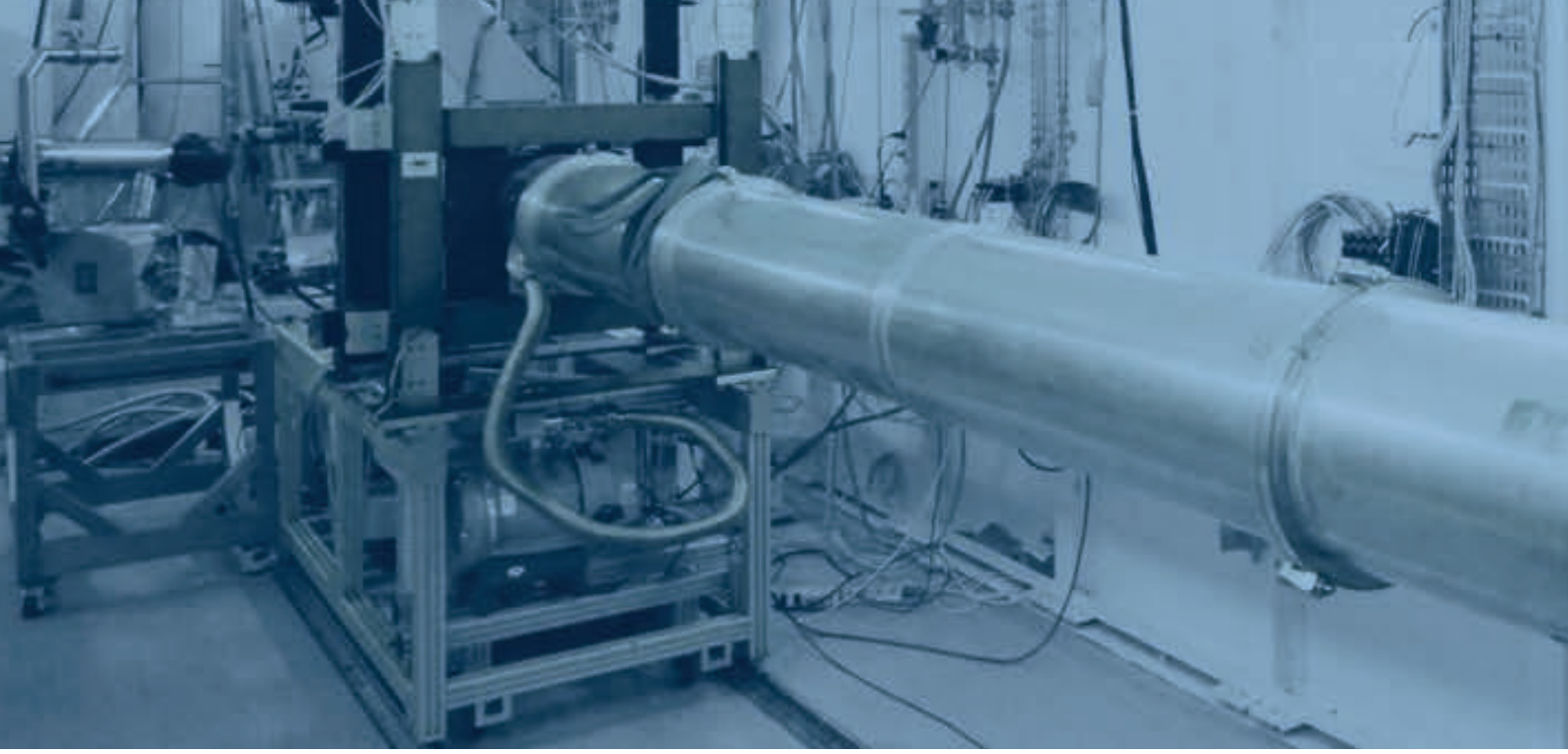
[3] H. P. Austin *et al.* "Characterization and Engineering of a Plastic-Degrading Aromatic Polyesterase." Proceedings of the National Academy of Sciences 115(19), E4350 (2018)

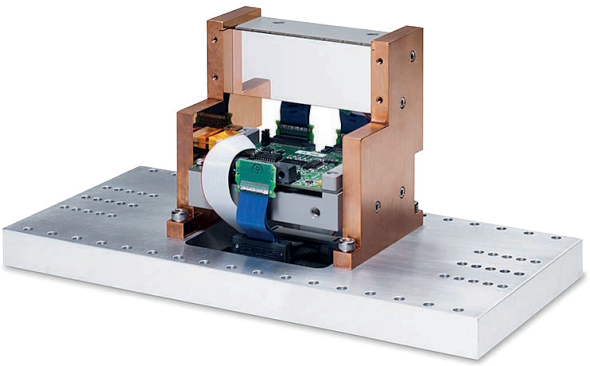


Diffraction image from a crystal of a germanium oxide framework structure collected in vacuum. Data courtesy of Armin Wagner, Diamond Light Source.

"Long-term experience with PILATUS detectors at DLS, their high data quality and huge scientific success, encouraged us to start the ambitious in-vacuum low-energy PILATUS 12M development project with DECTRIS. Most important for realizing a complex beamline project, DECTRIS proved to be a very competent and reliable partner and remained on schedule."

Armin Wagner, Diamond Light Source, Oxfordshire (UK)





In-vacuum PILATUS 100K detector for the inelastic X-ray-scattering spectrometer at SPring-8

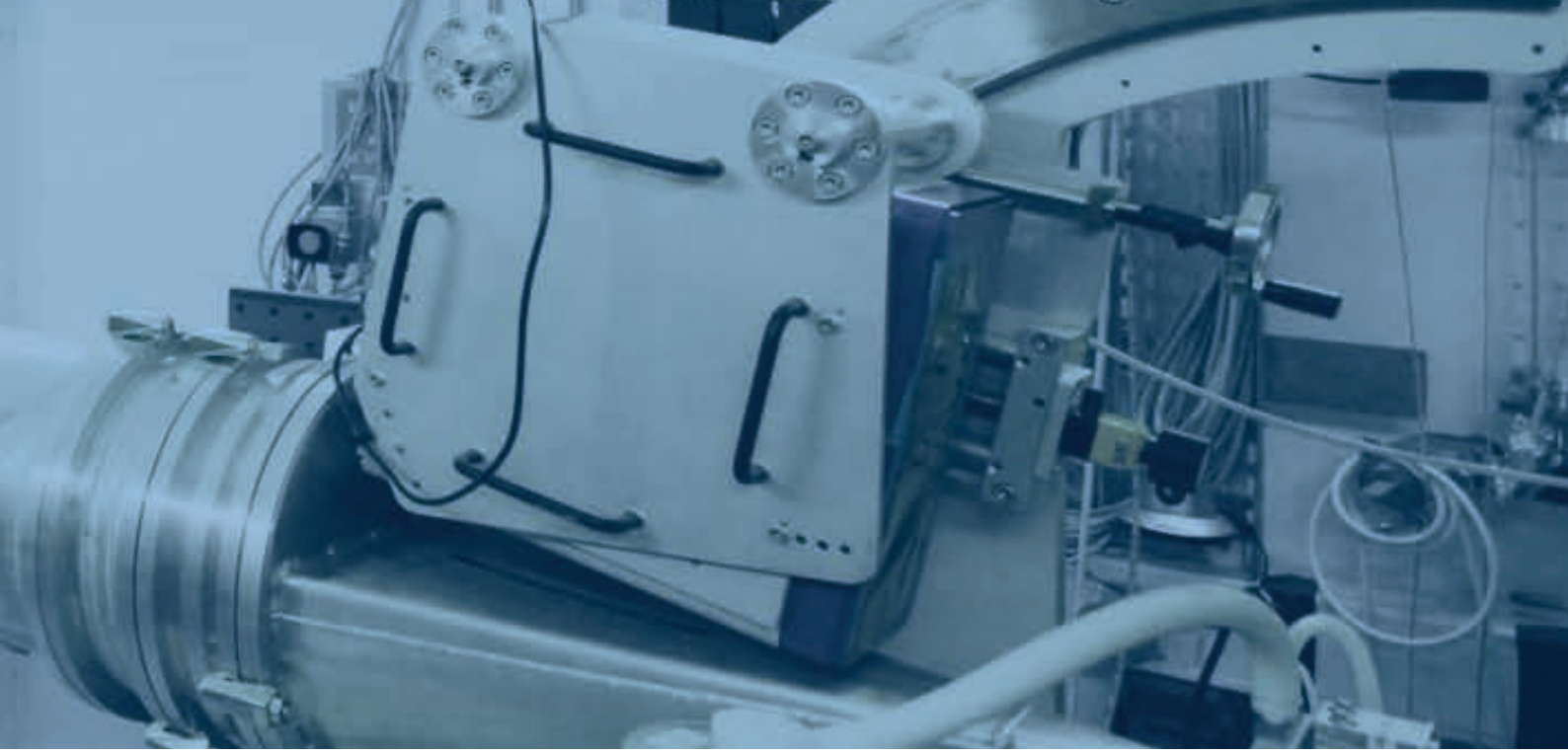
The PILATUS 100K module is split into two parts to meet the stringent space requirements for the in-vacuum experiment setup. Inelastic X-ray scattering is synonymous with extremely low signals. By shortening the standard module to 30 mm and making use of a 1000 µm silicon sensor, it is possible to simultaneously maximize the solid angle and the quantum efficiency at 16 keV photon energy for the SPring-8 BL43LXU medium-resolution spectrometer [1].

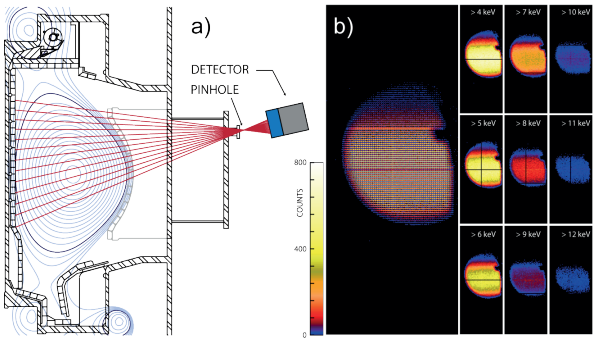
[1] A. Q. R. Baron "RIKEN Quantum NanoDynamics Beamline (BL43LXU): The Next Generation for Inelastic X-Ray Scattering." SPring-8 Information 15(1), 14 (2010)



EIGER X 1M-MAX IV

The EIGER X 1M-MAX IV is a highly compact design for the X-ray emission spectrometer SCANIA-2D at the Balder beamline at MAX IV. The detector consists of a short detector head, with all connectors on the side of the housing and also featuring a separate electronics box. This custom design makes the photon-counting detector compatible with the limited space that is available inside the spectrometer. It allows the Rowland circle below the beam to have its maximum radius, while leaving free space for *in-situ* environments above the beam. In addition, defined mounting points are placed on the housing; these hold fiducial markers for optical detection of the exact detector position in three dimensions.





„Our collaboration with DECTRIS led to significant improvements in the high-resolution X-ray spectroscopy of hot tokamak and stellarator plasmas. Thanks to the implementation of noise-free single photon counting detectors from DECTRIS in our X-ray imaging crystal spectrometers it is now possible to perform Doppler measurements of the ion temperature and plasma flow velocity profiles with much higher temporal and spatial resolutions than was previously feasible“

Manfred Bitter, Princeton Plasma Physics Laboratory, Princeton (USA)

Spectral X-ray imaging with pixel-wise energy calibration:

A special X-ray imaging camera based on the PILATUS3 100K has been built by the Princeton Plasma Physics Laboratory (PPPL) to image the intensity of different emission lines simultaneously [1].
DECTRIS assisted PPPL in setting up a special energy calibration, in which each pixel in a sub-array of 3 x 3 pixels can be set to a different threshold, e.g. as shown, between 4 keV and 12 keV in steps of 1 keV. This creates a combination of imaging and energy resolution that makes it possible to distinguish the emissions of different elements [2].

[1] N. A. Pablant et al. “Novel Energy Resolving X-Ray Pinhole Camera on Alcator C-Mod.” Review of Scientific Instruments 83(10), 10E526 (2012)
[2] L. F. Delgado-Aparicio et al. “Simulation, Design, and First Test of a Multi-Energy Soft x-Ray (SXR) Pinhole Camera in the Madison Symmetric Torus (MST).” Review of Scientific Instruments 89(10), 10G116 (2018)



In-vacuum detector for X-ray plasma spectroscopy

This PILATUS3 900K-IPP detector system was designed for the Institute of Plasma Physics (IPP) in Hefei, China. The detector head, comprising nine PILATUS3 modules, is part of a new X-ray imaging crystal spectrometer (XICS) for the detection of X-rays ranging from 3.1 keV (Ar emission) to 13 keV (Kr emission) for the EAST Tokamak. The fast readout time of only 0.95 ms and the high frame rate of 500 Hz, which are enabled by the PILATUS3 technology, provide real-time feedback for the experiment.



Technical specifications of the detector modules

Specific solutions can be based on PILATUS3, EIGER, MYTHEN and EIGER2 Hybrid Photon Counting detector modules.

	PILATUS3	EIGER2	MYTHEN
Detector type	pixel detector	pixel detector	strip detector
Pixel size/strip pitch [µm²]	172 × 172	75 × 75	50
Sensitive area (width × height) [mm²]	83.8 × 33.5	77.1 × 38.4	64 × 8
Number of pixels/strips per module	487 × 195	1,028 × 512	1,280
Maximum frame rate [Hz]	500	2,000	1,000
Readout time [ms]	0.95	continuous readout	0.089
Sensor options [µm]	Si: 450, 1,000 CdTe: 1,000	Si: 450 CdTe: 750	Si: 320, 450, 1,000
Lowest threshold energy (low-energy calibration) [keV] *X-ray energies down to 4 keV are available only with 320 µm x 4 mm sensors	Si: 2.3 (1.6) CdTe: 8 (6)	~ 2.7	6 (4.5*)

All specifications are subject to change without notice.

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