Application example:
Conventional and coherent imaging

The LAMBDA pixel detector is designed for high-end X-ray experiments, particularly at synchrotron sources. It achieves an extremely high image quality by combining effectively noise-free photon-counting operation with a small pixel size of 55 µm. For fast and time-resolved experiments, LAMBDA can be read out at up to 2000 frames per second with no time gap between images. But speed and resolution are not the only thing LAMBDA excels at, you can find a more information at www.x-spectrum.de . Or contact us anytime at info@x-spectrum.de

Key features:

- **Effectively zero noise (photon counting)**
- **55 µm pixel size**
- **Up to 2000 frames per second**
- **Deadtime-free readout**
- **up to 1536 by 1536 pixels (85 x 85 mm²)**
- **Energy binning capability**

Every version of the LAMBDA pixel detector is available with different sensor layers for different X-ray energy ranges. For hard X-ray detection, the GaAs and CdTe LAMBDA systems replace the standard silicon sensor layer in LAMBDA with a “high-Z” (high atomic number) sensor. This provides high quantum efficiency at high X-ray energies (75% at 40 keV for GaAs, and 75% at 80keV for CdTe), while retaining single-photon-counting performance and our high frame rate of up to 2 kHz. Upon request we also provide LAMBDA versions that can be operated in vacuum.

Comparison of different LAMBDA sizes; a 750K single module of 1528 x 512 pixels and a 2M system with three-module system and 1528 x 1536 pixels.

Ever since the first prototypes of the LAMBDA camera have been developed it has been used in different applications. The following example has been chosen to demonstrate the capabilities of the system. LAMBDA has already found its way into routine operation at a few light sources, so the following example highlight only a fraction of the many possible ways LAMBDA cameras can be used.

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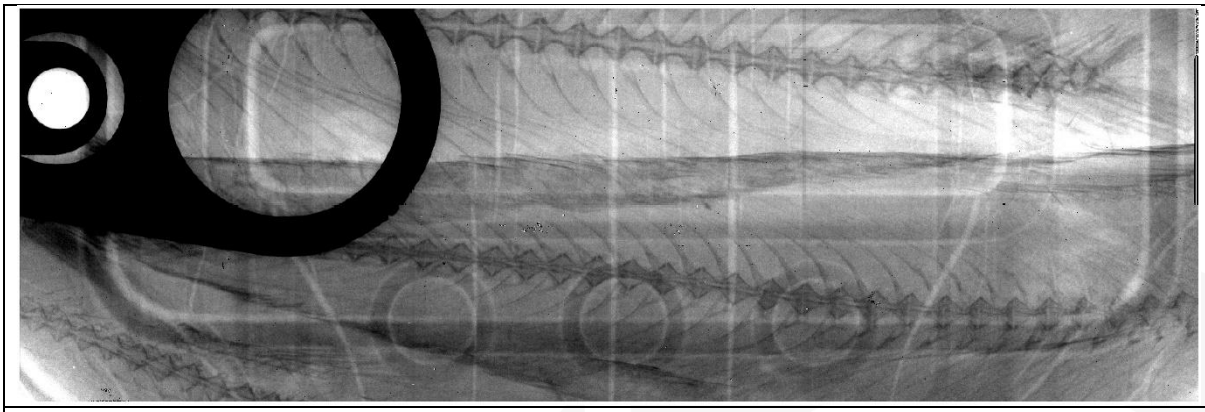
Conventional and coherent imaging

One of the most classic applications of an X-ray detector is imaging an object in transmission geometry. In this example a tin of sardines was place in front of the detector and illuminated by an X-ray tube more than a metre away. The resulting radiograph is shown in the figure below, and it reveals both the structure of the can (e.g., scratches are seen as white vertical stripes) and the fine fish bones of the sardines with a very high resolution [1].



An X-ray image of a sardine can, taken with a LAMBDA 750K camera with silicon sensor. The vertical white stripes are caused by scratches on the back of the tin [1].

This example was one of the first demonstrations of the capability of the camera. It shows the high spatial resolution and sensitivity of the system. There are no gaps in the image; all photons that are interacting in the sensor are counted.

At synchrotron beamlines, objects can be imaged with higher spatial resolution using a range of “coherent imaging” techniques which take advantage of X-ray diffraction, rather than just transmission. One common approach is ptychography. In this technique, a finely-focused beam (hundreds of nm in size) is raster scanned across a sample. At each point in the scan, a diffraction pattern is recorded by the detector. The step size is chosen so that overlapping regions are illuminated during the scan. From this diffraction data, it is possible to reconstruct an image of the sample on length scales significantly smaller than the beam (down to 10 nm). One particular appeal of this approach is that it can be combined with a range of other synchrotron techniques; for example, by measuring fluorescence emitted from the sample during the scan, it is possible both to image the sample and map its elemental composition. For these experiments, a detector with high sensitivity, high speed and good spatial resolution is required, to perform the scan in a reasonable length of time. LAMBDA has been used in ptychography experiments to obtain images with a spatial resolution of around 20 nm [2].

[1] Pennicard, D. et al., "LAMBDA — Large Area Medipix3-Based Detector Array", Journal of Instrumentation 7 (2012), C11009.

[2] Wilke, R. N., et al. "High-flux ptychographic imaging using the new 55 µm-pixel detector ‘Lambda’ based on the Medipix3 readout chip." Acta Crystallographica Section A: Foundations and Advances 70.6 (2014): 552-562.