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LAMBDA 2M GaAs – A multi-megapixel hard X-ray detector for synchrotrons

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Synchrotrons provide very intense and focused X-ray beams, which can be used to study the structure of matter down to the atomic scale. In many experiments, the quality of the results depends strongly on detector performance; in particular, experiments studying changes in samples over time require fast, sensitive X-ray detectors.

"LAMBDA" is a photon-counting hybrid pixel detector system for synchrotron experiments, based on the Medipix3 readout chip. Its main features are a combination of relatively small pixel size (55µm), high readout speed at 2000 frames per second with no time gap between images, a large tileable module design, and compatibility with high-Z sensors for efficient detection of higher X-ray energies.

A large LAMBDA system for hard X-ray detection has been built using Cr-compensated GaAs as a sensor material. The system is composed of 6 GaAs tiles, each of 768 by 512 pixels, giving a system with approximately 2 megapixels and an area of 8.5 by 8.5 cm^2. While the sensor uniformity of GaAs is not as good as that of silicon, its behaviour is stable over time, and it is possible to correct nonuniformities effectively by postprocessing of images. By using multiple 10 Gigabit Ethernet data links, the system can still be read out at the full speed of 2000 frames per second.

The system has been used in hard X-ray experiments studying the atomic-scale structure of samples under extreme pressure in diamond anvil cells. These experiments can provide insight into geological processes. Thanks to the combination of high speed readout, large area and high sensitivity to hard X-rays, it is possible to obtain useful information about atomic-scale structure on a millisecond timescale during rapid changes of pressure or temperature.

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