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An Ultra-fast Linear Array Detector for MHz Line Repetition Rate Spectroscopy

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We developed an ultra-fast linear detector with a frame rate of up to 10^6 frames per second (fps) in order to improve the acquisition rate and the resolution of Electro-Optical Spectral Decoding (EOSD) setups currently installed at several light sources (ANKA, European XFEL, TELBE).
The system consists of a detector board, an FPGA readout board and a high-throughput data link. The detector board mounts a single linear array sensor with 256 pixels and a 50 μm pitch. InGaAs or Si sensors are used to detect near-infrared (NIR) or visible light. The GOTTHARD chip, developed at PSI, is used as charge-sensitive preamplifier. Four analog outputs, each one connected to 32 pixels through an analog multiplexer, operate at a maximum switching frequency of 33 MHz, resulting in a maximum frame rate of 10^6 fps.
The analog outputs are digitized by a multi-channel ADC with 14 bits resolution. The data acquisition, the operation of the detector board and its synchronization with synchrotron machines are handled by the FPGA. The readout architecture is based on a PCI-Express high-throughput data link which allows continuous data acquisition at 450 MB/s when operating at a frame rate of 1 Mfps. The system is completed with a real-time data analysis module based on Graphics Processing Units (GPU) systems. We present the experimental measurements taken with a NIR laser operating at a repetition rate of 900 kHz, as well as the current performance in terms of frame rate and noise figures.

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