Contribution ID: **154** Type: **Poster**

KALYPSO: a 1D Detector for High-Repetition Rate Experiments at Light Sources

Wednesday 13 September 2017 17:00 (15 minutes)

KALYPSO is a 1D imaging detector with 10 MHz frame-rate developed for high repetition-rate experiments, such as electro-optical beam profile measurements with sub-ps resolution at ANKA and Eu-XFEL. KALYPSO consists of a Si or InGaAs microstrip sensor coupled to a front-end readout, integrated with an FPGA readout card. A Low Gain Avalanche Diode (LGAD) sensor is being developed to improve the time resolution. A DAQ framework transmits data to external GPU-based clusters, where data is processed in real-time at 7 Gbytes/s and a latency in the order of a few µs. We describe the system and the experimental results.

Summary

We present KALYPSO (KArlsruhe Linear arraY detector for MHz-rePetition rate SpectrOscopy), a 1D detector with a maximum frame-rate of 10 MHz. The detector has been developed to enable shot-to-shot beam profile measurement at different accelerators operating at MHz repetition rates (i.e., 4.5 MHz at European XFEL, 10 MHz at TELBE, 2.7 MHz at ANKA in single-bunch mode). In particular, Electro-Optical Spectral Decoding (EOSD) setups use a near-IR pulsed laser to probe the beam profile with sub-ps resolution.

The main characteristic of KALYPSO with respect to other detectors is the possibility to achieve MHz repetition rates while operating in full streaming mode: data are continuously acquired and processed with minimum latency, as required in real-time beam monitors and fast-feedback systems for beam correction. KALYPSO consists of a detector board and an FPGA-based readout card.

The detector board mounts a microstrip sensor, the front-end readout ASIC and a commercial Analog-to-Digital Converter (ADC). Depending on the demanding application, the sensor is a Si or an InGaAs linear array, with 256 pixels and a pitch of 50 µm, to detect radiation in the visible and near-infrared spectrum. In parallel with the development of the system, two custom microstrip sensors are being designed: one on a 300 µm Si substrate with 25 µm pitch, and the second in Low Gain Avalanche Diodes (LGADs) technology with 50 µm thickness and 50 µm pitch.

Because of their fast charge collection time, the internal gain mechanism and the possibility to produce highly segmented detectors, LGADs are attractive for future beam diagnostic detectors at synchrotron facilities, where low-intensity light pulses are produced with extremely high repetition rates (500 MHz at ANKA in multi-bunch mode).

The sensor is connected to the readout ASIC with high-density gold ball-to-wedge wire-bonds. A dedicated readout front-end chip is used as front-end amplifier. The analog outputs are digitized by a commercial ADC at 125 MS/s and 14 bits resolution. The detector card is connected to the back-end card through an industry-standard FMC connector.

The readout card is based on a Xilinx Virtex7 FPGA and controls detector operation. Real-time data processing can be performed both on the FPGA and on Graphical Processing Units (GPUs). To enable high system performance, a direct FPGA-GPU communication has been developed based on a custom PCI-Express 3.0 Direct Memory Access engine, with a throughput of more than 7GB/s and latencies below 2 µs. The first version of KALYPSO are in operation at the EOSD experimental setups at ANKA and Eu-XFEL. The commissioning at other facilities (DELTA, TELBE, SOLEIL) is planned for late 2017.

In this contribution, we describe the KALYPSO system and its applications, together with the ongoing de-

velopment activities, namely the integration of the custom sensor based on LGADs. An overview of the experimental results obtained with KALYPSO will be also shown.

Authors: ROTA, Lorenzo (KIT); CASELLE, Michele (Karlsruhe Institute of Technology)

Co-authors: WEBER, Marc (KIT - Karlsruhe Institute of Technology (DE)); BALZER, Matthias Norbert (KIT - Karlsruhe Institute of Technology (DE)); PATIL, Meghana (Karlsruhe Institute of Technology); KOPMANN, Andreas (KIT); MOZZANICA, Aldo (PSI - Paul Scherrer Institut)

Presenter: ROTA, Lorenzo (KIT)

Session Classification: POSTER Session

Track Classification: Systems, Planning, Installation, Commissioning and Running Experience