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The Adaptive Gain Integrating Pixel Detector for fast experiments at the European XFEL

Monday 25 June 2018 16:00 (1 hour)

Adaptive Gain Integrating Pixel Detector (AGIPD) is designed in a collaboration between Deutsches Elektronen-Synchrotron (DESY), Paul-Scherrer-Institut (PSI) and the Universities of Hamburg and Bonn. It is a hybrid pixel X-ray detector developed for the new cutting-edge science experiments at the European XFEL, whose key features are the high brilliance coherent pulses with a specific bunch structure [1]. The detector should be able to capture multiple images at a 4.5 MHz burst mode frame rate with a dynamic range from 1 to 10⁴ 12.5 keV photons. In order to fulfill the mentioned requirements an Application Specific Integrated Circuit (ASIC) was designed [2]. The ASIC has 64x64=4096 pixels in total, each containing an analogue signal pipeline, driven by the digital periphery block. The input interface are three CML signals and the output are 4 analog differential lines.

<p>A hybrid of front-end module, consisting of a silicon sensor bump-bonded to 16 ASICs, contains 128x512 pixels, 200x200 μm² each, and is served by back-end electronics including external ADC and FPGA boards. The 1M pixel detector incorporates four quadrants of 4 modules each, operating in vacuum. The output of the detector via 16x10G optical links makes the data handling a challenge. Behind the successful start of operation of Eu-XFEL in the September 2017 there were a lot of efforts for different parts involved. From the detector side it was a big challenge for both Eu-XFEL and DESY teams to commission the AGIPD at the SPB instrument in a very short time before the first experiments started, although some precision work is still ongoing. The commissioning itself included mechanical, electrical and infrastructure integration of AGIPD into the Eu-XFEL, low level tuning and optimization of the detector operation for a given beam structure. A big task is also to perform an on-a-beamline calibration of the detector including the processing of Terabytes of calibration data to enable the correction of scientific data. It is particularly difficult to calibrate the detector in the Eu-XFEL-specific run mode and to estimate the precision of data post-correction. <p>One system was installed and commissioned (see Figure 1 for an example of commissioning activity) at the SPB experimental station of the European XFEL. A second 1M system is ready for the delivery to the MID station. A 4M version for the SFX experimental station is now in development, some of the system's building blocks are already under test. Assembly, commissioning and applied calibration efforts will be presented.

<p>References:

<p>[1] M. Altarelli et al., European X-ray Free Electron Laser. Technical design report, (2006) [ISBN:978-3-935702-17-1]. <p>[2] A. Klyuev et al., Front end ASIC for AGIPD, a high dynamic range fast detector for the European XFEL. Journal of Instrumentation 11 ·January 2016. DOI: 10.1088/1748- 0221/11/01/C01057

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