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### A new AGIPD detector generation

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The Adaptive Gain Integrating Pixel Detector (AGIPD), a megahertz frame-rate, high-dynamic range integrating pixel detector, was developed for photon science experiments at the European X-Ray Free Electron Laser (European XFEL) and tailored to its unique specifications. Two 1-Megapixel AGIPD detector systems have been installed at the European XFEL and are producing numerous scientific publications. In order to further improve the existing systems, and to provide dedicated systems for two user consortia, we have been developing the next generation of hardware. These developments will also reach out into entirely new areas.

Two new generation of ASICs have been developed. AGIPD1.2 corrects a problem with the gain encoding in AGIPD1.1, which made it difficult or impossible to distinguish whether a pixel was in medium or low gain, effectively reducing the useful dynamic range of the system. The improved gain bit encoding was tested and verified in a test beam experiment at the HED scientific instrument at the European XFEL in November 2020. The other generation, AGIPD1.3, is an electron collecting version of the ASIC, needed for readout of high-Z sensor materials such as Gallium-Arsenide (GaAs), Cadmium-Telluride (CdTe), or Cadmium-Zinc-Telluride (CdZnTe). Such sensors are needed to provide higher absorption efficiencies for photon energies in the range from 15-30 keV, which are demanded by a number of user communities.

On the backend, new, more compact, read-out electronics have been developed most notably including a new FPGA, firmware, and all-optical communication with new multifibre Gbit transceivers.

A 0.5-Megapixel prototype system, using the new readout electronics, firmware and AGIPD1.2 ASIC has been built, commissioned and operated in user experiments at the HED instrument in 2020 (see figure). This system provided the first Megahertz diffraction capabilities for HED science at the European XFEL.

This new generation of AGIPD will be used to build two new detector systems. A 4-Megapixel system for the SFX user consortium at the SPB/SFX station, and a 1-Megapixel system with high-Z sensors for the HED instrument at the European XFEL. In addition, also the existing AGIPD detectors at SPB and MID will be equipped with new front-end modules containing AGIPD1.2.

In this talk we will present and discuss the current status of all AGIPD developments on the front-end and read-out electronics and show results from the data of the Second Generation prototype AGIPD system at HED.

**Authors:** LAURUS, Torsten (Deutsches Elektronen-Synchrotron DESY); DELFS, Annette (DESY); FRIDMAN, Sergei (DESY); GRAAFSMA, heinz (DESY); HIRSEMANN, Helmut (DESY); KLYUEV, Alexander (Deutsches Elektronen-Synchrotron); LANGE, Sabine (Desy); SCHNEIDER, Sandra (DESY); SHEFER SHALEV, Ofir (DESY); SMOLJANIN, Sergej (DESY); STERN, Stephan (DESY); STOYE, Thorsten (DESY); TRUNK, Ulrich (DESY)

**Presenter:** LAURUS, Torsten (Deutsches Elektronen-Synchrotron DESY)

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