# The new AGIPD detector generation

#### 22<sup>nd</sup> iWoRID

Torsten Laurus Photon Science - Detector Group (FS-DS)

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### AGIPD

#### **Adaptive Gain Integrating Pixel Detector**

- Burst mode 352 images at 4.5 MHz (6.5 MHz max)
- Single photon sensitivity at 7 keV
- 10<sup>4</sup> ph/pixel/image dynamic range (at 12.4 keV)
- Noise below Poisson statistics
- 200 x 200 micron<sup>2</sup> pixels
- 64 x 64 pixels per ASIC
- 2 x 8 ASICs per module







### **Operational AGIPD Systems at EuXFEL**

#### **1MPix Systems at SPB and MID**





### **AGIPD Systems in Development**

#### **New Electronics**



### **AGIPD Systems in Development**

#### **Mini-Half Prototype System**





- 8 Readout Boards, 8 front-end modules = 500kpix
- 4x AGIPD1.1, 4x AGIPD 1.2 FEMs
- 1 Receiver Board without interlock functionality, link to EuXFEL Clock&Control
- Operated in air, water cooled



### **Commissioning at HED instrument at EuXFEL**

### Objectives

- Integration into EuXFEL's controls
  environment
- Commissioning together with HED/HIBEF's dynamic DAC and pulsed laser setup
- Characterization of new readout electronics and AGIPD 1.2 ASICs

#### Procedure

- Assembly and testing at CFEL lab
- Commissioning at EuXFEL's detector laboratory without beam
- Commissioning beamtime at HED instrument in Nov 2020

### First light on AGIPD Mini-Half – $LaB_6$ at 17.8keV



### AGIPD 1.2

### ASIC for improved gain encoding

- Each pixel encodes the used gain analogue in a storage cell matrix
- AGIPD 1.1: During readout, the analogue level of the low gain drops, making the two gains indistinguishable





### **AGIPD 1.2**

### ASIC for improved gain encoding



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### **AGIPD 1.2**

#### ASIC for improved gain encoding

Gradient towards ASIC periphery



#### Strong temperature dependency



## **Gain Switching Transition Region**

Late gain switching leads to incorrect intensities









- Late gain switching leads to incorrect intensities
- Longer Integration time is expected to reduce probability

### **Integration Time**

### Impact on late gain switching

Waterjet data taken with SPB 1M AGIPD system



Figures courtesy of J. Sztuk-Dambietz (EuXFEL)

Reduction by two orders of magnitude

### **Single-Train MHz-pulse-resolved diffraction**

#### X-ray (and laser-) heated Platinum in diamond-anvil cells



intra-train thermal peak shift and melting

### **Electron-collecting (ec)AGIPD for High-Z Sensors**

#### ecAGIPD

- High-Z sensors (e.g., GaAs, CdTe, CZT) needed for photon energies ≥15 keV
- High-Z sensors need electron-collecting ASIC

#### AGIPD 0.6

AGIPD1.3

16 x 16 pixel ecAGIPD prototype, works

Full-scale (64 x 64 pixel) ecAGIPD **Design complete, ready for tape-out** 

Procurement via CERN ongoing

Input to AGIPD 1.3 design



#### X-ray energy (keV)





High-Z test sensors with (hole-collecting) AGIPD 1.1 ASICS on FEM





### **Electron-collecting (ec)AGIPD for High-Z Sensors**

#### AGIPD 0.6 with a GaAs sensor



- Ag  $K_{\alpha}$  fluorescence
- Sensor temperature: 50-70°C
- ENC =  $294e^-$  (after correction) corresponds well to simulation results

### **Summary**

- AGIPD Mini-Half successfully integrated into EuXFEL's control and DAQ system
- Characterization
  - AGIPD 1.2 shows a significantly improved gain level encoding
  - Late gain switching can be significantly reduced by increasing the integration time.
- First scientific experiments with HED/HIBEF's dynamic DAC and pulsed laser setup performed
- ecAGIPD ready for tape-out



