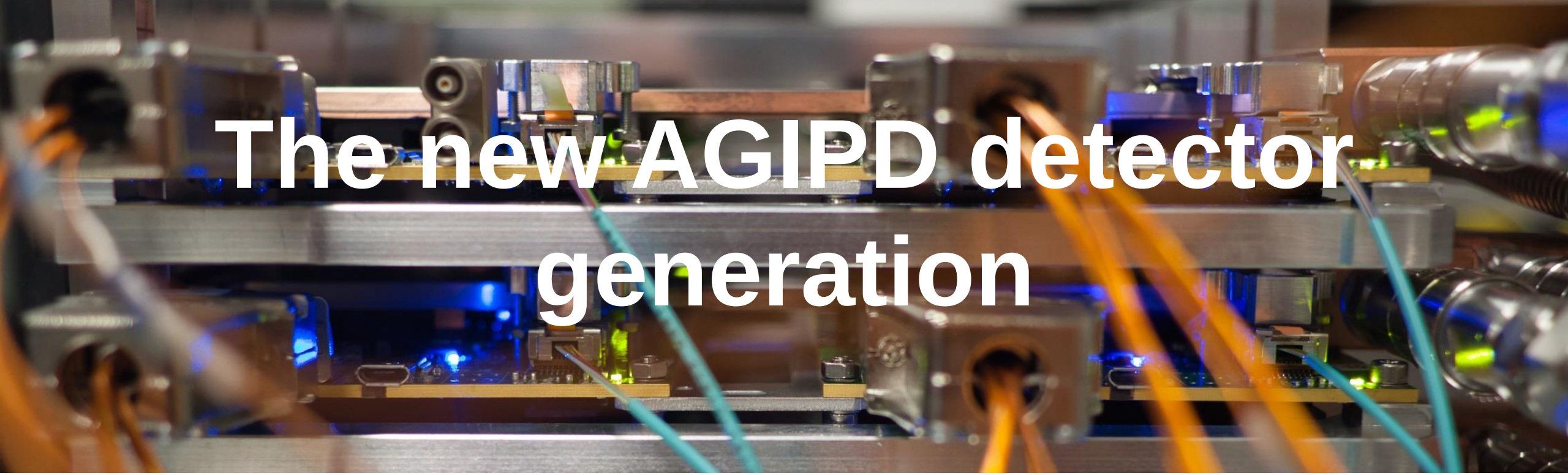


The new AGIPD detector generation

IFDEPS-2021 Virtual Thursdays

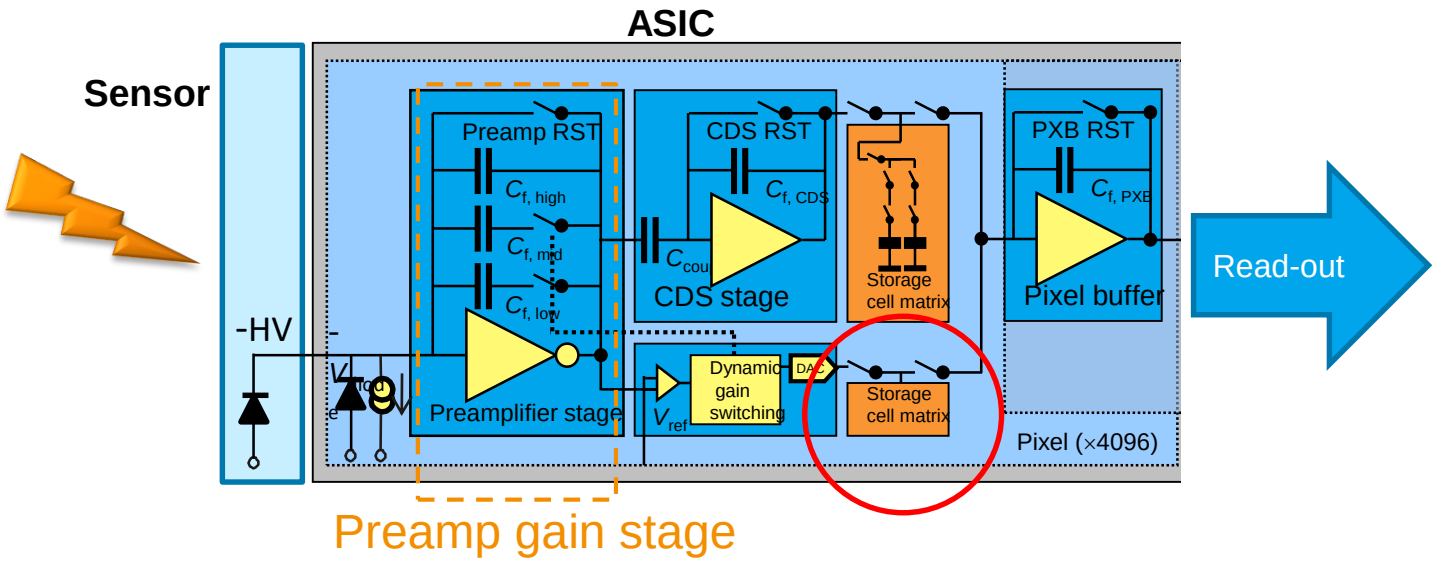
Stephan Stern
Photon Science - Detector Group (FS-DS)

April 1, 2021

HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

DESY.

New ASIC: AGIPD1.2



AGIPD general

- AGIPD adaptive gain (3 stages) requires saving analogue image and the info in which gain stage it was taken (in AGIPD, gain also encoded in analogue way, 3 levels)
- 2 datasets per image: analogue and gain-stage info (high- (H) , medium- (M), or low (L) gain stage)

AGIPD 1.1

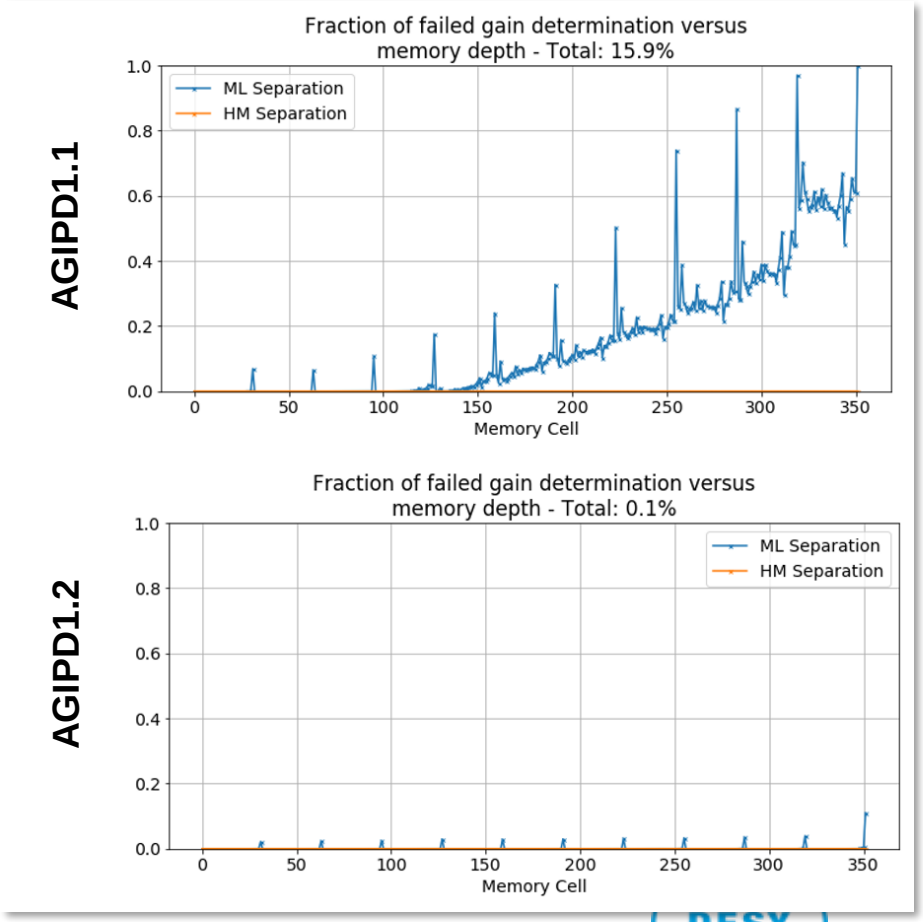
- insufficient separation of medium (M) and low-gain (L) level information at cells which are read-out later

AGIPD 1.2

- New ASIC **AGIPD1.2** to fix gain-bit encoding of 3rd gain stage (low gain) in order to increase effective dynamic range

AGIPD1.2 vs. 1.1

- Huge improvement in gain bit encoding of low-gain (L) with AGIPD1.2 over 1.1



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

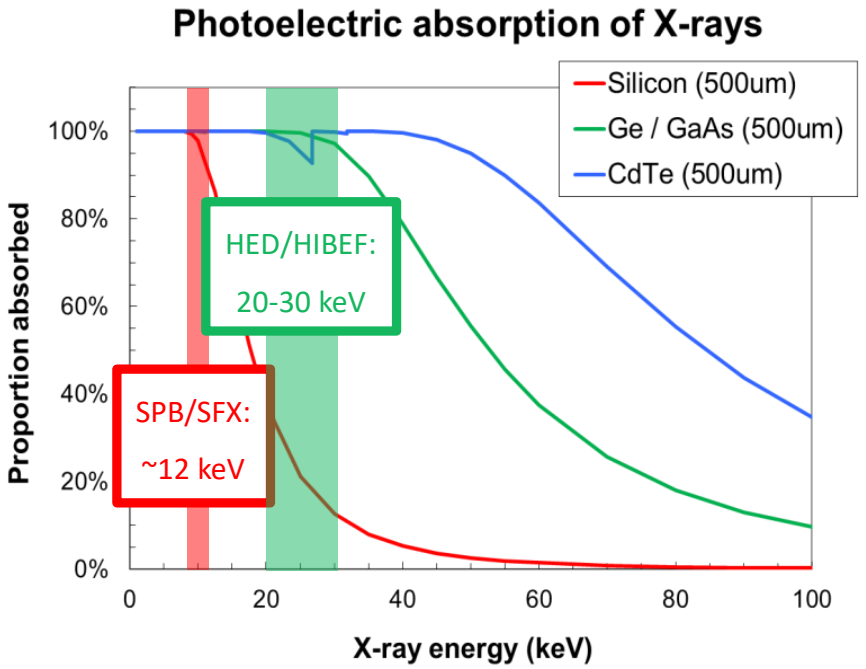
- 16 x 16 pixel ecAGIPD prototype, works
- Input to AGIPD 1.3 design

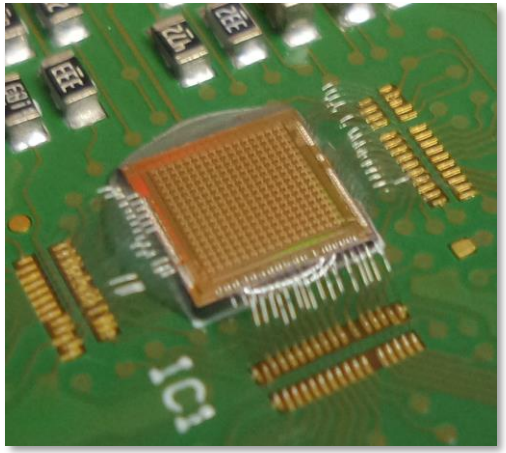
AGIPD1.3

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

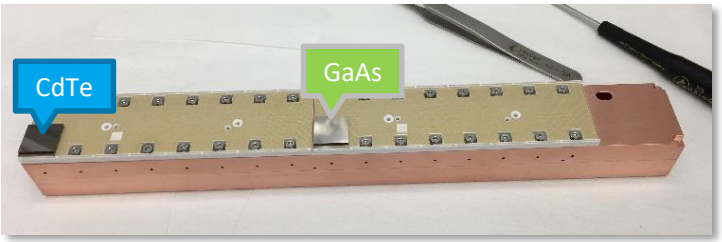
Currently remaining tasks:

- measurements with AGIPD 0.6/GaAs sensor assembly
- Contract/procurement via CERN

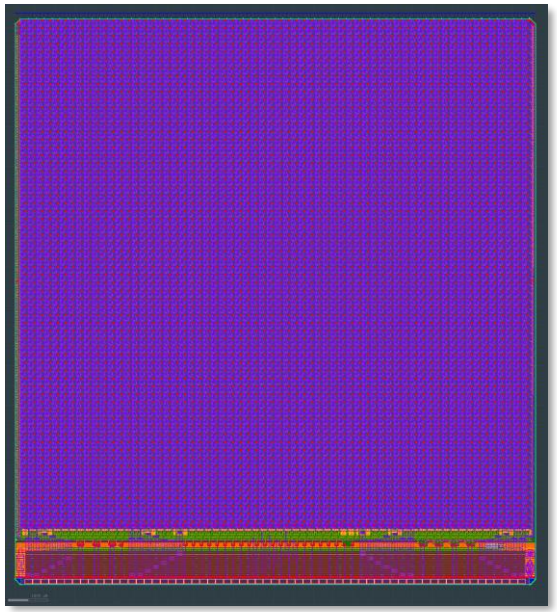




AGIPD 0.6

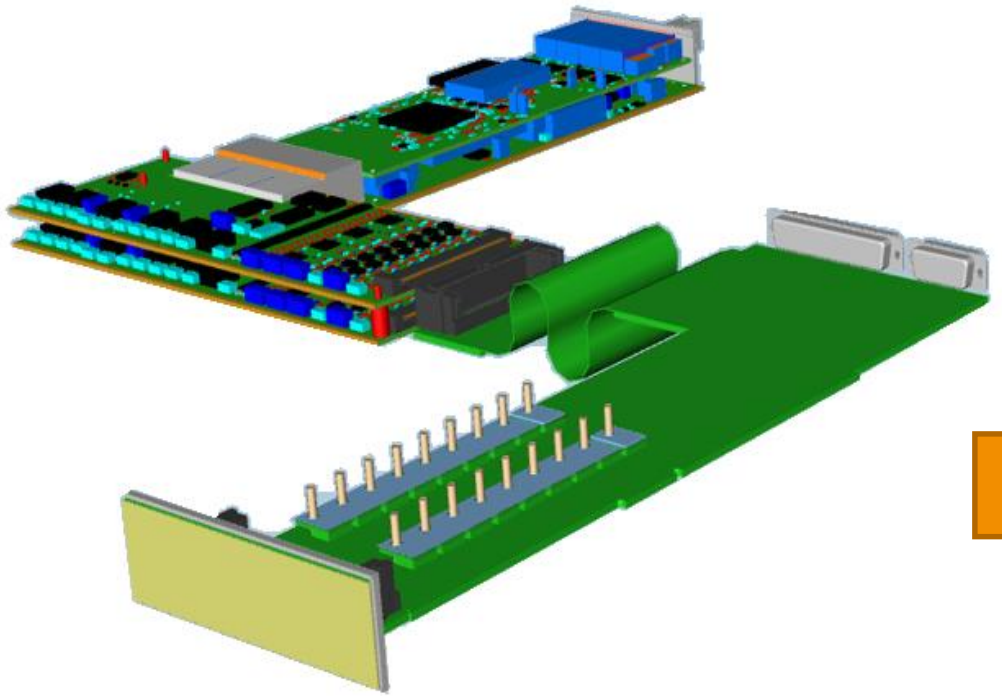


High-Z test sensors with (hole-collecting) AGIPD 1.1 ASICS on FEM



AGIPD 1.3

New electronics

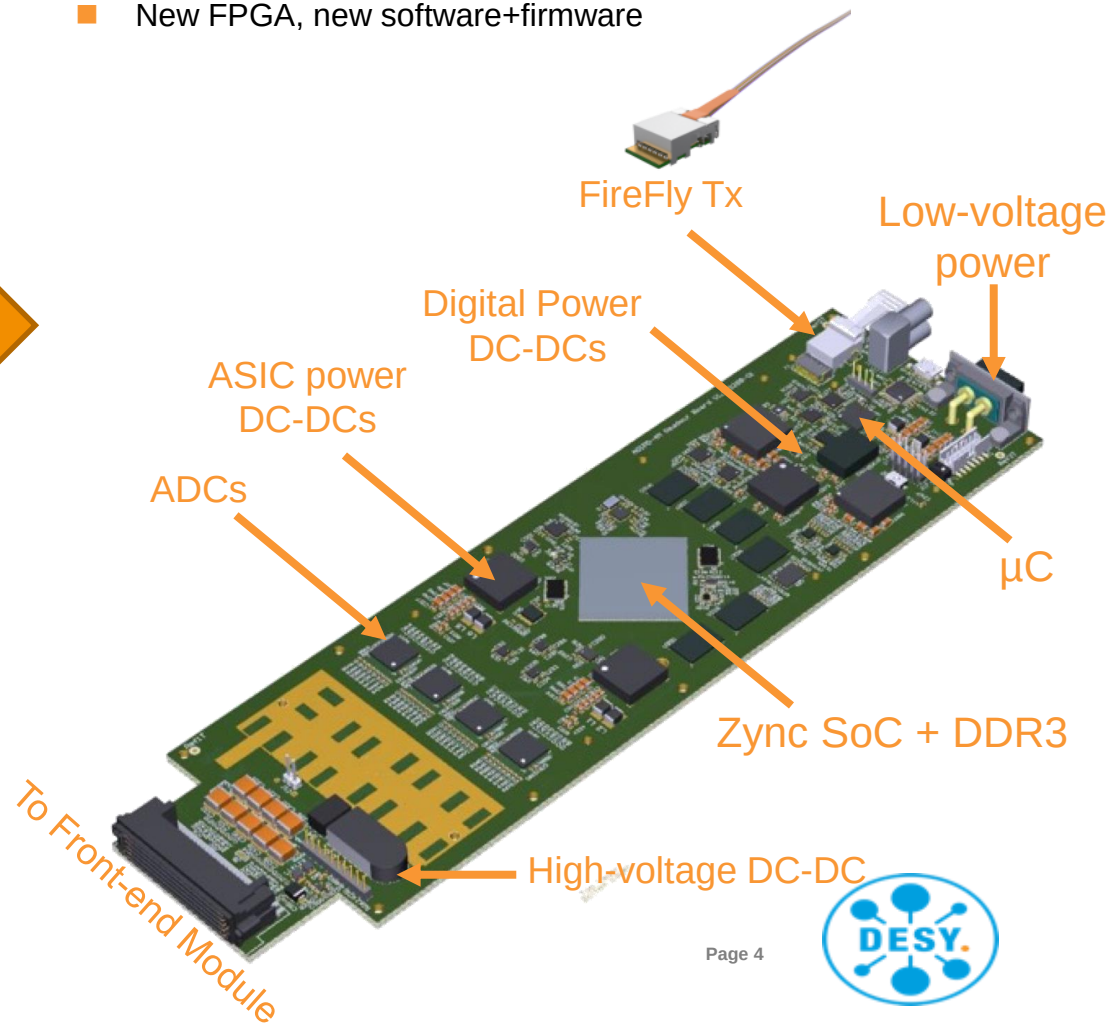


1st generation read-out electronics

- 3 boards
  - Vacuum board (high-voltage-, ASIC power distribution)
  - ADC board
  - FPGA board
- External power distribution (many external cables)
- Different, mixed (copper, fibre), separate fibre-pairs/cables for controls, data readout, timing/sync, interlocks

2nd generation read-out electronics

- 1 Read-out Board, all in-vacuum, small footprint, short analog pathlengths
- On-board power distribution incl. High-voltage generation
- FireFly multifibre Tx for controls, data, timing/sync, interlocks
- New FPGA, new software+firmware

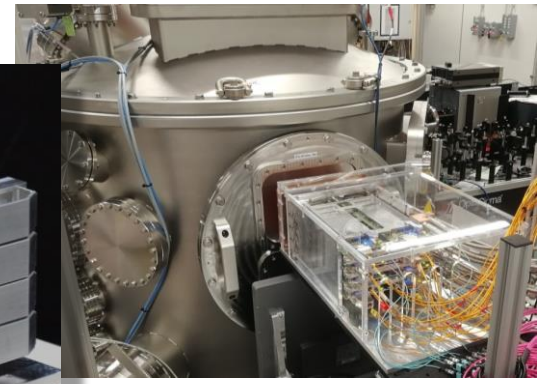


“AGIPD Mini-Half” prototype

2nd generation hardware prototype for HED/HIBEF at European XFEL

- 8 modules (AGIPD1.1 + 1.2) = 500 kpix

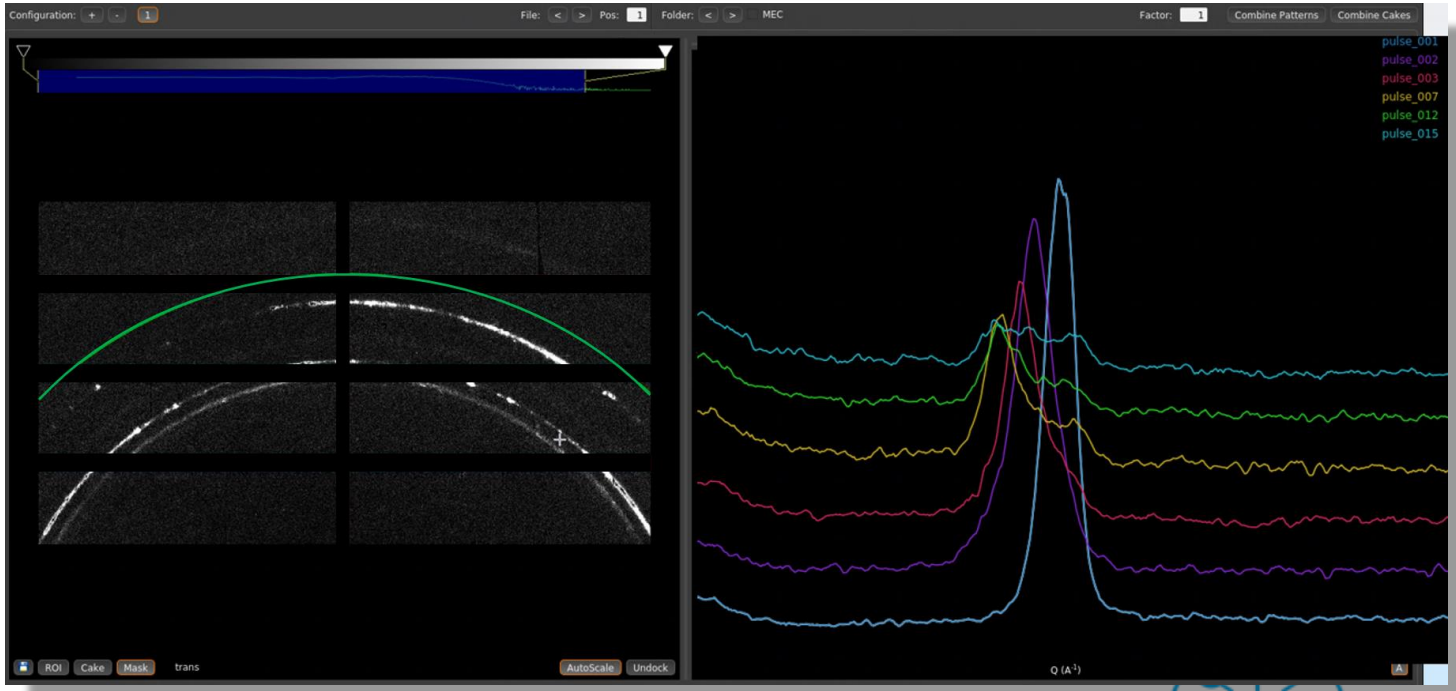
AGIPD Mini-Half in the laboratory



…and at the HED instrument, HIBEF chamber

November 2020 beamtime

- Integration into European XFEL (controls-, timing, DAQ)
- “Hot” commissioning and characterization (ASICs, calibration, electronics)
  - Feedback to AGIPD 2nd generation development (firmware)
  - Characterize AGIPD1.2 with XFEL
- Science: First Mhz-pulse-resolved diffraction at HED
  - X-ray- and laser-heated Platinum in diamond-anvil cell
  - intra-train thermal peak shift and melting



X-ray-heated Pt in diamond-anvil cell (DAC)

Two new 2nd generation Megapixel systems:

- AGIPD-4Mpix for SFX User Consortium at SPB/SFX instrument
- AGIPD-1Mpix for HIBEF User Consortium at HED instrument