

Data @ MID

Corrections, analysis, ...



Overview

- General remarks
 - Data sources
 - Karabo

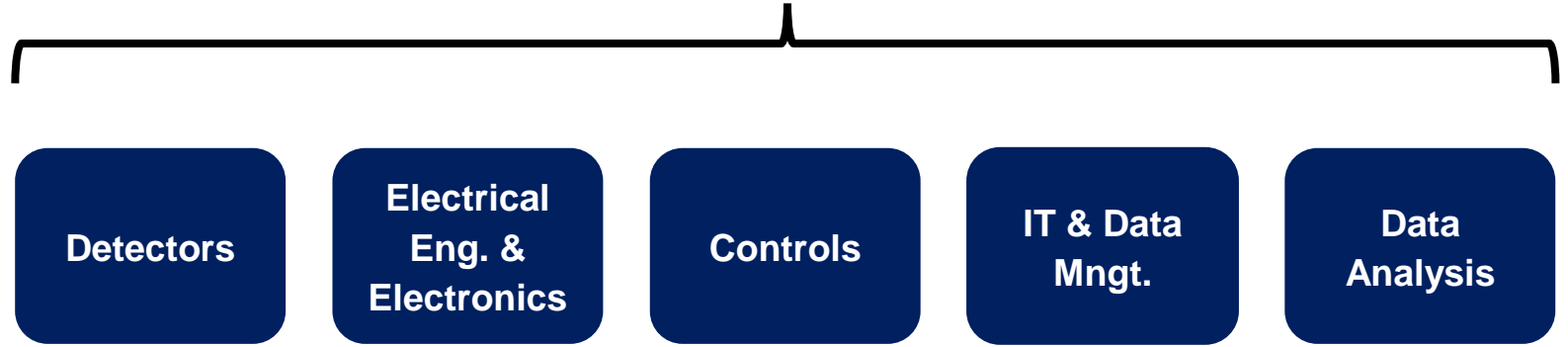
- Corrections and analysis
 - Online
 - Offline

- AGIPD
 - Single photon sensitivity / sparse data
 - Dynamic range / gain switching
 - future operation scenarios

EuXFEL data department



+



Roman Shayduk,
Markus Scholz
MID detector scientist

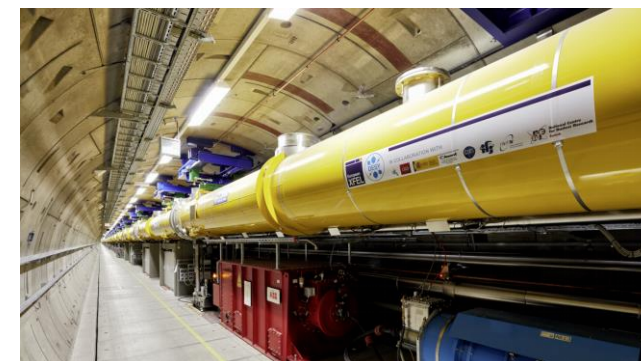
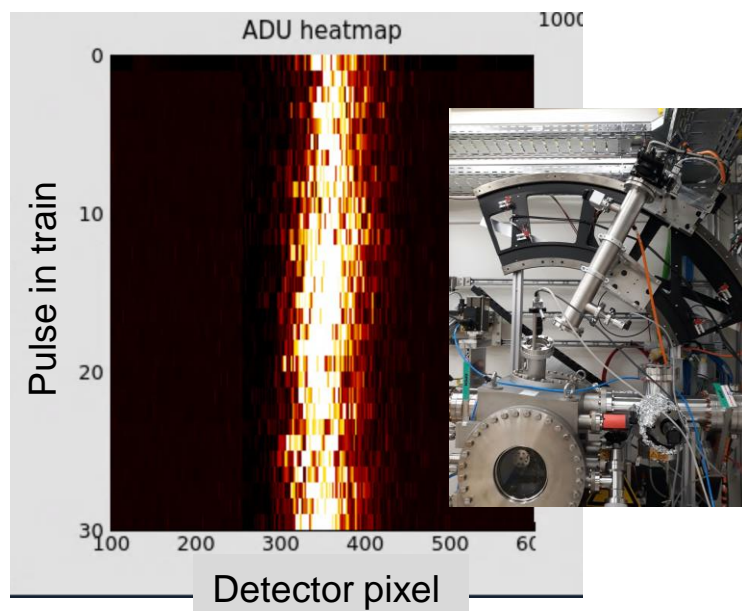
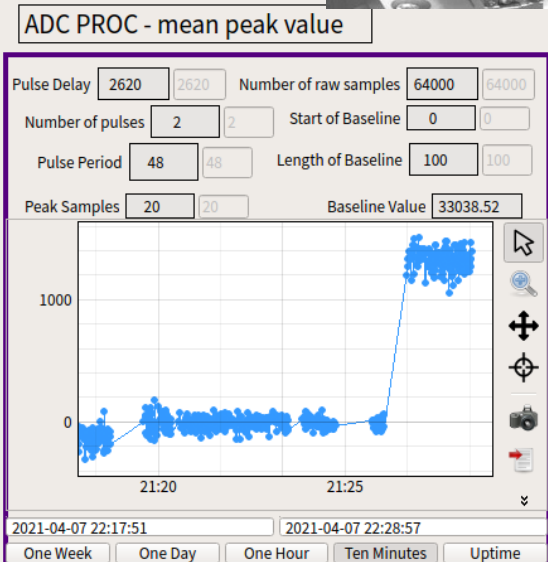
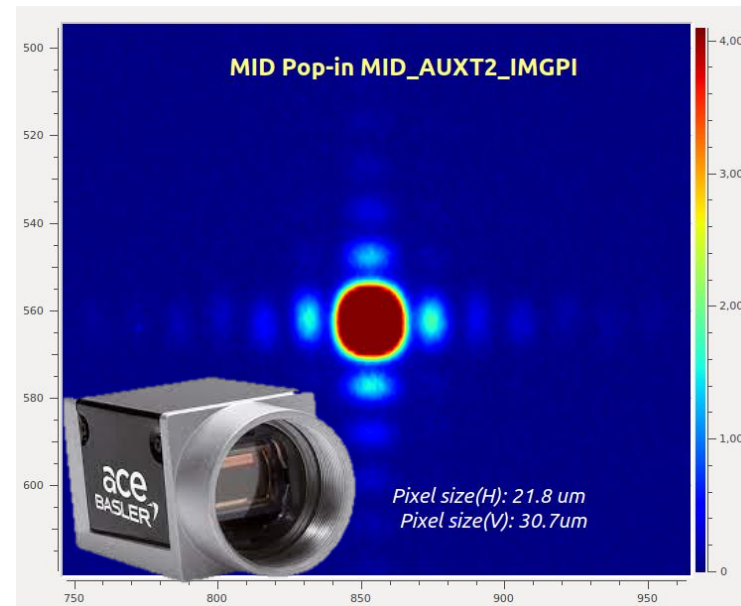
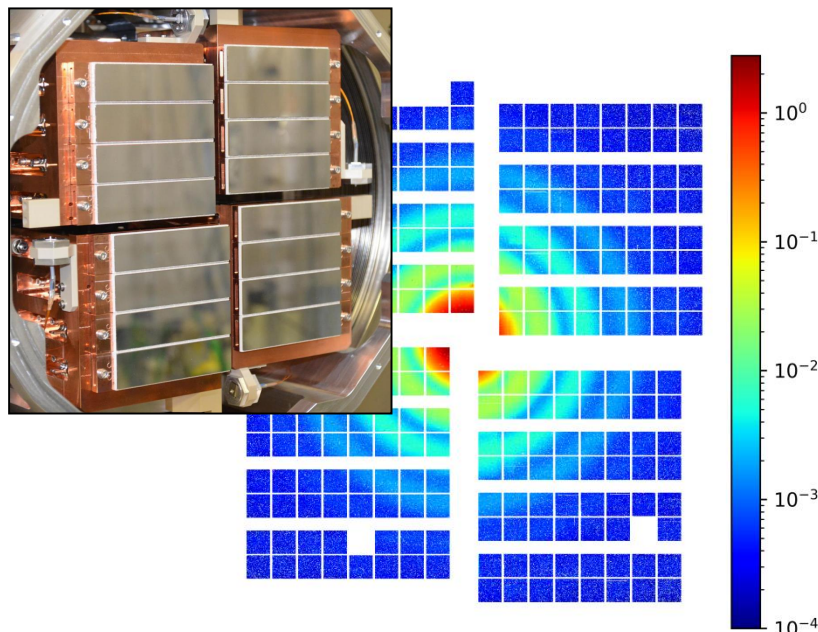
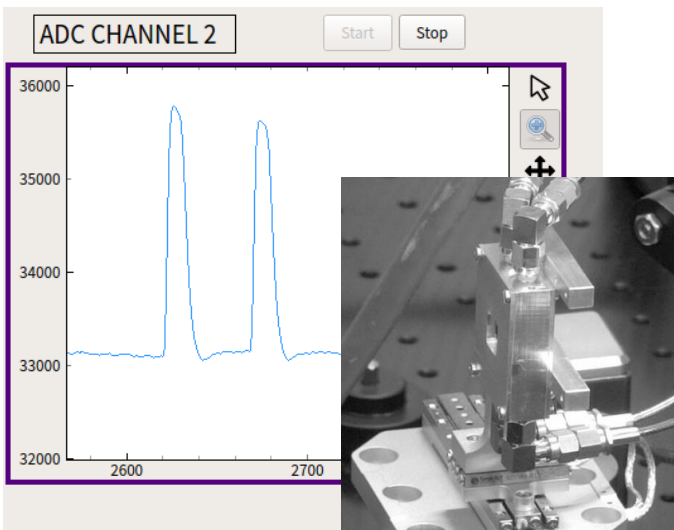


Andrea Parenti,
Riccardo Fabbri,
Robert Schaffer,
controls

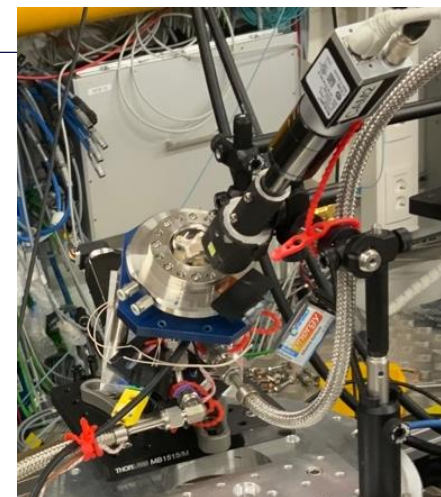
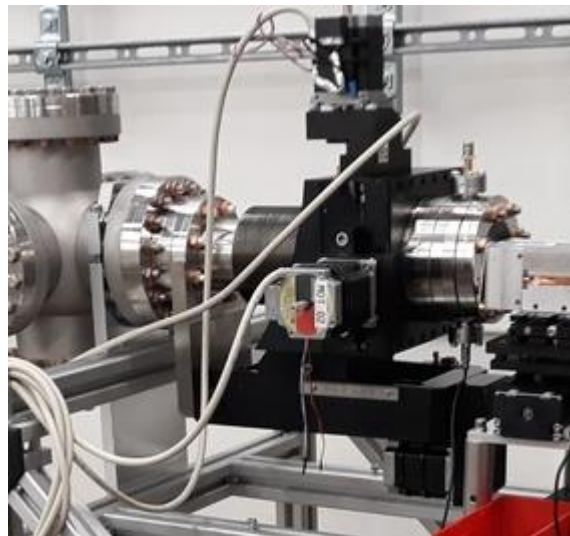
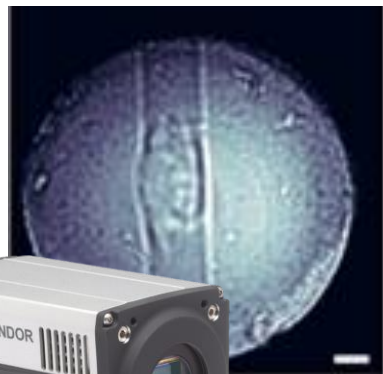
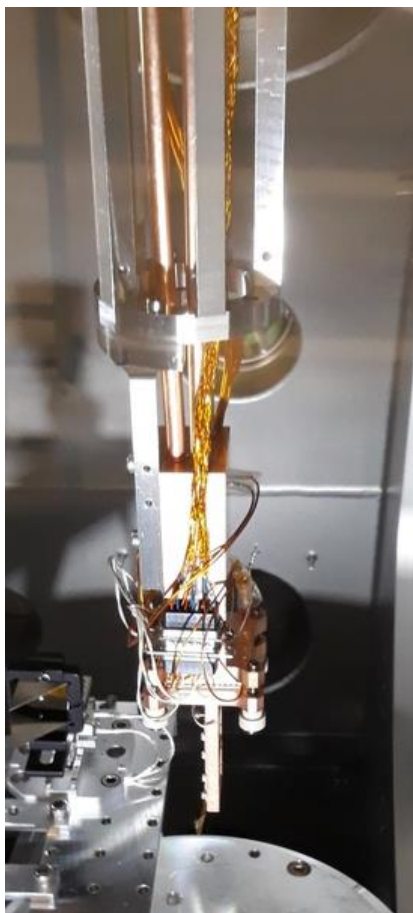


James Wrigley,
Fabio Dall'Antonia
data analysis

Data sources



User equipment



- User Patch Panel (UPP)
 - motor control
 - pump control
 - pressure gauges
 - temperature readout
 - ...
- Digitizers
- Detectors / cameras



karabo

European XFEL - Karabo GUI 2.13.1 - TOPIC: MID

File Panels Settings Links View Help

System Topology Device Topology Projects

Find: CAM1 Filter Clear Filter

No Status Filtering

Service Manager

Host - Server - Class - Device

- MID_EXP_SAM/CAM/CAM1
 - pythonServer/mid_exp_sam_cam
 - ImageAverager
 - MID_EXP_SAM/AVG/CAM1
 - ImageProcessor
 - MID_EXP_SAM/PROC/CAM1
 - mid-rr-sys-con-14
 - cppServer/mid_exp_des_cam
 - AravisBaslerCamera
 - MID_EXP_DES/CAM/CAM1 (selected)
 - pythonServer/mid_exp_des_cam_ca...
 - ImageAverager
 - MID_EXP_DES/AVG/CAM1
 - ImageProcessor
 - MID_EXP_DES/PROC/CAM1
 - mid-rr-sys-con-15
 - cppServer/mid_cam_sdl_yag
 - AravisBaslerCamera
 - MID_OPT_SDL/CAM/CAM1
 - pythonServer/mid_cam_sdl_yag
 - ImageProcessor
 - MID_OPT_SDL/PROC/CAM1
 - mid-rr-sys-con-16
 - cppServer/mid_auxt3_lic_cam
 - AravisBaslerCamera

Configuration Editor

Property	Current value on device	Value
Camera ID	mid-exp-des-cam-cam1	
Packet Delay	48 ns	
Auto Packet Size	True	
Packet Size	1576 B	
Acquire		
Stop		
Software Trigger		
Refresh		
Reset		
Frame Rate		
Frame Rate Enable	False	
Target Frame Rate	10.0 Hz	
Actual Frame Rate	10.005524 Hz	
Image Latency		
Polling Interval	20 s	20 s
Camera ID	22576225	
Vendor Name	Basler	
Model Name	acA2500-14um	

Shutdown instance Apply all Decline all

2022-01-17 13:34:00 - INFO - Started Karabo GUI application ...
 2022-01-17 13:34:05 - INFO - Successfully connected to gui server (topic: mid-rr-sys-con-gui1:44444 (MID))

mid-rr-sys-con-gui1:44444 (MID)

MID_EXP_DES/CAM/CAM1

ON Frame Rate 0 Hz Mean Latency 0 ms

X-axis (pixels) 0 1000 2000

Y-axis (pixels) -200 0 200 400 600 800 1000 1200 1400 1600 1800 2000 2200

MID Run Controller

Data Source Groups

source	type	behavior	monit
<input checked="" type="checkbox"/> MID_SCANTOOL			
<input type="checkbox"/> AGIPD1M_XTDF			
<input type="checkbox"/> BEAM_COND_1			
<input type="checkbox"/> BEAM_COND_2			
<input type="checkbox"/> BEAM_COND_3			
<input type="checkbox"/> JFSOOK_CTRL			
<input type="checkbox"/> JFSOOK_M1			
<input type="checkbox"/> JFSOOK_M2			
<input type="checkbox"/> MID_AGIPD1M_CTRL			
<input type="checkbox"/> MID_AGIPD1M_POWER_HV			
<input type="checkbox"/> MID_AGIPD1M_TEMP			
<input type="checkbox"/> MID_AGIPD1M_TSYS			
<input type="checkbox"/> MID_AGIPD_MOTION			
<input type="checkbox"/> MID_ANDOR_CAM			
<input type="checkbox"/> MID_AUXT2_IMGPI			
<input type="checkbox"/> MID_AUXT3_PAM			
<input type="checkbox"/> MID_AUXT3_PAM_CAM1			
<input type="checkbox"/> MID_AUXT3_PAM_CAM2			
<input type="checkbox"/> MID_BAM			
<input type="checkbox"/> MID_DES_GOTTHARD			
<input type="checkbox"/> MID_DOC_ADHOC			
<input type="checkbox"/> MID_ENERGY			
<input type="checkbox"/> MID_EXP_ADQ			
<input type="checkbox"/> MID_EXP_DES			

Group to Data Aggregator Mapping

Data source	Alias	Data aggregator
0 @MID_EXP_SAM_SSHEX	DA01	MID_DAQ_DATA/DA/1
1 @MID_SCANTOOL	DA04	MID_DAQ_DATA/DA/4
2 @MID_EXP_SAM_MOTOR	DA05	MID_DAQ_DATA/DA/5

Preparation

Proposal number 800255

Retrieve proposal Push to DAQ Ignore data

Time Scan

Gain 0 Exposure Time 89985 Trigger Source Line1

Scenes

DAQ

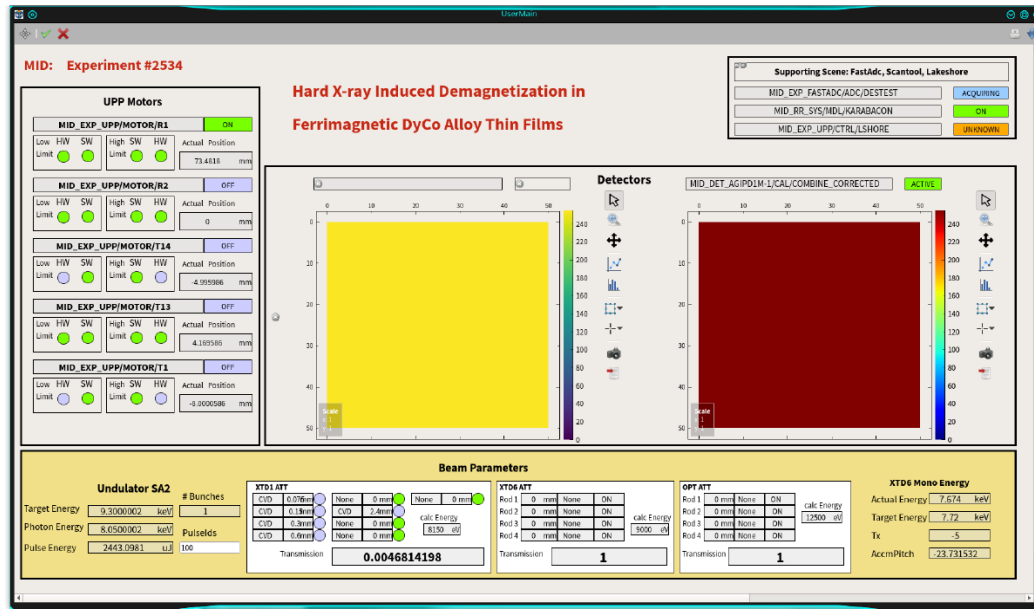
2929_xpcs

```

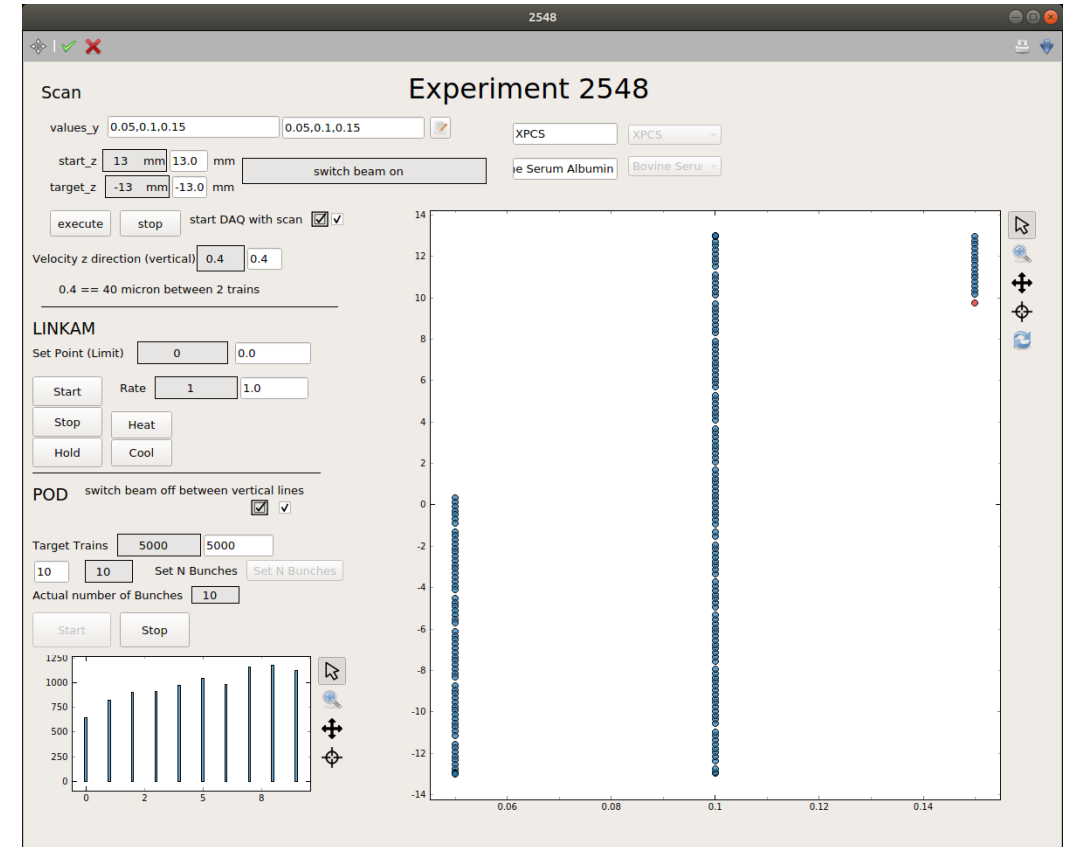
27
28 @Slot()
29 @coroutine
30 def execute(self):
31     print("Hello {}!".format(self.name))
32     self.alive = True
33     yield from self.Init()
34     self.task = background(self.measurement)
35
36 @coroutine
37 def Init(self):
38
39     #connect to motors
40     self.motor_z = yield from connectDevice('HW_MID_EXP_SAM_MOTOR_SSHEX_Z')
41     self.motor_y = yield from connectDevice('HW_MID_EXP_SAM_MOTOR_SSHEX_Y')
42
43     #connect to attenuator
44     self.att = yield from connectDevice('MID_AUXT2_ATT/MDL/ATT')
45
46     #connect to DAQ and get a list of all active DAs
47     self.daqController = yield from connectDevice('MID_DAQ_DATA/DM/RUN_CONTROL')
48
49 @coroutine
50 def measurement(self):
51     self.printText = 'start'
52     if self.switch DAQ:
53         if self.daqController.globalState.daqGlobalState != State.MONITORING:
54             self.printText = 'stopped. DAQ needs to be in monitoring state.'
55         return
  
```

macros / middlelayers

Customized scenes & macros



- Customized user scenes
- Visualization of experiment
- Remote access
- Integrated equipment can be implemented in dedicated macros



- Talk to your local contact!

Corrections & Analysis

➔ **Detectors at the European XFEL**

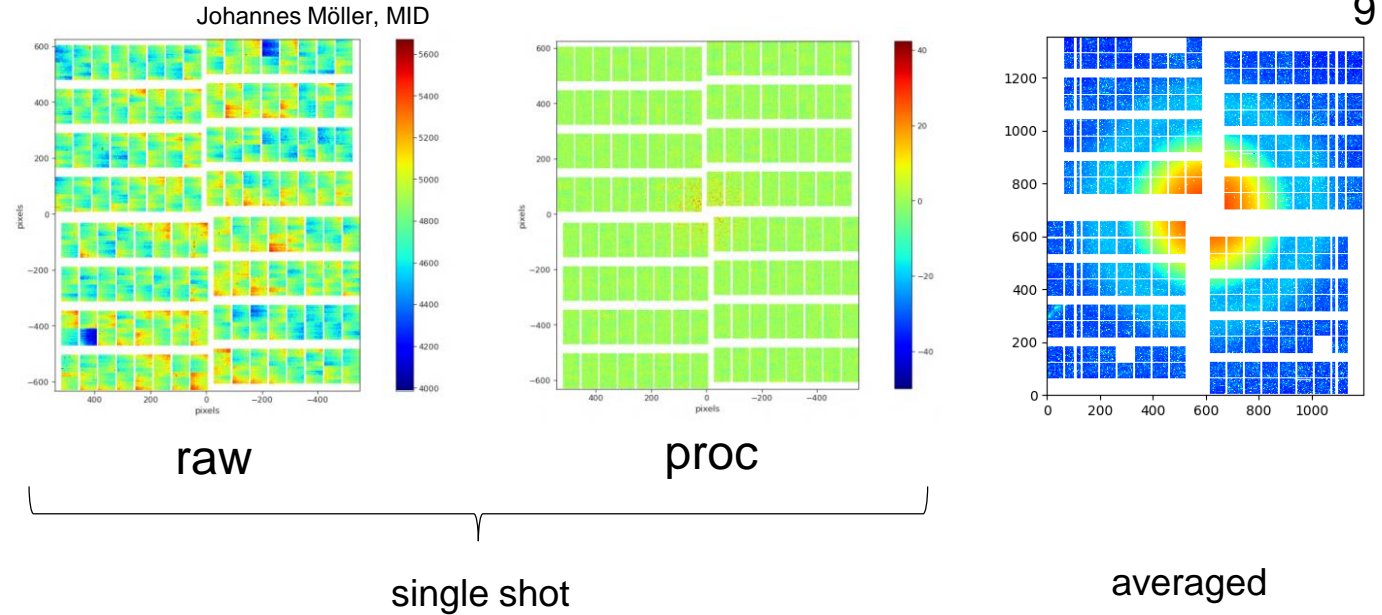
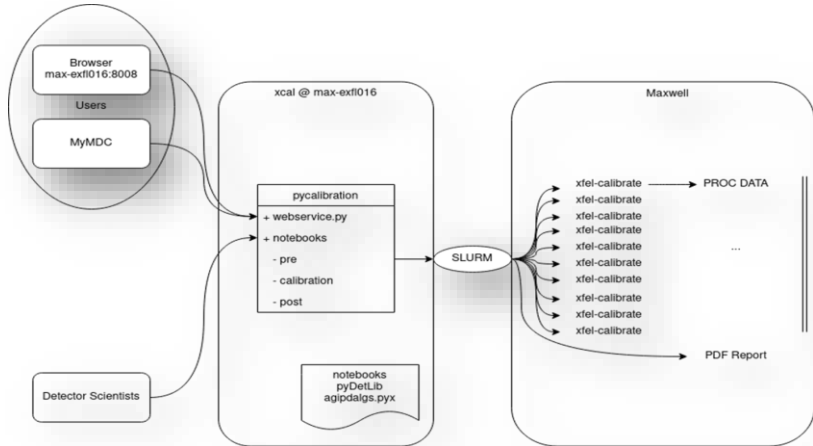
January 24, 2021, 14:00 CET
Virtual Meeting (Zoom)

➔ **Data analysis at the European XFEL**

Tuesday, 25 January 2022
Virtual Meeting (Zoom)

Offline Calibration Pipeline

- Many 2D detectors require corrections to process “raw” detector data into analysis-ready “proc”
- Raw data processing (calibration request through myMdC (metadata catalogue, in.xfel.eu/metadata)
- XFEL offline calibration (xfel-calibrate) runs on DESY HPC cluster (Maxwell), jobs are distributed across nodes using SLURM

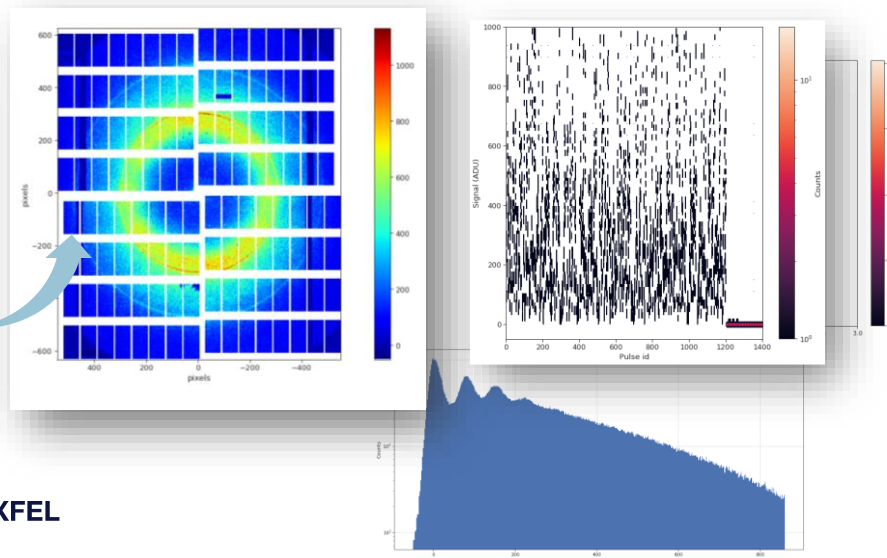


The screenshot shows the myMDC interface for proposal no. 900090. The interface includes navigation tabs (General, Public Information, Runs, Logbook, Team, Repositories, Calibration Constants, Publication, History) and a table of 'Proposal Runs'. The table has columns for Run Number (alias), Run type, Sample Name, Start date, Run status, Data Assessment, Calibration, Run Comment, and Edit. A blue circle highlights the 'Calibration' column for run 0692, which has a '(Re)calibrate' button.

Run Number (alias)	Run type	Sample Name	Start date	Run status	Data Assessment	Calibration	Run Comment	Edit
0693	XPCS	vycor	2019-09-23 00:00:34 +0200	Closed	Good	[Dropdown]		[Icon]
0692	XPCS	vycor	2019-09-22 23:57:14 +0200	Closed	Good	(Re)calibrate		[Icon]
0691	XPCS	vycor	2019-09-22 23:52:46 +0200	Closed	Good	[Dropdown]		[Icon]
0690	XPCS	vycor	2019-09-22 23:46:20 +0200	Closed	Good	[Dropdown]		[Icon]
0689	XPCS	vycor	2019-09-22 23:42:27 +0200	Closed	Good	[Dropdown]		[Icon]
0688	XPCS	vycor	2019-09-22 23:38:47 +0200	Closed	Good	[Dropdown]		[Icon]

Offline Calibration Pipeline

- Processed data (.h5) and .yaml file with calibration metadata is stored in proc/ folder of the proposal
- Automatically generated reports are available for each run in usr/Report folder:
 - Control plots to validate image quality
 - Information about configuration, used calibration constants
 - Configuration of offline corrections is not yet exposed to Users
 - If you spot inconsistencies or you have doubts about the settings: Talk to your local contact!!



```

Terminal
File Edit View Terminal Tabs Help
CORR-R0130-AGIPD02-S00016.h5 CORR-R0130-AGIPD08-S00010.h5 CORR-R0130-AGIPD14-S00004.h5
CORR-R0130-AGIPD03-S00000.h5 CORR-R0130-AGIPD08-S00011.h5 CORR-R0130-AGIPD14-S00005.h5
CORR-R0130-AGIPD03-S00001.h5 CORR-R0130-AGIPD08-S00012.h5 CORR-R0130-AGIPD14-S00006.h5
CORR-R0130-AGIPD03-S00002.h5 CORR-R0130-AGIPD08-S00013.h5 CORR-R0130-AGIPD14-S00007.h5
CORR-R0130-AGIPD03-S00003.h5 CORR-R0130-AGIPD08-S00014.h5 CORR-R0130-AGIPD14-S00008.h5
CORR-R0130-AGIPD03-S00004.h5 CORR-R0130-AGIPD08-S00015.h5 CORR-R0130-AGIPD14-S00009.h5
CORR-R0130-AGIPD03-S00005.h5 CORR-R0130-AGIPD08-S00016.h5 CORR-R0130-AGIPD14-S00010.h5
CORR-R0130-AGIPD03-S00006.h5 CORR-R0130-AGIPD09-S00000.h5 CORR-R0130-AGIPD14-S00011.h5
CORR-R0130-AGIPD03-S00007.h5 CORR-R0130-AGIPD09-S00001.h5 CORR-R0130-AGIPD14-S00012.h5
CORR-R0130-AGIPD03-S00008.h5 CORR-R0130-AGIPD09-S00002.h5 CORR-R0130-AGIPD14-S00013.h5
CORR-R0130-AGIPD03-S00009.h5 CORR-R0130-AGIPD09-S00003.h5 CORR-R0130-AGIPD14-S00014.h5
CORR-R0130-AGIPD03-S00010.h5 CORR-R0130-AGIPD09-S00004.h5 CORR-R0130-AGIPD14-S00015.h5
CORR-R0130-AGIPD03-S00011.h5 CORR-R0130-AGIPD09-S00005.h5 CORR-R0130-AGIPD14-S00016.h5
CORR-R0130-AGIPD03-S00012.h5 CORR-R0130-AGIPD09-S00006.h5 CORR-R0130-AGIPD15-S00000.h5
CORR-R0130-AGIPD03-S00013.h5 CORR-R0130-AGIPD09-S00007.h5 CORR-R0130-AGIPD15-S00001.h5
CORR-R0130-AGIPD03-S00014.h5 CORR-R0130-AGIPD09-S00008.h5 CORR-R0130-AGIPD15-S00002.h5
CORR-R0130-AGIPD03-S00015.h5 CORR-R0130-AGIPD09-S00009.h5 CORR-R0130-AGIPD15-S00003.h5
CORR-R0130-AGIPD04-S00000.h5 CORR-R0130-AGIPD09-S00010.h5 CORR-R0130-AGIPD15-S00004.h5
CORR-R0130-AGIPD04-S00001.h5 CORR-R0130-AGIPD09-S00011.h5 CORR-R0130-AGIPD15-S00005.h5
CORR-R0130-AGIPD04-S00002.h5 CORR-R0130-AGIPD09-S00012.h5 CORR-R0130-AGIPD15-S00006.h5
CORR-R0130-AGIPD04-S00003.h5 CORR-R0130-AGIPD09-S00013.h5 CORR-R0130-AGIPD15-S00007.h5
CORR-R0130-AGIPD04-S00004.h5 CORR-R0130-AGIPD09-S00014.h5 CORR-R0130-AGIPD15-S00008.h5
CORR-R0130-AGIPD04-S00005.h5 CORR-R0130-AGIPD09-S00015.h5 CORR-R0130-AGIPD15-S00009.h5
CORR-R0130-AGIPD04-S00006.h5 CORR-R0130-AGIPD10-S00000.h5 CORR-R0130-AGIPD15-S00010.h5
CORR-R0130-AGIPD04-S00007.h5 CORR-R0130-AGIPD10-S00001.h5 CORR-R0130-AGIPD15-S00011.h5
CORR-R0130-AGIPD04-S00008.h5 CORR-R0130-AGIPD10-S00002.h5 CORR-R0130-AGIPD15-S00012.h5
CORR-R0130-AGIPD04-S00009.h5 CORR-R0130-AGIPD10-S00003.h5 CORR-R0130-AGIPD15-S00013.h5
CORR-R0130-AGIPD04-S00010.h5 CORR-R0130-AGIPD10-S00004.h5 CORR-R0130-AGIPD15-S00014.h5
CORR-R0130-AGIPD04-S00011.h5 CORR-R0130-AGIPD10-S00005.h5 CORR-R0130-AGIPD15-S00015.h5
CORR-R0130-AGIPD04-S00012.h5 CORR-R0130-AGIPD10-S00006.h5 CORR-R0130-AGIPD15-S00016.h5
CORR-R0130-AGIPD04-S00013.h5 CORR-R0130-AGIPD10-S00007.h5 CORR-R0130-AGIPD15-S00017.h5
CORR-R0130-AGIPD04-S00014.h5 CORR-R0130-AGIPD10-S00008.h5 CORR-R0130-DA01-S00000.h5
CORR-R0130-AGIPD04-S00015.h5 CORR-R0130-AGIPD10-S00009.h5 CORR-R0130-DA01-S00001.h5
CORR-R0130-AGIPD04-S00016.h5 CORR-R0130-AGIPD10-S00010.h5 CORR-R0130-DA01-S00002.h5
CORR-R0130-AGIPD05-S00000.h5 CORR-R0130-AGIPD10-S00011.h5 CORR-R0130-DA01-S00003.h5
CORR-R0130-AGIPD05-S00001.h5 CORR-R0130-AGIPD10-S00012.h5 CORR-R0130-DA01-S00004.h5
CORR-R0130-AGIPD05-S00002.h5 CORR-R0130-AGIPD10-S00013.h5 CORR-R0130-DA01-S00005.h5
CORR-R0130-AGIPD05-S00003.h5 CORR-R0130-AGIPD10-S00014.h5 CORR-R0130-DA01-S00006.h5
CORR-R0130-AGIPD05-S00004.h5 CORR-R0130-AGIPD10-S00015.h5 CORR-R0130-DA01-S00007.h5
CORR-R0130-AGIPD05-S00005.h5 CORR-R0130-AGIPD10-S00016.h5 CORR-R0130-DA01-S00008.h5
CORR-R0130-AGIPD05-S00006.h5 CORR-R0130-AGIPD11-S00000.h5 CORR-R0130-DA02-S00000.h5
CORR-R0130-AGIPD05-S00007.h5 CORR-R0130-AGIPD11-S00001.h5 CORR-R0130-DA03-S00000.h5
CORR-R0130-AGIPD05-S00008.h5 CORR-R0130-AGIPD11-S00002.h5 CORR-R0130-DA04-S00000.h5
CORR-R0130-AGIPD05-S00009.h5 CORR-R0130-AGIPD11-S00003.h5 karabo_data_map4.json
[moeLler]@max-exf10151/gpfs/exfel/exp/MID/202102/p002638/proc/r0130%
  
```

EXtra-data

extra-data.readthedocs.io

github.com/european-xfel/extra-data

- Python library for *offline* analysis, designed to give easy access to saved data in runs.

- Opening a run:

```
import extra_data

run = extra_data.open_run(proposal=900193, run=39)
```

- Iterate over all trains in a run as Numpy arrays:

```
agipd = run.select("MID_DET_AGIPD1M-1/DET/*CHO:xtdf", "image.data")
for train_id, data in agipd.trains():
    # Read AGIPD data into a numpy array of shape (pulses, modules, x, y)
    agipd_train = extra_data.stack_detector_data(data, "image.data")
```

- Also supports Pandas and xarray.

data analysis on the maxwell HPC cluster:
<https://max-jhub.desy.de>

```
In [1]: import extra_data

run = extra_data.open_run(proposal=2638, run = 130)
run.info()

# of trains:      4147
Duration:         0:06:54.7
First train ID:  1166809705
Last train ID:   1166813851

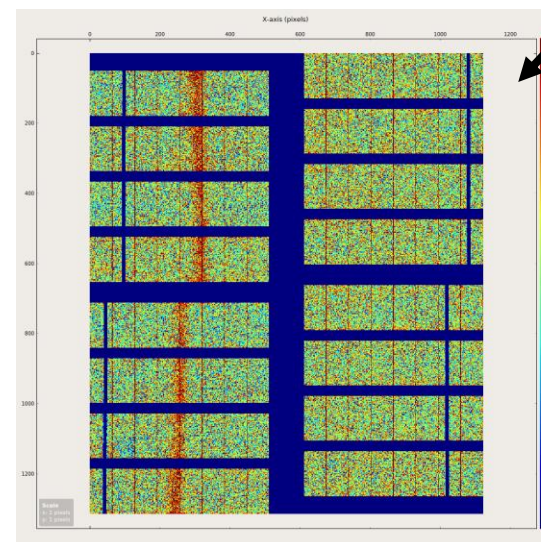
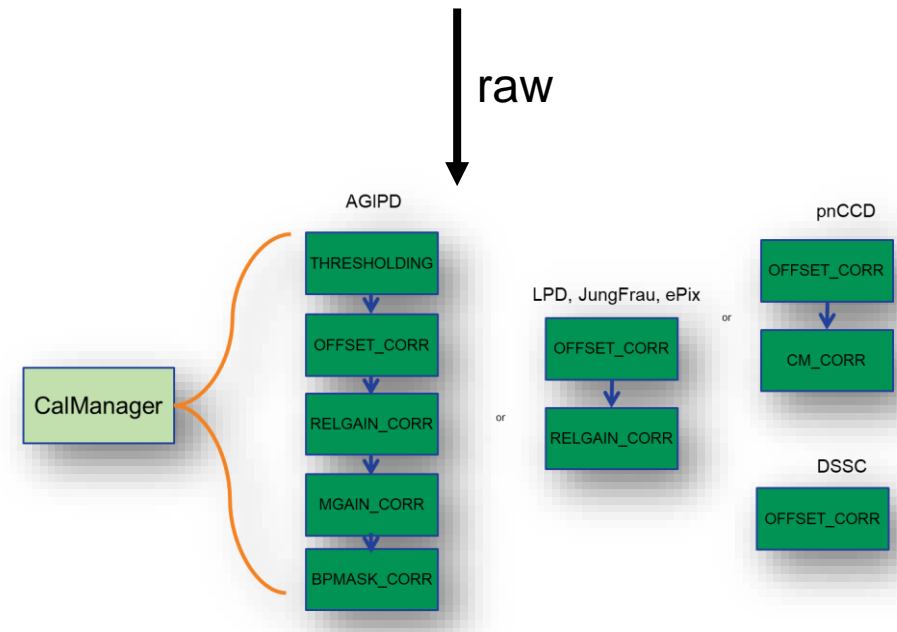
16 detector modules (MID_DET_AGIPD1M-1)
e.g. module MID_DET_AGIPD1M-1 0 : 512 x 128 pixels
MID_DET_AGIPD1M-1/DET/0CHO:xtdf
64 frames per train, up to 265408 frames total

3 instrument sources (excluding detectors):
- MID_EXP_FASTADC/ADC/DESTEST:channel_3.output
- MID_RR_SYS/MDL/KARABACON:output
- SA2_XTD1_XGM/XGM/DOOCS:output

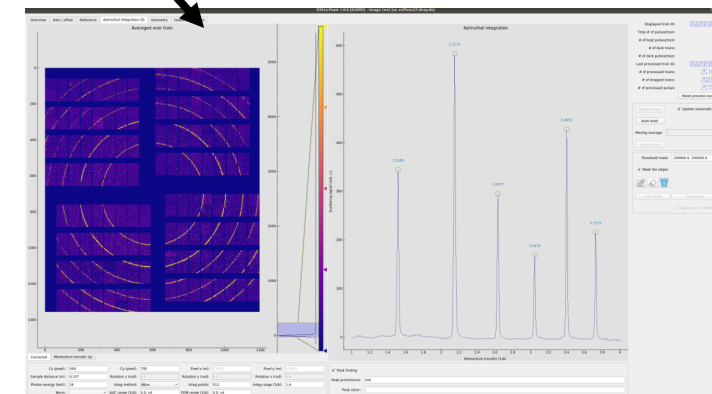
53 control sources:
- MID_AUXT2_ATT/MDL/ATT
- MID_AUXT2_ATT/MOTOR/ROD1_IN_OUT
- MID_AUXT2_ATT/MOTOR/ROD2_IN_OUT
- MID_AUXT2_ATT/MOTOR/ROD3_IN_OUT
- MID_AUXT2_ATT/MOTOR/ROD4_IN_OUT
- MID_DET_AGIPD1M/CC/MON_0
- MID_EXP_AGIPD1M/GAUGE/PG1
- MID_EXP_AGIPD1M/MOTOR/Q1M1
- MID_EXP_AGIPD1M/MOTOR/Q1M2
- MID_EXP_AGIPD1M/MOTOR/Q2M1
- MID_EXP_AGIPD1M/MOTOR/Q2M2
- MID_EXP_AGIPD1M/MOTOR/Q3M1
- MID_EXP_AGIPD1M/MOTOR/Q3M2
- MID_EXP_AGIPD1M/MOTOR/Q4M1
- MID_EXP_AGIPD1M/MOTOR/Q4M2
- MID_EXP_AGIPD1M/PSC/HV
- MID_EXP_AGIPD1M/TSENS/H1_T_EXTHOUS
- MID_EXP_AGIPD1M/TSENS/H2_T_EXTHOUS
- MID_EXP_AGIPD1M/TSENS/Q1_T_BLOCK
- MID_EXP_AGIPD1M/TSENS/Q2_T_BLOCK
- MID_EXP_AGIPD1M/TSENS/Q3_T_BLOCK
- MID_EXP_AGIPD1M/TSENS/Q4_T_BLOCK
- MID_EXP_AGIPD1M1/CTRL/MC1
- MID_EXP_AGIPD1M1/CTRL/MC2
- MID_EXP_AGIPD1M1/FPGA/MASTER_H1
- MID_EXP_AGIPD1M1/FPGA/MASTER_H2
- MID_EXP_AGIPD1M1/MDL/FPGA_COMP
- MID_EXP_FASTADC/ADC/DESTEST
- MID_EXP_KEITHLEY/CTRL/KEITHLEY_2611
- MID_EXP_SYS/TSYS/UTC-2-S4
- MID_EXP_UPP/CTRL/LSHORE
- MID_EXP_UPP/MOTOR/R7
```

Online Calibration Pipeline

- Online calibration:
 - Correction of data “on-the-fly” with limited number of corrections
 - Possibility to interface external analysis tool via Karabo bridge
 - Next generation pipeline with improved performance in development
 - For analysis during the experiment only
 - ▶ No files saved
 - ▶ Offline calibration



proc

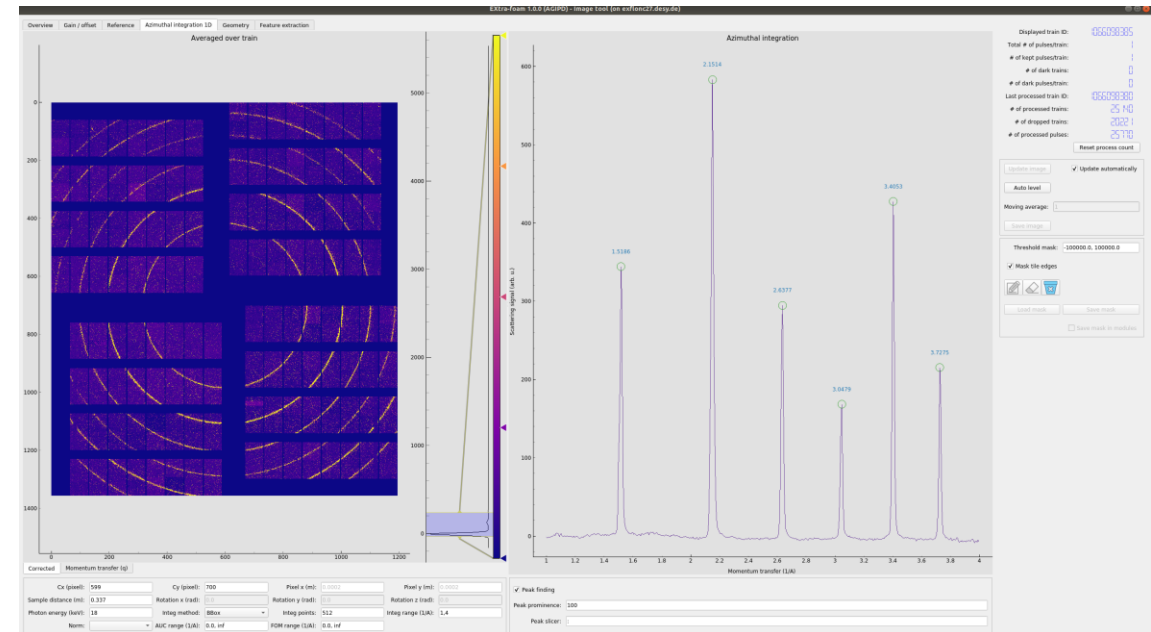


EXtra-foam

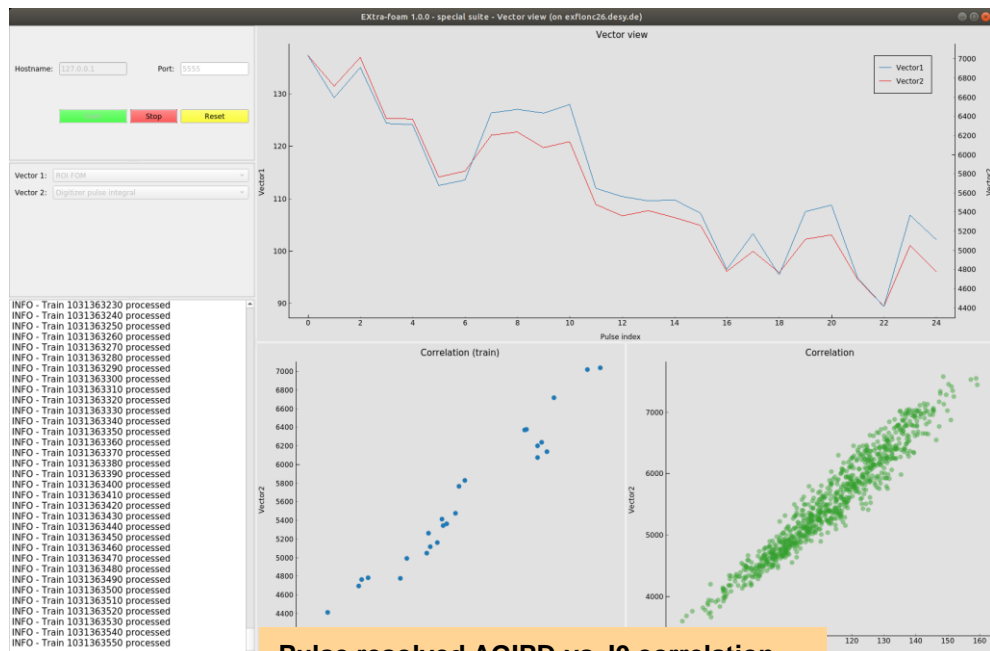
extra-foam.readthedocs.io

github.com/european-xfel/extra-foam

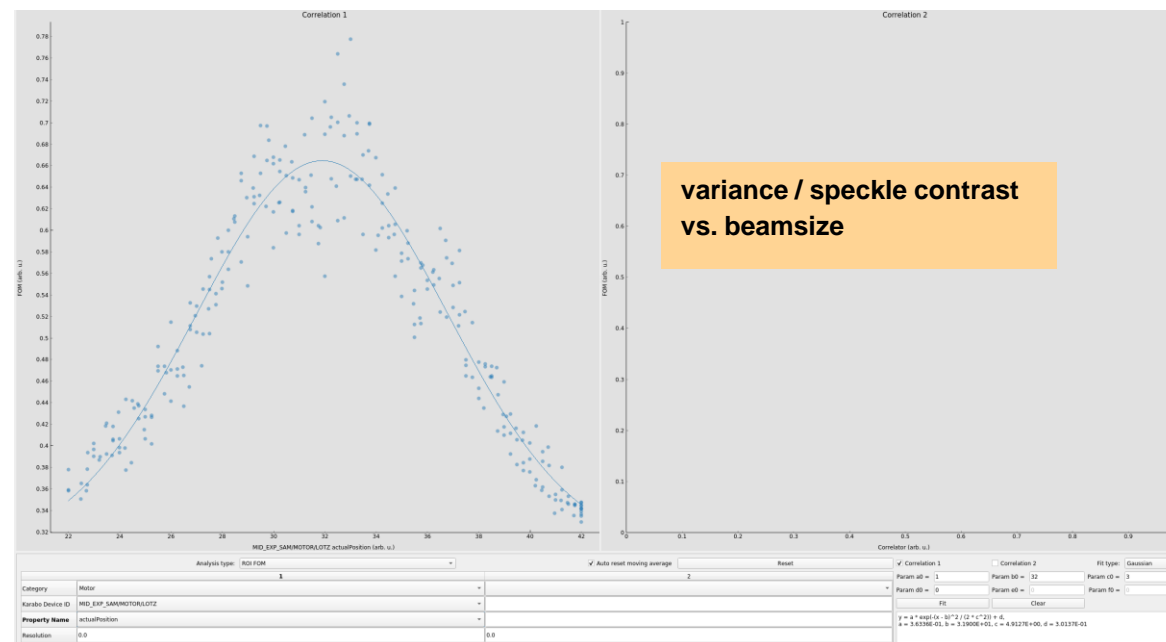
- Fast **O**nline **A**nalysis **M**onitor
- Graphical program for *online* analysis.
- Supports features such as:
 - Azimuthal integration
 - ROI analysis (histogramming, correlations, normalization)
 - Feature extraction (concentric rings, edge detection)
- Good for commonly used kinds of analysis.



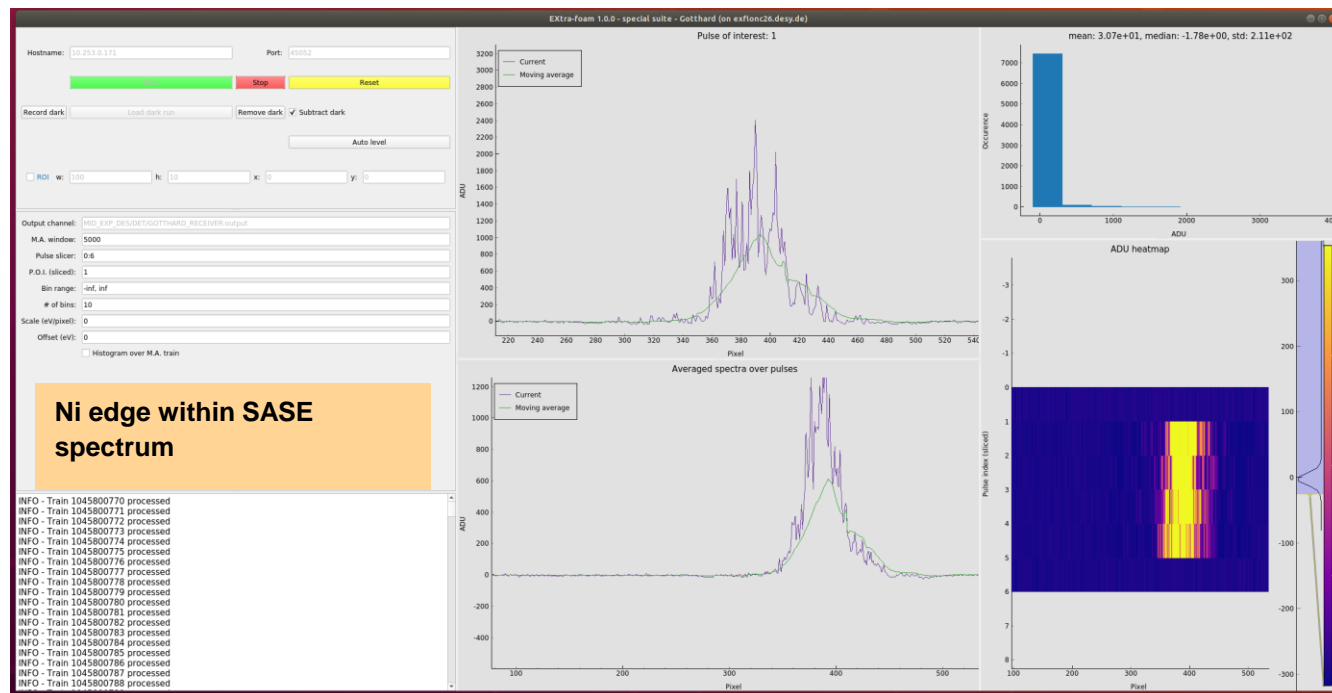
some examples



Pulse resolved AGIPD vs. IO correlation



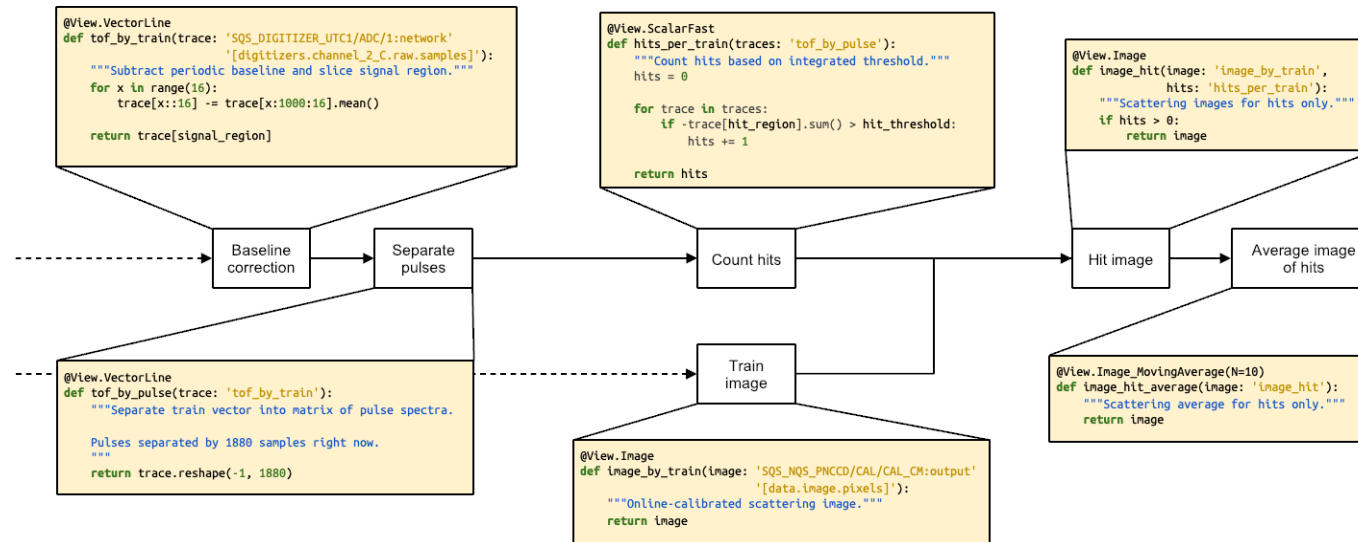
variance / speckle contrast vs. beamsize



Ni edge within SASE spectrum

EXtra-metro

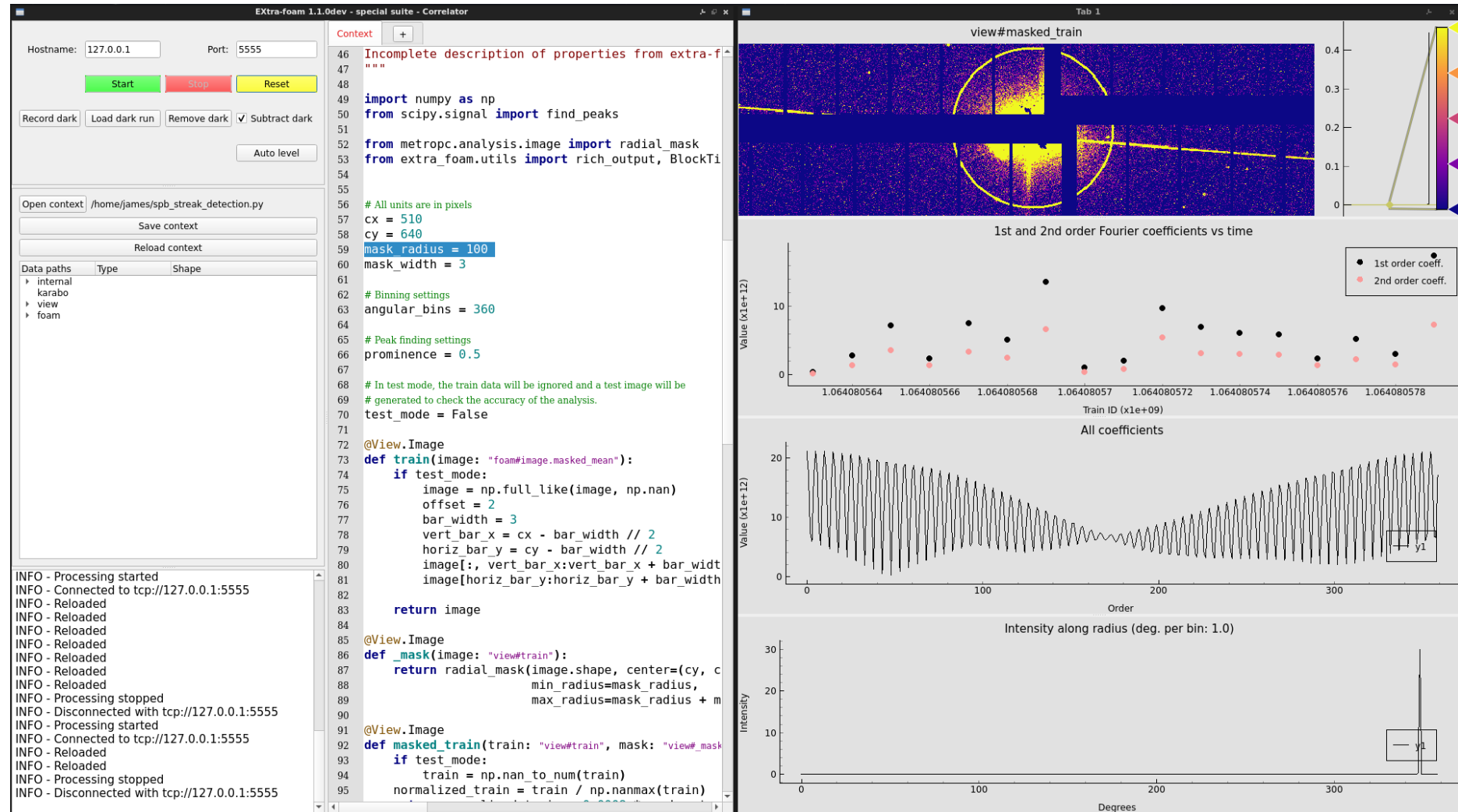
<https://desy.de/~schmidtp/metropc-docs>



- Processing framework for *online* analysis, not a GUI program.
- Very flexible, all pipelines are written as Python scripts and may be reloaded on-the-fly.
- Well suited for specialized analysis.
- Integrated in Karabo and EXtra-foam for control and visualization.

EXtra-metro + EXtra-foam

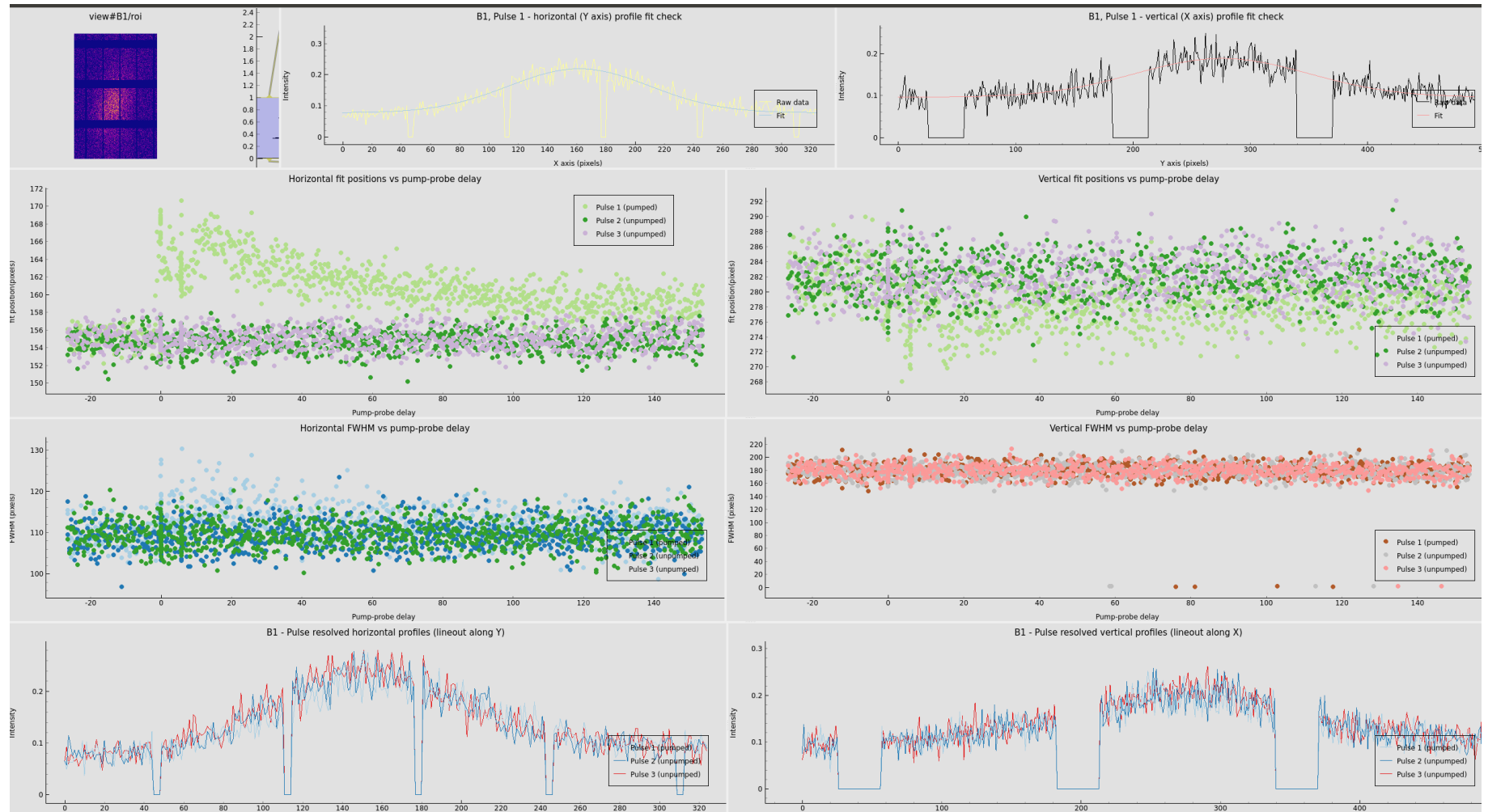
- Combining GUI interfaces for visualization, masking, ROI definition, ...
- + flexibility of customizable, simple analysis code
- Customizable GUI windows for display of results



One example

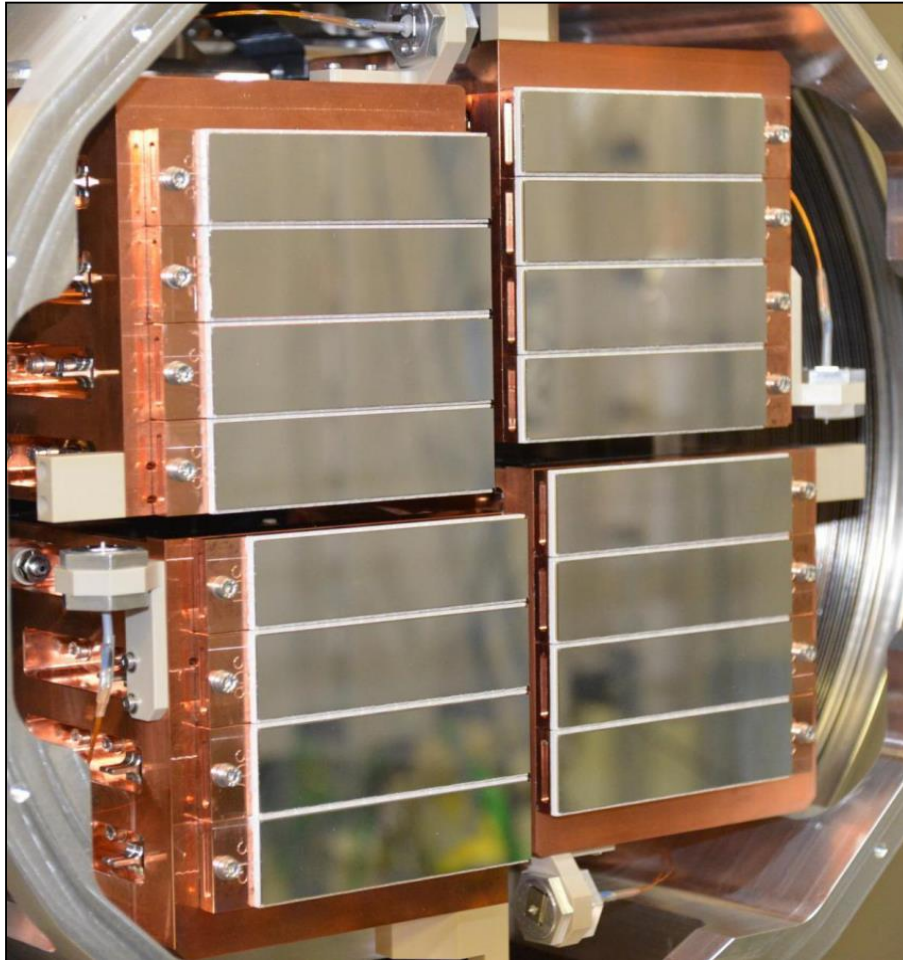
■ Pulse resolved, pump-probe Bragg peak analysis

➔ 12:30 Thursday,
Plenary session,
A. Stierle (DESY)

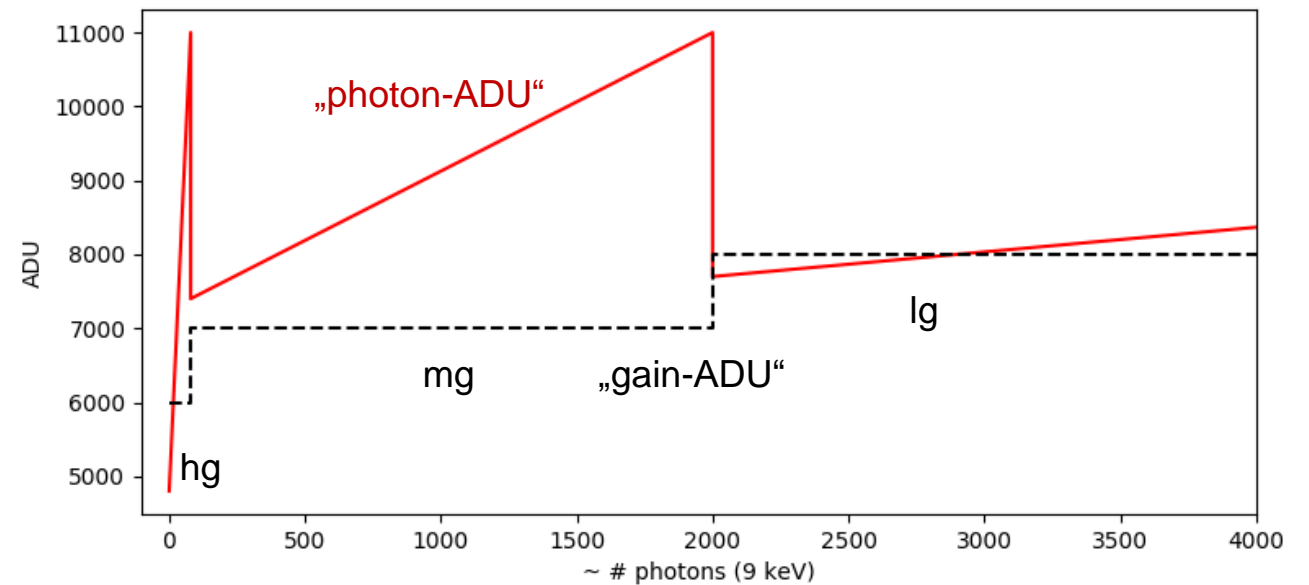


AGIPD

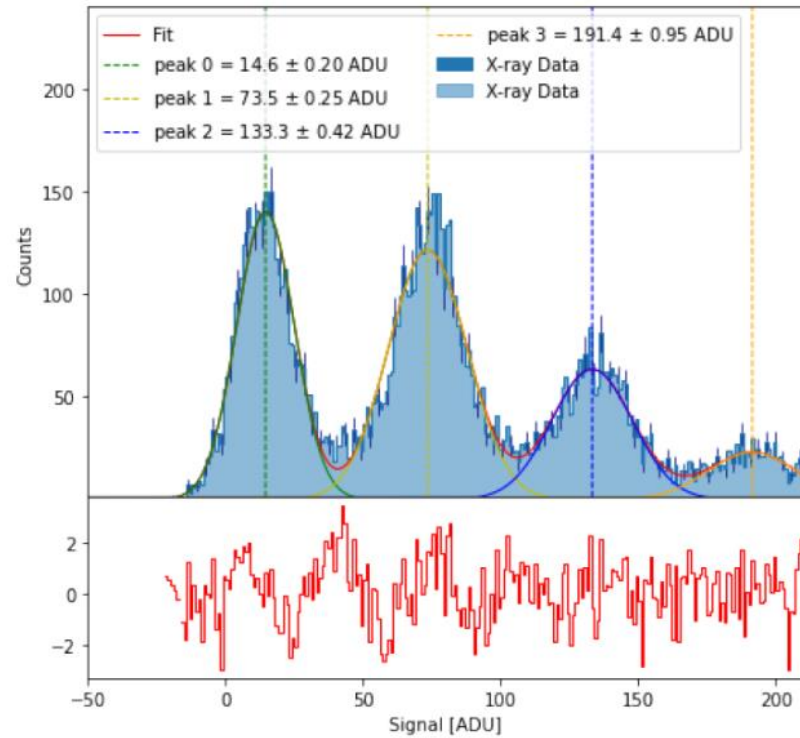
Adaptive Gain Integration Pixel Detector AGIPD



- 1M Pixel
- pixel size $200 \times 200 \mu\text{m}^2$
- Capable of 4.5MHz
- 352 storage cells (352 images/train)
- Single photon sensitive
- Up to 10^4 photons/pixel with 3 gain

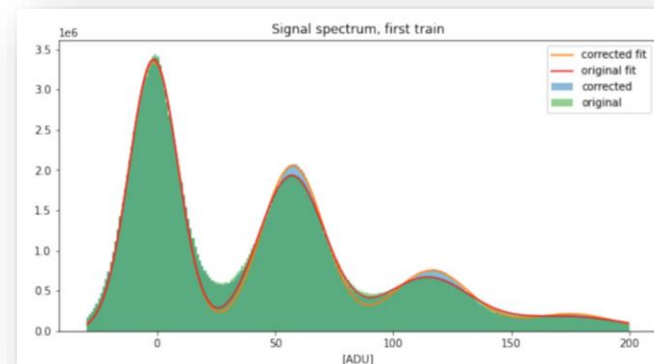
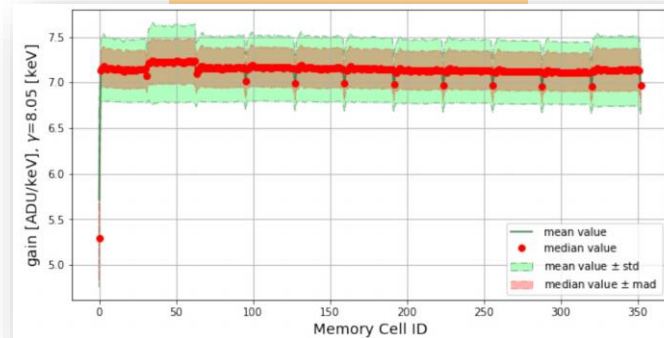


Flatfields

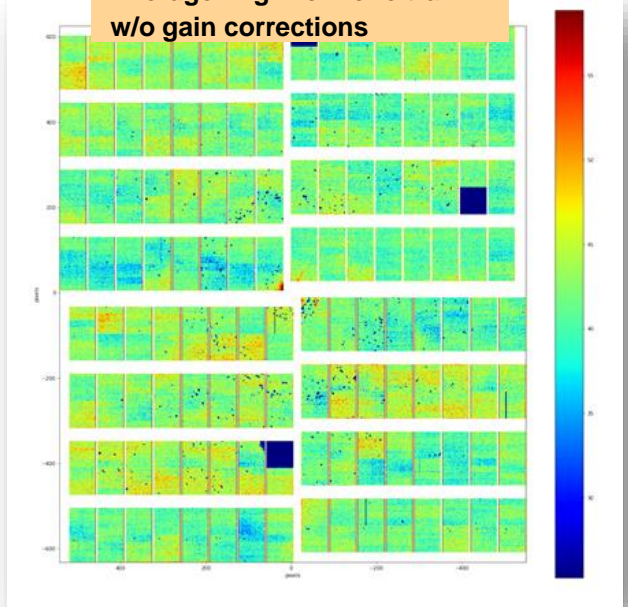


- Development and validation of high gain calibration with single photon peaks (gain maps per pixel and mem. cell)

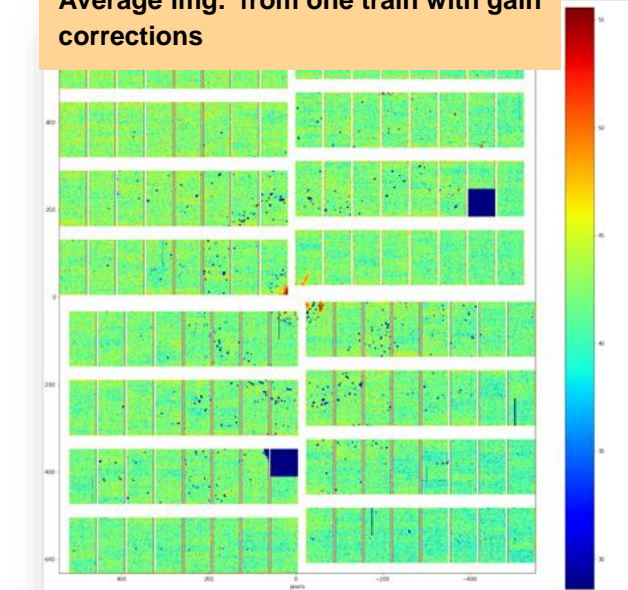
Gain values vs. mem.cell



Average img. from one train w/o gain corrections



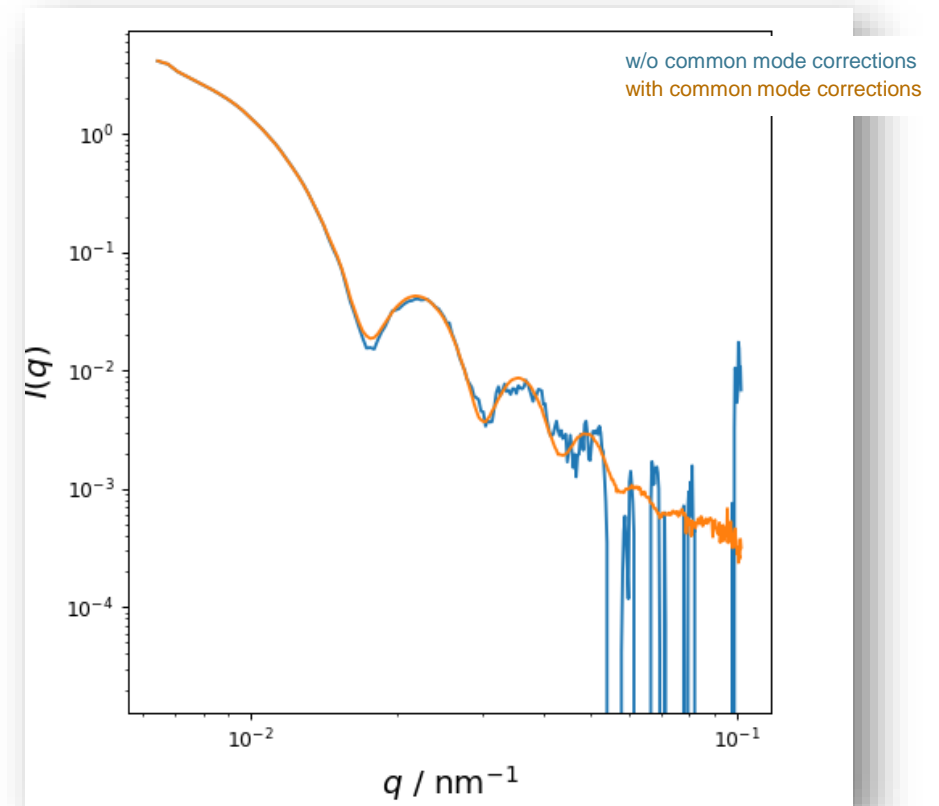
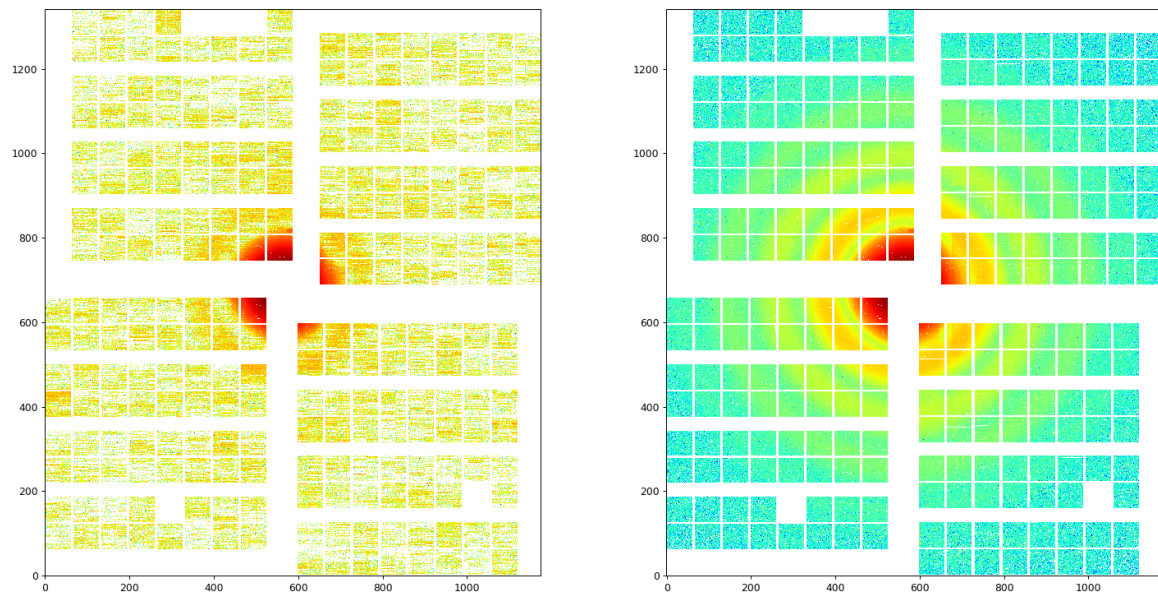
Average img. from one train with gain corrections



Common mode

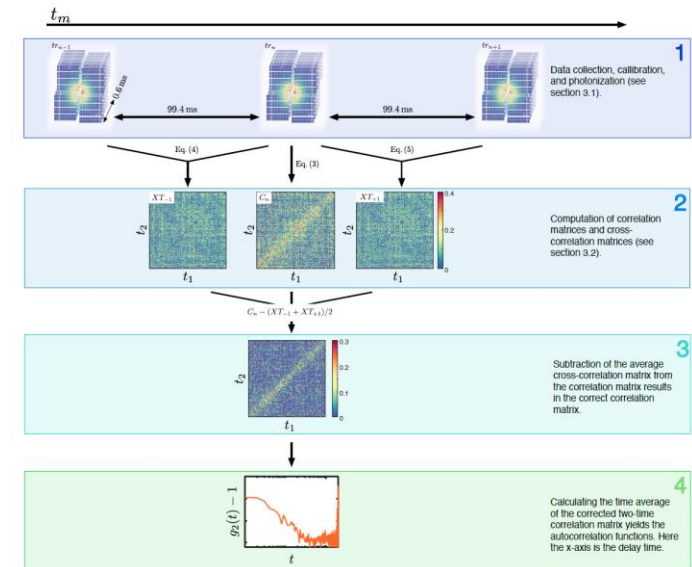
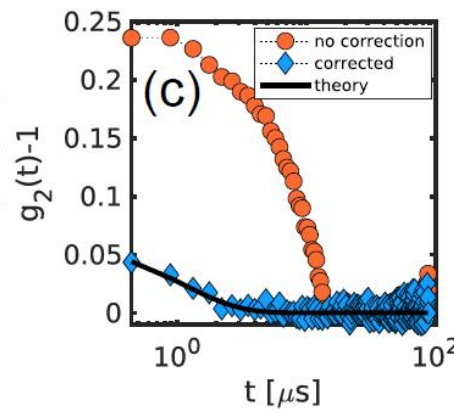
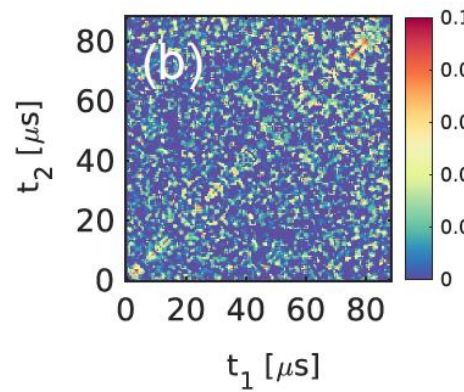
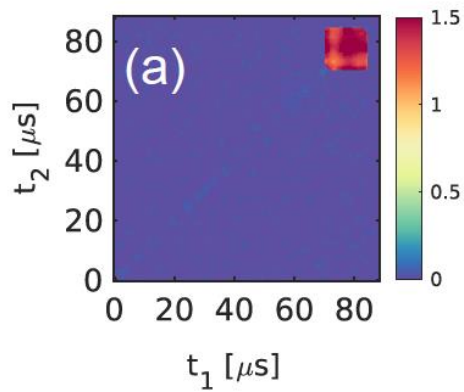
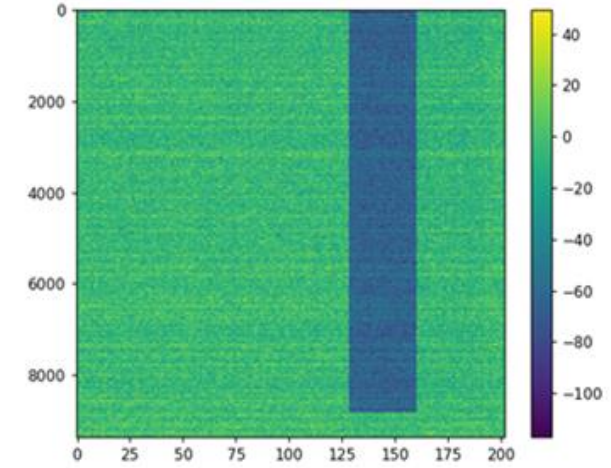
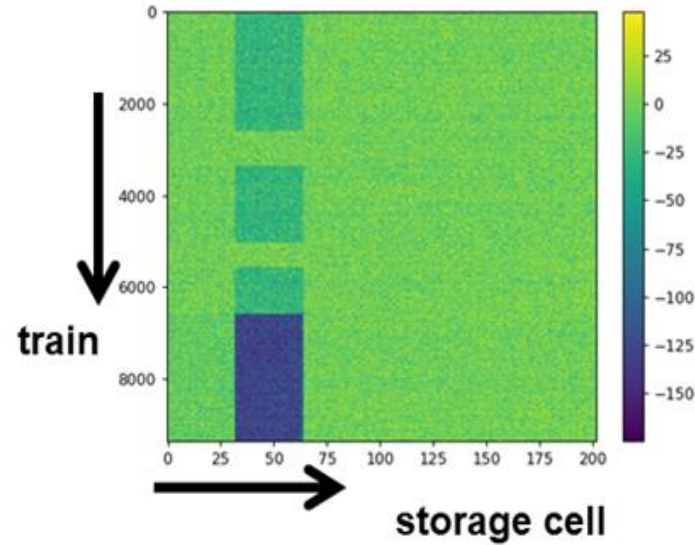
- Pedestals can fluctuate, drift and jump on various timescales
 - Single shot \leftrightarrow hours
 - Deviations from “dark constant”
 - ▶ Non-zero contribution of dark pixels

- AGIPD common mode correction
 - More precise pedestal subtraction
 - Identifies empty pixel within single ASIC and empty storage cells within one pixel
 - Subtraction of mean



Jumping pixels and XPCS

- Pedestals can fluctuate, drift and jump on various timescales
 - Jumps are rare but correlated
 - Amplitude of jump: up to 1 photon
 - ▶ Negligible for most analysis
 - ▶ Serious artifact for XPCS
 - Remove by intra-train cross correlation



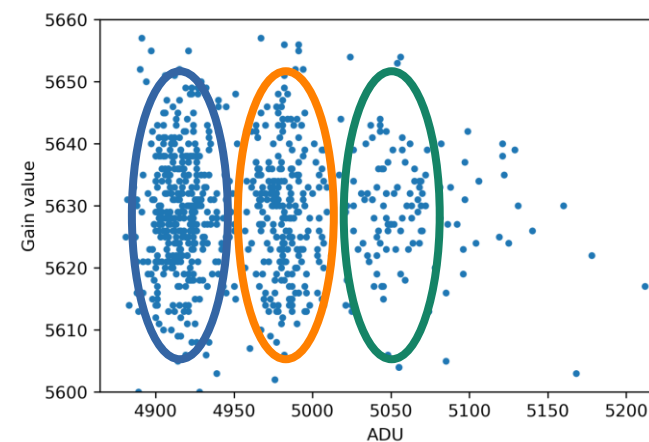
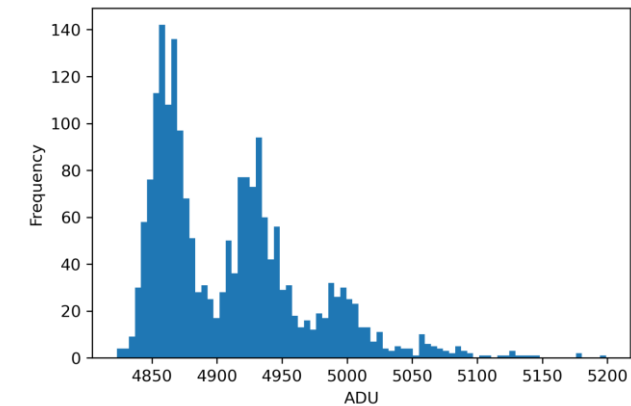
R&D Project GOAST: GPU-Computing for calibration & online analysis

Online analysis of AGIPD data requires very efficient algorithms, especially when temporal or spatial correlations are desired due to the enormous amount of data per second

We are exploring GPU-based **streaming algorithms**, which incrementally update calibration constants and analysis results with every processed image → ideal for live operation

Online calibration is based on **on-the-fly fitting** of a pixel's histogram (zero- and one-photon peak)

At low count rates ($\ll 1$ phot/pix/pulse), we can use the GPU to remove all zero counts (saves storage on the order 1 minus count rate!)

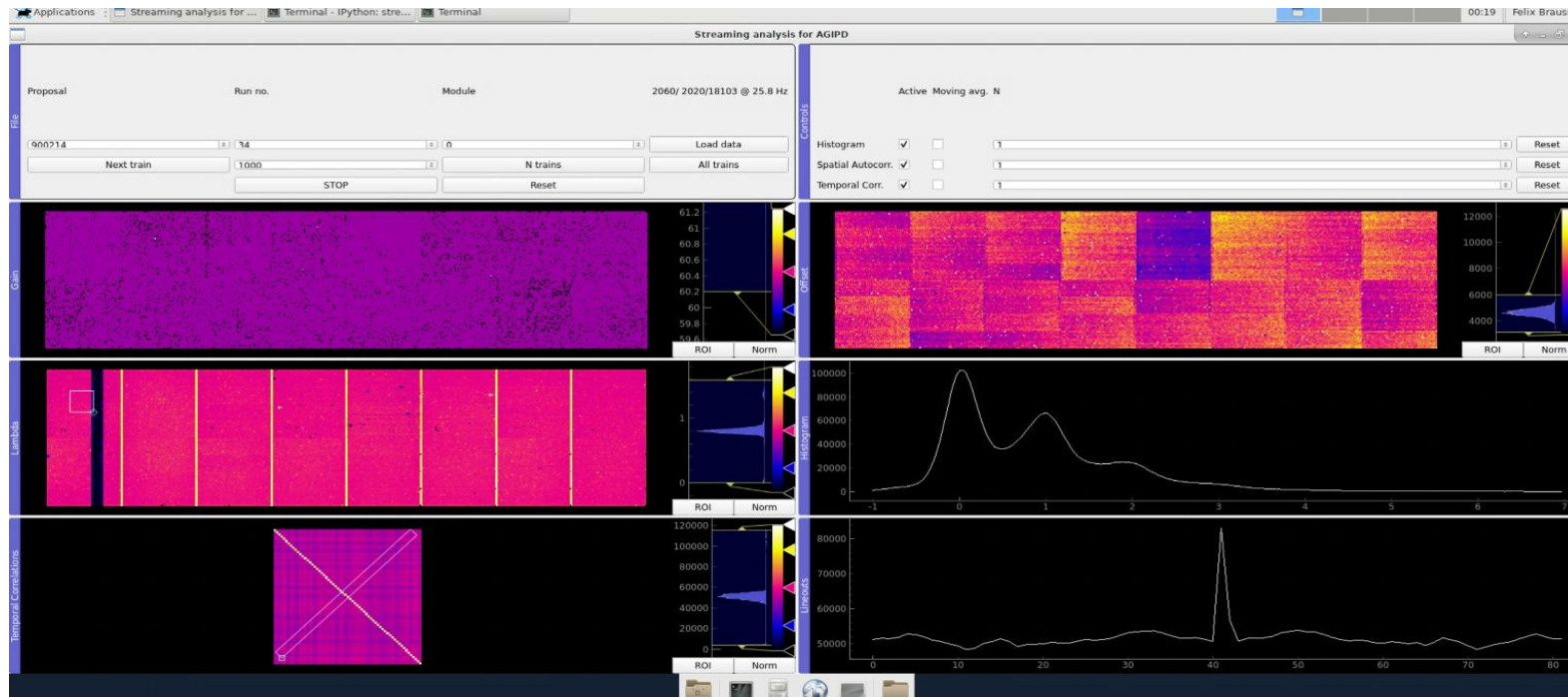


0 1 2 photons



Tuesday 14:00,
DA workshop,
F. Brauße

R&D Project GOAST: GPU-Computing for calibration & online analysis



→ Tuesday 14:00,
DA workshop,
F. Brause

- Prototype of a streaming algorithm for calibration and online analysis under development together w/ experimental GUI for processing stored data
- Photon statistics, temporal correlations (XPCS) and spatial correlations (speckle analysis) implemented
- Processing rate > 100 Hz for 1 module, 352 memory cells (planned to run on GPU cluster to process all 16 modules)
- First live tests planned for spring

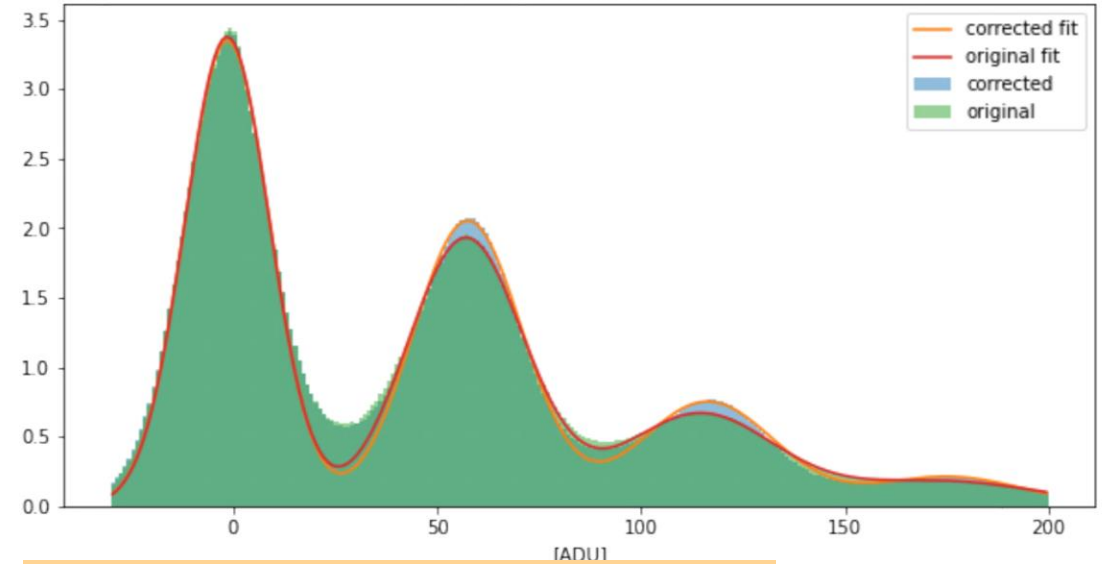
High-high gain mode

- two possible settings of the CDS stage
 - normal CDS – high CDS
 - Correlated double sampling buffer
 - U. Trunk et al., Proc. of SPIE, 10328, 1032805-1

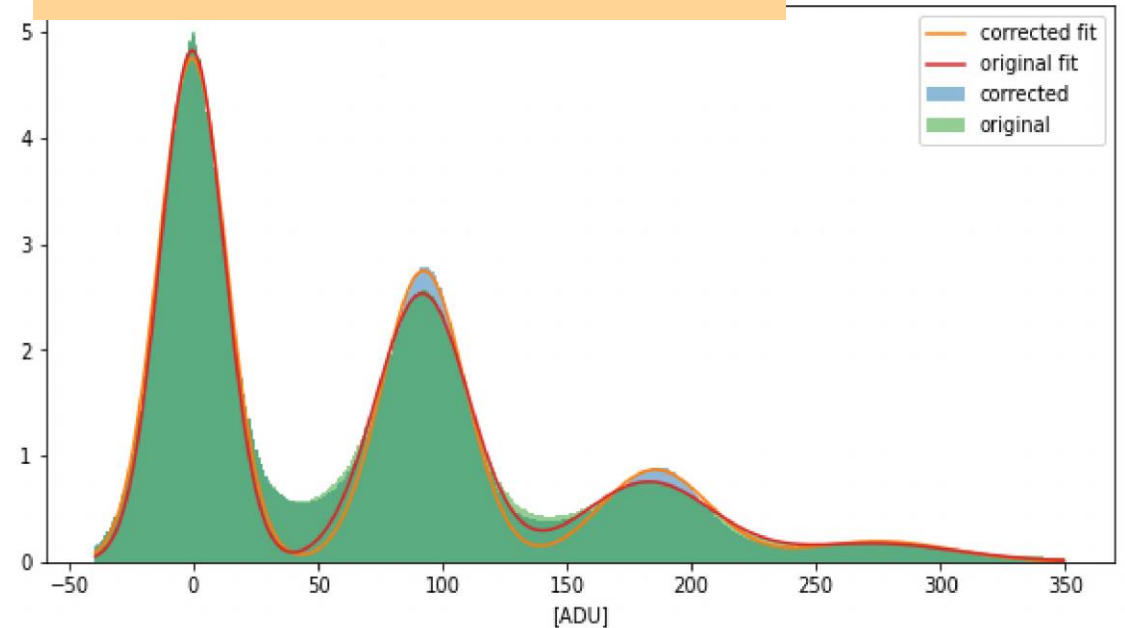
- normal CDS mode used as default so far
 - high CDS
 - Higher gain
 - Earlier (less photons required) gain switching
 - Less noise (1.3 keV → ~0.9 keV)

- Fixed gain mode for further reduced noise to be commissioned in the future

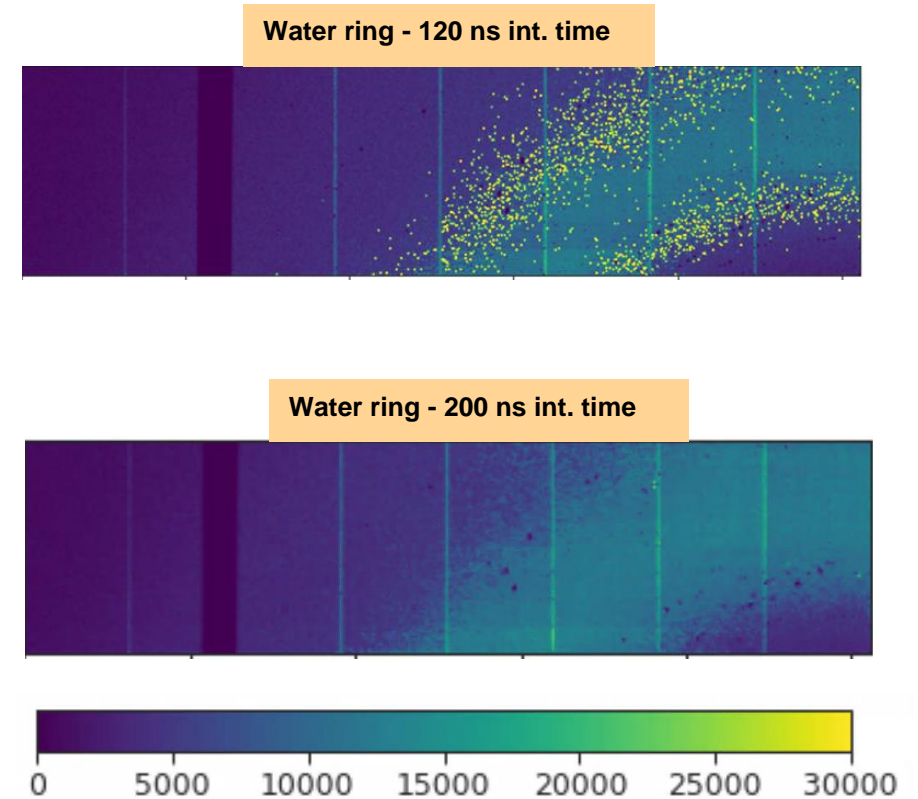
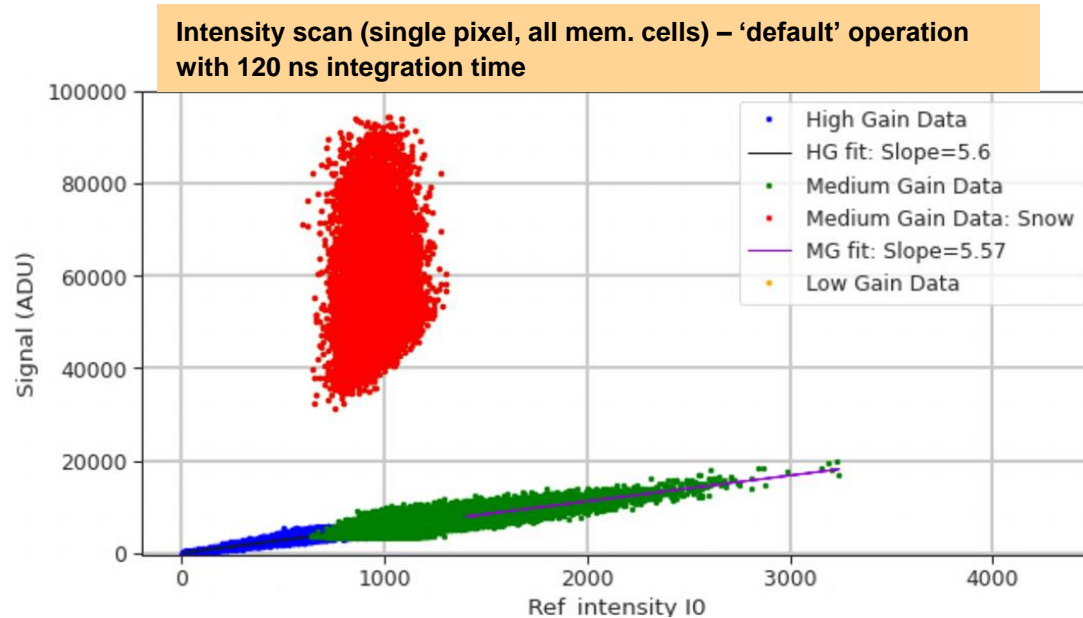
Cu fluorescence in default-high gain mode



Cu fluorescence in high-high gain mode



HG-MG gain switching



- Measured intensity close the switching point between HG and MG
- Artificially high intensities (so called snowy pixels)
- Intensity discontinuity
- Work on understanding and the transition region is ongoing:
 - Longer integration time for operation below 4.5 MHz
 - X-ray data collected at SPB/SFX (water jet ring) → reduction of “snowy pixels” by two orders of magnitude
 - Noise increase by 3-4 %data (collected in August)

Future operation scenarios for AGIPD

■ High-high gain operation

- ▶ High-CDS mode
- ▶ default integration time 120 ns

- Reduced noise (1.3 keV \rightarrow ~0.9 keV)
- For data below $< 20\text{-}30$ ph/pix/shot
- up to 4.5 MHz

■ Large dynamic range mode

- ▶ Normal-CDS setting
- ▶ increased integration time 200 ns

- Less “snowy” pixel during gain switching
- Increased noise (3-4%)
- Only up to 2.2 MHz

Thank you for your attention!

■ https://www.xfel.eu/facility/instruments/mid/index_eng.html

■ Mid-info@xfel.eu

■ <https://rtd.xfel.eu/docs/data-analysis-user-documentation/en/latest/index.html>