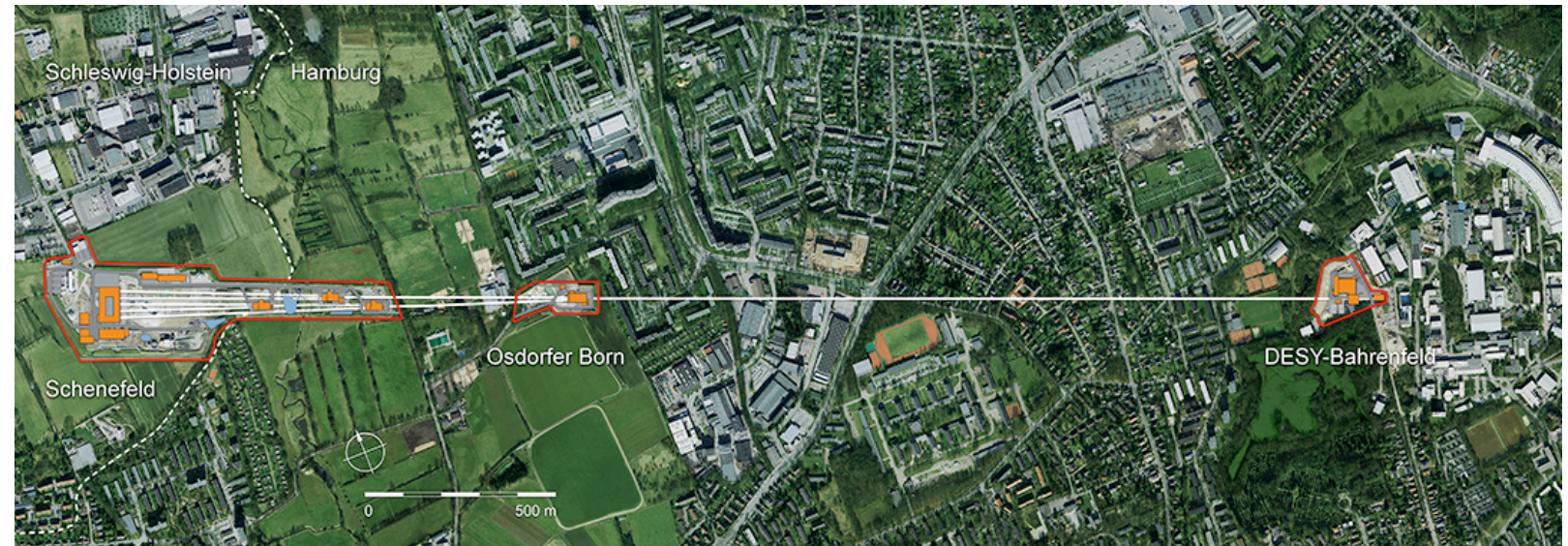


European XFEL facility overview

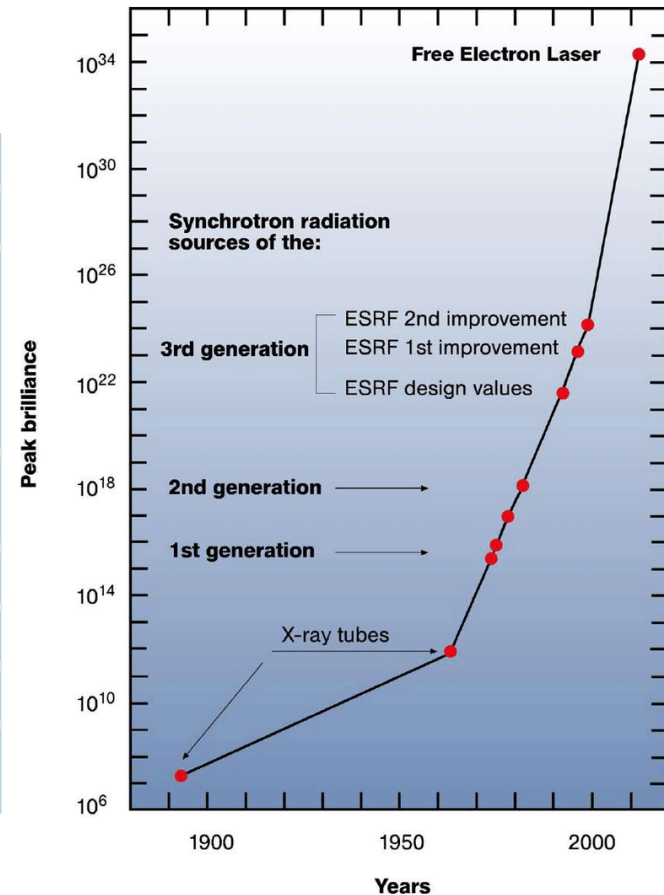
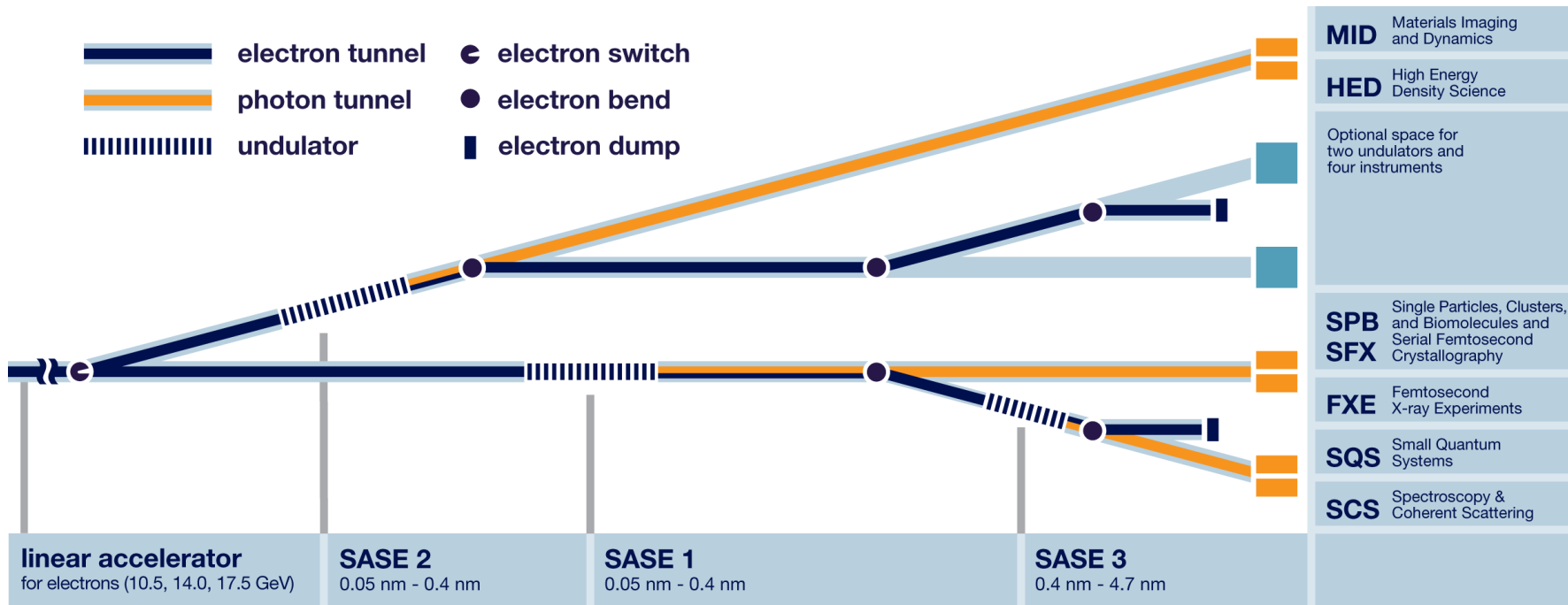


Monica Turcato
Detector Operation
Group leader

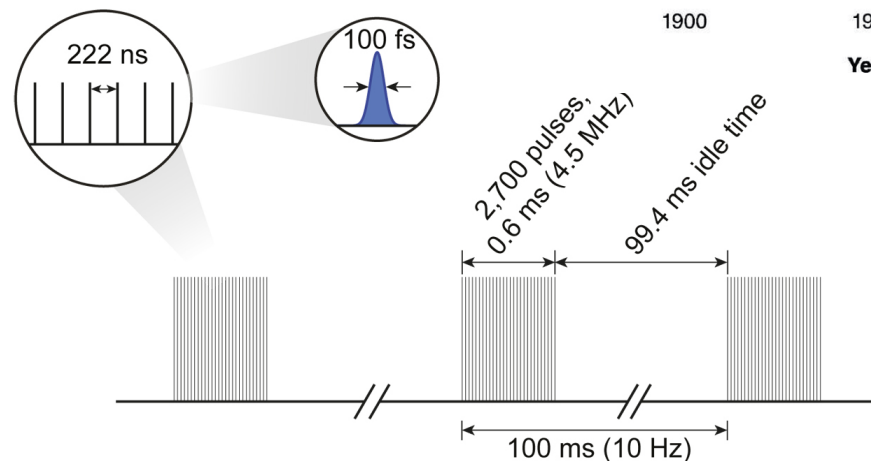
Schenefeld, March 25, 2021



The European XFEL beamlines



The specific time structure of the EuXFEL challenges detector design



Detectors for EuXFEL

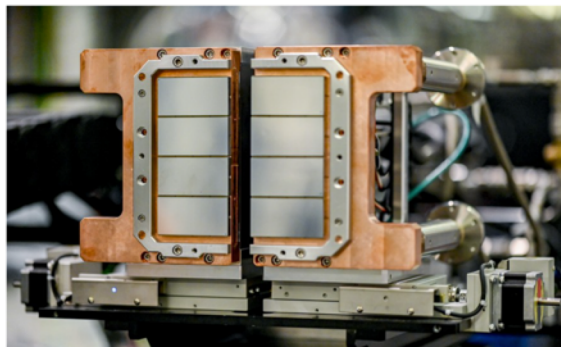
X-ray
energy

Hard
X-rays
6-25 keV



Noise: 50 e- (HG)
Dyn range: 100 8 keV ph

ePix100 (MID, HED)



Jungfrau x 17 (all hard X-ray inst.)

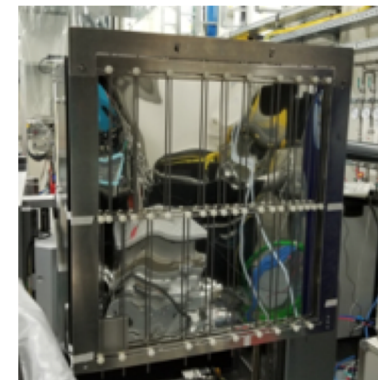
Noise: 80 e- (HG)
Dyn range: 10⁴ 12 keV ph

AGIPD (SPB/SFX, MID)



Noise: 350 e- (HG)
Dyn range: 10⁴ 12 keV ph

LPD (FXE)

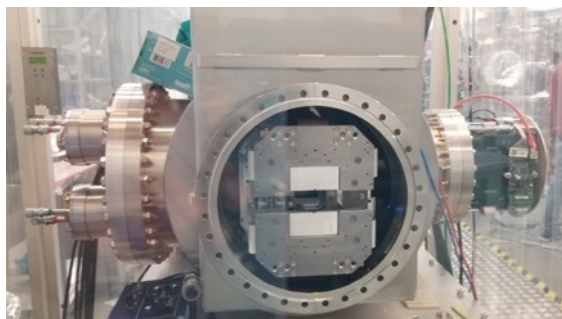


Noise: 2010 e- (HG)
Dyn range: 10⁵ 12 keV ph



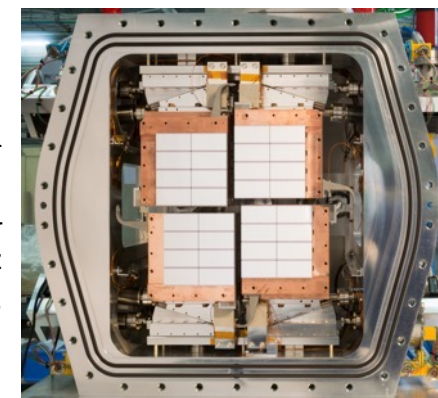
Soft
X-rays
0.5-3 keV

pnCCD (SQS)



Noise: 3 e-
Dyn range: 1500-3000 1 keV ph

DSSC (SCS, SQS)

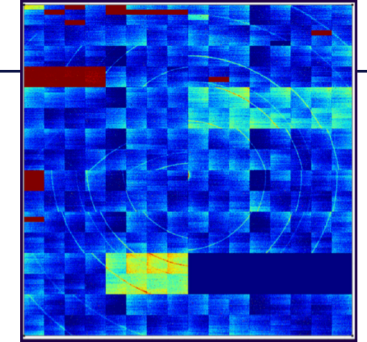


Noise: 60 e-
Dyn range:
N x 256 ph @ 4.5 Mhz –
N x 512 @ f ≤ 2.2 MHz
N ≤ 1 for single ph sens.

10 Hz

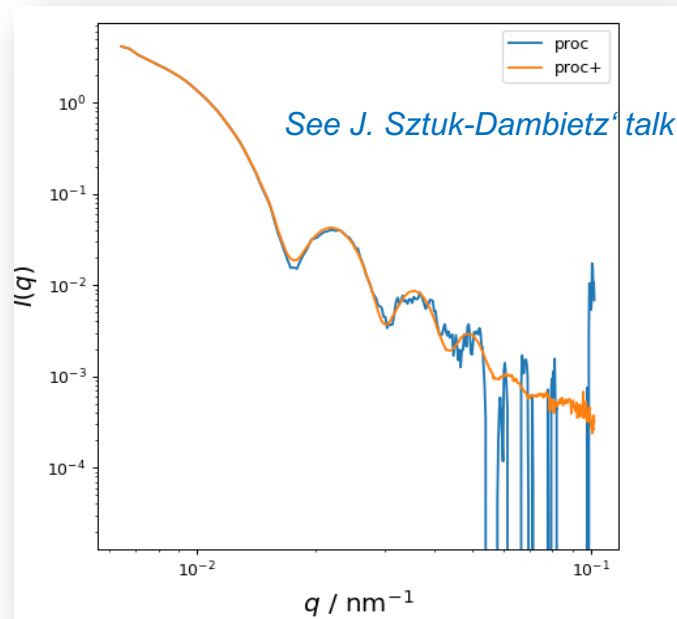
4.5 MHz

Rate

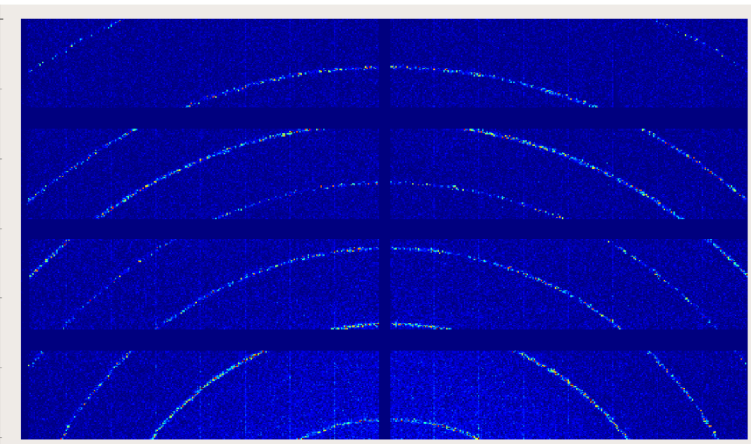
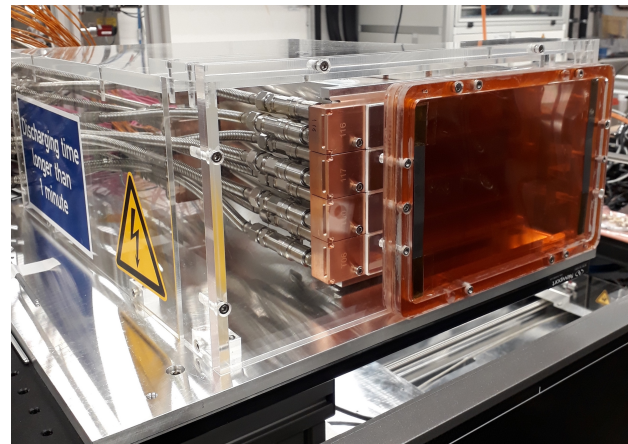


Status of present detectors at the European XFEL – AGIPD

- AGIPD (SPB/SFX, MID) installed since 2017
 - EuXFEL effort mostly in detector calibration and characterisation, to provide good data quality to the users
 - Hardware optimisation ongoing to solve existing features (baseline shift, gain separation). Tests performed with new ASIC version last fall



Results of common mode correction for MID data



AGIPD500K@HED prototype: first image from Nov 2020

Significant effort (EuXFEL-DESY cooperation) on cooling concept and mechanics for the new AGIPD detectors (for HED and for the 4 Mpixel for SPB/SFX)

Status of present detectors at the European XFEL – LPD and DSSC

■ LPD (at FXE since 2017): detailed detector understanding over the full dynamic range ongoing

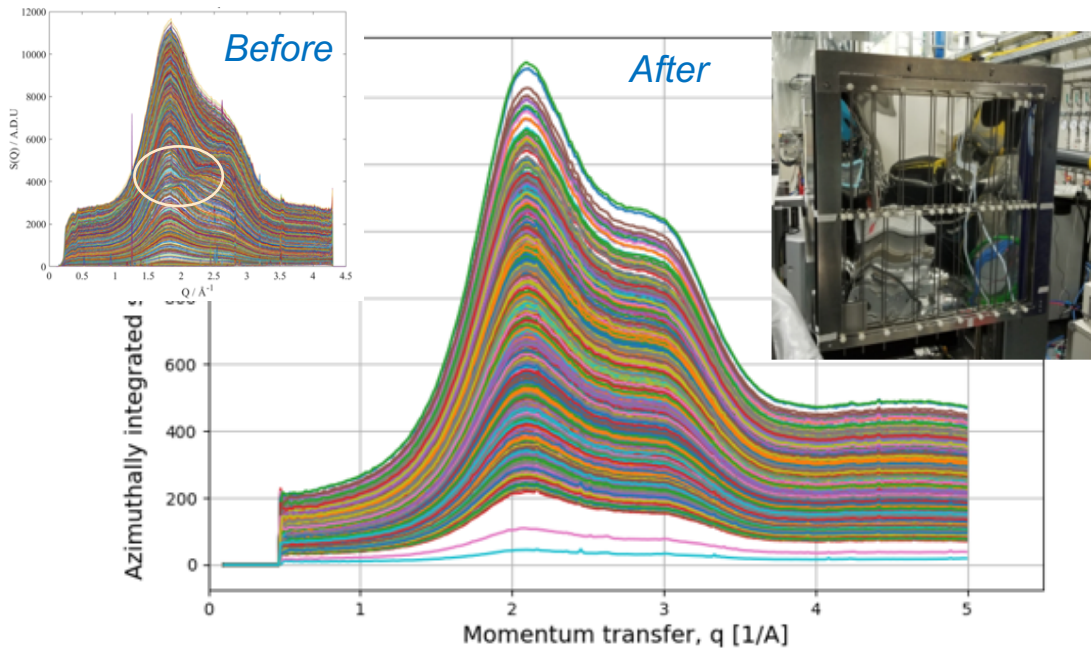
■ Commissioning and user experiments planned for May

■ DSSC MiniSDD installed in 2019 at SCS:

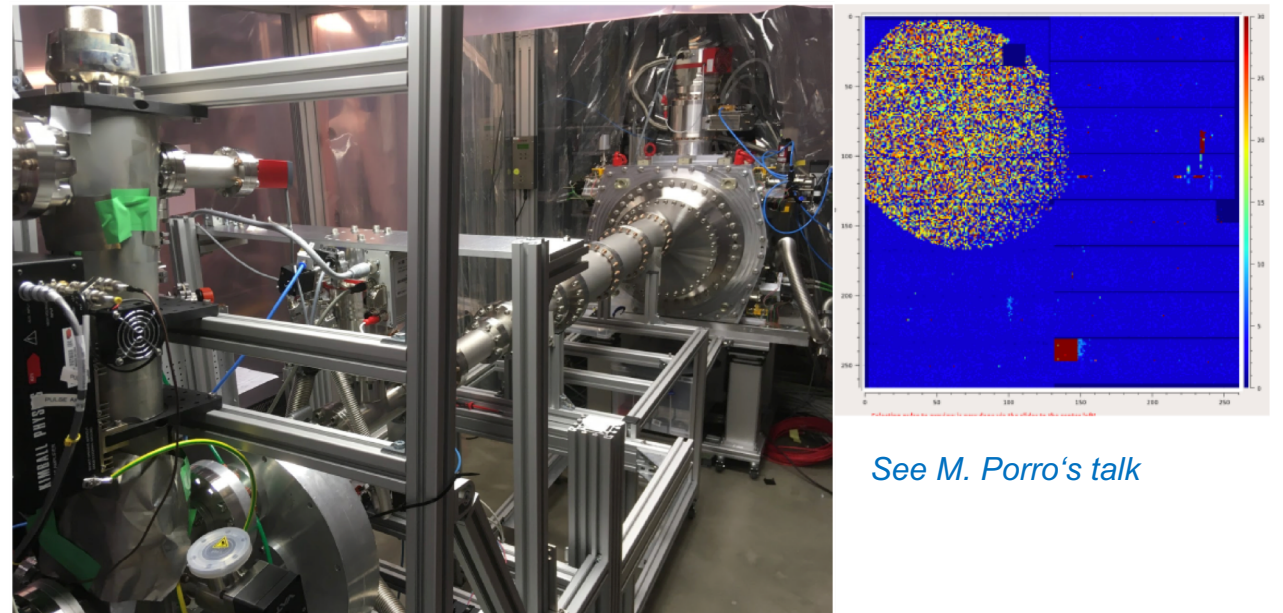
■ Used for a number of user experiments (despite COVID), first publication out, *Büttner & al. Nat. Mater. 20, 30 (2021)*

■ Ongoing work to optimise detector performance and test all the available operating modes

■ Existing version based on MiniSDDs with linear readout electronics. This limits the dynamic range in single photon detection mode. A second camera with non-linear DEPFETs is under development.



Liquid scattering data from LPD



Calibration of DSSC with the PulXar source

See M. Porro's talk

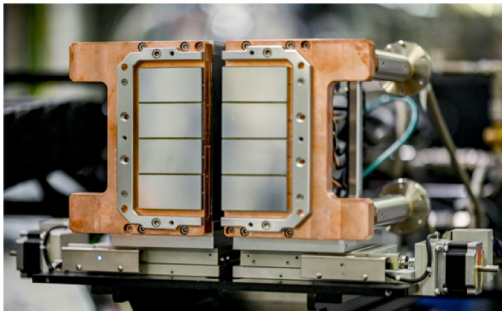
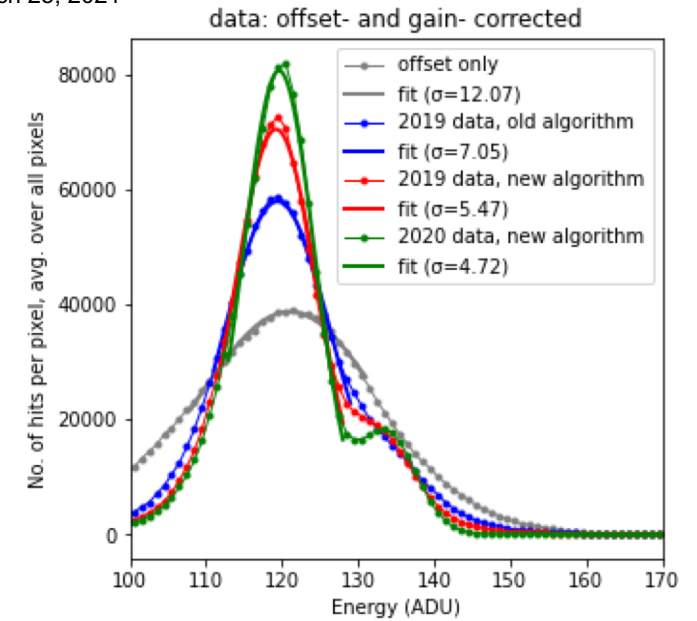
Status of present detectors at the European XFEL – III

- Jungfrau (17 instances)
 - Reliably used at 10 Hz
 - Issues under investigation in burst mode (with PSI)

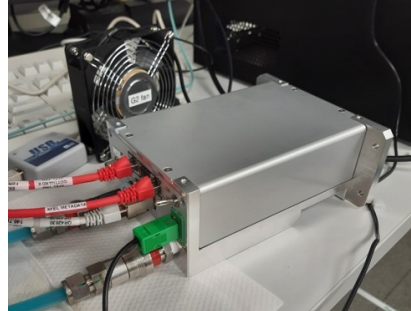
- Gotthard-II (29 to come)
 - First prototypes reached EuXFEL
 - Activity delayed due to COVID, but integration ongoing

- ePix100 (4 instances)
 - Reliably used at 10 Hz
 - Effort on calibration

- pnCCD
 - Reliably used at SQS
 - Effort on calibration

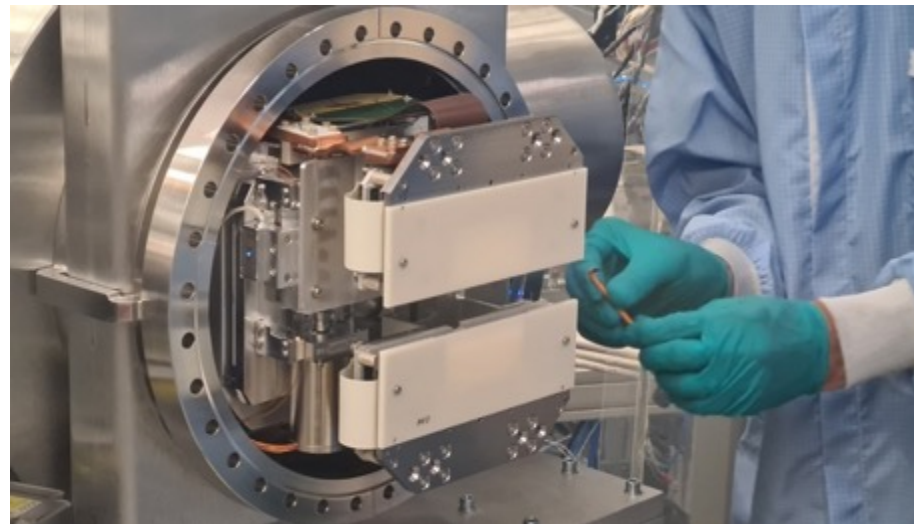


4M JF at SPB/SFX



G-II in DetOp lab

See M. Ramilli's talk



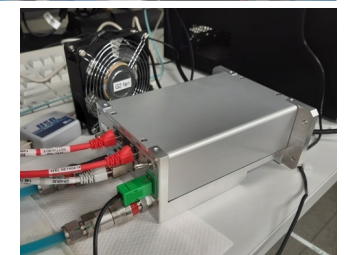
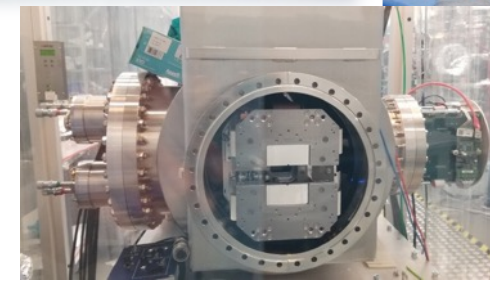
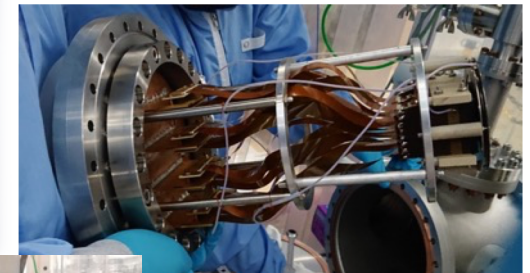
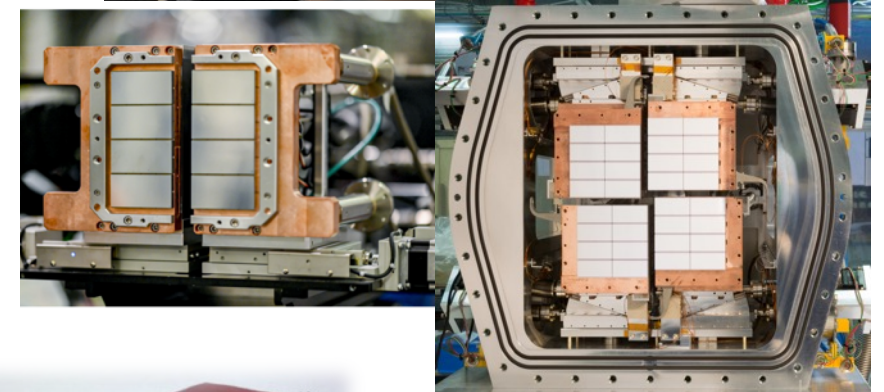
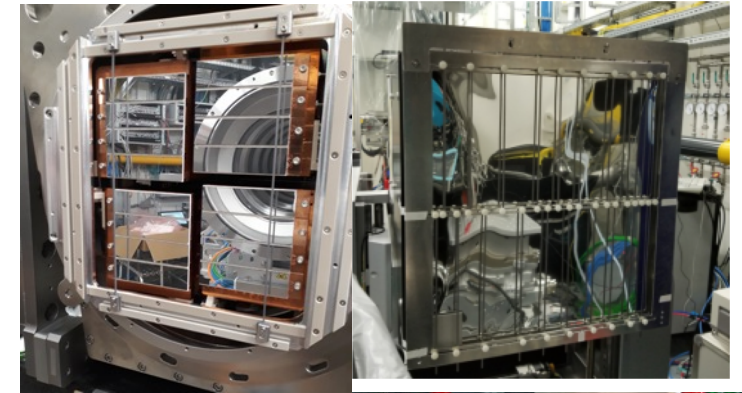
See K. Setoodehnia's talk

Data integrity challenges

The MHz detectors are one (or few) of a kind

- First produced devices, by definition ‘prototypes’
- Any effect is a new one, which nobody has seen before
- Users need well-understood and good quality data
 - Focus has to be on improvement of data correction
 - Need automatization in setup, operation and corrections
- Huge amount of collected data → working on data reduction

				bytes	
dtype		proc	raw		total
instrument					
SPB		3.5 PiB	10.3 PiB		13.8 PiB
MID		3.7 PiB	7.5 PiB		11.1 PiB
SCS		353.2 TiB	3.5 PiB		3.8 PiB
FXE		1.5 PiB	1.8 PiB		3.4 PiB
SQS		78.1 TiB	636.6 TiB		714.6 TiB
HED		43.9 TiB	317.7 TiB		361.6 TiB
total		9.2 PiB	24.0 PiB		33.2 PiB



Thank you for your attention

Backup

Detectors Specs (only installed detectors)

Parameter	AGIPD	DSSC	LPD	Jungfrau	ePix100	pnCCD
Sensor type	2D - Pixellated passive sensor Si 500 um	2D – MiniSDD pixel sensor – thick 450 um	2D Hybrid Pixel, Si sensor 500 μm	2D - Pixellated passive sensor Si 320 um/ 450 um	2D – Pixellated modular detector - Si 500 um	2D – Pixellated, fully depleted Si, back illuminated, 450 um
Pixel size	200x200 um	Hexagonal pixels. Pixel pitch 204 x 236 um	500μm x 500μm	75x75 um	50x50 um ²	75x75 um
# Pixel	1M (SPB, MID) 0.5M (HED)	1M	1M	500K/module	0.5M	1M
Sensitive energy range (keV)	3-13*	Optimized for 0.5 – 6 keV **	7 - 25	2-20	3 – 13 keV	0.3 – 25
Optimum energy	10		≥12 keV	10	8keV	
Dynamic range	10 ⁴ ph @ 12keV ph	N x 256 ph @ 4.5 Mhz – N x 512 @ f≤2.2 MHz N ≤ 1 for single ph sensitivity	10 ⁵ ph @ 12 keV	10 ⁴ ph @ 12keV ph	100 @ 8keV	1500 – 3000 photons at 1 keV
Noise (ENC)	350e- r.m.s. (HG)	60 e- r.m.s.	2010 e- (HG)	80 e- r.m.s. (HG)	50e- r.m.s. (after processing)	3e- r.m.s. (HG)
Frame rate	4.5 MHz	4.5 MHz	4.5 MHz	1.6 kHz (cont.) ~200 kHz (burst)	120Hz	Up to 150 Hz
Max. number of images per train	352	800	510	16	1	500
Installed at	SPB/SFX, MID, HED	SCS, SQS	FXE	SPB/SFX, FXE, MID, HED	HED, MID	SQS