DECTRIS®

detecting the future

EIGER performance and prospects

Stefan Brandstetter, DECTRIS LTS, SRI 2015, NYC

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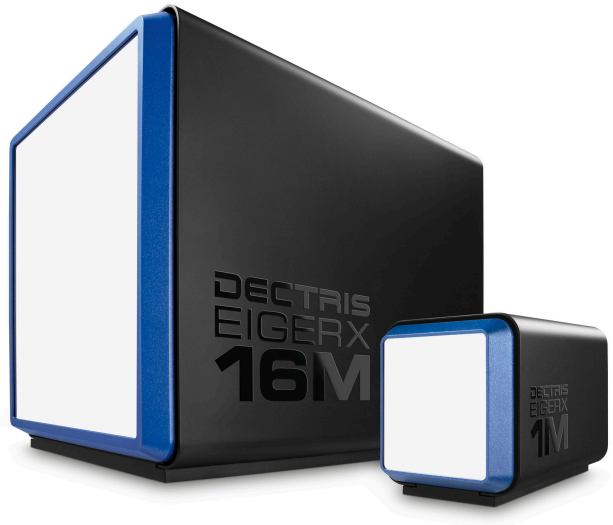
Motivation

Cutting edge science needs cutting edge X-ray detectors

- *fast*
- *high dynamic range*
- *small pixels*

- *Reliable instruments for 24/7 operation*

- *Best support*



EIGER Development Team



EIGER team developed

- *readout electronics*
- *firmware*
- *software*
- *mechanics*
- *calibration*



Detector performance

Characterization of

- *spatial resolution*
- *sensitivity*
- *count rate*

System

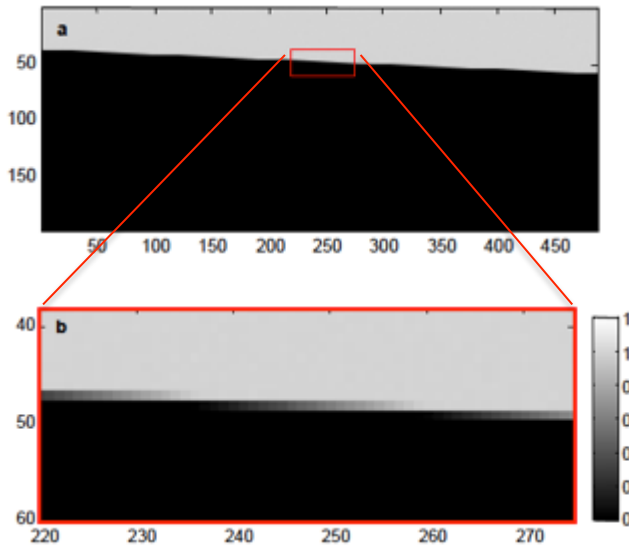
- *frame rate*
- *reliability*



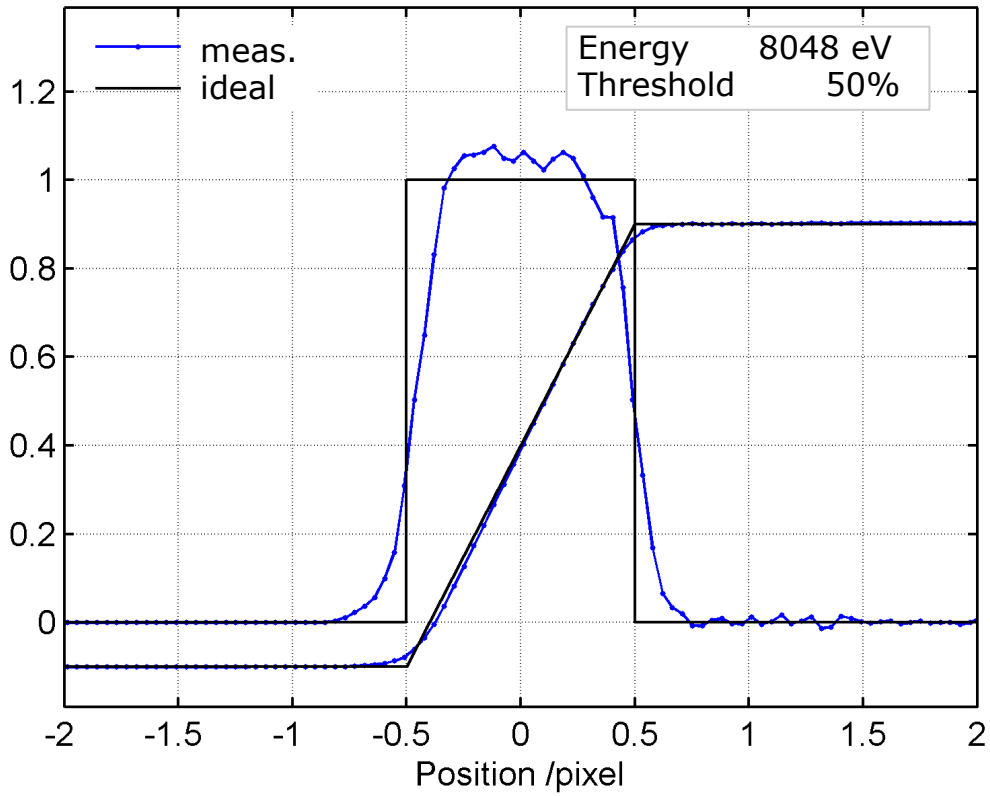
EIGER – spatial resolution

Edge Spread Function

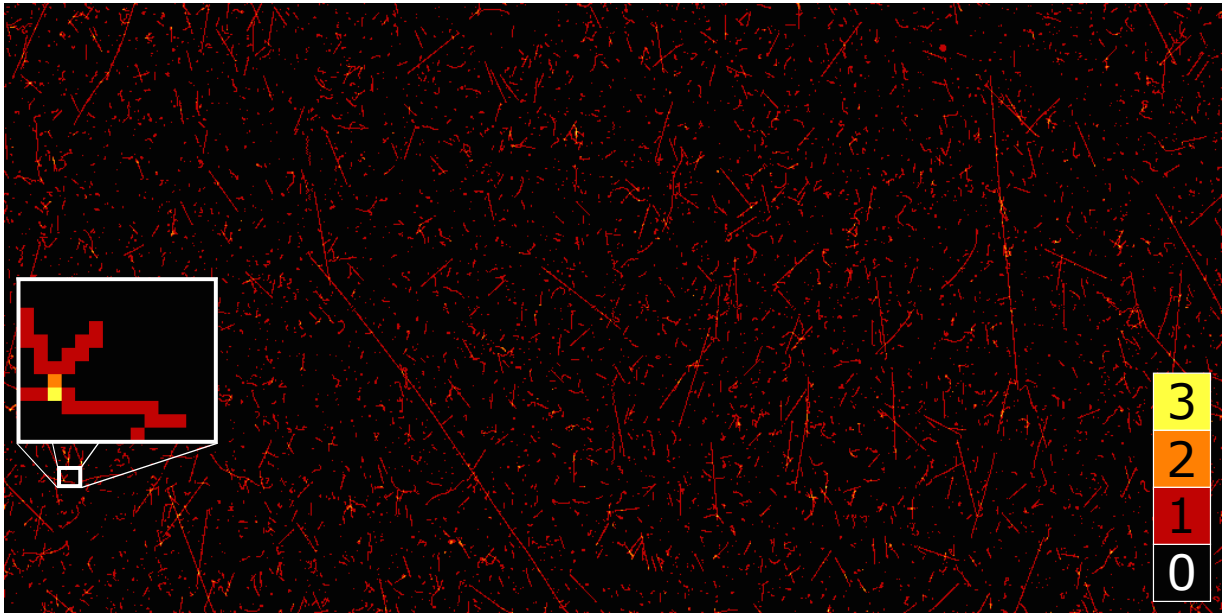
by slanted-edge method



Derivative (ESF) => LSF



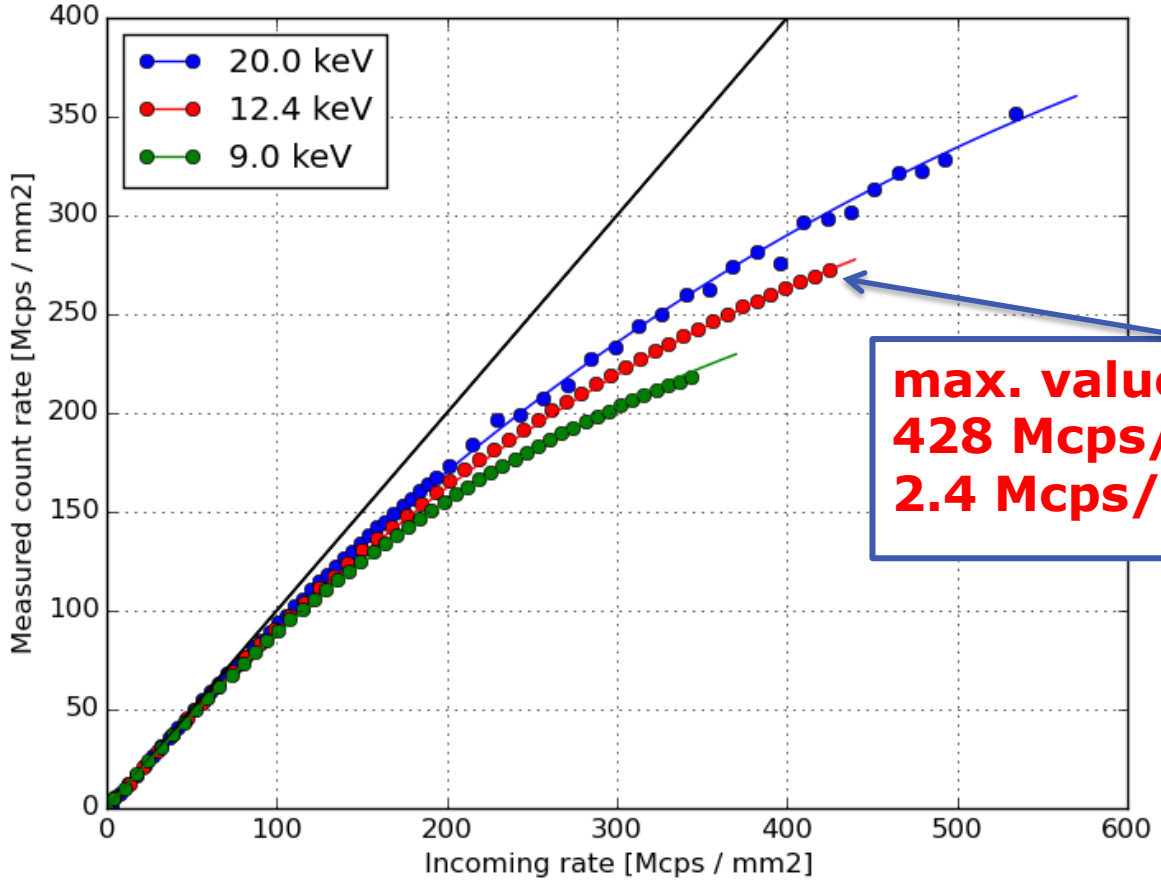
No readout noise
No dark current



1h dark image of an EIGER module.

Average background count rate is as low as 0.07 cts/pixel/hour

Count rate performance excellent at all energies



max. value at 12.4 keV
428 Mcps/mm²
2.4 Mcps/pixel

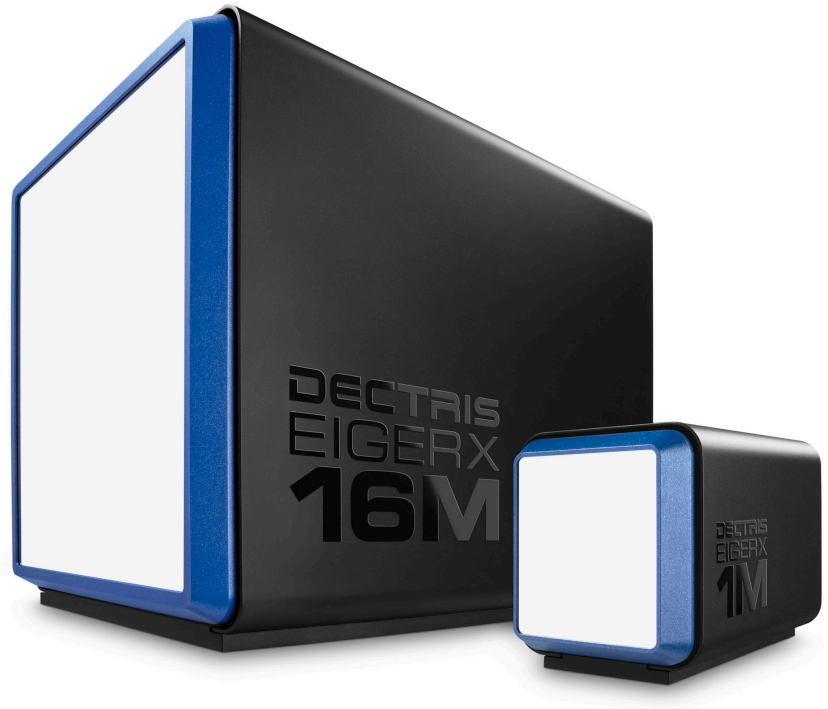
Detector performance

Characterization of

- *spatial resolution*
- *sensitivity*
- *count rate*

System

- *frame rate*
- *reliability*



Performance of the EIGER family

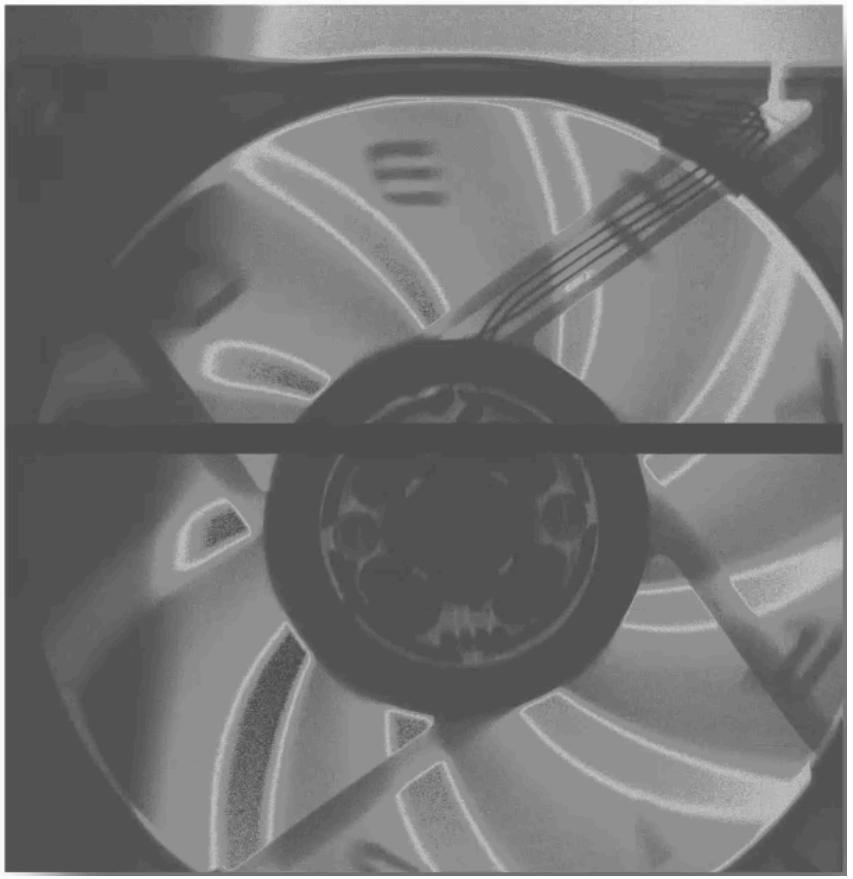
	max. frame rate [Hz]	# of images at max. frame rate	continuous frame rate [Hz]
EIGER X 1M	3000	> 90.000	1500
EIGER X 4M	750	> 22.000	375
EIGER X 9M	238	> 7.100	119
EIGER X 16M	133	> 4.000	66



EIGER X 1M

High-speed X-ray imaging

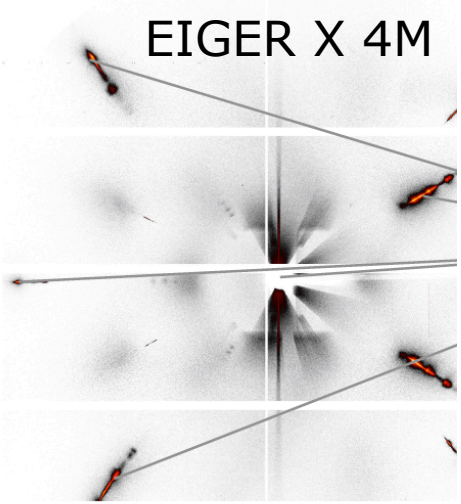
Sequence recorded at 3000 fps
Real time 1 s
Fan rotating at 2000 rpm

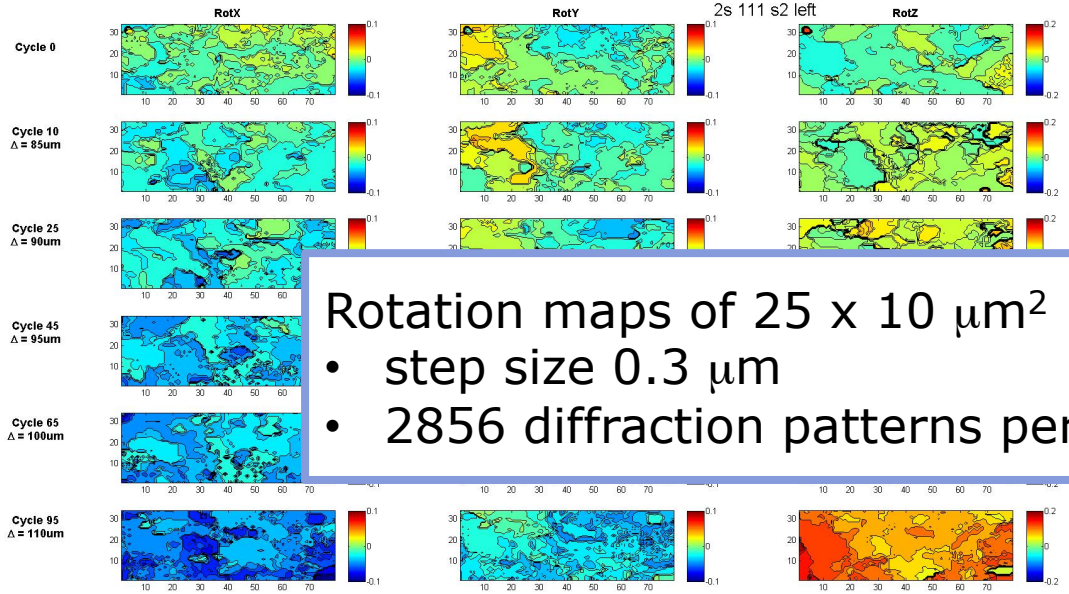


real speed (100%)

full resolution at full speed

Crystal orientation mapping of Cu foils by Laue diffraction





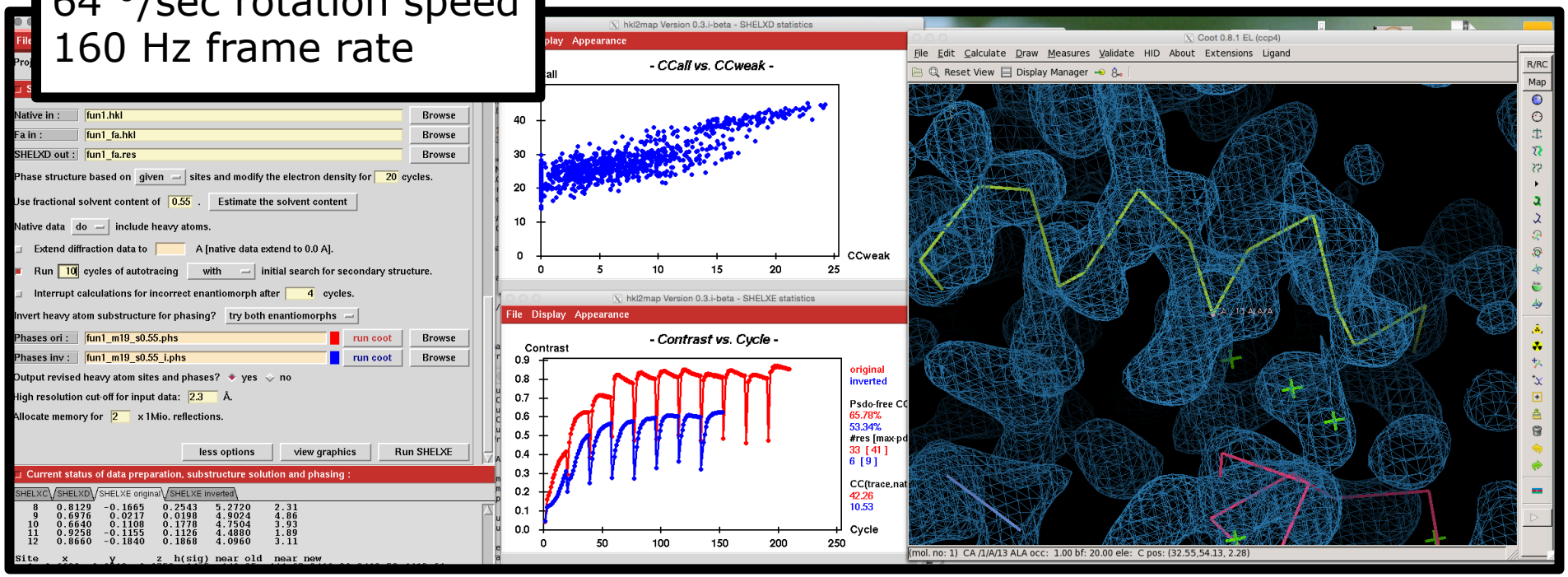
Rotation maps of 25 x 10 μm²
- step size 0.3 μm
- 2856 diffraction patterns per map

- high dynamic range and suppression of the fluorescence signal => resolve very weak peaks
- high frame rates => detailed grain rotation maps

One second native-SAD experiment

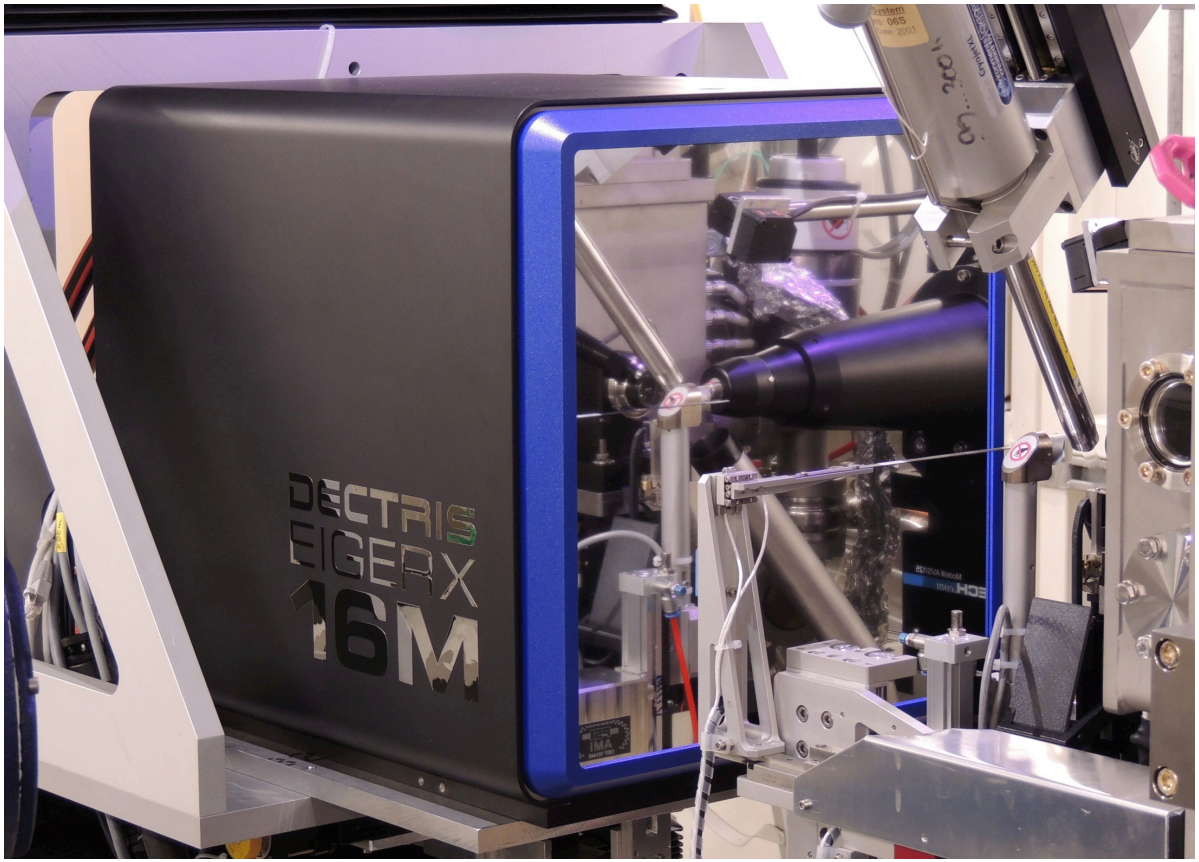
EIGER X 4M

Insulin data
8 keV (1.54 Å)
64 °/sec rotation speed
160 Hz frame rate



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EIGER X 16M at PSI



EIGER X 16M test at the PX beamline

Standard scan:
3600 images at 133Hz

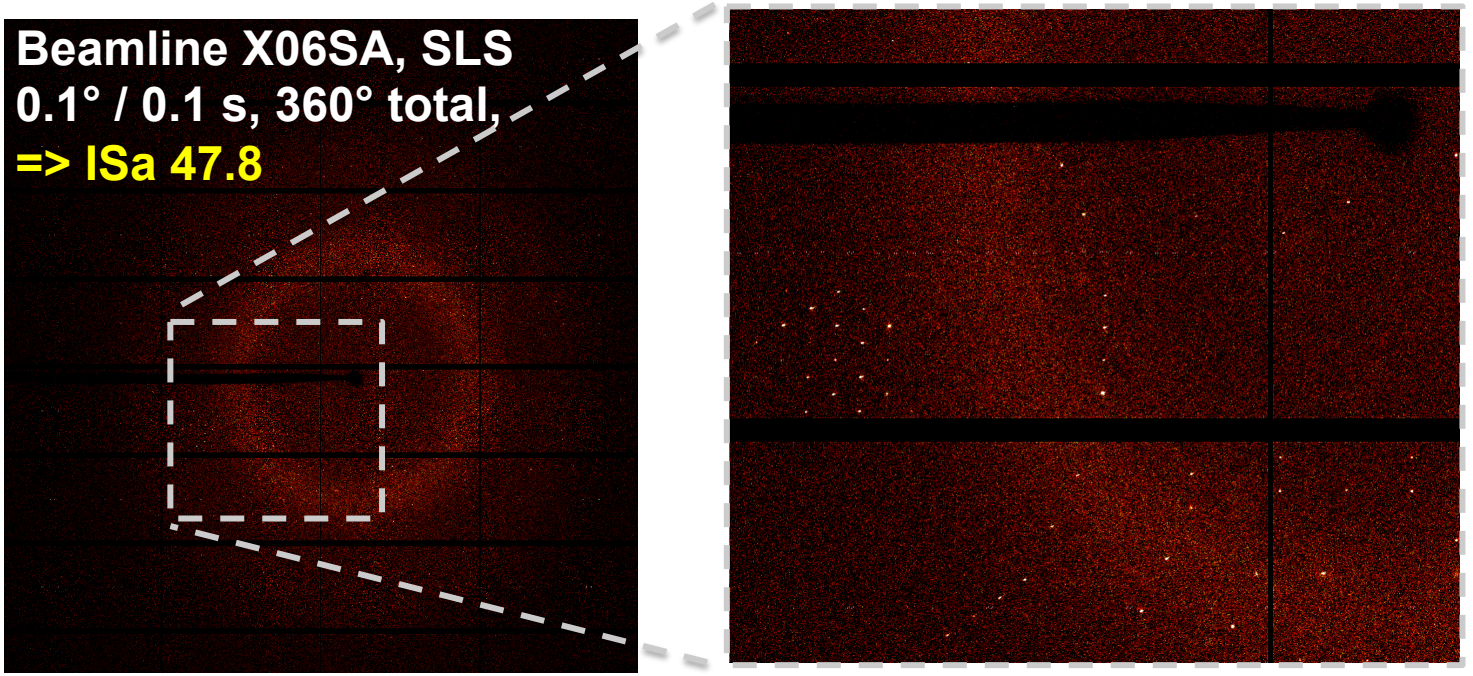
Very good data quality!

Stable operation for one week of test beamtime.

EIGER 16M data from insulin crystal

SUBSET OF INTENSITY DATA WITH SIGNAL/NOISE >= -3.0 AS FUNCTION OF RESOLUTION

RESOLUTION LIMIT	NUMBER OF REFLECTIONS OBSERVED	UNIQUE	POSSIBLE	COMPLETENESS OF DATA	R-FACTOR observed	R-FACTOR expected	COMPARED	I/SIGMA	R-meas	CC(1/2)	Anomal Corr	SigAno	Nano
3.88	29669	778	780	99.7%	1.8%	1.9%	29669	218.03	1.8%	100.0*	71*	1.934	623
2.75	56210	1350	1350	100.0%	2.4%	2.4%	56210	164.30	2.4%	100.0*	33*	1.240	1194
2.24	68309	1704	1694	100.6%	4.7%	4.5%	68309	88.36	4.8%	100.0*	19*	1.054	1546
1.95	82794	1986	1996	99.5%	9.0%	8.4%	82794	48.78	9.1%	100.0*	6	0.947	1836
1.74	91128	2275	2275	100.0%	19.6%	18.5%	91128	22.43	19.8%	99.7*	-3	0.854	2113
1.59	99814	2491	2480	100.4%	46.5%	45.0%	99814	9.52	47.1%	98.3*	0	0.832	2340
1.47	99707	2708	2719	99.6%	85.8%	89.6%	99707	4.29	87.0%	91.6*	-1	0.775	2547
1.38	67486	2895	2895	100.0%	131.6%	147.4%	67486	1.78	134.5%	58.6*	2	0.706	2745
1.30	34441	2863	3078	93.0%	192.3%	222.3%	34408	0.64	200.7%	10.7*	-2	0.619	2160
total	629558	19050	19267	98.9%	3.7%	3.7%	629525	38.44	3.7%	100.0*	2	0.880	17104



DECTRIS® detecting the future

Performance outlook

- Work on PPU (PILATUS Processing Unit) **successor** for **EIGER** in progress

- **Reduced arm time** to start a data collection series
  < 5 s for EIGER X 9M and EIGER X 16M
  < 1 s for EIGER X 1M and < 2 s for EIGER X 4M
  December 2015

- **ROI** for the EIGER X 9M and EIGER X 16M
  March 2016

- **Low energy** calibration
  2.3 keV low energy
  1.9 keV ultra low energy
  2016

Acknowledgement

- **PX Team at SLS**
  - Meitian Wang
  - Arnau Carsanas
  - Ezequiel “Zac” Panepucci
- **NXMM and MicroXAS team from PSI**
  - Ainara Irastorza
  - Steven Van Petegem
  - Daniel Grolimund

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Thank you for your attention!

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