DECTRIS EIGER2 X CdTe Detectors

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ESRF User Meeting, 8 January 2021
EIGER2 X CdTe detectors

- **High frame rates up to 2 kHz** with **continuous readout** (100 ns deadtime)
- High angular resolution with **75 µm pixel** at up to **16M pixel** (4M for lab series)
- High quantum efficiency up to 100 keV
- Gating with dual probe in two counters
**EIGER2 X and XE CdTe detectors**

<table>
<thead>
<tr>
<th></th>
<th>EIGER2 X CdTe 500K</th>
<th>EIGER2 X CdTe 1M</th>
<th>EIGER2 X CdTe 4M</th>
<th>EIGER2 X CdTe 9M</th>
<th>EIGER2 XE CdTe 16M</th>
<th>EIGER2 X CdTe 1M-W</th>
<th>EIGER2 X CdTe 2M-W</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of</td>
<td>1 x 1</td>
<td>1 x 2</td>
<td>2 x 4</td>
<td>3 x 6</td>
<td>4 x 8</td>
<td>2 x 1</td>
<td>4 x 1</td>
</tr>
<tr>
<td>detector modules</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitive area</td>
<td>77 x 39</td>
<td>77 x 80</td>
<td>155 x 162</td>
<td>233 x 245</td>
<td>311 x 328</td>
<td>77 x 80</td>
<td>77 x 80</td>
</tr>
<tr>
<td>(width x height)</td>
<td>[mm²]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>rate [Hz]</td>
<td></td>
<td></td>
<td></td>
<td>XE: 550</td>
<td>X: 400, burst 550</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

EIGER2 X and XE CdTe detectors, ESRF UM 2021
HPC with EIGER2

a) Suppression of low- AND high-energy background

b) Higher count rate performance

c) More than 4 billion counts per pixel and image

No saturation issues

More than ten orders of magnitude dynamic range
**High energy single crystal diffraction data**

Anisotropic displacement parameters ($\hat{A}^2$) for MgSiO$_3$

<table>
<thead>
<tr>
<th>Atom</th>
<th>$U^{11}$</th>
<th>$U^{22}$</th>
<th>$U^{33}$</th>
<th>$U^{12}$</th>
<th>$U^{13}$</th>
<th>$U^{23}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mg(1)</td>
<td>0.012(2)</td>
<td>0.020(3)</td>
<td>0.016(1)</td>
<td>-0.001(1)</td>
<td>-0.001(1)</td>
<td>0.000(1)</td>
</tr>
<tr>
<td>Mg(2)</td>
<td>0.011(1)</td>
<td>0.025(2)</td>
<td>0.017(1)</td>
<td>0.000(1)</td>
<td>-0.002(1)</td>
<td>-0.001(1)</td>
</tr>
<tr>
<td>Si(1)</td>
<td>0.009(1)</td>
<td>0.023(2)</td>
<td>0.015(1)</td>
<td>0.000(1)</td>
<td>0.000(1)</td>
<td>-0.002(1)</td>
</tr>
<tr>
<td>Si(2)</td>
<td>0.012(1)</td>
<td>0.018(2)</td>
<td>0.017(1)</td>
<td>0.000(1)</td>
<td>-0.002(1)</td>
<td>0.001(1)</td>
</tr>
<tr>
<td>O(1)</td>
<td>0.014(2)</td>
<td>0.013(5)</td>
<td>0.021(2)</td>
<td>0.002(2)</td>
<td>0.000(2)</td>
<td>0.000(1)</td>
</tr>
<tr>
<td>O(2)</td>
<td>0.014(2)</td>
<td>0.018(4)</td>
<td>0.022(2)</td>
<td>-0.002(2)</td>
<td>0.000(1)</td>
<td>-0.004(1)</td>
</tr>
<tr>
<td>O(3)</td>
<td>0.012(2)</td>
<td>0.031(5)</td>
<td>0.017(1)</td>
<td>-0.003(2)</td>
<td>0.003(1)</td>
<td>0.003(2)</td>
</tr>
</tbody>
</table>

Image courtesy of M. Mezouar, ID27, ESRF.
Standard Samples

LaB6

LaB6 in Diamond Anvil Cell

Courtesy of M. Mezouar, ID27, ESRF
Eiger2 vs Pilatus1M (single crystal)

Same reflection

better sampling of peaks & increased angular resolution

Test at Sector 13, 1-5 Nov 2020

Pilatus CdTe 1M

Eiger2 CdTe 1M

172 x 172

75 x 75

Courtesy of Vitali Prakapenka and Stella Chariton, GSECARS, sector 13, APS, ANL
Pulsed laser-heating in DAC using EIGER2 External Gating mode

Graphite loaded in DAC with Al2O3 pressure transmitting medium at 14 Gpa

Gate pulse 1 us wide, 10kHz, 500k pulses

Shortest gate in range 10 - 100 ns

New Gating Mode: Dual probe!

EIGER2 X CdTe at Sector 13

1700 K RT
New: EIGER2 CdTe 9M @ ESRF ID15B
High Pressure Diffraction Beamline

In total 7 EIGER2 CdTe detectors at ESRF
Largest EIGER2 CdTe detector at a high-pressure beamline yet
– Delivered & commissioned Oct 2020

ESRF SAT: “The test shows that the detector is extremely stable, with high signal to noise ratio, even weak signals can be extracted easily.”

Courtesy: Michael Hanfland, Davide Comboni
Weak diffraction - Background subtraction

Quartz glass (SiO2) in DAC

30 GPa in DAC, He medium, 30 keV, with EIGER2 X CdTe 9M at 180 mm distance.

SiO2 signal = Sample - Reference

Courtesy: Michael Hanfland, Davide Comboni
Single-grain mapping with EIGER2 X CdTe

Azimuthal map

PETRA III P21.2 test in June 2019
Detector: EIGER2 CdTe 1M (prototype)
Energy: 52 keV (narrow BW)
Rocking interval: 0.01 deg
Exposure time: 0.1 s

Courtesy: Ulrich Lienert, PETRA3 P21.2, DESY
Excellent data at 12 keV

Comparison of PILATUS3 6M and EIGER2 X CdTe 9M

- Beamline I24 at Diamond Light Source.
- Selenium-labeled thaumatin crystal.
- Identical data collection parameters.
  - 10 ms/img, 0.1°/img, 1% transmission, d = 200 mm.
  - Data collection below (12.4 keV) and above (12.673 keV) selenium edge.

Thanks to Robin Owen
Strong anomalous signal

Comparable data quality

– Data quality from E2 X CdTe 9M at 12.4 keV is comparable to that of P3 6M.
– High-resolution data is poorer because of size.
– Anomalous signal is comparable.

There is no disadvantage to collecting with a CdTe sensor.

Thanks to Robin Owen