The XPAD hybrid pixels detector

This work is a collaboration between:
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☞ the Laboratoire de Cristallographie (CNRS-Grenoble) (C. Mouget)
☞ the CRG-D2AM beamline (J.-François Bérar, N. Boudet, B. Caillot)

The needs
☛ available 2D detectors not suited to quality of beam

CCDs vs Pixels for X-rays

<table>
<thead>
<tr>
<th>Pixel size</th>
<th>Coupling</th>
<th>Energy res.</th>
<th>Read-out</th>
<th>Max flux</th>
<th>Shutter</th>
<th>Sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Si 20 µm</td>
<td>Si 330 µm</td>
<td>10%</td>
<td>90%</td>
<td>10^4ν/s</td>
<td>X</td>
<td>0.001ν/s/pixel</td>
</tr>
<tr>
<td>fluo screen 50 µm</td>
<td>1μm optic (intens)</td>
<td>10%</td>
<td>0.5s</td>
<td>10^5ν/pixel</td>
<td>X/optic</td>
<td>0.5ν/s/pixel</td>
</tr>
<tr>
<td>Si 330 µm</td>
<td>3000e^-</td>
<td>10%</td>
<td>0.005s</td>
<td>10^6ν/pixel</td>
<td>electronic gate</td>
<td>0.01ν/s/pixel</td>
</tr>
</tbody>
</table>

How does it work?
☞ photons ☞ continuous polarized sensor ☞ electron cloud ☞ bump ☞ pixelated electronic chip ☞ amplifier ☞ discriminator ☞ counter

Each pixel is parallelized
Very short reading times
On-board memories for real time kinetics

Results
Berar et al., JAC 35 2002

saturation 2.5 10^6 ph/s/pixel energy response tested between 10 and 24 keV resolution ≈ 1keV broad dispersion in the threshold level

SAXS on Silver Behenate: up to 7 orders of diffraction and intensity close to the direct beam.
20 keV, continuous diode bumped to 2 rows of 5 chips. White pixels: tuning out of range, truly dead pixel < 2 %.

Bragg peaks and diffuse scattering of CdYb quasicrystal. Inserts are zooms using a gray scale shifted by 2 orders of magnitude.
Pixel detectors can attain the performances needed for high dynamic studies.

Our present detector: 200 × 192 pixels ≈ 68 × 68mm²
Several modules to be tiled together Challenges: reducing shading and dead zones adjust all the pixels threshold

Recent images at 20keV

Front view of the 8 modules assembly:
the 500µm thick Si diodes.

Futur developments: XPAD3
✔ under design ✔ radiation-hard submicronic technology (0.25 microns) ✔ pixel size reduced to 100 – 150µm ✔ challenge: similar or enhanced performance ...