

The "pixel detector consortium" and European developments

Heinz Graafsma (DESY)
on behalf of the consortium

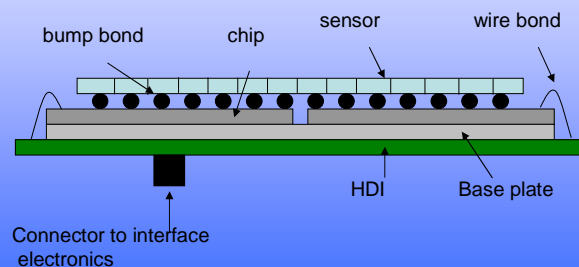
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Layout ?

- Who are we?
- What will we become?
- What is going on in Europe?



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Who are we ?

- History:
 - Late 2004 the idea came up to have a small meeting between SR's to create info exchange on ongoing and future pixel detector projects
 - 6/7 April 2005 first meeting at DIAMOND. Decided to:
 - Try to build together a small fast SAXS system based on PILATUS (never worked)
 - Keep meeting regularly to exchange information
 - Follow-up meetings:
 - 7th July 2005 IWORID meeting ESRF (short)
 - 18/19 October 2005 SLS users meeting
 - 24 April 2006 SOLEIL
 - 18/19 February 2007 ELETTRA
 - Meetings have been mainly an exchange of information!
 - Meetings have been "open"
 - Consortium is a subset of the IA-SFS

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What will we become ?

- Maybe stay who we are: Informal and open discussion group, with no money involved.
- Maybe become an official Networking Activity under the IA-SFS; discussed today and tomorrow.
- Hopefully get a Joint Research Activity on a specific detector project (Sensors); discussed today and tomorrow.

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What is going on in Europe ?

- ESRF: Medipix-2 parallel readout

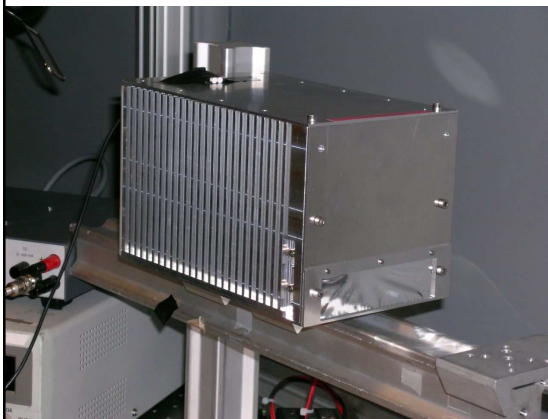
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European Synchrotron Radiation Facility

MAXIPIX high frame rate pixel detector



Based on **MEDIPIX2*** photon-counting readout chip

1280 x 256 pixels (5 readout chips)
Pixel size 55 x 55 μm^2
6–20 keV range (500 μm thick Si sensor)
> 10^5 counts/pixel/s
290 μs readout dead time
300 Hz frame rate (full frame)
1000 Hz frame rate (256x256 pixels)

Applications :

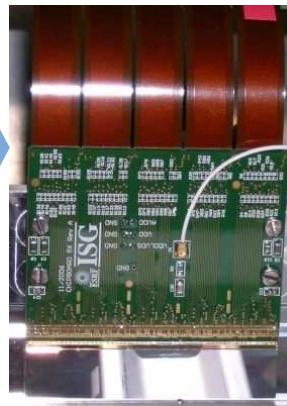
Developed for time-resolved, noiseless and high spatial resolution X-ray detection.

- Inelastic scattering
- XPCS
- SAXS, GISAXS
- Diffraction
- possibly imaging

* <http://medipix.web.cern.ch/MEDIPIX/>

MAXIPIX high frame rate pixel detector

5x1 multichip module (1280 x 256 pixels)
 3-sides buttable, allowing to build large area layouts



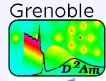
Future plans :

- 1280 x 512 pixels module (5x2 chips)
- Other layouts depending on requests:
 - e.g. 512 x 512 pixels (2x2 chips), linear arrangements
- High energy versions (high-Z sensors)

What is going on in Europe ?

- ESRF: Medipix-2 parallel readout
- D2AM/Marseille/SOLEIL: XPAD3

XPAD3, hybrid pixel detector



- A joint project involving **D2AM/CRG-ESRF, Inst. NEEL, CPPM-IN2P3, Sync. SOLEIL**
 - S. Basolo, J.-F. Bézar, N. Boudet, P. Breugnon, B. Caillot, J.-C. Clemens, P. Delpierre, B. Dinkespiler, S. Hustache, I. Koudobine, K. Medjoubi, M. Menouni, P. Pangaud, R. Potheau, E. Vigeolas
- New analog and digital architecture using 0.25 μm technology

	XPAD2	XPAD3S	XPAD3C
polarization	both	e^+ (Si)	e^- (CdTe)
pixel size	$330 \times 330 \mu\text{m}^2$		$130 \times 130 \mu\text{m}^2$
chip size	$8 \times 10 \text{mm}^2$		$10 \times 15 \text{mm}^2$
counting rate	2.10^7ph/s/pixel	2.10^6ph/s/pixel (\equiv count/surface)	2.10^5ph/s/pixel (\equiv count/surface)
photons rate	2.10^6ph/s/pixel		
counters (bits)	$16 + 16 \text{ext}$	$12 + 16 \text{ext}$ (\equiv count/surface)	
energy range	(5) $15 \rightarrow 25 \text{keV}$	$5 \rightarrow 32 \text{keV}$	$7 \rightarrow 60 \text{keV}$
energy edges	low level 5	low level	low and up levels
pixels/chip	$24 \times 25 = 600$		$80 \times 120 \approx 1.10^4$
pixels/module	$8 \times 600 \approx 5.10^3$		$\approx 7.10^4$
pixels/detector	$\approx 4.10^4$		$\approx 5.10^5$
geometries	8×8 or 2×5		7×8 and ...

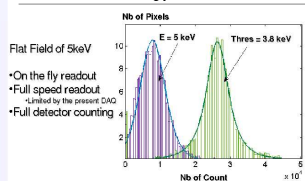
berar@esrf.fr, ALBA meeting, Sept. 27-28th, 2007 XPAD : pixel detector for material sciences

Si bounded XPAD3S detector

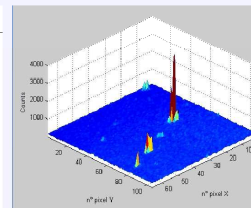
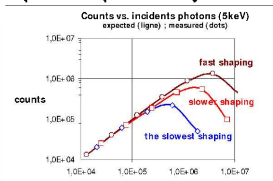
- All chips have been delivered and single chip Si detectors tested.
- Multichips Si modules under assembly will be delivered in october.
- Chips bounded with CdTe detector have to be tested with beam.

Prototype Si detectors, using XPAD3S chips, have been tested using beam from 5keV to 25keV, they fulfill the chip requirements and work in the whole energy range.

Minimum Energy threshold



Up to 10^6 photons by second



On right, an image from a Lysozyme data collection at Soleil at 5.9keV.

Multimodules detector will be delivered at the end of the year.

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What is going on in Europe ?

- ESRF: Medipix-2 parallel readout
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- **PSI/SLS: Pilatus and Mythen**

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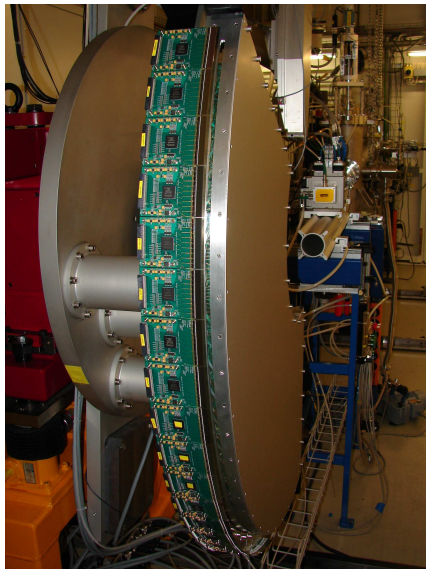
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The MythenII Detector System



- Modular system: 1 to 24 modules, for XRPD at SLS 24 modules covering 120°
- System works reliably, will be in regular use at SLS PD from November onwards
- Full 120° PD spectrum in <1s, typically 0.1s
- Energy range: 5-40 keV (at SLS PD)
- Low noise: 190-240 ENC lowest threshold at 3 keV (noise limited)
- High countrate: >3 MHz/channel (with x-rays)
- Fast readout: 32-300 μ s (implemented currently 300)
- Frame rate 100Hz for 1 and 10Hz for 24 modules, in future 10Khz and 1kHz
- Other applications: (C)SAX, imaging,...

Paul Scherrer Institut • 5232 Villigen PSI

Bernd Schmitt

MythenII module

Silicon sensor with 1280 strips
8 mm long, 50 μm pitch, 300 μm thick

Read out chip:

- 0.25 μm readout chip, 128 channels
- low noise preamp: 240 e⁻ ENC
- 24 bit binary counter
- Readout Time: variable length (4-24bits)
32-64 μs (currently 300 μs)
- 6 bit DAC for threshold fine tuning
1.4keV without trimming and 140eV
Trimmed

Development will continue at PSI:

- 25 μm pitch
- Deadtime free readout
- ...



What is going on in Europe ?

- ESRF: Medipix-2 parallel readout
- D2AM/Marseille/SOLEIL: XPAD3
- PSI/SLS: Pilatus and Mythen
- **Daresbury: XSTRIP**

What is going on in Europe ?

- ESRF: Medipix-2 parallel readout
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- PSI/SLS: Pilatus and Mythen
- Daresbury: XSTRIP
- ESRF/DESY: APD-array (start-up)

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- For the European XFEL (start-up):

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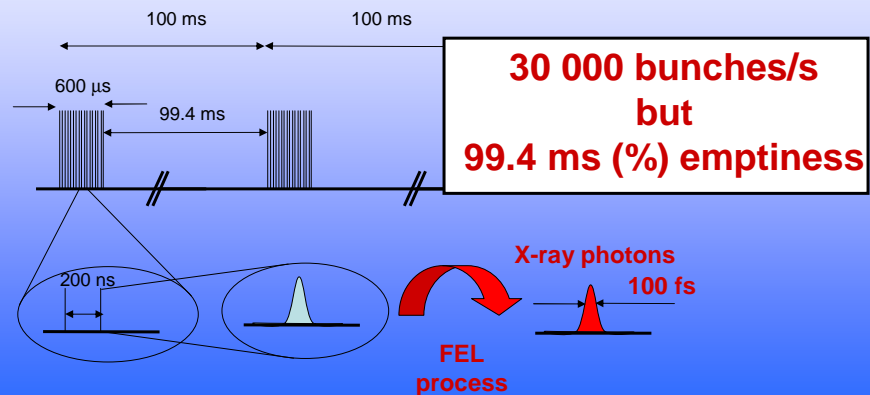
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The XFEL Detector challenge?

Time structure: difference with “others”

Electron bunch trains; up to 3000 bunches in 600 μ sec, repeated 10 times per second.
Producing 100 fsec X-ray pulses (up to 30 000 bunches per second).



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- ESRF/DESY: APD-array (start-up)

For the European XFEL:

- **STFC (RAL): LPD**

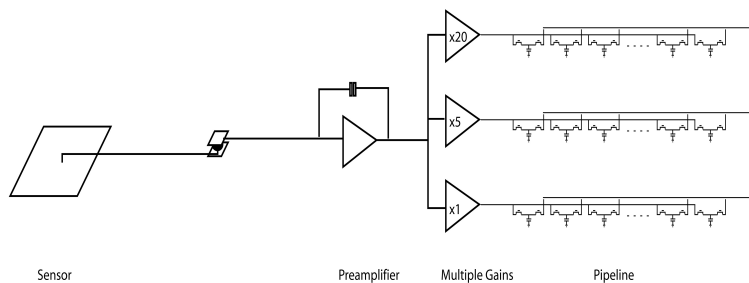
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The XFEL LPD-Detector principle

- Multiple gains in parallel
- Large depth analogue pipelines



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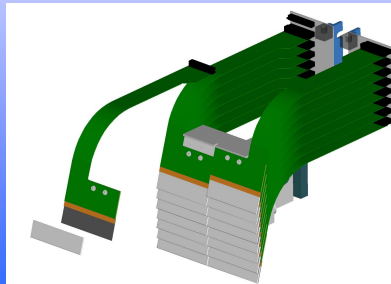
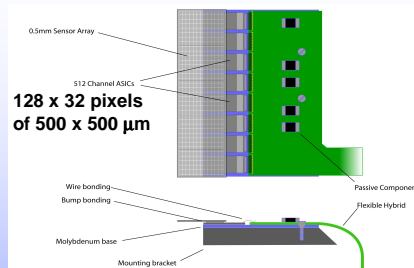
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The XFEL Large Pixel Detector

Basic parameters

- 500 μm pixels
- 5 MHz framing speed
- Single photon sensitivity
- 10^5 dynamic range, using 3 gains in parallel.
- 512 image storage depth (for all 3 gains)
- 128 x 32 pixels monolithic tiles
- Roof tile structure



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What is going on in Europe ?

- ESRF: Medipix-2 parallel readout
- D2AM/Marseille/SOLEIL: XPAD3
- PSI/SLS: Pilatus and Mythen
- Daresbury: XSTRIP
- ESRF/DESY: APD-array (start-up)

For the European XFEL:

- STFC (RAL): LPD
- **DESY/PSI: ap-HPAD**

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ap-HPAD

BASIC PARAMETERS

- 200 μm pixels
- 5 MHz framing speed
- Single photon sensitivity
- 2×10^4 dynamic range, using 3 switched gains
- 400 to 1000 image storage depth
- 256 x 512 monolithic tiles
- Flat detector

Connector to interface electronics

B

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HELMHOLTZ GEMEINSCHAFT DESY PAUL SCHERRER INSTITUT PSI universität bonn U+H Universität Hamburg

The gain switching and Pipeline

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What is going on in Europe ?

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- D2AM/Marseille/SOLEIL: XPAD3
- PSI/SLS: Pilatus and Mythen
- Daresbury: XSTRIP
- ESRF/DESY: APD-array (start-up)

For the European XFEL:

- STFC (RAL): LPD
- DESY/PSI: ap-HPAD
- **MPI-HLL/DESY: LSDD**

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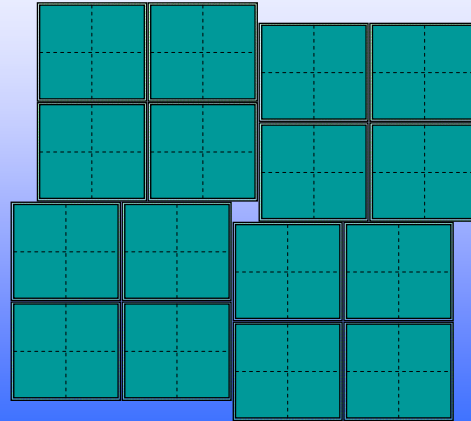


The XFEL LSD-Detector

BASIC PARAMETERS

- 200 μm pixels; (1st dimension by strip size, 2nd by time)
- 1 MHz framing speed (i.e. 600 frames)
- Single photon sensitivity (to at low energies < 500eV)
- 10^3 (10^4) dynamic range
- 512 x 512 pixel monolithic tiles (256 x 256 phase 1)
- Flat detector

Final detector: 1k x 1k pixels

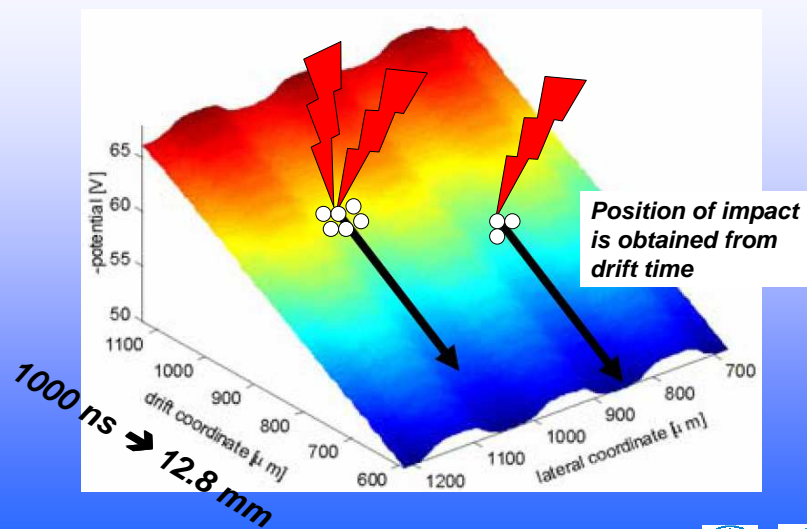


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The XFEL LSD-Detector principle



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Conclusion

- Various projects in Europe (more than in USA or Japan).
- Projects have reached stage of working systems (more than prototype chips)
- Not all are easily available to others
- All operational systems based on silicon, GaAs & CZT on prototypes.
- What added value can our consortium bring?
 - Establishing a reliable source for high-Z sensors?
 - Avoid duplication of efforts (interfacing, calibration,...)?
 - Exchange information (raising knowledge level)
 - Political weight.

