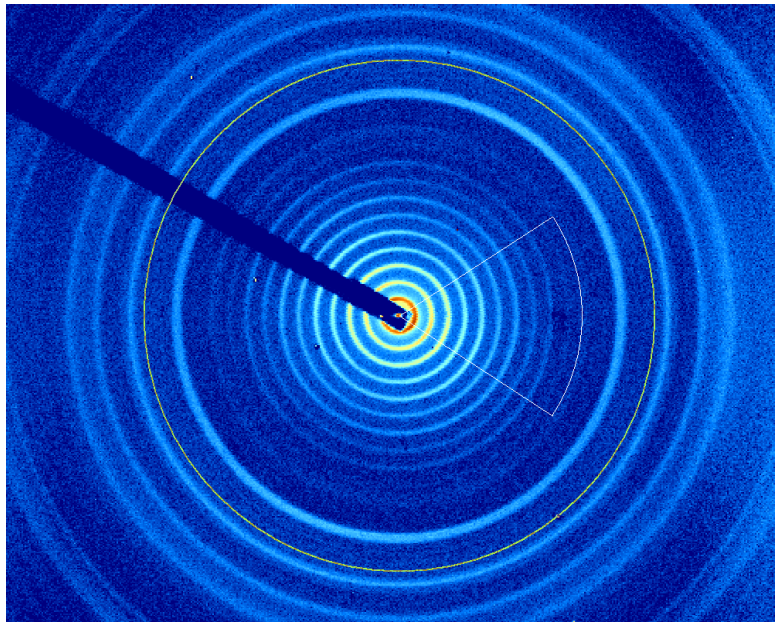
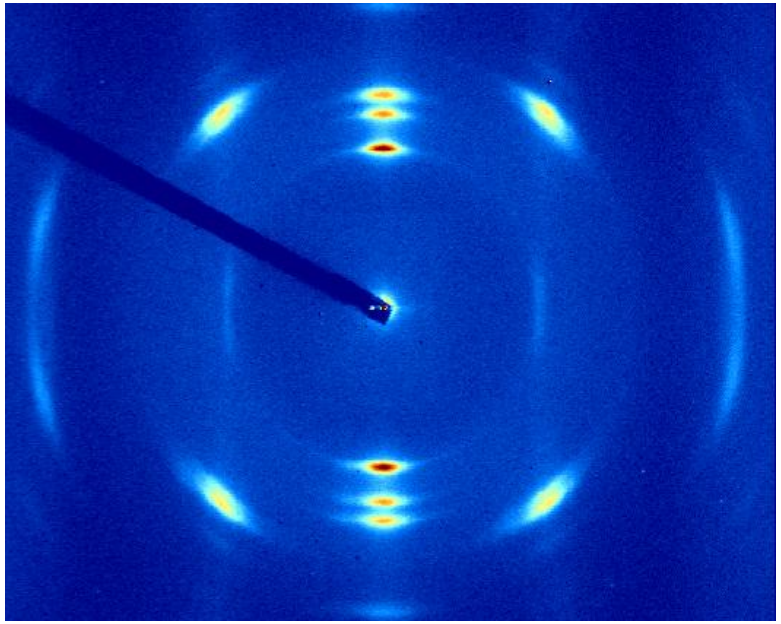
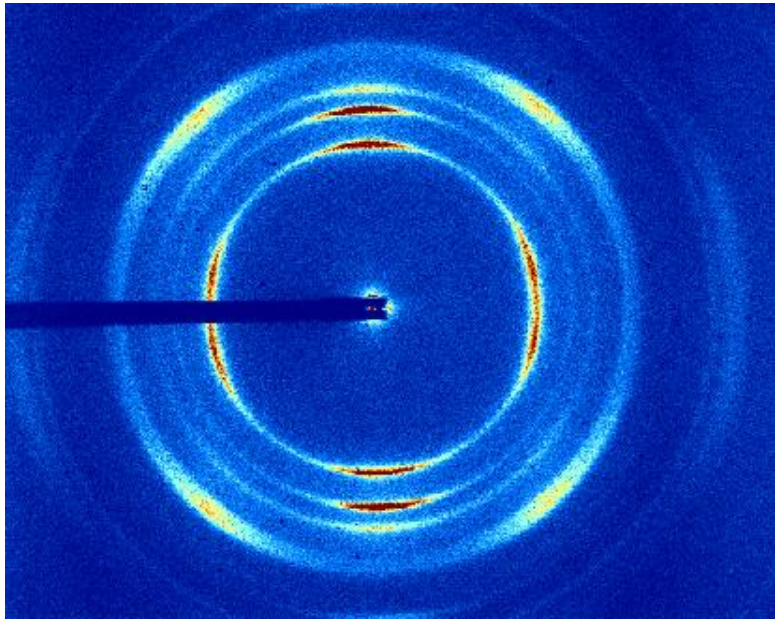
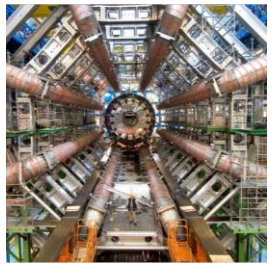




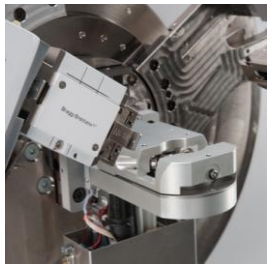
Pseudo-3D pixel detectors for powder diffraction

Martijn Fransen

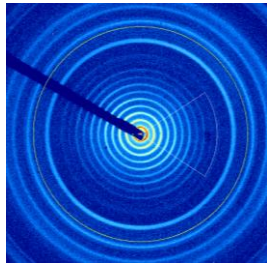
Agenda



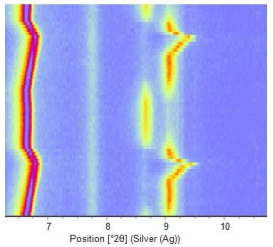
Solid state position-sensitive detectors @PANalytical



Dealing with polychromatic radiation

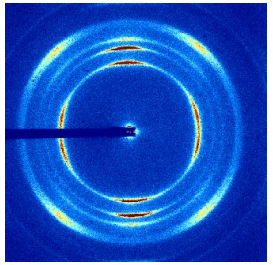


Spatial resolution … in three dimensions



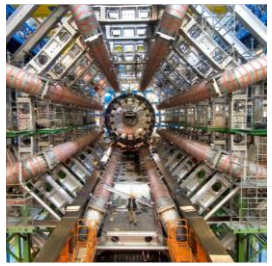
The challenges of non-Cu radiation

The importance of dynamic range



Conclusions

Agenda



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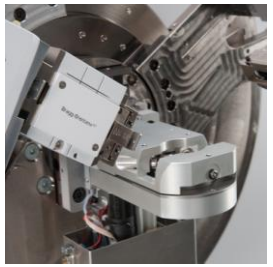

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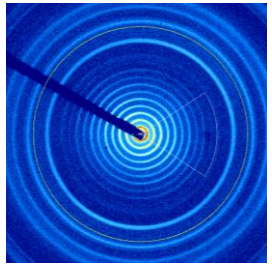

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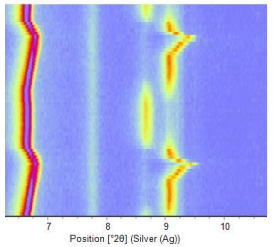

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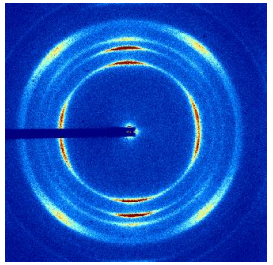

Conclusions

PANalytical: pioneer in solid-state position-sensitive detectors

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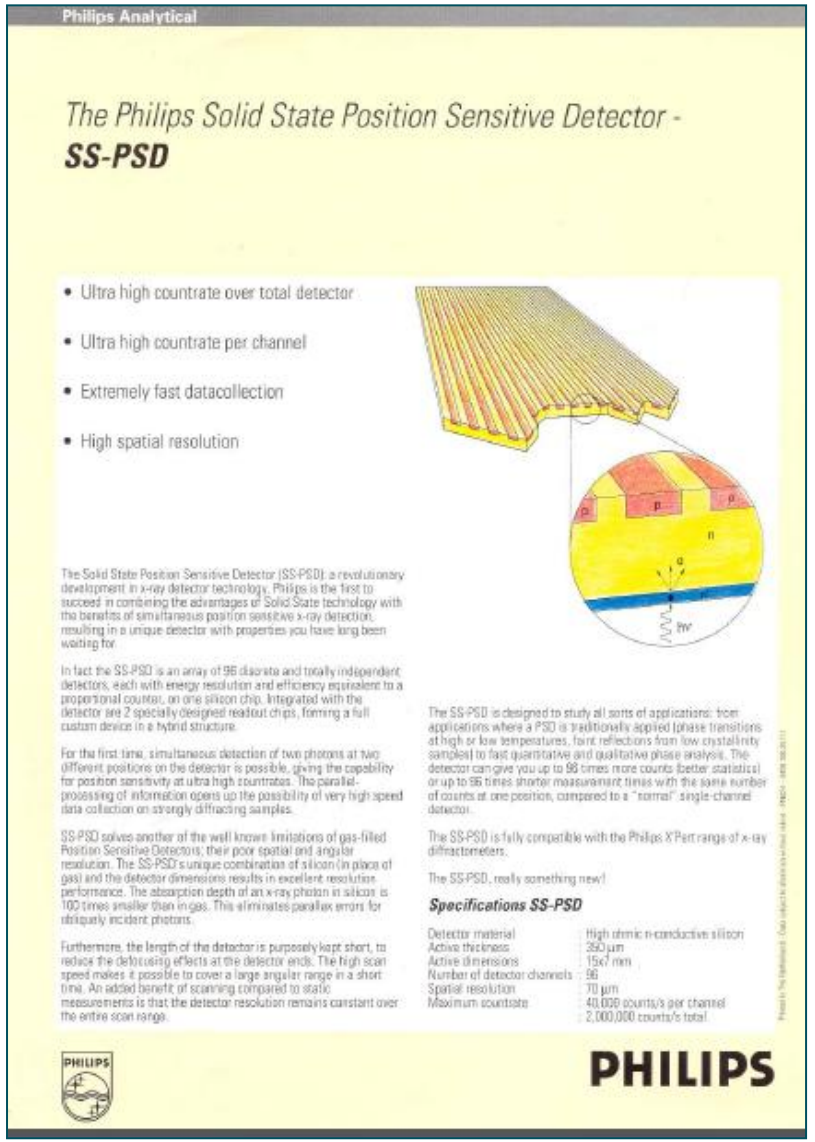
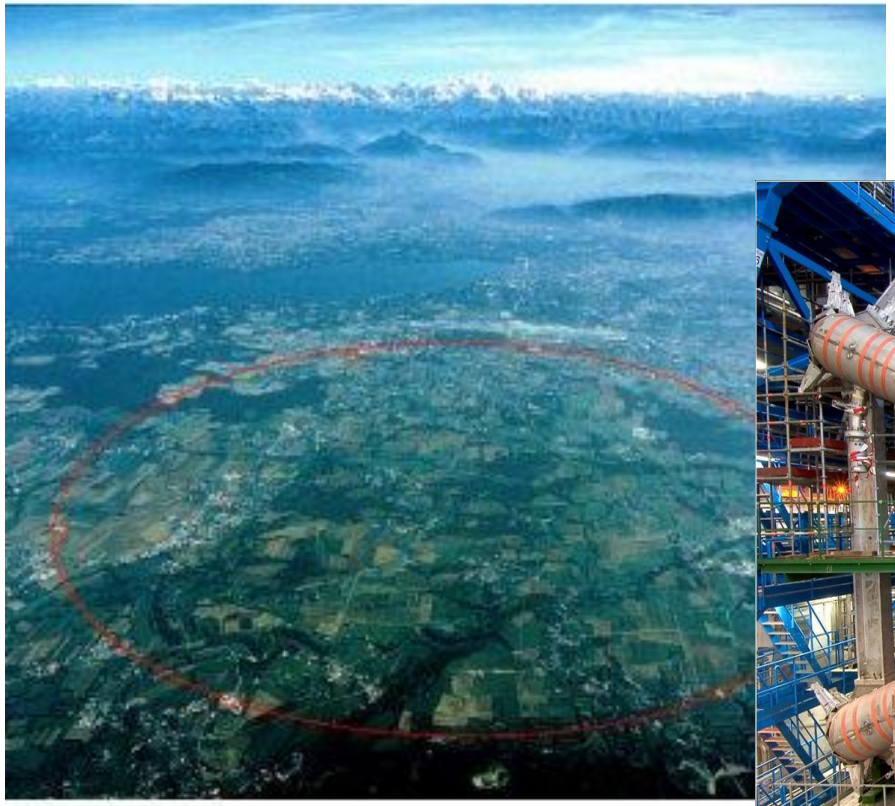
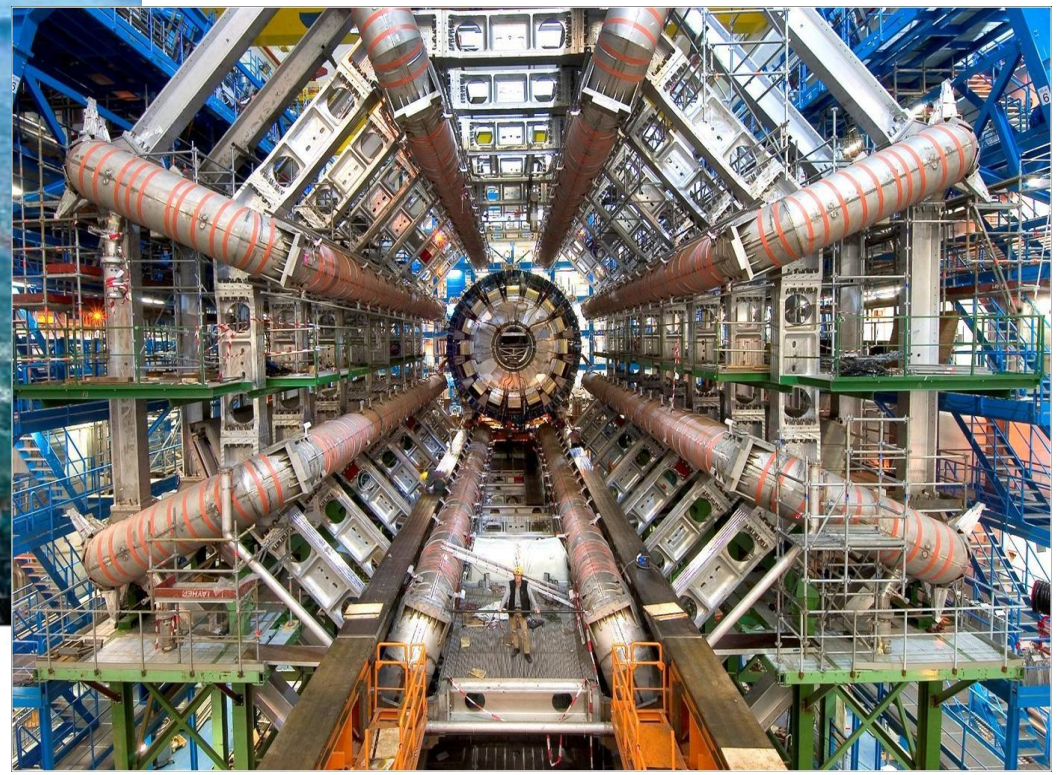
- Around 1985 Philips started with position-sensitive detectors
- 2001: **X'Celerator**: the world's first solid state strip detector reducing measurement time for powder diffraction data from hours to minutes
- 2007: **PIXcel^{1D}**: a solid state strip detector with more and narrower channels and a highly improved dynamic range, based on ***Medipix2*** technology
- 2010: **PIXcel^{3D}**: the first solid-state hybrid pixel detector allowing 0D-1D-2D-3D experiments
- 2012: **PIXcel^{3D} 2x2**: enlarged angular coverage
- 2014: Introduction of ***Medipix3*** technology; enhanced wavelength coverage
- 2015: Introduction of **GaliPIX**: a new large solid-state 2D detector, optimized for hard radiation experiments



The origin of Medipix technology





From the huge Atlas detector…

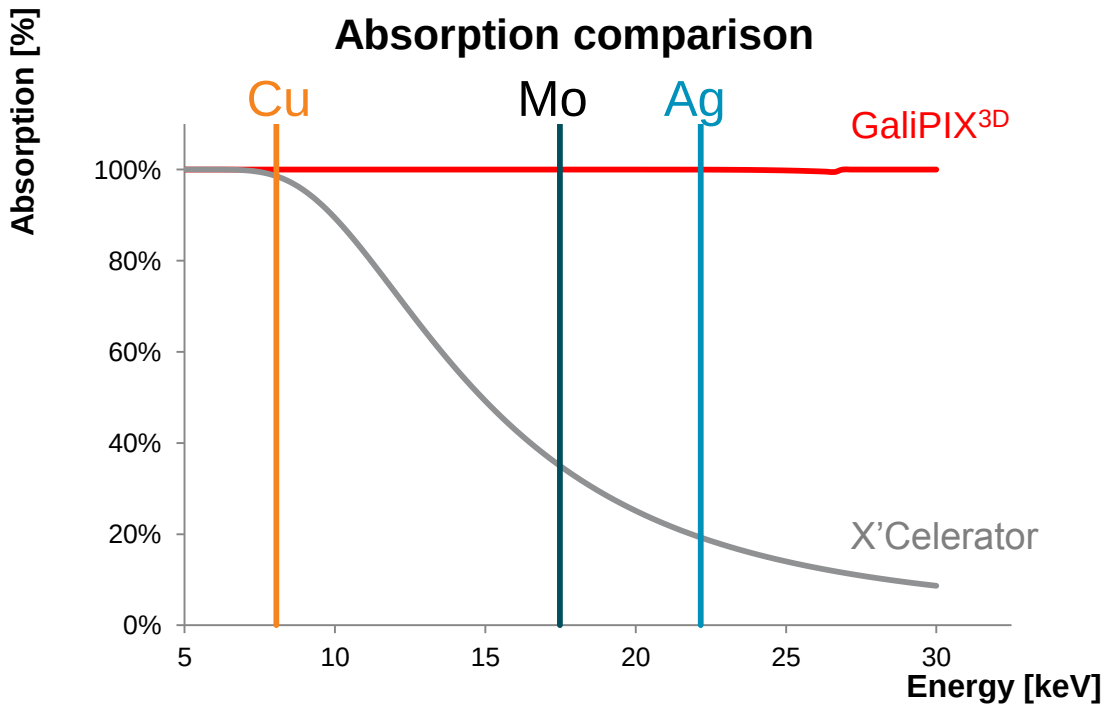
… to the PIXcel detector family that fits a lab diffractometer

The latest addition: GaliPIX^{3D}

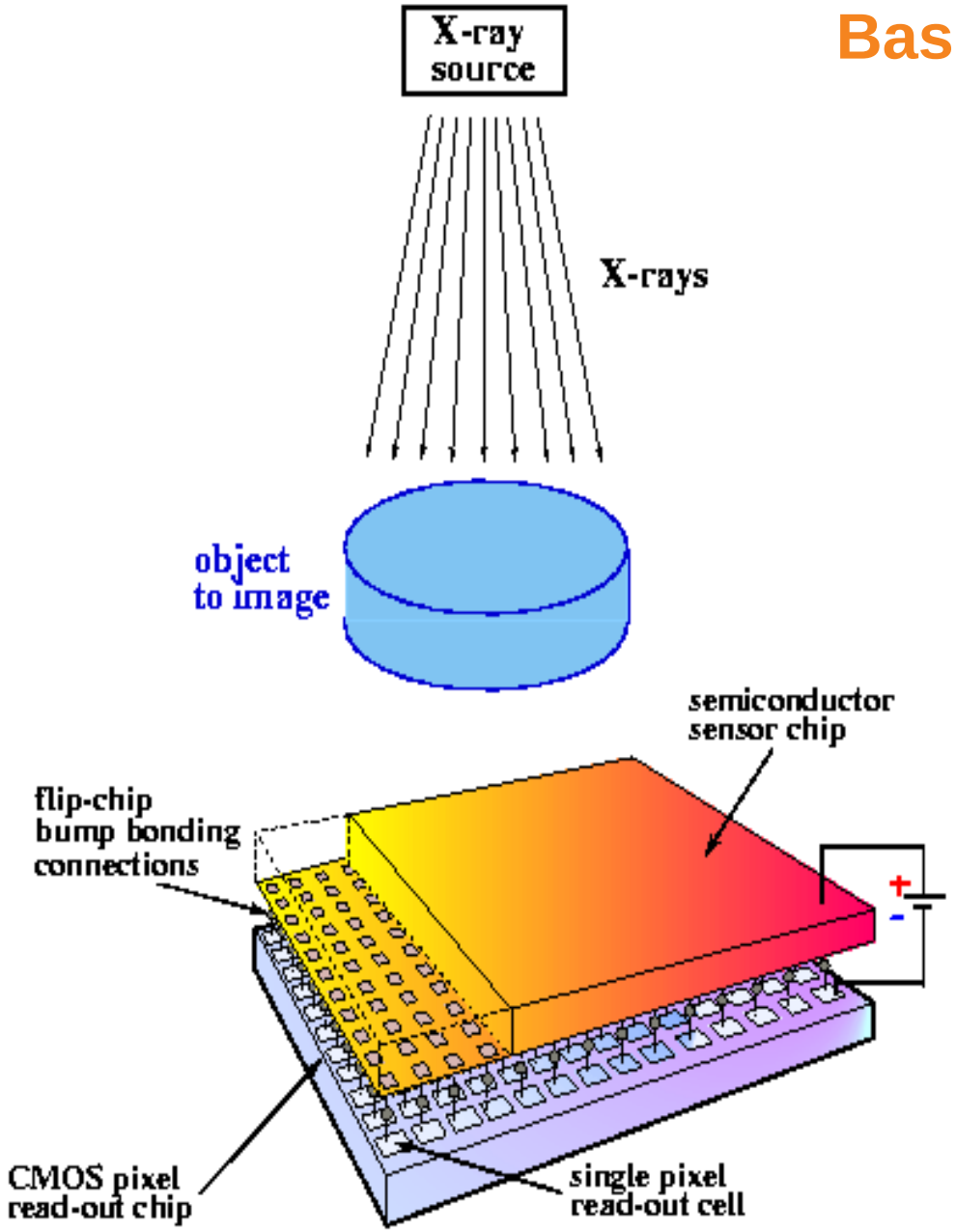
- Developed by Pixirad, an INFN spin-off
- High-quality sensor material
  - Large stopping power of Cd and Te
  - 100% absorption efficiency @ 25 keV
- High resolution
  - Pixel size 60 µm
- Large field of view
  - Active area 31 x 25 mm^2

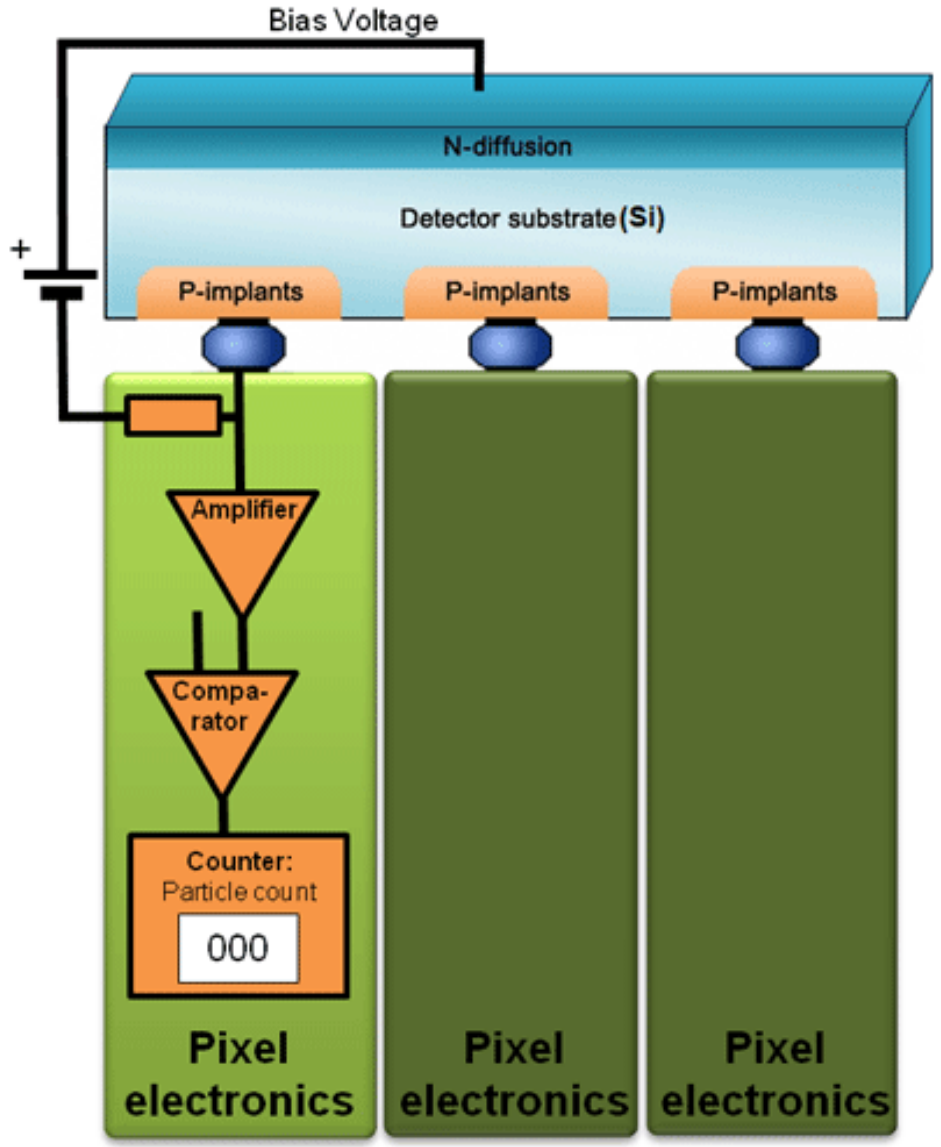
Galileo Galilei

(1564 – 1642)



Basic working principles





Key specifications

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	PIXcel^{3D}	PIXcel^{3D} 2x2	GaliPIX^{3D}
Detector size (pixels)	256 x 256 pixels	516 x 516 pixels	512 * 476 pixels
Detector size (mm)	14.1 mm * 14.1 mm	28.4 mm * 28.4 mm	30.1 mm * 24.2 mm
Pixel size	55 μm * 55 μm		60 μm * 51 μm
Point spread function	1 pixel		
99 % linearity range	0 - 6.5 x 10^9 cps - Overall 0 - 25 x 10^6 cps - Column	0 - 5.2 x 10^9 cps - Overall 0 - 1 x 10^7 cps - Column	0 - 3.9 x 10^9 cps - Overall 0 - 7.8 x 10^6 cps - Column
Background noise (whole detector)	< 0.5 counts / s	< 2 counts / s	< 6 counts / s
Dynamic range	> 10^9		
Energy discrimination	Two level discriminator (user adjustable)		
Calibration by user	None		
Exchange of detection medium	None (solid state technology)		

Hybrid pixel detectors: four modes of operation

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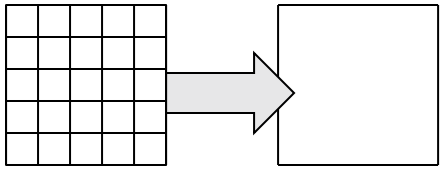
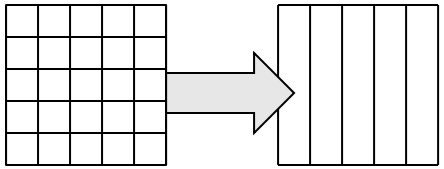
0D



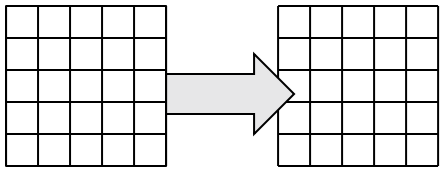
The signal from all pixels is added up to lead one value as a function of detector position

1D



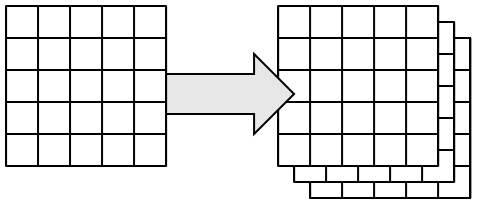
The signal from each column is added up, creating a static or scanning 1D detector

2D



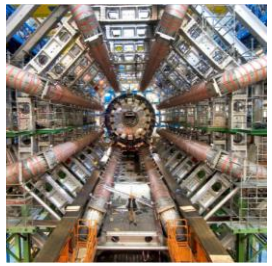
The signal from each pixel is stored individually, the detector is used static or scanning. In scanning mode, a 'strip file' is created which resembles a Debye-Scherrer film

3D



The signal from each pixel is stored individually, the sample is rotated in order to get multiple radiographs for 3D reconstruction

Agenda



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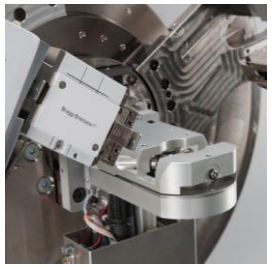
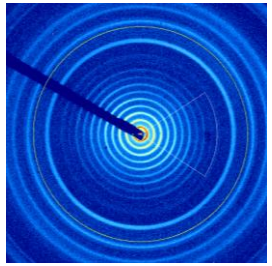


Dealing with polychromatic radiation



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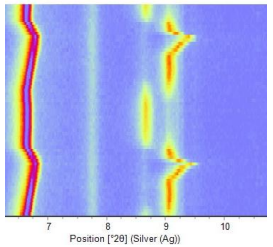
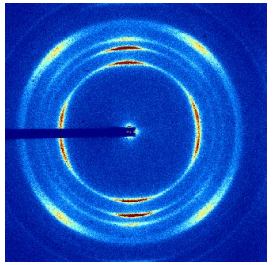


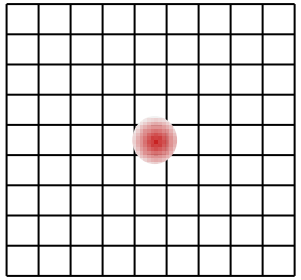
The challenges of non-Cu radiation

The importance of dynamic range

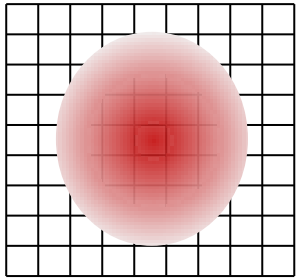


Conclusions

Point spread function (PSF)



Hybrid pixel technology



Other technology

- The point spread function (PDF) describes the spread of one event (an incoming photon) over its neighbors
- With hybrid pixel technology, this effect is virtually absent: the PSF has a width of 1 pixel

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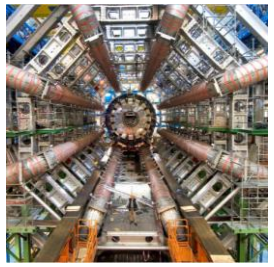
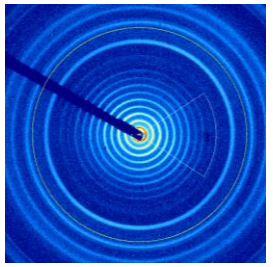
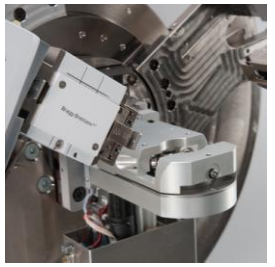
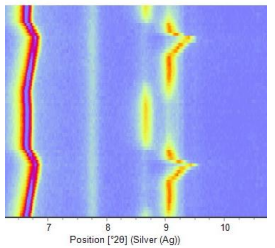
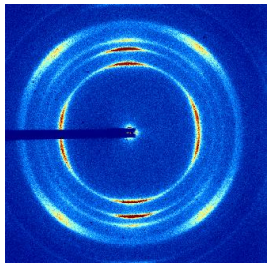
martijn.fransen@panalytical.com

Summary

- Hybrid pixel detectors are the state-of-the-art in X-ray detection
- Key detector parameters for the powder lab:
  - **Spatial resolution** in x, y and z, angular coverage
  - **Dynamic range** and low noise
  - **2-level energy discrimination** to deal with the tube-sample spectrum
  - Ability to deal also with **non-Cu radiation**



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•As such, recipients will not be limited to any brand of instrument, but rather to research that utilised an X-ray source to reach their conclusions.

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