

Pixel detectors - Demonstrators



XRAY
IMATEK
PHOTON COUNTING DETECTORS



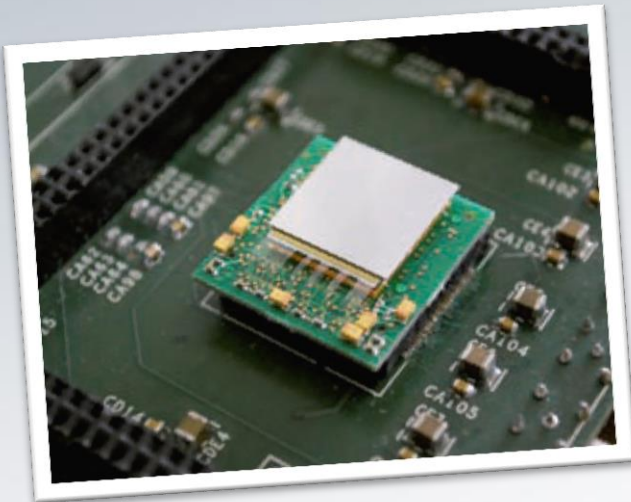
Taller de Altas Energías
2013

Albert Sancho
September 26, 2013

About X-Ray Imatek

X R A Y
IMATEK

PHOTON COUNTING DETECTORS



Our detector is the Medipix2/Timepix, a CMOS-based developed at CERN by the Medipix2 Collaboration.



- X-Ray Imatek S.L. is a spin-off company from IFAE focused in research, development and marketing detectors based in photon counting technology to be applied in a large number of sectors.

- Based on a combined research experience expanding more than three decades, XRI can provide unmatched expertise delivering a state-of-the-art solution for x-ray imaging based on CERN's Medipix2/Timepix chip.

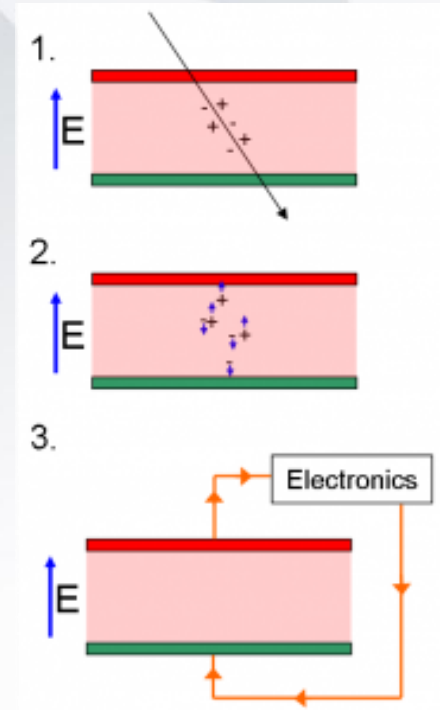
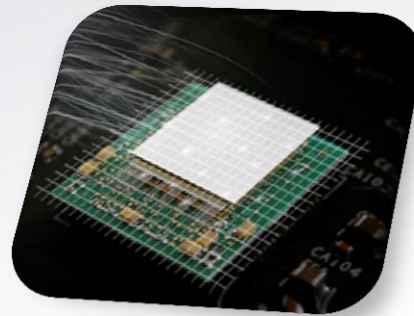
- XRI has developed its own readout system including the electronics and the software, and offers tailored solutions for research and industry and end-customer devices as well.

- XRI aims to position the company among the x-ray detectors market leaders thanks to its innovative technology, ethics and high quality standards.



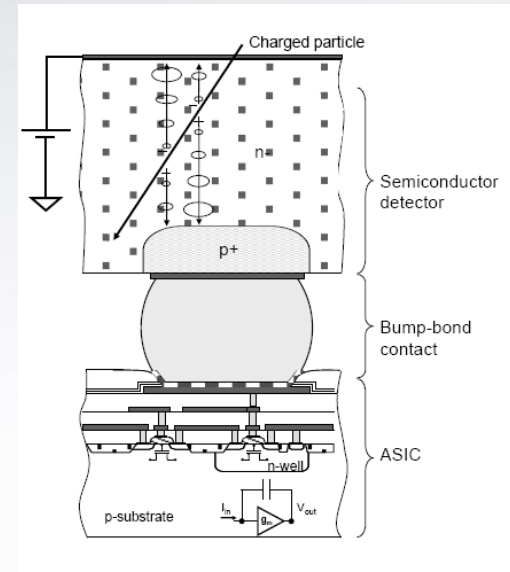
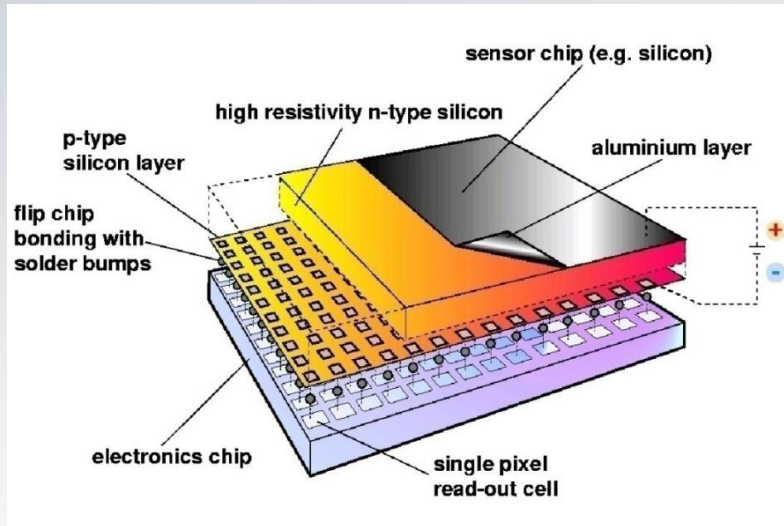
Pixel Detectors

- Different kinds of pixel detectors: charge integration, photon counting, hybrids, monolithic...
- Commonly used in colliders such LHC for particle tracking.
- When a particle passes through the detector material, it knocks loose a bunch of electron-hole pair which are pulled in opposite directions by an electric field, and pulled into electronics.
- The idea of pixel detectors is to divide the detector material into many independent segments to obtain x/y coordinates: pixels.



Hybrid pixel detectors

- Medipix2/Timepix is used as an hybrid pixel detector → CMOS readout ASIC + Semiconductor detector.
- Other present day systems: Pilatus, XPAD, PiXirad.
- The detector can be optimized for application: Si, GaAs, CdTe. All of them in different thicknesses
- Sometimes no sensor is used : Gas gain grid for gas detector readout, micro channel plate...



Medipix – An hybrid photon counting pixel detector

The Medipix2/Timepix

The Medipix2/Timepix CMOS ASIC is a photon counting chip developed by the Medipix2 Collaboration at CERN.

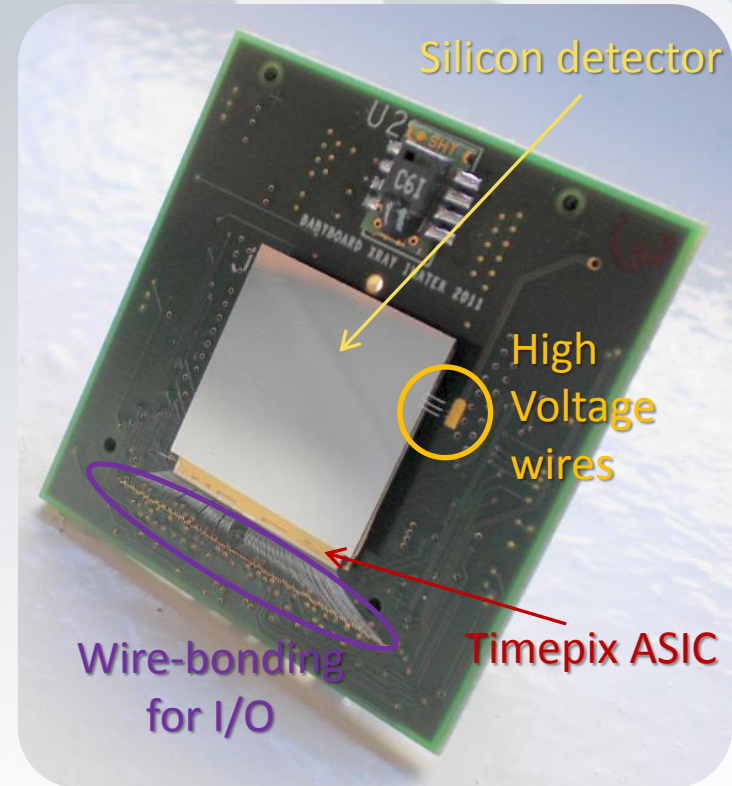


The Medipix2
Collaboration

Main Features

- Pixels: 256 x 256 (65,536)
- Pixel Size: 55 x 55 μ m
- Area: 14.1 x 14.1 mm²
- Count Rate: 1 MHz
- Low Noise: < 75 e⁻
- Sensors: Si, CdTe GaAs...

It is a pixel-detector readout chip consisting of 256 x 256 identical elements, each working in single photon counting mode for positive or negative input charge signals. Each pixel occupies a total area of 55 μ m x 55 μ m where a 20 μ m octagonal opening connects the detector and the amplifier via bump bonding.

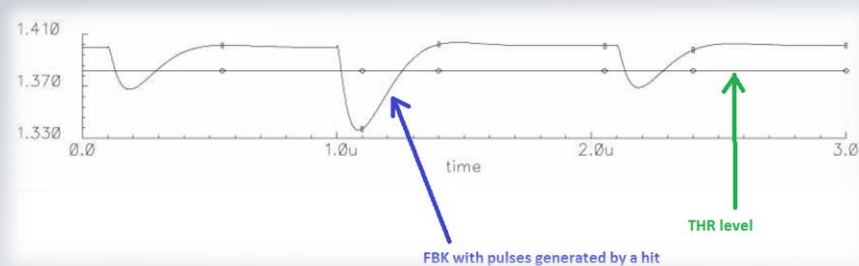


The Medipix2/Timepix assembled in a baby board.

Advantages and drawbacks

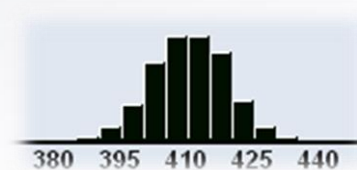
Advantages of photon counting:

- No Dark Current \rightarrow Better S/N ratio
- Adjustable Energy Threshold \rightarrow Energy resolution and possibility of color images



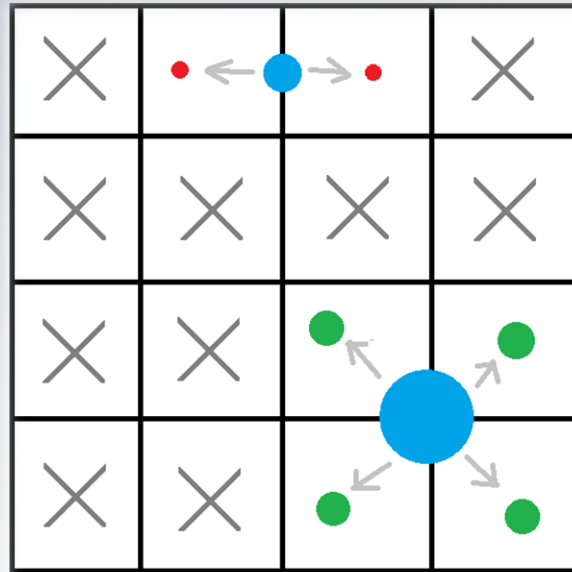
Drawbacks:

- Channels (pixels) are independent \rightarrow Equalization needed



Charge Sharing

- Charge Sharing → Main drawback of pixelated detectors.
- It requires special techniques / sensors needed to minimize it. Example: 3D sensors.



No hit



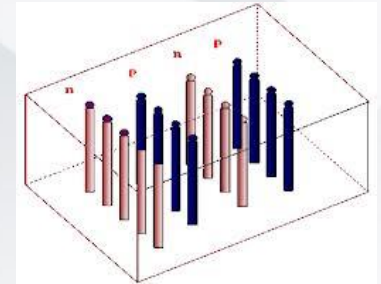
Hit



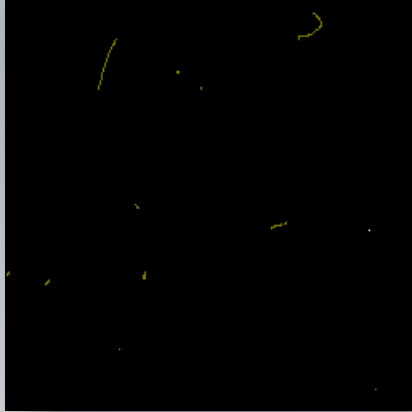
Charge counted as hit



Charge ignored by threshold

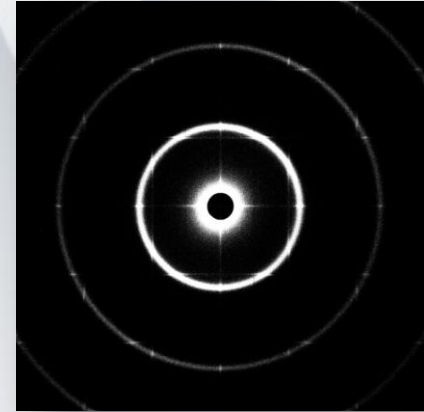
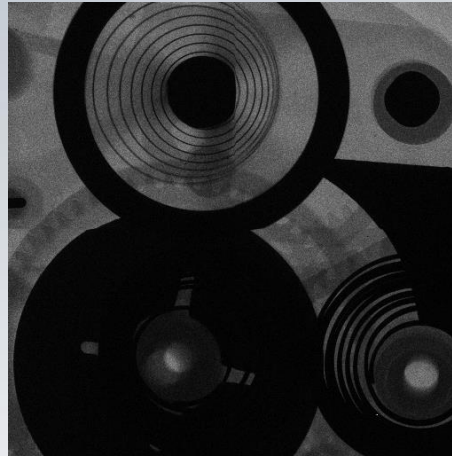


Applications of Medipix

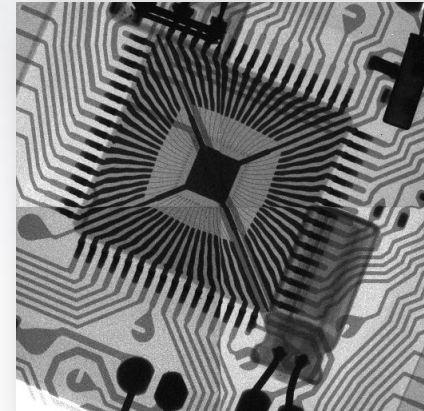
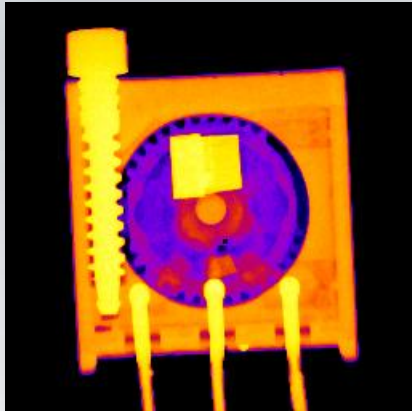


Particle Physics

Imaging / NDT

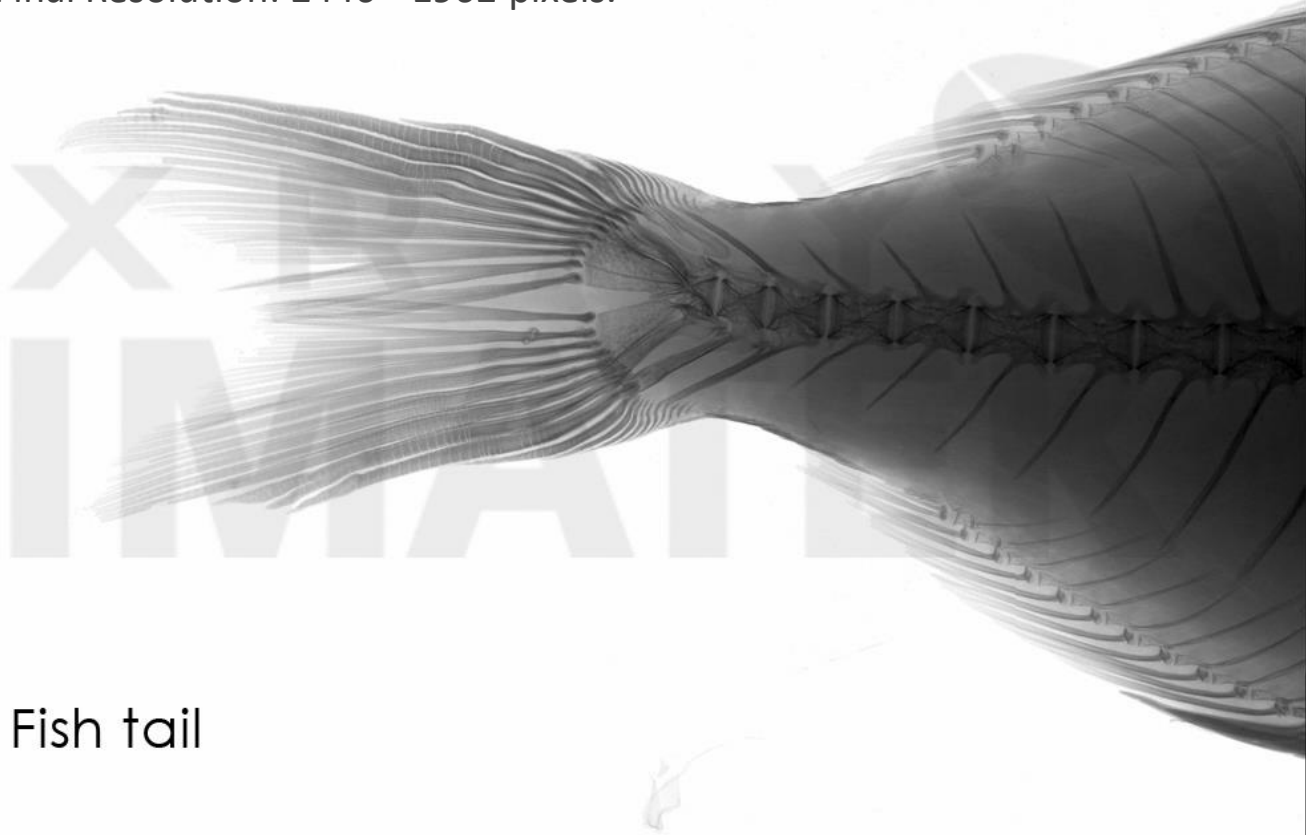


Crystallography and X-ray diffraction



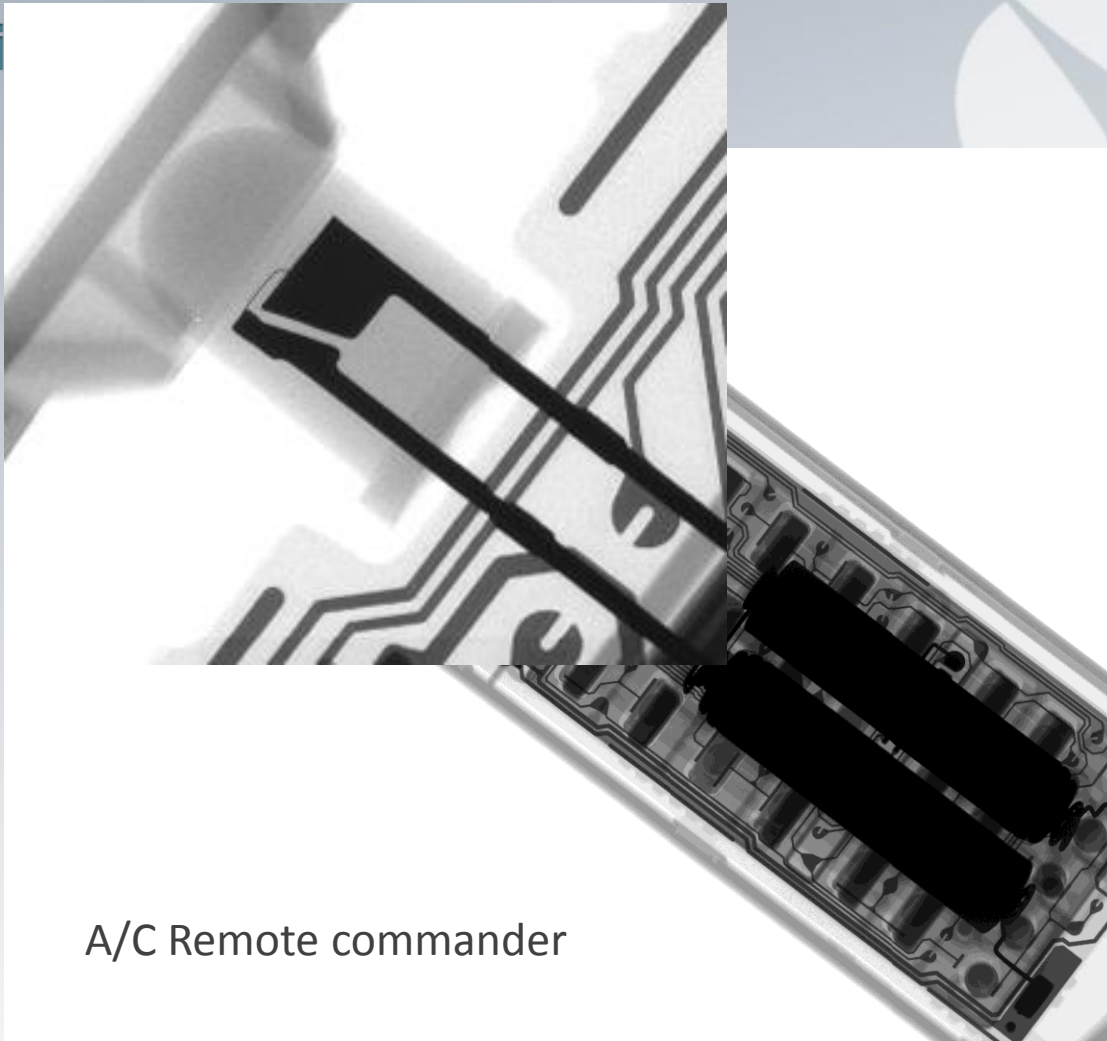
Large image samples

Image from a fish tail taken with the XRI-1 detector
Final Resolution: 2446 × 1962 pixels.



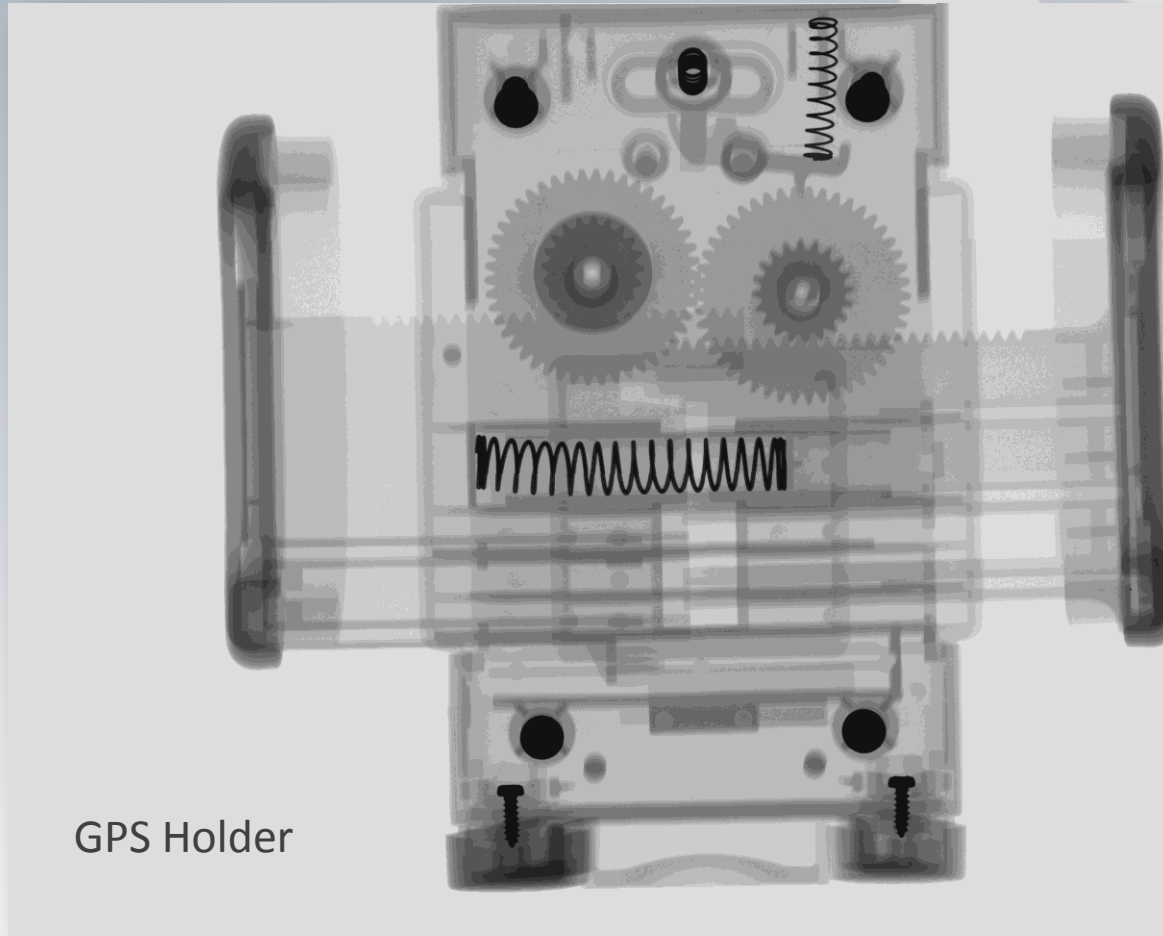
Fish tail

Large i



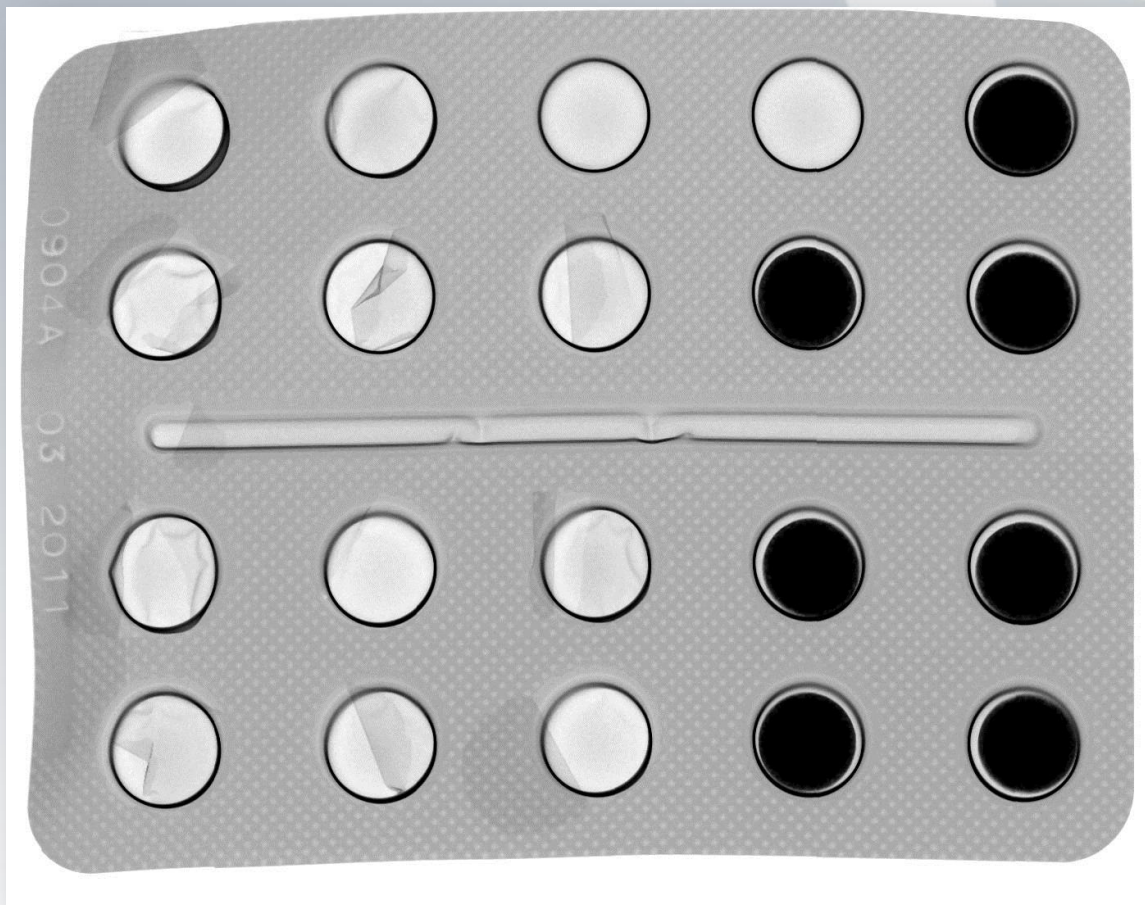
A/C Remote commander

Large image samples



Large image samples

Pills Blister Pack



Product Line – Medipix demonstrators

The XRI Series



The X-Ray Imatek's XRI Series are the first affordable and completely portable x-ray detectors assembled with the successful Medipix2/Timepix chip.

There are two different configurations available, a single-chip module, XRI-UNO, and a 2x2 quad module, the XRI-QUATRO. Both models can be equipped with 3 different flavors of sensors: Si, CdTe and GaAs.

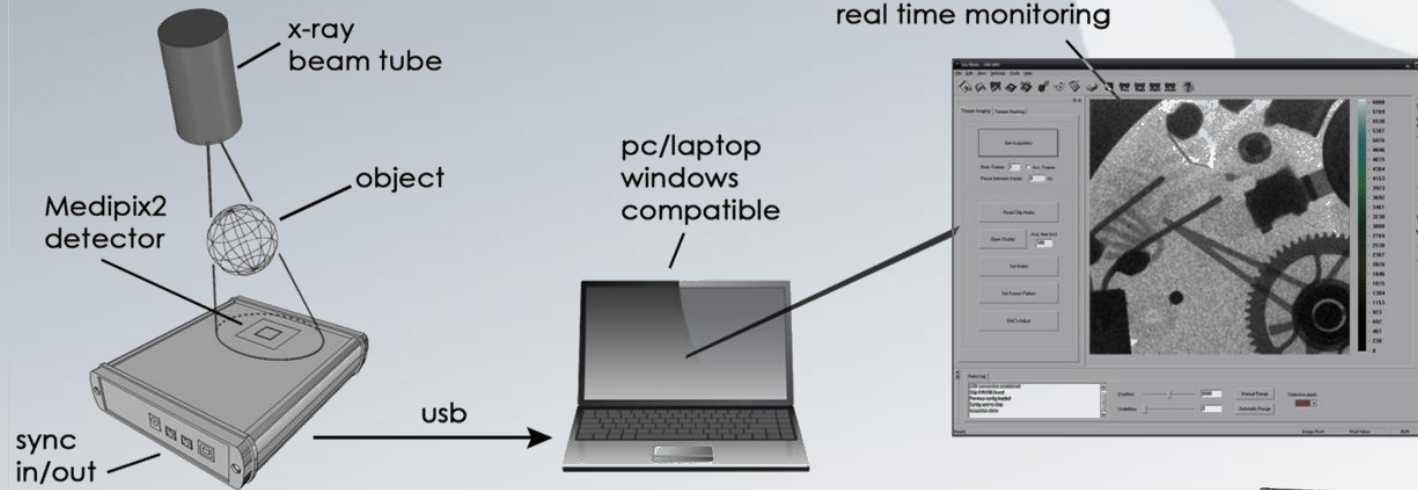
Most Valued Features:

- 55 μ m Pixel Pitch
- 65K and 262K Image Resolution
- 14,1mm² and 28,2mm² FOV
- High DQE / High Contrast
- 3 Pixel Operation Modes
- Variable Energy Threshold
- 10⁵ counts/pixel/s
- USB 2.0 Interface
- Up to 500 fps. video recording
- Several Output Formats

Common Applications:

- Medical & Dental Imaging
- Non-Destructive Testing (NDT)
- Industrial/Food Inspection
- mCT Purposes
- Cosmic Rays Detection
- Research on Particle Physics

Product Line – XRI Series



Ready-to-Use

The XRI Series is a complete system ready to work, they only require a PC (Microsoft Windows OS) and a compatible outlet to operate. The power supply and USB cable needed are included with the unit. There is no need of additional power supplies or any other accessory to operate the system. The XRI Software suite included allows you to switch between the operation modes, calibrate the unit and select the image format acquisition.



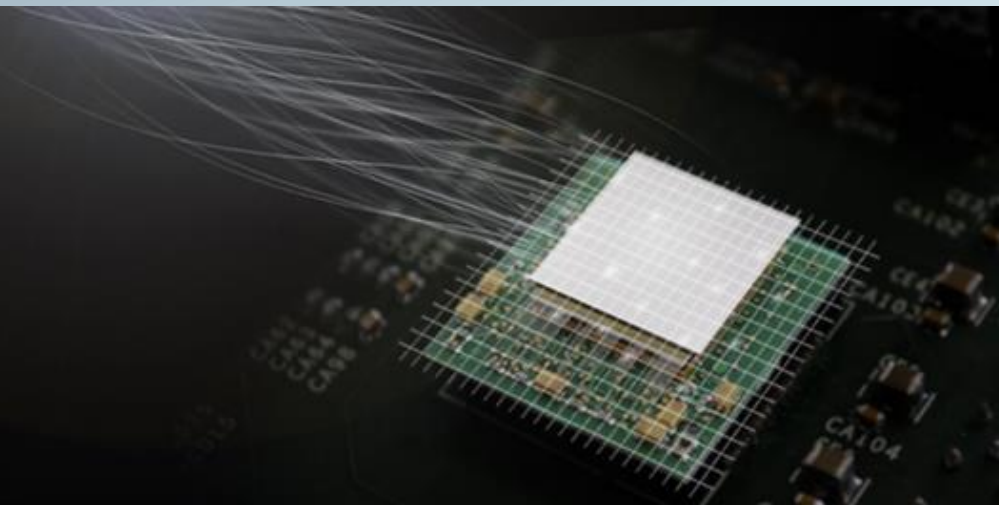
What we can see today

- Some “baby-boards” where you can see three different assemblies:
 - Single chip Si assembly (300um thick)
 - Single chip CdTe assembly (1mm thick)
 - Quad Si assembly (300um thick)
- XRI-QUATRO unit partially dismantled
- XRI-UNO unit working
 - Although it is difficult to show the operation of the system without any radiation source. We will try see some cosmic rays.



Thank you!

Every photon counts.



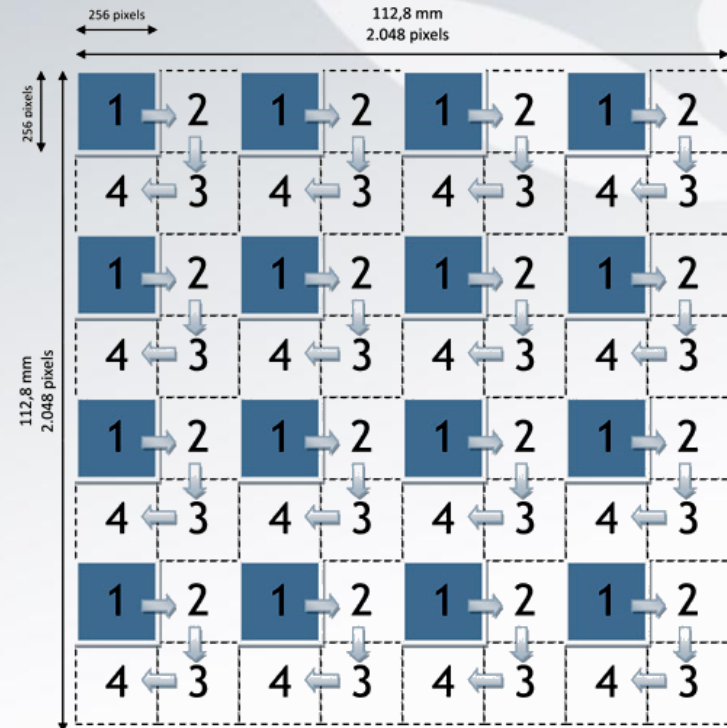
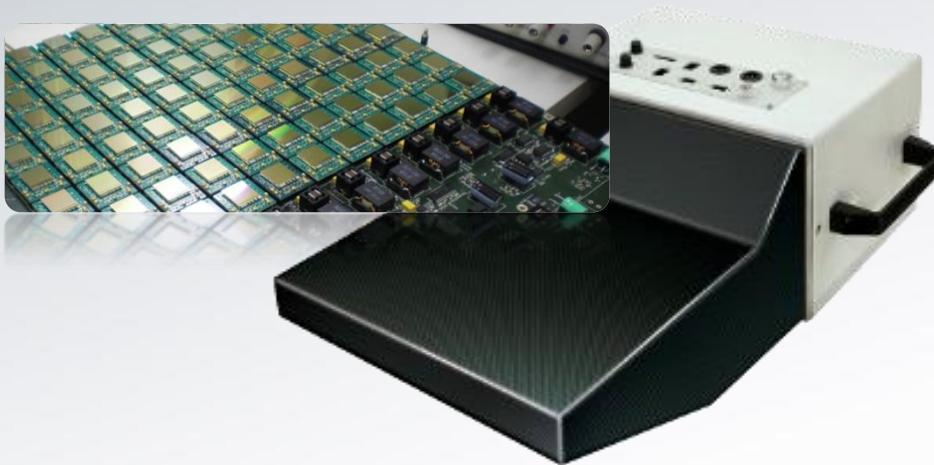
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Research & Development – Large area detectors

The XRI-1: How to Achieve a Large Area of Detection with the Medipix2

Large Area Field of View (FOV)

The Timepix chip only covers an area of roughly 2 cm². In order to obtain large images, X-Ray Imatek has developed a multichip design built on a mechanical table which performs a 2D scan. This movement allows the detector to cover any area of interest in less than 1,5 sec. The user is unaware of the 2D motion and the full reconstructed image is presented as if it was taken with a monolithic detector



Costumers



UNIVERSITY OF
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Location

X-Ray Imatek is located in the Eureka Building,
inside the UAB Research Park in Barcelona.



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