MEDIPIX COLLABORATION MINIPIX-EDU

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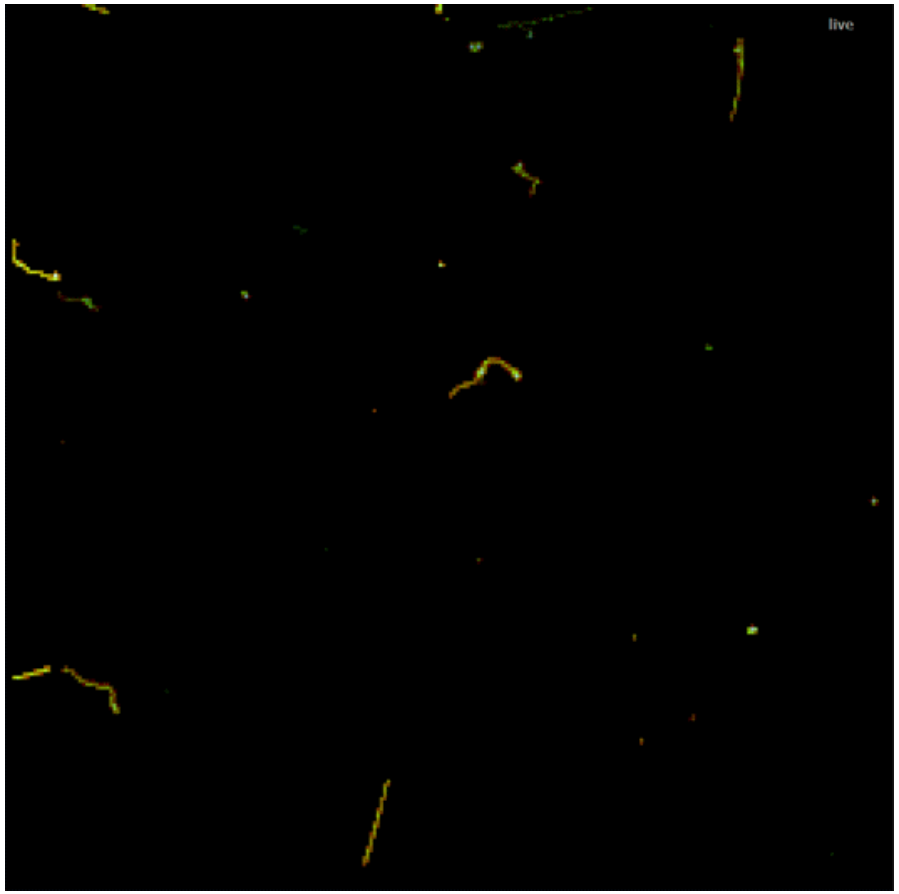
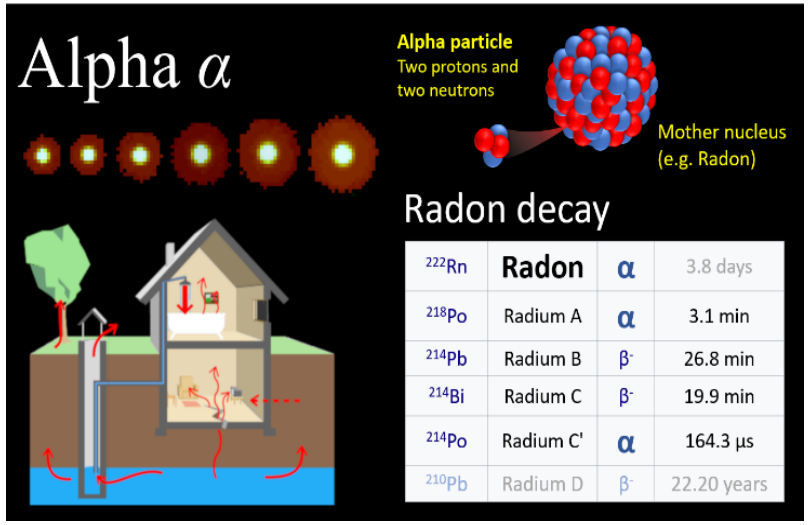
IPPOG
28/11/23

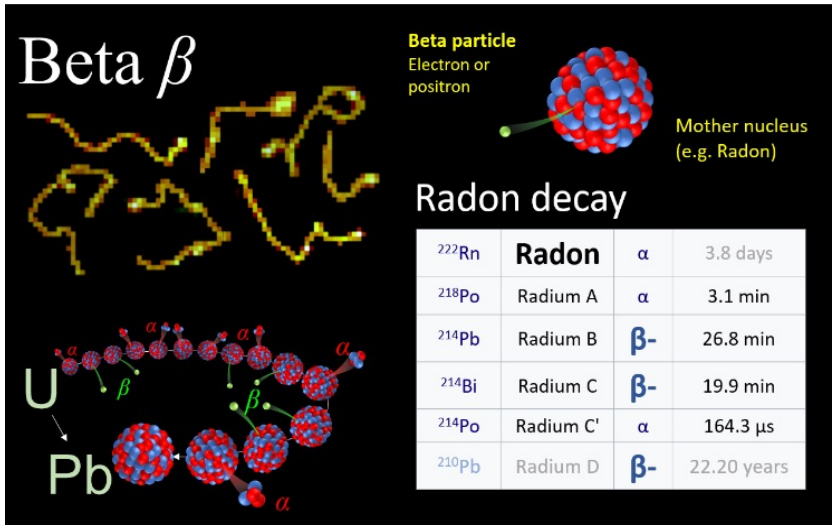
Minipix-Edu: Wow a particle in my screen!

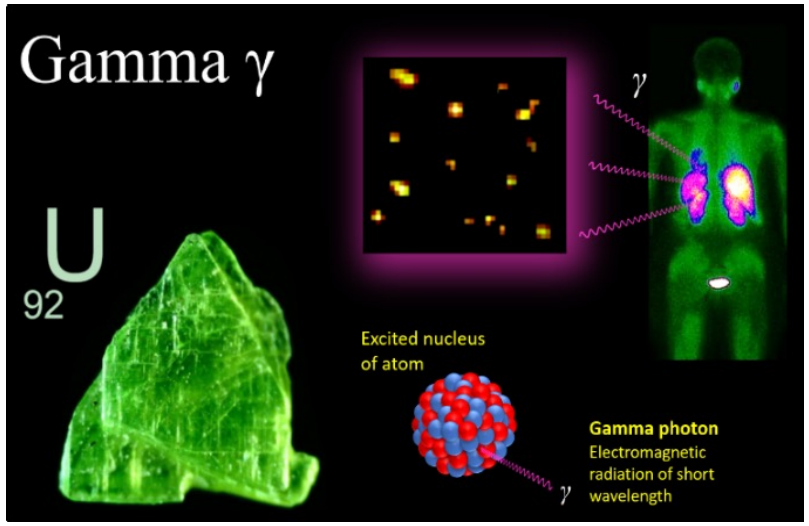
https://www.linkedin.com/pulse/fascinating-patterns-drawn-radiation-particle-physics-jan-jakubek/

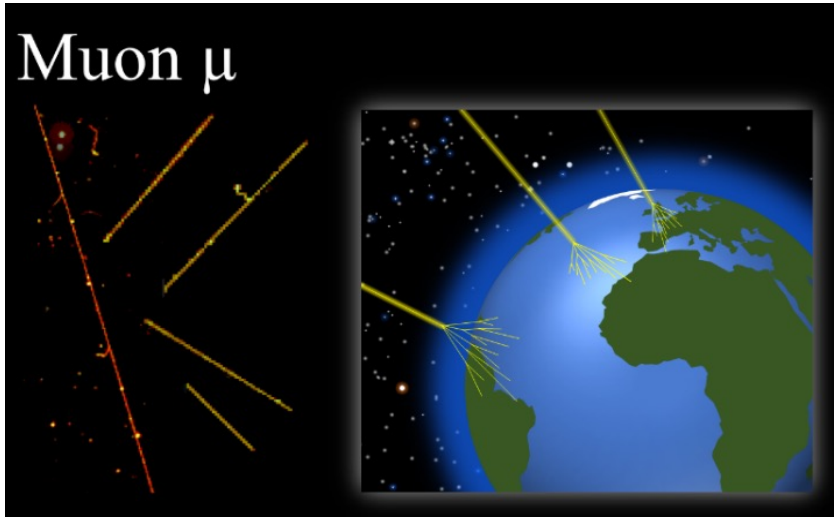


Particle identification





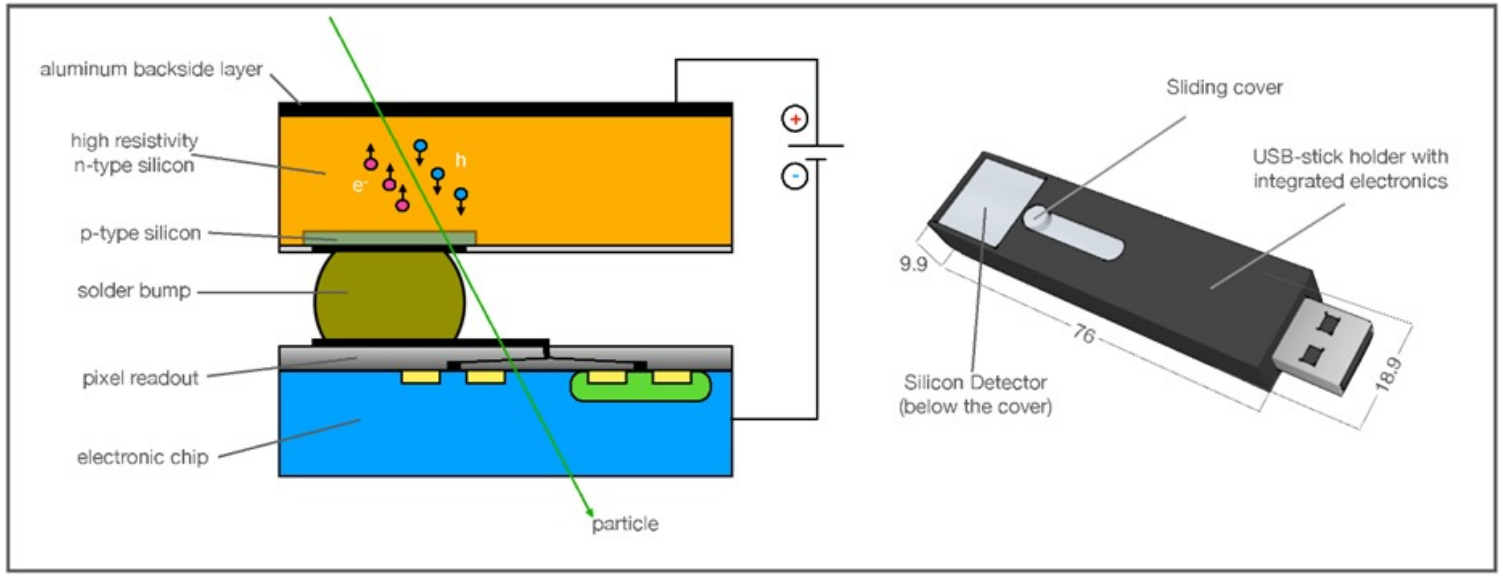




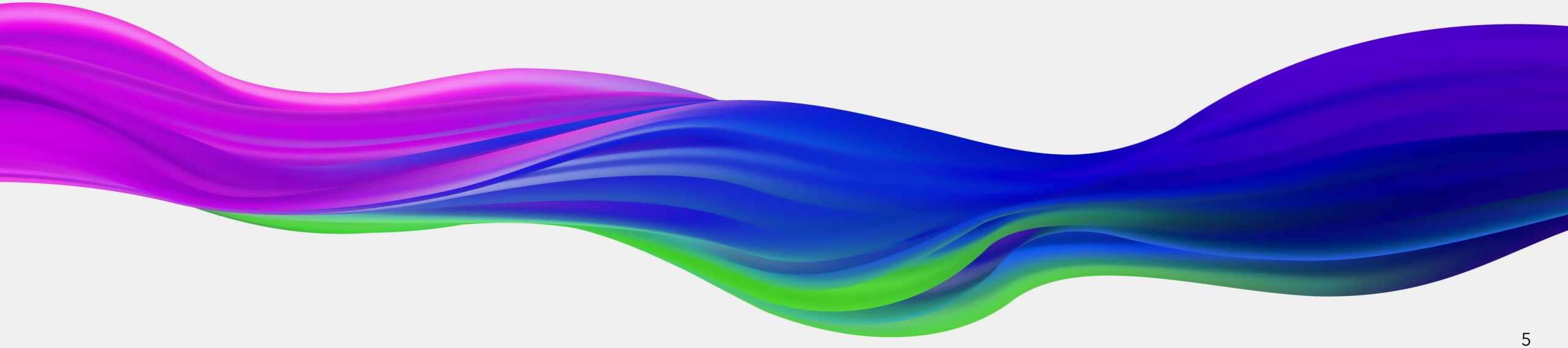
https://www.linkedin.com/pulse/fascinating-patterns-drawn-radiation-particle-physics-jan-jakubek/

How it works: Photon counting hybrid pixelated detector

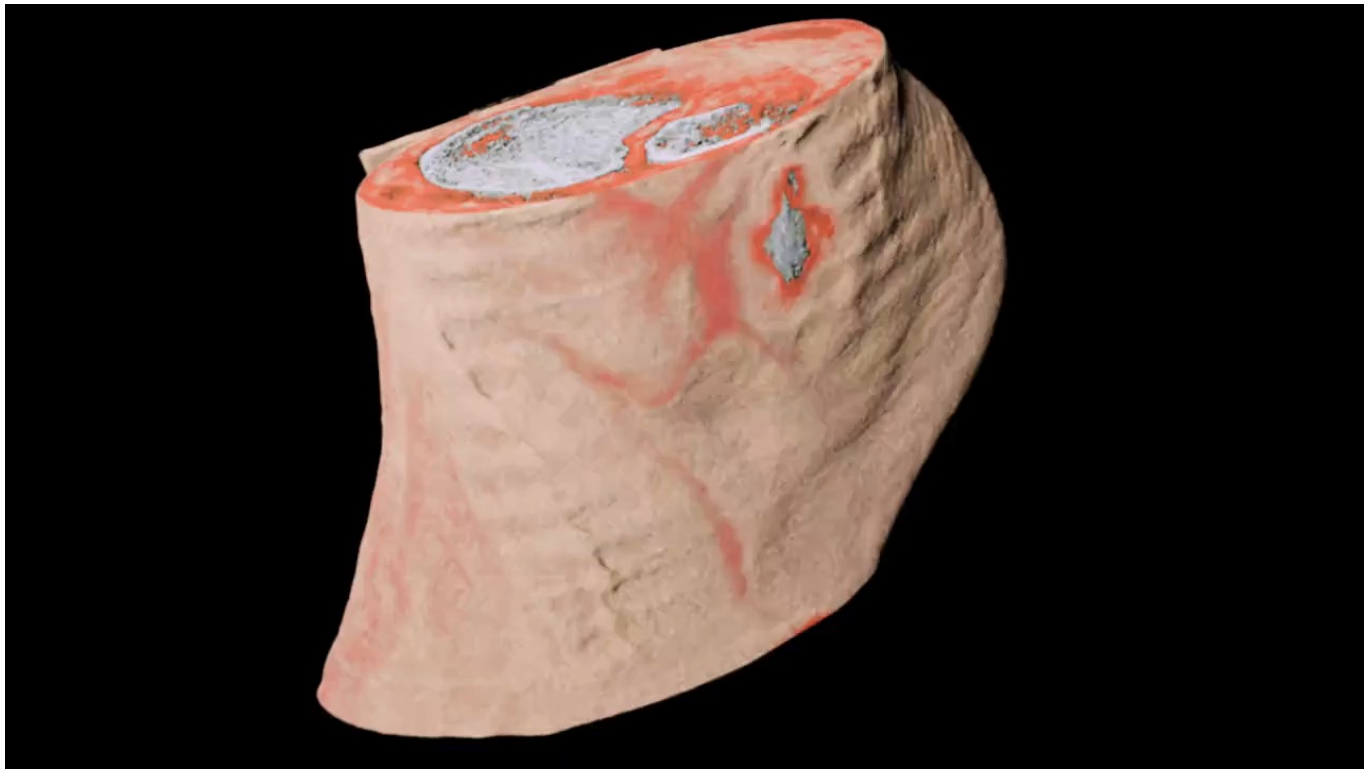
Photon counting detector:
Information of individual photons
Pixelated detector: 256 x 256 pixels
Pixel size: 55 x 55 µm
Hybrid detector: sensor is bump bonded to electronics
Sensor material: Silicon or CdTe
Dark current: none
Maximum frame rate: 45 fps
Operating temperature range: 0-55 °C



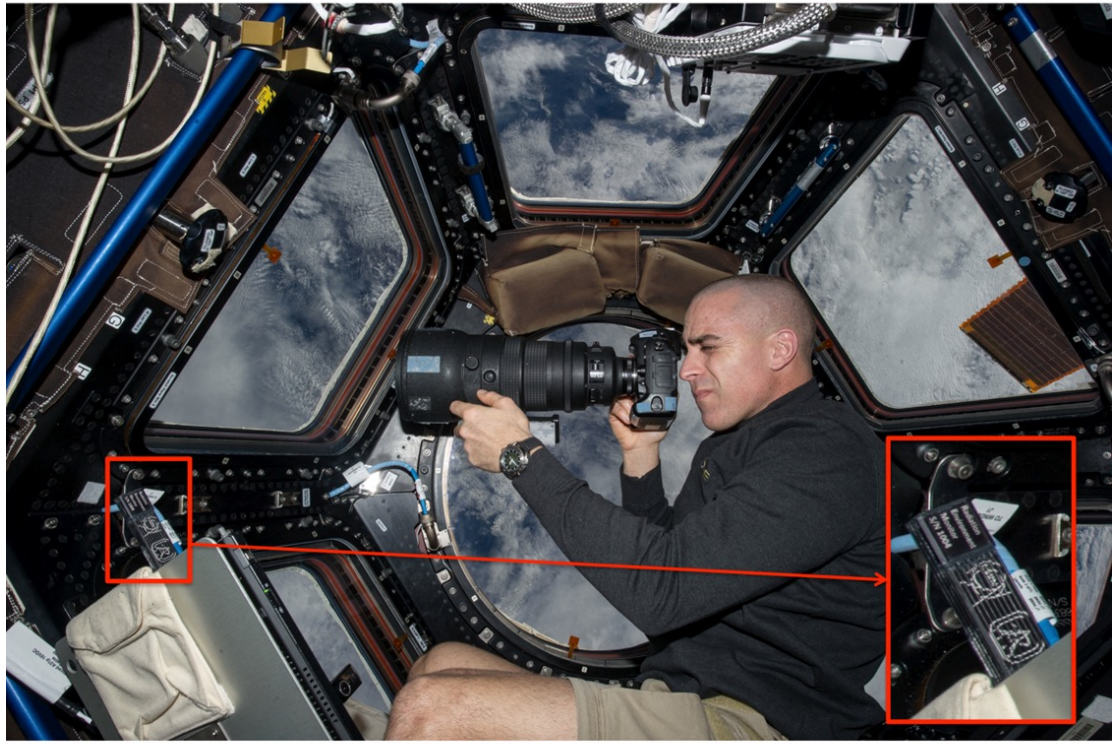
Applications of the MEDIPIX detectors



Spectroscopic X-ray imaging



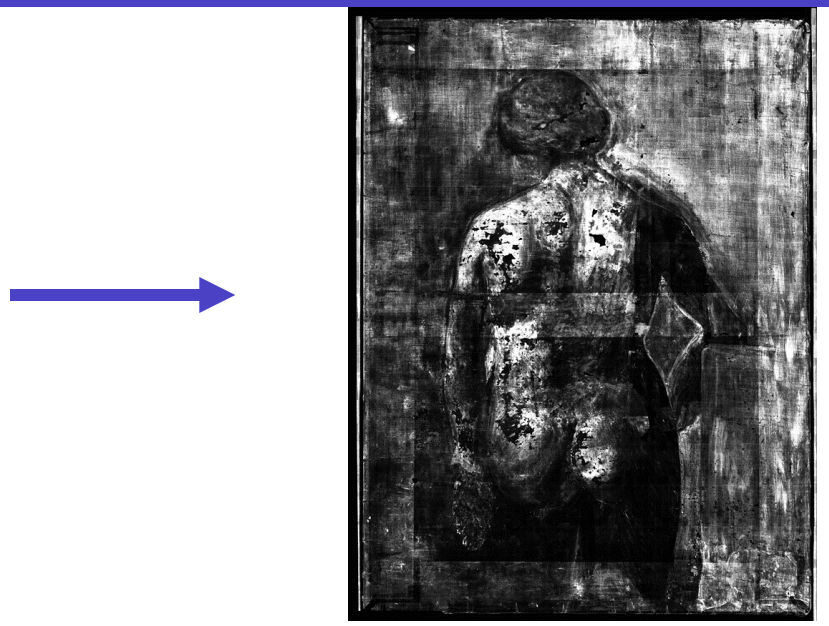
Application in Space Dosimetry



Timepix is being exploited for radiation monitoring in NASA's Orion rocket and at the International Space Station

Image of the astronaut Chris Cassidy working near the Timepix USB on the International Space Station (*Courtesy of NASA, photo ref. no. iss036e006175)*

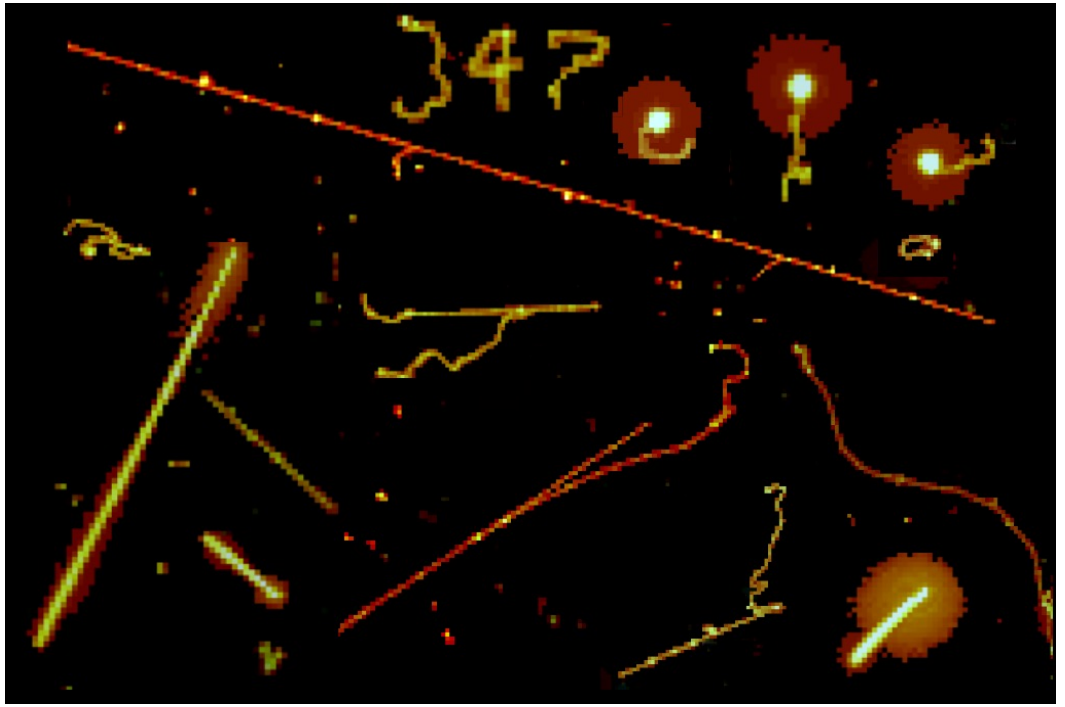
Application: Art restoration



Single particle counting X-ray imaging detectors + Robotic arms! *https://insightart.eu/*

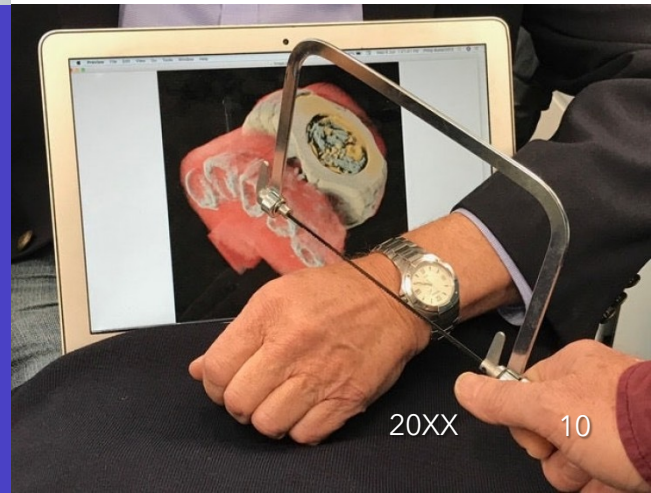
Application in Education

Type	Description	Track	Comment
Alpha, α	Helium nucleus: high energy, low speed and high mass	Appears as a spot 	On entering the silicon alphas are stopped very quickly, with energy spread uniformly
Beta, β	Electrons or positrons: high energy, high velocity	Wiggly line 	Wiggle is produced as beta moves further through the chip. Energy spread over a larger number of pixels than alpha
Gamma, γ	High frequency electromagnetic radiation	Dot 	Gamma continues to pass through the detector only interacting with a small number of pixels



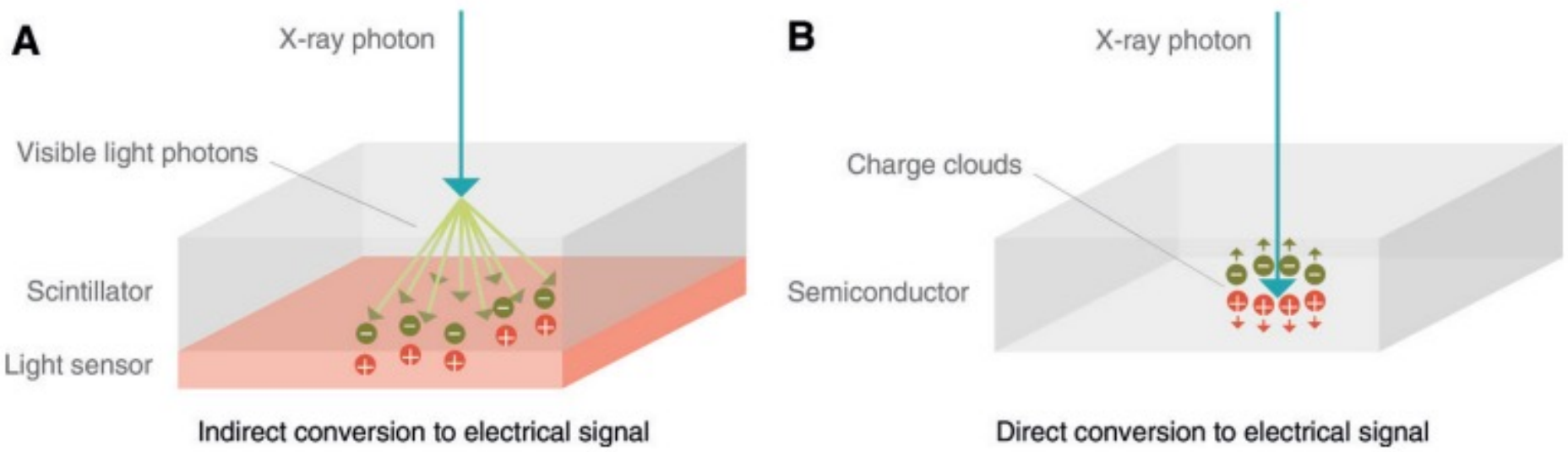
- *Is there a difference between day and night radiation?*
- *Does the radiation change when somebody enters the room?*
- *What happens if I would place a piece of granit close to the detector? And what about ash? Or air filter?*
- *Is there some preference in directions of muons? And beta rays?*
- *Does the neodymium magnet affect the particles?*
- *Can I find some new particles in mountains? Or in mines? Or on board of plane? What about lightning during the storm? Can I use natural radiation to make an image of something?*

Thank you



EXTRA SLIDES

Photon counting detectors
1. Direct conversion

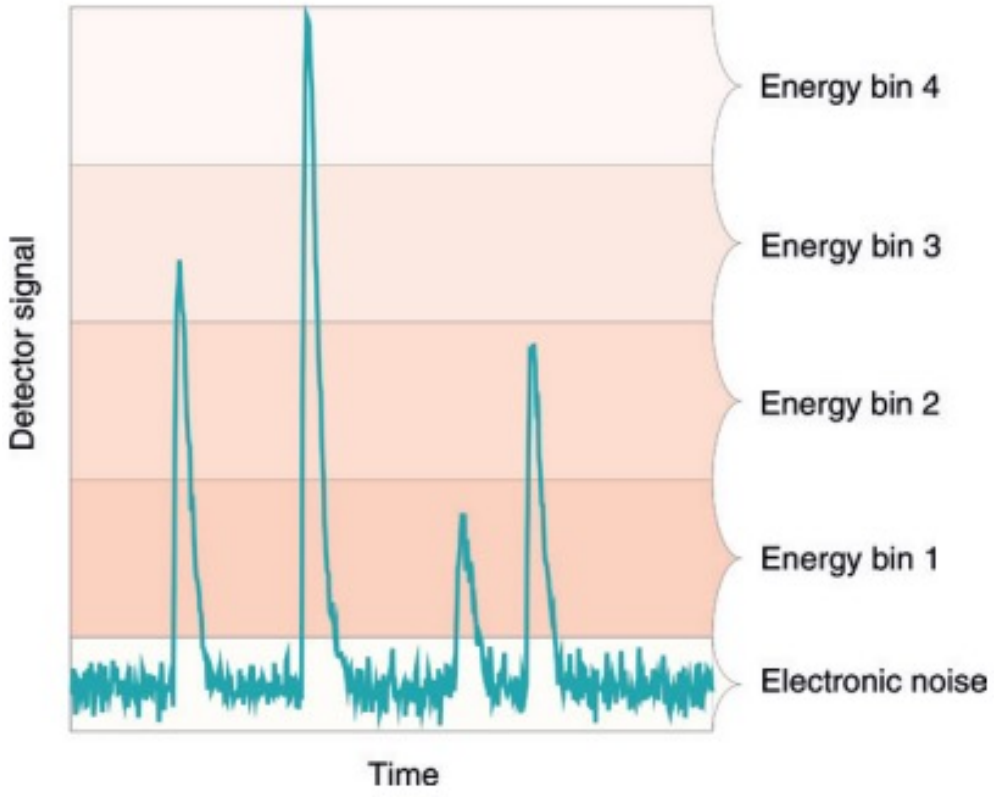


Conventional energy-integrating detector

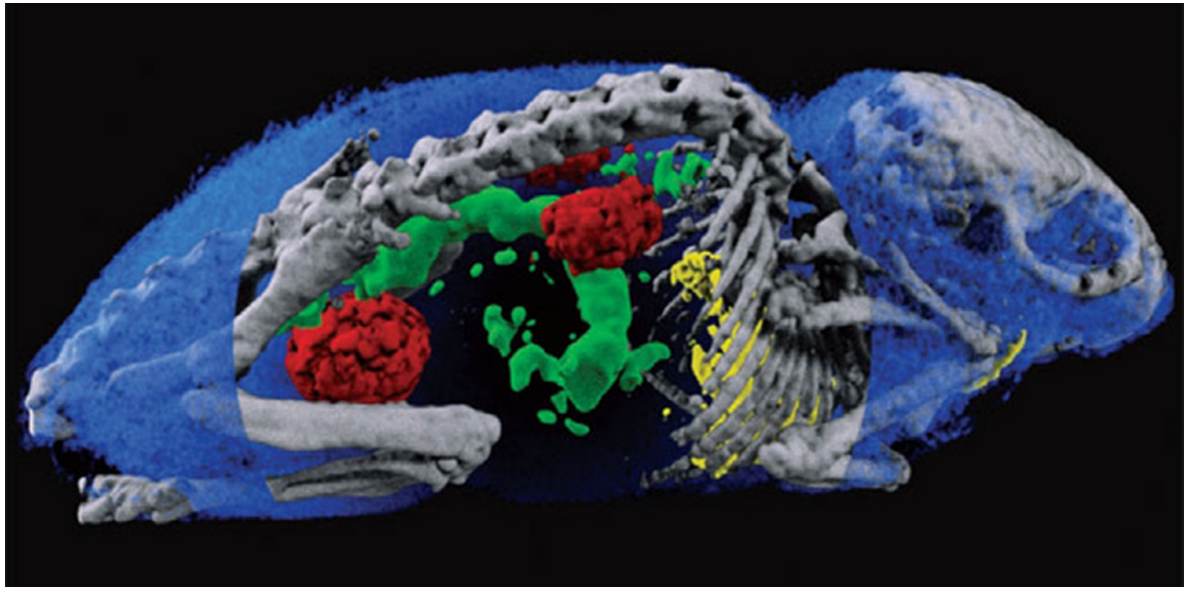
Photon-counting detector

https://doi.org/10.1148/radiol.2018172656

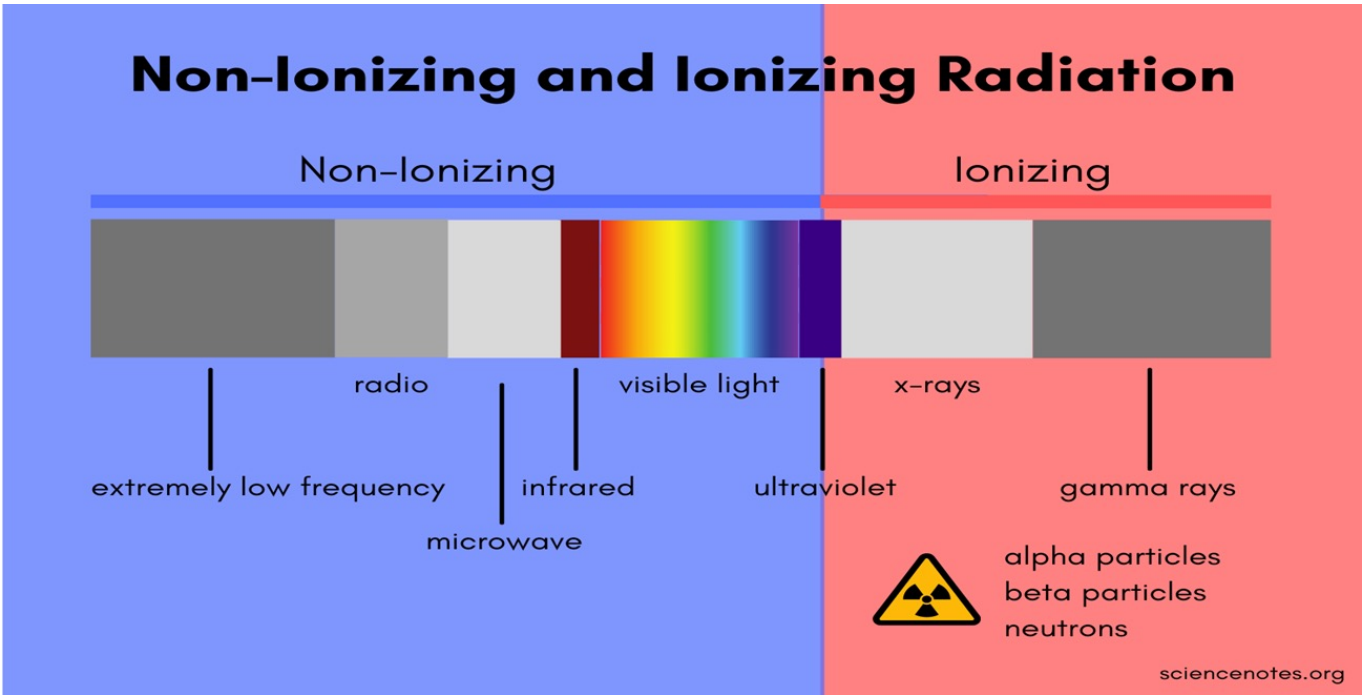
2. Elimination of electronic noise



- able to discriminate the energy of each incident x-ray photon.



Introduction about Radiation

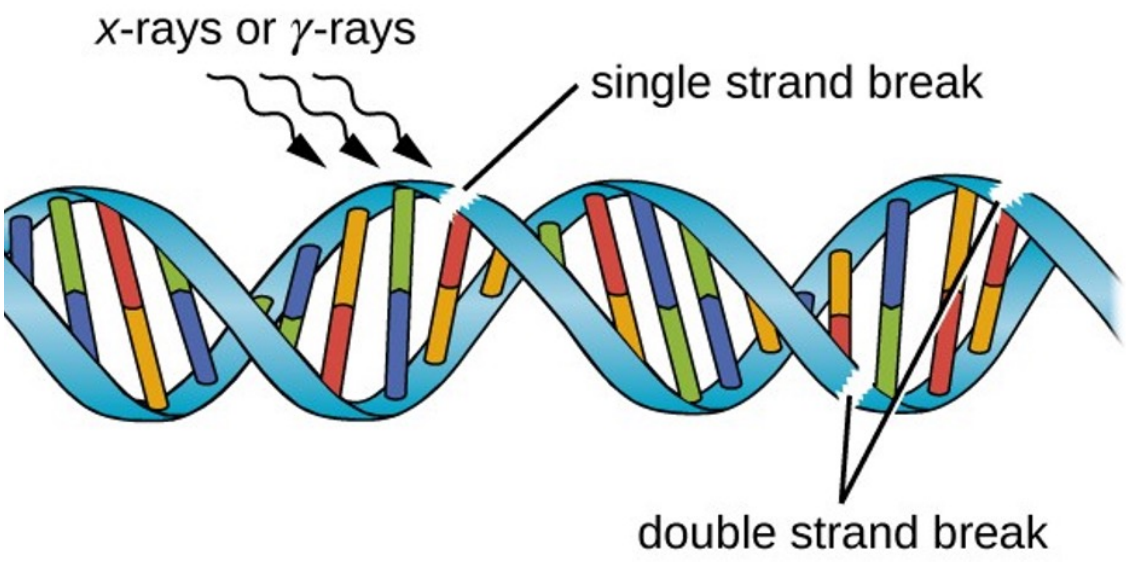


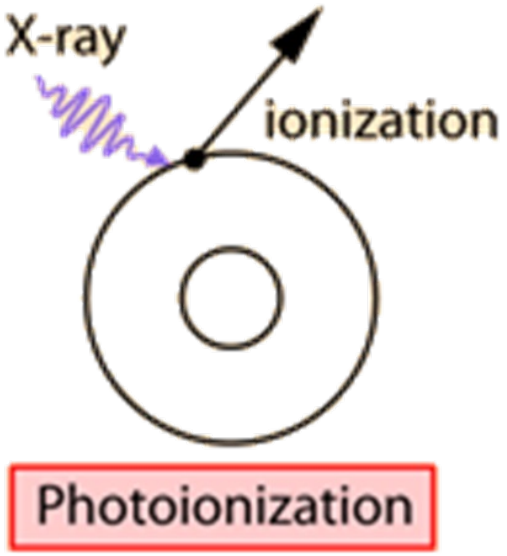
What is radiation?
Radiation is the emission or transmission of energy in the form of waves or particles through space or through a material medium.

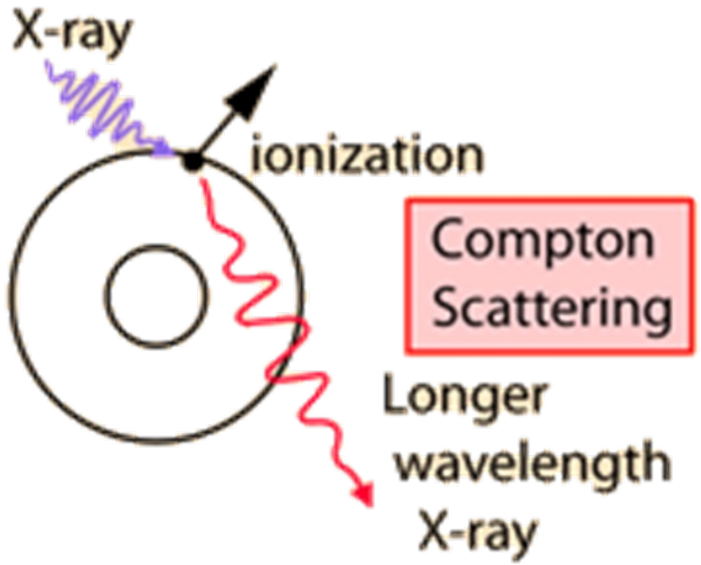
Radiation is often categorized as either **ionizing** or **non-ionizing**

Ionization

Ionization is the ejection of one or more electrons from an atom or molecule to produce a fragment with a net positive charge (positive ion)

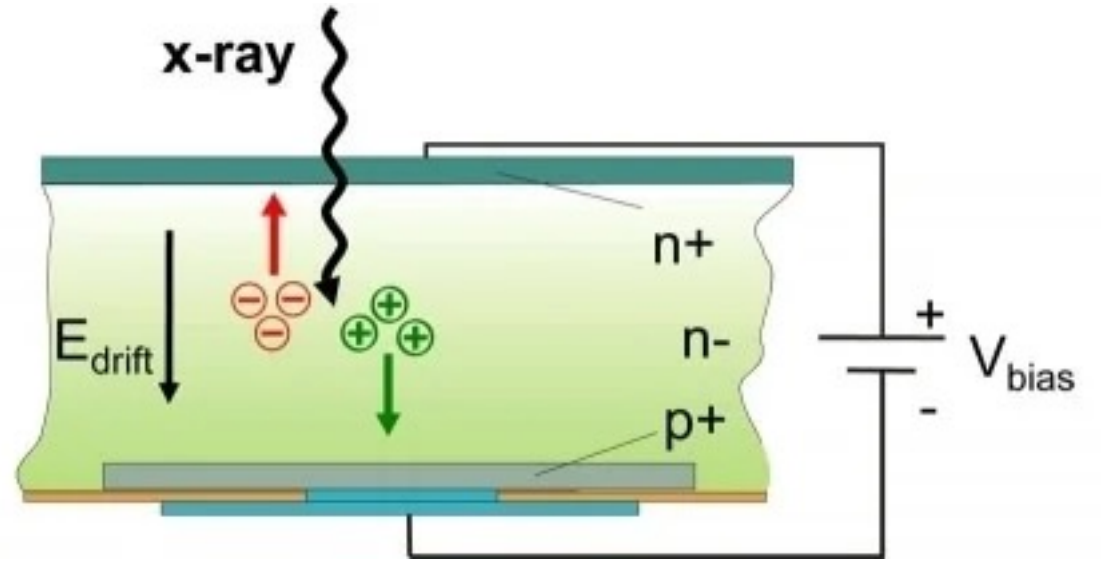




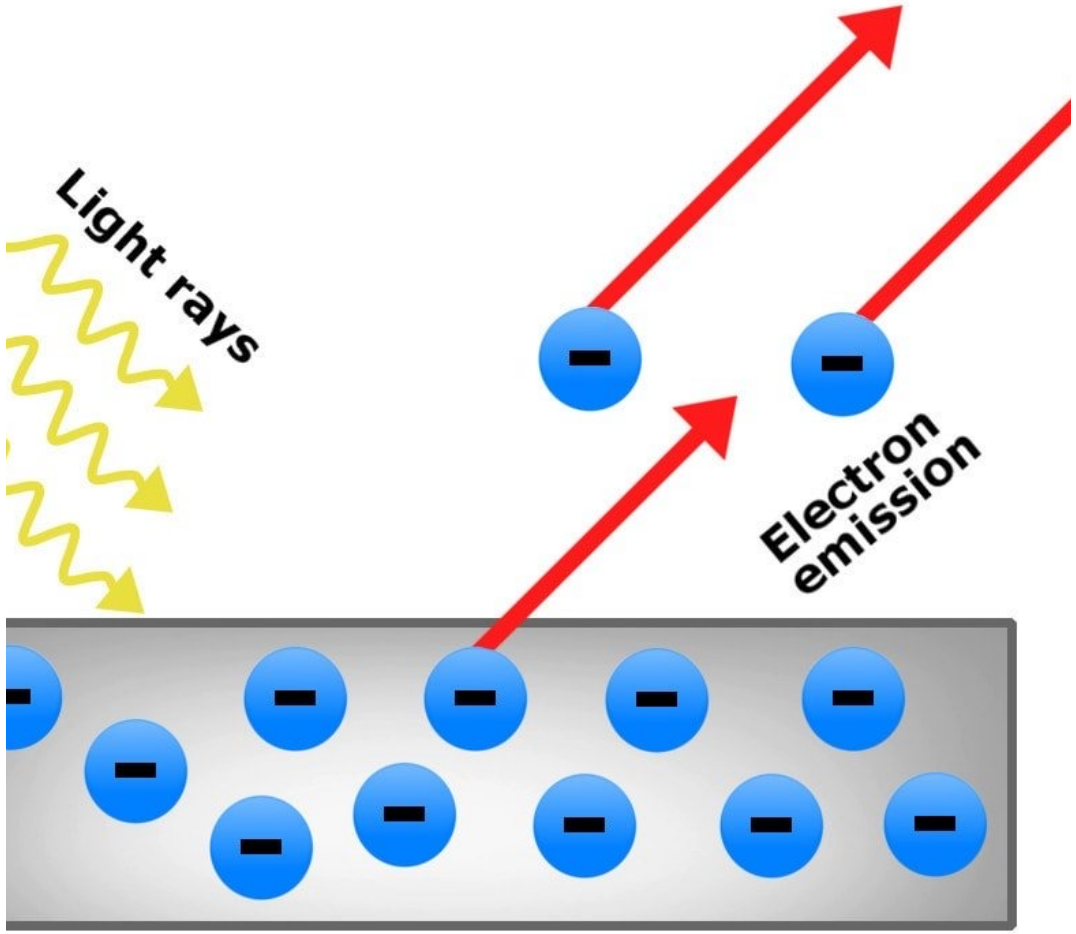


Sensor in hybrid detectors

When ionising radiation strikes the detector its energy is deposited in the silicon layer.
This is then converted into an electrical signal and amplified.



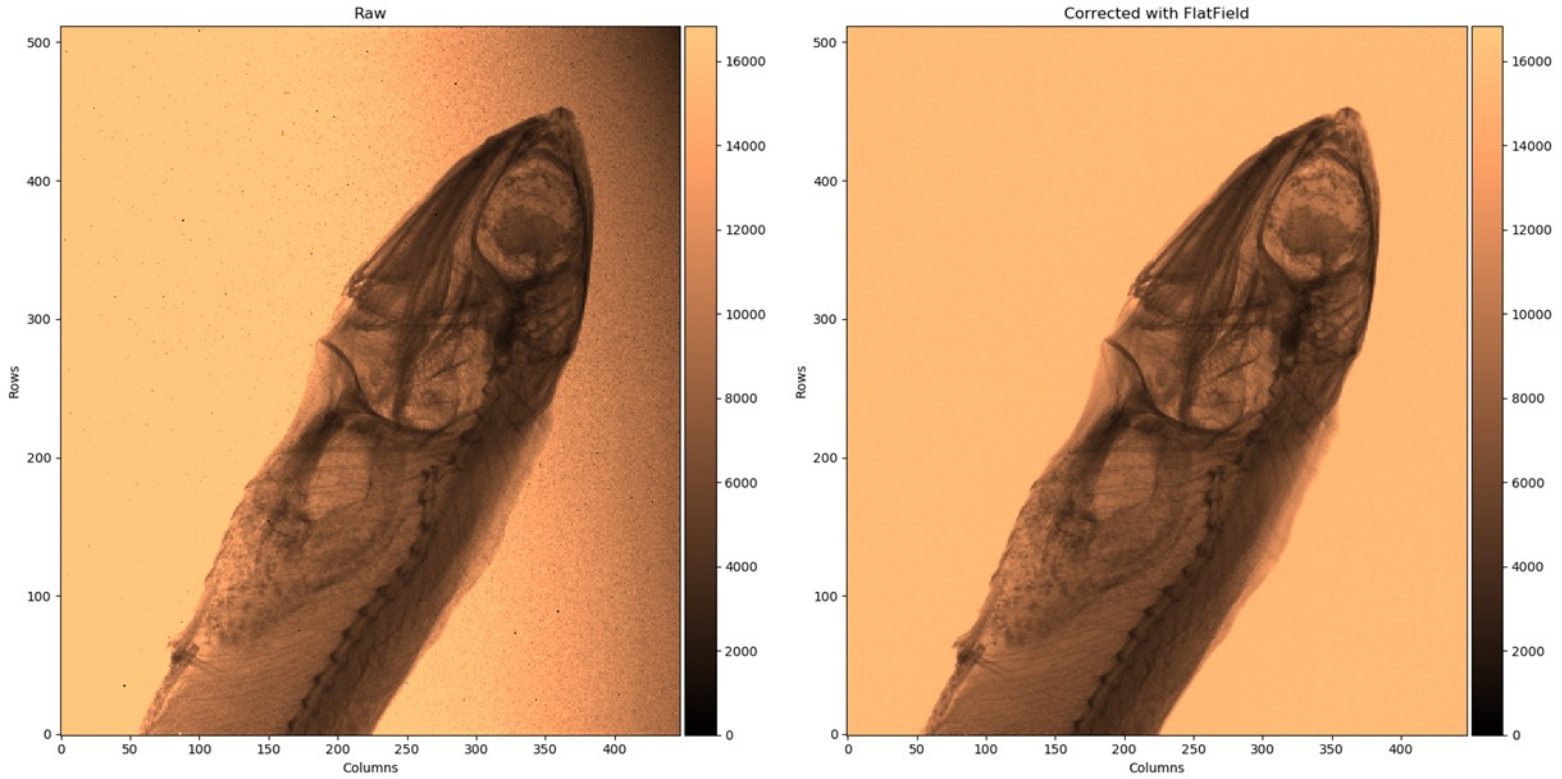
X-rays



The mechanisms of interaction for ionizing radiation in the form of x-rays and gamma-rays include the

1. Photoelectric effect,
2. Compton scattering and at high enough energies,
3. Electron positron pair production.

Photon counting image Timepix4



Timepix4 paper:
X. Llopart *et al* 2022 *JINST* **17** C01044