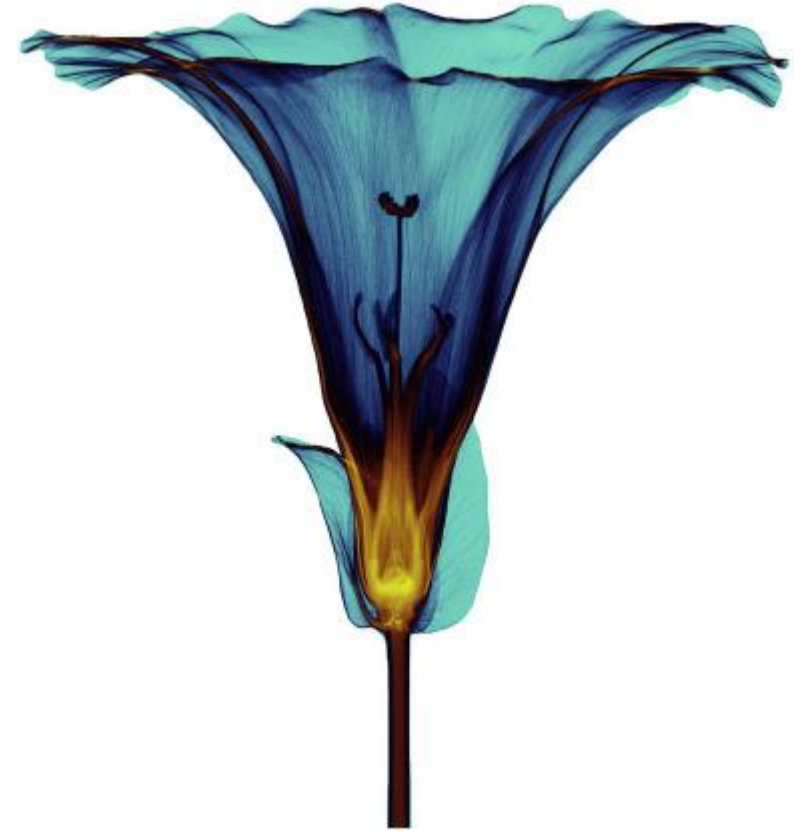
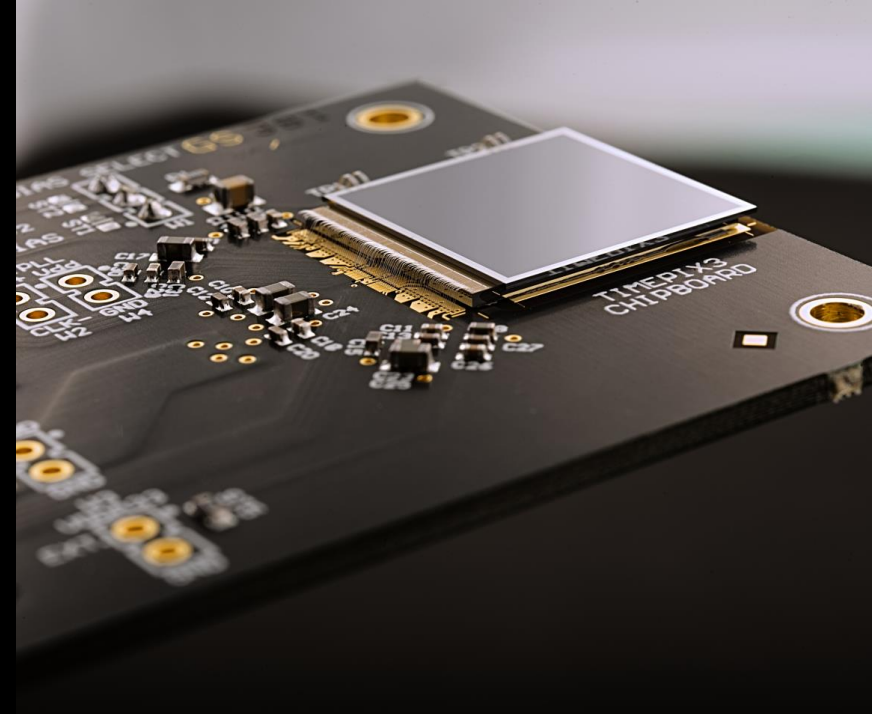
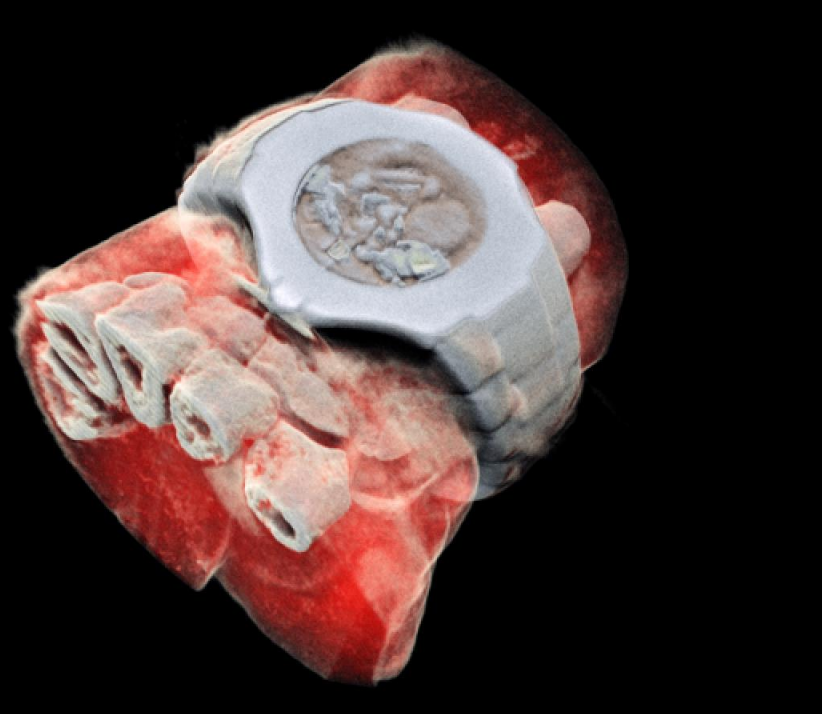


# MEDIPIX DETECTORS



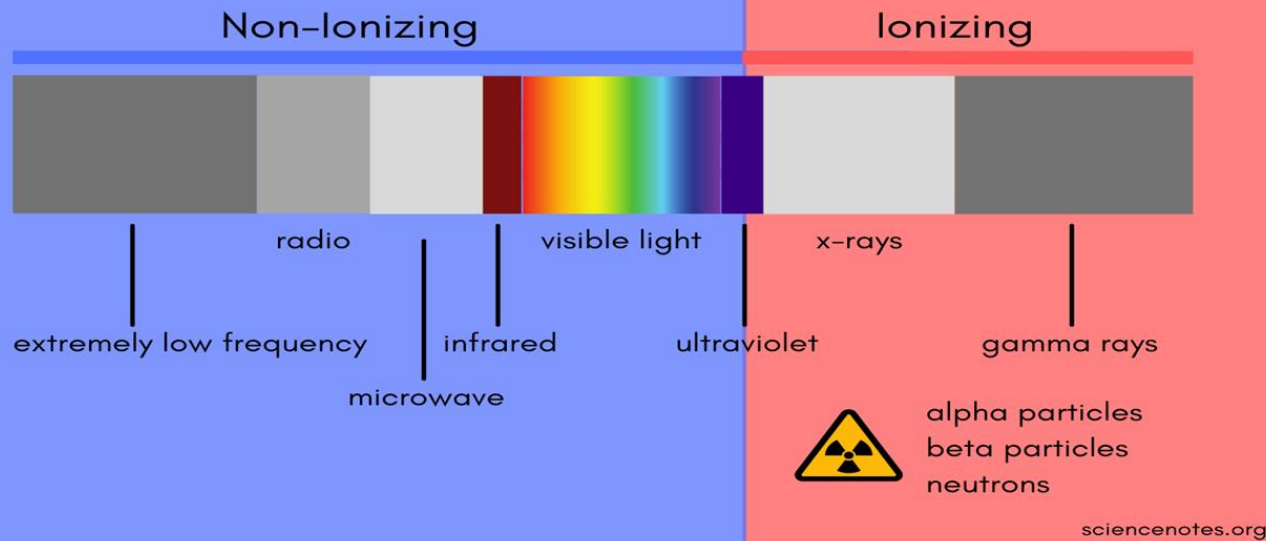
# Outline



- Interaction of radiation with matter
- Photon counting detectors
- Medical applications

# Introduction about Radiation

## Non-ionizing and Ionizing Radiation



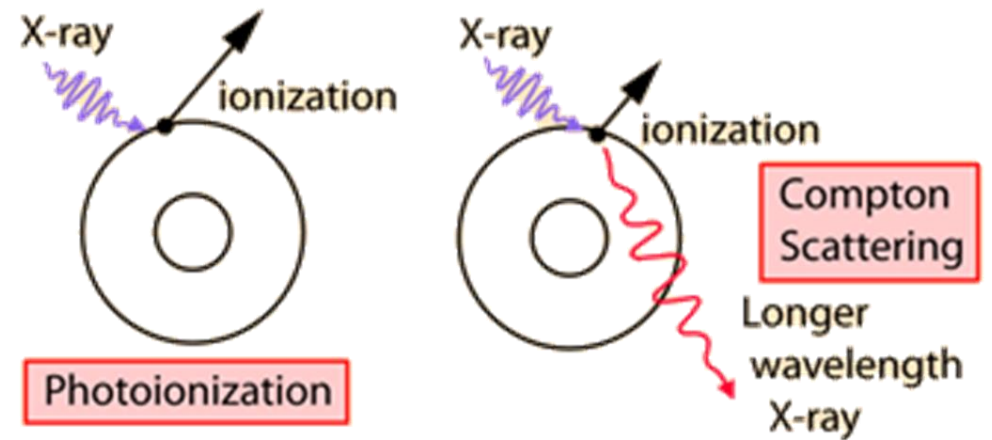
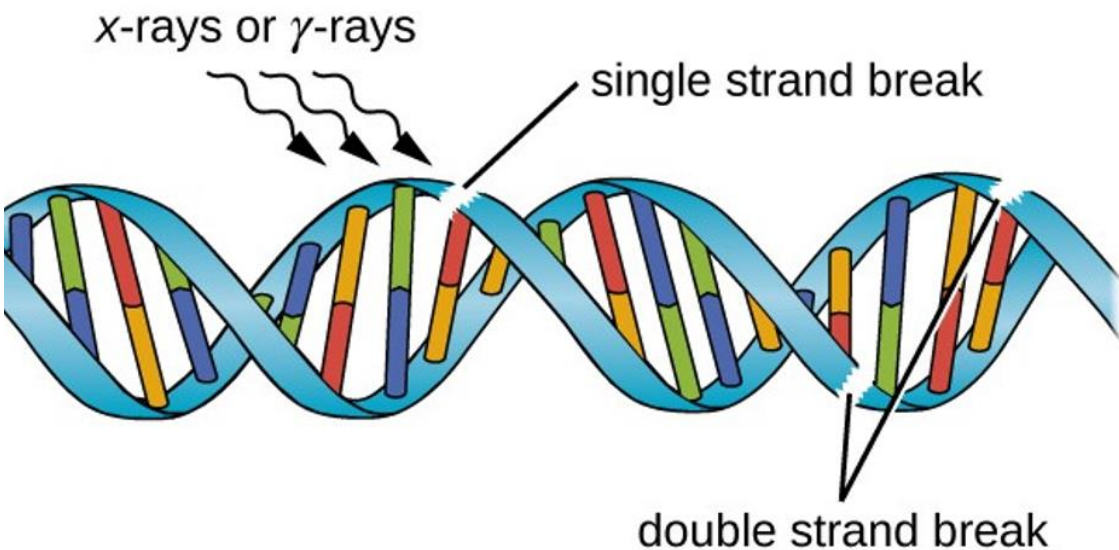
What is radiation?

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

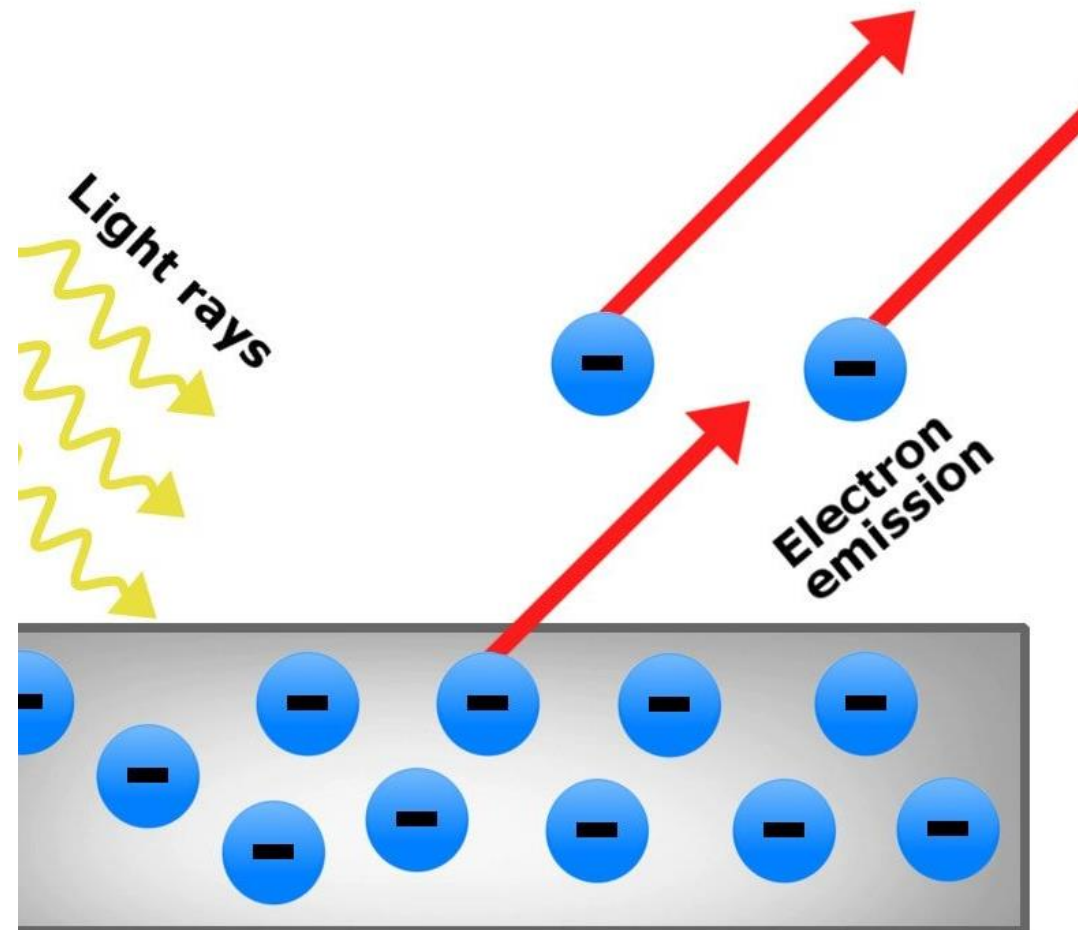
Radiation is often categorized as either **ionizing** or **non-ionizing**

# 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)



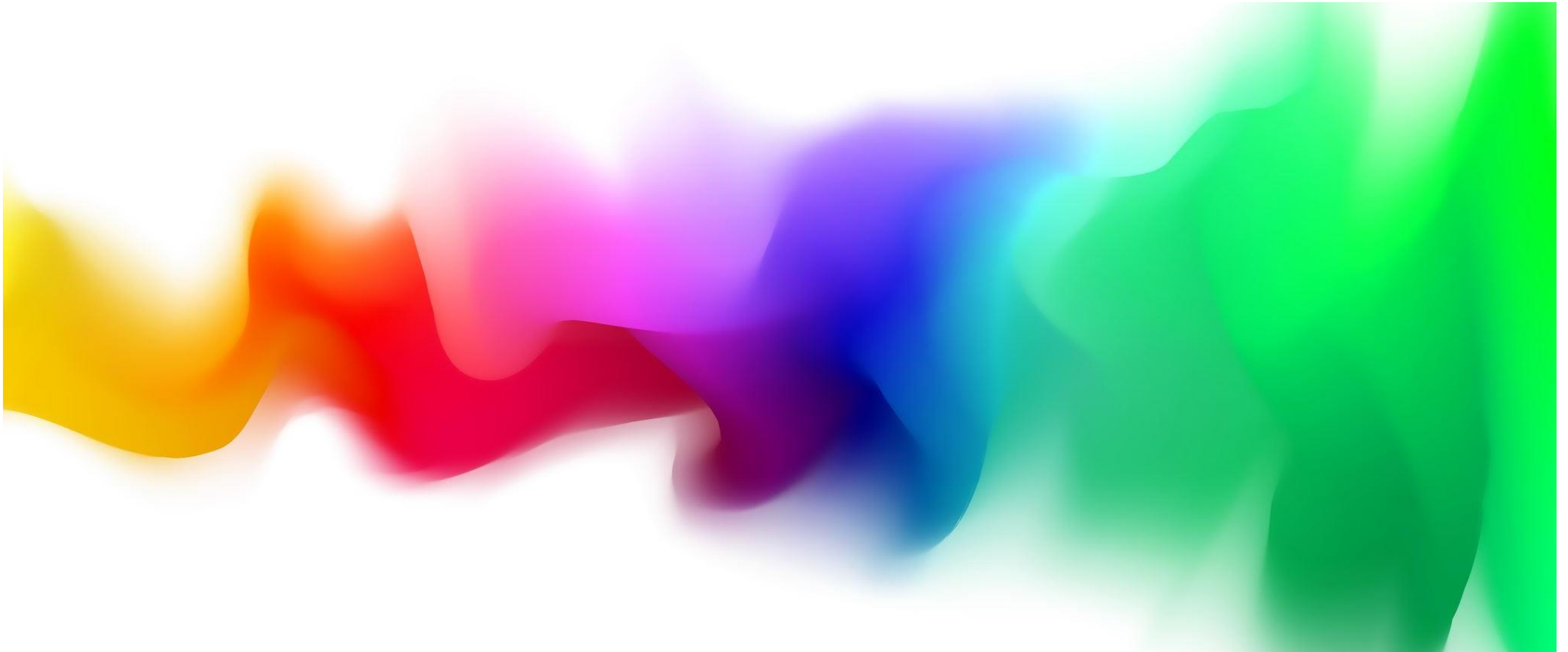
# X-rays



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

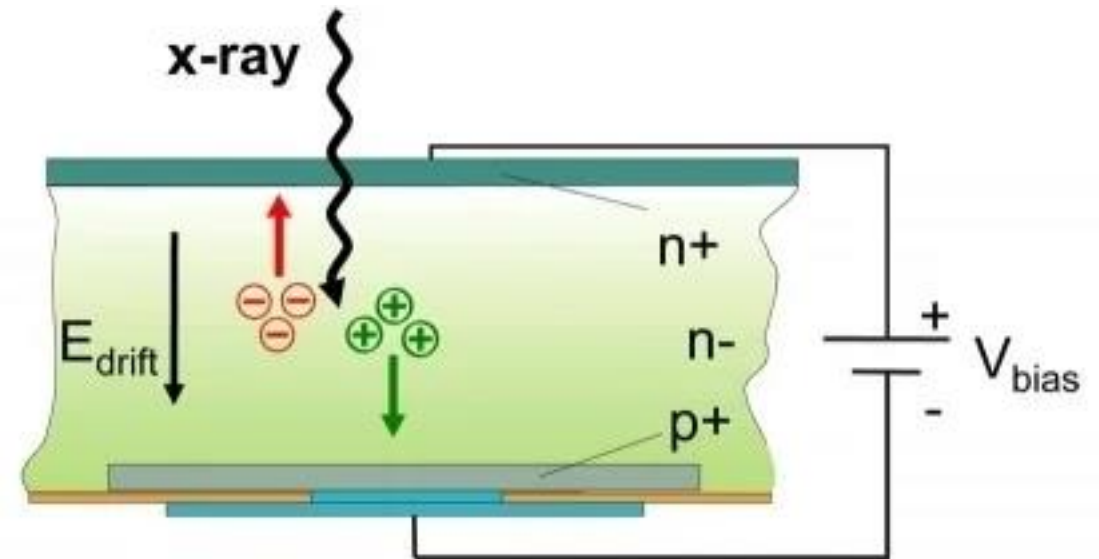
1. Photoelectric effect,
2. Compton scattering and at high enough energies,
3. Electron positron pair production.

# Photon counting detectors

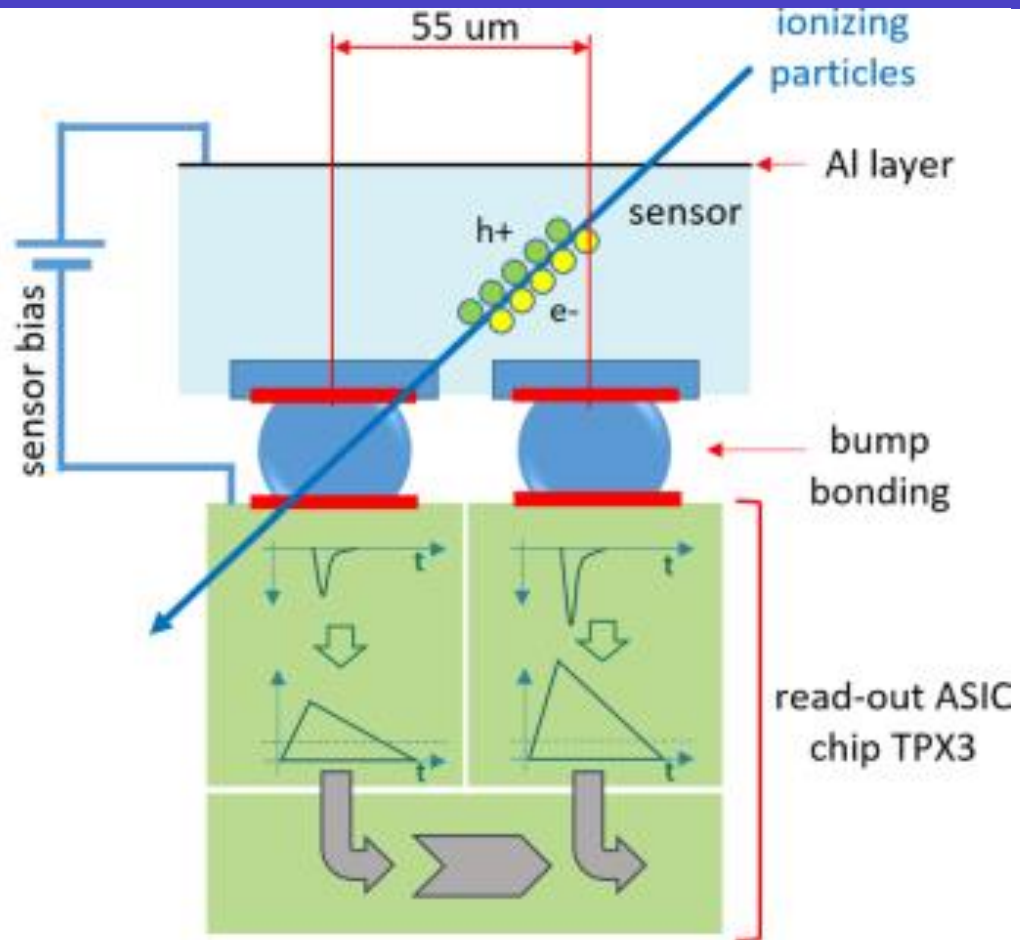


# Sensor in hybrid detectors

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



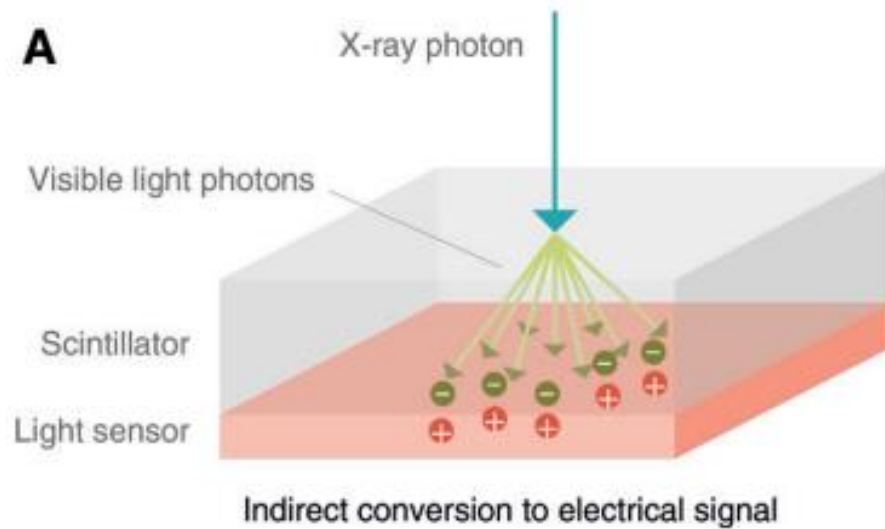
# Timepix3 detector



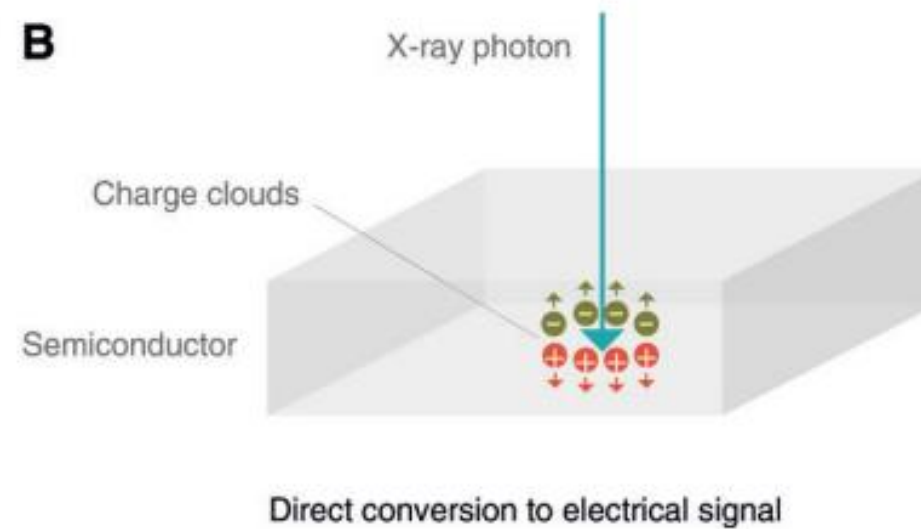


# Photon counting detectors

## 1. Direct conversion

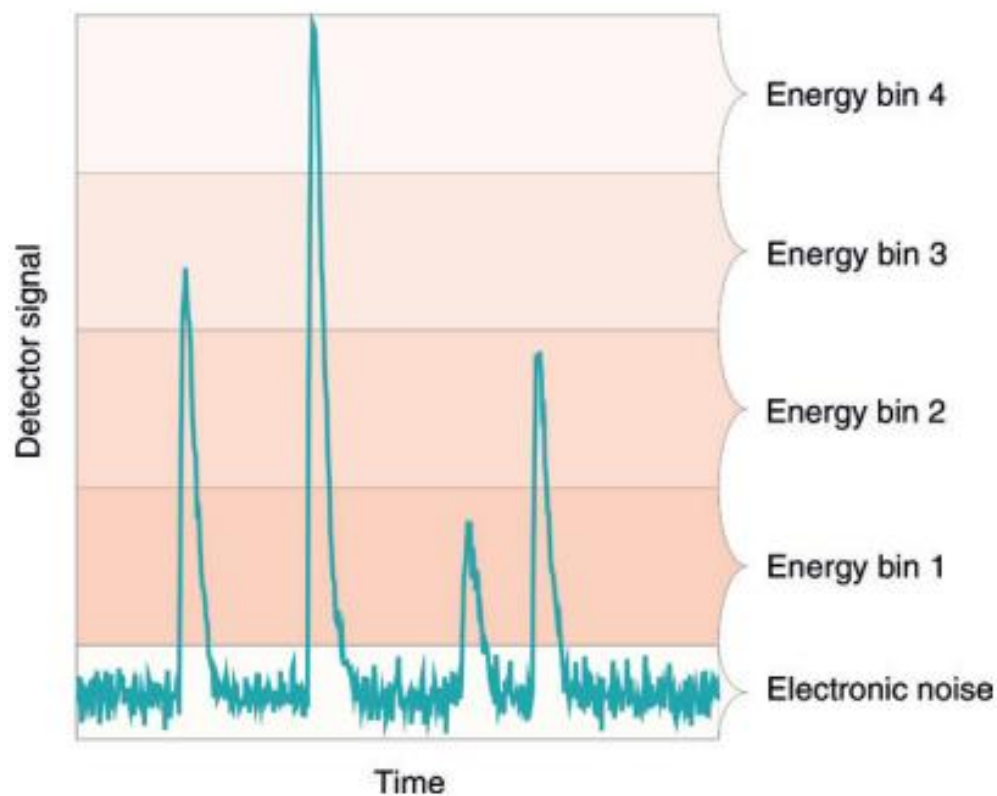


Conventional energy-integrating detector

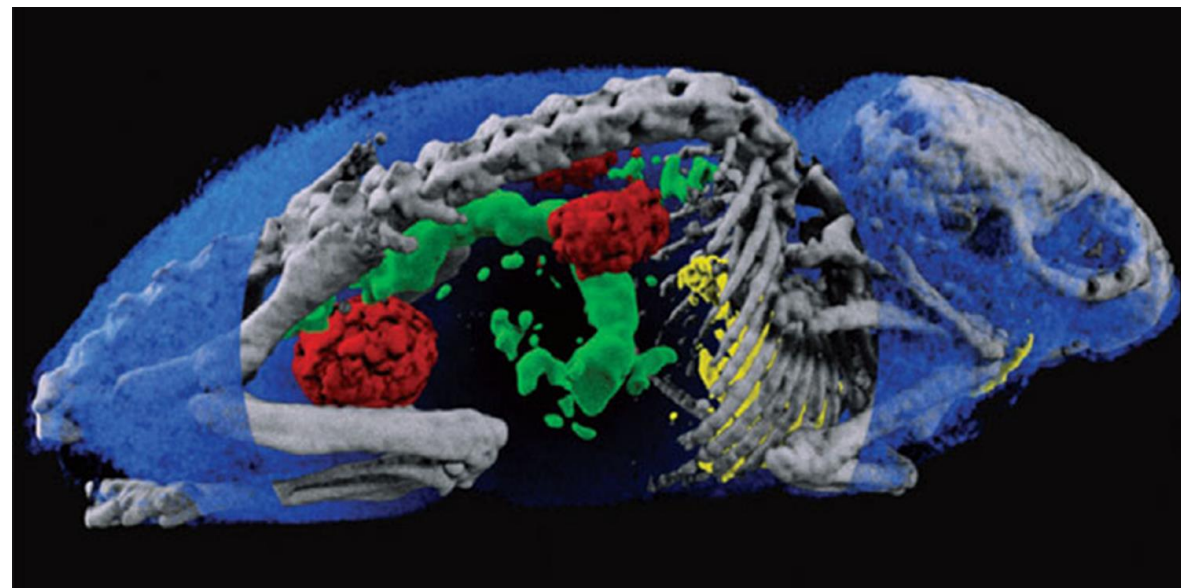


Photon-counting detector

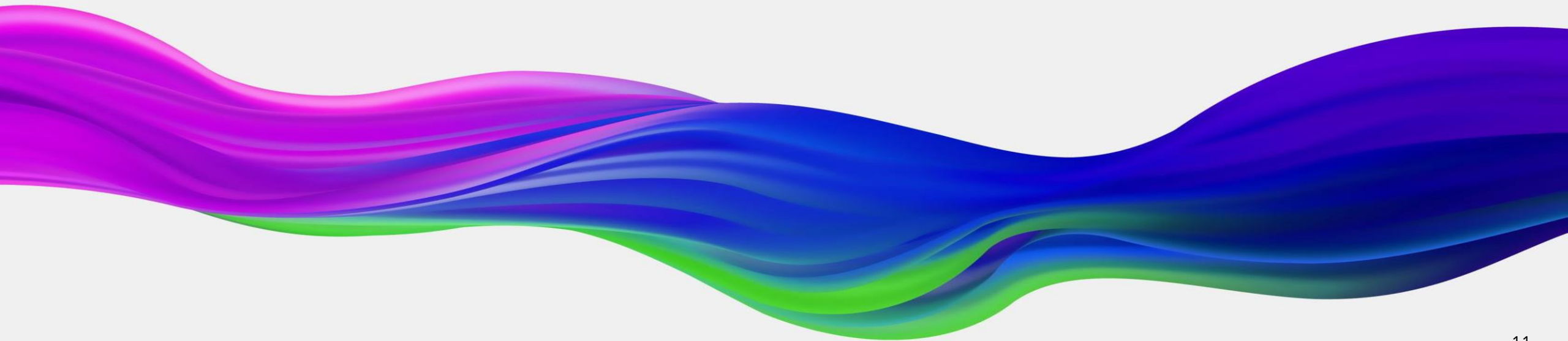
## 2. Elimination of electronic noise



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



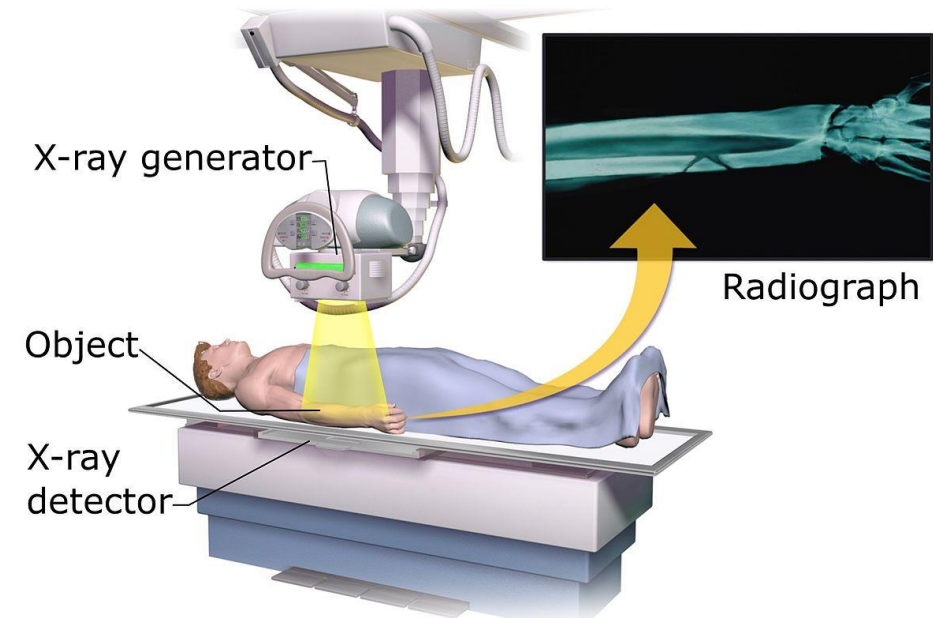
# Medical applications



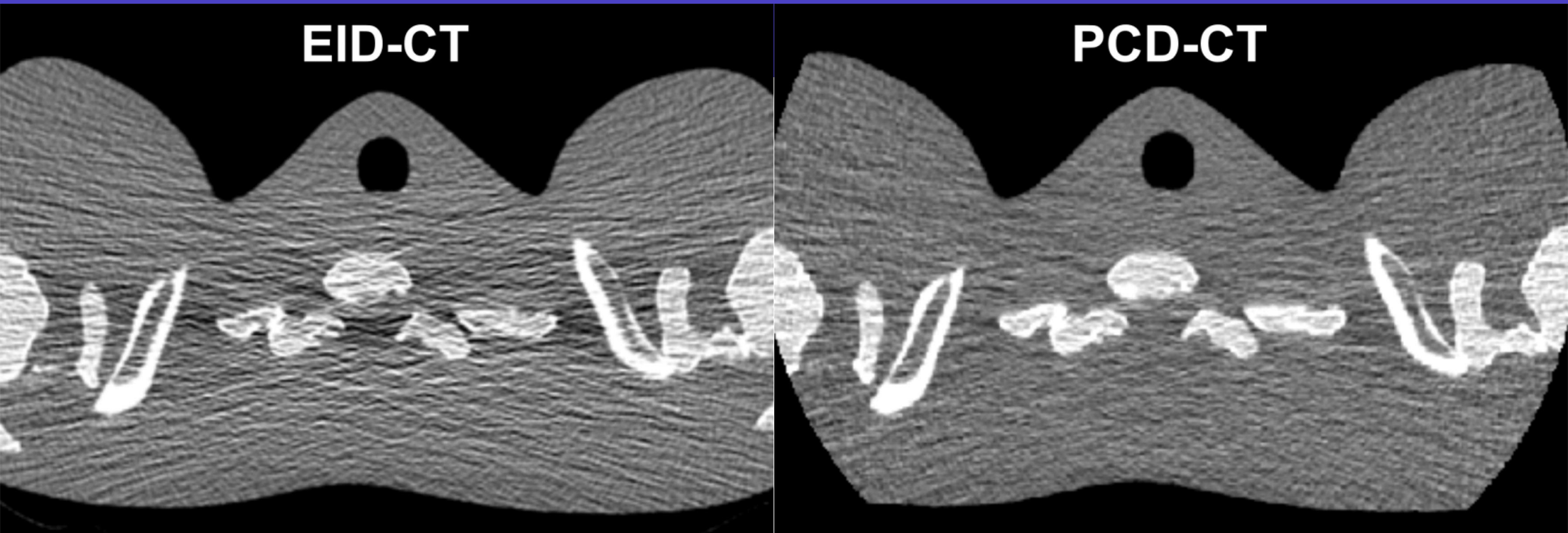
# Conventional X-ray imaging



## Projectional radiography

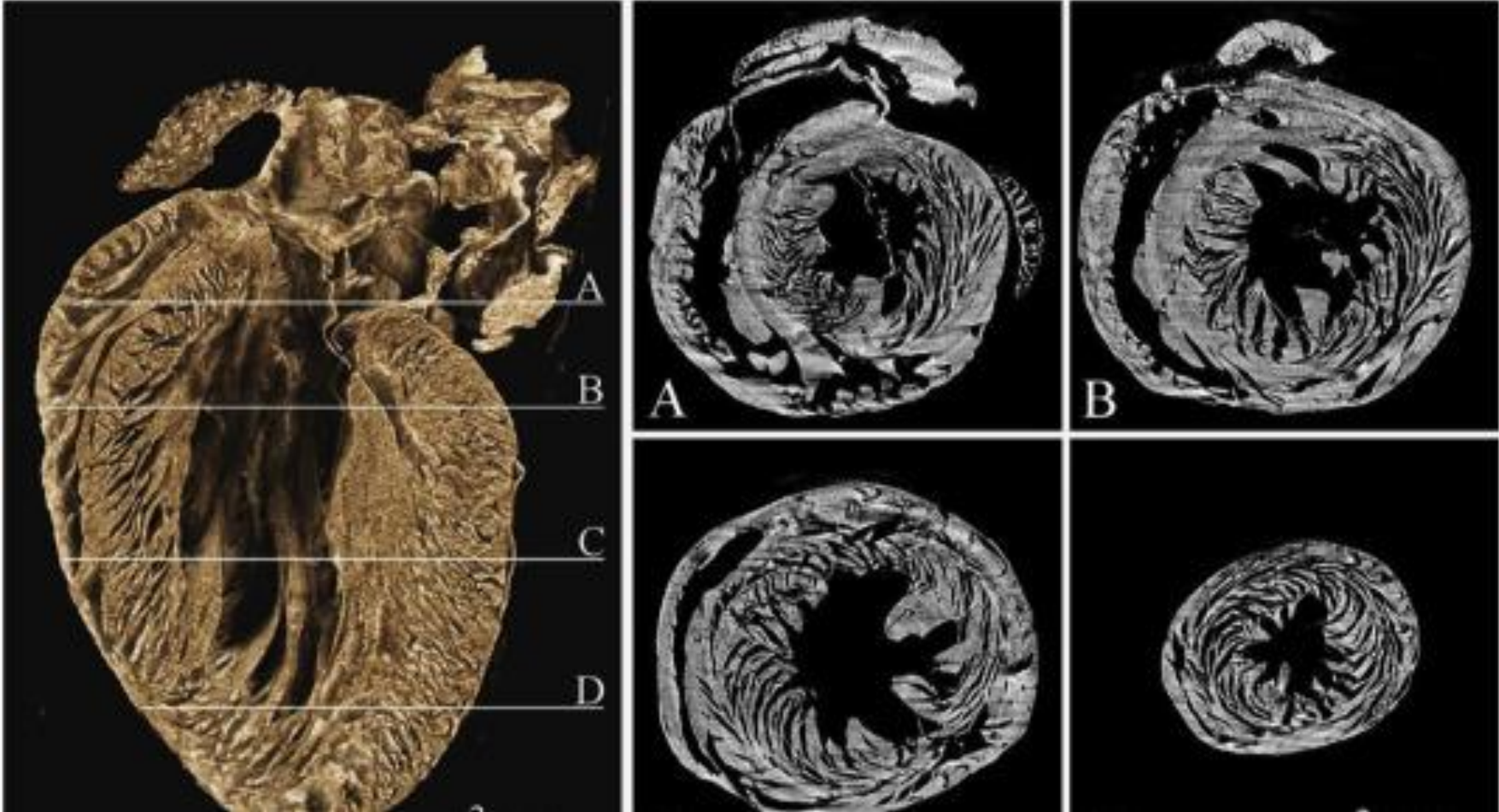


# Medical applications: CT

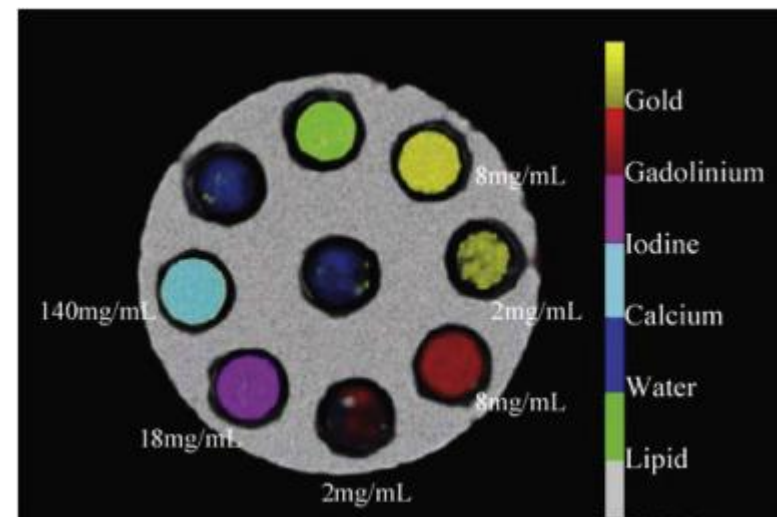
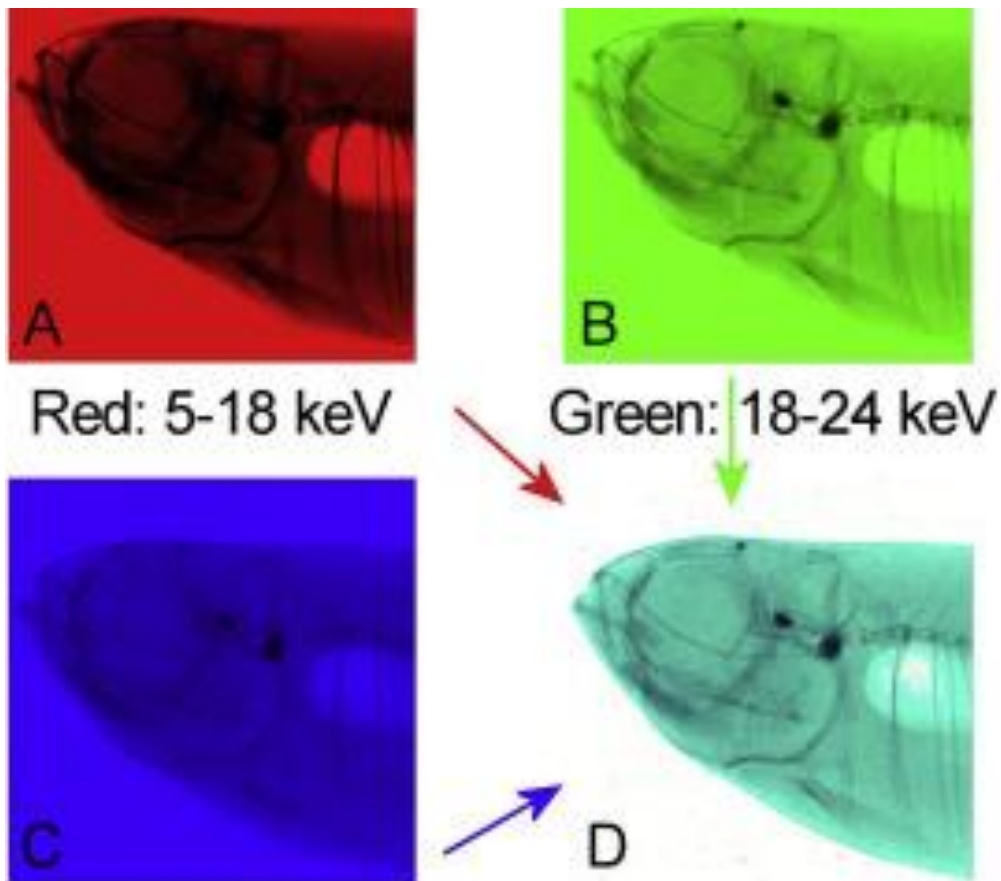


The shoulder section of a thorax phantom reconstructed from data acquired with EID CT **(a)** and with PCD CT **(b)** using the same x-ray tube potential and radiation dose

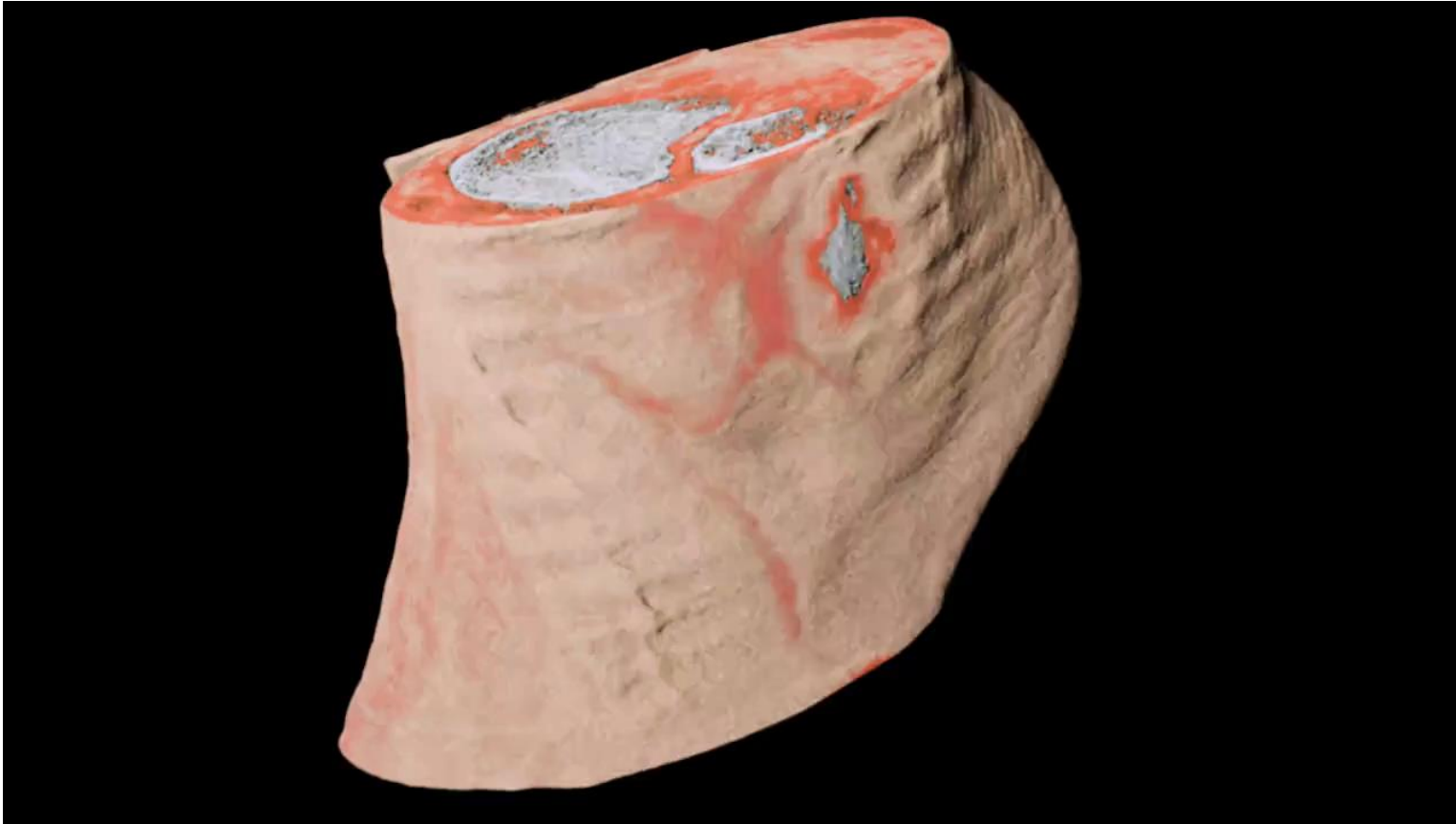
Tomographic reconstruction of a mouse heart



# Coloured X-ray imaging using the head of a small fish

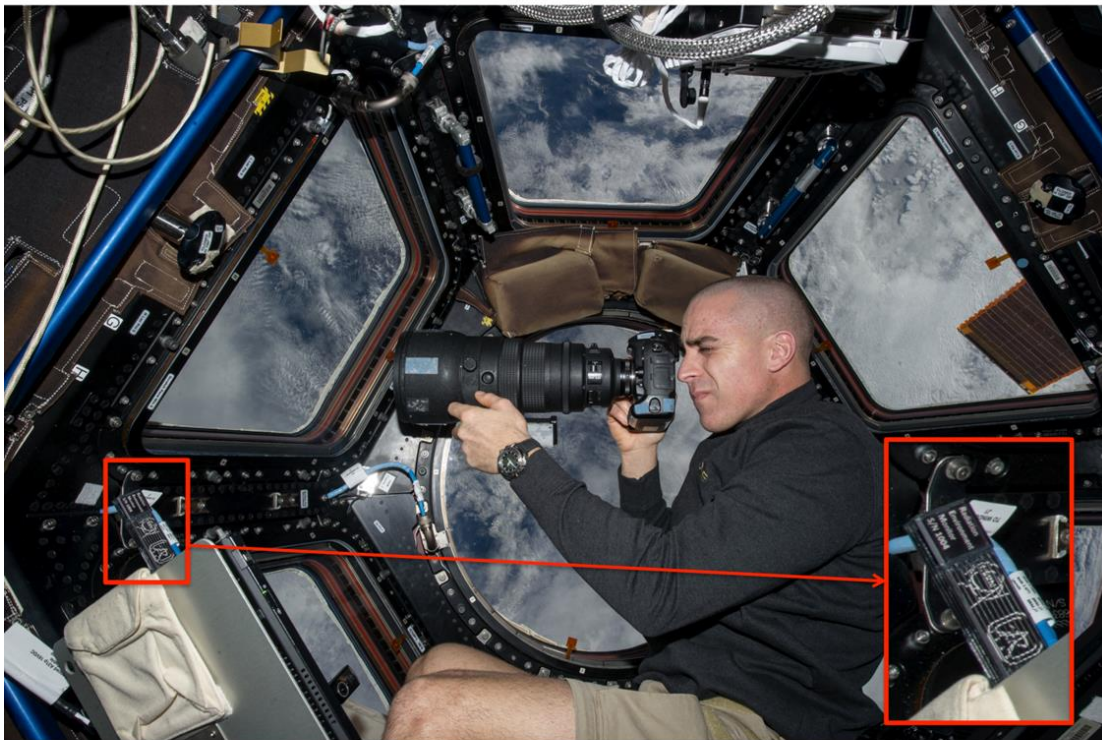


# Spectroscopic X-ray imaging





# Application in Space Dosimetry


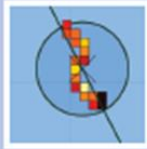



Timepix is being exploited for radiation monitoring in NASA's Orion rocket and at the International Space Station

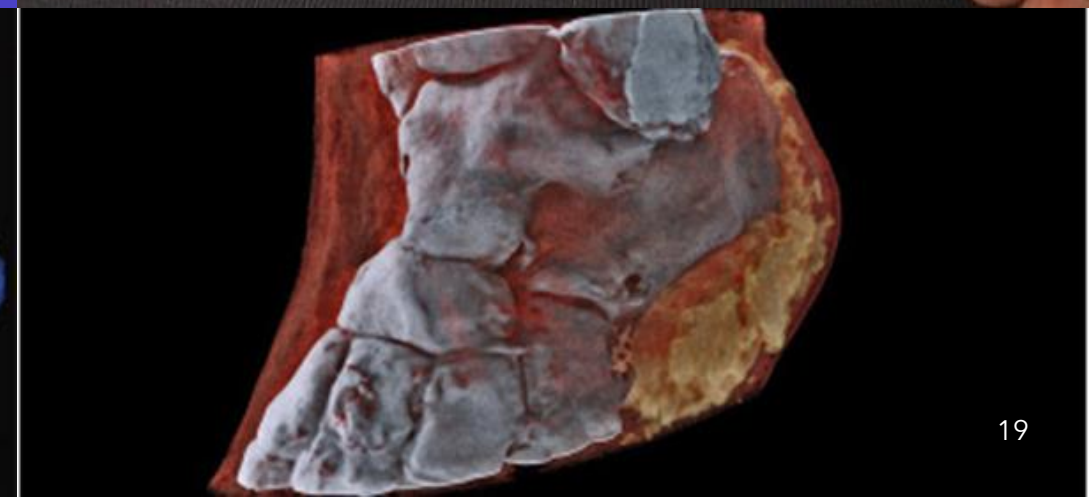
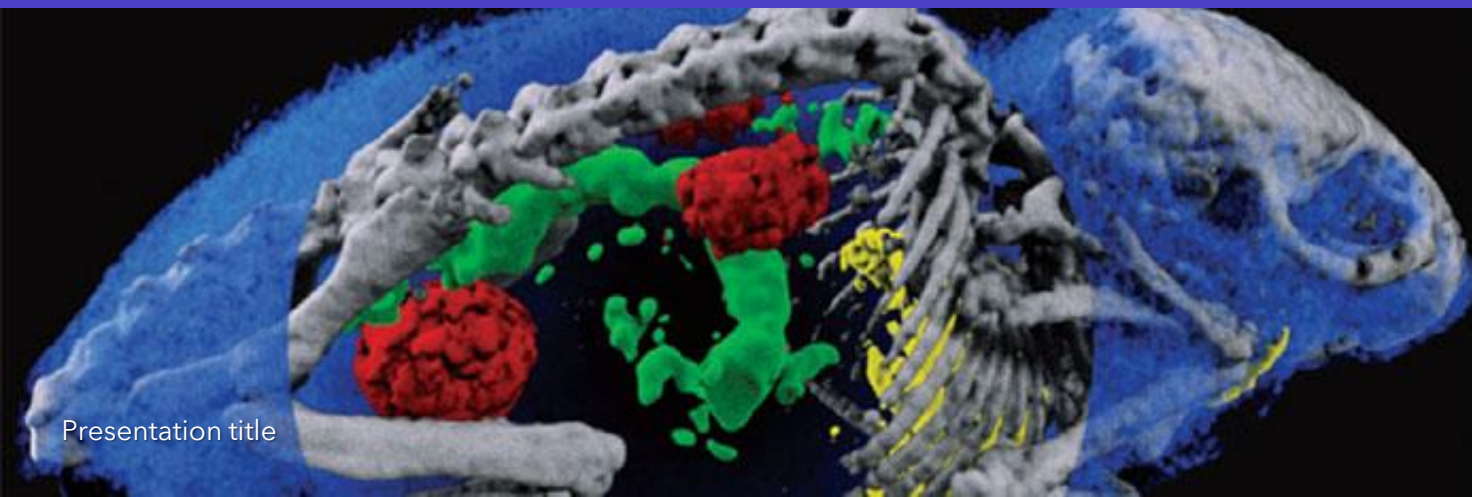
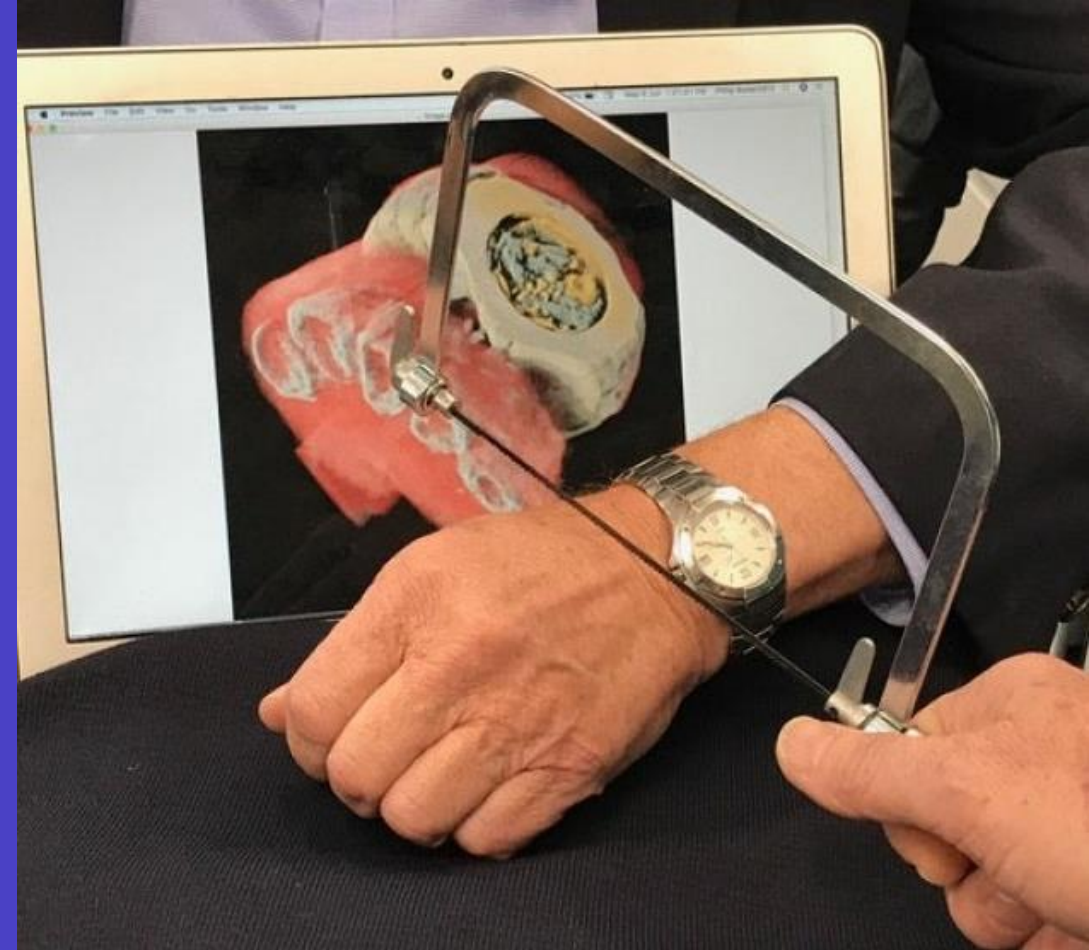
Image of the astronaut Chris Cassidy working near the Timepix USB on the International Space Station (Courtesy of NASA, photo ref. no. iss036e006175)

# Application: school projects

## Particle identification

Type	Description	Track	Comment
Alpha, $\alpha$	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, $\beta$	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, $\gamma$	High frequency electromagnetic radiation	Dot 	Gamma continues to pass through the detector only interacting with a small number of pixels

# Thank you



# Extra slides

# Comparison of background radiation

