PET
POSITRON EMISSION TOMOGRAPHY

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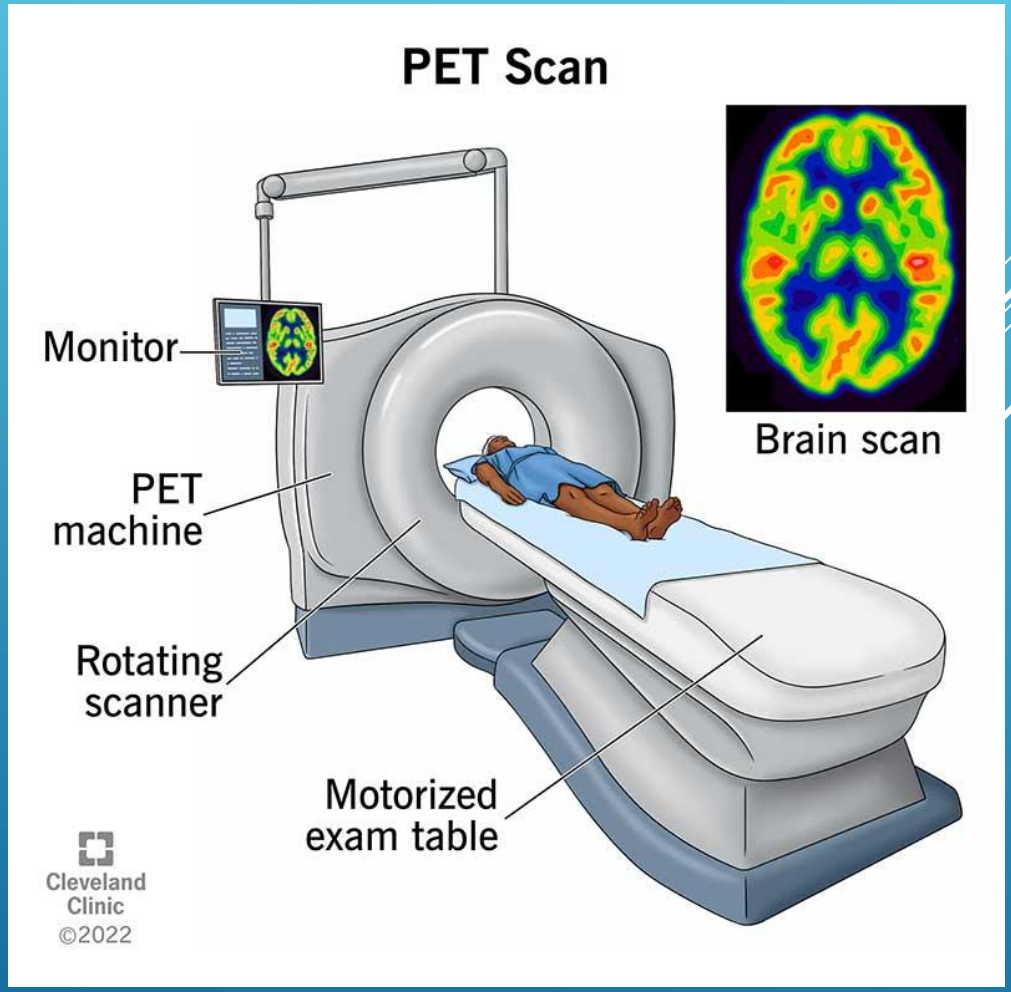
Experiments in Modern Physics Seminar

Budapest, 2023

WHAT IS PET?

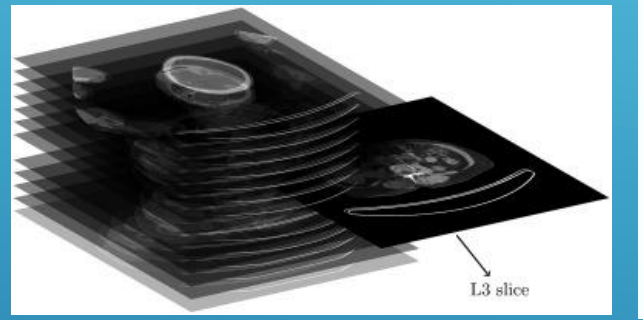
- Imaging technique that uses radioactive substances (radiotracers).
- β^+ decay radiopharmaceuticals + e^--s → gamma rays detected by gamma cameras
- 3D imaging
- Both a medical and research tool used in pre-clinical and clinical settings

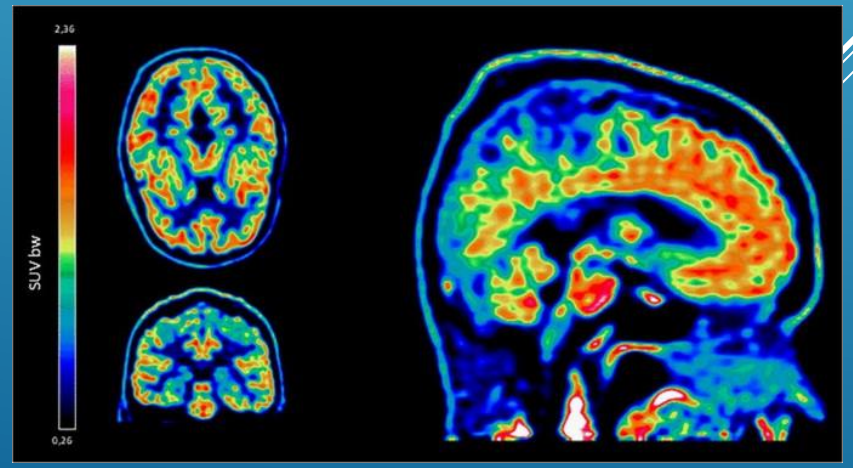


Source: https://my.clevelandclinic.org/health/diagnostics/10123-pet-scan

IMAGING TECHNIQUES

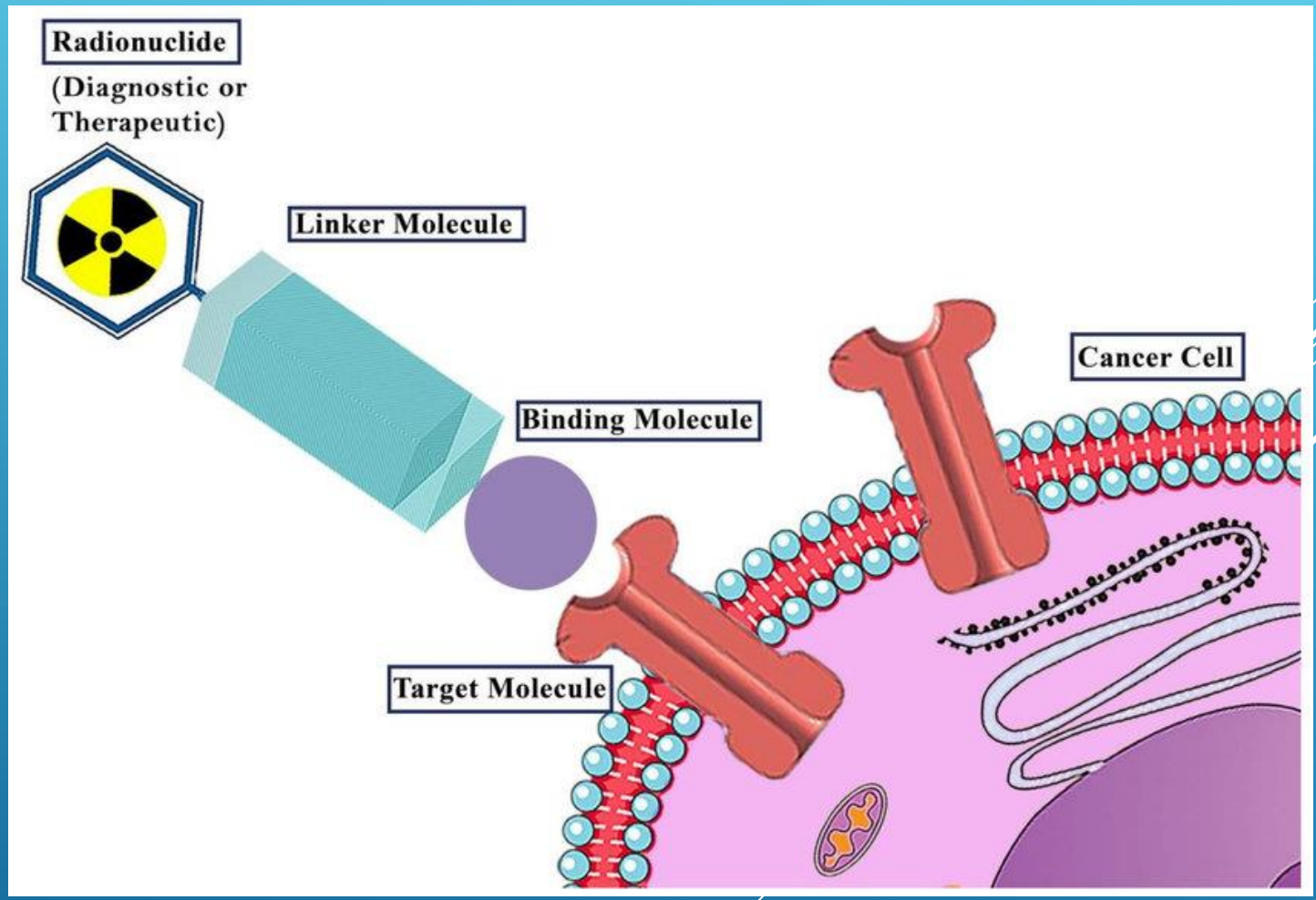
- The image can be defined as the location dependence of some property (physical, chemical) of the system.
- Several types of imaging:
  - 2D projection imaging (RTG)
  - tomography (CT, PET, SPECT, MRI)
  - structural imaging (RTG, MRI, US)
  - functional imaging (fMRI, PET)





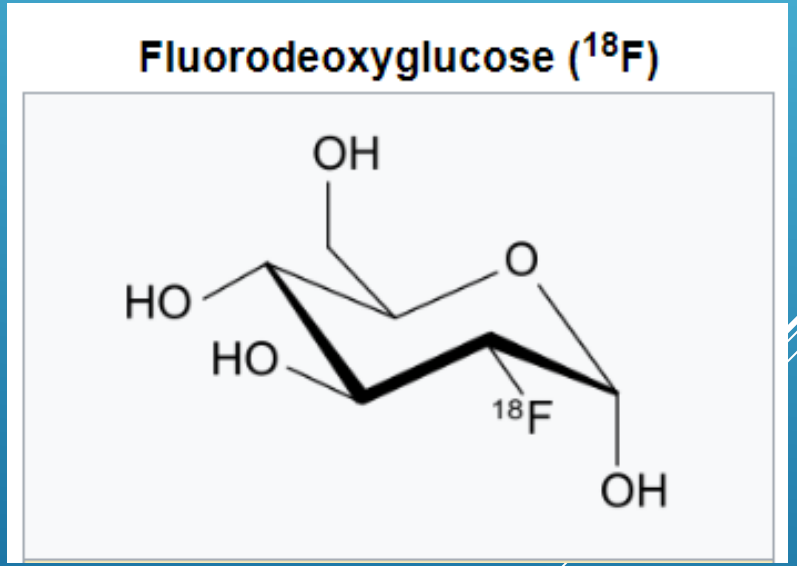
RADIOPHARMACEUTICALS

- Targeting
- Tag with β^+ decay radionuclids
- These molecules behave the same as their non-radioactive pairs.
- We have to choose the suitable isotopes.



A négy leggyakrabban alkalmazott PET izotóp magfizikai jellemzői		
Izotóp	Felezési idő (min)	Maximális pozitron energia (keV)
18F	109,7	635
11C	20,4	960
13N	9,96	1190
15O	2,07 -	1720

- Widely used $C_6H_{11}FO_5$ molecule
- Tissues with high metabolic activity can be diagnosed
- Can be used for diagnosis, staging and monitoring treatment of different type of cancers: breast cancer, lung cancer, melanoma



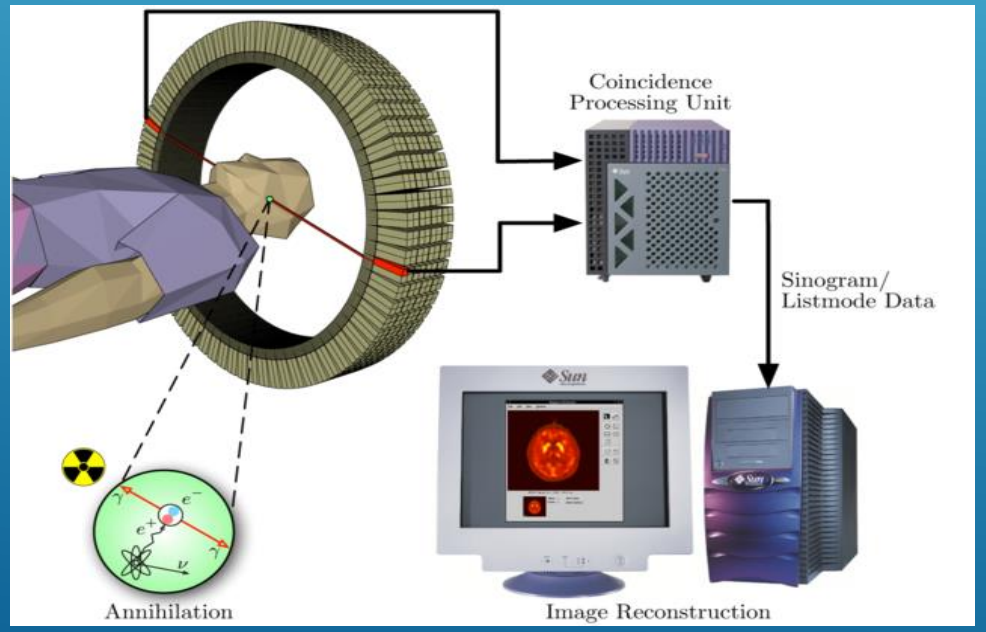
2 AREAS FOR DEVELOPMENT

Radiopharmaceuticals:

New pharmaceuticals => wider field of possible examinations

Instrument and measurement technique:

Researches for get more sensitive instruments and get better resolution

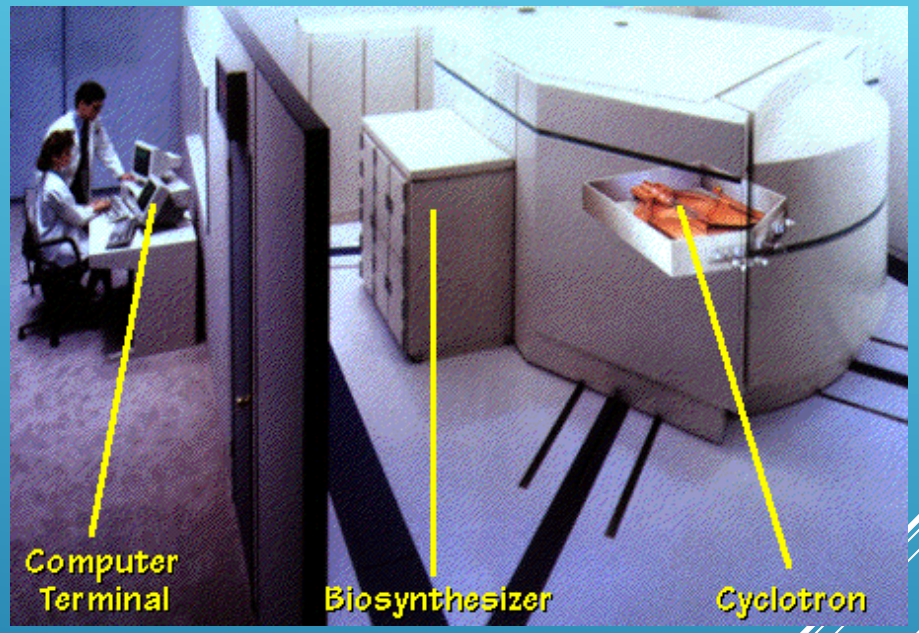


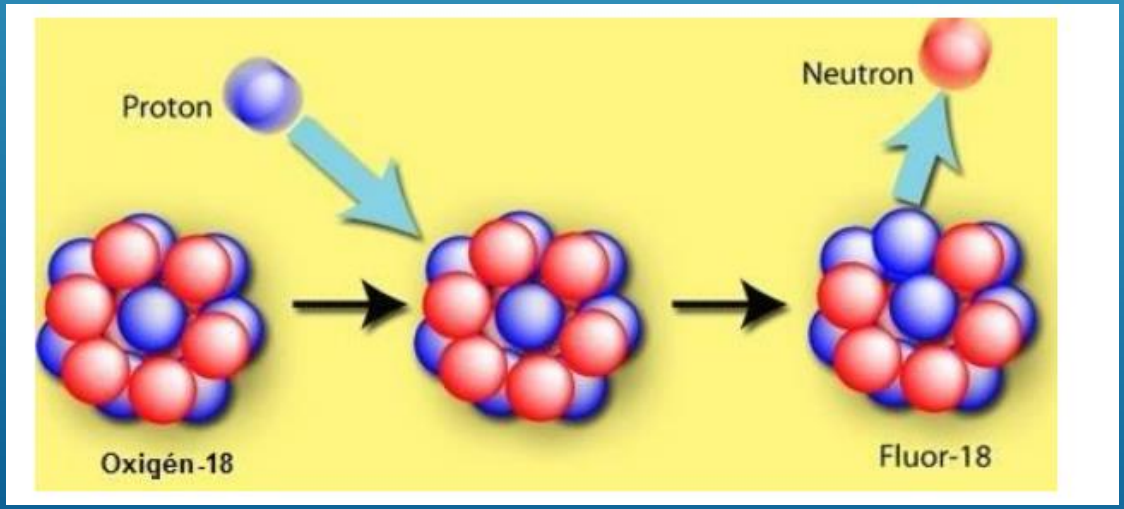
DISADVANTAGES!

- Short half life

  => must need a cyclotron

- Expensive

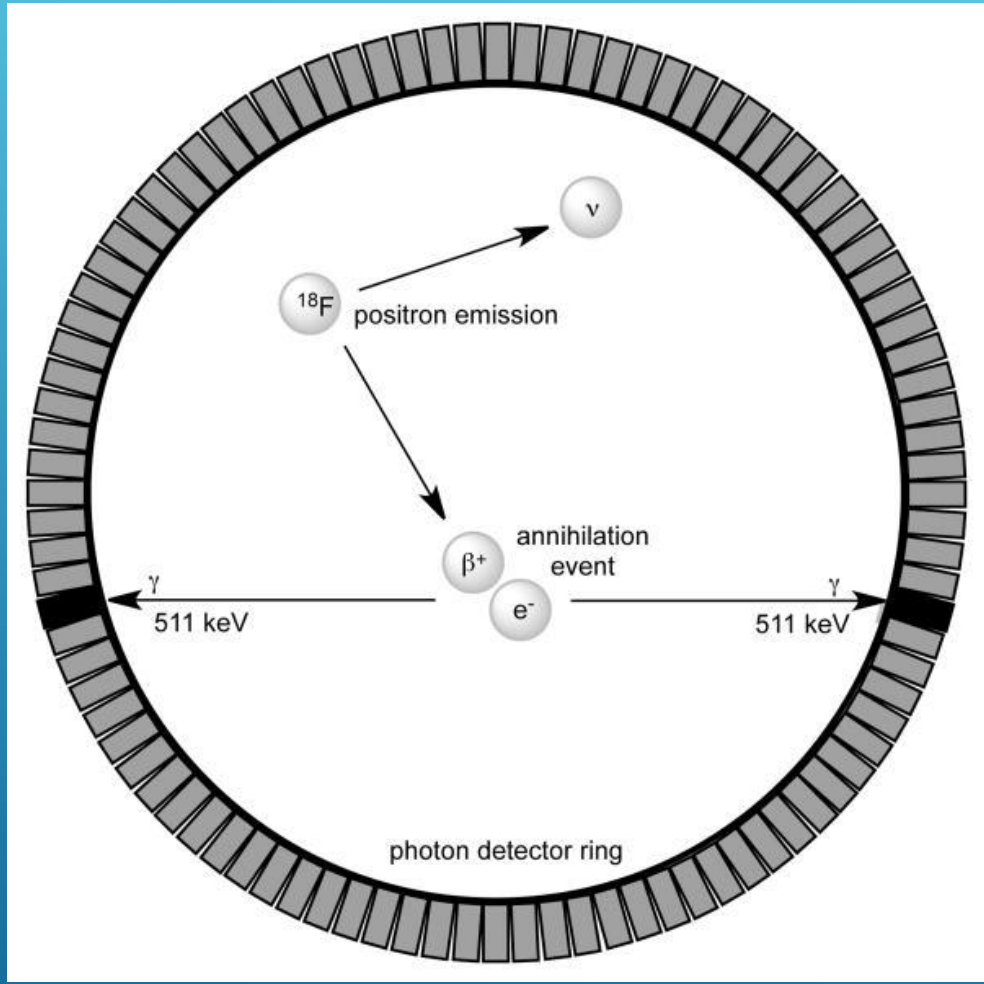




THE POSITRON EMISSION

$$^{18}_{9}F \rightarrow {}^{18}_{8}O + {}^{o}_{+1}e + \nu_e$$

Fluorine - 18 | Oxygen - 18 | Positron



GAMMA CAMERAS

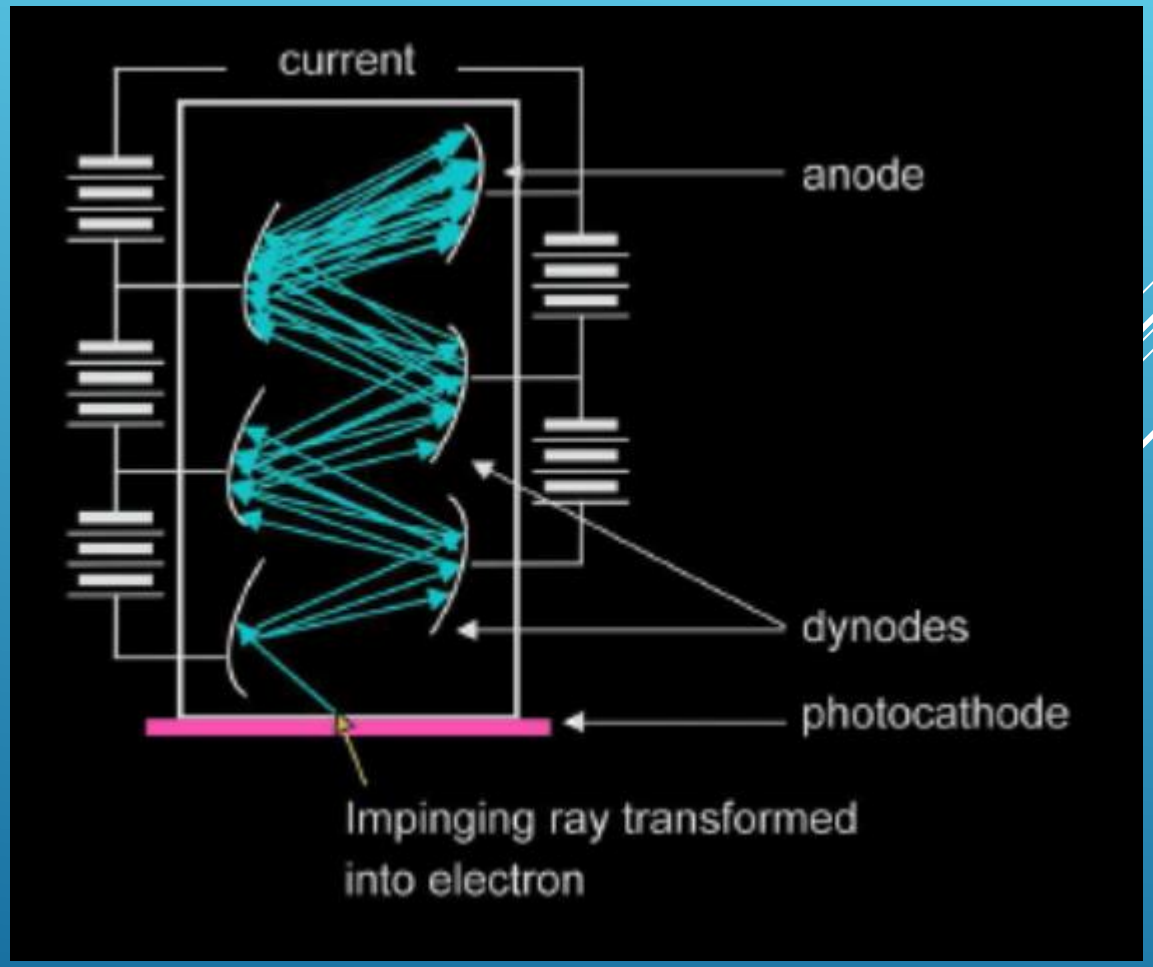
Gamma photons captured with gamma cameras

Photons and the detector interact -> the scintillator (inorganic crystal) emit visible photons.

They create photoelectrons

⇒Photomultipliers

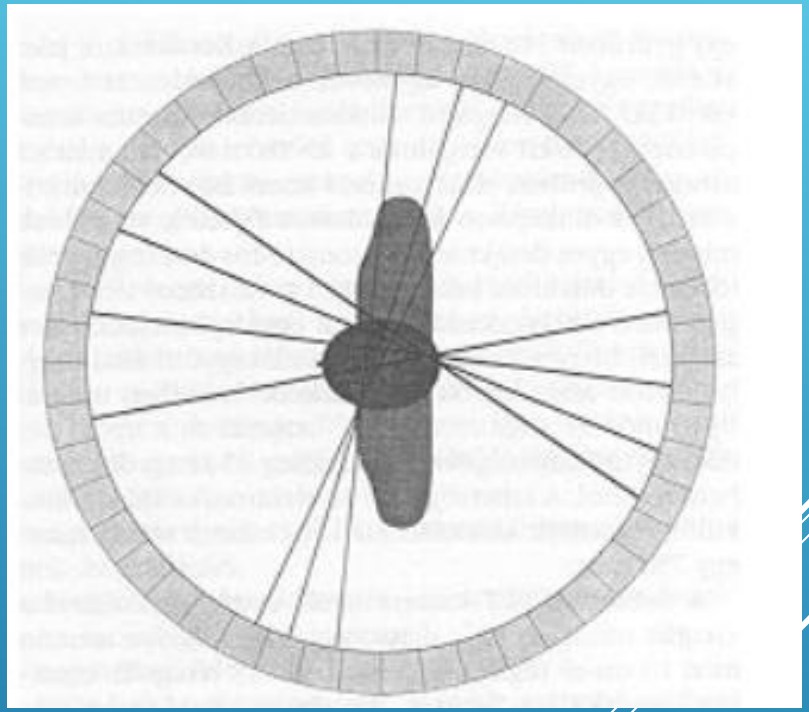
The result is 10^6-10^8 times bigger signal.



Two detectors connected to a coincidence circuit. It gives an impulse if it’s input get 2 signals at the same time.

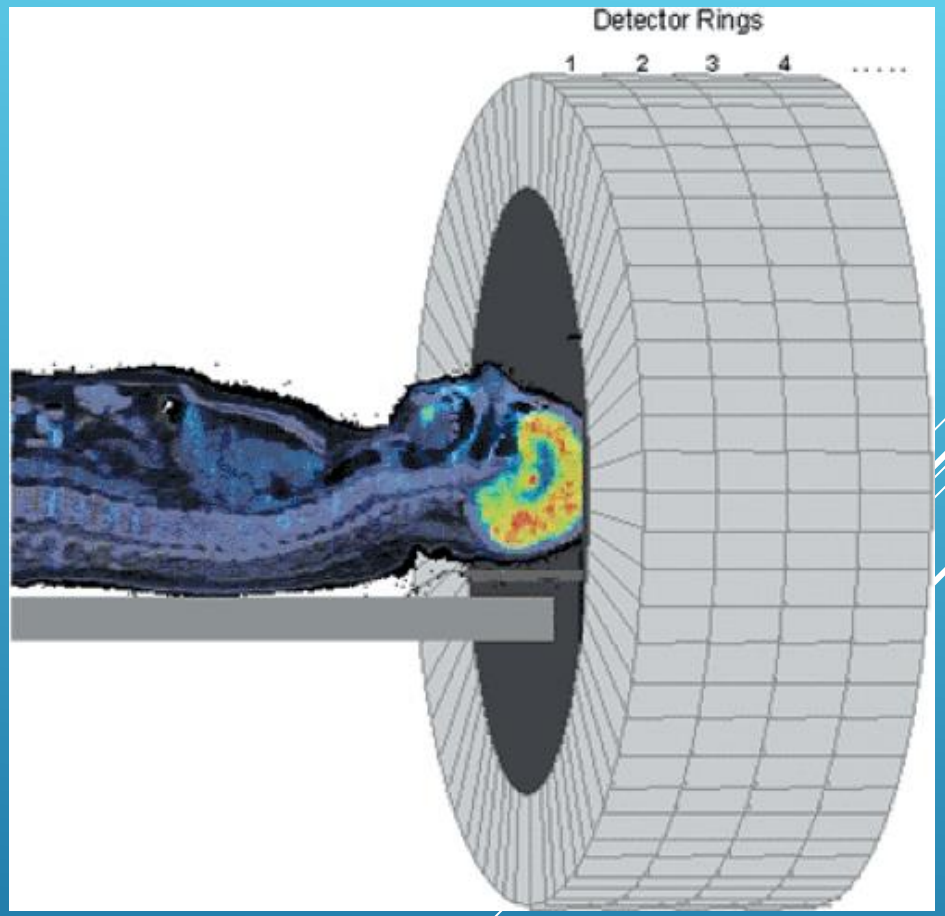
The impulse means that there was a radiation somewhere around the line that connects the 2 detectors

The intersections of these lines define the sites of accumulation of radiopharmaceuticals.



The identifier of detectors that give 1-1 impulse at the same time are stored. After the data collection the spatial distribution of the radiopharmaceuticals can be calculated.

3D image can be created from the examined system at the same time by taking slices. For this more detectors placed one above the other must be formed.



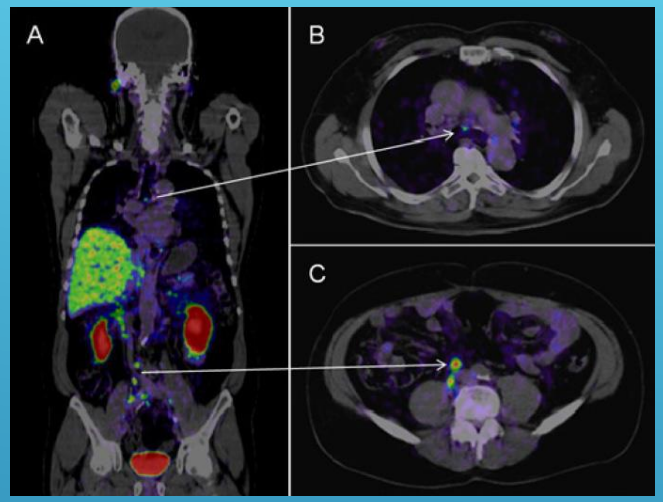
MOVING DETECTORS

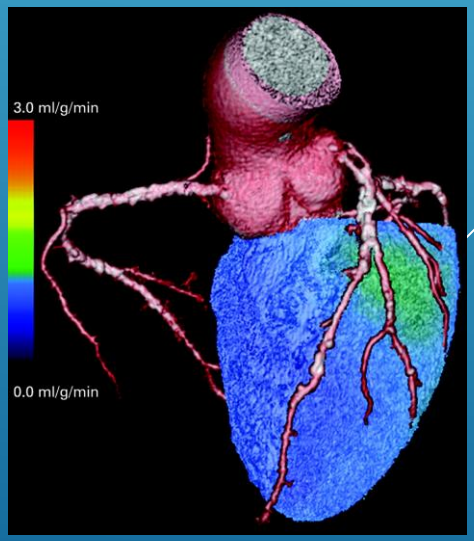
- Allow faster data collection, because they can collect data from multiple angles simultaneously.
- It can improve image quality.
- It can improve the spatial resolution, because they can be positioned much closer to the patient's body.

APPLICATION POSSIBILITIES

- Tumor diagnosis
- Amino acids (protein-synthesis)
- Cell wall synthesis with kolin monitoring
- Hipoxia
- Receptors
- Vasculature

- Help to define the target volume for treatment after surgery.






SIEMENS
Biograph


SIGNA

THANK YOU FOR YOUR ATTENTION!

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Slides from Ionizing radiation in medicine course.