POSITRON EMISSION TOMOGRAPHY

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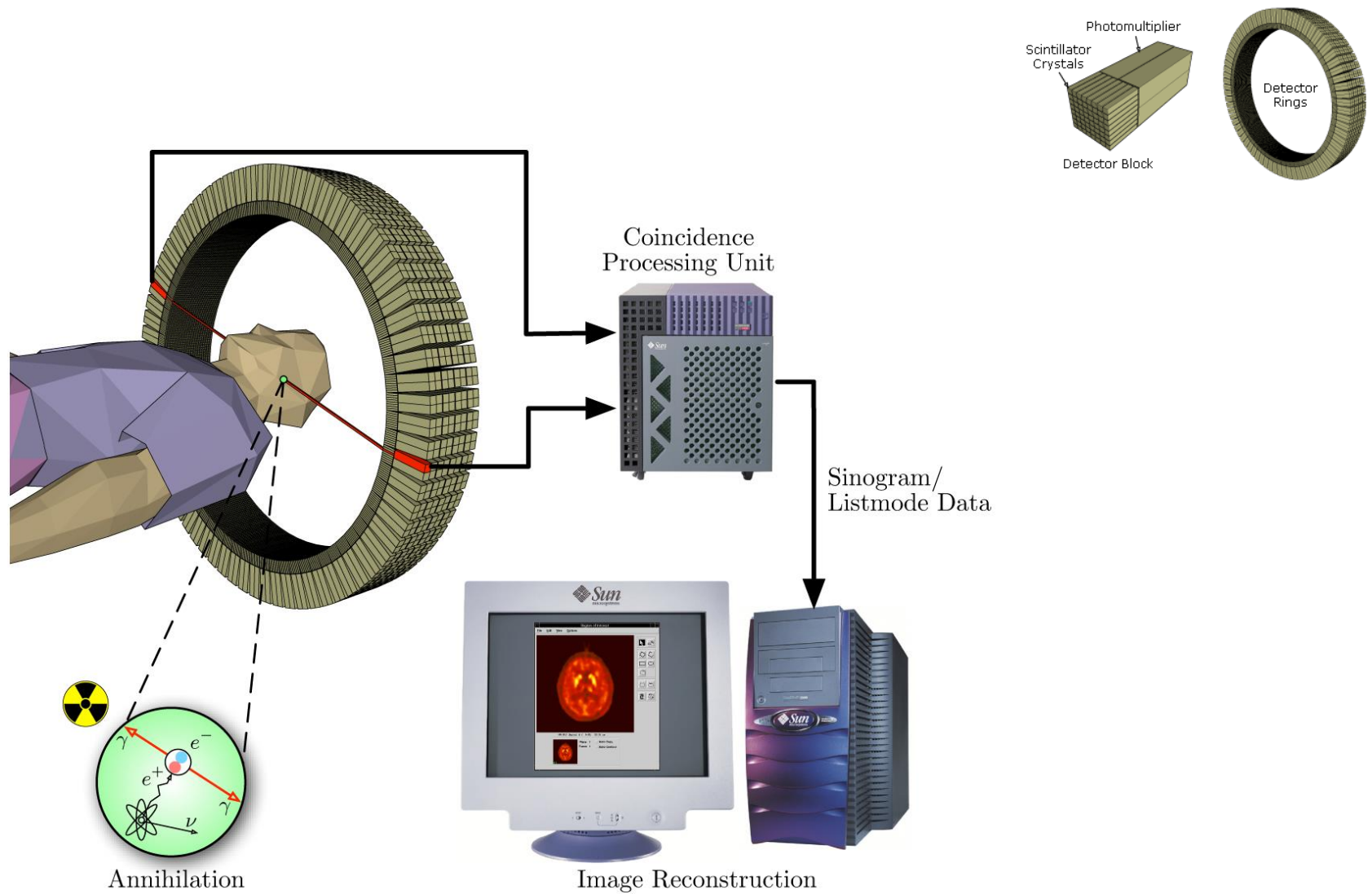Proposed template

Principle
Positron-emission tomography (PET) focuses on differences in the body's metabolism. PET uses molecules involved in metabolic processes, which are labelled by a positron-emitting radioisotope. The molecule, once injected, is taken up in different proportions by healthy and cancerous cells. The emitted positrons annihilate with electrons in the surrounding atoms and produce a back-to-back pair of γ rays of 511 keV. The γ radiation is detected to reveal the distribution of the isotope in the patient's body.
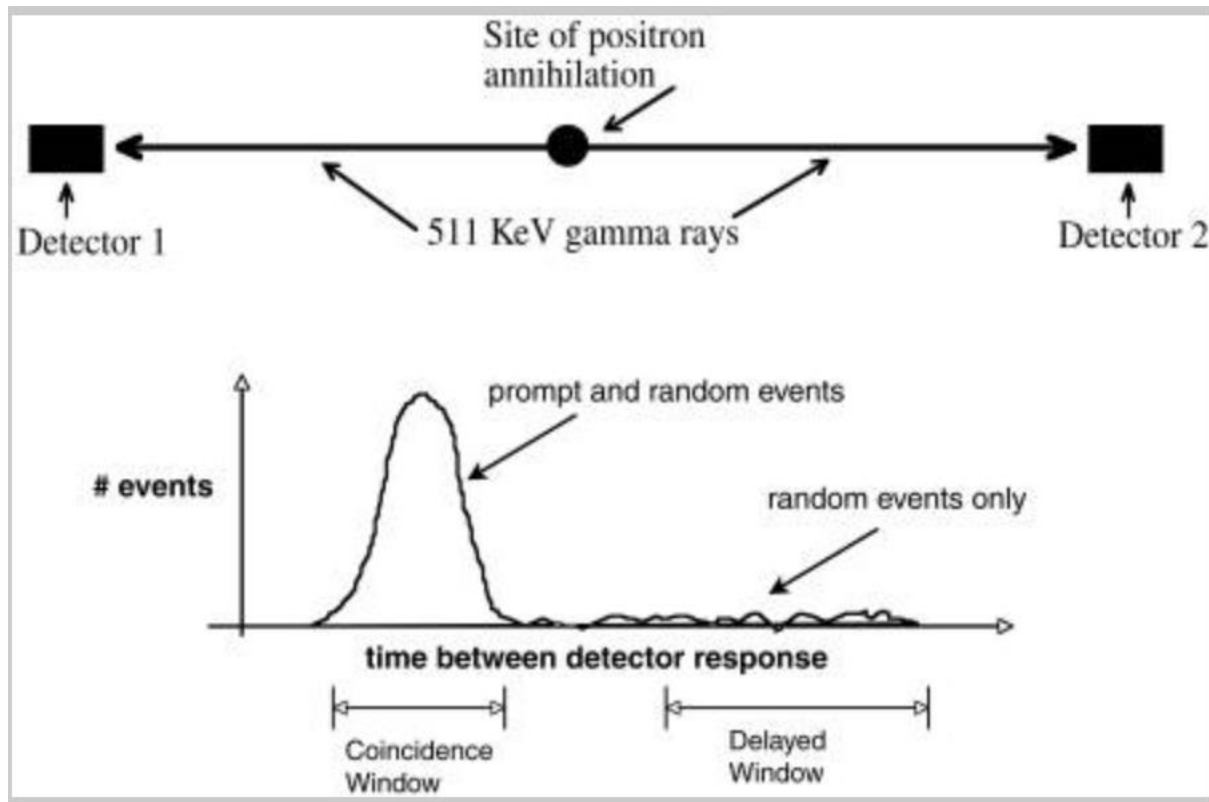
Required equipment
Photon detectors with good energy resolution (for low-energy photons)

Application (from particle physics)
The photon detectors used are basically are scintillators coupled to photomultipliers; development of TOF (Time-Of-Flight) PET is of particular interest, since it provides accuracy in localizing the tumor with less dose for the patient.

Photomultiplier

Scintillator
Crystals

Detector
Rings

Detector Block

Coincidence
Processing Unit

Sinogram/
Listmode Data

Image Reconstruction

Annihilation

γ

e^-

e^+

ν

γ

Detectors used

NaI (Tl) with PMTs in the early PET scanners

New scintillators introduced in the course of the years (already developed for particle physics experiments)
BGO ($Bi_4Ge_3O_{12}$)
CsI(Tl)
LSO (Lu_2SiO_5 Cerium-doped lutetium oxyorthosilicate) etc

Photomultiplier tubes evolved to multichannel photomultipliers, Avalanche Photodiodes (AVDs) and Silicon PhotoMultipliers

About TOF-PET

Useful Links

Positron Emission Tomography and CERN (history of PET)
https://drive.google.com/file/d/1YbwygQPNc_6Qd0Z4ninEGqNfcQTN_vRl/view

Recent developments in PET Detector Technology
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2891023/

https://cerncourier.com/a/clearpem-clarifies-breast-cancer-diagnosis/

New opportunities for high time resolution clinical TOF PET
https://link.springer.com/article/10.1007/s40336-019-00316-5

Add interview (mentioned by Yiota)