PET

L14

PET stands for **"Positron Emission Tomography"**. Similar to CT in that the scanner detects radiation using a ring of detectors.

Different than a CT scanner because the radiation is **emitted from inside the body**, rather than being **transmitted through the body (as in CT).**

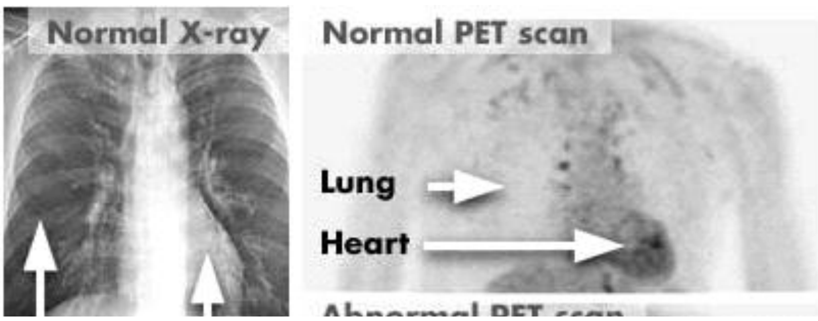
PET is a **functional imaging** modality. That means it is used to observe **where** in the body a particular function is occurring. For example, one might want to know where rapid tissue growth is taking place (to locate growing tumors). This is different from viewing the tissue itself.

How does it work?
A small amount of positron-emitting radioisotope is injected into the subject. This radioisotope is bound to a metabolite that is used in the function we wish to observe. For example, glucose can be tagged to produce

fluoro-2-deoxy-D-glucose (FDG)

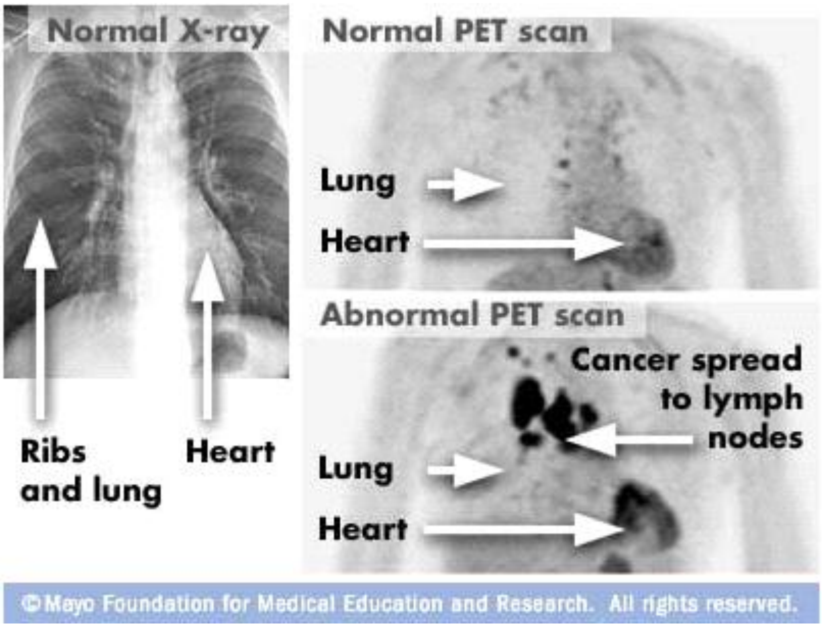
The FDG will migrate to the sites where glucose is being consumed rapidly. Malignant tumors require a lot of glucose to grow, and tend to cause a locally high concentration of FDG. PET imaging can estimate the concentration of the radioisotope in tomographic sections (slices).

High concentration is shown dark.

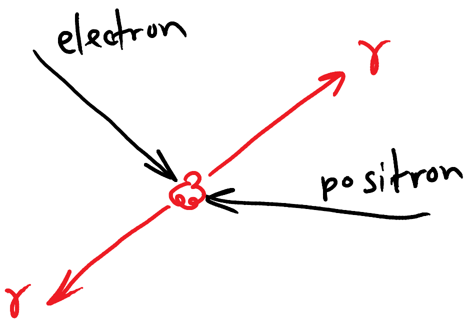


(slices).

High concentration is shown dark.

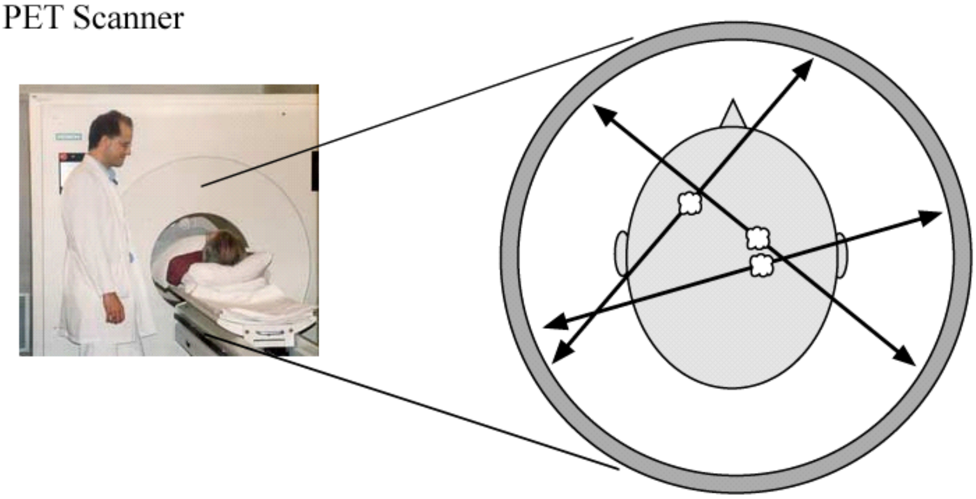


As the radioisotope decays, it gives off positrons. Each positron collides with an electron, and they **annihilate** each other. But the event releases two **gamma rays in opposite directions**. These rays are each **511 keV**.



The scanner listens for 2 gamma rays being acquired **at the same time…** these 2 rays likely originated from the same annihilation event. Hence, we know that the radioisotope was somewhere **along the line connecting the two detectors.**

PET Scanner



The raw data that comes out of a PET scanner is very similar in nature to the Radon transform in CT.

Properties of PET

Speed

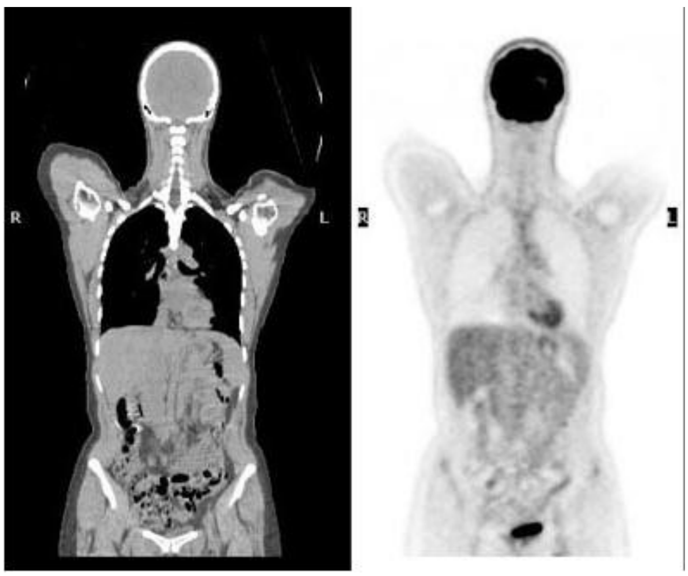
PET scans take a long time (30 mins. To 3 hrs.), so patient motion is a problem. After that time, the radioisotope has decayed to a very low level; the half-life of FDG is 108 minutes.

Ionizing Radiation

As the gamma rays exit the body, they encounter tissues. Just like in normal x-rays, these gamma rays can be **absorbed**, and the probability depends on the tissue type (eg. Bone absorbs better than fat).

To properly reconstruct the isotope concentration, one needs to know the map of attenuation coefficients… that's essentially what a CT scan gives. So, a PET scan is always accompanied by a CT scan. In fact, many PET scanners have built-in CT scanners.

CT PET



http://www.brighamandwomens.org/

Tradeoffs

Just like in CT...

resolution ⟷ SNR

resolution ⟷ dose

dose ⟷ SNR

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