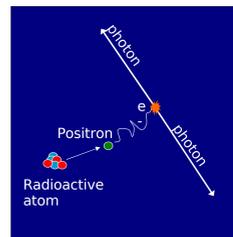


## PET System Based on Liquid Xenon Gamma Ray Detectors

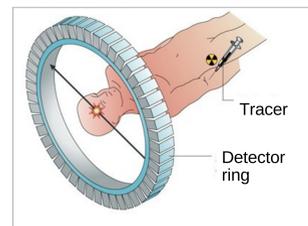
### Positron emission tomography

Positron emission tomography (PET) is an imaging technique that provides information about the function and the metabolism of the organs.

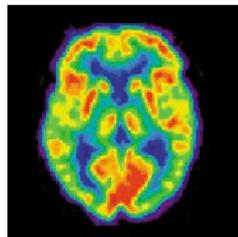
PET is an invaluable tool in the diagnosis of several diseases, including cancer, cardiac and neuropsychiatric diseases.



**Annihilation:** The positron emitted by the radioactive atom combines with an electron. Their mass is converted into two gamma rays.



**PET concept:** A radioactive tracer is administered to the patient. The emitted positron generates two annihilation gamma rays that are detected by the PET ring.



**PET image:** Distribution of the tracer in the human brain

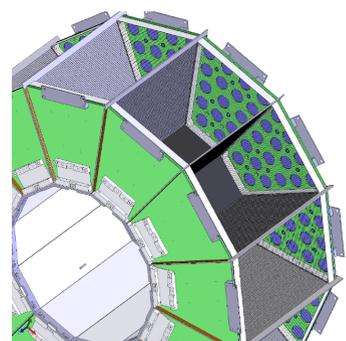
### How does PET work?

- A small amount of a radioactive substance (tracer) is administered to the patient by injection
- The radioactive substance travels to a specified location in the body and decays emitting a positively charged particle with the same mass as an electron called a positron
- The positron travels a short distance, then it annihilates with an electron: two anti-parallel gamma rays are created
- The two gamma rays are detected by the ring of detectors surrounding the patient
- The image of the distribution of the tracer is reconstructed from the positions of interaction of the gamma rays in the detector ring

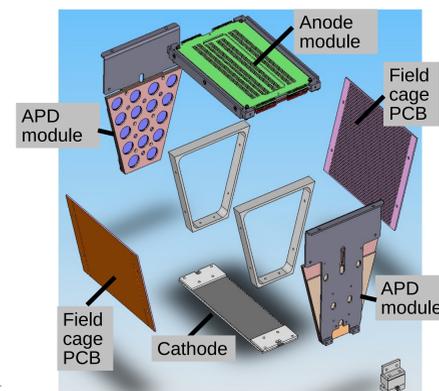
### Li Xenon PET

The prime objective of the project is to improve PET imaging to approach its ultimate capability which would provide nuclear medicine with a superior imaging system for diagnosing and investigating diseases.

The new PET system takes advantage of the properties of the liquid xenon. When the photons interact with the detector material (liquid xenon) they produce scintillation light and electrons due to the ionization. The simultaneous measurements of the charge and the light lead to a significant improvement of image quality and sensitivity.



**Liquid xenon detector PET ring:** 12 sectors arranged in a ring geometry for the detection of the annihilation photons.



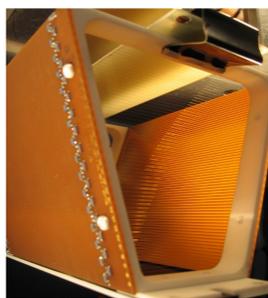
**Sector:** exploded view of one of the 12 detectors composing the PET detector ring.

**APD module:** 16 avalanche photodiodes (APD) for the detection of the scintillation photons.

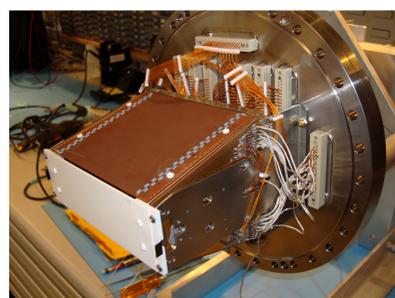
**Field cage:** it consists of 64 wires generating a uniform electric field inside the sector.

**Anode module:** it is segmented in 96 wires and 96 orthogonal strips. It collects the charge created by the ionization.

**Cathode:** resistive kapton on ceramic plate.



**Field cage:** field cage generating the uniform electric field inside the sector.



**PET sector:** a sector mounted on a flange.

### Principle of operation

Each sector is a time projection chamber (TPC) filled with liquid xenon. Photons entering the sector produce scintillation light and ionization. The scintillation light is detected by the light sensors (avalanche photodiodes). The ionization electrons drift under the electric field applied between the cathode and the anode of the TPC and they are collected on the anode.

For more information on Li Xenon PET:  
<http://lixenon.triumf.ca>