SNS COLLEGE OF TECHNOLOGY

(AN AUTONOMOUS INSTITUTION)

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Department of Biomedical Engineering

RADIOLOGY AND EQUIPMENT

III Year : VI Semester

TITLE:PRINCIPLES OF PET

POSITRON EMISSION TOMOGRAPHY

•Positron Emission Tomography is an imaging technique which uses small amounts of radiolabeled biologically active compounds to help in the diagnosis of disease.

•The tracers are introduced into the body, by either injection or inhalation of a gas.

•PET scanner is used to produce an image showing the distribution of the tracer in the body.

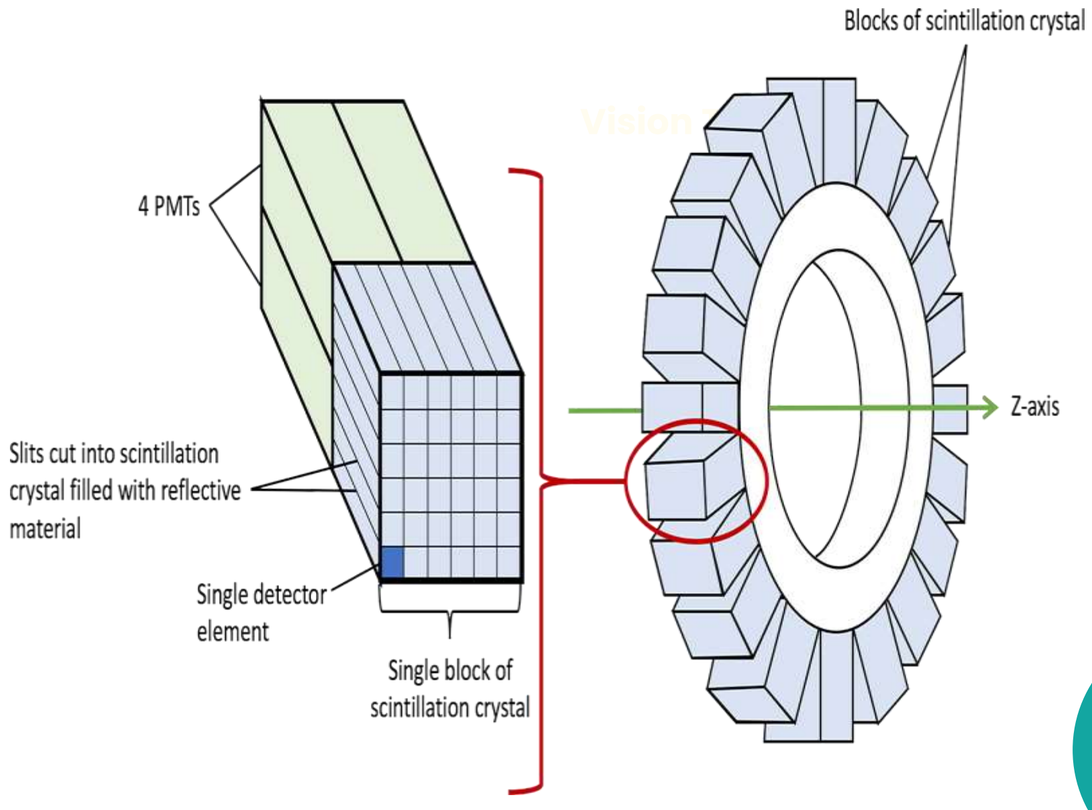
MAIN SYSTEM COMPONENTS

- Scanner
- Gantry
- Detector
- Septa
- Coincidence Circuit
- Table
- Computer
- Cyclotron

DETECTOR

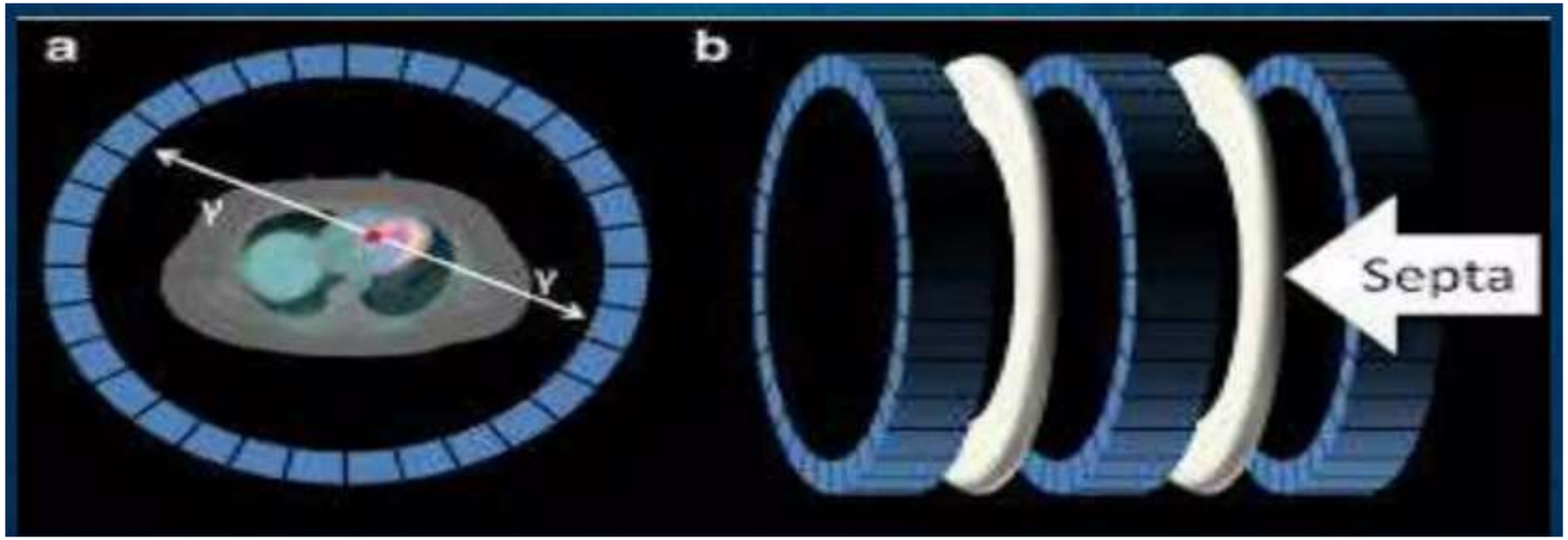
- Comprised of an 8 x 8 scintillation, inorganic crystals which emits light photons after the interaction of photons Blocks of scintillation crystal

- 4 photomultiplier tubes (PMTs) arranged in a circular pattern around the patient.



SEPTA

- Lead or tungsten circular shield mounted between the detector rings. Limits scattered radiation from the object reaching the detector (scattered out the transverse plane)



Coincidence circuit

- Specific electronic circuits "coincidence" circuits pick up gamma pairs due to the two gamma rays emitted during the positron annihilation almost simultaneously.
- This coincidence is a very strong signature that distinguishes them from other photons.On the image it is requested that the signals coming from the scintillators A and B coincide within 12 billionths of a second (nanosecond).

Cyclotron

A machine used to produce the radioisotopes (radioactive chemical elements) which are used to synthesize the radiopharmaceuticals.

The most frequently used radioisotopes in PET are:

- Carbon-11
- Nitrogen-13
- Oxygen-15
- Fluorine-18
- 18FDG (Fluorodeoxyglucose) is the most widely used PET tracer.

Table

- The bed is capable of moving in and out of the scanner to measure the distribution of PET radiopharmaceuticals throughout the body, and it adjusts to a very low position for easy patient access.

Computer

- A computer analyzes the gamma rays and uses the information to create an image map of the organ or tissue being studied.

Principle of PET

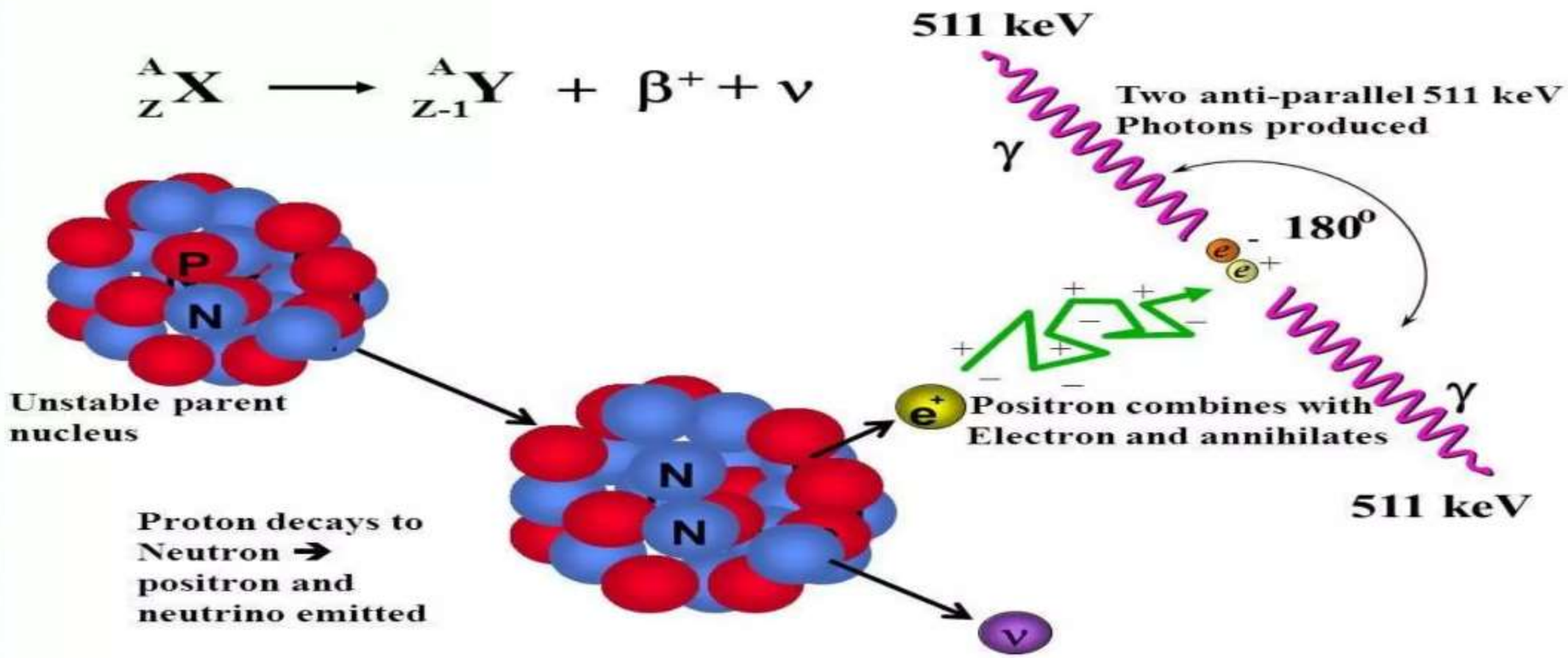
Positron Emission

- Positron Emission occurs when the isotope decays and a proton decays to a Neutron, a Positron and a Neutrino. After traveling a short distance (3-5mm), the positron emitted encounters an electron from the surrounding environment. The two particles combine and "annihilate" each other, resulting in the emission of two gamma rays in opposite directions of 0.511 MeV each.

Emission Detection

- As positron annihilation occurs, the detector detects the isotope's location and concentration. The resultant light photons are converted to electrical signals that are registered by the system electronics almost instantly

Positron Emission…



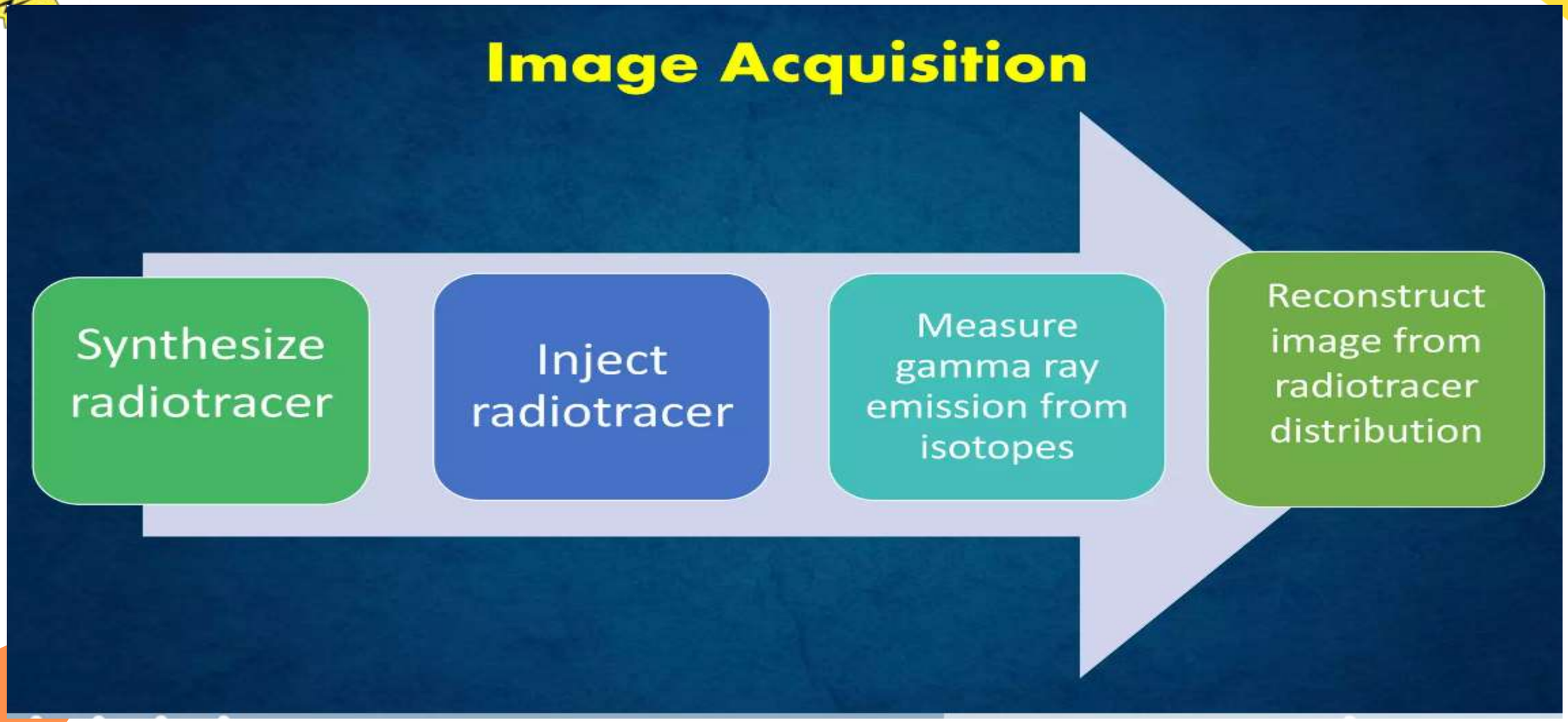


Image Acquisition
Synthesize radiotracer
Inject radiotracer
Measure gamma ray emission from isotopes
Reconstruct image from radiotracer distribution

Image Acquisition

The image acquisition is based on the external detection in coincidence of the emitted Gamma rays. Valid annihilation event requires a coincidence within 12 nanoseconds between two detectors on opposite sides of the scanner. For accepted coincidences, lines of response connecting the coincidence detectors are drawn through the object and used in the image reconstruction.

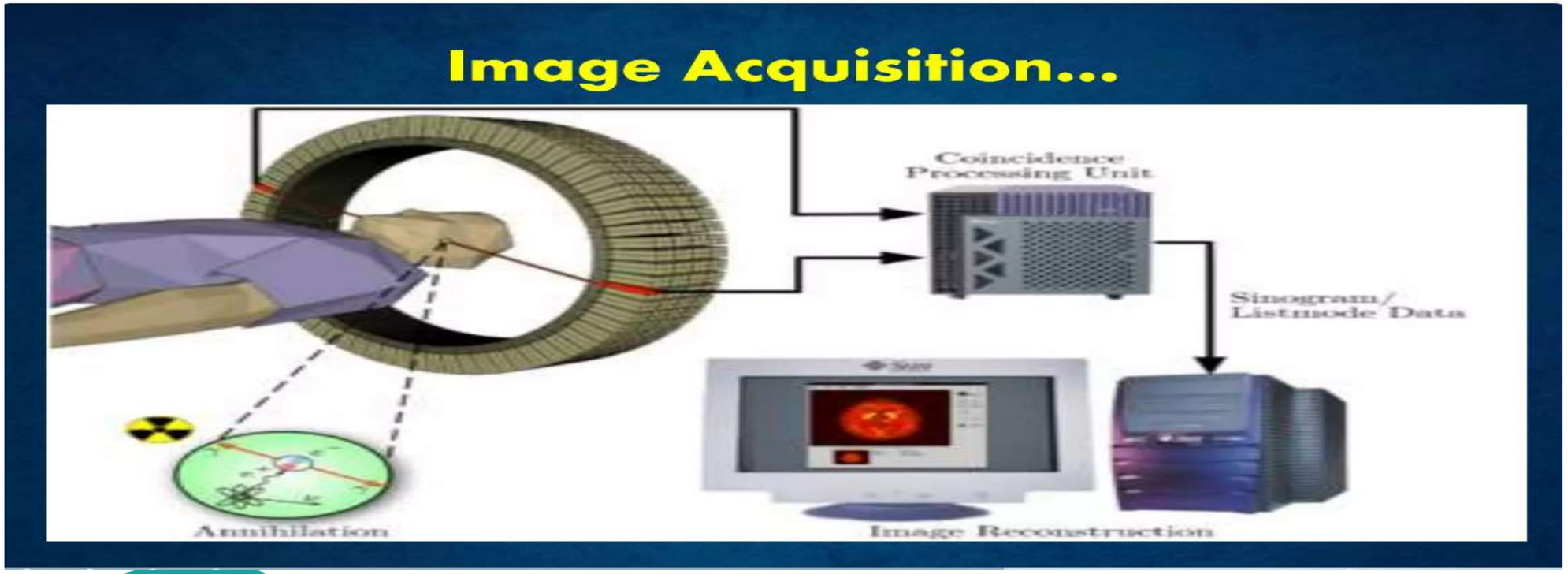


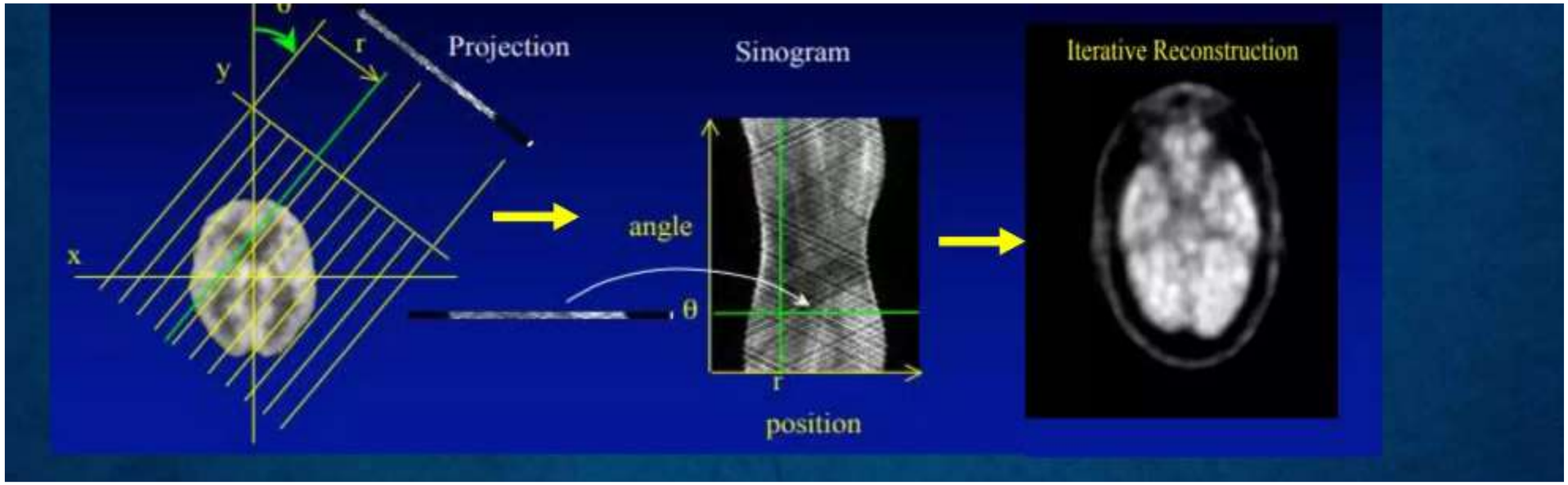
Image Reconstruction...

- Images are created from raw data collected as rays corresponding to each detected annihilation event.
- The basic principles of tomographic image reconstruction from projections of an object is common to CT.

Process.

- The detectors collect a series of lines of responses LORS,
- A profile of counts versus distance is produced for each angle of LORS
- Each profile maps the location of the source in the direction parallel to the scan profile (however, the source can lie at any depth along the line perpendicular to that profile).
- The source distribution can be obtained by projecting the data from each scan profile back across the entire image grid. [backprojection]

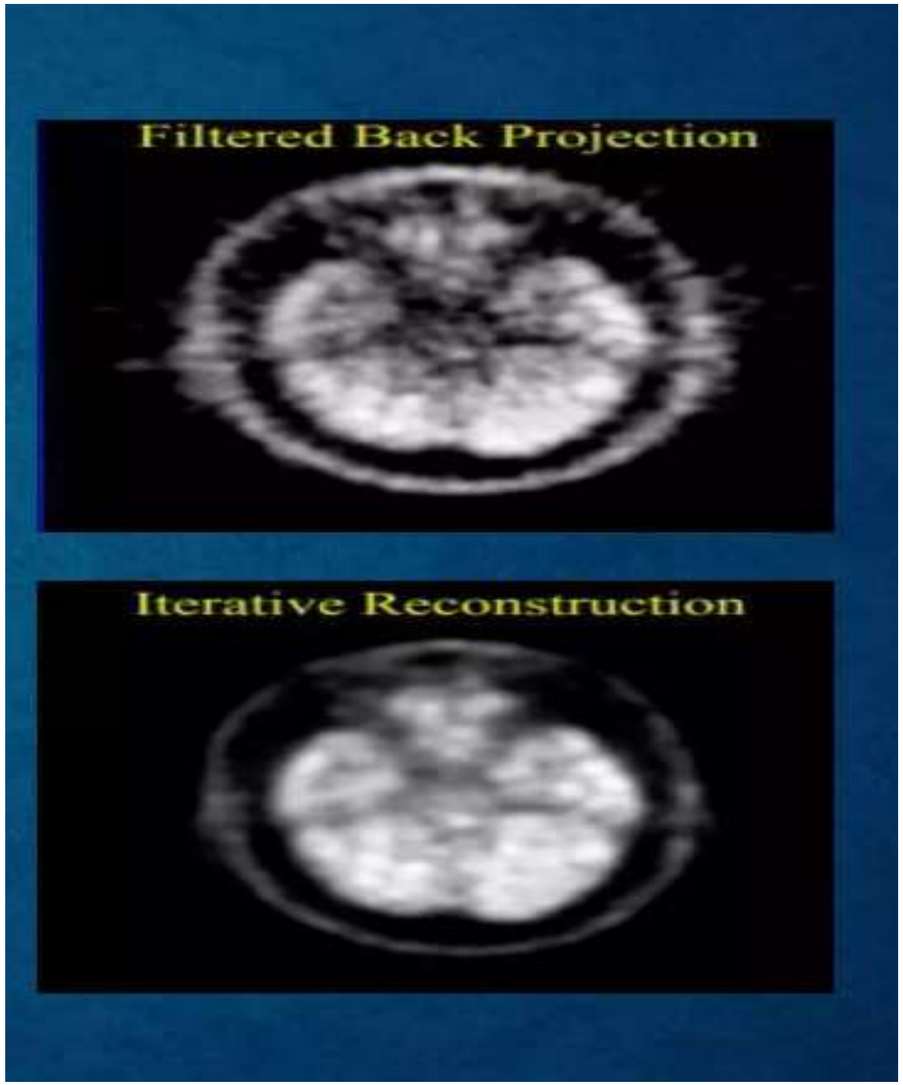
- Back projections of scan profiles at different angles are then added together (linear superposition), to produce an approximation of the original radioactivity distribution . This operation is called linear superposition of back projections (LSBP).
- There is an inherent blurring in this technique, which is removed by performing a filtering operation on the projections or scan profiles .



PET Reconstruction Algorithms:

- Filtered Back Projection
  - Simple
  - Quick
  - Streak artifacts

- Iterative Reconstruction
  - Need fast computer



THANKYOU