Biomedical instrumentation

المرحلة الرابعة فيزياء طبية

اعداد

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- In 1969 Godfrey N. Hounsfield Designed the first clinically useful CT head scanner
- In 1979 G.N. Hounsfield shared the Nobel Prize with Allan M. Cormack in Physiology & Medicine when developed solution to mathematical problems involved in CT.

Computed Tomography

- Tomos=slice, graphin= to write
- Imaging of an object by analyzing its slices.

Computed Tomography

- (CT scan or CAT scan) - is a medical technique that uses x-rays and computers to create three-dimensional images of the human body, but it is different from traditional x-rays that are used to image dense parts such as bones, as it gives details of soft tissues such as muscle tissue, blood vessels or organs, like a brain. It also depicts cross-sections of the body while conventional x-rays give flat, two-dimensional images.

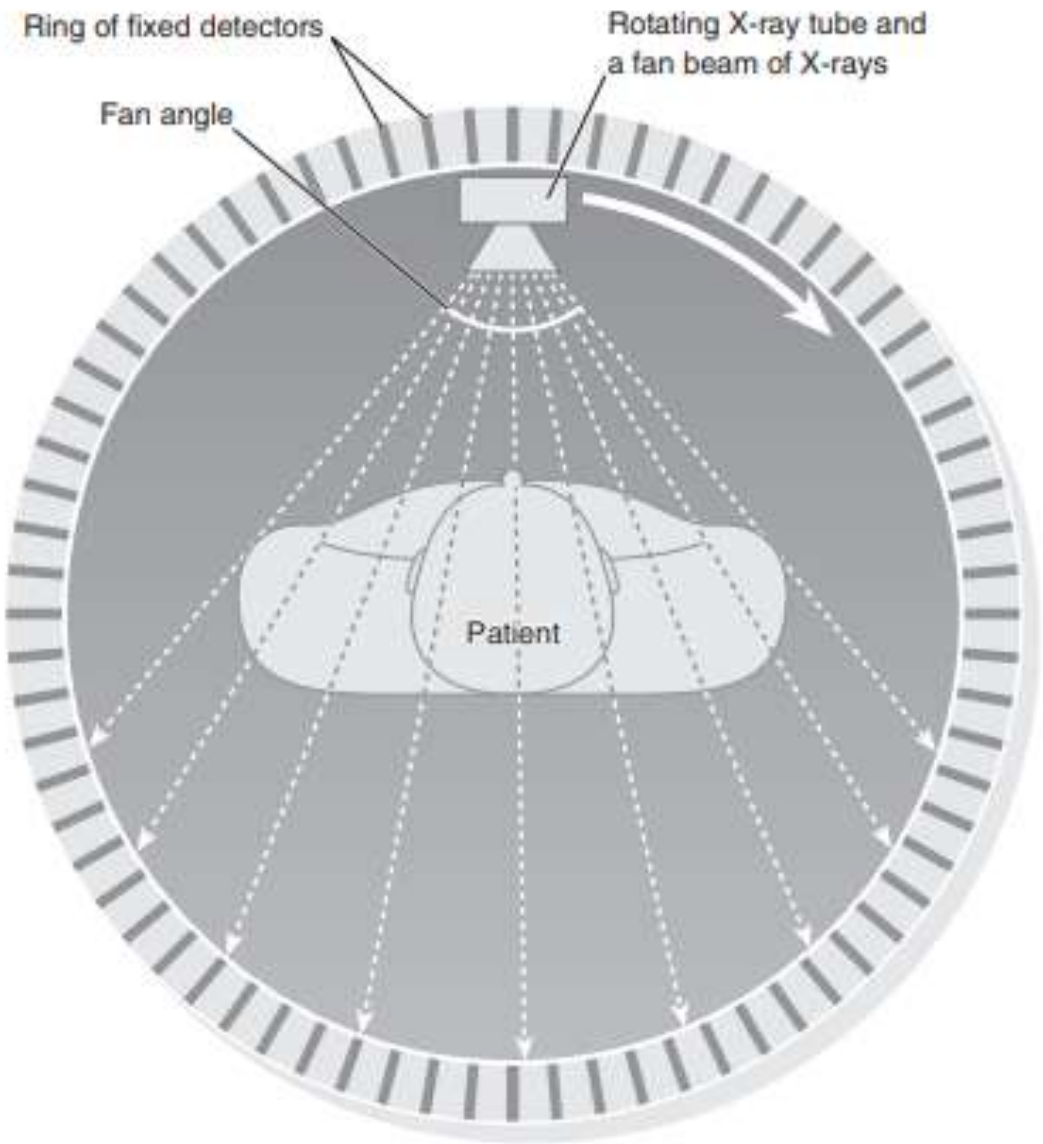
The component of CT machine

- Energy source (140kV)+ slip rings
- X-ray source
- Detectors
- Collimators
- DAS (data acquisition system)
- table

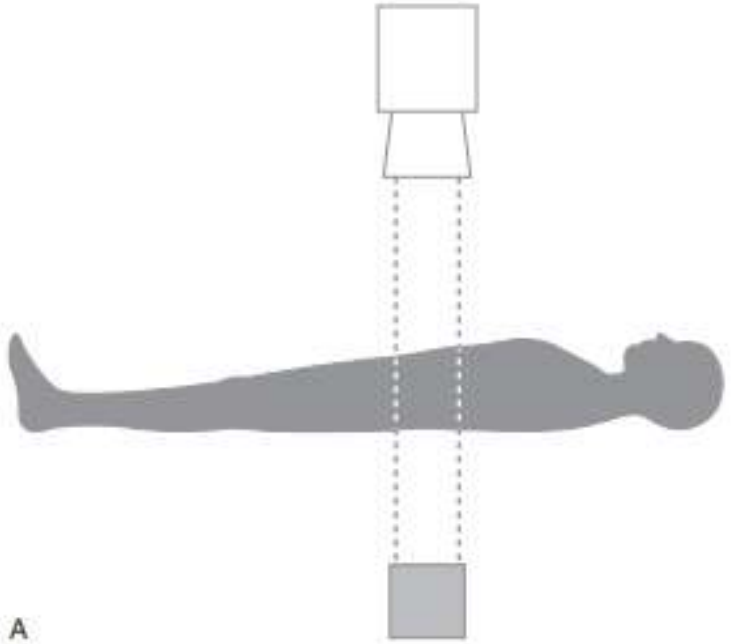
- CT scans use a rotating X-ray machine to create a three-dimensional cross-sectional image of any part of the body.
- The gantry contains an X-ray tube that rotates around the patient, shooting narrow X-ray beams through the body.
- X-rays are picked up by digital detectors located directly opposite them.

- A narrow X-ray beam that circles around one part of the body. This provides a series of images from many different angles. A computer uses this information to create a cross-sectional picture. Like one piece in a loaf of bread, this two-dimensional (2D) scan shows a “slice” of the inside of the body.
- This process is repeated to produce a number of slices. The computer stacks these scans one on top of the other to create a detailed image of the organs, bones, or blood vessels.

Image generation *continued*



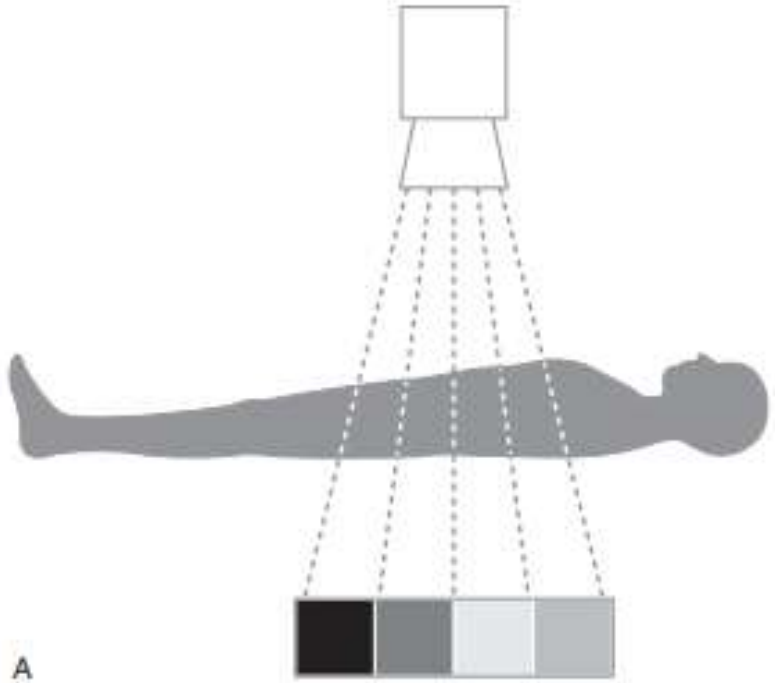
- In helical or spiral CT the X-ray tube rotates continuously in one direction whilst the table on which the patient is lying is mechanically moved through the X-ray beam. The transmitted radiation thus takes on the form of a helix or spiral.
- Instead of acquiring data one slice at a time, information can be acquired as a continuous volume of continuous slices . This allows larger anatomical regions of the body to be imaged during a single breath hold, there by reducing the possibility of artifacts caused by patient movement.
- Faster scanning also increases patient throughput and increases the probability of a diagnostically useful scan in patients who are unable to fully cooperate with the investigation.



(A) Single-slice system (one ring).

The X-ray tube rotates continuously and the patient moves through the X-ray beam at a constant rate.

(B) Single-slice helical CT.

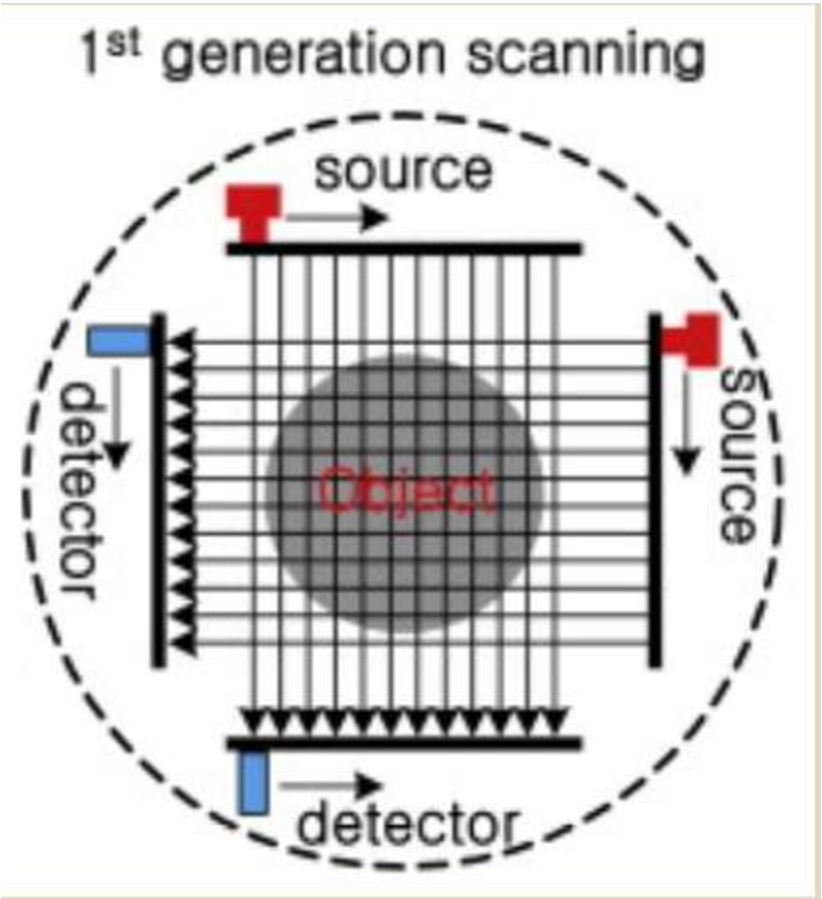


detector system (four rings shown here).

(B) Multislice helical CT

First generation CT – Parallel beam geometry

- This is the first time that CT was performed and is the basis for the Nobel Prize in Medicine
- X-ray tube and single detector are connected and move together by translation and then rotation
- x-ray beam has linear (pencil-like) shape



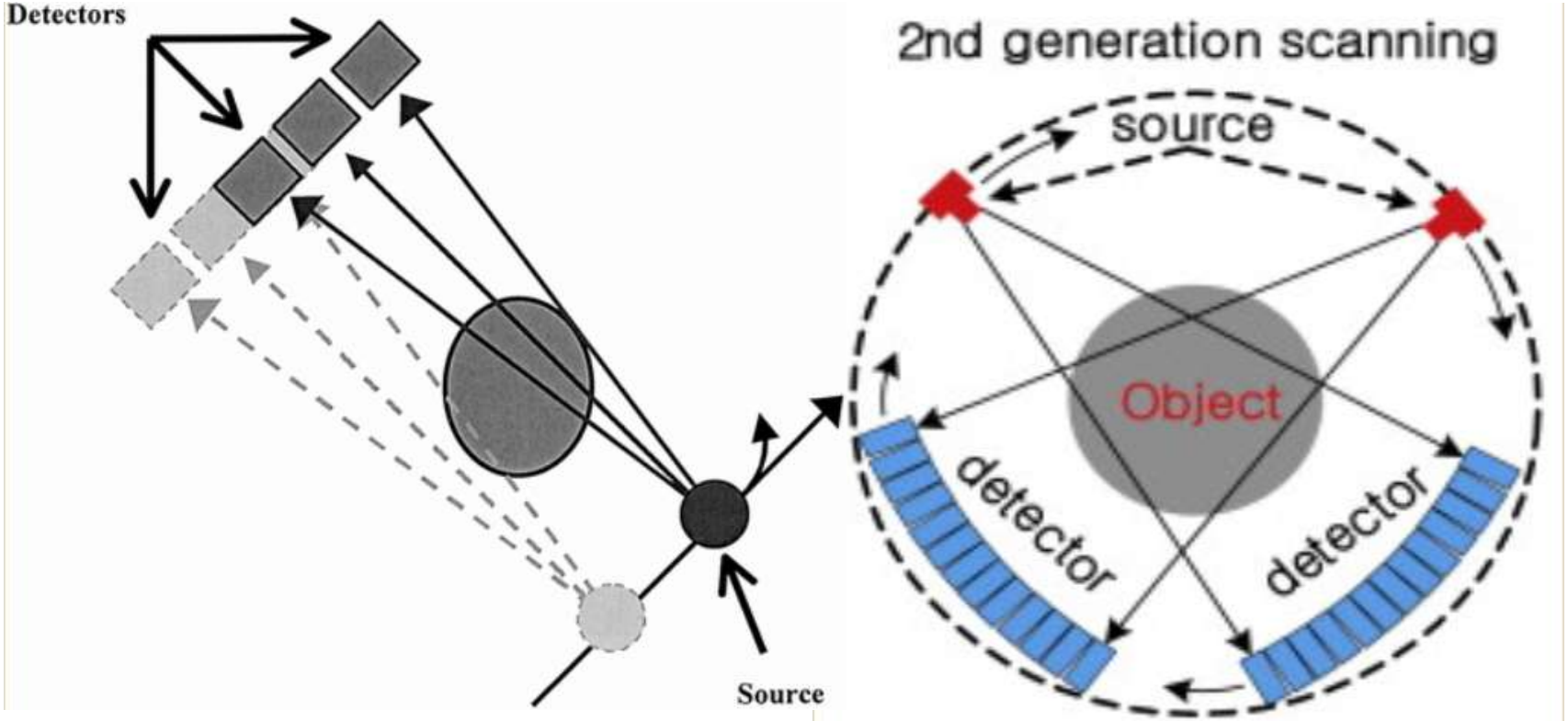
First generation CT – Parallel beam geometry


1st Gen CT Benchtop
x-ray source
x-ray detector
translate

1st Gen Rotating CT

Second generation CT

- same type of movement
- multiple detectors arranged in a row (5-53)
- fan shaped x-ray beam instead of linear shape



2nd Gen CT

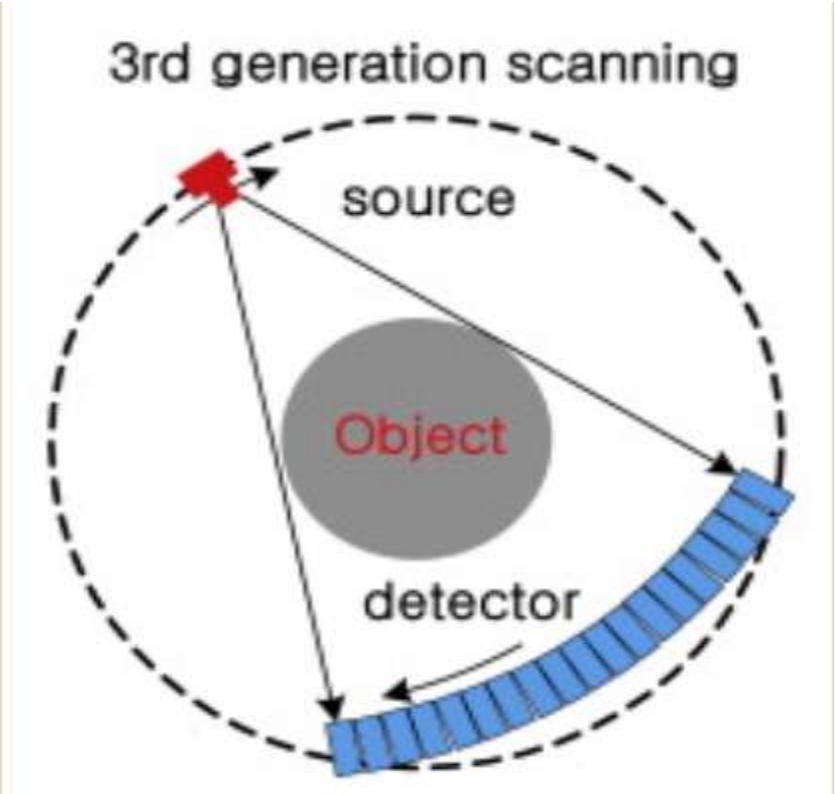
x-ray source

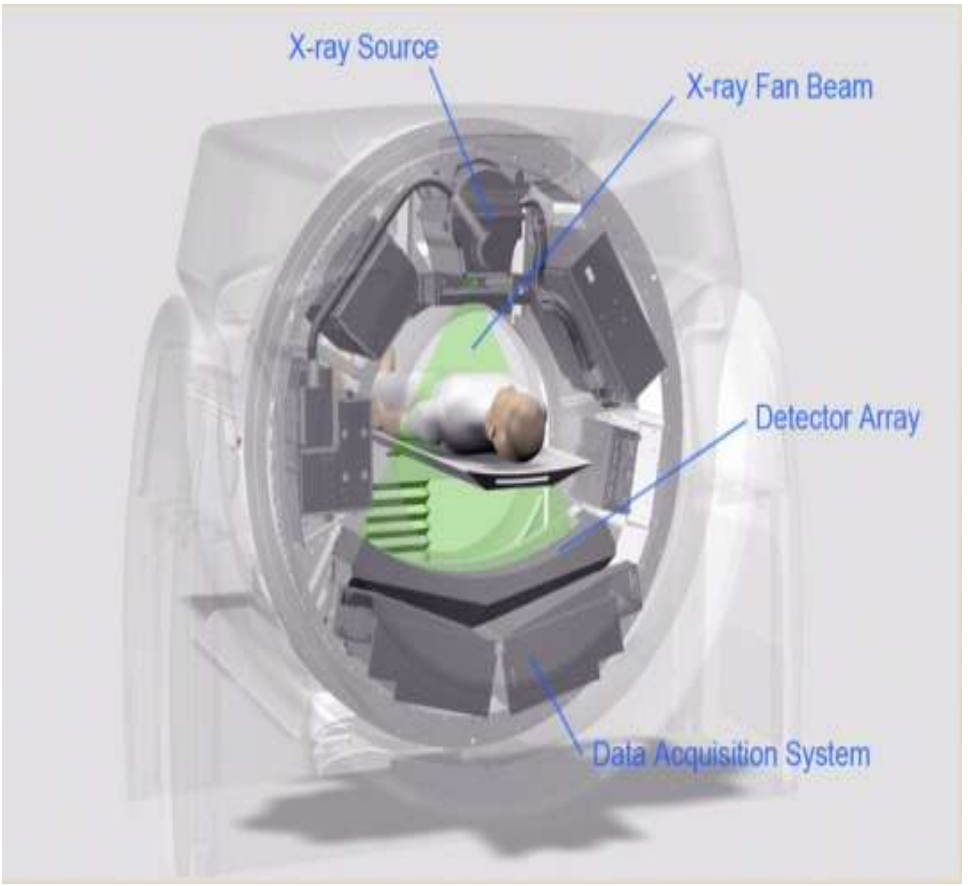
translate

x-ray detector

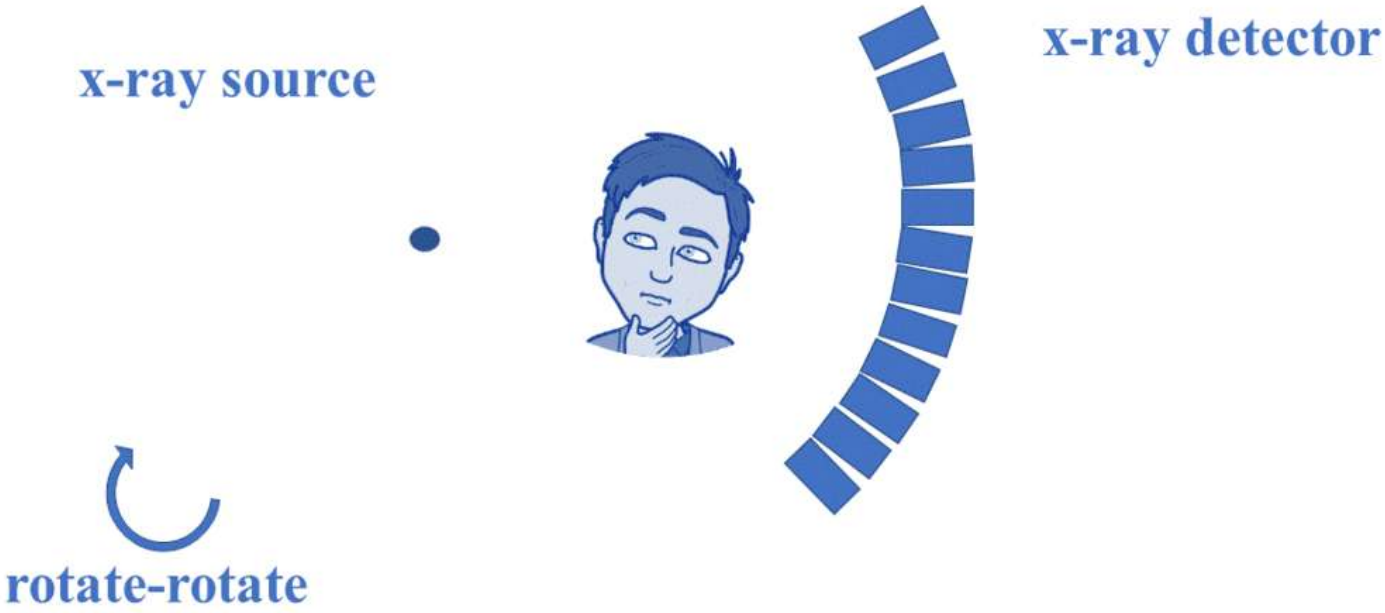
Third generation

- full rotation of x ray tube + detectors complex



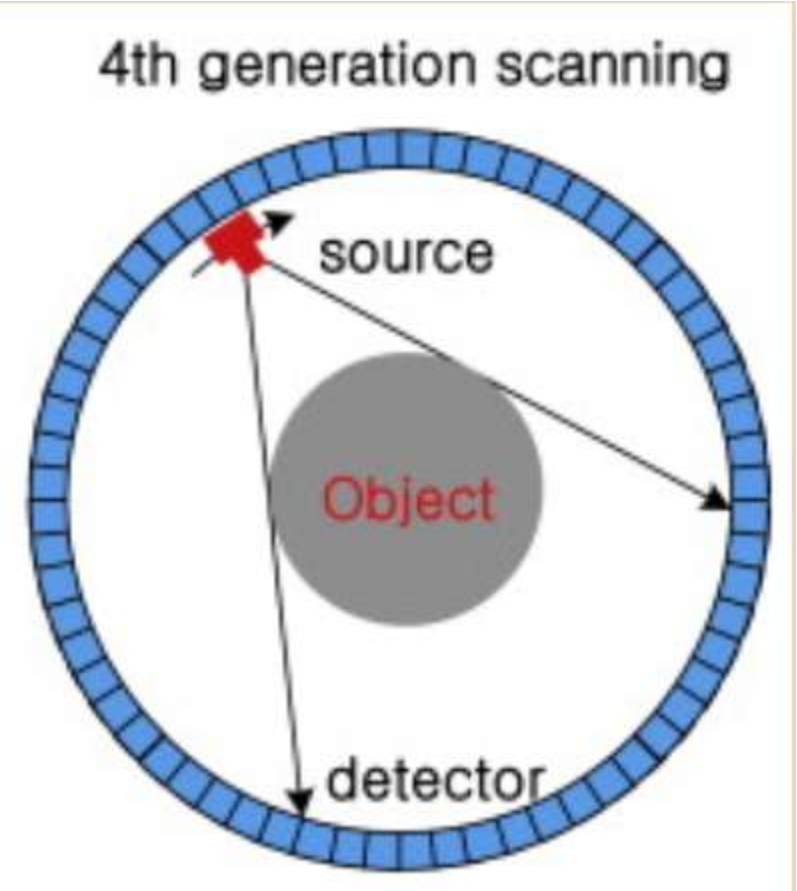


3rd Gen CT

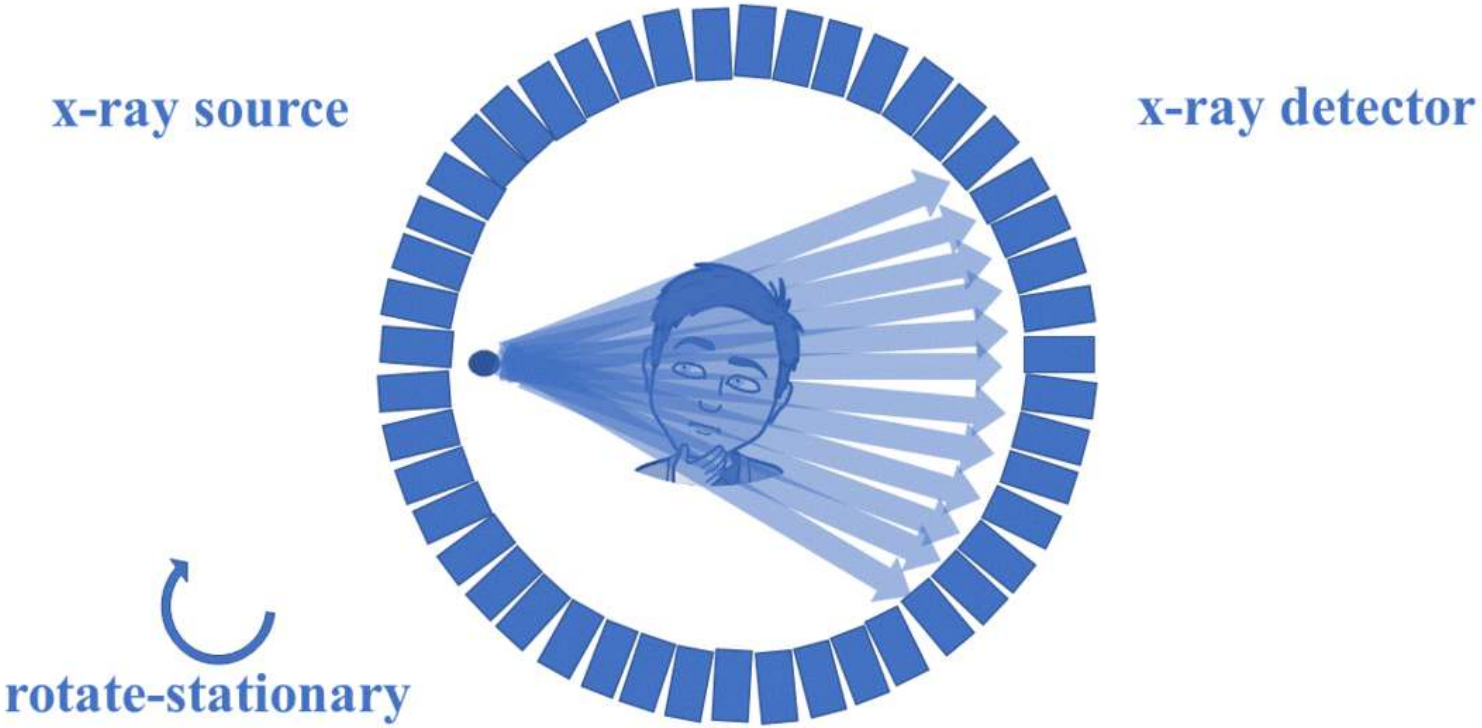


Fourth generation

- only x ray tube rotates, detectors are stationary.
- this technology was later ignored.

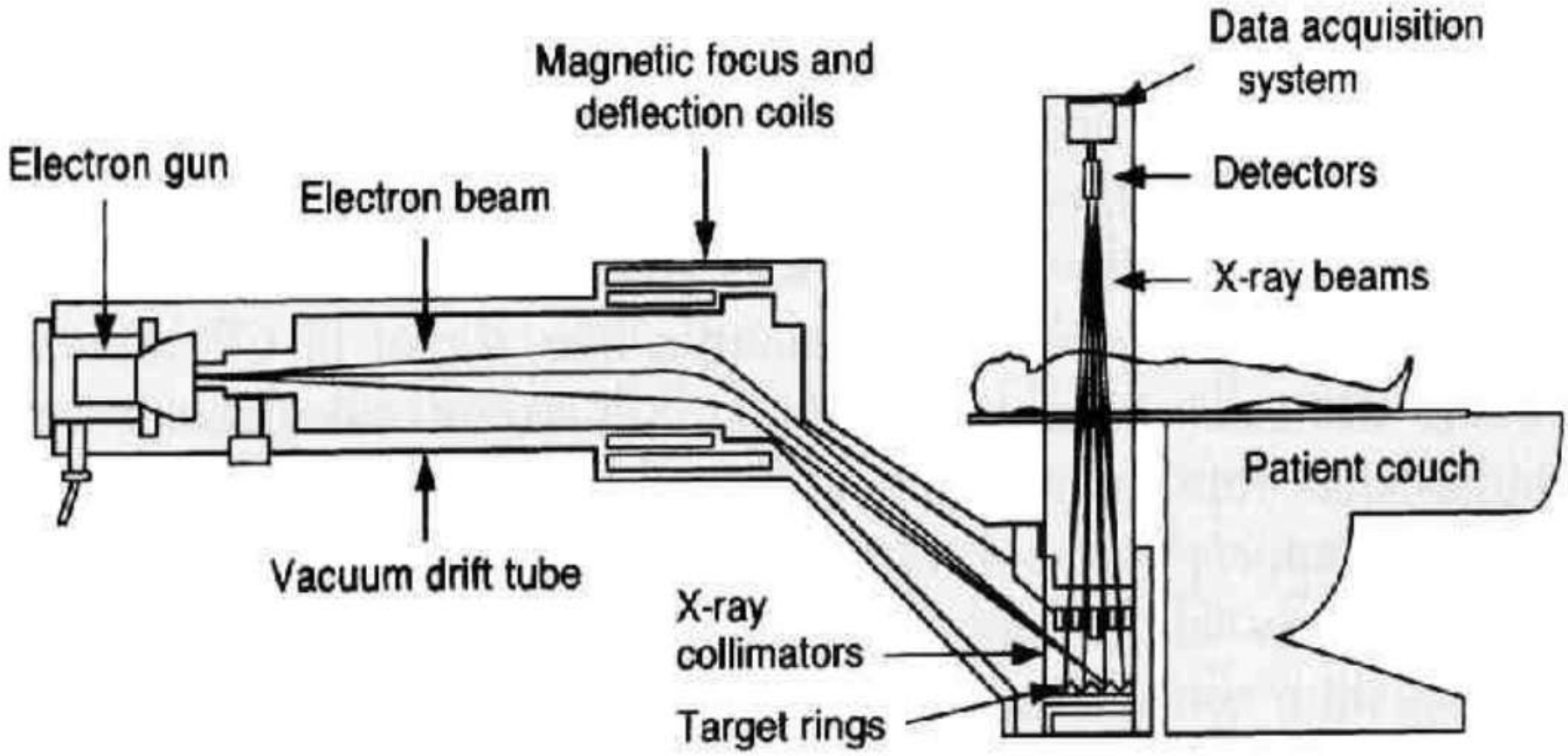


4th Gen CT

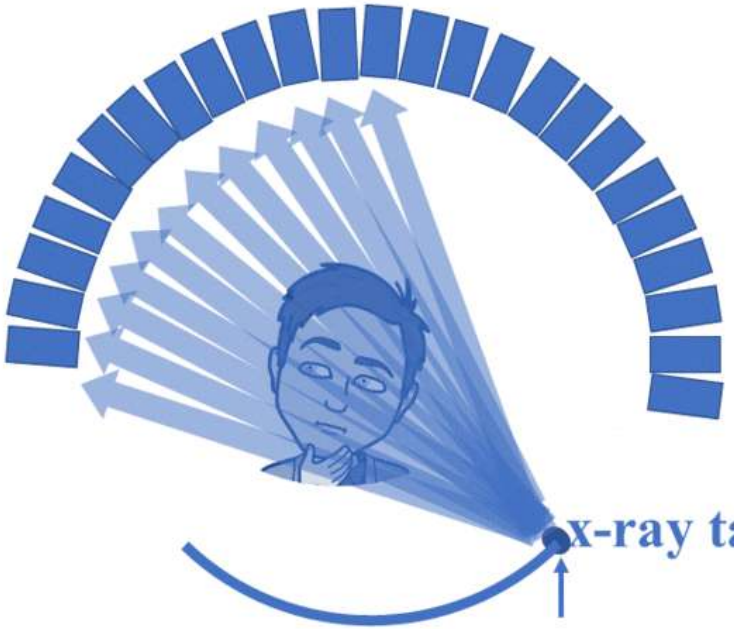


Fifth generation

- In 5th generation CT both the x-ray source material and the detector are stationary. In this sense this is a stationary-stationary design.



5th Gen CT



stationary-stationary electron beam

CT scan Used For?

- CT scans can detect bone and joint problems, like complex bone fractures and tumors.
- If any condition like cancer, heart disease, or liver masses, CT scans can spot it or help doctors see any changes.
- They show internal injuries and bleeding, such as those caused by a car accident.
- They can help locate a tumor, blood clot, excess fluid, or infection.
- Doctors use them to guide treatment plans and procedures, such as biopsies, surgeries, and radiation therapy.
- Doctors can compare CT scans to find out if certain treatments are working. For example, scans of a tumor over time can show whether it’s responding to chemotherapy or radiation.