



Physics of Computed Tomography

Second Semester

Practical Part –Experiment -2

Weeks 6-7: Generations of CT scanners

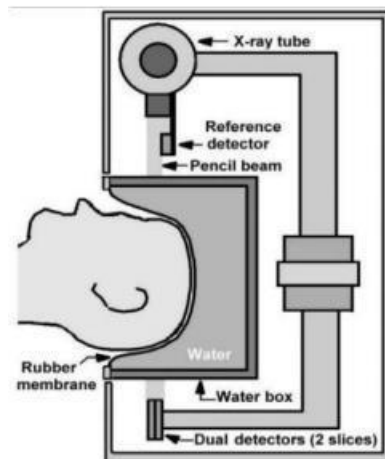
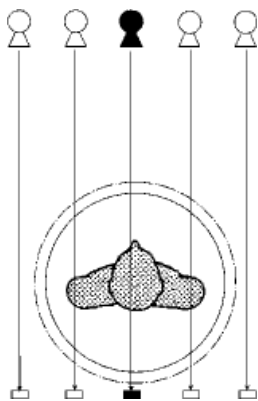
By

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✚ **First Generation: (Parallel-Beam Geometry)**

- First-generation CT systems are characterized by a single X-ray source (pencil beam or parallel-beam geometry).
- Both, the source and the detector, translate simultaneously in a scan plane, where the beam is translated in a linear motion across the patient to obtain a projection profile (**translate – rotate scanning motion**)
- **The advantages** of this design are simplicity, good view-to-view detector matching, flexibility in the choice of scan parameters (such as resolution and contrast),
- **This scanner was limited because;**
 1. Only head scans could be performed.
 2. Generates a lot of heat, therefore, require an elaborate cooling system.
 3. Scan time was very slow. About 1 minute per slice therefore the duration of scan (average): 25-30 mins

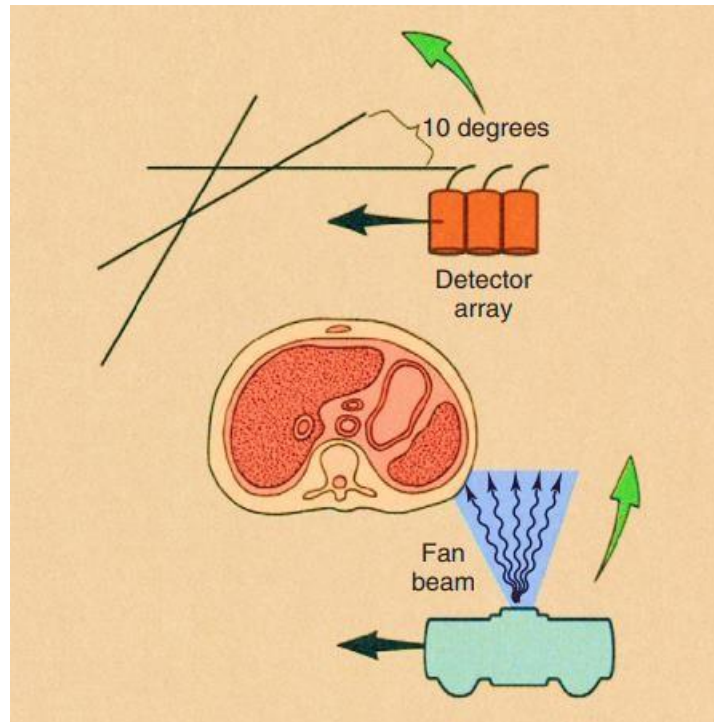


Fig(1)

✚ **Second Generation: (Fan Beam, Multiple Detectors)**

- ✚ Second-generation CT systems use the same translate/rotate scan geometry as the first generation.
- ✚ The 2nd generation CT scanners were developed to overcome some of the challenges of the 1st generation scanners.

1. Multiple detector (up to 30 detectors)
2. Shorter imaging times were possible about 20 seconds per slice therefore duration of scan (average): less than 90 sec
3. Fan-shaped x-ray beam (fan angle 10°)



Fig(2)

✚ Third Generation: (Fan Beam, Rotating Detectors)

This generation of scanners was developed to primarily reduce scan time.

1. wide fan beam between 30 and 60 degrees
2. Arc of detectors (500 to 1000)
3. Tube-detector movements: Rotate-rotate (no rotate-translate)
4. Scan time of as fast as 0.5sec per rotation or per slice therefore duration of scan (average): approximately 5 sec

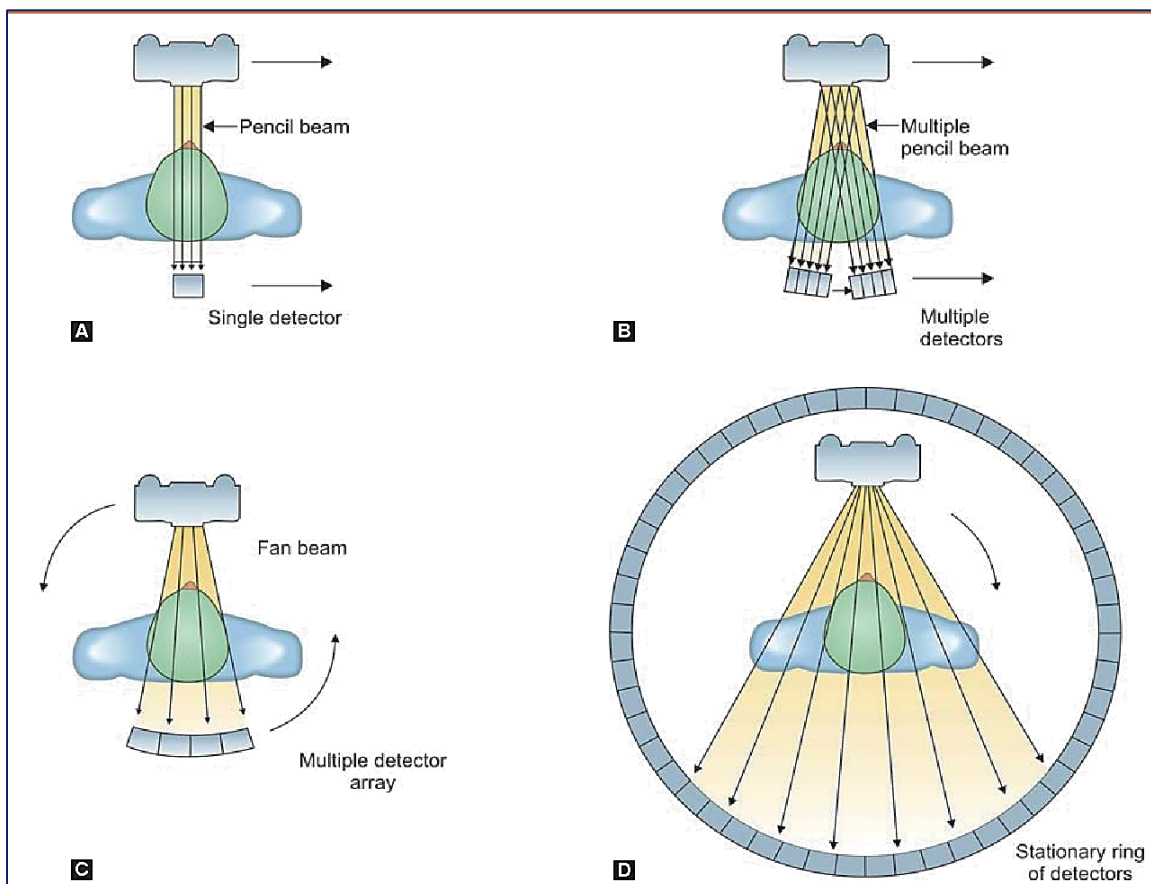
** Ring artifacts can occur in third-generation computed tomography imaging systems because each detector views an annulus (ring) of anatomy during the examination

✚ Fourth Generation: (Fan Beam, Fixed Detectors)

Fourth-generation CT were developed because they are free of ring artifacts.

1. The x-ray source rotates, but the detector assembly does not

2. x-ray beam is fan shaped
3. Duration of scan: sub second imaging time



Fig(3)

Fifth Generation: (Electron beam scanning EBSCT)

The fifth generation scanner is a stationary/stationary system, developed specifically for cardiac tomography imaging

1. No conventional X-ray tube is used, instead large arc of tungsten
2. duration of scan very fast (50 ms)
3. electron gun that deflects and focuses a fast moving electron beam along tungsten target ring

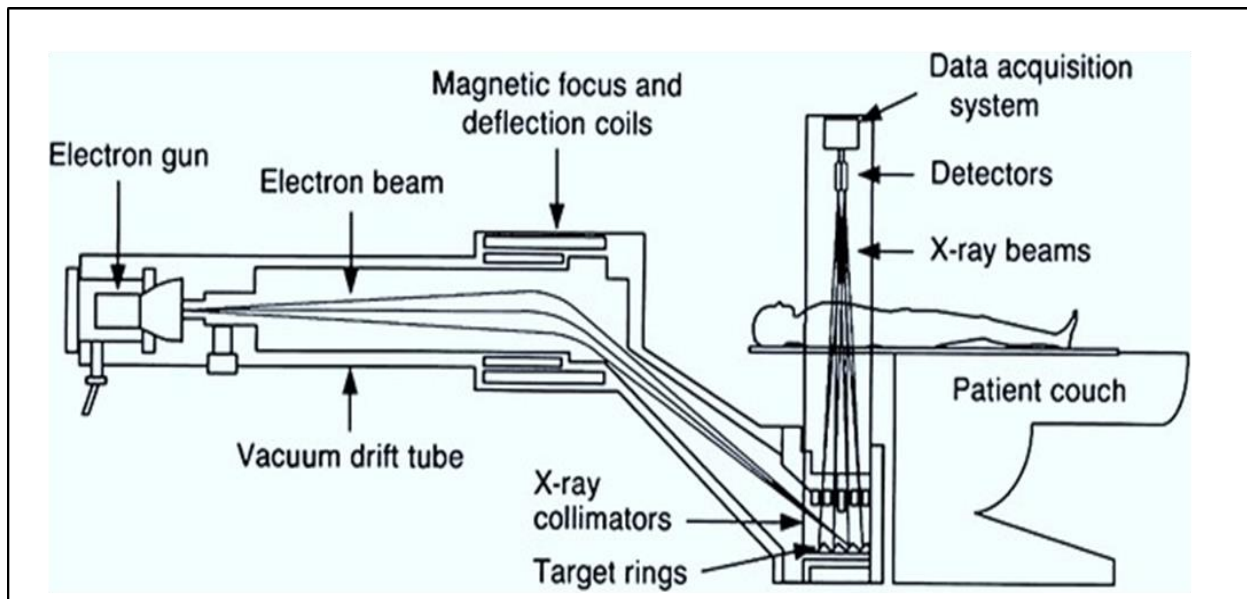
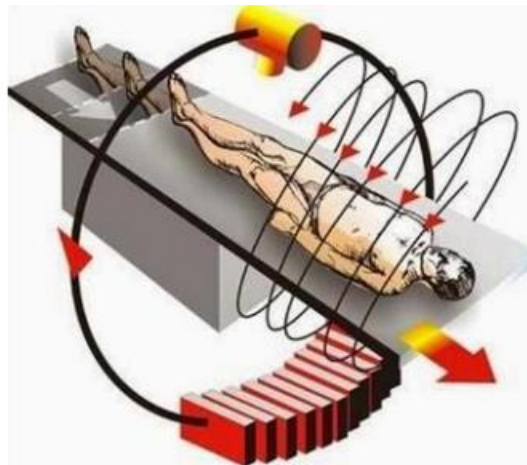


Fig. (4) : Electron beam scanning EBSCT

✚ Sixth Generation Slip Ring Technology and Helical Scans:

- ✚ When the examination begins, the x-ray tube rotates continuously. While the x-ray tube is rotating, the couch moves the patient through the plane of the rotating x-ray beam. The x-ray tube is energized continuously, data are collected continuously, and an image then can be reconstructed at any desired z-axis position along the patient (see figure below)



✚

Fig(5)

✚ Eighth Generation (Dual sources CT)

- ✚ The Dual Source CT (DSCT) equipped with two data measurement systems, that it is possible to double the resolution compared with that of a single source CT, and increase the speed of data acquisition.
- ✚ Dual Source Dual Energy (DSDE)

- Utilizes two X-ray tubes and two detectors to obtain simultaneous dual energy acquisition and data processing. X-ray tubes are set at different energies (different kV-settings, e.g., 80 kVp and 140 kV), which is the key to high sensitivity and specificity in imaging, customized for each patient and each acquisition.

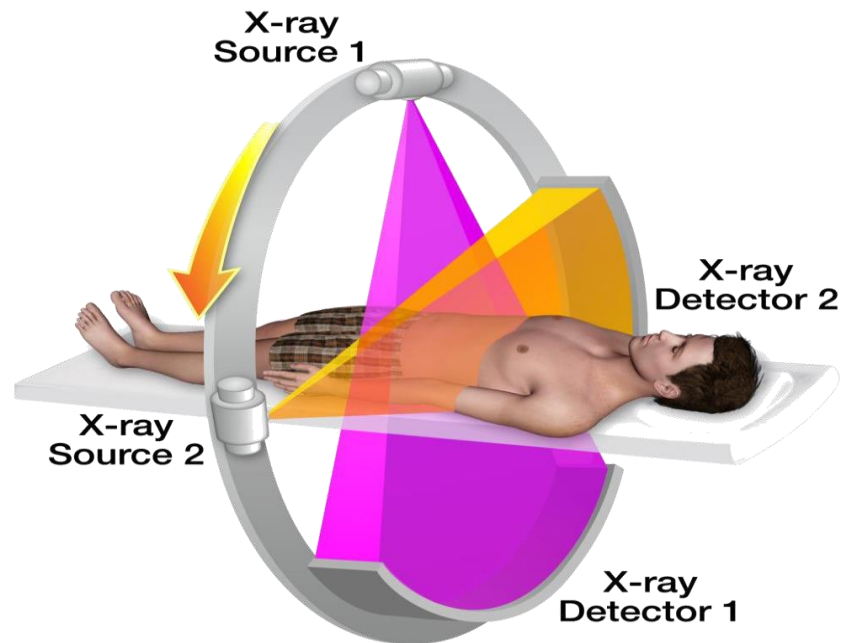


Fig (6)