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Course Two

Lecture 10: Computed Tomography (CT scan)

(Introduction and Generation of CT scan)

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Introduction

Nobel prize was given to the discovery computed tomography scanner in 1979, for both GN Hounsfield (UK) and Alan M Cormack (USA). In 1963, Alan Cormack built laboratory model for image reconstruction.

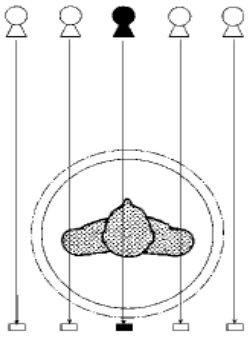
- The gantry includes the x-ray tube, the detector array, the high-voltage generator, the patient support couch
- Multislice helical CT x-ray tubes are very large. They have an anode heat storage capacity of 8 MHU or more. They have anode cooling rates of approximately 1 MHU per minute because the anode disc has a larger diameter, and it is thicker
- CT x-ray tubes are expected to last for at least 50,000 exposures.
- Detector array converts the projection values, in the form of radiation intensities, into electrical quantities.
- All multislice helical CT imaging systems operate on high-frequency power

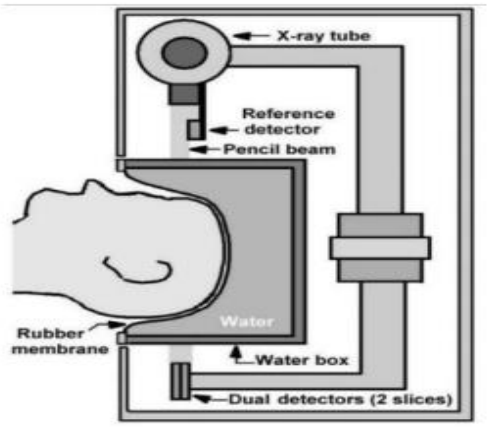
Generations of Computed Tomography

First Generation CT Imaging Systems

This scanners where limited because

1. Only head scans could be performed. Type of beam: pencil-like X-ray beam
2. Generates a lot of heat requiring water and an elaborate cooling system.
3. Translate-rotate movement of tube-detector
4. Scan time was very slow. About 1 minute per slice therefore the duration of scan (average): 25-30 mins and single detector

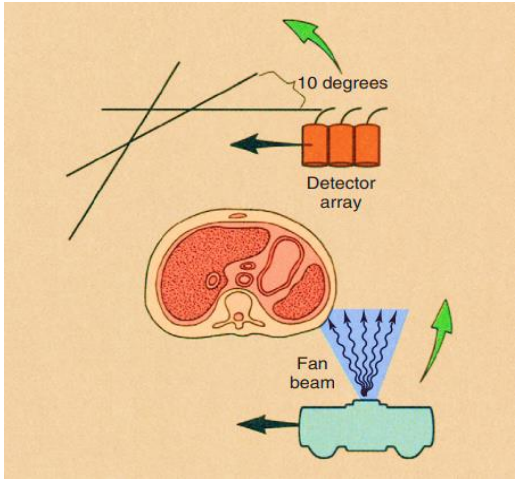




Second Generation CT Imaging Systems

The 2nd generation CT scanners were developed to overcome some of the challenges of the 1st generation scanners.

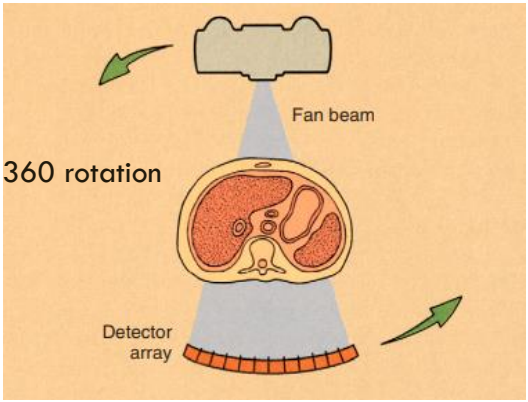
1. Multiple detector (up to 30 detectors)
2. Shorter imaging times were possible about 20 seconds per slice therefore duration of scan (average): less than 90 sec
3. Fan-shaped x-ray beam (fan angle 10 ^{o})



Third Generation CT Imaging System

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

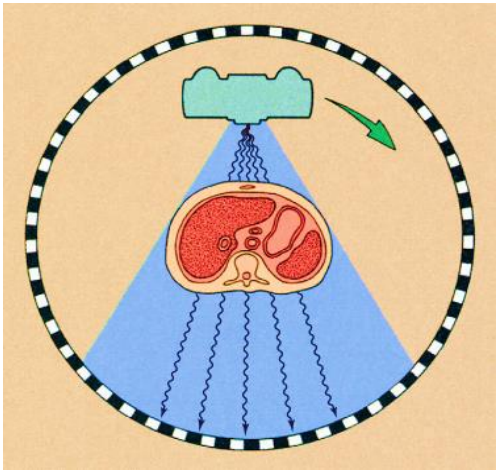


- Ring artifacts can occur in third-generation computed tomography imaging systems because each detector views an annulus (ring) of anatomy during the examination.

Fourth Generation CT Imaging System

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

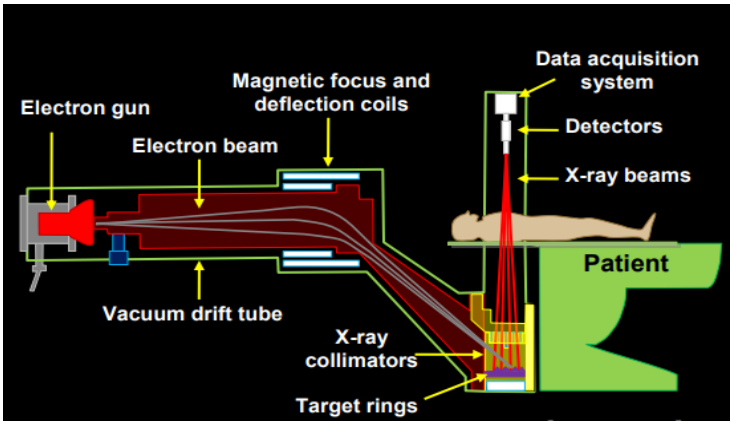
1. The x-ray source rotates, but the detector assembly does not
2. x-ray beam is fan shaped
3. Duration of scan: subsecond imaging time



Fifth Generation CT Imaging System

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



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)