Physics of Computed Tomography

Second Semester

Week 5: Components of CT Scanner

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The three major components of a CT imaging system: the operating console, the computer, and the gantry (Figure 28-17). Each of these major components has several subsystems.

The Gantry

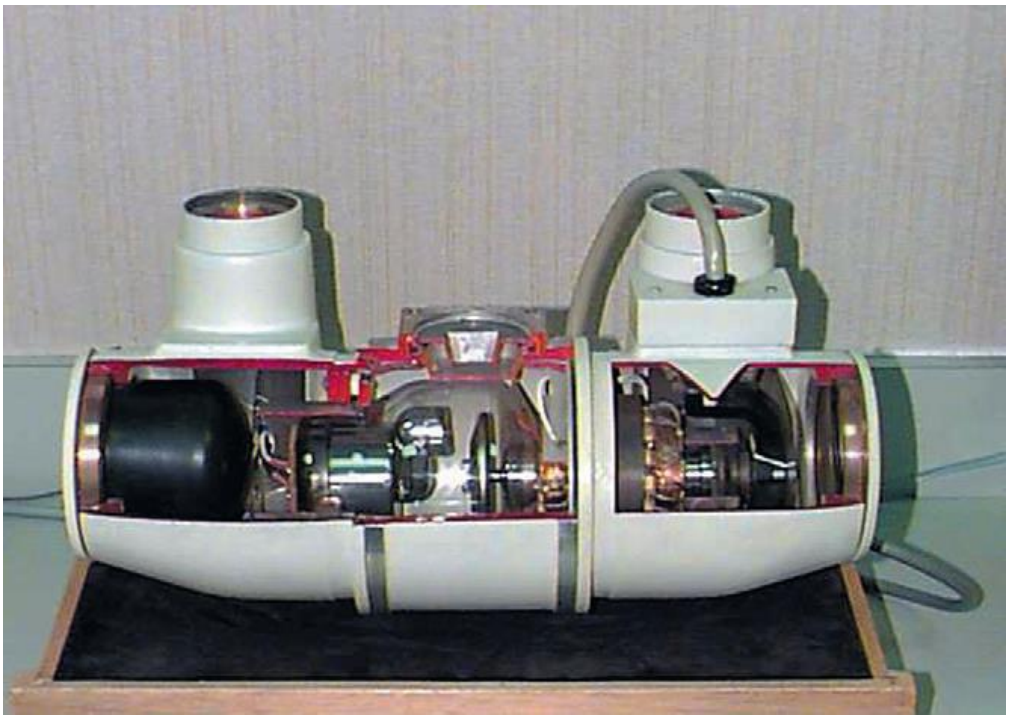
The gantry of a computed tomography scanner (CT) is a **ring or cylinder,** into which a patient is placed. The x-ray tube and x-ray detector spin rapidly in the gantry, as the patient is moved in and out of the gantry.

The gantry includes:

- The x-ray tube,
- The detector array,
- The high-voltage generator,
- Collimators and filters,
- The patient support couch,

The x-ray tube

X-ray Tube. X-ray tubes used in multislice helical CT imaging have special requirements. Multislice helical CT places a considerable thermal demand on the x-ray tube.



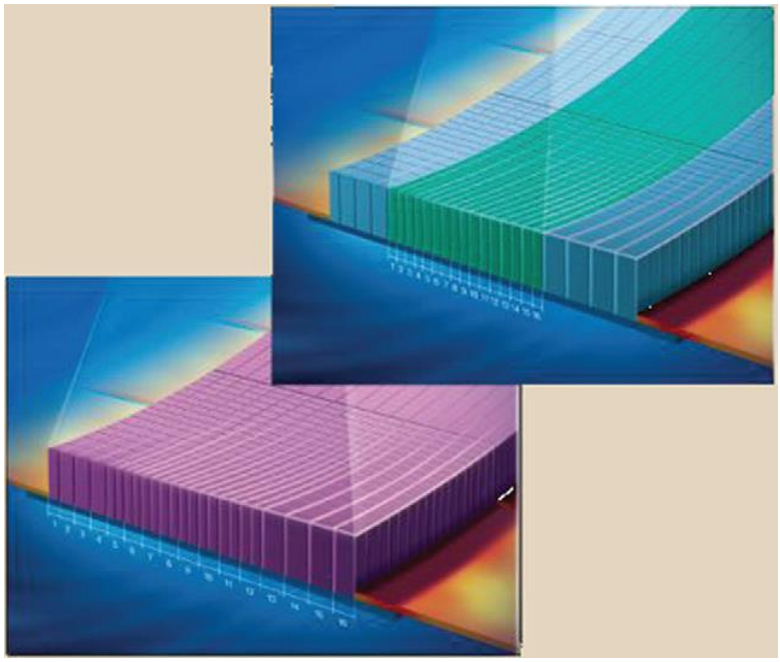
- CT procedures facilitate the use of large exposure factors, (high mA and kVp values) and short exposure times
- CT systems produce x-radiation continuously or in short, millisecond bursts or pulses at high mA and KvP. values.

 Multislice helical CT x-ray tubes are very large. They have an anode heat storage capacity of 8 MHU or more.

 CT imaging systems designed for high spatial resolution imaging incorporate x-ray tubes with a small focal spot.

Detector Array

Multislice helical CT imaging systems have multiple detectors in an array that numbers up to tens of thousands (Figure2). Previously, gasfilled detectors were used, but now, all are scintillation, solid state detectors.



Sodium iodide (NaI) was the crystal used in the earliest imaging systems. This was quickly replaced by:

 bismuth germanate ($Bi_4Ge_3O_{12}$ or BGO) and cesium iodide (CsI).

 Cadmium tungstate ($CdWO_4$) and special ceramics are the current crystals of choice

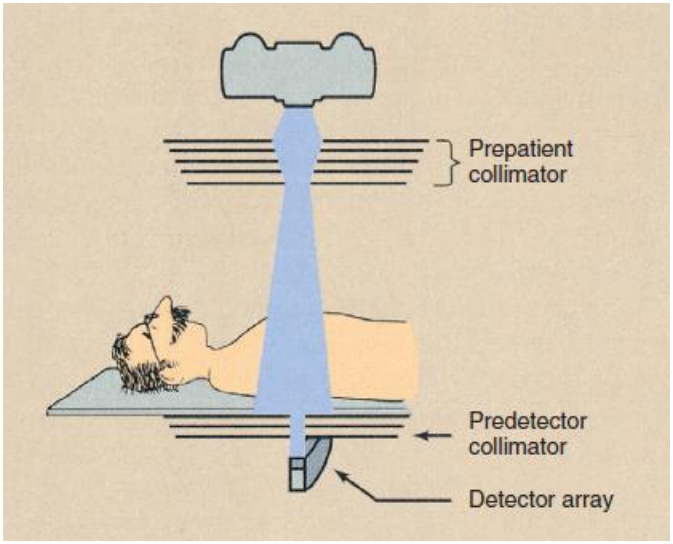
Scintillation detectors have high x-ray detection efficiency. Approximately 90% of the x-rays incident on the detector are absorbed.

Collimation

Proper collimation reduces patient radiation dose by restricting the volume of tissue irradiated.

 Even more important is the fact that it improves image contrast by limiting scatter radiation.

- ✓ In radiography, only one collimator is mounted
- ✓ In CT imaging, two collimators are used



i. **The prepatient collimation**
Determines the radiation dose profile and patient radiation dose.
ii. The predetector collimator

1. Restricts the x-ray beam viewed by the detector array
2. Improving image contrast by collimator reduces scatter radiation that reaches the detector array
3. defines the slice thickness

Filtration

There are two types of filtration utilized in CT.

 Inherent tube filtration and filters made of aluminum or Teflon are utilized in CT to shape the beam intensity by filtering out low energy photons that contribute to the production of scatter.

 Special filters called "bow-tie" filters absorb low energy photons before reaching the patient

Operating Console

The operating console contains meters and controls for selection of proper imaging technique factors, for proper mechanical movement of the gantry and the patient couch, and for the use of computer commands that allow image reconstruction and transfer.

 Operation is usually in excess of 120 kVp.

 The maximum mA is usually 400 mA and is modulated (varied) during imaging according to patient thickness

 Slice thickness is selected from the console by adjustment of the automatic collimator and by selection of various rows of the detector assembly.

 Nominal thicknesses are 0.5 to 5 mm

Data Acquisition System (DAS)

1-Once the detector generates the analog or electrical signal it is directed to the data acquisition system (DAS)

2-Amplifying the electrical signal is one of the tasks performed by the data acquisition system (DAS)

3-The DAS is located in the gantry right after or above the detector system

4-The computer does not "understand" electrical signals therefore; the information must be converted to digital information. This task is accomplished by an analog to digital converter which is an essential component of the DAS

5-The array processor solves the statistical information using algorithmic calculations essential for mathematical reconstruction of a CT image

6-There are many image reconstruction methods is used by most modern CT scanners such as filtered back-projection