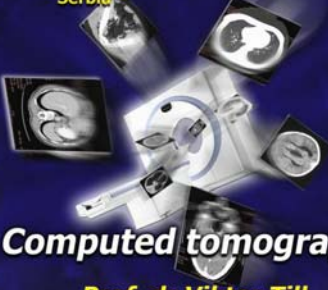

**Clinical Center Novi Sad**  
**Institute of Radiology**  
**Serbia**


**University of Novi Sad**  
**Faculty of Medicine**



**Computed tomography**  
**Prof. dr Viktor Till**

## CT computed tomography


- Computed tomography (CT) has revolutionary changed radiology
- CT is the new method of originate image versus classical tomography
- M. Lündgren consider that CT is the most important invention in radiology from the moment when Konrad W. Röntgen found X ray beam



RÖNTGEN 1895

## CT

- **Tomography** is the Greek word consists of two words : **Tomos + graphia** it means to draw lay
- Fundamental of CT is to visualize sharply **one** anatomical layer

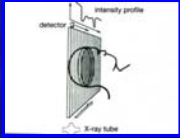
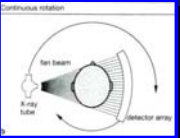
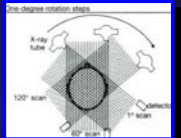


- Basic constructive design was first announced and published by **Sir Geoffrey Hounsfield** in 1973.





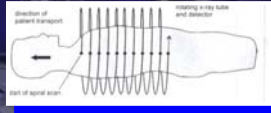
- From the early 70's (EMI MARK I) till nowadays has been constructed **four** generation of conventional scanner.
- Four-generation of the scanner different **number of detectors**
- Detectors are **static** or synchronize **rotate** with X ray tube.

## CT vs. CLASSICAL TOMOGRAPHY

	CT	Classical tomography
Overlapping of the layer	no	yes
Possible to measure density of the tissue	yes	no

- From the early 90's developed new method - **spiral computed tomography**



- Multidetector CT** from 2000



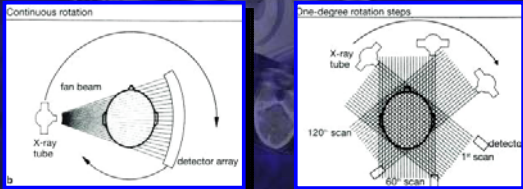
## Hardware parts of the scanner

- Hardware of all generation of the scanners is similar
- Basic parts:
  1. Gantry
  2. Console
  3. Camera



## Gantry

- X ray tube
- Collimate system of the plates
- Detectors of X ray beam
- Rotate motor



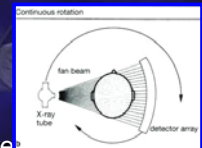
## X ray tube for CT

- Specific **technical characteristics** versus x-ray tube for classical tomography
- Much more **massive** anode
- Anode with much **higher** temperature **capacity**
- Scanning from all angles in the circle (360°)

- Collimator** (determine the thickness of layer), consist of many **iris**, the last is in contact with aperture where is the patient positioned
- Detectors: **scintillate** (CDWO4, Gd2O2S) or **gas** (xenon)

## Basic principle in originate of the image on CT

- Image originate when the patient or object of tomography is static while x-ray tube and detectors correspondently move around
- X ray tube and detectors are on the opposite site of the imagine circle, and moving synchronically.



- Detectors systems consist of **scintillations crystal in row**, which produce light after induced by photons of x ray beam.
- **Light photons** from detectors system photomultiplier convert in electric impulse which intensity is proportional with intensity of the light.
- Intensity of the light from detectors system directly depends of **coefficient of the absorption of tissue**

- Light photons by **photomultiplier** are **transformed** in electrical analogue impulse of determined intensity.
- **Analogue** electrical impulse by converter is transformed **in digital** signal, which computer further processed

## Technique of scanning

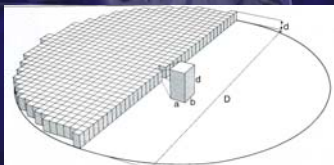
- Body of the patient on the table goes in the gantry, and scanned in the plane of the x-ray beam.
- If the plain of the gantry is perpendicular on the longitudinal axis of tomography images are **transversal**.



- The image produced on the CT consists of the **pixels**.
- Every pixel corresponds with the small part of transversal section of anatomical region and structure.



- More **pixels** in the **matrix** of image give better resolution, and better visualization of anatomical structure
- When the **pixel** has third dimension that is **voxel** it means thickness of the



## Tissue in the human body have different degree of the absorption

- The degree of the attenuation of the energy X ray beam i.e. absorption of the x-ray beam in different tissue is validate by CT UNITS
- In honor of inventor of the CT these units call **HOUNSFIELD**.
- In the scale from **- 1000 to + 1000** units determine all tissues

water	0
bone	+ 1000
air	- 1000



## White-black scale

Corresponds with type of tissue and absorption coefficient:

- Bone is white,
- air is black,
- water is "light" gray,
- soft tissue are "dark" gray

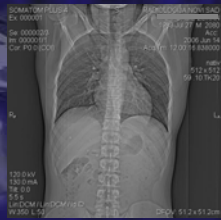


- All parts of the human body can be visualized by CT, thus exists different protocols for performing the examination.



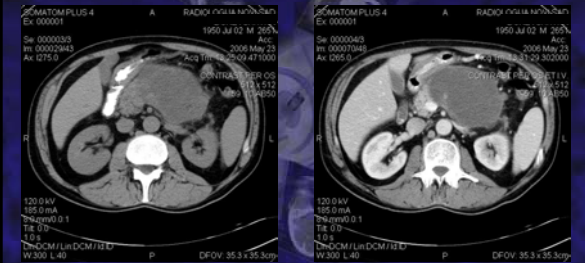
## CT examination

- Patient is lying on the table, and move in the gantry
- On the monitor is visualized profile or posterior-anterior projection of the body similar with classical view on RTG (scout).



Gantry is tilting in the adequate position based on topogram (also determine the slice thickness).

- CT native and post contrast scans (iv.).

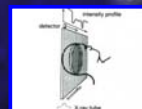


## Spiral computed tomography

- Begins at 1989's
- The first commercial scanner from 1992 Kalender et al.

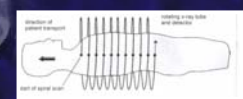
### Conventional CT

- Recorded scan by scan ( scan time varies between 0,7 to 2 s, inter scan time is 4 to 12 s)
- Movement of the table correspond with slice thickness, image of the one transversal section.
- All transversal section define volume region.



### Spiral CT

- X-ray tube is rotating while at the same time the table is moving.
- Scan duration 12-40s, table feed 1- 20mm/s.
- Due to short scan time, the entire region can be examined in one single respiratory phase.
- Respiratory artifacts can be avoided.

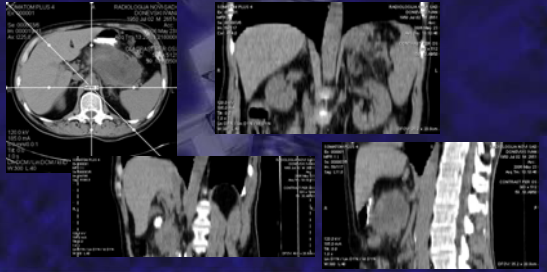


- High flow contrast media application up to 4ml/s allows dynamic examinations in combination with spiral CT.



- Spare time and contrast material possible to see adequate phase of opacification of blood vessels.
- Different post processing algorithms are provided to reconstruct the image matrix from the raw data
- Bone algorithms - bone structures
- Soft algorithms - soft tissue

- Post processing algorithms allow reconstruction of the scanned volume in further slice orientations.
- 3 D images visualization of anatomical structure is performed by applying two methods:MPR, SSD and MIP



## Spiral CT vs. conventional CT

	spatial resolution	speed and continuity	retrospective analyze	CTA
HELICAL CT	same in all planes	yes	yes	yes
CONVENTIONAL CT	no	no	no	no