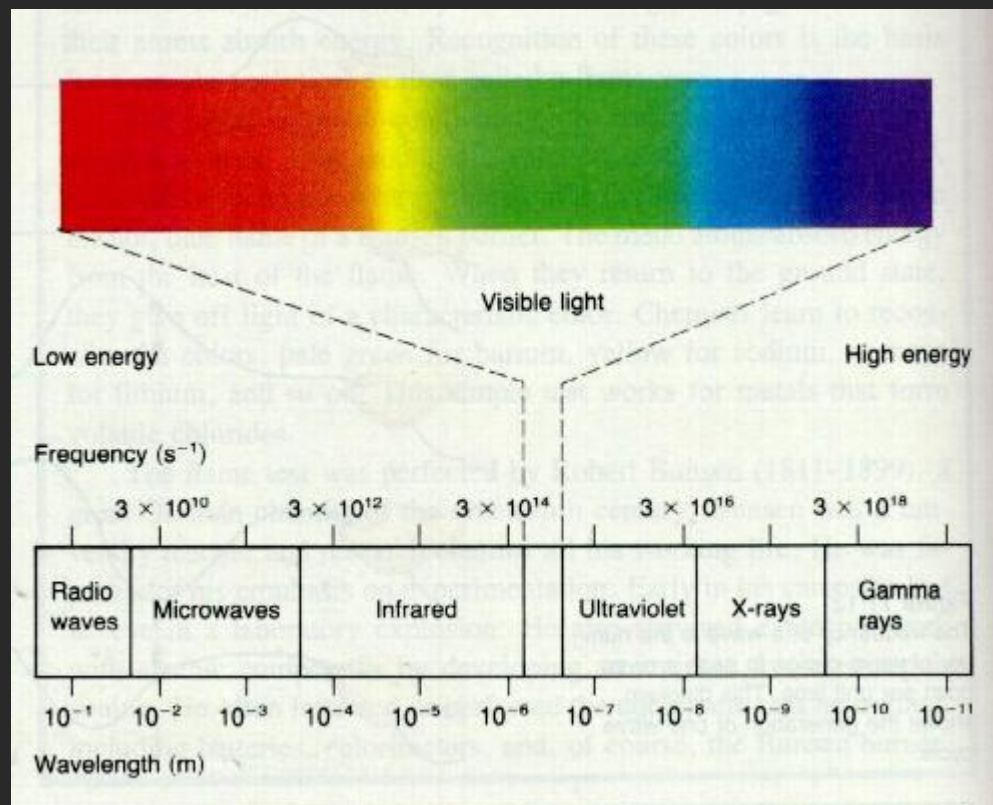


X-Rays and CT Scans



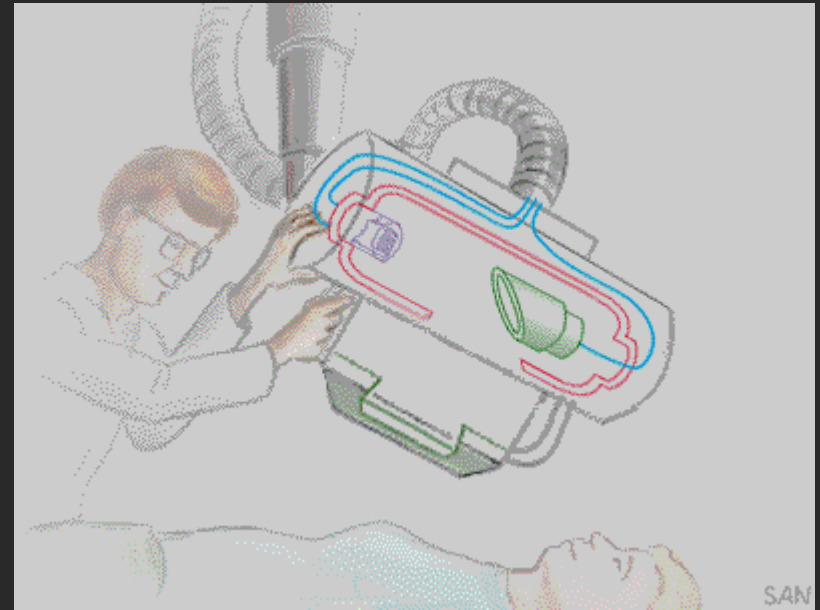
- X-Rays were discovered accidentally in 1895 by Wilhelm Conrad Röntgen
- Due to their short wavelength, on the order of magnitude of cells, and their high energy, they can penetrate skin and other soft tissue.
- Within 2 months, they were being used in Europe and North America to visualize internal organs and bones



Characteristics of X-Rays

- Displays in shades of gray
- Takes a 3-D structure and convert to 2-D projection
- Can resolve distances of .025mm.
- Resolutions range from .05-.08mm.
 - can be limited by contrast limitations of film used.
- Physical differences, such as density or atomic number will increase contrast.
 - Since most soft tissue and body fluids have similar compositions, there is little contrast between them
 - X-Rays are most useful for imaging bones
 - Contrast dyes aid in the study of soft tissues.
- Common problems: Noise and Blurring

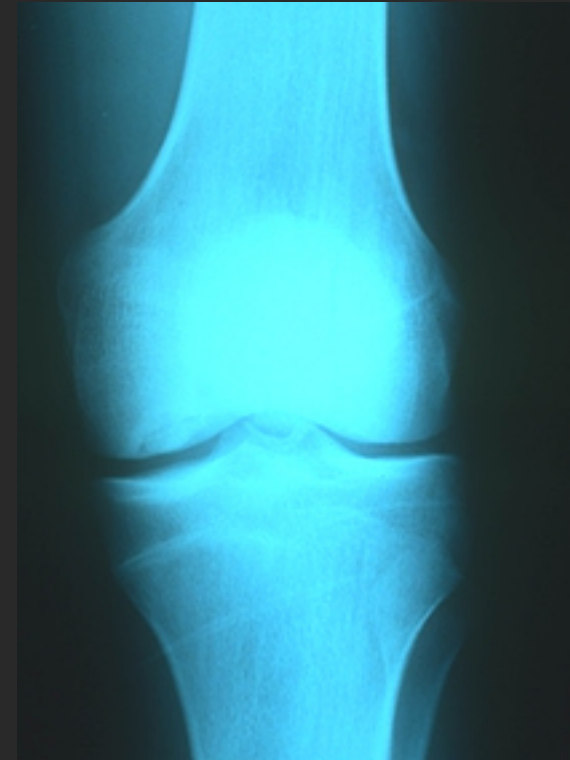




Below the patient, there would be an intensifying screen and standard photograph film. The intensifying screen converts the X-Rays into visible light, which then strikes the film and causes it to expose.

Noise

- Noise is a result of overlying structures or random scattering of X-Rays
- This “structure noise” can be removed by taking X-Rays from different angles. This gives two views which can be compared, by reversing one image then subtracting it from the other.
- These subtraction images are especially useful in orthopaedics.



Blurring

Due to

- Size of X-Ray tube focal spot
- Movement of the object during exposure
- Spreading of light within the intensifying screens

- Commonly in the range of .15 - 1mm

- Can be reduced by using a small focal spot and/or minimizing the distance between the film receptor and the object.

- Smaller focal spots result in increased heat in the X-Ray tube.

- Decreased object-receptor distance results in greater exposure of scattered radiation.



3 Methods To Reduce Scatter

- **Collimators** reduce the field size of the X-Ray beam, reducing the amount of scattered radiation. It is practical to limit the beam to the field of the area desired to get better contrast and resolution.
- “**Air Gap**” Increases the **distance** between the object and the film receptors. This causes increased magnification and blurring. Adverse effect is that patient exposure is greater.
- **Using Grids**. A grid is placed between the object and the film receptors. This grid has slits made of absorbent material that are aligned with the direction that the X-Ray beam is coming from. So that the beams coming in at the expected direction are allowed to pass through to the film, but scattered beams coming in at unexpected angles are absorbed by the slits.

Computer Assisted Tomography (CT Scan)

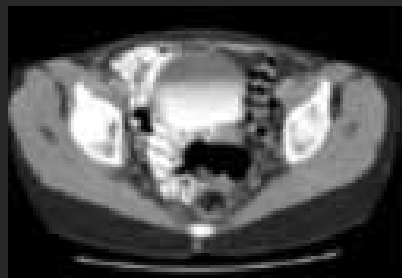
Similarly to X-Rays :

- Imaging by passing X-Rays through the body

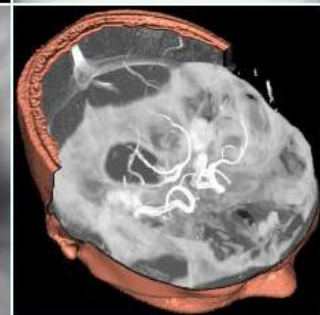
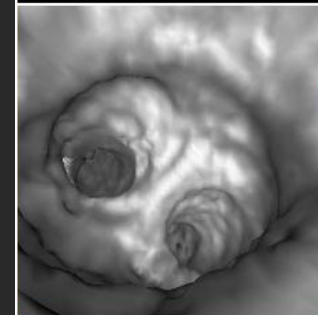
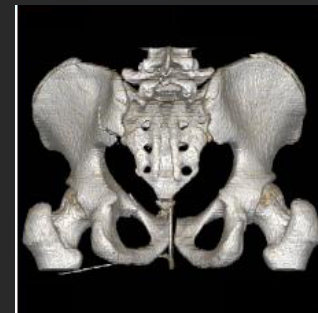
Differ in:

- An X-Ray is a projection parallel to the axis of the film (not object)
- A CT scan image is a slice perpendicular to the axis of the object.
- CT scan is a series of information from recording X-Ray beams (not planes) in angular increments, and then reconstructing them to make a cross sectional view.

<http://www.radiologyinfo.org/content/ct-abdomen.htm>

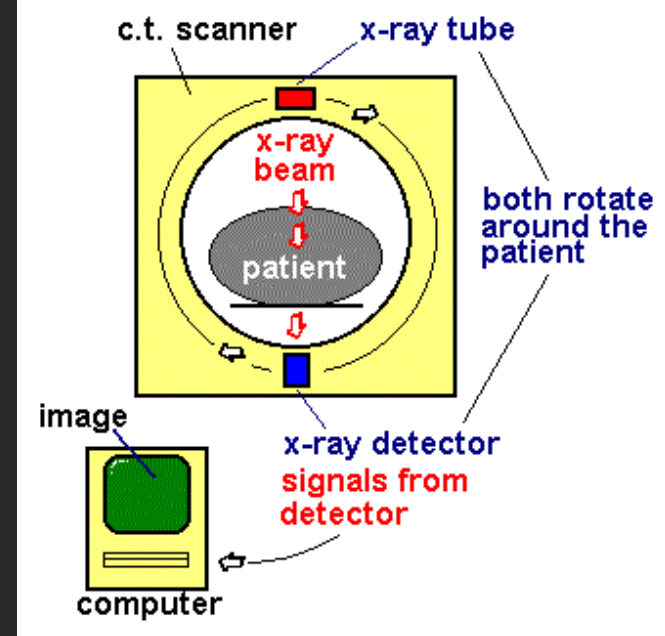


CT of the pelvis



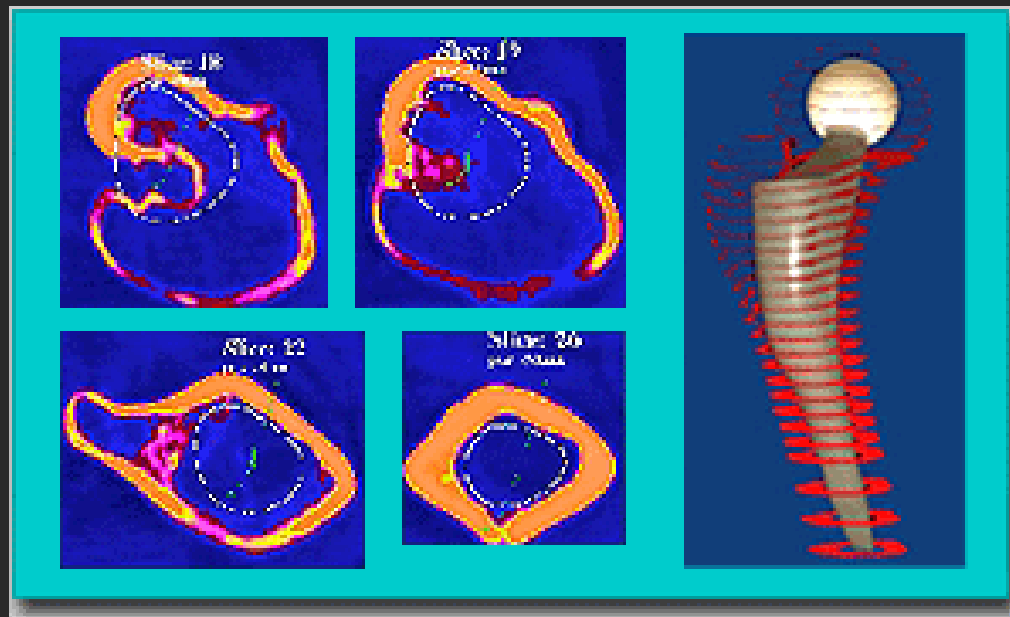
How does CT work?

- The X-Ray beams are more focused using collimators. They still have a fan shape.
- The X-Ray beam moves around the object in a circle at small angular increments and sensors take measurements for each position. Giving many independent ray values along the fan, and then giving a multitude of rays for each angular value.
- Using high speed computers, these ray values can be reconstructed using a method known as “Filtered Back Projection” into a 2-dimensional slice.



Numerical Values

- Slice thickness is usually of 5 mm, it can take slices as small as 1mm thick.
- Resolution is between 0.5-1mm
- Actual image dimensions are generally 256x256 or 512x512 pixels.
- Similar to standard X-Rays, greater resolutions and minimal noise are achieved at the cost of higher radiation dosages to the patient.



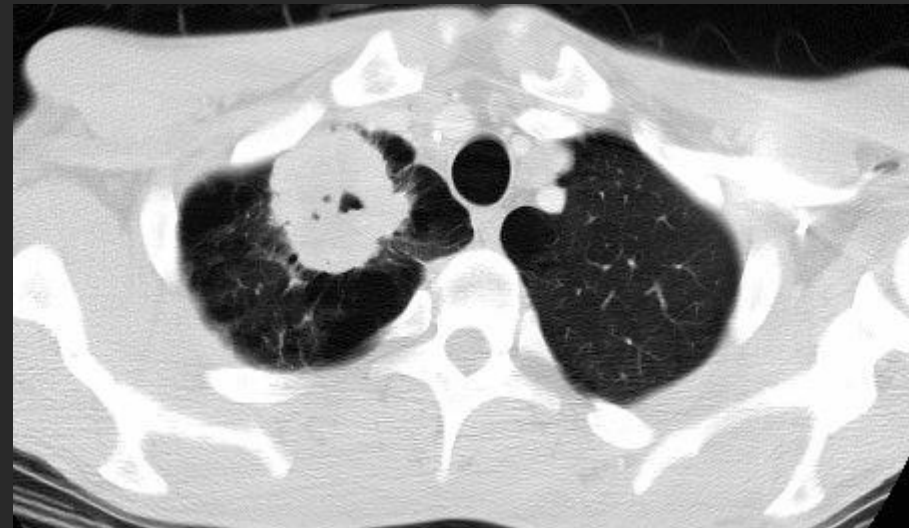
Advantages and Disadvantages

Disadvantages

- The resolution of a CT scan is worse than the resolution of a standard X-Ray

Advantages

- Since there is no film involved, resolution is not limited by film quality.
- More sensitive to soft tissue, can contrast more similar materials.
- More functional. These slices can be reconstructed into 3-dimensional models with a variety of applications.
- CT scanners can also be used to take standard X-Rays in significantly less time, resulting less patient exposure to radiation.
- CT scanners can be set to low resolutions, such that computers can reconstruct them in seconds, this allows scanners to be used dynamically as a real time diagnostic tool, allowing a doctor to quickly find the area of greatest interest and take a higher resolution scan of that particular area.

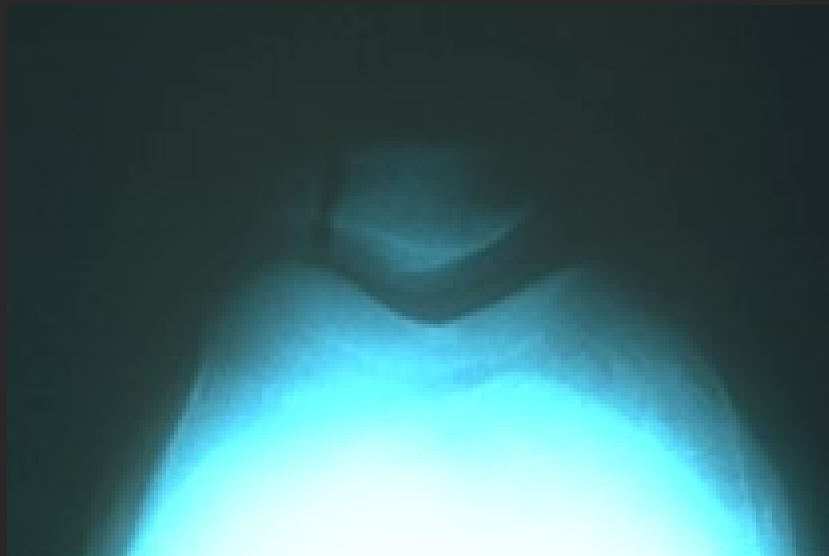


Notes on Radiation Dosage Values

The values on the following page are the dosages received at the surface of the body. Dosage values at the center of the patient can be approximated to be one half the value at the surface.

The doses shown reflect the amount of energy deposited in the body per unit of mass. This is known as a the “real dosage.” Another commonly used unit is the “effective dosage.” The effective dosage incorporates a crude adjustment for types of ionizing radiation and a “tissue weighting factor” to calculate the probability of cancer (fatal or non-fatal) in different organs.

Every website has a different formula to calculate an “effective dose” of radiation.



Radiation Dosages

Area	X-Ray	CT Scan
Chest	.02 rads	2-5 rads
Breast	.2 rads	<5 rads
Heart (multi-slice)	-	10-20 rads
Head	-	3-7 rads
Abdomen	-	2-5 rads

1 rad = 0.01 joules/kilogram; 1 krad = 10 J/kg.

New X-RAY Equipment Helps

A particle detector that won its inventor the Nobel Prize in Physics in 1992, has been developed into X-RAY equipment that exposes the patients to 100 times less radiation than conventional machines.

The X-RAY system is based on the proportional multiwire chamber, developed by Georges Charpak, a Ukranian Scientist, which is able to detect individual photons. This counting mechanism is far more efficient than using film, which requires a greater number of photons to act on the emulsion.

The sensitivity of the detector, together with the use of finely trained X-RAY beam allows radiologists to cut down the dose of radiation. The system provides digital data that can be used for reproduction, transmission or filing. It can be converted to a clear picture by coding the scan into 64,000 shades of grey.

The system which has been developed by Biospace Radiologie of France, is undergoing a nine month clinical evaluation at Saint-Vincent-De-Paul Hospital in Paris.

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