X-Ray Imaging

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Advantages

- Easy diagnosis → bone, teeth, joint etc.
- Fast diagnosis → emergency treatments with immediate diagnosis in least invasive manner
- Inexpensive → equipments, compared to CT and MRI
- Availability → majority of the facilities: hospitals, nursing homes, family physician clinics, etc.
- Minimum radiation exposure → radiation does not remain in patient's body, precaution and care is taken
- No side effects → risk of getting cancer is very small

http://benefitof.net/benefits-of-x-rays/

Disadvantages

- High voltage → voltage breakdown can jump inches from power supply, heat
- Radiation exposure → additional radiation will increase cancer risk by 0.6-1.8% (age 75)
- Soft-tissue imaging → dense tissues appear lighter than surrounding soft tissue
- 2D imaging → limit detection ability, not enough details for diagnosis

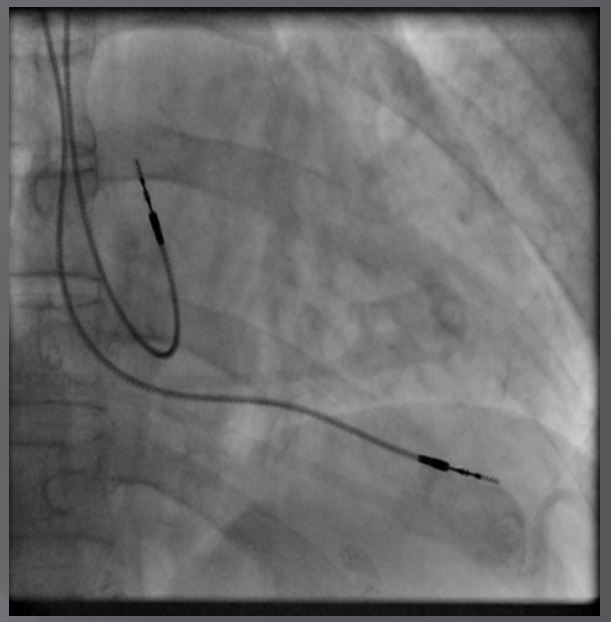
Aston, Richard. *Medical Imaging Equipment Theory*. 2ndnd ed. Pennsylvania: ABC Engineering Research, 2008. 38-53. Print.

Medical Application

- Radiography → 2D image, find orthopedic damage, tumors, pneumonias, foreign objects, etc.
- Mammography → capture images as mamograms of internal structures of breasts
  - Types: screen-film and full field digital

Radiography - diagnosis of Orthopedic damage
http://is.sdsmt.edu/AreasofSpecialization/PreprofessionalHealthSciences/MedicalRadiographyRequirements/

- CT → computed tomography, x rays pass through different parts of body creating cross-sectional images, later put together
- Radiation Therapy → ionizing radiation for cancer treatment
- Fluoroscopy → displaying movement of body part or instrument or dye through body
  - Examinations: view GI track, angioplasty or angiography, blood flow studies, orthopedic surgery, etc.

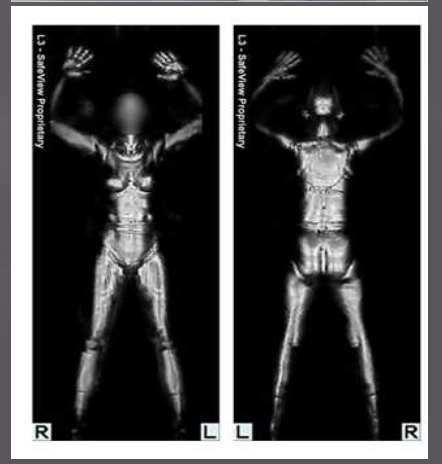


Fluoroscopy – pacemaker leads right atrium ventricle, Pace maker implant procedure

- http://youtu.be/RueXmL-Dz3w?t=5m28s

Non-Medical Application

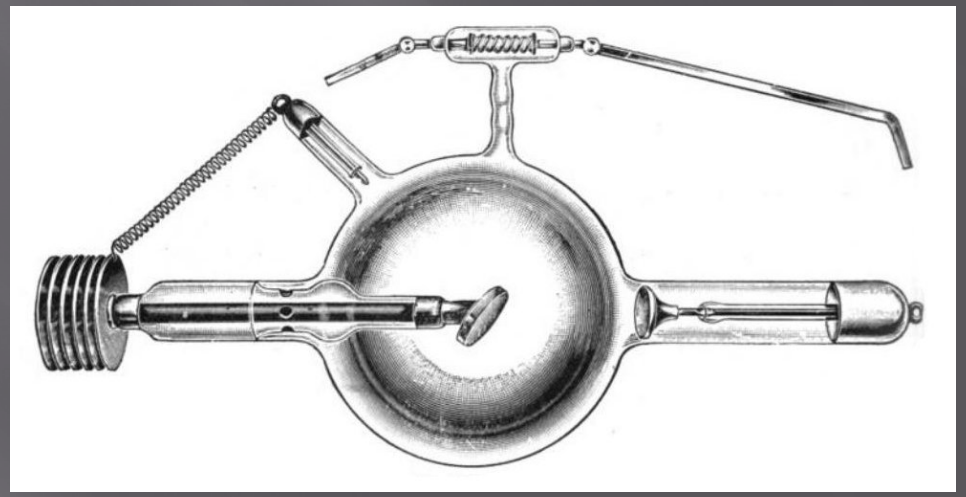
- Astronomy → the telescopes bounce X-ray photons off curved mirrors into and from space, sun pot images
- Industrial Imaging → NDI examines industrial materials for defects (quality control)
- Transportation Security → uses back scatter X-ray for airport screening, scanned moving energy rapidly over form, the signal strength detected and allows for highly realistic image
- Crystallography → diffraction of X-rays through crystals causes distinct atomic patterns to emerge, determine molecular structure, distance between atoms



http://www.ehow.com/list_7553903_nonmedical-uses-xrays.html

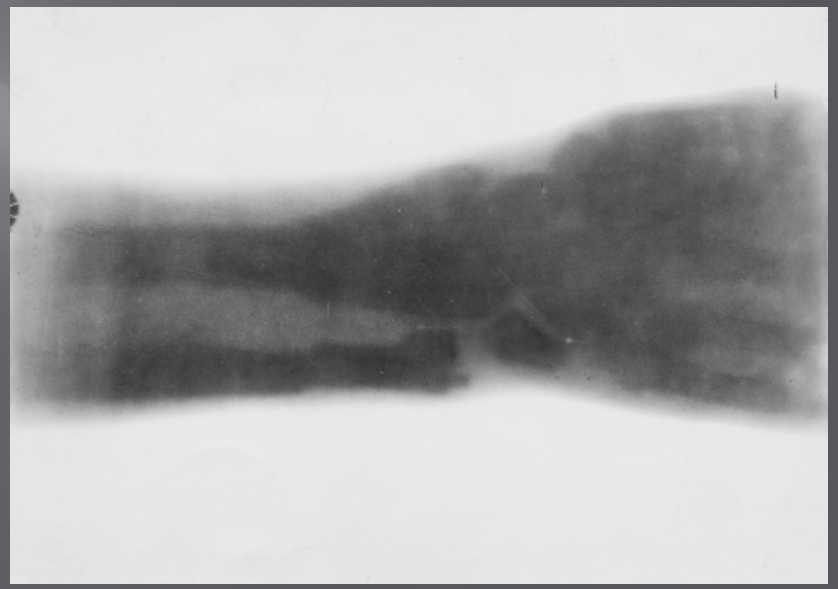
Early Pioneers

- Wilhelm Conrad Roentgen (1845 – 1923)
- On November 8th, 1895, while using Crookes Tubes noted a fluorescent effect on barium platinocyanide screens.
- ***Labeled the mysterious rays, X-Rays.***
- Dec 22, 1895. Takes a medical x-ray image of his wife, Anna Bertha. First X-ray Image.
- Wins Nobel Prize in Physics in 1901. The first recipient of the Nobel Prize in Physics



Krohmner J.S. 1989. *Radiography and Fluoroscopy, 1920 to present.* Radiographics. Vol. 9 no.6. pp. 1129-53

- January 1896→ Frank Austin of Dartmouth College found a discharge tube, designed by Ivan Pulyui, that produced the “x-rays”.
- February 3rd, 1896→ Frost brothers take image of broken wrist bone on gelatin photographic plates.

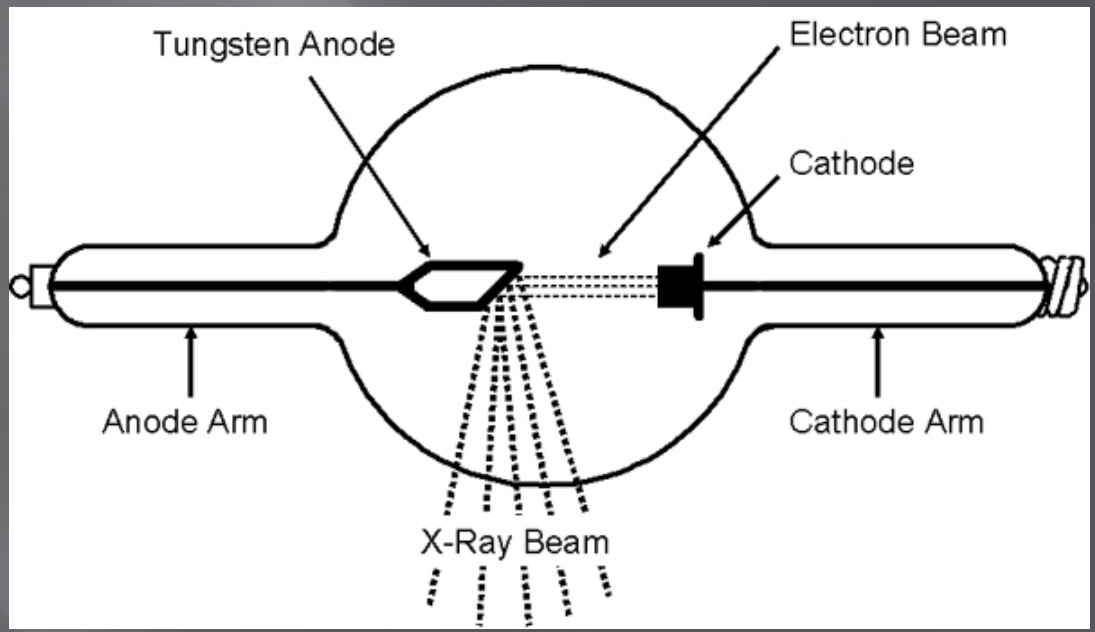


Frost, E. B. (1930,April). The First X-Ray Experiments in America. *Dartmouth Alumni Magazine.*

Coolidge Tube

- William D. Coolidge (1873 - 1975)
- In 1913 invents the *Coolidge Tube*, an improvement over the Crookes Tube.
- Cathode filament made of Tungsten
- Became commercially available by **1917**

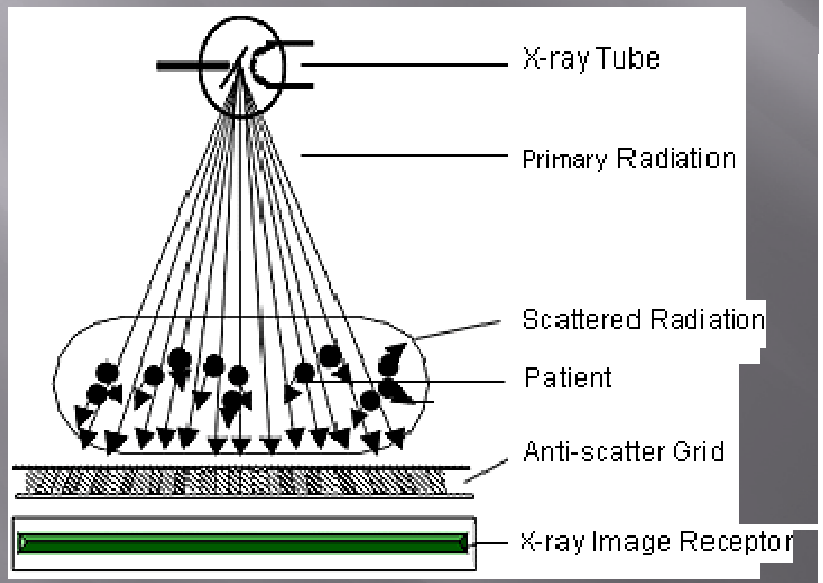
- http://youtu.be/RueXmL-Dz3w?t=3m36s

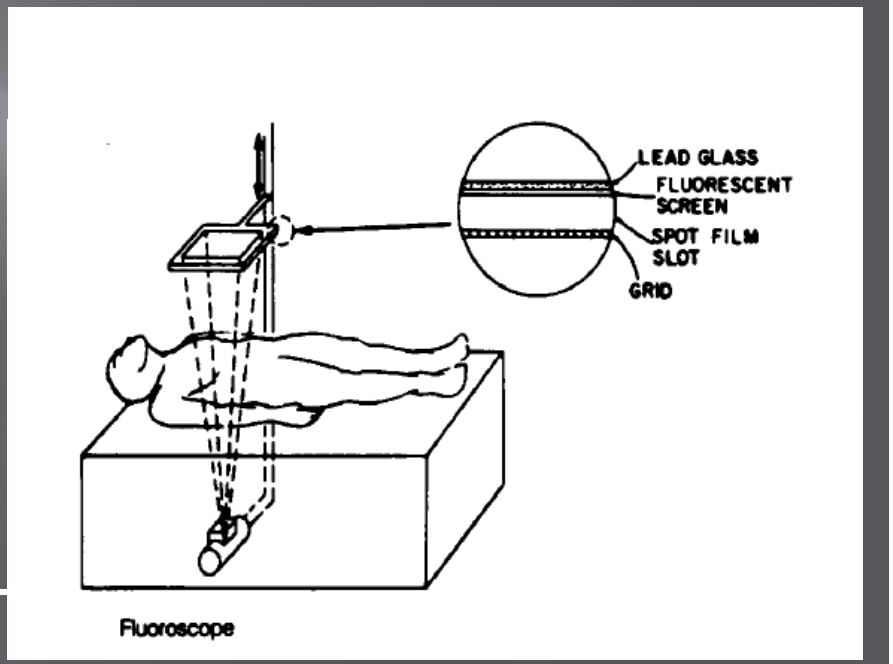


http://www.orau.org/ptp/collection/xraytubescoolidge/coolidgeinformation.htm

Early in the decade

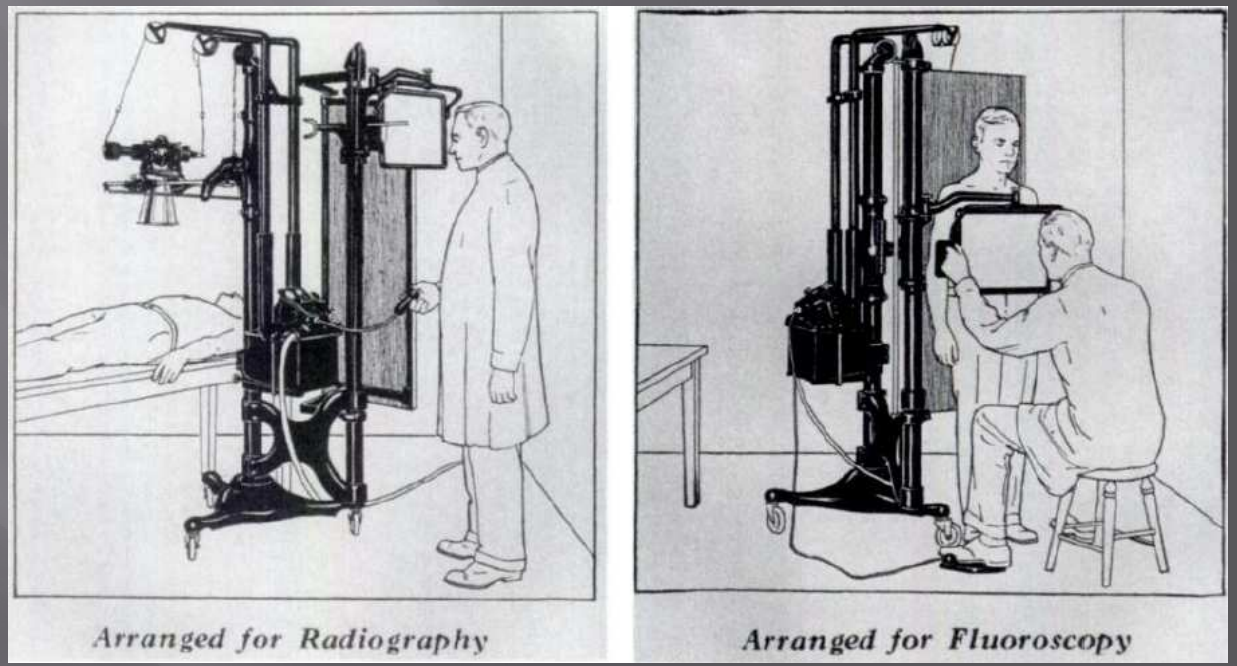
- 1896→ Thomas Edison invents a modified fluoroscope with a calcium tungstate screen.
- 1912→ the tilting table is made by Eugene W. Caldwell
- 1913→ Gustave Bucky creates the anti-scatter grid. Still the most effective device for reducing scattered radiation





http://www.jpihealthcare.com/xray-grid

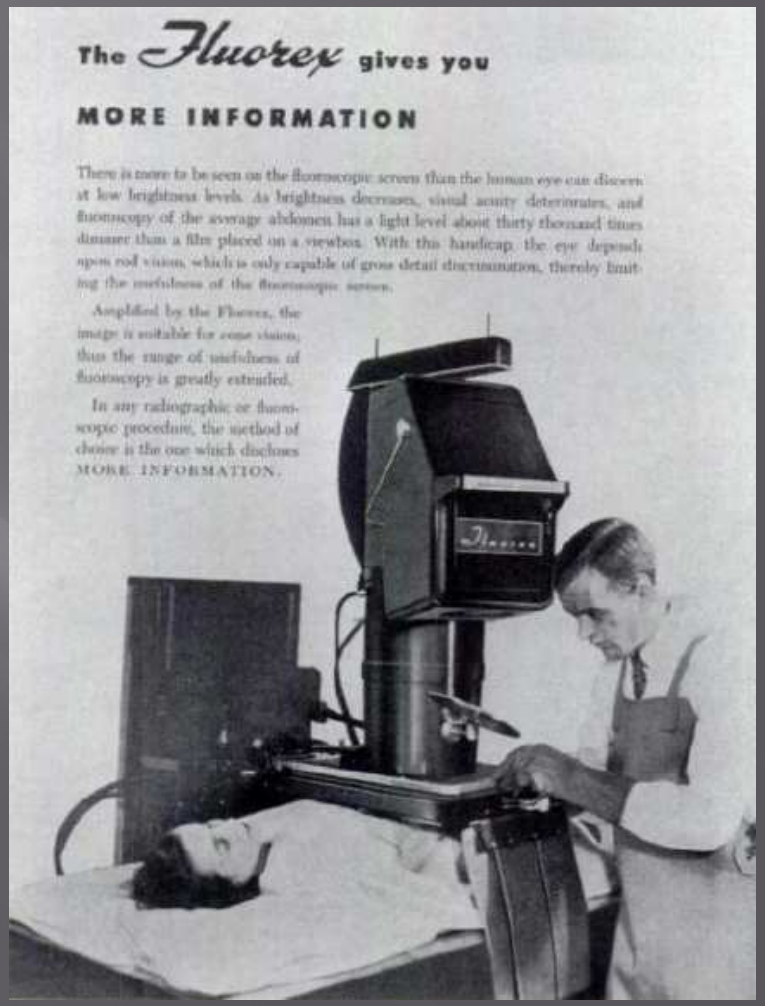
- 1926→ Engeln Electric Co. in Cleveland Ohio introduces the *Duplex*.
- 1929→ First rotating anode x-ray tube by Phillips was manufactured. Named the *Rotalix*.



ReferenceKrohmner J.S. 1989. *Radiography and Fluoroscopy, 1920 to present.* Radiographics. Vol. 9 no.6. pp. 1129-53

Westinghouse Electric Co.

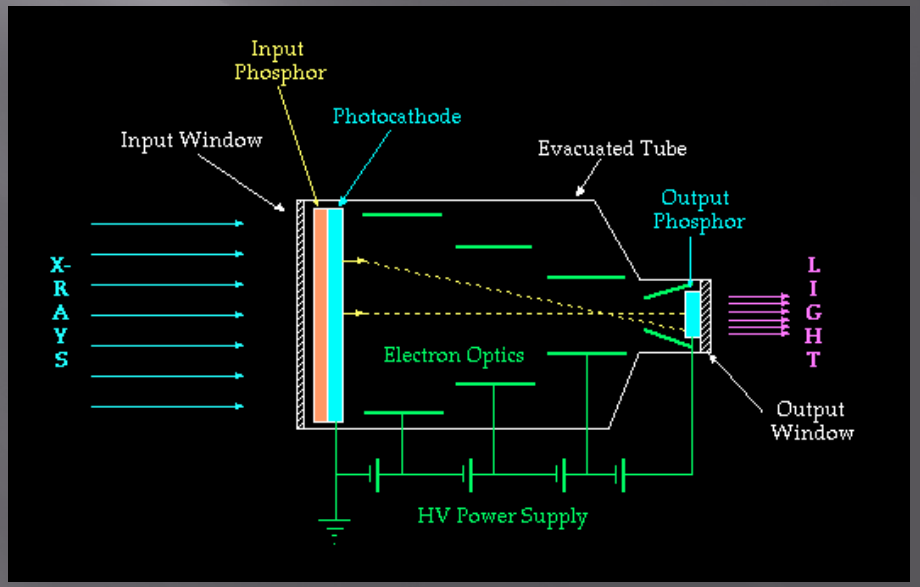
- 1945→ Westinghouse Electric Co. markets the first *phototimer*.
- 1948→ J.W. Coltman from Westinghouse Electric Co. develops the first *X-ray Image Intensifier*.
- 1953→ the *Fluorex* is introduced. First commercial image intensifier unit.
  - Less scattered radiation
  - Less exposure
  - Less examination time



Classic papers in modern diagnostic radiology
By Adrian Thomas, Arpan K. Banerjee, Uwe Busch

X-Ray Image Intensifier

- Converts x-rays to visible light
- Requires lower doses of X-ray due to more efficient conversion of x-ray to visible light.
- CCTV in late 1950s and XRII allowed for real-time imaging through television screen viewing.



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- 1952 the *Imperial* unit by General Electric.
- Used as both a radiographic & fluoroscopic unit.
  - Provided 360^{o} table rotation
  - Power assisted table movement

Krohmner J.S. 1989. *Radiography and Fluoroscopy, 1920 to present*. Radiographics. Vol. 9 no.6. pp. 1129-53

New Age: Digital Radiography

- In 1983, H.Kato *et al*. pave way for new techniques in digital radiograph at Fuji Film Co. of Japan.
- The basic principle of the system is the conversion of the x-ray energy pattern into digital signals utilizing *scanning laser stimulated luminescence* (SLSL).
- Eliminated the drawbacks of screen film radiography
  - Digital image processing
  - Digitization of the x-ray energy pattern by SLSL

http://www.ncbi.nlm.nih.gov/pubmed/6878707

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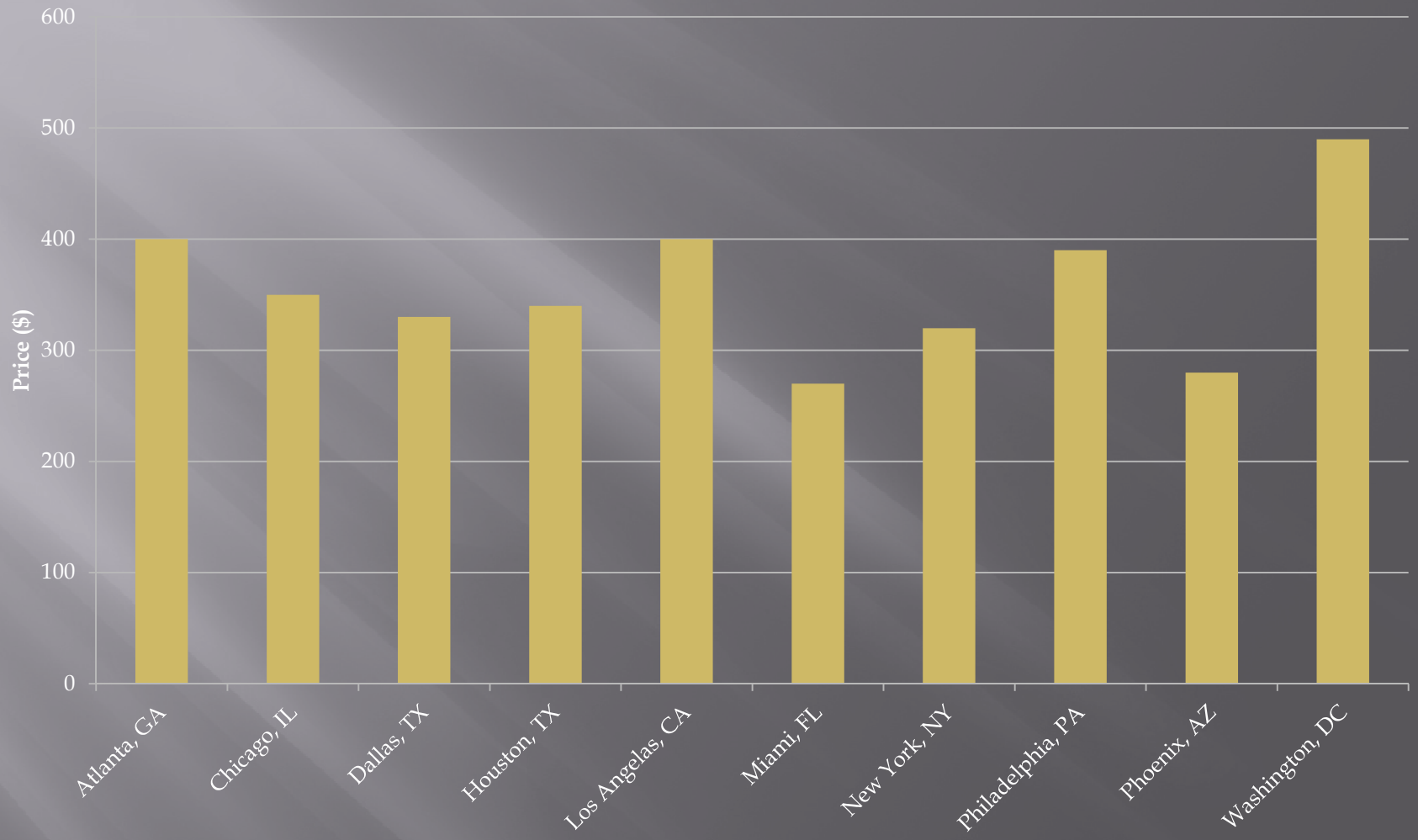
21st Century

- 2005 → Scientists at UNC at Chapel Hill and Xintek, Inc. Invent new x-ray tube using carbon nanotube cathode.
- Advantages:
  - Programmable electron and x-ray intensity
  - Ultra-fine focal spot
  - Longer lifetime

http://xintek.com/newspr/news/index.htm

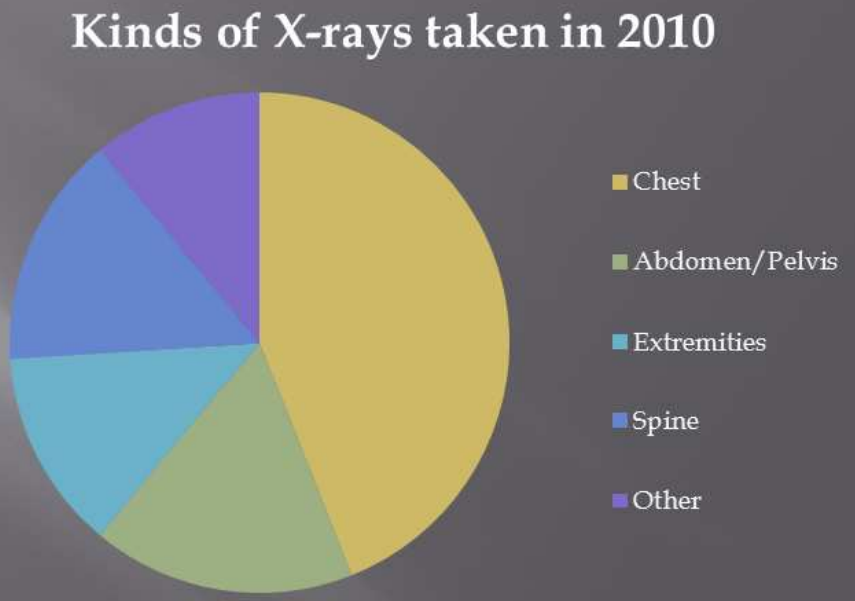
Average Cost per X-Ray Scan



"X-Ray Cost | NewChoiceHealth.com." *New Choice Health*. New Choice Health, Inc. Web. 30 Jan. 2012. <http://newchoicehealth.com/X-Ray-Cost>.

Average Cost for Specific Procedures

X-ray Procedure	Cost ($)
Finger	100
Skull	290
Eye	650
Body	1,100
Salivary Duct	1,250
Brain	1,450
Vein in Liver	6,200
Vein in Neck	18,100
Artery in Pelvis	20,300
Artery in Abdomen	30,800



"X-Ray Cost | NewChoiceHealth.com." *New Choice Health*. New Choice Health, Inc. Web. 30 Jan. 2012. <http://newchoicehealth.com/X-Ray-Cost>.

Prochaska, Gail. "IMV Reports General X-ray Procedures Growing at 5.5% per Year, as Number of Installed X-ray Units Declines." *PRWeb*. 11 Feb. 2011. Web. 30 Jan. 2012. <http://www.prweb.com/releases/2011/2/prweb8127064.htm>.

Cost of the X-Ray Machine

- The cost varies greatly depending on the part of the body the design is meant for.
- Small devices, such as oral X-rays can range from $3000-$8000
- Larger devices can cost anywhere from $12,000-$25,000 if they are film based. The cost to operate this machine and develop the film is around $400 per month.
- Digital radiology machines are $50,000-$150,000, the maintenance costs that come with digital X-ray machines can reach $10,000.

"Animal Insides - Digital Radiography Costs for the Veterinary Technician." *Animal Insides - Welcome to Animal Insides*. Animal Insides. Web. 30 Jan. 2012. <http://www.animalinsides.com/learn/the-digital-practice-integration/271-coststech.html>.

"Dexis Delivers a Return on Your Investment." *DEXIS: Digital X-ray for Dental Practitioners*. Dexis Digital Diagnostic Imaging. Web. 30 Jan. 2012. <http://www.dexis.com/index.php?option=content>.

X-Rays in the USA

- In 2010, it was estimated that 182.9 million X-rays were taken in US hospitals, and 67.6 million procedures were performed in other locations which perform radiology.
- That is a constant growth rate of 5.5% since 2005.

Prochaska, Gail. "IMV Reports General X-ray Procedures Growing at 5.5% per Year, as Number of Installed X-ray Units Declines." *PRWeb*. 11 Feb. 2011. Web. 30 Jan. 2012. <http://www.prweb.com/releases/2011/2/prweb8127064.htm>.