



UNIVERSITÀ DI PISA

Medical Physics: a historical perspective

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What is Medical Physics?

- ▶ Medical Physics emerged as a distinct scientific discipline early in the 20th century in response to the growing use of ionising radiation in diagnosis and treatment.
- ▶ The relation between Physics and Medicine has a much longer history [Keevil, 2012, Duck, 2014]



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- ▶ Hippocrates (circa 460-377 BC) developed a technique that was actually a form of thermal imaging.



Figure: Reproduction of Hippocratic thermography [Otsuka and Togawa, 1997]

- ▶ Samothrace (circa 200 AD): magnetic rings to treat arthritis
- ▶ Alhazen (circa 1000 AD) describes the physics of vision



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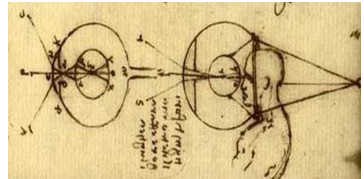
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- ▶ Leonardo da Vinci (1452-1519): first medical physicist, developed the principle of eye contact lenses.



- ▶ Heart as a pump (Vasalius (1514-64) and blood circulation Harvey (1578-1657)
- ▶ René Descartes (1596-1650) *Traité de l'Homme et de la formation du foetus*



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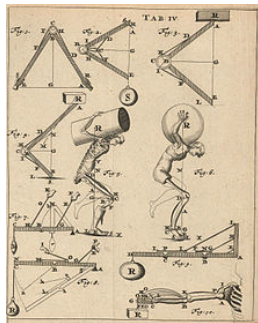
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- ▶ Iatrophysics was a school of medicine which, in the 17th century, attempted to explain physiological phenomena in mechanical terms.
- ▶ particles: Anton von Leeuwenhoeck and Robert Hooke studied the cells
- ▶ mechanics: Giovanni Borelli studied the human body mechanisms.
- ▶ fluids: bloods circulation, arteries, veins and vessels. (Marcello Malpighi).
- ▶ temperature: Galileo and first thermometer (Santorio Santorio ~1600).





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- ▶ Luigi Galvani (1737-98) and Alessandro Volta (1745-1827) demonstrated that electricity generates muscular activity
—→New discipline: electrophysiology.
- ▶ Research about magnetism: the diseases can be treated by application of magnets to correct the magnetic vital fluid distribution.
- ▶ Daniel Bernoulli (circa 1720) investigated the flow of fluids: understanding the relationship between the speed at which blood flows and its pressure. To investigate, Bernoulli experimented by puncturing the wall of a pipe with an open ended straw and noted that the height to which the fluid rose was related to the fluid's pressure in the pipe.



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- ▶ Thomas Young (1773-1829): physiology of vision, accommodation of the eye and astigmatism.
- ▶ Hermann von Helmholtz (1821-94): invented the ophthalmoscope and measured the speed of signals in nerves.
- ▶ Adolph Fick (1829-1901): published *Medizinische Physik* → stethoscope.
- ▶ Michael Faraday (1791-1867): lectures at St George's Hospital in London.



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- ▶ Wilhelm Röntgen (1845-1906) discovered X-rays, Nov 8, 1895.
- ▶ March 1896: radiography was used in the battlefield
- ▶ April 1896: medical imaging had its first scientific journal: Archives of Clinical Skiagraphy.
- ▶ July 1986: therapeutic use of x-rays to treat stomach cancer.
- ▶ 1897: world's first radiological society in London
- ▶ 1898: Röntgen Society established a Committee on X-rays Injuries.
- ▶ →New discipline: Radiology





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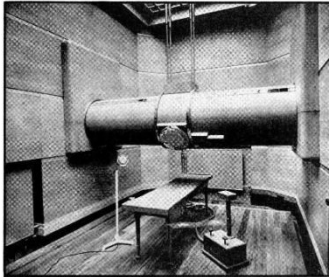


Figure: Megavolt x-ray tube -
St Bartholomew Hospital 1937

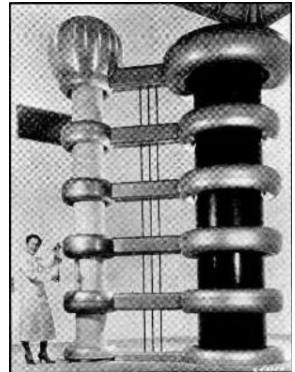


Figure: Megavolt x-ray machine -
Los Angeles Institute of
Radiology 1938



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- ▶ Henry Becquerel (1852-1908) discovered natural radioactivity (1896) and Pierre and Marie Curie (1859-1906, 1867-1934) discovered radium and radioactive isotopes → brachytherapy and radium teletherapy.
- ▶ Frederic Joliot and Irene Curie in 1934 produced the first artificial radionuclide (^{30}P) → George de Hevesy reported the incorporation of (^{30}P) phosphate in bone (birth of radiotracers).
- ▶ Ernest Lawrence developed the cyclotron (~1930) and Enrico Fermi (1942) demonstrated the first self-sustained nuclear chain reaction → stable production of radioisotopes
- ▶ Carl D. Anderson discovered the positron (1932) and E. Fermi explained the β^+ decay → β^+ radiotracers
- ▶ → New discipline: Nuclear Medicine



Nuclear Medicine

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- ▶ First medicine radioisotopes: ^{131}I . It was used for thyroid investigation and it was produced at the Berkley cyclotron (1939)
- ▶ First medical cyclotron: Washington University, St. Louis (1941)
- ▶ Benedict Cassen invented the rectilinear scanner (1951) [Blahd, 2000]
- ▶ β^+ emitter used to trace red blood cells (1951)
→ scintillation material replace Geiger counters
- ▶ Hal Anger (11920-2005) invented the gamma camera (1958)
→ better investigation of the distribution of radiotracers.



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- ▶ Ultrasound Imaging
- ▶ Computerized Tomography
- ▶ Single Photon Emission Computed Tomography (SPECT)
- ▶ Positron Emission Tomography (PET)
- ▶ Nuclear Magnetic Resonance (superconducting magnets)
—→non invasive technique for morphological and functional imaging
- ▶ Lasers
—→optical scalpel
—→eye surgery
—→dermatology



List of Nobel Prizes

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Physics

- ▶ 1901 Röntgen
- ▶ 1903 Bequerel, Pierre and Marie Curie
- ▶ 1915 Bragg
- ▶ 1939 Lawrence
- ▶ 1951 Cockroft-Walton
- ▶ 1952 Block and Purcell

Physiology and Medicine

- ▶ 1962 Crick: DNA Discovery
- ▶ 1963 Hodgkin-Huxley: Nerve pulses
- ▶ 1969 Dellbruck; replication of viruses
- ▶ 1979 Cornack-Hounsfield: CT development
- ▶ 2003 Mansfield: MRI development



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Physics has made a lot of contribution to Medicine

- ▶ New disciplines
- ▶ Measurements
- ▶ Diagnosis and treatment
- ▶ Medical Physicist

Let's see what comes next!



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