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ULTRASOUND AND COMPUTED TOMOGRAPHY: SPIN-OFFS OF THE WORLD WARS*

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Important losses to the ships of the allied troops by the attacks of the German submarines during World War I led researchers to find specific detecting devices as a means of defence.
In 1880 Pierre Curie and his brother, discovered the production of ultrasound waves. Langevin, their student, applied this invention to the localisation of boats. At the end of WW I, research and results ended up being forgotten, but gained attention again with the sonar when WW II loomed on the horizon.
At the end of the war, a former military medical doctor, G. Ludwig (US Navy), tried to localize gallstones with a left-over sonar apparatus. This definitely led to firm conclusions. Other researchers in several countries contributed to refining this new imaging technique which is nowadays widely applied.
During WWII, the American and British army developed considerable research in the field of the calculator (computer) to speed up deciphering the secret codes.
Coupling the principles of tomography discovered during WWI with the computing capability of the calculators developed during WWII, computerized axial tomography could be obtained. This new technology, which is used daily, probably is one of the greatest acquisitions of the 20th century in the field of medical imaging.

Key-word: Radiology and radiologists, history.

In the sixth century B.C. the Greek philosopher Herakleitos of Ephese (570-480) stated that war laid the foundation of everything. Recent examples have demonstrated this statement in the field of medical imaging: they were supplied throughout the history of the discovery of ultrasound and computed tomography.

From bat to medical ultrasound

In the animal world, whales, dolphins, and bats have been moving around for thousands of years using ultrasound. It is not until 1794 that man discovered the existence of this phenomenon. The Italian naturalist Lazzaro Spallanzani (1729 - 1799) carefully studied bats and discovered that they didn't use their visual capacity to move around but rather their acoustic capacity. This capability enables them to avoid obstacles in absolute darkness (1).

It took another century before man could generate ultrasound. In 1880, the brothers Pierre (1859-1906) and Jacques Curie (1855-1941), who analyzed the piezoelectric qualities of crystals, discovered how to produce ultrasound (2). The first practical application – according to Pallardy et al. – is ascribed to Sir F. Galton (1822-1911) who used an ultrasonic whistle to call his dog (3).

The sinking of the Titanic in 1912 and the great loss of ships torpedoed by German submarines in World War 1, led to the perfection of specific targeting and navigational technology.

P. Langevin (1872-1946), P. Curie's student, recalled his mentor's discovery and used the technology to locate a submarine that was sank (April 23-1916) in shallow water (4).

After the war, the research was put aside and a little forgotten. It was again resumed at the event of World War 2. These circumstances gave rise to the Sonar (Sound Navigation and Ranging) that was frequently used during the second World War.

However, the use of low energy ultrasound already existed before the war in industrial applications. The Russian S. Sokolov (1897-1971) is regarded as the father of industrial ultrasound. An attempt to medical application was exercised in 1942 by the Austrian neuropsychiatrist K. Dussik (1908-), who was assisted by his brother, the physicist (5).

Using a continuous ultrasonic emitter, they attempted to interpret the bizarre images from the patient's brain. The resulting images led to an enormously controversial interpretation. This method was abandoned when it became evident that the research through bony structures (the skull) was a contraindication for ultrasonic examinations.

Due to the war, the research field of wave productions and their echoes rapidly expanded. The ability to generate pulsed echoes (reflectoscope) was perfected in the United States by F. A. Firestone (1898-1986) and led to the appearance of Radar, which also played an important part in the second World War (6).

At the end of the war the medical application of this field progressed when several medical teams started using the leftover military materials such as Sonar and Radar. Even though they didn't monopolize the research, one has to admit that the Americans played an important role in it (Fig. 1). It is generally assumed that G. Ludwig, internist and former US navy military physician, and his assistant F. Struthers, a US Navy engineer, were the first who could precisely detected bile stones they had put in beefsteaks (7).

J. Wild (1914-), an English surgeon who immigrated to the US and his assistant D. Neal, a US Navy engineer, are the first to realize a coherent medical iconography at the marine base Chamberlain using a surgical device as test material (8) (Fig. 2). However, the most prominent figure appears to be the American radiologist D. Howry (1920-1969). His team created the first live ultrasonic image using declassified military material taken from the gun turret of a B29 bomber (Fig. 3).

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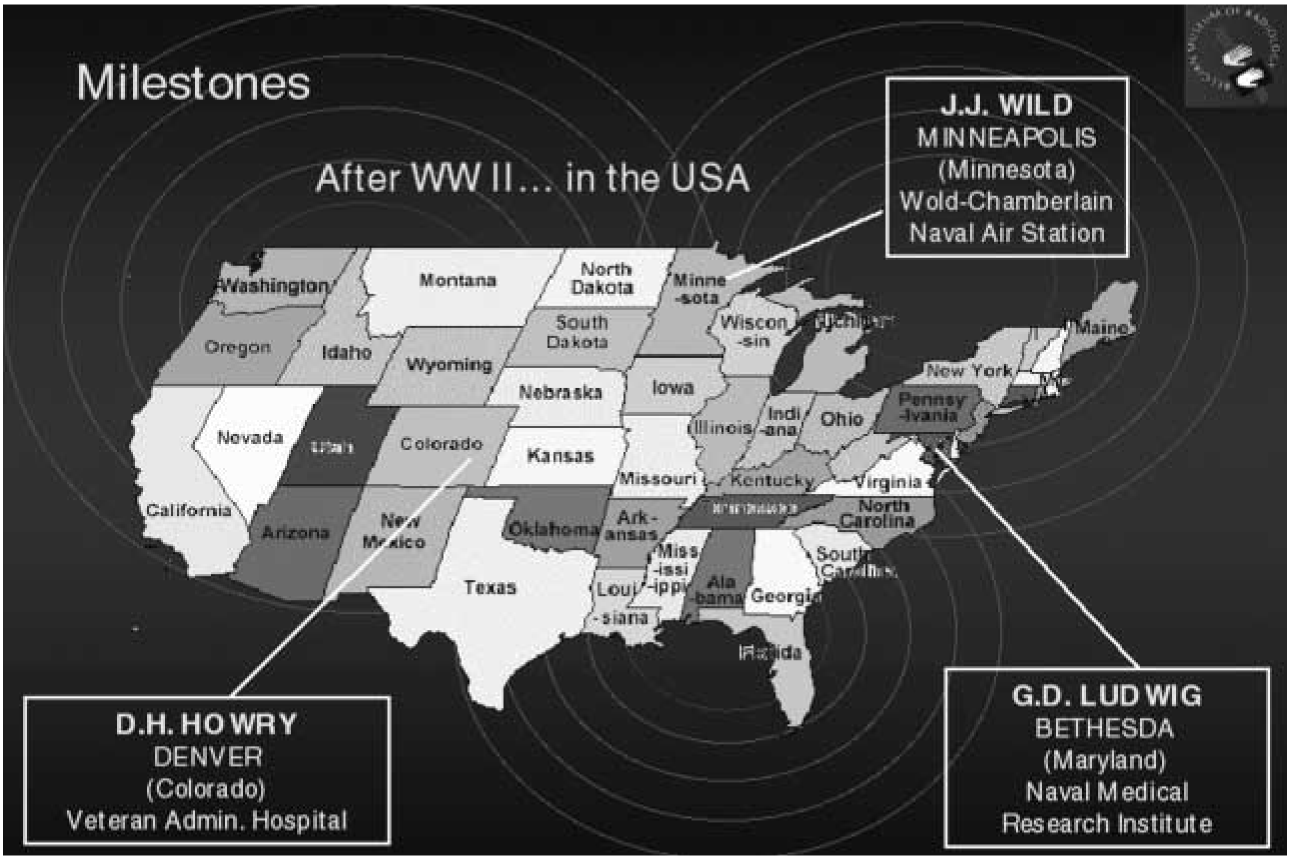
Milestones
After WW II… in the USA
J.J. WILD
MINNEAPOLIS
(Minnesota)
Wold-Chamberlain
Naval Air Station
D.H. HOWRY
DENVER
(Colorado)
Veteran Admin. Hospital
G.D. LUDWIG
BETHESDA
(Maryland)
Naval Medical
Research Institute
Washington
Montana
North Dakota
Minne -sota
Oregon
Idaho
Wyoming
South Dakota
Wiscon -sin
Maine
New York
Nebraska
Iowa
Pennsy -lvania
Nevada
Colorado
Kansas
Illinois
Indi -ana
Ohio
California
Missouri
Kentucky
Virginia
Arizona
New Mexico
Oklahoma
Ark- ansas
North Carolina
Texas
Miss -issi -ippi
Ala -bama
Georgi
Loui -siana
South

Fig. 1


Milestones
1949
US device
Brain
J. Wild and his assistant D. Neal, a US engineer are the first to detect malignancies in living tissues with a device designed by de US Navy for training pilots in the use of radar.
(uni – directional A – mode US)
WILD JJ and NEAL D "Use of high frequency ultrasonic waves for detection changes of texture in living tissue"
Lancet 260 : 655 - 657, 1951

Fig. 2

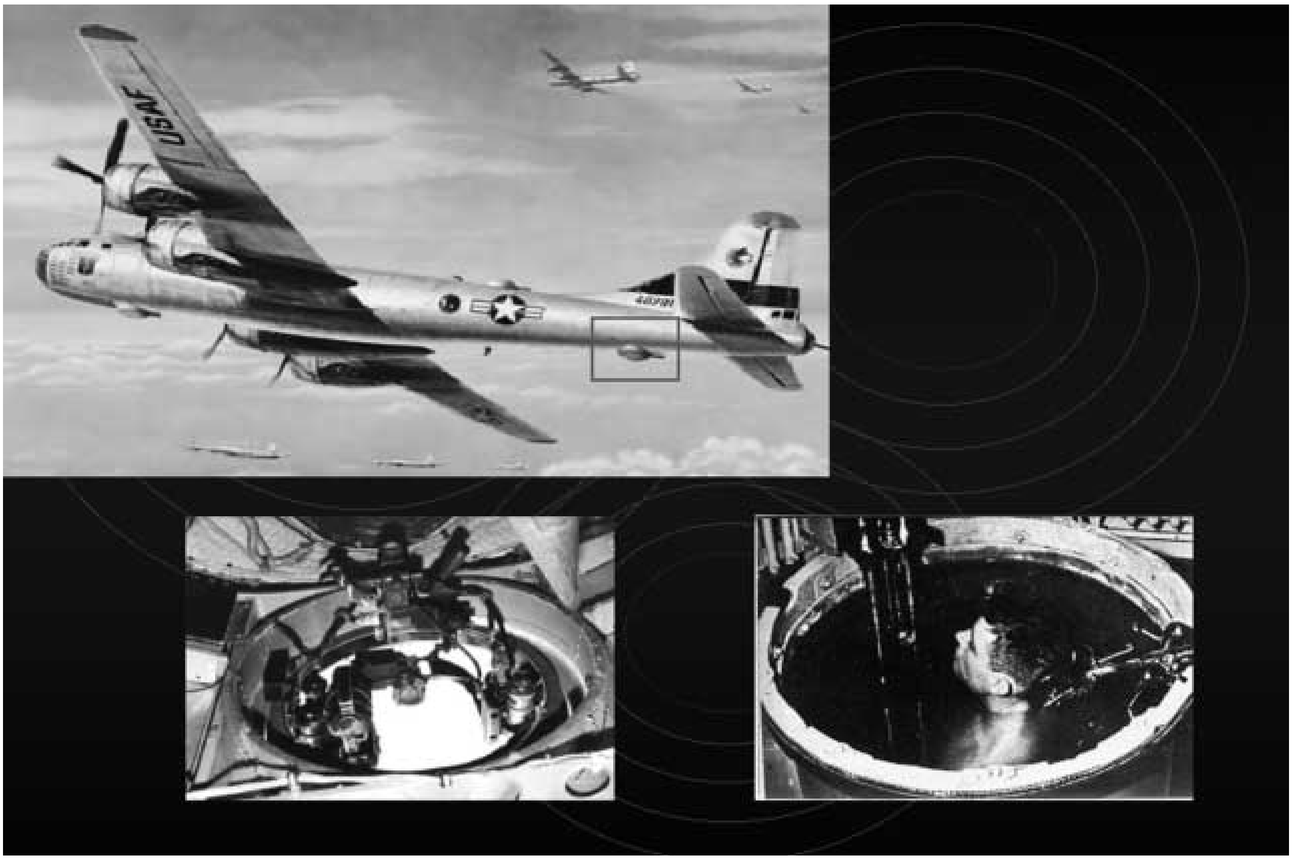
USAF

Fig. 3

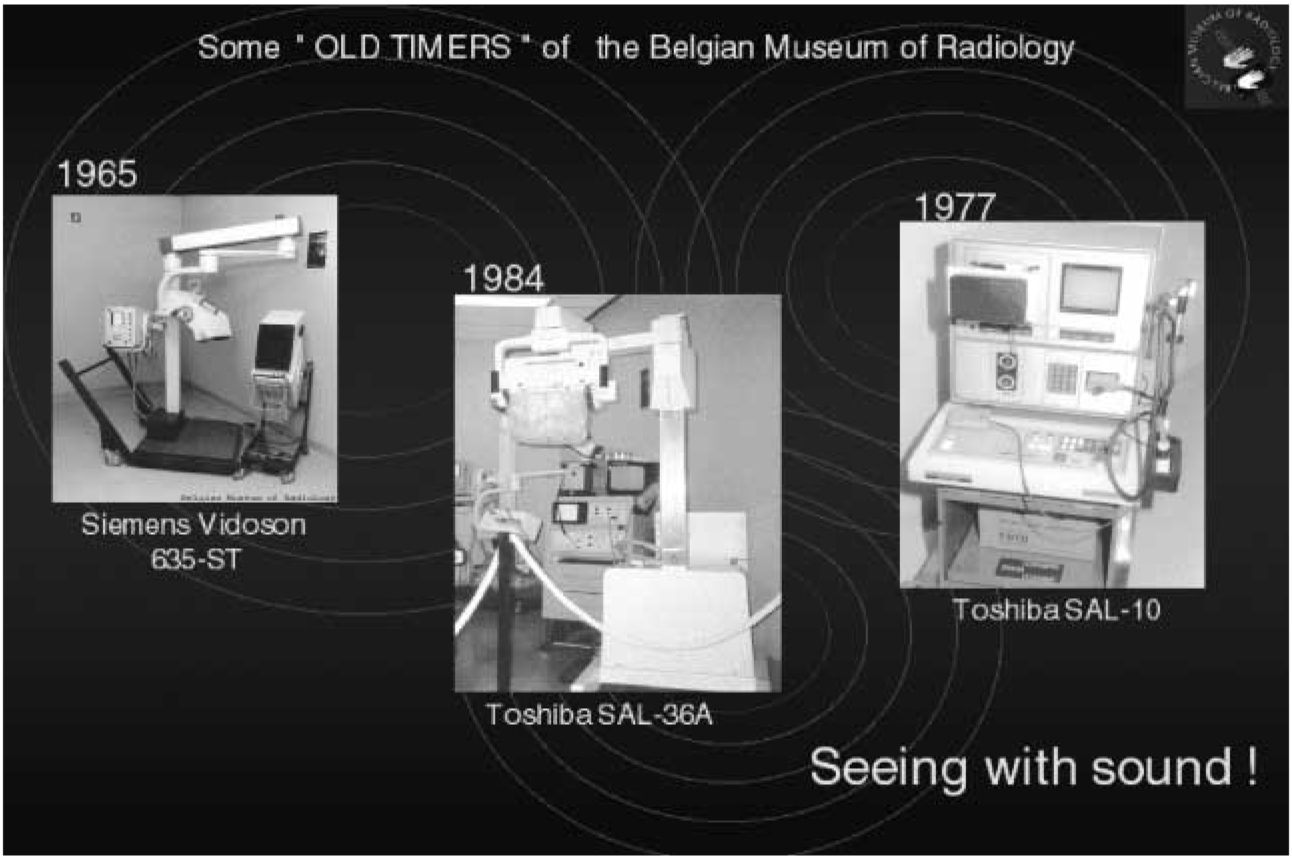
Some " OLD TIMERS " of the Belgian Museum of Radiology
1965
Siemens Vidoson
635-ST
1984
Toshiba SAL-36A
1977
Toshiba SAL-10
Seeing with sound !

Fig. 4

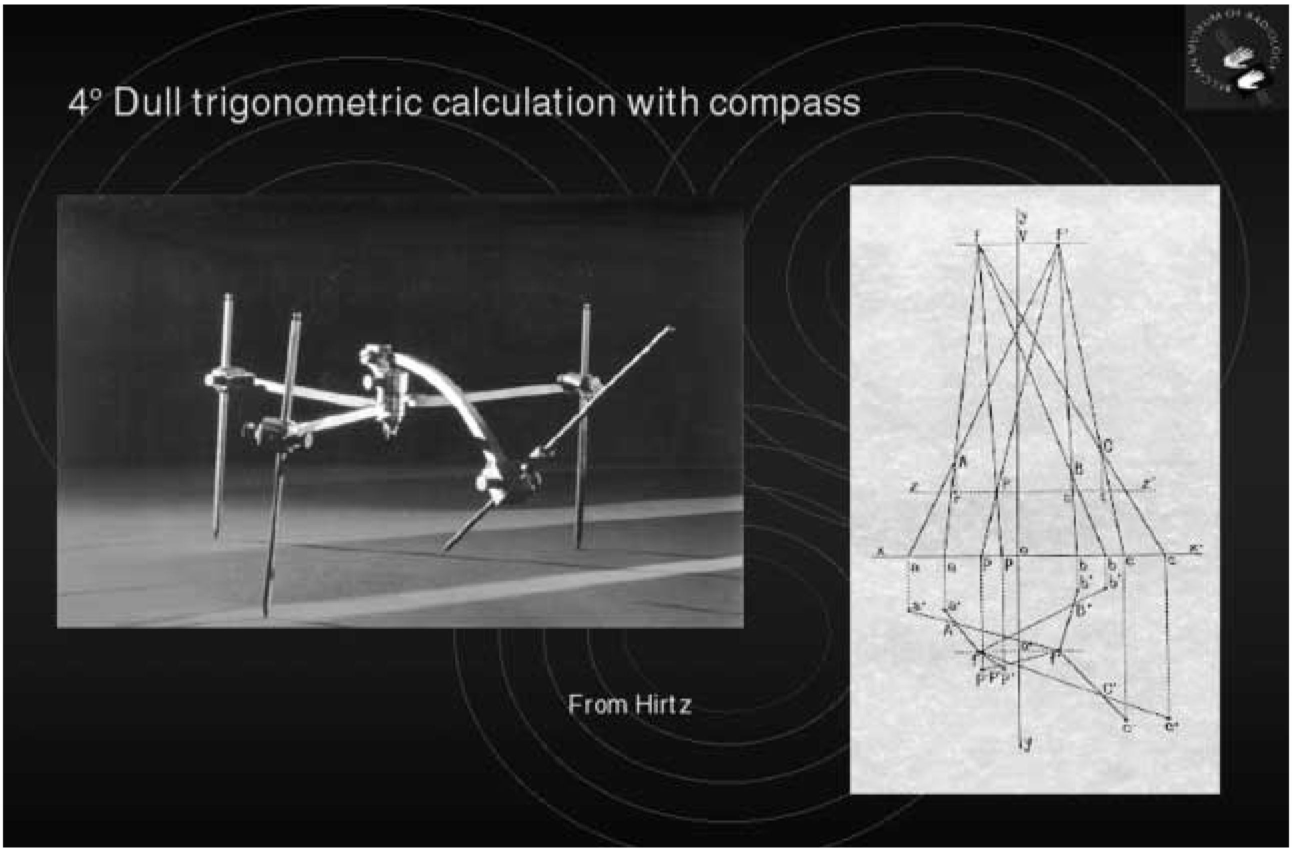

Fig. 5

The patient was seated on an old dentist chair and was submerged in the water-containing gun turret from the neck down (9).

The necessity of aquatic submergence seriously diminished the application possibilities, for example with patients who had undergone surgery. The search for procedures, which are too numerous to name, continued to avoid the submergence in water and to produce more centered and focused ultrasonic waves.

A decisive step was taken in 1958 with the introduction of contact ultrasound by the Scottish gynecologist I. Donald (1910-1987). Instead of aquatic submergence, he used a viscous gel, a substance still in use today (10). This procedure was immediately applied to the medical world, especially gynecology and obstetrics.

Other researchers from various countries (Fig. 4) refined this imaging technique in such a manner that is still being used today.

The old dream of visualizing medical ultrasounds and their echoes was finally realized. Until that time only the one listening to the echoes could form an image from them in his own brain.

For about forty years now, the physician has been able to visualize ultrasounds for medical purposes.

The computer tomography or the quest for the third dimension

The history of the development of the CT-scan is shorter but not less interesting.

It resulted from the desire to possess a three-dimensional medical imaging technique. Röntgen's (1845-1923) discovery in 1895 (Nobel Price for physics in 1901) enabled a sort of autopsy of the living. But the images captured on film only represented a two-dimensional image of a three-dimensional anatomical structure (11).

Because it was difficult to determine the depth and the precise location of organs or metal objects (e.g. bullets, metallic splinters), the French dermatologist A. Bocage (1892-1953), drafted during World War 1, came up with a real solution. By means of a stereographic radiographic procedure using complex trigonometric calculations, it was possible to determine the exact depth of a metal object in the patient's body (Fig. 5). To avoid these strenuous calculations he developed a radiographic technique that made longitudinal sections of the body possible in order to choose a research plan.

Even though the discovery was made during the first World War, Bocage didn't submit his patent until 1921. It was registered in 1922 (12) (Fig. 6).

In this period several researchers, unaware of each other's discoveries, independently developed similar techniques. Among these researchers we distinguish a few names: G. Grossmann (1878-1957) from Germany (13), A. Vallebona (1899-1987) from Italy (14), B.G. Ziedses des Plantes (1902-1993) from the Netherlands (15). Towards the sixties, this research gave rise to prominent tomographs such as the Polytome from Philips-Massiot, made in France in 1947 and its counterpart the Stratomatic, designed in 1968 by a Belgian team from the Antwerp company De Man. The latter was later taken over by the French Compagnie Générale de Radiologie (C.G.R.) that in its turn merged with the American General Electrics (G.E.)

Until present time the military used encrypted codes to transmit messages. During the second World War the British and American milita-

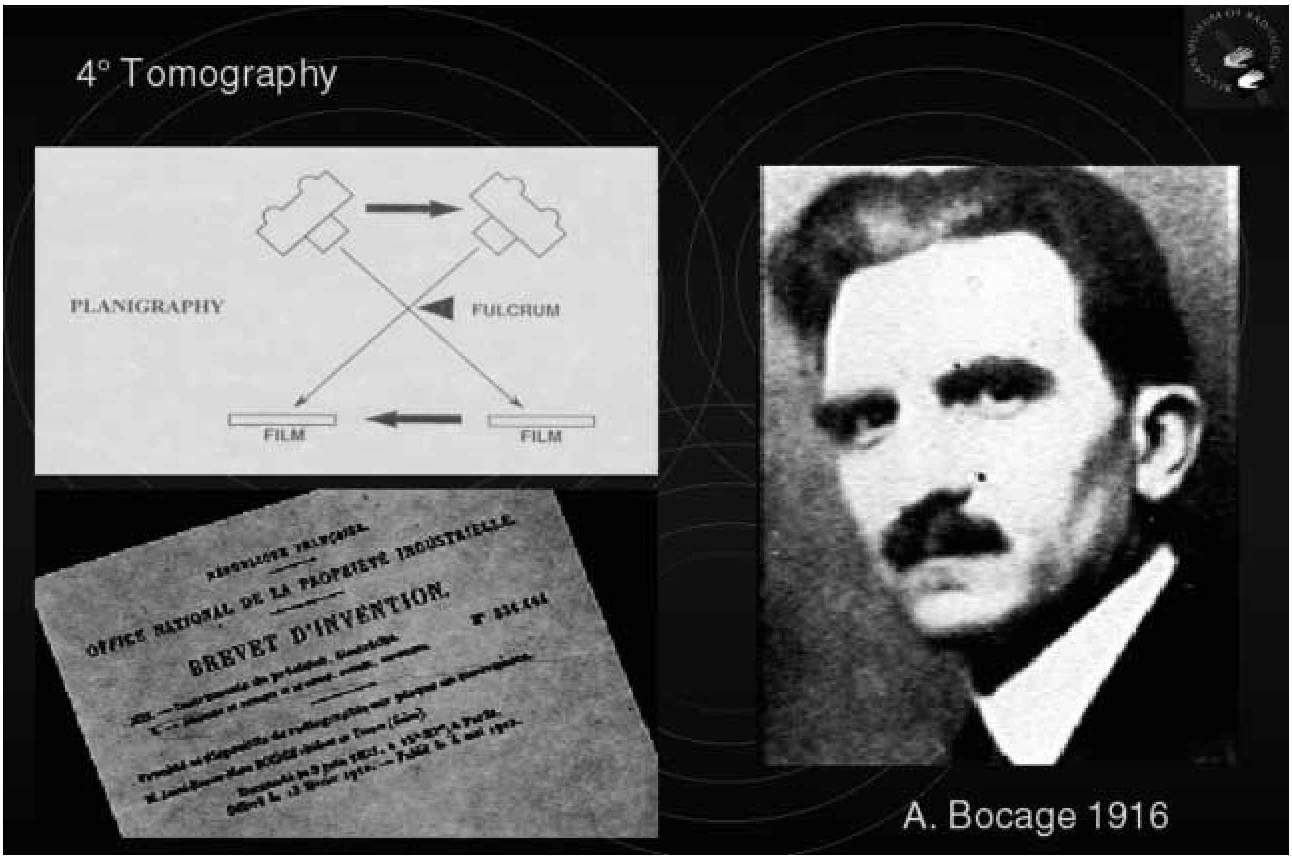
4° Tomography
PLANIGRAPHY
FULCRUM
FILM
FILM
OFFICE NATIONAL DE LA PROPRIÉTÉ INDUSTRIELLE
BREVET D'INVENTION
A. Bocage 1916

Fig. 6


EMI scanner 1972
Belgian Museum of Radiology
G. H. Hounsfield
Radar expert for the Royal Air Force during WW II.
In the 1950s he began developing computer and X-ray technology.
1979 Nobel prize with A. Cormack who independently published
the mathematical basis of CAT in 1963-64.

Fig. 7

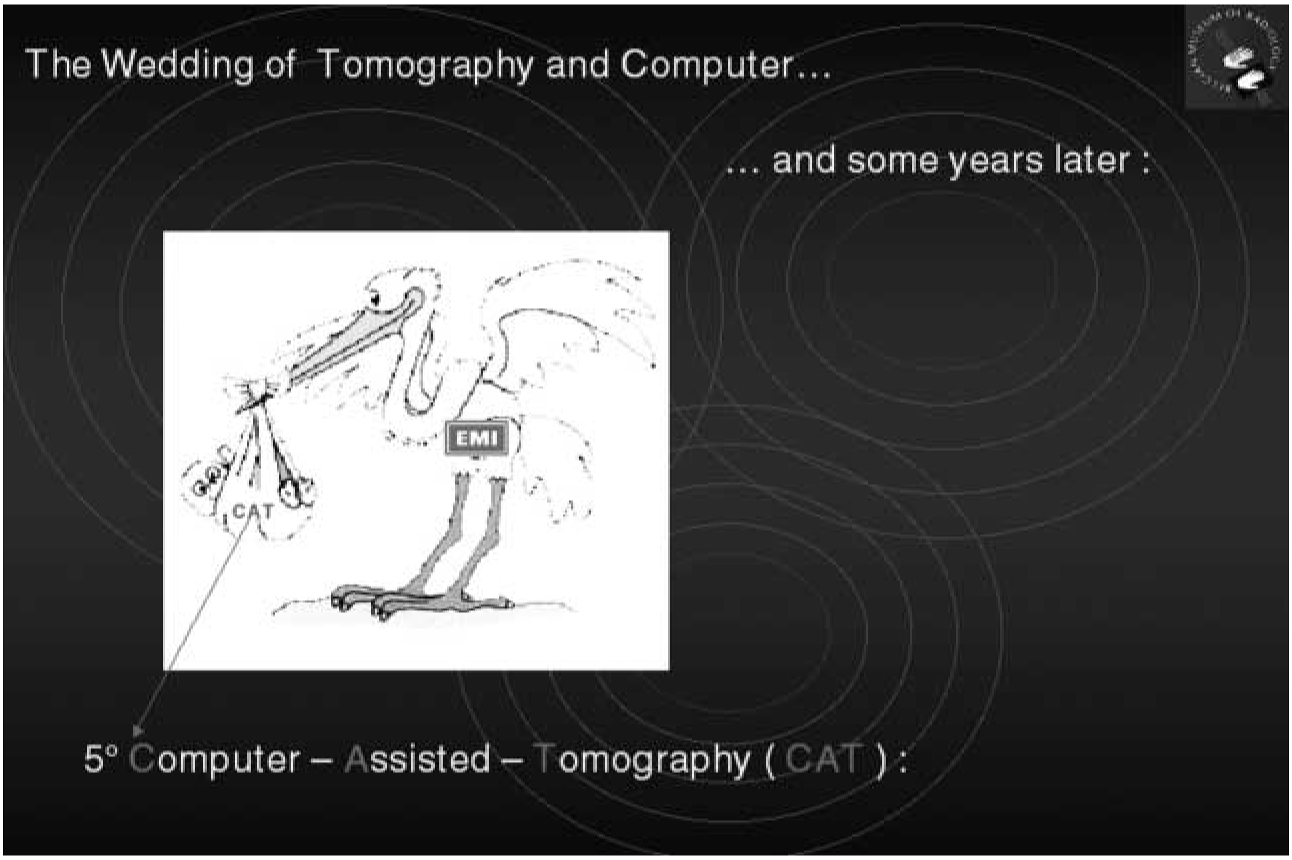

Fig. 8

ry performed important research in the field of computers in order to faster decrypt German and Japanese encoded communications.

As an anecdote, we mention the important contribution made by brilliant linguists, mathematicians, decryption engineers (code breakers)... but also credit chess masters and the American Navaho Indians. In the spring of 1940 in England, these delicate research projects led to little esoteric though efficient mechanical devices such as "Bombes" that were able to crack the famous German "Enigma" and "Lorenz" codes. The first electronic decoding machine (Colossus) appeared in 1943.

The American military teams stayed busy as well. Research teams led by John William Mauchly (1907-1980) created the first electronic computer in 1945: the ENIAC (Electronic Numerical Integrator and Computer). The first civilian application of this device appeared in 1951 under the commercial name UNIVAC (16).

Thanks to these computers and the development of electronics, several scientists, formerly active in military projects, searched for a better solution in their quest for the third dimension.

The honor is bestowed upon A. Cormack (1924-) who was a professor at Tufts University (Massachusetts). Using computers, he constructed a three-dimensional image with radiographic recordings from experimental manikins. His first publication in 1963 barely generated any interest in the medical community (17). G. Hounsfield (1919-), an engineer at the English EMI (Electro-Musical Instruments) was the first to apply in 1973 computer tomography (18) to medicine.

On a side note it is mentioned that the same company made a fortune through the record sales of the Beatles. EMI invested its profits in bold research projects which led to commercialization of a revolutionary computer tomography device: the Emiscanner (Fig. 7).

The scientific world was not mistaken when it awarded the Nobel Price Medicine (1979) to Hounsfield and Cormack.

The epic story continued with countless improvements in the techniques (19).

Conventional tomography, discovered during World War 1, led to the birth of computed tomography, one of the most important acquisitions to the medical world of the 20th century (Fig. 8).

Conclusion

War has often contributed to a number of technical revolutions. This brief historic overview demonstrates the wars involvement in the development of medical imaging.

Ultrasound and CT, frequently used in medical diagnosis and imaging, are clear evidence of peaceful developments of techniques that were originally designed for military purposes.

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