

Medical Imaging

Past, Present... And Coming



Peter Scott

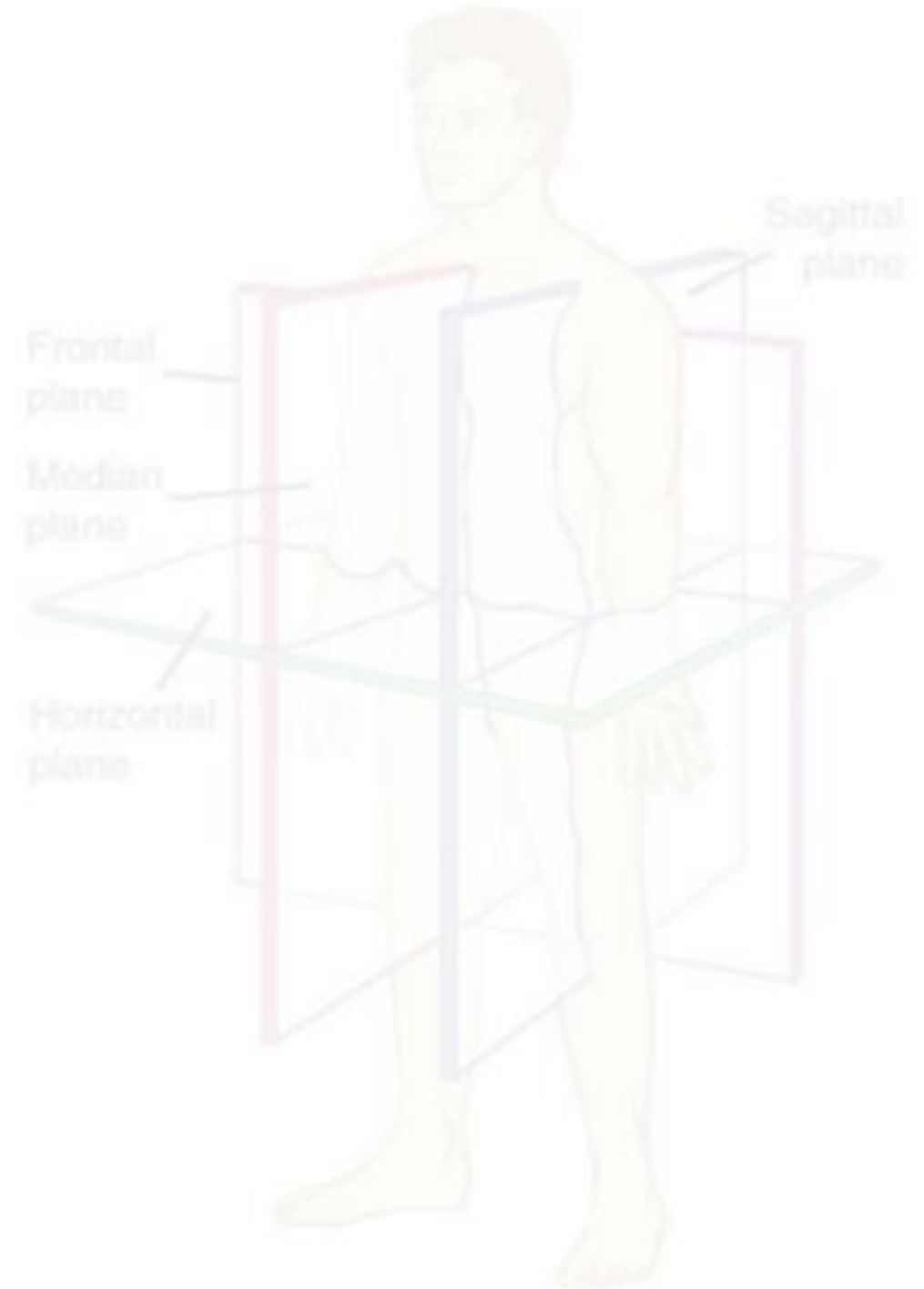
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704 Crestwood Dr (Prov. Park)

We'll take a look at:

- X-Ray and CT
- Visible light images
- Nuclear imaging
- MRI
- Ultrasound
- Image quackery
- On the way



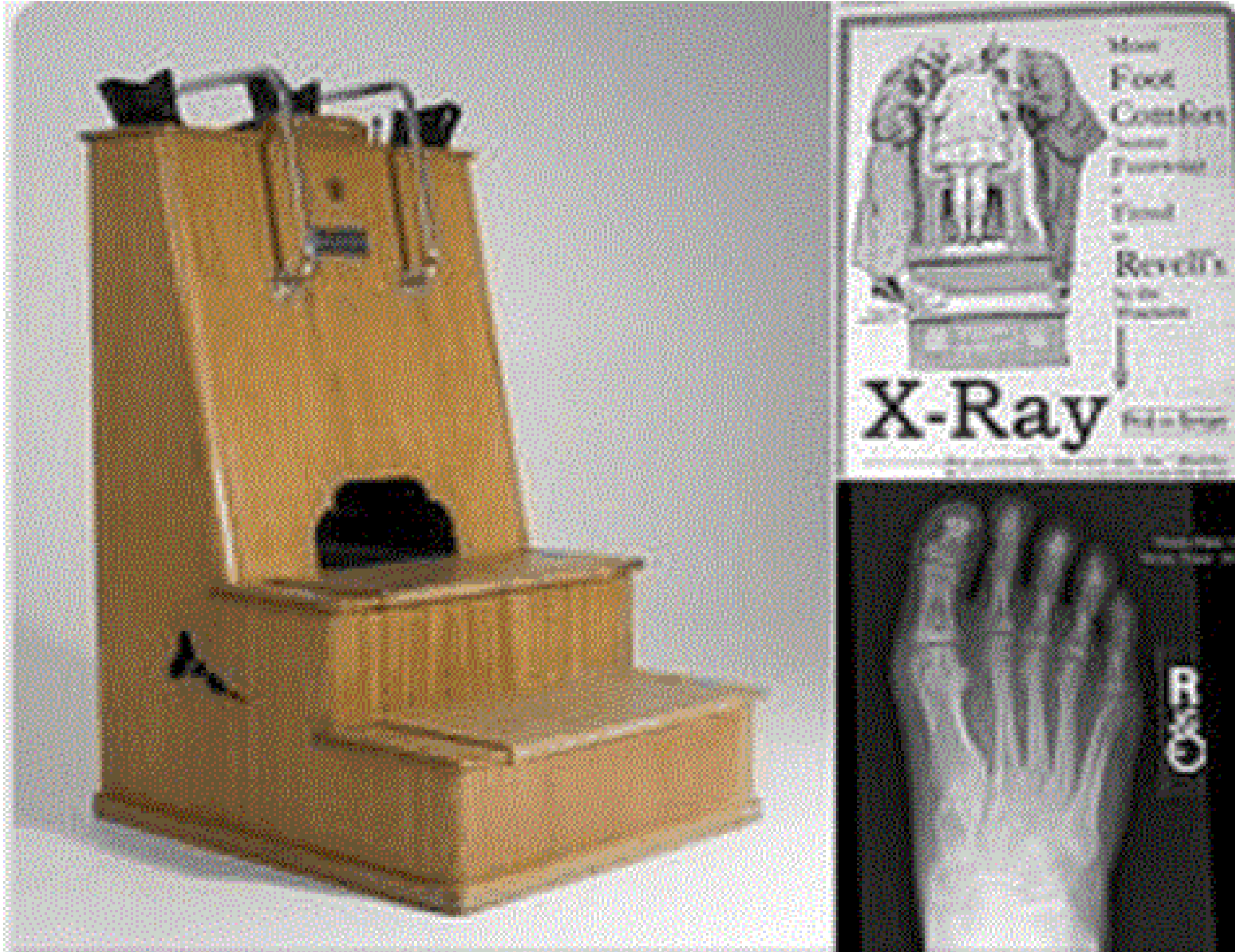
X-ray



Wilhelm
Röntgen
(1845–1923)



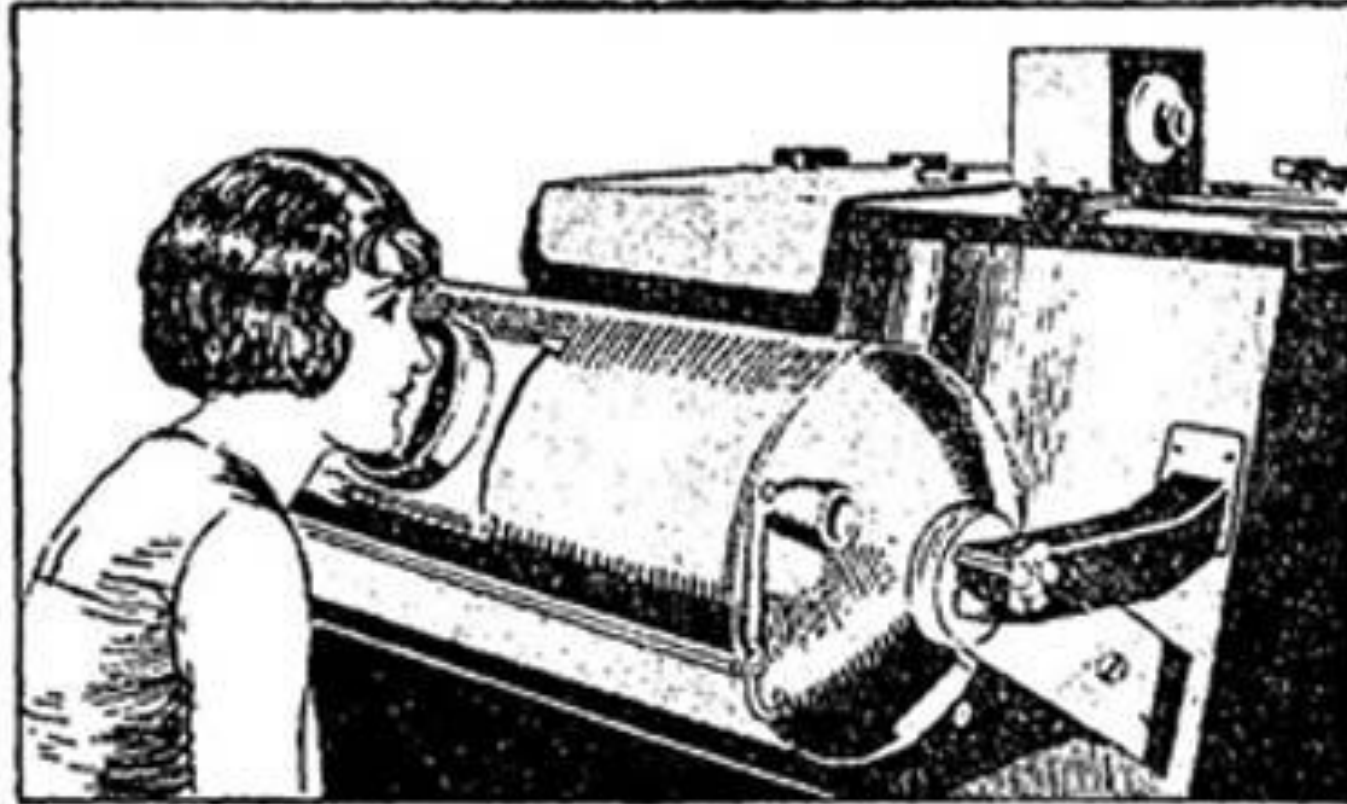
X-ray



X-ray

*Painless and harmless...
guaranteed to be permanent*

Hair Removed Permanently



Patient receiving treatment on the cheek. No pain or sensation of any kind.

The **INFALLIBLE** method successfully used for 16 years by Dr. Albert C. Geyser, late Professor of Electrical Therapeutics at Cornell University and endorsed by many leading physicians.

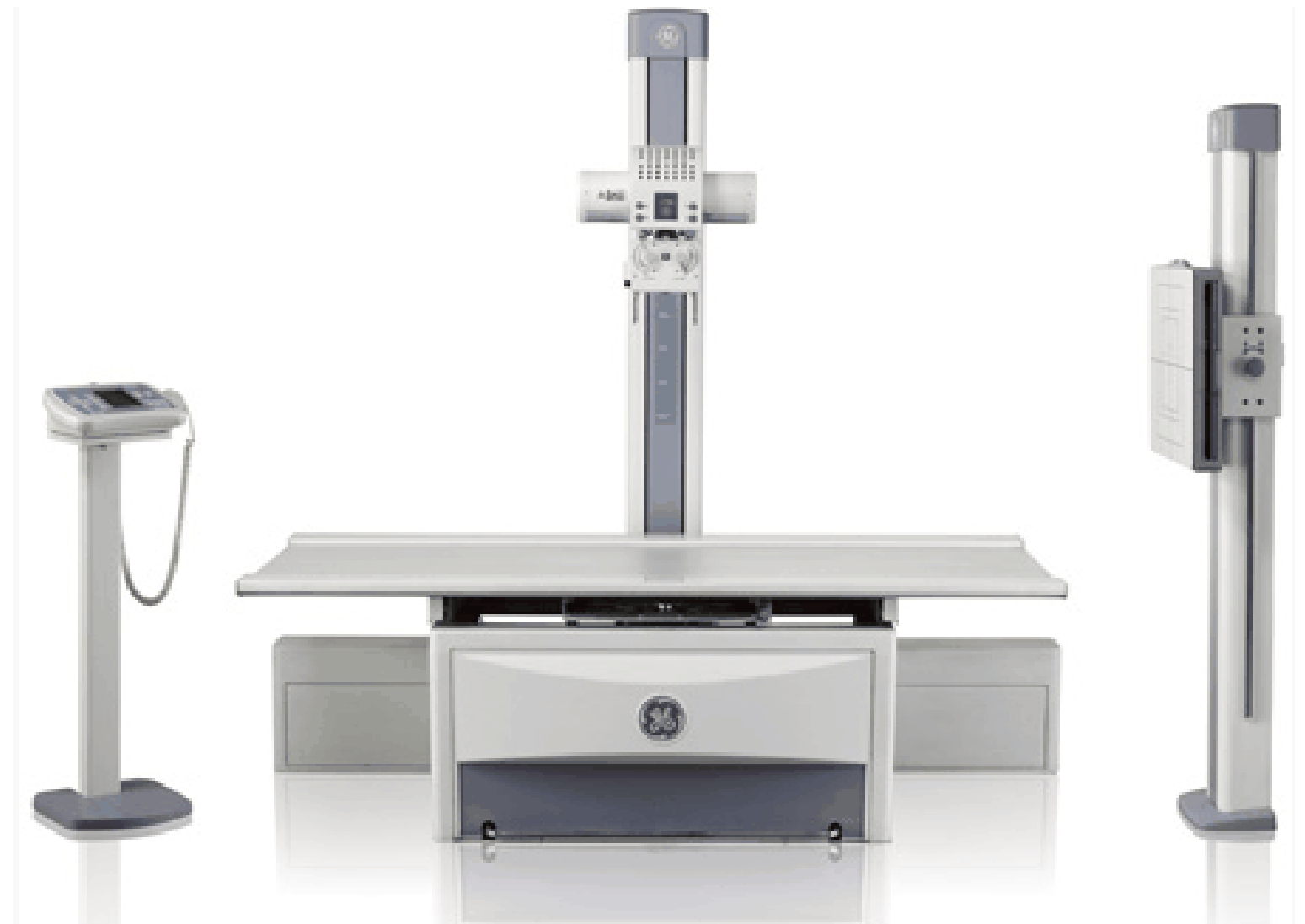
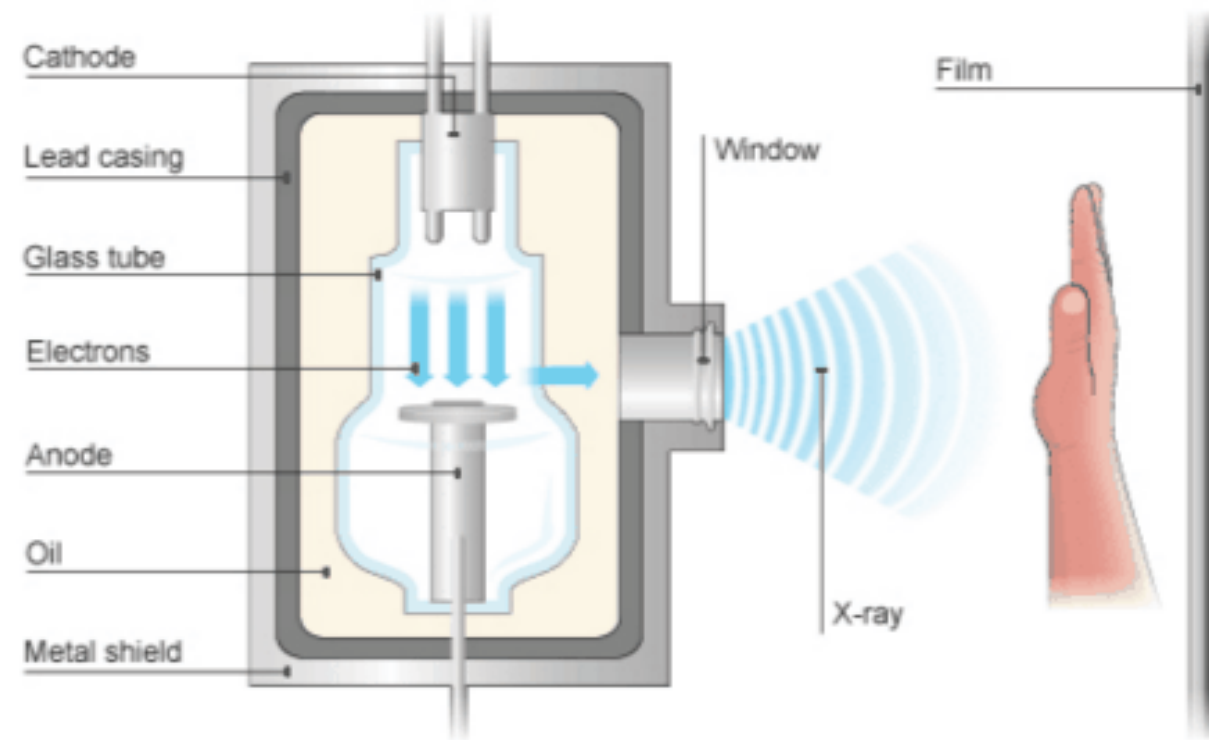
*No Needle, No Wax, No Chemical
Painless and Harmless—Guaranteed to be Permanent*

Tricho System

Central 1010 State-Lake Bldg. 190 N. State St. Free
5013 Booklet



x-ray

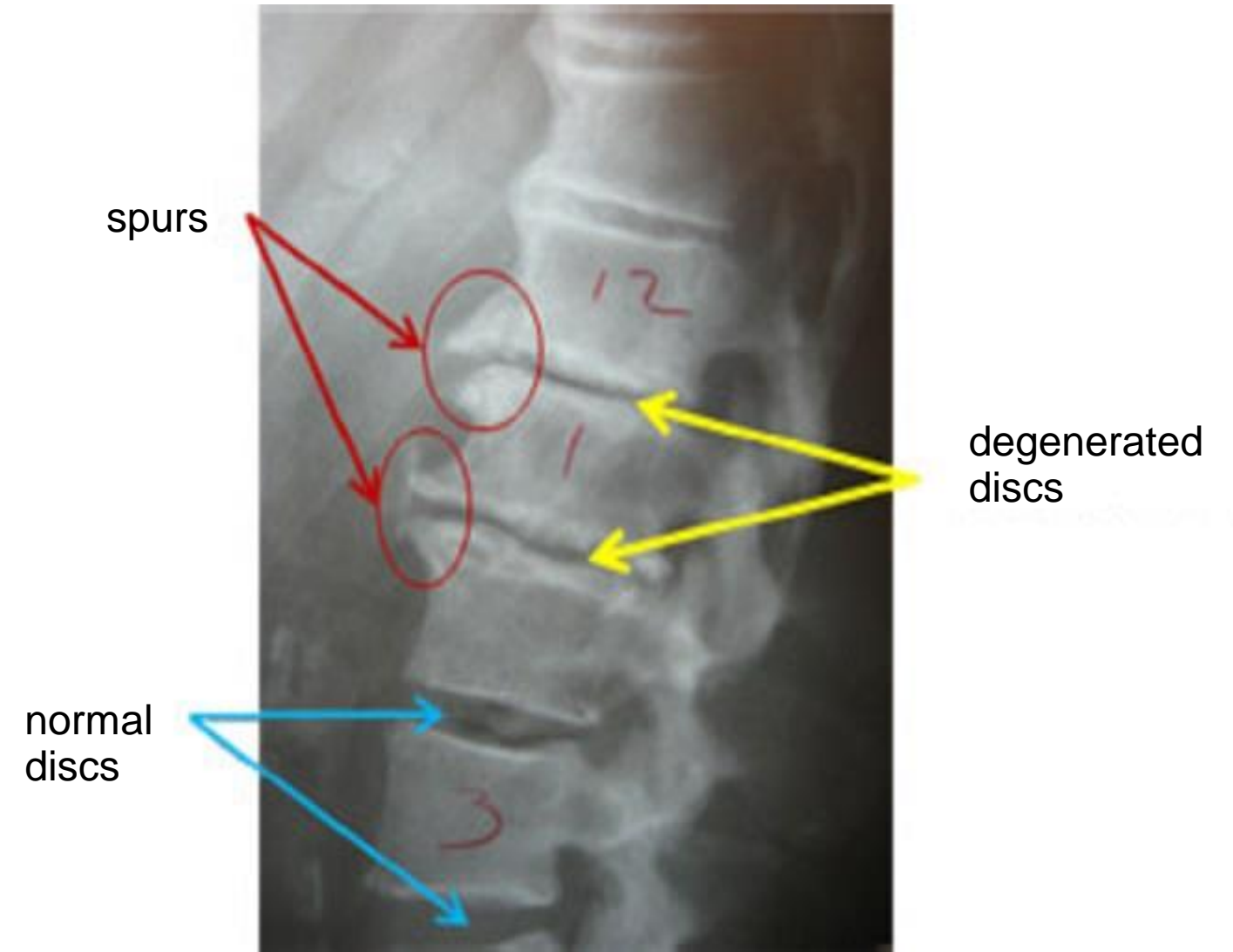


Philips X- Ray | LH A302

X-ray orthopedic

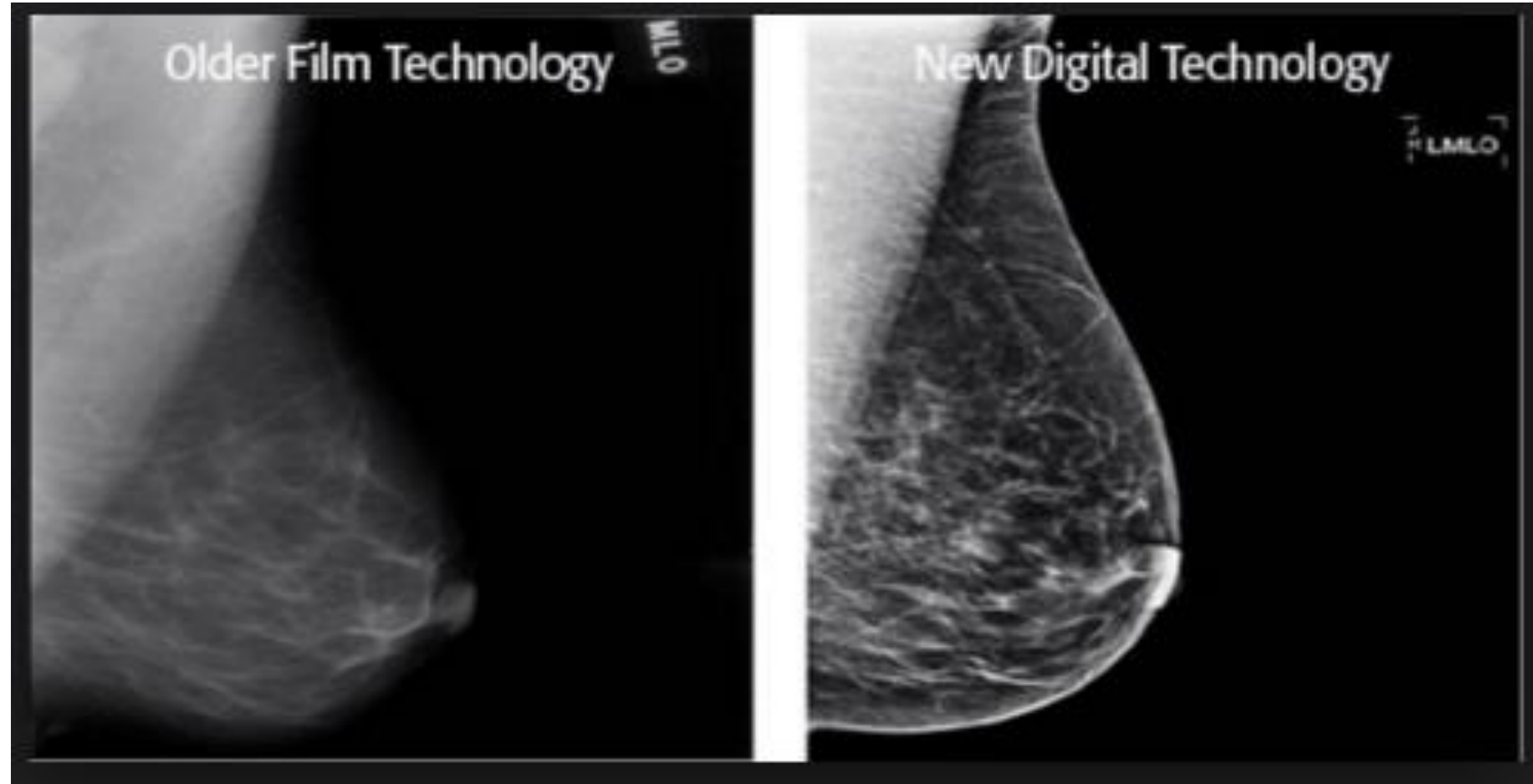
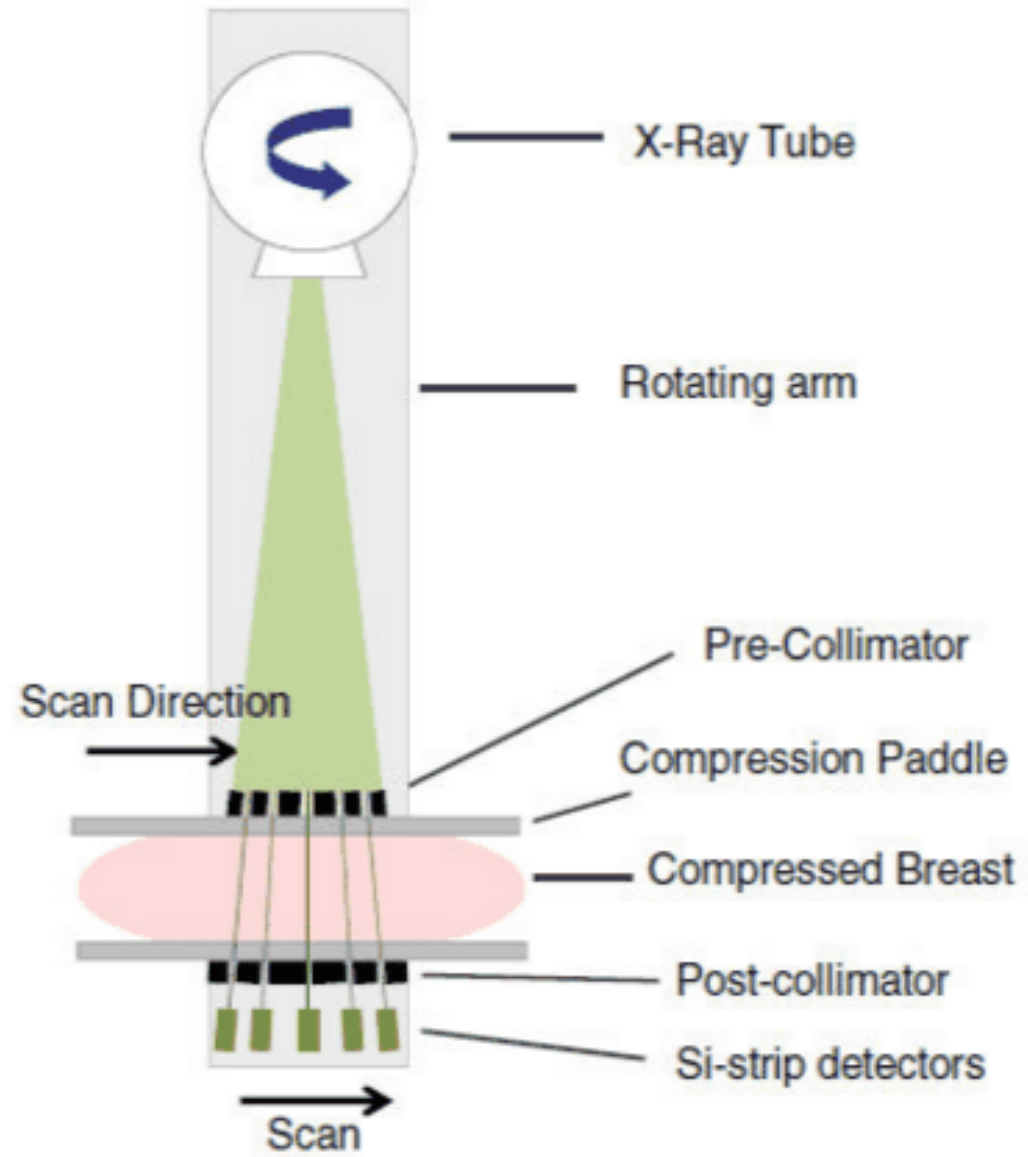


Knee replacement

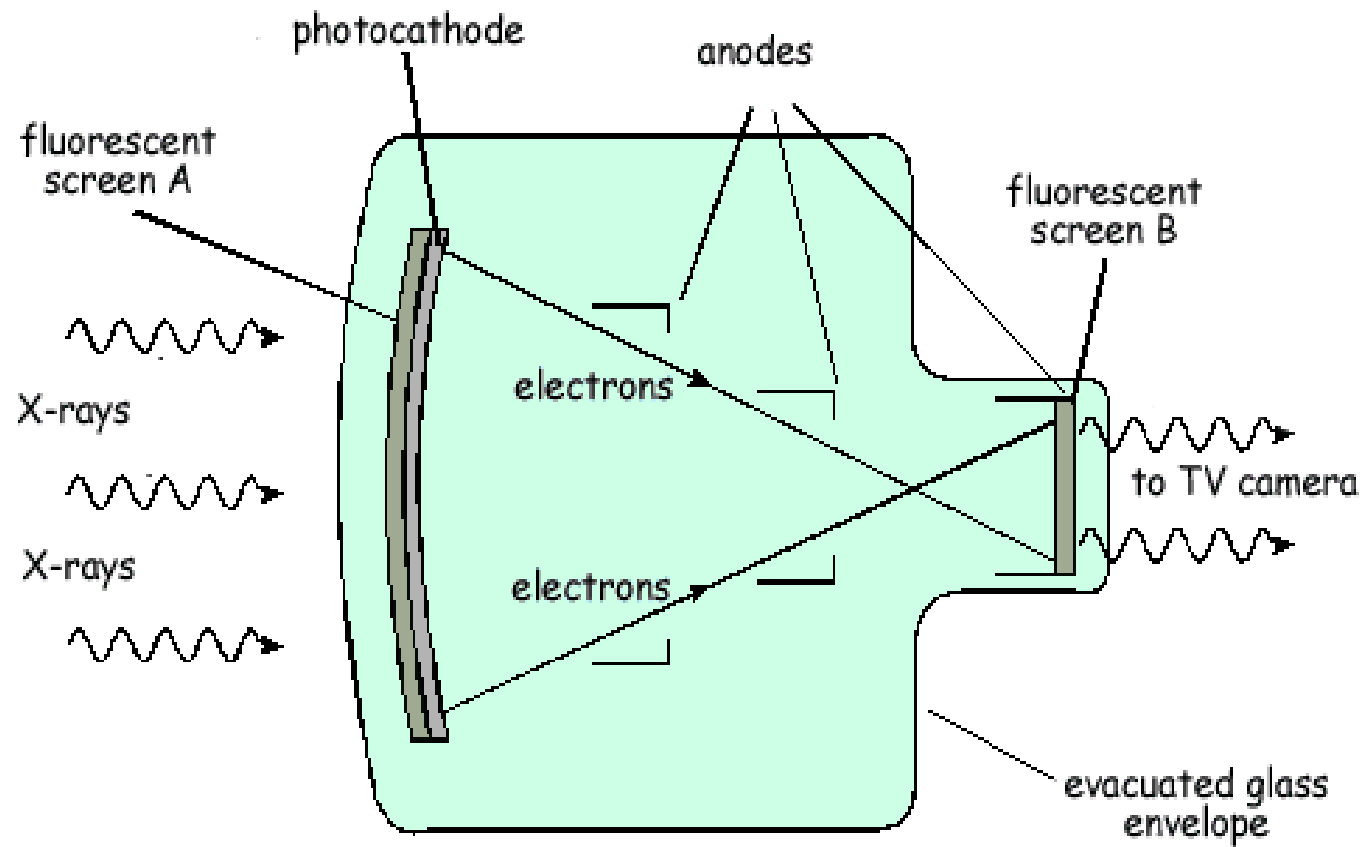


lumbar spine x-ray

X-ray mammography



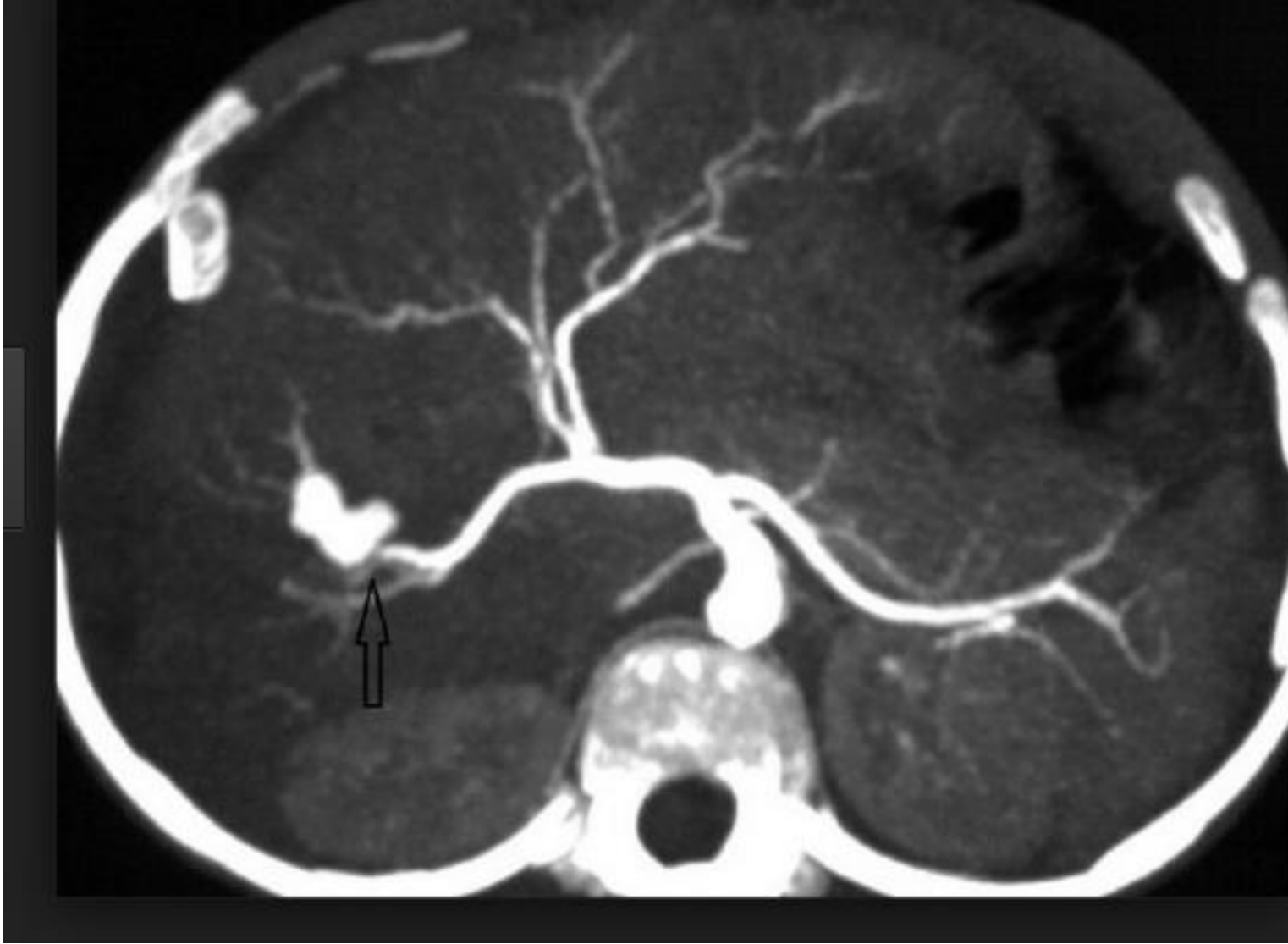
X-ray flouroscopy



X-ray flouroscope receiver



X-ray angiography



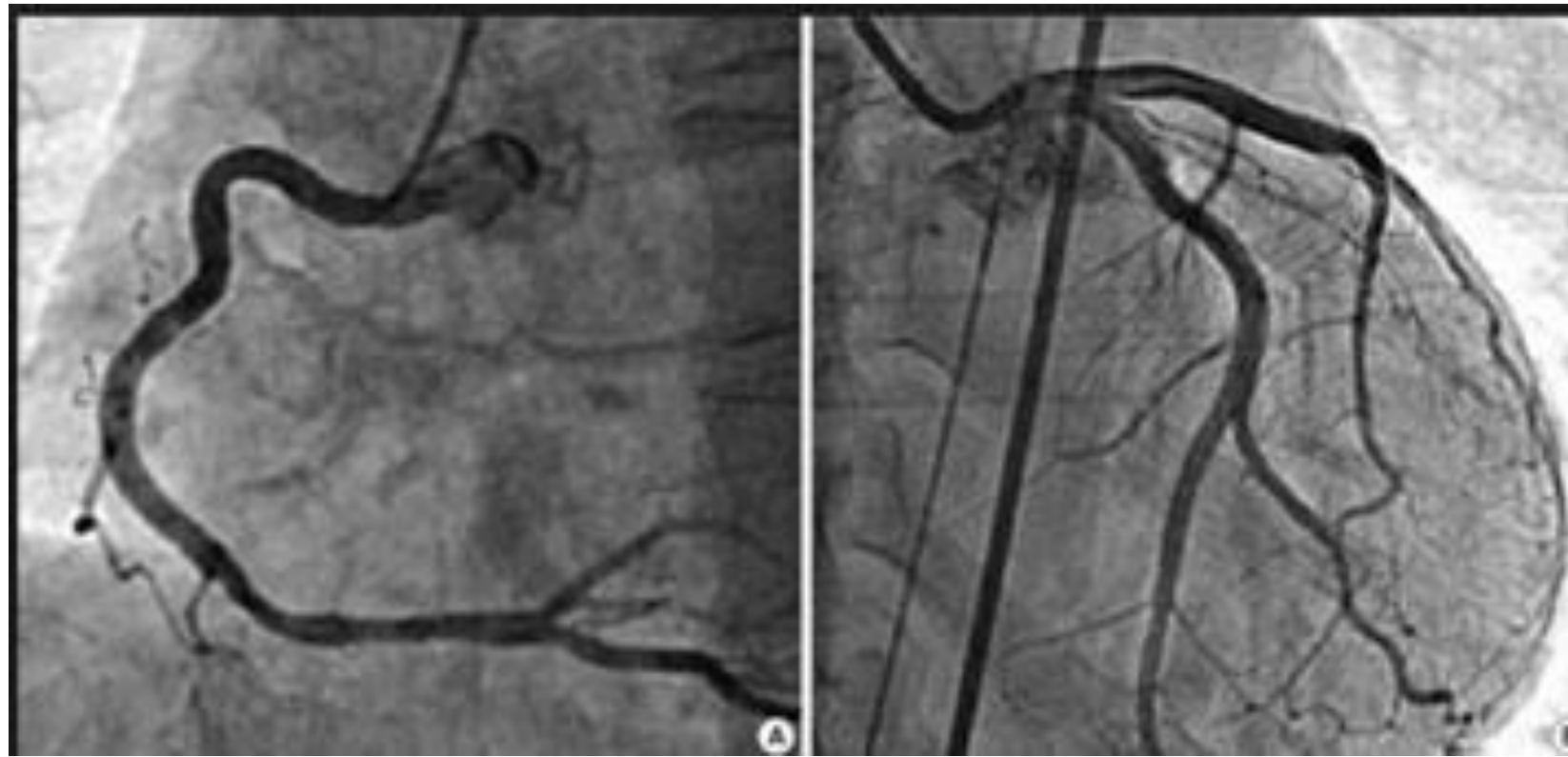
Pseudoaneurysm of right branch of hepatic artery



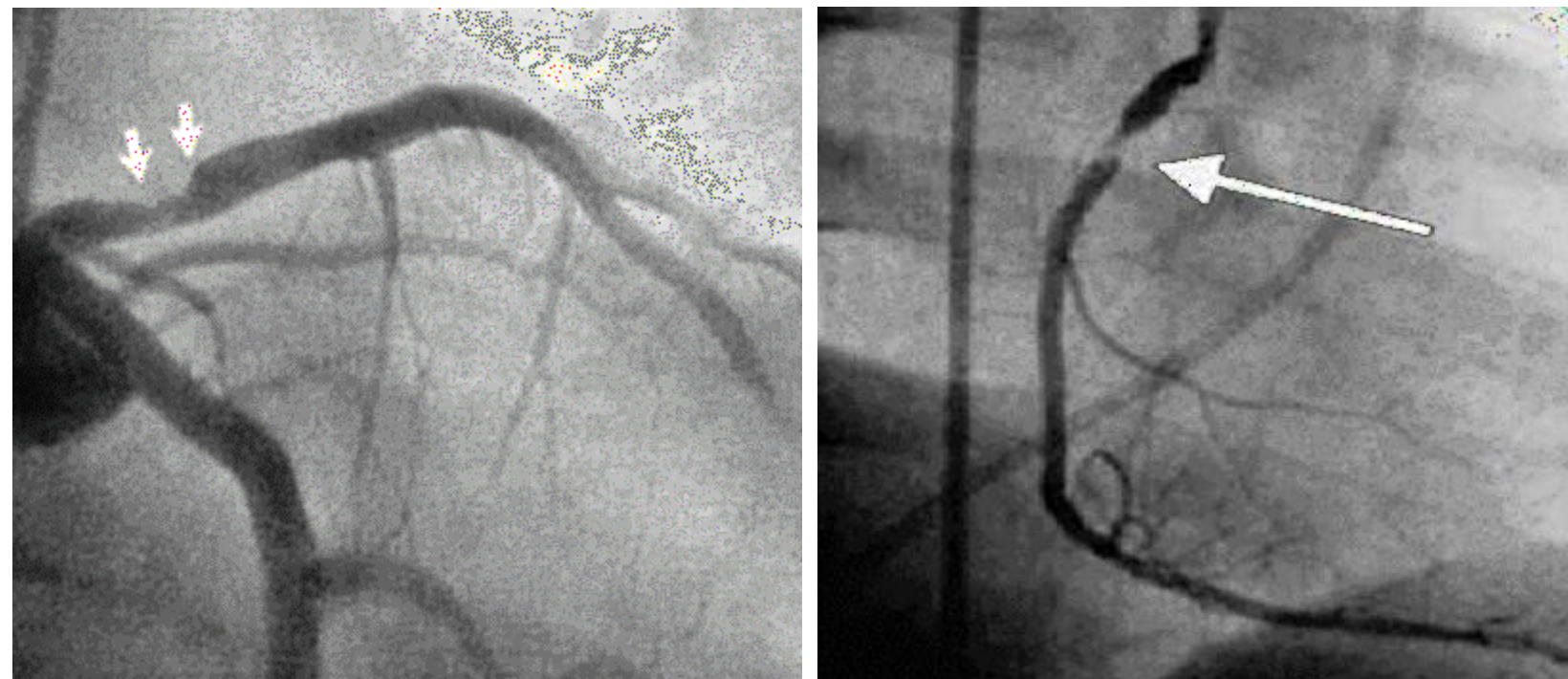
Liver metastasis

X-ray angiography

Normal coronary arteries

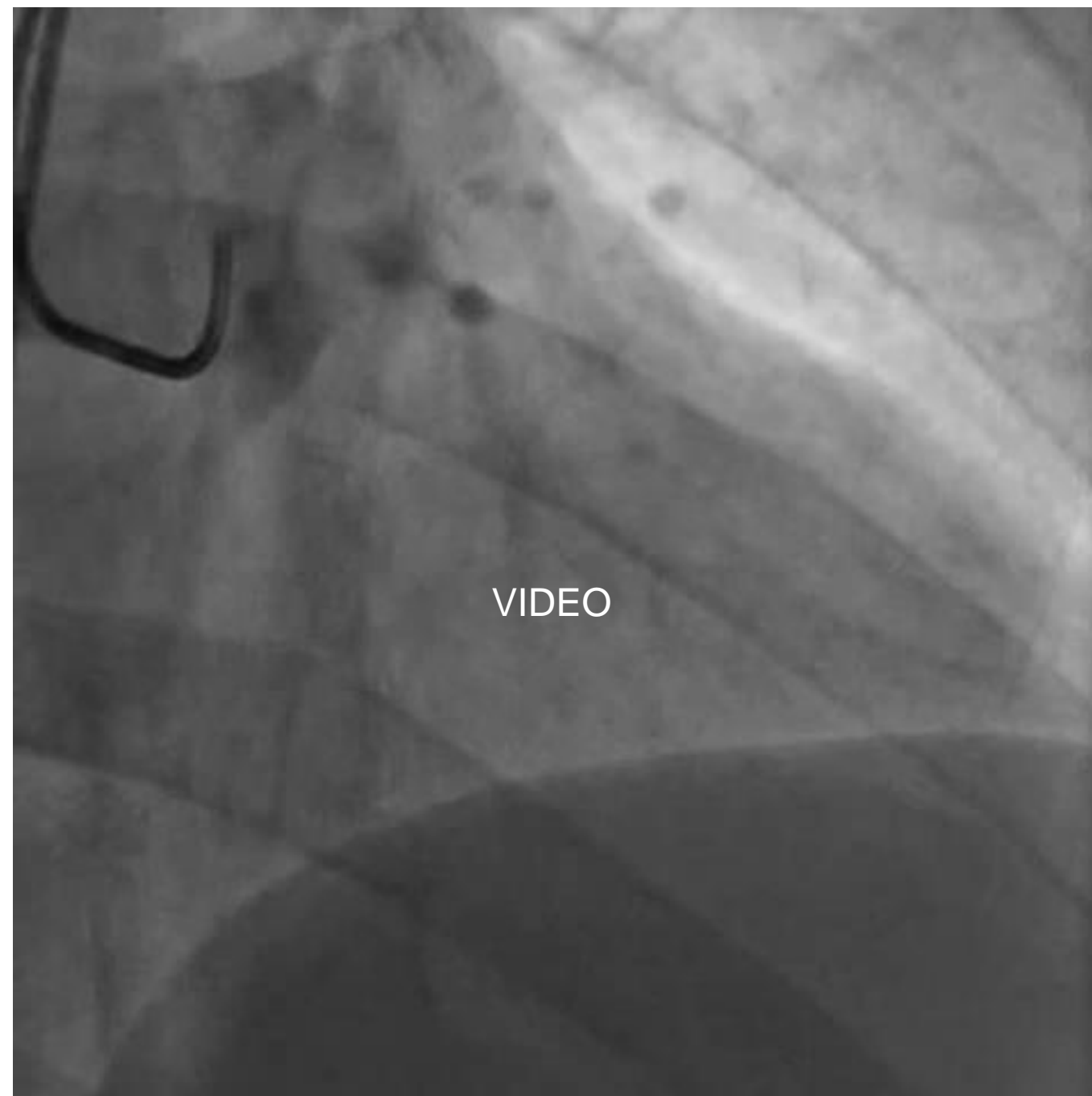


Partial occlusion of coronary arteries



X-ray angiography

Filling of coronary arteries



X-ray flouroscopy



1936 Nazi experiments with whole body flouroscopy

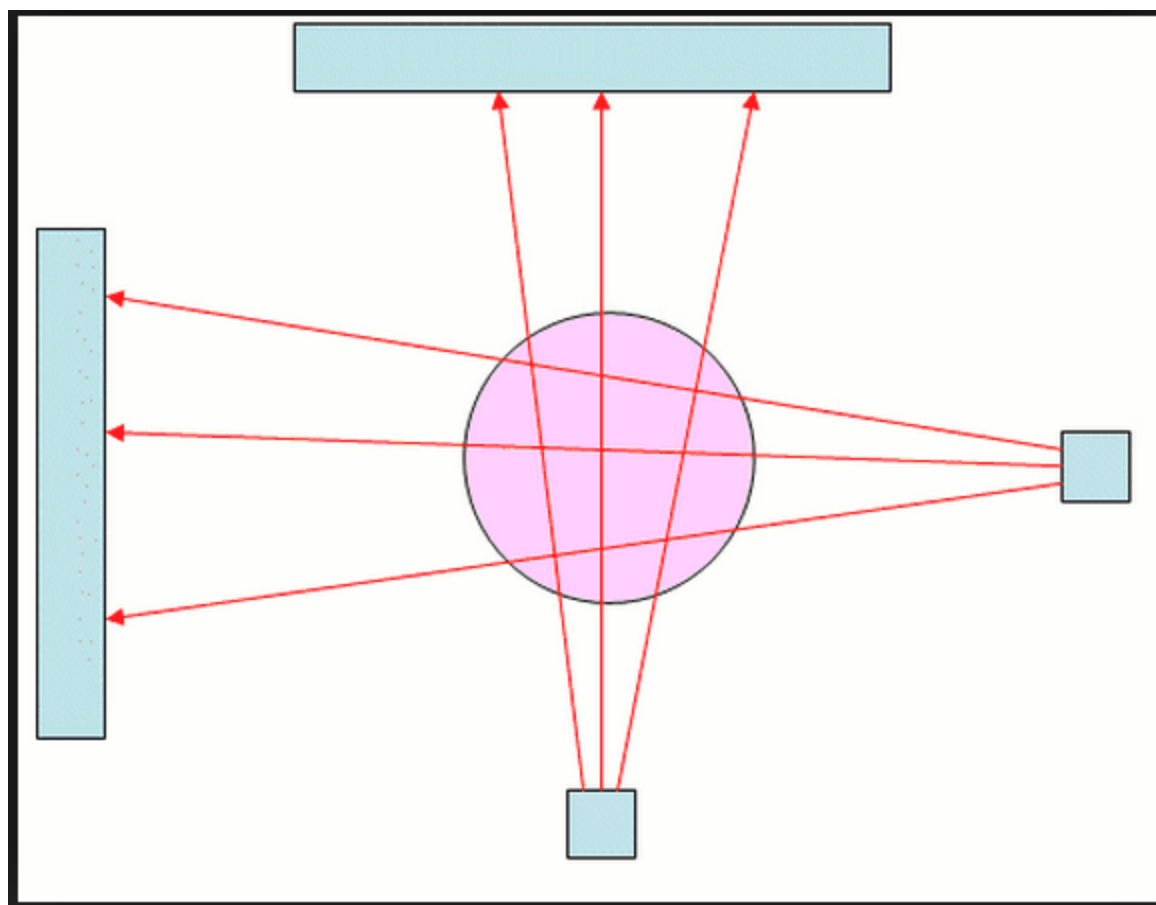
X-ray flourscopy

With suitable contrast medium, x-ray flouroscopy is useful for many organ system studies.



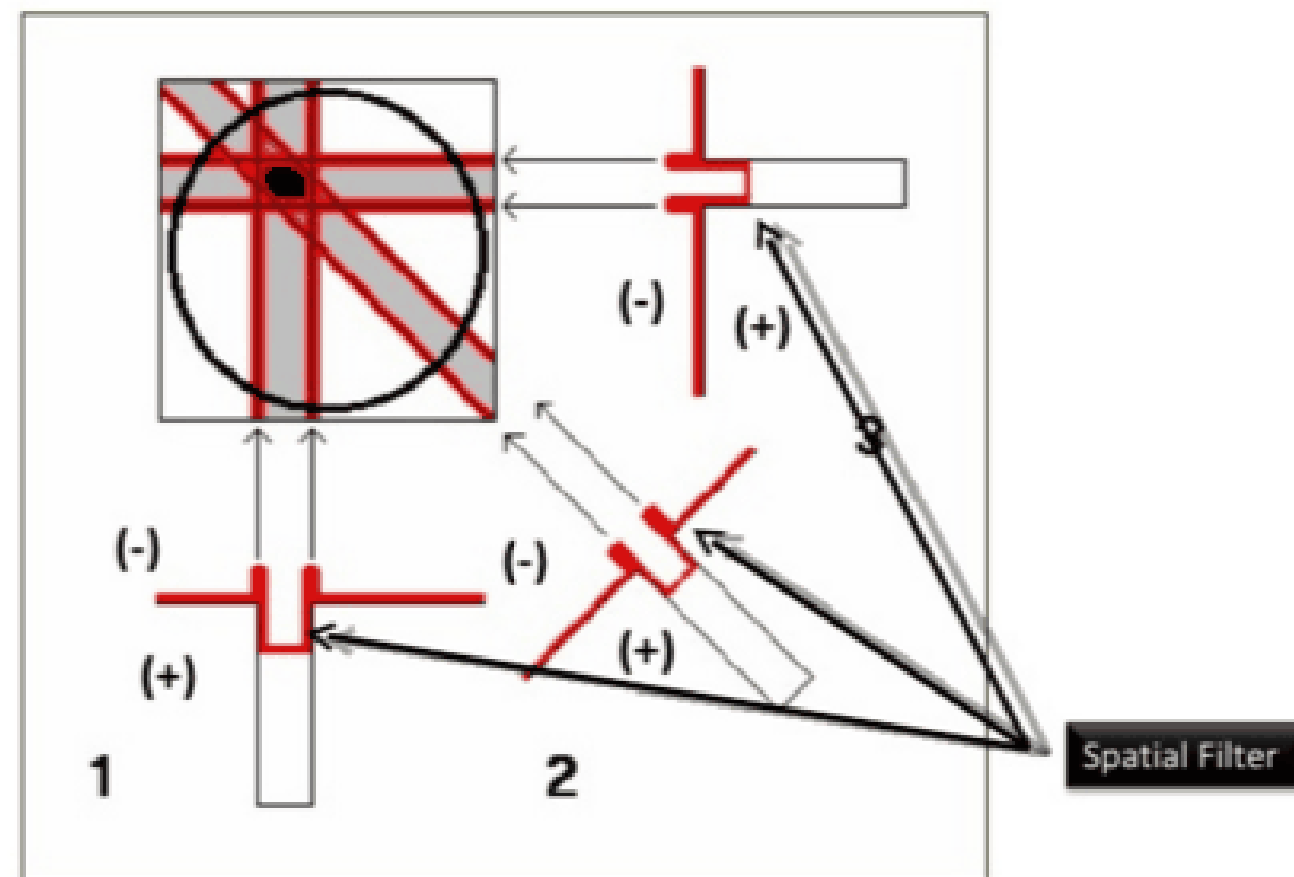
X-Ray Computerized Tomography: CT

Gathering data



Rotating 2-D fan-beam x-ray sources and image planes

Analyzing data



Back projection and summing of all the 1-D image lines

СТ

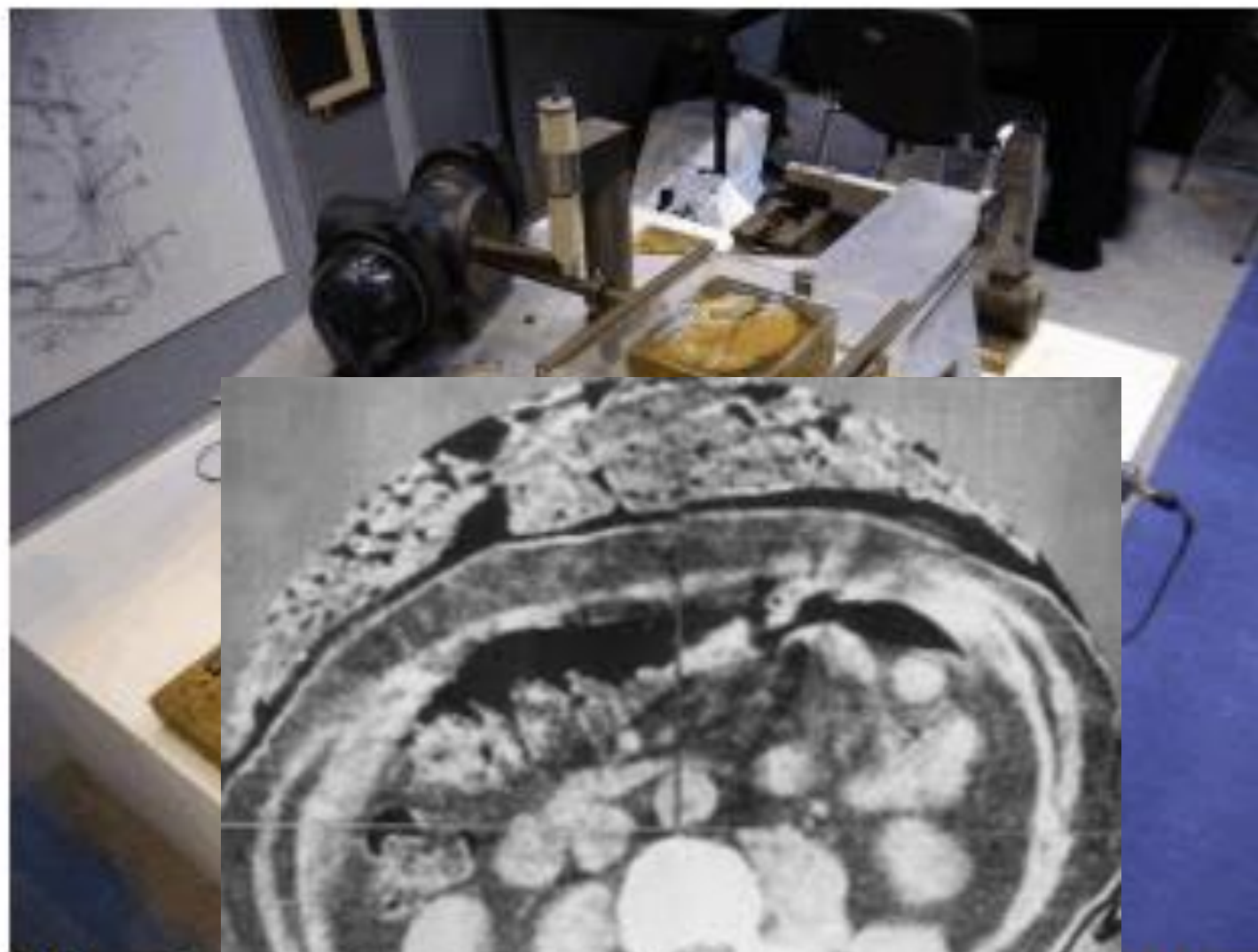
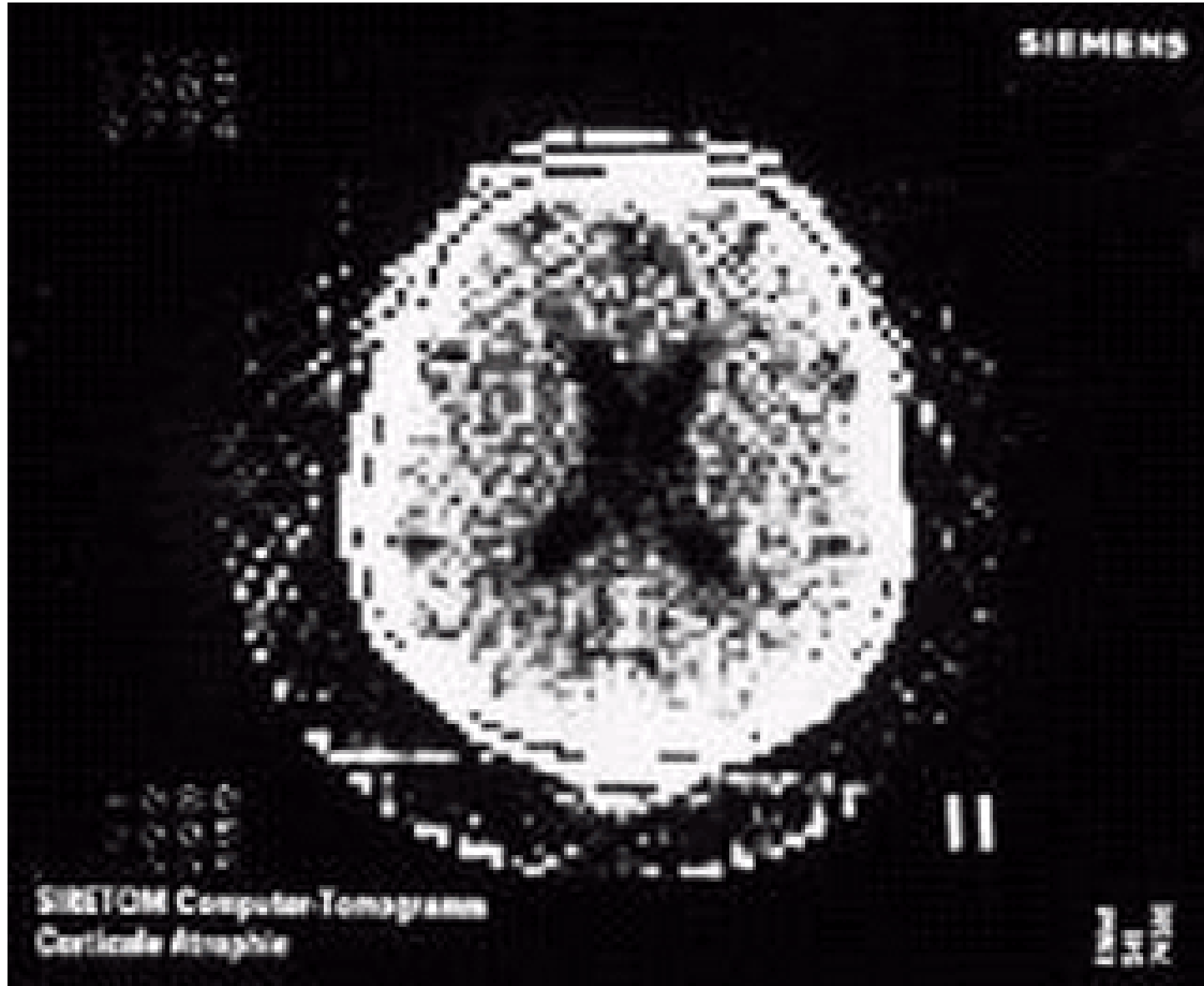


Рис. 1.

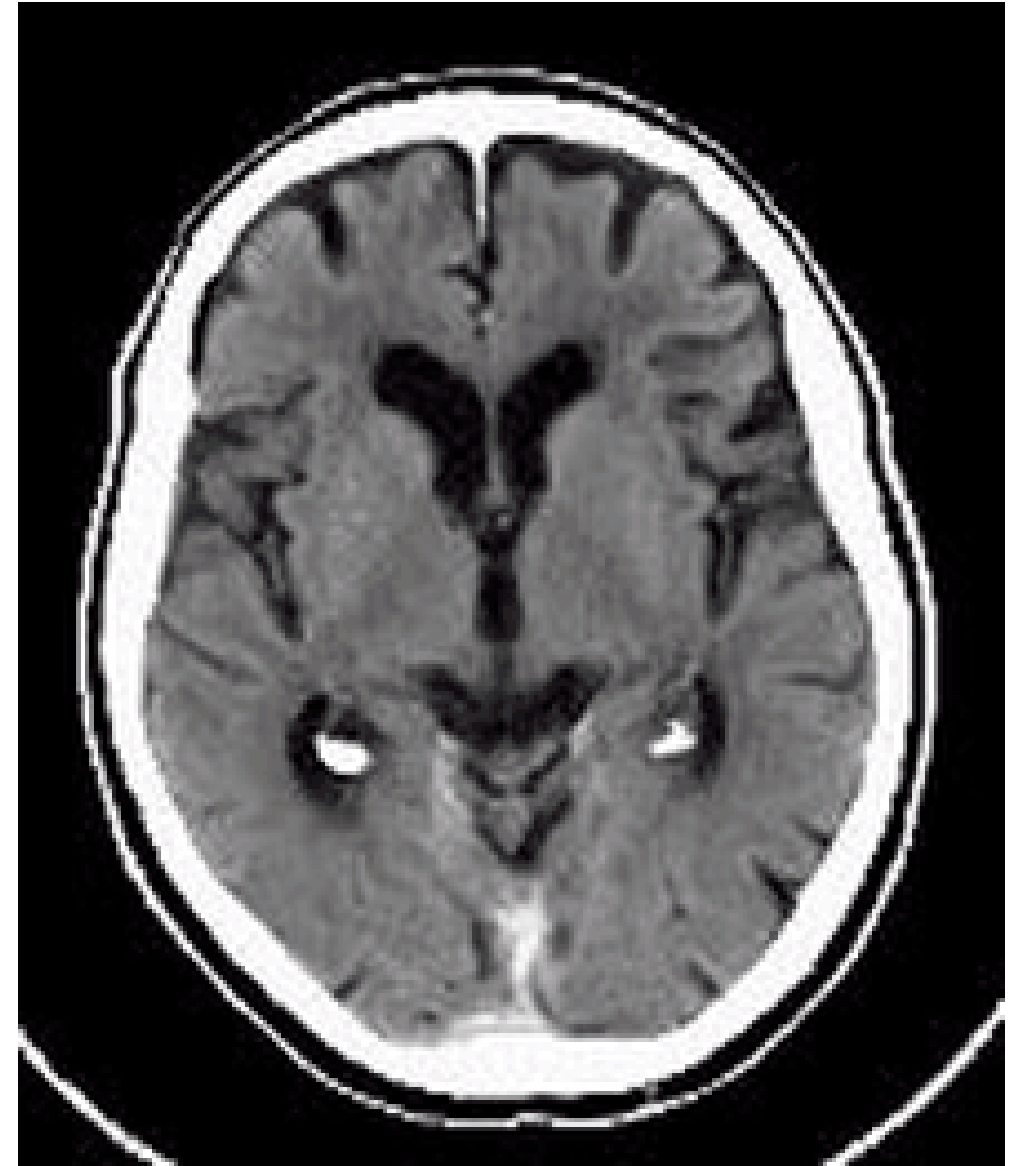
кого



Modern CT machine



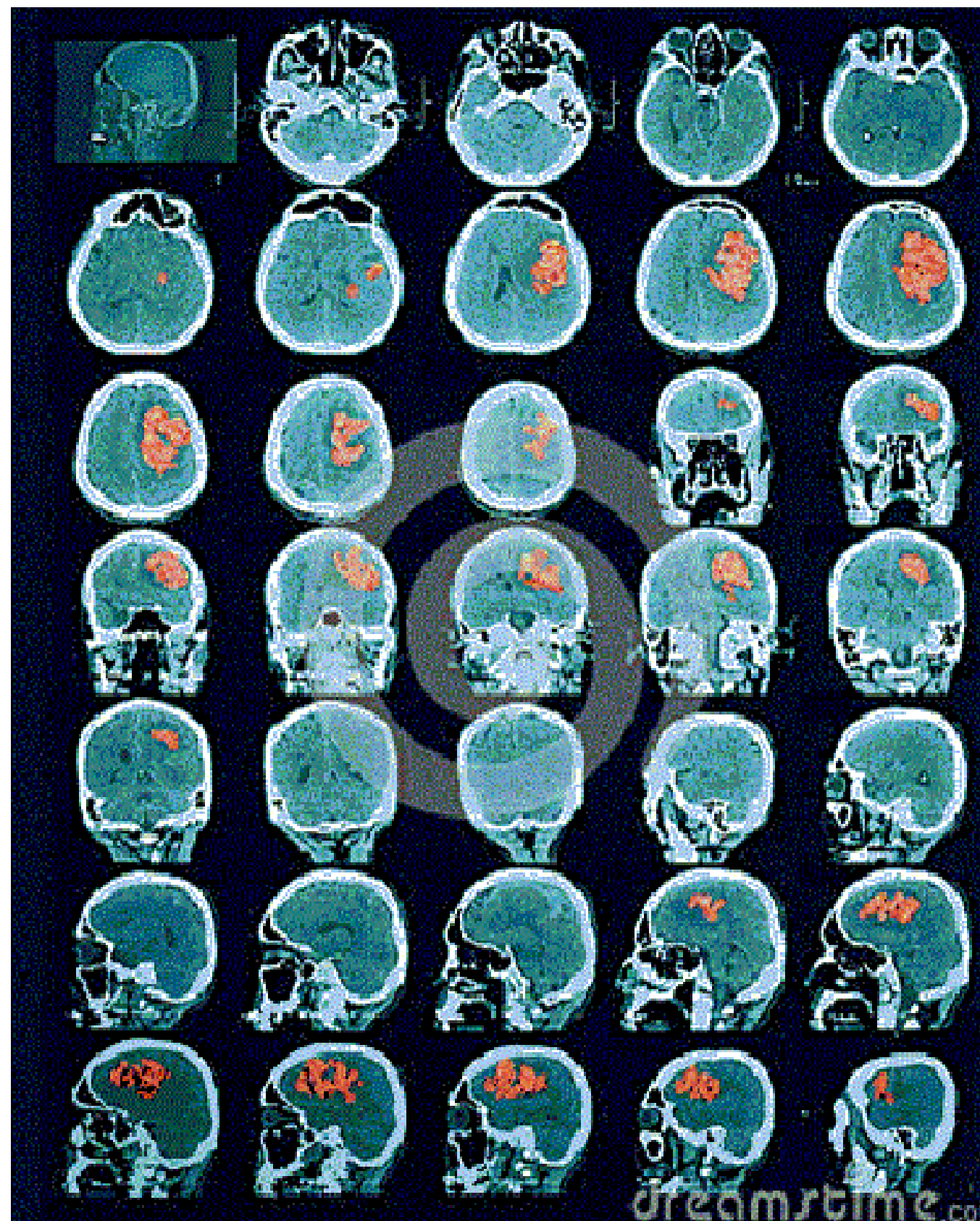
First-gen (1975) commercial CT image

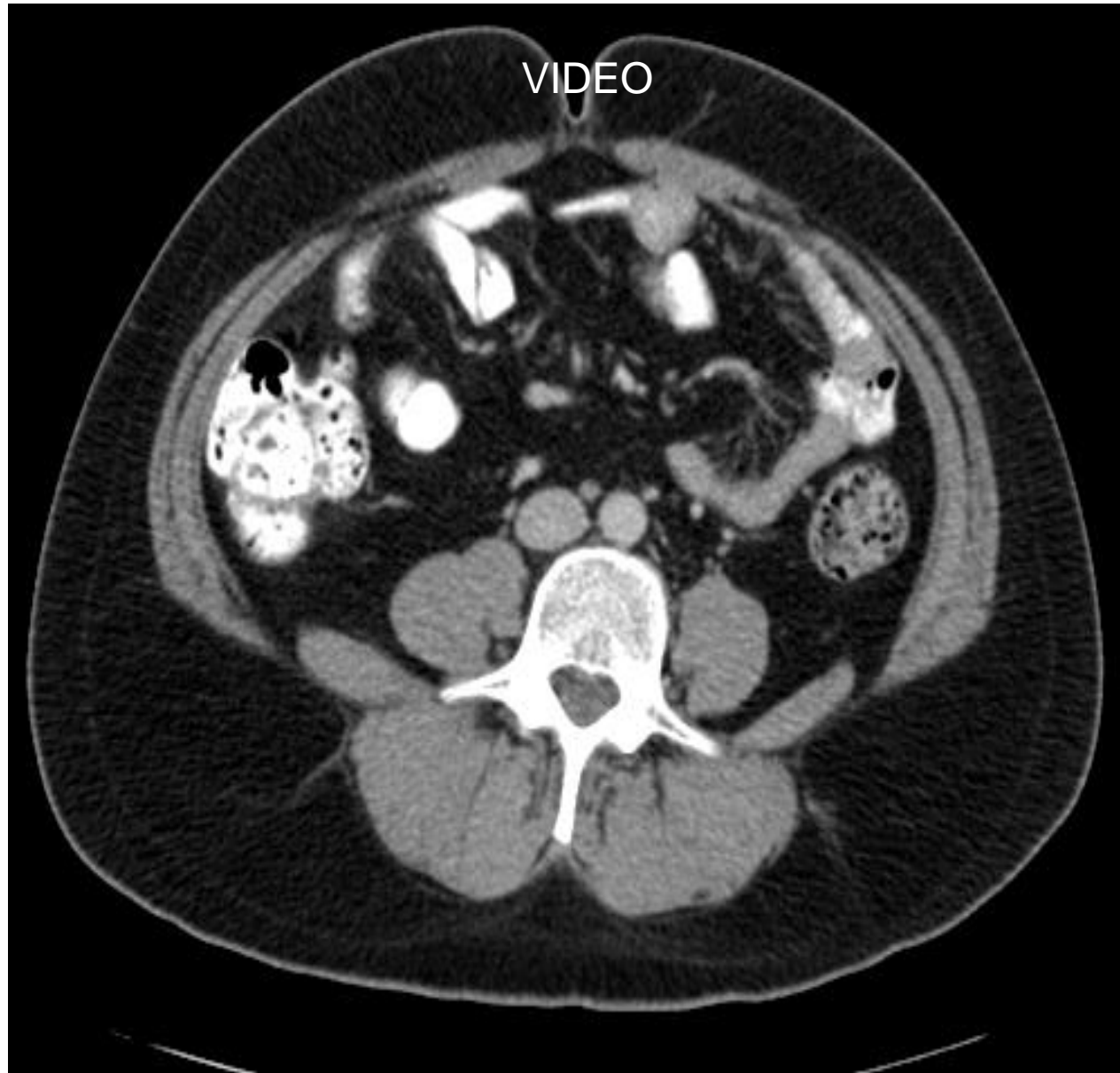


Modern CT resolution

CT

CT brain scan mapping
hemorrhagic stroke site
and extent



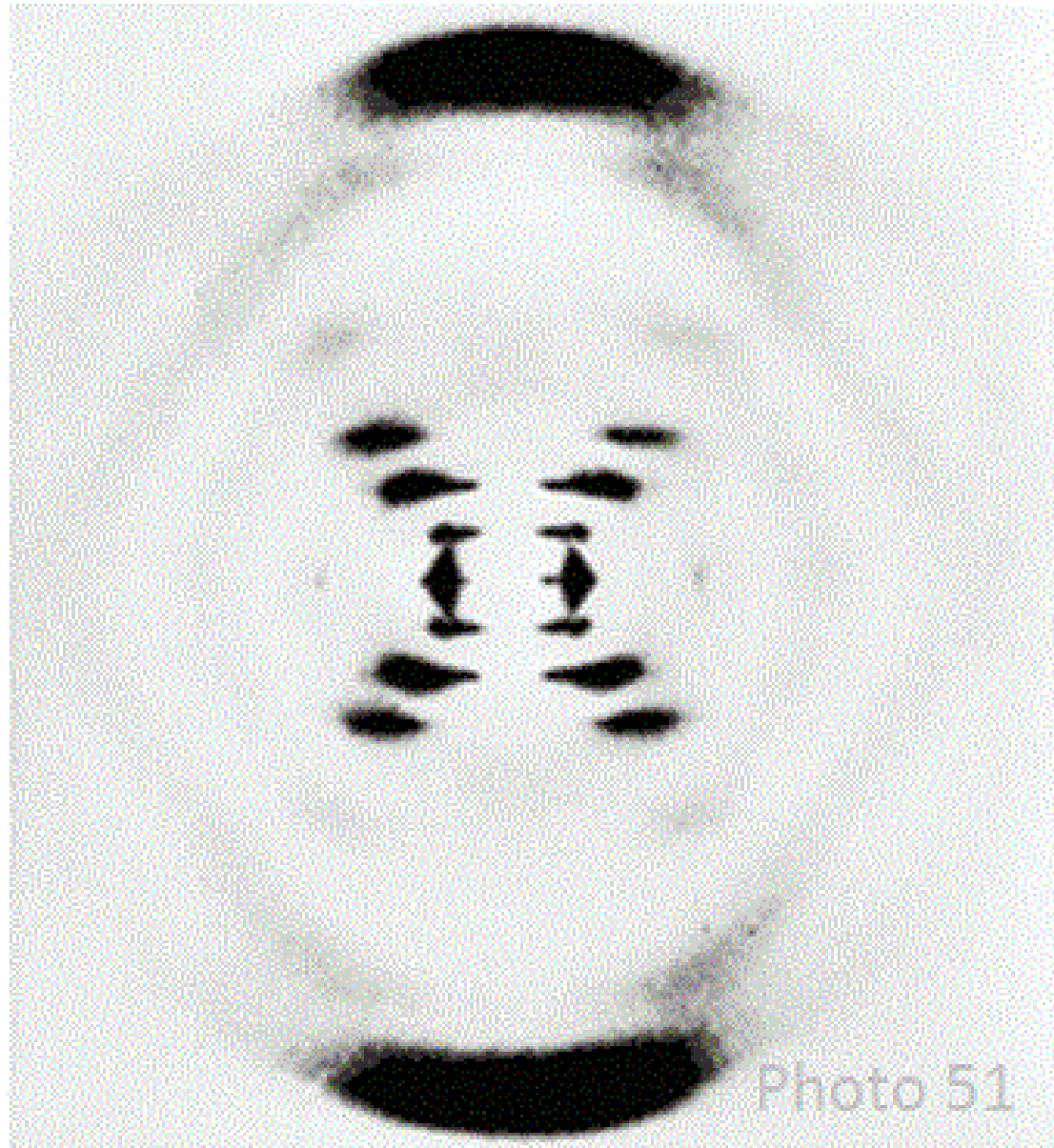


Axial CT study of normal abdomen



Coronal CT study of chest

X-ray diffraction

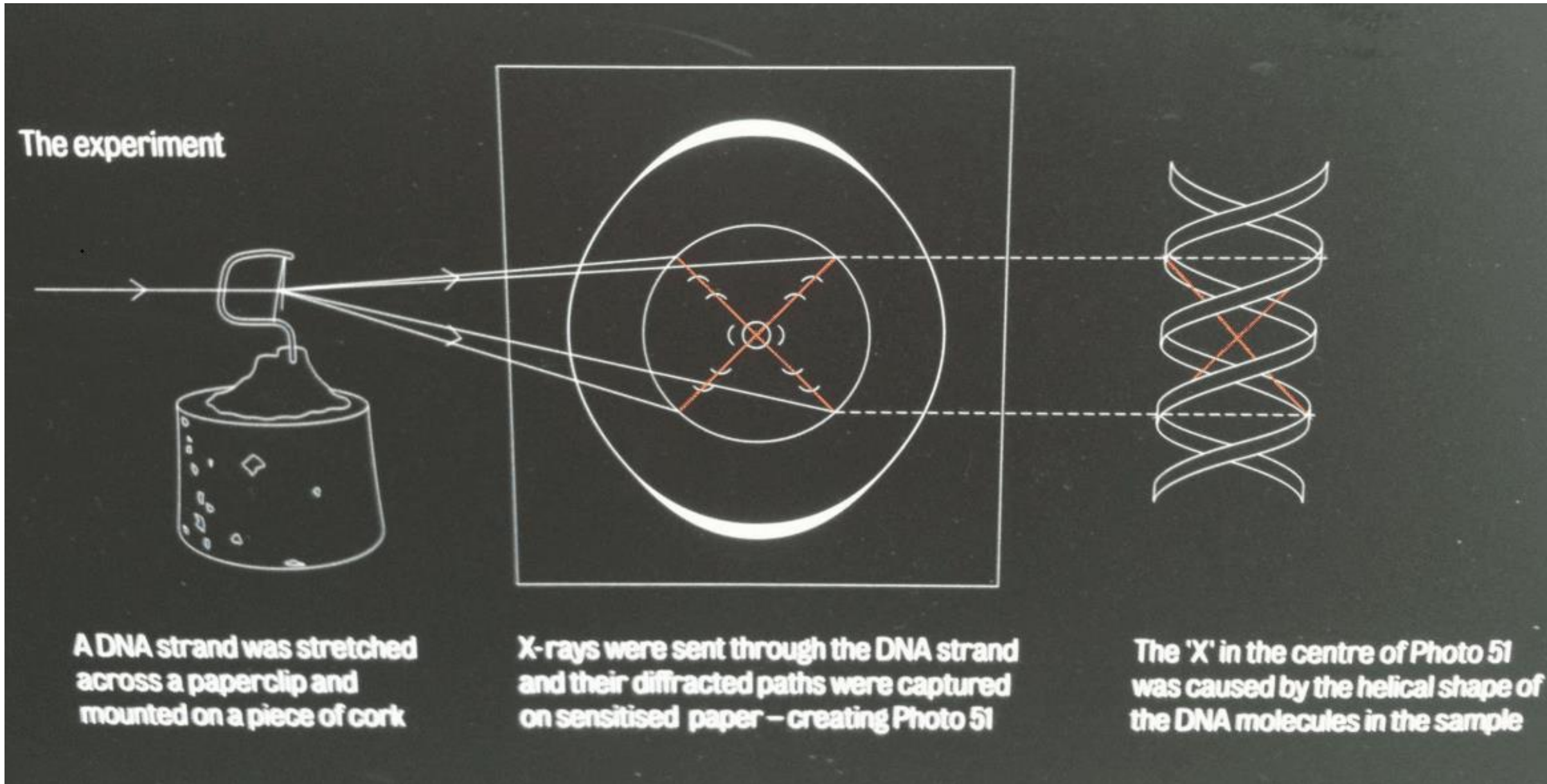


X-ray diffraction photograph of DNA



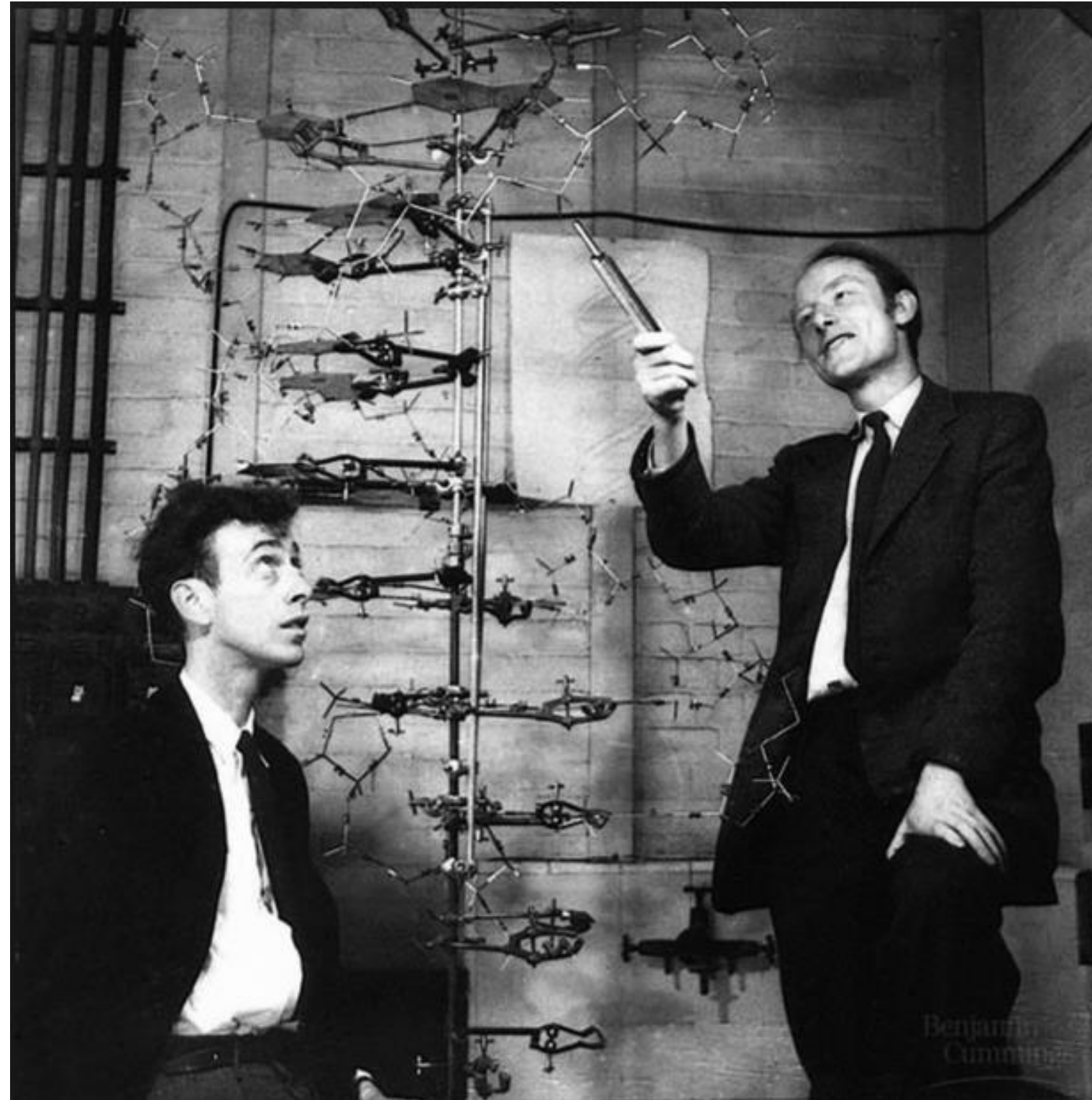
Rosalind Franklin

X-ray diffraction



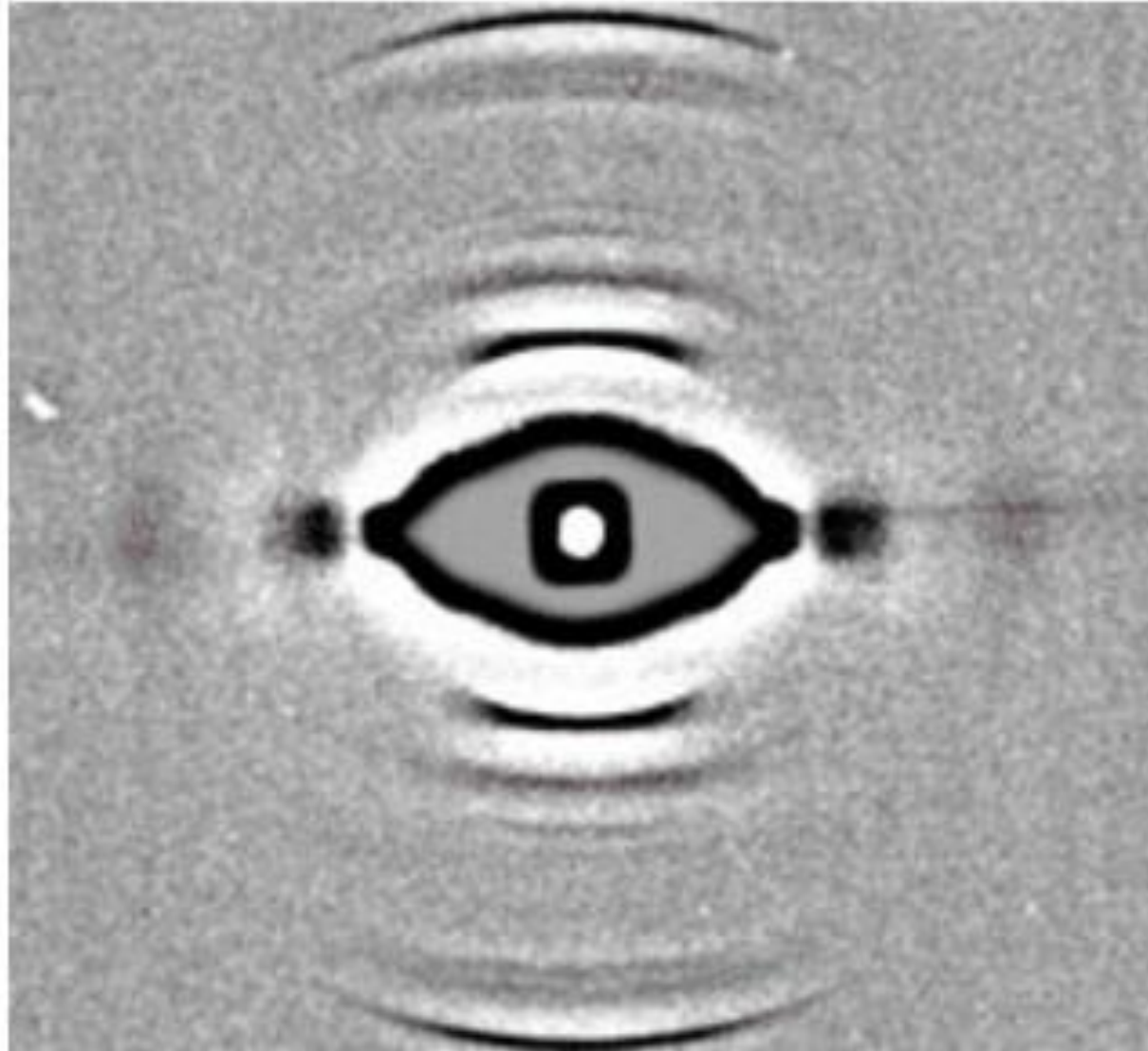
X-ray diffraction

Watson & Crick's
Double Helix Model
(1953)

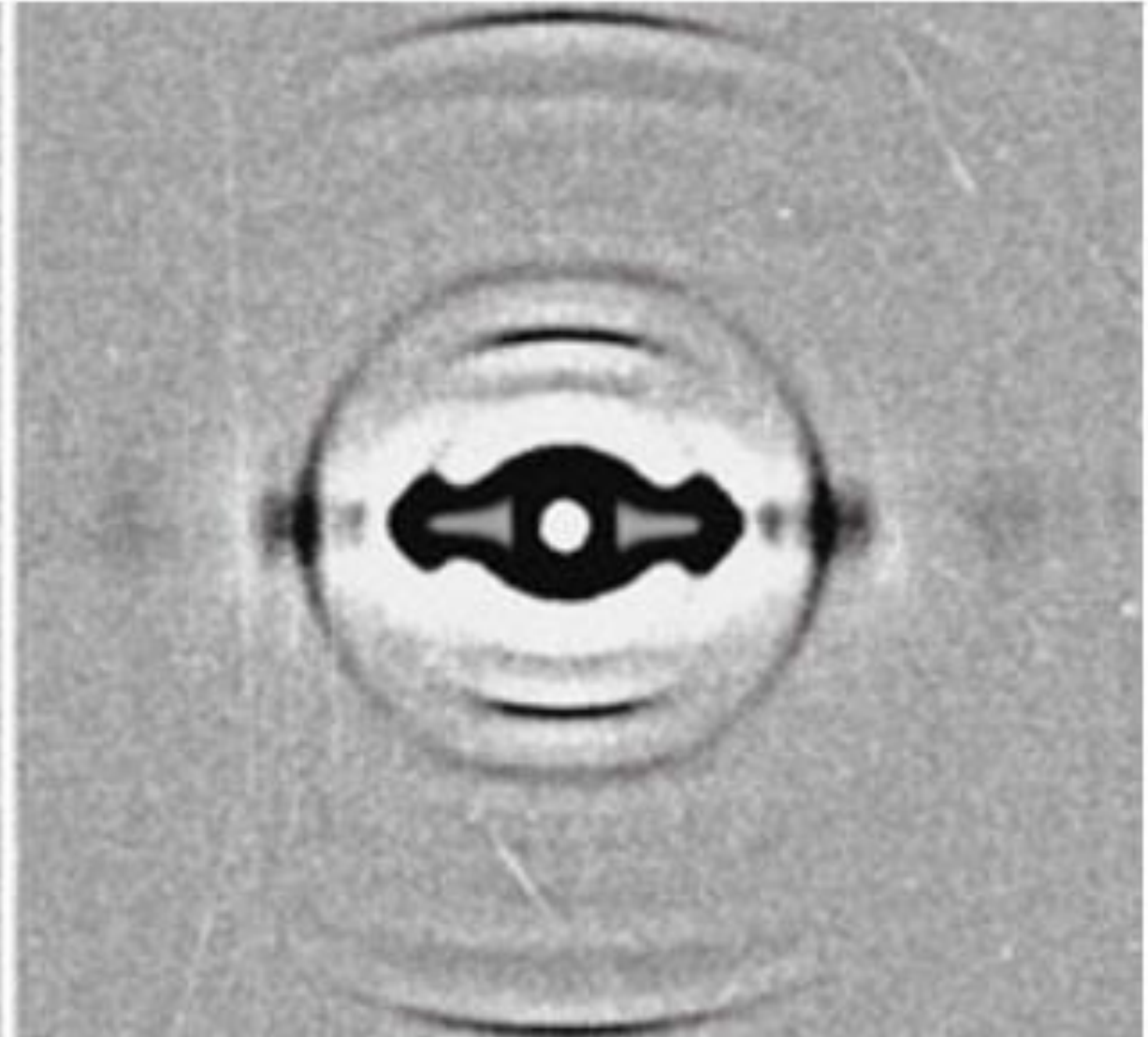


X-ray diffraction

normal strand of hair

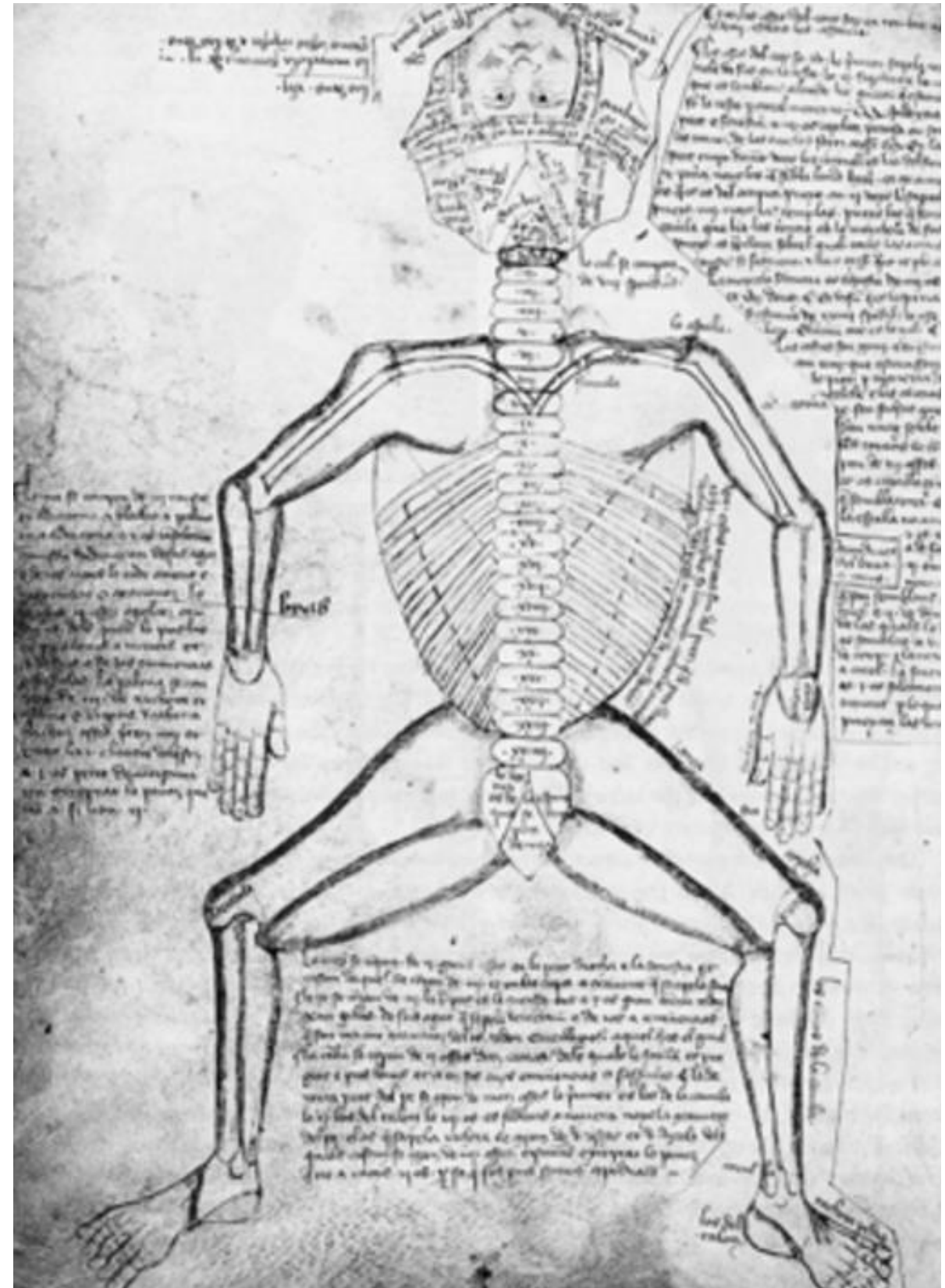


hair from breast cancer patient



Ring identified 12/13 cancer patient, wth false positives in 3/20 controls.

Turning from X-rays to images created in ordinary light...

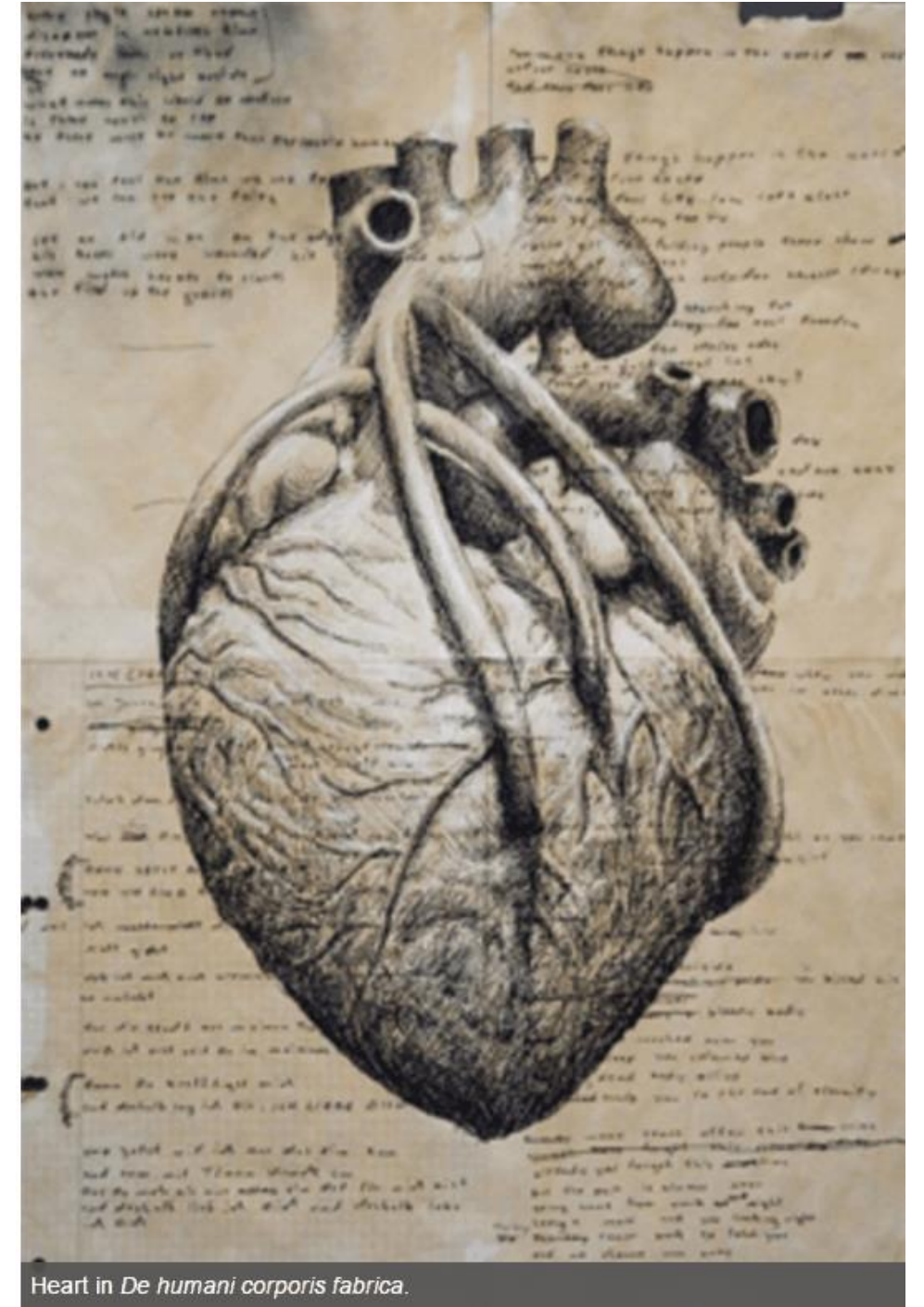


Galen
(129-200AD)

Early illustrations

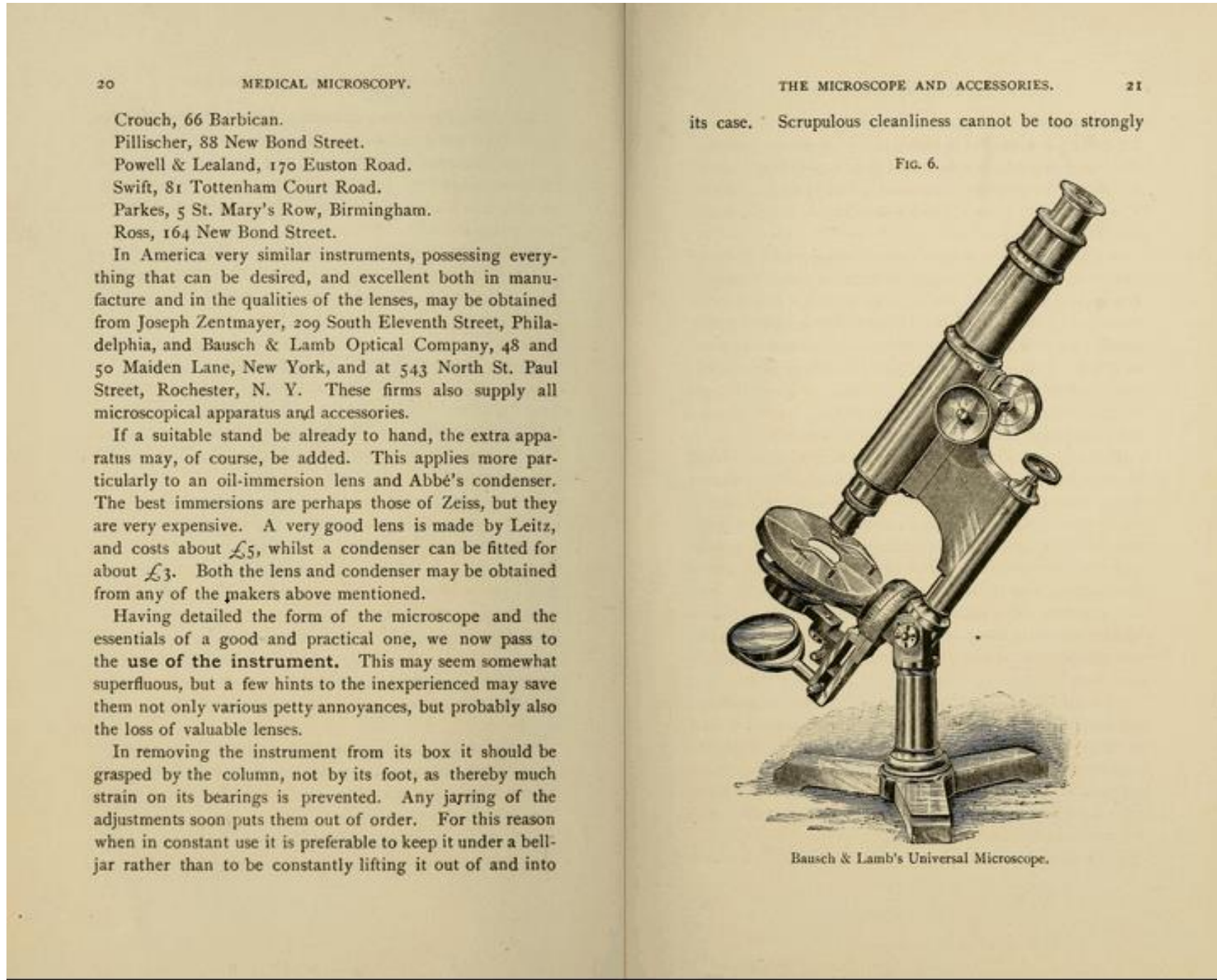


Vesalius
(1514-1564)



Heart in *De humani corporis fabrica*.

The next step:

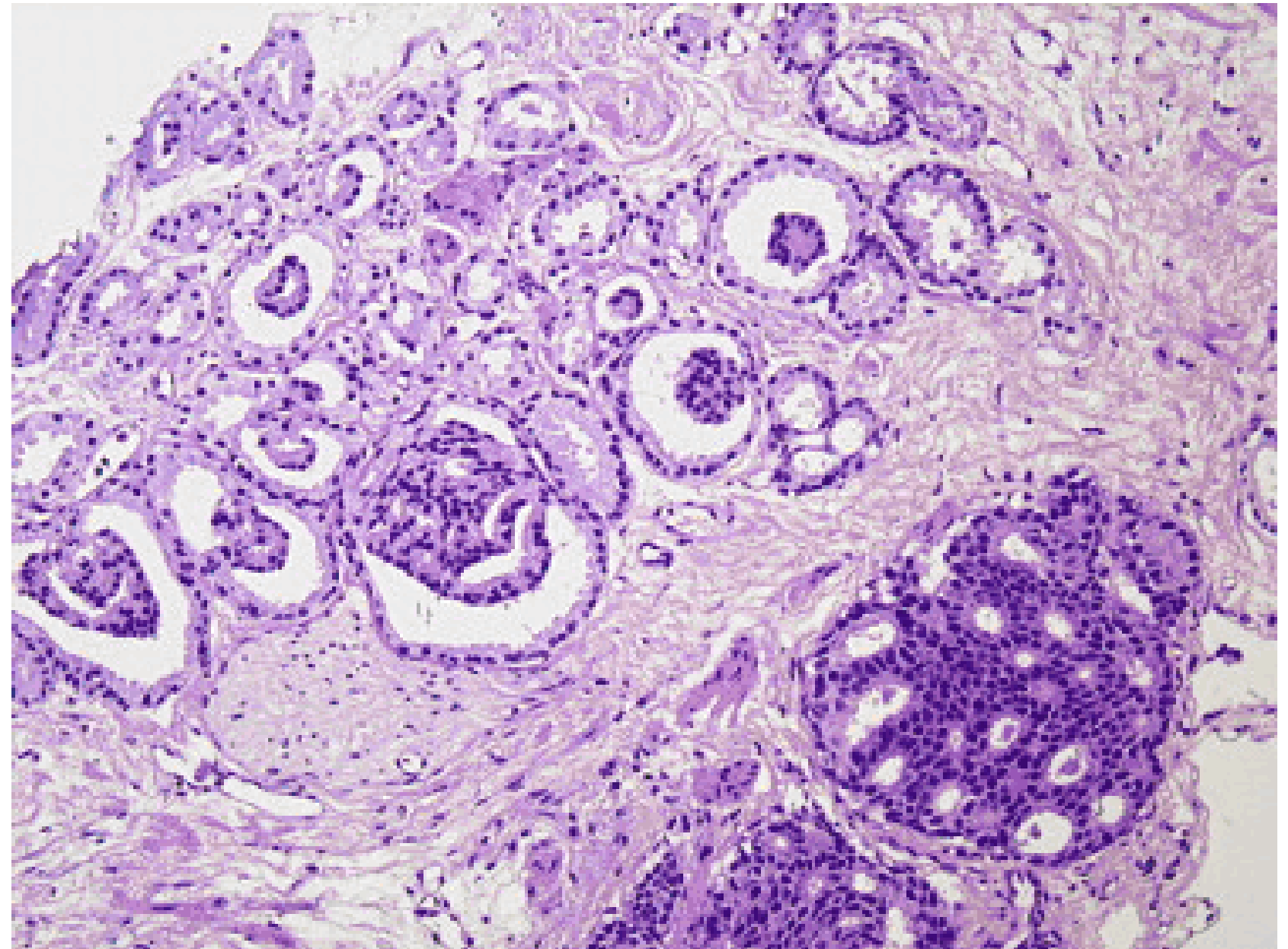


1898 optics textbook



Modern monocular microscope with multiple objectives

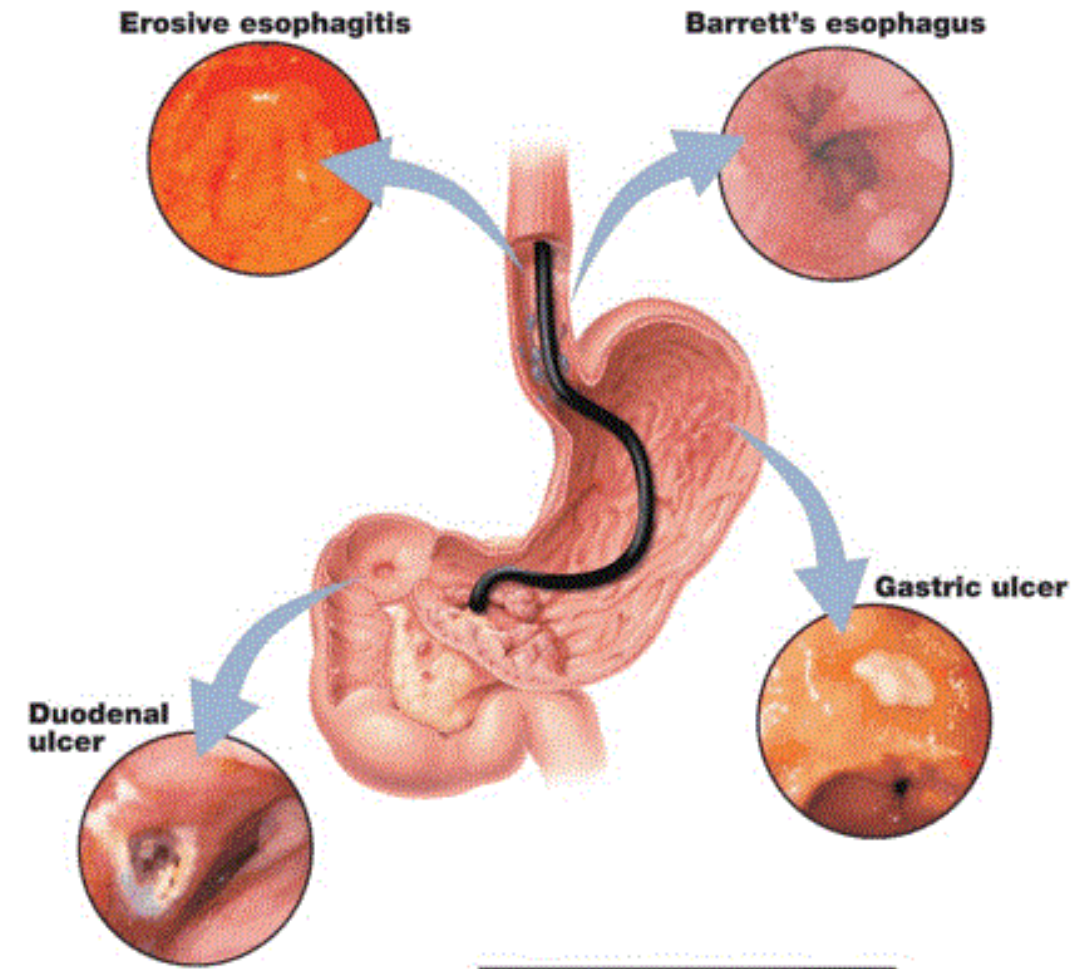
Biopsy

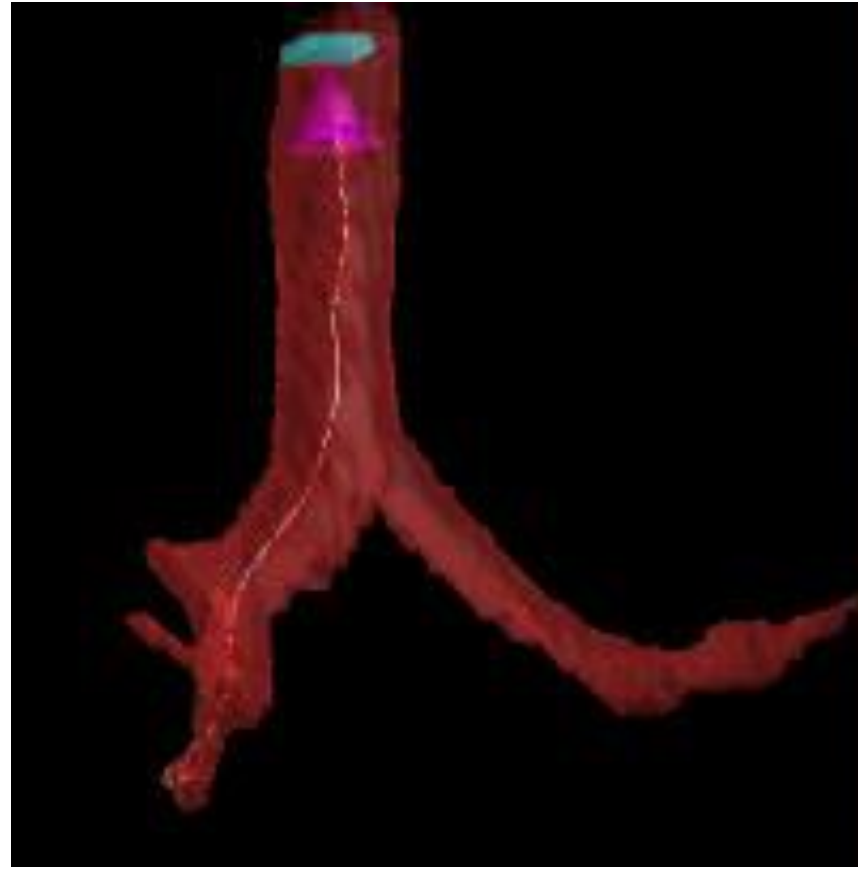


Patch of tissue imaged: 0.003" x 0.004"

Fig. 3 Glomerulations demonstrating significant morphologic overlap with and transition to cribriform Gleason pattern 4 carcinoma.

Endoscopy





camera location



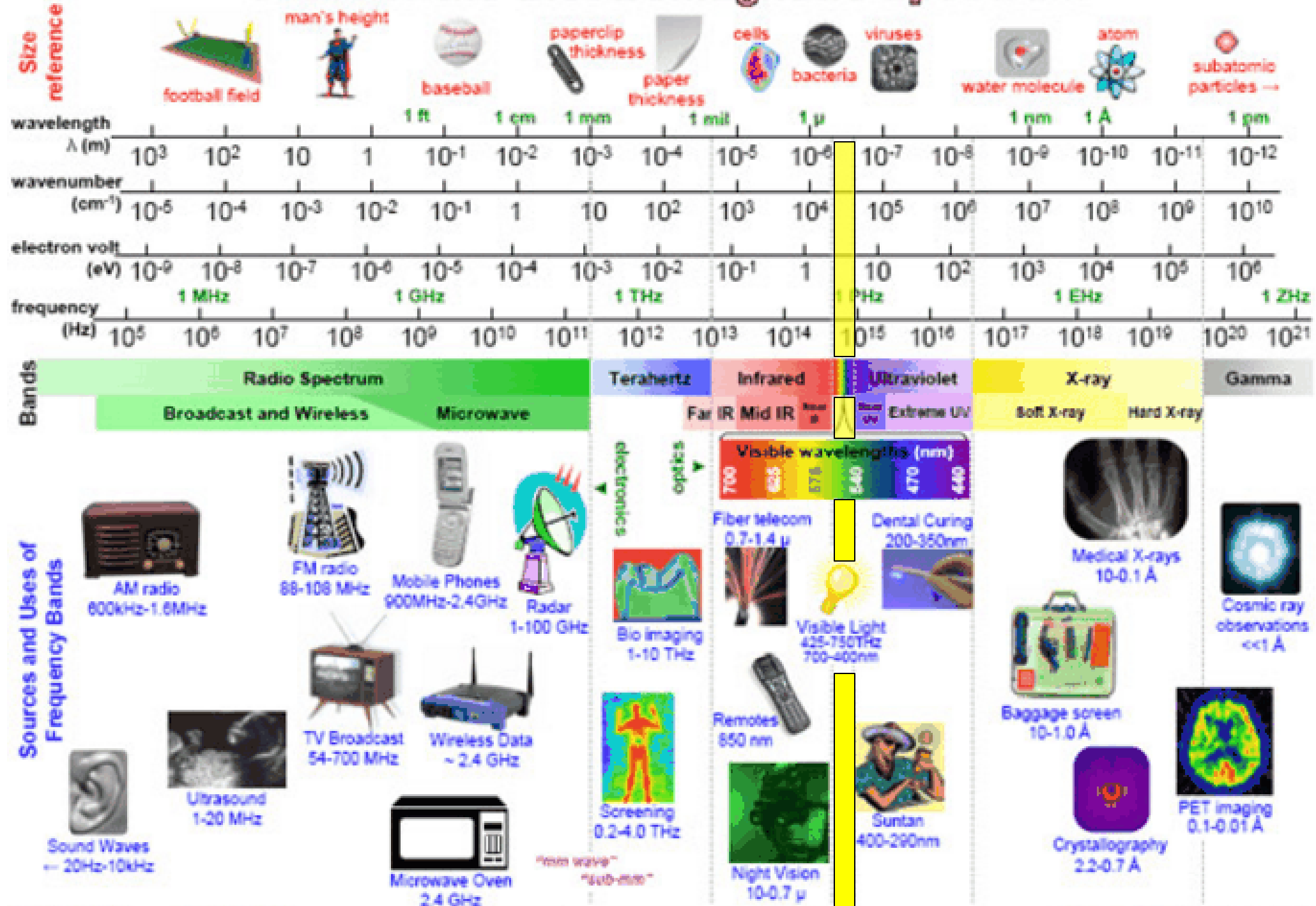
pass 1



pass 2

Endoscopic exam of normal trachea

Chart of the Electromagnetic Spectrum



Other places to look

$$\lambda = 3 \times 10^8 / \text{freq} = 1 / (\text{wn} \times 100) = 1.24 \times 10^{-4} / \text{eV}$$

Microscopy

E Coli about one ten-thousandths of an inch long
T4 one-tenth as large as E Coli host



Giant Microbes T4 (T4-Bacteriophage) Plush Toy

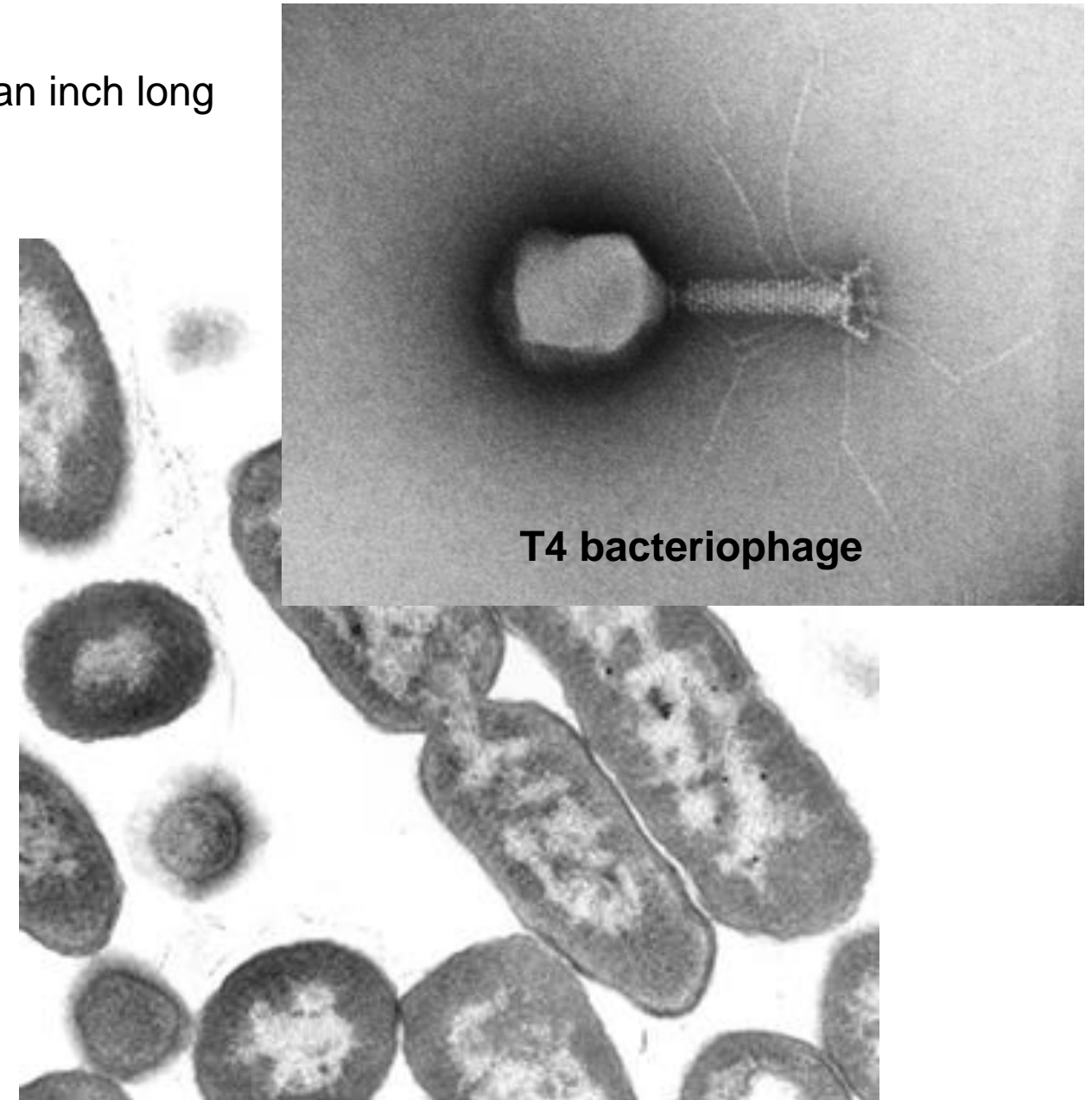
by Giant Microbes

★★★★★ 29 customer reviews

List Price: ~~\$27.22~~

Price: **\$12.95** Prime

You Save: **\$14.27 (52%)**



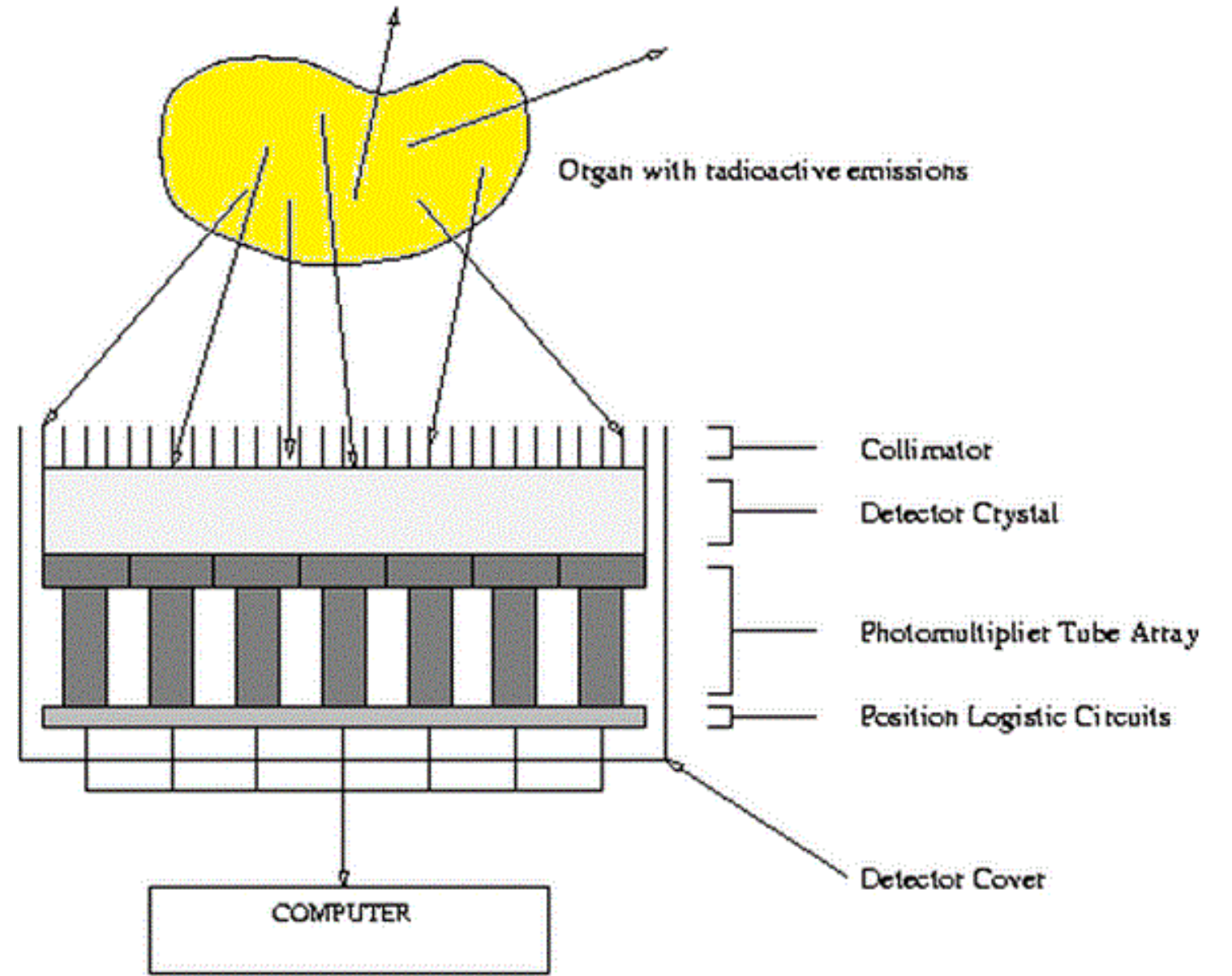
T4 bacteriophage

TEM image of E Coli bacteria

Nuclear Imaging



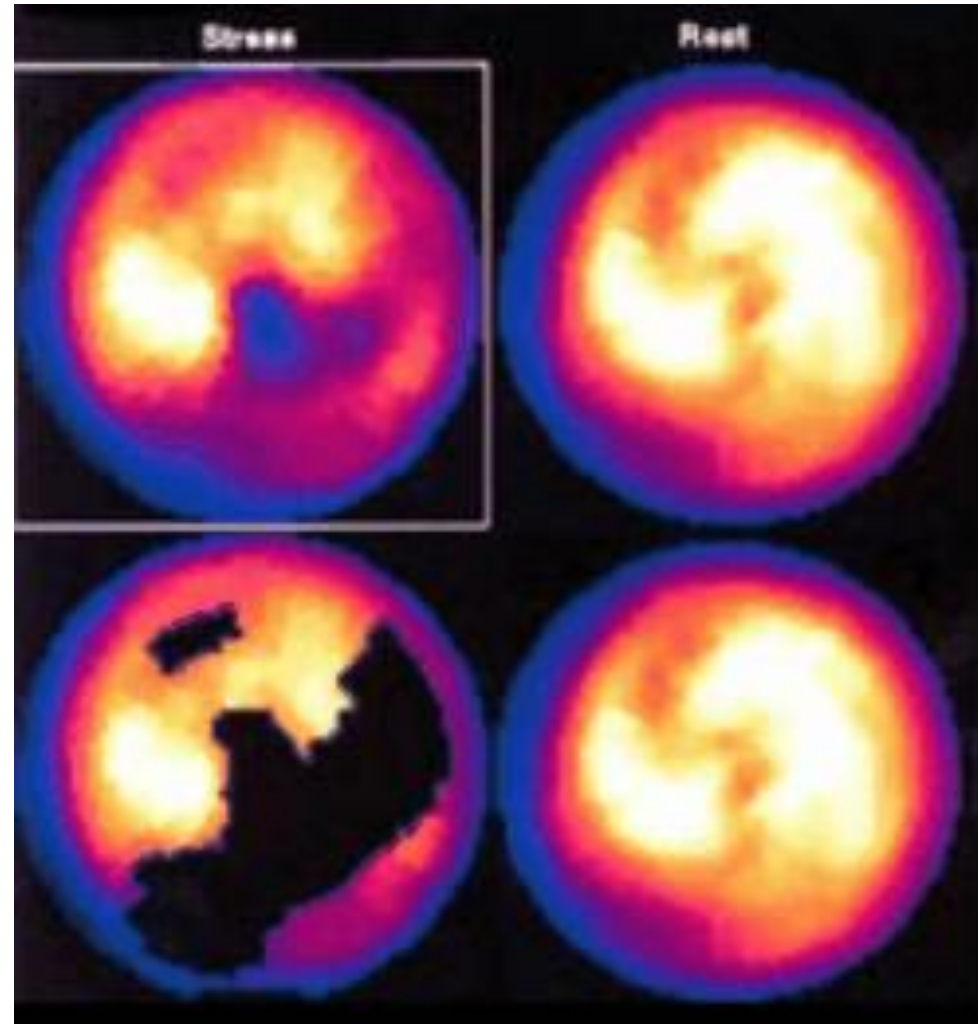
SPECT (Single Photon Emission Computerized Tomography)



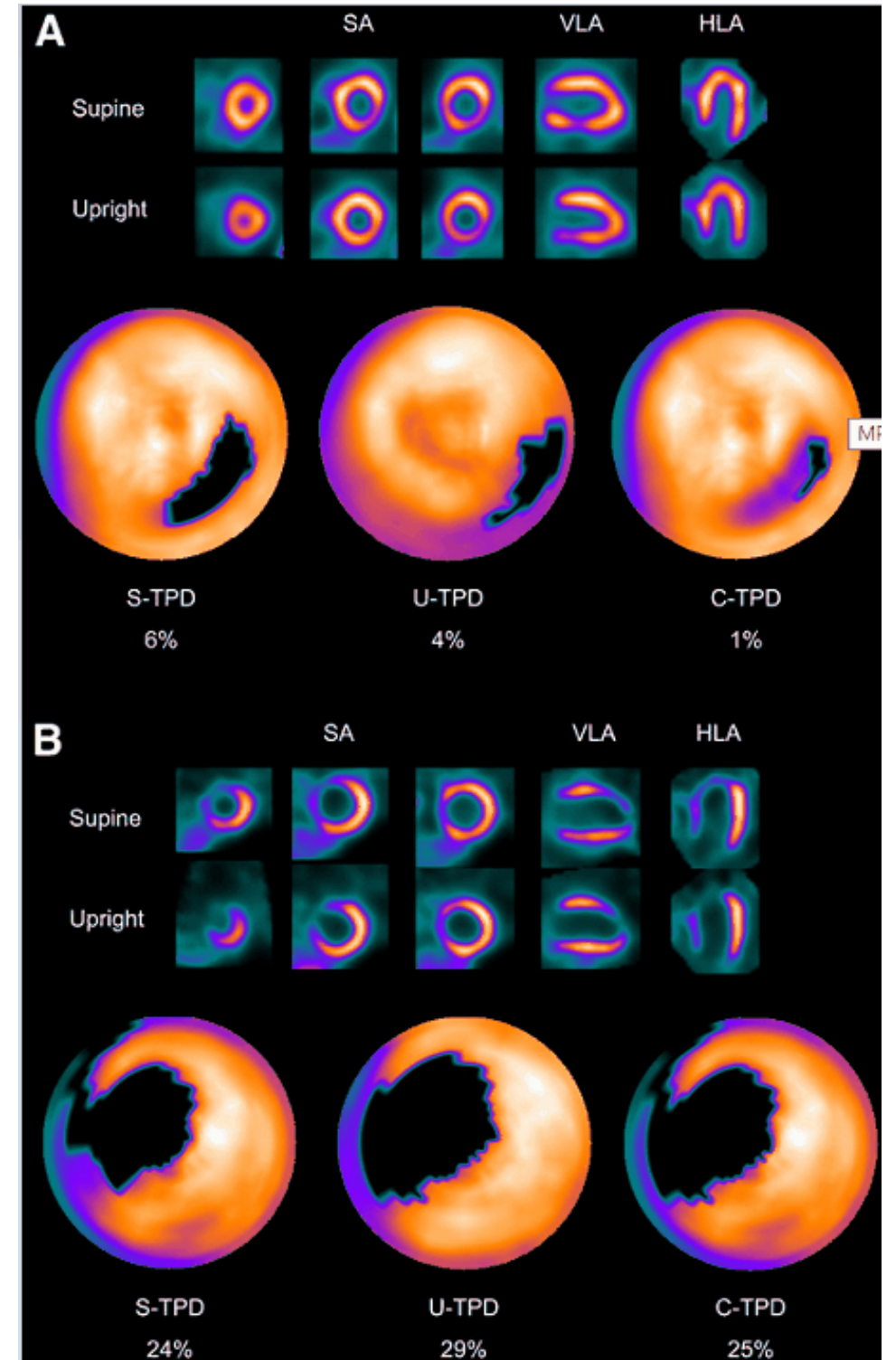
Gamma camera

Nuclear imaging - SPECT

Thallium myocardial perfusion stress test

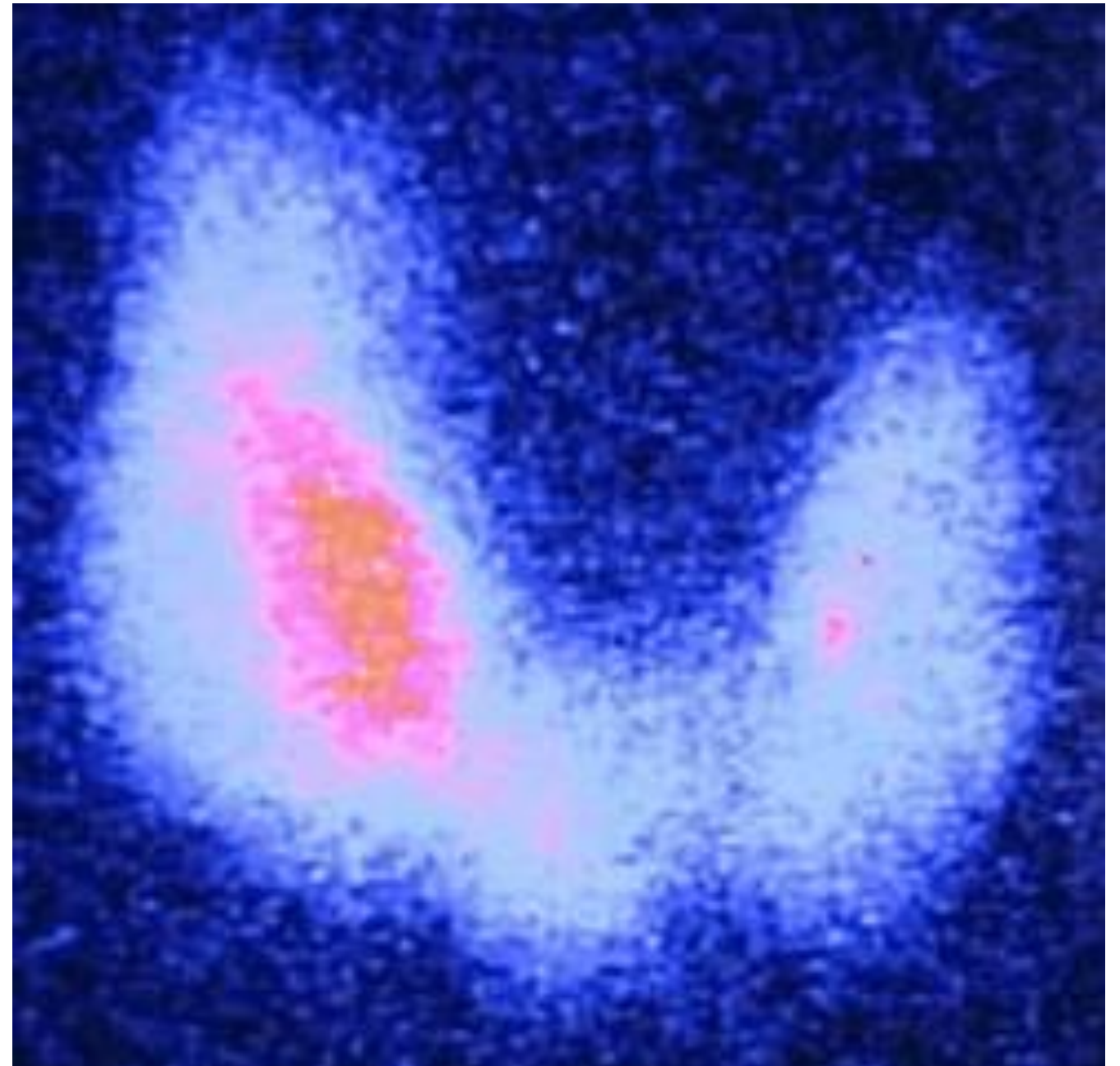


Dark areas of the heart muscle have low perfusion



Nuclear imaging - SPECT

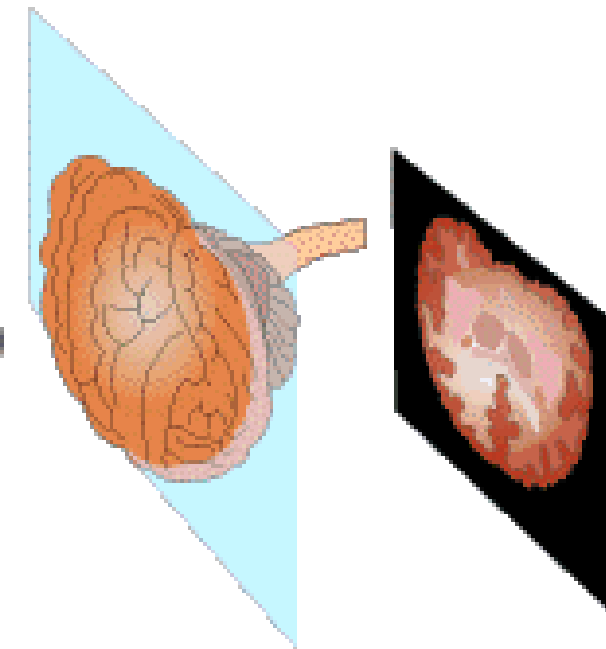
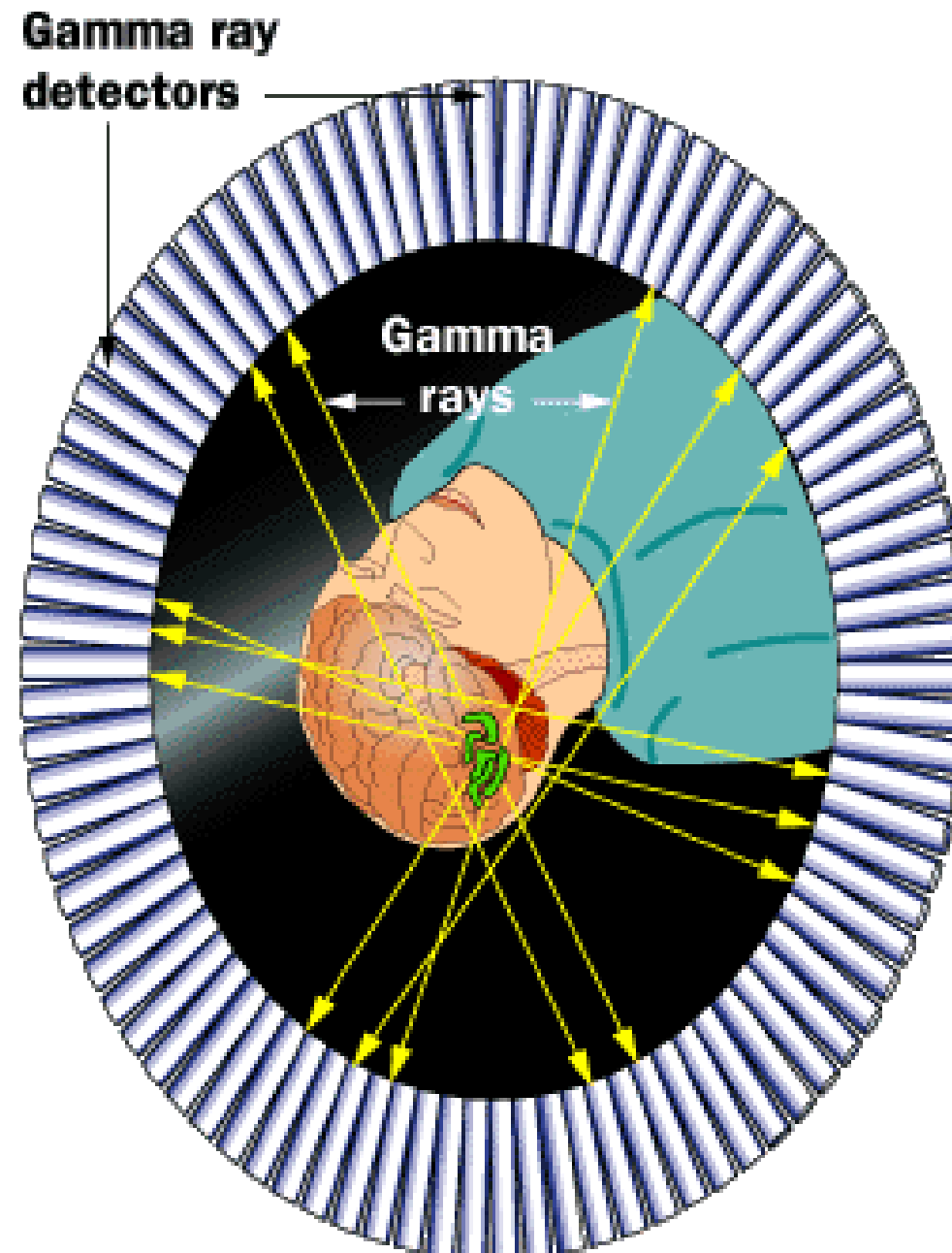
Lung scan: tumor cells
are more active



PET: Positron Emission Tomography

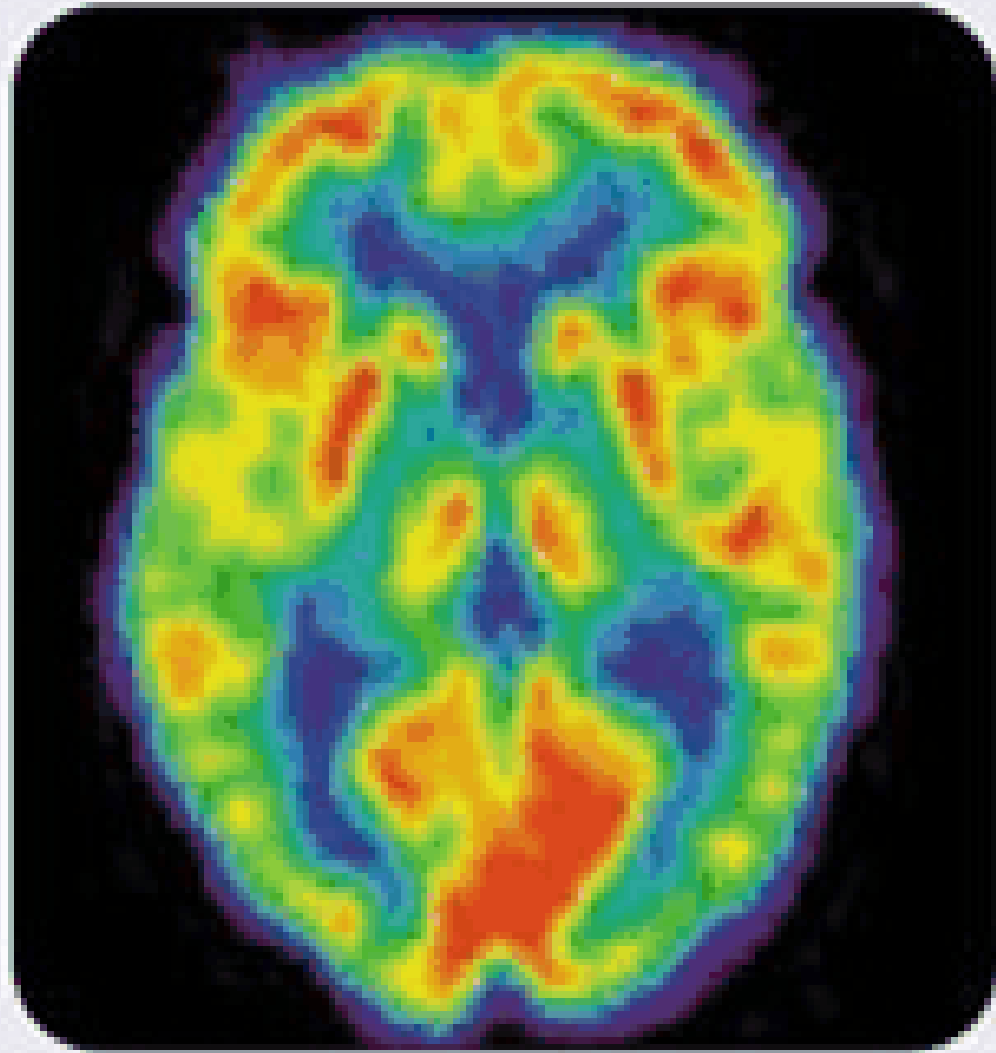


Radionuclide tracer: FDG, a form of glucose. The more metabolically active the tissue, the more FDG will flow there.

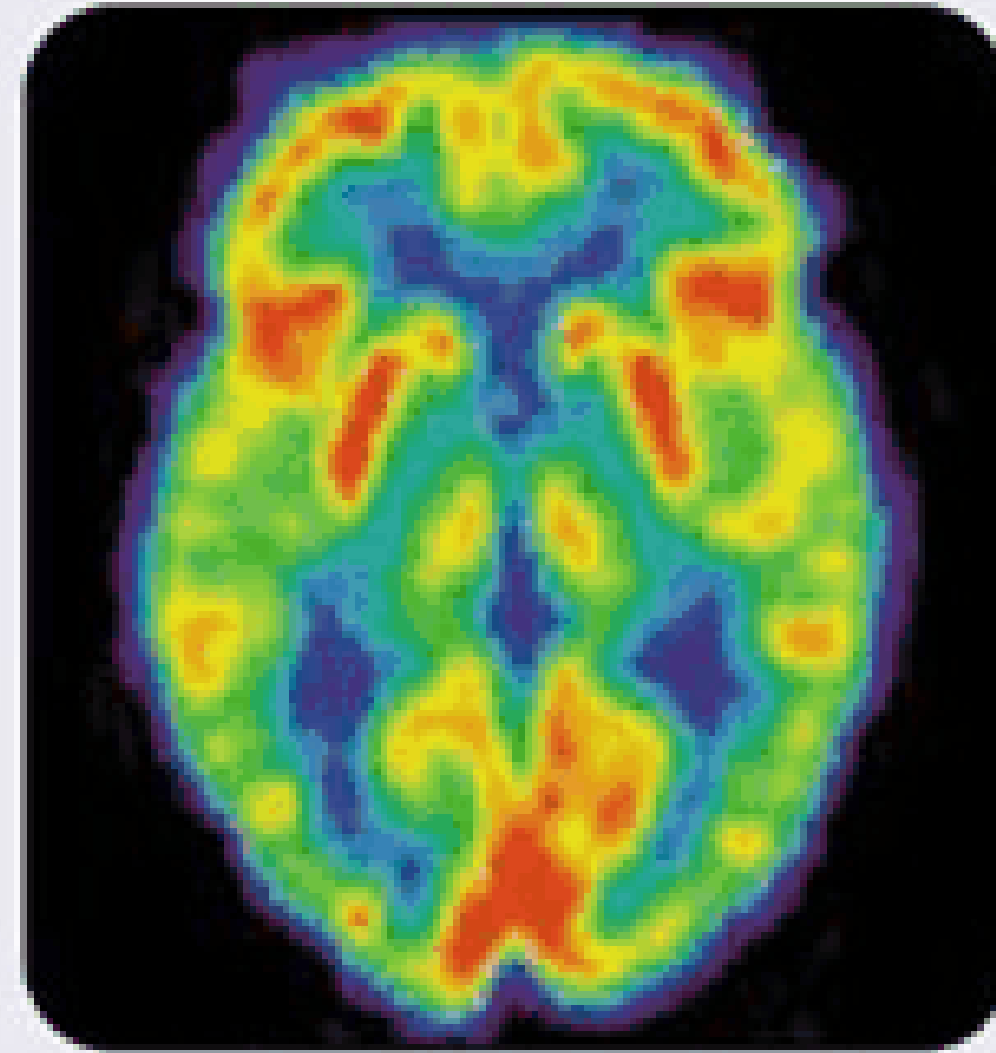


©2000 How Stuff Works

X-ray CT codes for structure, PET for **activity**



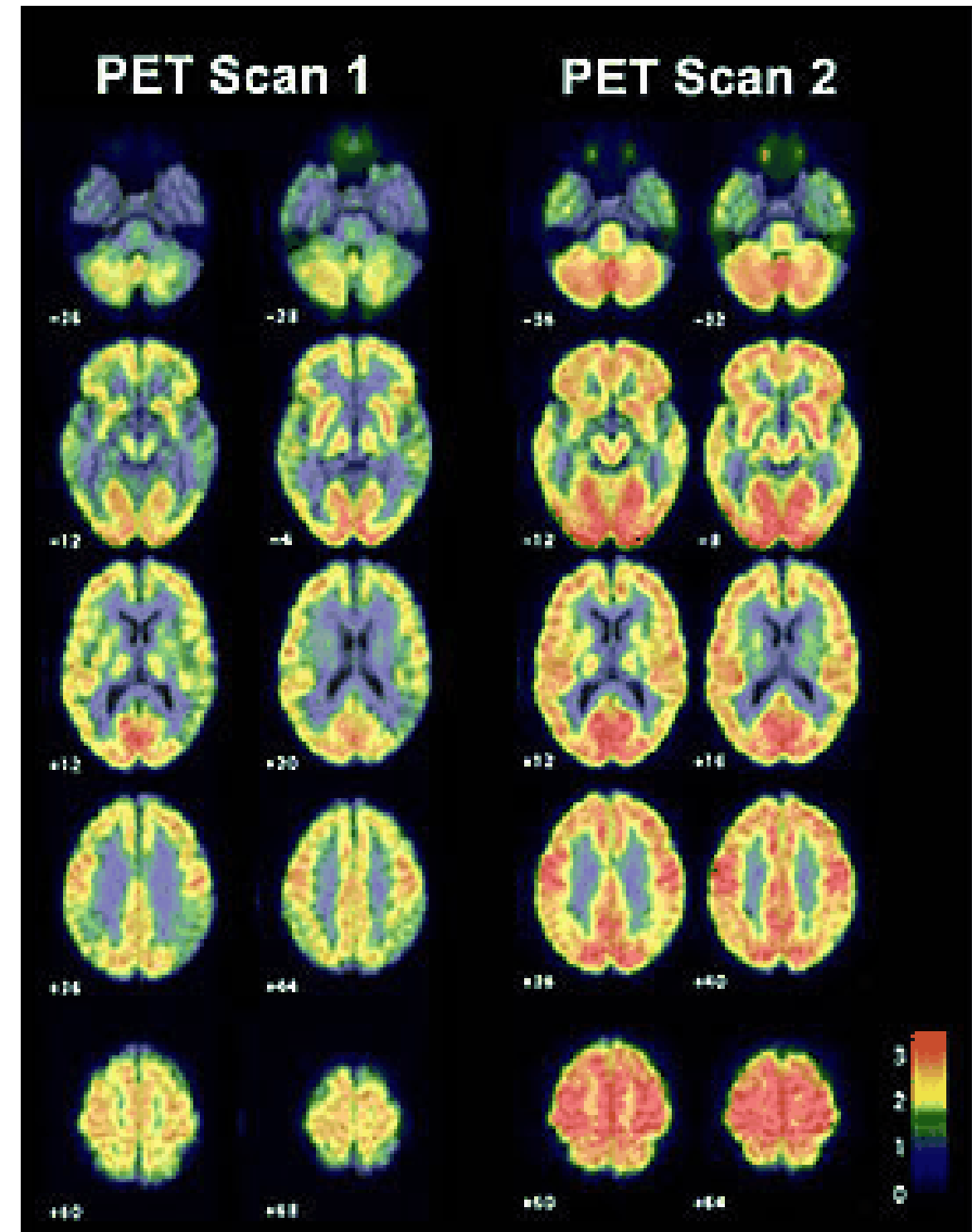
PET Scan of 20-year-old Brain



PET Scan of 80-year-old Brain

There's hope for us people of a certain age!

Activity coding (radio-isotope tagged glucose-like ^{18}F FDG) data overlaid on standardized MRI templates.



Comparing the two nuclear imaging modalities:

PET
<ul style="list-style-type: none">▪ Emits positrons▪ Higher resolution▪ Costlier scanner▪ Limited halflife of radiopharmaceuticals

SPECT
<ul style="list-style-type: none">▪ Emits gamma radiations▪ Lower resolution▪ Less capital intensive scanner▪ Longer lived radioisotopes

Combined PET/CT scan

CT Scan

Organs and bones



PET Scan

Cell activity

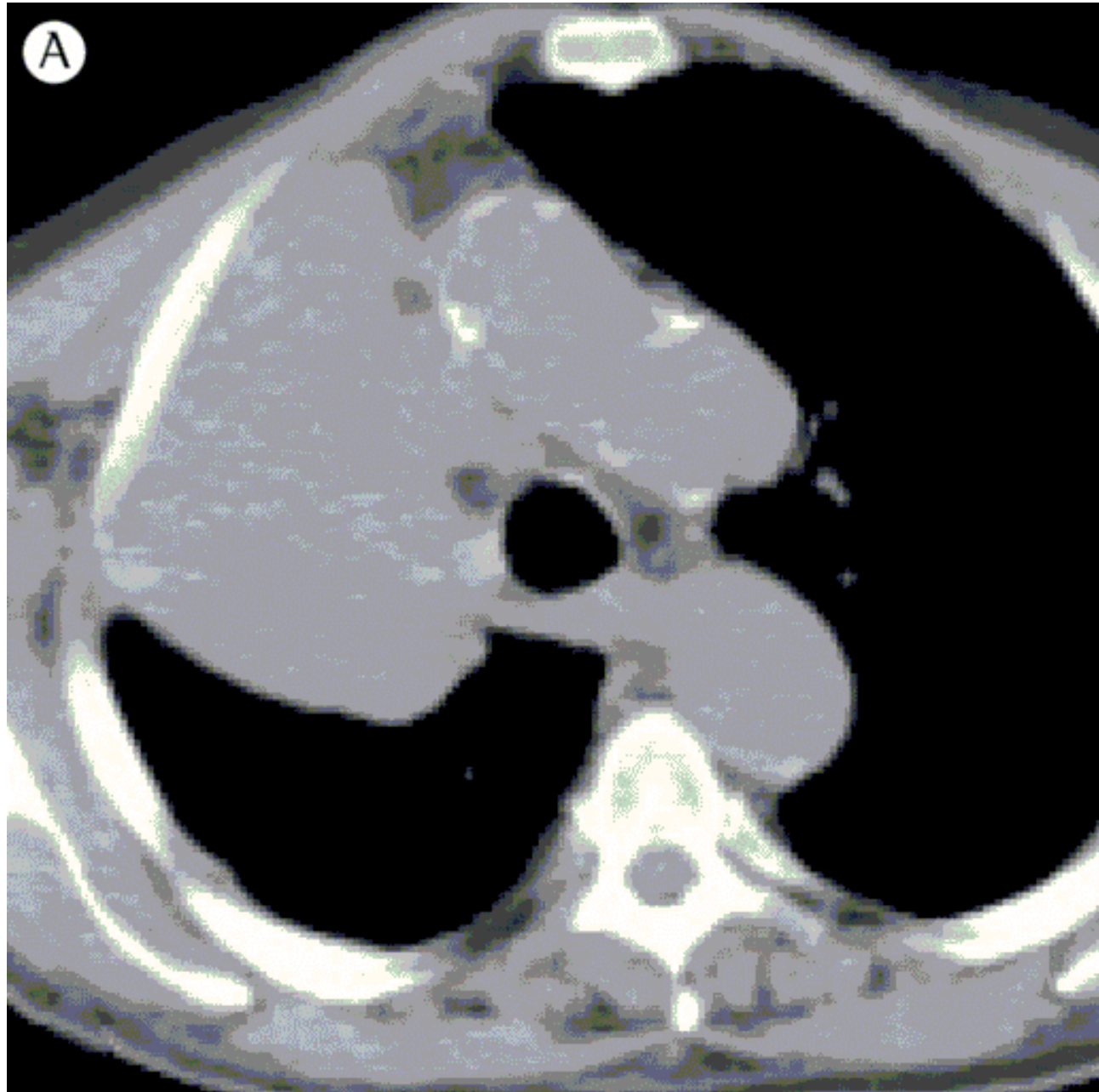


PET/CT Scan*

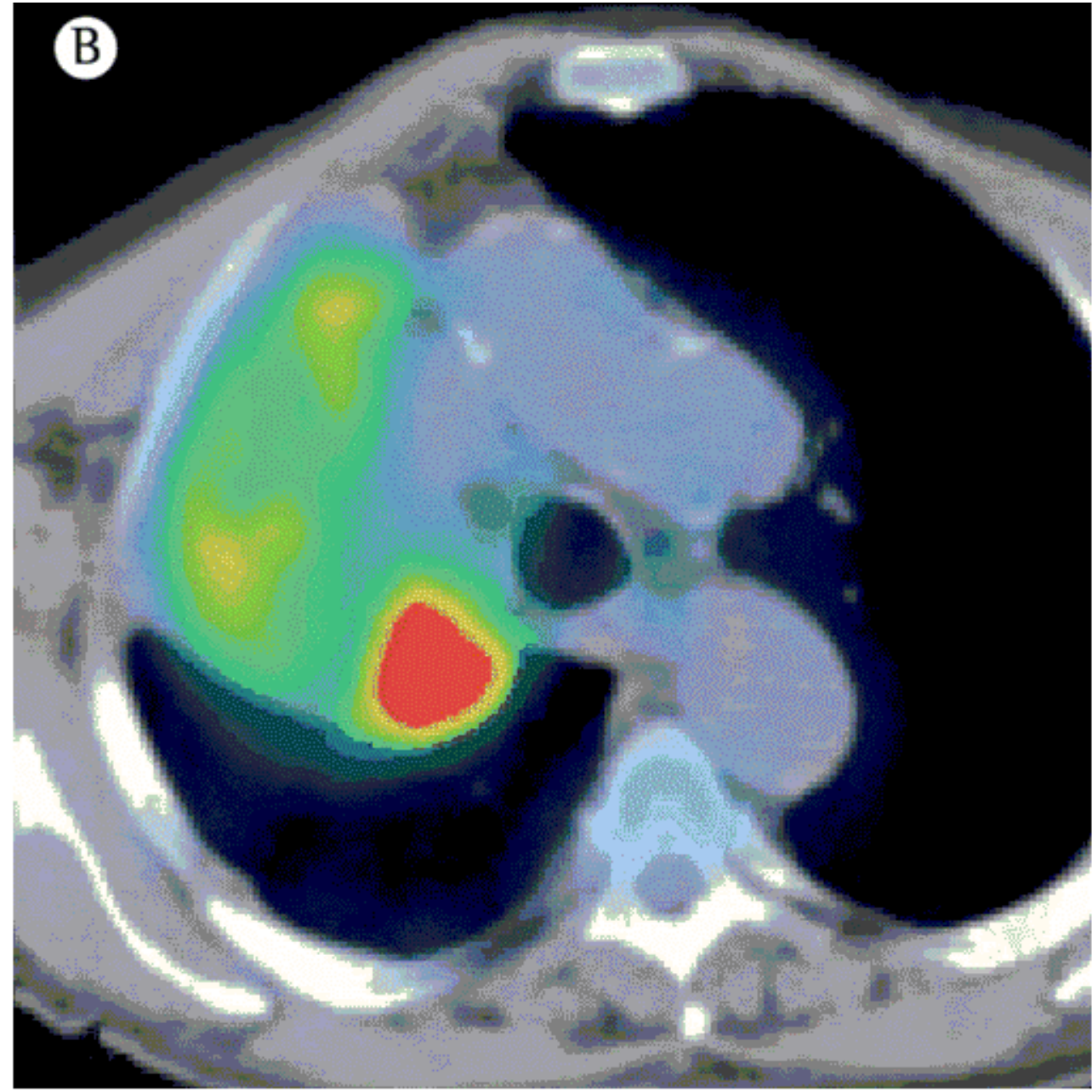
Exact location of high cell activity



Comparison: CT alone vs PET/CT



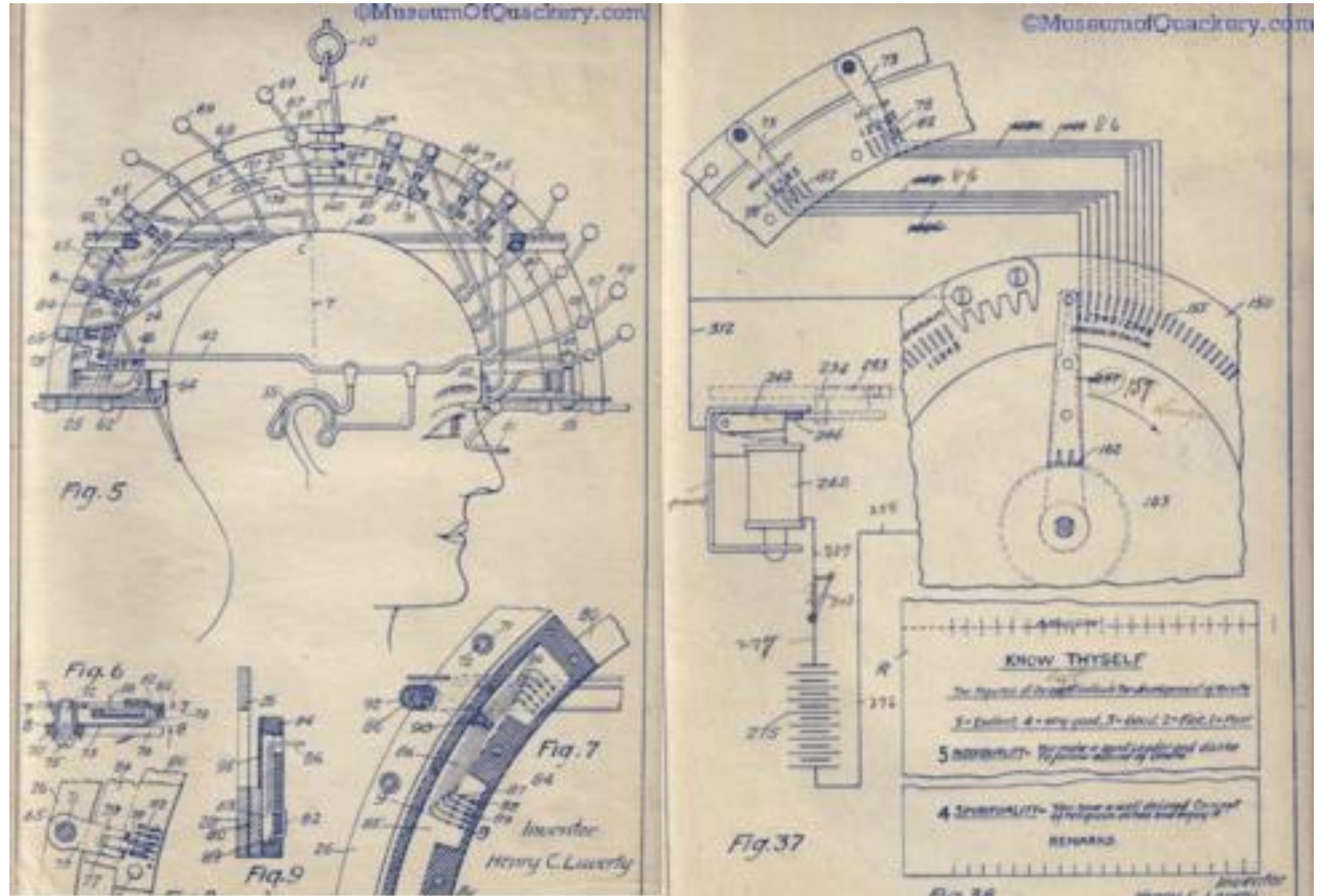
Axial CT image of lungs showing large mass in left lung



Combined CT/PET image showing tumor

And now for something completely different...

Medical Imaging
Quackery



The Psychograph: A phrenology imager

Pseudoscience imaging

Proper application
of psychograph
helmet





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Nervo-Scope® ETS-9A



Item #: CHR-ETS-9A

Nervo-Scope® reliably detects and measures minute heat differences in the tissues along the spine. The instrument can be used comfortably for both pre and post adjustment assessment.

In today's world, cell phones, tablets, laptops, Blue Tooth systems, wireless networks, radio transmitters, fluorescent lights, etc. are everywhere. In essence, RFI is at an all time high.

As a result of feedback from the Chiropractic community, EDL's newest Nervo-Scopes® (ETS-9 and ETS-9A) are engineered to reject the influence of these sources and give stable, accurate readings every time the instrument is used.

EDL's newest Nervo-Scopes® have the same sensitivity as our previous models. The ETS-9A is compatible with the Analograph® Graph Recorder and both models are designed to automatically power down after ten minutes.



Each Nervo-Scope® includes a foam-padded carrying case and cleaning brush.
All of the ETS series Nervo-Scopes are protected by a full two-year warranty against workmanship and defective components.

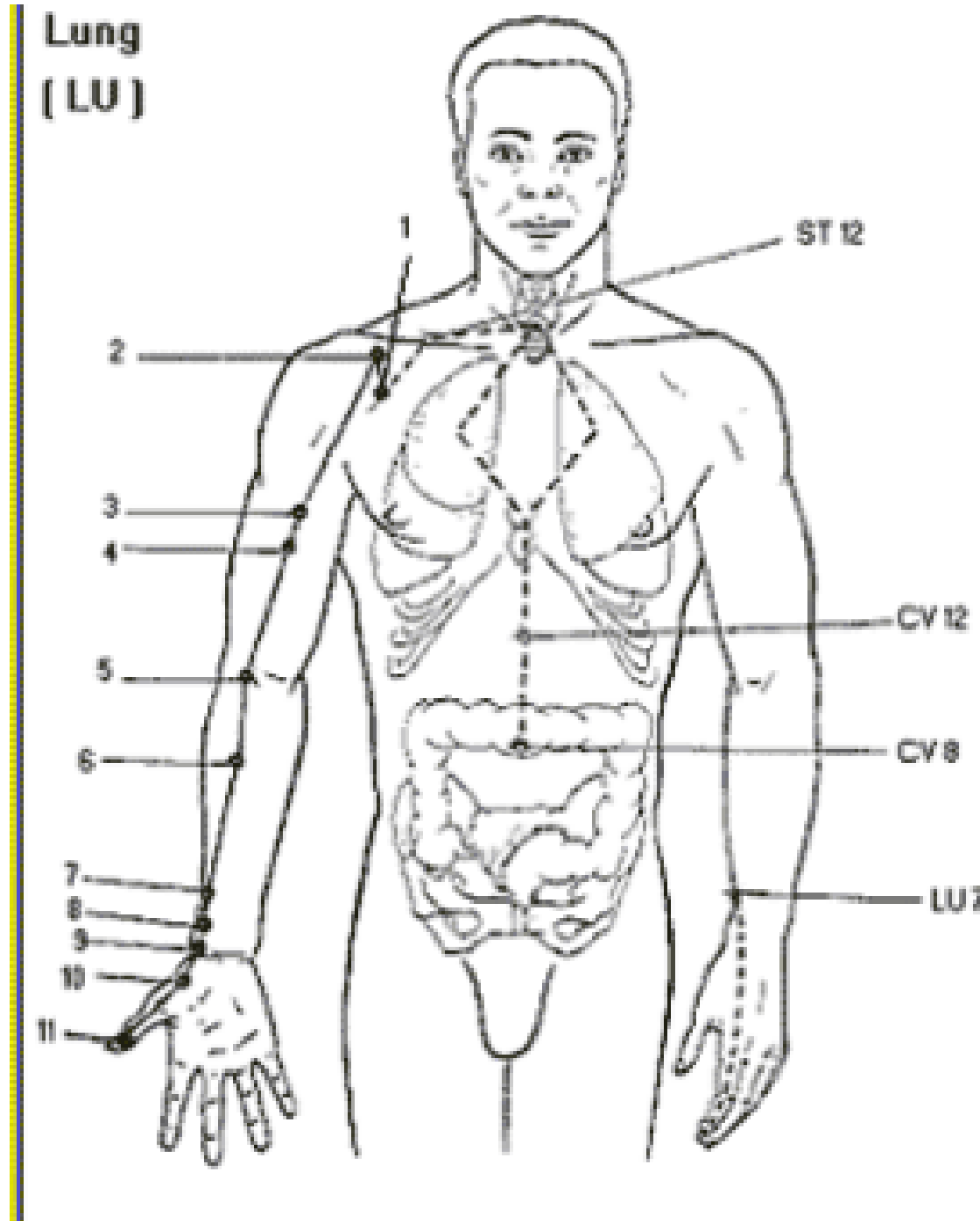
Pseudoscience: system of thought claiming scientific validity but lacking a scientific evidentiary base

'Nervo-Scope" delivers thermographic data at the level of hundredths of a degree along the spine.

No published replicated experiments to show any diagnostic value.

Pseudoscience imaging

Note: EMI is not acupuncture, which has proven therapeutic, if not diagnostic, value.



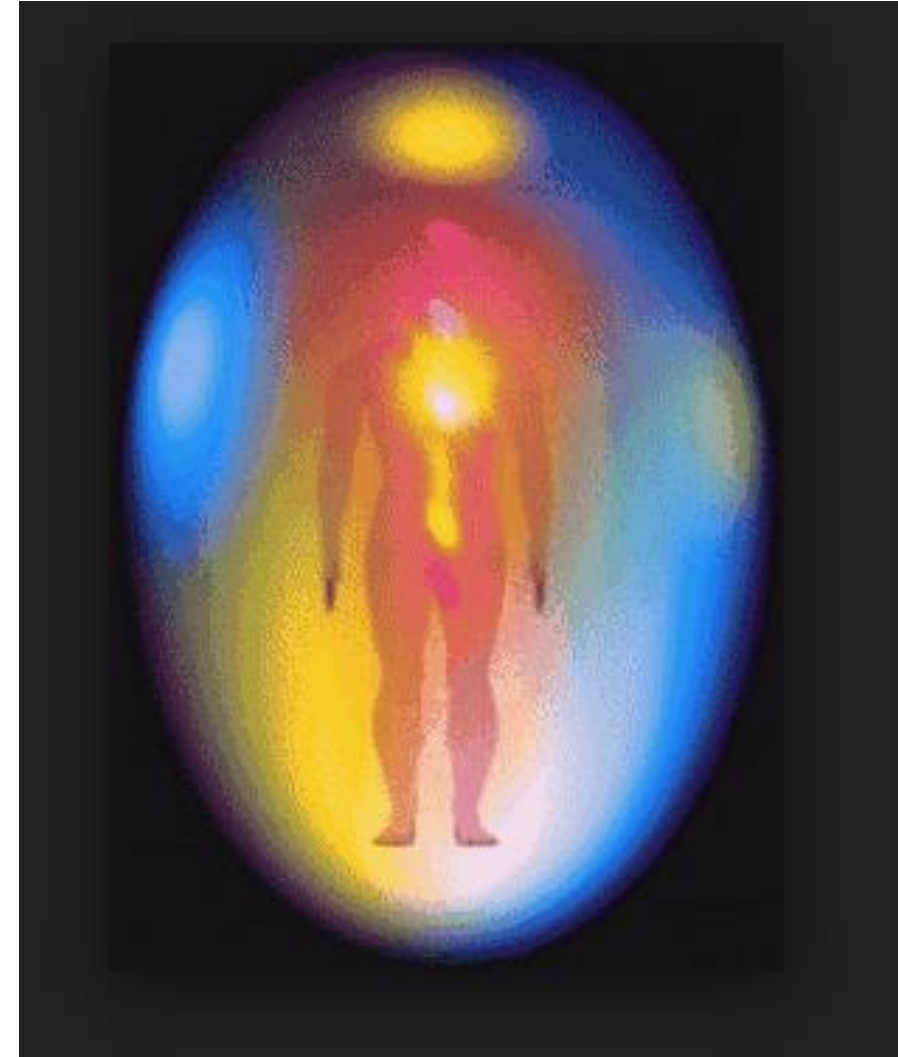
- Alarm - LU 1
 - Associated - BL 13
 - LU 5 - Water-Sedation-Sea
 - LU 6 - Hsi
 - LU 7 - Luo
 - LU 8 - Metal-Horay-River
 - LU 9 - Earth-Tonify-Source-Stream
 - LU 10 - Fire - Spring
 - LU 11 - Wood-Tsing-Well
- Five Elements
 - Alarm
 - Associated
 - Source, Tsing
 - Tonification
 - Sedation
 - Luo
 - Xi-Hsi-Cleft Points
 - Horay Points
 - Lung
 - Large Intestine
 - Stomach
 - Spleen
 - Heart
 - Small Intestine
 - Bladder
 - Kidney
 - Pericardium
 - Tri-Heater
 - Gallbladder
 - Liver
 - Vessel (GV, CV)
 - 30 Primary Points
 - Auriculotherapy 1
 - Auriculotherapy 2
 - Auriculotherapy 3
 - Herbs 1
 - Herbs 2
 - Herbs 3

EMI: Electro-Meridian Imaging

Pseudoscience imaging



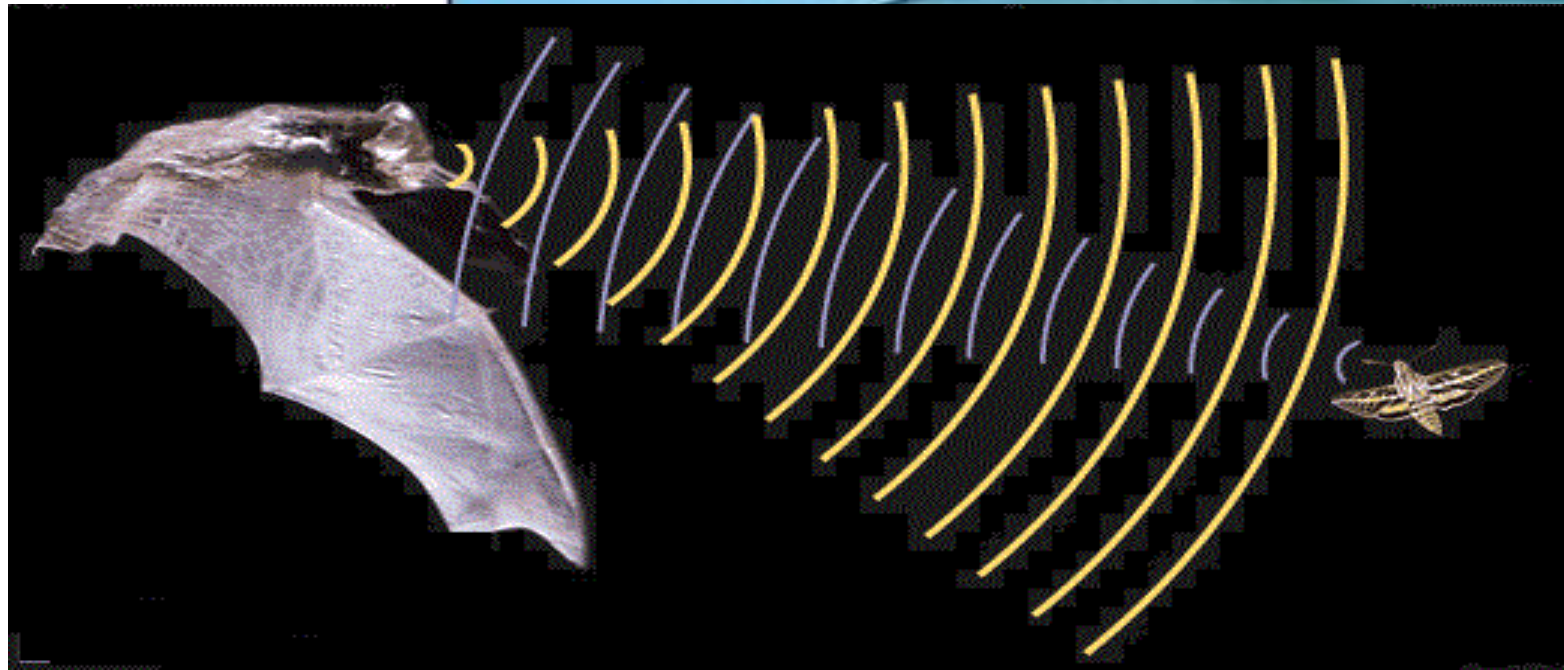
Kirlian photograph: high frequency pulsed contact film image claimed to visualize "life force"



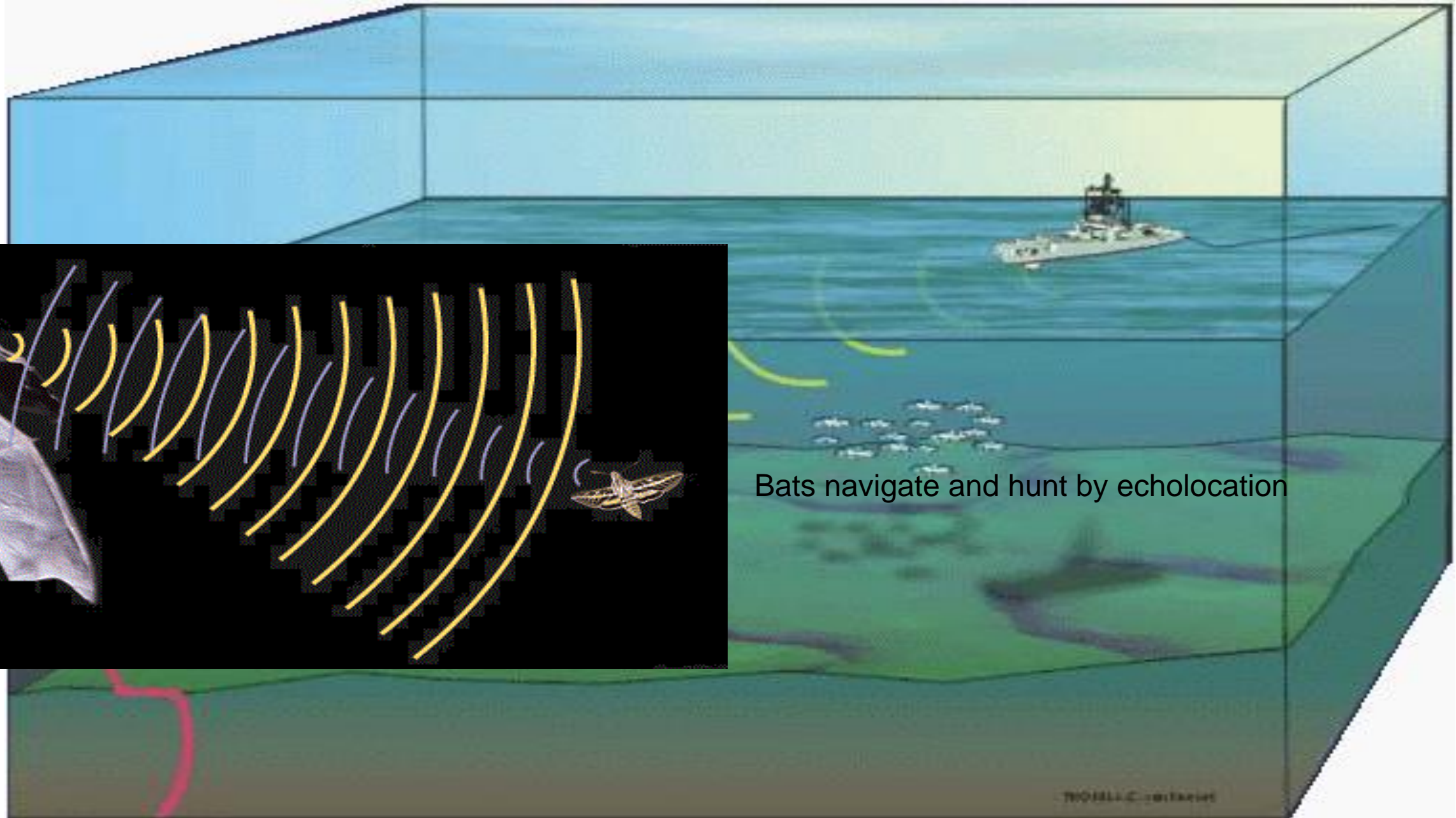
Aura image: claimed to visualize "chakra spiritual energy."

Ultrasound

Ultrasound

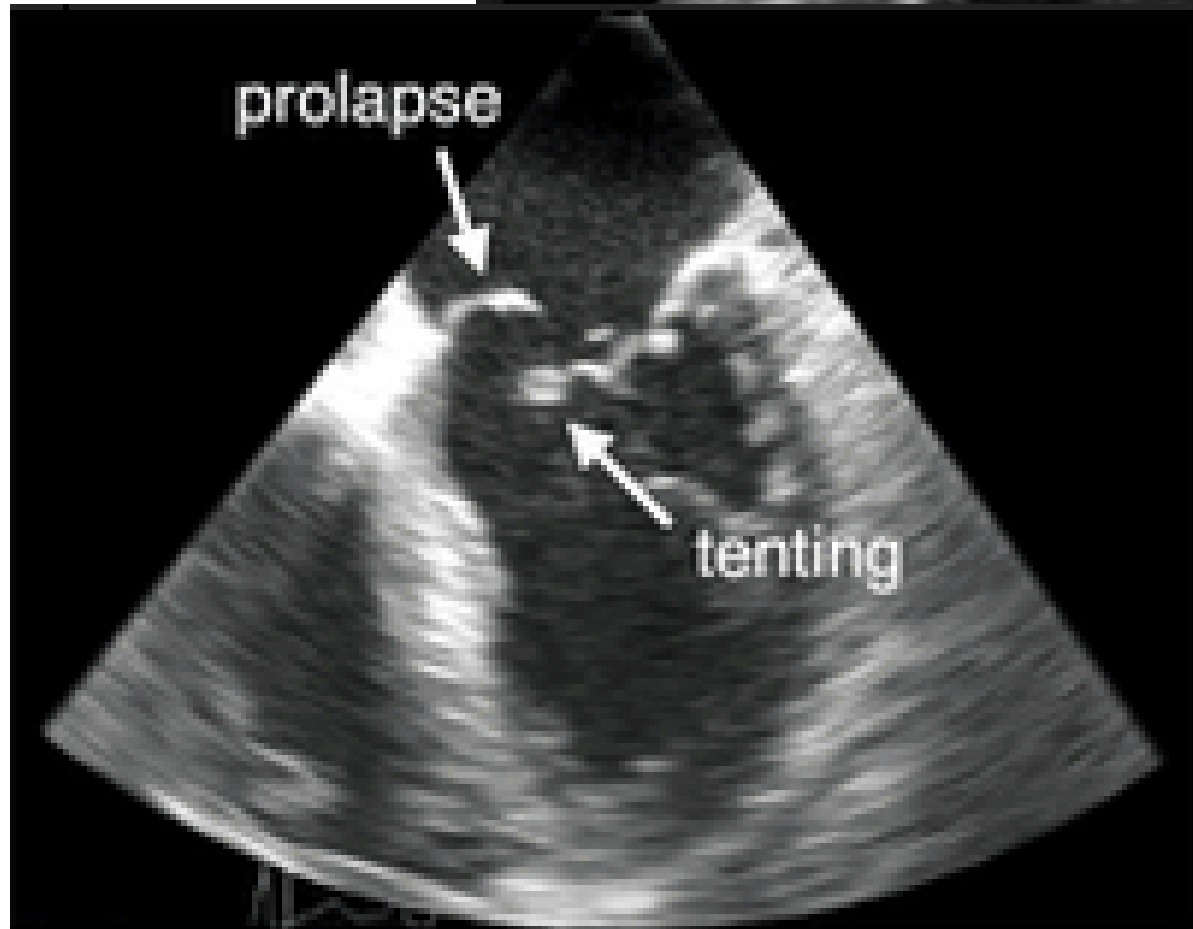


Bats navigate and hunt by echolocation

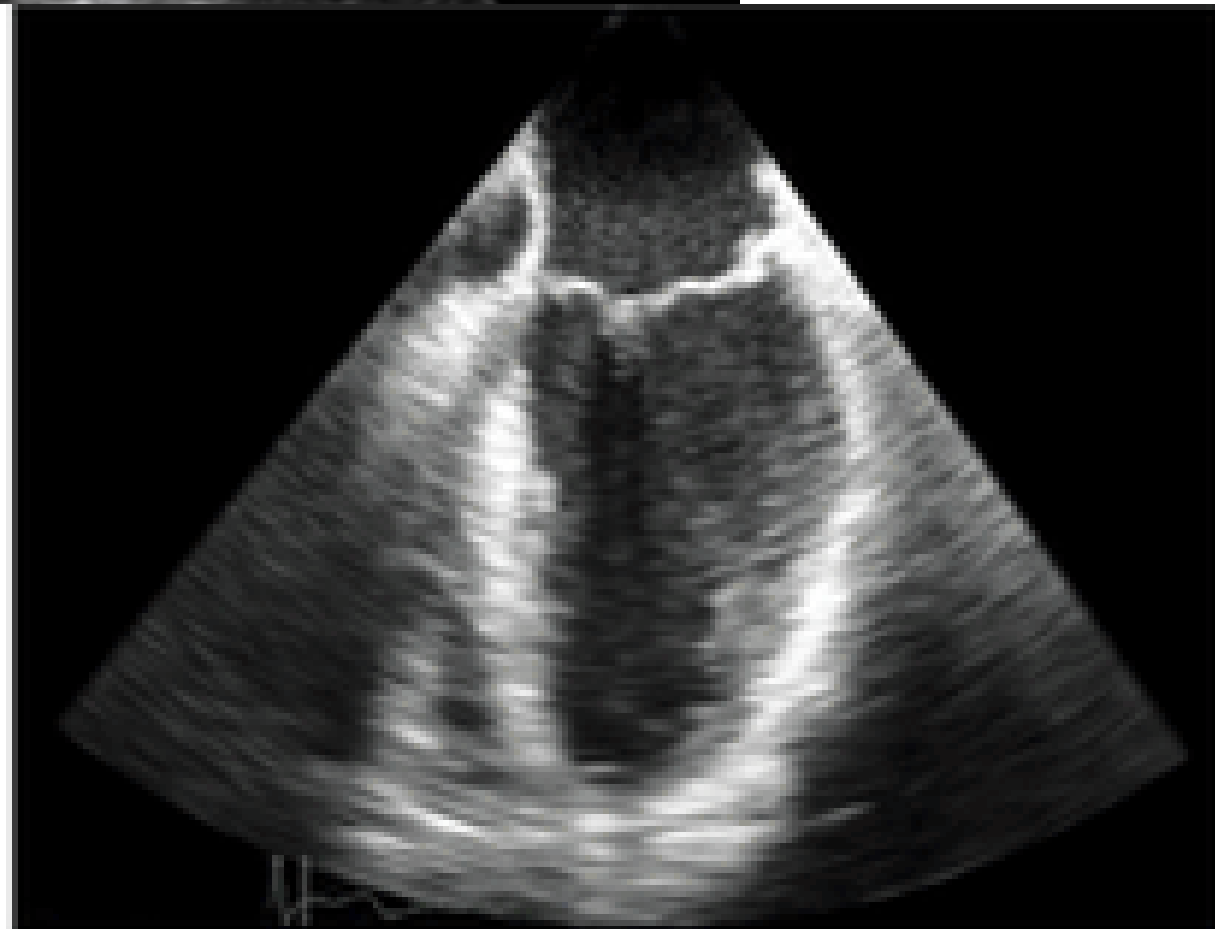


Sonar works by echolocation

Ultrasound



mitral valve defect



normal mitral valve image

The Difference Between

2D



3D



VIDEO

4D



Ultrasound Scans

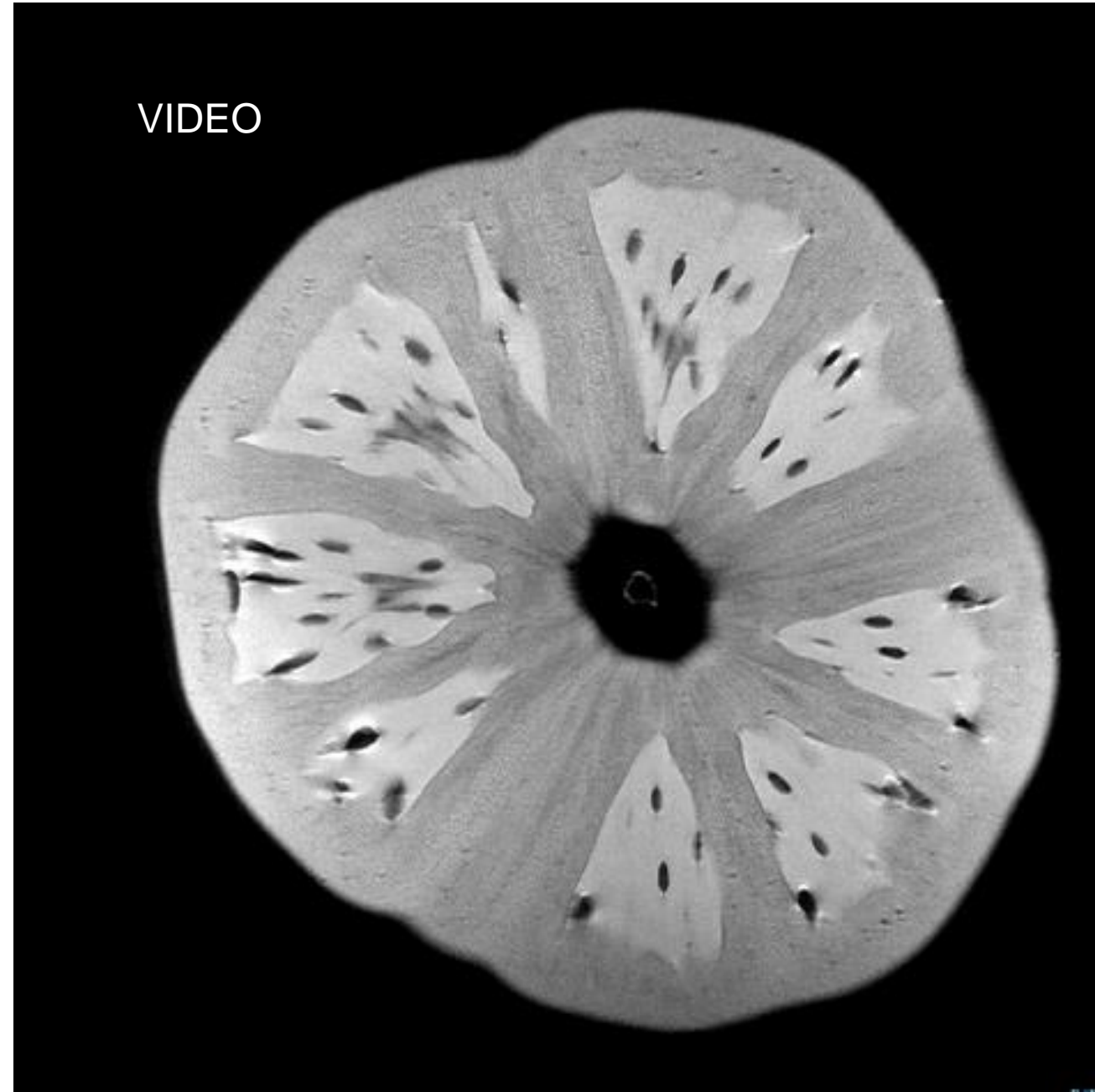


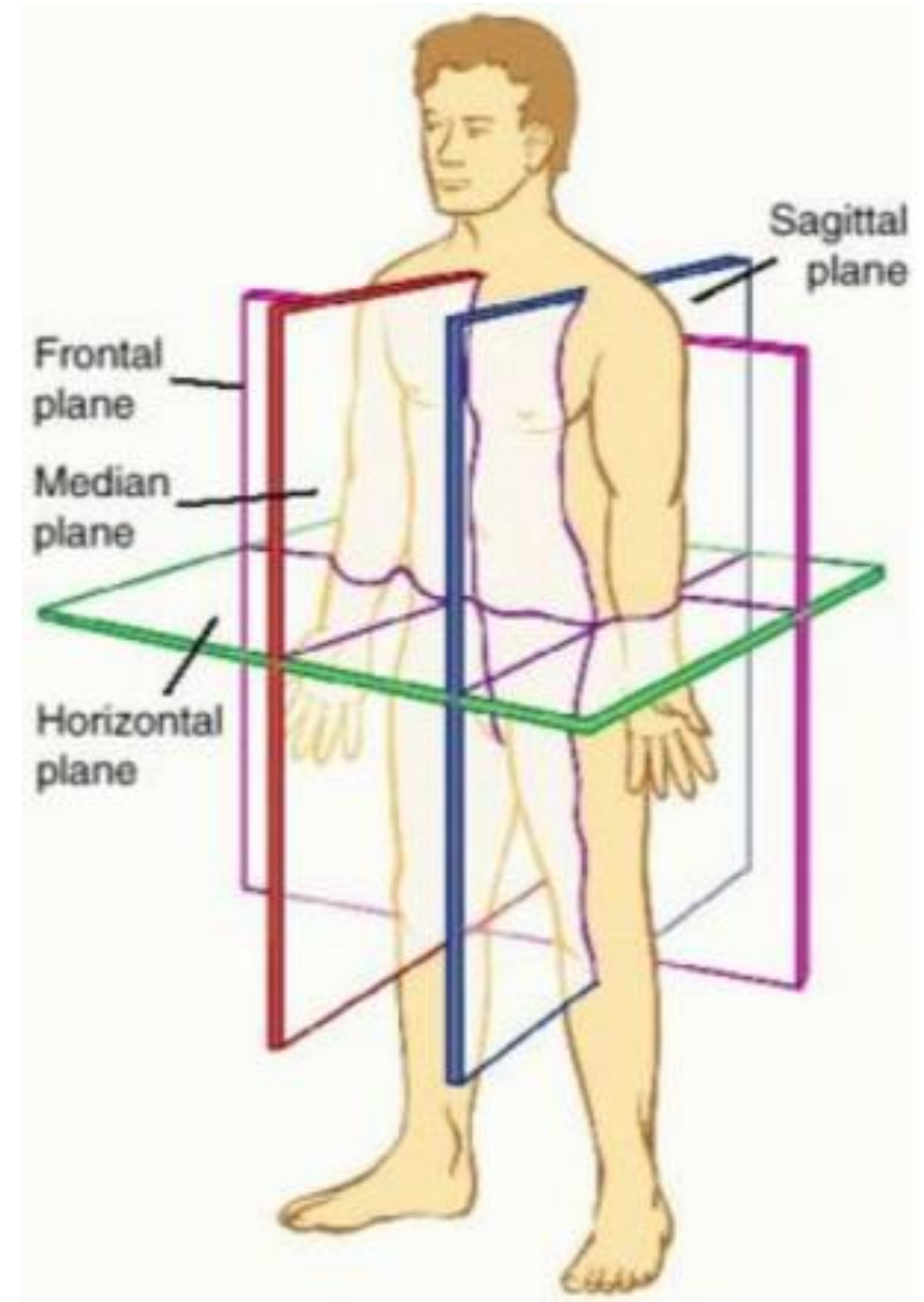
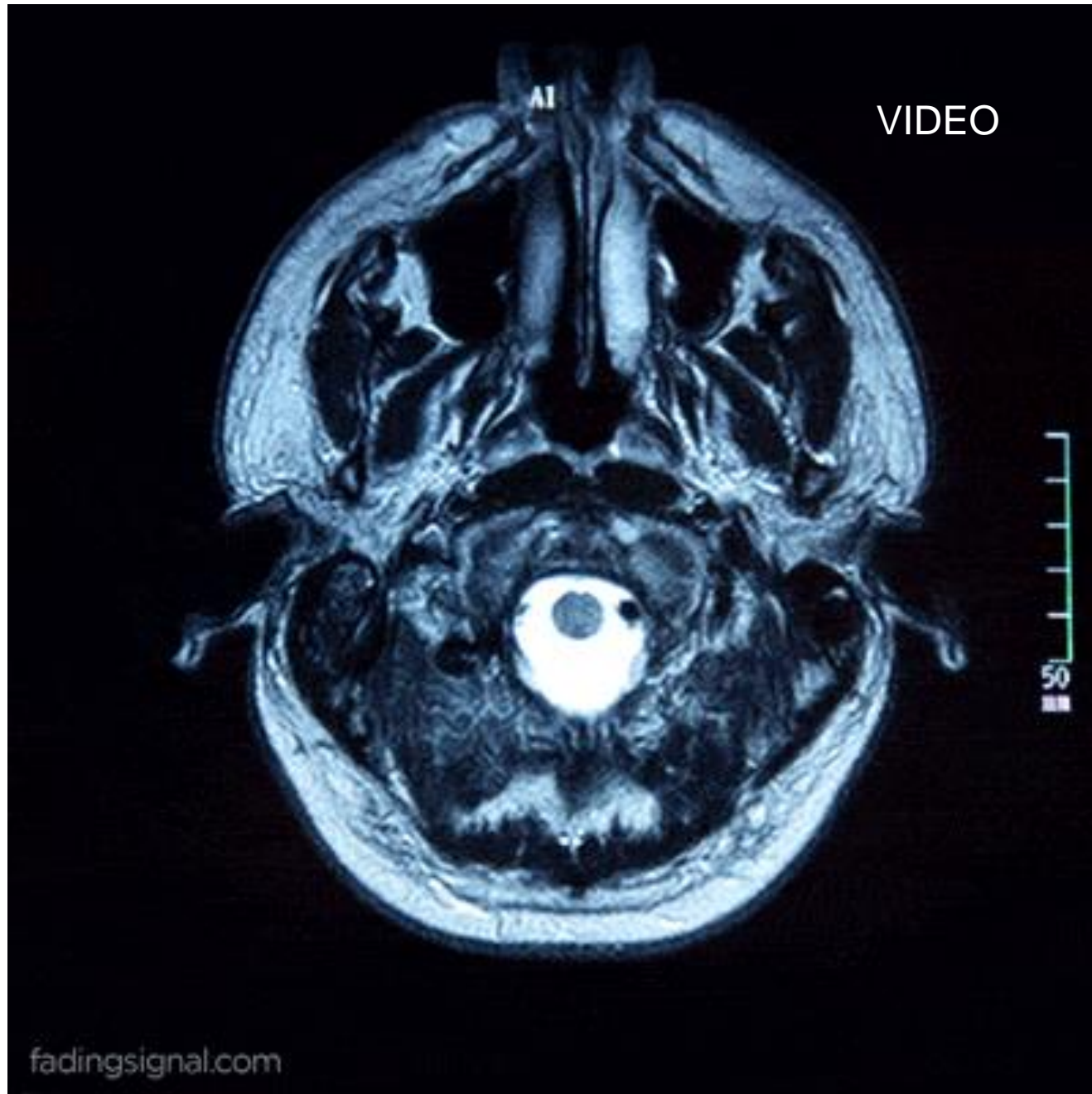
Same baby pre- and post-partum

MRI: Magnetic Resonance Imaging

Raymond Damadian showed in 1968 that Nuclear Magnetic Resonance (NMR) could be used to distinguish cancer from normal tissue (SUNY Downstate).

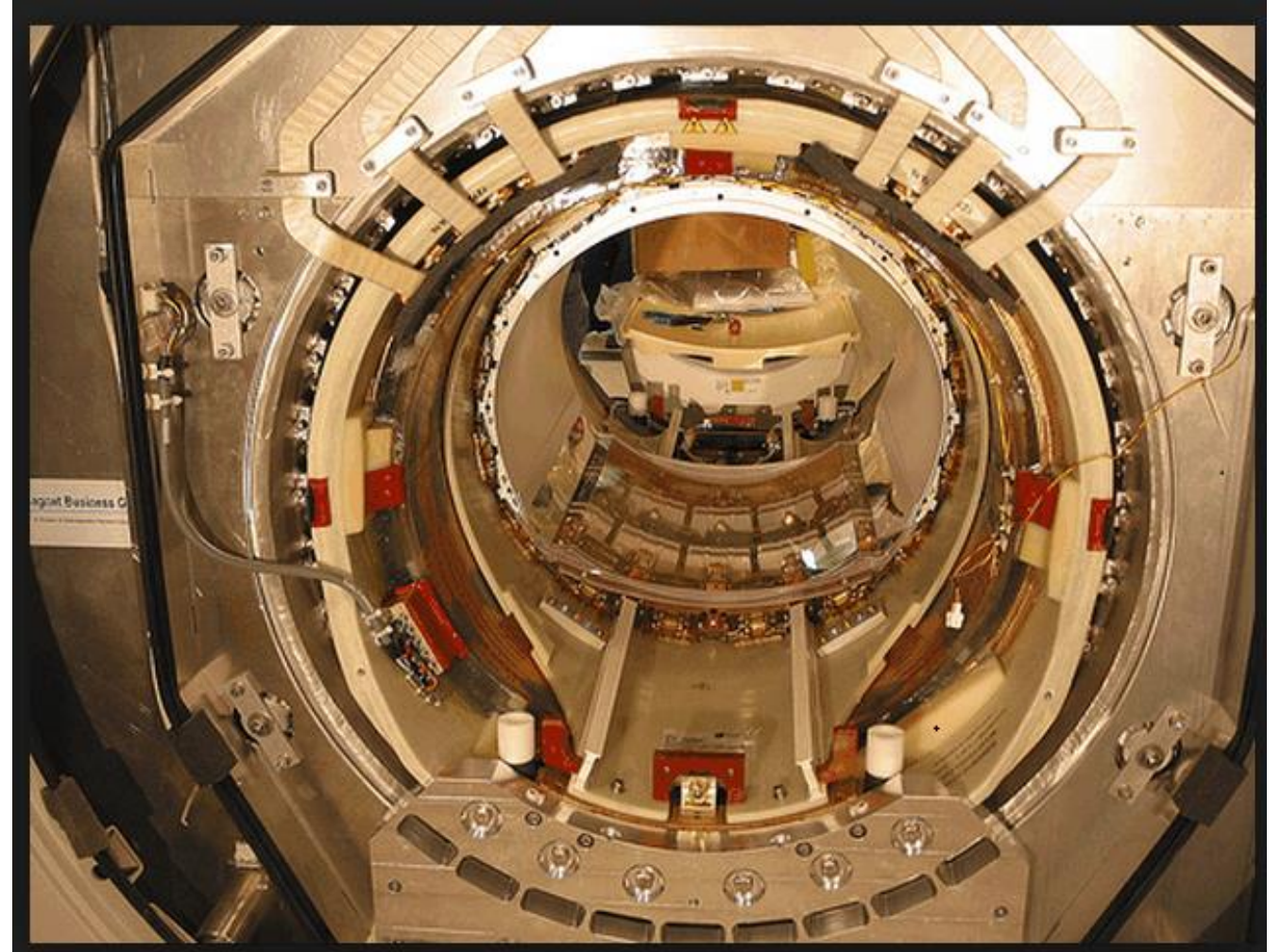
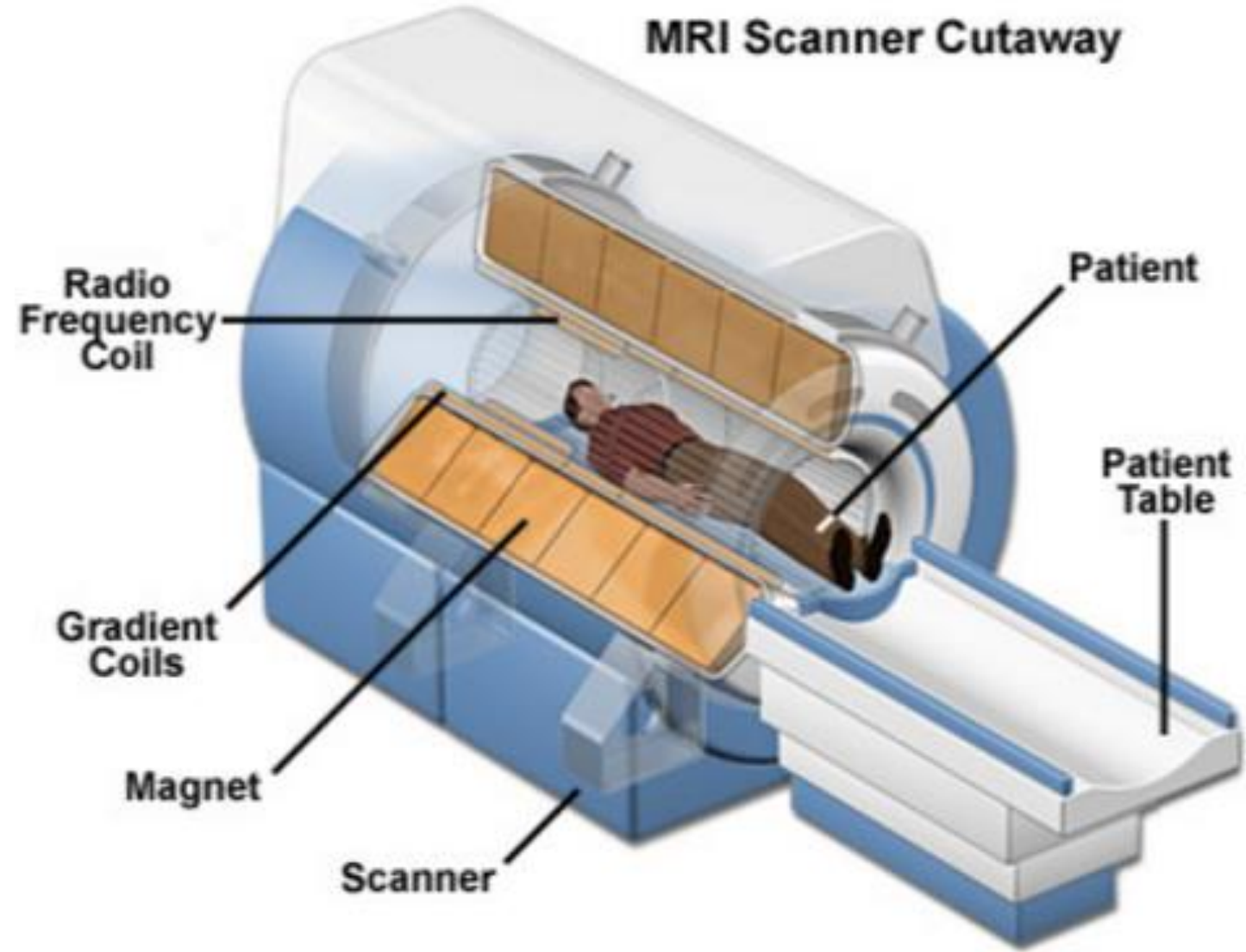
First MRI (NMR) medical image: Paul Lauterbur 1973 (SUNY Stonybrook)





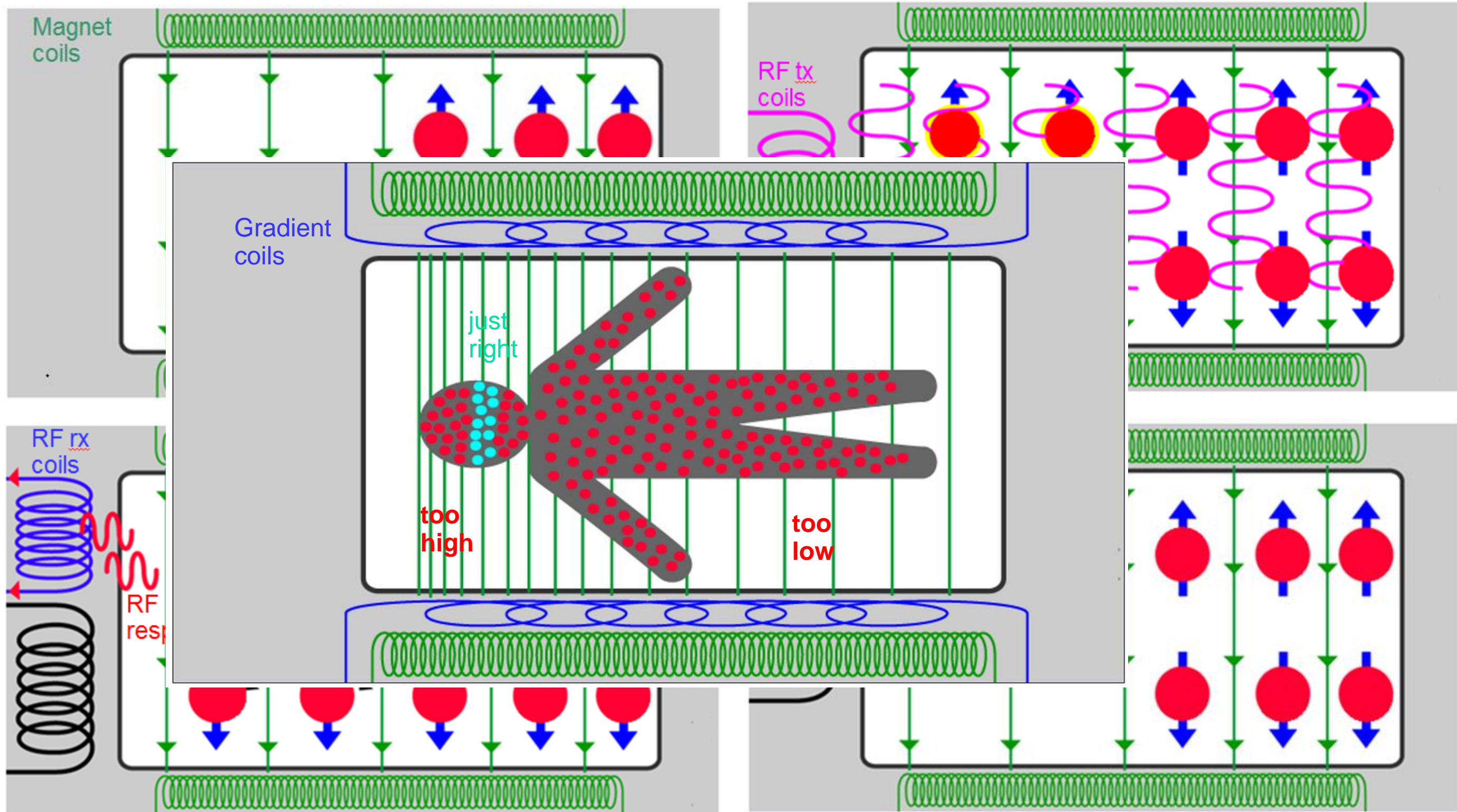
Horizontal Plane MRI sequence: normal adult head

MRI



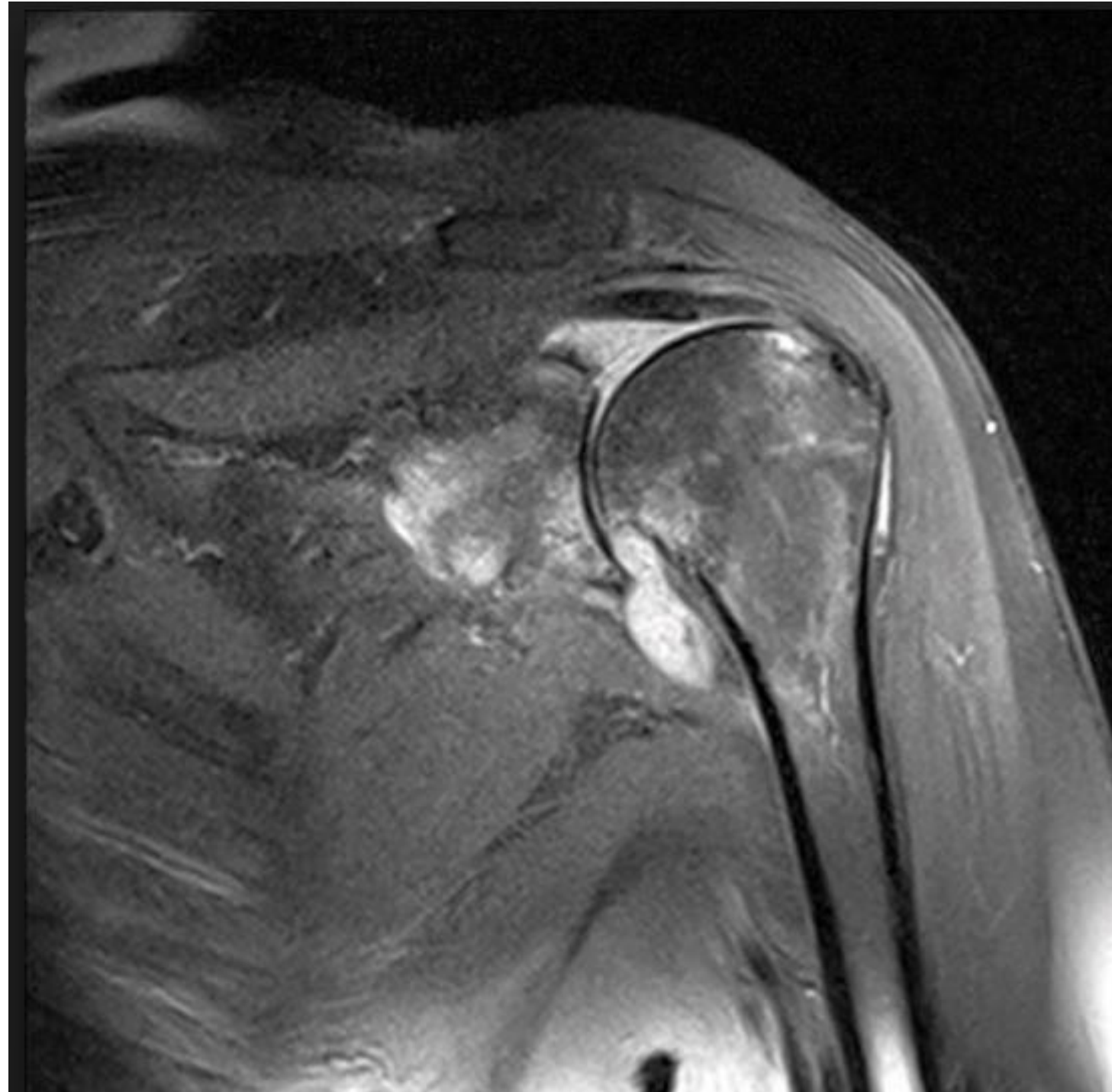
Magnet Chamber

How MRI works

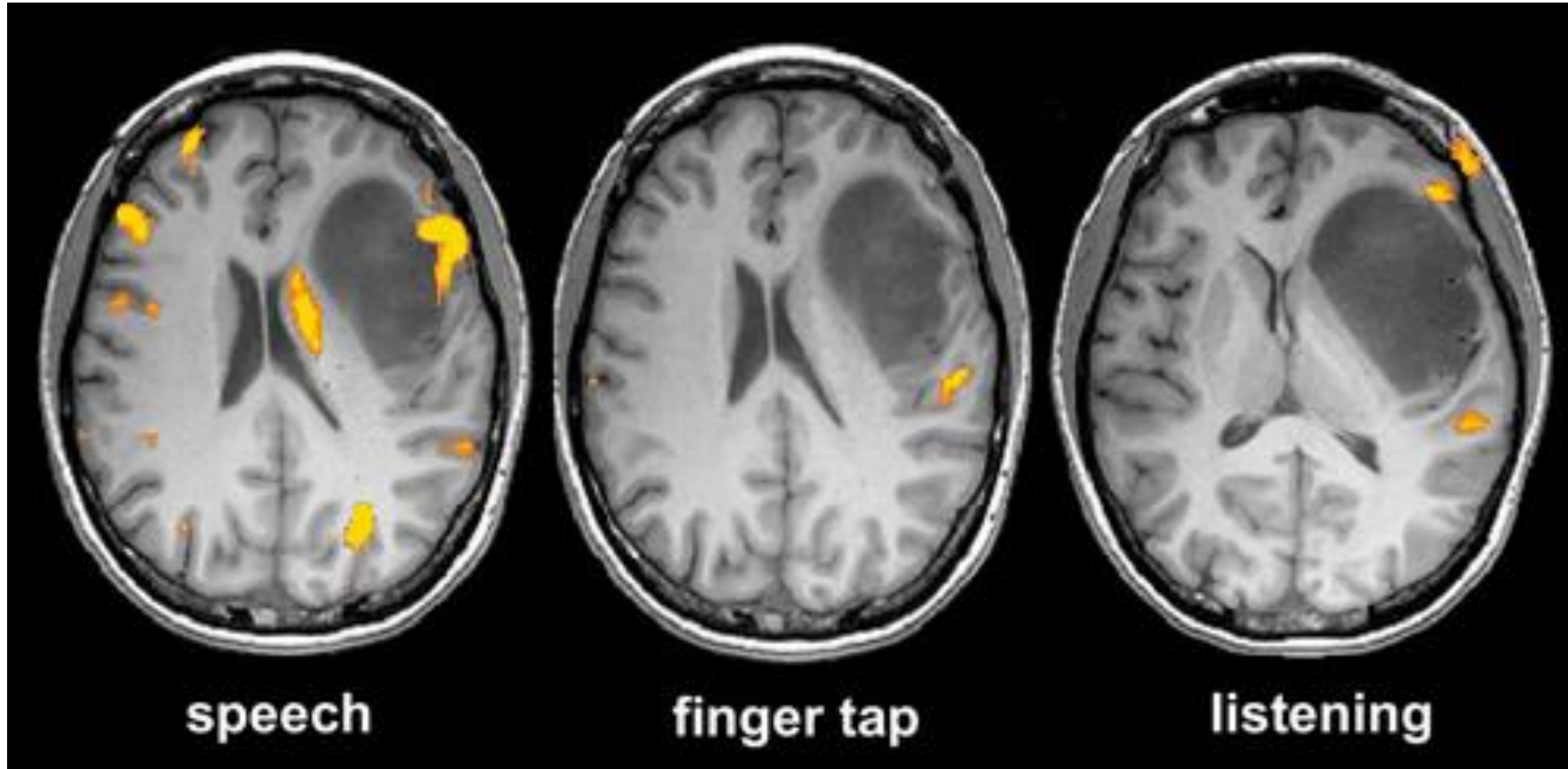


MRI

Inflammation invisible on x-ray
and CT can be identified in MRI



MRI



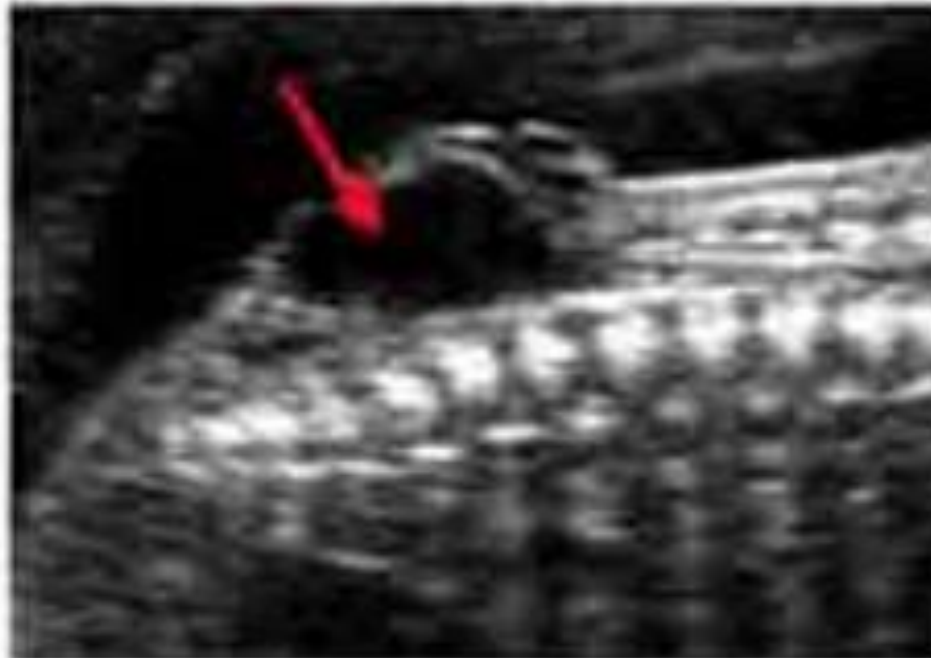
Functional MRI (fMRI): blood flow to a region of the brain increases the density of water molecules, thus increases contrast in MRI.

MRI

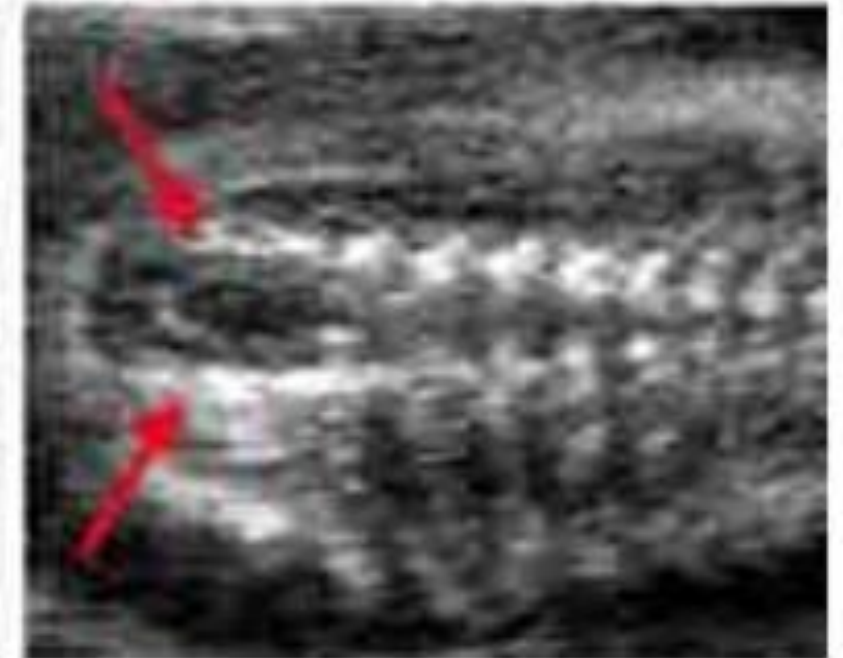
Axial Plane



Saggital Plane



Coronal Plane

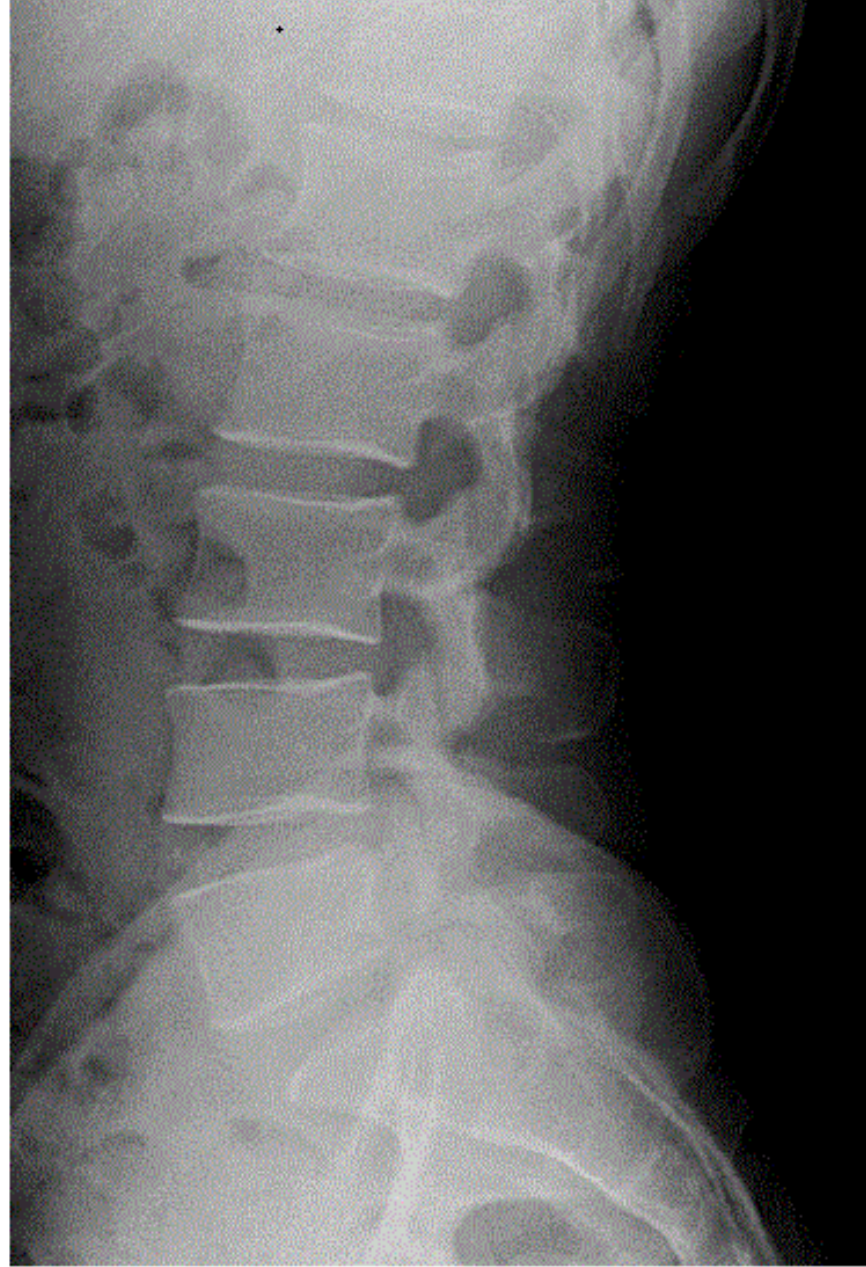


Fetal MRI revealing spina bifida

Comparisons



X-ray



CT



MRI

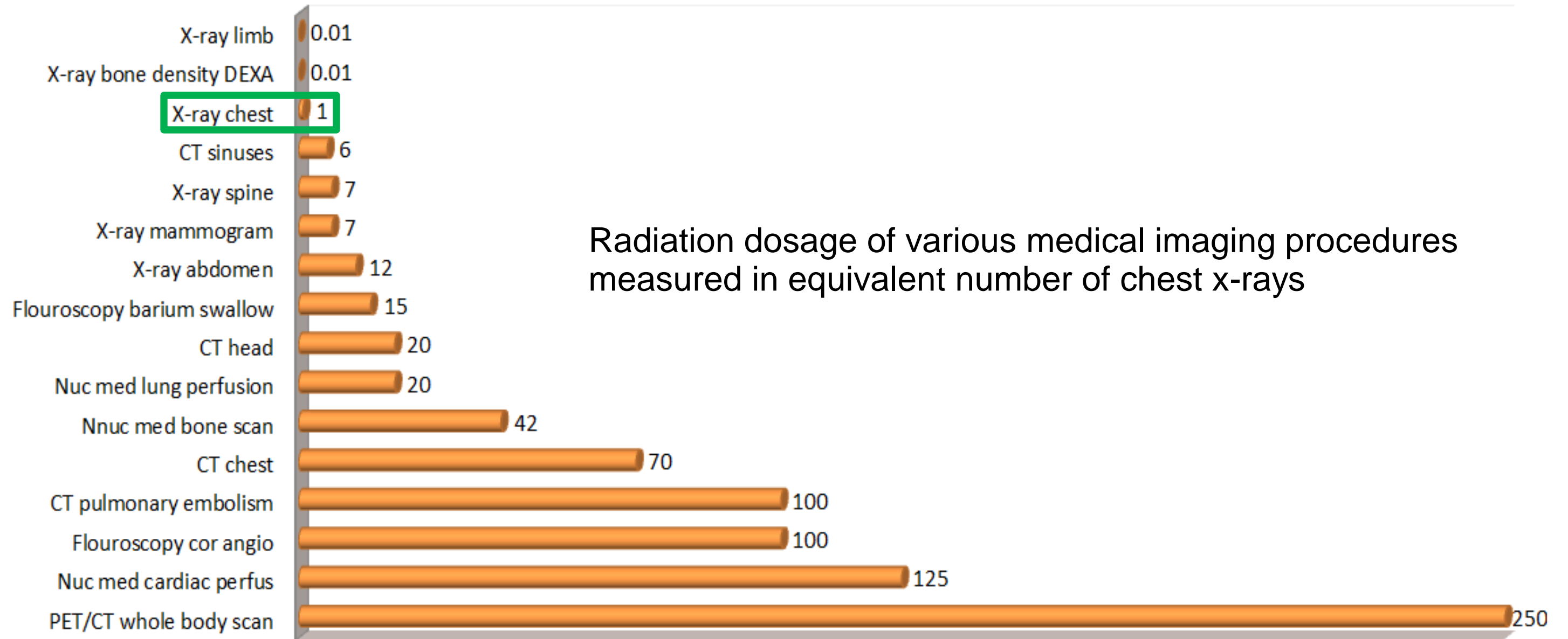
Imaging Risks and Concerns

Radiation Dosages

Everyday Activities	Radiation Dose	Medical Imaging	Radiation Dose
Watching television	0.01 mSv/year	Chest X-ray (1 film)	0.1 mSv
Air travel (roundtrip from D.C. to L.A.)	0.05 mSv	Nuclear med. thyroid scan	0.14 mSv
Average annual exposure from breathing radon gas	2 mSv	Mammogram (4 views)	0.4 mSv
Average annual exposure living in the United States	3 mSv/year	Nuclear med. lung scan	2 mSv
Annual dose limit for radiation workers in U.S.	50 mSv/year	Nuclear med. bone scan	4.2 mSv
		Tc-99m cardiac diagnostic	11 mSv
		Abdominal CT scan	8 mSv
		F-18 FDG PET/CT study	14 mSv
		Cancer treatment	50,000 mSv

Average increase in lifetime cancer risk due to CT scans is from 42.0% to 42.7% (Brig & Women's Hopa 2009 study)

Imaging risks and concerns

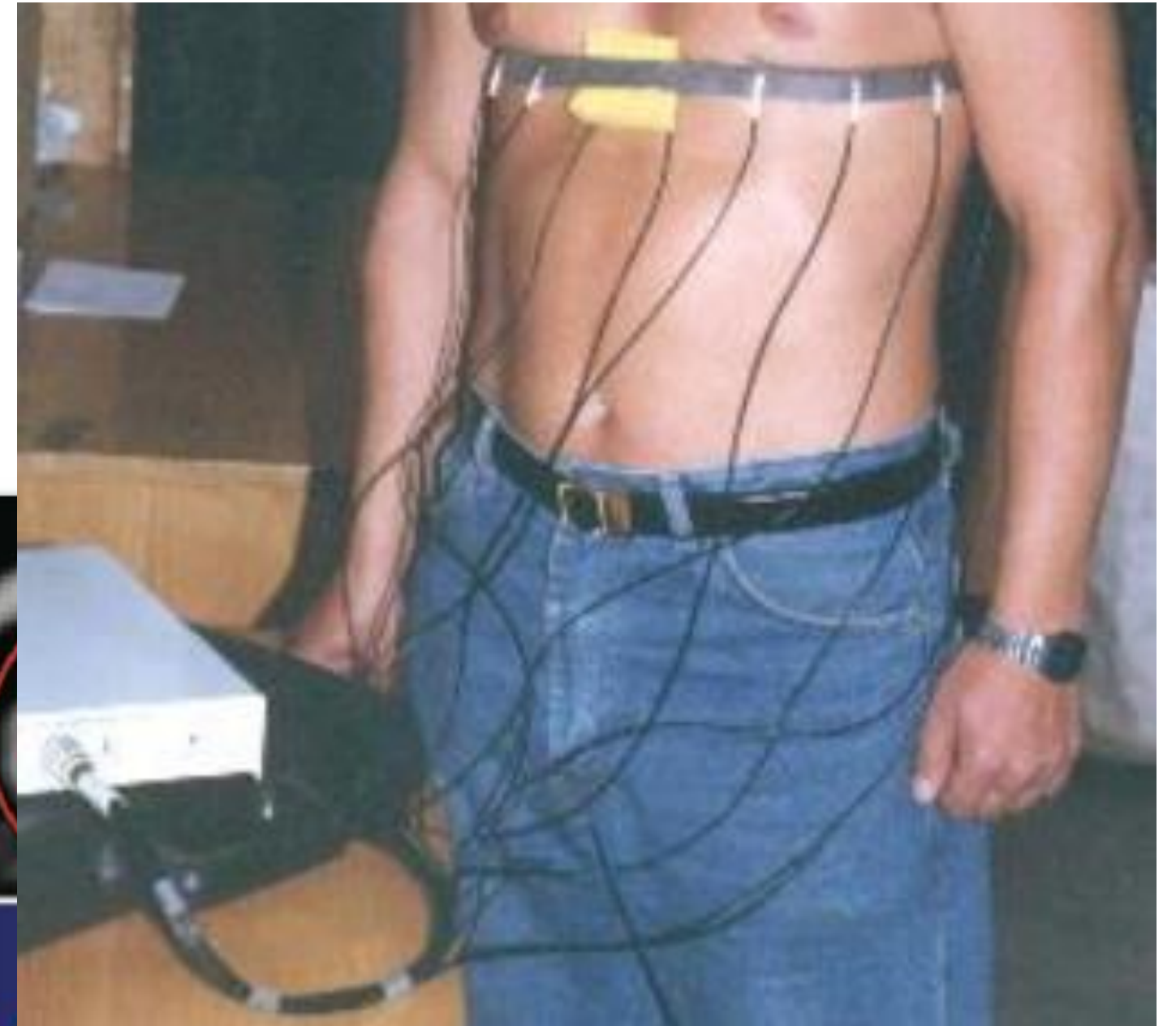


Permissible annual radiation dosage for heath care workers: 500 chest x-rays (50 mSv)

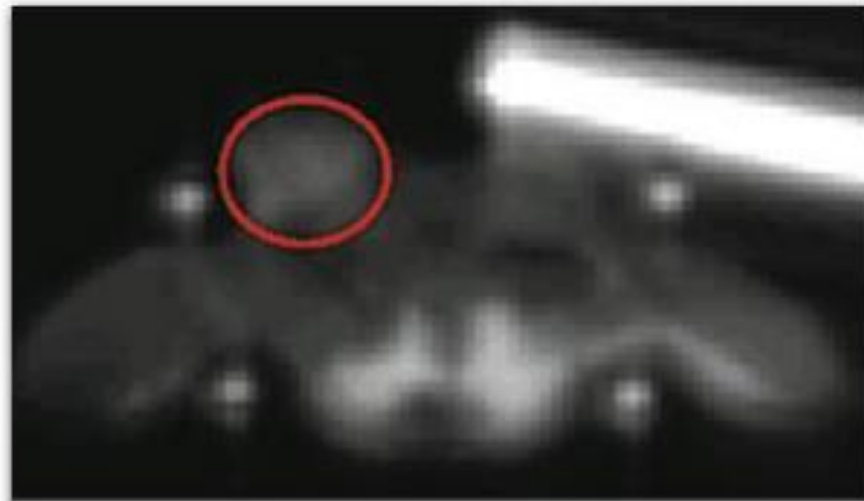
Dosage at which clear increased cancer risk can be proved: 1000 chest x-rays (100 mSv)

Othe imaging modalitites

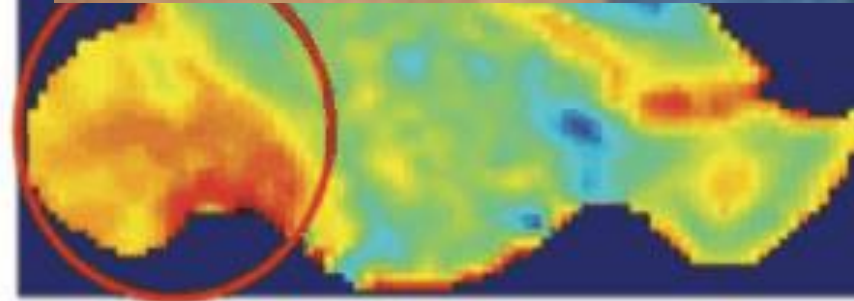
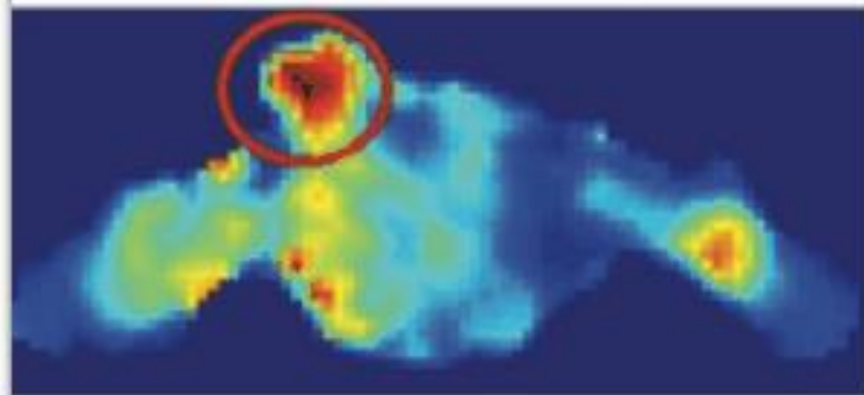
EIT: Electrical Impedance Tomography



SPECT images



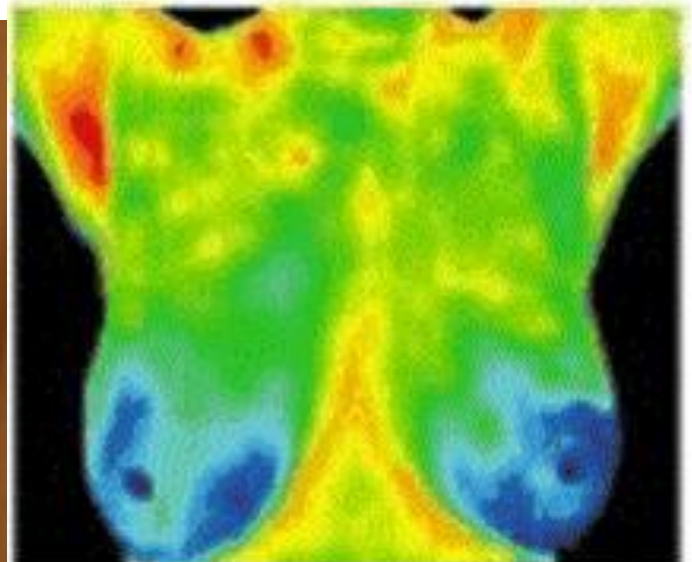
EIT images



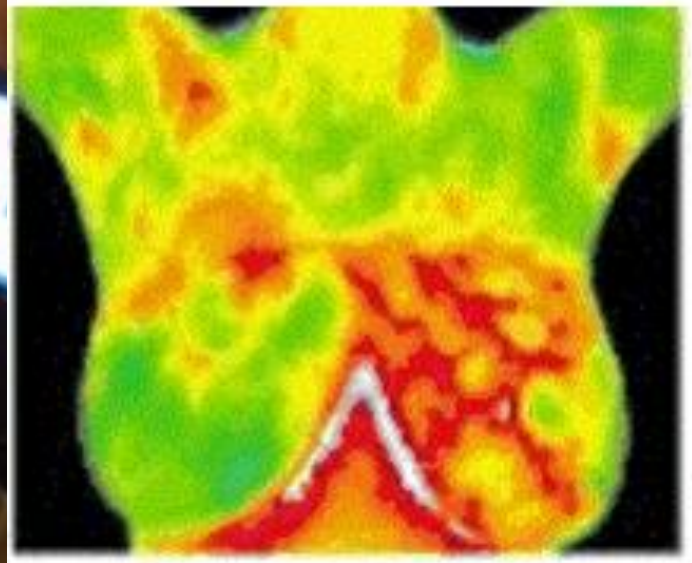
Microwave thermography



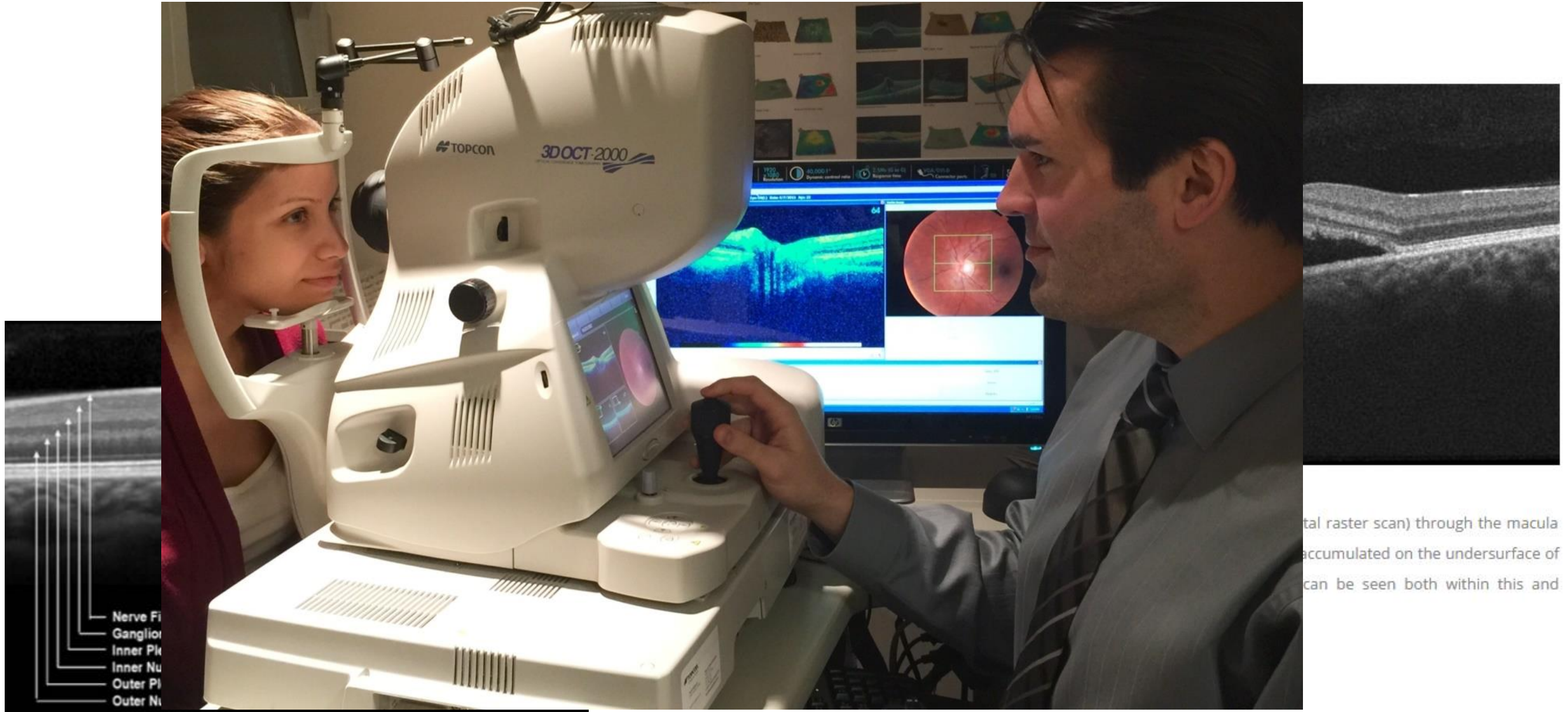
normal breasts



cystic disease



OCT: Retinal Optical Coherence Tomography



(horizontal raster scan) through the macula
accumulated on the undersurface of
can be seen both within this and

Imaging in Therapy: Robotic Surgery

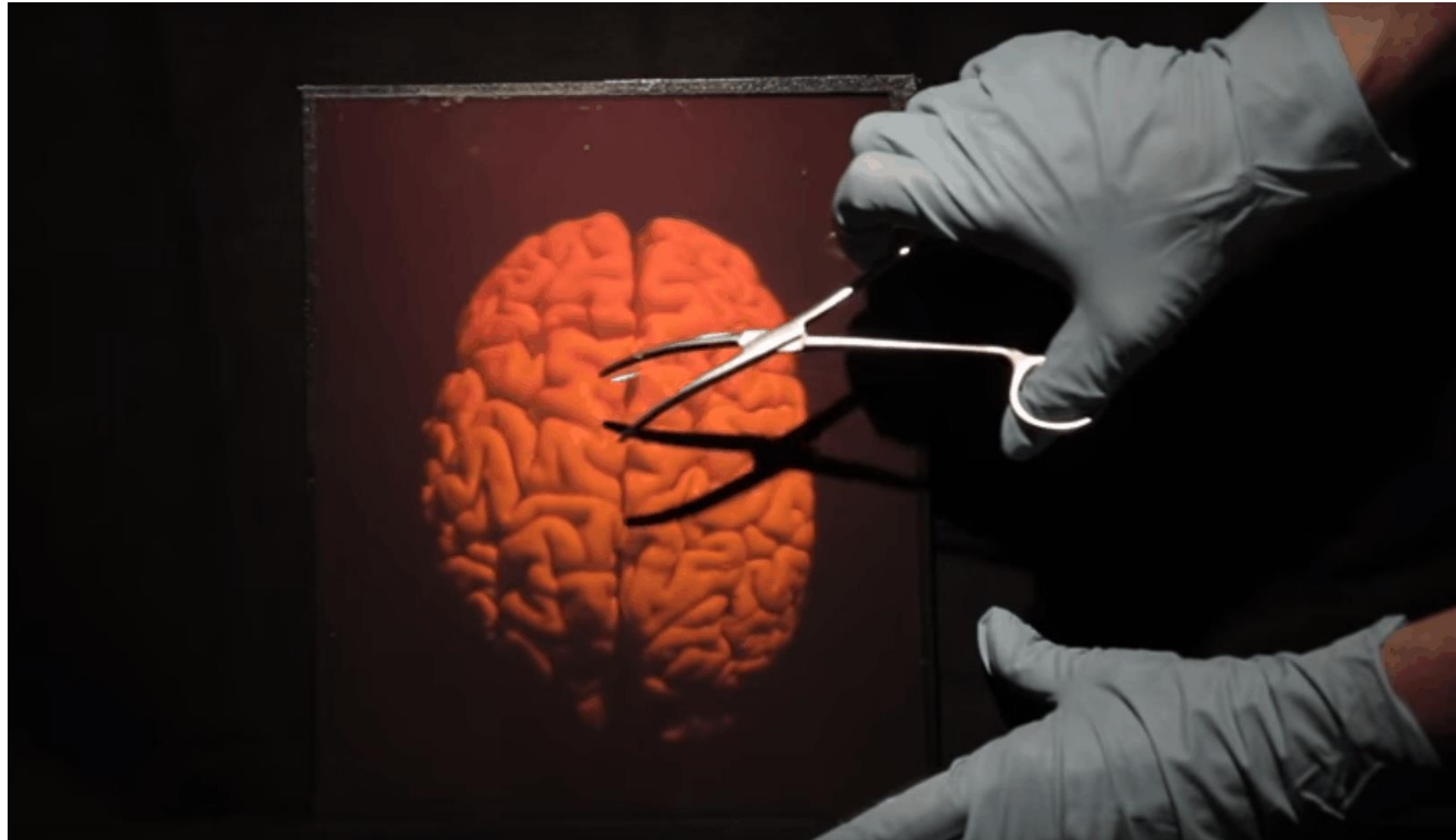


Coming: Imaging Modalities Currently Under Testing and Certification



Virtual autopsy

Holographic robotic surgery



After combined CT/MRI scan of brain, robotic surgery is linked to hologram in real time. Shadow is simulated to make scene lifelike to surgeon.

Future: Automated detection of brain aneurysms

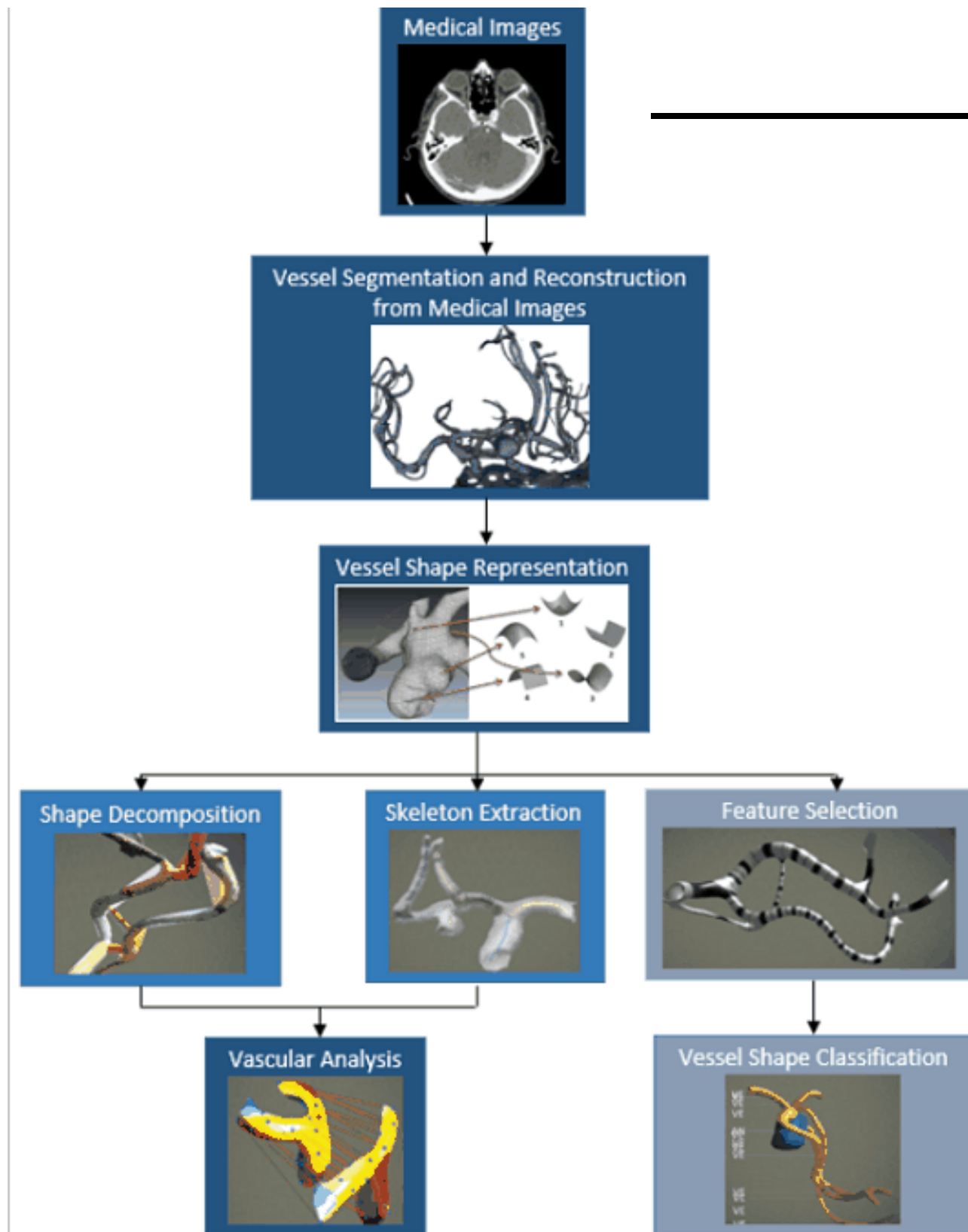
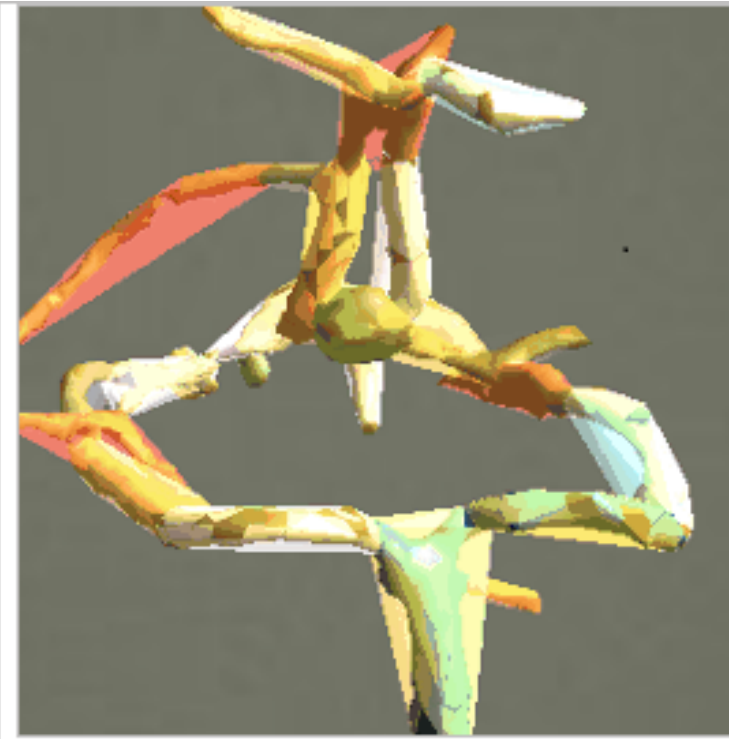


Image to vessel shape classification by machine learning methods

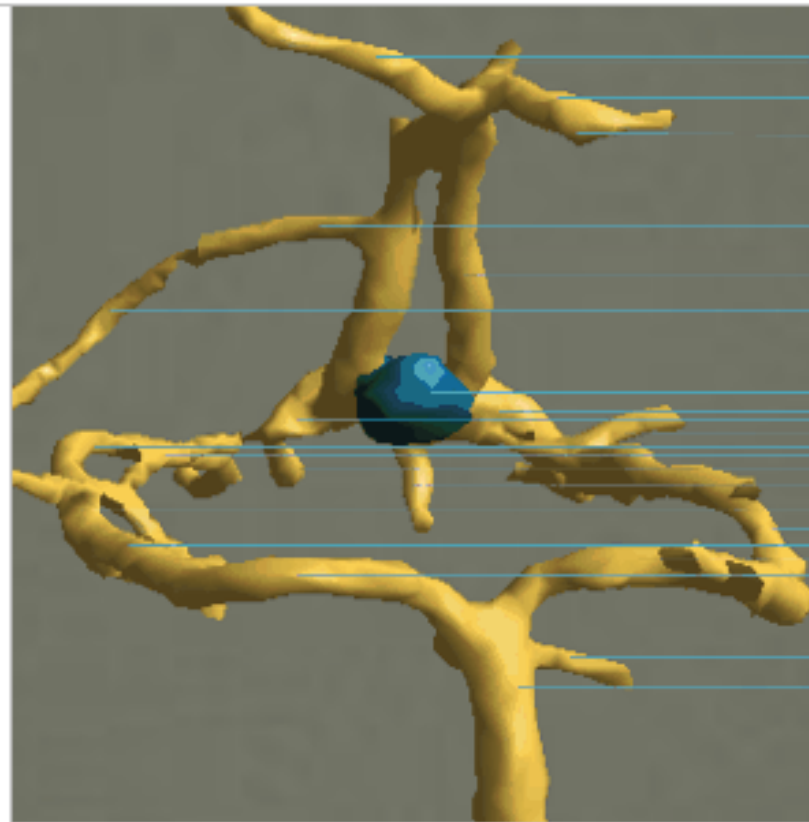
Future: automated aneurysm classification

3-D reconstruction from MRI



Geometric patch analysis

Discovery of aneurysm within otherwise normal vasculature



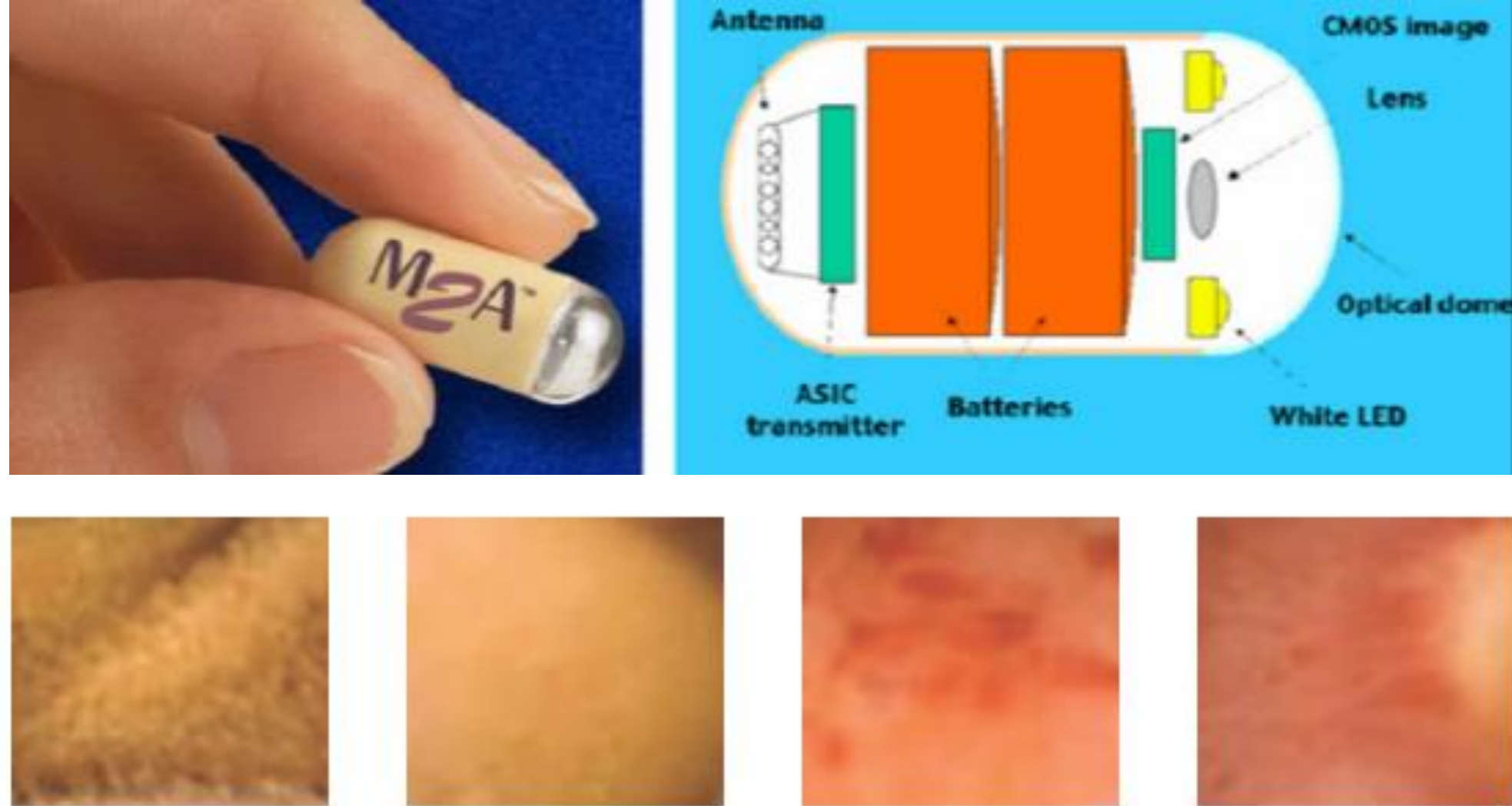
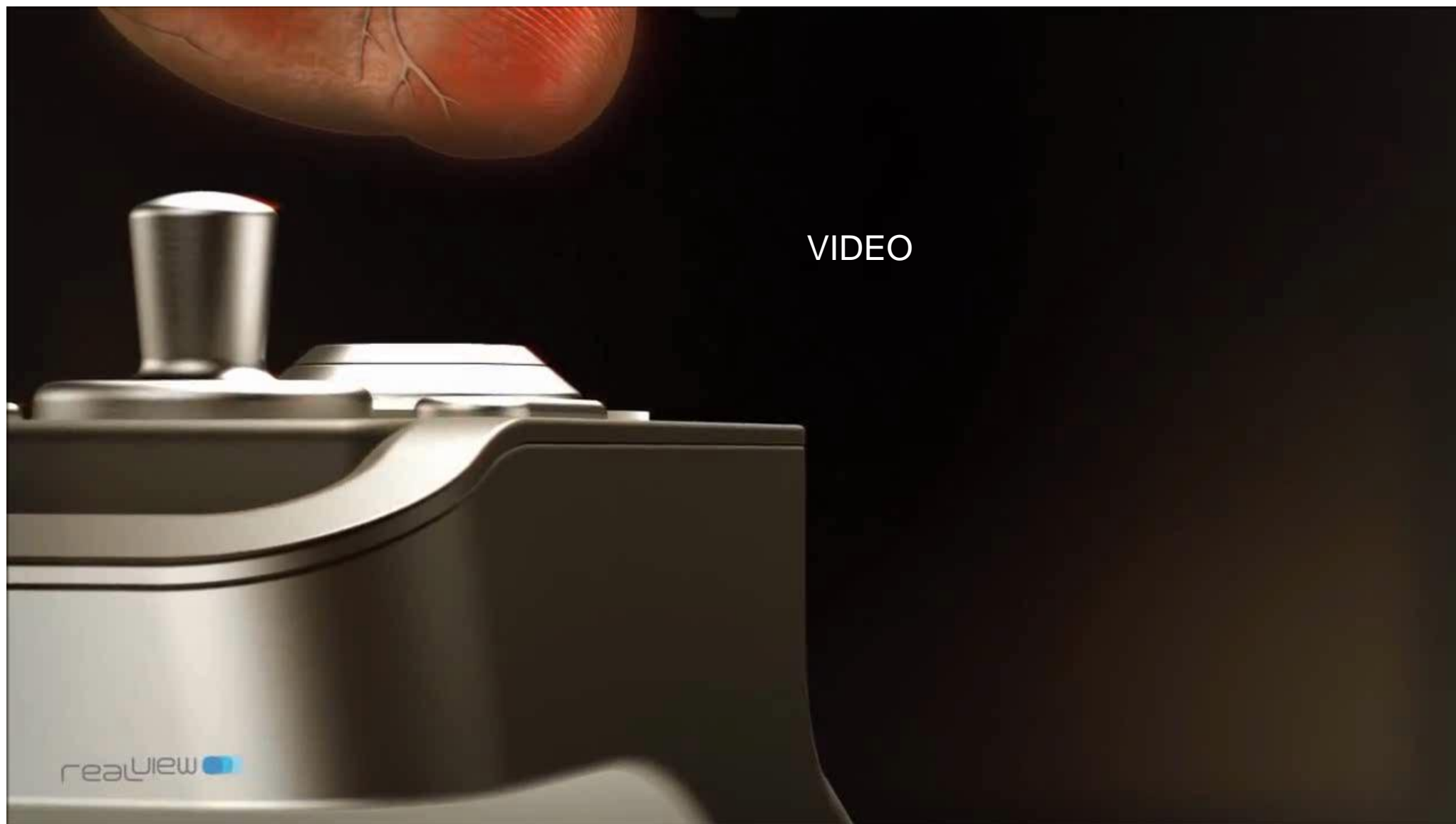


Fig. 1. Candidate regions selected by the mean shift algorithm. The left two images are normal regions and the right two images are Crohn's disease inflammation regions.

Future: Holography

Interactive 4-D holographic manipulation



Thanks!



For a list of sources for these images and videos (url's, bibliographic references) please send an email to my address:

peterdscott@gmail.com