Medical Imaging Science and Technology

Understanding What Your Doctor Is Recommending

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Emory University
and
Sprawls Educational Foundation

www.sprawls.org/ipad

OSHER LIFELONG LEARNING INSTITUTE

IEEE
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Science

The knowledge of ourselves and the world in which we live.

Comes from

Observation, Experience. Discovery, and Research

Technology

Equipment, Instruments, and Gadgets

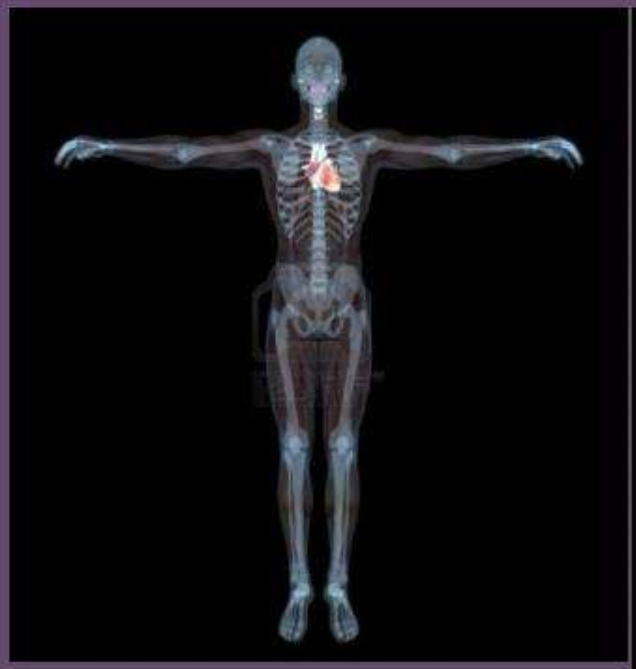
Comes from

Invention and Development

The Challenge

We can only see the surface

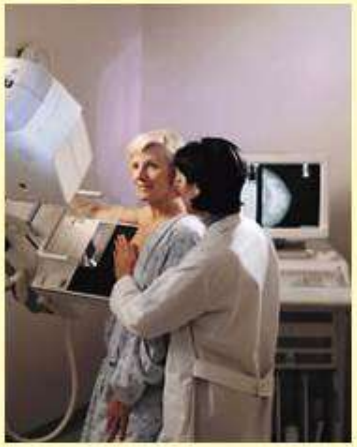
Medical Imaging
Is the Solution




Computed Tomography
Magnetic Resonance Imaging
Positron Emission Tomography
Ultrasound
Single Photon Emission Tomography
Radiography
Fluoroscopy
Digital Image Management Systems

Medical Tests

Sensitivity



Specificity

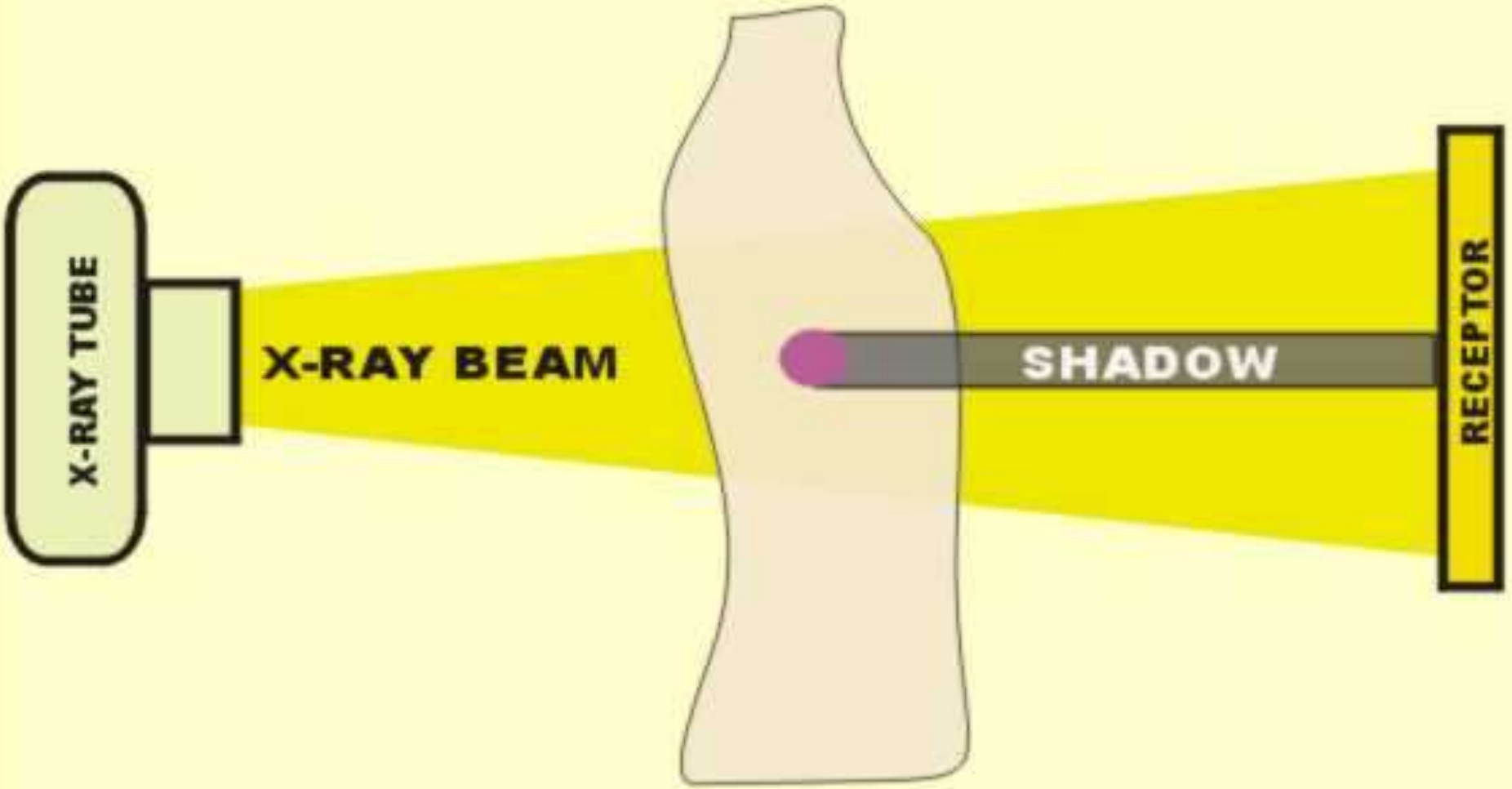
Benefit ⟷ **Risk**

Screening OR **Diagnostic**

Roentgen's Discovery

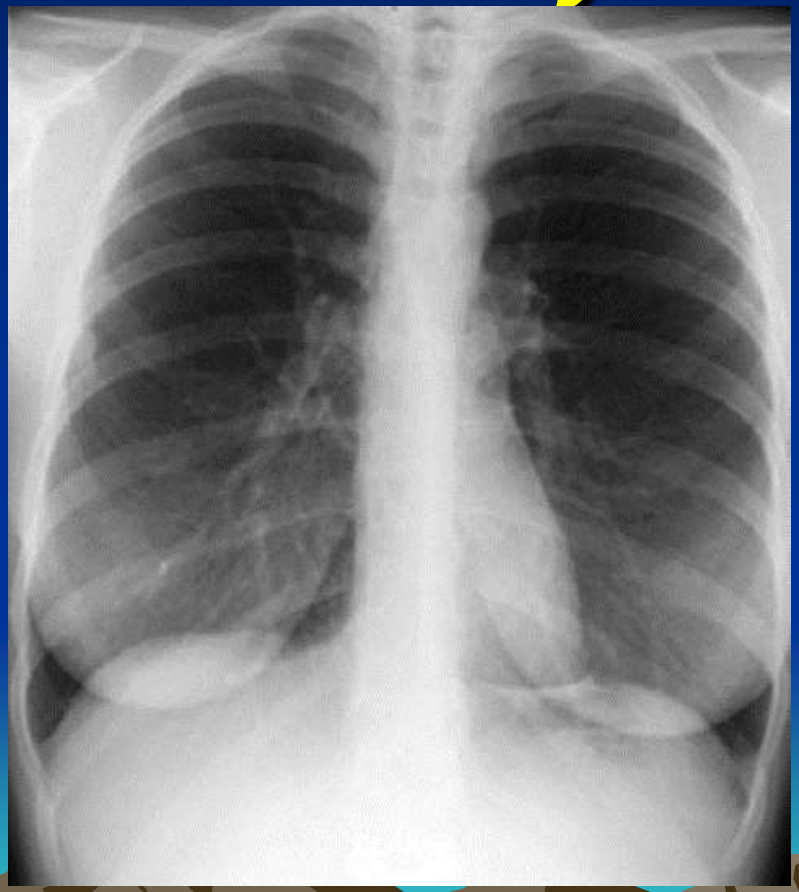
January 23, 1896

X-RAY IMAGE CONTRAST

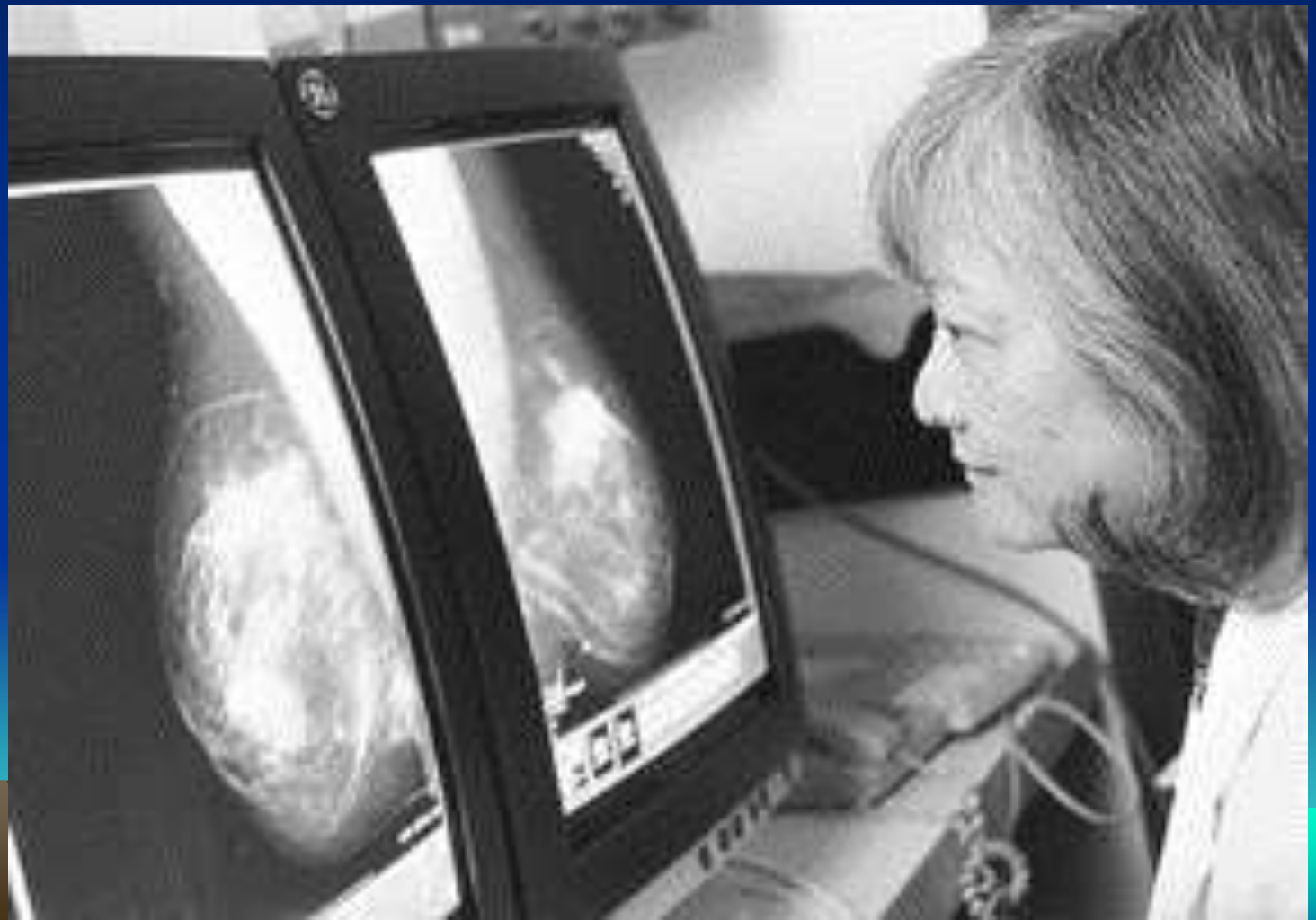


Radiography

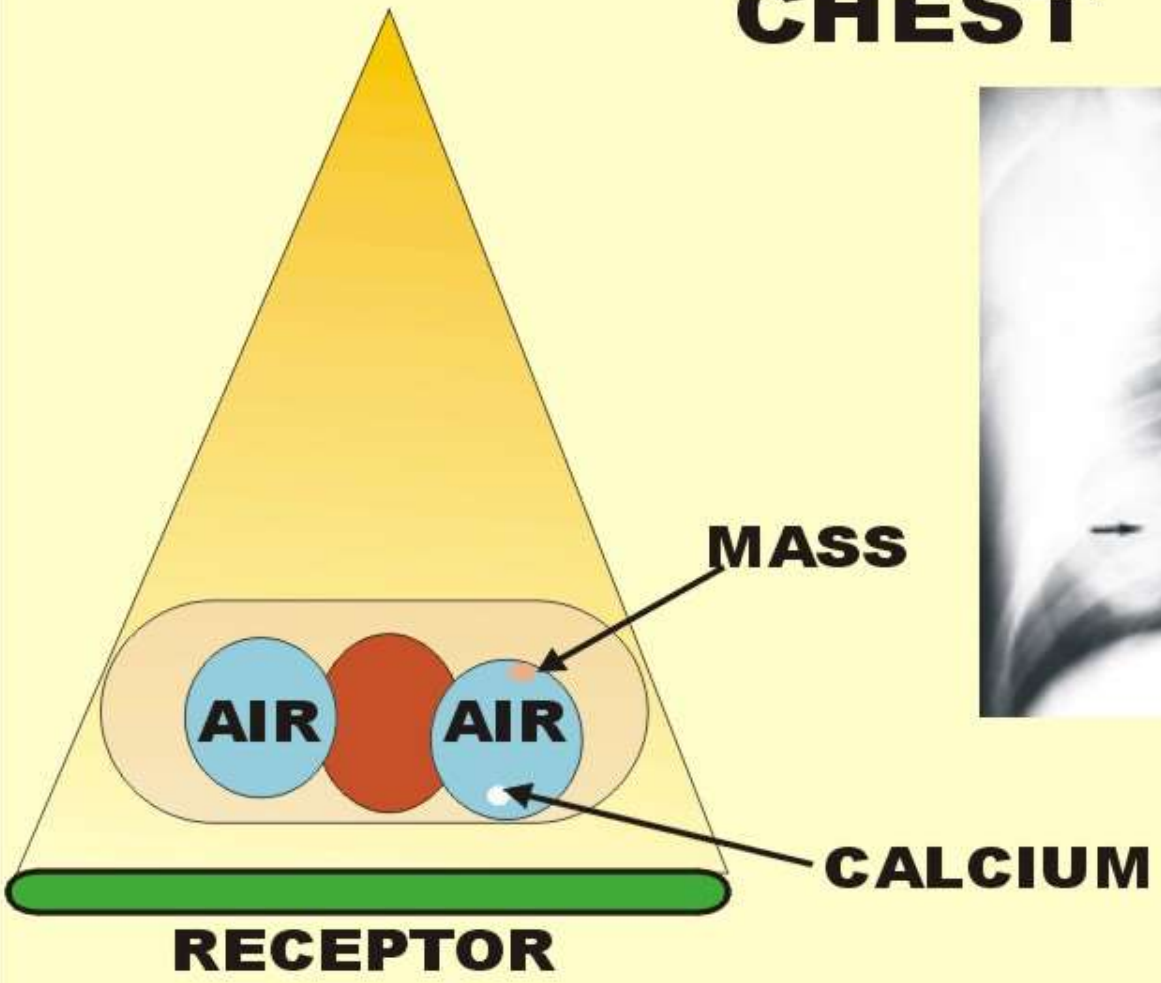
X-ray Photography

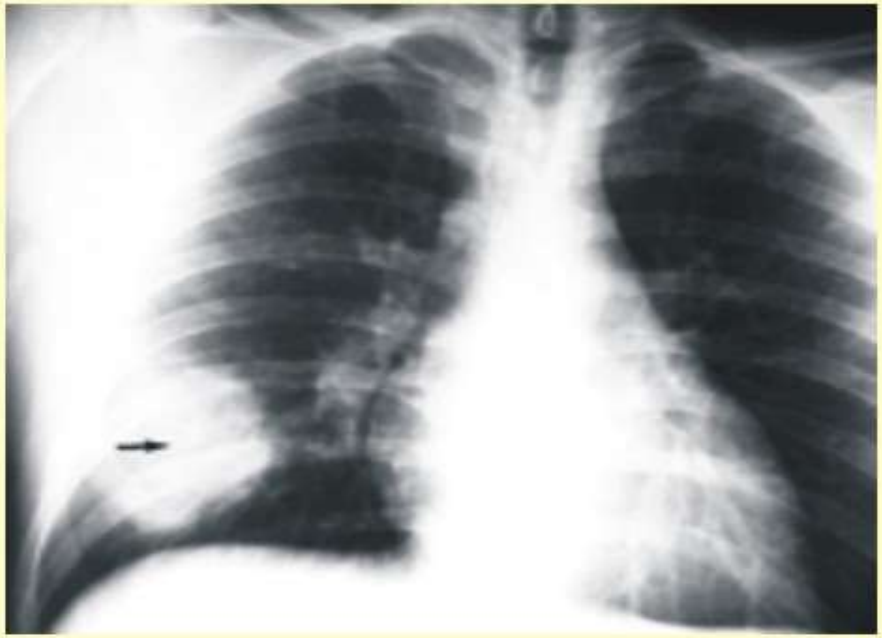


Viewing Digital Images



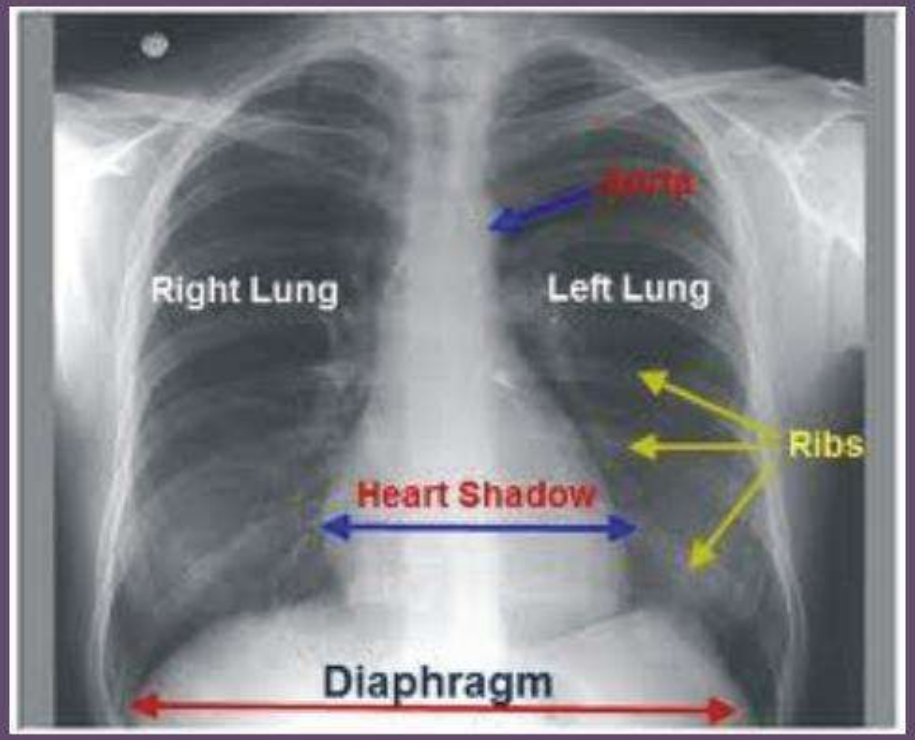
PHYSICAL CONTRAST in CHEST



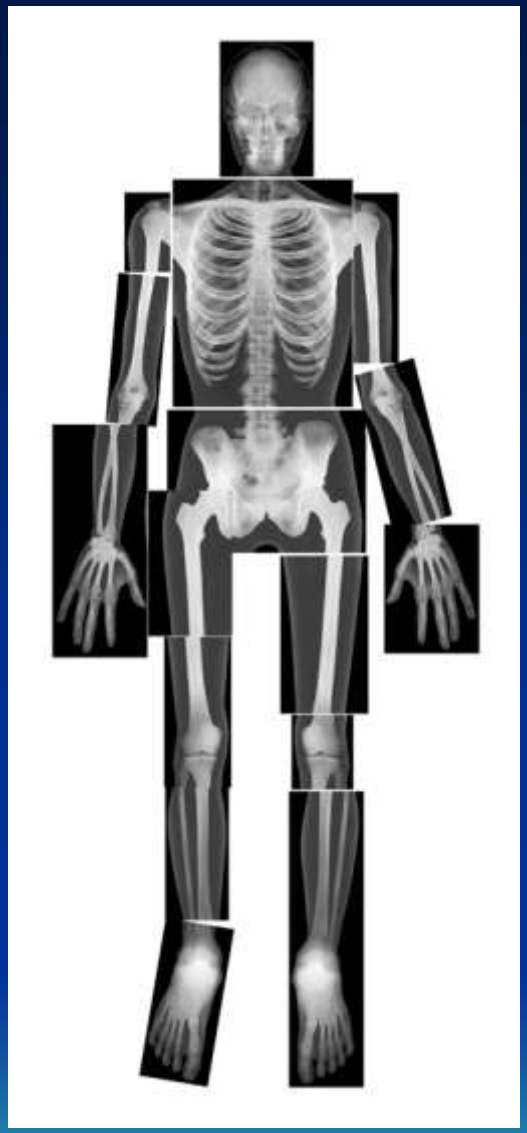


Sprawls

Chest Radiograph

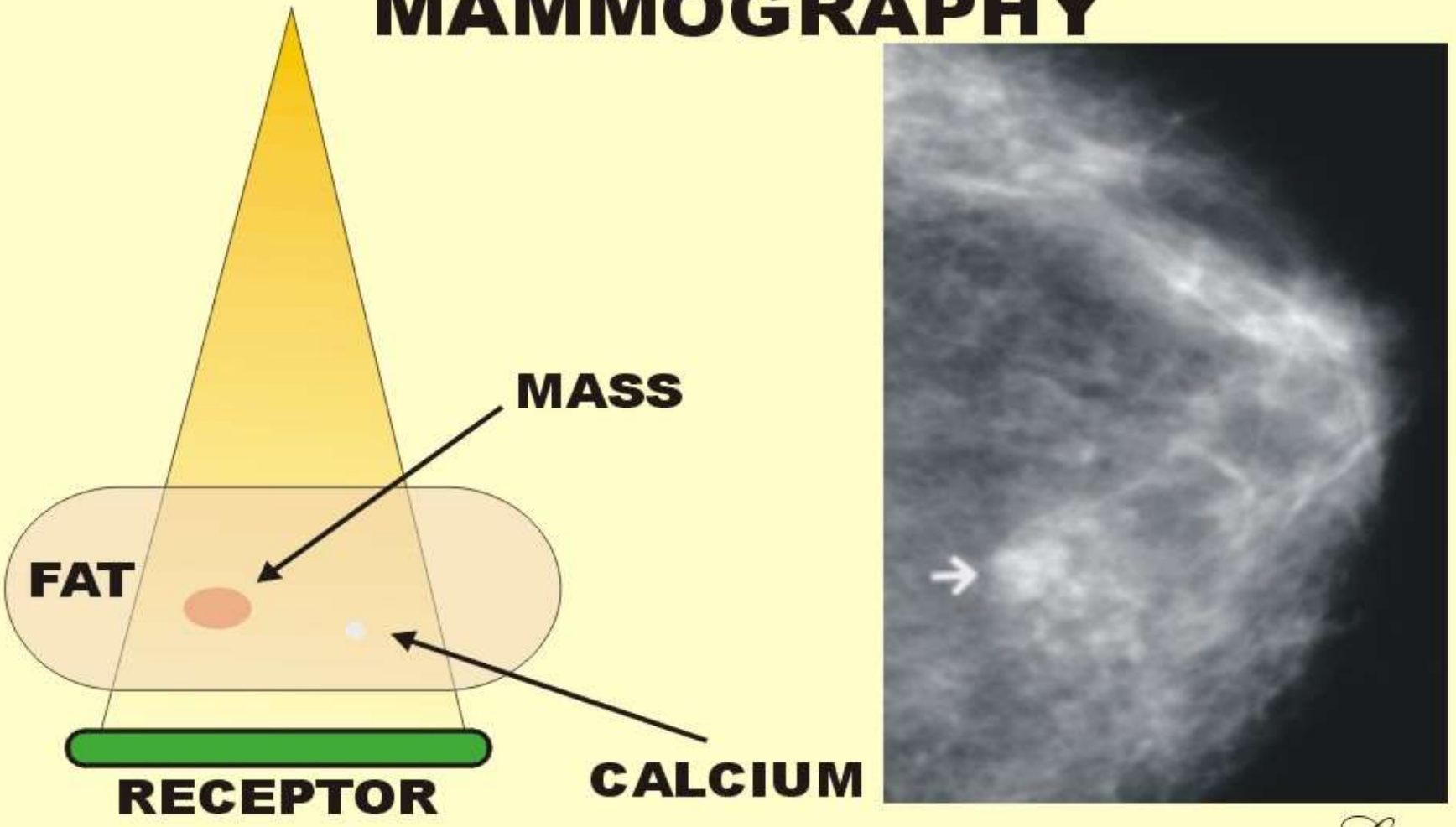


Cancer



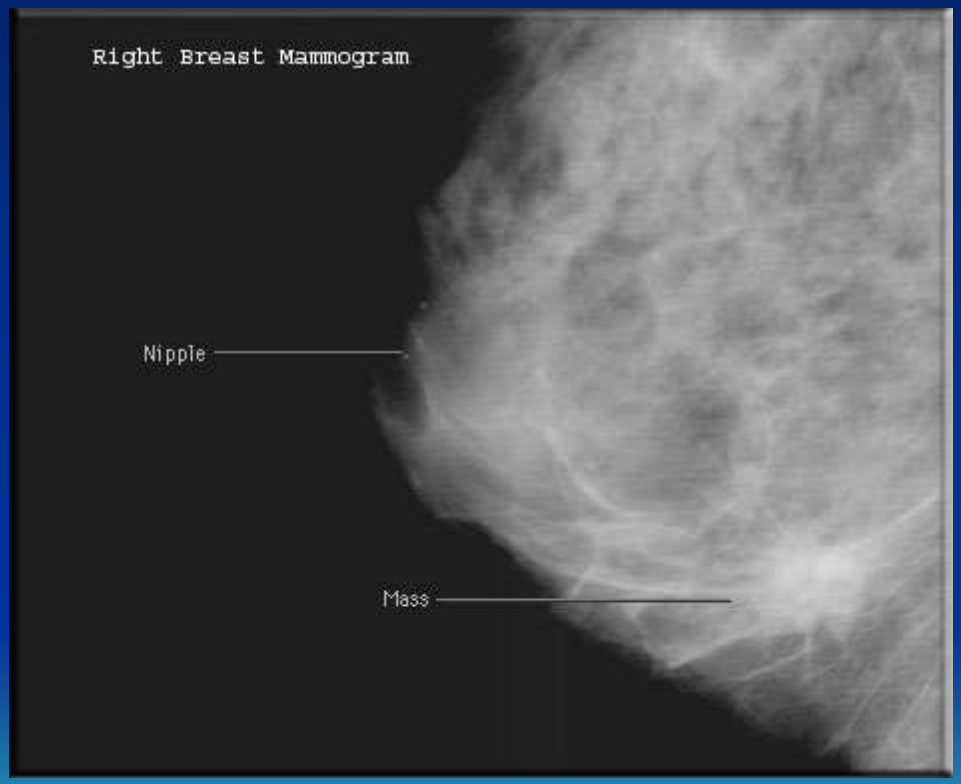
Mammography

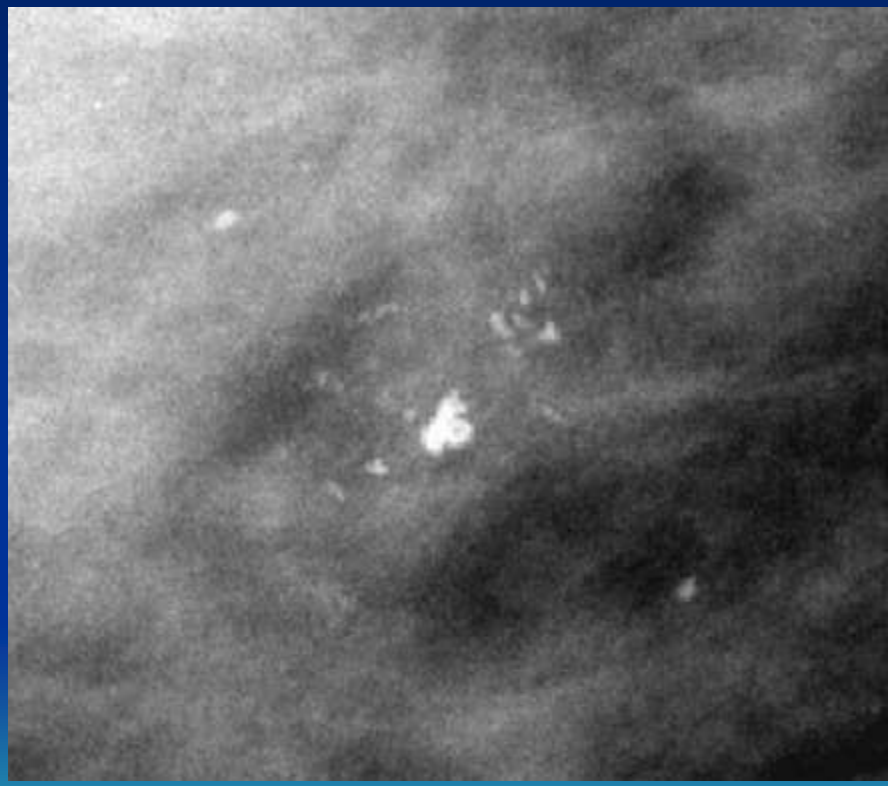
PHYSICAL CONTRAST in MAMMOGRAPHY



Sprawls

Signs of Breast Cancer

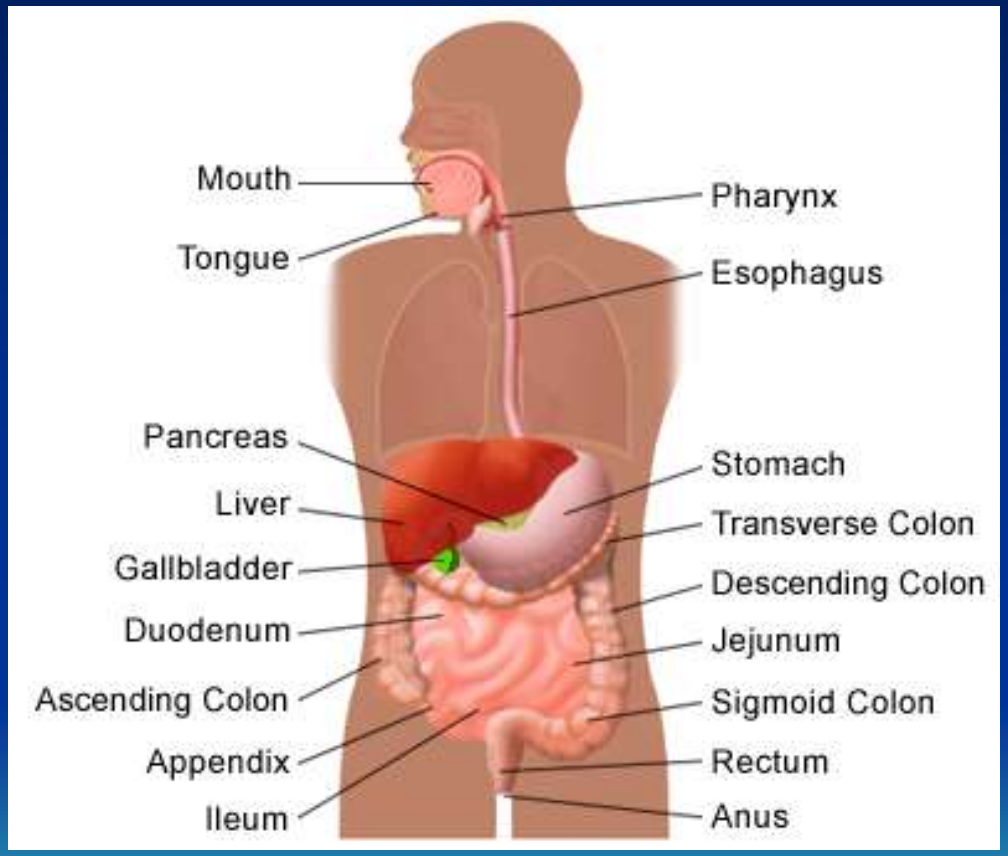




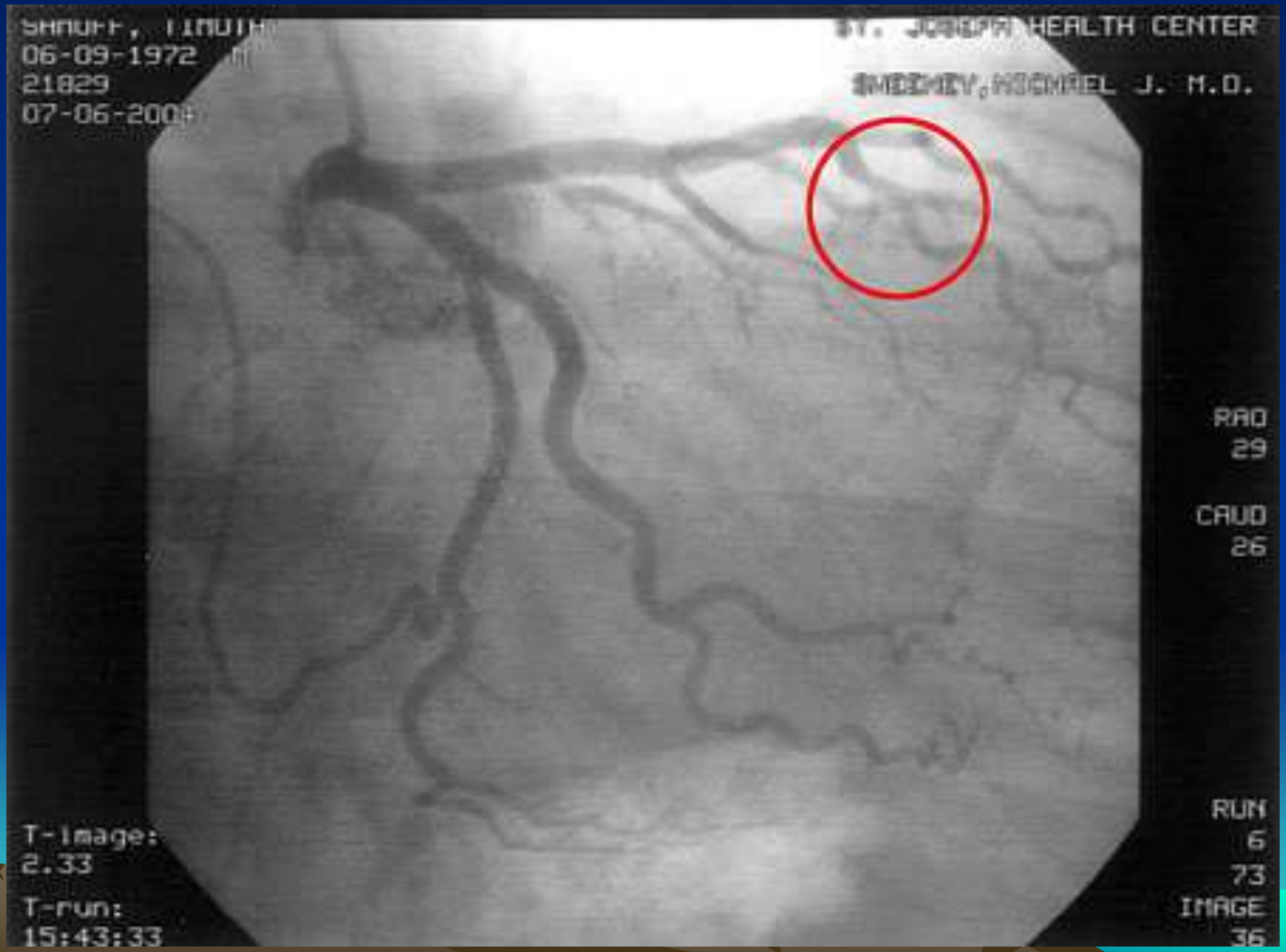
Mammography

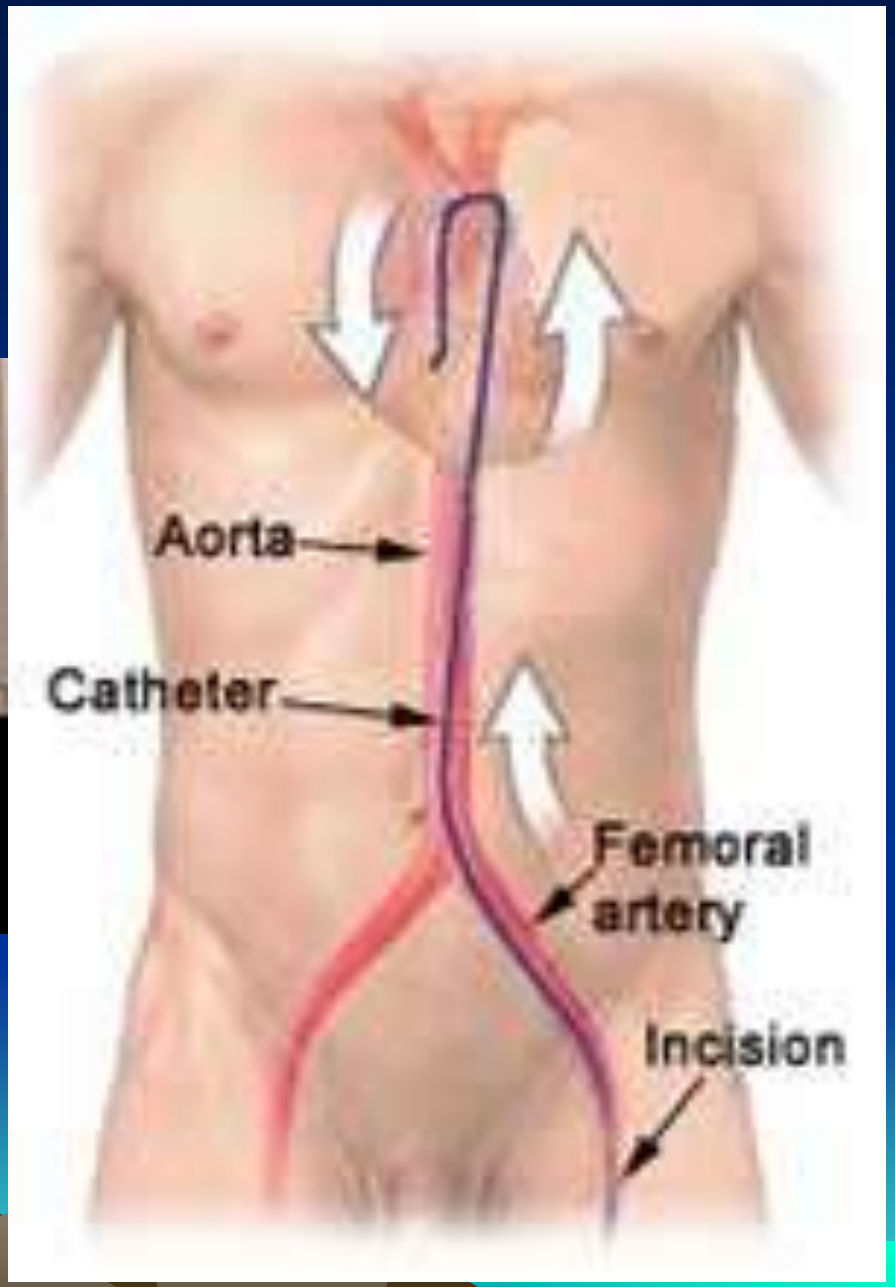
Fluoroscopy

Barium Contrast Media

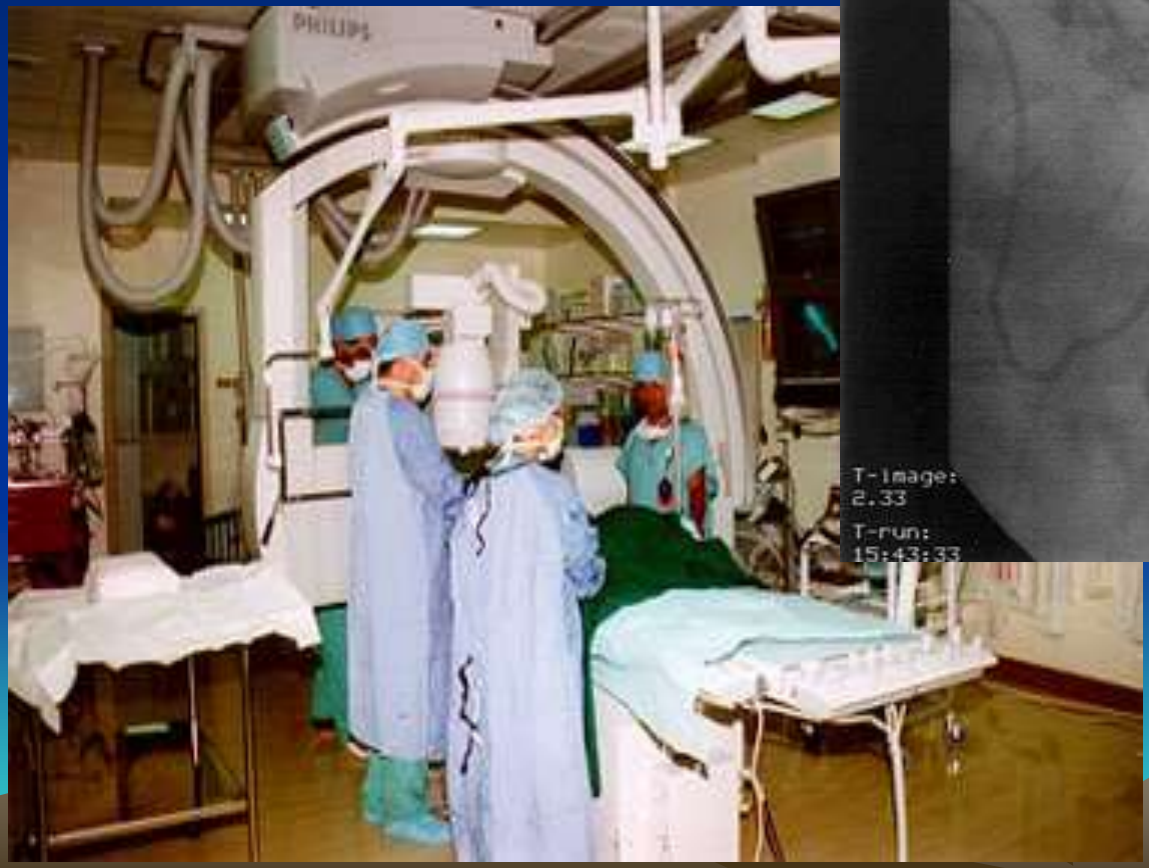


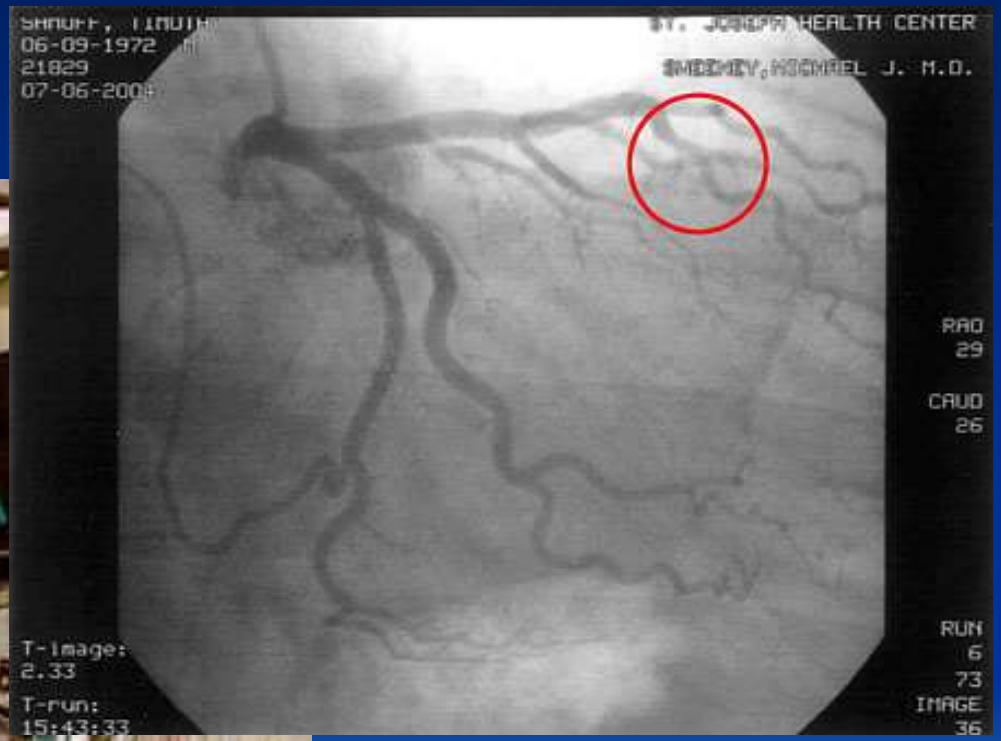
Iodine Contrast Media




Aorta
Catheter
Femoral artery
Incision

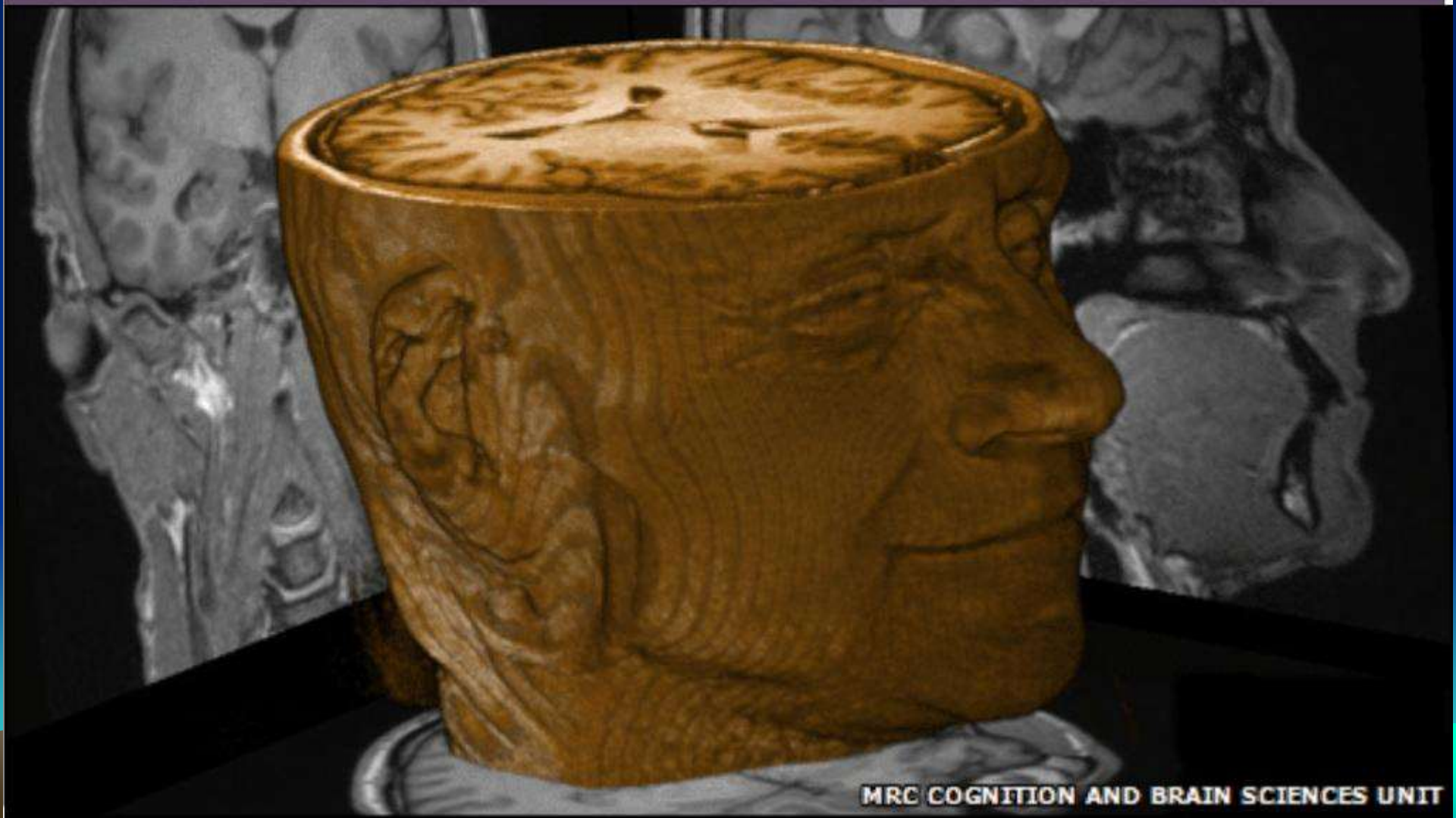
Cardiac Cath Lab



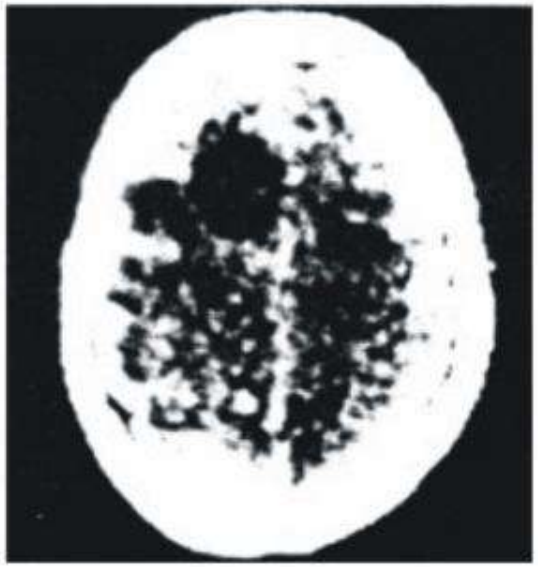


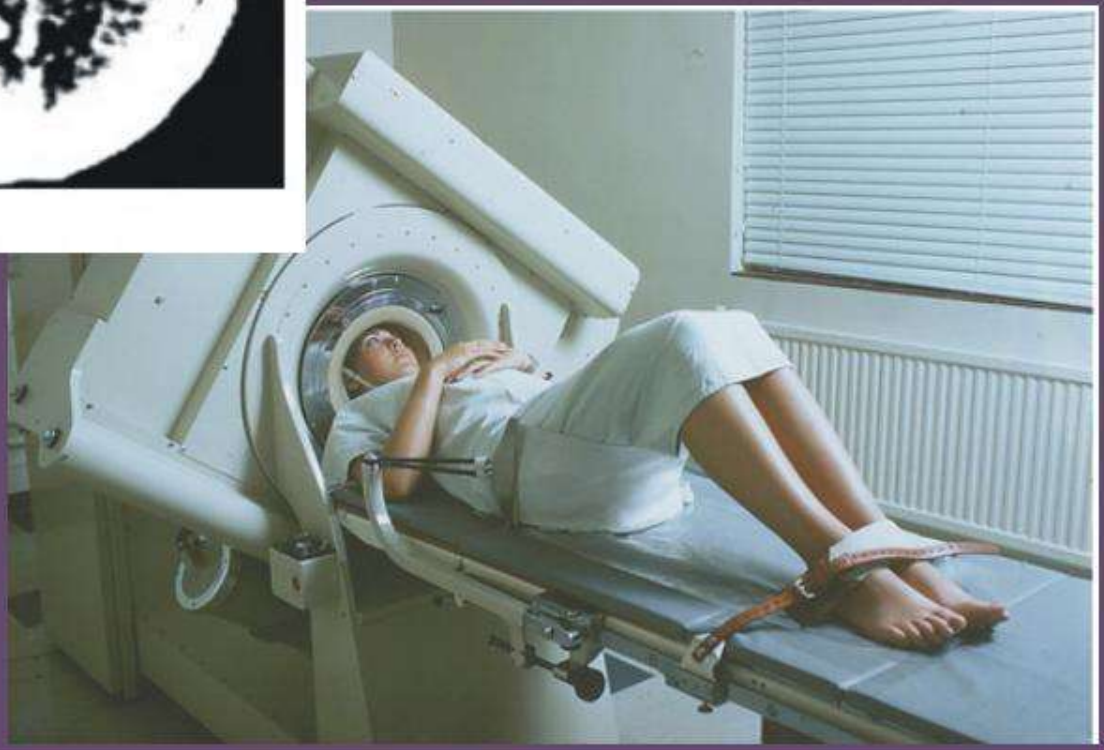
Limitations of Radiography

Tomography



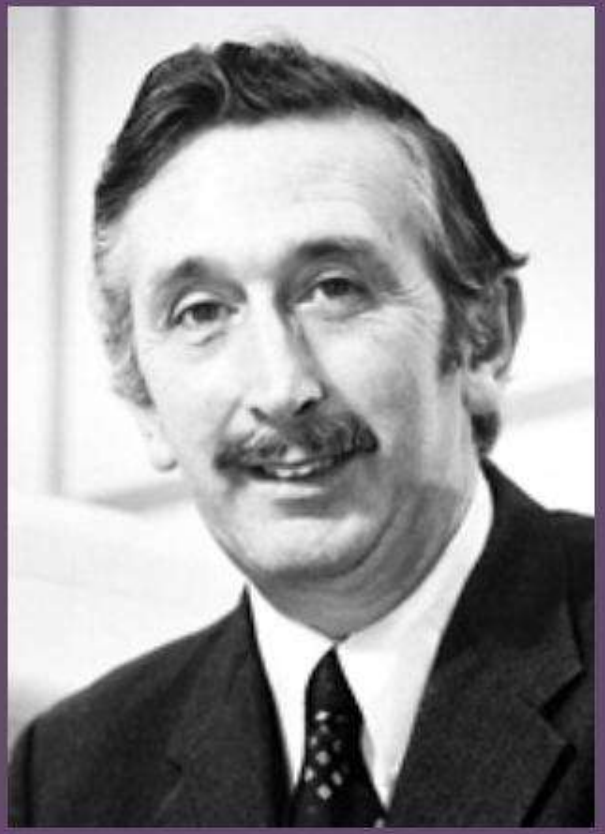
Computed Tomography



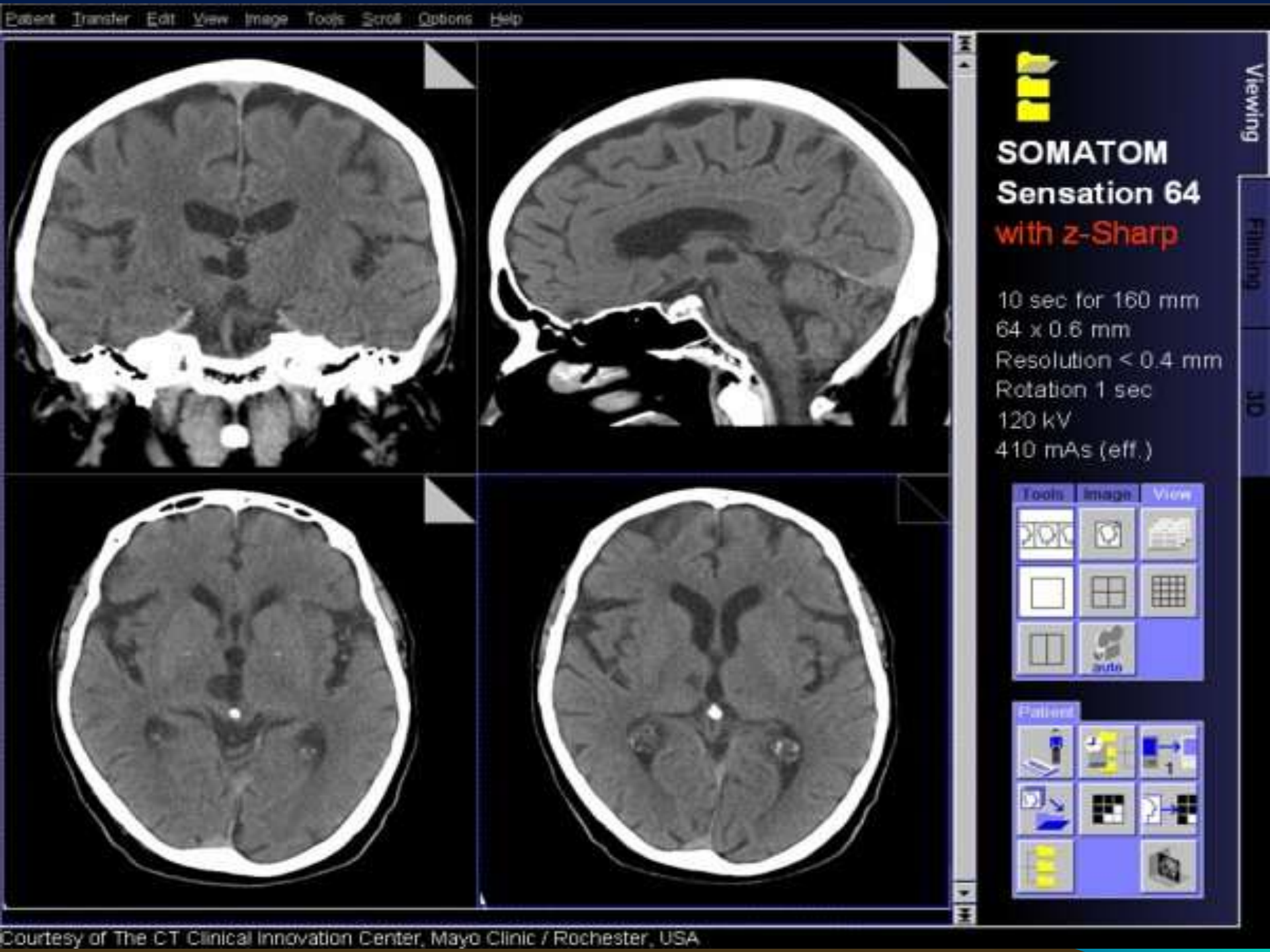


The Nobel Prize in Physiology or Medicine 1979

Cormack



Hounsfield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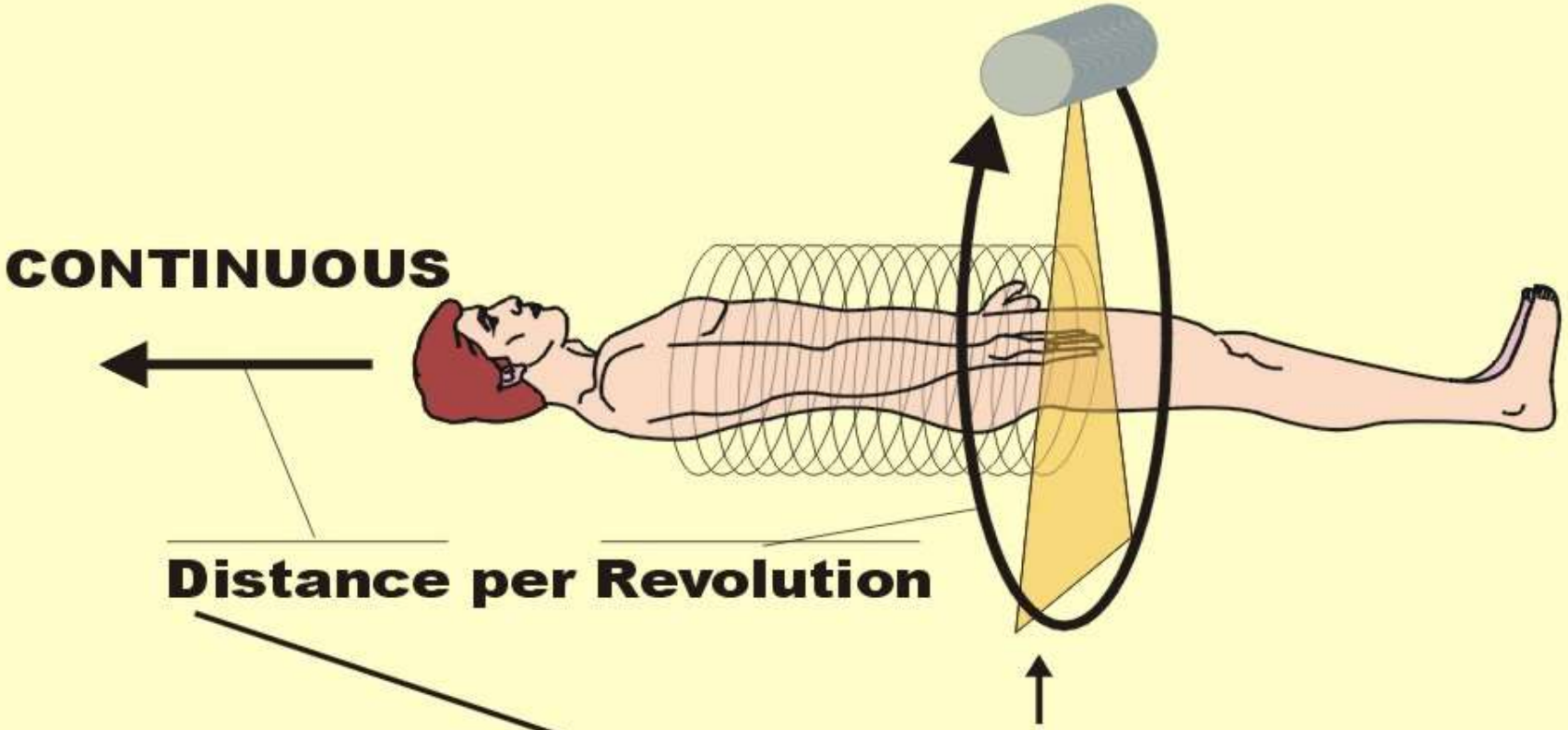
120 kV
410 mAs (eff.)
Viewing
Filming
3D
Tools
Image
View
Patient
Courtesy of The CT Clinical Innovation Center, Mayo Clinic / Rochester, USA

COMPUTED TOMOGRAPHY


X-Ray Tube

SPIRAL SCAN



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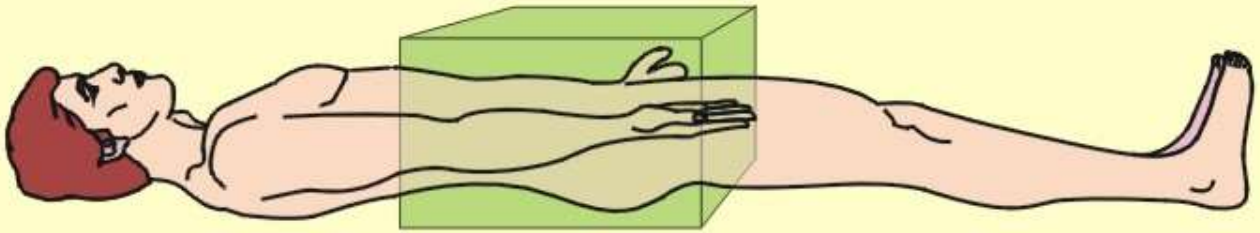
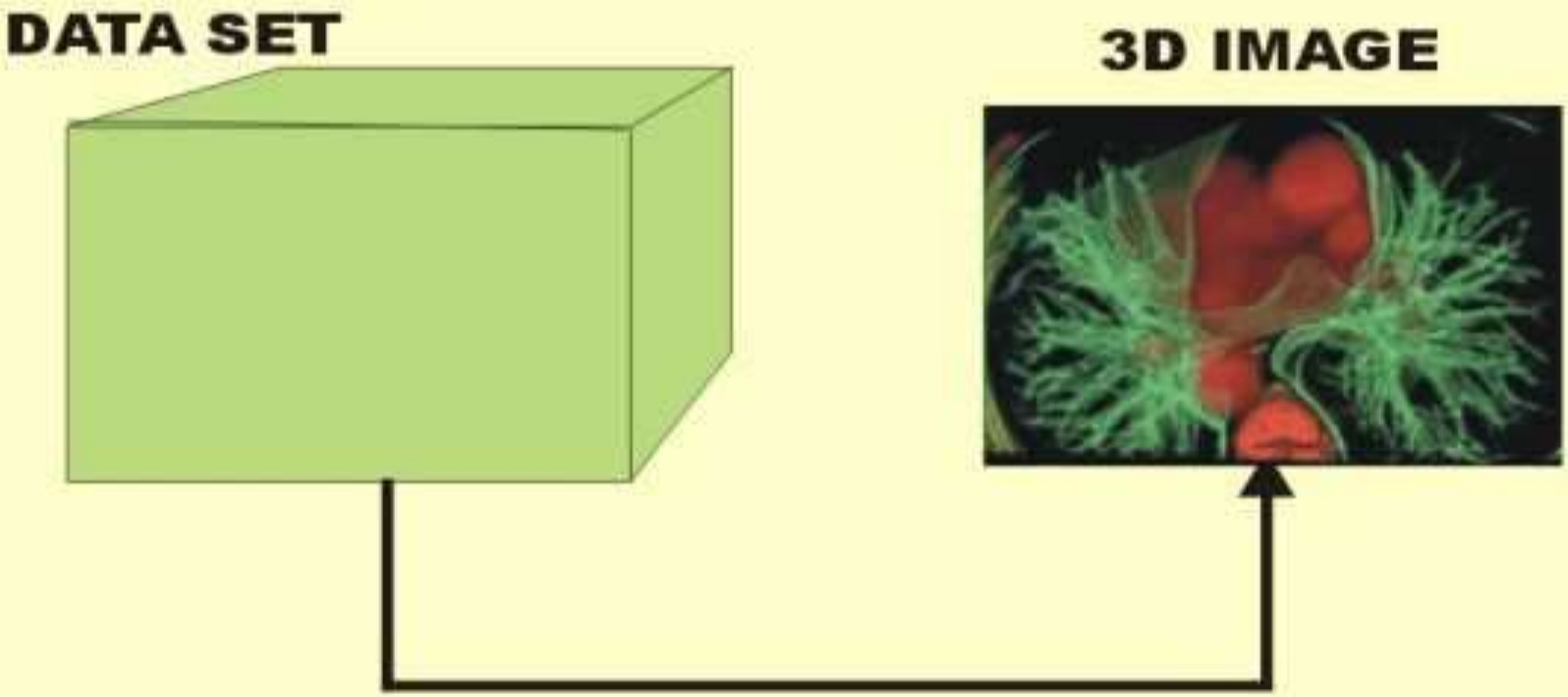
VOLUME ACQUISITION
HELICAL/SPIRAL SCAN



DATA SET

Sprawls

RECONSTRUCTION
from
VOLUME DATA SET



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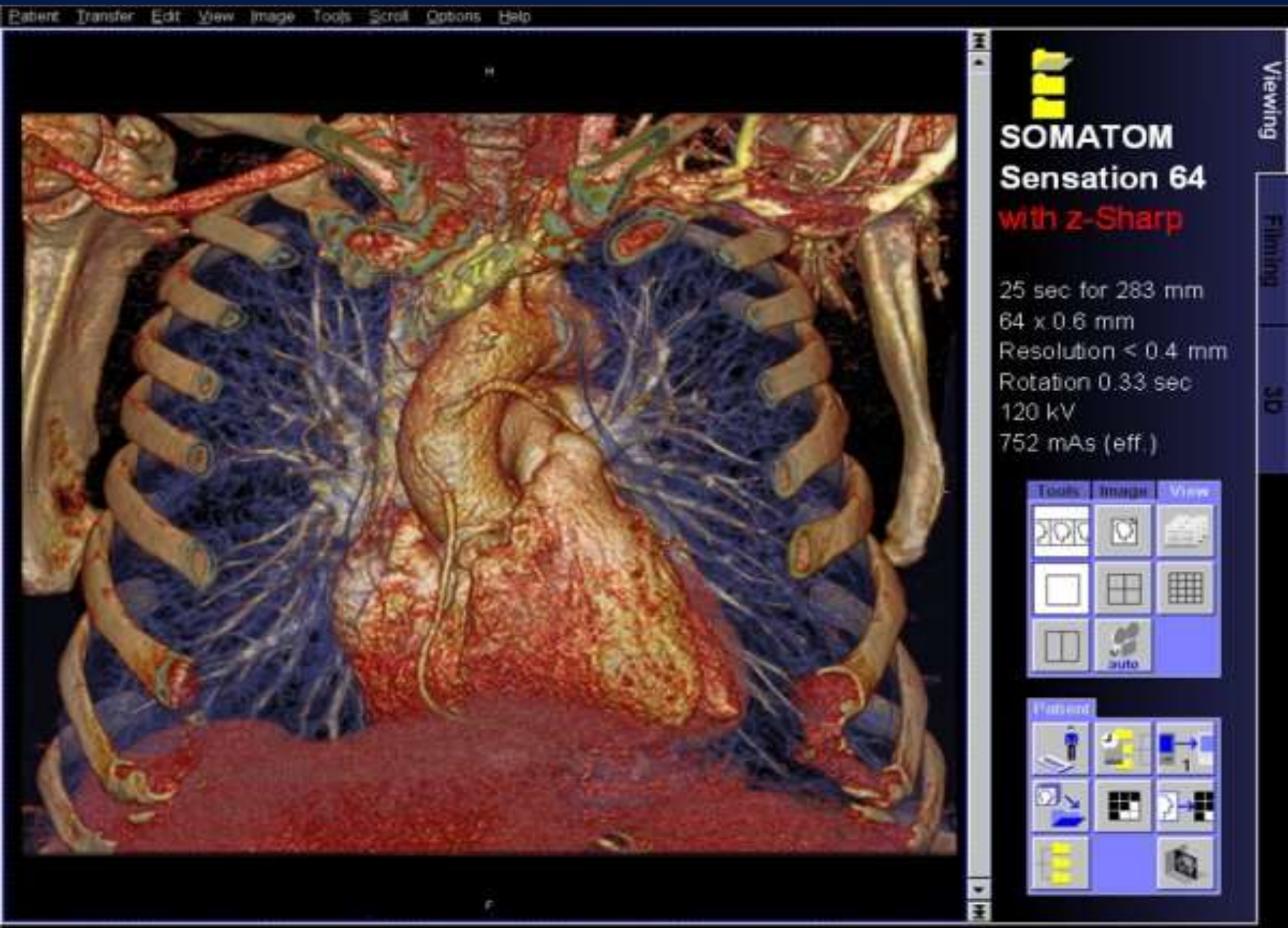
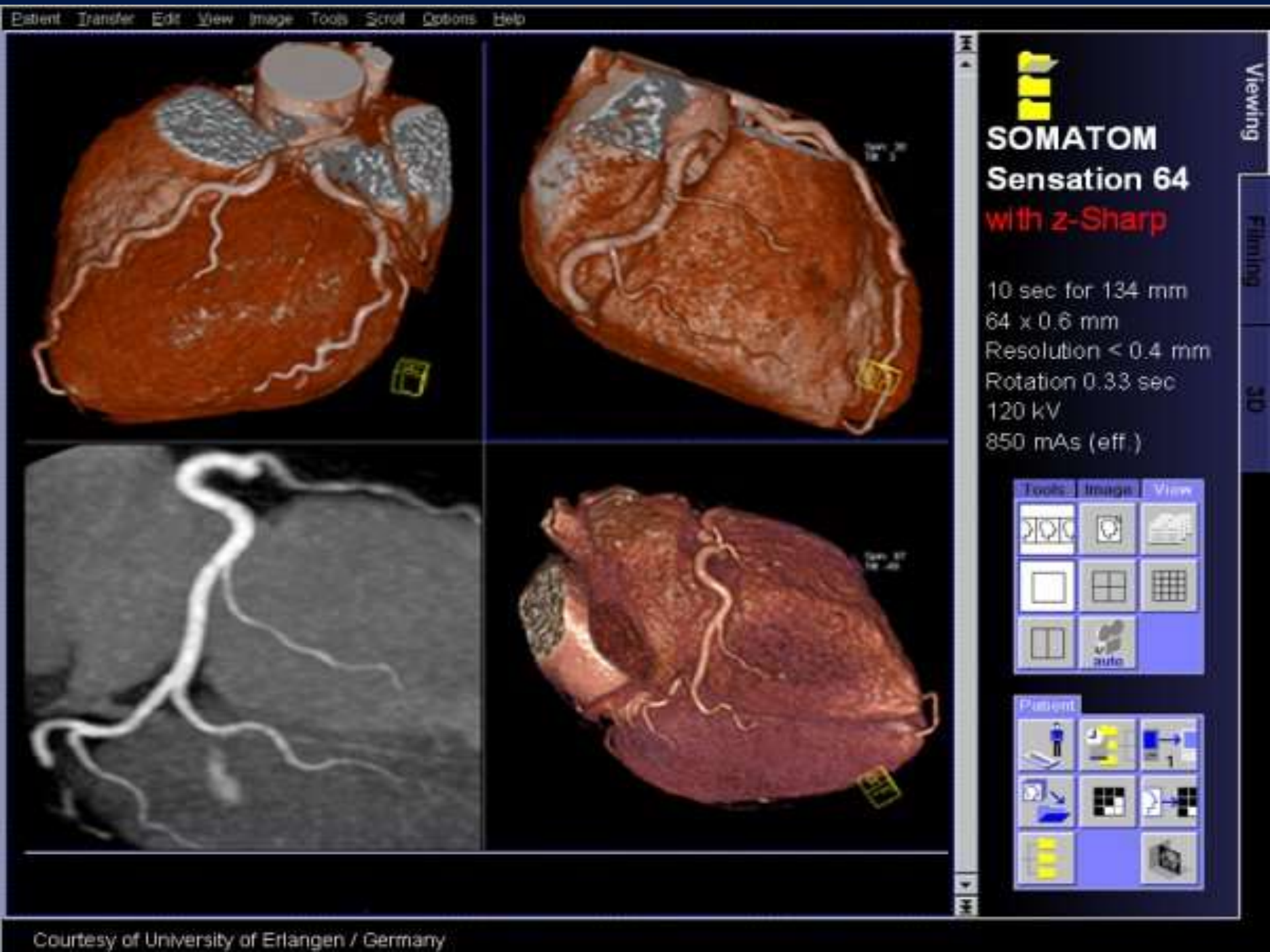


Courtesy of University Medical Center Grosshadern, München Germany


Patient Transfer Edit View Image Tools Scroll Options Help
SOMATOM
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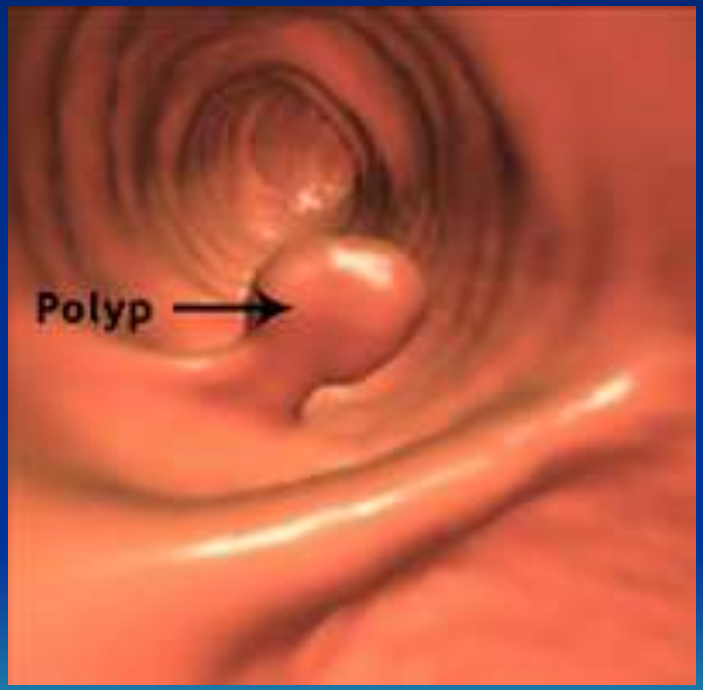
Rotation 0.33 sec
120 kV
850 mAs (eff.)
Viewing
Filming
3D
Tools
Image
View
auto
Patient
Courtesy of University of Erlangen / Germany

Colonoscopy

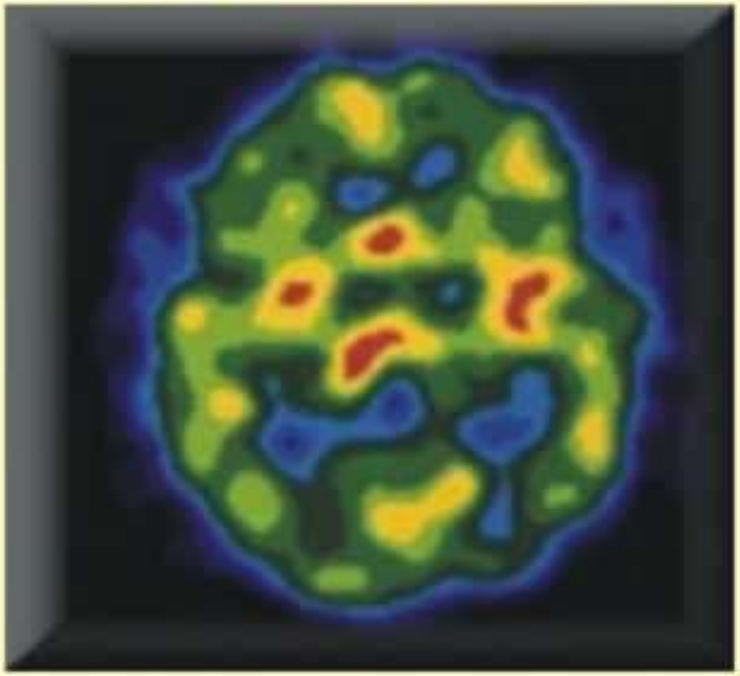
Virtual Colonoscopy



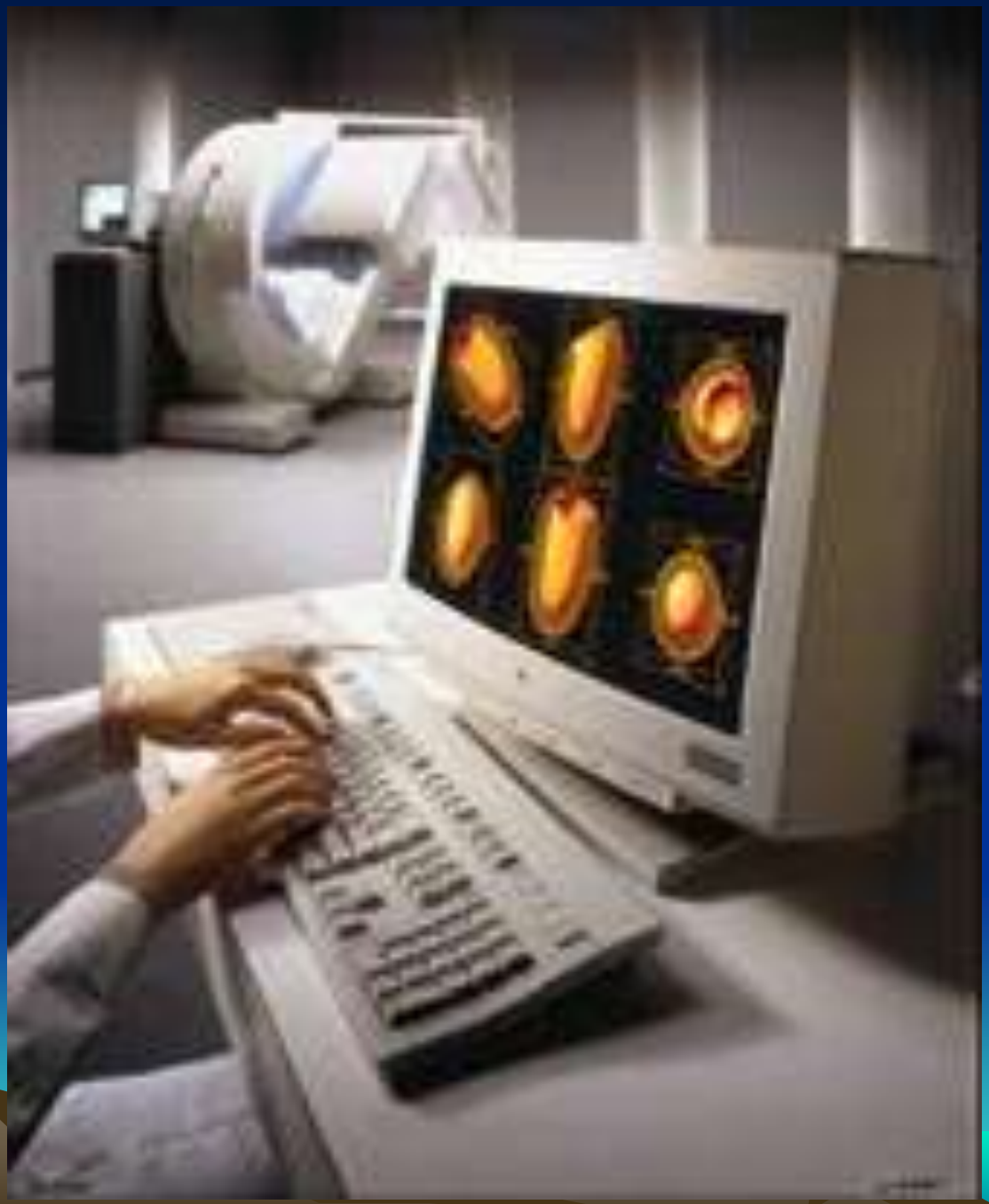
RADIONUCLIDE IMAGING

CONTRAST
SENSITIVITY

ADJUST TO RADIATION ENERGY

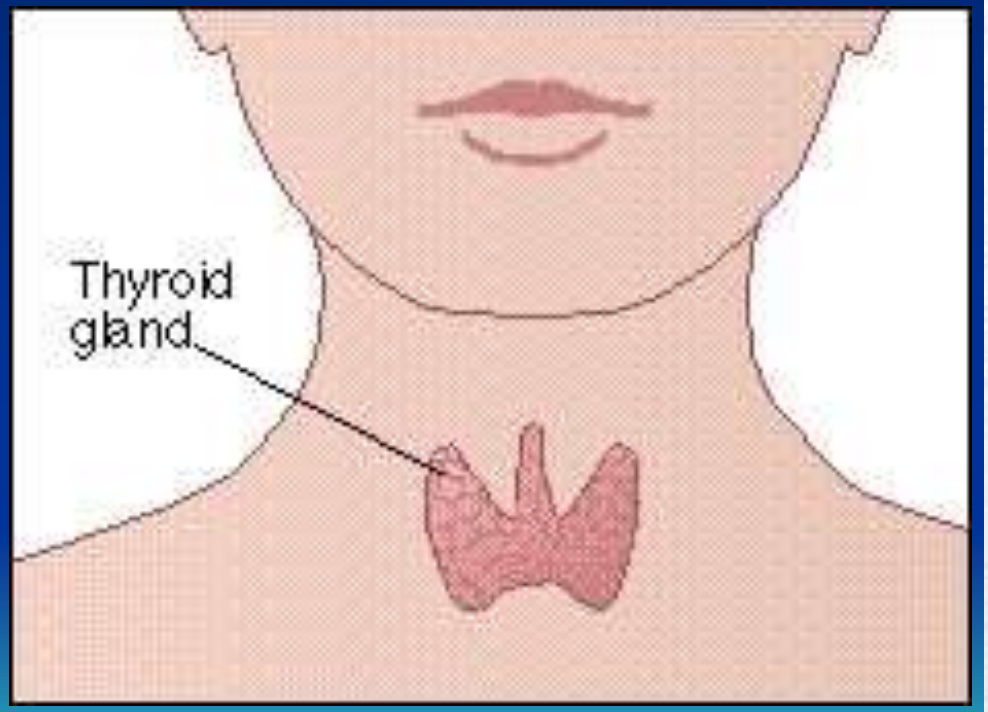


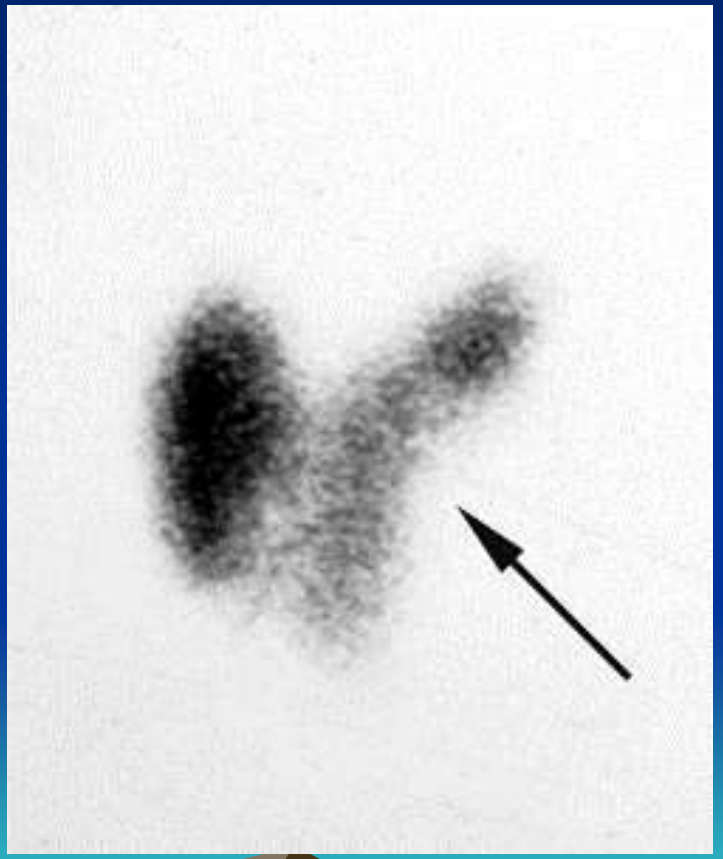
RADIOACTIVITY
PHYSICAL CONTRAST



Gamma Camera

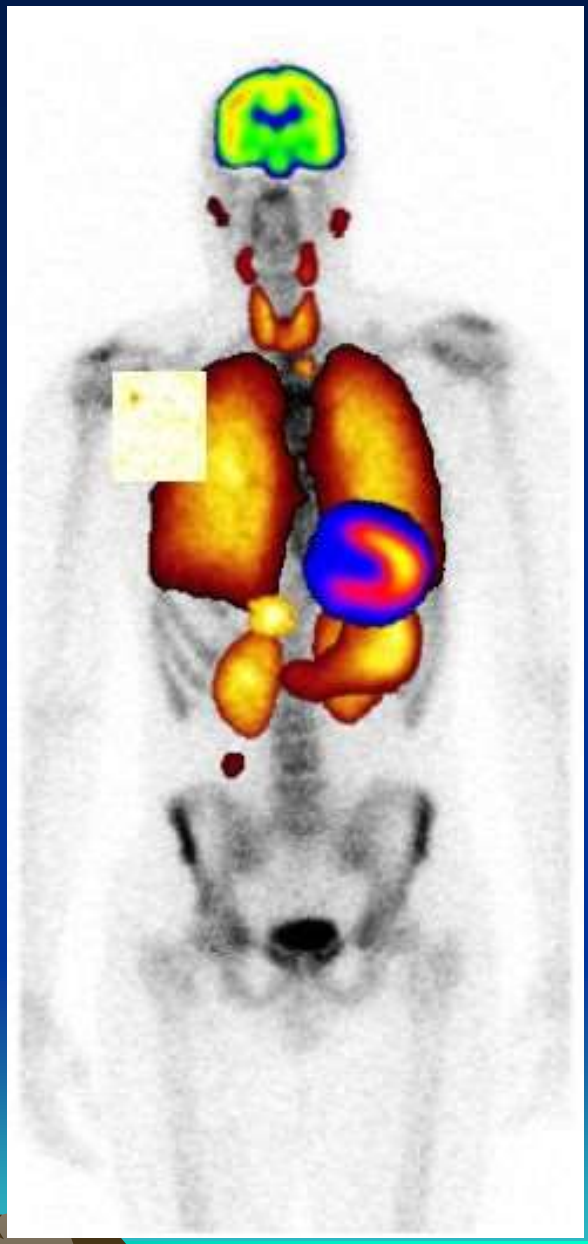
Thyroid Imaging



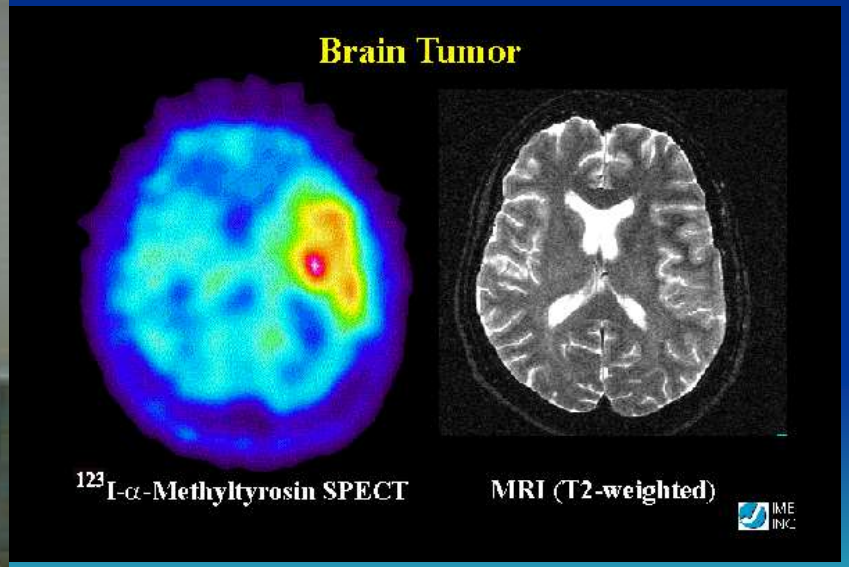


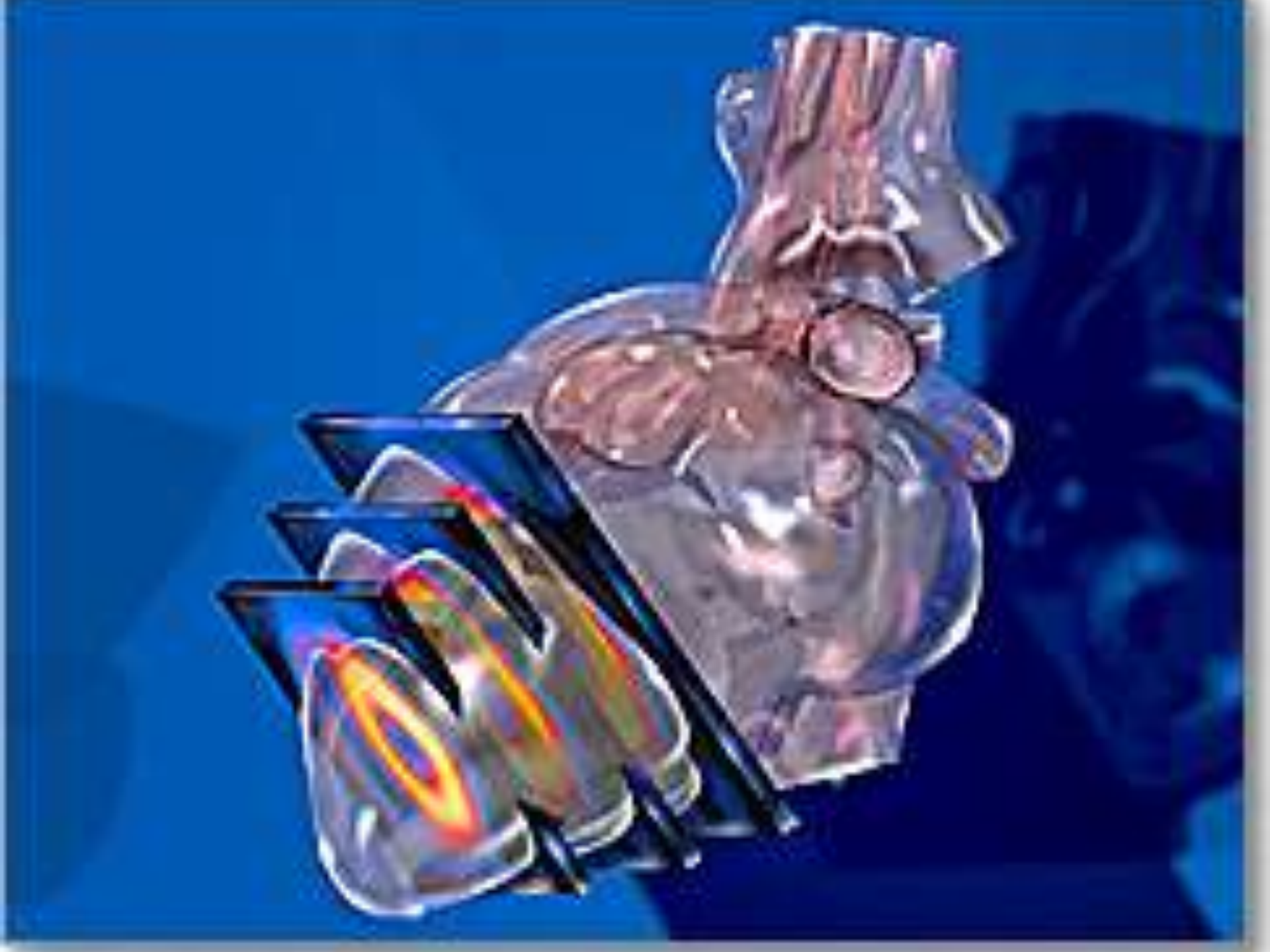
Radionuclide Bone Scan


SIEMENS
1

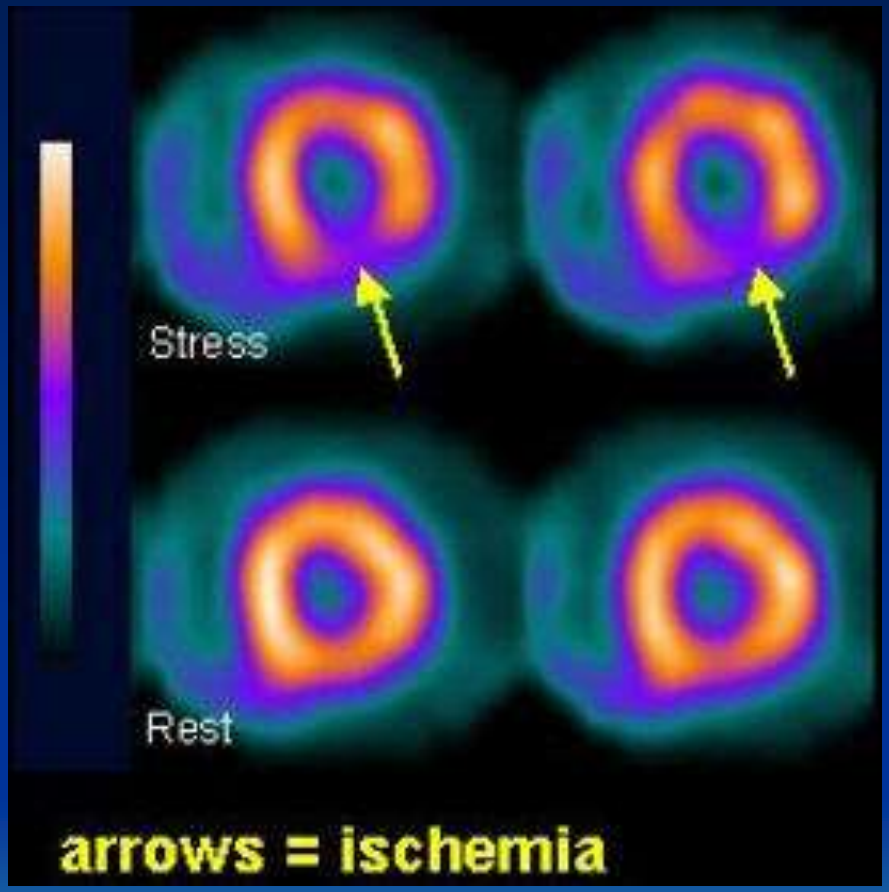


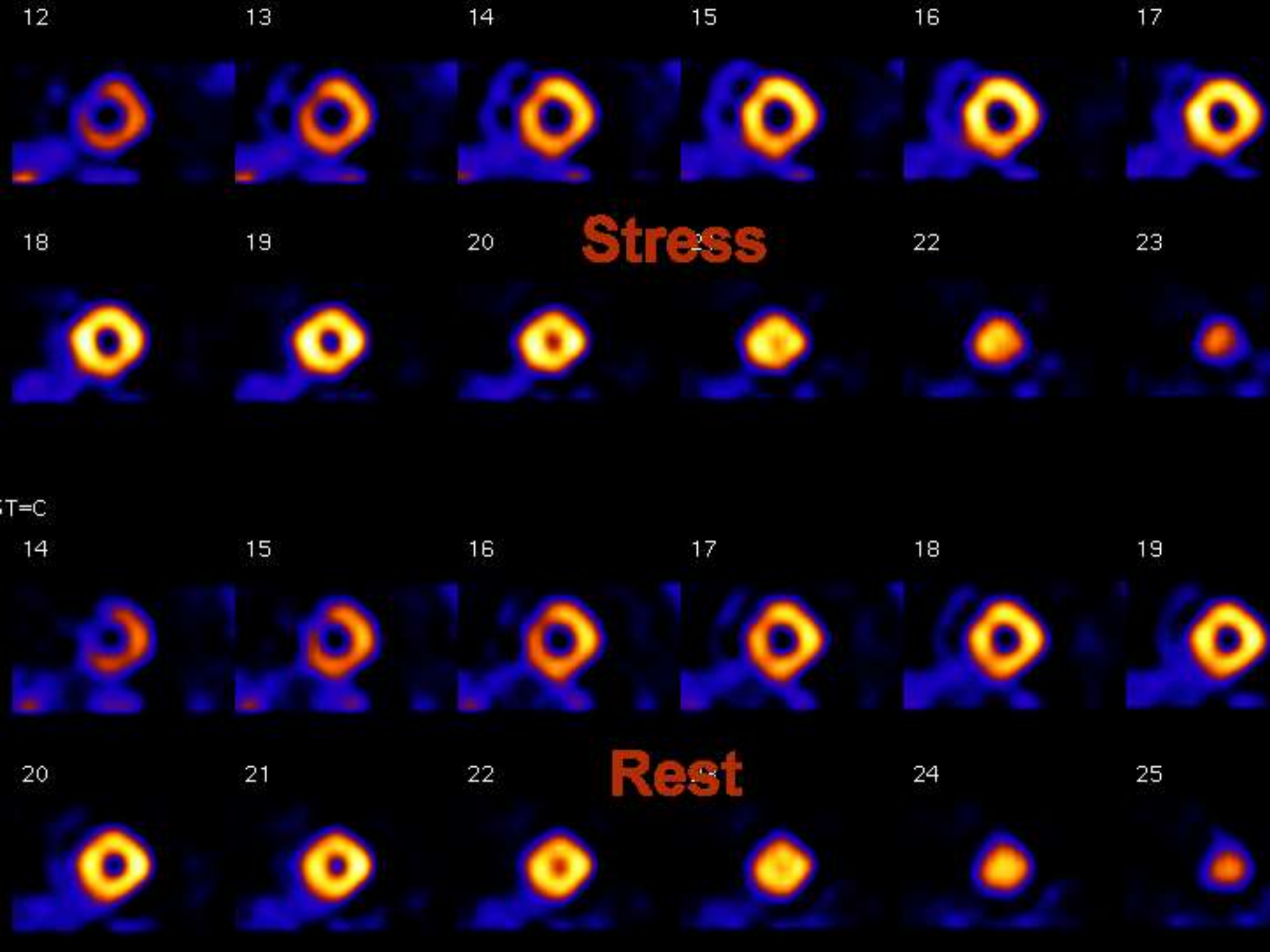
Single Photon Emission Tomography



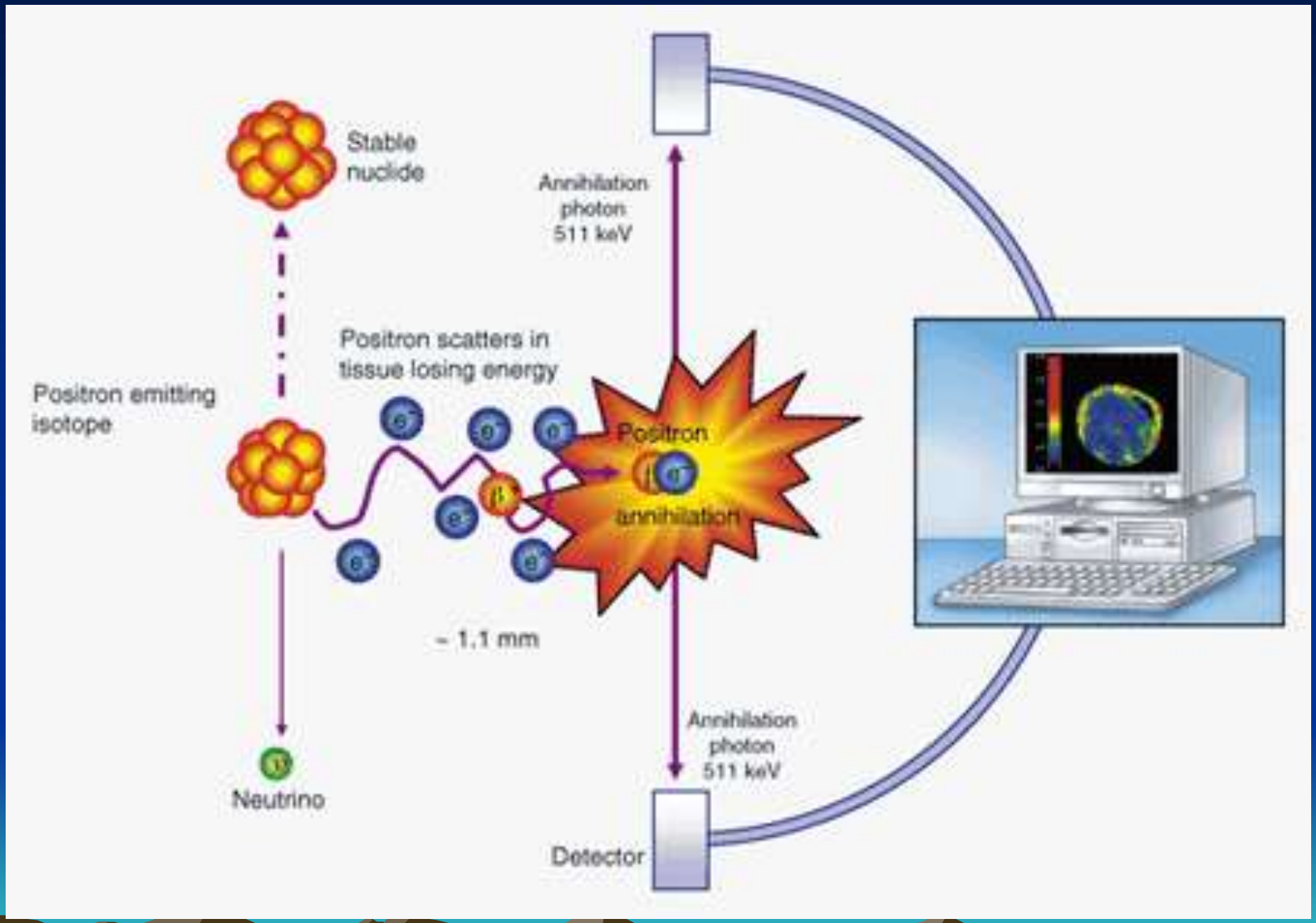


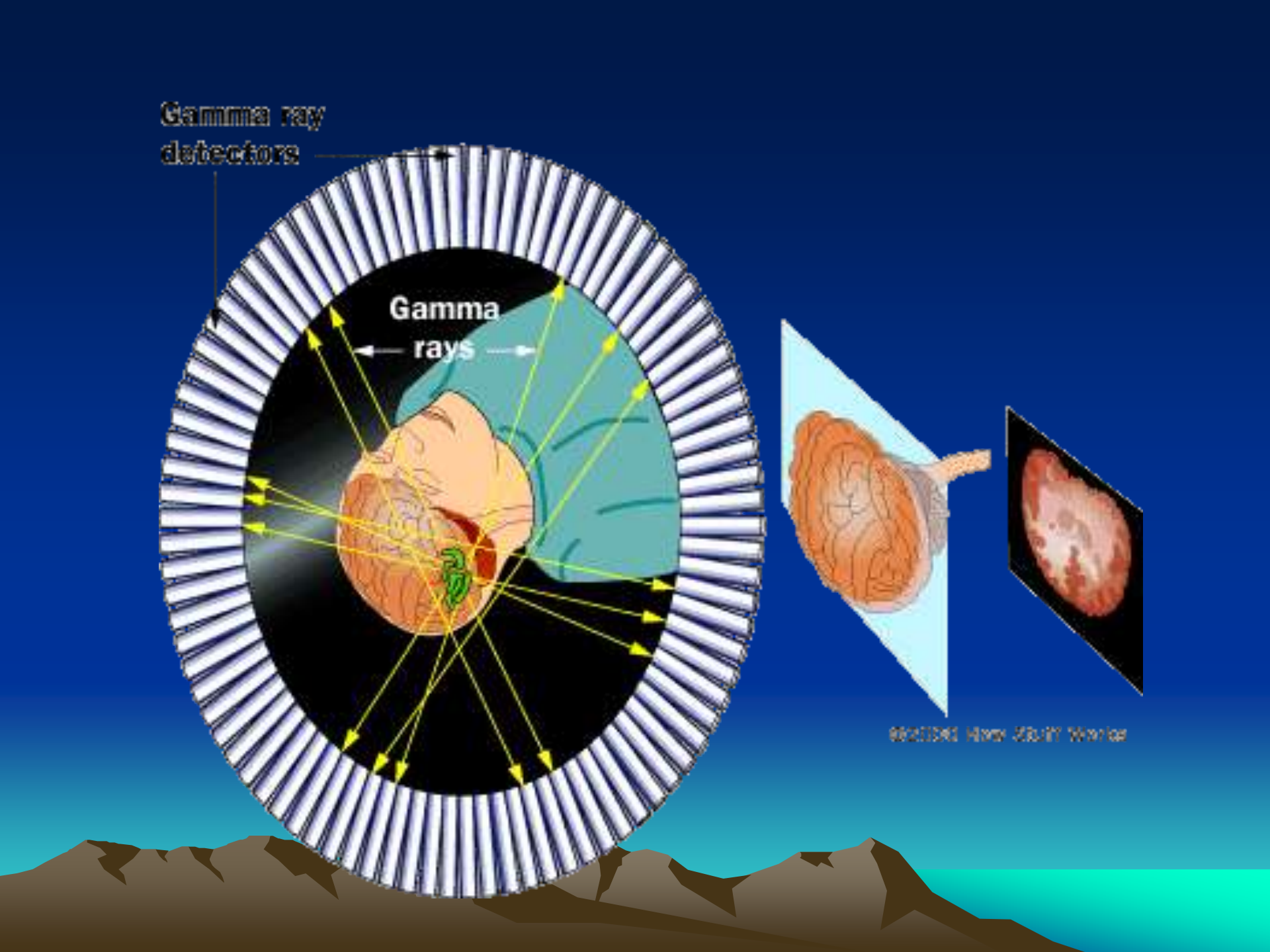

© Patrick J. Lynch, 2006


Stress
Rest
arrows = ischemia


12
13
14
15
16
17
Stress
18
19
20
22
23
T=C
14
15
16
17
18
19
Rest
20
21
22
24
25

PET Scanner


Stable nuclide
Annihilation photon 511 keV
Positron scatters in tissue losing energy
Positron emitting isotope
Positron
annihilation
~ 1.1 mm
Neutrino
Annihilation photon 511 keV
Detector


Gamma ray detectors
Gamma rays

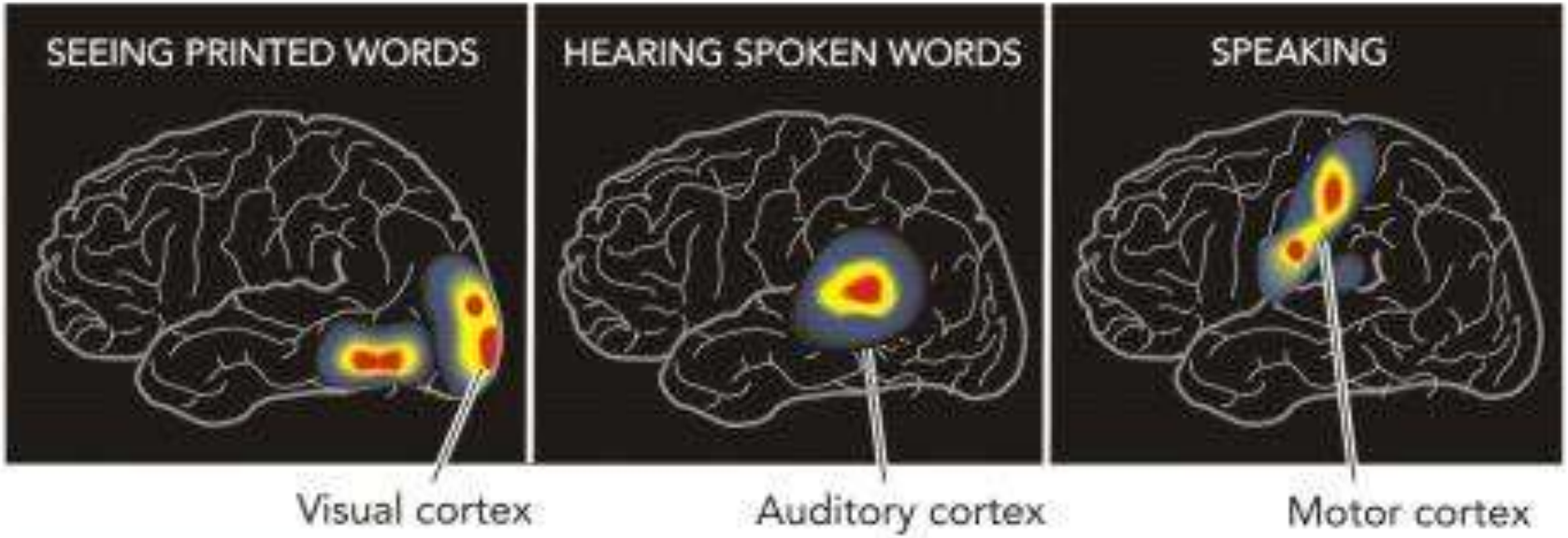
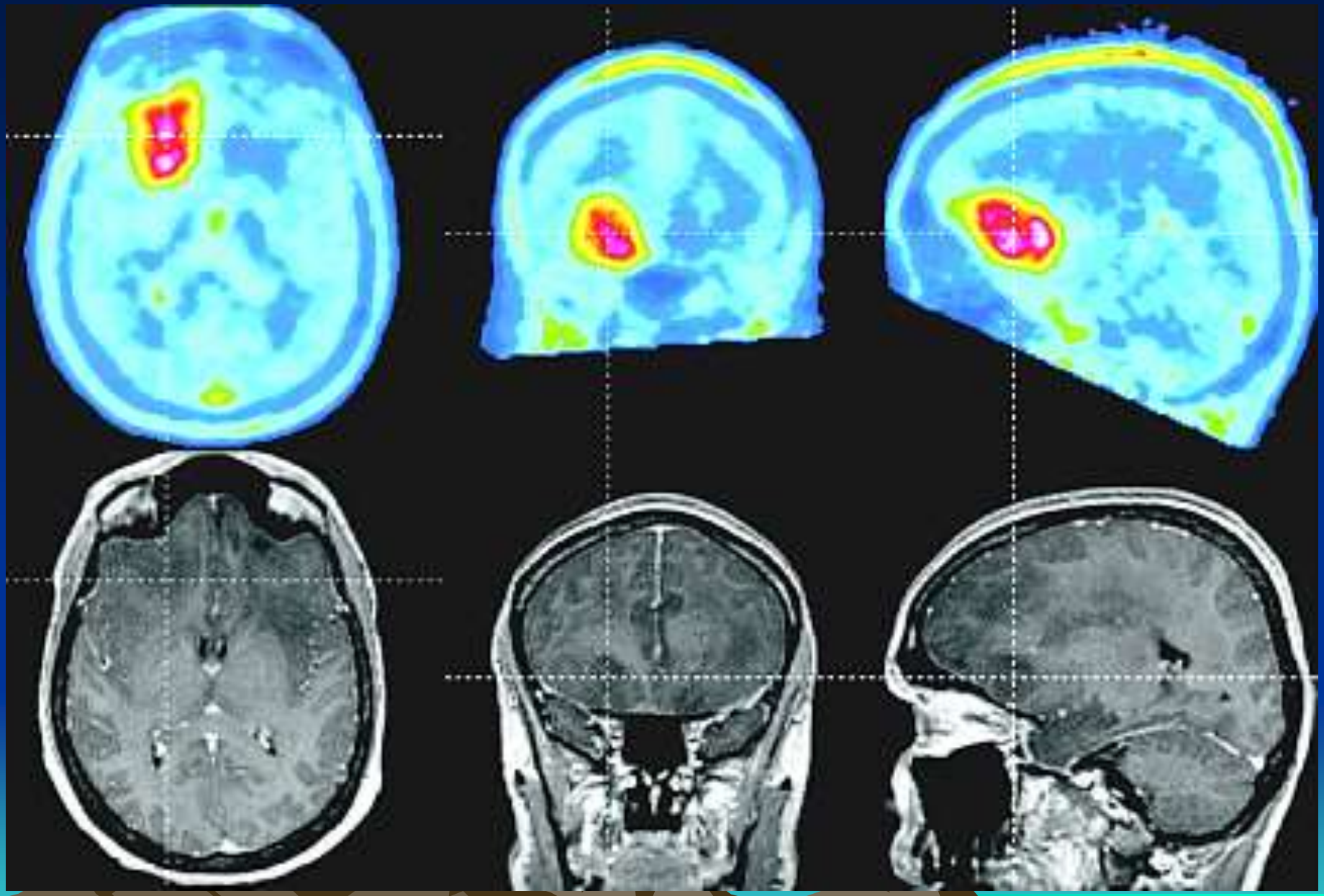
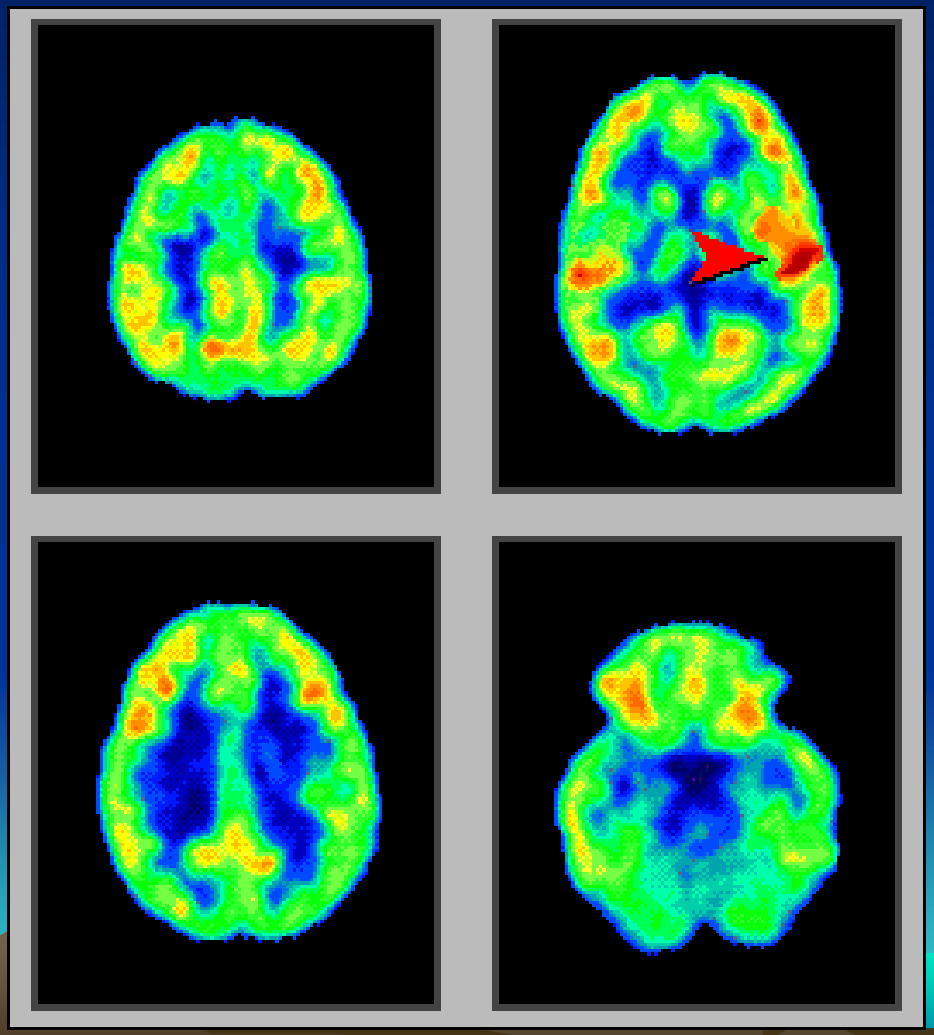


Figure 7-20 PET imaging of the brain



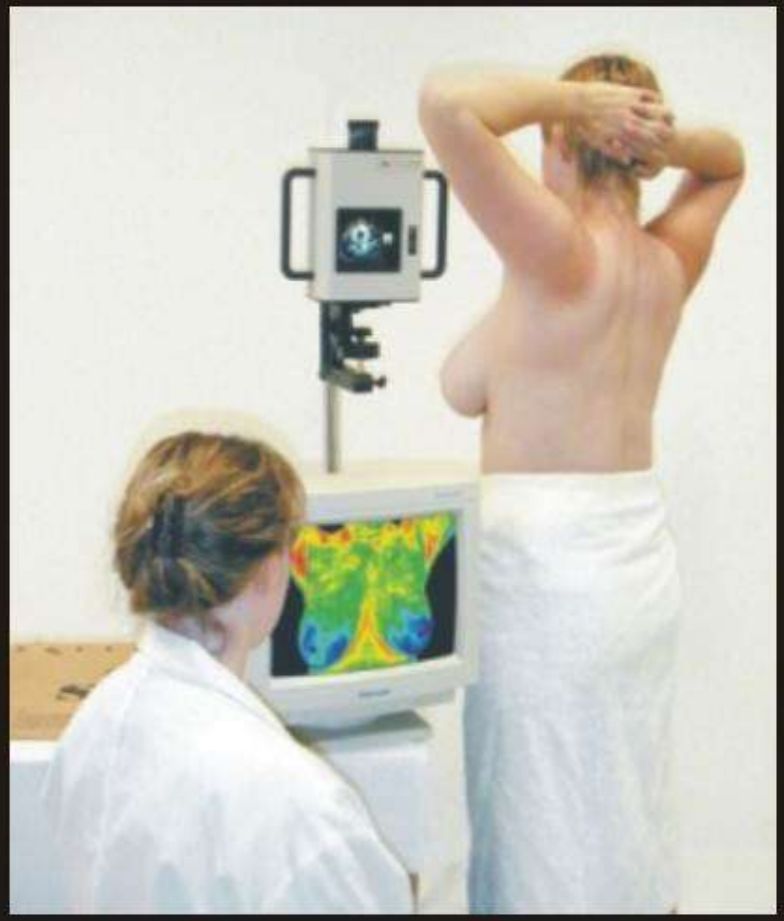
Positron Emission Tomography

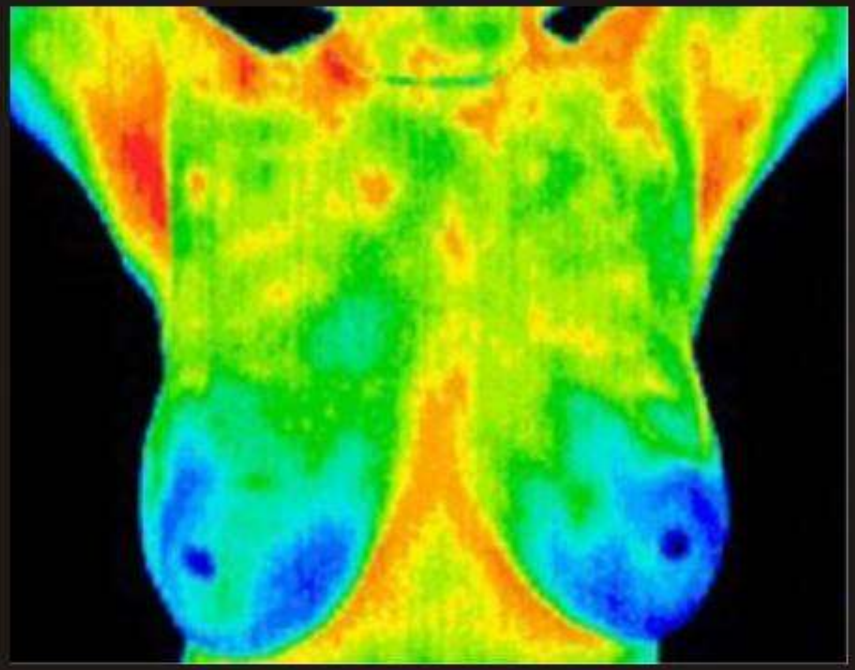


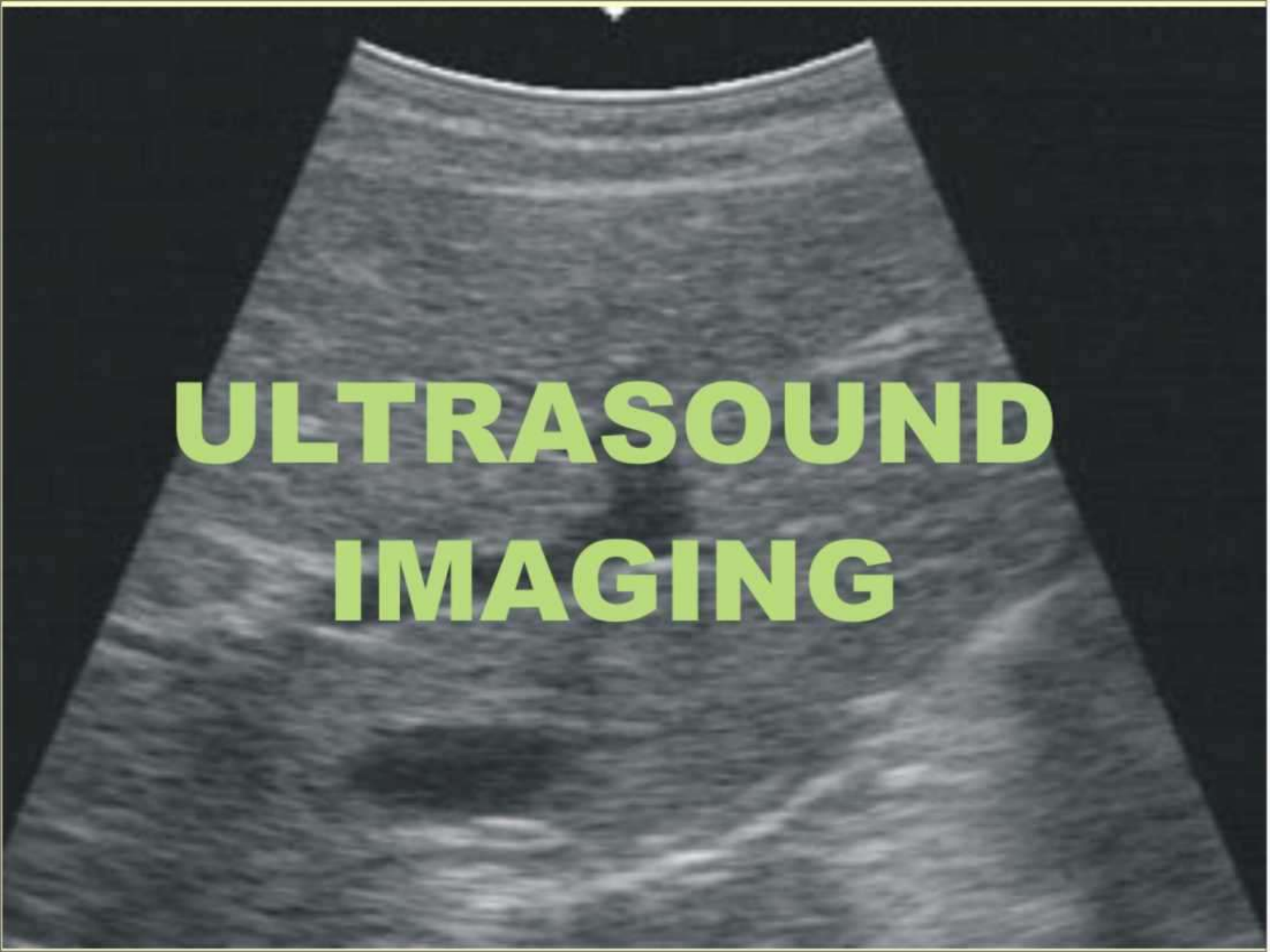
MEDICAL IMAGING
NON-IONIZING RADIATION METHODS

- **Radiography and Mammography**
- **Fluoroscopy**
- **Computed Tomography (CT)**
- **Radionuclide Scan**
- **Single-Photon Emission CT**
- **Positron-Emission Tomo. (PET)**
- **Ultrasound**
- **Magnetic Resonance Imaging (MRI)**

Thermography






ULTRASOUND
IMAGING

The Ultrasound Image

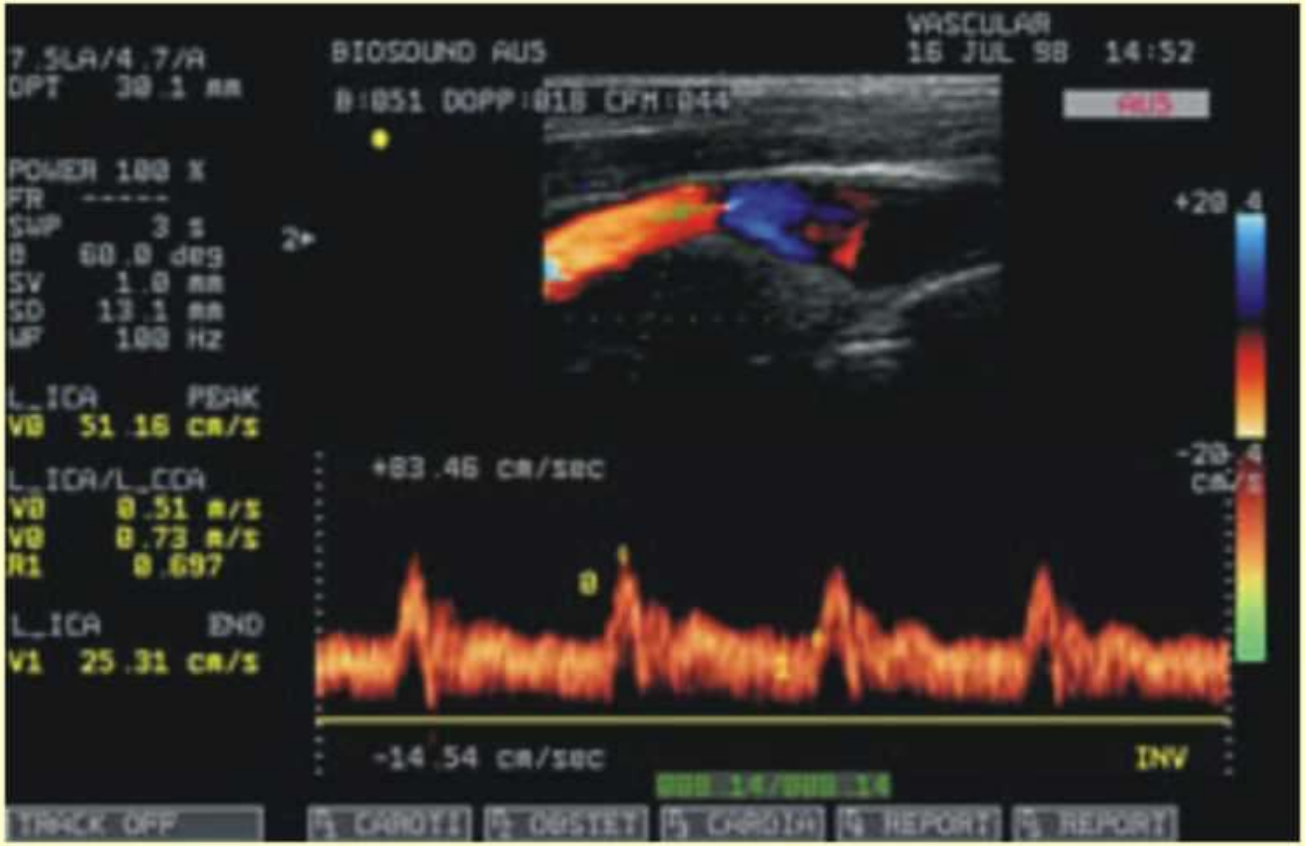
What do you see?

Echo Sites

Sprawls

The Ultrasound Image

What do you see?



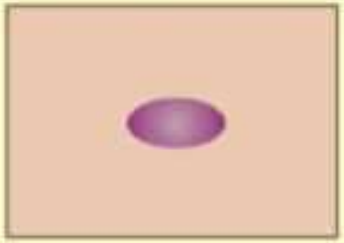
Flowing Blood

Sprawls

CONTRAST SENSITIVITY

ULTRASOUND

OBJECT



PHYSICAL CONTRAST

ACOUSTIC IMPEDANCE

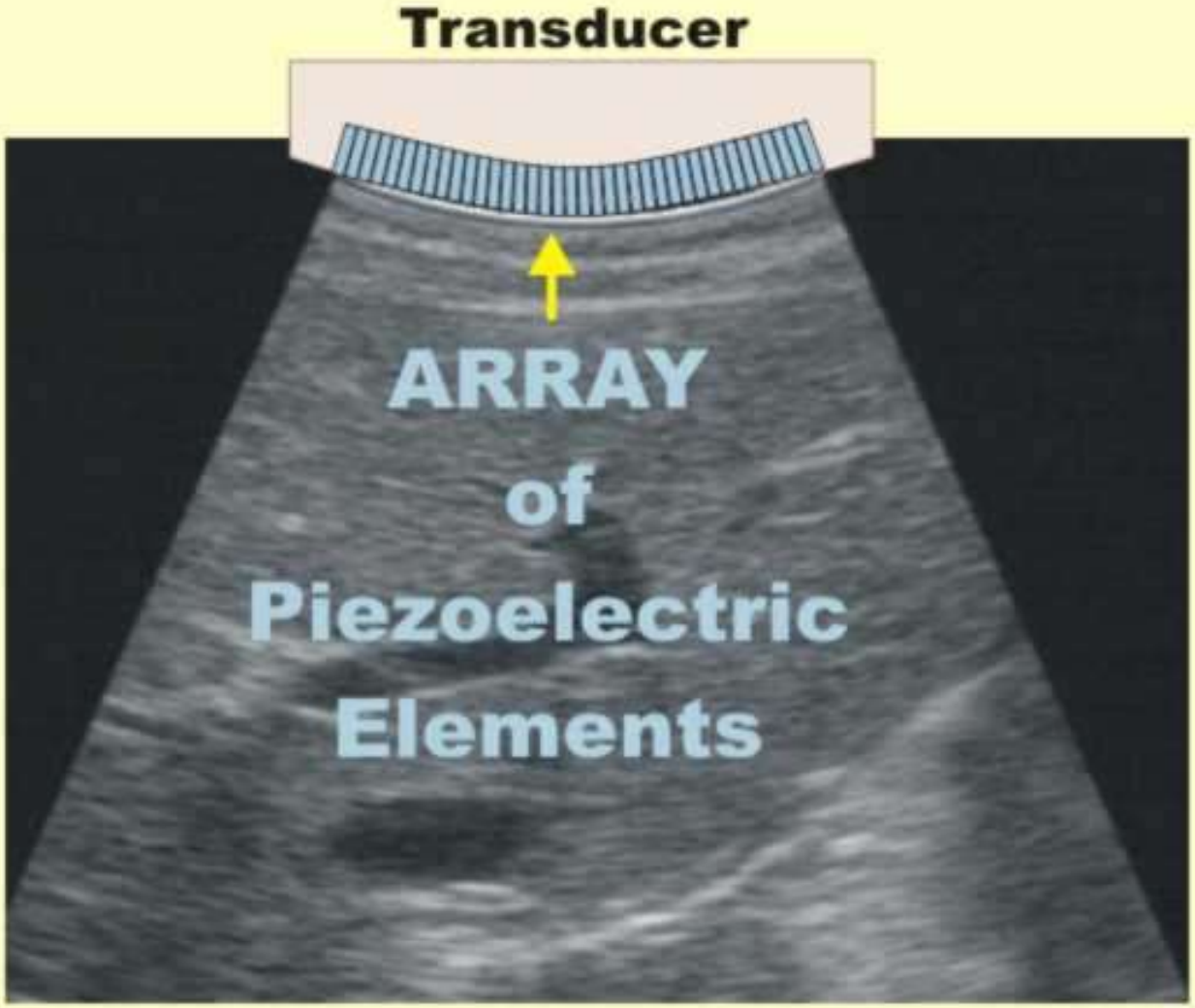
B Mode

RBC Motion

Doppler Mode

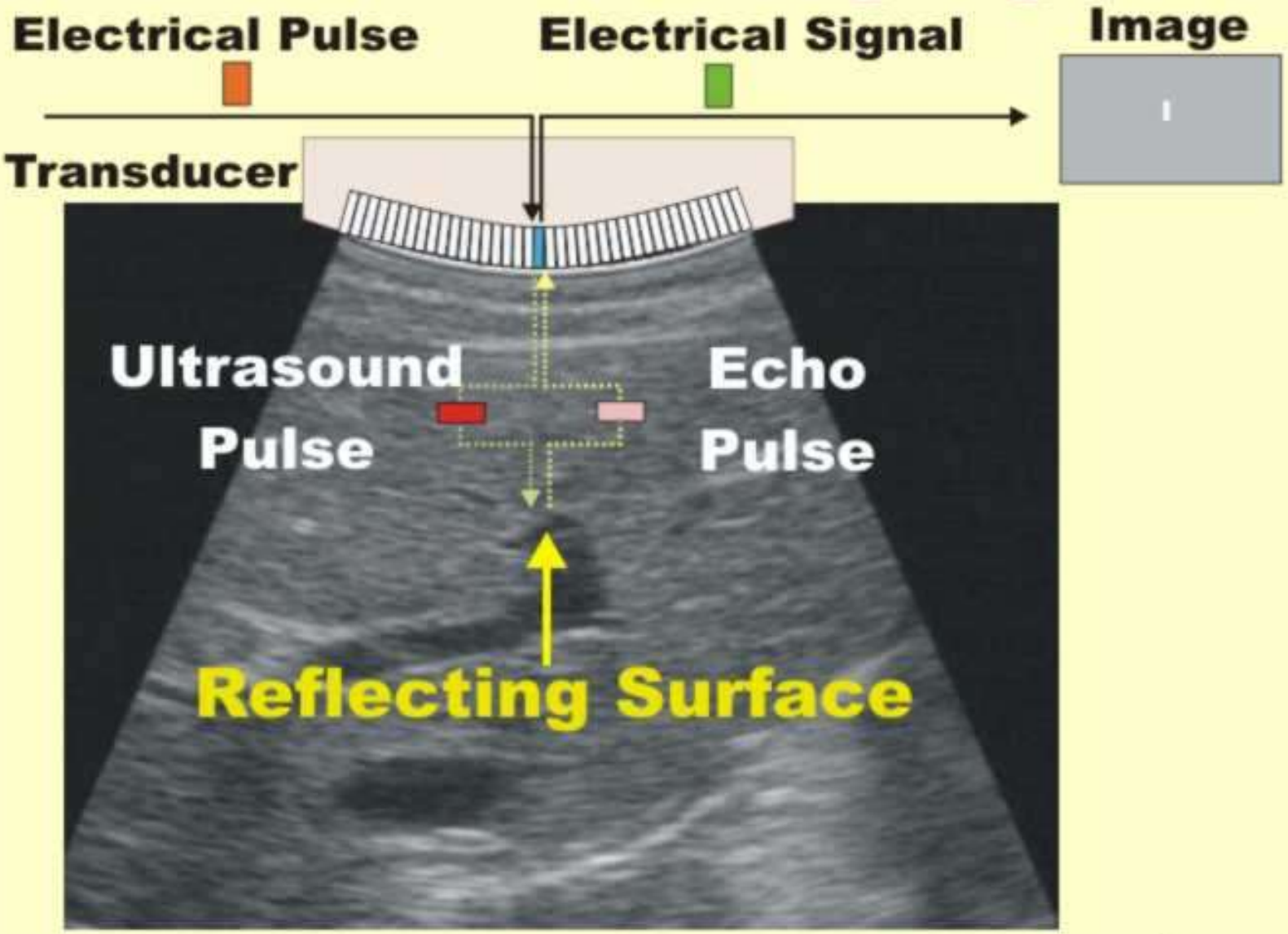
Sprawls

Ultrasound Imaging



Sprawls

Ultrasound Imaging



Sprawls

Baby's First Picture


PHILIPS
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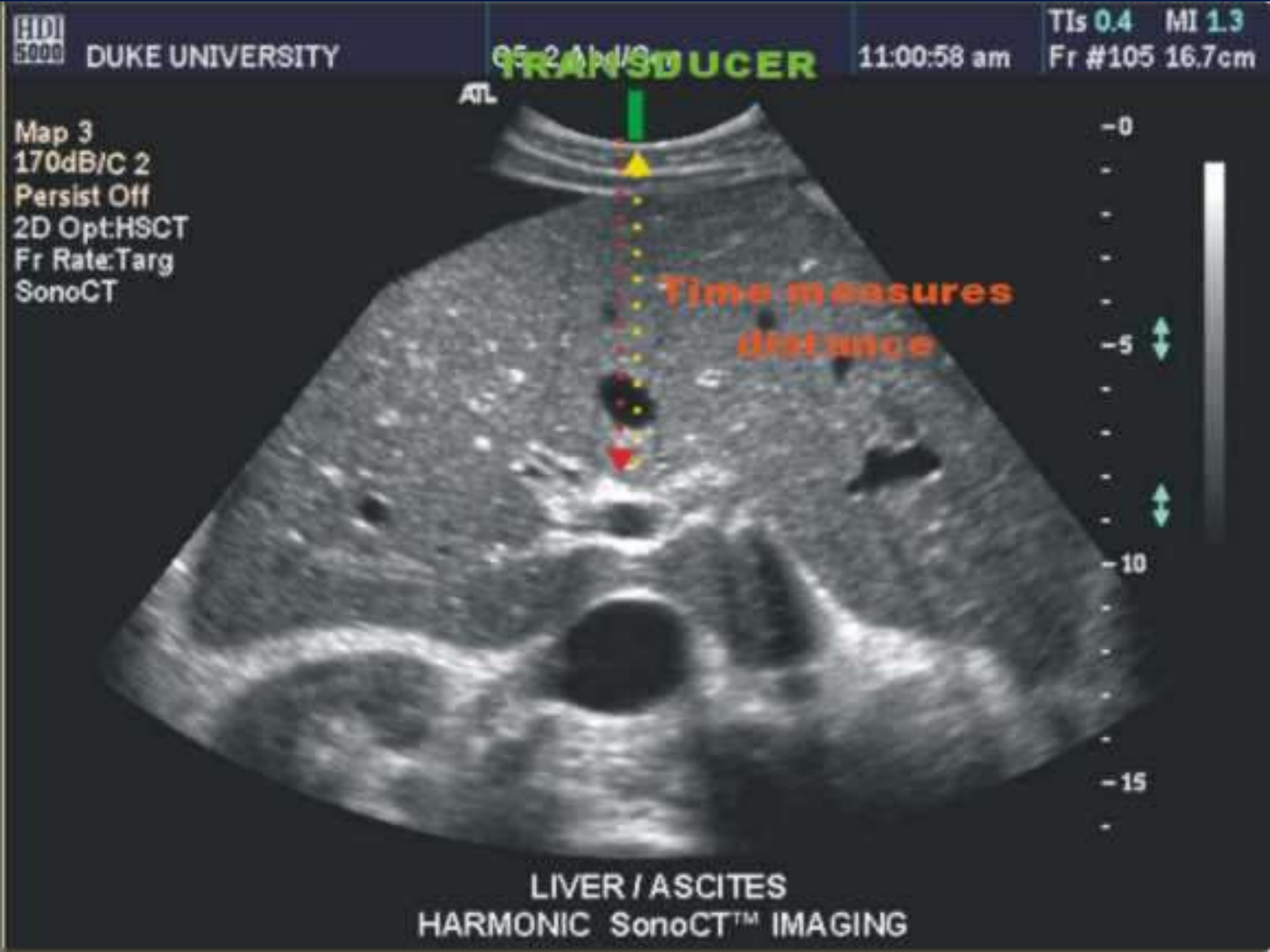
C9-4/OB Gen
FR 35Hz
RS
2D
64%
C 54
P Low
Res
AGC
M4
0
X
5
17 - WEEK FETAL PROFILE


acuson
128XP
acuson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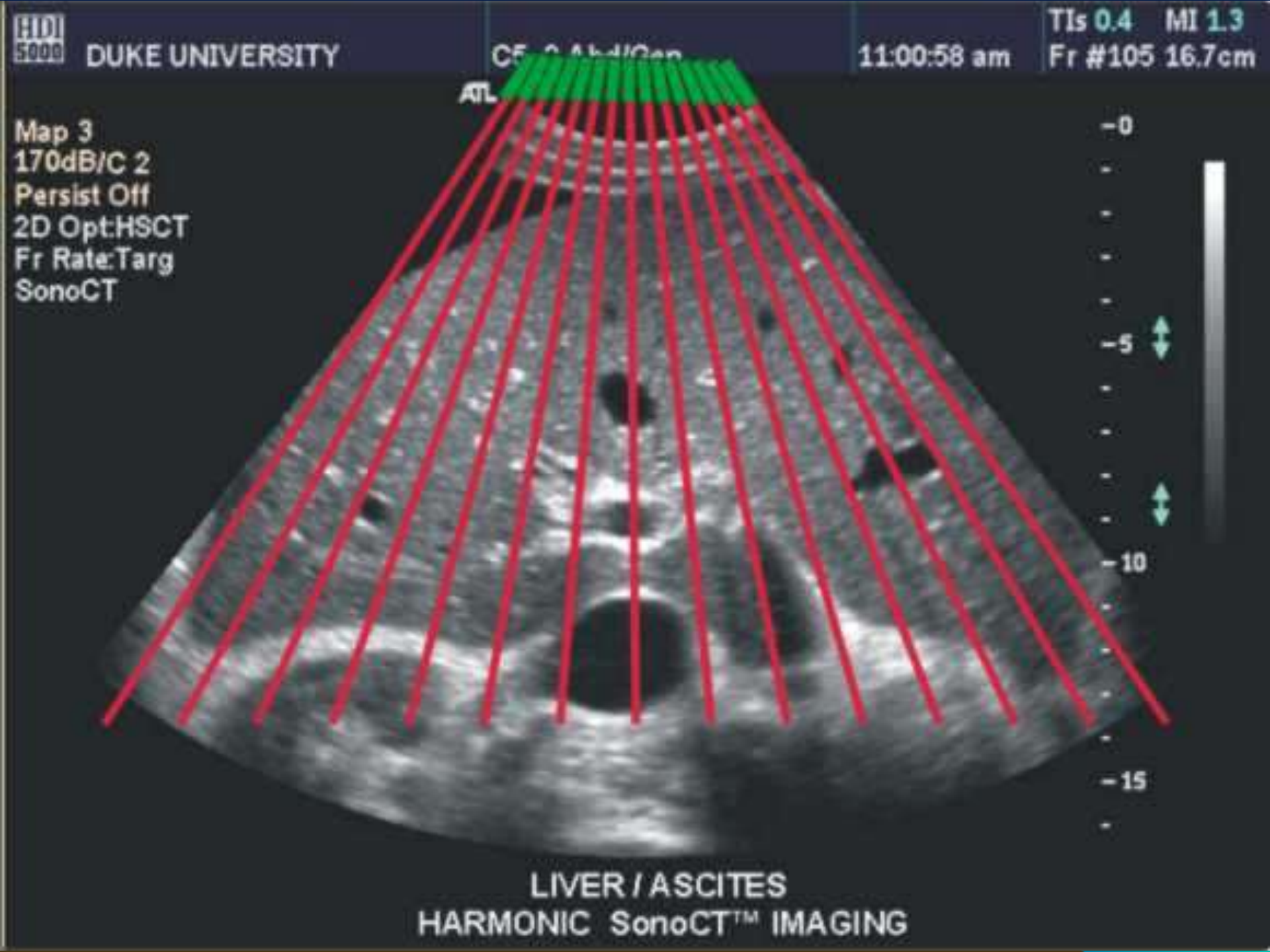
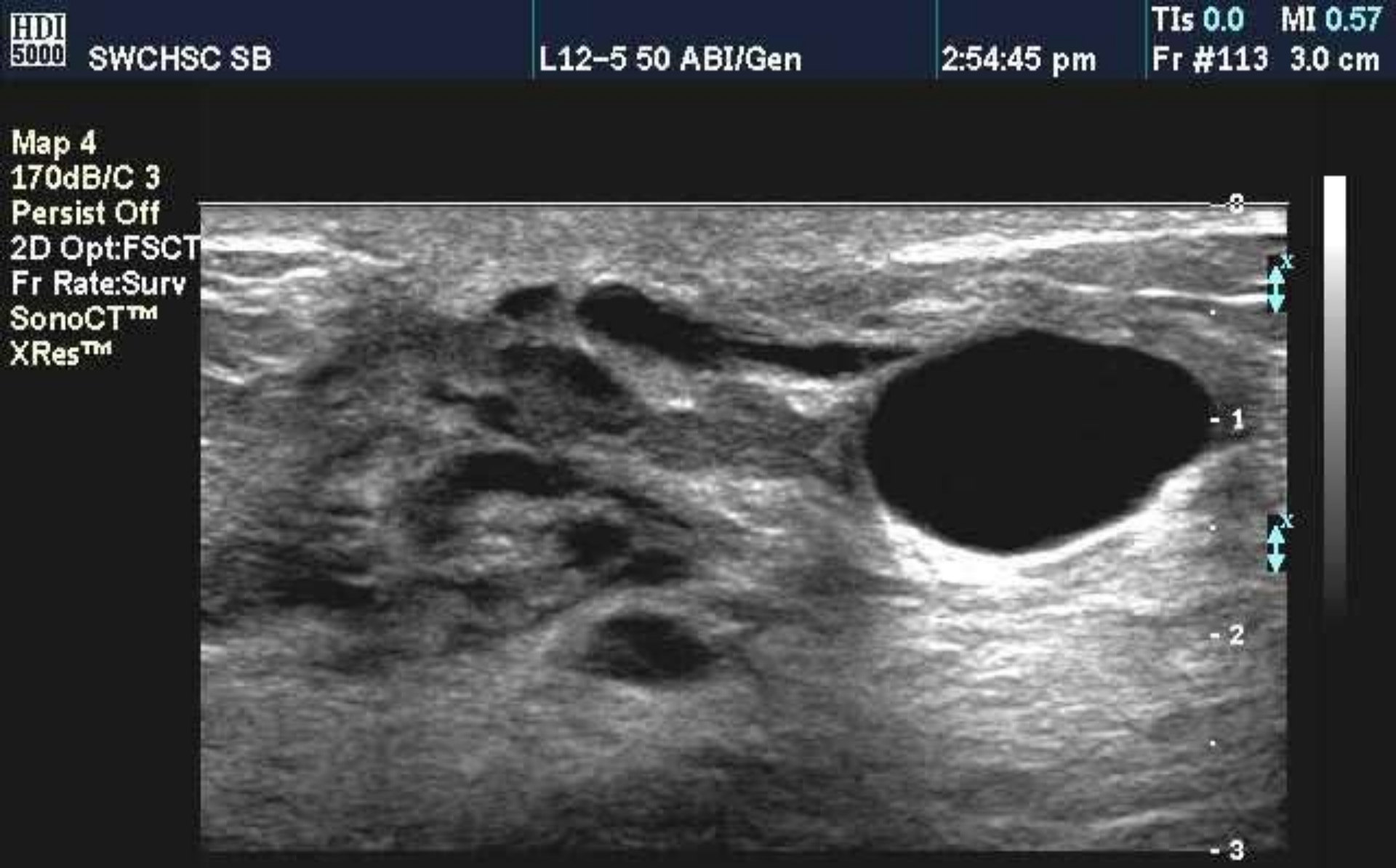
DUKE UNIVERSITY
11:00:58 am
TIs 0.4 MI 1.3
Fr #105 16.7cm
TRANSDUCER
ATL
Map 3
170dB/C 2
Persist Off
2D Opt:HSCT
Fr Rate:Targ
SonoCT
Time measures
distance
0
5
10
15
LIVER / ASCITES
HARMONIC SonoCT™ IMAGING

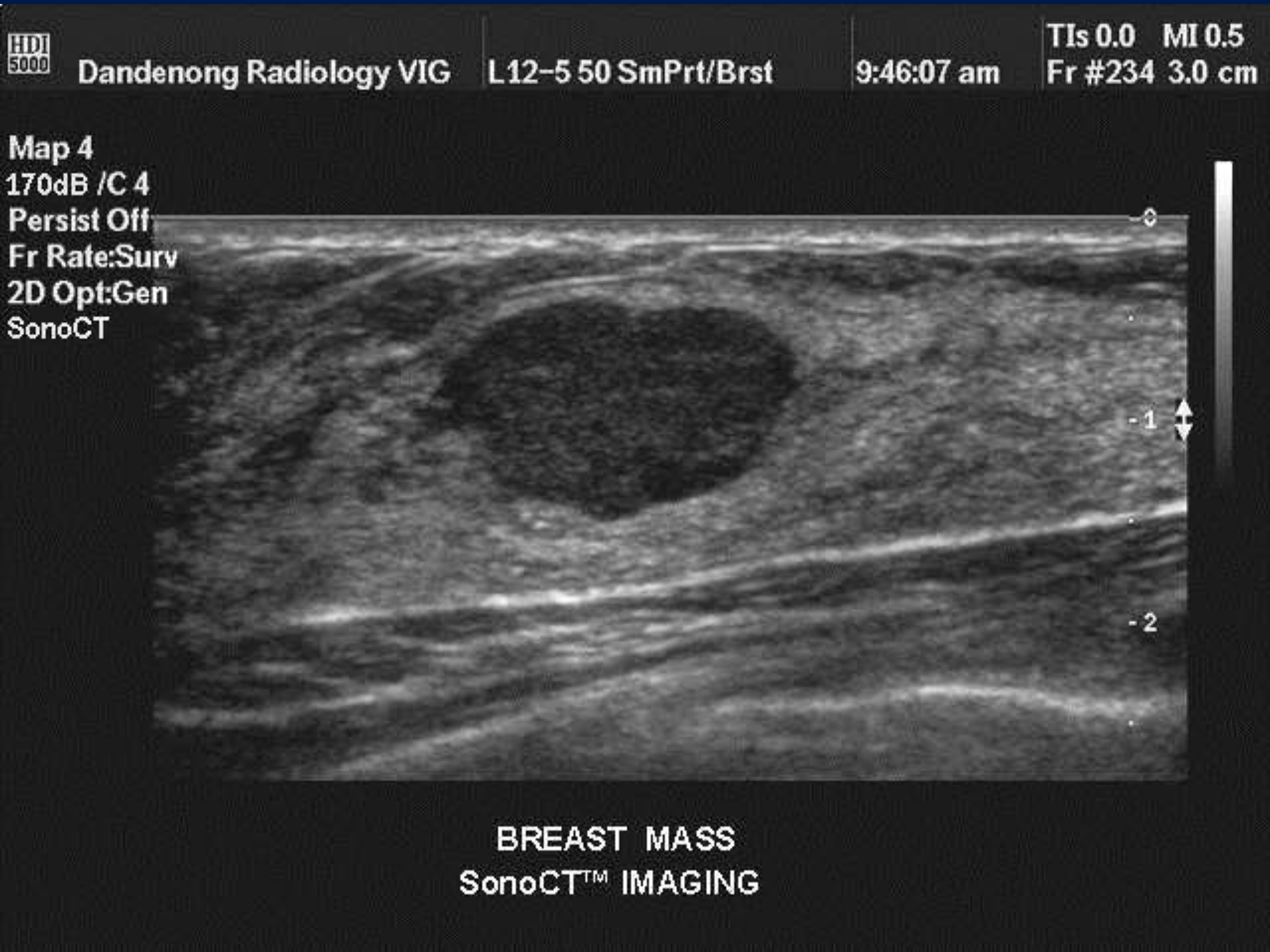

HDI 5000
DUKE UNIVERSITY
11:00:58 am
TIs 0.4 MI 1.3
Fr #105 16.7cm
ATL
Map 3
170dB/C 2
Persist Off
2D Opt:HSCT
Fr Rate:Targ
SonoCT
0
5
10
15
LIVER / ASCITES
HARMONIC SonoCT™ IMAGING


HDI 5000
DUKE UNIVERSITY
C5-2 Abd/Gen
11:00:58 am
TIs 0.4 MI 1.3
Fr #105 16.7cm
ATL
Map 3
170dB/C 2
Persist Off
2D Opt:HSCT
Fr Rate:Targ
SonoCT
0
5
10
15
LIVER / ASCITES
HARMONIC SonoCT™ IMAGING

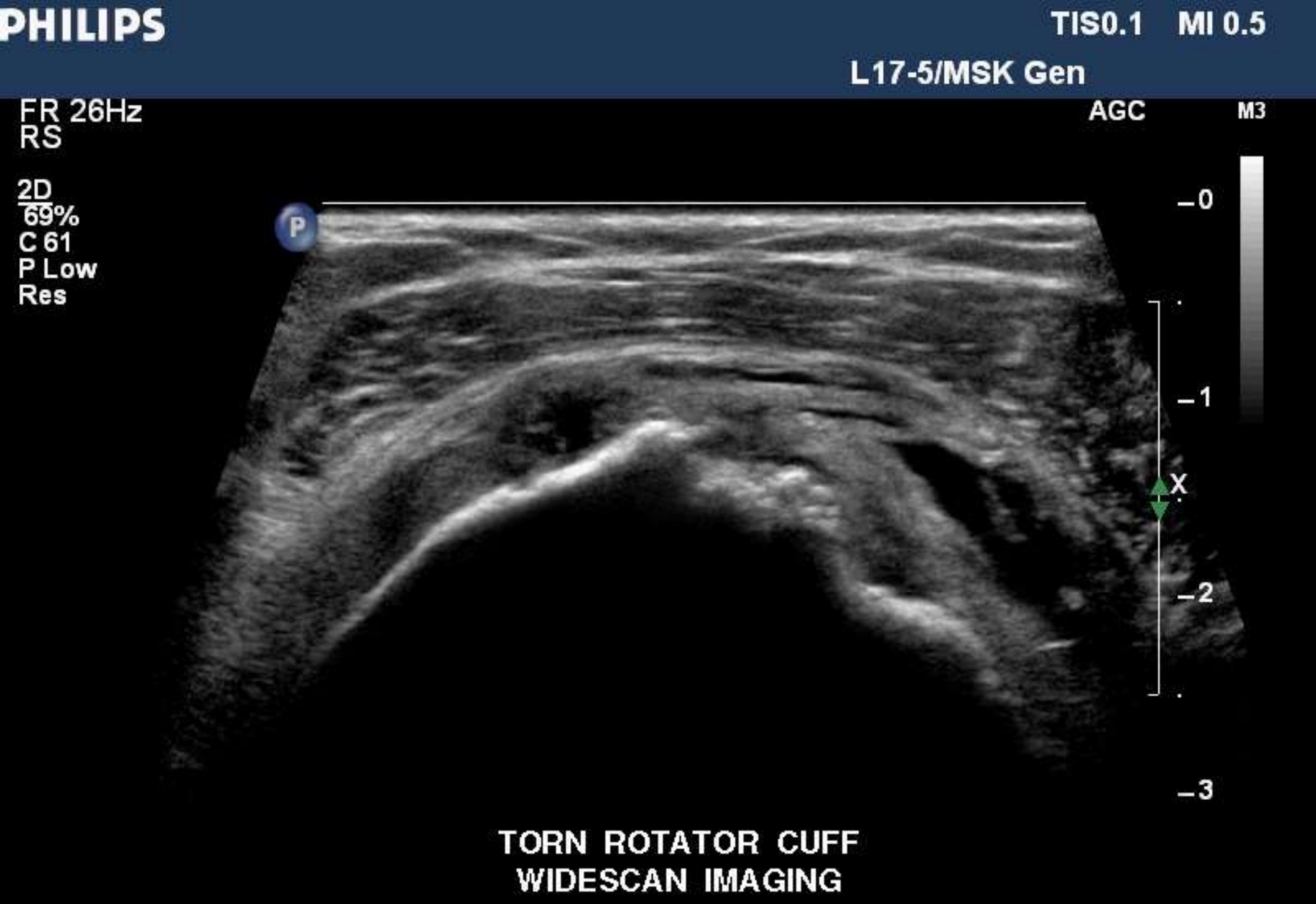


BREAST CYST / DUCTAL ECTASIA

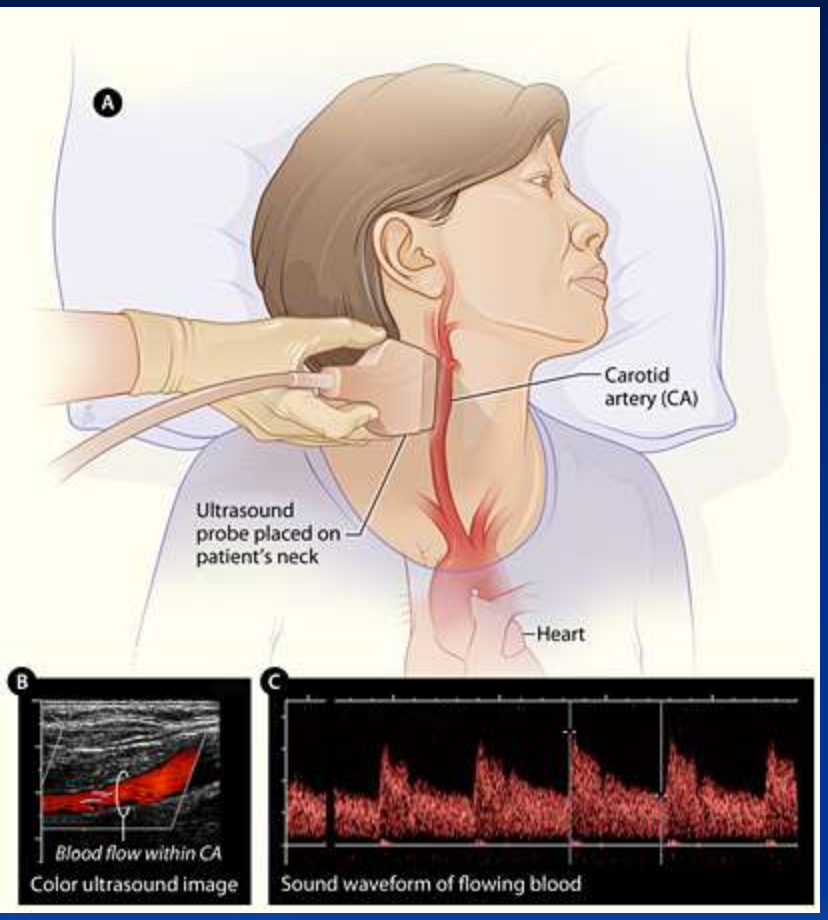
SonoCT™ IMAGING WITH XRES™ TECHNOLOGY


HDI 5000
Dandenong Radiology VIG
L12-5 50 SmPrt/Brst
9:46:07 am
TIs 0.0 MI 0.5
Fr #234 3.0 cm
Map 4
170dB /C 4
Persist Off
Fr Rate:Surv
2D Opt:Gen
SonoCT
0
1
2
BREAST MASS
SonoCT™ IMAGING


PHILIPS
Abd Gen
C5-2
53Hz
7cm
2D
HGen
Gn 60
56
3/3/3
35 mm/s
P
G
P
R
2.0 4.0
ABNORMAL GALLBLADDER

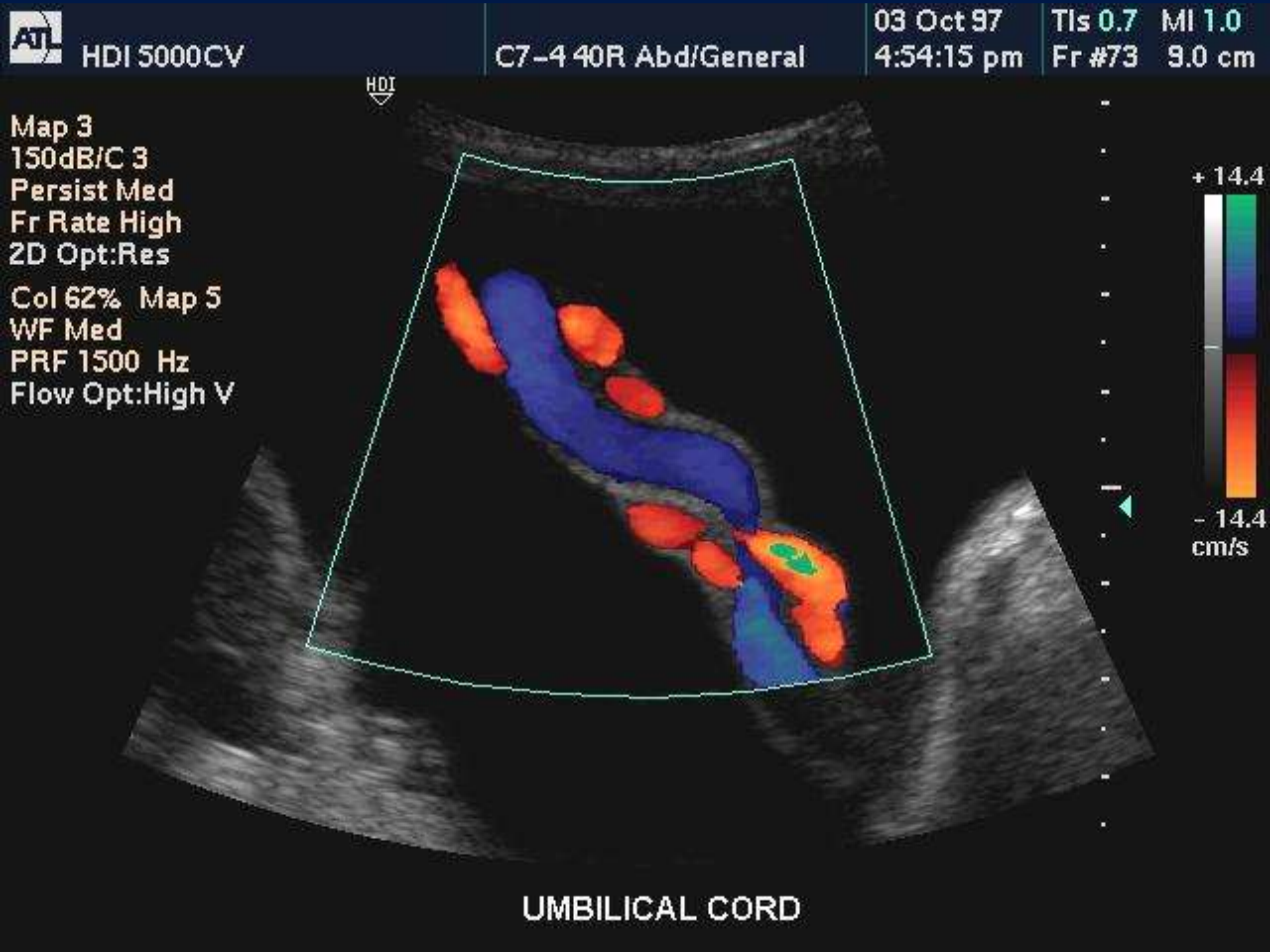

PHILIPS
TIS0.1 MI 0.5
L17-5/MSK Gen
FR 26Hz
RS
AGC
M3
2D
69%
C 61
P Low
Res
P
0
1
X
2
3
TORN ROTATOR CUFF
WIDESCAN IMAGING

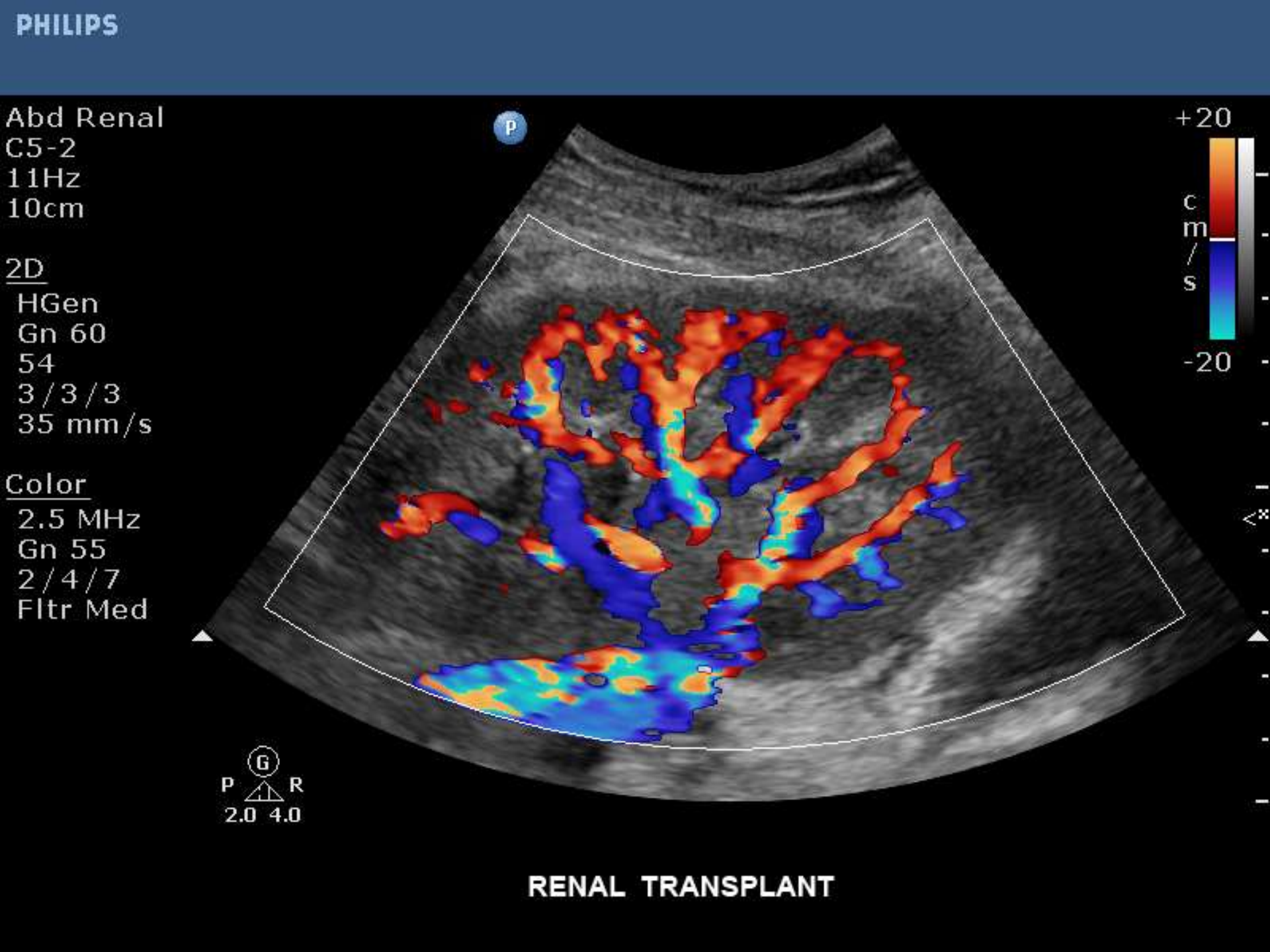

9:55AM EST 23-JAN-1999
© 1999 ACCU WEATHER, INC.
WWW.ACCUWEATHER.COM


A
Carotid artery (CA)
Ultrasound probe placed on patient's neck
Heart
B
Blood flow within CA
Color ultrasound image
C
Sound waveform of flowing blood

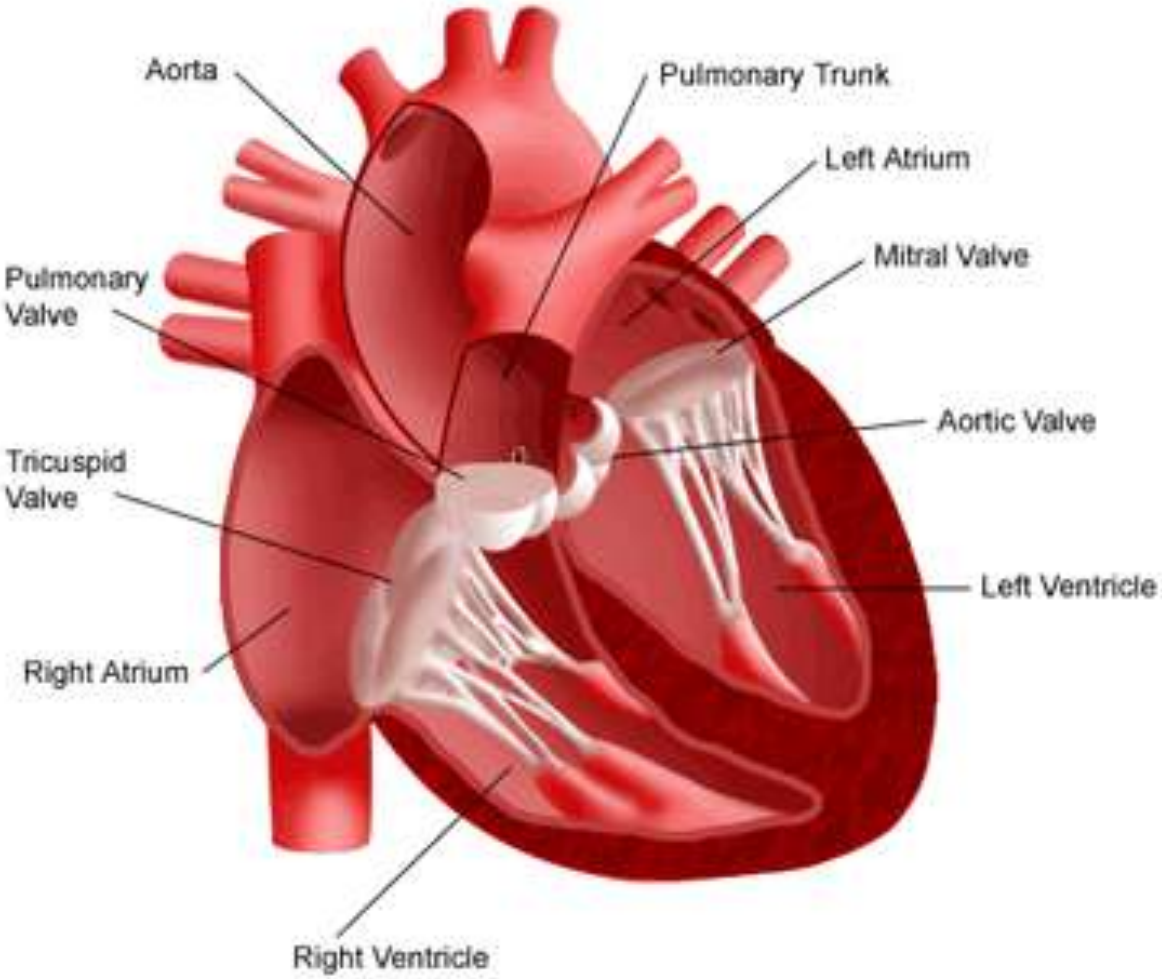

PHILIPS
TIS0.5 MI 1.2
L11-3/Carotid
FR 30Hz
3.0cm
AGC
M3 M3
+32.1
2D
55%
C 60
P Low
Pen
CF
53%
5.5MHz
WF Low
Med
-32.1
cm/s
INTERNAL CAROTID ARTERY STENOSIS

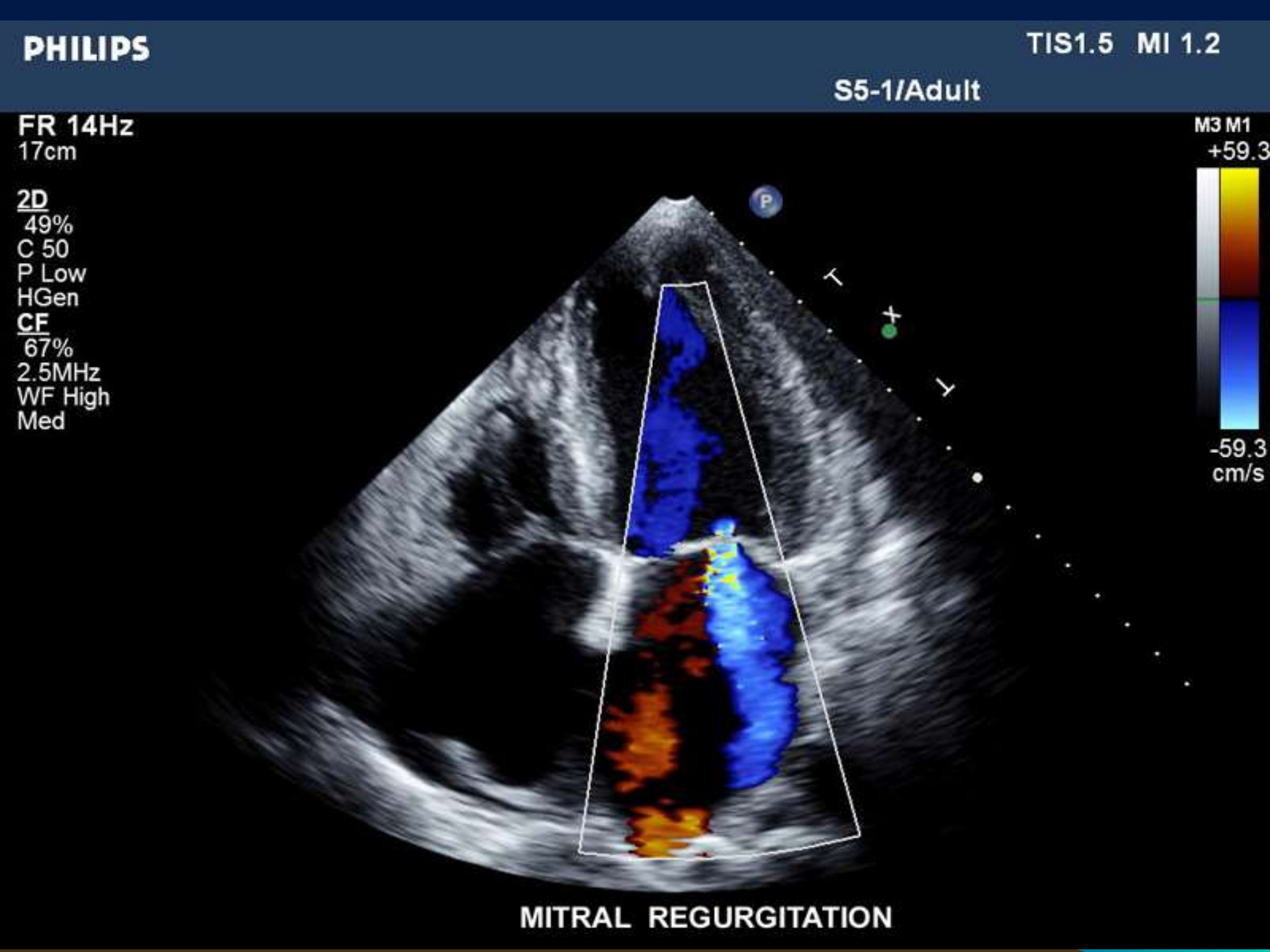

MAR-27-00 14:45:11
BAPTIST MEDICAL CENTER
3cm 5739L
1380P
CAROTID
145F
CINE 0047
32CG
19G
IM#2
72DR
R1 A9 P16
GE
PWR
PWR
CAROTID BIFURCATION
TIS=2.8 MI=1.1 AO=69%


HDI 5000CV
C7-4 40R Abd/General
03 Oct 97
4:54:15 pm
TIs 0.7
MI 1.0
Fr #73
9.0 cm
HDI
Map 3
150dB/C 3
Persist Med
Fr Rate High
2D Opt:Res
Col 62% Map 5
WF Med
PRF 1500 Hz
Flow Opt:High V
+ 14.4
- 14.4
cm/s
UMBILICAL CORD


PHILIPS
Abd Renal
C5-2
11Hz
10cm
2D
HGen
Gn 60
54
3/3/3
35 mm/s
Color
2.5 MHz
Gn 55
2/4/7
Fltr Med
+20
cm/s
-20
P
G
P
R
2.0 4.0
RENAL TRANSPLANT

Valves of the Heart

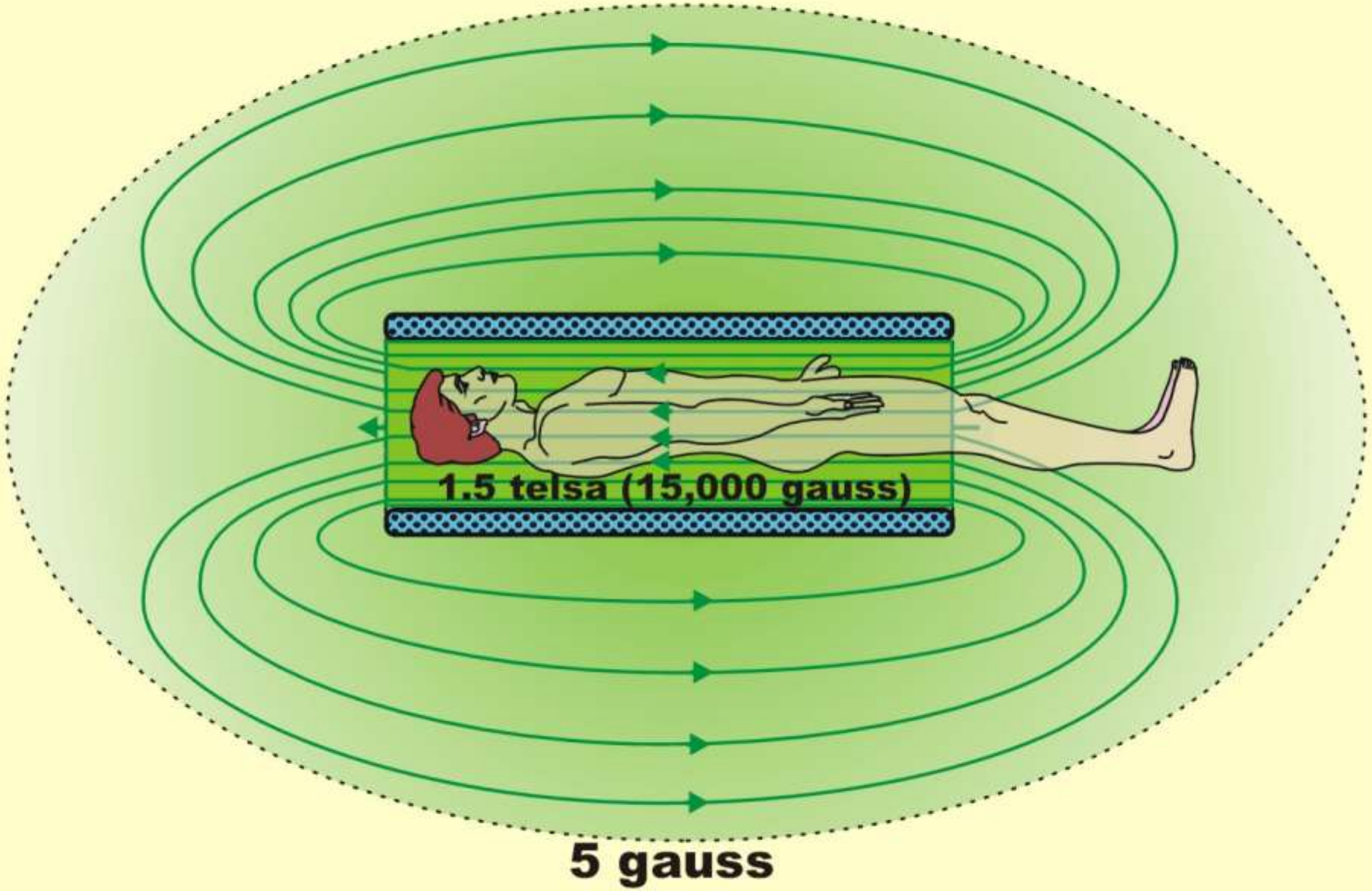



PHILIPS
TIS1.5 MI 1.2
S5-1/Adult
FR 14Hz
17cm
2D
49%
C 50
P Low
HGen
CF
67%
2.5MHz
WF High
Med
M3 M1
+59.3
-59.3
cm/s
MITRAL REGURGITATION


PHILIPS
TIS1.4 MI 1.3
S5-1/Adult1
FR 12Hz
16cm
2D
46%
C 54
P Low
HGen
CF
70%
2.5MHz
WF High
Med
M3 M1
+61.6
-61.6
cm/s
MITRAL VALVE STENOSIS
bpm

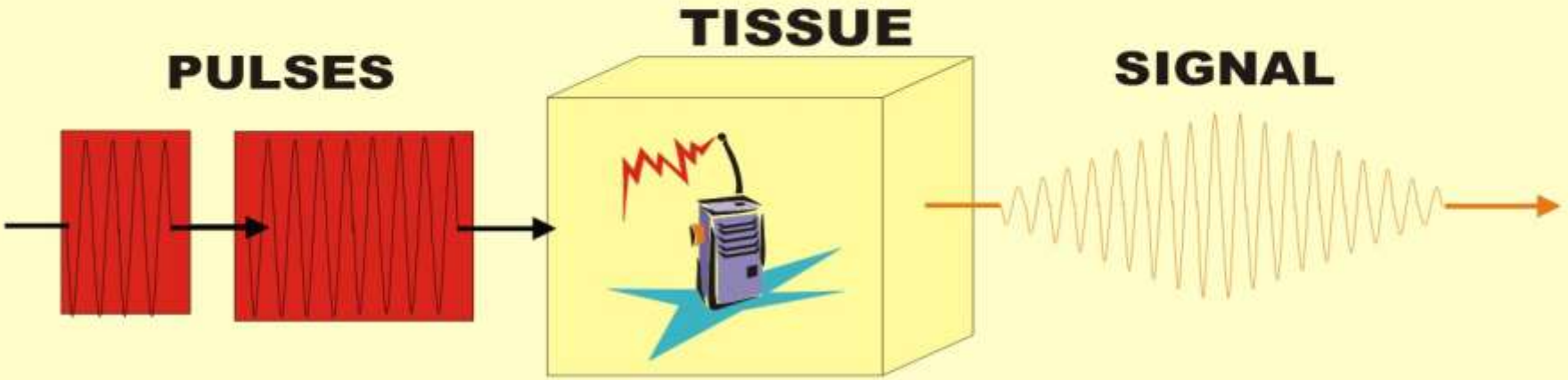
MAGNETIC RESONANCE IMAGING

THE MAGNETIC FIELD



Strawls

MAGNETIC RESONANCE



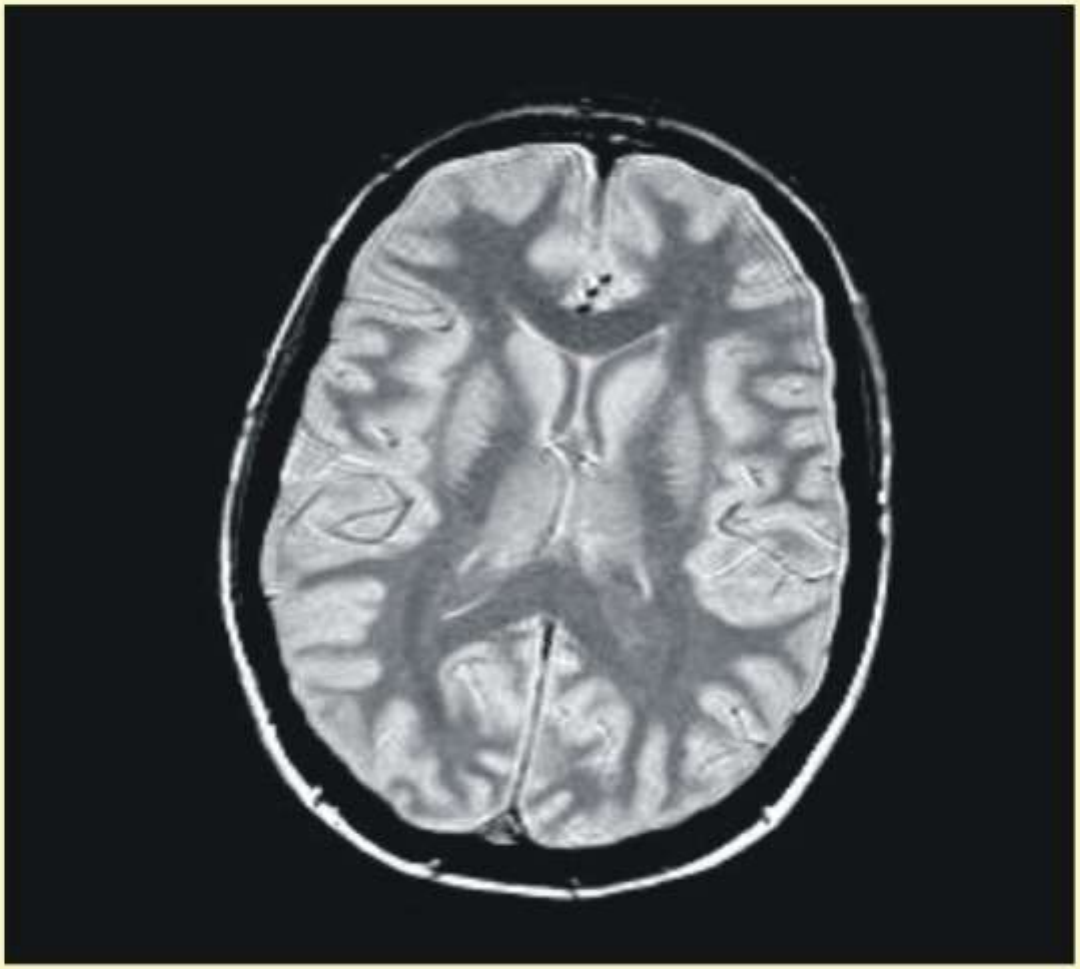
RESONANT (LARMOR) FREQUENCY

DETERMINED BY:

- **NUCLIDE** (H-1, 42.58 MHz/T)
- **FIELD STRENGTH**
- **MOLECULAR STRUCTURE** (Chemical Shift)

Sprawls

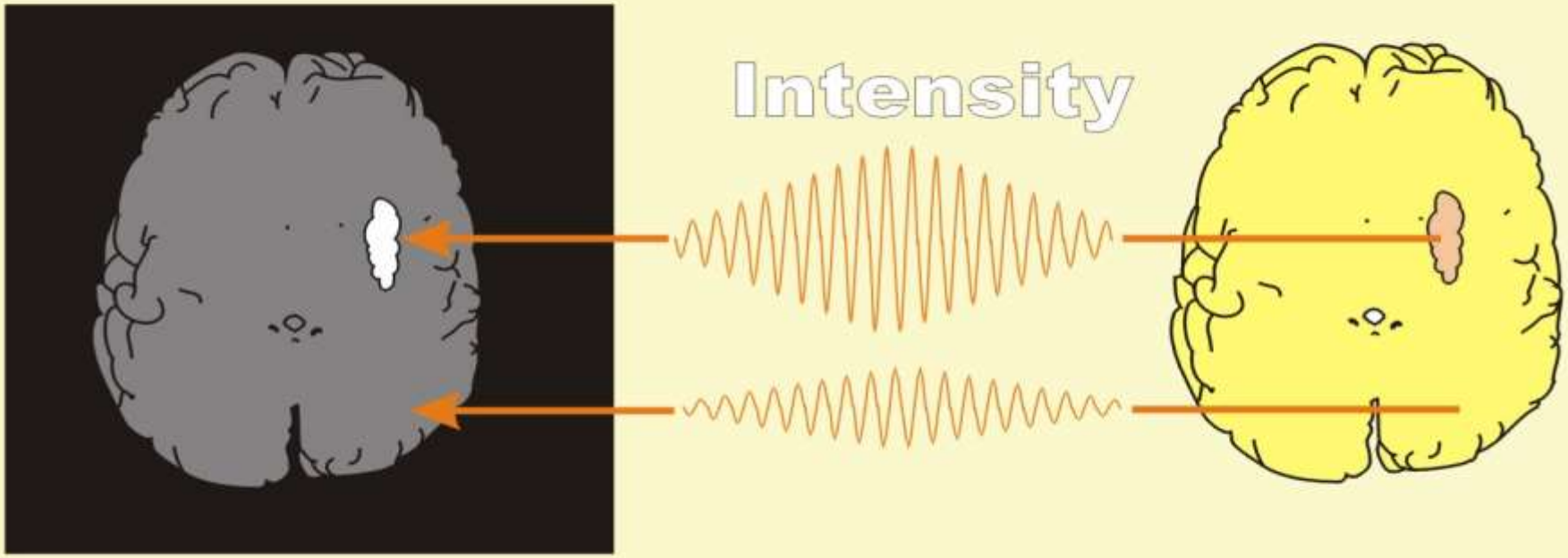
MAGNETIC RESONANCE IMAGE
(WHAT DO YOU SEE?)
FROM A PHYSICAL PERSPECTIVE



Sprawls

MAGNETIC RESONANCE IMAGE

(WHAT DO YOU SEE?)

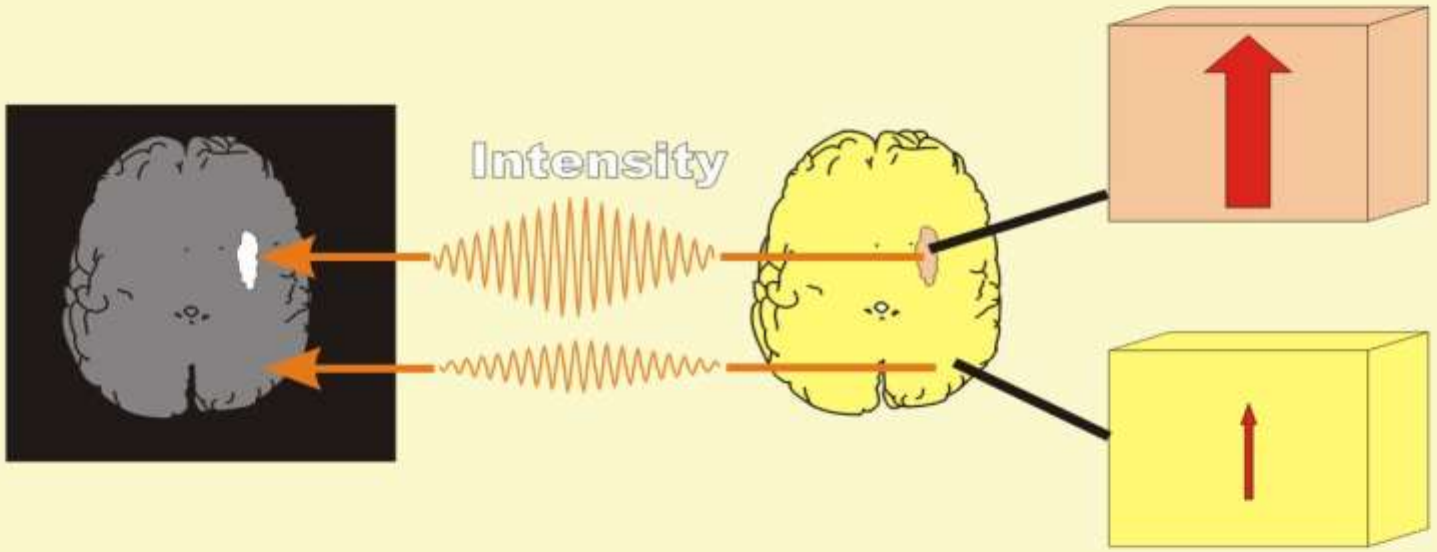


RADIO FREQUENCY SIGNALS

Sprawls

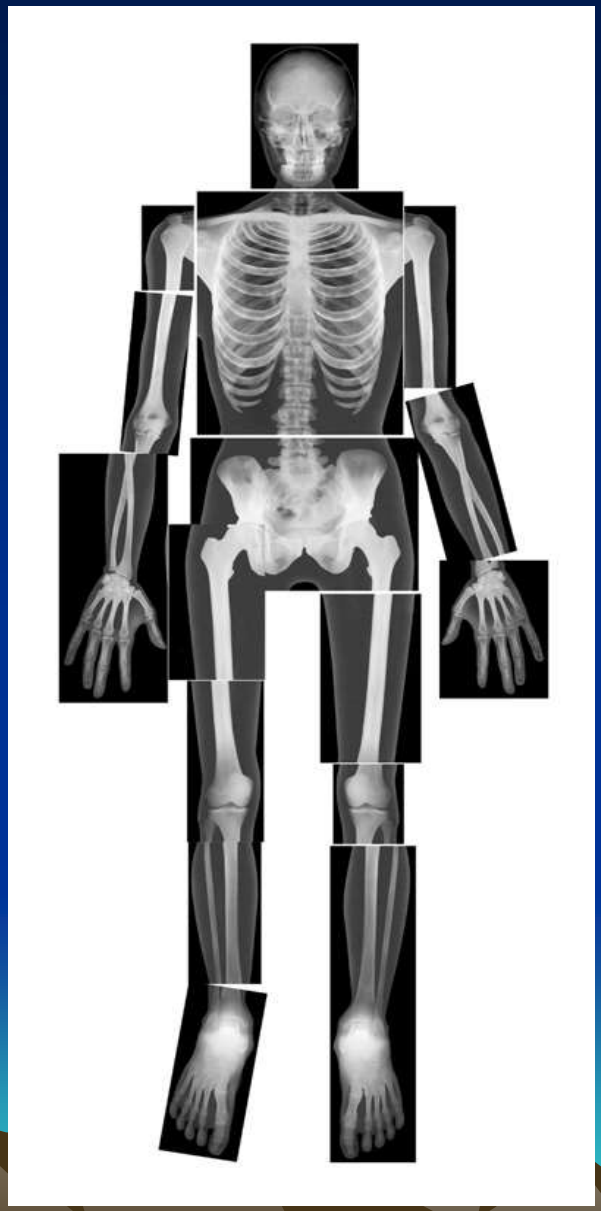
MAGNETIC RESONANCE IMAGE

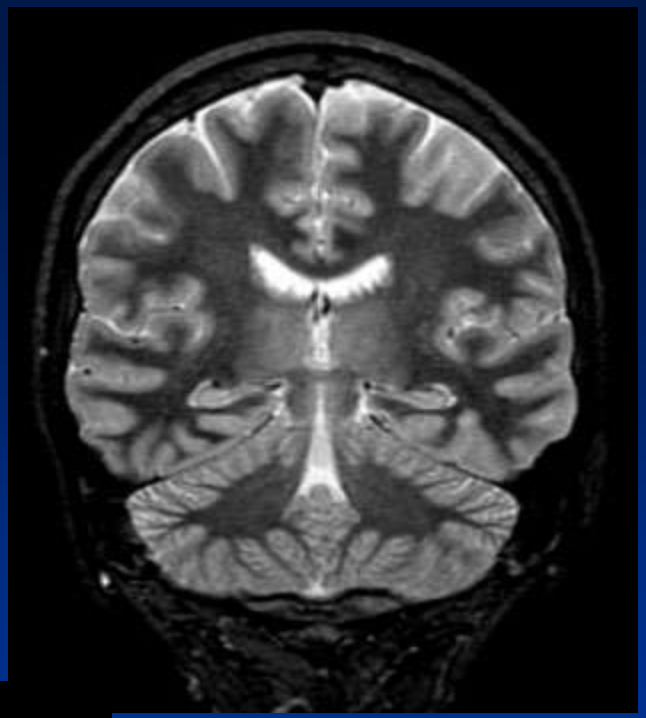
(WHAT DO YOU SEE?)

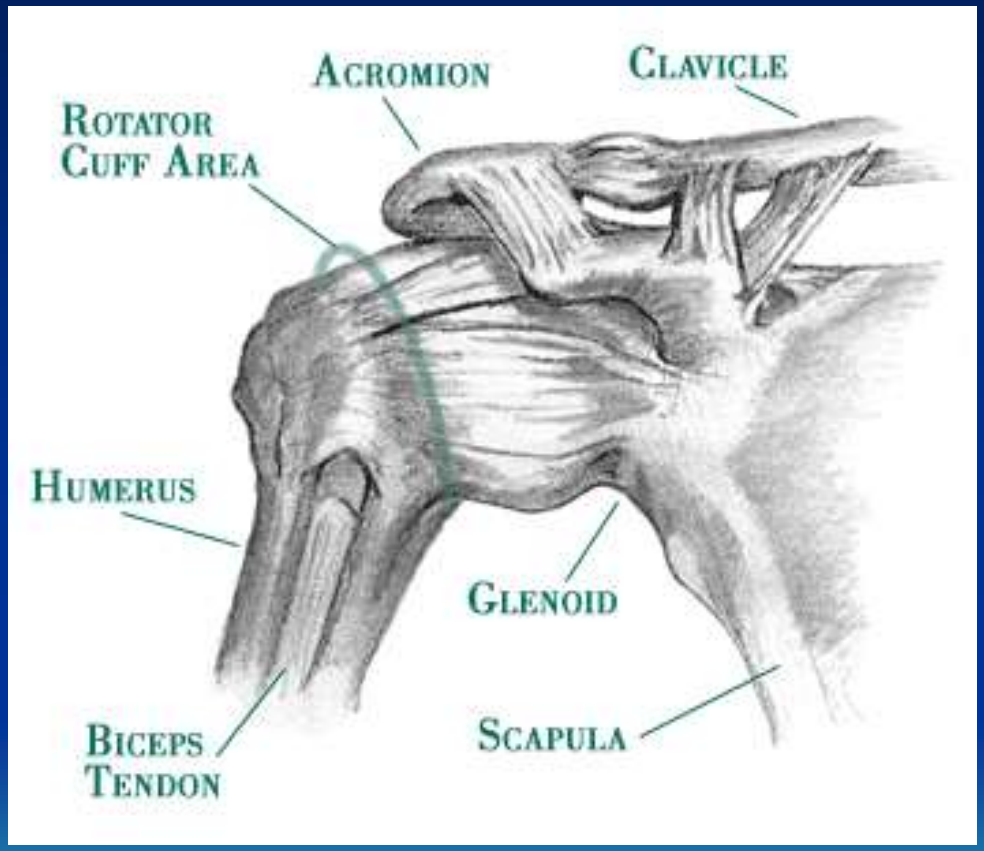


MAGNETIZED TISSUE

Sprawls



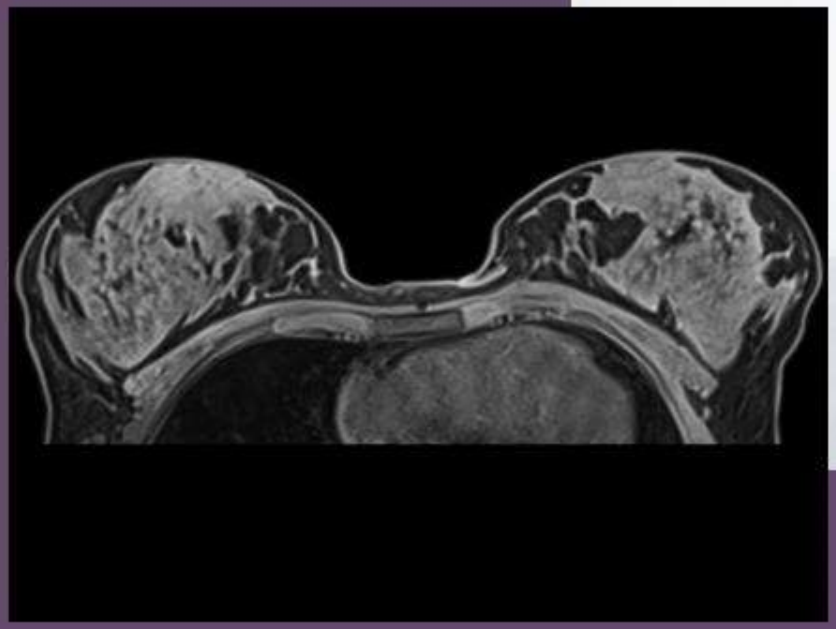


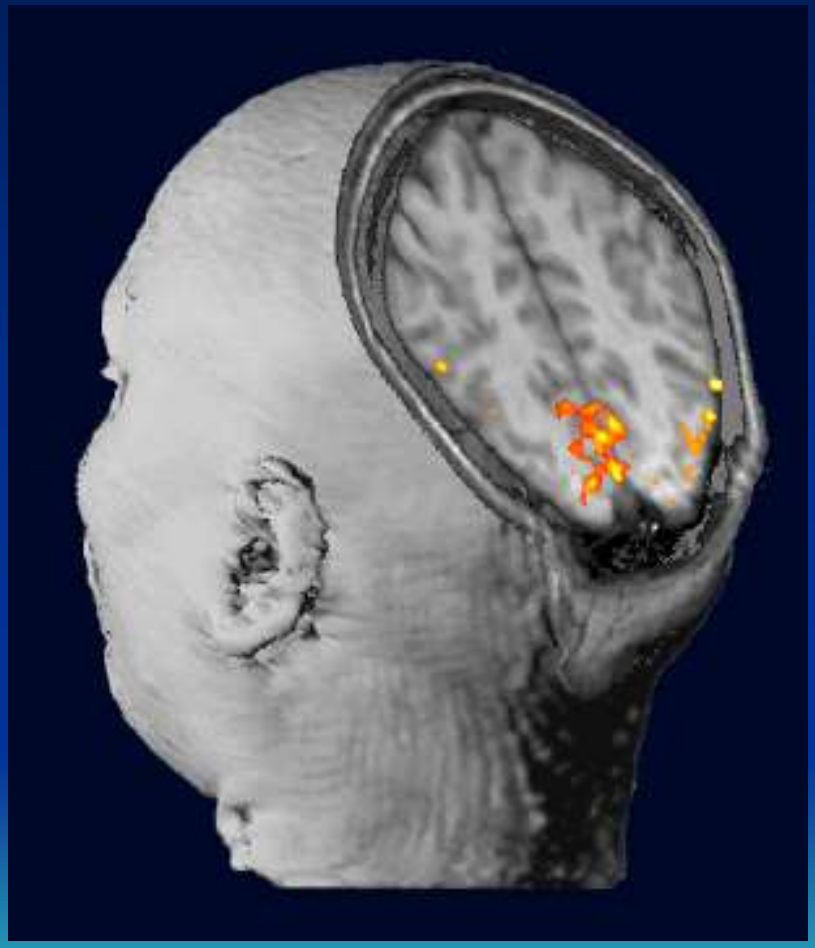

ACROMION
CLAVICLE
ROTATOR CUFF AREA
HUMERUS
GLENOID
BICEPS TENDON
SCAPULA

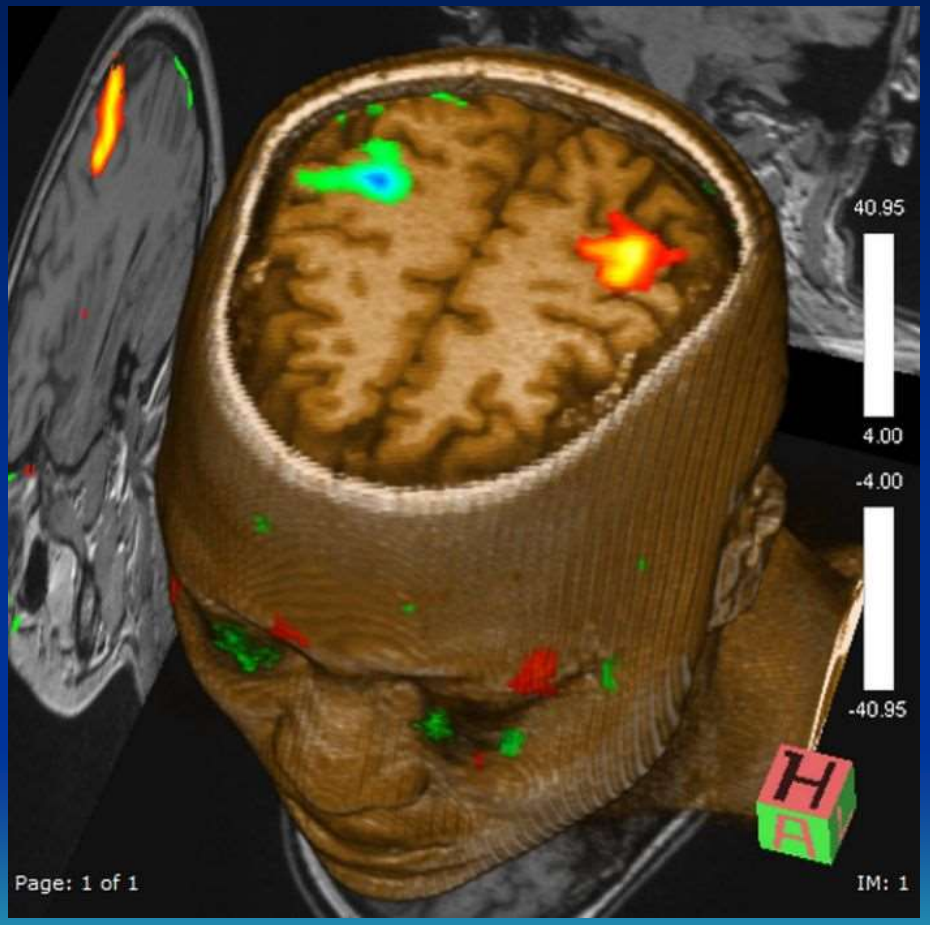

399518
11-NOV-1963
14:43
20-MAY-1997
IMAGE 24
STUDY 3
Western Inf , Glasgow.
MAGNETOM EXPERT-
H-SP VB31B
A
sel 90
*RI
1 SAT
TR 363.0
TE 15.0/1
TA 03:43
AC 3
SP -8.2
SL 5.0
FoV 313*500
202 *512o
Sag
W 1734
C 540


12

Breast MRI



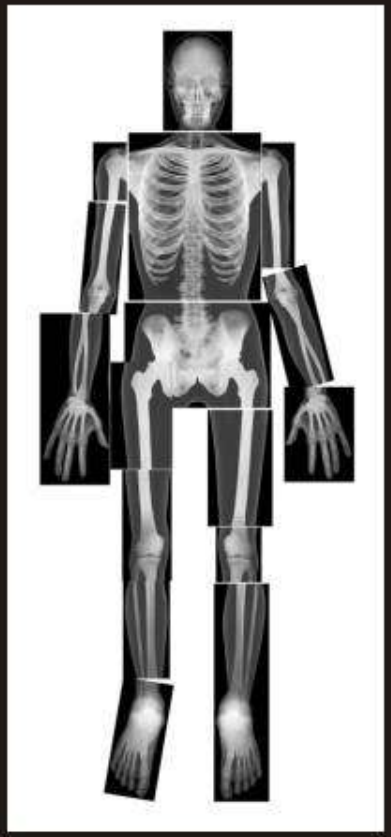


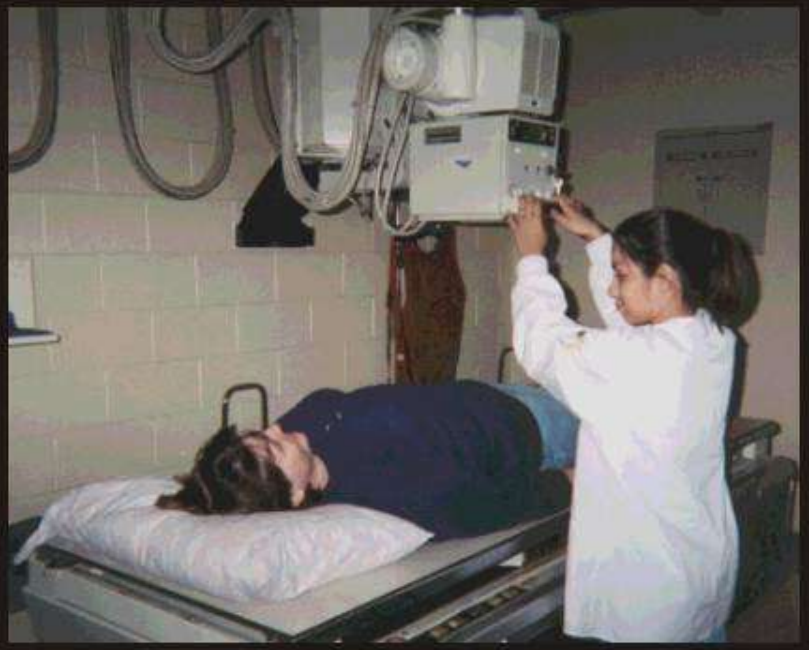

40.95
4.00
-4.00
-40.95
H
A
Page: 1 of 1
IM: 1

Exploring

The Human Body

X-Ray

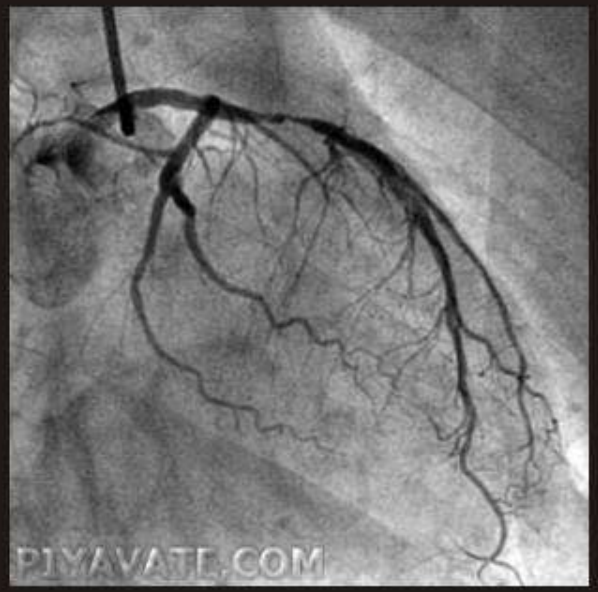




X-Ray

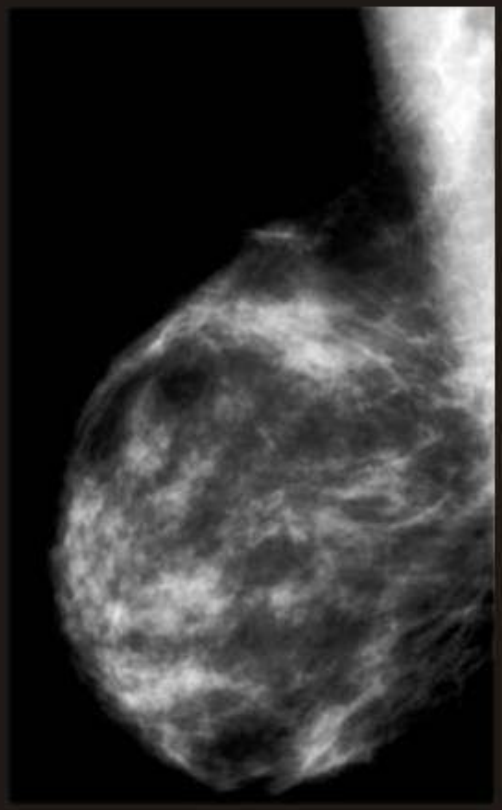
Barium

X-Ray



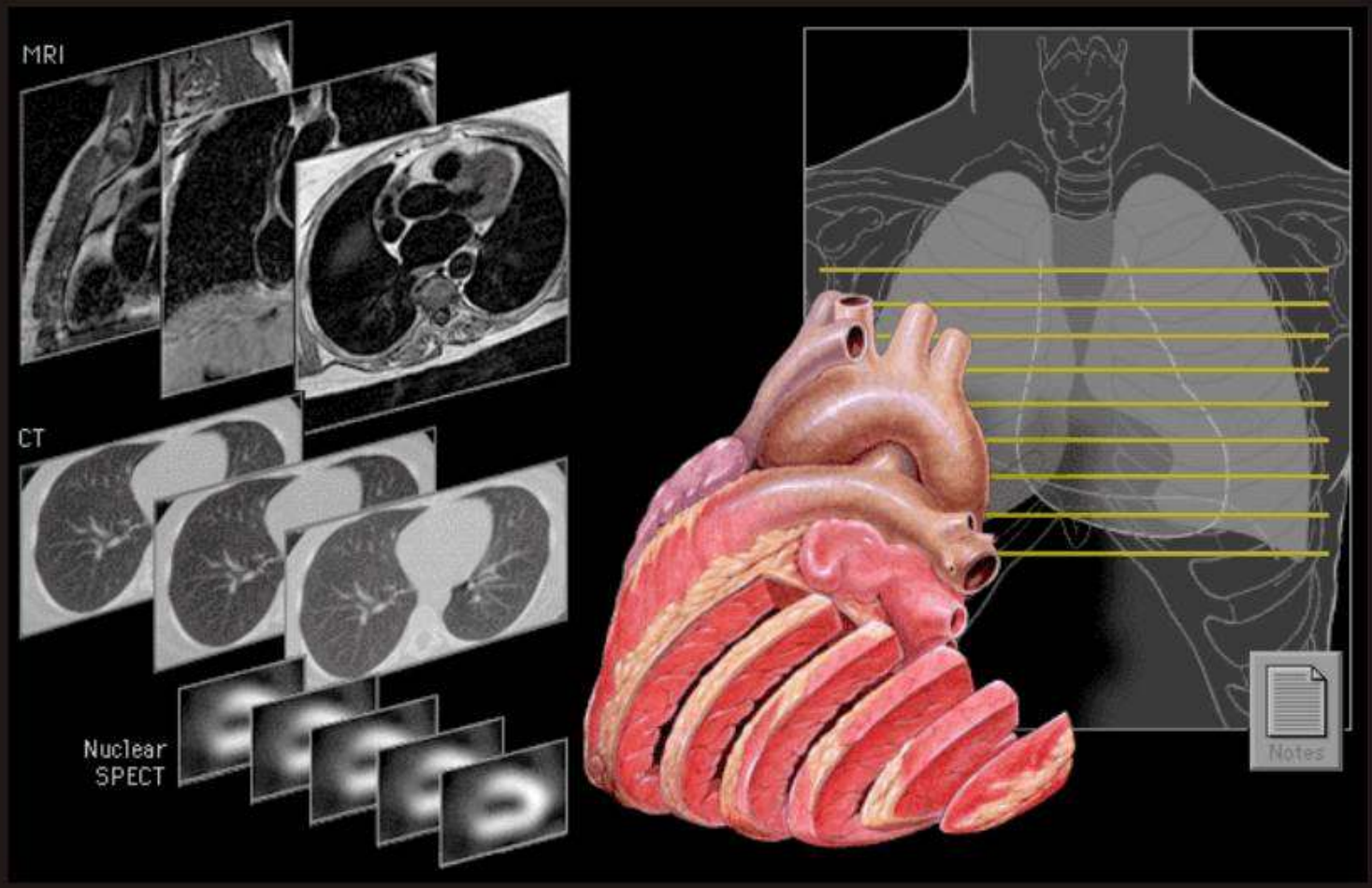
Iodine

X-Ray

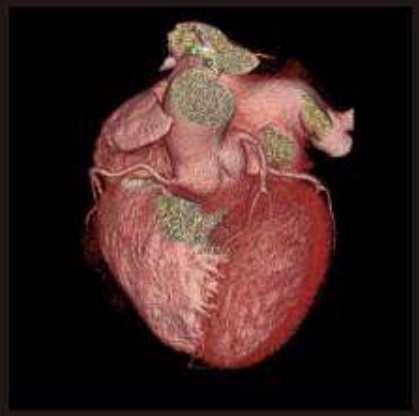


Mammography

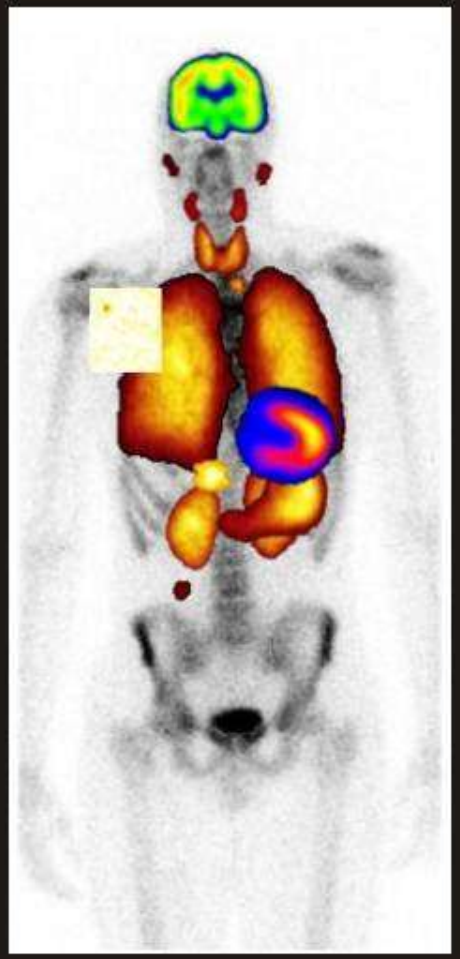
Tomographic Imaging



Computed Tomography



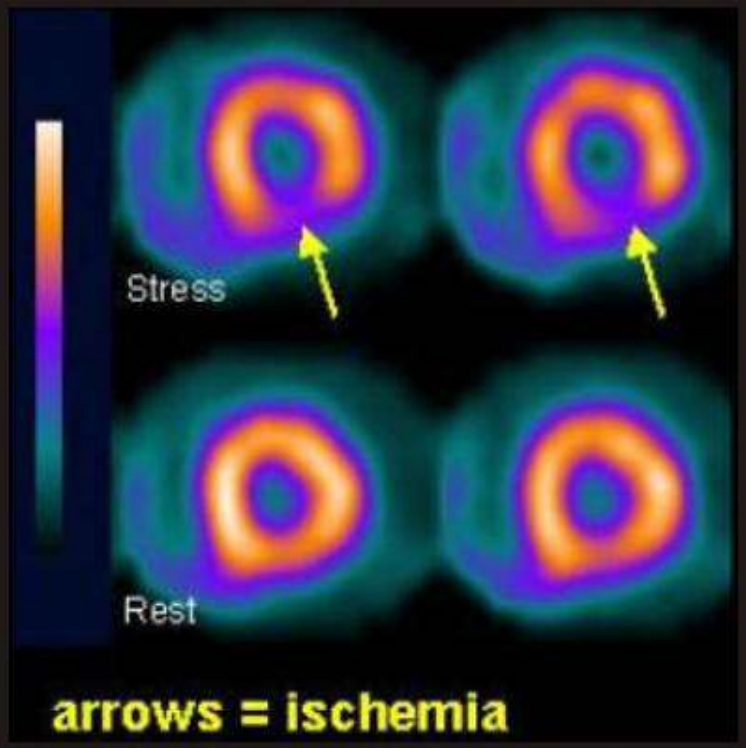
Nuclear Medicine



Gamma Camera

Radioactive Pharmaceuticals

Nuclear Medicine



SP Emission Tomography

Nuclear Medicine

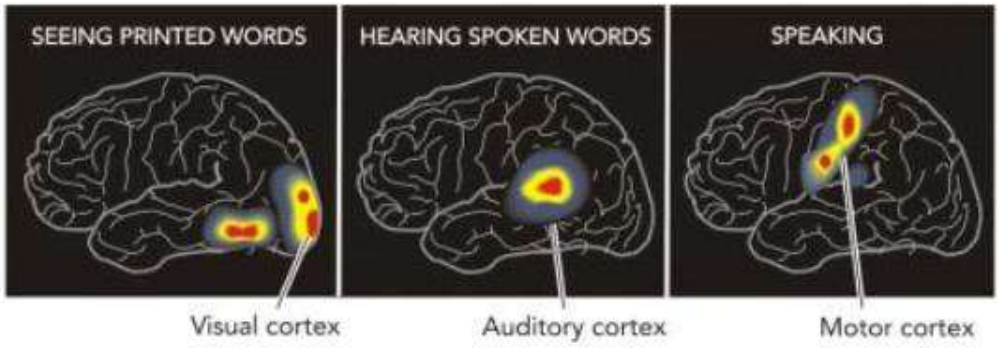


Figure 7-20 PET imaging of the brain

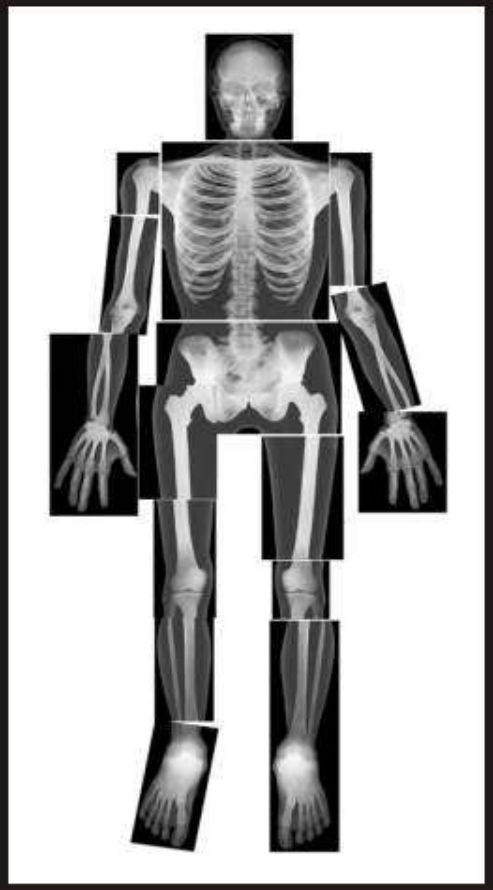
Positron Emission Tomography

Magnetic Resonance Imaging

Magnitized Tissue

Magnetic Resonance Imaging

MRI

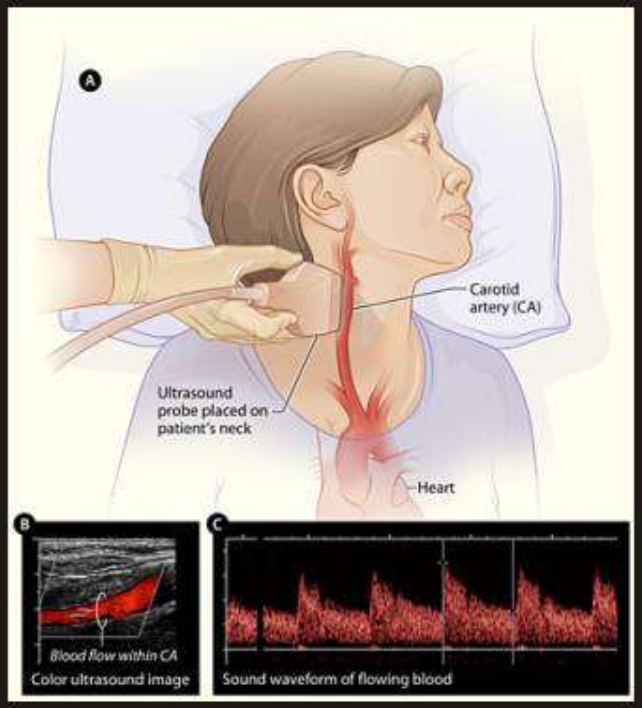


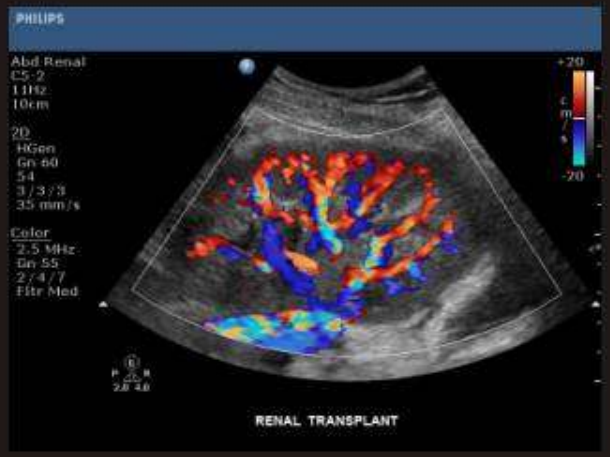
X-Ray

Ultrasound

Echos

Doppler Ultrasound





Medical Imaging Science and Technology

Understanding What Your Doctor Is Recommending

Perry Sprawls, Ph.D.
Emory University
and
Sprawls Educational Foundation

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