Medical Imaging

Physics Applied to Medicine

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Medical Imaging…

- is the creation of a diagnostic picture, either structural or functional, of the body
- is a good example of how basic science can benefit society through applied science
- has a variety of *modalities*
- uses high energy waves/particles (photons), radio waves, and sound

Nuclear medicine

- A radioactive substance is introduced into the body
- The radiation released is detected as a function of position
- Detection of brain function, blood supply, detection of cancer (metastasis)
- Provides functional imaging
- Takes a very long time to create an image, poor image detail, very invasive

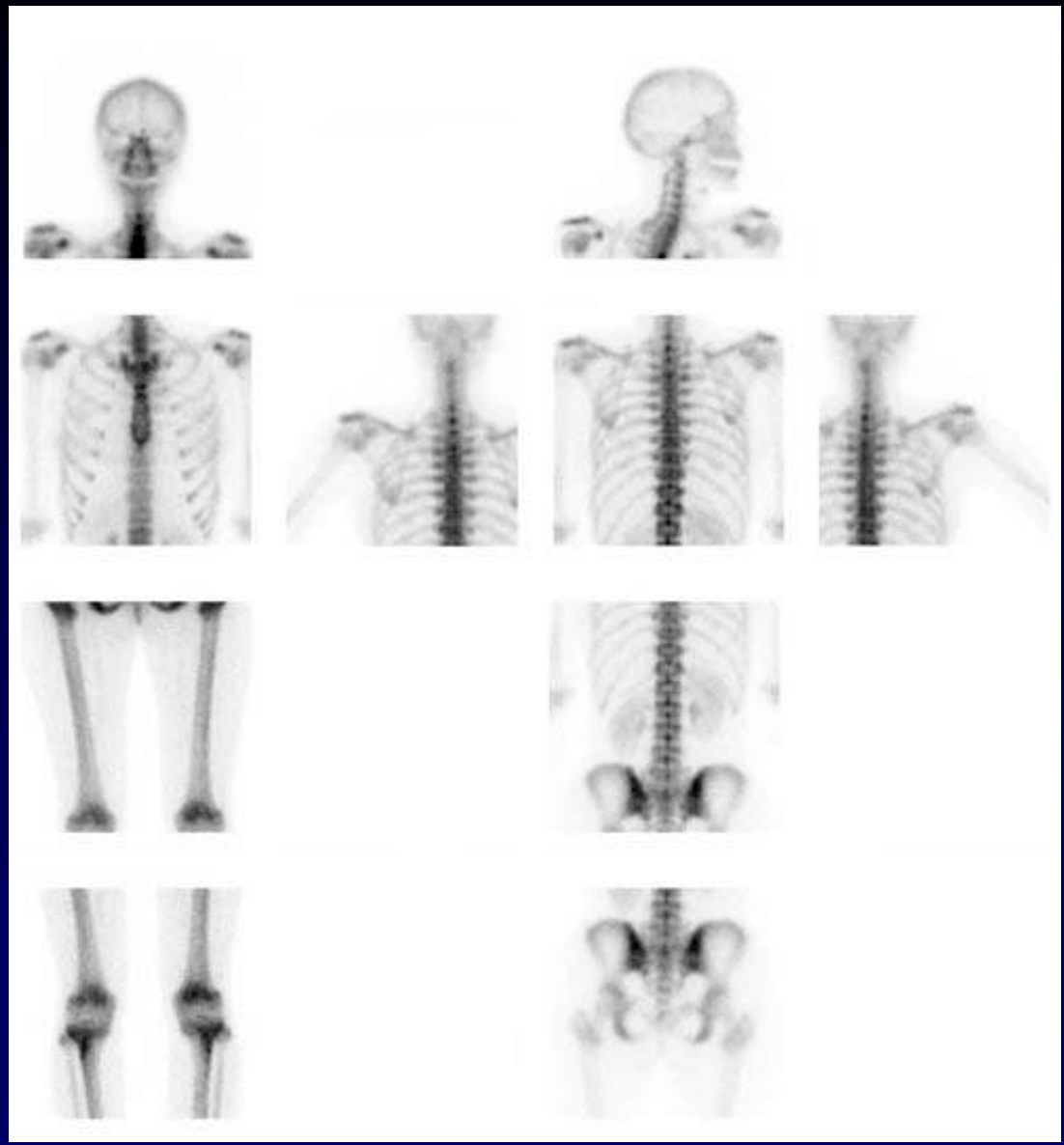
Scintillation detectors and “Gamma cameras”

- A scintillation detector is a radiation detector that is scanned over the patient to create in image in nuclear medicine
- Based on a photo-multiplier tube behind a *collimator* and a *scintillation material*
- A gamma camera has many detectors working together and can make a picture without scanning

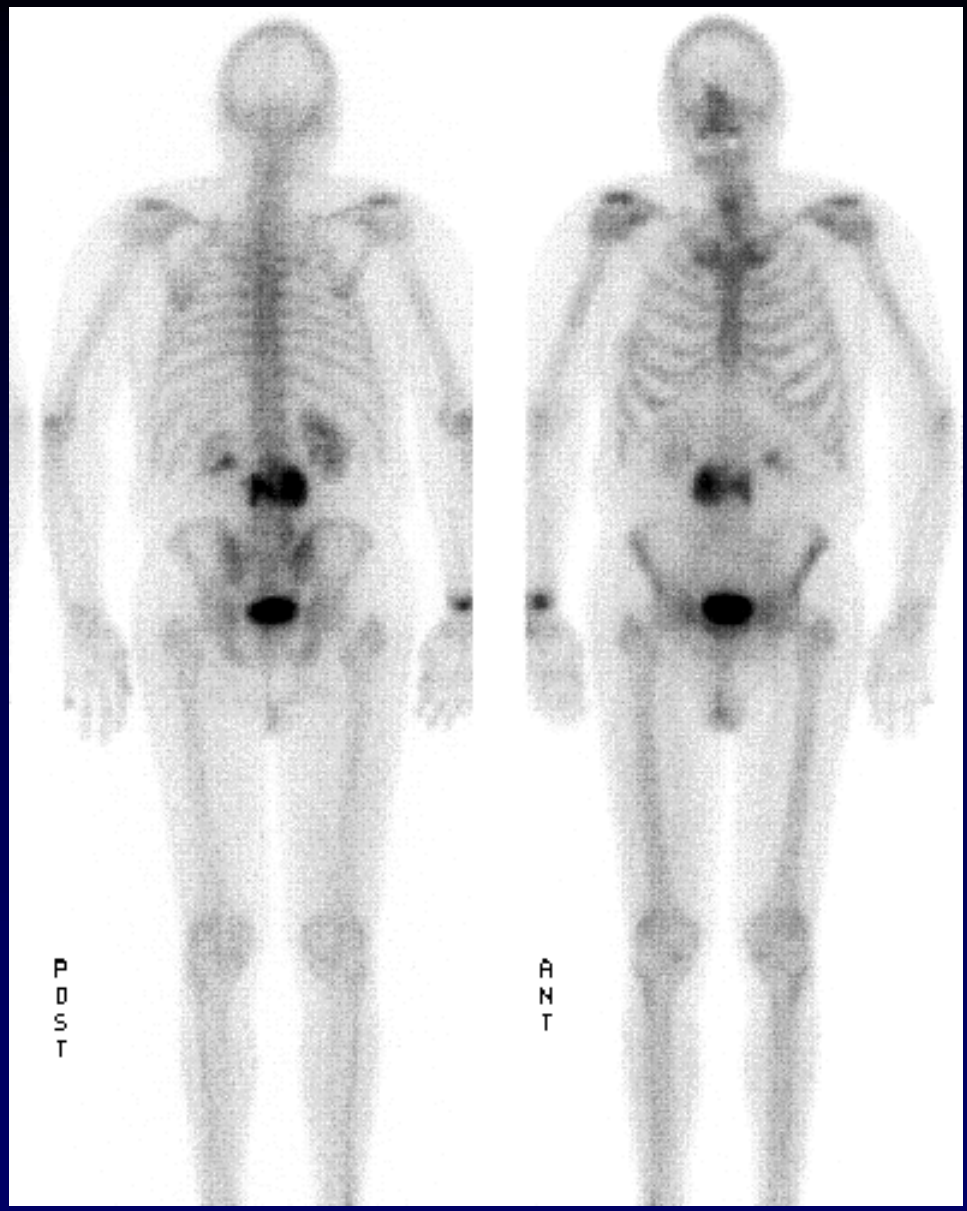
PET scanner

Orthogonal gamma camera scanner

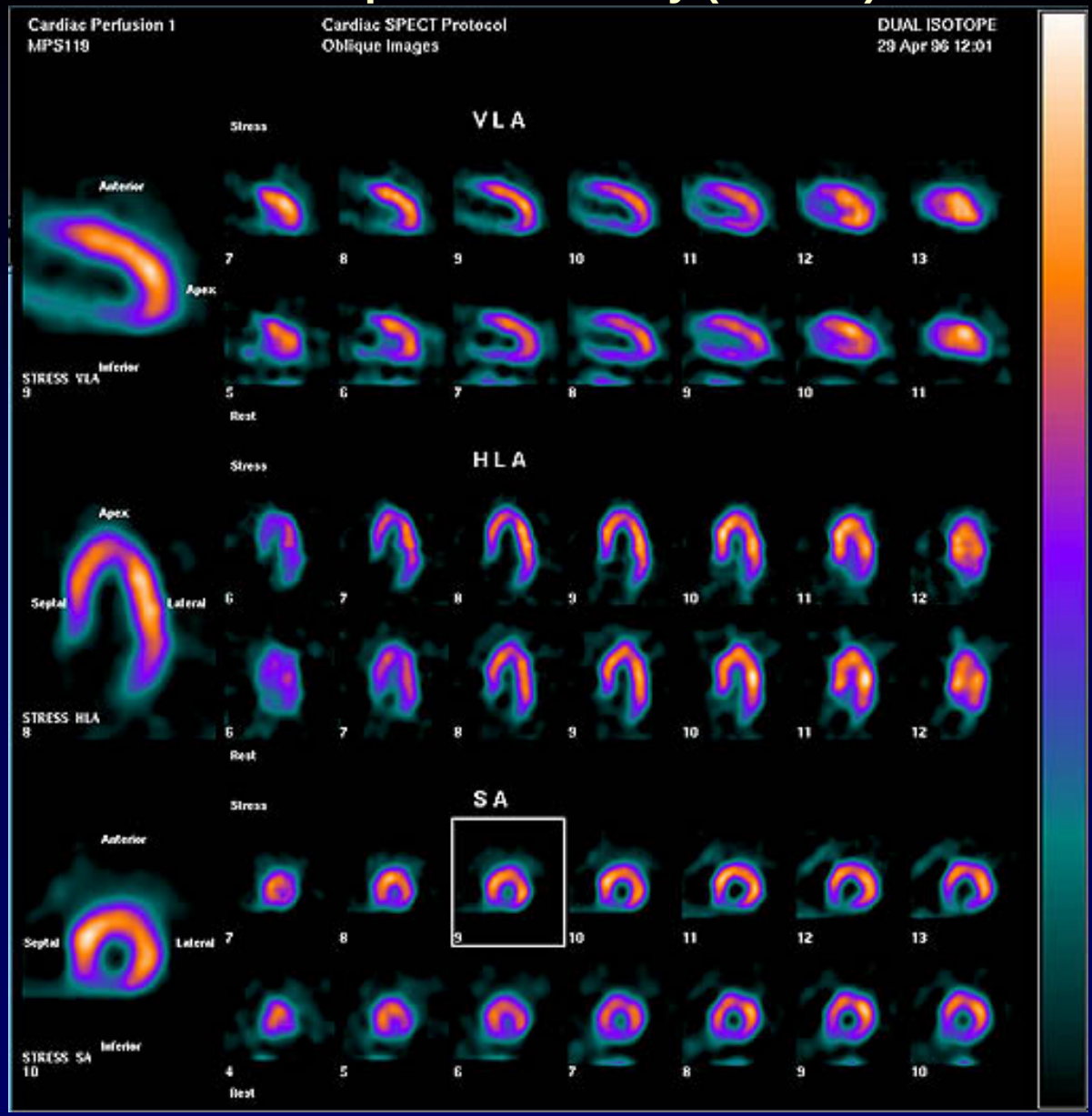
Normal bone scan



Radiation induced osteosarcoma of lumbar spine



Cardiac perfusion study (SPECT)



X-ray

- High-energy photons are transmitted through the body and collected on film or with a digital camera
- Images the shadow cast by the parts of the body
- Soft- and hard-tissue imaging throughout the body
- Inexpensive, easy to compare among hospitals
- Harmful radiation, images can be ambiguous due to overlapping shadows

Conventional X-ray machine, table type

Fractured orthopedic hardware

Enchondroma of the left first metacarpal

Renal cell carcinoma with metastasis to right proximal tibia

T1-weighted sagittal section

X-ray CT

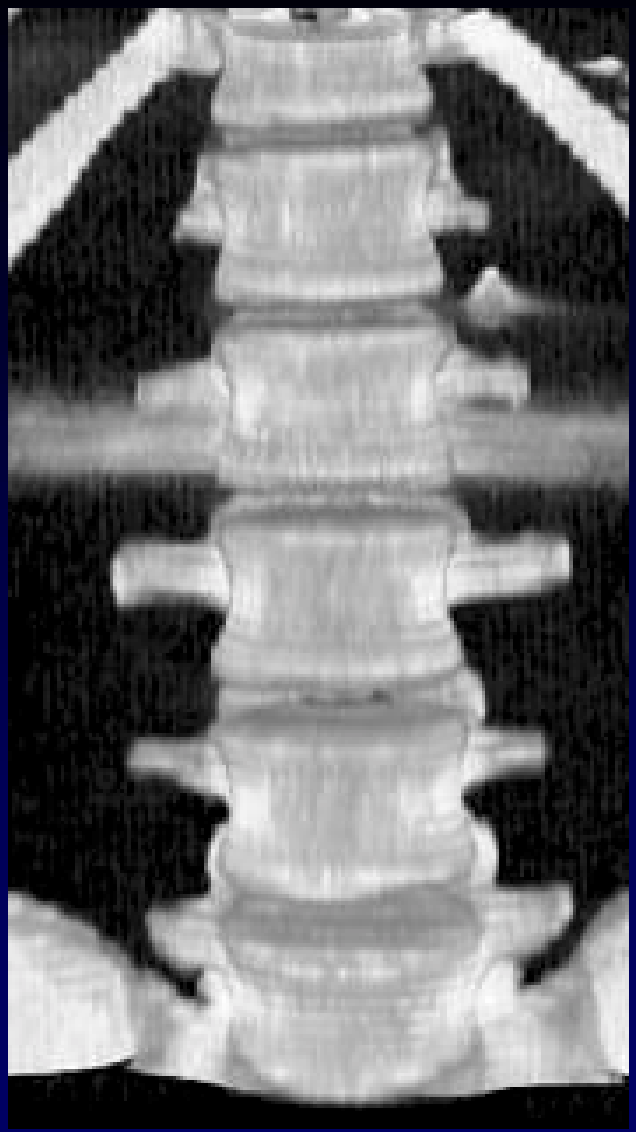
- X-ray imaging applied in 2 or 3 dimensions
- *Tomographic* soft- and hard-tissue imaging throughout the body
- Overcomes some limitations of conventional X-ray, off-line manipulation possible
- Large radiation dose, expensive

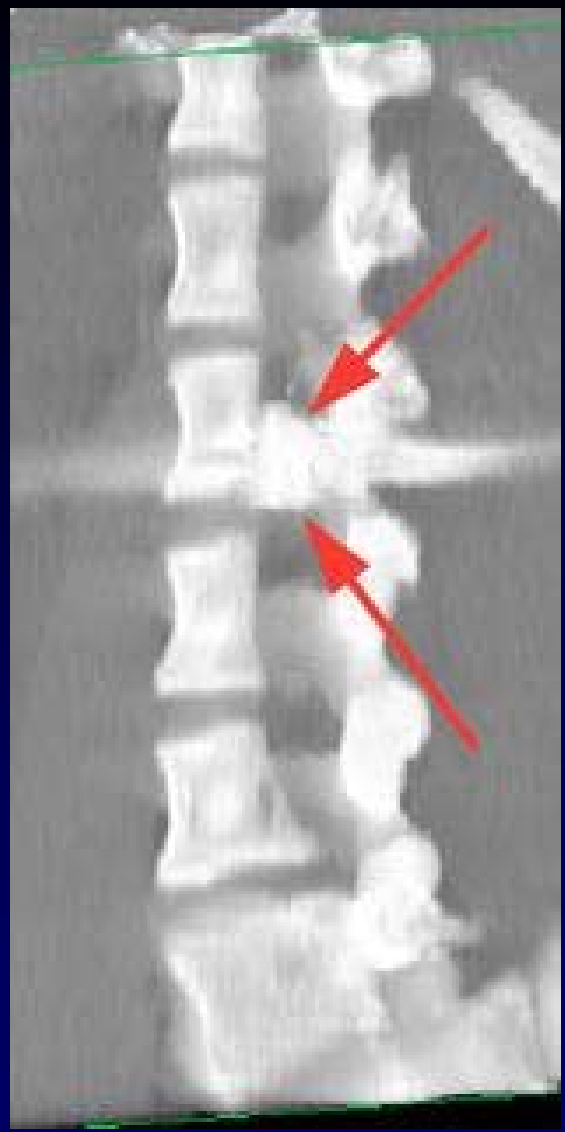
X-ray CT scanner

Normal skull

Missing pectoral muscle

Gunshot victim with bullet lodged in spine





Parosteal osteosarcoma

Ultrasound

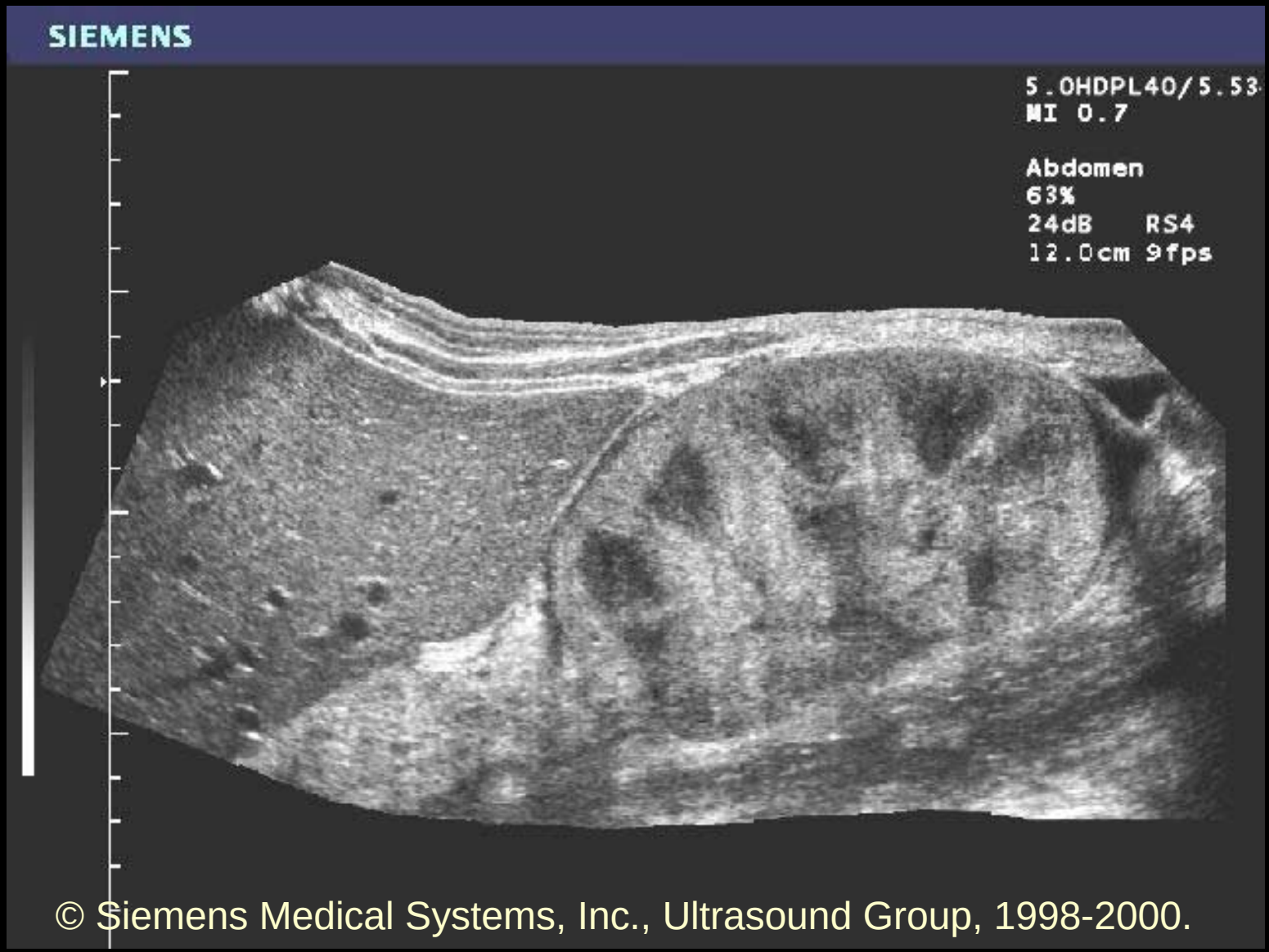
- High-frequency sound is transmitted into the body
- Images echoes from structures within the body
- Soft-tissue and blood-flow imaging throughout the body
- No harmful radiation used, inexpensive, portable, real-time blood flow imaging
- Less image detail than other methods, cannot penetrate bone and air, inconsistent results among hospitals

BME ultrasound lab

Features a Siemens ultrasound scanner connected to computers

Research in better ways of imaging with ultrasound

MULTIPLE LIVER MASSES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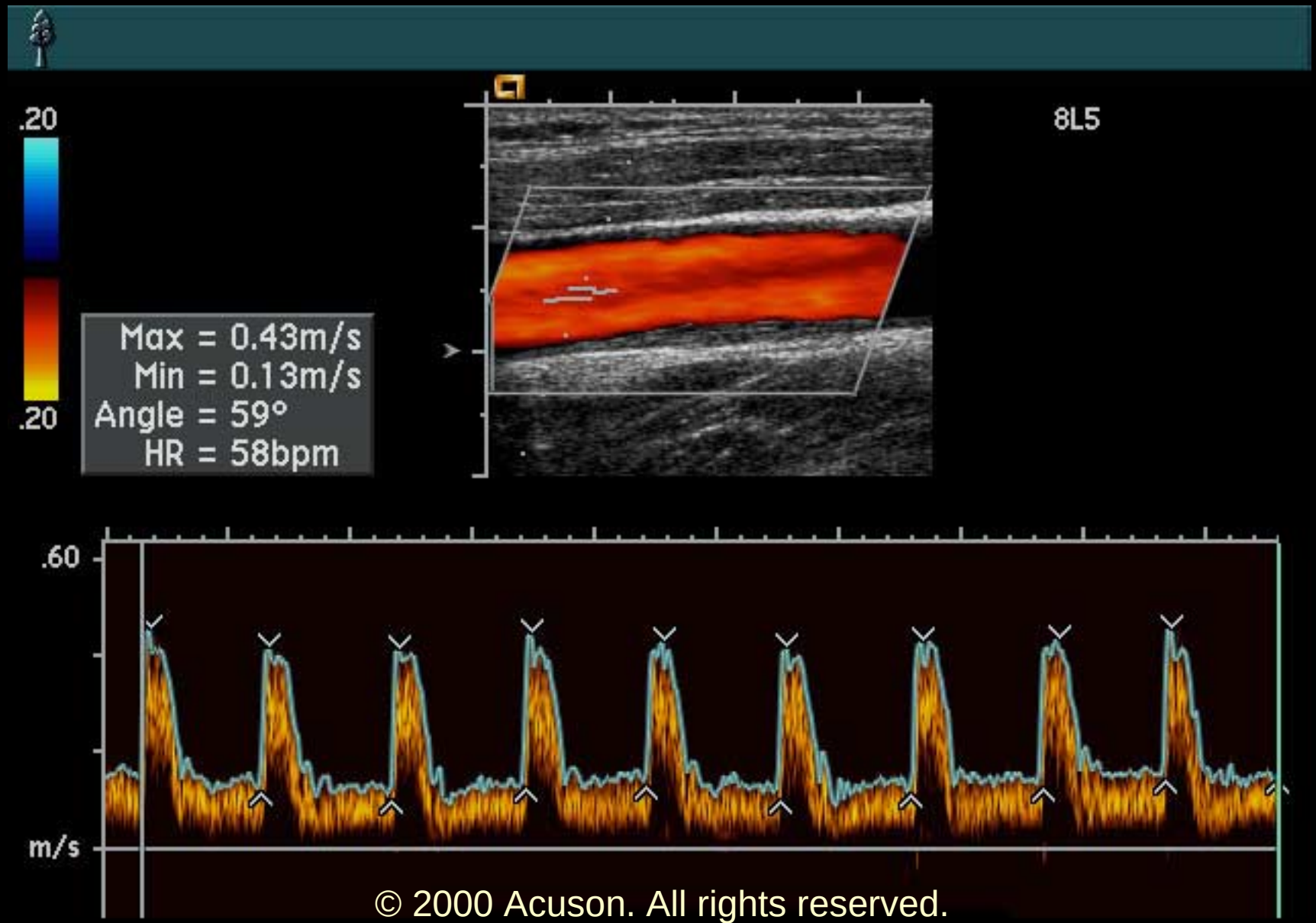
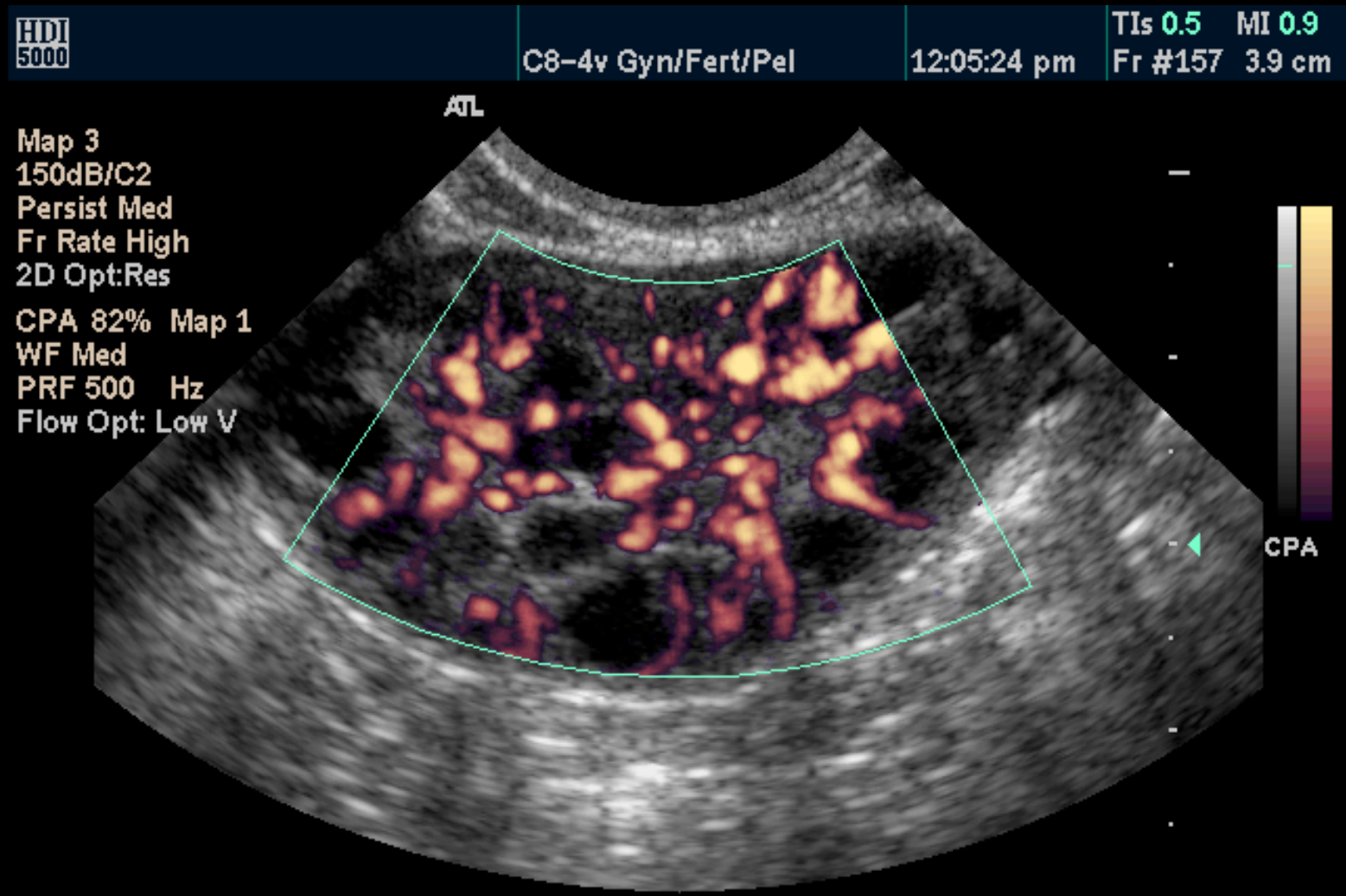
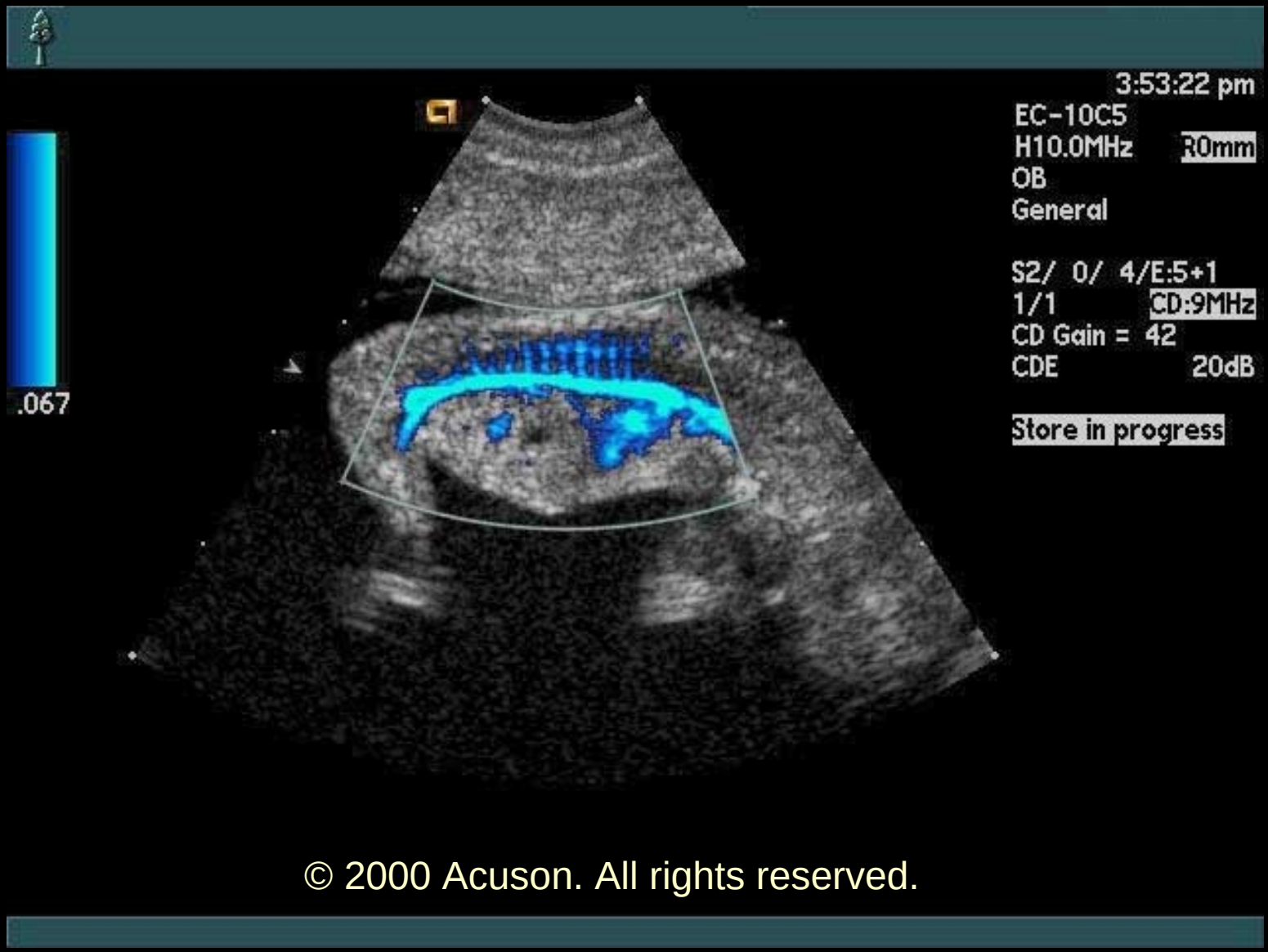
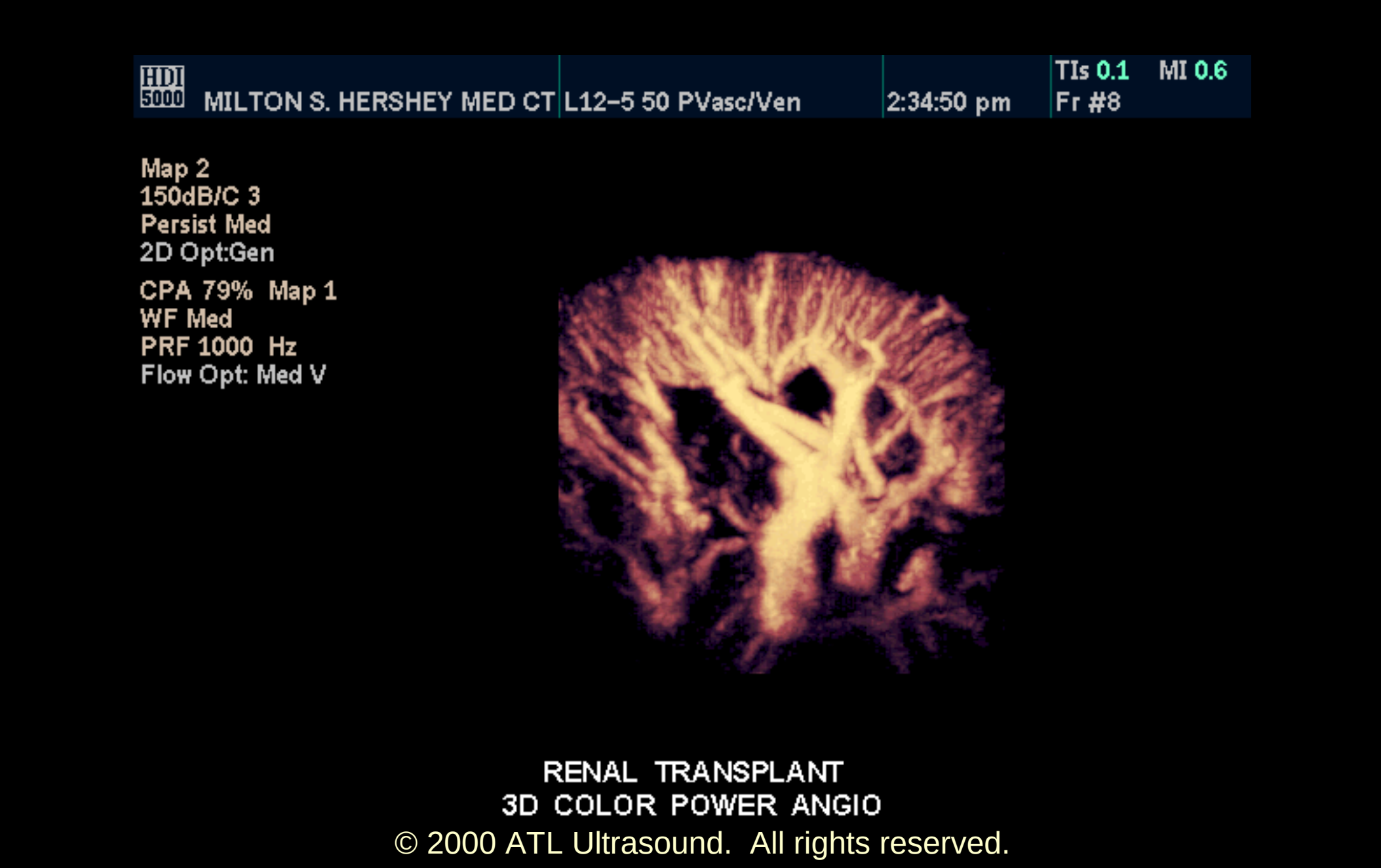
© Siemens Medical Systems, Inc., Ultrasound Group, 1998-2000.



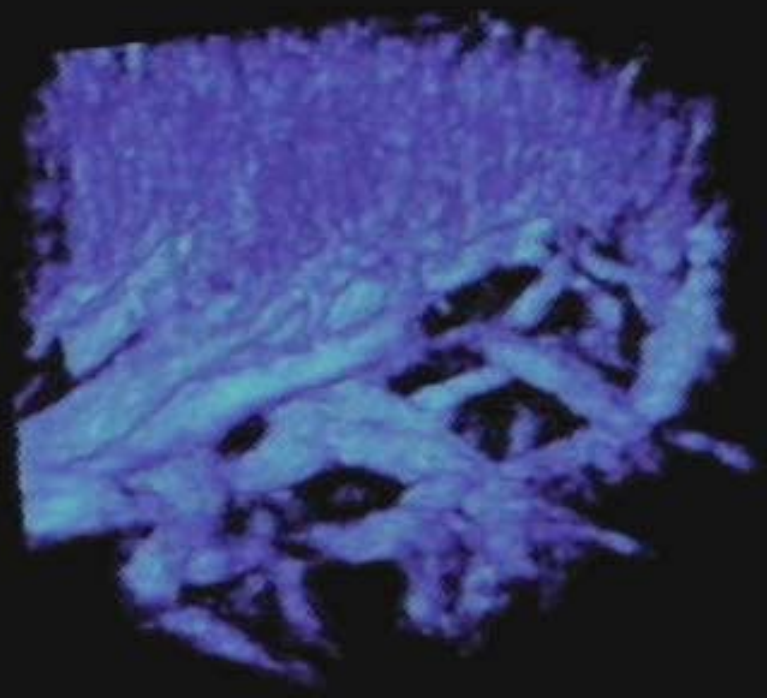


OVARIAN VASCULATURE



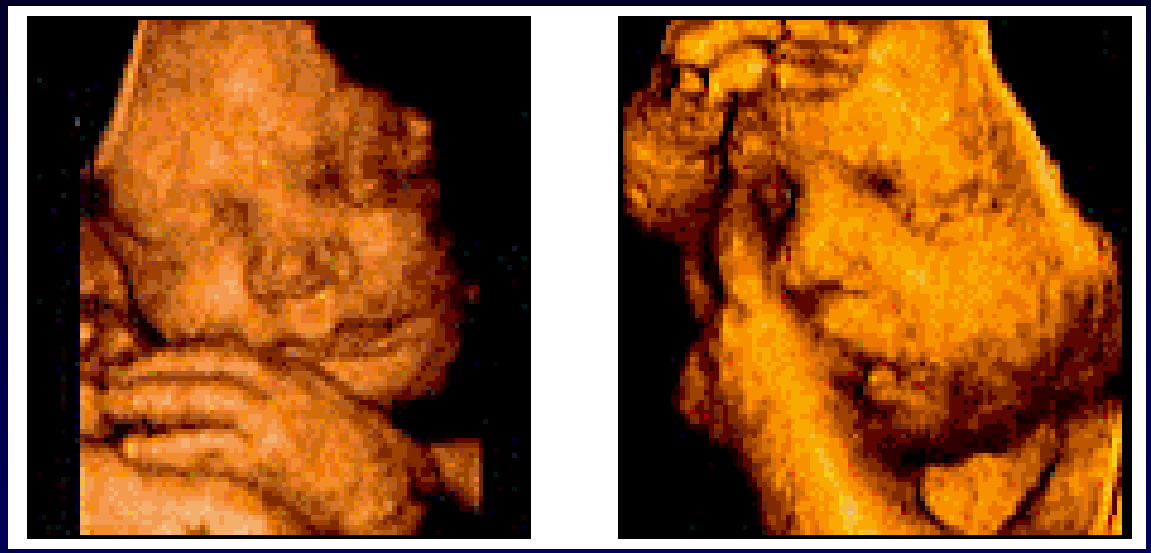


ADVANCED 3D



RENAL VASCULATURE

3D Ultrasound



- Various applications are under investigation
  - Obstetric, guided biopsy, cardiac

Magnetic resonance imaging (MRI)

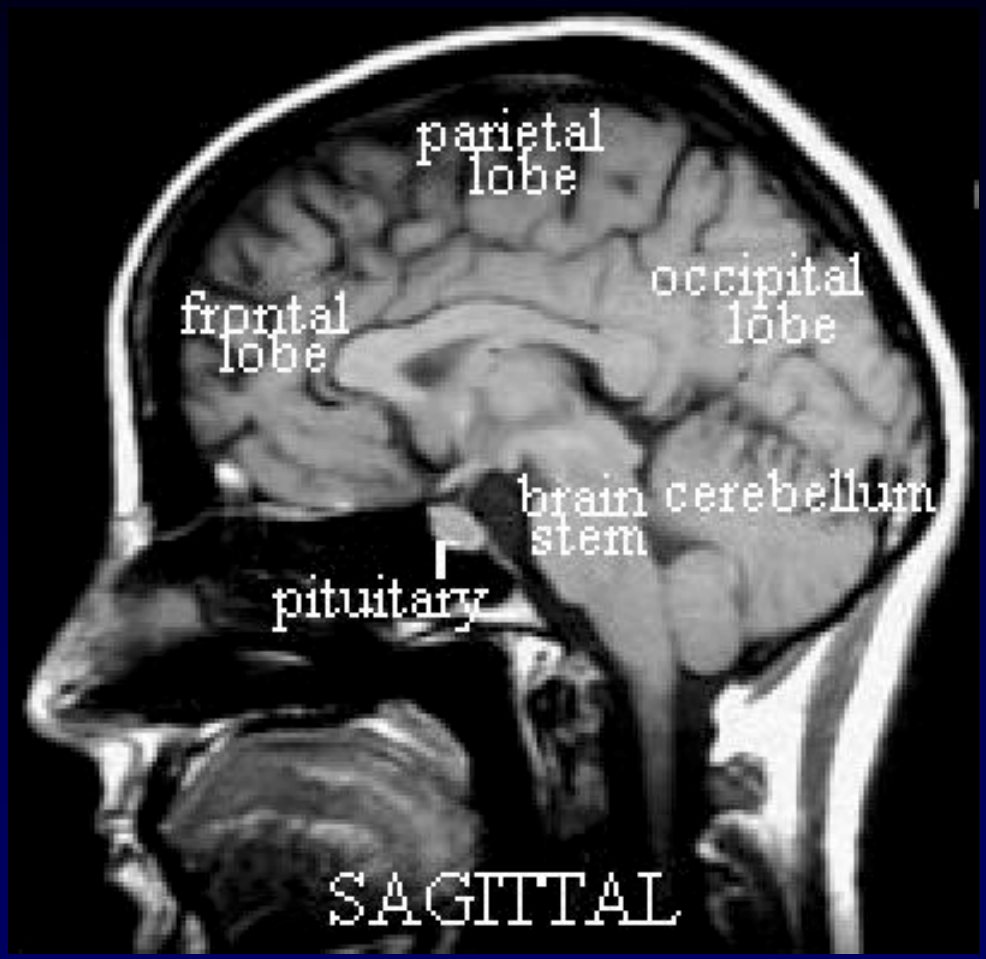
- Atoms in the subject are aligned within a strong magnetic field and probed with radio waves
- Images radio signature of different types of tissues
- Tomographic and functional soft- and hard-tissue and blood-flow imaging throughout the body
- No harmful radiation used, off-line manipulation possible
- Takes a long time to create an image, claustrophobic, no metal allowed, expensive

MRI scanner

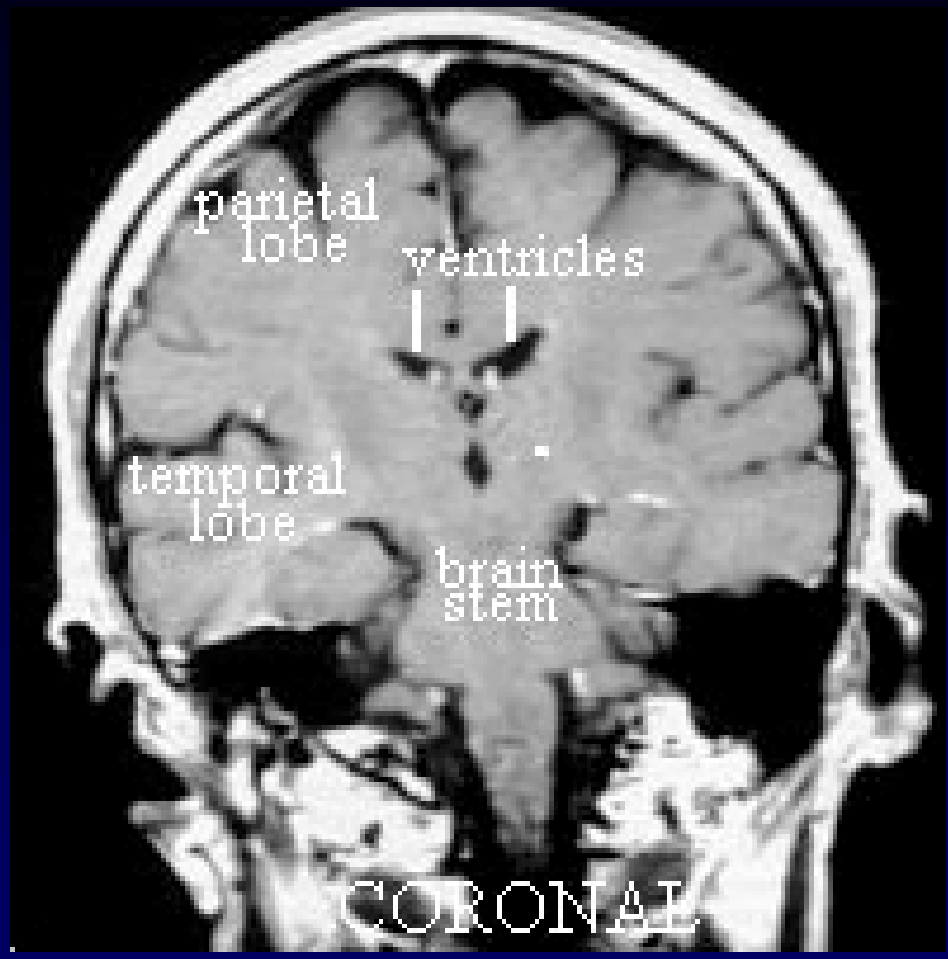
Steven H. Brick, M.D., Drs. Groover,
Christie & Merritt, P.C.

Open core MRI scanner

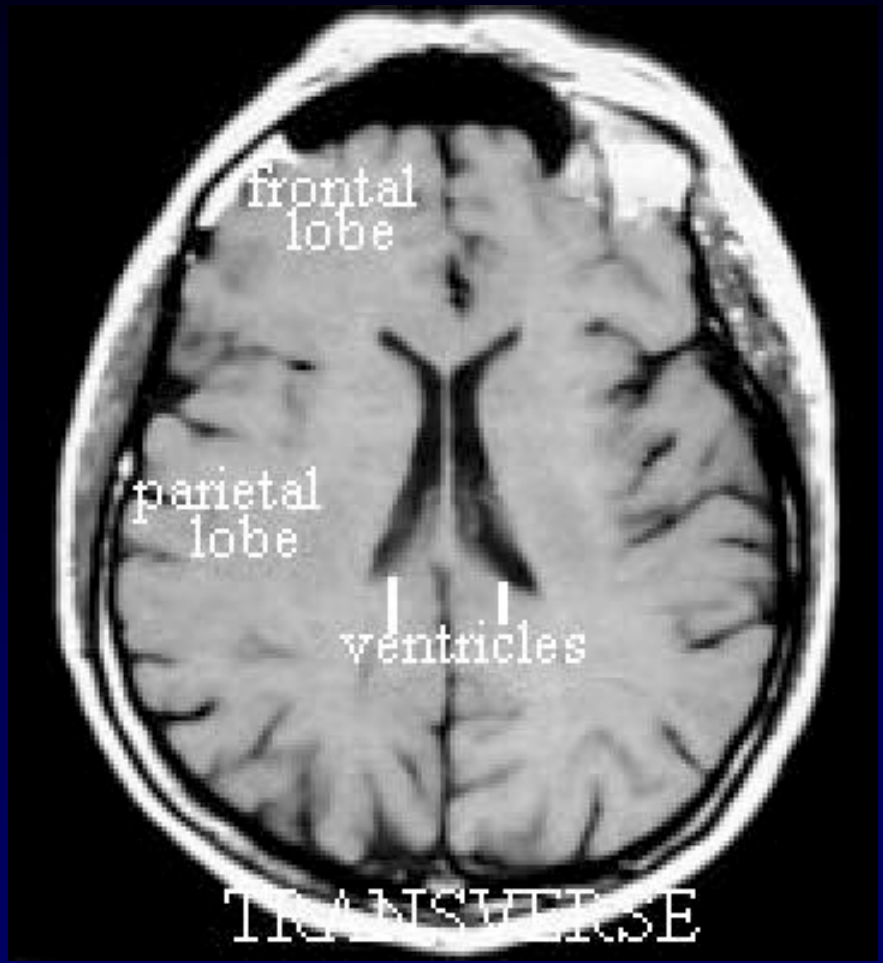
Sagittal brain section



Coronal brain section

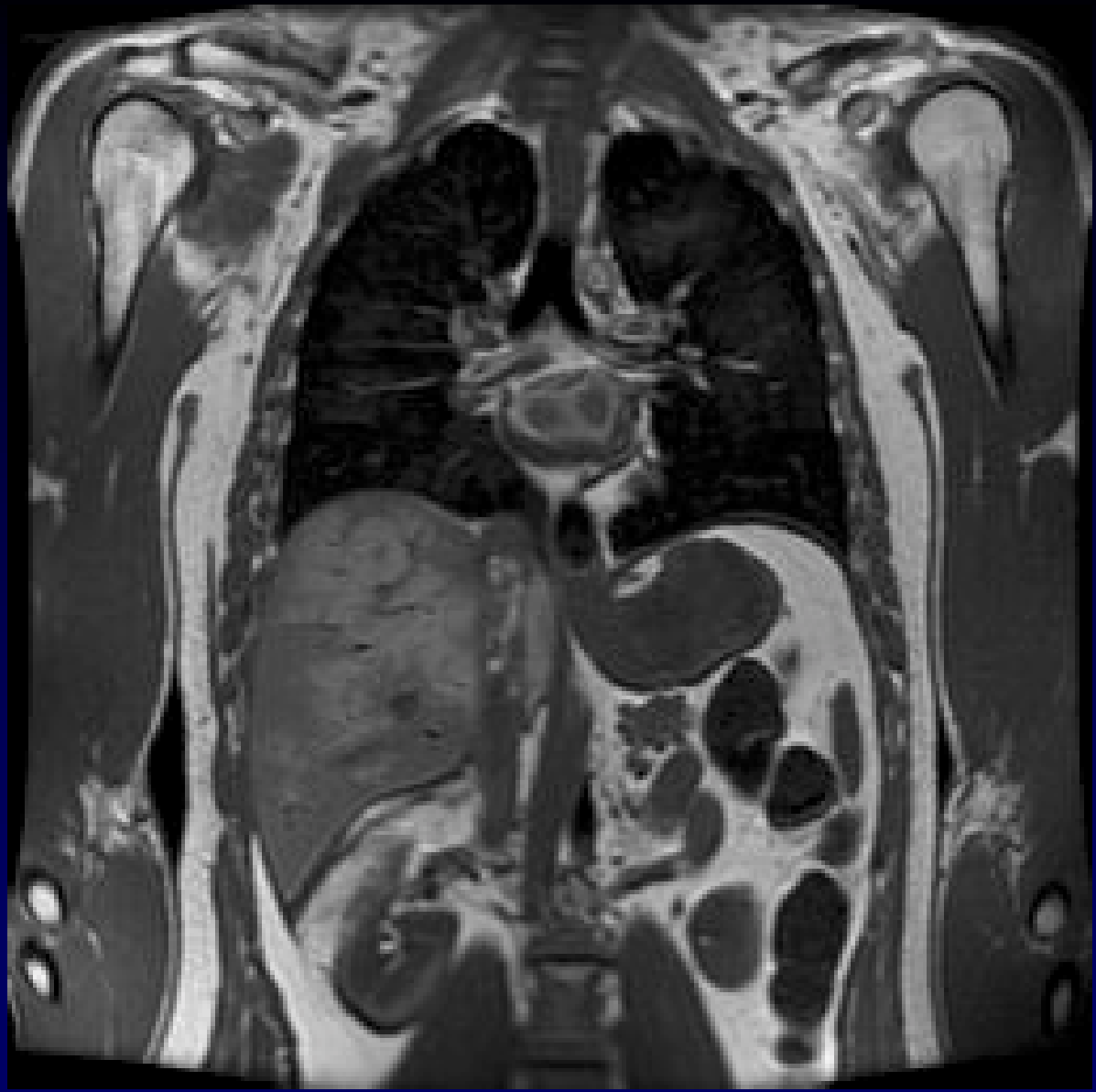


Transverse brain section



Transverse brain MRA: circle of Willis

Coronal torso section



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