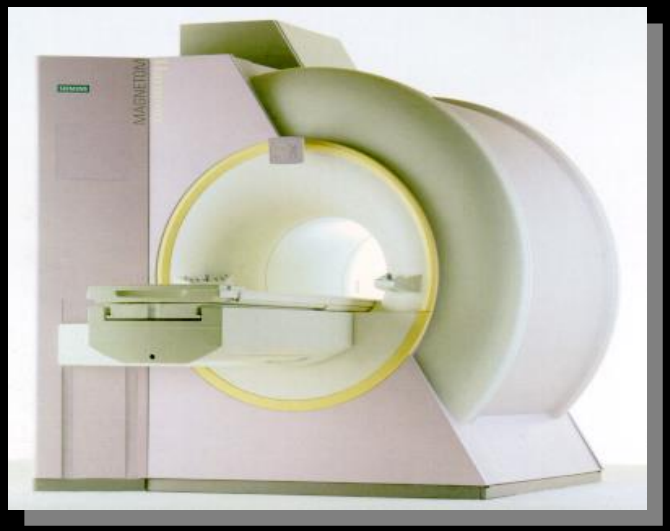
MRI INTRODUCTION

PART I.

MRI SYSTEMS

SIEMENS



Symphony

Signa MR/i

PHILIPS

Gyroscan NT

MR System 정의

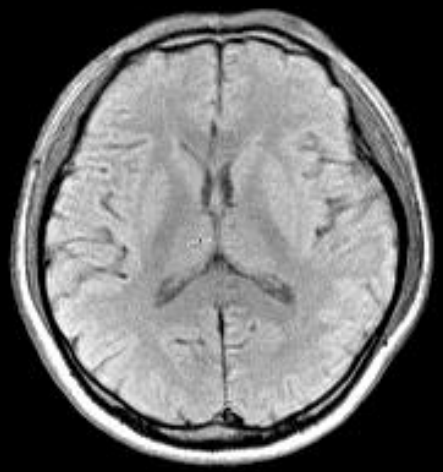
- 고 자장을 이용
- 비파괴 검사 장치
- 물체 내부의 단면 영상 또는 분광정보
- 질병 진단에 이용 :
  - 첨단 고부가 가치의 의료 영상 장치

MRI의 특징

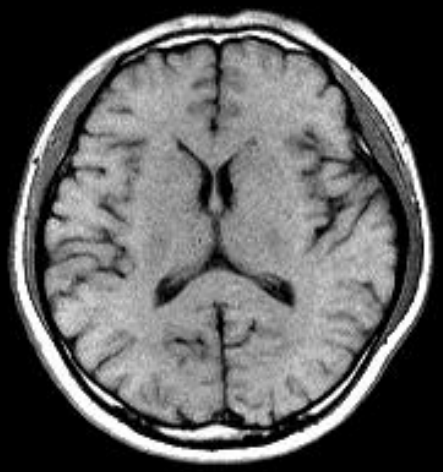
- 인체에 무해
- 연부조직의 대조도가 우수
- 다양한 변수(r,T1, T2, ν, D, s, etc.)
- 임의의 방향으로 영상이 가능
- 해부학/분광학적 영상 및 기능적 영상이 가능
- 실시간 중재적 시술 및 영상유도 수술

MRI Contrast

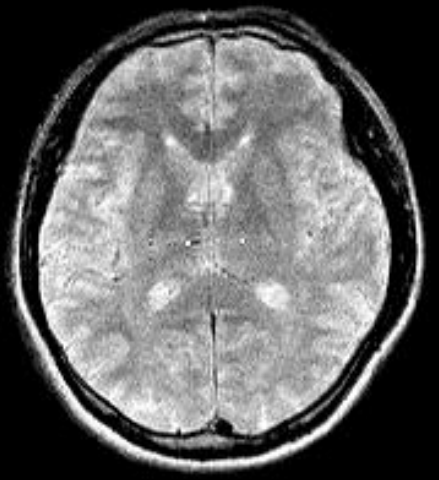
- 영상 변수에 따른 대조도의 차이



Proton Density Image
(수소 밀도 영상)

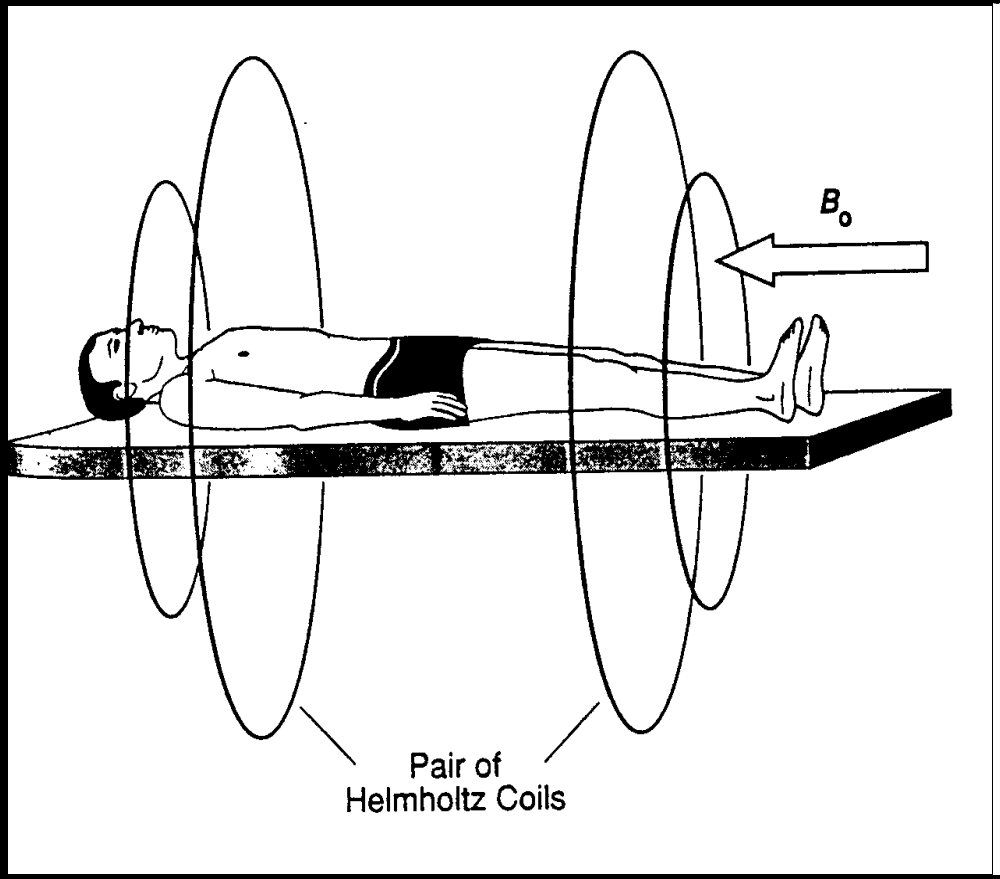


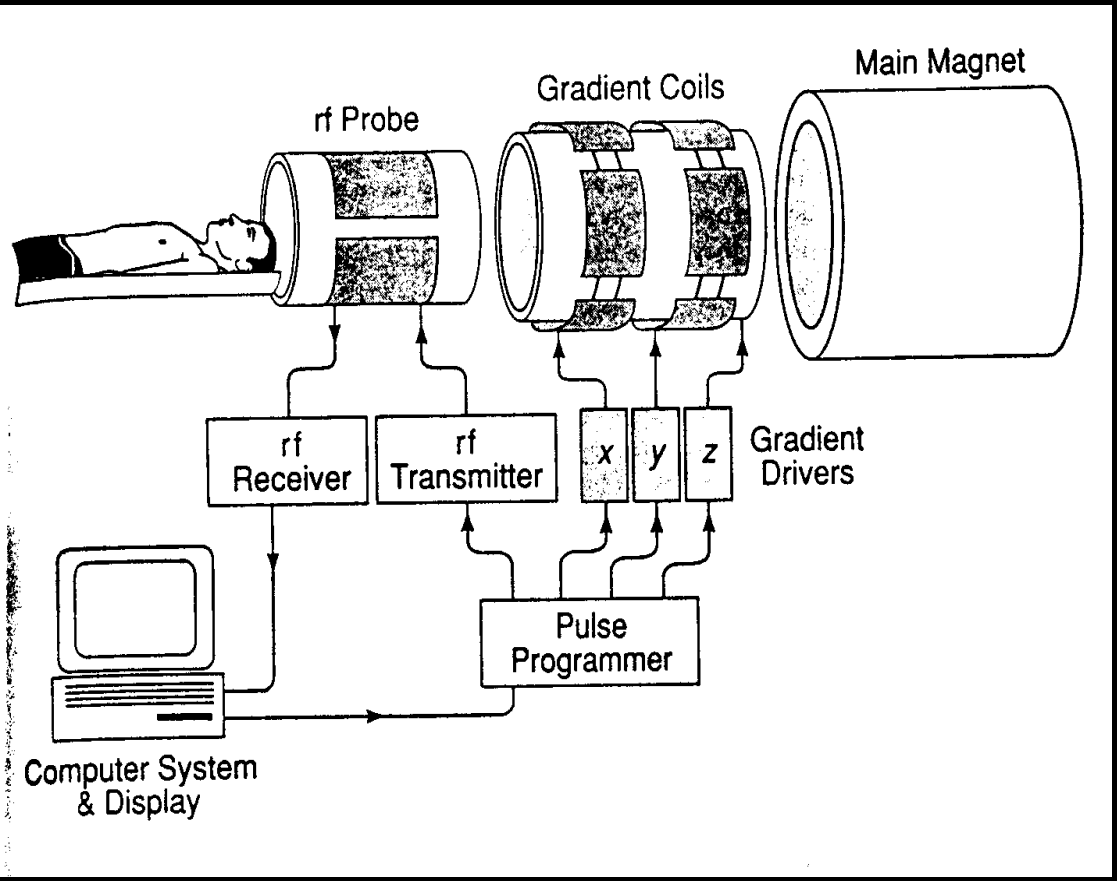
T1 Image
(T1 강조 영상)



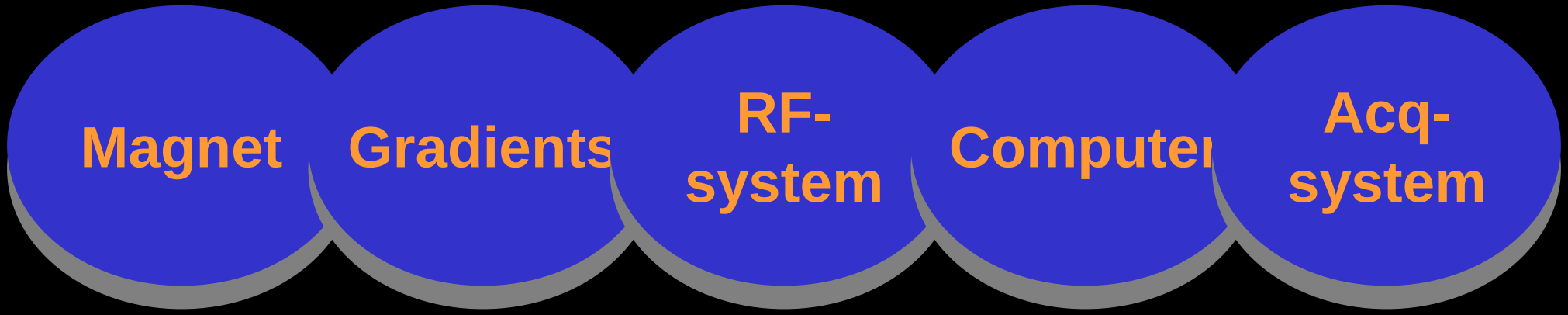
T2 Image
(T2 강조영상)

MRI Hardware





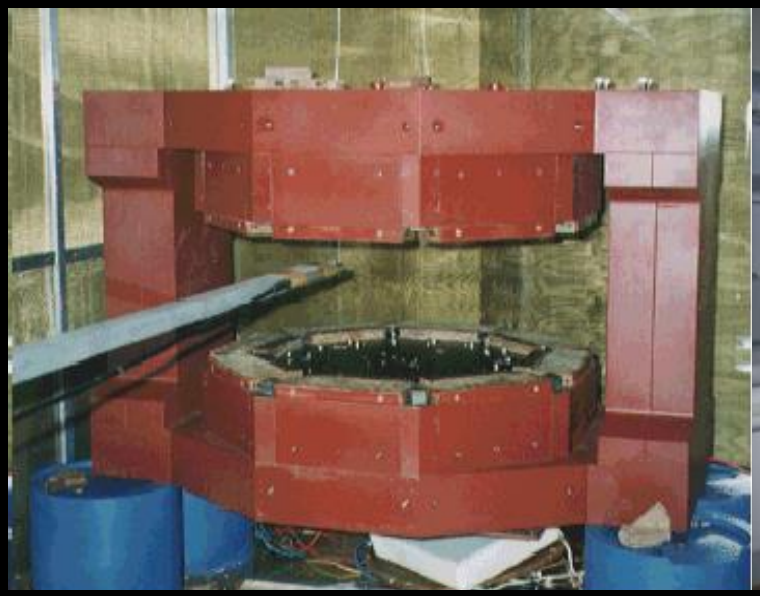
MRI Hardware Structure



MRI MAGNETS

Permanent Magnet

- Low Magnetic Field Strength (< 0.5T)
- Low Operating Cost
- Open Structure, Vertical Magnetic Field



Samsung

GE

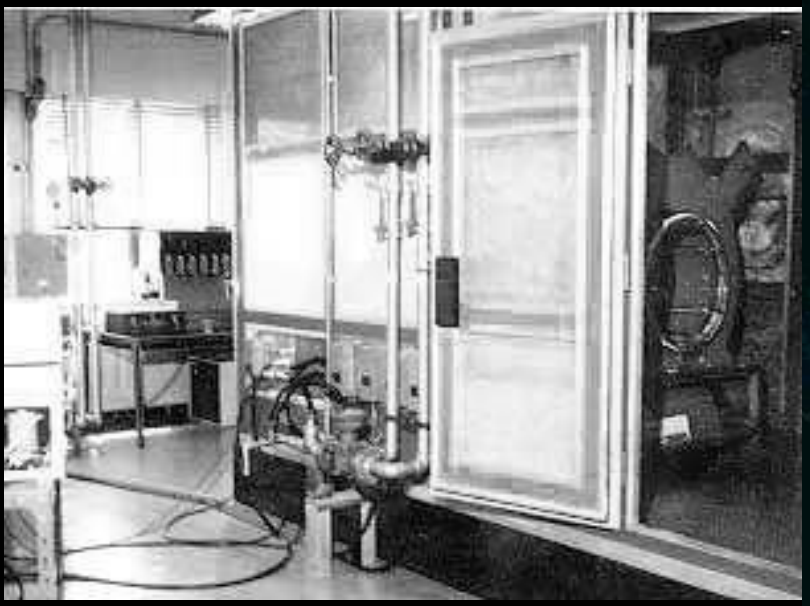
Hitachi

Open Magnet for Interventional MRI

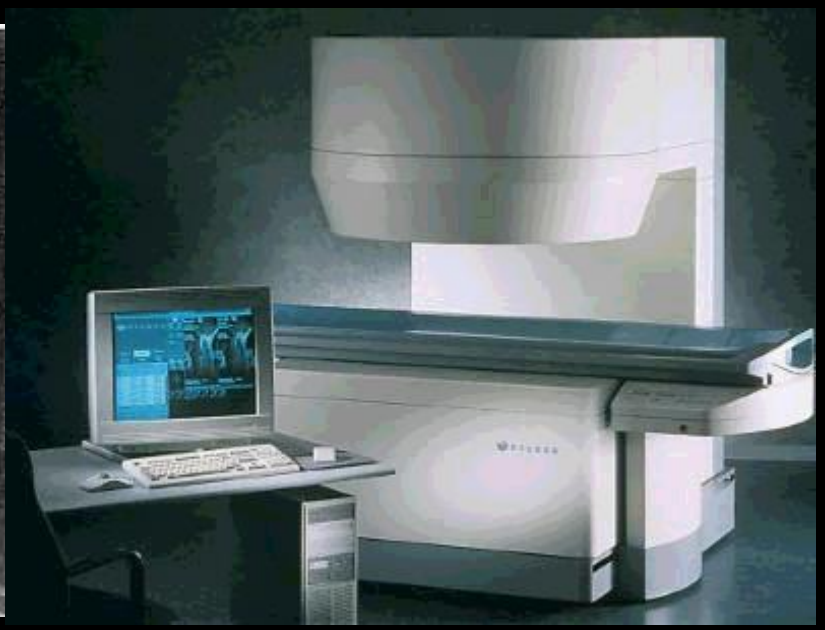
C-type magnet

Resistive Magnet

- Low Magnetic Field Strength (0.15 ~ 0.25T)
- Magnetic Field ON/OFF
- Cooling System



KAIST

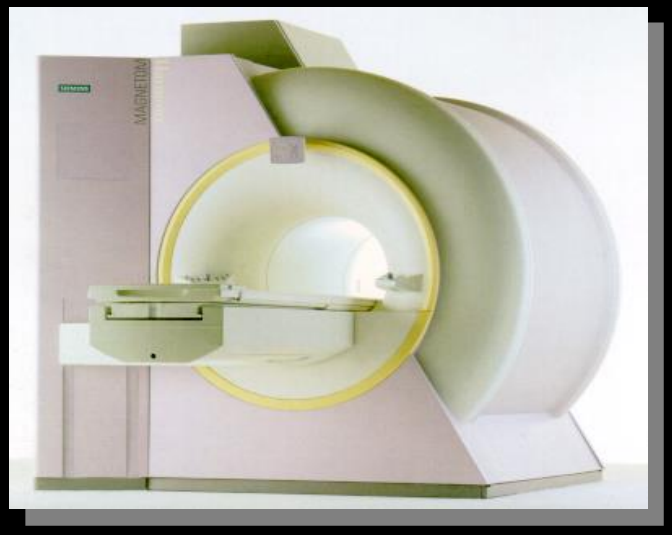


Picker

Siemens

Superconducting Magnet

- High Magnetic Field Strength (> 0.5T)
- Small Field Inhomogeneity
- LHe, LN2 Refill



Symphony

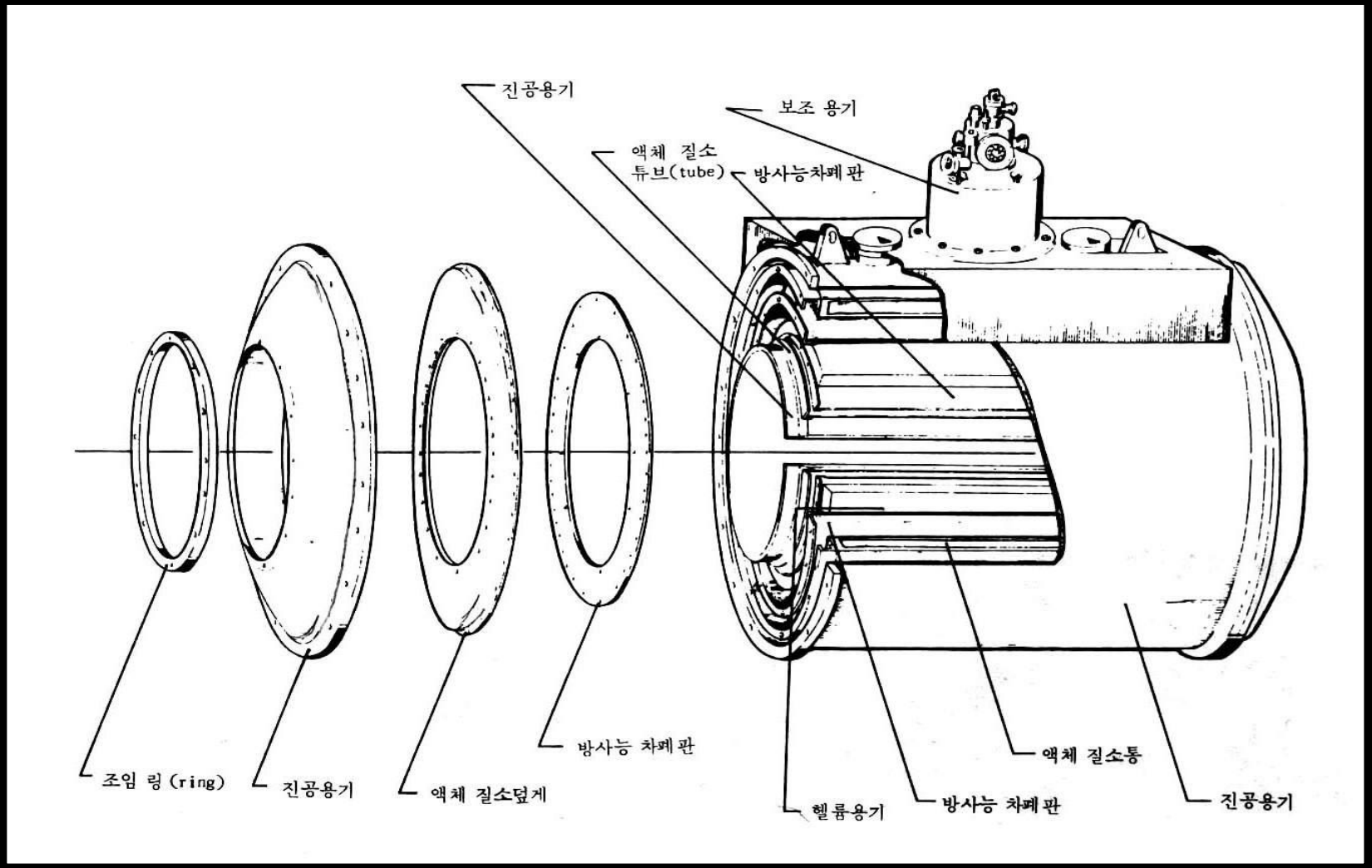
Signa MR/i

Gyroscan NT

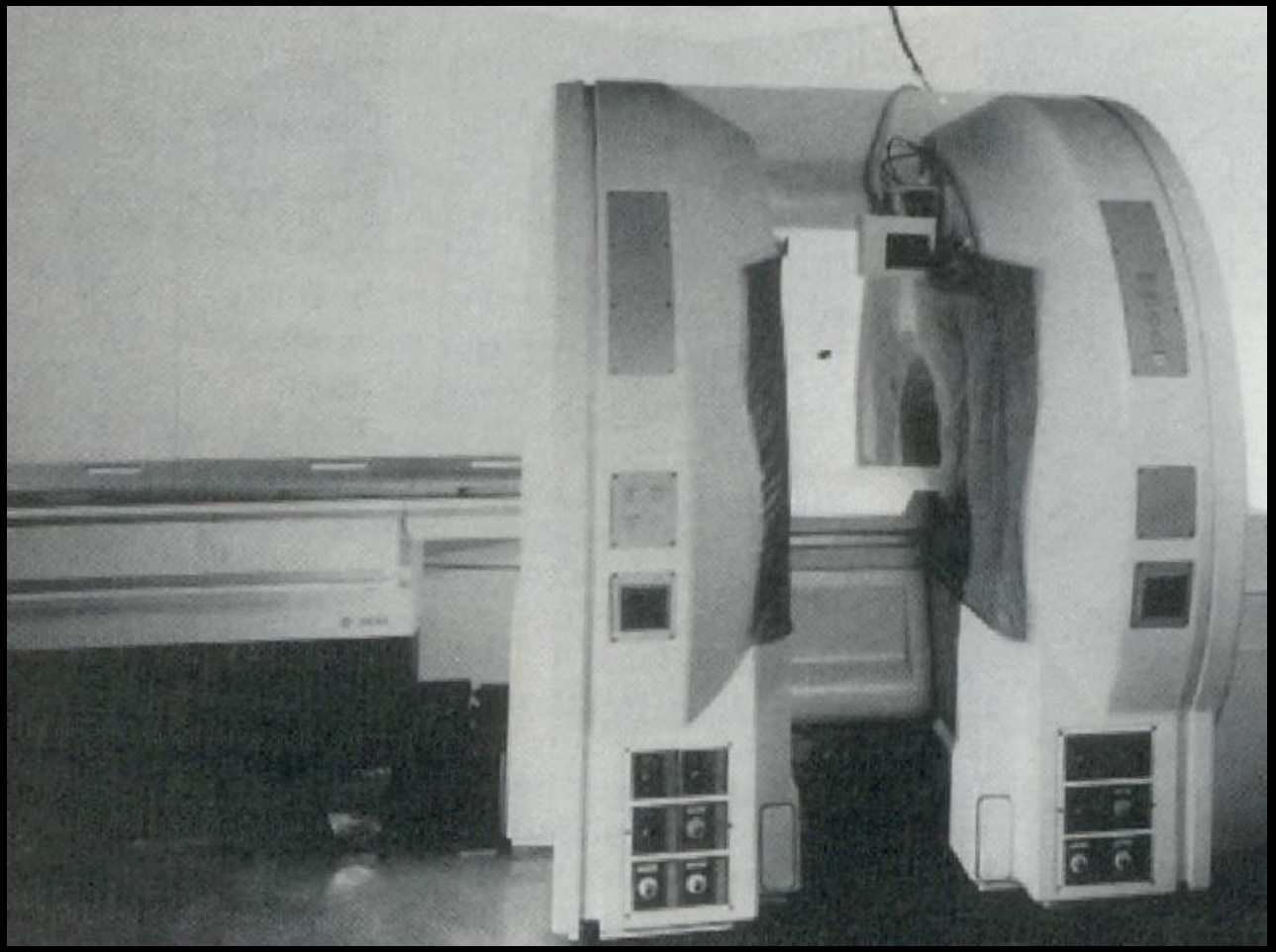
Superconductor

- Metal alloy
- Electrical resistance : zero at low temperatures.
- Titanium-niobium wires embedded in a larger copper wire
- Cooled with liquid helium(LHe) to about 4°K.
- The copper acts to conduct away heat and also acts as an insulator at superconducting temperatures.

Superconducting Magnet

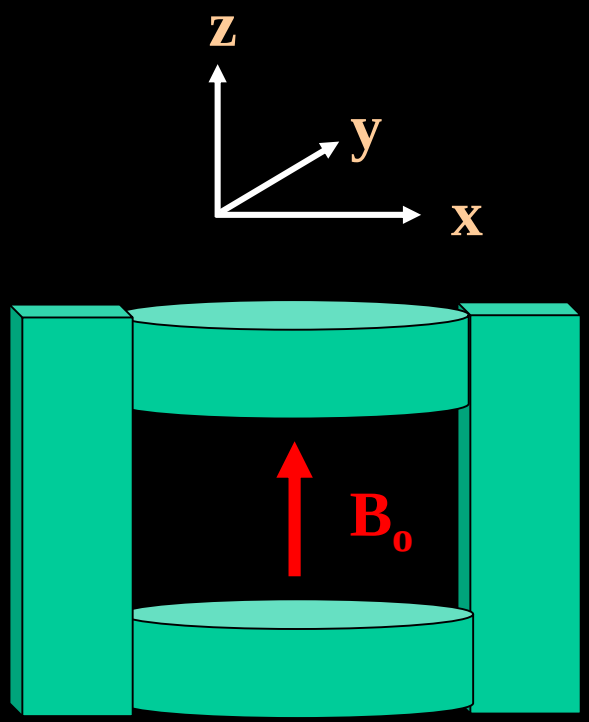


Interventional MRI

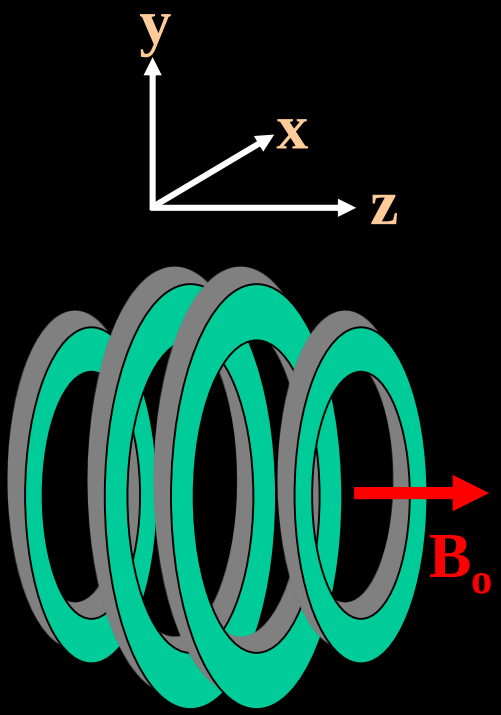


Double Donuts Type (GE)

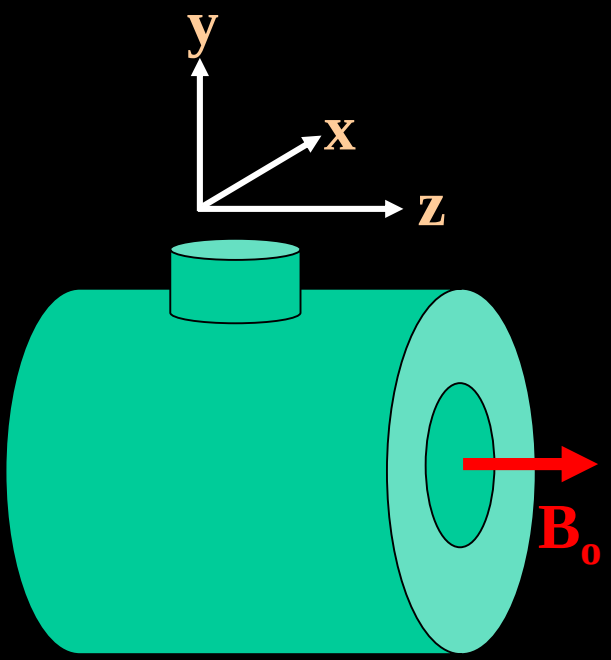
Convention of Coordinate Axis



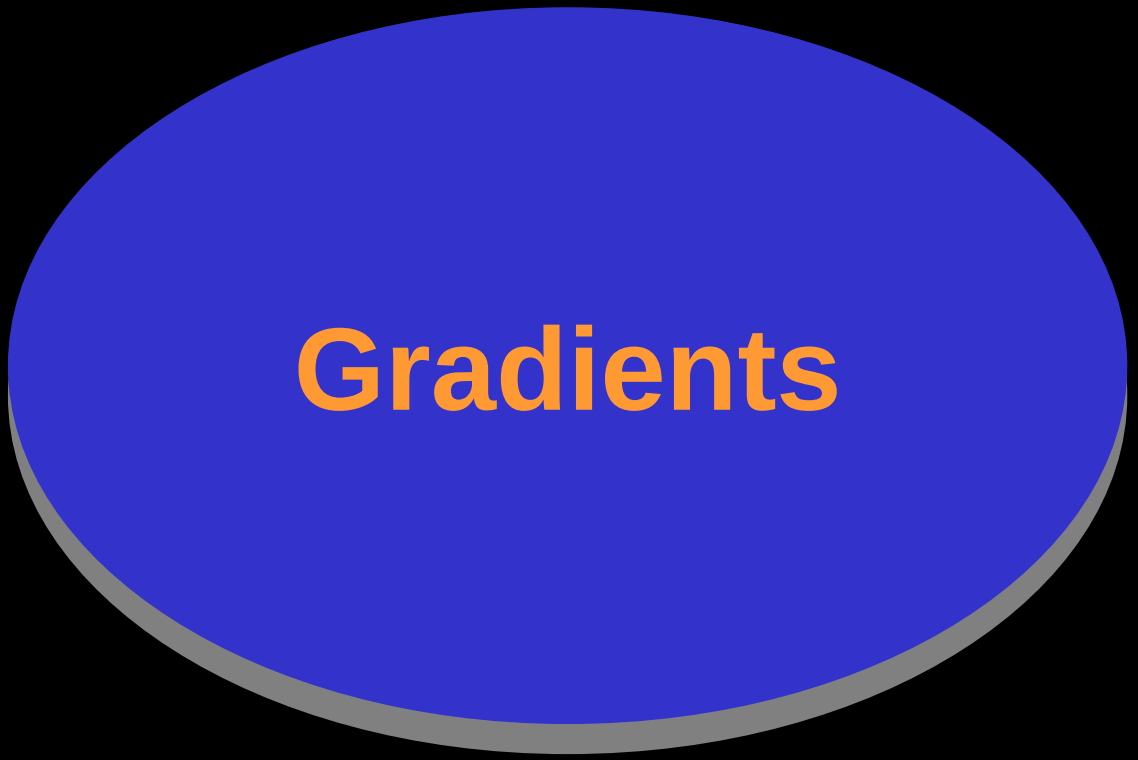
Permanent Magnet



Registive Magnet



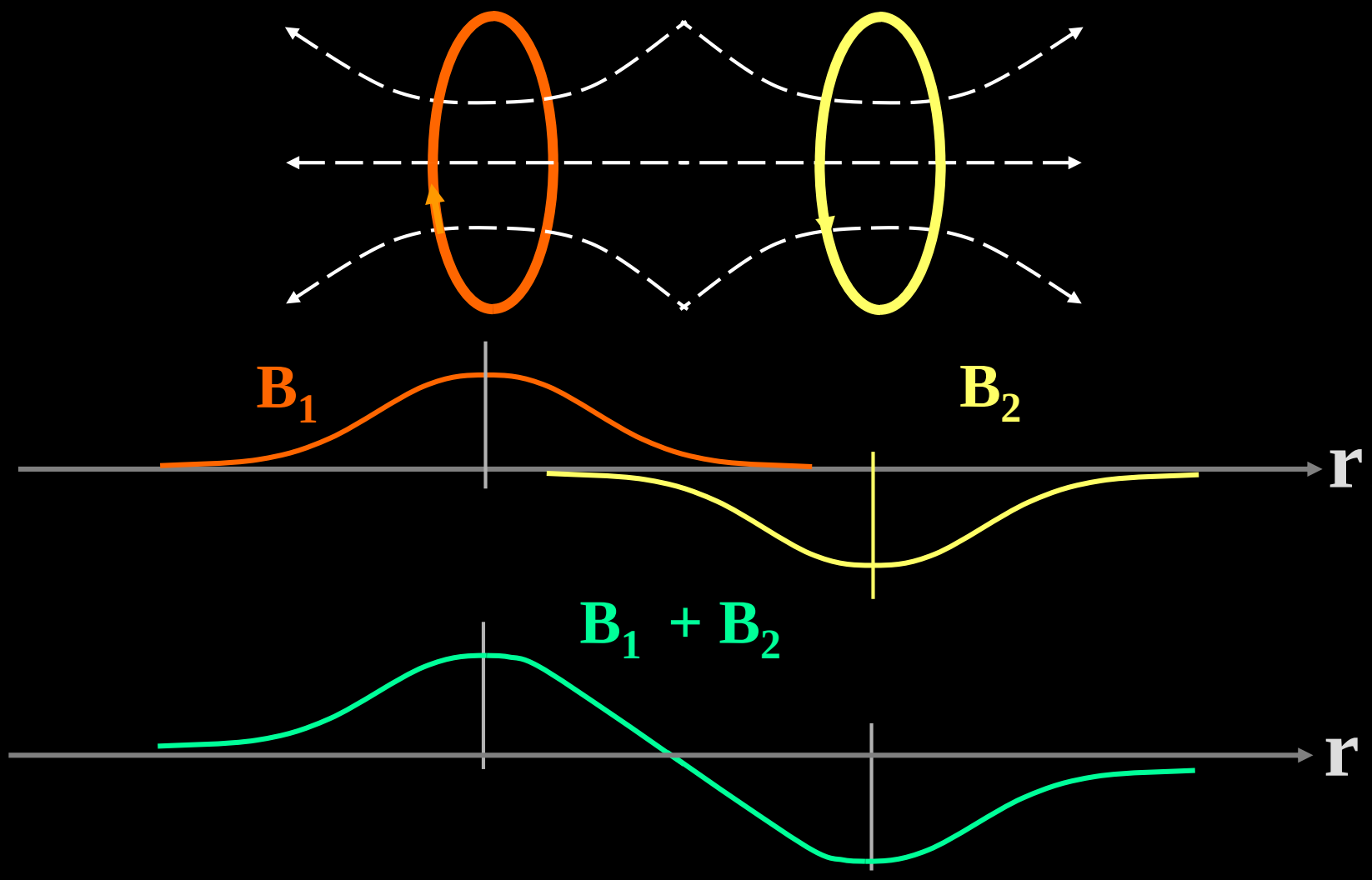
Superconducting Magnet


Gradients

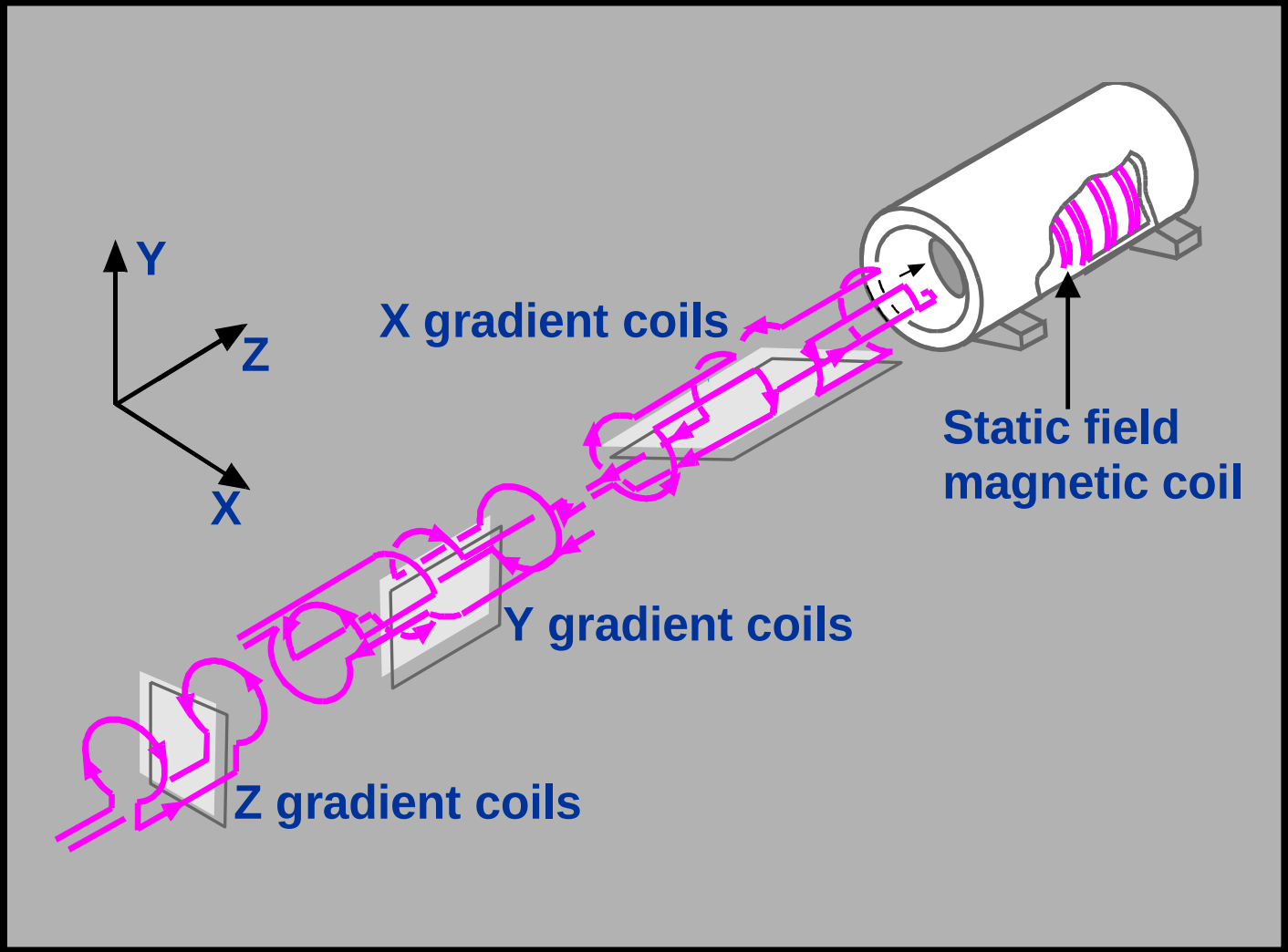
Gradient Coils

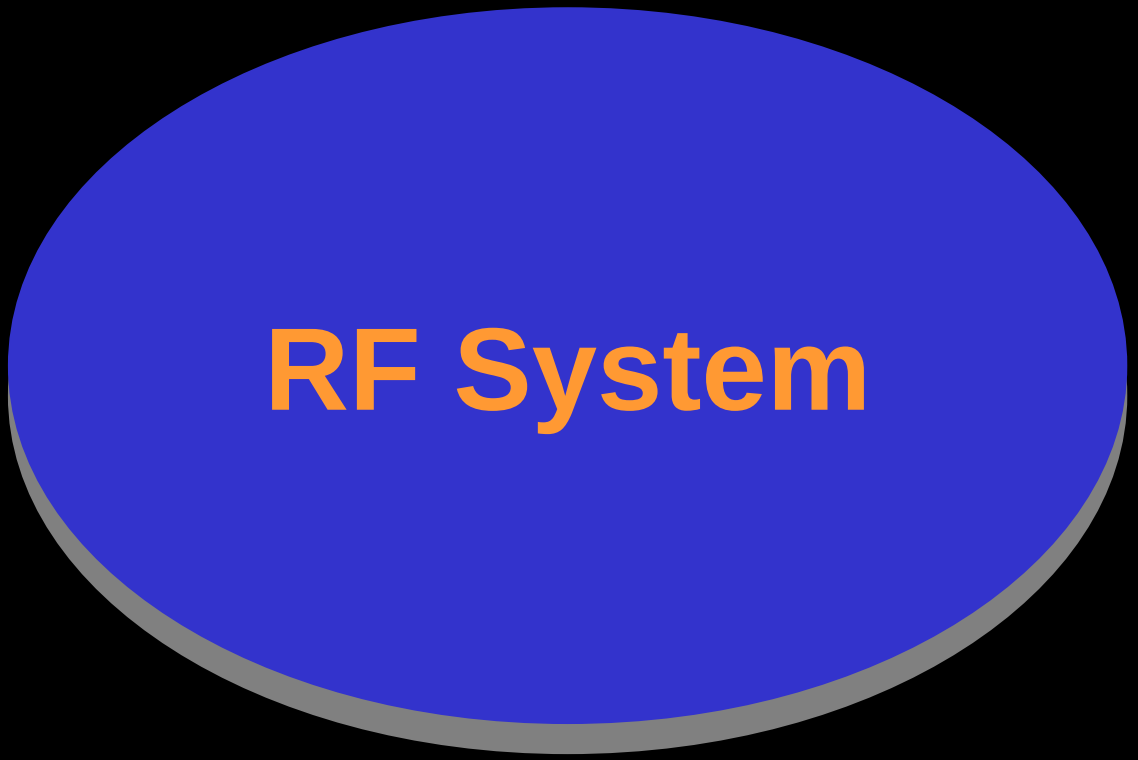
- **Gradient Coil**
  - Magnetic gradient field
  - x, y, z direction
  - Spatial information
- **Gradient Amp**
  - Drive gradient coil
- **Eddy Current Compensation**

Gradient Field Generation



Installation of the Gradient Coils

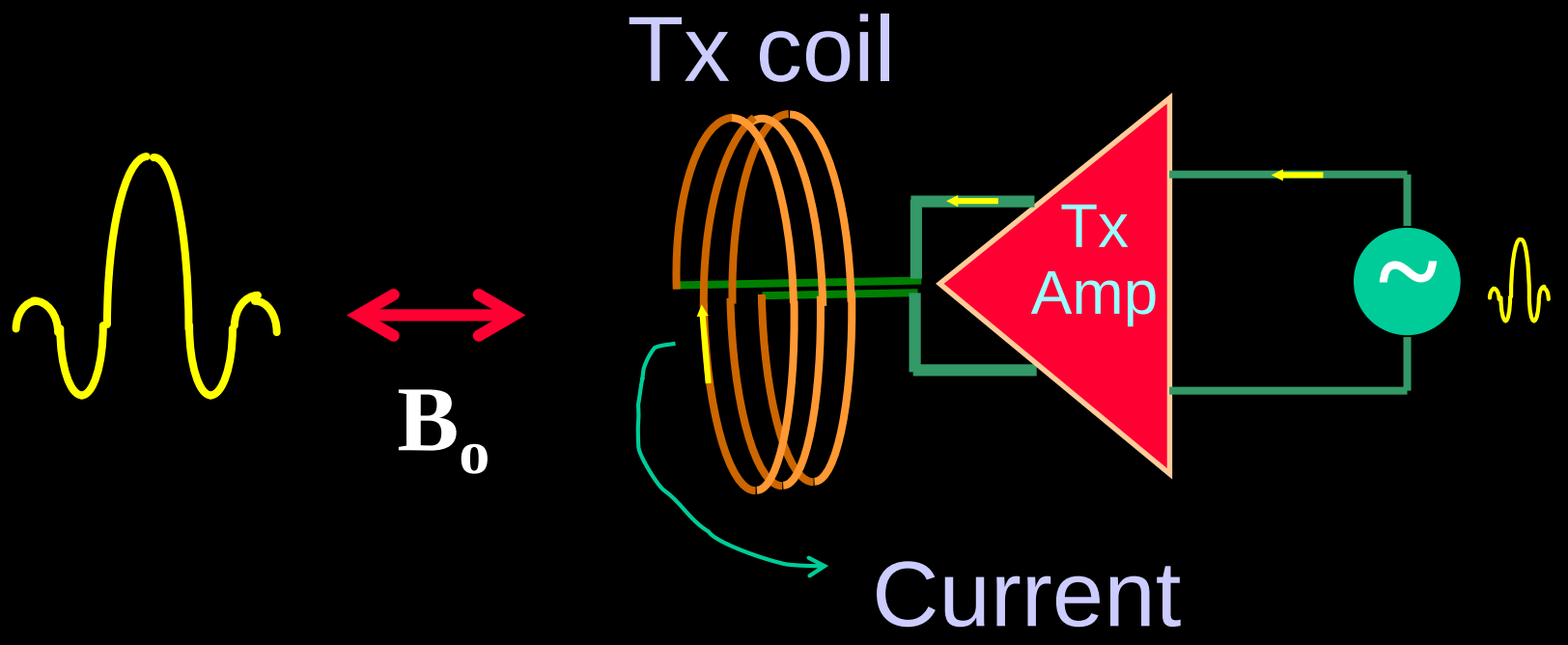



RF System

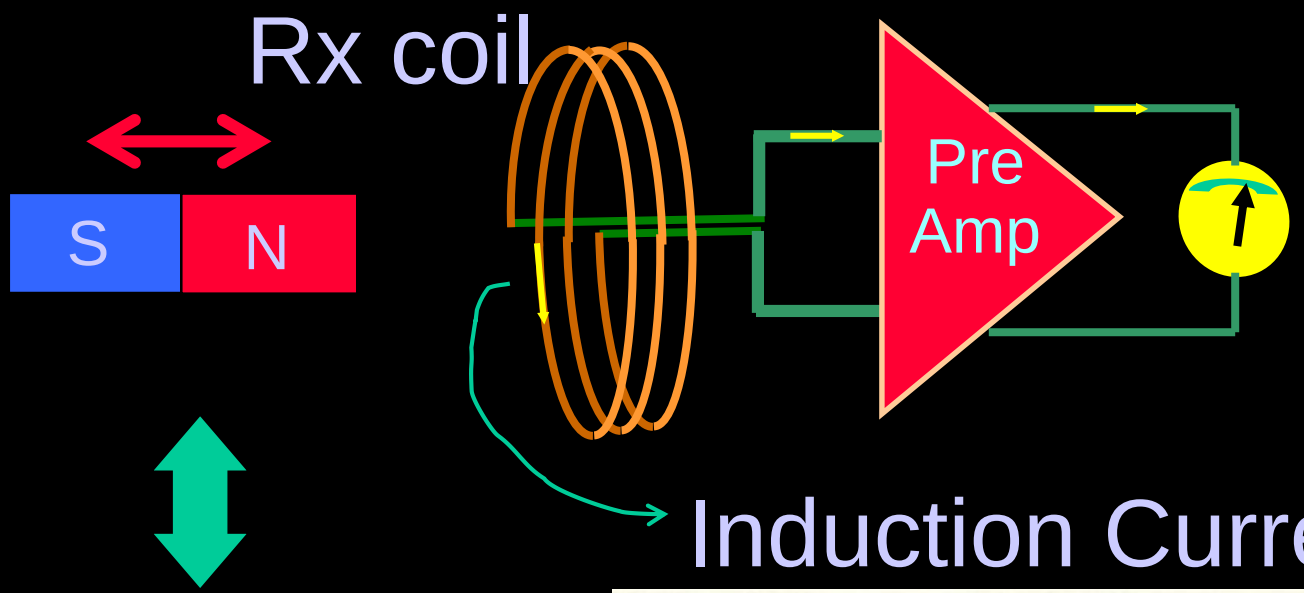
Radio-Frequency System

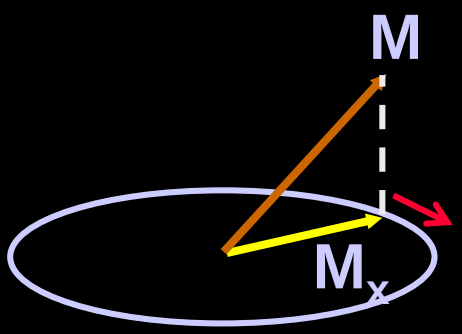
- **RF Coil**
  - EM waves with radio-frequency
  - RF Transmitter
  - RF Receiver (Detector)
- **RF Power Amp (to Tx coil)**
  - Amplification of RF pulse
- **Preamp (from Rx coil)**
  - Amplification of detected MR signal

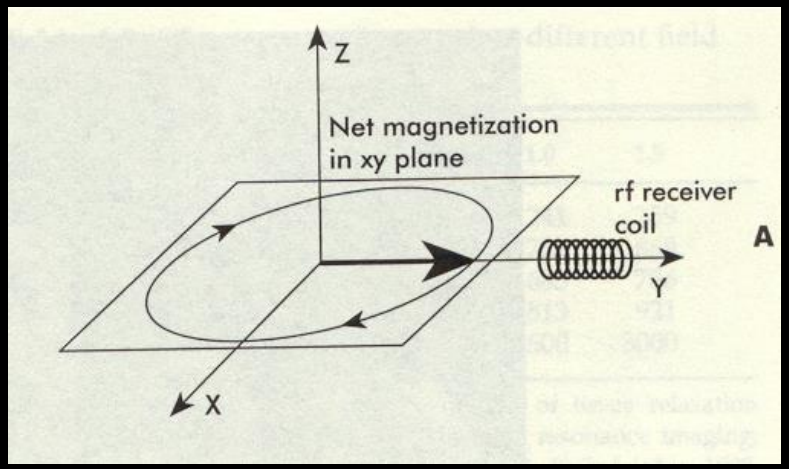
Tx Coil System



Rx Coil System

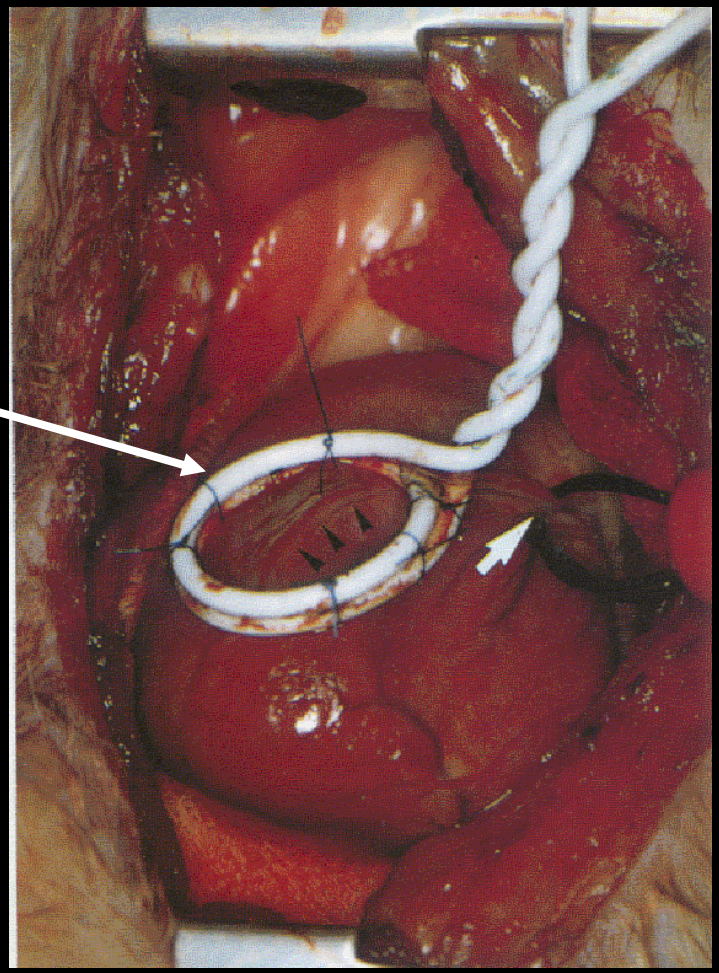




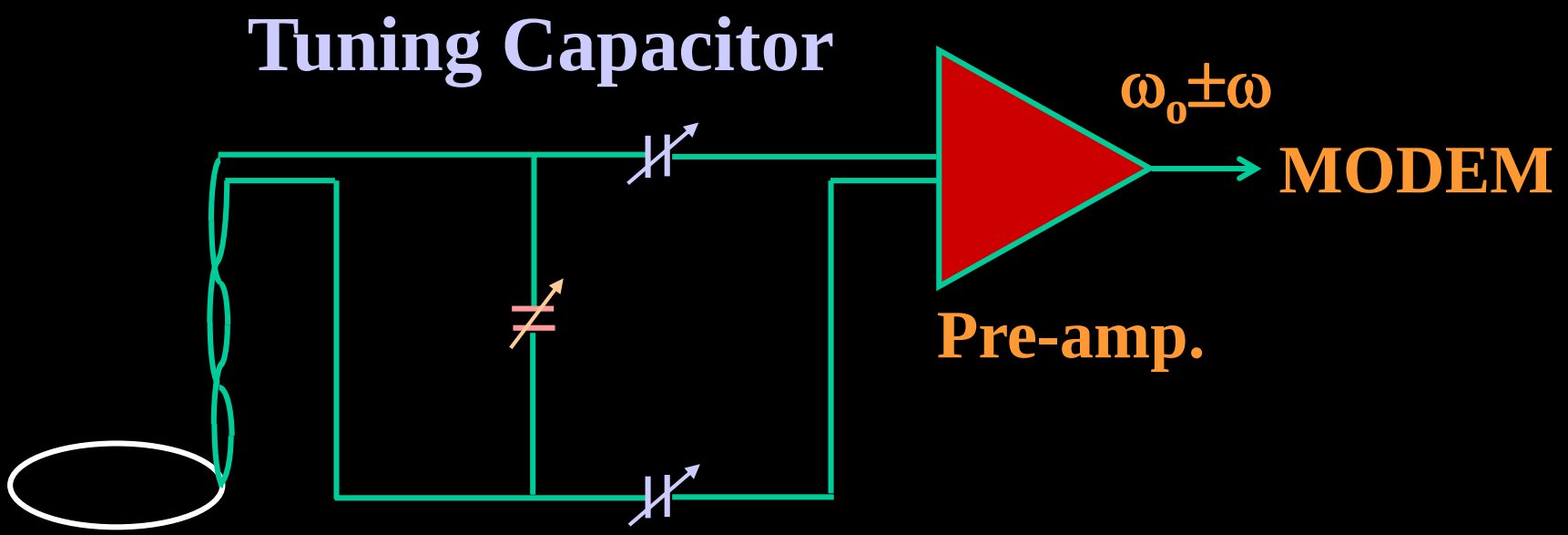


Example of Rx Coil

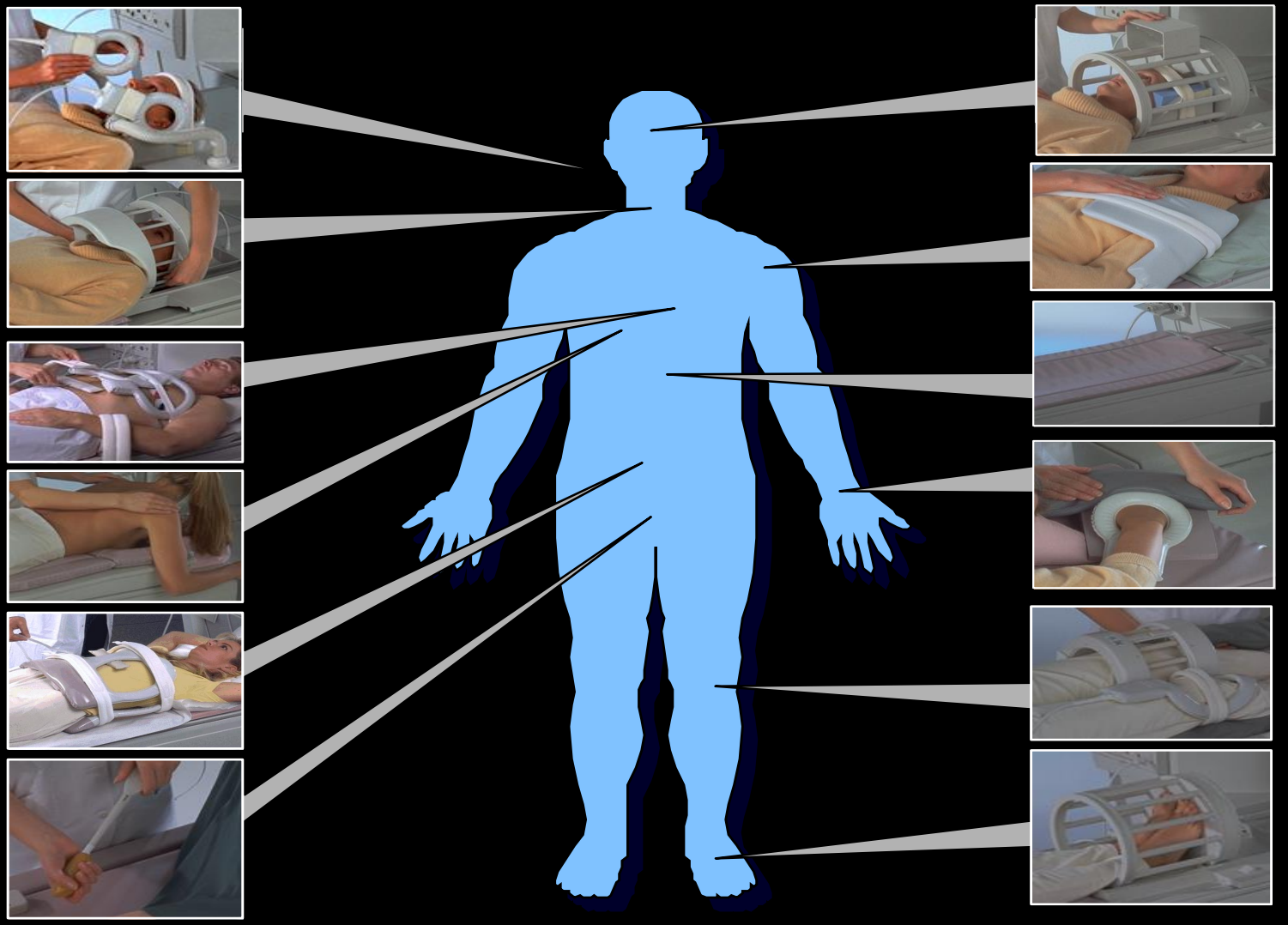
Rx surface coil



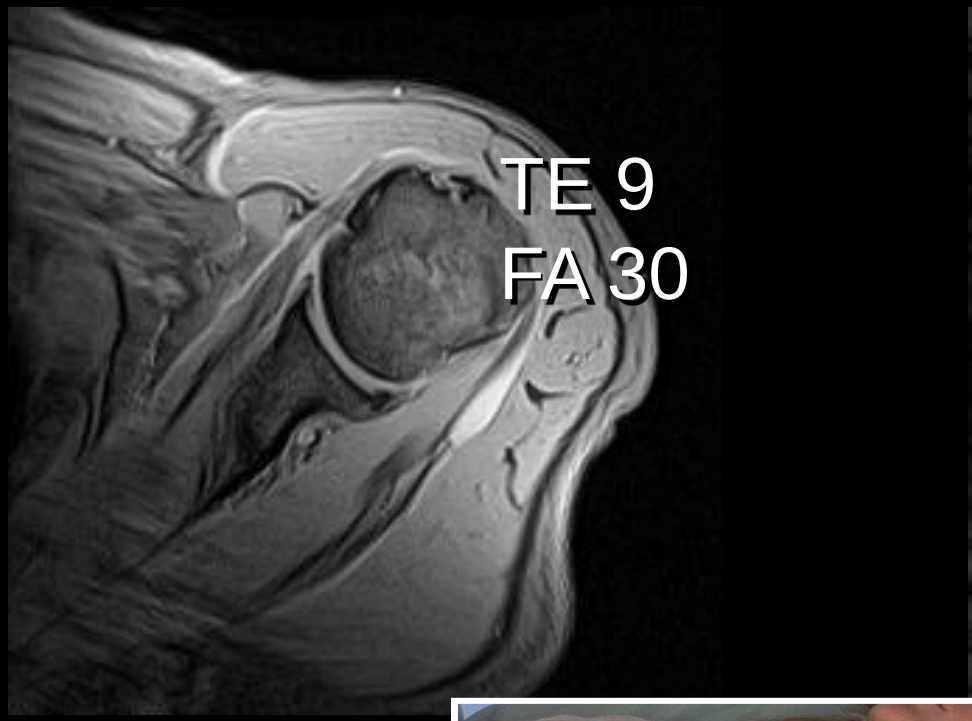
Example of Rx Coil



An Application of Various Rx Coil

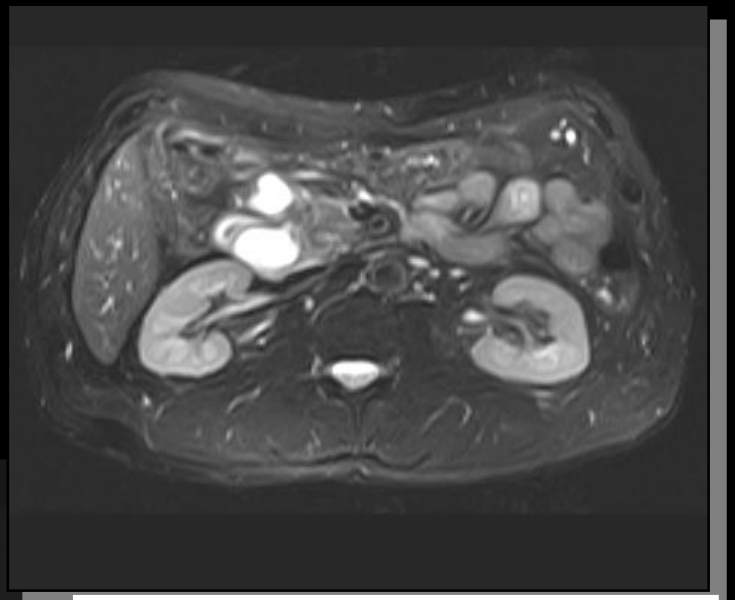


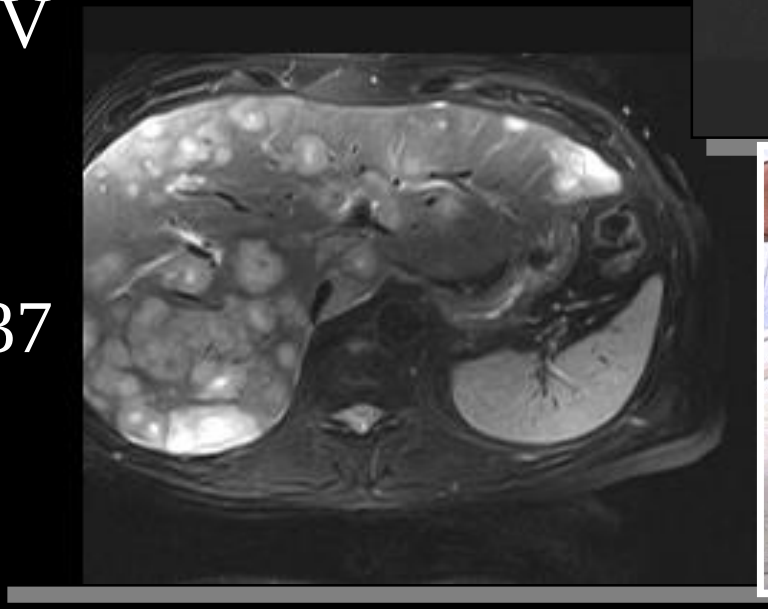
Shoulder Image



Abdomen Image

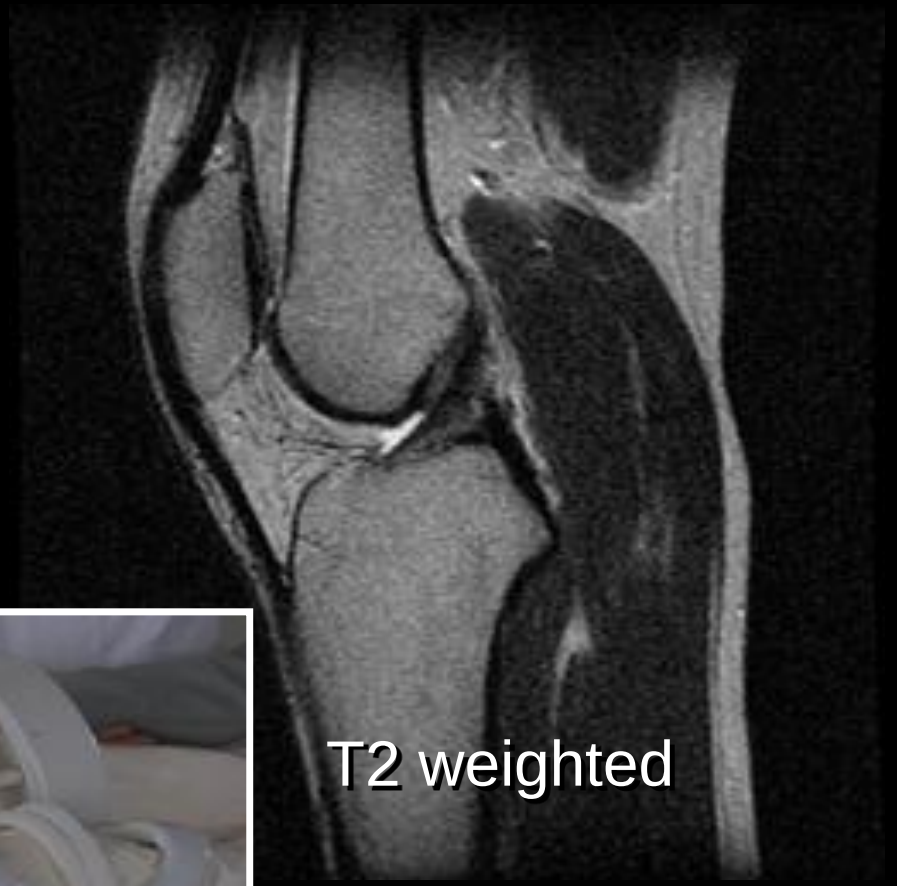
- SPIR fat suppression
- TSE
- 256 resolution
- 350 mm FOV
- 4 mm slice thickness
- scantime 2:37





Knee Image

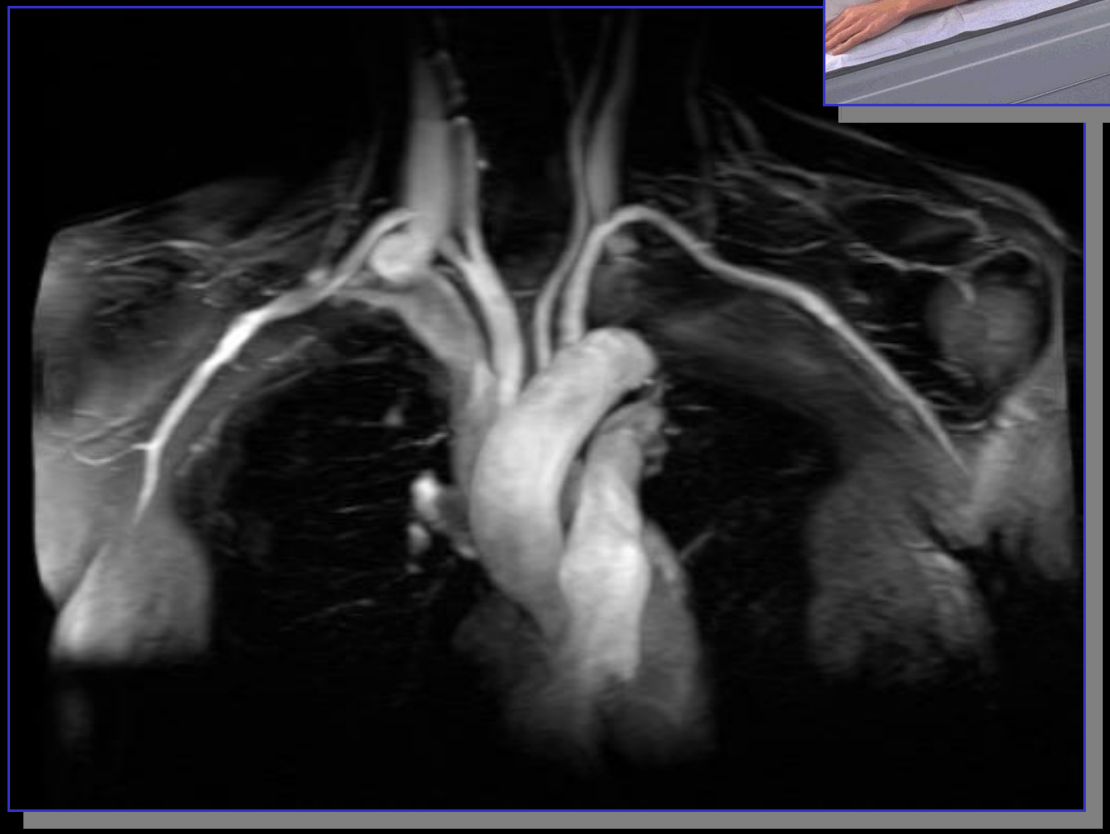
PD weighted



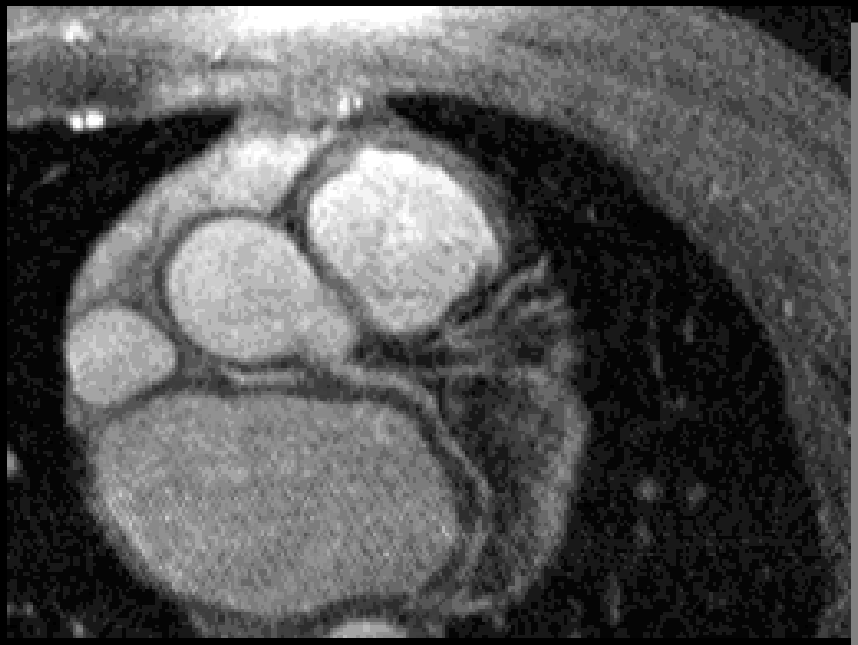
T2 weighted

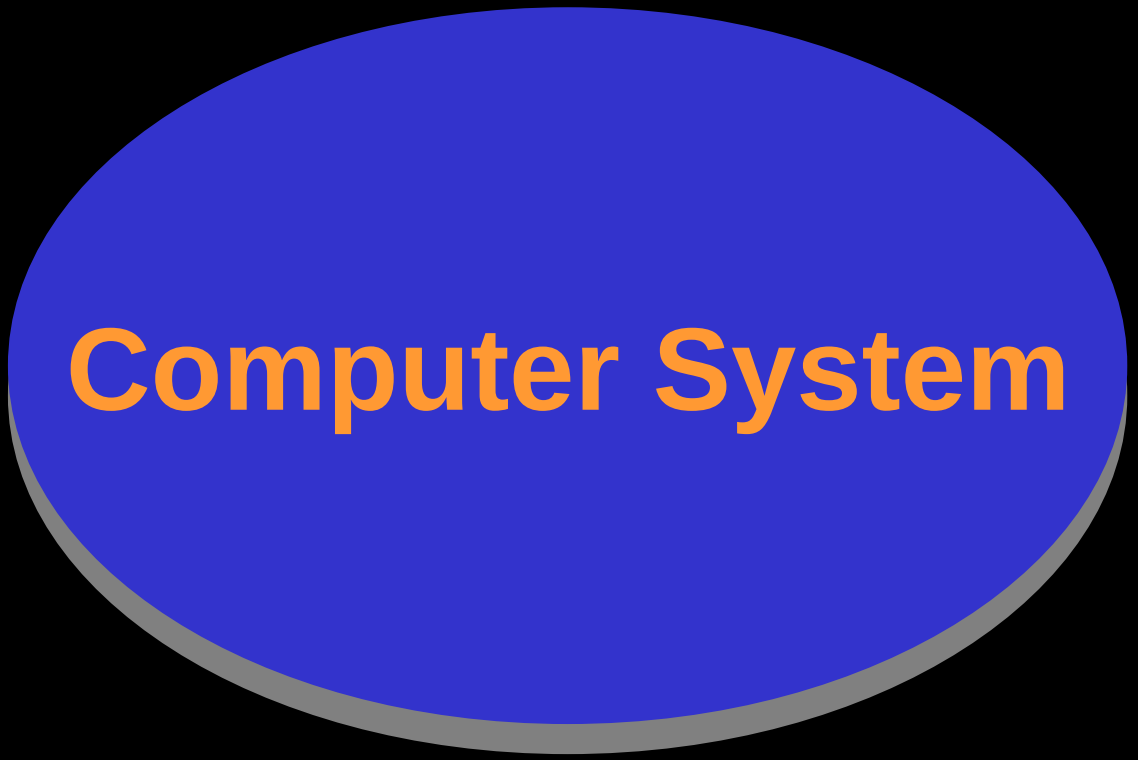
Thorax MR Image

- Contrast enhanced
- 3D-FFE
- 512 scan resolution
- 450 mm FOV
- scantime 45 seconds



MR Coronary Artery Imaging




Computer System

Computer System (I)

Operating Console

Storage Device

Computer System (II)

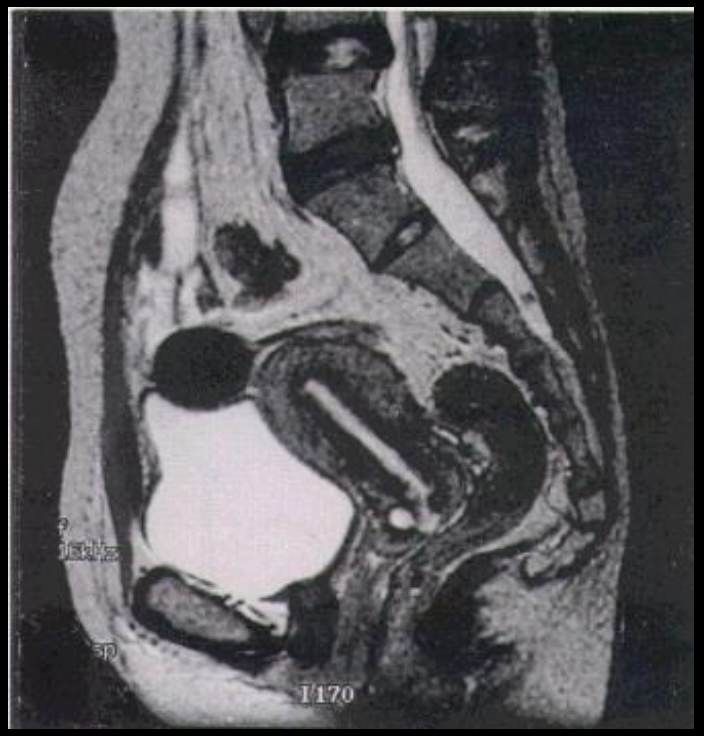
- Control MR Hardware
- Storage Device
  - Patient information, image, parameters
  - High speed, large capacity : Optical disk
- Display
  - Color, volume, cinema
  - High speed image display and adjustment

Computer System (III)

- Operating, Remote Console
  - Monitor, keyboard, mouse
  - Scan parameter display / adjustment
  - Scan status
  - MR image display
- Data Processing
  - FFT
  - Volume/Surface rendering

Example of MRI

MR Image of Endovaginal Coil



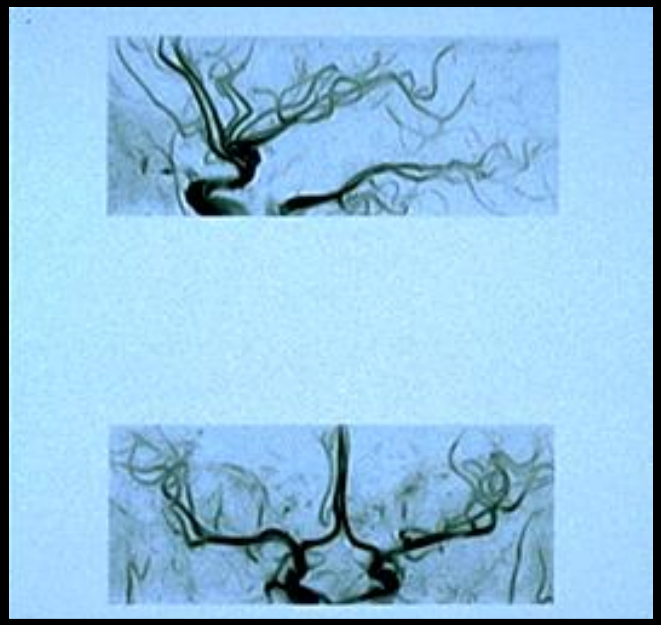
Body coil

Endovaginal coil

Cardiac MR Imaging

Courtesy: University Hospital Uppsala

Head MR Angiography



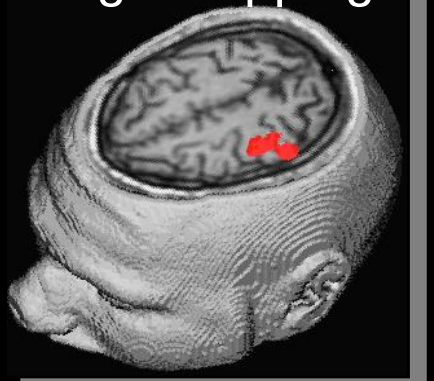
Abdomen MR Angiography

- Left: renal Angio,
  gated PCA,
  VS 50 cm/sec,
  1 NSA,
  400 mm FoV
  (coil rotated)

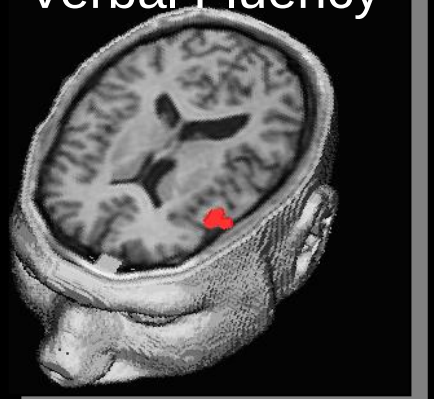
- Right: renal stenosis
  contrast angio,
  350 mm FOV, MIP,
  scantime 0:27 (!)

3D Functional Brain Imaging

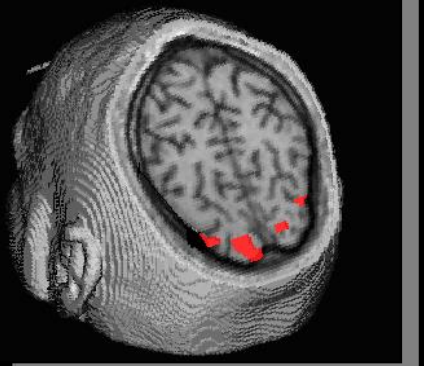
Finger Tapping



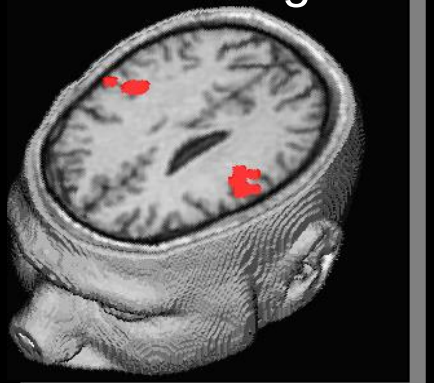
Verbal Fluency



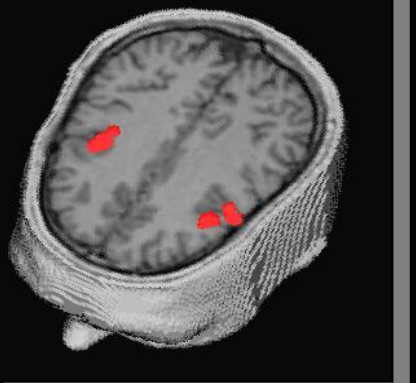
Checker board



Lateral Tongue

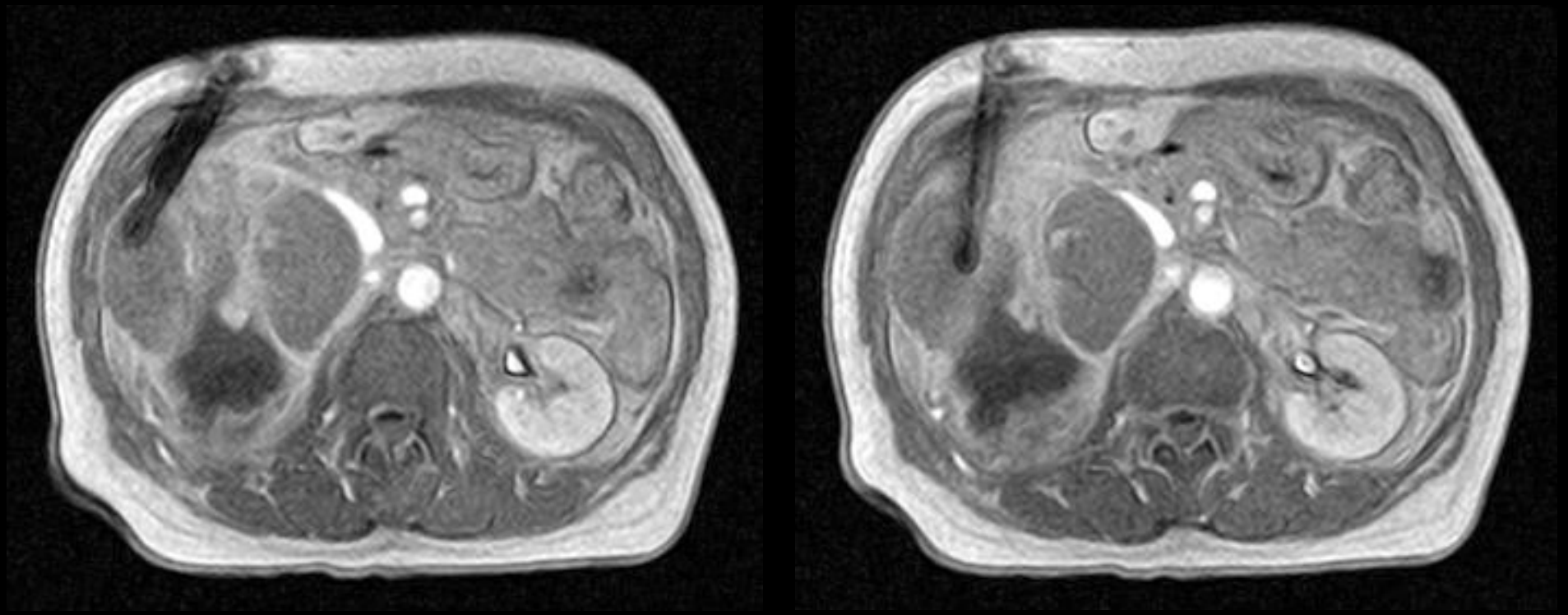


N-back task



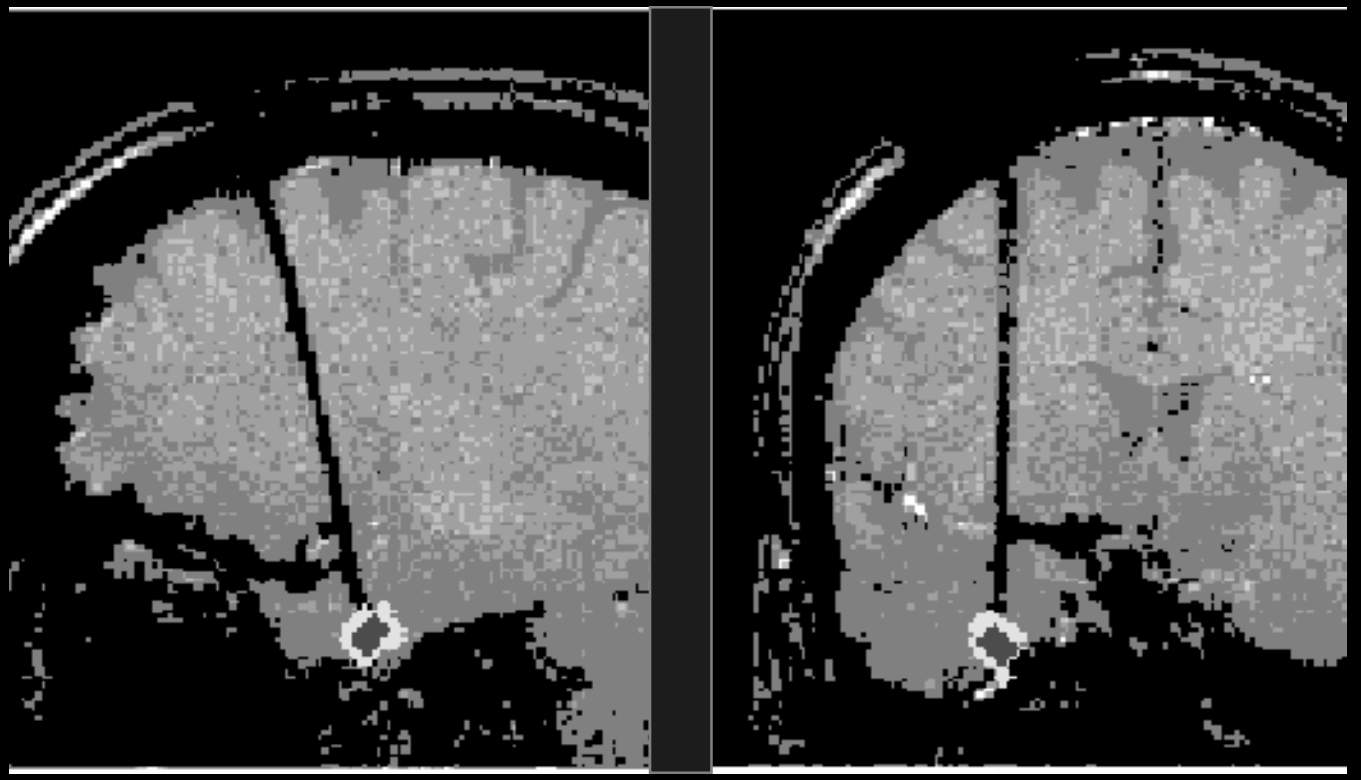
Interventional MRI System

Interventional MR Image



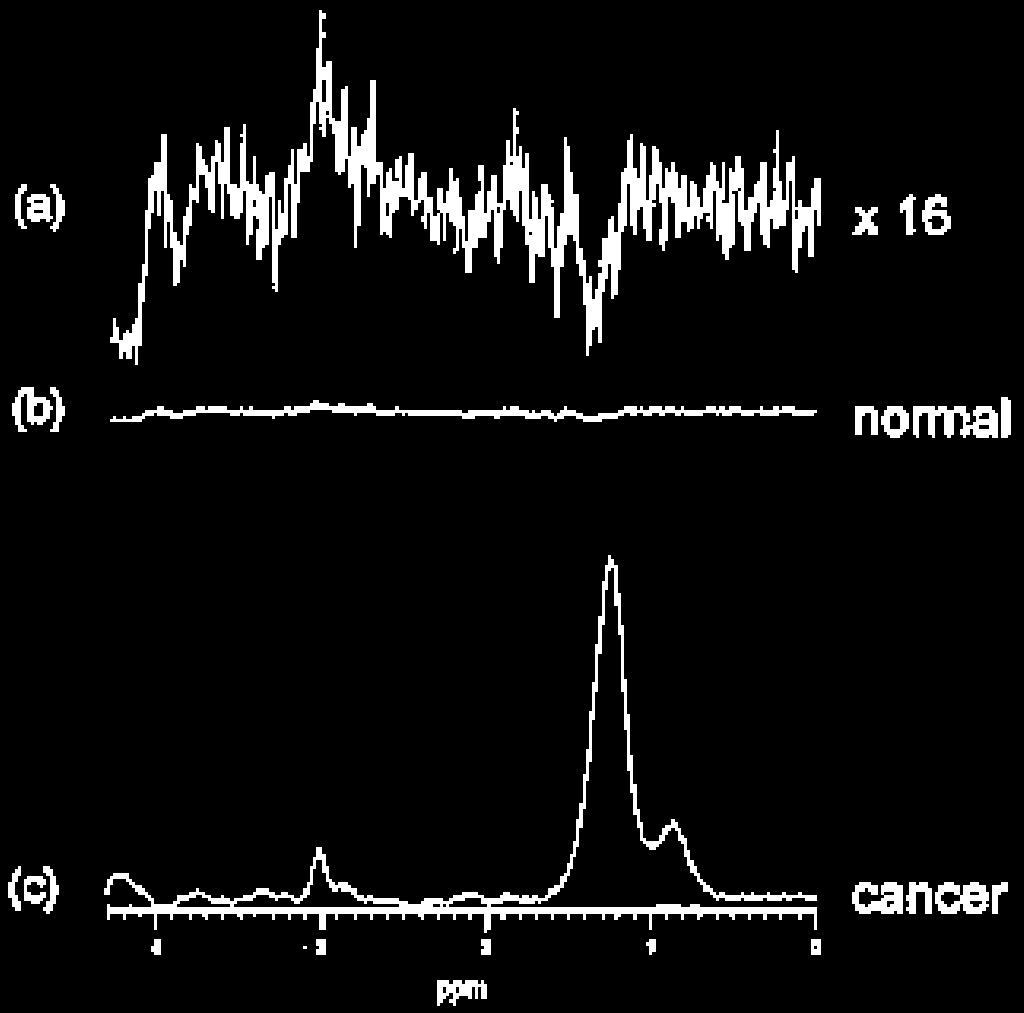
MR-guided liver biopsy

Interventional MR Image

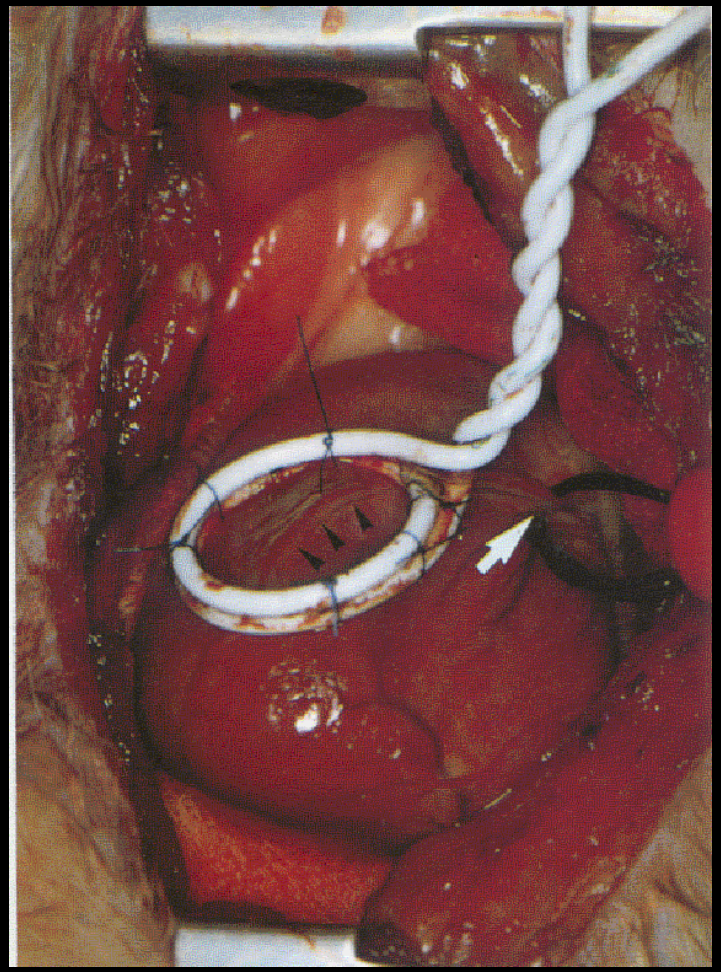


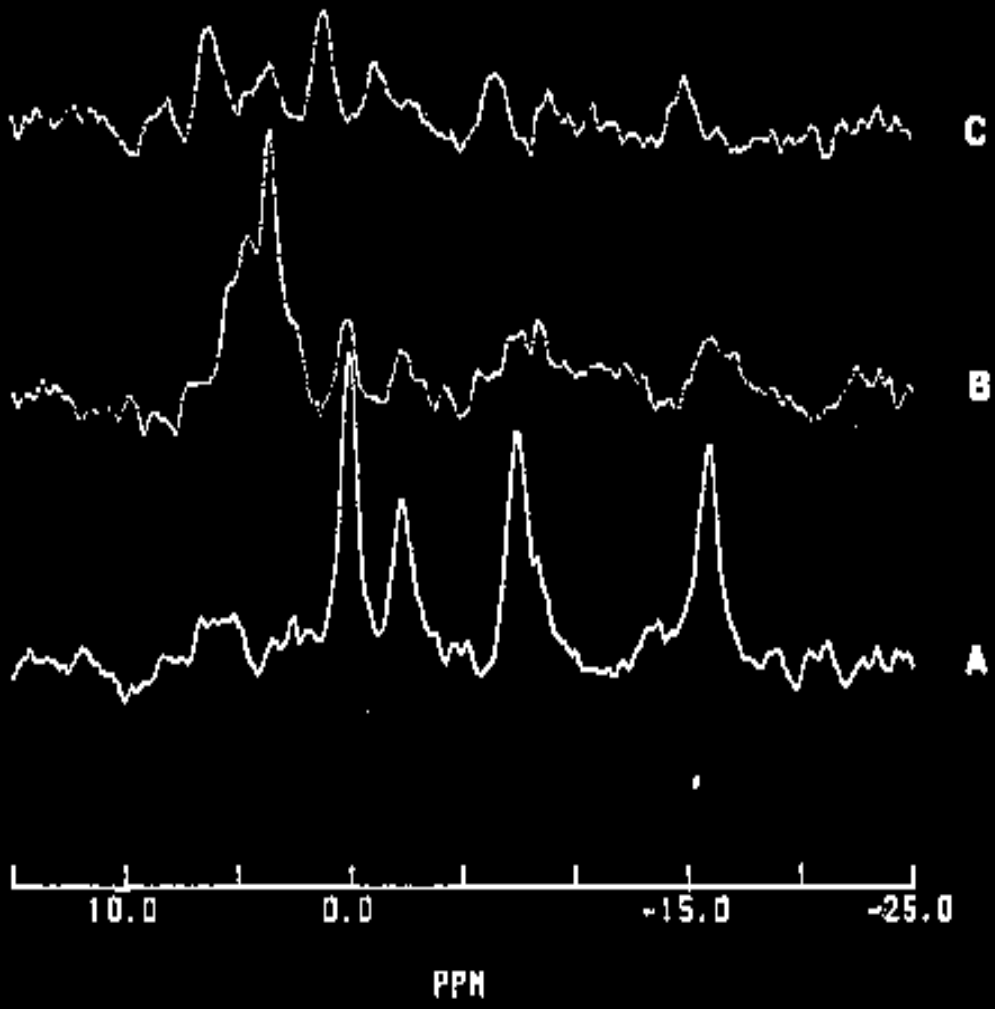
MR-monitored laser ablation.
Courtesy University of Graz, Austria

MRS of Cervix (^{1}H)



MR Spectroscophy Data(^{31}P)





기타 MRI

Moving bed
technique used to
image the whole body
in a single scan