

Medical Equipment II - 2010

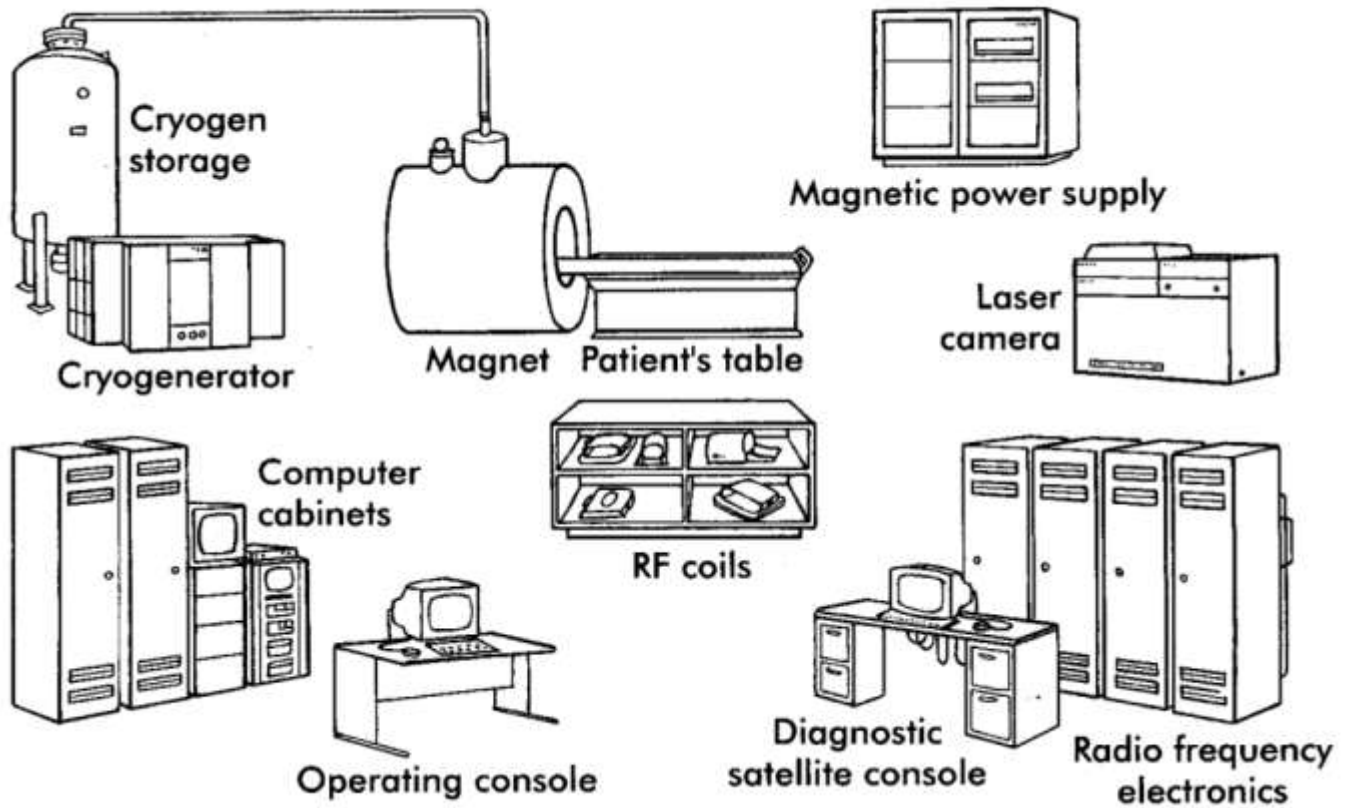
Magnetic Resonance Imaging⁽⁴⁾

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Web: <http://ymk.k-space.org/courses.htm>



[Block Diagram of MRI System]



[Primary Magnetic Field (B_0)]

- Permanent magnet
- Resistive magnet
- Superconductive magnet

[Permanent Magnet]

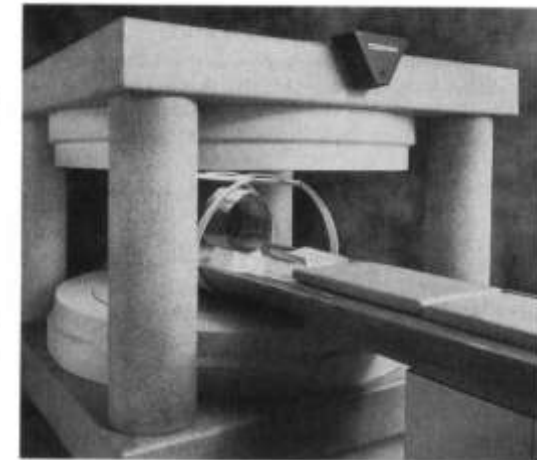
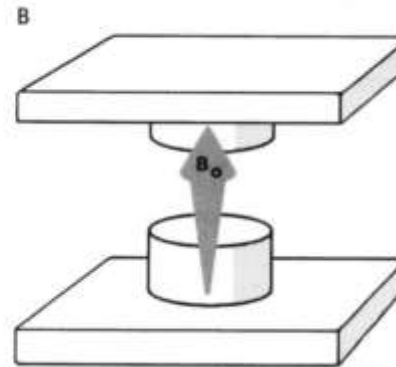
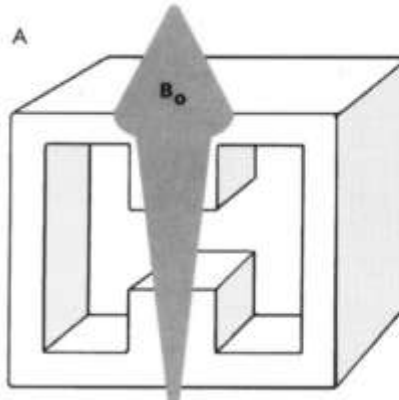


Table 11-1 Characteristics of a permanent magnet magnetic resonance imager

Feature	Value
Magnetic field (B_0)	Up to 0.3 T
Magnetic field homogeneity	50-100 ppm
Weight	90,000 kg
Cooling	None
Power consumption	20 kW
Distance to 0.5 mT fringe field	< 1 m

[Resistive Magnet]

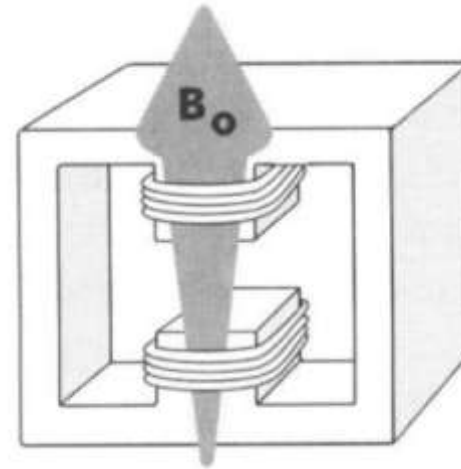
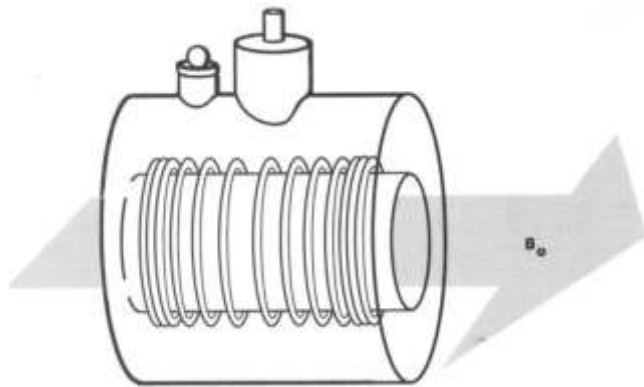


Table 11-2

Characteristics of a resistive electromagnet MR imager

Feature	Value
Magnetic field (B_0)	Up to 0.3 T
Magnetic field homogeneity	10-50 ppm
Weight	4000 kg
Cooling	Water, heat exchanger
Power consumption	80 kW
Distance to 0.5 mT fringe field	2 m

Superconductive Magnet

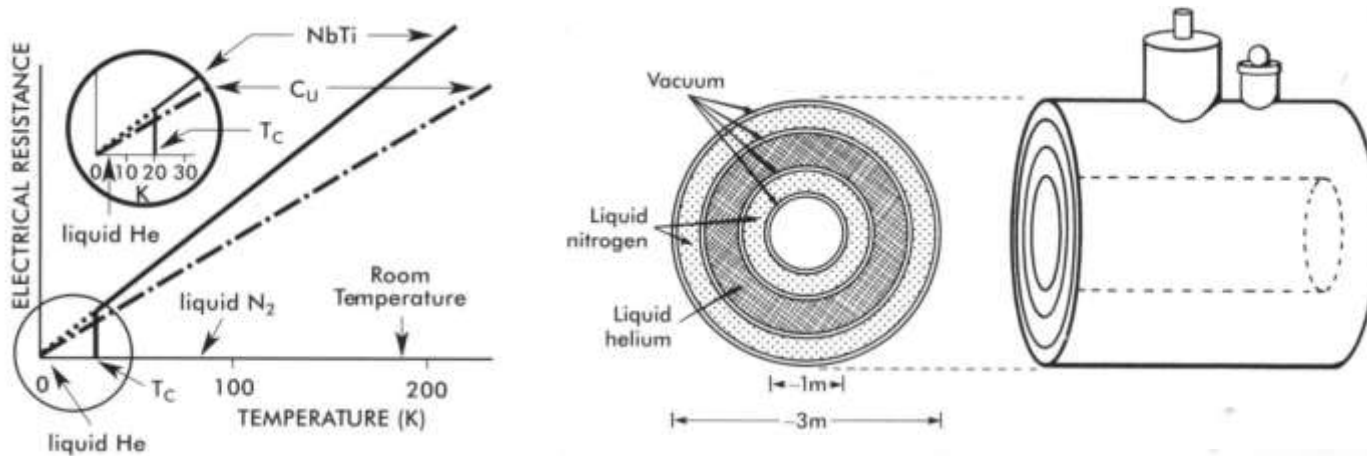


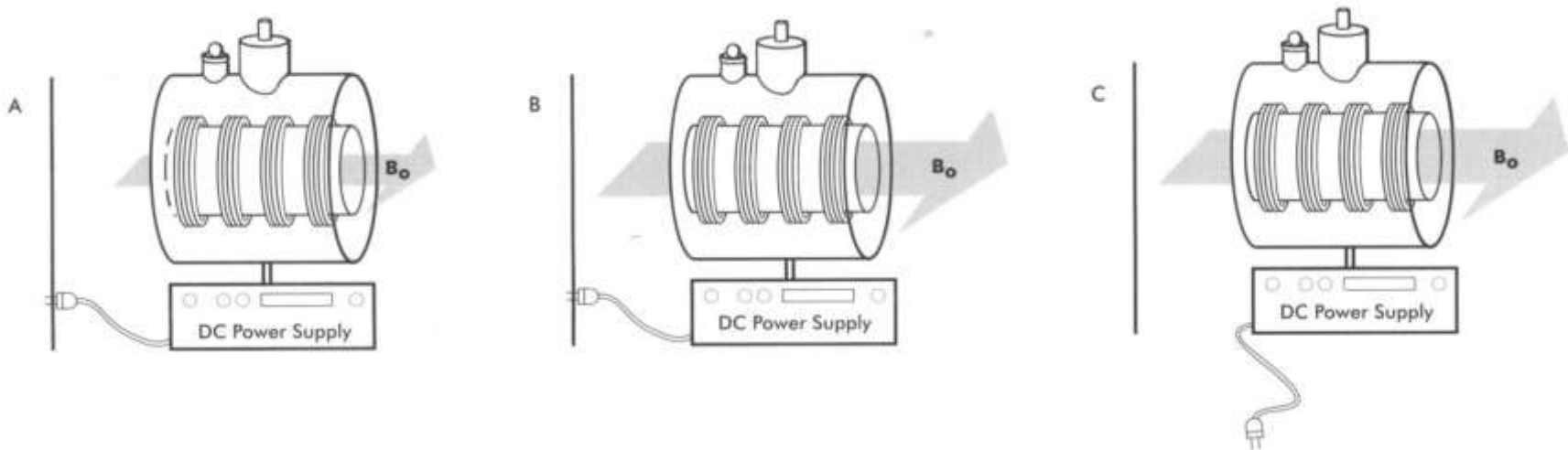
Table 11-3

Characteristics of a superconducting electromagnet magnetic resonance imager

Feature	Value
Magnetic field (B_0)	0.3 T to 4 T
Magnetic field homogeneity	1-10 ppm
Weight	10,000 kg
Cooling	Cryogenic
Power consumption	20 kW
Distance to 0.5 mT fringe field	10 m

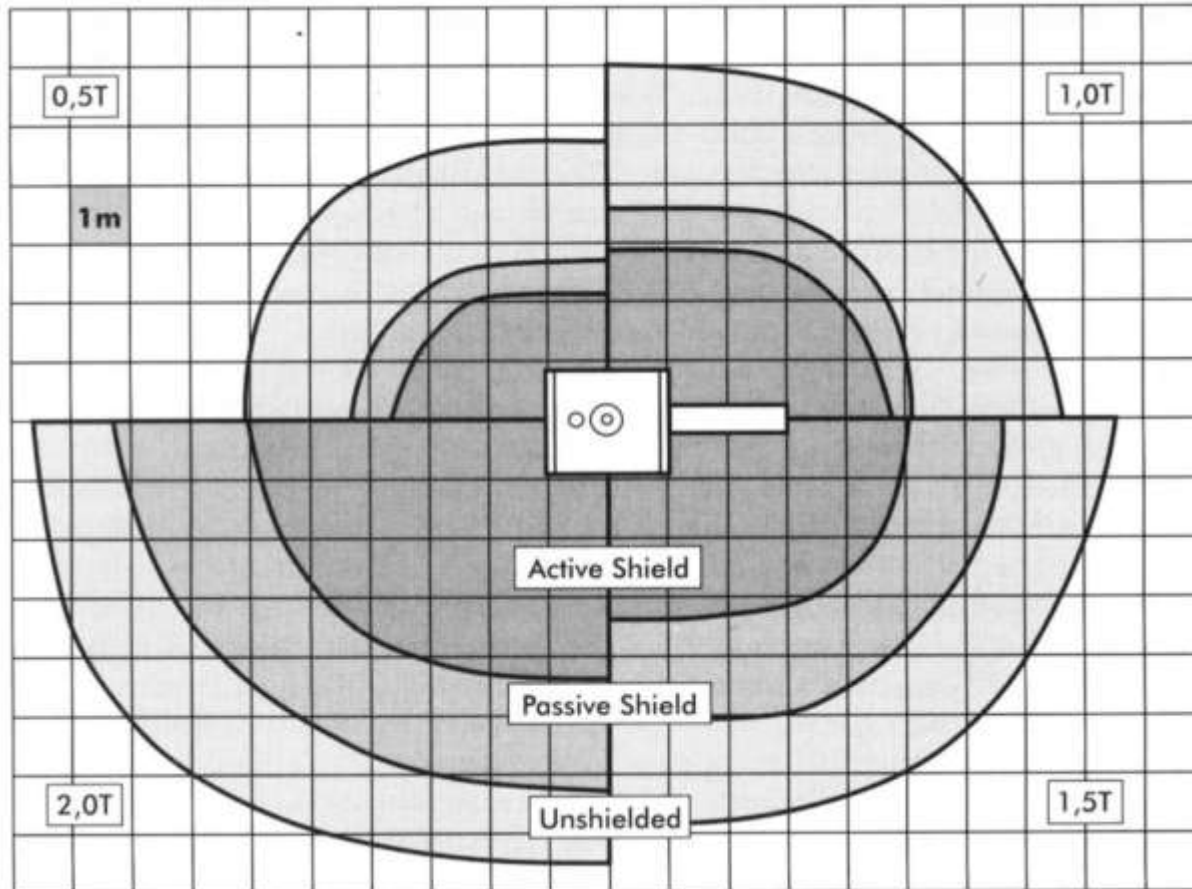
[Superconductive Magnet]

- Magnetic field ramp-up



- Ramp-down: catastrophic quenching

[Shielding]

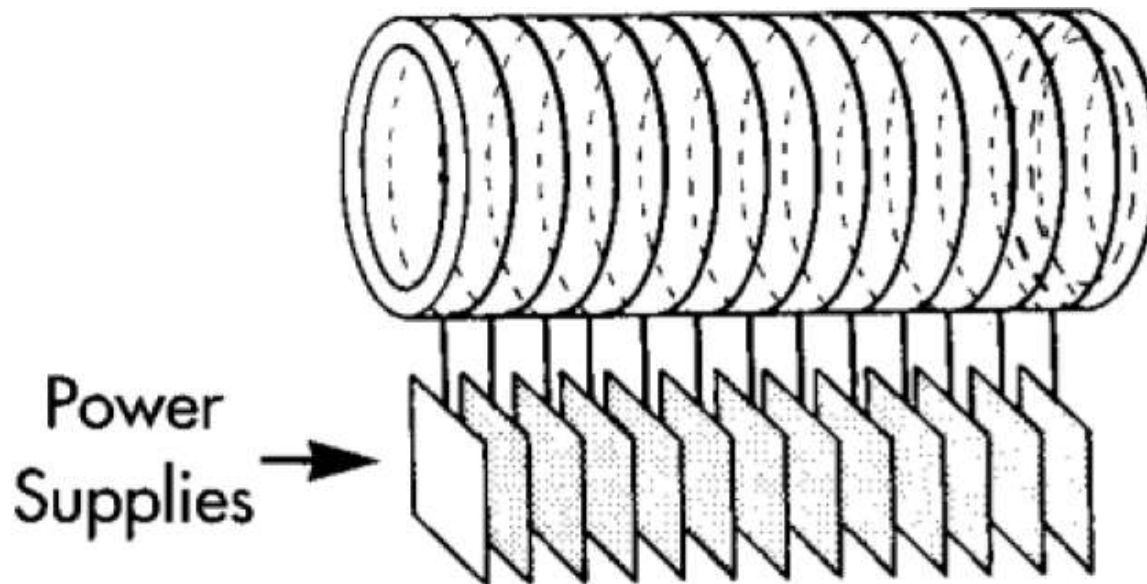


[Secondary Magnets: Coils]

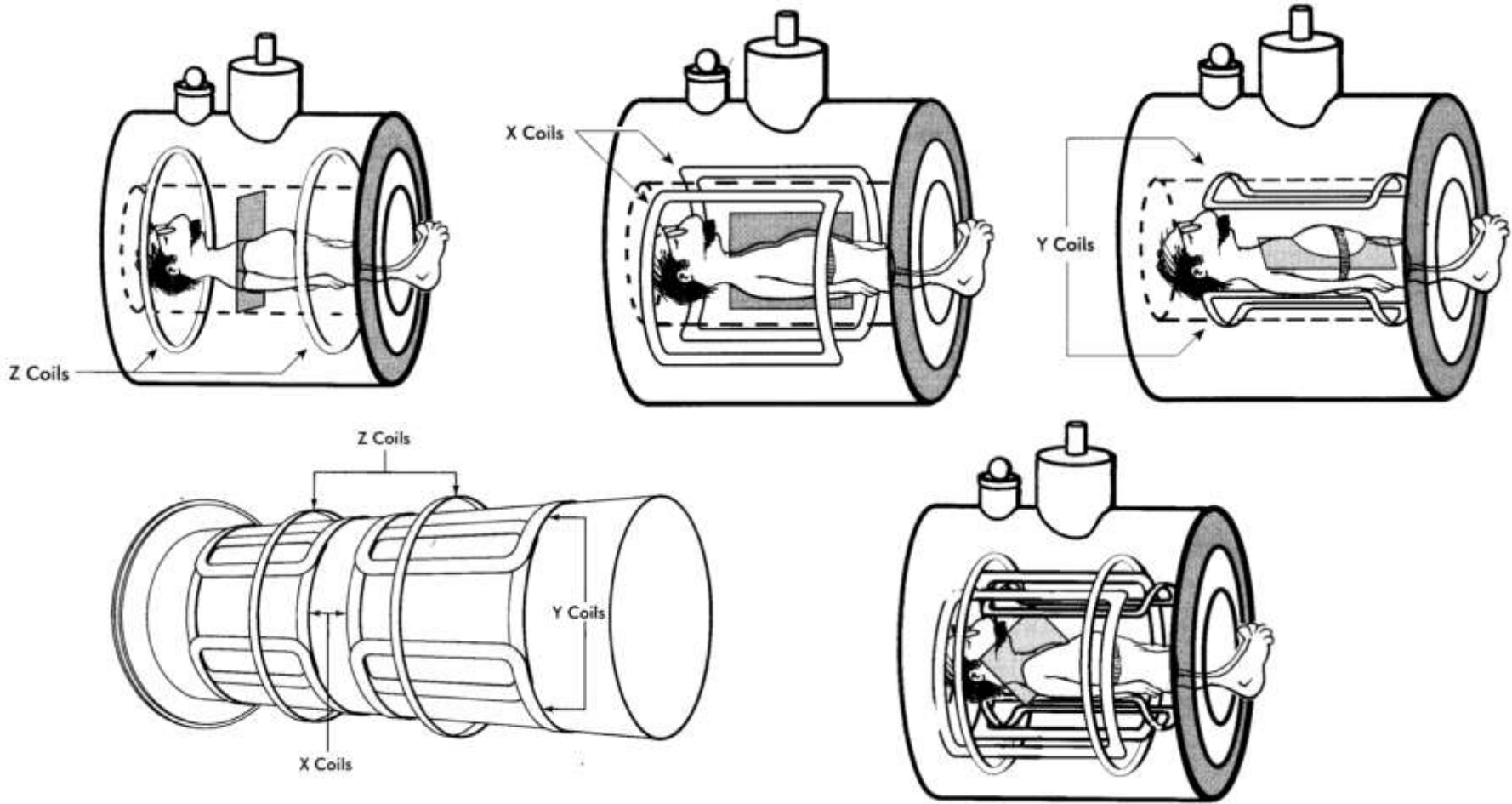
- Shim coils
 - ppm scale
- Gradient coils
- RF coils

[Shim coils]

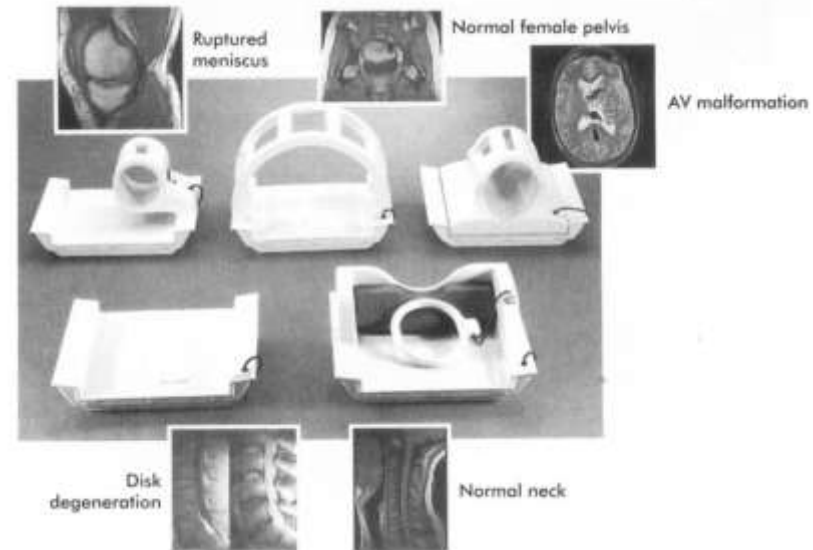
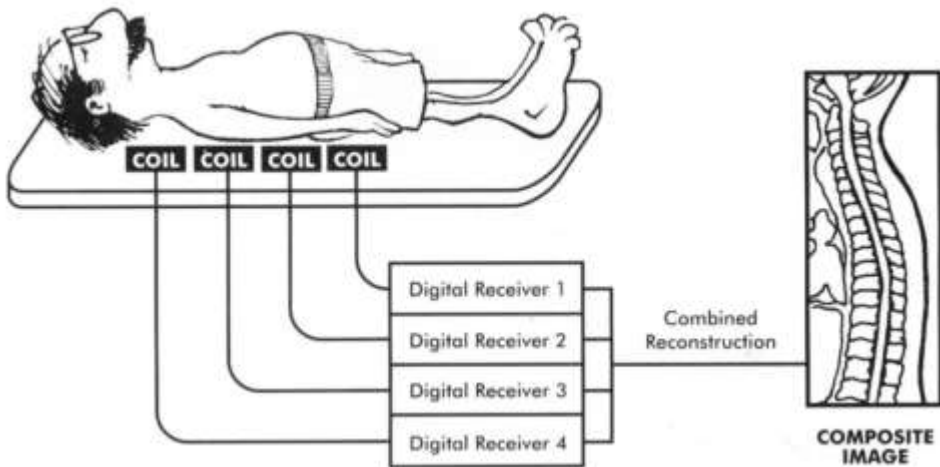
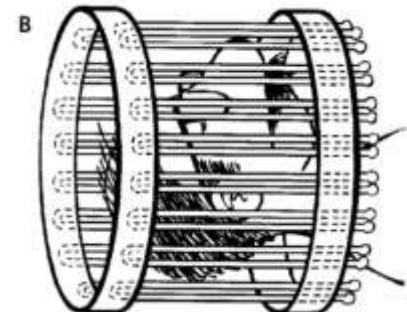
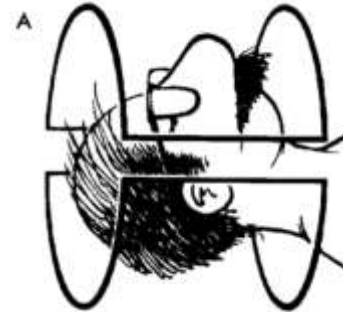
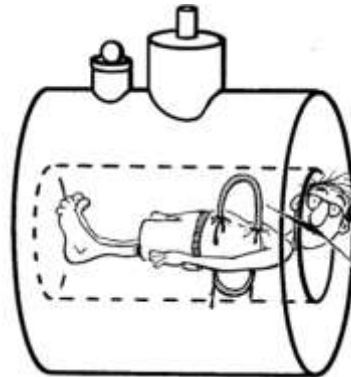
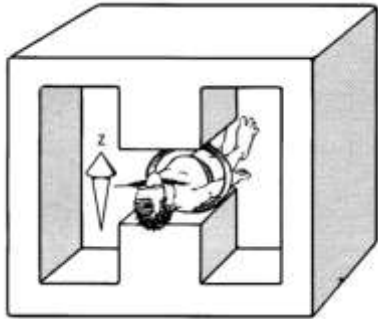
- Make small adjustments to make B_0 uniform throughout the volume
 - Inhomogeneity measured in ppm units



[Gradient coils]



[RF Coils]

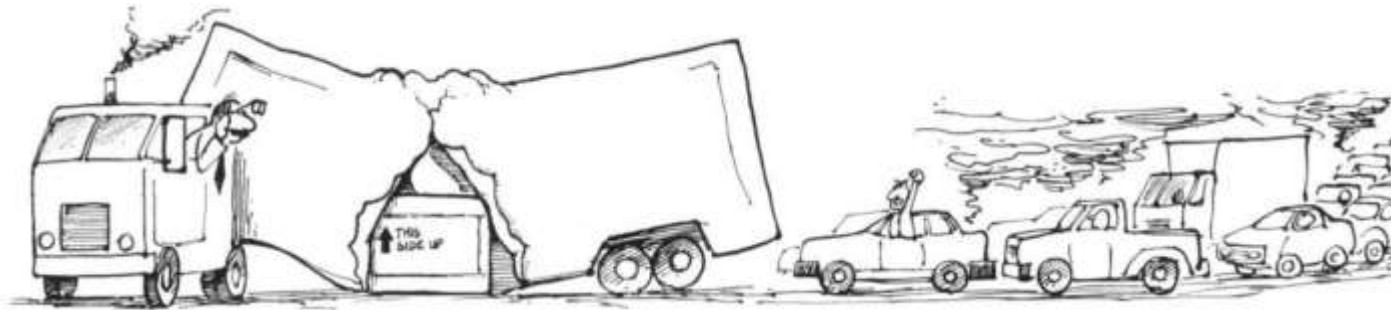


Choosing a Magnet Type

Table 13-1

Characteristics of magnetic resonance imagers

Characteristics	Permanent magnet	Resistive magnet	Superconducting magnet
Field strength (T)	0.1-0.3	0.15-0.4	0.5-4.0
Cost ($\$ \times 10^6$)	0.5-1.0	0.8-1.2	1.0-2.5
Approximate size (m)	1.5×2.0	2.1×2.3	2.3×3.0
Weight ($\text{kg} \times 1000$)	4.5-30	5.5-9.0	4.5-8.1
Power requirements (kW)	20	80	25
Distance to 0.5 mT fringe field (m)	<1	0.5-2	3-10



Choosing a Magnet Type

Table 13-2 Advantages and disadvantages of magnetic resonance imagers

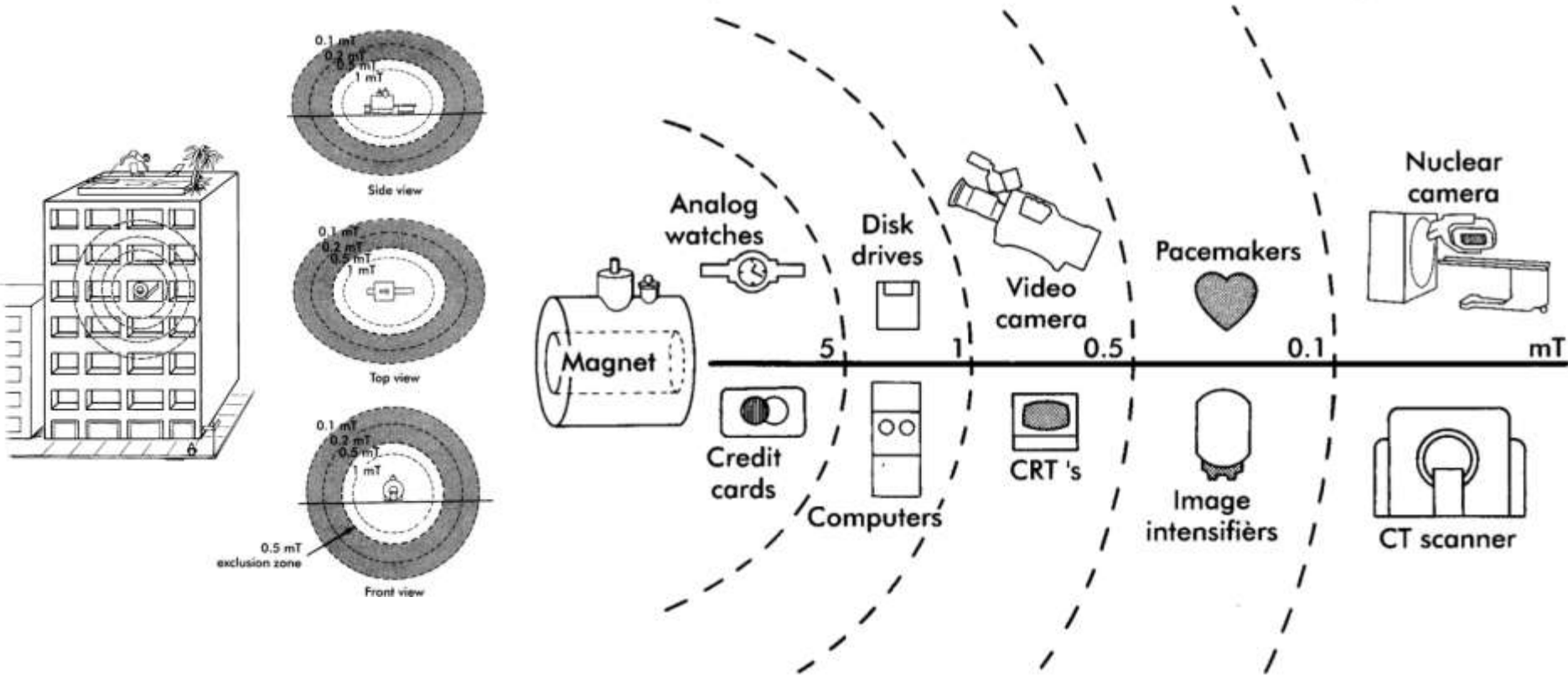
Advantages	Disadvantages
Permanent Low capital cost Low operating cost Negligible fringe field	Limited field strength Fixed field strength Very heavy
Resistive Iron Core Low capital cost Easy coil maintenance Negligible fringe field	High power consumption Water cooling necessary Potential field instability
Resistive air core Low capital cost Lightweight Easy coil maintenance	High power consumption Water cooling necessary Significant fringe field
Superconductive High field strength High field homogeneity Low power consumption	High capital cost High cryogen cost Intense fringe field

Choosing Location for MRI

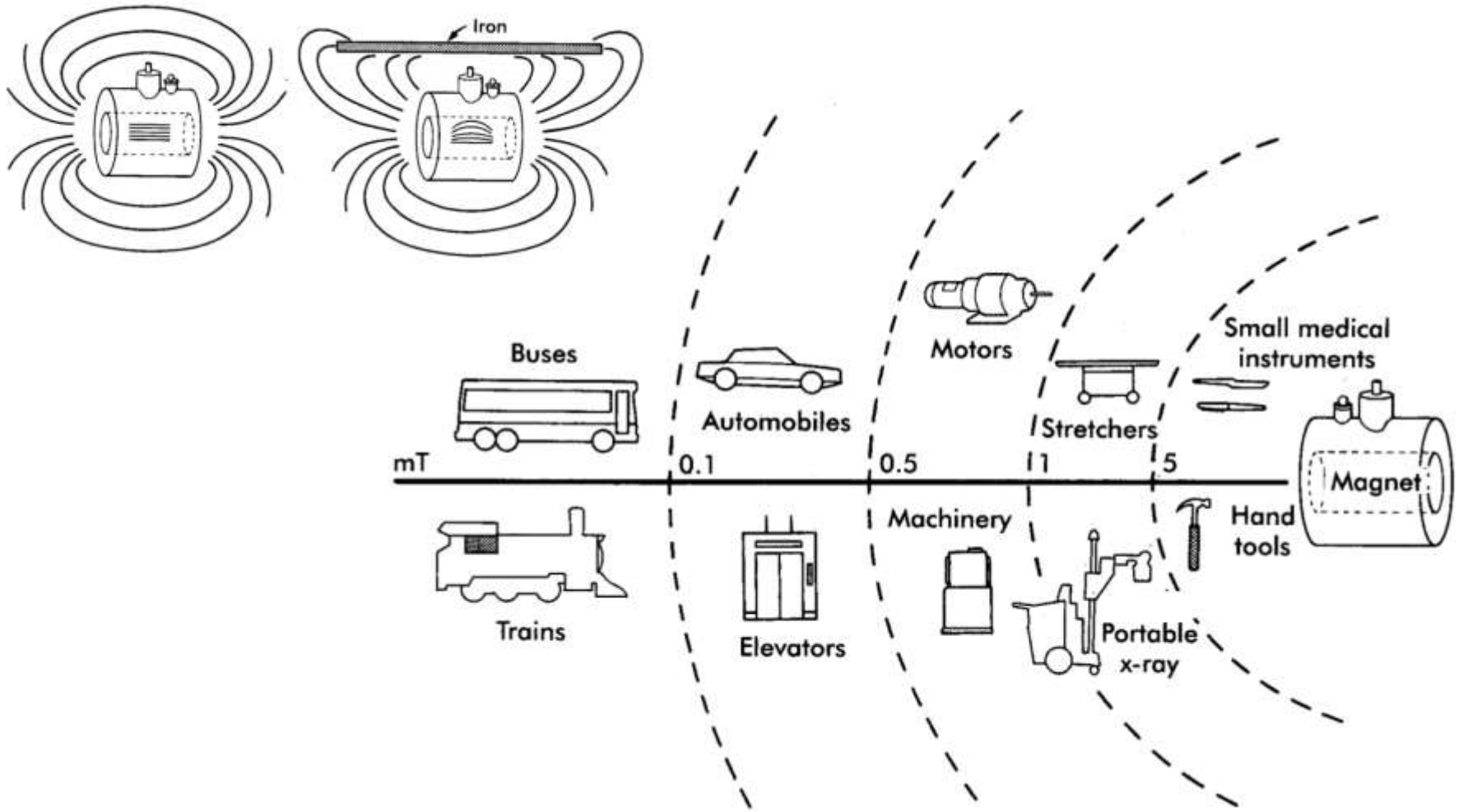
Table 13-3 Considerations for locating a magnetic resonance imager

Advantages	Disadvantages
New construction Easier to plan for fringe magnetic field Custom design	Cost Possibly remote
Existing building Proximity to other services Use of existing facilities	Accommodation of fringe magnetic field, higher renovation cost
Temporary building Short time to operation Easier to plan for fringe magnetic field	Possible compromised patient access Unightly addition
Mobile Cost effective for low workload Learning period for all	Scheduling Time required for setup

Effect of MRI on Environment



[Effect of Environment on MRI]



[Problem Assignments]

- No assignments for this part.