

# **MR REGISTRY REVIEW**

**Additional Material  
useful to get you  
ready for the  
MR Registry.**

**Good Luck!**  
*Gregory*

# Useful Formulas

## Larmor Equation

$$\omega_0 = \gamma B_0$$

$$\omega_0 = B_0 \gamma$$

## Scan Time for 2DFT imaging

Scan time = TR(msec) x Npe x Nex / 60,000(msec)

Npe: Number of phase steps

Nex: Number of acquisitions, Naq, NEX, Nacq

Scan time in minutes

## Scan Time for 3DFT imaging

Scan time = TR(msec) x Npe x Nex x Nslices / 60,000(msec)

Nslices: Number of slices

Scan time in minutes

## Scan Time for Fast Imaging

Scan time = TR(msec) x Npe x Nex / ETL / 60,000(msec)

FOV = Matrix x Resolution (Pixel)

FOV / Matrix = Resolution

Inphase / Out of Phase TE

1.  $3.5\text{ppm} \times \text{the imaging system's operating frequency} = \text{separating frequency (hz)}$
2.  $1 / \text{separating frequency} \times 1000 = \text{inphase TE(msec)}$
3.  $\text{Inphase TE} / 2 \pm \text{inphase TE} = \text{out of phase TE(msec)}$

## HISTORY OF MAGNETIC RESONANCE IMAGING

MRI, uses strong magnetic fields and radio waves to produce three dimensional images and has only been clinically used for ten years. However, it has enhanced the diagnostic ability of imaging procedures in ways no other imaging modality has had the sophistication to accomplish.

Traditionally, diagnostic imaging procedures used to evaluate the body's inner most mysteries have relied on the use of radiographic procedures. These procedures include traditional radiography, fluoroscopy, computed tomography, nuclear medicine and ultrasound. With the exception of ultrasonography, these imaging procedures are known to be biologically hazardous. The development of magnetic resonance imaging has propelled the imaging field into realms of visualization not previously encountered. In addition, there are no known biologic hazards associated with MRI.

<b>Technique</b>	<b>Method</b>	<b>Advantage</b>	<b>Disadvantage</b>
X-ray	penetrates visually opaque objects	fast, cost effective	x-radiation, more specific to bony abnormality
CT	computer reconstructed detail of tissue density	fast, 3D cross-sectional	x-radiation, limited tissue characterization, single slice imaging
Nuclear Medicine	functional distribution of isotope within a target organ	fast, efficient, quantitative detail,	no structural gamma radiation
Ultrasound	measures the time delay between an ultrasonic pulse and the reflection of it's echo from a discontinuous surface	no ionizing radiation	only soft tissue seen
MRI	soft tissue characterization using strong external magnetic fields and radio waves	non ionizing, non invasive, volumetric imaging, excellentRF soft tissue characterization	long scan times, power deposition, claustrophobia, certain implant contraindications

The first MR experiments were reported by **Felix Bloch** in 1945 at Stanford University and independently by **Edward Purcell** and his group at Harvard University. The 1952 Nobel Prize in Physics was subsequently awarded to these researchers who became known as the "Fathers of Spectroscopy". Spectroscopy is the science that deals with the absorption or emission of energy from matter. It uses magnetic fields and radio waves as the source of the experiment. A number of laboratories around the world began using excised tissue samples and perfused tissues for MR spectroscopic studies in the late 1960's and early 1970's. In vitro spectroscopy was accomplished for two decades before **Jasper Jackson** produced what is believed to be the first MR signal from a live animal in 1969.

In 1971, the application of NMR to clinical medicine was tested by **Raymond Damadian** who would observe pathologic tissue changes in a mouse tumor. Then, in 1972, **Paul Lauterbur**, produced the first 2D MR image of a water sample using special imaging algorithms he developed. Lauterbur and Damadian would later be known as the "Fathers of MR Imaging".

In 1973, **Leon Kaufman**, working in conjunction with the University of California, San Francisco, and the state of California was issued a grant to develop a superconductive imager. The first image of a biologic specimen was obtained in 1974 at the University of Aberdeen, Scotland, and demonstrated pathology in a mouse. Successful images of the abdomen and brain followed in the late seventies and early eighties.

Today, MRI imaging procedures are performed in virtually every anatomic region of the body. In addition to traditional imaging procedures, MRI is being used as a functional imaging technique to investigate regions of the brain associated with various motor and sensory functions. MRI is also being tested as an imaging modality to use in localization procedures such as breast tumor biopsy.

As the sophistication of this imaging technique improves, so will its ability to diagnose disease processes as they are occurring.

# Magnetic Resonance Imaging

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## Suggested Reading

Berlex Laboratories. MRI made easy (...well almost).

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