

Lesson 2: Magnetic Marvels

Exploring inside the MRI



Image from: pexels.com/maxmishin



MRI Marvels

Your Journey into Biomedical Engineering

Review

L1: Magnetic Resonance Imaging

- MRI's strong magnetic fields align hydrogen nuclei, and radiofrequency pulses disrupt this alignment, starting the imaging process.
- The relaxation of nuclei emits signals and creates images that aid physicians in diagnosing various conditions.
- The future of MRI is bright, with prospects for faster imaging, higher resolution, and even portable machines that could extend healthcare reach.

Inventor Spotlight

Dr. Raymond Vahan Damadian was an Armenian-American physician and inventor who is known by many as “The Father of MRI”

What Did He Do?

- Dr. Damadian discovered that different parts of our body, like muscles and tumors, "relax" at different speeds. This discovery is one of the main ideas that makes MRI work.
- He built the first full-body MRI scanner, known as "Indomitable," in 1977



Raymond Vahan Damadian

Lesson Objective

In this lesson we will delve deeper into the components and applications of MRI.

By the end of this lesson you will:

- Learn about the components that make up an MRI machine
- Learn about the principles of MRI safety



What's Inside an MRI machine?

An MRI machine is made up of several elements that all work together to capture images inside your body:

Magnet

Gradient Coils

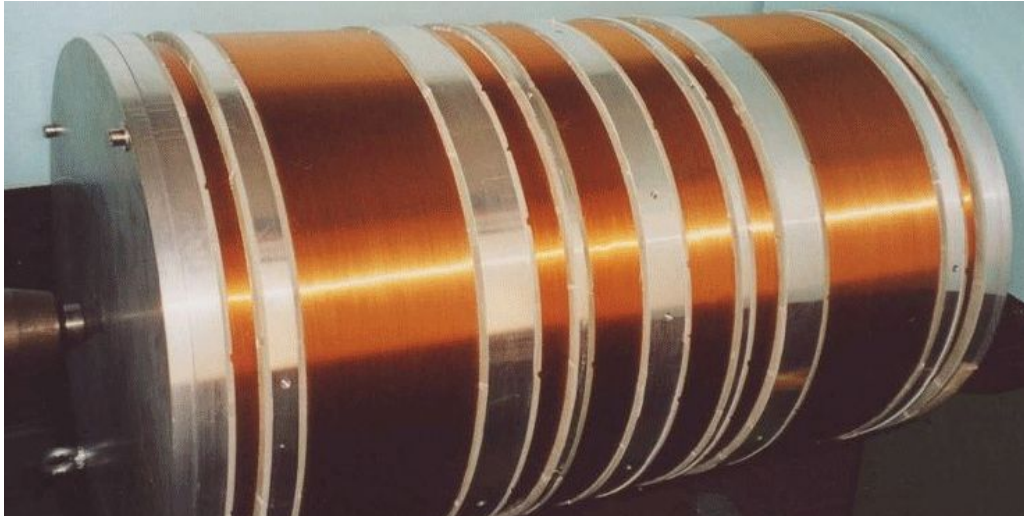
**Radiofrequency
Coils**

**Computer
Software**



Main Magnet

The largest part of an MRI machine is a **large superconducting** magnet that **creates a strong and unified magnetic field** that aligns the atomic nuclei within the body.



Interesting Fact!

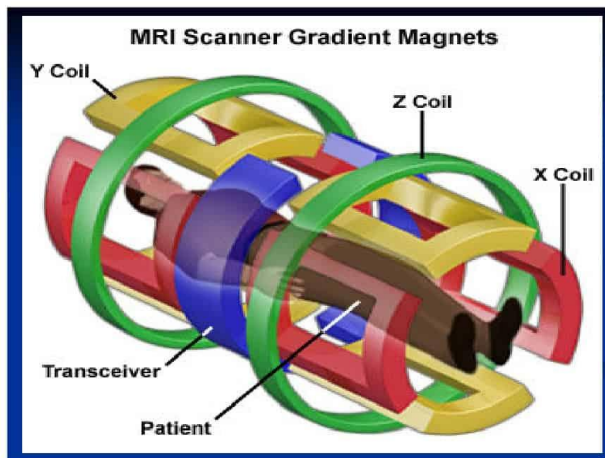
MRI machines use superconducting magnets that can be thousands of times stronger than the Earth's magnetic field (0.00005T).

MRI magnets can be as strong as **3T** making them **60,000** times more powerful than Earth's magnetic field!



Gradient Coils

These coils help create detailed images by varying the magnetic field. They help to spatially encode signals from the body by varying field at specific regions.

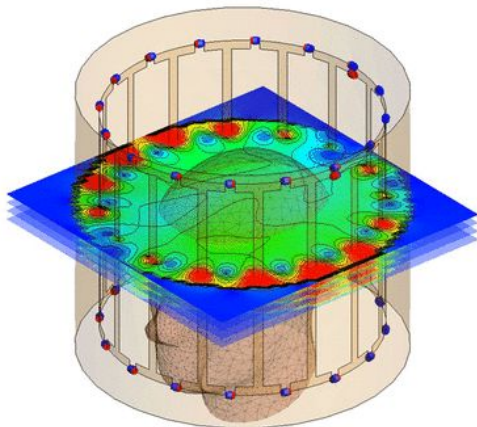
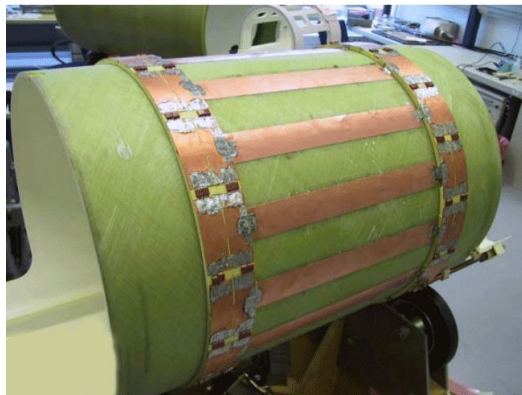


Compare to a Camera 📷

Think of these coils like the zoom and focus features on a camera. The gradient coils make adjustments to the magnetic field which allow the MRI to take precise image of the body.

Radiofrequency (RF) Coils

In an MRI machine, these RF coils send radio waves to the hydrogen atoms in your body and then listen for the echoes that come back. They use these echoes to construct images of the inside of your body.



Think about data in waves 📡

In our daily life we use devices that construct data from waves. This is very similar to how RF coils send radio waves that help create images. Can you think of any devices that do this?

Examples:

- Cell Phones
- Radios

Computer and Software

After capturing the data sophisticated computers and specialized software processes and reconstruct MRI data into detailed image. This highlights the role of advanced computing in producing the high-quality MRI images we see today.



Where have you interacted with computer generated images??

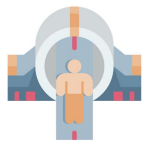
These computers in MRI machines are like the graphic programs that create stunning video games or animated movies.

What Is MRI Safety

MRI safety is an important part of the overall medical imaging process. It ensures the **well-being** of both **patients and doctors** and helps with the accuracy of the image. Remember we're working with a **very strong magnet!**



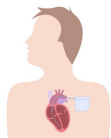
Principles of MRI Safety



No skin contact with the scanner or skin-to-skin contact. The strong magnetic field can cause heating which could lead to **burns or discomfort**



Remove all **metal objects** including jewelry and keys



Check if the patient has any implants or medical devices. As these can be **metallic** and disrupted by the magnet



Check if the patient is **claustrophobic**. The MRI scanner is a tight space and we want to ensure the patient is not anxious



Provide **ear protection** as the MRI machine can be very loud



Remember the magnet is **always on!** Be very careful around the MRI machine as the large magnetic field is on even when the machine is not scanning

Lesson Summary

MRI is a powerful tool that helps doctors see into your body to diagnose various conditions. This tool is made up of several components: magnet, gradient coils, RF coils, and software.

In **this lesson** you learned about each component of the MRI machine and the important safety principles to follow when working with MRIs.

In the **next lesson** you will learn more about the how an MRI is used to diagnose various conditions.



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