

Siemens Magnet Technology Ltd

Company Profile

November 2007



Siemens Magnet Technology, part of the Siemens Group, is a world leader in the design and manufacture of superconducting magnets for MRI body scanners and has achieved significant export growth and technological advancement. Since its introduction in the early 1980's, MRI (Magnetic Resonance Imaging) has quickly become accepted as the leading diagnostic imaging modality in healthcare. Siemens Magnet Technology has contributed to this through its position as a world-leading manufacturer with proven capability to incorporate high quality aspects of volume production into novel high-field superconducting magnet designs for MRI. More than a third of all MRI scanners installed in hospitals around the world have at their heart a superconducting magnet designed and manufactured by Siemens Magnet Technology.



At Siemens Magnet Technology, we take enormous pride in developing truly innovative technology to produce superconducting magnet solutions of exceptional quality. It is our commitment to continuously improve our performance and products that makes us special. Individually and as a team we recognise the vital contribution we make in creating medical equipment that transforms healthcare and the lives of people everywhere.

What is Magnetic Resonance Imaging?

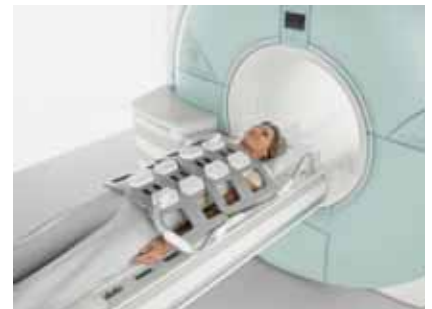
MRI has become the imaging modality preferred by clinicians and patients alike. Utilising strong magnetic fields and weak radio waves, it can produce extraordinarily clear images of the internal organs of the body.

MRI enables the safe visualisation of soft tissue at any point in the body. Its application in both routine diagnosis and in research is extensive, but principal uses include:

- ∞ Diagnosis of tumours, including those in the brain and pituitary gland
- ∞ Diagnosis of multiple sclerosis
- ∞ Diagnosis of infections in the brain, spine and joints.
- ∞ Imaging of damaged ligaments in the wrist, knee and ankle, and of shoulder injuries.
- ∞ Diagnosing tendonitis.
- ∞ Evaluating masses in soft tissue.
- ∞ Evaluating spinal bone tumours, cysts or herniated discs.
- ∞ Diagnosing strokes, even at their earliest stages.
- ∞ Studies of the vascular system.
- ∞ Exploring brain function disorders.

MRI is a non-invasive, painless procedure that can eliminate the need for explorative surgery. It carries no risk of prolonged exposure to the ionising radiation that is inherent in procedures, such as CT, which are based on X-rays.

The patient is moved into the scanner on a couch that carries the low power Radio Frequency (RF) coils wrapped around the parts to be imaged. For most people, there is no sensation of the RF or of the powerful magnetic field in the scanner bore. They hear the pulsing of image-localising gradient magnetic fields superimposed on the main field during the scan, which takes anything from a few minutes to an hour or more, during which time they can talk to the radiographer in charge of the MRI procedure.

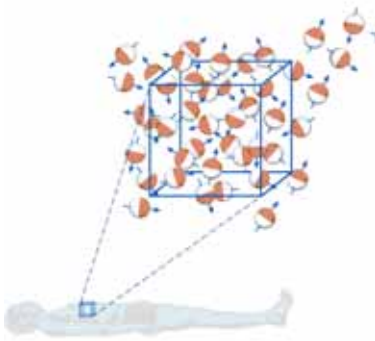


How does MRI work?



There are around a trillion, trillion, trillion water molecules in the human body, where one trillion equal a million million. Each molecule of water (H_2O) includes two hydrogen atoms, the nucleus of each of which is a single spinning proton that behaves like a tiny magnet that align with an applied magnetic field, just as a compass points in the direction of the earth's magnetic field. The alignment is not complete, however, and the axis of proton or nuclear spin wobbles or precesses about the magnetic field direction, rather like a spinning top or gyroscope does in the earth's gravitational field. The precession rate is dependent on the magnetic field strength; for every one Tesla, the protons in the hydrogen atoms of the water molecules in our living tissue precess at precisely 42.6 million times per second - ie, at 42.6MHz.

When radio waves in the form of pulses of electromagnetic transmission coil close to the frequency as the precession the RF energy is absorbed by precession dynamics. This is the RF pulses switch off, the state, re-emitting RF energy at which is picked up by a radio computer analysed. The differs between normal and detection of abnormal tissue energy emitted by each resonant nucleus is miniscule, but there are so many nuclei involved that a viable signal is produced.



low power Radio Frequency energy are shone from a body, and at exactly the same rate of those protons, some of the protons, altering their known as *resonance*. When protons recover to their initial that same resonant frequency, reception antenna and duration of the recovery period abnormal tissue, permitting the such as tumours. The RF

By superimposing a second precisely controlled but much weaker variable magnetic field - the gradient field - on to the strong field generated by the MRI magnet, the region of the body which is at the correct magnetic field for resonance can be focused into a layer or slice as thin as a few millimetres. As the gradient field slides through the body, so a stack of these slices can be imaged to complete the scan along one of the main x, y, z axes. A full three axis scan of the head, for example, can be completed in a few minutes with a high field MRI scanner. The detail is provided by the variation in density of the water molecules in the different tissues, and by the variation in recovery period for different tissues, and can be clearer than a slice of tissue prepared as a microscope slide, but without the surgical procedure.

Why is the magnet so important?

The Key Role of the Magnet in MRI

To achieve the fast & incredibly high quality images now taken for granted from MRI the magnet must have several key characteristics.

For an image to be performed fast (minutes rather than hours), very high magnetic fields are needed to increase the data acquisition rate. A typical MRI magnet will deliver a steady field of 1.5T, 15,000 times stronger than the Earth's 0.5G magnetic field, over a volume large enough to take a human being.

For a high quality image, the magnetic field must not vary over the patient volume by more than a few parts per million. In effect, this means that over a 50cm diameter sphere, the magnetic field in a 1.5T magnet must be controlled to within about 0.05 gauss - one tenth of the Earth's field!

For a patient friendly scanner, it needs to be as open as possible. SMT has continually reduced the length of its products, while at the same time improving system performance and reducing cost. For example, the 1.5T product has reduced in length from 2.3m in the 1980s to 1.2m today

For a hospital friendly scanner the stray field has to be tightly controlled. In 1986 SMT introduced the Active Shield technology allowing self-shielding of the magnet itself allowing MRI systems to be installed at sites previously thought impossible. This SMT innovation has become the industry standard.

Superconducting Magnet Technology for MRI



A conventional 1.5T electromagnet suitable for MRI; with electric current passing through copper wires would consume megawatts of electrical power subsequently wasted in a water-cooling circuit. The cooled electrical windings alone would occupy a very large room, while operating costs and maintenance would be prohibitive. The development at SMT of superconducting magnets for MRI has dramatically relieved this situation. When superconducting wires are immersed in liquid helium at -269° Celsius (or 4.2K), they offer no resistance to the flow of electric current. This reduces the power requirement enormously, albeit at the expense of sourcing liquid helium, but makes MR imaging at high fields economically viable.

A 4.0T AS magnet used in MRI research has 170km (105 miles) of superconducting wire wound on large aluminium formers machined to micron precision. The windings must resist movement when subjected to the operational electromagnetic forces of 1,100 tonnes and stored energy of 26MJ, while generating the highest field precision possible. The coils are welded inside a cryostat containing up to 3,200 litres of liquid helium to keep them superconducting and minimise the helium evaporation rate. This maximises the time between refills and minimises running costs. Once energised, and the power supply removed, the magnet persists at field, with no further external source of electricity. So long as there is no interruption to the conditions required for superconductivity, the field could persist for years before requiring a current top-up.

Since the introduction of superconducting magnets, SMT has heavily invested in research and development, in a continuous drive to improve performance and reduce cost, enabling the design of shorter more patient-friendly and affordable MRI systems. SMT is the undisputed world leader in the development and volume manufacture of these superconducting magnets for MRI, combining expertise in magnetism, cryogenics, vacuum techniques, mechanical engineering, and electronics in a range of products that can truly benefit every one of us.

SMT as Market Leader - Heritage, Experience and Innovation

In 1959, Martin Wood, then a Senior Research Officer at the Physics Faculty of Oxford University, started a small business with his wife Audrey, initially working from their garden shed. Their objective, sanctioned and supported by the University, was to design, manufacture and supply equipment for generating high magnetic fields for a small number of researchers who were to make major contributions to the way we live today.

The company they founded was Oxford Instruments, a global leader in advanced instrumentation for scientific research, industrial chemical analysis and quality control, semiconductor processing, and healthcare.

Oxford Instruments produced the world's first superconducting magnet in 1961 and, by the 1970s, the company was pioneering Magnetic Resonance Imaging. It created the first resistive full body magnet in 1979, and the following year it introduced the world's first superconducting full body MRI magnet.

Such was the pace of development required by the medical industry, that in 1982 Oxford Instruments formed a subsidiary company, Oxford Magnet Technology Ltd, located on the Oxford Instruments site. At this time OMT were producing fewer than 50 magnets per year. Two years later, in 1984, a purpose built factory was established on the current site in Eynsham, designed with a production capacity of 300 magnet systems per year. In Sept. 1989 Siemens acquired 51% of Oxford Magnet Technology in a joint venture with Oxford Instruments. In November 2003 the business was fully acquired by Siemens and in June 2004 the company name changed to Siemens Magnet Technology Ltd. As the world-wide demand for MRI systems has grown rapidly since the early 1980's so has the company and today, following two further factory expansions, the manufacturing capacity is heading towards 1500 units per year.



SMT works in partnership with the world's leading MRI system manufacturers, and supplies 40% of the magnets for this purpose. There are currently over 10,000 SMT MRI magnets in use in over 100 countries. The company now produces over one thousand magnets year, worth over £150 million per year.

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SMT employs 570 people at its 200,000 sq ft production facility in Oxfordshire, UK, 65 of whom are dedicated to research and development. Thorough partnerships with Siemens Regional Units and Oxford Instruments, SMT maintain Service support offices in Europe, USA, Japan and China. Throughout its history the company has focused on technological excellence. The business has won six Queen's Awards in recognition of its high-tech achievements and export success - 95% of the magnets produced here go overseas - and contribution to the development of MRI technology. Some of the notable highlights include:

- 1980 The world's first superconducting whole body MRI magnet developed.
- 1982 SMT formed as a subsidiary to concentrate on MRI magnet and technology development.
- 1984 Dedicated factory opened at Eynsham, Oxfordshire (UK).
- 1986 The world's first Active Shielded magnet.
- 1989 Joint Venture with Siemens Medical.
- 1989 The world's first 1.5T Active Shielded magnet
- 1994 The world's first Open MRI magnet
- 1997 New generation compact MRI magnets introduced
- 1997 The world's first 3T Active Shielded magnet
- 2000 The world's first 4T Active shield magnet
- 2000 The world's shortest 1.5T MRI magnet
- 2003 Siemens acquired the remaining 49% of SMT from Oxford Instruments, making SMT a wholly owned subsidiary of Siemens plc.
- 2004 Factory extended to increase production capacity to 1,500 magnets per year 2004 - The world's first 1.5T Open-bore magnet.