How a Bell Pepper Convinced the Siemens Med Board

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"The best way to predict the future is to invent it."

Theodore Edward Hook, 1825

In 1983, the first Siemens MRI system bearing the MAGNETOM name was installed at the Mallinckrodt Institute of Radiology, in St. Louis, Missouri, USA. Ever since those early days, the name MAGNETOM has been associated with technological innovation and advances, such as the first wide bore 70-cm MRI system, new coil concepts like Tim and Tim4G ("from local to total") and, most recently, with the innovations of the BioMatrix platform. This allows the operator to adapt scanning to patient individuality via special sensors and interfaces and, thanks to the most modern acceleration techniques, also makes MRI faster and more patient friendly, for example with free breathing examinations.

This is the first part in a series of articles that take a retrospective view to see how we got to MRI of today.

Without doubt, Magnetic Resonance Imaging, or MRI for short, is the most flexible of all imaging methods and the diagnostic modality of choice for many clinical indications. Siemens Healthineers is the global leader in this technology. However, in the beginning MRI at Siemens was not mainly driven by market analysis or scientific progress.

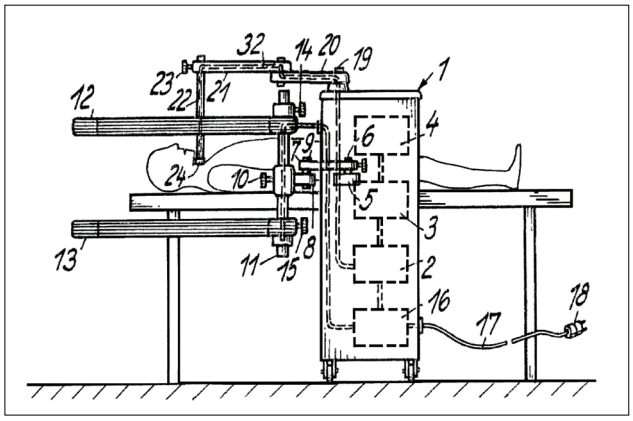
In 1973, the British recording company EMI presented a completely new X-ray device at the RSNA Annual Meeting: the first computer tomograph. For established X-ray manufacturers like Siemens Medical and most of its competitors, there did not seem to be much future in such a development. Spatial resolution was of outmost importance, while few realized the benefit of significantly improved soft tissue contrast. Therefore, a tiny focal spot and a high-resolution image amplifier seemed to be what the market craved for.

When in 1976 the London Evening Standard published the headline "EMI on brink of a super scanner" in its June 11 edition, readers learned that the company was working on another revolutionary scanner, this time based on high-frequency radio waves, alarm bells started ringing: This time Siemens was not going to miss this trend.

Siemens, in fact, had its very own dedicated researcher, Dr. Alexander Ganssen, who had been investigating the possibilities of electromagnetic waves below the X-ray frequency spectrum for some time. Yet, there was little interest in Dr. Ganssens's proposals (Fig. 1) for the medical application of NMR (nuclear magnetic resonance) to determine blood flow, cystic fibrosis, and blood viscosity.

However, the article in the Evening Standard provided reason enough to visit Paul Lauterbur, a later recipient of the Nobel Prize, in the U.S. and Dr. Mansfield in England, on a fact-finding mission about advances in this field.

As a result, it was proposed that Siemens start its own work. In the fall of 1977, high-level preliminary discussions took place between Dr. Schittenhelm, Dr. Ganssen,



1 Dr. Ganssen's diagnostic equipment for determining the distribution of substances using nuclear magnetic resonance.

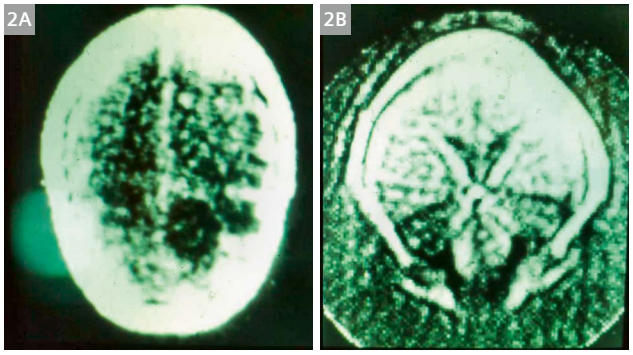
Mr. Kuckuck, Mr. Schmidt (Siemens), Dr. Mansfield (University of Nottingham, UK), Dr. Maudsley (Zürich University, Switzerland), and Dr. Oppelt (Technical University Darmstadt, Germany). This marked the beginning of the Siemens project.

The managing board now also approved the proposal. Dr. Mansfield was hired as a consultant, and Andrew Maudsley, who as part of his dissertation under Mansfield had been the first person to scan a human finger in vivo using NMR, and Arnulf Oppelt, one of the authors of this article, joined Siemens on February 1, 1978.

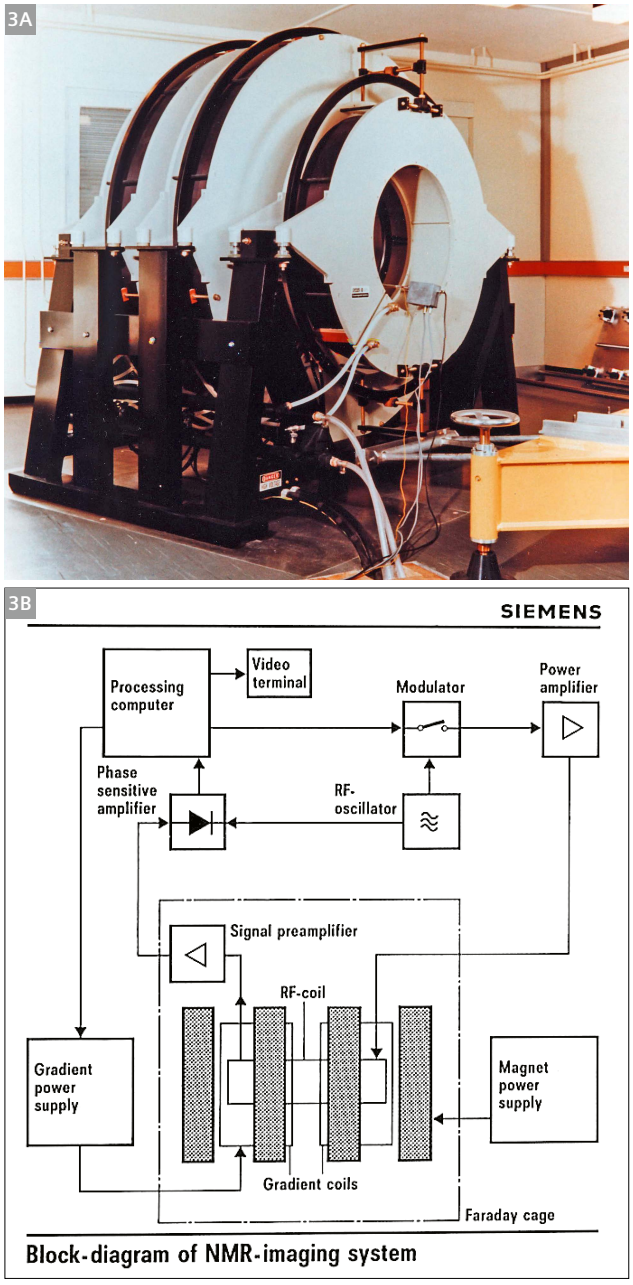
Development costs of some two million German Mark (DM) were approved, the head of the X-ray development department, Professor Gudden, was able assert himself amid strong protests from the X-ray CT sales department who would have liked to see that money used to further CT development. However, an image of a head presented by EMI at the RSNA in 1978 (Fig. 2) was too powerful an argument.

Specifications were drawn up for a trial scanner and an air-core whole-body magnet was ordered from Oxford Instruments (OI) in England. The gradient coils and power supply were developed at the Siemens research laboratories, RF and control electronics as well as the software were tasked to Siemens Med. A number of components were already available from Dr. Ganssen's preliminary work, such as a Magnion iron core experimental magnet, a frequency synthesizer, a 10 W RF power amplifier. A state-of-the-art PDP 11 minicomputer was available from the CT group. These components were combined to form a small imaging test set-up to develop and test the software for the planned large scanner. In particular, an experimental device for "spectroscopic imaging" was developed in order to allow fast measurements of the magnetic field homogeneity. This was published in 1979 in the Siemens Research and Development Reports [1]. At the end of 1978, the resistive whole-body magnet with a field strength of 0.1 Tesla was delivered (Fig. 3) and installed in the research system on the grounds of the Siemens research center housed in a purpose-built wooden hut, which contained no ferromagnetic parts, not even iron nails (Figs. 4 and 5).

By this time, Andrew Maudsley had again left Siemens to head an even more ambitious MRI project in the U.S. using superconducting magnets. He was succeeded by Dr. Wilfried Loeffler from CT development, the other author of this article. 1979 was spent eliminating faults in the software and hardware. It took rather a long time before we realized that the radio-frequency interference that caused us such a headache was entering via the magnet



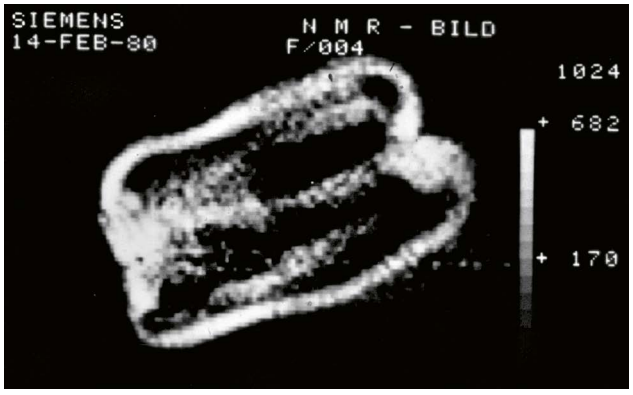
2 Comparison of an early CT image and an image of the head made with a new "radio wave scanner" at the EMI booth at RSNA 1978.



3 (3A) 0.1T whole-body magnet manufactured by Oxford Instruments for Siemens in 1978. (3B) Block diagram of an NMR imaging system.

4 First MRI measuring system at Siemens 1978.

5 RF Faraday cage built around the 0.1T magnet.



6 First Siemens MRI image of a bell pepper, 1979.

power supply cables. Although an RF filter for a current of 80 A was a product available from Siemens, the delivery time was three months. Time was running out. The business and budget negotiations for the coming year were about to begin and we were told in no uncertain terms that immediate proof of the functioning of the system in the form an image was the precondition for continuing the project. Luckily, this hard ultimatum did not shock us into forgetting all our basic physics and we remembered that random signal disturbances can be averaged out by repeated measurement. We would need an hour of measurement time to resolve this problem but the result proved worth waiting for.

We chose a green bell pepper as our measurement object, suitable because it would certainly keep still, contained water, was large enough to represent a human organ, and could be cut open to demonstrate the similarity between image and true anatomy of the object.

Since scanning took such a long time, we were not able to present the results to the managing board until the next day (Fig. 6).

Everyone involved was extremely happy with the image produced by the measurement. Little image noise, only one artifact. It took a few weeks before the cause of the artifact in image reconstruction was found. That is why the date of reconstruction that appears on the image is February 14, 1980, even though the object was scanned in November 1979.

A bell pepper had been instrumental in convincing the Siemens Med board of the potential of MRI. The decision to approve continuation of the project was a wise one, as history has shown.

Development moved fast, the first head images were presented at the annual meeting of the German Society of Neuroradiology in 1980 in Munich and at the German Röntgen congress in 1981 in Munich. Device developments were reported on in 1981 [2]. A year later, the business unit MR Tomography was established and product development started.

References

1 A.A. Maudsley, A. Oppelt, A. Ganssen Rapid Measurement of Magnetic Field Distributions Using Nuclear Magnetic Resonance Siemens Forsch. u. Entwickl. Ber. Vol. 8 (1979), No. 6, pp. 325–331.
2 A. Ganssen, W. Loeffler, A. Oppelt, F. Schmidt Kernspin-Tomographie Computertomographie 1, pp. 10–18 (1981).

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