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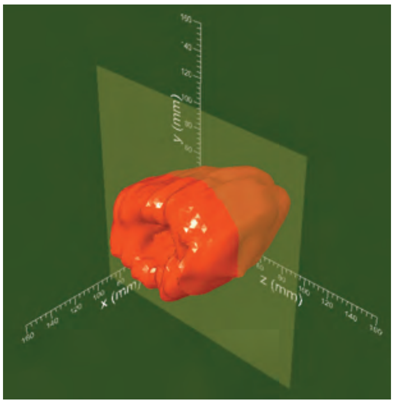
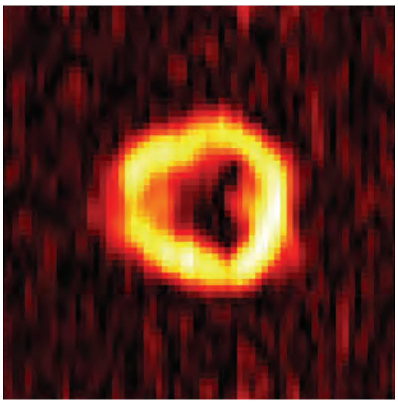
Hands-on learning of MRI & NMR principles

Terranova-MRI is the world's only teaching instrument that can do 2D and 3D magnetic resonance imaging.

Students start with simple experiments that demonstrate basic NMR principles and progress to MRI experiments that enable understanding of more complex ideas with a hands-on approach.





3D spin-echo MRI of a red pepper acquired using Terranova-MRI. A 2D slice of the image, taken along the plane indicated, is shown on the bottom right. The 3D image was acquired in 1.5 hours.

Designed for teaching and training of MRI & NMR

Terranova-MRI is ideal to
Give students hands-on NMR and MRI experience
Teach graduates advanced MRI principles
Demonstrate NMR and MRI in the classroom
Perform MRI outside and in-the-field
Enable low-field NMR and MRI research

Terranova-MRI

Earth's field MRI & NMR teaching system

- Compact and Affordable
- Works almost anywhere
- Easy to install
- Low running costs
- Samples up to 75 mm diameter
- No cryogens
- No permanent magnets
- Autoshim
- Relaxation time measurements
- 1D, 2D and 3D NMR Imaging
- Projection reconstruction
- Spin-echo imaging
- Gradient-echo imaging
- Spectroscopy

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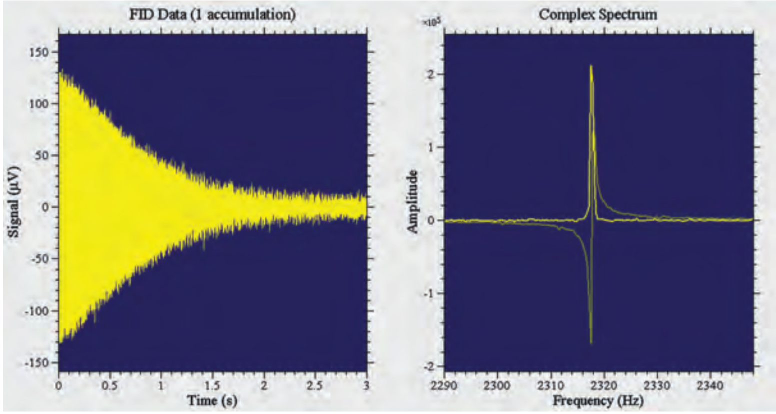
NMR//experiments

Pulse and Collect

The simplest of all NMR experiments is a single RF pulse followed by acquisition of FID data. When first using the system, the student will need to find the NMR resonance frequency, tune the RF coil, and select suitable parameters for the experiment. Thus concepts such as resonant circuits, Larmor precession, Fourier transforms and Boltzmann equilibrium are introduced to the student in a practical hands-on way. The student can vary all of the experimental parameters and see the effects of those changes directly on the FID signal.

Pulse and Collect

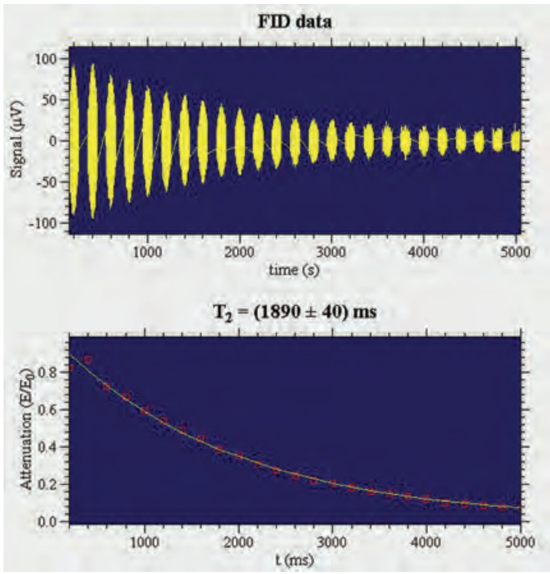


An FID of a water sample collected for 3 seconds to show the enhanced amplitude and linewidth obtained following shimming and tuning. (Note that the data has been processed in complex rather than magnitude mode - this enables the linewidth to be correctly determined).

CPMG

The Carr-Purcell Meiboom-Gill experiment demonstrates the effectiveness of a train of 180 degree RF pulses for continuously refocusing the magnetisation in an inhomogeneous field. The resulting envelope of the CPMG sequence can be analysed to demonstrate how a "single-shot" T_2 measurement is made. The student can see the effect of varying the phase of the refocusing pulses. This experiment demonstrates advanced concepts such as phase cycling, T_2*, and how to compensate for the effect of imperfect 180 pulses.

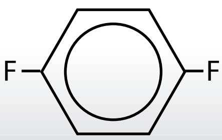
CPMG



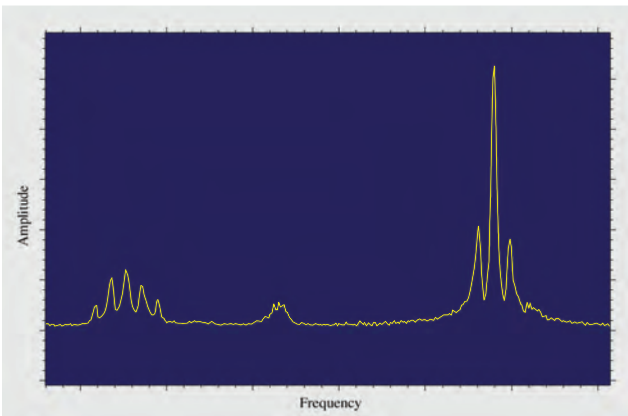
Typical results for a measurement of the T_2 of a tap water sample using the CPMG sequence. These results were obtained in de-shimmed conditions.

Spectroscopy

As a demonstration of quantum mechanics in action students can observe the field-independent splitting caused by *J*-couplings allowing them to directly count spins. The spectrum of 1,4- difluorobenzene demonstrates intramolecular spin-spin (*J*-coupling) between the fluorine and hydrogen nuclei as mediated by the electrons in the molecule. Terranova-MRI can be tuned to transmit and receive both ^{19}F and ^{1}H frequencies simultaneously because the Larmor frequencies only differ by about 150 Hz in the Earth's magnetic field.



Spectroscopy



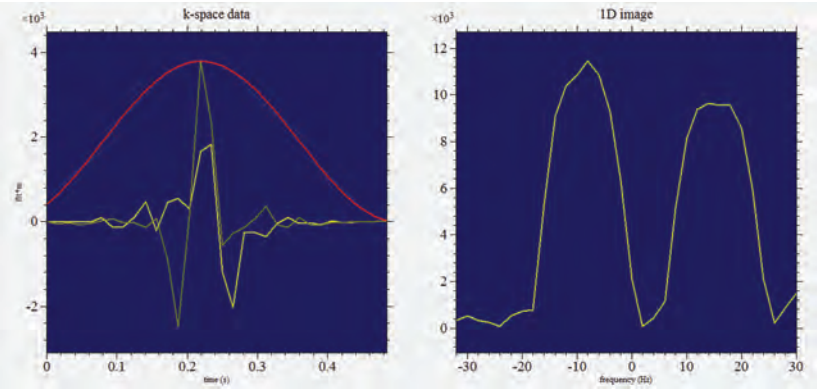
Heteronuclear *J*-couplings observed simultaneously between ^{19}F and ^{1}H in 1,4-difluorobenzene. The four-proton triplet is observed on the right at 2425 Hz and two atom ^{19}F quintuplet at 2275 Hz on the left. (A 50 Hz noise harmonic is visible near the centre.)

MRI//experiments

1D MRI

The simplest MRI sequence uses a single gradient to generate a projection of the spin density along a particular direction. The student can observe how the bandwidth of the image is affected by gradient strength, and change the direction of the gradient along the different axes.

1D MRI

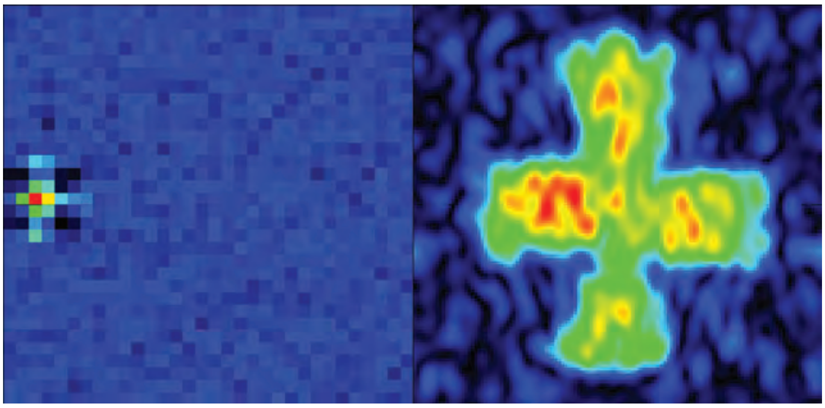


A 1D imaging sequence using a spin echo and a single gradient. On the left is the acquired echo and on the right is the Fourier transform of the echo showing the 1D projection image. The sample shown here is the two tube phantom supplied with the Terranova-MRI.

2D MRI

A range of 2D MRI sequences is available so that the student can explore the different MRI methods and observe how the experimental parameters affect the resulting images. Ideas such as k-space and 2D Fourier transforms are introduced through direct experimentation and more complex experiments demonstrate relaxation weighting of images, showing the importance of contrast in MRI.

2D MRI

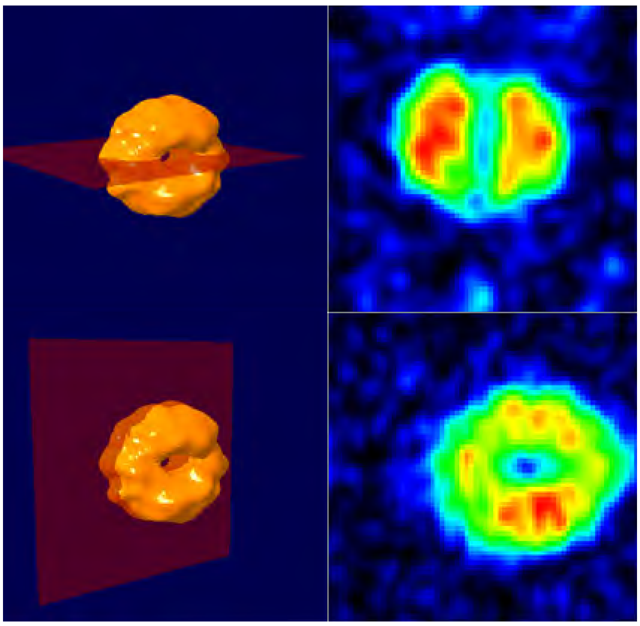


A 2D spin-echo image of a potato cut into the shape of a Maltese cross . On the left is the k-space data of echoes and on the right is the 2D Fourier transform of the data to show the MRI of the potato. Imaging time was 4 min.

3D MRI

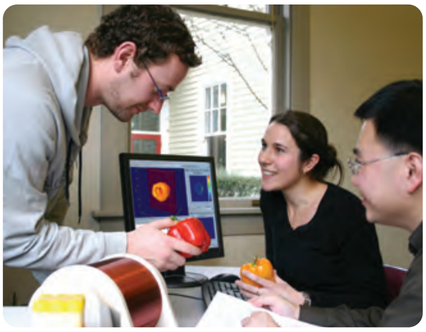
Terranova-MRI includes the ability to do 3D imaging using the spin-echo or gradient echo methods, providing a challenge for the advanced student. The software has a range of surface reconstruction and 3D visualization tools to display the data.

3D MRI



Surface renderings of a gradient-echo image of a mandarin (32 x 32 x 32 pixels) with 2D cross-sections shown to the right. Total imaging time was 4 hours with an isotropic field of view of 110 mm.

Terranova-MRI includes



Terranova-MRI includes a Student Guide that presents a range of experiments suitable for a laboratory-based teaching course.

Each section includes background information and theory, practical experiments with instructions and questions for the students to answer on each topic.

The instructor can choose which experiments they want the student to undertake, tailoring the material to the course work. Answers to the questions are provided at the end of each section.

- Earth's Field NMR probe
- Earth's Field MRI & NMR spectrometer
- Prospa NMR/MRI data processing software
- Terranova-MRI User manual
- Terranova-MRI Student teaching guide
- Prospa manual
- Cable connecting spectrometer to probe
- USB cable
- 24 V DC power supply
- Sample bottle
- Imaging phantom
- 3D magnetic compass

Terranova-MRI specifications

Probe:

Dimensions:	28 x 26 x 19 cm (11x10.2x7.4 in)
Weight:	9 kg (20 lbs)
Polarising Coil Diameter:	17 cm (6.7 in)
Polarising Field:	18.8 mT @ 6 A
Gradient Coil Diameter:	10.5 cm (4.1 in)
Imaging Gradient Strength:	80 μTm^{-1} @ 300 mA
Diffusion Gradient Strength:	9.5 mTm^{-1} @ 2 A
B_1 Coil Diameter:	8.4 cm (3.3 in)
Tuning Range:	1800 Hz to 3000 Hz
Sample Diameter:	7.5 cm (maximum) (2.9 in)

Spectrometer:

Dimensions:	36 x 26 x 16 cm (14.2x10.2x6.2 in)
Weight:	4 kg (8.8 lbs)

Power supply (included)

Input:	110 / 240 V (50 / 60 Hz) 2.0 A
Output:	24 V DC 6.25 A

PC requirements: (not included)

Windows XP / Vista / 7 PC with USB interface
100 MB of free hard disk space
256 MB of RAM minimum
700 MHz processor or faster

For further information please contact:

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