Personal Computer Supervising an NMR Imaging Experiment without Magnet

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1 Introduction

The NMR Imaging experiments are mostly supervised trough specially designed computers. Also an extremely homogeneous magnetic field has to be made in the area where tissues are to be placed.

Due to the homogeneity and time stability of the Earth's magnetic field we decided to build an apparatus for making NMRI in the Earth's magnetic field. Different coils were made for constructing necessary magnetic field gradients and RF fields.

Because of the strength of the Earth's magnetic field, which is of several orders of magnitude lower then the homogeneous magnetic field used in common NMRI, also slightly different technique of signal detection is used.

The sample is prepolarized in the direction perpendicular to the Earth's magnetic field. Then the prepolarization field is switched off adiabaticlly. This causes the magnetization to rotate in the direction of the Earth's magnetic field preserving its magnitude (Fig. 1). Now the situation is the same as in the common NMRI experiment and so the same pulse sequences can be used (Fig. 2). The Earth's magnetic field determines the frequency induced in the receiving coil (2 kHz).

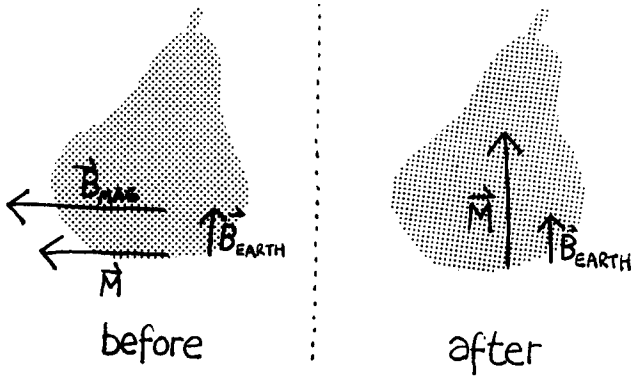


Figure 1

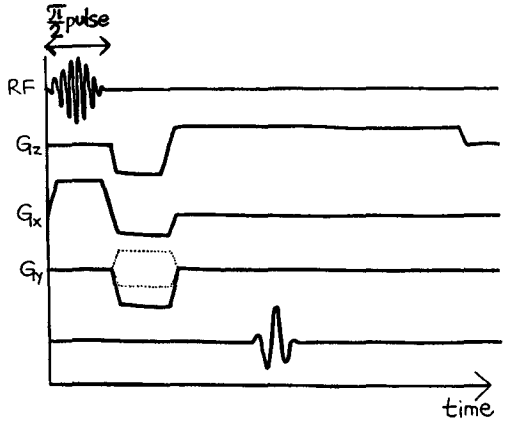


Figure 2

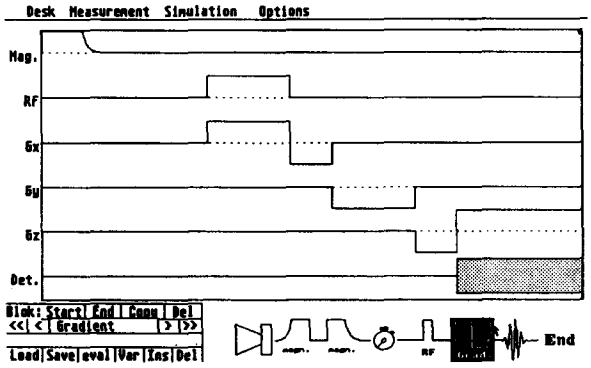


Figure 3

2 Hardware

Several coils have to be present in the NMRI experiment. These are: prepolarization coil, RF coil, x, y and z gradient coils and receiving coil.

The currents flowing trough those coils are controlled via Z80 CPU based computer, which was developed in our laboratory. For this purpose 4 8bit digital to analog converters, 2 analog to digital converters and 16 digital input/output ports are provided on the same board. The Z80 based computer collects and preprocesses the data and sends them via RS232 interface to the computer ATARI 1040ST where the data processing takes place.

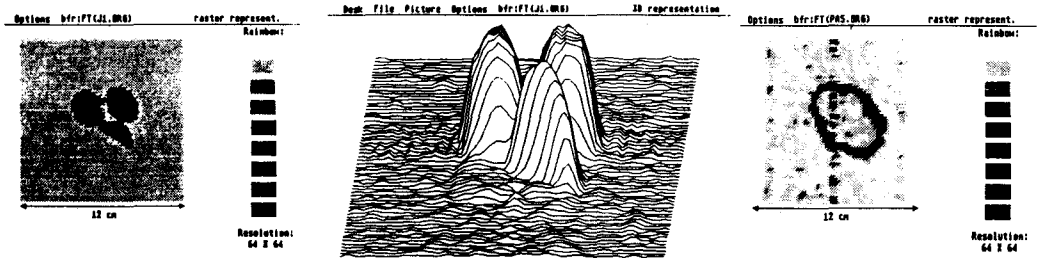
3 Software

A program was developed which controls the experiment, collects the data and processes it. Several NMRI sequences can be composed using the program running on the host computer–Atari. The program allows us to build each sequence from a chain of basic items: magnetization, RF pulse, [3] delay, gradient values determination, acquisition ...etc. (Fig. 3).

The data processing software allows filtering and machine code based FFT procedure on 128 × 128 integer grid. The result (spatial density distribution of the magnetic moments of the hydrogen nuclei) can be monitored through the raster (Figs. 4,6) and 3D representations (Fig. 5). Special care was devoted to user friendly interface so that all operations can be performed via menus and dialogues.

4 Results

Samples containing pure water and some vegetables have been imaged so far. In the first figure an image of three test tubes containing water is shown. The second one is an image of a green pepper.



Figures 4 - 6