



# Spin Track TD-NMR Spectrometer

Applications and Instrumentation Review

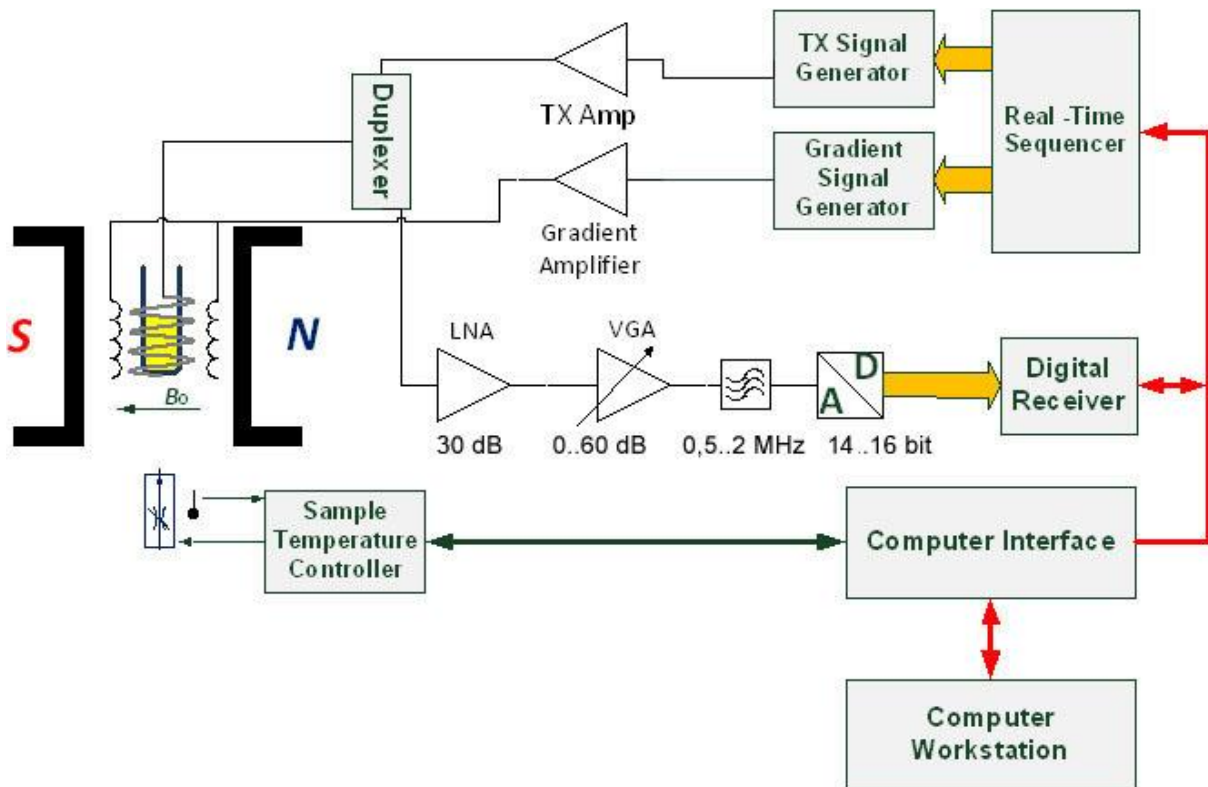


"Spin Track" Time-Domain (TD) NMR spectrometer is a high quality time-domain NMR instrument with wide range of applications, advanced software and peripherals like Variable Temperature Controller and Pulsed Gradient Unit.



Basic version of "Spin Track " TD-NMR spectrometer with standard magnet

The Spin Track diagram:



## Specifications of TD-NMR spectrometer “Spin Track”:

### Standard electronics:

Spectrometer mainboard	Frequency range: 1 kHz - 100 MHz Sequence time resolution: 20 ns Frequency resolution: 1 Hz Pulse sequence: Fully programmable ADC bits: 14 or 16 Programmable RF-pulses phase shift step: 5° PC connection: High Speed USB 2.0
Preamplifier:	Gain: 30 dB Input / Output impedance 50 Ω Noise figure: <1.5 dB Dead time: <7 μs
Power Amplifier	Input / Output impedance: 50 Ω Maximal output power: 300 W
Power Supply	Input: 220 V (50 Hz / 60 Hz), 110 V on demand
Relax Software	Supported OS: Windows 7, 8 Data compatibility: CSV text, ASCII, Microsoft Excel®
Dimensions	Spin Track: 423x271,5x151 mm Spin Track mini (can't be equipped by pulse gradient system): 297x210x150 mm
Weight	Spin Track: 9 kg Spin Track mini: 5 kg

### Standard magnets\*:

For NMR tube with outer diameter 10 mm	<sup>1</sup> H Frequency: 22 MHz Dimensions: 282 x 175 x 270 mm Weight: 33 kg
For NMR tube with outer diameter 18 mm	<sup>1</sup> H Frequency: 20 MHz Dimensions: 282 x 175 x 270 mm Weight: 33 kg
For NMR tube with outer diameter 40 mm	<sup>1</sup> H Frequency: 14 MHz Dimensions: 350x240x250 mm Weight: 50 kg

\* Depending on customer request we can produce magnet system for any NMR tube diameter within the range 1,7..40 mm

## Applications



**Determination of Solid Fat Content (SFC) in fats, oils and margarines (complies with ISO 8292, AOCS Cd 16b-93, AOCS Cd 16-81)**

Quality of food products containing fats and oils depends on solid fat content (SFC). SFC determination is an essential measurement in the baking, confectionery and fat industries. NMR has been established as the method for SFC

determination by ISO 8292. Measurements of SFC by NMR-spectrometer Spin Track can be performed quickly and accurately with great benefit to the manufacturer.

The detailed description of SFC determination procedure can be found at [http://www.nmr-design.com/sites/default/files/downloads/en/solid\\_fat\\_content.pdf](http://www.nmr-design.com/sites/default/files/downloads/en/solid_fat_content.pdf)



### **Simultaneous express-determination of Oil and Water in seeds (complies with ISO 10565)**

Sunflower, soybean, groundnut, rape and mustard seeds are appreciated for their oil content, but excess water content reduces their value. Thus, an accurate and fast determination of oil and water content is important to both manufacturers and customers. NMR-spectrometer "Spin Track" fulfils ISO 10565 requirements and allows the simultaneous determination of oil and water content. Using the Spin Track, you are able to say if there is the reason to collect the Sunflower harvest from the fields or to wait until the oil content becomes optimal.

The detailed description of moisture/oil determination procedure can be found at [http://www.nmr-design.com/sites/default/files/downloads/en/oil\\_moisture\\_in\\_seeds.pdf](http://www.nmr-design.com/sites/default/files/downloads/en/oil_moisture_in_seeds.pdf)



### **Spin Finish Analysis**

Spin Finish or Oil Pick Up (OPU) measurements on artificial fibers are essential in textile industry. For a couple of recent decades, it is successfully being done by the Time Domain Nuclear Magnetic Resonance (TD-NMR) techniques. Apart from the former wet chemical extraction method, TD-NMR demonstrates high accuracy and repeatability along with the fastest possible results outcome. By using the Spin Track analyzer, the measurement takes no longer than one minute, it does not require any solvents or complicated sample preparation and there is no need in qualified personnel with chemical education.

The detailed description of moisture/oil determination procedure can be found at [http://www.nmr-design.com/sites/default/files/downloads/en/spin\\_finish\\_analysis\\_by\\_the\\_spin\\_track.pdf](http://www.nmr-design.com/sites/default/files/downloads/en/spin_finish_analysis_by_the_spin_track.pdf)



### **Simultaneous Rapid Determination of Fats, Sugar and Water in Chocolate and Cacao-Products**

Time of storage of food products depends strongly on moisture content. Excess moisture leads to microbiological activity and can make food consumption dangerous. Fat and moisture content influence taste. Manufacturers must disclose exact fat content data on required product labeling. NMR is the most rapid and accurate method to determine these essential parameters. The "Spin Track" NMR spectrometer is especially suitable for regular analysis of food quality. NMR analysis is applicable for cacao-powder, cacao beans, nuts, praline, icing, fondants, and pure chocolate. Measurement time is less than 2 minutes.



### **Determination of Fat and Moisture Content in Milk Powder**

This is another useful test in the food industry. Other types of analysis often require considerably longer analysis time and consume other chemical material as solvents. In contrast, utilization of the Spin Track NMR the user is able to determine fat content of milk powder in several minutes.



### **Evaluation of a Porous Structure in Cheese**

Time-intensive cheese fermentation starts from the structural formation of very small pores. By measuring the distribution of Spin-Spin/Spin-lattice NMR relaxation times and diffusion coefficients it is possible to predict if the 'pre-cheese' will develop into the desired quality product.



### Estimating of Solid Proteins Content in Milk-based products

Low resolution NMR is able to give information about the solid protein content in many types of dairy product. An extremely useful analysis!



### Rock Cores Analysis

The possibility for oil production can be defined more exactly the initial exploratory stage by using NMR. Rock cores saturated by hydrocarbons and/or water provide information on the degree of saturation, hydrocarbon structure, and core porosity. This information allows prediction of hydrocarbon yield and suitability of rock core geological formations to production. The "Spin Track" NMR spectrometer with 40 mm is well suited to these analyses.



### Medium- and High-Resolution NMR Analysis of Hydrocarbons in Petroleum and Refined Petroleum Products

The dedicated **Spin Track 60** NMR spectrometer allows acquisition of high-resolution NMR spectra containing detailed chemical shift information. These spectra can be utilized to predict chemical and physical properties of petroleum streams as well as monitoring of process reactions.



### Curing degree and elasticity analysis in rubber-type materials

Rheology is widely known now as a basic methodology utilized in rubber investigations for many years. However, rheology instrumentation can be extremely expensive and complicated. NMR is very sensitive to the structure and properties of elastomer materials. The Spin Track NMR spectrometer yields data that is complementary to rheology data and may, in fact, be more informative.

The detailed description of curing degree and elasticity analysis can be found at <http://www.nmr-design.com/sites/default/files/downloads/en/rubber.pdf>



### Ecological monitoring

NMR is widely used for evaluation of water pollution, or the degree of forest degradation. A portable NMR-spectrometer offers additional advantage for mobile laboratories equipping – rapid analysis at the scene.



### Scientific Investigations

A huge area of applications! Typically, scientists who purchase the Spin Track NMR spectrometer create their own experiments and pulse sequences. Many articles on the application of low-resolution NMR appear in peer-reviewed journals annually. NMR R&D activity significantly helps to establish new industrial techniques. Low-resolution NMR allows observation of:

- Proton density and mobility distribution;
- Ratio between fractions;
- Diffusion and self-diffusion speed.



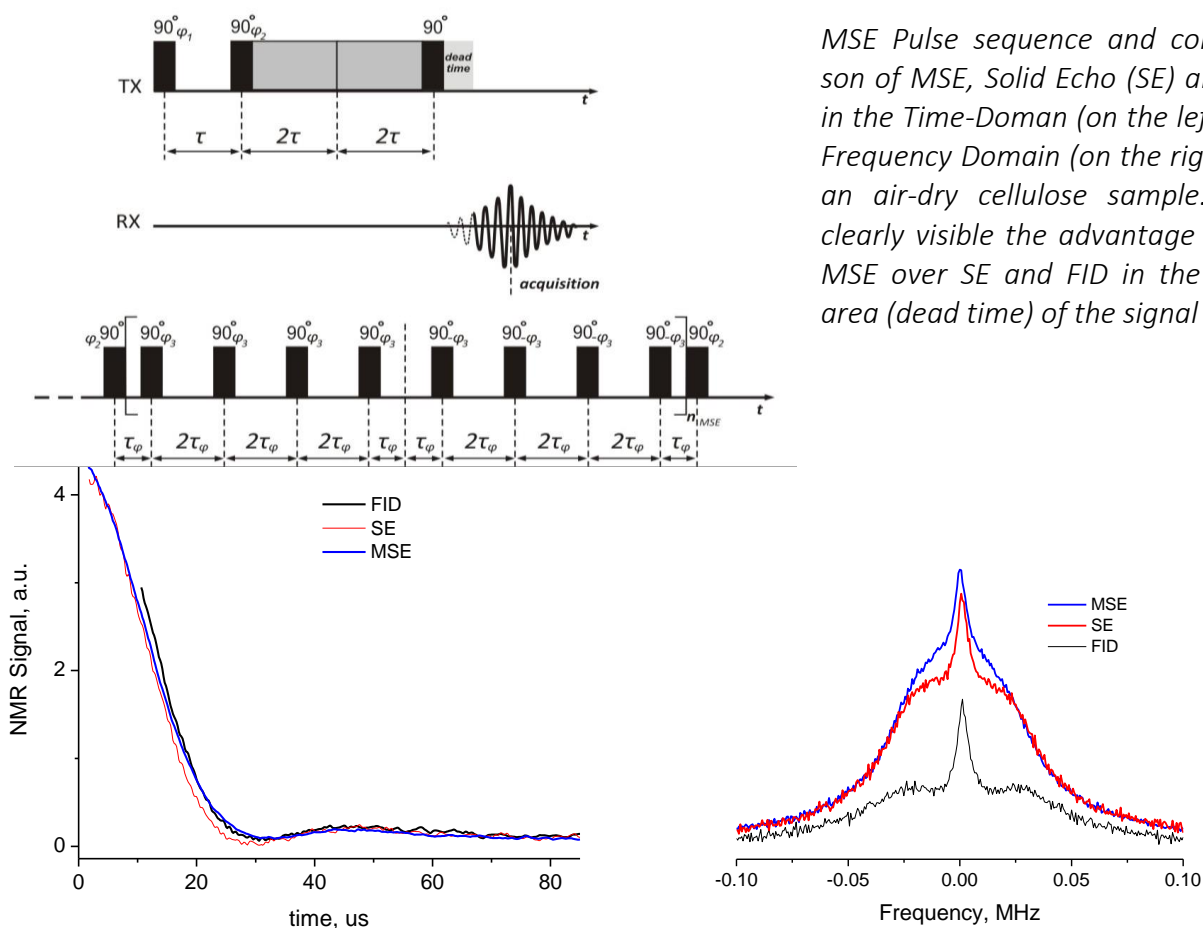
## Academic Classrooms - Teaching Students

The "Spin Track" NMR spectrometer can be directly used in demonstrations and practical training of students in quantum physics, chemistry, physical chemistry, geochemistry, electronics and signal processing.

The possibilities of NMR are not limited to the applications mentioned above. Please contact Resonance Systems Ltd. to discuss the utilization of affordable NMR technology in your business.

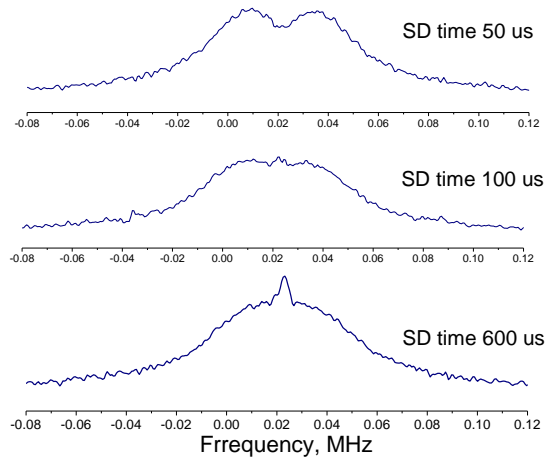
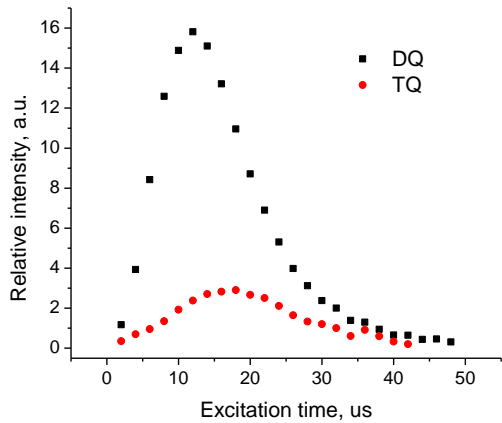
## Special Pulse Sequences for Scientific Applications

Experienced NMR customers can create their own application as well as use the supplied sequences. Special attention is paid to solid-state samples applications because the Spin Track NMR spectrometer offers accurate and up-to-date high-standard measurements with very low ringing time of the probe and exceptional sensitivity. Besides well known Free Induction Decay (FID), Hahn Echo, CPMG, Inversion-Recovery and Saturation-Recovery routines for  $T_1$  time we offer sequences with virtually zero dead time like Magic Sandwich Echo (MSE)



MSE Pulse sequence and comparison of MSE, Solid Echo (SE) and FID in the Time-Domain (on the left) and Frequency Domain (on the right) for an air-dry cellulose sample. It is clearly visible the advantage of the MSE over SE and FID in the initial area (dead time) of the signal

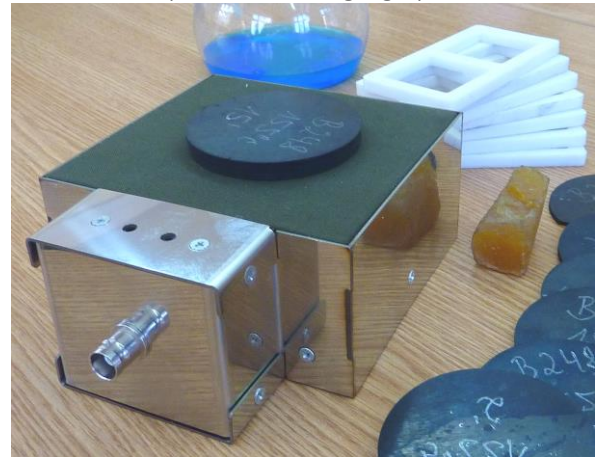
In recent years for solid polymers investigations the great advance was done by using so called Double Quantum (DQ) and Triple-Quantum (TQ) NMR. Spin Track spectrometer can be easily used for measuring of *DQ build-up curves* as well as for *DQ decays* and *Spin Diffusion* (SD) measurements both by DQ-SD or Goldman-Shen sequences.



The listed figures display Double-Quantum and Triple-Quantum build-up curves (on the left) and spectra for Double-Quantum Spin Diffusion MSE experiment (on the right) showing the possibility to resolve contributions from crystalline and amorphous fractions of a polymer sample (cellulose)

### Surface NMR sensor Spin Surf

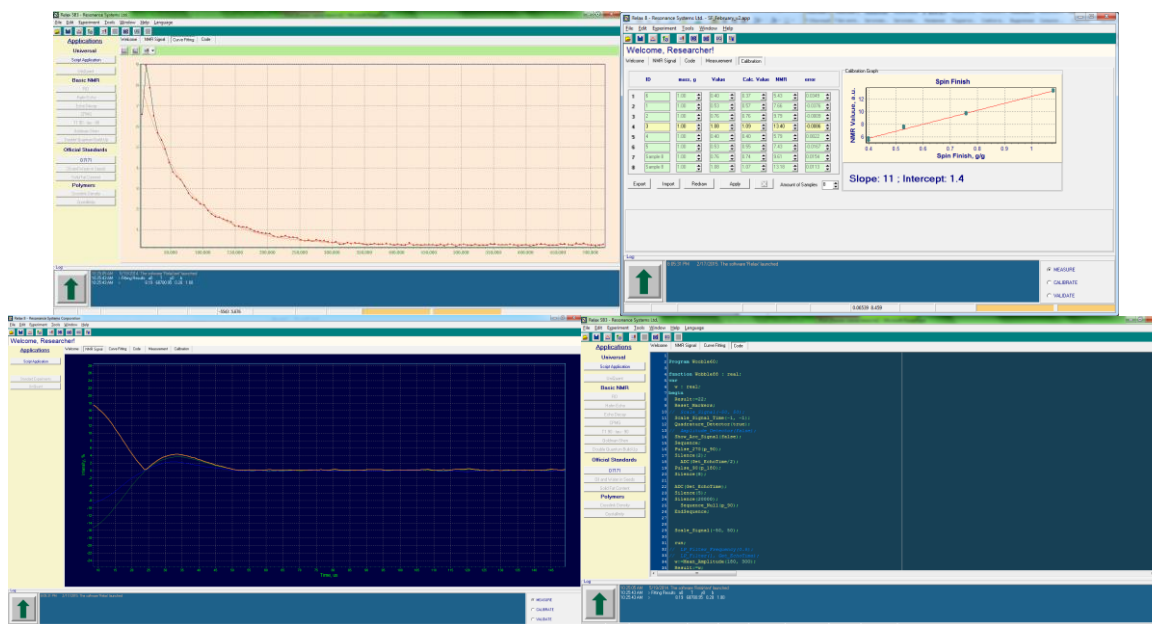
Resonance Systems Ltd. has developed a non-standard NMR approach and sensors for the analysis of surfaces and manufactured products. These types of sensors were developed for investigations of large objects. The sample volume is not limited using this sensor type. The procedure of sample preparation is very simple and does not require placement of part of the sample into a tube as with conventional NMR devices. It provides an absolute non-destructive analysis process. For applications with specific requirements a different geometry of RF-coil and magnets construction are possible. These types of sensor are also suitable for the development of imaging systems.



**Spin Surf specifications:**

<sup>1</sup> H frequency on surface	19,8 MHz
Vertical penetration depth	6 mm
Dimensions	132x109x54 mm
Weight	1,5 kg

## Software



### Relax Software interface screenshots

The spectrometer software, Relax, is a powerful package allowing utilization of standard NMR relaxation routines and creation of new ideas for pulses, gradients, gains, attenuations and phase cycling of TX and RX at any complexity level. The built-in script language is based on widespread Pascal syntax. The script supports dialogue windows, static messages, user-defined diagrams, and data manipulation procedures. Relax allows direct processing of spectra, that enables Spin Track for use as an NMR spectrometer. It is possible to write custom pulse sequences, change TX power and RX sensitivity, frequency, repetition periods, etc. The language has built-in support of fitting routines, Fourier and Inverse Laplace transforms, interface windows, MS Excel® tables, user graphs, and report generation. The great variety of examples, autotunes and embedded applications can help to readily control the **Spin Track** spectrometer.

## Additional hardware

The Spin Track NMR-spectrometer can be provided with several additional hardware modules that increase the range of possibilities of the device:

1. **High-temperature airflow controller** provides high-precision discrete maintenance of sample temperature. Temperature range – up to 150 °C. Removes dependence on external thermostats required by some applications.
  2. **Pulse gradient system** allows expansion of measured values range (e.g. in moisture content in seeds application), method time savings by removal of sample drying requirements, and diffusion process investigations are simplified.
- Experimental parameters of these devices can be tuned according final customer requirements. Contact Resonance Systems Ltd. for detailed information.



## Service and warranty

Service support is available in USA, Europe, Asia and Russian Federation. Warranty period for EU is 2 years.

## Contacts

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