Terahertz Registration System TRS-16

FEATURES

- Real-Time Measurements and Adjustments
- "No Bearing" Design Of Fast Delay Line – Virtually Unlimited Lifetime
- Increases Signal To Noise Ratio*
- Does not require Lock-in Amplifier
- Complete PC control
- Powerful System Control, Data Acquisition and Analysis Software Package

INTRODUCTION

The traditional method for getting terahertz waveforms has relied on a sampling technique by using the slow stepper motor, in which the delay of the gating pulse is swept relative to that of the other, and the average photocurrent generated in the detector is measured as a function of delay time. Most of the time the signal is acquired with a lock-in amplifier. Since this requires a lock-in time constant in the range of tens to hundreds of milliseconds, the sweep time of the delay is quite slow on the order of hundreds of milliseconds per data point. At this rate, it takes several minutes to acquire a single 1024-point terahertz waveform and only after that measurement THz spectrum is calculated.

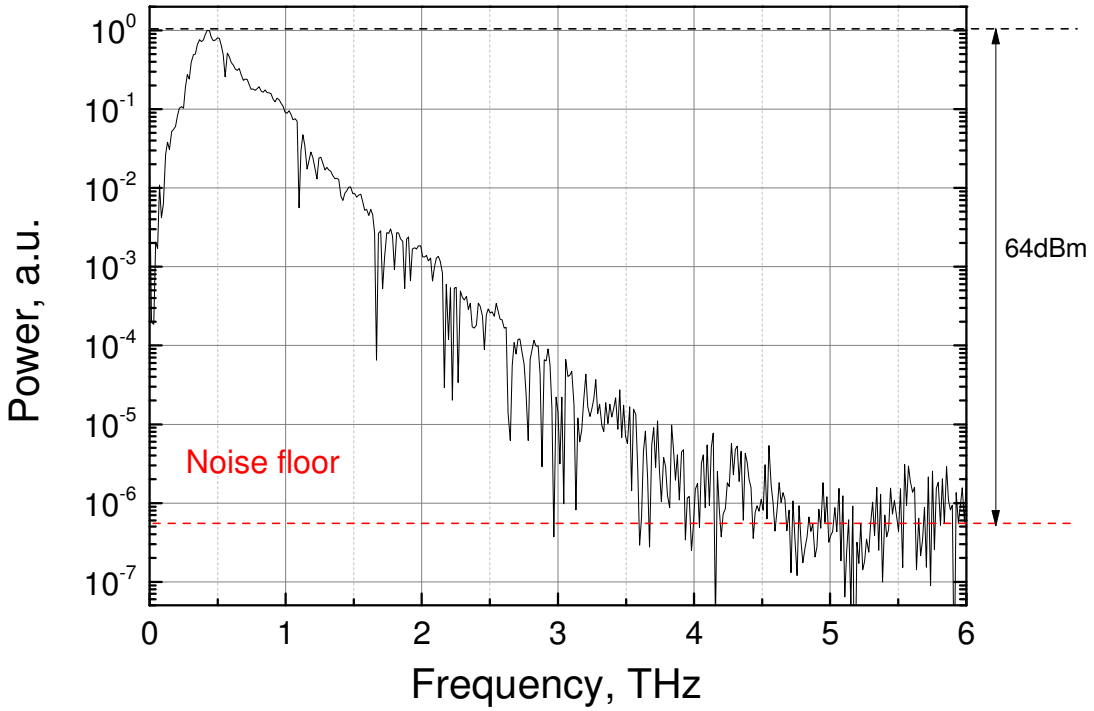
THz registering system TRS-16 with fast optical delay line (an upgrade to the old THz system) is suggested to use for the purpose to reduce acquisition time, to obtain possibility to perform measurements and system adjustments in real time (THz signal and it spectrum are shown in real time), to get better signal to noise ratio and to avoid lock-in amplifier at all. The lock-in amplifier is no longer relevant as far as this device is used. TRS-16 electronic also is a supplier of bias for the photoconductive THz emitter and for the operational preamplifier. Also, it replaces the usage of several scientific instruments and it is equipped with powerful system control, data acquisition and analysis software package.

This advanced electronics is used in our T-SPEC and T-Fiber series terahertz spectrometers. Now it is also available as stand-alone product named TRS-16. It can be used for home-made opto-electronic or electro-optic pulsed THz spectroscopy systems. The complete set includes electronics module, operational preamplifier and fast scan delay line based on voice coil, with possibility to connect three slow delay lines based on stepper motor.

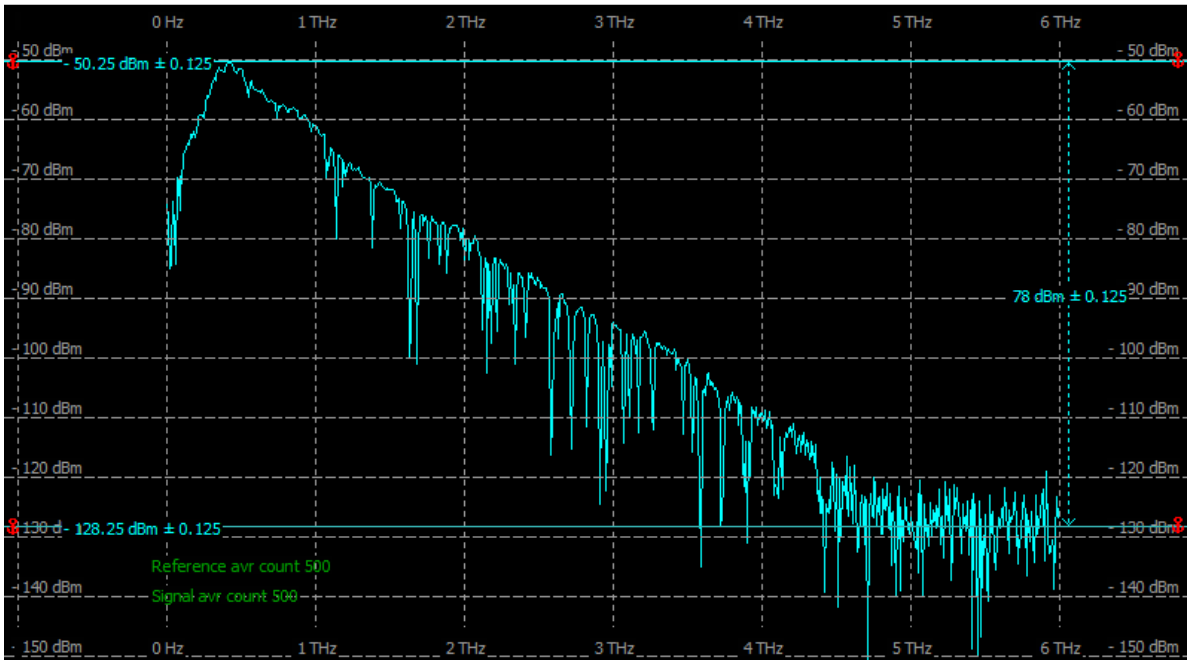
*An examples of the measurements are shown below

EXAMPLES OF THE MEASUREMENTS

The registered THz spectrum with traditional method (with slow delay line and lock-in amplifier: 1024-point terahertz waveform, 30ms integration time, 10 µm step) and with the Terahertz Registration System TRS-16 (SNR increases >14dBm) are shown bellow.



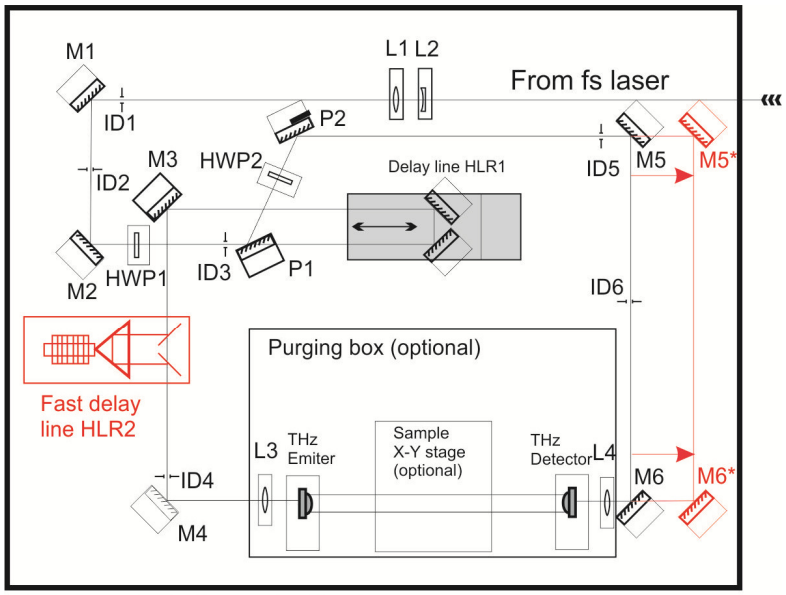
THz pulse FFT Spectrum in the air registered **with slow delay line and lock-in amplifier**



THz pulse FFT Spectrum in the air registered **with the Terahertz Registration System TRS-16**

INSTALLATION

Installation of TRS-16 system is very simple. Current THz setup remains practically unchanged. Additional new fast delay line will be placed on the emitter or detector optical path together with already currently used delay lines. Added new fast delay line increases an optical path by ~16 cm, which must be compensated either in the detector or in the emitter arm (depending where fast delay line is placed). In most cases no additional mirrors are required. It is enough just to change a position of one or two appropriate mirrors by increasing common optical path by 16 cm. An example of the installation of the fast delay line in the THz setup is given below.



NEW element - Fast delay line HLR2
M5*, M6* - new possition of mirrors M5 and M6

Upgrade of the THz system: an example of the installation of the new additional fast delay line

TRS-16 is also compatible with SM4A or SM5 stepper motor controller and has possibility to control four delay lines: new fast one and three slow. The sole new THz software will control all these lines. Scan window of fast delay line is 116ps and corresponds to spectral resolution of $\Delta f \sim 8$ GHz. By using slow delay line (old line in THz setup) in addition to fast delay line it is possible to extend scan window from 116 ps to 928 ps or more and obtain spectral resolution of $\Delta f \sim 1$ GHz or better.

Our TRS-16 registering system is also developed to register optical pump THz probe signal. Dedicated software could be added additionally to the product package as a bonus.

Detailed technical description of the product is given below.

PRODUCT TECHNICAL DESCRIPTION

TRS-16 set includes electronics module, operational preamplifier and fast scan delay line.

ELECTRONICS

The electronic module of TRS-16 system consists of two main parts: delay lines control and signal registration. It has possibility to control fast and three slow (SM4A or SM5 stepper motor controller needed additionally). Fast delay line based on voice coil allows real time data acquisition at 10 scans/s rate with 116 ps scanning window. Use of the optical linear encoder ensures the extremely low jitter, thus registration system can achieve high dynamic range up to 90 dB. The registration part has embedded 16 bit analog to digital converter, operational preamplifier and the THz emitter

bias modulator. TRS-16 system also provides bias for the photoconductive THz emitter in range from 20 to 85 V DC and for the operational preamplifier ±12 V DC.

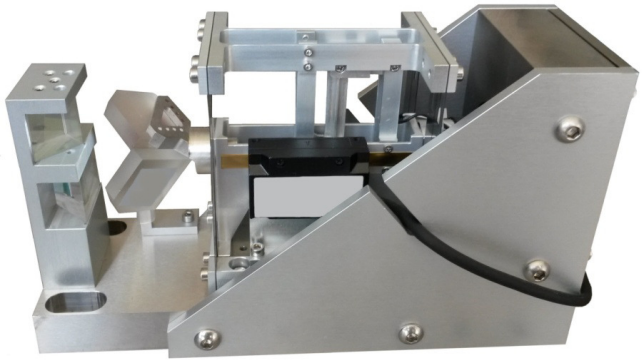
Operational preamplifier is designed to amplify weak detector signals up to measurable level. His conversion coefficient is not less than 10^6. Preamplifier head is equipped with SMA connector that is matched with Teravil THz detector holder connector.

SPECIFICATIONS

Analog to digital converter	16 bit
Operational preamplifier conversion coefficient	not less than 10^6
Dimensions (L×W×H)	230 × 170 × 55 mm

MECHANICS

The fast scan delay line is designed without bearings and uses a magnetically coupled drive which makes it extremely reliable and significantly extends the lifetime. A special mechanical design makes movement of retroreflector straight along one axis, which results perfect beam pointing of the beam passing through the delay line. The maximum line scanning rate is matched with its resonance frequency. This feature substantially reduces energy consumption, vibrations and heat generation.



SPECIFICATIONS

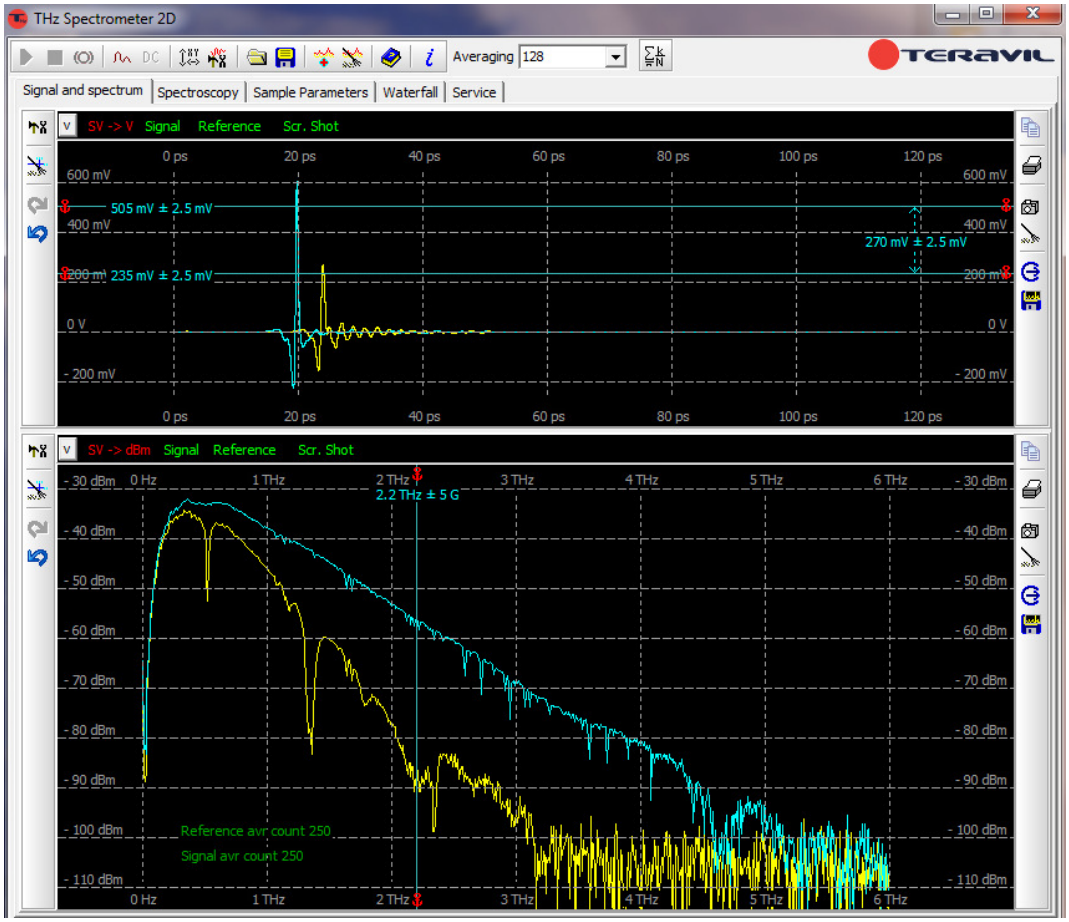
Maximum scan window	116 ps
Speed (at max scan window)	10 Hz
Dimensions (L×W×H)	214 × 75 × 120 mm

SOFTWARE

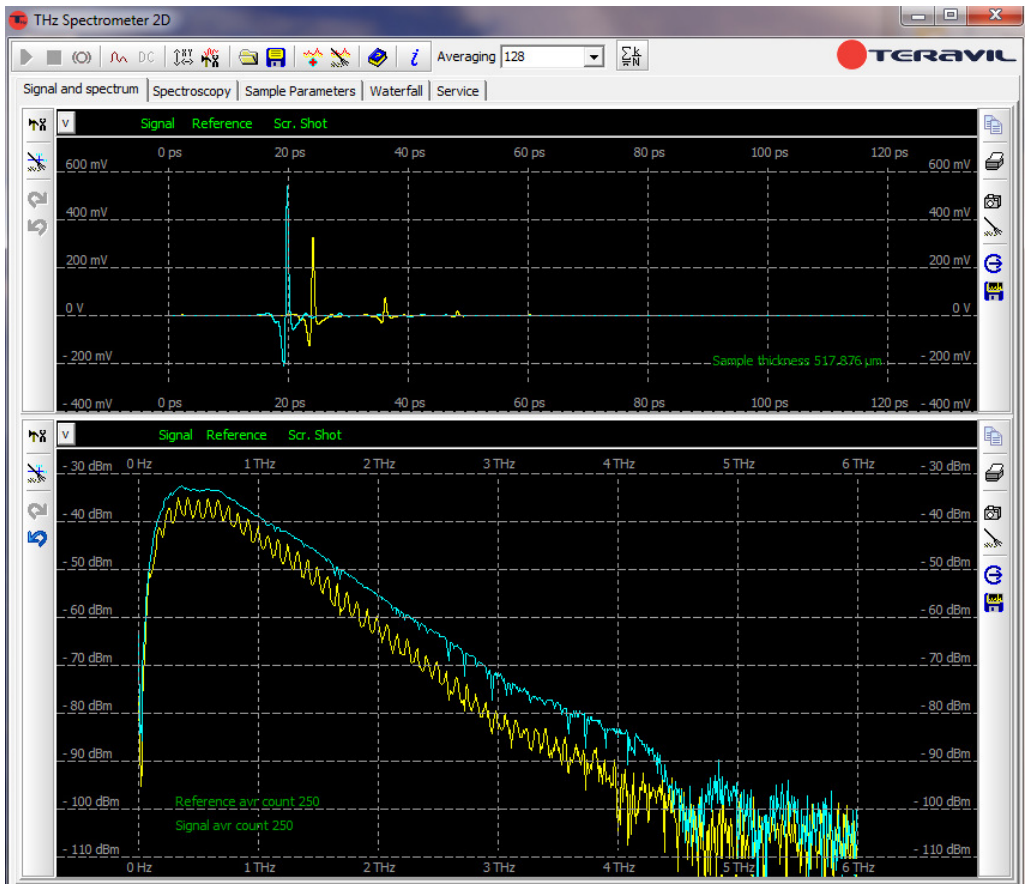
The Terahertz Registration System TRS-16 comes with dedicated software capable to:

- register THz signal, get FFT spectrum, absorbance and transmittance in real time (10 scans/s);
- make a raster scan image using standard stepper motor XY stage (standard scan area 24x24 mm, but no any restrictions to use bigger XY stages). Standard stepper motor driving technique is used;
- find the absorption, transmission and thickness of the sample;
- THz signal continuous data-flow recording;
- find complex index of refraction, complex conductivity and complex dielectric constant;
- register optical pump THz probe signal.

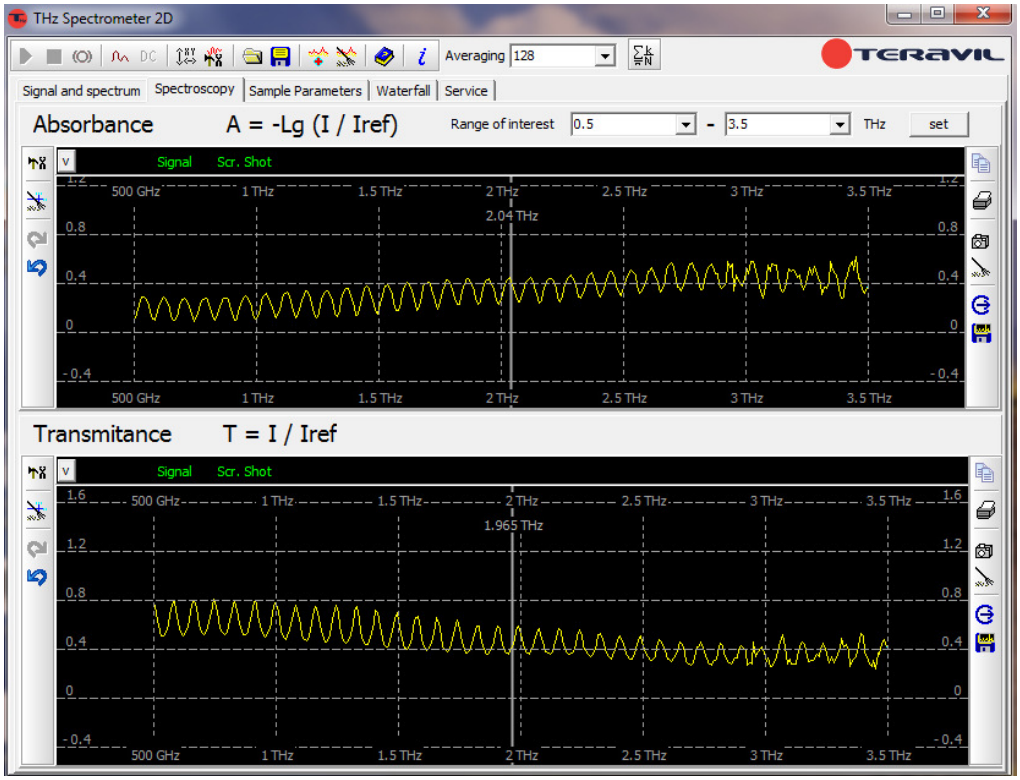
Examples (print screens) of various measurements with THz software is presented below



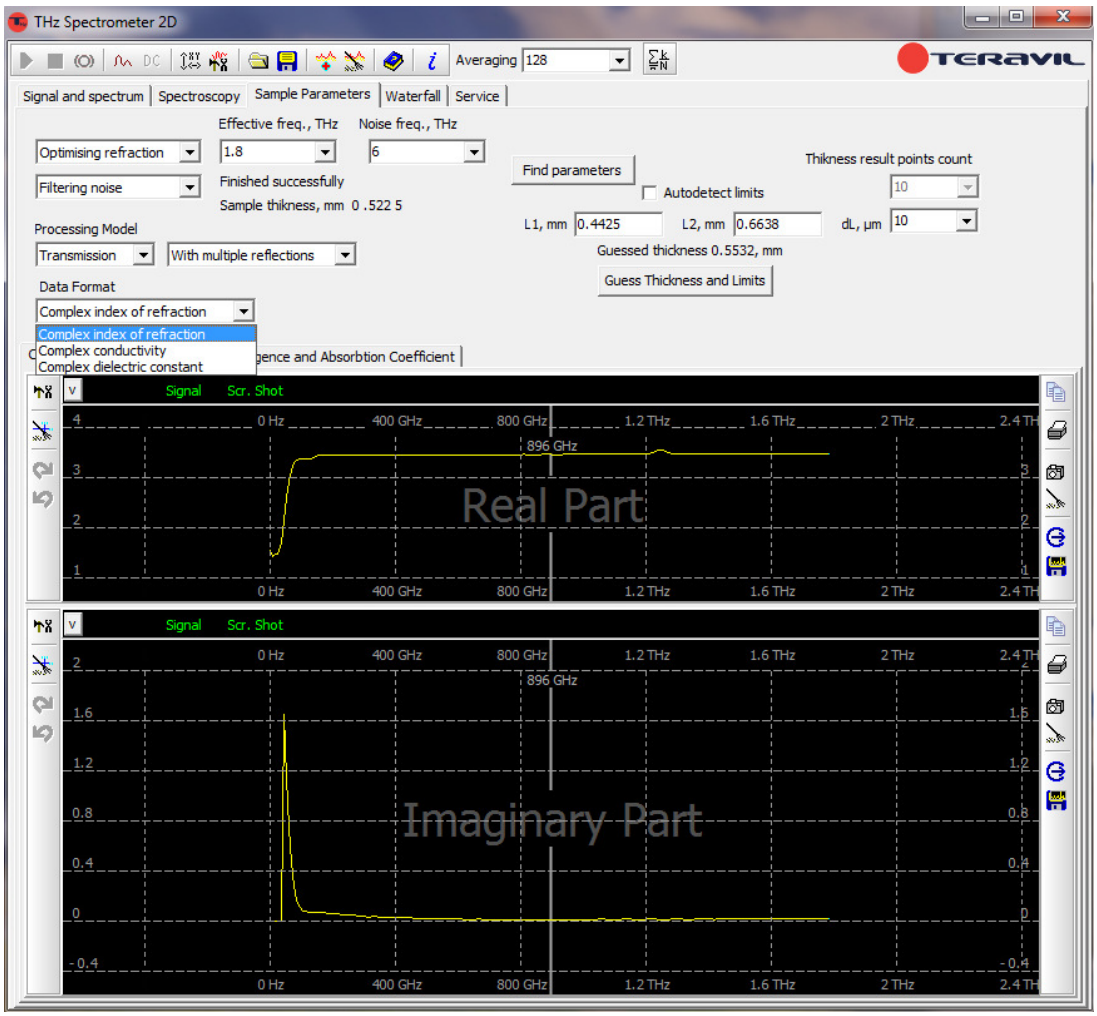
THz signal and it FFT spectrum of “Xanax” in nitrogen environment



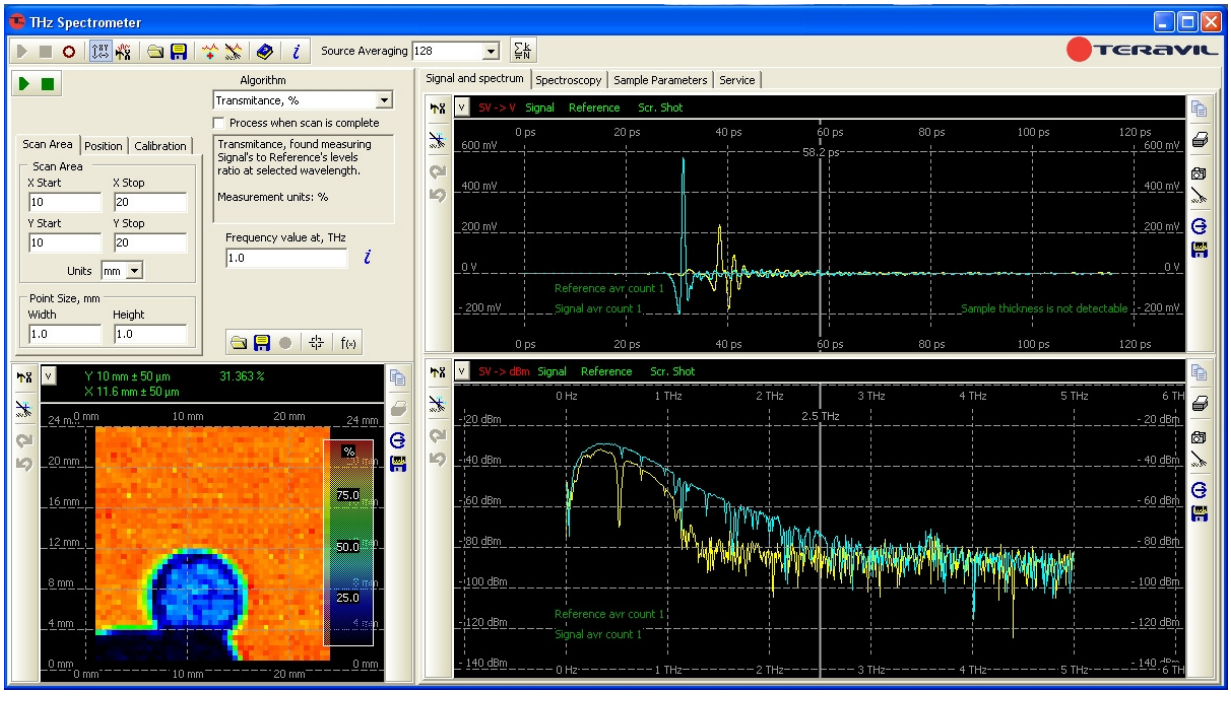
THz signal and it FFT spectrum of “HRFZ Si” in nitrogen environment



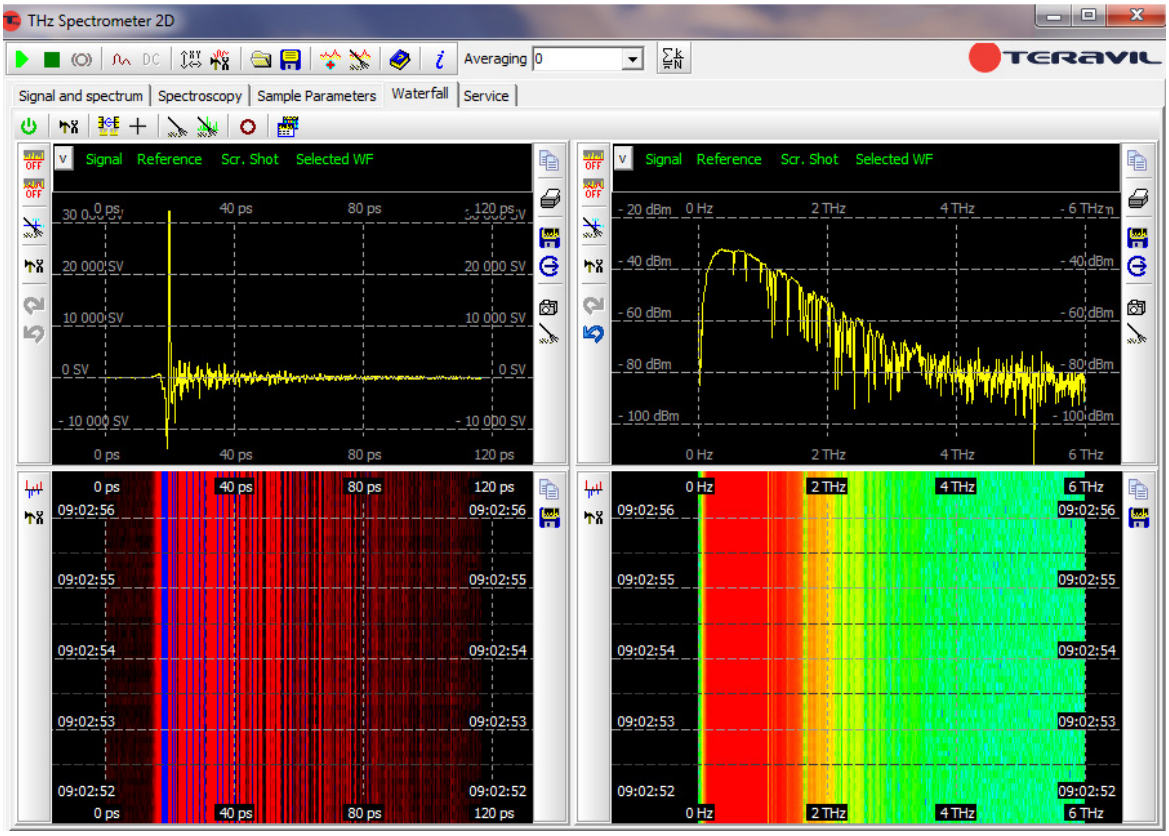
Absorbance and transmittance of “HRFZ Si” in nitrogen environment



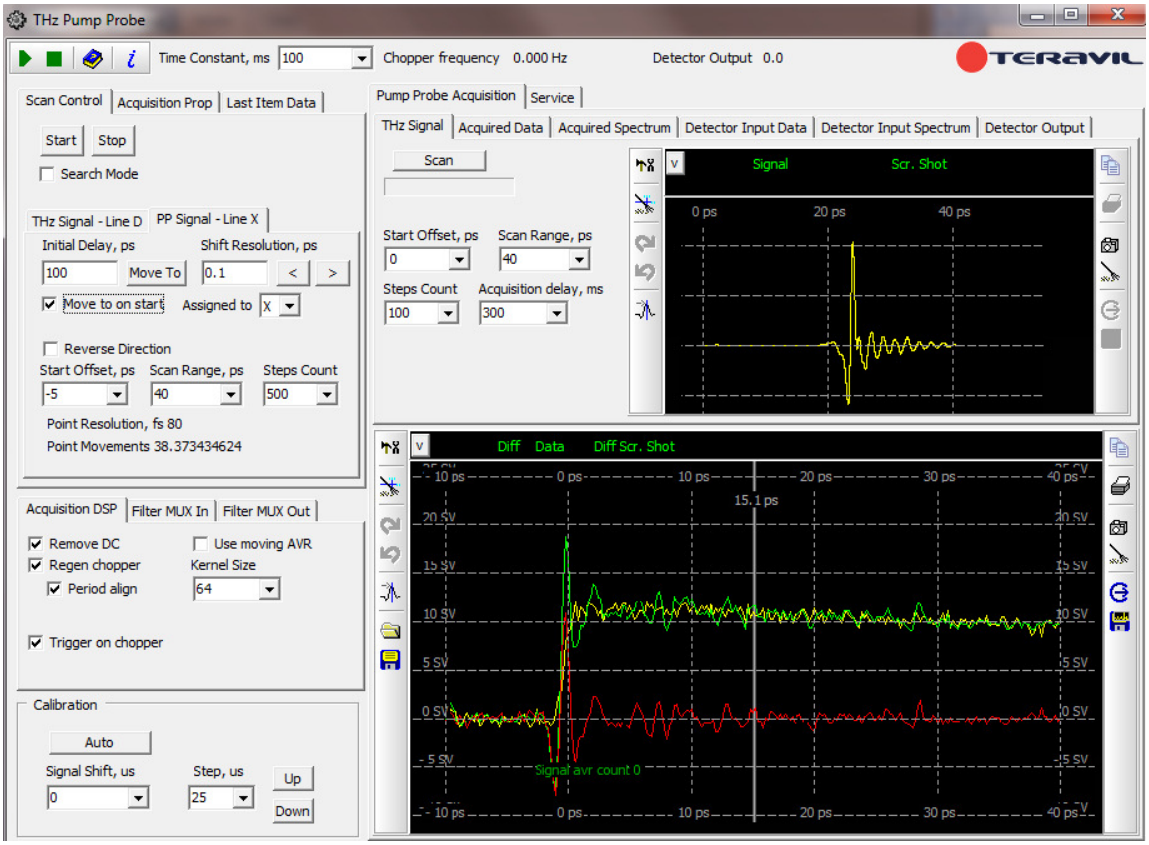
Optical constants calculation (HRFZ Si plate)



Raster scanning of round sample containing lactose with Spectrometer 2D software



Continuous data-flow recording



Optical pump terahertz probe measurement