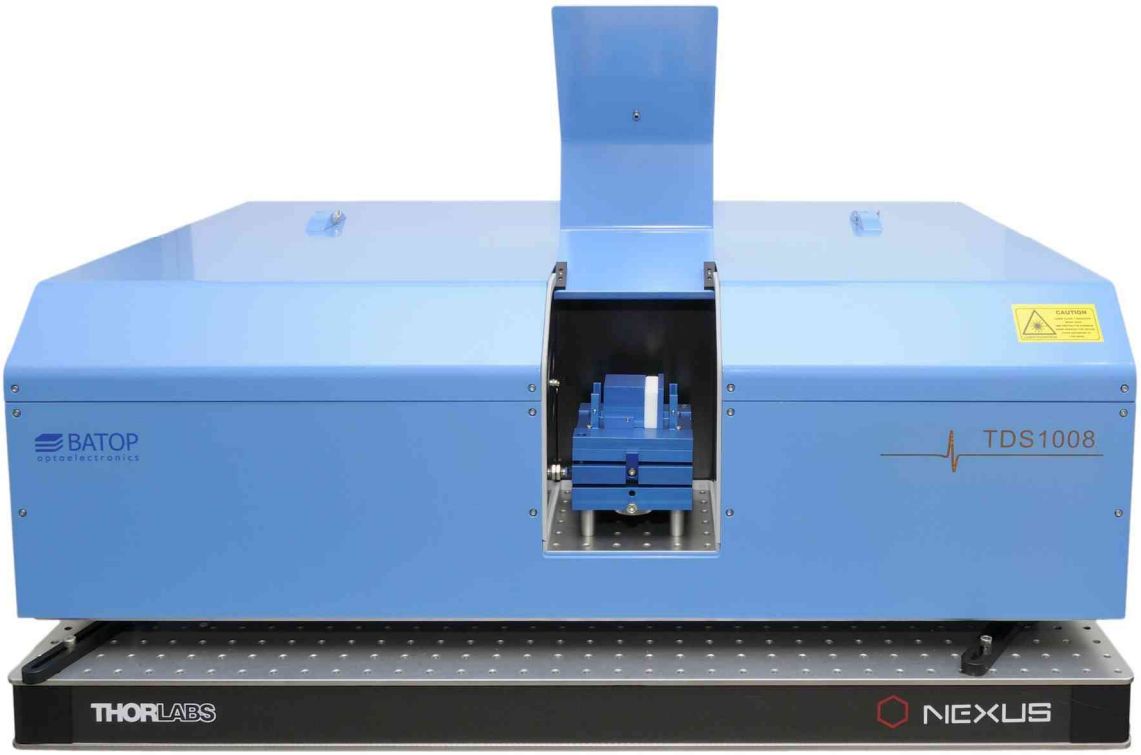
THz Time Domain Spectrometer TDS 10XX



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0. The TDS10XX family

Every terahertz time-domain spectrometer (TDS) uses a short pulse laser with ~ 100 fs pulse duration in order to drive the terahertz emitter and detector antennas. However, there exists a trade-off between the price for short pulse lasers and the performance of photoconductive antennas for different wavelengths. The best performance is obtained for photoconductive antennas (PCA) operating at wavelengths around 800 nm whereas antennas for 1550 nm wavelength suffer from low dark resistance and a longer relaxation time of the active material. Unfortunately, the price for a 1550 nm femtosecond laser is generally lower then that for an 800 nm femtosecond laser.

Therefore, we offer the TDS system with fs lasers working at different wavelengths:

- TDS1008 with 780 nm fs laser
- TDS1010 with 1060 nm fs laser
- TDS1015 with 1560 nm fs laser

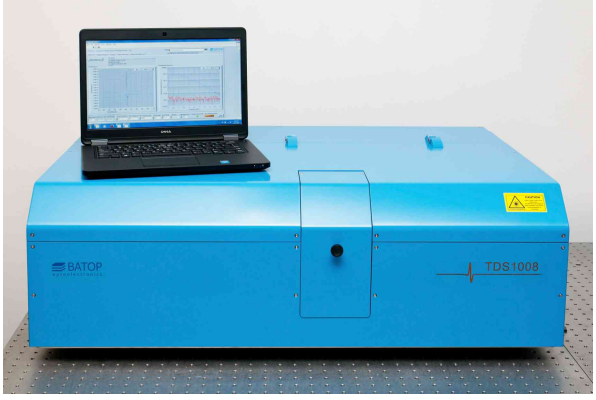
1. Basic TDS system

The TDS10XX is a benchtop terahertz time-domain spectrometer containing the following components inside the spectrometer housing:

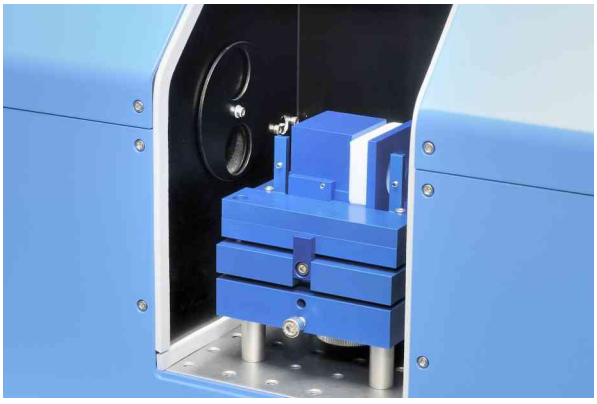
- Sample compartment, which can be purged dry nitrogen gas
- Sample holder for transmission measurements inside the sample compartment
- Complete optics (including the femtosecond laser) and electronics to run the spectrometer

A laptop with the spectrometer software T3DS is connected via USB to operate the TDS system. A second software package is used in order to determine the sample properties using the data collected.

The photoconductive THz antennas and collimating TPX lenses are positioned inside the spectrometer housing together with the laser beam optics. The samples are placed inside the sample compartment that can be purged with nitrogen or dried air. The sample holder for transmission measurements comes with every TDS system and includes focusing TPX lenses as well as an adapter for small samples.



TDS10XX basic system:
spectrometer + laptop

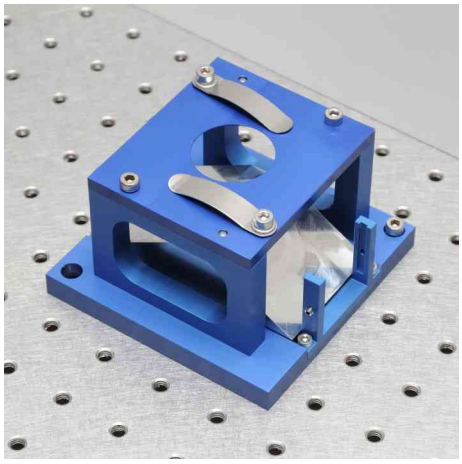


Sample compartment with sample holder for transmission measurements.

1.1 Option SHR - Sample Holder Reflection

Alternatively, a sample holder for reflection measurements can be ordered that replaces the sample holder for transmission. The angle of incidence for this setup is fixed to 30 degrees. Similar to the transmission stage this option comes with focusing TPX lenses and an adapter for small samples. Replacing the transmission stage with the SHR takes very few steps and is done within a couple seconds. In order to simplify the formulas applied by the T3DS calculator the THz beam inside the sample compartment is polarized horizontally.

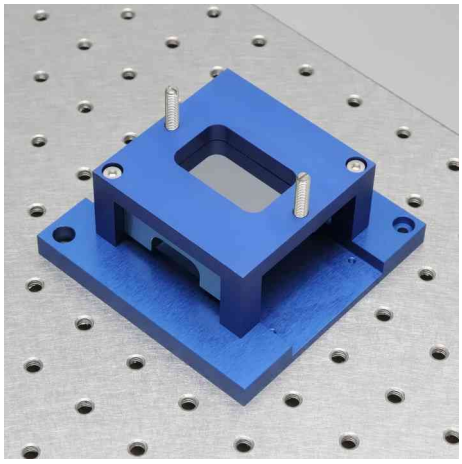
SHR - Sample Holder for Reflection measurements, removed from the sample compartment



1.2 Option SHA - Sample Holder for Attenuated total reflection

Another measurement option is the sample holder for attenuated total reflection measurements which can also replace the sample holder for transmission. A silicon prism is used in order to deflect the collimated beam and investigate the properties of strong absorbing samples with a refractive index lower than 2.5. The angle of incidence for this setup is fixed to 51.6 degrees. Replacing the transmission stage with the SHR takes very few steps and is done within a couple seconds. Furthermore, a lid is provided that seals the small sample chamber on top of the silicon prism in order to reduce fumes in the sample compartment due to evaporation volatile fluids.

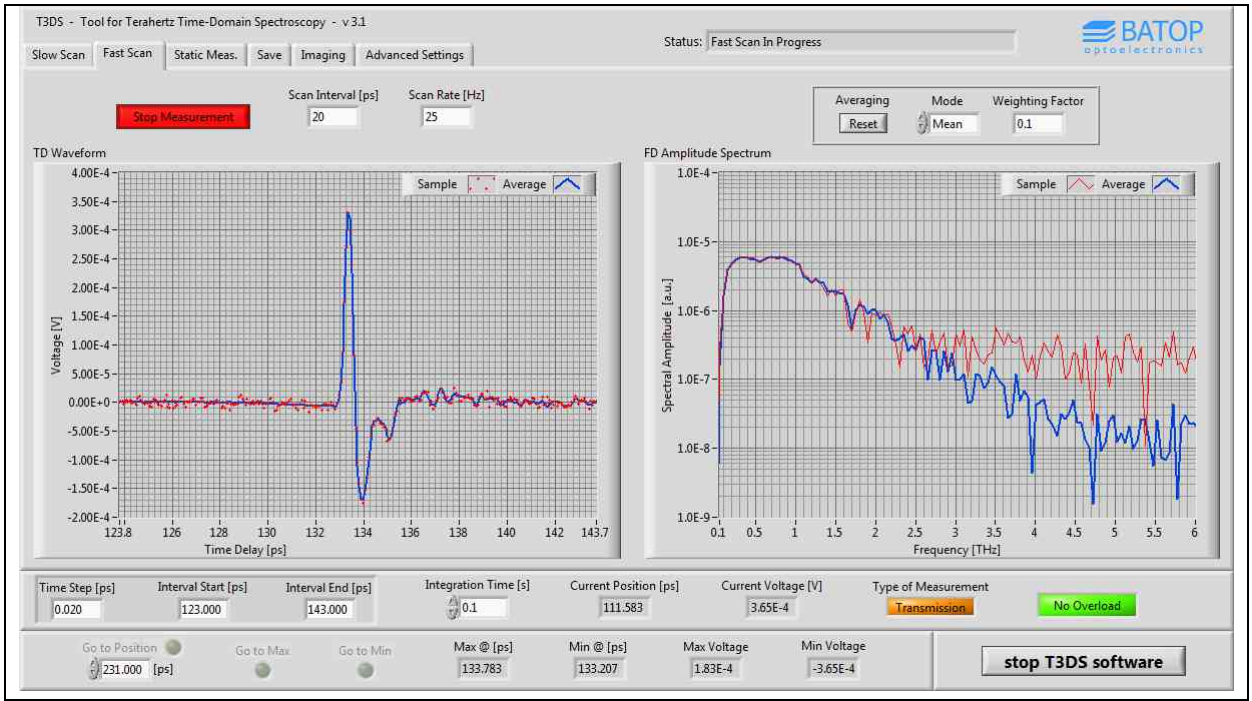
SHA - Sample Holder for Attenuated total reflection measurements, removed from the sample compartment



1.3 Option FSU – Fast Scan Unit

In order to have a live picture of the THz pulse you may want to order the fast scan unit. This hardware option gives you the possibility to optimize the THz signal within a very short amount of time which is typically needed if you change the measurement setup very often (transmission / reflection / ATR or adding / removing the focusing TPX lenses). The fast scan unit uses a voice coil that oscillates in order to scan a short time interval with a frequency of a few hertz. During the adjustment procedure the software displays a live picture of the THz pulse and the corresponding spectrum.

The voice coil allows scanning an interval of up to 40 ps with a frequency of 5 Hz. But you can also scan with a frequency of 100 Hz if an interval of 5 ps works for you. Please note that because of the limited time interval and the very rapid data acquisition this option is not meant for material analysis but only for signal optimization.



T3DS software during a fast scan measurement.

2. TDS10XX family description

All TDS systems share some common parameters that are listed in this paragraph. For the spectral bandwidth and the dynamic range please see the subsequent sections.

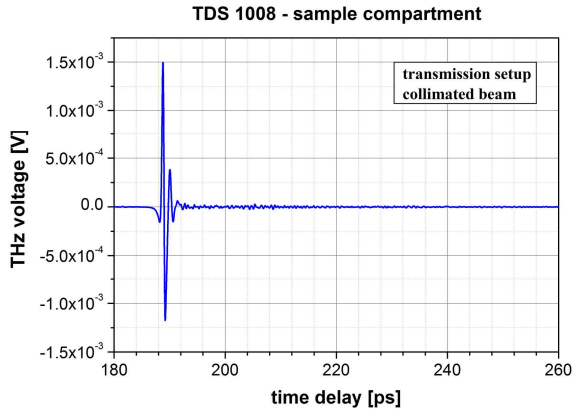
- maximum scan rage: 650 ps
- spectral resolution: < 2 GHz
- THz beam diameter: collimated: 22 mm
  focused: ~ 1 mm @ 1 THz
- sample size: collimated: 30 mm x 30 mm
  focused: 10 mm x 10 mm
- supply voltage: 110 .. 240 VAC, 50 – 60 Hz
- dimensions: 60 cm x 60 cm x 30 cm or 90 cm x 60 cm x 30 cm
- weight: 60 – 100 kg, depending on chosen configuration

2.1 TDS1008

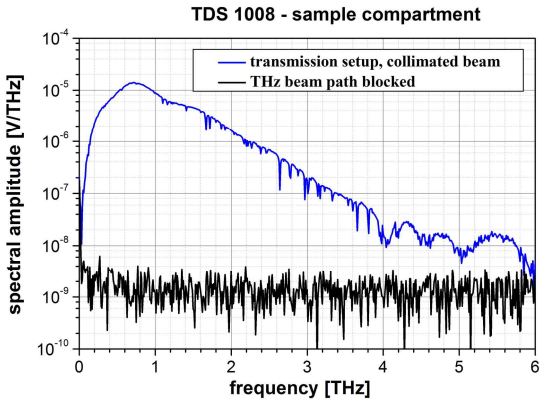
A TDS1008 THz spectrometer contains a femtosecond pulse laser with a wavelength of 780 nm and pulse duration ~ 100 fs. This laser in combination with high performance photoconductive antennas allows a large spectral bandwidth and a high dynamic range.

The TDS1008 parameters inside the sample compartment are:

- spectral bandwidth: 0.05 – 4.0 THz
- dynamic range: ≥ 85 dB



THz pulse for the sample compartment, nitrogen purge applied.



THz spectrum for the internal antennas with small absorption bands due to the air humidity.

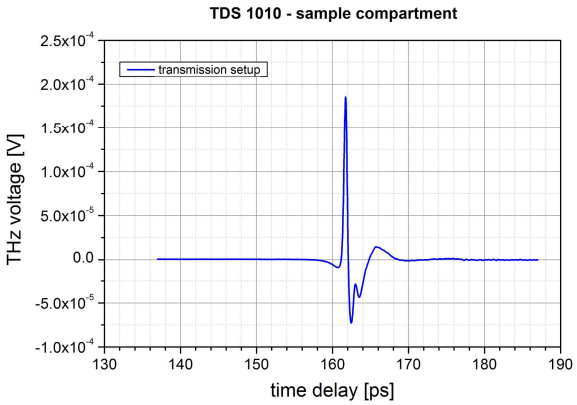
Additionally, the TDS system can be ordered with fiber coupled antennas that enable measurements on larger objects with more flexibility outside the spectrometer housing.

2.2 TDS1010

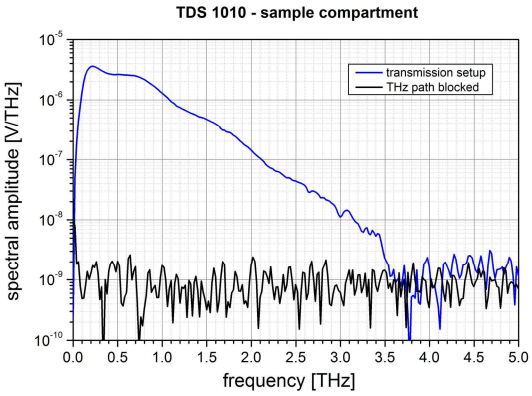
The TDS1010 THz spectrometer contains a femtosecond pulse laser with a wavelength of ~ 1060 nm and pulse duration ~ 120 fs.

The TDS1010 parameters inside the sample compartment are:

- spectral bandwidth: 0.05 – 3.0 THz
- dynamic range: ≥ 65 dB



THz pulse for the sample compartment, nitrogen purge applied.



THz spectrum for the internal antennas. There is almost no water related absorption due to the nitrogen purge.

2.3 TDS1015

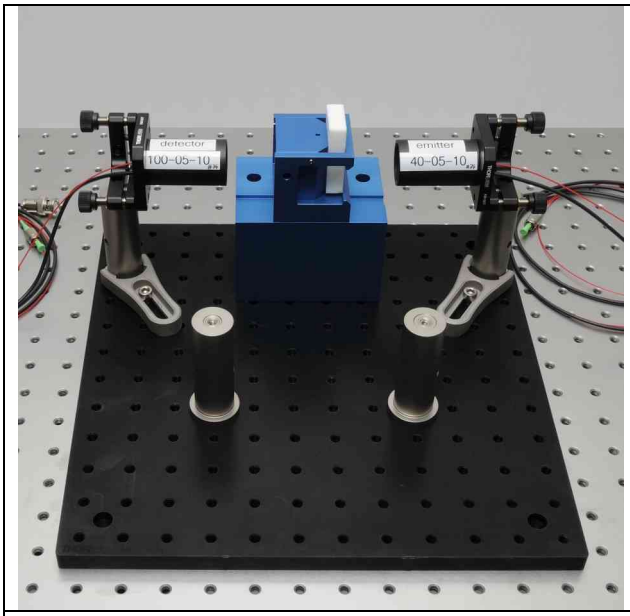
The TDS1015 THz spectrometer contains a femtosecond pulse laser with a wavelength of 1560 nm and pulse duration ~ 80 fs. Because of the reduced electrical resistance and the longer relaxation time of the photoconductive antennas for 1560 nm wavelength the spectral performance of TDS1015 is substantially lower then that of the TDS1008.

The TDS1015 parameters inside the sample compartment are:

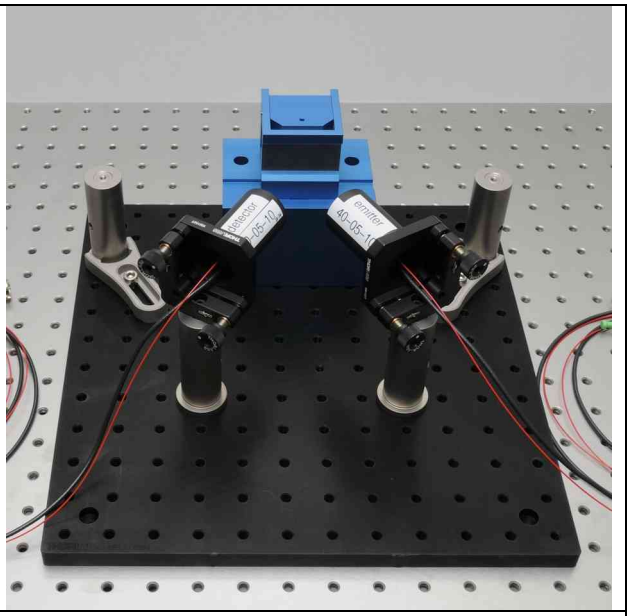
- spectral bandwidth: 0.05 – 1.5 THz
- dynamic range: ≥ 65 dB

3. TDS systems with fiber coupled antennas

You may order a TDS system with fiber coupled antennas which are used to perform transmission or reflection measurements on larger objects outside the spectrometer housing. Dispersion compensation measures have to be applied inside the spectrometer in order to avoid a broadening of the laser pulse which would lead to a very poor THz performance compared to the regular free space setup. Hence, the system has to be set up for fiber coupled antennas. In order to comply with the correct formulas used by the T3DS calculator for reflection measurements the emitter antenna incorporates a polarizer to get a vertical polarization of the THz beam.



Simple transmission setup for fiber coupled antennas, including the sample holder.



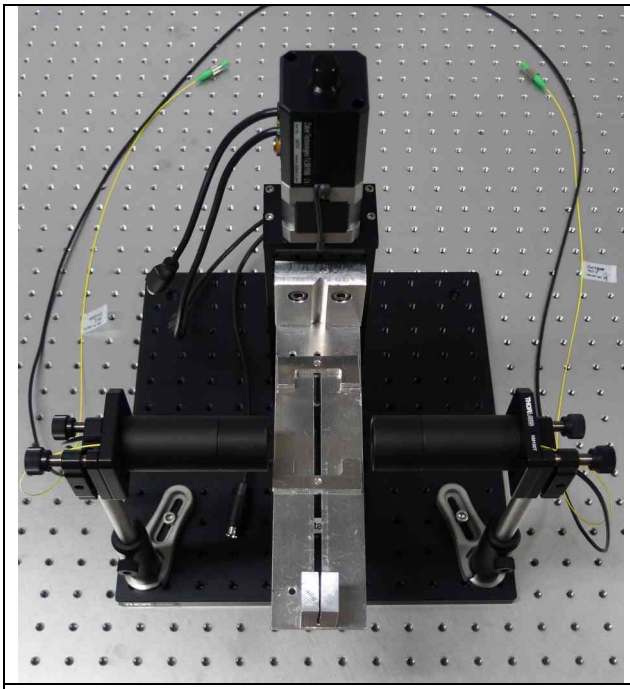
Simple reflection setup for fiber coupled antennas, including the sample holder.

The fiber coupled antennas come with a simple setup for reflection and transmission measurements as well as a sample holder for large and small samples. In case of small samples the focusing TPX lenses need to be attached directly to the lens tubes of the THz antennas. Please note that the standard reflection setup for fiber coupled antennas works at an angle of incidence of about 30 degrees – similar as the internal sample holder for reflections measurements.

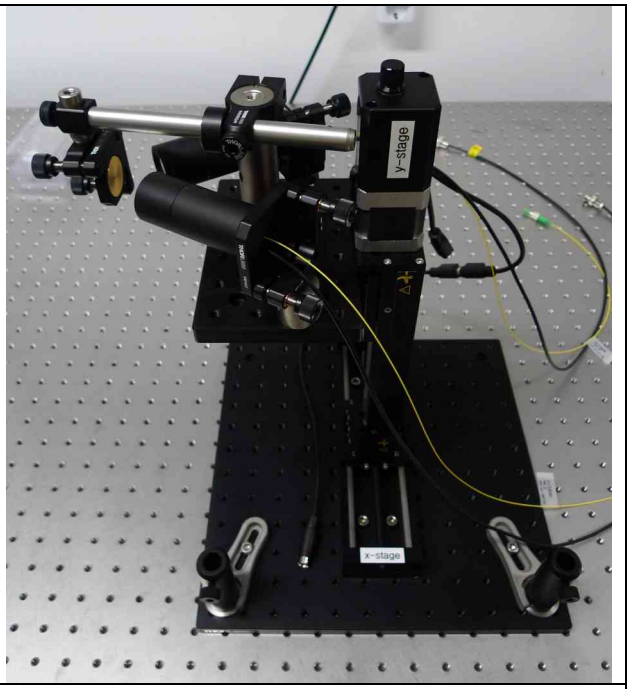
3.1 Option IU150 – Imaging Unit 150mm x 150mm

The imaging unit needs a set of two fiber coupled antennas in order to conduct measurements. The standard imaging area is 150mm x 150mm but smaller and larger scan ranges are available on request. The T3DS software adapts to the chosen imaging unit and enables the user to conduct fully automated imaging measurements.

There are different ways to scan over a designated area. A fast imaging measurement can be conducted using a fixed delay time in order to measure a height profile in reflection or a thickness profile in transmission. In contrast, a complete time domain scan at each x-y position can be executed to get the complete spectral information over the whole sample area. The scan results are displayed in-situ and stored automatically for subsequent data processing with the T3DS calculator software.



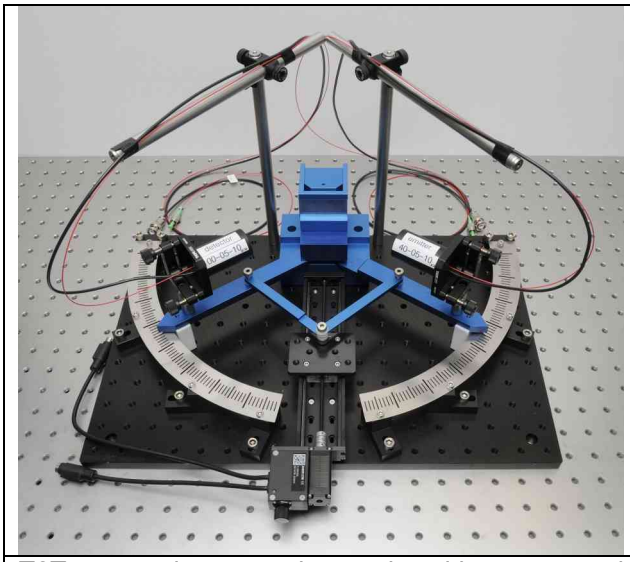
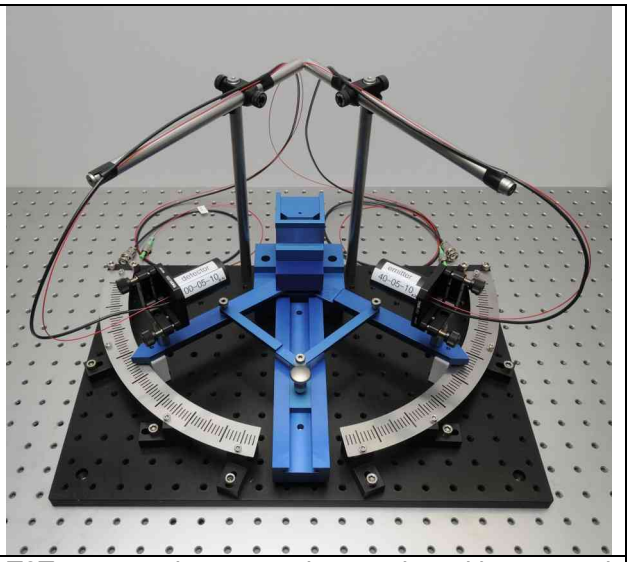
Imaging Unit IU150 set up in transmission (sample holder is not included in shipment).



Imaging Unit IU150 set up for reflection measurements on large objects. Alternatively, a small sample may be attached to the imaging unit while the THz antennas are mounted to the breadboard.

3.2 Option T2T – Theta-2-Theta Angular Scanning Unit

The angular scanning unit T2T also requires two fiber coupled antennas in order to be fully functional. During measurement the detector and emitter antenna rotate around the sample symmetrically, collecting data at different angles of incidence. Similar as with the imaging unit the T3DS software directly includes the necessary features to operate the automated T2T setup.

	
T2T-a angular scanning unit with automated positioning of the THz antennas using a linear stage.	T2T-m angular scanning unit with manual positioning of the THz antennas.

3.3 Option 2FCA – Two fiber coupled antennas

An additional set of two fiber coupled antennas may be ordered in case you want to change between a large bandwidth and a high dynamic range. These antennas come with collimating TPX lenses and removable focusing TPX lenses – similar to the fiber coupled antennas the system was delivered with. Again, the emitter antenna package includes a polarization filter.

4. Contact details

If you have any further questions or remarks, please do not hesitate to contact us.

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