Adjustment manual for free space Time-domain Terahertz-Spectrometer

Contents:

To ensure a good performance of your THz-Time-Domain-Spectrometer the following steps have to be carried out carefully.

0. Set up the laser

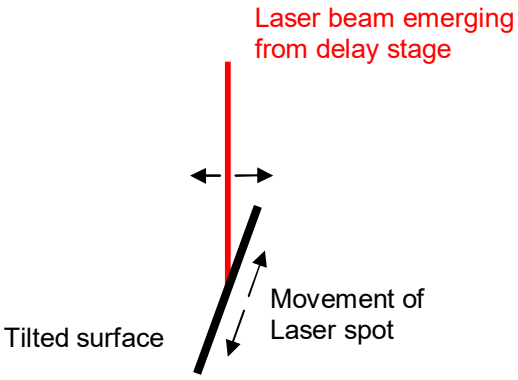
Find an appropriate spot for your laser head. Try to match the height of the laser aperture with the height of the other optical components as far as possible. The laser should be positioned on an even surface.

1. Positioning the beam splitter

Place the beam splitter in the pulsed laser beam. Make sure that the reflected beam has an angle of roughly 45° towards the incoming laser beam. Take care that the reflected beam is parallel to the table surface (breadboard).

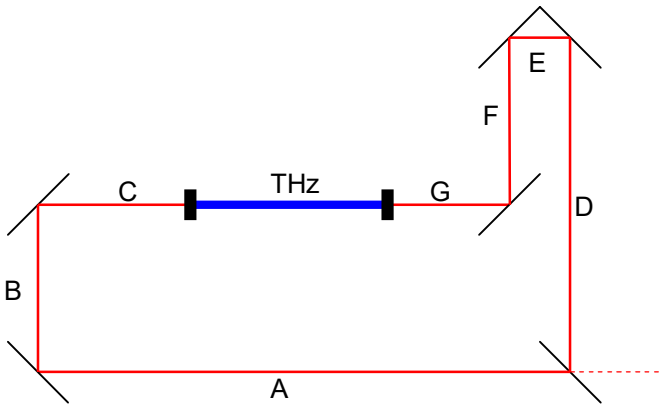
2. Alignment of the delay stage

In the next step you have to align the delay stage very carefully. If it is not properly aligned, you will get a deviation of the laser spot on your emitter while the retroreflector is moving. To make sure that the laser beam hits the same spot for every delay position you have to orientate the incoming beam exactly parallel to the direction of movement of the motorized stage. This is essential for both horizontal and vertical direction. Check your alignment by monitoring the emerging beam on a tilted surface. While moving the motorized delay stage no deviation of the laser should be visible on the surface.



3. Matching the pulse propagation times

Furthermore you have to meet the requirement of temporal overlap of the exciting laser beam and THz beam on the detector PCA chip. Therefore you have to define the position of the detector Antenna. Please keep in mind that if you are using PCAs with silicon substrate lenses with a refractive index of about 3.4. When the detector is roughly in place you have to measure the distance from the beam splitter to the detector antenna and compare it with the sum of the laser path length to the emitter antenna and THz path length. Please take the refractive indices of the substrate lenses and other beam shaping objects into account. In the sketch below the delay line is within the optical path to the emitter antenna.



$$A + B + C \equiv D + E + F + G + THz$$

It is advised to meet this condition with the delay stage positioned approximately centred.

4. Assure overlap of excitation beams

To achieve excellent results you have to match the optical axis of the THz beam with the axis of the exciting laser beams. This is done best when the PCAs are removed temporarily.

5. Corse positioning of PCAs

In this step you place the PCAs into the laser beam. Adjust the lateral position as well as the height of the antennas and monitor their electrical resistance. Try to find a minimum value. For detector antennas that carry a preamplifier you have to monitor the offset voltage of the amplifier output and achieve a minimum offset. In this case the laser spot hits the central gap area of the PCA quite well.

6. Record your first THz-pulse

If all the alignment steps were done with great care you should be able to get your first THz-pulse. Connect the emitter PCA to the power supply and choose an appropriate bias voltage (according to the PCA data sheets) and modulation frequency (suggestion: 500 Hz – 10 kHz). Connect the detector PCA to the Lock-In-Amplifier (LIA) input. Start your Terahertz Spectroscopy Software and do a fast scan over the whole range of the delay stage. You should now see a characteristic THz-Pulse. Do a fine measurement with a small time frame to receive the maximum position.

7. Aim for the best

Move the delay stage towards the maximum position and refine your adjustment to maximize the signal strength. It is recommended to adjust the phase at your LIA at the position of maximal signal strength.