Instruction manual and data sheet PCA-100-05-10-1060-x

Photoconductive THz antenna for laser excitation wavelengths λ ~ 800 nm … 1130 nm

PCA – Photoconductive Antenna

PCA-100-05-10-1060-0 - unmounted antenna chip 4 mm x 4 mm with 4 bond contact pads

PCA-100-05-10-1060-h - mounted antenna on hyperhemispherical silicon substrate lens

PCA-100-05-10-1060-a - mounted antenna on aspheric focusing silicon substrate lens

PCA-100-05-10-1060-h-f - fiber coupled antenna on hyperhemispherical silicon substrate lens

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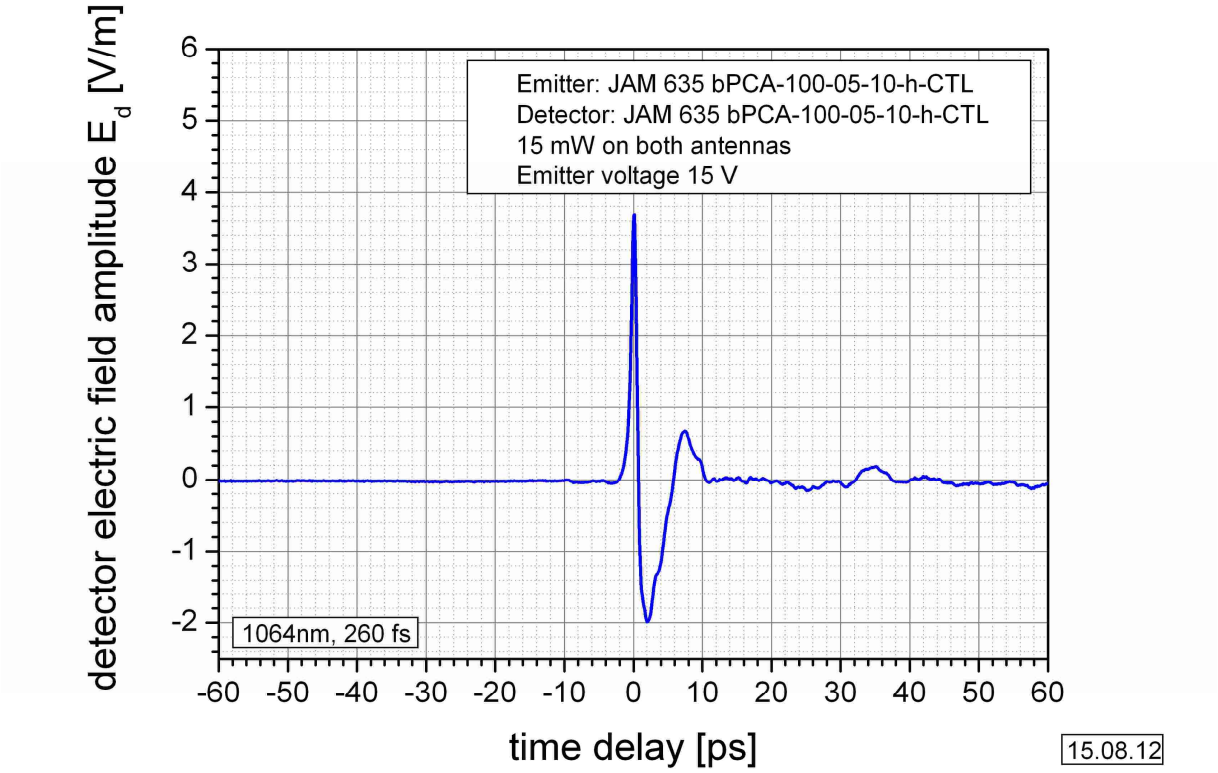
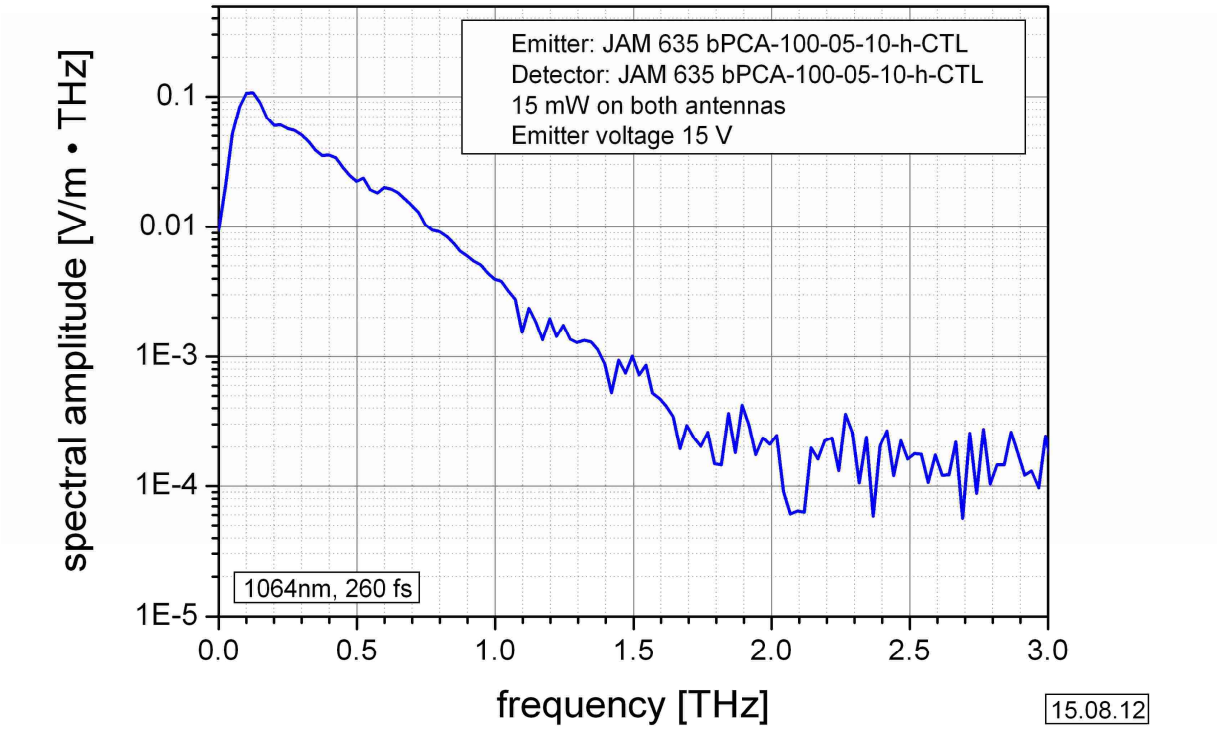




2. PCA applications

The PCA can be used as terahertz (THz) emitter or detector in pulsed laser gated broadband THz measurement systems for time-domain spectroscopy in the frequency region from 0.1 to 2.0 THz. It also can be used as photomixing emitter or detector in tunable cw THz measurement systems up to 0.5 THz.

Main PCA data

- Laser excitation wavelength 1060 nm
- Antenna gap: 5 µm
- Bow tie antenna length 100 µm
- Antenna chip size 4 mm x 4 mm

3. Antenna Design

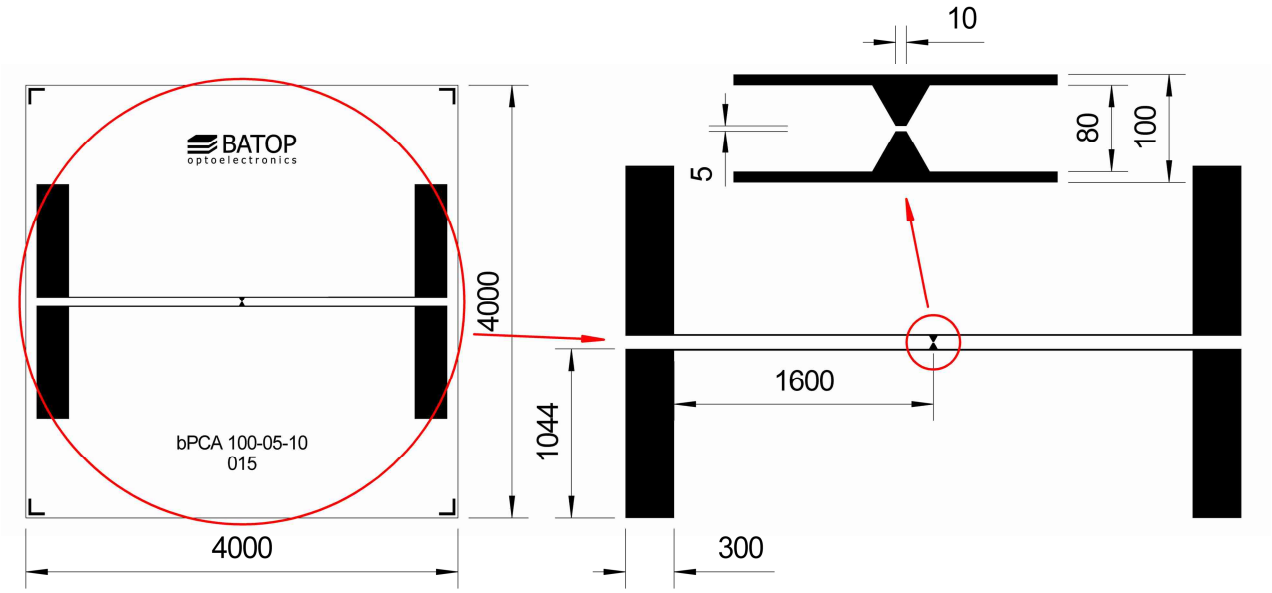


Photo PCA 100-05-10-1060 (survey)

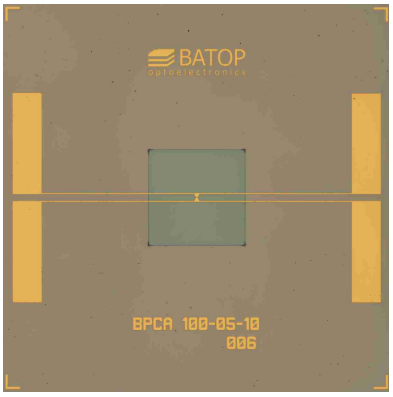


Photo PCA100-05-10-1060

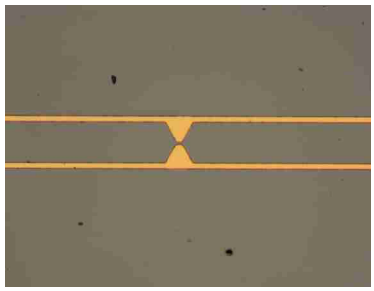
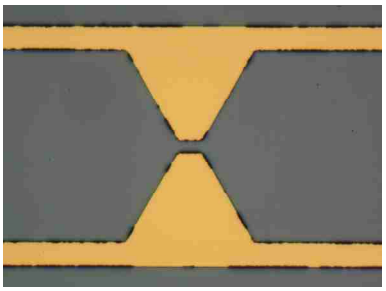


Photo PCA 100-05-10-1060 (detail)

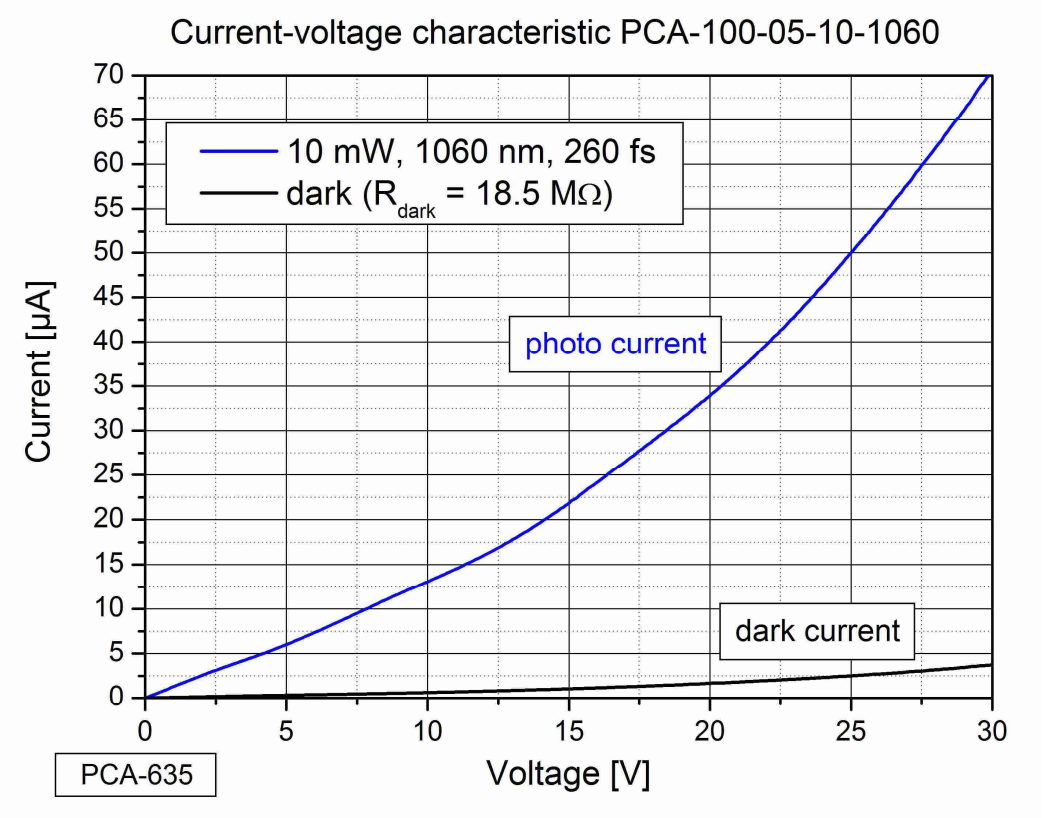


4. Antenna parameters

Electrical parameters

Parameter	minimum ratings	standard	maximum ratings
Dark resistance	15 MΩ	18 MΩ	25 MΩ
Dark current @ 10 V	8 µA	13 µA	20 µA
Voltage		15 V	20 V

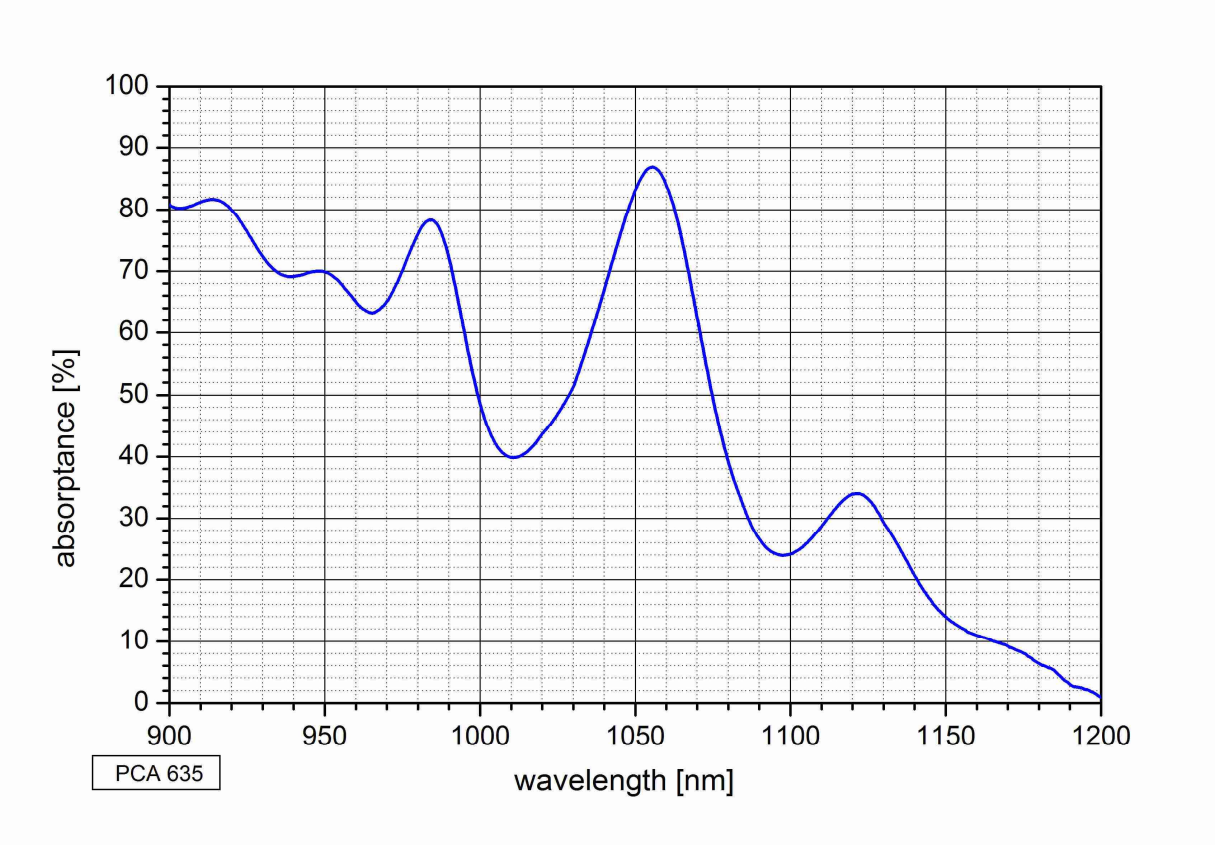
Dark current voltage characteristic at T = 300 K



Optical excitation parameters

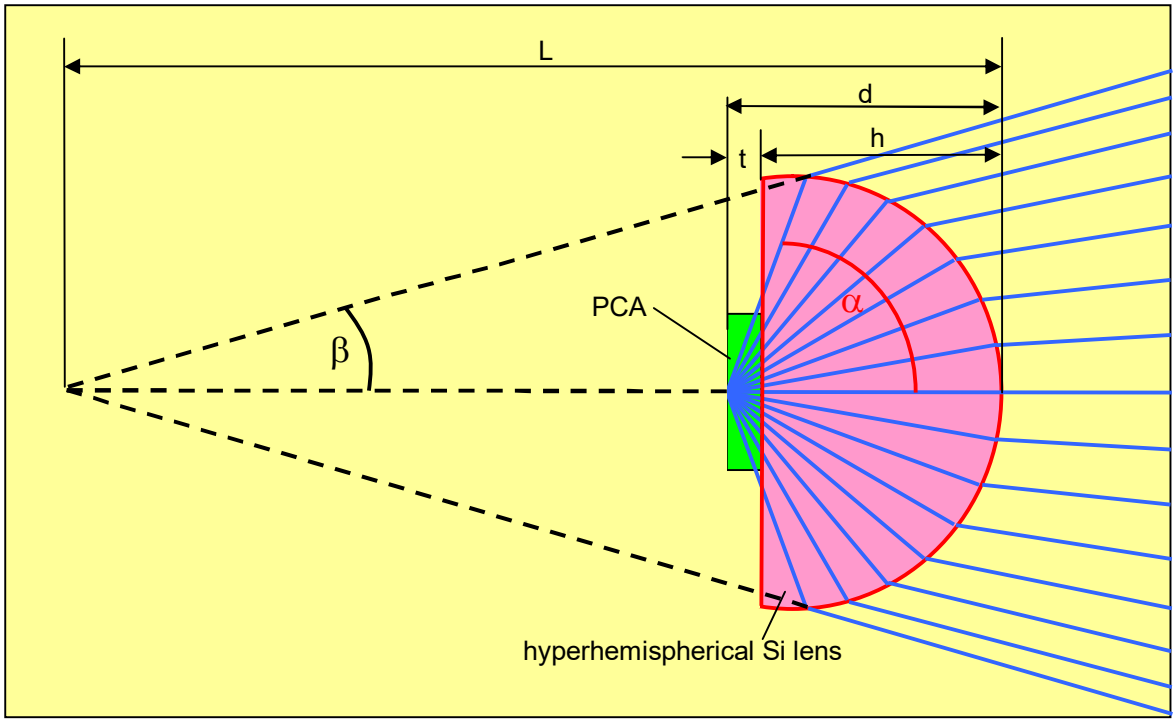
Parameter	standard	maximum
Optical absorption	84% @ 1060 nm	
Optical mean power	20 mW	30 mW
Carrier recovery time	300 fs	

Spectral absorbance



5. Mounted PCA on hyperhemispherical substrate lens: PCA-100-05-10-1060-h

Photoconductive antenna	substrate	semi-insulating GaAs
	chip area	4 mm x 4 mm
	thickness t	630 µm
Hyperhemispherical lens	material	undoped HRFZ-silicon,
	specific resistance ρ	>10 kΩcm
	refractive index n	3.4
	diameter	12 mm
	height h	7.1 mm
	distance d	7.7 mm
Terahertz beam	collection angle α	57°
	divergence angle ß	15°
	virtual focus length L	26.4 mm



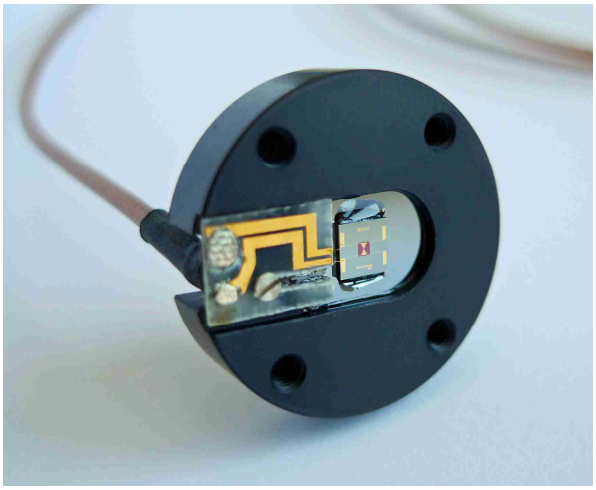
Aluminium mount	25.4 mm diameter, 6 mm thick
Coaxial cable	type RG174 U, impedance 50Ω, capacitance 96pF/m, 1 m long
Connector type	BNC or SMA

- The PCA chip is optically adjusted and glued on the hyperhemispherical silicon lens. The alignment of the PCA chip centre is done with respect to the optical axis of the silicon lens.

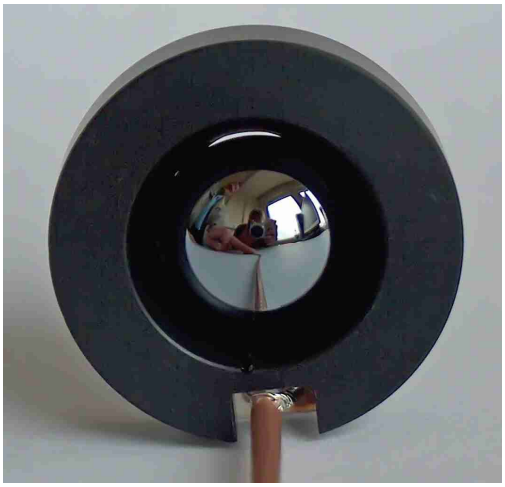
- The silicon lens is glued on the aluminium mount.
- The two antenna contacts are wire bonded on a printed circuit board, which provides the connection to a 1m long coaxial cable with BNC or SMA connector
- A central hole in the aluminium mount allows the Terahertz radiation to escape from the hyperhemispherical silicon lens

PCA with hyperhemispherical silicon lens, coaxial cable RG 178 and BNC connector

Front view on mounted PCA (laser side)



Back view on mounted PCA (THz side)



The antenna can be used as terahertz emitter or detector in pulsed laser gated broadband THz measurement systems for time-domain spectroscopy and as photomixing emitter or detector in tunable cw THz measurement systems in the frequency region from 0.1 to 2.0 THz (see schematics below).

Schematic of a time-domain spectroscopy setup

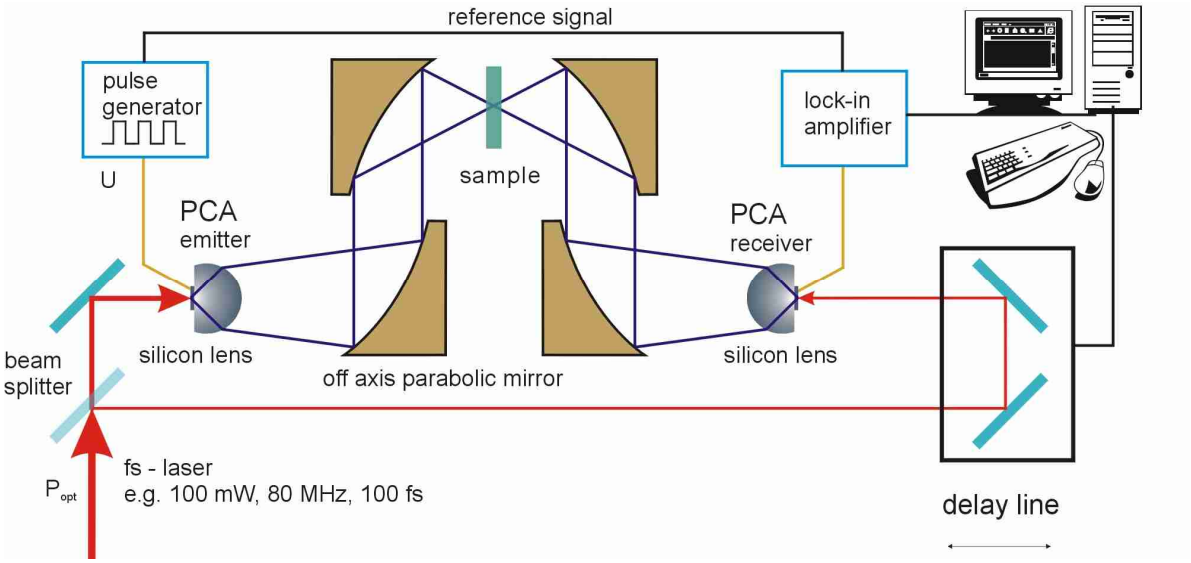
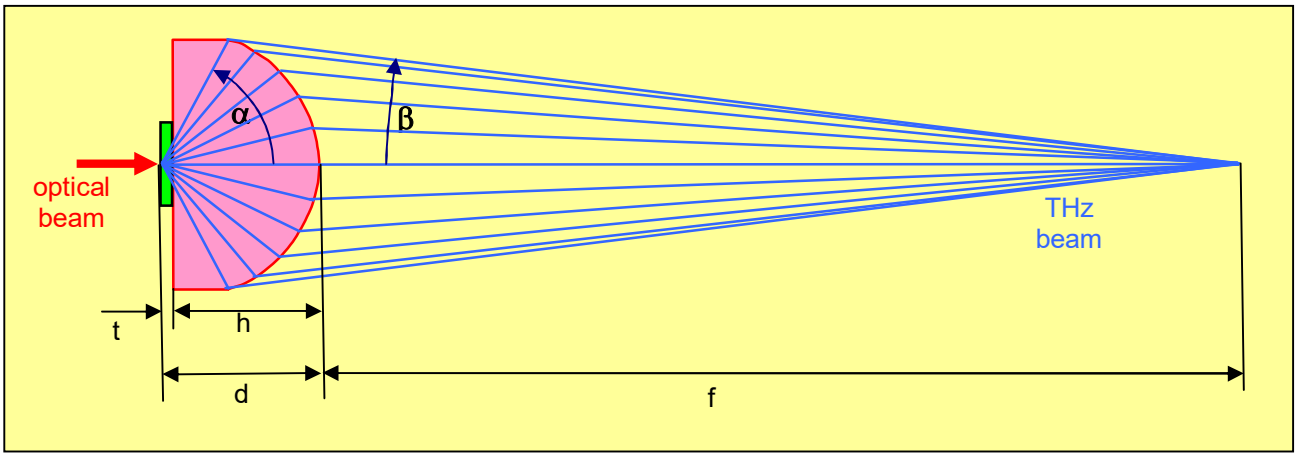


Fig.1 Schematic of a time-domain spectroscopy setup

6. Mounted PCA on aspheric focusing substrate lens: PCA-100-05-10-1060-a

Photoconductive antenna	substrate	semi-insulating GaAs
	chip area	4 mm x 4 mm
	thickness t	630 µm
Aspheric lens	material	undoped HRFZ-silicon
	specific resistance ρ	>10 kΩcm
	refractive index n	3.4
	diameter	12 mm
	height h	8 mm
	distance d	8.6 mm
	rough AR surface	
Terahertz beam	focal length f	53 mm
	collection angle α	57.6°
	convergence angle ß	6.8°
Airy disc diameter	at 300 GHz	5 mm
	at 1 THz	1.5 mm
	at 3 THz	0.5 mm



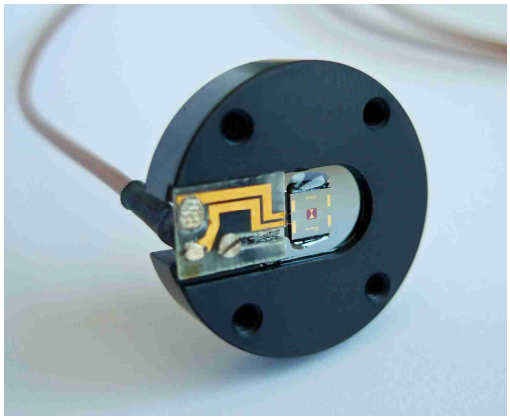
Aluminium mount	25.4 mm diameter, 6 mm thick
Coaxial cable	type RG174 U, impedance 50Ω, capacitance 96pF/m, 1 m long
Connector type	BNC or SMA

- The PCA chip is optically adjusted and glued on the aspheric silicon lens. The alignment of the PCA chip centre is done with respect to the optical axis of the silicon lens.

- The silicon lens is glued on the aluminium mount.
- Two antenna contacts are wire bonded on a printed circuit board, which provides the connection to a 1m long coaxial cable with BNC or SMA connector
- A central hole in the aluminium mount allows the Terahertz radiation to escape from the aspheric silicon lens as a focused beam with a focus 53 mm away and an Airy disc diameter dependent on the THz frequency.

PCA with aspheric silicon lens, coaxial cable RG 178 and BNC connector

Front view on mounted PCA (laser side)

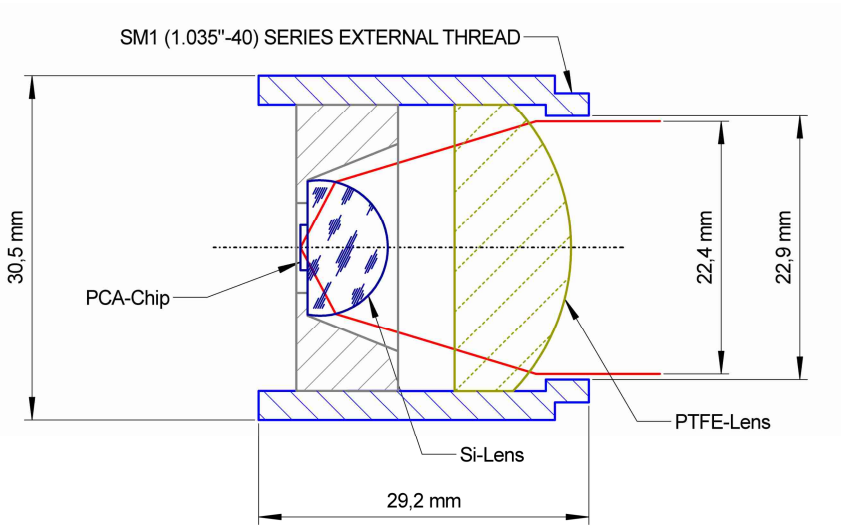


Back view on mounted PCA (THz side)

7. Setup with Teflon lenses

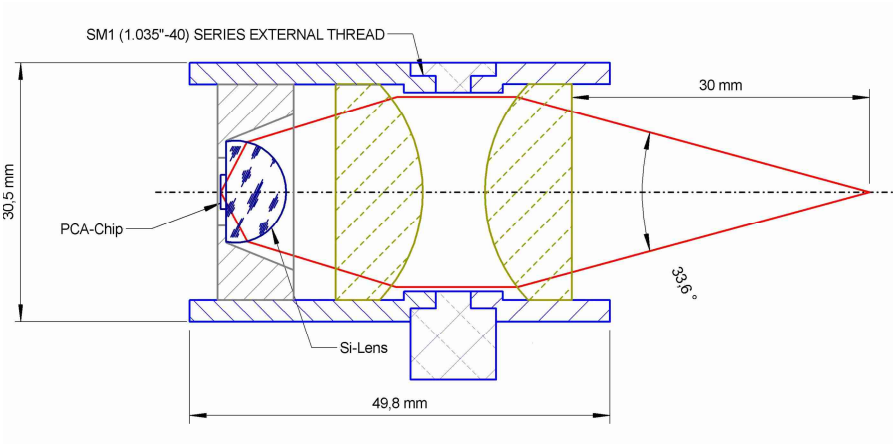
We recommend the usage of PTFE lenses for the THz beam optics. This solution ensures good spectral performance of your spectrometer and is easier to handle as the usage of off-axis-parabolic mirrors. We offer mounted antennas with collimating teflon lenses (CTL-D25). These mounts can be upgraded with a second lens with a focal length of 30 mm (FTL-f30mm). You can then choose if you like to work with a collimated or focused THz beam.

Module CTL-D25



THz beam in the module

CTL-D25 combined with FTL-f30mm



THz beam in the combination of CTL-D25 and FTL-f30mm

8. Instructions for use of the PCA-100-05-10-1060-x

Emitter:

The pulsed laser beam (in case of time domain spectroscopy) or the mixed cw laser beam (in case of cw THz emitter) has to be focussed onto the antenna gap using an appropriate lens or objective with a beam diameter of about 5 µm to bridge the antenna gap with photo-excited carriers within the semiconductor. At the same time a voltage U of ~ 15 V (maximum 20 V peak voltage) has to be supplied on the gap by connecting the BNC connector cable to a voltage source. The recommended optical mean laser power P_{opt} is 20 mW (maximum 30 mW).

Receiver:

The pulsed laser beam (in case of time domain spectroscopy) or the mixed cw laser beam (in case of cw THz emitter) has to be focussed onto the antenna gap using an appropriate lens or objective with a beam diameter of about 5 µm to bridge the antenna gap with photo-excited carriers within the semiconductor. The phase of the laser beam with respect to the beam on the emitter site has to be adjusted by using an optical delay line in such a way, that the measured value of the THz field on the antenna meets a maximum of the optical beam. By changing the path difference between the emitter and receiver antenna the time-dependent shape of the THz field can be measured. The cable with the BNC connector must be connected with a sensitive electronic current amplifier.

PCA-100-05-10-1060-x-y-p with Integrated preamplifier:

If the antenna has an integrated preamplifier on the PCB, the four wire cable of the antenna (2 wires for bias supply, 2 wires for the amplified output signal) must be connected to the power supply using the Sub-D connector. The output signal is then available on the BNC connector on the power supply to measure it using an oscilloscope or a lock-in detector.

Attention: Please be sure, that the focusing lens or the lens mounting parts does not touch the antenna chip or the tiny gold contact wires between the antenna chip and the PCB. See figure “front view on mounted PCA (laser side)” above.

Lock-in detection

Because of the small detector signal a lock-in detection scheme is recommended. The following two possibilities for lock-in detection can be used:

- An optical chopper can be used in front of the emitter antenna to chop the optical beam with a frequency ~ 1 kHz. The result is a chopped emitted THz signal, which meets the detector antenna. The output of the detector antenna is than an alternating current, which can be amplified using an ac amplifier and rectified using a standard lock-in system. The disadvantage of this system is the loss of 50 % of the optical excitation power on the emitter antenna.

- A square wave voltage generator with an output voltage U of maximum +/- 20 V and a frequency of some kHz can be used as supply for the emitter antenna. The result is an emitted alternating THz signal, which meets the detector antenna. The output of the detector antenna is than an alternating current, which can be amplified using an ac amplifier and rectified using a standard lock-in system. This setup is shown in fig.1.

9. Order information

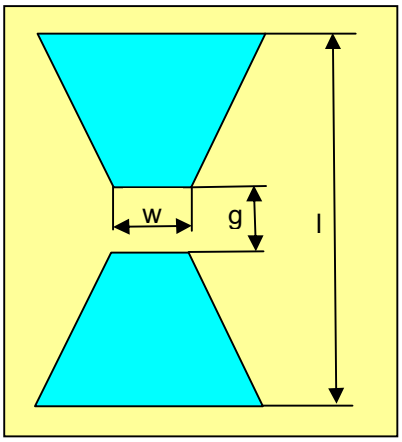
PCA-100-05-10-1060-**x** Photoconductive antenna

length l = 100 µm

gap g = 5 µm

width w = 10 µm

laser wavelength λ = 1060 nm
(800 nm … 1130 nm)



x denotes the type of mounting as follows:

x = 0	unmounted chip 4 mm x 4 mm with 4 bond contact pads
x = h	mounted on an Al disc with 25.4 mm ∅ and **h**yperhemispherical silicon substrate lens, 1m coaxial cable with BNC or SMA connector
x = a	mounted on an Al disc with 25.4 mm ∅ and aspheric focusing silicon substrate lens, 1m coaxial cable with BNC or SMA connector
x = h-f	fiber coupled antenna with hyperhemispherical silicon substrate lens