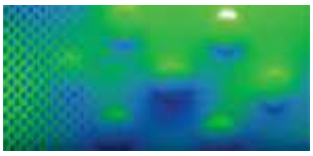

A NEW WAY TO SEE
protemics

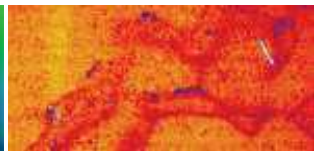
Terahertz microprobe

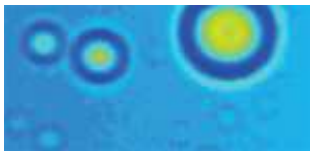
Application areas

Terahertz microprobing technology:

Taking advantage of Terahertz range benefits without being compromised by wavelength-based resolution limitations.







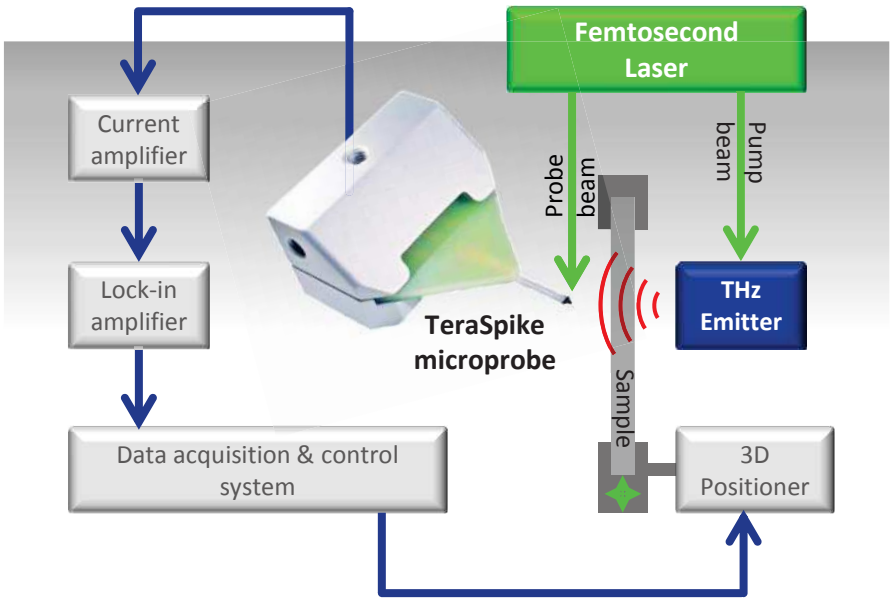
Terahertz Research	Thin-film Inspection	Chip-package Testing	Volume Screening
Application areas: • Metamaterials • Plasmonics • Passive devices • Emitters • Antennas • Waveguides • Sensor surfaces • Graphene	**Application areas:** • Solar cells • Displays • Flexible electronics • Semiconductors • Graphene • Transparent conductors	**Application areas:** • Time-domain reflectometry • Fault isolation • Packaging level inspection • 3D integration • Through silicon via (TSV)	**Application areas:** • Laser plastic weld inspection • Fiber inforced polymers • Chip underfill inspection • Organic layer screening
Benefits: • Near-field access • Cost-efficient system extension • High-sensitivity • Low-invasiveness • Polarisation sensitive • Broadband	**Benefits:** • Sheet resistance imaging • Contactless • Micron-scale resolution • Large-area scanning • High-speed scanning	**Benefits:** • Market leading TDR resolution • Sub-ps rise-times • Contactless • Non-destructive • Cost advantage over all-electronic systems	**Benefits:** • Non-destructive • Fast inspection • Screening of Vis/IR opaque plastics • Detection of micron-scale structures

Optoelectronic

Terahertz technology

Femtosecond-laser-based THz systems

Photoconductive TeraSpike microprobes are the key enabling components for high-resolution Terahertz imaging offering unprecedented sensitivity, resolution and non-invasiveness.



Simplified exemplary scheme of a TeraSpike-enabled THz near-field imaging system.

We offer

- **Systems**: Near-field imaging systems, sub-systems, modules & custom solutions
- **Components**: THz microprobes, THz emitters, accessories,…
- **Measurement services**

Please contact us for further information or inquiries.

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THz near-field scanning system

TeraCube Scientific

new

The new standard for micron-scale resolution THz imaging on large areas

The TeraCube Scientific is a fully automated THz near-field scanning system. The system provides a high-efficient source for the optical generation of broadband THz pulses which can be transmitted through planar samples. Spatially and temporally resolved detection of the transmitted pulses in the near-field of sample surfaces is enabled by Protemics TeraSpike microprobes integrated near-field detectors. The system enables measurements on arbitrary surface topographies through active control of the detector/surface distance. It can be driven by an existing or new fs-laser source with suitable specifications.

Application areas

- THz Metamaterial research and sensing application
- Semiconductor wafer inspection
- Sheet resistance imaging
- Graphene analysis
- THz device characterization
- Microstructure analysis
- Non-destructive testing

Key features

- High-speed continuous move scanning & data acquisition
- Optical sample topography detection for scanning at constant microprobe/surface-distance
- Synchronized motion-control and real-time position detection
- Linear polarized and rotatable THz emitter for polarization-dependent measurements
- High performance THz emitter/detector component
- High dynamic range Lock-in detection
- Integrated CCD camera module for monitoring of microprobe tip and sample position
- System control and measurement automation software on integrated PC unit
- Software-implemented alignment monitoring function and system health check electronics
- Software assisted microprobe-tip to sample surface approximation
- Time-domain signal preview mode for fast optical alignment
- Data-export as plain-text or Matlab-compatible format
- System housing for laser beam and dust protection
- Open extendable lab-type system platform

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THz near-field scanning system

TeraCube Scientific

Technical data

Type	TeraCube Scientific
Spectral range	0.05 - 4 THz
Maximum sample size (x, y, z)	20 cm, 20 cm, 1 cm
Maximum scanning speed (x, y)	750 mm/s
Min. scanning time per pixel	10 ms
Maximum scanning range (x, y, z)	18 cm, 18 cm, 3 mm
Time-domain scanning range	1000 ps
Time-domain step resolution (dt)	6.6 fs
Bi-directional repeatability (x, y, z)	+-0.1 µm, +-0.1 µm, +-0.15 µm
Step resolution (dx, dy, dz)	<3 nm, <3 nm, <2 nm

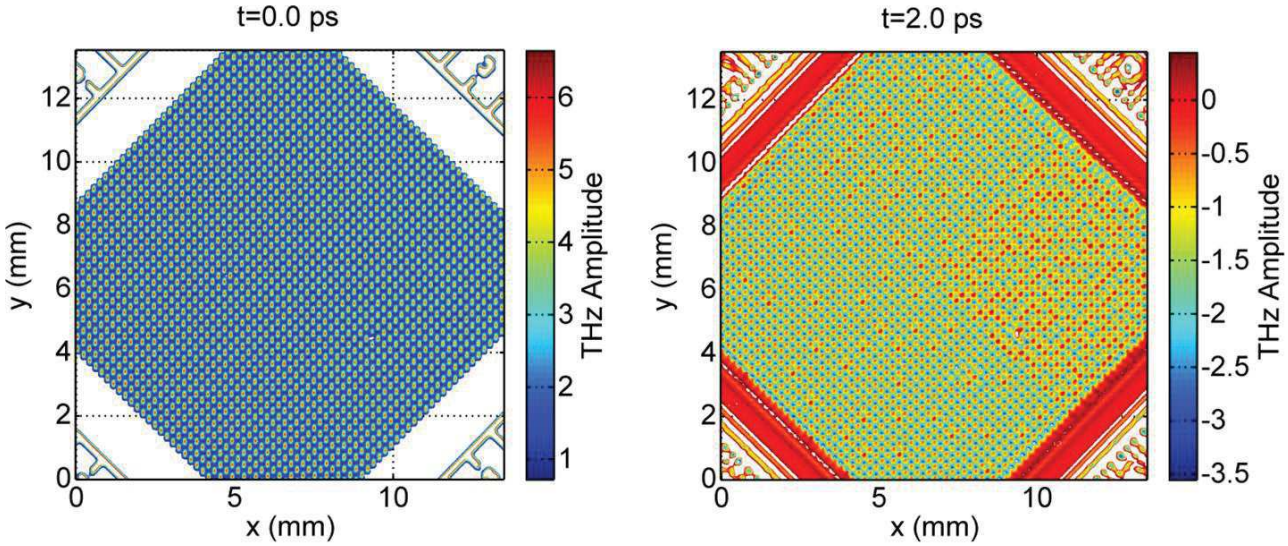
Installation requirements

- Vibration-damped optical table with 1m x 1m x 1m of space for system placement
- Laser laboratory specification of class 3b or higher

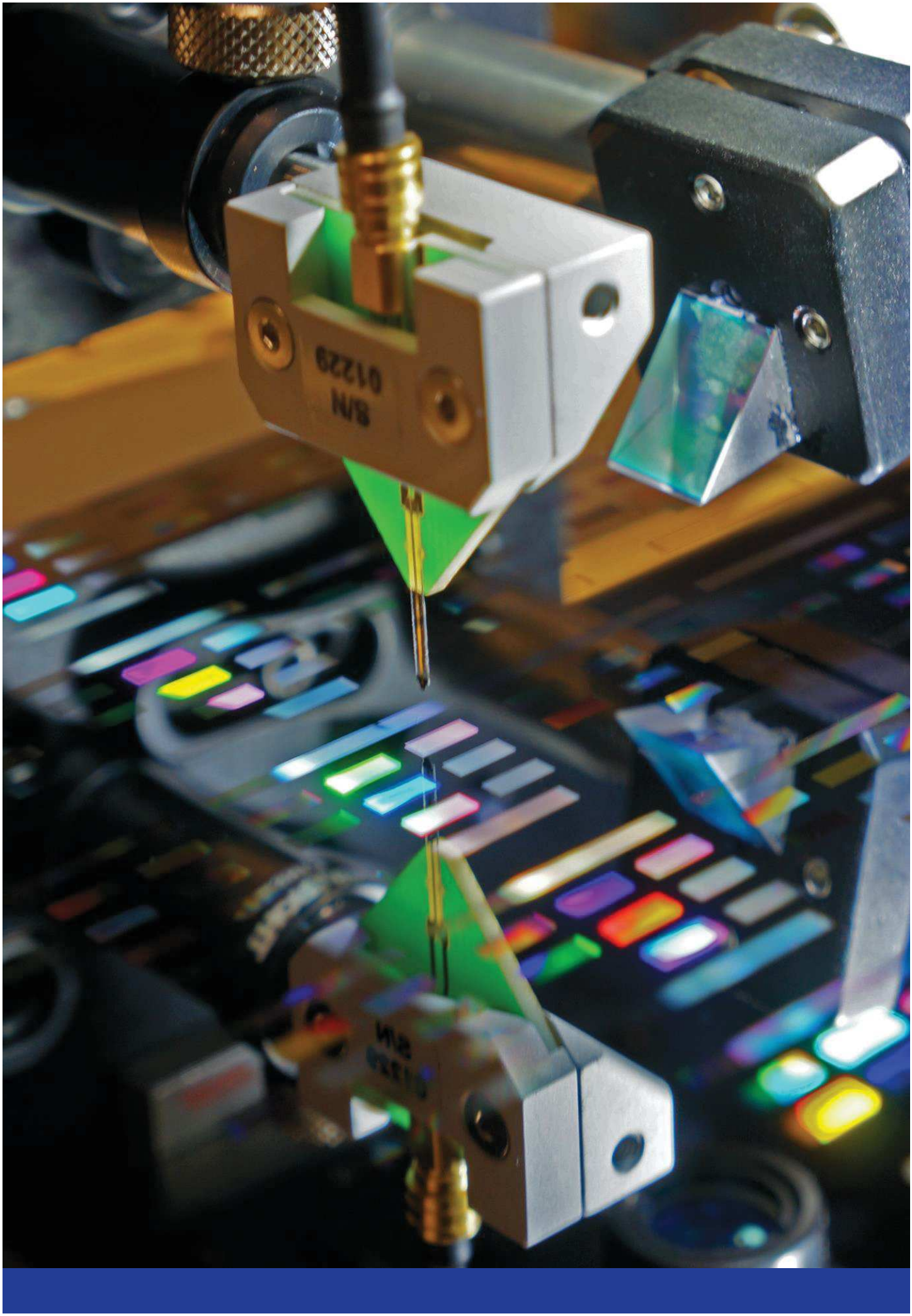
fs-Laser requirements

- Center wavelength: 770 nm ... 820 nm
- Repetition rate: 10 MHz ... 1 GHz
- Avg. optical power: 60 mW ... 1.5 W
- Pulse duration: < 150 fs

Measurement example



Example plots of the THz near-field destribution measured at a metamaterial surface for sensing applications which is locally loaded with sample material. Left: Peak excitation state, right: 2 ps after excitation.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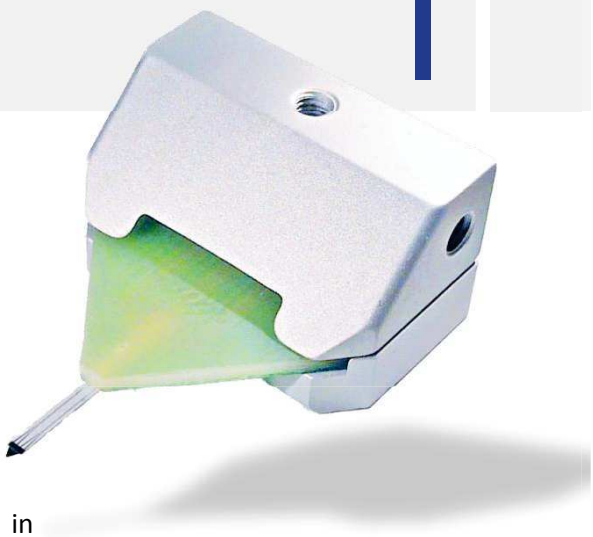
Next generation

Terahertz microprobe series



TeraSpike

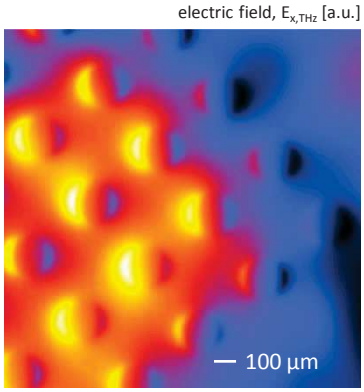
LT-GaAs photoconductive field detector

The microprobe device series TeraSpike has been introduced in 2013. Since then through our customers' feedback and application-driven demands the functional range of the microprobes has been continuously extended. The TeraSpike microprobe is a versatile detector for radiated and surface-near electric fields in the THz frequency-range offering unprecedented performance, robustness and applicability. It is the key component of the TeraCube Scientific near-field scanning system. Furthermore, it seamlessly fits into most other THz time-domain systems with optical excitation wavelengths below 860 nm. It is the most cost-efficient solution to turn your system into a powerful high-resolution near-field THz system.

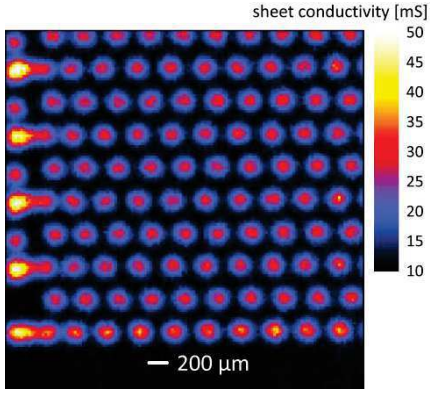
Your laser-based THz system can do much more than just spectroscopy – discover the fascinating world of high-resolution THz applications!

Key features

- Smallest active THz probe-tip on the market with only 1 µm cantilever thickness based on a patented design (DE 10 2009 000 823.3)
- Spatial resolution up to 3 µm
- Frequency range 0 – 4 THz
- Adaptable to all laser-based THz-Systems with λ < 860 nm
- Mounting compatible with standard opto-mechanical components
- Required optical excitation power < 1 mW



Measured near-field image of a pulse-excited THz metamaterial surface.



Measured sheet conductivity image of a laser-doped multicrystalline silicon wafer.

Applications

- Terahertz research: Metamaterials, plasmonics, graphene, waveguides, …
- High-resolution Terahertz near-field imaging
- Contact-free sheet resistance imaging of semiconductors
- MMIC device characterization
- Non-destructive chip inspection
- Time-domain reflectometry (TDR)

Transversal field microprobes

TeraSpike TD-800-X

Technical data

TeraSpike TD-800-X-	HR	HRS
Max. spatial resolution	3 µm	20 µm
PC gap size	1.5 µm	2 µm
Dark current @ 1 V Bias	< 0.5 nA	< 0.5 nA
Photocurrent (*)	> 1 µA	> 0.6 µA
Excitation wavelength	700 .. 860 nm	
Avg. excitation power	0.1 .. 4 mW	
Connection type	SMP	

(*) For a focus diameter of circa 20 µm, bias voltage 1 V , average optical excitation power 4 mW.

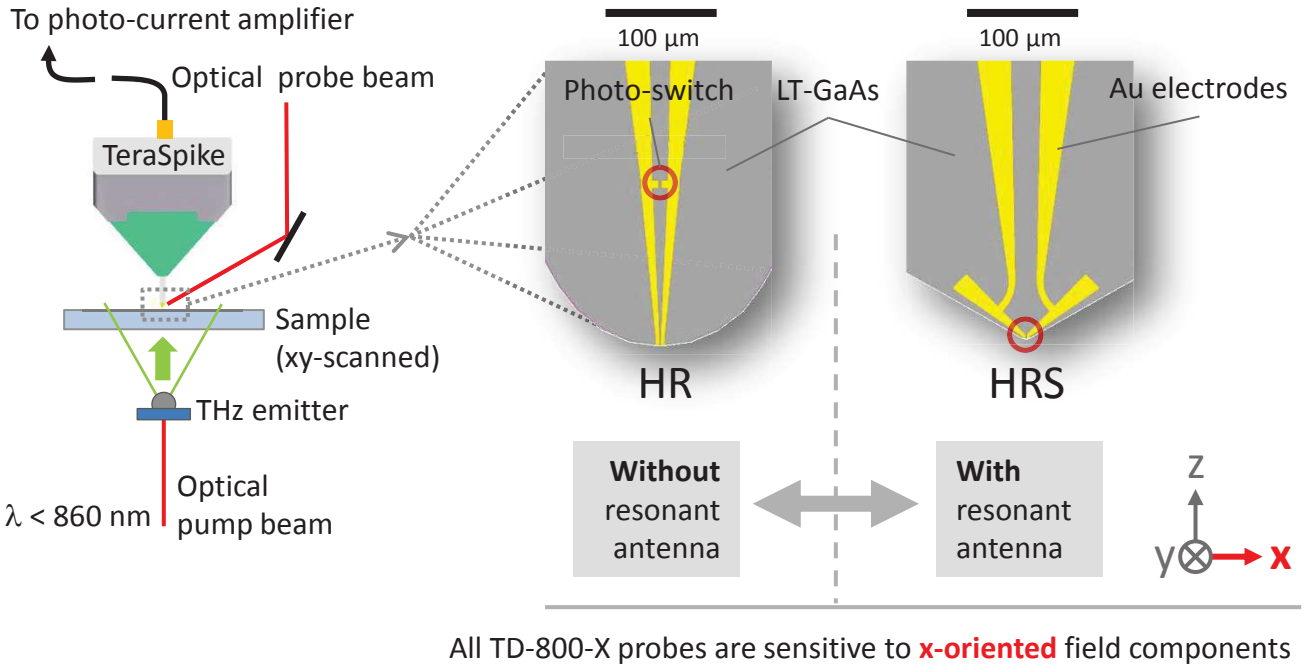
Product details

- Photoconductive probe-tip with integrated overvoltage protection optimized for pulsed excitation
- Mount for variable probe orientation
- Simple & safe probe removal from the set-up
- Robust probe storage box
- Test certificate & manual

Accessories

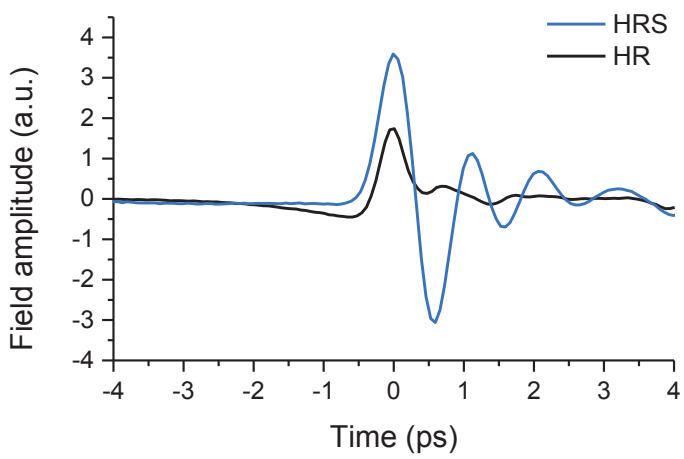
- SMP to SMA/BNC cable connection
- Photo-current amplifier
- Probe-tip dummy structure
- Mounting & focusing units
- Starter Kit

Set-up (exemplary for near-field transmission measurements)



All TD-800-X probes are sensitive to **x-oriented** field components

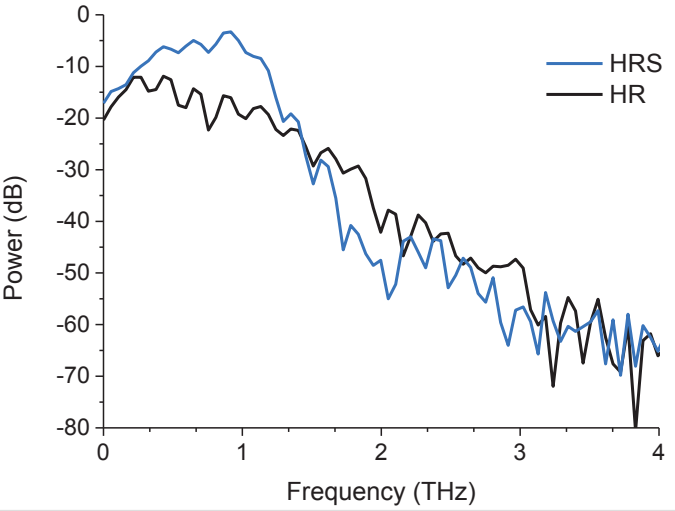
Time-domain measurement data



Key feature:

- Highest sensitivity for 0.5 THz < f < 1.3 THz

Frequency-domain measurement data



Key feature:

- Highest spatial resolution
- Highest bandwidth

Longitudinal field microprobe

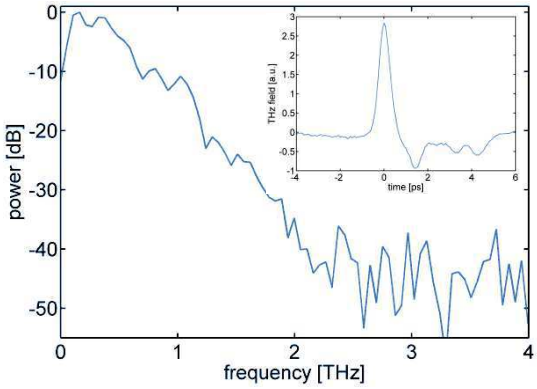
TeraSpike TD-800-Z

Technical data

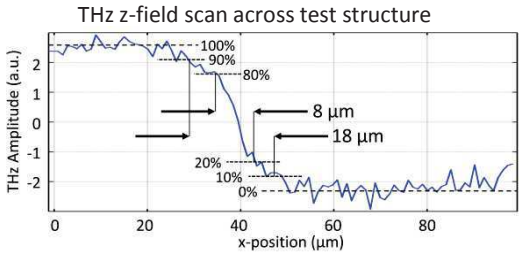
TeraSpike TD-800-Z-	A-500G
Max. spatial resolution	8 µm
PC gap size	5 µm
Dark current @ 1 V Bias	< 0.4 nA
Photocurrent (*)	> 0.5 µA
Excitation wavelength	700 .. 860 nm
Avg. excitation power	0.1 .. 4 mW
Connection type	SMP

(*) For a focus diameter of circa 20 µm, bias voltage 1 V, average optical excitation power 4 mW.

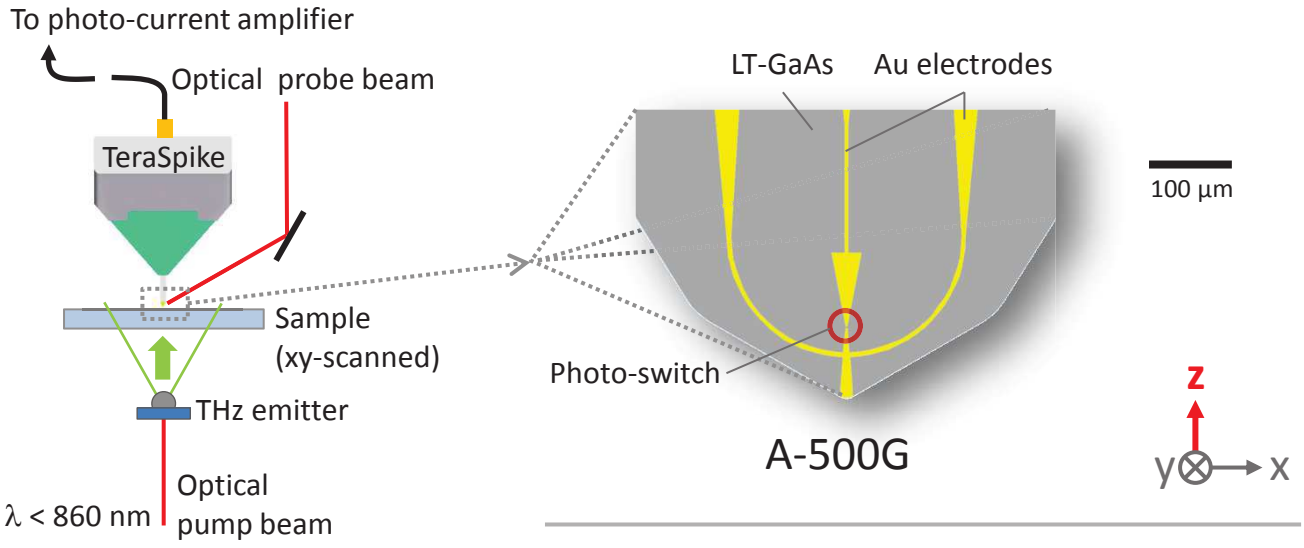
Time-domain (FFT) data



Spatial resolution



Set-up (exemplary for near-field transmission measurements)

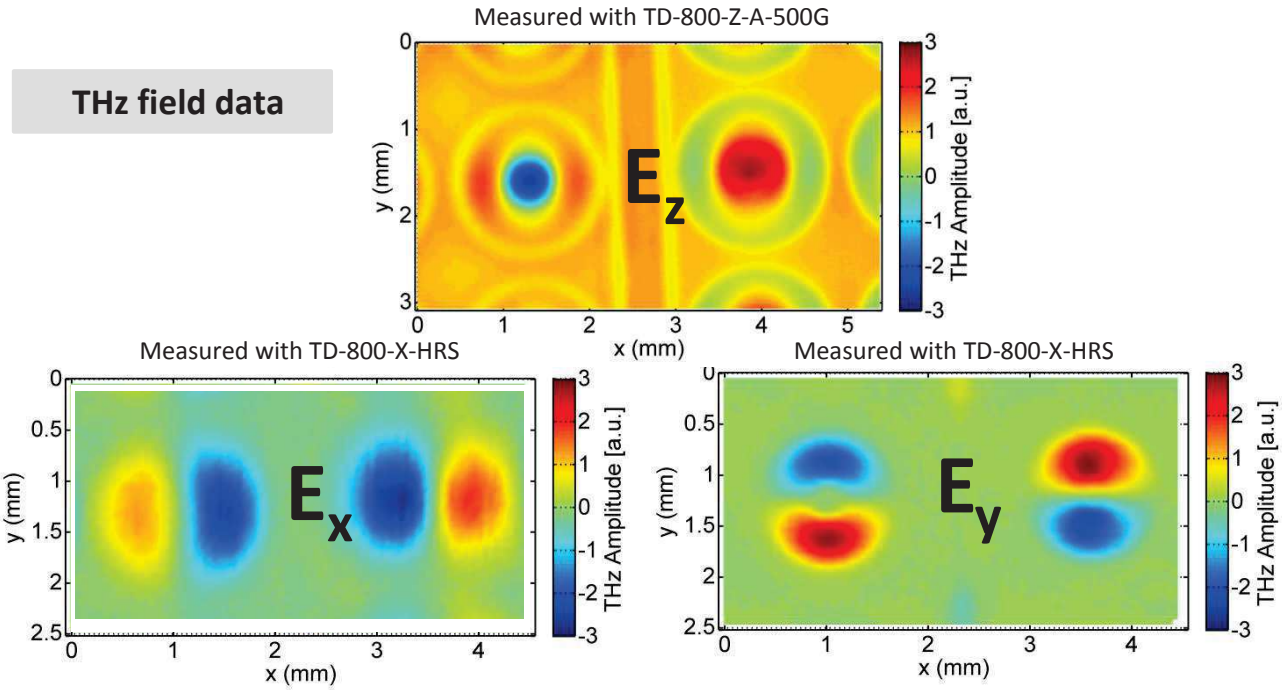


All TD-800-Z probes are sensitive to **z-oriented** field components

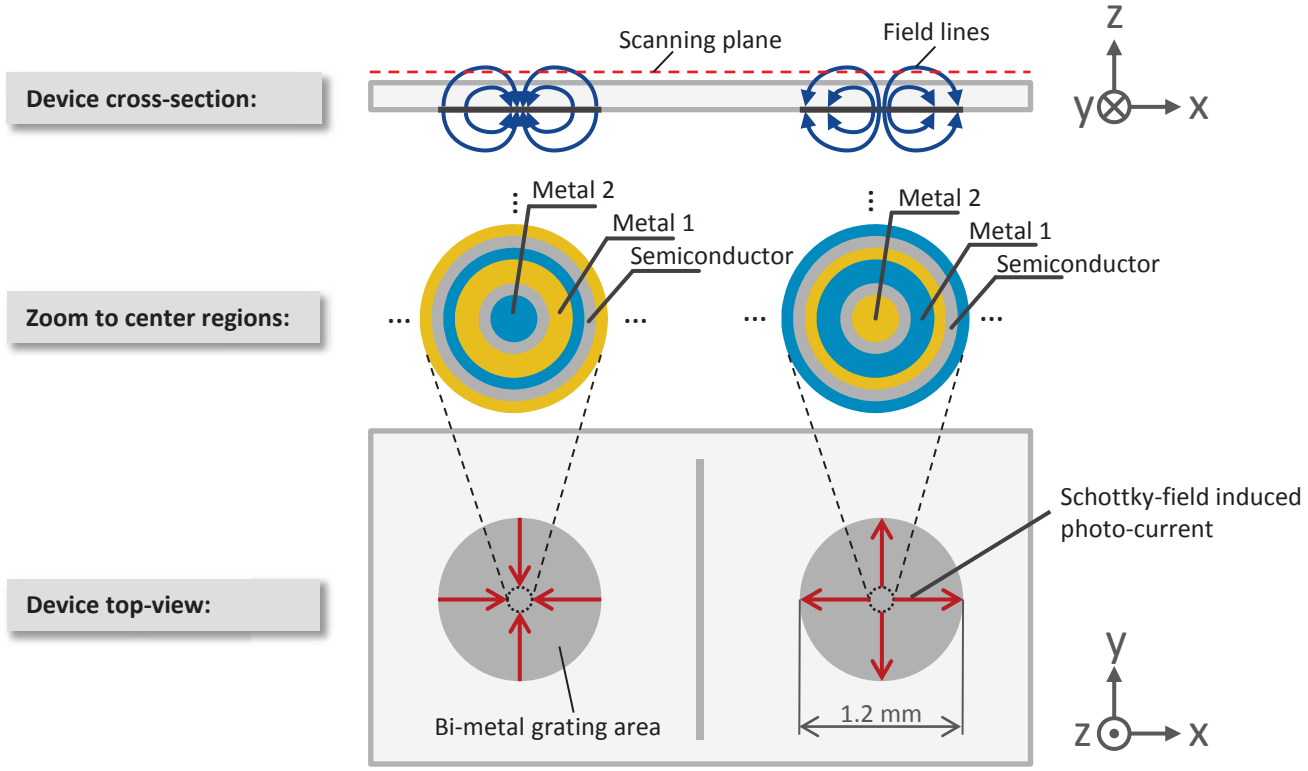
Measurement example:

3D vector field mapping

THz field data



Device under test: Radial-mode emitter pair



Pair of radial-mode THz emitters based on planar bi-metal gratings

Bias-free THz pulse generation probe

TeraSpike TD-1550-Y-BF

Technical data

TeraSpike TD-1550-Y	-BF
Pulse rise time	<1 ps (down to 0.4 ps)
Bandwidth*	0.01 .. 2.5 THz
Excitation wavelength	700 .. 1600 nm (<860nm recommended)
Avg. excitation power	0.1 .. 4 mW
Cantilever material	InGaAs (n-type)
Lateral tip radius	8 .. 12 µm
Cantilever length	570 .. 600 µm

*For excitation with optical pulses of 90 fs duration.
#Other designs possible on request.

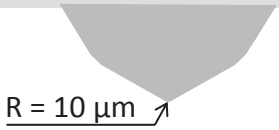
Product details

- Probe-tip for surface-near bias-free optical generation of pulsed THz signals
- Mount for variable probe orientation and simple removal from the set-up
- Robust probe storage box
- Test certificate & manual
- Patent pending DE 10 2013 020 216.7

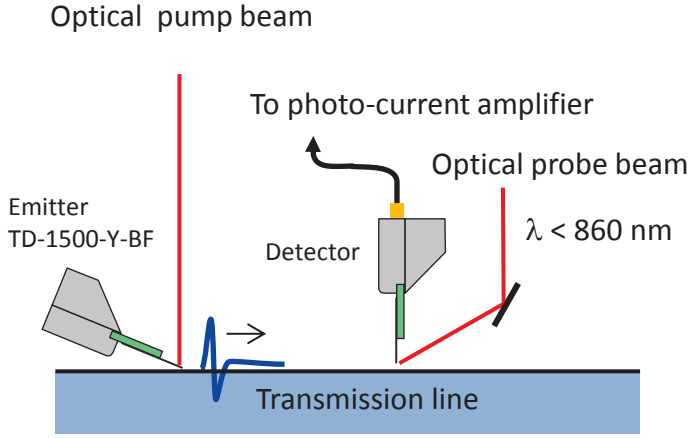
Accessories

- Probe-tip dummy structure
- Mounting & focusing units

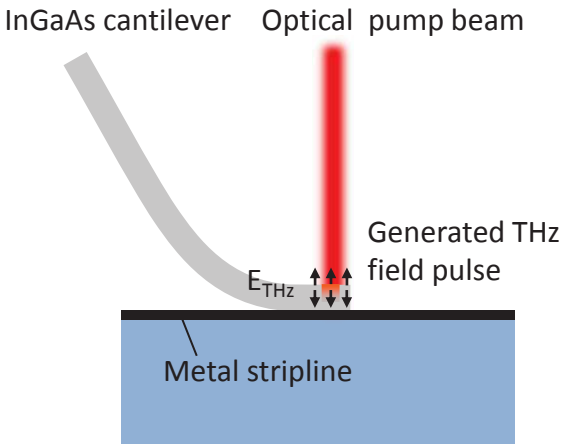
Tip design (standard)



Set-up (example for TDR)



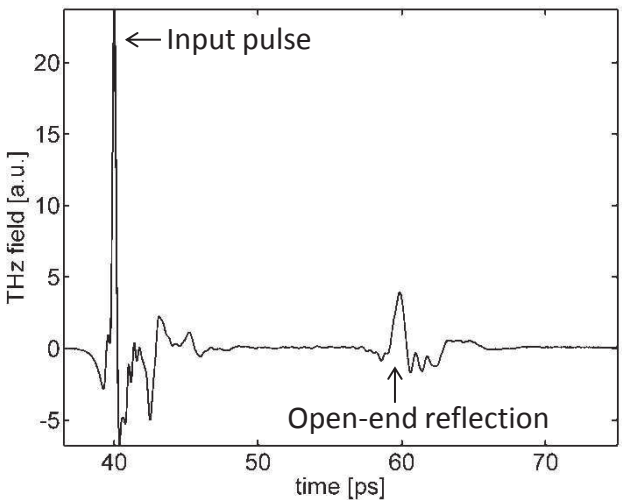
Emitter scheme



Measurement example:

THz TDR measurement

Time-domain measurement data

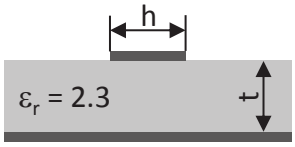


Sample data:

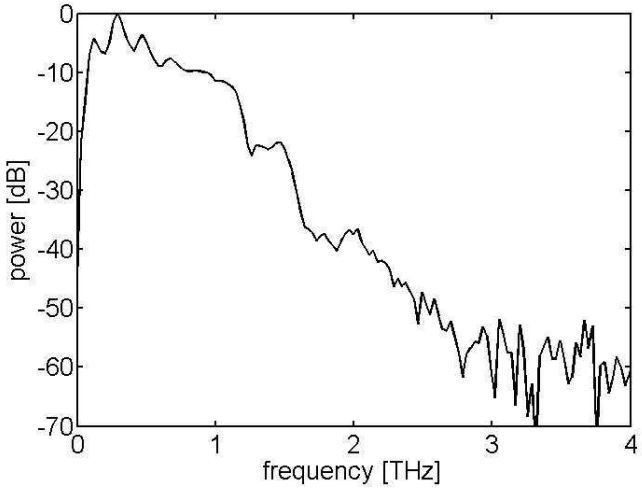
Thin-film microstrip line

- Z_0 = 110 Ω
- w = 35 µm
- h = 57 µm

Cross-section:



Frequency-domain measurement data



Set-up:

Applied Laser:

- Wavelength: 780 nm
- Pulse length: 90 fs
- Repetition rate: 100 MHz

Emitter:

- TeraSpike TD-1500-Y-BF
- Optical power: 4 mW

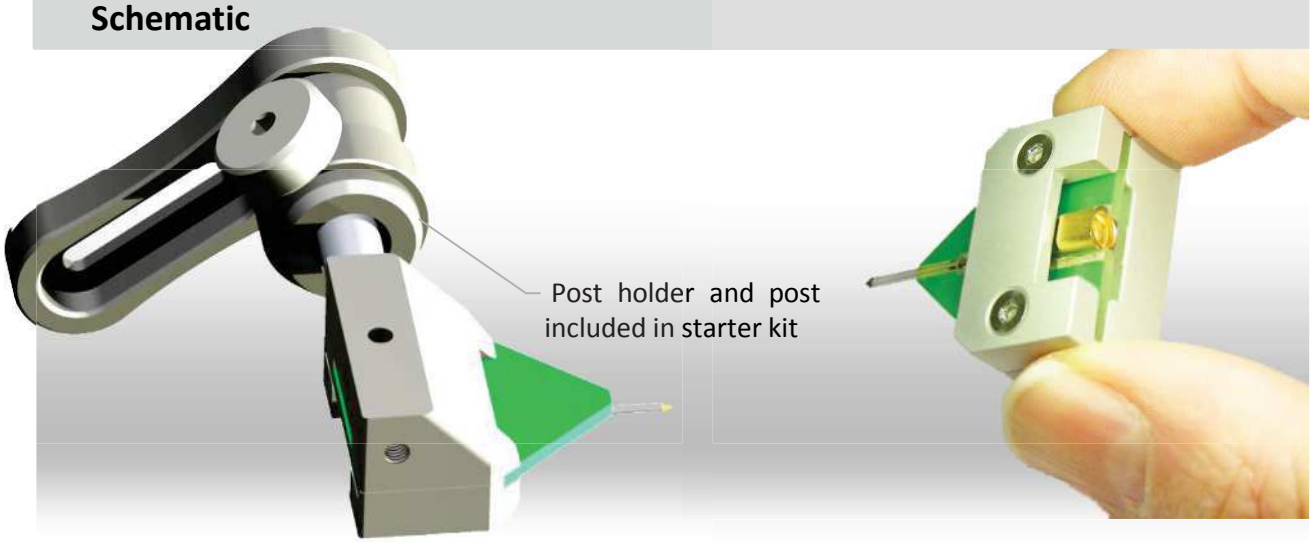
Detector:

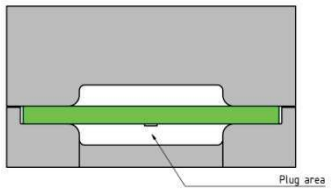
- TeraSpike TD-800-X-HRS
- Amplification: 10^8 V/A
- Optical power: 3 mW

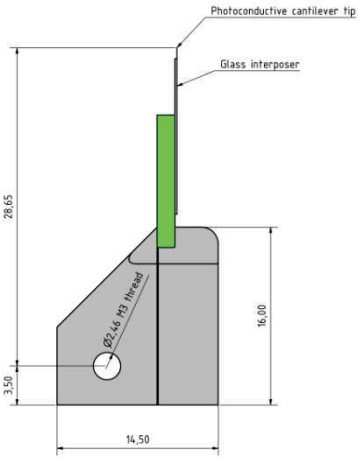
THz microprobe series

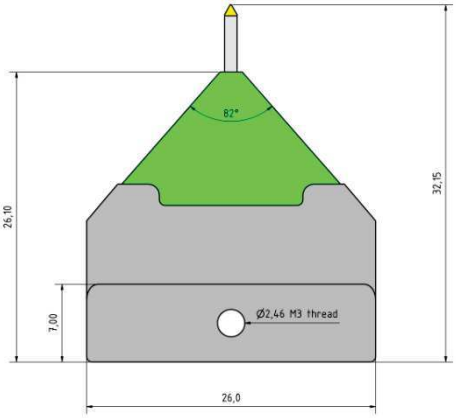
TeraSpike

Schematic









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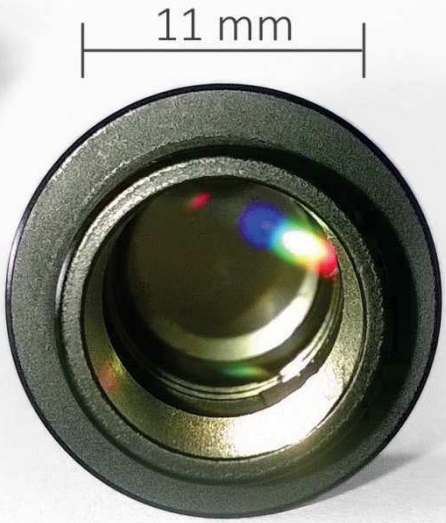
Bias-free Terahertz emitter

TeraBlast

new



Background

The new bias-free Terahertz emitter series TeraBlast from Protemics are optically pumped THz sources which can be used with a wide range of femtosecond laser sources (such as low power oscillators or amplified lasers with wavelengths in the range of 700..1600 nm).

They are ideally suited and tested for near-field imaging applications including TeraSpike micro-probe operation. The TeraBlast is also a great emitter for classic far-field spectroscopy and other THz applications.

Technical data

TeraBlast TD-1550-L-165	Standard	-AR[a]
Excitation wavelength range	700 .. 1600 nm	
Typ. average excitation power range	5 mW .. 1000 mW	
Average THz emission power	> 2.5 µW [b]	> 1.75 µW
Active area diameter	ca. 11 mm [c]	
Adapter dimension (Outer diameter)	1/2 inch	

[a] With THz anti-reflection coating on out-put surface.
[b] Measured with pyroelectric detector (Spectrum Detector Inc. SPI-D-62-THz) for 370 mW optical pump power.
[c] Larger active areas possible. Please request!

Key benefits

- Recommended THz source for TeraSpike microprobe operation
- High emission power
- Patent pending design (DE102012010926 A1)
- Virtually no alignment or focusing effort
- Can be used as a point source or array emitter
- Linearly polarized emission
- Extremely robust due to bias-free operation
- No device failure on local short-cut defects
- No dark current
- No parasitic off-set signal generation in lock-in detection schemes

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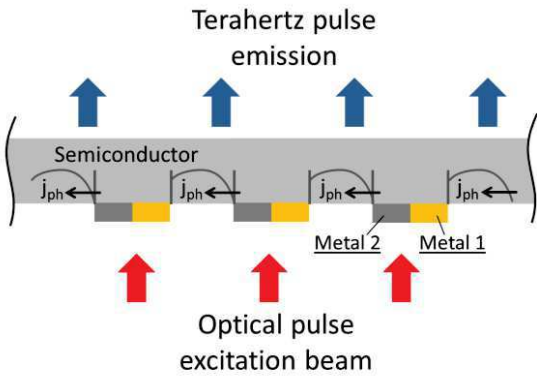
Bias-free Terahertz emitter

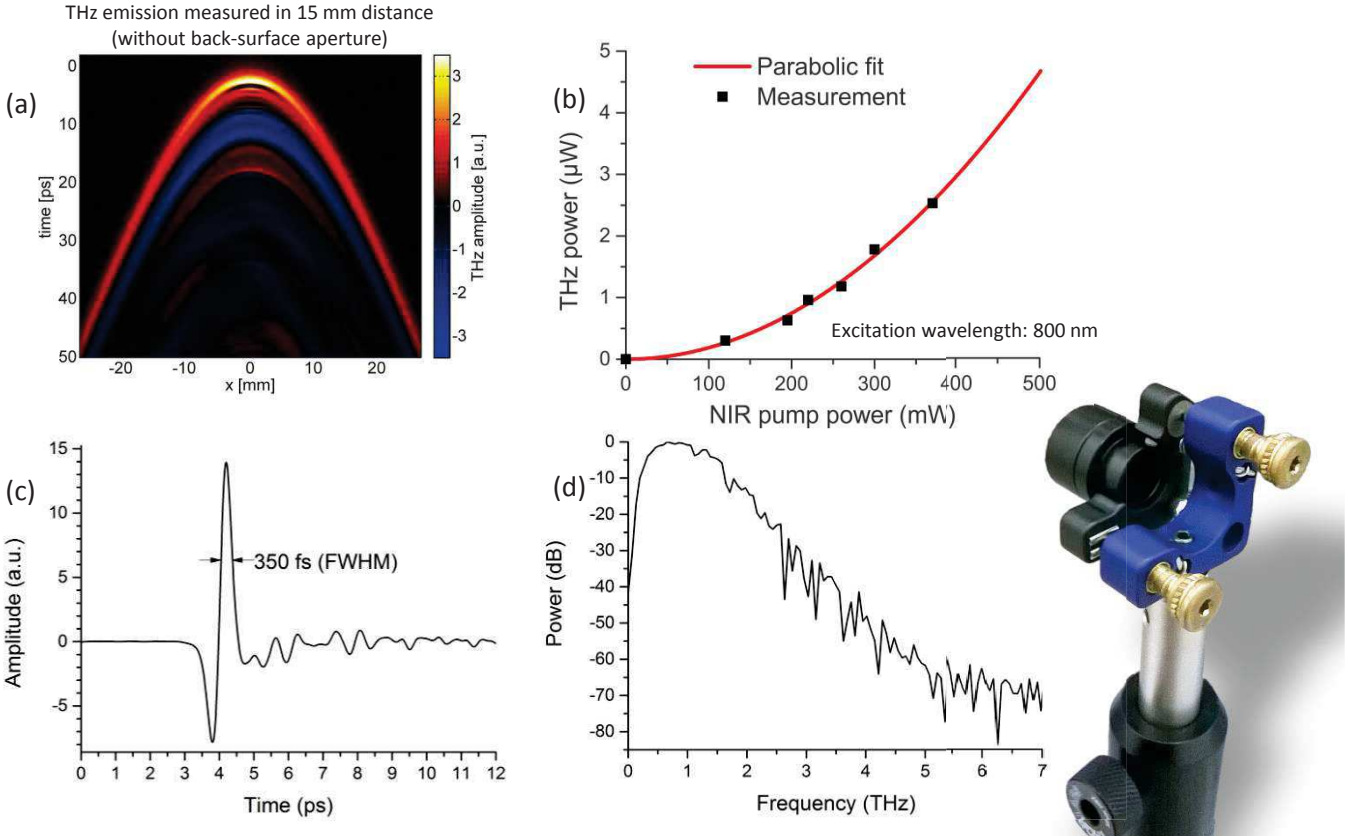
TeraBlast

Emitter scheme



Dimensions

Exemplary measurement data

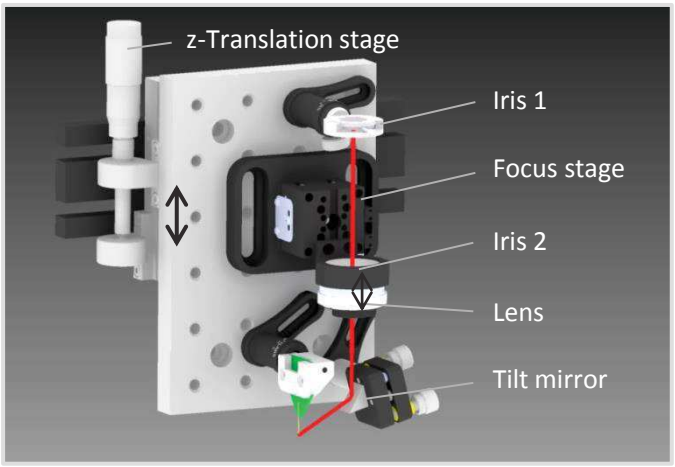


(a) Measured with TeraSpike TD-800-X-HRS, (b) Measured with SPI-D-62-THz from Spectrum Detector Inc. (c) & (d) Far-field transmission through atmosphere measured with a femtosecond laser from Laser Quantum („taccor“) and electrooptic detection in a 400-µm-thick GaP crystal using ASOPS based time-domain spectroscopy.

Integration components

Sub-system modules

Sub-system D-B1



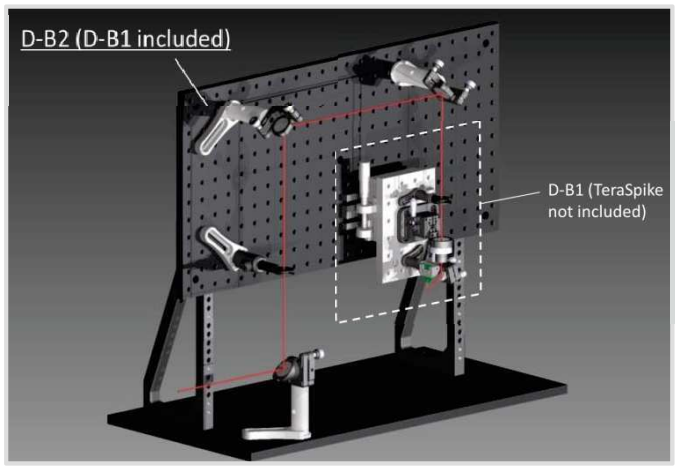
Description

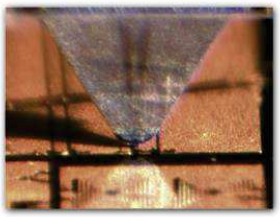
Mini-board set-up with pre-aligned opto-mechanical components for the system integration of TeraSpike microprobes.

Functions:

- Microprobe mount
- Manual beam-to- microprobe focusing
- Manual beam-to- microprobe alignment
- Manual microprobe height variation

Sub-system D-B2





Exemplary CCD camera image of a TeraSpike microprobe tip above sample microstructure.

Description

Multi-board set-up with pre-aligned opto-mechanical components.

Functions:

- Motherboard including sub-system D-B1 in customized height
- Assembly brackets
- 2 alignment apertures
- 2 tilt mirrors
- Extendable with CCD camera and distance sensor

Option (-CAM):

- Integrated CCD microscope camera system with variable illumination for monitoring of probe-tip to sample surface approximation and sample positioning

Order information

Scanning systems	
TeraCube	THz near-field imaging system
	Scientific
Terahertz microprobes detectors	
TeraSpike	THz PC probe-tip with SMP plug
	Series: TD-800-X- (Type: HR or HRS)
	Series: TD-800-Z- (Type: A-500G)
Starter Kit	Includes: TeraSpike microprobe, TS Phantom, TS Cable, mount
Terahertz microprobe emitters	
TeraSpike	InGaAs cantilever microprobe
	Series: TD-1550-Y-BF
Large-area bias-free Terahertz emitters	
TeraBlast	**TD-1550-L-165**
	Option (-HPF): Back-surface high-pass filter
	Option (-AR): THz anti-reflection coating
Sub-system modules	
D-B1	Axial positioning, focusing, alignment unit
D-B2	Vertical board base unit including D-B1
	Option (-CAM): Integrated microscope camera
Current amplifiers	
DLPCA-200	Variable gain current amplifier with 50 kHz Bandwidth @ 10^7 V/A amplification
DHPCA-100	Variable gain current amplifier with 220 kHz Bandwidth @ 10^7 V/A amplification
Accessory	
TeraSpike Phantom	Dummy probe-tip device
TS Cable	SMP to SMA/BNC probe connection cable

Service offer

- Not sure how to integrate TeraSpike into your system or do you have other questions? We are happy to advise you!
- Custom microprobe designs are possible on request.

- We offer **measurement services** including detailed data analysis reports for your samples in our laboratories.

- On-site installation support
- Training courses
- Component repair and maintenance services

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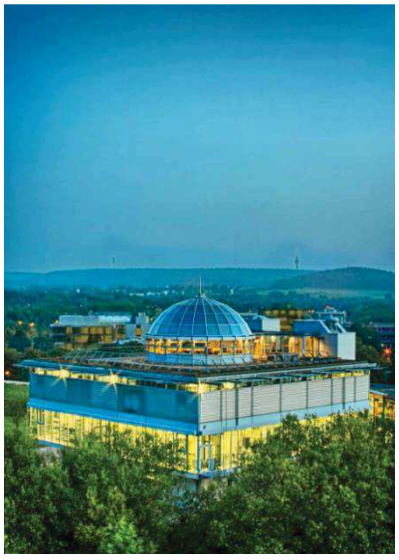
Terahertz microprobing

Solutions

References

Fraunhofer IZM · BOSCH · ROLITH · ECN · RWTH AACHEN UNIVERSITY · SAMSUNG TECHWIN

Applications



- Non-destructive testing
- Terahertz research
- Near-field analytics
- Transparent conductors
- Flexible electronics
- Graphene
- Wafer inspection
- Thin-film analysis
- Metamaterials
- Solar cell inspection
- Terahertz device analysis
- Fault location
- Time-domain reflectometry
- Terahertz waveguide analysis
- Marker-free biosensing
- Plasmonics

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