MenloSystems

Ultrafast Solutions

Frequency Combs, Ultrafast Lasers, THz-Technology, Timing, and Synchronization

February 2013

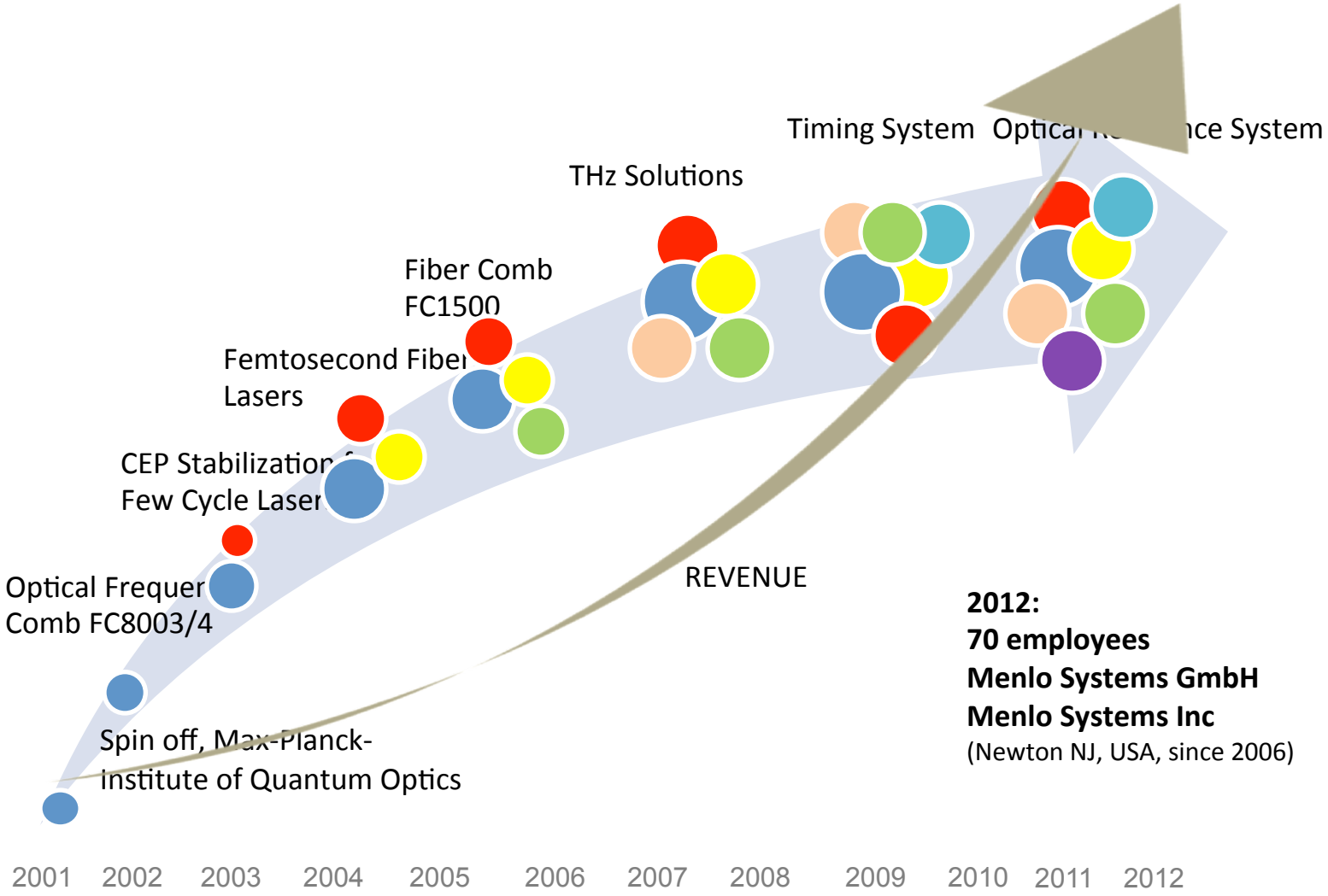
Patrizia Krok

MenloSystems

Headquarters at the Innovation Center in Martinsried (IZB), near Munich, Germany

Evolution through Innovation

MenloSystems



2012:
70 employees
Menlo Systems GmbH
Menlo Systems Inc
(Newton NJ, USA, since 2006)

MenloSystems

FC1500-250-WG

Optical Frequency Synthesizer

OPTICAL FREQUENCY COMBS

FC1500-250-WG: Er Fiber Comb

MenloSystems

Stabilized comb spectrum:
480-1000 nm, 1050-2100 nm
250 MHz mode spacing
Accuracy: 10^{-14}
Stability: $5 \cdot 10^{-13}$ in 1 sec.

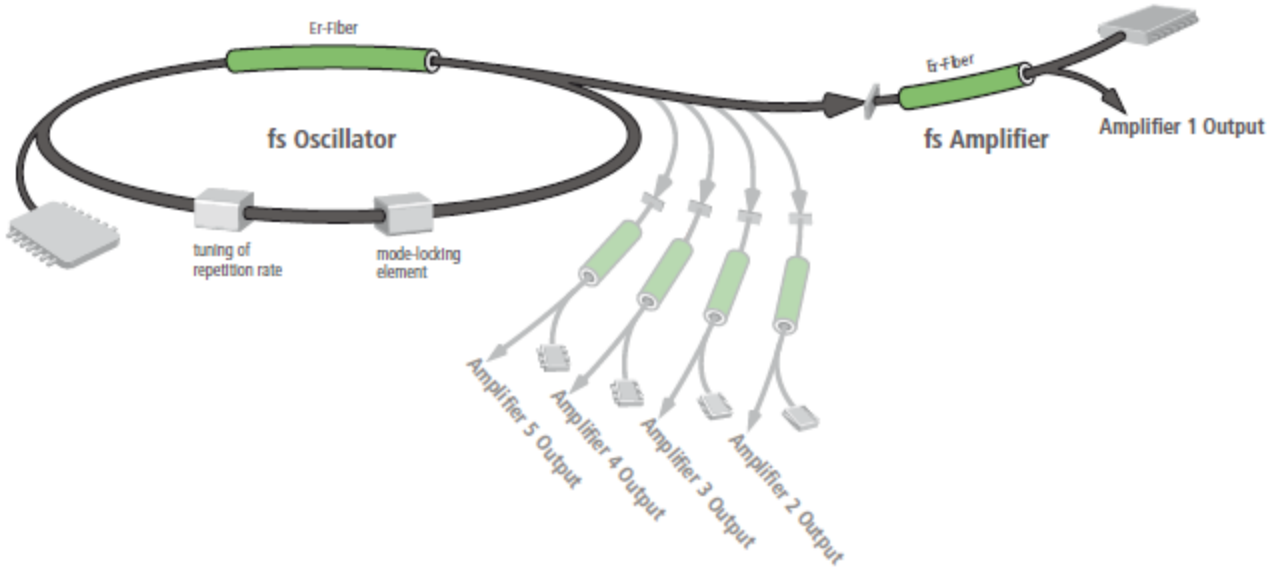
MenloSystems

FEMTOSECOND LASERS, SYNCRONIZATION

Laser Architecture

MenloSystems

- Flexible system configurations



MenloSystems

time-resolved spectroscopy, two-color spectroscopy, THz-TDS

ASOPS SYSTEMS

What is ASOPS?

MenloSystems

Asynchronous Optical Sampling

- Synchronization electronics

- Dual laser head:
- 100 MHz or 250 MHz Erbium & Ytterbium oscillators
- DUAL COLOR of 1560, 780, 1030, 515 nm

MenloSystems

Ultra Stable 1-Hz Laser Source

OPTICAL REFERENCE SYSTEM

ORS1500 Optical Reference System

MenloSystems

MDF-Box

In-coupling platform

Active vibration isolation platform; piezo actuators and acceleration sensors

Acoustic insulation foil

SYNCRO
Locking electronics

PDH seed

MenloSystems

TDS Time-Domain Spectroscopy, TERA K15

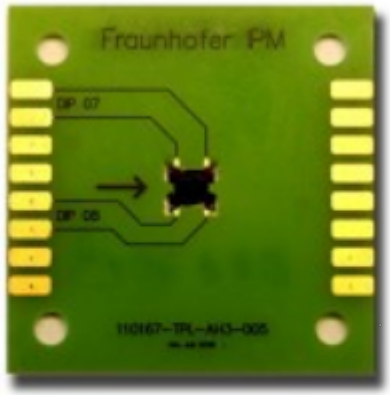
THz SYSTEMS

THz PCAs

MenloSystems

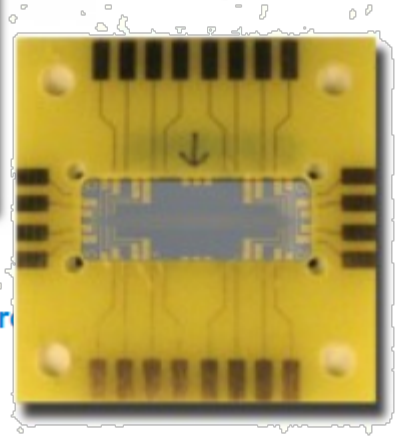
- Joint projects with Institutes of the Fraunhofer Society
- Manufacturing know-how of the IPM and HHI

TERA8-1



single photoconductive switch optimized for laser wavelengths ar 800 nm

TERA8



multiple photoconductive switches optimized for laser wavelengths around 800 nm

TERA15

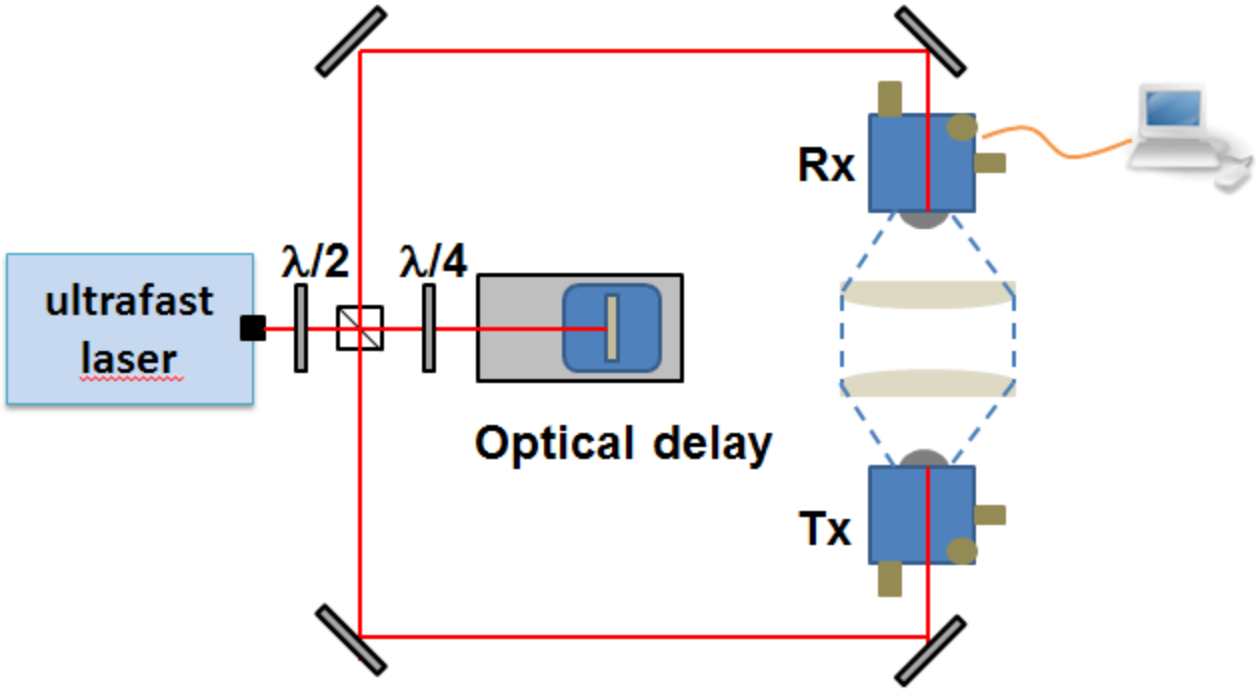
photoconductive switch optimi laser wavelengths around 1550

TERA15-FC

fiber-coupled photoconductive switch optimized for laser wavelengths around 1550 nm

Conventional THz-TDS Systems

MenloSystems



- The same pulse in both arms → setup is immune for timing jitter

TERA K8 THz-TDS Spectrometer

MenloSystems

- Based on 780-nm laser source
- Free space optics

TERA K15 Fiber-coupled THz-TDS

MenloSystems

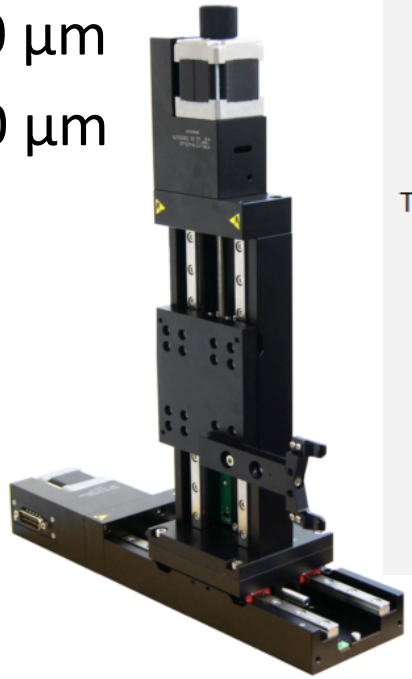
- Compact setup
- Adjustment free
- TPX lenses as THz beam
- Fiber-coupled delay line

THz Add-ons: TERA Image

MenloSystems

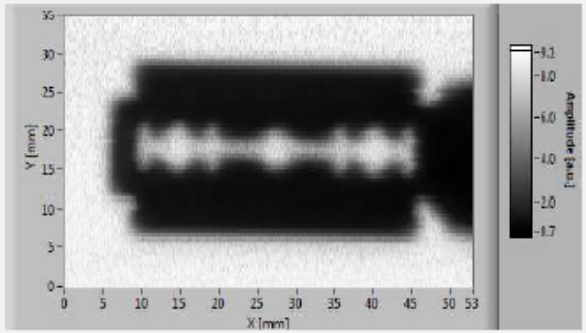
Automated translation stage with 10x10 cm^2 scan range and software package for image reconstruction

- LabView- based software
- resolution x-direction 150 µm
- resolution y-direction 500 µm
- typical measuring time 2.5 h / 10 x 10 cm^2

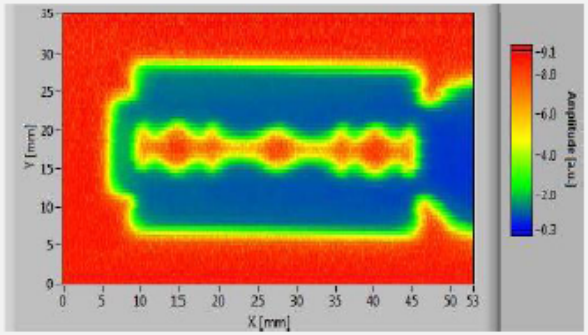


Metal sample:

Transmission pattern (grey scale):



Transmission pattern (color scale):



MenloSystems

High-speed THz Imaging, OSCAT-TDS

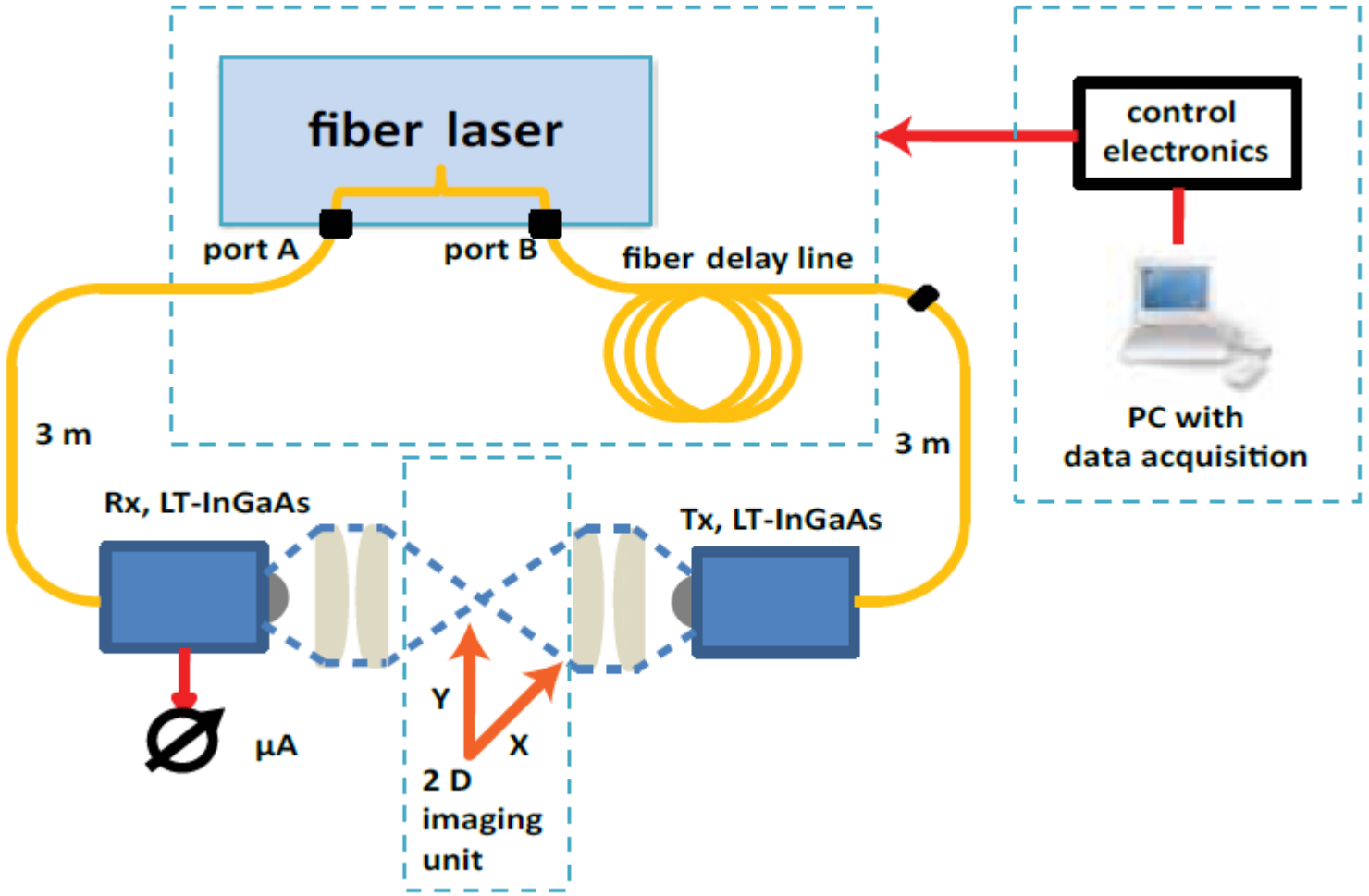
OSCAT TECHNIQUE

All-fiber THz OSCAT System

MenloSystems

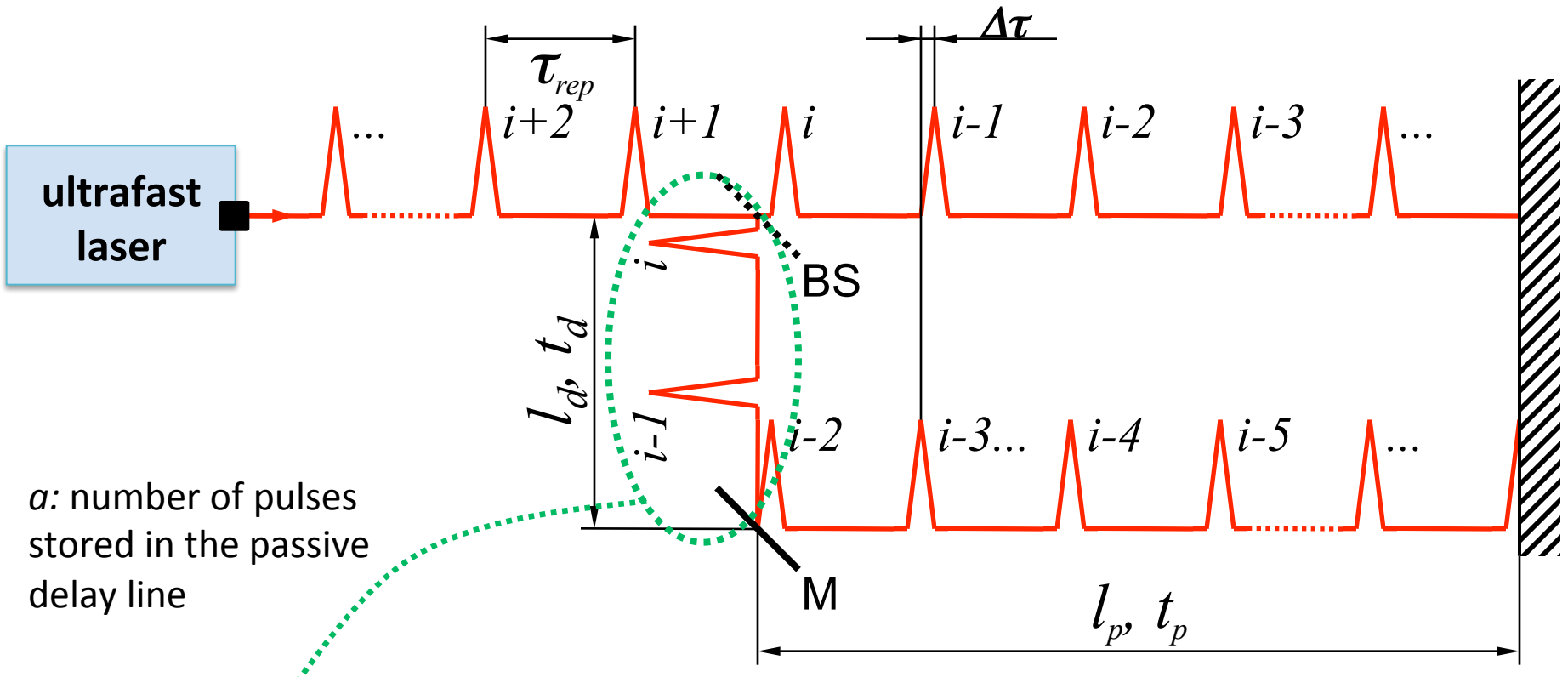
OSCAT Scheme

MenloSystems



Principle of Operation

MenloSystems



a: number of pulses stored in the passive delay line

$$\Delta\tau = a\left(\frac{1}{f_{\min}} - \frac{1}{f_{\max}}\right)$$

$$l_d = \frac{\Delta\tau \cdot c_0 \cdot \left(f_{rep} + \Delta f\right)}{\Delta f \cdot n}$$

- **Scales with *a* → low timing jitter**
- **High f_{rep}, Δf required for long l_d delay line length**

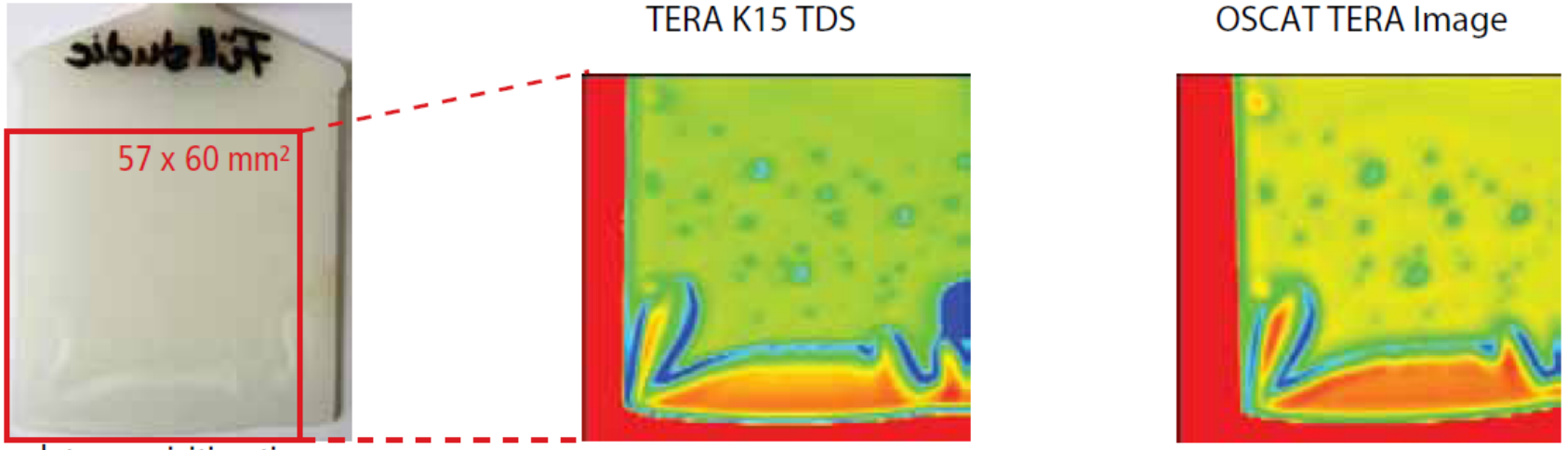
Optical Sampling by CAvity Tuning

MenloSystems

- no external moveable delay line
- capability of high speed measurements
- long scanning range
- no need for precise temporal adjustment
- single ultrafast laser

PHOTO IMAGE
PA6 plate with laminar interspace

THz IMAGING RESULTS
laminar interspace and air bubbles or shrinkholes are clearly visible



data acquisition time:
1/60 s

data acquisition time:
approx. 5 hr

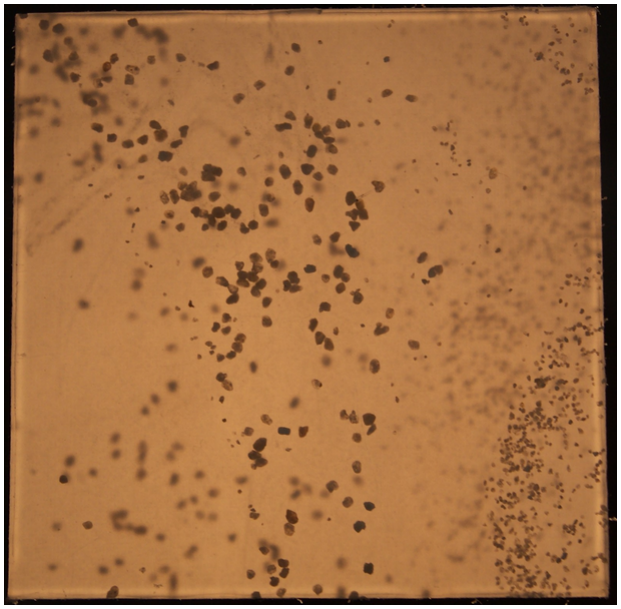
data acquisition time:
approx. 15 min

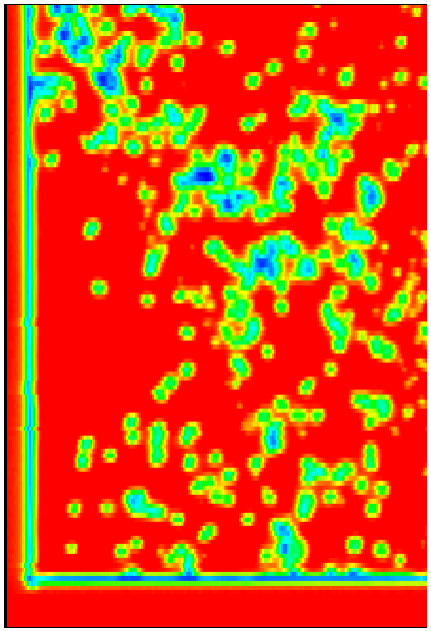
OSCAT THz Imaging

MenloSystems

Polymer samples with typical defects that can occur the in production line

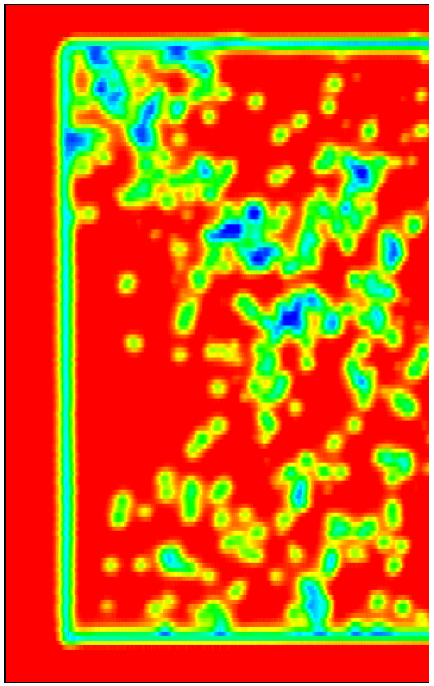
- The grains are fully enclosed with the polymer material
- Every grain can be detected and identified





TERA K8

47 x 75 mm^2



OSCAT TERA Image