



10. - 11. November 2025 | Linz

Der Gastgeber stellt sich vor

Peter Burgholzer
GF der RECENTDT –
Research Center for Non-
Destructive Testing GmbH,
Österreich





We're looking into it!

„Unser Ziel ist es,
auf **neuartige** und **zerstörungsfreie Weise**
Erkenntnisse über **Materialien**,
Stoffe und **Prozesse** zu gewinnen.“

RECENDT - REsearch CEnter for Non-Destructive Testing

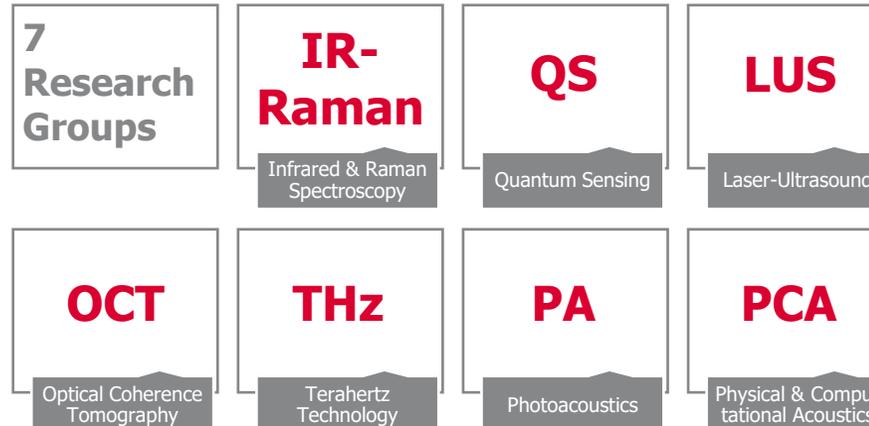


Science Park @ Johannes Kepler University
Linz, Austria

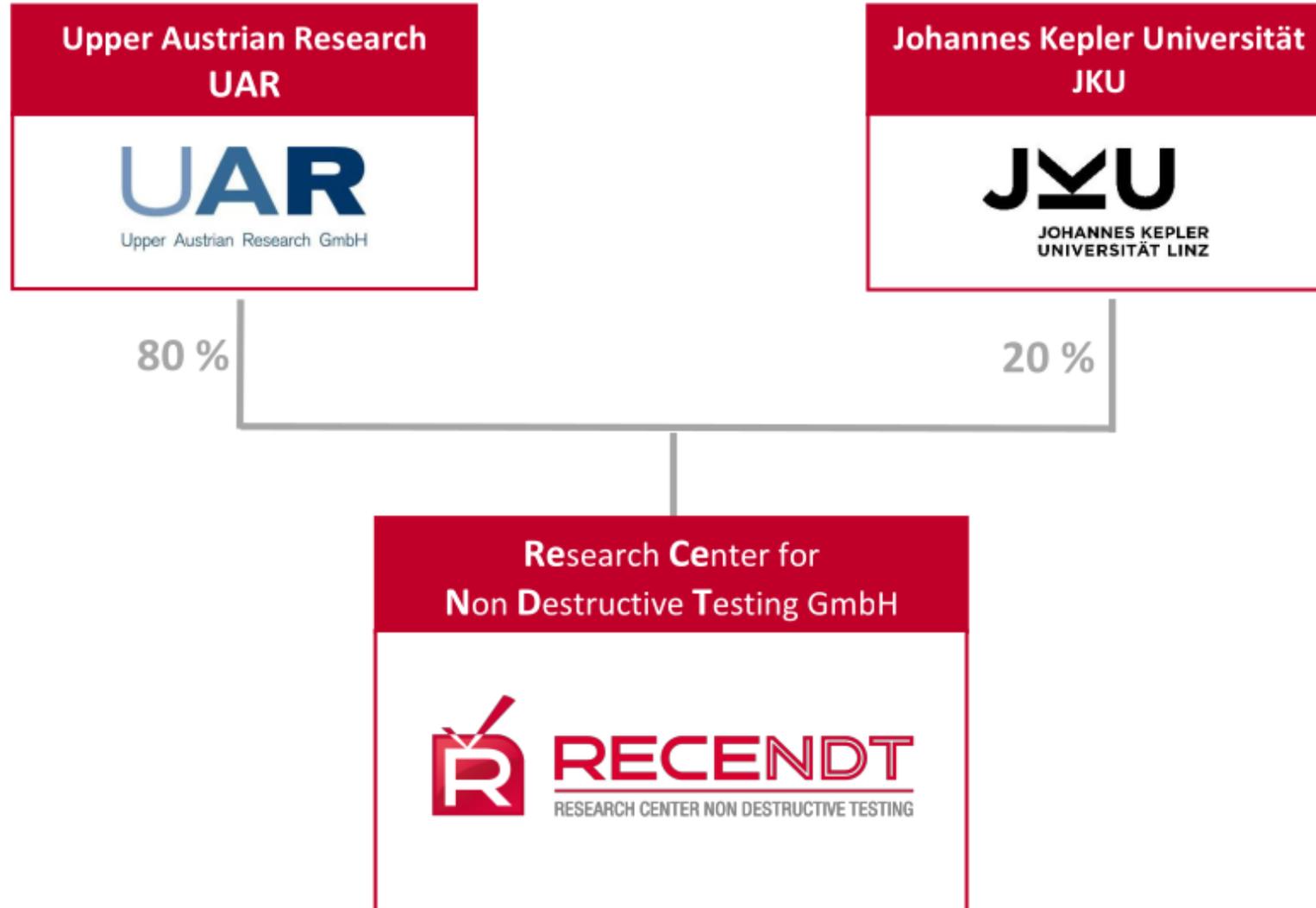
- Founded in 2009
- ~40 researchers
- Funded research (national, H2020, HEU, ITN, ...)
- Contract research



from the lab ...



... to the industry



Member of
UAR INNOVATION
NETWORK



Members of UAR Innovation Network



Partners of UAR Innovation Network

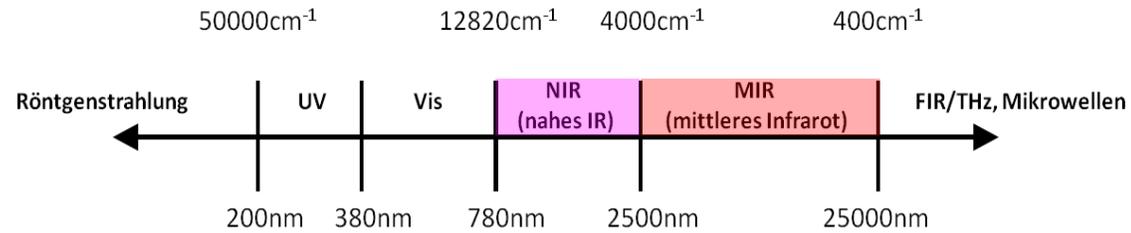
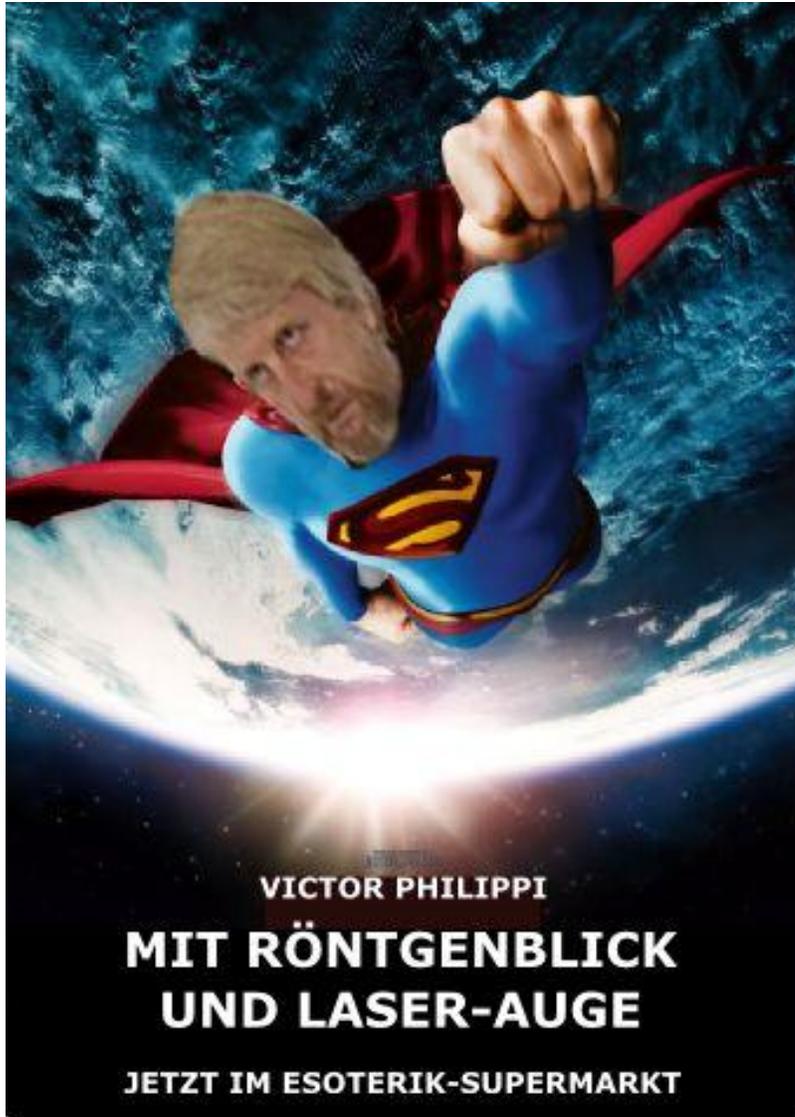


Battery4Life



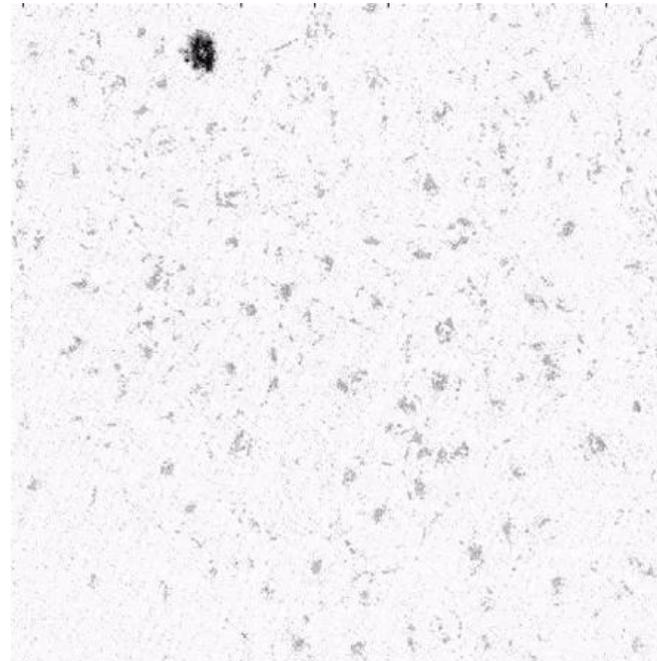
FFoQSI



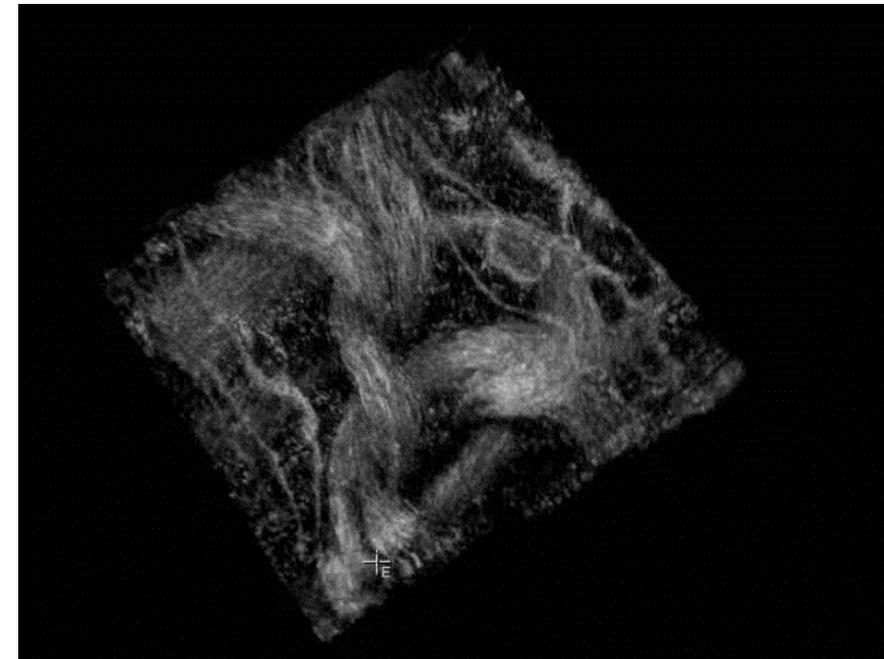


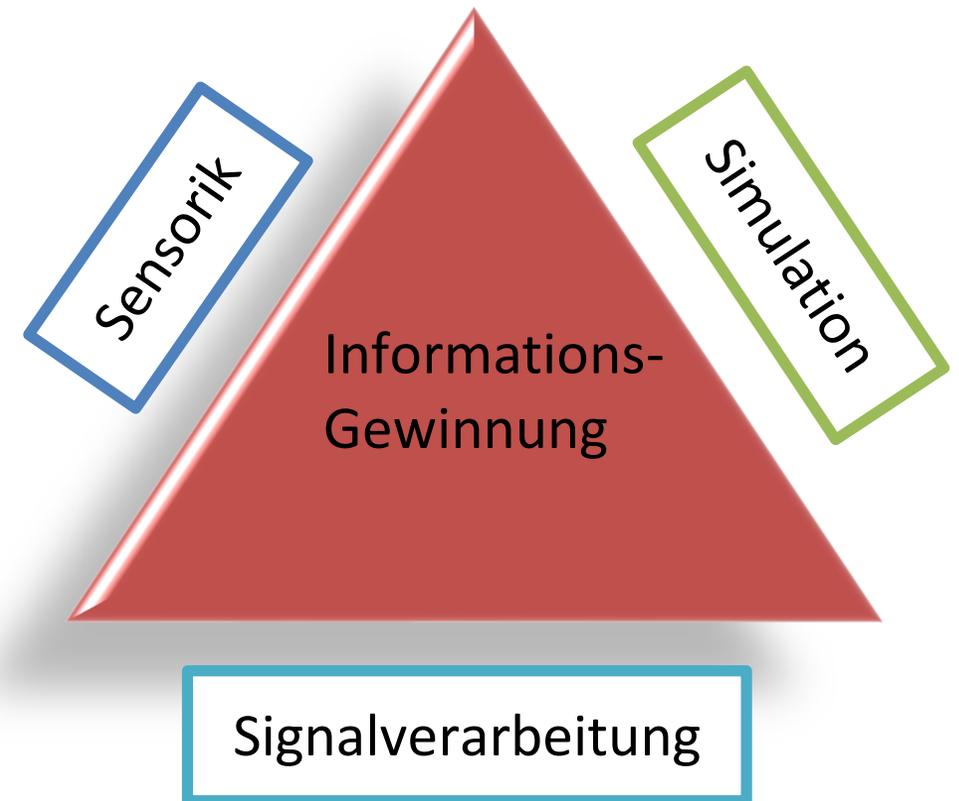
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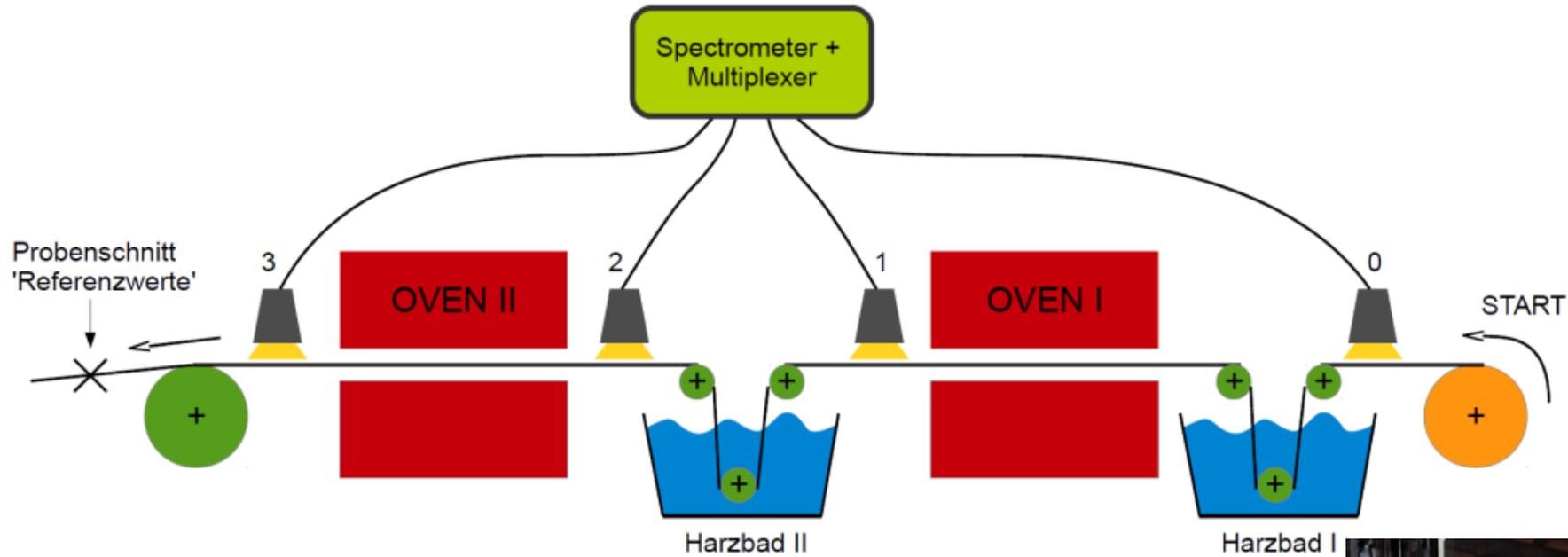
Infrarot Licht kann unter die Oberfläche sehen (OCT und THz)



Akustische Wellen werden durch Laser angeregt und berührungslos detektiert (Laser-Ultraschall, PA)







Strategic Research – Cooperation Partners



Industrial Cooperation Partners



Due to existing non-disclosure agreements not all of our partners are displayed on this page!

- **Laser Ultrasonics (LUS)**

What: defect detection, material characterization

How: feasibility studies → method development → customized systems and services, consulting

- **Complementary methods**

Ultrasound: piezoelectric/electromagnetic/aircoupled; medical ultrasound, photoacoustics, acoustic emission

- **Infrared- and Raman Spectroscopy (IR)**

In-line process control and quality assurance, e.g. analysis of chemical compositions

- **Terahertz Technology (THz)**

Imaging and spectroscopy of non-conductive materials

- **Optical Coherence Tomography (OCT)**

High-resolution imaging of non-conductive layer structures

- **Quantum Sensing (QS)**

Quantum optical interferometry for spectroscopy, imaging, and OCT



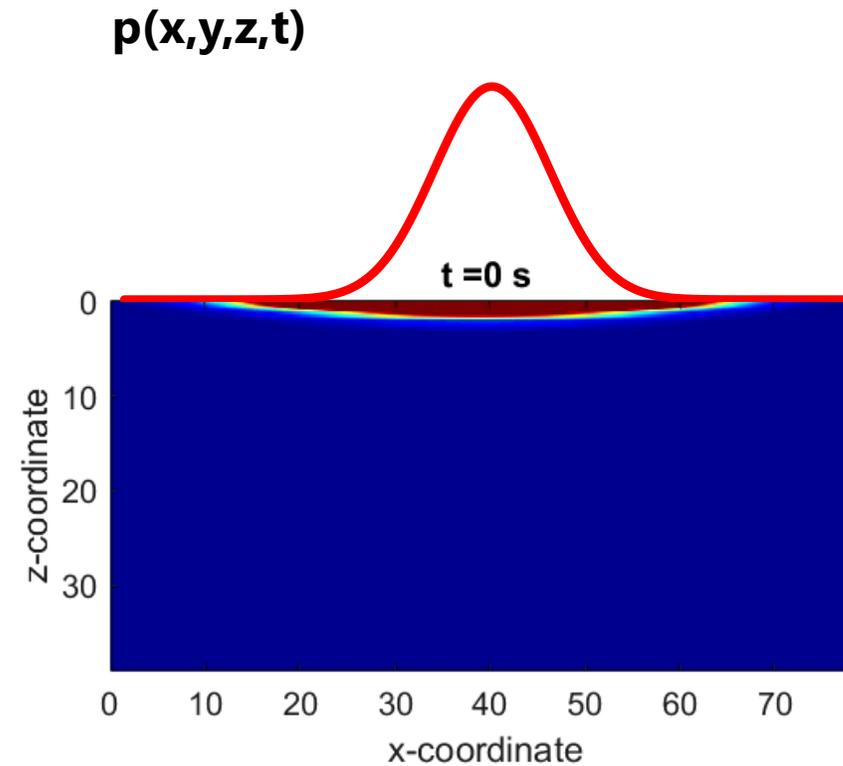
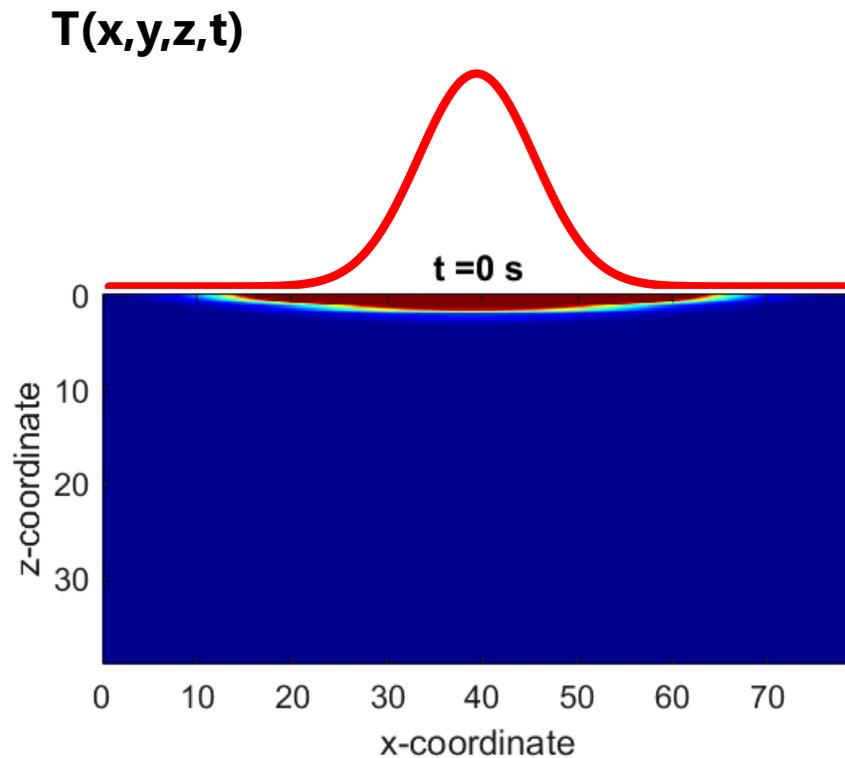
Process of laser-heating (“photothermal”):

- Absorption of light
- Heating and thermal diffusion



Response of the continuum (photoacoustic, $c=1$):

- thermal expansion
- generation of elastic waves

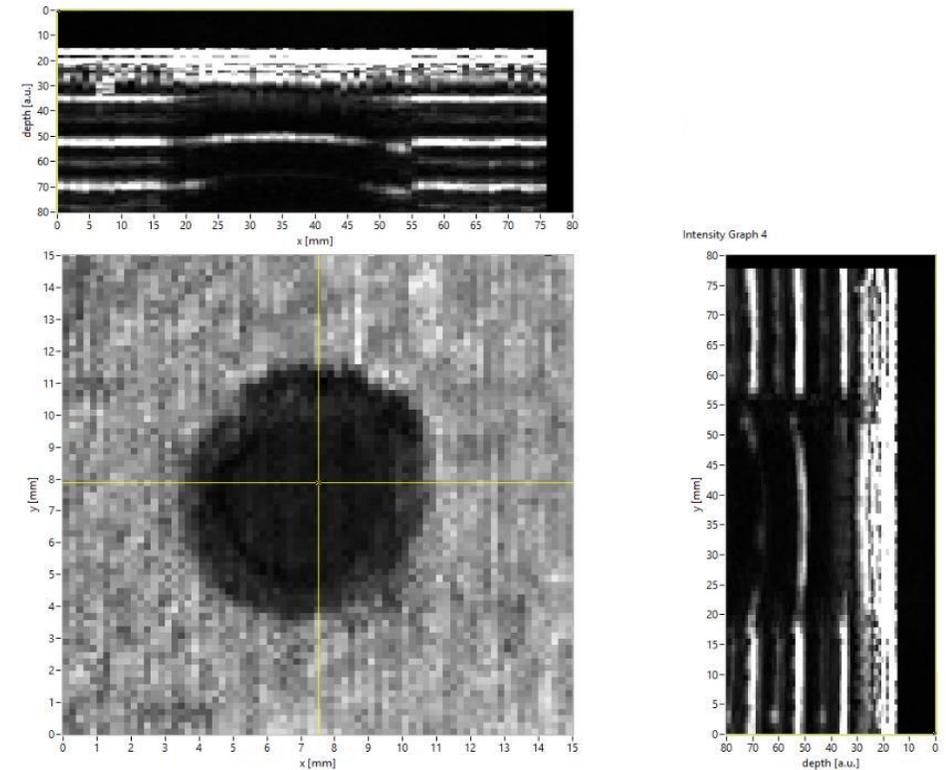


Analysis of a spot weld



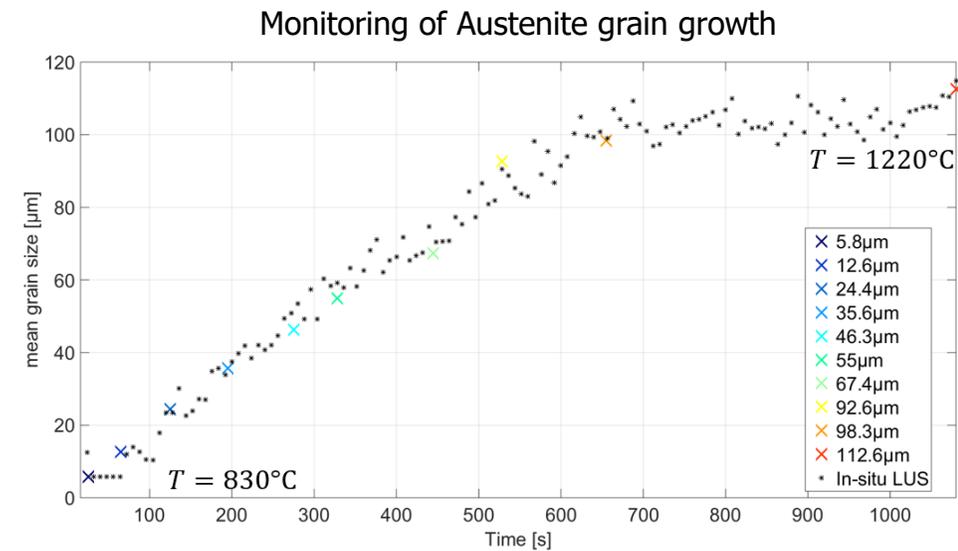
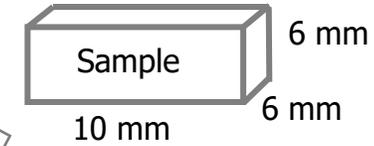
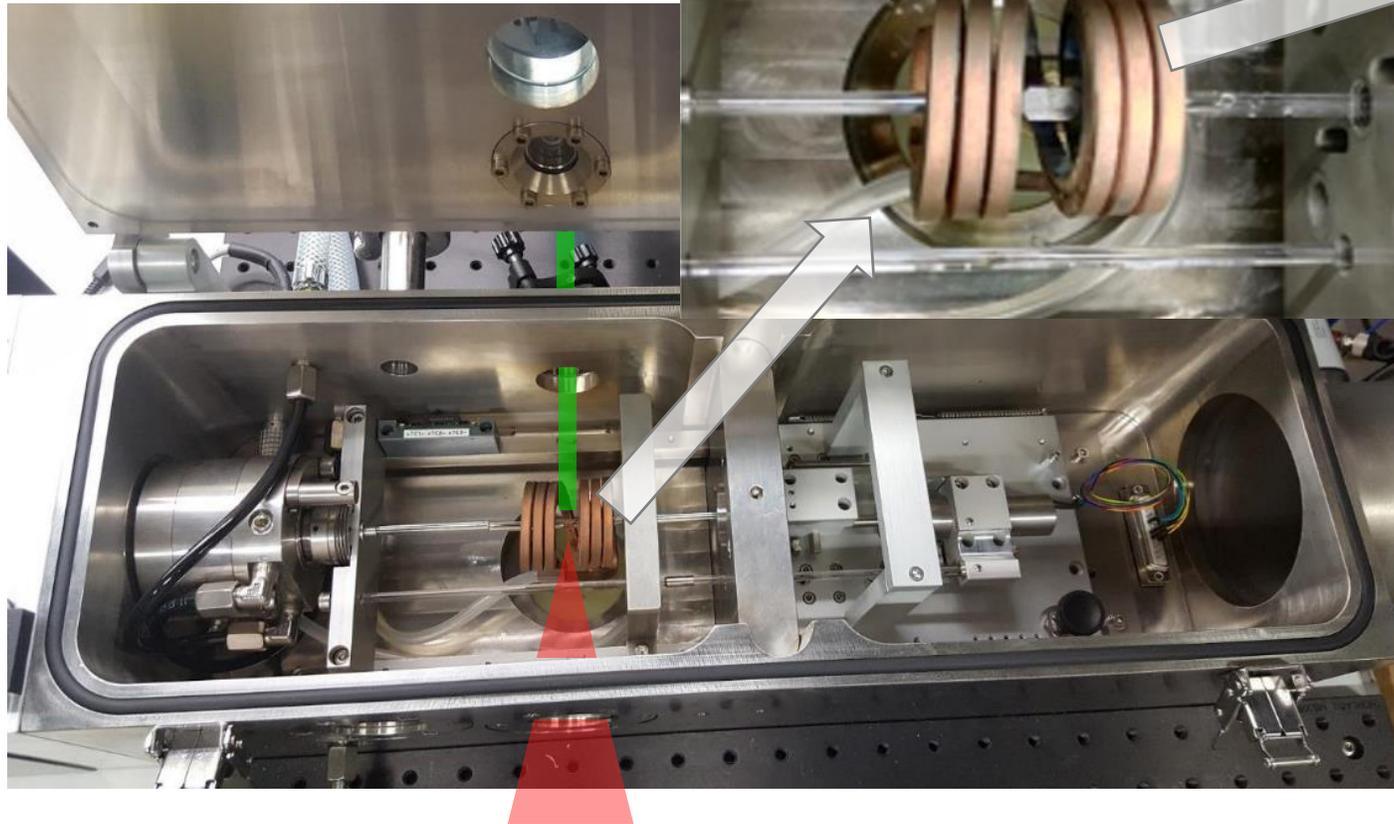
Test at project partner.

Photo of spot weld



LUS C-scan of joining plane and corresponding slices (B-scans) show complete weld through.

Monitoring of phase changes and grain size evolution during thermal cycles



Black dots: Determination of grain size by calibrated LUS-model on one sample.
Colored x: metallographic determination on a series of quenched samples.

- **Infrared- and Raman Spectroscopy (IR)**

Technology for in-line process control and quality assurance, e.g., analysis of chemical compositions

- **Terahertz Technology (THz)**

Technology for non-destructive material characterization (imaging and spectroscopy) of non-conductive materials

- **Optical Coherence Tomography (OCT)**

Technology for non-destructive characterization of the internal structures of plastics, ceramics,...

- **Quantum Sensing (QS)**

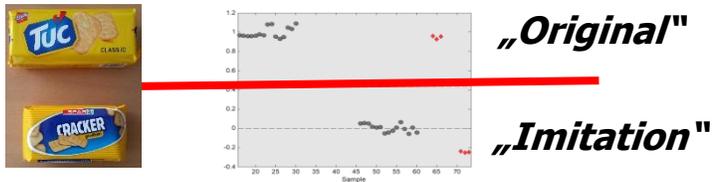
Emerging technology:
Quantum optical interferometry for spectroscopy, imaging, and OCT



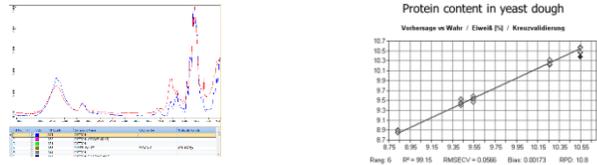
Material characterization

Chemical characterization

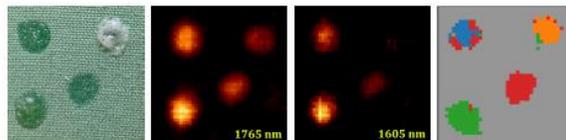
Classification



Identification & Quantification



Chemical imaging

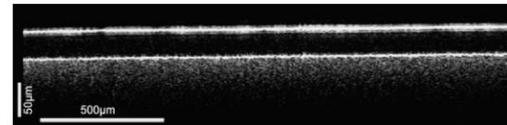


Technologies: IR/Raman & THz Spectroscopy
Measurement devices:

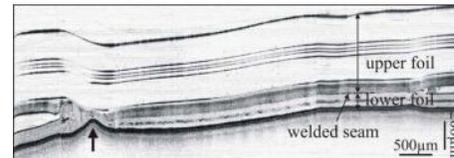
- Commercial FTIR Spectrometer & microscope
- Homebuilt MIR Laser based spectrometer
- Commercial THz TDS Spectrometer system
- Homebuilt reflection/transmission imaging system

Physical characterization

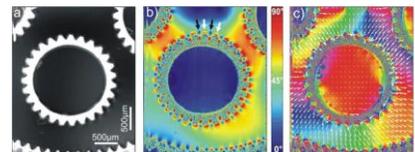
Layer thickness measurements



Defect detection



Internal stress/strain visualization



Technologies: OCT & THz imaging
Measurement devices:

- Commercial OCT devices (1300 nm)
- Homebuilt OCT setups (800 nm, 1500 nm with PS, 2000 nm und 4200 nm)
- Homebuilt THz imaging und PS system

Industrial Process Monitoring

Development of inline sensors

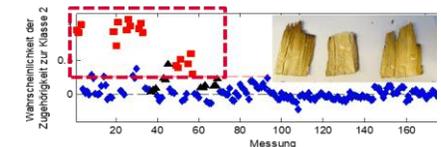


NIR based



OCT based

Custom solutions for QA lab



MIR spectroscopy based
incoming goods inspection



OCT based layer thickness
measurement device

Allows a deeper look into materials and to identify them

Advantages:

- Contactless and non-destructive
- High penetration depths for many dielectric materials
- Non-ionizing radiation
- Chemical „fingerprints“
→ **Layer thickness, 2D-Imaging, 3D-Computed Tomography** and **Spectroscopy**

Materials:

- Plastics, glass fiber-composites, ceramics, semiconductors, ...
- Pharmaceuticals, explosives,...

Wavelength & Resolution:

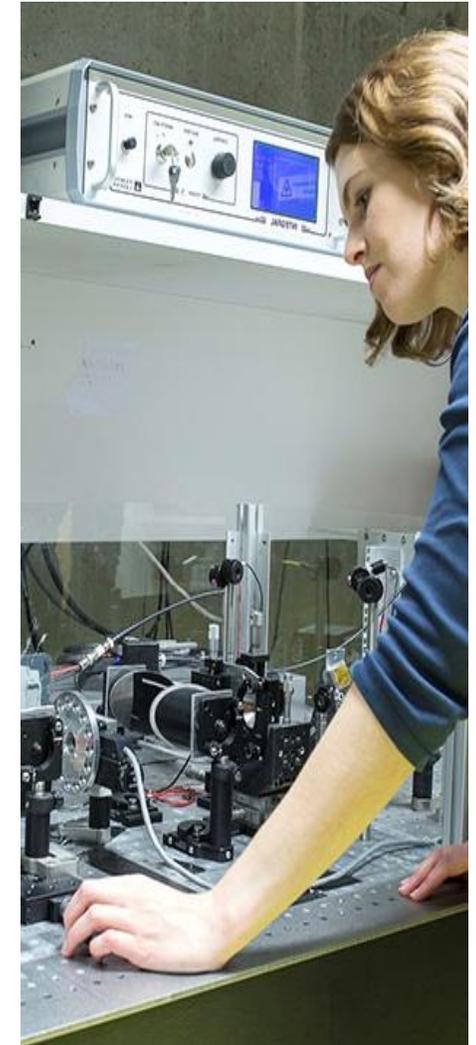
- 300 μm ..3 mm (1 THz...10 THz)
- Mm to sub-mm range

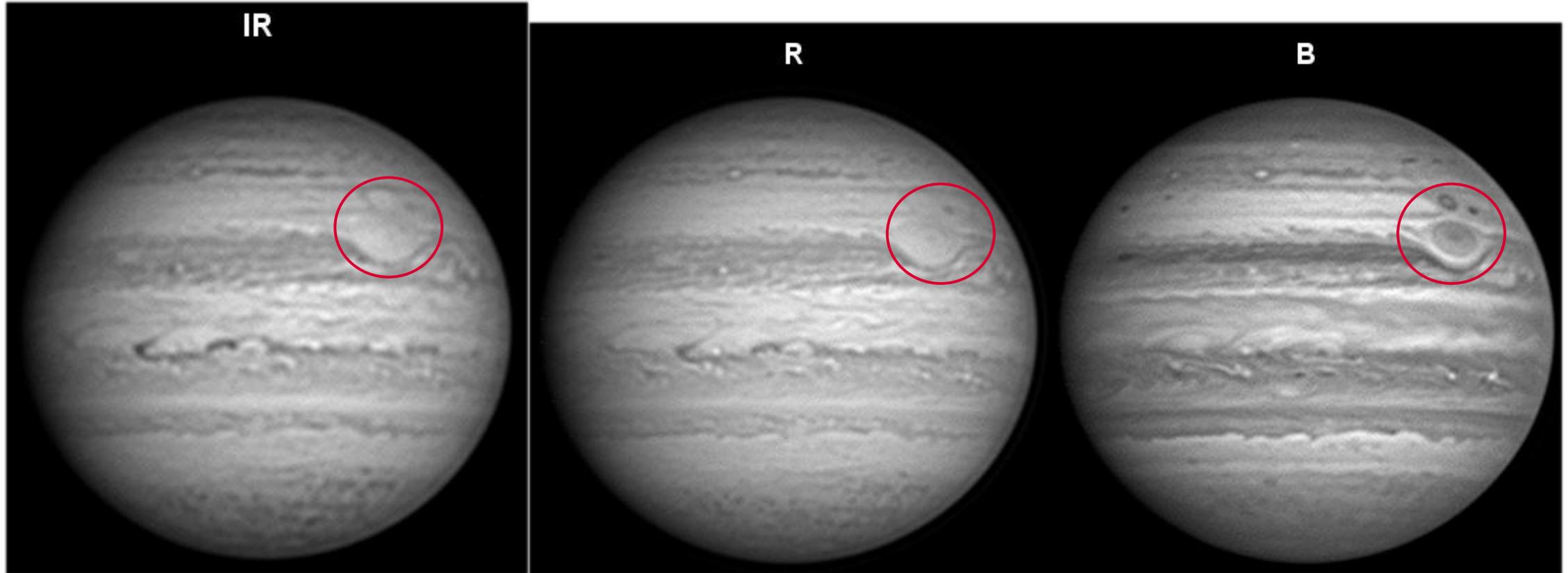
Accuracy:

- < 100 μm

Contact person:

- Dr. Sandrine van Frank (Dr. Bettina Heise)

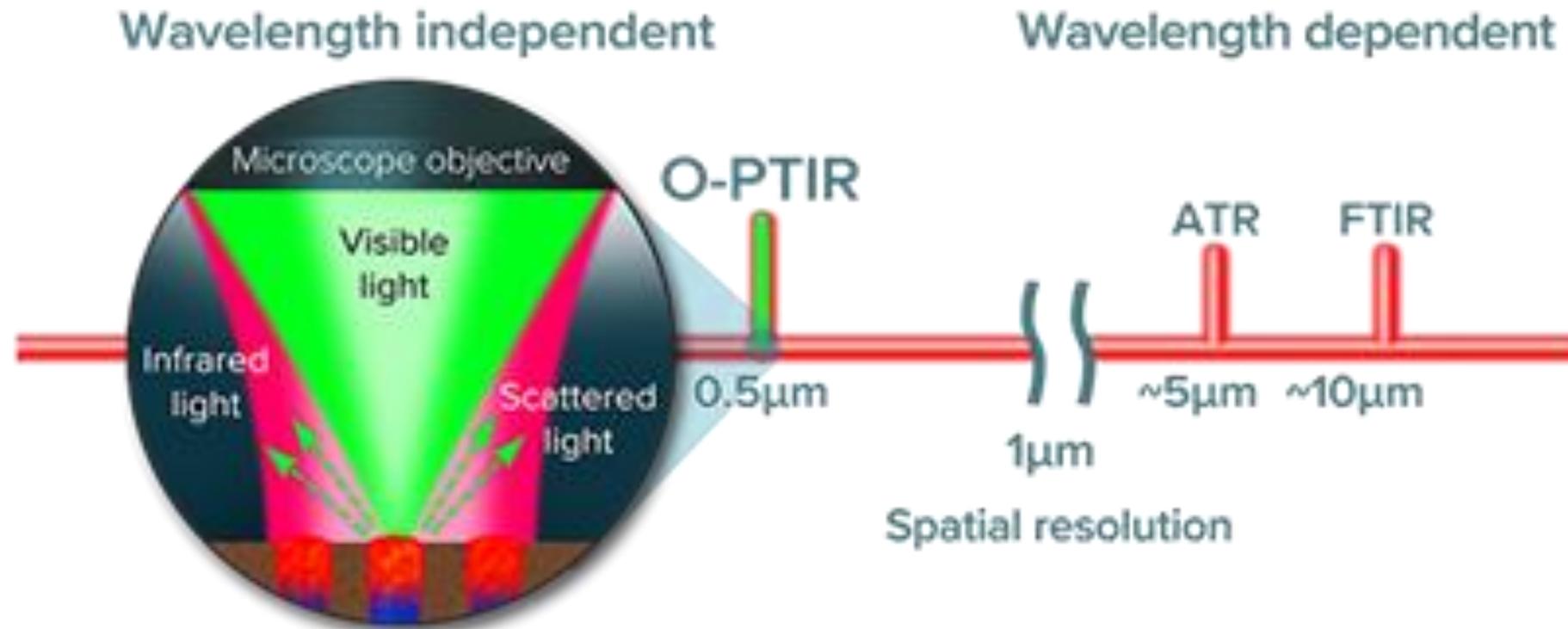




The optical resolution and the wavelength



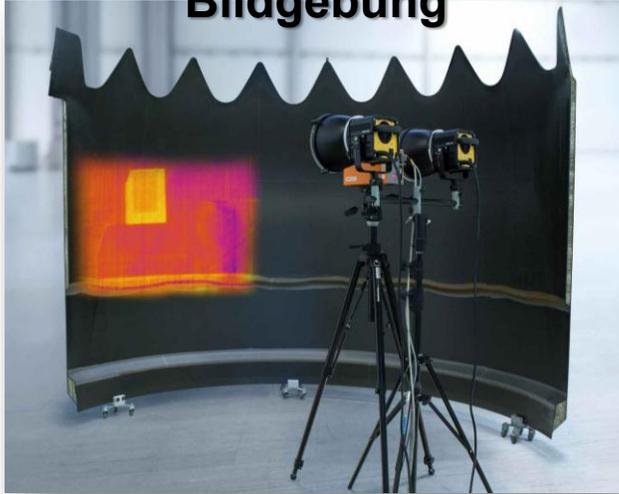
By **CHRISTOPHE PELLIER** — 2 July 2013 2 Comments



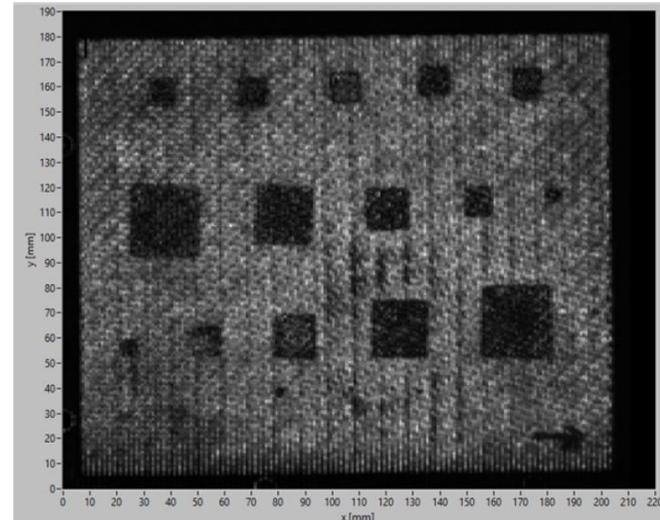
O-PTIR system (Photothermal Spectroscopy Corp.)

- QCLs, several 100 kHz rep. rates for excitation
- Lock-in technology (frequency domain): amplitude is used, phase for future work
- Same detection scheme also used in PARS (with UV excitation)

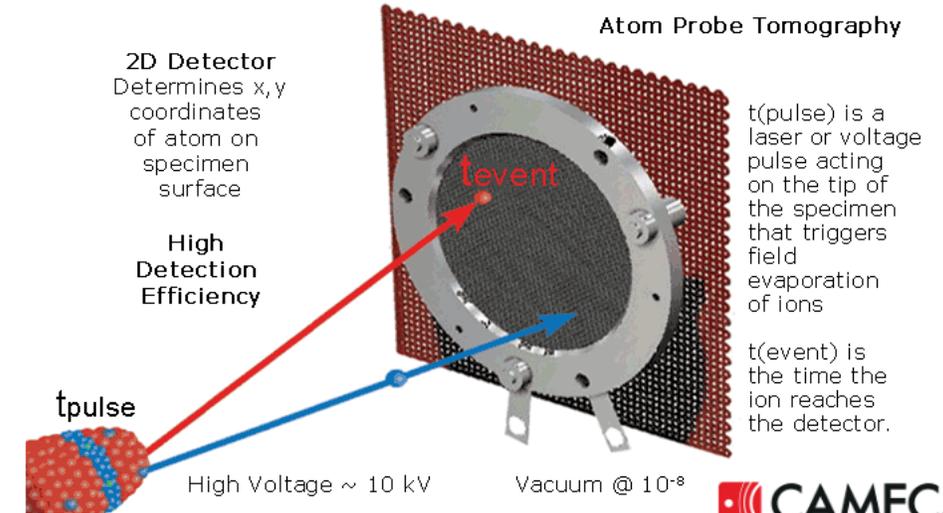
Thermografische Bildgebung



Akustische Bildgebung



Atomsonden- Tomographie

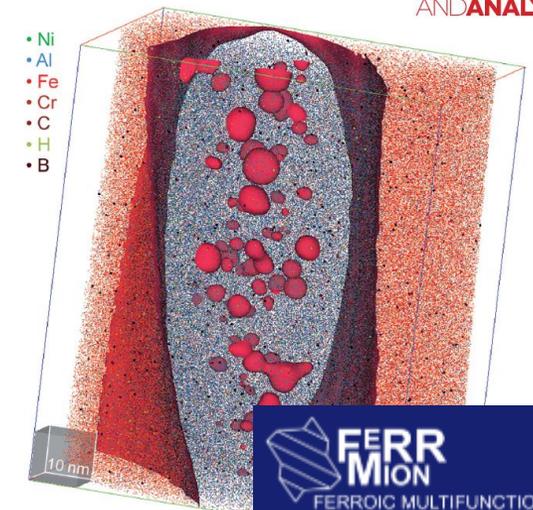


... mehr als 1 Million Detektor Elemente, berührungslos



~100 – 1000 Detektorelemente, hohe Auflösung

APT kann die Element Konzentration mit nm Auflösung in 3D bestimmen



VWC: lokale Transformation zwischen gemessener Temperatur und virtuellem Wellensignal (2D-Simulation)

$$T_{virt}(\mathbf{r}, t) := \frac{p(\mathbf{r}, t)}{\beta c^2 \rho_0} \quad T(\mathbf{r}, t) = \int_{-\infty}^{\infty} T_{virt}(\mathbf{r}, t') K(t, t') dt',$$

$$\text{with } K(t, t') \equiv \frac{c}{\sqrt{\pi \alpha t}} \exp\left(-\frac{c^2 t'^2}{4 \alpha t}\right) \text{ for } t > 0$$

Diskretisiert, um eine Matrixgleichung zu erzeugen:

$$\mathbf{T} = \mathbf{K} \mathbf{T}_{virt}$$

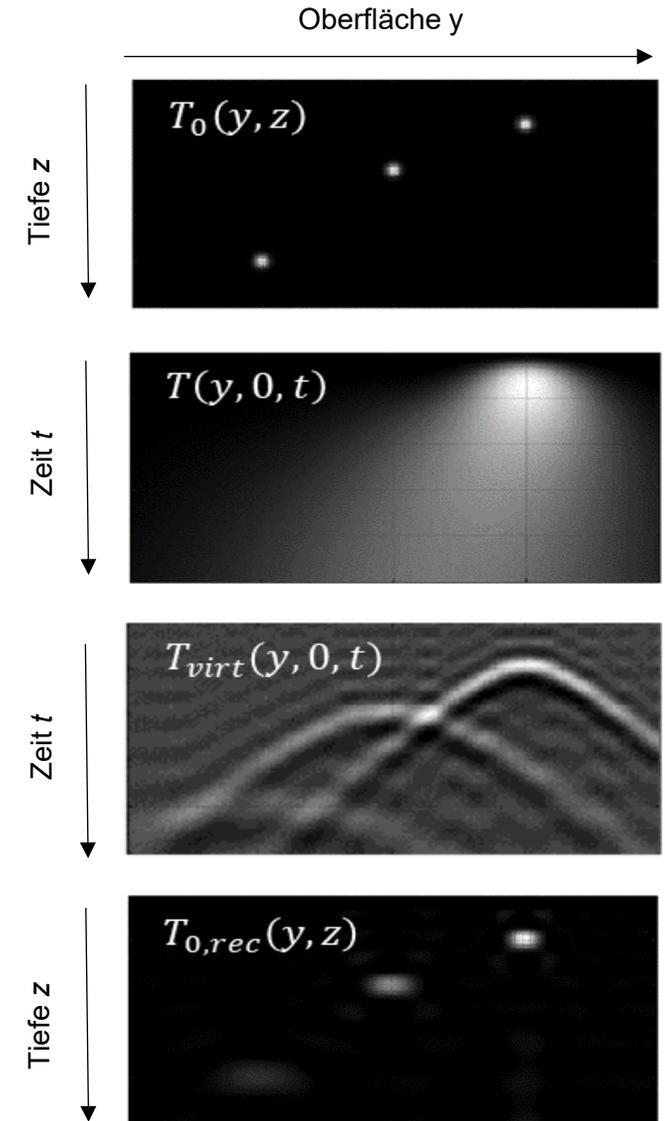
Truncated Singular Value Decomposition (SVD)-Methode: Rekonstruiertes Signal \mathbf{T}_{rec} als Schätzung für \mathbf{T}_{virt} vom thermografische Signal \mathbf{T} :

$$\mathbf{K} = \mathbf{U} \mathbf{S} \mathbf{V}^t \text{ mit unitären Matrizen } \mathbf{U} \text{ und } \mathbf{V}$$

In der Matrix \mathbf{S}^+ werden für alle singulären Werte in \mathbf{S} ihre Kehrwerte genommen oder Null für alle singulären Werte, die kleiner sind als $1/SNR$:

$$\mathbf{T}_{rec} = \mathbf{K}^+ \mathbf{T} \text{ mit der Pseudoinversen } \mathbf{K}^+ := \mathbf{V} \mathbf{S}^+ \mathbf{U}^t$$

Oder Minimierung $\|\mathbf{K} \mathbf{T}_{virt} - \mathbf{T}\|_2^2 + \lambda \|\mathbf{T}\|_1$ mit DR oder ADMM



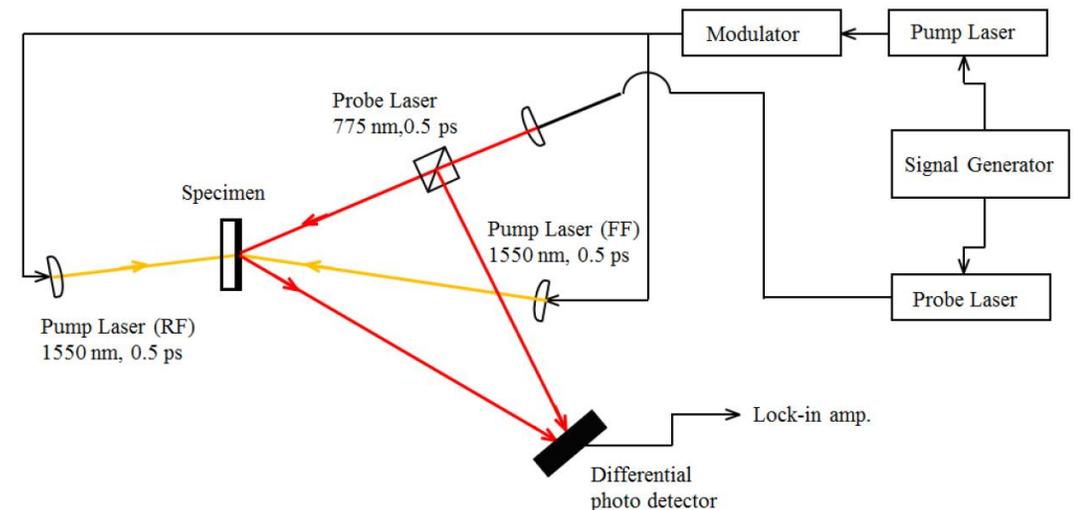
More sophisticated in terms of unequal sampletimes!

As usual in the field of TDTR, the phase² was used for these investigations.

Resolution: 1 ps
Observation time: 50 ns

Examined scenarios:

- RF (Transmission)
 - Downsampling $t_s = 1e-10$ s (use whole data)
 - $t_s = 1e-12$ s (only first 2000 frames are used)
- FF (Reflection)
 - Downsampling $t_s = 1e-10$ s (use whole data)
 - Downsampling $t_s = 1e-11$ s (first 2800 frames)
 - $t_s = 1e-12$ s (only first 2000 frames are used)



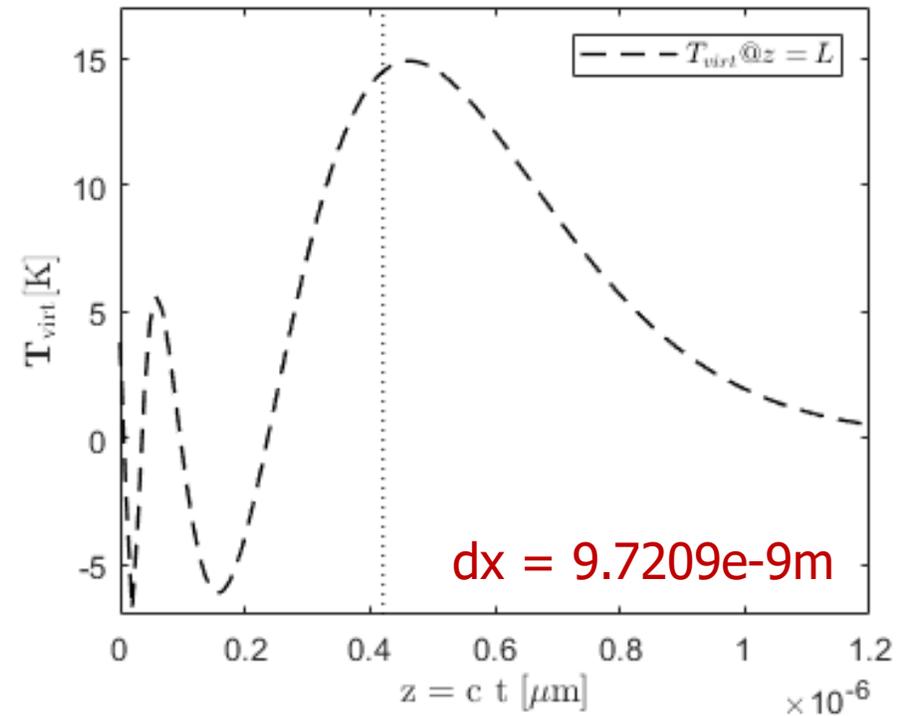
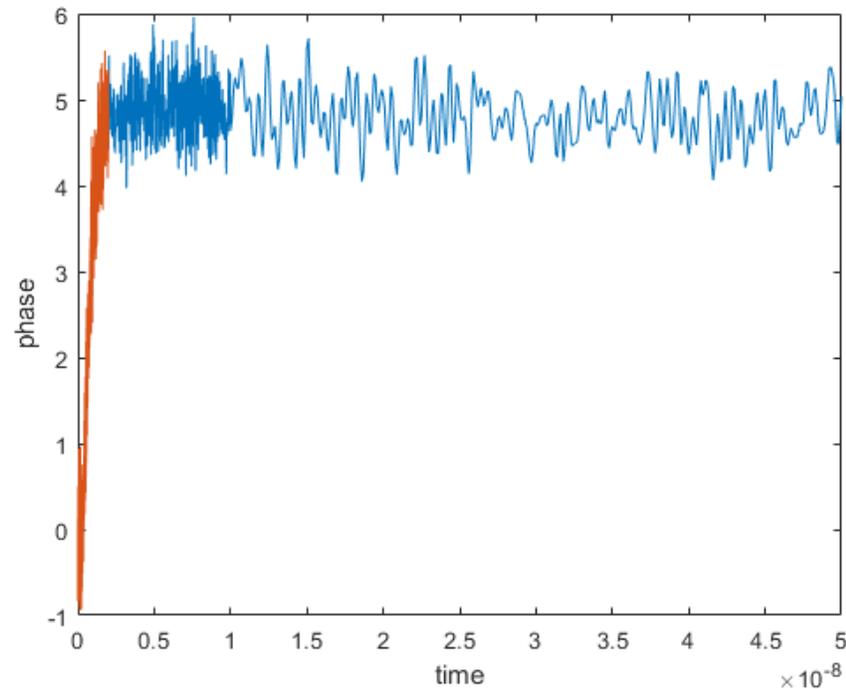
¹ Materials Center Leoben GmbH

² P. Jiang, X. Qian, R. Yang, Journal of Applied Physics (2018) doi:10.1063/1.5046944

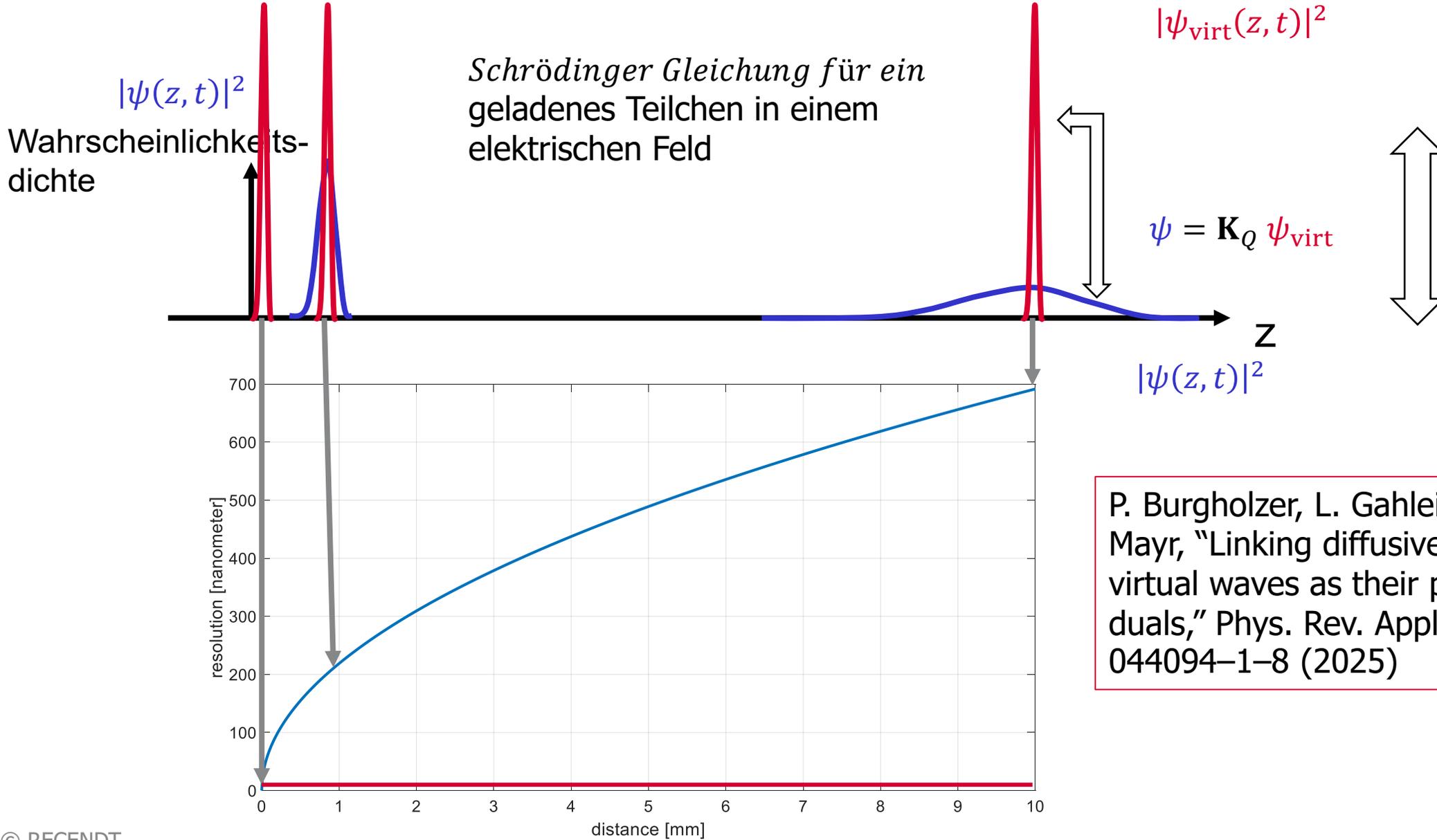
PicoTR (421nm Mo) $t_s = 1e-12$ s Results RF

Measurement data (1:2000 frames)

$L_{est} = 4.66e-7m$ $\lambda_{est} = 97.69$ W/mK



Dispersion von Quanten-Wellenpaketen (1D)



P. Burgholzer, L. Gahleitner and G. Mayr, "Linking diffusive fields to virtual waves as their propagative duals," Phys. Rev. Applied 24, pp. 044094–1–8 (2025)

We are RECENDT GmbH



Danke für Ihre Aufmerksamkeit

