Thermoacoustic tomography using integrating detectors

M. Haltmeier
Department of Computer Science, Universität Innsbruck, Technikerstraße 25, A-6020 Innsbruck, Austria
markus.haltmeier@uibk.ac.at

G. Paltauf
Department of Physics, Karl-Franzens-Universität, Graz, Universitätsplatz 5, 8010 Graz, Austria

P. Burgholzer
Upper Austrian Research, Hafenstraße 47-51, A-4020 Linz, Austria

Current research demonstrates that thermoacoustic computed tomography (TCT) is a promising hybrid imaging technique for non-destructive evaluation and medical imaging. It combines the advantages of purely optical imaging (high contrast) and ultrasound imaging (high resolution) since it uses either pulsed radio frequency or pulsed laser as energy input but measures the induced thermoacoustic pressure field.

The induced thermoacoustic pressure field p(x, t) depends on the spatially varying energy deposition function f(x) inside the illuminated sample. This dependence assigns the direct thermoacoustic problem. Thermoacoustic tomography tries to solve the inverse problem, i.e., to acquire the energy deposition from measurement data of the acoustic pressure outside the illuminated sample.

So far rigorous reconstruction formulas have been established for point measurement data for various geometries, i.e., formulas calculating f(x) using values p(x, t). Since small transducers are used to simulate point measurement data, this approximation causes blurring in the reconstruction and limits the spatial resolution of the reconstruction.

To overcome this approximation we propose to acquire measuring data with integrating detectors that are extended in either one or two dimensions (i.e., lines, planes) and the detector dimension is larger compared to the imaged object. The resolution of small structures reconstructed from data measured with a point transducer is physically limited by the detector size. There is no such limit for the proposed tomography method because the reconstruction algorithm assumes detector dimensions larger than the sample dimensions. Spatial resolution is limited only by the bandwidth of the detector and therefore high resolution can be achieved. We present experimental setups how to collect full data and derive reconstruction algorithms for both cases, i.e. we show how to calculate the energy deposition function from data of either line detectors or plane detectors.

Acknowledgment
This work of Markus Haltmeier is supported by the *FWF (Austrian Science Foundation)*, grant Y-123 INF N04.