University Hospital Zurich — Dept. Gynaecology, Division of Neonatology

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3D Imaging in Medicine

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Tomographic Methods in Medicine

- UST   Ultra Sound Tomography

• Near-Infrared Tomography

3D-image-reconstruction

Stent struts

St st

tumor
(increased vascular density)

imaging of inhomogenities

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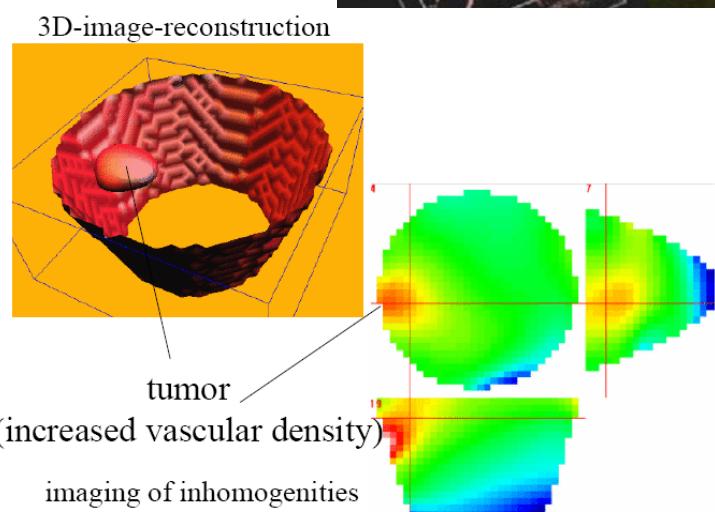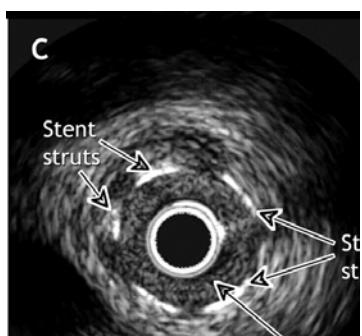
Optical tomography

- Brain in neonates
- Breast cancer screening
- Muscle


Head of neonate
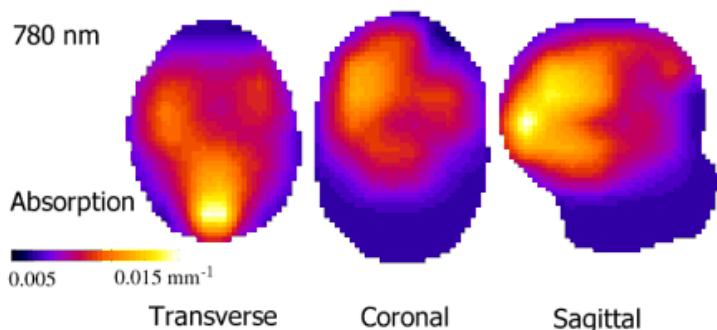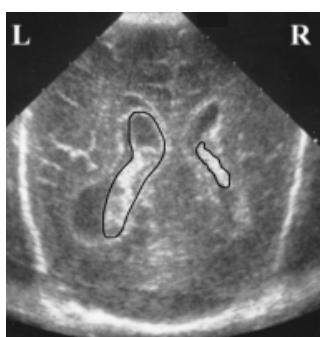

**Ultrasound** **Optical absorption tomography**

Picture credit: J. Hebden

Optical tomography of arm
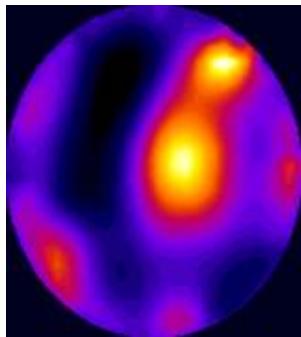
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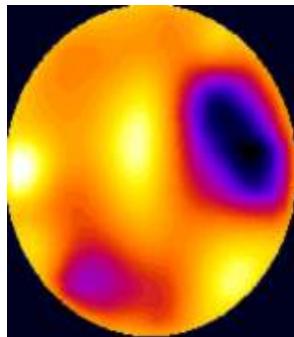
Absorption
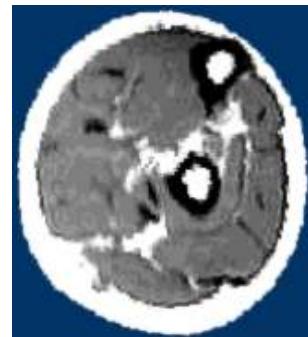
MRI

Set-up

Picture credit: J. Hebden

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3D Near Infrared Imaging

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State of the art:

- Low spatial resolution ~1cm
- Low time resolution ~10min
- Bulky system
- Limited number of sources/detectors


[Wells K *et al* Proc. SPIE 1997]

Aim:

- Address these issues

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SPAD Image Sensor: LASP Chip

I/O interface

128x128
SPAD array

32 TDCs

100ns range

97ps res.

[Niclass *et al* JSSC 2008]

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Experimental Setup

Collimator & diffuser

SPAD sensor & acquisition electronics

Telecentric objective

Collimator & diffuser

4 cm

Intralipid phantom

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Impulse response
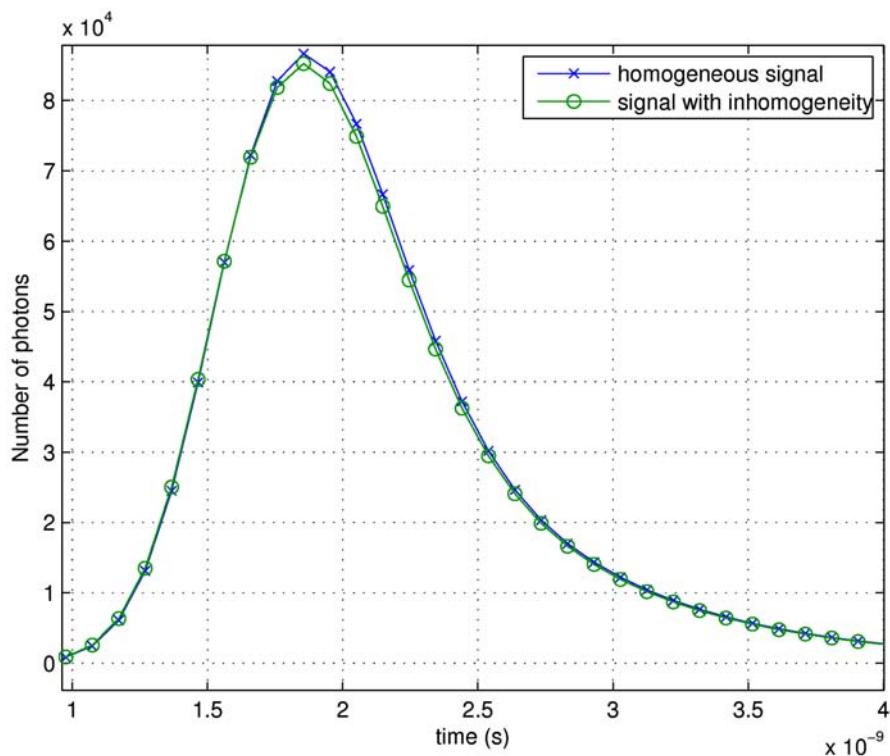
In vitro results
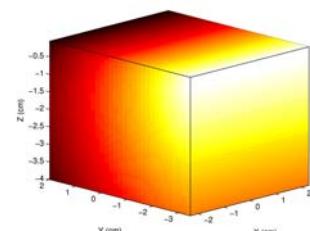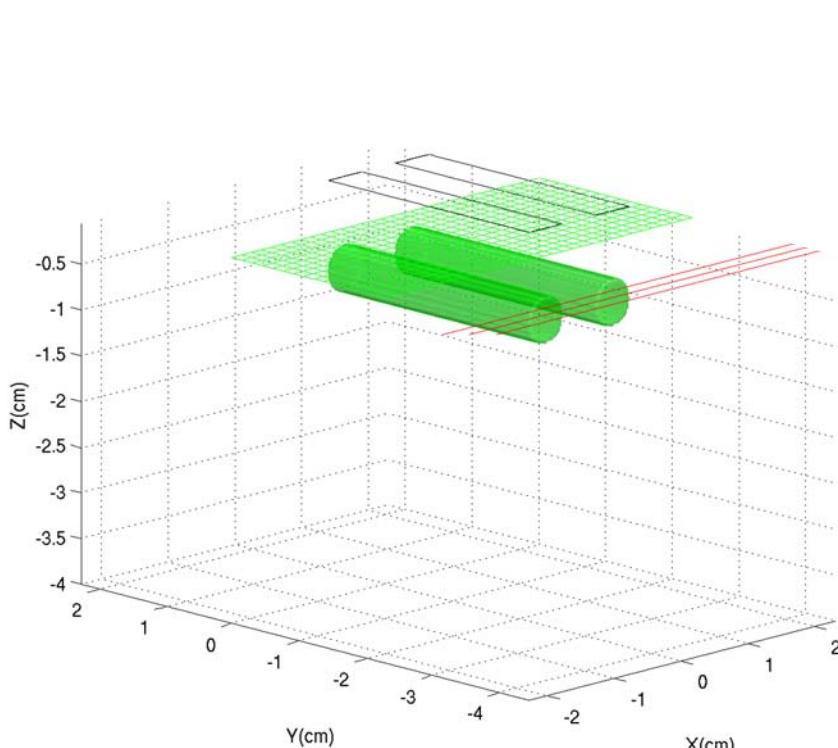
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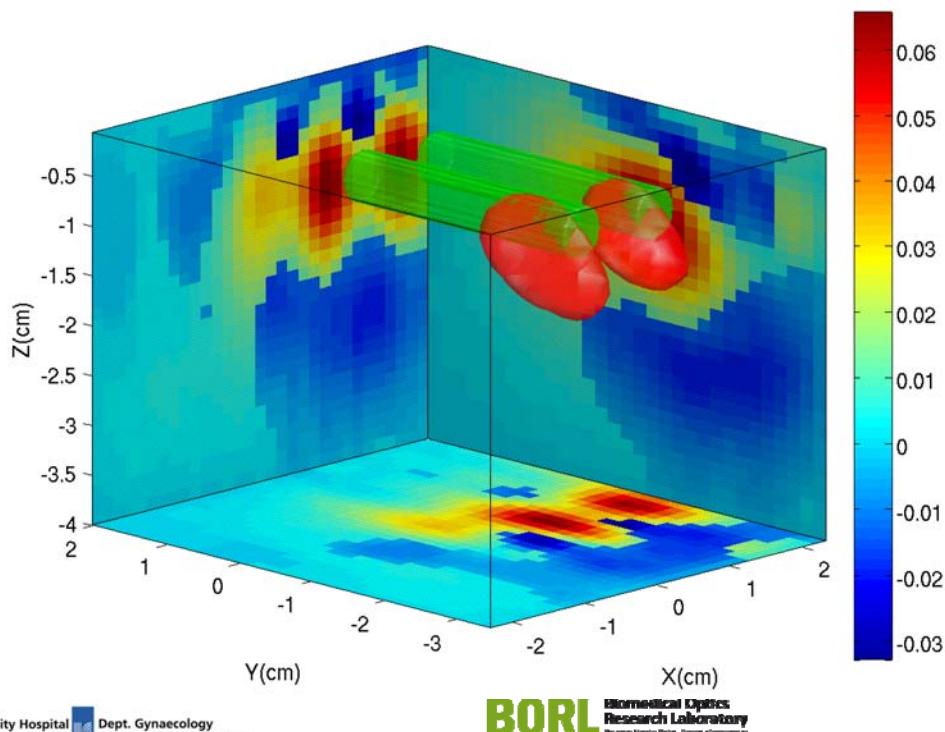

## Tomographic Methods in Medicine

- UST   Ultra Sound Tomography

• Photoacoustic Tomography

3D-image-reconstruction

tumor
(increased vascular density)
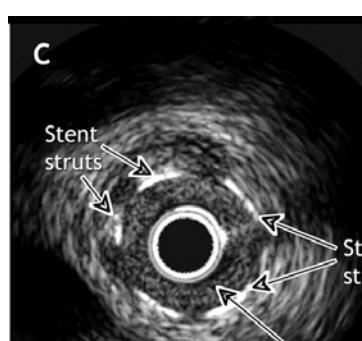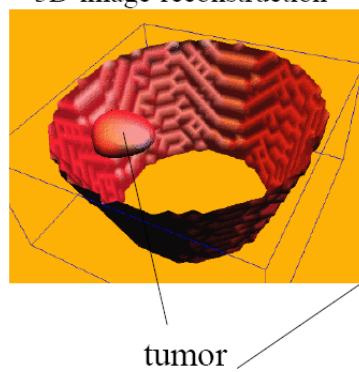
imaging of inhomogenities
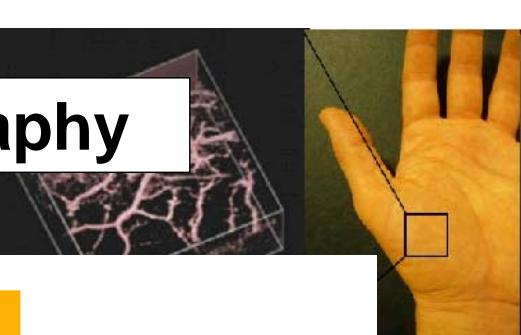
Photoacoustic Imaging
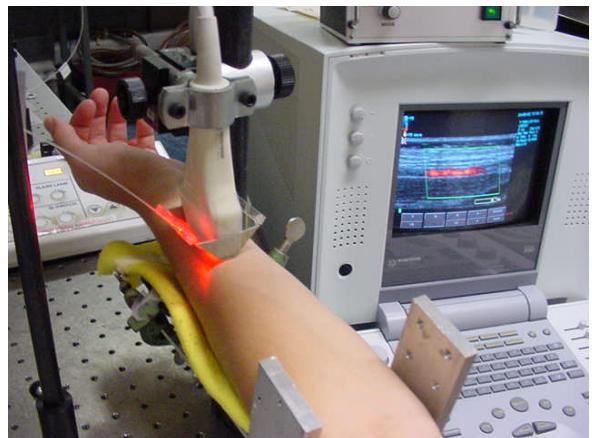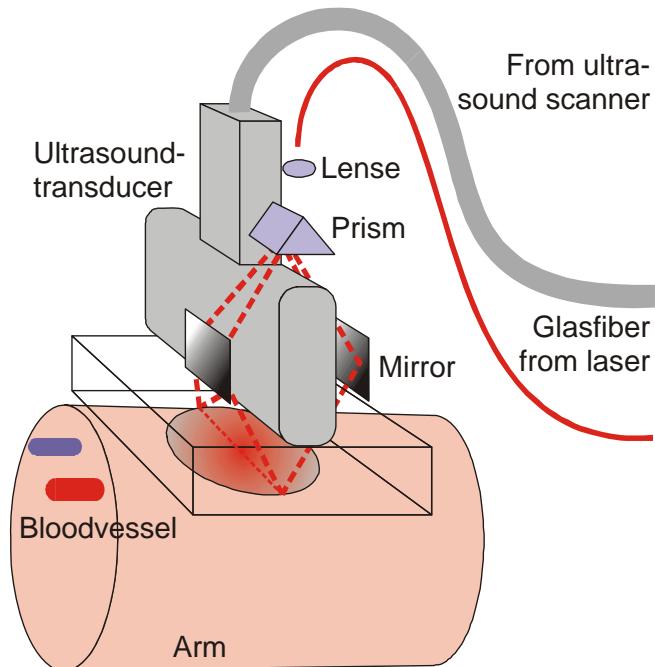
Ultrasound-transducer

Lense

Prism

Mirror

From ultra-sound scanner

Glasfiber from laser

Bloodvessel

Arm

Picture credit: M. Frenz

Comparison
Photoacoustic - Ultrasound

→ Methods are complementary

Finger Bloodvessels

Bone

Optoacoustic image
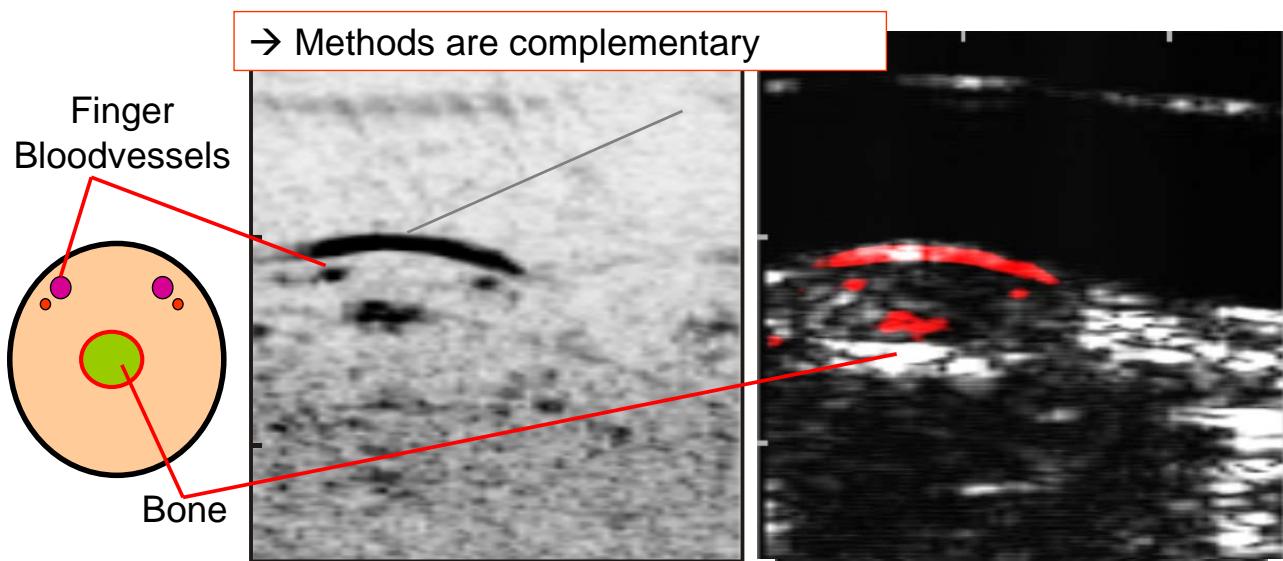
Ultrasound image

Parameters:
2.6 x 2.6 cm
15 mJ Energy

Picture credit: M. Frenz

High resolution photoacoustics
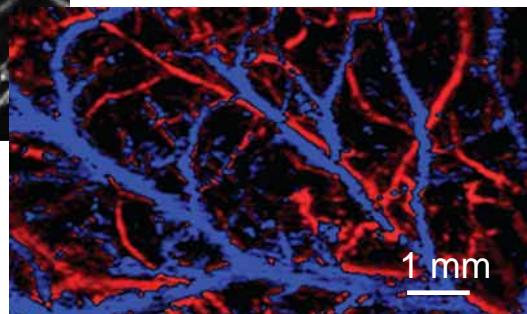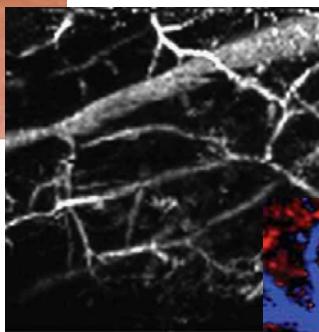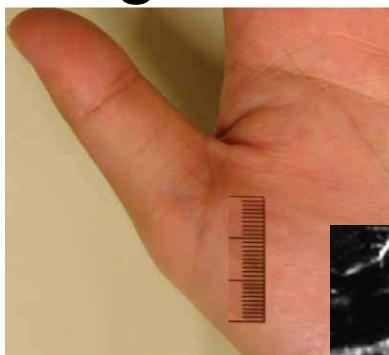
Zhang, Nat Biotec 2006

1 mm

Conclusions

- Near-infrared imaging
  - Resolution ~3-5mm, ~s
  - Non-contact
  - Inexpensive
- Optoacoustic
  - Resolution excellent
  - Contact
  - Many possibilities

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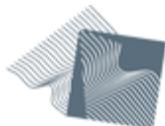
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