Angiogenesis betrays breast cancer to near-infrared photoacoustic imaging

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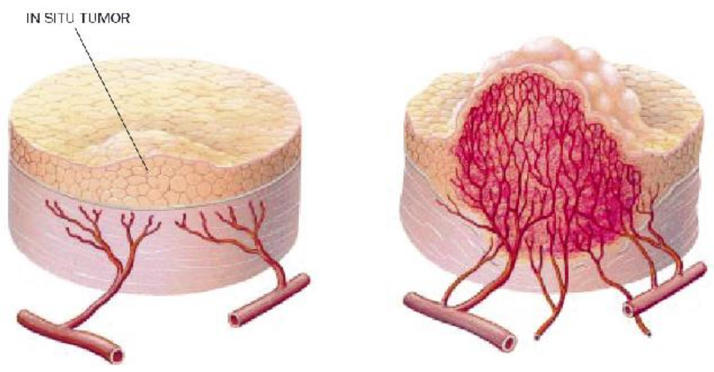
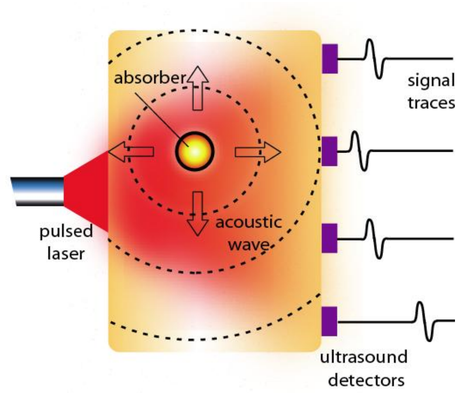
Cancer angiogenesis and optical contrast

- Angiogenesis results in enhanced blood content at tumor site
- Hemoglobin provides absorption contrast for detection using light



Photoacoustic imaging

- Light pulses converted to acoustic pulses at absorbing sites in tissue
- Acoustic pulses detected using ultrasound detectors
- Arrival time of pulses localizes position of absorber

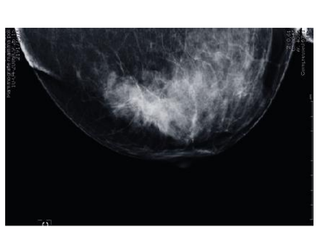


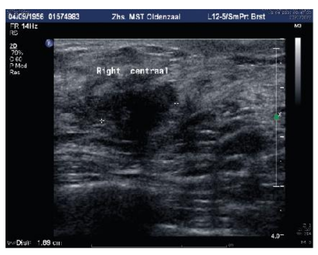
The Twente Photoacoustic Mammoscope

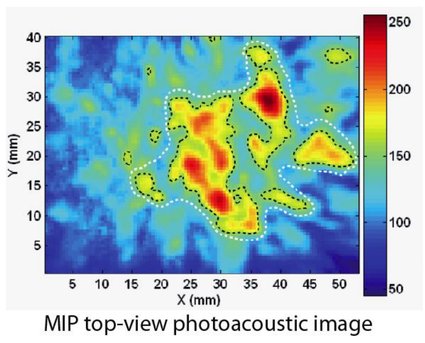
- Developed at the University of Twente[1]
- Uses 1064 nm, 5 ns pulsed light for excitation
- Detection with a 90 mm diameter, 1 MHz, unfocused ultrasound detector array
- Resolution 3.5 mm; imaging depth 35+ mm[1]

[1] *S. Manohar et al., Phys. Med. Biol., 2005*

Case 1: 50 year old with infiltrating ductal carcinoma[2]



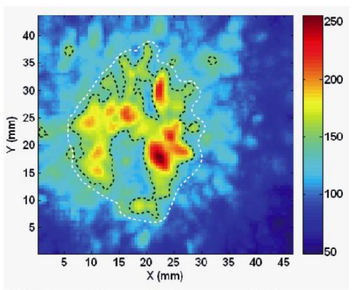




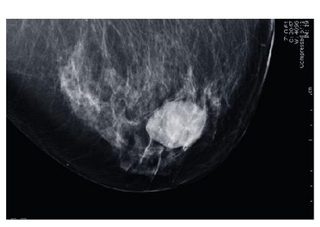
MIP top-view photoacoustic image

- High intensity regions in photoacoustic images
- These regions correspond to higher optical absorption due to hemoglobin
- Photoacoustic ‘hot spots’ attributed to heterogeneous distribution of vascularization associated with cancer
- Extent of cluster in photaocustic image; comparable with cancer size derived histopathologically

Case 2: 57 year old with infiltrating ductal carcinoma[2]



MIP top-view photoacoustic image



[2] *S. Manohar et al., Optics Express, 2007*

Current clinical study:

BIRADS 5	BIRADS 4	BIRADS 3	BIRADS 2	BIRADS 1
Almost certain malignancy.	Suspicious for malignancy.	Probably benign lesion.	Benign lesion.	Normal breast tissue.

Phase 1 &2:

Nr. of subjects: 60 (BIRADS 4,5)
Months: 1-16
Goals:

- Improve measurement methods
- Find photoacoustic malignancy markers
- Guide developments towards PAM II

Phase 3:

Nr. of subjects: 20 (BIRADS 1,2)
Months: 14-18
Goal:

- Evaluate absence of malignancy markers
- Guide developments towards PAM II

Future Plans (PAM II):

- Full view breast imaging
- No breast compression
- Shorter measurement duration
- Multiple wavelengths

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