Optical detection of photo-acoustic signals

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Cooperation with SpectraCure AB

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KUNGL. FYSIOGRAFISKA SÄLLSKAPET I LUND

Lund Laser Centre

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General objective

- Developing a technique that can perform optical imaging with sub mm resolution down to substantial depths in the body
- Optical imaging is able to provide molecule specific information not obtainable by e.g. X-rays, ultrasound or magnetic resonance imaging
- We would like to reach large depths and to carry out measurements within a short time

Comparison of techniques

- **Photoacoustic Tomography (PAT) (Konventionell fotoakustik)**
- **Ultrasound optical tomography (UOT) (Optisk ultraljudstomografi)**

Comparison of penetration depth & S/N for oxygenation measurements using PAT & UOT

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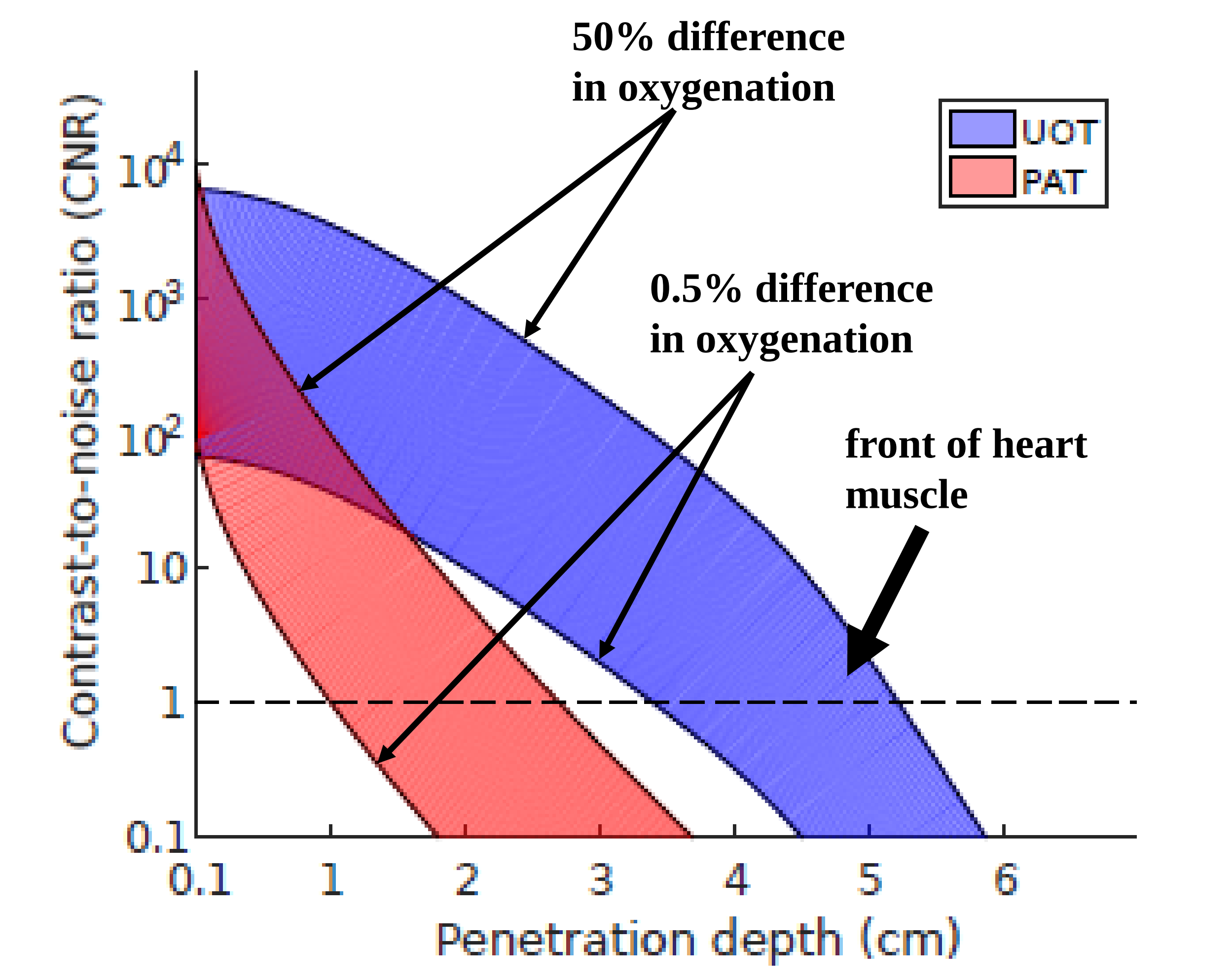
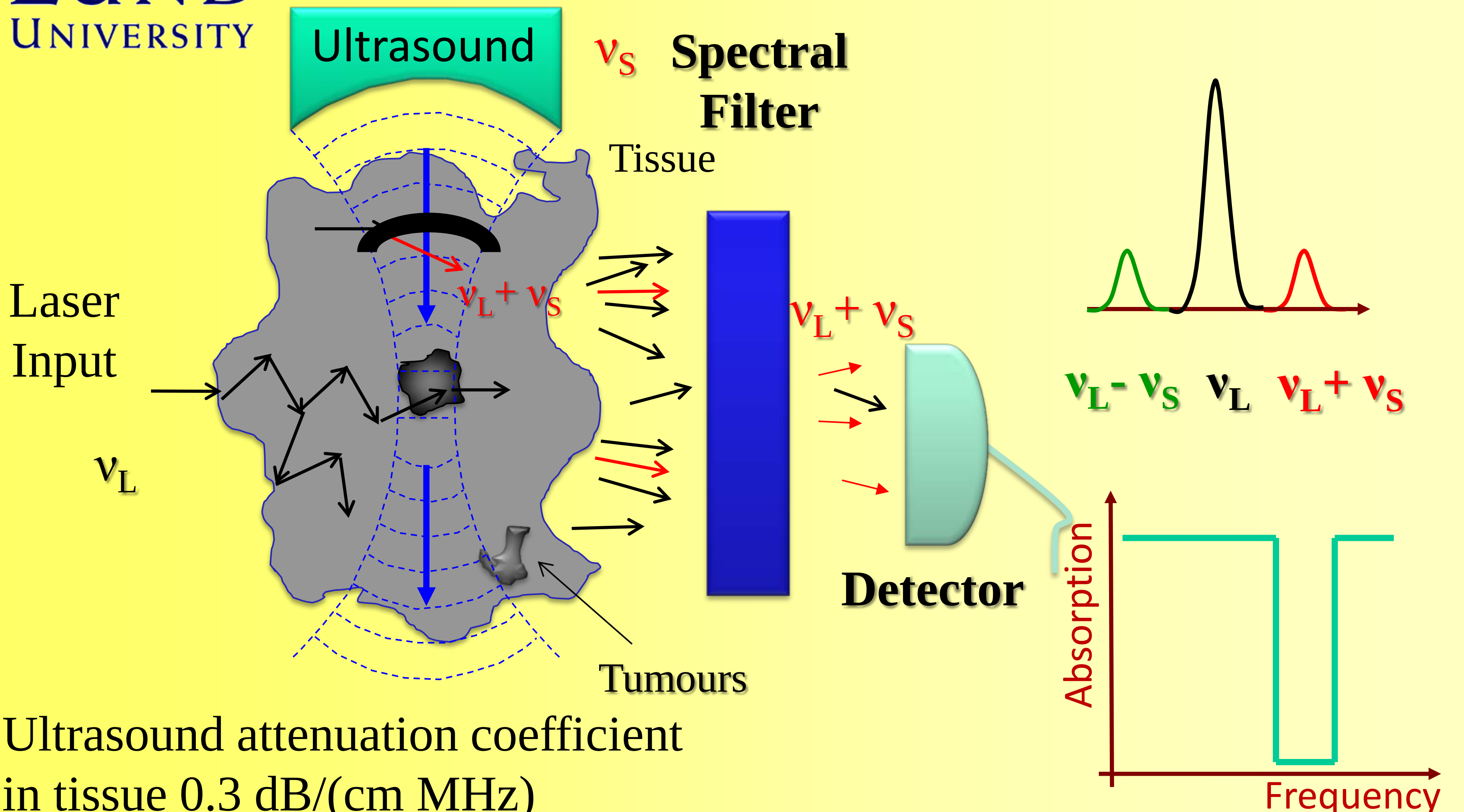
Light source inside –
Double distance

Does theory and experiment agree?



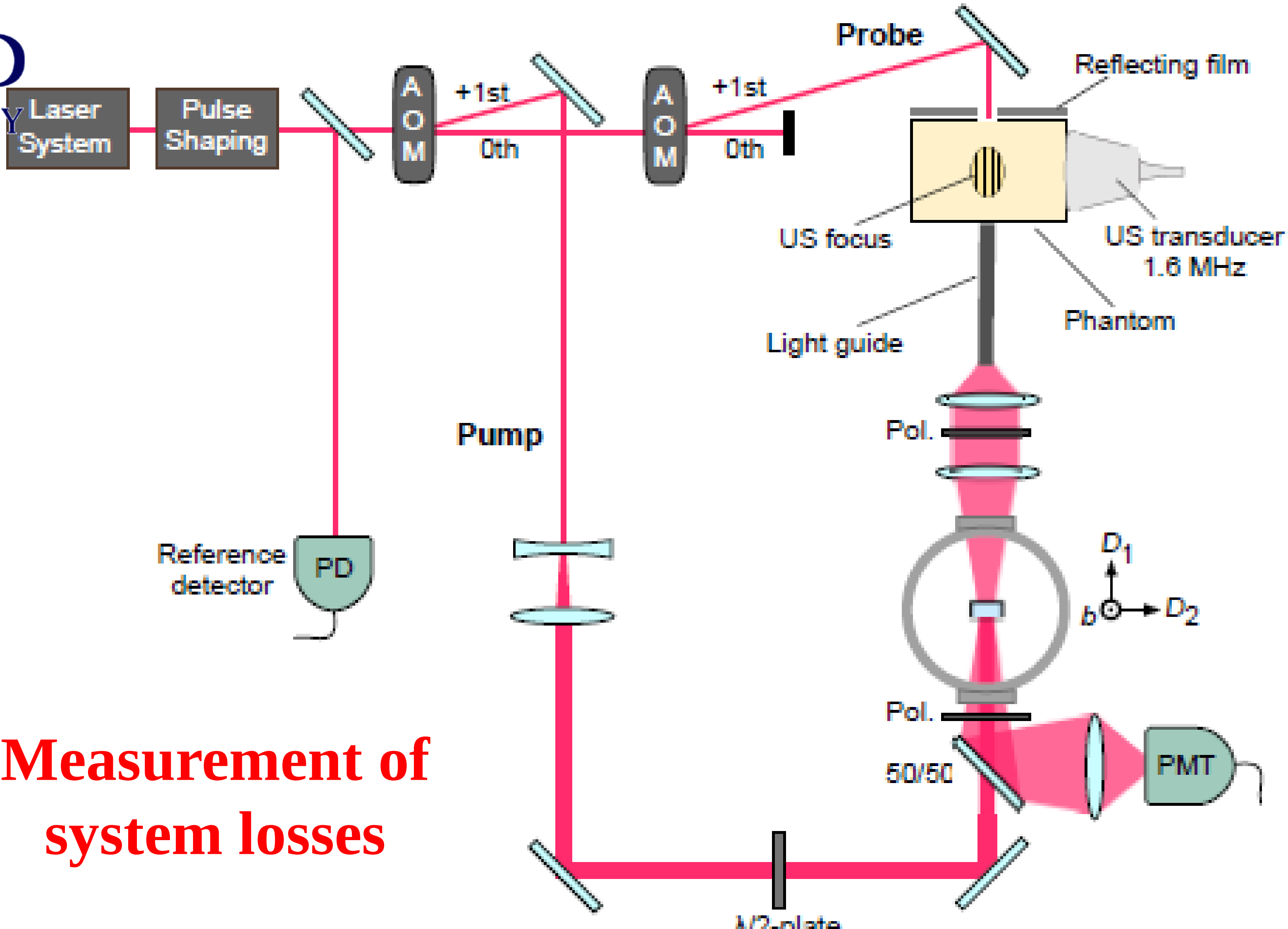
Spatial resolution: ~30 elements, ~3x3x3 mm each, measurement time, ~3s

Ultrasound optical tomography



Ultrasound attenuation coefficient in tissue 0.3 dB/(cm MHz)

UOT test experiment

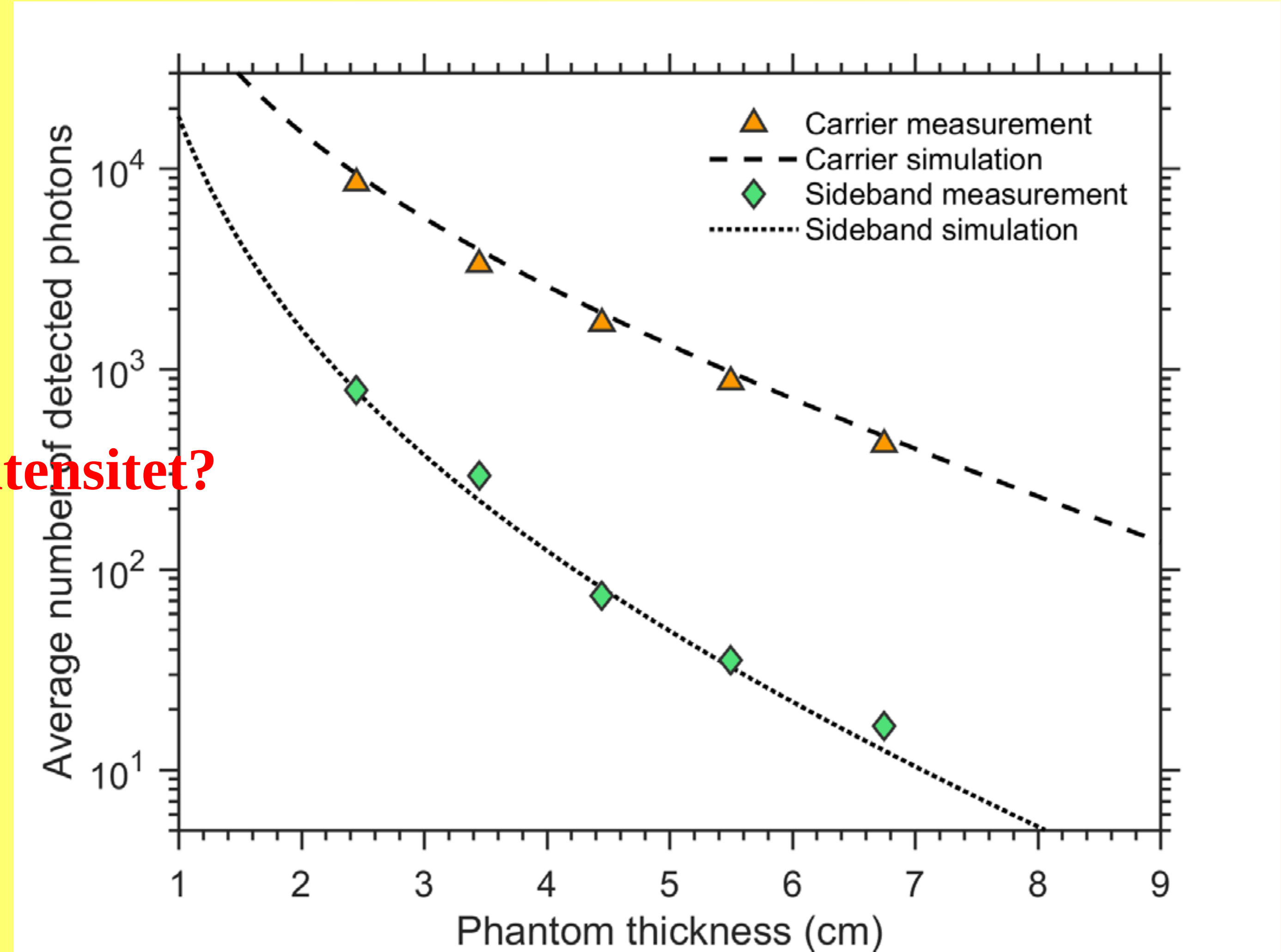


Measurement of system losses

Carrier and tagged light transmission vs phantom thickness Comparison with simulations

Errorbars?

Ultraljudsintensitet?



Signal strength and shape

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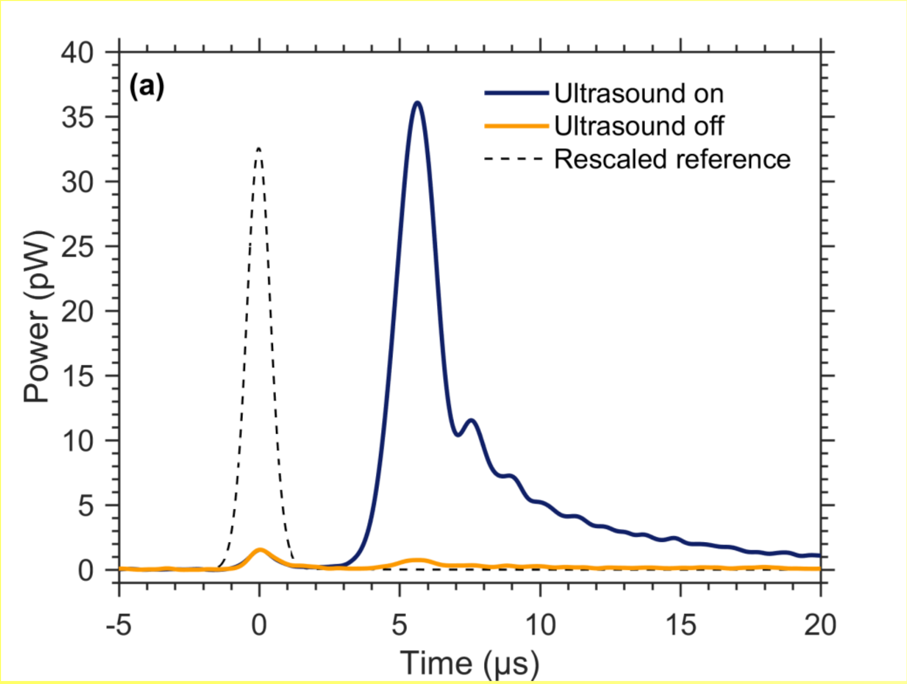
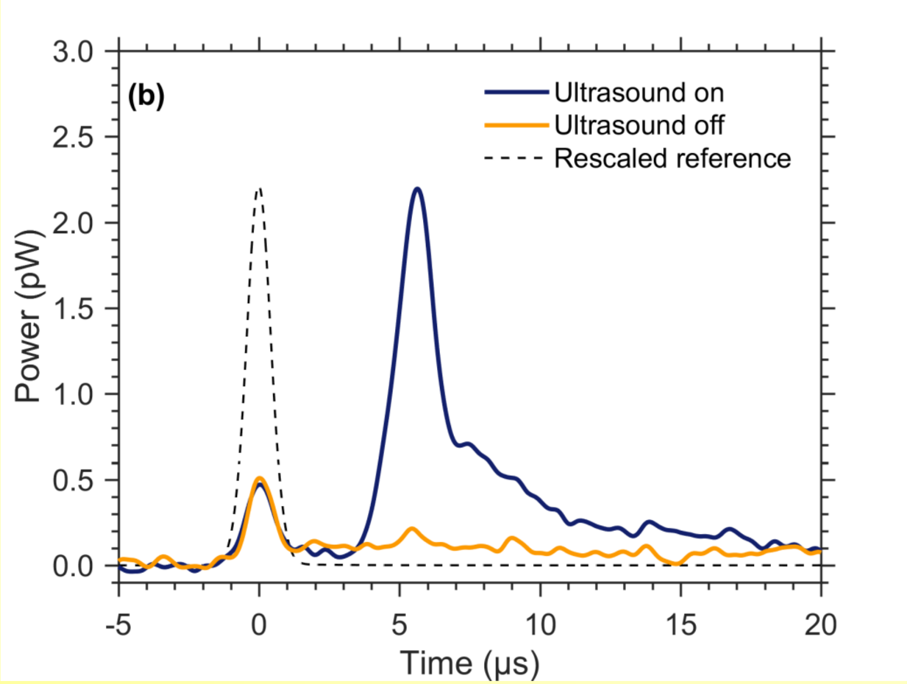
3.5 cm phantom



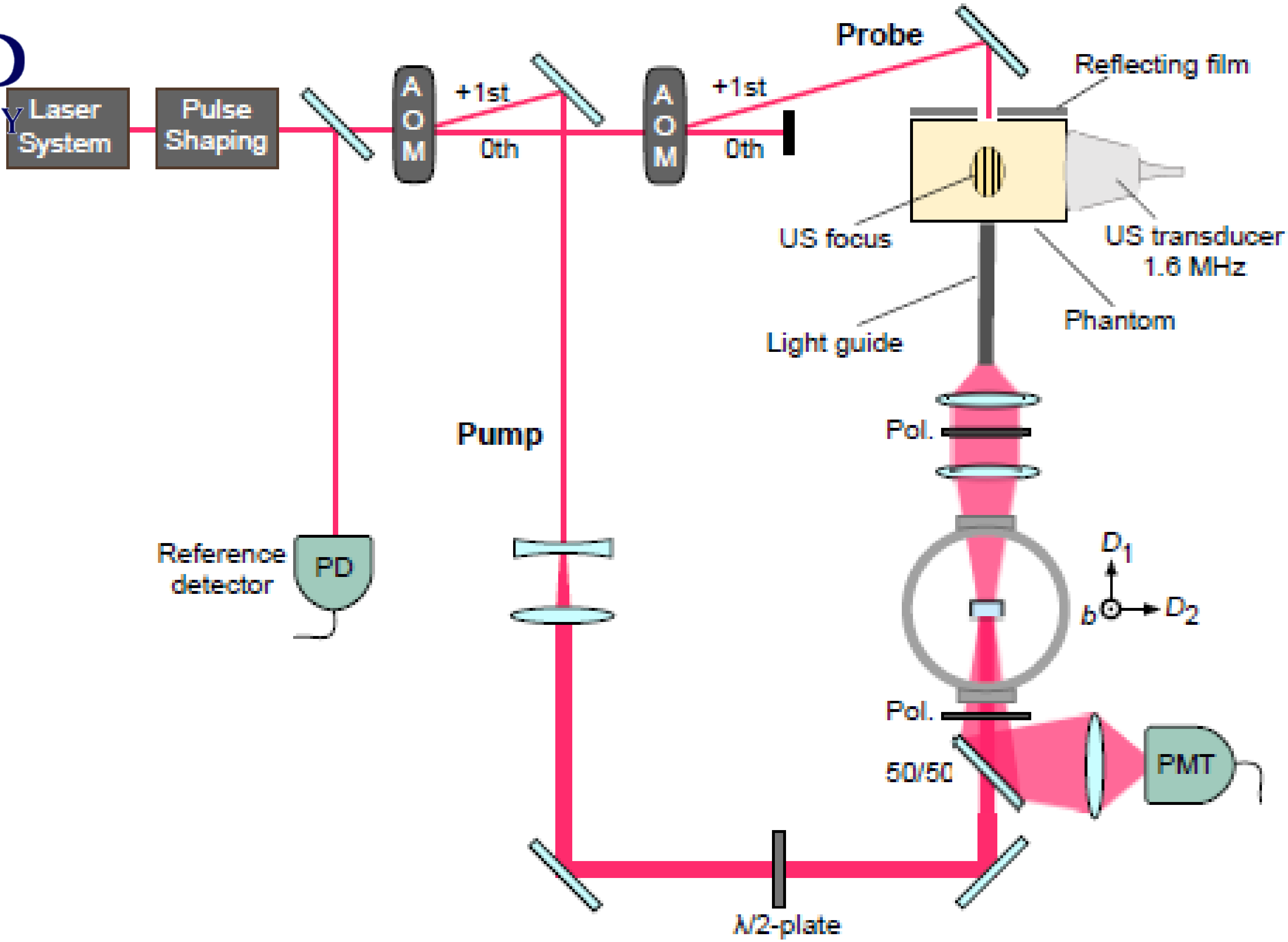
6.8 cm phantom



Light speed reduces from 300.000 km/s to 2 km/s

Reduced scattering coefficient 6.1/cm
Absorption coefficient 0.008/cm
Ultrasound frequency 1.6 MHz

UOT test experiment



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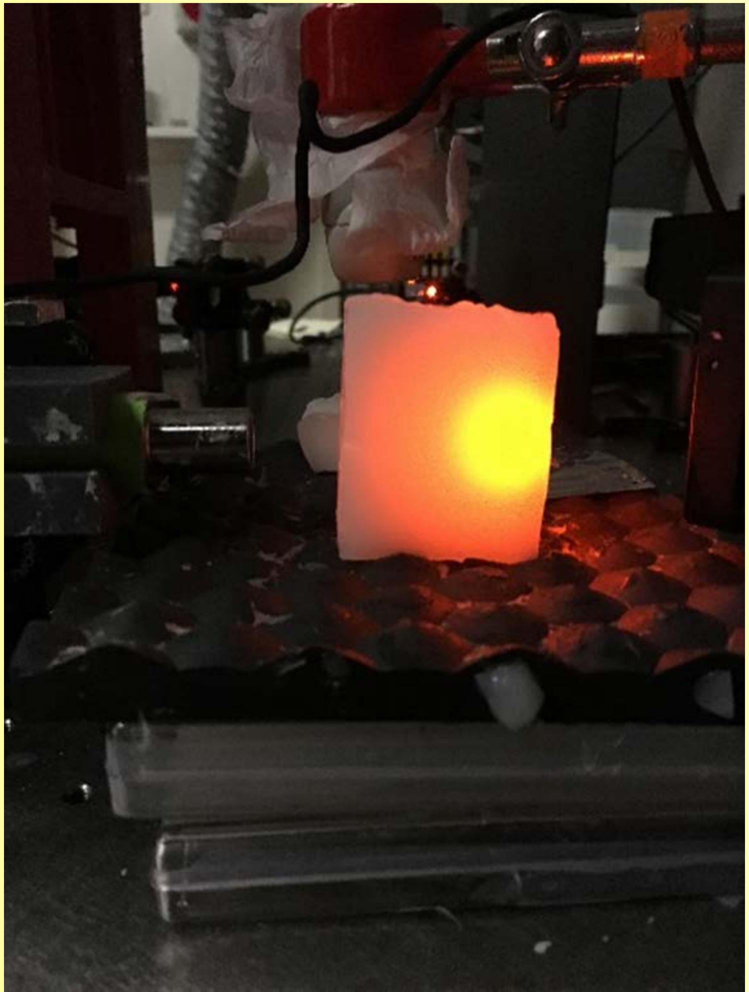
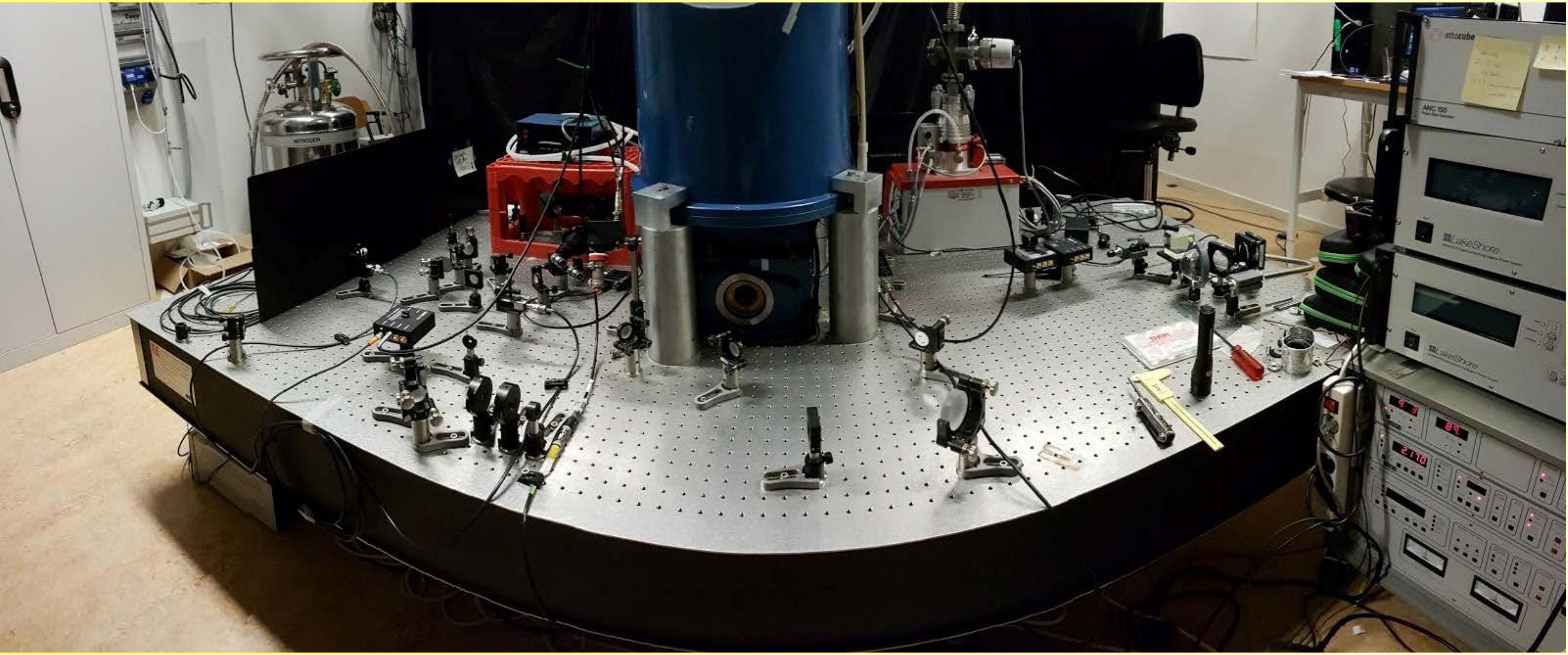
Laser & phantom

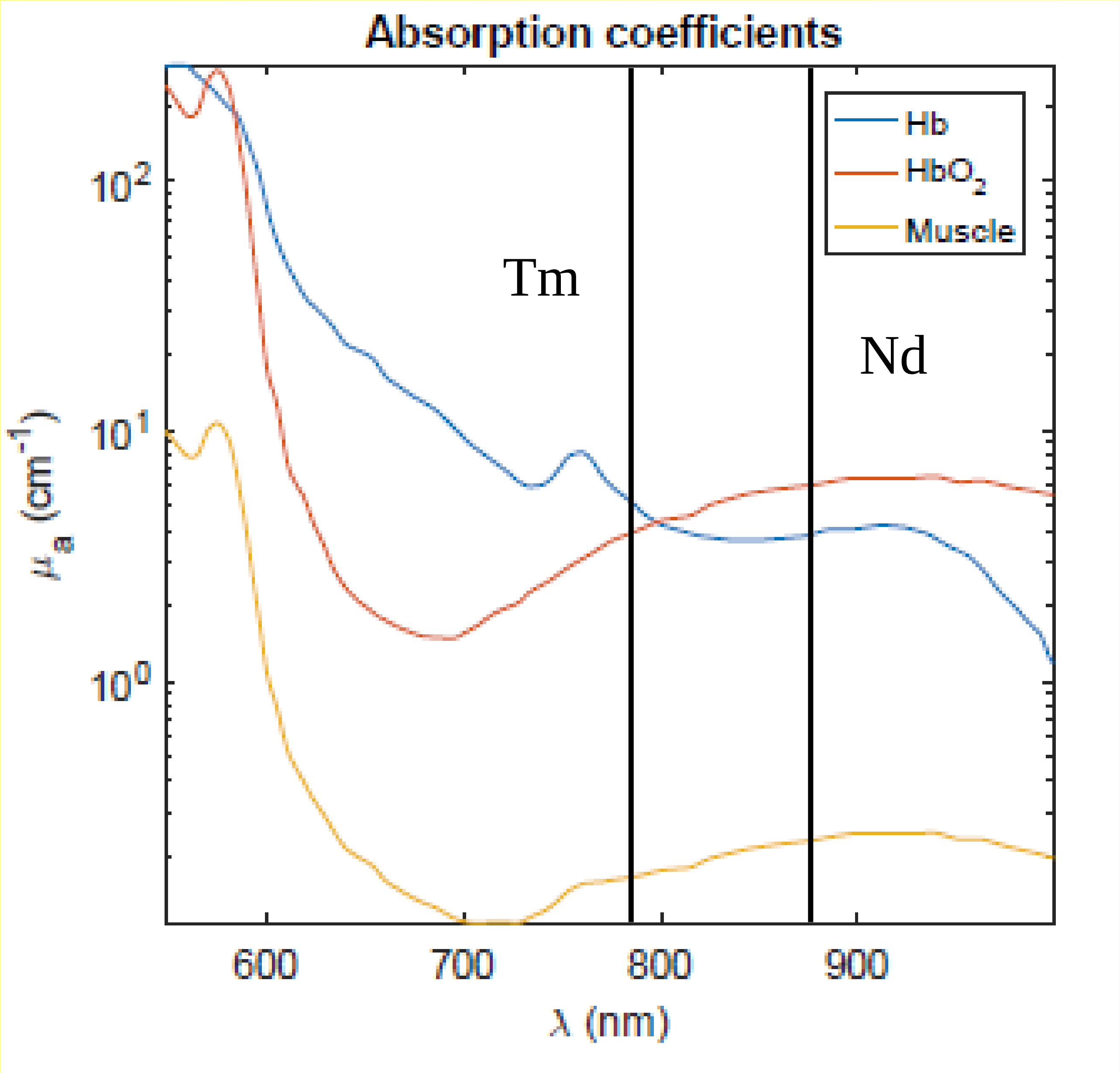


More from the experimental set-up

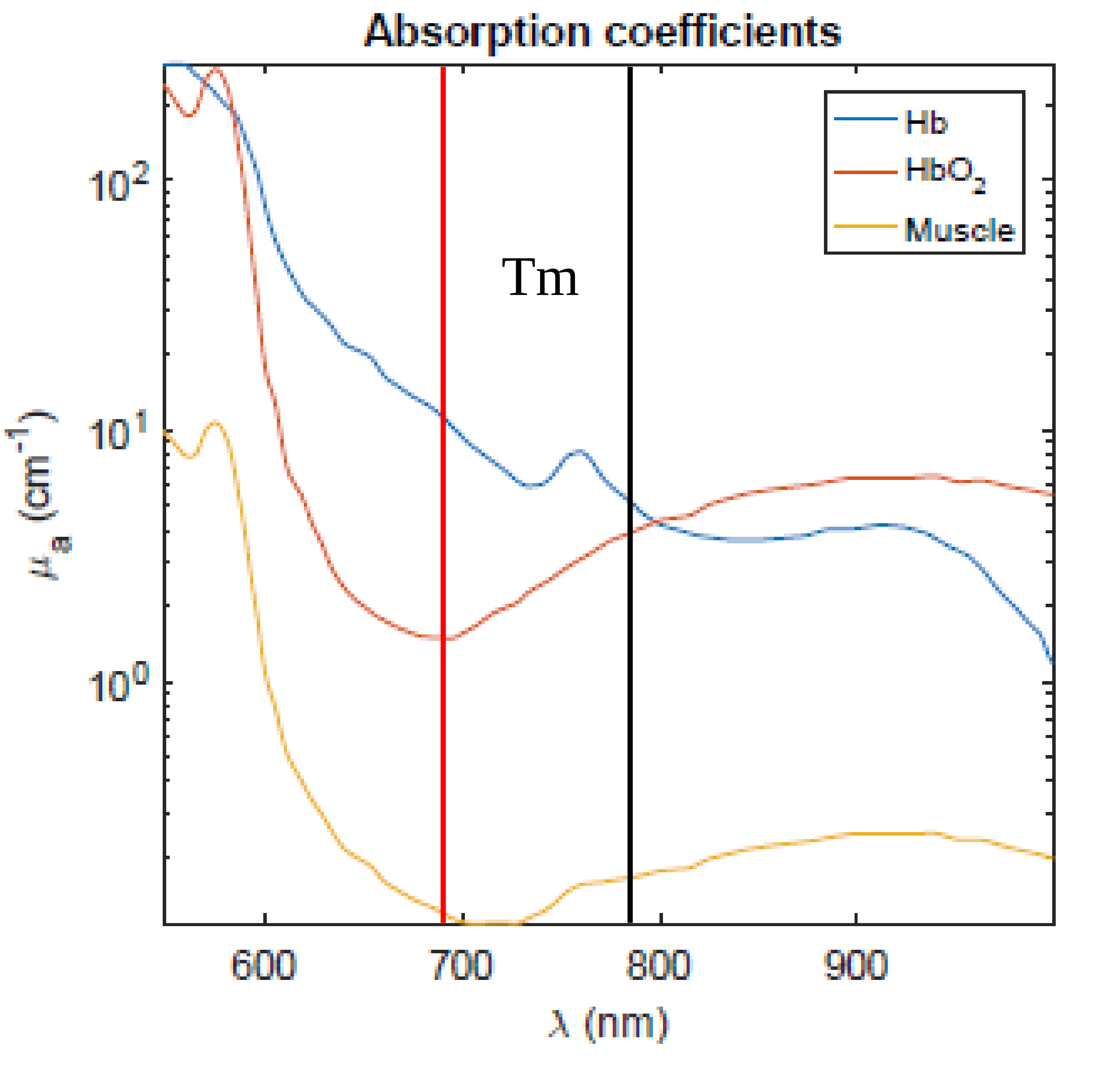


Every piece of equipment should be mountable in an 19 inch rack

Hemoglobin oxygenation



Hemoglobin oxygenation



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Current status

- Simulations show significantly better signal-to noise than PAT as well as larger depth
- Experiments support simulation results
- Read to test materials at tissue transparent wavelengths

Future

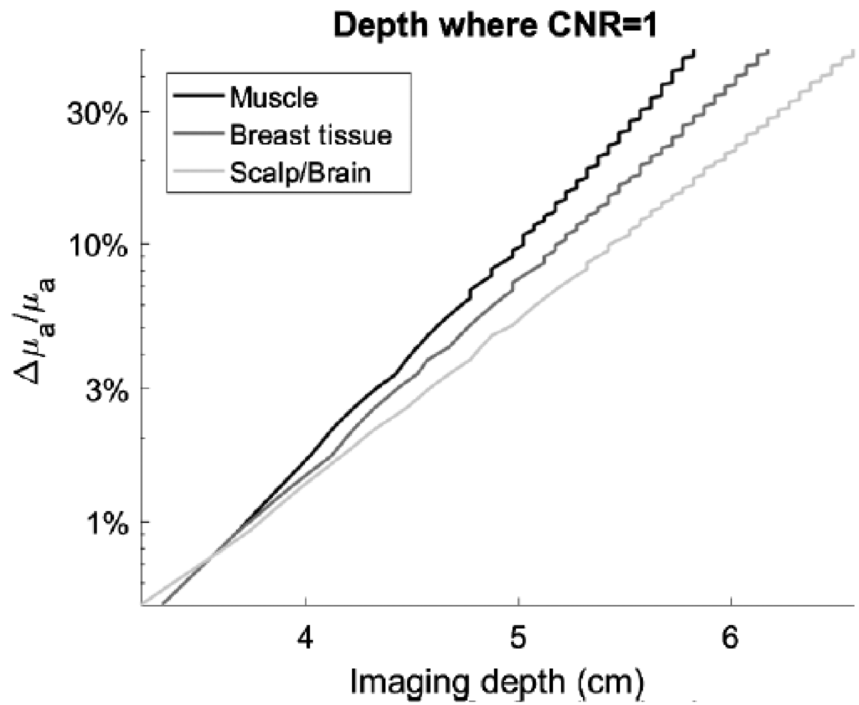
- If the new materials work we are ready for real tissue mimicking (3D) phantoms and tests on healthy volunteers
- Development of mobile system for measurements on animal models

Vävnadsegenskaper

	Muscle @880 nm	Breast@880 nm	Scalp/skull	Brain
Absorption coefficient	0.2 cm^{-1}	0.08 cm^{-1}	0.095 cm^{-1}	0.14 cm^{-1}
Scattering coefficient	50 cm^{-1}	100 cm^{-1}	120 cm^{-1}	40 cm^{-1}
Transport scattering coefficient	5 cm^{-1}	10 cm^{-1}	12 cm^{-1}	4 cm^{-1}

According to simulations measurements can reach slightly larger depths in breast and brain tissue than in muscle tissue

Gunther, Walther Rippe Kröll & Andersson-Engels, J. of Biomed. Optics **23**, 071209 (2018)



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Thank you