

***SPIE Photonics West
Biophotonics Hot Topics 2018***

**Biophotonics Applications
of
Gas in Scattering Media
Absorption Spectroscopy (GASMAS)**

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Sweden***

***South China Normal University
Guangzhou***



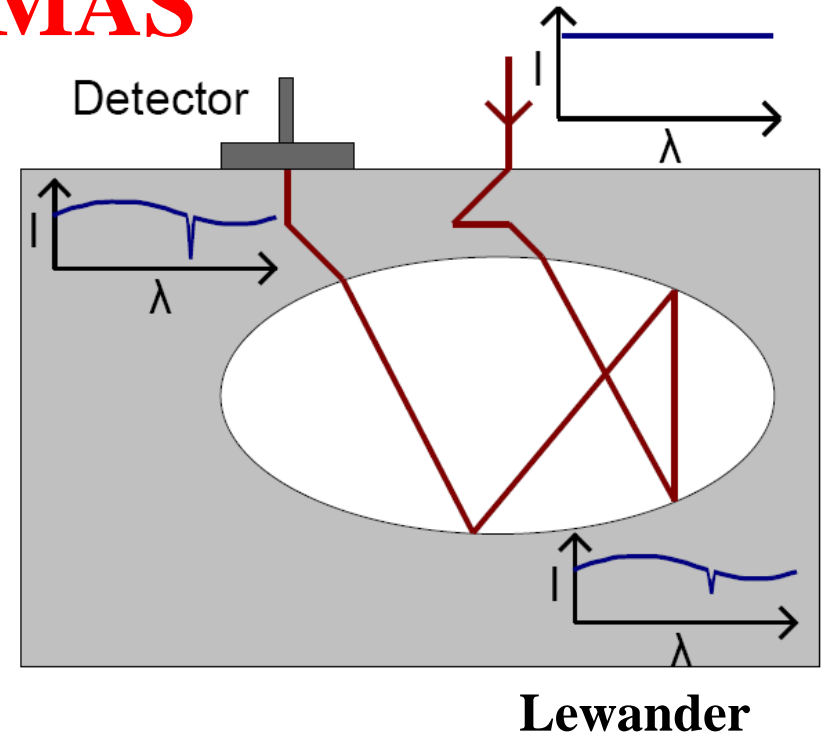
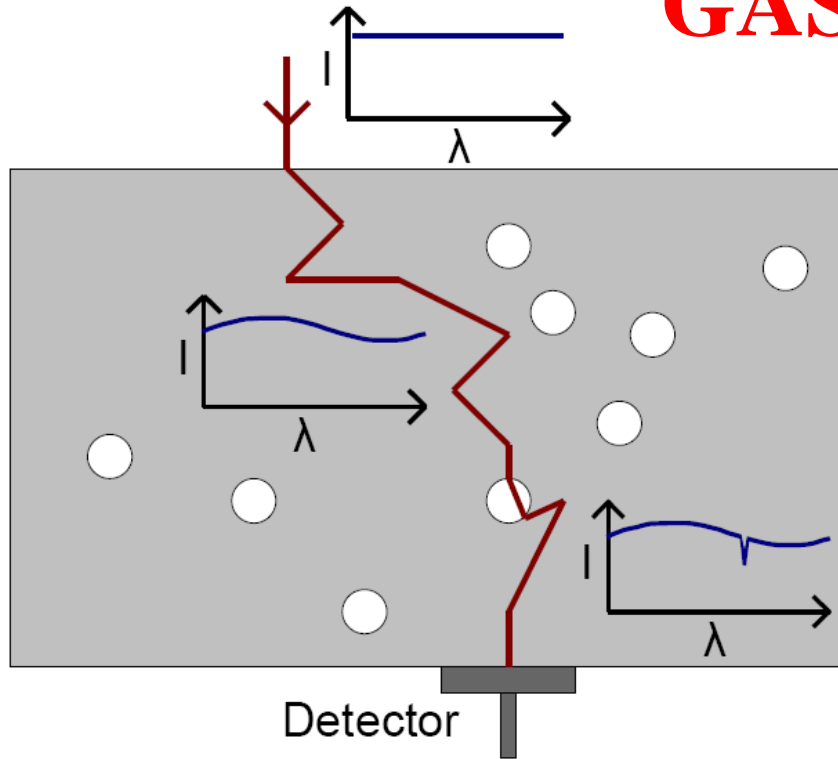
**LUNDS
UNIVERSITET**



TRANSMISSION

GASMAS

BACKSCATTERING



Detector

Lewander

Materials, pharmaceuticals, food stuffs and packages, biomedicine ...

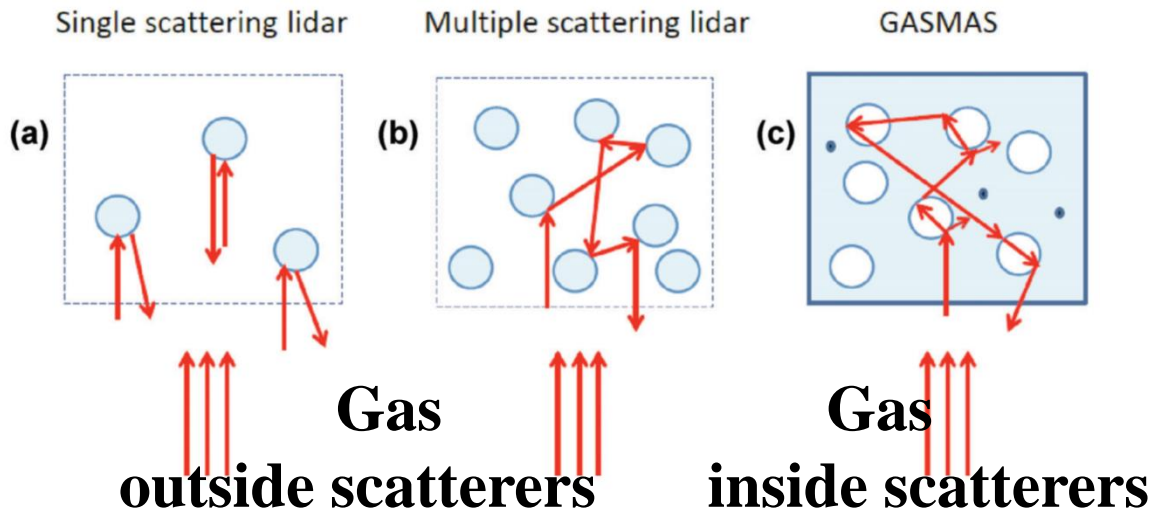
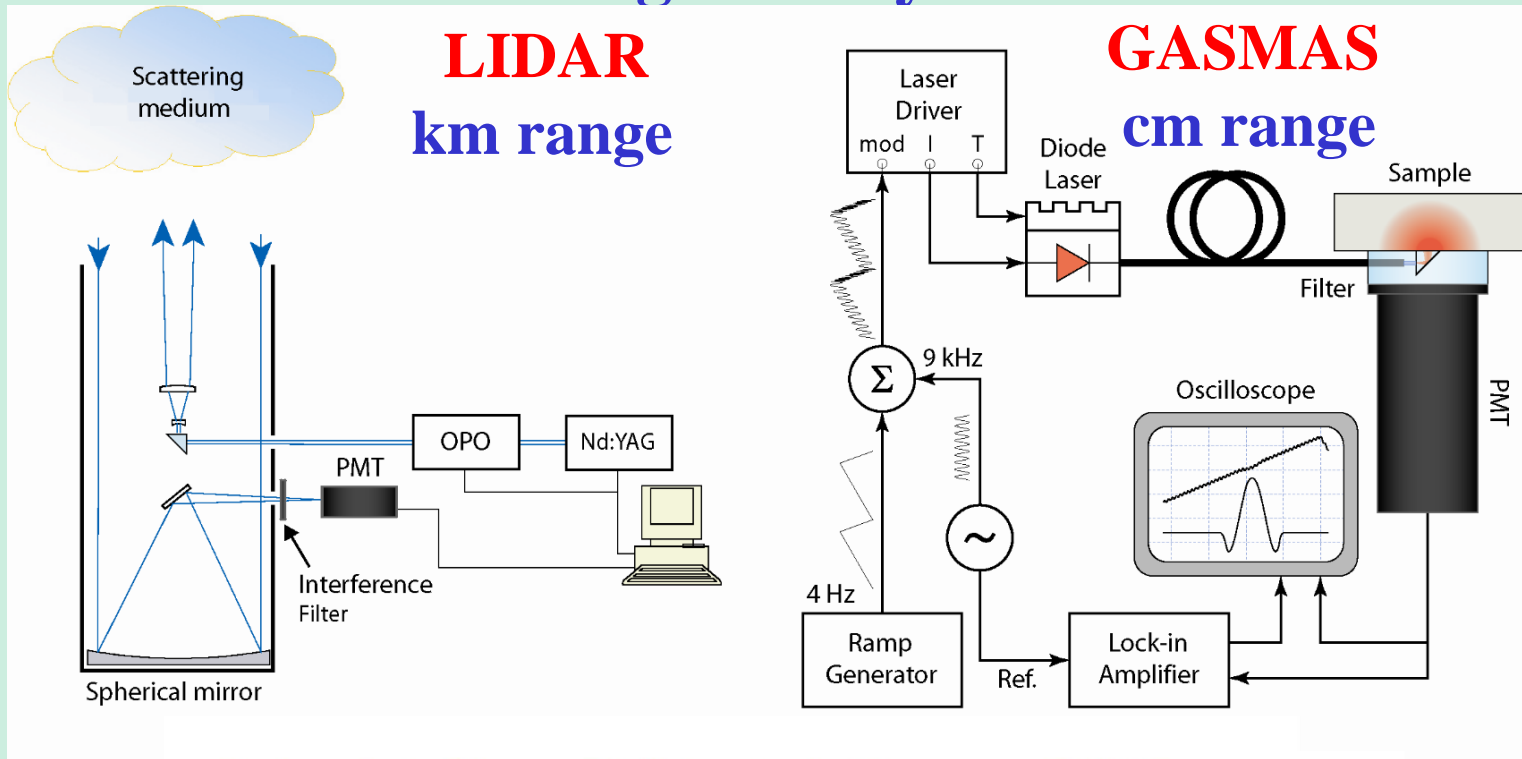
How to handle the path-length problem? Normalize on water vapor!

Collaborators in Sweden and China

M. Andersson, S. Andersson-Engels, P. Chen, D.L. Chen, V. Fellman, W. He, L.N. Hu, J. Huang, E. Krite Svanberg, J. Larsson, M. Larsson, T.Q. Li, W.S. Li, Y. Li, H.Y. Lin, M. Lewander, P. Lundin, S. Lindberg, L. Mei, L. Persson, R. Siemund, G. Somesfalean, T. Svensson, C. Xu, H. Zhang

Spin-off: GASPOROX AB

Large- and small-scale sensing for gas analysis



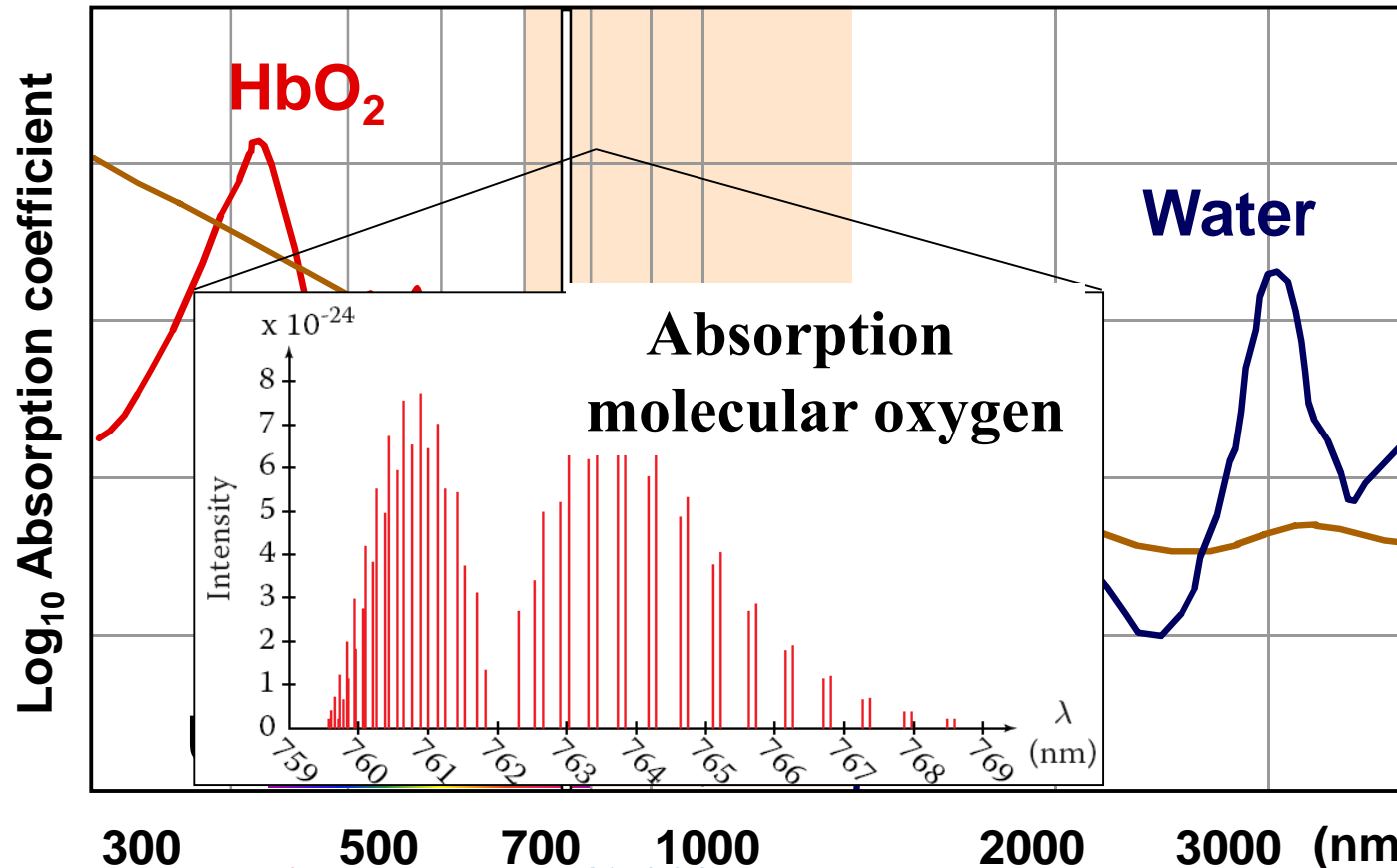
Tissue and Free Gas Absorption

Key to GASMAS:

10,000 times difference in linewidth!

Use lock-in wavelength modulation spectroscopy !

Absorption of light in tissue



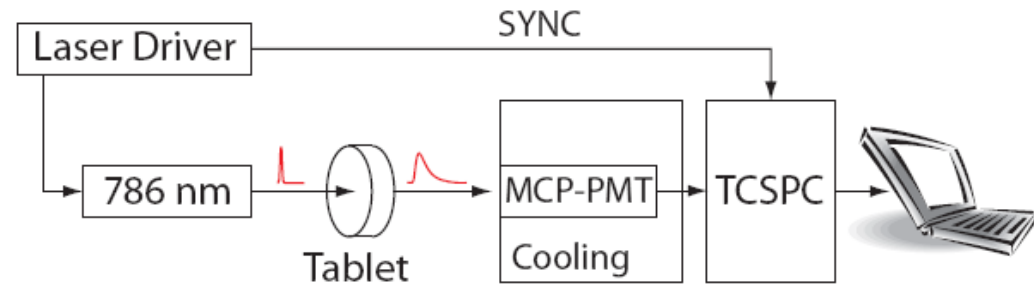
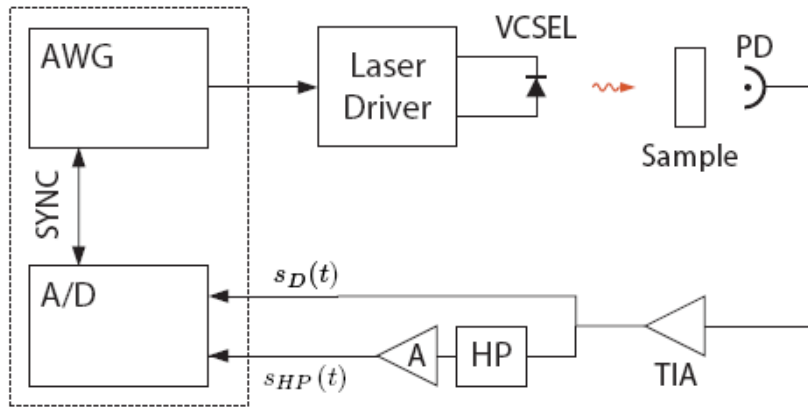
Strongest oxygen line: R7R7: 761.003 nm - We must be correct in the 6th digit!

Spectroscopy on Pharmaceutical Tablets – Coll. AstraZeneca

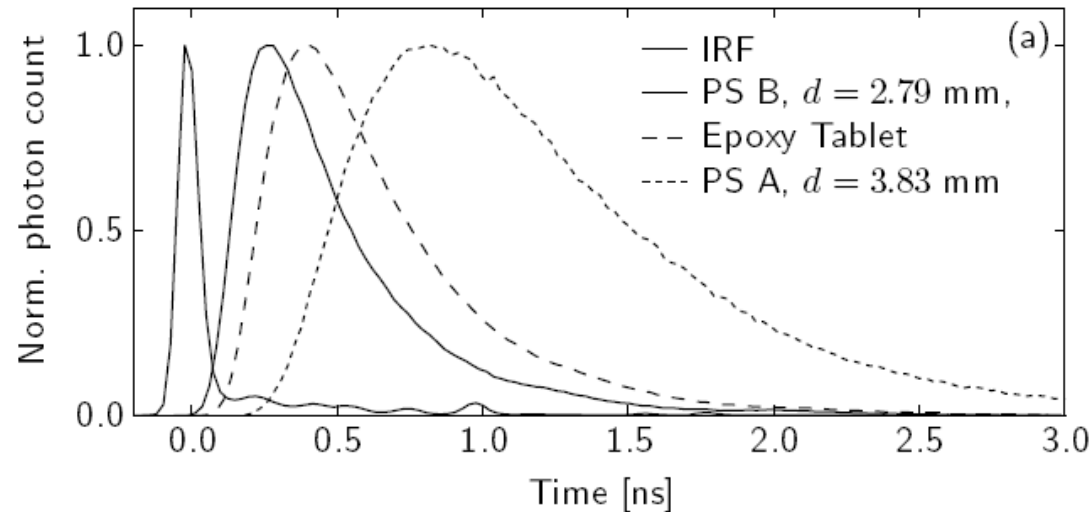
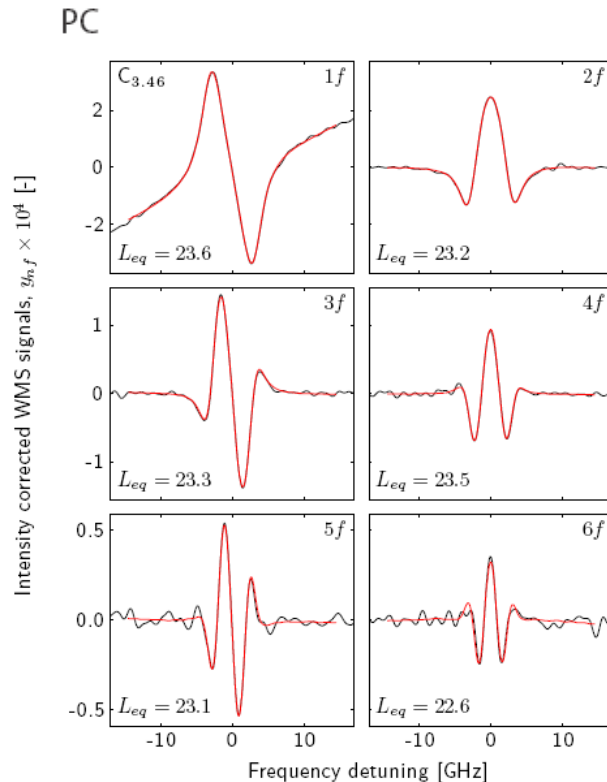
Porosity studies/delayed release

Frequency domain, oxygen

Time domain, TOF/Lidar



T. Svensson et al.



Follow-up: Alignment-free multi-pass gas cell made of nanoporous ceramics -750 times path enhancement !!
Svensson et al. PRL (2011)

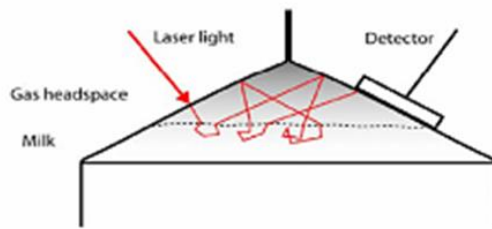
FOOD MONITORING – FOOD SAFETY - FRESHNESS

Most food is packed
in modified atmosphere
(low O₂, high N₂, CO₂)

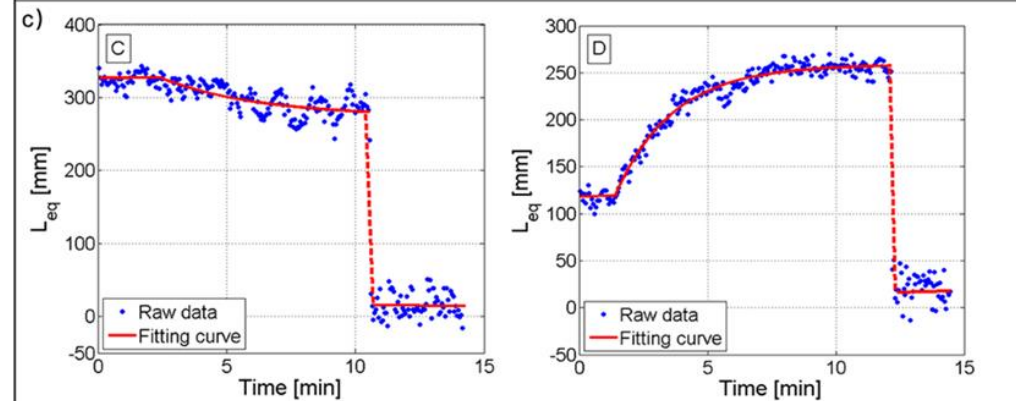
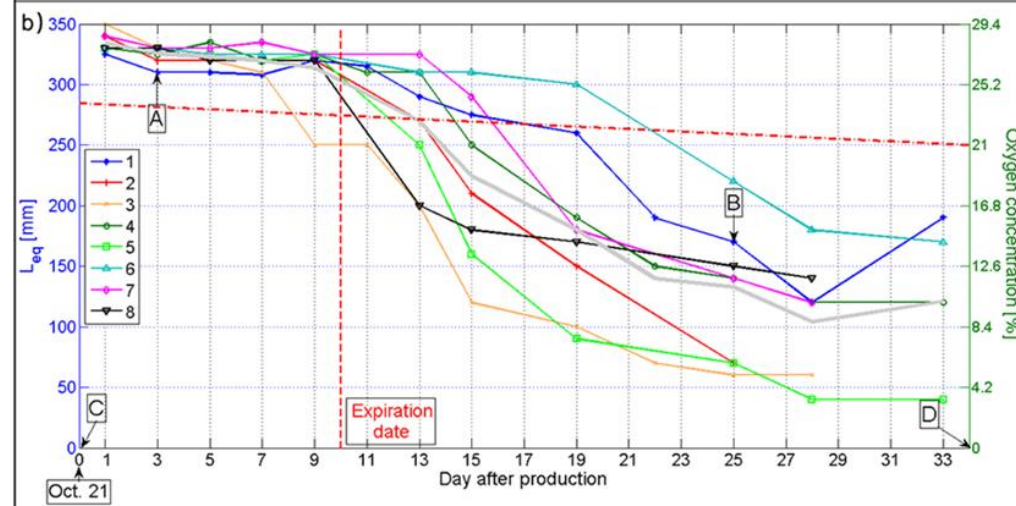
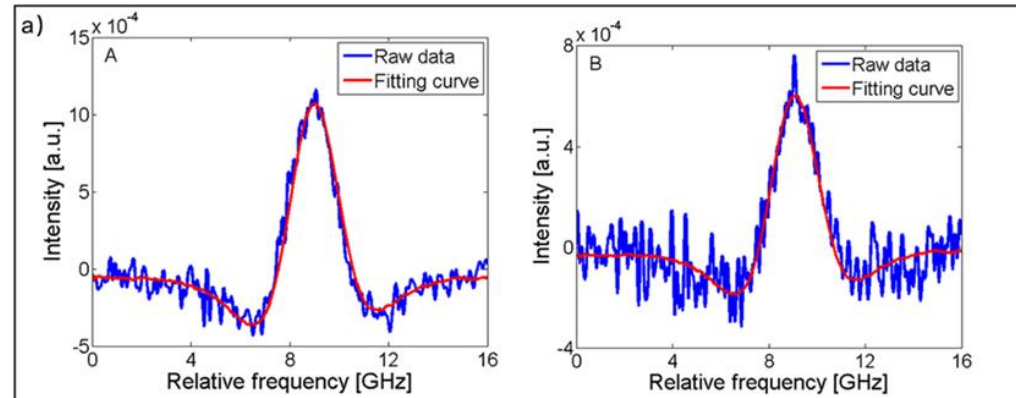
Milk, bread, meat, eggs ..



Lewander *et al.*; Li *et al.*



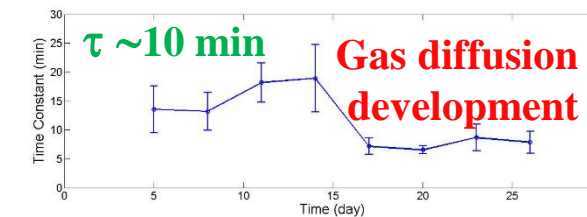
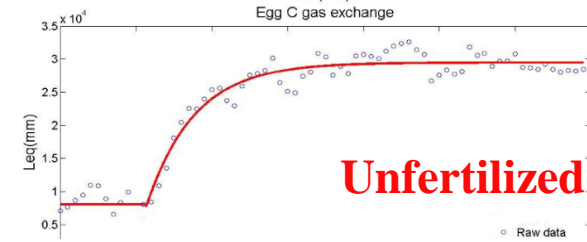
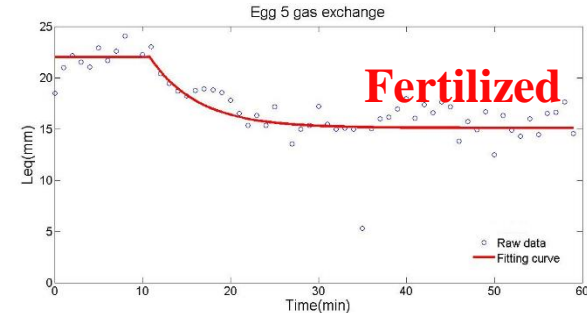
European SAFETYPACK project



Detection of free oxygen and water vapor in hen eggs

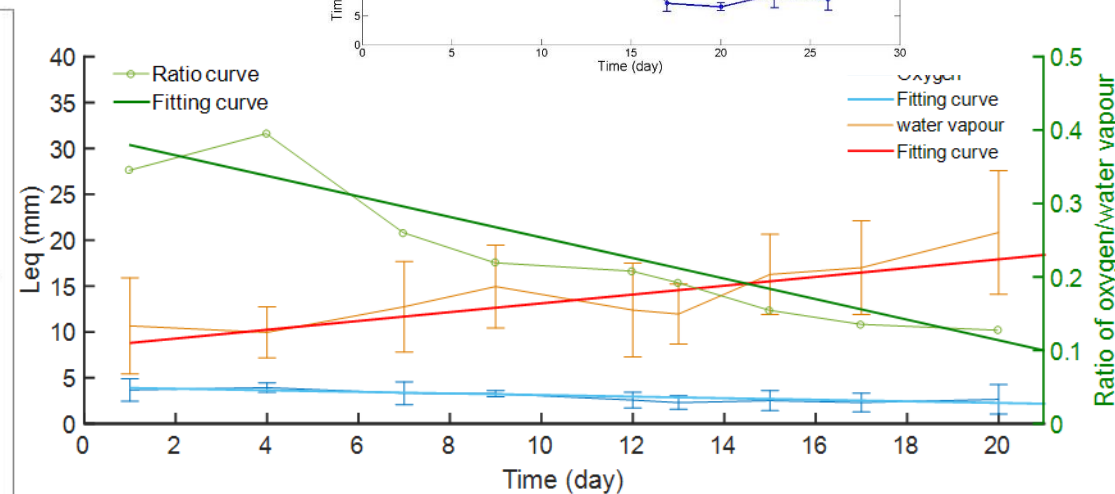
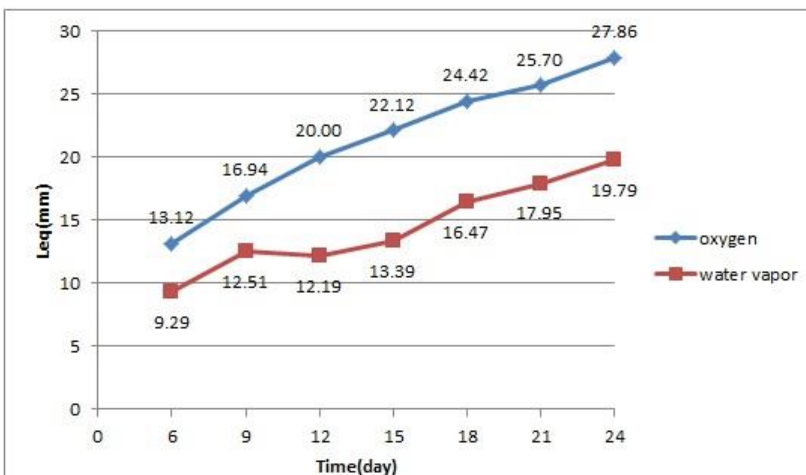
Exploration of diagnostics possibilities

Li *et al.* J. Biophotonics 2017



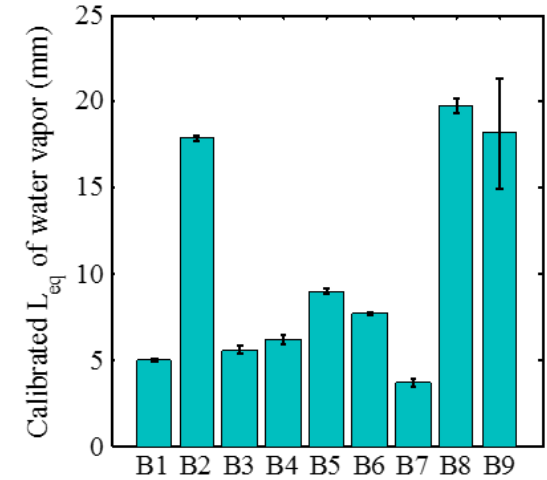
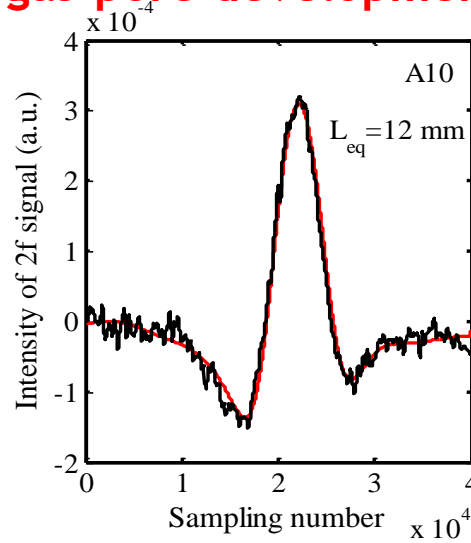
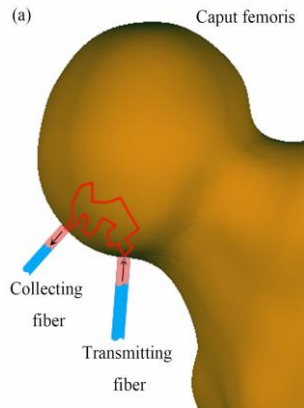
Unfertilized

Fertilized



Hip replacement - developing GASMAS for diagnostics

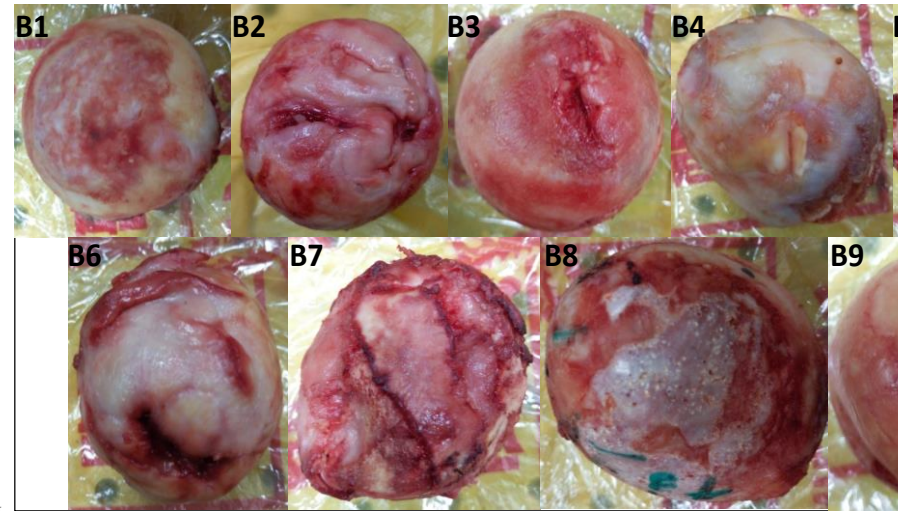
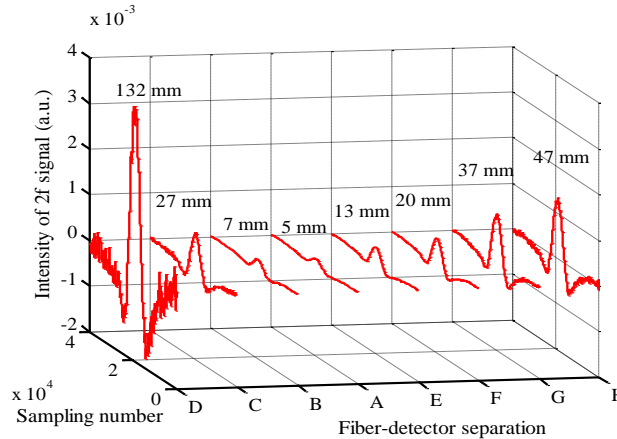
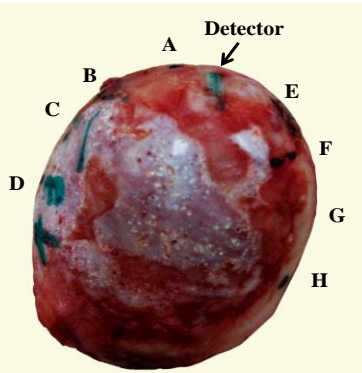
Degradation is accompanied with gas-pore development and impaired blood flow



(a)

(b)

Lin *et al.* J. Biophotonics (2017)



Combine with Laser Doppler Blood Flow Measurement:

Comes for free!

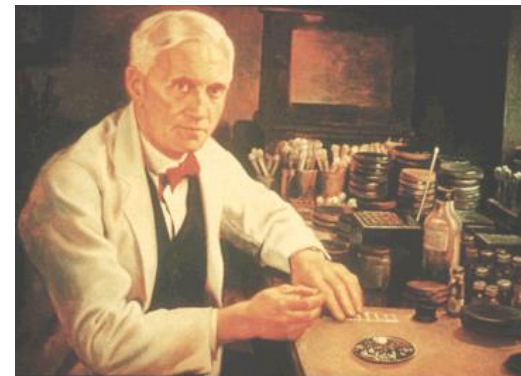
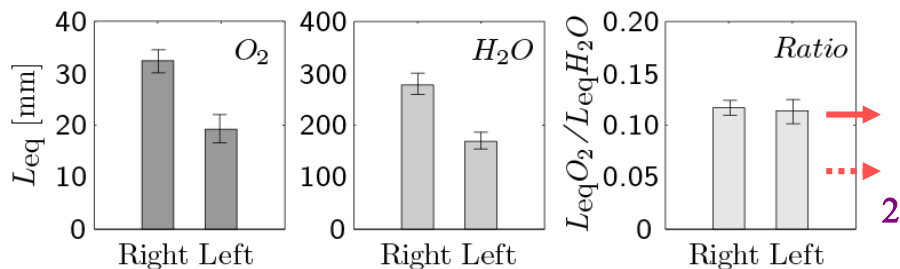
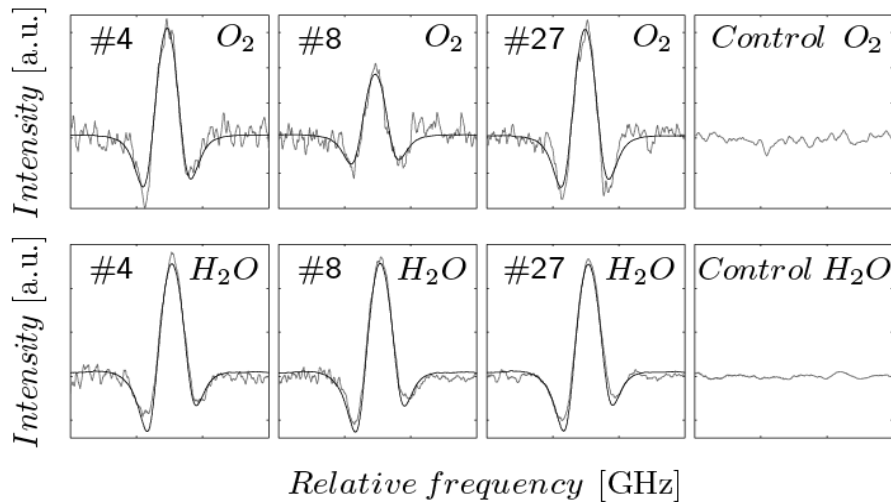
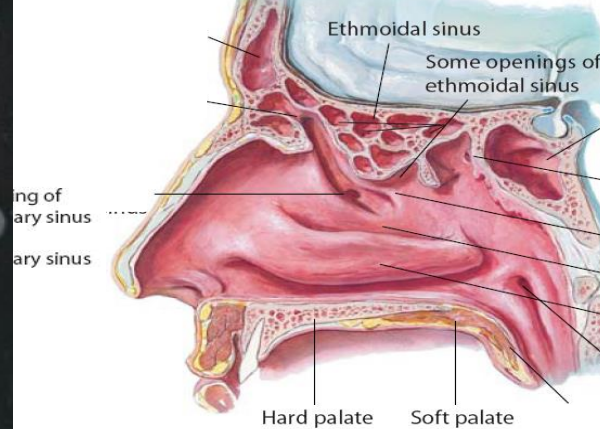
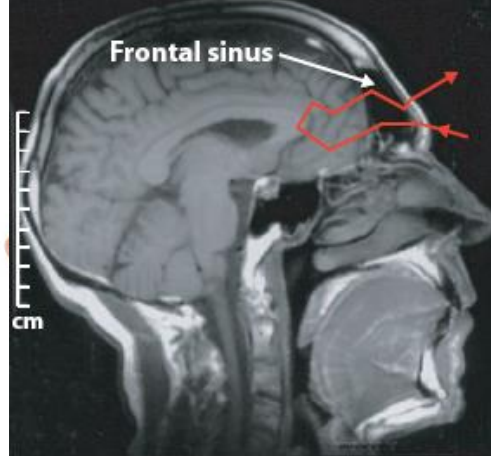
$$\frac{\Delta f}{f} = \frac{v}{c}$$

Fighting bacterial antibiotics resistance!

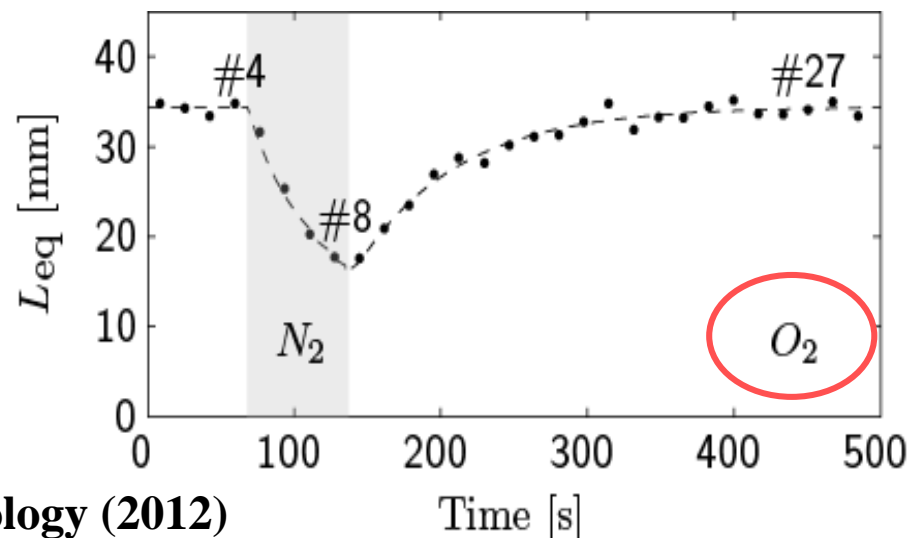
Worldwide concern!

Sinusitis diagnostics

Frontal, maxillary, mastoideal

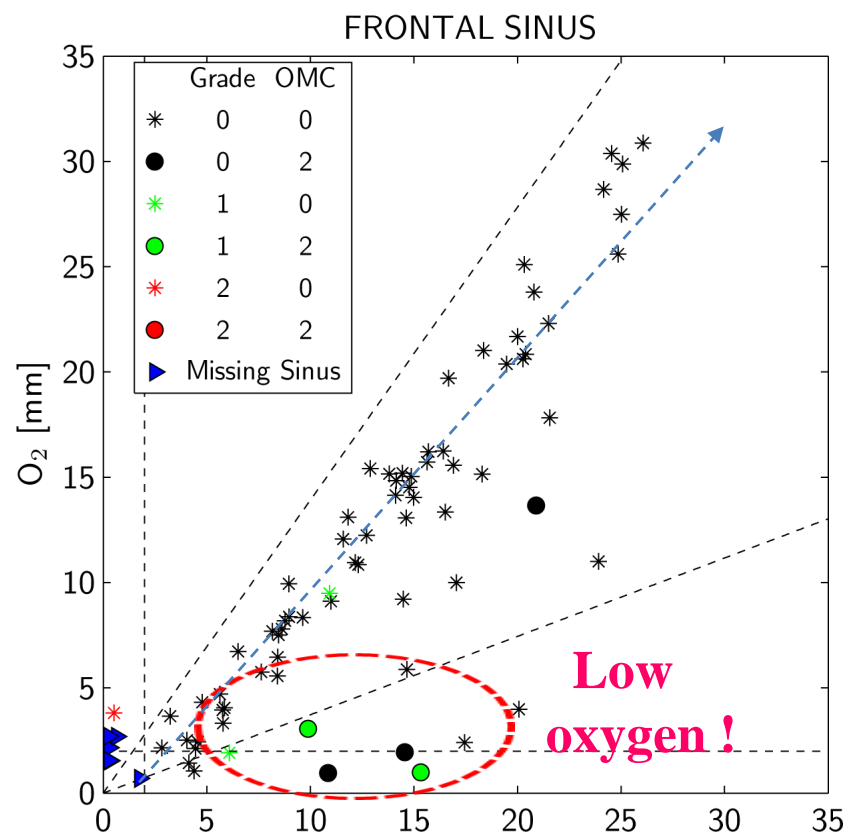
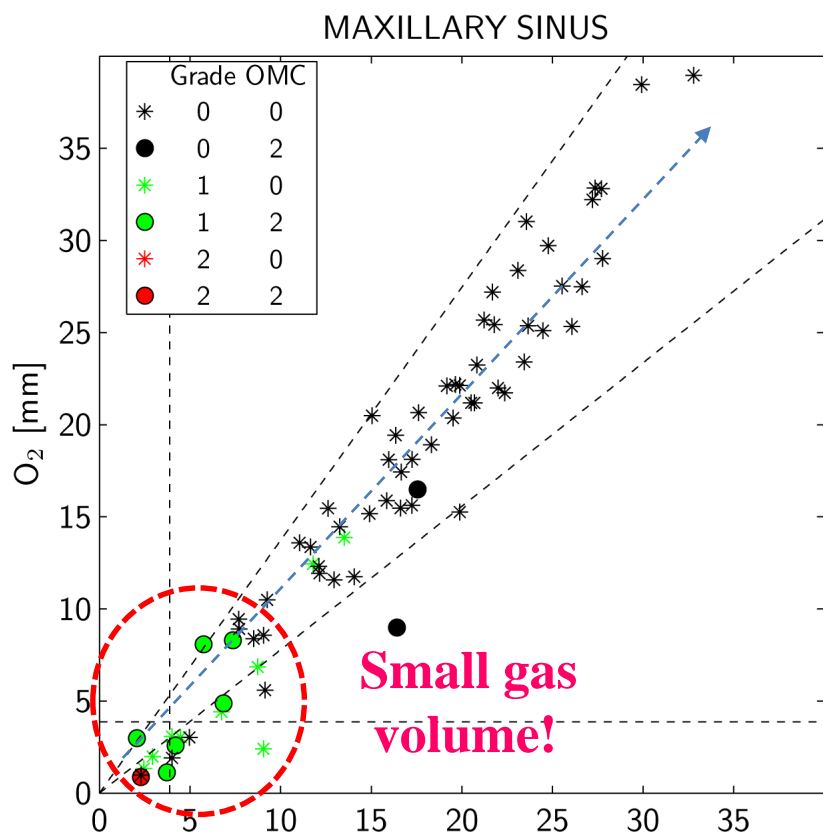
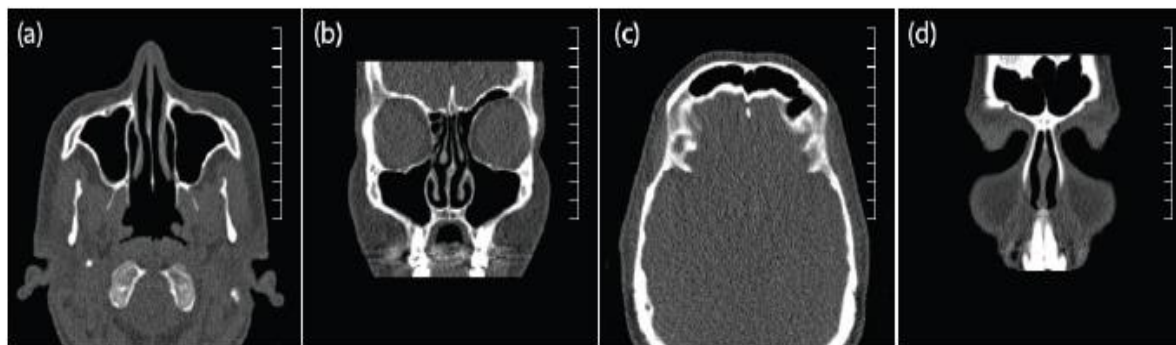


**Fleming
Nobel
Prize
1945**

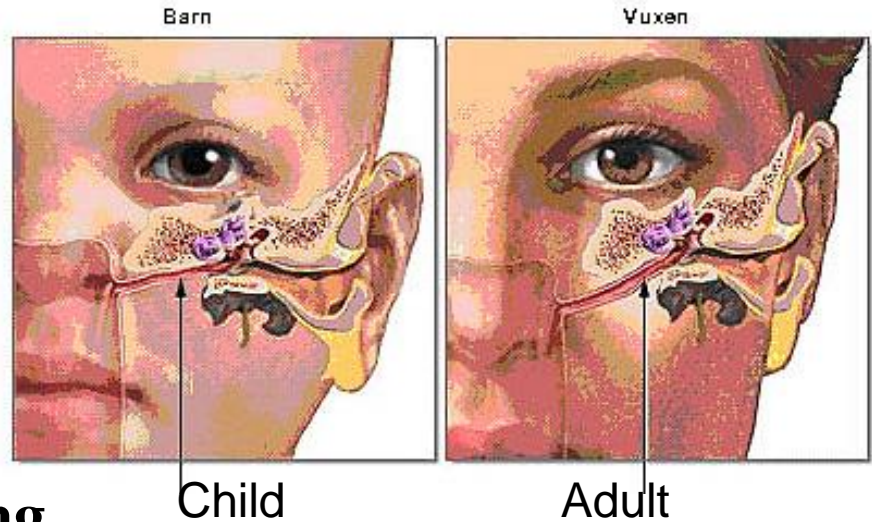


Clinical study on 40 patients

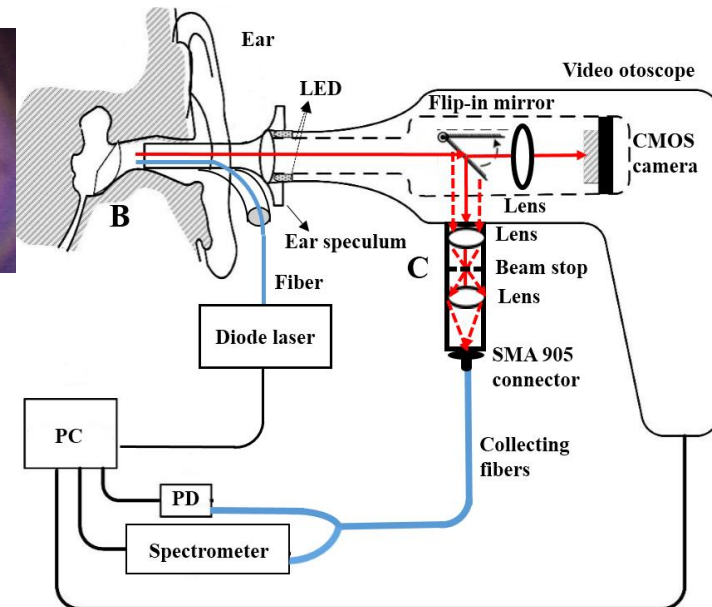
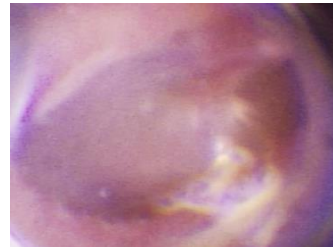
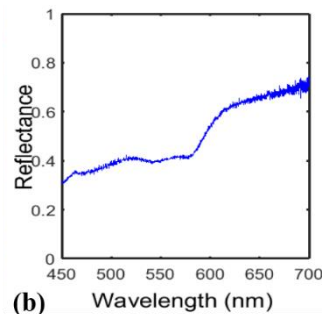
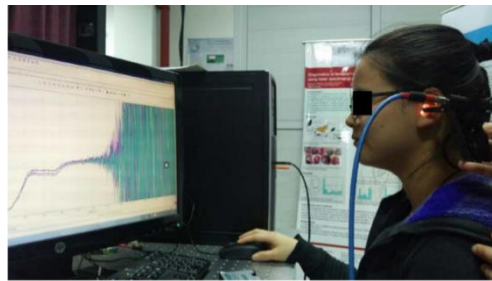
Lewander *et al.* Rhinology (2012) – Results comparable to CT



Middle ear infection (otitis)

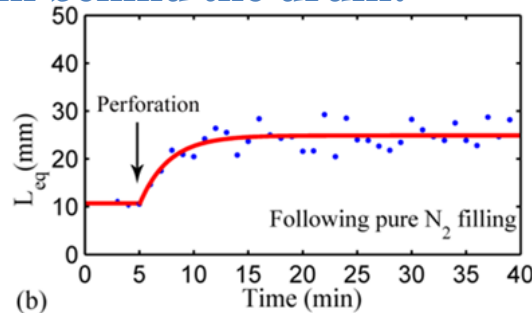
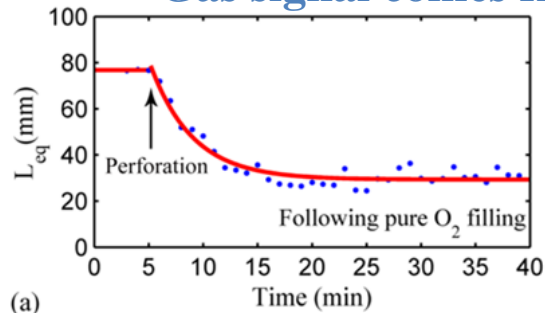


Ear-drum color monitoring



GASMAS Phantom experiments: Zhang *et al.* 2016

Gas signal comes from behind the drum!

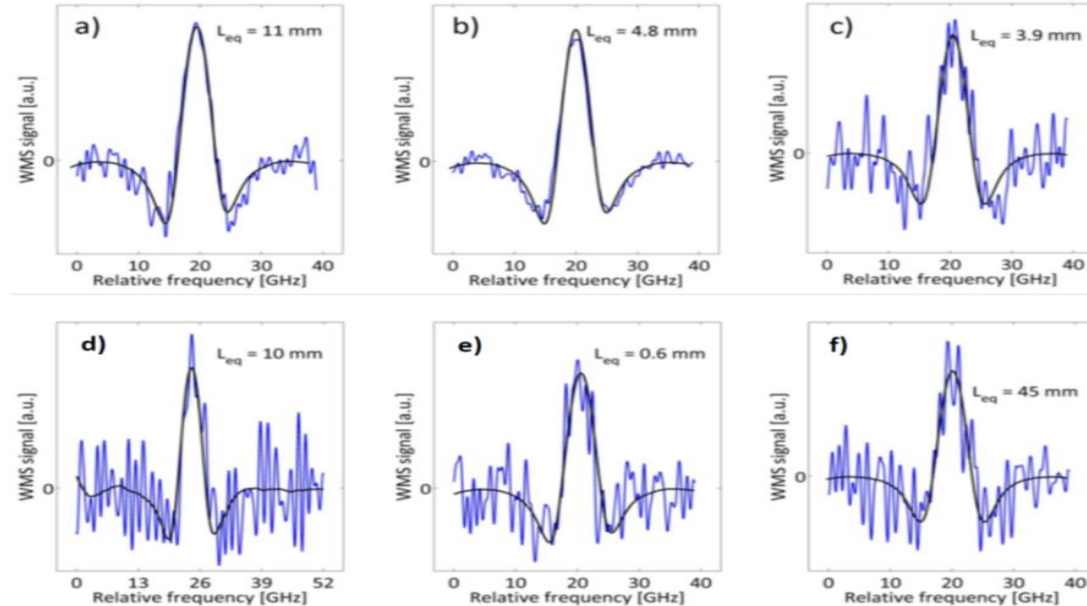
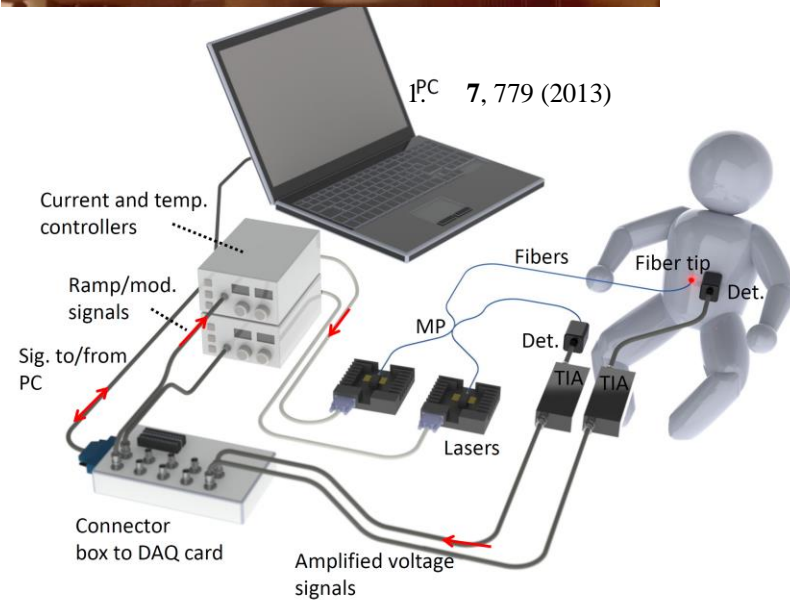
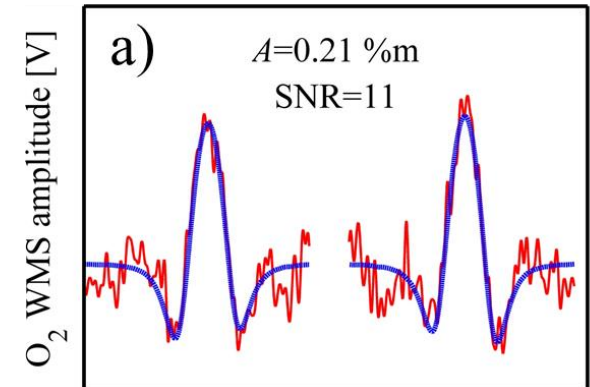


Li *et al.* 2018

Neonatal/Premature child monitoring

Lack of surfactant – lung problem! Eliminate X-rays! 24 h cot-side monitoring of O₂

Lundin et al., Krite-Svanberg et al. (2015)



GASMAS Reviews: S. Svanberg, *Laser and Photonics Reviews* 7, 779 (2013)

K. Svanberg, S. Svanberg, in *Frontiers in Biophotonics for Translational Medicine*,

U.S. Dimish and M. Olivo (eds) (Springer, Singapore 2015) 307-321