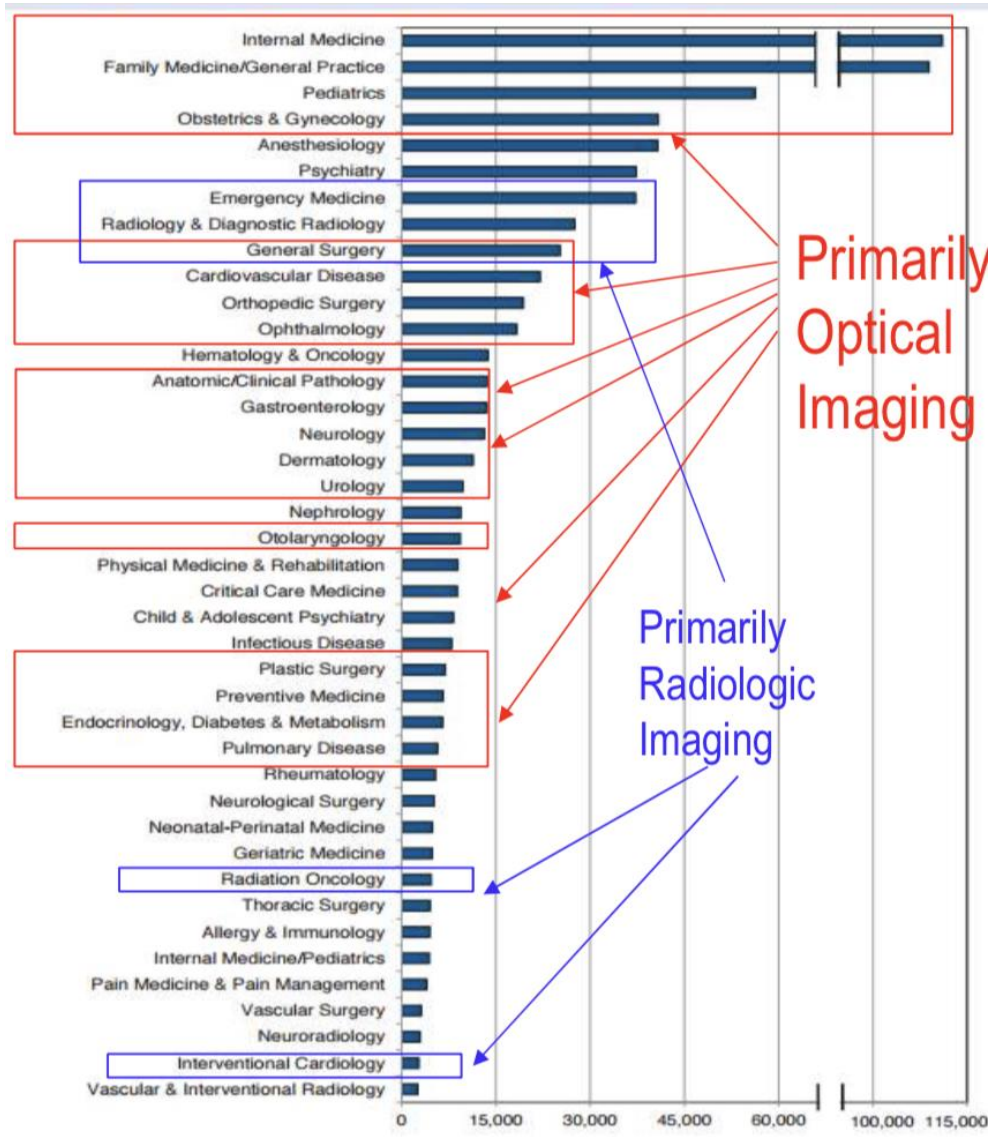
Lecture 25 – Other Imaging modalities

This lecture will cover:

– Optical Imaging

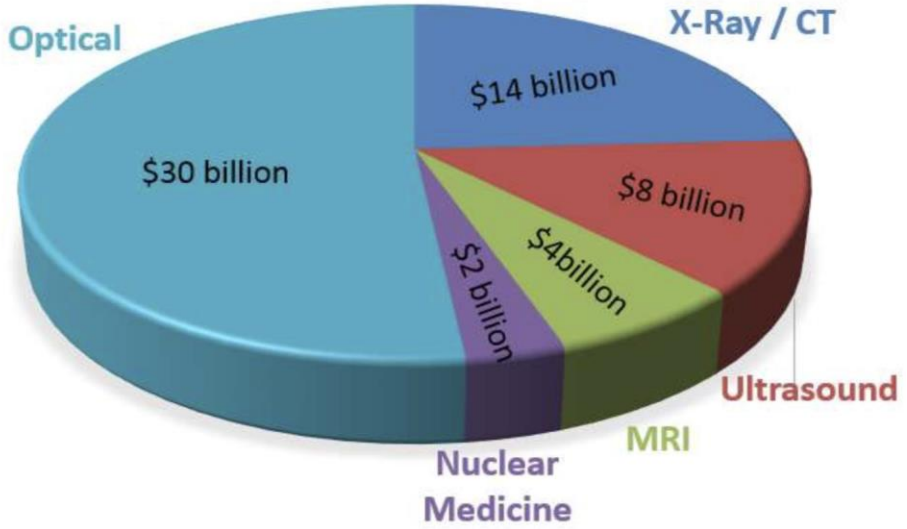
– Near-infrared Spectroscopy (fNIRS)

How important is optical imaging?



Source: AMA Physician Masterfile (December 2013)

Number of Active doctors



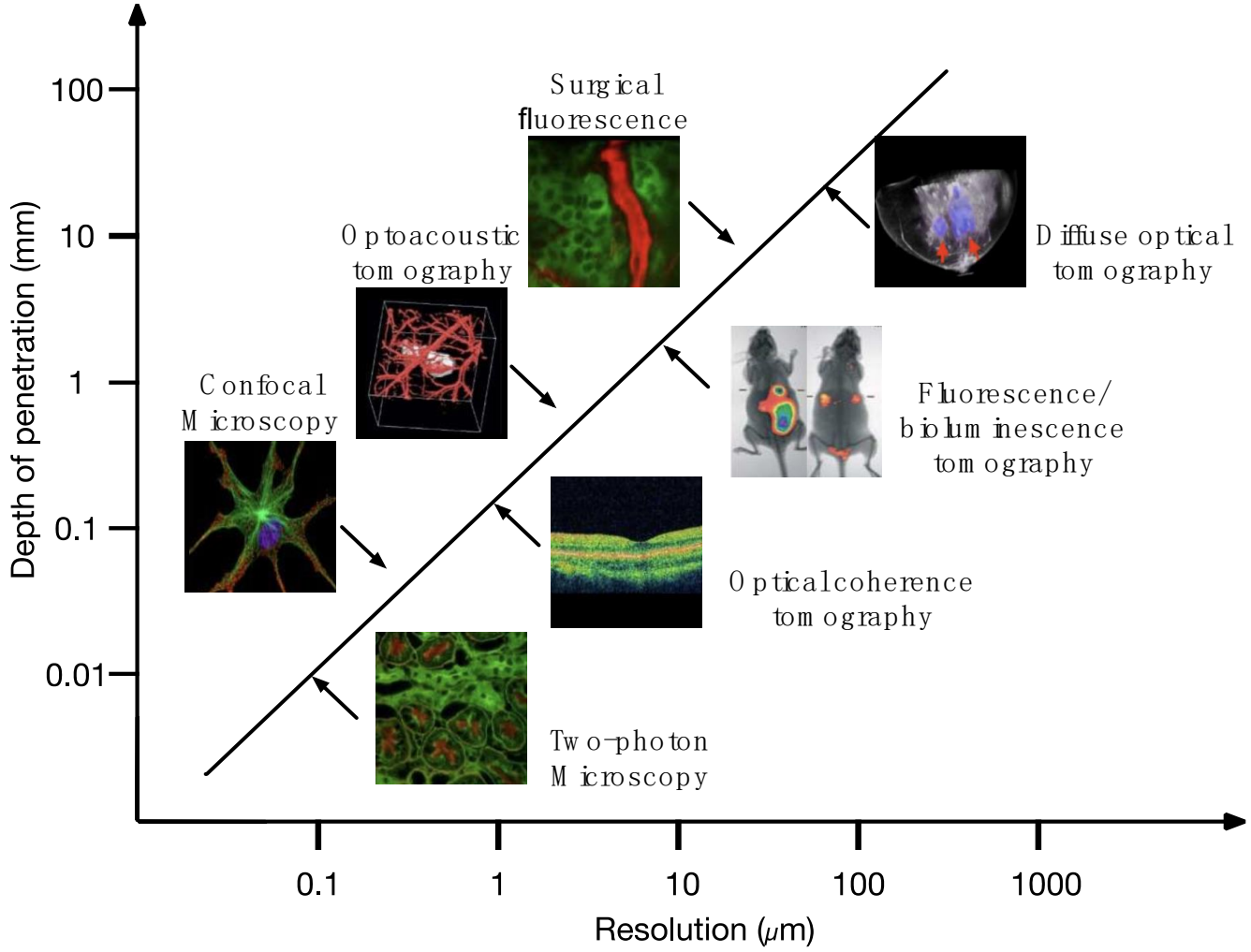
Market analysis

Refs: BCC Research, IBIS World, AMA

Optical imaging

Advantages:

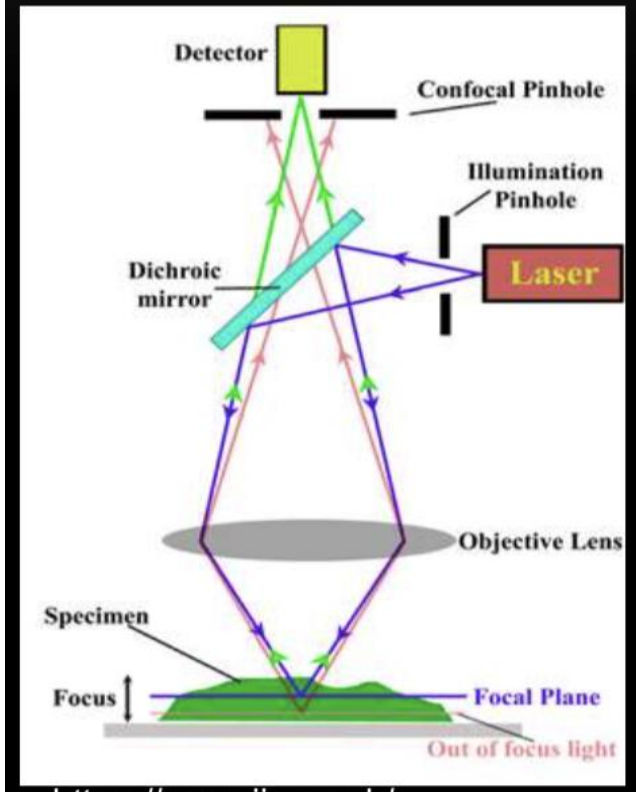
- High sensitivity
- Rich contrast
- Non-ionizing radiation
- Low cost



Confocal Microscopy (共聚焦显微镜)

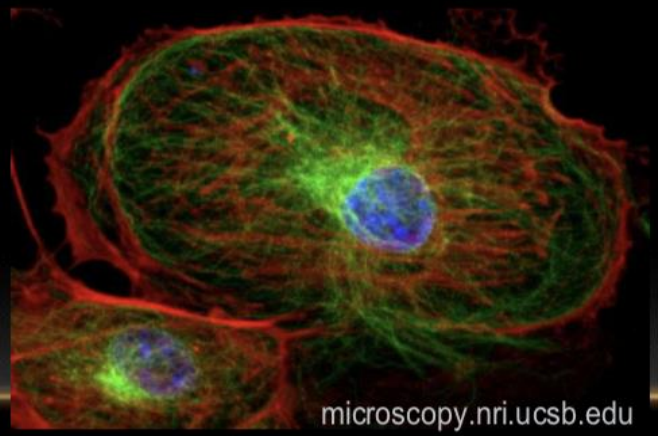
上海科技大学 ShanghaiTech University

Confocal microscopy



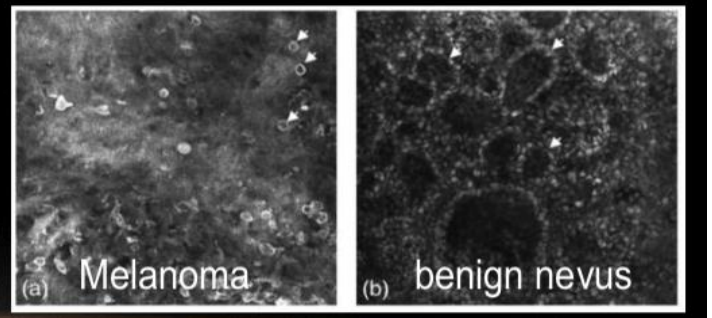
https://www.jic.ac.uk/

In vitro



Resolution ≅ 0.20 um
Penetration ≅ 40 um

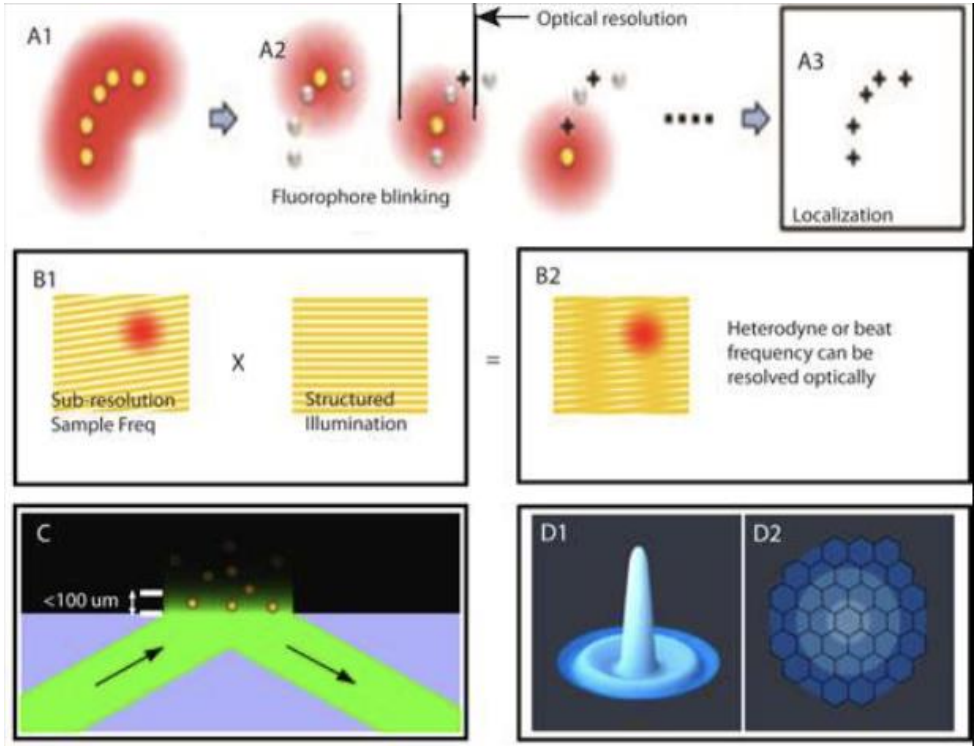
In vivo

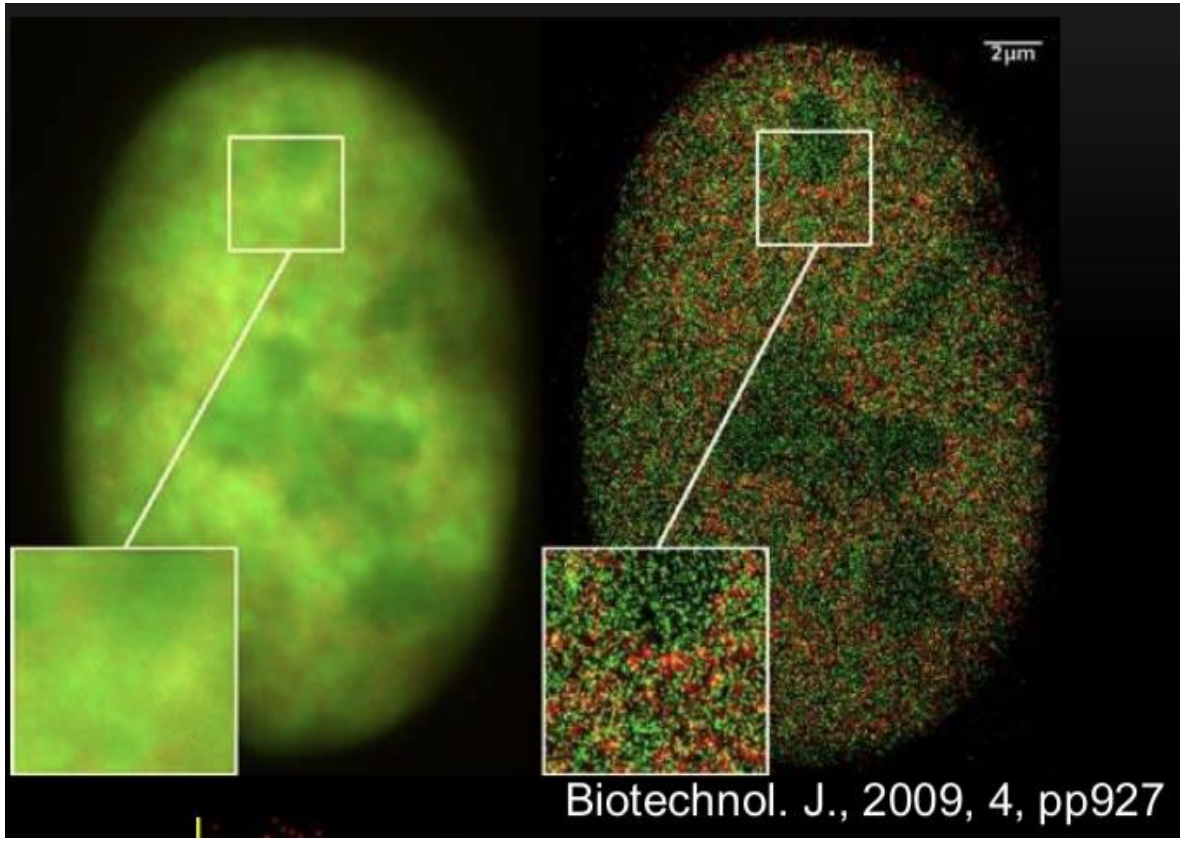


Resolution ≅ 2.0 um
Penetration ≅ 400 um

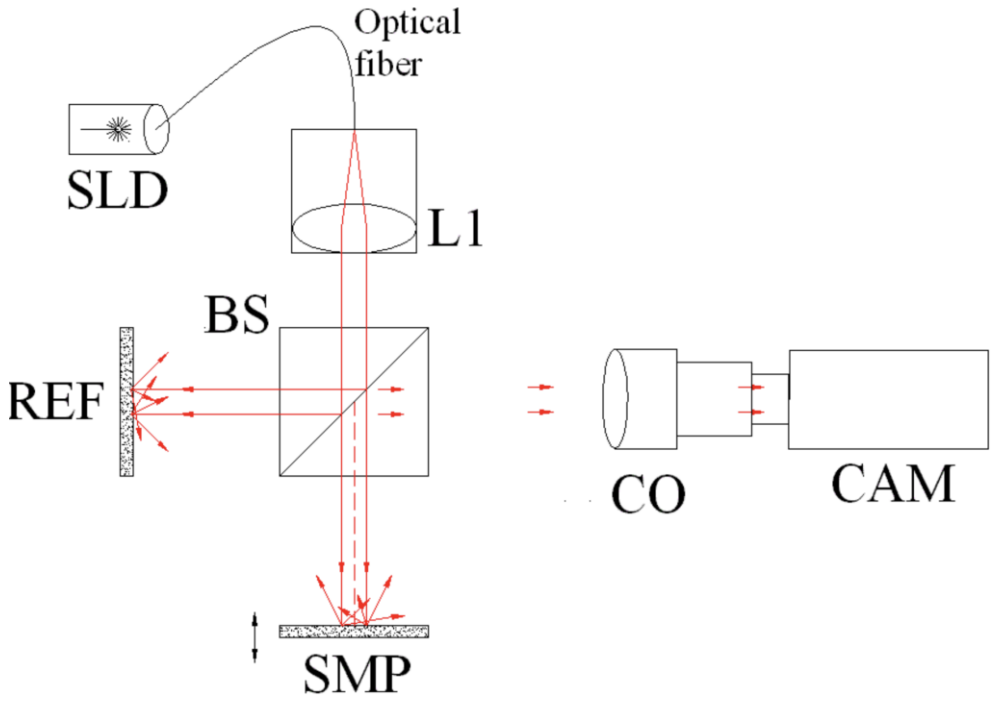
Super resolution Microscopy (超分辨显微镜)

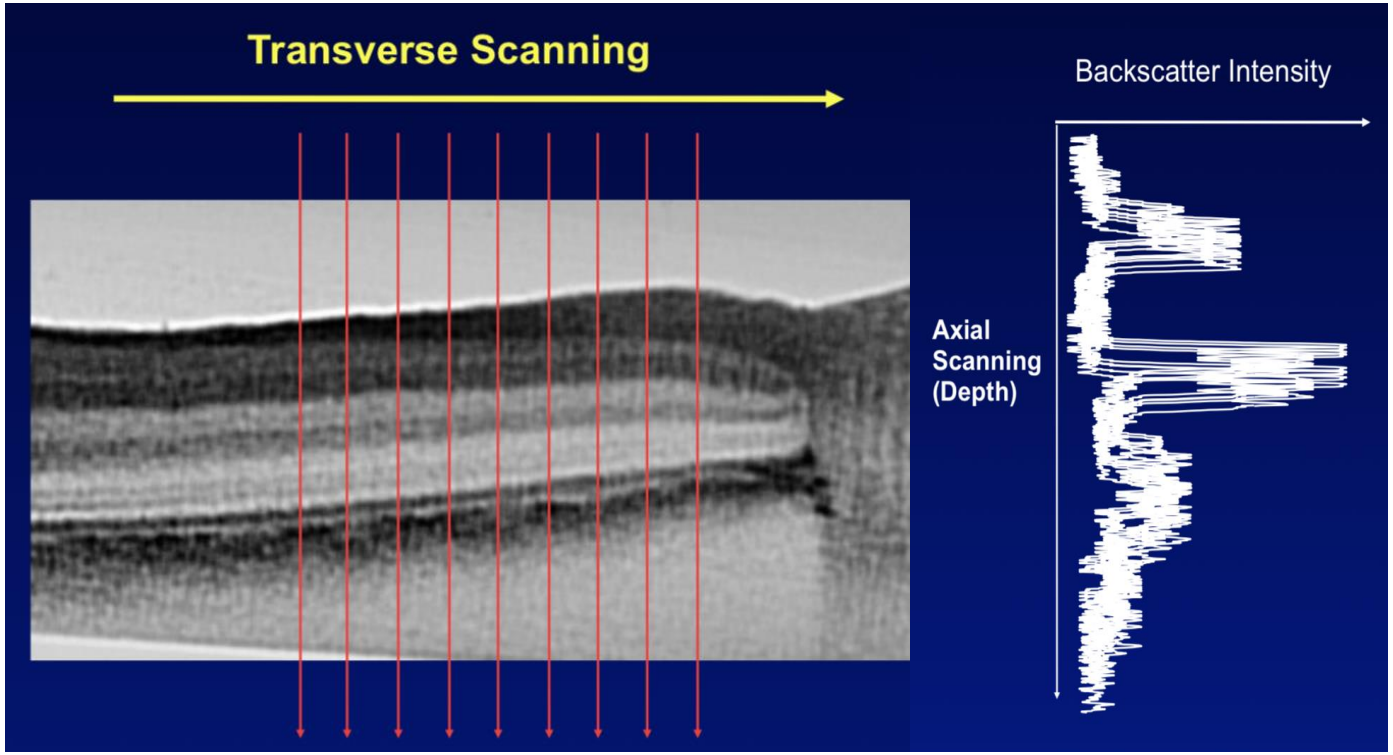
- Stimulated Emission Depletion Microscopy (STED)
- Photoactivated localization microscopy (PALM)，Stochastic optical reconstruction microscopy (STORM)

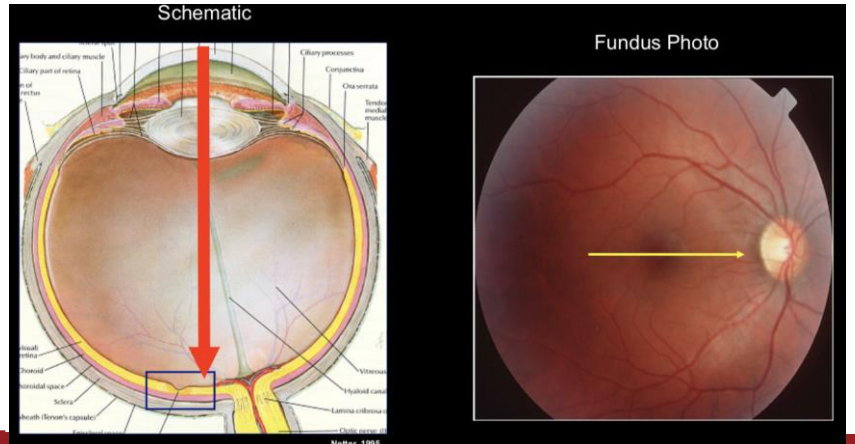




Optical Coherence Tomography（光学相干断层扫描技术）



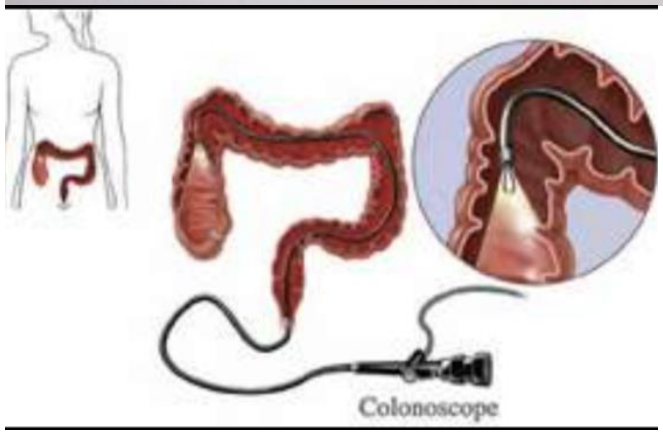




~1 um resolution (mircon)

Endoscopy (内窥镜)

Resolution = ~0.10 mm
Penetration = ~2 mm



Introduction to fNIRS

- Near-infrared spectroscopy: irradiating the subject with light in the near-infrared region and examining the change in absorbance of light;
- Measuring the changes of cortical deoxygenated and oxygenated hemoglobin concentrations

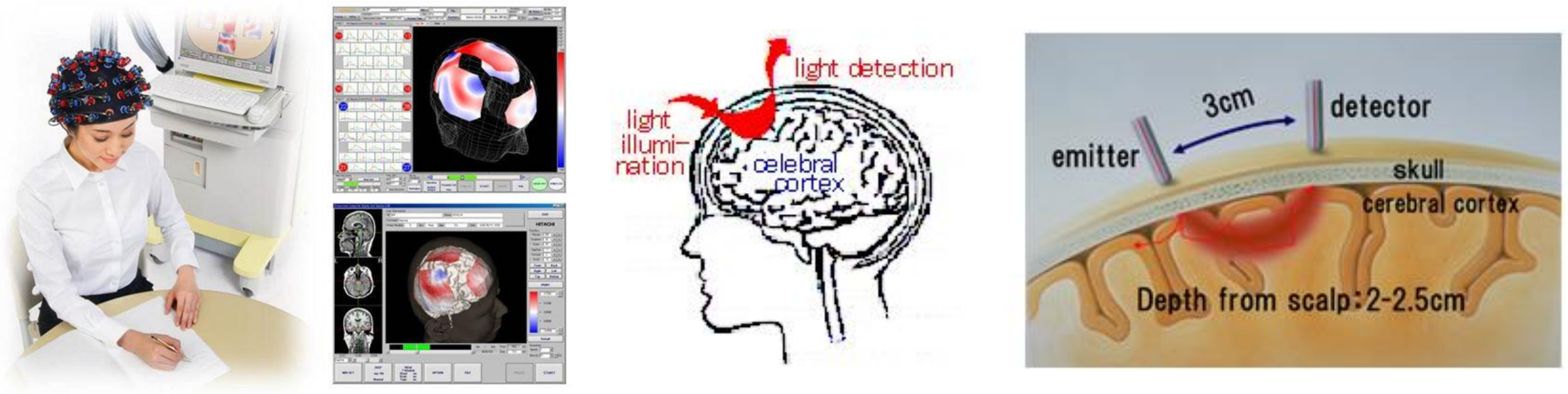
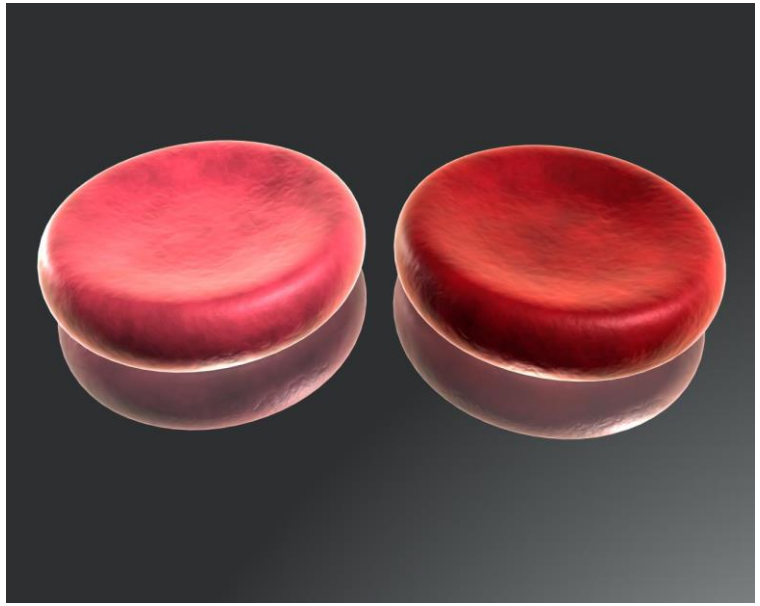


Fig. Demonstration of percutaneous measurement of cerebral cortex beneath the skull using fNIRS.

Optical Window

- 650–900 nm spectral interval;
- skin, tissue, and bone are mostly transparent;
- Hemoglobin (Hb) and deoxygenated-hemoglobin (deoxy-Hb) are strong absorbers



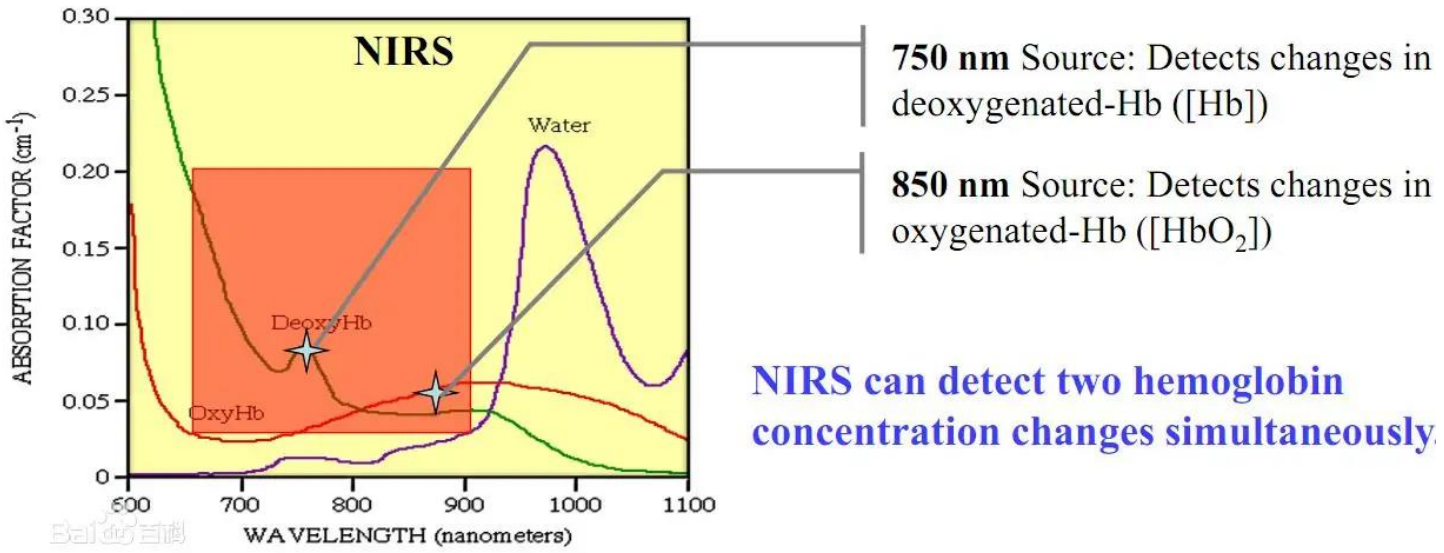


Fig. (Left) Oxygenated and Deoxygenated Hemoglobin; (Right) Absorption spectra for oxy-Hb and deoxy-Hb for near-infrared wavelengths.

Features

- Techniques: continuous Wave, frequency Domain, time-Domain
- Advantages: wearable and portable, noninvasiveness, low-cost modalities, perfect safety, high temporal resolution, full compatibility with other imaging modalities, and multiple hemodynamic biomarkers.
- Disadvantage: low brain sensitivity, low spatial resolution, and shallow penetration depth

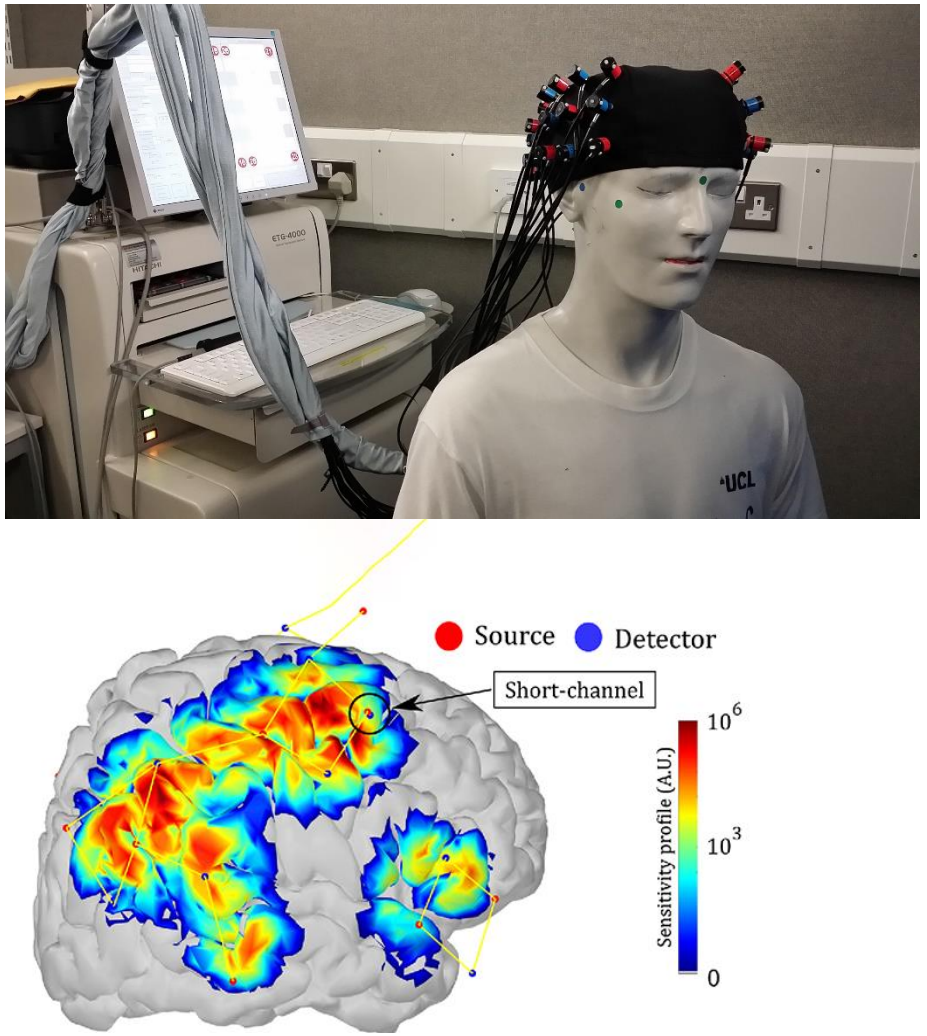


Fig. (Top) a fNIRS system. (bottom) fNIRS brain imaging