

# Measurement of Diffuse and Specular Reflections Through Single Cell Layers

Presented at SAIP July 2006

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National Laser Center

7 July 2006



# Outline

- **Background**  
Why a Biophotonics group
- **Determination of tissue optical properties**  
Optical properties, Diagnostic window, scattering elements and Integrating Sphere measurements
- **Experimental techniques**  
Phantom and cells
- **Experimental results**

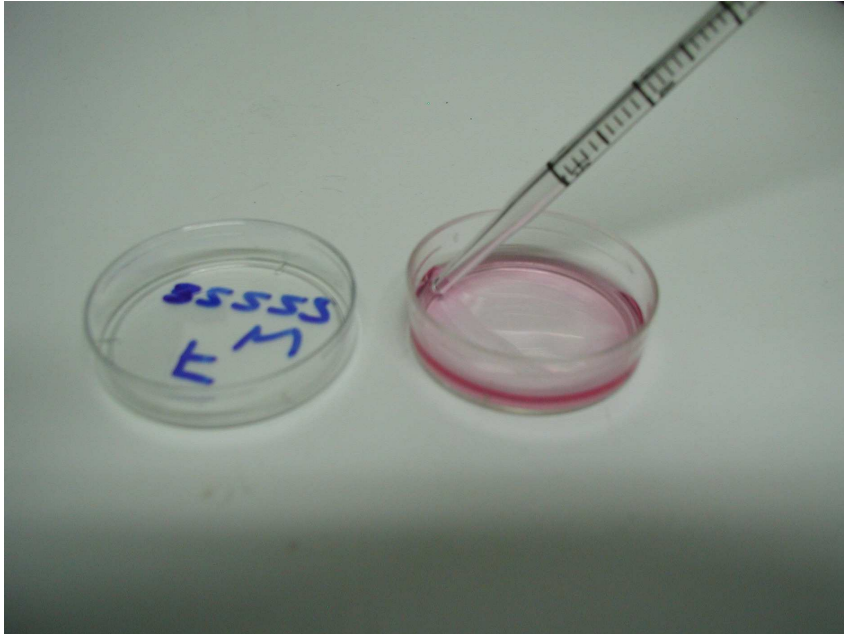
# Background

- Biophotonics – new in SA
- Group at NLC aims to:
  - Address health problems through research using lasers and other light sources
  - Stimulate the use of lasers in health related research
  - Focus on Cancer and Diabetes
- Cancer (1993 – 1995)
  - On average 50 000 new cases/year
  - LR at least
    - Male: 1 in 6
    - Female: 1 in 7

# Background

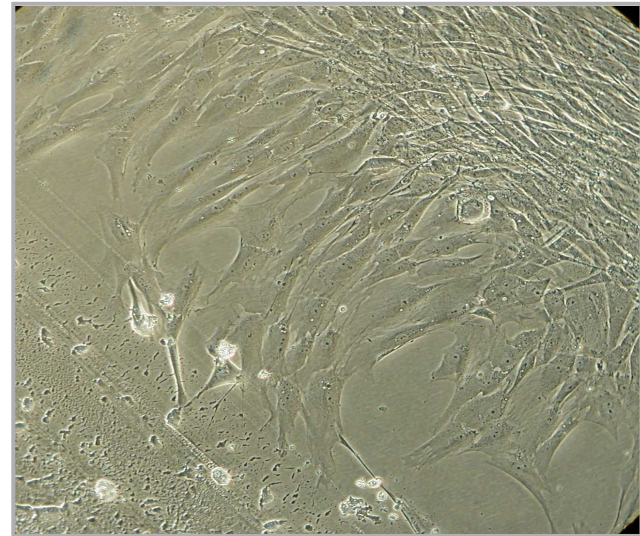
- Diabetes
  - High prevalence in SA
  - Not a notifiable disease
    - Indian: Av. 17% (11% - 30%)
    - Black: 8%
    - White: 6%
  - Type II diabetes on the increase
  - Limb amputation
- Research aimed at PDT and accelerated wound healing

# Experimental work at UJ



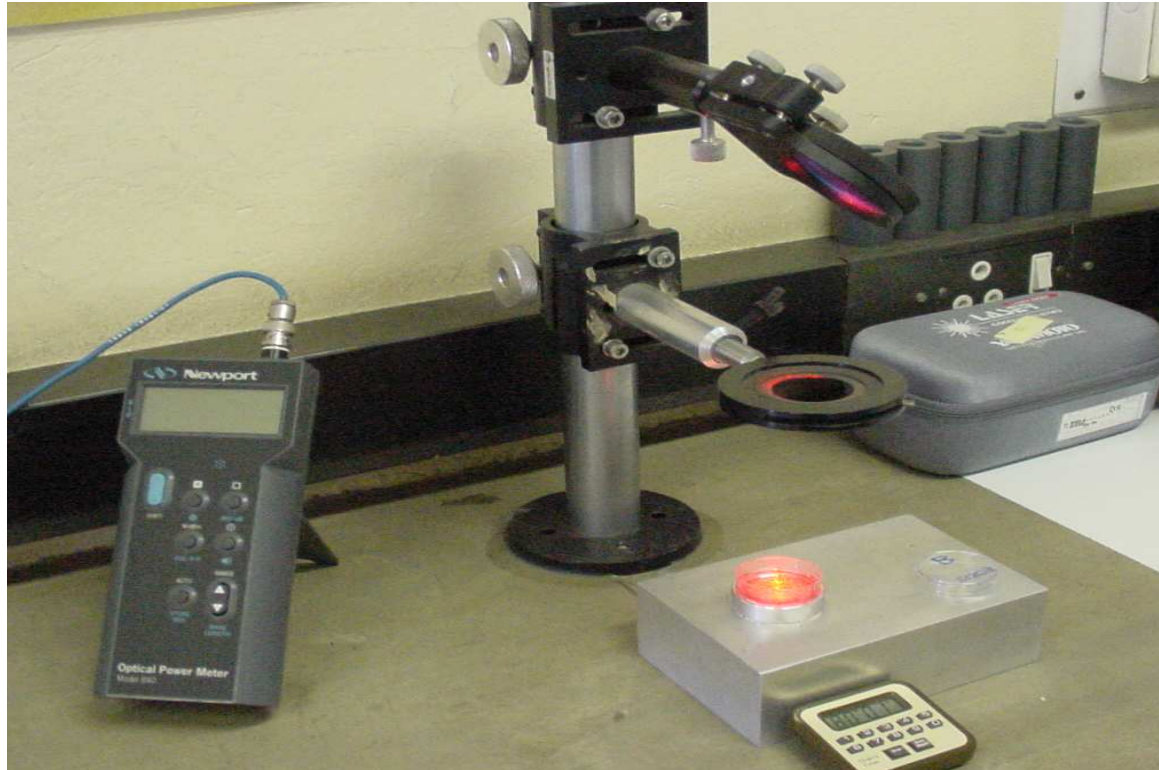
WS1 Cell line

Induce wound: sterile  
pipette



Single cell layers, single scattering events

# Laser irradiation



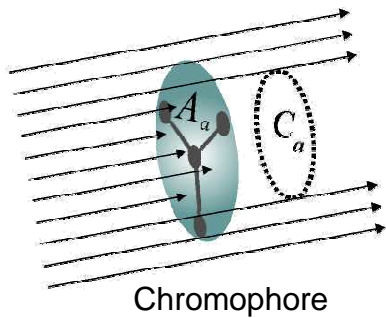
# Determination of tissue optical properties

- Definition of optical properties
- Diagnostic window and scattering elements
- Integrating Sphere measurements

# Definition of optical properties...

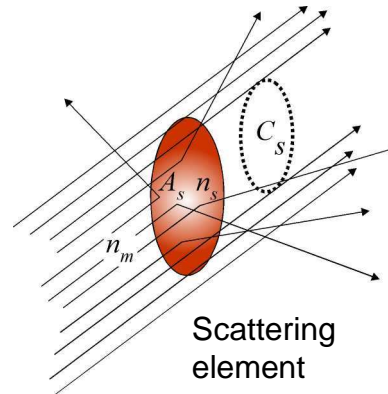
## Absorption coefficient

$$\mu_a = C_a \cdot \text{conc}_a \quad (\text{cm}^{-1})$$



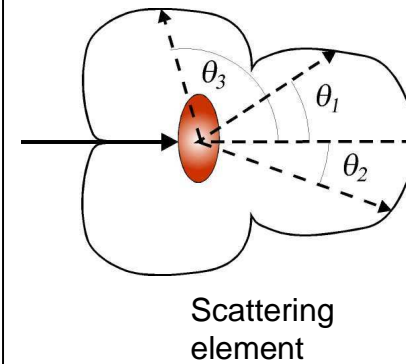
## Scattering coefficient

$$\mu_s = C_s \cdot \text{conc}_s \quad (\text{cm}^{-1})$$



## Anisotropy factor

$$g = \langle \cos \theta \rangle \quad ( )$$

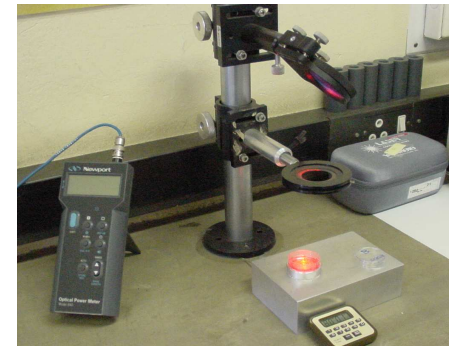
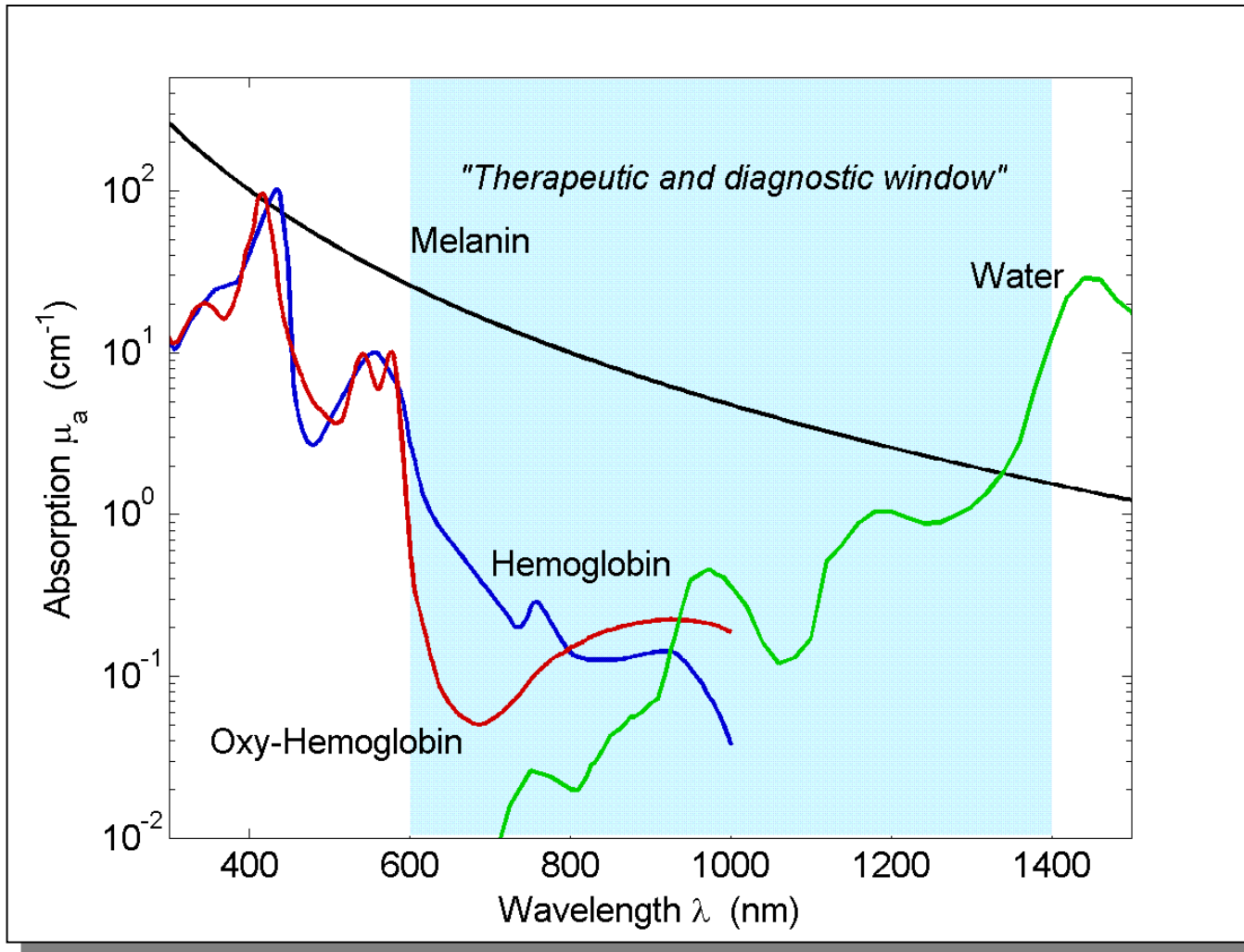


## Reduced scattering coefficient

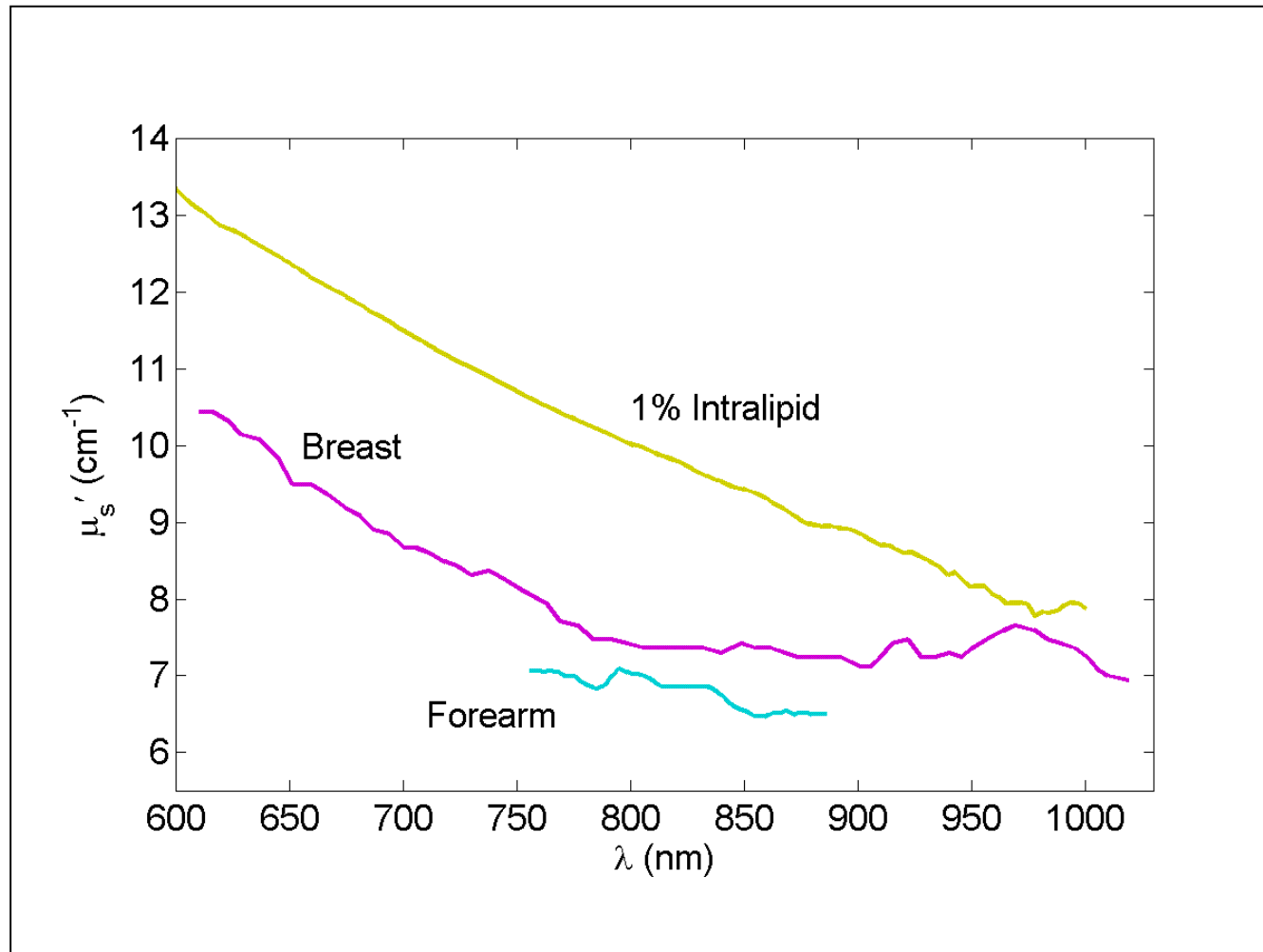
$$\mu'_s = (1 - g)\mu_s \quad (\text{cm}^{-1})$$



# Some important tissue chromophores

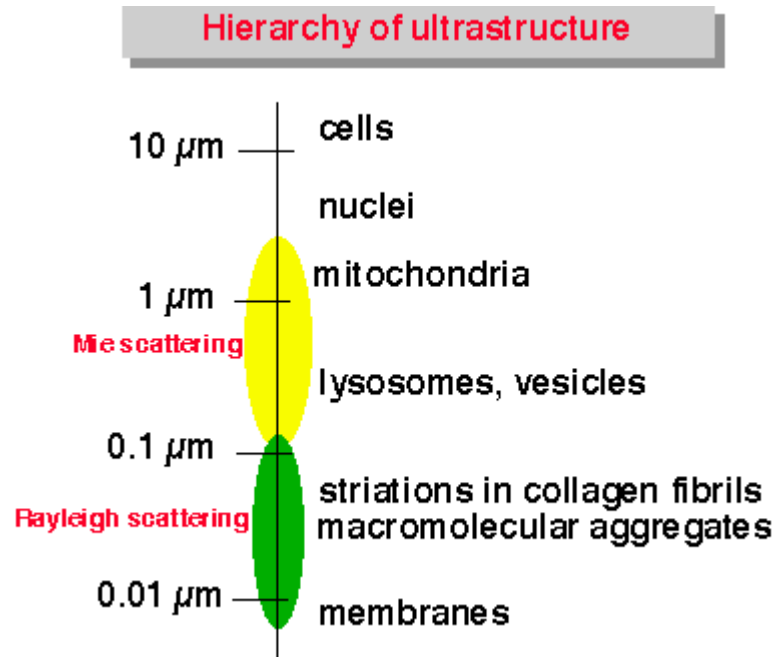


# Scattering spectra of various tissue types



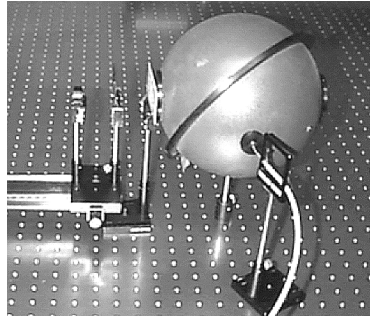
# Scattering in Biological Tissue

Human tissue is considered a highly scattering media



ECE532 Biomedical Optics ©1998 Steven L. Jacques, Scott A. Prael, Oregon Graduate Institute

# Integrating Sphere measurements



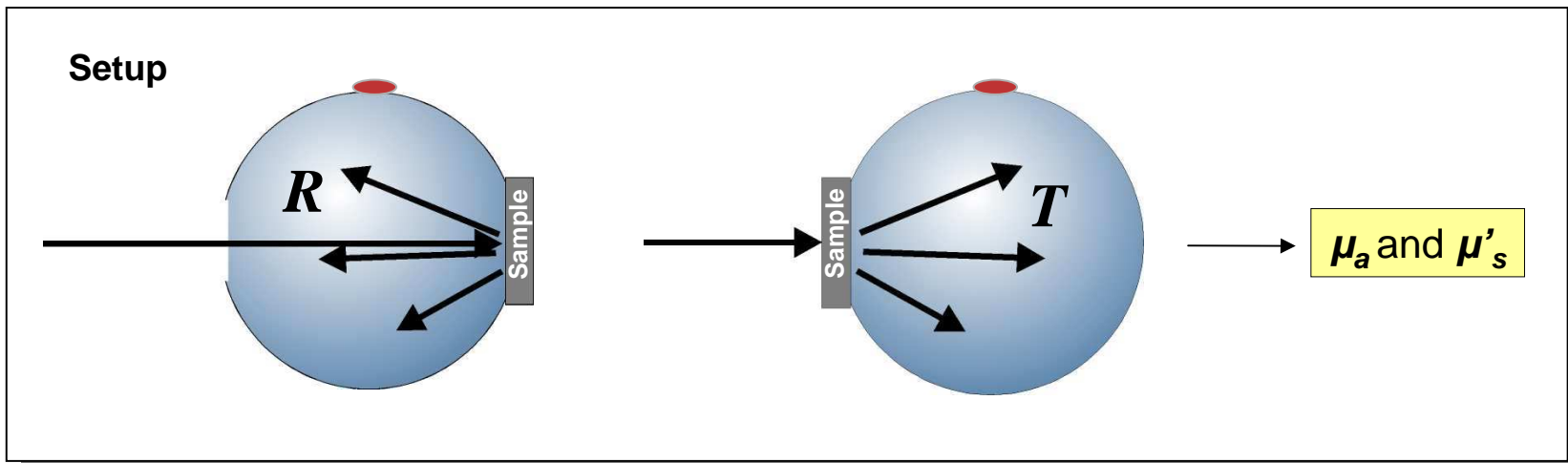
“Measurements of the total transmittance and reflectance of a thin slab-shaped multiple scattering sample can yield the absorption- and the reduced scattering coefficient of the sample”

$$R = R_{BS}(I_R/I_{ref})$$

Beer-Lambert Law

$$T = I_T/I_{ref}$$

$$I = I_0 \exp(-\mu_t d)$$



# Experimental techniques

- Phantom measurement
- Cell measurements

# Phantom measurements

- Used to test the experimental setup
- Itralipid (IL) - Intralipid 20% emulsion from Sigma,

Batch # 075K1124

- Vary concentrations

- Need IL: 1% - 5%/volume
- Calculate @  $\lambda = 632.8$  nm
  - $\mu'_s = 1.104 \text{ mm}^{-1} \times \text{conc}$
  - $\mu'_a = 0.15 \times 10^{-2} \text{ mm}^{-1} \times \text{conc}$

From K Michielsen et al, Physics Reports,304, (1998) p89-144

- Green food colour

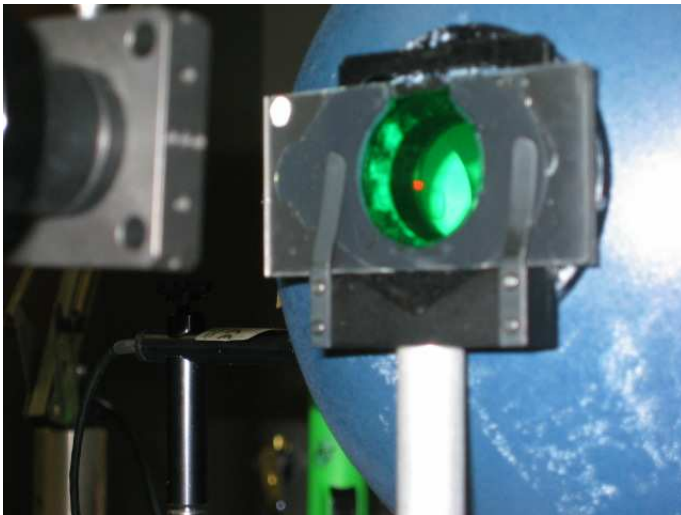
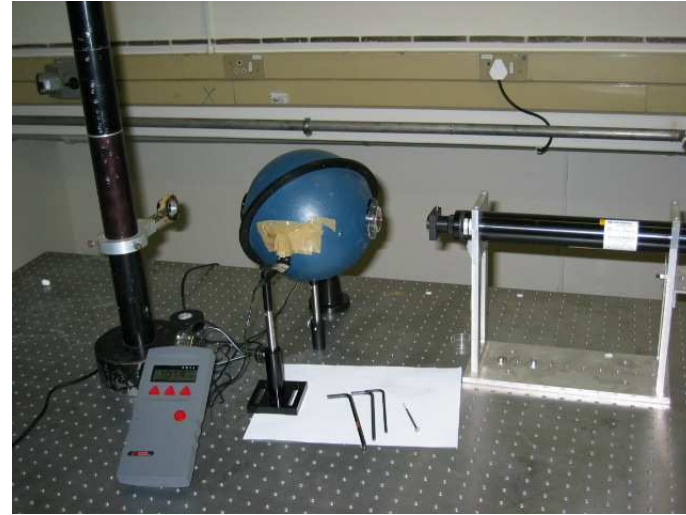
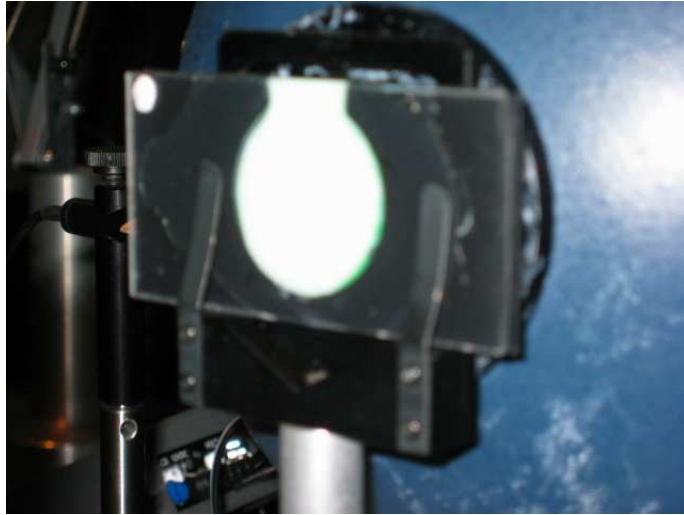
- Measure  $I$  and  $I_0$  and calculate  $\mu_a$  and  $\mu_s$  using:

$$I = I_0 \exp(\mu_t \cdot d)$$

Path length:  $d = 1.68$  mm



# Experimental setup



Phantom

Intralipid: 20%

Green food colourant

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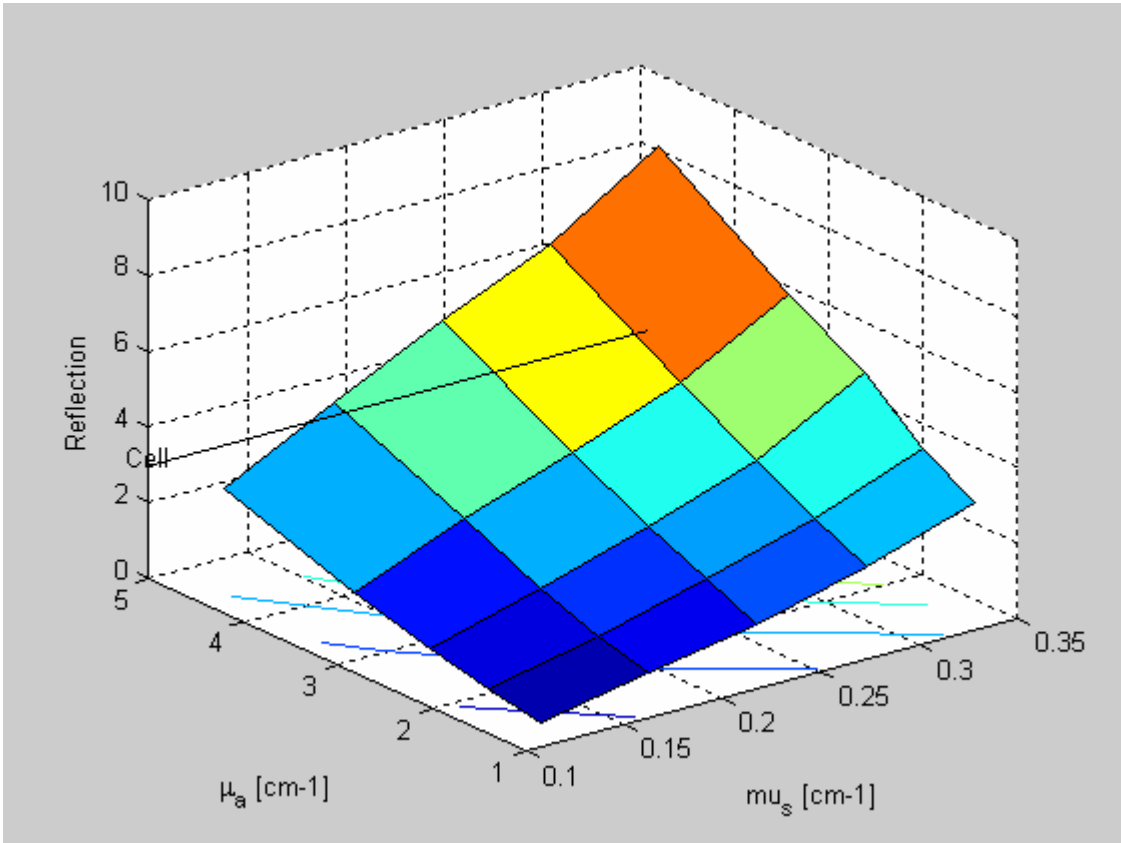
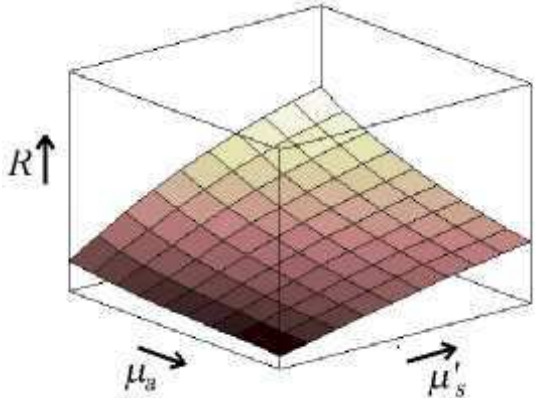
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# Experimental results

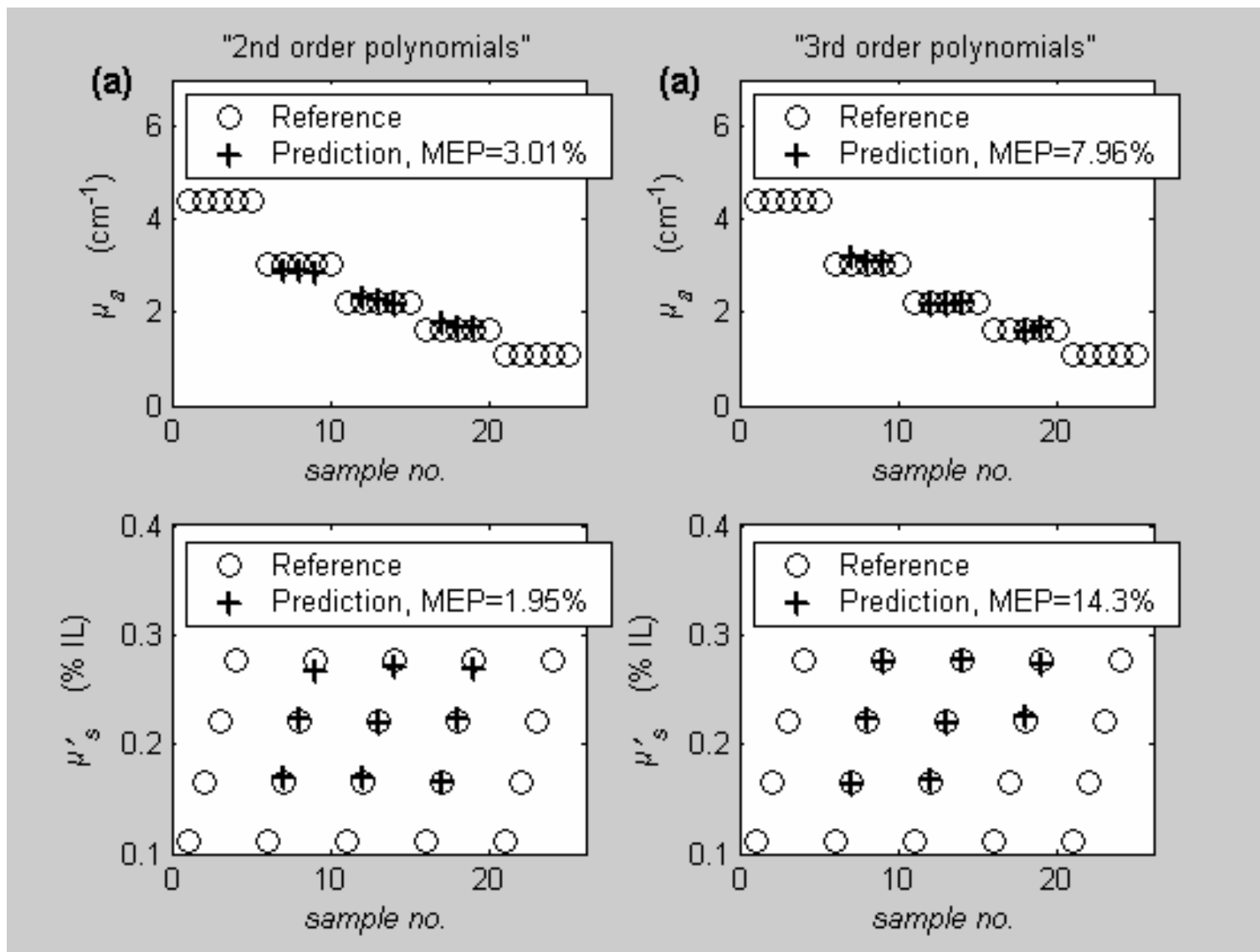
- Phantom measurement
- Cell measurements



# Data



# Results of prediction



# Thank You



Ann Singh and Thapelo Mabaka

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