Two Source Diffusion

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Biomedical Optics in Taiwan

Two Layer Diffusion

- Two sources, one in each tissue layer
- First layer has a thickness L, second layer is semi-infinite
- Each source has a strength/weight
  - Weight is based on albedo, L, and absorption and scattering coefficient

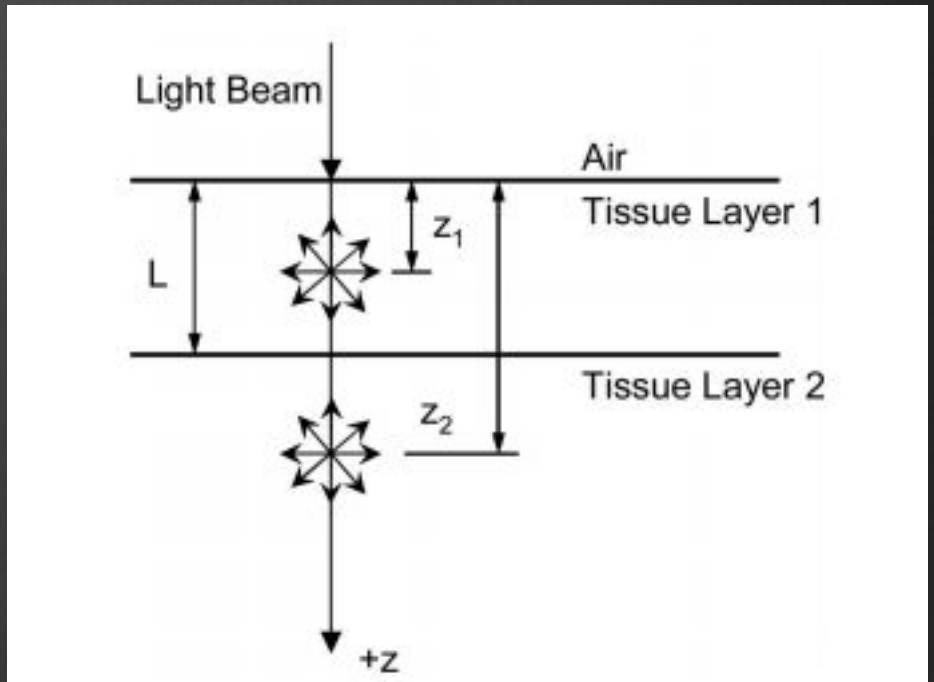


Fig. 1. Positions of isotropic point sources in a two-layer medium. The first layer has a thickness of L.

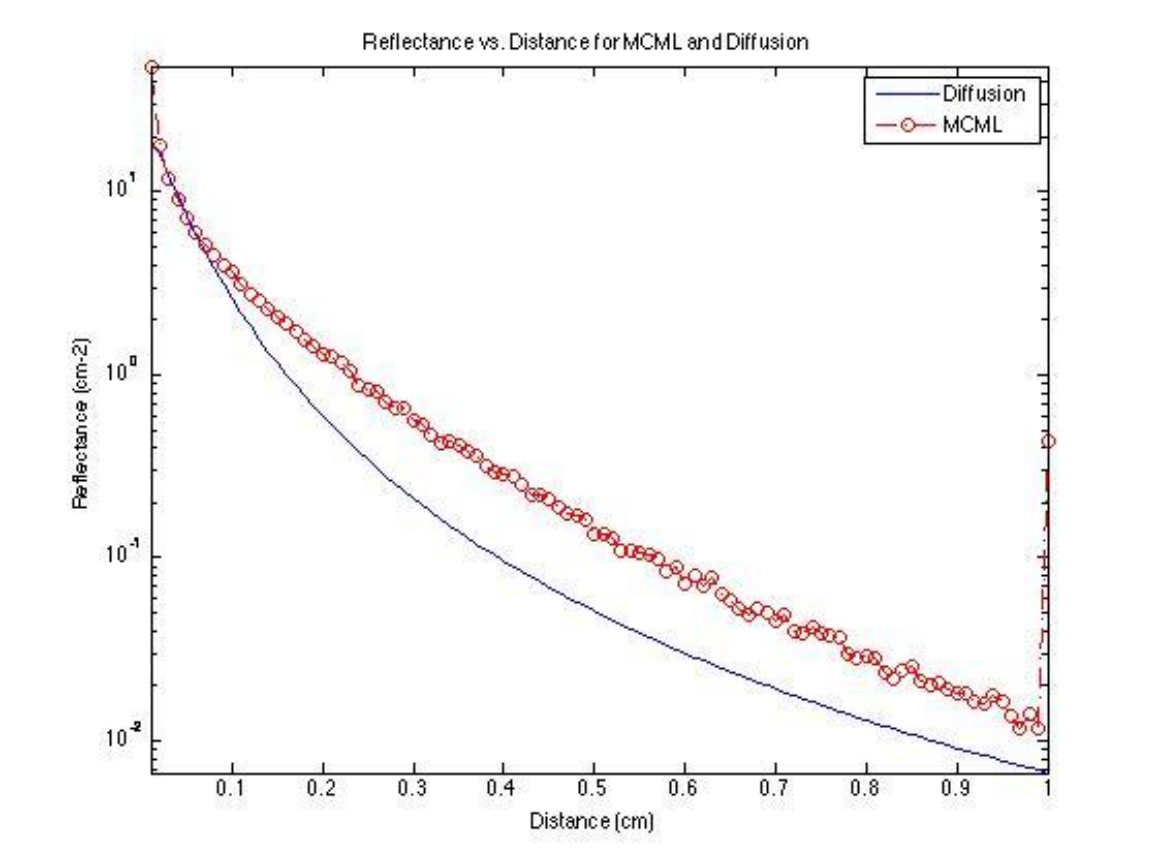
Resolved Diffuse Reflectance

- Reflectance as a function of ρ
  - Find the Fluency Rate at z=0 and then the slope at z=0

$$R(\rho) = \frac{1}{4}\Phi_1(\rho, z=0) + \frac{1}{2}D_1 \frac{\delta\Phi_1(\rho, z)}{\delta z}\Big|_{z=0}$$

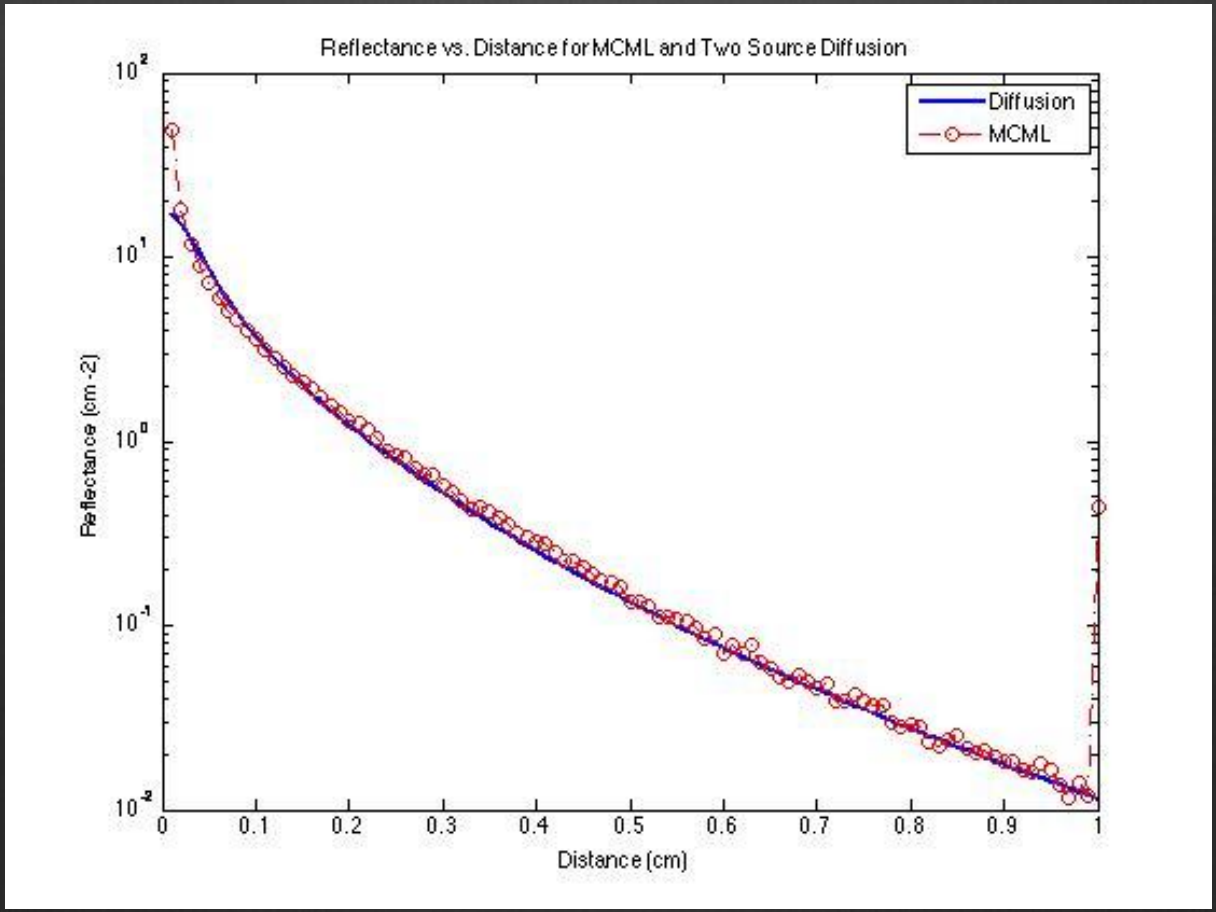
Our Results

- Compare the Diffusion results to MCML results
- High Error due to integration method

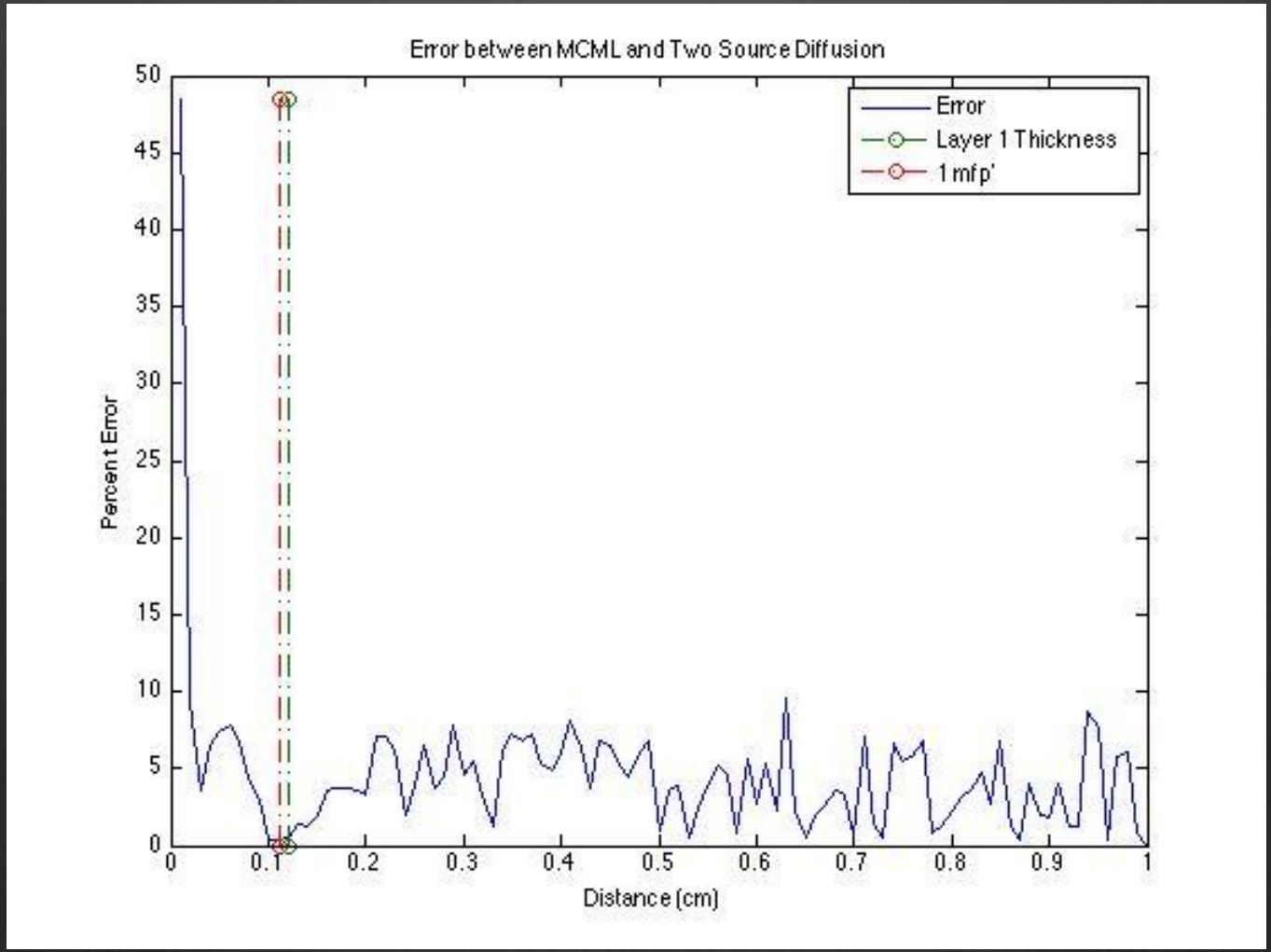


Joe's Results

- He uses Simpson's integration, which uses quadratics to determine area under the curve



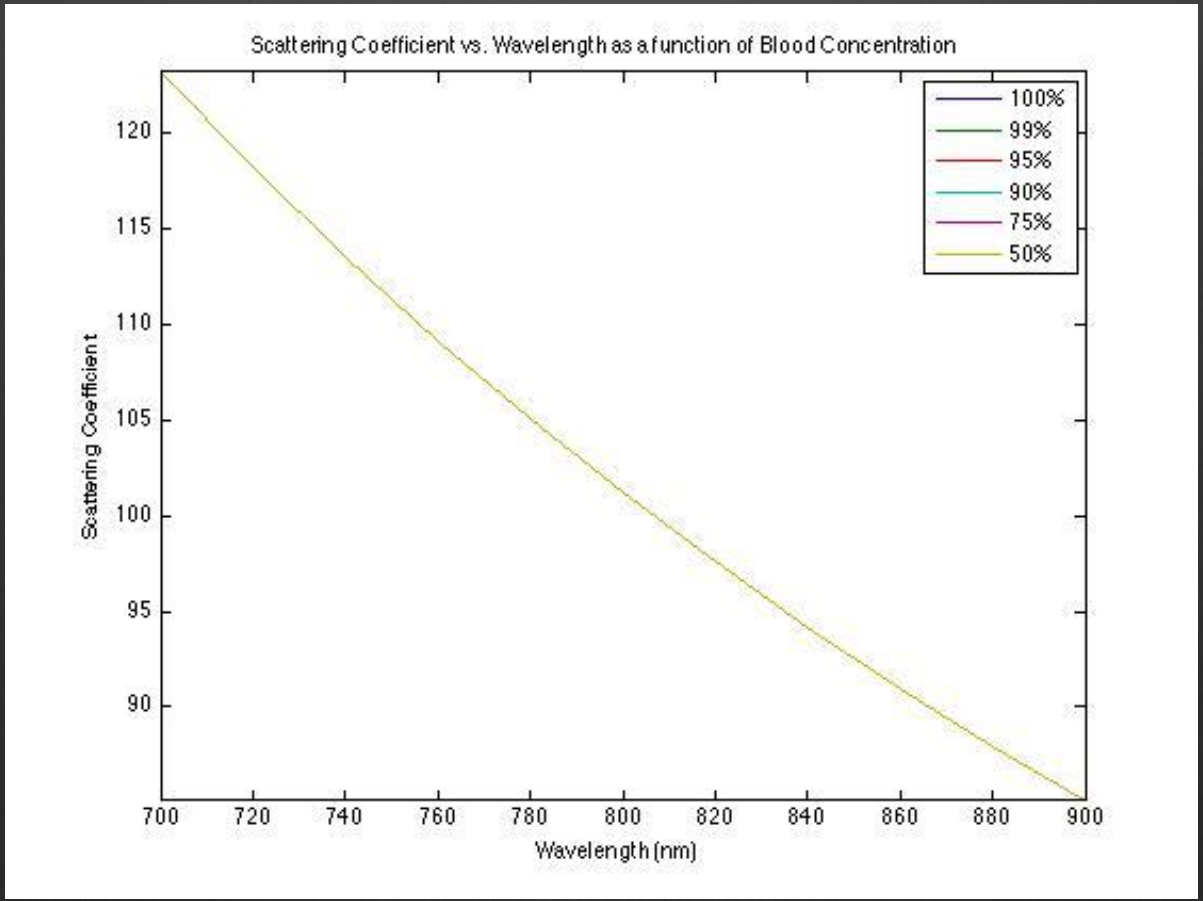
Relative Error



Next Task

- Bone properties based on:
  - Blood Concentration
  - Wavelength
- Our Goal:
  - Create a model which:
  1. Gives power for different wavelengths (700 - 900nm)
  2. Gives power for different blood concentrations (50 - 100 %)
  3. Gives power at different detector distances (15 and 25mm)
- Assumptions:
  - Anisotropy is constant between skin and bone (g=0.81)
  - Detector has 2mm radius

How Blood Concentration Affects Scattering Coefficient



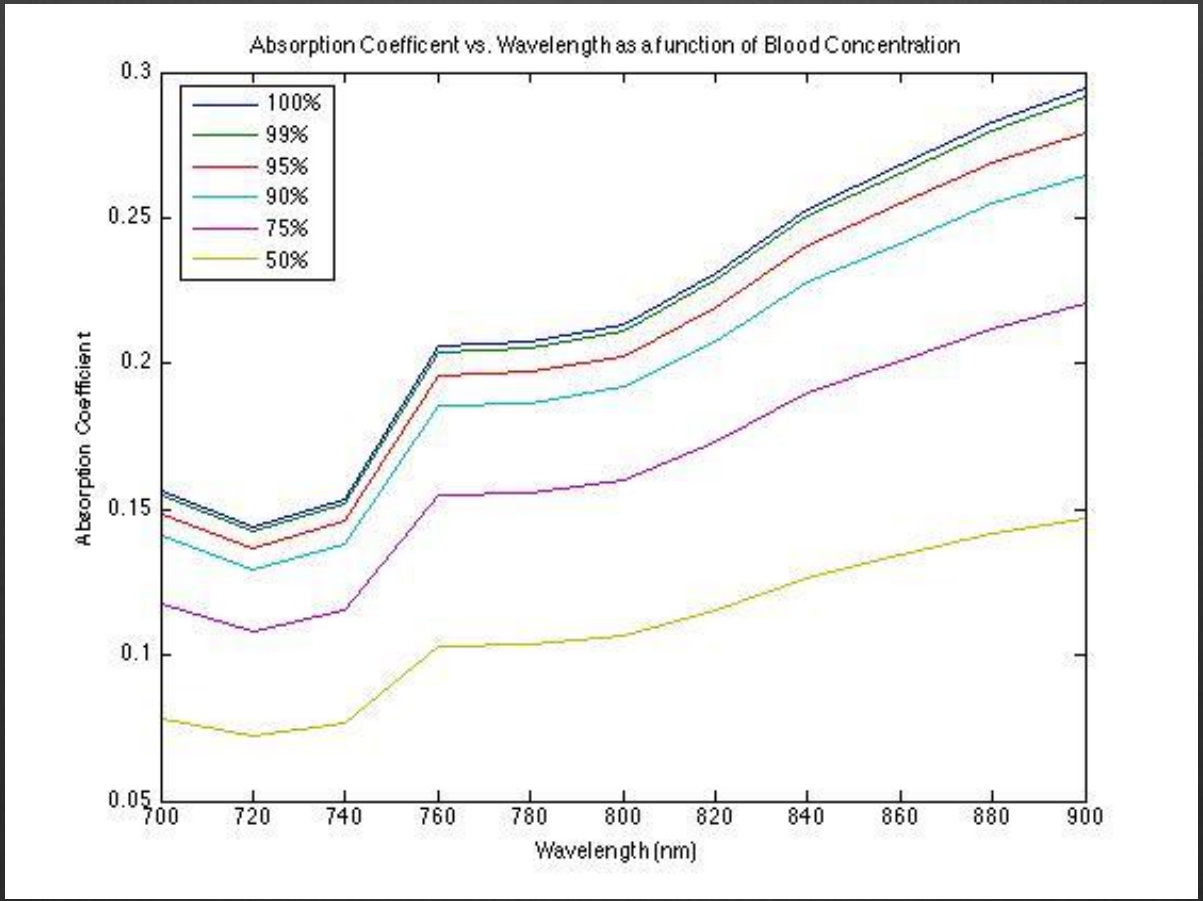
Calculating μ_a of Bone

- μ_a is largely dependent on the concentration of blood, but more specifically, the concentration of hemoglobin

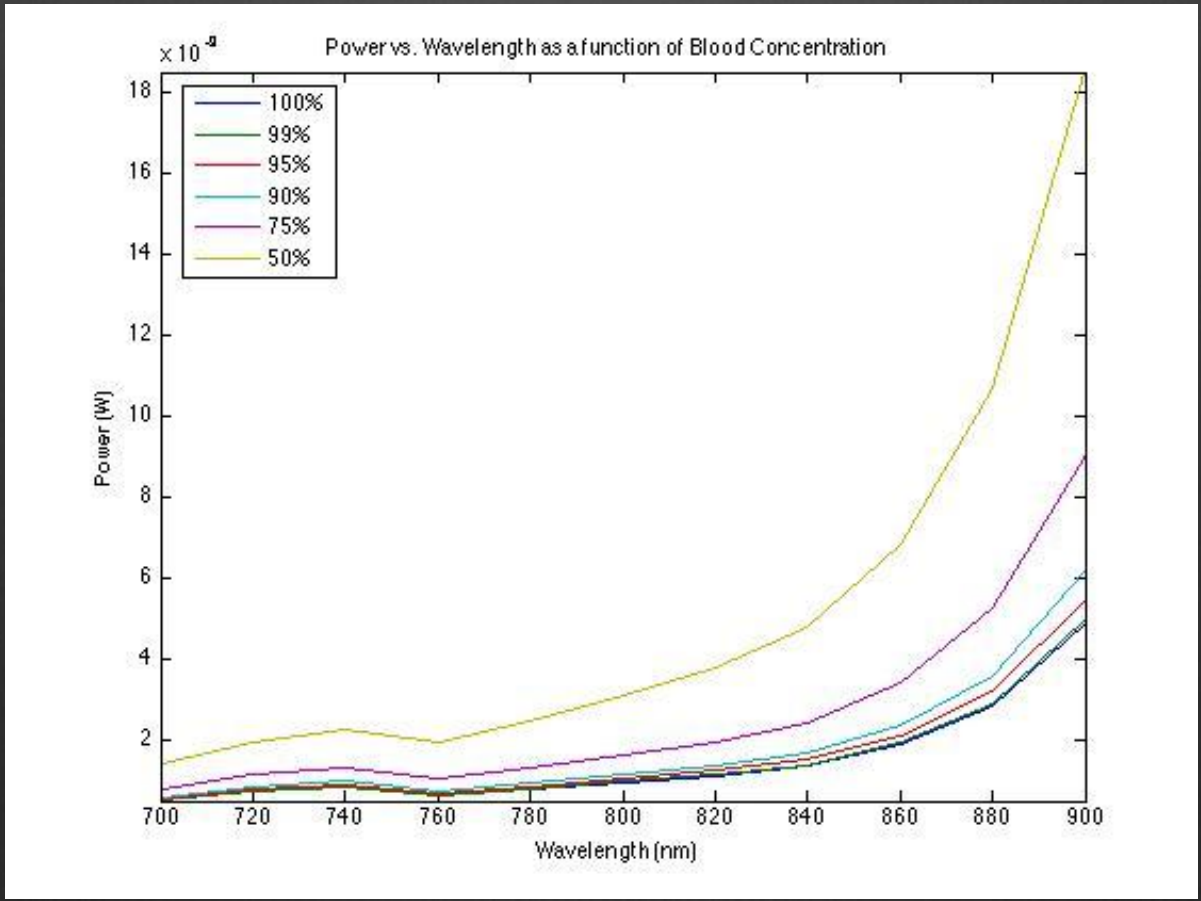
$$\mu_a = 2.303 * (MC_{blood}) * (C_{BinT}) * (Hb\varepsilon) * (C_{HbO},\ C_{Hb})$$

- Normal molar concentration of blood ~ 2.3e-3 g/mole
- Concentration of blood in tissue ~ 5%
- Concentration of HbO in blood ~ 80%

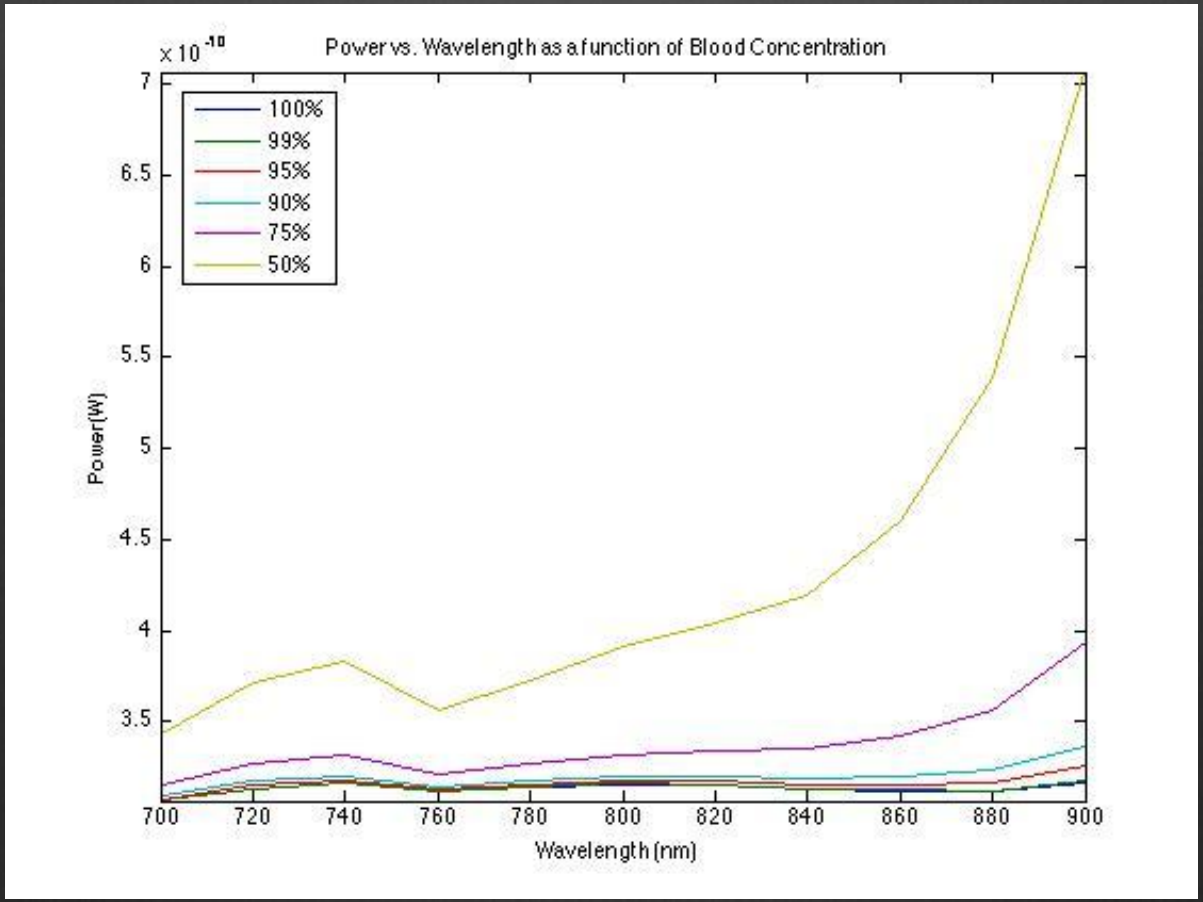
How Blood Concentration Affects Absorption Coefficient



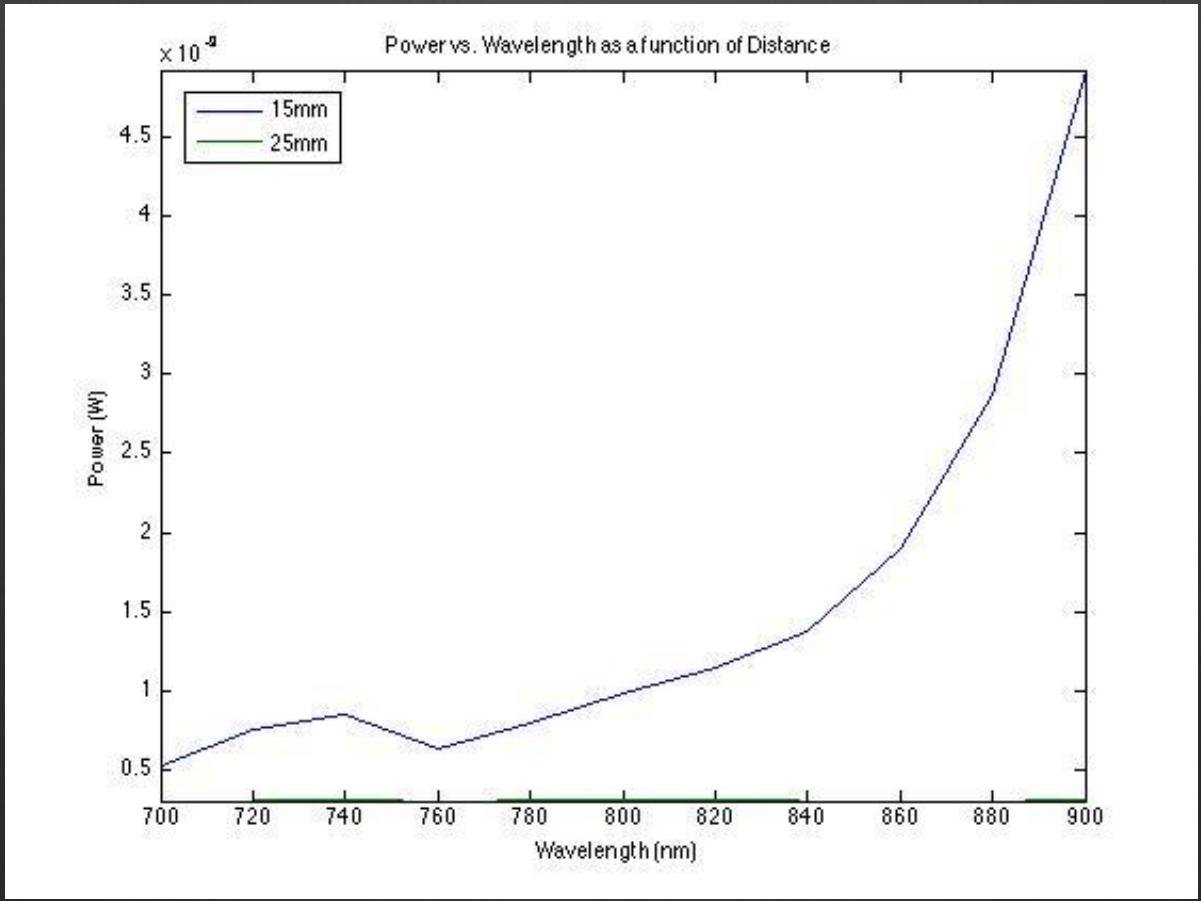
Initial Results (15mm)



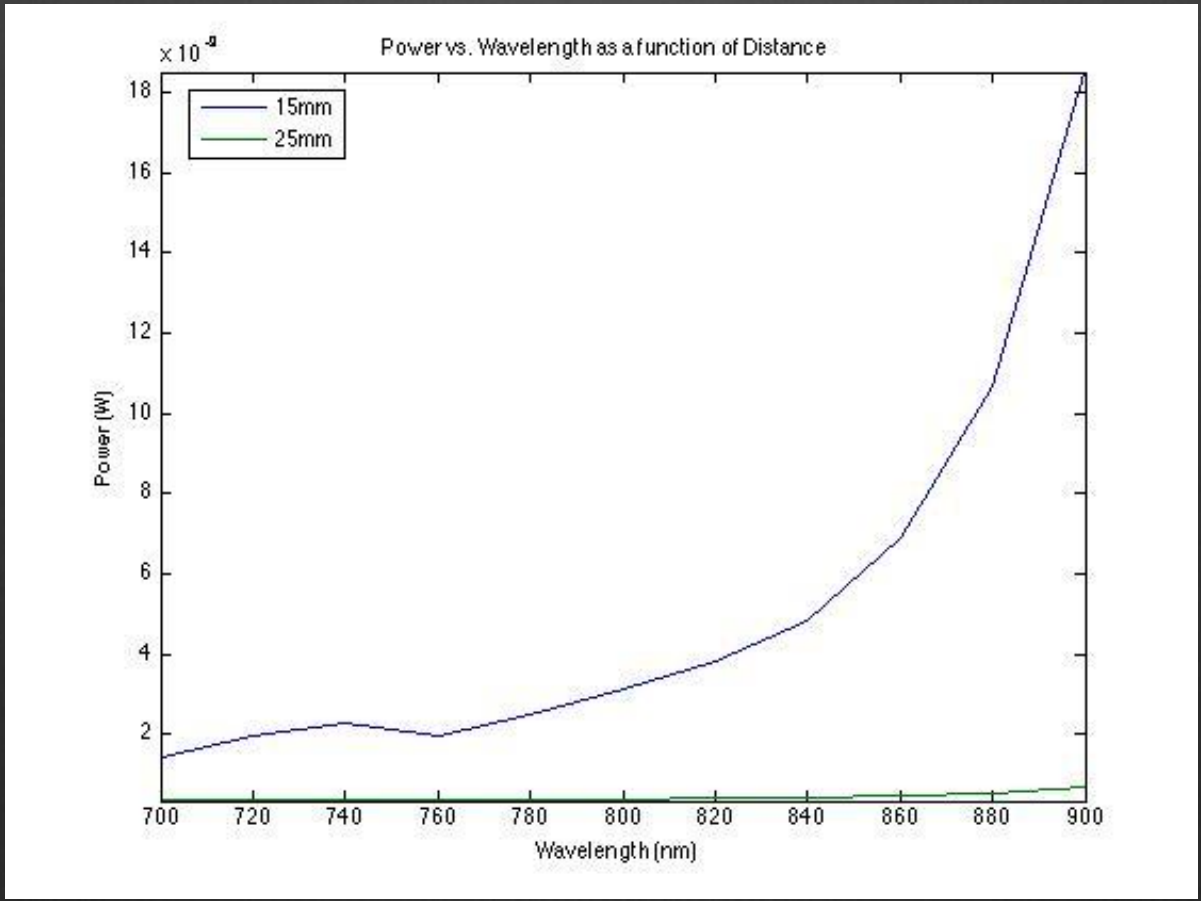
Initial Results (25mm)



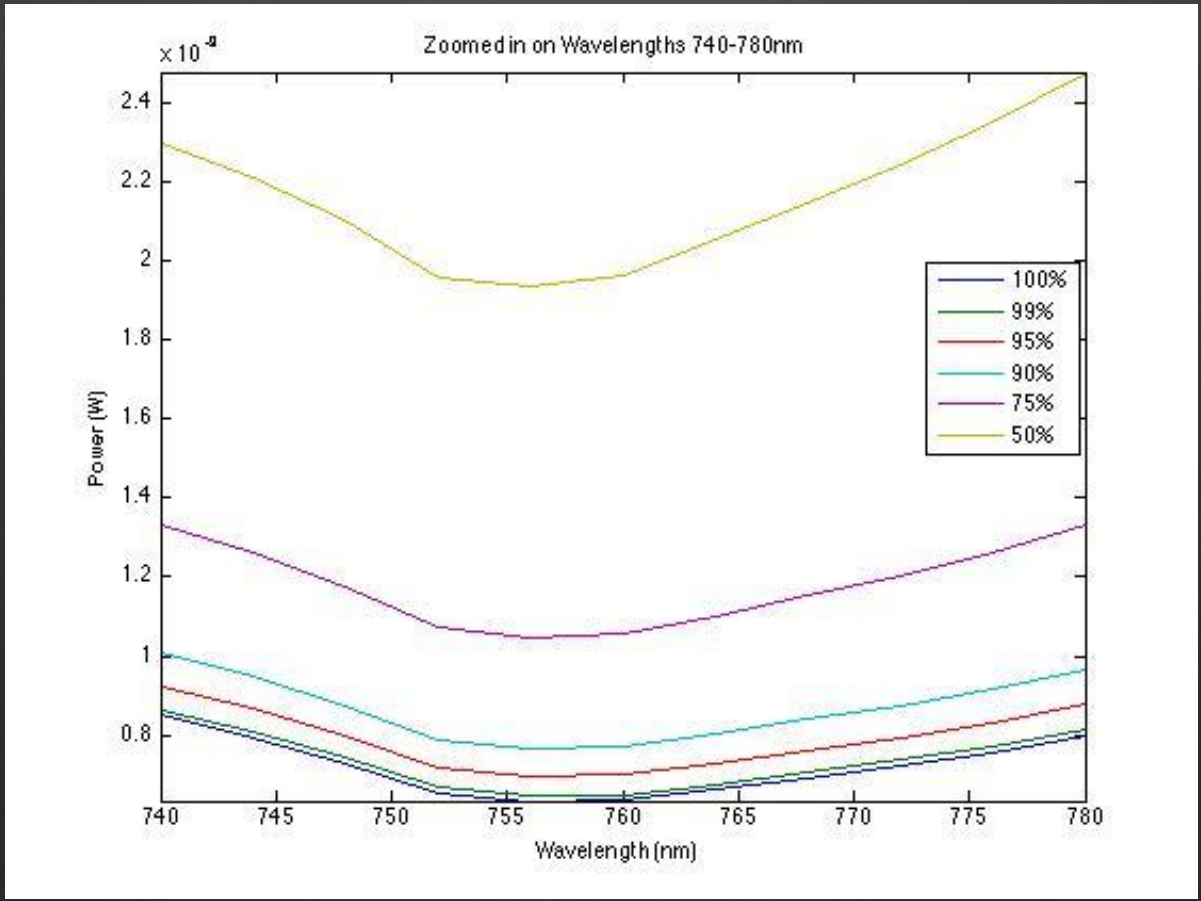
Initial Results (100% BC)



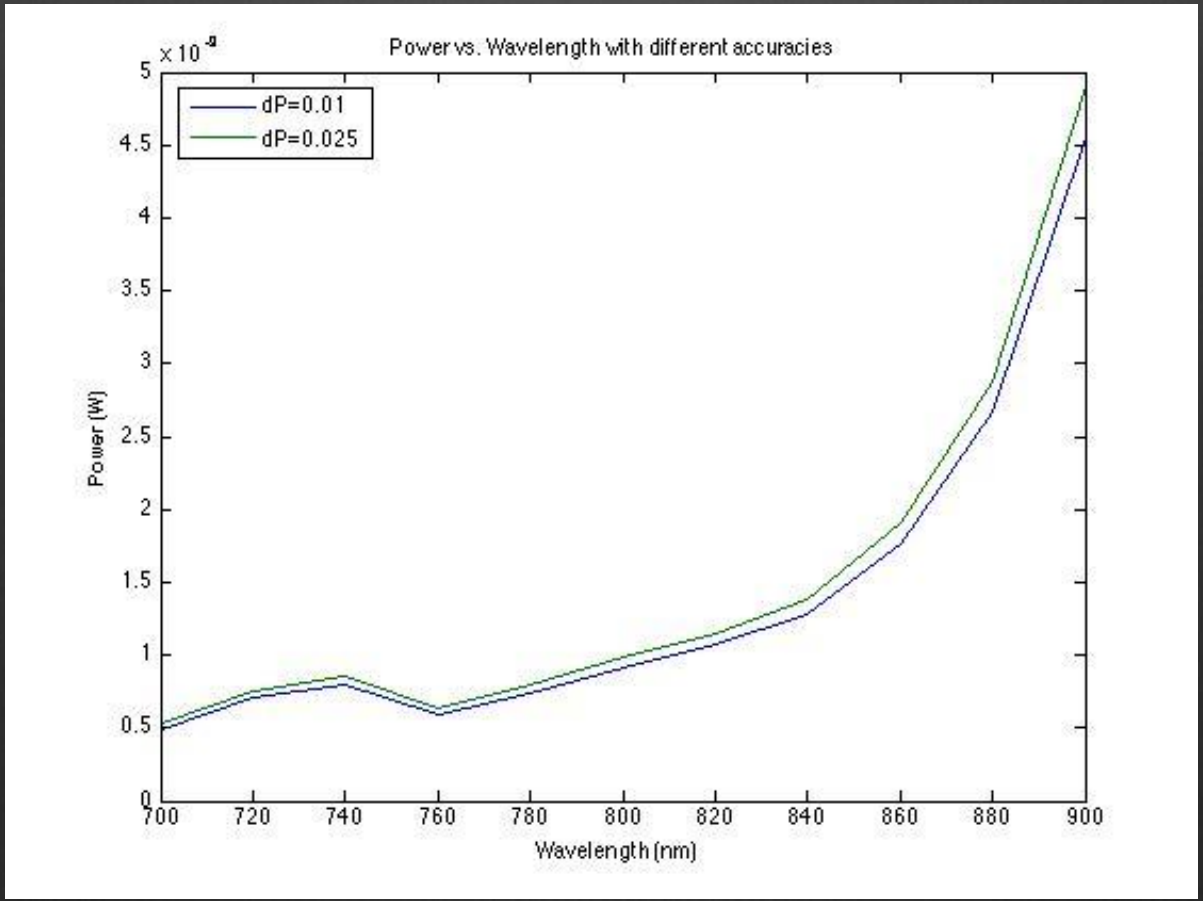
Initial Results (50% BC)



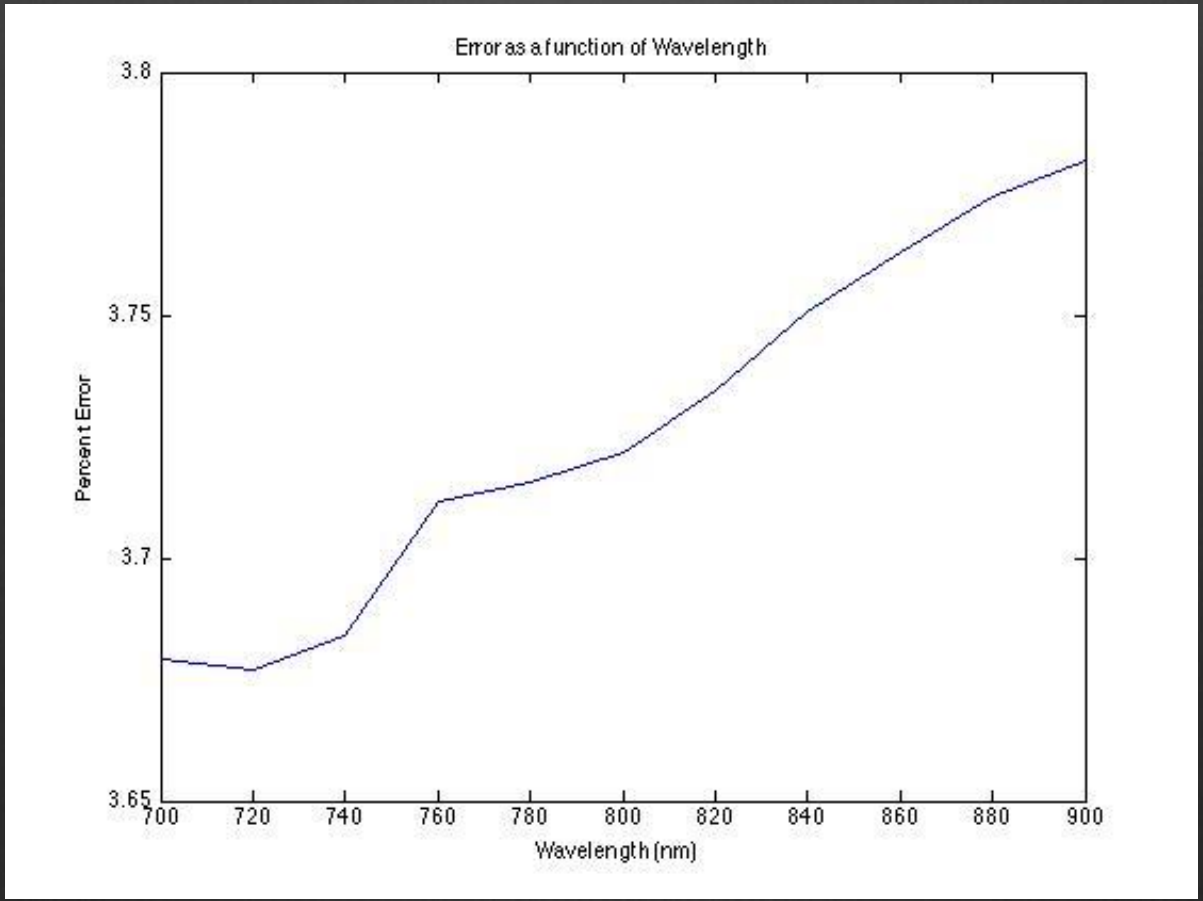
What is the Relationship Between μ_a and Power?



Convergent Studies



Relative Error



Conclusions & Future

- CONCLUSIONS:
  - As the concentration of blood decreases, the effect of μ_a on power also decreases
  - Decreasing the blood concentration has a larger effect on the increase in power
- FUTURE:
  - Sample data from 14-16mm and 24-26mm instead of 0 to 30mm which would decrease the run time by up to 85%.
  - The next part of this experiment to try would be to send the light into the tissue at an angle.

Questions?