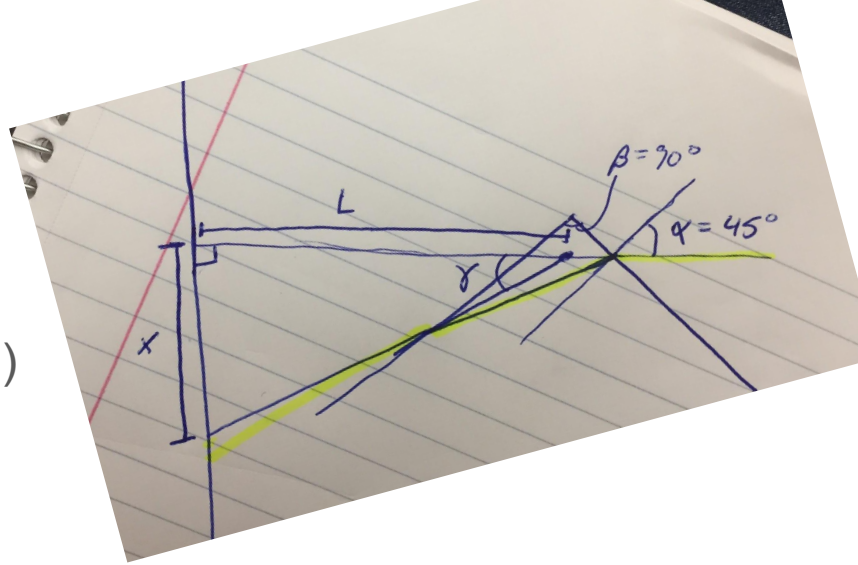
Aerogel Index of Refraction

Meeting 7/26

Calculations

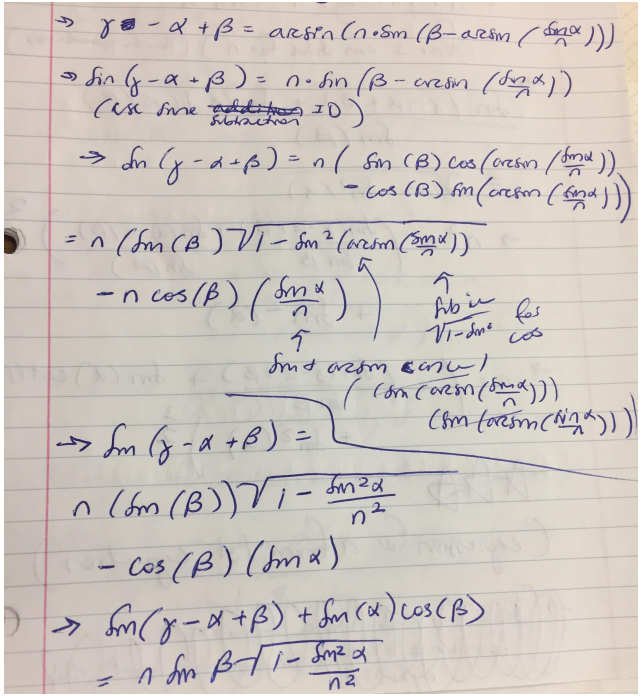


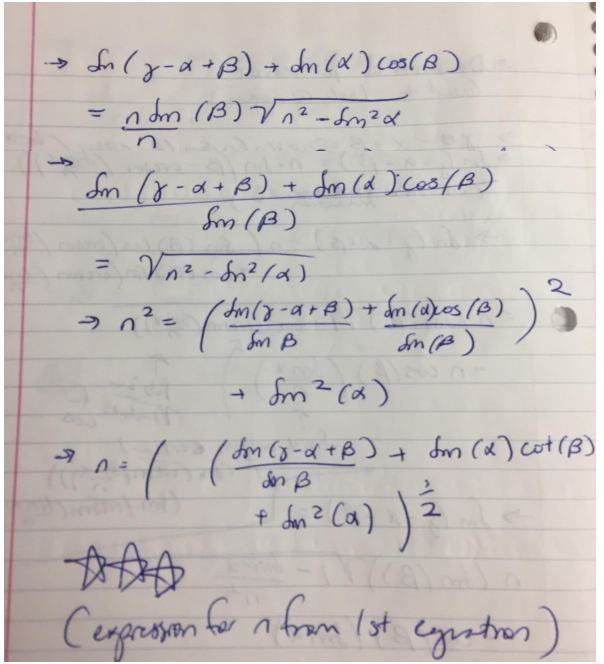
Equations (1): n = 1.029 +/- .001

- $\gamma = \alpha - \beta + \arcsin(n(\sin(\beta - \arcsin((\sin\alpha)/n))))$
- $n = \sqrt{(\sin^2\alpha + \sin^2(\gamma + \alpha))}$
  - - assumes β is a right angle
- $\delta n(\alpha,\gamma) = \sqrt{((\partial n/\partial\alpha)\delta\alpha)^2 + ((\partial n/\partial\gamma)\delta\gamma)^2}$
- $\partial n/\partial\alpha = (\cos(\gamma - \alpha)\sin(\gamma - \alpha) + \sin(\alpha)\cos(\alpha))/(\sqrt{\cos^2(\gamma - \alpha) + \sin^2(\alpha)})$
- $\partial n/\partial\gamma = (-\cos(\gamma - \alpha)\sin(\gamma - \alpha)/(\sqrt{\cos^2(\gamma - \alpha) + \sin^2(\alpha)})$
- https://docs.google.com/spreadsheets/d/1RAnGFBmL_D1iQxKTcW4Yfsl09JV-1IP1-hGFo8ZTCdM/edit#gid=0

Modified Equations (including Beta)

- Looked back at original derivation for Beta = 90 deg. equation to find an expression for n from the original equation
- Found derivatives using W.A. then went back and double checked by hand

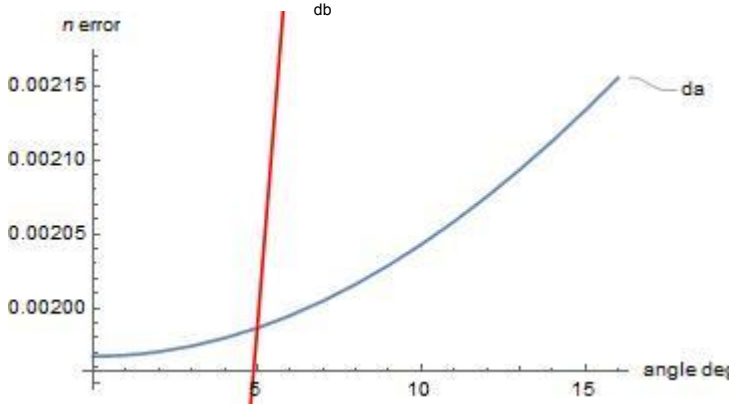


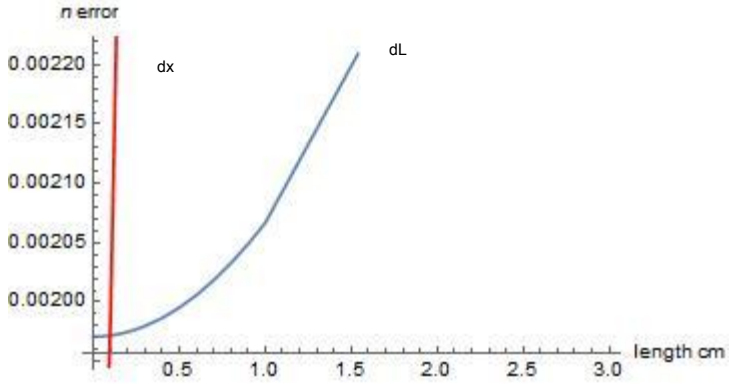


Error Analysis

- The Original Equation is very sensitive to error in Beta and x, not as sensitive to error in Alpha and L
- An error of less more than 2 deg. In Beta means an error of abt. 0.002 in n
- The x measurements are already precise, just need to double check to make sure everything is aligned properly
- Used Starting measurements of:

Ai = 45 deg	dAi = 5 deg
Bi = 90 deg	dBi = 5 deg
Li = 45.6 cm	dxi = .1 cm
xi = 2.6 cm	dLi = .4 cm

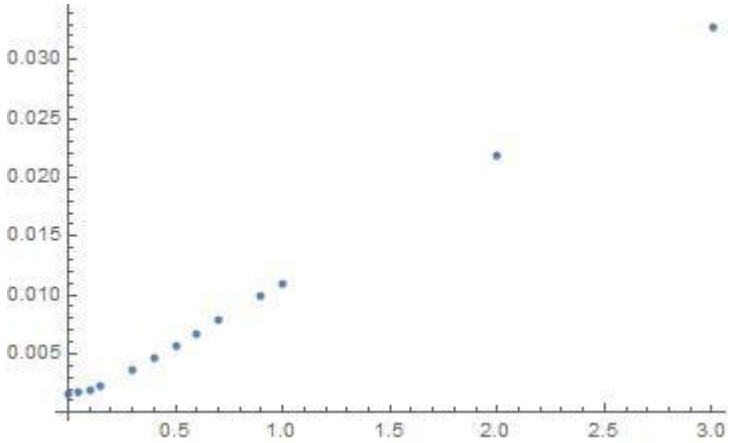


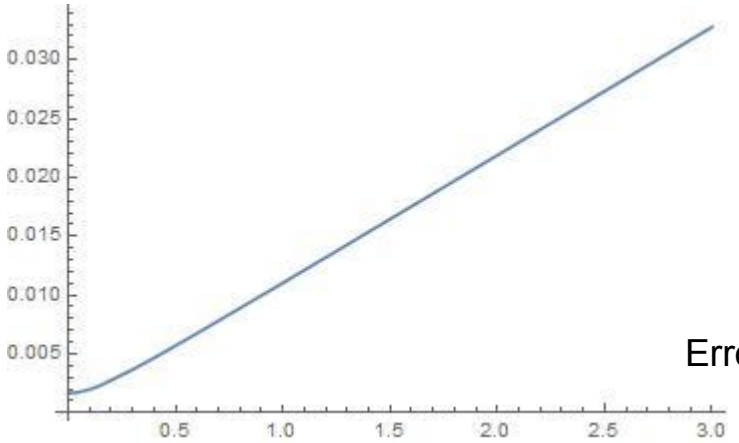


https://docs.google.com/spreadsheets/d/1HJZ5eK6huzZO94GtAjLsAfnvpXzxYXvuAw74P8qCl84/edit#gid=0

Error in x and L

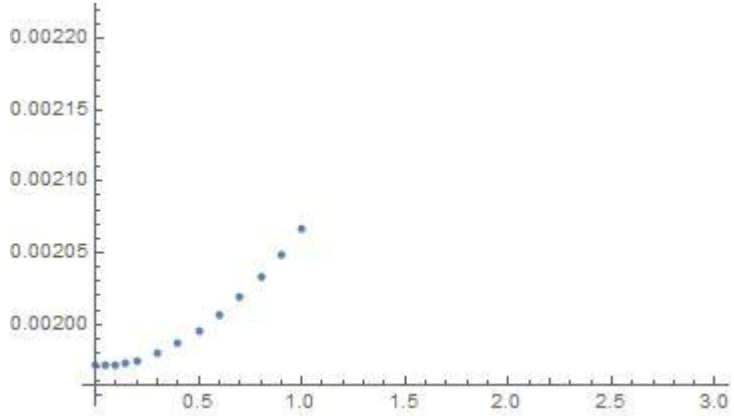
Error in n

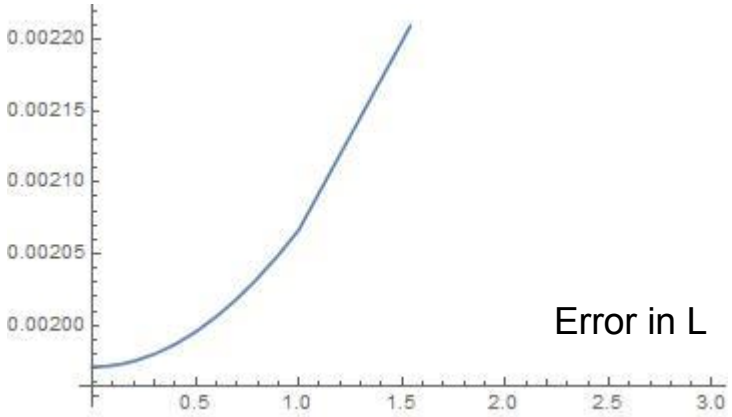




Error in x

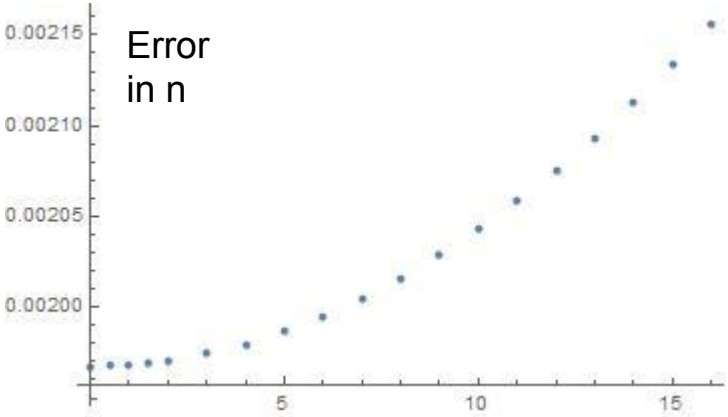
Error in n

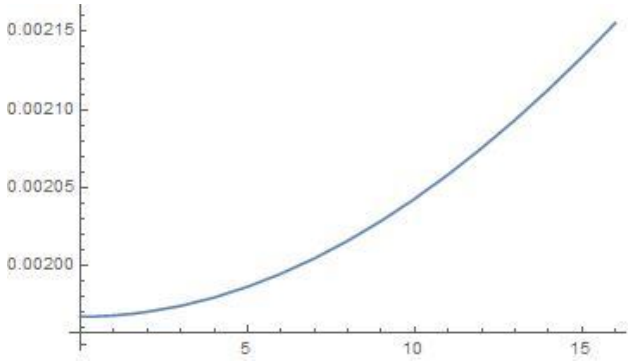




Error in L

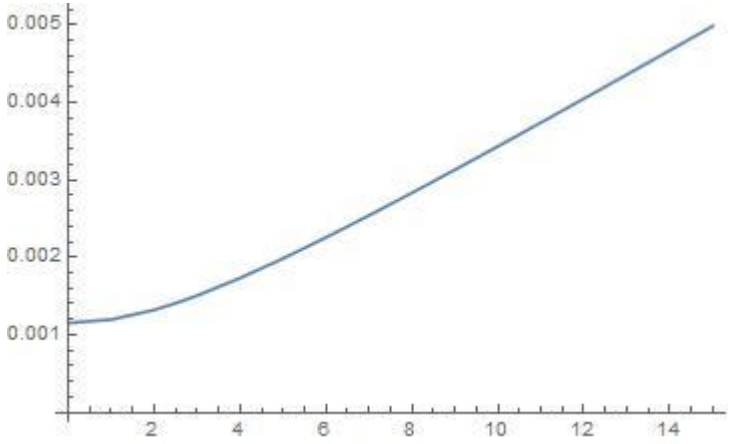
Error in Alpha and Beta

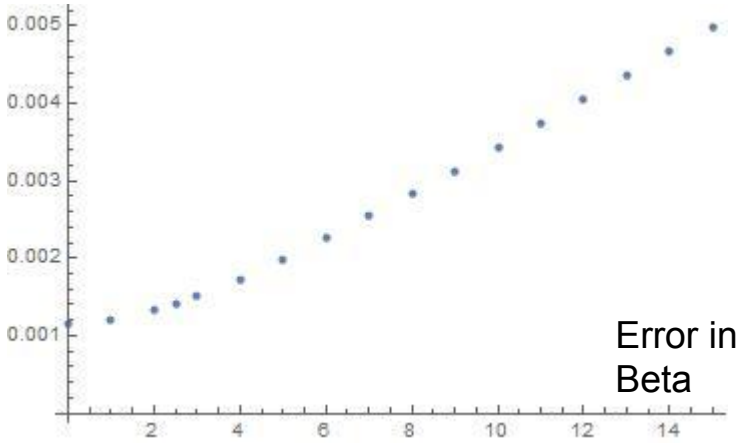




Error in
Alpha

Error
in n

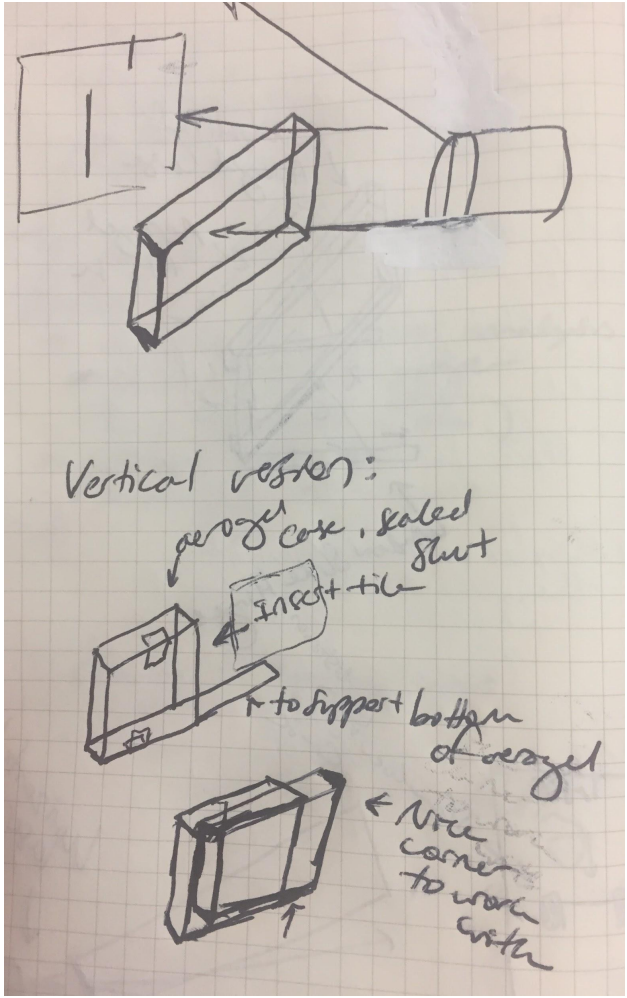




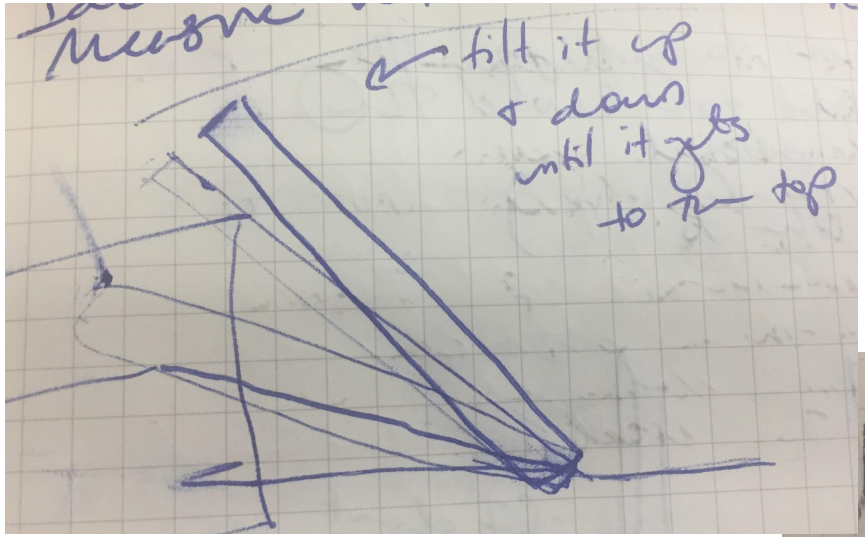
Error in
Beta

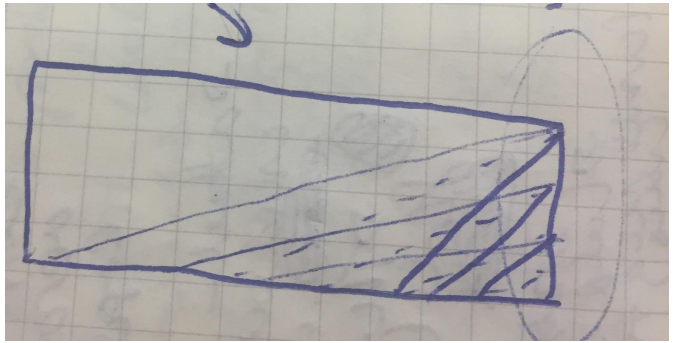
Ideas for Measuring n across the long edges

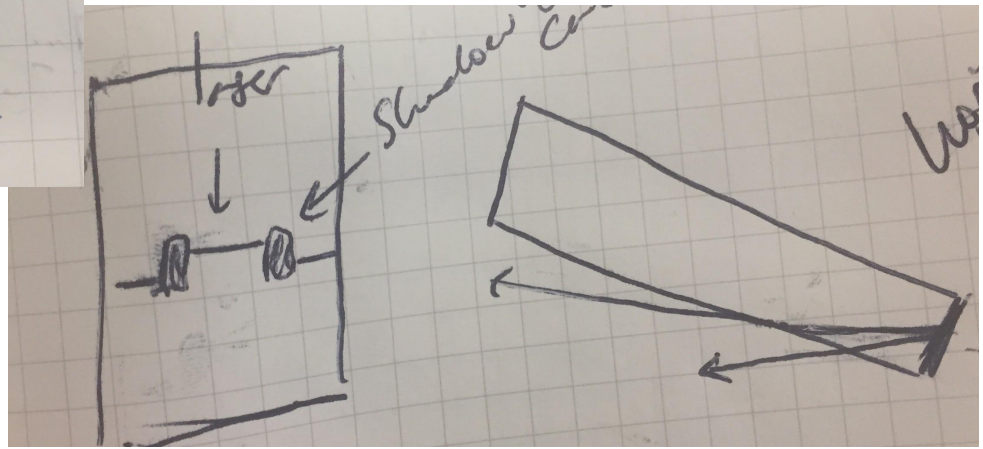
- Change the angle and depth of the laser position (using graph paper)



Idea for Measuring n across the long edges

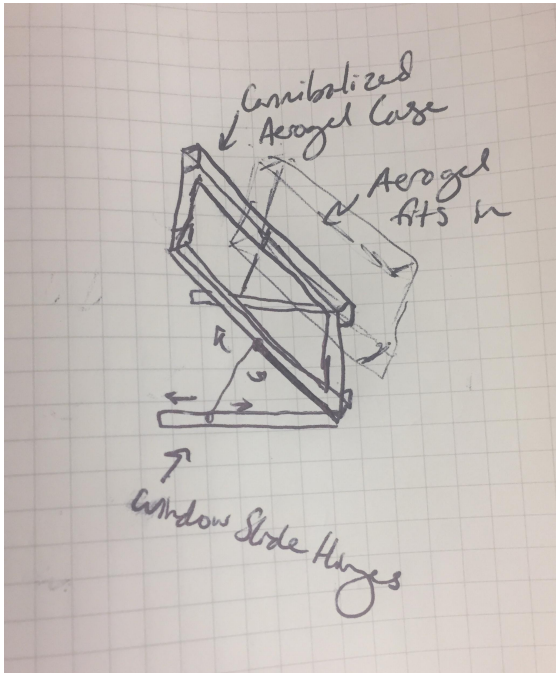




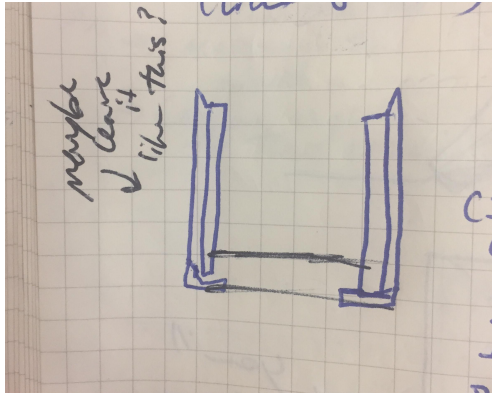


Idea for Measuring n across the long edges

- Preferable to just vertical version because you can use a greater portion of the tile
- Also doesn't put all the weight of the tile on one edge (safer?)
- Tilting movement - Aerogel moved instead of laser



Might be hard to measure angles - definitely overly complicated anyway



https://www.amazon.com/Truth-Hardware-Casement-Hinge-28-15-5/dp/B005E0MXLK?ref_=fsclp_pl_dp_15

Transmittance Measurements

- Take a vertical measurement of n near the edge of the tile and then use transmittance measurements to n across the rest?
- Fresnel equations
  - $R_s = (n_1\cos(\theta_i) - n_2\sqrt{(1 -(n_1/n_2)\sin(\theta_i))})/(n_1\cos(\theta_i) + n_2\sqrt{(1 - (n_1/n_2)\sin(\theta_i))})$
  - $R_p = (n_1\sqrt{(1 - (n_1/n_2)\sin(\theta_i))} - n_2\cos(\theta_i))/(n_1\sqrt{(1 - (n_1/n_2)\sin(\theta_i))} + n_2\cos(\theta_i))$
  - $R_{eff} = ½ (R_s + R_p)\theta$
- T = (1-R)^2 + α*thickness
  - (R = Reflectance and α = absorbance)

Next Week

- Examine effect of error more closely
- Retake measurements with more accurate x and beta
- Vertical measurements? Transmittance?
- Model of index variations in the tile
- Meeting with Nick - Mathematica