DFM
Danish National Metrology Institute

# BRDF analysis for SiMetrics ARS

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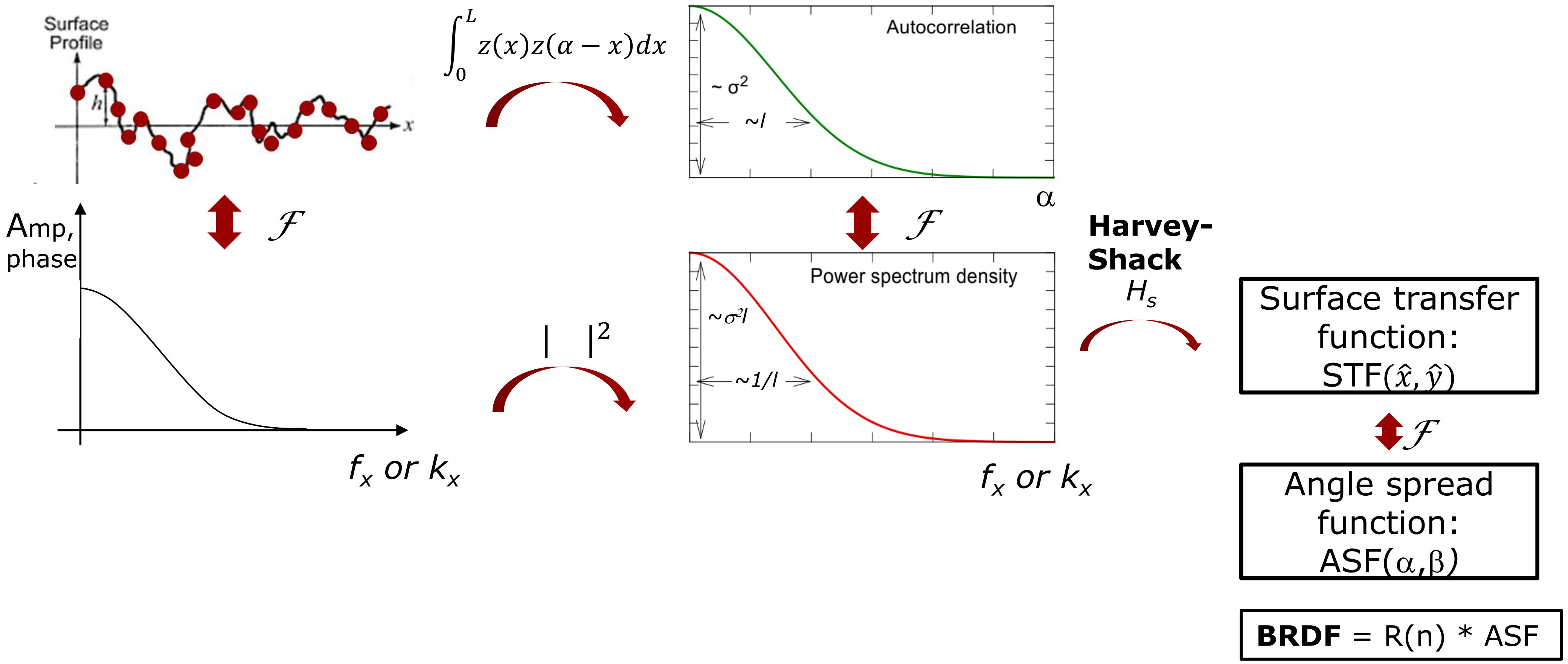
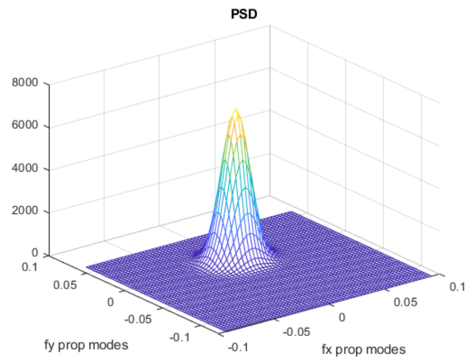
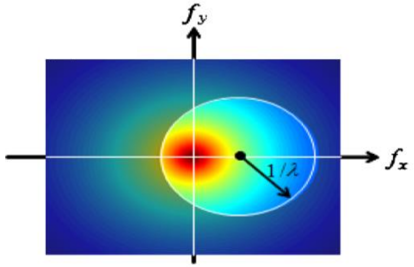
# BRDF of a random rough surface



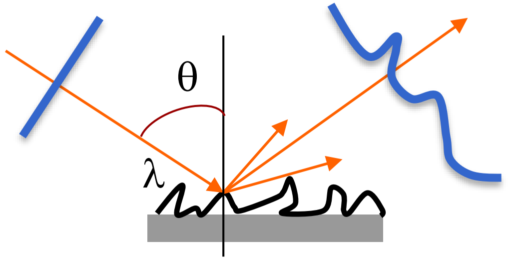
# Modelling the BRDF of a random rough surface




Angular depending PSD seen by the light



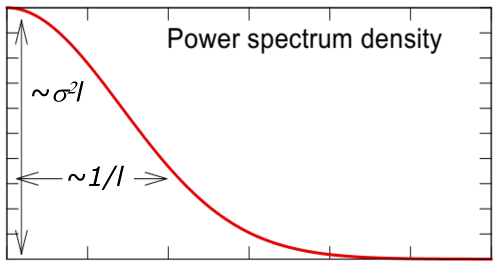

$$f_0 = \frac{sin(\theta)}{\lambda}$$




Information in propagating modes → Roughness:

$$\sigma_s^2 = \int_{-\frac{1}{\lambda}+f_0}^{\frac{1}{\lambda}+f_0} PSD(f)\, df$$

Light matter correlation length $l_c$ (ASF and STF) is found from BRDF fit.




$f_x$ or $k_x$

**Harvey-Shack**
$H_s$

Surface transfer function: STF($\hat{x}$,$\hat{y}$)

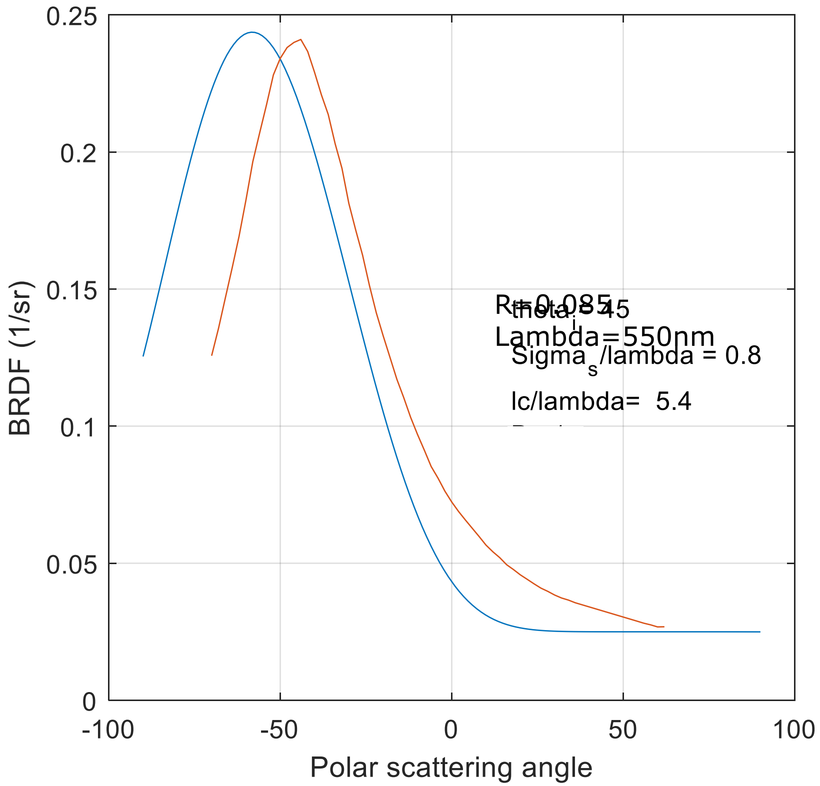
$\mathcal{F}$

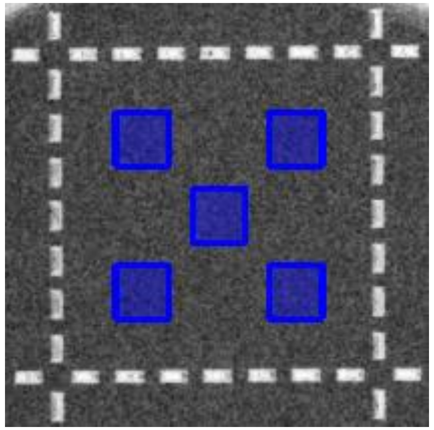
Angle spread function: ASF(α,β)

**BRDF** = R(n) * ASF

# Study 1 with scaling

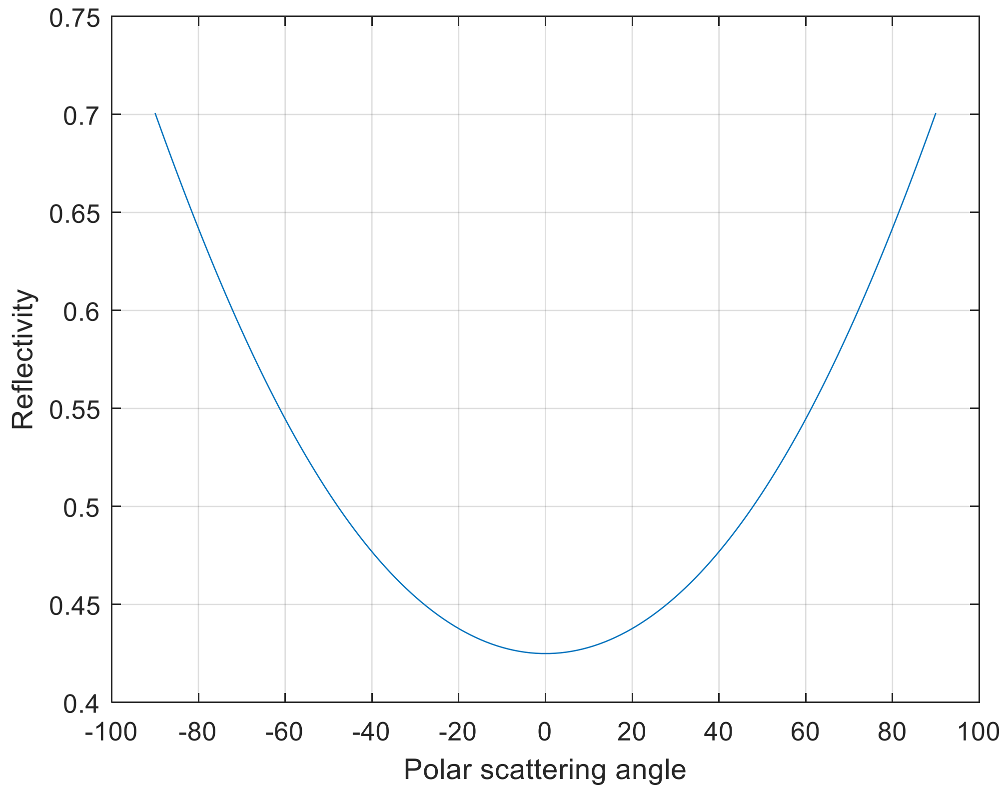
- We use the nominal values for autocorrelation length ($l_c$) and RMS roughness ($\sigma_s$) from AFM measurements
- The reflectivity parameter (R) in the GHS theory is treated as **one** angular independent scaling/fitting value
- We fit the BRDF signal. The fit is done for s-pol incident light

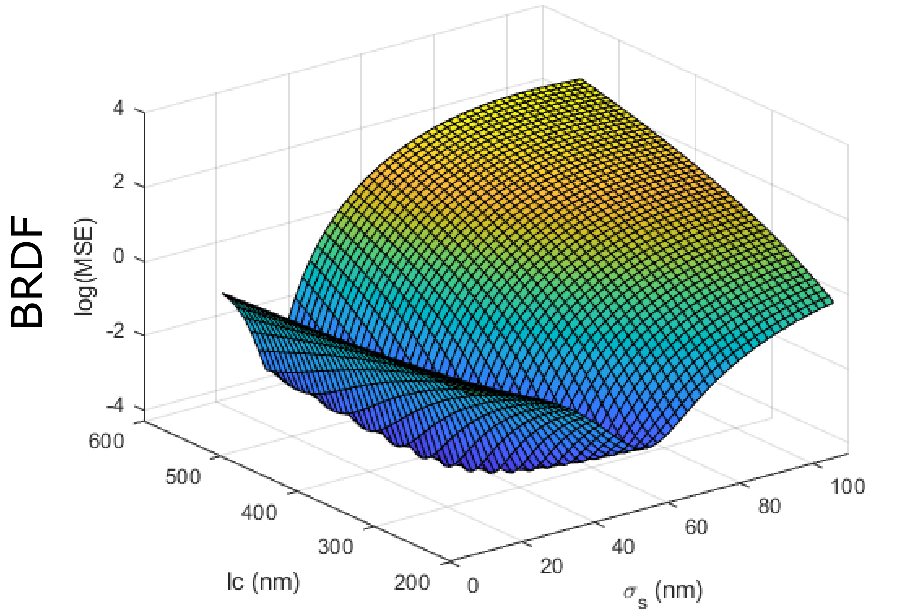


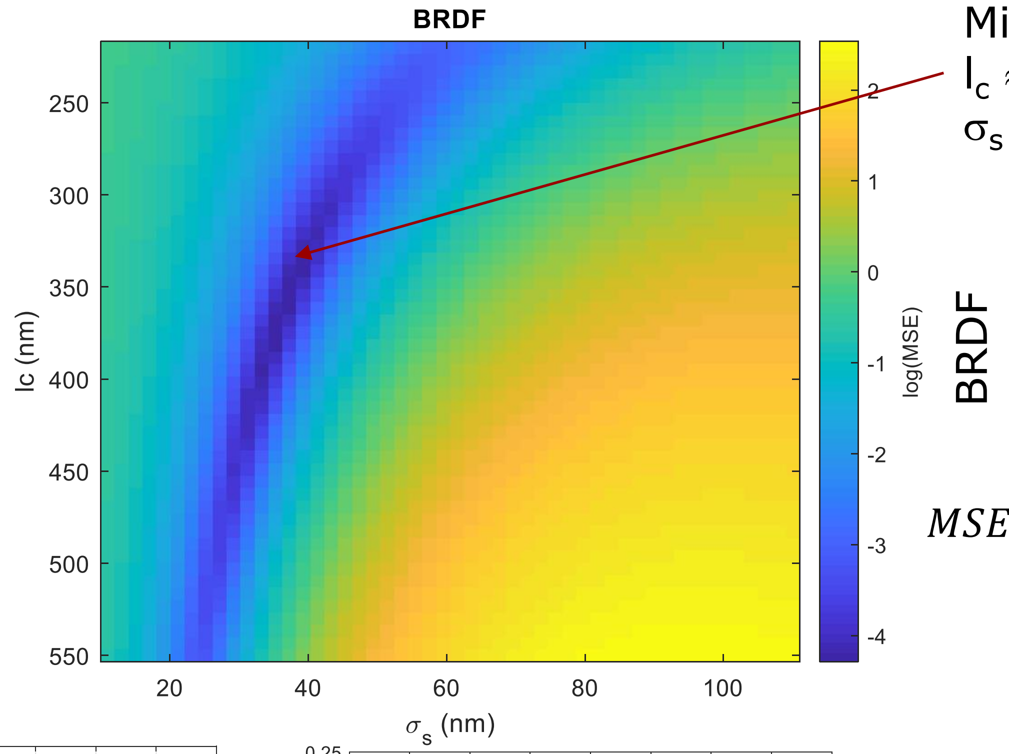



# Study 2 without scaling

- We fit the values for autocorrelation length ($l_c$) and RMS roughness ($\sigma_s$)
- The reflectivity parameter (R) in the GHS theory is given by generalized Fresnel equations assuming known optical constants
- We fit the BRDF signal. The fit is done for s-pol incident light

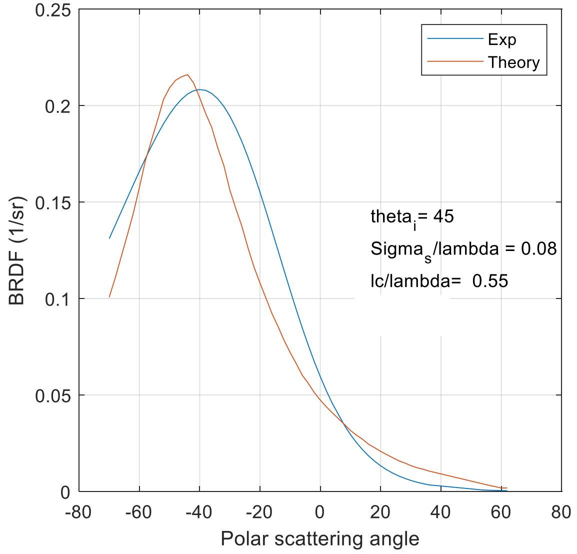


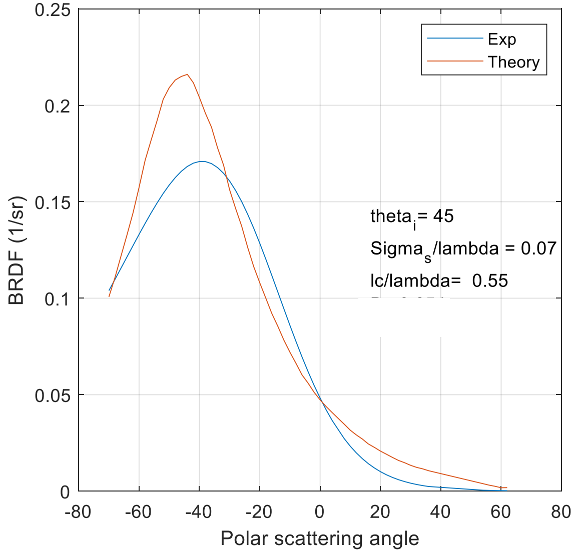


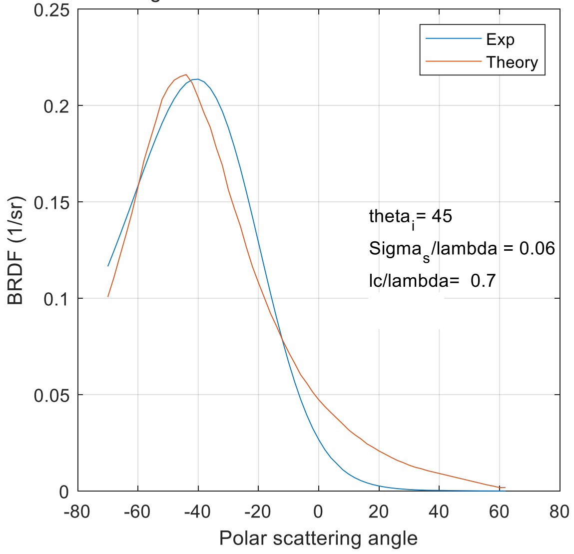




Minima
$l_c \approx 0.55*lambda$
$\sigma_s \approx 0.07*lambda$

$$MSE = \left(BRDF_{exp} - BRDF_{GHS}\right)^2$$

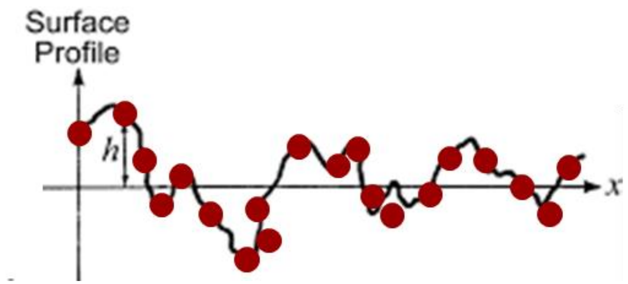


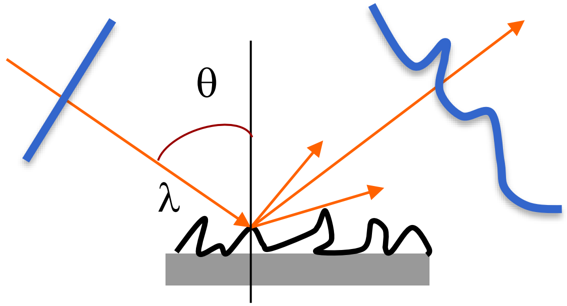



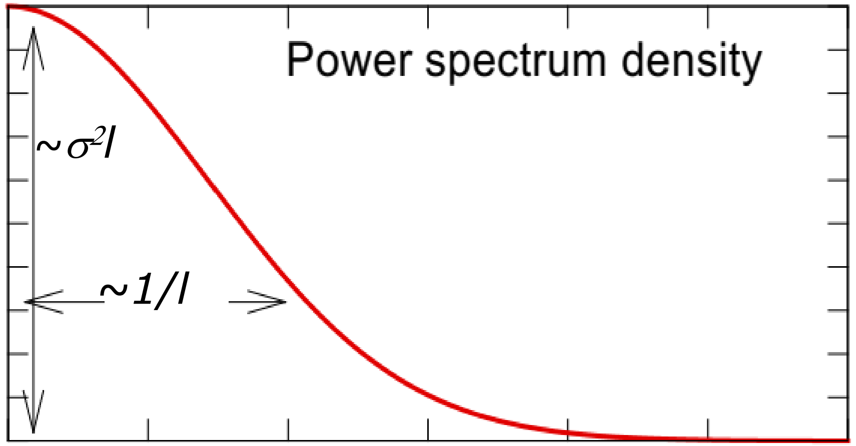



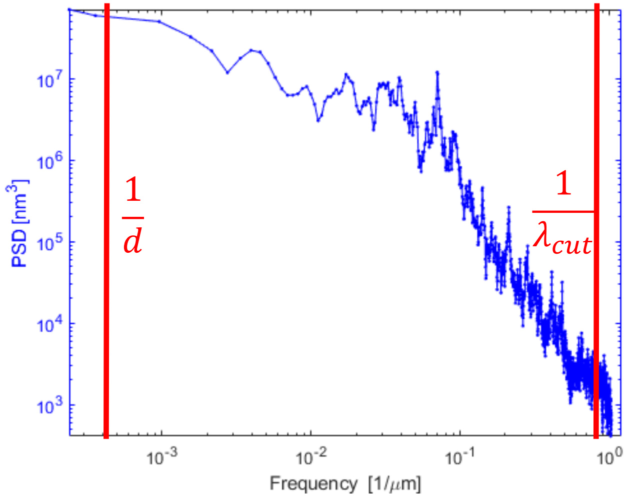

Needs to do High resolution minima search

Looks like GHS explain the main features but not able to fit the whole spectrum




$$\sigma_{eff}^2 = 4\int_{f_{min}}^{f_{max}} PSD(f)\, df$$

$$\frac{1}{d} < f < \frac{1}{\lambda_{cut}}$$