Biomedical Measurement using NIR-light
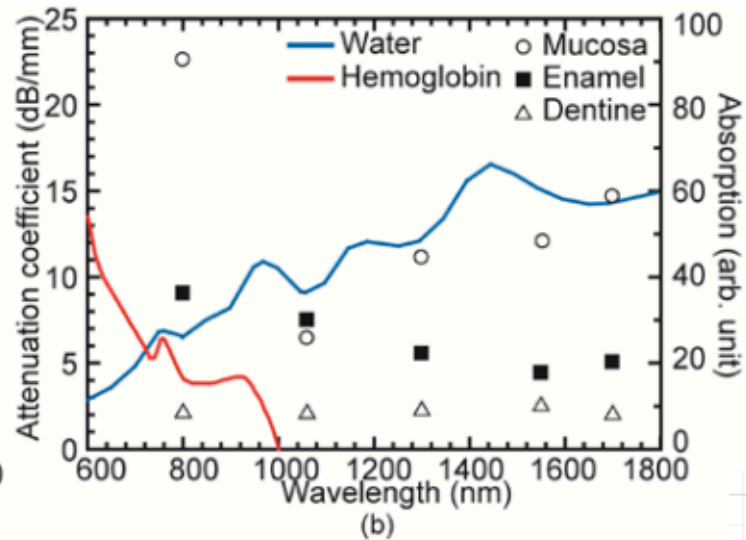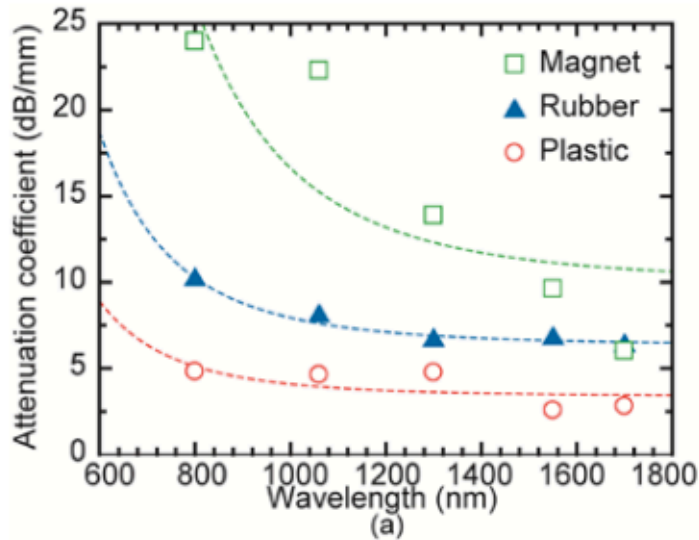
HOMEWORK

seminar@Hase

2012/07/05

HOMEWORK

- The fitted curve obtained from Rayleigh scattering theory

- A balanced detection

- Sonication

- Why doesn't THG generate from interface of PTD and ITD?
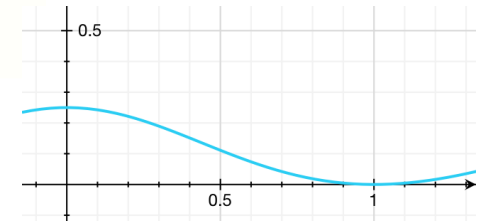
- The position of deformable mirror

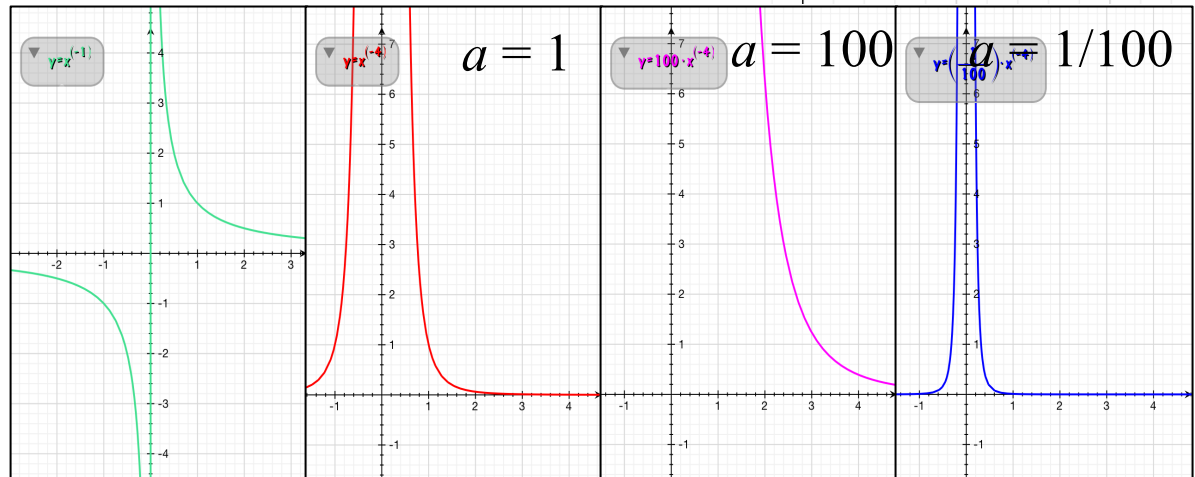# The fitted curve obtained from Rayleigh scattering theory

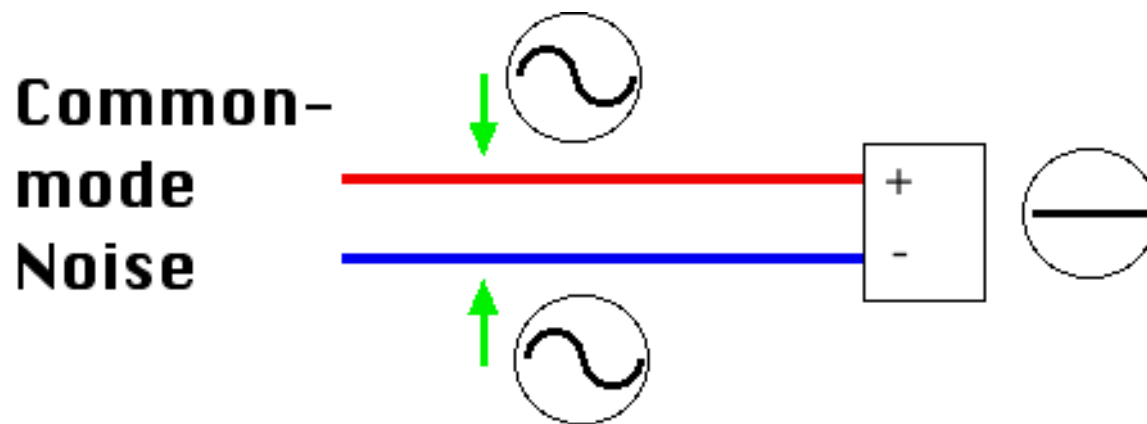$$k_s = \frac{2\pi^5}{3} n \left(\frac{m^2 - 1}{m^2 + 2}\right)^2 \frac{d^6}{\lambda^4}$$

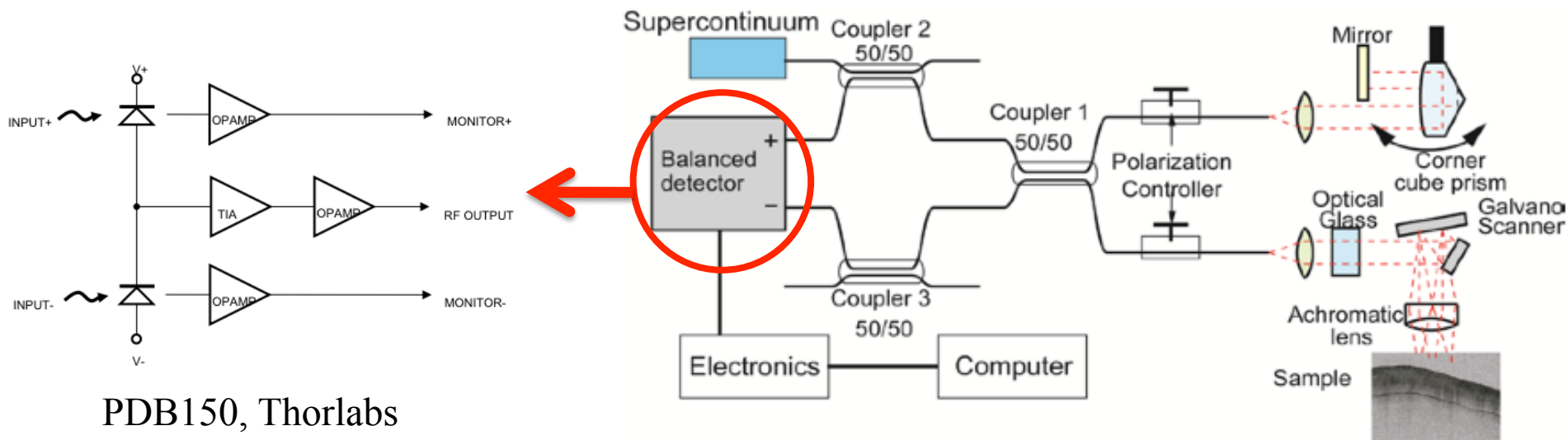$$k_s = a\lambda^{-4}$$

$a = 1$ $a = 100$ $a = 1/100$
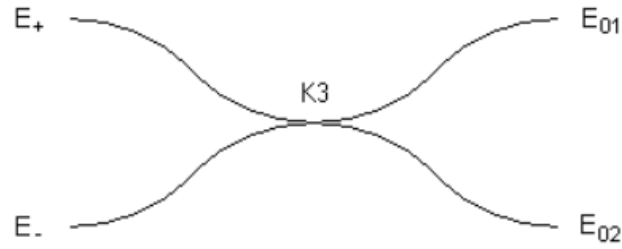
k_s: scattering coefficient
n: particle number
m: refractive coefficient
d: particle diameter
λ: wavelength

A balanced detection

PDB150, Thorlabs

Common-mode Noise

$$\mathbf{E}_+ = \frac{1}{\sqrt{2}}(\mathbf{E}_{01}e^{-i\omega t} + \mathbf{E}_{02}e^{-i\omega t - \frac{\pi}{2}i})$$

$$\mathbf{E}_- = \frac{1}{\sqrt{2}}(\mathbf{E}_{01}e^{-i\omega t - \frac{\pi}{2}i} + \mathbf{E}_{02}e^{-i\omega t})$$

$$
\begin{aligned}
I_+ &= \left\langle |\mathbf{E}_+|^2 \right\rangle = \frac{1}{2}\left\langle (|\mathbf{E}_{01}|^2 + |\mathbf{E}_{02}|^2 + \mathbf{E}_{01}\mathbf{E}_{02}^* e^{-i\omega t}e^{i\omega t}e^{\frac{\pi}{2}i} + \mathbf{E}_{01}^*\mathbf{E}_{02}e^{i\omega t}e^{-i\omega t}e^{-\frac{\pi}{2}i}) \right\rangle \\
&= \frac{1}{2}\left\langle (|\mathbf{E}_{01}|^2 + |\mathbf{E}_{02}|^2 + \mathbf{E}_{01}\mathbf{E}_{02}^* e^{\frac{\pi}{2}i} + \mathbf{E}_{01}^*\mathbf{E}_{02}e^{-\frac{\pi}{2}i}) \right\rangle \\
I_- &= \left\langle |\mathbf{E}_-|^2 \right\rangle = \frac{1}{2}\left\langle (|\mathbf{E}_{01}|^2 + |\mathbf{E}_{02}|^2 + \mathbf{E}_{01}\mathbf{E}_{02}^* e^{i\omega t}e^{-i\omega t}e^{-\frac{\pi}{2}i} + \mathbf{E}_{01}^*\mathbf{E}_{02}e^{-i\omega t}e^{i\omega t}e^{\frac{\pi}{2}i}) \right\rangle \\
&= \frac{1}{2}\left\langle (|\mathbf{E}_{01}|^2 + |\mathbf{E}_{02}|^2 + \mathbf{E}_{01}\mathbf{E}_{02}^* e^{-\frac{\pi}{2}i} + \mathbf{E}_{01}^*\mathbf{E}_{02}e^{\frac{\pi}{2}i}) \right\rangle
\end{aligned}
$$

$$
\begin{aligned}
I_+ - I_- &= \frac{1}{2}\left\langle \mathbf{E}_{01}\mathbf{E}_{02}^*(e^{\frac{\pi}{2}i} - e^{-\frac{\pi}{2}i}) - \mathbf{E}_{01}^*\mathbf{E}_{02}(e^{\frac{\pi}{2}i} - e^{-\frac{\pi}{2}i}) \right\rangle \\
&= i\left\langle (\mathbf{E}_{01}\mathbf{E}_{02}^* - \mathbf{E}_{01}^*\mathbf{E}_{02}) \right\rangle
\end{aligned}
$$

Sonication

· To clean the samples
· To penetrate the solution

Murray solution

refractive index close to that of dentin
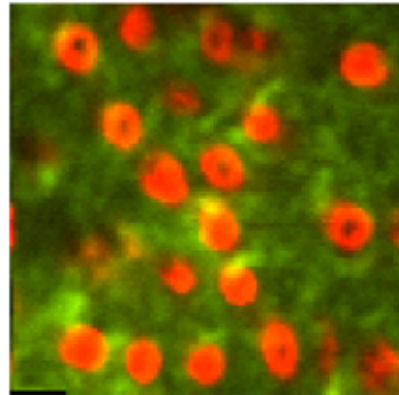it penetrates into the lumen of the tubules
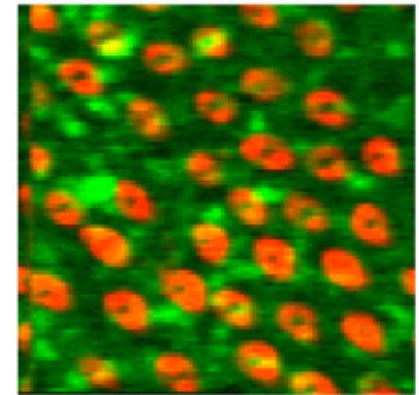↓
The dentin becomes nearly transparent

HBSS solution

only the dental part which is constructed
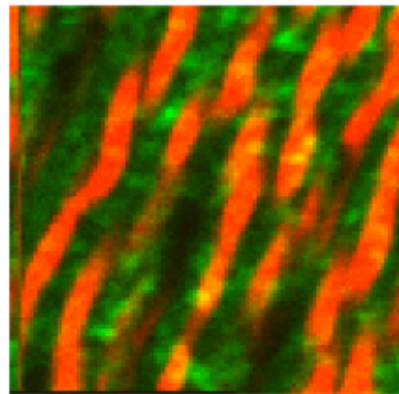from tubules perpendicular to the section
surface is transparent.

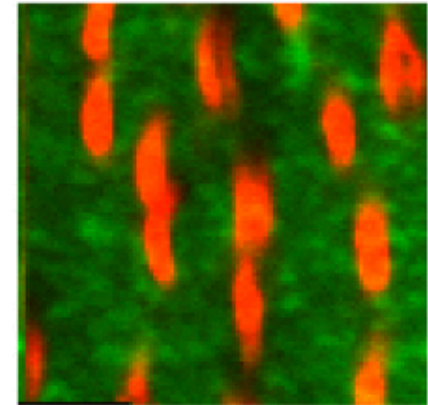

(a) – Deep root dentin (section A)

(b) – Deep crown dentin (section C)

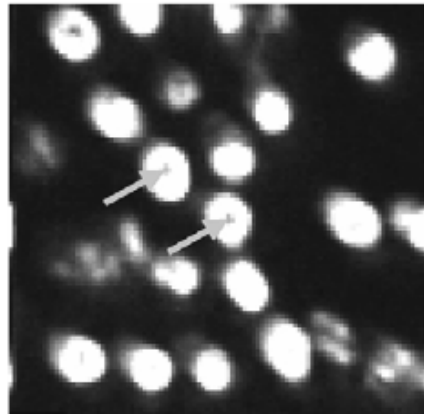(c) – Shallow crown dentin (section C)
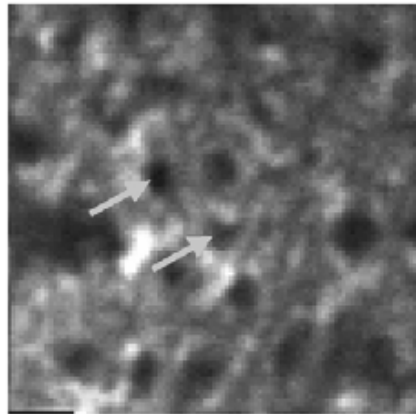
(d) – Shallow crown dentin (section D)

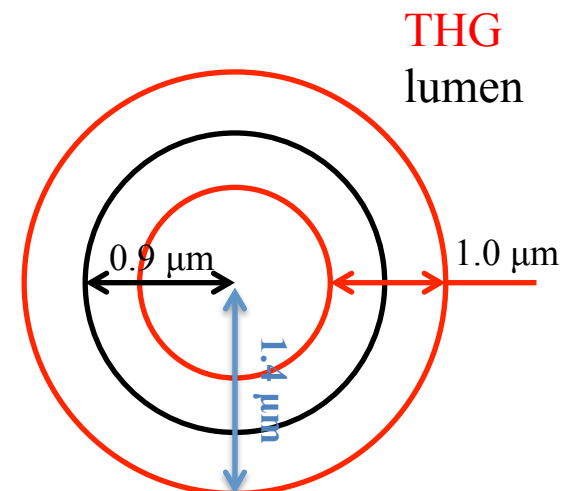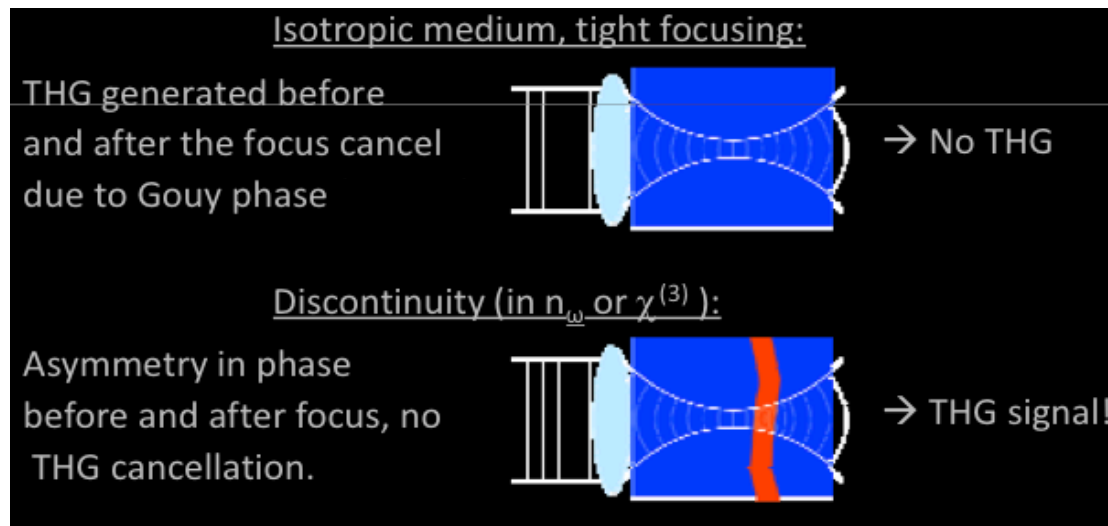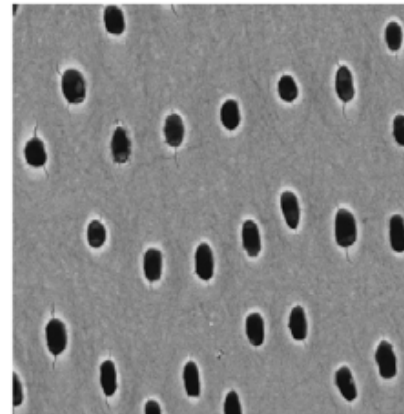# Why doesn't THG generate from interface of PTD and ITD?
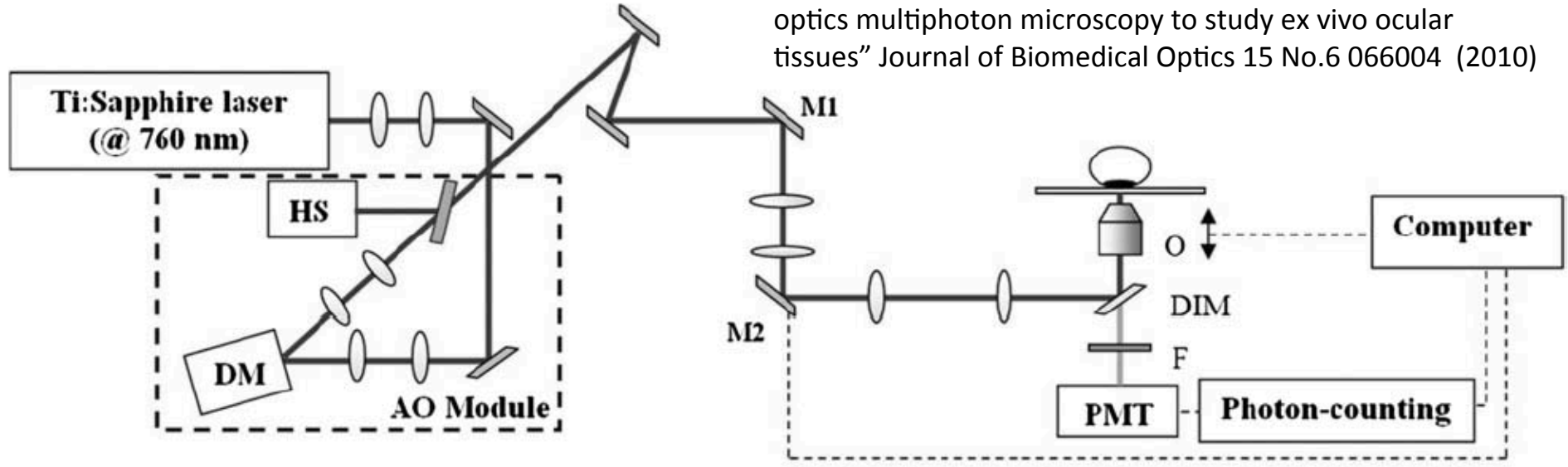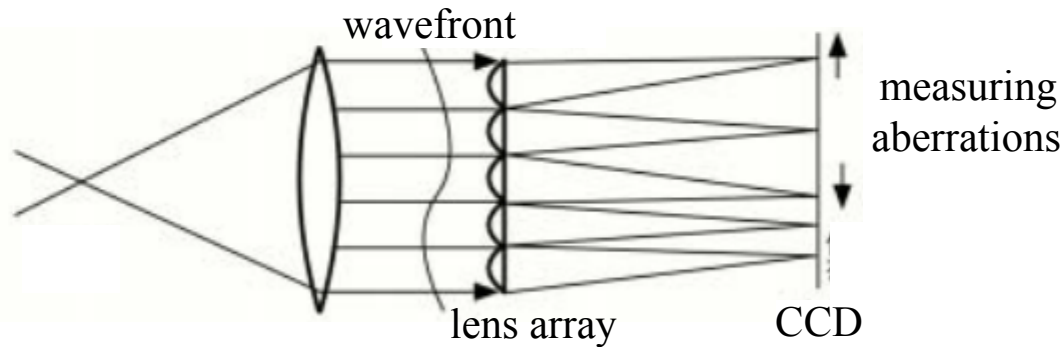

(a) – THG micrograph

(b) – SHG micrograph

(c) – ESEM micrograph

Isotropic medium, tight focusing:

THG generated before and after the focus cancel due to Gouy phase → No THG

Discontinuity (in n_ω or $\chi^{(3)}$):

Asymmetry in phase before and after focus, no THG cancellation. → THG signal!

THG lumen

0.9 μm   1.0 μm

1.4 μm

The position of deformable mirror

Hartmann-Shack (HS) wavefront sensor

deformable mirror