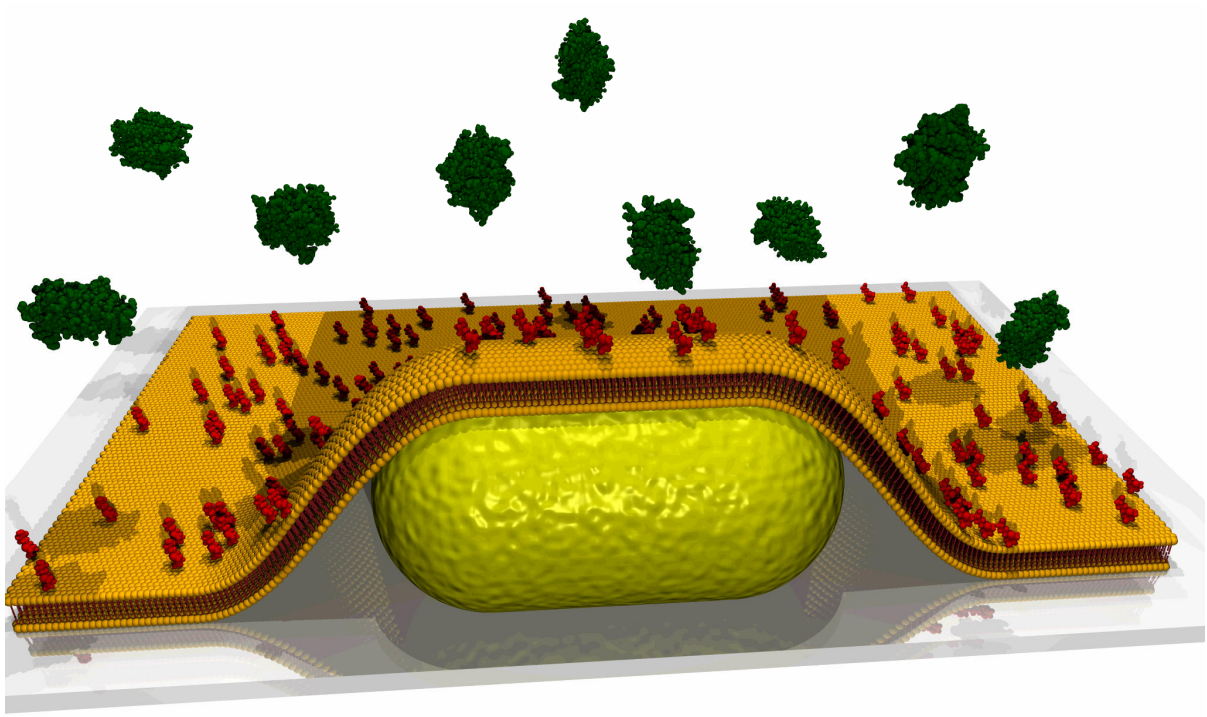
Protein–Membrane Interaction Probed by Single Plasmonic Nanoparticles



Jan Becker – Ultrafast Nanooptics (Bad Honnef 2008)

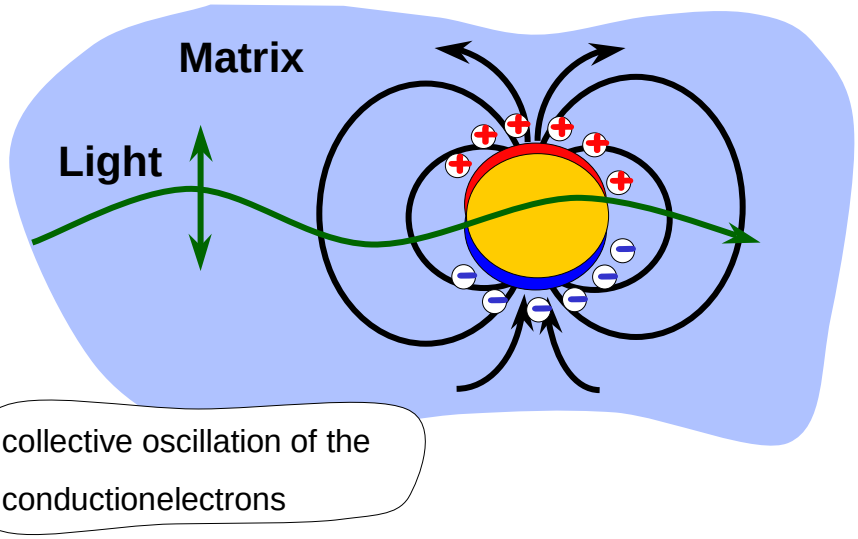
JOHANNES GUTENBERG UNIVERSITÄT MAINZ

nanobiotechnology group
INSTITUTE FOR PHYSICAL CHEMISTRY

Outlook

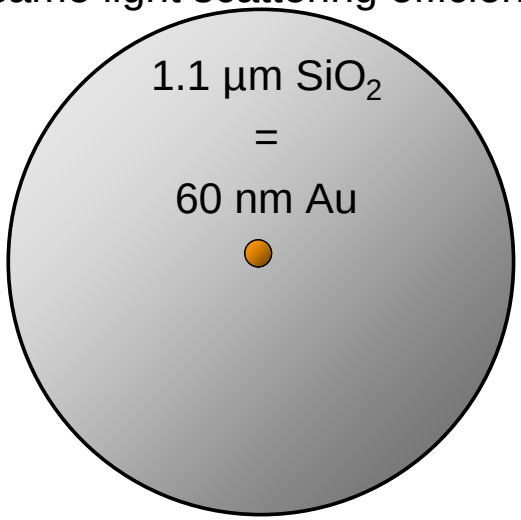
- Introduction to plasmonic particles
- Darkfield-Microscopy and the novel fastSPS setup
- Protein-Membrane interaction
- Conclusions

Plasmons scatter light strongly



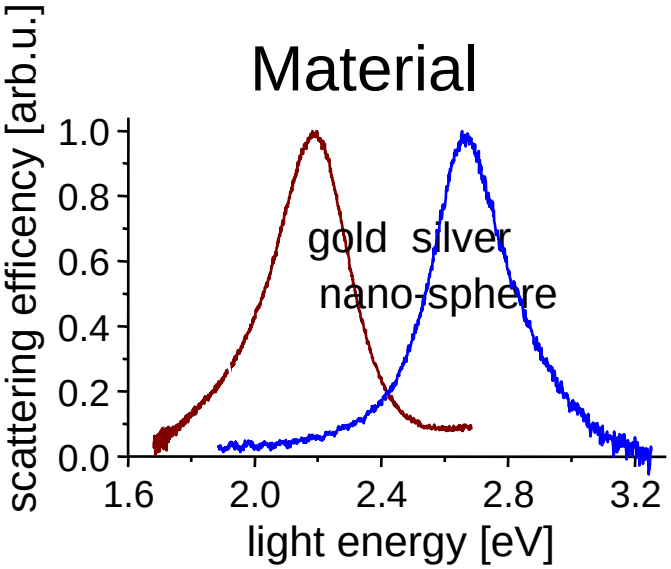
collective oscillation of the conductionelectrons

same light scattering efficiency

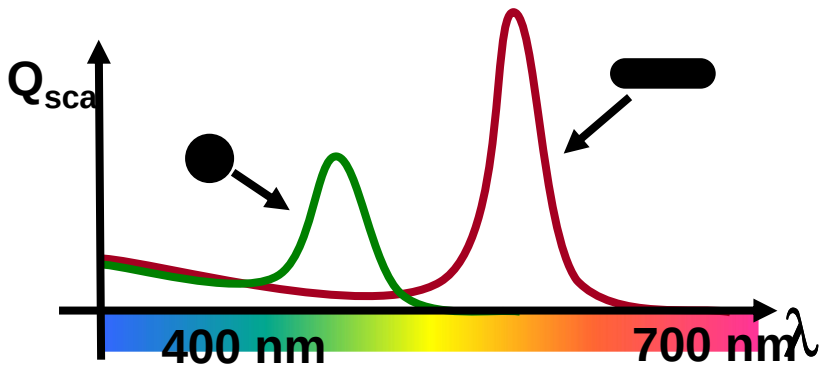


Resonance Wavelength depends on:

Material

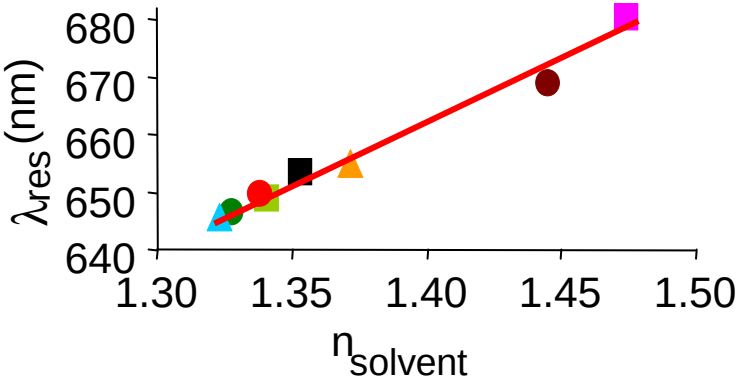


Shape



Interparticle spacing

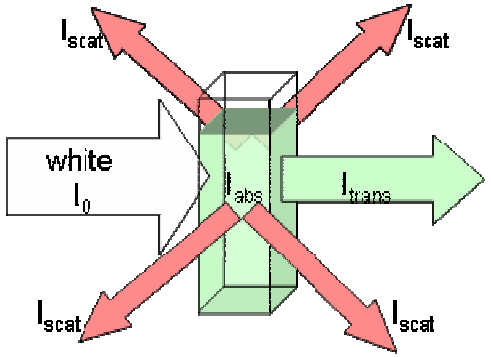
Surrounding refractive index



Transmitted vs. Scattered Light

Transmitted light

(Back)-Scattered light



Transmitted light has complementary color to scattered light

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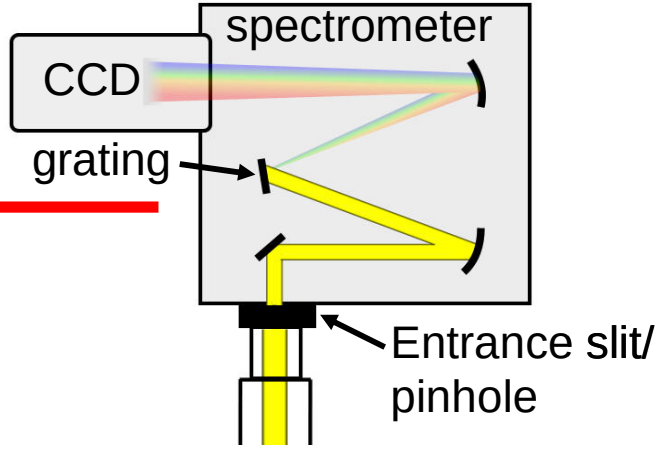
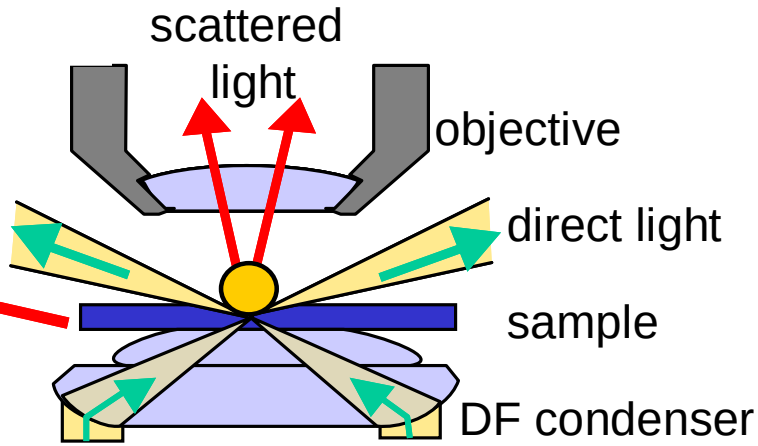
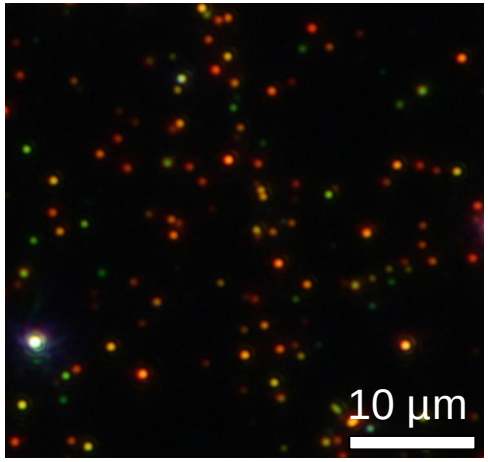
Darkfield Microscopy

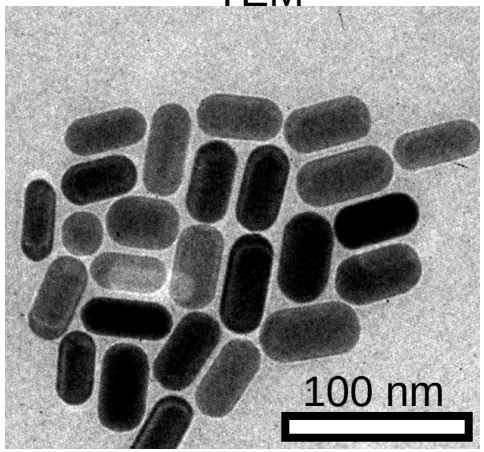




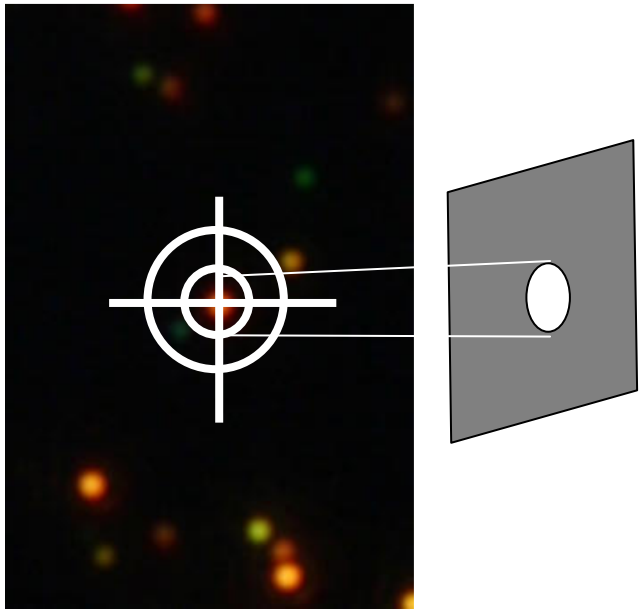
Real color image



TEM

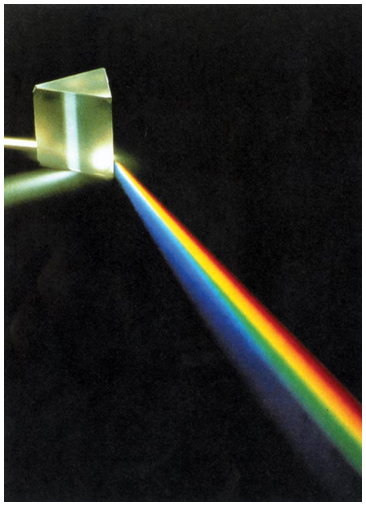


Conventional Method to Measure Single-Particle Spectra

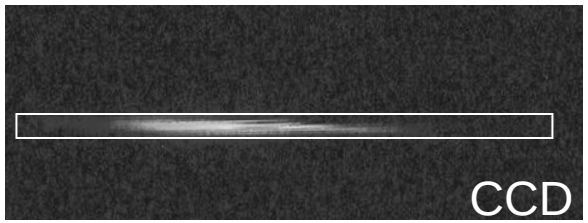


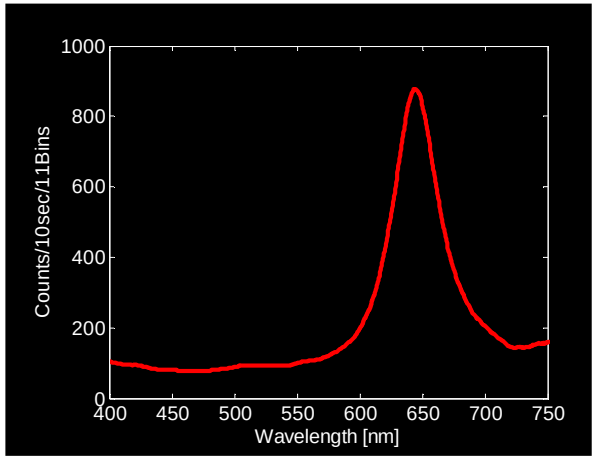
Select one particle

Disperse light



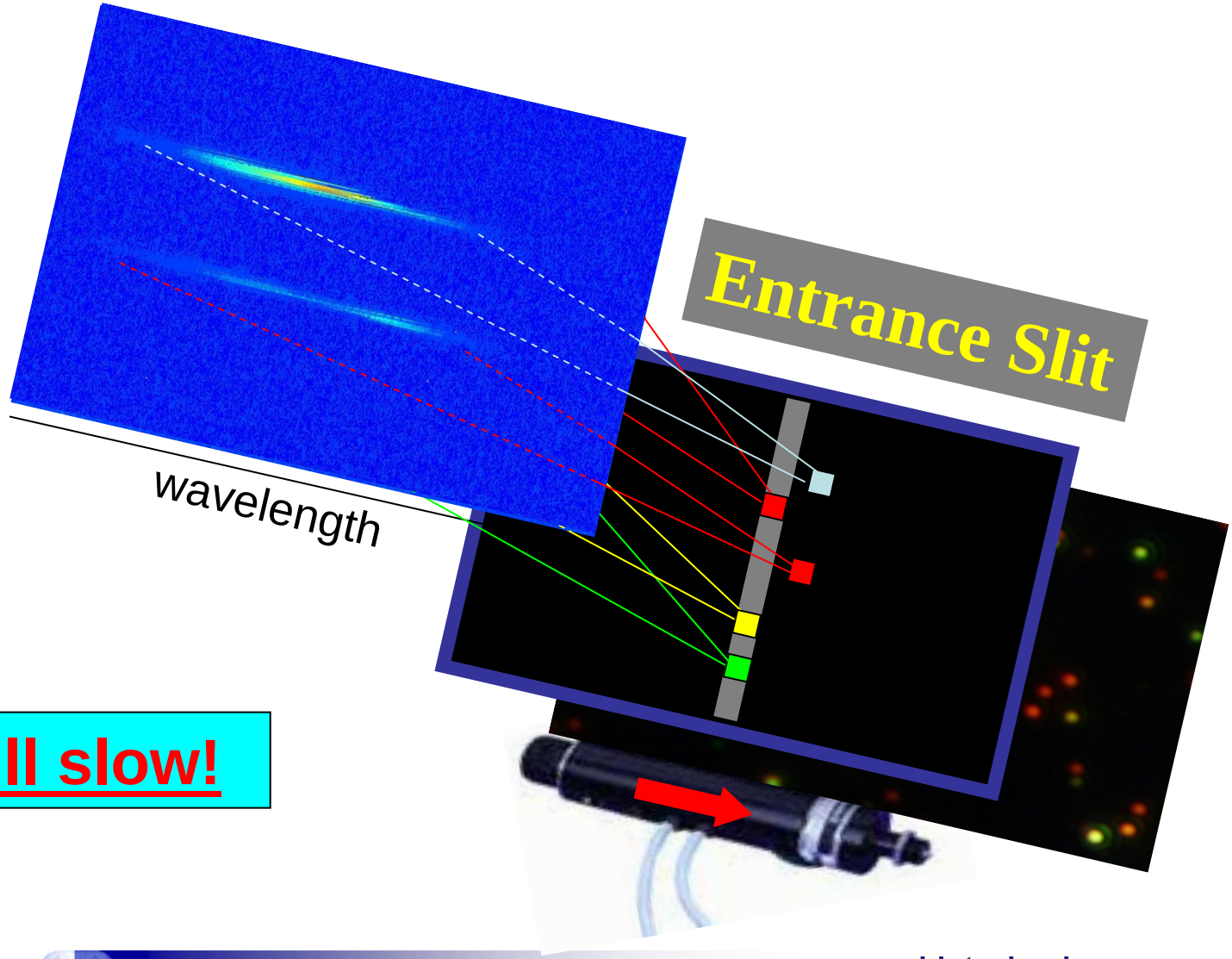
Capture the spectrum





serial process ➔ very slow!

The Scanning Method

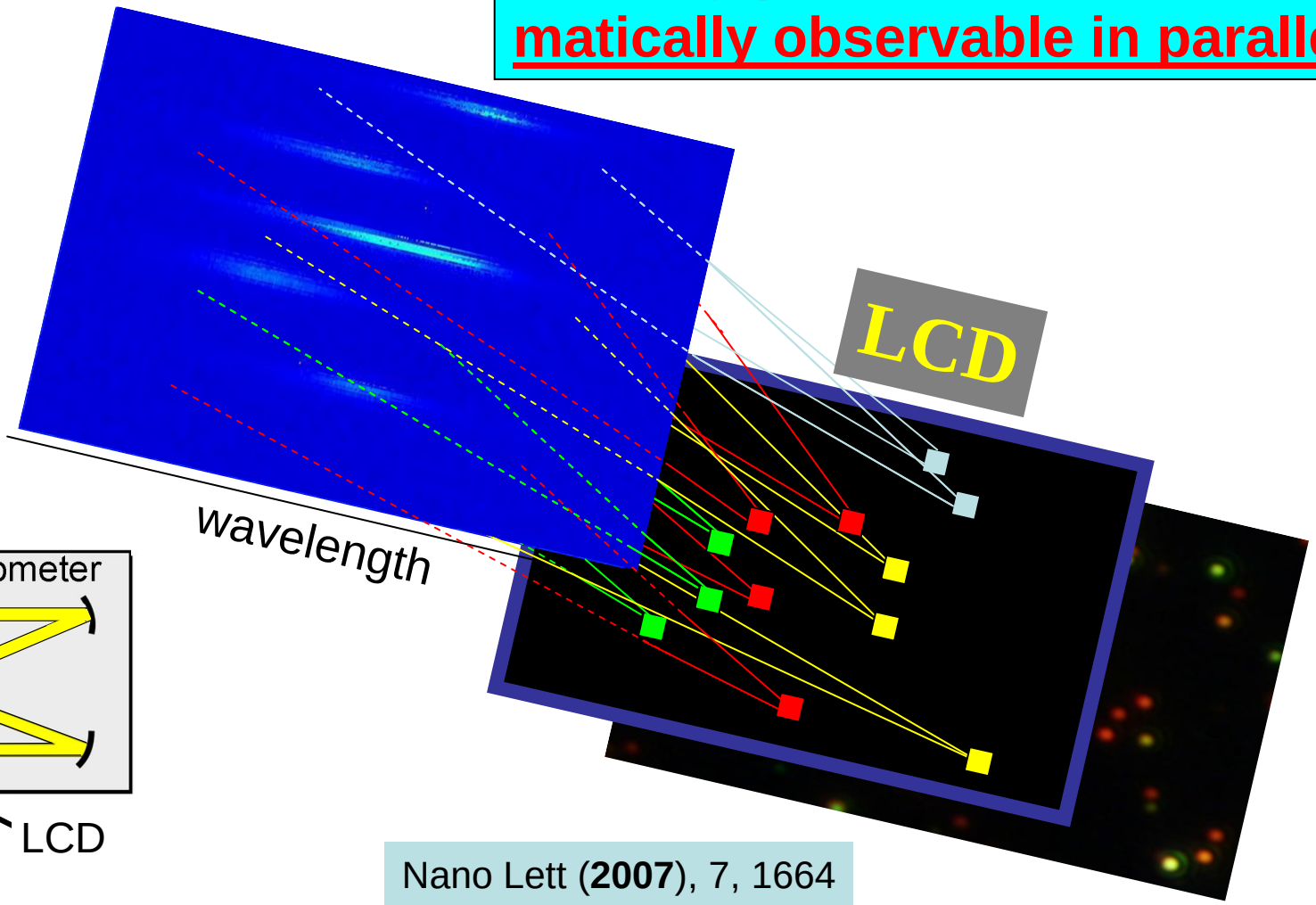


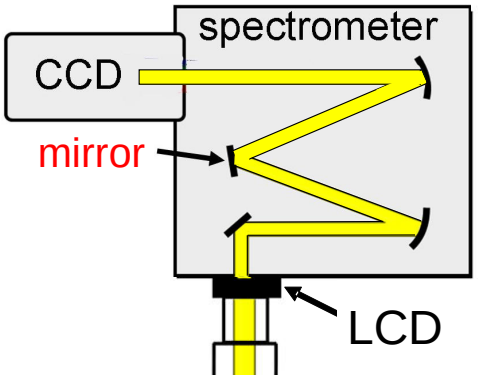
➔ still slow!

The fastSPS Method

fastSPS: fast Single Particle Spectroscopy

➔ many particles auto-matically observable in parallel





Nano Lett (**2007**), 7, 1664

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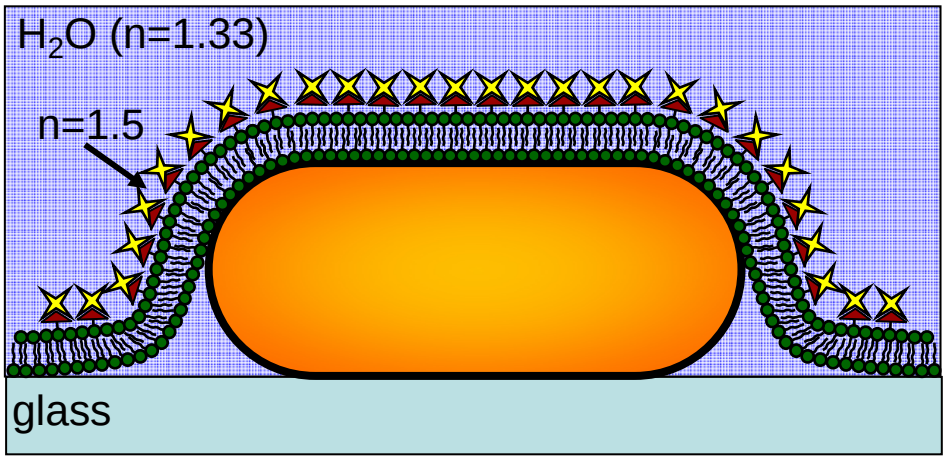
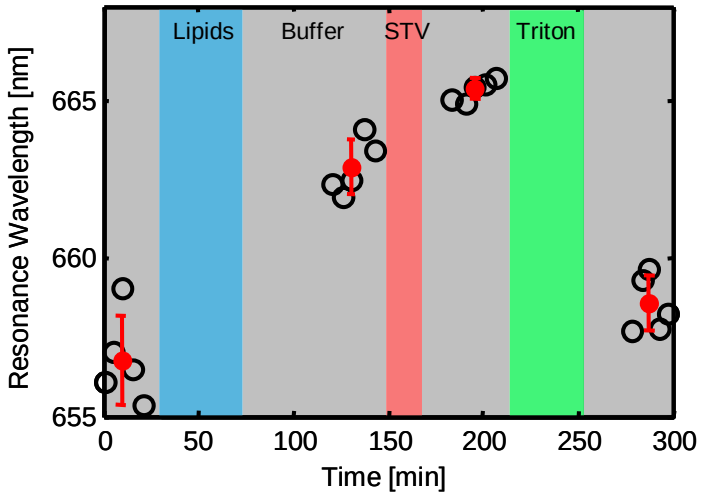
Au rods as Biosensor for Protein Binding

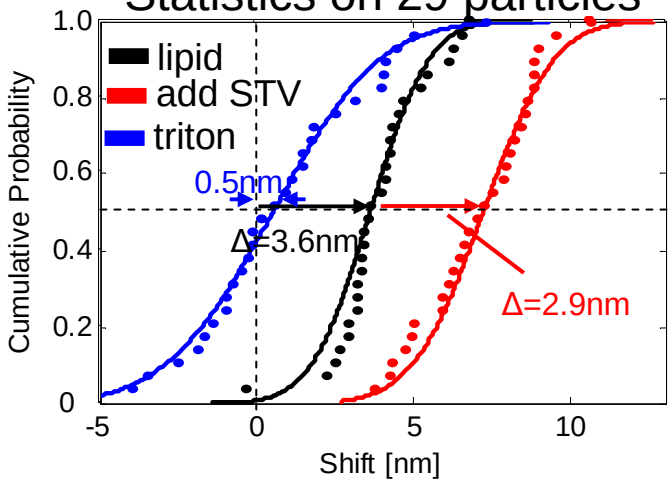
Au rods coated with a biotinated lipid bilayer



Single particle spectra:



Statistics on 29 particles



➢ Membrane and protein binding can be detected by shift in resonance wavelength

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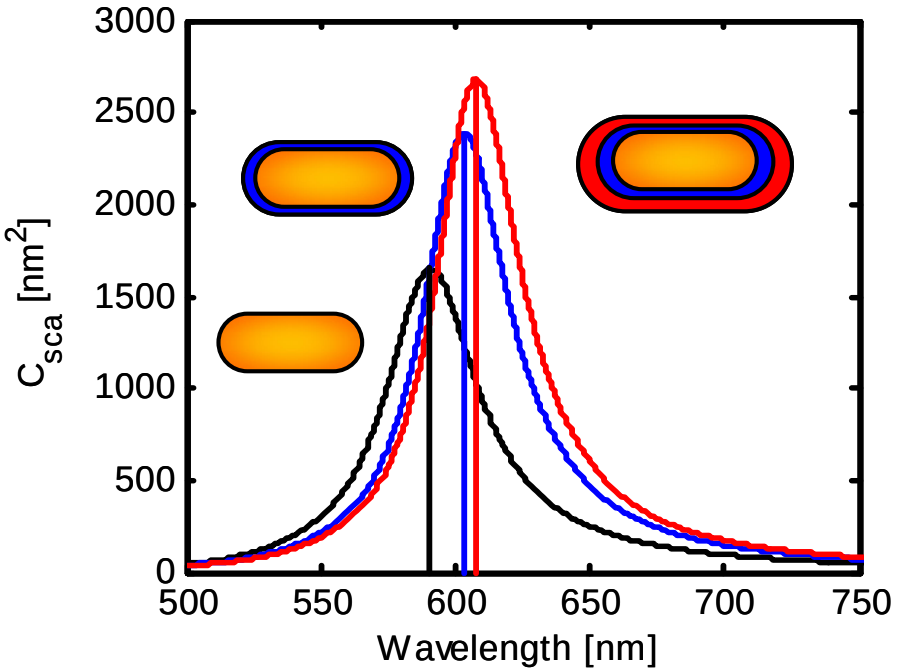
Theoretical Calculations

Scattering spectra calculated using quasi-static approximation



1. Shell of 4 nm thick layer with n=1.5 (≙membrane) leads to:
   Δ = 15nm

2. Second shell (2.3 nm thickness, n=1.5 ≙streptavidin) leads to:
   Δ = 5.8nm

Measurement

Membrane	Streptavidin
Δ = 3.6 nm	Δ = 2.9 nm

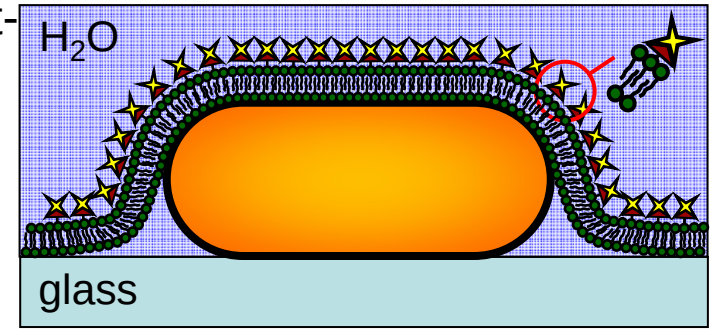
Difference to measured value:

- In experiment only half of the rod is coated
- In experiment a small water layer is between membrane and goldrod

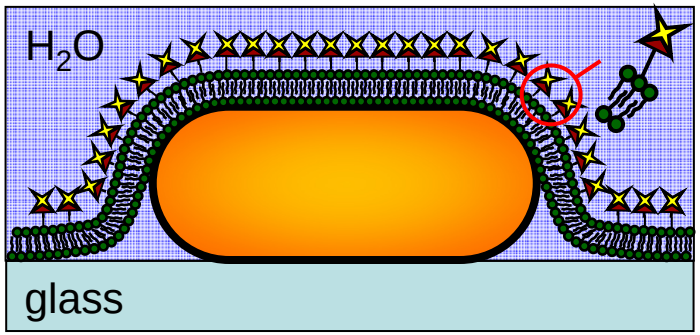
Different Types of Lipid Bilayer

Shift due to strept-avidin binding:

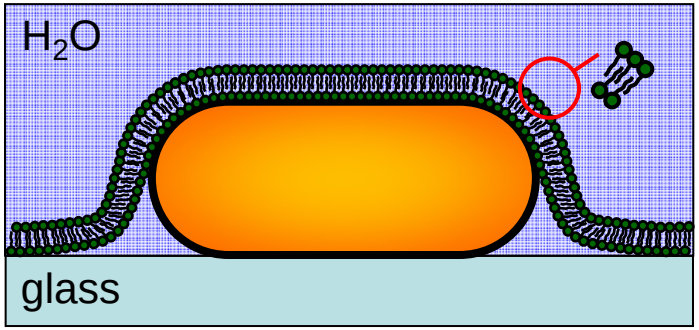
Incl. biotin:
Δ=5.3 ± 3.1nm

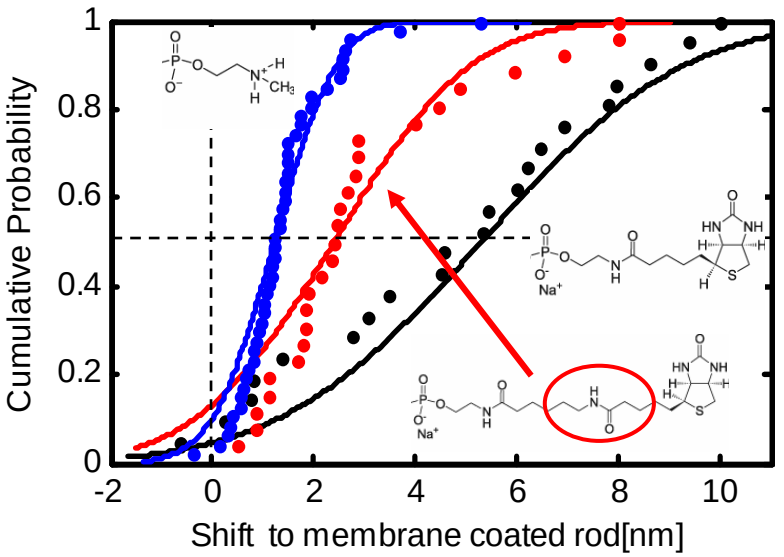


Incl. spacer
Δ=2.4 ± 2.1nm



No biotin
Δ=1.2 ± 1.0nm





- Attaching Streptavidin via a spacer results in a smaller spectral shift
- Membrane coating suppress unwanted nonspecific interactions

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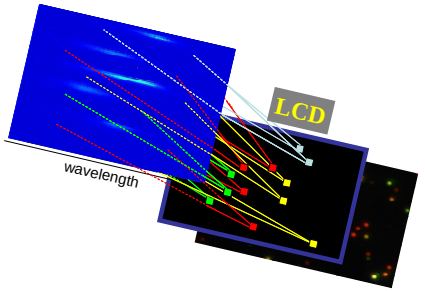
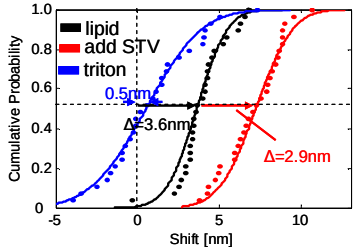
Conclusions

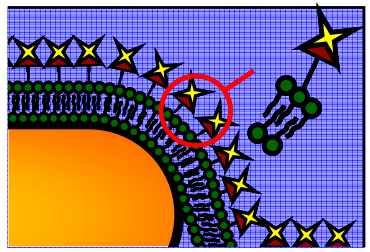
- fastSPS allows continuous observation of many (up to 30) nano-particles in parallel



- Membrane and protein binding can be detected by shift in resonance wavelength of single nanorods



- Due to high functionalizability of membranes (plenty with different headgroups available) this is an ideal characterization tool for biomolecules



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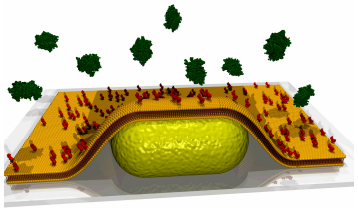

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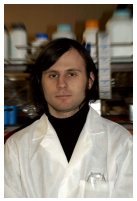
Y. Khalavka 

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