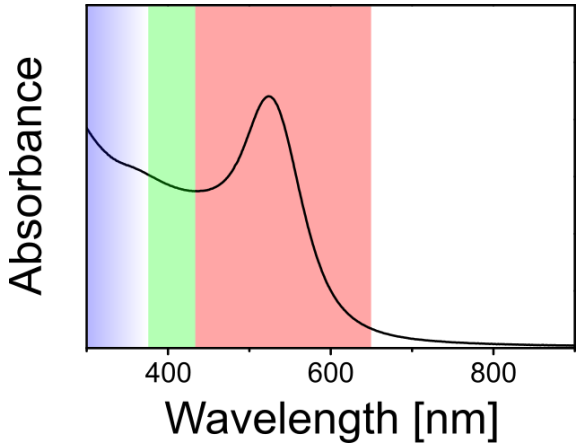
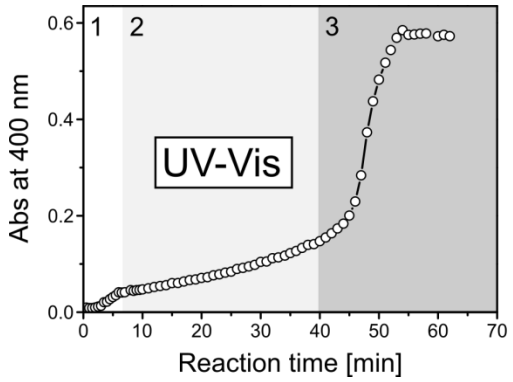
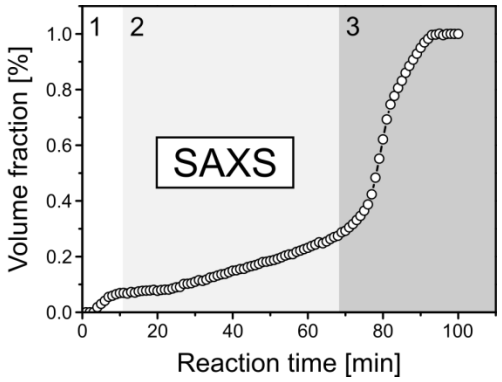
Thomas Hendel (CFM San Sebastián)

In Situ Determination of Colloidal Gold Concentrations with UV–Vis Spectroscopy: Limitations and Perspectives







T. Hendel et al., *Anal. Chem.*, **2014**, 86(22), 11115

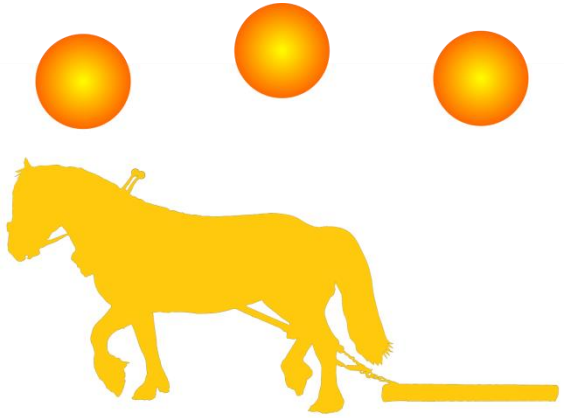
Now and then…

Prof. Yury Rakovich

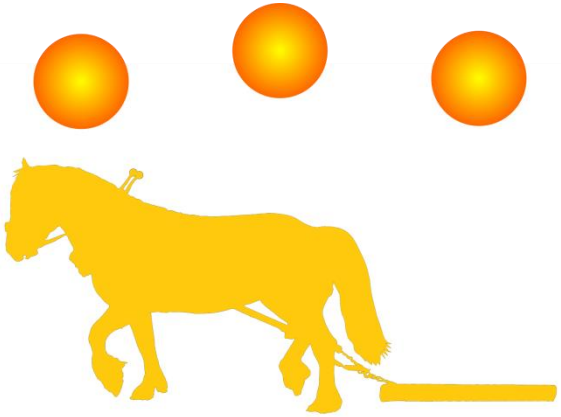
Prof. Klaus Rademann (HU Berlin)

Dr. Jörg Polte (HU Berlin)

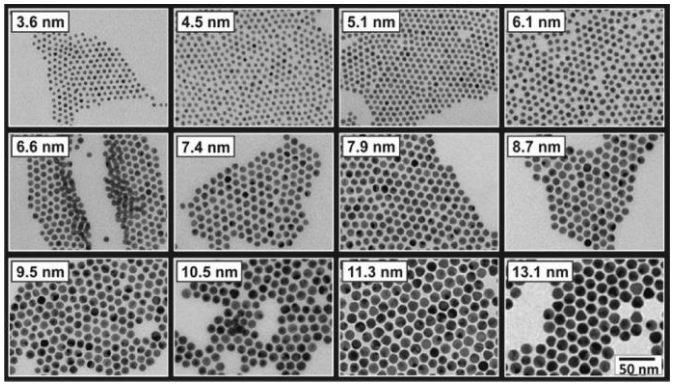
Gold nanoparticles –
The workhorse of nanoscience



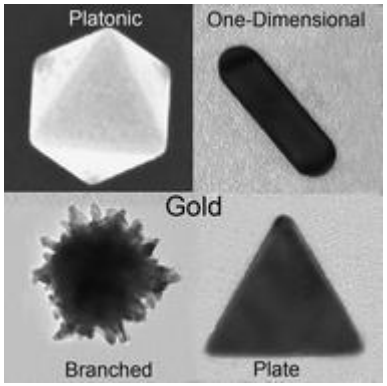
Gold nanoparticles – The workhorse of nanoscience



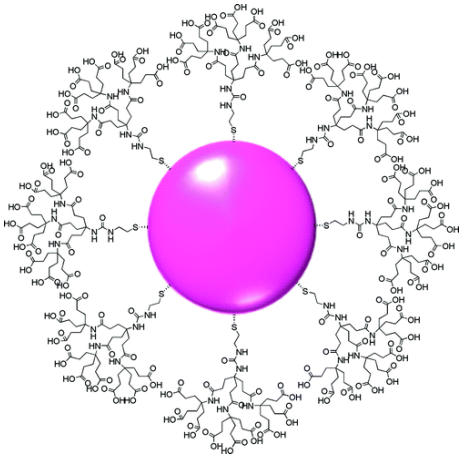
Size



Shape

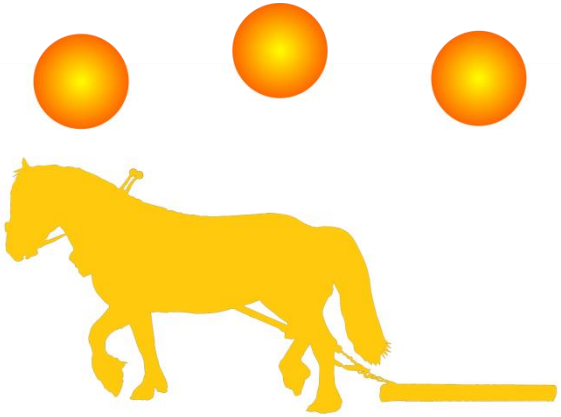


Surface functionality



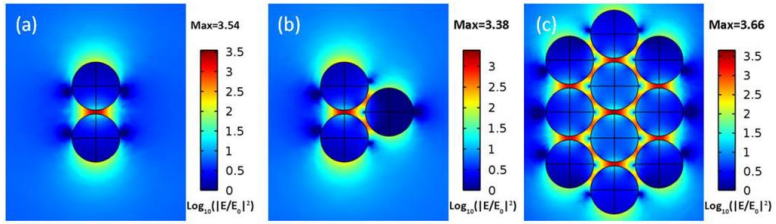
J. Piella et al., *Chem. Mater.*, **2016**, 28, 1066
M. Grzelczak et al., *Chem. Soc. Rev.*, **2008**, 37, 1783
T. J. Cho et al., *Chem. Mater.*, **2011**, 23, 2665

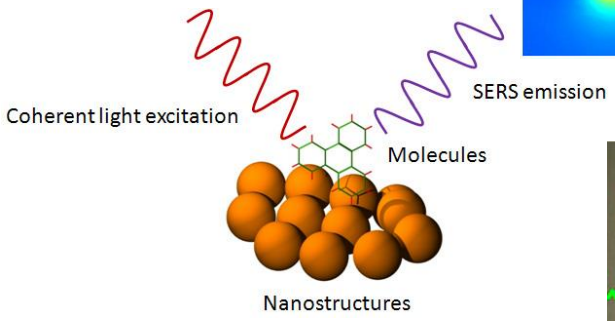
Gold nanoparticles – The workhorse of nanoscience

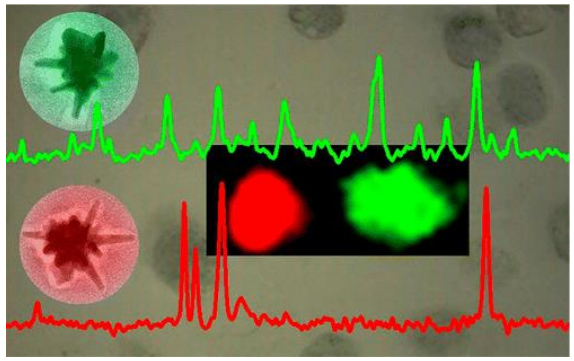


Applied in…

- plasmonics
- SERS
- biomedicine







J. Yang et al., *Photonics* **2014**, 1(4), 380
http://www-personal.umich.edu/~maungk/SERS.html
D. Jimenez de Aberasturi et al., *Chem. Mater.*, **2016**, 28, 6779

Size, morphology, optical properties are well described

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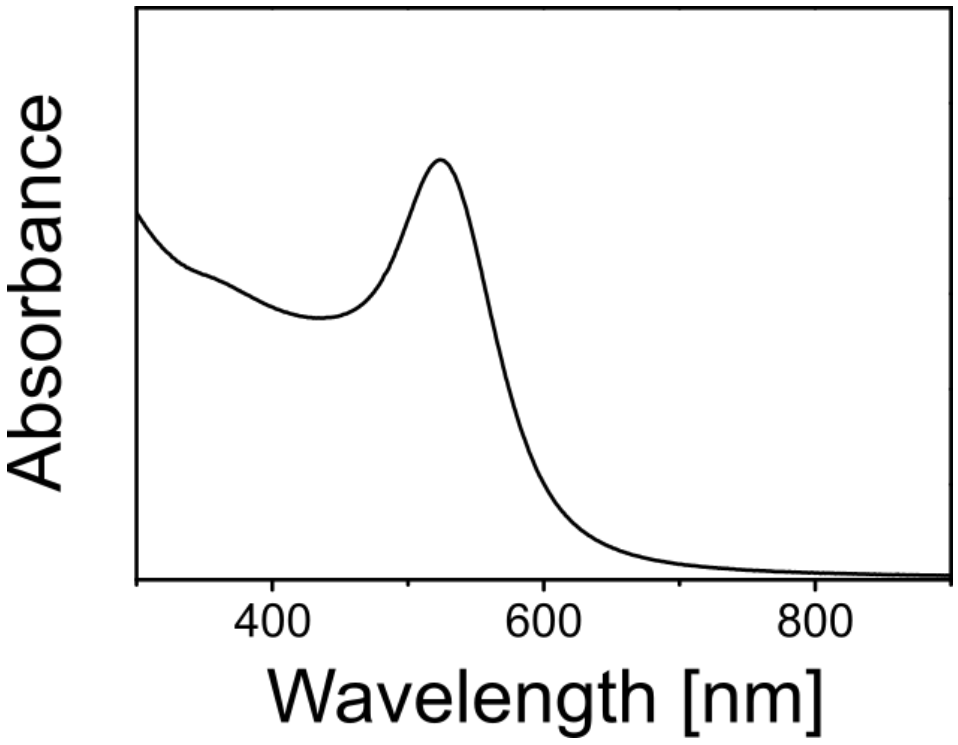
but

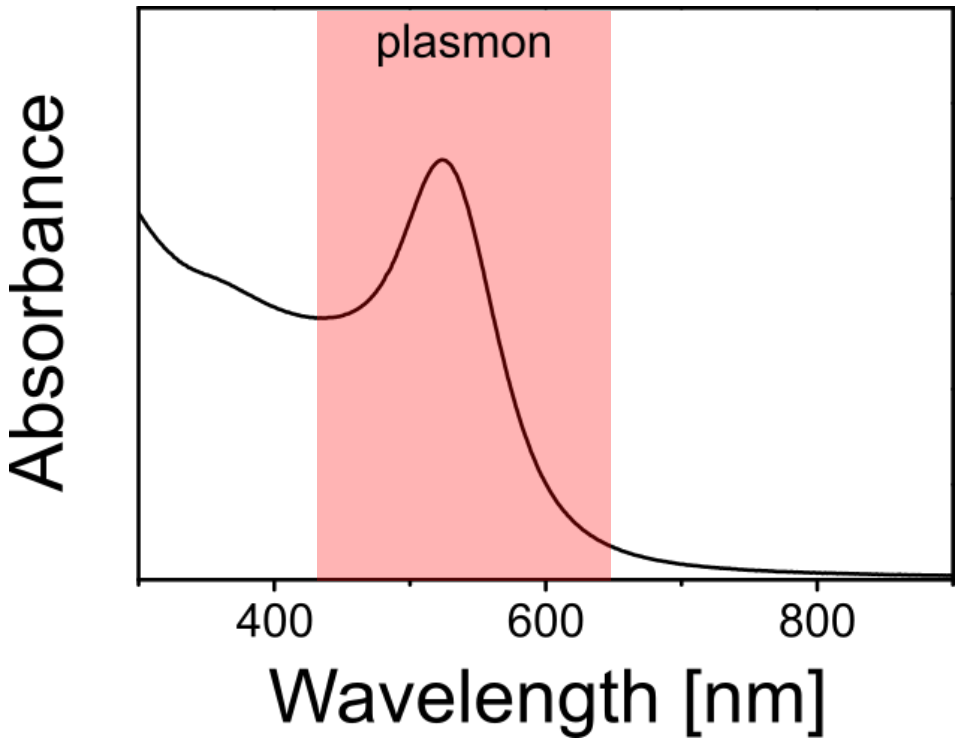
What is the molar concentration of gold in a gold colloid?

How to measure it fast, simply and reliably?

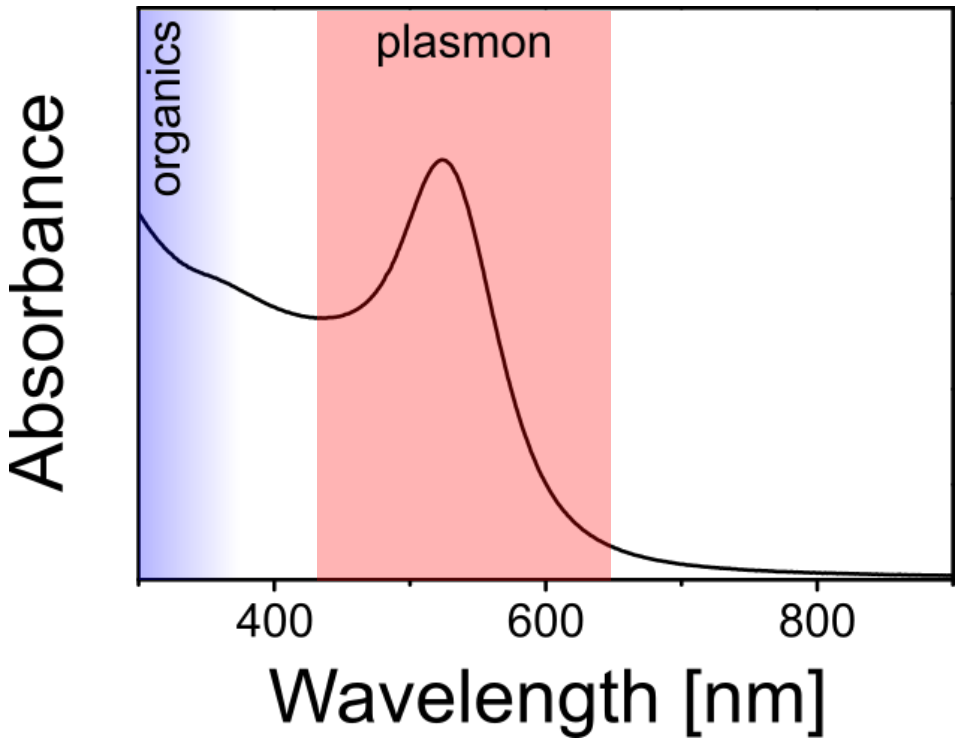
UV-vis spectrum of GNP



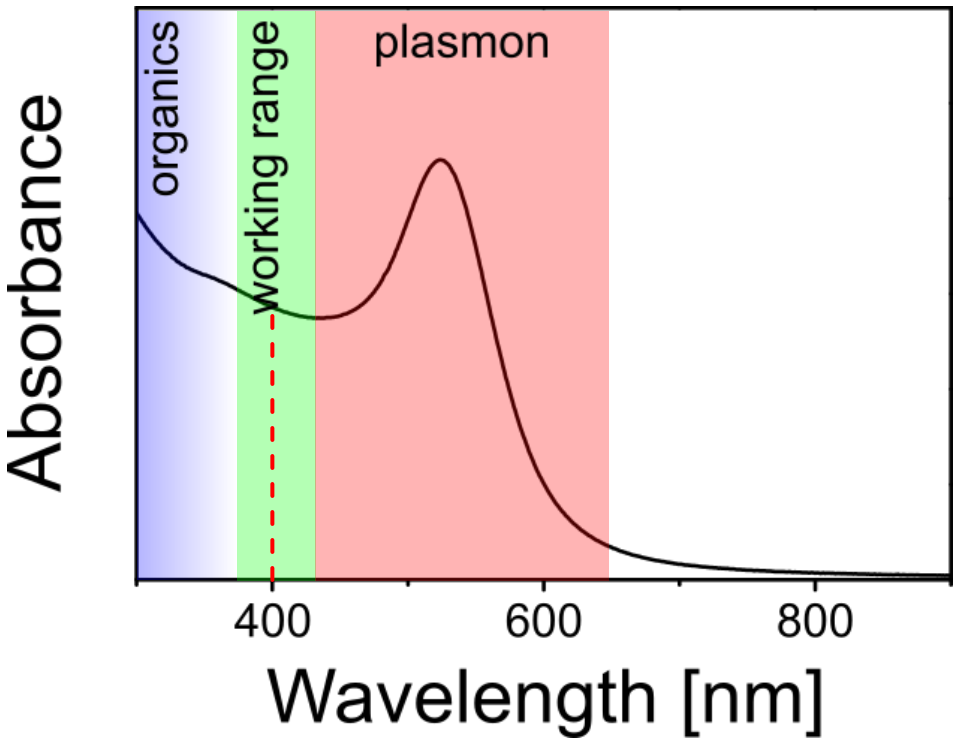
UV-vis spectrum of GNP



UV-vis spectrum of GNP



UV-vis spectrum of GNP



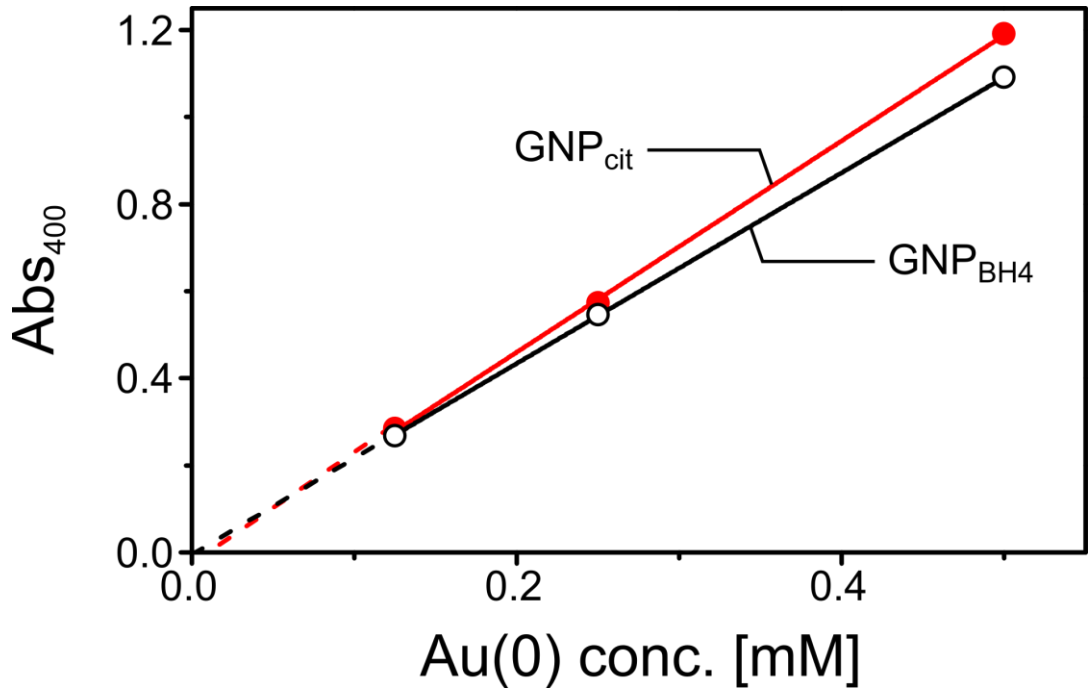
➔ Absorbance at 400 nm (Abs_{400})

as a measure for gold concentration

Proof of principle

➔ two different syntheses ($NaBH_4$ or citrate reduction)

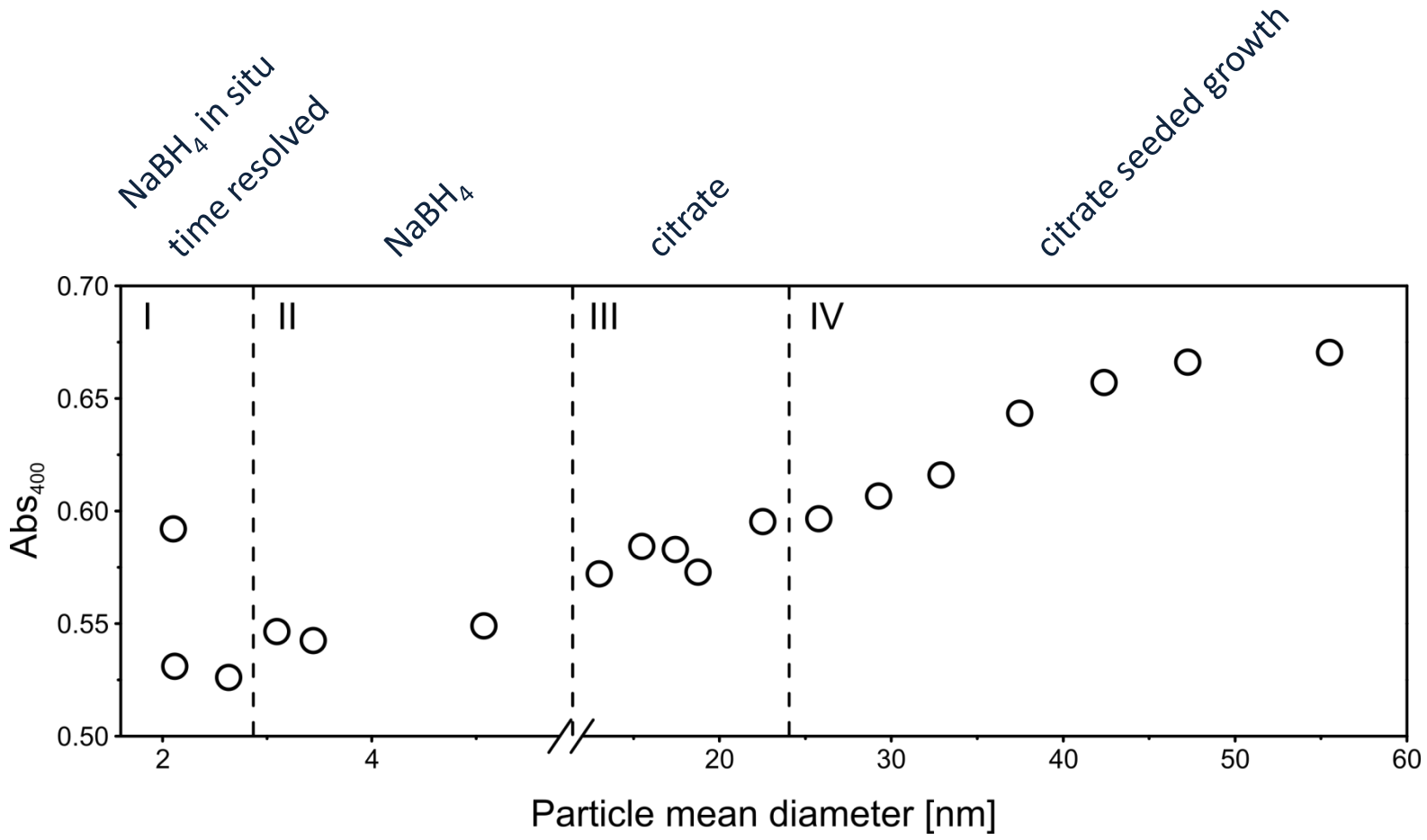
➔ three different concentrations (0.125, 0.25, 0.5 mM)



Influence of particle size

➔ Au(0) concentration 0.25 mM

➔ sizes range from 3 - 55 nm



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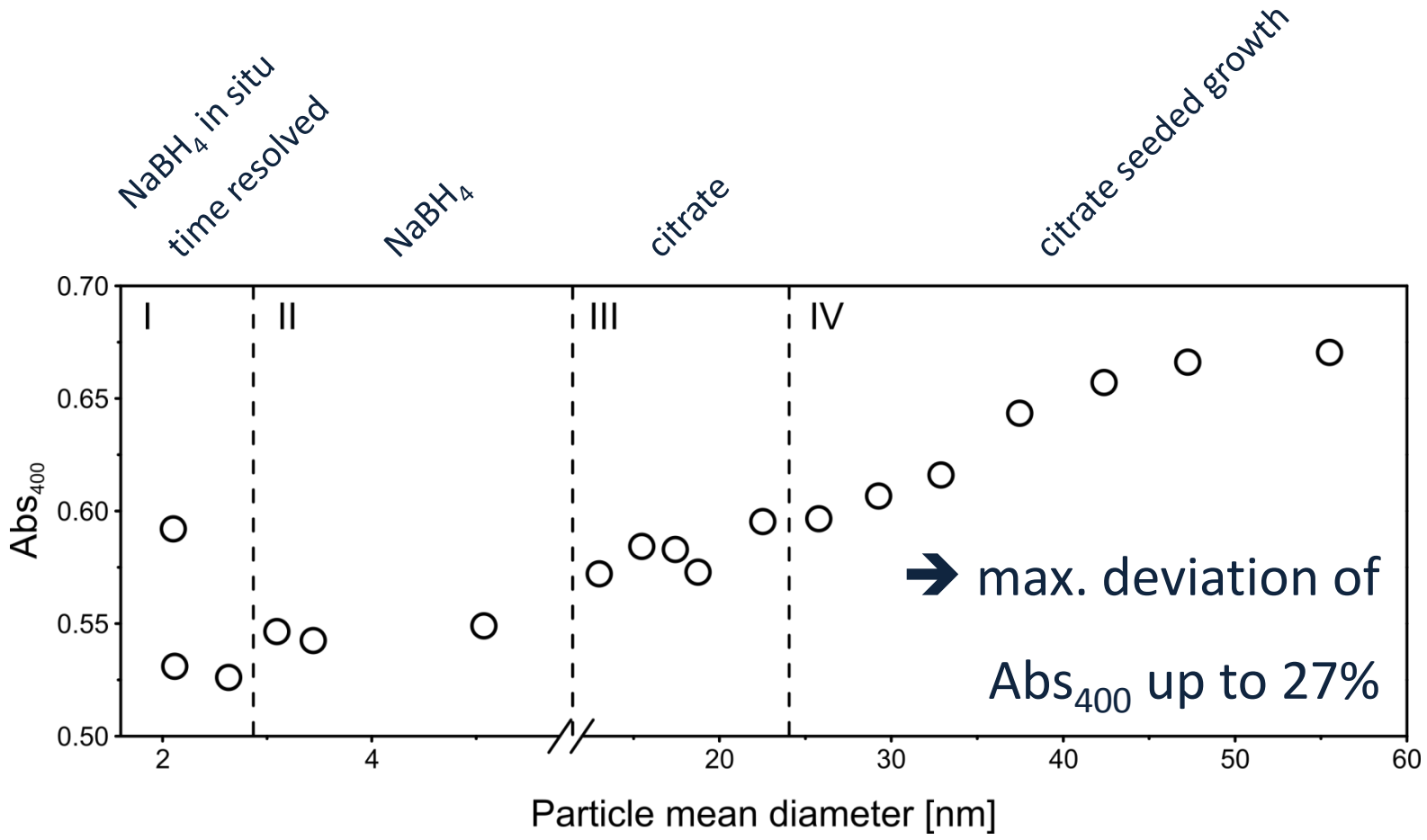
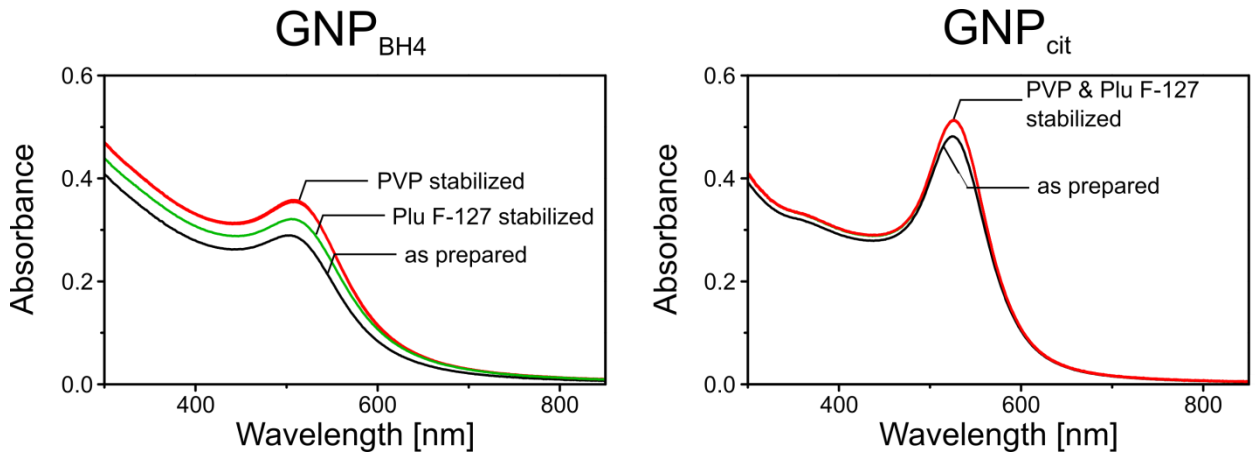


Sterical stabilizers

➔ PVP (different M_W) and Pluronic F-127



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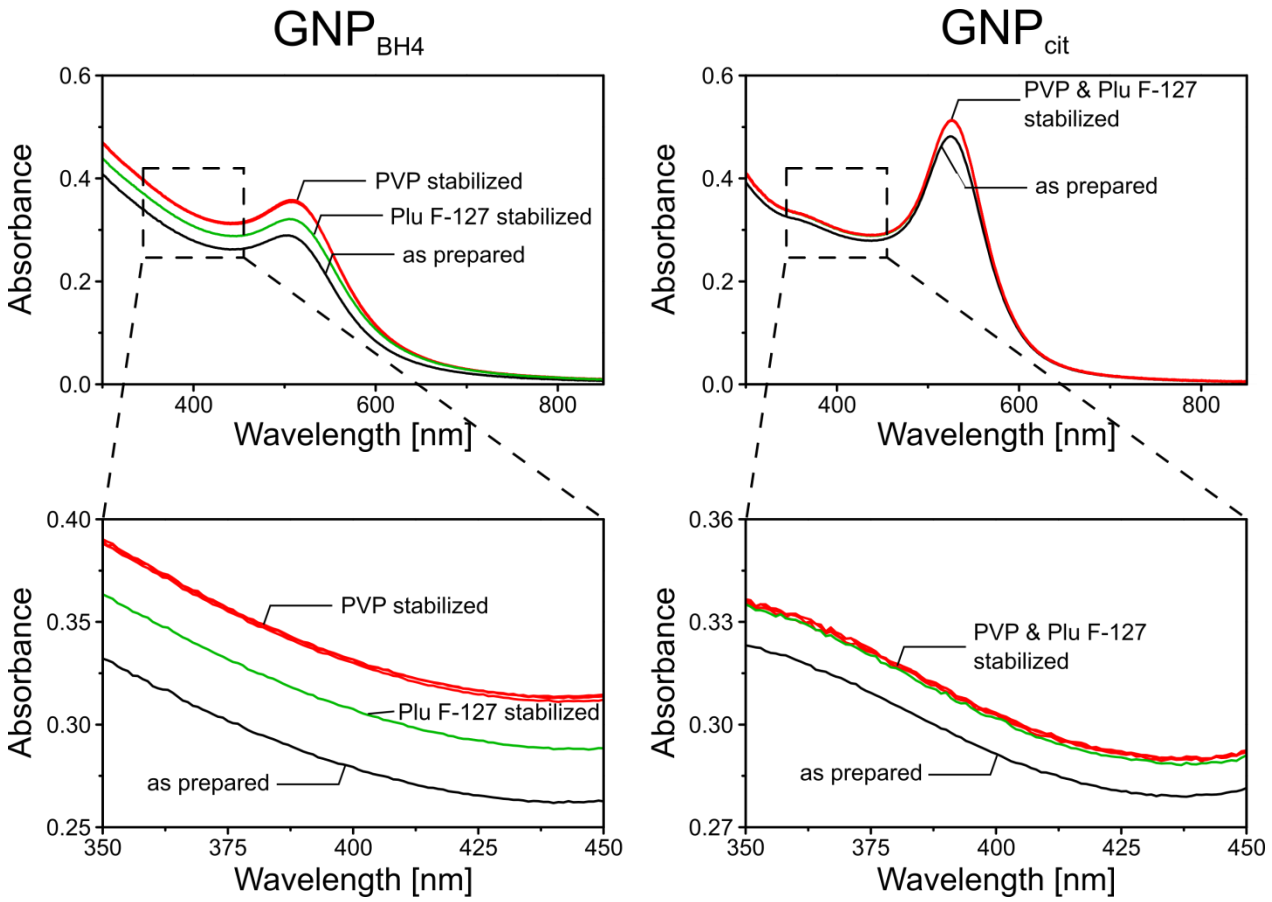

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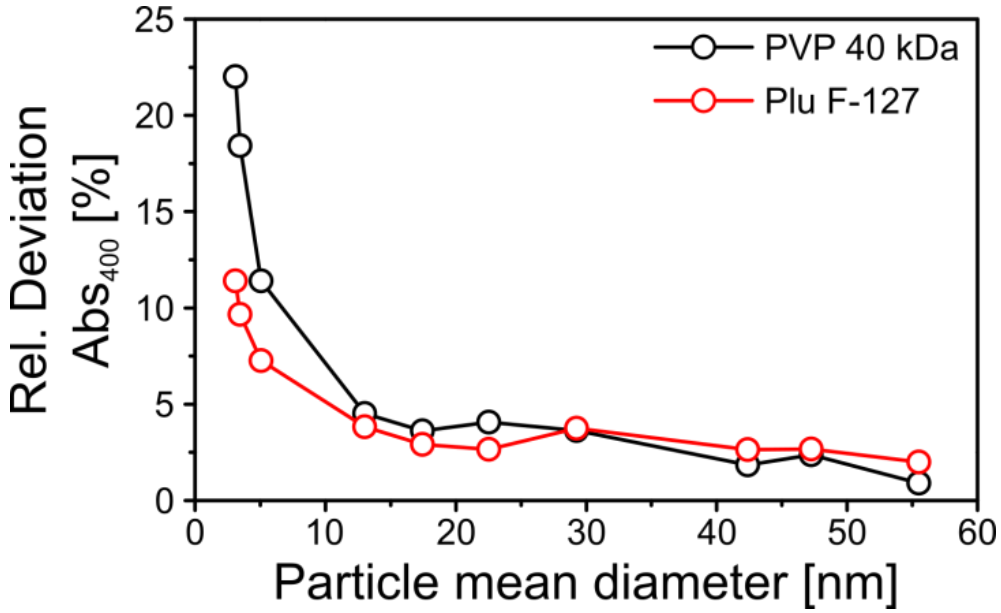


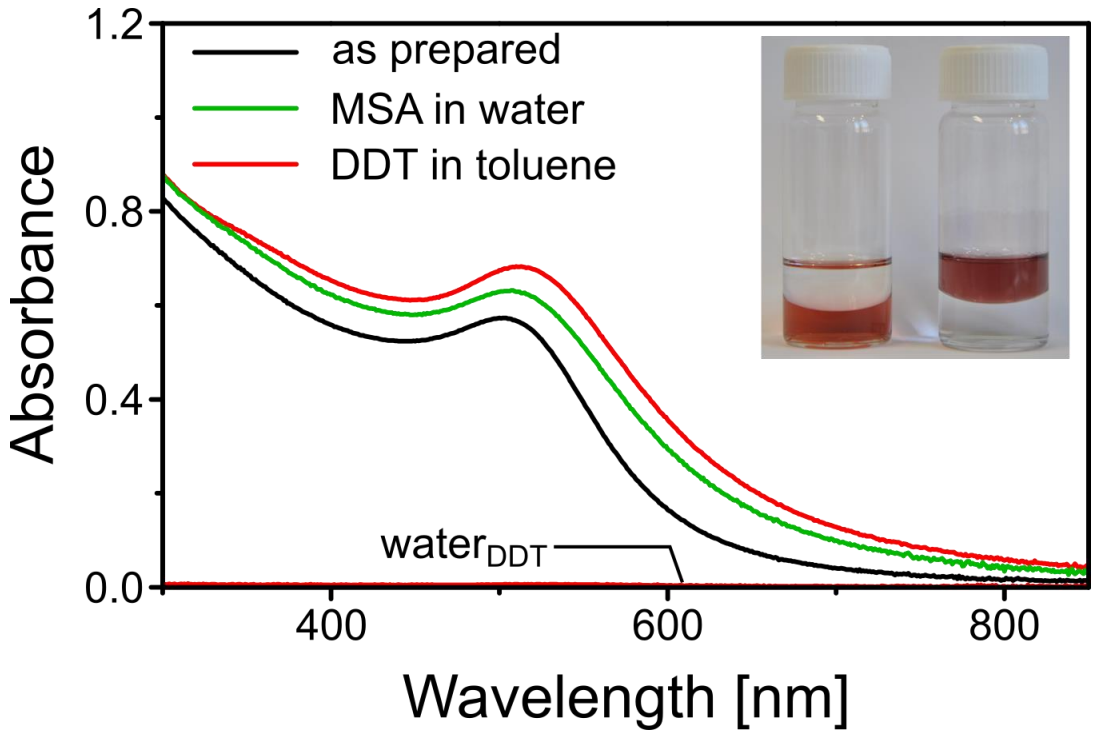
➔ particle sizes constant (SAXS)

➔ deviation of Abs_{400}: 2 - 23%

Thiol stabilization

➔ mercaptosuccinic acid (MSA) and 1-dodecanethiol (DDT)

➔ broadening, damping, red-shift



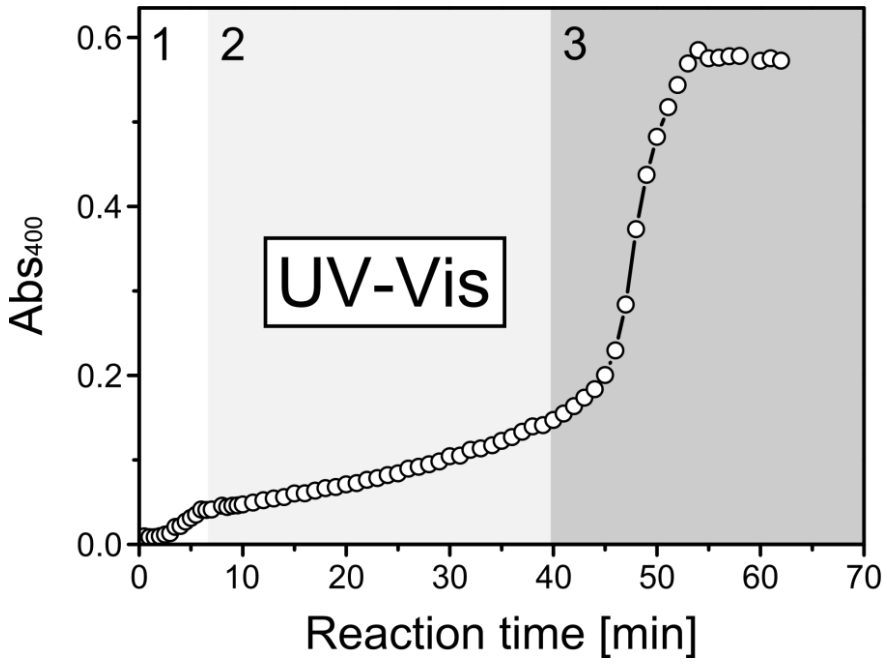
➔ particle sizes constant (SAXS)

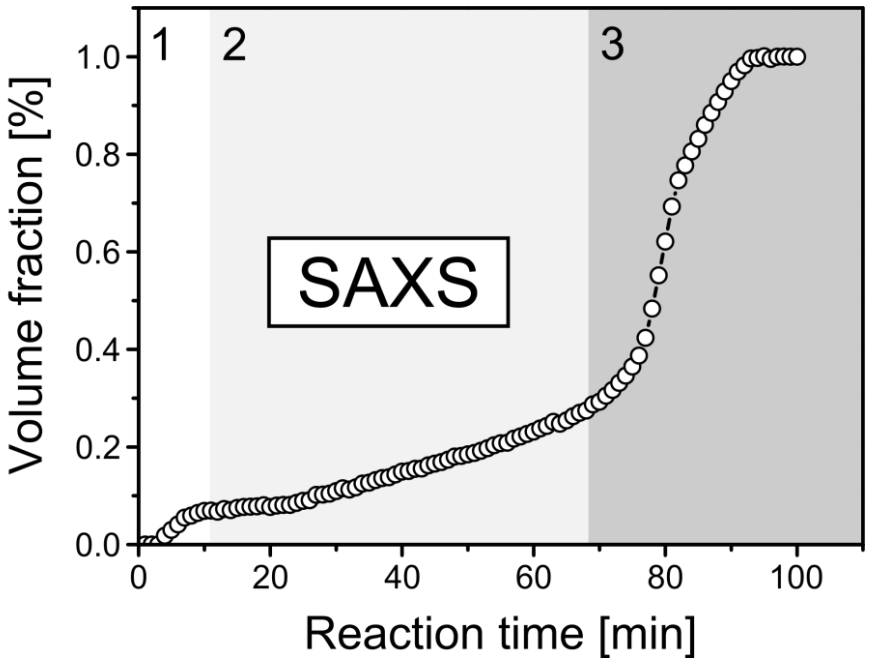
➔ deviation of Abs_{400}: 11% (MSA) and 17% (DDT in toluene)

Time-resolved UV-Vis

➔ standard citrate reduction

➔ comparison to time-resolved SAXS





J. Polte et al., *Chem. Comm.* **2010**, 46 (48), 9209–9211

T. Hendel et al., *Anal. Chem.*, **2014**, 86 (22), 11115-11125

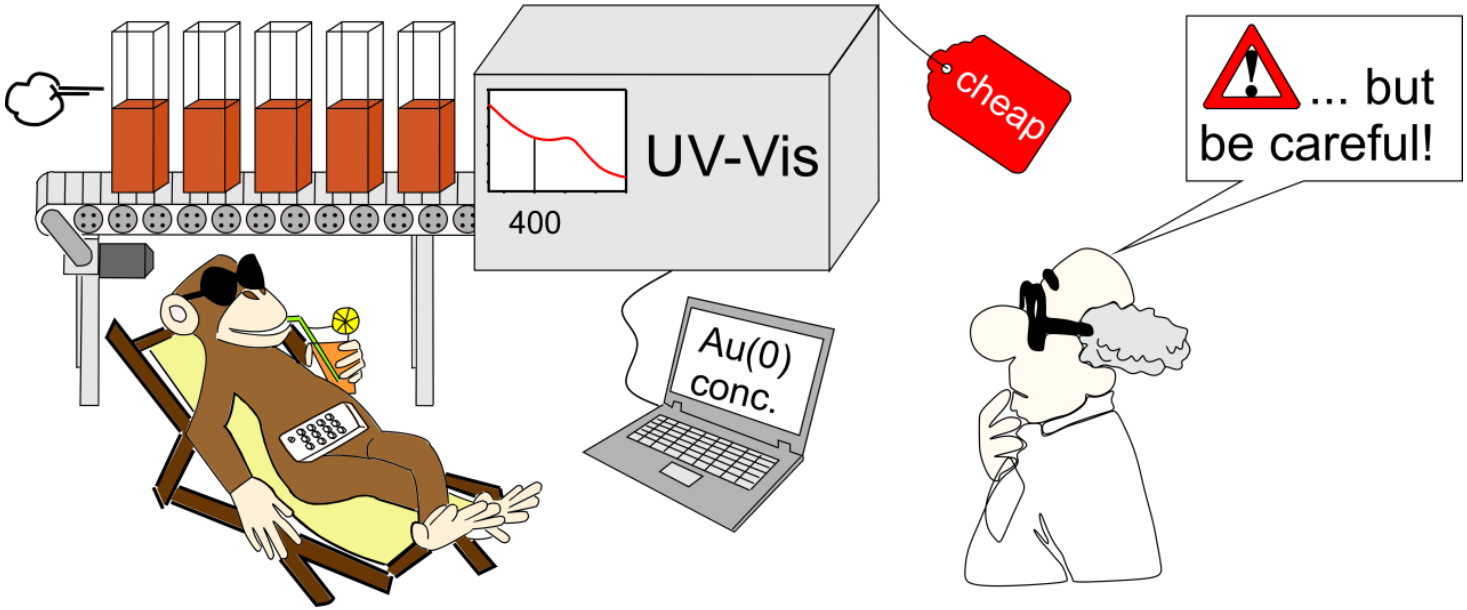
The molar extinction coefficient ε_{400}

	ε_{400} [l·mmol^{-1}·cm^{-1}]		
sample / size	as prepared	PVP stabilized	Plu F-127 stabilized
GNP_{BH4} / 3 - 5 nm	2.14 - 2.23	2.43 - 2.65	2.34 - 2.46
GNP_{cit} / 10 - 20 nm	2.29 - 2.38	2.38 - 2.43	2.36 - 2.41
GNP_{cit} / 20 - 40 nm	2.38 - 2.57	2.45 - 2.51	2.44 - 2.52
GNP_{cit} / 40 - 56 nm	2.63 - 2.68	2.68 - 2.71	2.70 - 2.74

➔ ε_{400} range: 2.14 – 2.74 L·mmol^{-1}·cm^{-1} (up to 30%)

➔ with known size and surface modification deviation < 5%

Abs_{400} for concentration determination



➔ deviation up to 30% but with known parameters < 5%

➔ simple, cheap, precise

➔ in-situ and with high time resolution

T. Hendel et al., *Anal. Chem.*, **2014**, 86 (22), 11115-11125

Thanks for your attention!