Detection of engineered nanoparticles (ENP) in the environment: Analytical challanges

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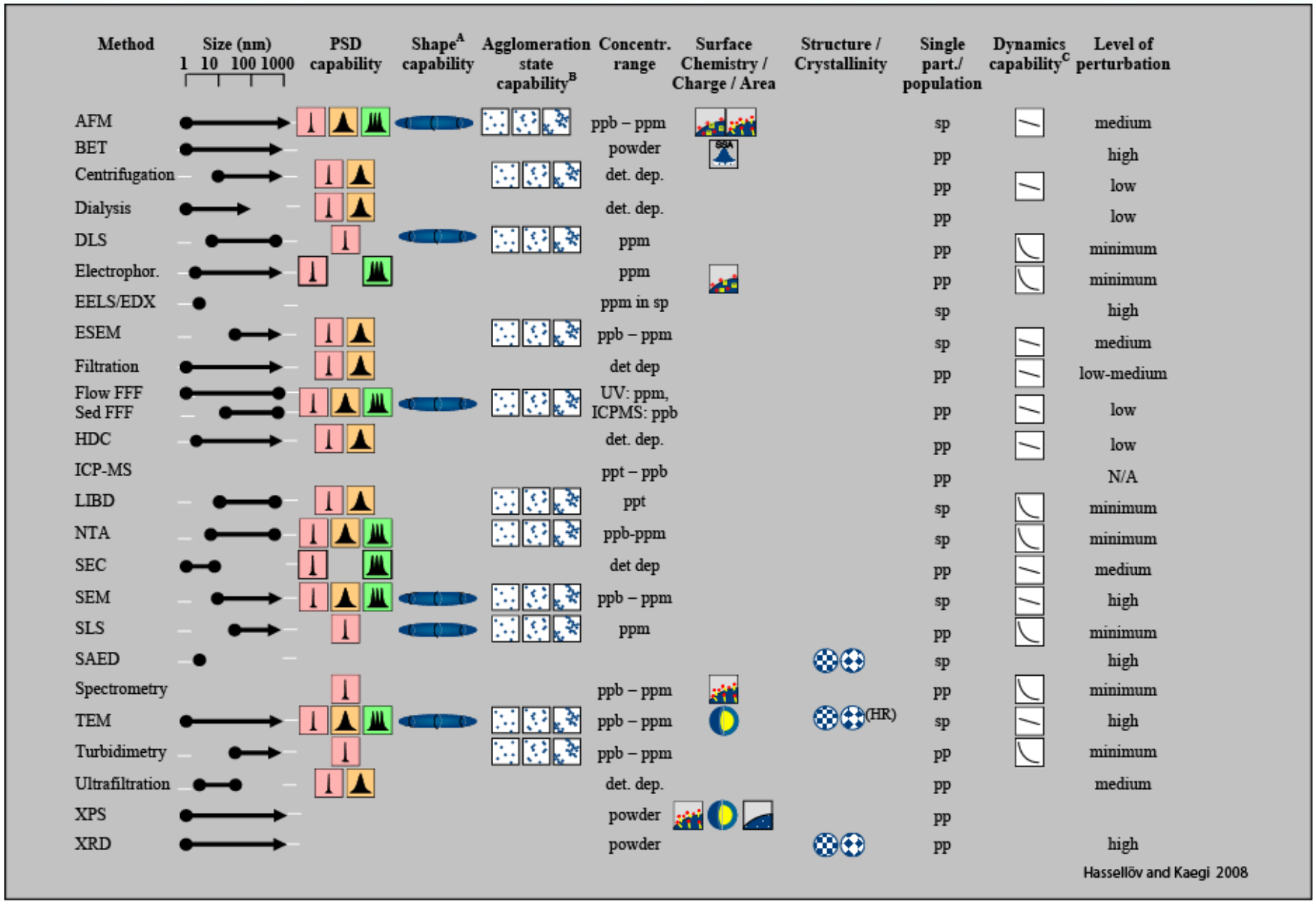
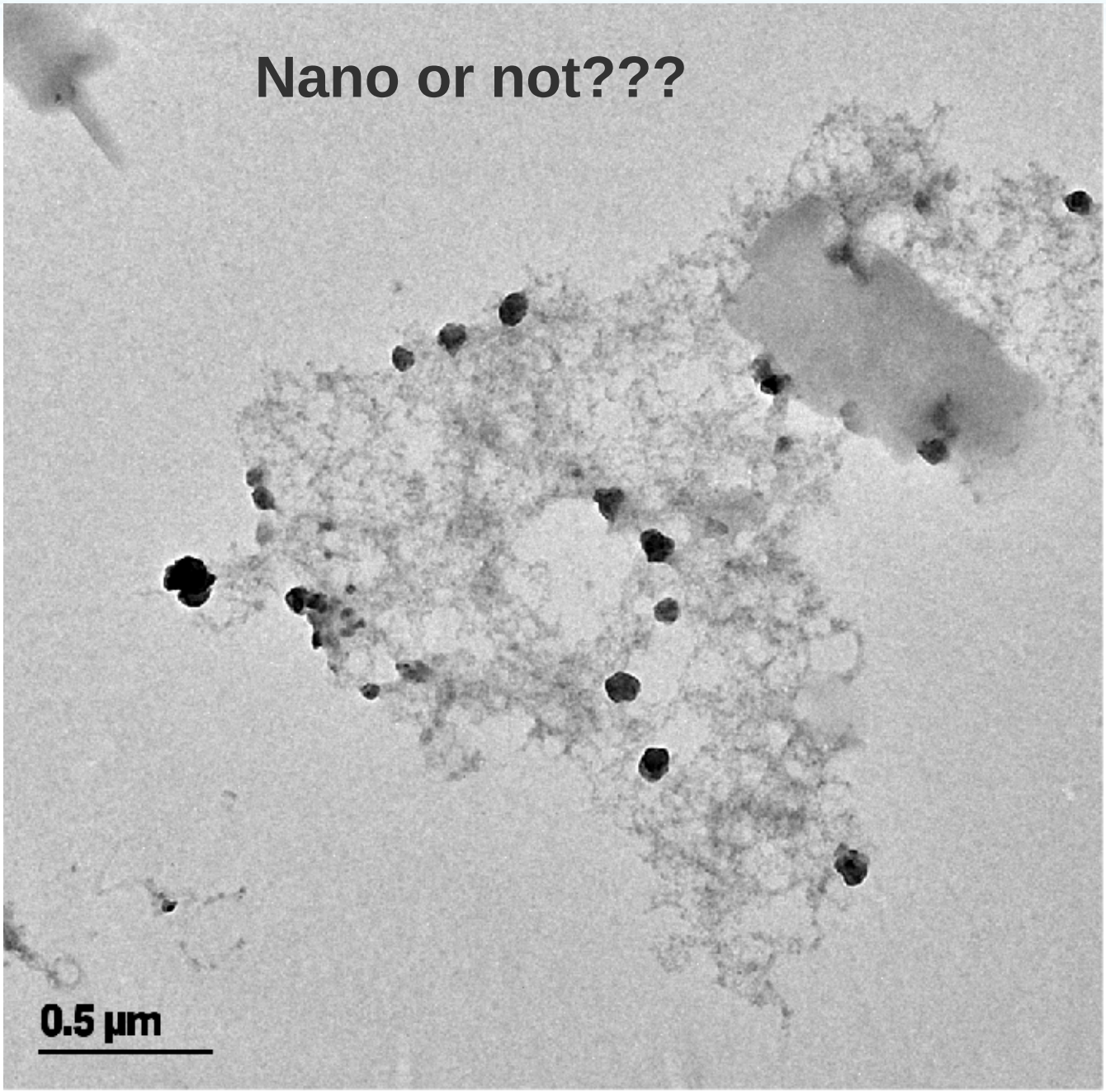
Acknowledgements:
Michael Burkhadt (Hochschule Rapperswil), Steffen Zuleeg (Kuster und Hager), Brian Sinnet, Harald Hagendorfer (Empa), Markus Boller, Hansruedi Siegrist, Andreas Voegelin

Swiss Light Source (SLS), Microscopy Centers of ETH (EMEZ) and Empa

Methods to characterize ENP



M. Hassellov, R. Kaegi, in *Nanoscience and Nanotechnology, 2008*

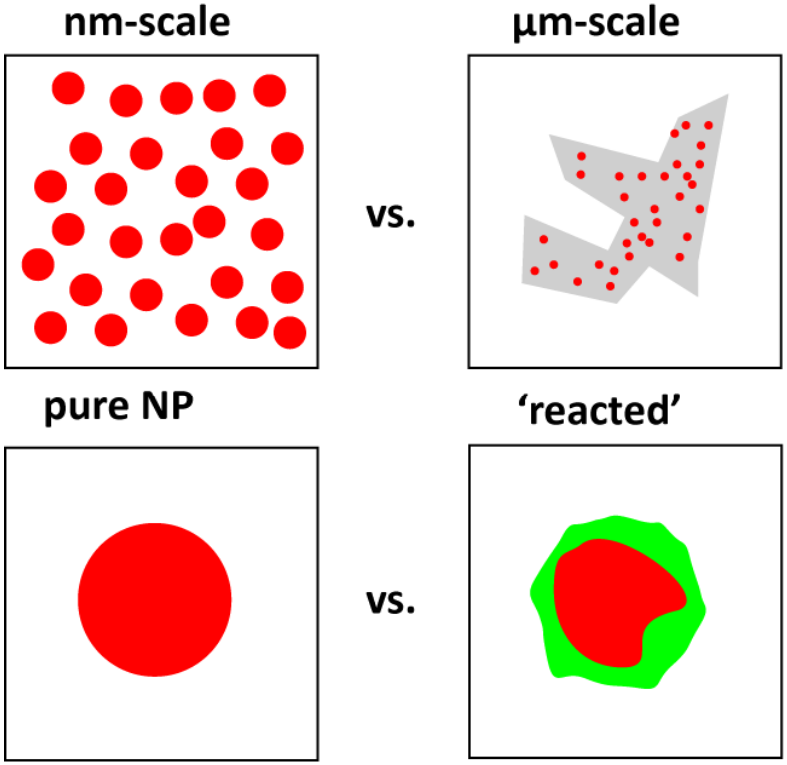

Nano or not???
0.5 µm

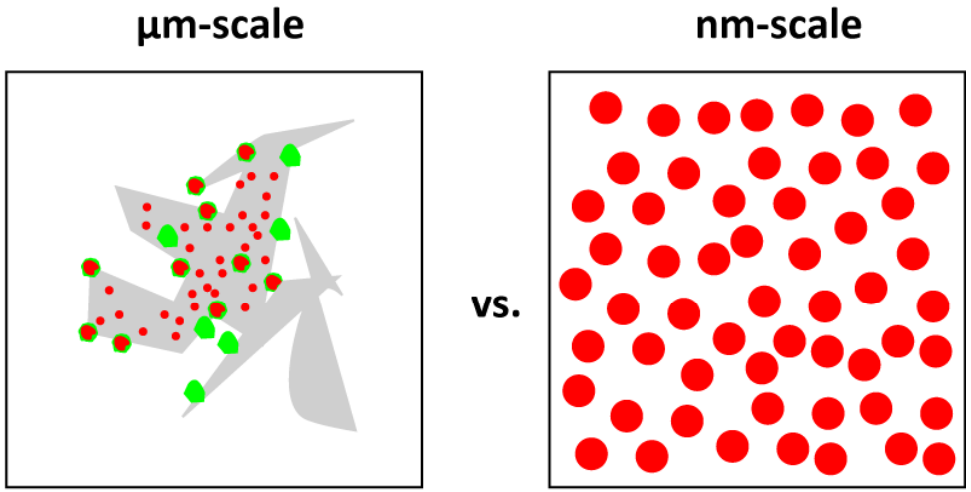
Laboratory vs. environment

release
(LCA, are the NP released as individual NP or as 'composite ' particles?

transport →

exposure & hazard
that what forms of NP are we exposed and is there a hazard





reality?

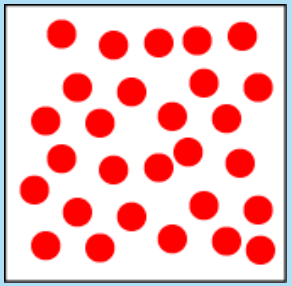
Lab scale experiments are based on 'the red dot system', risk assessments are based on lab experiments, and decisions are made based on risk assessments. Is this a reasonable approach for NP?

Analytical challenges

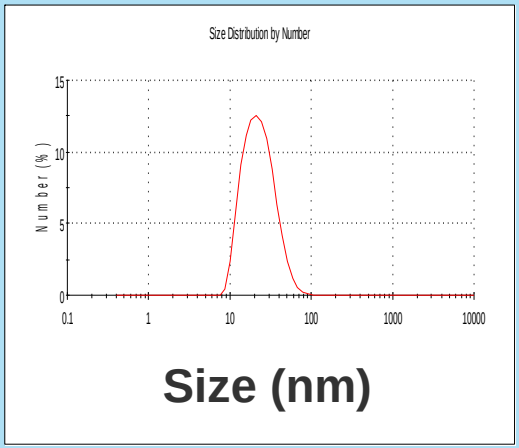
- ***discriminate*** between natural ‚NP' (colloids) and ENP.
- ***detect*** ENP in complex colloids.

(Ag-NP)

Laboratory



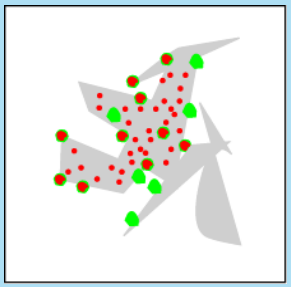
DLS (dynamic lightscattering)



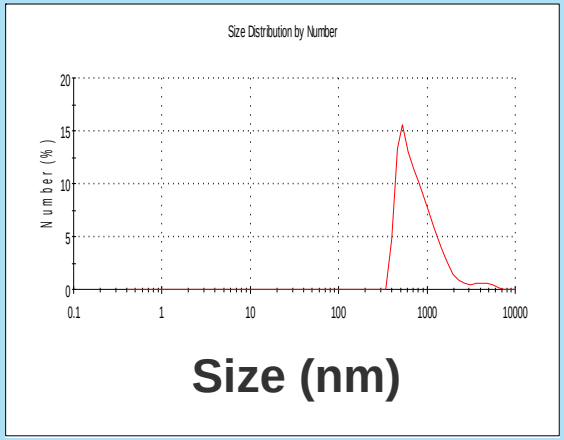
ICPMS

250 ppm Ag

Environment



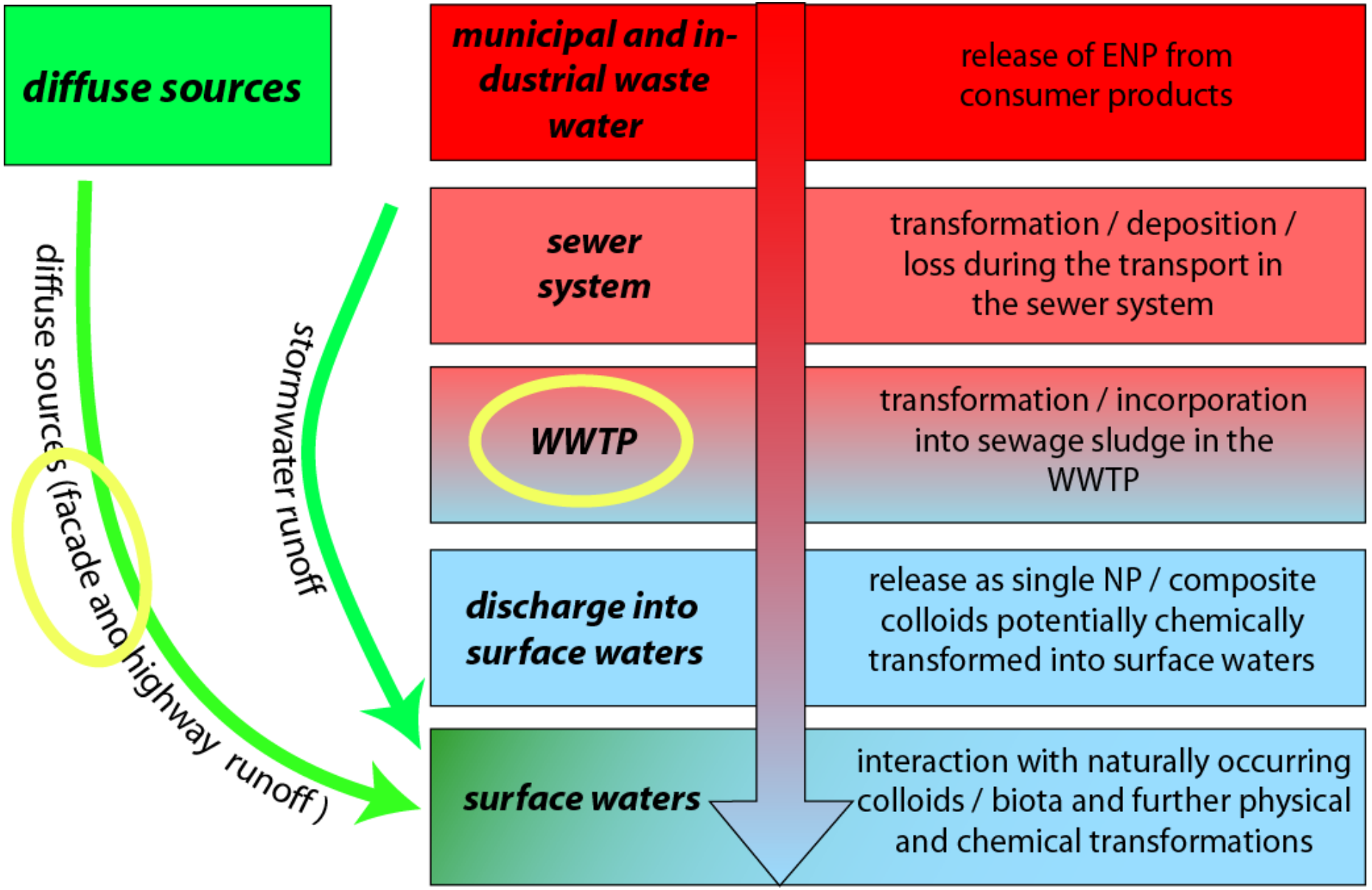
DLS



ICPMS

10 ppb Ag

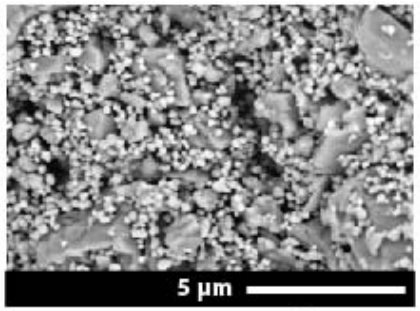
ENP in the urban watercycle



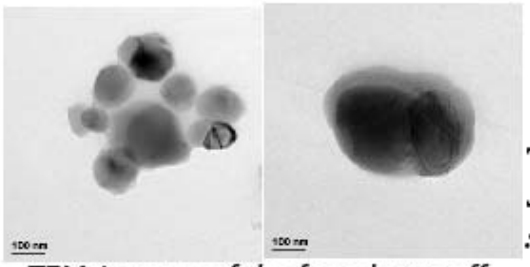
Runoff from facades I: TEM and ICP-MS

Kaegi *et al.*, *Env. Poll.* **156**, 233

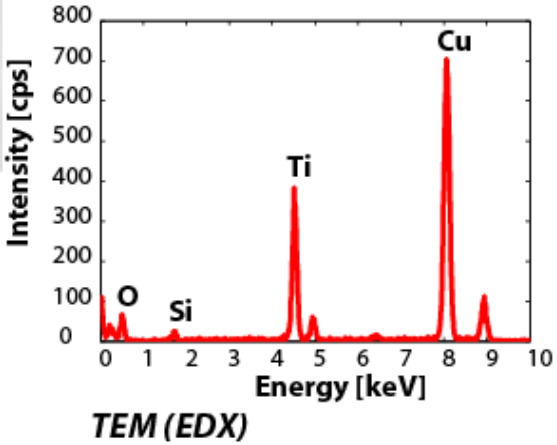
New facade (1.3 m2)



SEM(BSE) image of the new facade

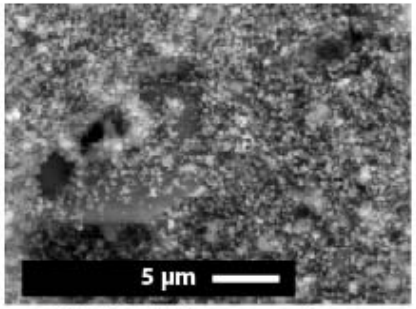


TEM-images of the facade runoff (new facade)

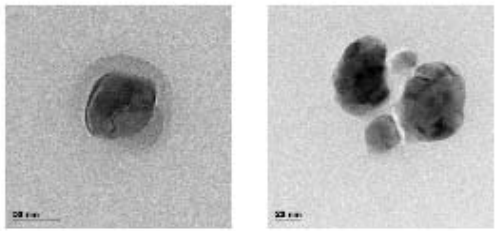


TEM (EDX)

Building facade (painted with the same product as the new facade)

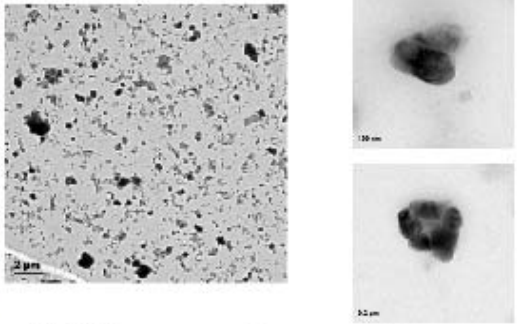


SEM(BSE) image of the new facade

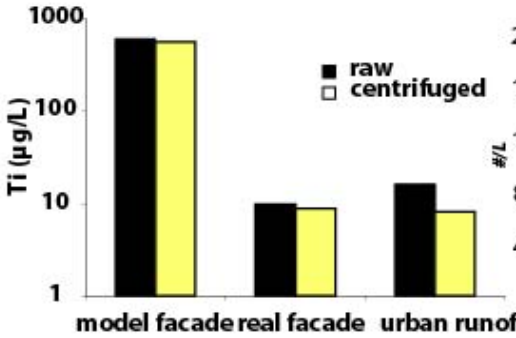


TEM-images of the facade runoff (aged facade)

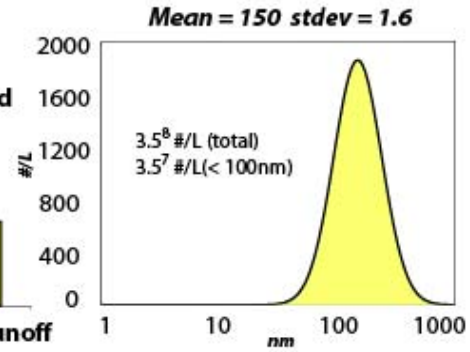
Discharge of the runoff into the urban creek



TEM-images of the runoff



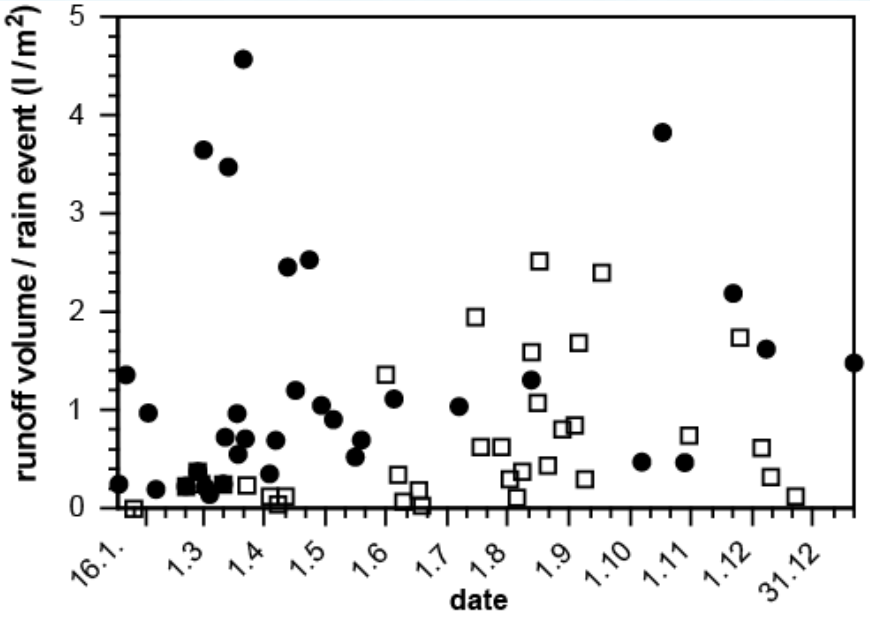
Ti concentrations in the raw and in the centrifuged samples (ICP-MS)

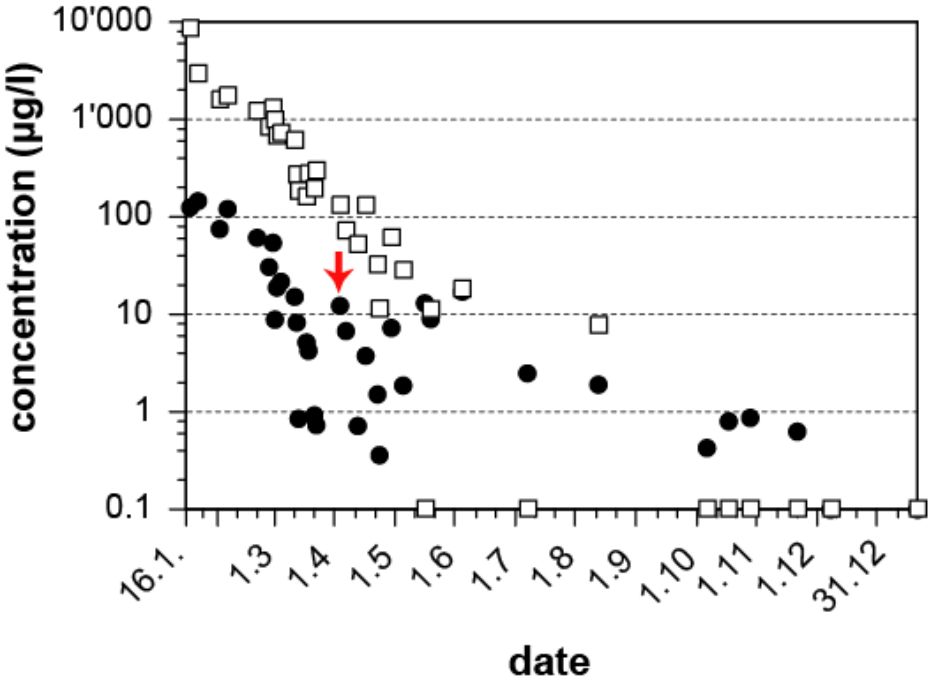


Modeled log-normal distribution of the TiO2 particles in the runoff.

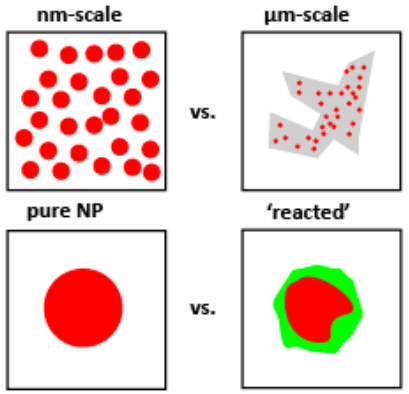
Runoff from facades II: (more) TEM and ICP-MS

Kaegi et al (2010), Env. Pol., 158,(9), 2900-2905





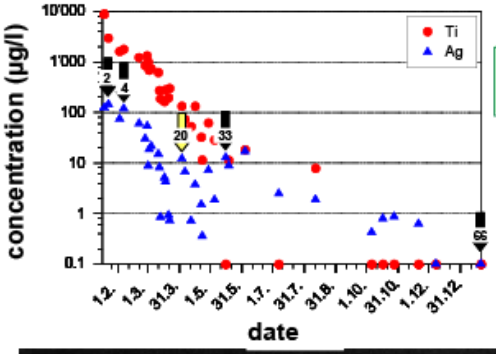
A strong leaching of the Ag-NP was observed during the initial runoff events with a maximum concentration of 145 µg/l Ag. After a period of one year, more than **30%** of the Ag-NP were released to the environment.

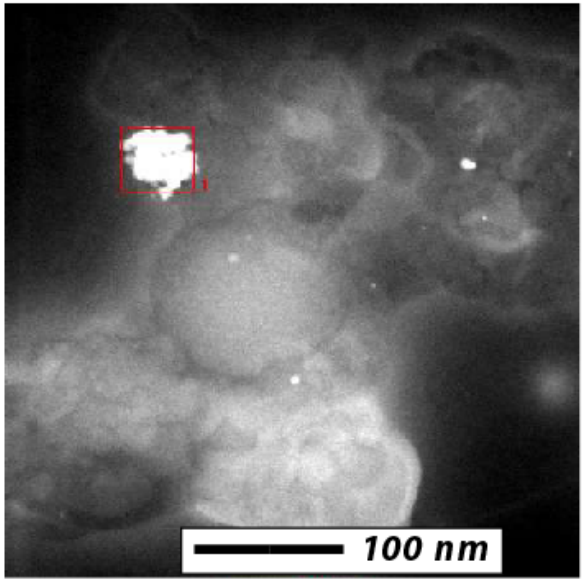


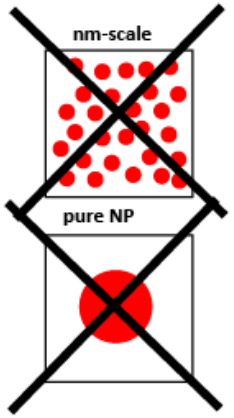
Ag-NP in composite colloids

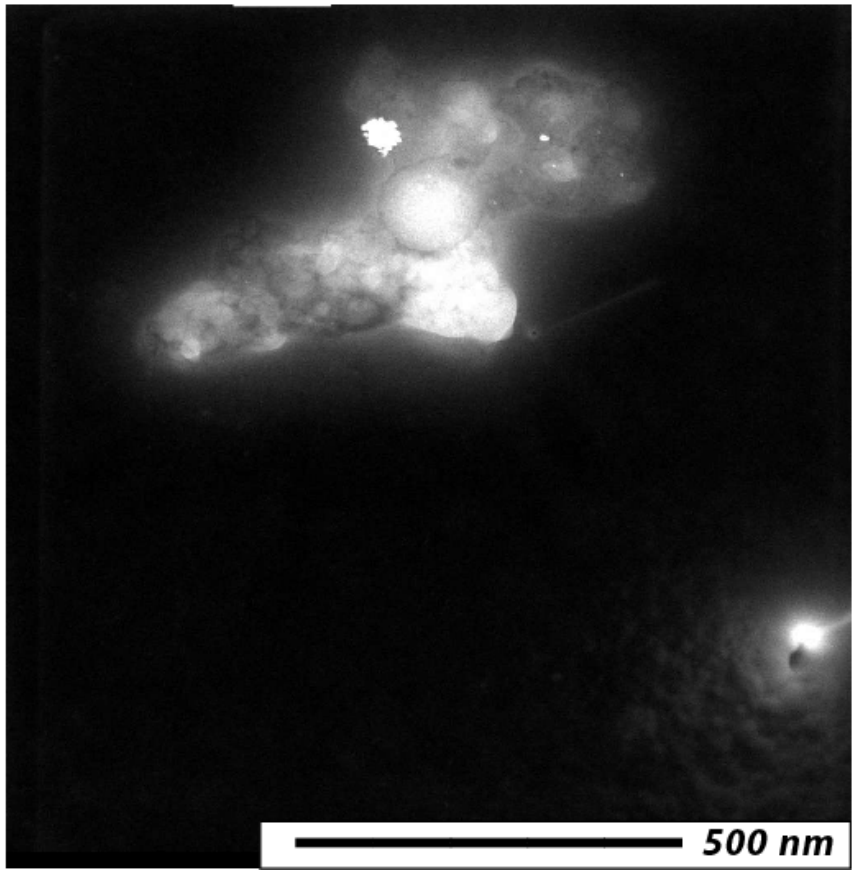
Ag-NP released from facades: Runoff event 20

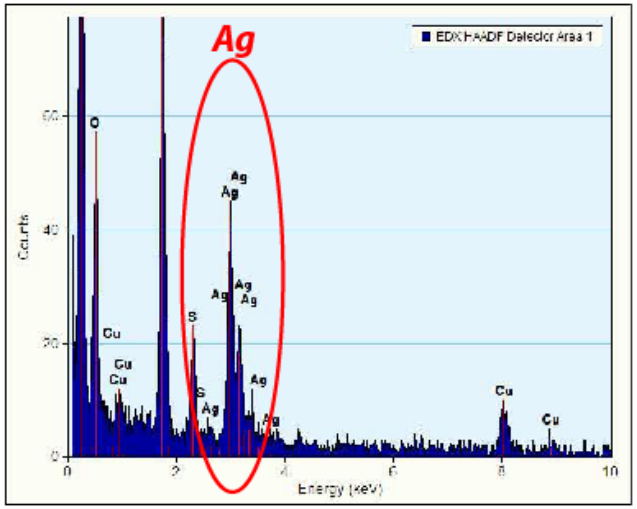
Ag concentration: 12 µg/L; runoff: 0.35 L/m²

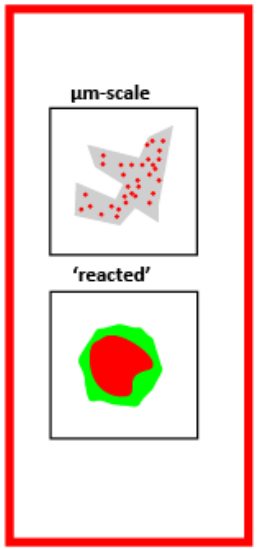






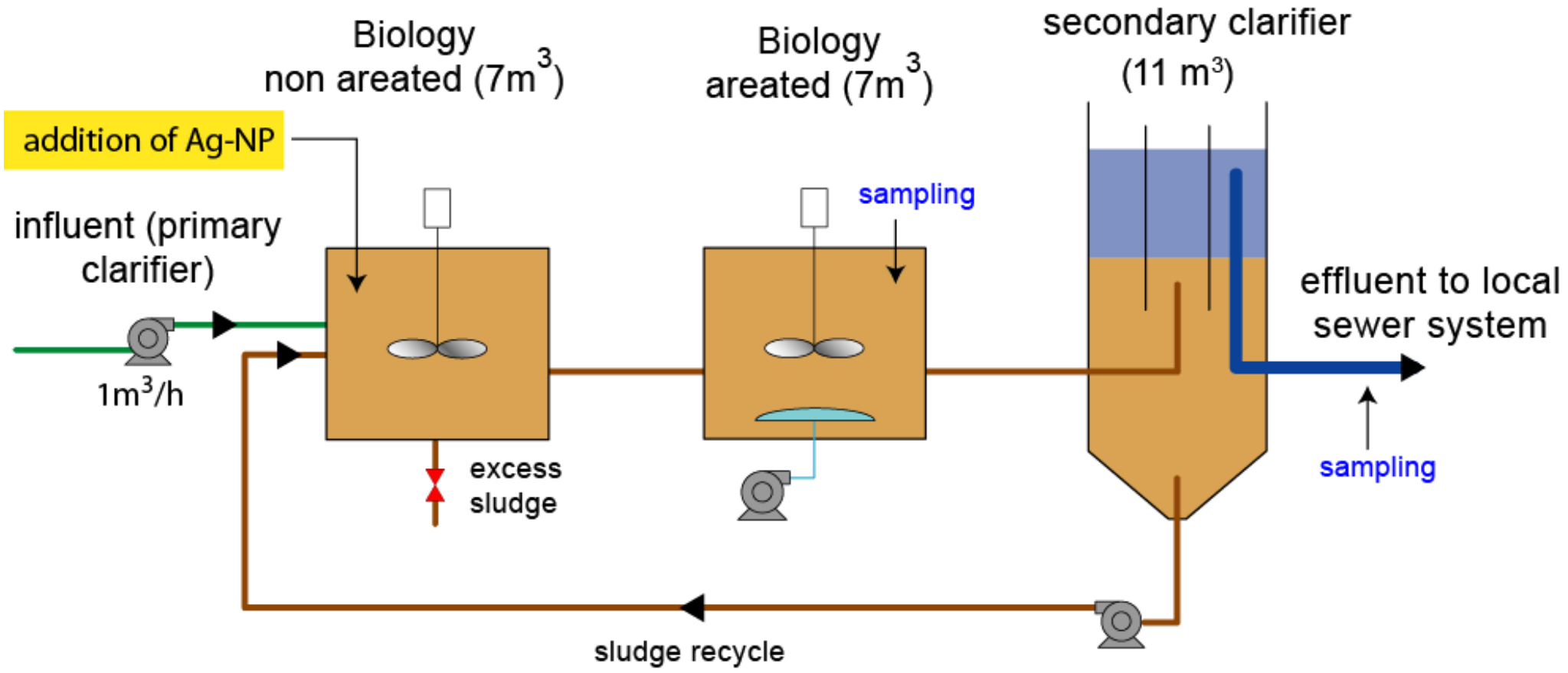




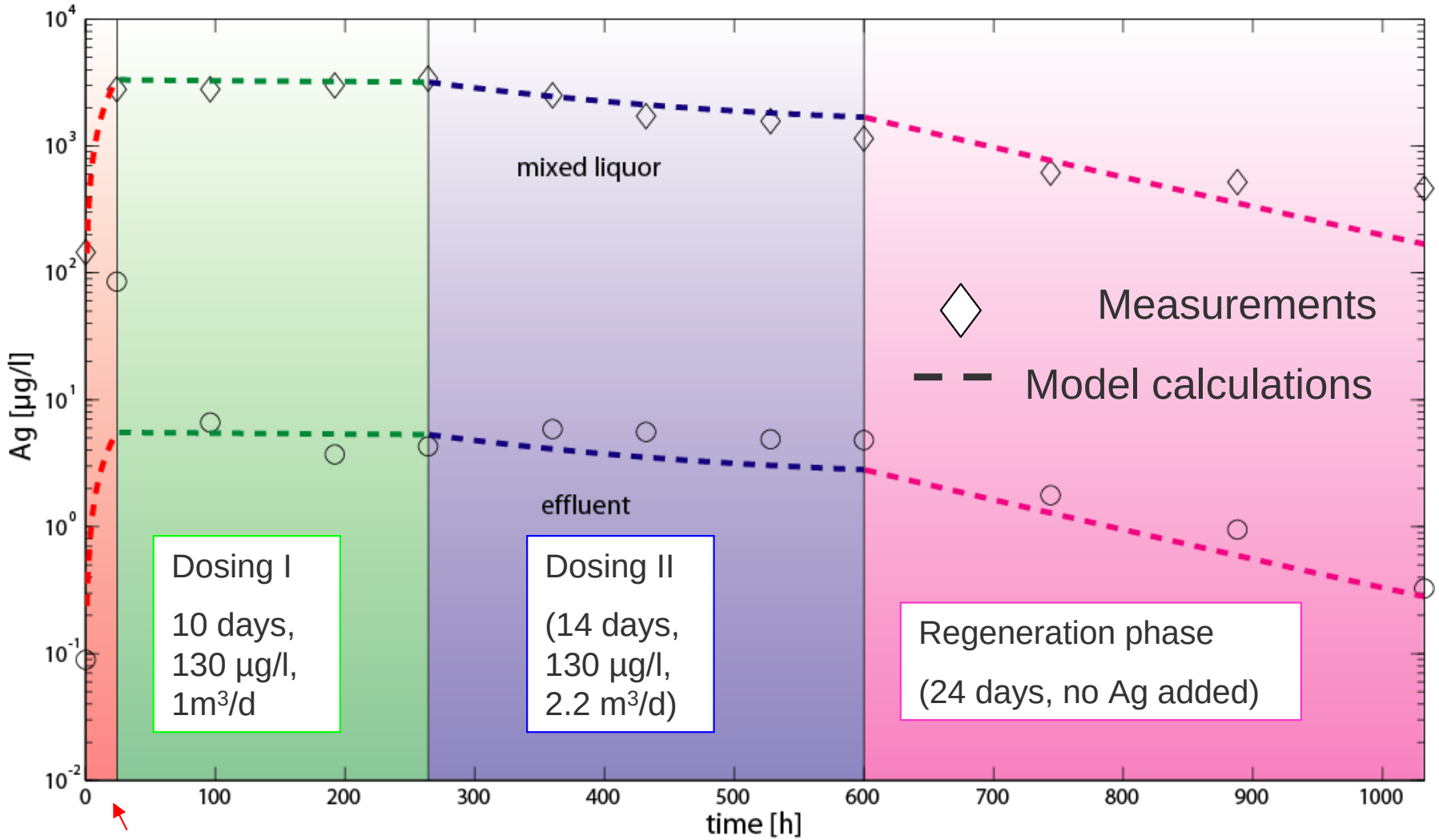


Wastewater treatment: TEM, ICP-MS and XAS, and some common sense

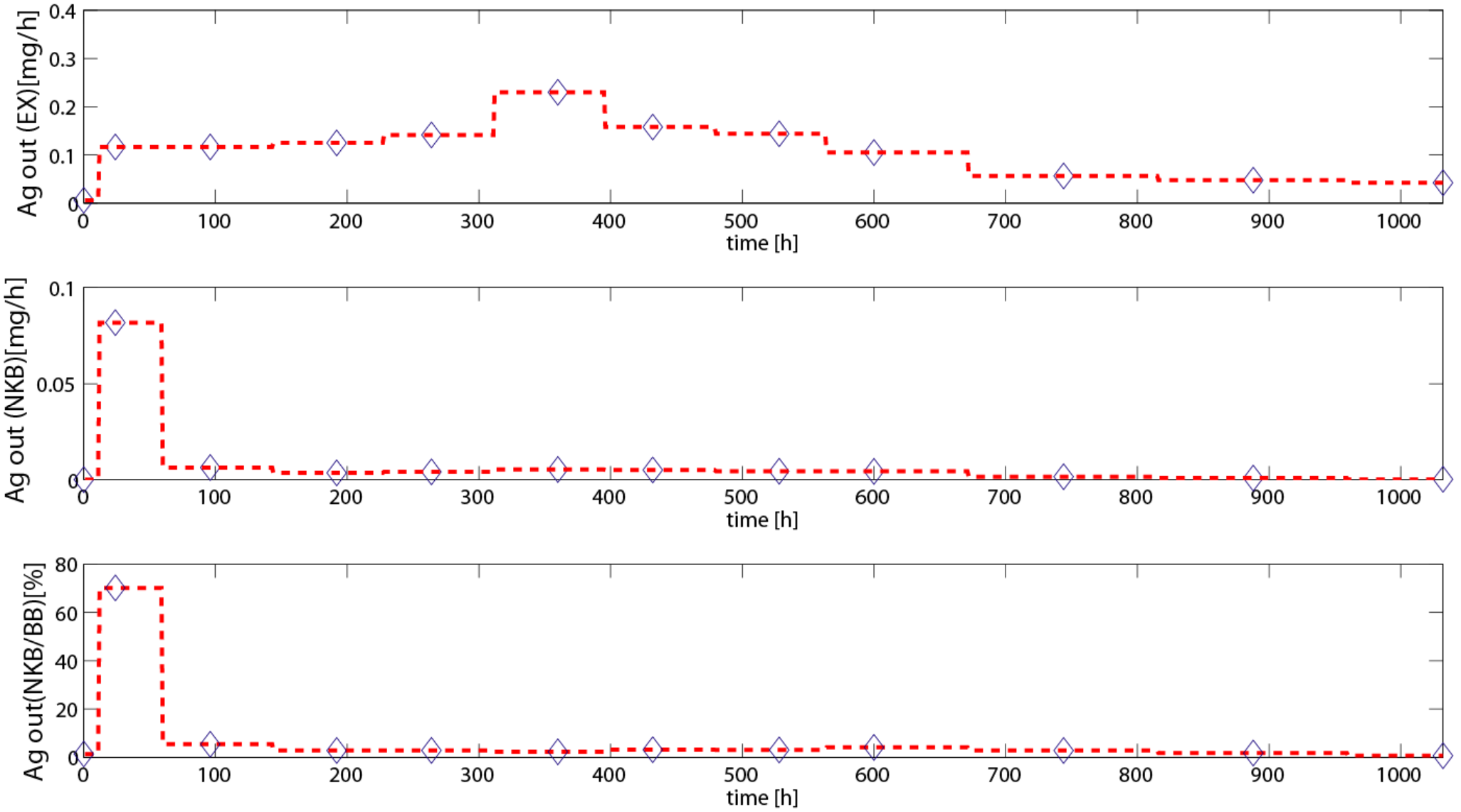
Experimental setup I



Experimental setup II and model calculations

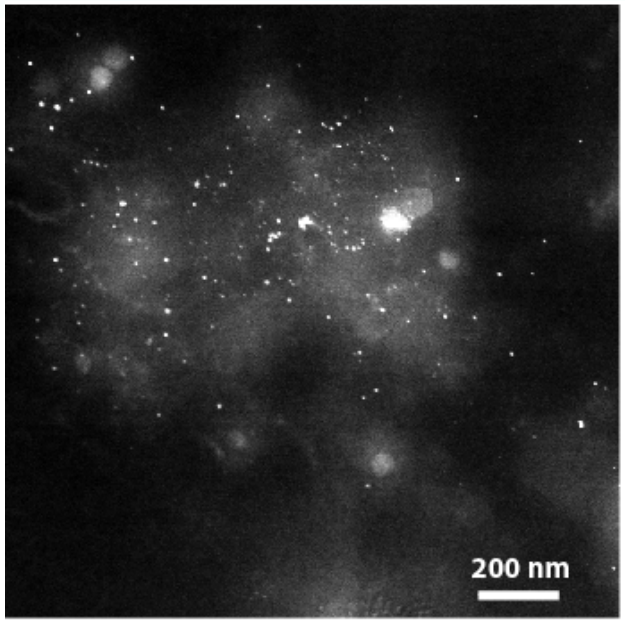


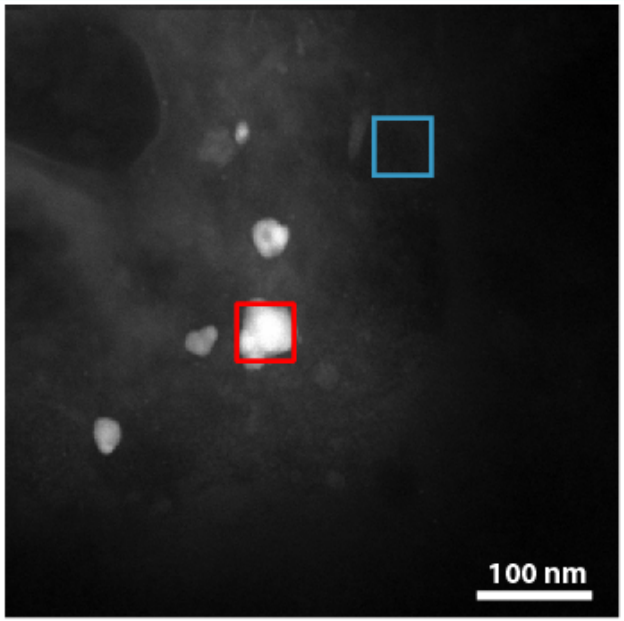
Mass flux of Ag

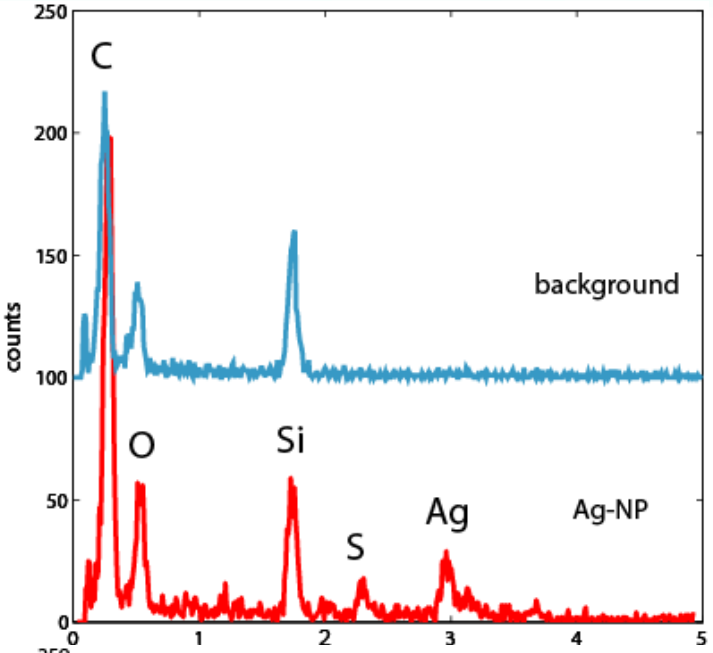


TEM: HAADF and EDX

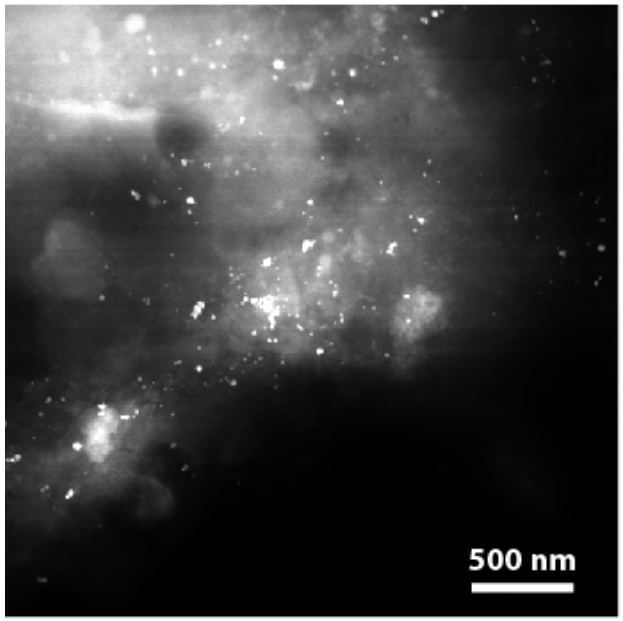
Aerated tank

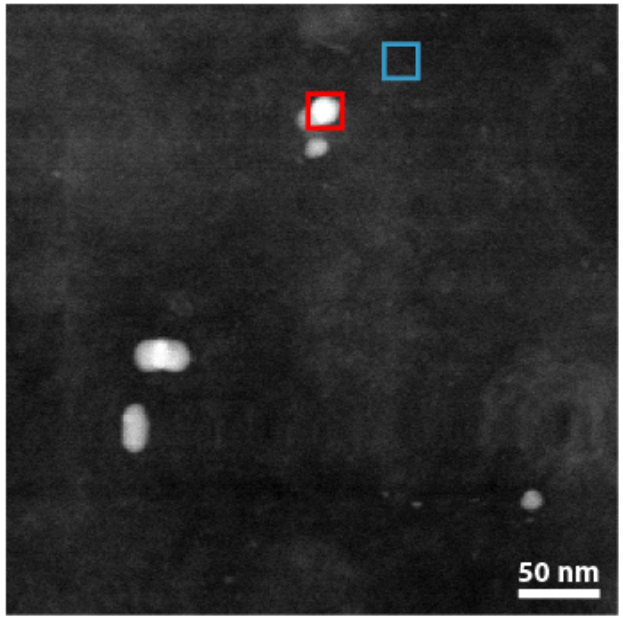


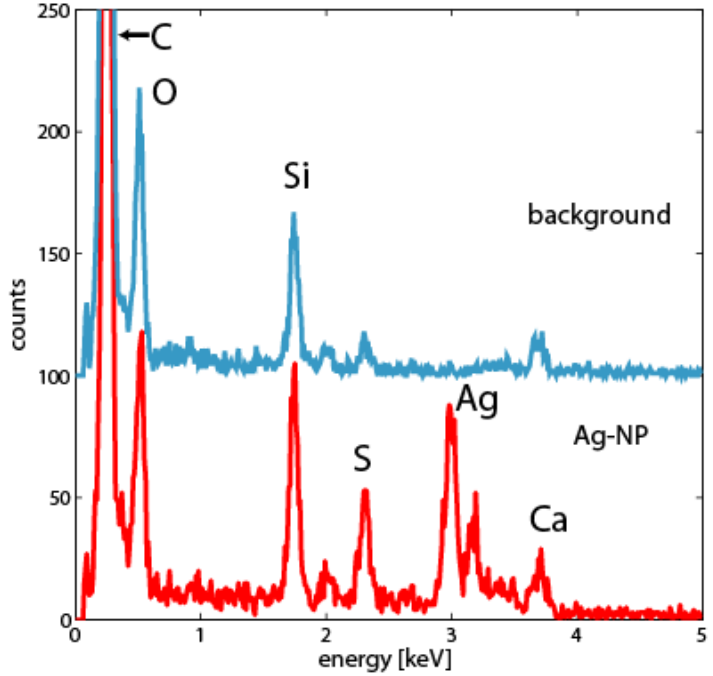




Secondary clarifier

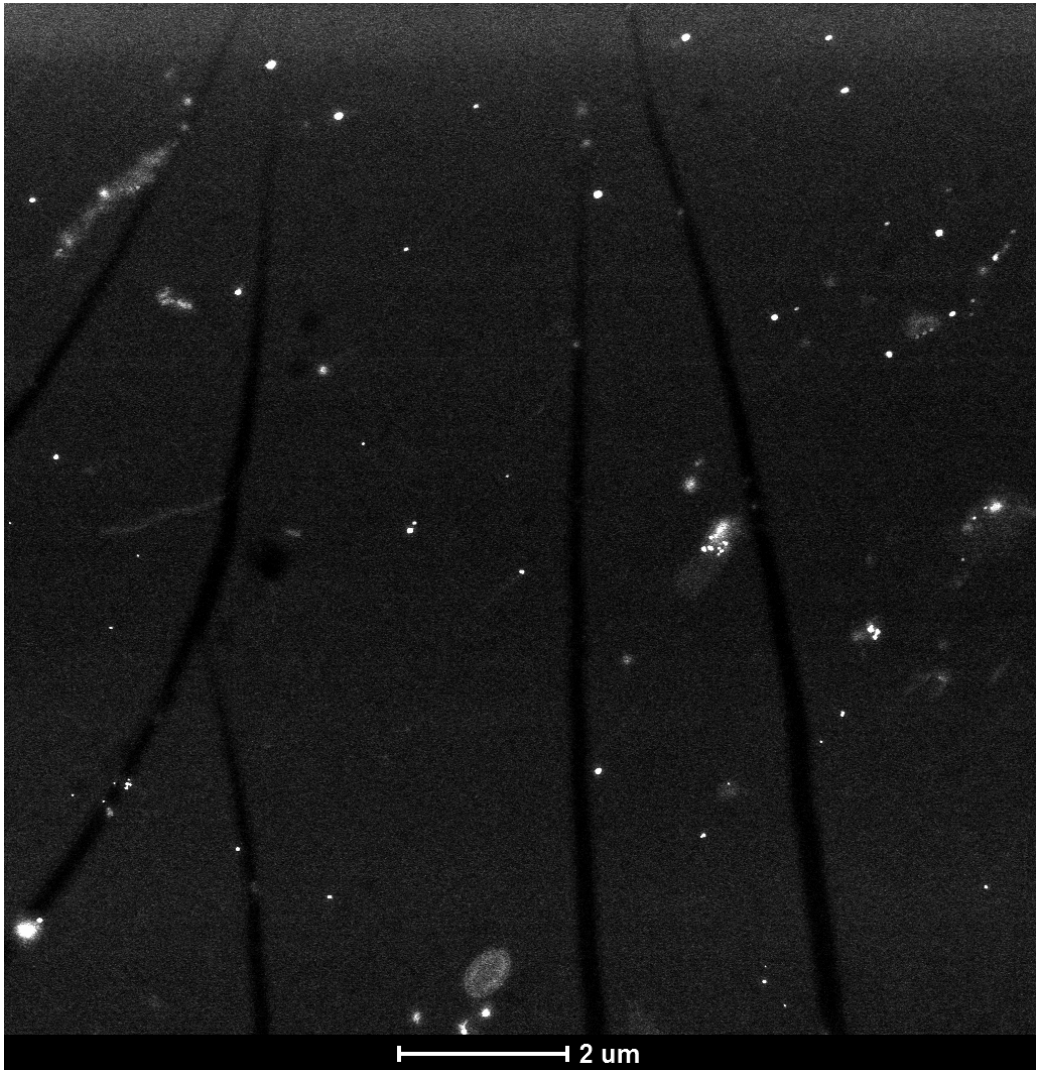


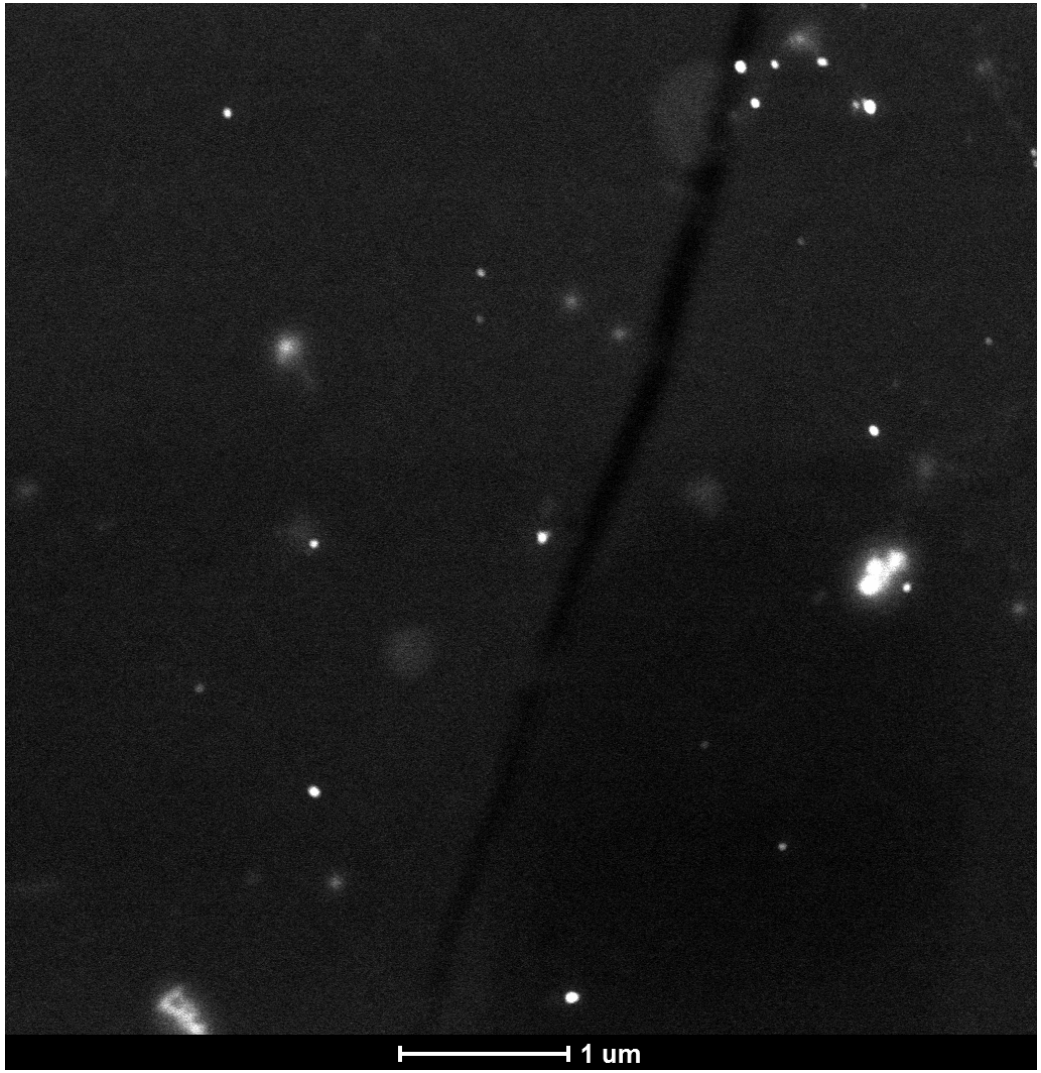




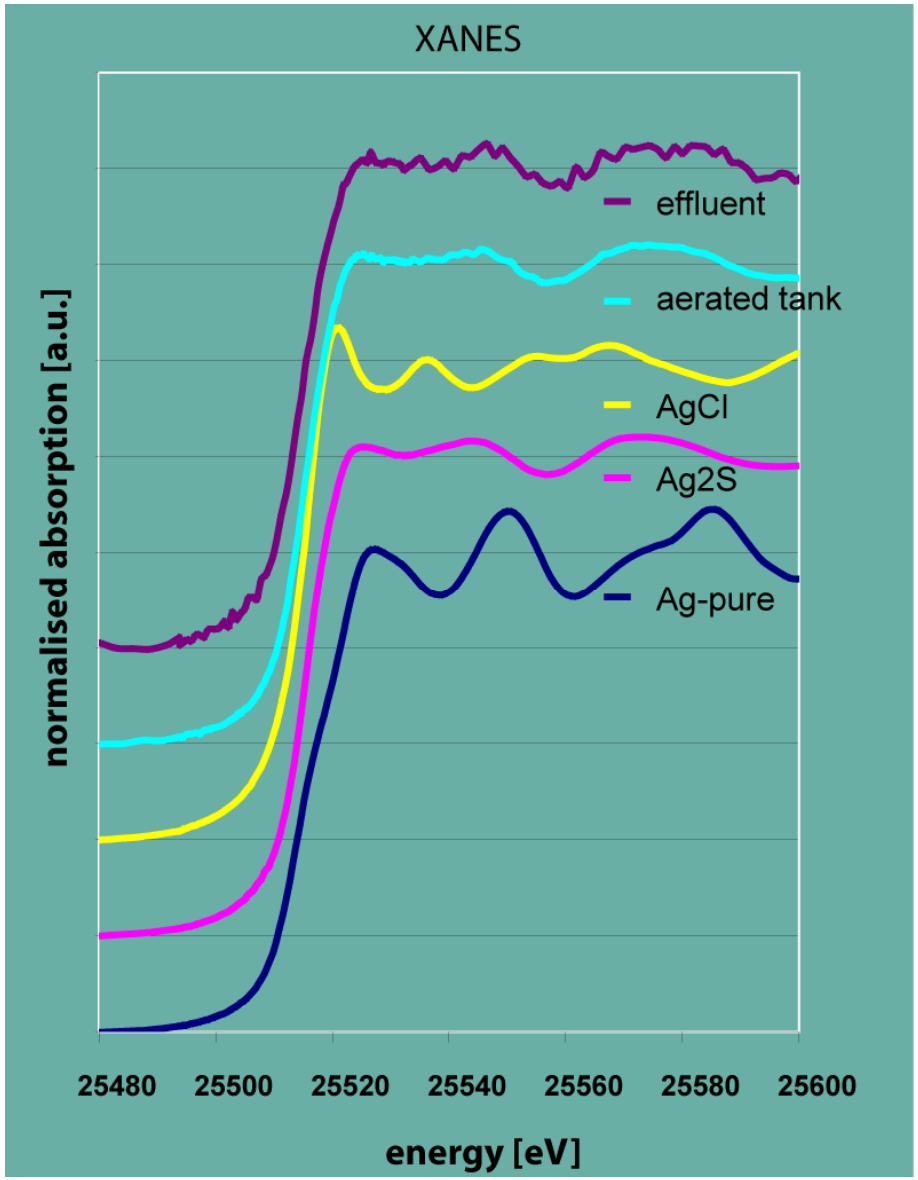
TEM: HAADF

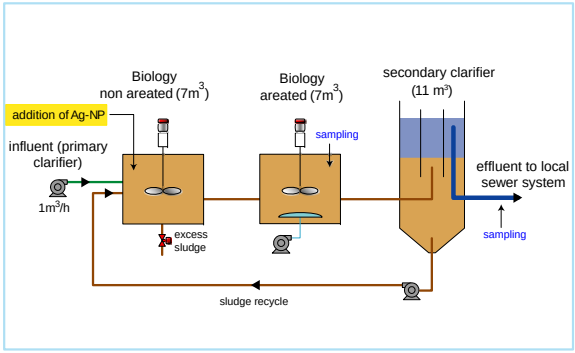
Secondary califier after the initial dosage





Speciation of Ag: XANES





XAS performed on bulk samples allows determining the speciation of the Ag. For that purpose, measured spectra are combined with spectra from reference materials (linear combination fitting)

LCF XANES

	Ag-pure	Ag2S	Sum	R-value
Pilot - ARA				
aerated tank	2%	98%	100%	0.00007
effluent	15%	87%	101%	0.00050

Conclusions