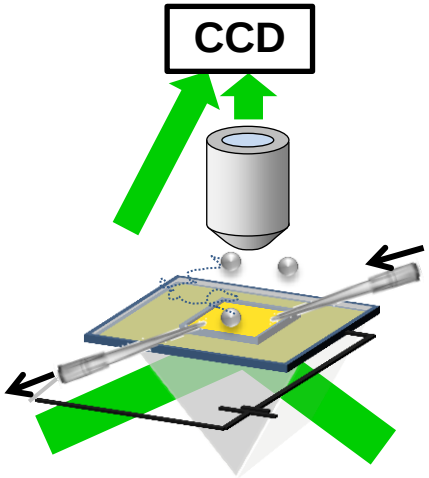
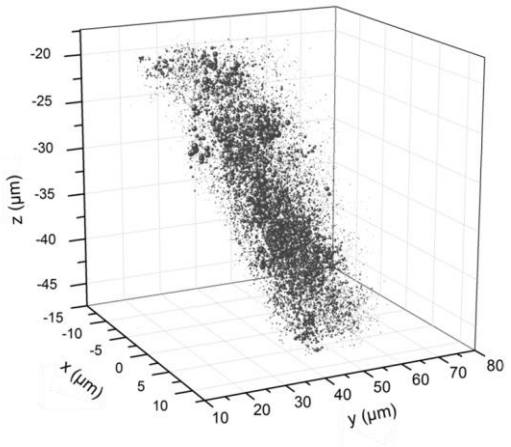
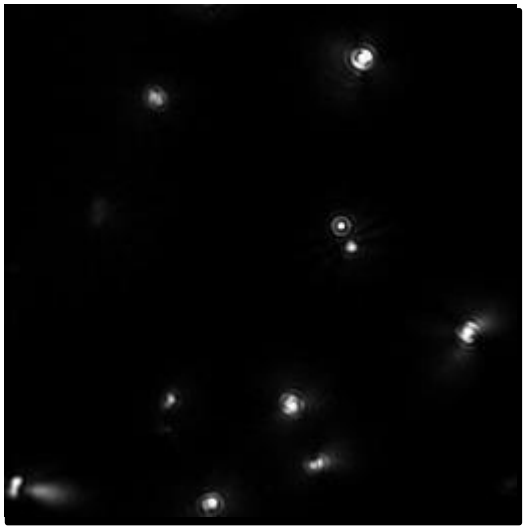
Holographic superlocalization of individual metal nanoparticles:

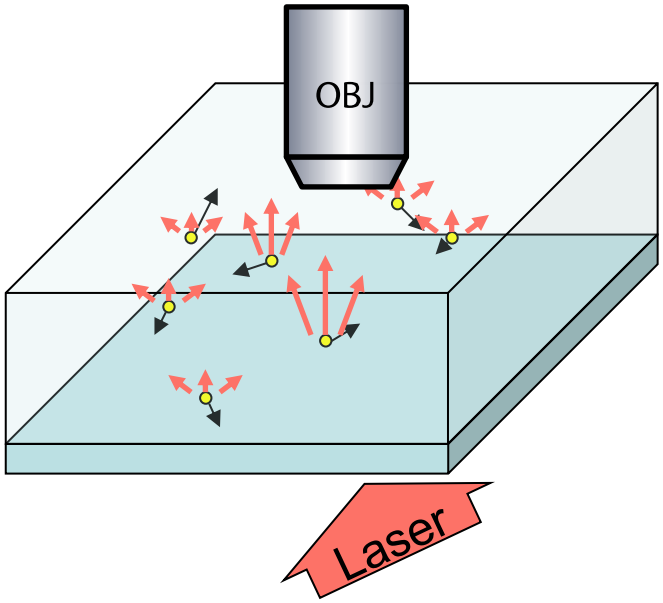
Electrochemical impacts tracking and near-field mapping

Vitor Brasiliense, Pascal Berto, Ariadna Martinez-Marrades, Catherine Combellas, Frederic Kanoufi, Gilles Tessier





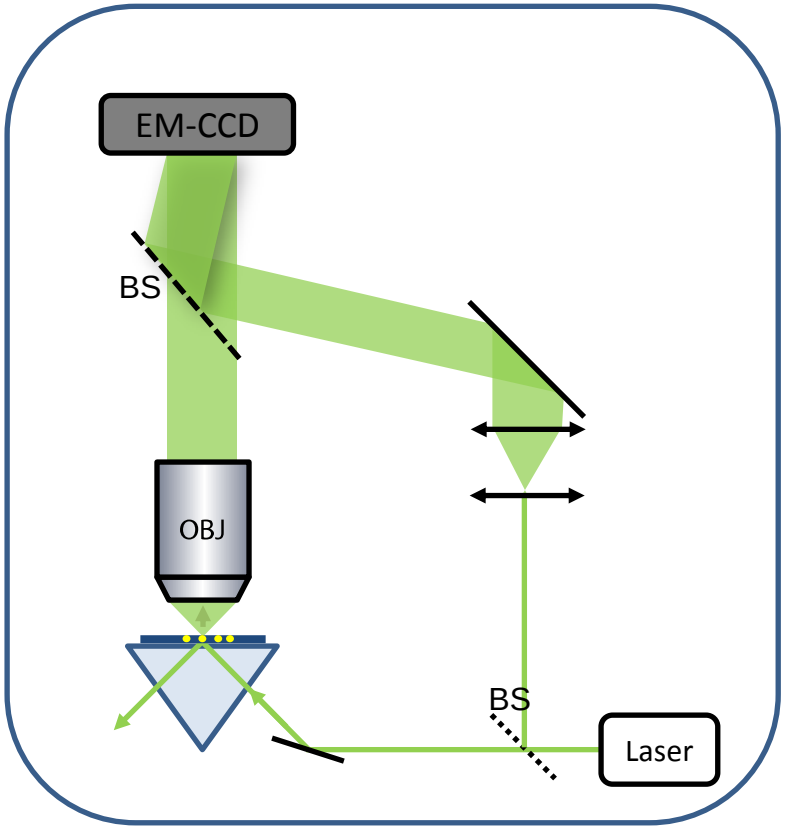




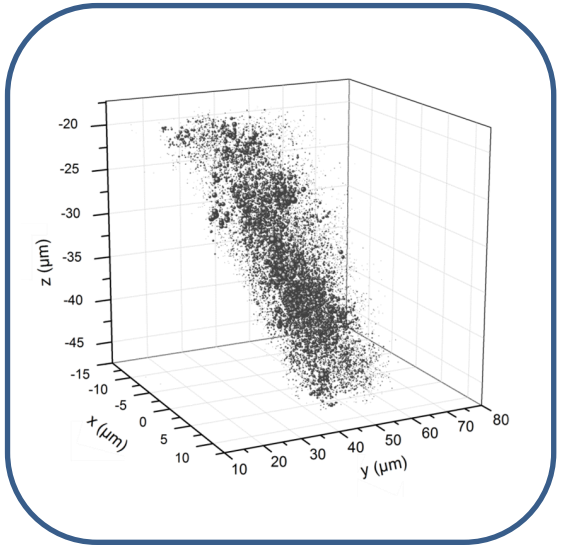
Small objects, moving in 3 dimensional way

Dark field imaging , holography

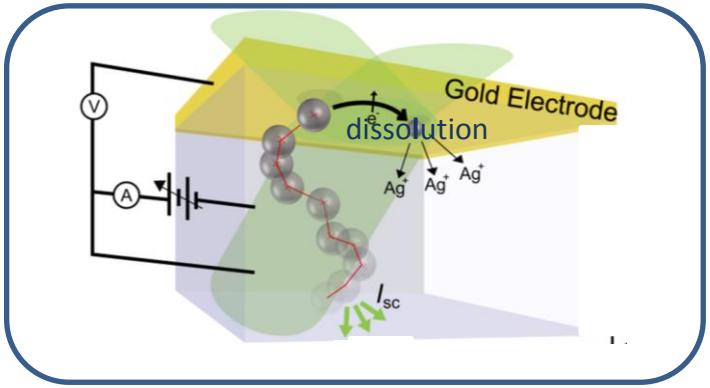
1. Holographic Superlocalization of NP

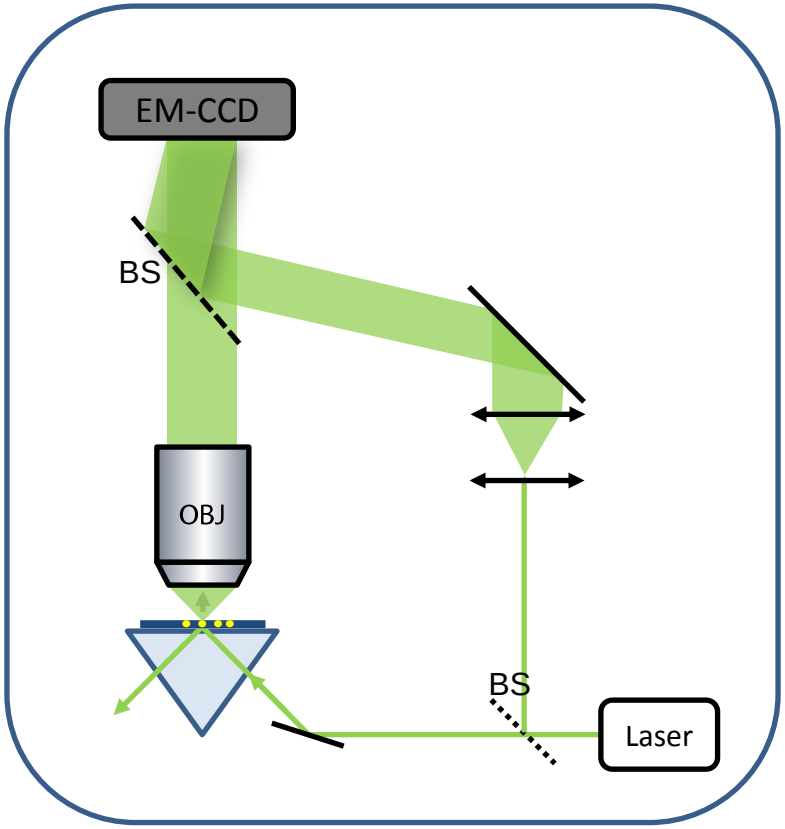


2. Imaging Optical Field Distribution



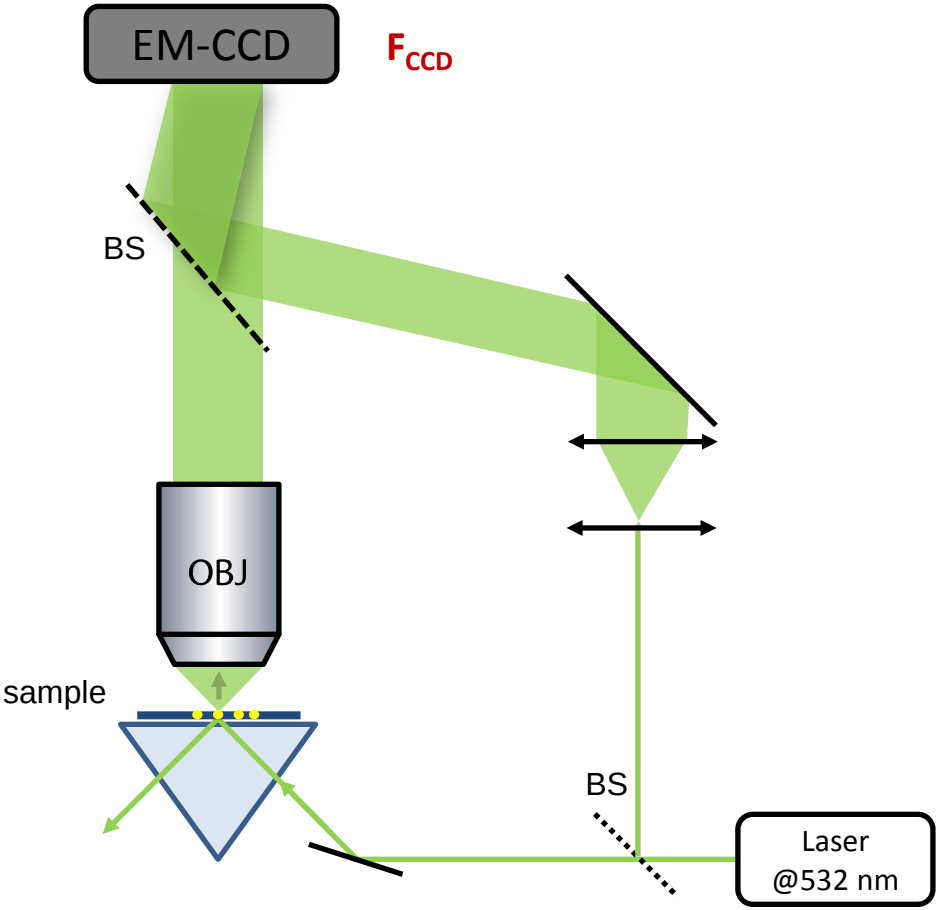
3. Tracking Electrochemical Impacts



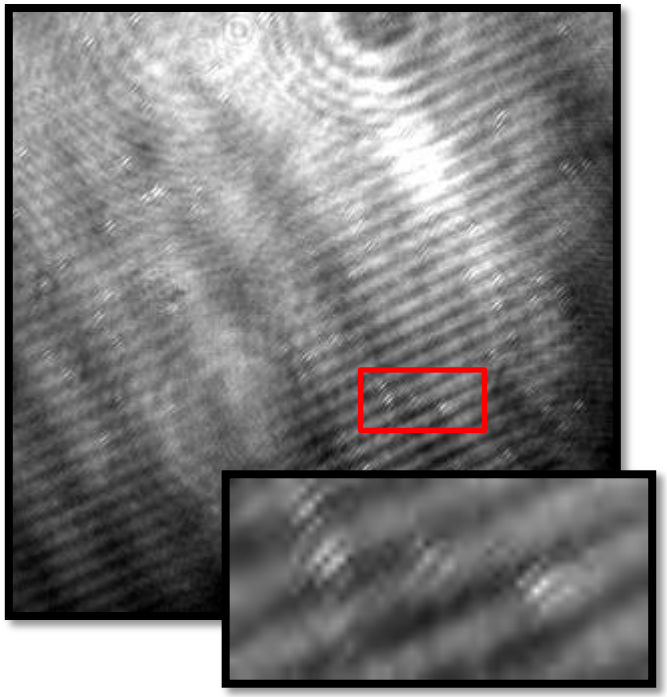


Holographic Superlocalization of NP

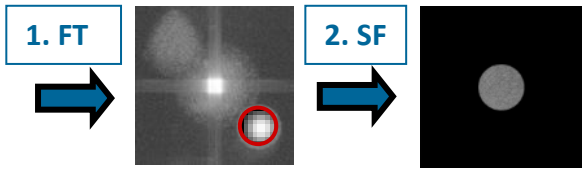
Digital Holography

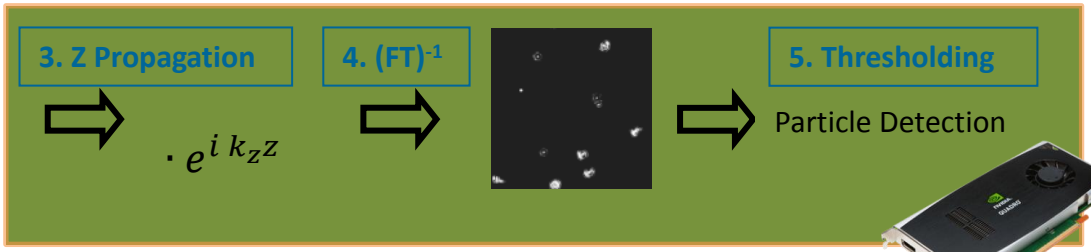


Hologram

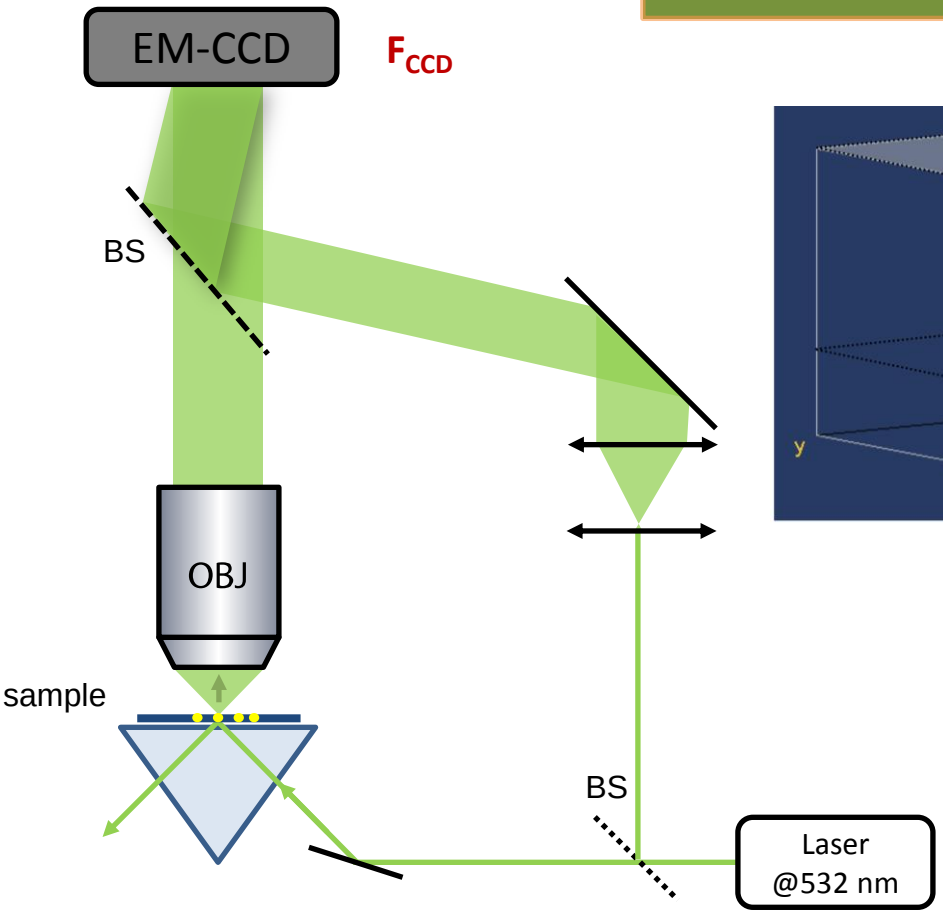


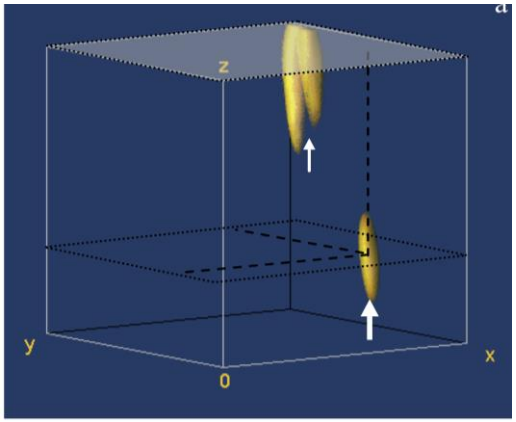
Digital Holography

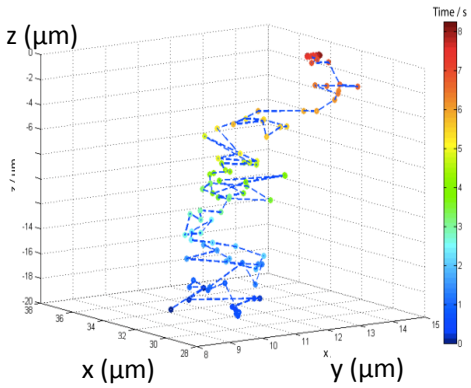




GPU



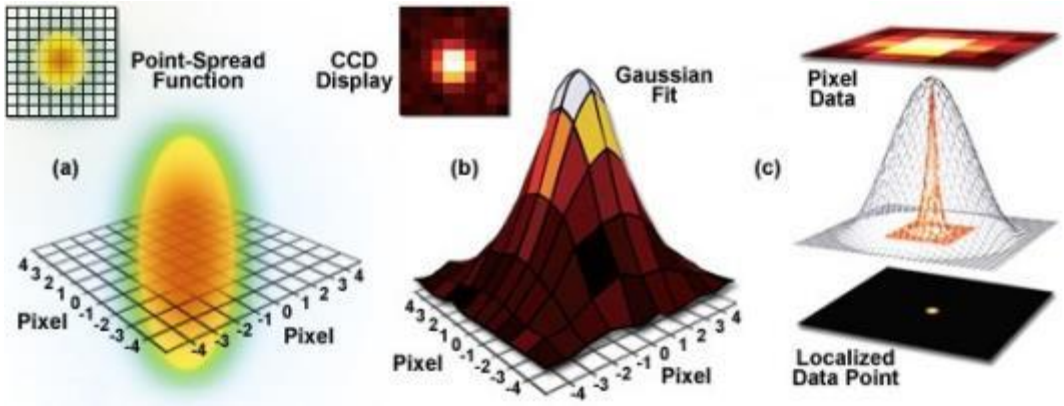




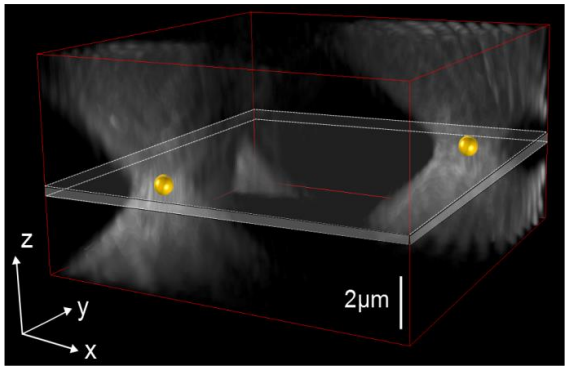
C.Batchelor-McAuley et al., Chem. Phys. Lett. , CP Letters 31938 (2014)

M. Gross *et* M.Atlan, Opt. Lett. 32, 909 (2007)

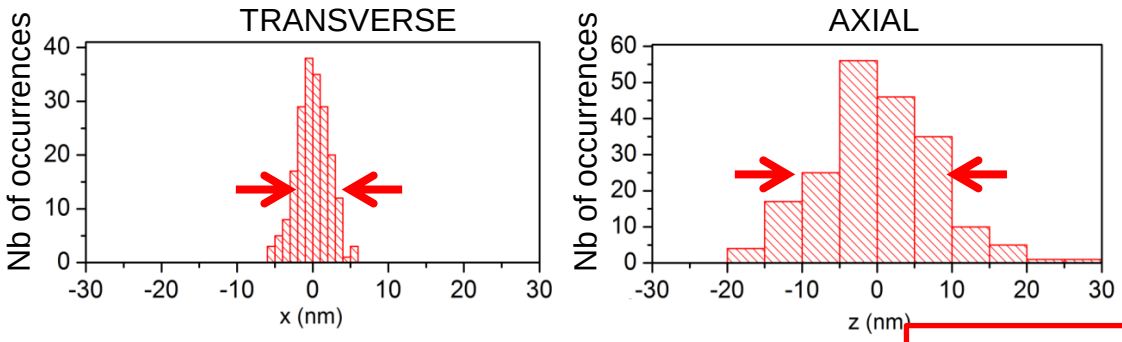
Localization Precision



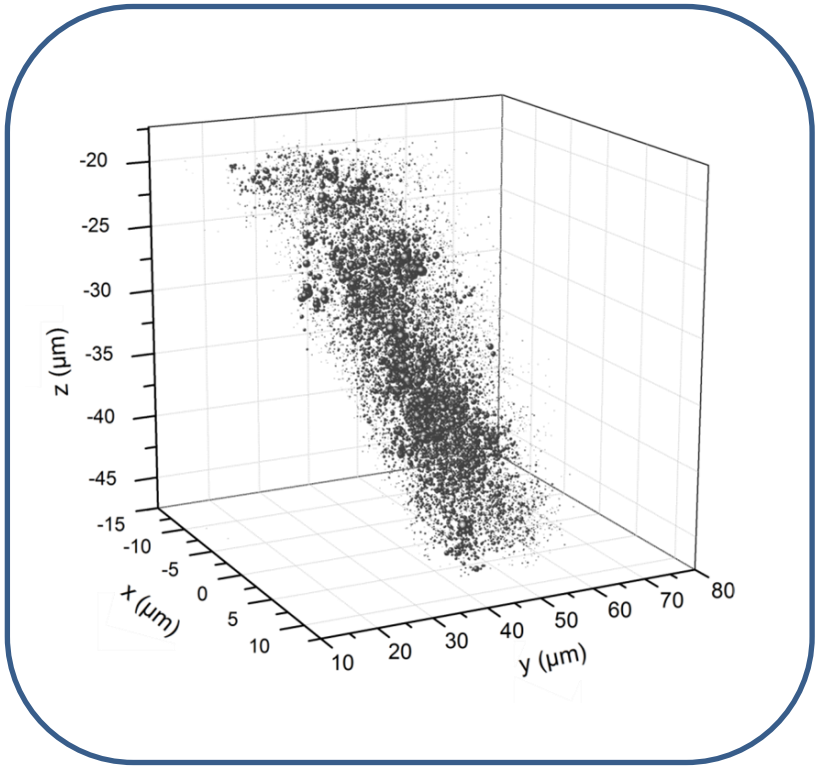
(adapted from Moerner et al.)



Localisation position histograms for still particles (Au, 50 nm)

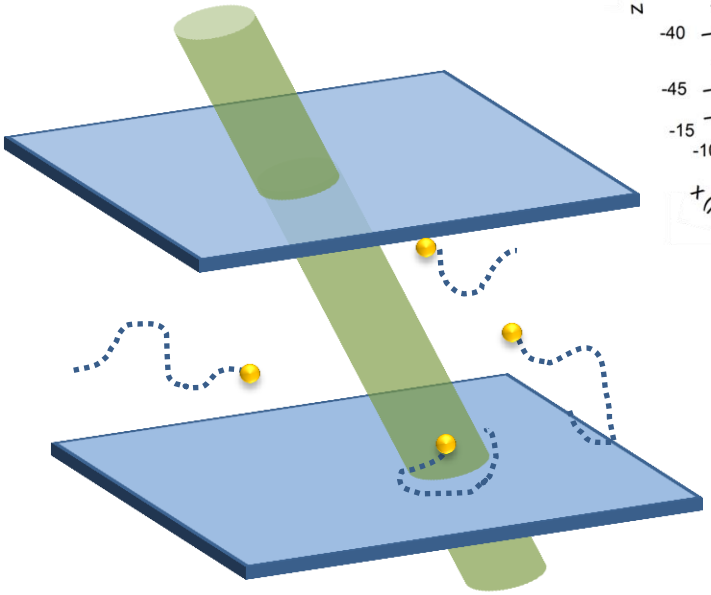


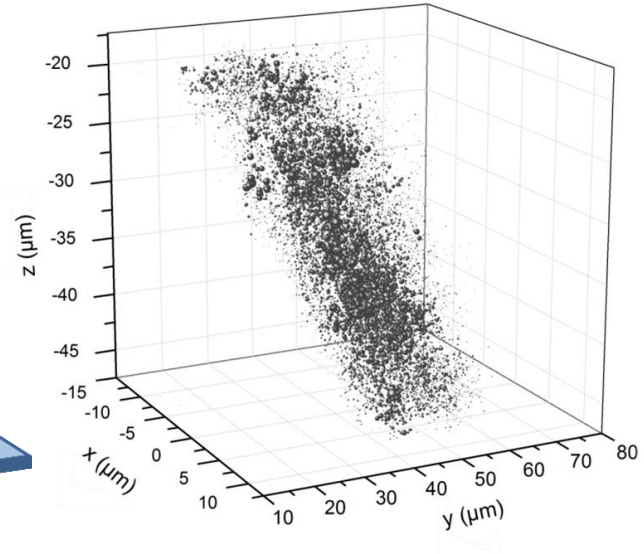
For SNR ≈ 70
Lateral localization precision : **3 nm**
Vertical localization precision : **10 nm**
Large investigated volume : **100x100x30 µm**



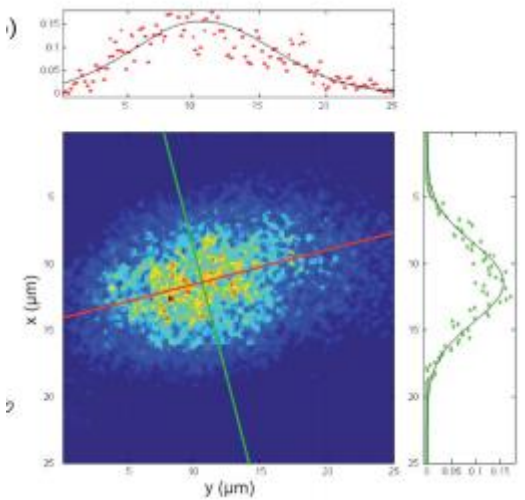
Imaging Optical Field Distribution

Near-field mapping from Gold Nanoparticles



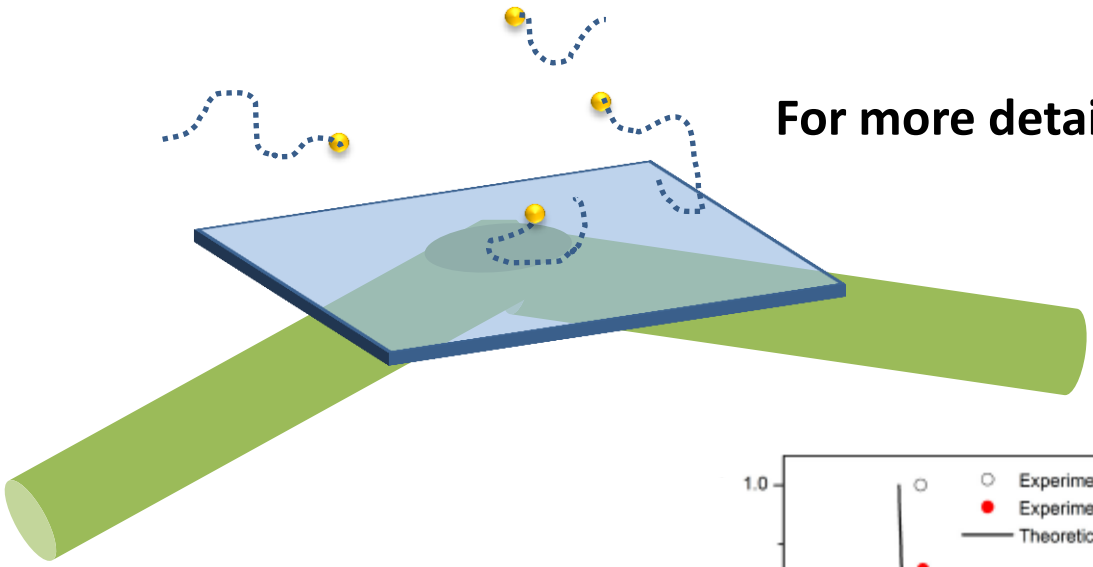


36000 particle detections
Large Volume reconstruction

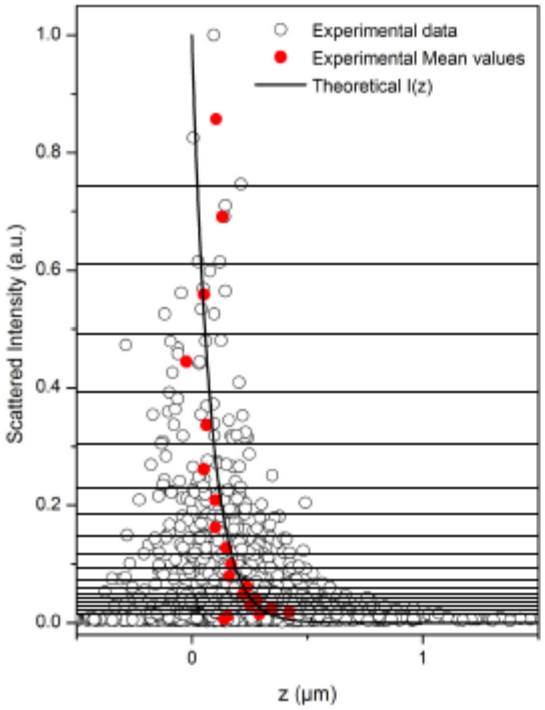


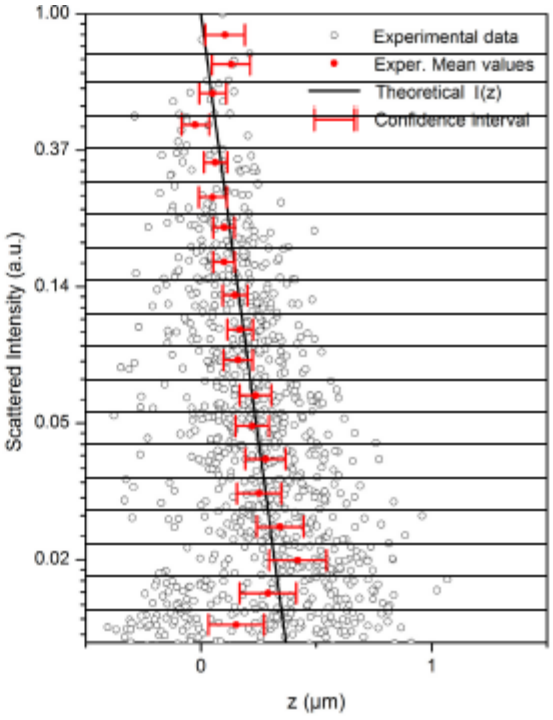
A. Martinez-Marrades, J. Rupprecht , M. Gross , G.Tessier, Optics Express 22 29191 (2014)

Near-field mapping from Gold Nanoparticles

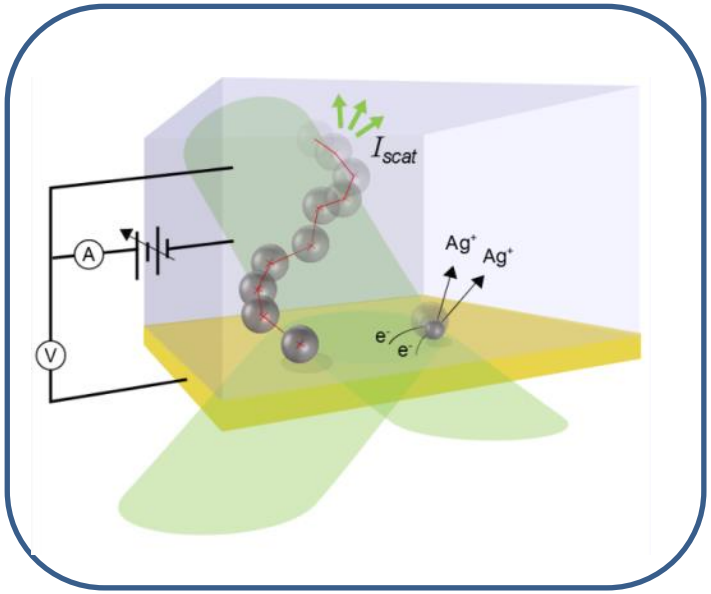


For more details: See P. Berto in Poster Section

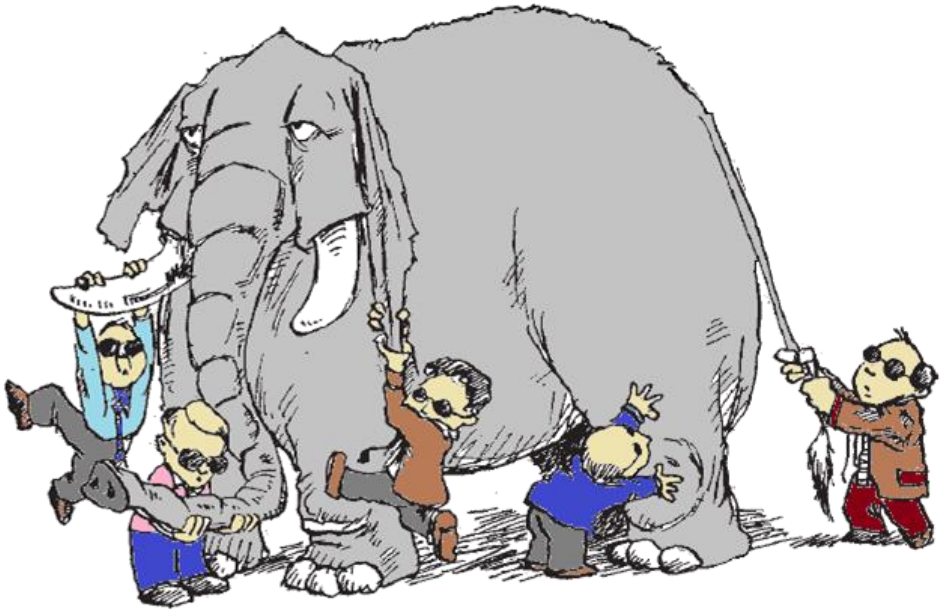




A. Martinez-Marrades, J. Rupprecht , M. Gross , G.Tessier, Optics Express 22 29191 (2014)



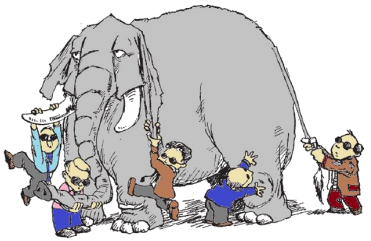
Tracking Electrochemical Impacts

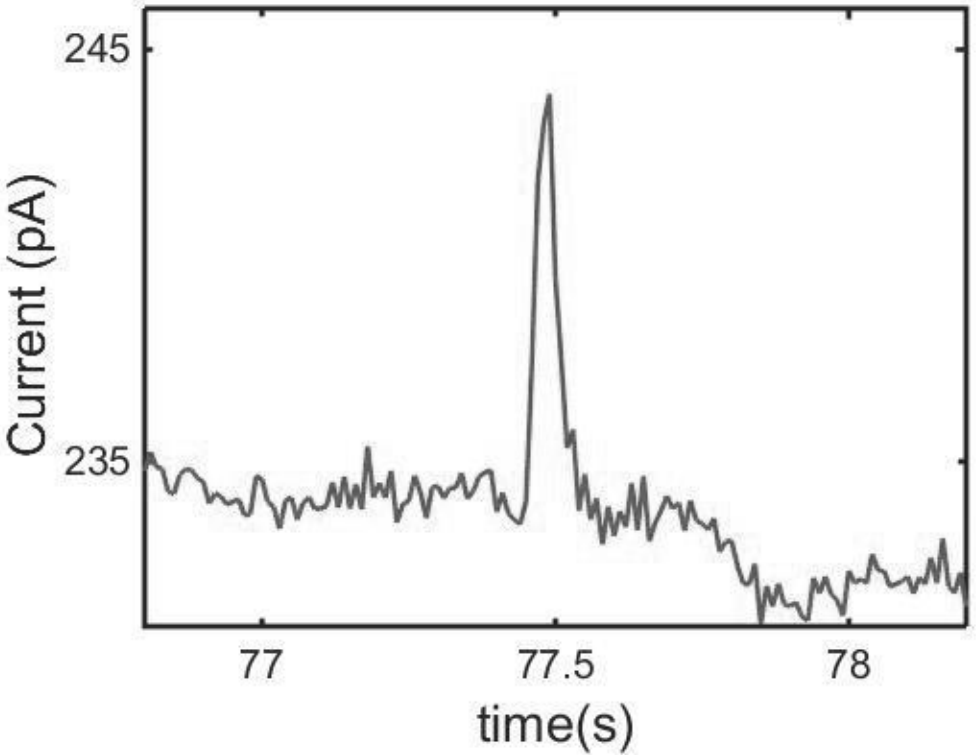


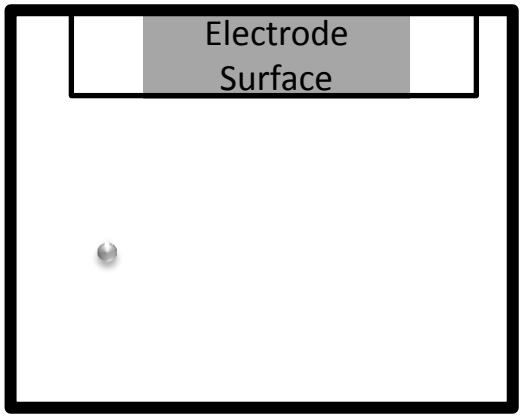

Ag


nanosilver

Seeing with electrochemical eyes





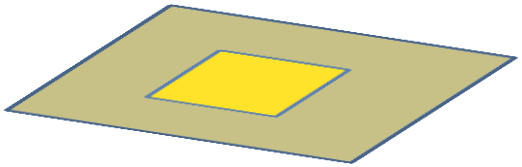


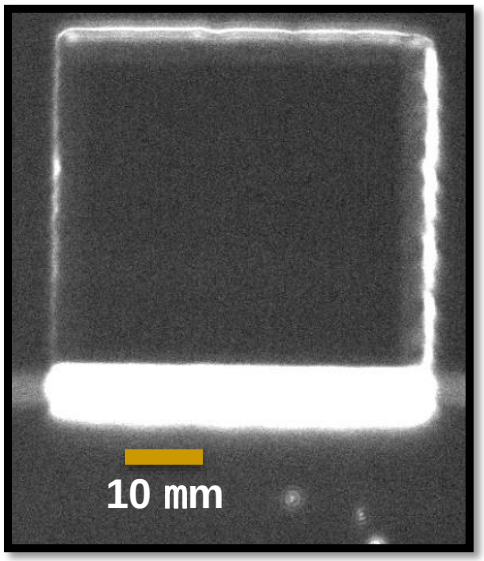
But...

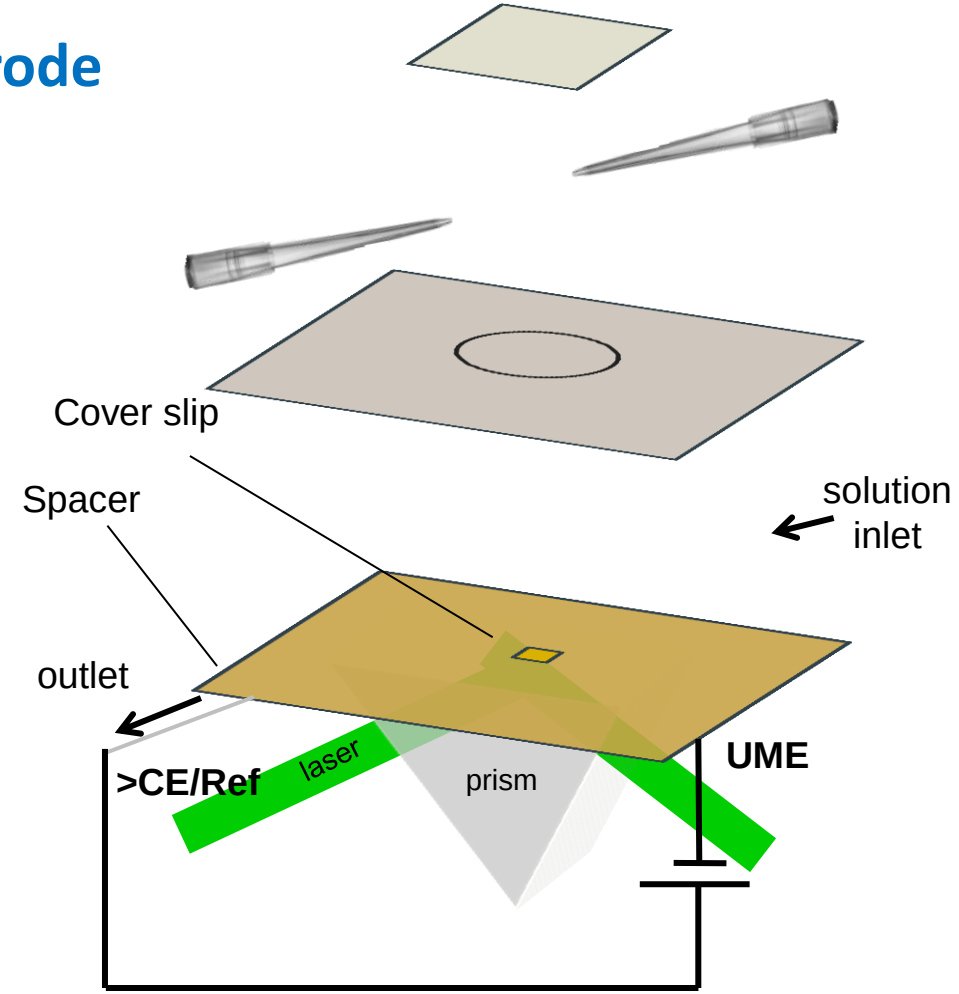
- Partial oxidation?
- Single Particle?
- Agglomerate Single response?

Designing a transparent electrode

Ultra Micro Electrode



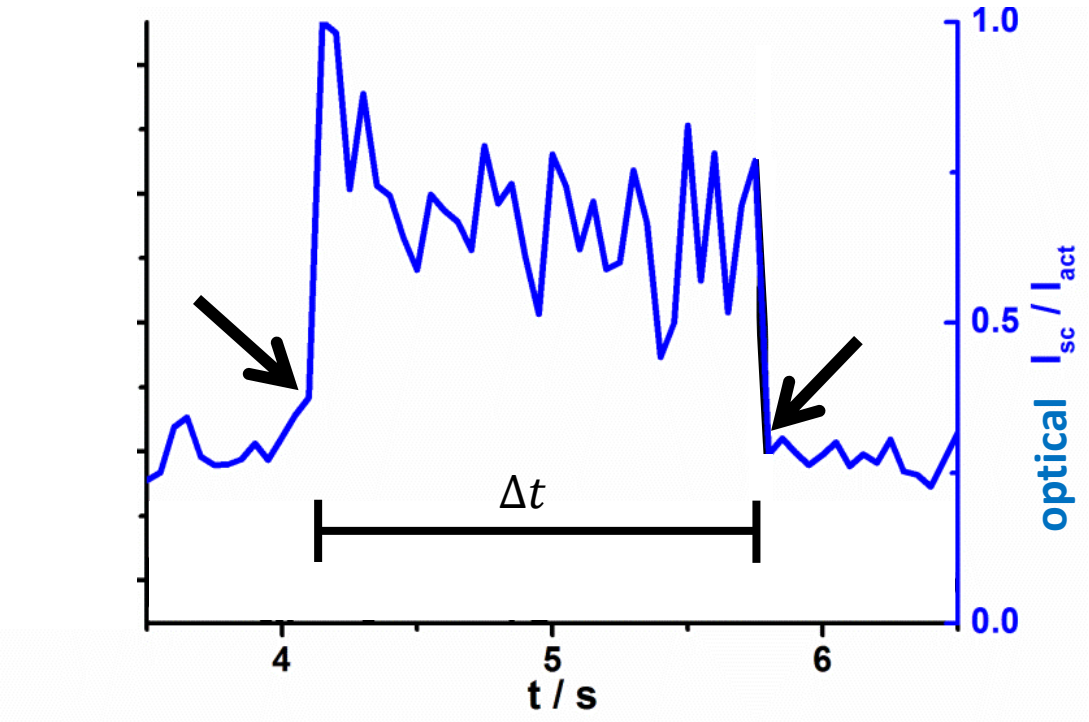




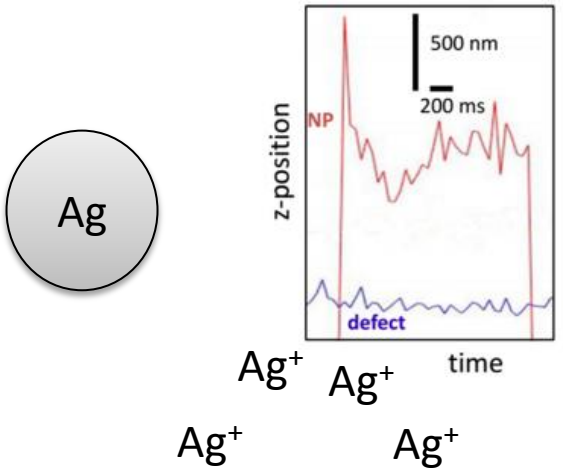
V.Brasiliense, et al JACS (2016 accepted) DOI: 10.1021/jacs.5b13217

A.Patel, A.Martinez-Marrades, V.Brasiliense, et al Nanoletters 22 29191 (2014)

Direct particle Oxidation:
Synchronized Charge Injection/Dissolution



In presence of NO_3^- :



V.Brasiliense, et al JACS (2016 accepted) DOI: 10.1021/jacs.5b13217

A.Patel, A.Martinez-Marrades, V.Brasiliense, et al Nanoletters 22 29191 (2014)

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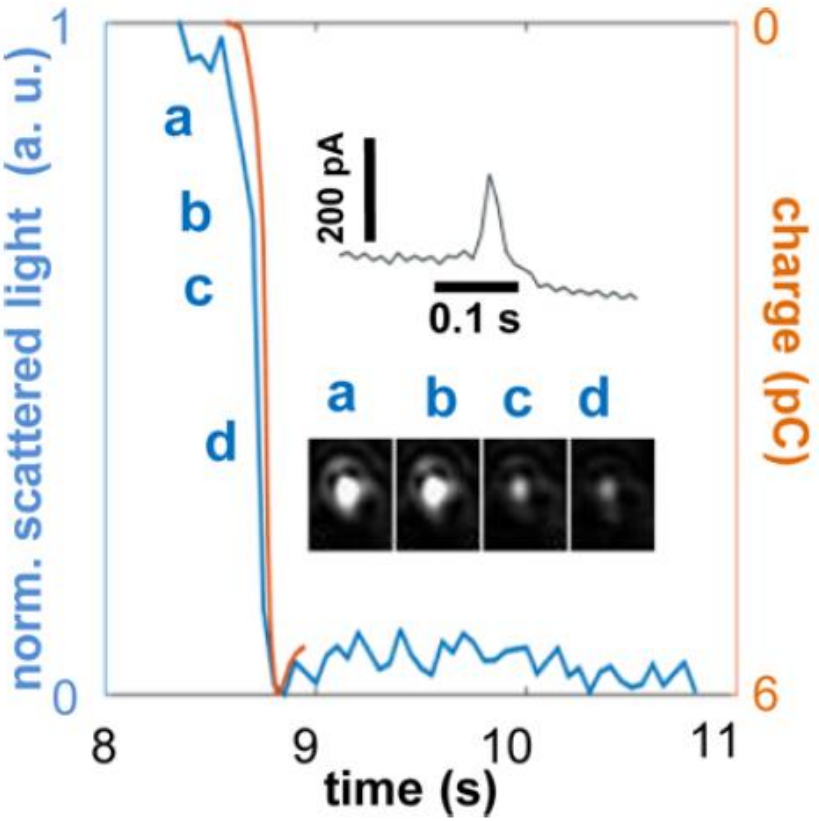
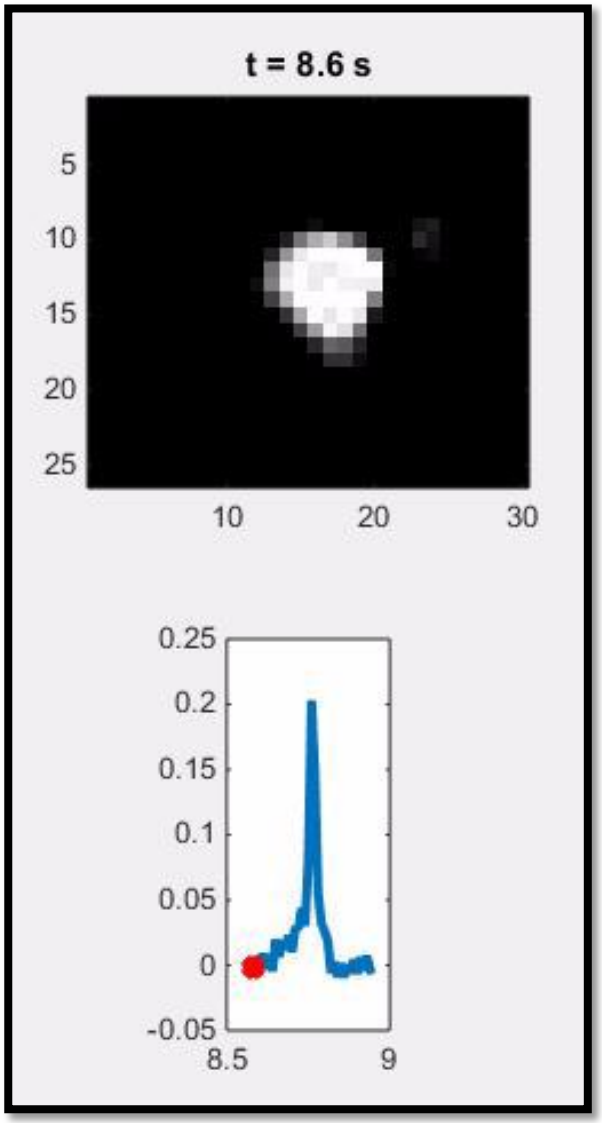
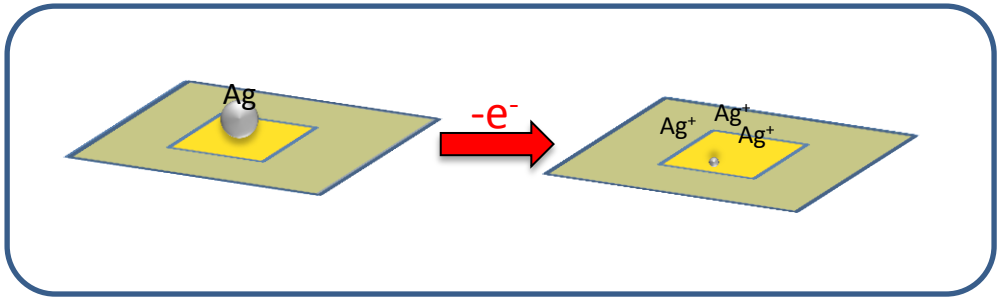


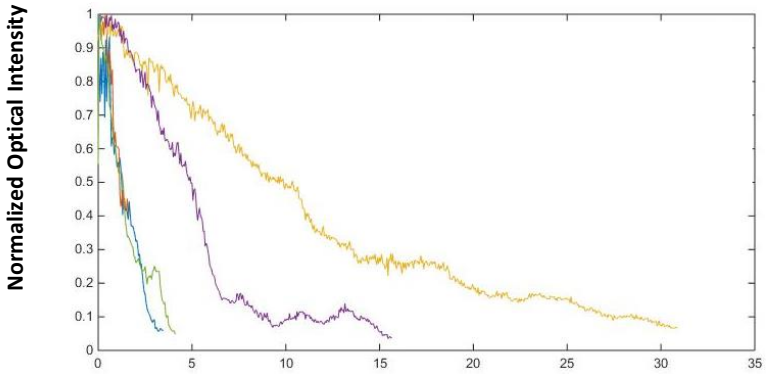


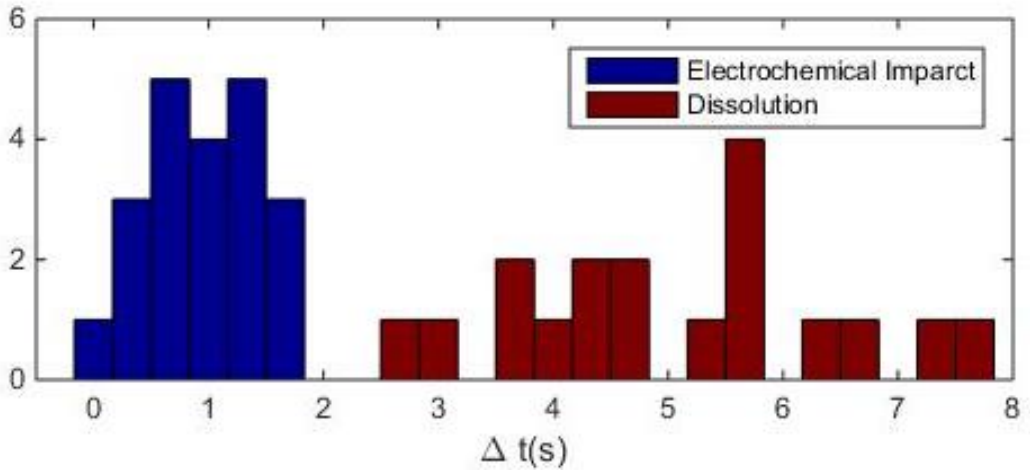


V.Brasiliense, et al JACS (2016 accepted) DOI: 10.1021/jacs.5b13217

A.Patel, A.Martinez-Marrades, V.Brasiliense, et al Nanoletters 22 29191 (2014)

Oxidation in a precipitating medium (KSCN): Uncoupled Charge Injection/Dissolution





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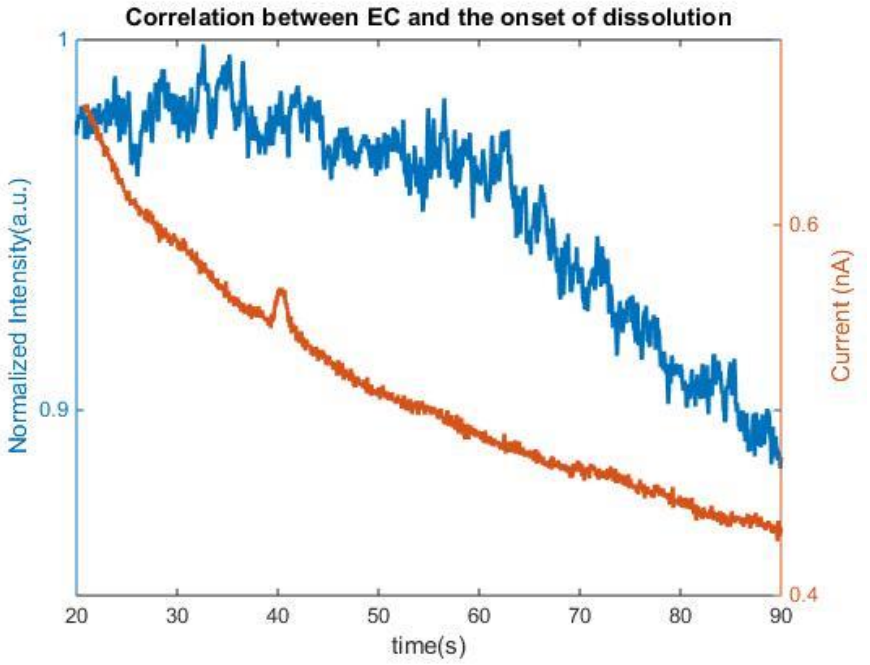
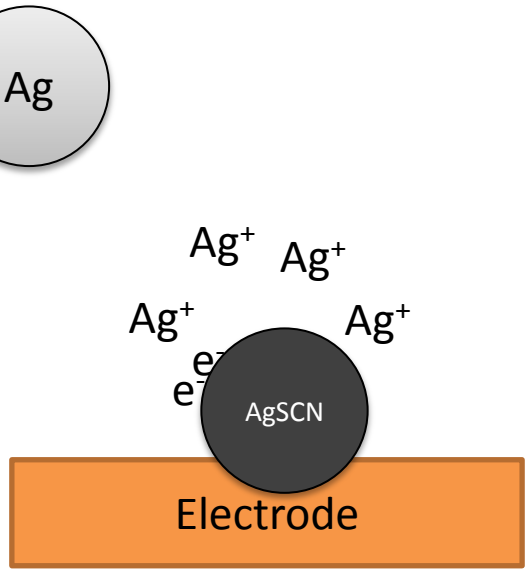
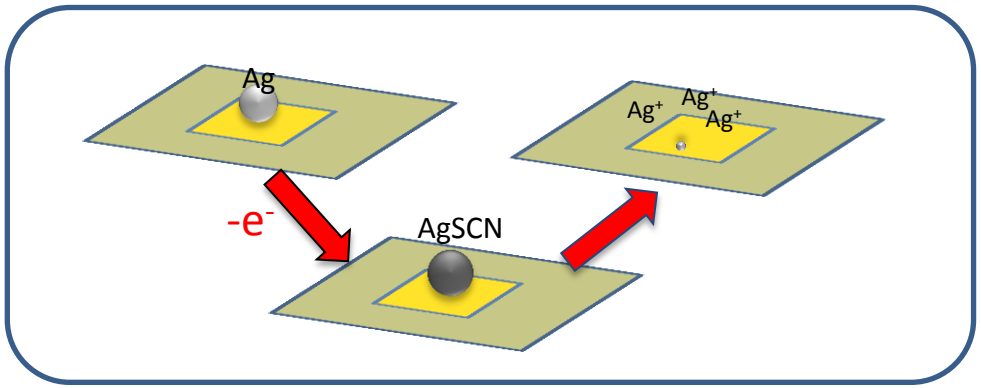


In presence of SCN^- :





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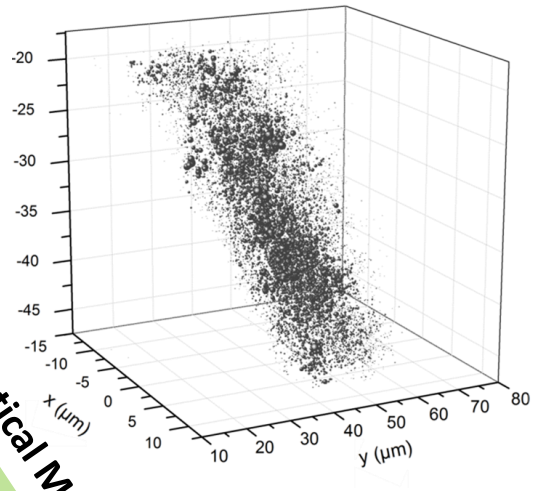
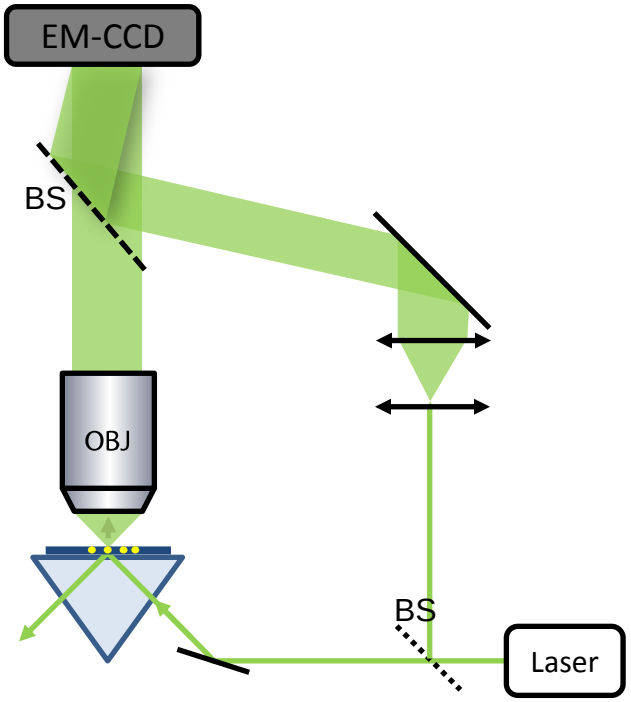
A.Patel, A.Martinez-Marrades, V.Brasiliense, et al Nanoletters 22 29191 (2014)

Conclusions





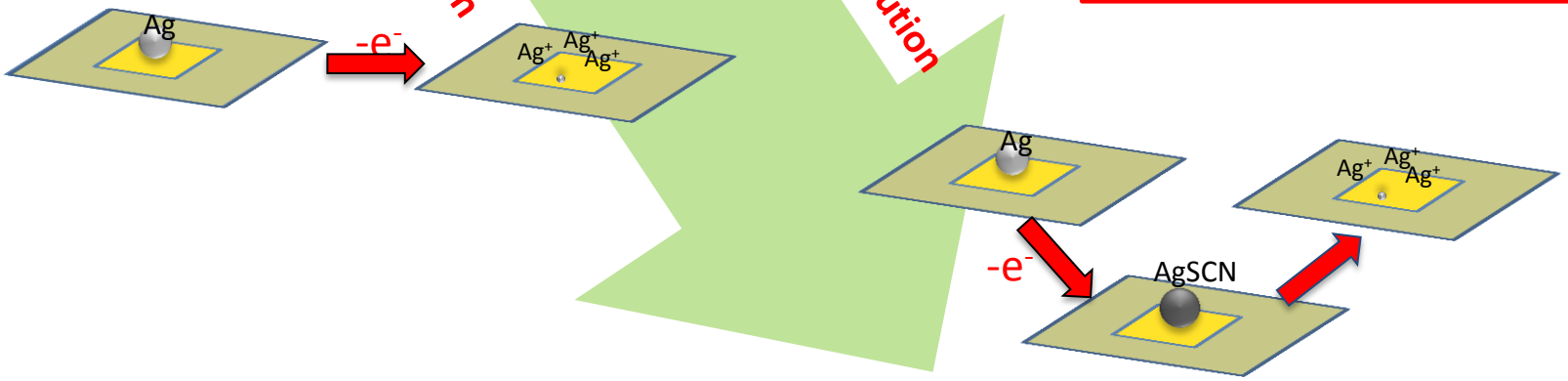
Near Field Optical Mapping

Electrochemical Dissolution

Increasing Complexity

Delayed Dissolution

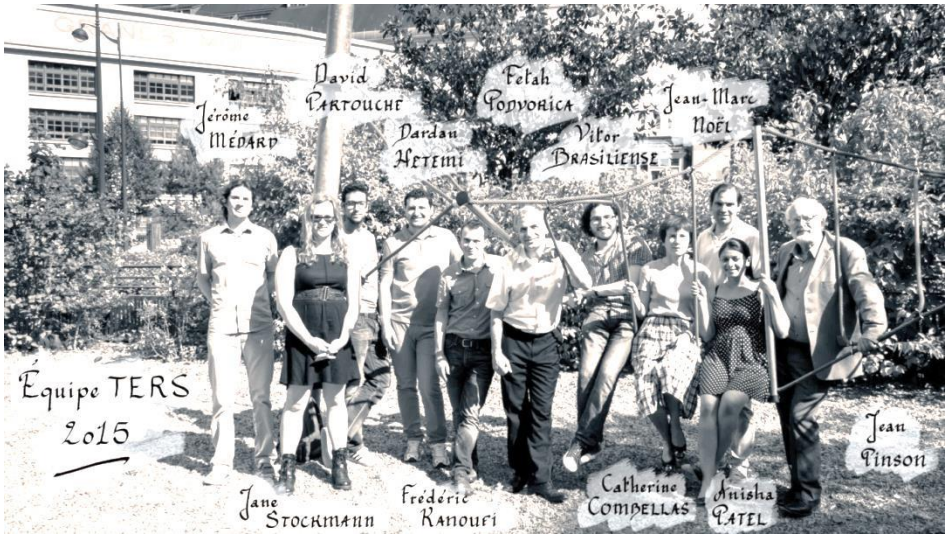
Lateral precision : **3 nm**
Vertical precision : **10 nm**
Investigated volume : **100x100x30 µm**



Thank you!


G. Tessier


F. Kanoufi




P. Berto


R. Kuszelewicz


A.Martinez

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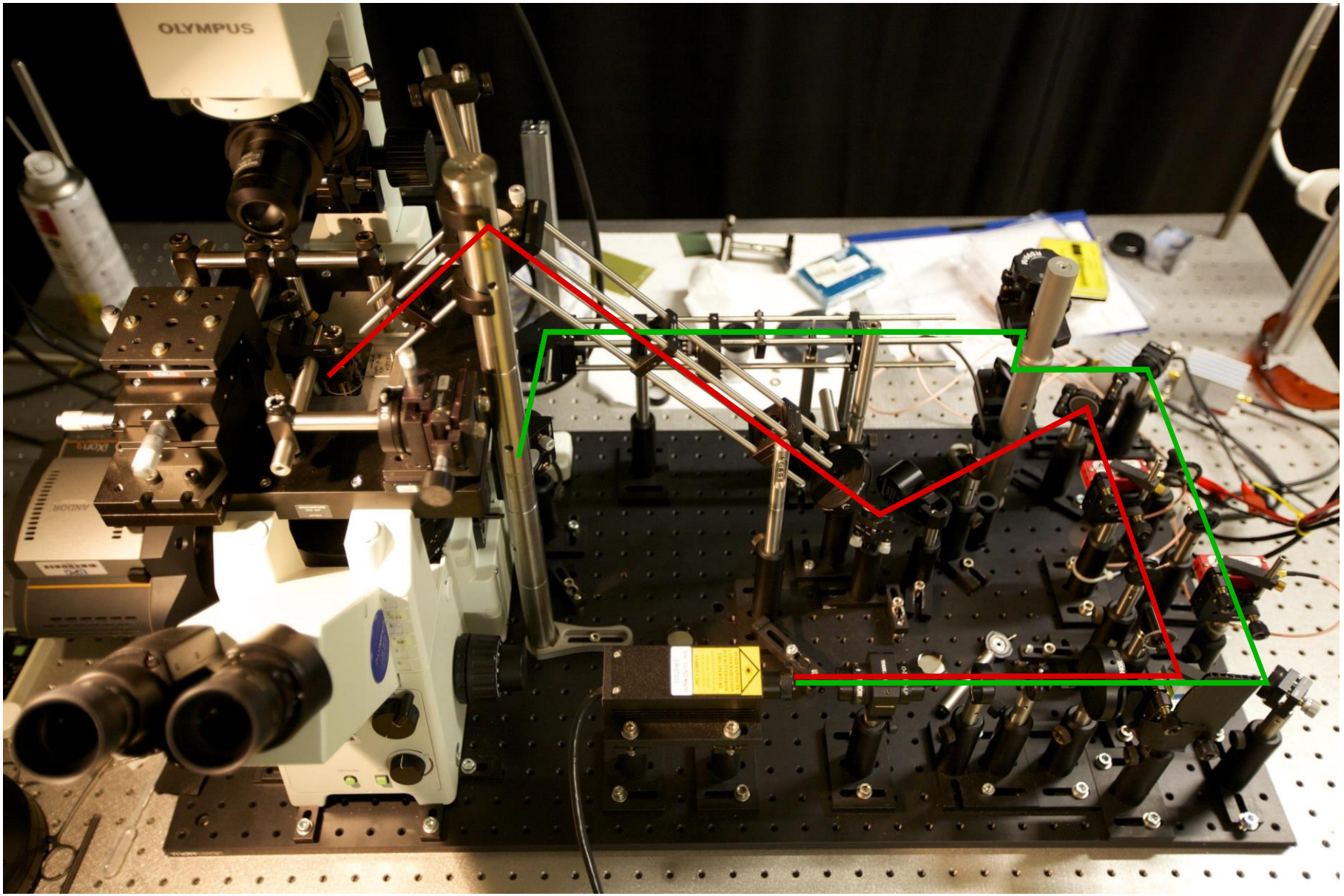
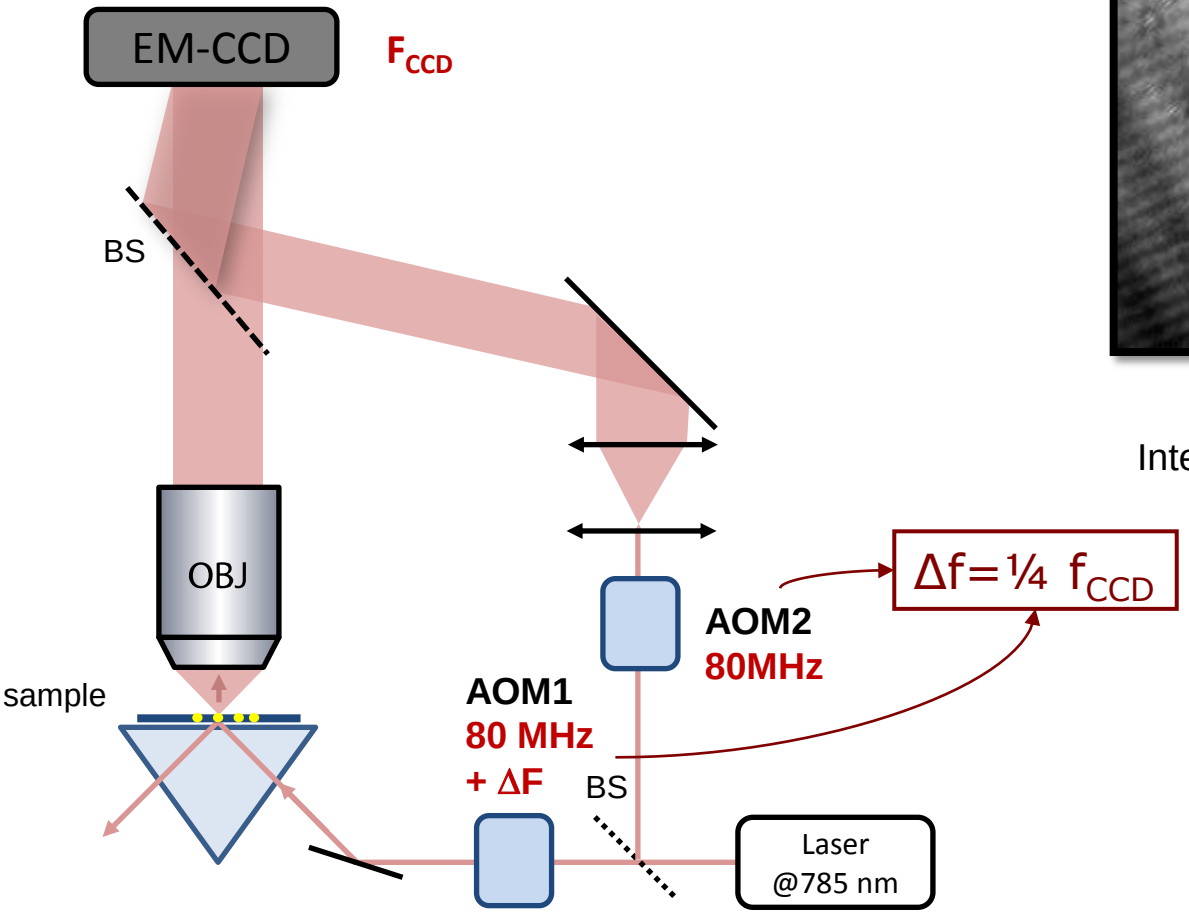
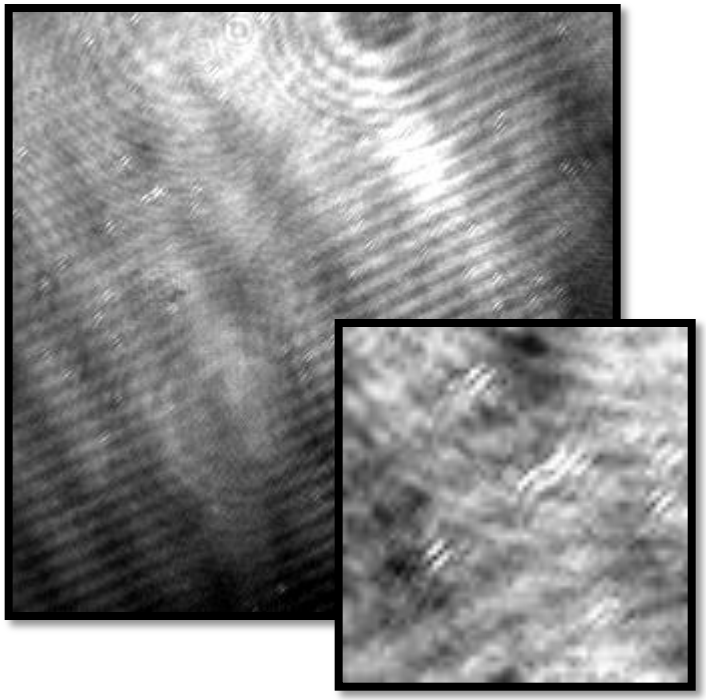

OLYMPUS

Digital Heterodyne Holography



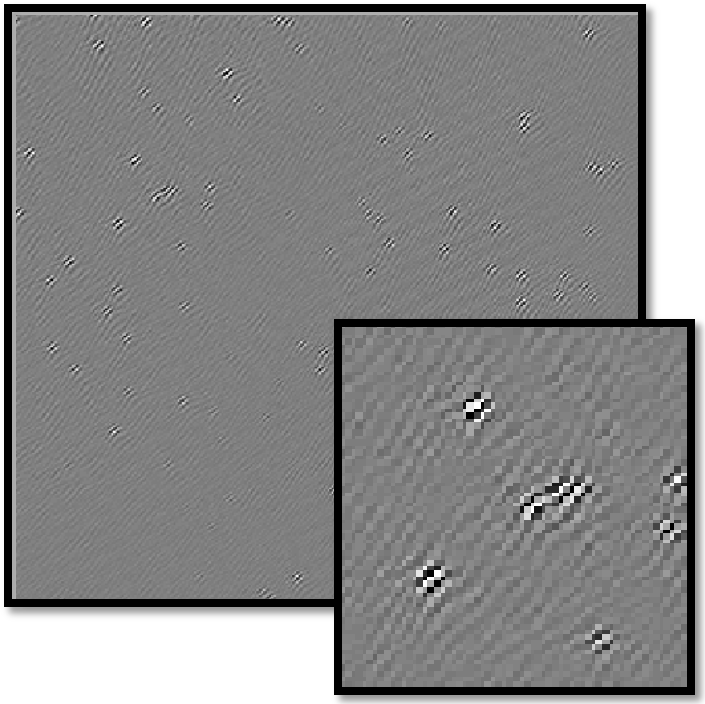
Heterodyne Hologram

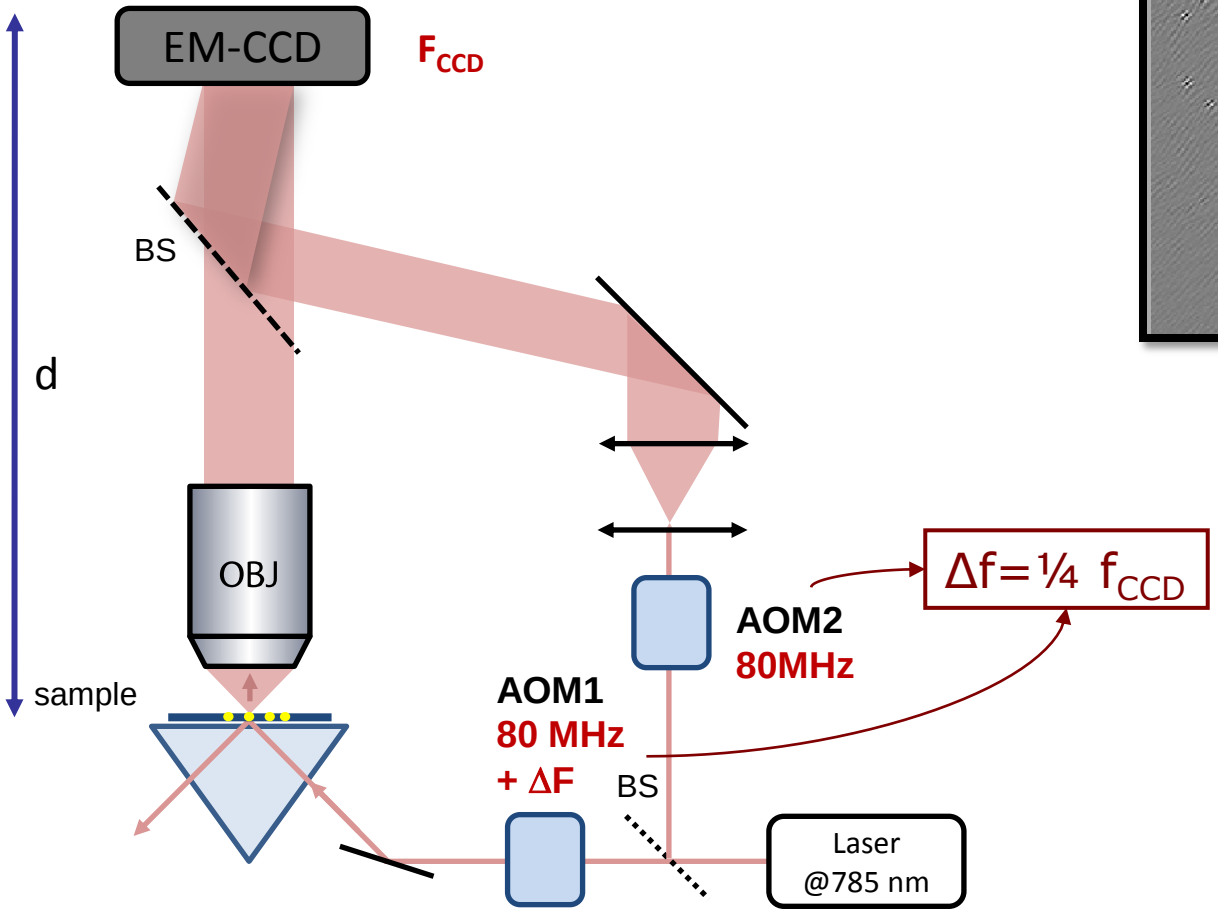


Interference pattern modulated at 4Hz

M. Gross *et al.*, Opt. Lett. 32, 909 (2007)

Digital Heterodyne Holography



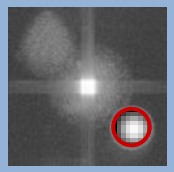


M. Gross *et al.*, Opt. Lett. 32, 909 (2007)

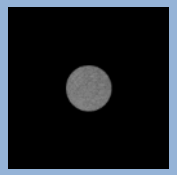
Reconstruction and Superlocalization

From a single hologram:

1. FT



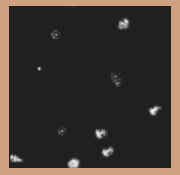
2. SF



3. Z Propagation

$\cdot e^{i k_z z}$

4. $(FT)^{-1}$

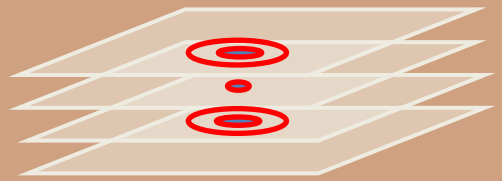


5. Thresholding

Particle Detection

x Nb of Z plans

6. Localization



1) Particle localization in z
2) Precise relocalization in (x,y) plan

x Nb of Nanoparticles

x Nb of Holograms (for different times t)

⟶ (x,y,z, Intensity) for different particles at different times,
Several hundred times faster than CPU calculations