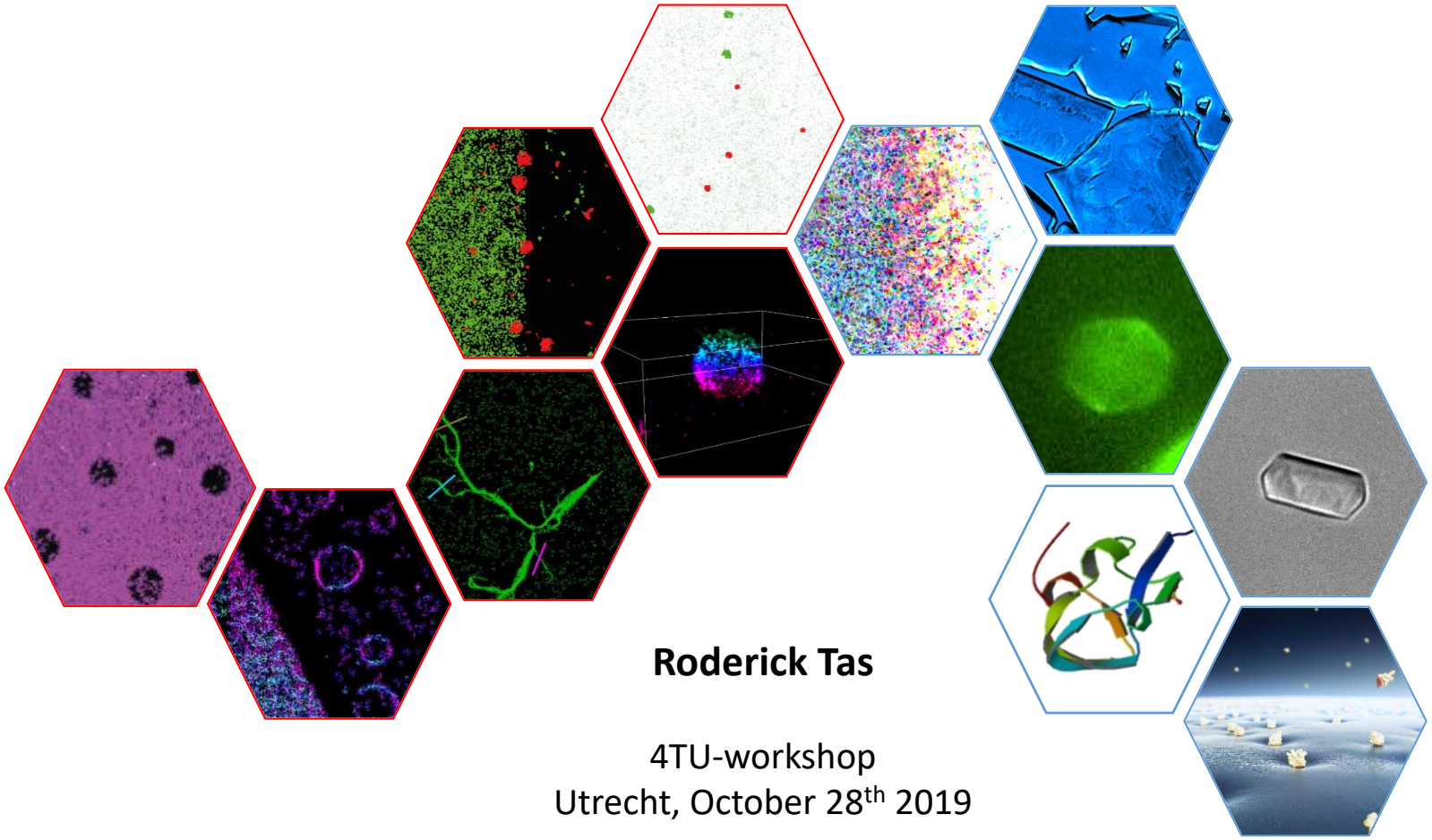
Nanoscopy at the interface

From Materials to Ice



Roderick Tas

4TU-workshop
Utrecht, October 28th 2019

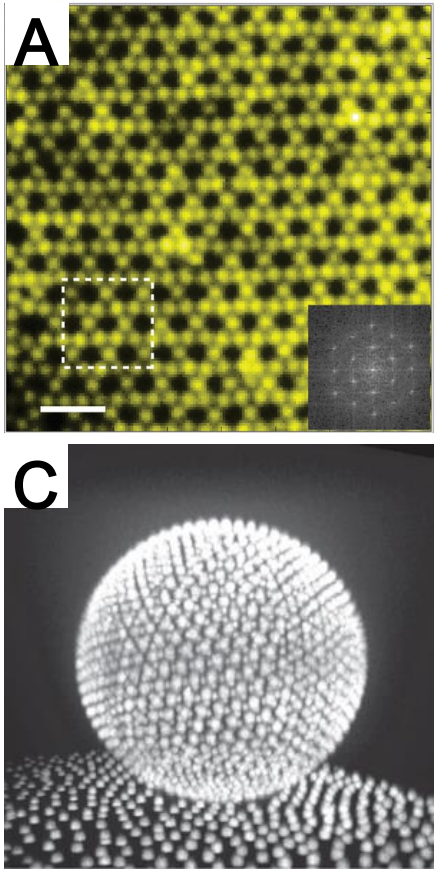
Voets Lab
Self-Organizing Soft Matter

TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

Institute for Complex Molecular Systems

Nanoscale assemblies in chemistry and soft matter

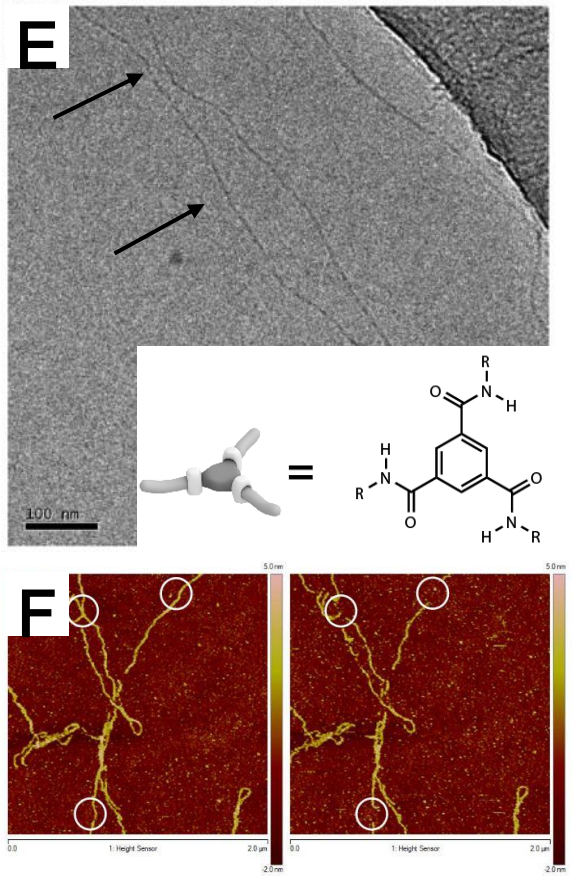
Assembly of colloids and colloidal crystals



A) Q. Chen et al., *Nature, **2011**.*
B) M.E. Leunissen et al., *Nature*, **2005**.

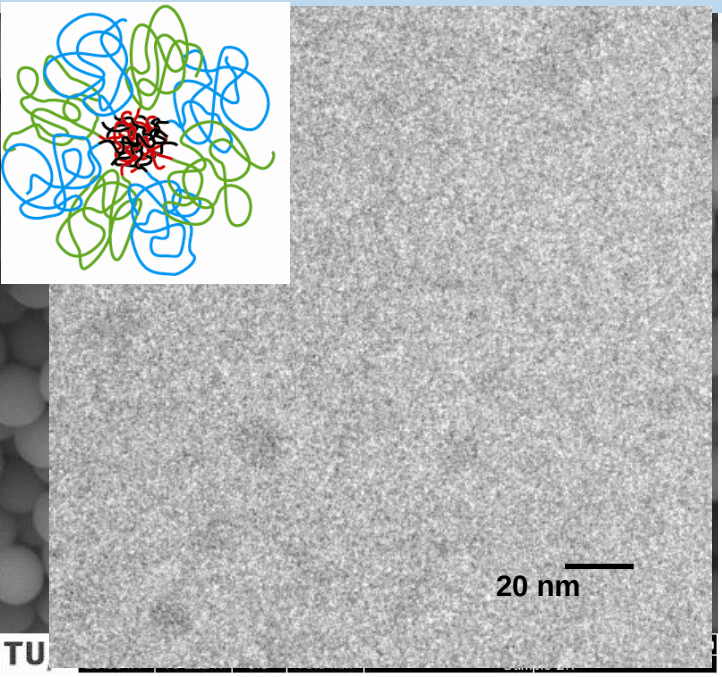
C) W.T.M. Irvine et al., *Nat. Mater., **2012**.*
D) A. Yethiraj et al., *Nature*, **2003**.

Assembly of supramolecular molecules



E) C.M.A. Leenders et al., *Chem. Comm., **2013**.*
F) M. Beuwer et al., *Pol. Chem.*, **2016**.

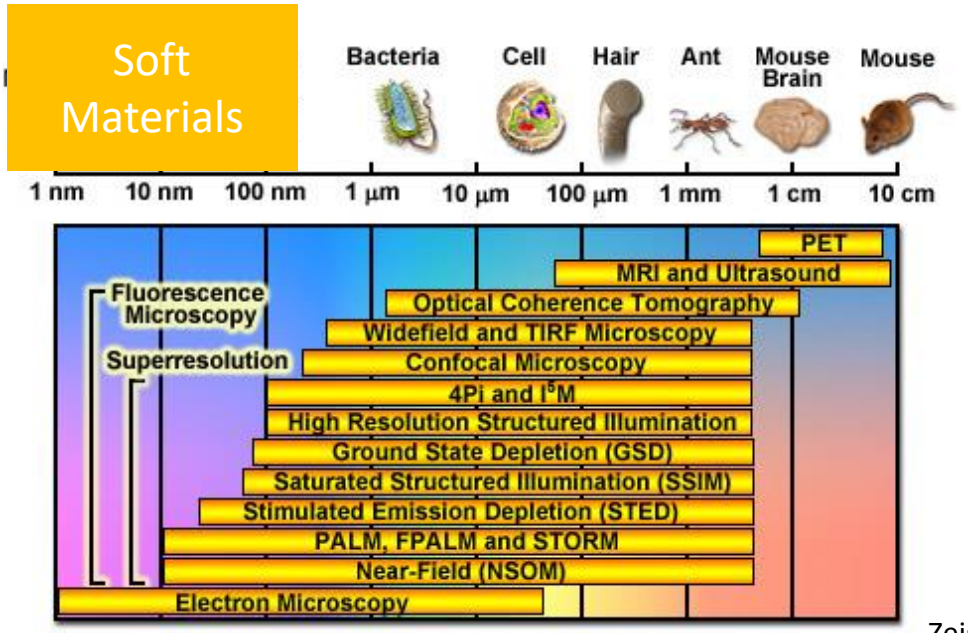
Soft Matter microscopy



Electron Microscopy

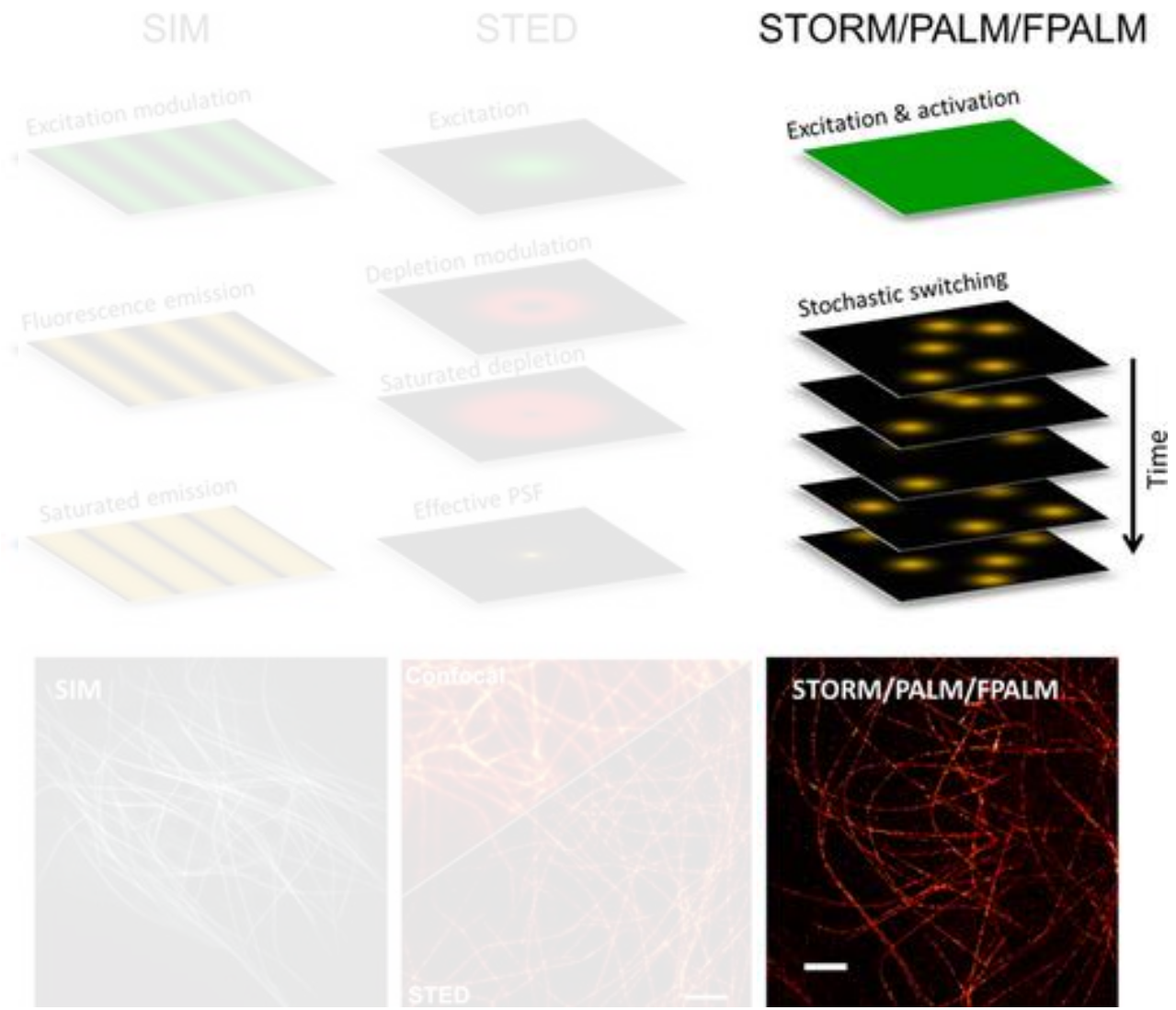
Super resolution microscopy

In Situ imaging
Labeling specificity
Dynamic information



Zeiss

Flavours of super-resolution microscopy

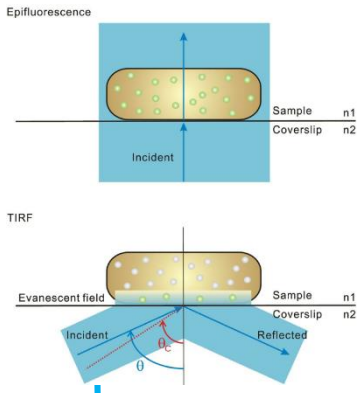


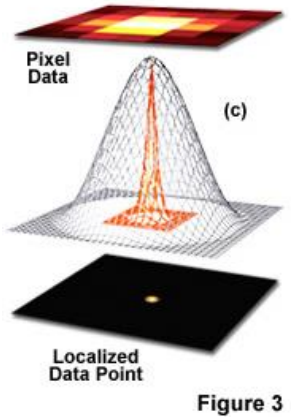
Single Molecule Localization Microscopy (SMLM)

Lateral resolution	~100nm	~50nm	~10nm
Temporal resolution	~s	~s	~min

Ni et al., 2017 JBioPhotonics

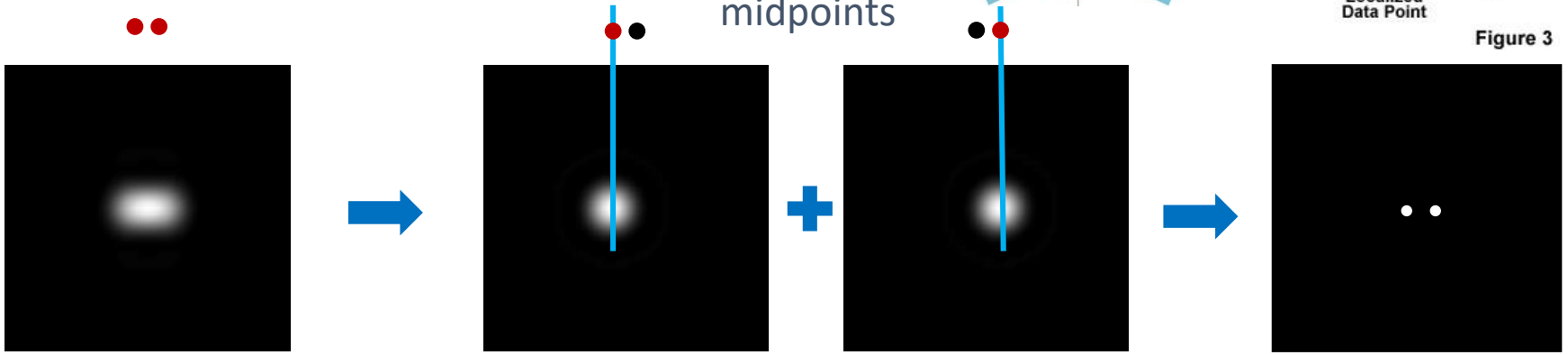
Single molecule localization microscopy



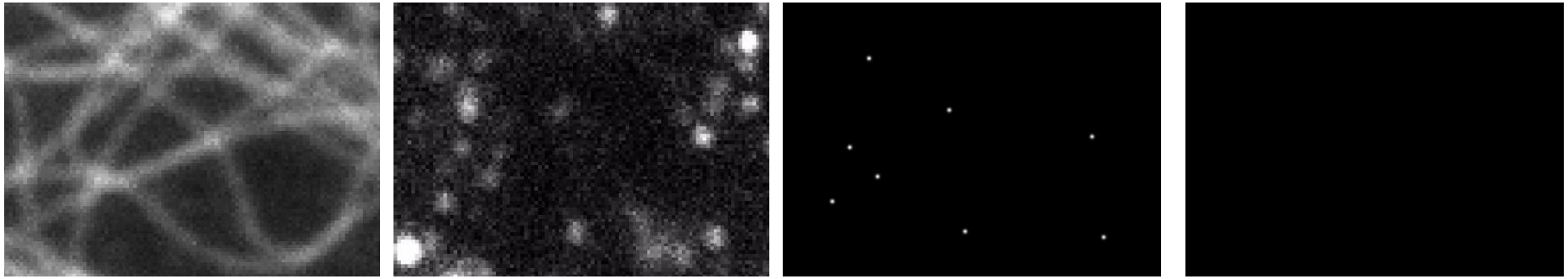


200nm

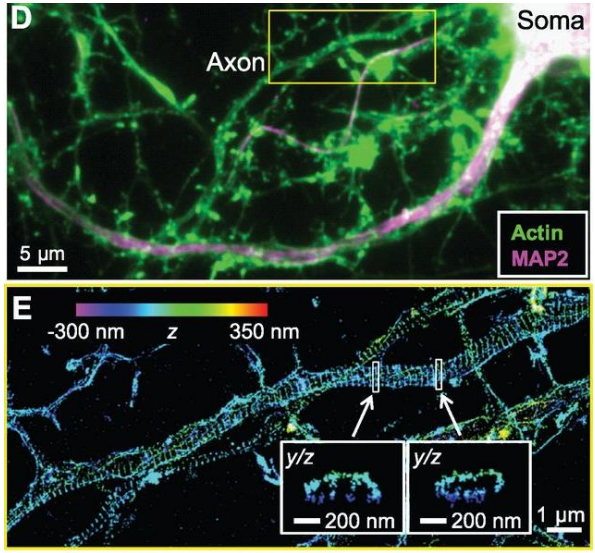
midpoints



widefield image | acquisition | localizations | reconstruction

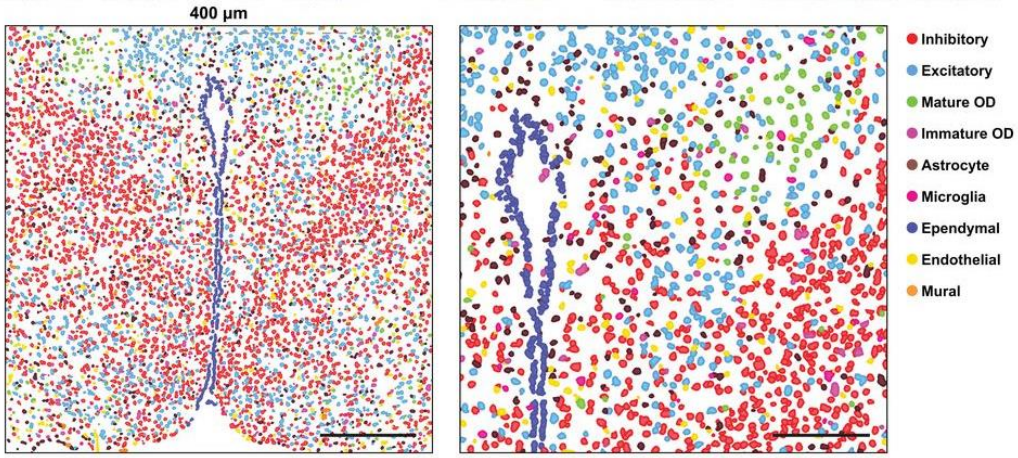


Lessons from biology



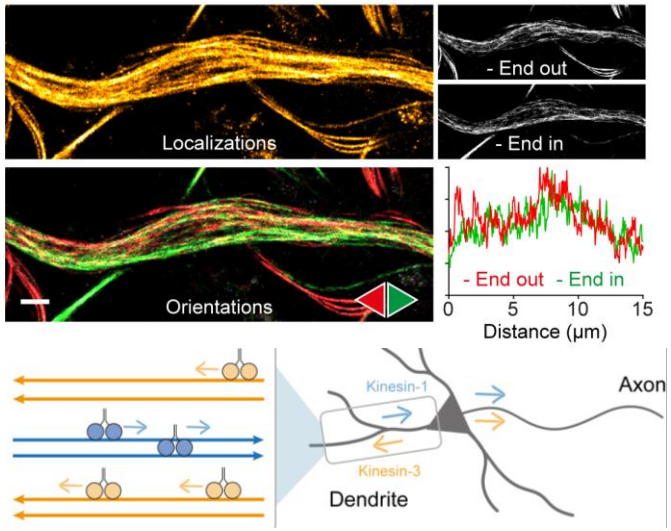
Periodic rings in neuronal neurites

Xu et al., 2015 Science



Spatially resolved single-cell RNA profiling

Moffit et al., 2018 Science

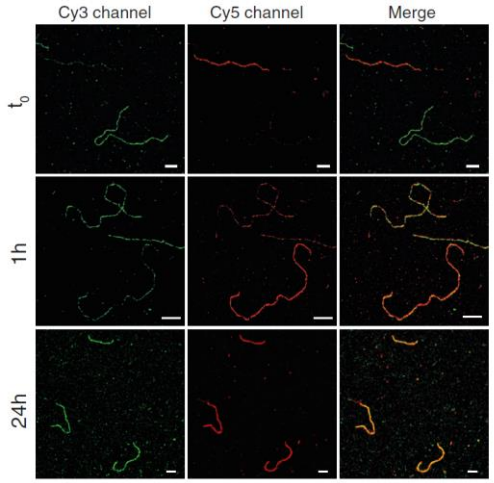


Microtubule orientations dictate selective transport in neurons

Tas et al., 2018 Neuron

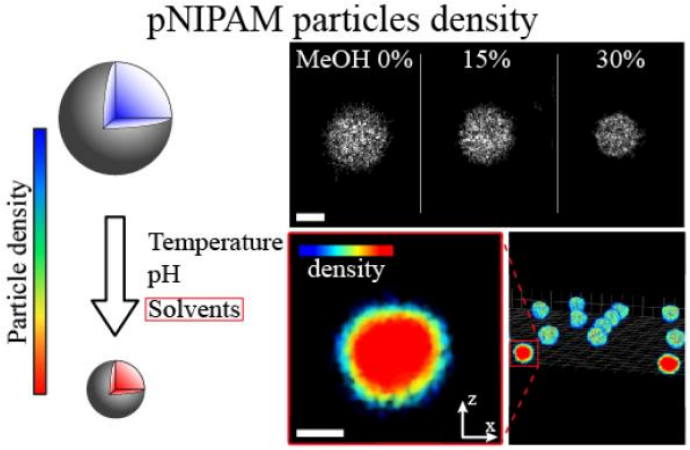
Nanoscopy in material sciences

supramolecular polymers



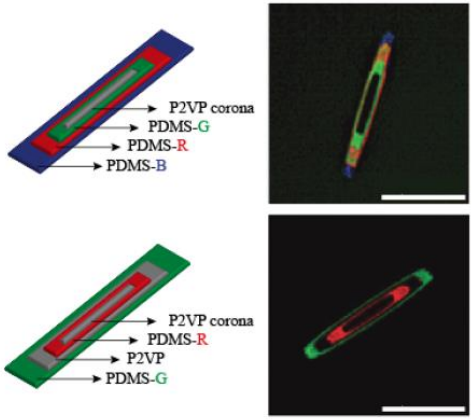
Albertazzi et al., 2014 Science

Particle composition and density



*Conley et al., **2016** CSA*

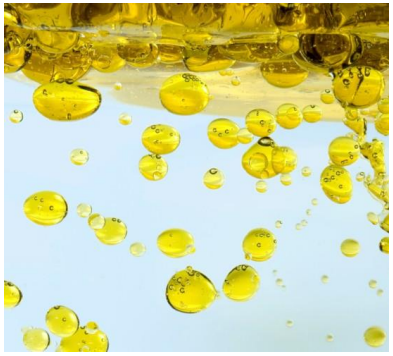
2D micelles characterization



Qiu et al., 2016 Science

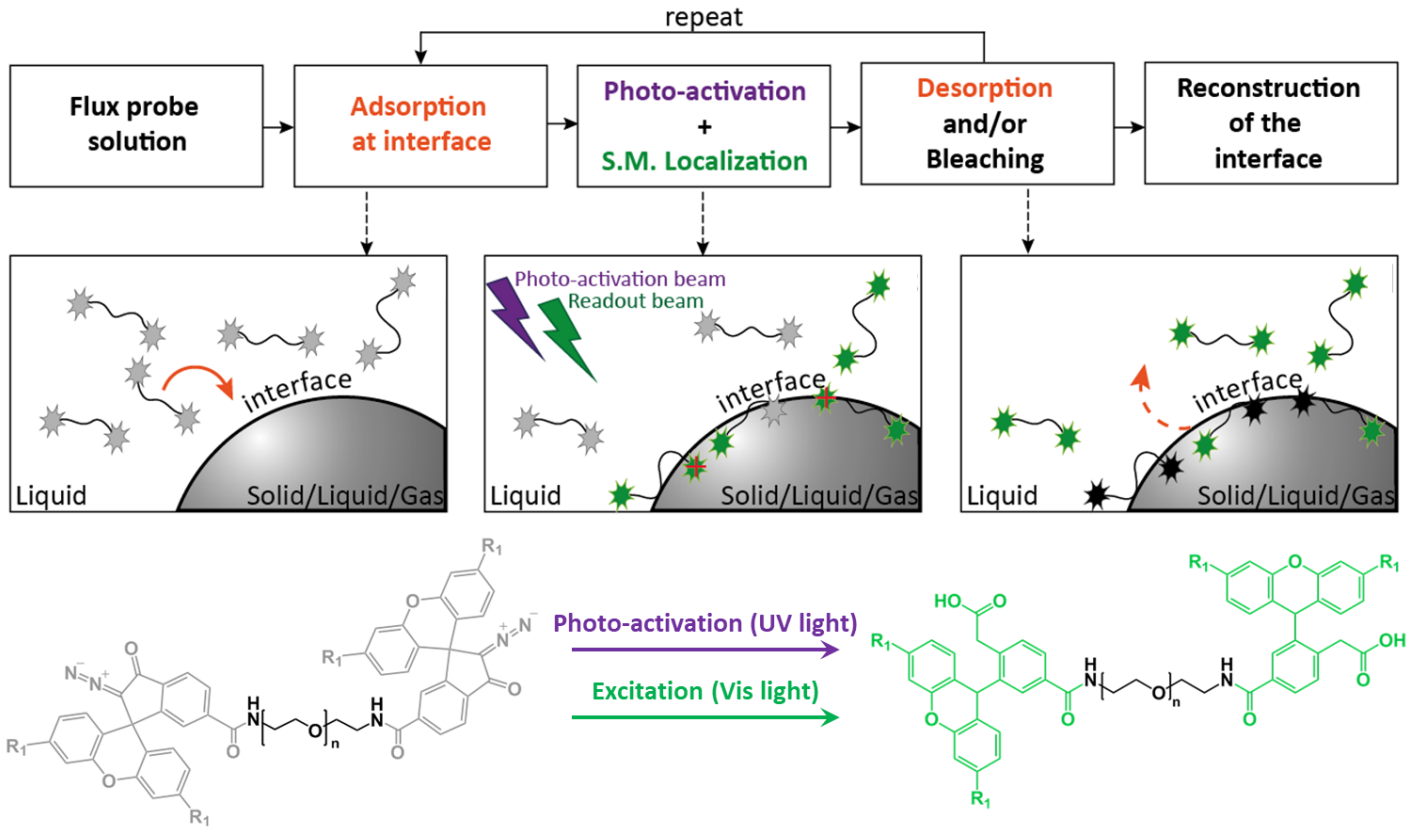
Outline: Applications of SMLM to understand soft matter

- **iPAINT: a versatile SMLM tool to study soft matter**
  - Colloidal dispersion in fluid-fluid interfaces
  - Complex supramolecular polymers



- **Resolving antifreeze proteins at the ice-water interface to study their mechanisms**

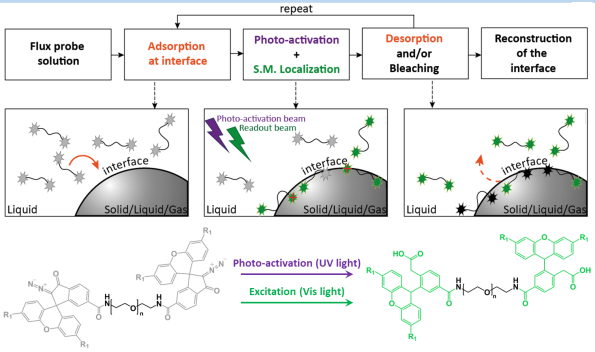
iPAINT



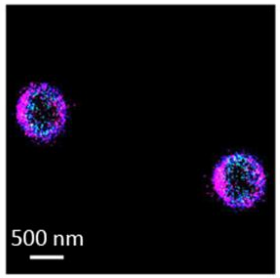
Transient non-covalent adsorption of fluorophores at interfaces

Aloi et al., 2016, Nanoscale

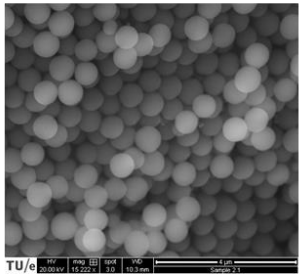
iPAINT: Colloidal dispersions and interfaces

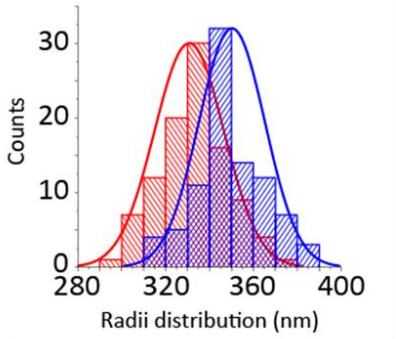


iPAINT



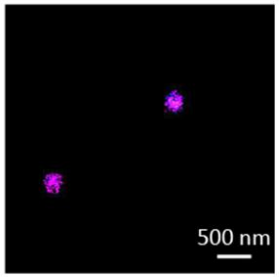
SEM



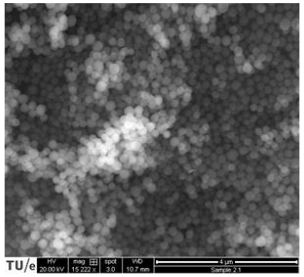


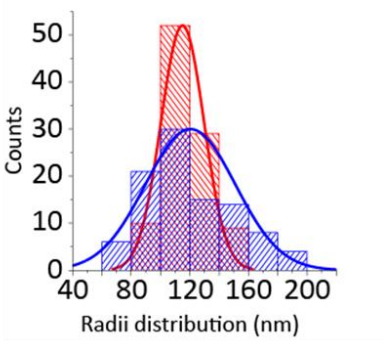
iPAINT
SEM
$\overline{R} = 350 \pm 15 nm$
$\overline{R} = 332 \pm 18 nm$

iPAINT



SEM

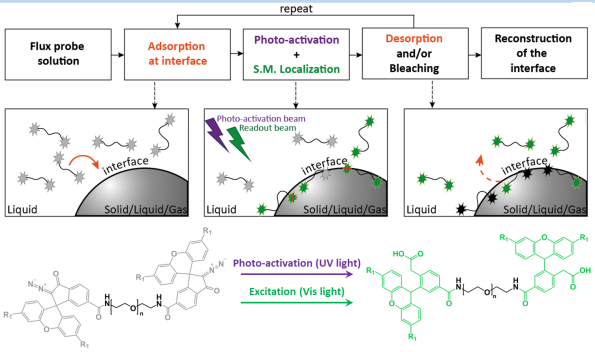




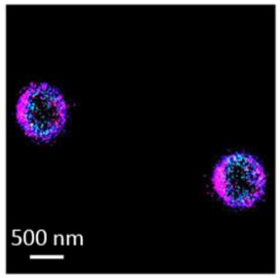
iPAINT
SEM
$\overline{R} = 118 \pm 26 nm$
$\overline{R} = 115 \pm 14 nm$

Aloi, IKV, RSC Nanoscale 2016

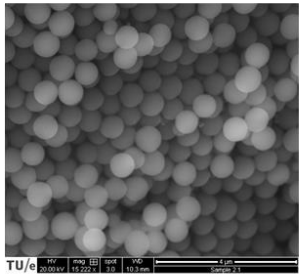
iPAINT: Colloidal dispersions and interfaces



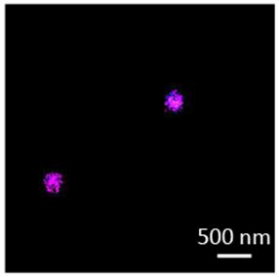
iPAINT



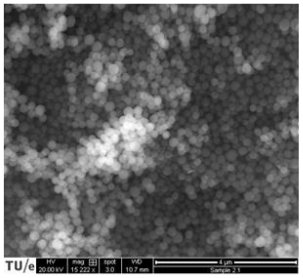
SEM



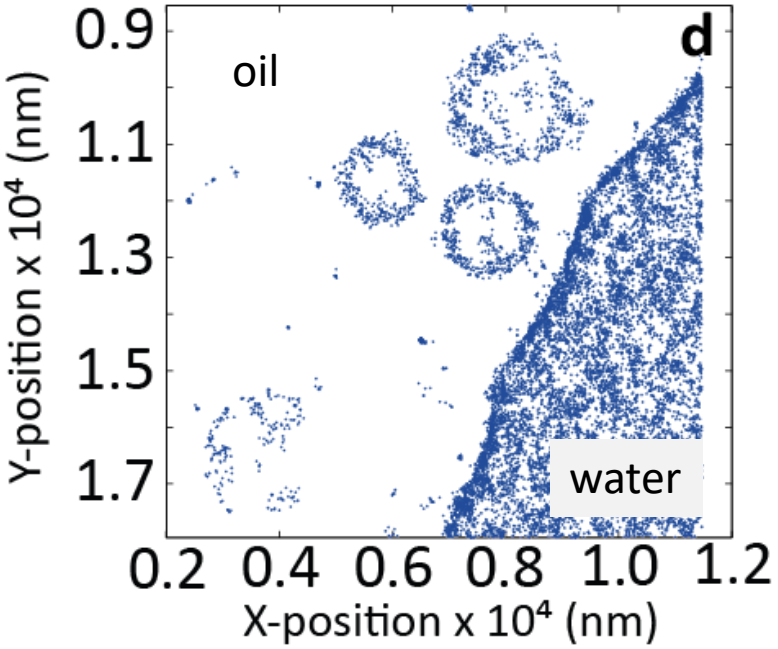
iPAINT



SEM



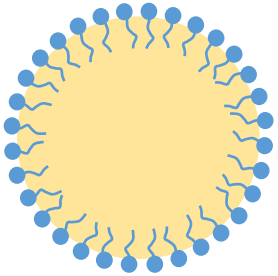
iPAINT of a liquid-liquid interface



Aloi, IKV, RSC Nanoscale 2016

iPAINT: Colloidal dispersions in a fluid interface

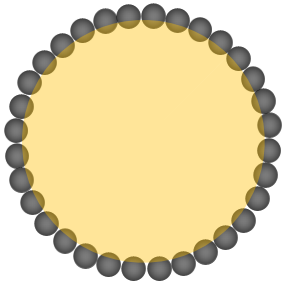
Surfactants



Lowers interfacial tension

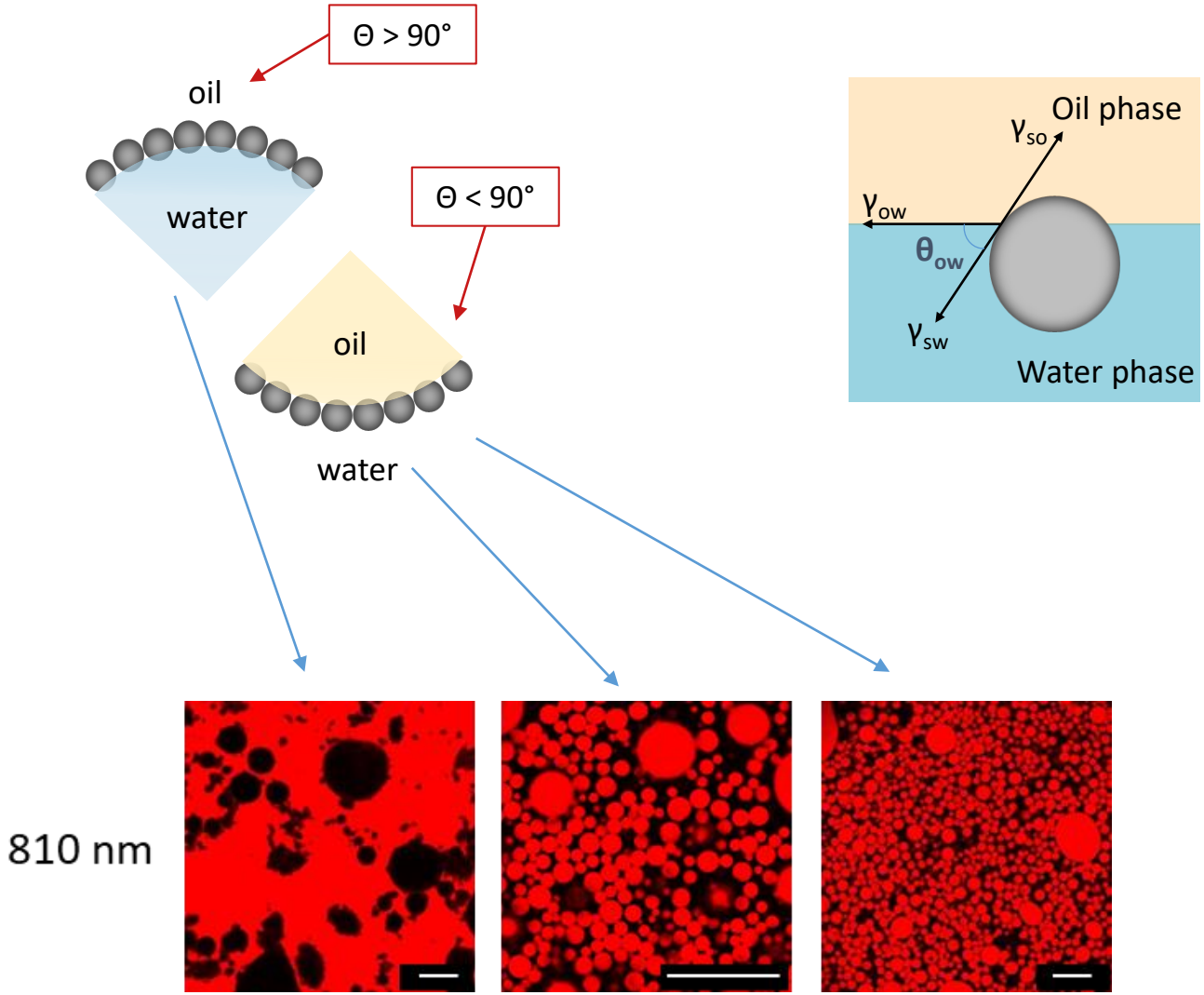
Reversibly adsorbed

Particles



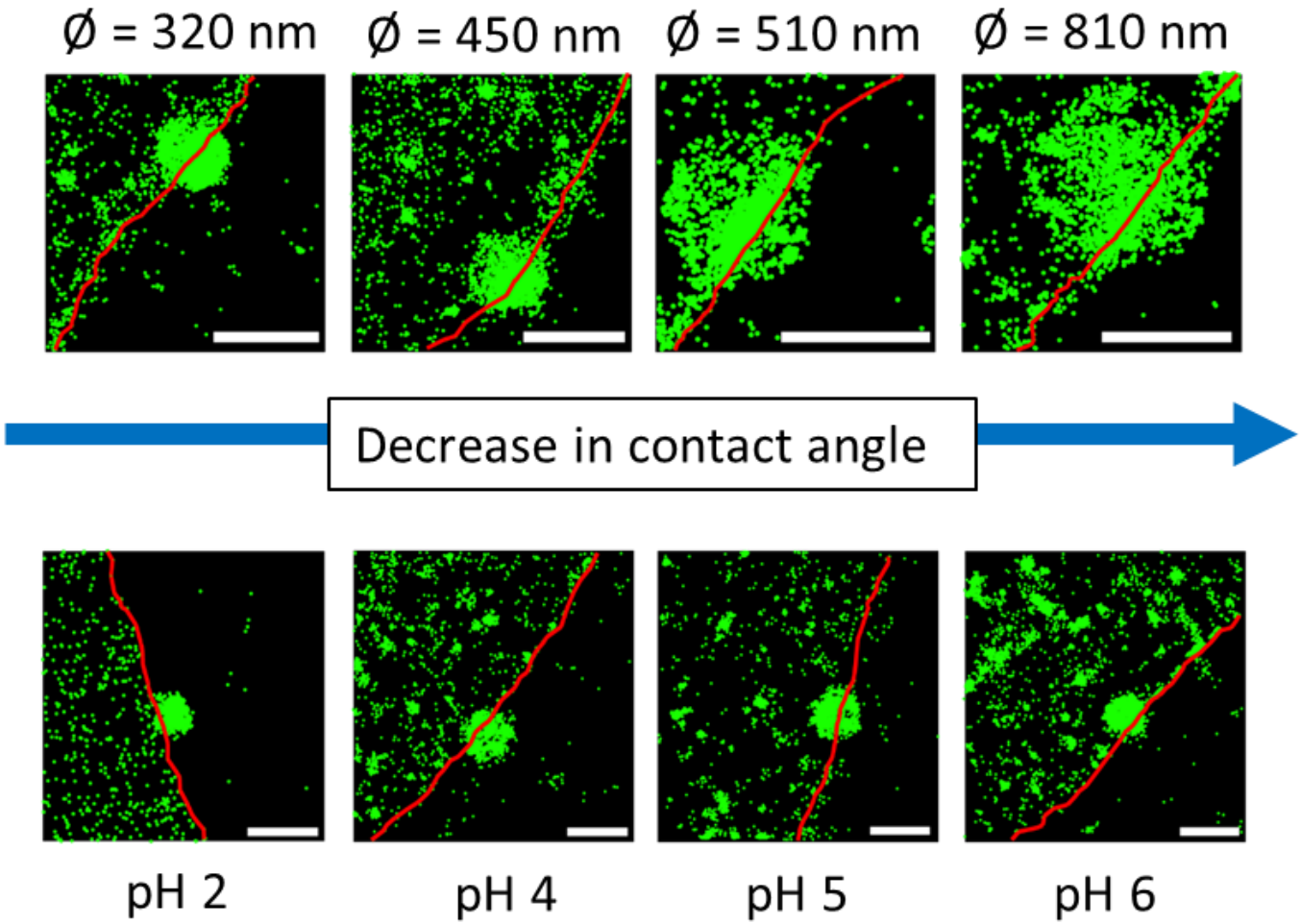
Lowers interfacial tension
Forms steric barrier
Irreversibly adsorbed

iPAINT: Colloidal dispersions in a fluid interface



E. C. Giakoumatos et al., In preparation.

iPAINT: Colloidal dispersions in a fluid interface



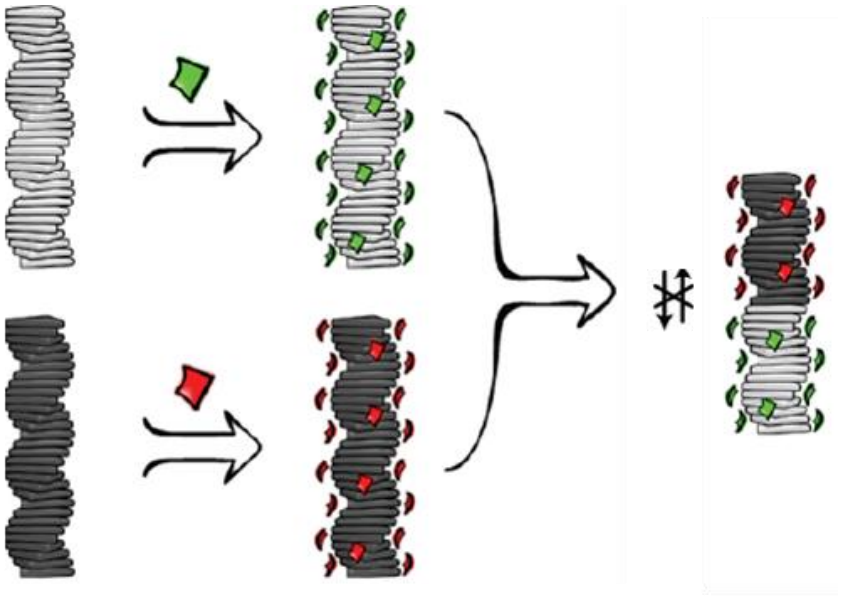
Scale bar 500 nm

E. C. Giakoumatos et al., In preparation.

iPAINT: In situ polymer assembly (in organic solvent)

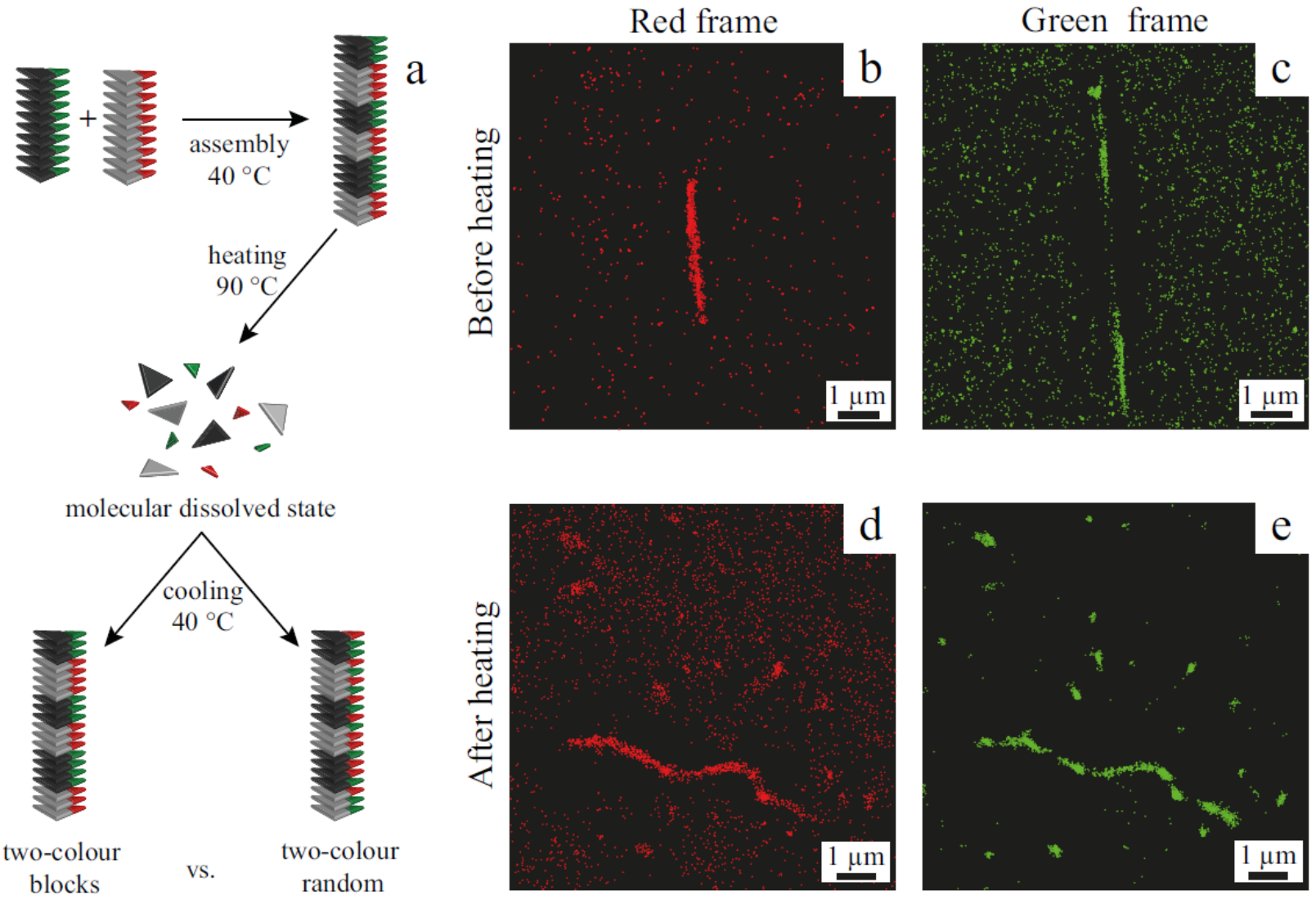
Water
Probe exchange

Organic Solvent
No exchange



B. Adelizzi,* A. Aloi* et al., ACS *Nano*, ***2018***.

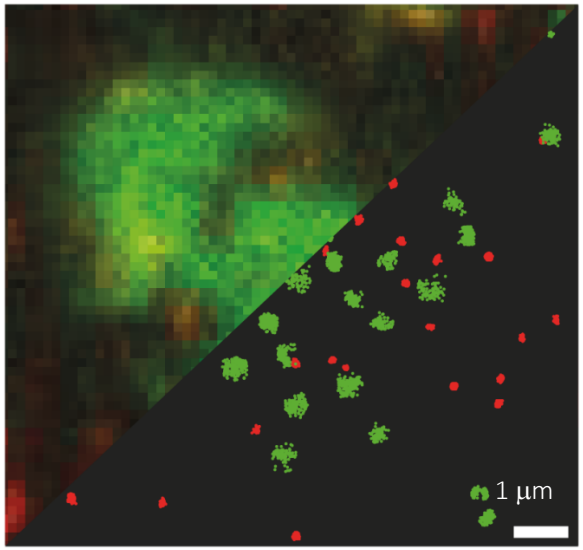
iPAINT: In situ polymer assembly (in organic solvent)



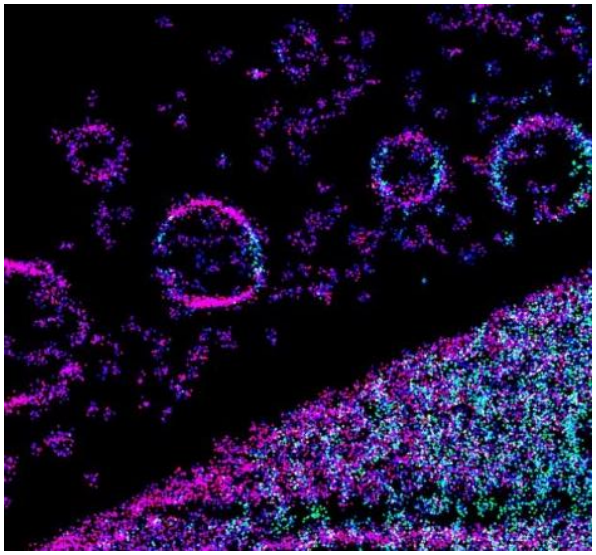
B. Adelizzi,* A. Aloi* et al., ACS *Nano*, ***2018***.

iPAINTing soft matter

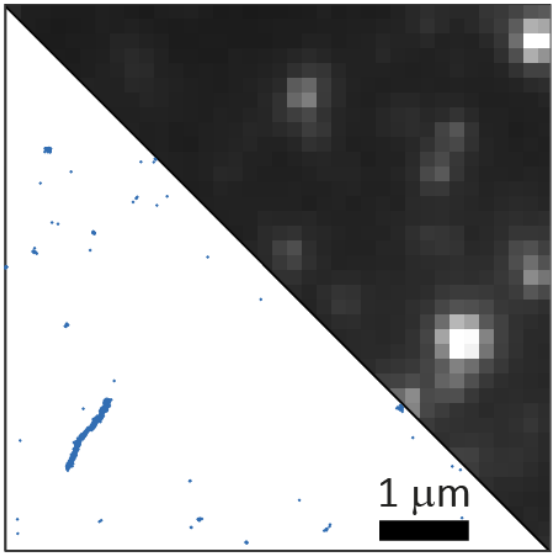
Colloidal dispersions



Interfaces



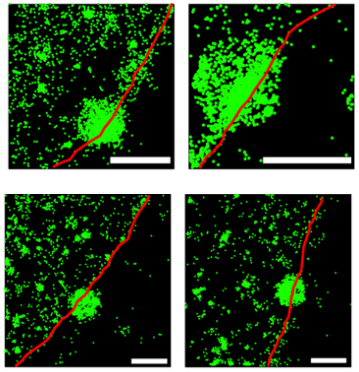
Supramolecular systems



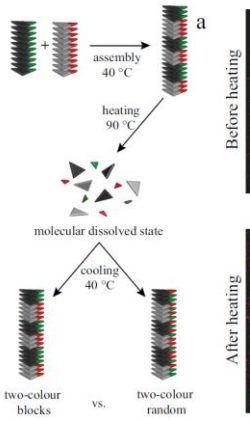
Aloi, IKV, RSC Nanoscale 2016

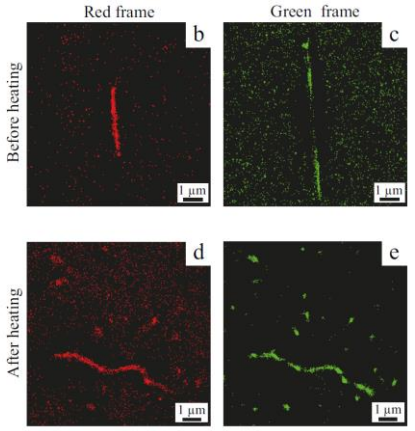
Summary: SMLM to understand soft matter

Colloidal dispersions in fluid-fluid interfaces

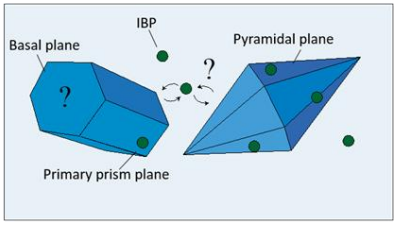


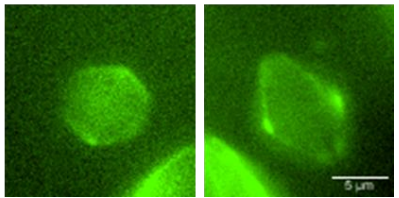
Complex supramolecular polymers





Ice growth inhibition by Antifreeze proteins





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Christian Sproncken

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