

# Forschungszentrum Jülich

## Helmholtz Society of Research Centres

29. November 2019 | Peter R. Lang



## European infrastructure for synthesis spectroscopy, scattering and imaging of soft matter





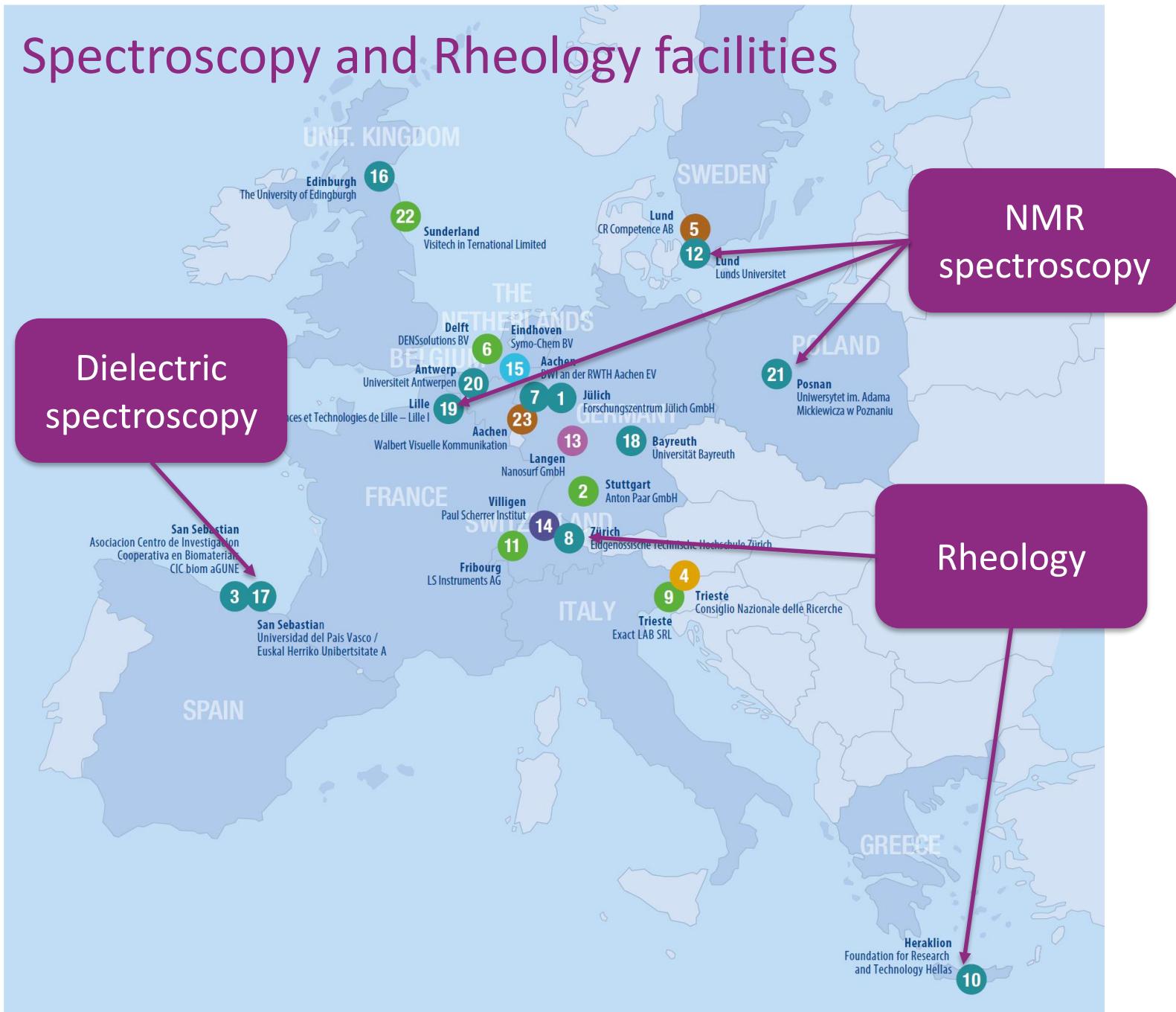
## Transnational Access to:

- Spectroscopy and Rheology
- Scattering and diffraction
- Imaging
- Synthesis
- Supercomputing

Joint Research activities to improve and develop instrumentation

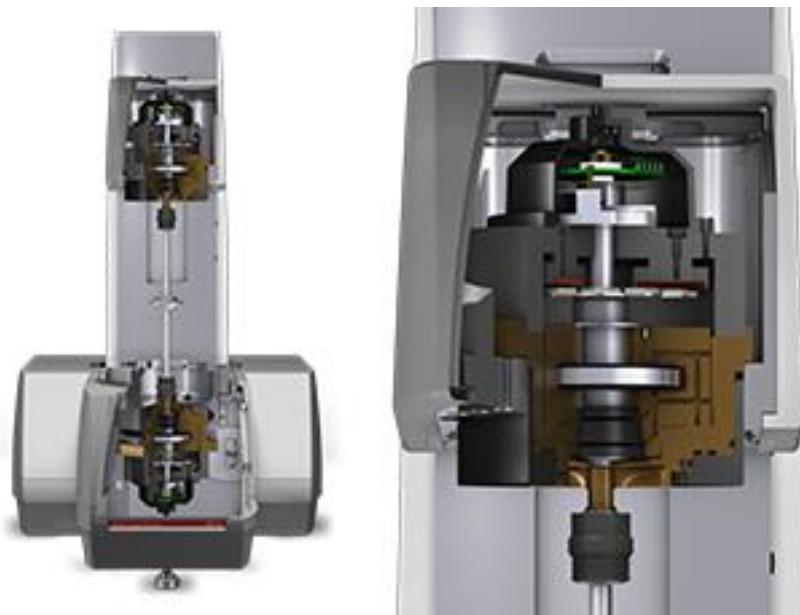
Networking activities for the dissemination of soft matter related knowledge

# Spectroscopy and Rheology facilities



## Rheology and spectroscopy:

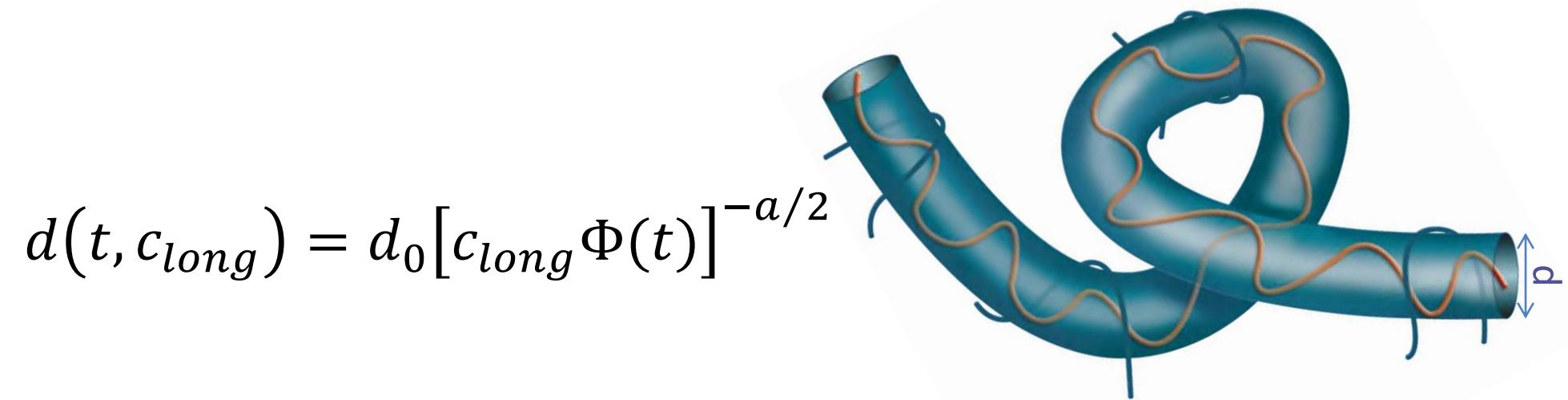
- Rheology: FORTH (GR), ETHZ (CH)
- Dielectric Spectroscopy: UPH/EHU (ES)
- NMR spectroscopy: AMU (PL), USTL (F)



## Scattering and diffraction:

- Neutrons: FZJ-JCNS (D)
- X-rays: PSI (CH), ULUND (S)
- Light: ULUND (S), FCJ-ICS3 (D)





$$d(t, c_{long}) = d_0 [c_{long} \Phi(t)]^{-a/2}$$

value of  $a$  is controversial:

- $a=1$  ?
- $a=4/3$  ?
- $a=2$  ?

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PHYSICAL REVIEW LETTERS **122**, 088001 (2019)

## Direct Assessment of Tube Dilation in Entangled Polymers

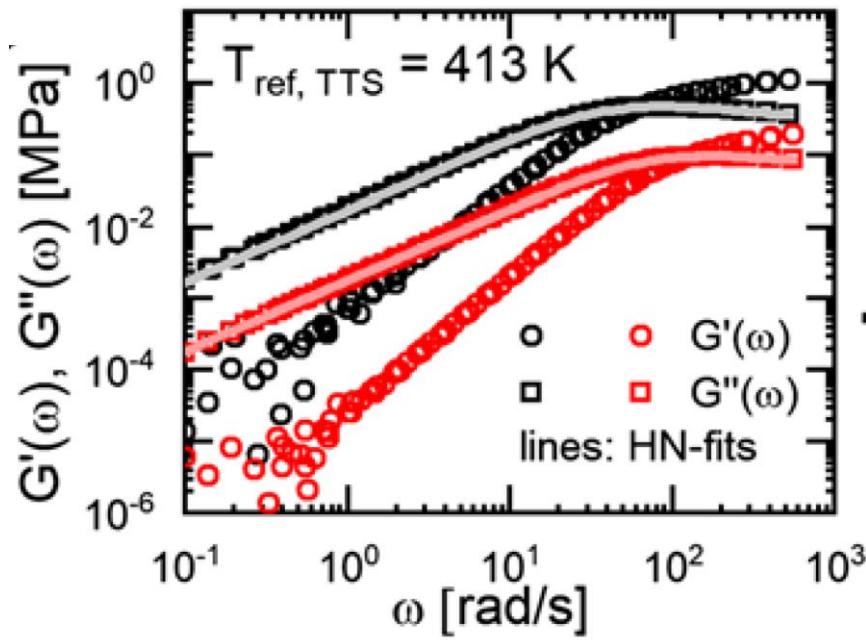
B. J. Gold,<sup>1,\*</sup> W. Pyckhout-Hintzen,<sup>1</sup> A. Wischnewski,<sup>1</sup> A. Radulescu,<sup>2</sup> M. Monkenbusch,<sup>1</sup> J. Allgaier,<sup>1</sup> I. Hoffmann,<sup>3</sup> D. Parisi,<sup>4,5</sup> D. Vlassopoulos,<sup>4,5</sup> and D. Richter<sup>1</sup>

# Combining Synthesis, Rheology, SANS and NSE

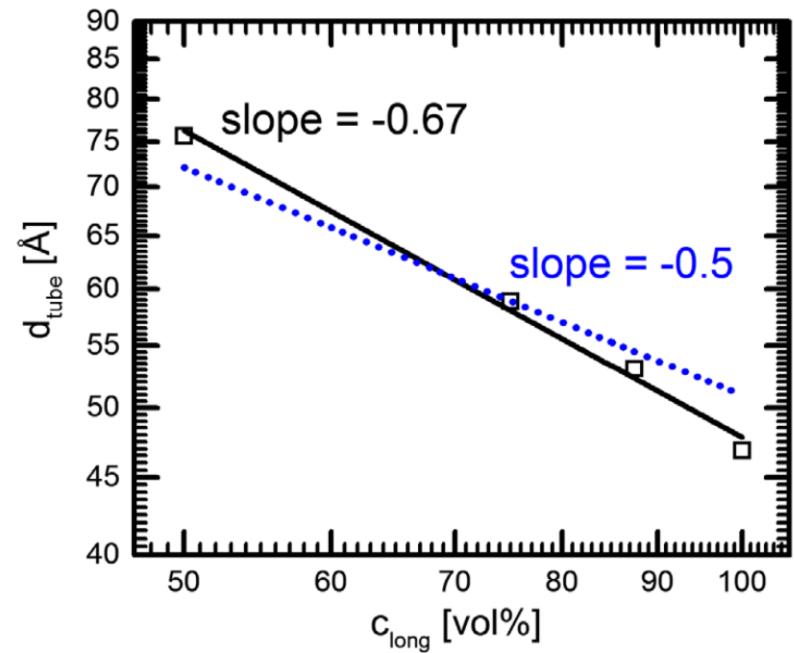
Samples: long chain PEO ( $c_{long}$ ) melt in short chain PEO

$$G''(\omega)_{max} \propto c_{long}^{1+a}$$

$$d \propto c_{long}^{-a/2}$$



$$a = 1.3 \pm 0.11$$



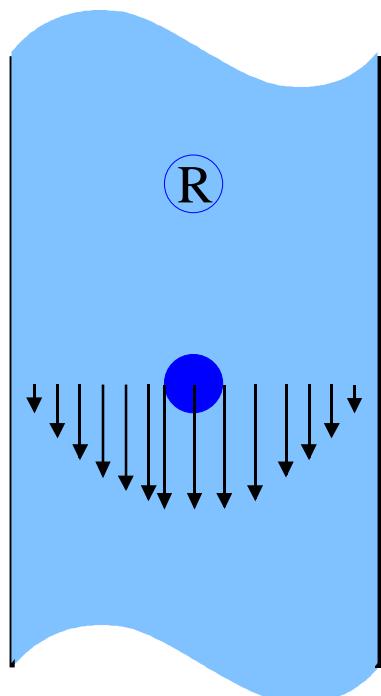
$$a = 1.34 \pm 0.04$$

# Scattering facilities



# Dynamics close to walls

Parallel to walls



Sedimentation of a single sphere

Stokes law

$$\mathbf{F}_0 = -6\pi\eta\mathbf{v}R = -\xi\mathbf{v}$$

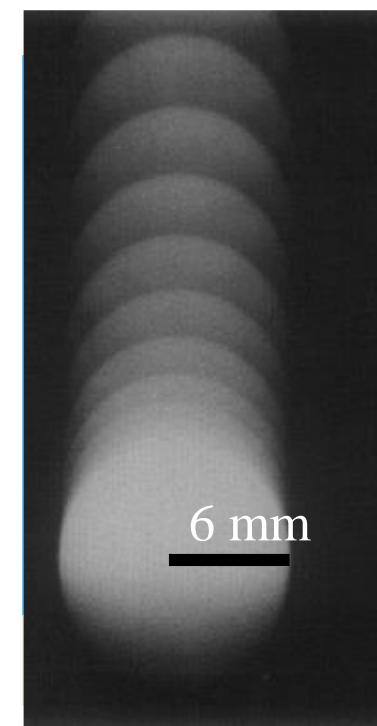
unbounded:

$$\mathbf{F}_0 = -\mathbf{G} \Rightarrow \mathbf{v} = \frac{4\pi R^3 \Delta \rho g}{3\xi} = \frac{2R^2 \Delta \rho g}{9\eta}$$

tube of diameter  $d$

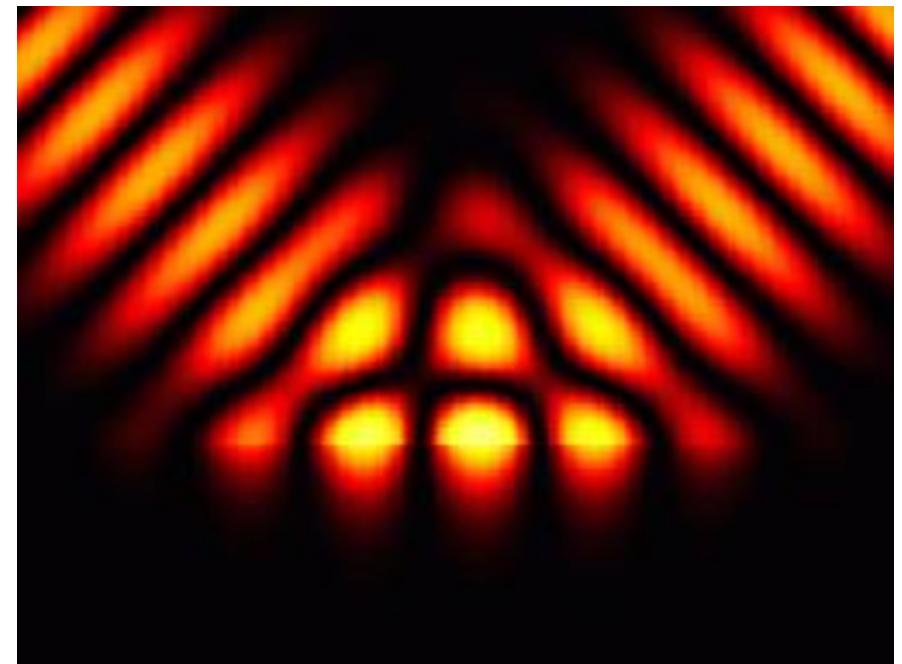
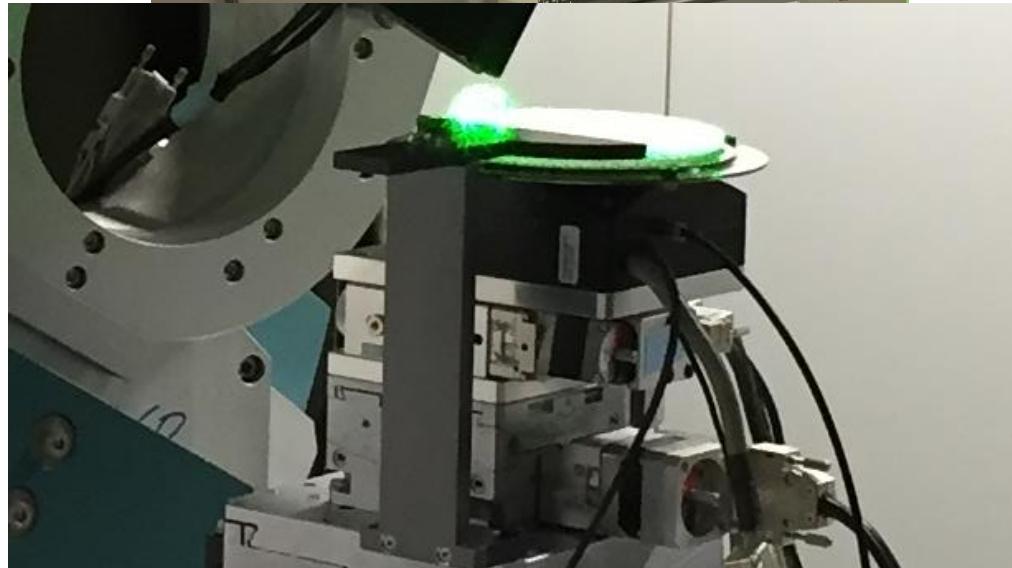
$$v_{\parallel} \approx \frac{4\pi R^3 \Delta \rho g}{3\xi(1 + 4.2R/d)} = \frac{G}{\xi\lambda_{\parallel}}$$

Vertically towards  
a solid wall



Adamczyk et al  
J. Colloid Interface Sci. 1983

# Evanescent Wave Dynamic Light Scattering



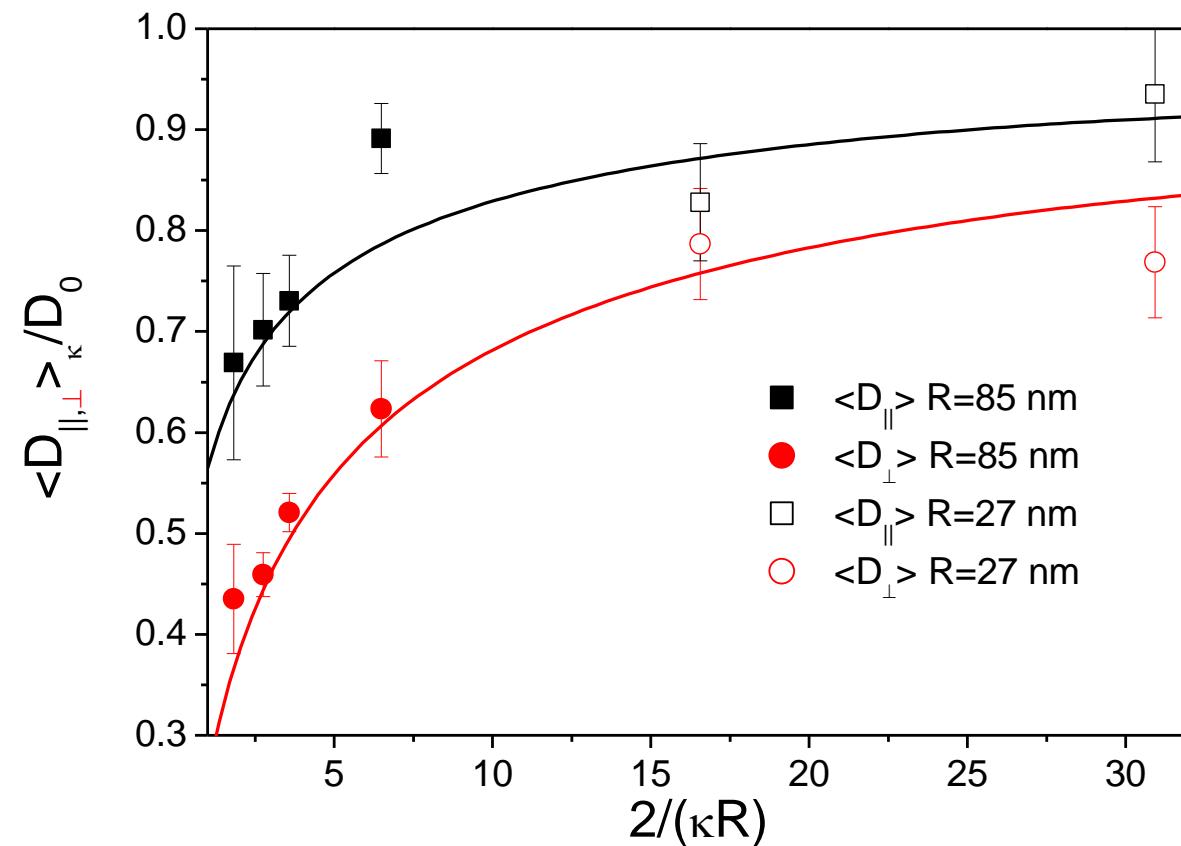
# Near Wall Diffusion of Hard Spheres

System:

PS Particles  
 $10^{-2}$  mol/L NaCl

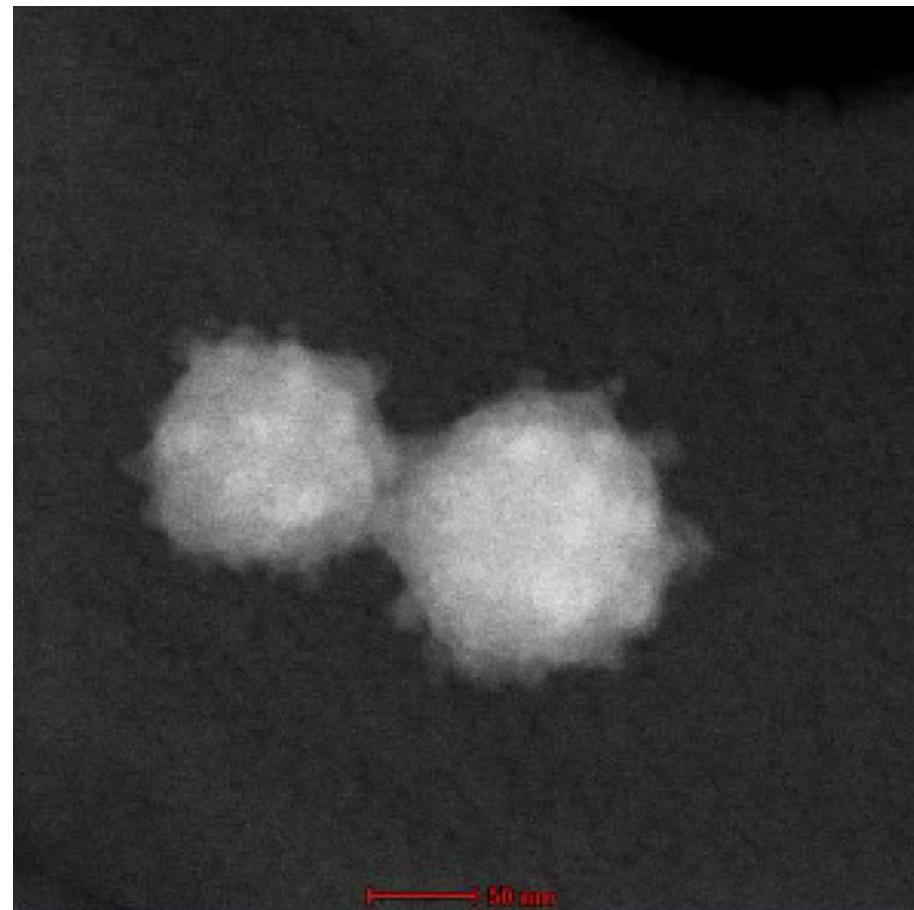
$R=85$  nm;  $\sigma < 0.05$   
 $D_0 = 2900$  nm $^2$ /ms

Holmqvist, et al  
JCP **126**, 044707 (2007).

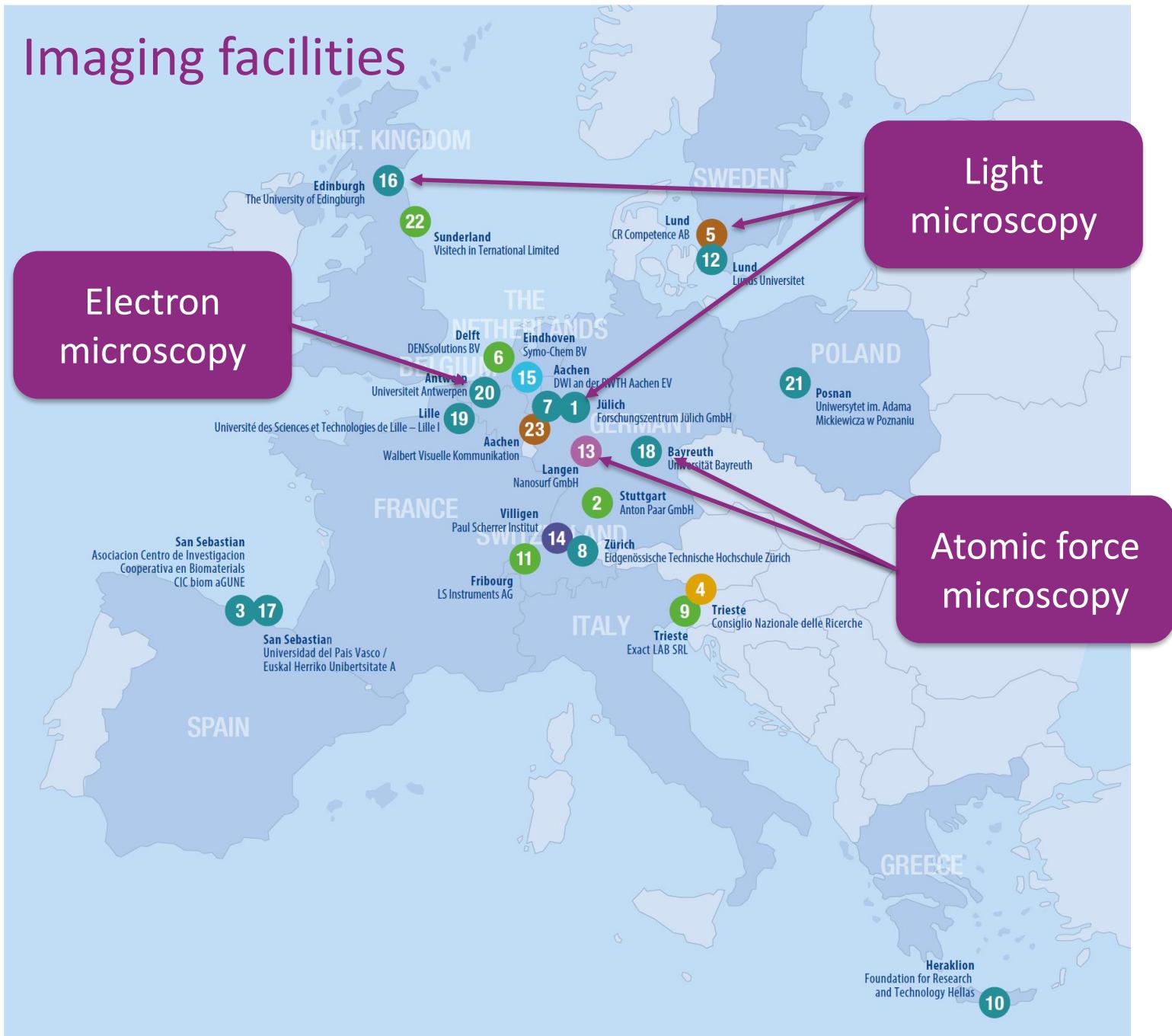


## Current EUSMI project

Influence of particle  
roughness

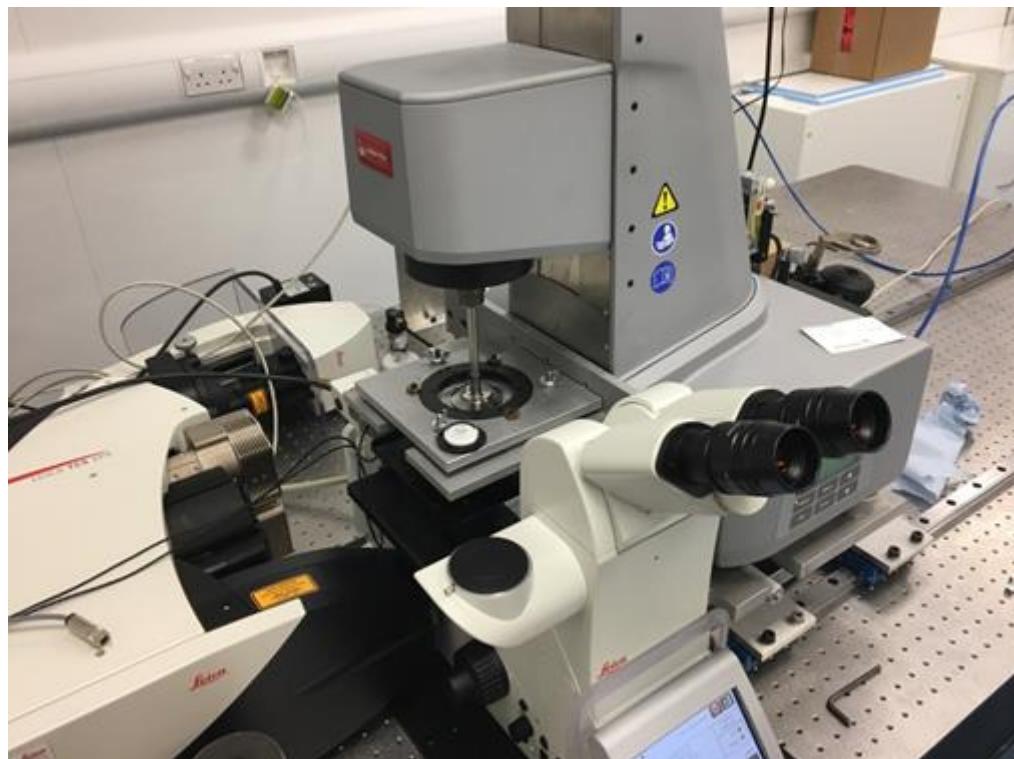


# Imaging facilities

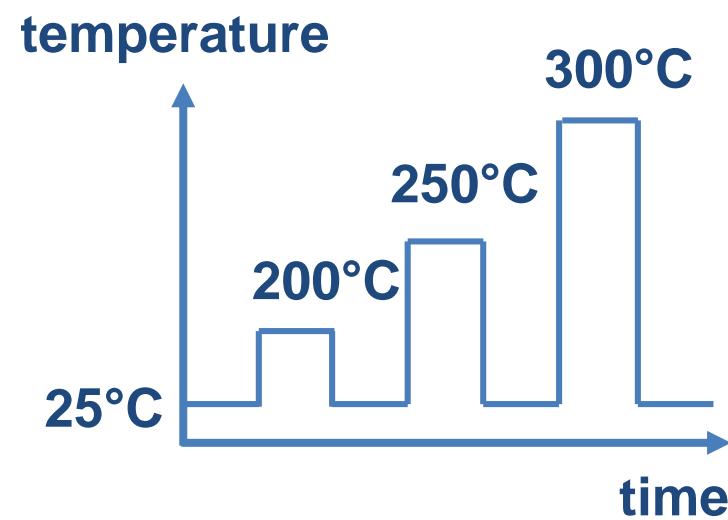
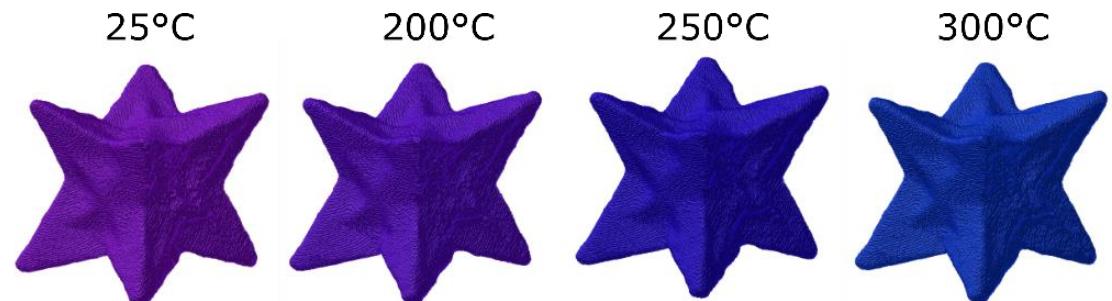


## Imaging

- Electron microscopy: EMAT @ UANT (B)
- Optical Confocal: COSMIC @ UEDIN (UK), ULUND
- Atomic force microscopy: AFM key lab @ UBT (D)



## Heating TEM tomography Au/Pd octopods



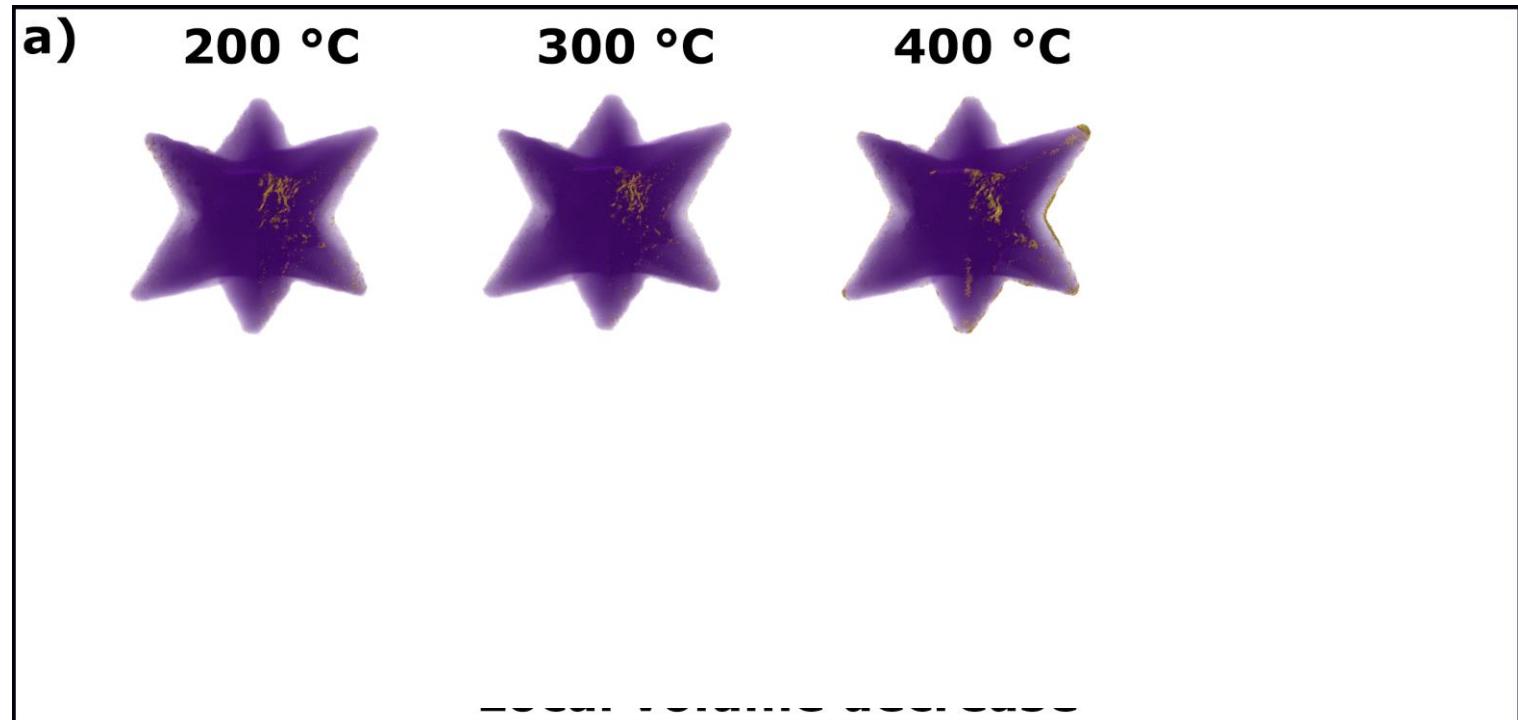
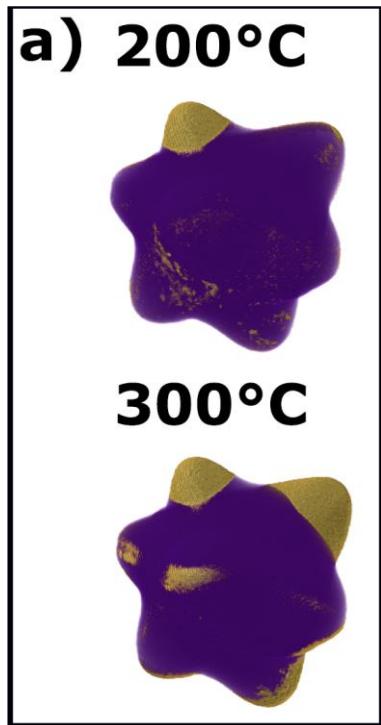
 Indiana University Bloomington  
Prof. Sara Skrabalak

# Heating TEM tomography

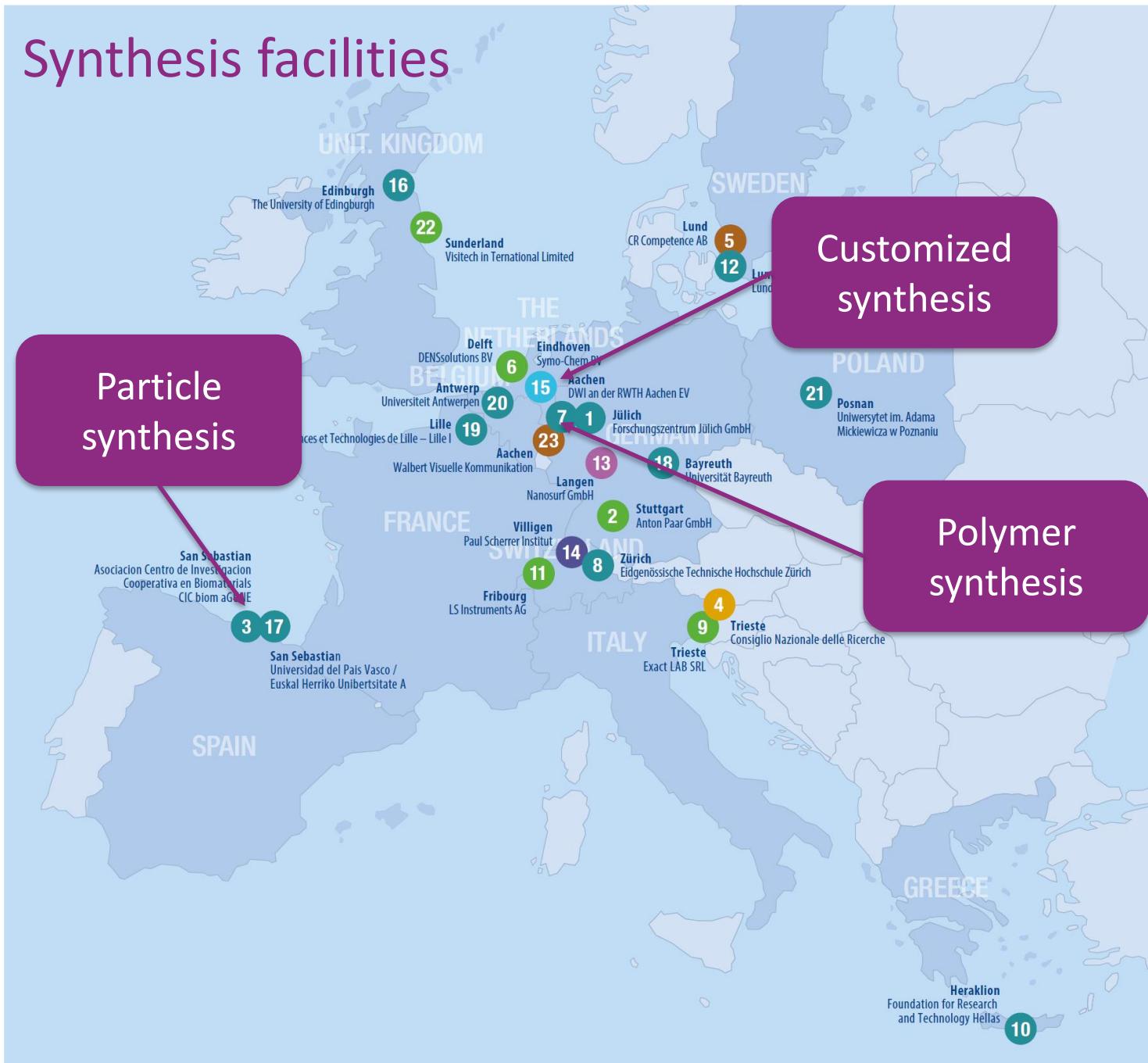
Au/Pd octopods

Au:Pd = 100:0

Au:Pd = 91:9

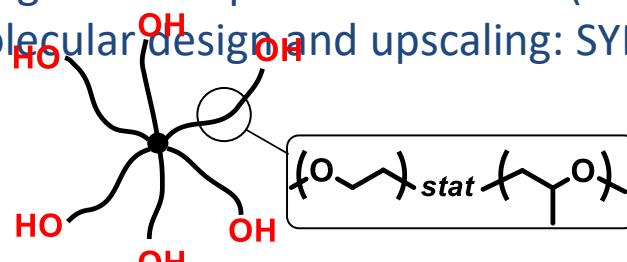


# Synthesis facilities



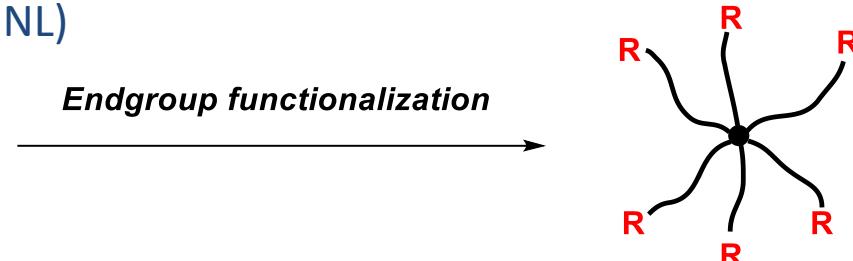
## Synthesis of functionalized PEGs (DWI)

- Polymeric material: DWI (D)
- Inorganic nanoparticles: BIOMA (ES)
- Molecular design and upscaling: SYMO (NL)



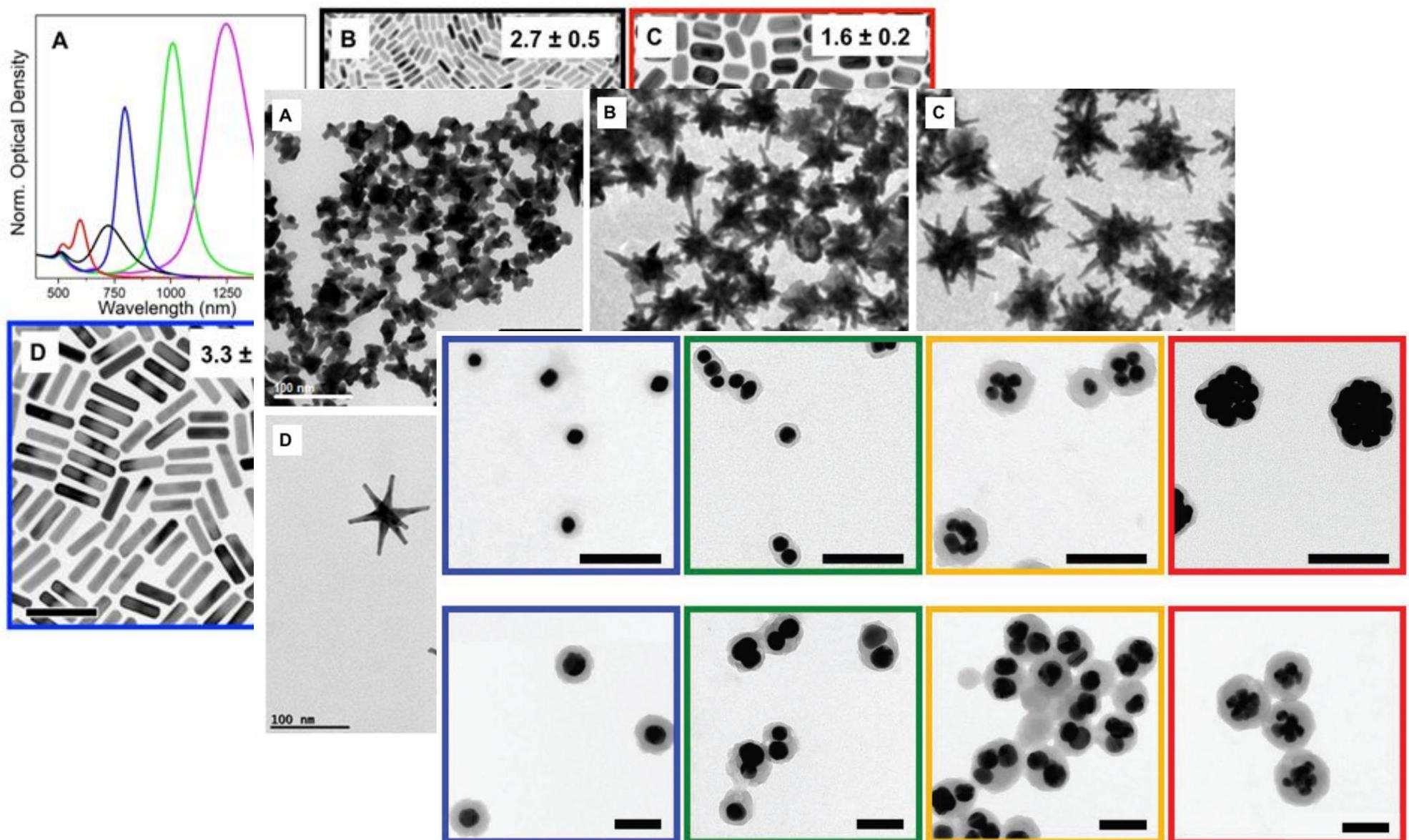
MW = 3 kDa, 12 kDa, 18 kDa

R =	name
	sPEG-Isocyanate
	sPEG-Acrylate
	sPEG-Vinylsulfonate
	sPEG-Vinylsulfon
	sPEG-Allyl
	sPEG-Thiol

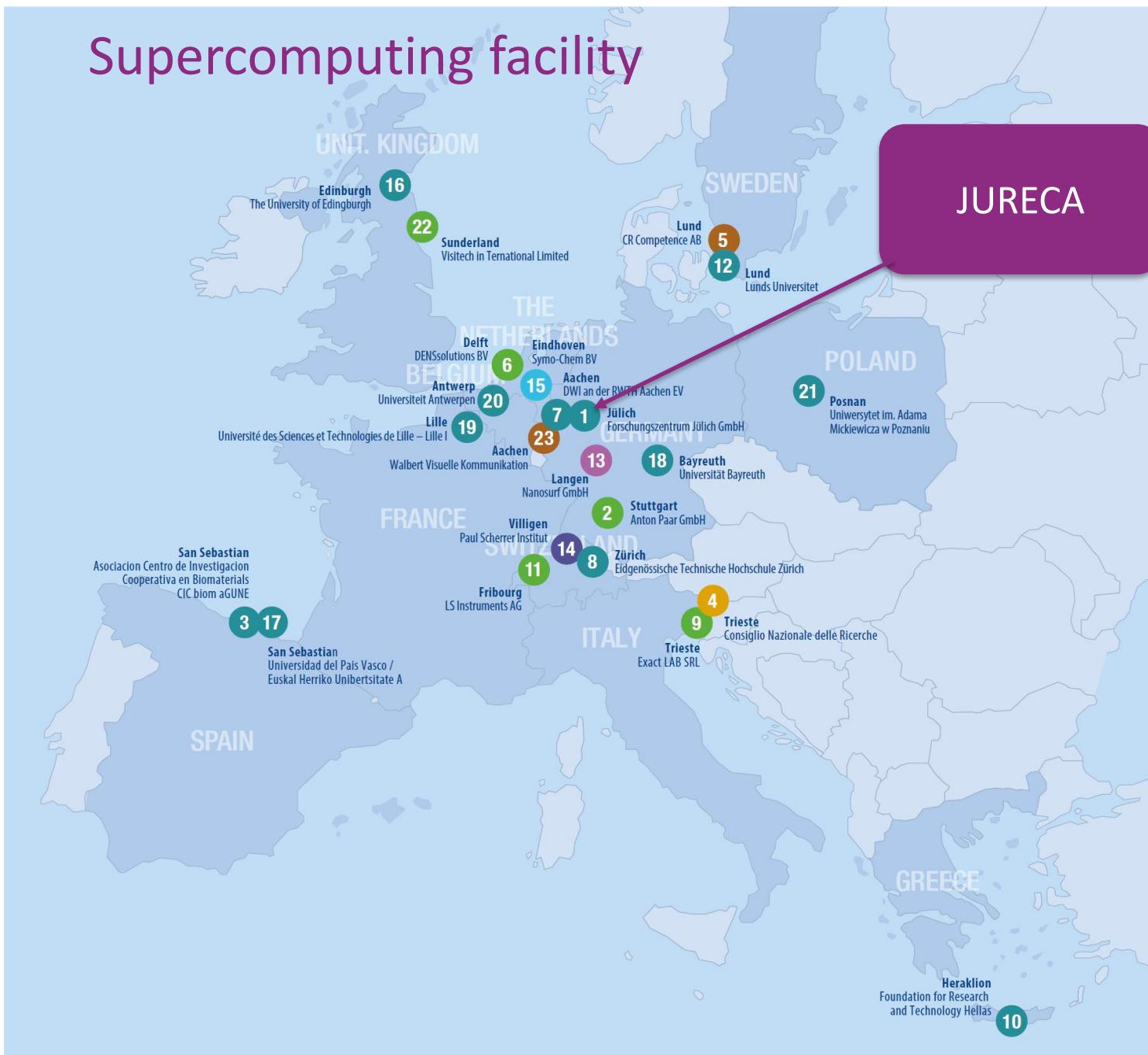


R =	name
	sPEG-Epoxyde
	sPEG-Carbonate
	sPEG-Mesyl
	sPEG-Azide
	sPEG-Amine

# Library of nano-particles (BIOMA)



# Supercomputing facility





Support by JSC simulation labs

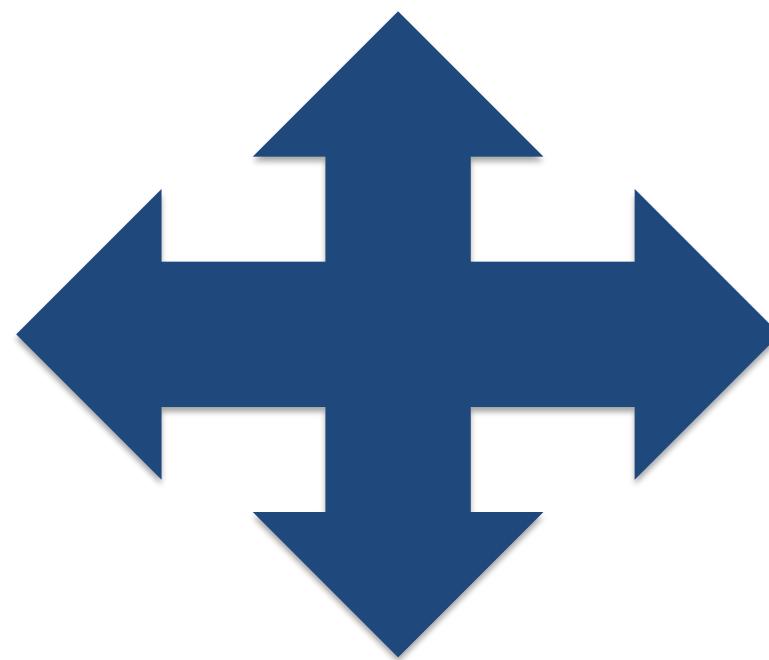
Video courtesy Jens Elgeti FZJ

Saggiorato et al Nature Comm. 8:1415 DOI: 10.1038/s41467-017-01462-y

## Organic polymer synthesis

Photonic nano-  
crystals

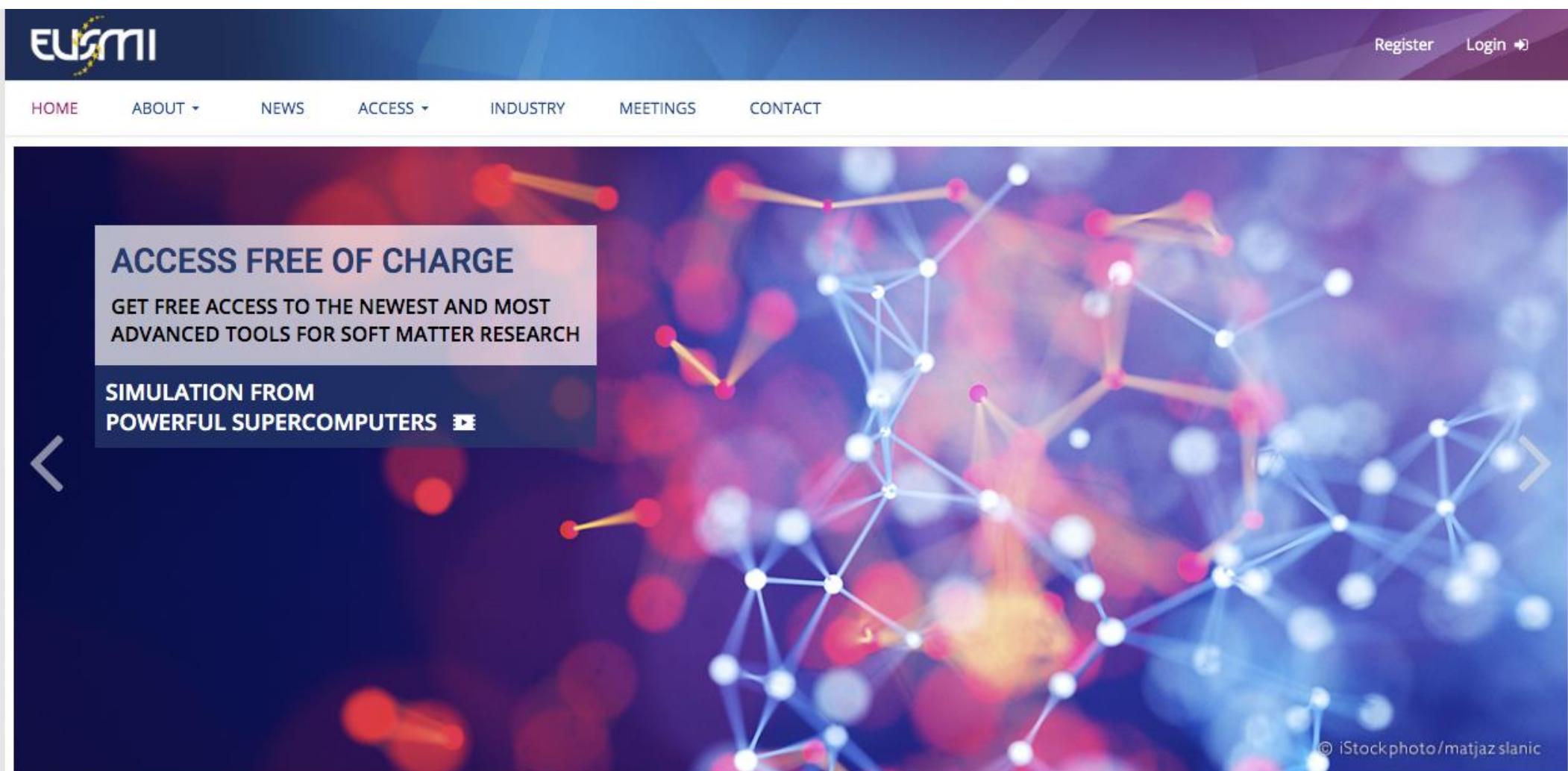
Active living  
matter



Computer simulation

# Apply for Access at: <http://eusmi-h2020.eu>

Registration → find your instrument → write and submit the proposal



The screenshot shows the EUSMI website's main page. At the top, there is a dark blue header bar with the EUSMI logo on the left and 'Register' and 'Login' buttons on the right. Below the header is a navigation menu with links for 'HOME', 'ABOUT', 'NEWS', 'ACCESS', 'INDUSTRY', 'MEETINGS', and 'CONTACT'. The main content area features a large, abstract background image of a molecular or atomic structure with red and blue spheres and connecting lines. Overlaid on this background are two white rectangular callout boxes. The top box contains the text 'ACCESS FREE OF CHARGE' and 'GET FREE ACCESS TO THE NEWEST AND MOST ADVANCED TOOLS FOR SOFT MATTER RESEARCH'. The bottom box contains the text 'SIMULATION FROM POWERFUL SUPERCOMPUTERS' and includes a small video camera icon. In the bottom right corner of the main image, there is a small credit line: '© iStockphoto/matjazslanic'.



**covers costs for:**

- **Access to facilities**
- **Travel**
- **Accommodation and subsistence**

**Applications from industry welcome !**

## More information

- Web portal
  - <http://eusmi-h2020.eu>
- Write an email
  - [y.liu@fz-juelich.de](mailto:y.liu@fz-juelich.de)
  - [p.lang@fz-juelich.de](mailto:p.lang@fz-juelich.de)
- Follow EUSMI on Twitter
  - [@EUSMI\\_H2020](https://twitter.com/EUSMI_H2020)



### ACCESS TO:

- a neutron scattering facility
- a coherent x-ray beam line
- most advanced electron microscopes
- world leading synthesis laboratories
- one of the fastest supercomputers in Europe
- about 70 highly specialized instruments for a large variety of experiments

## How to make use of EUSMI

All soft matter scientists are invited to register at  
[www.eusmi-h2020.eu](http://www.eusmi-h2020.eu)

Registered users can take advantage of the EUSMI transnational access programme by submitting an application via the online proposal system at the EUSMI web portal. Proposals will be evaluated **within a month** by a panel of internationally renowned experts.

### WHEN A PROPOSAL IS ACCEPTED

All costs for using the EUSMI infrastructure, travel, accommodation and subsistence costs will be covered by EUSMI for up to 2 persons per proposal.