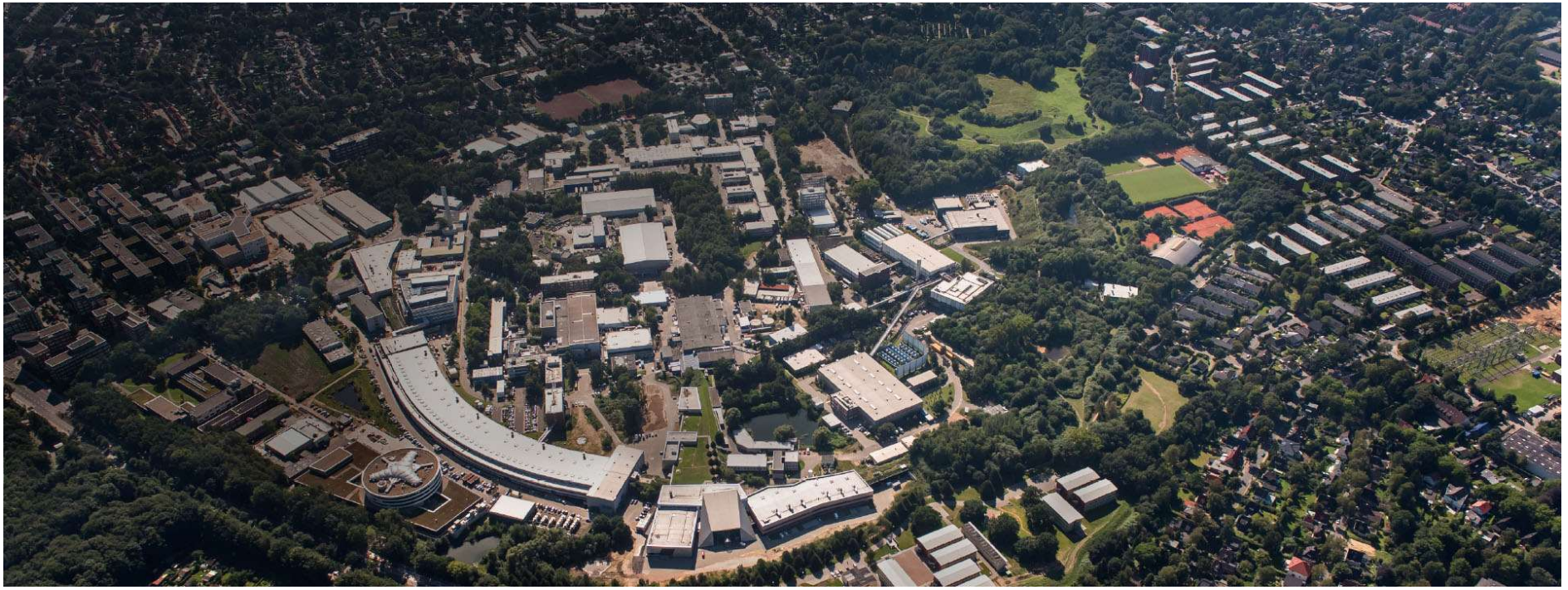
Liquid Structure in Nano-confinement; Nano-rheology and Tribology

DESY, PETRA III @Photon Science



Milena Lippmann
Hamburg, September 2020

HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

DESY.

DESY main Divisions

Accelerators

- Planning, Constricting and Operating of the Photon Science Facilities based on the Accelerator Technology
- Development of the next generation Accelerator Technology

Location: DESY, Hamburg, (M Bereich)

Photon Science

Science development at the Photon Science Facilities (Forschung mit Photonen)
Location: DESY Hamburg, DESY Hamburg-Schenefeld

Particle Physics

Research in the field of the Particle Physics with strong connection to CERN
Location: DESY, Hamburg

Astroparticle Physics

Research in the feeld of the Astroparticle physics
Location: DESY, Berlin

Photon Science

PETRA III

Planning, Constricting and Operating of the Beamline Stations and Sample Environment at PERTA III Storage Ring (the operation of the *Storage Ring* itself is done by the Accelerator Division) **Location: DESY Hamburg**

FLASH

Planning, Constricting and Operating the Beamline Stations and Sample Environment at FLASH -Laser Facility (*FLASH , UV Laser Facility* is operated by the Accelerator Division) **Location: DESY, Hamburg**

European EXFL GmbH

Planning, Constricting and Operating the Beamline Stations and Sample Environment at EXFL -Laser Facility (*EXFL, Röntgen Laser Facility* is operated by the Accelerator Division) **Location: DESY Hamburg, DESY Hamburg-Schenefeld**

Research Centers

CFEL – Center for Free-Electron Laser Science
CXNS – Center for Nanoscience
CSSB – Center for Structural Systems Biology
Water Institute, **Location: DESY, Hamburg**

Experimental Halls of PERA III and FLASH, as well as the beginning of the XFEL tunnel at DESY campus in Hamburg.

PETRA III

Synchrotron facility

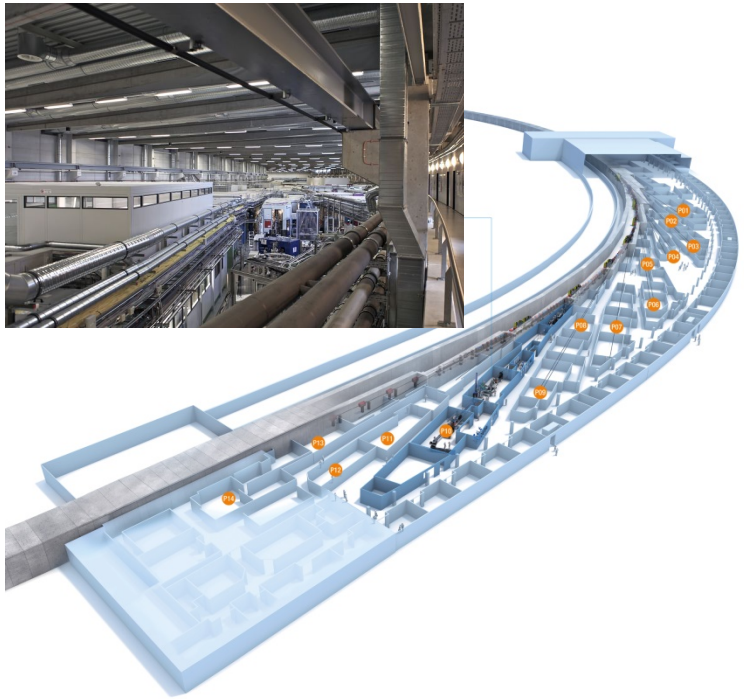
Petra III Storage Ring and the three experimental Halls around the ring

PETRA III synchrotron facility consists of PERTA III Storage Ring and 23 Beamline Stations (Experimental Stations) and Sample Environment Group. The Experimental station are dedicated to different science subjects divided in: **Health, Earth & Environment, Information Technology, Transport and Energy**

PETRA III Group is responsible for the operating of the Beamline Stations and supports the users at the Experimental stations.

I am part of the Sample Environment Group. I am planning, constricting and operating as well as supporting our users in the Chemistry Labs at PETRA III.

The largest experimental hall - Max von Laue



Currently we are working on the **future of PETRA III – PETRA IV synchrotron facility**. In the PETRA IV project, together with my colleague Anita Ehnes, I am responsible for the planning of the labor infrastructure at PETRA IV.

Why contact to Analytical Tribology Net ?

Scientific Project:

Liquid Structure in Nano-confinement; Nano-rheology and Tribology

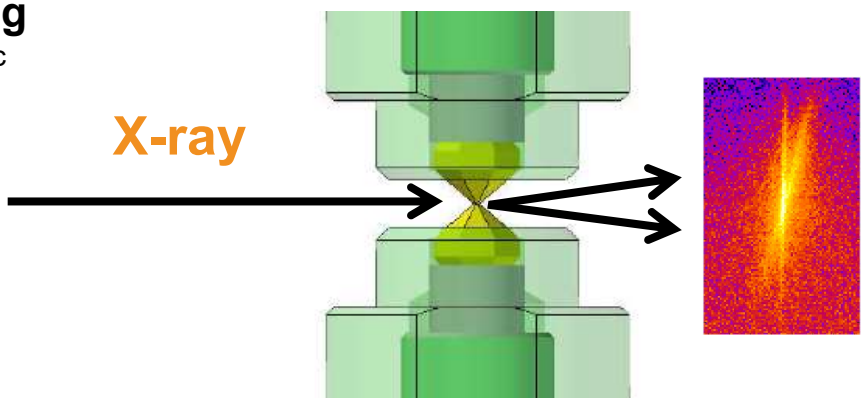
Milena Lippmann, Anita Ehnes, Oliver Seeck, DESY Hamburg,

Liquid Structure in Nano-confinement at DESY

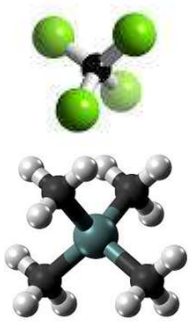
We developed and commissioned a setup for x-ray measurements of Confined Fluids.
Methods: **x-ray reflectivity and in – plane scattering**

M. Lippmann, A. Ehnes, O. H. Seeck: An x-ray setup to investigate the atomic order of confined liquids in slit geometry. Review of Scientific Instruments **85,** 015106 (2014) (DOI:doi.org/10.1063/1.4860057)

Diamond substrates with shape of the diamonds in the high pressure Diamond Anvil Cells.

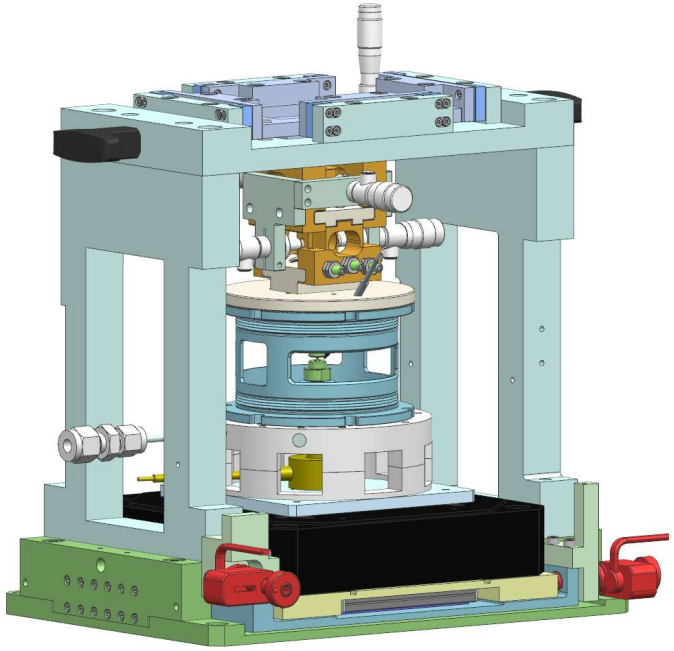


Liquids:



Carbon tetrachloride (CCl4)

Thetramethylsilane (TMS)



The reflectivity measurements allow to calculate the liquid density in the gap. The in-plane scattering measurements probe the structure in the plane of the substrates.

M. Lippmann, O. H. Seeck, A. Ehnes, K. Nygård, F. Bertram, and A. Ciobanu, Experimental Observation of Crystal−Liquid Coexistence in Slit-Confined Nonpolar Fluids, J. Phys. Chem. Lett. **10,** 1634 (2019) (DOI:10.1021/acs.jpclett.9b00331)

Prospective and Challenges

Prospective

The setup is able to produce structure data of the confined films in dependence of shear force.

In the future we would like to study **the interplay between the friction force, molecular architecture and dynamic of the fluids in confinement.**

We would like to explore different substrates (there are some constrains on the substrates due to the experimental conditions).

We would like to understand the role of the molecular architecture for the friction process.

Challenges

The models form the experimental data are ambiguous. We need support from the theoretical models and simulations.

We are looking for cooperation partners working on analytical methods.

or

cooperation with partners ready to combine their experimental method with the structure investigation by x-ray scattering and diffraction .

In the future at the PETRAIV storage ring the dynamic investigation by X-ray Photo Correlations Spectroscopy Measurement could be possible.

Thank you !

Kim Nygård

Oliver Seeck,
Anita Ehnes
Anca Ciobau

P08 beamline
Rene Kirchhof
Florian Bertram

P23 beamline
Dimitry Novikov

P06 Nanoprobe beamline
Andreas Schropp
Mikhail Lyubomirskiy
Jan Garrevoet

P10 beamline
Mihael Sprung
Fabian Westermeier

Dan Wang
Guest scientist - China and Germany Postdoctoral Exchange,
Nanjing University of Aeronautics and Astronautics

We are workin in cooperation with the group of,

Patrick Huber
Robert Meißner

on confined fluids in prose materials.