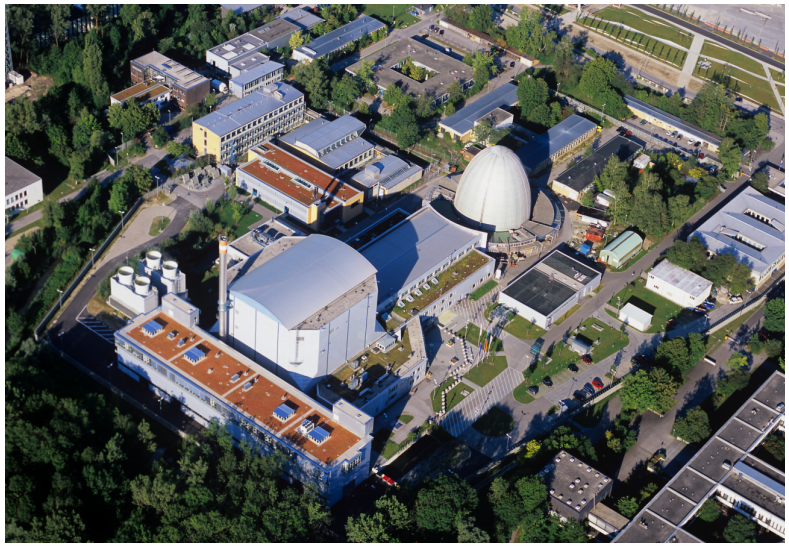
# Research with neutrons for the scientific challenges of the future

**Tobias Unruh, Partner and Industry Day**

**Bonn, January 22nd 2014**

# Unique achievements based on research with neutrons

**random selection of examples:**

Understanding of

- any type of magnetic effects and materials (data storage)
- superconductivity (dispersion of collective magnetic interactions)
- role of hydrogen for functionality of life (hydrogen bonds)
- atomic and molecular basis of functional materials (semiconductors)
- structure and dynamics of polymeric materials (semiconducting polymers in organic and organic/inorganic hybrid solar cells)
- origin of the universe (standard model, matter-antimatter asymmetry)
- geological processes in earth's interior ($C0_2$ circular flow, climate)

Development of new materials

- semiconductors (power electronics)
- high temperature materials (turbine buckets)
- light weight materials (Mg/Al alloys)

Production of radioisotopes in nuclear medicine

# Challenges for research with neutrons

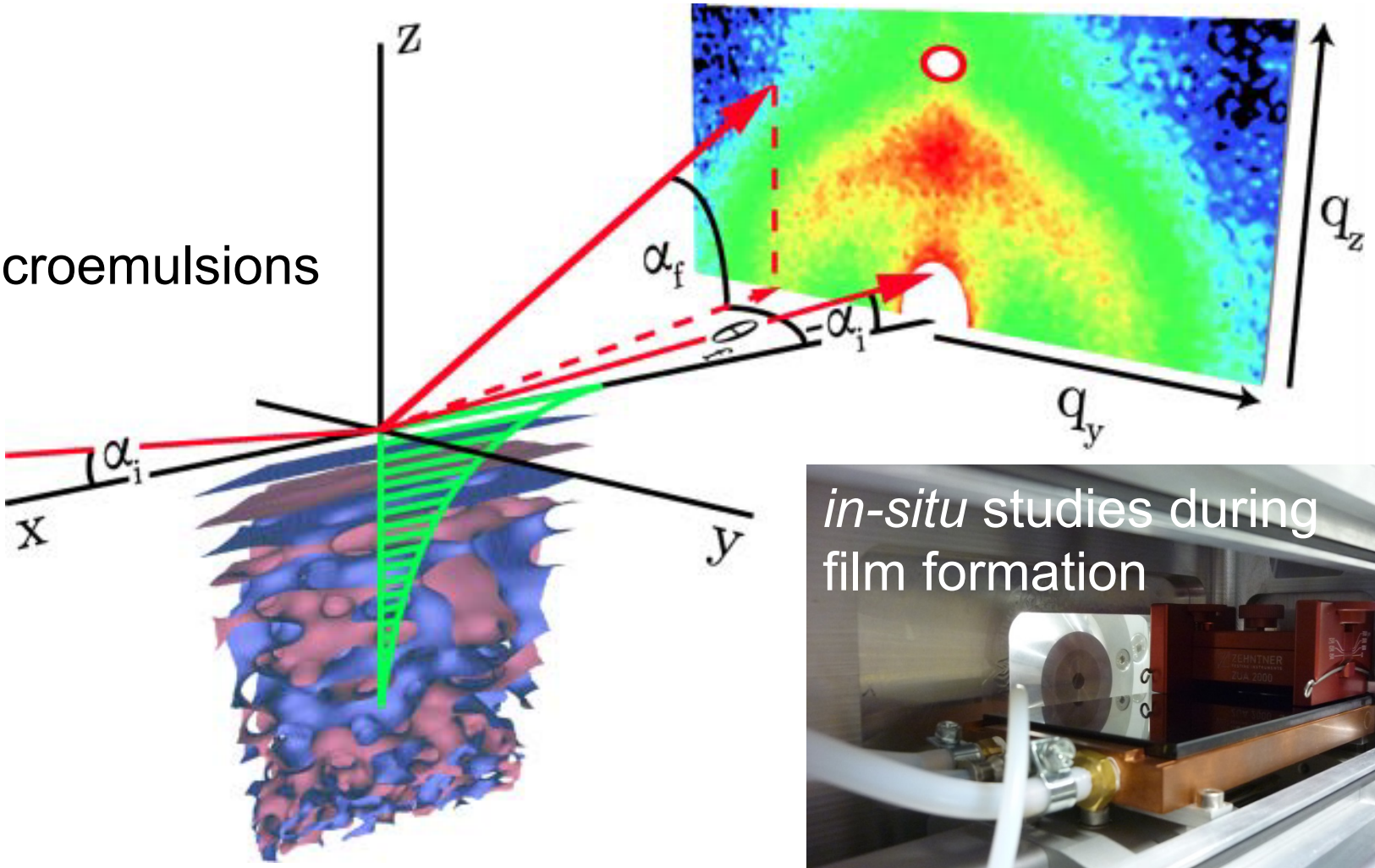
## Functionalization of interfaces

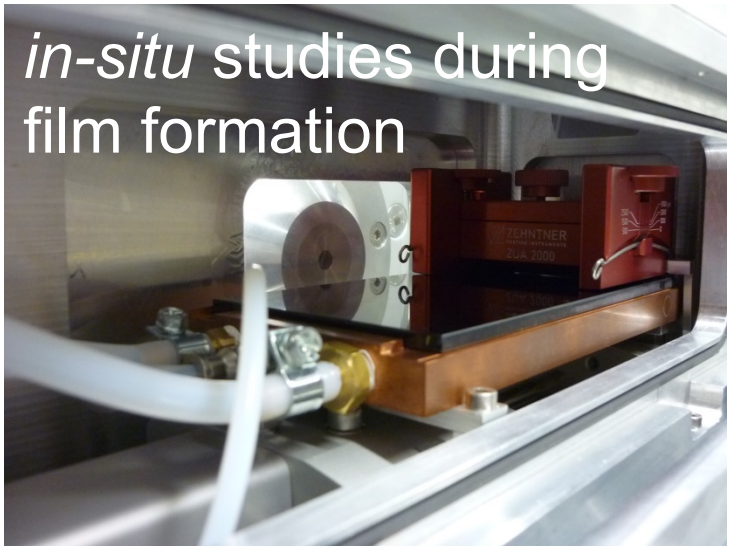
- Huge impact for industry (nanoparticles, materials, surfaces, interfaces, reduced friction, lubrication, …)
- Gold surfaces functionalized by thiols self-assembled monolayers (SAMs) for biomaterials and biosensors
- Silicates, aluminates, and titanates funtionalized by alkylsilanes for coupling agents on glasses and polymers, adhesion promoters, as cross-linking and dispersing agents, and for hydrophobization
- Poly(L-lysine) - grafted - poly(ethylene glycol) promote resistance to protein adsorption
- ...

# Challenges for research with neutrons

## Molecular structure and dynamics at interfaces

microemulsions



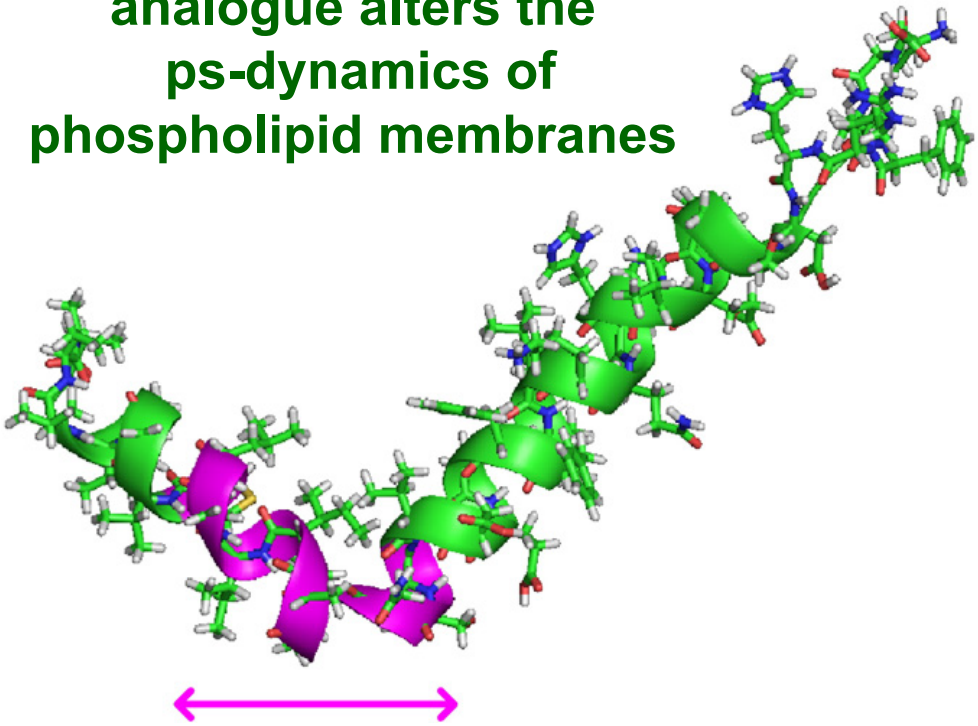




H. Frielinghaus, M. Kerscher, O. Holderer, M. Monkenbusch, D. Richter
JCNS: Jülich Centre for Neutron Science

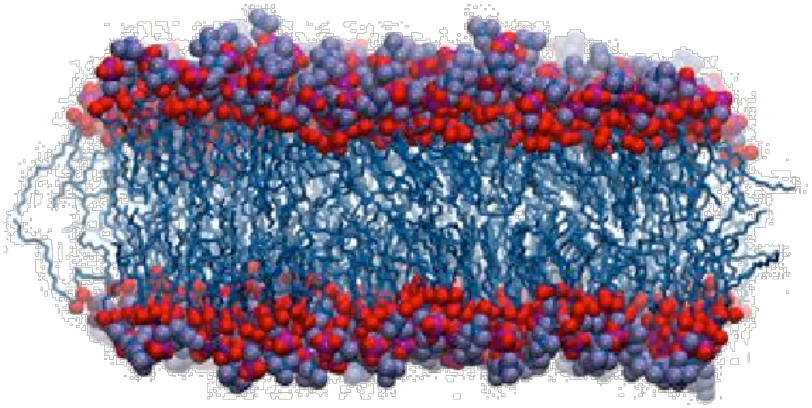
# Challenges for research with neutrons

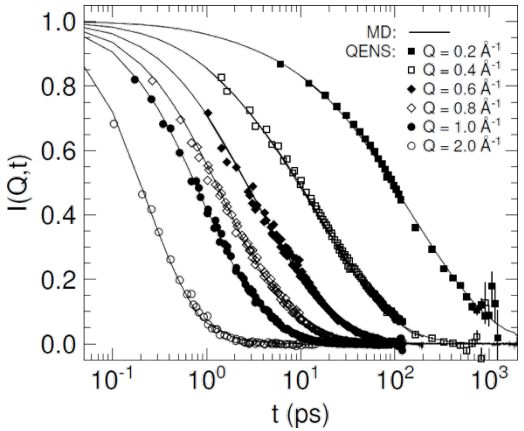
## Interactions at biological membranes

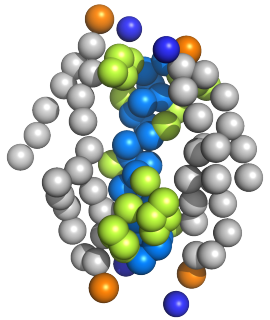
**Alzheimer's disease amyloid-β peptide analogue alters the ps-dynamics of phospholipid membranes**



amyloid-β peptide 25-35





**Combination of QENS with coupled atomistic – coarse-grained simulations**

Pluhackova, Wassenaar, Böckmann. Bookchapter in Membrane Biogenesis (2013)


A. Buchsteiner, T. Hauß, S. Dante, N.A. Dencher, BBA Biomembranes **1798** (2010) 1969

A. Buchsteiner, T. Hauß, N.A. Dencher, Soft Matter **8** (2012) 424

# The German Committee Research with Neutrons (KFN)

## Perspectives of Neutron Research in Germany (science case for neutrons)


**Neutronenforschung für die wissenschaftlichen Herausforderungen der Zukunft**

**Stellungnahme des Komitees Forschung mit Neutronen (KFN) zur wissenschaftlichen Attraktivität der European Spallation Neutron Source**

*T. Unruh, W. Petry*
*mit Beiträgen von T. Hellweg, R. Dronskowski, P. Fierlinger, P. Müller-Buschbaum, A. Ostermann, M. Hofmann, N. Paul, B. Keimer, O. Stockert, P. Böni, W. Lohstroh*

http://sni-portal.uni-kiel.de/kfn/SP11/

http://sni-portal.uni-kiel.de/kfn/Archiv/Neutronenforschung-2013.pdf

# The German Committee Research with Neutrons (KFN)

- The aim of the committee is to support research with neutrons
- The committee represents more than 1300 German researchers using neutrons for science: strongest fraction at universities (> 60%)
- The committee consists of 7 elected neutron scientists complemented by research centers, governmental authorities, and others (e.g. DFG)

# Members of the
# 9th Komitee Forschung mit Neutronen

Richard Dronskowski
Festkörper- und Quantenchemie, RWTH Aachen
(Infrastructure and Instrumentation)

Thomas Hellweg
Physikalische und Biophysikalische Chemie, Uni Bielefeld
(deputy chairman)

Regine v. Klitzing
Institut für Chemie, TU Berlin
(Education and Public Relations)

Georg Roth
Kristallographie
RWTH Aachen

# Members of the
# 9th Komitee Forschung mit Neutronen

Andreas Schreyer
Institut für Werkstoffforschung
HZG

Oliver Stockert
MPI Chemische Physik fester Stoffe
Dresden

Peter Fierlinger
Particle physics with neutrons
TUM

Tobias Unruh
Nanomaterials characterization
FAU

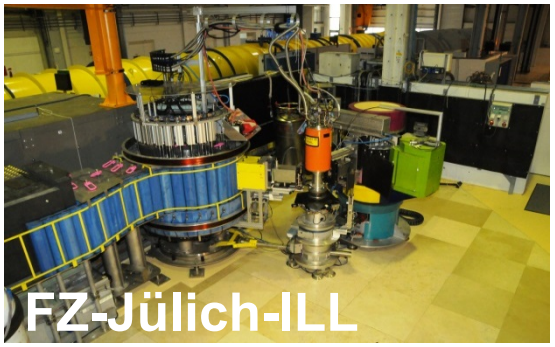
# The German Committee Research with Neutrons (KFN)

- The aim of the committee is to support research with neutrons
- The committee represents German researchers who use neutrons for their science.
- The committee is built up by 7 elected neutron scientists complemented by guests from research centers, governmental authorities, and others
- A central task of the committee is to conduct a regular dialog between the users of neutron facilities, the operators of neutron centers, and the representatives of the federal ministry for education and research.

# Unique German network for research with neutrons

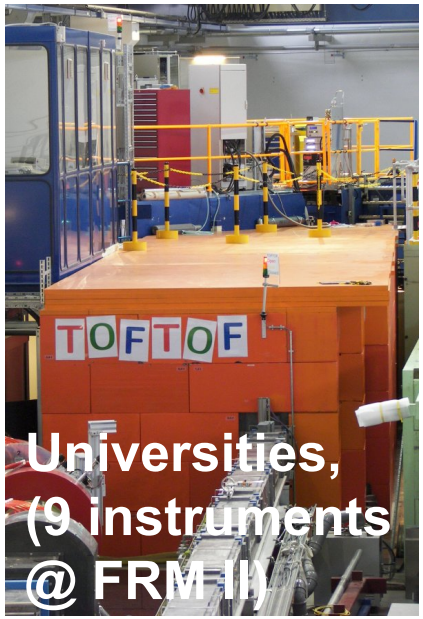

TRISP @ MLZ, picture: FRM II


JNSE @ MLZ, picture: JCNS



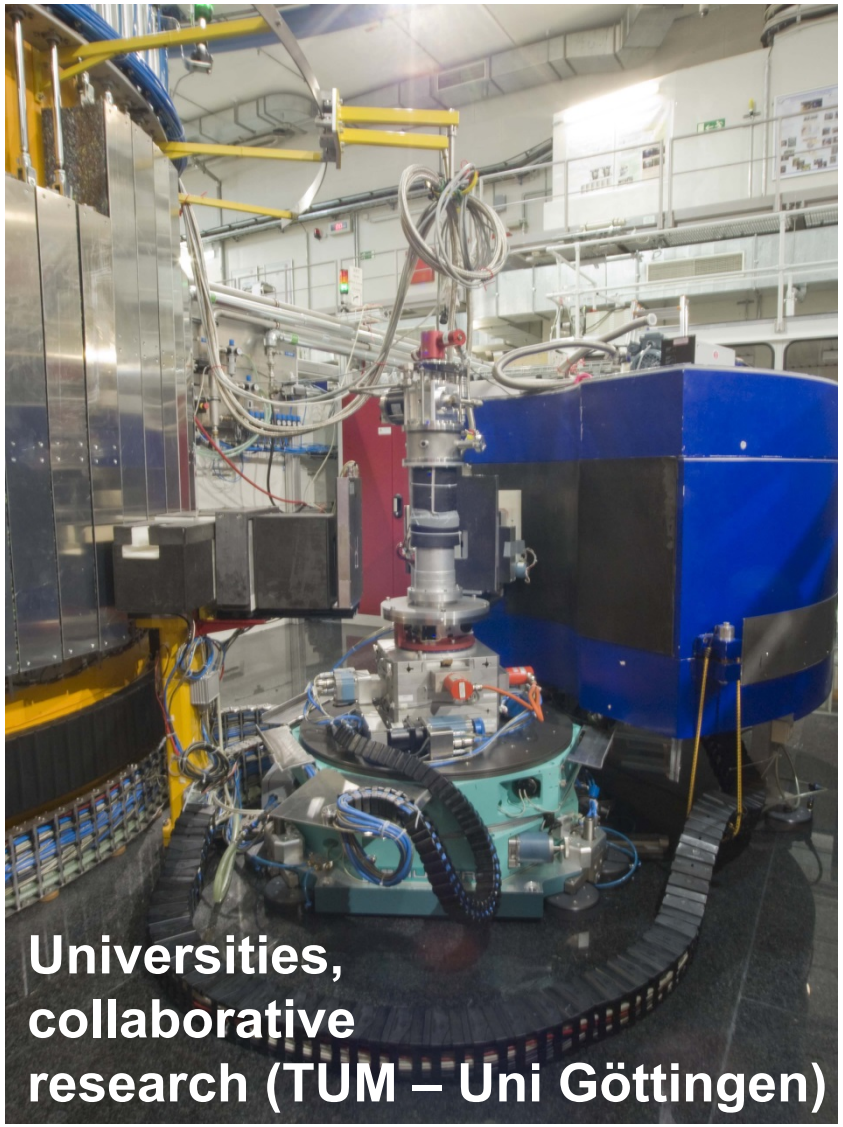

IN12 @ ILL, picture: S. Claisse, ILL


RefSANS @ MLZ, picture: GEMS




TOFTOF @ MLZ

# Collaborative research for research with neutrons




Puma @ MLZ, picture: FRM II

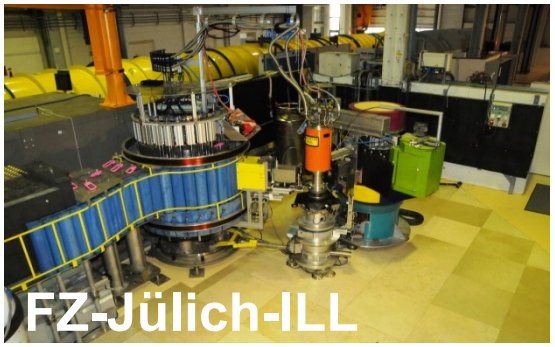

PowTEX, SANS @ ILL, picture: Uni Bochum


BioRef @ HZB, picture: HZB

# Unique German network for research with neutrons


TRISP @ MLZ, picture: FRM II


JNSE @ MLZ, picture: JCNS

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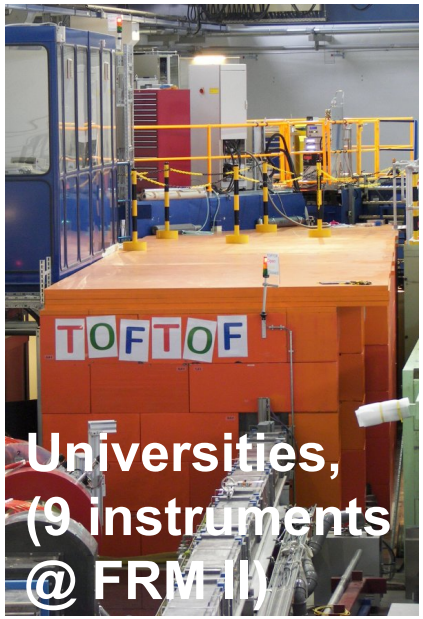


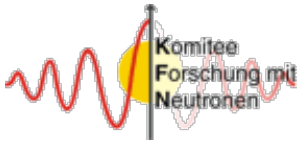

TOFTOF @ MLZ

**FRJ-2 (2006)**

**FRG-1 (2010)**

**BER II**


# Unique German network for research with neutrons

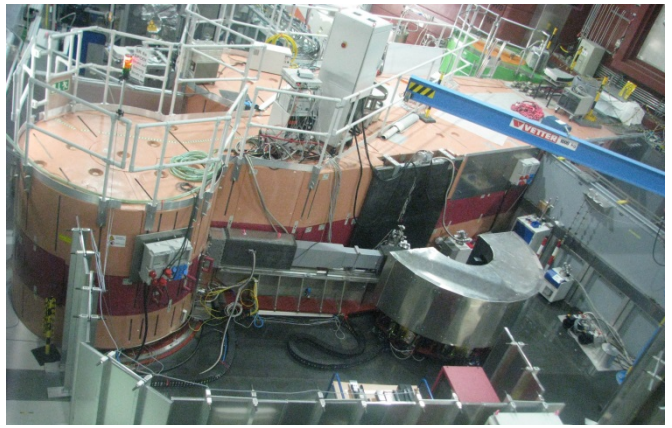



# Thank you for your attention

# Collaborative research for research with neutrons

## Instruments (Collaborative research)

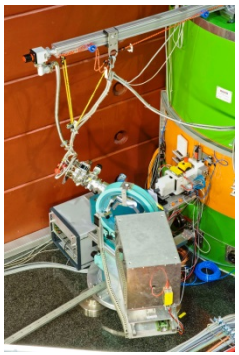
POWTEX
PUMA
BAMBUS@PANDA
POLI
KOMPASS
SAPHiR
Extension IN16B
SPODI
REFSANS
ADAM
…

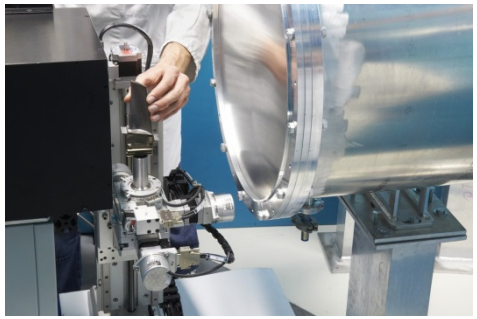


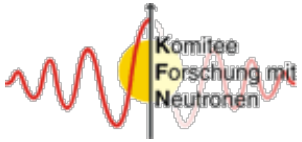
# Instruments built @ FRM II by university groups

## Instruments built @ FRM II by University groups

MIRA
TOFTOF
RESEDA
MEPHISTO
Panda
ANTARES
RESI
Heidi
Nectar
UCN
PERC/Mephisto






# Addressing the scientific challenges of the future

**Research with neutrons has a tremendous impact on the German science and technology sector.**

Research with neutrons will significantly contribute to solve the grand challenges of our society in science and technology:

- Energy
- Health
- Mobility
- Information technology
- Innovative (nano-)materials

# Challenges for research with neutrons

## Molecular structure and dynamics at interfaces