Beate Klösgen
Institute of Physics, University of Southern Denmark
Marité Cardenas, Ursula Bengaard Hansen
Niels Bohr Institute, Denmark
Jochen Stahn, Uwe Filges, Tobias Panzner
Paul Scherrer Institut, Switzerland

Selene-type reflectometer for liquid surfaces

aim:

use the flux gain and the pulse structure of the ESS to probe dynamics at liuid surfaces by neutron reflectometry
The scientic case for a horizontal reflectometer is the acquisition of data about interfaces and thin films at the liquid/gas or liquid/liquid boundary. The instrument is designed to study the structure and, to some extent, the dynamics of thin layers by covering a wide momentum transfer range in q_z of at least $0.01\,\text{Å}^{-1} < q_z < 0.2\,\text{Å}^{-1}$ in a quasi simultaneous mode.

approach:

The guide system is based on the Selene concept (→ poster 1/4).
Higher momentum transfer can be realised by either changing the inclination of the beam and lowering the sample, or, for solid/liquid cells or solid samples, by tilting the sample.
Moreover, lateral film structures will be probed by focusing GISANS when the detector is positioned at the focal plane with the sample located at the guide end.

goals:

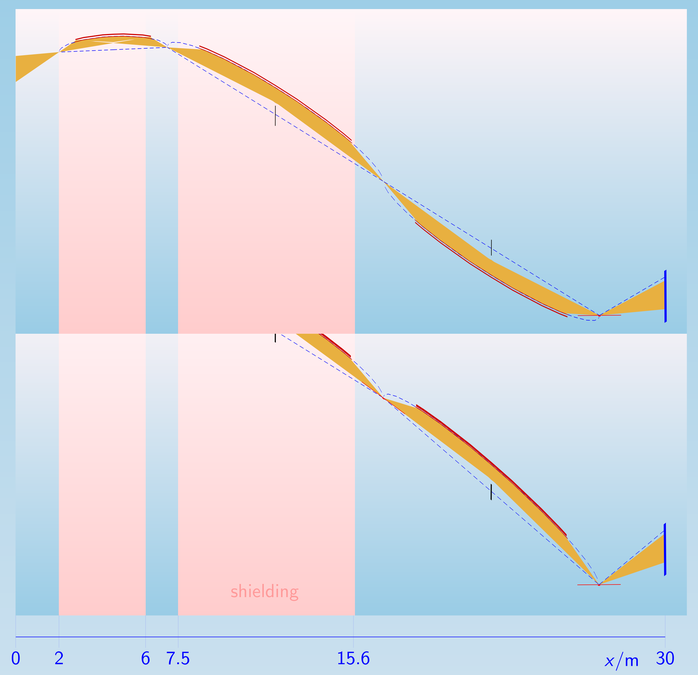
○ characterization of molecularly thin films (monolayers, bi-layers, and oligo-layers) in horizontal conformation such that liquid floating and as well supported liquid films can be studied
○ reduction of
– sample area ($3 \times 3\,\text{cm}^2$)
– subphase volume (for floating samples, e.g. Langmuir layers)
○ will allow for experiments with precious material (proteins, enzymes; expensive deuterated compounds)

this work is part of the
ESS Design Update Programme — Denmark & Switzerland

The Danish side of the project is generously supported by a grant to Neutron instrumentation for the European Spallation Source design update phase from the Danish Ministry for Research, Innovation, and Higher Education

contact:
Beate Klösgen, Institute of Physics, Chemistry and Pharmacy
University of Southern Denmark, 5230 Odense, Denmark
kloesgen@sdu.dk

instrument lay-out:



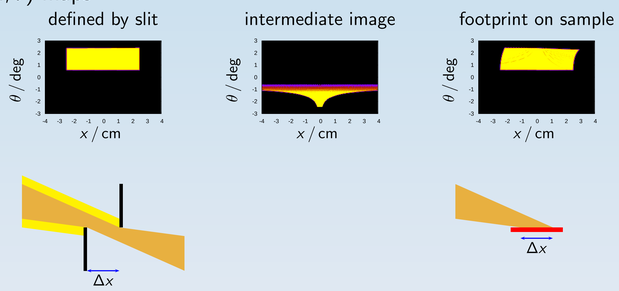
default setting
for liquid surfaces:

$\lambda = 3\,\text{Å} \ldots 11\,\text{Å}$
$\theta = 0.3° \ldots 2.8°$
$\Downarrow$
$q_z = 0.006\,\text{Å}^{-1} \ldots 0.20\,\text{Å}^{-1}$

extention ot higher q_z:
○ reflector after 1st guide
○ inverted 2nd guide

$\theta = 1.4° \ldots 3.9°$
$\Downarrow$
$q_z = 0.030\,\text{Å}^{-1} \ldots 0.30\,\text{Å}^{-1}$

$I(x, \theta)$ maps



science case

compositon, thickness and roughness of thin molecular films
○ PEG stabilized lipid protrusions in supported membranes
G. Fragneto *et al.* A Neutron Reflectivity Study of Supported Membranes Incorporating Terminally Anchored Polymers: Protrusions vs. Blisters. submitted to Langmuir (2012)
○ DNA-surfactant mixtures
M. Cárdenas *et al.* Structure of DANN-Catinic Surfactant Complexes at Hydrophobically Modified and Hydrophilic Silica Surfaces as Revealed by Neutron Reflectometry.Langmuir 2011, 27, 1250612514

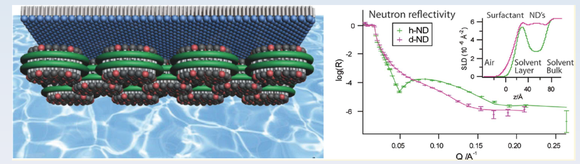
structure of proteinaceous layers at interfaces
○ saliva films on surfaces
M. Cárdenas *et al.* Human Saliva Forms a Complex Film Structure on Alumina Surfaces. Biomacromolecules 2007, 8, 65-69.

equilibrium conformations in membrane proteins
○ CPR protein in nanodiscs at the solid-liquid interface
M. Wadsäter *et al.* Shift in conformational equilibrium in Cytochrome P450 Reductase incorporated in nanodiscs as studied by neutron reflectivity. Manuscript 2012

formation of layered structures at liquid / liquid interfaces
○ polyelectrolyte layers
D. R. Carriere *et al.* 2004. Oscillations in solvent fraction of polyelectrolyte multilayers driven by the charge of the terminating layer. Langmuir 20:11465-11472.

slow dynamics at/in films;
○ slow reorganization/adsoprtion processes

future advanced dynamic methods
○ quasi-elastc scattering from thin films
○ lipid dynamics
B. Bruning *et al.* 2010. Influence of cholesterol on the collective dynamics of the phospholipid acyl chains in model membranes. Eur. Phys. J. E 31:419-428



A well organized nano disc film can be formed under the air-water interface taking advantage of electrostatic forces and density differences between h2o and d2o solutions. Schematics representing the model that best fits neutron reflection data for nano discs containing deuterated and hydrogenated nano discs are shown.
R. Wadsater *et al.* Nano discs at the air-water interface. A neutron reflectivity study. Langmuir, 2011, 27, 15065.