



the  
Swiss-Danish Instrument Initiative  
presents

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# Estia Εστία

a

focusing reflectometer for small samples  
based on the  
*Selene* guide concept



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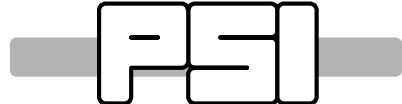
J. Stahn



the  
Swiss-Danish Instrument Initiative  
for reflectometry are

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PAUL SCHERRER INSTITUT



*Paul Scherrer Institut, Switzerland*

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P. Korelis

U. Filges

T. Panzner

E. Rantsiou

*University of Copenhagen, Denmark*

M. Cardenas

U. Bengaard Hansen

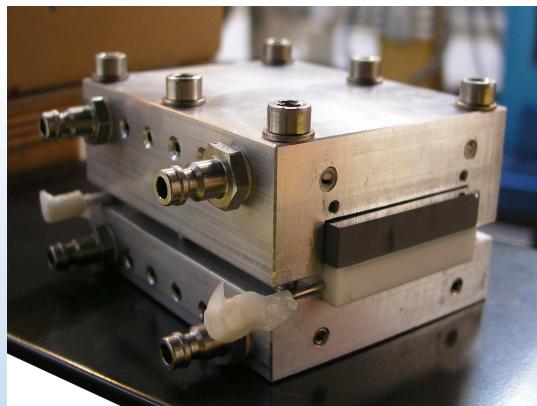
*University of Southern Denmark*

B. Klösgen

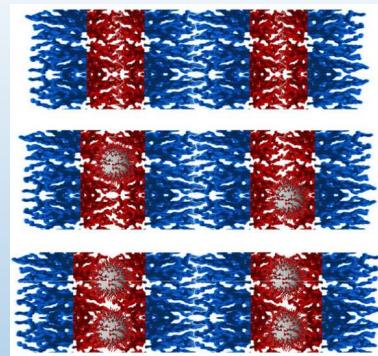


## science case

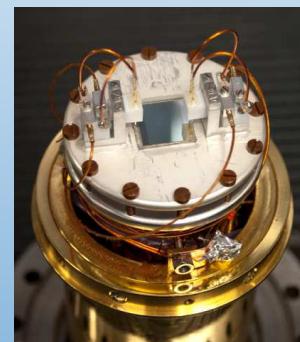
### depth-profiling of structural and magnetic densities lateral structures close to surfaces



organic films at a solid liquid interface

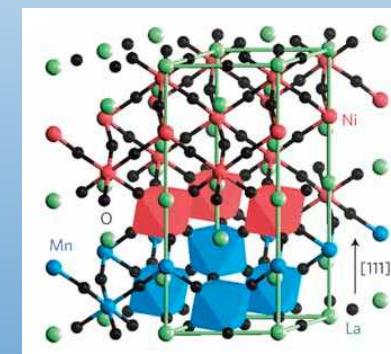


laterally structured (organic) films



functional devices

magnetic heterostructures



# instrument

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## key parameters

sample size       $1 \times 1 \text{ mm}^2$   
 to       $10 \times 50 \text{ mm}^2$

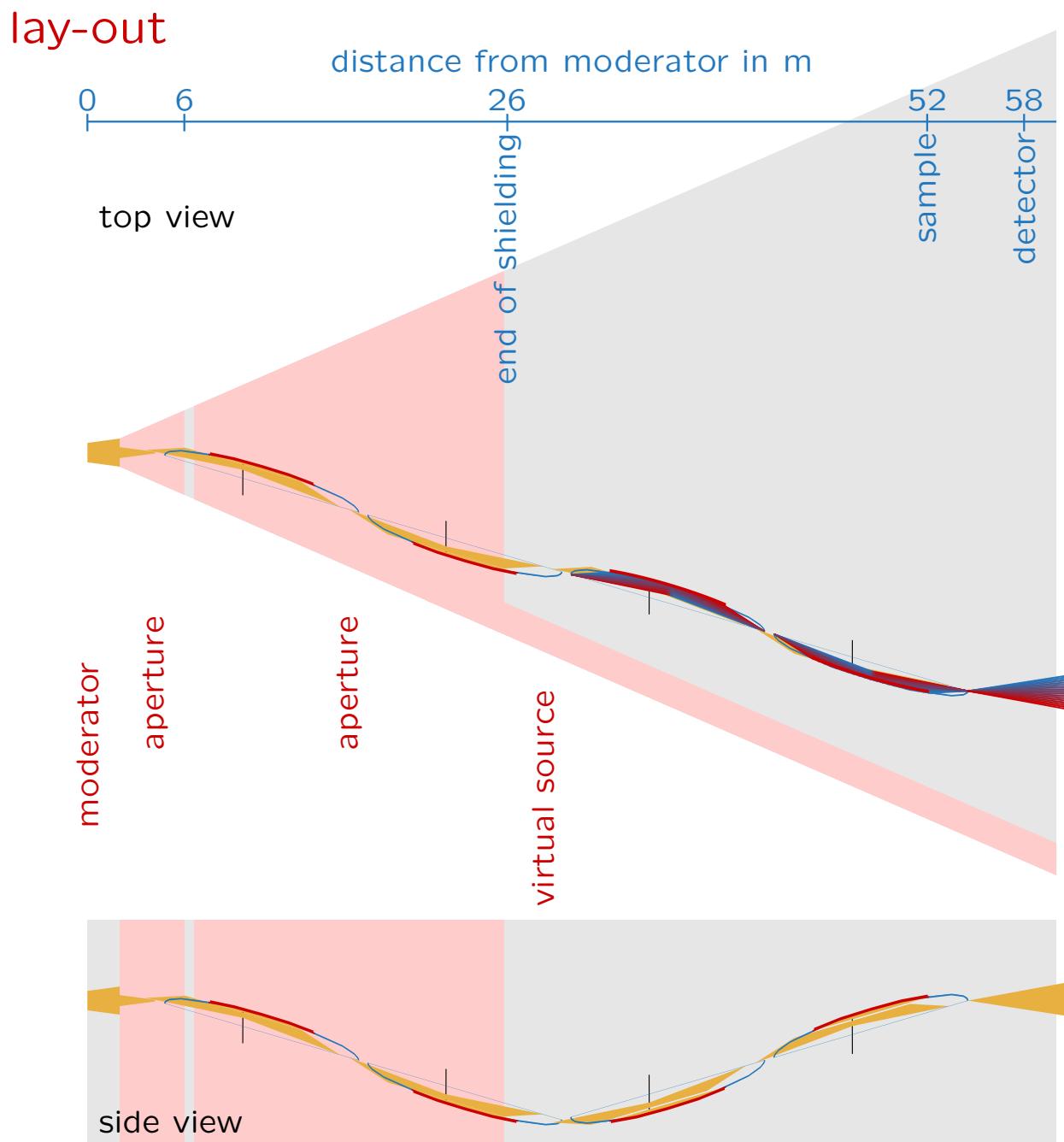
horizontal scattering plane

intrinsic resolution 2 to 4%

polarisation option

low background

**truly focusing**



# instrument

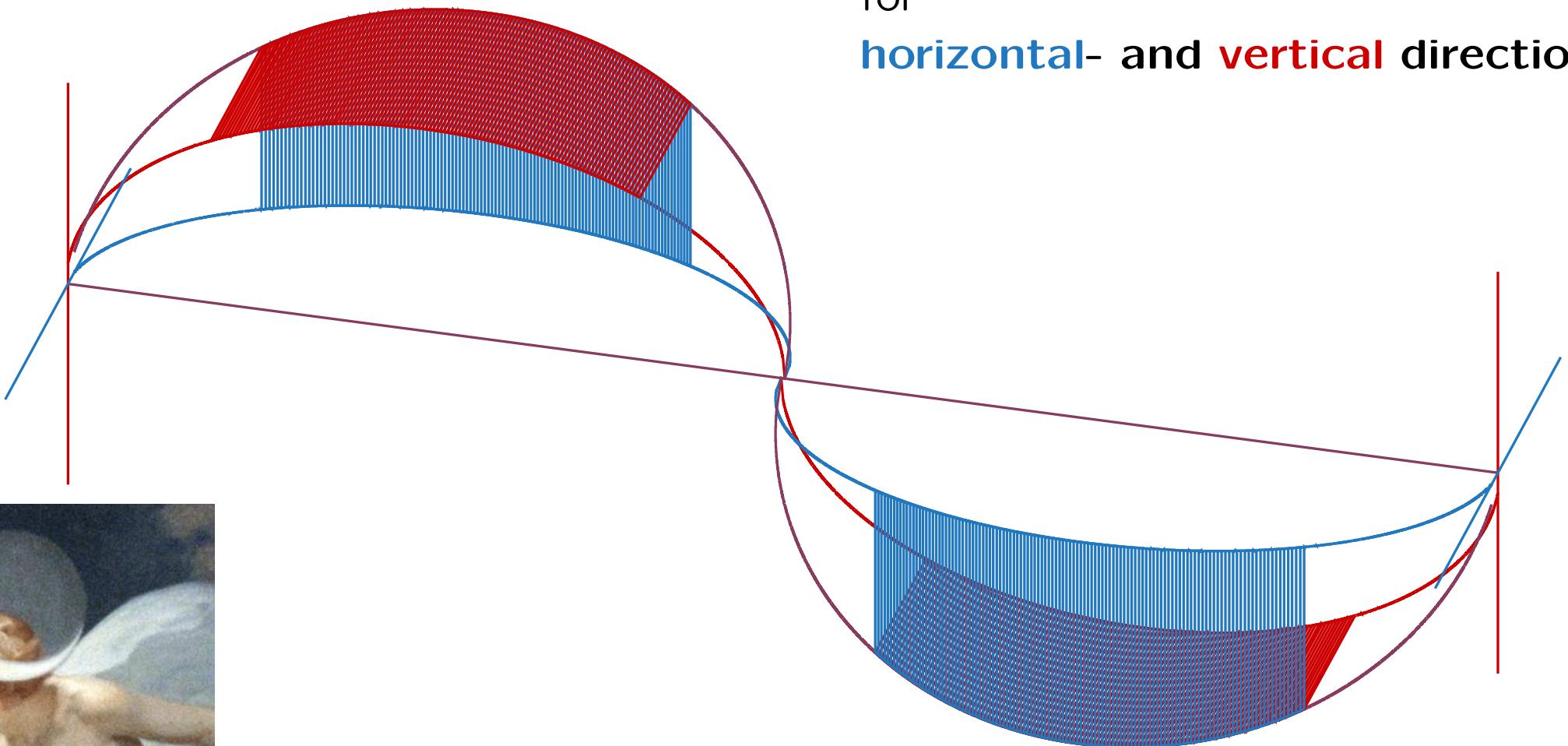
**point-to-point focusing**

with

**2 subsequent elliptical reflectors**

for

**horizontal- and vertical direction**

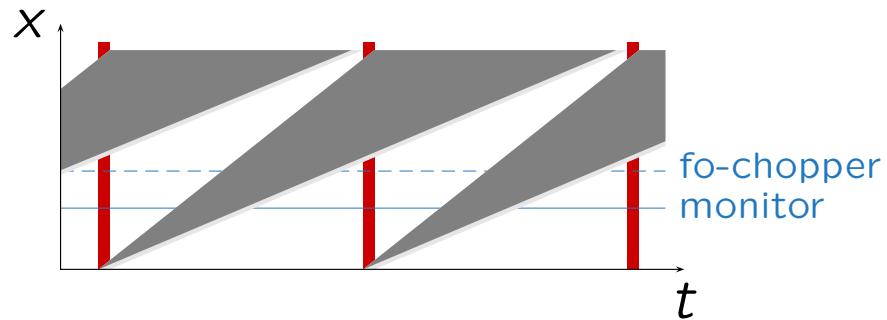


*Selene* guide concept

# instrument

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time regime



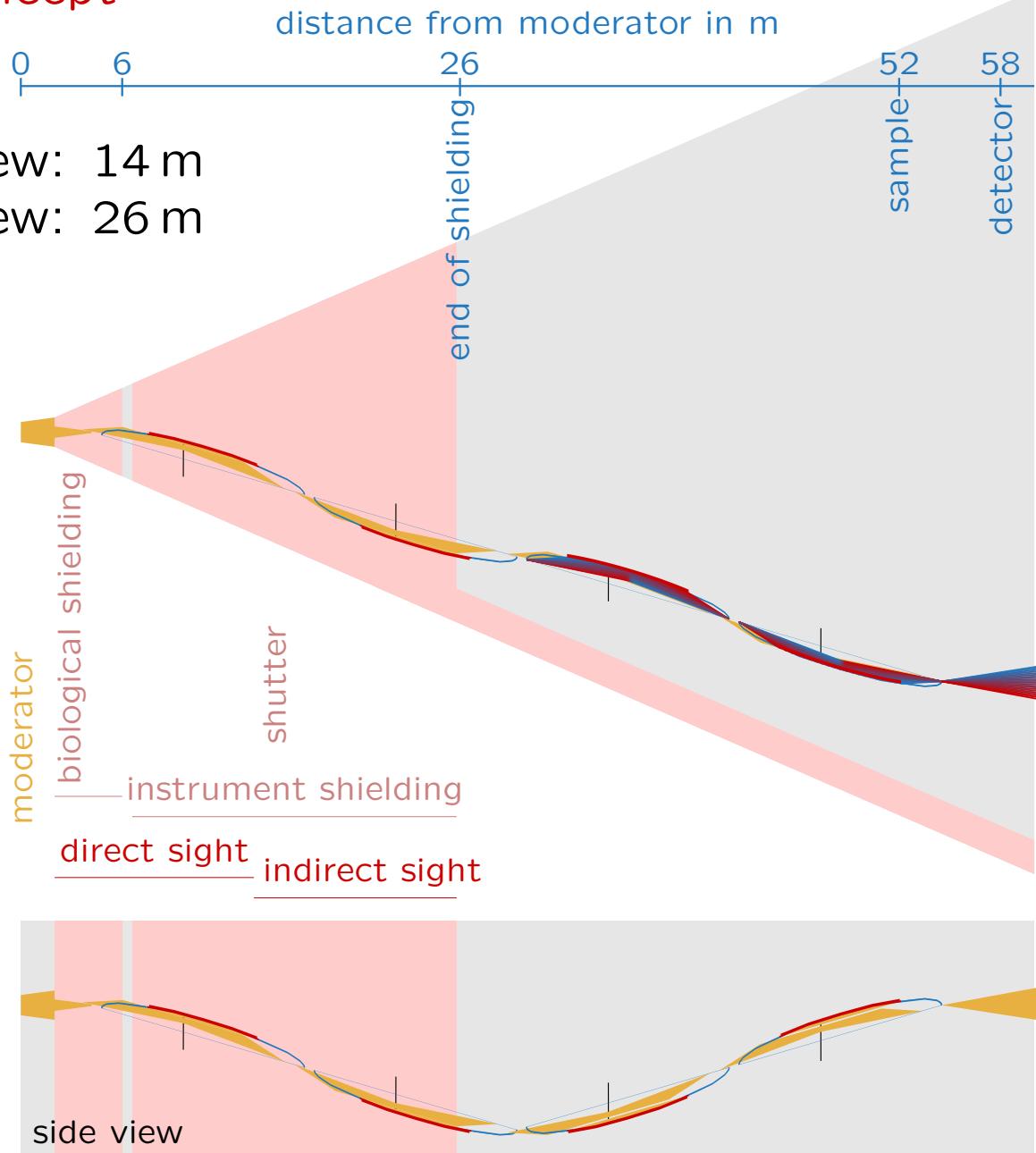
$$\lambda \in [5, 9.4] \text{ \AA}$$

$$\Delta\theta_{xy} = 1.5^\circ$$

$$\Delta\theta_{xz} = 1.5^\circ$$

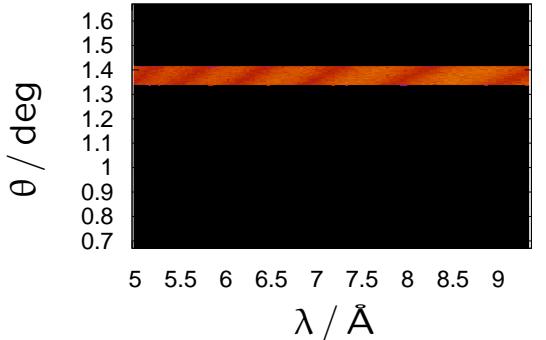
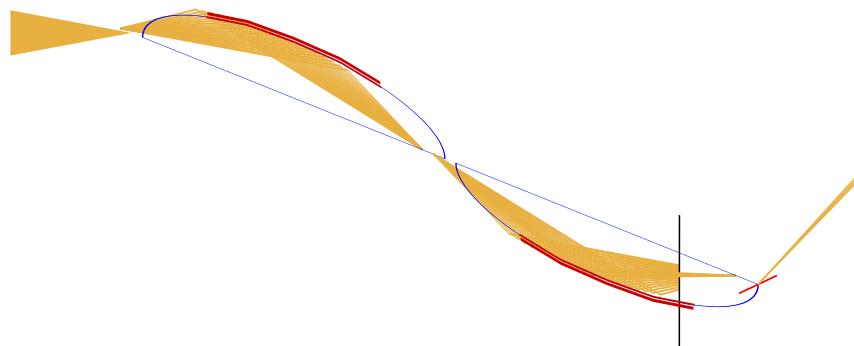
shielding concept

direct view: 14 m  
indirect view: 26 m



# operation modes

almost conventional



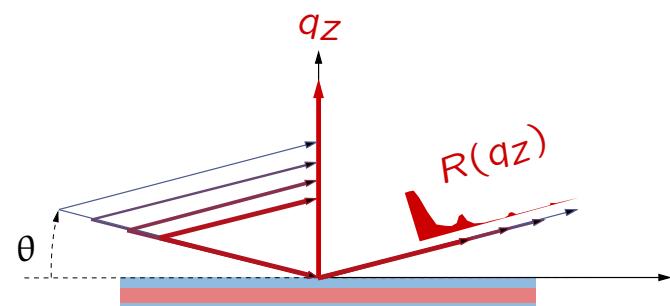
convergent beam

defined footprint

defined divergence

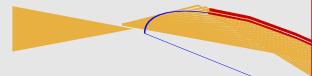
medium resolution ( $\approx 5\%$ )

specular & off-specular reflectometry



## operation modes

almost conventional



convergent beam

**defined footprint**

defined divergence

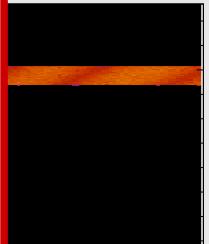
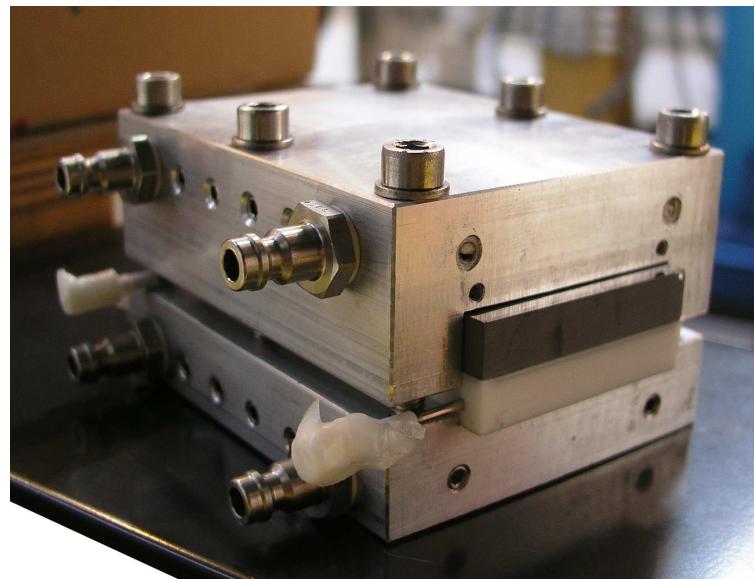
medium resolution ( $\approx 5\%$ )

specular & off-specular reflectometry

### liquid interfaces

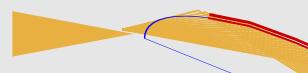
e.g. solid-liquid cell

avoid gasket & trough walls  
restrict to a homogeneous area



# operation modes

*almost conventional*



convergent beam

**defined footprint**

defined divergence

medium resolution ( $\approx 5\%$ )

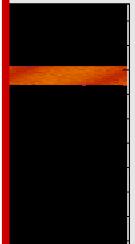
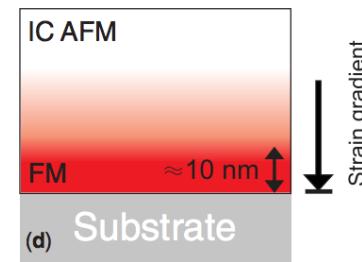
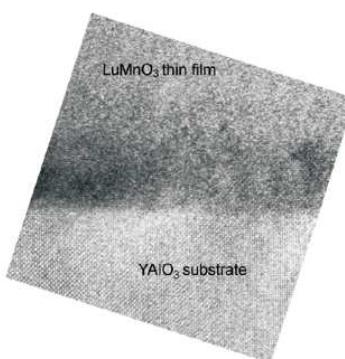
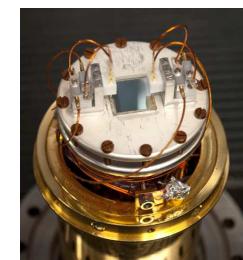
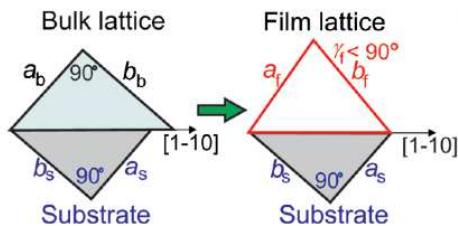
specular & off-specular reflectometry

## multiferroics

strain induced FM in  
multiferroic AFM  $\text{LuMnO}_3$

J. White et al.

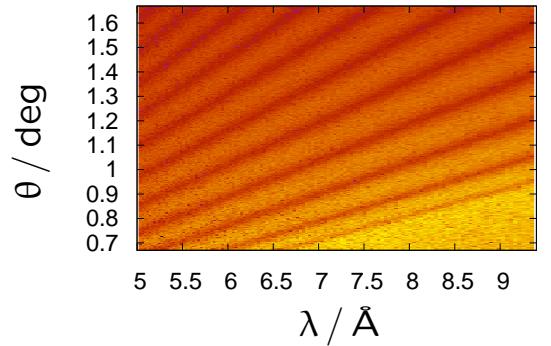
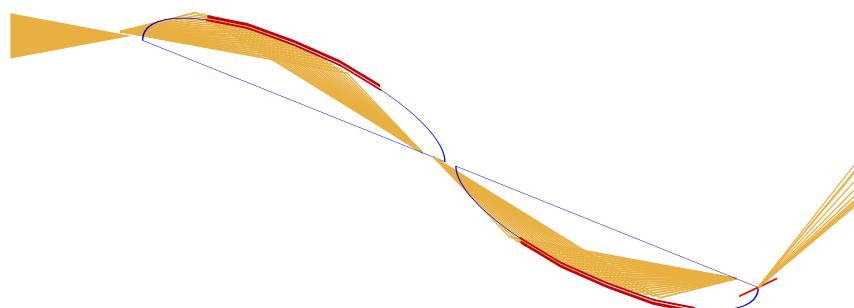
PRL 111, 037201 (2013)



8.5 9

## operation modes

high-intensity specular reflectivity



trading off-specular resolution for intensity

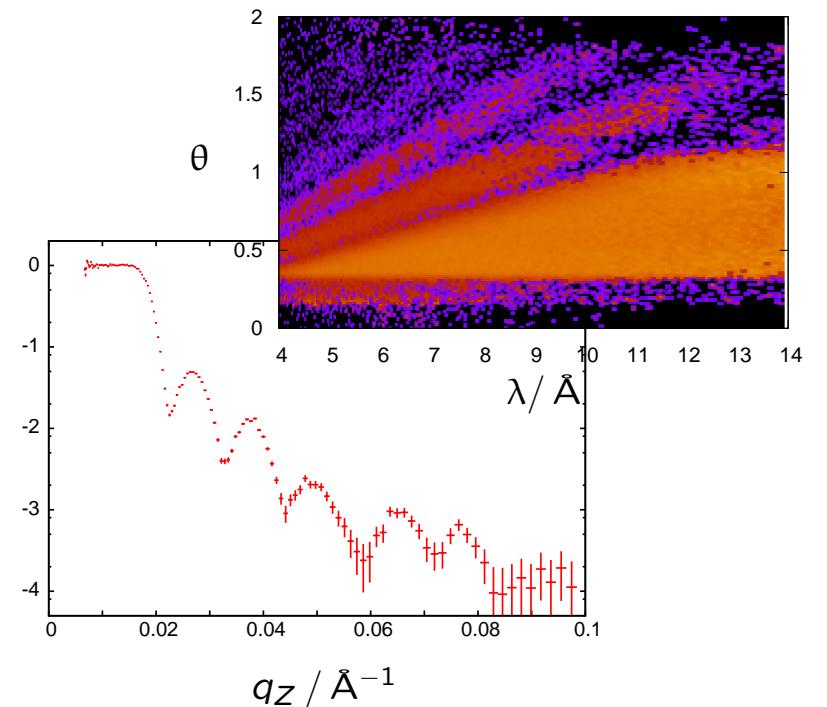
⇒ complex resolution function

*quick & dirty* way to scan a phase diagram

time-resolved studies

tiny samples

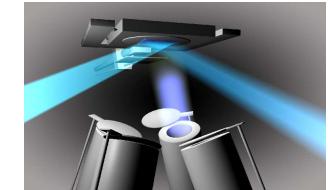
Si/Fe/Cu on Si



## operation modes

high-intensity specular

novel electronic phases  
at interfaces



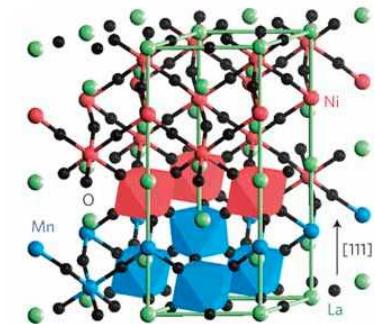
exchange bias in  $\text{LaNiO}_3$  (PM) /  $\text{LaMnO}_3$  (FM)  
superlattices

M. Gibert et al.

nature materials 11, 195198 (2012)

trading off-specular re-

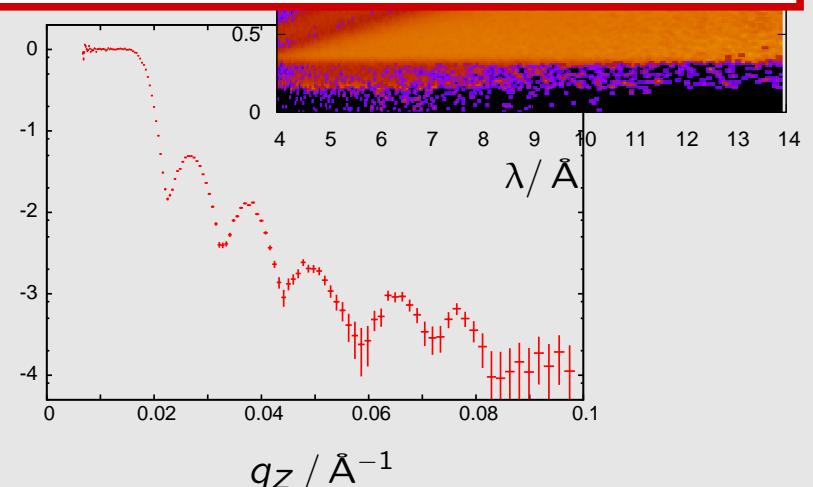
⇒ complex resolution



quick & dirty way to scan a phase diagram

time-resolved studies

tiny samples



# operation modes

high-intensity specular reflection



trading off-specular resolution

⇒ complex resolution function

*quick & dirty* way to scan a sample

**time-resolved studies**

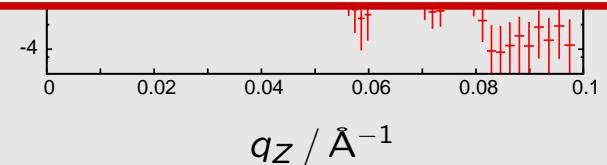
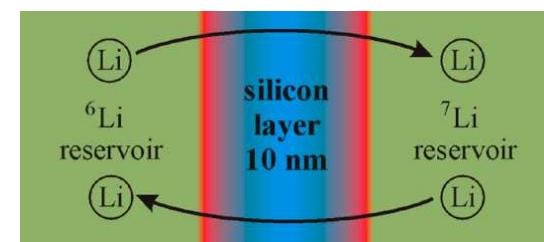
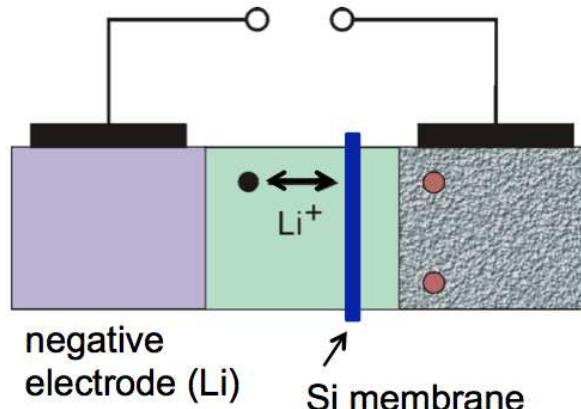
**tiny samples**

## interdiffusion

Li diffusion through a thin Si layer

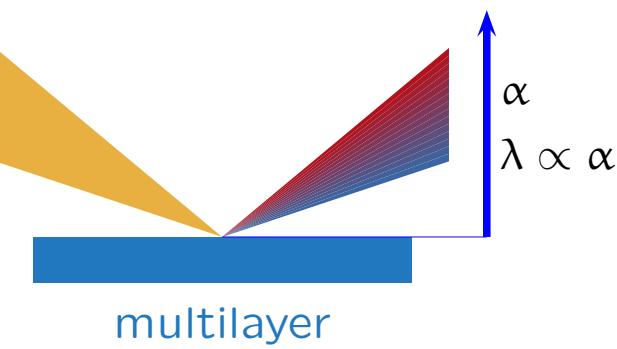
E. Huger et al.

Nano Lett. **13**, 1237 (2013)



# operation modes

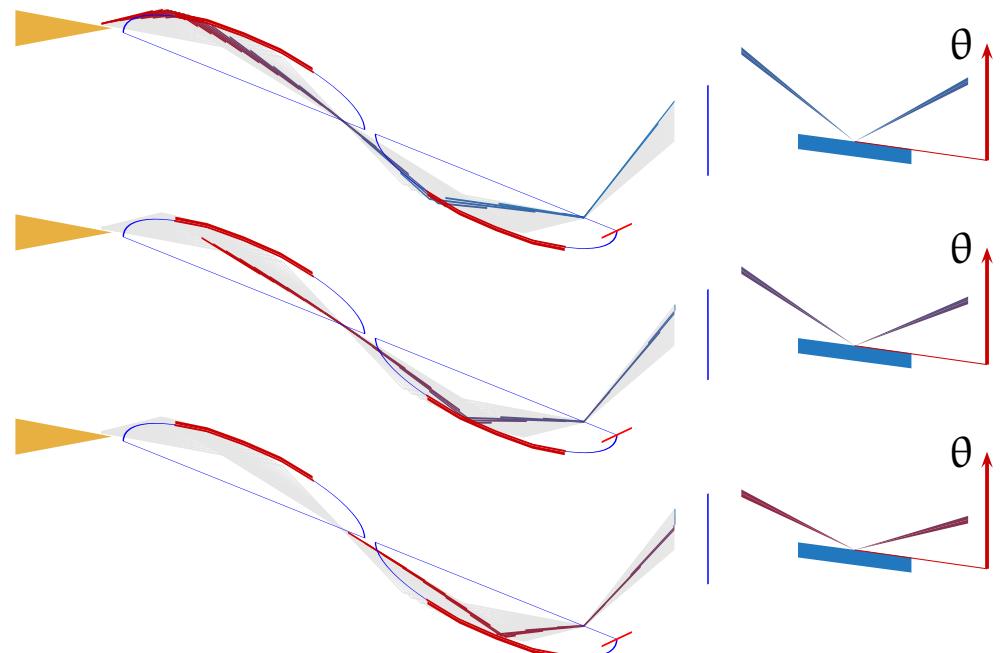
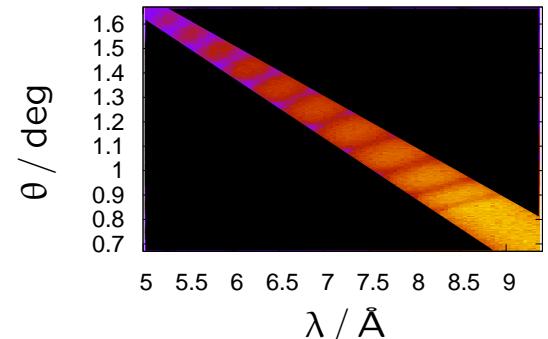
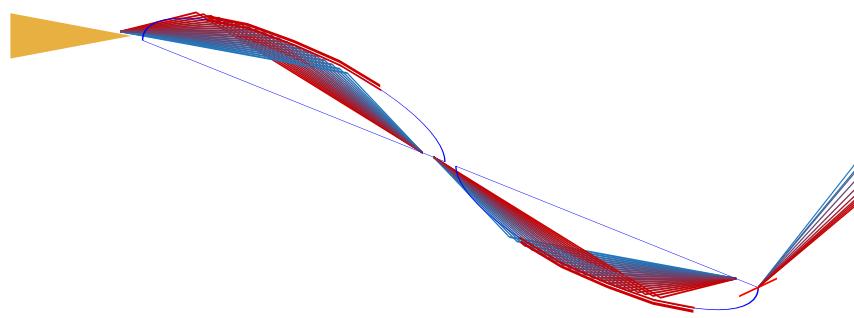
$\lambda$ - $\theta$  encoding



spectral analysis of the white beam

constant  $\Delta q/q$

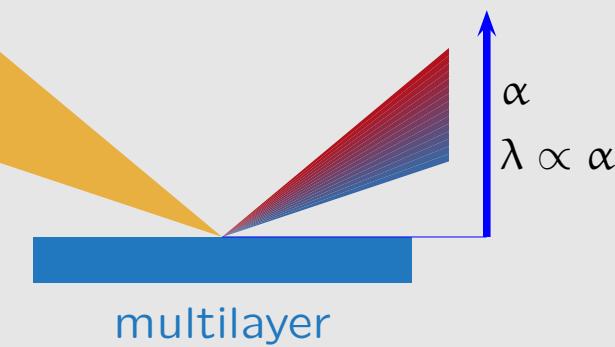
wide  $q_z$ -range



# operation modes

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$\lambda$ - $\theta$  encoding



spectral analysis of the w

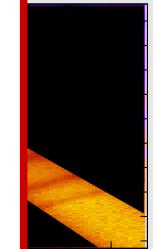
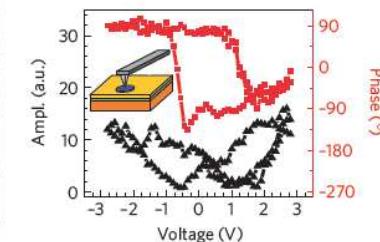
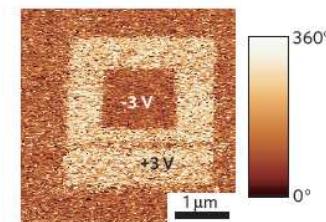
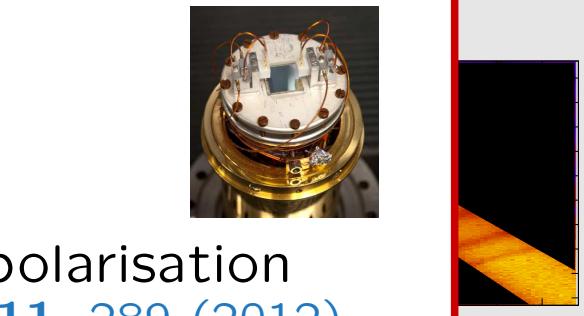
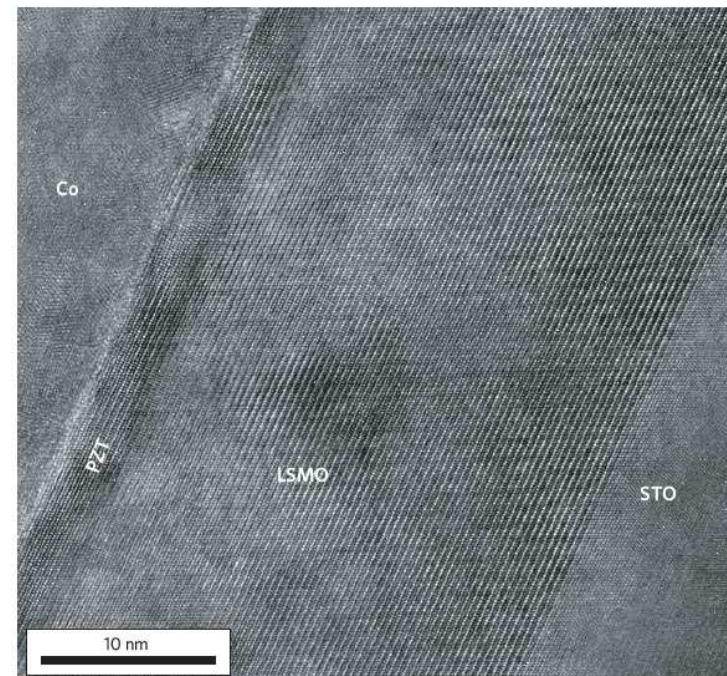
constant  $\Delta q/q$

wide  $q_z$ -range

## functional devices

electrical switching of spin polarisation  
D. Pantel et al. nature materials 11, 289 (2012)

active area  $< 50 \times 50 \mu\text{m}^2$



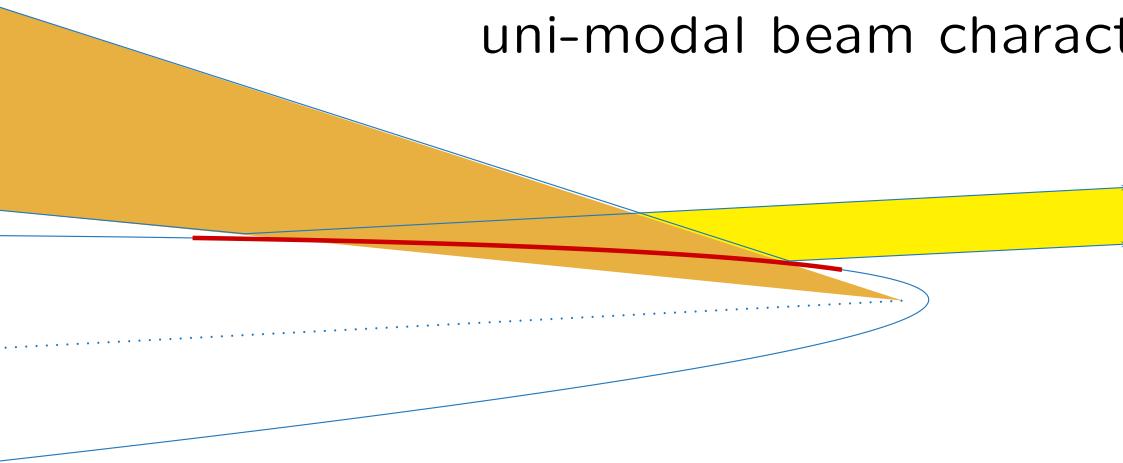
## operation modes

parallel beam

by reflection on a **parabolic** mirror

tunable divergence and beam size

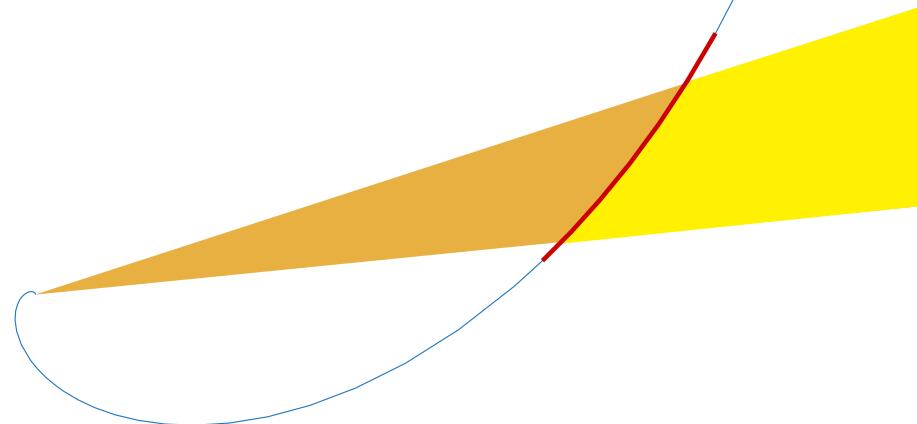
uni-modal beam characteristics



for  
laterally structured samples  
(GISANS)

polarisation

by selective reflection  
on a **log-spiral** mirror



constant angle of incidence  
low- $m$  coating  $\Rightarrow$  high  $P$

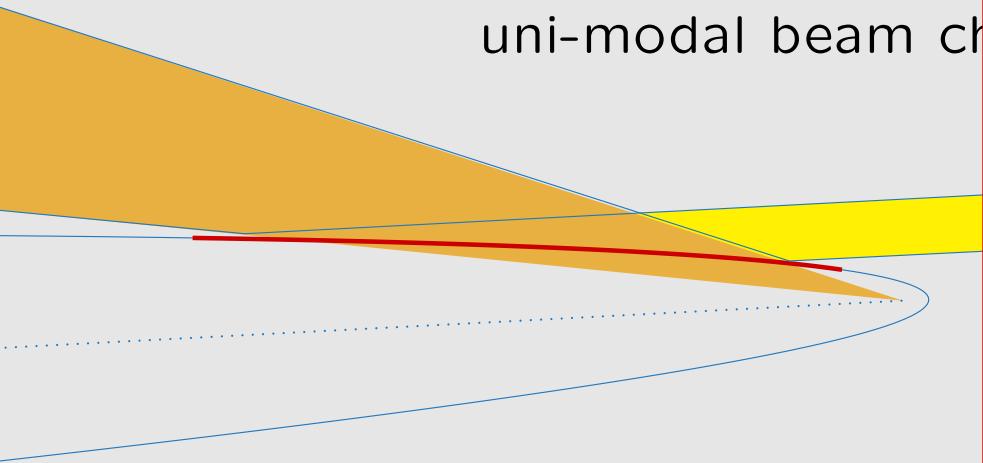
## operation modes

parallel beam

by reflection on a **parabolic** mirror

tunable divergence and

uni-modal beam char



for

**laterally structured samples**  
(GISANS)

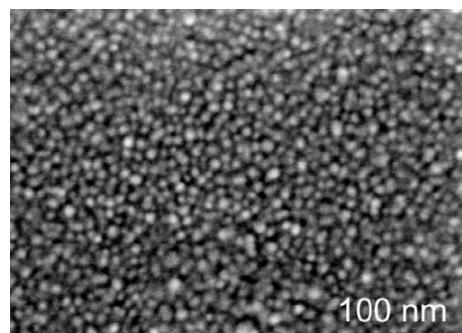
polarisation

by selective reflection

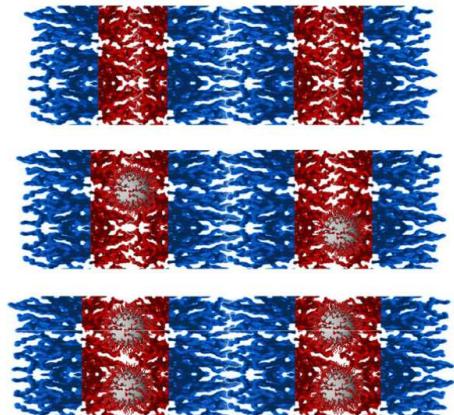
### structured surfaces

nanostructured diblock copolymer  
films with embedded magnetic  
nanoparticles

Xin Xia et al. J. Phys. 23, 254203 (2011)



SEM image



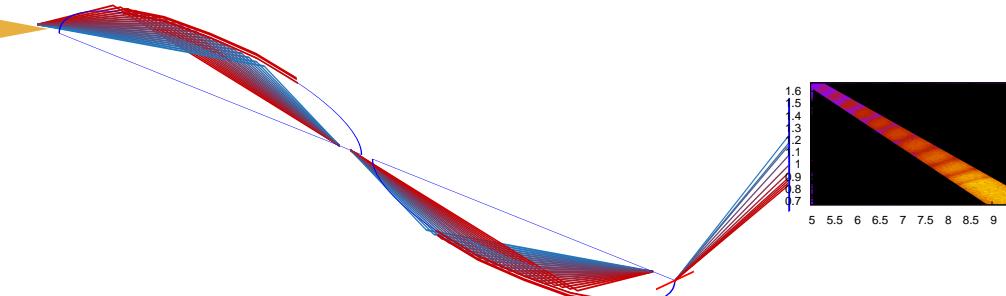
low- $m$  coating  $\Rightarrow$  high  $P$

# performance

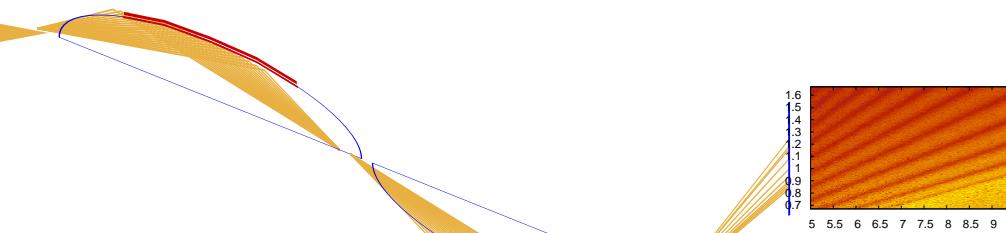
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obtained by McStas simulations

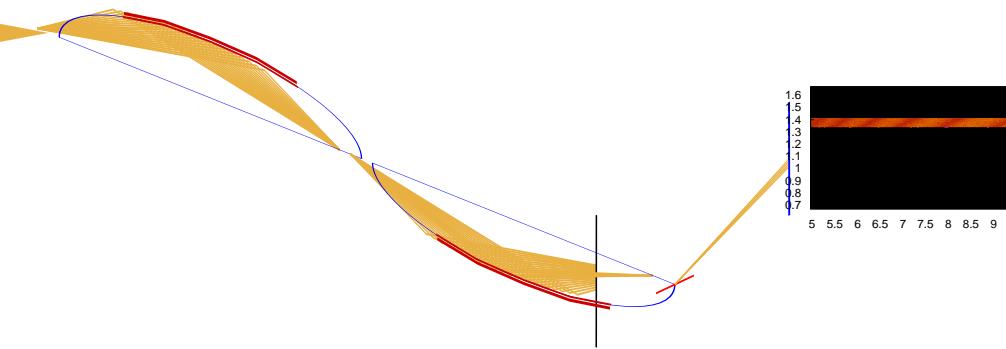
$\lambda$ - $\theta$  encoding



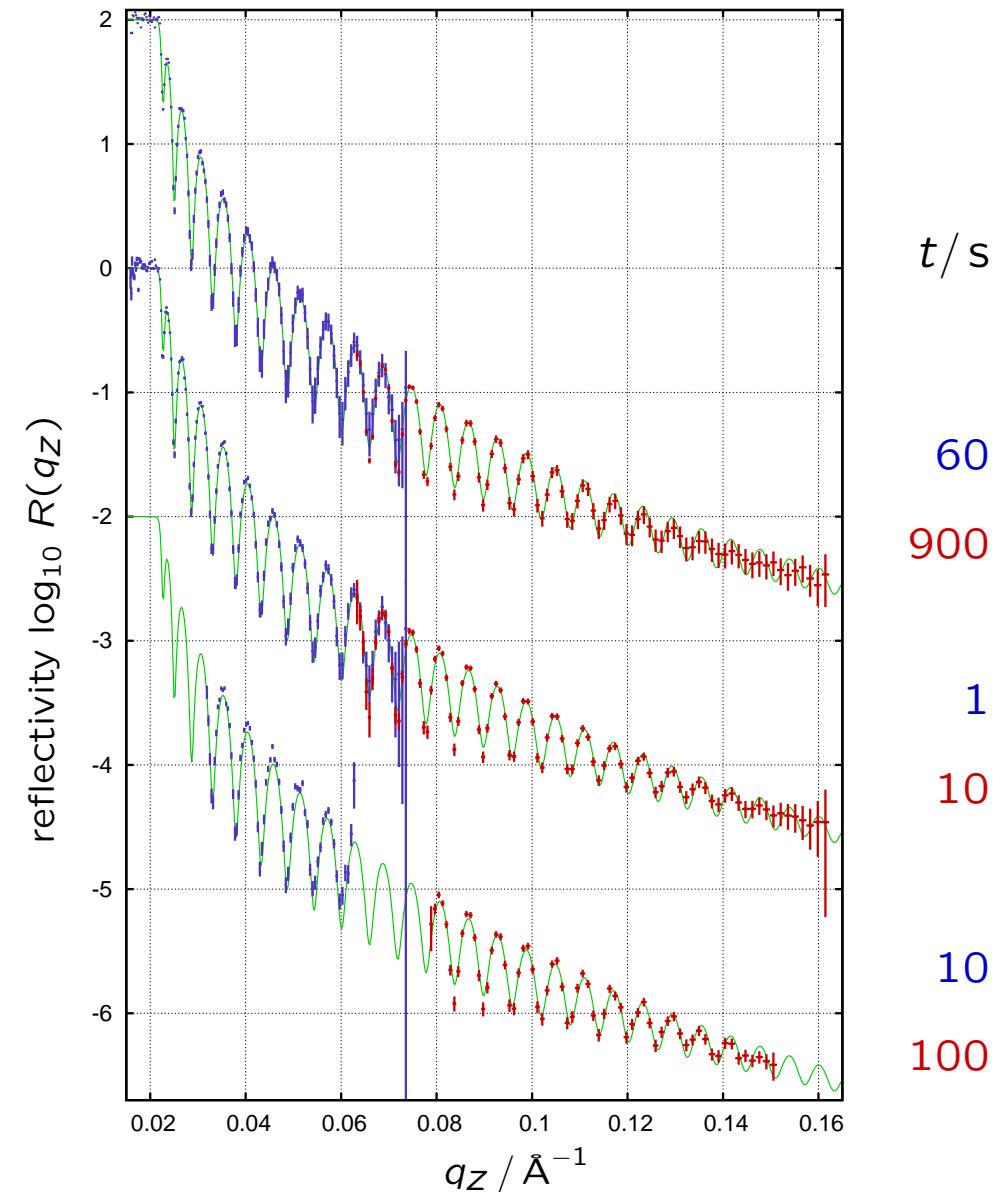
high-intensity specular reflectivity



almost conventional



1000 Å Ni on glass ( $5 \times 5 \text{ mm}^2$ )





# Estia Εστία

