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Selene-type reflectometer 2/4 for small samples

aim:

use flux-gain and time-structure of the ESS to open access to reflectometry on surfaces in the sub-mm^2 range (in addition to reflectometry on cm^2 samples)

aproach:

use a *Selene* type guide in horizonatl and vertical direction to focus the beam on a defined footprint (→ poster 1/4)

favoured applications:

- small samples ($1 \times 1\,\mathrm{mm}^2$)
- curved or bent surfaces
- spatially inhomogeneous samples
- restricted area on contacted or functional multilayers

also possible:

- moderately sized samples as on current instruments
- solid/liquid cells
- focusing GISANS (with larger sample surfaces)
- diffraction

key parameters & features:

sample area	$0.3 \times 0.3\,\mathrm{mm}^2$ to $20 \times 20\,\mathrm{mm}^2$	
λ range	3 Å to 9 Å	
q_z range	$0\,\text{Å}^{-1}$ to $1\,\text{Å}^{-1}$	reflectometry
	$0\,\text{Å}^{-1}$ to $4\,\text{Å}^{-1}$	diffraction
q_z resolution	$\Delta q_z/q_z = 2.5\%, 5\%, 10\%, 20\%$	
q_x resolution	$\Delta q_x = \Delta q_x(\lambda) = 10\% \ldots 3\%$	
options	polarisation & analysis	
	diffraction ($2\theta < 140°$, shorter detector arm)	
	focusing GISANS	

- adjustable footprint: sub-mm to cm
- horizontal and vertical scattering geometry possible
- encoding via multilayer monochromator (or prism, fast moving slits) ⇒ operation without choppers possible (but not mendatory)
- wide divergence for high-intensity specular reflectometry
- combination of high/low θ with low/high λ enables for a wide q_z range to be measured simultaneously
- free space around the sample (also free of diaphragms!) and between the guides ($\approx 4\,\mathrm{m}$) allows for all kinds of sample environment, add-on options like MIEZE or SERGIS can be installed

this work is part of the
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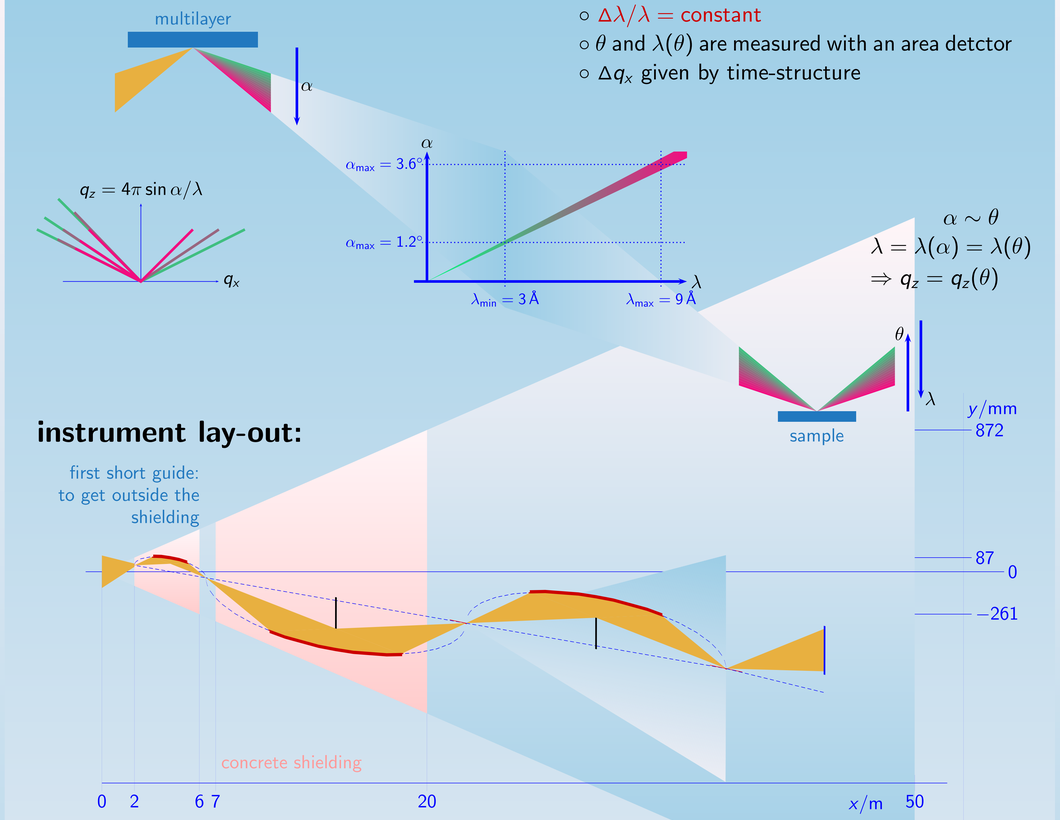
λ/θ encoding:

λ is encoded in θ via spectral anlysis by am multilayer

- no chopper needed
- $\Delta\lambda/\lambda$ = constant
- θ and $\lambda(\theta)$ are measured with an area detctor
- Δq_x given by time-structure

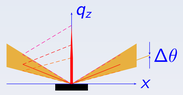


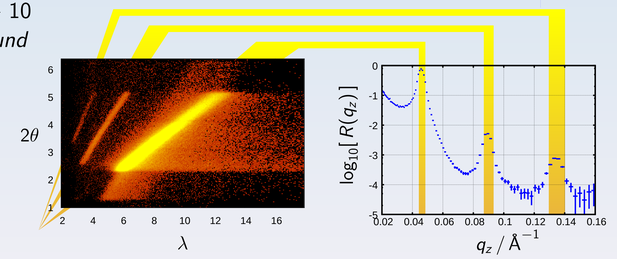
instrument lay-out:

high-intensity specular reflectometry:

full divergent beam, λ-resolution = 3% to 10% (9 Å to 3 Å)

- energy- and angle-dispersive ⇒ gain > 10
- off-specular scattering causes *background*
- for fast scanning of T, $\mathbf{H}$, $\mathbf{E}$ ...
- complex data analysis

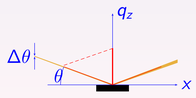


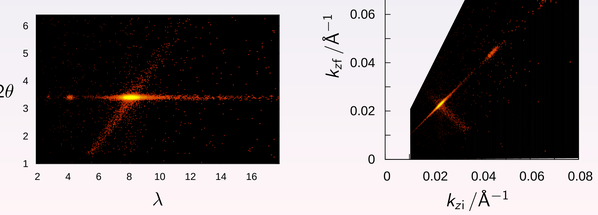


J. Stahn *et al.* EPJAP doi:10.1051/epjap/2012110295

fall-back to an *almost* conventional mode by reducing the divergence

- allows for off-specular reflectometry





science case

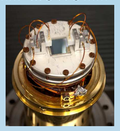
small sample area

$1 \times 1\,\mathrm{mm}^2 \ldots 5 \times 5\,\mathrm{mm}^2$

- restricted by prepapation technique
  e.g. PLD produces homogeneous films for $\varnothing < 6\,\mathrm{mm}$, only
  F. Miletto, Naples, Italy
  C. Schneider, PSI, Switzerlend
- expensive materials (e.g. certain isotopes)
  H. Schmidt, Claustal, Germany
- compatibility with other techniques (e.g. SQUID)

samples with perturbing sourroundings

$1 \times 1\,\mathrm{mm}^2 \ldots 5 \times 5\,\mathrm{mm}^2$

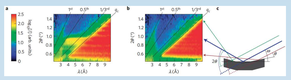


- contacted devices
  e.g. organic spin valve
  L. Schulz, A. J. Drew *et al.* NMAT
  doi:10.1038/nmat2912

unconventional surfaces

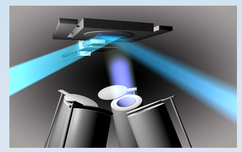
$0.3 \times 0.3\,\mathrm{mm}^2 \ldots 2 \times 2\,\mathrm{mm}^2$

- unsupported films
- curved or fracmentet surfaces
  J. Hoppler *et al.* NMAT
  doi:10.1038/nmat2383



in-situ combination

$5 \times 5\,\mathrm{mm}^2 \ldots 20 \times 20\,\mathrm{mm}^2$

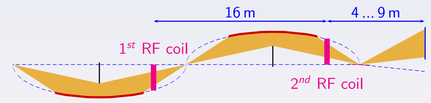


- MBE
  moderate t resolution
  no illumination of environment
  → poster W. Kreutzpaintner *et al.*:
  In-situ polarised neutron reflectometry on MBE-grown samples at ESS
- X-ray reflectometry

combination with spin-echo techniques

$1 \times 1\,\mathrm{mm}^2 \ldots 5 \times 5\,\mathrm{mm}^2$

- MIEZE
  magnetic dynamics in the range $100\,\mathrm{ps} < t < 500\,\mathrm{ns}$
  sample size determines resolution



→ poster W. Häußler *et al.*: Multi angle MIEZE beam Line at ESS
→ poster R. Georgii *et al.*: The scientific case for a MIEZE-NRSE-spectrometer at the ESS