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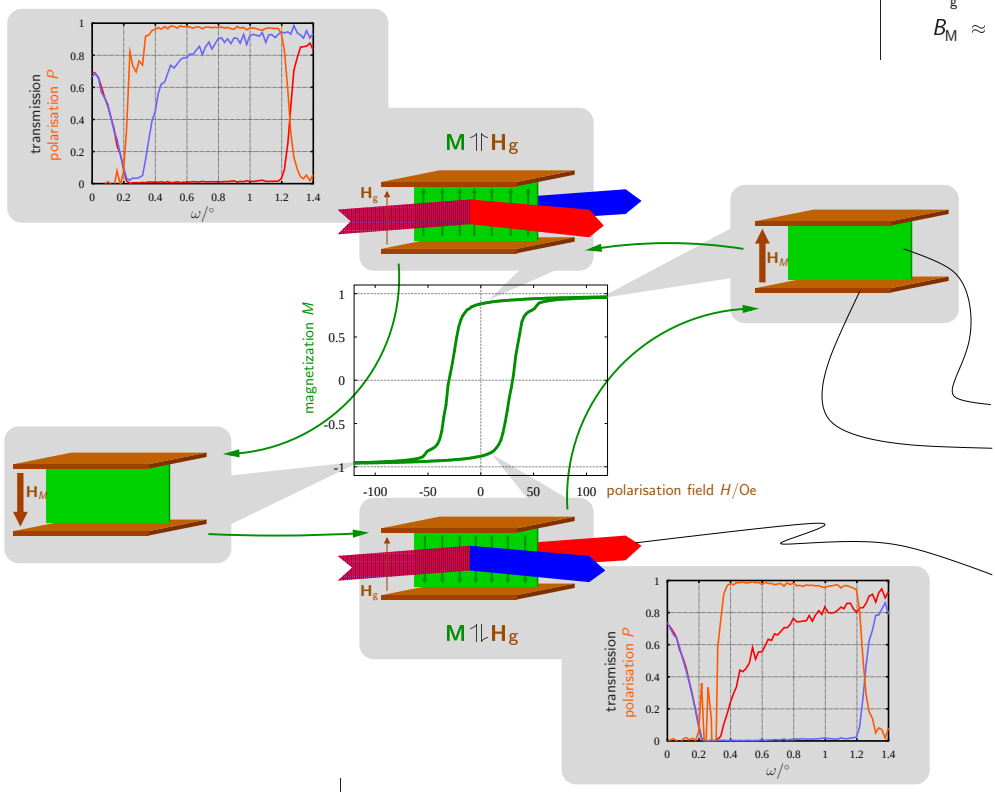
A switchable white-beam neutron polariser

Aim:	a polariser / analyser which • does not alter the beam path • accepts a wide bandwidth / divergence • does not interfere with the sample environment (no stray fields) • provides both spin states (without a flipper)
Approach:	Fe/Si supermirror (SM) on Si (deposited by magnetron sputtering) [1, 2]
Advantages:	magnetic hysteresis allows for switching [3] no magnetic fields (besides guide field $\mathbf{H}_g$) [4] reflection and transmission mode possible
Disadvantages:	q-range is limited by the stability of the coating $\Rightarrow$ only $m = 3$ with 600 layers is reachable [a]

operation principle for a remanent polariser



Si wafer with supermirror

electro magnet

$H_M \approx 120\,\mathrm{Oe}$

$H_g < 40\,\mathrm{Oe}$

unpolarised / polarised neutrons

polarising efficiency

$$P = \frac{I_{major} - I_{minor}}{I_{major} + I_{minor}}$$

applications

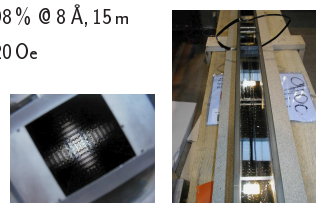
• V-shaped **polariser** [5] for SANS I
not yet switchable

$P_T \approx 93\,\%$ @ 5 Å, 5 m

$\approx 95\,\%$ @ 5 Å, 15 m

$\approx 98\,\%$ @ 8 Å, 15 m

$B_g \approx 20\,\mathrm{Oe}$



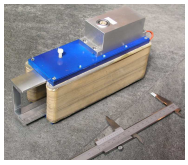
• Switchable **spin analyser** for the 2 axes diffractometer TOPSI
$m = 3$ Fe/Si SM on Si

$P_T \approx 96\,\%$, $\mathbf{M} \uparrow\uparrow \mathbf{Hg}$

$P_T \approx 95\,\%$, $\mathbf{M} \uparrow\downarrow \mathbf{Hg}$

$B_g \approx 16\,\mathrm{Oe}$

$B_M \approx 120\,\mathrm{Oe}$



future projects

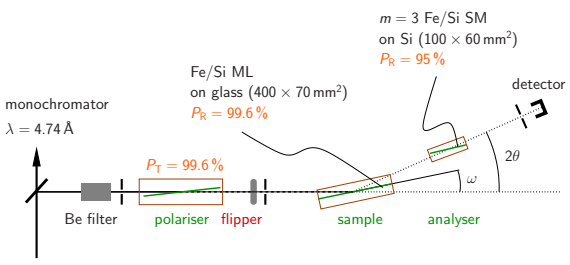
• analyser for the TOF reflectometer AMOR (switchable; usable in reflectometry and transmission mode simultaneously);

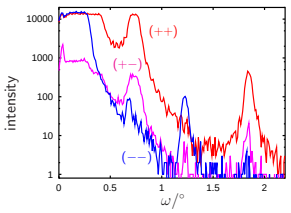
• compact polariser ($\approx 10\,\mathrm{cm}$ [?]) for beamwidths $> 1\,\mathrm{cm}$;

• improvement of the mechanical stability of the coating to allow for $m > 3$.

set-up for transmission and reflectivity measurements

Lay-out of the two axes spectrometer TOPSI @ SINQ





Reflectivity curves of a $[\mathrm{Fe}(80\,\text{Å})/\mathrm{Si}(80\,\text{Å})]_{10}$ multilayer: $I_{+-} = 2.4\,\%\, I_{++} + 3.1\,\%\, I_{--}$ (caused by the efficiencies of the analyser and of the spin-flipper).

references

[1] J. Stahn, D. Clemens: *Applied Physics A* **75**, S1532–S1534 (2002)
[2] J. Stahn, D. Clemens: *Proceedings of SPIE* **4785**, 126–133 (2002)
[3] F. Semadeni, B. Roessli, P. Böni: *Physica B* **297**, 152–154 (2001)
[4] C. Pappas et al.: *Physica B* **283**, 365–371 (2000)
[5] T. Keller et al.: *N.I.M. Phys. Res. A* **451**, 474–479 (2000)
[6] C. F. Majkrzak et al.: *Proceedings of SPIE* **1738**, 90–115 (1992)
[a] m is a measure for the critical angle θ_{SM}^c relative to Ni: $\theta_{SM}^c := m\,\theta_{Ni}^c$

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