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Improved Remanent Supermirror Polarisers

9th TECHNI Meeting
The Cosener's House, Abingdon
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Initial aims and results

design and manufacture of

– neutron focusing devices

simulations within SCANS

shifted to JRA3 “Neutron Optics”

– remanent neutron supermirror polarisers

reached: $m = 3$, $P \approx 97\,\%$

used at SINQ instruments and at FRM II

– self-supporting multilayer films

failed

provide beamtime and preparation facility for partners

has not been requested

(the upgrade of the sputtering plant led to delays)

Remanent neutron supermirror polarisers

- high efficiency
- low absorption
- compact
- large bandwidth — allow for large divergence / 'white' beam
- switchable — no need for a spin flipper
- no magnetic fields — no interaction with sample (environment)
- non-deflecting — simpler lay-out

Material choice: Fe / Si

– contrast matching: $\rho_{\mathrm{Fe}}(b_{\mathrm{Fe}} - p_{\mathrm{Fe}}) \approx \rho_{\mathrm{Si}} b_{\mathrm{Si}}$

$$\rho_{\mathrm{Fe}}(b_{\mathrm{Fe}} + p_{\mathrm{Fe}}) \gg \rho_{\mathrm{Si}} b_{\mathrm{Si}}$$

– matching to the substrate

– *rectangular* magnetic hysteresis

Preparation

magnetron sputtering (Leybold Z600)
conditions:

Fe in Ar

Si in Ar with N_2 and O_2 to

– match $\rho_{\mathrm{Fe}}(b_{\mathrm{Fe}} - p_{\mathrm{Fe}})$ and $\rho_{\mathrm{Si}} b_{\mathrm{Si}}$

– decrease the overall stress

new *ansatz* (for us, not e.g. for T. Krist):
introduce a soller slit for Fe

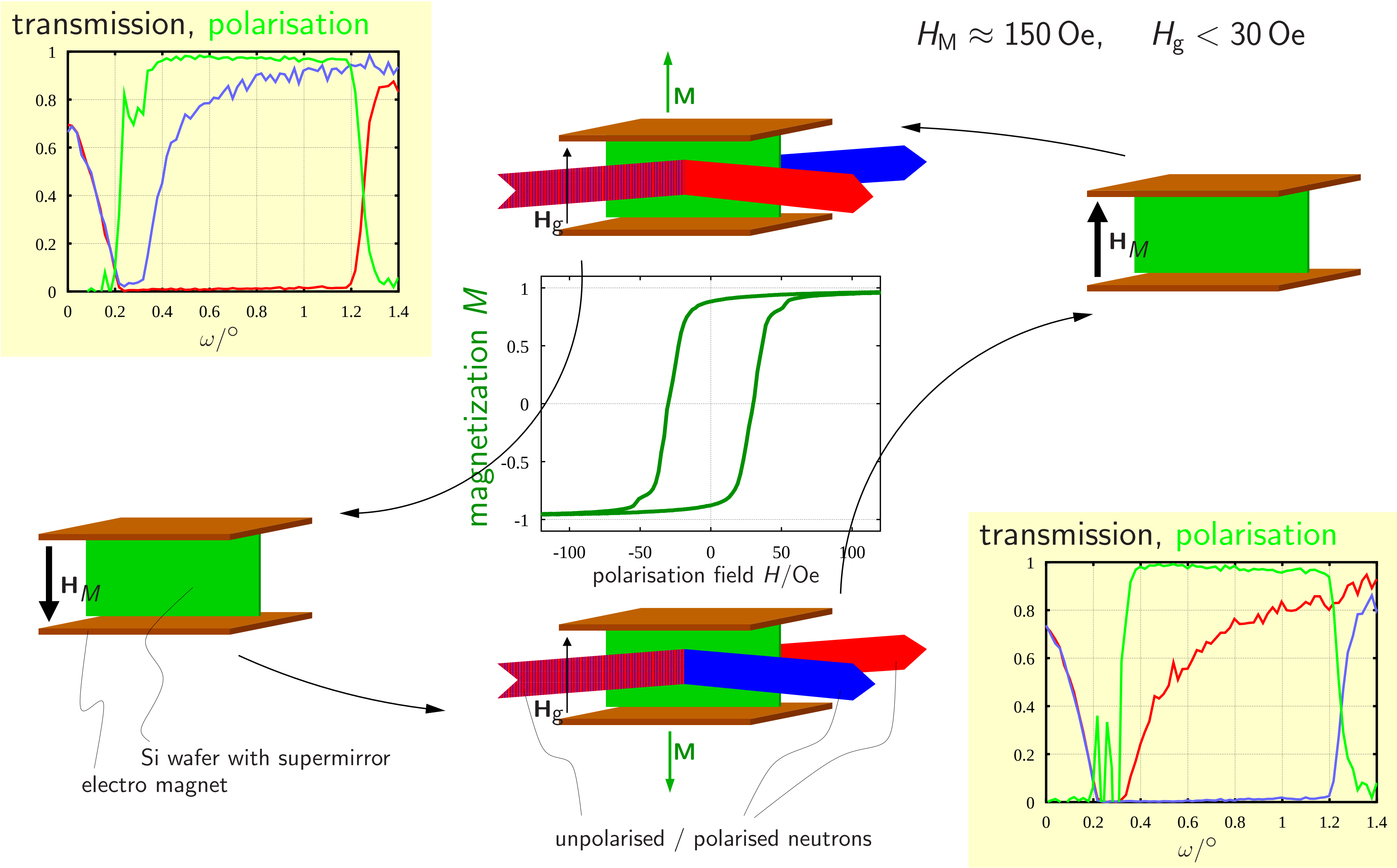
$\Rightarrow$ anisotropic deposition-angle distribution

$\Rightarrow$ anisotropic stress

$\Rightarrow$ no O_2 for Si

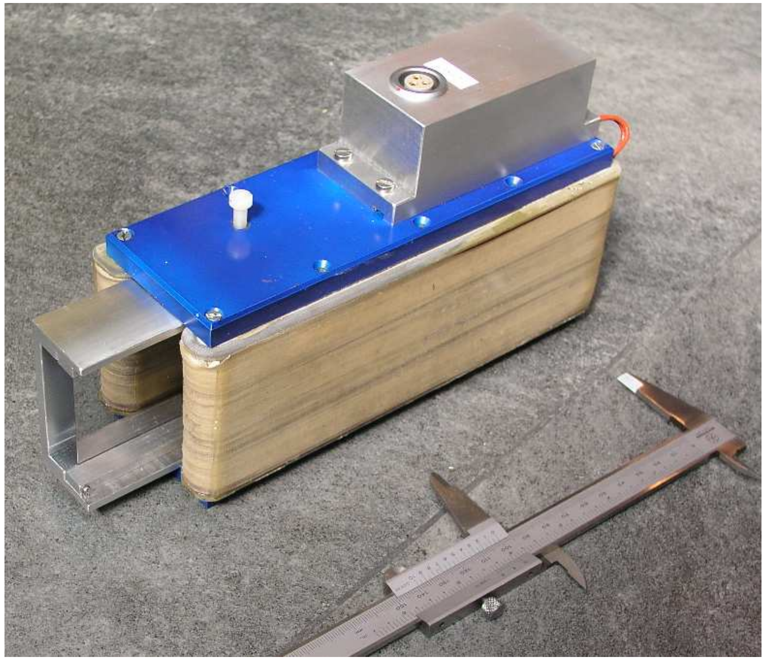
Application principle

$$H_\mathrm{M} \approx 150\,\mathrm{Oe}, \qquad H_\mathrm{g} < 30\,\mathrm{Oe}$$

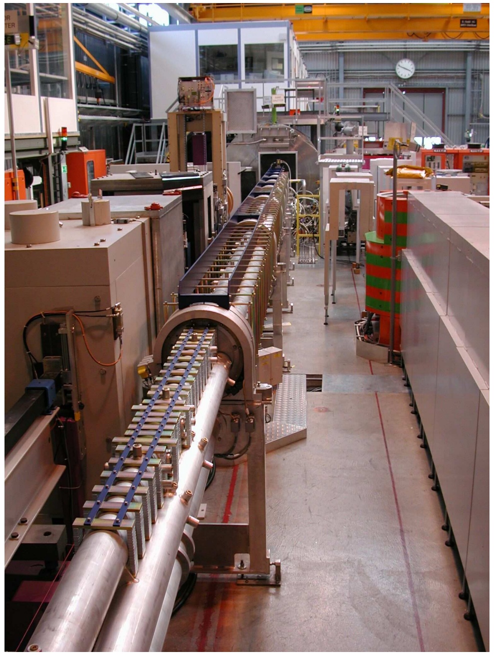


Compact transmission analyser

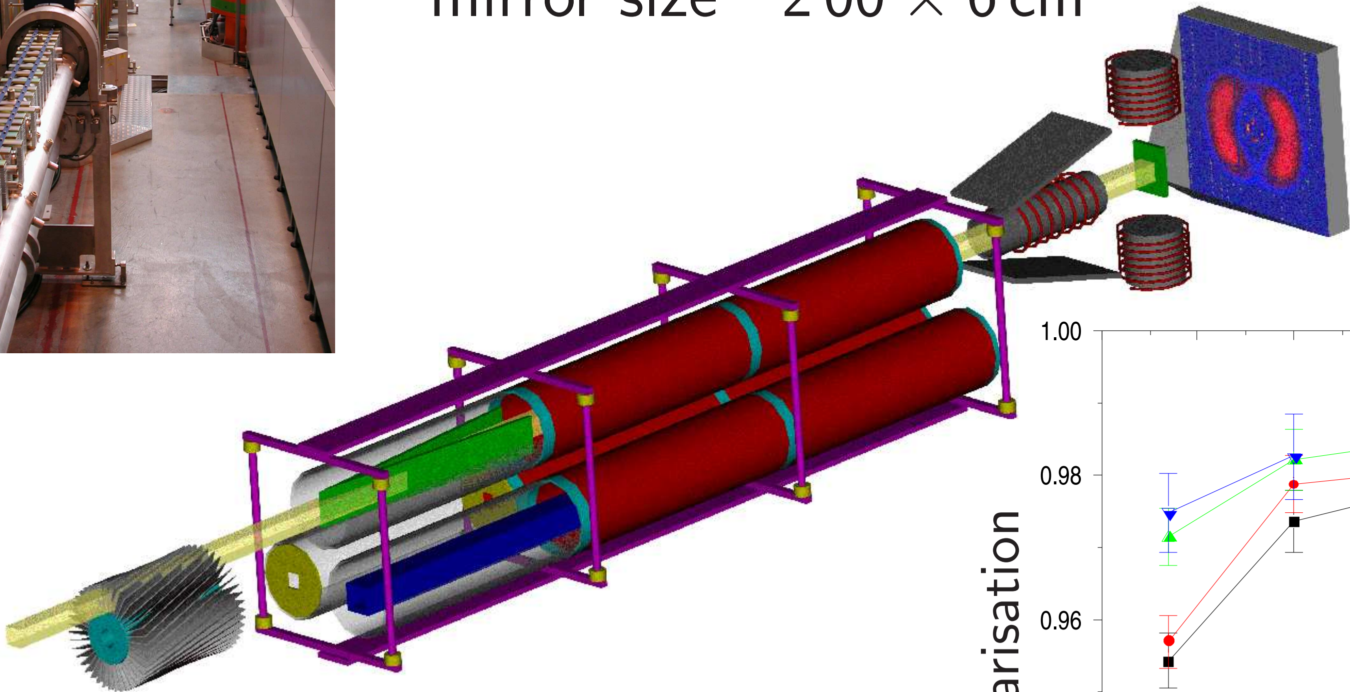
coating	Fe / Si:N:O
	$m = 3$, 599 layers
substrate	Si-wafer, 0.6 mm
mirror size	$200 \times 60\,\mathrm{mm}^2$
magnet size	$200 \times 100 \times 100\,\mathrm{mm}^3$
B_M	200 Oe
B_g	20 Oe
$P_{\mathrm{T},\upuparrows}$	$> 97\,\%$
$P_{\mathrm{T},\uparrow\downarrow}$	$> 95\,\%$

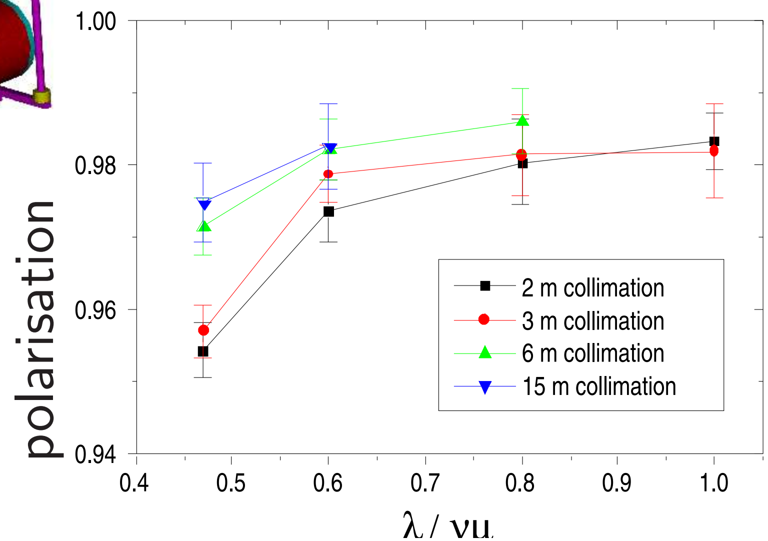


Transmission polariser at SANS-I @ SINQ



coating	Fe / Si:N:O
	$m = 2.4$, 299 layers
substrate	Si-wafer, 0.6 mm
mirror size	$200 \times 6\,\mathrm{cm}^2$





Ongoing an future projects

. . . in the field of neutron supermirrors:

– remanent polariser
  aim for $q > 3$
  build compact switchable device with bent supermirrors
  tune remanence by changing sputter geometry

– multilayers with non-sharp interfaces (J. Padiyath)

– laterally graded multilayers for focusing optics (JRA3-NO)
– build (scaled) prototypes to check MC simulation predictions on elliptic and parabolic guides

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