Spin-Flop-Induced Coarsening of Antiferromagnetic Domains in a Fe/Cr Multilayer

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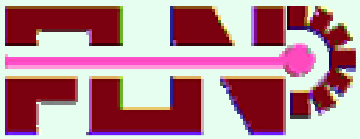

JINR-HAS Workshop
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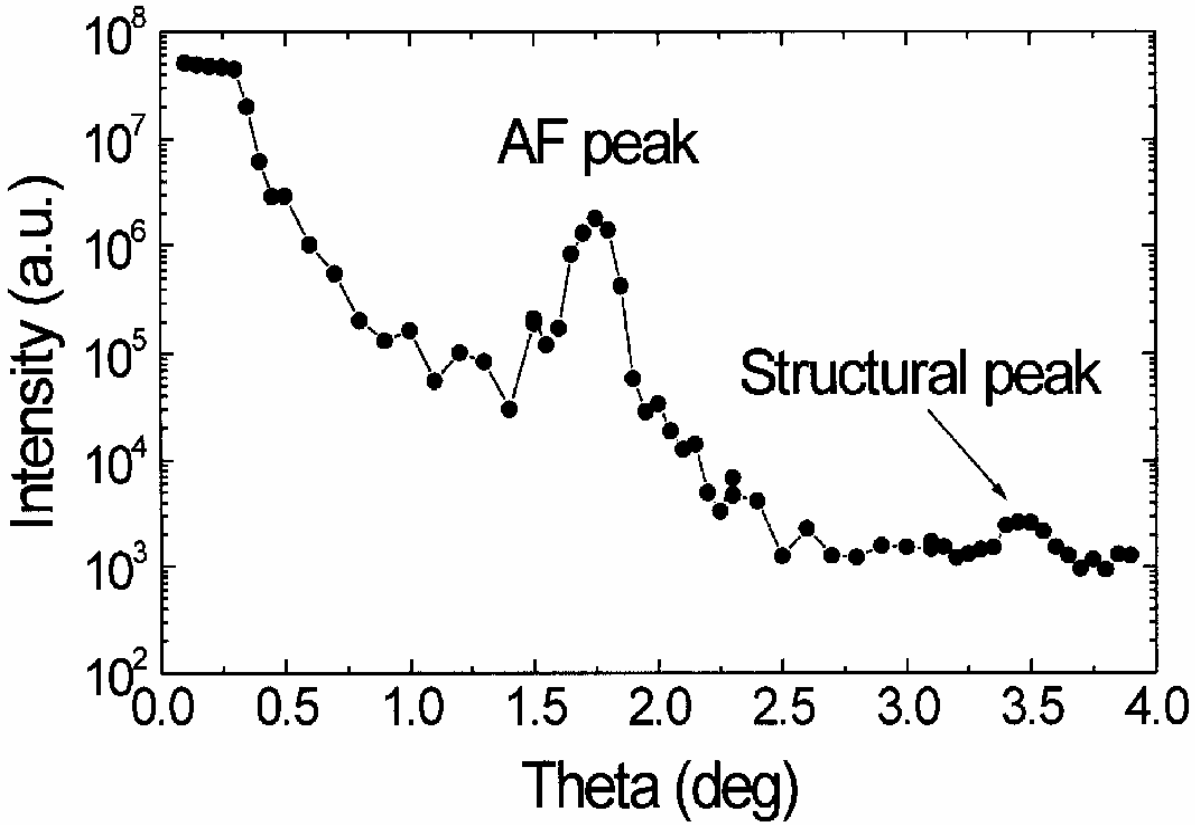
Outline

- Bulk spin flop in an antiferromagnetically coupled Fe/Cr multilayer
- Spin-flop-induced domain coarsening
- Spontaneous complex domain coarsening: the next possible PNR experiment

Bulk spin flop in a Fe/Cr multilayes (NR)

MgO(001)[Fe(25Å)/Cr(13Å)]$_{20}$, easy axis

K. Temst et al., Physica B **276-278**, 684 (2000).



Bulk spin flop in a Fe/Cr multilayes (PNR)

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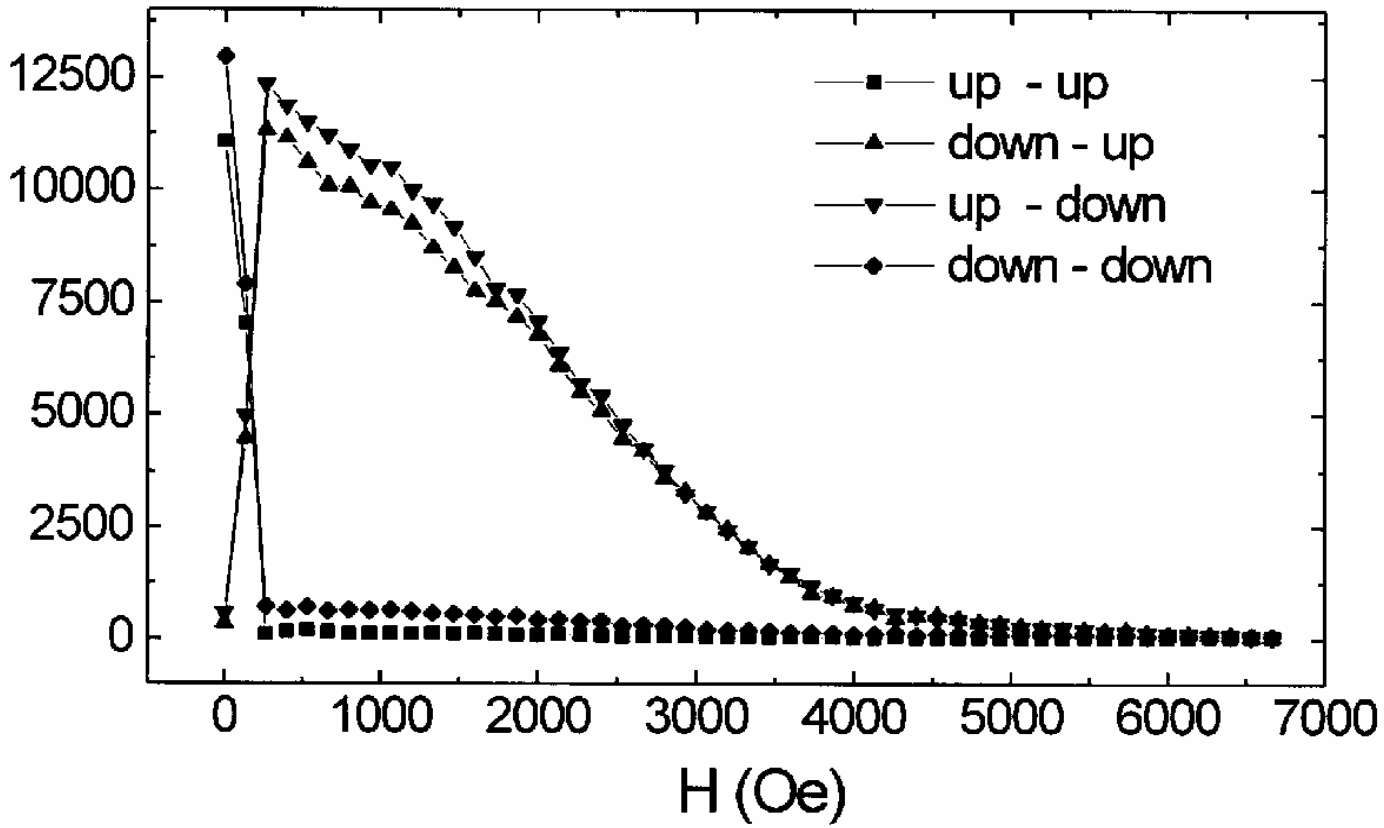
K. Temst et al., Physica B **276-278**, 684 (2000).



Bulk spin flop in a Fe/Cr multilayer (SMR)

MgO(001)[^{57}Fe(26Å)/Cr(13Å)]$_{20}$, easy axis

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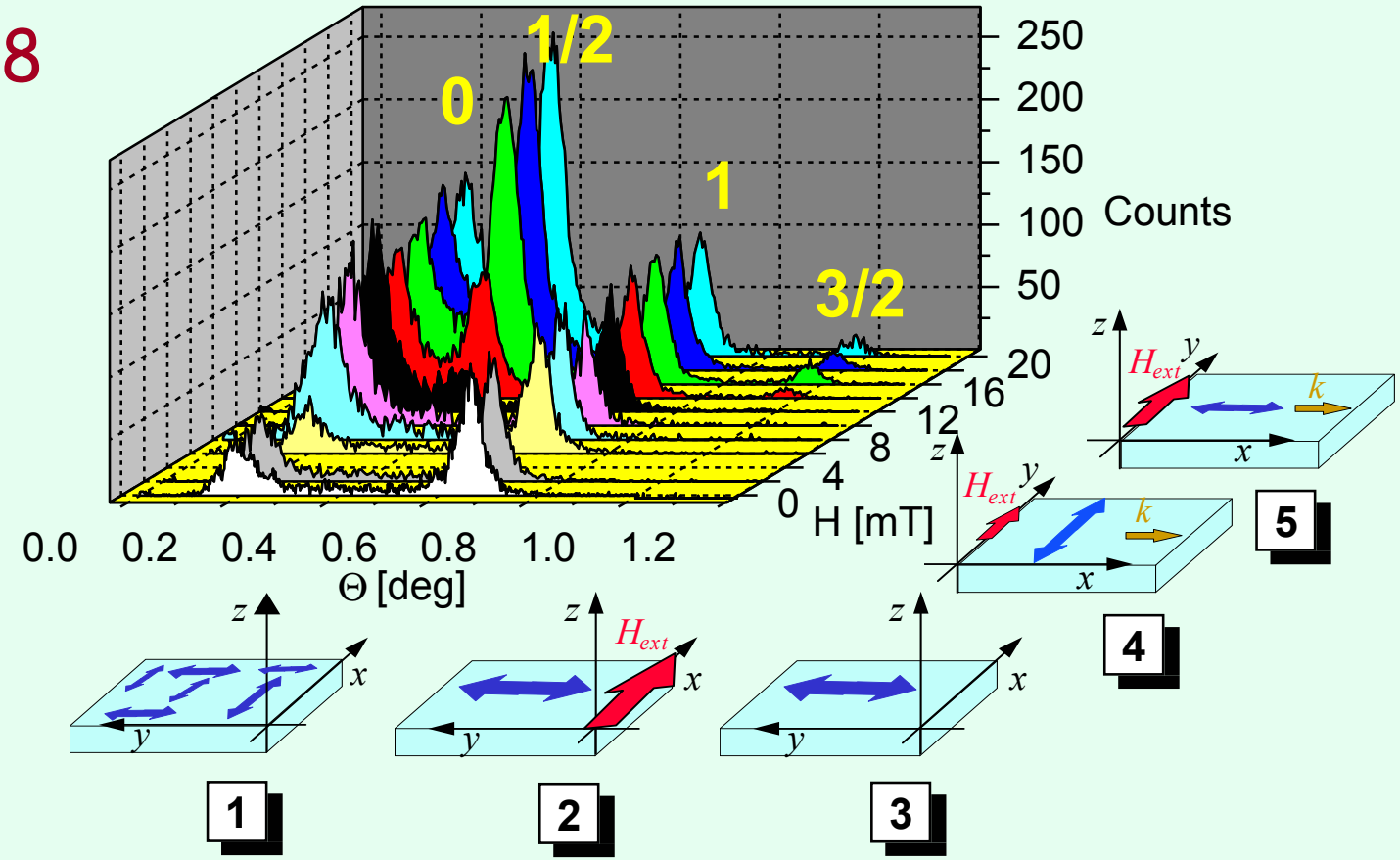
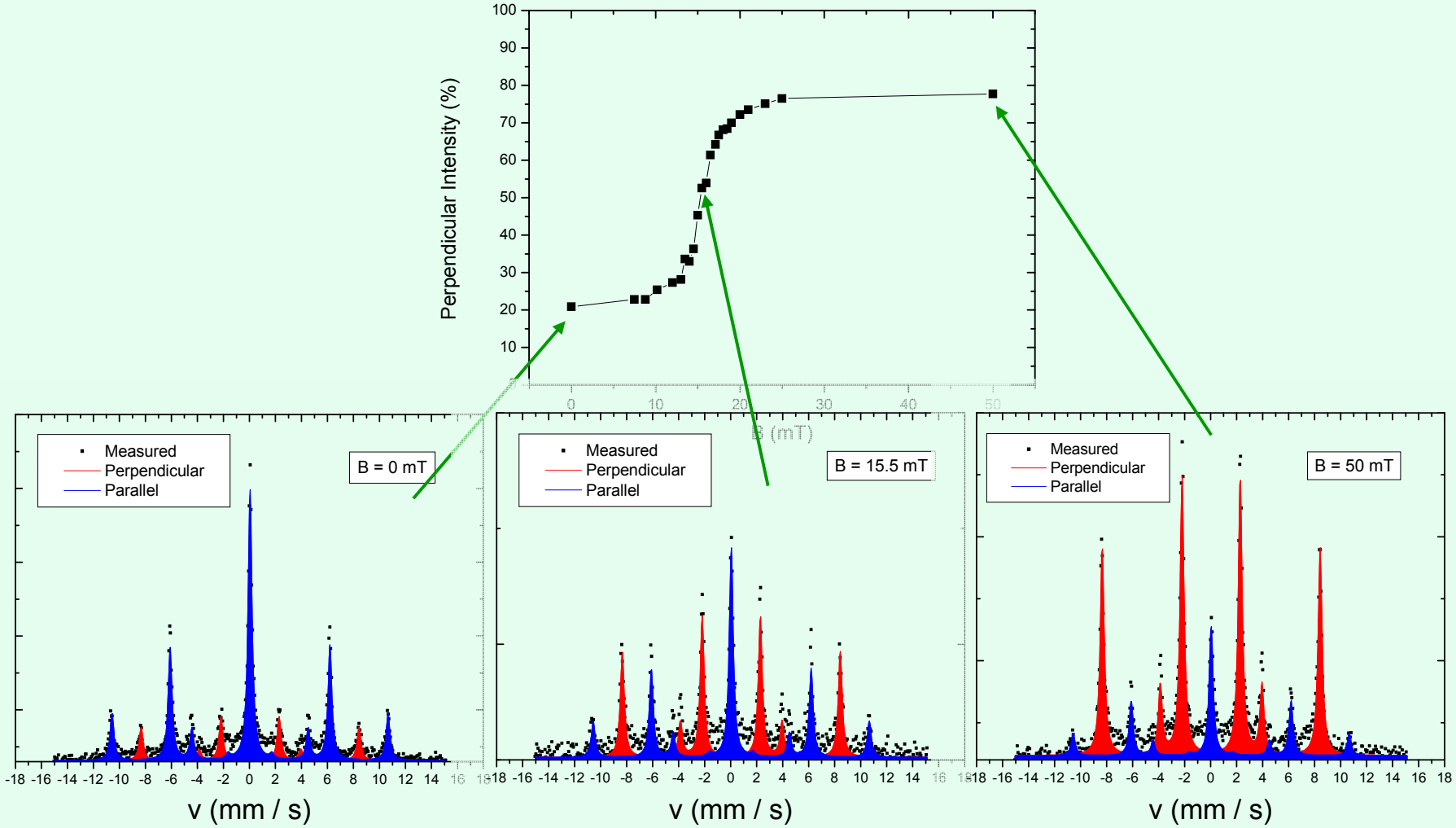


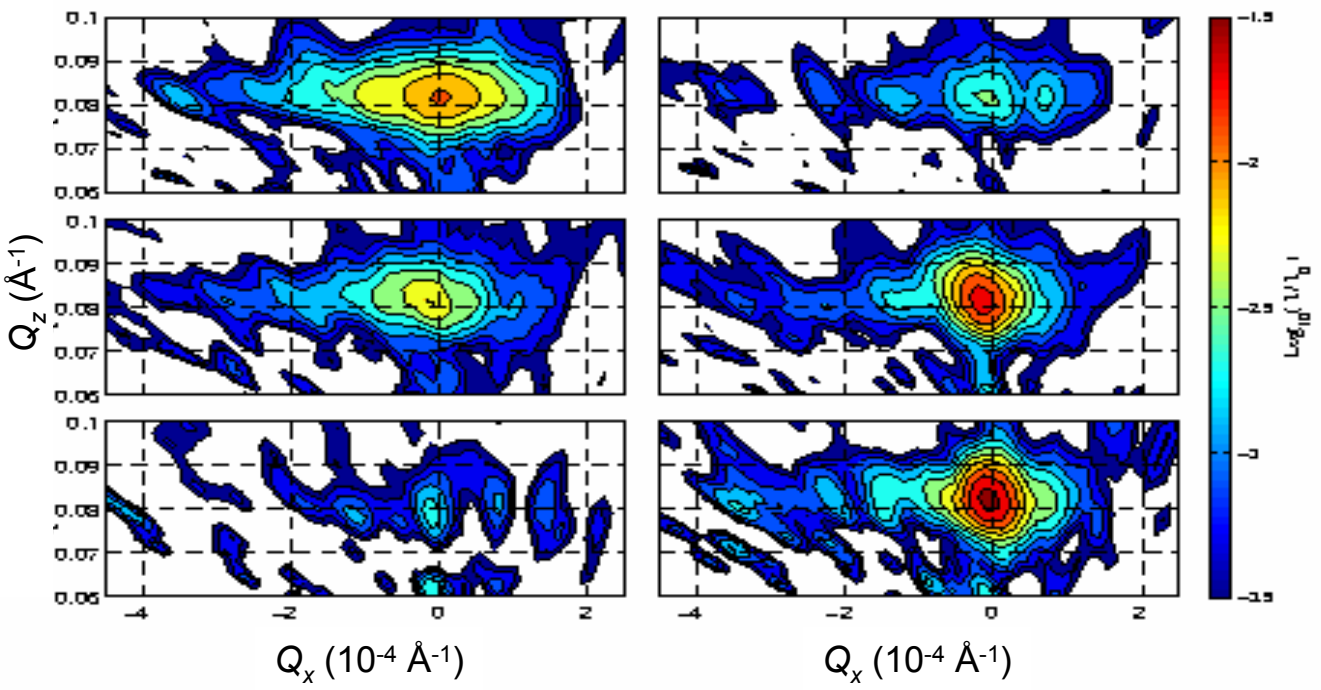
Bulk spin flop in a Fe/Cr multilayer (CEMP)

$MgO(001)[^{57}Fe(26Å)/Cr(13Å)]_{20}$, easy axis



Spin-flop induced domain coarsening (PNR)

MgO(001)[^{57}Fe(26Å)/Cr(13Å)]$_{20}$, easy axis



7 mT

14.2 mT

35 mT

non-spin-flip scattering $\mathbf{S}_n \parallel \mathbf{M}$

spin-flip scattering $\mathbf{S}_n \perp \mathbf{M}$

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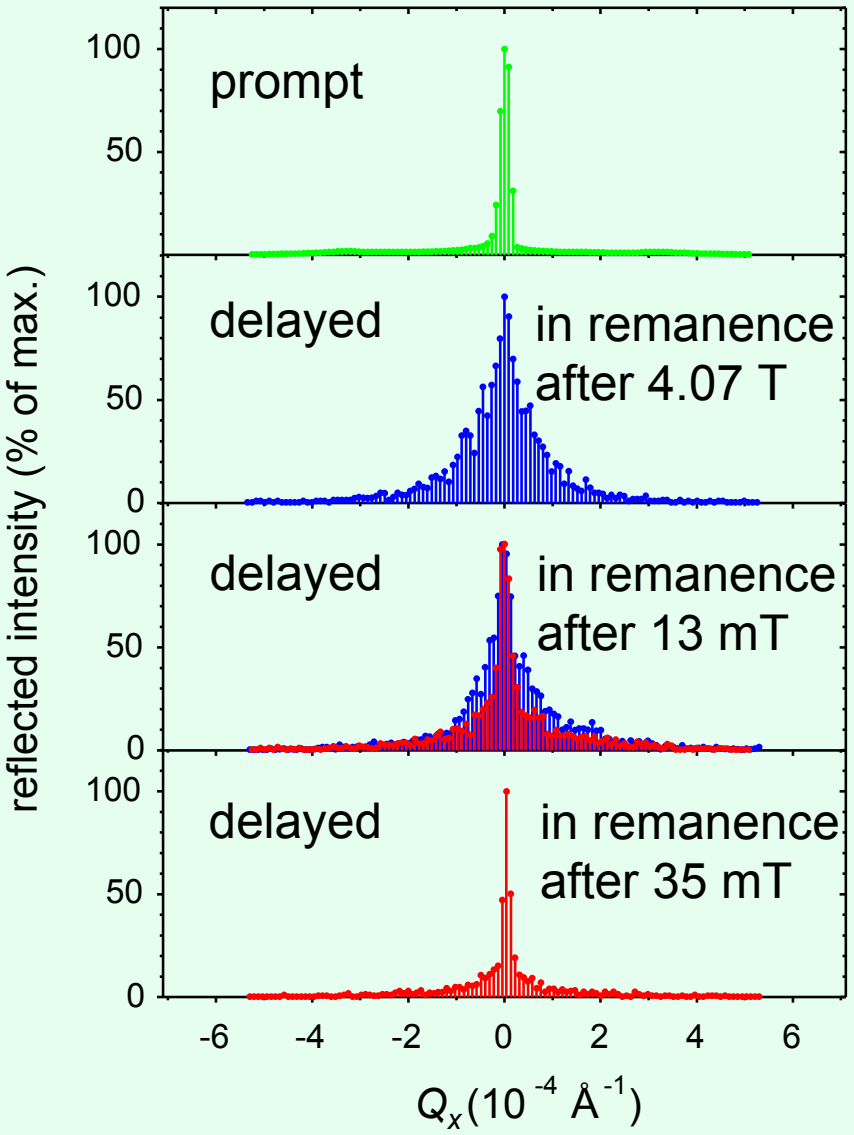
Spin-flop-induced domain coarsening (SMR)



← 90° rot.

$MgO(001)[^{57}Fe(26Å)/Cr(13Å)]_{20}$
2Θ @ AF reflection, easy axis

Correlation length:
$\xi = 1/\Delta Q_x$

Delayed photons
before the spin flop
ξ = 800 nm

Delayed photons
after the spin flop
$\xi_1 > 5$ μm
$\xi_2 =$ 800 nm

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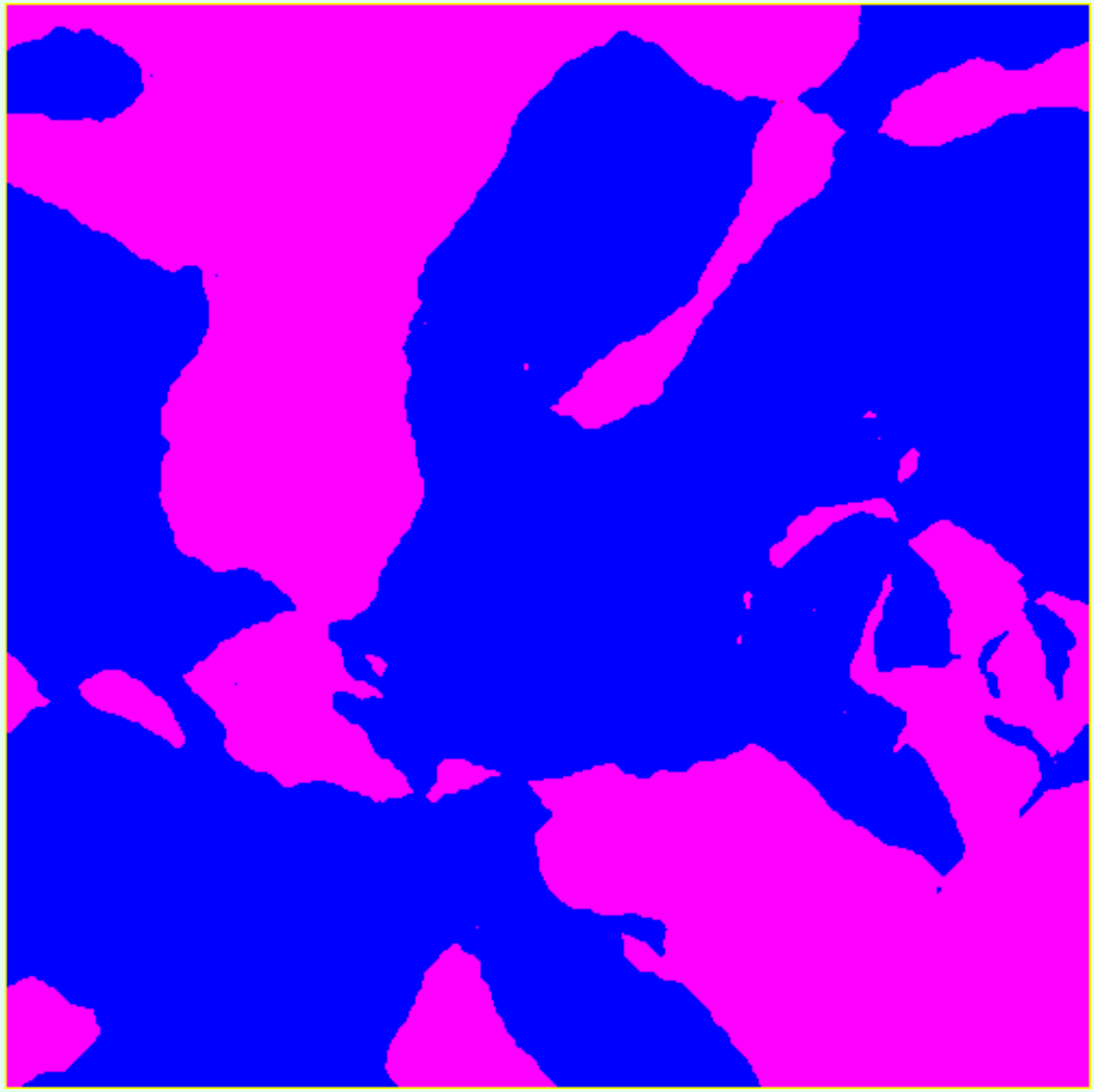
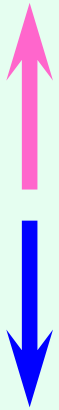
Domain coarsening on spin flop

- Coarsening on spin flop is an explosion-like 90-deg flop of the magnetization annihilating primary 180-deg walls. It is limited neither by an energy barrier nor by coercivity. Consequently, the correlation length of the coarsened patch domains ξ may become comparable with the sample size.

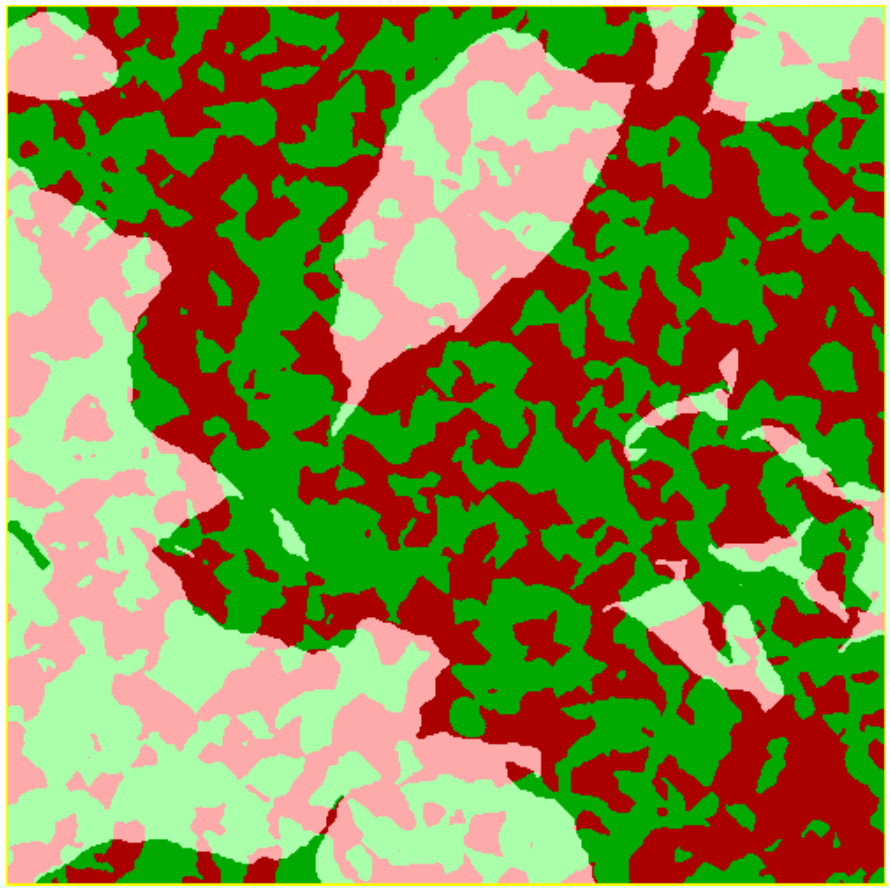
Domain coarsening during spin flop

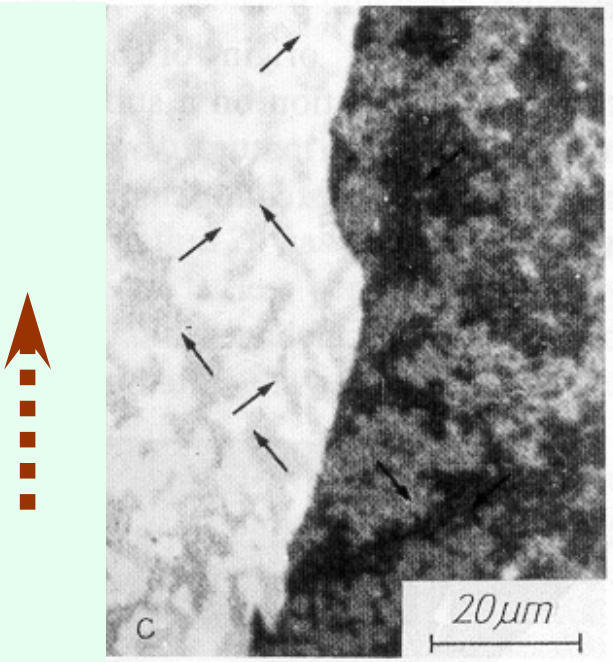




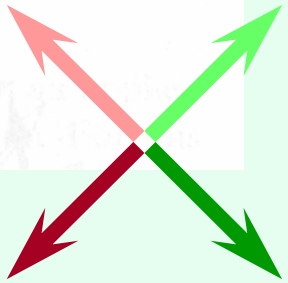
Spontaneous complex domain coarsening after decreasing the field along a hard axis

M. Rührig et al., Phys. Stat. Sol. (a) **125,** 635 (1991).



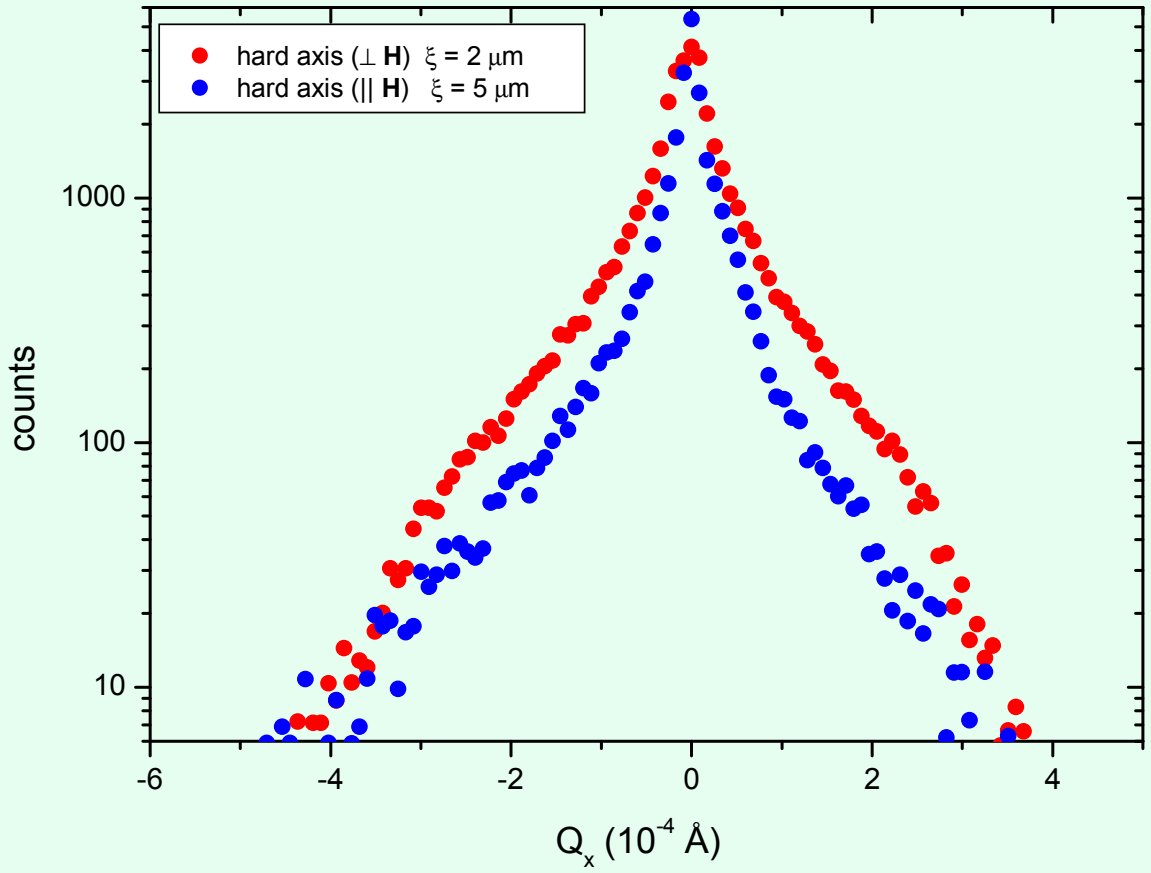


AF



Spontaneous complex domain coarsening after decreasing the field along a hard axis (SMR)

$MgO(001)[^{57}Fe(26Å)/Cr(13Å)]_{20}$



Precise (±0.5°) alignment in CEMS polarimeter

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Conclusions

With suitable magnetic field program, it is possible to shape the domain structure of AF-coupled multilayers.

- On leaving the saturation region sub-μm native patch-domains are formed in decreasing field.
- On further decreasing the field, the domain size spontaneously and irreversibly increases (ripening).
- The bulk spin flop leads to an explosion-like increase of the domain size (coarsening).
- In decreasing hard-axis field, a spontaneous complex domain coarsening takes place.