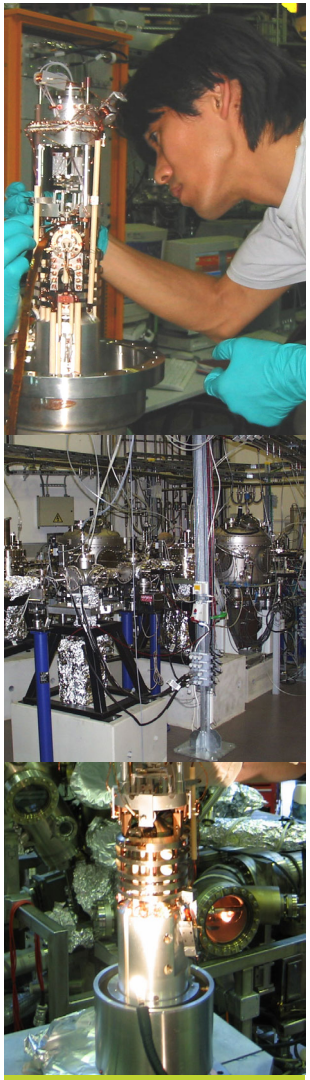
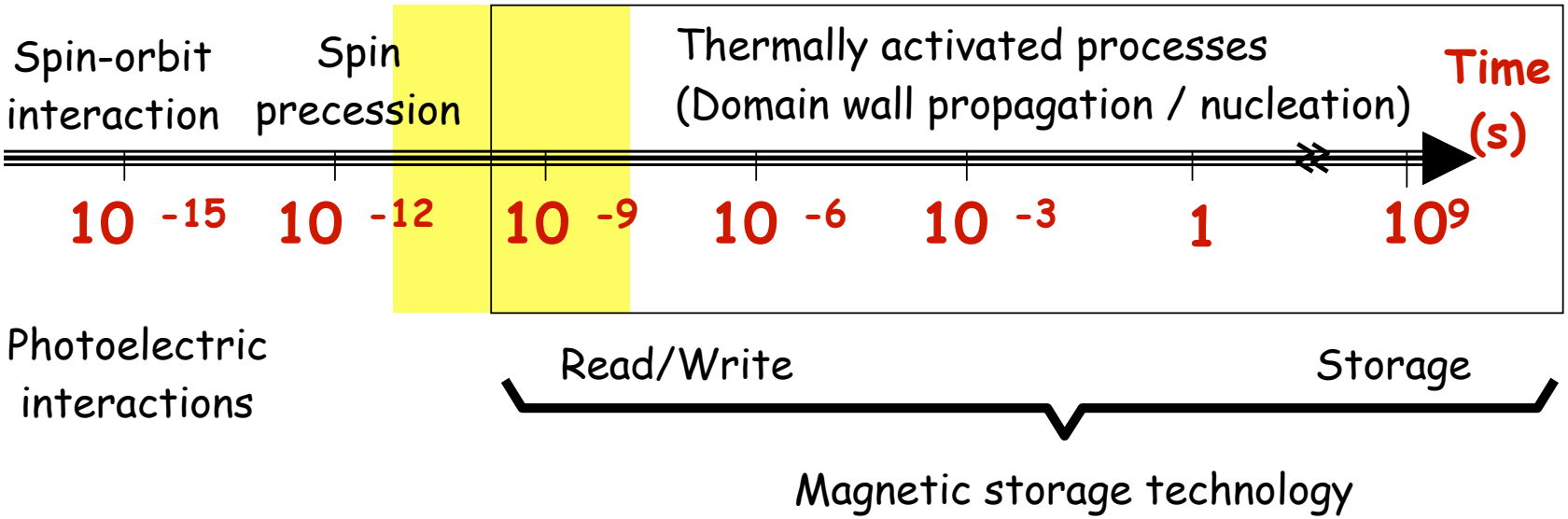


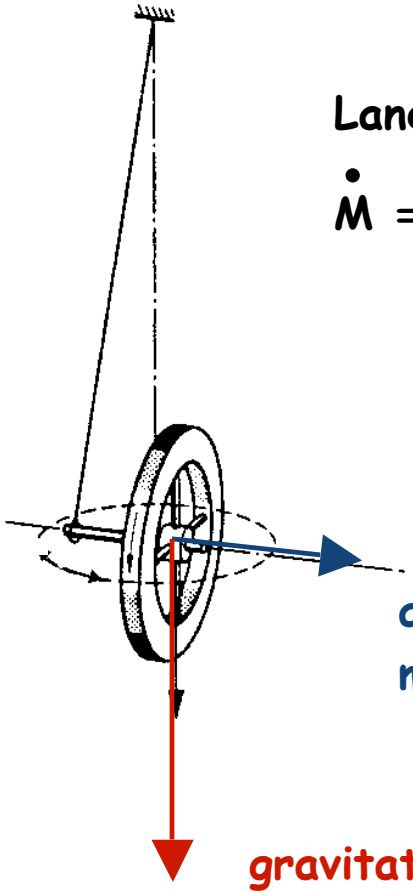
Imaging magnetization dynamics by x-ray magnetic circular dichroism photoelectron emission microscopy

Wolfgang Kuch, Freie Universität Berlin, Germany

timescales in magnetic materials

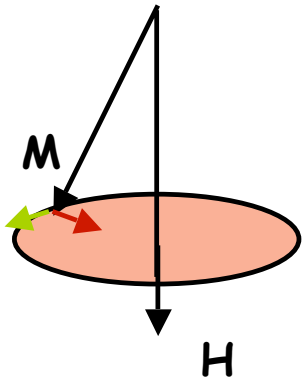


magnetization precession



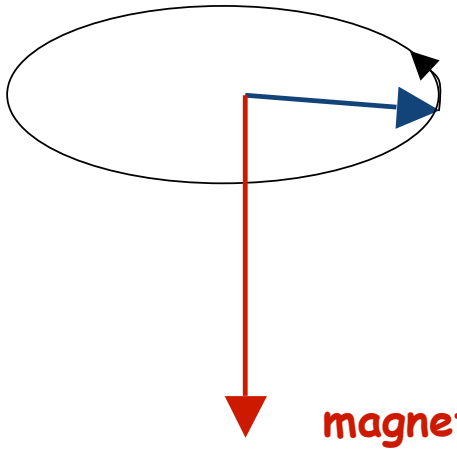
Landau-Lifshitz-Gilbert equation

$$\dot{\vec{M}} = -\gamma(\vec{M}\times\vec{H}) + \frac{\alpha}{M_S}(\vec{M}\times\dot{\vec{M}})$$



angular momentum

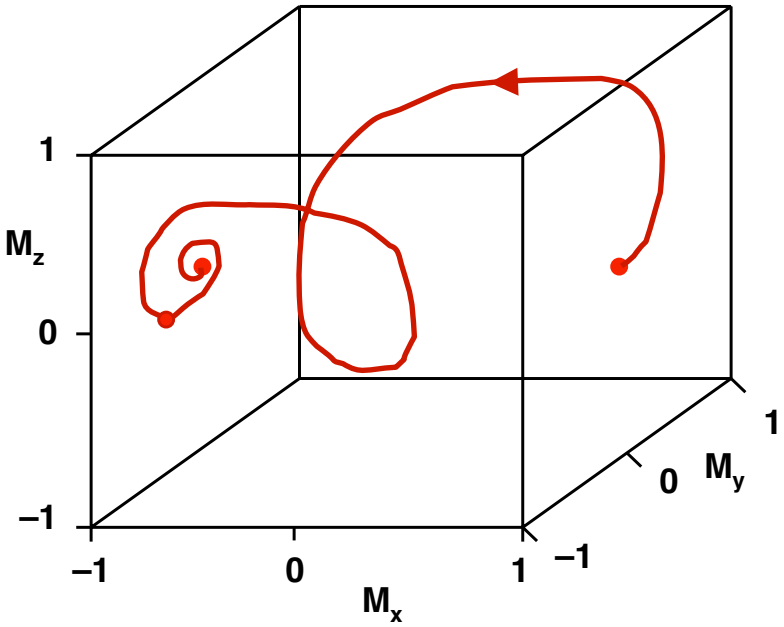
gravitation

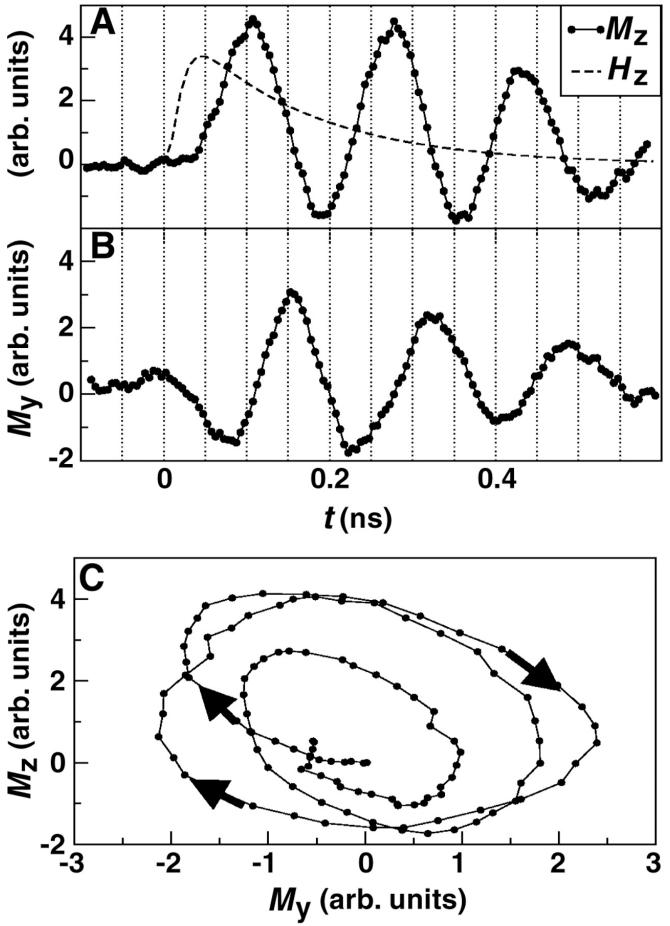


magnetization

magnetic field

precessional switching

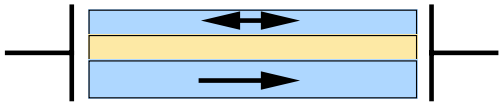




Y. Acremann et al., Science **290**, 492 (2000)

magnetic trilayers

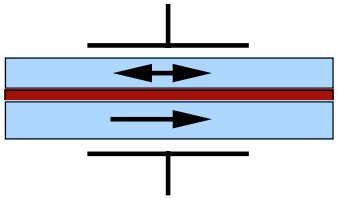
giant magnetoresistance (GMR)



metallic conductivity

(sensor, hard disk read head)

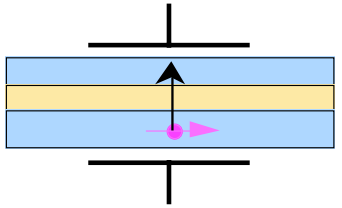
tunnel magnetoresistance (TMR)



tunneling current

(sensor, magnetic RAM)

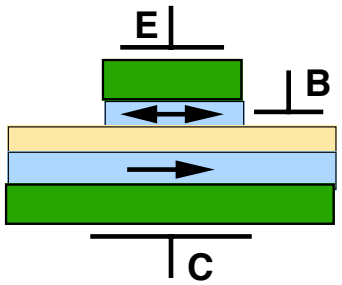
spin torque transfer



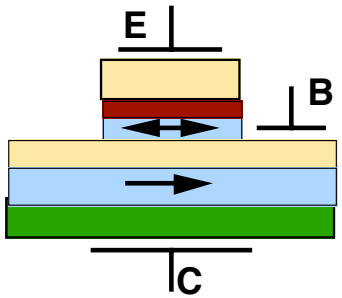
momentum transfer by spin polarised e^-

(fast switching)

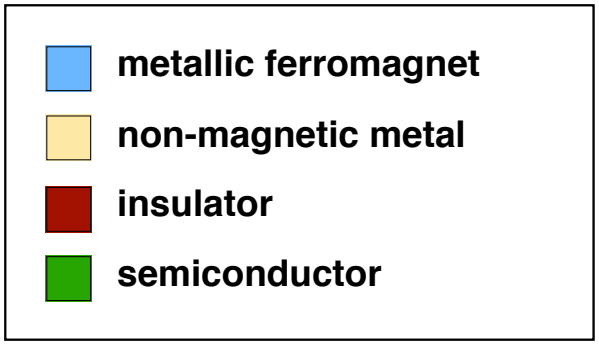
spin transistor



spin transistor with tunnel barrier

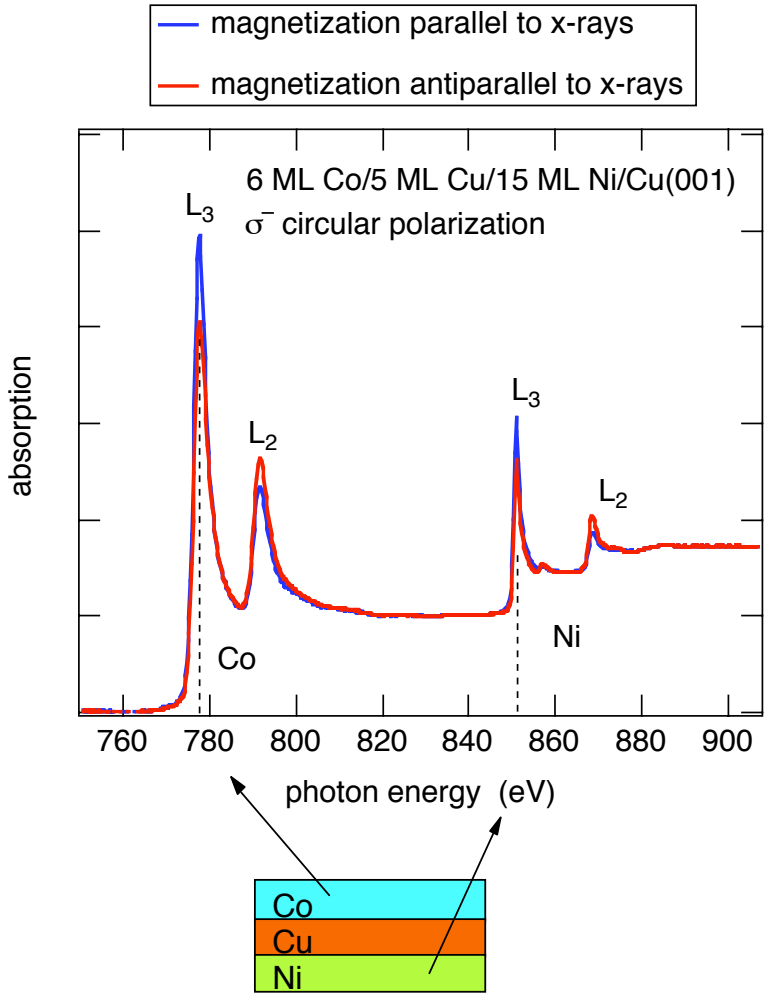


(logical devices, taking advantage of charge and spin)



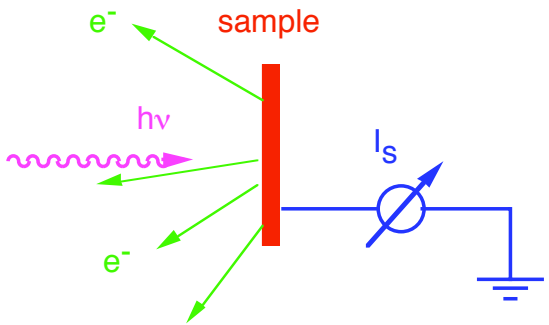
layer-resolved magnetic information

X-ray
Magnetic
Circular
Dichroism

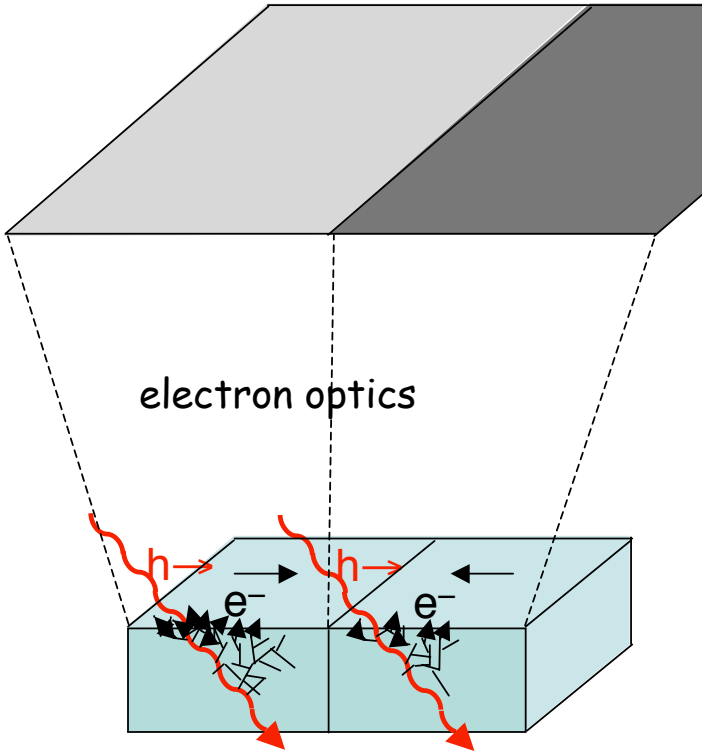


imaging x-ray absorption

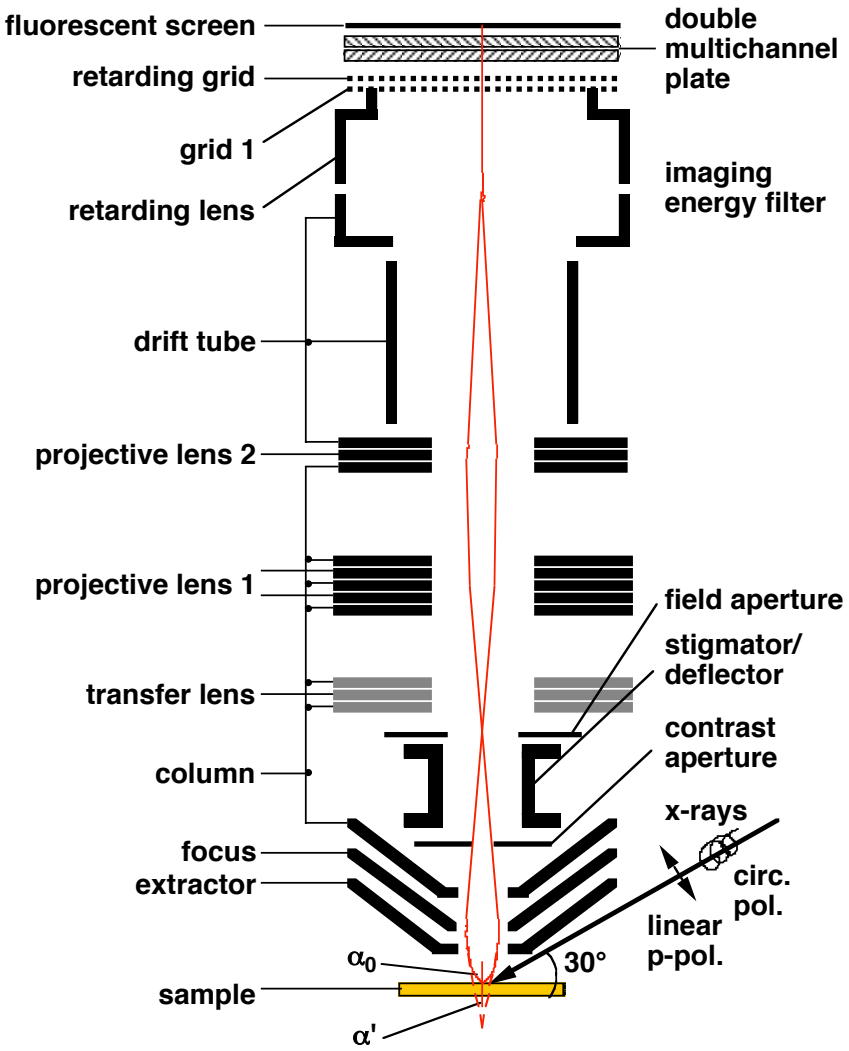
"Total electron yield"

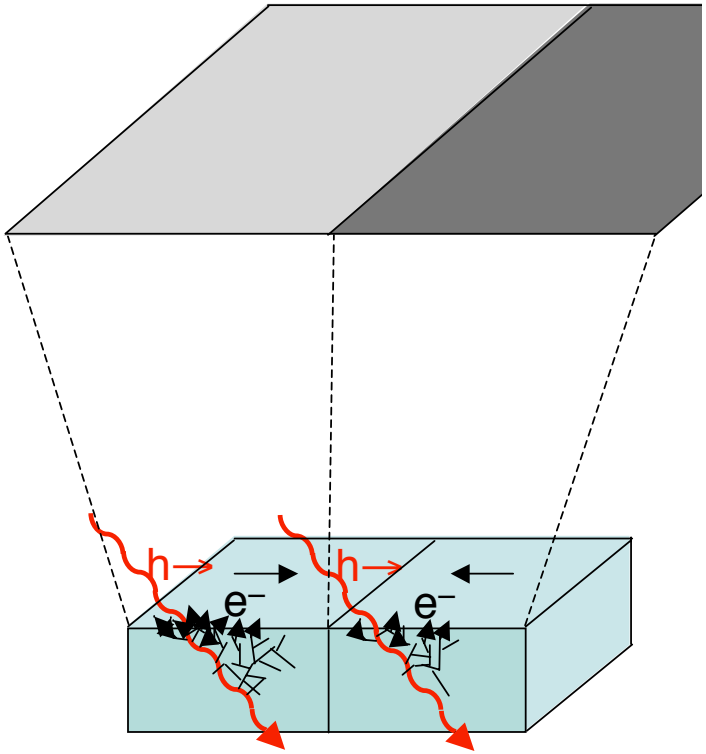


- μ proportional absorption
- surface sensitive ($\rightarrow \mu$ 20 Å)

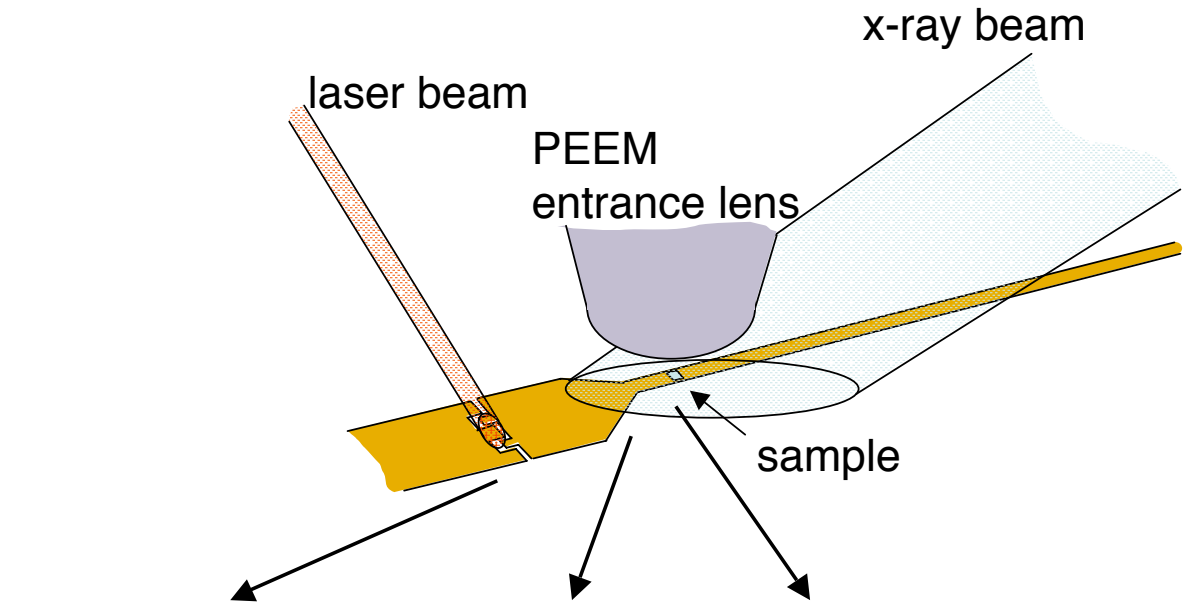


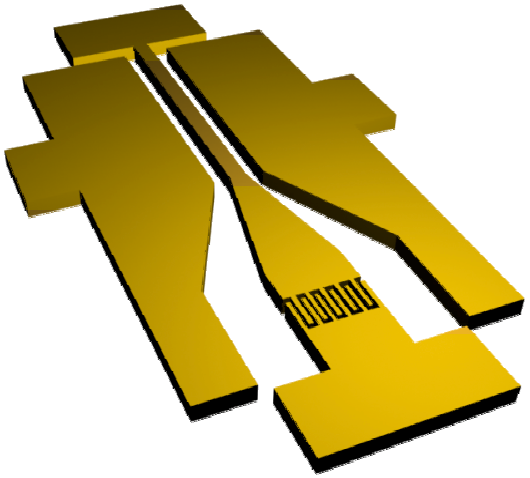
magnetic domain imaging by X-PEEM



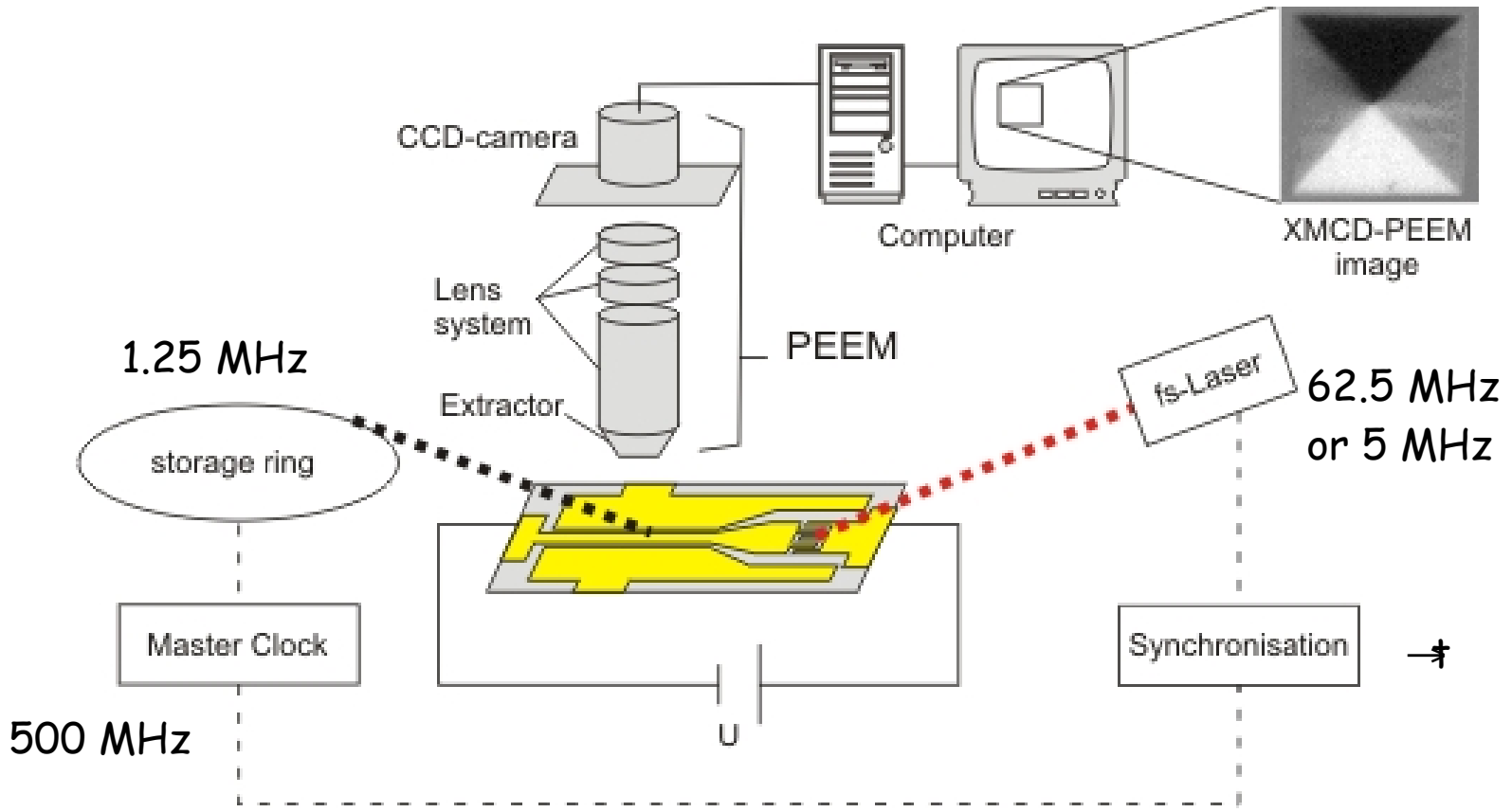


laser-induced magnetic field pulses

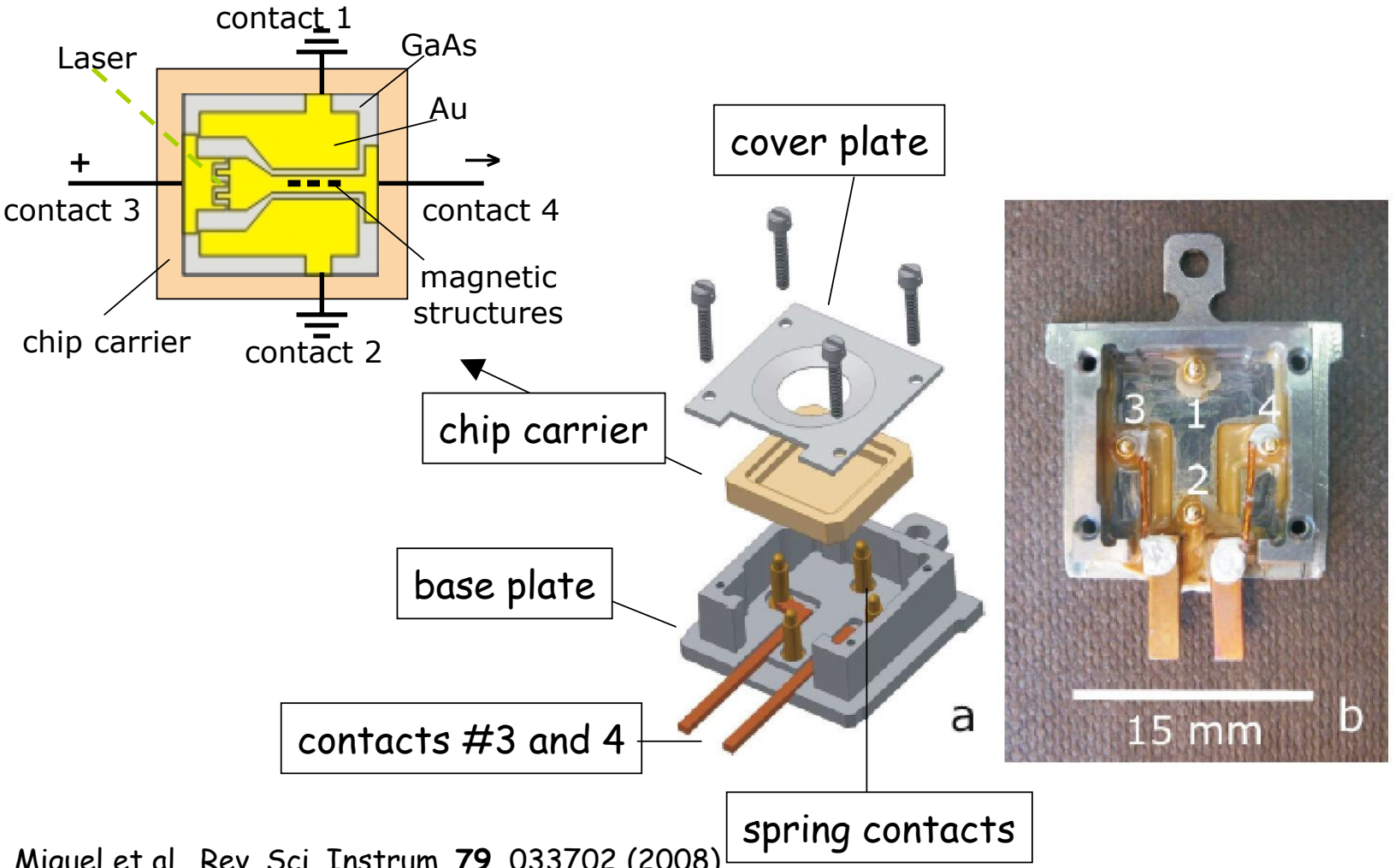




experimental set-up at BESSY



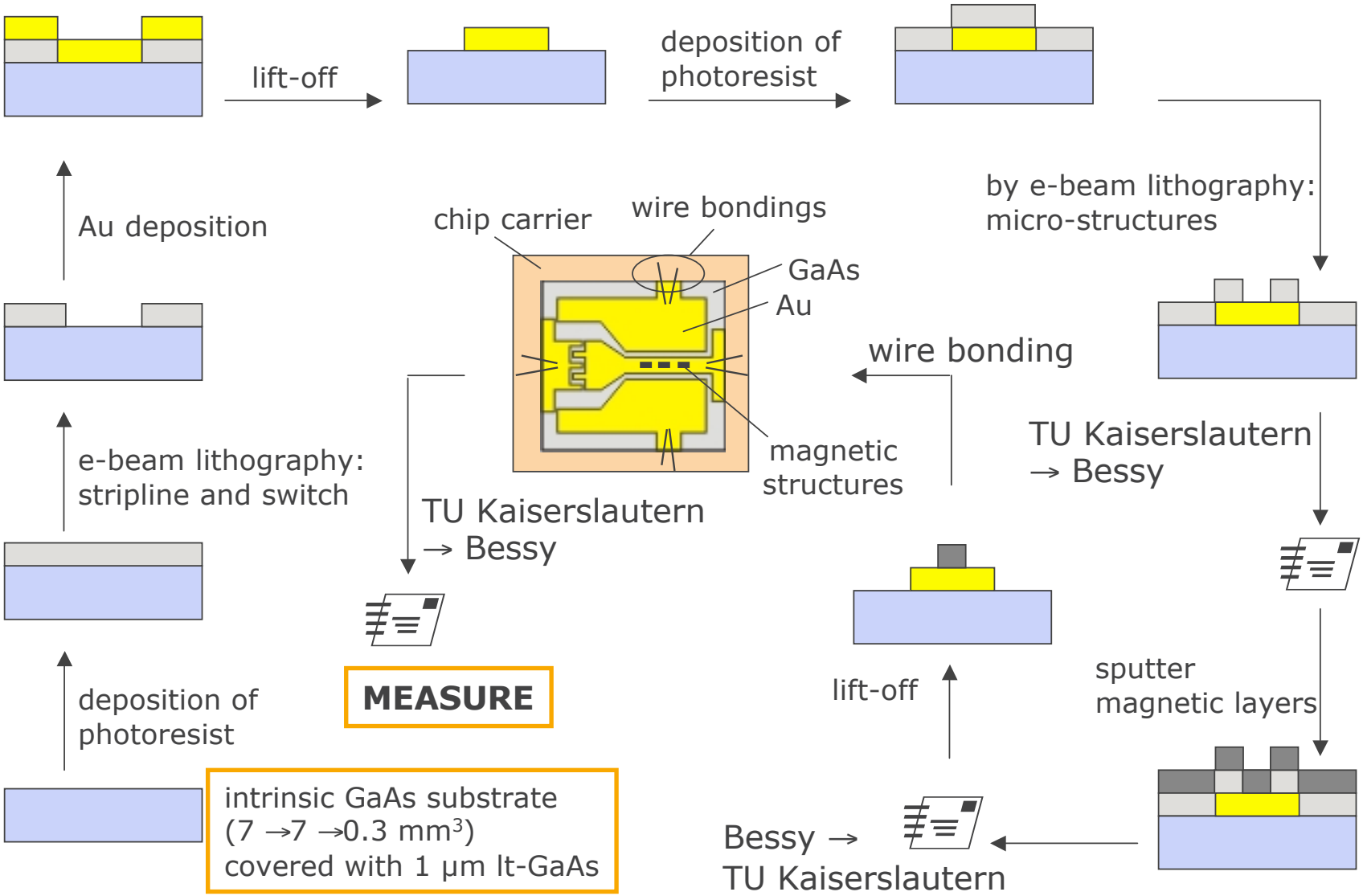
exchangeable sample holder (Omicron style)



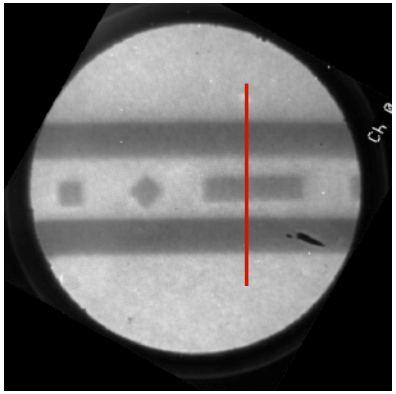
J. Miguel et al., Rev. Sci. Instrum. **79**, 033702 (2008)

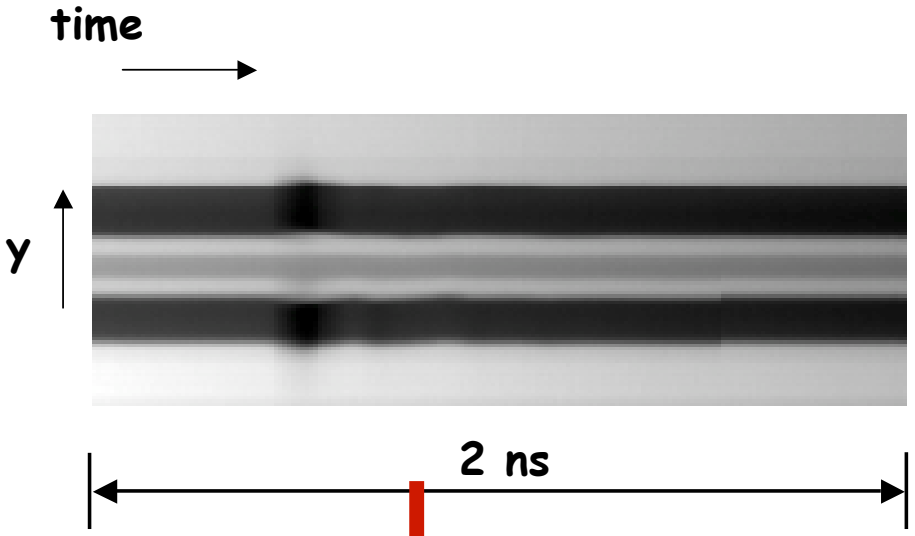
Sample fabrication

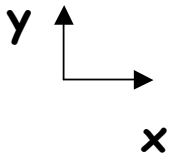
Freie Universität Berlin



determination of pulse shape

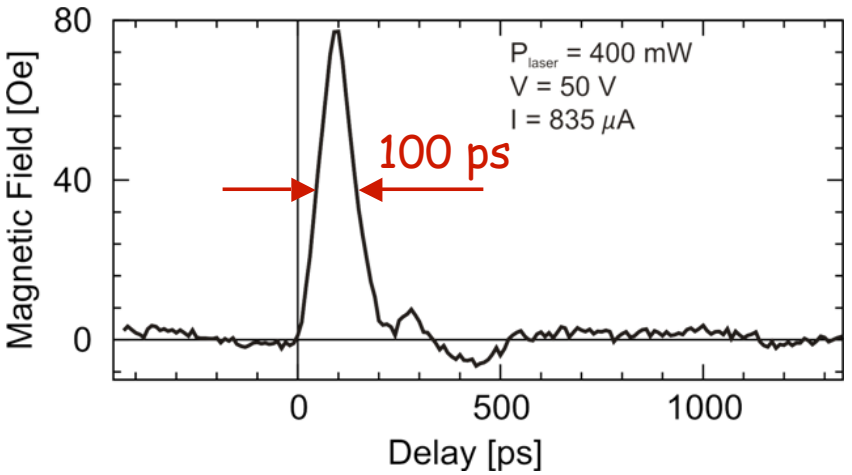




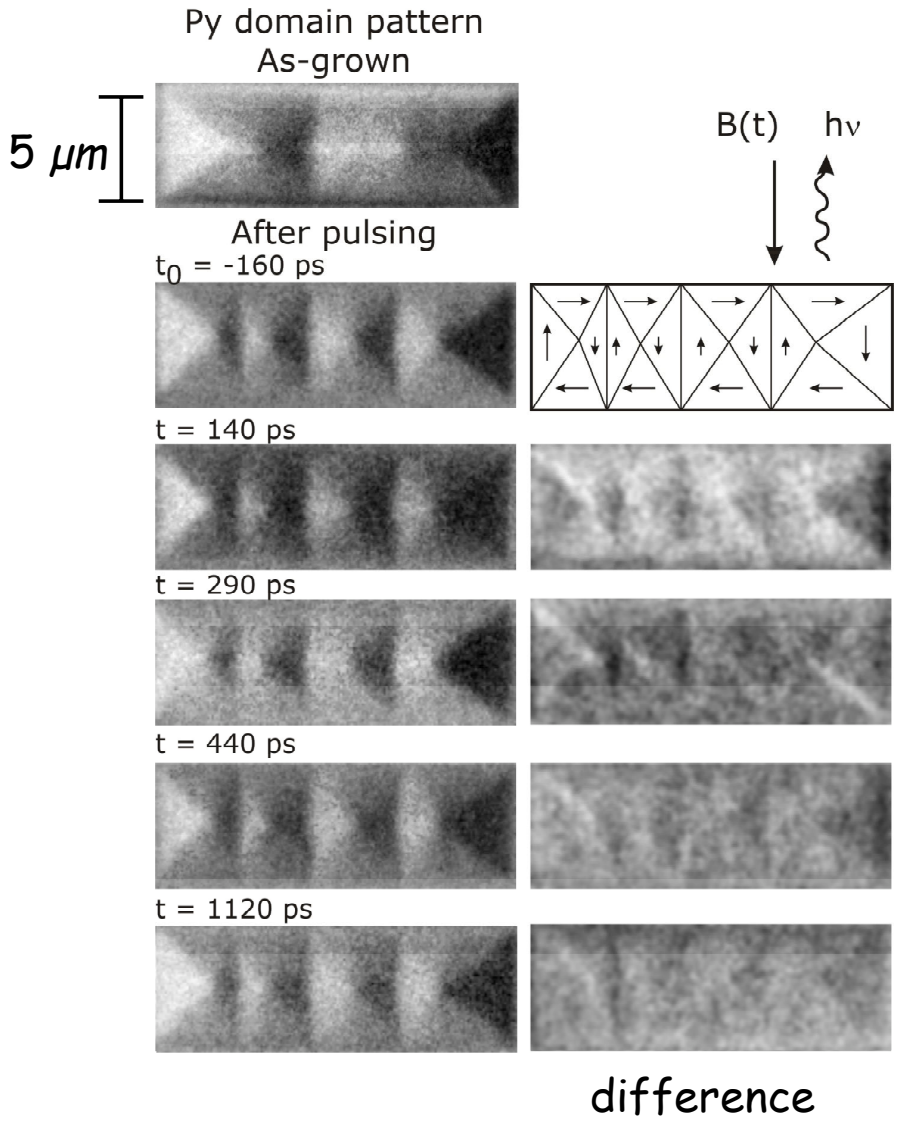


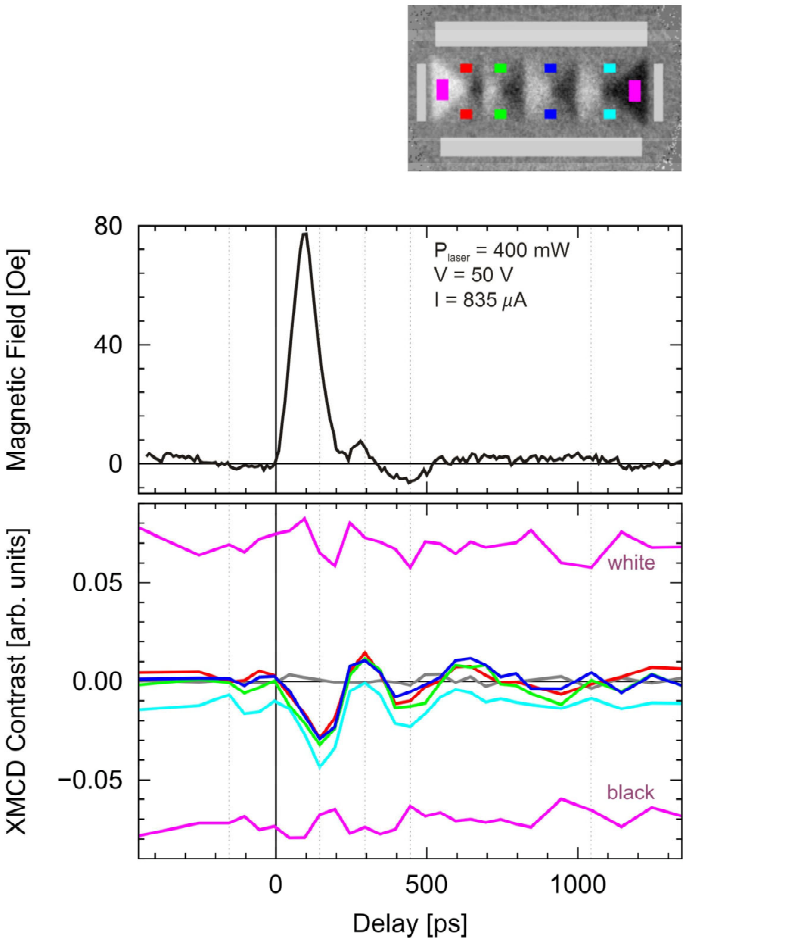
synchrotron pulses: μ 50 ps

→ field pulses: μ 80 ps FWHM, rise time < 40 ps

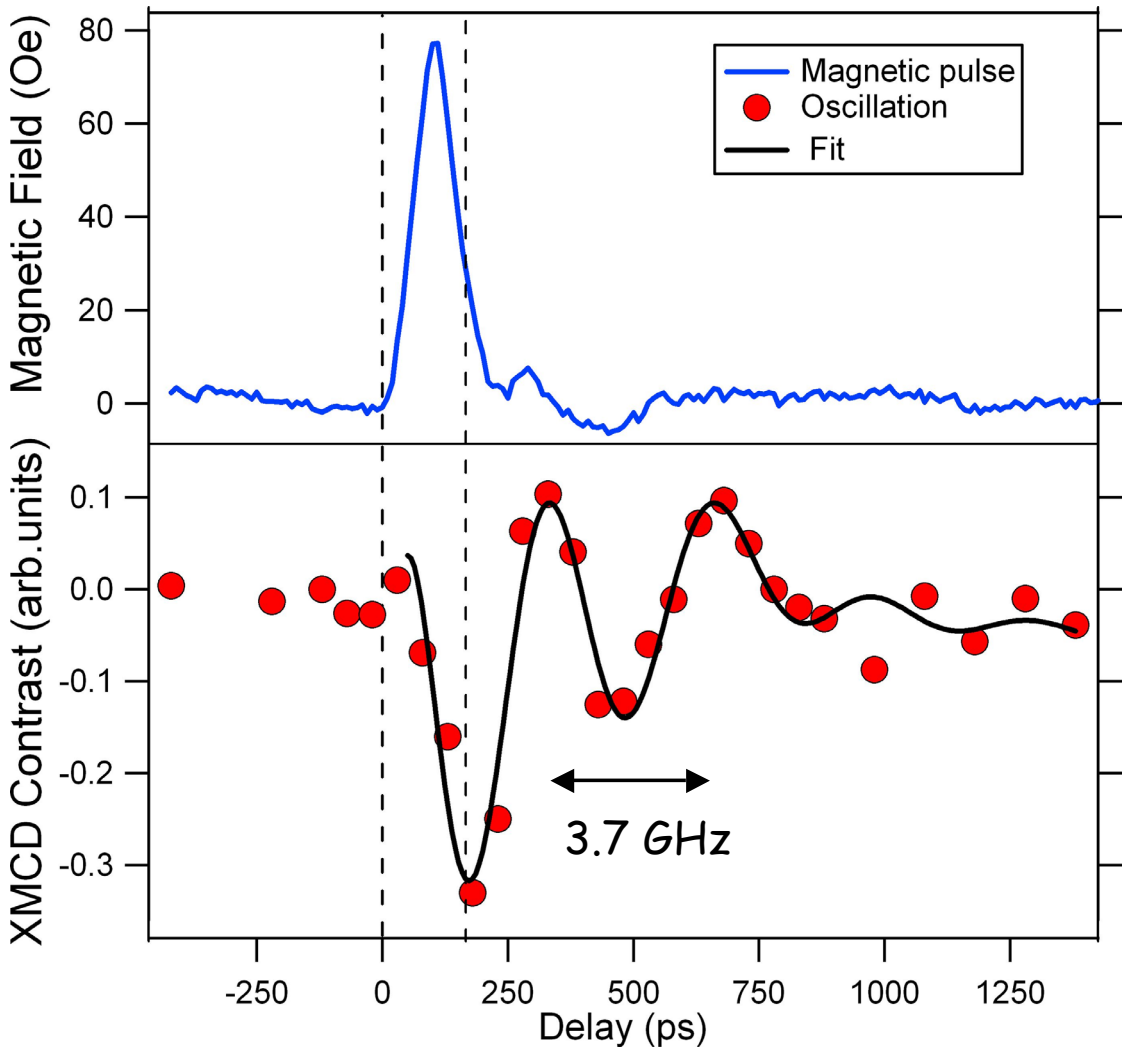


$Fe_{20}Ni_{80}$ microstructures

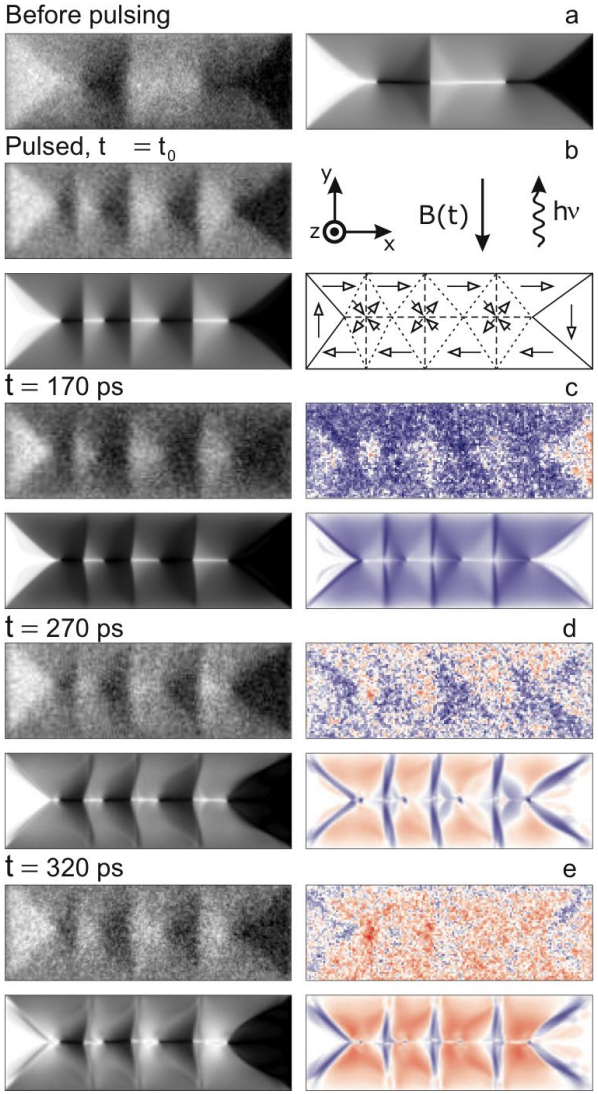




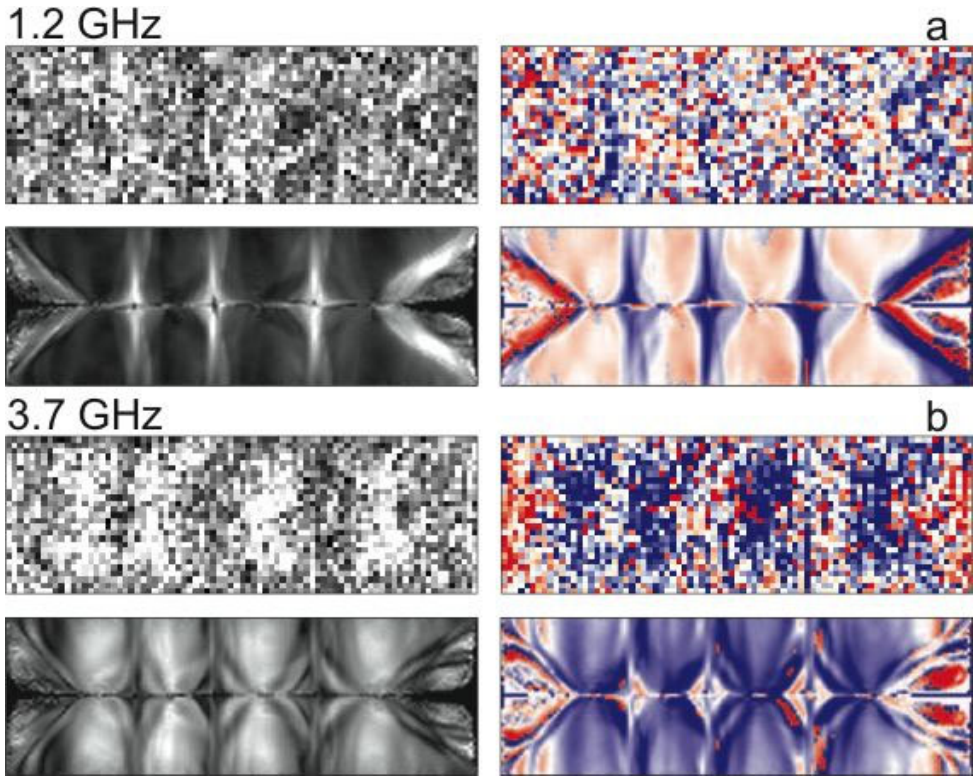
$Fe_{20}Ni_{80}$ microstructures



comparison to micromagnetic simulations

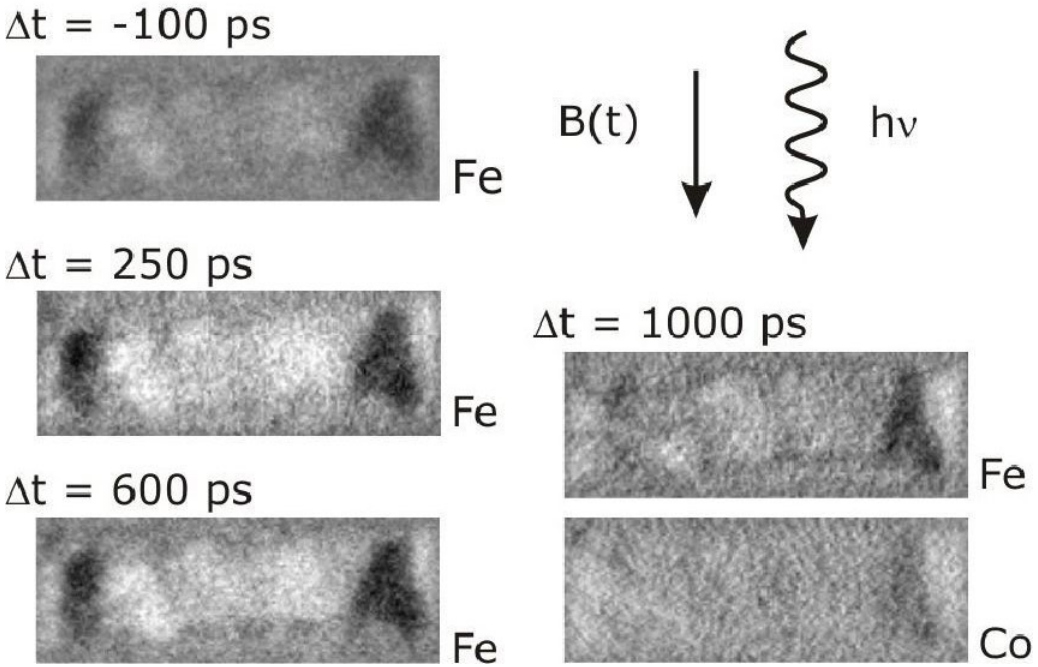


Fourier maps



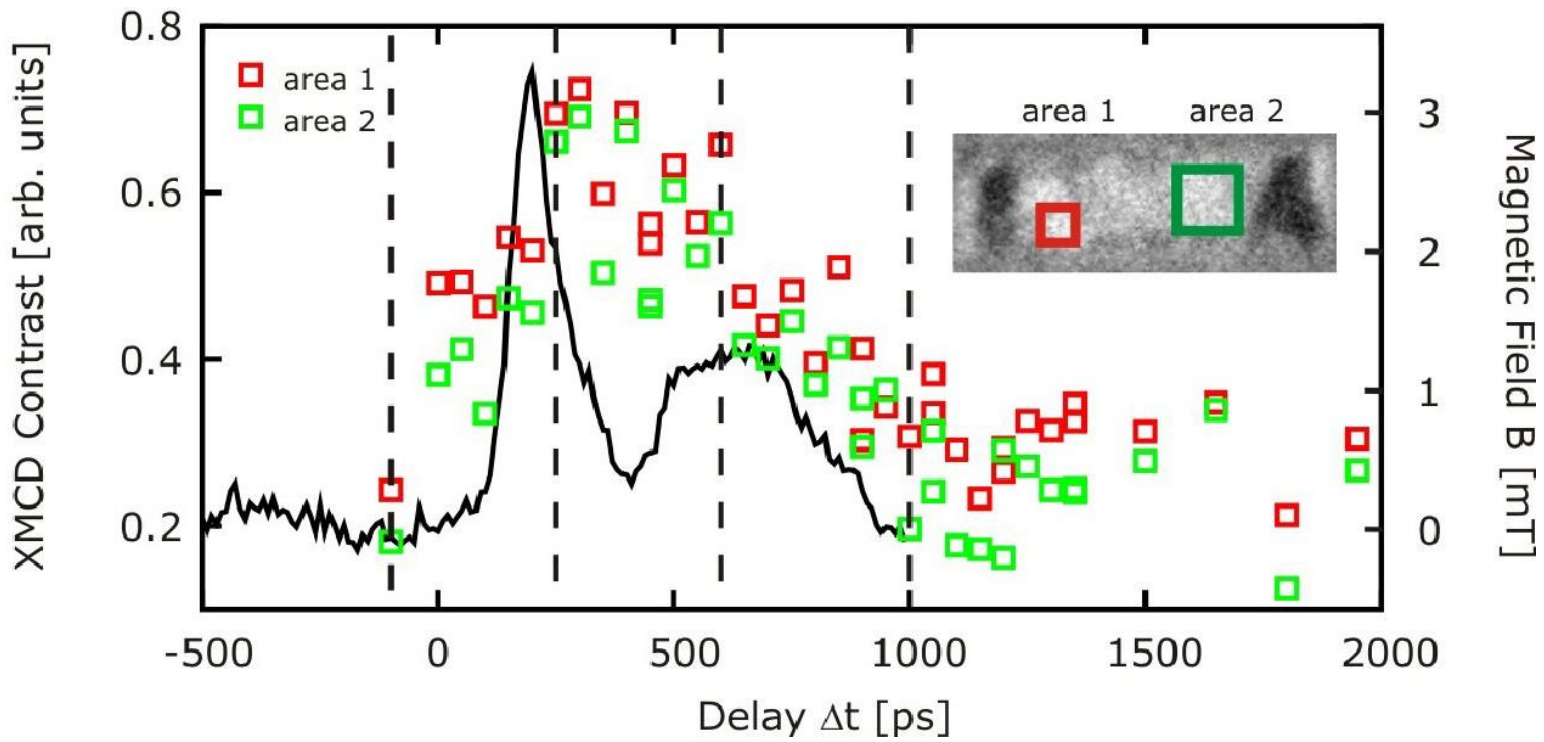
magnetization dynamics in trilayer: first results

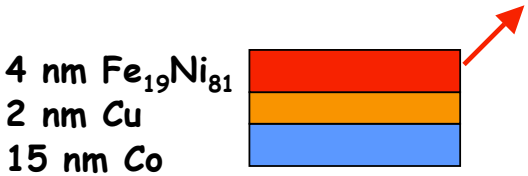
5 →15 μm^2



4 nm $Fe_{19}Ni_{81}$
2 nm Cu
15 nm Co

magnetization dynamics in trilayer: first results





summary

- imaging of field pulse-induced magnetization dynamics by XMCD-PEEM
- new sample holder design
- field pulses of 80 ps width, < 40 ps rise time, and 80 Oe amplitude
- precession in FeNi microstructures
- implemented technique to small-focus beamline with high-resolution Elmitec PEEM at BESSY

outlook

- investigate magnetic multilayered samples
- reduce laser repetition rate, increase pulse power: direct excitation of magnetic system

financial support: BMBF (05 KS4UK 1/4)

bmb+f - Förderschwerpunkt
Kondensierte Materie
Großgeräte der physikalischen Grundlagenforschung

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