



Prospects of Fs XAS with Slicing Sources

Hermann A. Dürr



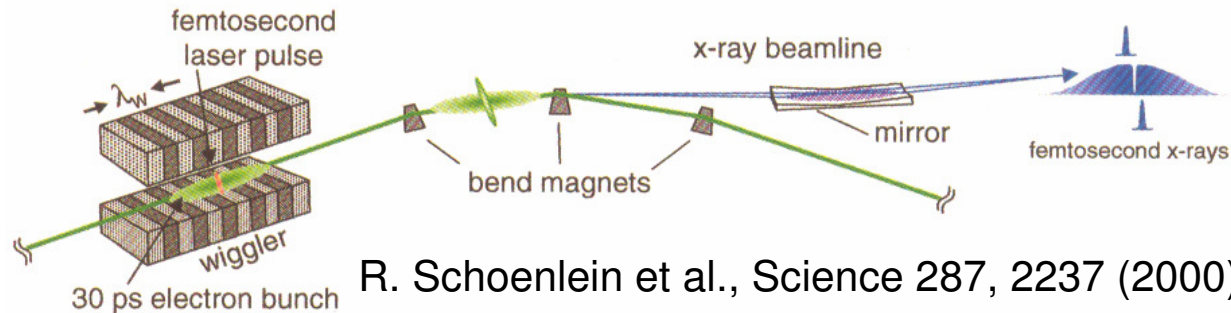
Hermann Dürr, Lund, 2007



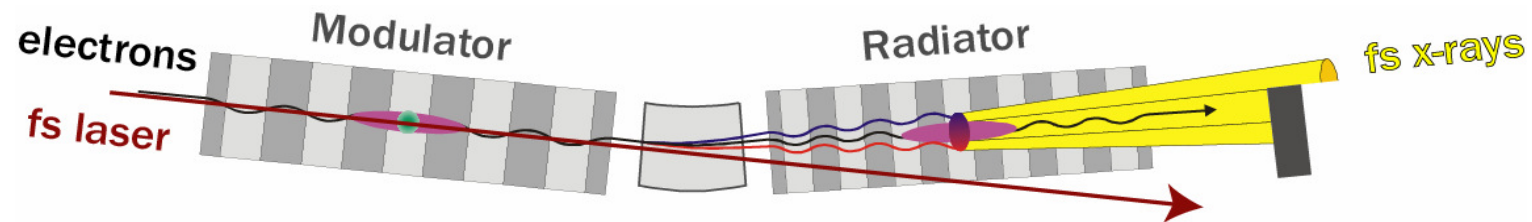
Generation of Fs X-Rays: FemtoSlicing

first setup at ALS

energy modulation of electron bunch by fs laser



new concept at BESSY (@SLS hard x-rays)



- circular and linear polarization
- x-rays generated by second undulator (“radiator”)
- angle separation for better background suppression

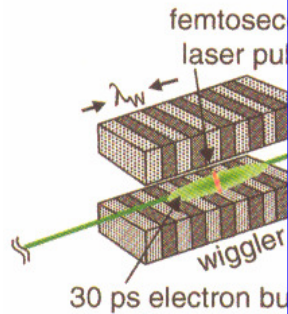


Generation of Fs X-Rays: FemtoSlicing

first setup at ALS

energy modula

HGHG-FEL Test Bench



Laser electron interaction
 Synchronization
 Energy transfer
 THz-Diagnostics

new conc



Pump-probe experiments
 Synchronization
 Beam transfer
 X-ray pulse characterization

-rays

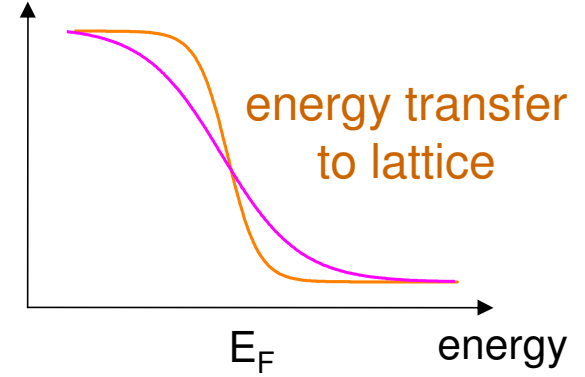
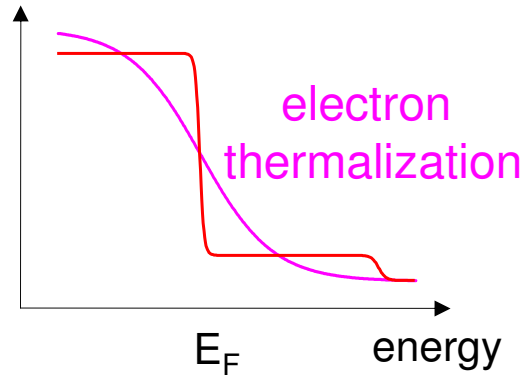
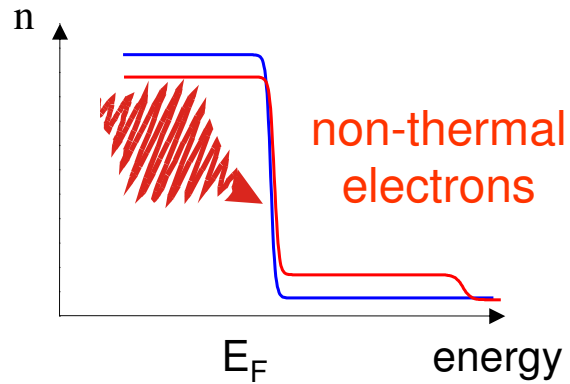
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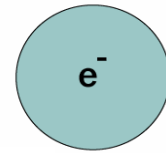
fs x-rays

- circular and linear polarization
- x-rays generated by second undulator (“radiator”)
- angle separation for better background suppression

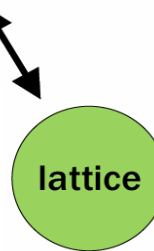
Femtosecond Energy Transfer



fs laser pulse

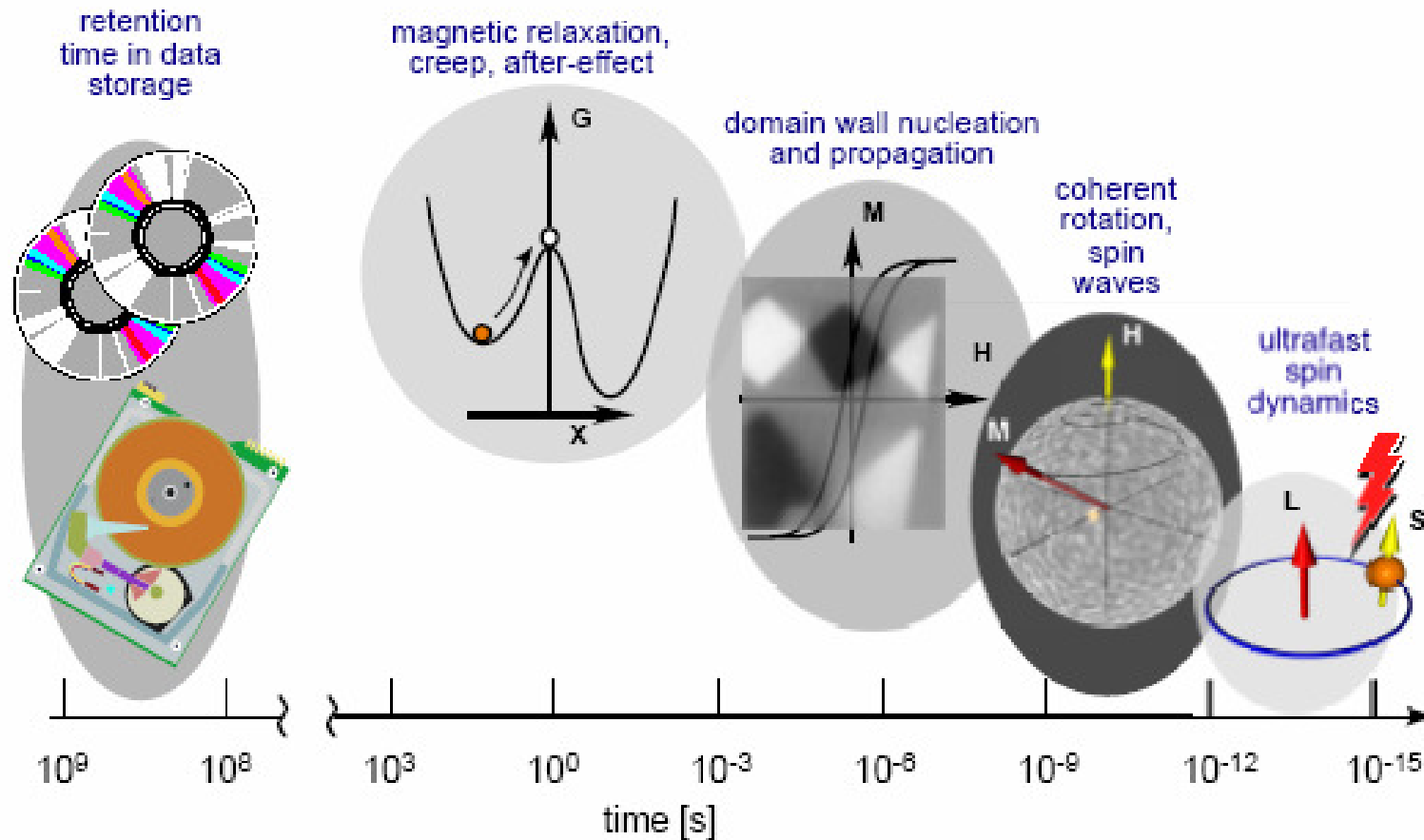


XAS: element specific electronic structure



ultrafast
 - meting
 - shock waves
 - coherent phonons

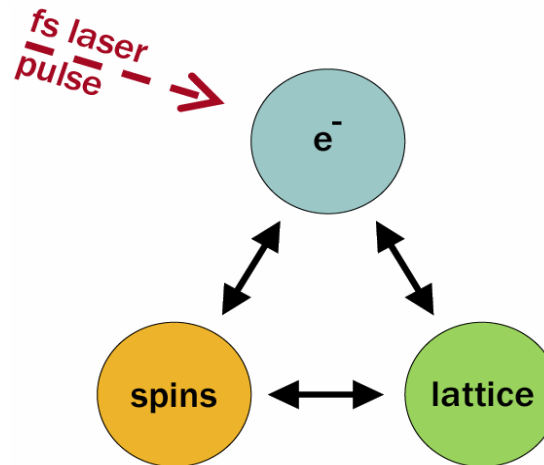
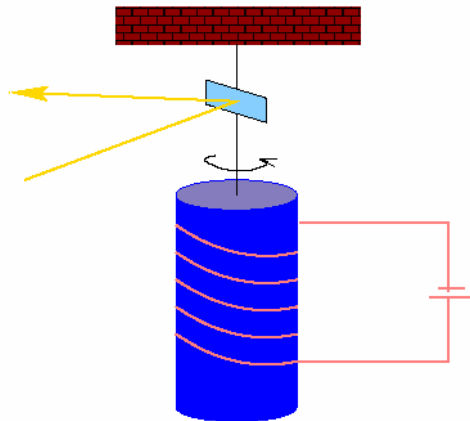
Time Scales in Magnetism



conserve total angular momentum

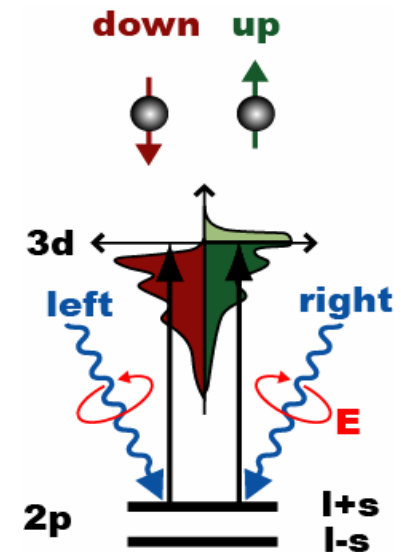
$$J = S_e + L_e + L(\text{lattice}) + L(\text{laser})$$

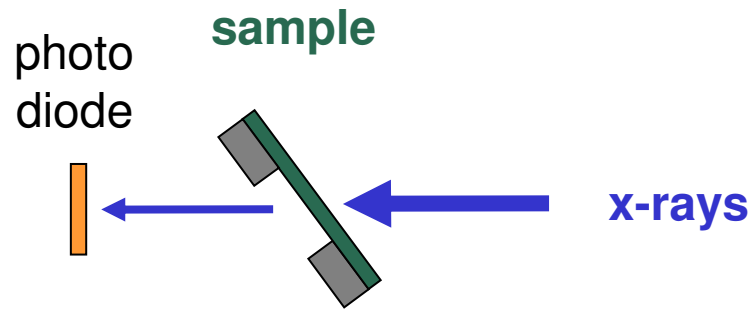
Einstein – de Haas Effect



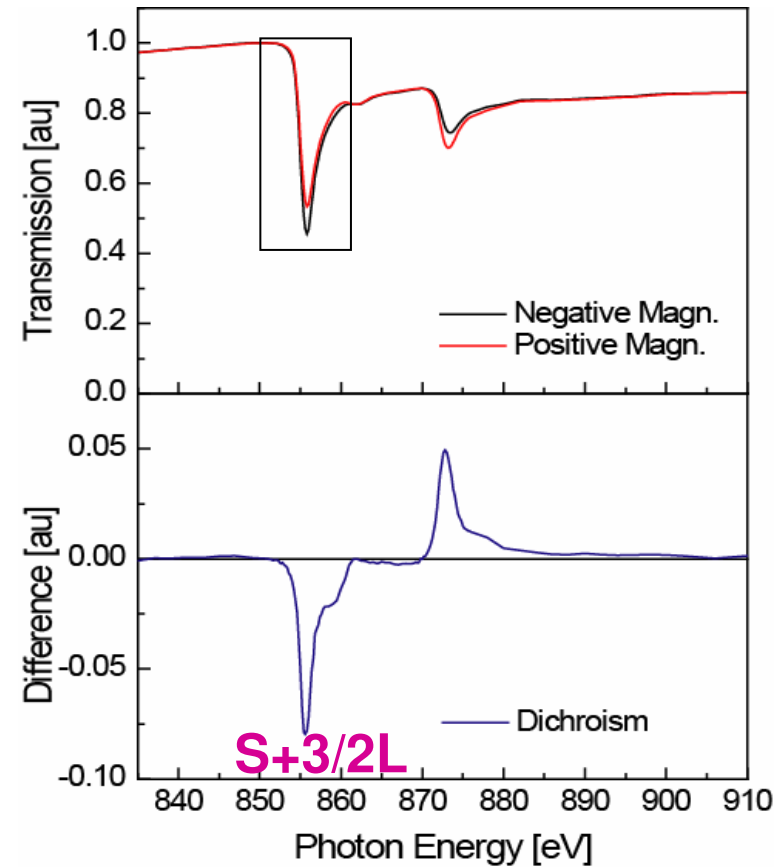
X-ray absorption spectroscopy

separation of spin and orbital angular momentum





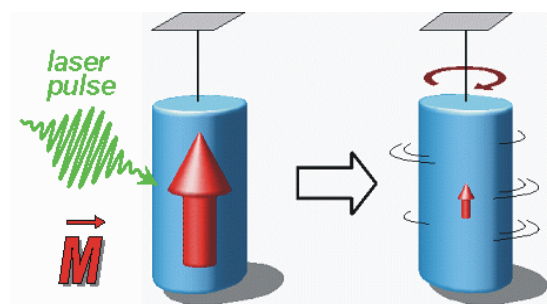
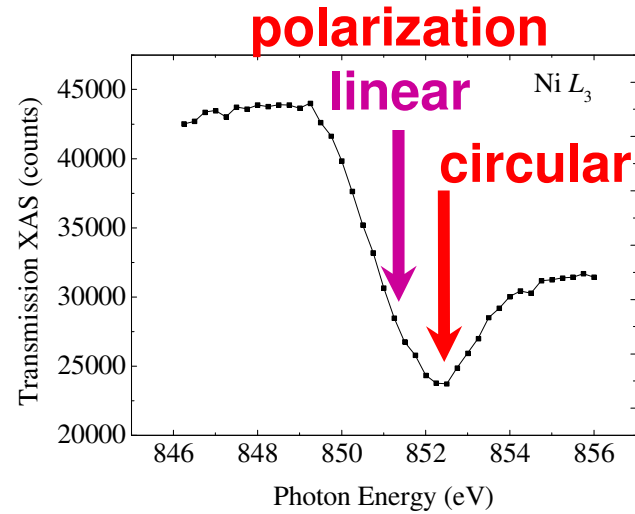
15 nm Ni film



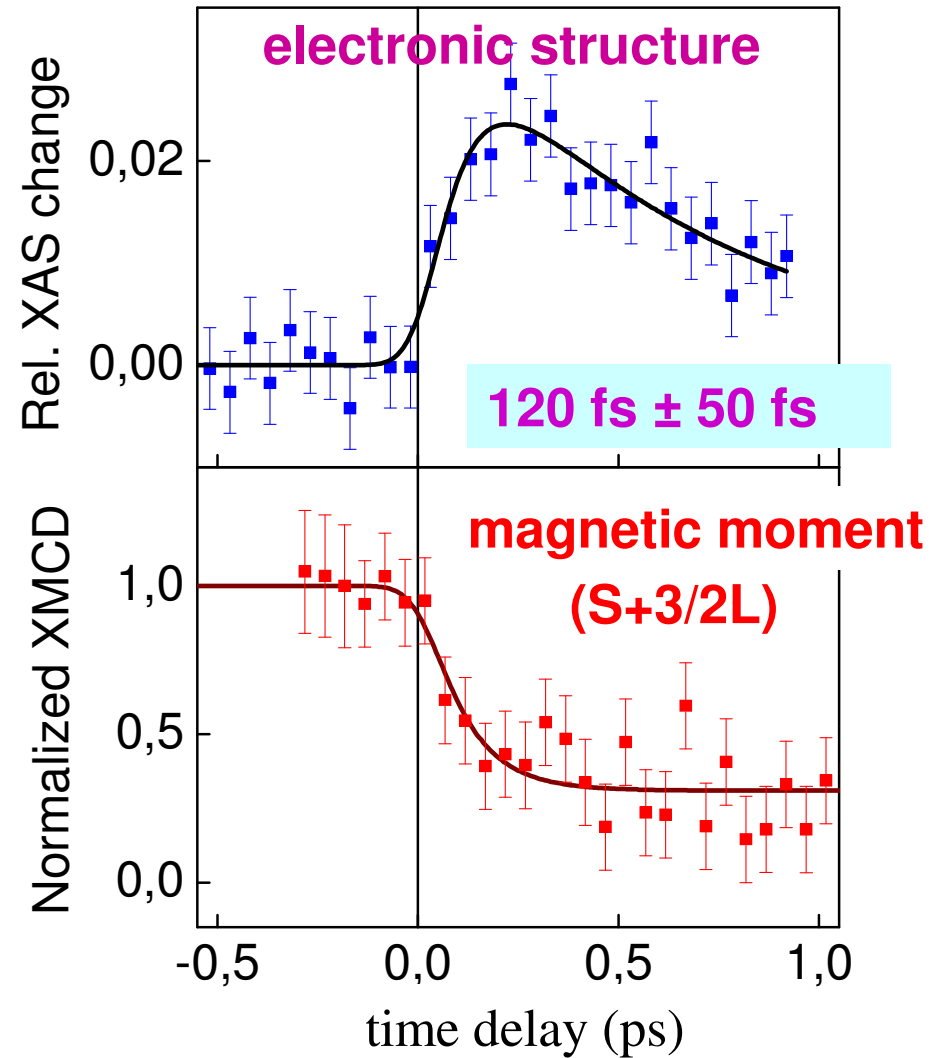
separate spin, S , and orbital, L , moments

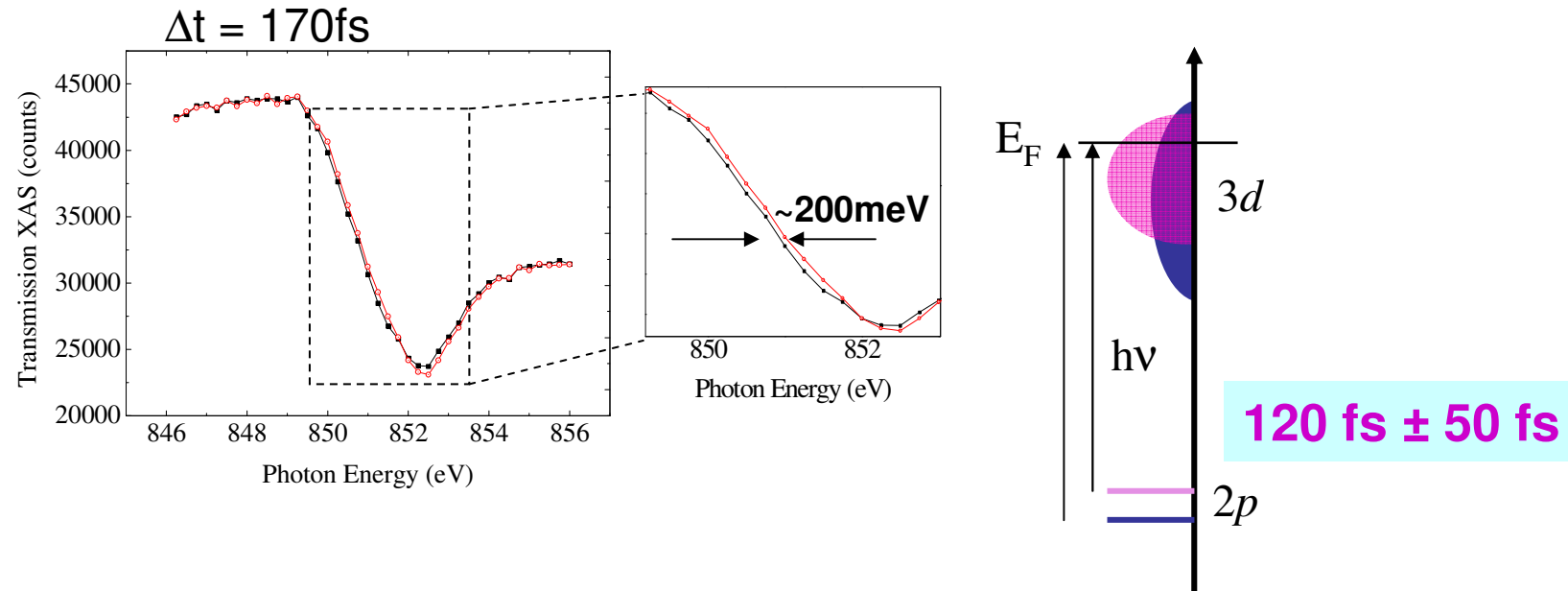


Fs Electron & Angular Momentum Dynamics



spin-lattice relaxation
120 ± 70 fs





photoemission shows no
 $\sim 200\text{meV}$ shift of E_F

Rhie, Dürr, Eberhardt,
 PRL **90**, 247201 (2003);
 Appl. Phys. A, **82**, 9 (2006).

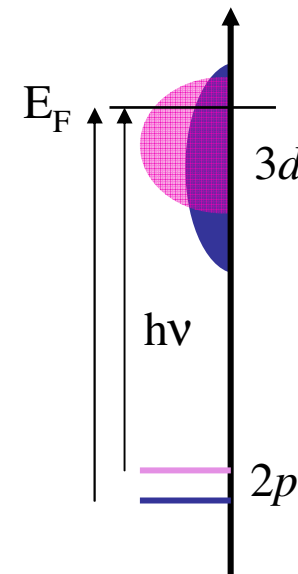
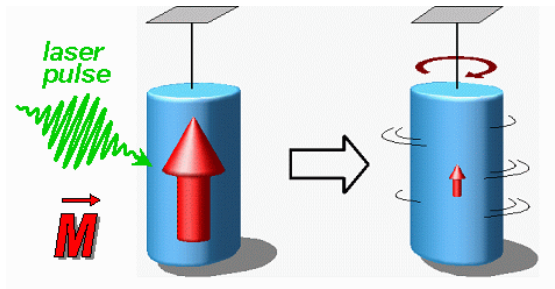
fs core level shift indicates
 valence electron localization
 due to electron-hole scattering

fs x-ray absorption spectroscopy can probe

spin-lattice relaxation

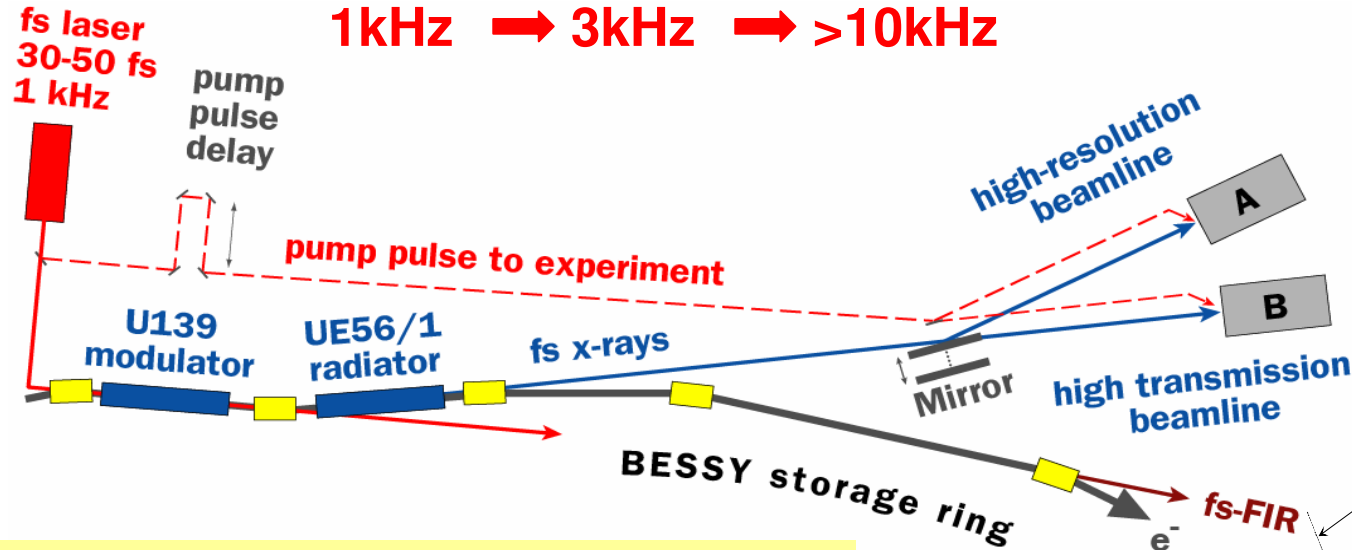
and

valence electron localization

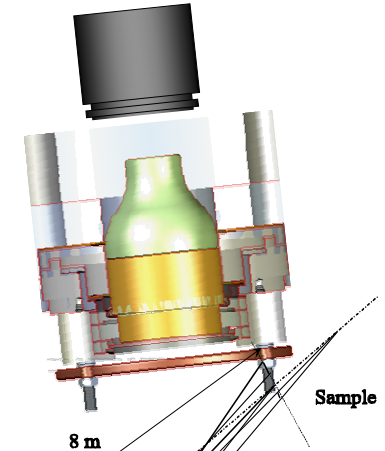


Outlook: FemtoSlicing Upgrade

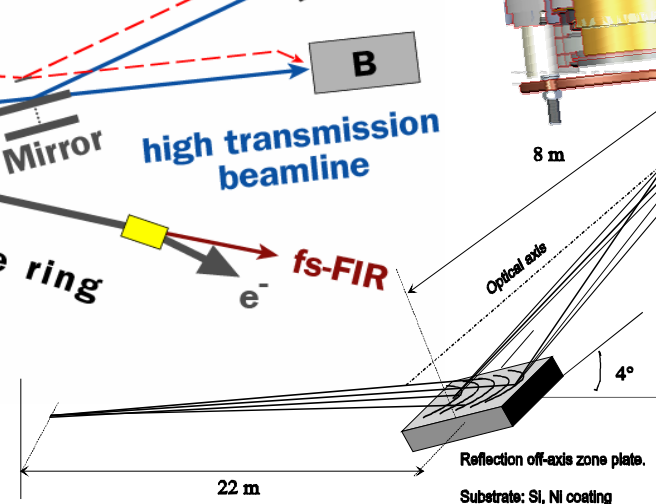
increase laser repetition rate
 1kHz \rightarrow 3kHz \rightarrow >10kHz



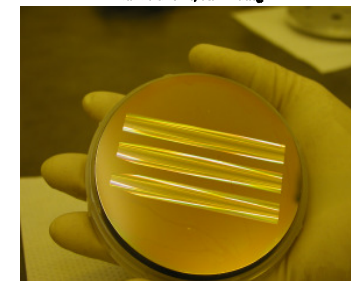
parallel detection

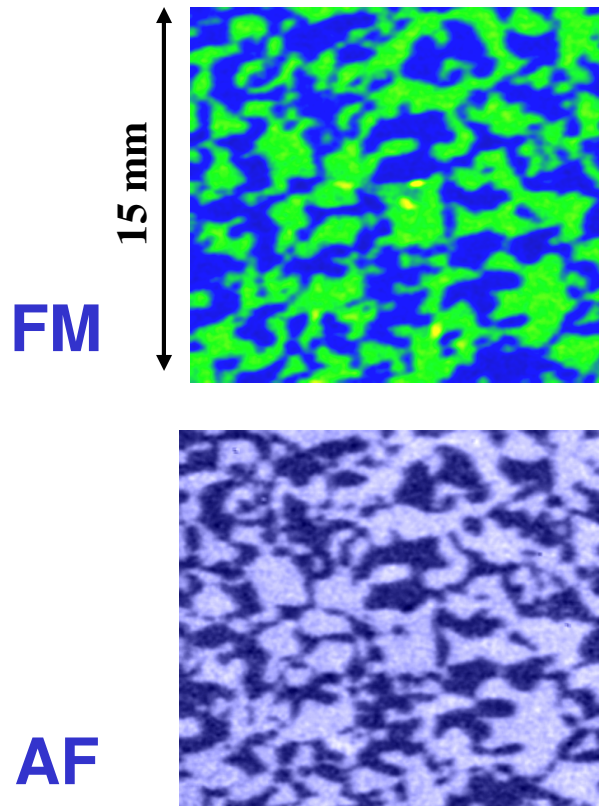


increase of photon flux
 $\sim 10^4 \text{ s}^{-1} \rightarrow > 10^7 \text{ s}^{-1}$

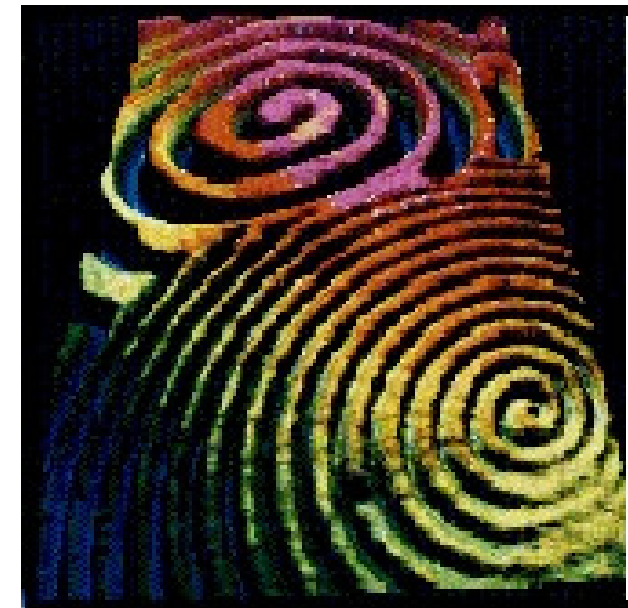
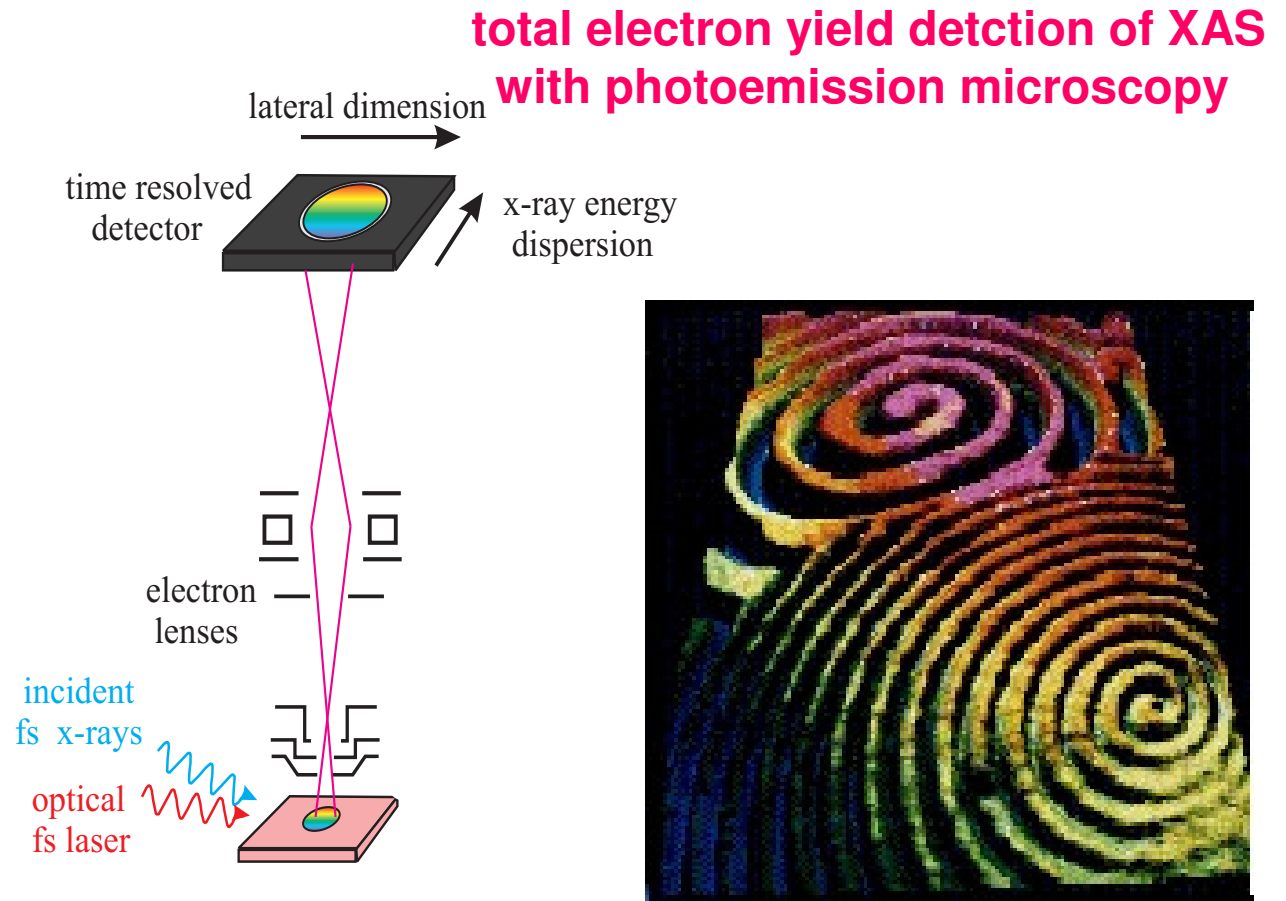


Fresnel zone plate as single optical element





FM and AF domain imaging
A. Scholl, ALS Berkeley



Pattern formation during a
chemical reaction
G. Ertl FHI Berlin