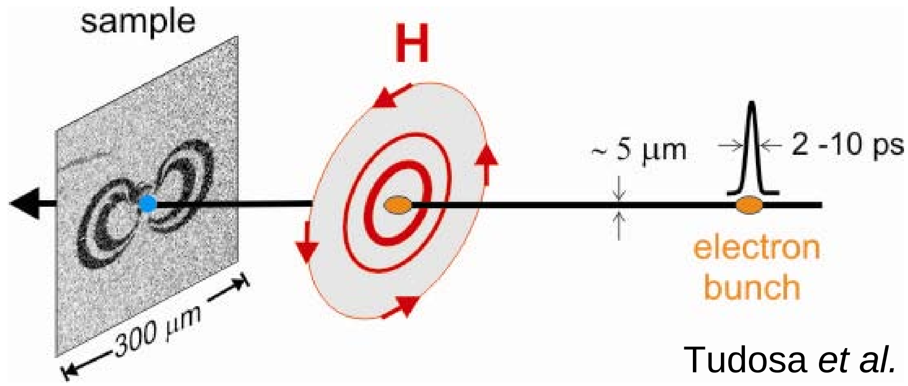
Condensed matter physics at ultra fast time scales

plenary talk presented by Yves Acremann

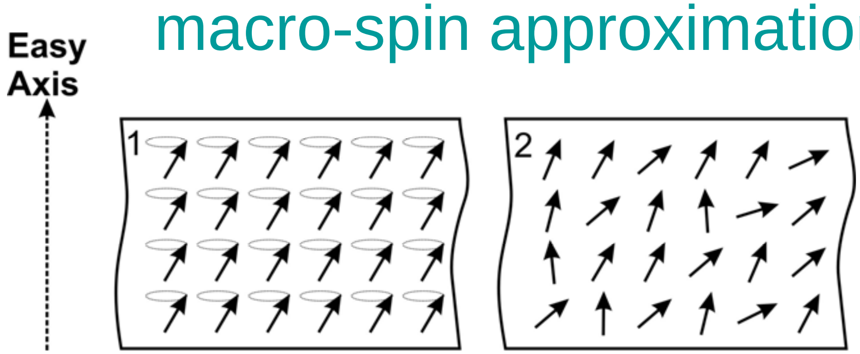
Ultrafast magnetization switching

Sara Gamble, Mark Burkhardt, Y. Acremann, Hans Siegmann, Joachim Stohr (SLAC)

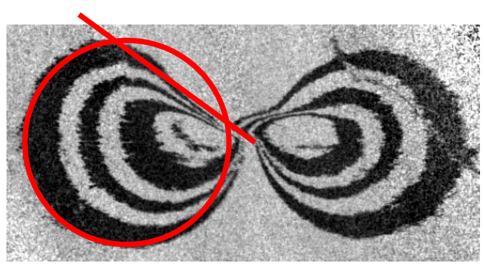


Tudosa *et al.* Nature **428**, 831 (2004)

Magnetization fracture,
breakdown of the
macro-spin approximation



Magnetic equation
of motion in
question!



New results with a 10 times shorter (167 fs) pulse

Magnetic pattern of 10 nm Fe film with

167 fs bunch length

Pattern size 470 µm by 980 µm

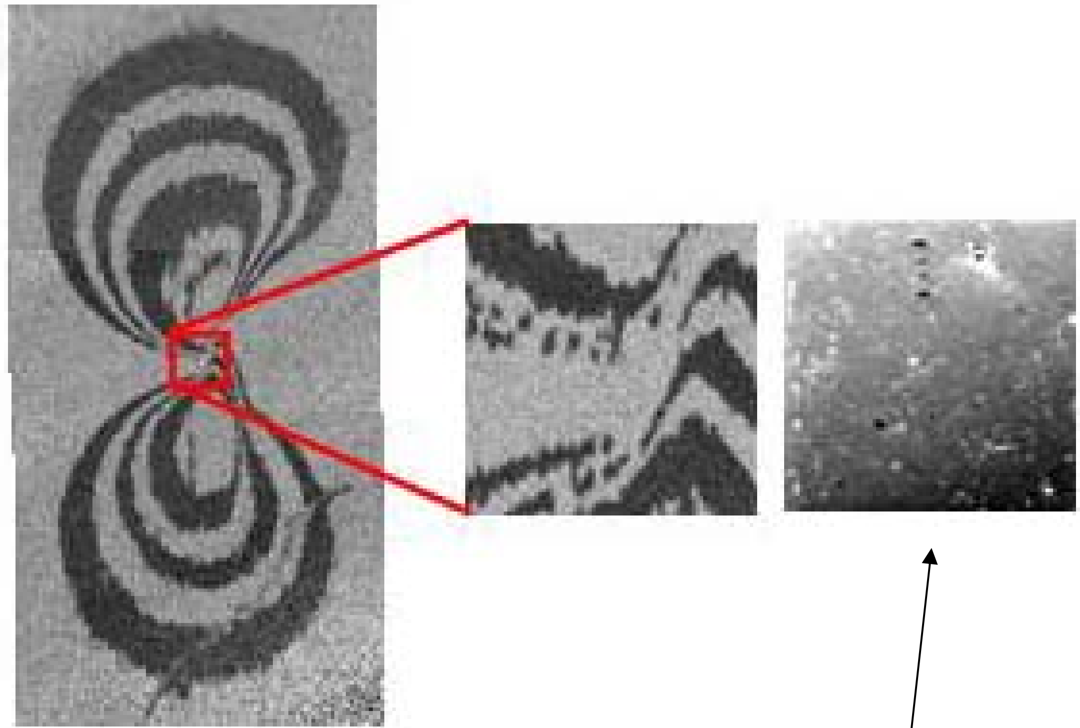
Pattern is severely asymmetric – should follow circles

No switching for certain magnetic field orientations !

Violates conventional laws of angle-dependence of magnetic torque

Puzzle is unresolved at present…..

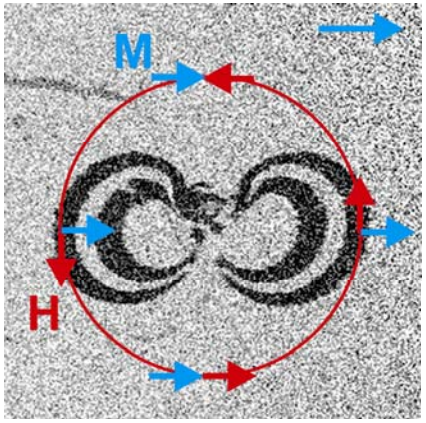
Surprising result: No beam damage at ultrafast time scales



- Inspection of beam impact area reveals no damage !
- Sample did not get hot !
- Sub-picosecond energy dissipation must exist (photons, electrons)
- Dissipation faster than electron-phonon relaxation time (ps)
- Essential for LCLS: how does a solid survive the beam?

Ultrafast magnetization switching

- Phase 1: Pump with SABER, look at it later

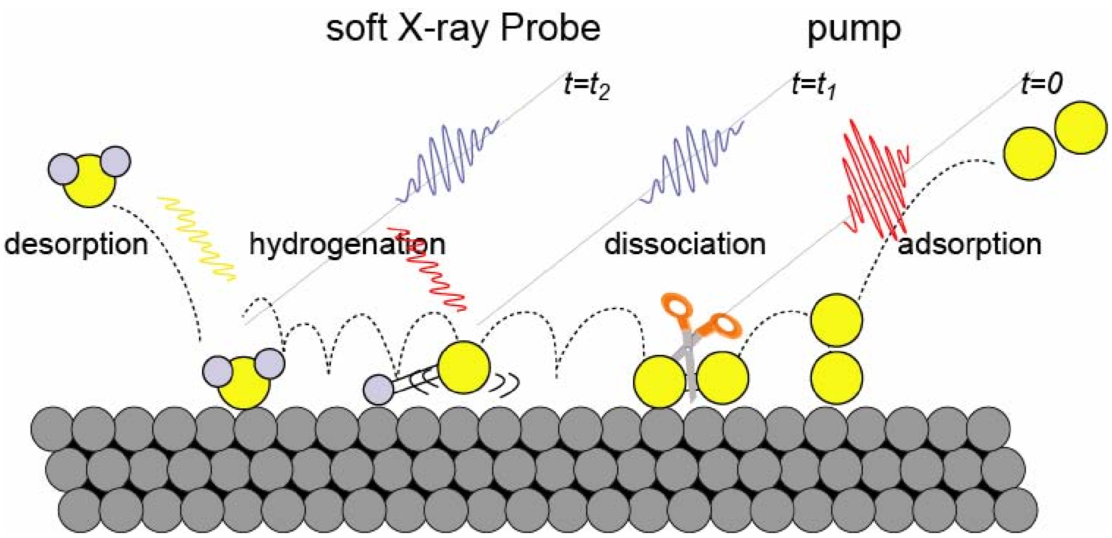


- Phase 2: SABER pump, laser probe

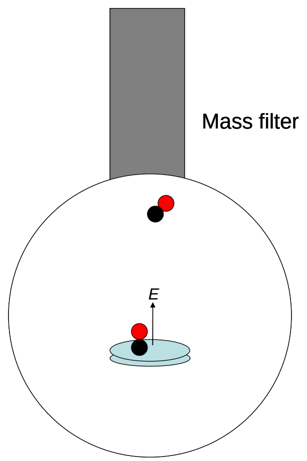
Coherent Control of Surface Reactions using THz Radiation and electric field pulses

Hirohito Ogasawara Dennis Nordlund and Anders Nilsson,

Stanford Synchrotron Radiation Laboratory

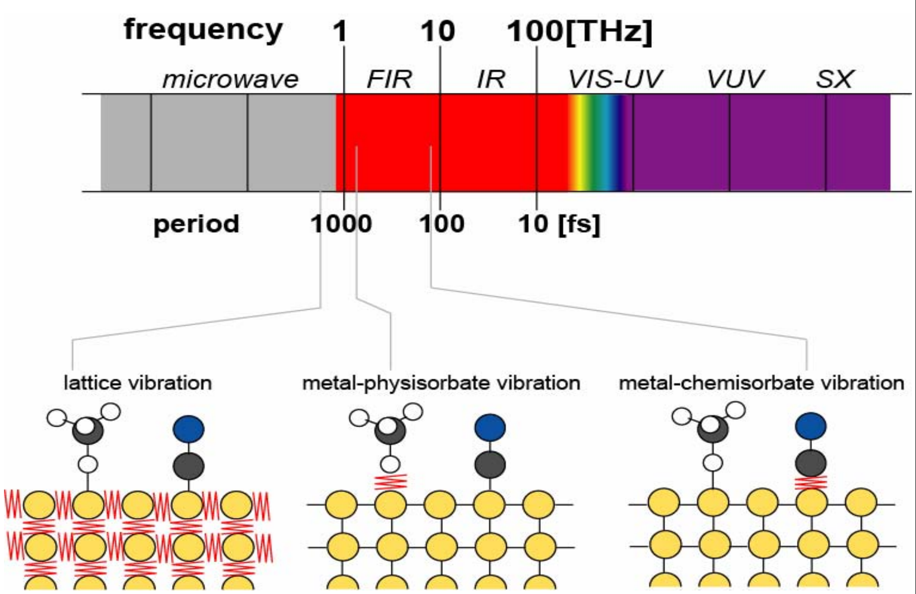


Pre-experiment for LCLS:



Coherent Control of Surface Reactions using THz Radiation and electric field pulses

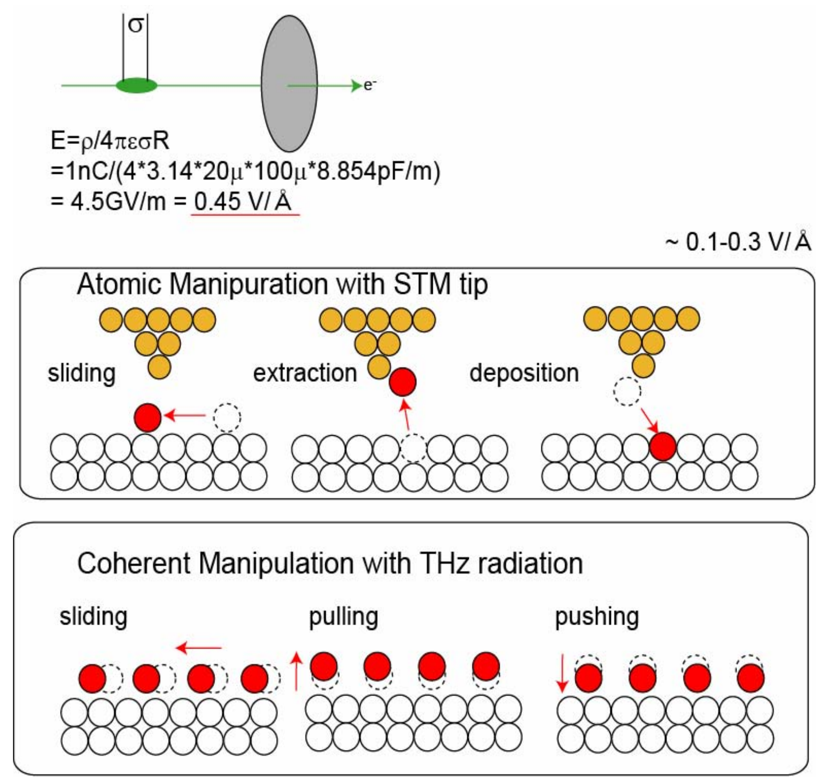
Controlling chemical reactions with THz radiation (coherent control)



fs laser: hot electron problem

THz: NO hot electrons

Controlling chemistry by huge electric field pulses



Requirements: Beam

- Pulse length tunable 10 ps - <100 fs, for THz-chemistry: as short as possible
- Beam size: < 20x20 µm, gaussian
- Beam position stability: 20 µm

Requirements: diagnostics

- Pulse length diagnostics:
  - THz-interferometer
  - Electro-optical sampling (phase 2 of ultrafast magnetism)?
  - Peak field ionization detector (may be part of THz-chemistry)

- Beam profile / position diagnostics

Space requirements

- For all experiments: 3ft room above the beam pipe, otherwise very little space
- Ultrafast magnetism, phase 2: laser table close to the experiment (if possible < 10m)
- A central femtosecond laser system as a central part of SABER!

Beam time

- Ultrafast magnetism, ready for phase 1 (immediately)
- THz-chemistry: ready in 1-2 years

- Required beam time: 1-2 weeks every 3-4 months (depending on how much time is needed for beam tuning)