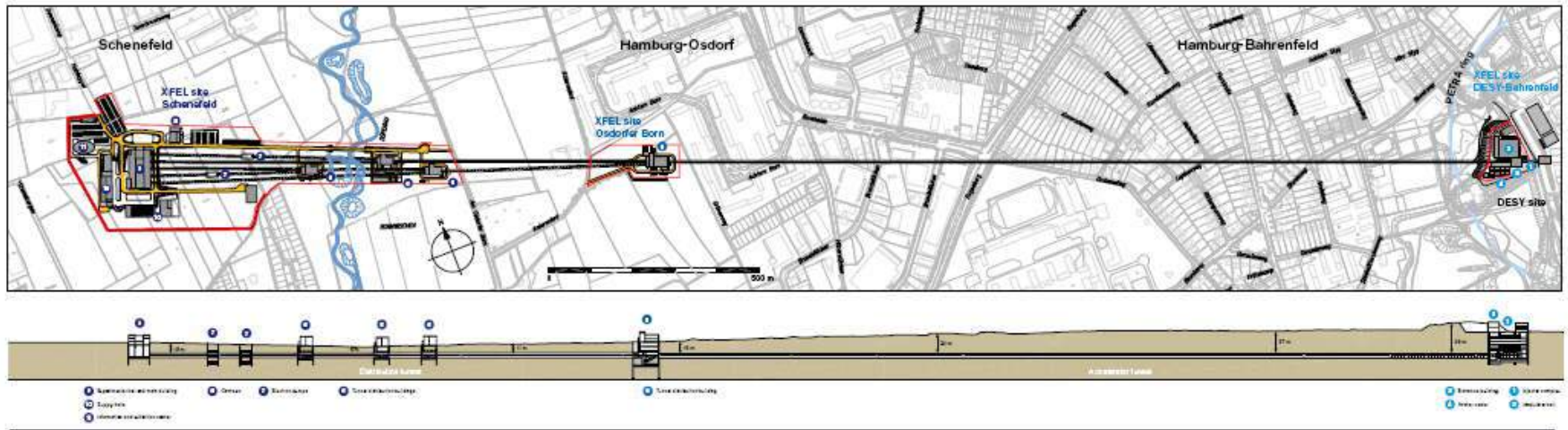
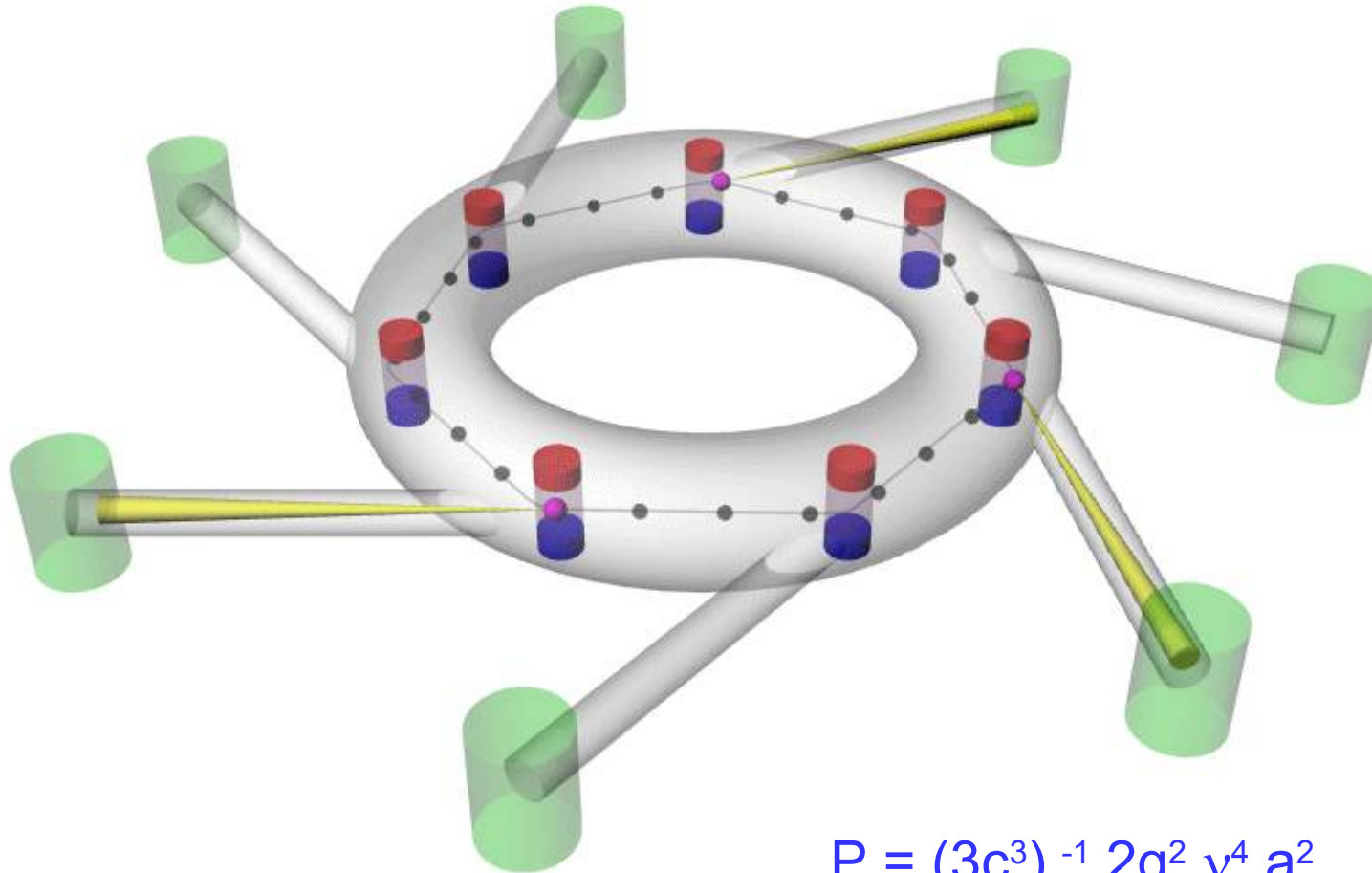




New Dimensions for Time- and Angle-Resolved PES at European XFEL

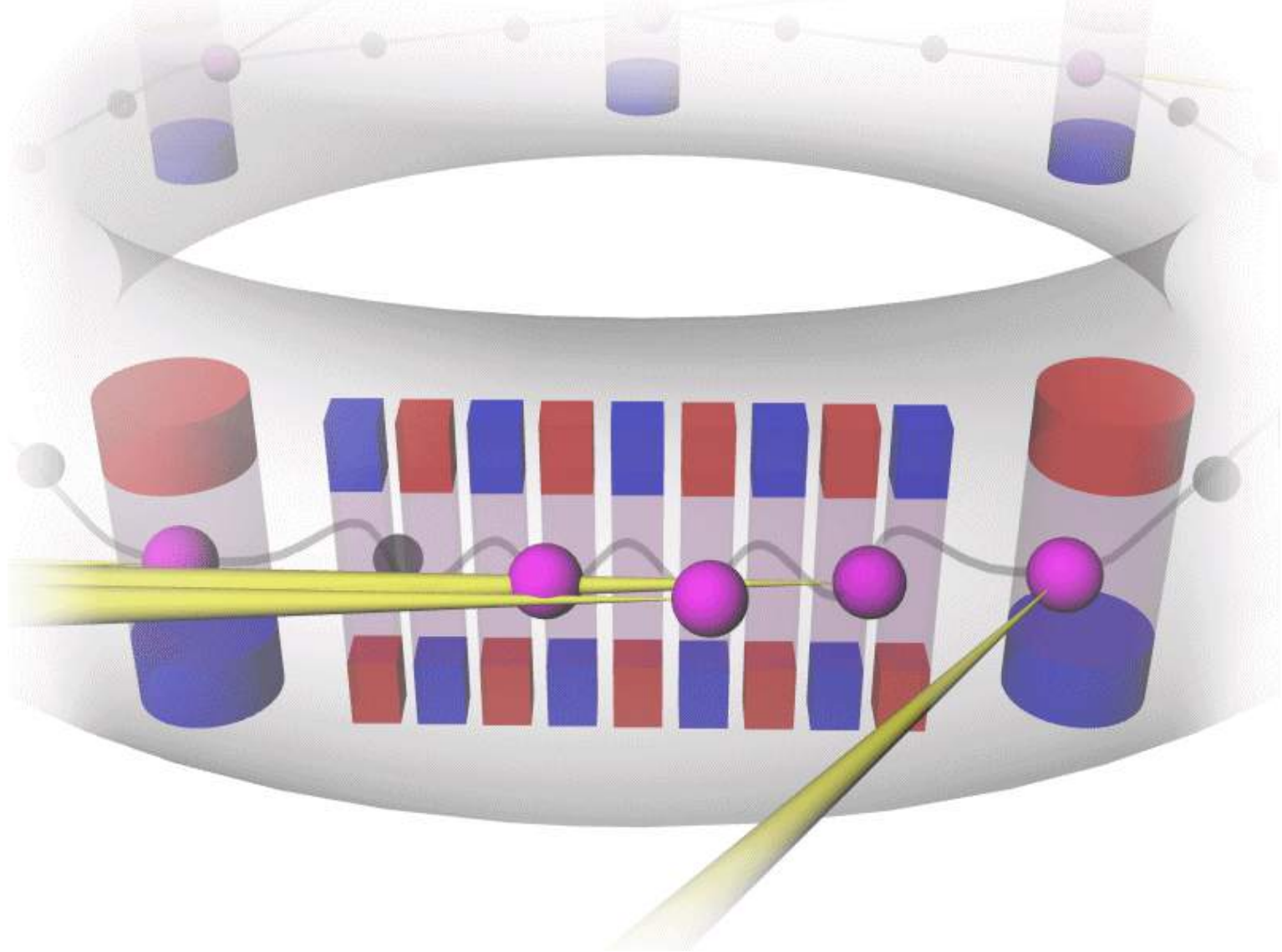
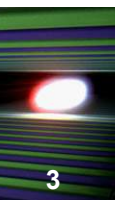
Serguei L. Molodtsov, European XFEL, Hamburg

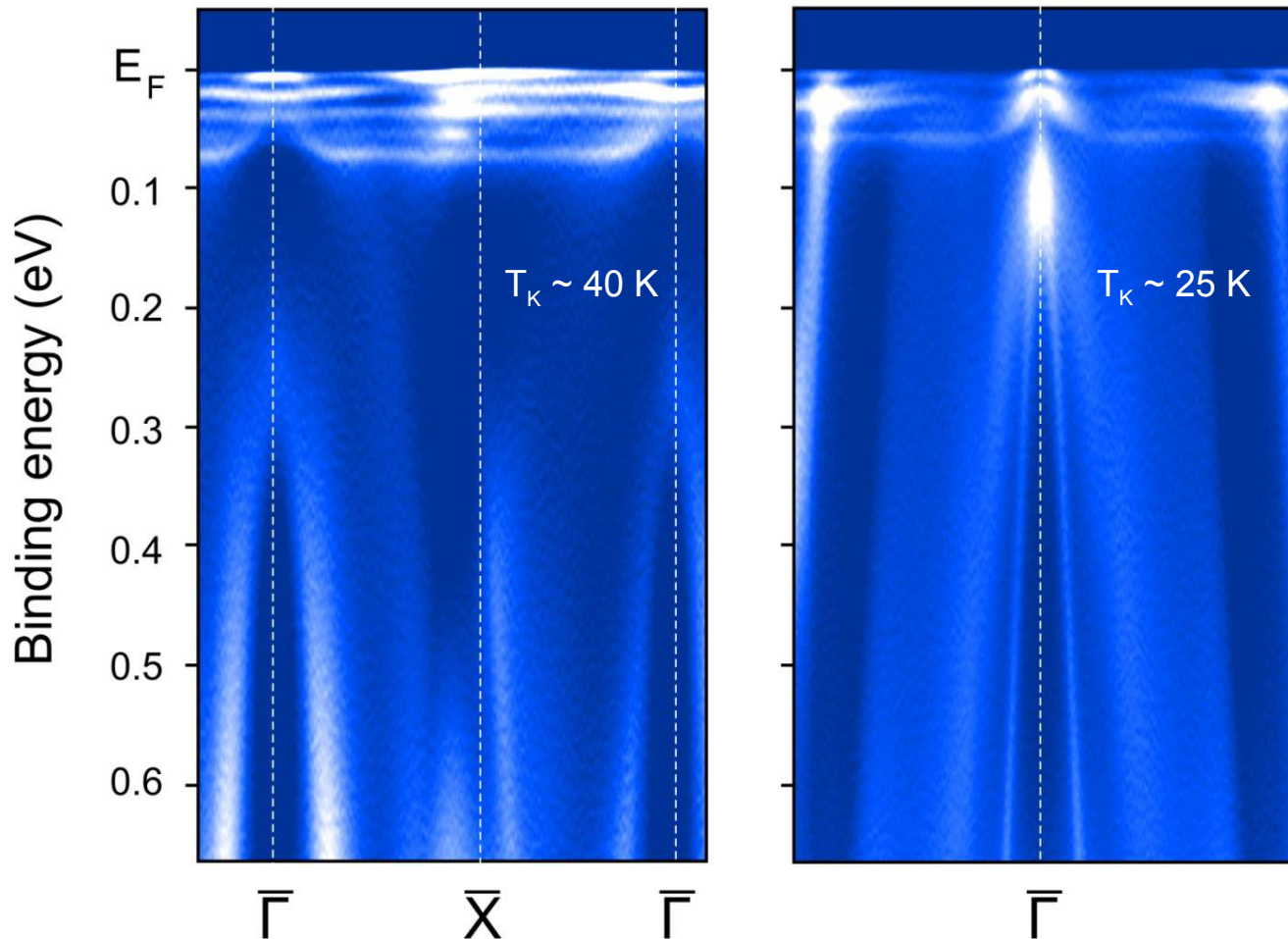
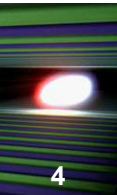




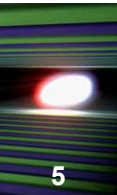
$$P = (3c^3)^{-1} 2q^2 v^4 a^2$$

P – radiated power; c – light velocity; q – particle charge; a – acceleration; v - normalized energy

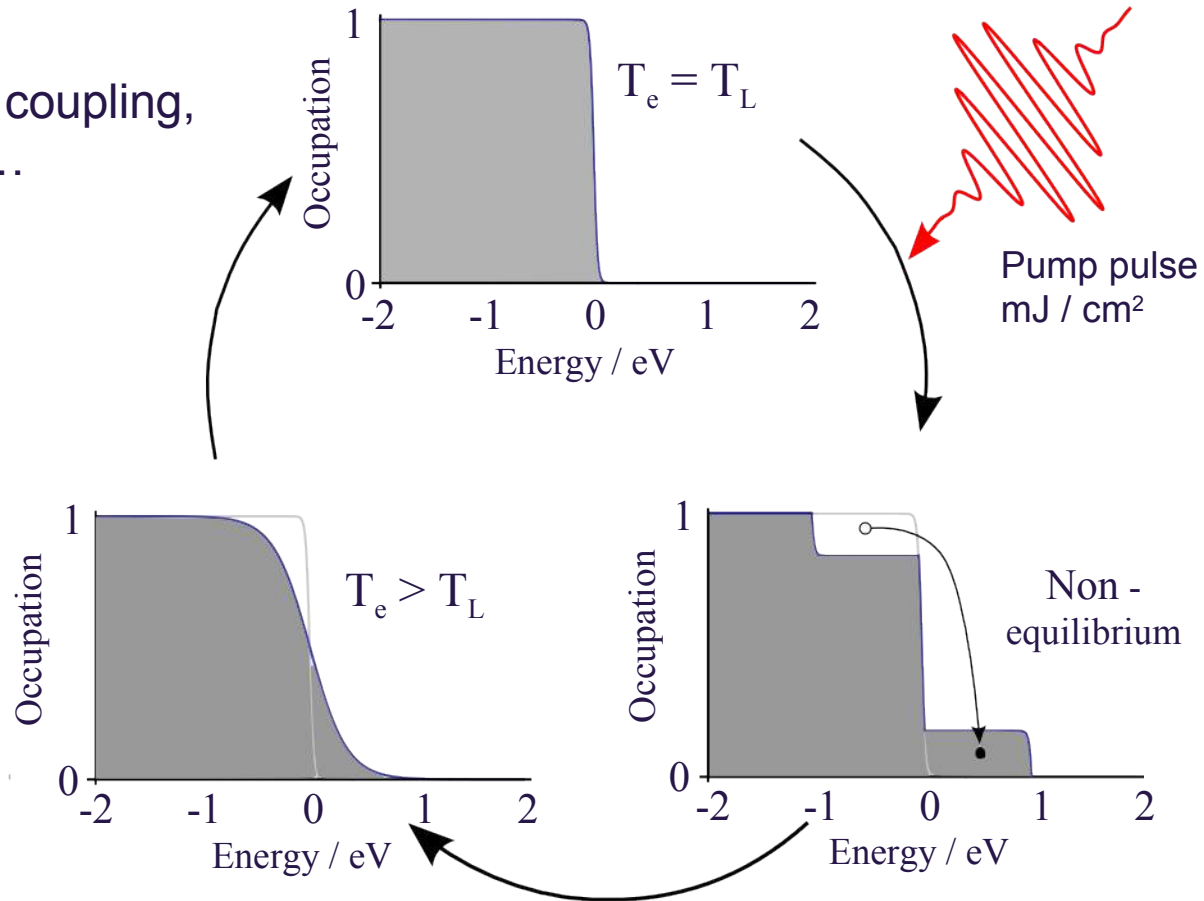




- effective mass mapping (transport phenomena)
- crystal field-split $4f$ states probing (magnetic properties)
- strength of electron states correlation (Kondo behavior)

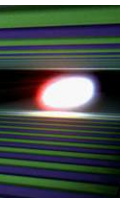


Electron-phonon coupling,
Spin dynamics, ...
0.1 to 100 ps

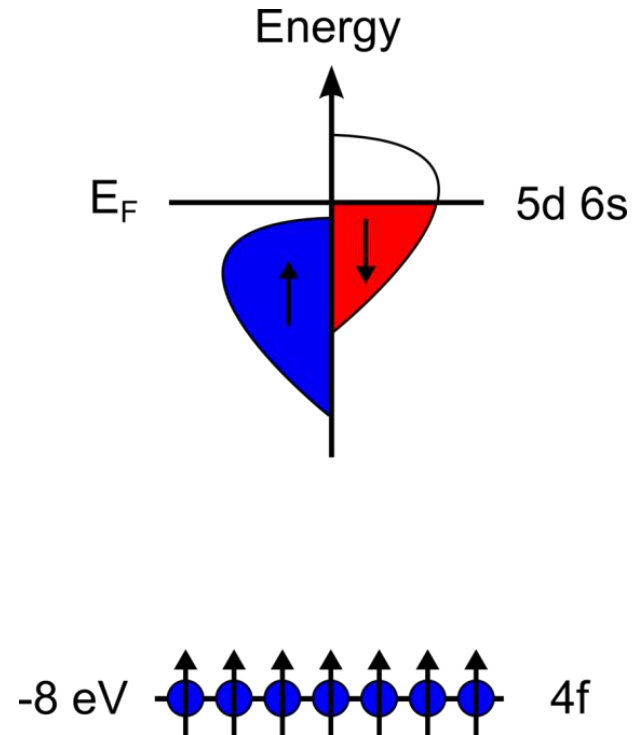
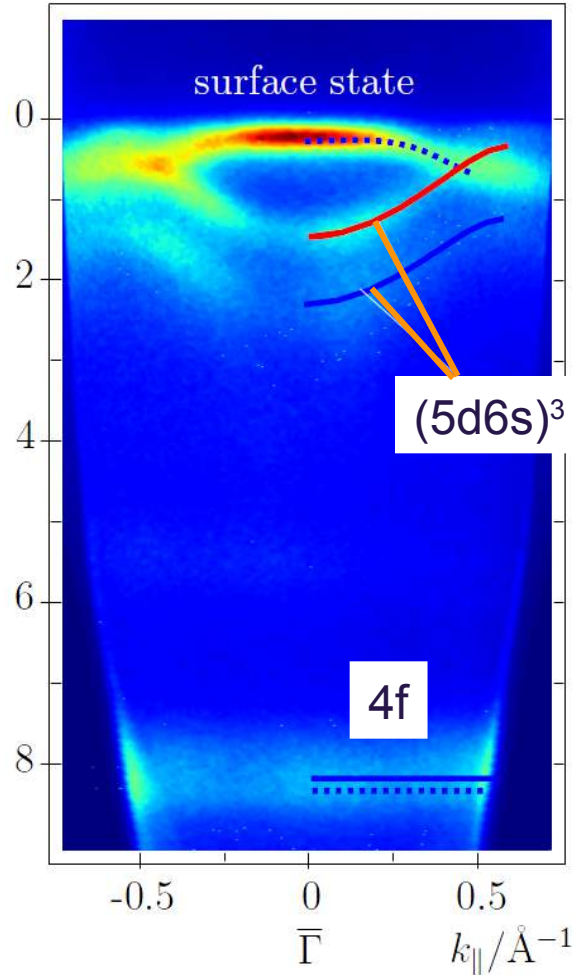


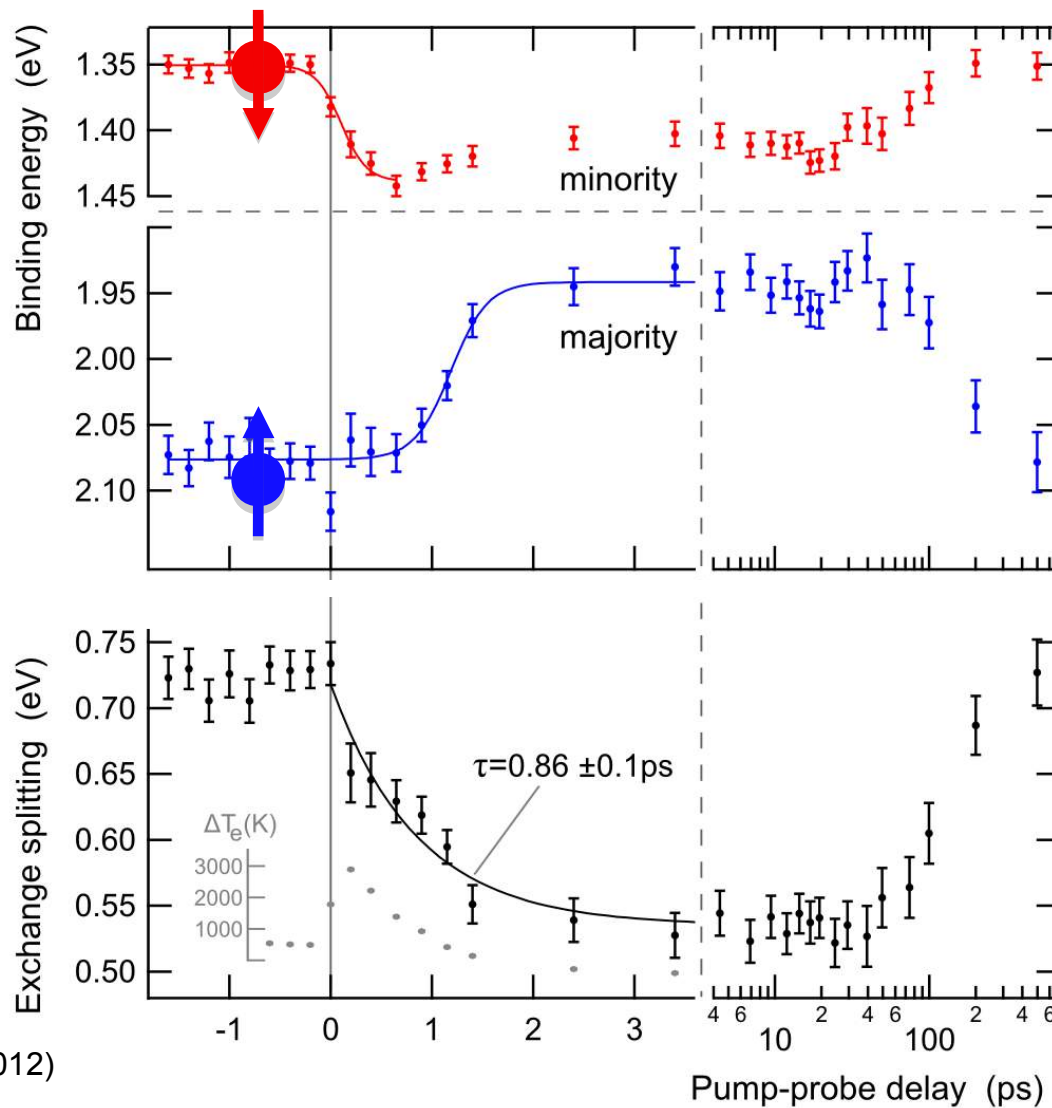
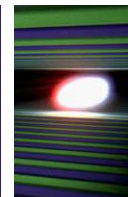
Basov *et al.* Rev.
Mod. Phys. **83**,
472 (2011)

Electron thermalization: 10 to 100 fs

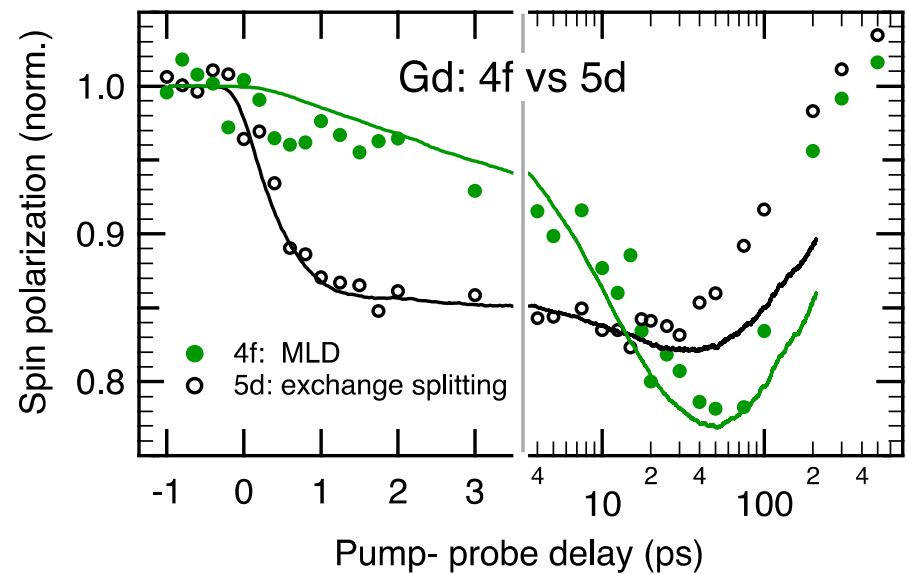
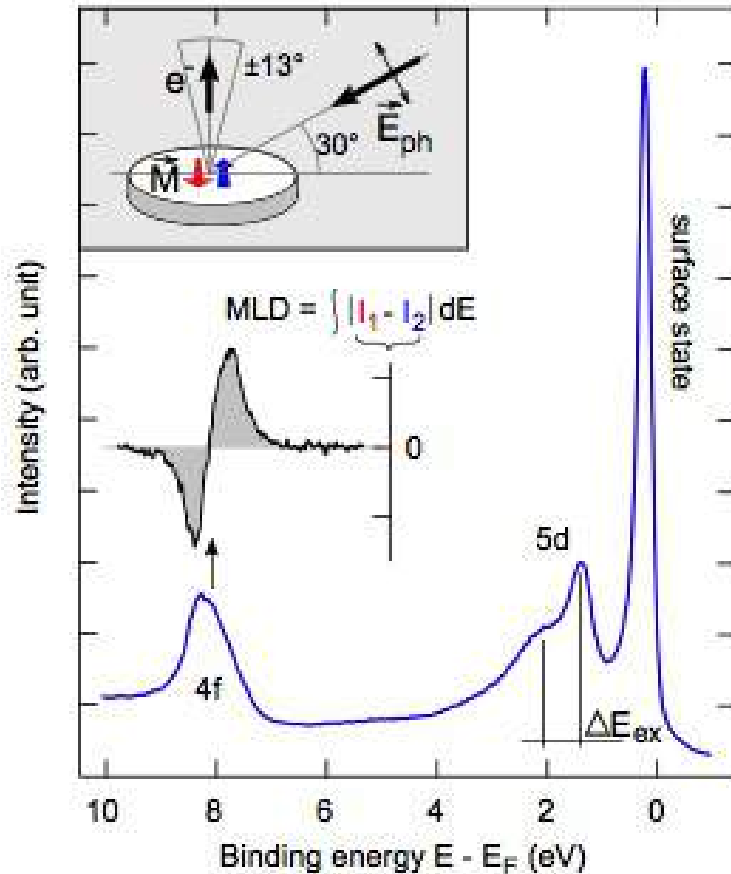
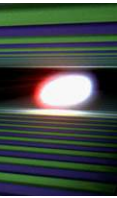


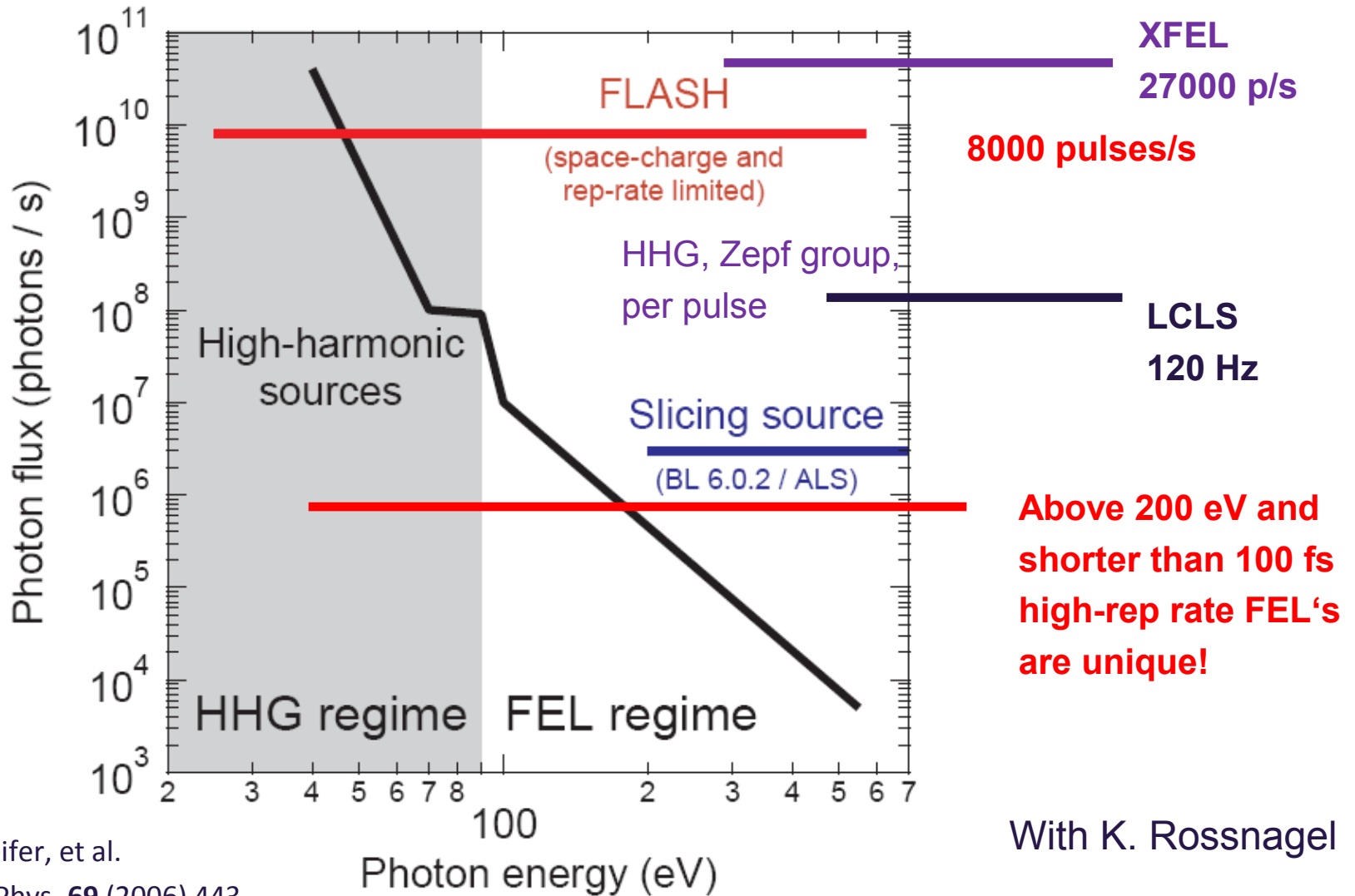
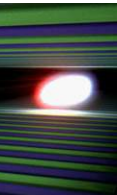
E_b/eV ■ $h\nu = 36 \text{ eV}$





Carley *et al.*
PRL **109**, 057401 (2012)

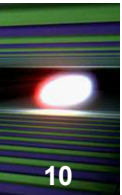




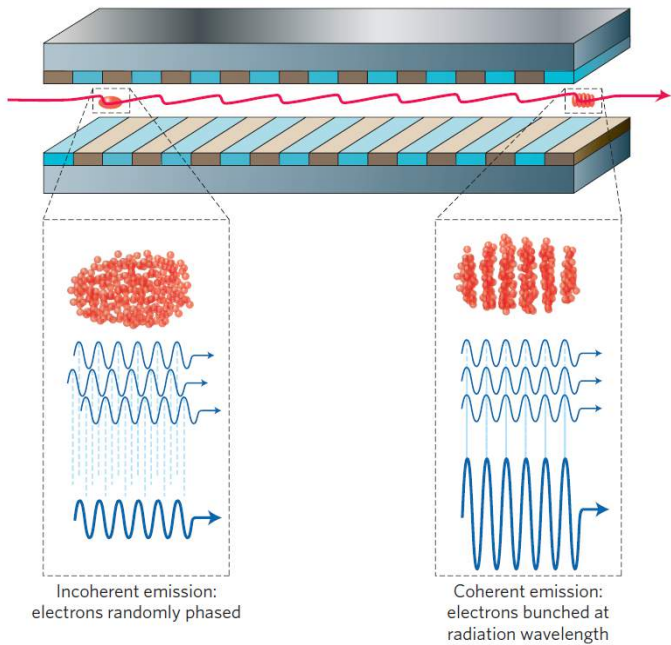
With K. Rossnagel

HHG, T. Pfeifer, et al.

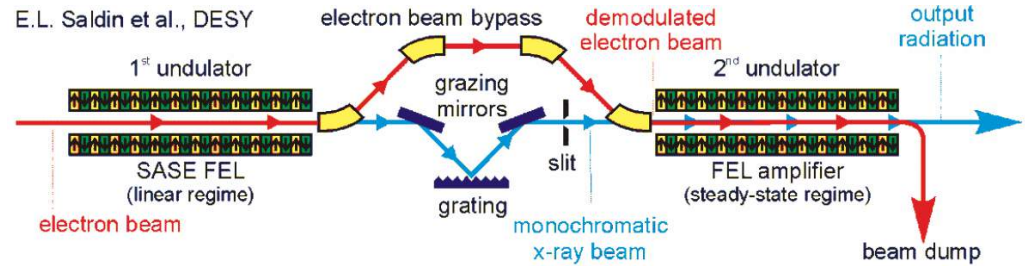
Rep. Prog. Phys. **69** (2006) 443



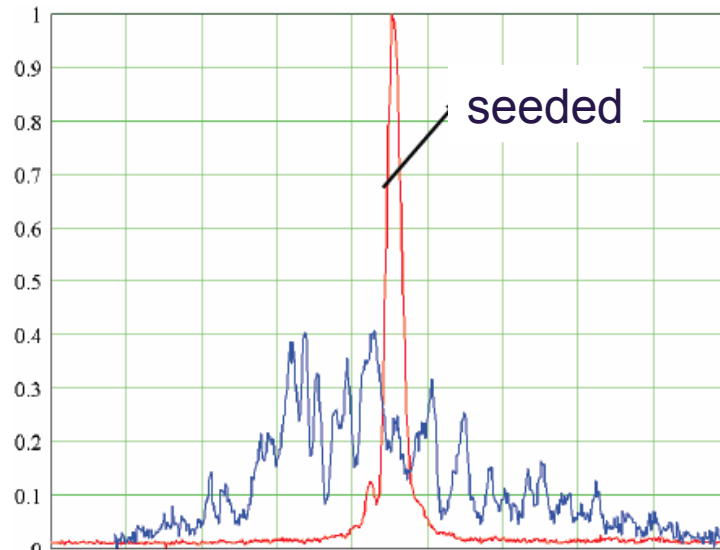
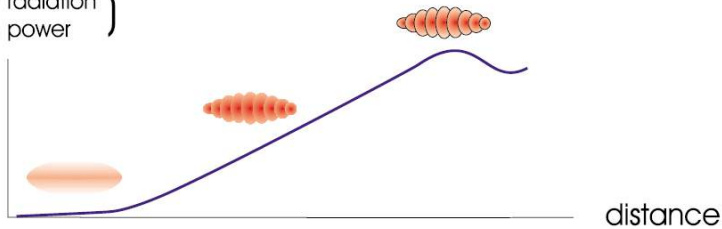
SASE

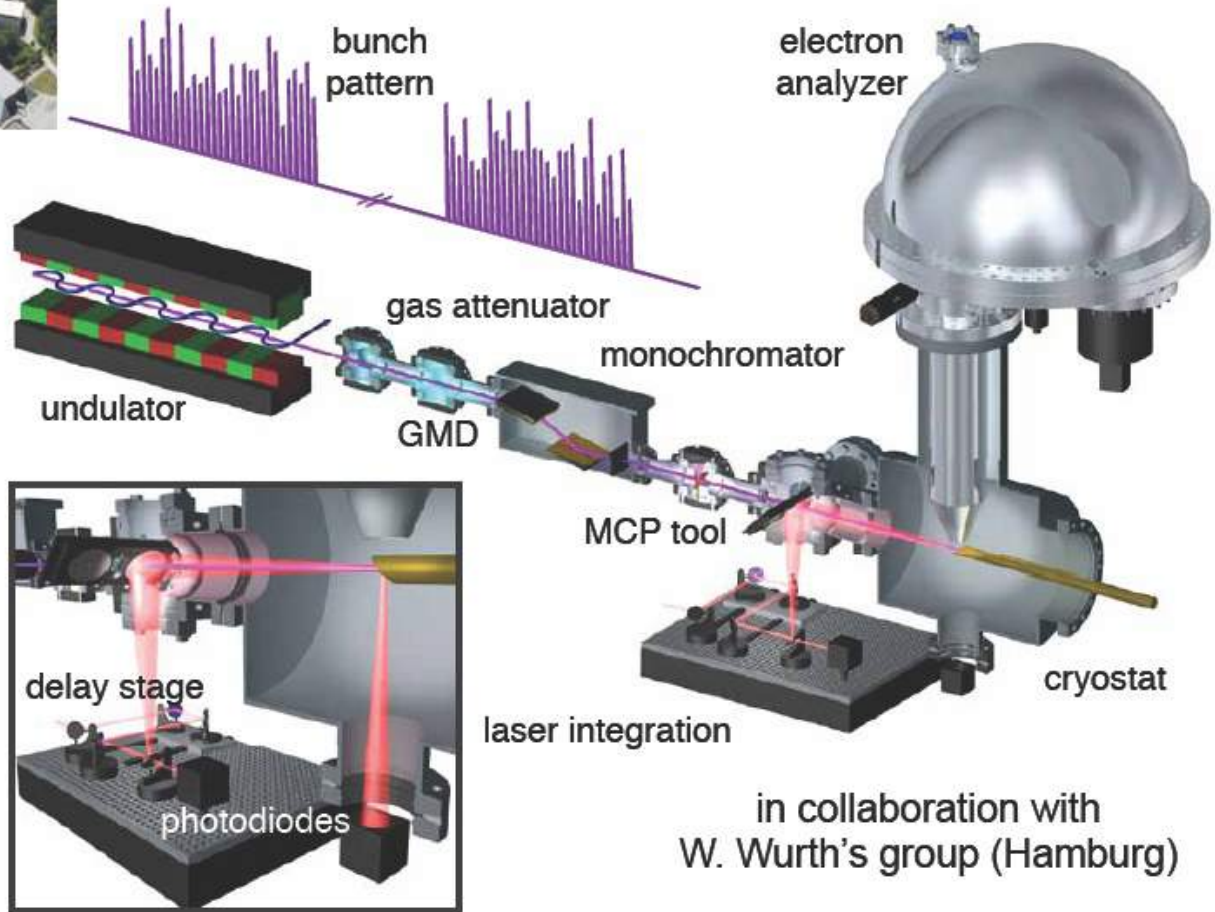
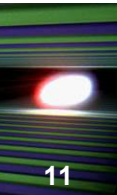


Self Seeding



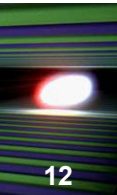
$\log(\text{radiation power})$





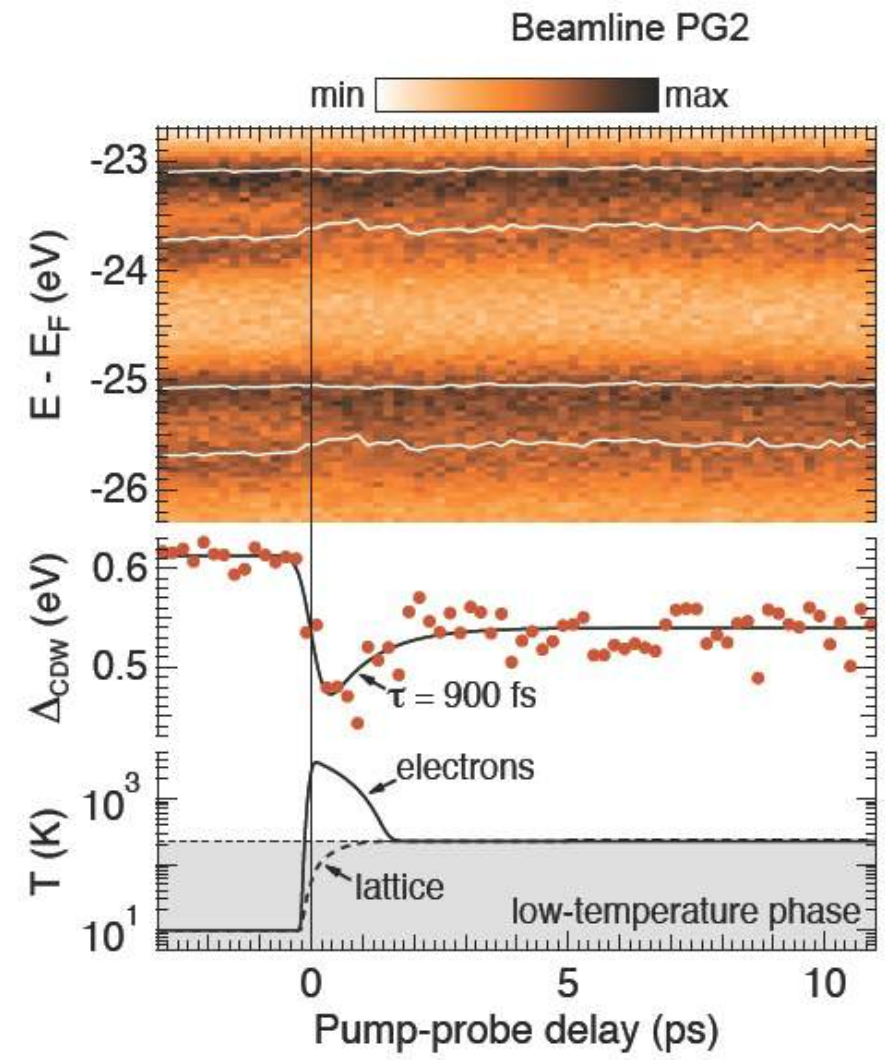
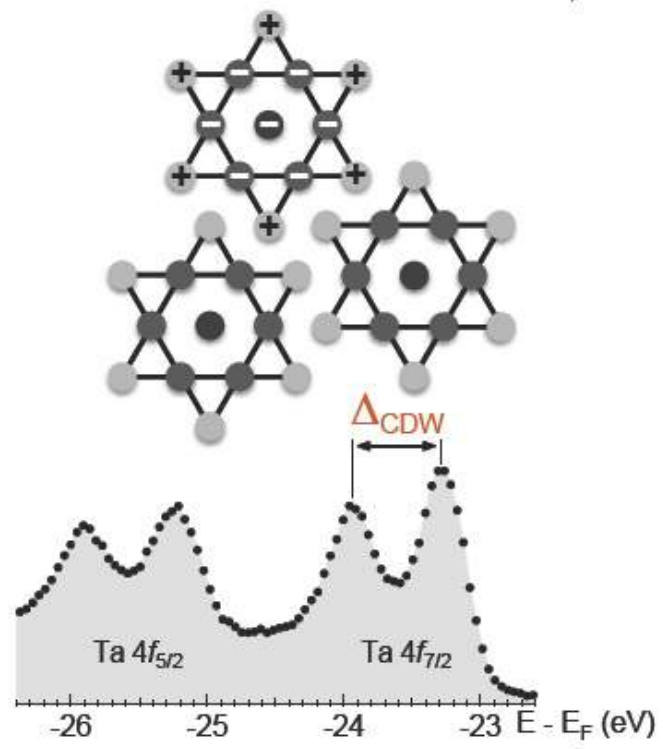
in collaboration with
W. Wurth's group (Hamburg)

1 $T\text{-TaSe}_2$: tr-XPS using FLASH

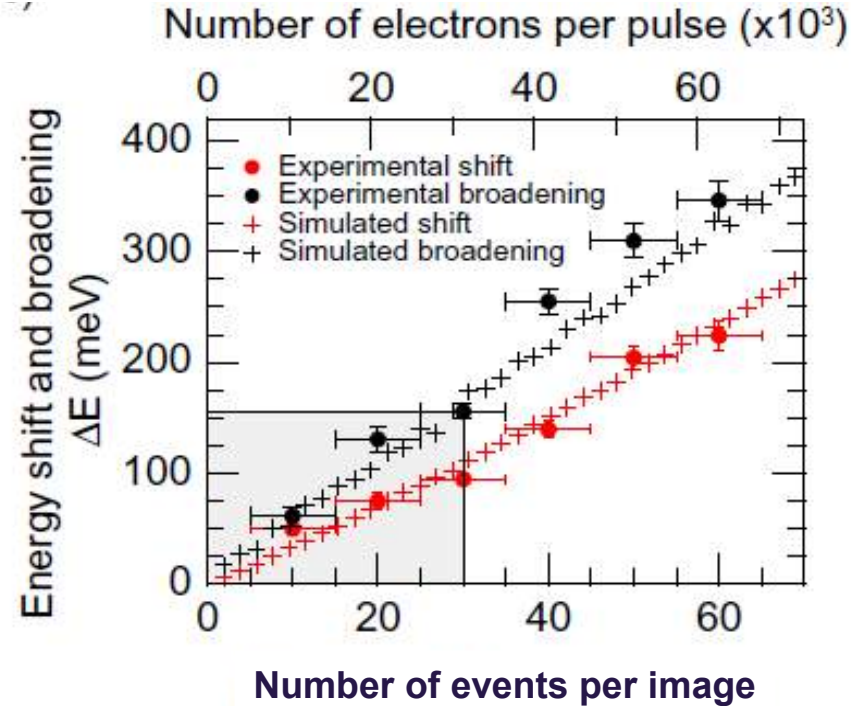
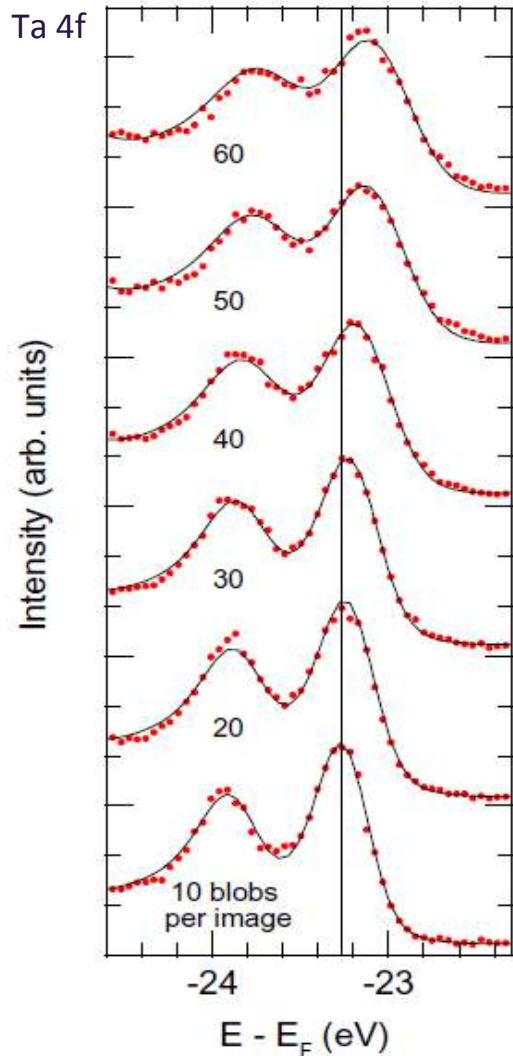
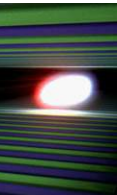


Beamline PG2

$T = 10 \text{ K}$
 $h\nu_{pump} = 1.55 \text{ eV}$. $h\nu_{probe} = 156 \text{ eV}$
 $\Delta E \approx 300 \text{ meV}$. $\Delta t \approx 700 \text{ fs}$
 $F = 1.8 \text{ mJ/cm}^2$



Hellmann et al PRL **105**, 187401 (2010)



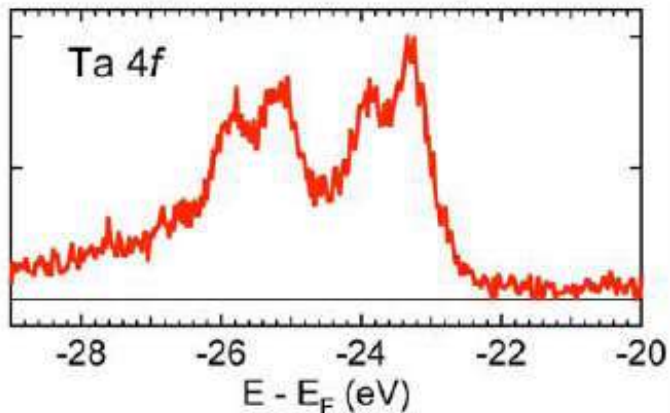
Poses physical limits on number of electrons per pulse
But can be controlled !

S. Hellmann et al.,
New Journal of Physics 14 (2012) 013062

- Energy resolution: **<100 meV**
- Time resolution: **<500 fs**
- Time per spectrum: **<10 min**

XPS

1T-TaS₂, $\hbar\omega = 115.5$ eV (3rd harm.)

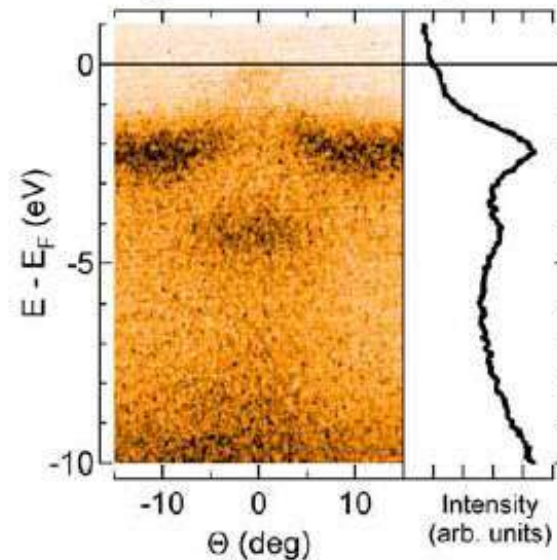


≈9 min

56347 pulses, 100 pulses/s (5 Hz)

ARPES

1T-TiTe₂, $\hbar\omega = 38.3$ eV (1st harm.)



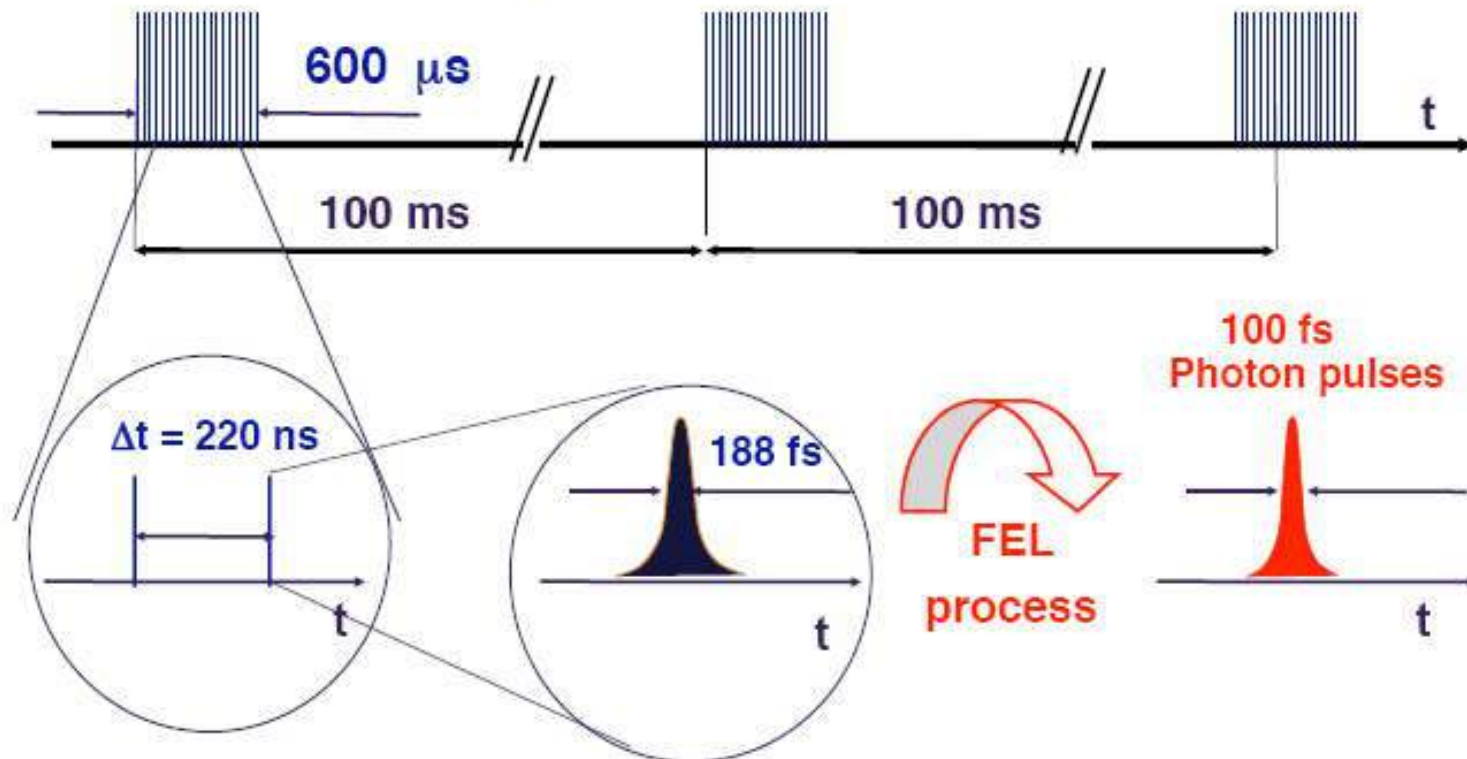
≈9 min

21440 pulses

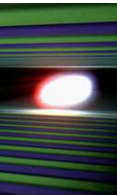
40 pulses/s

(2 Hz)

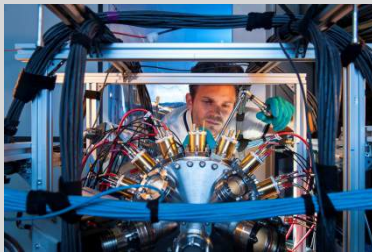
Electron bunch trains (with up to 2700 bunches à 1 nC)



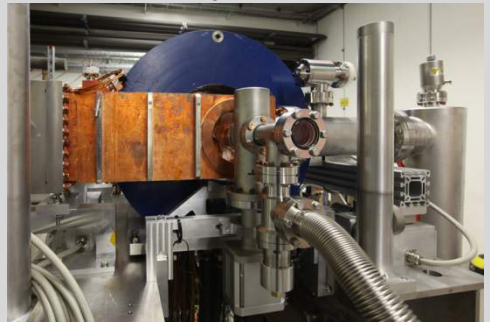
Superconducting LINAC technology provides 27.000 light pulses/s in burst-like structure. It makes XFEL.EU attractive for photon-hungry experiments.



Scientific instruments and instrumentation



Electron injector

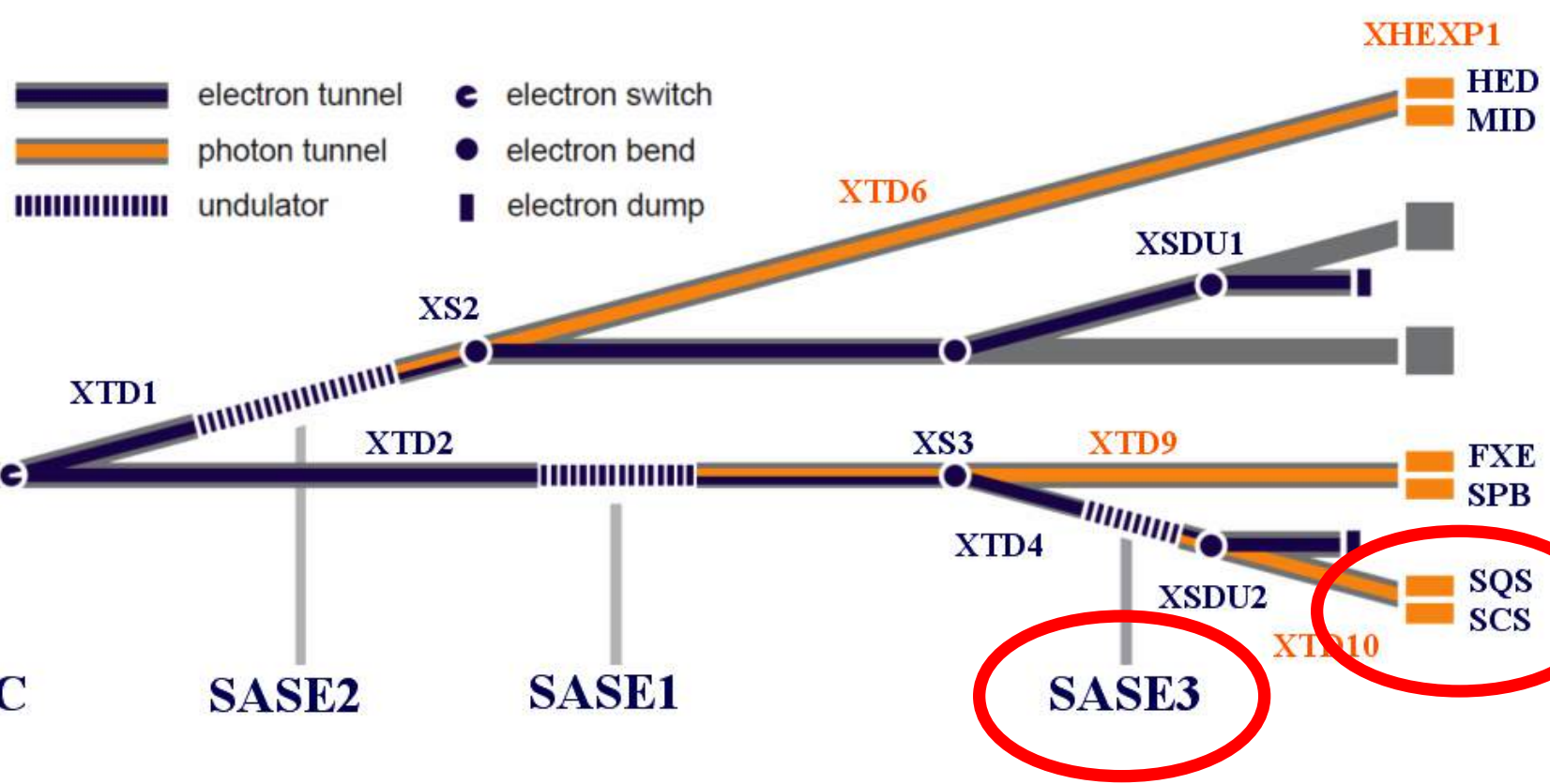
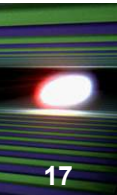


Undulator systems



Superconducting electron accelerator

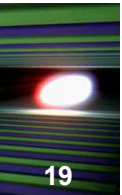




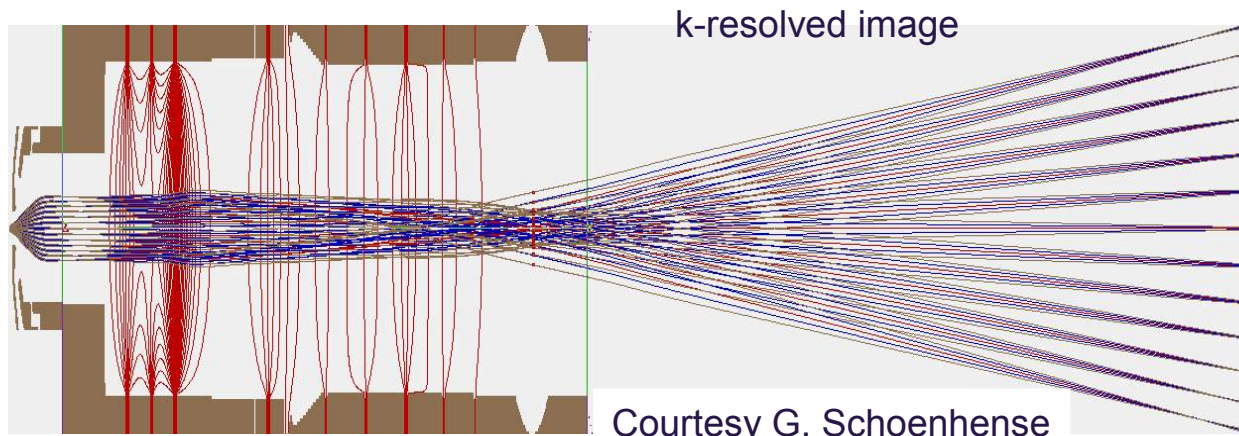
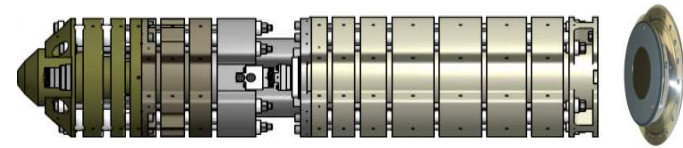
SCS: Spectroscopy & Coherent Scattering

User Consortium

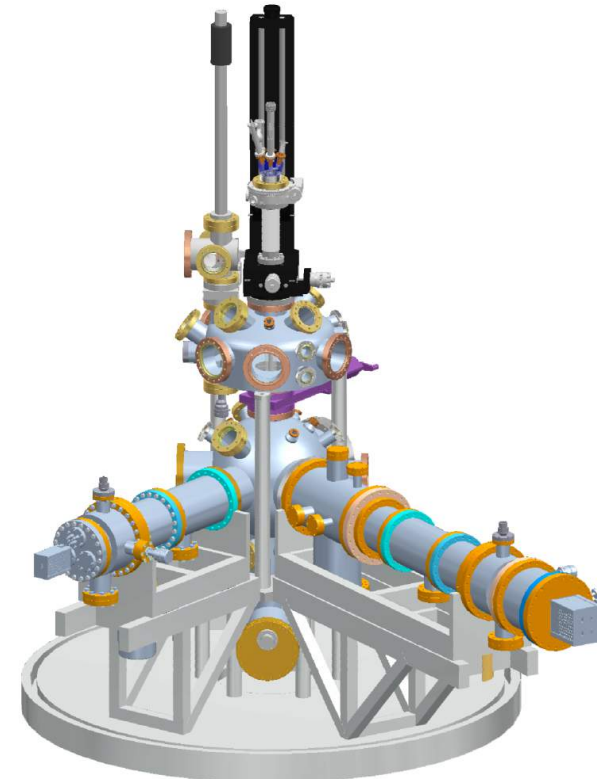
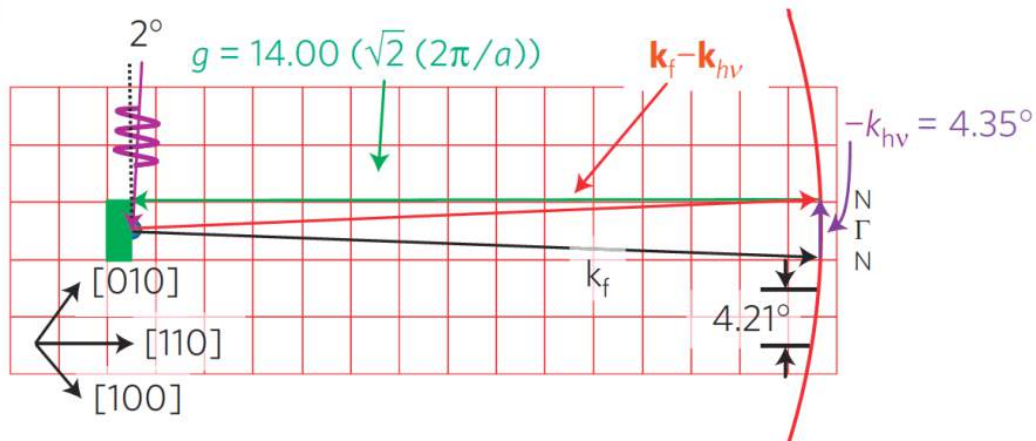
tr-XPS and tr-ARPES

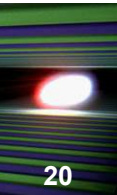


1000eV Start energy

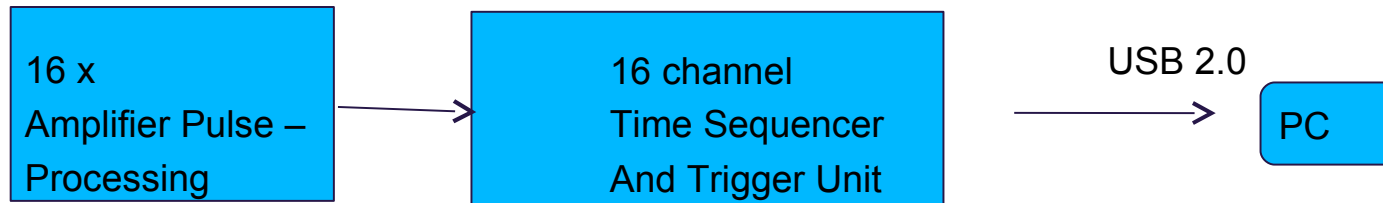
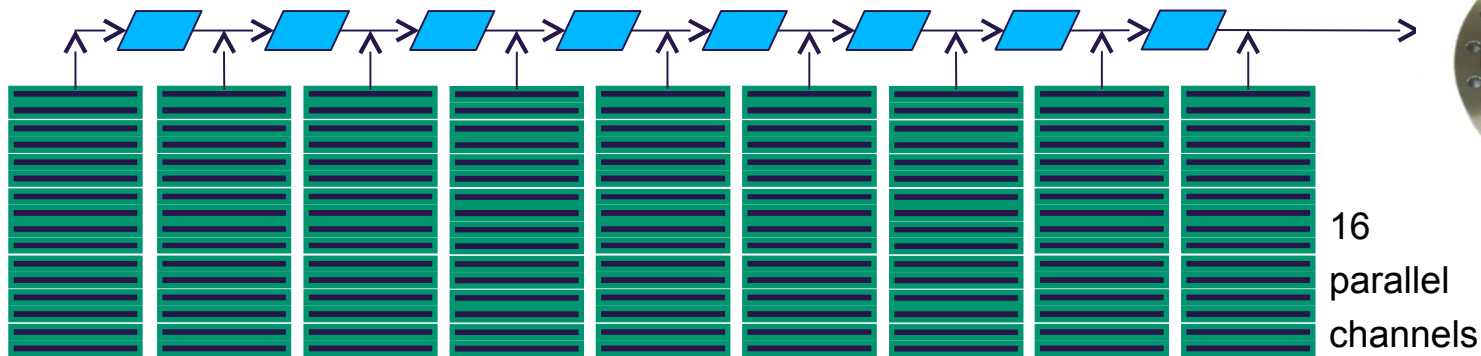


High angular resolution required for HARPES





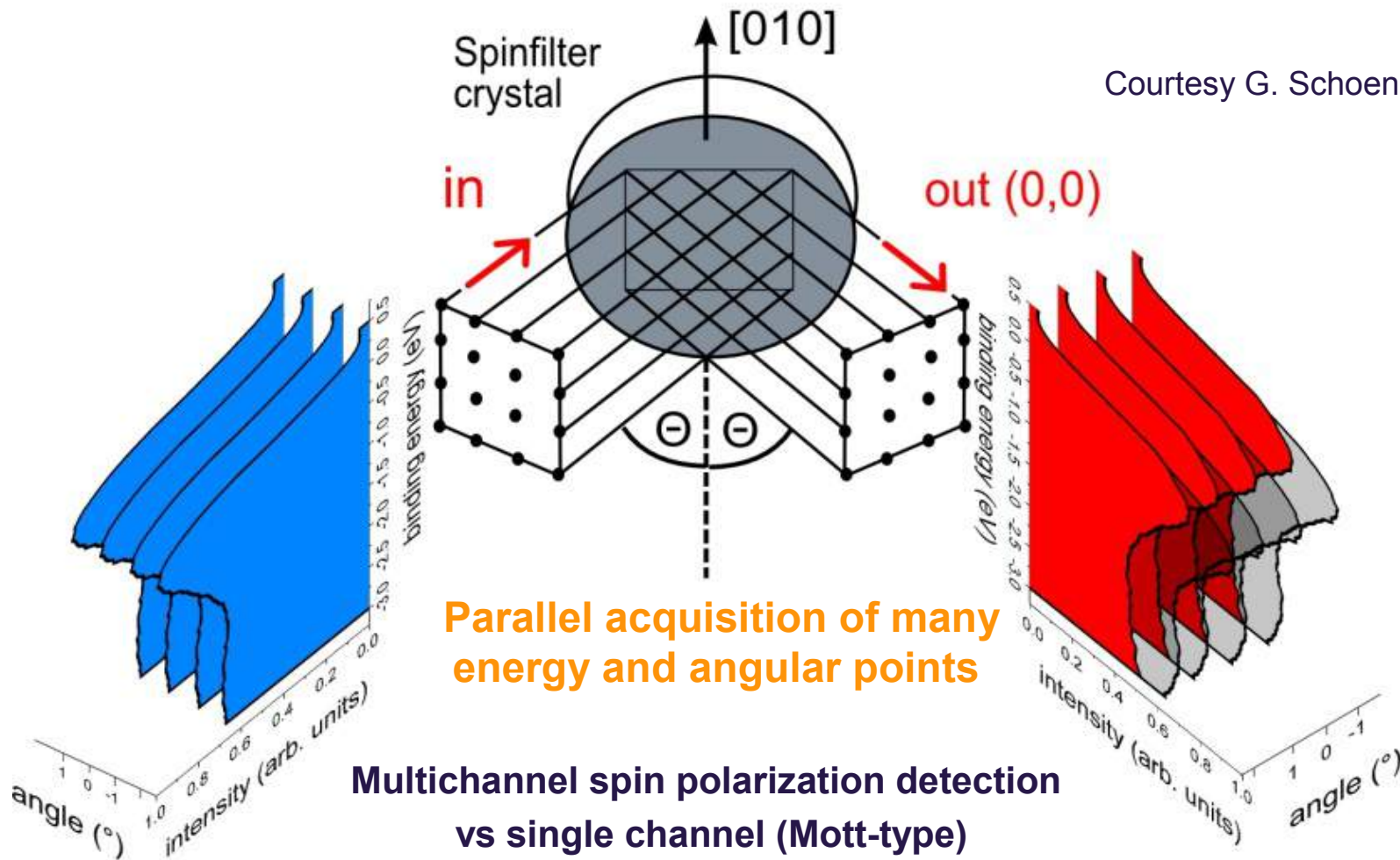
16 x 8 delays of 12 ns integrated into detector anode in vacuum



Trigger from/to FEL

256 (may be 512) channel DLD in development (BMBF project with CFEL/UHH)



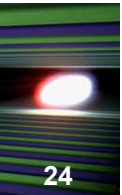


Courtesy G. Schoenhense

„Established“ for hemispherical analyzers – concepts for TOF spectrometers



















Together with DESY Photon Sciences Users' Meeting:
822 registered participants, of which:
388 from Hamburg (DESY, XFEL.EU, University, CFEL,..)
434 from elsewhere than Hamburg

**You are very welcome
to plan your experiments
at European XFEL**

Martin Weinelt
John Bowlan
Kristian Döbrich
Björn Frietsch
Martin Teichmann
Cornelius Gahl

Serguei Molodtsov

Andreas Scherz
Manuel Izquierdo

