



#### Wir schaffen Wissen – heute für morgen

## Priority SwissFEL experiments

#### **Bruce Patterson**



### SwissFEL specialties

Priority experiments
Biochemical structure and dynamics
Photochemistry in solution
Surface catalysis and artificial photosynthesis
Dynamics in nuclear materials
Switching in electronic materials
X-ray non-linear optics







## Phase-I ARAMIS endstations (2016-2017)

**ESA:** Multi-purpose pump-probe

**ESB:** Pump-probe crystallography

**ESC:** Coherent diffraction imaging





### Broadband mode

#### 4% FWHM bandwidth, using accumulated wake fields





#### Two-color pulses

chirped electron pulse, slotted spoiler in bunch compressor



Patterson, SLAC Tech. Rep (2010)



### Time vernier serial crystallography

vary XFEL timing  $\pm 5 \ \mu s$  to increase hit rate sub- $\mu m$  crystal detection with

"Second Order Non-linear Imaging of Chiral Crystals" (SONICC)



factor 100 reduced crystal usage



### High-field THz pump

generate single-cycle THz pulse with non-linear crystal



synchronized with XFEL gun and pump lasers magnetic switching, initiation of chemical reactions THz-streaking XFEL pulse arrival time diagnostic



### <sup>57</sup>Fe Mössbauer resonance

5 neV at 14.4 keV,  $\tau$  = 141 ns; 300 resonant photons/pulse requires 6 GeV and monochromator



#### background-free

pump pulse induces magnetic perturbation (quantum beats)

in a waveguide cavity: super-radiant Dicke state

Röhlsberger, Science (2010)

## 1. Biochemical structure and dynamics

What conformational changes are induced in GPCRs by binding to pharmaceutically important ligands?



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jet-injection nano-crystallography





ptychographic 2D-crystallography on cryo-stage

Kewish, NJP (2010)

pump-probe Laue crystallography



Schotte, Science (2003)



## 2. Photochemistry in solution

 To follow in real time the structural changes accompanying a biochemical reaction in solution.

photo-trigger:

caged molecules



instantaneous structure:

#### cross-correlation scattering



Pedrini, in press (2012)

## 3. Catalysis and artificial photosynthesis

How do the timescales for charge separation, trapping and transfer influence catalytic efficiency?

characterize short-lived intermediate states (fs – ns)



Rh 111

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Ichsanow, Chimia (2011)

single-shot *p-p* XANES / XES spectroscopy



# **4. Dynamics in nuclear materials**

Do molecular dynamics calculations correctly describe the development of defect cascades in irradiated steel?





With which phonon velocity does the electric polarization propagate in a switched multiferroic BiFeO<sub>3</sub>, and with what delay does the magnetization develop?



Bibes and Barthelemey, Nat Mat (2008)





Is stimulated RIXS efficient enough to allow ps time-resolved studies?







## Thank you for your attention.

