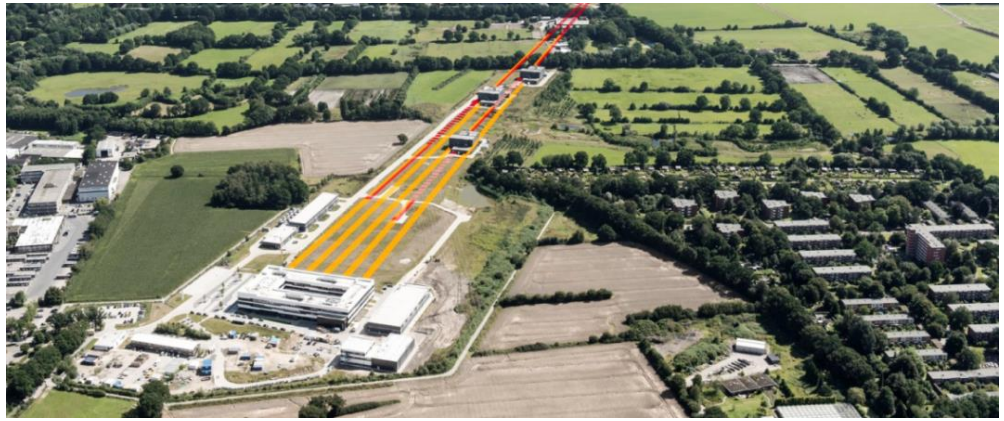
European XFEL

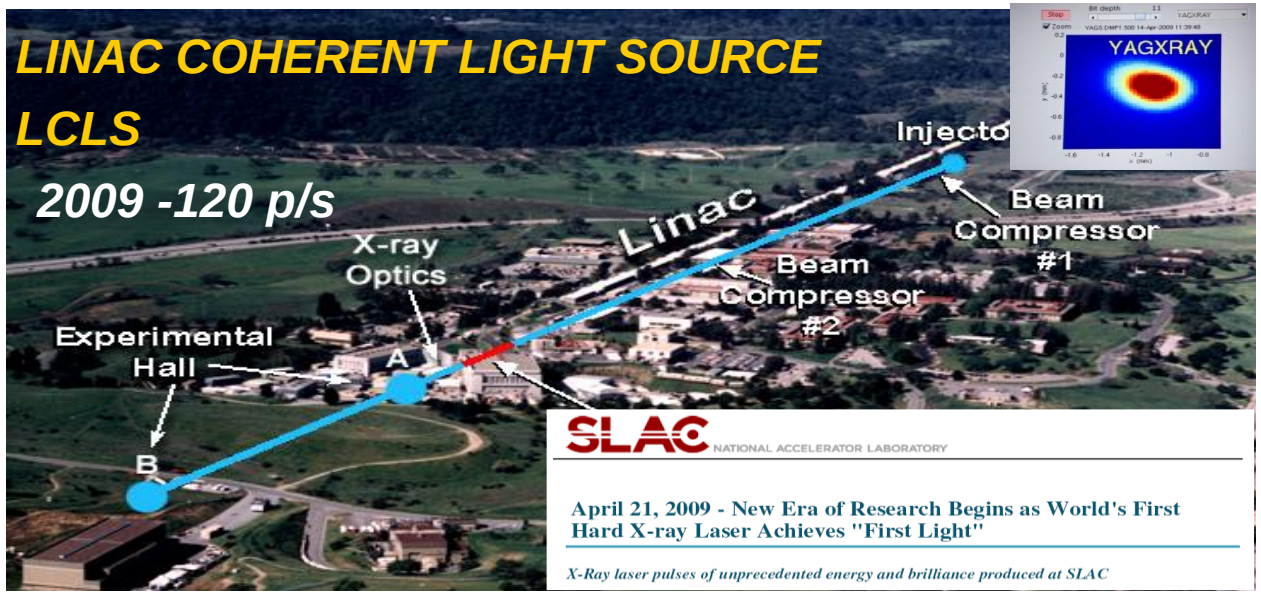
Prof. Christian Bressler
Leading Scientist

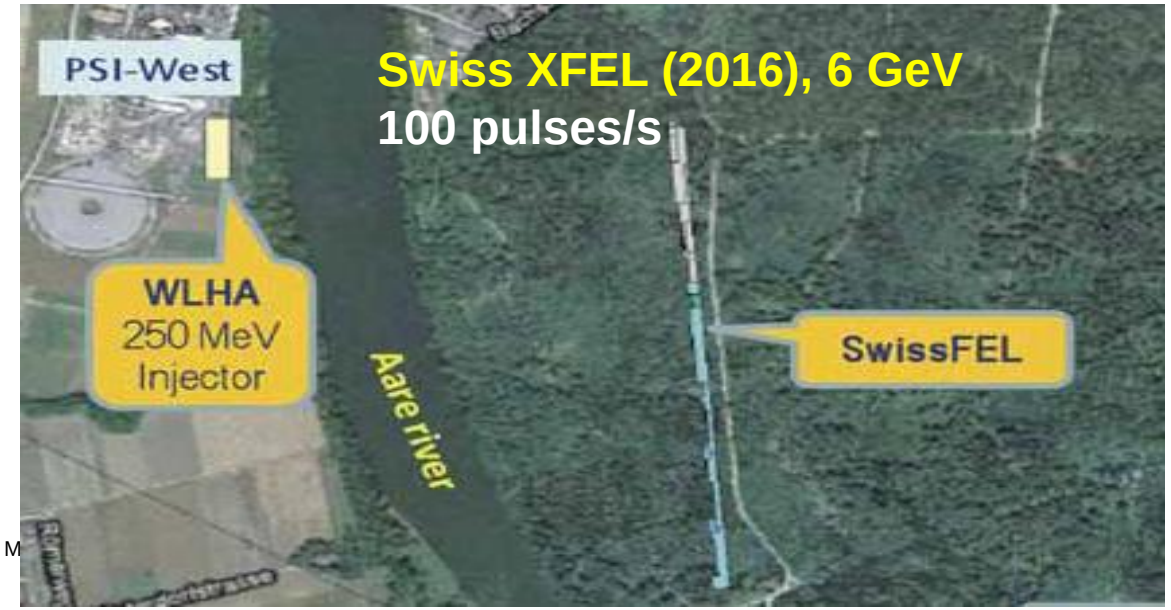
European XFEL

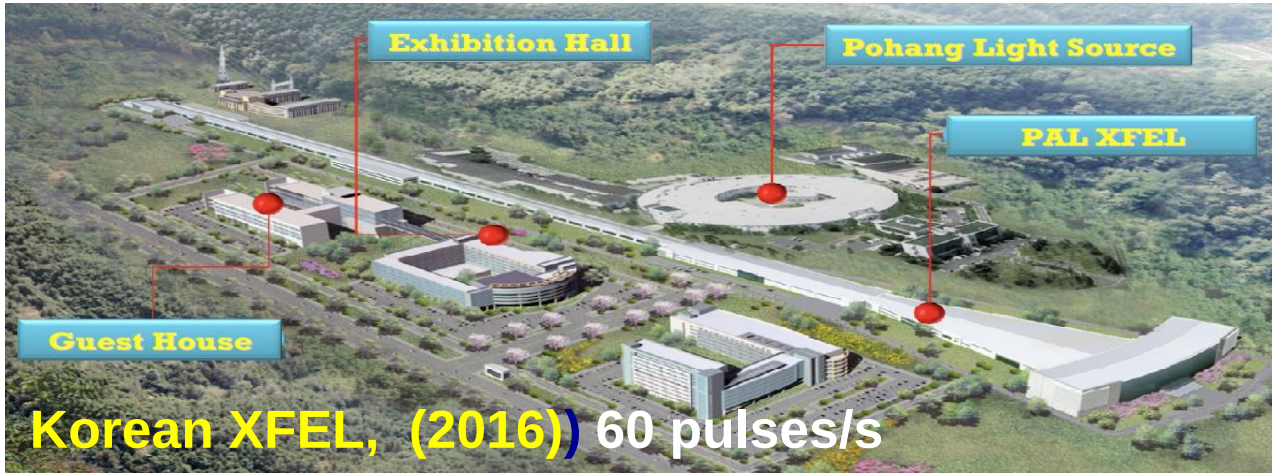


Management Board and Council Chair

The European XFEL in the International Context : Hard X-ray FELS







General layout of the European X-ray Free Electron Laser

Hamburg

Undulator/Photon Tunnels

Schenefeld

Osdo

Experiment Hall
in Schenefeld

We generate the strongest X-ray beam in the World

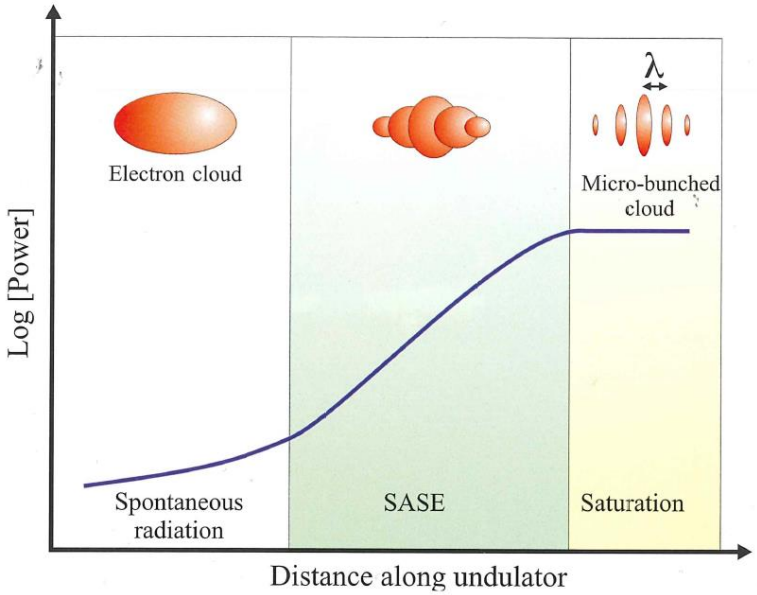
Injector at DESY
campus

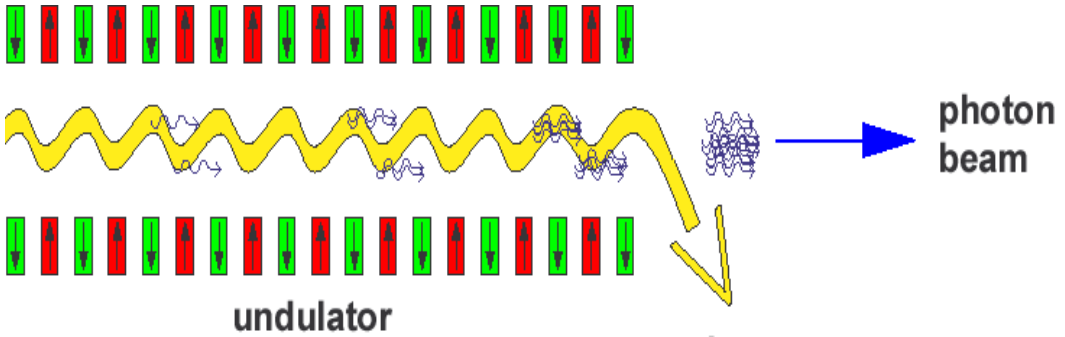
Linear Accelerator
1.9 km
17.5 GeV

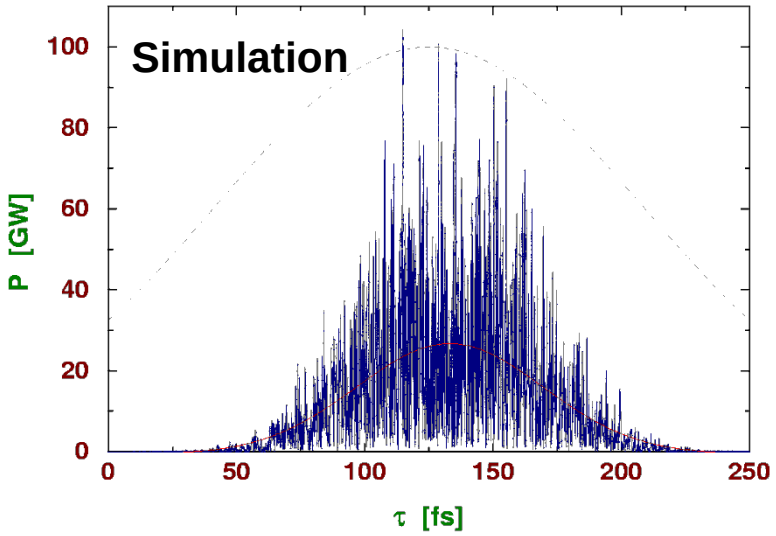
DE -Bahrenfeld

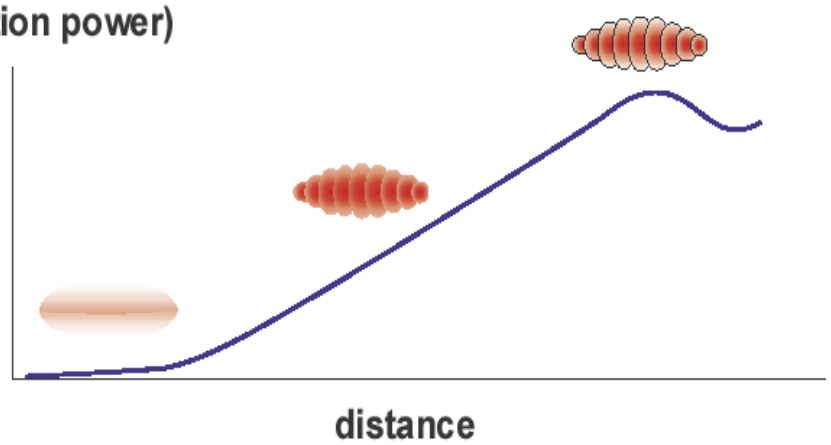
Lasing in one Pass : Self Amplified Spontaneous Emission (SASE)

Tightly collimated (low emittance) electron beam in a long undulator: coherent emission results from microbunching, produced by amplification of shot-noise density fluctuations at the resonant [illegible]s it progresses through the bunch.



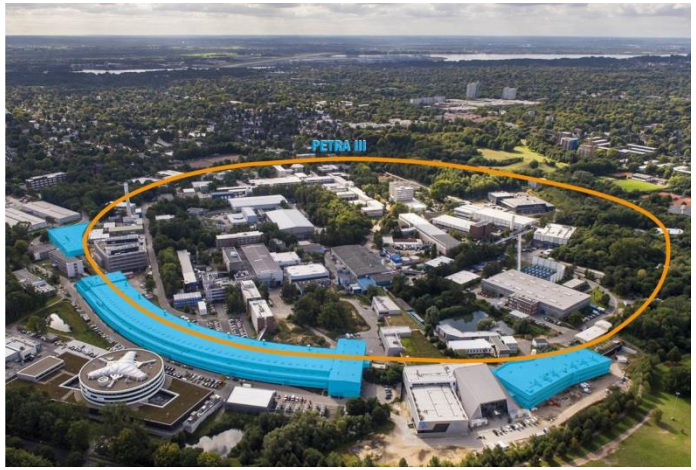


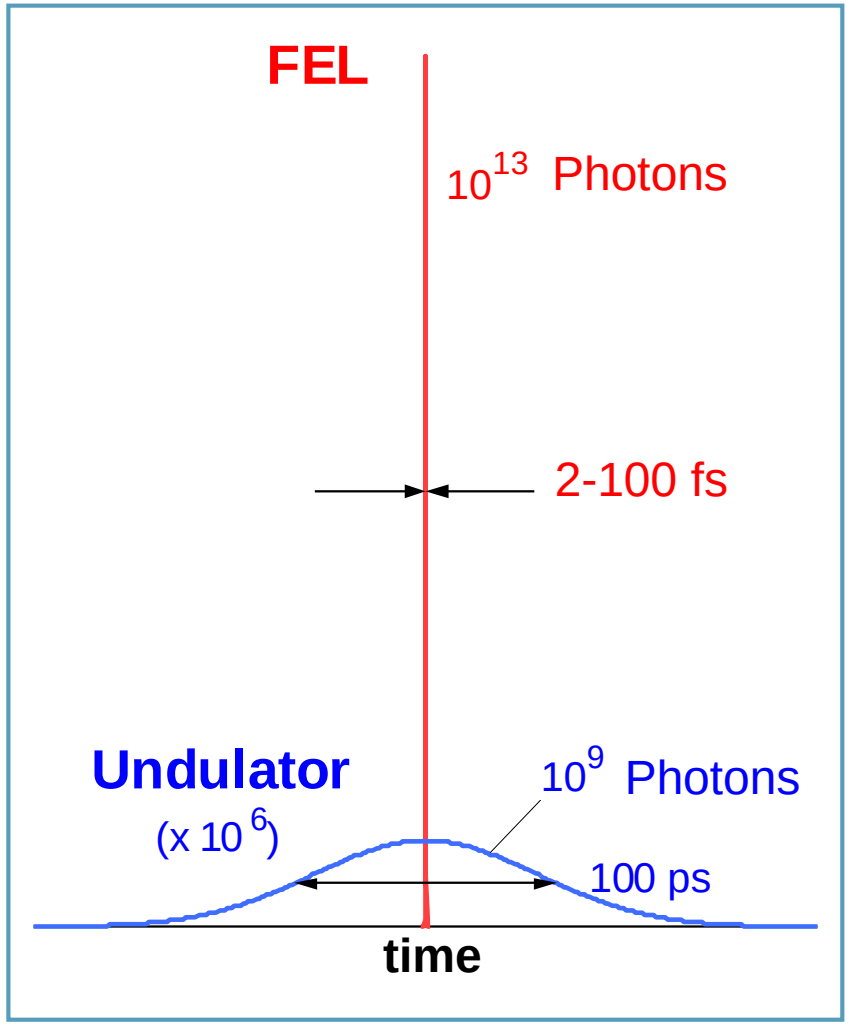




Kondratenko, Saldin (1979)
Bonifacio, Pellegrini, Narducci (1984)

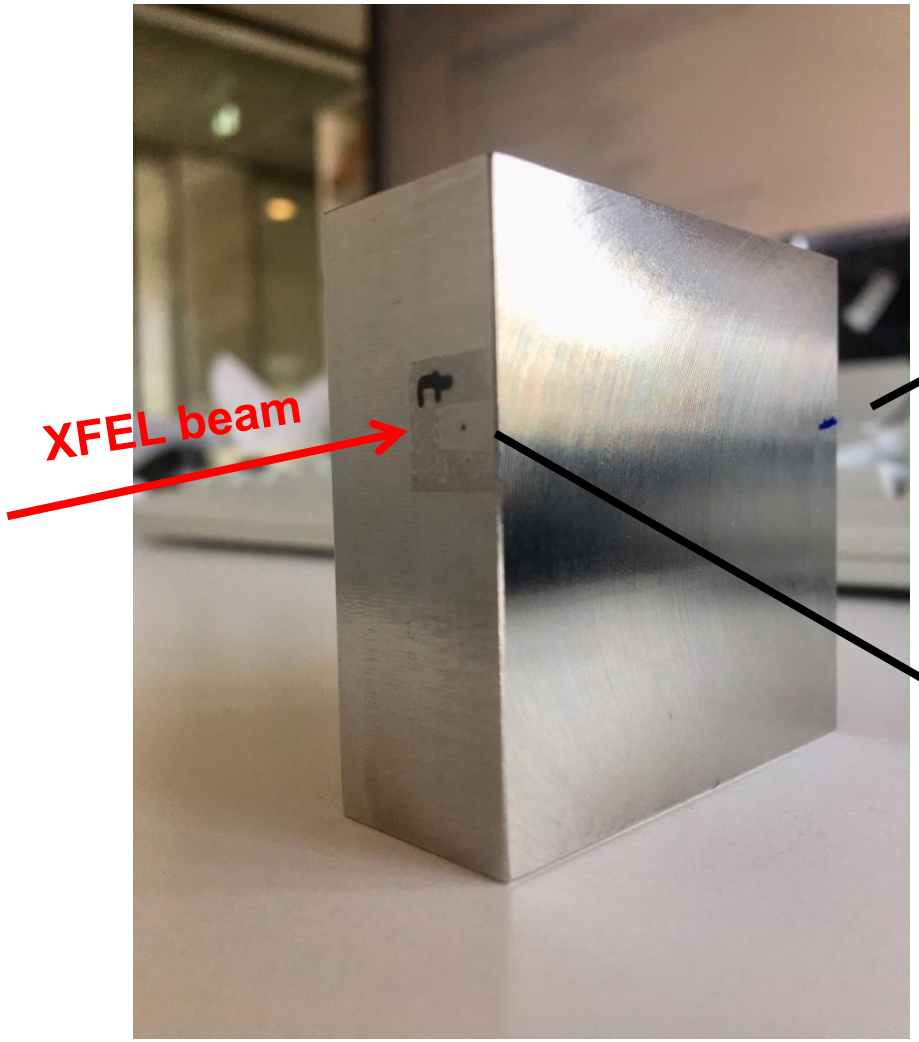
What is the difference between Synchrotron Radiation and X-ray Lasers?

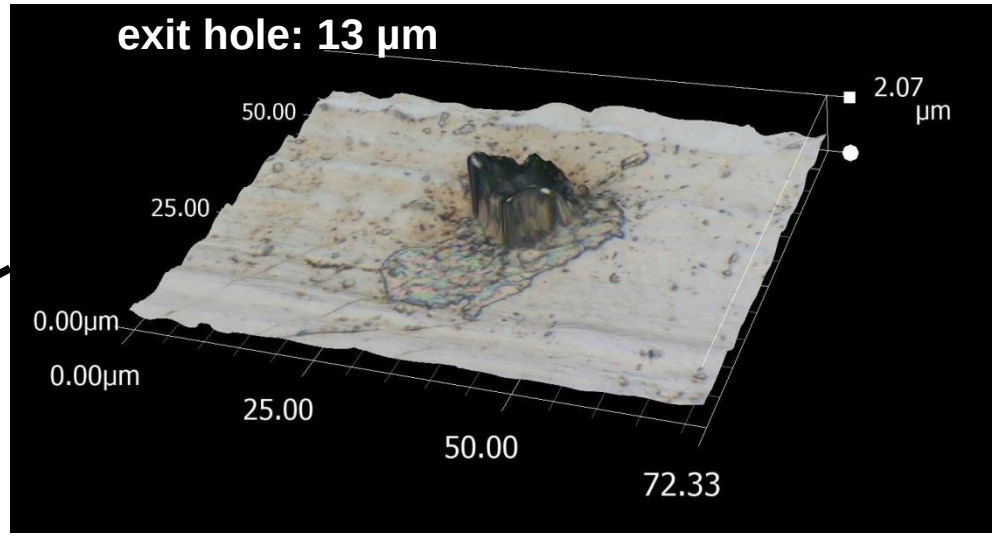


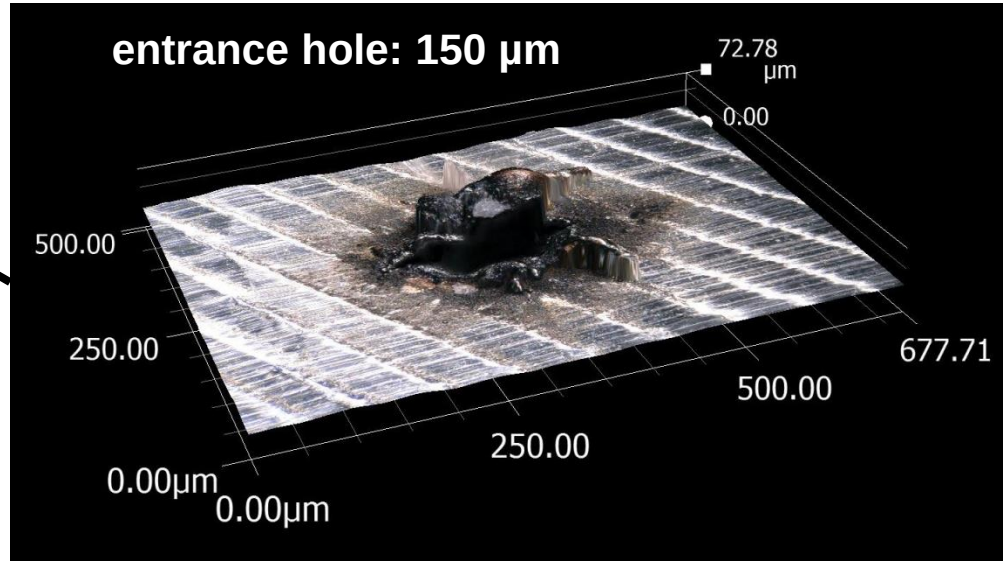


Courtesy Harald Sinn

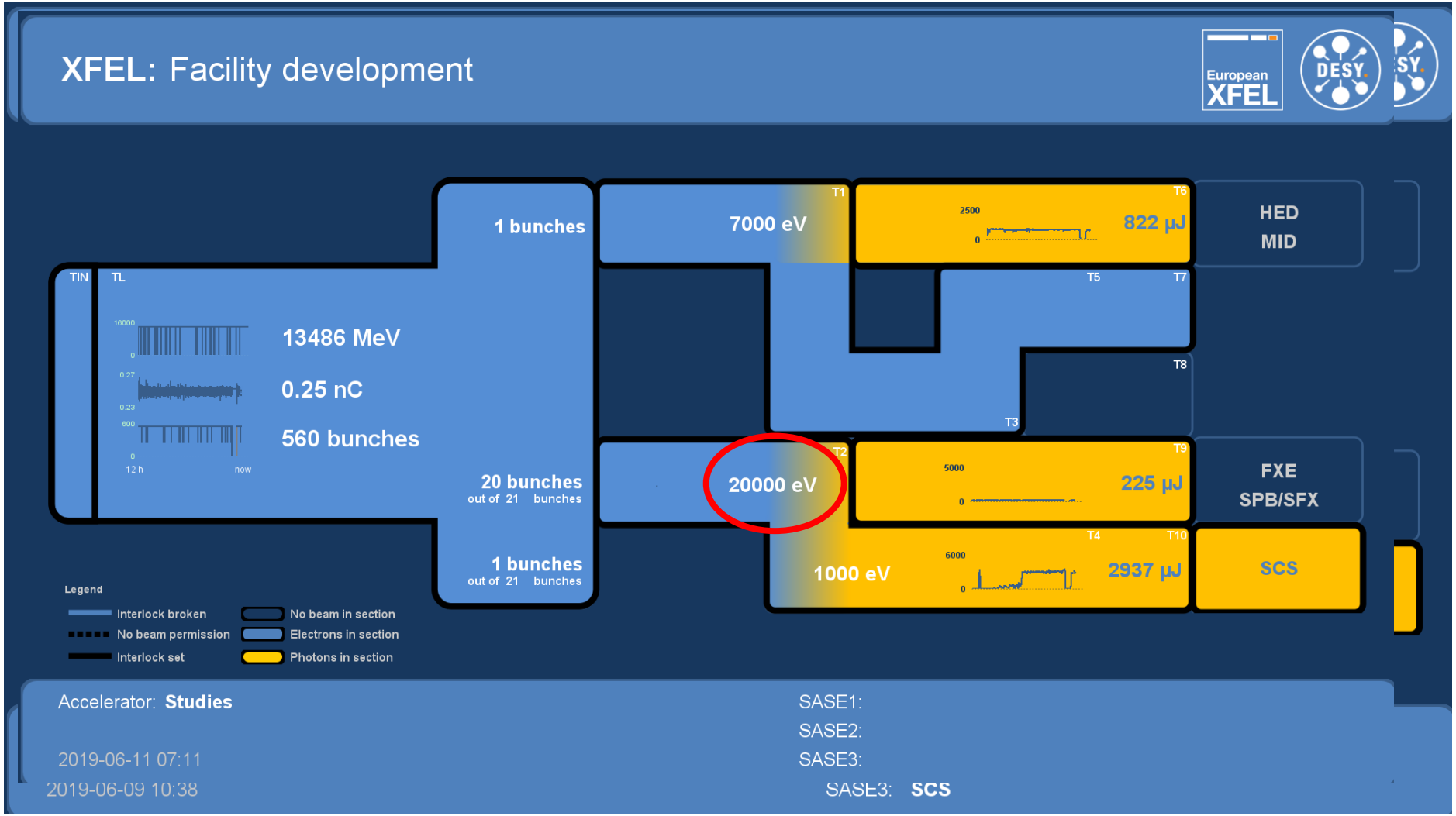
We have an exceptionally strong beam: Drilling with XFEL beam through 50 mm of steel in 26 seconds





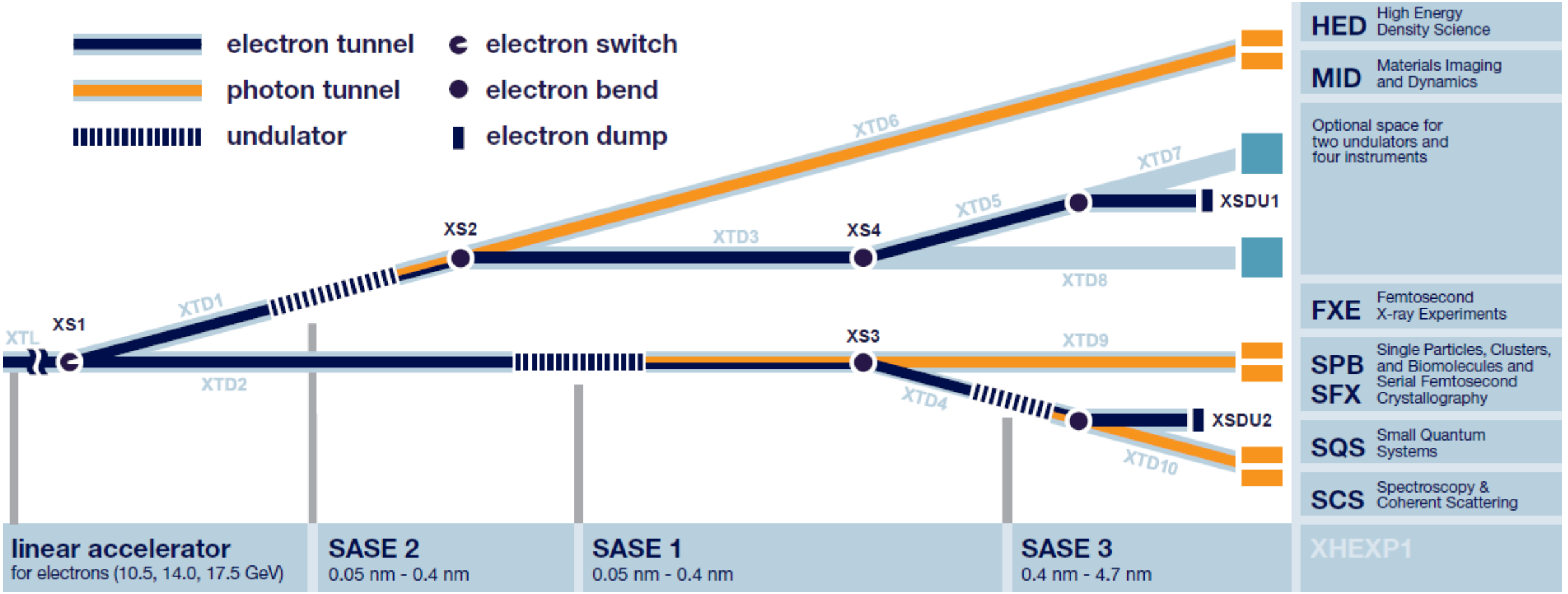


Screeshot Machine Status : Note the measurement is pulse energy

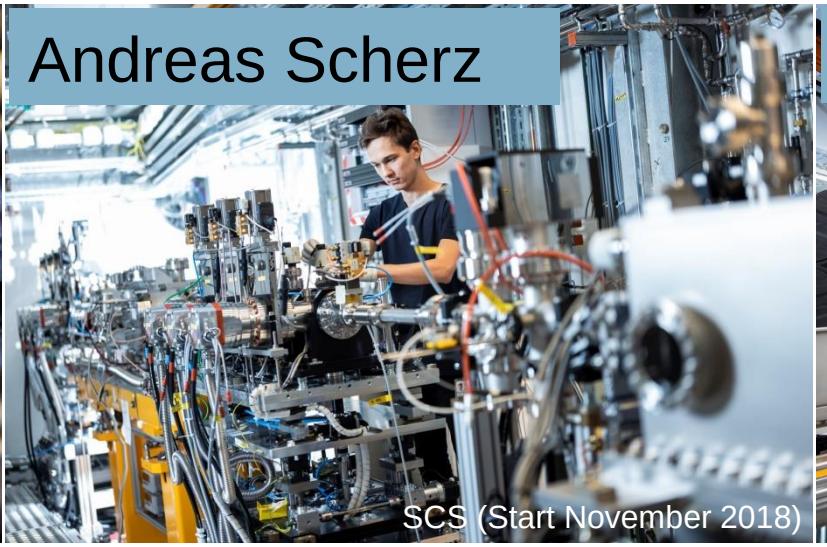


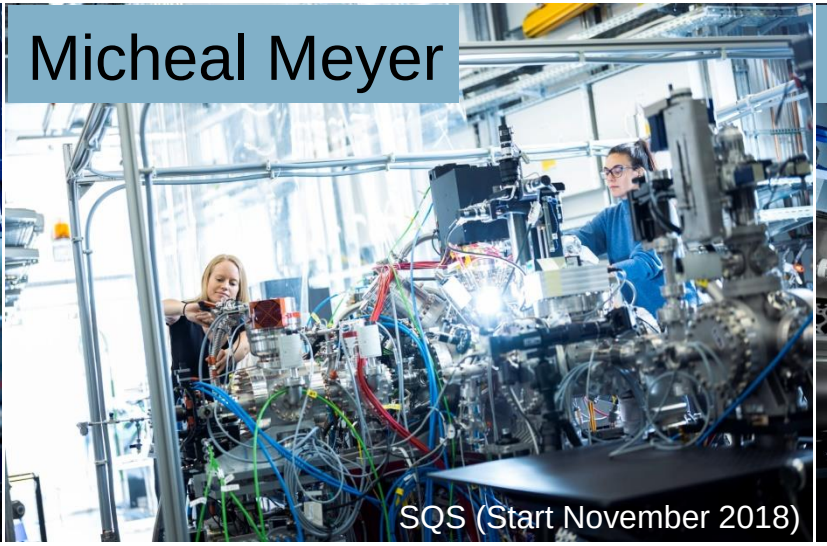
- Six Experimental Stations
- Typically running in 12 hour mode
- 3 Experiments run simultaneously

Experimental Hall



All six Instruments are in Users Operation





Scientific instruments

SASE1

FXE (Femtosecond X-ray Experiments)

- Ultrafast dynamics of liquids and solid matter
- Combination of spec. & scat. techniques

Team: D. Khakhulin et al.

SPB/SFX (Single Part., Bioimaging, & SFX)

- Coherent diffraction imaging from single part.
- Serial fs nano-crystallography

Team: A. Mancuso et al. / **SFX UC** (H. Chapman et al.)

SASE2

MID (Materials Imaging & Dynamics)

- CDI from nano-structured samples
- XPCS of nanoscale dynamics

Team: A. Madsen et al.

HED (High Energy Density science)

- Ultrafast dynamics of highly excited matter
- Combinations of scattering, diff. & spectroscopy

Team: U. Zastrau et al. / **HiBEF UC** (T. Cowan et al.)

SASE3

SQS (Small Quantum Systems)

- Ultrafast dynamics of atoms, ions & clusters
- Combination of spec. & coh. scat. techniques

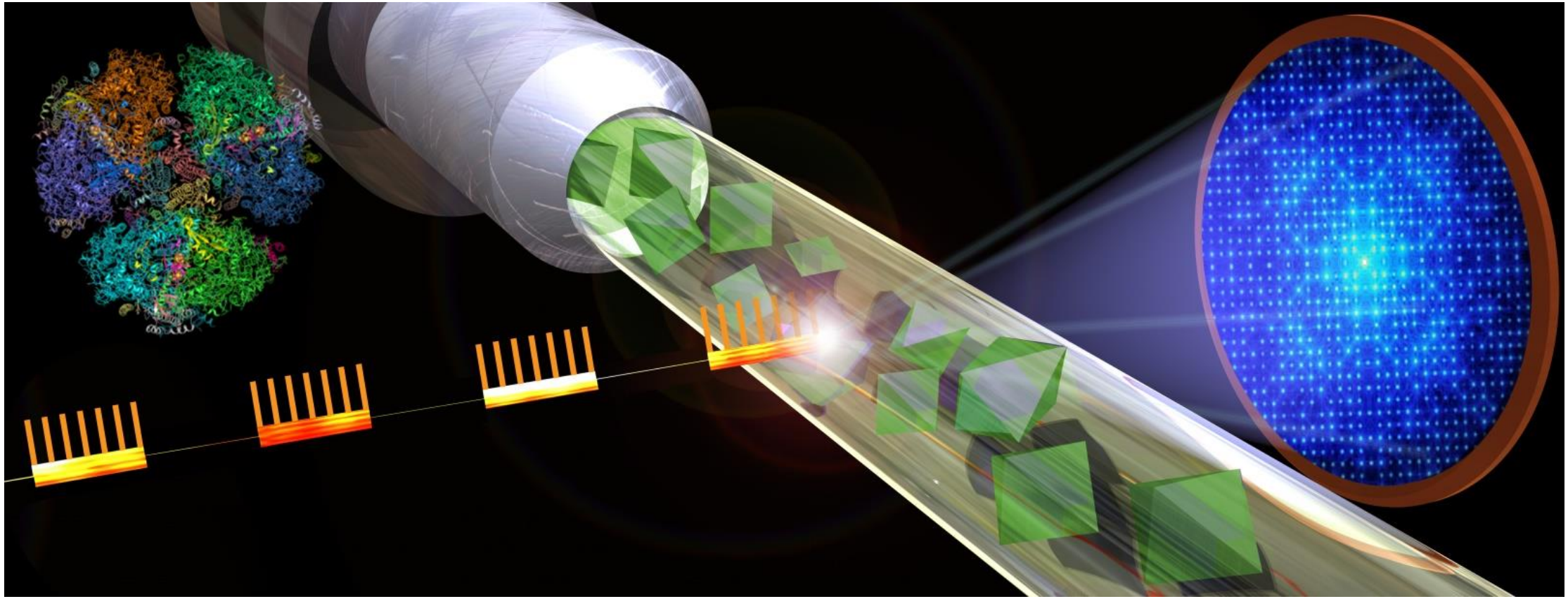
Team: M. Meyer et al.

SCS (Spectroscopy & Coherent Scattering)

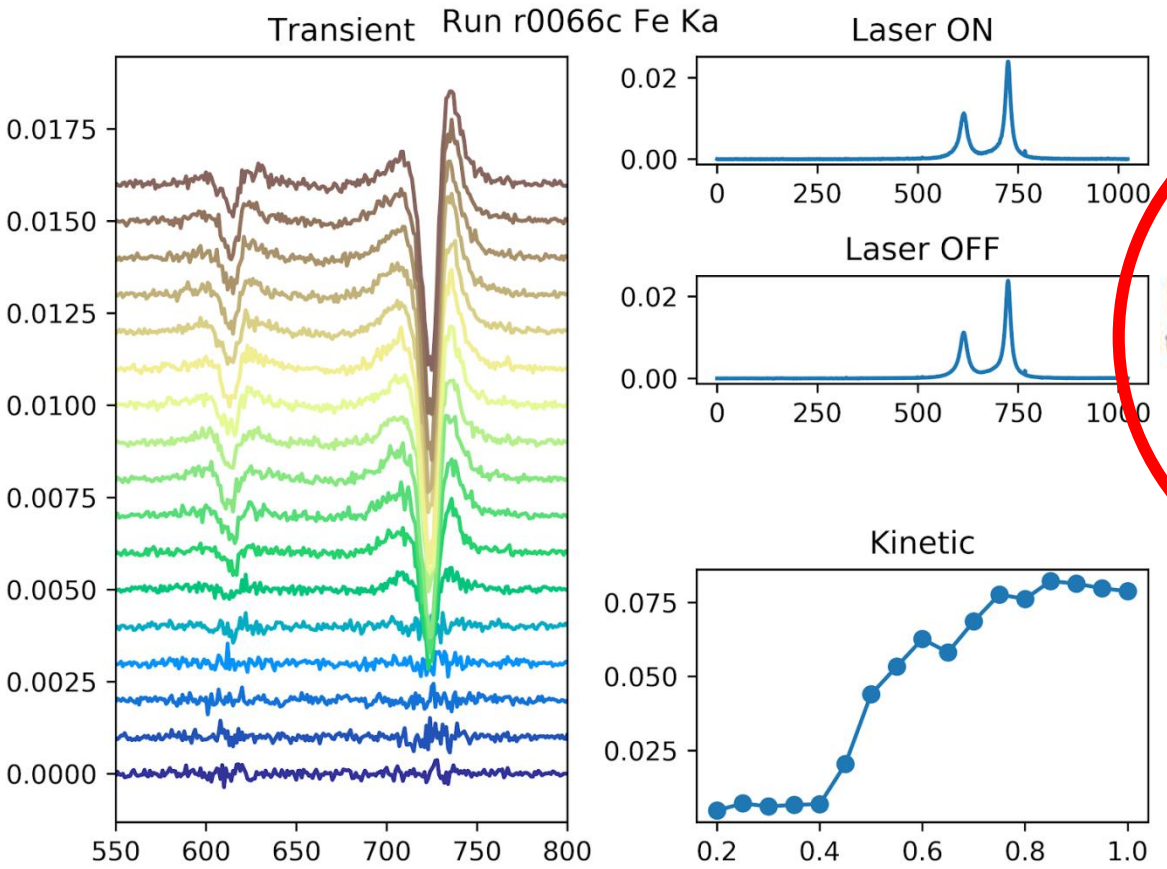
- Ultrafast dynamics of complex solids
- Combination of hr-inelastic spec. & coh.scattering

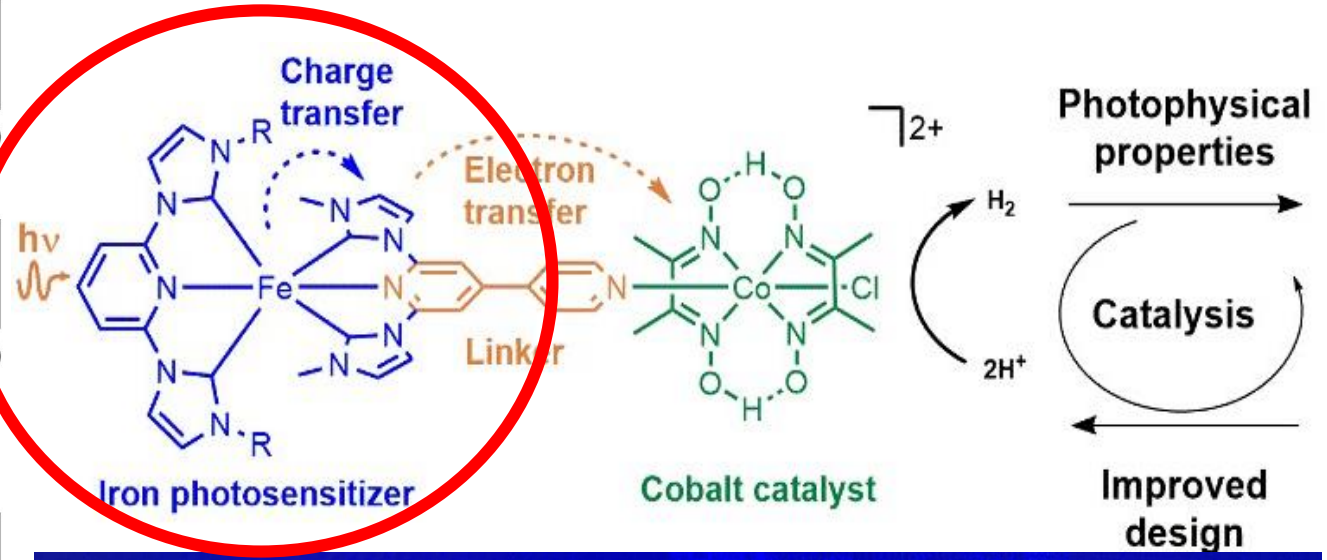
Team: A. Scherz et al. / **hRIXS** UC (A. Föhlisch et al.)

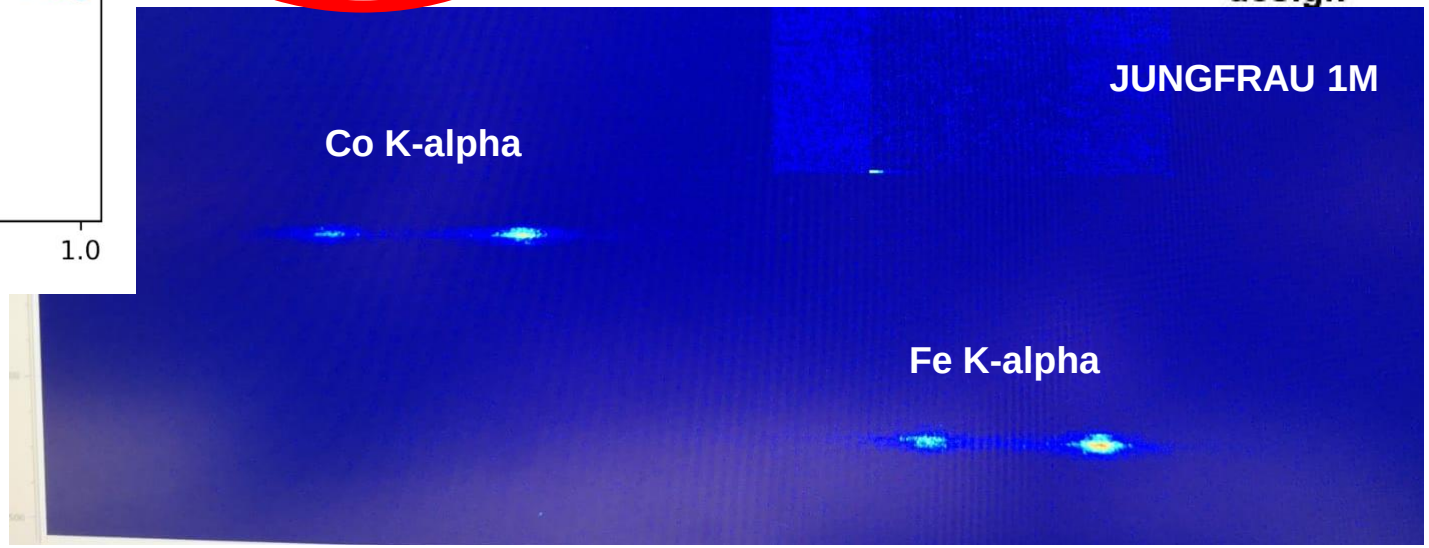
Experiments are typically done in a radical different manner



FXE: Recent User Experiment (Matthias Bauer, Uni. Paderborn)







nature COMMUNICATIONS

nature photonics

ARTICLES

https://doi.org/10.1038/s41566-020-0607-z

Check for updates

THE JOURNAL OF PHYSICAL CHEMISTRY Letters

The Journal of Chemical Physics

A MHz-repetition-rate hard X-ray free-electron laser driven by a superconducting linear accelerator

First Lasing Paper

The European XFEL is a hard X-ray free-electron laser (FEL) based on a high-electron-energy superconducting linear accelerator. The superconducting technology allows for the acceleration of many electron bunches within one radio-frequency pulse of the accelerating voltage and, in turn, for the generation of a large number of hard X-ray pulses. We report on the performance of the European XFEL accelerator with up to 5,000 electron bunches per second and demonstrating a full energy of 17.5 GeV. Feedback mechanisms enable stabilization of the electron beam delivery at the FEL undulator in space and time. The measured FEL gain curve at 9.3 keV is in good agreement with predictions for saturated FEL radiation. Hard X-ray lasing was achieved between 7 keV and 14 keV with pulse energies of up to 2.0 mJ. Using the high repetition rate, an FEL beam with 6 W average

W. Decking[1]✉, S. Abeghyan[2], P. Abramian[3], A. Abramsky[4], A. Aguirre[5], C. Albrecht[1], P. Alou[5], M. Altarelli[2], P. Altmann[1], K. Amyan[1], V. Anashin[4], E. Apostolov[6], K. Appel[2], D. Auguste[7], V. Ayvazyan[1], S. Baark[1], F. Babies[2], N. Baboi[1], P. Bak[4], V. Balandin[1], R. Baldinger[8], B. Baranasic[2], S. Barbanotti[1], O. Belikov[4], V. Belokurov[1], L. Belova[4], V. Belyakov[9], S. Berry[10], M. Bertucci[11], B. Beutner[1], A. Block[1], M. Blöcher[1], T. Böckmann[1], C. Bohm[12], M. Böhnert[1], V. Bondar[2], E. Bondarchuk[9], M. Bonezzi[11], P. Borowiec[13], C. Bösch[1], U. Bösenberg[2], A. Bosotti[11], R. Böspflug[1], M. Bousonville[1], E. Boyd[2], Y. Bozhko[1], A. Brand[1], J. Branlard[1], S. Briechle[1], F. Brinker[1], S. Brinker[1], R. Brinkmann[1], S. Brockhauser[2], O. Brovko[14], H. Brück[1], A. Brüdgam[1], L. Butkowski[1], T. Büttner[1], J. Calero[3], E. Castro-Carballo[1], G. Cattalanotto[5],

How to take part in the activities? (Apart from the current BSN initiative)

- Come to our Users Meeting in January (27-31 Jan)
  - Many parallel sessions at the users meeting
- Engage with European XFEL
  - Many specialized parallel workshops at the users meeting
  - Sabbatical
  - Joint PhD positions?
- Before writing a proposal
  - Contact one of the instrument scientists (**or contact me!)**
  - Discuss your idea with an instrument scientist
  - Investigate the possibility to join a (larger) community proposal initiative
  - Test sample preparation in our Bio laboratories (XBI)
- Write an appealing and exciting proposal
  - Proposal Review Panel consists of external Experts
  - Competitive: Rejection rates are rather high

HAPPY USERS in 2019