European XFEL

Prof. Robert Feidenhans'l
Chairman of the European XFEL Management Board

The European XFEL - a Status report

European XFEL

Prof. Robert Feidenhans'l
Chairman of the European XFEL Management Board

- Organisation
- From first lasing to first users
- First results
- Outlook

European XFEL Schenefeld *Photon Systems*

August 17 2017

- Schenefeld und Hamburg
- European User Facility for X-ray Science
- Start of operation: July 1. 2017
- First robust users 14. September 2017.

FP14

About the Europ

- Start 2009
- Task : Constructior
- Germany 58%, Ru
- DESY operates the
- Staff XFEL about 4
- Start of operation 1
  - 1,22 Mrd. € (20
  - 600 Mio € in ca
  - Yearly running costs 117,6 Mio € (2018)

Slide 4

FP14 Flaggenleiste mit HH und S-H? Gerade wegen letzterem.

Poppe, Frank; 30.01.2017

New organisational structure at European XFEL : 3 Divisions

Management Board

Administration | **Science** | **Operation & Development**

- Challenges to be met:

- We have to more efficient and use the resources better
- Review of the Operation Cost in 2019
- **From 2019 and onwards the operation cost will be fixed (apart from escalation)**

Goals for the coming 5 years

- We have to reach an acceptable work load for the Instruments
- We have to deliver 4000 hours/year of beamtime to the users for all 6 instruments
- We will offer new instrumentation to the users program
- We have to develope a vibrant R&D program
- We will work towards new instruments in SASE 4 and SASE 5

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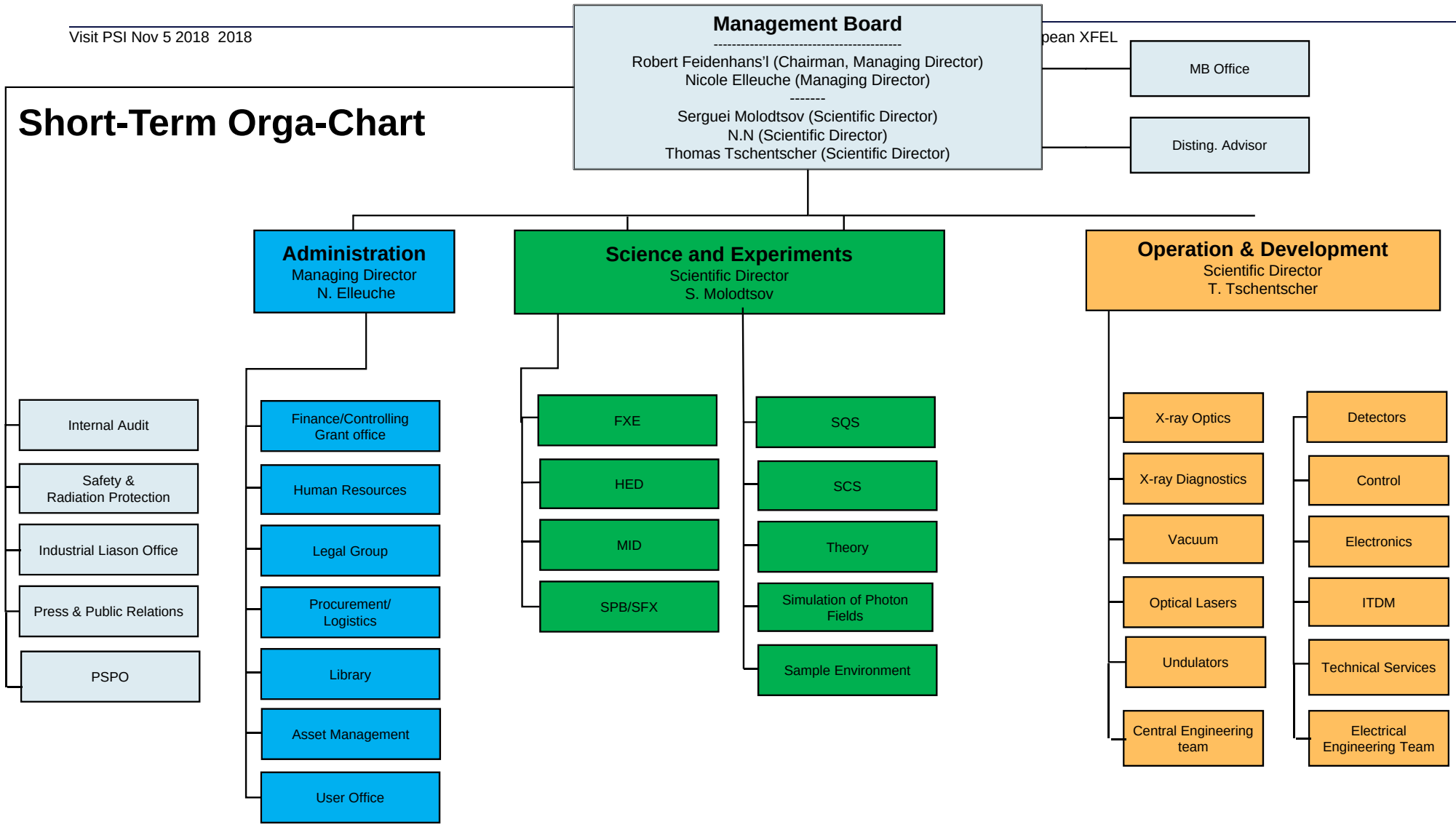
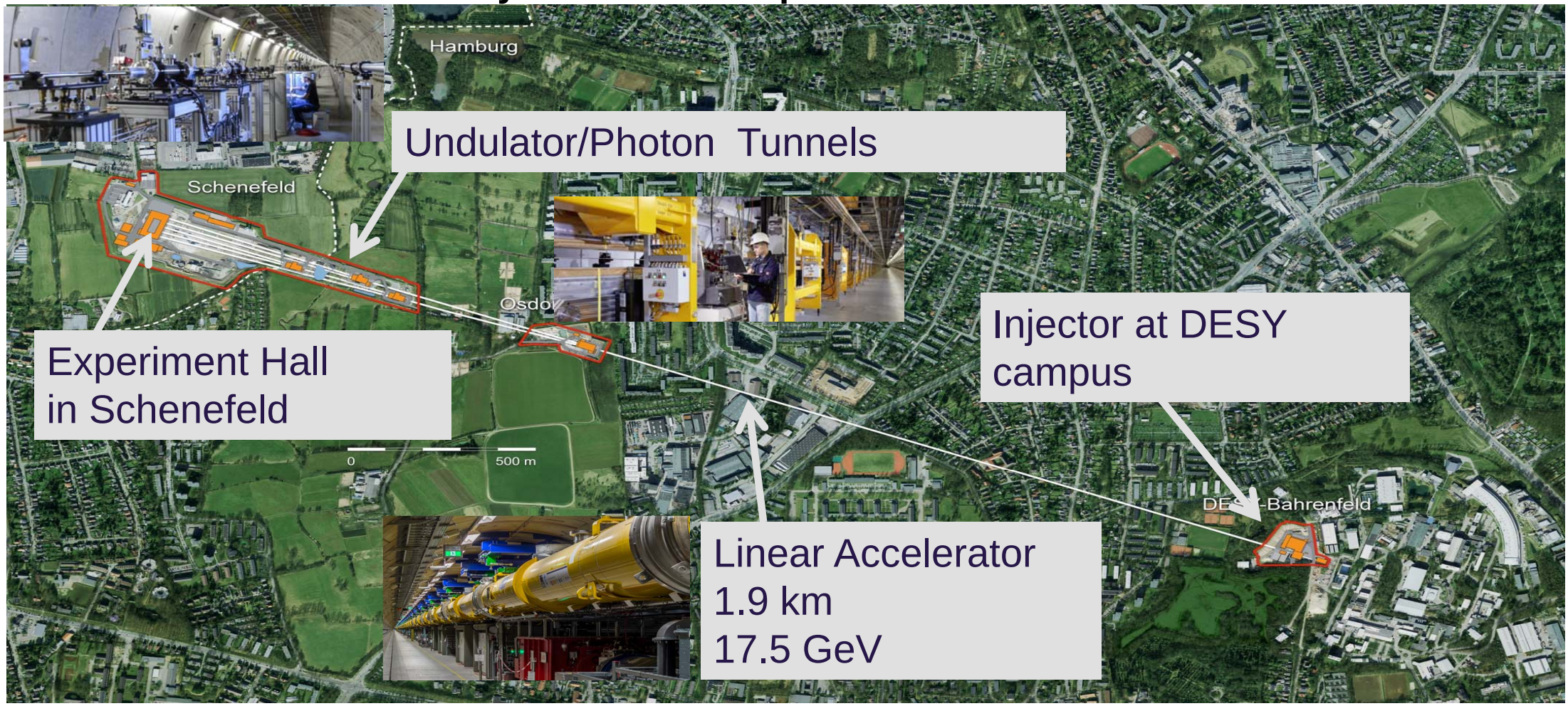
Short-Term Orga-Chart

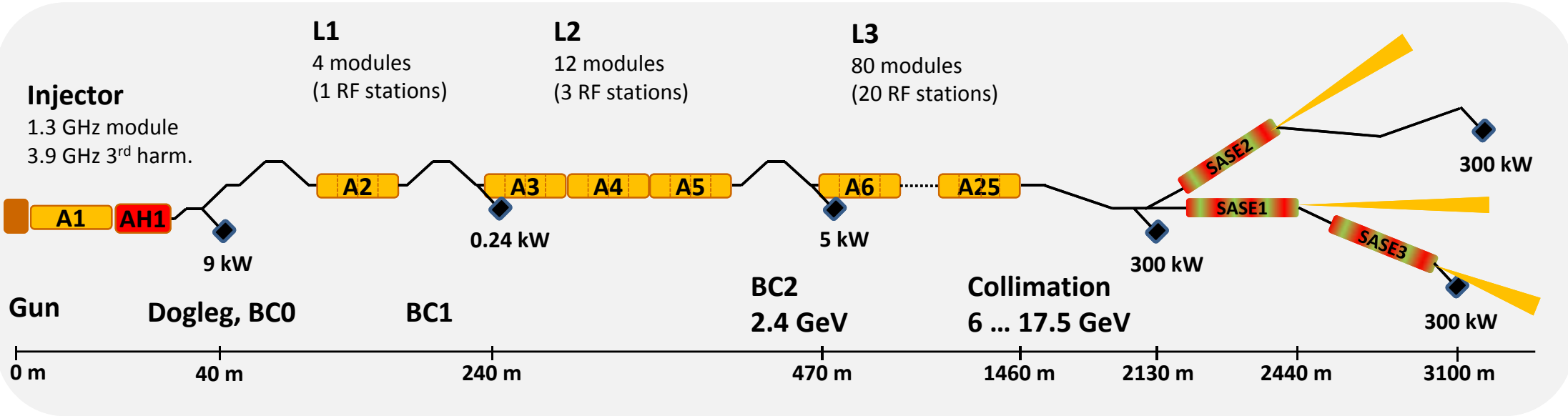


General layout of the European XFEL



Schematic accelerator overview









Courtesy Winni Decking

/svn/XFEL/Status/XFEL_FEL_StatusDisplay.xml ///

FEL May 2 : Simultaneous Lasing on all three SASE

Facility Development

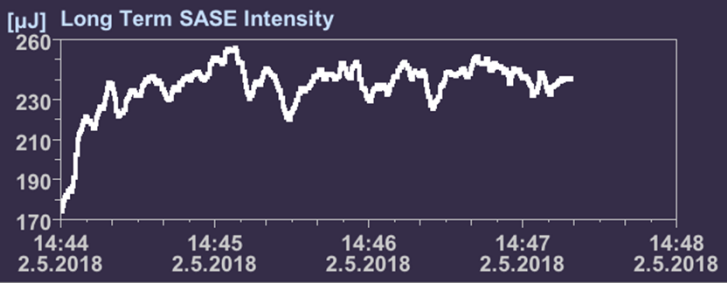
2018-05-02 14:47:20

XTD9 (SASE1) Beam Permission XTD6 (SASE2) Beam Permission

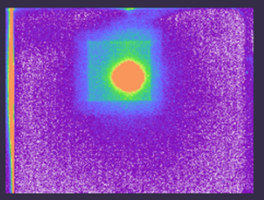
SASE 1

240.05 µJ NaN % @ 9.20 keV 1.35 Å

variation over last 500 trains

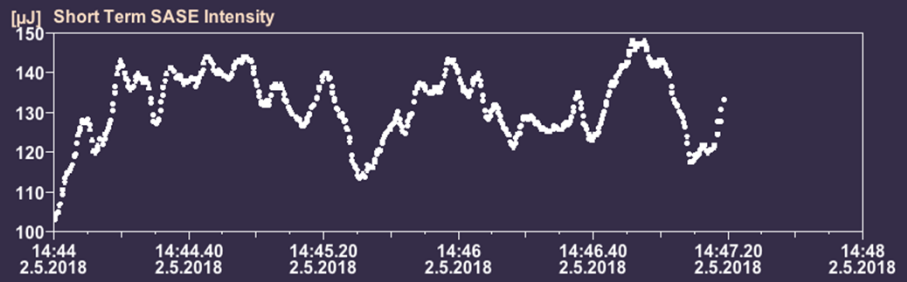


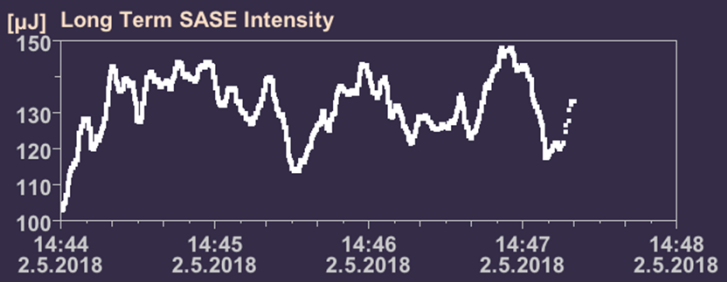
Beamview



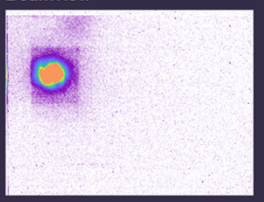
SASE 2

133.53 µJ @ 7.00 keV 1.77 Å





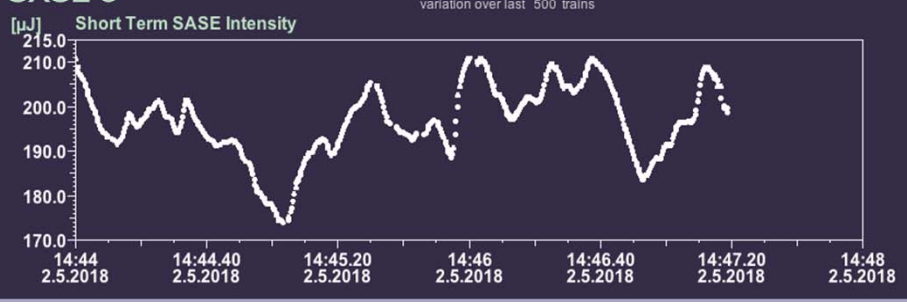
Beamview

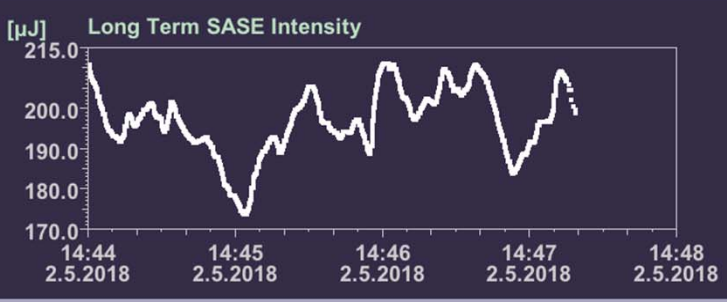


SASE 3

198.91 µJ NaN % @ 0.70 keV 17.71 Å

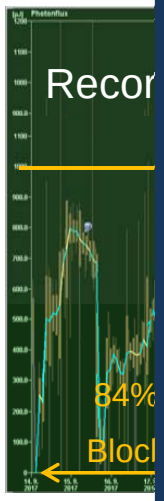
variation over last 500 trains

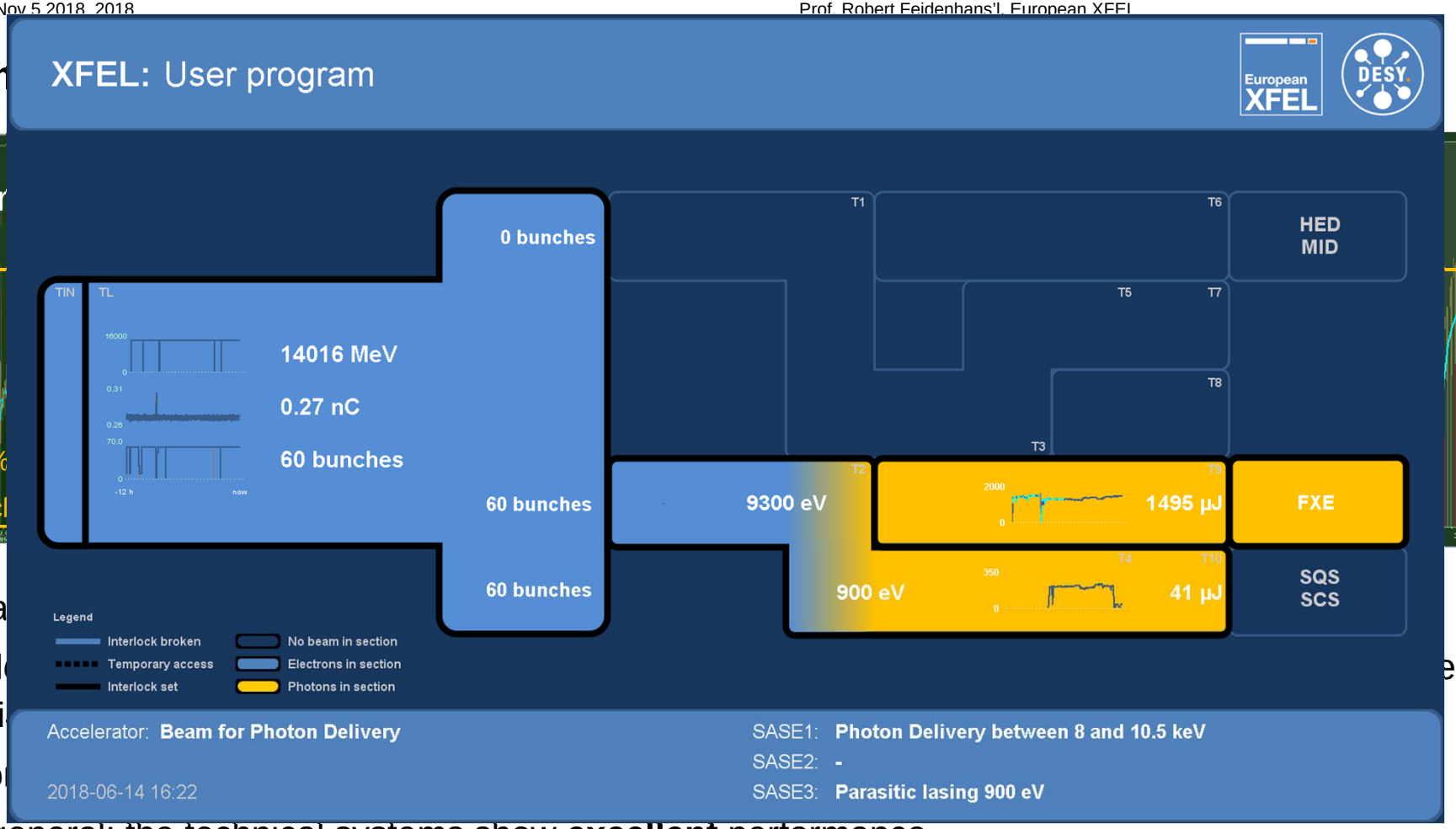


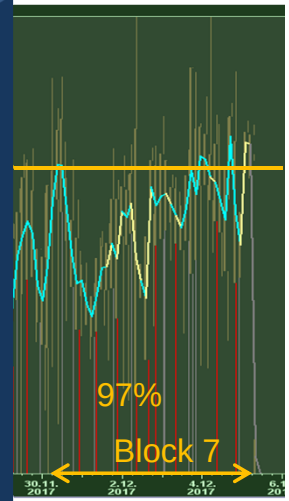


Beamview

Bean



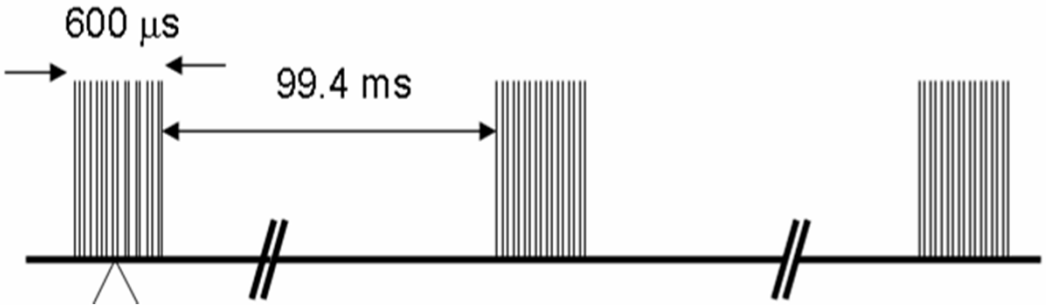




- Ava
- Littl es and vari
- Pro
- In general: the technical systems show **excellent** performance

Key parameters of European XFEL

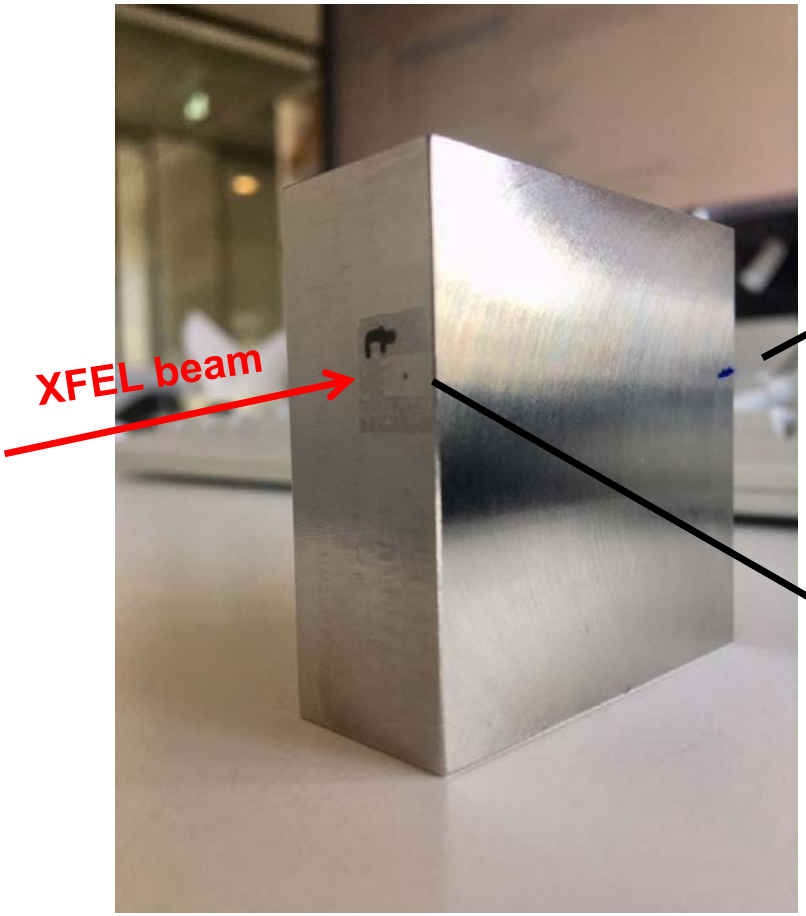
Parameter	Value
Electron Energy	8.5 – 17.5 GeV
Photon energy	0.26 - >25 keV
Pulse duration	2 – 100 fs
Seeding	In preparation
# of pulses	27000 /s
# of FELs	3
# of instruments	6
Start of operation	2017

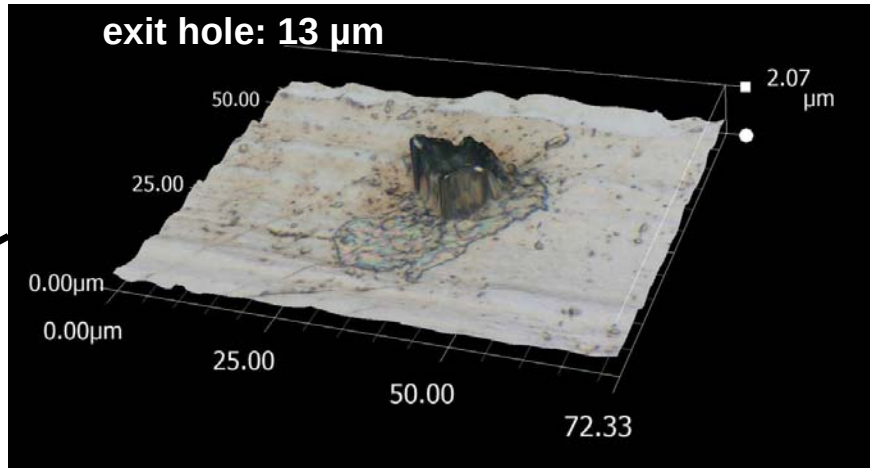


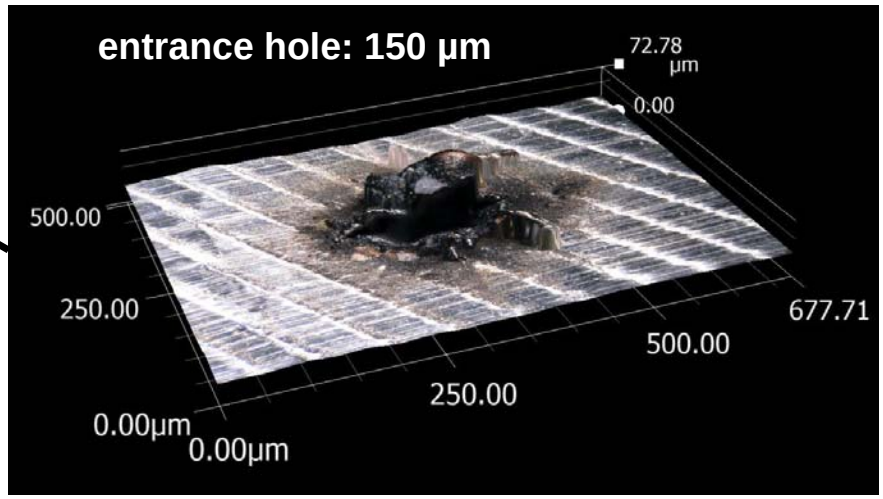
- Specific electron & x-ray beam delivery pattern
  - Follows from pulsed RF system
  - Trains of e-/x-ray pulses
  - Max. = 2.700 per train / 27.000 per sec
  - High average brilliance
  - Feedback & time and space stabilization
  - Dedicated pulse delivery

Courtesy Harald Sinn

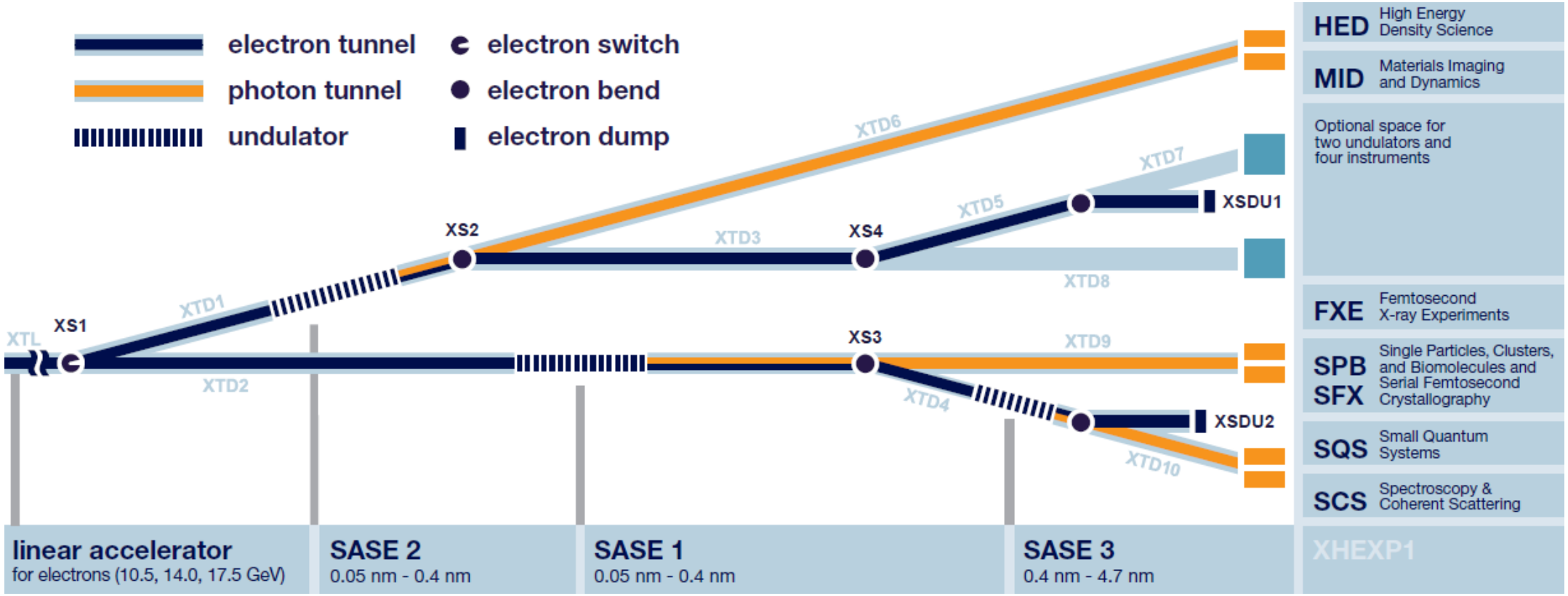
We have an exceptionally strong beam:
Drilling with XFEL beam through 50 mm of steel in 26 seconds





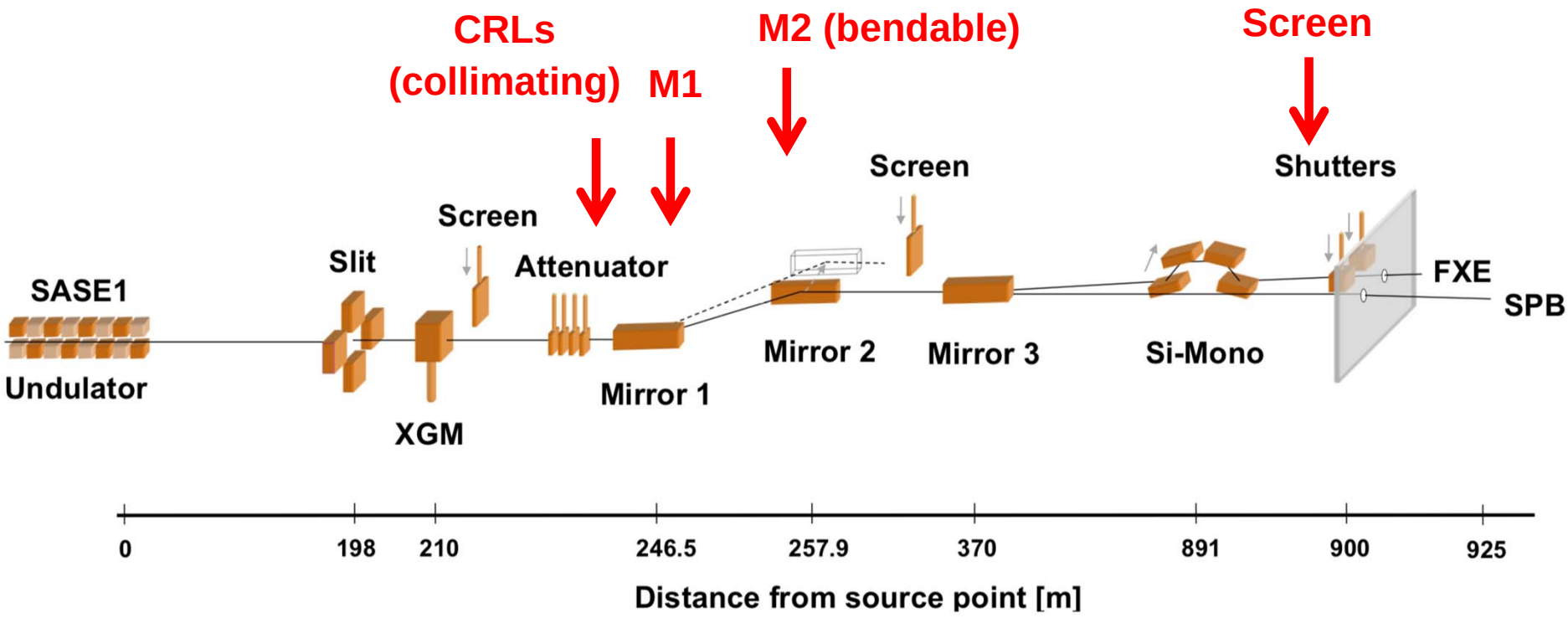


Experimental Hall



European XFEL

Photon Beamline SASE1



Courtesy Harald Sinn

Scientific instruments

SASE1

FXE (Femtosecond X-ray Experiments)

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

Team: Ch. Bressler 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)

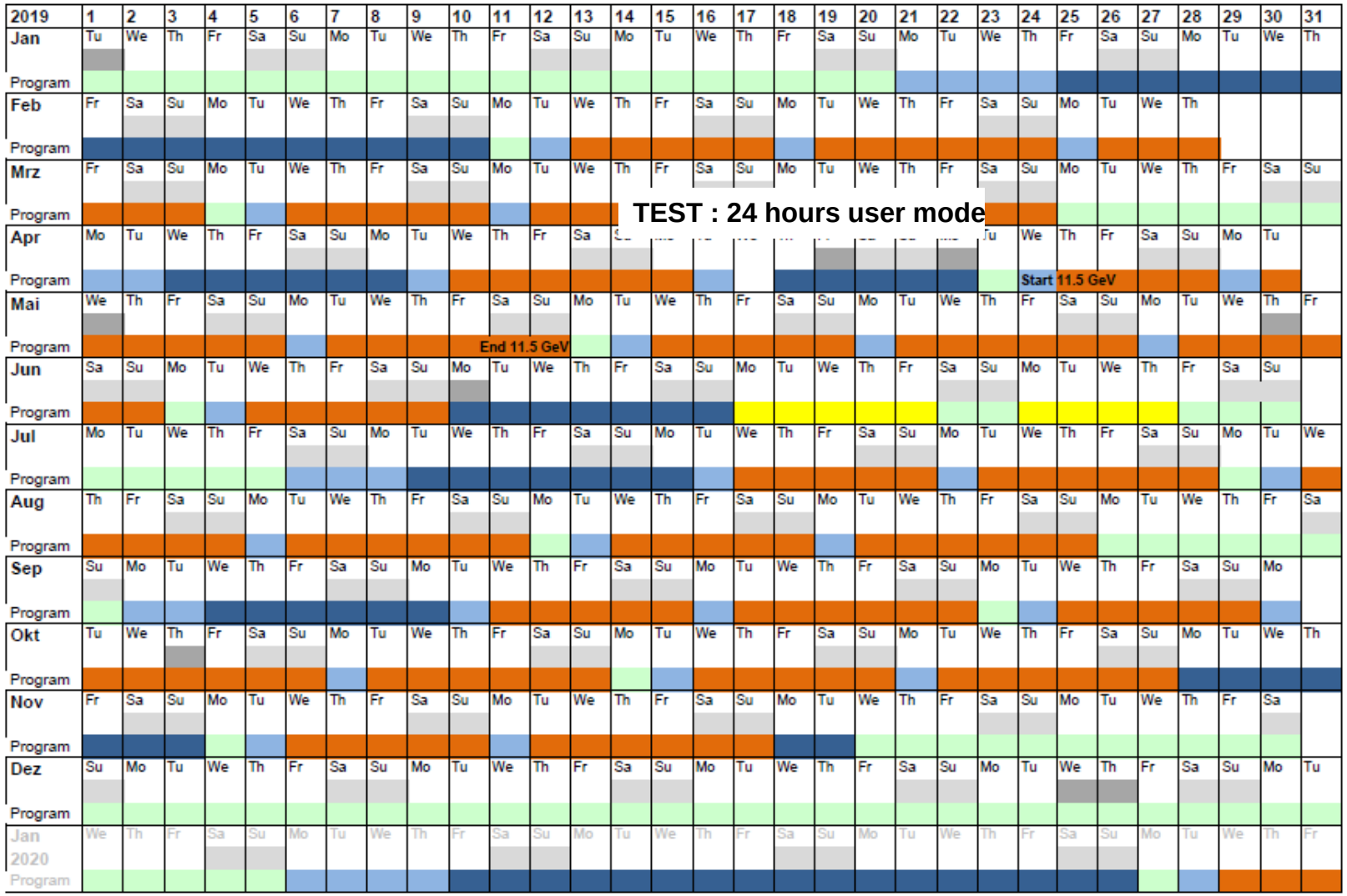
- Ultrafast dynamics of complex solids
- Combination of hr-inelastic spec. & coh.scattering

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

Users Statistics Proposal round 1 and 2

Beamtime Allocation Period	201701 (Sep.-Dec. 2017)	201801 (Aug.-Oct. 2018)
Proposals submitted	63	61
Total proposers	505	440
User shifts requested	275	341
Proposals for FXE Beamtime allocated	37 7	42 6
Proposals for SPB/SFX Beamtime allocated	26 7	19 6
Users in Sep.-Dec.		
Users visits Schenefeld	463	
Remote access users	41	
Individual users	341	

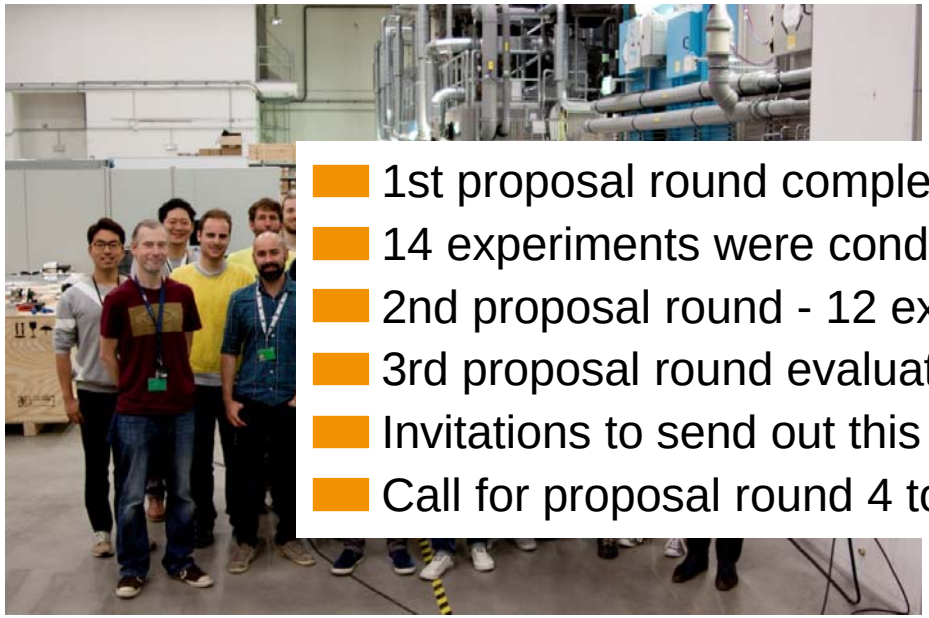
Outline Annual Operation Schedule 2019 (FINAL-2, 28/08/2018)

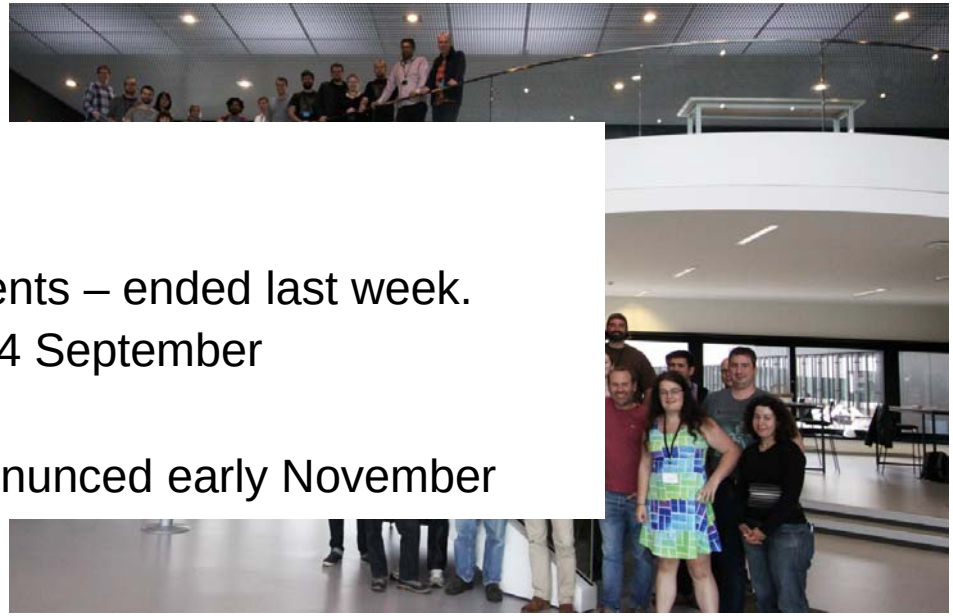


RP Radiation protection
ST Setup, access, tuning
FD Facility development
XP X-ray program

The X-ray program
Includes external (user) and internal commisioning and other internal use

First users – September 14 2017

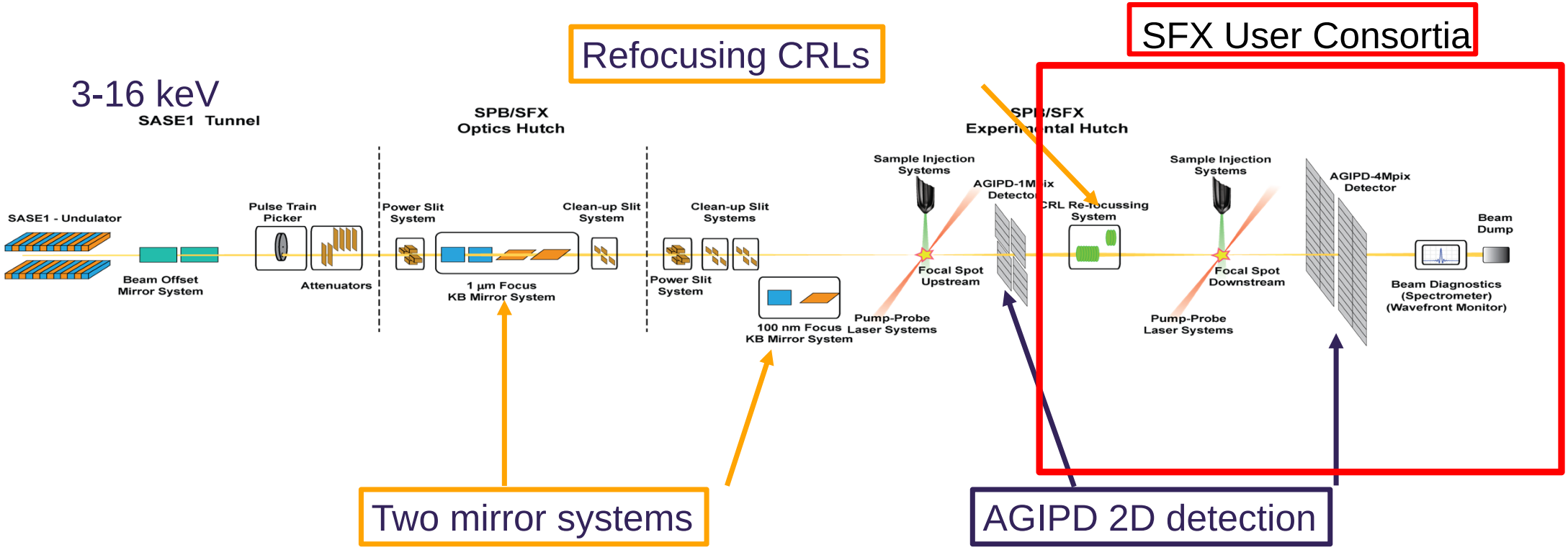




- 1st proposal round completed.
- 14 experiments were conducted.
- 2nd proposal round - 12 experiments – ended last week.
- 3rd proposal round evaluated 3 - 4 September
- Invitations to send out this week
- Call for proposal round 4 to be annunced early November

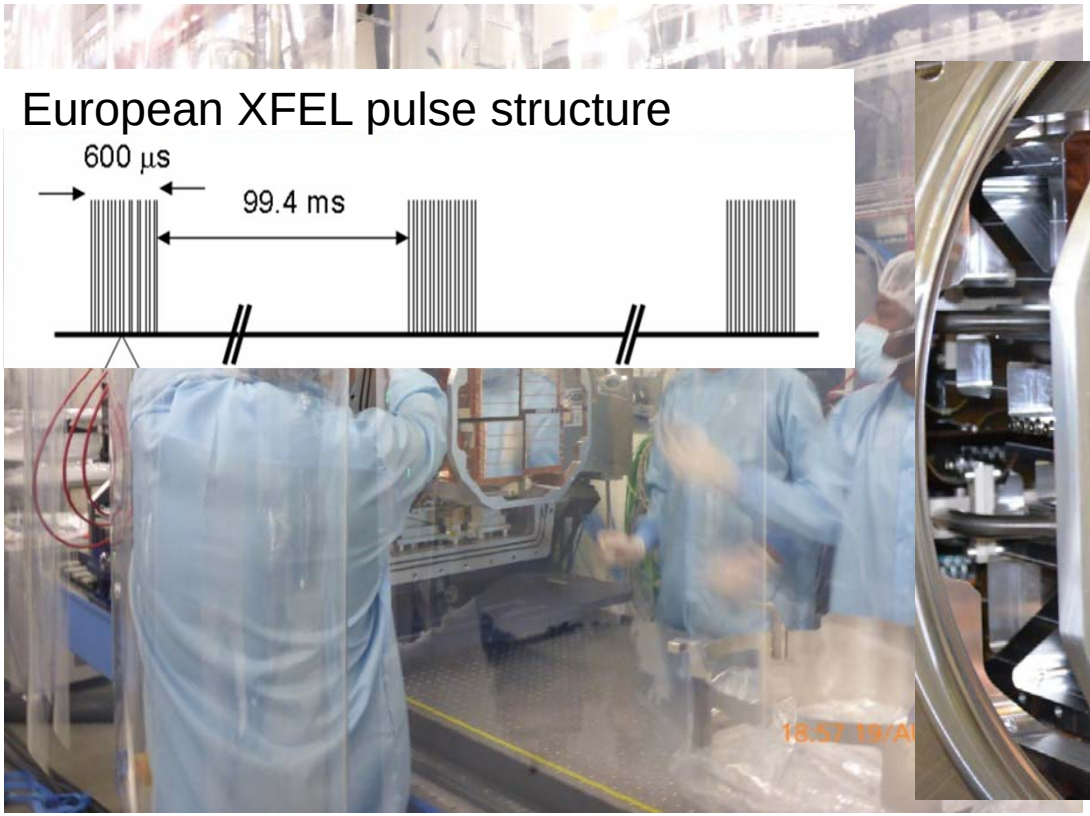
Four Months from first lasing to user operation !

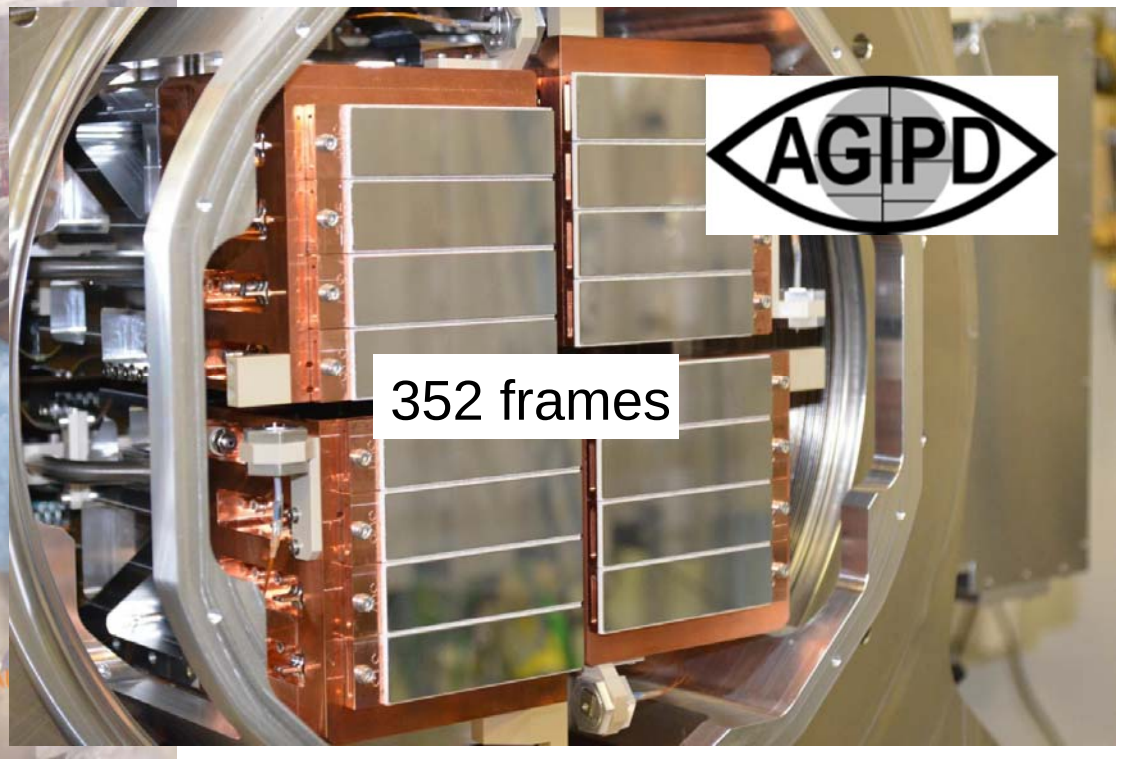
Schematic overview of the SPB/SFX Instrument



Courtesy Adrian Mancuso

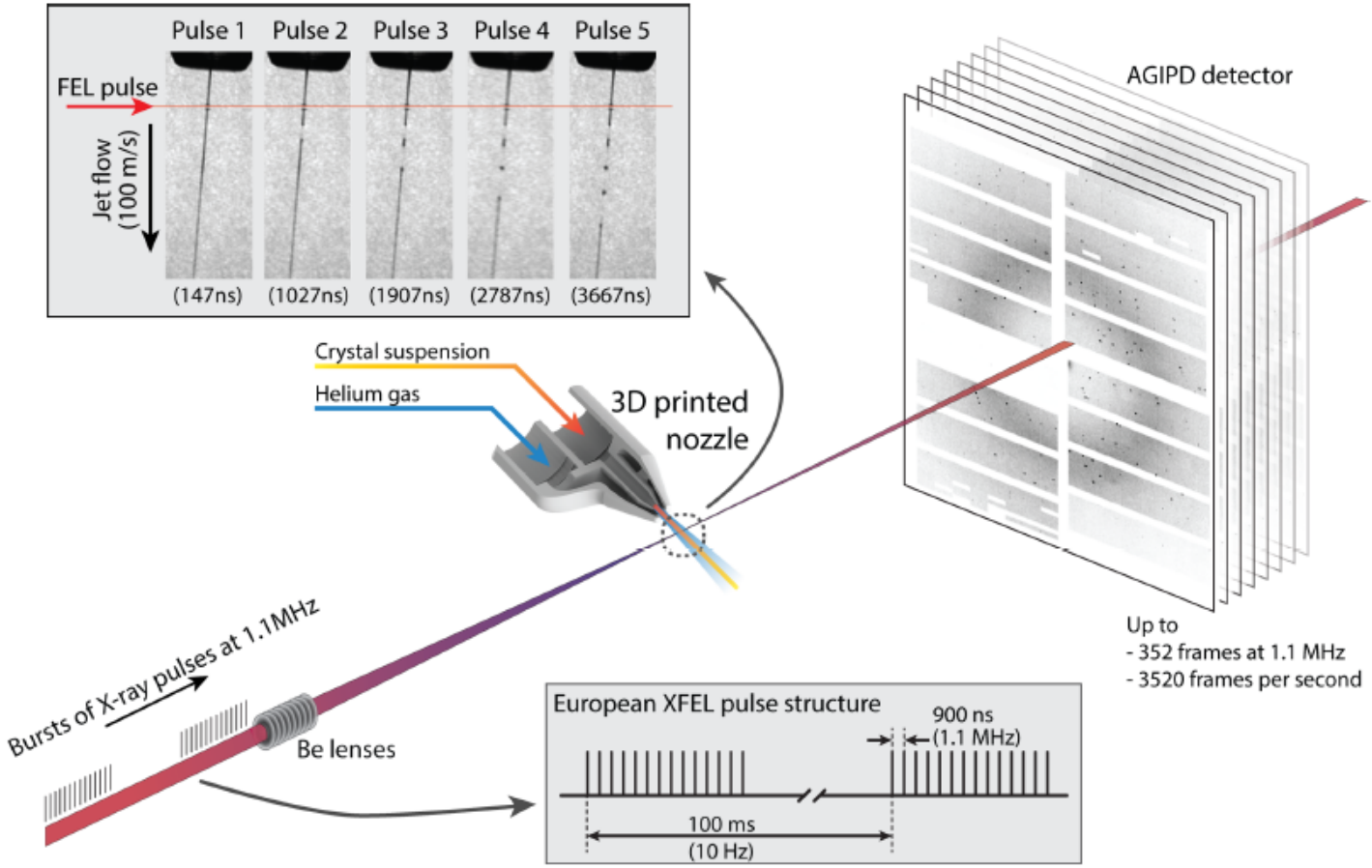
AGIPD Detector at SPB/SFX : Adaptive gain detector



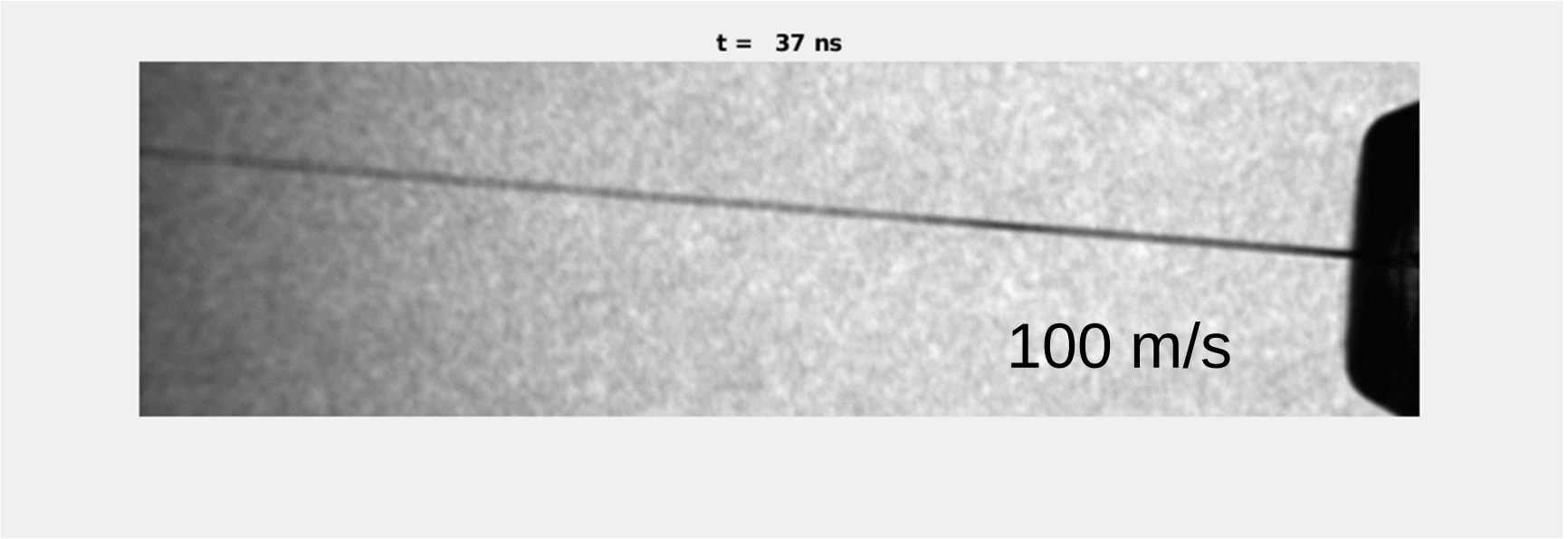


Courtesy Adrian Mancuso

Serial Femtosecond X-ray Crystallography



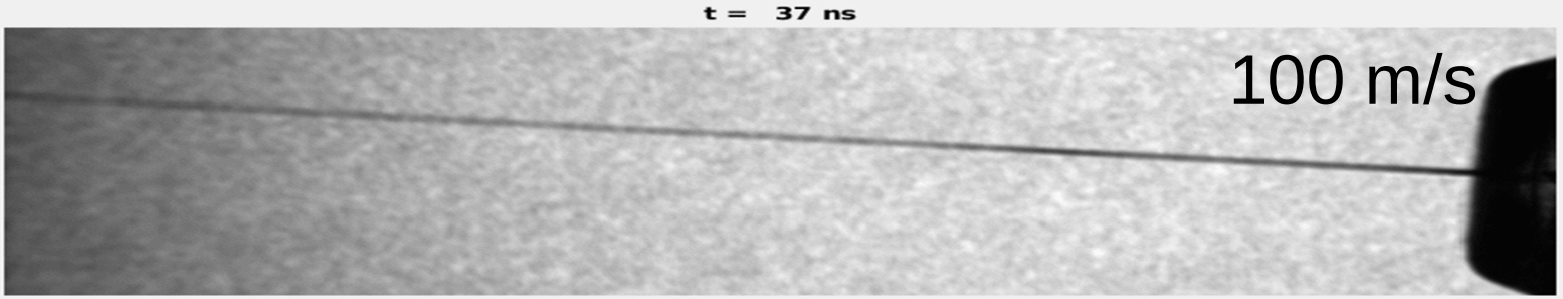
Fast jets recover in time for the next pulse at 1.1 MHz repetition rate

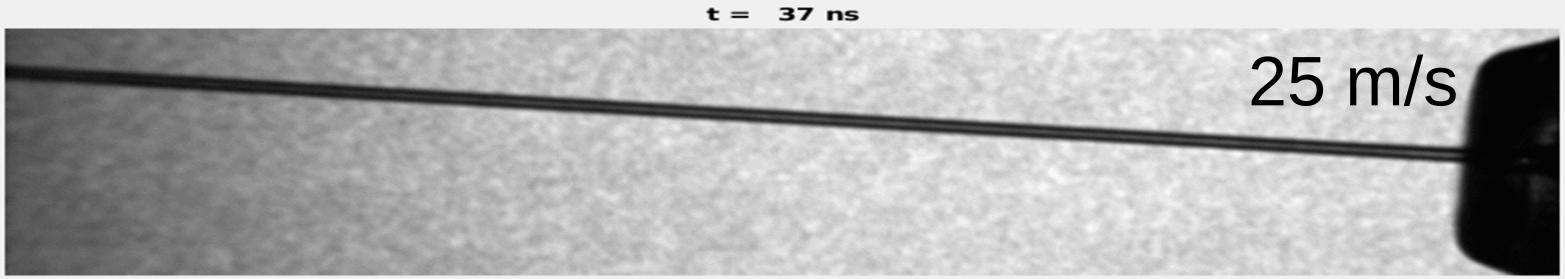


9.3 keV
580 mJ XFEL pulses
10 µm FWHM focus (or smaller)
1.1 MHz repetition rate

(courtesy A. Barty, H. Chapman)

CFEL-designed fast jets recover in time for the next pulse at 1.1 MHz repetition rate





Max Wierdorn, Claudio Stan
European XFEL

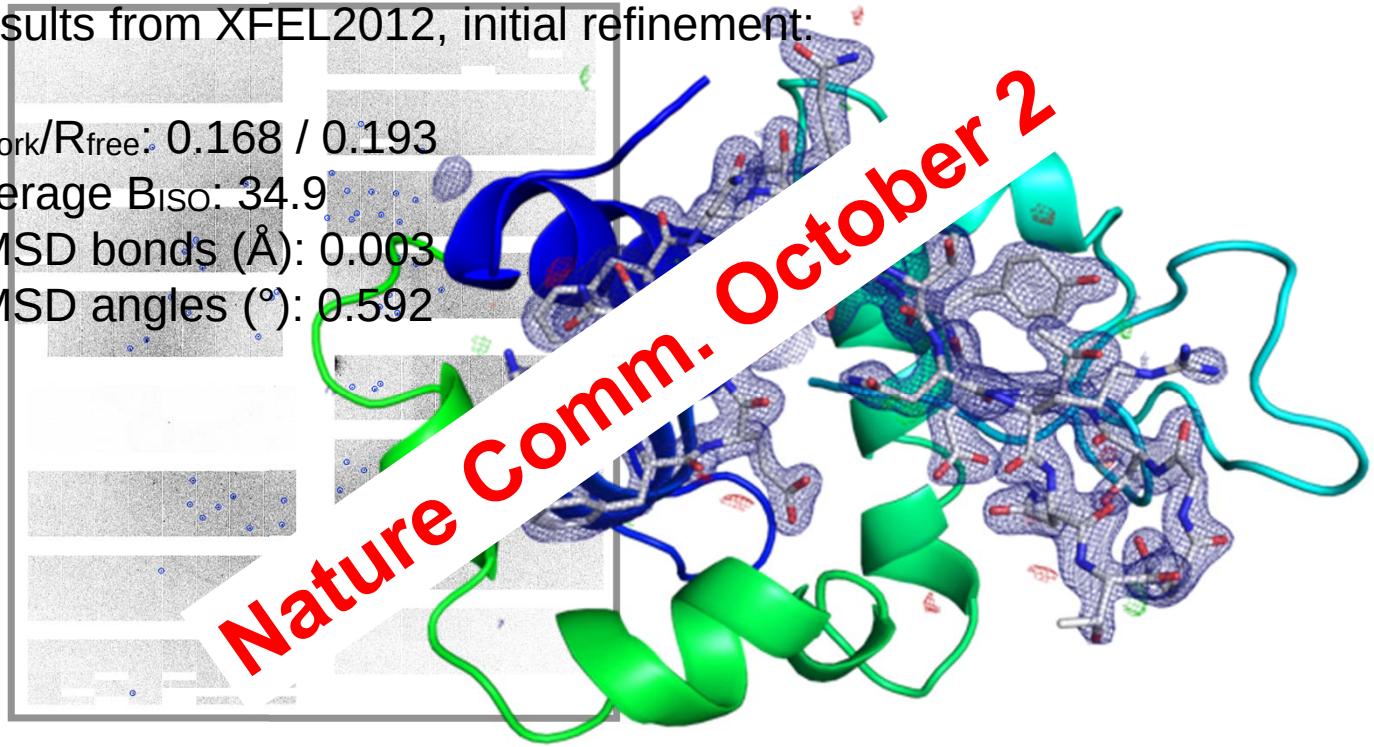
(courtesy A. Barty, H. Chapman)

CFEL SCIENCE

SPB/SFX experiment #2012: Many thousands of frames of diffraction data was collected and successfully analysed to give a structure!

Results from XFEL2012, initial refinement:

R_{work}/R_{free}: 0.168 / 0.193
Average B_{ISO}: 34.9
RMSD bonds (Å): 0.003
RMSD angles (°): 0.592

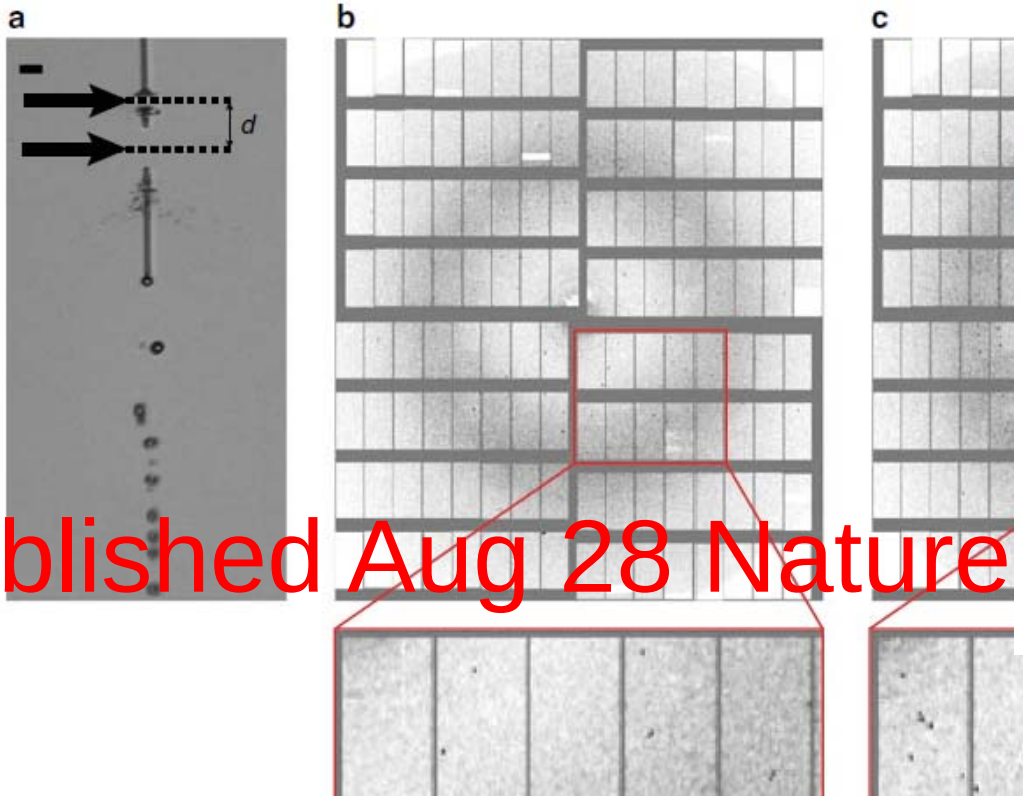


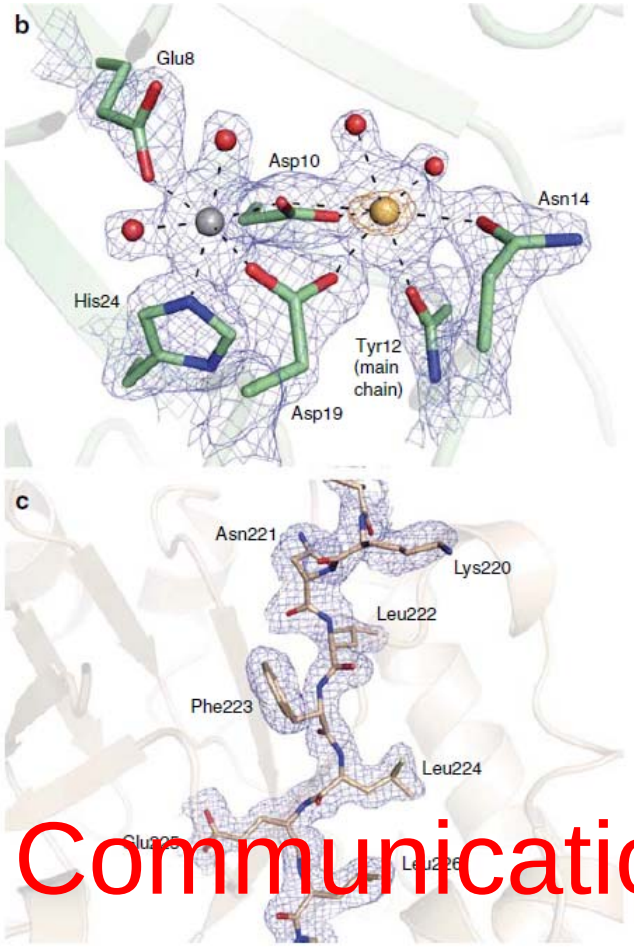
- This is the first realisation of the European XFEL's purpose—a complete experiment from start-to-end demonstrated in the very first user experiment at the facility at the SPB/SFX instrument (Data September 2017, Analysis November 2017). That is, structural biology works at XFEL!

Courtesy Adrian Mancuso

Megahertz data collection from pro microcrystals at an X-ray free-elec

Marie Luise Grünbein[1], Johan Bielecki[2], Alexander Gorel[1], Miriam Stricker[1], R
Marco Cammarata[3], Katerina Dörner[2], Lars Fröhlich[4], Elisabeth Hartmann





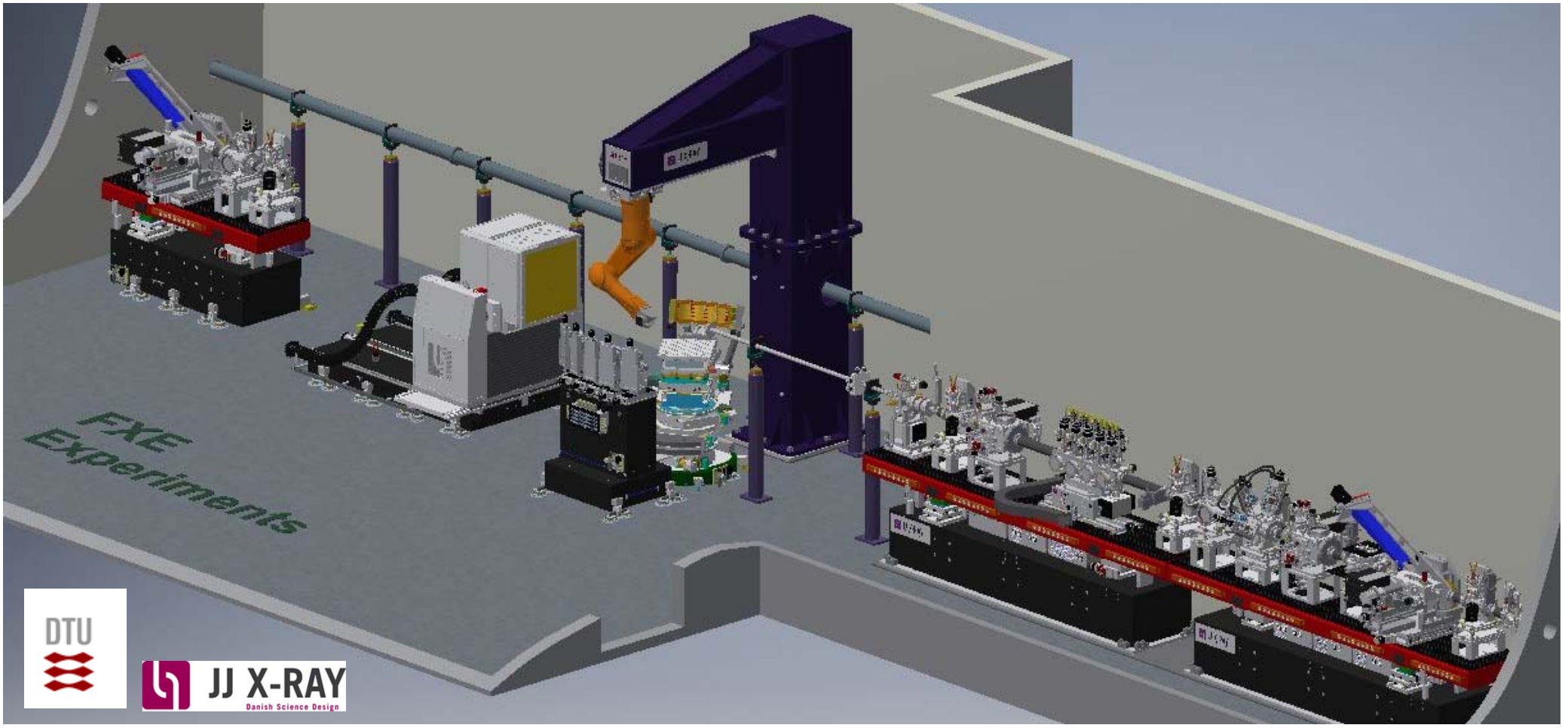
Published Aug 28 Nature Communication

XBI Bio Laboratories for Users

- 5-15 Users per SPB Beamtime (about 40 in total)
- Very positive feedback
- Usage:
  - Handling of cells
  - Dark room
  - Cold room
  - Anaerobic Box
  - Centrifugation
  - Cryogenic storage
  - Sample analysis
  - Microscopy
  - Growing crystals
  - Characterization
  - Preparation for injection

Courtesy Kristina Lorenzen

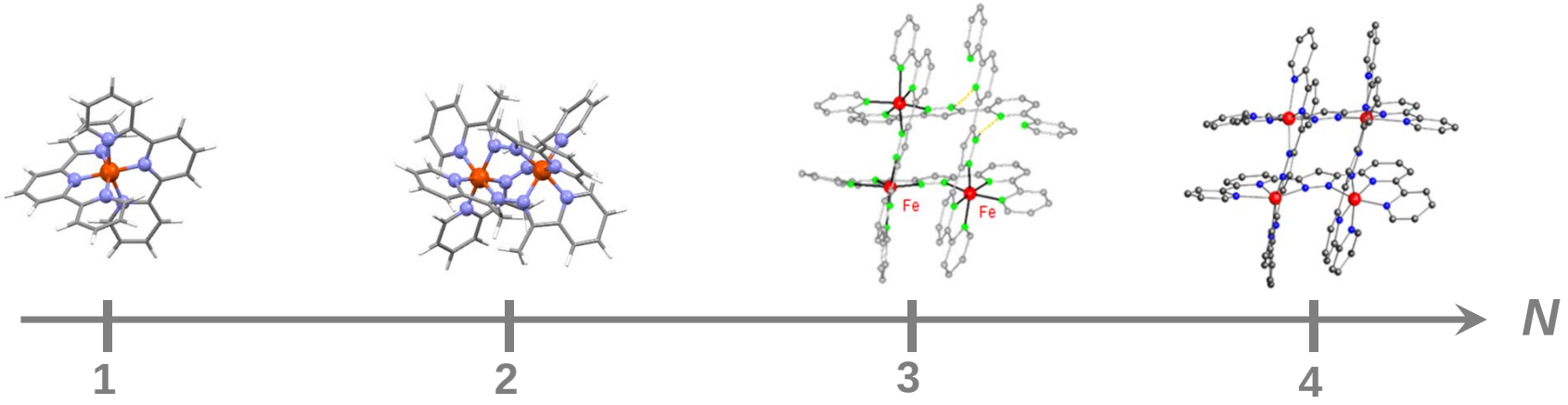
FXE scientific instrument (Christian Bressler)



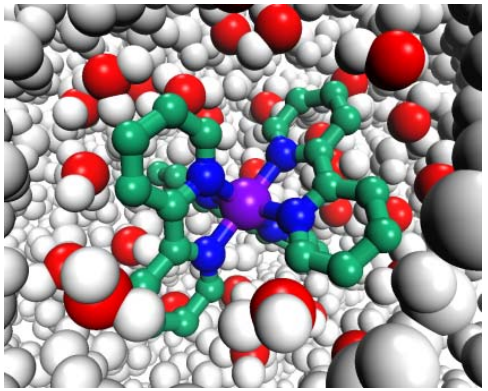
FXE : Controlling spin-state switching in the condensed phase (Experiment #2050)

30.11. – 04.12.2017 Sophie Canton (DESY/ELI)

- **Characterizing the fs spin and structural dynamics as function of *N***



- **What is the role of the solvation shell ?**

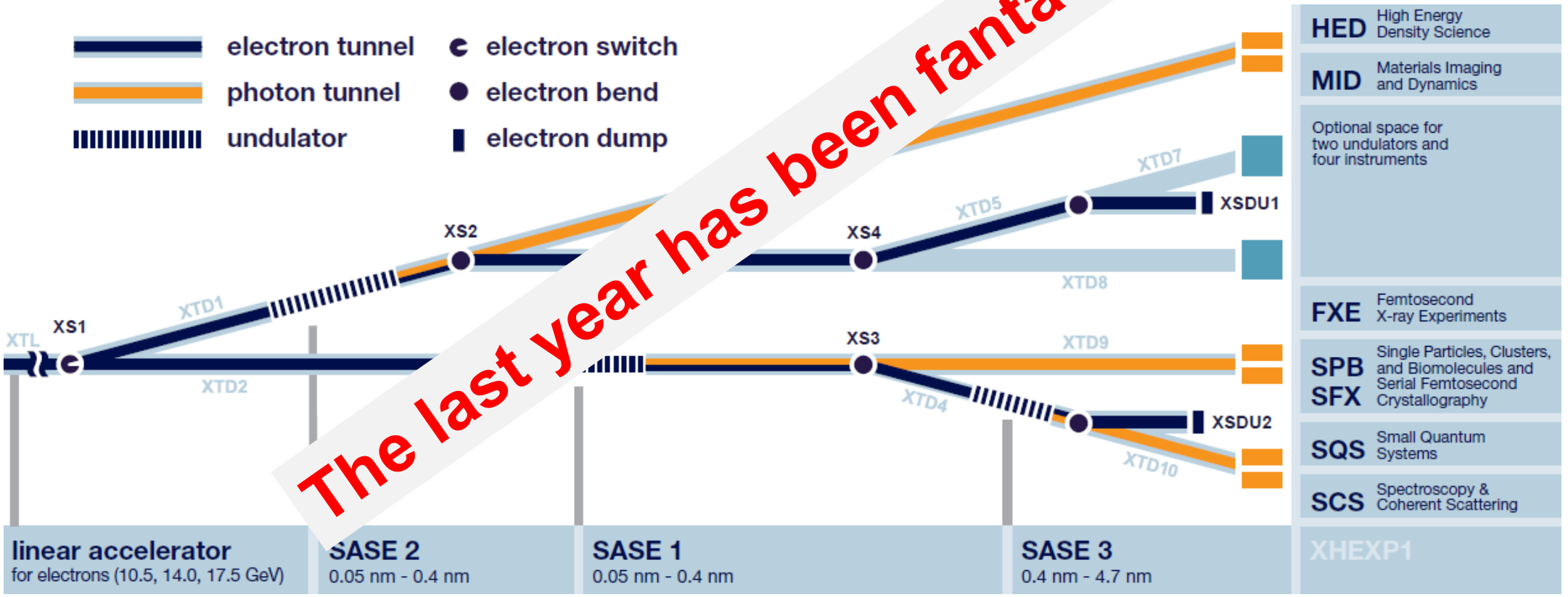


Implications

Molecular electronics, quantum information
Energy management in multichromophoric systems

Outlook

Experimental Hall



The last year has been fantastic

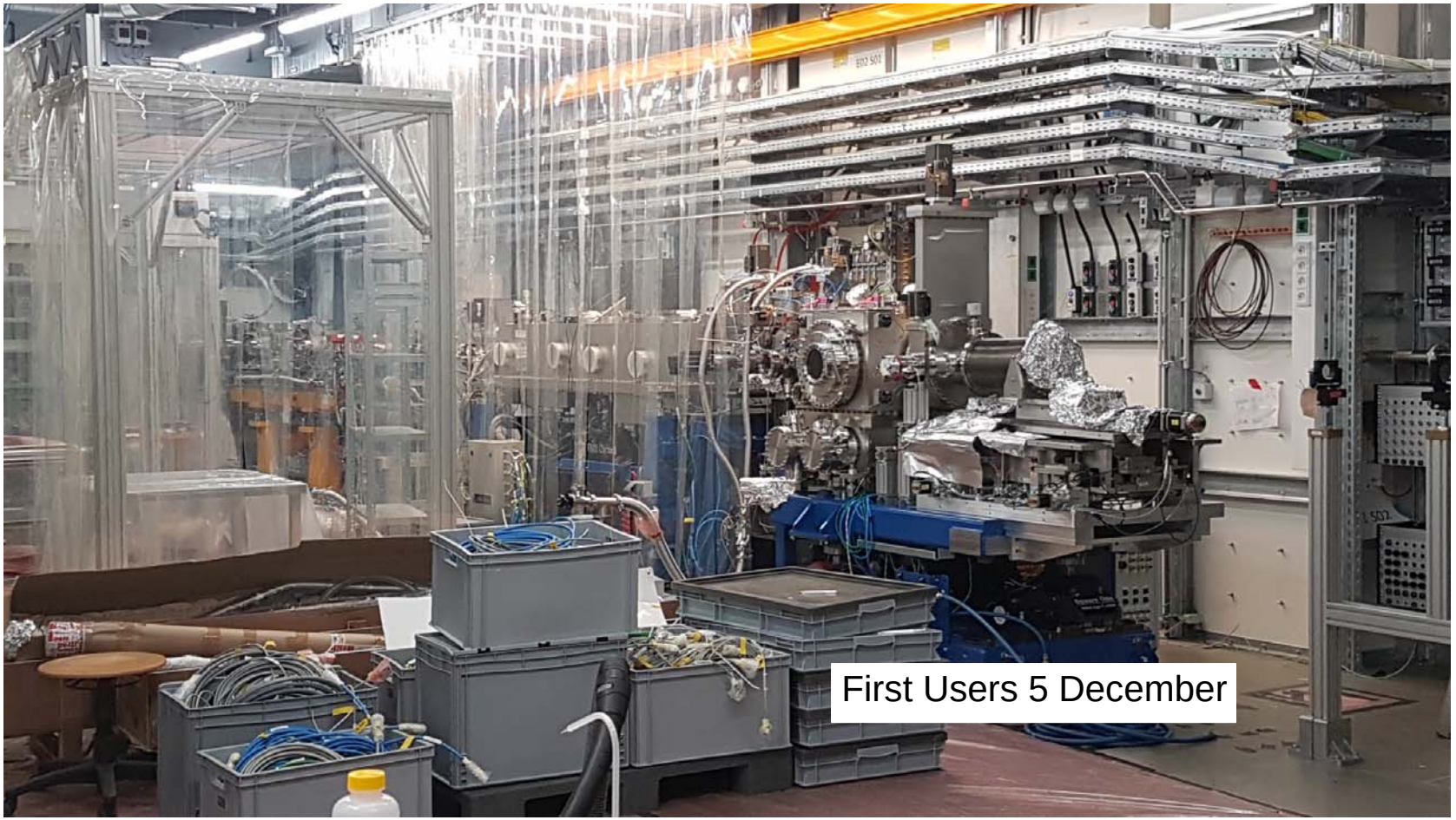
European XFEL

Sep 5 : European XFEL celebrates one year of user operation

Progress SASE 2 and SASE 3

27.08.2018 – SQS experiment

27.08.2018 – SCS experiment



25 October – First Beam at MID

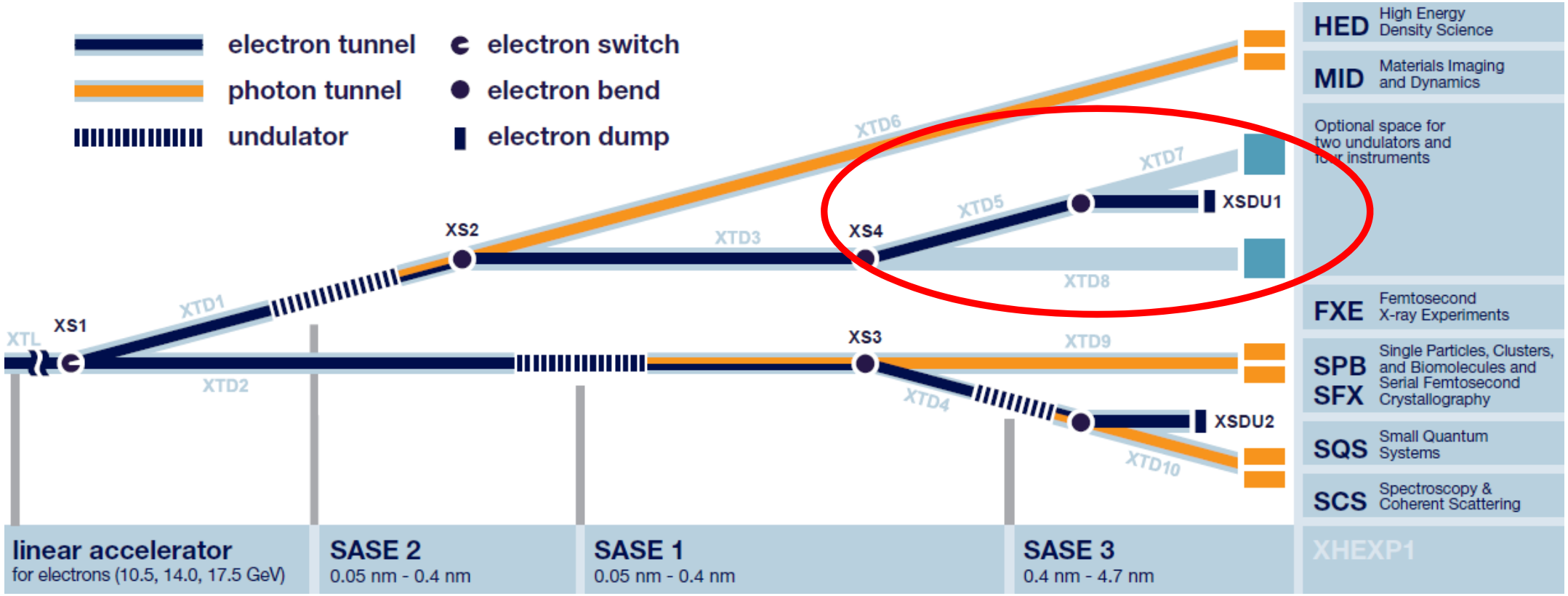
27.08.2018 – MID experiment

- Long detector arm being commissioned by PINK

First Users 30 March

27.08.2018 – HED experiment

Experimental Hall



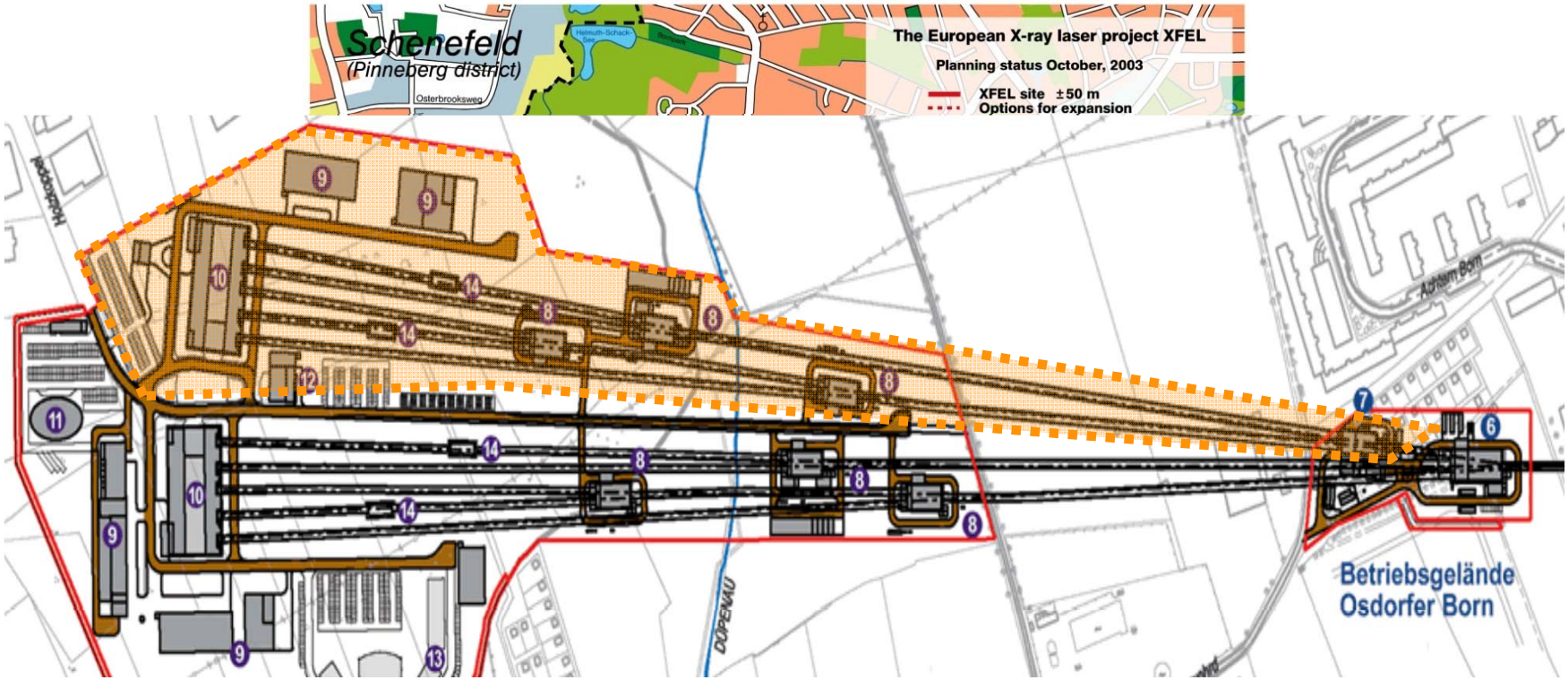
Shaping the Future : first workshop on Dec 6/7

options for the SASE4/5 tunnels

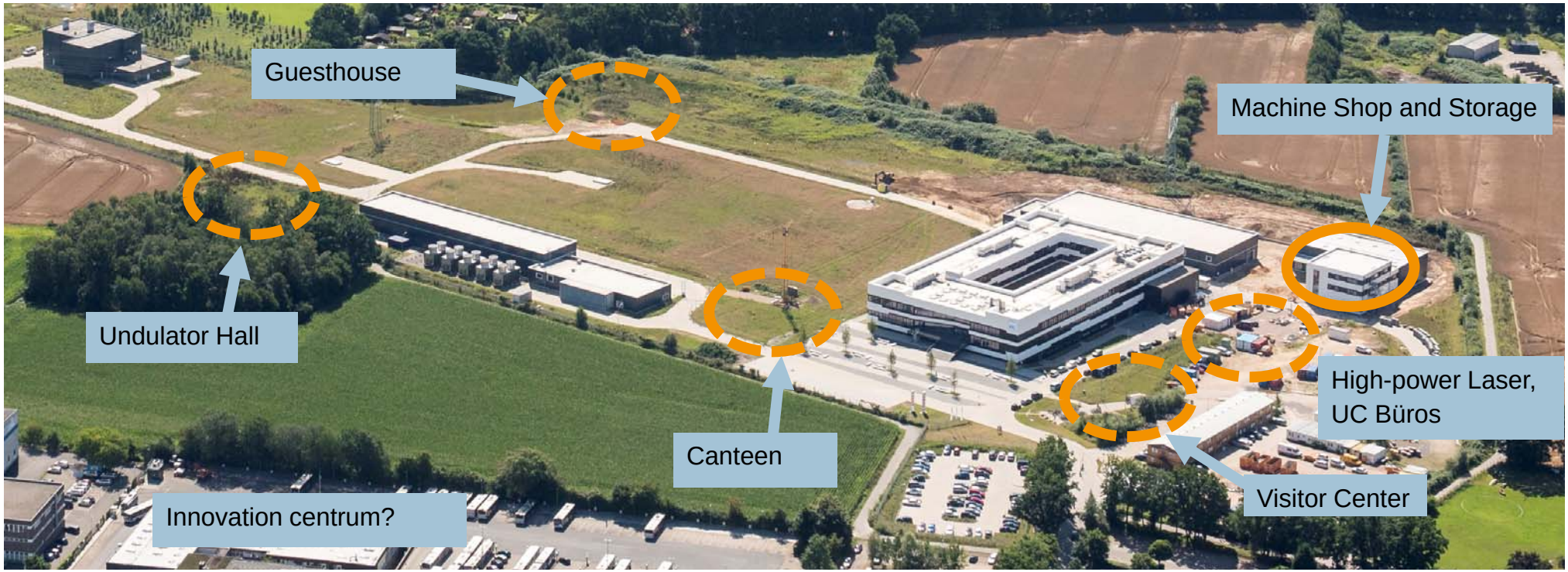
- Day 1 : Session I : Introduction - Facility Description - Scientific trends
  - A hard (7 keV - 25 keV) and ultra-hard X-ray source (25 keV -100 keV) for the European XFEL at 17.5 GeV
  - Super-X: Simulations for super-hard X-ray generation with short period undulators for the European XFEL
  - Hard X-ray generation at SHINE
- Day 1: Session II : Hard X-rays
  - A soft X-ray line for generating pulses between 1nm and a few 10s nm for the European XFEL
  - External seeding possibilities at the European XFEL and THz addition
  - Superradiance for Soft X-Ray production
- Day 2 : Session III: Soft X-Rays
  - A soft X-ray line for generating pulses between 1nm and a few 10s nm for the European XFEL
  - External seeding possibilities at the European XFEL and THz addition
  - Superradiance for Soft X-Ray production

- Session IV : Other concepts

Long term plan (~ 2027 - 2032) . Second fan and c.w.

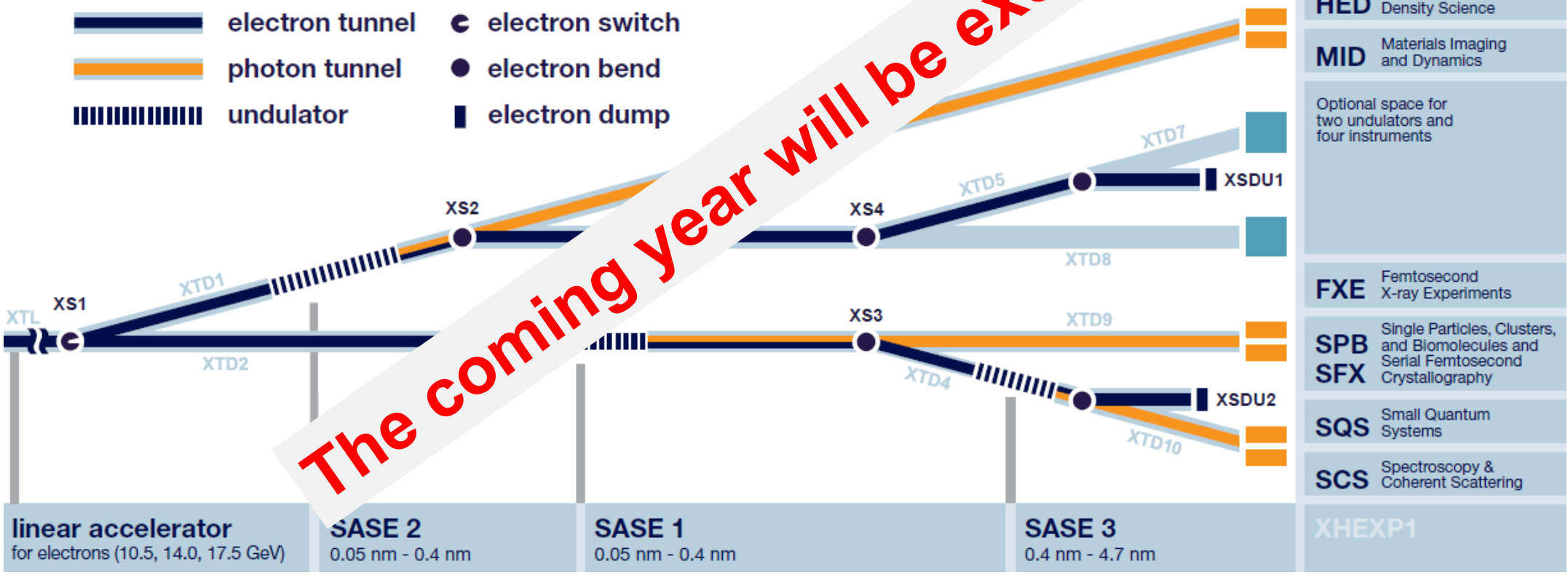


Campus Schenefeld including planned Canteen und Guesthouse



Outlook

Experimental Hall



The coming year will be exciting

European XFEL

Acknowledgement to the fantastic staff at European XFEL

And to the fantastic Accelerator Staff