



Facility Update

European X-ray Free-Electron Laser Facility

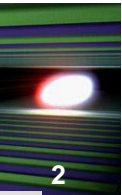
Massimo Altarelli

On behalf of the Management Board

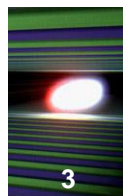
European X-Ray Free-Electron Laser Facility
22869 Schenefeld, Germany

massimo.altarelli@xfel.eu

European XFEL Construction: coming to an end

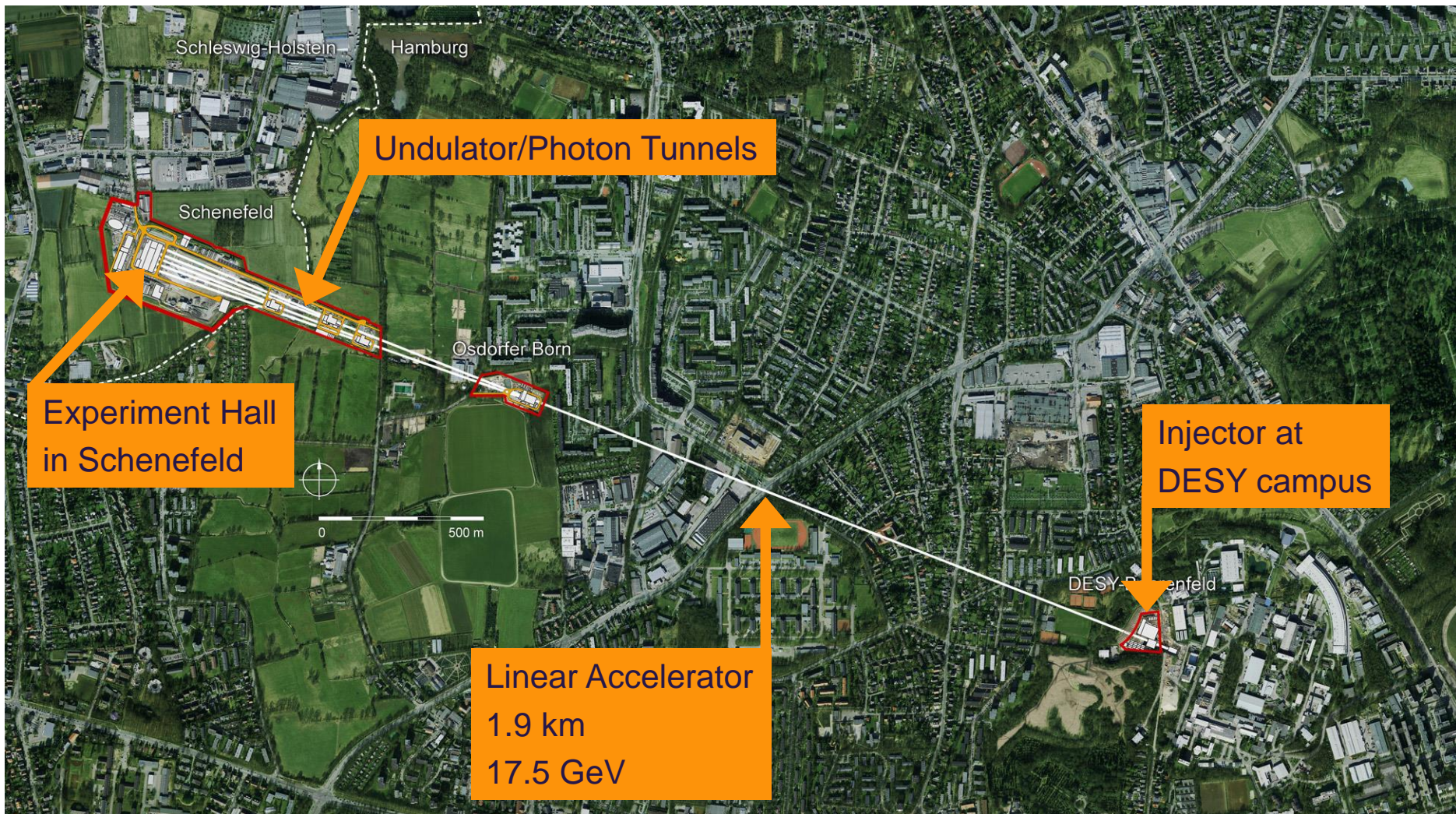
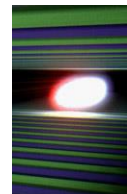


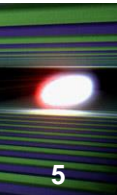
Smooth move to Schenefeld on 17-20 June 2016



Headquarter - XHQ

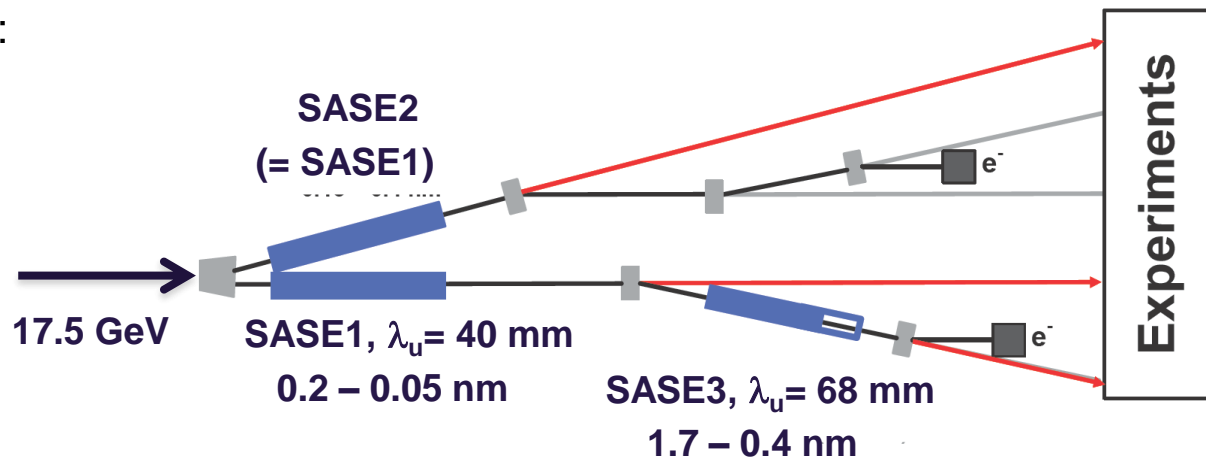
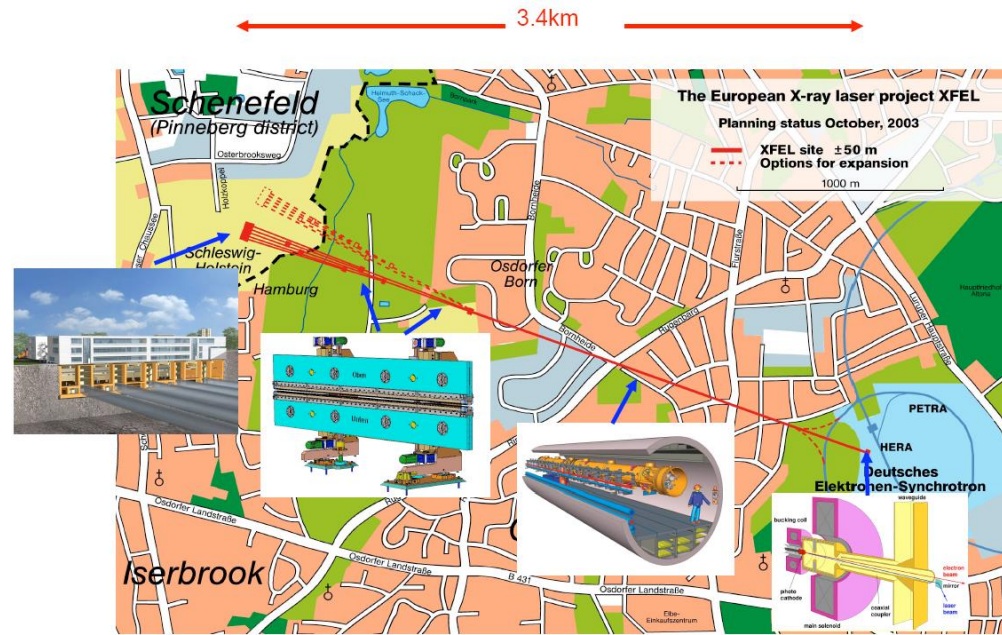
European XFEL: the most brilliant X-ray source



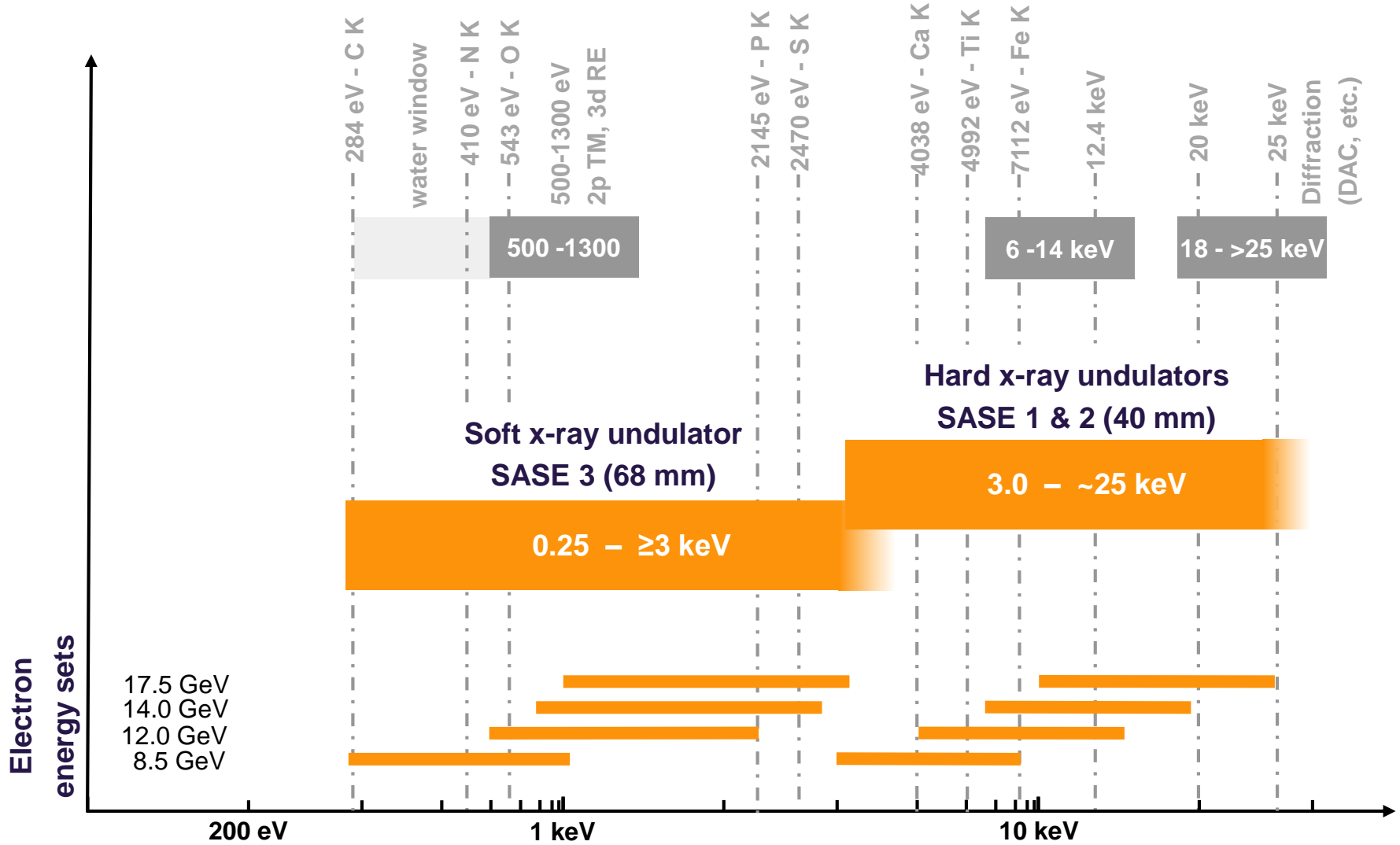
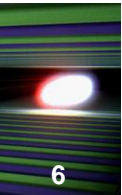


Some specifications

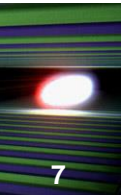
- Photon energy 0.3-24 keV
- Pulse duration ~ 10-100 fs
- Pulse energy few mJ
- Superconducting linac. 17.5 GeV
- 10 Hz (27 000 b/s)
- 5 beamlines / 10 instruments
 - Start version with 3 beamlines and 6 instruments
- Several extensions possible:
 - More undulators
 - More instruments
 -
 - Variable polarization
 - Self-Seeding
 - CW operation



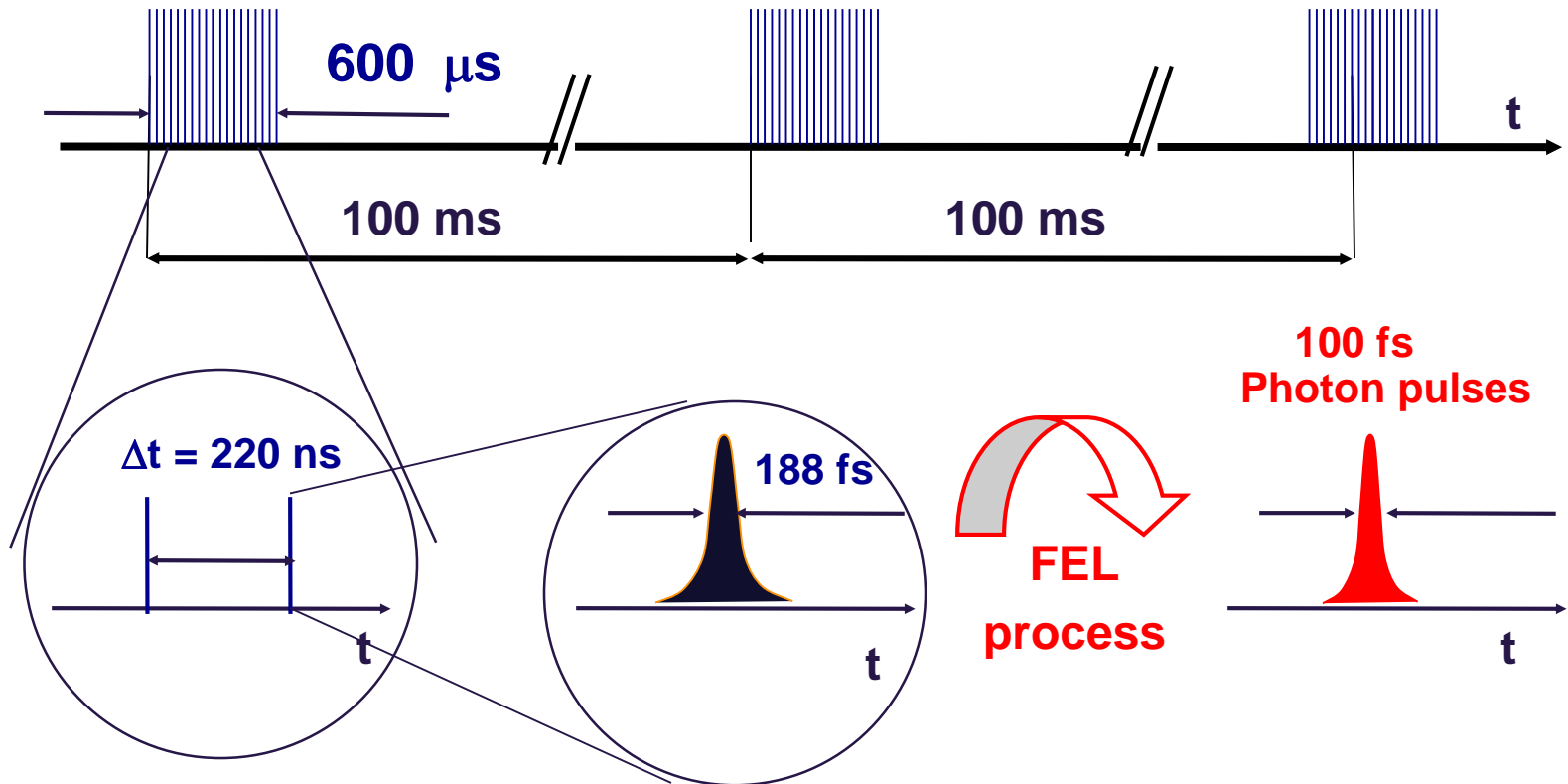
Undulator Spectral Range



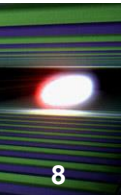
European XFEL Project - Time Structure



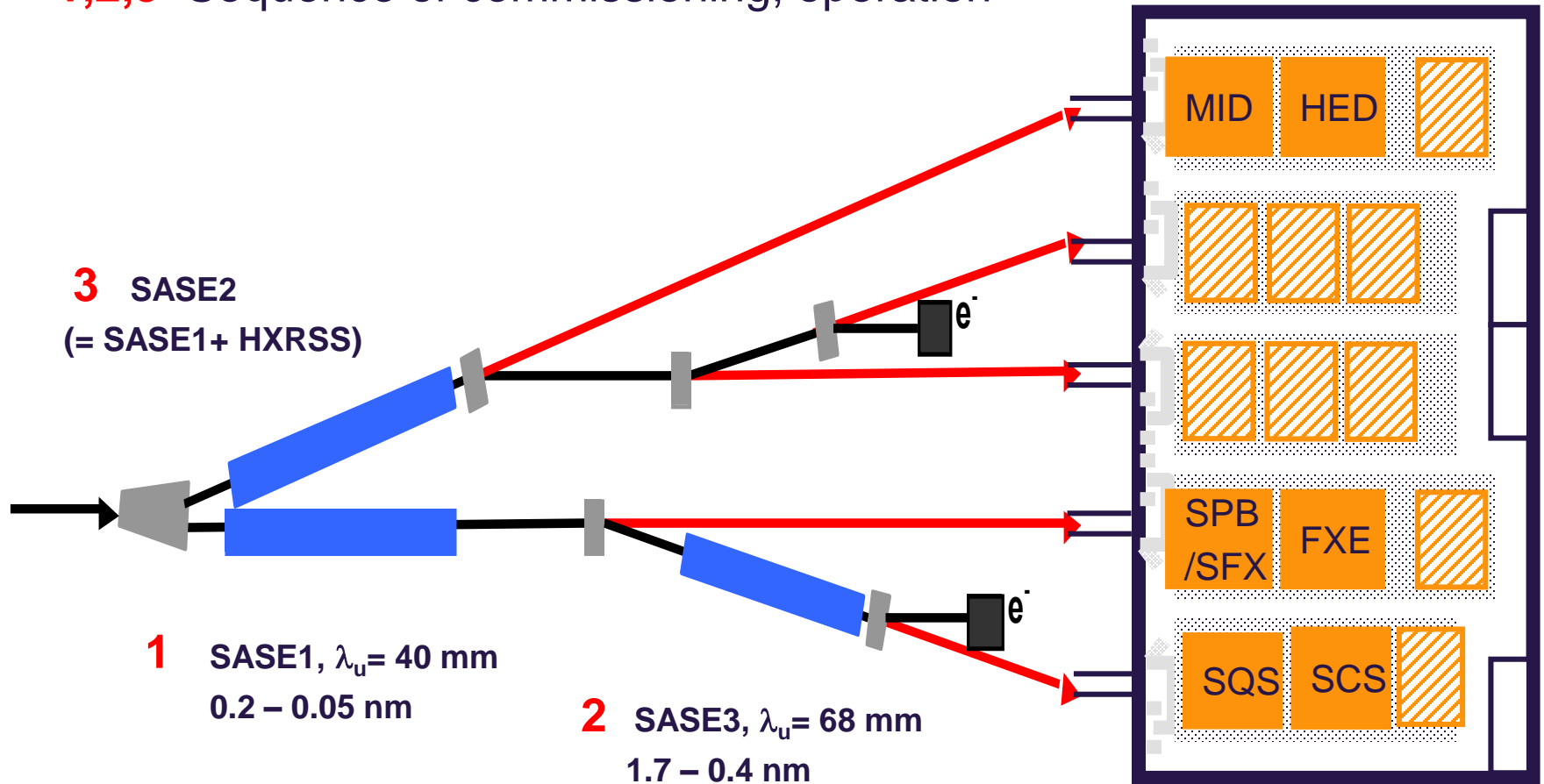
Electron bunch trains (with up to 2700 bunches à 1 nC)

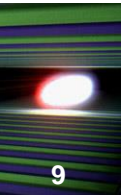


Schematic distribution of the instruments



■ **1,2,3** Sequence of commissioning, operation

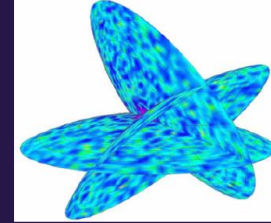




Hard X-rays

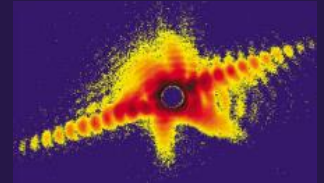
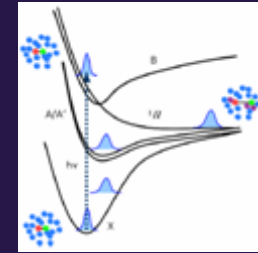
SPB/SFX: Ultrafast Coherent Diffraction Imaging of Single Particles, Clusters, and Biomolecules

Structure determination of single particles: atomic clusters, bio-molecules, virus particles, cells.



MID: Materials Imaging & Dynamics

Structure determination of nano-devices and dynamics at the nanoscale.

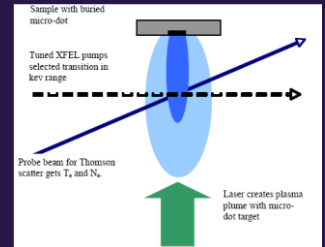


FXE: Femtosecond X-ray Experiments

Time-resolved investigations of the dynamics of solids, liquids, gases

HED: High Energy Density Matter

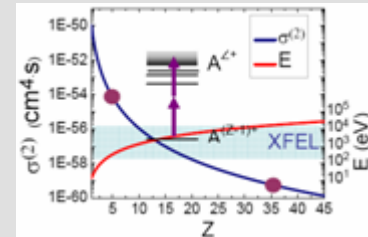
Investigation of matter under extreme conditions using hard X-ray FEL radiation, e.g. probing dense plasmas



Soft x-rays

SQS: Small Quantum Systems

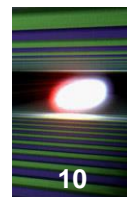
Investigation of atoms, ions, molecules and clusters in intense fields and non-linear phenomena



SCS: Soft x-ray Coherent Scattering/Spectroscopy

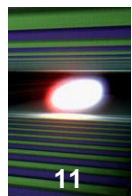
Electronic and real structure, dynamics of nano-systems and of non-reproducible biological objects

User consortia: presently accepted proposals

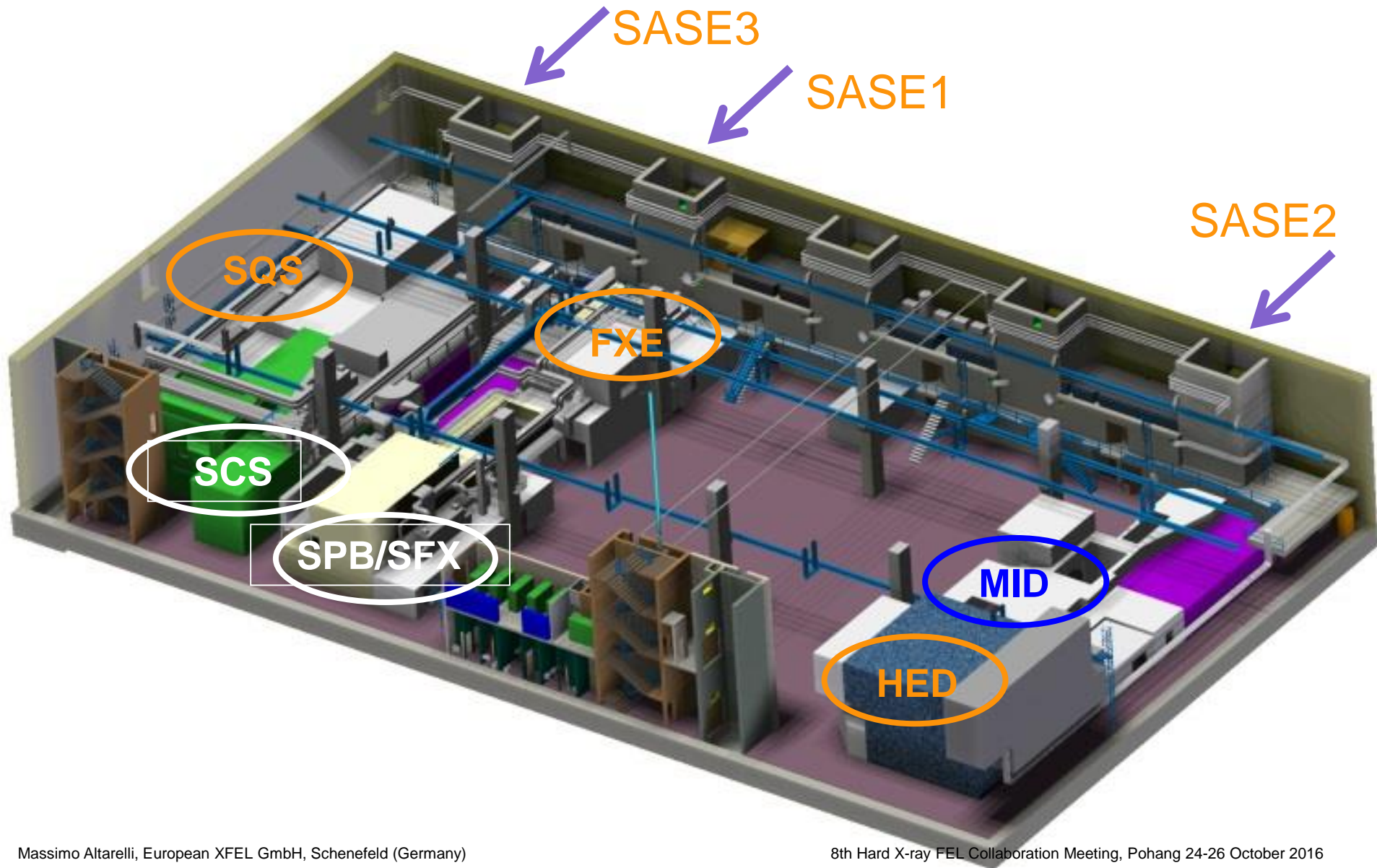
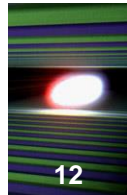


- 1. Bio-labs in XHQ, ancillary facilities **XBI**
- 2. Expansion of computational capabilities **DataXpress**
- 3. A station for nanocrystallography on a hard X-ray branch **SFX**
- 4. High-energy lasers and pulsed high field magnet for the High Energy Density Instrument **HIBEF beamline**
- 5. An additional versatile experimental chamber for oriented molecular species **COMO**
- 6. A RIXS station for the soft X-ray branch **hRIXS**

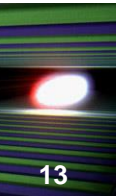
Laboratories in Headquarter ground floor



Experimental Hall plan with SASE1, 2, 3 hutches

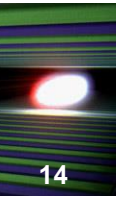


SASE1 stations FXE and SPB/SFX



Hutch construction and installation of technical infrastructure complete





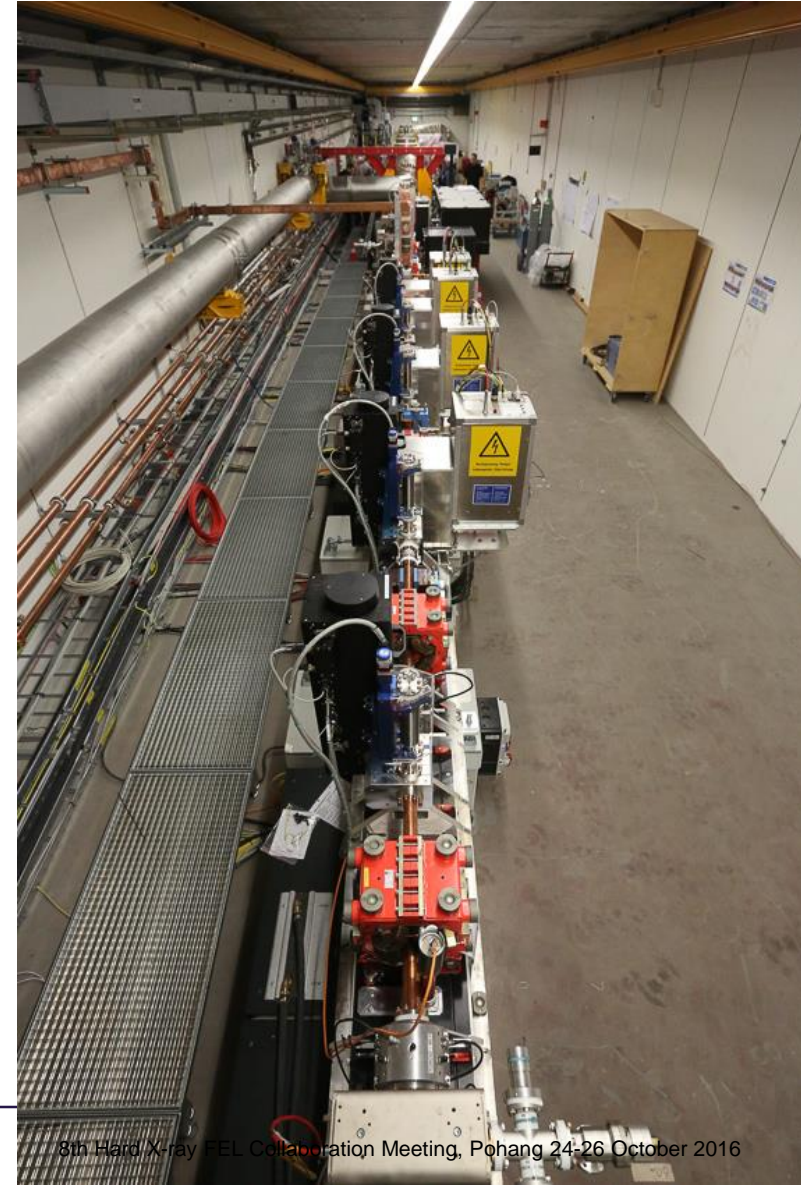
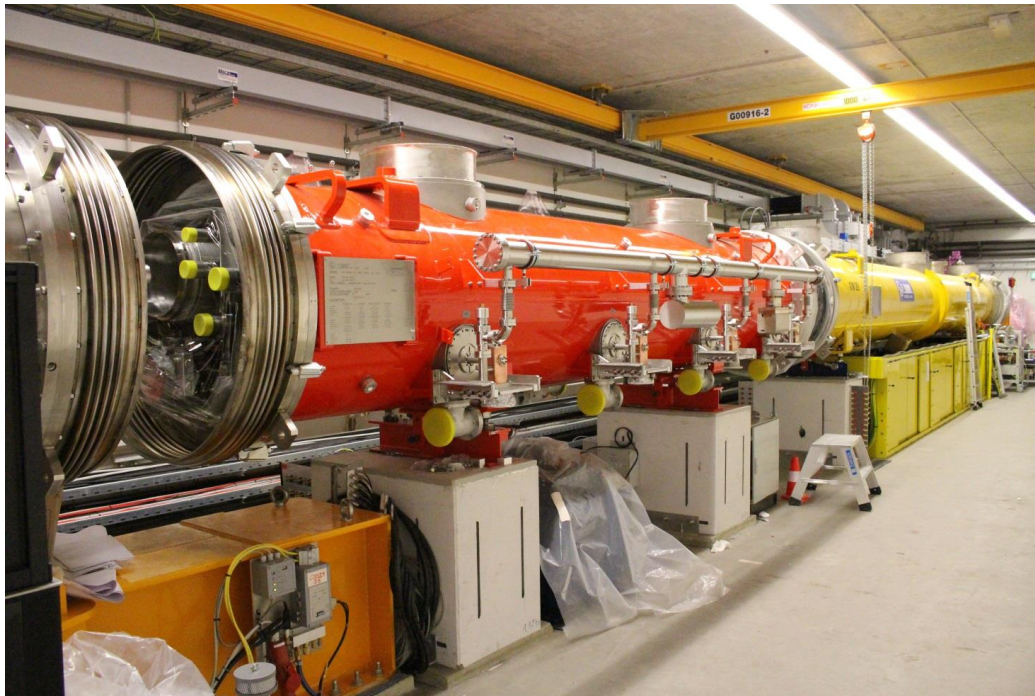
Experiment hutch



- See a short movie about status (September 2016)

Injector commissioning (talk by M. Scholz on Tuesday pm)

- **Injector commissioning started**, injector tunnel closed, cool down to 2 K successful.
- **First 130 MeV Electron beam on 18.12.2015**



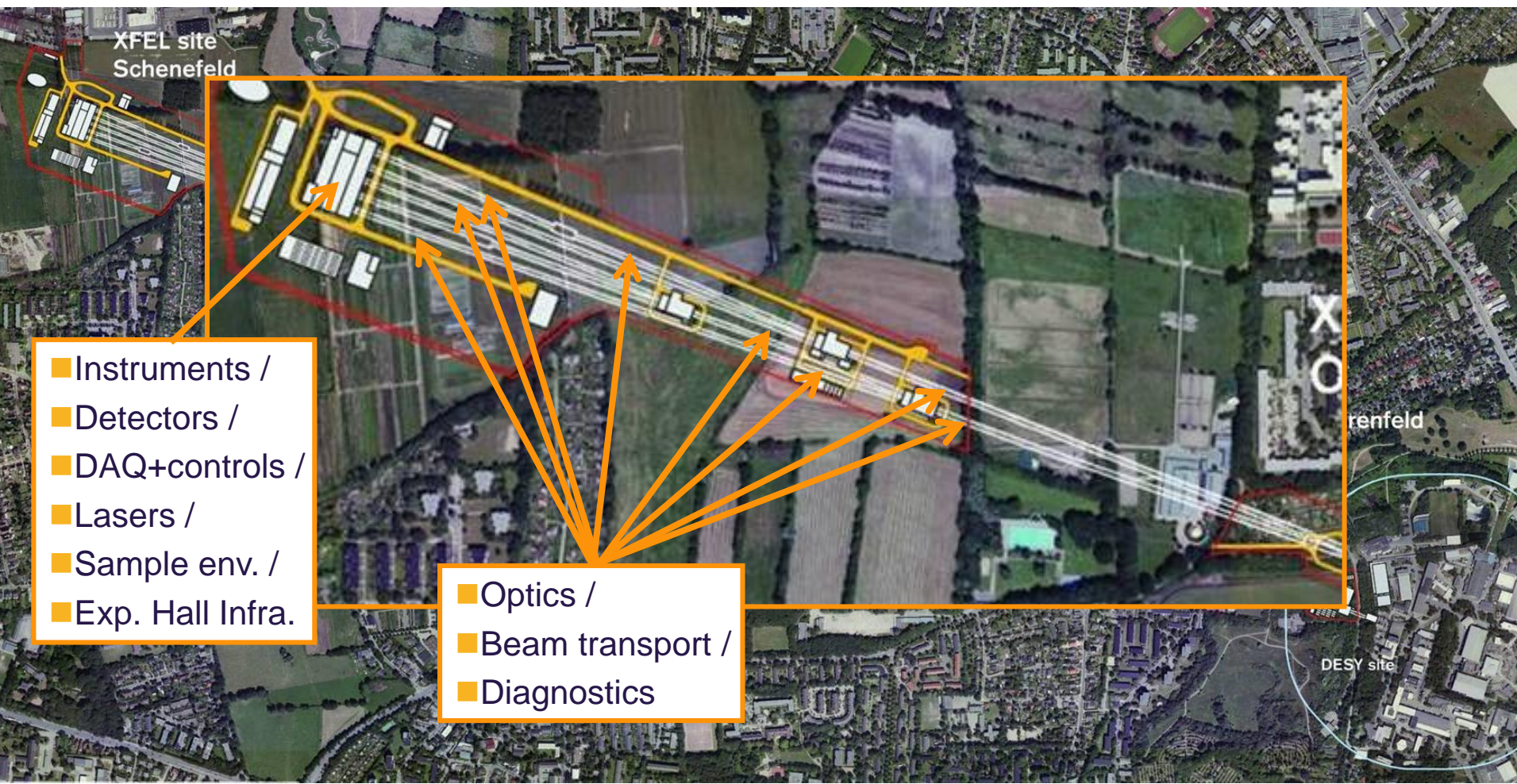
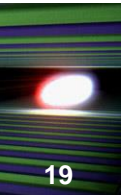
- Preliminary test of cryogenic components in view of linac cool down, 11 October
- An exhaust pipe running along the Linac, foreseen to catch He gas in case of a boil-off, did not withstand a pressure test, suffered an elongation and detached from the ceiling at its downstream end.
- Damage is under evaluation, but this incident shall delay the linac cool down and commissioning by approximately 3 months
- See talk by Winni Decking later today



Tentative timetable...now delayed by ~ 3 months

- 2016** Initial commissioning of linac, to bring electron beam in first undulator (SASE1).
FIRST CALL FOR PROPOSALS!
- 2017** Bring first X-ray FEL beam to XHEXP.
Continue commissioning of accelerator.
Initial commissioning of X-ray beam transports and instruments.
Start “early user experiment” program (peer-reviewed).
- 2018** Reach full performance of accelerator.
Development of X-ray beam transports and instruments towards full performance.
Continue “early user experiment” program (peer-reviewed).
During 2nd half 2018 gear up towards full scope user program (peer-reviewed).
- 2019** Regular operation (4000 hrs for user programme).

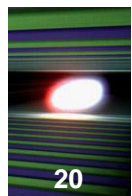
Overview of high repetition rate challenges



- Instruments /
- Detectors /
- DAQ+controls /
- Lasers /
- Sample env. /
- Exp. Hall Infra.

- Optics /
- Beam transport /
- Diagnostics

Optics, diagnostics, see presentation by H. Sinn



FLAT super-polished mirrors TypeA #5264-1

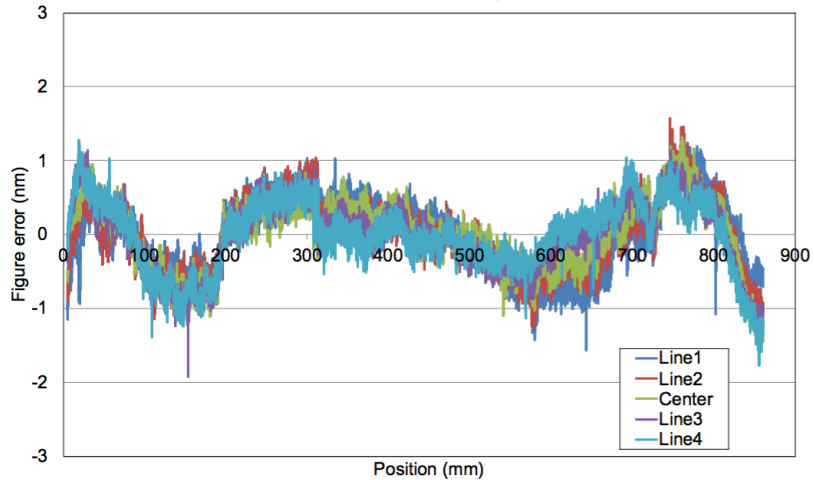
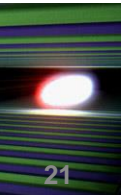





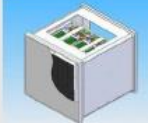
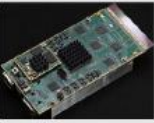
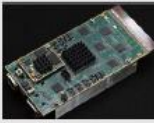

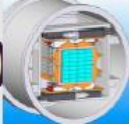

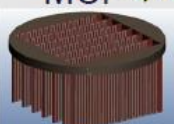
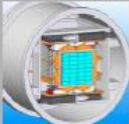
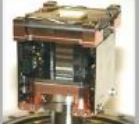
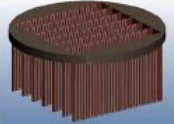


Figure 1-2: Tangential shape error profiles of Mirror #5264-1.

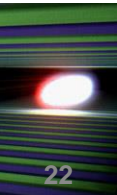


Detectors and instruments matching

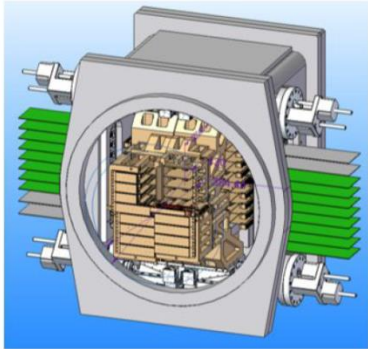


SASE 2 High E	SASE 1 Single Particles, Clusters and Biomolecules (SPB)	AGIPD 	Gotthard V2 	Fast CCD 
	Materials Imaging & Dynamics (MID)	AGIPD 	Gotthard V2 	
	Femto Second X-ray Experiments (FXE)	LPD 	Gotthard V2 	Gotthard V1 
	High Energy Density Matter (HED)		Gotthard V2 	
SASE 3 Low E	Small Quantum Systems (SQS)	DSSC 	Fast CCD 	MCP 
	Spectroscopy and Coherent Scattering (SCS)	DSSC 	Fast CCD 	MCP 

Three Detectors (Mpixel, 4.5 MHz frame rate) +...

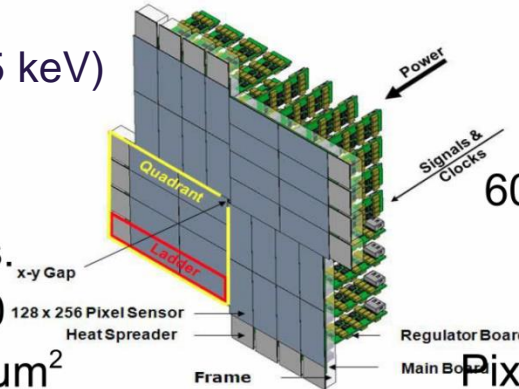


AGIPD Adaptive Gain Integrating Pixel Detector (AGIPD) 2017



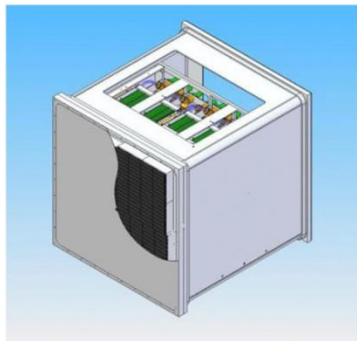
Energy range
3 - 13 keV (25 keV)
Dynamic range
 $10^4 @ 12 \text{ keV}$
Single Photon Sens.
Storage Cells ≈ 360
Pixel Size $200 \times 200 \mu\text{m}^2$

DEPFET Sensor with Signal Compression (DSSC) 2018



Energy range
0.5 - 6 keV (25 keV)
Dynamic range
 $6000 \text{ ph/pix/pulse} @ 1 \text{ keV}$
Single Photon Sens.
Storage Cells ≈ 800
Pixel Size $\approx 236 \times 236 \mu\text{m}^2$

Large Pixel Detector (LPD) 2017



Energy range
5 (1) - 20 keV (25 keV)
Dynamic range
 $10^5 @ 12 \text{ keV}$
Single Photon Sens.
Storage Cells ≈ 512
Pixel Size $500 \times 500 \mu\text{m}^2$

Other Detectors

- 1D detectors for high repetition rate applications (e.g. dispersive spectrometers)
- Small areas, low rep. rate, low energy 2D imaging detectors
- CCDs for low speed imaging
- 0D detectors (veto) coming soon

■ Courtesy M. Kuster

AGIPD planning

- Handover of 1st 1M-system (SPB) October 2016 (with AGIPD 1.0)
- Replacement of AGIPD 1.0 with AGIPD 1.1 for SPB early 2017 (before first beam)
- Handover second 1M-system (MID) early 2017 (with AGIPD 1.1)
- Development of 4M system for SFX (new layout of electronics) has started (see H. Chapman's talk)



Thank you for your attention!



■ SASE3 Soft X-ray Undulator