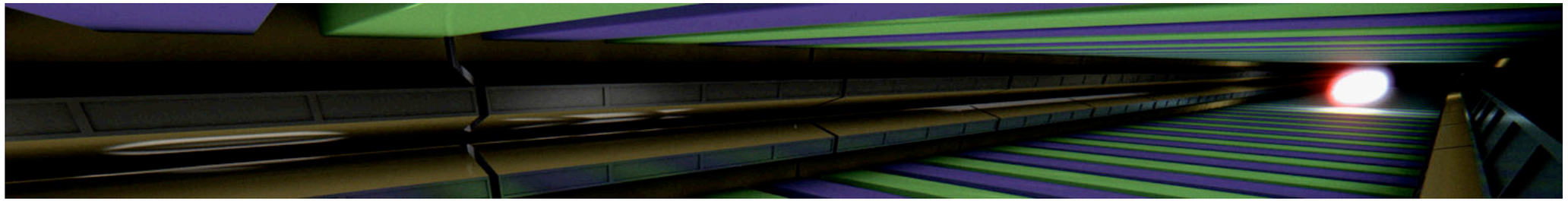


The European XFEL Project

Current Status and Future Developments

Tobias Haas

European XFEL GmbH

27 August 2012

European XFEL

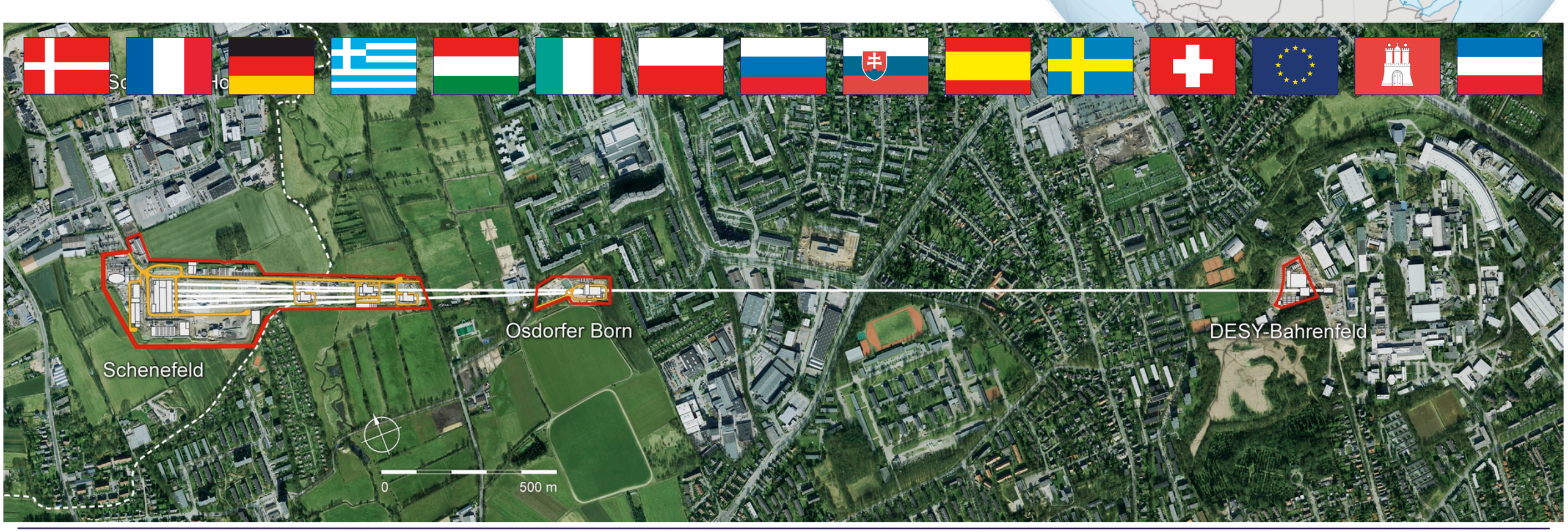
Overview

- The European XFEL Project
- Project Status
  - Civil Construction
  - Infrastructure Installation
  - Major Machine Components
    - LINAC
    - Undulator
    - Beam Lines
  - Instruments
  - Software
- Schedule/Milestones
- Extensions, proposals and upgrades

European XFEL

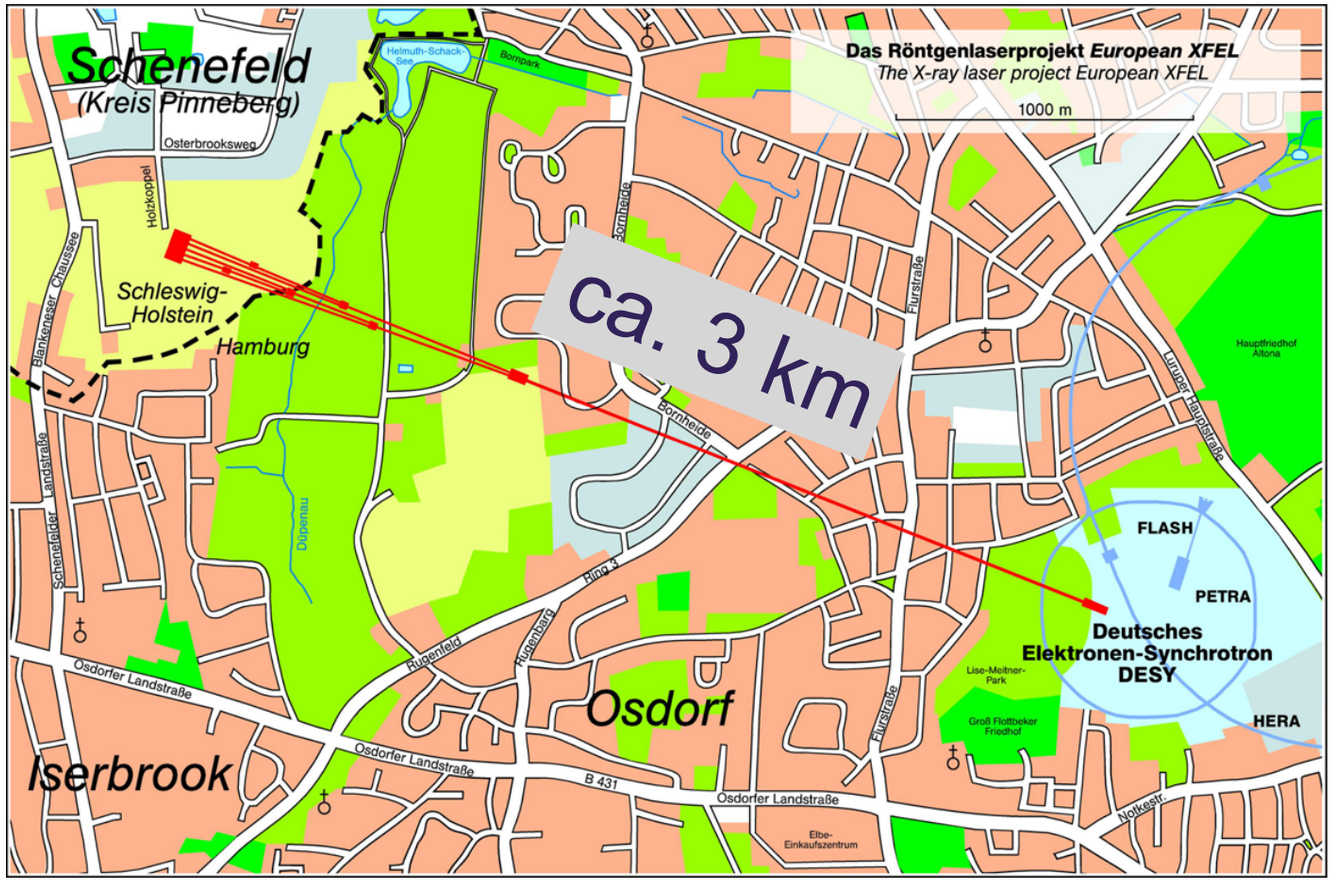
The European XFEL Project

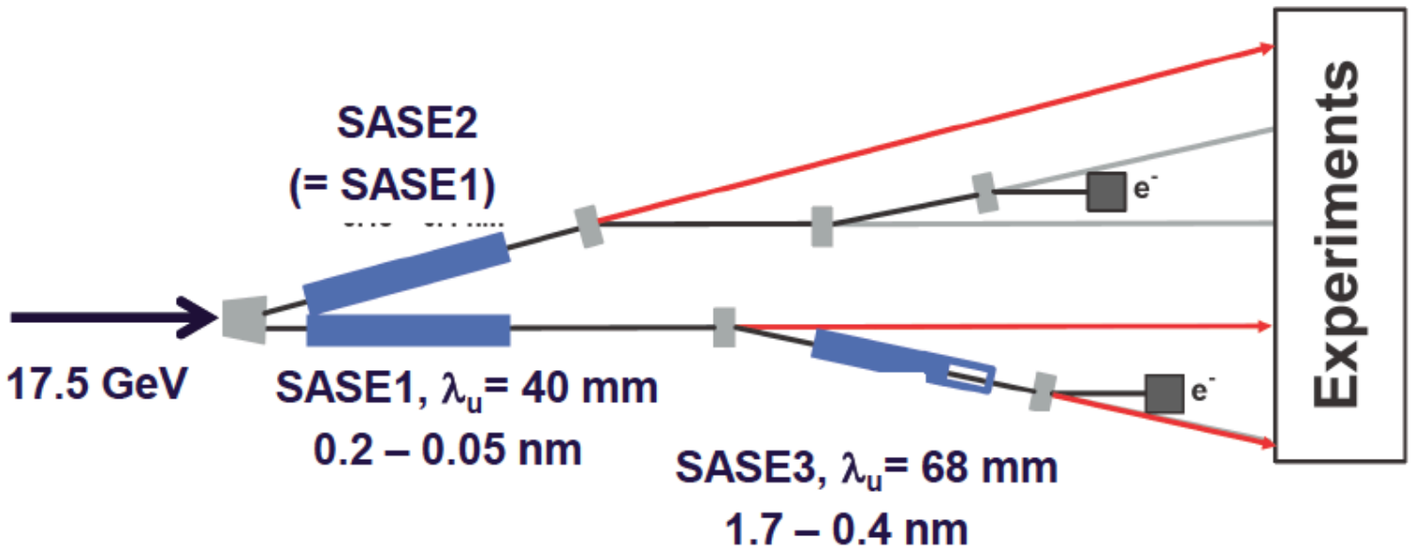
- 12 Countries
- 6 km tunnels
- 1.1 G€
- 27000 Hz
- First lasing possible: Dec 2015



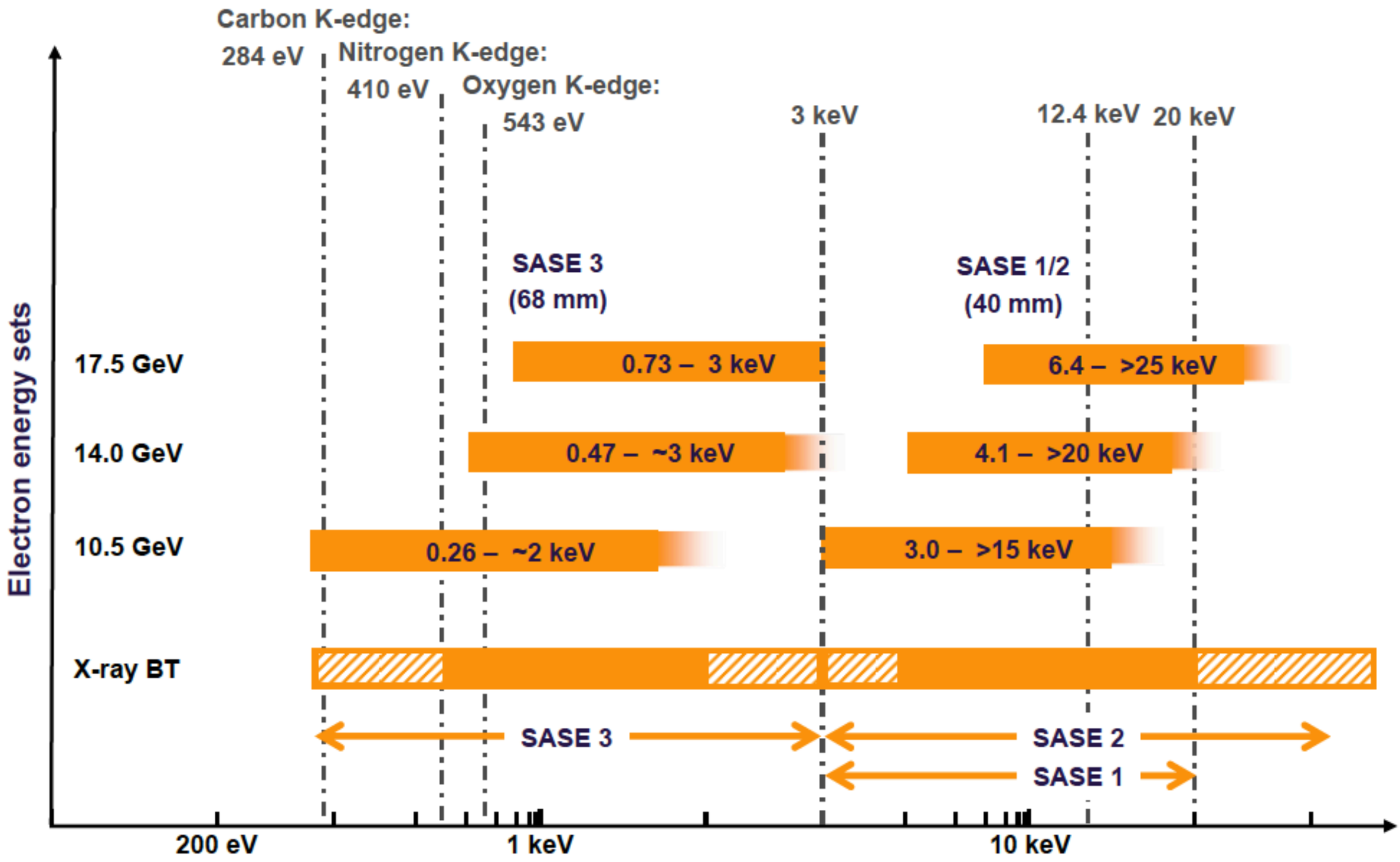
The European XFEL Machine

- Photon energy 0.3 - 24 keV
- Pulse duration ~ 10 - 100 fs
- Pulse energy few mJ
- Superconducting LINAC 10 - 17.5 GeV
- 10 Hz (27000 bunches/s)
- 5 beam lines/15 instruments:
  - Start version: 3 beam lines/6 instruments
- Possible Extensions:
  - More instruments
  - More undulators
  - Self-seeding
  - ...
  - Polarization control
  - CW operation





XFEL Operating Range



European XFEL

European XFEL Ingredients

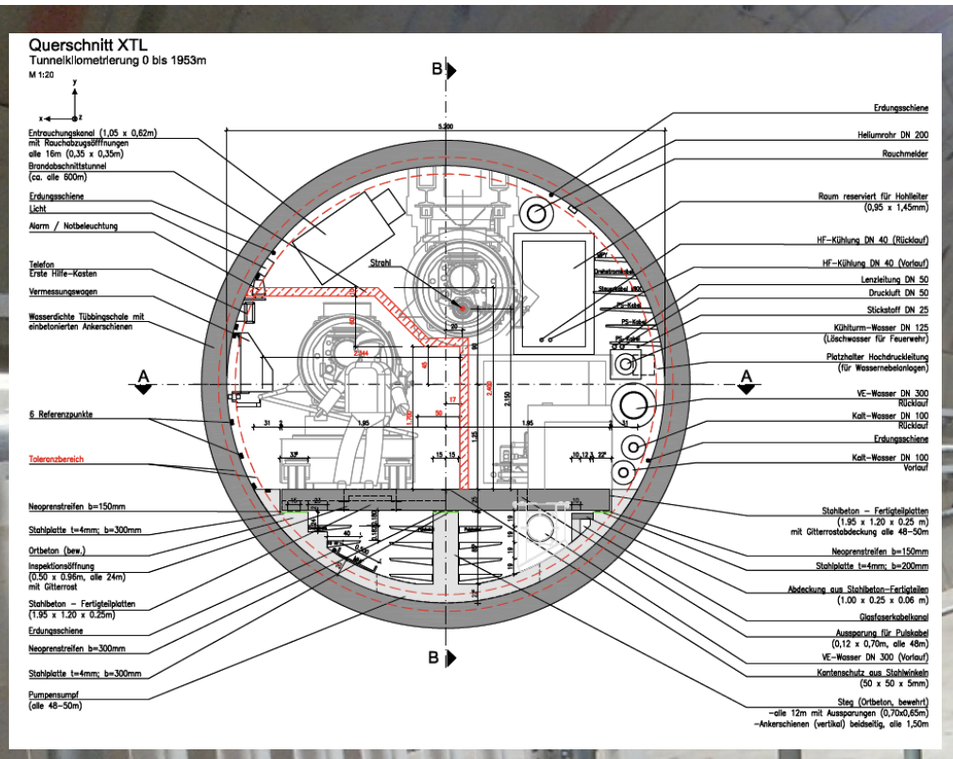
- Civil Construction
  - ca. 6000 m of Tunnels
  - 6 shaft buildings, 2 dump shafts, 1 large Experimental Hall
  - 11 Auxiliary halls on the surface
  - 1 Lab and office building
- 1 gun + injector
- 103 superconducting accelerator modules
- 91 Undulators
- 6 Instrument end stations
- 6 km vacuum systems, diagnostics, cryo and general infrastructure

Civil Construction

- Tunnel construction (5777m) is complete
- LINAC tunnel and injector building handed over
- Underground construction complete: May 2013
- Above ground construction continues until 2014

European XFEL

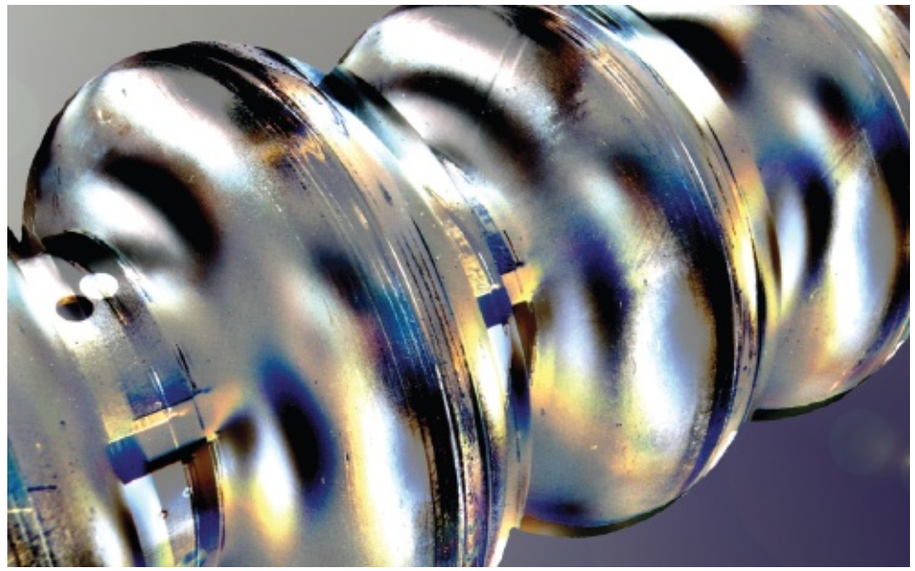
Infrastructure Installation

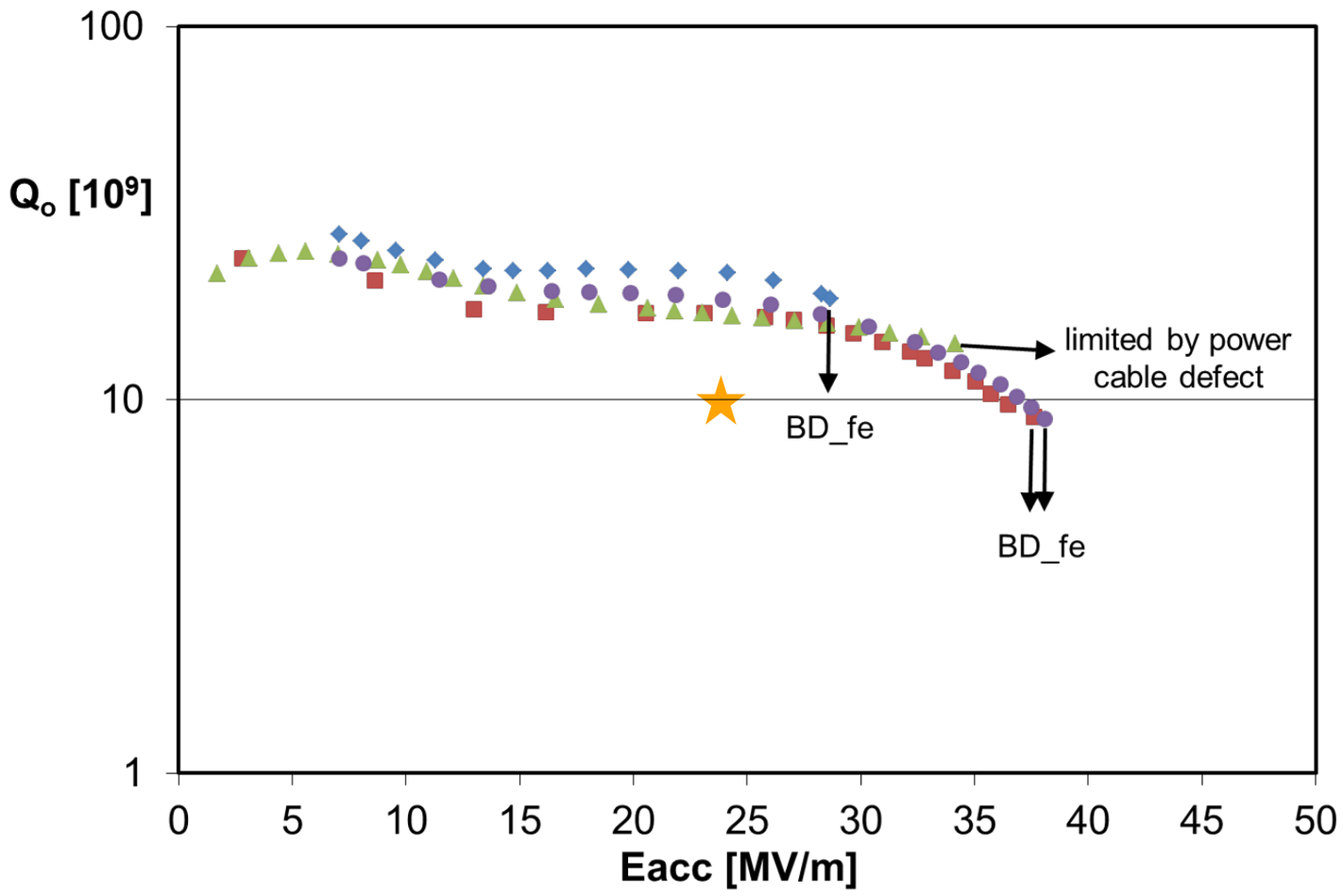


- Technical Infrastructure: 10% of total project cost
- Infrastructure installation started in March 2012
- Goes on for 3 years

LINAC: Cavities

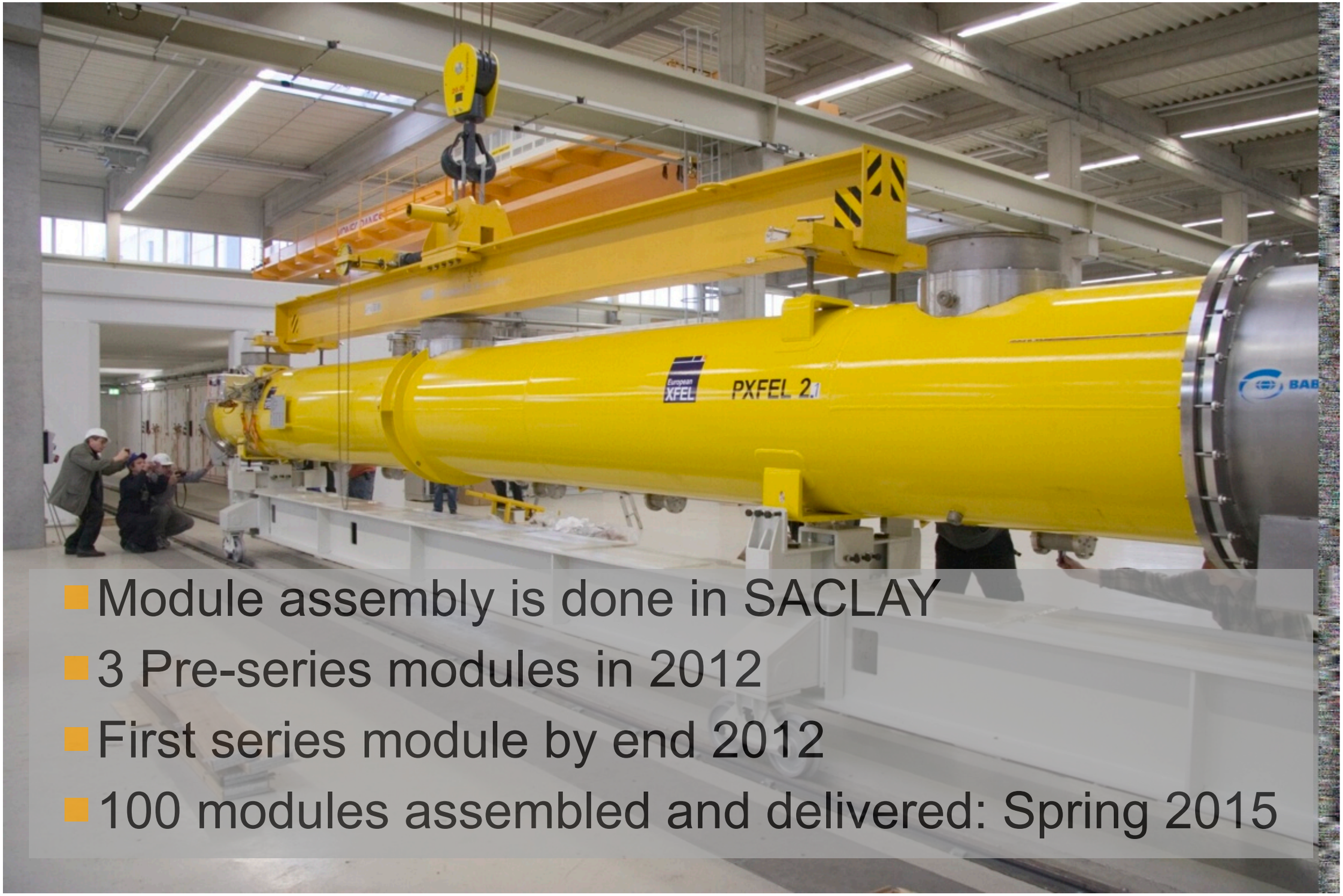
- First production cavities have been tested
- 50 cavities by end 2012
- Excellent gradients:





European XFEL

LINAC: Modules

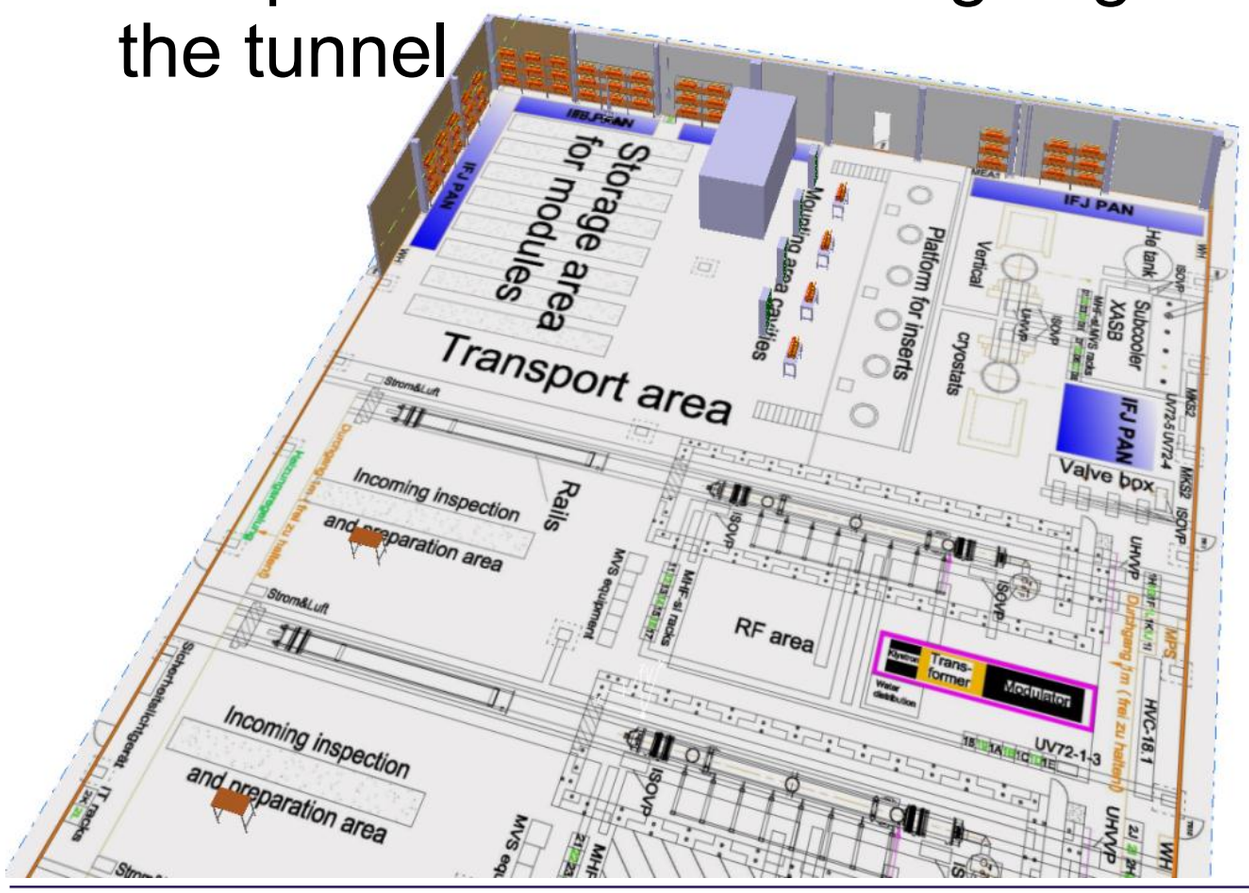


- Module assembly is done in SACLAY
- 3 Pre-series modules in 2012
- First series module by end 2012
- 100 modules assembled and delivered: Spring 2015

European XFEL

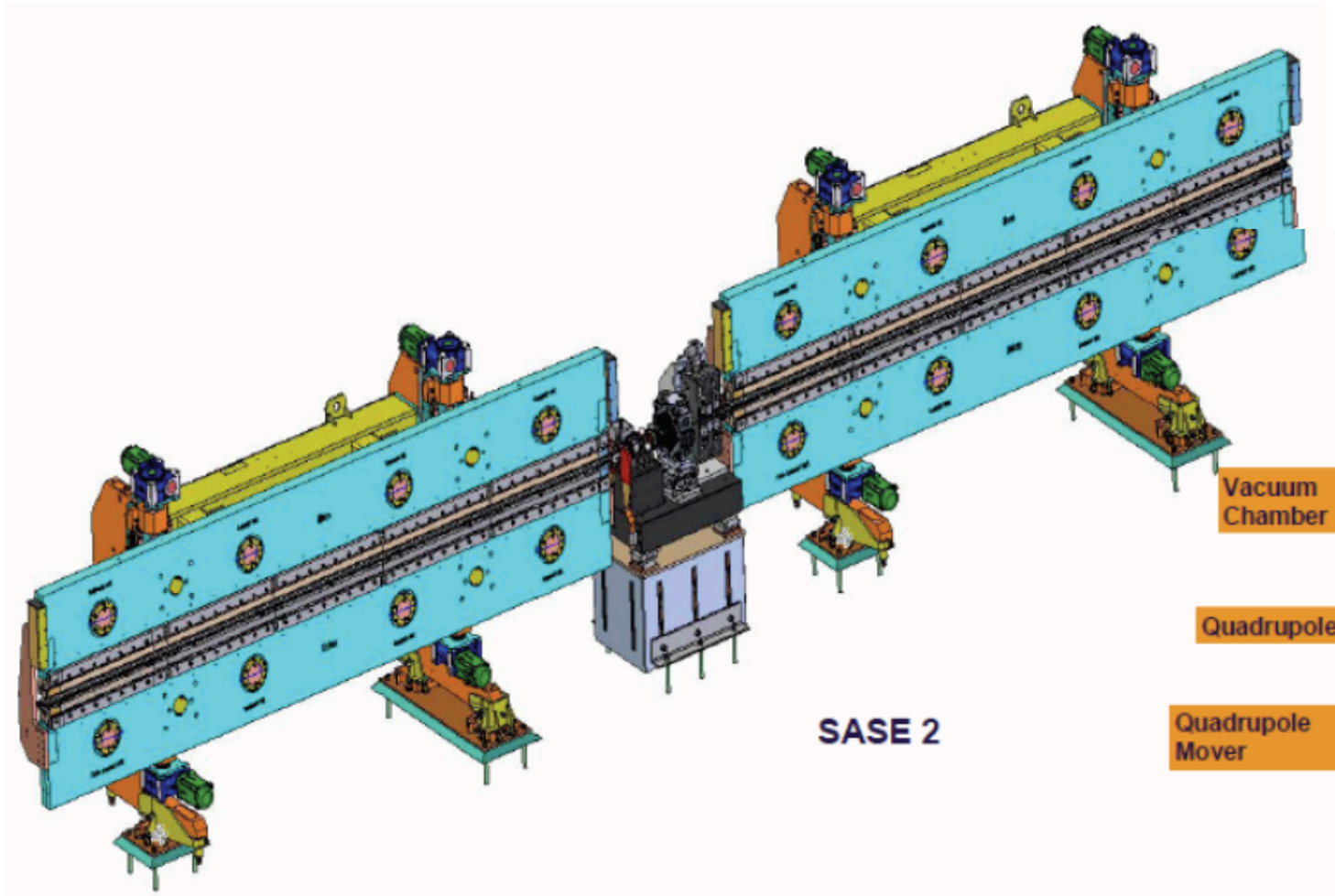
LINAC: Cavity and Module tests

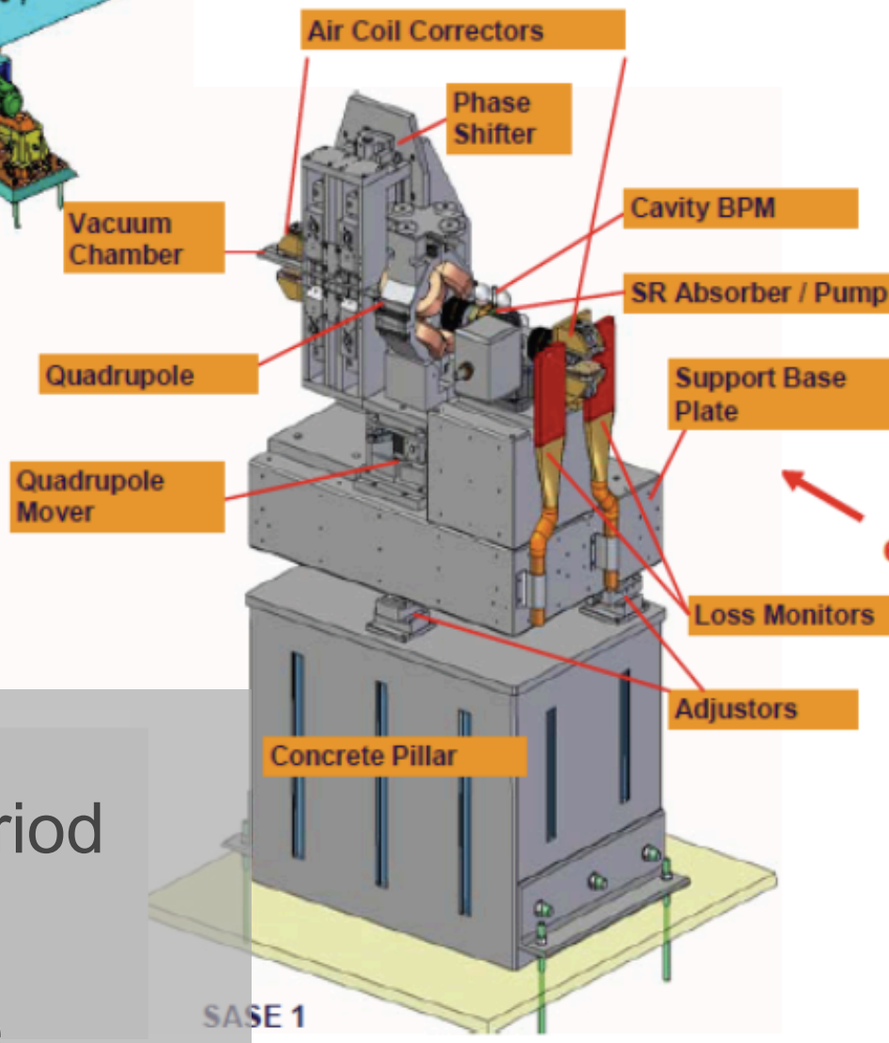
- Large dedicated hall for cryo and RF tests:
  - First cavity tests: late 2012
  - First module test: early 2013
- All cavities and all modules will be operated here before going to the tunnel



European XFEL

Undulator System

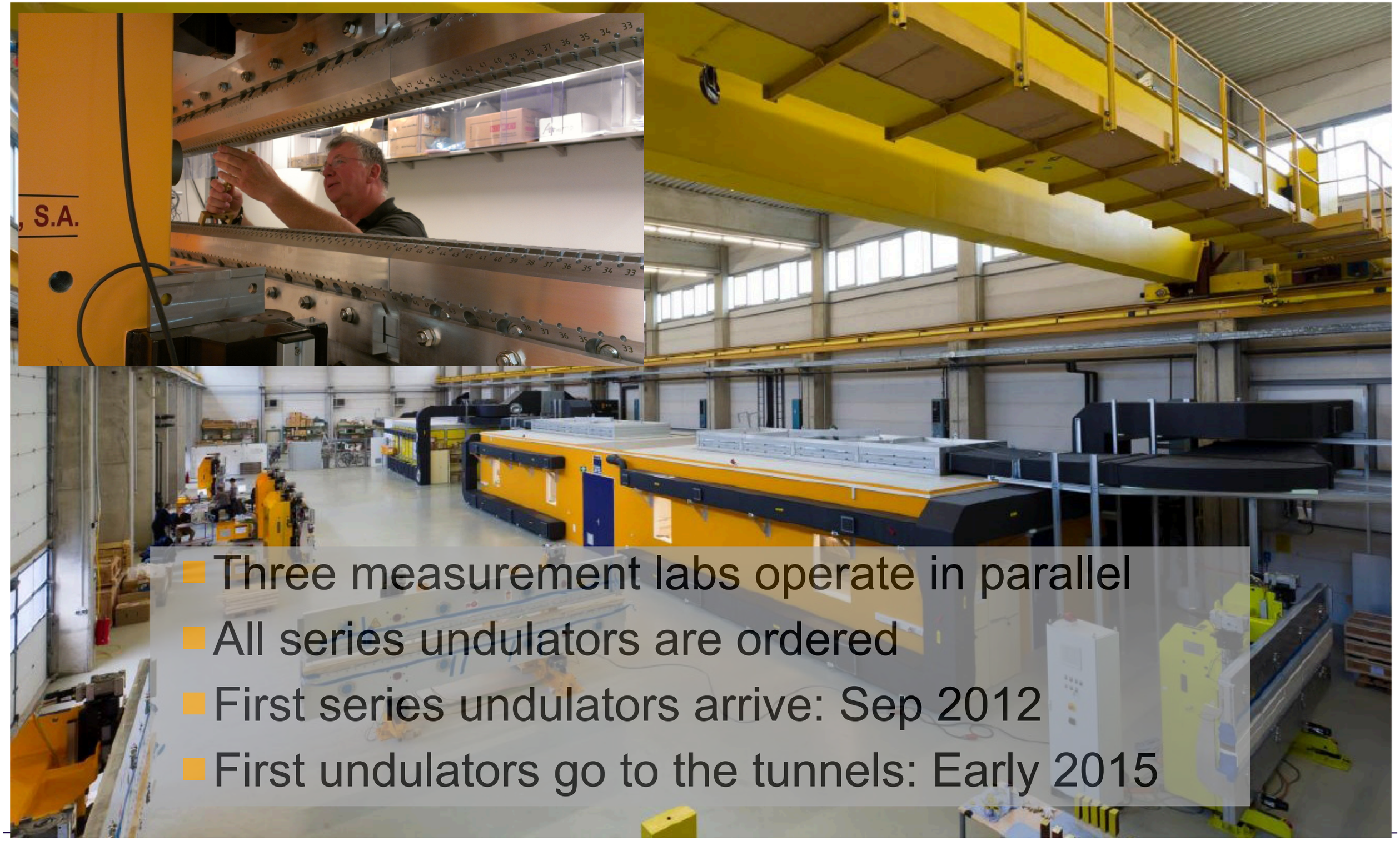




- 91 mechanically identical undulator units:
  - 2 x 35 with 40mm period, 1 x 21 with 68mm period
- 93 corresponding intersection units:
  - Beam focussing, correction, diagnostics, phase matching

European XFEL

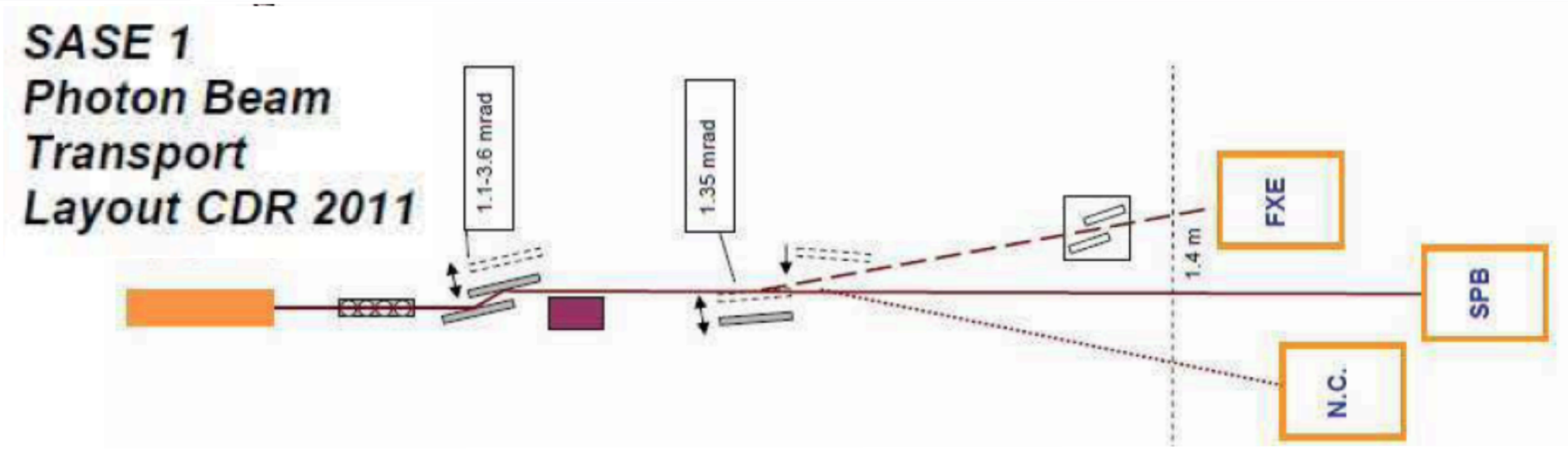
Magnetic Measurement Labs



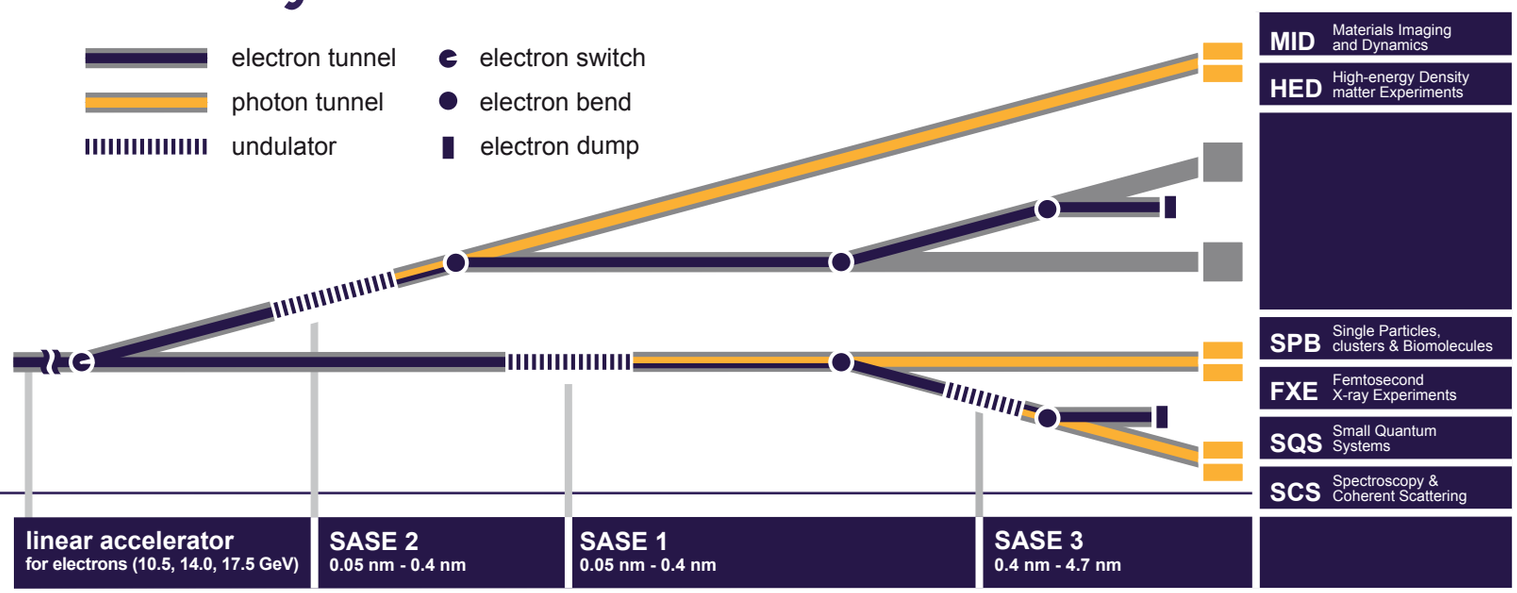
- Three measurement labs operate in parallel
- All series undulators are ordered
- First series undulators arrive: Sep 2012
- First undulators go to the tunnels: Early 2015

European XFEL

Photon Beam Lines



FEL source point
230m CRLs
270 - 280m offset mirrors
300m B.S. Collimator
370m left distribution
380m right distribution
900m Exp. area

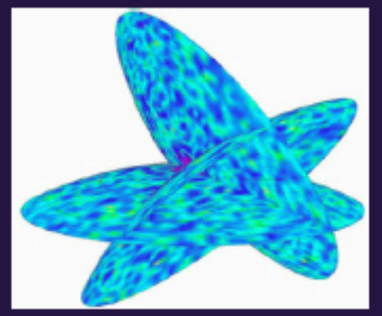


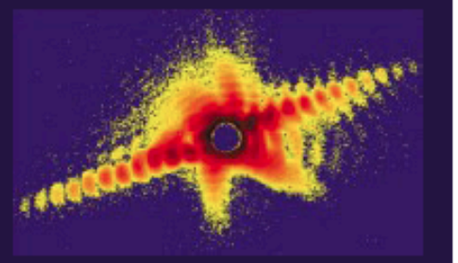
European XFEL

Scientific Instruments: Baseline

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

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



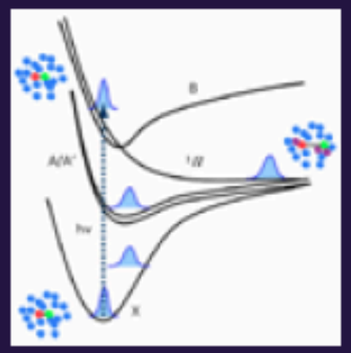


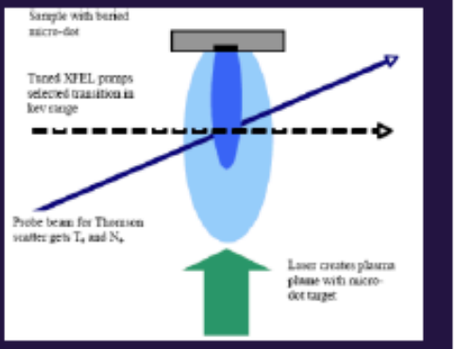
MID: Materials Imaging & Dynamics

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





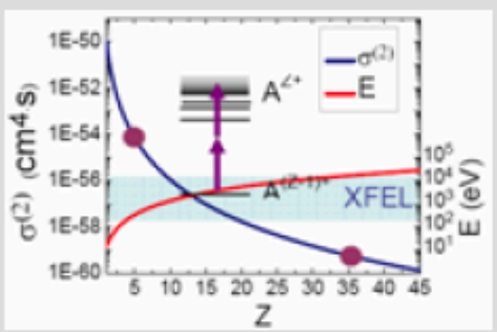
HED: High Energy Density Matter

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



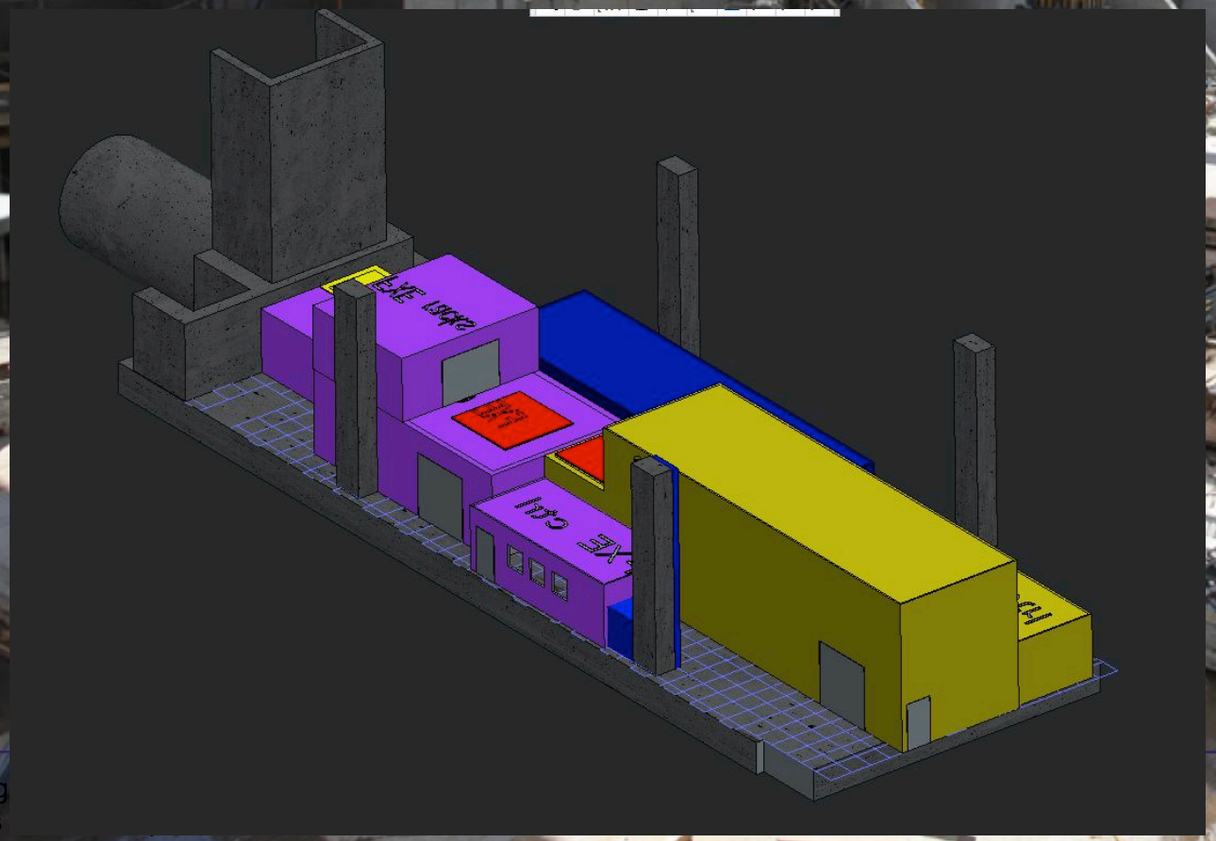
SCS: Soft x-ray Coherent Scattering/Spectroscopy

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

European XFEL

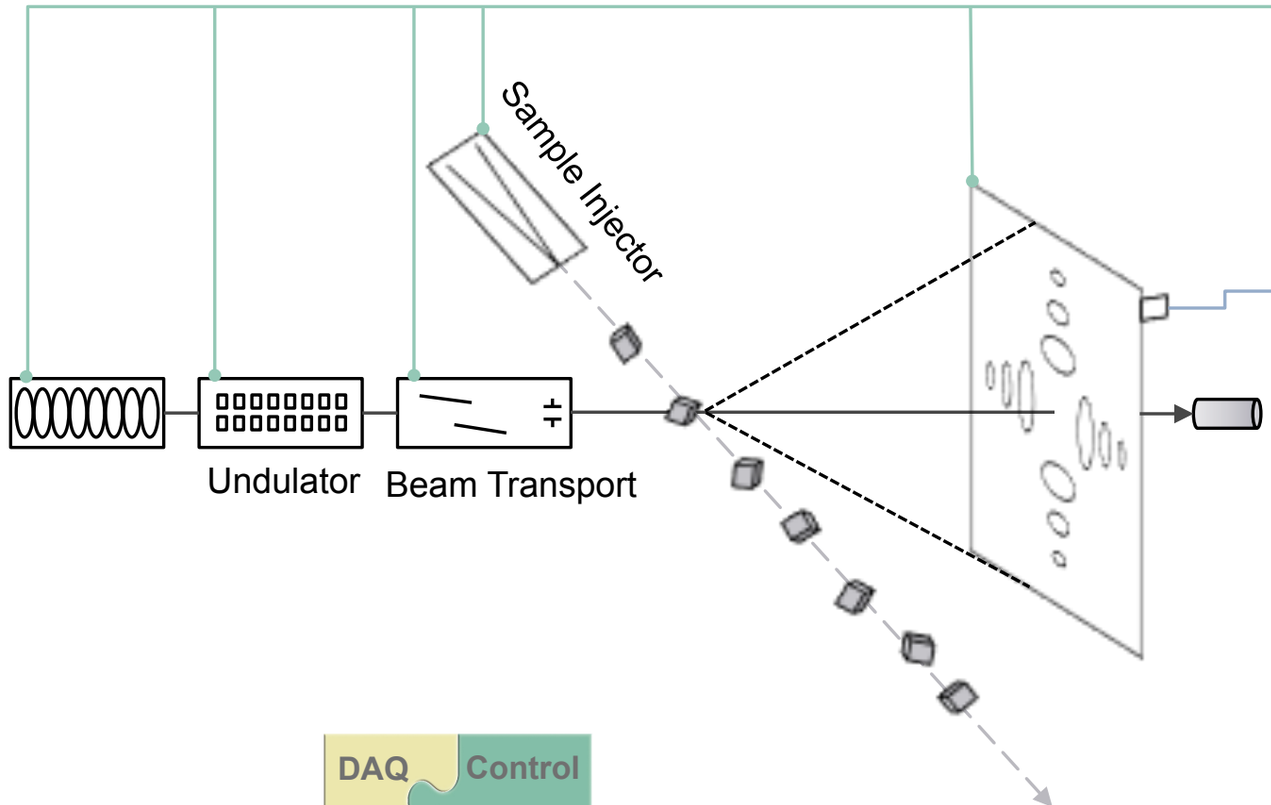
Instruments and Experimental Hall

- Conceptual design done for 4 instruments
  - FXE, SPB, MID, SQS ➔ Technical Design
- Fall 2014: Construction of hutches and infrastructure
- Early 2015: First instruments on the ground
- Late summer 2015: Ready to open beam shutters



Software

- A homogenous environment with fast/simple interaction between Control, DAQ, Data Management and Scientific Computing



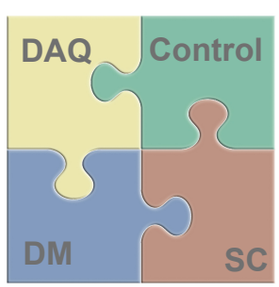
Control
drive hardware and complex experiments
monitor variables & trigger alarms

DAQ
data readout
online processing
quality monitoring (vetoing)

show online data whilst running

DM
storage of experiment & control data
data access, authentication authorization etc.

SC
processing pipelines
distributed and GPU computing
specific algorithms (e.g. reconstruction)



Tight integration of applications

European XFEL Milestones

2012

Sep ’12: Start Acc. Module Production

2013

May ’13: Underground Constr. Finished

Aug ’13: Start Machine Inst.

2014

Jun ’14: Injector Closed

Sep ’14: First Beam to Injector Dump

2015

Jun ’15: LINAC closed

Dec ’15: First Lasing SASE1

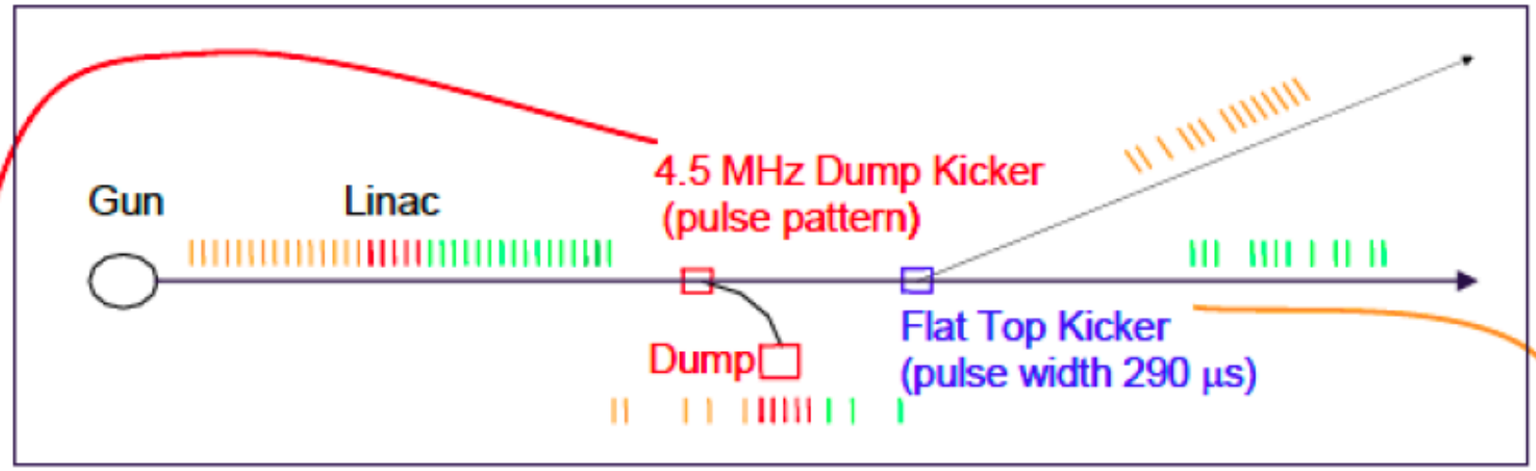
2016

Mar ’16: SASE1 User Operation

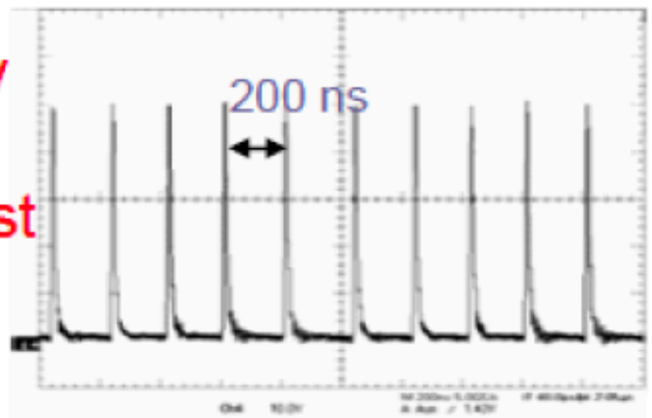
Apr ’16: SASE3 User Operation

Jul ’16: SASE2 User Operation

Beam Switching

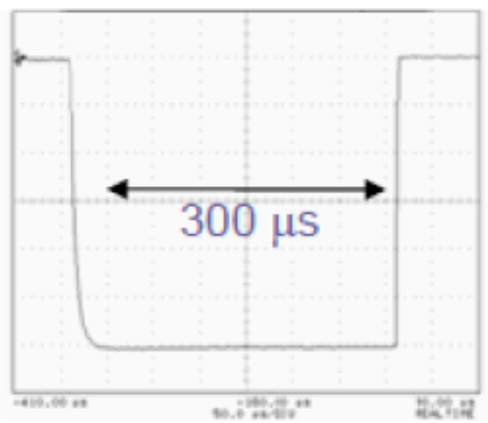


- low accuracy (>1 %)
- 4.5 MHz burst operation



example:
pulser prototype measurement

- high accuracy (< 0.01 %)
- 10 Hz operation

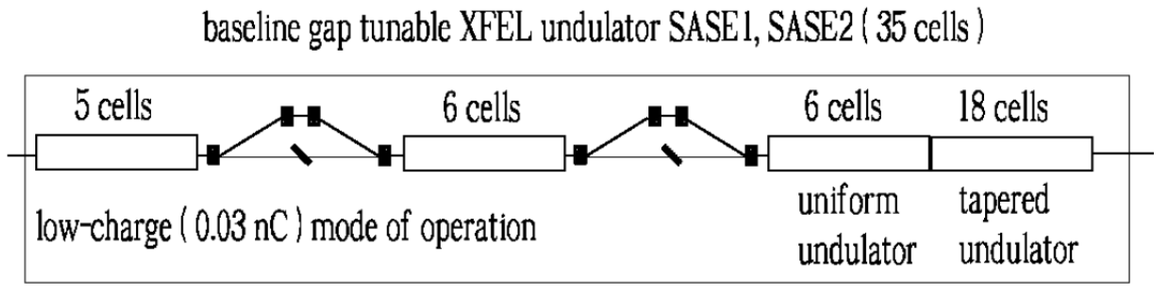


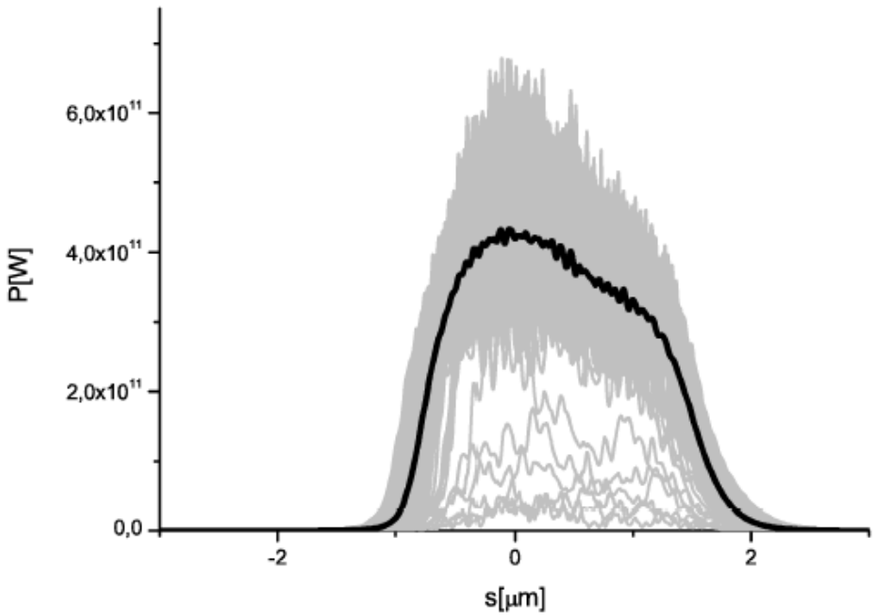
example:
pulser prototype measurement

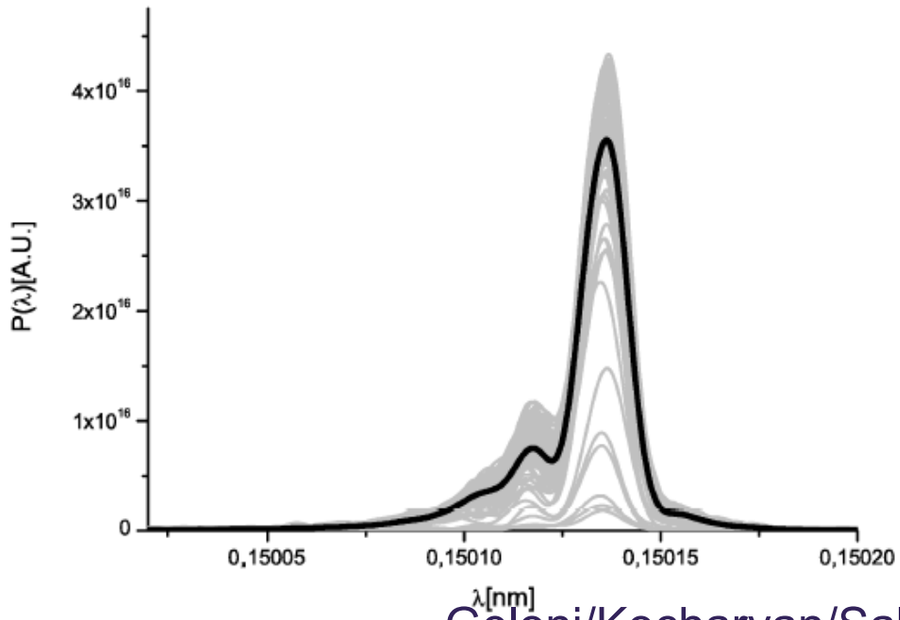
European XFEL

Hard X-ray Self-Seeding (Proposal)

- Successfully demonstrated at LCLS
- Install HXRSS setup asap, ideally before tunnel closing in 2015
- Commission with SASE first using phase shifters in place of chicanes





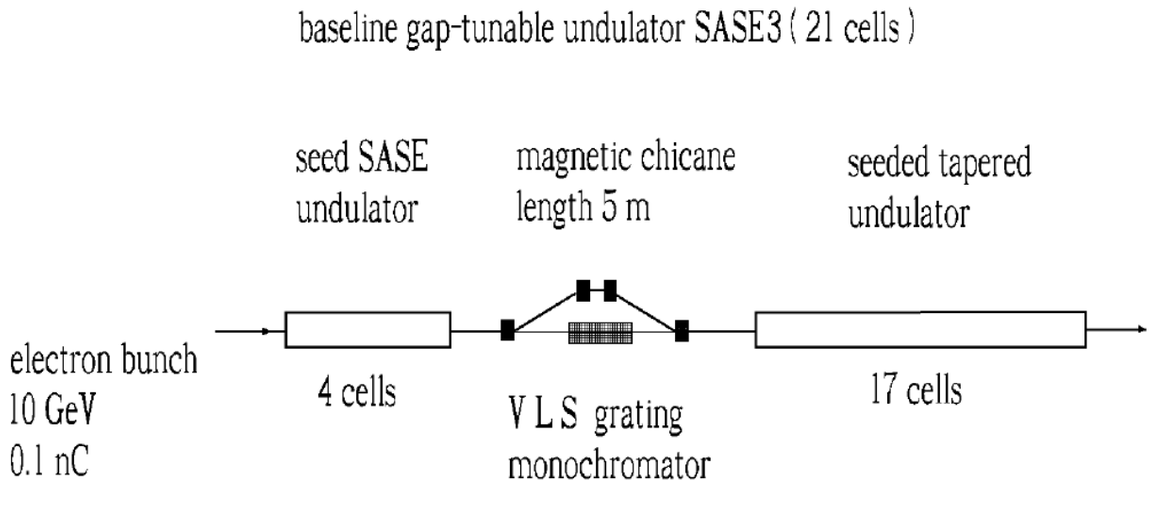


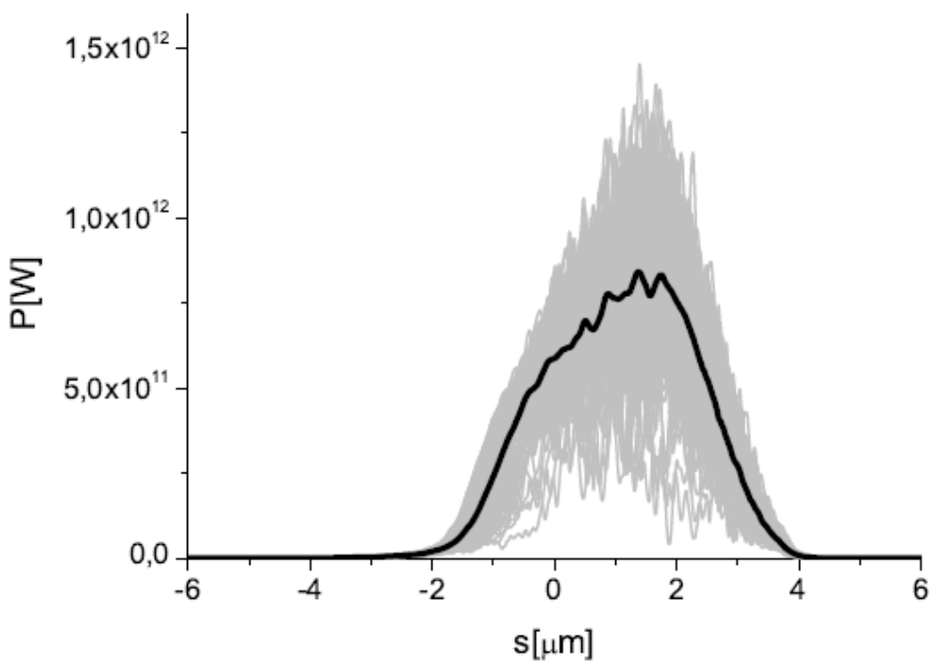
Geloni/Kocharyan/Saldin (DESY 11-165)

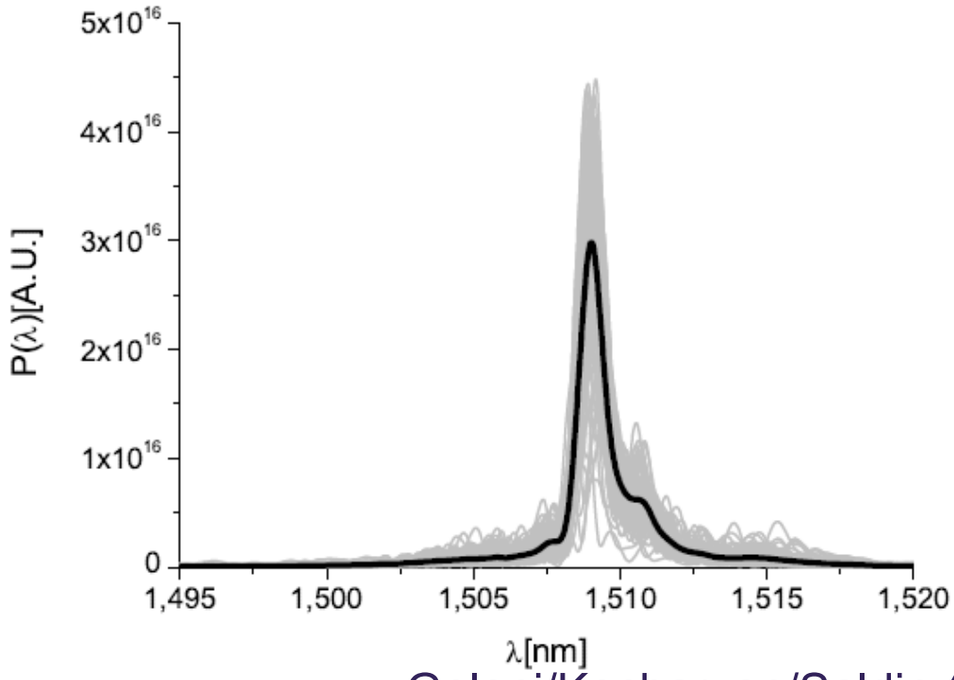
European XFEL

Soft X-ray Self-Seeding (Proposal)

- Install a SXRSS setup at SASE3, pending validation of the method at the LCLS
- Unlikely to be implemented before tunnel closing in 2015
- But prepared to proceed at next available opportunity



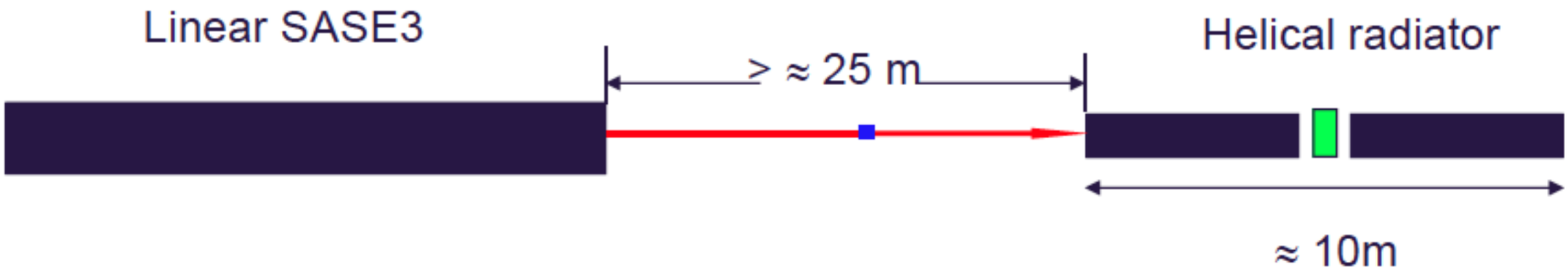




Geloni/Kocharyan/Saldin (DESY 12-034)

Helical Afterburner for SASE3 (Proposal)

- Modified version of proposal in DESY 11-096



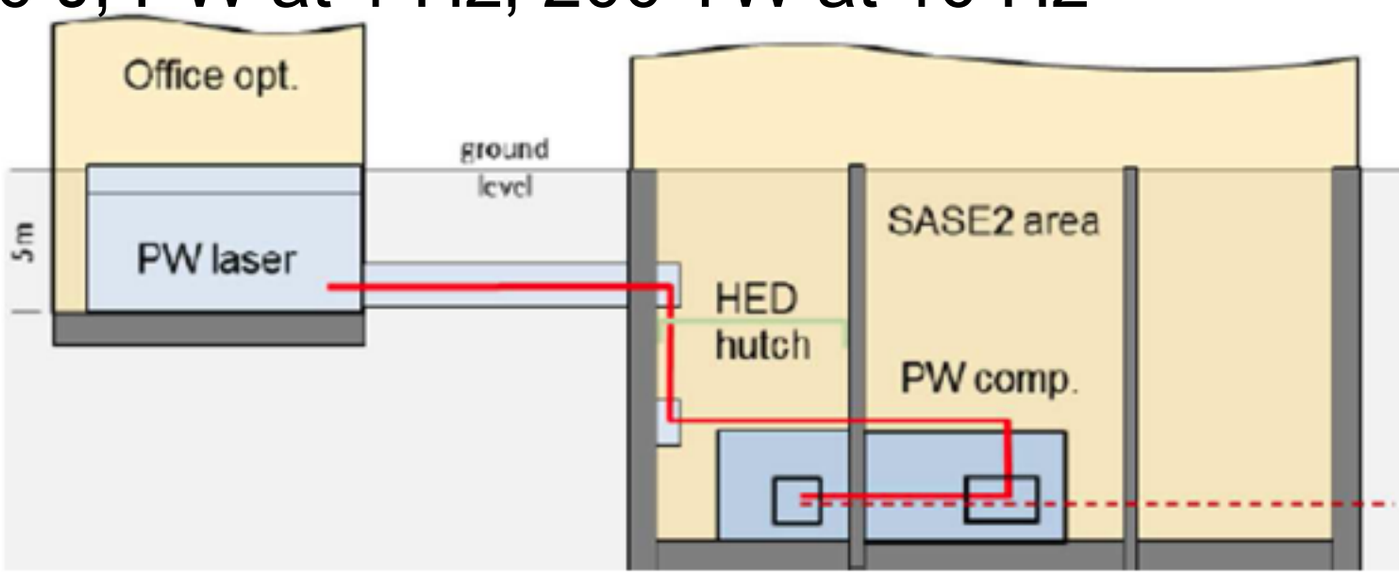
- Improves the scope of EuXFEL significantly
- R&D needed for separating CP and linear beams
- Installation requires modification or 30 - 50m of SASE3
- Needs a longer shutdown
- Earliest installation after a first user run

Geloni/Kocharyan/Saldin (DESY 11-096)

European XFEL

Helmholtz-Beamline Proposal

- User Consortium
  - 62 institutes from Germany, Switzerland, Czech Republic, Spain, France Hungary, Poland, Russia, Sweden, UK, China, India, Japan, and the U.S.
  - Led by T. C. Cowan, HZDR, Dresden/Rossendorf
- Drive matter to extremes of temperature, density, pressure, field strength, particle irradiation to be probed with the XFEL beams
- Petawatt Optical Laser Facility:
  - High energy (kJ) laser system with ns pulse duration
  - High power (PW) laser: pulses with 35/100 fs duration and pulse energies ranging from 30 - 200 J, PW at 1 Hz, 200 TW at 10 Hz
- Pulsed magnet device:
  - ms pulses with B up to 50 T.



European XFEL

Summary & Conclusions

- Construction and installation of EuXFEL are in full swing
- Commissioning starts with the injector in 2014
- First lasing possible before the end of 2015
- Next steps are the expansion of the startup scope to turn this into a fully versatile user facility