Community

News

https://doi.org/10.1515/aot-2017-0059

World's strongest X-ray laser inaugurated

The European XFEL, the largest and most powerful X-ray laser in the world was officially inaugurated on 1st September 2017. With a budget of €1.22 billion it is Germany's most expensive research device. Equipped with superconducting accelerator coils it will generate 27 000 X-ray flashes per second to capture images of individual atoms with less than 100 fs time resolution.

In the first week of August the people in Hamburg (Germany) were excited by a very unusual nightly spectacle: several green laser beams were shining on famous buildings in the city at a height of 50 m. They learnt from local media that this installation welcomes a new scientific tool for the research on the structure of matter.

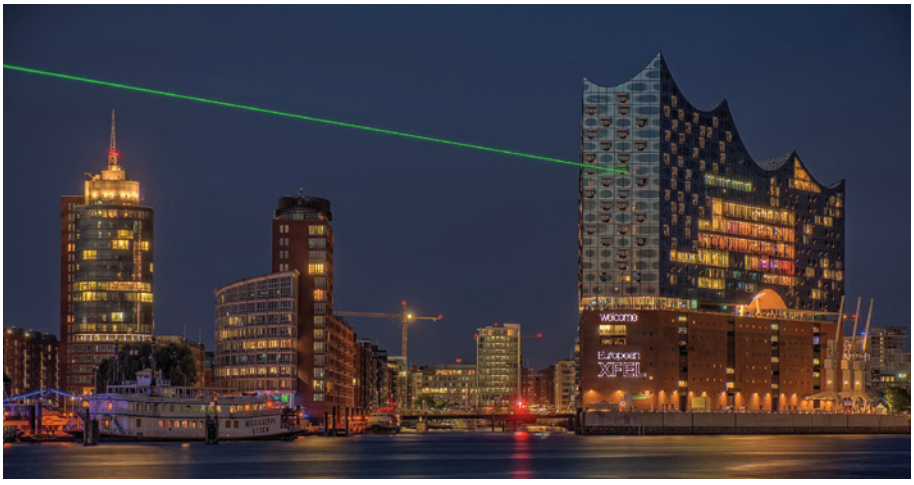
The device itself is barely visible: the European XFEL is located mainly in underground tunnels which can be accessed on three different sites. The 3.4 km-long facility will run from the DESY campus in Hamburg to the town of Schenefeld in the adjacent federal state of Schleswig-Holstein.

At present, 11 countries are participating in the project: Denmark, France, Germany, Hungary, Italy, Poland, Russia, Slovakia, Spain, Sweden and Switzerland. The United Kingdom is in the process of joining. The construction costs of the facility amount to €1.22 billion (price levels of 2005). Germany covers 58%, Russia bears 27% and the other international partners between 1% and 3%.

After 8 years of construction the facility was officially inaugurated on 1st September 2017. Eight hundred guests including Ministers for Science from Germany and France and high ranking politicians from Russia joined for this event. Prof. Dr. Helmut Dosch, Chairman of the DESY Board of Directors, said: 'What started as a vision and was set in motion at DESY more than 20 years ago has now become a reality: the world's most powerful laser for X-ray light. Now scientists from around the world will conduct research at this most advanced high-speed camera for the nanocosmos in the world, and I wish them many exciting results – both fundamental and revolutionary'.

How it works

Precise electron bunches are generated by knocking the particles out of a piece of metal using a conventional laser.



The laser in the night sky and the message on the base of Hamburg's new concert hall and landmark, the Elbphilharmonie, welcomes the European XFEL (Copyright: Michael Schmidt/European XFEL).

Table 1: Copyright European XFEL.

	European XFEL	LCLS	LCLS-II, CuRF	LCLS-II, SCRF	SACLA	SwissFEL	PAL-XFEL
Abbreviation for	European X-ray free-electron laser	Linac coherent light source	Linac coherent light source II	Linac coherent light source II	SPRing-8 compact free-electron laser	Swiss free-electron laser	Pohang accelerator laboratory X-ray free-electron laser
Location	Germany	USA	USA	USA	Japan	Switzerland	South Korea
Start of commissioning	2016	2009	2019	2020	2011	2016	2016
Accelerator technology	Super-conducting	Normal-conducting	Normal-conducting	Super-conducting	Normal-conducting	Normal-conducting	Normal-conducting
Number of light flashes per second	27 000	120	120	1 000 000	60	100	60
Minimum wavelength of the laser	0.05 nm	0.15 nm	0.05 nm	0.25 nm	0.08 nm	0.1 nm	0.06 nm
Maximum electron energy	17.5 GeV	14.3 GeV	15 GeV	5 GeV	8.5 GeV	5.8 GeV	10 GeV
Length of the facility	3.4 km	3 km	3 km	3 km	0.75 km	0.74 km	1.1 km
Number of undulators	3	1			3	1	2
Number of experiment stations	6	5			4	3	3
Peak brilliance (photons/s/mm^2/mrad^2/0.1% bandwidth)	5×10^{33}	2×10^{33} (2.75×10^{34} with seeding)	2×10^{33}	1×10^{32}	1×10^{33}	1×10^{33}	1.3×10^{33}

The linear accelerator of the European XFEL is the longest superconducting linear accelerator in the world. It drives electrons up to 17.5 GeV energy (Copyright European XFEL).

Those electrons are then injected into a 1.7 km-long linear accelerator that brings them to high energies at nearly the speed of light.

The accelerated electrons then race through long undulators, periodic arrangements of magnets that force the electrons onto a tight slalom course. There, electrons emit X-ray radiation that amplifies more and more.

Because the radiation is faster than the speed of the electrons, the radiation overtakes the electrons flying ahead and interacts with them along the way, accelerating some of them and slowing others down. The electrons gradually organize themselves into a multitude of thin disks. The key property of this process is the fact that all of the electrons in a given disk emit their light 'in sync'. This produces extremely short and intense X-ray flashes with the properties of laser light.

In its initial configuration, the European XFEL will provide three undulators with six experiment stations. Eventually, this will be expanded to five undulators with ten instruments, and perhaps even more.

Compared to other FEL projects (Table 1) the European XFEL offers the best parameters for a number of fundamental and applied research projects ranging from medicine and pharmacology to chemistry, physics and materials.

(A modified version of this text has been previously published with *Laser Focus World*)

Conference Calendar

October

ASSL
Nagoya, Japan
1–5 October 2017
www.osa.org/en-us/meetings/global_calendar/events/advanced_solid_state_lasers/

SPIE Optifab
Rochester, New York, USA
16–19 October 2017
http://spie.org/x6567.xml

FOC 2017 Frontier of Optical Coating
Guangzhou, China
22–26 October 2017
http://foc.tongji.edu.cn

ICALEO
Atlanta, Georgia, USA
22–26 October 2017
www.lia.org/conferences/icaleo

V2017
Dresden, Germany
24–26 October 2017
www.v-workshopwoche.net/v2017.html

32nd ASPE Annual Meeting
Charlotte, North Carolina, USA
October 29–November 3, 2017
http://aspe.net/technical-meetings/32nd-annual-meeting/

November

OSA Light, Energy and the Environment Congress
Optical Nanostructures and Advanced Materials for Photovoltaics (PV), Optics and Photonics for Energy and the Environment (E2), Optics for Solar Energy (SOLAR), Solid-State Lighting (SSL)
Boulder, Colorado United States
06–09 November 2017
www.osa.org/en-us/meetings/osa_meetings/osa_light_energy_and_the_environment_congress/

The 22nd Microoptics Conference MOC2017
Tokyo, Japan
19–22 November 2017
www.moc17.com

2018

January

SPIE Photonics West
San Francisco, California, USA
27 January–1 February 2018
Exhibition: 30 January–1 February 2018
http://spie.org/pw

February

SPIE Advanced Lithography
San Jose, California, USA
18–22 February 2018
http://spie.org/al

March

OFC
11–15 March 2018
San Diego, California, USA
www.ofcconference.org

Symposium Photonischer Leichtbau
14–15 March 2018
Hannover, Germany
www.photonischer-leichtbau.de

April

SPIE Defense + Commercial Sensing
Orlando, Florida, USA
15–19 April 2018
http://spie.org/dcs

OSA Biophotonics Congress: Biomedical Optics
Clinical and Translational Biophotonics
Optics and the Brain
Optical Tomography and Spectroscopy
Hollywood, Florida, USA
03–06 April 2018
www.osa.org/en-us/meetings/osa_meetings/osa_biophotonics_congress_biomedical_optics/

SPIE Photonics Europe
Strassbourg, France
23–26 April 2018
Exhibition: 24–25 April 2018
http://spie.org/pe

May

AKL'18 International Laser Technology Congress
Aachen, Germany
2–4 May, 2018
www.lasercongress.org

CLEO
San Jose, California, USA
13–18 May 2018
www.cleoconference.org

EOS Topical Meeting on Terahertz Science and Technology (TST 2018)
Berlin, Germany
6–9 May 2018
http://www.myeos.org/events/tst2018

Optatec
Frankfurt, Germany
15–17 May 2018
www.optatec–messe.de

June

LASYS
Stuttgart, Germany
5–7 Juni 2018
www.lasys-messe.de

SLT'18 – Stuttgart Laser Technology Forum
Co-located with LASYS
Stuttgart, Germany
5–7 Juni 2018
www.slt.uni-stuttgart.de

SPIE Astronomical Telescopes and Instrumentation
Austin, Texas, USA
10–15 June 2018
http://spie.org/astronomical-instrumentation.xml

August

SPIE Optics + Photonics
San Diego, California, USA
19–23 August 2018
Exhibition: 21–23 August 2018
http://spie.org/op

September

SPIE Security + Defence
Berlin, Germany
10–13 September 2018
Exhibition: 11–12 September 2018
http://spie.org/sd

FiO/LASER Science: 102nd OSA Annual Meeting
Washington, DC, USA
16 Sep 2018–26 Sep 2018
www.frontiersinoptics.com/home/

ECOC European Conference on Optical Communications
Rome, Italy
23–27 September 2016
www.ecoc2018.org

October

European Optical Society Biennial Meeting (EOSAM) 2018
Delft, The Netherlands
8–12 October 2018
www.myeos.org/events/eosam2018

2019

SPIE Photonics West
San Francisco, California, USA
2–7 February 2019
Exhibition: 5–7 February 2019
http://spie.org/pw

SPIE Advanced Lithography
San Jose, California, USA
19–22 February 2019

5. UKP-Workshop
Aachen, Germany
10–11 April 2019

SPIE Optifab
Rochester, New York, USA
14–17 October 2019