

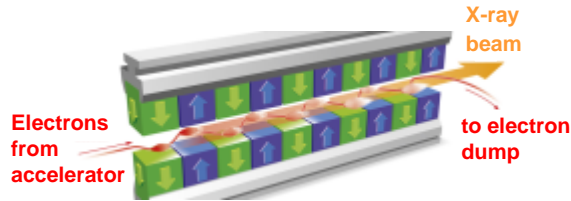


**EIRO** forum  
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ESI 2019 Project Day Technologies - XFEL

# X-ray free-electron lasers:

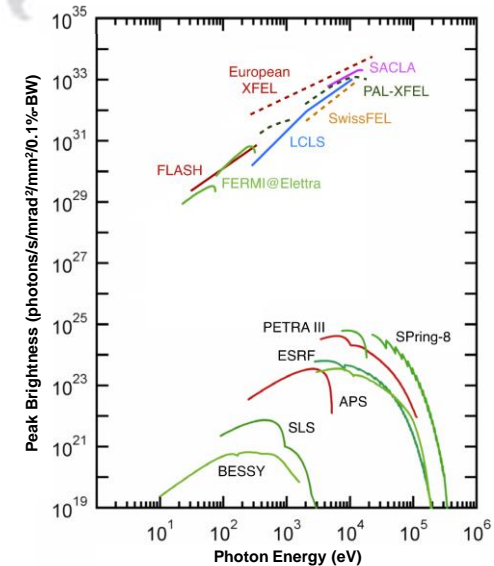
## high-intensity coherent X-ray sources



Bunches of electrons are accelerated to high energies and then directed through special arrangements of magnets (undulators). In the process, the particles emit radiation that is increasingly amplified until an extremely short and intense X-ray flash is finally created.

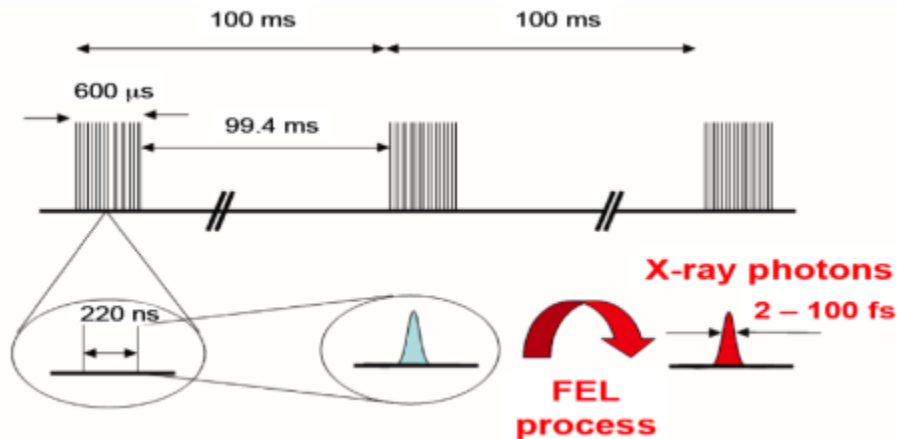


Facility	LCLS USA	LCLS-II CuRF	LCLS-II SCRF	SACLA Japan	European XFEL	SwissFEL Switzerland	PAL-XFEL South Korea	SCLF China
Max. electron energy (GeV)	14.3	15	5.0	8.5	17.5	5.8	10	8
Wavelength range (nm)	0.1–4.6	0.05–5.0	0.25–5.0	0.06–0.3	0.05–4.7	0.1–7	0.06–10	0.05–3.1
Photons/ pulse	$\sim 10^{12}$	$2 \times 10^{13}$	$3 \times 10^{13}$ (soft X-rays)	$2 \times 10^{11}$	$\sim 10^{12}$	$\sim 5 \times 10^{11}$	$10^{11}–10^{13}$	$10^{10}–10^{13}$
Peak brilliance	$2.7 \times 10^{34}$ (with seeding)	$2.7 \times 10^{34}$ (with seeding)	$1 \times 10^{32}$	$1 \times 10^{33}$	$5 \times 10^{33}$	$1 \times 10^{33}$	$1.3 \times 10^{33}$	$1 \times 10^{33}$
Pulses/ second	120	120	1 000 000	60	27 000	100	60	1 000 000
Date of first beam	2009	2019	2020	2011	2017	2016	2016	2025
Start of user operation	2009	2019	2020	2012	2017	2018	2017	2025



More information: [https://www.xfel.eu/facility/overview/index\\_eng.html](https://www.xfel.eu/facility/overview/index_eng.html)

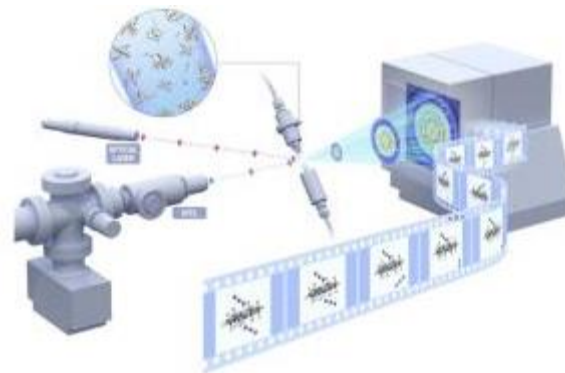
# European XFEL: MHz coherent X-ray flashes of femtoseconds duration



- The European XFEL can produce 27 000 X-ray laser flashes per second
- Experiments formerly worked with max 120 flashes per second
- Bunch trains: 4.5 MHz total repetition rate

## Special Performances

- ➡ **X-ray light**  
Samples at atomic resolution
- ➡ **Ultrashort flashes**  
Femtosecond dynamics
- ➡ **Intense X-ray pulses**  
Low intensity sample



## More information:

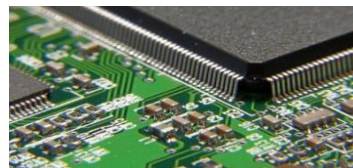
[http://xfel.desy.de/technical\\_information/tdr/tdr/](http://xfel.desy.de/technical_information/tdr/tdr/)  
[http://xfel.desy.de/technical\\_information/photon\\_beam\\_parameter/](http://xfel.desy.de/technical_information/photon_beam_parameter/)

# European XFEL: Applications

## Characterization of unseen sample and phenomena



Enhancing structure and behaviour of nanomaterials



Studying materials magnetic structure to build ultrahigh-capacity hard drives



Uncover catalyst action to improve catalytic converters and lessen impact of emissions



Understanding disease mechanism to make more effective drugs

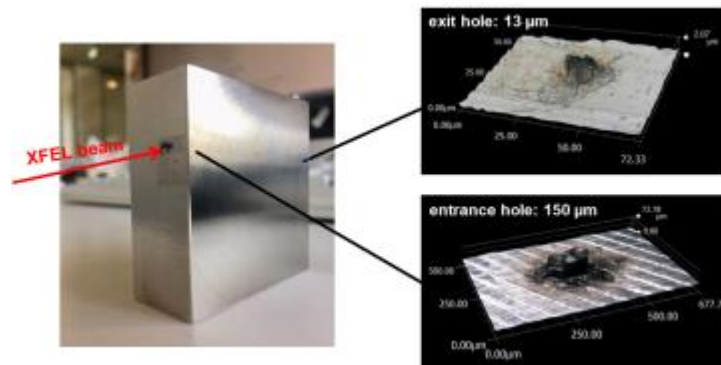


Investigating extreme states of matter to study material stress response



Realizing artificial photosynthesis after comprehending its process

## Possible process looking for applications



Drilling with XFEL beam through 50 mm of steel in 26 seconds

# Thank you

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