



European X-Ray Free-Electron Laser Facility GmbH

Holzknappel 4

22869 Schenefeld

Germany

For the Working Group on operation costs: On the mission and vision of European XFEL

I. The European XFEL mission

The **mission** of the European XFEL was incorporated in its founding documents, i.e. the intergovernmental Convention and the Articles of Association (AoA). The expectations of the Contracting Parties are already expressed in the preamble of the Convention where it reads: *“desiring to further strengthen Europe’s and the Contracting Party countries’ position in research in the world, and to intensify scientific co-operation across disciplinary and national boundaries”* and furthermore *“recognizing that this new kind of facility with unprecedented quality of the X-Ray radiation regarding coherence, spectral brilliance and time resolution will in the future be of great significance in many different fields of fundamental and applied science and for industrial applications”*. Also the expectations of the scientific community worldwide are very high.¹

The AoA bindingly lay out the objectives of the European XFEL GmbH (Art. 3):

- a) to design, construct, operate, and develop, for the use of scientific research, a linear accelerator based Free-Electron Laser source and associated instruments (hereinafter referred to as "the European XFEL Facility");

¹ See e.g. *Science*, **354**, 22-23 (2016), DOI: 10.1126/science.354.6308.22

- b) to support the use of the Company's facilities by providing experimental stations to the scientific communities;
- c) to draw up and execute programs of scientific research using the European XFEL Facility;
- d) to carry out any necessary research and development work on the accelerator, the Free-Electron Laser process and experimental techniques;
- e) to ensure that new technologies and methods of the Company are made available to interested entities in the Contracting Party countries;
- f) to foster general public outreach and knowledge transfer.

Art. 4 AoA stresses that the Company acts in a non-profitable way and points out that the Company's funds and resources must be used exclusively for the objects set out in Art. 3.

II. Translation of the mission into a vision for the European XFEL Facility

From the general mission statements, an ambitious **vision** for the European XFEL emerges. The following section shall describe where and how we want the European XFEL Facility to be in five years from now (i.e. at the end of 2021).

In agreement with the above mentioned Art. 3 AoA, the following core goals shall be achieved (formulated from the facility's point of view in the year 2021):

1. As the world-leading facility among hard X-ray free-electron lasers, the European XFEL offers optimal research opportunities to academic and industrial users, providing a unique source, excellent scientific infrastructure and in addition excellent user service, during the entire scientific process, starting from the calls for proposals for experiments up to data analysis. Thereby, the facility creates all conditions to obtain

a large number of high-impact scientific results, and delivers breakthroughs in fundamental and applied research, enabled by the unique characteristics of the European XFEL beams. In doing so the European XFEL has created a vibrant scientific community in all its member states within the use of X-ray and free electron laser science and has thereby contributed to the competitiveness of the Science and Technology development making Europe a leader within the field of X-ray Science and Technology.

2. The European XFEL is an efficiently and cost effectively operated facility, providing a maximum number of shifts to users and thereby maximizing the scientific and technological return of the large investment made for its construction.
3. To seize the very wide range of scientific opportunities opened up by the European XFEL, the facility has created a broad user community spanning all its member states, and extended the application of FEL X-rays into completely new areas of science, including (i) ultrafast structural and electronic dynamics in atoms, molecules, (ii) dynamics in liquid solutions of chemical and catalytic compounds, (iii) dynamics in complex soft and hard materials and nanomaterials, (iv) high energy dense matter and (v) static structures and kinetics of biomolecules and complex bio-systems. These are areas where scientific breakthroughs inevitable will lead to new technologies that are not only important for our industry, but might also be decisive for the directions our society will develop in terms of health, transportation, communication, energy and sustainability. New drugs and targeted medical treatments will be developed on the basis of a better understanding on the structure and dynamics of membrane proteins, new complex materials with advanced functionalities will be developed for computing and sensing, new energy storage materials will be developed for batteries and the improved understanding of the dynamics of materials will lead to longer lifetimes and more advanced functionalities.
4. Recognizing the success of its user program the European XFEL is in the process of implementing the remaining two undulators and four to six additional scientific instruments. An upgrade strategy is under

discussion with Council and European strategy groups regarding the further development of European XFEL, with the aim to increase the scientific capabilities and capacities of the facility in order to satisfy the needs from the increasing user community.

5. Acting as a leading research infrastructure in the field of photon science, the European XFEL has a high visibility in the European and international context and is an attractive partner in scientific and technological collaborations due to its vivid scientific environment and its innovative technological approach attractive to both academic as well as technological partners including industry.
6. As an international scientific landmark, the European XFEL manages to attract the best staff from all member states and offers an exciting and enjoyable international work environment to its staff. The European XFEL also has an attractive scientific visitors program in order to engage the local communities in the member states and to enhance knowledge transfer.
7. The European XFEL runs a vibrant R&D program to stay at the forefront of research with accelerators and X-rays. Here the interplay of advances in the accelerator and in experimental techniques are crucial: seeding, self-seeding, continuous wave (CW) acceleration and other developments aiming at a better longitudinal coherence will open the possibility of higher energy and spatial resolution experiments; two-color generation with split pulses promises new modes of X-ray pump – X-ray probe experiments; generation of high-intensity, very short-wavelength pulses by harmonic lasing will lead to enable new material science applications. Progress in source stabilization and jitter suppression, and generation of sub-fs pulses will be of importance in improving the time resolution for experiments. The European XFEL is in front with development of new technologies that are crucial for keeping the facility at the forefront. This includes front line development within accelerator technologies (in partnership with DESY), undulators, detector, fast electronics, X-ray optics, data analysis and data management, sample environment, bio-handling and instrument. This development will be done in close collaboration with other institutions

including industries in the member states hereby transferring knowledge to other areas of science and technology.

8. The European XFEL is a hub for training and educational efforts within X-ray Free Electron Laser Science for the benefit of creating the next generation of European scientists and to foster a close scientific collaboration within the member states of the facility. The training will be on all levels from apprenticeships, B.Sc., M.Sc. and Ph.D. students up to post docs and scientists that want to participate in the scientific and technological activities. The European XFEL will also take a lead in assisting the user communities in the shareholder countries to develop their priorities and strategies for the scientific and technological visions.
9. In the long run, the European XFEL will lead to socio-economic impact by utilizing new knowledge and creating new technologies. In order to achieve this long-term goal, the facility has a vigorous technology transfer program in place that will facilitate new technologies developed at the European XFEL to be transferred into economic growth. Furthermore, the European XFEL promotes knowledge transfer via human capital.
10. The European XFEL is a lighthouse facility not only in scientific terms but also in terms of public outreach in all its member states. The European XFEL visitor center informs a wide public audience about the research done at the facility, and its applications and importance to society. It presents a picture of modern science and, offering a non-school place of learning, fosters the enthusiasm of children and teenagers for scientific and technical topics and it will be in forefront in applications tools as e-learning and possibly virtual reality to be able make high-impact outreach also in the member states. It will contribute significantly to the public understanding of science.