



# XFEL Accelerator R&D Program

Approval Process, R&D Pillars

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## 1 Introduction

The European XFEL R&D program aims to enhance the capabilities of the European XFEL in the areas of accelerator, FEL, photon transport and experiments. It is pursued in a comprehensive and coordinated manner and supports the mid- and long-term strategic goals of European XFEL.

In this context DESY proposes and conducts a vigorous accelerator R&D program<sup>1</sup> to keep the European XFEL at the forefront of FEL facilities worldwide and ensure the accelerators competitiveness for decades to come. These activities shall be in-line with and support the overall strategy of developing and upgrading the European XFEL facility. The program at the same time addresses future operational needs that require research and development prior to being put into practice and provides scientific and technological challenges especially for early career engineers and scientists.

An annual budget envelope is allocated within the mid-term financial estimate to support the R&D activities focused on the accelerator. Proposals are typically funded for up to three years, with the possibility of a one year extension. This allows execution of longer time scale projects such as commonly associated to the pillars that aim at mid- and long-term goals.

The accelerator R&D program is coordinated with the European XFEL GmbH, and many topics are pursued together. There are as well synergies with DESY's other R&D activities for accelerator development, the other DESY user facilities, and within the framework of the Helmholtz Accelerator Research and Development (ARD) program. Thus, European XFEL and DESY R&D activities mutually benefit from each other, make common use of infrastructure and join forces for developments in many areas.

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<sup>1</sup> Operation Agreement, Article 8: Research and development / further accelerator development

The Parties accord high priority to the European XFEL Facility's scientific and technical further development. For this purpose, an R&D budget is determined as an integral part of the annual budget. On its basis, DESY shall propose an R&D programme for the further development of the accelerator to be executed following consultations by mutual consent with the European XFEL GmbH.

DESY and European XFEL also attract third party funding complementing the accelerator and photon R&D funds.

A formal procedure to set-up R&D activities for the XFEL accelerator was established in 2018 and has been successfully executed since. The European XFEL GmbH follows a similar process while considering inherent differences in the scope of the individual projects, e.g., regarding duration and overall budget.

## 2 Accelerator R&D Process

Accelerator R&D projects are reviewed and, if successful, approved through an internal review process.

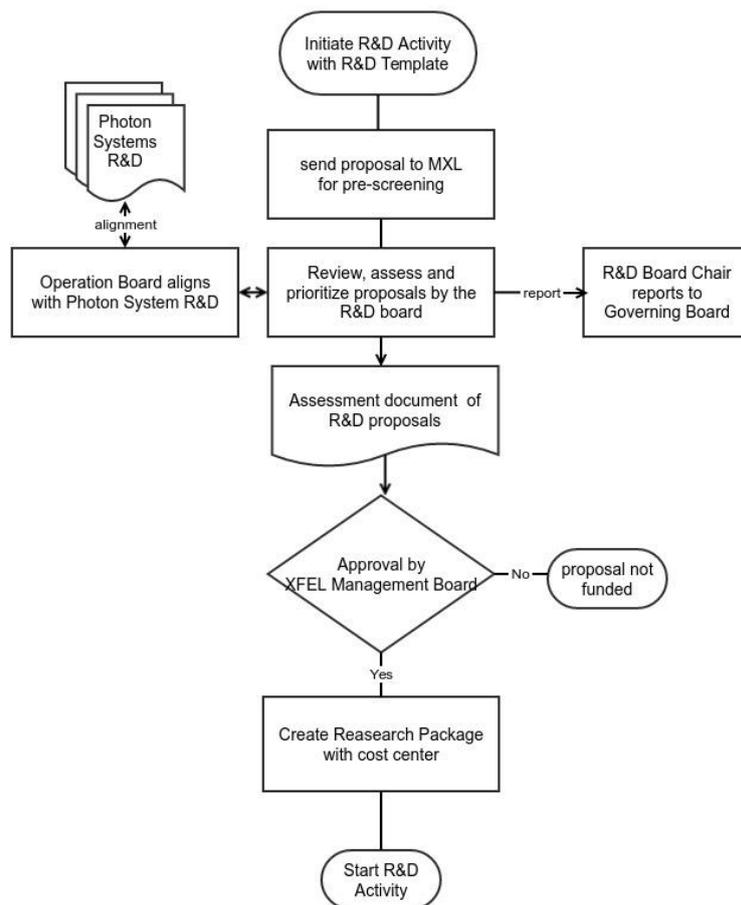


Figure 1: Flow diagram for the initiation and approval of accelerator R&D activities.



An accelerator R&D proposal (see <https://xfel.desy.de/rd/>) is submitted to MXL by a principal investigator and follows a prescribed template. The project description must contain the mandatory content of scope description, time-line, and personnel and financial resources. In order to ensure the strategic consistency of the overall R&D program, accelerator R&D proposals are not only put forward by the technical groups/operation packages but are also actively solicited by the accelerator coordinators, accelerator R&D pillar spokespersons, or the accelerator R&D Board. Depending on the budget situation, the accelerator R&D Board can issue an open call for proposals once per year.

The accelerator R&D Board reviews and assesses incoming proposals as well as the status of running accelerator R&D projects. The board consists of:

- M Division Director (Chair)
- MXL Group Leader
- MXL Operation and accelerator R&D Administration

Board meetings are called at least twice per year or when necessary. Review and assessment of proposals can also be obtained by written procedure (e-mail). The proposals will be pre-screened by MXL to ensure that the proposal template has been properly filled out and all required information is provided by the applicant(s). At this point all proposals will be discussed with the European XFEL Scientific Director Development and Operations (Accelerator Liaison) to receive feedback, especially concerning the overall European XFEL strategy and synergies to photon systems R&D goals.

Where applicable, MXL will assess the compatibility with the operations of the XFEL accelerator and infrastructure.

The proposal review is carried out by the accelerator R&D Board according to the following criteria:

- Compliance to the overall R&D strategy for the XFEL facility
- Scientific and/or technological excellence
- Advances on current and future operational aspects and beam delivery modes
- Feasibility of the team to meet the goals of the proposal in the proposed time frame with the requested resources

Funding level will be determined based on the request and the available funds, also considering already approved accelerator R&D activities and envisioned future strategic developments. In case of an expected over-committed budget, approval will



only be granted annually for proposals received until a set deadline. Declined proposals have to be re-submitted.

After the initial review by the accelerator R&D Board, proposals are submitted to the XFEL Operation Board<sup>2</sup> for further discussion and alignment with the photon systems R&D activities. The feedback of the Operation Board is considered in the final assessment of the accelerator R&D Board, which is then forwarded to the European XFEL Management Board for approval.

Once per year the accelerator R&D program is presented to the Governing Board<sup>3</sup>.

Progress of the individual accelerator R&D activities is tracked with a template-based status report which is requested every year from the Principal Investigator, typically in the first quarter. The status contains achievements and difficulties as well as an update to the time-line and resource plan in comparison to the previous report. The status report will be orally presented to and reviewed by the accelerator R&D Board. R&D activities that have not been begun within 1 year after their anticipated start date shall be canceled.

New proposals and status and updates of running projects are regularly reported to the European XFEL MAC, in special cases as well to the SAC, for advice and guidance in both an overview fashion in the accelerator status presentation and with dedicated talks on individual activities.

R&D projects in the accelerator portfolio are formally closed with a final report and closure of the respective accounting objects.

## 2.1 Role Definitions

- Principal Investigator: proposes, conducts and reports
- M Division Director (Chair): chairs the accelerator R&D Board meetings, and in his/her capacity of Accelerator Director carries the responsibility for proper

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<sup>2</sup> See also the [Rules of Procedure of the Operation Board](#), Article 1: Preparation, formulation and follow-up of the R&D programme for the accelerator further development (Art.8 of the Operation Agreement)

<sup>3</sup> Operation Agreement, Article 12.1.1: Governing Board: The Governing Board discusses and coordinates all matters of strategic or otherwise superior significance between the DESY Directorate and the European XFEL GmbH Management Board. This involves especially:

- ...
- Coordination on R&D program for further development of the accelerator (Article 8).



execution of the accelerator R&D portfolio and reports on the status of the accelerator R&D portfolio on an annual basis to the Governing Board.

- MXL Group Leader: launches call for proposals, carries out proposal pre-assessment for consistency with accelerator R&D pillars, calls accelerator R&D Board meetings and participates in reviews.
- MXL Operation and accelerator R&D Administration: tracks financial matters and interfaces with PIs to ensure that progress reports are submitted on time.
- XFEL Accelerator R&D Board: recommends which proposals to fund, and proposes strategic directions
- Operation Board: assesses proposals with regards to operation aspects and synergy of accelerator and x-ray systems, coordinates between accelerator and photon related topics
- Management Board: approval of the proposals
- Governing Board: takes note, discusses strategic orientation
- Machine/Scientific Advisory Committee => reviews for advice on single proposals or complete program

### **3 Accelerator R&D Structure**

The accelerator R&D portfolio is structured in R&D pillars as guiding topics, to better develop and follow-up the strategic goals of the program. Six pillars are in place but an alteration of this structure is of course possible at any time if new areas or technologies will be explored which don't fall in the currently available pillars.

Each pillar is assigned a spokesperson that should ensure progress and consistency of the specific accelerator R&D topics. Spokespersons are selected by the accelerator R&D Board. The accelerator R&D Board will assign a mid-term budget corridor to each pillar to allow the spokesperson to actively develop the accelerator R&D field within given boundaries.

More details on the current structure and scope is available in Appendix 1 of this document.

# Appendix

## 1 Structure and Scope of the Accelerator R&D Portfolio

The accelerator R&D portfolio is structured into six so called *accelerator R&D Pillars* or guiding topics, grouping individual projects and activities:

- *Open* short-term accelerator R&D and coordination
- Continuous Wave (CW) operation of XFEL
- *Improvement* of operational stability, efficiency and the burst mode capabilities
- *Extension* of the facilities parameters and performance range
- Intelligent Process Control (IPC) and Robotics
- *Advanced Accelerator Concepts*

Figure 1 shows the overall pillar structure of the accelerator R&D program including the current projects associated with each pillar.

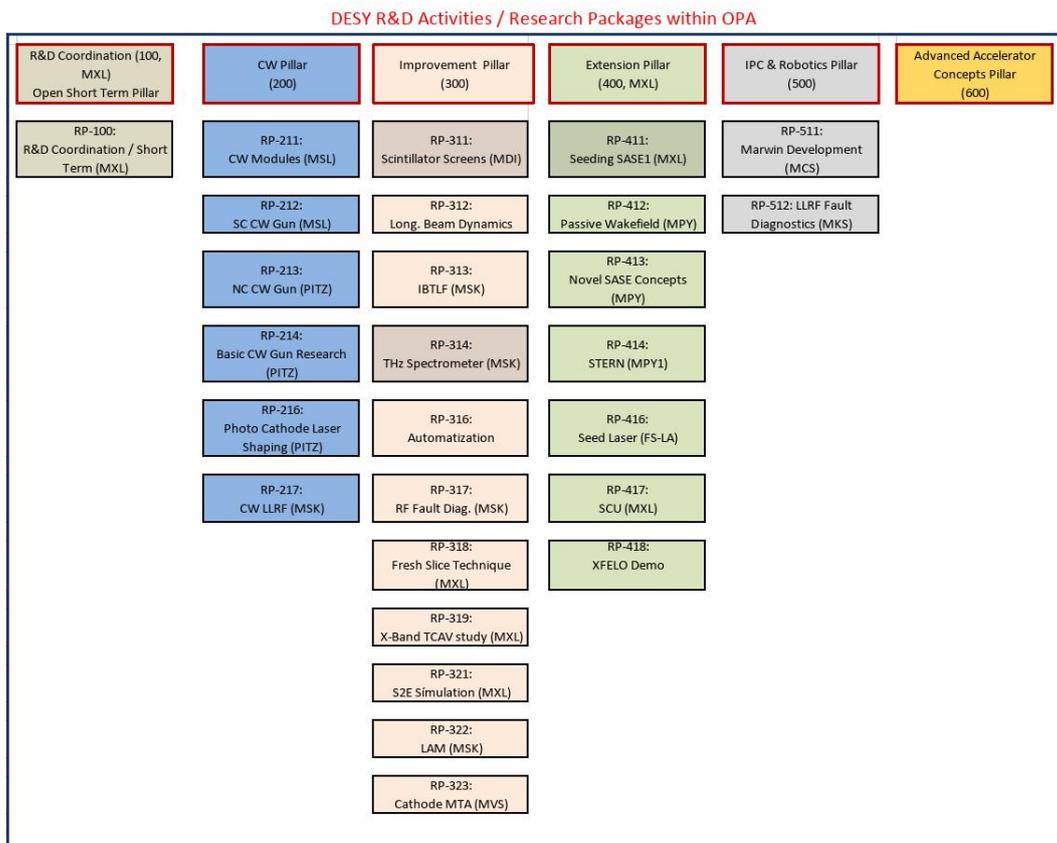


Figure 1: Structure of the accelerator R&D portfolio



## **1.1 Open accelerator R&D on short-term disposal for machine coordination**

Whilst the accelerator R&D activities of the package groups mentioned before will pursue mid- to long-term goals, a small amount of investment capital is foreseen for free and yearly distribution by the accelerator coordination to enable ad-hoc activities and 'off the beaten path' developments.

## **1.2 The CW Pillar**

CW or quasi-CW operation of the European XFEL would increase the flexibility in the photon beam time structure. A more even distribution of photon pulses can enable certain new classes of experiments. For many applications the average pulse rate could be substantially increased, depending on bunch charges up to the beam power limit at the beam dump. Furthermore, CW operation would ideally support an extension of the facility with additional beam lines.

Several accelerator R&D topics have to be pursued to come up with a credible proposal for such an upgrade to the European XFEL. Most of the topics require a long-term commitment and substantial financial effort. The pillar also supports the competitiveness and personnel development of the respective technical groups.

## **1.3 The Improvement Pillar**

Continuous accelerator R&D improves operational stability and efficiency of the facility. This includes the optimization of existing hardware as well as the further development of the burst mode capabilities.

## **1.4 The Extension Pillar**

Extension of the European XFEL performance range will require R&D in various areas. This accelerator R&D program has strong interconnections to the photon systems R&D. It depends and should drive developments in the field of FEL physics and experimental techniques.

## **1.5 The IPC and Robotics Pillar**

Efficient and flexible operation of the facility requires the control of thousands of partly interlinked process variables. Operation today would already not be possible without the use of advanced control algorithm. More automated and robust state changes, standardized and automated start-up procedures, faster and reliable tuning algorithms based on virtual diagnostics will pave the way to an autonomous facility operation. Analysis of the largely available monitoring data will optimize the choices for preventive



maintenance and repair, thus reducing down time and resource needs. Robotics can also help for remote and in-situ measurement and repair. Priorities in this pillar will be largely set by operational needs and experiences and are interlinked with activities in the improvement pillar.

### 1.6 Advanced Accelerator Concepts Pillar

Long term operation of European XFELs scientific program requires accelerator research complementing the superconducting technology, to ensure competitiveness in the future and allow for specialized applications. Accelerator R&D is thus necessary for specific applications of advanced accelerator concepts to the European XFEL cause

## 2 Pillar Spokespersons

Each pillar has an assigned a spokesperson that should solicit proposals, ensure progress and consistency of the specific accelerator R&D topics. The current spokespersons are given in the table below:

R&D Pillar	Spokesperson
Open R&D	Riko Wichmann
Continuous Wave	Hans Weise
Improvement	Shan Liu
Extension	Marc Guetg
IPC & Robotics	Annika Eichler
Advanced Accelerator Concepts	Jens Osterhoff

Table 1 List of spokespersons for each pillar in the Accelerator R&D portfolio