

European XFEL Tuning Strategy

15 August 2025

Tuning of the accelerator and FEL sources, or even of other parts of the photon beamlines, shall be applied to achieve and maintain a high performance of the electron and x-ray beams. Usually, the tuning is part of setting up and preparing for a specific experiment and/or use of the beam. These tuning procedures are not addressed in this document, but rather tuning that is applied during the x-ray delivery period. As a general rule tuning shall occur only during defined periods and address only specific parameters to be tuned (see appendices). Excluded from these restrictions are tuning activities that are necessary after a failure or a major problem in accelerator operation.

Tuning activities that have no influence on other beamlines can be decided alone in consultation with the corresponding instrument colleagues. A list of these tuning activities can be found in the appendix A.

In general, there should be no tuning activities that have not been previously agreed upon.

Performance conservation tuning

In order to compensate for possible performance losses due to drifts etc., operators are instructed to carry out a number of minimally invasive tuning steps every day from 7:00 -7:30 am. The performance conservation steps are listed in Appendix B.

Tuning activities requested to boost a specific parameter

On working days

1. The shift crew and the RC evaluate the machine status in the morning and compare the current performance with the previous day's data. A list of important/critical parameters is provided for this purpose in appendix B.
2. A short summary of the status should be passed on from the RC to the PRC at 10 am via the logbook.
3. The PRC discusses the findings with the responsible colleagues of the instruments with priority status in the respective week, who will give feedback to the PRC by 12 noon whether tuning is necessary or not. Tuning will be applied if at least one of the instruments is requesting it.
4. The PRC informs the RC about the decision.
5. Tuning takes place between 2 and 3 pm. However, it should be aimed that tuning is finished after 30 minutes. The PRC has to be informed as soon as the interventions have been completed.

6. The RC as well as the PRC will participate in the daily operation meeting (3:30 pm) to discuss the success and/or problems.

On weekends and holidays

- Since there are no daily meetings on these days and since the coordinators are not on regular shift, the above rules cannot be applied.
- The PRC shall be informed if one of the instruments needs tuning. He or she will reach an agreement on the scope and timing of the tuning with all instrument colleagues and the shift crew in the control room.

Appendix A

The following table lists tuning activities that can be carried out after consultation with the respective instrument colleagues in charge, without the need for additional consultation with the coordinators.

Beamline(s)	Tuning activity
SASE2, SASE3	Trajectory corrections using the launch correctors and/or the air coils in the undulator. This includes the use of the adaptive feedback.
SASE2, SASE3	Phase shifter scans.
SASE2, SASE3	Modifications of the undulator taper settings.
SASE1, SASE2, SASE3	Bunch compression modifications if only bunches for the selected instrument are in the relevant RF beam region.

Appendix B

The following list shows the possible tuning steps for the Performance Conservation time daily from 7-7:30 am.

In general

- Variation of the laser heater position up and down in steps of 0.01 mm.
- Variation of the gun phase in steps of +-0.1 degree.

FELs operated in SASE mode (not for HXRSS nor 2-color operation)

- The adaptive feedbacks should be used in all beamlines.
- Small changes of compression parameter (feedback loops must be open). Possible step sizes are:

Location	Injector	L1	L2
Chirp	0.01	0.1	1.0
Curvature	10	-	-
Cubic coefficient	1000	-	-

FELs operated in HXRSS mode

- The HIREX spectrometer is important for all tuning steps and is typically available during seeding weeks. The tuning parameters are the same as for the SASE setups, but the following must be taken into account:
 - The peak signal of the spectrometer is the monitor signal for all improvement activities. In case the spectrometer is not available, find an agreement with the instrument colleagues how to continue.
 - The XGM counts also the SASE background, thus it is not a reliable parameter for seeding tuning.

Appendix C

Parameters that should be evaluated for the status and tuning report. The current status should be compared with the results from 24h earlier.

- Pulse intensity developments over time and intensity variation over the pulse train.
- XGM pointing data.
- Monitor and actuator data from the compression feedbacks.
- Beam energies in I1, B1, B2 and CL-sections for all RF beam regions.
- Beam trajectories in all machine sections.
- If the spectrometer is available: Precise photon energy, bandwidth and estimation of the pulse length.