FLASH User Operations Newsletter, September 2021

Dear colleagues,

in order to support and inspire you when writing a proposal for FLASH, we put together this eighth issue of our newsletter. With this, we want to keep you updated on our recent activities and developments at the FLASH user facility. References and contact names for the corresponding in-depth information on new instrumentation and features are added to the brief summaries given here. This and all former newsletters are also available at http://photon-science.desy.de/facilities/flash/news_and_research_highlights/user_operations_newsletter/index_eng.html

We would be happy to provide you with further specific details on request and are looking forward to receiving your experiment proposal.

With best regards,

Martin Beye and *Rolf Treusch* for the *FLASH team*

Current plans for the future operation schedule until 2025

- **First FLASH2020+ shutdown:** November 2021 – August 2022, then startup and commissioning until end October 2022
- **User period between shutdowns:** November 2022 – December 2023 with two proposal calls (deadlines 1.10.2021 and summer 2022), with higher maximum electron energy and variable polarization afterburner at FLASH2 (cf. last Newsletter)
- **Second FLASH2020+ shutdown:** January 2024 – December 2024
- January 2025 user operation resumes, then with seeding and variable gap & polarization undulators at FLASH1 and substantially upgraded photon diagnostics and pump-probe lasers.

Energy upgrade in the first FLASH2020+ shutdown: What does that mean for the minimum wavelength, resp. the highest photon energies?

During the coming shutdown in the first half of 2022, the FLASH accelerator will be upgraded to reach an electron energy of 1.35 GeV (present limit: 1.25 GeV). Based on our presently shortest fundamental wavelength of about 4 nm, this energy upgrade translates into a shortest (fundamental) wavelength of about 3.4 nm (365 eV). This is well above the Carbon K-edge and in the ‘water window’, and for the time between the two FLASH2020+ shutdowns (i.e. from end 2022 to end 2023) what one can expect as limit for the fundamental of the user

operation range at FLASH1. At FLASH2, with the coming harmonic afterburner undulator ([1], see also last Newsletter 2021_07) or advanced schemes such as harmonic lasing self-seeding (HLSS [2]) we will then be able to cover a wavelength range down to about 1.3 nm (i.e. a maximum energy of up to about 950 eV) in the harmonics, with variable polarization (if demanded) and supposedly still with decent intensities of about 1 µJ or a bit more (also depending on the required pulse length). With this, the Nitrogen and Oxygen K-edges as well as the L-edges of the magnetic 3d metals are in reach for your potential applications.

[1] M. Mehrjoo et al., *Expected Radiation Properties of the harmonic afterburner at FLASH2*, Proc. FEL2019; https://doi.org/10.18429/JACoW-FEL2019-WEP072

[2] E.A. Schneidmiller et al., *First operation of a harmonic lasing self-seeded free electron laser*, Phys. Rev. Accel. Beams **20**, 020705 (2017), http://dx.doi.org/10.1103/PhysRevAccelBeams.20.020705

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Planning to use our local endstations?: Connect and collaborate with our experts

If you envisage to use our state of the art endstations in a collaboration with our local teams, which applies for example to the condensed matter photoemission chambers HEXTOF and WESPE, the AMO / Femto-Chemistry endstations CAMP and REMI or one of the many others, please get in touch with our local experts at an early stage of your experiment preparation, preferably even before finalizing your proposal.
In addition to all the information which is accessible on our web pages (https://photon-science.desy.de/facilities/flash/beamlines/index_eng.html), they can provide you with all the subtle features of our setups which could, beside the general feasibility, be quite important for turning your planned experiment into an exciting success story.

We also would like to stress, that it is extremely beneficial for the successful outcome of such collaborations with the local experts running the endstations, if sufficient colleagues from your team are trained beforehand and allocated for near real-time online analysis of the data during the experiment itself. Working under pandemic conditions, we found that the data analysis tasks can equally well be performed from remote or by joining the experiment on-site.

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and others … (see our web pages or ask R.Treusch)

The new Time-Delay Compensating Monochromator Beamline FL23 at FLASH2

As already announced in one of our recent newsletters and described in the DESY Photon Science Annual Reports, a new Time-Delay Compensating Monochromator (TDCM) beamline is planned at FLASH2 (see Figure 1).

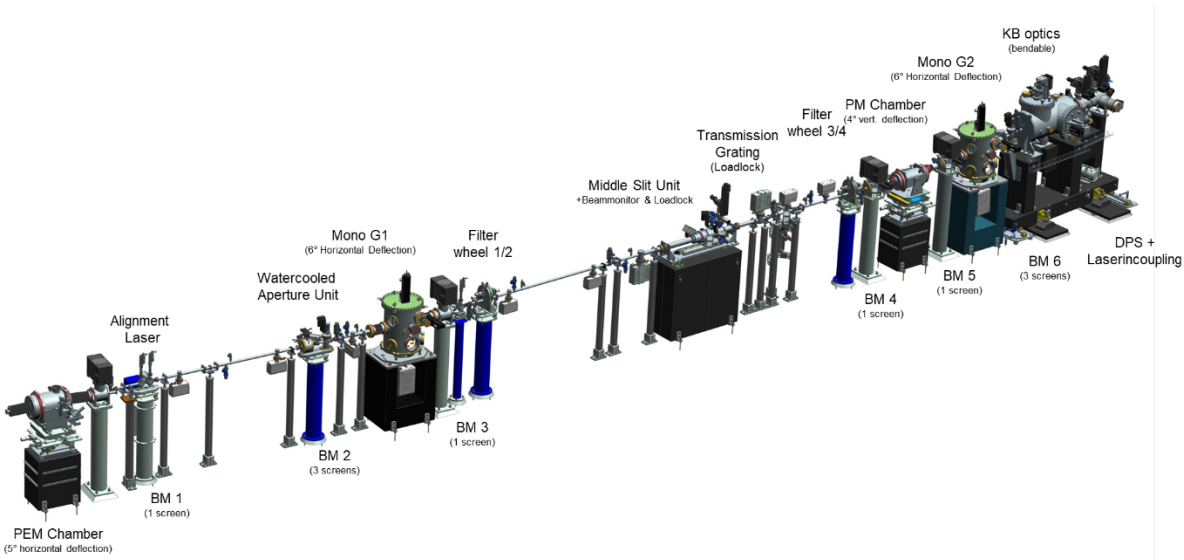

Figure 1: **3D-CAD drawing of the TDCM beamline FL23 (PEM = plane elliptical mirror, BM = beam monitor, G1/2 = grating, PM = plane mirror, DPS = differential pumping stage).**

The double grating monochromator design of beamline FL23 will provide a narrow spectral bandwidth of the FLASH2 photon pulses while preserving the ultrashort FEL pulse duration of < 50 fs. The bendable Kirkpatrick-Baez (KB) mirror system focuses the monochromatized radiation down to approx. 5 x 5 µm² beam size at the target (further parameters in Table 1). Due to a movable exit arm, the monochromator can be used in double- or single-grating configuration, the latter allows higher throughput and is thus particularly interesting when using harmonics at short wavelengths. FL23 will offer an open port for user-supplied endstations or for collaborations using the FLASH-provided mobile endstations.

Parameter		Value
Wavelength	(nm)	1.2 - 20.0 (including harmonics)
Pulse length	(fs)	< 50
Resolution	($\lambda/\Delta\lambda$)	≥ 2000
Flux at beamline end	(photons/pulse)	10^{10}

Table 1: **Expected parameters of the FL23 TDCM beamline at FLASH2.**

Meanwhile, most of the beamline components have been built and delivered, and the preparations for the beamline installation are ongoing. The installation of the individual components will start at the beginning of the upcoming FLASH shutdown in November.

Assuming no further (in particular pandemic-related) delays, we expect to be ready for commissioning of FL23 with beam end of 2022/early 2023 and will accept experiments with 'friendly users' in 2023 (to be announced).

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Parameters of the optical lasers in the coming beamtime period

In the coming user operation period between the two FLASH2020+ shutdowns. i.e. from end 2022 to end 2023, we are preparing everything to provide you with the same laser systems and parameters as right now. Apart from some foreseen improvements with respect to stability and synchronization of the individual systems, at FLASH1, a pulse train laser ('PIGLET') will be provided for the PG endstations at a fundamental wavelength around 1030 nm and a 10 Hz, 800 nm, mJ-laser ('HIDRA') will be available at CAMP@BL1 and the open port beamline BL3. The pump-probe laser system in the FLASH2 laser hutch, presently serving FL24 and FL26, will undergo a replacement of the front-end, yielding more stability and robustness. We expect no changes in the output parameters of ~200 µJ per pulse with tunable wavelength (700 nm to 900 nm) and pulse durations (100 fs to sub-20 fs) at 100 kHz repetition rate inside the burst, for the user operation between the shutdowns.

During the second shutdown in 2024 we plan a complete re-design of both the FLASH1 and FLASH2 systems. The pump lasers will be upgraded to 5 kW in-burst average power and the endstations will be equipped with modular setups providing increased wavelength flexibility, reduced timing jitter and in-burst repetition rates up to 1 MHz. For more options and details you are kindly referred to our web pages and the experts in our laser group FS-LA.

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