FLASH

Beamlines

FLASH1 experimental hall 'Albert Einstein'

BL1	non-monochromatic FEL photons Kirkpatrick-Baez (KB) focusing optics, FEL focal spot of ≈ 7 µm × 8 µm (FWHM)	
	split-and-delay unit for XUV-pump–XUV-probe experiments (mirrors for 13.57 nm, −30 ps to + 650 ps delay)	*TU Berlin*
	optional pump–probe experiments using the FLASH1 optical laser system for BL1 and BL3	
	4-mirror polariser for variable FEL polarisation from 30–70 eV	*TU Berlin*
	permanent end station: multipurpose CAMP chamber with pnCCD detectors, electron and ion spectrometers and collinear incoupling optics for optical laser	
BL3	non-monochromatic FEL photons, spectral range: > 4.5 nm (carbon coated optics) focused to ≈ 20 µm / unfocussed beam size ≈ 5–10 mm (FWHM, depending on wavelength)	
	optional pump–probe experiments using the FLASH1 optical laser system for BL1 and BL3	
	4-mirror polariser for variable FEL polarisation from 30–70 eV	*TU Berlin*
	optional pump–probe experiments using THz radiation: - tunable: 10–230 µm; up to 150 µJ/pulse; ≈ 10% bandwidth - broadband at 200 µm; up to 10 µJ/pulse; ≈ 100% bandwidth - synchronised and phase stable to X-ray pulses (down to 5 fs) - delivered to the experiment via vacuum beamline as: (i) ultra-high vacuum (≈ 10^{-8} mbar), shorter delay between THz and X-ray (≈ 4 m path difference); can accommodate up to 0.3 m wide setup (ii) high vacuum (≈ 10^{-6} mbar), longer delay between THz and X-ray (≈ 7 m path difference); can accommodate up to 2 m wide setup - UHV chamber with mounts for refocusing XUV optics to compensate for XUV/THz path delay	
	about 3 × 4 m platform for user-provided end station	
PG1	high-resolution plane grating XUV monochromator (SX 700 type, < 10^{-4} bandwidth, carbon coated optics): - variable combination of photon flux and resolution (from high flux to high resolution) - controlled temporal-spectral properties at moderate resolution for pump–probe experiments - high photon flux with harmonic filtering Kirkpatrick-Baez (KB) refocusing optics, FEL focal spot down to 5 µm FWHM (vertically, monochromator exit slit size dependent)	
	permanent end station: - XUV-Raman spectrometer TRIXS for high-resolution and time-resolved RIXS measurements on solid samples (15–400 K, resolving power ≈ 1700, time resolution 170–300 fs FWHM) - optional pump–probe experiments (RIXS; XAS + reflectivity with angular resolution) using the FLASH1 optical laser system for PG1 and PG2	
PG2	uses the same monochromator as PG1 50 µm focus	
	XUV beam splitter with variable time delay (± 6 ps) for time-resolved studies	
	optional pump–probe experiments using FLASH1 optical laser system for PG1 and PG2	
	about 3 × 4 m platform for user-provided end station	

FLASH1 optical / NIR laser system for pump–probe experiments for beamlines BL1 and BL3

central wavelength	810 nm
spectral bandwidth	25 nm
intra-burst repetition rate	single pulse
number of pulses per burst	1
pulse duration	< 60 fs FWHM, < 200 ps FWHM (uncompressed)
timing jitter to FEL	< 60 fs (rms)
pulse energy	0–10 mJ (before coupling to chamber), 0–7 mJ (at interaction region)
polarisation	flexible
peak intensity	> 10^{14} W/cm²
time delay to FEL	−4 ns to +4 ns, 10 fs resolution, larger delays optional
energy stability	< 10% pulse-to-pulse peak (3% (rms))

Harmonic generation conversion to 400 nm, 266 nm and 200 nm central wavelength are available with conversion efficiencies of > 30% SHG, > 5% THG

FLASH1 optical / NIR laser system for pump–probe experiments for beamlines PG1 and PG2

central wavelength	1030 nm
spectral bandwidth	30–50 nm (pre-set for experiment)
intra-burst repetition rate	1 MHz
number of pulses per burst	1–800
pulse duration	60–100 fs FWHM
timing jitter to FEL	< 60 fs (rms)
pulse energy	0–30 µJ (at interaction point at 1030 nm)
polarisation	flexible
peak intensity	> 10^{14} W/cm^2
time delay to FEL	−4 ns to 4 ns, 10 fs resolution, larger delays optional
energy stability	< 10% pulse-to-pulse peak (3% (rms))

Harmonic generation conversion to 515 nm, 343 nm or 257 nm central wavelength can be provided

FLASH2 experimental hall 'Kai Siegbahn'

FL24	non-monochromatic FEL photons wavelength range: 4–90 nm fundamental Kirkpatrick-Baez (KB) focusing optics with variable foci down to < 10 µm (FWHM)/unfocussed beam size ≈ 5–10 mm (FWHM, depending on wavelength)	
	optional pump–probe experiments using FLASH2 optical laser system	
	grazing incidence split-and-delay unit with ± 12 ps time delay	*Univ. Münster*
	about 3 × 4 m platform for user-provided end station	
FL26	non-monochromatic FEL photons wavelength range: 6–90 nm fundamental	
	optional pump–probe experiments using FLASH2 optical laser system	
	permanent end station: - reaction microscope (REMI) for time-resolved AMO spectroscopy - grazing incidence delay line and refocusing optics: FEL focal spot < 10 µm × 10 µm (FWHM, depending on wavelength) - ± 2.7 ps time delay range, 1 fs precision - grating spectrometer for online spectral distribution monitoring and for transient absorption spectroscopy	*MPI-K Heidelberg*

FLASH2 optical / NIR laser system for pump–probe experiments for beamlines FL24 and FL26

central wavelength	700–900 nm (fast tuneable)
spectral bandwidth	–100 nm (pre-set for experiment)
intra-burst repetition rate	100 kHz
number of pulses per burst	1–80
pulse duration	15–35 fs FWHM (compressed to 1.1 × bandwidth limit), < 500 fs FWHM (uncompressed)
timing jitter to FEL	< 60 fs (rms)
pulse energy	0–250 µJ (before coupling to chamber), 0–150 µJ (at interaction region)
polarisation	flexible
focus size (1/e^2 diameter)	FL24: < 100 µm, FL26: < 50 µm
peak intensity	> 10^{14} W/cm^2
time delay to FEL	−4 ns to 4 ns, 10 fs resolution, larger delays optional
energy stability	< 10% pulse-to-pulse peak (3% rms)

Harmonic generation conversion to 400 nm and 266 nm central wavelength are available with conversion efficiencies of > 30% SHG, > 5% THG

All FLASH beamlines provide online photon diagnostics for intensity, wavelength and beam position, fast shutter, aperture and filter sets.

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