First lasing in the water window with 4.1 nm at FLASH

FLASH.
Free-Electron Laser in Hamburg

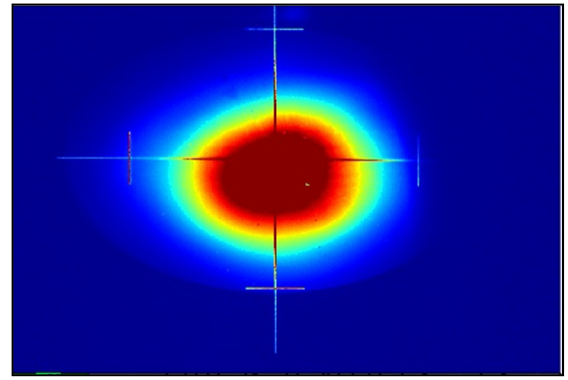
FLASH free-electron laser user facility at DESY

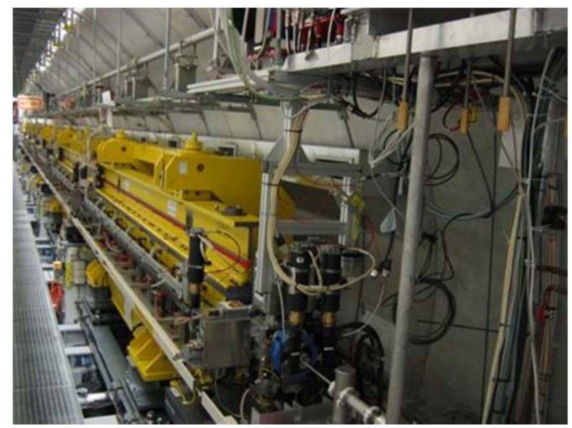
Siegfried Schreiber
DESY

for the FLASH team

FEL 2011
Shanghai, China
Aug 22-26, 2011

Session:
X-ray FEL, TUOBI2





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FLASH at DESY in Hamburg

FLASH.
Free-Electron Laser in Hamburg

FLASH at DESY in Hamburg

FLASH. Free-Electron Laser in Hamburg

> Single-pass high-gain SASE FEL
  - **SASE = self-amplified spontaneous emission**

> Photon wavelength range from vacuum ultraviolet to soft x-rays

> Free-electron laser user facility since summer 2005
  - 1st period: Jun 2005 – Mar 2007
  - 2nd period: Nov 2007 – Aug 2009
  - 3rd period: Sep 2010 – Sep 2011
  - 4th period: scheduled for 2012

> FLASH is also a test bench for the European XFEL and the International Linear Collider (ILC)

> FLASH II, a second undulator beam line is in preparation

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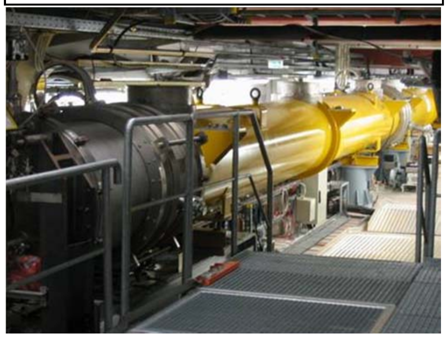
FLASH layout

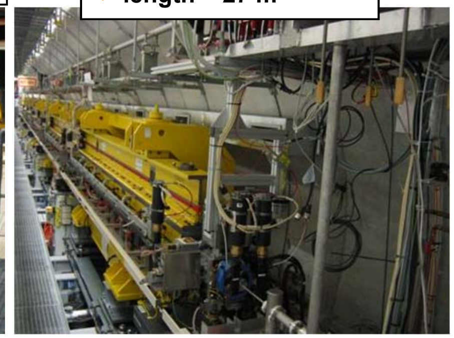
FLASH. Free-Electron Laser in Hamburg

> 3rd harmonic cavity 3.9 GHz

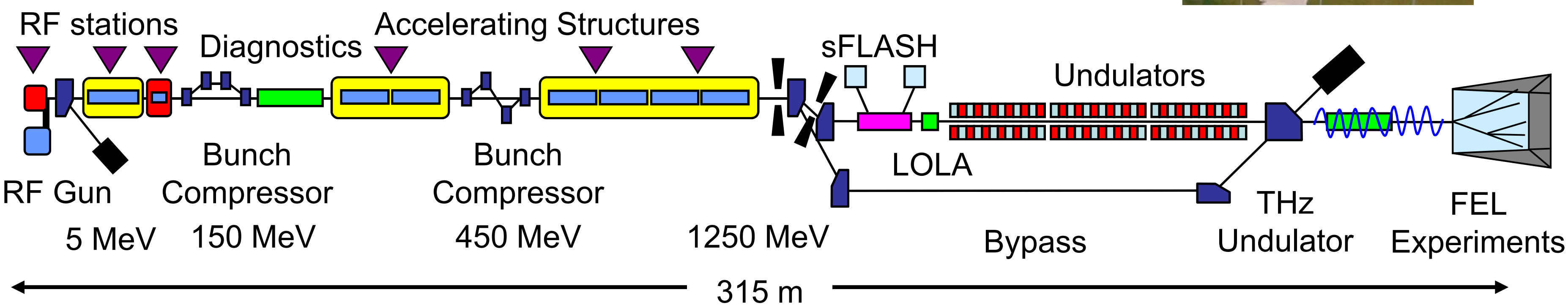
> TESLA type superconducting accelerating modules



> Fixed gap undulator
> length ~ 27 m



> FEL Experimental Hall



> Normal conducting 1.3 GHz RF gun
> Ce_2Te cathode
> Nd:YLF based ps photocathode laser

> Diagnostics and matching

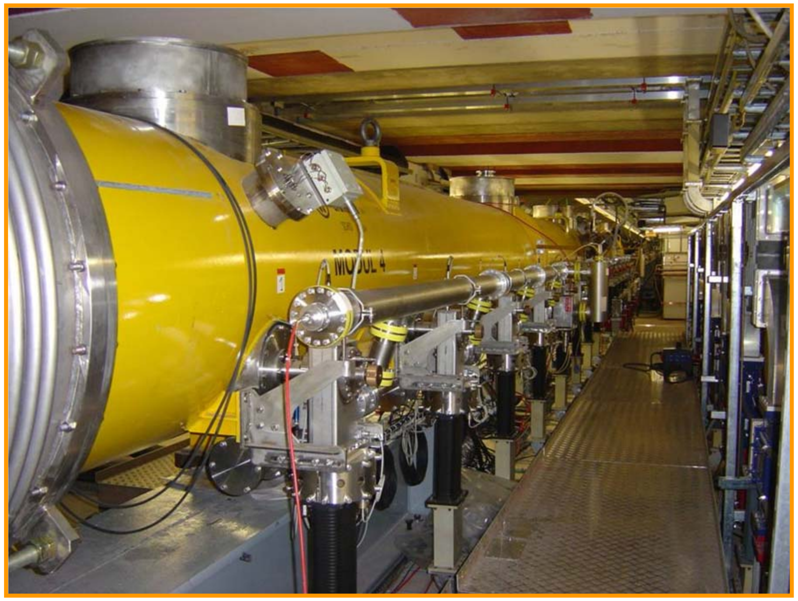
> sFLASH undulators

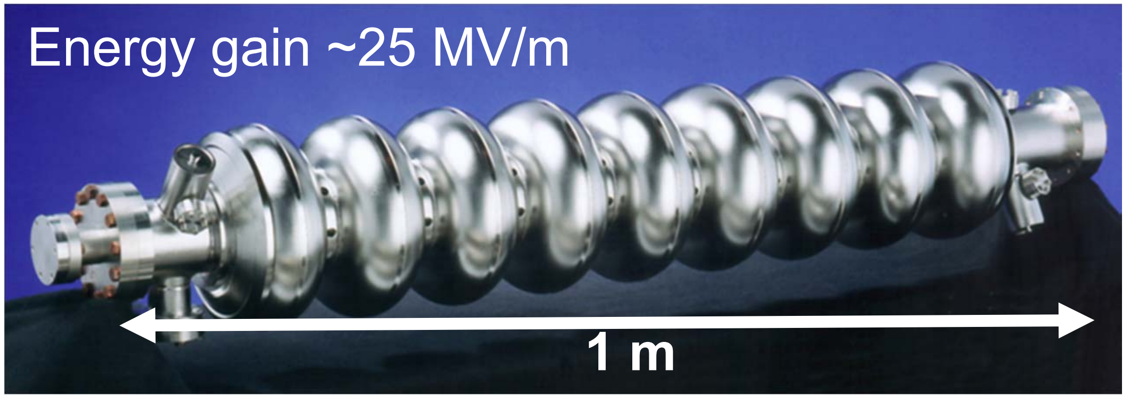
> FEL Experimental Hall

FLASH Accelerator

FLASH. Free-Electron Laser in Hamburg

- FLASH uses TESLA technology
- Seven accelerating modules: each with eight 9-cell superconducting cavities operated at 1.3 GHz
- Burst mode: acceleration for 800 μs at 10 Hz
- Efficient acceleration due to high Q ~ 10^{10} (loaded Q = 2 x 10^{6})





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Energy upgrade

FLASH. Free-Electron Laser in Hamburg

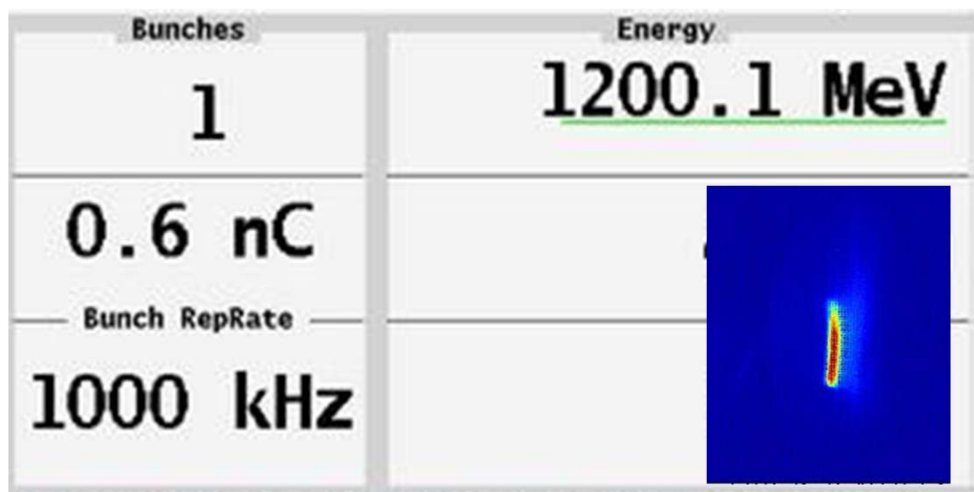
> Originally designed for 1 GeV and a wavelength of 6.4 nm

> Upgrade 2009/10:

> Installation of a 7th superconducting accelerating module

- Prototype module for the European XFEL
- Cryostat from China
- Energy reach 240 MeV

1.2 GeV demonstrated with beam in May 2010



3.9 GHz (3rd harmonic) Module and Module 1

FLASH.
Free-Electron Laser in Hamburg

- New 1st accelerating module with improved cavities and Piezo tuners
- 3rd harmonic module with four nine-cell superconducting cavities operated at 3.9 GHz
  - with RF system and LLRF regulation
  - built at FNAL (Fermilab) in a collaboration with DESY

Fermilab DESY

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First Lasing in the Water Window

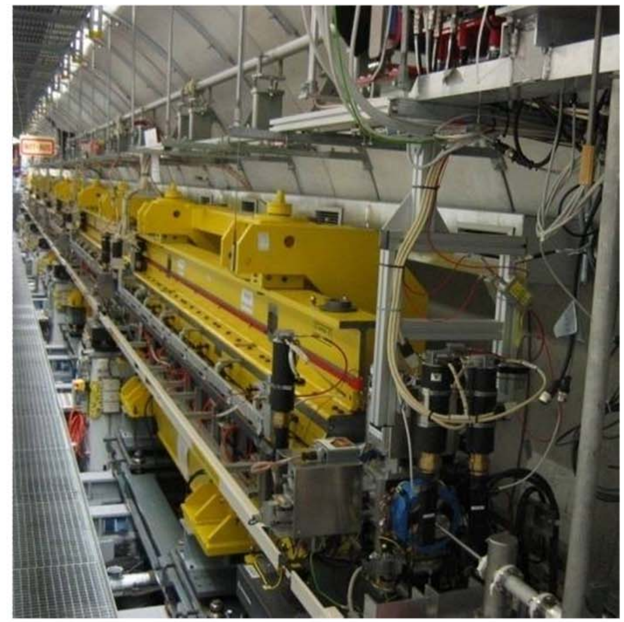
FLASH Undulators

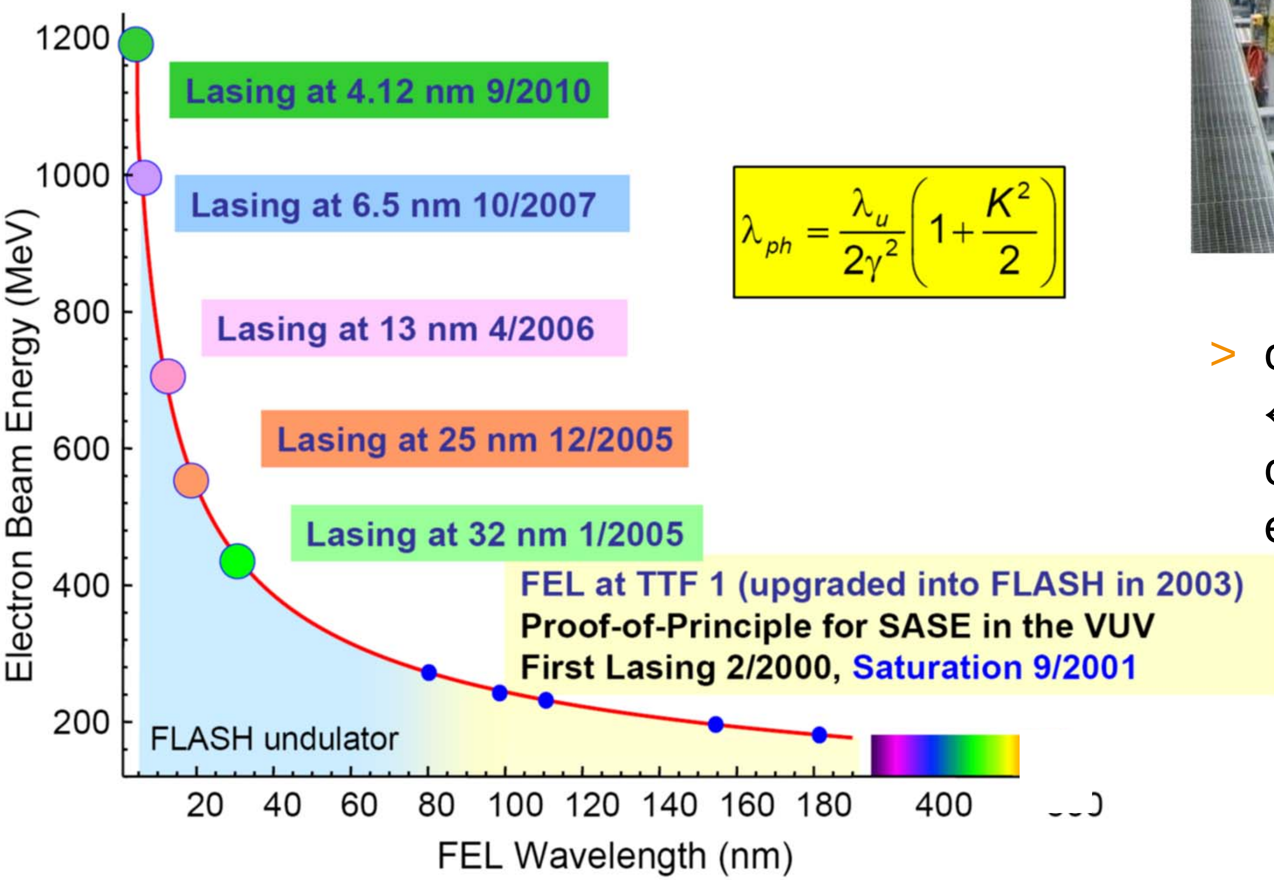
FLASH. Free-Electron Laser in Hamburg

> 6 undulator modules, total length 27 m

> Fixed gap of 12 mm

- permanent NdFeB magnets
- peak B = 0.48 T, K = 1.23, period of 27.3 mm





$$\lambda_{ph} = \frac{\lambda_u}{2\gamma^2}\left(1 + \frac{K^2}{2}\right)$$

> change of wavelength ↔ change of electron beam energy

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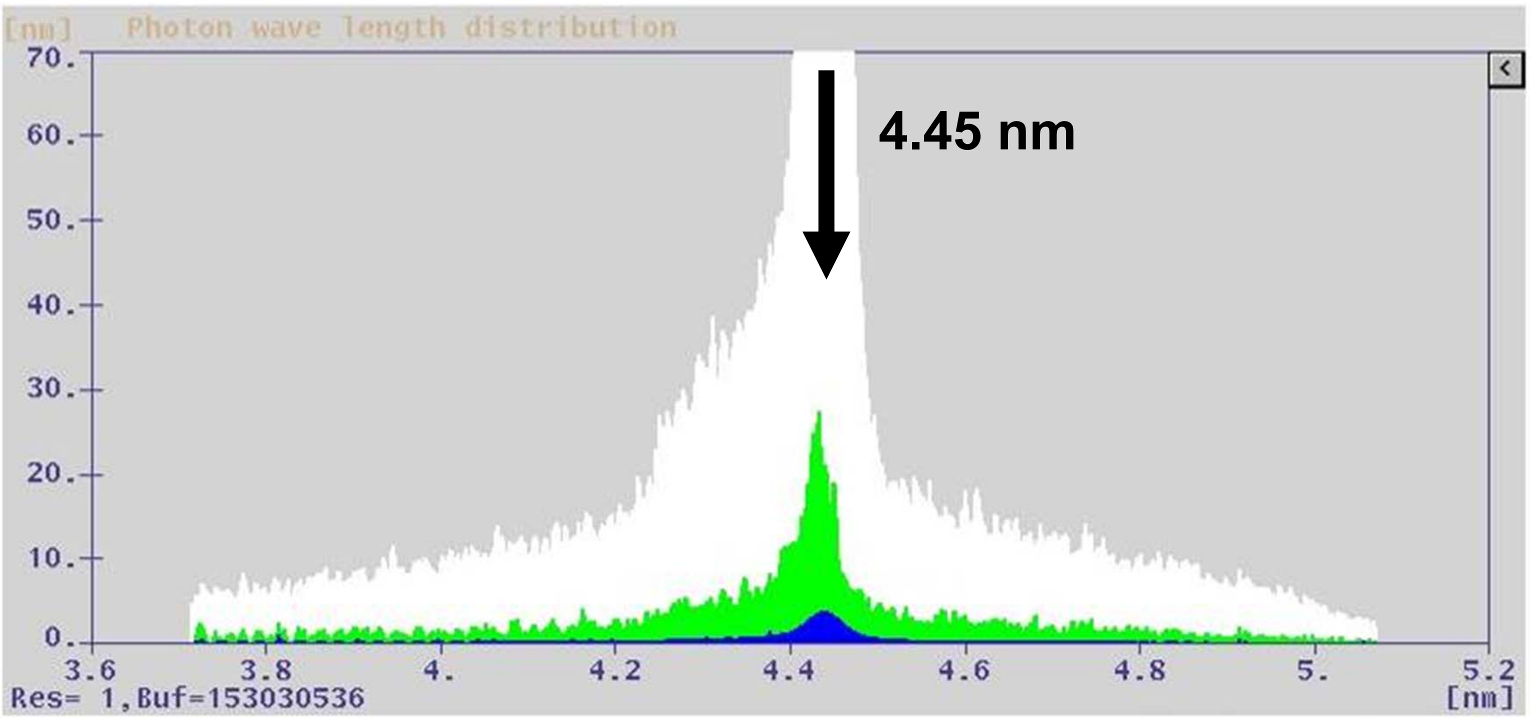
Commissioning Goal: Lasing below 5 nm

FLASH.
Free-Electron Laser in Hamburg

> First lasing below 5 nm in June-6 @ 4.45 nm

> Next steps: improve overall performance:

- Coupler conditioning, RF power distribution, low level RF



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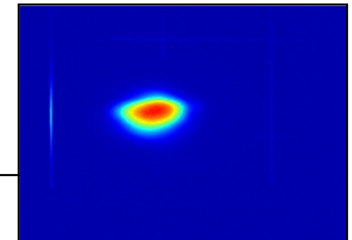
FLASH reaches the water window

> On 25-Sep-2010 we have been able to increase the beam energy to 1250 MeV

> First lasing at a wavelength of 4.12 nm in the fundamental



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Deutsches Elektronen-Synchrotron
Ein Forschungszentrum der Helmholtz-Gemeinschaft

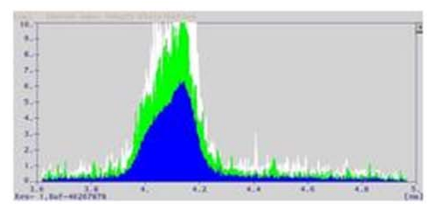
WASSERFENSTER.

Home / Aktuelles / DESY News / 2010 / Wasserfenster

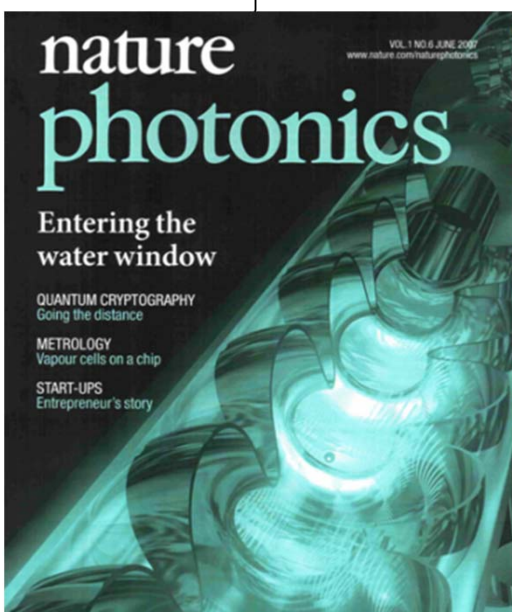
Hamburg 28.09.2010

FLASH eröffnet den Blick durchs Wasserfenster

Der Freie-Elektronen-Laser FLASH (Free-Electron Laser in Hamburg) hat einen neuen Rekord aufgestellt: Am Wochenende hat die FLASH-Beschleunigermannschaft den FEL mit einer Elektronenenergie von 1,25 Giga-Elektronenvolt betrieben und so eine Wellenlänge von 4,12 Nanometern erzielt. Damit hat FLASH zum ersten Mal in seiner Grundwellenlänge Laserlicht im so genannten Wasserfenster erzeugt – bisher war dies nur mit Oberschwingungen des Lasers erreicht worden. Die kurzwelligen Lichtblitze hatten eine durchschnittliche Energie von 70 und eine Spitzenenergie von 130 Mikrojoule.



Der Plot für Experten: Das Spektrum eines FLASH-Blitzes bei 4,12 Nanometern Wellenlänge.

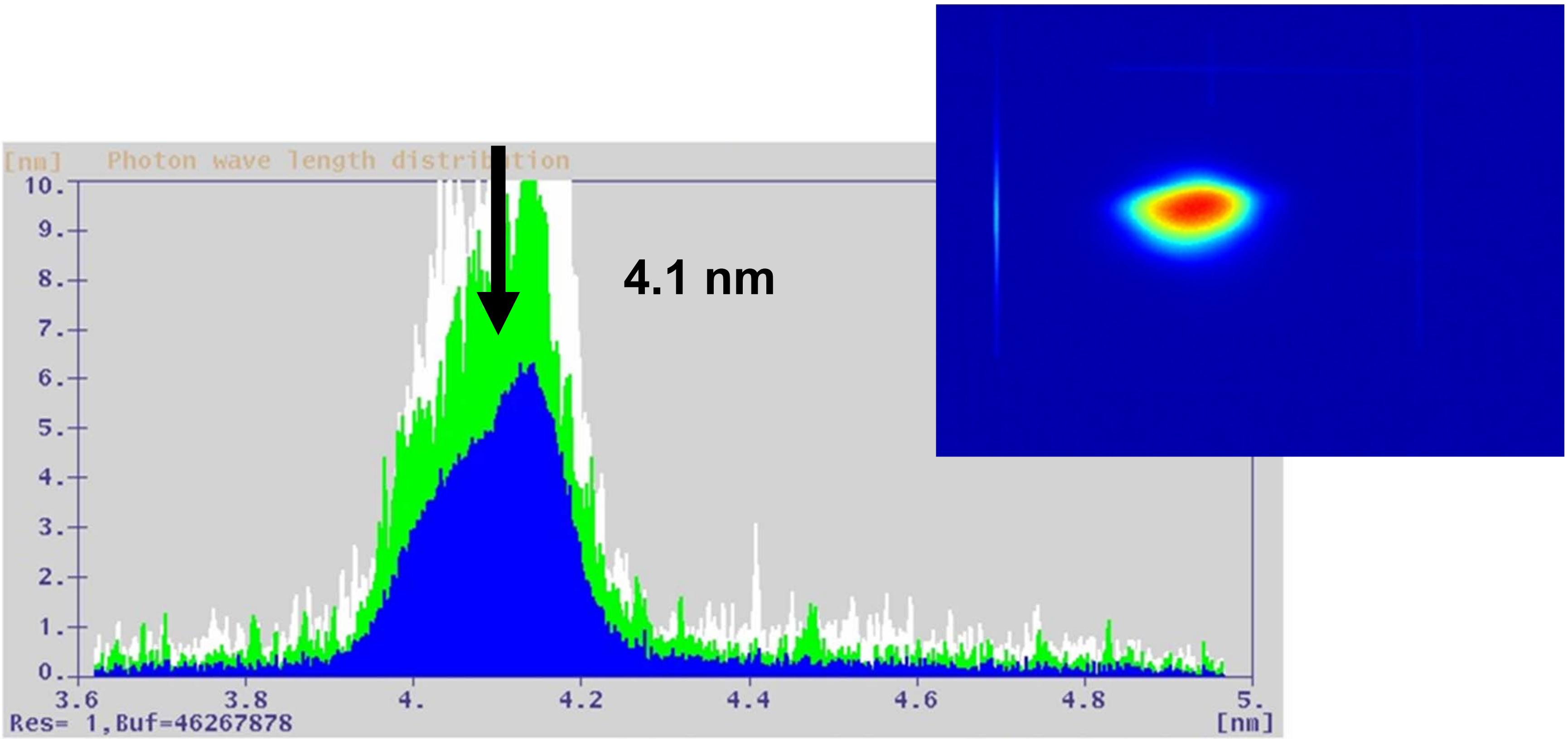


Nature photonics **1** (2007) 336

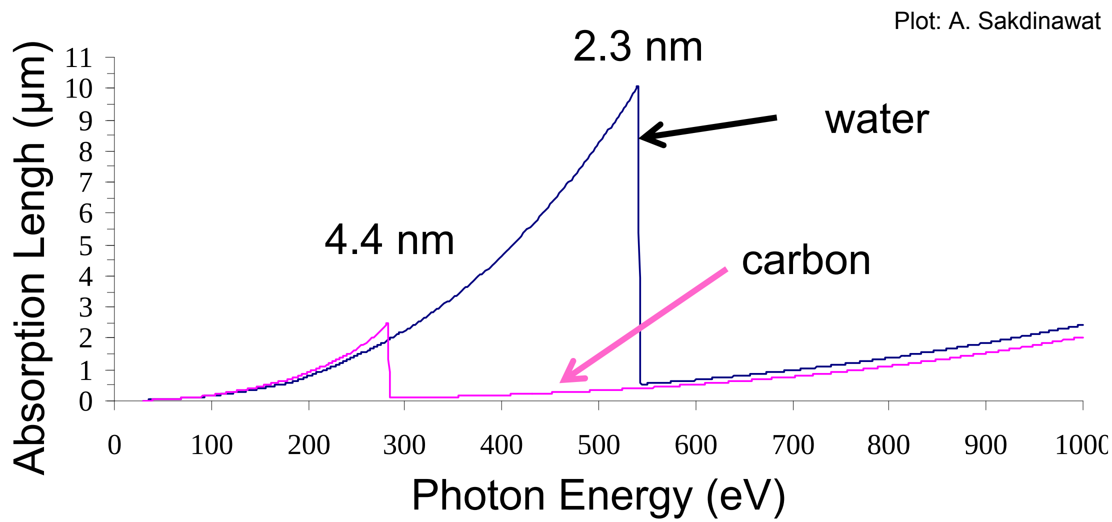
First Spectrum in the water window

FLASH.
Free-Electron Laser in Hamburg

- Wavelength 4.12 nm (fundamental)
- Single pulse energy ~130 µJ (max), ~70 µJ (av)



The Water Window



> The water window is the wavelength region between the K (1s) absorption edges of Oxygen (λ_{O2} = 2.3 nm, 543 eV) and Carbon (λ_C = 4.37 nm, 284 eV)

> Carbon absorbs the FEL radiation, water becomes more and more transparent

> Now also at FLASH, in-vivo experiments with biological probes in water solution, study of carbon containing molecules, etc.

First Water Window Experiment

FLASH. Free-Electron Laser in Hamburg

> First proof of principle experiment in the water window at 4.3 nm

> In-house experiment (FLASH Crew with K. Tiedtke et al. and external partners (PTB, M Richter et al.)

> Direct double photo-ionization in the focused FEL beam (3-5 µm) at CO_2, ZrO_2 und O_2

> Ion-ToF Spectra and fluorescence detection

> Especially the decay channel of the fluorescence signal is interesting

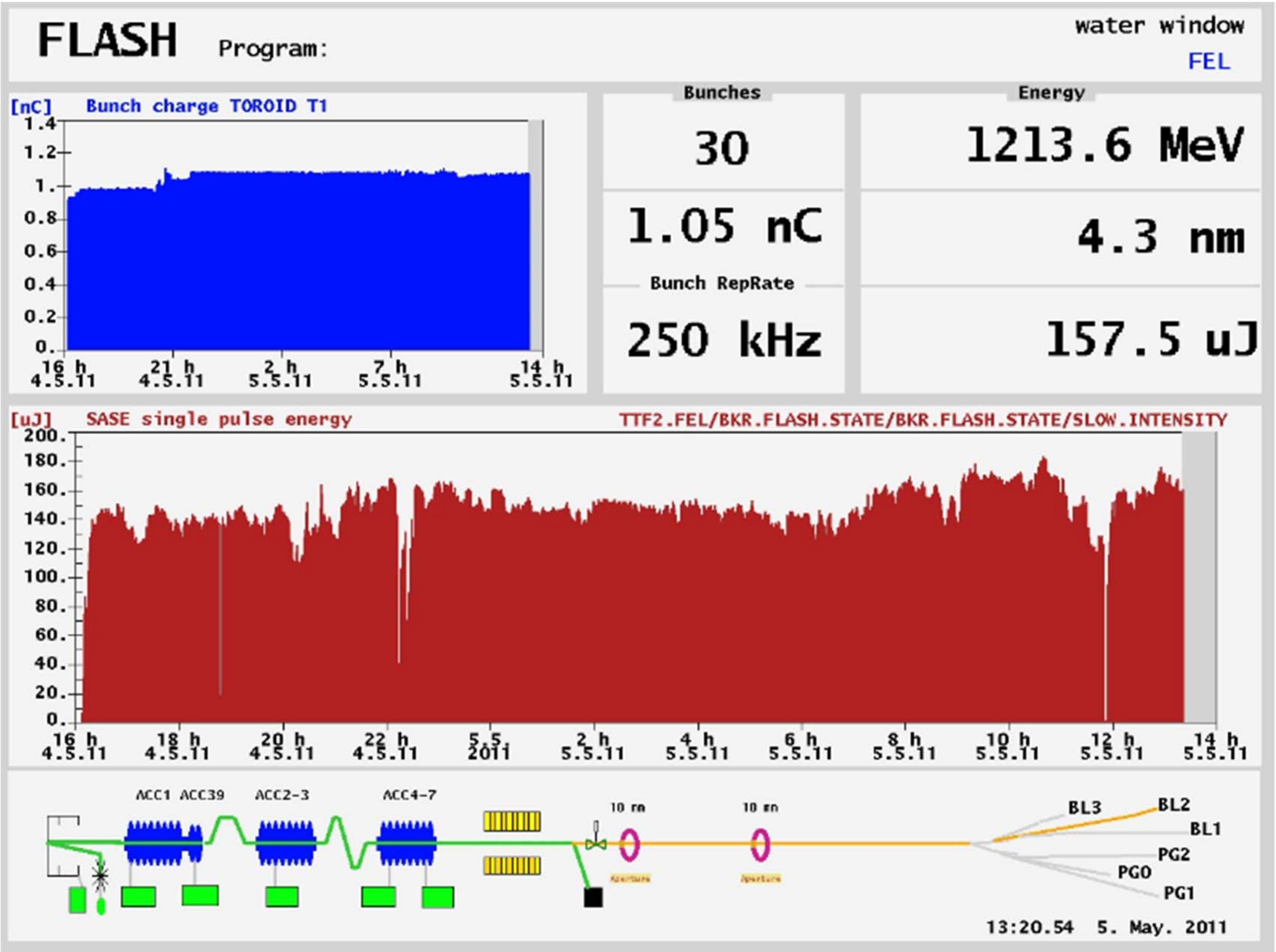
> We showed, that we can transport the radiation to one beamline (BL2) (impossible with standard carbon coated Silicon mirrors)

> Good transmission ~45 % with two Ni-coated plane mirrors and a spherical multilayer mirror to focus the beam

> We saw nice ion- and fluorescence spectra at different targets, like 1s-oxygen (gas phase) and Al-oxide (solid)

Water Window Experiment

FLASH. Free-Electron Laser in Hamburg



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SASE Parameters for 4.3 nm

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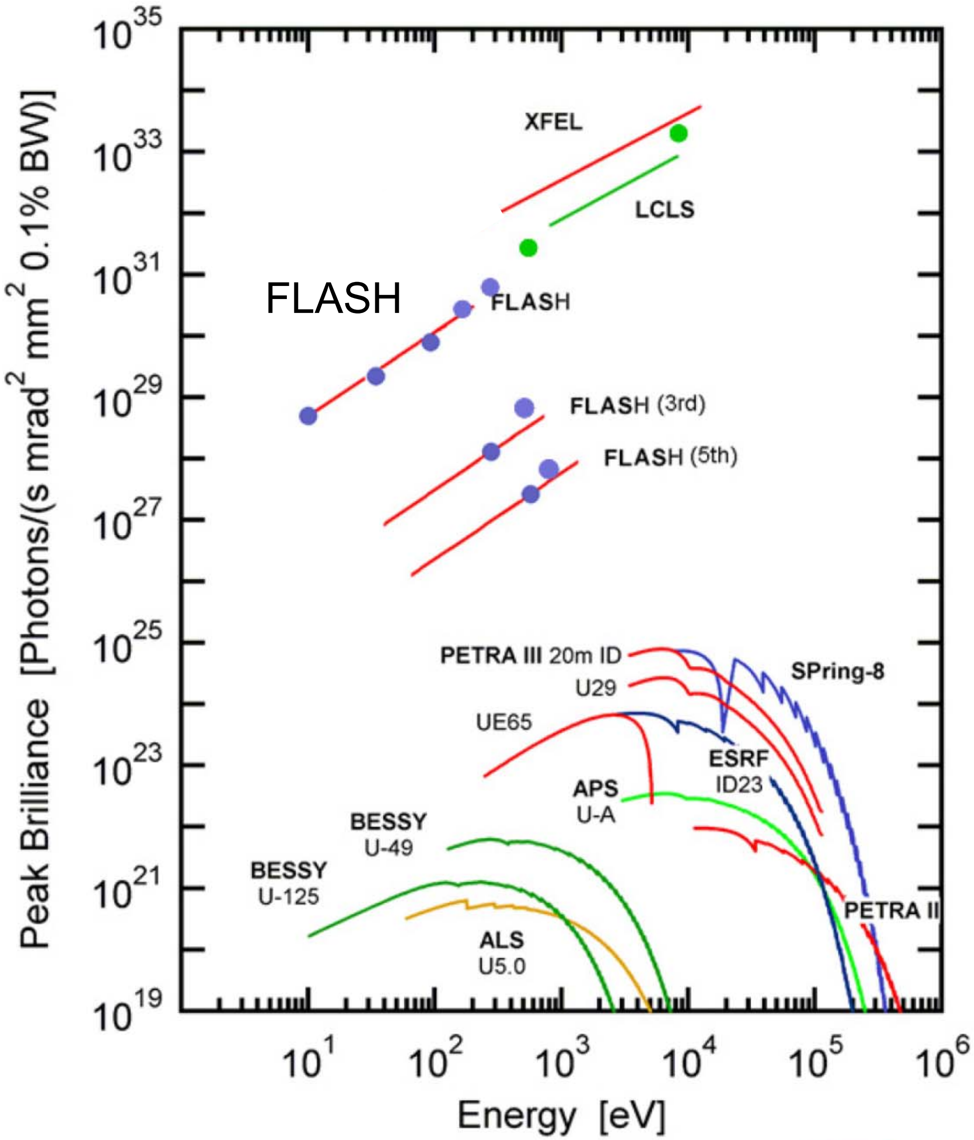
Preliminary data for 4.3 nm:

- Energy 160 µJ (av.)
- Peak power ~ 2 GW (estimate)
- bandwidth ~1 % fwhm
- Peak Brilliance

B ~ 10^{30} - 10^{31} photons/s/mrad^2/mm^2/0.1%bw



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Lasing Performance
3rd User Period

Sep 2010 – Sep 2011

3rd User period

FLASH. Free-Electron Laser in Hamburg

> Sep-2, 2010 – Sep-12, 2011

> 75 proposals reviewed, 29 proposals accepted

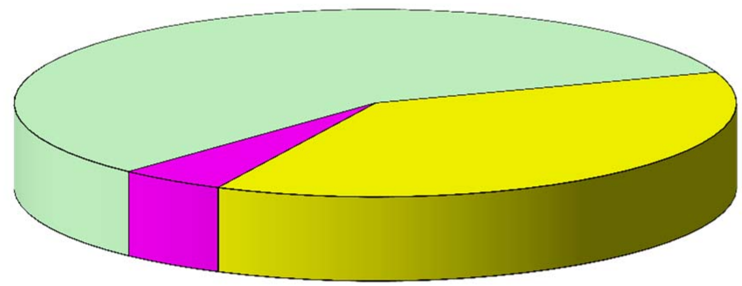
> 333 x 12 h-shifts are scheduled plus ~10 % for in-house experiments and contingency

- 8 user blocks of ~ 4 weeks each

Requested Pulse Pattern	
Single bunch	47 %
multi-bunch with different bunch spacing	53 %
Requested FEL pulse duration	
< 50 fs fwhh	28 %(*)
50 -100 fs	54 %
not critical, but high intensity	18 % (**)

(*) 72 % multi-bunch (**) mostly multi-bunch

FEL User run 57%



Scheduled off 5%

FEL and Accelerator studies 38%

	37	13.Sep - 19.Sep	1		
	38	20.Sep - 26.Sep	2	FEL studies	
	39	27.Sep - 3.Oct	3		preparation user run
	40	4.Oct - 10.Oct	1	User Run	
	41	11.Oct - 17.Oct	1		
	42	18.Oct - 24.Oct	1		
	43	25.Oct - 31.Oct	1		
	44	1.Nov - 7.Nov	2	FEL studies	
	45	8.Nov - 14.Nov	2		
	46	15.Nov - 21.Nov	3		preparation user run
	47	22.Nov - 28.Nov	1	User Run	
	48	29.Nov - 5.Dec	1		
	49	6.Dec - 12.Dec	1		
	50	13.Dec - 19.Dec	1		
	51	20.Dec - 26.Dec	5	Maintenance	
January	52	27.Dec - 2.Jan	5		
2011	1	3.Jan - 9.Jan	4		preparation accelerator studies
	2	10.Jan - 16.Jan	4	Accelerator studies	
	3	17.Jan - 23.Jan	4		
	4	24.Jan - 30.Jan	2	FEL studies	
	5	31.Jan - 6.Feb	2		
	6	7.Feb - 13.Feb	3		preparation user run
	7	14.Feb - 20.Feb	1	User Run	
	8	21.Feb - 27.Feb	1		
	9	28.Feb - 6.Mar	1		
	10	7.Mar - 13.Mar	1		
	11	14.Mar - 20.Mar	2	FEL studies	test personnel interlock
	12	21.Mar - 27.Mar	3		preparation user run
	13	28.Mar - 3.Apr	1	User Run	
	14	4.Apr - 10.Apr	1		
	15	11.Apr - 17.Apr	1		
	16	18.Apr - 24.Apr	1		
	17	25.Apr - 1.May	2	FEL studies	
	18	2.May - 8.May	2		
	19	9.May - 15.May	3		preparation user run
	20	16.May - 22.May	1	User Run	
	21	23.May - 29.May	1		
	22	30.May - 5.Jun	1		
	23	6.Jun - 12.Jun	1		
	24	13.Jun - 19.Jun	2	FEL studies	
	25	20.Jun - 26.Jun	3		preparation user run
	26	27.Jun - 3.Jul	1	User Run	
	27	4.Jul - 10.Jul	1		
	28	11.Jul - 17.Jul	1		
	29	18.Jul - 24.Jul	1		
	30	25.Jul - 31.Jul	2	FEL studies	
	31	1.Aug - 7.Aug	3		preparation user run
	32	8.Aug - 14.Aug	1	User Run	
	33	15.Aug - 21.Aug	1		
	34	22.Aug - 28.Aug	1		
	35	29.Aug - 4.Sep	1		
	36	5.Sep - 11.Sep	1		
	37	12.Sep - 18.Sep	6	FLASH II construction	shutdown starts 15-Sep

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Other requested FEL parameters

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- More than 30 different wavelengths between 4.7 nm and 45 nm
  - Call did not include the water window
  - ~ 1/3 of accepted experiments requested < 10 nm
  - ~ 1/3 around 13.5 nm
  - ~ 1/3 > 20 nm
- Different train patterns (all 10 Hz)
  - single bunch
  - up to 100 bunches (50 kHz / 100 kHz / 200kHz / 250 kHz / 500 kHz/ 1 MHz)
  - 150 to 300 bunches (1 MHz)
- Small bandwidth < 1%
- Exact wavelength within the bandwidth
- With pump-probe laser (single pulse laser/multi-pulse laser)
- Split and delay unit, THz radiation
- …

Poster: TUPA17
Online-Spectrometer

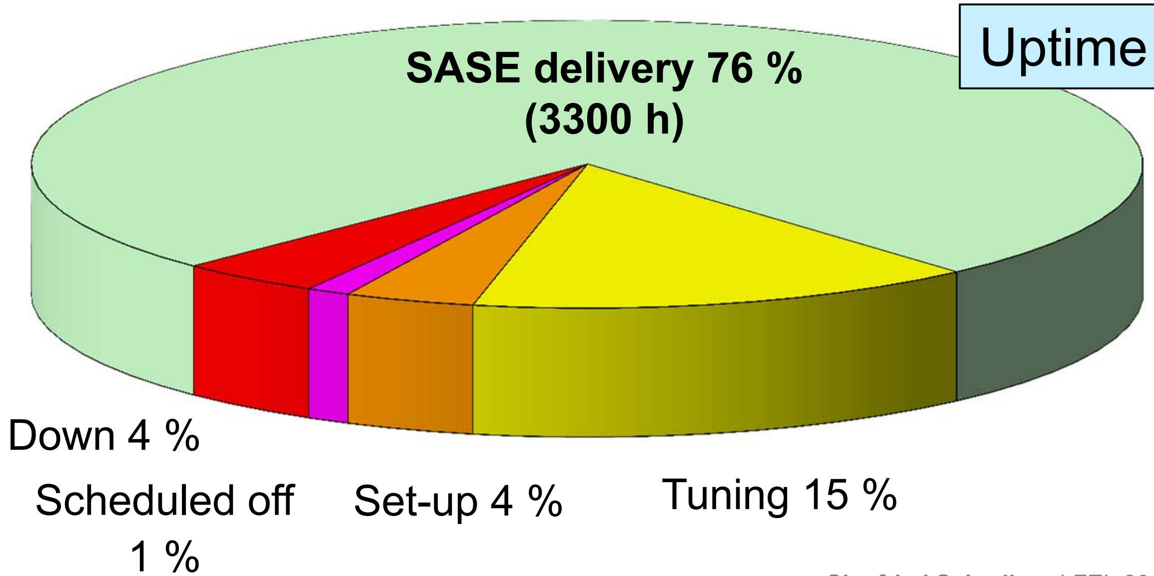
Summary Sep 2010 – July 2011

> SASE actually delivered to experiments 3300 hours
  - 101 % of time when compared with originally scheduled beam time for users
  - Thus, we could manage to compensate tuning time, downtime using contingency and partially in-house research time

> 2 experiments run in parallel at different beamlines

> Experiments and beam parameters are often changed once or twice per day, some users run extended blocks of several shifts

Uptime accelerator 96%



Example of a user block schedule

FLASH. Free-Electron Laser in Hamburg

> Colors indicate a different experiment

> The schedule is a delicate balance between beamline availability, pump-probe lasers, set-up time, probe changes, and many other constraints

May-June 2011 / Beamblock 6

last update: 25./26.5.'11 (parameter change Wernet, Moshammer & Wurth, distribution of Cont. and Inhouse res.)

L = optical pump-probe laser SD= Split and delay

		day shift (7:00-19:00)						*night shift (19:00 -7:00)*					
16.5.11	Mo	machine setup for users		13.7nm				inh. research - Düsterer	13.7 nm ± 0.1 nm	30 bunches, 100kHz, <50fs	BL2	L	
17.5.11	Tu	inh. research - Düsterer	13.7 nm ± 0.1 nm	30 bunches, 100kHz, <50fs	BL2	L		machine setup for users		change to 4.7 nm			
18.5.11	We	Senz / Meiwes-Broer	4.7 nm ± 0.1 nm	800b,1MHz,high int.,small bandw.	BL1			Senz / Meiwes-Broer	4.7 nm ± 0.1 nm	800b,1MHz,high int.,small bandw.	BL1		
19.5.11	Th	Johnsson	13.7 nm ± 0.1 nm	30 bunches, 100kHz, <50fs	BL2	L/(THz)		Johnsson	13.7 nm ± 0.1 nm	30 bunches, 100kHz, <50fs	BL2	L/(THz)	
20.5.11	Fr	Senz / Meiwes-Broer	4.7 nm ± 0.1 nm	800b,1MHz,high int.,small bandw.	BL1			Senz / Meiwes-Broer	4.7 nm ± 0.1 nm	800b,1MHz,high int.,small bandw.	BL1		
21.5.11	Sa	Johnsson	13.7 nm ± 0.1 nm	30 bunches, 100kHz, <50fs	BL2	L/(THz)		timeslot for inhouse research					
22.5.11	Su	Johnsson	13.7 nm ± 0.1 nm	30 bunches, 100kHz, <50fs	BL2	L/(THz)		Johnsson	13.7 nm ± 0.1 nm	30 bunches, 100kHz, <50fs	BL2	L/(THz)	
23.5.11	Mo	Senz / Meiwes-Broer	4.7 nm ± 0.1 nm	800b,1MHz,high int.,small bandw.	BL1			Senz / Meiwes-Broer	4.7 nm ± 0.1 nm	800b,1MHz,high int.,small bandw.	BL1		
24.5.11	Tu	Maintenance + machine startup						Johnsson	13.7 nm ± 0.1 nm	30 bunches, 100kHz, <50fs	BL2	L/(THz)	
25.5.11	We	Johnsson	13.7 nm ± 0.1 nm	30 bunches, 100kHz, <50fs	BL2	L/(THz)		Johnsson	13.7 nm ± 0.1 nm	30 bunches, 100kHz, <50fs	BL2	L/(THz)	
26.5.11	Th	machine setup for users		change to 4.7 nm				Senz / Meiwes-Broer	4.7 nm ± 0.1 nm	800b,1MHz,high int.,small bandw.	BL1		
27.5.11	Fr	Wernet	10.1 nm ± 0.2 nm	2 bunches, 100kHz, <=100fs	PG2	L		Contingency (8h Wernet, 4h setup 8 nm)					
28.5.11	Sa	Vartaniants	8 nm ± 0.2 nm	single bunch, ~100fs	BL3			Vartaniants	8 nm ± 0.2 nm	single bunch, ~100fs	BL3		
29.5.11	Su	Wernet	10.1 nm ± 0.2 nm	2 bunches, 100kHz, <=100fs	PG2	L		Wernet	10.1 nm ± 0.2 nm	2 bunches, 100kHz, <=100fs	PG2	L	
30.5.11	Mo	Wernet	10.1 nm ± 0.2 nm	2 bunches, 100kHz, <=100fs	PG2	L		Contingency (Wernet)					
31.5.11	Tu	Contingency						Wernet	21.9 nm ± 0.2 nm	2 bunches, 100kHz, <=100fs	PG2	L	
1.6.11	We	Wernet	21.9 nm ± 0.2 nm	2 bunches, 100kHz, <=100fs	PG2	L		machine setup for users (from 3p.m.!)		change to 44nm ± 1nm, 200b., 500 kHz, <50fs			
2.6.11	Th	Moshammer	44 nm ± 1 nm	100b., 250 kHz, <50fs	BL2		SD	Moshammer	44 nm ± 1 nm	100b., 250 kHz, <50fs	BL2		SD
3.6.11	Fr	Wernet	21.9 nm ± 0.2 nm	2 bunches, 100kHz, <=100fs	PG2	L		Wernet	21.9 nm ± 0.2 nm	2 bunches, 100kHz, <=100fs	PG2	L	
4.6.11	Sa	Moshammer	44 nm ± 1 nm	100b., 250 kHz, <50fs	BL2		SD	Moshammer	44 nm ± 1 nm	100b., 250 kHz, <50fs	BL2		SD
5.6.11	Su	machine setup for users		change to 6nm ± 0.5nm, 200b., 500 kHz, <50fs				Moshammer (former timeslot for inhouse research)					
6.6.11	Mo	Moshammer	6 nm ± 0.5 nm	50b., 200 kHz, <50fs	BL2		SD	Moshammer	6 nm ± 0.5 nm	50b., 200 kHz, <50fs	BL2		SD
7.6.11	Tu	Contingency (setup for Vartaniants)						Vartaniants	8 nm ± 0.2 nm	single bunch, ~100fs	BL3	L	
8.6.11	We	Vartaniants	8 nm ± 0.2 nm	single bunch, ~100fs	BL3	L		Vartaniants	8 nm ± 0.2 nm	single bunch, ~100fs	BL3	L	
9.6.11	Th	machine setup for users		change to 6nm ± 0.5nm, >=40b., 100 kHz, <50fs				Moshammer	6 nm ± 0.5 nm	>=40b., 100 kHz, <50fs	BL2		SD
10.6.11	Fr	Moshammer	6 nm ± 0.5 nm	>=40b., 100 kHz, <50fs	BL2		SD	Contingency (Moshammer)					
11.6.11	Sa	Moshammer	6 nm ± 0.5 nm	>=40b., 100 kHz, <50fs	BL2		SD	Moshammer	6 nm ± 0.5 nm	>=40b., 100 kHz, <50fs	BL2		SD
12.6.11	Su	machine setup for users		change to 6.5 nm ± 0.1nm, 30 b., 500kHz, <50fs				Wurth	6.5 nm ± 0.1 nm	30b., 500 kHz, <50fs	PG2	L	
13.6.11	Mo	Wurth	6.5 nm ± 0.1 nm	30b., 500 kHz, <50fs	PG2	L		Wurth	6.5 nm ± 0.1 nm	30b., 500 kHz, <50fs	PG2	L	

…. you are not supposed to read the details

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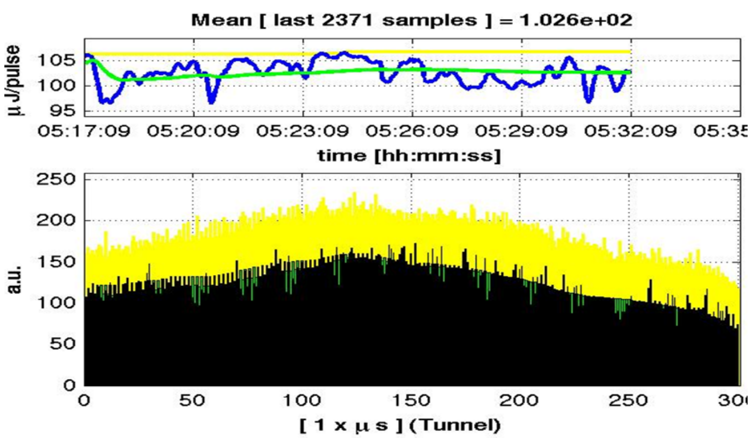
FLASH Parameters 2011

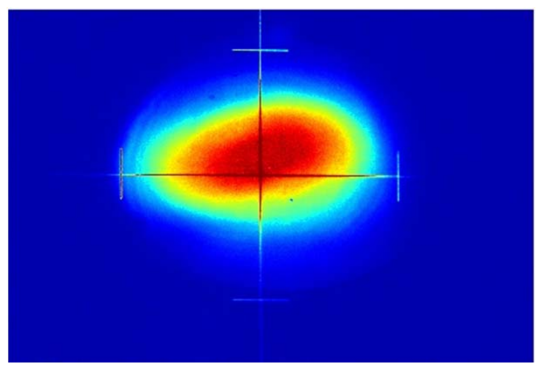
FLASH. Free-Electron Laser in Hamburg

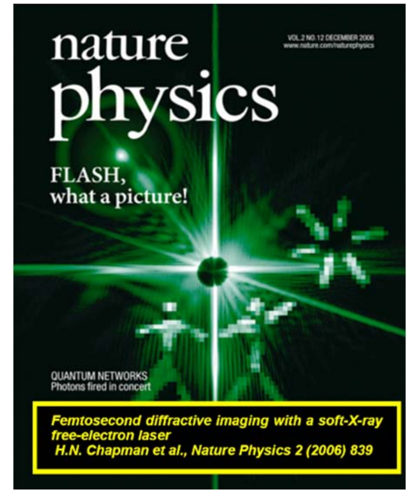
FEL Radiation Parameters 2011

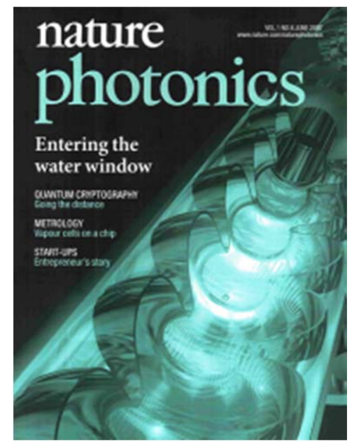
Wavelength range (fundamental)	4.1 – 45 nm
Average single pulse energy	10 – 400 µJ
Pulse duration (FWHM)	50 – 200 fs
Peak power (from av.)	1 – 3 GW
Average power (example for 3000 pulses/sec)	~ 300 mW
Spectral width (FWHM)	~ 0.7 - 2 %
Average Brilliance	$10^{17} – 10^{21}$ *
Peak Brilliance	$10^{29} – 10^{31}$ *

* photons/s/mrad^2/mm^2/0.1%bw









> Up to now 150 publications on photon science at FLASH, many in high impact journals
  - http://hasylab.desy.de/facilities/flash/publications/selected_publications

> 400 µJ, single bunch 13.5 nm, ~ 0.9 nC

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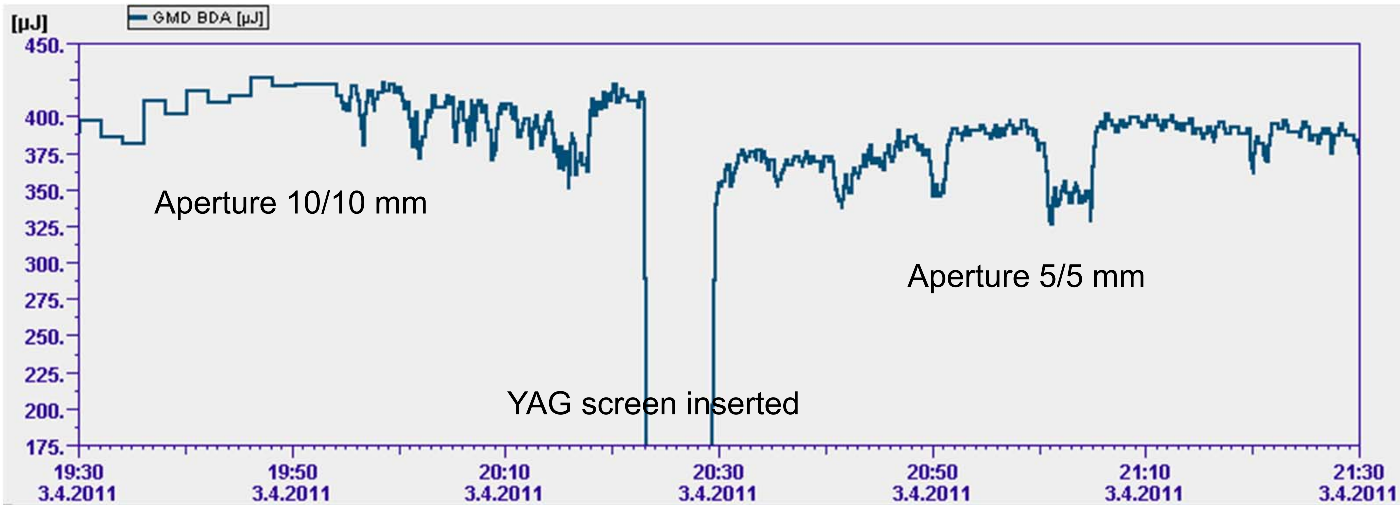
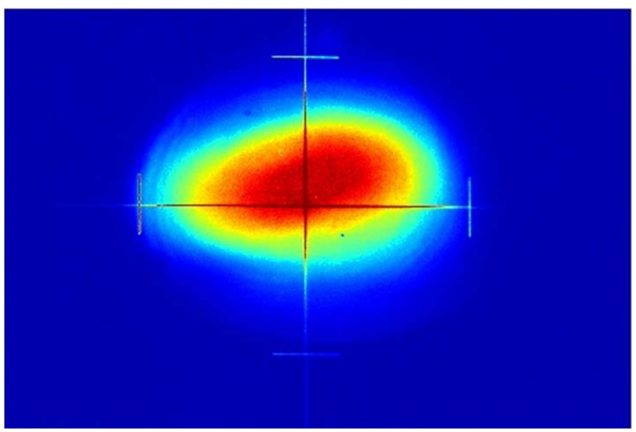
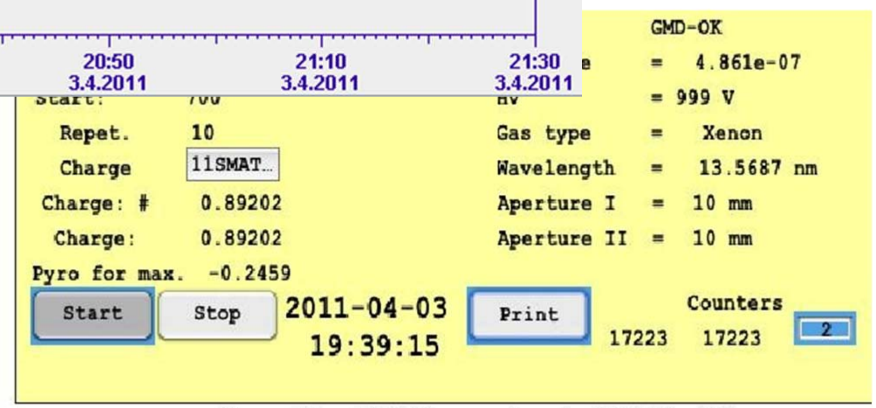
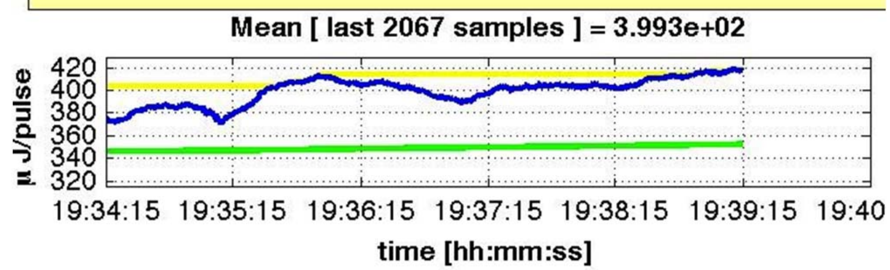
Free-Electron Laser in Hamburg





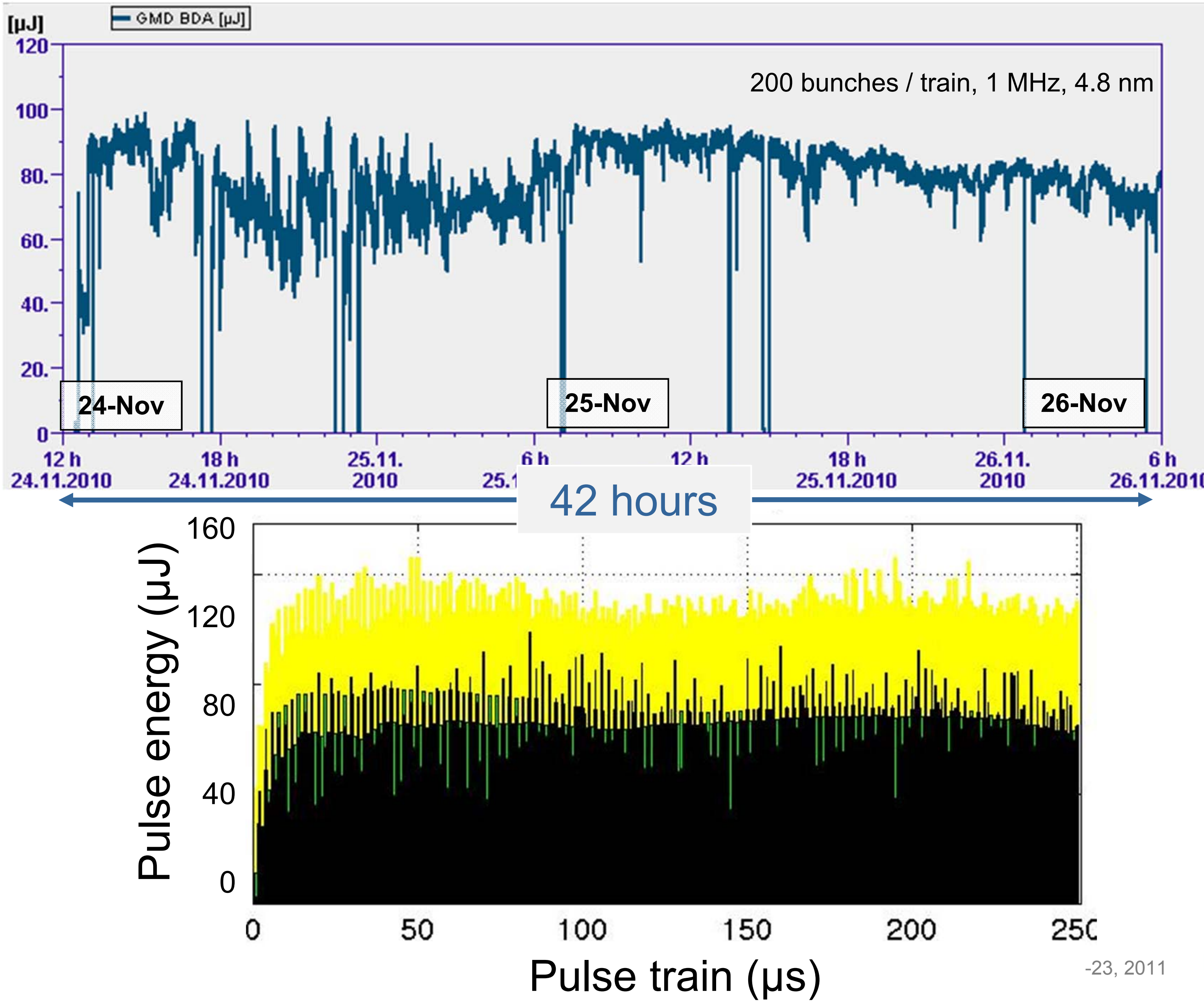




DESY

4.8 nm, 200 - 250 pulses/train, 1 MHz

FLASH.
Free-Electron Laser in Hamburg

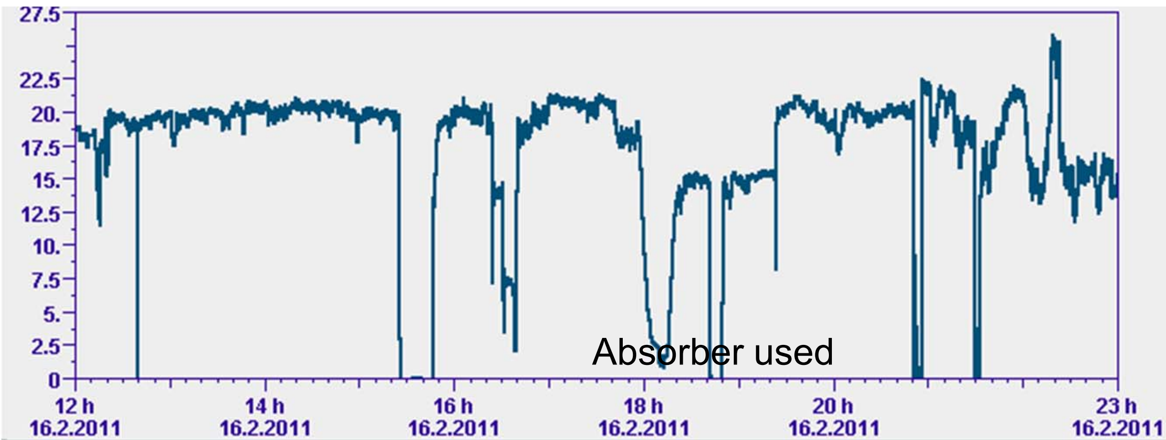


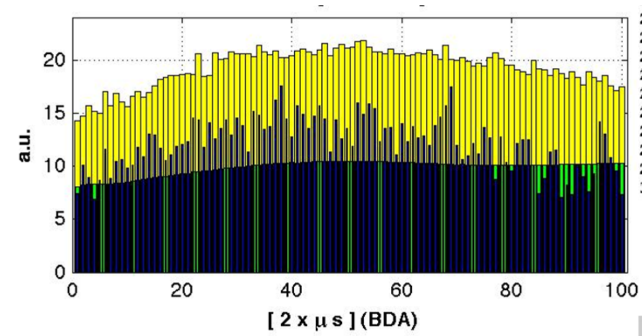
DESY

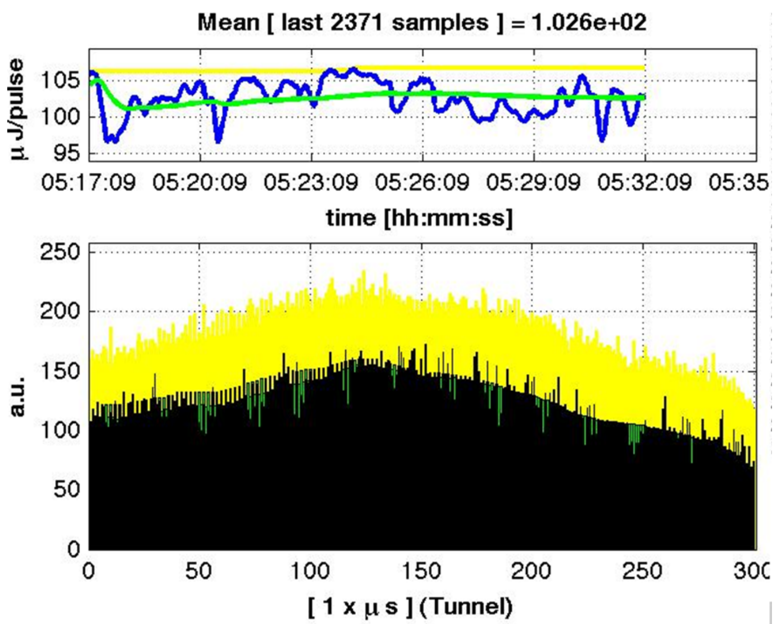
Very small charge / multi-bunch examples

FLASH.
Free-Electron Laser in Hamburg

- SASE with small charge 120 pC for short pulses
- 20.3 nm, 100 bunches / 500 kHz





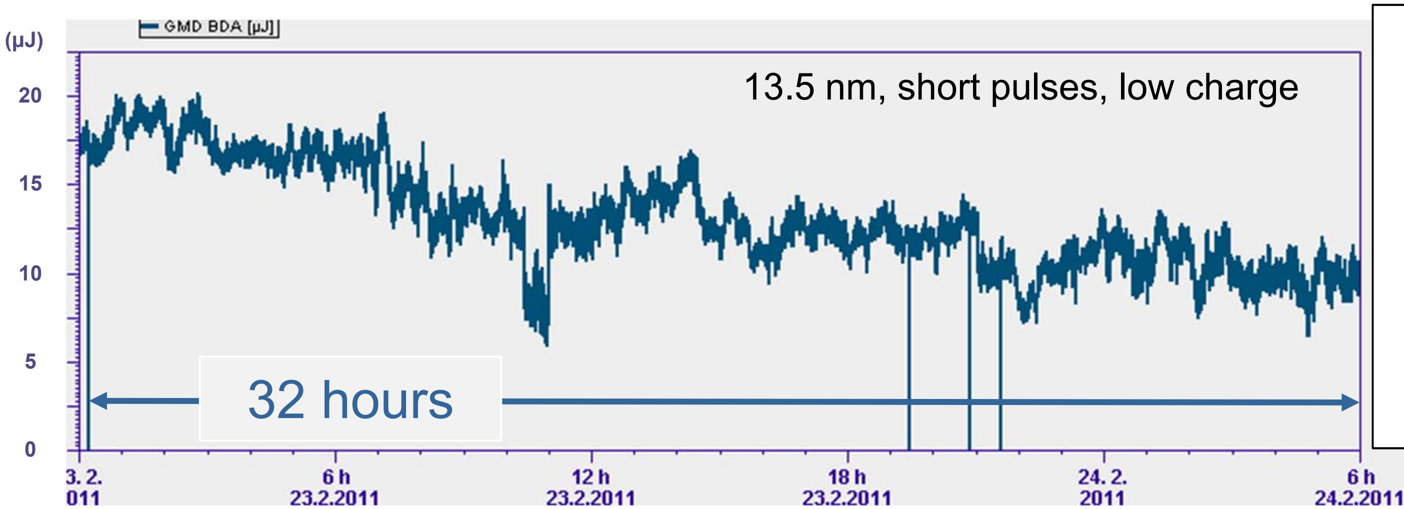


- 6.9 nm, 300 bunches, 1 MHz

New record for FLASH:
Average power exceeds 300 mW

DESY

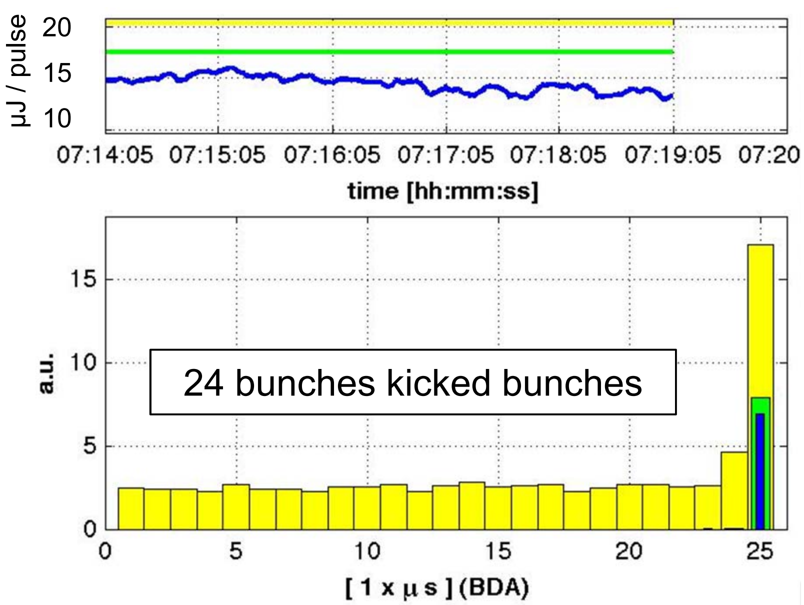
Pump-probe experiment + arrival time stabilization

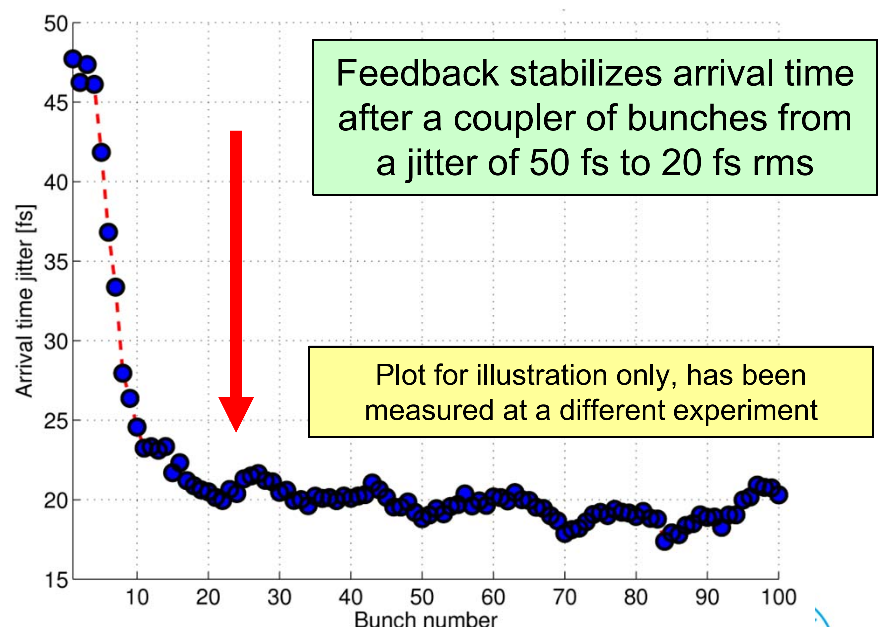


Orbit of 24 bunches kicked,
only 25th lasing lasing,
quick set-up time

arrival time feedback running

Stable over days





Sych@FLASH: WEPA07, WEPA08, WEPA19, THPA26

Measurement of short FEL pulses

FLASH. Free-Electron Laser in Hamburg

> The issue for us is to actually measure and monitor the photon pulse length

> Experiments to compare different techniques are being performed in a regular manner

> Electron bunch length is measured with LOLA and is also estimated using coherent radiation

> Methods to measure FEL pulse duration being used or tested

- THz streak camera
  with THz undulator, Edge radiation, external laser
- THz undulator as afterburner (optical replica of the FEL-pulse)
- High resolution spectrometer
- Statistical method
- Autocorrelation (several set-ups)
- Reflectivity pump-probe method

Preliminary data on comparison methods

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	FEL Pulse duration in fs (FWHM)			
	0.5 nC	0.25 nC	0.15 nC	
Statistical method	100		35-40	
THz streak		50 – 70		Preliminary estimate
Spectrometer	100		20	20/-/3-4 spikes
Afterburner	170–200		25-70	FROG resolution 25 fs
	Estimate from electron pulse (FWHM, e^- length / 2)			
Coherent radiation			50	
LOLA	150	50 – 70	35	

> In general good agreement for the short pulses - within a factor of 2

> Larger uncertainties for longer pulses

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Example of Longitudinal Electron Bunch Profile

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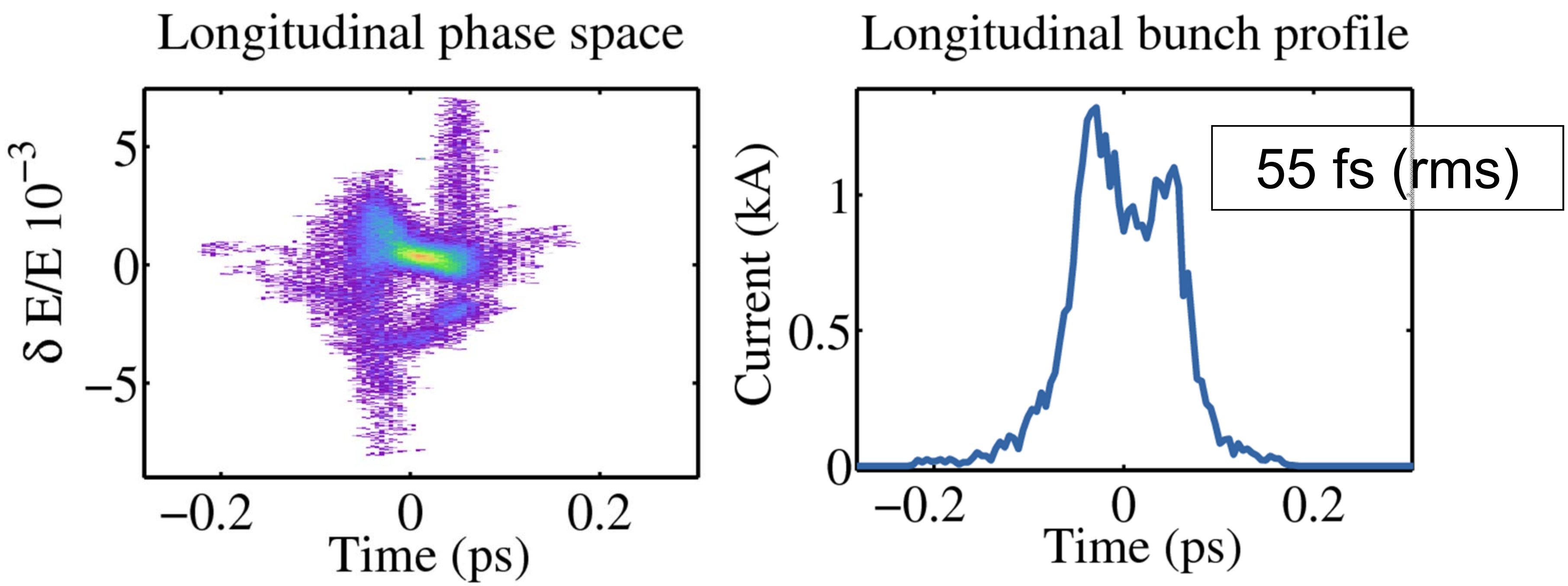
- Phase space distribution measured with LOLA (bunch charge 200 pC)



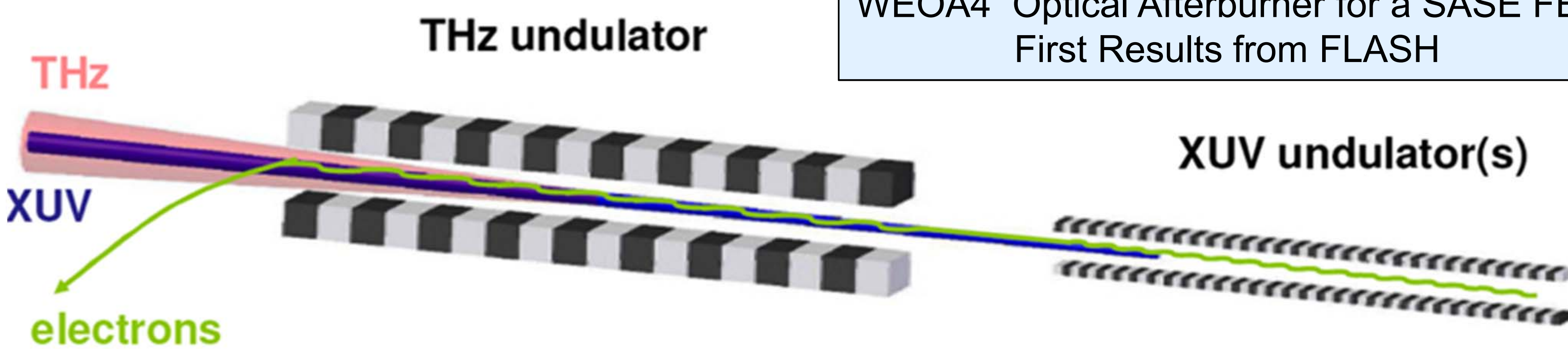
THPA07 Multichannel Wavelength Resolved Coherent Radiation Detector for Bunch Profile Monitoring at FLASH

THOCI1 Measurement and Control of the Longitudinal Phase Space at High-Gain Free-electron Lasers

THz Undulator

FLASH.
Free-Electron Laser in Hamburg

WEOA4 Optical Afterburner for a SASE FEL: First Results from FLASH



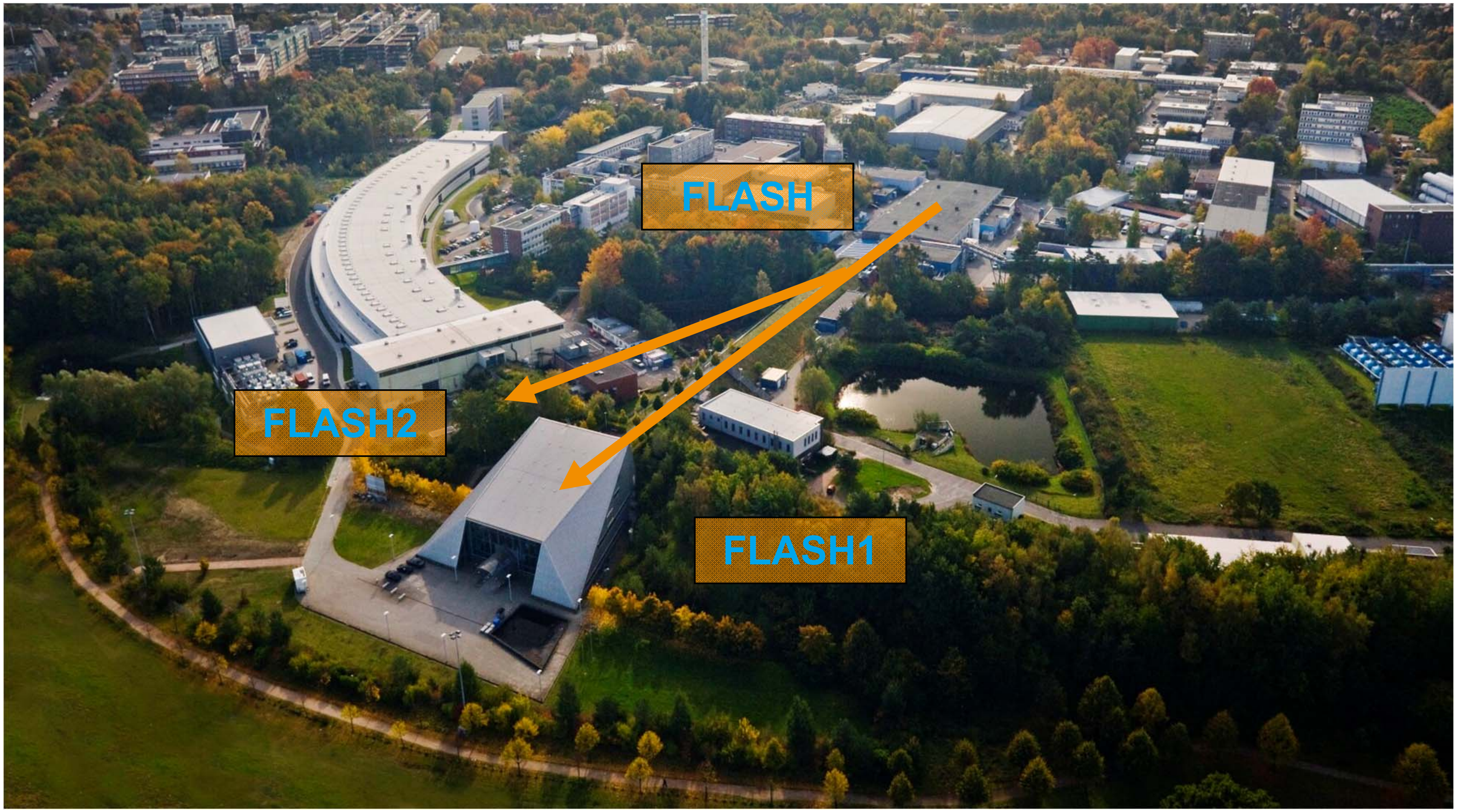
> Cascaded design: THz radiation together with FEL radiation
> Electromagnetic Undulator
  - 10 periods
> Wavelength 0.5 – 230 µm
  - Up to 70 µJ pulse energy
> Single cycle pulses (edge radiation)
  - Up to 10 µJ
> Synchronized to XUV pulse < pulse length

FLASH II

FLASH II

FLASH. Free-Electron Laser in Hamburg

> Second undulator beam line and experimental hall



DESY

FLASH II

FLASH. Free-Electron Laser in Hamburg

> View of the buildings for second beam line FLASH2

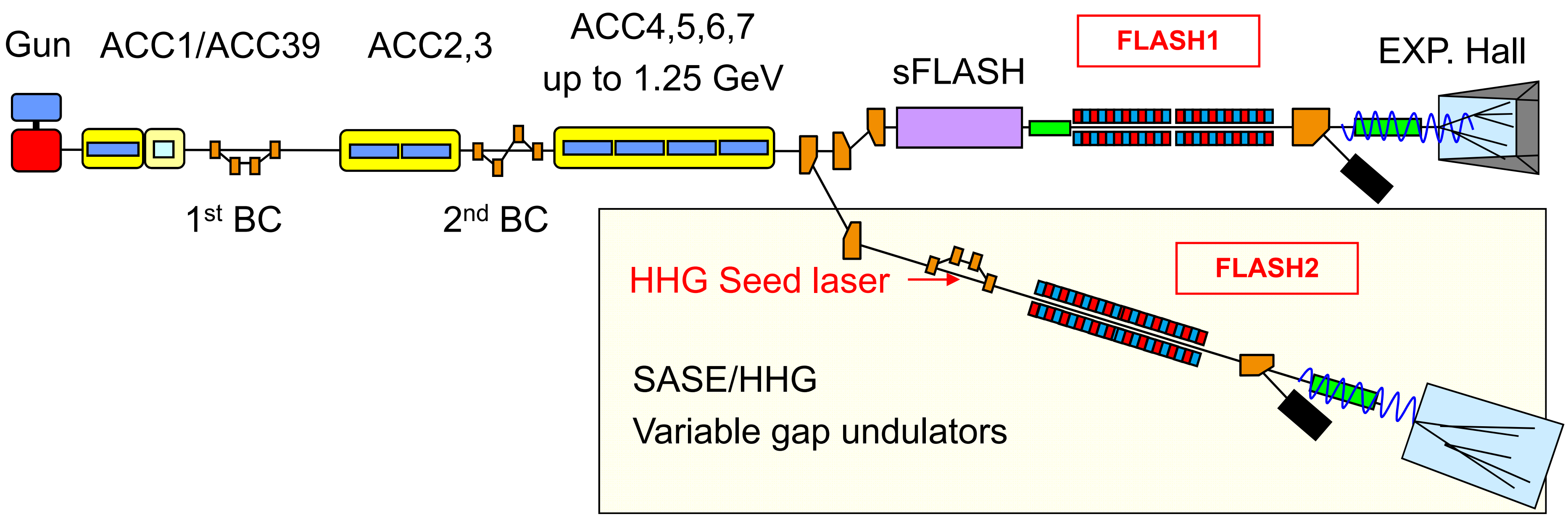
> New experimental hall integrated with FLASH1 hall and PETRA III extension hall

TUPA22 Status of the FLASH II Project

Layout of the FLASH2 beamline

FLASH. Free-Electron Laser in Hamburg

- Use of existing infrastructure up to last accelerating module
- Extend user capacity with SASE and HHG seeding
- Long pulse trains are split and serve both beamlines with 10 Hz bursts
- Tunability of FLASH2 wavelength by variable gap undulators



THPB21 Extraction Arc for FLASH2

FLASH 2 Parameters

Beam Energy	0.5 – 1.25 GeV
Normalized emittance (proj.)	1.4 – 3 mm mrad
Energy spread	0.5 MeV
Peak Current	2.5 kA
Bunches per second	<8000 (**)
Bunch Charge	0.02 – 1 nC
Undulator parameters	
Period	31.4 mm
Segments nb x length	12 x 2.5 m
Radiation	**SASE**
Wavelength range SASE (nm)	4 – 60
FWHM Pulse Length (fs)	10 – 500
Peak Power (GW)	1 – 5
Bandwidth (%)	0.5 – 2%
Peak Brilliance*	10^{28} – 10^{31}
Pulse Energy (µJ)	1 – 500

*Photons/(s mrad^2 mm^2 0.1%)

(**) to be shared with FLASH1

FLASH. Free-Electron Laser in Hamburg

DESY

Summary and Outlook

FLASH. Free-Electron Laser in Hamburg

- Energy upgrade to 1.25 GeV
- First lasing in the water window at FLASH with the fundamental
  - 25-Sep-2011: wavelength 4.12 nm, ~130 µJ (max), ~70 µJ (av)
- The 3rd user period Sep. 2010 – Sep. 11 with 217 days for users
- Excellent SASE performance
- Single photon pulse energies of up to 400 µJ
- Phase space linearization with 3rd harmonic works excellent
- FLASH II construction starts mid Sept. 2011
- 4th user run scheduled for 2012/13

FLASH.
Free-Electron Laser in Hamburg

- ID: 1181 - MOPB28 Gas-filled Cell as a Narrow Bandwidth Bandpass Filter in the VUV Wavelength
- ID: 1179 - MOPB31 Self-seeding Scheme with Gas Monochromator for Narrow-bandwidth Soft X-ray
- ID: 1246 - MOPC05 HGHG Scheme for FLASH II
- ID: 1538 - MOPC24 Effect of Coherent Synchrotron Radiation on EEHG Options for FLASH II
- ID: 1293 - TUOBI2 First Lasing in the Water Window with 4.1nm at FLASH
- ID: 1317 - TUPA04 sFLASH - Present Status and Commissioning Results
- ID: 1087 - TUPA17 First results from the Online Variable Spacing Grating Spectrometer at FLASH
- ID: 1292 - TUPA22 Status of the FLASH II Project
- ID: 1305 - TUPA27 Few-femtosecond Timing at Fourth-generation X-ray Light Sources
- ID: 1294 - TUPB04 Status of the FEL User Facility FLASH
- ID: 1537 - TUPB10 Echo Seeding Experiment at FLASH in 2012
- ID: 1555 - TUPB23 High Accuracy Measurements of Partial Photoionization Cross Sections of Rare Gases for Measuring the Photon Flux …
- ID: 1303 - WEOA4 Optical Afterburner for a SASE FEL: First Results from FLASH
- ID: 1301 - WEPA07 Femtosecond Precision Phase-Lock of Ti:Sapphire Laser Oscillators to the Optical Synchronization System at FLASH
- ID: 1302 - WEPA08 Review of the Laser-Based Synchronization Infrastructure at FLASH
- ID: 1291 - WEPA19 Report on the Redesign of the Fiber Link Stabilization Units at FLASH
- ID: 1553 - WEPB08 Radiometric Comparison for Measuring FEL Radiant Power in the Extreme Ultraviolet and X-ray Regime
- ID: 1422 - THOCI1 Measurement and Control of the Longitudinal Phase Space at High-Gain Free-electron Lasers
- ID: 1310 - THPA07 Multichannel Wavelength Resolved Coherent Radiation Detector for Bunch Profile Monitoring at FLASH
- ID: 1326 - THPA12 Beam Energy Measurements in the Injector at FLASH using a Synchrotron Radiation Monitor and Bunch Arrival Monitors
- ID: 1542 - THPA14 Upgrade of the Optical Synchronization System for FLASH II
- ID: 1299 - THPA[illegible] Operation of the FLASH Photoinjector Lasersystem
- ID: 1296 - THPA1[illegible] [illegible]hotocathodes at FLASH
- ID: [illegible]199 - THPA[illegible] Feedback Strategies for Bunch Arrival Time Stabilization at FLASH Towards 10 fs
- ID: 1[illegible]04 - THPA32 Femtosecond Stable Laser-to-RF Phase Detection Using Optical Modulators
- ID: 1306 - THPB16 Beam Profile Measurements Using a Fast Gated CCD Camera and Scintillation Screen to Suppress COTR
- ID: 1217 - THPB21 Extraction Arc for FLASH2