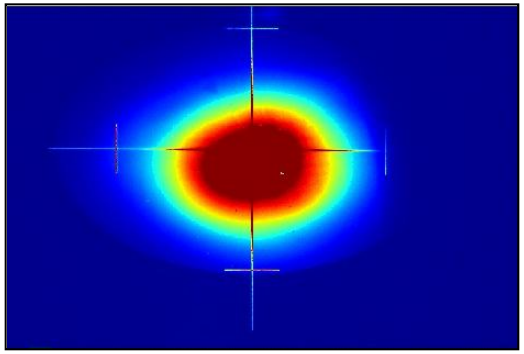
First Lasing at FLASH with 4.45 nm

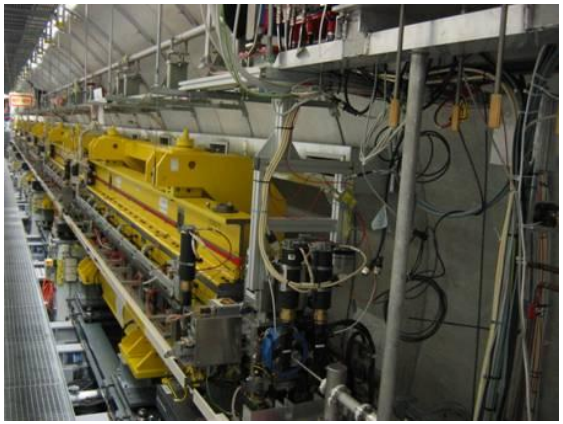
FLASH.
Free-Electron Laser
in Hamburg

FLASH – free-electron laser user facility at DESY

Siegfried Schreiber
DESY

FEL 2010
Malmö, Sweden
Aug 23-27, 2010





FEL
- MMX Sweden -

HELMHOLTZ GEMEINSCHAFT

DESY

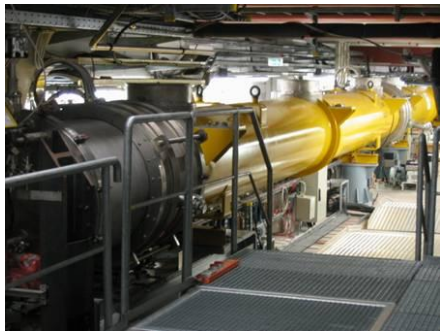
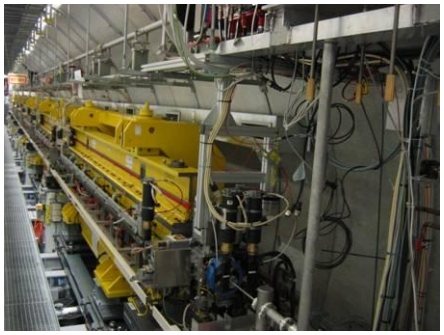
FLASH at DESY in Hamburg

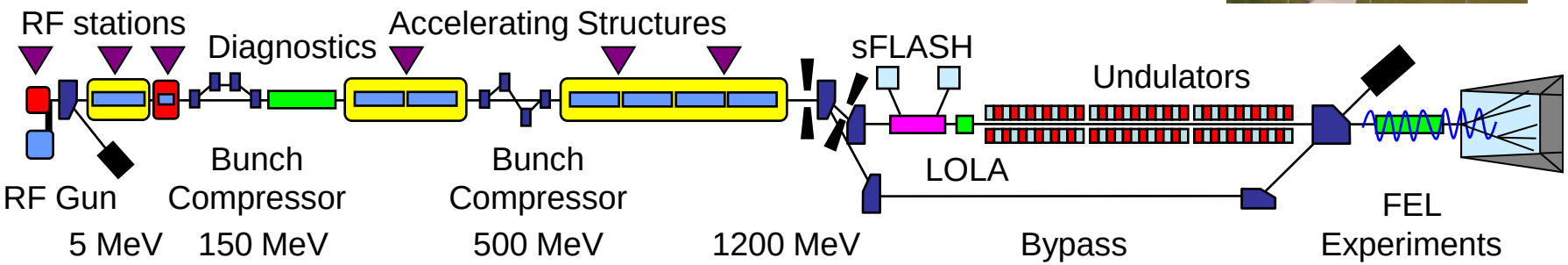
FLASH.
Free-Electron Laser in Hamburg

- 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
- 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

The new FLASH layout

FLASH.
Free-Electron Laser in Hamburg




DESY

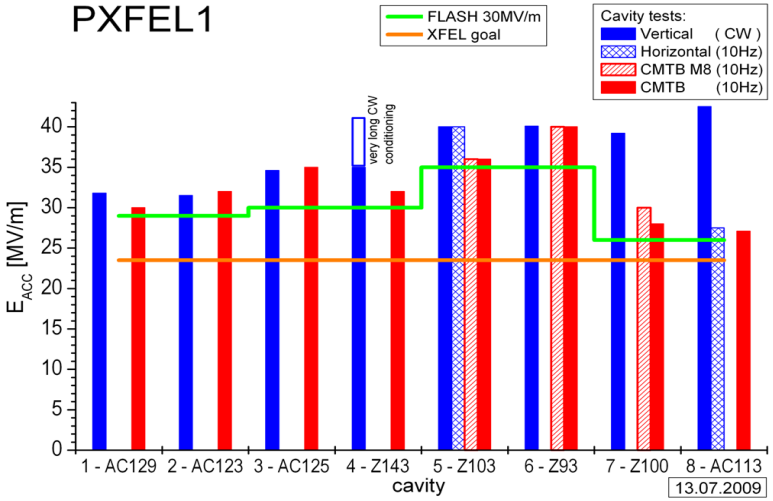
Energy upgrade

FLASH.
Free-Electron Laser in Hamburg

- Shutdown Sep. 2009 – Feb. 2010
- 7th superconducting TESLA type accelerating module installed
  - Prototype module for the European XFEL
  - Energy reach 240 MeV
- Electron beam energy 1.2 GeV

1.2 GeV demonstrated with beam in May 2010

Results of cavity tests



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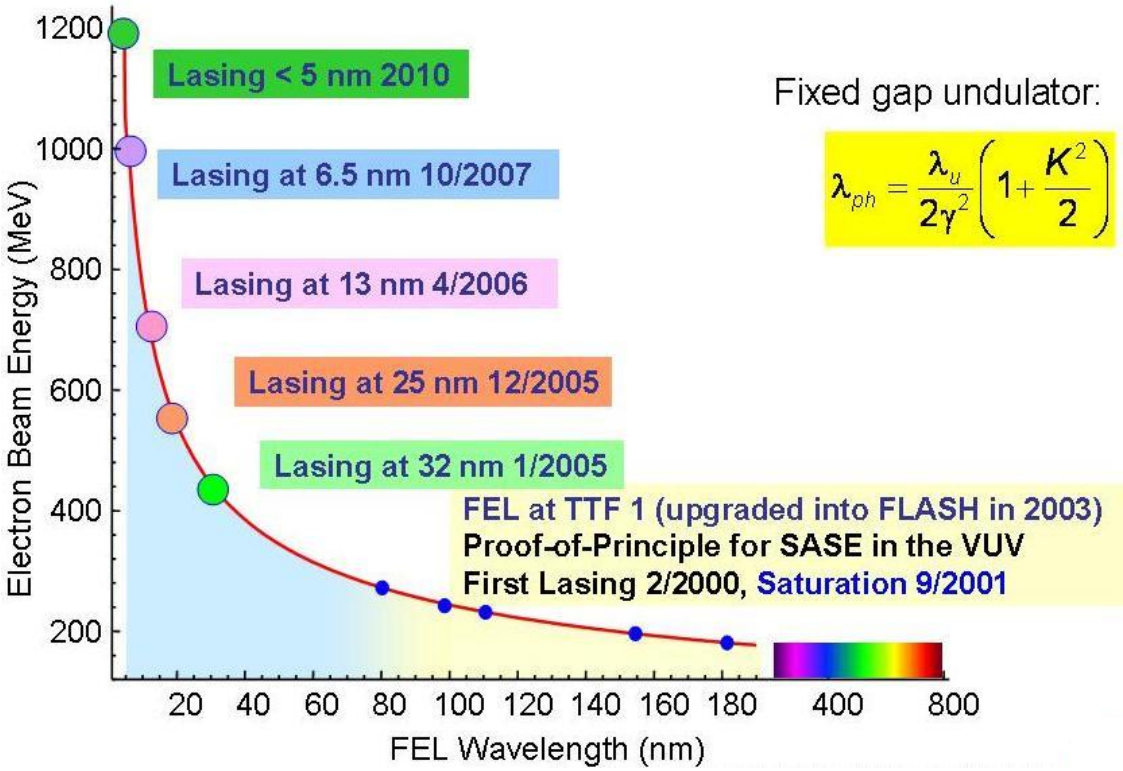
FLASH undulators

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



Fixed gap undulator:

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

- change of wavelength
  ↔
  change of electron beam energy

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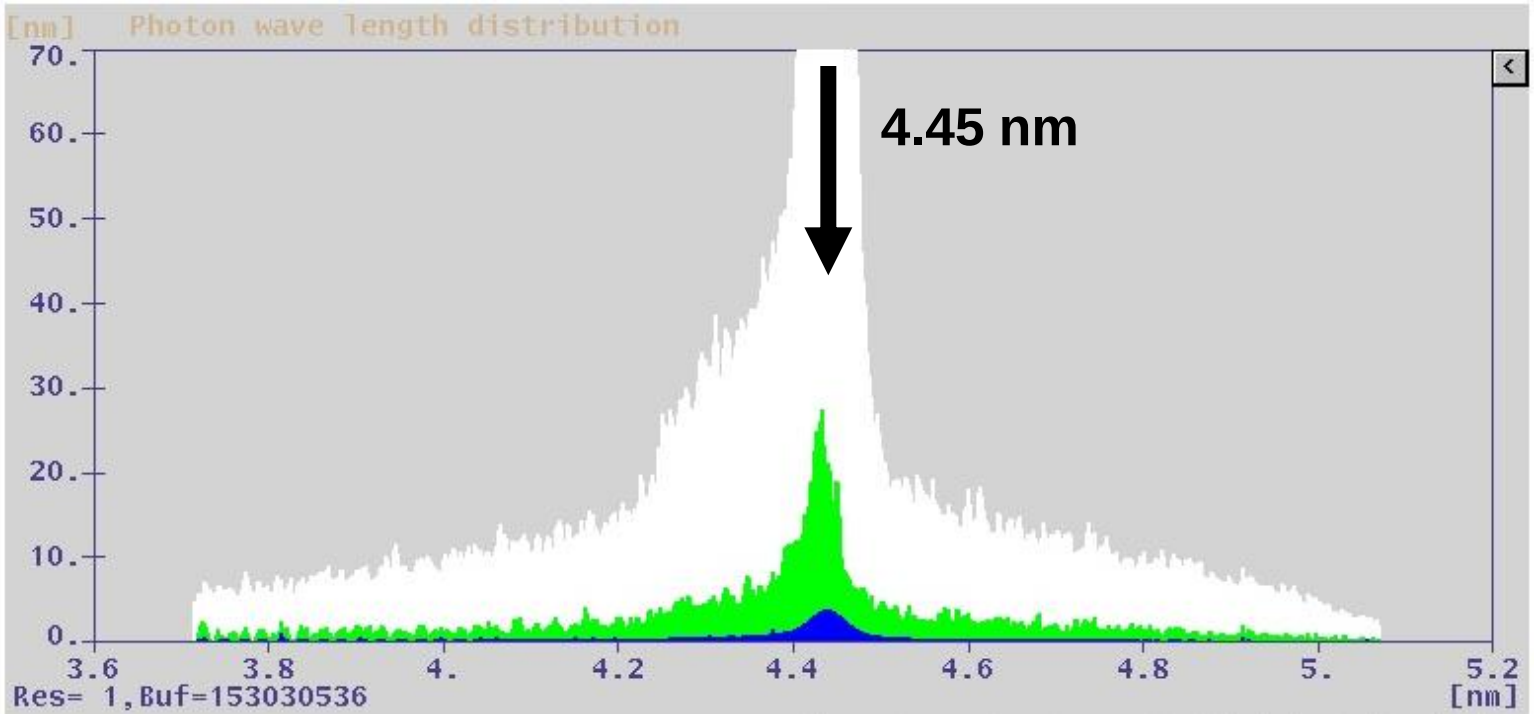
Commissioning step 4: Lasing below 5 nm

FLASH.
Free-Electron Laser in Hamburg

- Lasing at 4.x nm scheduled Jun-4 – Jun-11
- First lasing after upgrade in May-25 (12.5 nm)
- First lasing with linearized phase space (ACC39 on) in June-3 (12.5 nm)
- First lasing below 5 nm in June-6 @ 4.45 nm



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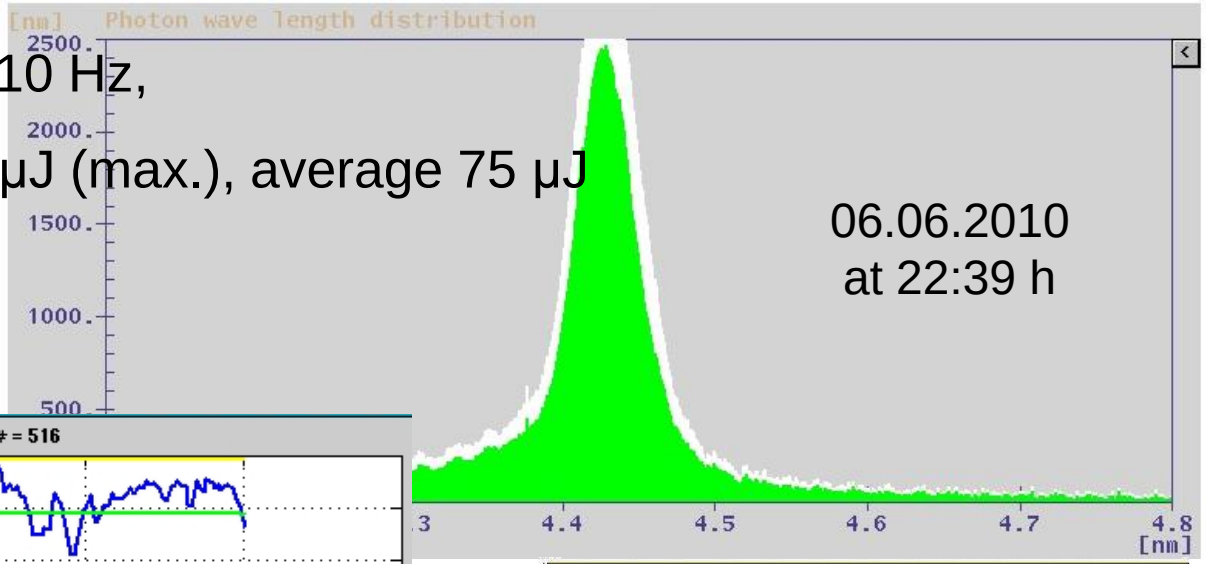
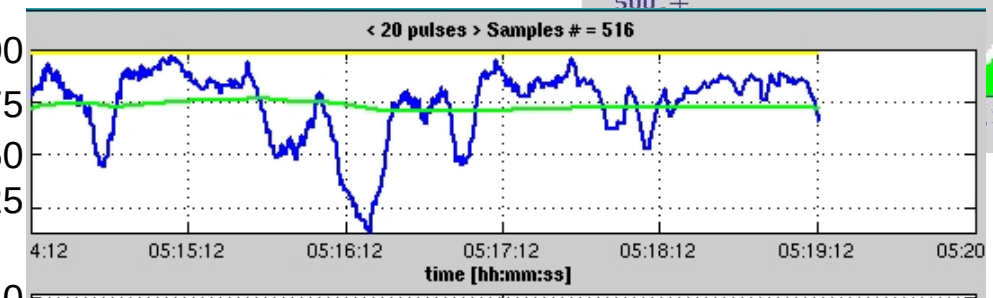
First Lasing at 4.45 nm

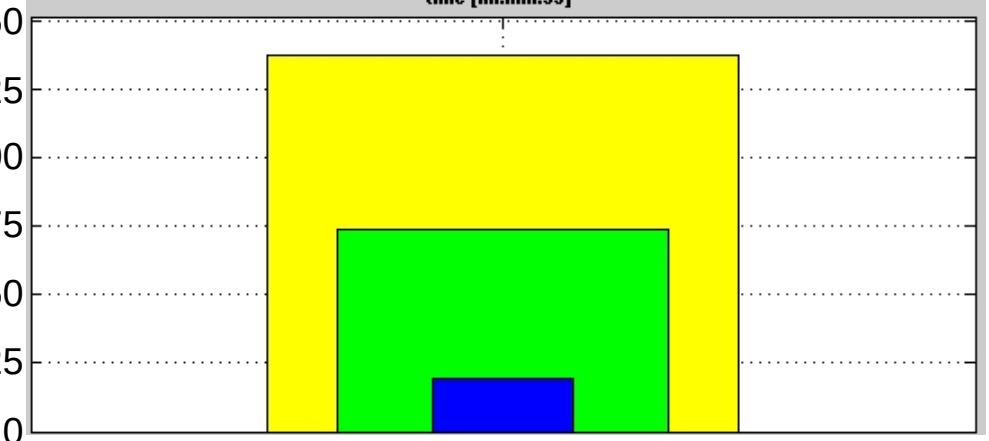
FLASH.
Free-Electron Laser in Hamburg

- Example: 1 bunch/train, 10 Hz,
- single pulse energy 140 µJ (max.), average 75 µJ



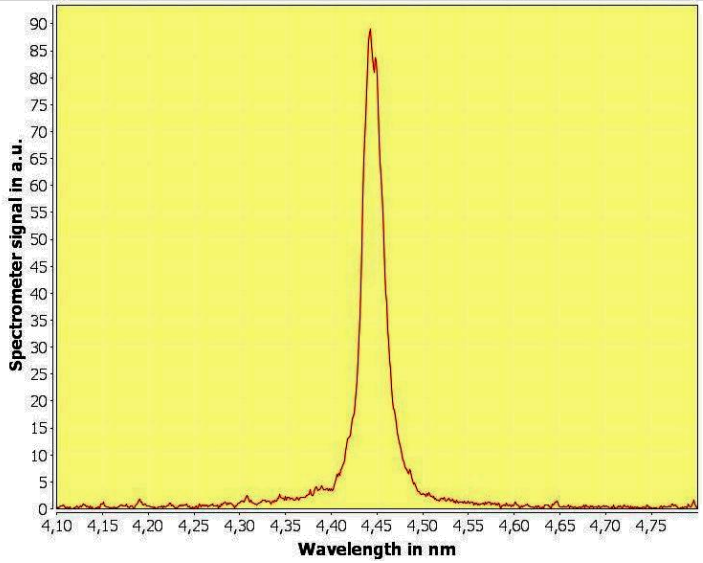
06.06.2010
at 22:39 h





Energy (µJ)

Bunch Number



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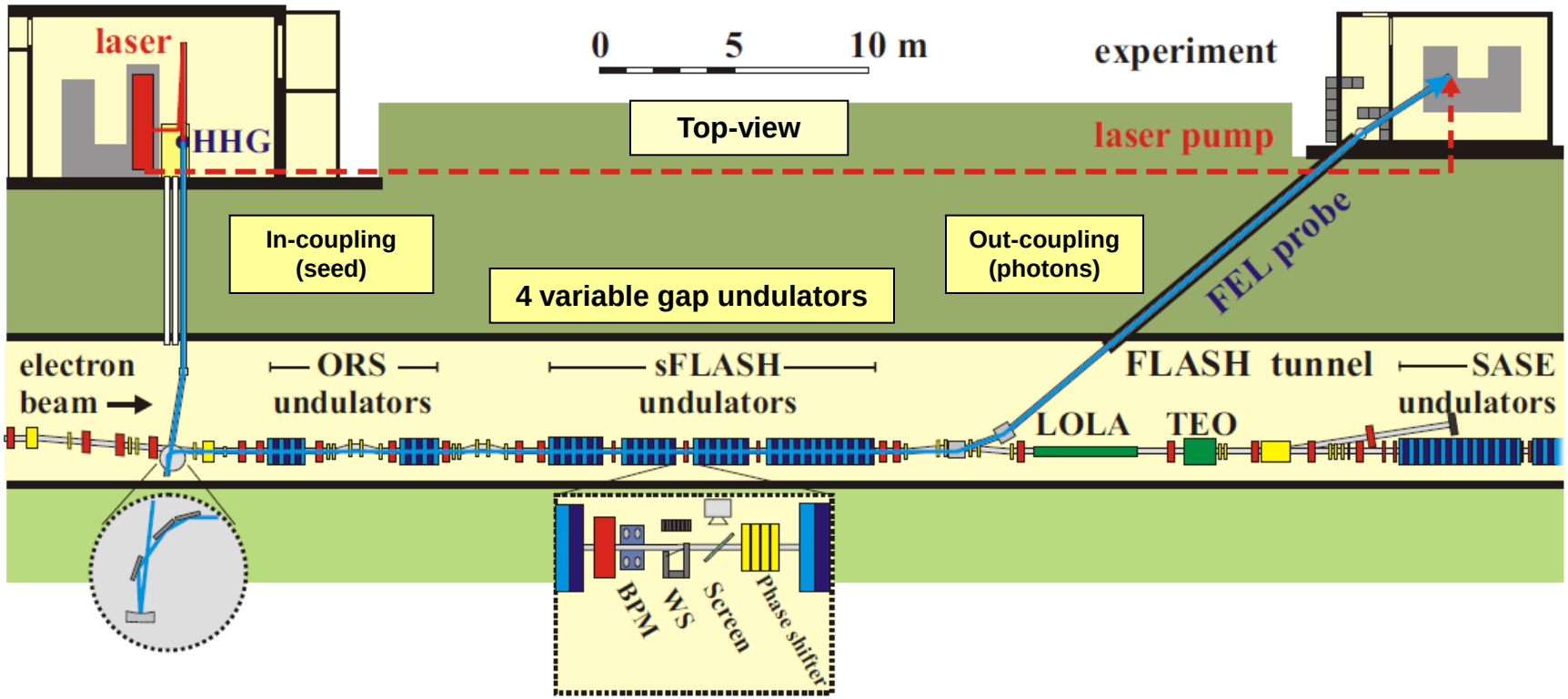
sFLASH: experiment for seeded FEL radiation

FLASH.
Free-Electron Laser in Hamburg

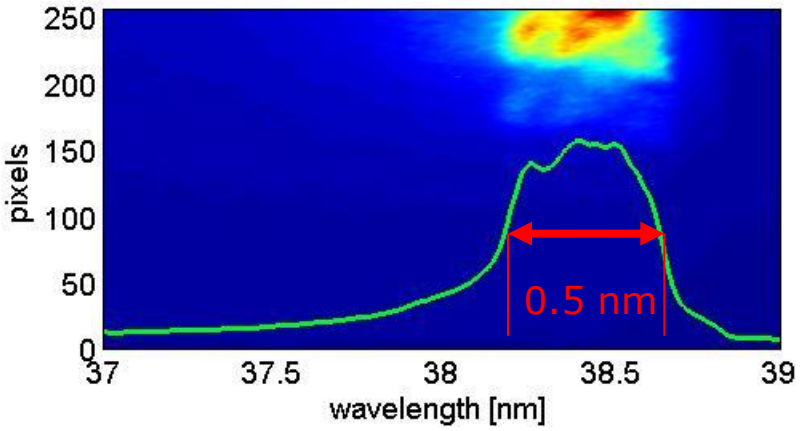
- Goal: generation of seeded FEL radiation for piloting experiments
- Installed between the collimator and SASE undulators in the FLASH linac → new electron beamline with a length of ~ 40 m
- HHG (high harmonic generation) seeding at ~ 38 nm (~ 13 nm as an option)
- synchronisation goal for pump probe experiments: 10 fs
- Collaboration of DESY and University Hamburg

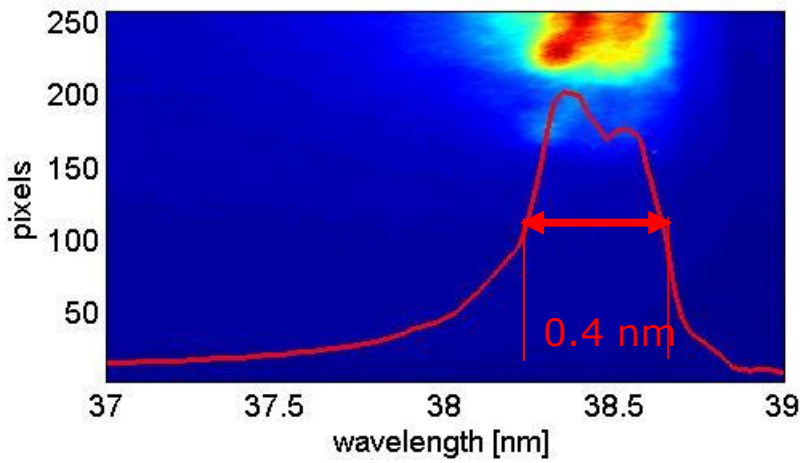


First SASE at sFLASH at 38.4 nm

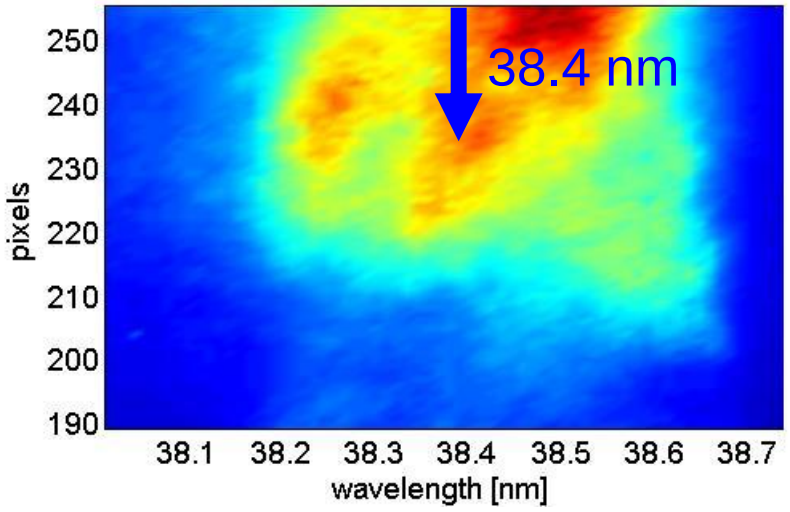
FLASH.
Free-Electron Laser in Hamburg

- SASE spectra, single shot
- center wavelength 38.4 nm, width ~0.5 nm





Talk on We 9:00 h WEOAI2
by Joern Boedewadt



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Summary

FLASH.
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- FLASH upgrade shutdown Sept 2009 to Feb 2010
- Major modifications:
  - energy upgrade to 1.2 GeV (7th accelerating module installed)
  - installation of the 3rd harmonic module
  - sFLASH seeding experiment
- First lasing at 4.45 nm
- SASE lasing of sFLASH at 38.4 nm