

Recent results of HHG-seeding experiment at FLASH

Seeding and Self-seeding at New FEL Sources

Trieste

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on behalf of the sFLASH group

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- Supported by BMBF under contract 05 ES7GU1
- DFG GrK 1355
- Joachim Herz Stiftung



FLASH layout

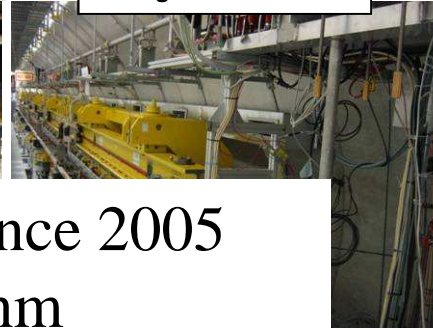
> 3rd harmonic cavity 3.9 GHz



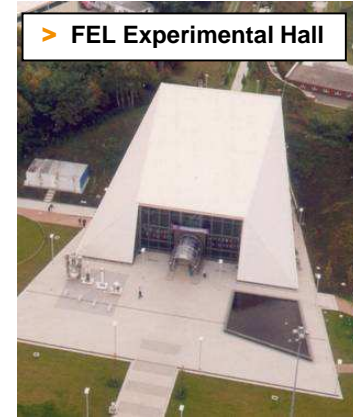
> TESLA type superconducting accelerating modules



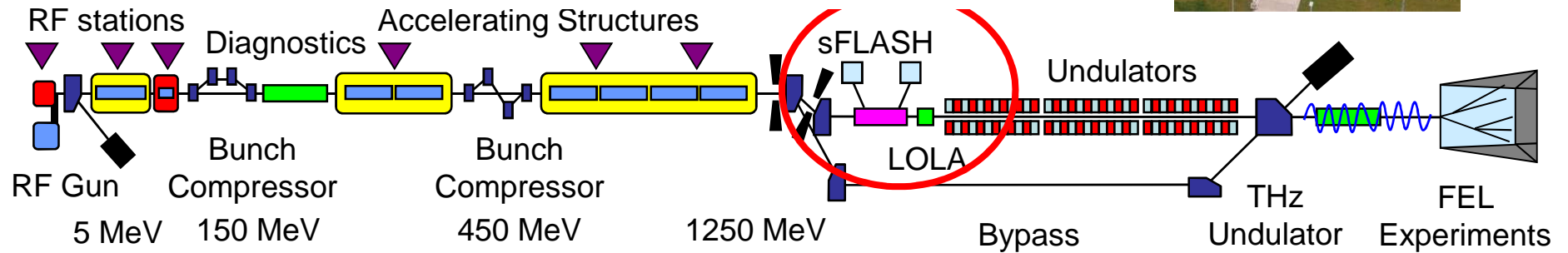
> Fixed gap undulator
> length ~ 27 m



> FEL Experimental Hall



Running for users down since 2005
Wavelengths down to 4.1 nm



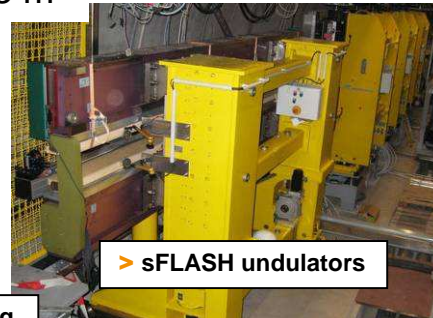
315 m



> Normal conducting 1.3 GHz RF gun
> Ce₂Te cathode
> Nd:YLF based ps photocathode laser



> Diagnostics and matching

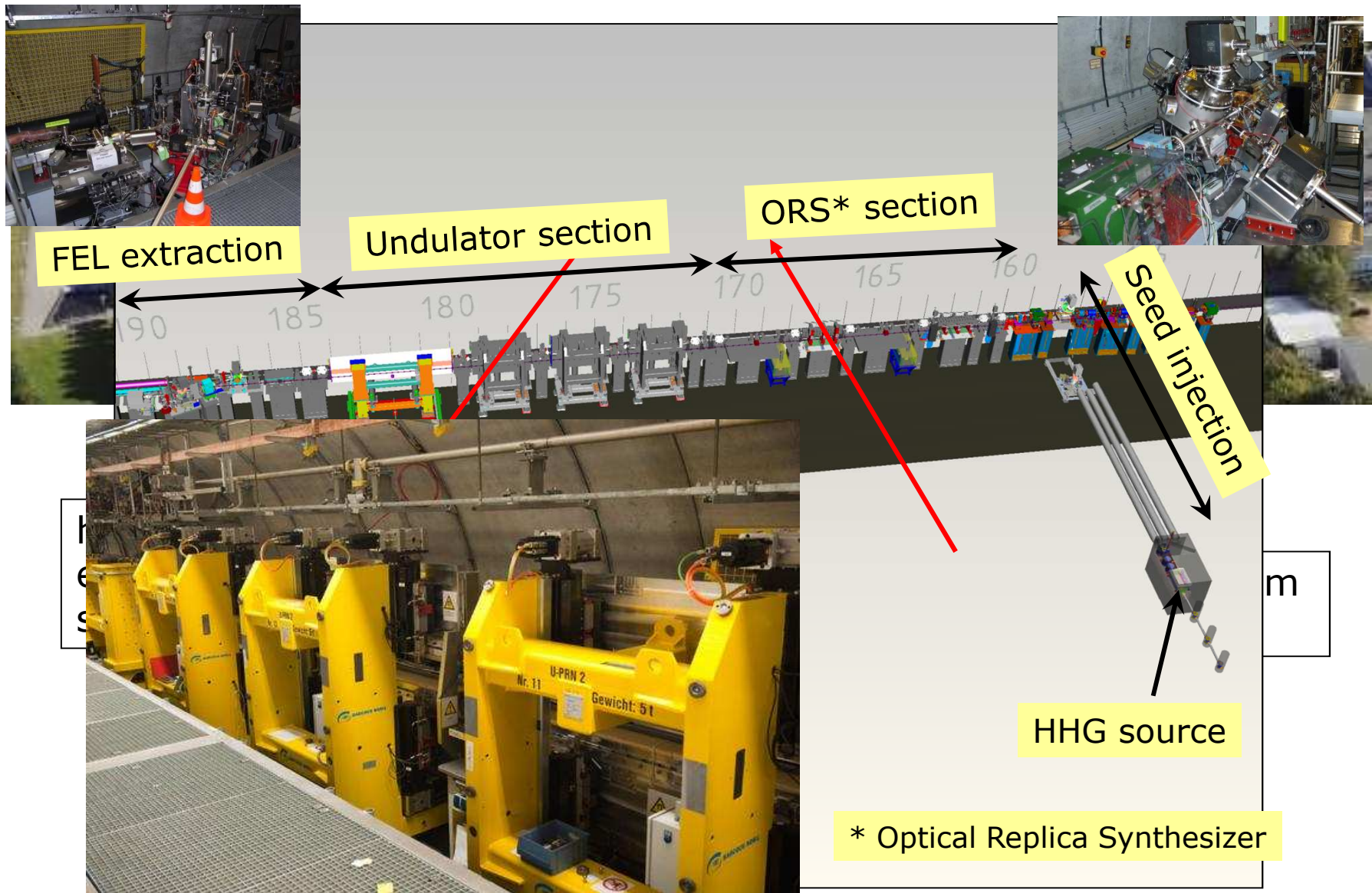


> sFLASH undulators

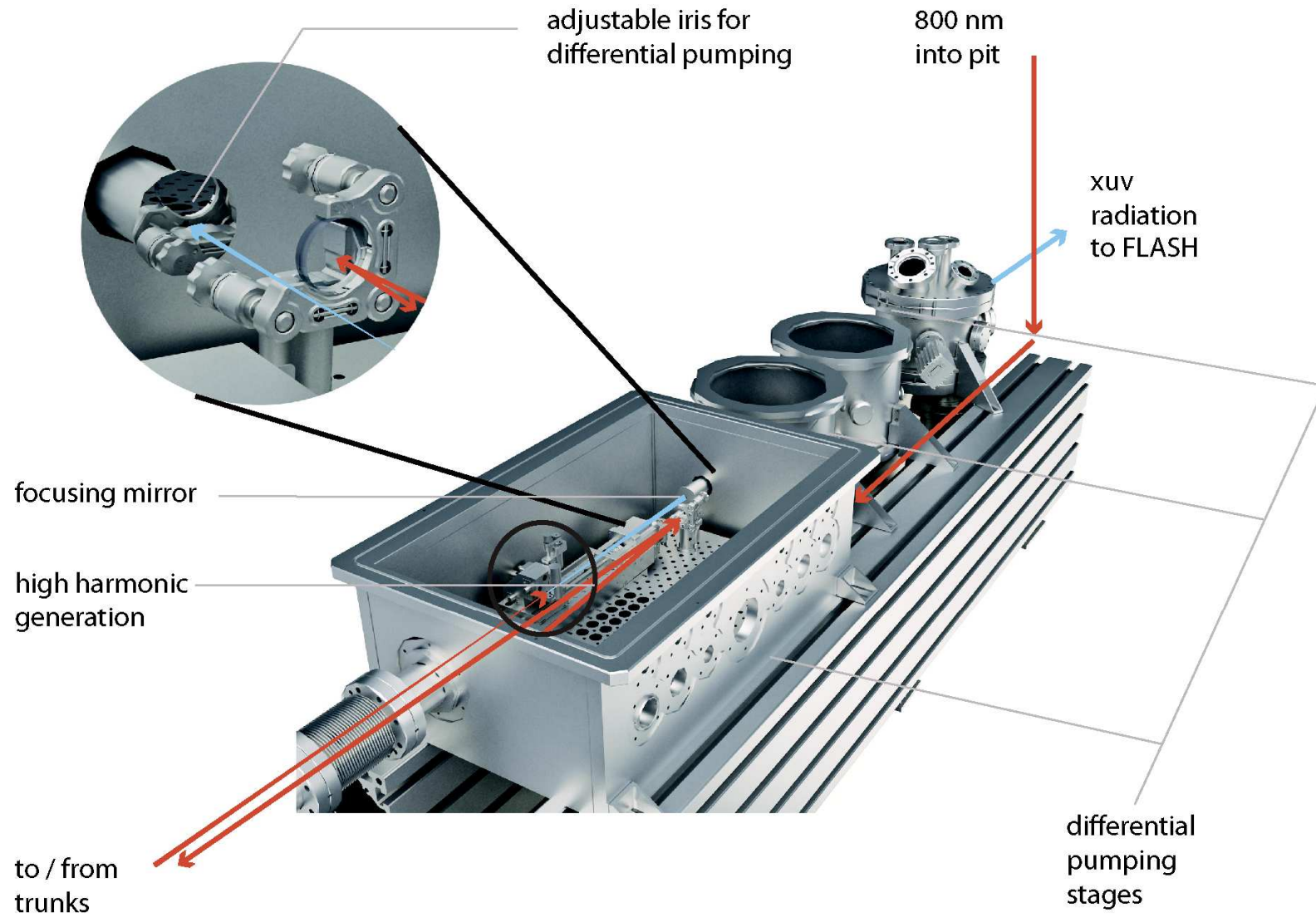


> FEL Experimental Hall

sFLASH building blocks

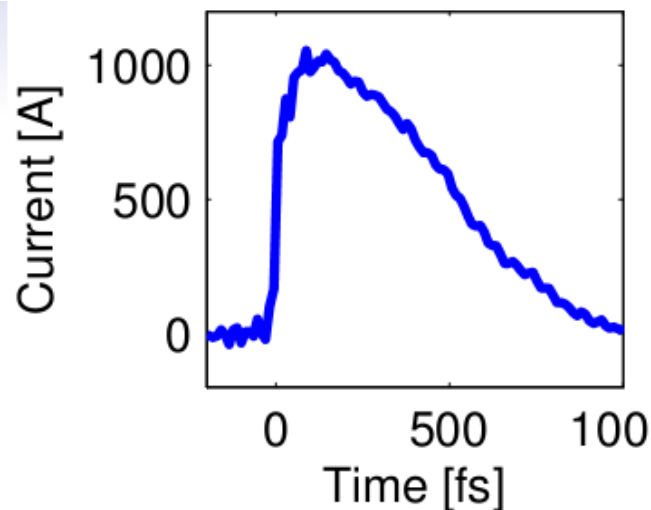


HHG source schematic



Linac set up

- setup accelerator for 700 MeV
 - bunch charge 0.5 nC
 - feedback systems for compression and energy
- establish high FEL gain at correct wavelength
 - tuning sFLASH to SASE
 - spectral overlap of 21st harmonic ($\lambda = 38.1$ nm) and sFLASH SASE
- transverse overlap (tolerances 50 μm , 50 μrad)

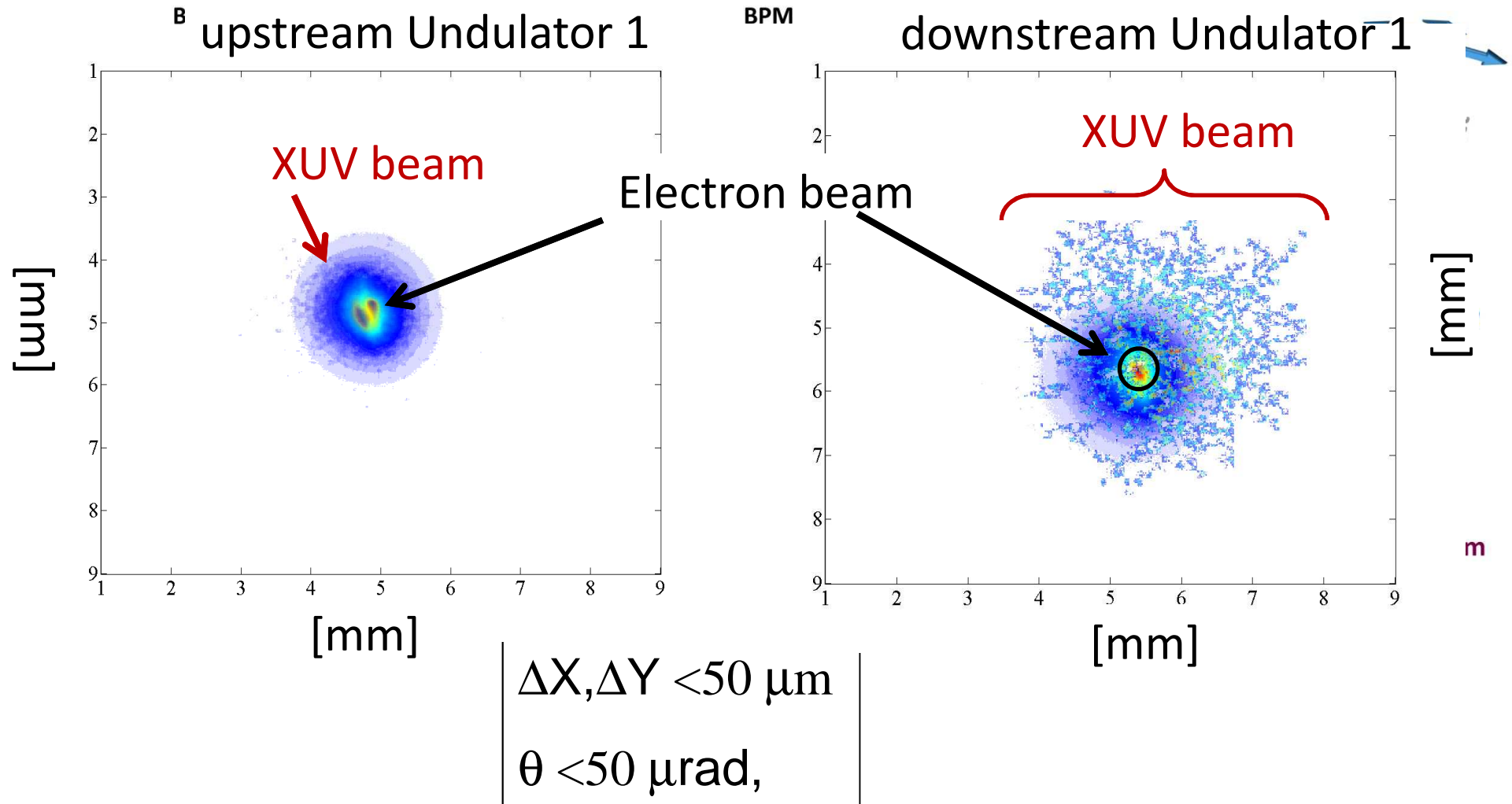


Example for **longitudinal current profile** of the electron bunches used for the seeding experiment.

Single-shot measurement using a coherent radiation intensity spectrometer.

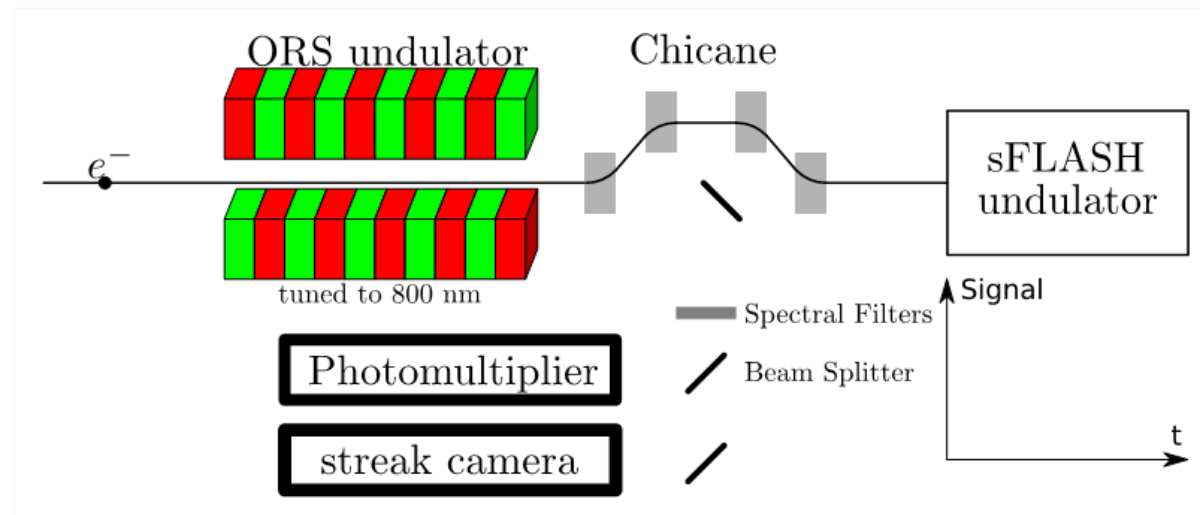
Transverse overlap

Superimposed beam profiles measured on Ce:YAG screen



Temporal overlap

- temporal overlap
 - down to 1 ns: photomultiplier + oscilloscope
 - down to 10 ps: streak camera
 - finally: time scan (100 fs steps)



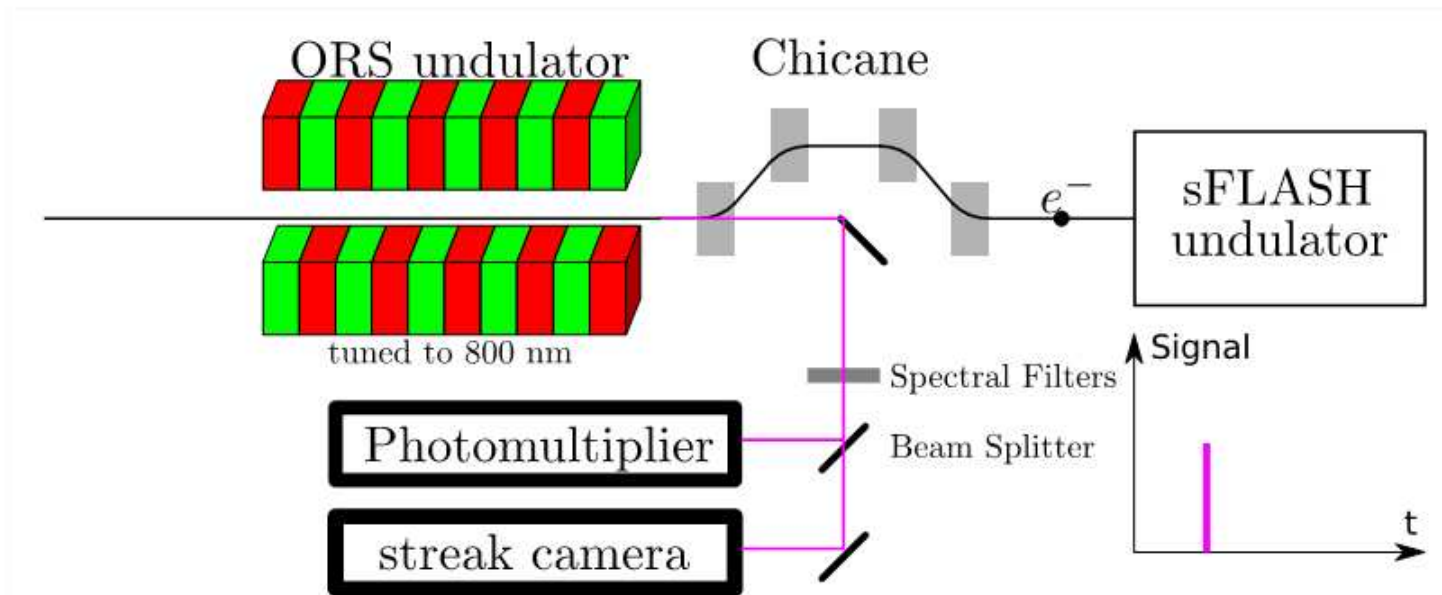
durations (FWHM):
 electron bunch 300-400 fs
 HHG seed pulse 20 fs
 Tolerance 100 fs

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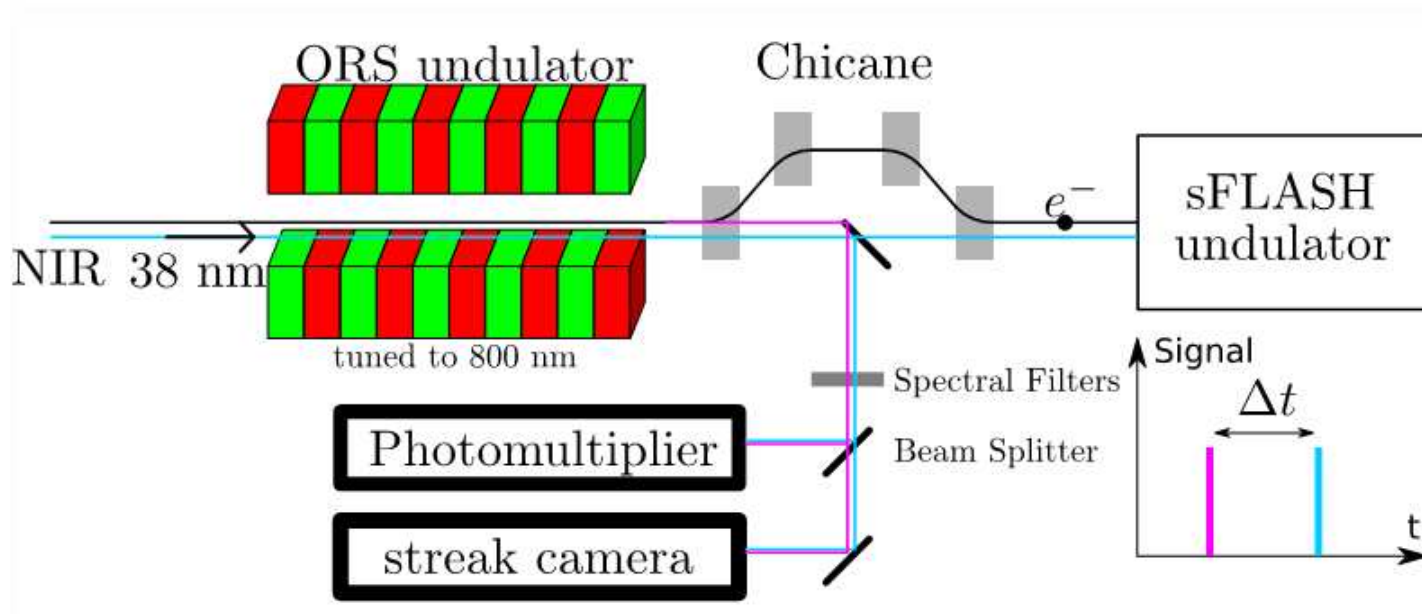


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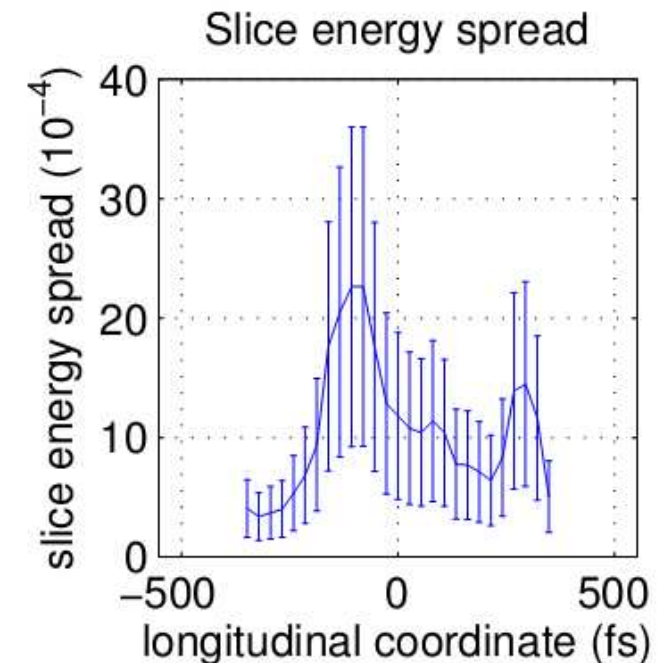
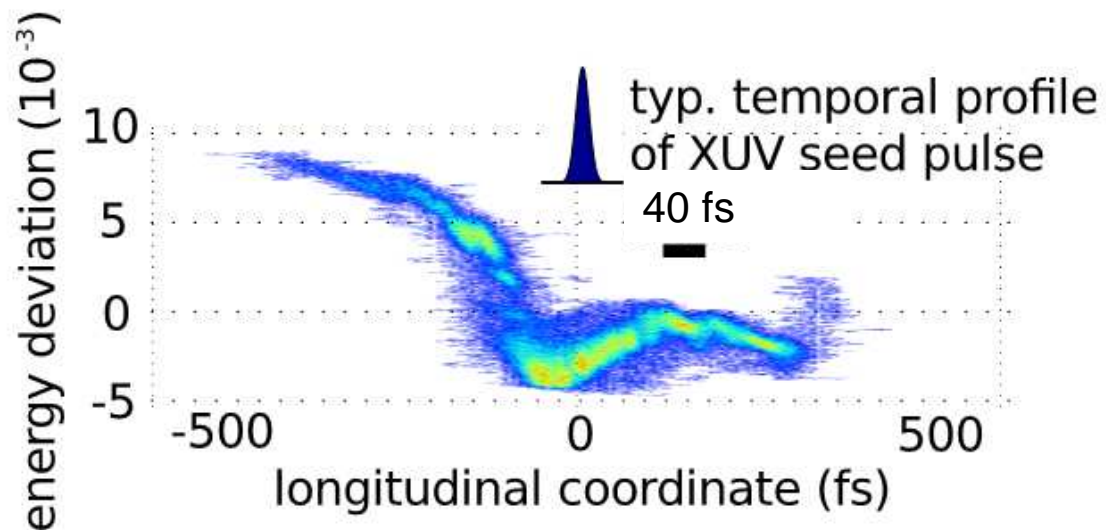
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Longitudinal phase-space characterisation

With the LOLA transverse deflecting structure (TDS) one can measure the longitudinal phase space after sFLASH undulators ...



Summary and outlook

- HHG seeding at $\lambda = 38\text{nm}$ demonstrated
- Energy contrast in the order of 10 possible.
- Power contrast ~ 100 possible; should be OK for (some) users.
- HHG relies on perfect control and stability.

Outlook

- Establish seeding quicker & reliably (use ORS-timing, online spectrometer, optimized bunch length, intrabunch RF feedback)
- Parallel operation with FLASH SASE
- Pilot pump-probe experiment
- THz streaking for photon pulse length measurement
- Tests of HHG and EEHG at FLASH -> decision on FLASH II later

On behalf of the sFLASH team

Sven Ackermann, Armin Azima, Jörn Bödewadt, Francesca Curbis, Hossein Delsim-Hashemi, Markus Drescher, Stefan Düsterer, Josef Gonschior, Eugen Hass, Ulrich Hipp, Katja Honkavaara, Rasmus Ischebeck, Shaukat Khan, Tim Laarmann, Theophilos Maltezopoulos, Atoosa Meseck, Nils Mildner, Velizar Miltchev, Manuel Mittenzwey, Heinrich Münch, Otto Peters, Benjamin Polzin, Marie Reders, Jörg Rossbach, Ernst-Otto Saemann, Holger Schlarb, Sebastian Schultz, Michael Schulz, Angad Swiderski, Roxana Tarkeshian, Markus Tischer, Antonio de Zubiaurre Wagner, Marek Wieland, Torsten Wohlenberg, and others

