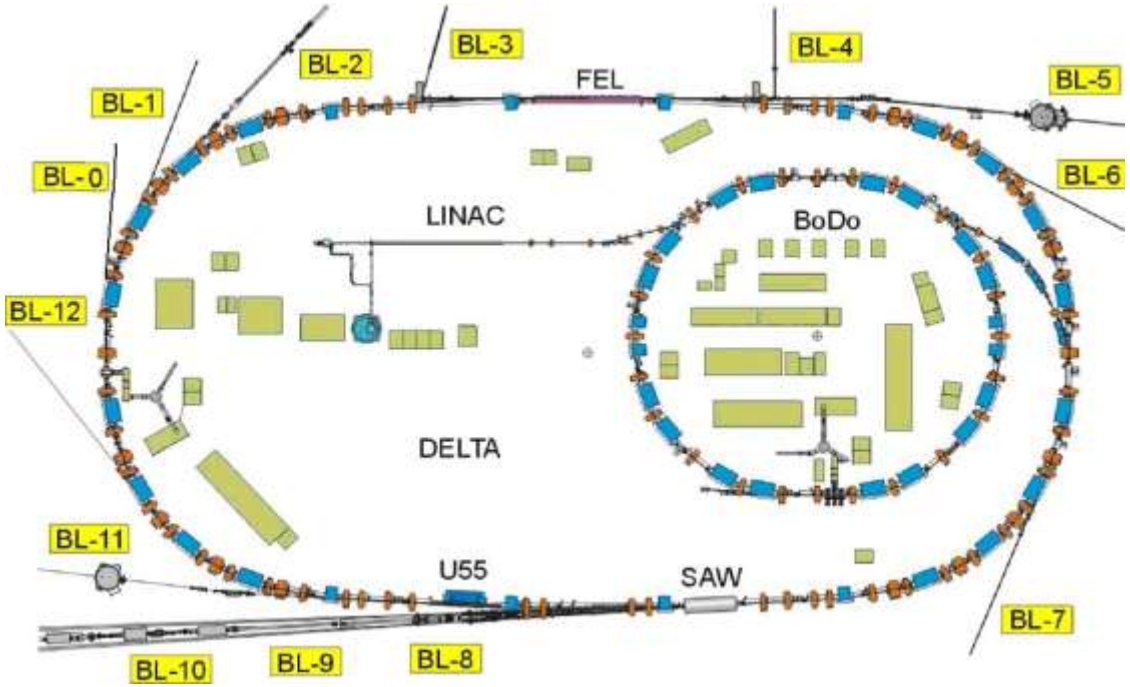
Status of DELTA and the New Short-Pulse Facility

A. Nowaczyk
Center for Synchrotron Radiation - DELTA

Dortmund **El**ec**t**ron **A**ccelerator



DELTA is a synchrotron light source operated by the TU Dortmund University, Germany

electron energy	1.5 GeV
rf-frequency	500 MHz
circumference	115.2 m
beamcurrent	max. 130 mA
lifetime	11 h @ 100 mA

Last Years Performance

Distribution of machine utilization:

20 weeks / year user operation

10 weeks / year machine shifts

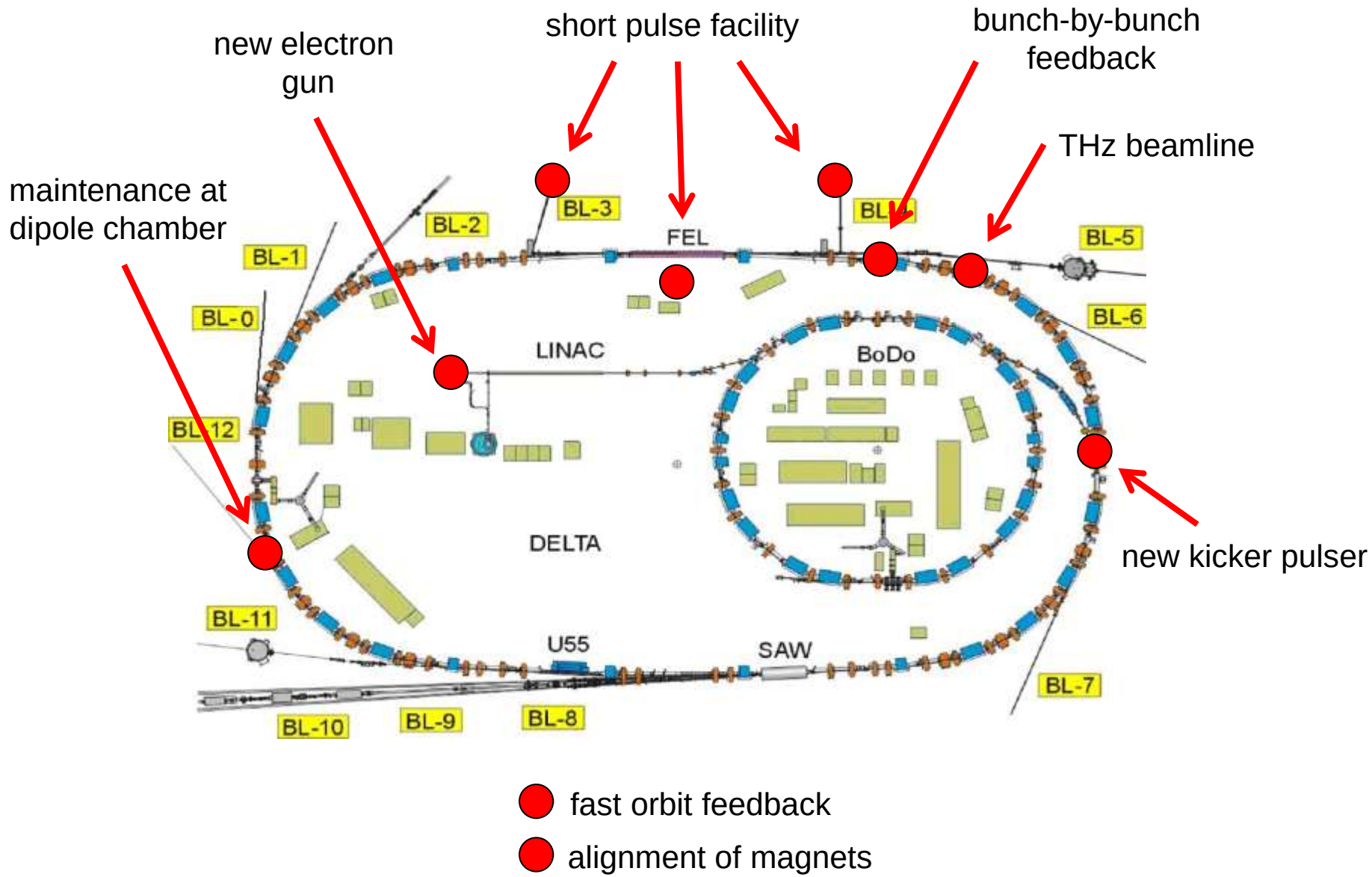
Weekly machine operation from Monday to Friday

2000 h / year user operation

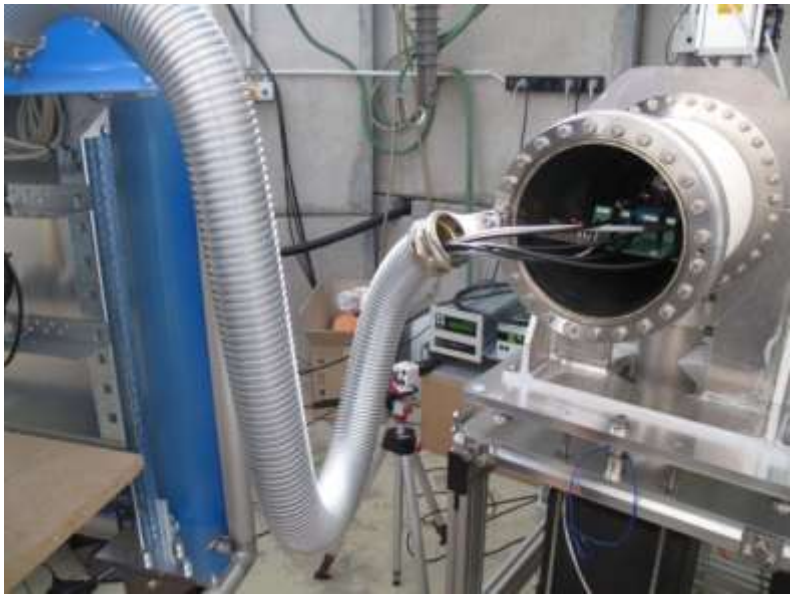
1000 h / year machine shifts

90% of availaibility 2011

Projects and Improvements during 2011



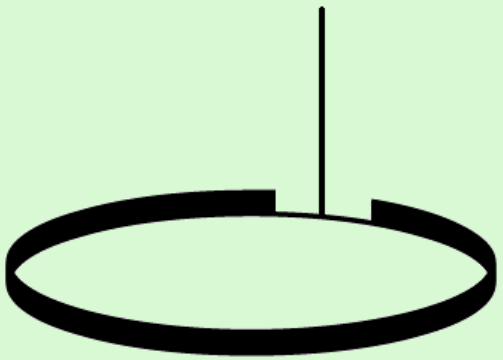
New Electron Gun



Replacement of the old gun during the summer shutdown 2011.

Improvements:

- higher injection stability
- switching between single- and multibunch injection
- hybrid filling pattern

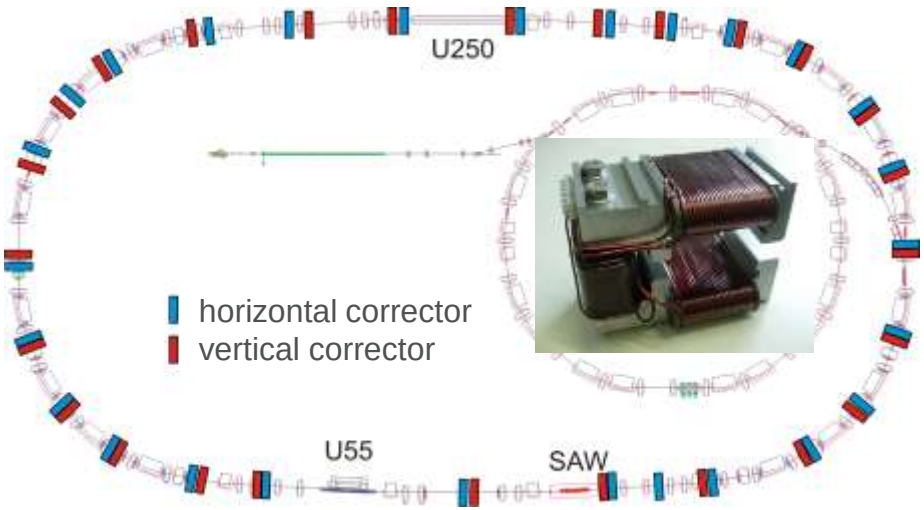


(Peter Hartmann, Vadim Kniss)

Fast Orbit Feedback

General Information

- working orbit feedback bandwidth **0.1 Hz**
- bandwidth of fast orbit feedback **500 Hz**
- reduction of influence from girder vibrations (5 Hz) and power supplies (50 Hz)



(Gerrit Schünemann and Patryk Towalski)

BPM-Extender (14x)

- readout of four BPM-signals
- data aquisition rate of 10 kHz
- hardware already installed
- minor software upgrades needed

Correction Magnets

- prototypes ordered and tested
- ready to order magnets and power supplies

Bunch-by-Bunch Feedback System

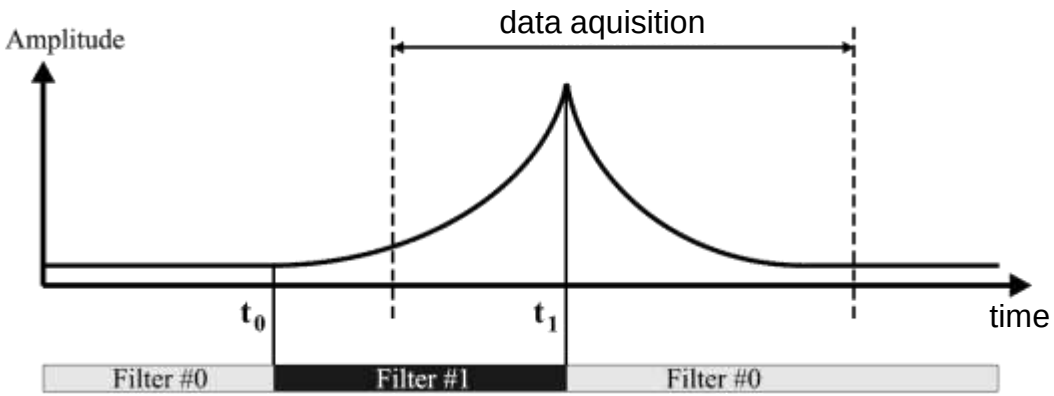
- longitudinal + transversal
- installation of the kicker structure in May 2011
- kicker design equivalent to BESSY II and MLS structures

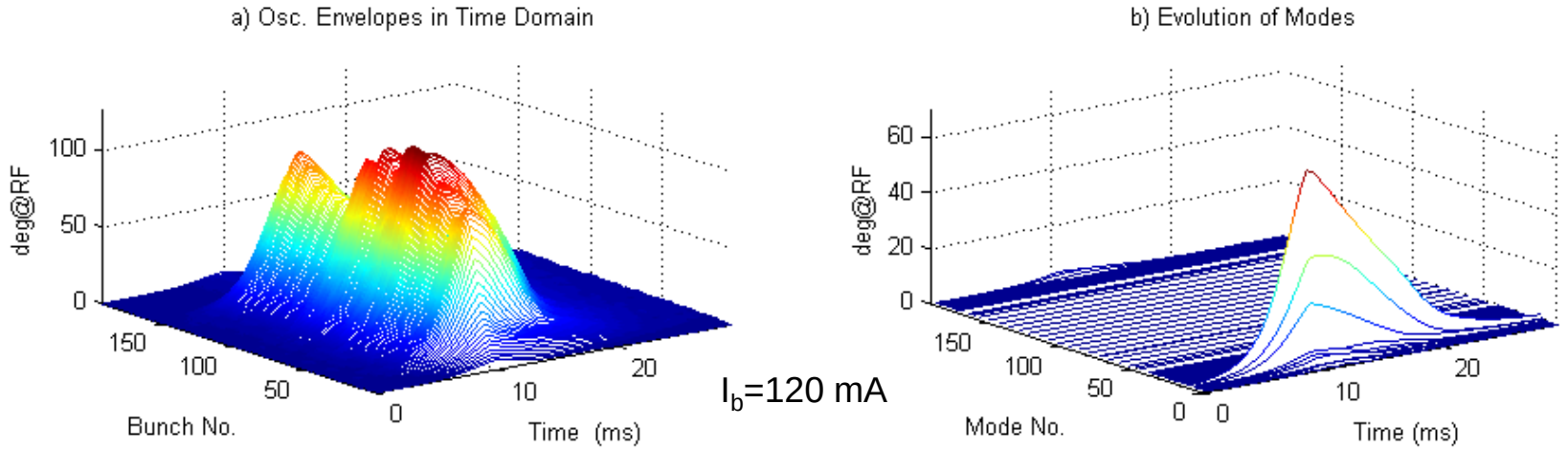
- DIMTEL signal processing units
- all systems operating since August 2011
- used for diagnostics and bunch cleaning

(Bernhard Hippert and A. N.)

Bunch-by-Bunch Feedback System

- **timing setup** studied in a bachelor thesis (J. Verwohlt)
- first **grow damp** experiments
- **trigger** data aquisition with external sources (injection)





I_b=120 mA

Special thanks to: Volker Dürr,

Fjodor Falkenstern, Jörg Feikes, Markus Ries and Dmitry Teytelman

Short-Pulse Facility

Goal: Radiation with

short wavelength (vacuum UV)

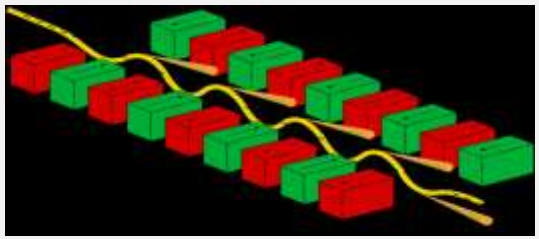
and

short pulse length

simultaneously and in user operation.

Goal: Radiation with

short wavelength (vacuum UV)



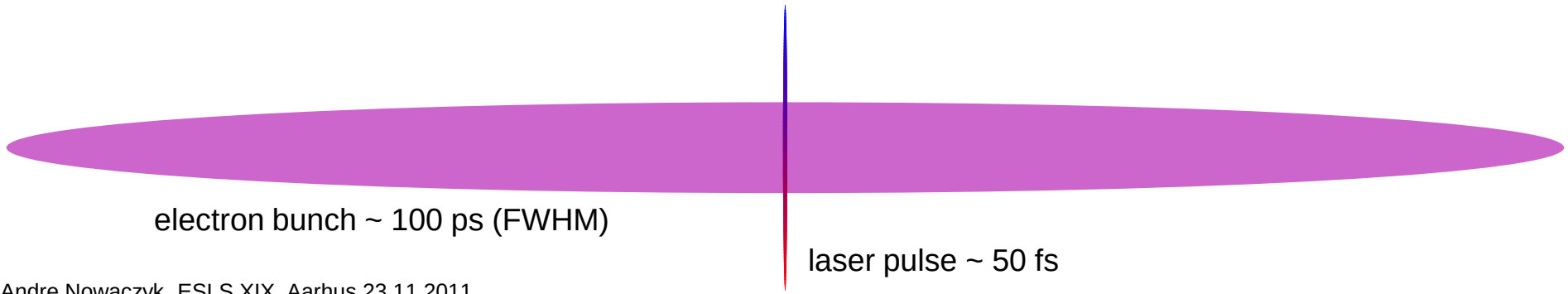
undulator radiation

and

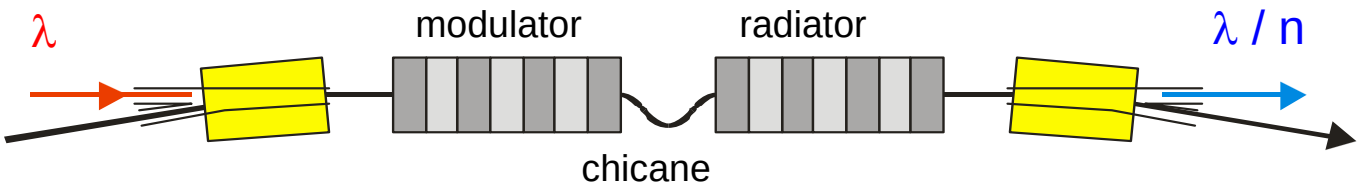
short pulse length

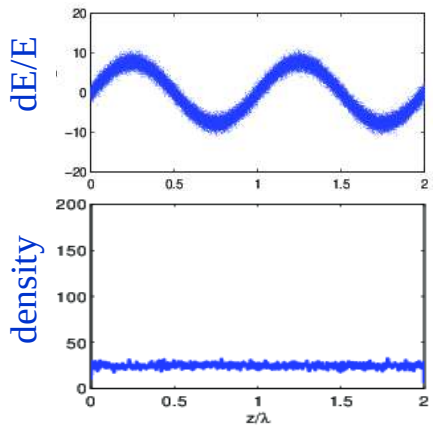
femtosecond laser system

simultaneously and in user operation.

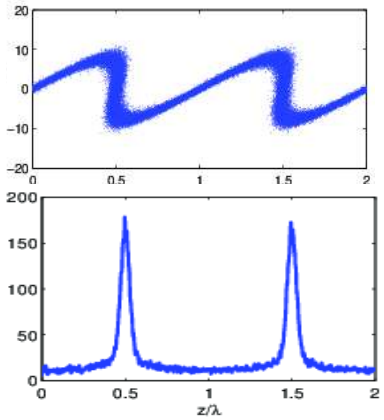


Principle of Coherent Harmonic Generation





energy modulation



density modulation

- efficient wavelength conversion up to **n≈5**
- high intensity due to **coherent radiation** (P_{rad}~n_e^2)
- ultrashort pulselength (≈ **50 fs**)
- emitted pulses are **laser synchronized** (pump probe experiments)

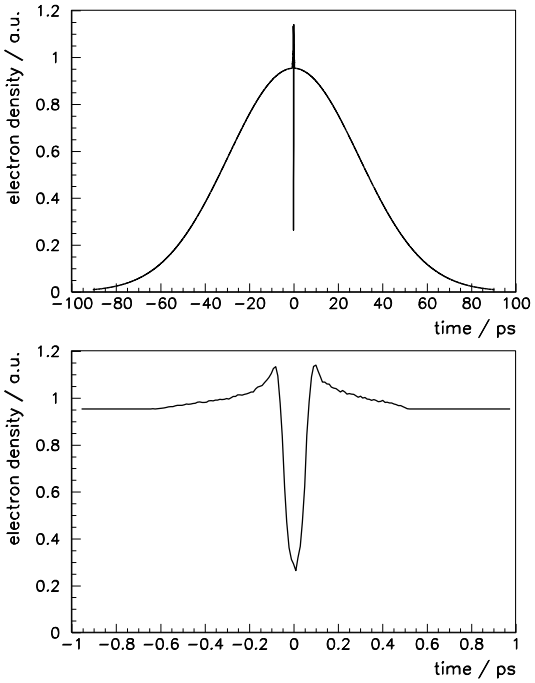
ACO: B. Girard et al., PRL 53 (1984), 2405
ELETTRA: E. Allaria et al., PRL 100 (2008), 174801
UVSOR II: M. Labat et al., PRL 101 (2008), 164803

Formation of THz Radiation

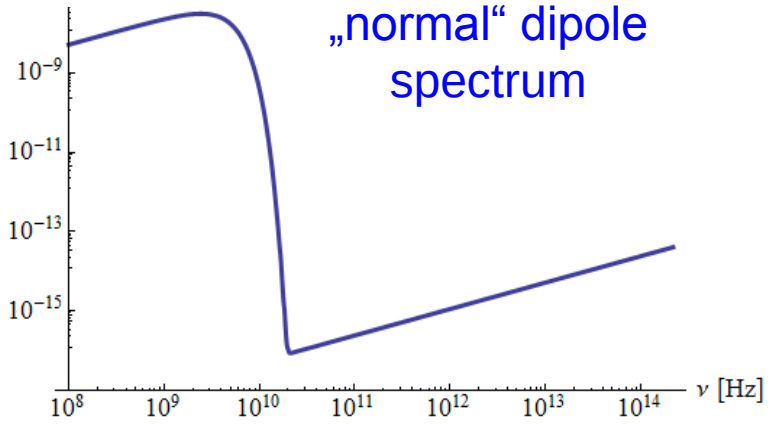
propagation of energy modulated electrons through **dispersive section**

formation of **sup-ps dip** in electron density

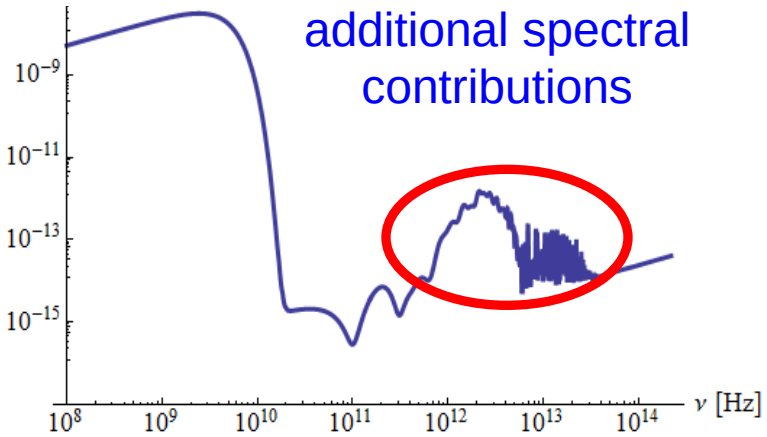
radiation in the **THz-region**



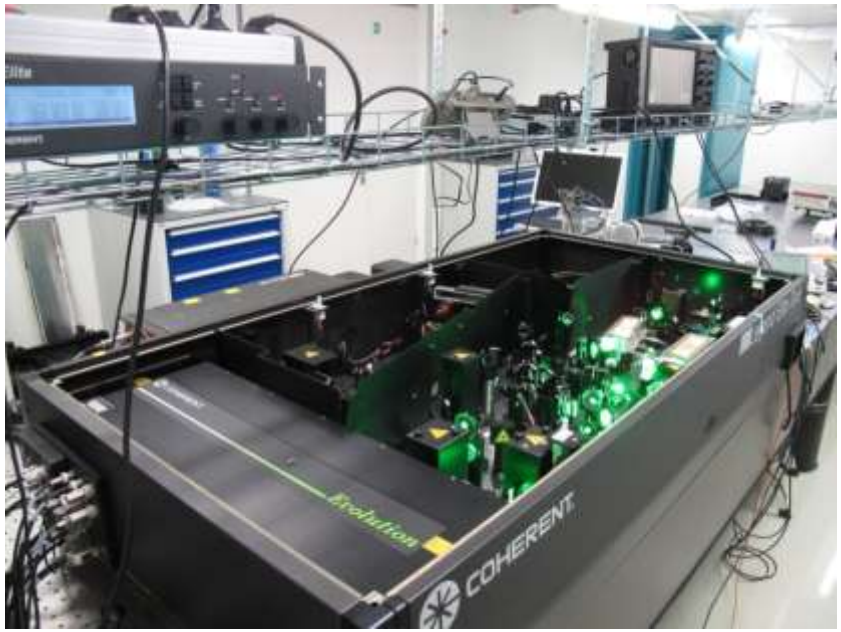
„normal“ dipole spectrum



additional spectral contributions



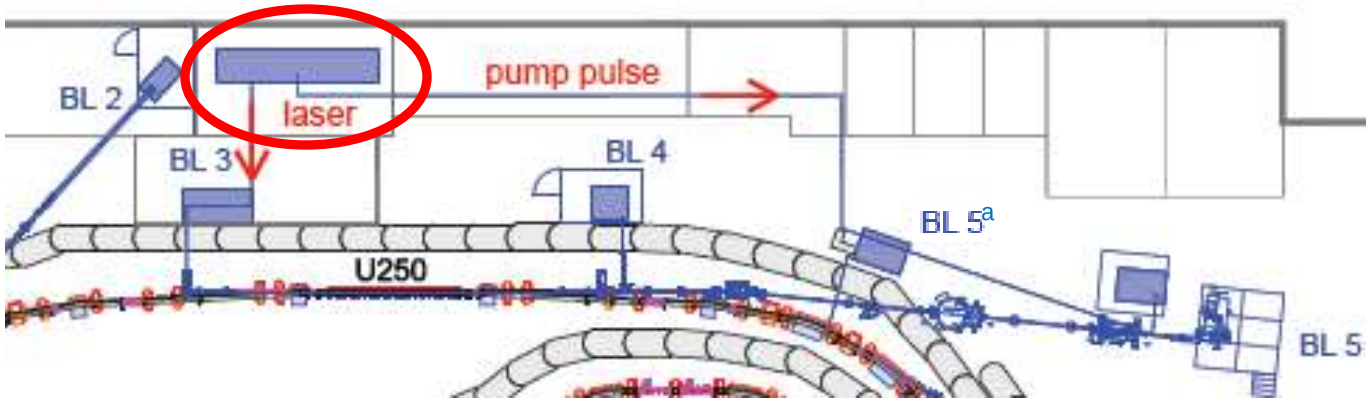
CHG-Setup at DELTA (laser system)



Titanium:sapphire laser system

- mode-locked oscillator + Nd:YVO4 pump
- regenerative CPA amplifier + Nd:YLF pump
- wavelength 795 nm
- pulse energy 2-8 mJ
- repetition rate 1-5 kHz
- pulse duration 25-35 fs

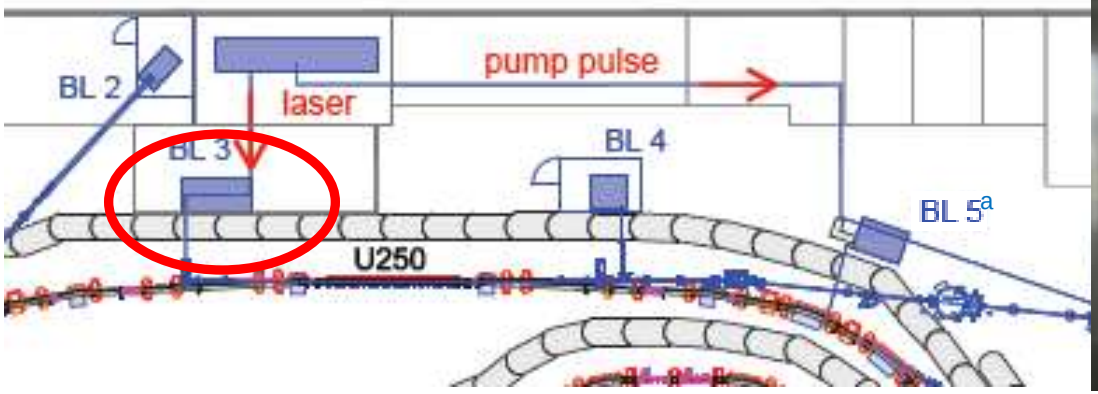
laser installed and in operation
second/third harmonic generation
optical parametric amplifier
SPIDER (pulse duration measurement)



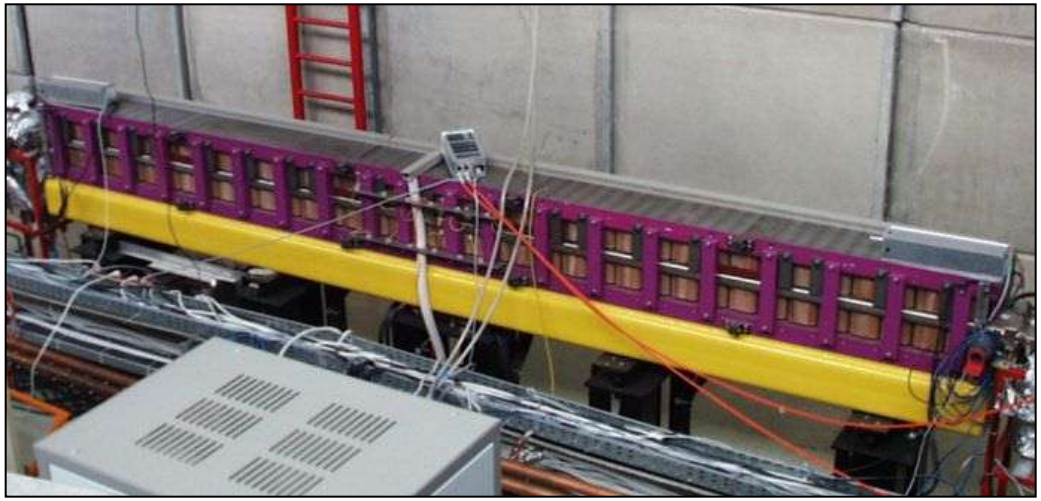
CHG-Setup at DELTA (seeding beamline)

Laser beamline to the undulator

- installed, not yet evacuated
- telescope with motorized lenses
- remotely controlled mirrors
- remotely controlled screens/cameras



CHG-Setup at DELTA (optical klystron)

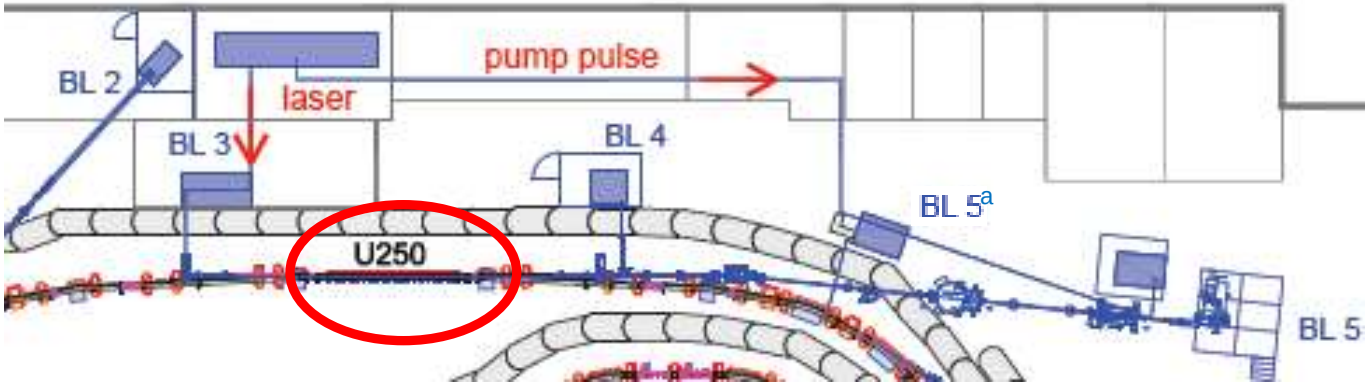


Existing undulator can be operated as an optical klystron

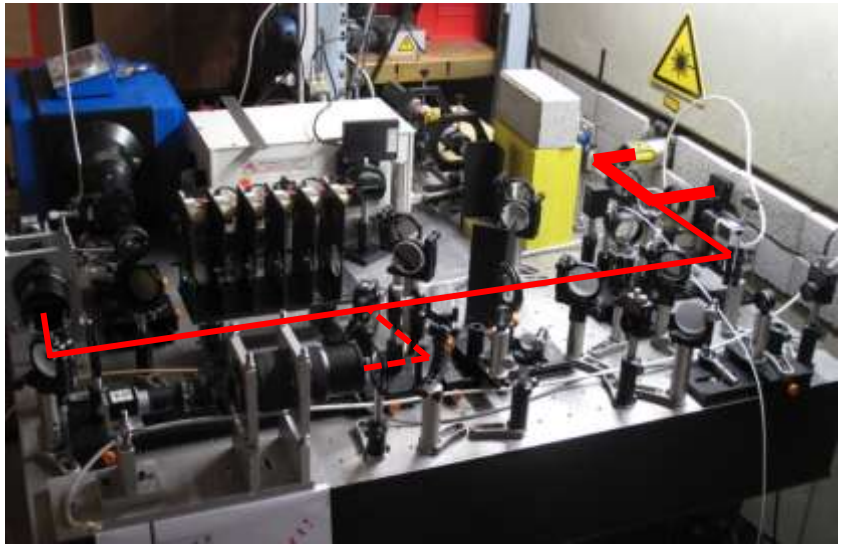
(serves as modulator, chicane and radiator)

New undulator power supplies

- installed and in operation
- modulator and radiator independent
- maximum wavelength 800 nm
- resonant with the laser at 1.5 GeV

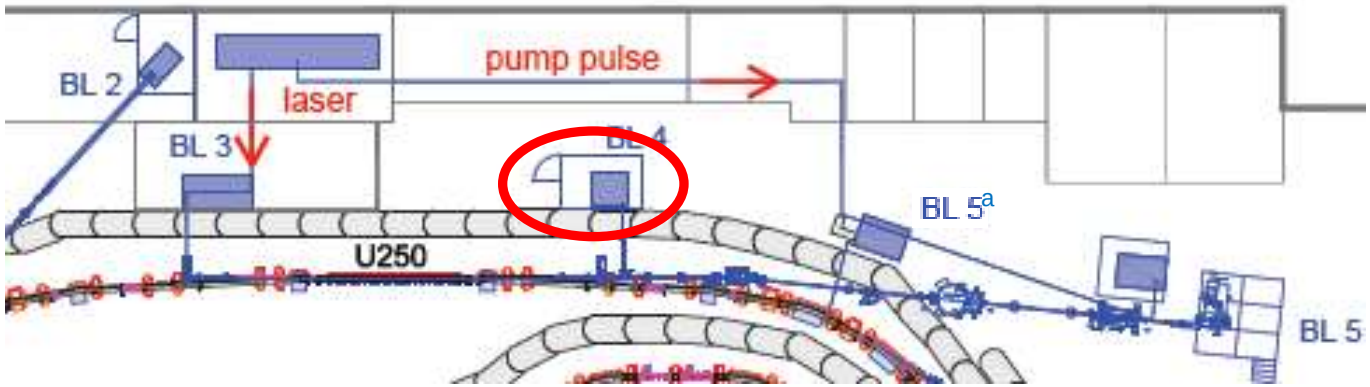


CHG-Setup at DELTA (diagnostics)

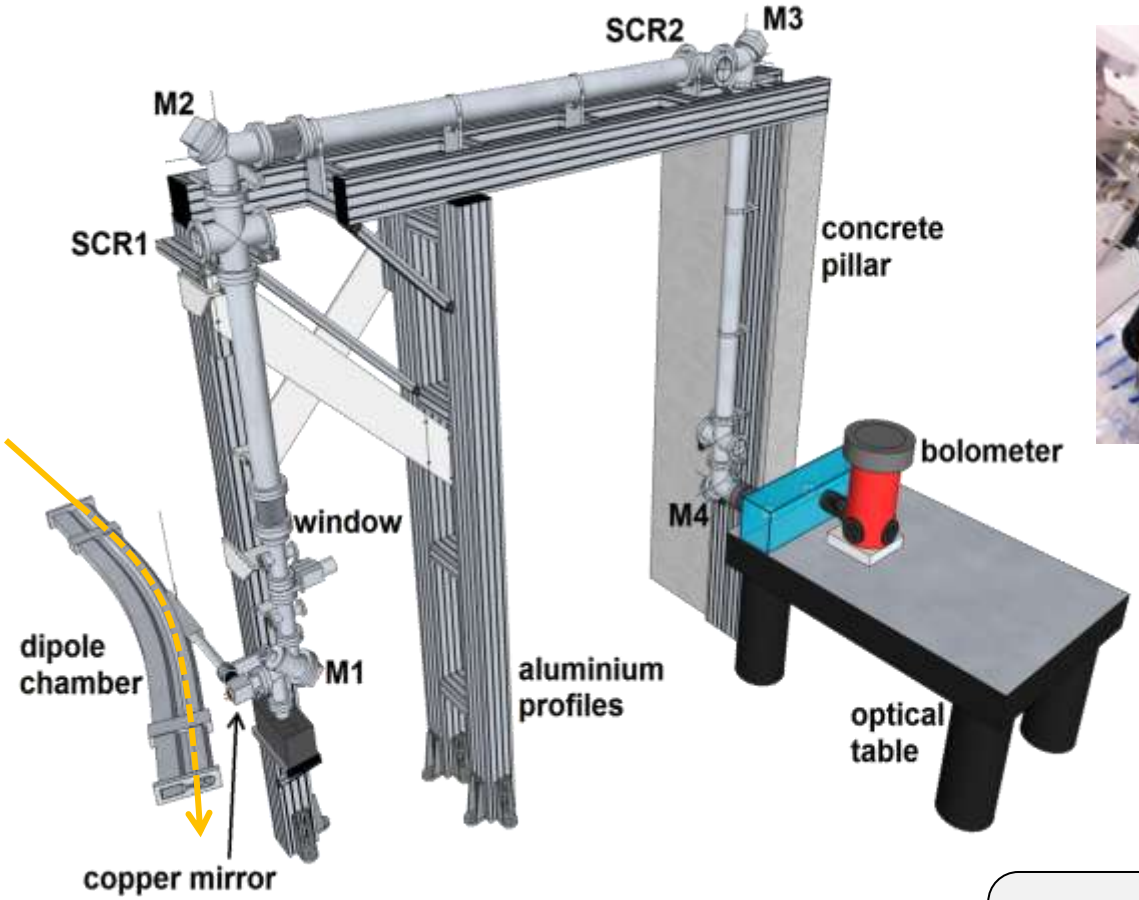


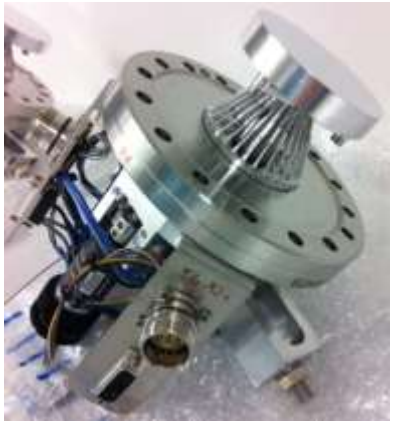
Diagnostics station

- CCD cameras for transverse overlap
- photodiodes for nanosecond timing
- streak camera for picosecond timing
- slow CCD spectrometer
- scanning spectrometer
- powermeter



THz-Beamline





(BESSY design)

Special thanks to: Karsten Holldack and Arne Hoehl

(Markus Höner and Peter Ungelenk)

THz Beamline

- remotely controlled mirrors
- remotely controlled screens/cameras
- LHe-cooled hot-electron InSb bolometer
- in future: FT-IR spectrometer

First Results

June 29: first coherent THz signal

June 30: first CHG signal at 400 nm

- strong THz signal at 1 kHz
- enhanced signal at 400 nm
- quadratic dependence on bunch current
- time-bandwidth product close to Fourier limit

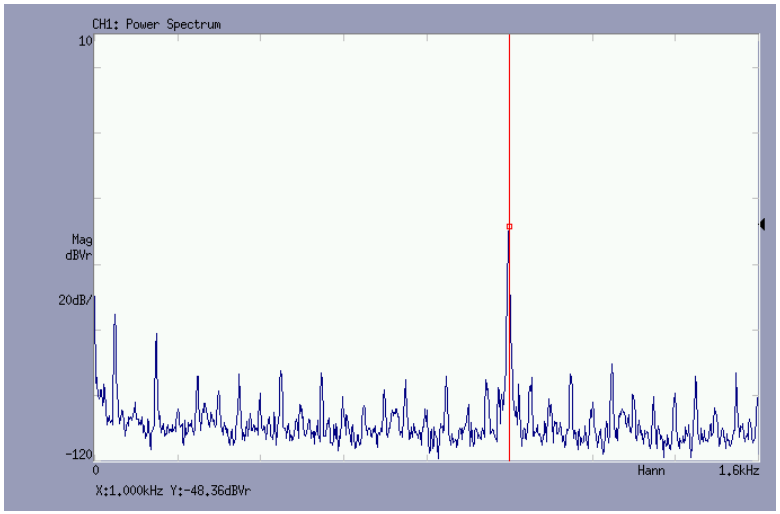
July: THz/CHG in user operation

October 14: first CHG signal at 266 nm

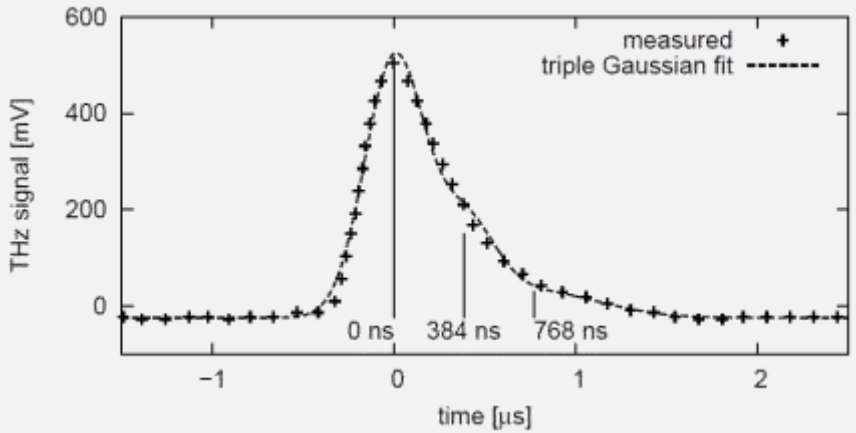
FFT analyzer as a diagnostic tool for THz radiation

- THz radiation syncronous to laser repetition rate of 1 kHz
- supression of additional spectral components in bolometer signal
- laser blocked periodically

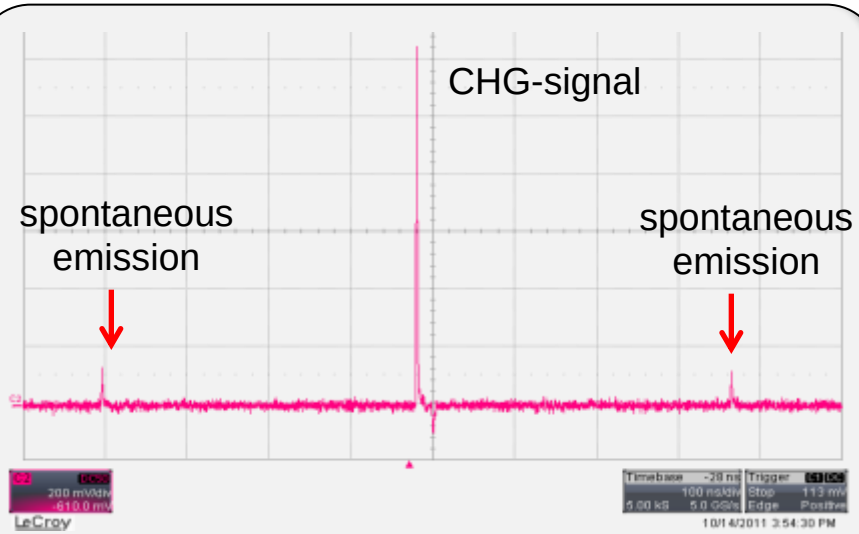
MVI_3240.MOV



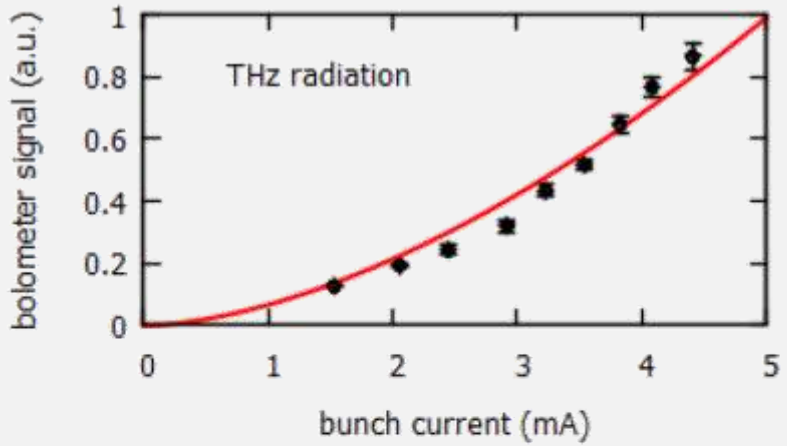
First Results

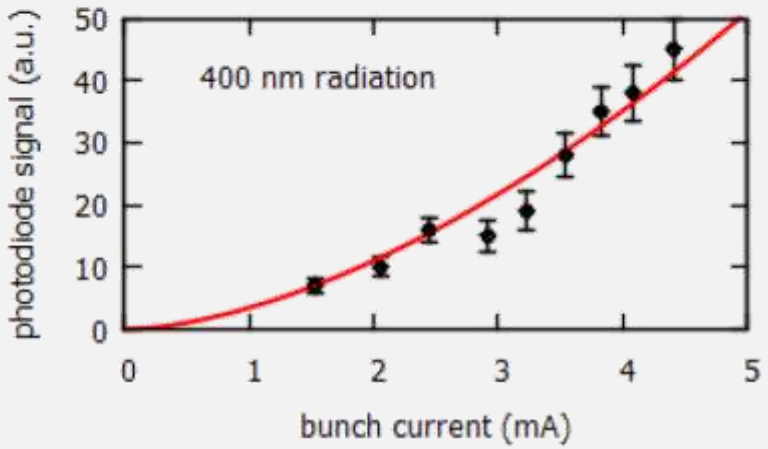


Bolometer signal



Photodiode signal





Quadratic dependence of the CHG and the THz signals on the bunch current.

Future Plans CHG

reaching shorter wavelengths

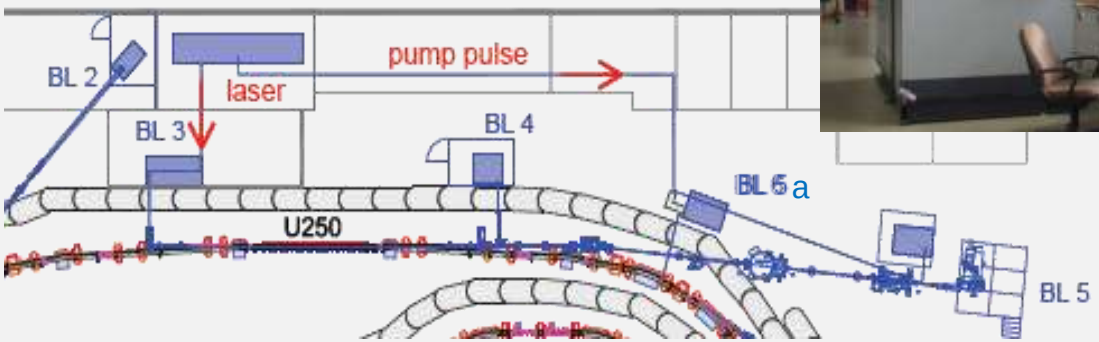
- higher harmonics of CHG (4th and 5th)
- seeding with 2nd- or 3rd-harmonic of laser wavelength (SHG- and THG-units)

increase stability and simplify handling of the experimental setup

- introduce control loops
- identify and reduce noise sources

extend and finish hardware

- evacuate the laser beamline
- FT-IR spectrometer at THz-BL
- construction of pump beamline to experiment



Thank you for your attention!

DELTA Team

Wolfgang Brembt, Mohammed Bakr, Günther Dahlmann, Thomas Dybiona, Alessandro Ferrarotto, Andreas Erpelding, Jochem Friedl, Peter Hartmann, Bernhard Hippert, Markus Höner, Holger Huck, Shaukat Khan, Vadim Kniss, Peter Kortmann, Petra Lindemann, Robert Molo, Helge Rast, Bernhard Riemann, Hans-Peter Ruhl, Detlev Schirmer, Gerald Schmidt, Gerrit Schünemann, Tanja Schulte-Eickhoff, Patrick Towalski, monika Voigts-Besli, Thomas Weis, Klaus Wille, Peter Ungelenk, Marjam Zeinalzadeh

Colleagues at

HELMHOLTZ ZENTRUM BERLIN für Materialien und Energie

DESY

elettra

JÜLICH FORSCHUNGSZENTRUM

KIT Karlsruhe Institute of Technology

GSI

TU berlin

PAUL SCHERRER INSTITUT PSI

UH

PTB

Financial Support

DFG Deutsche Forschungsgemeinschaft

Bundesministerium für Bildung und Forschung

Ministerium für Innovation, Wissenschaft und Forschung des Landes Nordrhein-Westfalen

NRW.