Status of DELTA: Light Source and Short-Pulse Facility
Shaukat Khan, Zentrum für Synchrotronstrahlung
Lund November 29th 2016
Parameters and availability

Parameters
- circumference: 115.2 m
- beam energy: 1.5 GeV
- beam current: 130 mA multi-bunch
- beam current: 20 mA single bunch
- beam lifetime: ~16 h at 100 mA
- hor. emittance: ~16 nm rad
- bunch length: 40 ps rms

user operation: 2000 h/y (20 weeks/y)
machine studies: 1000 h/y (10 weeks/y)
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(J. Friedl, G. Schmidt, P. Ungelenk)
Insertion devices
Alignment of the storage ring

(U. Berges, G. Dahlmann, T. Dybiona, B. Isbarn, B. Hippert, P. Kortmann, G. Pike**, H. Rast, G. Schmidt, T. Schulte-Eickhoff; **Faculty of Physics, TU Dortmund)

Vertical alignment completed in 2013
- improved stability, radiation level, lifetime...

Horizontal alignment underway
- 180 reference panels for Taylor-Hobson spheres
- laser tracker
Superconducting wiggler

(W. Brembt, P. Hartmann, B. Hippert, S. Khan, V. Kniss, P. Kortmann, R. Molo, M. Paulus, D. Schirmer, G. Schmidt, C. Sternemann, M. Tolan)

Superconducting asymmetric wiggler
- is ageing, no support from manufacturer
  new device funded and ordered (end of 2018)
- no asymmetry option
- higher field \(5.3 \text{T} \rightarrow 7 \text{T}\)
- more periods \(5 \rightarrow 10\)
- less He consumption \(130 \text{l/week} \rightarrow \text{none}\)

Additional issues
- second RF cavity and solid-state RF amplifier
- modified storage ring lattice
- new vacuum chamber and absorber
- integration into control system
- radiation safety
RF upgrade

(W. Brembt, P. Hartmann, V. Kniss, T. Weis)

**500 MHz European HOM-damped cavity**
- funded and ordered (beginning of 2018)

**500 MHz Solid-state amplifier**
- funded and ordered (February 2017)
- 75 kW for the storage ring
- 20 kW for the booster synchrotron

(Courtesy Research Instruments GmbH)
Stability, lifetime and all that

(M. Höner, S. Khan, M. Sommer)

Bunch-by-bunch feedback systems (installed 2011)
- damp longitudinal and transverse oscillations, used for accelerator studies and diagnostics

example: longitudinal damping rates

M. Sommer, M. Höner et al., IPAC 2015, Richmond, USA, p. 179
Stability, lifetime and all that

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example: RF phase modulation

M. Sommer, M. Höner et al., IPAC 2015, Richmond, USA, p. 179
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example: RF phase modulation

RF phase modulation influences BPM data
Facility for ultrashort VUV and THz pulses

Facility for ultrashort VUV and THz pulses

Coherent harmonic generation (CHG)

- laser-induced energy modulation within a bunch "slice"
- density modulation in a magnetic chicane
- coherent radiation at harmonics of the laser wavelength
  (so far 80 nm, goal 53 nm)

Coherent terahertz (THz) radiation

- short "dip" due to energy-dependent path length
- broadband coherent THz radiation
- narrowband coherent THz radiation from multiple dips
Facility for ultrashort VUV and THz pulses

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recently: first pump-probe result
shift of photoelectron kinetic energy due to space charge
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S. Khan et al., IPAC 2016, Busan, Korea, p. 2851

compare with:
D. Gauthier et al., PRL 115, 114801 (2015)
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Facility for ultrashort VUV and THz pulses

**RF-phase modulation**
- suppresses coupled-bunch instabilities
- improves the beam lifetime

**RF-phase modulation and CHG**
- synchronize modulation with laser pulses
- phase scans (i) electronic delay
  (ii) frequency mismatch (beating)
- CHG and THz signal enhanced, out of phase

M. Jebramcik et al., IPAC 2016, Busan, Korea, p. 2847
Facility for ultrashort VUV and THz pulses

Coherent emission of Terahertz radiation

- diagnostics of laser-electron interaction
- short laser pulse: broadband THz radiation
- long modulated pulse: narrowband THz radiation
- sub-THz signal after 1/2 synchrotron period
- construction a sub-THz spectrometer
- electro-optical sampling

P. Ungelenk et al., IPAC 2014, Dresden, Germany, p. 1936
C. Mai et al., IPAC 2015, Richmond, USA, p. 823
Echo-enabled harmonic generation at DELTA

Supported by Helmholtz ARD initiative (FZ Jülich)

- modulators: 2 short undulators
- radiator: present U250 undulator
- requires longer straight section
- modified storage ring optics
- additional undulator for "slicing"

G. Stupakov, Phys. Rev. Lett. 102, 074801 (2009)
Z.T. Zhao et al., Nature Photonics 6, 360 (2012)
E. Hemsing et al., Nature Photonics 10, 512 (2016)
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- undulator chambers ordered


S. Hilbrich et al., FEL 2014, Basel, 255

Courtesy Scanditronix AB
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S. Hilbrich et al., FEL 2014, Basel, 255
Accelerator physics in the bachelor and master curriculum

Bachelor, master, PhD theses
One-semester course on instruments
- 2 hrs lecture
- 1 hr exercises
Two-semester accelerator course
- 2 hrs lecture
- 1 hr exercises
- 1 hr seminar
- field trips
  (Berlin, Hamburg, Mainz...)

![Image of accelerator tunnel with students]
The Future of DELTA

Workshop on July 15, 2016

The next 10 years

- consolidation and improvement
- 7-T wiggler and RF upgrade
- EEHG short-pulse source
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and beyond ...
Tack så mycket!