AKBP 10: Synchrotron Radiation and FELs

Time: Thursday 14:00–16:15 Location: AKBPa

AKBP 10.1 Thu 14:00 AKBPa

Computational Studies for the Future EEHG Upgrade at DELTA Short-pulse Facility — •Arjun Radha Krishnan, Benedikt Büsing, Arne Held, Shaukat Khan, Hubertus Kaiser, and Carsten Mai — Center for Synchrotron Radiation (DELTA), TU Dortmund University, Dortmund, Germany

The short-pulse facility at the 1.5-GeV synchrotron light source DELTA, operated by the TU Dortmund University, currently employs the Coherent Harmonic Generation (CHG) technique to generate ultrashort VUV pulses. This will be upgraded to Echo Enabled Harmonic Generation (EEHG) scheme to reach even shorter EUV wavelengths in the future. The two-stage energy modulations in combination with two dispersion sections allow more flexibility towards optimizing the parameters for the setup.

Results of the computational studies regarding the optimization of undulator, laser, and chicane parameters with an aim of producing coherent emission at 20 nm (40th harmonic of seed wavelength) will be presented.

This project is funded by BMBF under contract 05K19PEB.

AKBP 10.2 Thu 14:15 AKBPa

Status of the Short-Pulse Source at DELTA — •Hubertus Kaiser, Benedikt Büsing, Arne Held, Shaukat Khan, Daniel Krieg, Arjun Radha Krishnan, and Carsten Mai — Center for Synchrotron Radiation (DELTA),TU Dortmund University, Dortmund, Germany

The short-pulse source at the 1.5-GeV electron storage ring DELTA operated by the TU Dortmund University employs the coherent harmonic generation (CHG) technique to provide ultrashort pulses in the vacuum ultraviolet and terahertz regime. Here, a modulation of the electron energy induced by an interaction with an ultrashort laser within an undulator (modulator) tuned to the laser wavelength is transformed into a density modulation by a magnetic chicane. Recently, the influence of the Gouy phase shift in the laser pulse on the laser-electron interaction has been investigated. It causes a shift of the wavelength the undulator needs to be tuned to. Additionally, the magnetic setup of the short-pulse source allows to investigate the coherent emission of edge radiation. Furthermore, a setup for Compton backscattering featuring a high-power continuous-wave CO2 laser and a gamma-ray spectrometer will be implemented at DELTA. It allows for precise measurements of the electron beam energy and energy spread. Funded by BMBF under contract 05K19PEB.

AKBP 10.3 Thu 14:30 AKBPa

Current status of the electro-optical electron bunch measurement setup at the DELTA short-pulse source — •Ihsan Mohammad, Shaukat Khan, and Carsten Mai — Center for Synchrotron Radiation (DELTA), TU Dortmund University, Dortmund, Germany

At the 1.5-GeV electron storage ring DELTA operated by the TU Dortmund University, the interaction with femtosecond pulses from a Ti:sapphire laser system in an undulator modulates the electron energy within a slice of the electron bunch and gives rise to the coherent emission of ultrashort pulses in the VUV range. Along the storage ring lattice, the off-energy electrons leave a dip in the longitudinal electron distribution causing the coherent emission of (sub-)THz radiation.

The talk reviews recent results obtained in the study and manipulation of coherently emitted THz radiation and presents the status of an electro-optical (EO) setup to measure the laser-induced temporal structure within the electron bunch. Using the EO effect, the temporal profile of THz radiation is mapped onto the spectrum of a chirped laser pulse. This can be done either in the far field with THz radiation passing through an EO crystal or with a near-field setup inside the storage ring with the electron bunches passing close to the crystal.

This project is supported by the BMBF under contract 05K19PEC.

AKBP 10.4 Thu 14:45 AKBPa

Progress of the development of a superconducting undulator as a THz source for FELs — •Julian Gethmann[1], Andreas Grau[2], David Saez de Jauregui[2], Nicole Glamann[2], Sara Casalbuoni[2,3], and Anke-Susanne Müller[1,2] — [1]LAS, KIT, Karlsruhe — [2]IBPT, KIT, Karlsruhe — [3]European XFEL GmbH, Schenefeld

To produce radiation in the THz wavelength range at X-ray free electron lasers, undulators with large period length, fields, and gaps can be used. These demands can be fulfilled by superconducting undulators. In this contribution the actual requirements on the main parameters of the superconducting undulator will be discussed. The progress of the design of one such undulator will be presented.

This work is supported by the BMBF project 05K19VK2 SCUXFEL (Federal Ministry of Education and Research) and by the DFG-funded Doctoral School "Karlsruhe School of Elementary and Astroparticle Physics: Science and Technology (KSETA)".

AKBP 10.5 Thu 15:00 AKBPa

Status of the CompactLight Design Study — Regina Rochow[1], Gerardo D'Auria[1], and •Andrea Latina[2] — [1]Elettra Sincrotrone Trieste — [2]CERN - European Organization for Nuclear Research

CompactLight (XLS) is a H2020 Design Study funded by the European Union under grant agreement 777431 and carried out by an International Collaboration of 26 partners and 5 third parties. The project started in January 2018 with a duration of 48 months and aims at designing an innovative, cost-effective and compact hard X-ray FEL facility beyond today's state of the art. This will be achieved using an advanced C-band photo-injector, high gradient X-band accelerating structures, and novel short period undulators. The hard X-ray FEL will be complemented by a soft X-ray source that can be operated up to 1 KHz pulse repetition rate. The presentation, held on behalf of the CompactLight Consortium, will give an overview of the state of the project, focusing in particular on the facility design and its potential regarding future user needs.

AKBP 10.6 Thu 15:15 AKBPa

Numerical simulation of a superradiant THz source at the PITZ facility — •natthawut chaisueb[1,2], prach boonpornprasert[3], mikhail krasilnikov[3], xiangkun li[3], anusorn lueangaramwong[3], and sakhorn rimjaem[1] — [1]Plasma and Beam Physics Research Facility (PBP), Department of Physics and Materials Science, Faculty of Science, Chiang Mai University, Chiang Mai, Thailand — [2]Doctor of Philosophy Program in Physics (International Program), Department of Physics and Materials Science, Faculty of Science, Chiang Mai University, Chiang Mai, Thailand — [3]DESY, Zeuthen, Germany

An accelerator-based THz source is under development at the Photo Injector Test Facility at DESY in Zeuthen (PITZ). The facility can produce high brightness electron beams with high charge and small emittance. Currently, study on development of a tunable high-power THz SASE FEL for supporting THz-pump, X-ray probe experiments at the European XFEL is underway. An LCLS-I undulator, a magnetic chicane bunch compressor, and THz pulse diagnostics will be installed downstream the current setup of the PITZ beamline. Additionally to the SASE FEL, a possibility to generate superradiant THz undulator radiation from short electron bunches is under investigation. Numerical simulations of the superradiant THz radiation by using sub-picosecond electron bunches with energy of 6 - 22 MeV and bunch charge up to 2 nC produced from the PITZ accelerator are presented and discussed in this contribution.

AKBP 10.7 Thu 15:30 AKBPa

HTS undulators: status of prototype coils for compact FELs — •Sebastian C. Richter[1,2], Daniel Schoerling[1], Axel Bernhard[2], Kantaphon Damminsek[2], Julian Gethmann[2], and Anke-Susanne Müller[2,3] — [1]CERN - 1211 Geneva 23 - Switzerland — [2]LAS, KIT, Karlsruhe, Germany — [3]IBPT, KIT, Karlsruhe, Germany

Compact free electron lasers (FELs) require short-period high field undulators in combination with shorter accelerator structures to produce coherent light up-to X-rays. Applying high-temperature superconductor (HTS) in form of coated REBCO tape conductors allows reaching higher magnetic fields and larger operating margins as compared to low-temperature superconductors (LTS). This contribution discusses and summarizes the potential of HTS for the major superconducting undulator geometries (horizontal, vertical racetrack and helical) as well as the status of prototype coils for each type, to be wound with coated

REBCO tape conductor.

This work has been supported by the Wolfgang Gentner Programme of the German Federal Ministry of Education and Research (grant no. 05E15CHA).

AKBP 10.8 Thu 15:45 AKBPa

Operational experience and characterization of a superconducting transverse gradient undulator for compact laser wakefield accelerator-driven FELs — •Kantaphon Damminsek, Axel Bernhard, Julian Gethmann, Maisui Ning, Robert Rossmanith, Sebastian Richter, Yuancun Nie, Yimin Tong, and Anke-Susanne Müller — Karlsruhe Institute of Technology

A 40-period superconducting transverse gradient undulator (TGU) has been designed and fabricated at the Karlsruhe Institute of Technology (KIT). Combining a TGU with a laser wakefield accelerator (LWFA) is a potential key for realizing extremely compact free electron laser (FELs) radiation sources. The TGU scheme is a viable option to compensate the challenging properties of the LWFA electron beam in terms of beam divergence and energy spread. In this contribution, we report on the operational experience of this TGU inside its own cryostat and show first results of the characterization measurement, current status of the TGU and the further plan for experiments.

This work is supported by the BMBF project 05K19VKA PlasmaFEL (Federal Ministry of Education and Research).

AKBP 10.9 Thu 16:00 AKBPa

Divergence Study of an Echo-Enabled Harmonic Generation Free-Electron Laser — •Fabian Pannek[1], Sven Ackermann[2], Enrico Allaria[2], Pardis Niknejadi[2], Georgia Paraskaki[2], Lucas Schaper[2], and Wolfgang Hillert[1] — [1]Universität Hamburg, Hamburg, Deutschland — [2]Deutsches Elektronen-Synchrotron (DESY), Hamburg, Deutschland

At FLASH, the Free-Electron LASer in Hamburg, an upgrade of one of the existing beamlines towards echo-enabled harmonic generation (EEHG) is planned. With this upgrade, FLASH will be the first seeded FEL facility that provides high repetition rate radiation in the XUV and soft X-ray regime. A critical quantity characterizing the radiation is its divergence, which is crucial for the design of photon diagnostics and the transport of the radiation to the experiment. To investigate the impact of the electron beam and beamline parameters on the divergence, dedicated numerical simulations based on the FEL code GENESIS 1.3 version 4 have been carried out. We will present and discuss the first results of these studies.