AKBP 14: Light Sources and FEL's

Time: Thursday 16:15–18:00 Location: E 020

AKBP 14.1 Thu 16:15 E 020

Analytical And Numerical Studies On Experimental HGHG Data At FLASH — •Hendrik Wenzel[1], Sven Ackermann[2], Margarit Asatrian[1], Eugenio Ferrari[2], Samuel Hartwell[2], Wolfgang Hillert[1], Mehdi Kazemi[2], Tino Lang[2], Velizar Miltchev[1], Pardis Niknejadi[2], Fabian Pannek[3], Georgia Paraskaki[2], Dmitrii Samoilenko[1], Lucas Schaper[2], and Johann Zemella[2] — [1]Universität Hamburg, Hamburg, Germany — [2]Deutsches Elektronen-Synchrotron (DESY), Hamburg, Germany — [3]European XFEL, Hamburg, Germany

Free-**E**lectron **L**asers (FELs) generate ultrashort, transversely coherent laser pulses through **S**elf-**A**mplified **S**pontaneous **E**mission (SASE). Since SASE starts from the shot noise naturally present in the electron beam, it exhibits poor longitudinal coherence and shot-to-shot fluctuations both in spectrum and intensity. These limitations can be overcome by starting the FEL process deterministically, e.g., by using external seeding. Due to the lack of suitable seed laser sources at short wavelengths, seeding setups employing harmonic conversion are crucial to achieving full coherence in the XUV – X-Ray range. One such scheme is **H**igh-**G**ain **H**armonic **G**eneration – HGHG. There, a seed laser induces a coherent modulation of the phase space of the electron beam. Since the modulation contains components at higher harmonics of the seed laser wavelength, it is possible to generate powerful coherent radiation at the short wavelengths. We present analytical and numerical studies based on experimental results obtained at Xseed, the seeding experiment at the FLASH FEL at DESY, Hamburg.

AKBP 14.2 Thu 16:30 E 020

Power Buildup in a Strongly-Tapered FEL Oscillator — •Margarit Asatrian[1], Eugenio Ferrari[2], Andrew Fisher[3], Georgia Paraskaki[2], Pietro Musumeci[3], and Wolfgang Hillert[1] — [1]University of Hamburg, Hamburg, Germany — [2]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany — [3]University of California at Los Angeles, Los Angeles, California, USA

Free-Electron Lasers (FELs) can deliver high-energy pulses at MHz repetition rates and wavelengths down to XUV – X-Ray regime by extracting a fraction of energy of ultrarelativistic electron bunches. This fraction, corresponding to the FEL efficiency, depends on the FEL setup and typically lies below 0.1%.

A promising scheme for its improvement – Tapering Enhanced Stimulated Superradiant Amplification (TESSA), proposes using a high-power seed laser pulse in combination with strongly-tapered undulators for extracting a significantly larger fraction of the energy from a pre-bunched beam. Since there is a lack of sufficiently powerful seed laser sources at shorter wavelengths, one can consider implementing the TESSA scheme in an FEL oscillator, so that the seed is generated and stored within the cavity.

We present a simulation study addressing the challenges of power buildup in such a strongly-tapered FEL oscillator. In particular, we look into the possibility of using fast control on the beam energy and the undulator phase shifters for accelerating the buildup process.

AKBP 14.3 Thu 16:45 E 020

External Seeding via Echo-Enabled Harmonic Generation at FLASH — •Andreas Thiel[1], Sven Ackermann[2], Margarit Asatrian[1], Eugenio Ferrari[2], Samuel Hartwell[2], Wolfgang Hillert[1], Mehdi Kazemi[2], Tino Lang[2], Pardis Niknejadi[2], Fabian Pannek[3], Georgia Paraskaki[2], Dmitrii Samoilenko[1], Lucas Schaper[2], Hendrik Wenzel[1], and Johann Zemella[2] — [1]Universität Hamburg, Hamburg, Germany — [2]Deutsches Elektronen-Synchrotron (DESY), Hamburg, Germany — [3]European XFEL, Hamburg, Germany

Free-Electron Lasers (FELs) operating in Self-Amplified Spontaneous Emission (SASE) mode deliver high-power, transversely coherent and ultrashort pulses at wavelengths from THz down into the X-Ray regime. The limited longitudinal coherence and low spectral and pulse energy stability can be improved by various seeding schemes. In one of these, Echo-Enabled Harmonic Generation (EEHG), the electron beam is energy-modulated by two separate laser pulses in two modulators, each followed by a dispersive section. This results in a distinctive phase space profile containing density spikes, which allows the generation of fully coherent FEL radiation with narrow bandwidth at short wavelengths. At the FEL facility FLASH (DESY, Hamburg) possibilities for external seeding are explored within the Xseed environment, paving the path towards high repetition rate seeded FEL user operation, which is planned within the upgrade project FLASH2020+. In this contribution, the first experimental results of EEHG at FLASH are discussed along with the setup and hardware infrastructure.

AKBP 14.4 Thu 17:00 E 020

Optimization of the seeded THz-FEL at PITZ: study of shot noise and initial bunching factor impact for experimental beam conditions — •Xiaoyang Zhang, Xiangkun Li, Prach Boonpornprasert, and Mikhail Krasilnikov — Deutsches Elektronen- Synchrotron DESY, Zeuthen, Germany

The first operational high peak and average power THz SASE FEL at the Photo Injector Test Facility at DESY in Zeuthen (PITZ) has demonstrated up to 100 uJ single pulse energy at a center frequency of 3THz from electron bunches of 2-3 nC. The measured shot-to-shot radiation pulse energy has a fluctuation of ~10%. In previous studies, several seeding methods have been proposed in order to enhance the performance of the THz source, particularly in terms of shot-to-shot stability and temporal coherence. THz-FEL simulations with ideal electron beam parameters (temporal flattop with a peak current of 200A) have shown that a bunching factor of 10e-2 to 10e-3 is required for efficient seeding. In this talk, the seeding conditions for the PITZ experimental beam parameters (temporal Gaussian profile with a peak current of ~100 A) will be investigated, in particular the impact of the short noise and the initial bunching factor on the radiation pulse energy, stability and other properties of THz pulses.

AKBP 14.5 Thu 17:15 E 020

Advanced applicatons of the FLASH laser heater for short-pulse generation — •Carsten Mai[1], Philipp Amstutz[1], Shaukat Khan[1], and Christopher Gerth[2] — [1]Center for Synchrotron Radiation (DELTA), TU Dortmund University, Dortmund, Germany — [2]Deutsches Elektronen Synchrotron DESY, Hamburg, Germany

Laser heaters at FEL facilites are used to increase the electron energy spread and suppress the microbunching instability. A laser-heater has been installed as part of the FLASH2020+ upgrade program upstream of the first bunch compressor chicane at FLASH. As an extension of the standard laser heater operation, the FLASH Laser-Assisted Reshaping of Electron bunches (FLARE) project aims at the generation of short pulses by using the laser heater in an advanced configuration. Two different methods for the variation of the pulse duration using the laser heater and first measurements are presented.

AKBP 14.6 Thu 17:30 E 020

Seeding experiments using the echo-enabled harmonic generation scheme at DELTA — •Arjun Radha Krishnan[1], Benedikt Büsing[1], Shaukat Khan[1], Carsten Mai[1], Wa'el Salah[2], and Vivek Vijayan[1] — [1]Center for Synchrotron Radiation (DELTA), TU Dortmund University, Dortmund, Germany — [2]The Hashemite University, Zarqa, Jordan

Free-electron lasers use the echo-enabled harmonic generation (EEHG) scheme as a seeding method. However, the technique can be employed at storage rings for the generation of ultrashort radiation pulses, as well. At DELTA, a 1.5-GeV synchrotron light source operated by TU Dortmund University, recently an EEHG setup was implemented. Here, two-fold laser-electron interaction in two undulators, each followed by a magnetic chicane, is used to generate a density pattern with high harmonic content, leading to coherent radiation emission at harmonics of the laser wavelength. The implementation at DELTA is the world-wide first of its kind at a storage ring. The experimental setup and the present status of the project are presented.

AKBP 14.7 Thu 17:45 E 020

Methods for high-repetition THz production at XFEL — •Karel Peetermans[1], Wolfgang Hillert[2], and Francois Lemery[1] — [1]DESY — [2]Universität Hamburg

In order to exploit the full scientific potential of high-energy XFELs (electron energy > 10 GeV), it is necessary to provide adequate pump sources to enable pump-probe science. Users of the European XFEL have requested a THz pump source matching the machine repetition rate (10 Hz burst mode with up to 2700 bunches per burst). In addition, they have demanded a spectral range spanning 0.1-30 THz with a tunable bandwidth to investigate broad and narrow resonances in matter. The EuXFEL R&D project, STERN, is exploring beam-based radiation generation methods using Cherenkov waveguides and diffraction radiation to satisfy these user requirements. This presentation will provide an overview of radiation generation from Cherenkov waveguides and diffraction sources, including theory, simulation and previous experimental results. We will cover a technical overview of our experimental area including the lattice and vacuum design. We furthermore discuss the collection and transport of the generated THz radiation. Finally, we will mention plans for THz diagnostics to characterize the generated radiation.