AKBP 9: Seeding, Thomson and Compton Scattering

Zeit: Mittwoch 14:00–16:00 Raum: S1/05 122

Gruppenbericht AKBP 9.1 Mi 14:00 S1/05 122
(Group Report) Status of the Short-Pulse Facility at DELTA — •Fabian Götz, Fin Hendrik Bahnsen, Max Bolsinger, Svenja Hilbrich, Markus Höner, Marc André Jebramcik, Shaukat Khan, Nils Lockmann, Carsten Mai, Arne Meyer auf der Heide, Robert Molo, Rafael Niemczyk, Gholamreza Shayeganrad, Peter Ungelenk, and Dennis Zimmermann — Center for Synchrotron Radiation (DELTA), TU Dortmund University, Dortmund, Germany

At the 1.5-GeV synchrotron light source DELTA operated by the TU Dortmund University, femtosecond laser pulses interact with electrons in order to generate coherent ultrashort radiation pulses in the VUV regime (coherent harmonic generation, CHG). The electric field of the laser pulses modulates the electron energy. By passing a magnetic chicane, this energy modulation is converted into a density modulation, which gives rise to coherent radiation at harmonics of the laser wavelength. In this contribution, a general overview of the DELTA short-pulse facility and methods to characterize the CHG radiation are presented. To control the shape and the spectra of the CHG pulses, studies using a scanning monochromator with an APD as a detector and a single-shot spectrometer based on a gated CCD camera were carried out. The CHG radiation spectra change under variation of the laser pulse properties and chicance strengths. Finally, spectral measurements are compared with simulations of the microbunching process and the CHG radiation.

AKBP 9.2 Mi 14:30 S1/05 122
Influence of RF Phase Modulation on Laser-Induced Coherent Synchrotron Radiation — •Marc Andre Jebramcik, Fin Hendrik Bahnsen, Max Bolsinger, Svenja Hilbrich, Shaukat Khan, Carsten Mai, Arne Meyer auf der Heide, Robert Molo, Gholamreza Shayeganrad, and Peter Ungelenk — Center for Synchrotron Radiation (DELTA), TU Dortmund University, Dortmund, Germany

In circular accelerators, RF phase modulation is routinely used to prolong the beam lifetime and to damp multi-bunch instabilities. At the 1.5-GeV synchrotron light source DELTA operated by the TU Dortmund University, synchronized RF phase modulation has also been used to increase the intensity of the ultrashort coherent pulses in the VUV and THz regime generated by the coherent harmonic generation (CHG) technique since 2014. The quality of the laser-electron interaction is heavily influenced by the energy spread and density of the electron bunches. Hence, RF phase modulation can be used to modulate these parameters in order to achieve an increased intensity of the laser-induced radiation. An analysis regarding the relationship between synchronized RF phase modulation and the laser-induced radiation is presented.

AKBP 9.3 Mi 14:45 S1/05 122
Design of Vacuum Components for a EEHG-Based Short-Pulse Facility at DELTA — •Fin Hendrik Bahnsen, Max Bolsinger, Svenja Hilbrich, Marc Andre Jebramcik, Shaukat Khan, Nils Lockmann, Carsten Mai, Arne Meyer auf der Heide, Robert Molo, Gholamreza Shayeganrad, Peter Ungelenk, and Dennis Zimmermann — Center for Synchrotron Radiation (DELTA), TU Dortmund University, Dortmund, Germany

Since 2011, a short-pulse facility is in operation at the 1.5-GeV synchrotron light source DELTA. Coherent VUV radiation pulses with femtosecond duration are routinely generated using the coherent harmonic generation (CHG) technique which is based on the interaction of electrons with ultrashort laser pulses. In order to generate even shorter wavelengths, an upgrade employing the echo-enabled harmonic generation (EEHG) and femtoslicing schemes is planned for 2017. A new vacuum system for the modified section of the storage ring considering the boundary conditions given by the changed magnetic layout and the existing vacuum setup was designed. The results including simulations of the vacuum profile along the storage ring and wake fields in new chamber parts will be presented.

AKBP 9.4 Mi 15:00 S1/05 122
Recent Progress Towards the EEHG-Based Short-Pulse Facility at DELTA — •Nils Lockmann, Fin Hendrik Bahnsen, Max Bolsinger, Fabian Götz, Svenja Hilbrich, Marc Jebramcik, Shaukat Khan, Carsten Mai, Arne Meyer auf der Heide, Robert Molo, Raffael Niemczyk, Helge Rast, Gholamreza Shayeganrad, Peter Ungelenk, and Dennis Zimmermann — Center for Synchrotron Radiation (DELTA), TU Dortmund University, Dortmund, Germany

In the field of photon science, the demand for brilliant radiation at short wavelengths with shortest pulse durations keeps growing. At the synchrotron radiation source DELTA operated by the TU Dortmund University, this is achieved by an interaction of a short laser pulse with highly relativistic electrons. The currently used coherent harmonic generation (CHG) technique leads to femtosecond synchrotron radiation pulses in the VUV regime. However, the so-called echo-enabled harmonic generation (EEHG) scheme promises to reach much shorter wavelengths. Therefore, the short-pulse facility will be modified in order to implement EEHG as well as the femtoslicing technique, another method providing short pulses with short wavelengths using the laser-electron-interaction.

In this contribution the status of the upgrade will be presented, including the magnetic layout of the storage ring, the laser system and hardware components.

AKBP 9.5 Mi 15:15 S1/05 122
Design Study of a Traveling-Wave Thomson-Scattering Experiment for the Realization of Optical Free Electron Lasers — •Klaus Steiniger[1,2], Daniel Albach[1], Alexander Debus[1], Markus Loeser[1,2], Richard Pausch[1,2], Fabian Roeser[1], Ulrich Schramm[1,2], Matthias Siebold[1], and Michael Bussmann[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf — [2]Technische Universität Dresden

We present an experimental setup strategy for the realization of an optical free-electron laser (OFEL) in the Traveling-Wave Thomson-Scattering geometry (TWTS). In TWTS, the electric field of petawatt class, pulse-front tilted laser pulses is used to provide an optical undulator field. This is passed by a relativistic electron bunch so that electron direction of motion and laser propagation direction enclose an interaction angle. The combination of side scattering and pulse-front tilt provides continuous overlap of electrons and laser pulse over meter scale distances which are achieved with centimeter wide laser pulses. An experimental challenge lies in shaping of these wide laser pulses in terms of laser dispersion compensation along the electron trajectory and focusing. In the talk we show how diffraction gratings in combination with mirrors are used to introduce and control dispersion of the laser in order to provide a plane wave laser field along the electron trajectory. Furthermore we give tolerance limits on alignment errors to operate the OFEL. Example setups illustrate functioning and demonstrate feasibility of the scheme.

AKBP 9.6 Mi 15:30 S1/05 122
Compact x-ray sources - simulating the electron/strong laser interaction — •Anthony Hartin — DESY, CFEL, Notkestrasse 85, Hamburg 22607

The collision of an intense laser with an electron bunch can be used to produce x-rays via the inverse Compton scattering (ICS) mechanism. The ICS can be simulated via either a classical theory in which electrons and photons are treated in terms of classical electromagnetic waves - or a quantum theory in which charged particles interact with strong electromagnetic fields.

The laser intensity used in a practical ICS collision is likely to be at such a level that quantum effects may be significant and the use of quantum theory may become a necessity. A simulation study is presented here comparing the classical and quantum approaches to the ICS.

A custom particle-in-cell (PIC) software code, with photon generation by monte carlo of the exact quantum transition probability is used to simulate the quantum treatment. Peak resonant energies and the angular distribution of the x-rays are obtained and compared with those predicted by the classical theory. The conditions under which significant differences between the two theories emerges is obtained.

AKBP 9.7 Mi 15:45 S1/05 122

Detection of Inverse Compton Scattering in Plasma Wakefield Experiments — •Simon Bohlen[1], Darragh Corvan[2], Jens Osterhoff[1], Bernhard Schmidt[1], Jan-Patrick Schwinkendorf[1], and Matthew Streeter[1] — [1]Deutsches Elektronen-Synchrotron, Notkestrasse 85, 22607 Hamburg, Germany — [2]School of Mathematics and Physics, The Queen's University of Belfast, BT71NN Belfast, United Kingdom

Inverse Compton Scattering (ICS) of a laser pulse off an electron bunch can produce highly energetic photons. In combination with plasma wakefield acceleration, ICS offers a compact way to provide a source of directed gamma radiation. Besides industrial and medical applications, ICS may be utilized as a diagnostic for the electron bunch used in the interaction. By measuring properties of the gamma beam, electron beam information such as energy and divergence as well as its longitudinal properties can be determined.

Typical electron energies in plasma wakefield experiments lead to gamma-rays with energies on the order of about 1-100 MeV rendering the detection of the ICS photons challenging. Furthermore, the femtosecond duration of the produced gamma beams prevents the use of standard measurement techniques, which rely on diagnosing single photon events. Here, we present a discussion of novel detector techniques and their use to create functional diagnostics for plasma based ICS beams.