P 19: Plasma Diagnostics IV

Zeit: Mittwoch 15:00–16:00 Raum: HS 1010

P 19.1 Mi 15:00 HS 1010

Investigation of the self-modulation seeding by a short electron bunch within a long proton bunch — •Mathias Julius Hüther — Max-Planck-Institut für Physik (Werner-Heisenberg-Institut), München, Deutschland — Technische Universität München, Deutschland

The AWAKE (Advanced Wakefield Experiment) at CERN is world's first proton-driven plasma wakefield accelerator aiming for acceleration of externally injected electrons in gradients up to the GeV/m scale.
The 12 cm long proton bunch from CERN's Super Proton Synchrotron (SPS) propagates through a 10–m long laser induced plasma channel and is split into a train of micro-bunches on the order of the plasma wavelength by its electromagnetic interaction with the plasma.
This modulation is caused by the self-modulation instability (SMI), a transverse plasma instability. According to simulations, this instability does not significantly grow over a meter scale and in the experimental plan is therefore seeded by having an ionizing laser beam co-propagating at the centre of the proton bunch.
In this talk, we present calculations and simulations for a different concept of seeding the SMI by electron injection. The timing between laser and protons is shifted, so that the whole proton bunch propagates through a preformed plasma. The proton beam current is modulated by the external injection of a short electron bunch in the centre of the proton beam. The resulting sharp rise of the total current drives large wakefields that seed the growth of the SMI.
This seeding technique will also be tested experimentally.

P 19.2 Mi 15:15 HS 1010

Classical spin dynamics of electrons in strong electromagnetic fields — •Meng Wen, Heiko Bauke, and Christoph H. Keitel — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany

Dynamics of an electron in strong fields includes the precession of the spin as well as its orbital motion, which is determined by the Lorentz force, a spin-dependent Stern-Gerlach force and a radiation-reaction force. Classical investigations, however, often treat the electron as a spinless particle because of the lack of a definite classical unified description of the electron's orbital motion and its spin dynamics. Although many classical models have been proposed to include the spin, the validity of them was seldom investigated. We investigate the reliability of different classical spin models by numerical comparisons to the Dirac theory for specific strong-field setups and suggest a reliable model [1]. In strong fields where effects of the Stern-Gerlach force become relevant also radiation reactions are expected to set in [2]. Depending on the electron's energy and the field configuration either radiation reactions or spin effects may dominate. Spin contributions may be identified by considering electrons of opposite spin state and radiation reactions are verifiable by spin-averaged electron beams.

[1] M. Wen, H. Bauke, C. H. Keitel, "Identifying the Stern-Gerlach force of classical electron dynamics", *Sci. Rep.* **6**, 31624 (2016)

[2] M. Wen, C. H. Keitel, H. Bauke, "Spin one-half particles in strong electromagnetic fields: spin effects and radiation reaction", arXiv:1610.08951

P 19.3 Mi 15:30 HS 1010

Highly efficient source of Kα radiation driven by relativistic interaction of mid-infrared laser pulses with nanostructured solid targets — •Zhanna Samsonova[1,2], Sebastian Höfer[1], Ingo Uschmann[1,2], Vural Kaymak[3], Skirmantas Ališauskas[4], Audrius Pugžlys[4], Lukas Trefflich[5], Carsten Ronning[5], Alexander Pukhov[3], Andruis Baltuška[4], Eckhart Förster[1,2], Christian Spielmann[1,2], and Daniil Kartashov[2] — [1]Helmholtz Institute Jena, Jena, Germany — [2]Institute of Optics and Quantum Electronics, Abbe Center of Photonics, Friedrich-Schiller-University Jena, Jena Germany — [3]Institute for Theoretical Physics, Heinrich-Heine-University Düsseldorf, Düsseldorf, Germany — [4]Photonics Institute, Vienna University of Technology, Vienna, Austria — [5]Institute of Solid State Physics, Friedrich-Schiller-University Jena, Jena, Germany

We report on recent studies of a novel regime of relativistic laser-plasma interaction between solid nanostructures targets and ultra-intense mid-infrared pulses at 3.9 μm. We experimentally investigate the dependence of X-ray generation on the morphology of the targets and focusing conditions. A record high conversion efficiency of the essentially background free, cold Zn K-shell emission reaches a value of 3E-4 using only 20 mJ laser pulses. Numerical PIC-simulations predict solid density plasma with the electron temperature close to the estimations from the measurements. Our results suggest that relativistic interaction of long wavelength femtosecond laser pulses with nanostructured solids is a very promising way to realize highly efficient, femtosecond X-ray backlighter for high density plasma physics.

P 19.4 Mi 15:45 HS 1010

Development of an active bremsstrahlung detector for ultra-intense laser-plasma experiments — •Maria Molodtsova[1,2], Anna Ferrari[1], Alejandro Laso Garcia[1], Manfred Sobiella[1], Daniel Stach[1], David Weinberger[1,2], and Thomas Cowan[1,2] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Germany — [2]Technische Universität Dresden, Germany

Ultra-intense laser-matter interaction physics is of growing interest worldwide, because of its ability to create new extreme states of matter and to explore technologically interesting processes such as new concepts for particle acceleration, material science, and fusion energy. A critical component in laser-solid interaction is the acceleration of relativistic electrons and their transport in the material of the target, generating ultra-intense bremsstrahlung in a sub-ps time scale and with a high intensity ($\sim 10^{10}$ photons). Usual spectrometry techniques using pulse height analysis cannot therefore be used, and new active methods need to be developed. The concept of a novel detector is presented, based on a multi layered scintillator structure, which allows the characterization of the longitudinal development of the radiation. By measuring the deposited energy in each layer the photon spectrum can be reconstructed by using an unfolding technique. Via extensive FLUKA Monte Carlo simulations, the detector was optimized to resolve the photon spectrum in the dynamic range between 50 keV and 20 MeV, and the most promising model was chosen to realize the first prototype. In this talk the optimization process, together with the construction and the first tests, are presented.