4th European Advanced Accelerator Concepts Workshop

Report of Contributions

Contribution ID: **6** Type: **talk**

Force exerted on particle bunch propagating near plasma-vacuum boundary

Tuesday, September 17, 2019 5:00 PM (20 minutes)

If a charged particle bunch propagates near a plasma-vacuum boundary, it experiences an additional force caused by the boundary. Taking account of this force may be important for witness injection into plasma wakefields or in case of beam and plasma misalignments. For the linearly responding plasma and short and narrow bunch, this force is calculated analytically and approximated by elementary functions. The force is attracting to the boundary, if the bunch is in vacuum, and repelling otherwise. There are also additional focusing and defocusing components of the force. Numerical simulations of electron beam crossing the boundary at a small angle agree with the theory, proving validity of the both.

Primary authors: LOTOV, Konstantin (Novosibirsk State University); Dr PETRENKO, Alexey (Budker Institute of Nuclear Physics); PUKHOV, Alexander (uni duesseldorf)

Presenter: LOTOV, Konstantin (Novosibirsk State University)

Session Classification: WG6

Track Classification: WG6 - Theory and simulations

Contribution ID: **7** Type: **talk**

Particle acceleration in co-axial plasma channels

Wednesday, September 18, 2019 4:40 PM (20 minutes)

The attainable transformer ratio in plasma accelerators is limited by instabilities. Using three-dimensional particle-in-cell simulations, we demonstrate that these can be controlled using a hollow plasma channel with a coaxial plasma filament. The driver scatters electrons from the filament, and the slow pinch of the ions leads to a strong chirp of the effective betatron frequency, preventing beam breakup. We demonstrate the monoenergetic acceleration of an electron bunch to 20 GeV over 4.4 m, achieving a transformer ratio of 10, an energy efficiency of 40%, and an emittance of 1.8 μm.
We discuss the source of emittance growth inside the channel and options to eliminate it. This might open a path toward high energy acceleration of both electrons and positrons.
A practical possibility for creation of the co-axial plasma structure will be discussed as well.

Primary authors: PUKHOV, Alexander (University of Dusseldorf); Dr FARMER, John (University of Dusseldorf)

Presenter: PUKHOV, Alexander (University of Dusseldorf)

Session Classification: WG6-WG8 Joint Session

Track Classification: WG6-WG8 Joint Session

Contribution ID: **8** Type: **poster**

Coherent diffraction radiation of relativistic terahertz pulses from a laser-driven micro-plasma-waveguide

Monday, September 16, 2019 7:00 PM (1 hour)

We propose a method to generate isolated relativistic terahertz (THz) pulses using a high-power laser irradiating a mirco-plasma-waveguide (MPW). When the laser pulse enters the MPW, high charge electron bunches are produced and accelerated to 100 MeV by the transverse magnetic modes. A substantial part of the electron energy is transferred to THz emission through coherent diffraction radiation as the electron bunches exit the MPW. We demonstrate this process with three-dimensional particle-in-cell simulations. The frequency of the radiation is determined by the incident laser duration, and the radiated energy is found to be strongly correlated to the charge of the electron bunches, which can be controlled by the laser intensity and micro-engineering of the MPW target. Our simulations indicate that 100-mJ level relativistic-intense THz pulses with tunable frequency can be generated at existing laser facilities, and the overall efficiency reaches 1%.

Primary authors: YI, Longqing (Chalmers University of Technology); Prof. FÜLÖP, Tünde (Chalmers University of Technology)

Presenter: YI, Longqing (Chalmers University of Technology)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG6 - Theory and simulations

Contribution ID: **9** Type: **poster**

Characterization of wavebreaking time and dissipation of weakly nonlinear wakefields due to ion motion

Monday, September 16, 2019 7:00 PM (1 hour)

In an initially uniform plasma, the lifetime of a weakly nonlinear plasma wave excited by a short driver is limited by the ion dynamics. The wakefield contains a slowly varying radial component, which results in a perturbation of the ion density profile and consequent destruction of the plasma wave. We suggest a novel method of quantitative characterization of the plasma wave lifetime in numerical simulations. The moment of wave breaking is associated with the appearance of fast electrons and, consequently, quick modification of the energy flux in the co-moving frame. The method is precise enough to determine the moment of wave breaking to within a fraction of the plasma wave period. One of interesting results achieved with this method is the power 1/3 scaling of the wave lifetime with ion mass.

Primary authors: SPITSYN, Roman (Budker Institute of Nuclear Physics); LOTOV, Konstantin (Novosibirsk State University); Mr TIMOFEEV, Igor (Budker Institute of Nuclear Physics); SOSEDKIN, Alexander (Novosibirsk State University)

Presenter: SPITSYN, Roman (Budker Institute of Nuclear Physics)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG6 - Theory and simulations

Contribution ID: **10** Type: **talk**

Recent orientations in the Smilei particle-in-cell simulation software

Monday, September 16, 2019 6:00 PM (20 minutes)

Smilei is an open-source particle-in-cell (PIC) simulation code. It is developed by a collaboration of scientific computing experts and plasma physicists for applications ranging from astrophysics to laser-plasma interactions. In order to address this large variety of scientific cases, Smilei gathers many different features in a single software suit and adopts flexible data structures and methods. In this presentation we want to introduce two major evolutions of the code which have a direct impact in the field of laser-wakefield acceleration. The first is a vectorized version of the PIC operators. The proposed implementation aims at remaining efficient even for relatively low and contrasted numbers of particles per cell. The second is the possibility of a decoupled domain decomposition for fields and particles. This approach allows to keep small domains for particles, necessary for a good load balancing, while having large domains for the fields, thus minimizing synchronization and improving spectral solvers resolutions.

Primary authors: BECK, Arnaud (Laboratoire Leprince Ringuet); Mr DEROUILLAT, Julien (Maison de la Simulation); Dr LOBET, Mathieu (Maison de la Simulation); ZEMZEMI, imene; MASSIMO, Francesco (LLR - CNRS)

Presenter: BECK, Arnaud (Laboratoire Leprince Ringuet)

Session Classification: WG6

Track Classification: WG6 - Theory and simulations

Contribution ID: **11** Type: **talk**

Physics Opportunities at a Lepton Collider in the Fully Nonperturbative QED Regime

Wednesday, September 18, 2019 4:00 PM (20 minutes)

The presentation will discuss physics questions associated with a novel type of lepton collider, which exploits strong-field quantum effects [i]. In particular, the proposed collider mitigates beamstrahlung energy losses by utilizing highly compressed lepton bunches, which are shorter than the average photon emission length. It is therefore fundamentally different from existing designs for future high-luminosity lepton colliders such as CLIC and ILC, which minimize beamstrahlung energy losses for fixed luminosity by using flat and elongated bunches. This design raises the possibility of creating a gamma-gamma collider without Compton backscattering, relying instead on hard synchrotron radiation to generate the photons. This new approach depends on aspects of radiation in background fields in the strongly quantum regime that are poorly understood today. The presentation will address the extent to which physics models in this extreme high-field regime could be tested in the near- and mid-term by strong field QED experiments colliding high energy electrons with intense laser fields.

[i] V. Yakimenko et al. On the Prospect of Studying Nonperturbative QED with Beam-Beam Collisions, Phys. Rev. Lett. 122, 190404 (2019)

Primary author: YAKIMENKO, Vitaly (SLAC)

Presenter: YAKIMENKO, Vitaly (SLAC)

Session Classification: WG6-WG8 Joint Session

Track Classification: WG6-WG8 Joint Session

Contribution ID: **12** Type: **talk**

Passion Extreme Light

Monday, September 16, 2019 9:20 AM (40 minutes)

Extreme-light laser is a universal source providing a vast range of high energy radiations and particles along with the highest field, highest pressure, temperature and acceleration. It offers the possibility to shed light on some of the remaining unanswered questions in fundamental physics like the genesis of cosmic rays with energies in excess of 1020 eV or the loss of information in black-holes. Using wake-field acceleration some of these fundamental questions could be studied in the laboratory. In addition extreme-light makes possible the study of the structure of vacuum and particle production in "empty" space which is one of the field's ultimate goal, reaching into the fundamental QED and possibly QCD regimes.
Looking beyond today's intensity horizon, we will introduce a new concept that could make possible the generation of attosecond-zeptosecond high energy coherent pulse, de facto in x-ray domain, opening at the Schwinger level, the zettawatt, and PeV regime; the next chapter of laser- matter interaction.

Primary author: MOUROU, Gerard (Ecole Polytechnique)

Presenter: MOUROU, Gerard (Ecole Polytechnique)

Session Classification: Plenary Session 1

Track Classification: Invited Plenary Talk

Contribution ID: **13** Type: **talk**

Overview of optical plasma diagnostics for novel accelerators

Friday, September 20, 2019 9:00 AM (40 minutes)

The research activities in the field of plasma-based particle acceleration is shifting from the investigation of fundamental processes to the actual practical implementation of such promising technology. Laser wake-field acceleration is foreseen to be implemented in user oriented facility expected to deliver high-quality GeV electron bunches suitable for injection in a free-electron laser (FEL) [1]. Beam-driven plasma wake-field acceleration is also considered as suitable methodology for GeV injectors in compact FEL facility [2]. The implementation of plasma-based acceleration stages in user oriented facility requires the definition and deployment of proper diagnostic methodologies to monitor and control the acceleration process.
To this end, an overview is given about state-of-the-art optical diagnostics for density measurement in plasma-based acceleration stages with emphasis on well established and easy to implement approaches, highlighting real-time measurement capability. Optical interferometry in its various configurations from standard two-arm to more advanced common-path design is presented, along with spectroscopic techniques as Stark broadening and Raman scattering.

[1] Horizon 2020 EuPRAXIA design study,
J. Phys. Conf. Ser. 874, 012029 (2017).

[2] EuPRAXIA@SPARC_LAB Design study towards a compact FEL facility at LNF,
Nucl. Instr. Meth. Phys. Res. A 909, 134 (2018).

Primary author: BRANDI, Fernando (Istituto Nazionale di Ottica - CNR)

Co-author: GIZZI, Leonida Antonio (PI)

Presenter: BRANDI, Fernando (Istituto Nazionale di Ottica - CNR)

Session Classification: Plenary Session 9

Track Classification: Invited Plenary Talk

Contribution ID: **17** Type: **poster**

Betatron radiation diagnostic for AWAKE Run 2

Monday, September 16, 2019 7:00 PM (1 hour)

Proof-of-concept experiments in AWAKE Run 1 have demonstrated electron acceleration in a proton-driven wakefield[1]. A high momentum proton beam can drive a wakefield over long distances and overcome some limitations of lepton-driven schemes, which are susceptible to energy depletion. AWAKE Run 2 aims to preserve the beam quality of an injected electron beam throughout acceleration, and consequently a new diagnostic to measure the electron beam emittance after the plasma cell is required. Betatron radiation spectroscopy is a valuable diagnostic tool for the laser-plasma accelerator (LPA) community, and has been used to reconstruct the trace-space of an LPA-generated electron beam[2]. We propose implementing a similar system at the AWAKE experiment. The expected betatron emission from witness electrons at AWAKE is fully characterised using 3D quasi-static PIC simulations with the code QV3D[3], and a diagnostic system able to measure such a betatron spectrum is described. Initial measurements and challenges related to the proton driver are discussed.

[1]Adli, E. et al. Nature 561, 363-367 (2018).
[2]Curcio, A. et al. PRAB 20, 012801 (2017).
[3]Pukhov A. CERN Yellow Rep. 1 , 181 (2016).

Primary authors: WILLIAMSON, Barney (University of Manchester); XIA, Guoxing (Cockcroft Institute and the University of Manchester); PETRENKO, Alexey (CERN); GESSNER, Spencer (CERN); PUKHOV, Alexander (uni duesseldorf)

Presenter: WILLIAMSON, Barney (University of Manchester)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **18** Type: **talk**

Cerenkov-free RIP Maxwell solver: dispersionless along X

Thursday, September 19, 2019 6:20 PM (20 minutes)

A new multi-dimensional solver for Maxwell equations will be presented. It rips the volumetric Yee lattice to a transverse plane. The fields locations become Lorentz-invariant. The solver alleviates numerical dispersion for plane waves running along the selected axis and perfectly fits for problems of particle acceleration in plasmas. The solver has a compact local stencil and allows for parallelization along all three dimensions, while no Fourier transformations involved. Stability and accuracy of the solver will be discussed.
The Maxwell solver is free from numerical Cerenkov radiation for relativistic particles running along the selected axis in both directions.

Primary author: PUKHOV, Alexander (uni duesseldorf)

Presenter: PUKHOV, Alexander (uni duesseldorf)

Session Classification: WG6

Track Classification: WG6 - Theory and simulations

Contribution ID: **19** Type: **poster**

Design studies of the electron injector and beam transport for external injection at AWAKE Run 2

Monday, September 16, 2019 7:00 PM (1 hour)

The proton driven plasma wakefield acceleration experiment AWAKE at CERN demonstrated basic electron capturing and acceleration using a rather long electron bunch spreading out over several plasma wavelengths. For the second phase of the experiment, the aim is to inject a short electron bunch with appropriate emittance and charge to achieve full capture and emittance preservation of the injected electron bunch. The correct bunch charge will load the wakefield and lower the energy spread. At the plasma entrance a bunch length of 200 fs, charge of 100 pC and transverse dimensions of 5 um are needed. The design of the injector consisting of an S-band RF-gun and X-band acceleration and velocity bunching will be presented as well as first ideas of how to transport the beam to the plasma entrance and performing the final focusing.

Primary author: DOEBERT, Steffen (CERN)

Presenter: DOEBERT, Steffen (CERN)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **20** Type: **talk**

Efficient modelling of Laser WakeField Acceleration with realistic laser profile using azimuthal cylindrical geometry

Monday, September 16, 2019 6:20 PM (20 minutes)

The advent of ultra short high intensity lasers has paved the way to new and promising, yet challenging, areas of research in the laser-plasma interaction physics. The success of constructing petawatt femtosecond lasers, that helps designing future particle accelerators, intrinsically relies on the combination between experiments and massively parallel simulations. Hitherto, Particle-In-Cell codes have been successful to accurately describe the laser-plasma interaction. Nevertheless, its 3D numerical modelling can be a challenging task and computationally very expensive. This is due to the large dispersion between the scales involved in this process. In order to speed up such simulations significantly, we need to use reduced numerical models. Fourier field decomposition in azimuthal modes for the cylindrical geometry is a promising reduced model especially for physical problems that have close-to-cylindrical symmetry like Laser WakeField Acceleration. This geometry is implemented in the open-source code Smilei.
To investigate its accuracy, we study the impact of different physical and numerical parameters involved in the simulations. The obtained results are benchmarked with a full 3D cartesian description with a realistic laser profil as described by our collaborators from the experimental group of Apollon laser instead of using a gaussian analytical expression.

Primary author: ZEMZEMI, Imen (Laboratoire Leprince-Ringuet, Ecole polytechnique)

Co-authors: BECK, Arnaud (Laboratoire Leprince Ringuet); Mr DEROUILLAT, Julien (Maison de la Simulation); MASSIMO, Francesco (LLR - CNRS); SPECKA, Arnd (LLR - Ecole Polytechnique - CNRS/IN2P3)

Presenter: ZEMZEMI, Imen (Laboratoire Leprince-Ringuet, Ecole polytechnique)

Session Classification: WG6

Track Classification: WG6 - Theory and simulations

Contribution ID: **21** Type: **poster**

Collisional effects on solid density heavy ion laser-plasma targets

Monday, September 16, 2019 7:00 PM (1 hour)

The interaction of both linearly and circularly polarized laser pulses with high-Z solid targets is investigated through PIC simulations, using the SMILEI particle-in-cell code that features a thoroughly benchmarked relativistic collisional module. Even though circular polarization (CP) mitigates collisionless hot-electron acceleration processes compared with linear polarization, inverse bremsstrahlung leads to a significant hot electron tail in the 100 keV energy range, whose subsequent relaxation causes bulk electron heating up to 10s of keV temperatures. The main difference between CP and LP, is that LP produces a relativistic electron population which thermalizes weakly during the time scales studied, whereas CP gives a close approximate Maxwellian electron population.

Primary authors: SUNDSTRÖM, Andréas (Chalmers University of Technology); SIMINOS, Evangelos (Gothenburg University); Dr GREMILLET, Laurent (CEA, DAM); Dr PUSZTAI, István (Chalmers University of Technology)

Presenter: SUNDSTRÖM, Andréas (Chalmers University of Technology)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG2 - Ion beams from plasmas

Contribution ID: **22** Type: **poster**

High level software for beam phase space and trajectory characterization

Monday, September 16, 2019 7:00 PM (1 hour)

Operation of modern particle accelerators require high brightness beam and sensitive diagnostic system in order to monitories and characterize the beam during the acceleration and transport.
A turn-key high level software has been designed to fully characterise the 6D beam phase space and the trajectory in order to help operator during commissioning with an easily scalable suite for any high brightness LINAC. In this work will be presented BOLINA (Beam Orbit for LINear Accelerators) the high level software designed for the ELI-NP Gamma Beam System (GBS) providing tuneable gamma rays with narrow bandwidth (0.3%) and a high spectral density (104 photons/sec/eV) by the Compton backscattering effect. BOLINA architecture is designed machine independent and usable for any type of LINAC and is consistent with any type of control system, thanks to the interpreted and object oriented Python code.
Currently BOLINA suite interfaced with EPICS control system, manages automatically accelerator devices to allow electron beam diagnostic measurements. The diagnostic tool is part of BOLINA (Beam Orbit for LINAC Accelerators) suite that provides the simultaneous optimization of trajectory and dispersion granting the beam trajectory which reduces the emittance dilution trough the accelerator to reach accelerator's nominal parameters needed to maximize the beam luminosity.

Primary author: MARTINELLI, Valentina (INFN / LNF)

Co-authors: FERRARIO, Massimo (LNF); VACCAREZZA, Cristina (LNF); PIOLI, Stefano (LNF); GIRIBONO, Anna (LNF); ALESINI, David (LNF); BACCI, Alberto Luigi (MI); VARIOLA, Alessandro (LNF)

Presenter: MARTINELLI, Valentina (INFN / LNF)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **23** Type: **poster**

Simulations of a wakefield dissipation in a radially bounded plasma

Monday, September 16, 2019 7:00 PM (1 hour)

In modern experiments on plasma wakefield acceleration, relativistic electron bunches (or laser pulses) excite plasma wakes with energy density comparable to the rest energy density of plasma electrons. Breaking of such wake in a radially bounded plasma is followed by its energy redistribution between hot electrons, electric fields and radial ion motion and leads to plasma column expansion via ionization of surrounding gas. This relaxation dynamics determines repetition rate of plasma accelerators. Recent E224 experiments at the SLAC FACET provided ps-time-resolved optical shadowgraphic measurements of plasma density profiles after the passage of drive electron bunch. Results demonstrate growth of the plasma column radius with a nearly constant velocity from ~100 μm to ~2 mm over 1.5 ns.
This work presents results of numerical simulations of long-term plasma column evolution in this experiment. It is shown that a fraction of electrons expelled by the bunch from plasma column propels radial ion motion. Ions at the front of expansion wave create seed plasma through ion-impact ionization. Appearance of slow electrons at given location leads to subsequent exponential plasma density growth due to electron-impact multistage ionization. Quantitative agreement with the experimental data is achieved via simultaneous consideration of all the described microscopic effects.

Primary authors: KHUDYAKOV, Vadim; LOTOV, Konstantin (Novosibirsk State University); SOSEDKIN, Alexander (Novosibirsk State University)

Co-authors: ZGADZAJ, Rafal (University of Texas at Austin); DOWNER, Michael (The University of Texas at Austin); SILVA, Thales (GoLP/Instituto Superior Técnico (Lisbon)); VIEIRA, Jorge (Instituto Superior Tecnico); GESSNER, Spencer (CERN); HOGAN, Mark (SLAC National Accelerator Laboratory); LITOS, Michael (University of Colorado Boulder); YAKIMENKO, Vitaly (SLAC)

Presenter: LOTOV, Konstantin (Novosibirsk State University)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG6 - Theory and simulations

Contribution ID: **24** Type: **talk**

Efficient 3D envelope modelisation for two-stage laser wakefield acceleration experiments

Monday, September 16, 2019 6:40 PM (20 minutes)

Three dimensional Particle in Cell simulations of Laser Wakefield Acceleration require a considerable amount of resources but are necessary to have realistic predictions and to design future experiments. The planned experiments for the CILEX facility also include two stages of plasma acceleration, for a total plasma length of the order of centimiters. In this context, where traditional 3D simulations would be infeasible, we present the results of the application of a recently developed explicit 3D envelope method [1]. This model describes the laser pulse ant its self-consistent interaction with the plasma without the need to resolve its high frequency oscillations, considerably reducing the computation time. The implementation of this envelope model in the code Smilei will be described, as well as the results of benchmark simulations against standard simulations and its applications for the design of two stage CILEX experiments.
[1] D. Terzani and P. Londrillo, A fast and accurate numerical implementation of the envelope model for laser–plasma dynamics, Computer Physics Communications (2019), https://doi.org/10.1016/j.cpc.2019.04.007

Primary authors: MASSIMO, Francesco (LLR - CNRS); BECK, Arnaud (Laboratoire Leprince Ringuet); Mr DEROUILLAT, Julien (Maison de la Simulation); Dr LOBET, Mathieu (Maison de la Simulation); ZEMZEMI, imene; Dr GRECH, Mickael (LULI); Dr PÉREZ, Frédéric (LULI); SPECKA, Arnd (LLR - Ecole Polytechnique - CNRS/IN2P3)

Presenter: MASSIMO, Francesco (LLR - CNRS)

Session Classification: WG6

Track Classification: WG6 - Theory and simulations

Contribution ID: **25** Type: **talk**

Optical probing of pre-plasma dynamics for laser ion acceleration

Wednesday, September 18, 2019 4:00 PM (20 minutes)

Pre-plasma dynamics on the front side of a target foil in a laser-ion-acceleration process like Target-Normal-Sheath-Acceleration (TNSA) substantially influences the dynamics of the actual Debye-sheath formation and therefore eventually ion yield or ion energies. Acceleration dynamics on sub-picosecond timescales in the laser field are extremely challenging to probe experimentally. Therefore, Particle-In-Cell (PIC) simulations are used to investigate underlying processes, with accurate pre-plasma conditions being a necessary input for a realistic simulation. We realized an optical pre-plasma probing setup based on the well-known interferometric phase-measurement method to extensively study pre-plasma conditions and compare these results to the 1D hydrodynamics code MULTI-fs. Our setup produces laser-induced plasma from a $4 \cdot 10^{15}\,\mathrm{Wcm}^{-2}$ pump-laser with properties otherwise similar to the petawatt-class POLARIS laser main beam and can be operated with pulse repetition rates of $1\,\mathrm{Hz}$. The probe pulse of $130\,\mathrm{fs}$ duration can probe the plasma conditions starting at $20\,\mathrm{ps}$ up to $2\,\mathrm{ns}$ after the interaction. In a first experiment, we varied key parameters including angle of incidence, pump polarization and pump intensity. Our results show a wide range of influences to plasma formation and shape and allow the investigation of a simple model bringing MULTI-fs simulation and experiment to very good agreement.

Primary author: MÄUSEZAHL, Max (Friedrich-Schiller-University Jena, Institute for Optics and Quantum Electronics)

Co-authors: Dr KEPPLER, Sebastian (Helmholtz-Institute Jena); Mr TAMER, Issa (Helmholtz-Institute Jena); Dr HORNUNG, Marco (Helmholtz-Institute Jena); Mr BECKER, Georg Alexander (Friedrich-Schiller-University Jena, Institute for Optics and Quantum Electronics); Prof. KALUZA, Malte (Friedrich-Schiller-University Jena, Helmholtz-Institute Jena)

Presenter: MÄUSEZAHL, Max (Friedrich-Schiller-University Jena, Institute for Optics and Quantum Electronics)

Session Classification: WG2 - WG5 (Joint Session)

Track Classification: WG2-WG5 Joint Session

Contribution ID: **26** Type: **poster**

Optimization of the Arc Compressor performance in the MariX Free Electron Laser

Wednesday, September 18, 2019 7:00 PM (1 hour)

The MariX FEL is a compact GeV-class X-ray source exploiting a two-pass 2-way acceleration in a Super-Conducting linac operated in continuous wave mode. A key component of this peculiar machine layout is the Arc Compressor (AC), a 300 m long beamline consisting of 14 "Double Bend Achromat" cells and a bidirectional quadrupole focusing channel, which allows the beam to be u-turned while it is being compressed to greatly increase its brightness and peak current.
In this contribution we present the performance of the AC of MariX and the solutions we adopted to solve the main issues that the beam dynamics encounters in a line of this kind.
We show the beam dynamics in the AC matching line which is designed to operate on beams propagating in both directions, considering the anti-symmetric quadrupole focusing behavior.
We study the Coherent Synchrotron Radiation (CSR) emission in the AC showing a scheme that preserves the low emittance granting also a linear compression in presence of strong CSR effects.
Lastly, we present a strategy to correct the residual dispersion-based beam tilt that is introduced by the CSR kick and would otherwise spoil the FEL emission. Further, the projected emittance is minimized cancelling the dispersive contribution.

Primary authors: ROSSETTI CONTI, Marcello (INFN Milano); ROSSI, Andrea Renato (MI); BACCI, Alberto Luigi (MI); PETRILLO, Vittoria (Università degli Studi di Milano); SERAFINI, Luca (MI)

Presenter: ROSSETTI CONTI, Marcello (INFN Milano)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **27** Type: **talk**

Laser-PIXE using laser-accelerated proton beams

Monday, September 16, 2019 5:00 PM (20 minutes)

Laser-driven proton acceleration is a field of growing interest, in particular for its numerous applications, including in the field of materials science. A benefit of these laser-based particle sources is their potential for a relative compactness in addition to some characteristics at the source that differ from those of conventional, radio-frequency based proton sources. These features include, e.g., a higher brilliance, a shorter duration, and a larger energy spread. Recently, the use of laser-accelerated protons has been proposed in the field of Cultural Heritage, as alternative source for the Particle Induced X-ray Emission diagnostic ("laser-PIXE"), a particular ion beam analysis (IBA) technique that allows to precisely analyse the chemical composition of the material bulk. Experimental feasibility of laser-PIXE has been proven recently in a proof-of-principle experiment on a few materials, but some benefits of laser-driven proton characteristics are still unknown (larger energy-spread, higher flux, etc). Using Geant4 simulations and focusing on materials specifically of interest for the Cultural Heritage here we show that the laser-PIXE allows analysing a larger volume than conventional PIXE, profiting from the large energy spread of laser-accelerated protons. Furthermore, the large energy spread allows investigating multilayer materials, providing an advantage compared to conventional PIXE technologies.

Primary authors: Prof. BARBERIO, Marianna (INRS); ANTICI, Patrizio (INRS)

Presenter: ANTICI, Patrizio (INRS)

Session Classification: WG4

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **28** Type: **poster**

REGAE Beamline Upgrade

Monday, September 16, 2019 7:00 PM (1 hour)

The Relativistic Electron Gun for Atomic Exploration (REGAE) is a small accelerator located at DESY in Hamburg. The machine was designed and built to provide ultra-short electron bunches on the order of 10 fs, used as probe pulses for time-resolved electron diffraction experiments. Recently, REGAE has been upgraded and connected to the ANGUS high-power laser system. With this new configuration, additional experiments can be carried out at the accelerator. In particular, the setup now allows for external injection of electron bunches provided by REGAE into laser-driven plasma wakefields, driven by the ANGUS laser system. Also, due to new and improved diagnostics, studies of the longitudinal beam dynamics of the bunches created by the REGAE gun can be performed, aiming for an improved bunch compression.
An overview of the upgrade and the new capabilities of the machine will be given.

Primary author: ZEITLER, Benno (CFEL and University of Hamburg)

Presenter: ZEITLER, Benno (CFEL and University of Hamburg)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **29** Type: **poster**

Study of the Seeded Self-Modulation Growth in the AWAKE Experiment

Monday, September 16, 2019 7:00 PM (1 hour)

The Advanced Wakefield Experiment AWAKE develops the first plasma wakefield accelerator with a high-energy proton bunch as driver [1]. The 400 GeV bunch from CERN SPS propagates through a 10 m long rubidium plasma, ionized by a 4 TW laser pulse co-propagating with the proton bunch. The relativistic ionization front seeds a self-modulation process. The seeded self-modulation (SSM) transforms the bunch into a train of bunchlets resonantly driving wakefields [2,3]. Electrons are externally injected into, and accelerated by the wakefields [4].
We investigate the growth of the modulation and of the transverse wakefields amplitude near the ionization front. We measure the density modulation of the bunch, in time, with a streak camera with picosecond resolution. The observed effect corresponds to alternating focusing and defocusing fields. We attempt to measure the growth of the modulation along the bunch, the modulation depth and the charge in each bunchlet. This is important to understand the beam/plasma interaction as well as for the acceleration experiments. The latest experimental and analysis results will be presented.

Primary authors: BACHMANN, Anna-Maria (CERN); MUGGLI, Patric (Max-Planck-Institut für Physik); AWAKE COLLABORATION

Presenter: BACHMANN, Anna-Maria (CERN)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **33** Type: **talk**

Polarized Beams from Laser-Plasma Accelerators

Wednesday, September 18, 2019 6:00 PM (20 minutes)

The generation of polarized particle beams still relies on conventional particle accelerators, which are typically very large in scale and budget. Concepts based on laser-driven wake-field acceleration have strongly been promoted during the last decades. Despite many advances in the understanding of fundamental physical phenomena, one largely unexplored issue is how the particle spins are influenced by the huge magnetic fields of the plasmas and, thus, how highly polarized beams can be produced. The realization of laser-plasma based accelerators for polarized beams is now being pursued as a joint effort of groups from Forschungszentrum Jülich (Germany), University of Crete (Greece), and SIOM Shanghai (China) within the ATHENA consortium. As a first step, we have theoretically investigated and identified the mechanisms that influence the beam polarization in laser-plasma accelerators. We then carried out a set of Particle-in-cell simulations on the acceleration of electrons and proton beams from gaseous and foil targets. We could show that intense polarized beams may be produced if pre-polarized targets of high density are employed. Such polarized sources for electrons, protons, deuterons and 3He ions are now being built in Jülich. Proof-of-principle measurements at the (multi-)PW laser facilities PHELIX (GSI Darmstadt) and SULF (Shanghai) are in preparation.

Primary authors: LEHRACH, Andreas (Forschungszentrum Jülich / IKP-4 and RWTH Aachen University); Prof. BÜSCHER, Markus (Forschungszentrum Jülich / PGI-6 and Heinrich-Heine-Universität Düsseldorf); Ms HÜTZEN, Anna (Forschungszentrum Jülich / PGI-6); Dr ENGELS, Ralf (Forschungszentrum Jülich / IKP-4); Mr KANNIS, Chrysovalantis (Forschungszentrum Jülich / IKP-4); Dr THOMAS, Johannes (Institut für Theoretische Physik I, Heinrich-Heine-Universität Düsseldorf); Prof. JI, Liangliang (CAS Center for Excellence in Ultra-intense Laser Science); Prof. RAKITSIS, T. Peter (Foundation for Research and Technology - Hellas (FORTH) and University of Crete)

Presenter: LEHRACH, Andreas (Forschungszentrum Jülich / IKP-4 and RWTH Aachen University)

Session Classification: WG2

Track Classification: WG2 - Ion beams from plasmas

Contribution ID: **34** Type: **poster**

Installation and infrastructure for big PWA facilities: what we learnt from AWAKE Run 1 and challenges for AWAKE Run 2.

Monday, September 16, 2019 7:00 PM (1 hour)

The design, installation and operation of AWAKE (run1) infrastructure and equipment took place from 2013 until 2019. This was the first PWA facility of this large scale, which influences many choices regarding infrastructure and design. Lessons learnt from designing, installing and running the AWAKE facility's infrastructure are shown, and are extrapolated to show how they could be implemented for the AWAKE run2.

Primary authors: PARDONS, Ans (CERN); AWAKE COLLABORATION

Presenter: PARDONS, Ans (CERN)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG8 - Advanced and novel accelerators for High Energy Physics

Contribution ID: **35** Type: **talk**

Broadband, high-flux x-ray source from a hybrid laser plasma accelerator driven by picosecond lasers

Wednesday, September 18, 2019 5:00 PM (20 minutes)

A broadband (keV to MeV), high flux (1e12 photons/keV/sr) x-ray source from a hybrid laser plasma accelerator driven by picosecond lasers is characterized. The hybrid laser plasma accelerator uses self-modulated laser wakefield acceleration combined with direct laser acceleration to generate low divergence (<100 mrad), relativistic electron beams. These electrons are then used to produce broadband x-rays through a combination of three mechanisms: betatron, inverse Compton scattering, and/or bremsstrahlung. This x-ray source is used to radiograph static and dynamic objects and can be tuned to provide better contrast depending on the target being radiographed. This source has uses for many single shot experiments in high energy density science and laboratory astrophysics.

Primary authors: KING, Paul; CANDEIAS LEMOS, Nuno (Lawrence Livermore National Laboratory)

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Presenter: KING, Paul

Session Classification: WG4 - Thomson

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **36** Type: **poster**

High Charge Electron Beams Generated with a Hybrid Laser Plasma Accelerator Driven by Picosecond, Kilojoule class lasers

Monday, September 16, 2019 7:00 PM (1 hour)

A hybrid laser plasma accelerator (HLPA) has been developed to produce low divergence (<100 mrad), high charge (>60 nC) electron beams with energies greater than 150 MeV. The HLPA, driven by ps, kJ class lasers, uses an interplay between self-modulated laser wakefield acceleration and direct laser acceleration to trap and accelerate electrons through up to 10 mm of plasma. The resulting electron beams are used to generate x-rays capable of probing the dense, short lived materials common in high energy density and laboratory astrophysics experiments.

Primary author: KING, Paul

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Presenter: KING, Paul

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **37** Type: **talk**

Electron acceleration in beam-loaded and beam-dominated laser wakefields

Tuesday, September 17, 2019 4:20 PM (20 minutes)

We report on the generation of quasi-monochromatic electron beams with up to 1.2 nC beam charge, 18 pC/MeV spectral charge density and less than 1 mrad rms divergence using shock-front injection in a 100-TW-class laser wakefield accelerator. Due to the high charge density, beam loading clearly affects both the final energy and the spectral shape of the beams themselves. We explain these effects using quasi-3D particle-in-cell simulations and provide estimates for the longitudinal phase-space distribution in the weakly and strongly loaded cases. Additionally, we measure the influence of beam-loading on witness bunches, which are created via a colliding pulse injection or a modification of the shock-front. In a last experiment, we send the electron beams into a second gas target. We observe that the energy gain of the witness in this stage is dependent on the first beam's charge, which demonstrates plasma wakefield acceleration in a driver-witness configuration.

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Presenter: DÖPP, Andreas (LMU Munich)

Session Classification: WG1 - Plasma acceleration physics I

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **38** Type: **poster**

Wakefield Excitation in a Metallic-Density Electron Plasma by X-ray Laser Pulses

Monday, September 16, 2019 7:00 PM (1 hour)

Using newly available compact laser technology [1] one can produce 100 PW-class laser pulses with a single-cycle duration on the femtosecond timescale. With a fs intense laser one can produce a coherent X-ray pulse that is also compressed, well into the hard X-ray regime. Prof. T.Tajima suggested [2, 3] utilizing these coherent X-rays to drive the acceleration of particles. Such X-rays are focusable far beyond the diffraction limit of the original laser wavelength and when injected into a crystal it interacts with a metallic-density electron plasma ideally suited for laser wakefield acceleration [2, 3]. Also in [4-11] it has shown that at certain conditions in blowout regime (see [12-16]) the laser wakefield acceleration by plasma wakefield with time is replaced by a combined joint LPWA acceleration and selfinjected-beam-plasma wakefield acceleration. In this paper X-ray laser wakefield acceleration in a plasma of metallic density, the maximum accelerating gradient (approximately 10TV/m) in such a new medium, the transition to the regime of joint X-ray laser wakefield acceleration and selfinjected-beam-plasma wakefield acceleration are investigated by numerical simulation by code UMKA [17].

Primary authors: BONDAR, Denys (Karazin Kharkiv National University); Prof. MASLOV, Vasyl (NSC Kharkov Institute of Physics & Technology); Mrs LEVCHUK, Irina (NSC Kharkov Institute of Physics & Technology); Dr ONISHCHENKO, Ivan (NSC Kharkov Institute of Physics & Technology)

Presenter: BONDAR, Denys (Karazin Kharkiv National University)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **39** Type: **talk**

Homogeneous and Identical Focusing of Train of Relativistic Positron Bunches in Plasma

Tuesday, September 17, 2019 6:00 PM (20 minutes)

Focusing of electron and positron beams in collider is important [1-7]. The focusing mechanism in the plasma, in which all electron bunches are focused identically, has been proposed [5-7]. This lens is researched by simulation by lcode [8] in this paper for short positron bunches. It is shown that there are two lenses. It is necessary that in one case the length of 1st bunch should be equal to half of wavelength $L_{b1} = /2$, all other bunches are short, $L_b < /2$, the charge density of all other bunches is in two times larger than of 1st. The intervals between bunches should be $L = p, p = 1, 2, ...$ Focusing field is the same along the bunch $F_r = const$ in areas of bunches.
In the second case it is necessary that the charges of all bunches are in $(2)^{1/2}$ times larger than of 1st bunch. The interval between 1-st and 2-nd bunches equals to $(n + 1/8)$, $n = 1, 2, ...$ The interval between the other bunches is multiple to wavelength. It is shown that only 1st bunch is in the finite $Ez\ 0$. Other bunches are in zero longitudinal wakefield $Ez = 0$. Focusing force Fr is the same along the bunches.

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Presenter: BONDAR, Denys (Karazin Kharkiv National University)

Session Classification: WG8 - Positrons

Track Classification: WG8 - Advanced and novel accelerators for High Energy Physics

Contribution ID: **40** Type: **poster**

Transformer Ratio at Wakefield Excitation in Dielectric Resonator Electron-Positron Collider by Train of Electron Bunches with Linear Growth of Current

Wednesday, September 18, 2019 7:00 PM (1 hour)

The efficiency of electron bunch acceleration by wakefield, excited in two-beam electron-positron dielectric resonator collider by train of electron bunches is determined by transformer ratio [1-14]. Two trains are considered. First is train of homogeneous bunches, current grows linearly along a train. Current of the second train grows linearly along each bunch and train. The length of homogeneous bunch equals to half of wavelength λ/2. In 2nd case a short bunch-precursor of arbitrary shape and length with certain parameters is injected before the train. Interval between bunches is pλ, p=1, 2,… The conditions is formulated, when the wakefield pulses from all bunches are added. Bunch is injected, when the back wavefront of pulse is on the injection boundary. Bunch leaves the resonator, when the first wavefront of pulse is on the end of the resonator. The conditions for a large TR have been formulated. The wakefield and TR have been derived after N bunch. The computer simulation has been performed with dispersion spreading and transition radiations [15]. The dependence TR=2N (=2πN) is performed.
Advantage with large TR (resonant excitation for positron witness) that witness is injected, when back wavefront of pulse and maximum accelerating field is on the injection boundary.

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Presenter: BONDAR, Denys (Karazin Kharkiv National University)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG6 - Theory and simulations

Contribution ID: **41** Type: **poster**

Optimal Wakefield Excitation in Plasma by Non-resonant Train of Relativistic Electron Bunches

Monday, September 16, 2019 7:00 PM (1 hour)

Resonant wakefield excitation in two-beam electron-positron collider by a long train of relativistic electron bunches is difficult because it is difficult to support homogeneous and stationary plasma in experiment. In [1-5] the mechanism has been found of resonant plasma wakefield excitation by a nonresonant train of short electron bunches. The frequency synchronization results by defocusing of some bunches. In this material results are presented on 2.5D numeral simulation by 2d3v code LCODE [6] of resonant asymptote of wakefield excitation in plasma by nonresonant train of relativistic electron bunches. Under resonant asymptote we mean the excitation of the wakefield with the maximum growth rate, when the nonresonant train has already self-cleaned so that the interaction of the excited wakefield with the bunch electrons in the acceleration phases is negligible. Then the wakefield grows with steps. Optimum parameters are investigated at which the amplitude of the excited wakefield in the regime of resonant asymptote is the largest.

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Presenter: BONDAR, Denys (Karazin Kharkiv National University)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG6 - Theory and simulations

Contribution ID: **42** Type: **talk**

First Dielectric Wakefield Experiments at Daresbury Laboratory

Wednesday, September 18, 2019 4:20 PM (20 minutes)

First dielectric wakefield acceleration (DWA) experiments have been conducted on CLARA/VELA test facility at Daresbury Laboratory, UK. The DWA structure was of planar geometry with variable gap and dielectric thicknesses ranging from 0.025 to 0.2mm. The facility, in its current state, provided electron bunches with up to 100pC bunch charge, variable 0.2-2.0ps bunch lengths at the beam energy of 35MeV. All major wakefield effects have been demonstrated including energy modulation in longer bunches, energy dechirping, transverse streaking and focussing. With modest bunch charge of ~50pC, a decelerating field of ~8MV/m was measured. Using this variable gap planar structure, we have also demonstrated a continuously tunable narrowband THz generation (details will be given in a separate presentation). Summary of experimental results will be presented along with current status of the CLARA/VELA facility and its near future developments including implementation of the dielectric wakefield dechirper.

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Presenter: SAVELIEV, Yuri (STFC, Daresbury Lab., ASTeC)

Session Classification: WG3 - Dielectric Beam-driven Acceleration Thz acceleration

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **43** Type: **talk**

Coherent radiation studies for beam diagnostics and high-intensity THz sources at CLEAR

Thursday, September 19, 2019 4:40 PM (20 minutes)

We report on two years'studies of beam-based coherent radiation performed at the CLEAR facility of CERN.
Coherent Cherenkov-diffraction radiation has been exploited for the design of novel beam instrumentation both for beam position and bunch length monitoring.
With the aim to reach high-intensity THz generation in view of THz-acceleration experiments, different mechanisms have been explored and directly compared, as transition/diffraction radiation, Cherenkov-diffraction radiation and Smith-Purcell radiation.
The pros and cons of each radiation mechanism have been experimentally highlighted in terms of peak power, pulse duration, monochromaticity and collimation.
Finally, the importance of the Electromagnetic Shadowing affecting compact experimental setups of coherent radiation production has been extensively characterized, revealing different features of the same phenomenon.

Primary authors: CURCIO, Alessandro (CERN); Dr BERGAMASCHI, Michele (CERN); CORSINI, Roberto (CERN); GAMBA, Davide (CERN; John Adams Institute (JAI)); FARABOLINI, Wilfrid (CEA/IRFU and CERN); LEFEVRE, Thibaut (cern); Dr MAZZONI, Stefano (CERN)

Presenter: CURCIO, Alessandro (CERN)

Session Classification: WG5 - Diagnostics

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **45** Type: **talk**

A possible RF Design on the 35 GHz accelerating structure for the Compact Light XLS project.

Thursday, September 19, 2019 6:00 PM (20 minutes)

In the framework of the Compact Light XLS project, we have performed a possible RF design on the 35 GHz accelerating structure in order to linearize the longitudinal phase space. Detailed RF estimations and the wake-field effects on the beam dynamics are also reported. The numerical electromagnetic simulations have been carried out by using the code HFSS in the frequency domain and CST Microwave Studio in time domain.

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Presenter: SPATARO, Bruno (LNF)

Session Classification: WG3 - High Gradient RF Technology

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **46** Type: **talk**

Initial Studies on a Compact High-Gradient Ka-Band Accelerating Structure for Medical and Industrial Applications.

Thursday, September 19, 2019 6:20 PM (20 minutes)

Technological advancements are strongly required to fulfil demands for new accelerators devices from the compact or portable devices for radiotherapy to mobile cargo inspections and security, biology, energy and environmental applications, and ultimately for the next generation of colliders. New manufacturing techniques for hard-copper structures are being investigated in order to determine the maximum sustainable gradients around 150 MV/m and extremely low probability of RF breakdown. In this paper, the initial studies on the RF and mechanical design for a compact Ka-Band accelerating structure are presented as well as preliminary beam dynamics estimations.

Primary authors: FAILLACE, Luigi (INFN MI / LNF); SPATARO, Bruno (LNF); VARIOLA, Alessandro (LNF); Dr DOLGASHEV, Valery (SLAC - Menlo Park USA)

Presenter: FAILLACE, Luigi (INFN MI / LNF)

Session Classification: WG3 - High Gradient RF Technology

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **47** Type: **poster**

Innovative Analytical calculation of the Group velocity in accelerating travelling wave structures.

Monday, September 16, 2019 7:00 PM (1 hour)

Ultra high-gradient accelerating structures are needed for the next generation of compact light sources. In the framework of the Compact Light XLS project, we are studying a high harmonic traveling-wave accelerating structure operating at a frequency of 35.982 GHz, in order to linearize the longitudinal space phase. In this paper, we propose a new analytical approach for the estimation of the group velocity in the structure and we compare it with numerical electromagnetic simulations that are carried out by using the code HFSS in the frequency domain.

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Presenter: BEHTOUEI, Mostafa (INFN - LNF)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **48** Type: **poster**

Innovative Clamping and Braze-Free Accelerating Structure.

Monday, September 16, 2019 7:00 PM (1 hour)

Recent high RF power experiments show that hard structures, fabricated without high-temperature processes, achieve a better high gradient performance in terms of accelerating gradients. Two three-cell standing-wave accelerating structures, designed to operate in the pi-mode at 11.424 GHz, have been successfully built and cold tested. In order to guarantee a vacuum envelope and mechanically robust assembly, we used the Electron Beam Welding (EBW) and the Tungsten Inert Gas (TIG) processes. We present an innovative and compact type of accelerating cavity that avoids any high-temperature processes like brazing or diffusion bonding. Temperature characterization on the cell features during the welding process is also discussed.

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Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **49** Type: **poster**

Initial Design of a High-Power Ka-Band Klystron

Wednesday, September 18, 2019 7:00 PM (1 hour)

High-gradient high-frequency accelerating structures are in strong demand for the next generation of compact light sources. Accelerating structures operating in Ka-Band are foreseen to achieve gradients around 150 MV/m. Among possible applications of a Ka-Band accelerating structure we refer to the beam phase-space manipulation for the Compact Light XLS project as well and medical and industrial applications. In this paper, a Ka-Band Klystron amplifier is being investigated in order to feed Ka-Band accelerating structures. The initial design is presented including the high-power DC gun and the beam focusing channel.

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Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **50** Type: **talk**

Stability analysis of Laser-Plasma accelerators using quasi-cylindrical PIC simulations

Monday, September 16, 2019 5:00 PM (20 minutes)

Particle-in-Cell (PIC) codes have proven to be a vital tool for studying the physics of plasma based accelerators. However, the enormous cost of a single full 3D simulation limits their applicability for extensive stability or parameter studies. Further, numerical errors from commonly used finite difference solvers can cause unphysical results. The quasi-cylindrical, pseudo-spectral code FBPIC overcomes these limitations and allows insights beyond that of the few simulations often affordable with standard 3D codes. We will show that the resolution required for accurate results of typical LWFA problems can be much higher than what is commonly used and how the consideration of temperature effects in the plasma can improve the accuracy as well as the performance of the simulation.
As an example on how FBPIC allows insight into a new kind of problem, we will present a tolerance study of a laser plasma accelerator against laser driver fluctuations based on hundreds of accurate PIC simulations.

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Session Classification: WG6

Track Classification: WG6 - Theory and simulations

Contribution ID: **51** Type: **talk**

Dose controlled irradiation experiments with laser-accelerated protons at Draco Petawatt

Monday, September 16, 2019 6:40 PM (20 minutes)

We performed experiments with the Petawatt beam of the Dresden laser acceleration source Draco to investigate the feasibility of controlled volumetric tumour irradiations with laser-accelerated protons. Therefore, a beamline of two pulsed solenoid magnets was implemented to efficiently capture and shape the beam, which was then analysed by a comprehensive suite of detectors (ionization chamber, scintillator, radiochromic film, etc.).
We present studies how to manipulate and match lateral and depth dose profiles to the desired application and target. These were assisted by benchmark experiments at a conventional accelerator to further characterize the ion-optical properties of the solenoids and to investigate potential distortions of the transported proton beam.
With the characterized beamline first proof-of-principle irradiation studies of volumetric normal and tumour tissue samples have been performed successfully. To advance to full scale irradiation experiments, a higher mean dose rate is necessary to deliver high absolute dose values via multiple bunches (dose control) in short times (~min). Current limitations are the low repetition rate of the beamline and its long cooldown times. Therefore, we developed a novel, actively cooled pulsed solenoid, to be implemented in the beamline, enabling complex irradiation studies with high repetition rates and consequently high mean dose rates.

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Session Classification: WG2-WG4 Joint Session

Track Classification: WG2-WG4 Joint Session

Contribution ID: **54** Type: **talk**

Narrow energy spread electron beams from controlled injection

Wednesday, September 18, 2019 6:20 PM (20 minutes)

The demonstration of a free-electron laser presents one of today's main challenges in the field of plasma acceleration. Driving the FEL process with laser-plasma accelerated electron beams requires low transverse emittances and high spectral charge densities. Here we present our recent progress on the generation of high-quality electron beams at the LUX beamline. Few-percent relative energy spread beams at several hundred MeV with tens of pC charge are produced from controlled injection in tailored plasma targets. The impact of laser and target parameter variations on the injection and acceleration dynamics are discussed and validated by Particle-In-Cell simulations with FBPIC.

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Presenter: KIRCHEN, Manuel (University of Hamburg)

Session Classification: WG1 - Injection control

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **55** Type: **talk**

A spectral, quasi-3D, multi-GPU Particle-In-Cell code for plasma accelerators

Monday, September 16, 2019 4:40 PM (20 minutes)

Modelling the complex dynamics in plasma accelerators requires computationally demanding Particle-In-Cell codes. These codes self-consistently solve the electromagnetic particle interaction inside the plasma. We present the latest features of FBPIC - a highly efficient, multi-GPU Particle-In-Cell code. It features a quasi-3D geometry that greatly reduces the computational costs, a spectral electromagnetic solver that eliminates numerical instabilities common to traditional field solvers and the Lorentz-boosted frame technique that allows to scale down the required simulation time by orders of magnitude.

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Presenter: KIRCHEN, Manuel (University of Hamburg)

Session Classification: WG6

Track Classification: WG6 - Theory and simulations

Contribution ID: **56** Type: **poster**

Beam quality optimization in a beam loaded nanocoulomb-class laser wakefield accelerator

Monday, September 16, 2019 7:00 PM (1 hour)

Here we report on beam quality optimization in a stable and robust nanocoulomb-class laser wakefield accelerator. The self-truncated ionization injection scheme enables precise control over the amount of injected charges up to 0.5 nC (FWHM) at a quasi-monoenergetic peak. Stable operation of the accelerator is achieved, enabling us to study key parameters in statistical data-sets. Employing the optimal beam loading condition, the accelerating gradient is flattened and we eliminate additional energy spread contribution from the acceleration process[1,2]. Simultaneously minimizing beam divergence by limiting betatron coupling, high quality beams with peak currents of over ten kA are reached. Together with the accelerator's tunability and stable operation this paves the road for driving superradiant lights sources and enables the first proof-of-principle experiments exploiting the unique beam properties found in these compact accelerators.

1. J.P. Couperus, et.al., "Demonstration of a beam loaded nanocoulomb-class laser wakefield accelerator", Nature Communication, 8, 487 (2017)
2. A. Irman et al., "Improved performance of laser wakefield acceleration by tailored self-truncation ionization injection", Plasma Physics and Controlled Fusion, 60, 044015 (2018)

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Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **58** Type: **talk**

Development of Dielectric Disk Accelerators for Argonne 500MeV Short Pulse Two Beam Wakefield Accelerator Demonstrator

Monday, September 16, 2019 6:40 PM (20 minutes)

In order to validate the dielectric-based short-pulse wakefield Two Beam Accelerator concept on a relatively large scale without a significant budget increase, the High Energy Physics Division of Argonne National Laboratory plans to demonstrate a ~500-MeV module in the current Argonne Wakefield Accelerator facility within the next 5 years. A new high shunt impedance dielectric wakefield accelerator is the key element for this experiment. In the last two decades, the theoretical and experimental investigations of dielectric accelerating structures for application to wakefield acceleration have predominantly used a dielectric-lined waveguide, due to its simple geometry (i.e. low fabrication cost). However, in comparison with the prevailing metallic disk-loaded accelerators, the dielectric-lined waveguide suffers from a lower Q-factor and lower shunt impedance. Starting from 2019, we plan to develop a new dielectric-disk loaded accelerator (DDLA). The preliminary simulation shows that, even with 5e-4 of loss tangent dielectric material (eps=50), we can achieve ~200Mohm/m shunt impedance at 26GHz traveling wave operation (the beam aperture keep the same in the comparison), which is 4 times higher than those of the conventional dielectric loaded accelerator. This will meet the requirements of the proposed 500MeV demonstrator. We will report on the progress on this project.

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Presenter: KANAREYKIN, Alexei (Euclid Techlabs LLC/ANL)

Session Classification: WG3 - Dielectric Acceleration

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **59** Type: **poster**

Development of the millimeter wavelength accelerating structure

Monday, September 16, 2019 7:00 PM (1 hour)

We present the work on development of the millimeter wavelength accelerating structure. It consists of cylindrical cavities with the operating frequency of 96 GHz. The structure will be excited by the picosecond electron beam from the photocathode RF gun. In order to define exact both structure and exciting beam parameters, analytical estimations and simulations of the structure excitation were performed. We also studied in detail transverse dynamics of the exciting beam being of great importance because of the small structure inner aperture. For the successful propagation of the exciting beam through it, focusing system is needed, with its preliminary design being discussed. Prototype of the millimeter wavelength structure has been manufactured, its measurements are presented.

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Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **60** Type: **talk**

X-Ray Fluorescence Imaging with a Laser-Wakefield Thomson X-Ray Source

Wednesday, September 18, 2019 4:20 PM (20 minutes)

X-Ray fluorescence imaging (XFI) is a promising, new imaging method for in vivo localisation of low amounts of functionalised gold- nanoparticles (GNPs), enabling early cancer diagnostics and pharma- cokinetic tracking studies. At the moment, XFI is not applicable for human-scales, since the modality suffers from an intrinsic background, mainly caused by multiple Compton scattering processes. However, this limitation can be overcome by the use of highly brilliant X-Rays combined with advanced filtering schemes. Recent developments in high power laser technology offer the potential to develop very compact X-Ray sources by combining laser-wakefield acceleration and Thomson scattering. Such a source is capable of providing high flux X-Ray beams in the desired energy range around 100 keV, an energy that is high enough to penetrate through the body and is absorbed by GNPs. Further advantages are the tunability and the all-optical realisation of the source, making it compact enough to transfer XFI into clinical practice. To measure the outcoming X-Rays, detectors with high effiency and energy resolution at the desired energies are needed, ideally pixelated, spectroscopic devices, that have been tested beforehand. First results of a proof of principle experiment, based on theoretical and simulation work, are presented.

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Session Classification: WG4 - Thomson

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **61** Type: **poster**

THz-driven short period undulators

Monday, September 16, 2019 7:00 PM (1 hour)

In a variety of electron accelerator based light sources relativistic electron bunches propagate through an undulator and emit intense narrow band radiation. Here, we propose new types of short period undulators, which are based on the alternating electromagnetic field pattern of THz-driven surface plasmon polaritons in sub-wavelength structures. Analytic undulator models are derived and numerical simulations are performed for the undulator fields, the generated wake fields and the emitted radiation. Different undulator structures based on graphene and based on metallic split ring resonators are considered. For a moderate electron beam energy of 100 MeV a 40 mm long undulator is shown to emit narrow band 1 keV X-ray pulses, and therefore has potential for a compact and low cost X-ray source.

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Presenter: ROHRBACH, David (University of Bern)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **62** Type: **talk**

Excitation of beam driven plasma waves in a hybrid L|PWFA

Monday, September 16, 2019 6:00 PM (20 minutes)

Recent progress in laser wakefield acceleration (LWFA) has demonstrated the generation of high peak current electron beams with improved shot to shot stability [1]. Using high-current electron beams from a LWFA as drivers of a beam-driven plasma wakefield accelerator (PWFA) has been proposed as a beam energy and brightness transformer [2], aiming to fulfill the demanding quality requirements for applications such as FELs. It has been demonstrated experimentalythat electron beams from LWFA can actually drive plasma wakefields by themselves [3]. In order to further study the generation of plasma waves in the PWFA stage a sub-10 fs probe pulse was deployed and installed at HZDR. We observed beam driven plasma waves at different plasma densities, showing the capability of the LWFA beam to drive plasma wakefields in the self-ionizing regime. Furthermore we observed a correlation between the driver beam charge and the shape of the plasma wave. This enables us to find an optimum parameter set towards the experimental demonstration of the hybrid LPWFA.

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Session Classification: WG1-WG5 Joint Session - Ultrafast Dynamics Metrology

Track Classification: WG1-WG5 Joint Session

Contribution ID: **64** Type: **poster**

Comparison of OSIRIS/LCODE/QV3D simulations with the measurements of the proton beam in AWAKE experiment

Monday, September 16, 2019 7:00 PM (1 hour)

AWAKE (the Advanced WAKefield Experiment at CERN) aimed to demonstrate the first controllable self-modulation of a long ultrarelativistic proton beam in plasma and acceleration of electrons in the wakefield from the resulting train of microbunches. The experiment fully completed these tasks in 2017 and 2018. Three main diagnostics: OTR, CTR screens and imaging stations measured longitudinal and transverse portraits of the proton beam after seeded self-modulation in 10 meter plasma cell, and an electron spectrometer registered accelerated electrons with energies up to ~2 GeV depending on the plasma density.
Now the AWAKE collaboration is focused on development of the 2nd stage of the experiment (AWAKE Run II) in order to demonstrate the acceleration to higher energies preserving the quality of the electron witness. One of the most important questions lying on the way to AWAKE Run II is the predictable power of codes used for simulations of the proton-driven wakefield accelerators. It can be examined only by comparing the simulations to experimental data. The results presented in this work show the benchmarking of OSIRIS, LCODE and QV3D codes with measurements of the proton beam taken with the main AWAKE diagnostics.

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Presenter: LOTOV, Konstantin (Novosibirsk State University)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **65** Type: **talk**

Minimizing betatron coupling of energy spread and divergence in laser-wakefield accelerated electrons

Tuesday, September 17, 2019 4:00 PM (20 minutes)

Matched beam loading in laser wakefield acceleration (LWFA) flattens the accelerating electric field along the bunch and leads to the minimization of energy spread at high bunch charges. By using the self-truncated ionization injection scheme for controlling the injected charge, we demonstrate that minimal energy spread coincides with a reduction of the normalized beam divergence. Betatron radiation spectroscopy simultaneously confirms a constant beam radius at the plasma exit. Together, the decrease in divergence can be attributed to the reduction of chromatic betatron decoherence. Thus, beam loading enables the highest longitudinal and transverse phase space densities by optimizing energy spread and normalized divergence.

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Session Classification: WG1 - Plasma acceleration physics I

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **66** Type: **talk**

Contrast Dependence of Laser-Driven Proton Acceleration

Thursday, September 19, 2019 4:00 PM (20 minutes)

Laser-driven proton acceleration to high kinetic energies has great potential for applications in e.g. time-resolved radiography or in high-dose radio-biology. To date, however, a strong discrepancy remains between theoretical predictions of the maximum proton energies (Eprot) and the experimental results. Furthermore, a tremendous progress in laser development did not lead to a dramatic improvement of Eprot, which suggests principally limiting physical processes that need to be investigated in detail. For this reason, we carried out an experimental study on the POLARIS laser facility of the Eprot-scaling with laser energy, which was varied by more than one order of magnitude and with different levels of temporal intensity contrast. The results show a clear increase of the scaling exponent with reduced pre-plasma scale lengths from a root-like up to a linear Eprot scaling, which occurs for a scale length of $L \leq 2\mu m$. This is most likely induced by laterally recirculating hot electrons enhancing the rear-surface electric field. Furthermore, we see a clear limitation of Eprot, whereby a further increase of the laser energy does not lead to a further increase of Eprot. This, we attribute to stopping of hot electrons inside the target due to the onset of two-stream-instabilities.

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Presenter: KEPPLER, Sebastian (Helmholtz-Institute Jena)

Session Classification: WG2

Track Classification: WG2 - Ion beams from plasmas

Contribution ID: **68** Type: **poster**

Self-Modulation and Micro-Bunching Phase Stability Studies in AWAKE

Monday, September 16, 2019 7:00 PM (1 hour)

In the AWAKE experiment, a train of micro-bunches resonantly drives high-gradient wakefields in which electrons have been accelerated up to 2 GeV. The micro-bunches result from the 400 GeV CERN SPS proton beam self-modulating in a pre-formed plasma through a self-modulation (SM) process. Initial transverse wakefields focus and defocus the bunch at the scale of the plasma wavelength. When not seeded, the proton bunch modulates with randomly distributed phases from event to event. For a stable electron acceleration, the SM process must happen in a controlled manner. AWAKE uses a sharp relativistic ionization front to seed this process, called seeded self-modulation. For the analysis of the measurements presented here, we use a streak camera and a reference signal indicating the time-of-arrival of the ionization front on the streak camera images. We show that when not seeded, the phases of the SM with respect to the ionization front varies over the full range of 2π (i.e, no phase stability from event to event), called self-modulation instability. We demonstrate that the seeded SM leads to stable phases varying over only a small fraction of 2π. We determine the transition point between seeded and unseeded self-modulation and the corresponding seed level.

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Presenter: MUGGLI, Patric (Max-Planck-Institut für Physik)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **69** Type: **talk**

Modeling and simulation of transverse wakefields in PWFA

Tuesday, September 17, 2019 6:20 PM (20 minutes)

A simplified model describing the PWFA transverse instability in the form of a wake function parameterized only with an effective cavity aperture radius a is benchmarked against QuickPIC simulations. This wake function implies a $1/a^4$ scaling of the transverse wakefields, which indicates transverse intra-beam wakefields typically several orders of magnitude higher than in conventional acceleration structures. The constraint on main beam charge and effiency imposed by such transverse wakefields is addressed using a simplified theoretical model and numerical simulations, and a mitigation method inspired by BNS damping is also assessed.

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Presenter: CHEN, Jian Bin Ben (CERN/University of Oslo)

Session Classification: WG6

Track Classification: WG6 - Theory and simulations

Contribution ID: **70** Type: **talk**

Experimental demonstration of a continuously tunable terahertz source based on a dielectric wakefield structure

Wednesday, September 18, 2019 4:40 PM (20 minutes)

A continuously tunable THz source driven by wakefields in a dielectric lined waveguide (DLW) has been experimentally demonstrated at the CLARA/VELA test facility at Daresbury Laboratory, UK. The source was tuned across the range 0.55 –0.95 THz with a bandwidth of <50 GHz. The DLW was a planar structure with 25 um quartz dielectric layers and an aperture variable from 0.15 mm to 1.1 mm. Summary of experimental results on tunability range, modes spectra, pulse THz energy and comparison with theoretical predictions are presented.

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Presenter: PACEY, Thomas (STFC, ASTeC)

Session Classification: WG3 - Dielectric Beam-driven Acceleration Thz acceleration

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **71** Type: **talk**

Off-harmonic optical probing of high intensity laser interaction with cryogenic hydrogen jet target

Wednesday, September 18, 2019 4:20 PM (20 minutes)

High-intensity short-pulse lasers in the Petawatt regime offer the possibility to study new compact accelerator schemes by utilizing high-density targets for the generation of energetic ion beams. The optimization of the acceleration process demands comprehensive exploration of the plasma dynamics involved, for example via optical probing. In particular, experiments using low density cryogenic hydrogen jet targets with μm-scale transverse size are well suited to deliver new results which can then be compared to predictive particle-in-cell simulations. However, strong plasma self-emission and conversion of the plasma's drive laser wavelength into its harmonics often masks the interaction region and complicates data analysis. Here, we present a stand-alone probe laser system operating at 1030 nm, far off the plasma's drive laser wavelength of 800 nm and its implementation into an experiment dedicated to laser-proton acceleration from the hydrogen jet target irradiated by the DRACO PW laser at Helmholtz-Zentrum Dresden –Rossendorf. We show that the plasma self-emission in the probe images is significantly suppressed and we are able to measure the pre-expansion of the target by the DRACO PW laser for intrinsic and for plasma mirror enhanced laser contrast. The influence of the plasma pre-expansion on the measured proton acceleration performance is presented.

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Session Classification: WG2 - WG5 (Joint Session)

Track Classification: WG2-WG5 Joint Session

Contribution ID: **72** Type: **talk**

Observation of sub-femtosecond structures in laser wakefield accelerated electron bunches

Monday, September 16, 2019 4:00 PM (20 minutes)

Laser wakefield accelerators (LWFA) feature unique electron bunch characteristics, namely micrometer beam size with duration ranging from a few fs to tens of fs. Precise knowledge of the longitudinal profile of such ultra-short electron bunches is essential for the design of future table-top x-ray light-sources.
Spectral measurements of broadband transition radiation from LWFA electron bunches passing through a metal foil are especially promising for non-destructively analyzing ultrashort longitudinal bunch characteristics with single-shot capability.
We present recent experimental results of different LWFA injection mechanisms, such as self-truncated ionization-injection and self-injection. By analyzing the transition radiation spectra and reconstructing electron bunch profiles including error analysis, we determine electron bunch profiles and peak currents of the respective injection regimes. In addition to bunch durations and peak currents, we discuss sub-fs beam micro-structures and systematic experimental scans of the nitrogen doping concentration for ionization-induced injection.

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Session Classification: WG1-WG5 Joint Session - Advanced Beam Metrology

Track Classification: WG1-WG5 Joint Session

Contribution ID: **73** Type: **poster**

Laser frequency matching with Electron energy for Thomson source

Monday, September 16, 2019 7:00 PM (1 hour)

The bandwidth of Thomson sources are determined, amongst others, by the bandwidth- and the length of the laser pulse and the energy spread of the electrons. Here we show that if the electron bunch's energy spread is correlated, that the emitted radiation's bandwidth can be decreased by chirping the laser pulse. The instantaneous laser frequency is given by
\begin{equation}
\frac{\partial \eta}{\partial \zeta} = \left(\frac{\langle \gamma \rangle}{\gamma(X)} \right)^2 (1 + \vec{a} \cdot \vec{a}) \frac{\omega_{l,0}}{c},
\end{equation}

where $\omega_{l,0}$ is the central laser frequency, c is the speed of light, $\zeta = \frac{\omega_{l,0}}{c}(ct - z)$ is the plane wave laser phase, X is the variable along which the energy spread is correlated, γ is the Lorentz factor and $\vec{a}$ is the normalized vector potential containing the field of the laser pulse. We have solved how to construct the interaction when the energy spread is in the transverse- $\gamma = \gamma(x)$ and in the longitudinal direction $\gamma = \gamma(z)$. For each geometry the spectrum of a monochromatic electron bunch can be retrieved.

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Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG6 - Theory and simulations

Contribution ID: **74** Type: **poster**

First Operational Experience and Magnetic Characterization of a Superconducting Transverse Gradient Undulator for the Compact Laser Wakefield Acceleration-Driven FELs

Monday, September 16, 2019 7:00 PM (1 hour)

The transverse gradient undulator (TGU) scheme is a viable option to compensate for the challenging properties of the LWFA electron beam, in terms of beam divergence and energy spread, to enable FELs amplification. At Karlsruhe Institute of Technology (KIT, Germany), a 40-period superconducting TGU has been designed and built. In this contribution, we report on the first test operation of this superconducting TGU in its own conduction-based cryostat, the quench tests performed in this configuration, first results of the two-dimensional Hall probe mapping of the TGU field. We give an outlook to the preparation of proof-of-principle experiments with this TGU at the SINBAD facility/DESY and at the LWFA-setup at the JETI Laser laboratory operated by the University of Jena, which are aiming to show the potential of applying the TGU scheme to LWFA-driven FELs.

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Presenter: DAMMINSEK, Kantaphon (Karlsruhe Institute of Technology)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **75** Type: **talk**

Observation of the Hosing Instability in AWAKE

Wednesday, September 18, 2019 4:20 PM (20 minutes)

The AWAKE Experiment at CERN relies on the Seeded Self-Modulation (SSM) process, which transversely modulates the charge density of the SPS proton bunch and turns it into a train of microbunches. While the SSM process is axi-symmetric, the hosing instability (HI) is non-axi-symmetric and can grow from bunch or plasma axial asymmetries. As the growth rates of the Self-Modulation Instability (SMI) and the HI are similar, the hosing growth starting from noise can overcome the SMI growth. In this case, the transverse centroid of the bunch slices starts wiggling around the beam axis, which drastically reduces the useful acceleration length for a plasma wakefield accelerator. Even though the HI is not a limitation for the AWAKE experiment as it mainly appears at much lower plasma densities than those useful for acceleration, a better understanding of the physical processes is desired. We will introduce the experimental conditions where Hosing is observed, show results on the bunch centroid modulation and its frequency and a comparison to PIC-simulations in OSIRIS.

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Co-author: AWAKE, Collaboration

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Session Classification: WG1 - PWFA experimental results

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **76** Type: **talk**

Gamma-ray radiation in beam-plasma interaction as a diagnostics for emittance growth in PWFA and for beam filamentation instabilities

Monday, September 16, 2019 4:20 PM (20 minutes)

Low-emittance ultra-relativistic electron beams delivered for next gener- ation of plasma wakefield acceleration (PWFA) experiments are expected to produce very high wakefields over very large distances when going through a plasma. Assessing electron beam dynamics under such fields will be of key importance to achieve the next milestones of the PWFA concept. Here we report on the use of the betatron X-ray and gamma-ray radiation emitted by the electron bunches under these fields to assess the electron beam dynamics and emittance evolution. We will present simulation results showing how the betatron radiation emitted by a relativistic electron beam is correlated to its emittance growth when propagating through the plasma in the highly non-linear regime. Gamma-ray radiation can also be a powerful tool in a related context: the growth of electromagnetic filamentation instabilities during beam-plasma interaction, with plasma densities ranging from gas density to solid density. We will present simula- tion results showing how very large electromagnetic fields produced during the electron beam filamentation instability can cause the production of bright gamma rays, which in turn can be used to assess the onset and evolution of the instability.

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Session Classification: WG1-WG5 Joint Session - Advanced Beam Metrology

Track Classification: WG1-WG5 Joint Session

Contribution ID: **77** Type: **talk**

Geometric optimization of Dielectric Laser Accelerator (DLA) through PIC simulations

Monday, September 16, 2019 4:40 PM (20 minutes)

The quest to realize a particle accelerator on a chip has led to the emergence of dielectric laser accelerators (DLAs). DLAs have the capability of sustaining accelerating gradient in ~ GV/m using the grating-shaped dielectric microstructures. The geometry of these microstructures is one of the decisive features to affect the acceleration gradient and energy gain. Here we present an optimization study to compare the performance of different geometrical configurations of dielectric microstructures through particle in cell (PIC) simulations.
Assuming an electron beam with energy of 1 MeV traversing dielectric microstructures, excited by a laser with wave length of 1.93 μm, pulse length of 100 fs and electric field of 1 GV/m, we show that even with the same grating parameters, the designed shape/structure plays a crucial role in enhancement of energy gain.

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Session Classification: WG3 - Dielectric Acceleration

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **78** Type: **talk**

All-optical structuring of laser-driven proton beam profiles

Friday, September 20, 2019 11:40 AM (30 minutes)

Extreme field gradients intrinsic to relativistic laser-interactions with thin solid targets enable compact multi-MeV proton accelerators. The initial μm-scale acceleration phase is followed by ballistic proton propagation with negligible space-charge effects over millimeters to hundreds of centimeters to a site of analysis/application. The detected proton distribution can be influenced by the spatio-temporal intensity distribution in the laser focus, electron transport, plasma instabilities, as well as target geometry and surface properties.
Substantially extending this picture, our recent results show a critical influence of the mm-scale vacuum environment on the accelerated proton bunch, where residual gas molecules are ionized by the remnant laser light not absorbed into the target plasma but reflected or transmitted. In an experiment with μm-sized hydrogen jet targets, this effect lead to the counter-intuitive observation of laser near-field feature imprints in the detected proton beam profiles. Our results show that the remnant laser pulse induces a quasi-static deflecting field in the ionized residual background gas that serves as a memorizing medium and allows for asynchronous information transfer to the naturally delayed proton bunch. Occurring under typical experimental laser, target and vacuum conditions, all-optical imprinting needs to be taken into account for sensible interpretation of modulated proton beam profiles.

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Session Classification: Plenary Session 10

Track Classification: Invited Plenary Talk

Contribution ID: **79** Type: **poster**

Status of the development of single shot emittance measurement at SPARC_LAB

Wednesday, September 18, 2019 7:00 PM (1 hour)

In order to measure emittance in single shot, it is necessary to obtain information about beam spot, angular divergence and correlation term. The former and the second terms can be provided by a simultaneous measurement of beam size and Optical Transition Radiation (OTR) angular distribution. The latter is acquired by means of a microlens array, producing several contiguous replicas of OTR angular distribution. We report here the first results and the status of the development of this technique.

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Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **82** Type: **poster**

Laser-driven electron storage rings

Monday, September 16, 2019 7:00 PM (1 hour)

Advanced accelerator concepts usually address linear acceleration schemes. Storage rings, however, are often superior to linear machines regarding repetition rate, stability and efficiency. The radiative energy loss per turn in an electron storage ring is compensated by radiofrequency resonators with a wavelength of the order of 1 meter, which corresponds to the spacing between consecutive potential wells, so-called buckets, and a bunch length around 1 centimeter or several 10 picoseconds. As an alternative, this function could be performed by a laser wave co-propagating with the electrons in an undulator. Considering a continuous-wave carbondioxide laser beam as an example, the bucket spacing would be 10 micrometer with a bunch length in the femtosecond range. The paper will discuss chances and limitations of such a laser-driven storage ring concept with steady-state femtosecond bunches. Possible preparatory experimental studies at existing storage rings will be outlined.

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Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **84** Type: **talk**

Enhanced ion acceleration from a non-ideal laser pulse contrast

Tuesday, September 17, 2019 7:00 PM (20 minutes)

The major challenges of compact proton sources driven by an ultrashort high-intensity laser are currently to establish precise control over proton beam parameters and shot-to-shot stability. Shooting ultrathin targets has shown to yield higher proton energies, which became recently accessible due to temporal laser pulse shape control using plasma-mirror techniques. We find that the intensity ramp, transmitted to the target by the plasma mirror during the last picosecond before the pulse peak, becomes significantly decisive for the subsequent acceleration performance. Reliable characterization of this ramp with modern laser diagnostics remains challenging and immense computational needs required to fully resolve the plasma kinetics leave it mostly unexplored in today's simulations of laser-solid interaction. We present the results of 3D large-scale simulations with PIConGPU, taking into account realistic contrast conditions, bridging the scales from picosecond pre-plasma formation over transient, non-equilibrium dynamics of the tens of femtosecond laser duration down to attosecond plasma oscillations. Adding to beneficial acceleration conditions presented by hybrid acceleration mechanisms and onset of relativistic transparency, we show that the maximum proton energy can be optimized by a specific leading pulse edge via a combination of pre-thermal and thermal TNSA, surpassing the performance of the ideal diffraction limited Gaussian pulse.

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Session Classification: WG2-WG6 Joint Session

Track Classification: WG2-WG6 Joint Session

Contribution ID: **85** Type: **talk**

Laser-wakefield accelerators for high-resolution X-ray imaging of complex microstructures

Thursday, September 19, 2019 4:00 PM (20 minutes)

Laser-wakefield accelerators (LWFAs) are high acceleration-gradient plasma-based particle accelerators capable of producing ultra-relativistic electron beams. Within the strong focusing fields of the wakefield, accelerated electrons undergo betatron oscillations, emitting a bright pulse of X-rays with a micrometer-scale source size that may be used for imaging applications. Non-destructive X-ray phase contrast imaging and tomography of heterogeneous materials can provide insight into their processing, structure, and performance. To demonstrate the imaging capability of X-rays from an LWFA, we have examined an irregular eutectic in the aluminum-silicon (Al-Si) system. The lamellar spacing of the Al-Si eutectic microstructure is on the order of a few micrometers, thus requiring high spatial resolution. We present comparisons between the sharpness and spatial resolution in phase contrast images of this eutectic alloy obtained *via* X-ray phase contrast imaging at the Swiss Light Source (SLS) synchrotron and X-ray projection microscopy *via* an LWFA source. An upper bound on the resolving power of 2.7 ± 0.3 μm of the LWFA source in this experiment was measured. These results indicate that betatron X-rays from LWFA can provide an alternative to conventional synchrotron sources for high resolution imaging of eutectics and, more broadly, complex microstructures.

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Session Classification: WG4

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **86** Type: **talk**

On the Resonant Properties of THz Laminated Accelerating Structures

Wednesday, September 18, 2019 5:00 PM (15 minutes)

The results of theoretical, numerical and experimental studies of THz laminated structures for particle acceleration are presented. The two-layer metallic and metal-dielectric structures are considered. The analytical presentations for longitudinal impedance and wake potential are given. The resonant properties of the synchronous TM01 fundamental mode are discussed and the conditions for the single-mode traveling wave structure are examined.

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Session Classification: WG3 - Dielectric Beam-driven Acceleration Thz acceleration

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **87** Type: **talk**

Plasma devices: plasma dechirper and plasma lens

Tuesday, September 17, 2019 9:00 AM (40 minutes)

The Plasma wakefield acceleration (PWFA) techniques, despite being a promising approach to high gradient acceleration, create a number of challenges from a point of view of beam transport and beam manipulation. At the same time the progress in PWFA experiments has opened a road for creation of a number of plasma based tools for beam manipulations. In this talk we will consider two of such devices: a plasma lens, that uses the magnetic field of the high current discharge inside the plasma to focus the beam, and plasma dechirper, that uses self induced wakefield for beam phase space manipulation. This overview will present the basic principles, recent experimental results and future prospects of these two devices.

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Presenter: SHPAKOV, Vladimir (LNF)

Session Classification: Plenary Session 3

Track Classification: Invited Plenary Talk

Contribution ID: **88** Type: **talk**

Overview of positron acceleration in plasma-based accelerators

Wednesday, September 18, 2019 9:00 AM (40 minutes)

One of the main motivations for research in plasma wakefield acceleration is the advancement of high energy physics, and in particular the construction of a linear electron–positron collider. While great progress has been made in high-efficiency, high-gradient, high-quality acceleration of electron beams, acceleration of positrons is significantly more difficult in a plasma due to an inherent charge asymmetry. While several recent experimental and theoretical studies have attempted to bridge this gap, a complete solution is yet to be identified. In this talk, we will review the fundamental challenges of positron acceleration, ideas proposed to overcome these challenges, as well as past and future experiments.

Primary author: LINDSTRØM, Carl A. (DESY)

Presenter: LINDSTRØM, Carl A. (DESY)

Session Classification: Plenary Session 5

Track Classification: Invited Plenary Talk

Contribution ID: **89** Type: **talk**

FLASHForward: first experimental results

Wednesday, September 18, 2019 4:40 PM (20 minutes)

Plasma accelerators have great potential to form the basis of the next generation of compact linear colliders or FELs. Along with the high accelerating gradients inherent to plasma devices, another key requirement for such future machines is high beam quality—low emittance and low energy spread. The FLASHForward X-1 experiment is aimed at demonstrating the generation and subsequent acceleration of such ultra-high quality electron bunches. The unique combination of a stable, FEL-quality electron beam driver and a 10fs-level synhcronised 25 TW laser system allows for demonstration, development and detailed diagnosis of such plasma cathodes. The FLASHForward X-2 experiment will further demonstrate external injection and acceleration of high-quality electron bunches. Using a longitudinally shaped double bunch of electrons, the goal is to show emittance preservation, high-efficiency, low energy spread acceleration in a plasma. We report on the excellent recent progress of these two experiments, as well as our exciting plans for upcoming experimental campaigns.

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Session Classification: WG1 - PWFA experimental results

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **91** Type: **talk**

FLASHForward: Plasma wakefield accelerator science for high average power applications

Tuesday, September 17, 2019 7:00 PM (20 minutes)

FLASHForward is a beam-driven plasma-wakefield research facility at DESY (Hamburg, Germany), aiming at the stable generation and acceleration of electron beams of several GeV with small energy spread and emittance. High-quality GeV-, nC-class electron beams from the free-electron laser FLASH will act as the wake driver. The experimental setup will allow for studies of external injection as well as density-downramp-assisted internal injection. First experimentation at the FLASHForward facility began in earnest in the summer of 2018 with first results published earlier this year. Over the course of the last year many exciting experimental studies have been performed, aided by the exquisite stability, feedback, and repetition rate of the FLASH machine. This contribution will outline progress made at the FLASHForward facility during this time as well as an outlook to the unique high average-power functionality planned for the future.

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Session Classification: WG1 - Plasma acceleration physics II and high rep rates

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **92** Type: **poster**

Zemax simulations for laser propagation in plasma waveguides

Monday, September 16, 2019 7:00 PM (1 hour)

Plasma-based waveguides are currently employed for laser wakefield acceleration to extend the focal region
of laser beams. Indeed, a parabolic transverse plasma density profile can be formed in a dielectric capillary as a thermal consequence of a gas discharge.
In this work, we report on a new ray tracing model, based on the Zemax software, able to simulate the envelope of a laser beam propagating through a plasma waveguide. Thanks to the tools offered by Zemax, an ideal interferometry measurement will be shown as well as the design of a curved capillary.

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Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **94** Type: **poster**

Experimental scaling of fast electron beams generated by high-intensity laser-solid matter interactions

Monday, September 16, 2019 7:00 PM (1 hour)

High intensity ultra-short laser pulses interacting with thin solid targets are able to produce energetic proton and ion beams by means of extremely large accelerating fields. The process starts with the emission of fast electrons that, escaping the target, set an electrostatic potential, responsible for the subsequent acceleration of heavier particles. The characterization of such electrons is thus important in view of a complete understanding of the acceleration process. Here, we present temporally-resolved measurements of the fastest escaping electron component. Charge, electric field and temporal duration of the emitted fast electron beams are determined using a temporal diagnostics based on Electro-Optical Sampling with 100 fs temporal resolution. Experimental evidences of scaling laws for fast electron beam parameters respect to the impinging laser energy (0.25 –2.5 J range) are retrieved and compared with theoretical models, showing an excellent agreement. It allowed for the first time experimental evaluation of the cooling time of the fast electron electron component.

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Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG2 - Ion beams from plasmas

Contribution ID: **95** Type: **talk**

New Vulcan PetaWatt beamline: Ultra-broadband, picosecond OPCPA FrontEnd

Monday, September 16, 2019 4:00 PM (20 minutes)

In order to perform strong field physics experiments such as particle acceleration, laboratory astrophysics, high energy density physics, high-energy ultra-short pulses (PW peak power) are strongly required.
The generation of such pulses can be performed through the Optical Parametric Chirped Pulse Amplification (OPCPA) technique. OPCPA main advantages, respect to the CPA, are the high single-pass gain, lower thermal effects and the ability to support broader amplified spectrum. Those are crucial parameters to generate intense pulses in the PW-regime at high repetition rate (RR).
In this contribution, we present an auxiliary PW beamline to Vulcan system (CLF, RAL) fully based on OPCPA using LBO non-linear crystal, ensuring broadband phase-matching conditions. This new beamline, delivering 30J, sub-30fs pulses with high RR (shot/minute), will open up the potential for novel pump-probe experiments when operated with the existing PW and long pulse beamlines.
The first phase consisting of an ultra-broadband, ps OPCPA system centred at 870 nm is already operational; it will belong to the FrontEnd system consisting of four ps-stages and three ns-stages. Adopting the non-collinear phase-matching scheme, the bandwidth of amplified pulses was ~200nm, sub-10 fs transform limit pulses. The ps-OPCPA is designed to deliver mJ-level pulses with 100 Hz repetition rate.

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Session Classification: WG7

Track Classification: WG7 - High brightness power sources: from Laser Technology to beam drivers

Contribution ID: **96** Type: **poster**

Injector design for the MariX-FEL project

Wednesday, September 18, 2019 7:00 PM (1 hour)

The MariX project (Multi-disciplinary Advanced Infra-structure for Research with X-rays) is a free electron laser (FEL) light source proposed by the INFN-Milan. It will produce highly coherent X-rays, in the range 0.2-8 keV, with ultra-short pulses (10-50 fs) and a repetition rate up to 1MHz. At the same time, MariX will host a compact monochromatic X-ray source, called BriXS, by using an inverse-Compton scattering scheme, with energies up to 180 keV and a repetition rate of 100 MHz (continuous-wave CW operation) that will generate fluxes up to 10^13 photons per second.
In this paper, the Radio-Frequency (RF) and beam dynamics designs of the electron injector for the MariX-FEL project are presented. The choice of the main devices, such as the electron gun and the accelerating linear accelerators, as well as the main parameters for CW operation are discussed in details.

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Presenter: FAILLACE, Luigi (MI)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **97** Type: **talk**

Progress towards high-repetition-rate plasma accelerators

Tuesday, September 17, 2019 6:40 PM (20 minutes)

We provide an overview of three areas of our programme which seek to address the challenge of realizing controlled laser wakefield accelerators (LWFAs) operating at kilohertz repetition rates. Driving plasma accelerators with trains of laser pulses offers the potential to use laser systems capable of multi-kilohertz pulse repetition rate with high wall-plug efficiency. We describe a proof-of-principle demonstration of the multi-pulse laser wakefield accelerator (MP-LWFA) concept in which wakefields were driven by trains of up to seven laser pulses generated from a Ti:sapphire laser. Controlling the injection and trapping of electrons is necessary to improve the bunch parameters produced by LWFAs, but this is challenging for the quasi-linear regime in which MP-LWFAs operate. We describe how simultaneous space-time focusing can improve the properties of bunches trapped following two-pulse ionization injection in the quasi-linear regime. Finally, we describe our work to develop hydrodynamic optical-field-ionized (HOFI) plasma channels which are capable of generating long, low-density channels well suited to all types of LWFA. We present our latest results, which include demonstration of guiding of high-intensity laser pulses in HOFI plasma channels with axial densities as low as $n_\mathrm{e}(0) = 1.5 \times 10^{17}\ \mathrm{cm}^{-3}$ and lowest-order modes of spot size $W_\mathrm{M} \approx 40\mu\mathrm{m}$.

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Session Classification: WG1 - Plasma acceleration physics II and high rep rates

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **98** Type: **talk**

Ion acceleration from ultra-thin foil targets using a PW-class laser with optimized temporal pulse profile

Thursday, September 19, 2019 4:20 PM (20 minutes)

Laser-driven ion acceleration promises to provide a compact solution for demanding applications like radio-biology experiments. For that, controlling particle beam parameters particularly in experiments with high energy Petawatt class ultra-short pulse systems with high repetition rate is a mandatory, yet challenging task. The performance of the plasma acceleration is strongly dependent on the complex laser target interaction which in turn is determined by the temporal laser intensity profile and spatio-temporal couplings on a large dynamic range. Plasma mirror setups have proven to significantly improve the temporal contrast by reducing pre-pulse intensity and steepening the rising edge of the main laser pulse, enabling the investigation of laser proton acceleration using ultra-thin and near critical density targets. Here we present benchmark experiments using the DRACO Petawatt laser at HZDR irradiating ultra-thin foil targets. A combination of particle and plasma diagnostics for ions and electrons as well as reflected and transmitted light revealed clear indications of acceleration in the relativistic transparency regime. The experiments were complemented by a suite of different laser pulse diagnostics, including self-referenced spectral interferometry with extended time excursion for single shot contrast analysis to characterize the laser pulse properties at the high power focus as realistic as possible.

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Session Classification: WG2

Track Classification: WG2 - Ion beams from plasmas

Contribution ID: **100** Type: **talk**

Angstrom wavelength FEL driven by 5 GeV LWFA beam with external injection

Tuesday, September 17, 2019 6:20 PM (20 minutes)

In this contribution we report simulations assessing the feasibility of driving a Free Electron Laser (FEL) at the Angstrom wavelength level by a plasma boosted, high brightness electron beam.
A 500 MeV, 30 pC bunch, accelerated by a conventional Radio Frequency linac, is injected in a laser driven plasma wave and its energy boosted up to 5 GeV and more. A large beam charge portion retains the initial properties, in terms of brightness, allowing to trigger FEL instability. The bunch is matched into a 1.5 cm wavelength undulator, producing radiation at 1.1 Angstrom.
We assess stability of the acceleration process retrieving robustness against variation of many initial parameters.
This scheme is relevant both for EuPRAXIA and for related projects, like EuPRAXIA@SPARC_LAB.

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Presenter: ROSSI, Andrea Renato (MI)

Session Classification: WG1 - Plasma acceleration physics II and high rep rates

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **101** Type: **talk**

MariX: a Multi-disciplinary Advanced Research Infrastructure for the generation and application of X-rays

Wednesday, September 18, 2019 6:40 PM (20 minutes)

We present the conceptual design of a new, advanced radiation source facility called MariX (Multi-disciplinary Advanced Research Infrastructure for the generation and application of X-rays). The facility has been conceived, following a scientific case delineated by users of FELs and Light Sources, for delivering fs-scale, high repetition rate, X-ray pulses for time-resolved fine analysis of matter (spectroscopy and photon scattering) in the linear response regime. MariX is based on the original, advanced design of a two-pass two-way superconducting linear electron accelerator, equipped with an arc compressor, able to significantly reduce both footprint and construction/operation costs, although employing conventional super-conductive cavities. MariX will be operated in CW mode (1 MHz) providing FEL emission in the 0.2 - 8.0 keV range with 10^8 photons per pulse. The accelerator complex also includes an advanced inverse Compton source of very high-flux hard X-rays of energies up to 180 keV at 100 MHz repetition rate for realizing a broad science program and serving a multidisciplinary user community, covering fundamental science of matter and application to life sciences, including health at pre-clinical and clinical level.

Primary author: ROSSI, Andrea Renato (MI)

Presenter: ROSSI, Andrea Renato (MI)

Session Classification: WG4 - New Facilities, laser wakefield betatron for QED and HED

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **102** Type: **poster**

A concept for an active plasma undulator

Monday, September 16, 2019 7:00 PM (1 hour)

Acceleration of electron bunches in a plasma channel implies a matched beam spot size at the micron level: this property, together with generally low values for slice emittance and energy spread (and large peak current), boosts the rho pierce parameter value up to order of 10^-2 or even more. Upon leaving plasma channel, due to prompt electrons divergence, rho is reduced quickly so that allowing the bunch to wiggle within plasma seems mandatory to fully exploit its potential. To date, proposed plasma based undulators exploit plasma wave transverse fields to wiggle beam's particles, incurring in two main disadvantages, namely an initial transverse position dependent undulator parameter and a likely energy change due to longitudinal plasma field. We present the concept scheme for a new plasma based undulator enabling, in principle, to exploit the extremely large potential brightness of plasma accelerated beams. In our scheme, plasma only serves as a conductive media to allow properly tailored, intense currents to generate magnetic fields able to both wiggle and keep the electron bunch focused to micron size. The resulting device is a cheap and versatile undulator.

Primary author: ROSSI, Andrea Renato (MI)

Presenter: ROSSI, Andrea Renato (MI)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **104** Type: **talk**

Overview of high gradient X-band RF technology development

Tuesday, September 17, 2019 11:00 AM (40 minutes)

During the last years, Research and Development (R&D) of X-band technology for normal conducting particle accelerators has witnessed a tremendous growth. The driving force behind this has been the interest of the Scientific Community in the construction of a Multi-TeV Linear Collider at a reasonable size and costs. Accelerating gradients three to four times larger than those in operational S-C-band linacs have been demonstrated in prototype accelerating structures by the CLIC Collaboration at CERN. In addition to these applications, X-band technology is also rapidly expanding in the field of X-ray FELs and other photon sources, where it has shown great potential for very accurate beam diagnostics and e-bunch manipulations.
An overview of the state-of-the-art of high gradient X-band technology R&D and its main applications will be given.

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Session Classification: Plenary Session 4

Track Classification: Invited Plenary Talk

Contribution ID: **105** Type: **talk**

Driver/witness bunch PWFA experiments at FLASHForward

Friday, September 20, 2019 9:40 AM (30 minutes)

Owing to high gradient accelerating fields (>GV/m), plasma wakefield accelerators (PWFA) have the high potential of greatly reducing the size of high-average power accelerator facilities. The stability and quality of the acceleration process in the plasma largely depends on the incoming bunch structure. A precise control of the longitudinal bunch profile is essential for the optimisation of the energy transfer efficiency and the preservation of energy spread. At FLASHForward, driver/witness bunch pairs of adjustable bunch length and separation are generated by collimators in a dispersive section. This setup enables μm-level control of the longitudinal bunch profile. Here we present the most recent results of PWFA measurements at FLASHForward.

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Presenter: SCHROEDER, Sarah (DESY)

Session Classification: Plenary Session 9

Track Classification: Invited Plenary Talk

Contribution ID: **106** Type: **poster**

High Intensity Laser hybrid guiding for electron acceleration

Monday, September 16, 2019 7:00 PM (1 hour)

Controlled guiding of laser pulses at relativistic intensities in plasmas over distances exceeding the diffraction length is a crucial requirement of a Laser Plasma Accelerator Stage (LPAS) for achieving high quality electron beams. A new hybrid guiding scheme is proposed, in which first a laser pre-pulse (I ~ 10¹⁶ W/cm²) guided through a dielectric capillary ionizes and heats the target gas. Hydrodynamic expansion of the generated plasma then results in the formation of a plasma channel. The main laser (I ~ 2-5 10¹⁸ W/cm²) focused at the entrance of this structure can be efficiently guided by the combined refraction of this channel and reflection at capillary walls. This scheme has been investigated using numerical simulations including hydrodynamic expansion of the plasma, propagation of the high intensity laser beam and acceleration of electrons in the plasma wave.

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Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **109** Type: **talk**

Evolution of an ionized plasma column measured by proton beam self-modulation

Tuesday, September 17, 2019 6:40 PM (20 minutes)

The AWAKE experiment at CERN is a proof-of-concept proton beam-driven plasma wakefield accelerator. The plasma source is a 10 meter-long Rubidium vapor cell ionized by a high-intensity laser pulse. The proton beam is modulated by the plasma, which results in micro-bunching at the plasma frequency and resonant excitation of the plasma wave. We measure the frequency of the micro-bunching when the laser and proton beams are coincident, and when the proton beam propagates through the plasma long after the passage of the laser pulse. The plasma density is inferred from the frequency of modulation of the proton beam. We observe a microsecond-long plateau in the plasma density, followed by a power-law decay of the density versus time. We provide a model of the plasma column evolution by considering thermal and diffusive processes as well as three-body recombination.

Primary authors: GESSNER, Spencer (CERN); AWAKE COLLABORATION

Presenter: GESSNER, Spencer (CERN)

Session Classification: WG5

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **110** Type: **talk**

New directions in positron plasma wakefield acceleration

Friday, September 20, 2019 12:10 PM (30 minutes)

The acceleration of positrons in plasma is a long-standing problem in the field of plasma wakefield acceleration. Recently, several groups have proposed novel techniques for controlling the on-axis plasma electron density in order to provide uniform accelerating and focusing fields for a trailing positron bunch [1,2,3]. In this talk, I will discuss the role of the transverse plasma electron motion in establishing useful fields for accelerating positrons in a variety of plasma geometries.

1. J. Viera, et. al. "Nonlinear Laser Driven Donut Wakefields for Positron and Electron Acceleration." Phys. Rev. Lett. 112, 215001 (2014)
2. N. Jain, et. al. "Positron Acceleration by Plasma Wakefields Driven by a Hollow Electron Beam." Phys. Rev. Lett. 115, 195001 (2015)
3. S. Diederichs, "Positron Acceleration with Beam-Driven Plasma Accelerators." Masters Thesis. DESY (2019).

Primary authors: GESSNER, Spencer (CERN); CORDE, Sébastien (Ecole Polytechnique); YU, Siyi (Ecole Polytechnique)

Presenter: GESSNER, Spencer (CERN)

Session Classification: Van der Meer Award

Track Classification: WG1-WG8 Joint Session

Contribution ID: **111** Type: **talk**

A Compact High Brightness Electron Source

Tuesday, September 17, 2019 4:00 PM (20 minutes)

Short wavelength acceleration techniques, e.g. in the THz range, promise high field gradients but suffer from severe phase slippage at non-relativistic particle energies due to the small normalized vector potential that can be realized with these techniques. By combining a compact, amplifier driven S-Band rf gun with an adiabatically tapered dielectric-lined waveguide THz accelerator promising high brightness beam parameters have been found in simulations. We present prototype results of the compact rf gun and discuss the transverse and longitudinal beam dynamics in the subsequent adiabatically tapered acceleration section in terms of the normalized vector potential.

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Presenter: FLOETTMANN, Klaus (DESY)

Session Classification: WG3 - Particle Sources

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **112** Type: **talk**

Impact of ultrafast laser generated Weibel magnetic fields on propagation dynamics of relativistic electron bunches

Monday, September 16, 2019 6:20 PM (20 minutes)

During laser solid interactions, the onset of Weibel instability can generate super strong magnetic field structures (up to several kT) at the surface and within the bulk of the solid targets. Weibel magnetic fields can be used to understand several physical events in astrophysics [1], laser driven inertial confinement fusion process [2] and gamma-ray generation [3].
Here we report on the measurements of integrated Weibel magnetic fields at femtosecond time scale by using relativistic electron bunches from laser wakefield accelerators (LWFA) to probe the Weibel instability driven by the interaction between ultrashort (30 fs) intense ($I_0 > 10^{18} W/cm^2$) laser pulses and thin solid targets.
Experiments on hybrid Plasma Wakefield Acceleration, in which LWFA-generated electron beams are used to drive wakefield in another plasma target [4], demonstrated that the impact of such a strong magnetic field on relativistic electron bunch can cause significant beam quality degradation, which complicates its further transportation and utilisation. We will present experimental and simulation results showing few $kT\ \mu m$ integrated B-field, generated at the surface of the solid target within a few microns depth. The results show that the Weibel instability at femtosecond time scale can be explored with a convenient and simple method based on LWFA.

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Session Classification: WG1-WG5 Joint Session - Ultrafast Dynamics Metrology

Track Classification: WG1-WG5 Joint Session

Contribution ID: **113** Type: **poster**

Control of undulator radiation using a Laser Plasma Acceleration Source

Monday, September 16, 2019 7:00 PM (1 hour)

Spontaneous undulator radiation emission, after the COXINEL line using a Laser Plasma acceleration (LPA) source, has been observed. The line enables to manipulate the electron beam phase space such as emittance, dispersion and energy spread along a 10 m long transport. The large divergence is handled at a very early stage to mitigate the chromatic emittance, using high gradient permanent magnet based quadrupoles mounted on translation tables to enable Beam Pointing Alignment Compensation that allows for a dispersion free focused beam. The operating energy is between 161-180 MeV focused in a 2-m long cryo-ready undulator with a period of 18 mm emitting light in the Ultra-Violet range. The spectral flux is characterized using a spectrometer and the angular flux is captured by a CCD camera. The wavelength is tuned by either changing the electron beam energy or by adjusting the undulator gap. We show that the angular-spectral moon shape type pattern of the undulator radiation provides an insight on the electron beam quality and its transport. The radiation pattern signature is illustrated alongside its dependence on the energy spread that is modified by introducing a slit in a magnetic chicane where a small relative bandwidth of 2% has been achieved.

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Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **114** Type: **poster**

Simulation of a passive longitudinal phase space synthesizer concept based on 3D-printed dielectric-lined waveguides

Monday, September 16, 2019 7:00 PM (1 hour)

Precise control over the longitudinal phase space (LPS) of electron bunches in accelerators can be of interest for example for bunch-compression, where in the ideal case a completely linear LPS is needed to reach maximum compression. We present a compact and completely passive way to alter the LPS of a given electron bunch in a way that arbitrary, pre-defined shapes can be achieved. The concept is based on 3D-printed dielectric-lined waveguides, which makes the devices cheap and enables rapid prototyping and production. Here we discuss the underlying physics, technology, as well as results of numerical simulations of the LPS synthesizer (LPSS) in action. Finally, challenges and prospects are discussed.

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Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **115** Type: **poster**

Design and optimization of a 5 GeV beam-driven stage for EuPRAXIA

Monday, September 16, 2019 7:00 PM (1 hour)

At FLASHForward, the plasma wakefield is driven by a high-current-density electron beams extracted from the FLASH superconducting radiofrequency (RF) accelerator. Therefore, FLASHForward is in a unique position for studying and providing insight for the design study of next-generation light sources and high energy physics facilities such as EuPRAXIA, which aim to provide industrial beam quality and user areas. After completion of the start-to-end simulation for the initial base design—a 1 GeV case including one conventional RF stage and one electron beam driven plasma stage (PWFA)—the focus of the recent studies has been centered on the upgrade to the 5 GeV case which includes maximizing transformer ratio, staging and RF tolerance studies. Specific focus has been on the optimization of the drive electron beam, as well as the significance of the predicted tolerances from the RF stage on the outcome of the PWFA stage and the optimized case. Summary of these findings and their broader impact are discussed here.

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Presenter: NIKNEJADI, Pardis (DESY)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG6 - Theory and simulations

Contribution ID: **116** Type: **poster**

Status report on the dielectric laser acceleration experiments at the SINBAD/ARES linac

Wednesday, September 18, 2019 7:00 PM (1 hour)

We report on the status of the dielectric laser acceleration (DLA) experiments at the SINBAD/ARES linac at DESY, Hamburg. The experiments are performed in the context of the Accelerator on a CHip International Program (ACHIP). At SINBAD, the main goal is to show net energy gain of externally injected relativistic electron bunches in the high-gradient fields of a laser-illuminated dielectric grating structure with a period of ~2 μm. This is enabled by the ultra-short bunches from the ARES linac, which were simulated to be on the order of single fs. In a later stage of the experiment, a laser modulator and permanent magnetic chicane will be added. Since both the modulator and the DLA will be driven by the same laser, phase-synchronous injection of trains of ~350 as FWHM long microbunches were simulated to be possible. Here, the current status of the first experimental area (EA1) at ARES is discussed, which was designed specifically for research on DLA and other dielectrics-based schemes. This includes the focusing lattice, electron beam diagnostics, the 2 μm laser beam line, the experimental chamber, as well as the microbunching setup.

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Presenter: MAYET, Frank (DESY, Hamburg, Germany & University of Hamburg, Germany)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **117** Type: **poster**

Seeded Self Modulation of Transversely Asymmetric Long Proton bunches in Plasma

Monday, September 16, 2019 7:00 PM (1 hour)

The AWAKE experiment at CERN [1] recently demonstrated the world's first acceleration of electrons in a proton-driven plasma wakefield accelerator [2]. Such accelerators show great promise for a new generation of linear e-p colliders using GV/m accelerating fields. Effectively driving a wakefield in AWAKE requires 100-fold self-modulation of the 12 cm Super Proton Synchrotron (SPS) proton beam using a plasma-driven process which must be carefully controlled to saturation [3,4]. Previous works have modeled this process assuming cylindrical symmetry of the transverse space and momentum profiles of the proton bunch. In this work, 3D particle-in-cell simulations are used to investigate the self-modulation of non-round beams. Implications of such effects for effectively sustaining resonant wakefields are discussed.

[1] P. Muggli et al. (AWAKE Collaboration), Plasma Physics and Controlled Fusion, 60(1) 014046 (2017)

[2] M. Turner et al. (AWAKE Collaboration), Phys. Rev. Lett. 122, 054801 (2019)

[3] E. Adli et al. (AWAKE Collaboration), Phys. Rev. Lett. 122, 054802 (2019)

[4] E. Adli et al. (AWAKE Collaboration), Nature 561, 363–367 (2018)

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Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **118** Type: **talk**

X-band TDS simulations and commissioning

Thursday, September 19, 2019 5:00 PM (20 minutes)

Understanding of both driver and witness bunches in beam-driven plasma-wakefield acceleration (PWFA) experiments is critical in order to gain a deeper insight into what happens behind the scenes of the plasma cell i.e. validation of theory and control over the acceleration processes. However, witness bunches with lengths on the order of several femtoseconds are difficult to temporally resolve with traditional diagnostic methods. In order to characterise the longitudinal phase space of these short bunches a new polarisable transverse deflection RF structure (TDS) working in the X-Band range (11.99 GHz) will be installed at the FLASHForward facility at DESY. To assess the capabilities and limitations of this device during its upcoming operation, as well as to optimise the sometimes challenging transport of the accelerated electrons from the plasma cell to the TDS, particle tracking simulations have been performed. Here the results of these simulations for scenarios including external and internal injection will be presented.

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Session Classification: WG5 - Diagnostics

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **119** Type: **talk**

EuPRAXIA project and the UK plan to develop a centre for applications EuPRAXIA beamlines

Wednesday, September 18, 2019 6:20 PM (20 minutes)

EuPRAXIA is the first European project that develops a dedicated accelerator research infrastructure based on novel plasma concepts and laser technology. The aim is to construct electron accelerators with beam energy of 1 to 5 GeV, a significantly improved beam quality and demonstrated benefit in size and cost when compared to RF technology. EuPRAXIA accelerators will enable versatile applications in various domains e.g. compact FEL, compact medical imaging, a compact positron source, test beams for particle detectors and highly mobile, deeply penetrating X-ray sources for material testing, as well as development of new sources for applications such as plasma undulators and attosecond radiation.

The Central Laser Facility CLF (Rutherford Appleton Laboratory), the CLARA facility at Daresbury (Cockcroft Institute), the SCAPA facility in Glasgow (University of Strathclyde), together with several UK universities combine unique expertise in plasma accelerators. Coordinated by Plasma Wakefield Accelerator Steering Committee (http://pwasc.org.uk), the UK-based EuPRAXIA consortium plan to design, prototype and develop application beamlines, and play a major role in delivering them. Furthermore, if funded, Extreme Photonic Application Centre (EPAC) at CLF will transform the UK infrastructure with the focus on applications and high repetition rate accelerator operation.

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Session Classification: WG4 - New Facilities, laser wakefield betatron for QED and HED

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **120** Type: **poster**

Seeding with an electron bunch the self-modulation of a long, relativistic particle bunch in a plasma

Wednesday, September 18, 2019 7:00 PM (1 hour)

Seeding of the drive bunch self-modulation (SM) process is essential when using a long particle bunch (σz»λpe) to drive wakefields in plasma. Seeding in principle leads to a SM phase reproducible from event-to-event, allowing for deterministic injection of an electron witness bunch to be accelerated.
Since external injection requires generation of an electron bunch in an RF-gun or LWFA, we explore opportunities and challenges related to also using an electron bunch for seeding of the SM process in AWAKE. Seeding with an electron bunch has a number of possible advantages over seeding with a relativistic ionization front: no high-power laser needed, use of a source with preformed plasma (helicon, discharge, etc.), effective use of the entire drive bunch to drive wakefields, etc. It may also has have some difficulties: implementation of a plasma density step, evolution of the seed bunch if not matched to the plasma focusing force, energy loss and dephasing of the seed bunch, etc.

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Presenter: MUGGLI, Patric (Max-Planck-Institut für Physik)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG8 - Advanced and novel accelerators for High Energy Physics

Contribution ID: **121** Type: **poster**

Transverse Beam Breakup Instability in Dielectric Laser Accelerators

Monday, September 16, 2019 7:00 PM (1 hour)

Dielectric laser acceleration (DLA) is one of the advanced concepts for more compact accelerators. DLA gratings have apertures within the range of optical wavelengths. Wakefields limit the beam intensities of relativistic electrons required for possible applications. Particle tracking is needed to study the intensity limitations due to nonlinear laser fields in combination with wakefields. For this, we present the addition of self-consistent wake kicks to our tracking code DLAtrack6D. The literature on conventional linear accelerators introduces analytical models to describe the transverse beam breakup instability. The comparison of tracking results with these models shows that the respective intensity limits are also valid for DLA gratings, which limits the bunch charge to less than a femtocoulomb. Furthermore, we analyze the nonlinear dynamics in alternating phase focusing (APF) channels by calculating tune footprints of various bunch distributions. The APF scheme confines the beam longitudinally and in one transverse direction by alternating focusing and defocusing phases. We present tune spectrograms, i.e. tune spectra as function of the independent variable, calculated by reconstructing the single particle one-cell matrix. This is the basis to study damping mechanisms as BNS damping of the transverse beam breakup instability in DLA gratings.

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Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **122** Type: **talk**

Demonstration of a millimeter-scale electron-beam driven plasma wakefield accelerator based on hybrid staging

Thursday, September 19, 2019 6:00 PM (20 minutes)

Plasma based electron acceleration is widely considered as a promising concept for compact electron accelerators with broad range of applications. These accelerators can be driven by either ultra-intense laser beams (LWFA) or high-current particle beams (PWFA).
Here, we report on a novel approach to combine both schemes in a compact experimental setup. In our "LWFA + PWFA"hybrid accelerator, the electron beam generated by a LWFA stage drives a subsequent PWFA stage where a witness beam is trapped and accelerated. This aims to combine the unique features of both plasma acceleration techniques: the LWFA stage provides with a compact source of high-current electron beams required as PWFA drivers, while the PWFA stage acts as an energy and brightness transformer.
In this work, we show the first experimental evidence of accelerating a distinct witness bunch in a LWFA-driven PWFA (LPWFA) within only about one millimeter acceleration distance. In the self-ionizing case, we observe witness energies of around 50 MeV. By utilizing a counter-propagating pre-ionization laser, the interaction with the plasma becomes stronger, increasing the final energies to around 130 MeV. Thus, yielding a field gradient of 70 GeV/m which is comparable to what has been shown at large scale PWFA facilities.

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Presenter: HEINEMANN, Thomas (Univ. Strathclyde / DESY)

Session Classification: WG1 - Hybrid staging and future PWFA experiments

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **123** Type: **poster**

Diagnostics for an Electron Pulse Train Obtained by Modulation in a Laser-Driven Dielectric Structure at SwissFEL

Monday, September 16, 2019 7:00 PM (1 hour)

We investigate possibilities that dielectric accelerator structures, excited by fs lasers, offer for X-ray free electron lasers. The present scheme uses a dielectric laser accelerator to modulate an electron beam to create a pulse train of short (100 as) X-ray pulses in the undulators of SwissFEL. The implementation of such a scheme would be enabled by using the experimental chamber installed in the framework of the Accelerator-on-a-Chip International Program (ACHIP), and the chicane that will be installed for the Hidden, Entangled and Resonating Orders (HERO) project.
In this contribution, we will focus on electron beam diagnostics for the modulated and compressed electron beam.

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Presenter: HERMANN, Benedikt (Paul Scherrer Institut)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **124** Type: **talk**

A PWFA Multi-TeV gamma-gamma collider

Tuesday, September 17, 2019 4:30 PM (20 minutes)

The plasma wakefield accelerator has demonstrated high-gradient, high-efficiency acceleration of an electron beam. Numerical simulation results backed by theory indicate that also emittance preservation at the level needed for a high luminosity collider may be achievable in the blow out regime. Electron linacs based on plasma wakefield acceleration is therefore a promising technology for a compact future linear collider. However, there are currently no evident solutions for achieving the same performance for positron acceleration. Instead, two Multi-TeV electron linacs may be used to produce Multi-Tev gamma-gamma collisions. We discuss the option of a Multi-TeV gamma-gamma collider, including a brief look at the physics potential.

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Presenter: ADLI, Erik (University of Oslo, Norway)

Session Classification: WG8

Track Classification: WG8 - Advanced and novel accelerators for High Energy Physics

Contribution ID: **125** Type: **talk**

Modeling of capillary discharge plasmas for wakefield acceleration and beam transport

Tuesday, September 17, 2019 6:00 PM (20 minutes)

Next generation accelerators demand sophisticated beam sources to produce ultra-low emittances with large gradients. The subsequent beamline optics are equally critical to transporting these beams between accelerating stages or to interaction points. Capillary discharge plasmas may address each of these challenges. Capillaries have been demonstrated as sources capable of increasing the peak energy and beam quality of laser wakefield accelerators, and as active plasma lenses featuring orders-of-magnitude increases in peak magnetic field. These systems are sensitive to energy deposition, heat transfer, ionization dynamics, and magnetic field penetration; therefore, improved modeling will enable advances in capillary design. We present simulations of capillary discharge waveguides and active plasma lenses in using FLASH, a publicly-available multi-physics code in development at the University of Chicago. We report on the implementation of a 2D, cylindrically symmetric capillary model for capturing plasma density and temperature evolution with realistic conductivities and magnetic fields. We then illustrate the use of laser energy deposition to model low density channel formation for the matching and guiding of intense laser pulses. Lastly, we discuss simulations of active capillary plasmas with different fill species, which show agreement with experimental observations of nonlinearities in the current density profile and magnetic field.

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Presenter: COOK, Nathan (RadiaSoft LLC)

Session Classification: WG6

Track Classification: WG6 - Theory and simulations

Contribution ID: **126** Type: **poster**

Particle Acceleration using Carbon Nanotube Arrays

Monday, September 16, 2019 7:00 PM (1 hour)

Charged particle acceleration using solid-state nanostructures is attracting new attention in recent years as a method of achieving ultra-high acceleration gradients, in principle of up to ~1 TV/m [1]. The use of carbon nanotubes (CNT) has the potential to enable limitations of using natural crystals, e.g. in channeling aperture and thermo-mechanical robustness, to be overcome. In this work, we present an effective theory of the interaction of a relativistic particle beam with a single-walled CNT using a hydrodynamical model of conduction electrons in the CNT, with a view towards a description of electromagnetic (EM) fields in a CNT-array based accelerator. The model is compared to results from Particle-in-Cell simulations assuming similar beam parameters and conditions as at available facilities such as CLEAR at CERN and CLARA at Daresbury, UK. The roles of CNT wall-thickness, electronic properties, beam parameters, and CNT-array properties in the excitation of EM and plasmon modes are discussed.

[1] Y. M. Shin, D. A. Still, V. Shiltsev, Phys. Plasmas 20, 123106
(2013)

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Presenter: YADAV, Gyanendra (University of Liverpool)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **127** Type: **talk**

Beam Matching in PWFA with a Laser-Ionized Plasma Source

Tuesday, September 17, 2019 7:00 PM (20 minutes)

Plans for a laser-ionized, beam-driven plasma wakefield accelerator at SLAC's FACET-II facility are presented. The plasma source is formed by laser ionization of a volume of uniform density gas, and the plasma density profile is therefore determined by the focal pattern of the laser. This offers the advantage of a tunable density profile that can accommodate entrance and exit ramps suitable for beam matching. Analytical solutions to the transverse beam dynamics in a plasma ramp for near arbitrary ramp profiles will also be presented. Notably, the equations capture the beam envelope oscillations that take place in adiabatic plasma ramps, which have been ignored in previous literature and can contribute to both the emittance growth of the beam and the beam' s orientation in phase space at the plasma exit. Using the presented beam dynamics, idealized ramp shapes for beam matching are devised and evaluated. An example plasma source based on parameters relevant to beam-driven plasma wakefield acceleration experiments planned for FACET-II is considered, and the variational tolerance for the most significant adjustable parameters are calculated and shown to have a comfortable margin of error. Finally, experimental plans for the formation and diagnosis of the plasma source are presented.

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Presenter: LITOS, Michael (University of Colorado Boulder)

Session Classification: WG5

Track Classification: WG5-WG7 Joint Session

Contribution ID: **128** Type: **talk**

Energy resolved emittance measurements and chromatic emittance growth of laser-wakefield accelerated beams

Monday, September 16, 2019 4:40 PM (20 minutes)

A crucial parameter for the demonstration of a laser-plasma driven free-electron laser is the electron beam emittance and its stability. Here, we show energy resolved emittance measurements of ionisation-injected plasma electron beams performed with both a conventional quadrupole scan and measured from single-shots. We show that the initial phase-space properties obtained from both methods deviate by less than 10 % and are constant over a narrow energy-band considered for the retrieval. The initial beam emittance is as low as 0.7 mm mrad. Finally, we demonstrate first measurements of chromatic emittance growth for laser-plasma accelerated electron beams.

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Session Classification: WG1-WG5 Joint Session - Advanced Beam Metrology

Track Classification: WG1-WG5 Joint Session

Contribution ID: **129** Type: **talk**

Petawatt laser guiding and electron beam acceleration to 7.8 GeV in a laser-heated capillary discharge waveguide

Tuesday, September 17, 2019 9:40 AM (30 minutes)

In order to take advantage of the large acceleration gradients in laser plasma accelerators and achieve high beam energies, preformed plasma waveguides can be used to mitigate laser diffraction of focused laser pulses, which increases the acceleration length and the energy gain for a given laser power. Here we report on guiding of relativistically intense laser pulses with PW peak power over 15 diffraction lengths by increasing the focusing strength of a capillary discharge waveguide using laser inverse Bremsstrahlung heating. This allowed production of electron beams with quasi-monoenergetic peaks in energy up to 7.8 GeV [1], almost double what was previously demonstrated [2].

[1] A.J. Gonsalves et al. Phys. Rev. Lett. **122**, 08401 (2019)
[2] W. P. Leemans et al., Phys. Rev. Lett. **113**, 245002 (2014)

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Session Classification: Plenary Session 3

Track Classification: Invited Plenary Talk

Contribution ID: **130** Type: **talk**

Laser systems with accelerator-like performance, key for stable plasma electron beams

Monday, September 16, 2019 10:00 AM (30 minutes)

Successful applications of laser-plasma accelerators require stable electron beams. The drive laser plays a crucial role in the generation of such beams: even slight variations in laser pulse quality on target deform the shape of the plasma wake and thereby the fields inside the plasma cavity with direct impact on the generated electron phase space. All efforts to improve the laser performance therefore directly benefit the electron beam performance.
The LUX plasma accelerator is operated in a collaboration of Hamburg University and DESY. Driven by the ANGUS laser system it has been designed to test and develop concepts towards stable plasma acceleration. Providing a platform which continuously delivers electron beams provides new opportunities to take data with high statistics and to understand mechanisms that have so far been buried in noise. Here, we discuss our approach to operate the ANUGS laser like an accelerator, implementing diagnostics, controls and feedback loops for increased performance. We will present recent experimental results, and correlate laser parameters with properties of the plasma electron beam. Finally, we will show current limitations in performance, discuss improvements in electron quality that can be expected from specific modifications in the laser, and provide an outlook on future development.

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Session Classification: Plenary Session 1

Track Classification: Invited Plenary Talk

Contribution ID: **131** Type: **talk**

First experimental results of an OPCPA seed for a long-term stable plasma acceleration drive laser

Monday, September 16, 2019 4:40 PM (20 minutes)

Laser-plasma acceleration promises to be a powerful technology for driving future compact light sources. The LUX laser-plasma accelerator is driven by the 200 TW ANGUS Ti:Sapphire laser system which has been designed aiming for long-term stability, enabling stable operation over many hours. Demonstrating this during several 24-hour runs, enough data for reliable statistics could be taken. However, the experimental results indicate that additional development on the laser is required to further enhance the performance of the plasma accelerator.
Here, we will present first experimental results from MALCOLM, an OPCPA-based front-end for the ANGUS drive laser, which is currently being built in our group. With the white light seed and pump generated from the same commercial industrial grade femtosecond Yb:KGW laser, the initial OPCPA stage is designed for spectral and pulse energy stability.

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Session Classification: WG7

Track Classification: WG7 - High brightness power sources: from Laser Technology to beam drivers

Contribution ID: **134** Type: **talk**

SINBAD-ARES - A Photo-Injector for external Injection Experiments in novel Accelerators at DESY

Tuesday, September 17, 2019 6:00 PM (20 minutes)

The accelerator R&D facility SINBAD (Short innovative bunches and accelerators at DESY) will drive multiple independent experiments in the fields of production of ultrashort electron bunches and test of advanced high gradient acceleration concepts.
The SINBAD-ARES (Accelerator Research Experiment at SINBAD) linac has been designed to allow the production of high brightness ultrashort electron bunches with arrival-time stability of 10fs RMS. The accelerator will be used to study experimentally the optimization of the brightness for fs long electron bunches. Such electron bunches, with tunable characteristics, will be then injected into novel accelerators realized in the context of the ATHENA project, the ACHIP international collaboration and the ARIES program.
In this talk we describe the principal characteristics of the linac design, we underline the technical challenges connected to the production and characterization of fs bunches and we report about the status of the installations and commissioning.

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Presenter: MARCHETTI, Barbara (DESY)

Session Classification: WG4

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **135** Type: **poster**

Studies of Terahertz interactions with plasma for particle accelerators

Monday, September 16, 2019 7:00 PM (1 hour)

In this talk, I will discuss a diagnostic method for the electron plasma density and temperature based on the exploitation of wideband THz pulses. I will present the model accompanying the diagnostic method showing its utility to characterize the plasma density and temperature profile along a symmetry axis. This diagnostic is particularly interesting for plasma-acceleration schemes or laser-produced plasma. I will also briefly discuss the possibility to use high-intensity THz pulse to excite in the linear regime a high gradient plasma wakefield that can be exploited for Laser Wakefield Acceleration (LWFA).
Finally, I will present the THz research activities at "Sapienza"University of Rome.

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Presenter: PETRARCA, Massimo (ROMA1)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **136** Type: **poster**

Novel spectrometer design for laser driven ion acceleration diagnostic

Monday, September 16, 2019 7:00 PM (1 hour)

The continuous development of high power lasers (I > 10^{22} W/cm^2) allow to accelerate multi-species charged particles to higher and higher energies. For this new interaction regime nowadays it become crucial to develop diagnostic systems for comprehensive characterisation of plasma processes and ion acceleration phenomena for the range of energies not explored before.
The main goal of this work is to propose a novel spectrometer design for laser driven particles diagnostic capable of detecting the proton spectra from few MeV up to few hundreds MeV.For that purpose different sequences of magnetic and electric field profiles have been studied systematically varying the fields'parameters, through finite element numerical simulations. The optimized parameters of the spectrometer allow a study of high energetic particle emission from ultra-intensity laser-matter interaction in a broad energy range providing high energy and species resolution in highly resolved spatial and temporal domain.

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Presenter: MORABITO, Antonia (ROMA1)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **137** Type: **poster**

Coherent active THz phase modulation during Optical Rectification process for THz particle accelerators

Wednesday, September 18, 2019 7:00 PM (1 hour)

In this work, I will theoretically show how the phase modulation of the infrared pump pulse, used to generate the terahertz radiation via the Optical Rectification Process (OR) in the regime of weak-pump signal, affects the amplitude and the phase of the resulting THz field. I will also discuss the effects of THz generation under strong-pump signal. This theory can be used in many practical applications where a coherent control of the THz field is required as for example for the direct acceleration of electrons.

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Presenter: PETRARCA, Massimo (ROMA1)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG6 - Theory and simulations

Contribution ID: **138** Type: **poster**

Experimental progress towards an all-optical Thomson source for X-ray flourescence imaging

Monday, September 16, 2019 7:00 PM (1 hour)

Laser wakefield accelerators can provide a very compact source of electron beams, which combined with intense laser pulses can result in a versatile X-ray source. Of particular interest for medical imaging are X-rays in the 50-100 keV energy range, high enough energy to penetrate through human-sized objects. Highly collimated beams with such energies form the basis of an all optical Thomson source for X-ray Fluorescence Imaging (XFI) of (functionalized) gold-nanoparticles [F. Grüner et al., Sci. Rep. 8, 16561 (2018)]. Experimental progress in generating and diagnosing reproducible, stable electron beams that form the basis of such an X-ray source is detailed. Characterisation of the generated X-ray beam is also presented, along with details of the first proof of principle experiment.

Primary author: PODER, Kristjan (DESY)

Co-authors: BOHLEN, Simon (DESY - FLA); STAUFER, Theresa; Mr MEISEL, Martin (Deutsches Elektronen-Synchrotron); Dr BRUEMMER, Theresa (Deutsches Electronen Synchrotron DESY); Prof. GRUENER, Florian (University of Hamburg); OSTERHOFF, Jens (Deutsches Elektronen-Synchrotron DESY)

Presenter: PODER, Kristjan (DESY)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **139** Type: **talk**

Compact Radiation Sources Using Dielectric Laser Accelerators

Tuesday, September 17, 2019 6:40 PM (20 minutes)

Recent research into laser-driven dielectric structure accelerators has given rise to the potential to exploit novel coherent radiative processes with attosecond pulse lengths by exciting dielectric structures with optical-scale periodic features. The development of a solid state silicon-based near infrared (NIR) radiation source is a holy grail in the telecommunications industry. On-chip nanostructured electron sources could be readily coupled to similarly nano- to micron- scale silicon devices designed as optimized radiators. The demonstrated sub-cycle microbunching in DLA sources enables superradiant emission of NIR radiation, which, when coupled to photonic waveguides, would provide an on-chip, solid state solution for NIR power delivery to photonic circuit networks. We will discuss recent developments and near-term experimental plans for demonstrating DLA based radiation sources as part of the ongoing Accelerator on a Chip International Program (ACHIP).

Primary authors: ENGLAND, Joel (SLAC); HUANG, Zhirong (SLAC); Prof. HUANG, Yenchieh (National Tsing Hua University); Mr ODY, Alexander (Stanford University)

Presenter: ENGLAND, Joel (SLAC)

Session Classification: WG3-WG4 Joint Session

Track Classification: WG3-WG4 Joint Session

Contribution ID: **140** Type: **poster**

Electromagnetic and Beam Dynamics Studies for High Gradient Accelerators at Terahertz Frequencies

Monday, September 16, 2019 7:00 PM (1 hour)

THz radiation is the most important portion of the electromagnetic spectrum in terms of multi disciplinary use in basic science and technology. Beyond the numerous applications, a great interest is its potential for future, compact linear accelerators. Conventional high brightness radio-frequency accelerating structures operate with 30-50 MV/m gradients; terahertz-driven accelerating structures enable high-gradient electron accelerators (potentially up to the GV/m scale) with simple and compact accelerating structures. These compact terahertz accelerators hold great potential to have an impact for free electron lasers, linear colliders. Here we present electromagnetic and beam dynamics studies about the use of a dielectric loaded waveguide to accelerate electron bunches by mean of a narrow-band multi-cycle THz laser pulse. The excitation of the accelerating structure by the THz-pulse and the bunch acceleration in the excited field are investigated using CST Microwave Studio and GPT simulations; a check between different beam dynamics codes (namely CST Particle Studio, GPT and ASTRA) will be also presented.

Primary author: MARONGIU, Marco (INFN / LNF)

Co-authors: CHIADRONI, Enrica (LNF); CROIA, Michele (LNF); FERRARIO, Massimo (LNF); FICCADENTI, Luca (ROMA1); LUPI, Stefano (ROMA1); MARTINELLI, Valentina (LNF); MOSTACCI, Andrea (Sapienza); POMPILI, Riccardo (LNF); TOFANI, Silvia (Sapienza University)

Presenter: MARONGIU, Marco (INFN / LNF)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **142** Type: **poster**

Ionizing Laser Propagation at AWAKE

Monday, September 16, 2019 7:00 PM (1 hour)

The plasma source during AWAKE run 1 consists of a 10 meter long rubidium vapor source ionized by a laser pulse from a 4 TW titanium:sapphire system focused to a mm spot size. Because the plasma column geometry can have an effect on the formation of the proton driven plasma wakefields when the plasma skin depth approaches the size of the plasma column, the geometry needs to be understood. Since several resonances associated with atomic state transitions of the valence electron are within the bandwidth of the laser pulse, the pulse experiences strong nonlinear effects that can cause stretching and nonlinear focusing thereby dramatically affecting the resulting plasma column due changes in intensity. By experimentally studying the time resolved transverse profile and the spectrum from the output laser radiation, as well as the transverse profile of plasma column at the end of the vapor source using a schlieren imaging technique as a function of input intensity and rubidium density, a numerical model for the laser propagation is qualified. Using the propagation model, potential design studies for AWAKE run 2 are discussed.

Primary authors: MOODY, Joshua (Max Planck Institute for Physics); BACHMANN, Anna-Maria (CERN); LEE, Valentina; ALADI, Mark (MTA Wigner Research Center for Physics); RÁCZKEVI, Béla (MTA Wigner Research Center for Physics); KEDVES, M. Á. (MTA Wigner Research Center for Physics); DEMETER, Gabor (MTA Wigner Research Center for Physics); DJOTYAN, Gagik (MTA Wigner Research Center for Physics); GRANADOS, Eduardo (CERN); FEDOSSEEV, Valentin (CERN); GESSNER, Spencer (CERN); MUGGLI, Patric (Max-Planck-Institut für Physik)

Presenter: MOODY, Joshua (Max Planck Institute for Physics)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **143** Type: **talk**

Development and characterisation of non-invasive diagnostics for plasma acceleration

Thursday, September 19, 2019 4:00 PM (20 minutes)

FLASHForward is a beam-driven plasma wakefield accelerator located at DESY in Hamburg. Within the FLASHForward project, a laser-driven wakefield setup is used as testbed for the characterisation and development of diagnostics for plasma wakefield accelerators. These include different non-invasive charge diagnostics that are also tested for their usability in EMP noisy plasma environment. Another method investigated is Thomson Scattering, which is the interaction of relativistic electron bunches with a laser pulse resulting in X-ray beams. Results on using the dependence of the Thomson beam on the initial electron bunch parameters to study the electron bunches are presented.

Primary author: BOHLEN, Simon (DESY)

Co-authors: PODER, Kristjan (DESY); Dr BRÜMMER, Theresa (DESY); Prof. GRÜNER, Florian (University of Hamburg); Mr MEISEL, Martin (DESY); STAUFER, Theresa (University of Hamburg); OSTERHOFF, Jens (DESY)

Presenter: BOHLEN, Simon (DESY)

Session Classification: WG5 - Diagnostics

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **146** Type: **talk**

Concept of an OPCPA-seeded drive laser for long-term stable plasma acceleration

Monday, September 16, 2019 4:20 PM (20 minutes)

The LUX laser-plasma accelerator, built in close collaboration of the University of Hamburg and DESY, is designed to provide plasma electron beams with enhanced stability as a driver for future compact light sources. After significant in-house development of the driving 200 TW ANGUS laser system, the
laser has reached an operational stability, that enabled us to repeatedly demonstrate 24-hour operation of the laser-plasma accelerator with several 10k consecutive electron beams and high availability. However, it has become evident, that further improvements of the laser system are necessary to further enhance the quality of the generated electron beams.
We therefore are considering alternative approaches to overcome limitations in the system architecture of conventional Ti:Sapphire lasers. Here, we will present concepts, based on OPCPA technology, to provide seed laser pulses for the main amplification chain with a primary focus of long-term accelerator
operation. We derive laser stability requirements based on our experience with the LUX laser-plasma accelerator, discuss approaches for fulfilling these challenging demands, and present simulations to estimate the achievable performance.

Primary author: EICHNER, Timo (University of Hamburg/Center for Free-Electron Laser Science)

Co-authors: HÜLSENBUSCH, Thomas (University of Hamburg); Dr LANG, Tino (Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany); Dr WINKELMANN, Lutz (Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany); HARTL, Ingmar (DESY); MAIER, Andreas (Univ. Hamburg / CFEL)

Presenter: EICHNER, Timo (University of Hamburg/Center for Free-Electron Laser Science)

Session Classification: WG7

Track Classification: WG7 - High brightness power sources: from Laser Technology to beam drivers

Contribution ID: **147** Type: **talk**

Scalable particle-in-cell simulations on many-core hardware with the free and open source code PIConGPU

Monday, September 16, 2019 4:00 PM (20 minutes)

Exploring new regimes, optimizing experimental setups, or quantifying sensitivity of final beam parameters on experimental parameters, represent current challenges for simulations of laser plasma accelerators. Time-to-solution and scalability are key parameters for codes to minimize turnaround times in order to scan e.g. tens of parameters such as the laser leading edge, resolve solid density target physics and run full-scale start-to-end simulations. PIConGPU reaches unprecedented performance by accelerating 100% of its computations on many-core architectures and leveraging next-generation scalable I/O. High-resolution, full-geometry studies on top-ten listed supercomputers decisively enhance predictive capabilities. PIConGPU's design allows for utilizing various compute architectures, including modern X86 and ARM CPUs and GPUs with a single, adaptable code base. Users can now run PIConGPU on almost any machine, either by easy recompiling or using predefined Docker images, and everybody can download, use and contribute to the code without extensive knowledge in compute architectures. We highlight latest additions to PIConGPU such as scalable file I/O via a new openPMD-API including ADIOS2 support for on the fly loosely coupled data analysis, live visualization with particle and field rendering, non-standard Gaussian laser pulses via Laguerre modes, in-situ X-ray scattering image generation, and an pythonic simulation setup interface.

Primary author: STEINIGER, Klaus (Helmholtz-Zentrum Dresden-Rossendorf)

Co-authors: Dr BASTRAKOV, Sergei (Helmholtz-Zentrum Dresden-Rossendorf); COWAN, Thomas (Forschungszentrum Dresden-Rossendorf); DEBUS, Alexander (Helmholtz-Zentrum Dresden-Rossendorf); GARTEN, Marco (HZDR); Mr GOETHEL, Ilja (Helmholtz-Zentrum Dresden - Rossendorf); HUEBL, Axel (Helmholtz-Zentrum Dresden - Rossendorf); Dr JUCKELAND, Guido (Helmholtz-Zentrum Dresden-Rossendorf); Mr KELLING, Jeffrey (Helmholtz-Zentrum Dresden-Rossendorf); KLUGE, Thomas (HZDR); Mrs KOSSAGK, Sophie (Helmholtz-Zentrum Dresden-Rossendorf, Technische Universität Dresden); Mr MATTHES, Alexander (Helmholtz-Zentrum Dresden-Rossendorf, Technische Universität Dresden); PAUSCH, Richard (Helmholtz-Zentrum Dresden - Rossendorf); SCHRAMM, Ulrich (Helmholtz-Zentrum Dresden-Rossendorf); Mr STARKE, Sebastian (Helmholtz-Zentrum Dresden-Rossendorf); WIDERA, René (Helmholtz-Zentrum Dresden - Rossendorf); Mr WORPITZ, Benjamin (LogMeIn, Inc.); BUSSMANN, Michael (Helmholtz-Zentrum Dresden-Rossendorf)

Presenter: STEINIGER, Klaus (Helmholtz-Zentrum Dresden-Rossendorf)

Session Classification: WG6

Track Classification: WG6 - Theory and simulations

Contribution ID: **148** Type: **talk**

Development of a Beam Profile Monitor based on Silicon Strip Sensors for Low-Charge Electron Beams at ARES

Thursday, September 19, 2019 4:20 PM (20 minutes)

Novel accelerator techniques such as dielectric laser acceleration (DLA) will be studied at the SINBAD facility (DESY Hamburg) using the ARES linac. Due to the low charge of the accelerated beams, charge densities below 1 aC per square micron are expected at the spectrometer screen, which are challenging to measure with conventional techniques used in multi-pC accelerators. Therefore, a dedicated beam profile monitor, based on silicon strip sensors originally developed for the ATLAS inner tracker upgrade, was developed to measure these distributions with a sufficient spatial resolution of around 100 micron. Here, the design of the device and experimental tests with a prototype are presented.

Primary author: JASTER-MERZ, Sonja (DESY)

Co-authors: ASSMANN, Ralph (DESY); BURKART, Florian (DESY); DORDA, Ulrich (DESY); KRAEMER, Uwe (DESY); STANITZKI, Marcel (DESY)

Presenter: JASTER-MERZ, Sonja (DESY)

Session Classification: WG5 - Diagnostics

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **149** Type: **poster**

Study of external electron beam injection into proton driven plasma wakefields for AWAKE Run2

Monday, September 16, 2019 7:00 PM (1 hour)

During its first experimental run (2016-2018), AWAKE [1] reached two important milestones: the demonstration of the seeded self-modulation of the 400 GeV/c proton bunch delivered by the CERN Super Proton Synchrotron [2,3], and the acceleration of externally injected electrons from 19 MeV to 2 GeV [4]. The goal of the second run (starting in 2021) is to accelerate an electron bunch with a narrow final energy spread (%-level) and preserving its incoming emittance. To do so, we will exploit beam loading of the wakefields, full blow out of the plasma electrons by the accelerated bunch and beam matching to the plasma ion column [5]. Thus, at the injection point the electron bunch density has to be much higher than the plasma electron density and the beam beta function parameters matched to the plasma focusing. For AWAKE Run2 it is planned to use two separated plasma sections: one dedicated to the self-modulation of the proton bunch and one for the electron acceleration. We therefore investigate the injection properties and geometry of the electron bunch into the second section, including foils and suitable diagnostics for beam transverse size and vector measurements, given the spatial constraints of the vapor source.

Primary authors: VERRA, Livio (CERN); MUGGLI, Patric (Max-Planck-Institut für Physik); CALDWELL, Allen (Max Planck Institute for Physics); GSCHWENDTNER, Edda (CERN)

Presenter: VERRA, Livio (CERN)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **150** Type: **talk**

Plasma Target Characterisation at FLASHForward

Thursday, September 19, 2019 6:00 PM (20 minutes)

Precise knowledge of the temporal and spatial evolution of the plasma density within plasma targets is important for realising high quality accelerated beams in plasma wakefield accelerators like FLASHForward. A plasma target characterisation setup was assembled for the purpose of measuring the electrical discharge-generated plasma density in the different types of gas-filled targets used at FLASHForward. Three diagnostics are presently being commissioned: a common-path two-colour laser interferometer for measuring the average longitudinal plasma density with a time resolution of tens of picoseconds; a transversely aligned spectrometer for analysing Stark broadened line emission profiles with the flexibility to measure transverse and longitudinal density profiles with a spatial resolution of tens of microns and a temporal resolution of ~5ns; a transversely aligned Michelson interferometer with a spatial resolution of a few microns and a temporal resolution in the tens of femtosecond regime. A summary of the latest complementary measurements and results is presented.

Primary authors: GARLAND, Jimmy (Desy); Dr SCHAPER, Lucas (Desy); Ms TAUSCHER, Gabrielle (Desy); Dr OSTERHOFF, Jens (Desy); PODER, Kristjan (DESY); Mr TARGACZEWSKI, Jonathan (UHH)

Presenter: GARLAND, Jimmy (Desy)

Session Classification: WG5-Targets

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **151** Type: **talk**

Recent developments at the CLEAR Plasma Lens Experiment

Tuesday, September 17, 2019 6:00 PM (20 minutes)

The Plasma Lens Experiment at CERN is an experiment in active plasma lensing. It consists of a gas-filled sapphire capillary connected to a set of compact Marx banks, which breaks down the gas and drives a large current pulse through it. This generates a magnetic field, which is probed using the CLEAR electron beam and measured using various screens and magnetic elements behind the lens. We characterize the development of non-linearities in the current distribution and how to avoid them, over a range of gasses, capillary types, and currents. We show that emittance preservation in the lens is possible by carefully choosing the operating point of the lens. We also discuss the results and technical developments from the recent CLEAR runs.

Primary authors: LINDSTRØM, Carl A. (DESY); OSTERHOFF, Jens (Deutsches Elektronen-Synchrotron DESY); ADLI, Erik (University of Oslo, Norway); BOYLE, Gregory (DESY); SCHAPER, Lucas (University Hamburg / DESY); Mr MEISEL, Martin (Deutsches Elektronen-Synchrotron); DYSON, Anthony (Oxford University); HOOKER, Simon (University of Oxford); CORSINI, Roberto (CERN); FARABOLINI, Wilfrid (CEA/IRFU and CERN); Dr SJOBAK, Kyrre N. (University of Oslo)

Presenter: ADLI, Erik (University of Oslo, Norway)

Session Classification: WG5

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **152** Type: **poster**

A cryogenic undulator for a laser-plasma driven FEL experiment

Monday, September 16, 2019 7:00 PM (1 hour)

Laser-plasma accelerators are promising candidates to drive a next generation of compact FELs. The LUX plasma accelerator, developed and operated in a collaboration of Hamburg University and DESY, recently demonstrated the generation of spontaneous undulator radiation from a laser-plasma electron beam. A future upgrade of the beamline, currently under commissioning, will include the cryogenic FEL-ready undulator FROSTY to demonstrate first FEL gain from laser-plasma electron beams following the decomression scheme. By pushing the tolerances of the mechanical components to its limits, developing new magnetic alloys which unfold their full potential within cryogenic temperatures, and fulfilling the requirements of the high vacuum standard specified at DESY, we are currently commissioning an undulator with 15 mm period length and a peak field of 2.2 T. Our calculations show, that this undulator will support the demonstration of FEL gain from a plasma-accelerator using electron beams available in the lab already today. Here, we will present the design, manufacturing and the current commissioning status of the FEL undulator.

Primary author: TRUNK, Maximilian (Center for Free-Electron Laser Science & Department of Physics, University of Hamburg, Hamburg, Germany)

Co-authors: BAHRDT, Johannes (Helmholtz-Zentrum Berlin für Materialienund Energie GmbH); SCHULZ, Bodo (Helmholtz-Zentrum Berlin für Materialienund Energie GmbH); MAIER, Andreas R. (Center for Free-Electron Laser Science & Department of Physics, University of Hamburg, Hamburg, Germany)

Presenter: TRUNK, Maximilian (Center for Free-Electron Laser Science & Department of Physics, University of Hamburg, Hamburg, Germany)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **154** Type: **poster**

Energetic protons due to effective target heating from a near-critical plasma sphere using an ultra-short intense laser

Wednesday, September 18, 2019 7:00 PM (1 hour)

The prime challenge of laser-plasma based accelerators at the moment is to optimise the particle beams to obtain a steady mono-energetic and collimated bunch of energetic particles with the maximum possible efficiency. The present work is dedicated to optimising the laser and plasma parameters, and examining the ion acceleration processes that are present due to the laser plasma interactions. A 3D PIC simulation is performed using an ultra-short high intensity laser and a mass-limited near-critical plasma target. The focused laser energy due to the use of mass-limited target facilitates hot electron production. Effective electron heating and re-circulations helps in the formation of shocks which pushes the sheath accelerated protons further. Protons from a rectangular foil shaped target has been compared to those from a spherical target having the same dimensions. The target geometry has been observed to play a pivotal role in obtaining energetic protons. The curved front surface of the spherical target focuses the proton beam, whereas the curved rear surface hinders electrostatic sheath formation. Thus, the spherical target is favorable for the formation of quasi-monoenergetic beams of higher energetic protons due to a combined effect of various acceleration mechanisms, compared to a foil planar target.

Primary author: BHAGAWATI, Ankita (Tezpur University)

Co-authors: Dr KURI, Deep Kumar (Tezpur University); Prof. DAS, Nilakshi (Tezpur University)

Presenter: BHAGAWATI, Ankita (Tezpur University)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG2 - Ion beams from plasmas

Contribution ID: **155** Type: **talk**

Plasma Gratings as a Novel Target for Ion Acceleration

Thursday, September 19, 2019 6:00 PM (20 minutes)

With the trend towards higher repetition rate laser systems for applications, there is a demand for new, high repetition rate target solutions. This talk will look at efforts to develop shaped, thin, near-critical density gas targets for radiation pressure driven ion acceleration experiments using the high power, $10.6\mu m$ $\mathrm{CO_2}$ laser at Brookhaven National Laboratory. By suitably shaping a gas target, a ps laser pulse was used to first form a transient plasma grating structure in an underdense density ramp. Subsequently, protons were accelerated from the near-critical density plasma grating elements to multi-MeV energies, with few percent energy spreads with modest $\sim 10^{15}\ \mathrm{Wcm^{-2}}$ laser intensities. The measured proton energies were more than twice that predicted by the hole-boring scaling, $E_i = 4I/n_c c$. Multiple spectral features were observed on a significant fraction of shots. These results will be discussed, along with some future directions.

Primary author: ETTLINGER, Oliver (Imperial College London)

Co-authors: DOVER, Nicholas (National Institutes for Quantum and Radiological Science and Technology); Dr CHEN, Yu-hsin (Naval Research Laboratory); Dr HELLE, Mike (Naval Research Laboratory); DITTER, Emma-Jane (Imperial College London); HICKS, George (Imperial College London); GORDON, Daniel (Naval Research Laboratory); Dr TING, Antonio (University of Maryland); POLYANSKIY, Mikhail N.; POGORELSKY, Igor (BNL); NAJMUDIN, Zulfikar (Imperial College London)

Presenter: ETTLINGER, Oliver (Imperial College London)

Session Classification: WG2

Track Classification: WG2 - Ion beams from plasmas

Contribution ID: **156** Type: **poster**

Predicting the Trajectories of Relativistic Electron Beams for External Injection in Plasma Wakefield Acceleration

Monday, September 16, 2019 7:00 PM (1 hour)

The AWAKE project aims to accelerate electrons through proton driven plasma wakefields. The transverse extend of the wakefields is given by the plasma density and is of the order of one millimeter. With external injection, the exact position of the electron bunch in the wakefields determines the acceleration energy and the captured charge. The pointing jitter of the electron beam is of the order of the size of the wakefields, so single event analysis is desired. After the last two beam position monitors (BPMs) the electrons propagate in vacuum. Ballistics can be used to propagate the trajectory to determine the position of the beam with respect to the proton bunch. The co-propagating proton bunch interferes with the electron BPMs readings and they cannot be used to determine the electron trajectory for these common events. Therefore, we have to use BPMs upstream of the common line. We use a model based on beam-optics to propagate the electron bunch before and towards the plasma and predict its point of closest approach to the proton bunch. This method is used to investigate the measured accelerated charge from event to event.

Primary author: PEÑA ASMUS, Felipe (Max Planck Institute for Physics)

Co-authors: VELOTTI, Francesco (CERN); TURNER, Marlene (CERN/TU Graz); GESSNER, Spencer (CERN); MARTYANOV, Mikhail (CERN); BRACCO, Chiara (CERN); GODDARD, Brennan (CERN); MUGGLI, Patric (Max-Planck-Institut für Physik)

Presenter: PEÑA ASMUS, Felipe (Max Planck Institute for Physics)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **157** Type: **talk**

Numerical study of fabrication tolerances for dielectric laser acceleration (DLA) structures

Monday, September 16, 2019 6:20 PM (20 minutes)

DLA structures are five to six orders of magnitude smaller than conventional radio frequency accelerating structures. Precision of the microfabrication process will be crucial for the construction of a practical DLA device. In this study, finite-element method models are constructed for selected DLA structures to show what level of precision, in terms of a fraction of the driving wavelength, is required. Some speculation on the possible tuning of imperfect structures will also be presented.

Primary author: SZCZEPKOWICZ, Andrzej (University of Wroclaw)

Presenter: SZCZEPKOWICZ, Andrzej (University of Wroclaw)

Session Classification: WG3 - Dielectric Acceleration

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **158** Type: **talk**

500 MeV High Efficiency Demonstrator for the AWA Short-Pulse Two Beam Accelerator

Tuesday, September 17, 2019 5:10 PM (20 minutes)

The Argonne Wakefield Accelerator (AWA) group develops the Structure Wakefield Acceleration (SWFA) concept for a future multi-TeV electron-positron linear collider. The main SWFA approach being considered at the AWA is short-pulse (~25 nsec) two-beam accelerator (TBA). An important milestone for this technology will be to demonstrate substantial energy gain using the TBA scheme. To this end, the AWA is planning to install a "500 MeV high efficiency demonstrator" in the AWA facility. It will consist of two stages with two structures per stage to boost the main beam energy from 15 MeV to 500 MeV. Dielectric disk power extractors and high shunt impedance accelerators will be used to achieve 1.2 GW rf power generation and 250 MV/m gradient. The rf to main beam efficiency will also be improved by main beam shaping technologies developed at AWA.

Primary author: POWER, John (Argonne National Laboratory)

Presenter: POWER, John (Argonne National Laboratory)

Session Classification: WG8

Track Classification: WG8 - Advanced and novel accelerators for High Energy Physics

Contribution ID: **159** Type: **poster**

Numerical calculation of the Purcell-Smith radiation from dielectric laser acceleration (DLA) structures

Monday, September 16, 2019 7:00 PM (1 hour)

Intensities of the Purcell-Smith radiation from DLA-compatible grating and pillar structures are calculated numerically using the finite-element method. Geometric parameters are scanned in search of resonant radiation enhancement [1].

[1] Yi Yang et al, Maximal spontaneous photon emission and energy loss from free electrons, Nature Physics 14, 894–899 (2018)

Primary author: SZCZEPKOWICZ, Andrzej (University of Wroclaw)

Presenter: SZCZEPKOWICZ, Andrzej (University of Wroclaw)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **160** Type: **poster**

Electron Beam Shaping for High Efficiency Acceleration at the AWA Facility.

Monday, September 16, 2019 7:00 PM (1 hour)

A central challenge for next generation accelerator facilities (Linear Colliders and FELs) is to operate at high wall plug efficiency. However, the fraction of energy that can be transfer from the accelerating fields to the charge particle bunch is limited by beam loading. This is true for advanced acceleration schemes, Structure Wakefield Acceleration (SWFA), Plasma Wakefield Acceleration (PWFA) and Laser Wakefield Acceleration (LWFA) as well as conventional acceleration. In the typical case of a beam with a longitudinally Gaussian shape, heavy beam loading can induce an unacceptably high energy spread on the bunch. On the other hand, if the beam shape is chosen correctly then energy spread can be controlled. At the Argonne Wakefield Accelerator (AWA) facility, we are exploring several bunch shaping methods (emittance exchange based, laser controlled and deflecting cavities method) to address this issue. Plans to demonstrate high efficiency acceleration of a longitudinally shaped electron beam in a SWFA scheme called Two-Beam acceleration will be presented.

Primary authors: POWER, John (Argonne National Laboratory); CONDE, Manoel (Argonne National Laboratory); JING, Chunguang (Euclid Techlabs / ANL)

Presenter: POWER, John (Argonne National Laboratory)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **161** Type: **poster**

Corrugated Waveguide Based Wakefield Accelerator for an XFEL

Wednesday, September 18, 2019 7:00 PM (1 hour)

A highly efficient compact wakefield accelerator is being developed at Argonne National Laboratory for a future multiuser x-ray free electron laser facility [1]. A cylindrical metallic structure with a 2 mm internal diameter and fine corrugations on the wall is used to cause a Čerenkov radiation by a "drive"bunch at ~ 180 GHz in the fundamental mode and to obtain accelerating gradients on the order of 100 MV/m for the "witness"bunch. Each corrugated structure will be approximately a half meter long and the entire accelerator will span a few tens of meters. An ultra-compact transition region between accelerating structures has been designed to accommodate an output coupler, a notch filter, an integrated offset monitor, bellows, pumping and water cooling ports. The accelerator will decelerate a 1-GeV, 10-nC electron drive bunch to approximately 200 MeV and accelerate a 300-pC witness bunch to 5 GeV in order to generate hard x-rays in the small-aperture FEL undulator. The design of most of the components has reached a pre-construction phase, and we plan to fabricate a full module of the compact accelerator for a test with the electron beam at the AWA facility.

Primary authors: POWER, John (Argonne National Laboratory); ZHOLENTS, Alexander (Argonne National Laboratory)

Presenter: POWER, John (Argonne National Laboratory)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **162** Type: **talk**

Measurement of the decay rate of laser-driven linear wakefields

Thursday, September 19, 2019 6:20 PM (20 minutes)

Multi-pulse laser wakefield acceleration (MP-LWFA) is a promising scheme for increasing the repetition rate of LWFAs to to the kHz range [1-2] In this approach the laser wakefield is driven by a train of laser pulses spaced by the plasma wavelength such that the wakefields driven by each pulse interfere coherently.

A major consideration for MP-LWFA is the decay time of the wakefield, since this determines the maximum number of laser pulses that can be used. The decay time is determined by the motion of the plasma ions, which is usually neglected for short pulse drivers.

We present experimental and numerical investigations of the decay of wakefields driven in hydrogen and deuterium plasmas. The temporal decay of the amplitude of a wakefield, driven by a 44 fs laser pulse of laser parameter a0 ~ 0.5, was measured by the Temporally Encoded Spectral Shifting (TESS) method [3-4]. These results show that the amplitude of the wakefield decreases by 50% in approximately 1.3 ps, corresponding to 11 plasma periods. The experimental results are interpreted with the aid of 2D PIC simulations. A detailed design will be presented as a poster with title "Design of a laser-driven linear wakefield decay rate experiment".

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Session Classification: WG5-Targets

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **163** Type: **talk**

External Injection experiment: first accelerated beam

Wednesday, September 18, 2019 10:10 AM (30 minutes)

In recent studies on LWFA staging and external injection-acceleration in PWFA only a very small fraction (from below 0.1% to few percent) of the injected charge (the coupling efficiency) was accelerated. For future colliders where beam energy will need to be boosted using multiple stages, the coupling efficiency per stage must approach 100%. Here we report the first demonstration of external injection from a high-brightness RF photogun based conventional linear accelerator (LINAC) into a LWFA and subsequent acceleration without any significant loss of charge or degradation of quality. Stable 31-MeV, 20-fC electron beams from the LINAC were velocity bunched to the length of ~13fs (r.m.s.) in the high-gradient photocathode RF gun and then external injected into the linear wakefield excited by the 8TW, 40 fs laser. The experimental results show that nearly all the electrons can be mono-energetically accelerated with average gradient ~300 MV/m. This is achieved by properly shaping and matching the beam into the dedicatedly designed plasma structure. High capture efficiency of external injection has also been systematically validated by 3D PIC simulations. This is an important step towards realizing a high throughput, multi-stage high energy hybrid conventional-plasma accelerator.

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Presenter: HUA, Jianfei (Tsinghua University)

Session Classification: Plenary Session 5

Track Classification: Invited Plenary Talk

Contribution ID: **164** Type: **talk**

Measurement of Compressor Distortions on a TW Class Laser System.

Thursday, September 19, 2019 4:40 PM (20 minutes)

One of the main challenges for the development of 10 Hz petawatt-class lasers is the avoidance of grating heating in the compressor [1,2]. Beam distortions appear even at low average power [3], meaning mitigation strategies must be adopted for smaller scale systems. In this paper we describe detailed measurements of the compressor parameters in TA2 of the Gemini laser at the Central Laser Facility (CLF), delivering 500 mJ, 40 fs pulses in a 60 mm diameter beam. Traditionally, this has been a shot-on-demand area but driven by the demand for higher repetition rate to develop plasma accelerators, we are investigating the performance of the facility operating at 5 Hz.

We have found that at low energy density on the gratings (~20 mJ cm−2) a significant degradation is observed in the focal spot quality. Elongation in the focal spot and a lengthening of the compressed pulse duration indicate a degree of spatio-temporal coupling rather than heat-induced aberration. We will discuss the implications of these results and how they will affect future CLF high power laser developments.

[1] Leroux *et al.*, Opt. Express **26**, (2018).
[2] Alessi *et al.*, Opt. Express **24**, (2016).
[3] Fourmaux *et al.*, Opt. Express **17**, (2009).

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Session Classification: WG7

Track Classification: WG7 - High brightness power sources: from Laser Technology to beam drivers

Contribution ID: **165** Type: **talk**

PWFA-FEL: An exploratory study towards an ultra-compact x-ray free-electron laser

Tuesday, September 17, 2019 5:00 PM (20 minutes)

Plasma wakefield accelerators (PWFAs) are routinely accelerating electron beams to multi-GeV energies in cm-scale acceleration distances. This emerging technology is a promising approach towards ultra-compact X-ray free-electron lasers (XFELs). However, producing high-quality electron beams in plasma-based accelerators is still a challenging task. The R&D efforts within the community now concentrate on electron beam quality improvement. Novel avenues, such as the advanced plasma photocathode (aka "Trojan Horse"-injection), allow generating electron beams in PWFAs with 0.1%-level energy spreads, nm-level normalized emittance, and multi-kA peak currents. This results in unprecedented ultrahigh 6D-brightness electron beams. This presentation reports on the UK STFC funded R&D project PWFA-FEL. This project aims to develop PWFA-driven FEL concepts and technologies by combining the expertise of an international expert team in PWFA, Beam Transport and FEL from the University of Strathclyde, UCLA, SLAC FACET-II, and the Daresbury Laboratory CLARA. Further, we show simulation and experimental progress in generating these unprecedented beams and discuss new capabilities such as sub-femtosecond coherent x-ray pulses from ultra-compact XFELs. These bright X-ray flashes may allow, the observation and the study of electron dynamics within molecules on their natural timescale in university and industry-scale laboratories.

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Session Classification: WG4 - FEL

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **166** Type: **talk**

Modeling the L|PWFA hybrid accelerator using PIConGPU

Monday, September 16, 2019 4:20 PM (20 minutes)

The hybrid L|PWFA acceleration scheme combines laser- (LWFA) with plasma-wakefield acceleration (PWFA) to provide an ultra-compact, high-brightness electron source. Recently, the acceleration of a witness bunch using this hybrid scheme was demonstrated at HZDR. In this talk, we present recent start-to-end simulations, that accompanied the experimental campaign, and provided fundamental insights into the injection and acceleration process of this novel, compact accelerator. These accompanying simulations were performed using the 3D3V particle-in-cell code PIConGPU. A significantly enhanced agreement between theoretical predictions and experimental measurements could be achieved by resembling the experiment to a very high degree. Modeling the geometry, density distributions, laser modes, and gas dopings as measured in the experiments provided good comparability between experiment and simulation. With that degree of agreement, the wealth of information provided by the in-situ data analysis of PIConGPU provided insight into the plasma dynamics, otherwise inaccessible in experiments. The talk will not only focus on explaining the fundamental physical process behind this hybrid scheme but will further elaborate on the essential details that produce the quasi-monoenergetic witness bunches seen in experiment. Furthermore, we will discuss the associated challenges in maintaining numerical stability and experimental comparability of these long-duration simulations.

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Session Classification: WG6

Track Classification: WG6 - Theory and simulations

Contribution ID: **167** Type: **talk**

Evolution of relativistic transparency in nanometer-scale targets

Thursday, September 19, 2019 4:40 PM (20 minutes)

When a multi-terawatt laser pulse is incident onto a nanometer-scale target, strong electron heating and plasma expansion occurs. As the plasma expands, the target experiences a change in electron density which affects the type of interaction occurring. Of particular interest is the regime of relativistic transparency, when the target density drops below the relativistic critical density, γn_{crit}, and laser light is able to penetrate and transmit through the target.
When a 45 fs terawatt laser pulse with a_0 of 12.5 is incident onto a nanometer scale target, information on the plasma dynamics can be obtained from the optical diagnostics. In particular, the percentage of reflected and transmitted light as well as their spatial profiles is shown to be a good indication of electron density and target heating. Supporting simulations show rate of electron heating varying from 0.1 −1.7 MeV for different polarisations and targets in the range of 2-100nm. A strong correlation with plasma expansion is also seen. These results will be discussed and will be presented alongside analytical expectations.

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Session Classification: WG2

Track Classification: WG2 - Ion beams from plasmas

Contribution ID: **168** Type: **talk**

Elimination of Hosing Instability Via Ion Motion in Plasma Wake Field Accelerator

Thursday, September 19, 2019 4:30 PM (20 minutes)

Hosing instability is the most important instability needs to be controlled when building a future linear collider using plasma based acceleration. The normal method for mitigating the hosing instability requires energy chirps on the beam or longitudinally varying focusing force. However, these methods require additional manipulation on the witness beam, and the beam centroid oscillation exists all the time, which may result in additional emittance growth due to nonlinear process. In this work, we present a natural way to eliminate the hosing instability when accelerating an electron beam in a nonlinear plasma wake field through the plasma ion motion. The ion motion is caused by the large Coulomb force around the tightly focused beam. In fully resolved quasi-static particle-in-cell simulations, the initial centroid offset of the witness beam can be rapidly damped to zero. The emittance growth of the witness beam is acceptable and dependent on its initial seed for the hosing instability.

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Session Classification: WG1-WG6-WG8 Joint Session - Towards high energies and high qualities

Track Classification: WG1-WG6-WG8 Joint Session

Contribution ID: **169** Type: **talk**

Updates on QuickPIC Open Source

Tuesday, September 17, 2019 4:40 PM (20 minutes)

QuickPIC is a 3D parallel quasi-static PIC code for efficiently simulating the plasma based accelerator (PBA). It is developed based on the framework UPIC. QuickPIC has been widely used and played an important role in studying PBA problems. In 2017, we made QuickPIC an open source code on Github (https://github.com/UCLA-Plasma-Simulation-Group/QuickPIC-OpenSource). The open source QuickPIC was written in an object-oriented way using Fortran 2003. Recent development of QuickPIC will be introduced in this presentation including the field ionization module, the laser module and 2D QuickPIC in r-z cylindrical coordinates.

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Session Classification: WG6

Track Classification: WG6 - Theory and simulations

Contribution ID: **170** Type: **poster**

The SCAPA facility: Pioneering novel applications for next generation laser plasma accelerators

Monday, September 16, 2019 7:00 PM (1 hour)

Laser wakefield accelerators are highly tuneable sources of radiation with a correspondingly varied number of potential applications, including ultrafast imaging, high energy physics and radiation therapy. The Scottish Centre for the Application of Plasma-based Accelerators (SCAPA) is a facility designed to allow proof of concept investigations towards the realisation of next generation laser plasma accelerators to be performed. One beamline at SCAPA is dedicated to laser wakefield acceleration, driven by a 350 TW Ti:sapphire laser operating at up to 5 Hz at full power. The beamline will be used to study a variety of topics and is currently in the commissioning and first experiments stage. A deformable mirror coupled to a wavefront sensor has been utilised to improve the laser focal spot. Planned usage of the beamline includes characterisation of the betatron X-ray source spectrum and spatial profile using bespoke X-ray optics; generation of attosecond electron bunches by use of a tailored plasma density profile; and radioisotope production. Recent results will be presented alongside future planned experiments.

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Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **172** Type: **talk**

Generation of a spectrally two-component electron beam in a laser-wakefield accelerator

Thursday, September 19, 2019 6:20 PM (20 minutes)

A new take on ionization-assisted shock-front injection was used to create spectrally two-component beams in a laser-wakefield accelerator, with the goal of investigating the possibilities for such an injection scheme for beam-driven plasma-wakefield acceleration. Ionization injection was combined with shock-front injection to provide characteristic spectra with a broadband, continuous part from the ionization injection and a quasi-monoenergetic, spectrally separated peak at higher energies from the shock-front injection. This beam was subsequently sent into a second gas jet, which was pre-ionized by the laser pulse. As a result, electron beam divergence increase and deceleration was observed in the ionization-component and transverse focusing was observed for the shock-component. Under certain circumstances, an energy increase was also observed for the shock-component. These interactions were also typically accompanied by very collimated betatron X-ray beams with divergences of only a few mrad RMS, which suggests emission from an oscillation with a corresponding undulator K-parameter on the order of 1.

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Session Classification: WG1 - Hybrid staging and future PWFA experiments

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **173** Type: **poster**

Employing double-achromat bunch compressors for plasma-wakefield accelerator experiments

Monday, September 16, 2019 7:00 PM (1 hour)

Plasma-wakefield acceleration is a promising technique for future accelerators in that it can deliver significantly higher (factor of ~100-1000) accelerating fields compared to conventional RF accelerators, and also be used to generate beams of ultralow (⊠0.1 mm mrad) normalized emittance. However, many challenges remain to be overcome, one of which is the hose instability, where a witness bunch (in the case of external injection) or part of the driver bunch is offset transversely from the propagation axis. This can lead to severe beam degradation and –loss, particularly for tightly focused beams of low emittance. In the past few years, much progress has been made to understand the mechanisms of this instability and to mitigate its effects, but the most obvious way to circumvent the whole ordeal is to remove the offsets altogether. We have studied the use of double-achromat bunch compressors, within the setting of the MAX IV linear accelerator, to remove transverse offsets stemming from leaking higher-order dispersion and coherent synchrotron radiation, for the specific use in plasma-wakefield acceleration.

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Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **174** Type: **talk**

Ion motion and hosing suppression in plasma-based accelerators

Thursday, September 19, 2019 4:50 PM (20 minutes)

Plasma accelerators have been proposed as drivers for the next generation of colliders. Achieving high efficiency while preserving excellent beam quality (low emittance) is critical to realizing this application. High efficiency requires large longitudinal wakefield excitation by the witness beam, and this has an associated large transverse wakefield that will drive the hosing instability. Furtheremore, for high-energy beams with low emittance, the focusing forces in the plasma will pinch the witness beam and increase the beam density, orders of magnitude above the background ion density, leading to ion motion. This results in nonlinear focusing and emittance growth.
We present a solution to mitigate the hosing instability in plasma accelerators that relies on ion motion. The response of the ions to a high-density beam is described, including the coupling to the hosing instability. It is shown that the ion-motion-induced head-to-tail variation in the focusing experienced by the beam suppresses hosing.
A class of initial beam distributions are identified that are equilibrium solutions in the plasma wakefield, including ion motion. Using these beam distributions enables ion motion without emittance growth. Hence, stable acceleration in plasma-based accelerators is possible, while, by using proper bunch shaping, minimizing the energy spread and preserving the emittance.

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Session Classification: WG1-WG6-WG8 Joint Session - Towards high energies and high qualities

Track Classification: WG1-WG6-WG8 Joint Session

Contribution ID: **175** Type: **poster**

Simultaneous Space Time Focusing in Controlled Ionisation Injection

Monday, September 16, 2019 7:00 PM (1 hour)

Controlling the injection and trapping of electrons into plasma wakefields is key to improving the beam quality and reproducibility of accelerated beams. Injecting electrons into a narrow $(_{r\ p})$ transverse region of the wakefield is fundamental to achieving low beam emittance. Brief $(T_{inj}\ L_{acc}/c)$ injection into a short $(_{z\ p})$ longitudinal region yields low energy spread. Several schemes have been proposed for controlling injection by generating electrons within the wakefield itself by laser ionisation of a dopant species. These include Trojan Horse, Two-Pulse Ionization Injection (2PII), Resonant Multi-Pulse Ionization Injection (REMPI) and Two-Colour Laser-Ionization Injection. In this work we investigate how simultaneous space-time focusing (SSTF) of the injection pulse can reduce both the volume and duration of ionisation injection.

To test these ideas we investigate the use of SSTF pulses in the Trojan Horse scheme. We use PIC simulations to show that a correctly tailored SSTF pulse can reduce the normalized transverse emittance of the injected and accelerated bunch ($E = 350$ MeV) from $_N = 100$ nm rad to $_N = 6$ nm rad. The approach we present could be applied to injection schemes based on laser ionisation injection

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Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **177** Type: **talk**

A tunable plasma-based energy dechirper

Tuesday, September 17, 2019 5:00 PM (20 minutes)

A tunable plasma-based energy dechirper has been developed at FLASHForward to remove the correlated energy spread of a 681 MeV electron bunch. Through the interaction of the bunch with wakefields excited in plasma the projected energy spread was reduced from a FWHM of 1.31% to 0.33% without reducing the stability of the incoming beam. The experimental results for variable plasma density are in good agreement with analytic predictions and three-dimensional simulations. The proof-of-principle dechirping strength of 1.8 GeV/mm/m significantly exceeds those demonstrated for competing state-of-the-art techniques and may be key to future plasma wakefield-based free-electron lasers and high energy physics facilities, where large intrinsic chirps need to be removed. This exciting first result of its type, as well as the methods employed to achieve it, will be outlined in this contribution.

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Presenter: D'ARCY, Richard (DESY)

Session Classification: WG5 - Beam Transport

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **178** Type: **talk**

A plasma-based accelerator beamline for ultra-low energy spread beams in the 1 GeV range

Wednesday, September 18, 2019 4:20 PM (20 minutes)

A new multi-stage concept for plasma-based accelerators which could achieve unprecedented performance in terms of energy spread has recently been proposed. This concept considers splitting the acceleration process into two identical plasma stages joined by a magnetic chicane in which the beam chirp is inverted. So far, this concept has been explored in the context of the EuPRAXIA project for the production of 5 GeV beams. Here, we present an extension of this accelerating scheme towards the 1 GeV range, where the requirements on the laser system are less stringent and could be realized with current technology.

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Session Classification: WG6-WG8 Joint Session

Track Classification: WG6-WG8 Joint Session

Contribution ID: **179** Type: **talk**

Stable positron acceleration in self-generated hollow channels

Wednesday, September 18, 2019 6:00 PM (20 minutes)

Hollow plasma channels are promising candidates for the acceleration of electron and positron beams as the transverse forces are nearly vanishing inside the hollow channel. The acceleration is effective as long as the accelerated bunches are perfectly cylindrically symmetric and injected on the axis of the hollow channel structure. Furthermore, the accelerating fields can also be nearly constant provided that the accelerated bunch current profile is appropriately tailored. These features make it fundamentally possible to preserve beam quality during the acceleration. In realistic situations, however, small asymmetries in the beam profile or small misalignments between the beam and the hollow channel axis will seed the growth of the beam breakup instability, thus stopping the acceleration prematurely and degrading beam quality substantially. These beam breakup instabilities are a severe limitation on the use of hollow channels for particle acceleration.

Here, we investigate a new mechanism for stabilization of positron acceleration in hollow channels. Using theory and particle-in-cell simulations with the code OSIRIS, we show that the ion motion associated with the wakefield force can form a hollow plasma channel self-consistently. A second particle beam then drives a nonlinear plasma wave with focusing and accelerating fields for positrons.

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Session Classification: WG6 - Proposed solution(s) to physical problem, Envelope PGC model

Track Classification: WG6 - Theory and simulations

Contribution ID: **180** Type: **poster**

Parameter studies on dielectric gratings as electron accelerators

Monday, September 16, 2019 7:00 PM (1 hour)

Dielectric laser driven particle acceleration (DLA) is one of the candidates for novel high-gradient technologies to reduce the footprint of large scale particle acceleration facilities. On the other hand these devices can be used to interact with the particle beams of state-of-the-art photon science machines, especially with FELs, to manipulate the longitudinal phase space in a compact and cost effective way. The near-field surface modes of dielectric gratings can be used to interact with particle beams close to the surface. To achieve transversely homogeneous accelerating fields two gratings are opposed. The laser can be coupled from the side into the structure. In this work we present a study on the influence of the geometry parameters of the grating on the acceleration gradient and its transverse uniformity. Based on this study a design for production was chosen, which will be used for experiments at the ARES linac within the SINBAD facility at DESY. This work was carried out within the ACHIP project funded by the Gordon and Betty Moore Foundation (GBMF 4744).

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Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **181** Type: **talk**

Dosimetry of laser-accelerated carbon ions for cell irradiation at ultra-high dose rate

Monday, September 16, 2019 4:20 PM (20 minutes)

Charged particle radiotherapy is nowadays used in an increasing number of centres worldwide.
In particular, carbon ions have shown many advantages for the treatment of radioresistant tumours, thanks to their higher Linear Energy Transfer (LET) and Relative Biological Effectiveness (RBE).
The complexity of the conventional carbon therapy facilities has stimulated the investigation of alternative acceleration approaches such as the processes based on high-power laser interaction with solid targets.
Particularly, recent results demonstrating Radiation Pressure Acceleration (RPA) of carbon ions allowed us to investigate for the first time the biological effects of carbon ions at ultra-high dose-rate (109-1010 Gy/s) using the GEMINI laser system at Rutherford Appleton Laboratory (RAL).
Carbon ions up to 20 MeV/u were accelerated from ultrathin (10-20 nm) carbon foils and energy selected by a magnet allowing to irradiate the cells with an average carbon energy of 10 MeV/u +-10%.
A new dosimetry approach was required based on the use of unlaminated EBT3 Radiochromic films, specifically designed for these low-energy ions and calibrated using an innovative procedure. The details of the dosimetry procedure and the outcomes of the experiment will be presented in this contribution.

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Presenter: MILLUZZO, Giuliana (Queen's University Belfast)

Session Classification: WG4

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **183** Type: **talk**

Single Shot High Transformer Ratio Measurements in the Nonlinear Plasma Regime

Tuesday, September 17, 2019 5:00 PM (20 minutes)

We demonstrate the first single shot measurement of a multi-period, loaded PWFA wakefield, used to conduct measurements of the transformer ratio (TR), the ratio between the maximum accelerating and decelerating fields in a collinear wakefield accelerator, that far exceed previous measurements. The emittance exchange beamline at the Argonne Wakefield Accelerator was used to create a variable longitudinal drive profile with a long witness to sample multiple wakefield periods. A TR exceeding the limit of 2 for longitudinally asymmetric beams was observed for a linear ramp and wakefield flattening was observed for a beam with a parabolic head. These effects are important for efficient energy transfer from drive to witness beam, and for lengthening the interaction length of the process. Furthermore, by adjusting plasma density parameters, multi-period plasma wakefields were observed transitioning from linear to nonlinear regimes leading to experimental verification of theoretical wakefield properties. 3D Particle in cell simulations are used throughout to support the experimental findings.

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Presenter: ANDONIAN, Gerard (UCLA)

Session Classification: WG1 - Plasma acceleration physics I

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **184** Type: **talk**

Electron Beam Driven Wakefield Generation at the AWA Facility

Wednesday, September 18, 2019 4:00 PM (20 minutes)

Electron beam driven wakefield acceleration has been the main focus of research at AWA for many years, using high charge electron bunches (1 to 100 nC) for both Structure Wakefield Acceleration (SWFA) and Plasma Wakefield Acceleration (PWFA). We will present recent experimental results obtained with several types of X-band structures: metallic, dielectric loaded, photonic band gap (PBG), and metamaterial (MTM). RF pulses of a few hundred MW have been generated.

Primary authors: CONDE, Manoel (Argonne National Laboratory); ANTIPOV, Sergey (CERN); DORAN, D.Scott (Argonne National Laboratory); HA, Gwanghui (Argonne National Laboratory); JING, Chunguang (Euclid Techlabs / ANL); LIU, Wanming (Argonne National Laboratory); PENG, Maomao (Tsinghua University); POWER, John G.; ROUSSEL, Ryan (University of California Los Angeles); SEOK, Jimin (Ulsan National Institute of Science and Technology); SHAO, Jiahang (Argonne National Laboratory); WHITEFORD, Charles (Argonne National Laboratory); WISNIEWSKI, Eric (Illinois Institute of Technology)

Presenter: CONDE, Manoel (Argonne National Laboratory)

Session Classification: WG3 - Dielectric Beam-driven Acceleration Thz acceleration

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **185** Type: **poster**

Three dimensional bunch shaping for plasma wakefield accelerators

Monday, September 16, 2019 7:00 PM (1 hour)

Beam driven wakefield acceleration in plasmas is one of the most promising candidates for novel, compact accelerators. Several aspects of this acceleration scheme can be optimised by transverse and longitudinal shaping of the bunch that drives the wake and of the bunch that is accelerated in the wake. The ratio between acceleration of the witness and deceleration of the driver, the transformer ratio, can be increased when triangular driver bunch shapes are utilised. By shaping the witness bunch longitudinal profile, the beam loading of the wake can be tuned, which allows reduction of the energy spread of the accelerated beam. The necessary bunch shaping can be achieved by shaping of the photocathode laser pulses of a photoinjector. Here, we present simulations and first results of transverse and longitudinal bunch shaping with the new photocathode laser system at PITZ, with a pulse shaping section based on spectral masking using spatial light modulators.

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Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **186** Type: **poster**

Experimental investigation of hosing instability mitigation

Wednesday, September 18, 2019 7:00 PM (1 hour)

Beam-driven plasma wakefield accelerators (PWFAs) allow for high gradient acceleration of electron beams and hence are promising candidates for compact and cost-efficient drivers of applications demanding high brightness beams. One of the main challenges in these accelerators is to control beam-plasma instabilities with rapid growth rates which are induced by the strong transverse components of the wakefields. The hosing instability, a growing transverse oscillation of the beam centroid caused by inhomogeneities in the focusing wakefields, was predicted to set severe limits on the possible acceleration distance in PWFAs. Several methods have been proposed to damp or even suppress the growth of the particle deflections in the affected beam and thus prevent beam-break-up. Here, we present preparations and simulation studies aiming at the experimental investigation of hosing suppression mechanisms at the PITZ facility.

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Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **187** Type: **talk**

Bulk ion acceleration from ultrathin foils in PW-class interactions on the ASTRA GEMINI laser

Thursday, September 19, 2019 5:00 PM (20 minutes)

During the interaction of ultra-intense laser pulses with ultrathin foils, advanced mechanisms of ion acceleration take place which can be controlled and optimized in view of further progress towards high energy ranges of medical relevance on upcoming multi-PW facilities.
In the framework of the activities of the UK-wide A-SAIL project, recent campaigns at the ASTRA GEMINI laser facility (Rutherford Appleton Laboratory) have investigated and characterised ion acceleration from 2-100 nm thick Carbon foils irradiated by 40 fs laser pulses at intensities of 1020-1021 W/cm2. The experiments have highlighted a strong dependence of the ion energy from the target thickness and the laser polarisation, and suggested the onset of Light Sail Radiation Pressure acceleration from the bulk of the target when using circularly polarized pulses.
Following initial results (published in PRL, 119, 054801, 2017), following campaigns have led to an enhancement of the ion energies (up to ~35 MeV/n for Carbon 6+) and to observations of an intensity-dependent optimal thickness, consistently with analytical predictions. Comparison with extensive Particle-in-Cell simulations clarifies the complex interplay of multispecies dynamics during the acceleration, as well as the role of relativistically-induced transparency, and allows predictions of future performance at increased laser power and intensity.

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Session Classification: WG2

Track Classification: WG2 - Ion beams from plasmas

Contribution ID: **189** Type: **poster**

Chromatic Effects on Plasma Channels Formed with an Axicon Lens

Wednesday, September 18, 2019 7:00 PM (1 hour)

Laser Plasma Accelerators (LWFAs) operating in the linear and quasi-linear regime require the driving laser pulse to be guided over the length of the accelerator stage. Multi-GeV plasma stages, for example, require the driving pulse to be guided over 100s of millimetres of plasma of density $n_\mathrm{e}(0) \approx 10^{17}\ \mathrm{cm}^{-3}$. These challenging parameters can be met by hydrodynamic optical-field-ionized (HOFI) plasma channels.

In a HOFI plasma channel, OFI within a line focus generates a hot plasma column; this expands rapidly to drive a cylindrical shock wave, within which is formed a low density plasma channel. In our first demonstration of this approach the initial line focus was generated by a refractive axicon lens. Although plasma channels with the desired properties were generated, the incident intensity required to generate them was significantly higher than expected.

In this study, the effects of dispersion within the axicon on the intensity of the axicon focus are studied. The results of analytic and numerical simulations are presented; these are found to be in excellent agreement and suggest that chromatic aberrations were **not** significant in this case. Alternative reasons for the higher than expected threshold intensity are discussed.

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Presenter: ROSS, Aimee (University of Oxford)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **192** Type: **poster**

Advances in plasma-based beam dump modelling

Wednesday, September 18, 2019 7:00 PM (1 hour)

Plasma beam dumps use the large decelerating wakefields sustained by plasmas to achieve compact deceleration of spent beams. Besides the higher efficacy to absorb beam energy, plasma beam dumps are also safer if compared to conventional beam dumps. This is due to the lower production of radioactivation hazards in the low-density plasma medium. In this work, existing analytical models to estimate the beam energy loss for both passive and active beam dump schemes are reviewed. In the passive scheme, an electron beam undergoing a quiescent plasma is decelerated by its self-driven wakefield. In the active case, a beam or laser-driven wakefield enhances beam deceleration. For the passive case in particular, tailored plasma density profiles can improve beam-energy extraction by mitigating particle re-acceleration. A semi-analytical model, based on the dynamics of test-particles experiencing the existing wakefields, is presented for deceleration in the linear regime. Built upon previous models, which rely on the frozen-beam approximation, the semi-analytical model includes collective beam deformation as well as re-acceleration and defocusing of particles in the beam. This includes the formation of secondary beam density peaks due to particle re-acceleration. This information can be used to prevent decelerated beam particles from becoming highly relativistic again.

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Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG6 - Theory and simulations

Contribution ID: **193** Type: **talk**

Ultra-compact X-ray FEL Based on Advanced Cryogenic RF techniques

Tuesday, September 17, 2019 11:40 AM (30 minutes)

Recent advances in high gradient cryogenic copper structures RF research have opened the door to a use of surface electric fields between 250 and 500 MV/m. Such structures can be used to enable a new generation of photoinjectors with brightness an order of magnitude beyond the state-of-the-art. In addition, one may accelerate these beams to GeV scale in <10 m. Such an injector, when combined with ESASE bunching techniques can produce multi-kA beams with ~50 nm-rad emittance. These beams, when injected into innovative, short-period (1-10 mm) undulators based on advanced manufacturing technique enable ultra-compact X-ray FELs having footprints consistent with university-scale laboratories. We discuss the design and performance of this novel light source, which promises photon production per pulse of a few percent of existing XFELs. In the context of a nascent project on UCLA to develop this instrument, we review implementation issues including collective beam effects, compact X-ray optics systems, and various technical challenges. To illustrate the potential of such a light source to fundamentally change the current paradigm of XFELs with their limited access, we examine possible applications in biology, chemistry, materials, and atomic physics which may take advantage of this new model of performing XFEL science.

Primary author: ROSENZWEIG, James (UCLA)

Presenter: ROSENZWEIG, James (UCLA)

Session Classification: Plenary Session 4

Track Classification: Invited Plenary Talk

Contribution ID: **194** Type: **talk**

Measuring Transverse Displacement Between the Drive and Witness Beam for PWFA

Tuesday, September 17, 2019 6:20 PM (20 minutes)

Future beam-driven plasma wakefield accelerator (PWFA) experiments at the Facility for Advanced Accelerator Experimental Tests (FACET-II) will require several detectors monitoring a multitude of plasma and electron bunch parameters. We present simulations demonstrating the ability of an electro-optic sampling beam position monitor (EOS-BPM) to analyze the femtosecond electron bunches that will be employed at FACET-II. This diagnostic consists of two electro-optic crystal stationed on either side of the beamline. The electric fields co-propagating with the electron bunches induce a birefringence in the crystals which is probed via a chirped laser pulse allowing for a single, non-destructive measurement of the longitudinal profile of the bunches. In addition, the use of two EO crystals allows for determination of the relative transverse offset of the two bunches by leveraging the signal strength dependence on the proximity of each bunch to a given crystal. Utilizing the experimental parameter set for FACET-II, we study the optimal configuration for the laser and crystals and calculate the expected longitudinal and transverse resolution.

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Presenter: HUNT-STONE, Keenan (Univ. of Colorado, USA)

Session Classification: WG5

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **199** Type: **poster**

Guiding of high-intensity laser pulses through long, low-density hydrodynamic optical-field-ionised (HOFI) plasma channels

Wednesday, September 18, 2019 7:00 PM (1 hour)

To realise a 10 GeV laser plasma accelerator stage, high-intensity pulses must be guided through low-density ($\sim 1\times10^{17}\mathrm{cm}^{-3}$) plasma over distances of order 100s of millimeters.

We recently presented simulations which showed that plasma channels with these parameters could be generated by the hydrodynamic expansion of optical-field-ionised plasma columns formed with an axicon lens [1], and experiments using a spherical lens which demonstrated the generation of short (~ 4 mm long) low-density channels.

Here we report new experiments which demonstrate the formation of 16-mm-long channels with on axis densities as low as $1.5\times10^{17}cm^{-3}$ using an axicon lens [2]. Only 0.5 mJ of channel-forming laser energy was required per mm of channel. The hydrodynamic expansion of the plasma column and the properties of the resulting plasma channels are characterized by transverse interferometry. High-quality, highly reproducible guiding of pulses with peak axial intensities exceeding $4\times10^{17}\mathrm{Wcm}^{-2}$ through these channels is demonstrated at a repetition rate of 5 Hz.

We also report progress in using reflective axicons to generate HOFI plasma channels with lengths greater than 100 mm.

[1] Shalloo, R. J., et al. (2018) https://doi.org/10.1103/PhysRevE.97.053203

[2] Shalloo R. J., et al. (2019) https://doi.org/10.1103/PhysRevAccelBeams.22.041302

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Presenter: PICKSLEY, Alex (University of Oxford)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **200** Type: **talk**

Online Diagnostics and Stabilisation of the ANGUS 200 TW Laser

Thursday, September 19, 2019 4:00 PM (20 minutes)

Laser-plasma accelerators are prominent candidates to drive a next generation of high-brightness x-ray sources. The LUX laser-plasma accelerator, driven by the ANGUS 200 TW laser, has recently demonstrated the generation of few-nm-plasma-driven undulator radiation. Long-term operation of the plasma accelerator with reproducible and stable electron beams requires a highly stable drive laser. To reach this goal, we have integrated the ANGUS laser in an accelerator-grade control system. Enabled by the analysis tools at every stage we observe that changes in the front-end of the amplifier chain have a direct impact on both, laser parameters in all amplification stages and the properties of the generated electrons. We will report on long-term-drifts we have observed during laser operation and their effects on the laser system. Furthermore, we will present methods to stabilise the laser against these drifts.

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Presenter: MAIER, Andreas (Univ. Hamburg / CFEL)

Session Classification: WG7

Track Classification: WG7 - High brightness power sources: from Laser Technology to beam drivers

Contribution ID: **201** Type: **poster**

Novel method for transverse probing of low-density, hydrodynamic optical-field-ionised plasma channels

Monday, September 16, 2019 7:00 PM (1 hour)

Guiding high-intensity laser pulses over long distances through low density plasma ($\sim 1{\times}10^{17}\ \mathrm{cm}^{-3}$) is one of the key challenges to create laser plasma accelerators for high energy physics and industrial applications. We recently demonstrated that low density channels suitable for such guiding could be generated by the hydrodynamic expansion of optical-field-ionised plasma columns formed with an axicon lens.
Recently, we generated 16 mm long channels with on axis densities as low as $1.5 \times 10^{17}\ \mathrm{cm}^{-3}$ and demonstrated highly reproducible guiding of high-intensity pulses over 14 Rayleigh ranges [1]. Control of the channel parameters via adjustment of the initial cell pressure or the delay after the arrival of the channel-forming pulse was demonstrated.
Characterising these plasma channels via transverse probing is challenging since the phase shift through low-density plasma is on the order of 20 mrad, and a slight azimuthal asymmetry of the channel was observed. A novel, forward-fitting algorithm is presented, along with statistical fitting used to characterise channels. We present electron density profiles with parameters ideal for laser wakefield accelerators, with matched spot sizes in the range $20 \leq W_M \leq 40\mu\mathrm{m}$.

[1] Shalloo, R. J., et al., (2019), https://doi.org/10.1103/PhysRevAccelBeams.22.041302

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Presenter: PICKSLEY, Alex (University of Oxford)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **202** Type: **talk**

Electron acceleration in merging laser wakefields

Tuesday, September 17, 2019 6:00 PM (20 minutes)

Merging laser beams can be used to replenish the driver in a seamless multistage laser-plasma accelerator, and can enhance the X-ray emission produced by betatron electron oscillations. We experimentally demonstrate merging of two laser wakefields in plasma. A 150 TW peak-power laser beam is split in two halves which are focused at a small angle in a gas. Each laser pulse drives a plasma wakefield and accelerates relativistic electrons. When the laser pulses are synchronized, a single, high-charge electron beam is emitted along the bisector angle.

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Presenter: LUNDH, Olle (Lund University)

Session Classification: WG1 - Plasma acceleration physics II and high rep rates

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **205** Type: **talk**

Positron transport and acceleration in beam-driven plasma wakefield accelerators using a plasma column

Wednesday, September 18, 2019 5:00 PM (20 minutes)

The transport and acceleration of positron beams is a crucial challenge on the path towards plasma-based particle colliders. We propose a scheme that allows for the simultaneous acceleration and transport of positron beams in plasma wakefield accelerators. A finite-radius plasma column is employed, leading to a reduction of the restoring force acting upon the plasma electrons forming the plasma wake, which results in an elongation of the on-axis return point of the electrons and, hence, creating a long, high-density electron filament. As demonstrated by means of 3D PIC simulations, this filament induces the formation of a wakefield region that enables the acceleration and quality-preserving transport of 100 pC-scale positron beams for a range of plasma densities and drive beam parameters.

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Presenter: DIEDERICHS, Severin (University of Hamburg/DESY/LBNL)

Session Classification: WG6-WG8 Joint Session

Track Classification: WG6-WG8 Joint Session

Contribution ID: **206** Type: **talk**

Few-Cycle Microscopy of Stimulated Raman Side Scattering in a Laser Wakefield Accelerator

Thursday, September 19, 2019 6:40 PM (20 minutes)

We report on optical probing results using few-cycle microscopy obtained during a laser wakefield acceleration experiment carried out with the JETI-200 laser system at the Helmholtz-Institute Jena. When traveling through the plasma and exciting a plasma wave, the pump pulse can get scattered at plasma structures depending on the pump pulse's evolution inside the plasma, its chirp and the plasma electron density. This (stimulated) Raman Side Scattering (SRSS) was investigated using Few-Cycle Microscopy on a micrometer scale. Experimental results and numerical simulations will be presented.

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Session Classification: WG5-Targets

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **207** Type: **talk**

Investigating the stability of a GeV-class laser wakefield accelerator using few-cycle shadowgraphy and polarimetry

Monday, September 16, 2019 6:40 PM (20 minutes)

Wakefield acceleration of electrons to energies in the GeV range has been performed with a multitude of methods e.g. laser driven, particle driven or by a combination of the two. The overall improvement of the stability in terms of energy, pointing and emittance marks the path from acceleration to an accelerator. The injection process hereby plays a central role.
Using few-cycle microscopy to observe the evolution of the plasma wave's shape already gives a pristine insight into the laser-plasma interaction. Furthermore, using polarimetry the magnetic fields of the accelerated electron bunch and of the wakefield itself are accessible. The interplay of the laser pulse's evolution and the generated magnetic fields will be presented in this talk together with their role during the injection and accelerating process.

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Session Classification: WG1-WG5 Joint Session - Ultrafast Dynamics Metrology

Track Classification: WG1-WG5 Joint Session

Contribution ID: **209** Type: **poster**

Stability analysis of plasma photocathode produced ultrahigh brightness electron beams

Wednesday, September 18, 2019 7:00 PM (1 hour)

The plasma photocathode particle-driven Wakefield accelerator (TH-PWFA) is a promising path towards ultrahigh 5D-brightness and multi-GeV electron beams for application such as X-Ray free-electron laser (XFEL), inverse Compton scattering (ICS) and High Energy Physics (HEP). Recent experimental breakthroughs within the "E210: Trojan Horse PWFA" collaboration obtained at Stanford Linear Accelerator Center (SLAC) FACET and new conceptual energy spread reduction method suggest that unprecedented ultrahigh 6D brightness electron beams can be generated in university-scale laboratories. However, applications such as XFEL, ICS, and HEP require tight control over the shot-to-shot electron beam parameters for reliable operation. Therefore, for a mature technology, the evaluation of electron beam parameter stability is a mandatory task. Here, we report on a systematic jitter analysis of the plasma photocathode method generated electron beams in PWFA. We evaluate the influence of the injection laser pulse jitter and the charge particle driver beam on the trapped electron beam quality. The results from this study indicate that the electron beam parameter shot-to-shot stability is comparable to the state-of-the-art rf-based accelerators. These findings are very encouraging for the upcoming experimental campaigns at SLAC FACET-II: e.g "E310: Trojan Horse-II" and "E313: Multibunch dechirper for ultrahigh 6D brightness beams".

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Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **210** Type: **talk**

Scalable laser-plasma acceleration using Traveling-Wave Electron Acceleration

Thursday, September 19, 2019 5:10 PM (20 minutes)

While laser-plasma accelerators provide multi-GeV electron beams today, the acceleration to higher energies is limited. The sub-luminal group-velocity of plasma waves let electrons outrun the accelerating field. We present Traveling-Wave Electron Acceleration, a novel compact laser-plasma accelerator scheme which circumvents the LWFA constraints of electron beam dephasing, laser pulse diffraction and depletion.

For controlling the speed of the accelerating plasma cavity, TWEAC utilizes two pulse-front tilted lasers whose propagation directions enclose a configurable angle. The accelerating cavity is created along their overlap region in the plasma and can move at the vacuum speed of light. Such guiding-structure-free, lateral coupling of lasers into the plasma allows the field within this overlap region to be continuously replenished by the successive parts of the laser pulse. Supported by 3D particle-in-cell simulations, we show that this leads to quasi-stationary acceleration conditions for electron bunches along the total acceleration length, such that TWEAC is in principle scalable to arbitrarily long acceleration stages.

We discuss scaling laws and detail experimental design considerations. We find that for low-angle TWEAC setups, it is possible to accelerate nanocoulomb-class bunches with laser to electron beam energy efficiencies close to 50%, thus exceeding energy efficiencies typically attained with LWFA.

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Session Classification: WG1-WG6-WG8 Joint Session - Towards high energies and high qualities

Track Classification: WG1-WG8 Joint Session

Contribution ID: **211** Type: **poster**

Terahertz Fringe Fields Effects on the Beam Dynamics of a THz-driven Gun

Wednesday, September 18, 2019 7:00 PM (1 hour)

The nascent technology of terahertz (THz)-based electron acceleration holds great promise for development of compact relativistic electron sources with femtosecond bunch durations suitable for applications from ultrafast electron diffraction to injectors for THz-based accelerators and light sources. These so-called "THz guns"present unique capabilities, but also unique challenges associated with the small, millimeter-scale of the driving wavelength and the metallic structures. Here we present the results of simulations used to study the effects of fringing fields on the extracted electrons. The Thz gun considered is transversely pumped by two single-cycle THz pulses and possesses an interaction length and output orifice of 0.1 mm

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Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **212** Type: **poster**

High-brightness electron beams from hybrid LWFA-PWFA staging

Wednesday, September 18, 2019 7:00 PM (1 hour)

Plasma wakefield accelerators can provide gigavolt-per-centimetre energy gain, offering a promising path towards compact electron sources. They rely on the generation of plasma waves driven by either a high-current charged particle beam (PWFA) or an intense laser pulse (LWFA).
PWFAs offer particularly attractive regimes of injecting and accelerating a new high-quality electron beam, but typically require a large preceding accelerator providing the drive beam. However, compact laser-driven wakefield accelerators have recently demonstrated their capability of delivering such high-current electron beams with ideal drive beam properties.
This allows to combine both methods into a staged LWFA-driven PWFA, which effectively operates as a beam quality transformer.
Such a hybrid staging thus offers an attractive approach which promises to deliver high-brightness electron beams within a centimetre-scale accelerating structure.
The talk will summarise the unique aspects LWFA-driven PWFA and will present recent results of a first experimental implementation.
It will furthermore discuss current strategies for controlled injection towards the generation of high-brightness beams suitable for applications such as future compact light sources.

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Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **213** Type: **poster**

Characterization of optical properties of organic crystals required by high energy THz pulse generation for THz particle accelerators

Wednesday, September 18, 2019 7:00 PM (1 hour)

In accelerator physics, high energy THz radiation can be used for different purposes e.g. diagnostic, magnetic lenses, acceleration etc. For this purpose, it is needed a reliable source of high energy THz pulse. Between these sources, Optical Rectification by organic crystals has the highest optical conversion efficiency.
We are going to present new broadband measurements, from ultraviolet (36000 cm-1) to THz (50 cm-1), both in Transmittance and Reflectance, for the organic crystals HMQ-TMS and DSTMS. We will show the reconstructed optical properties for both crystals in all the frequencies range. From these data there will be shown new possibilities for high efficiency pumping wavelength in both crystals; it is to note an optimal pumping wavelength for the HMQ-TMS crystal at around 650nm. Using these data, simulations of the THz produced by Optical Rectification process will be presented for both crystals, showing how it will be possible to optimize the THz generation, to match the needs both in energy and spectra for the new applications in accelerators physics.

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Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **215** Type: **talk**

A Compact Gamma Ray Source Based on ICS

Wednesday, September 18, 2019 4:40 PM (20 minutes)

Inverse Compton Scattering is one of the best ways to generate mono-energetic gamma rays. After Tsinghu Thomson Scattering X-ray source –TTX has been developed and used as an experiment tool for advanced x-ray imaging and other applications, XGLS with the gamma ray energy of 3MeV is now under commissioning. In this paper, we will mainly descript the very compact gamma ray source with photon energy from 0.2 to 4.8MeV, which is newly designed. The linac is composed of an s-band photo-injector of energy 50MeV and 6 sections of x-band structures with gradient of more than 80MV/m to increase the electron energy to 350MeV. The electron bunch interacts with a 1.5J Ti:sapphire laser, and the flux of more than 10e9 ph/s can be generated. The length of the gamma-ray source is about 12meters long, which can be installed in a standard container.

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Session Classification: WG4 - Thomson

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **216** Type: **poster**

The dynamics and interplay of beam hosing and self-modulation in experimental conditions

Wednesday, September 18, 2019 7:00 PM (1 hour)

When long particle beams (compared to the plasma skin depth) propagate in plasma, they can be subject to two competing transverse instabilities: beam hosing and self-modulation. Hosing disrupts the beam and is considered a detrimental effect. Conversely, the self-modulation process can be seeded and exploited in plasma wakefield acceleration experiments to excite high-amplitude wakefields, while also suppressing the hose instability (as in the AWAKE experiment at CERN).

The initial growth stage of these instabilities has been studied in detail and can be described mathematically. Theory suggests, for example, that both instabilities can couple to each other when seeded at comparable levels, with the possible nefarious effect of enhancing hosing. Furthermore, and similarly with laser drivers, we also find that hosing will grow at different rates for different wavelengths of the perturbation (or modes). In this work we build on the available theory to investigate both of these effects, and use particle-in-cell simulations to consider them in regimes that are not accessible to linear theory. A deeper understanding of both the "coupled-hosing" regime and the evolution of different hosing modes will contribute to the evaluation of some of the experimental observations in AWAKE.

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Presenter: MOREIRA, Mariana (IST, CERN)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **217** Type: **poster**

Simulations study of compact and tunable active-plasma lens system for witness extraction and driver removal

Wednesday, September 18, 2019 7:00 PM (1 hour)

Plasma based technology will allow an unprecedented reduction of the size of accelerating machine. Both fundamental research and applied science and technology will take profit of this feature.
The same compactness is required downstream the accelerator module, where the plasma-accelerated beams usually experience a large angular divergences growth after the acceleration. Here compact, strong and tunable focusing devices are needed.
Active plasma lenses have been demonstrated to be a compact and affordable tool to generate radially symmetric magnetic fields several orders of magnitude larger than conventional quadrupoles and solenoids. In this contribution we will investigate the opportunity of using active plasma lenses and metallic collimators to catch and transport the witness bunch while removing the driver. Beam dynamics and particle-matter interaction simulations will be presented.

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Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **218** Type: **talk**

Coherent combination of unequal photonic crystal fibre lasers

Monday, September 16, 2019 6:00 PM (20 minutes)

There is increasing demand for high average, high peak power laser systems to drive laser wakefield plasma accelerators (LWFAs) at > kHz repetition rates. One promising route to these systems is the coherent combination of lower power laser systems and much attention has focused on fibre lasers as suitable candidates, in both filled and tiled aperture configurations. However, previous work has concentrated on the combination of exactly identical fibres. To achieve the pulse energies required for LWFA, many hundreds if not thousands of fibres would need to be combined together, which cannot all be entirely identical. In this work, we present research on the coherent combination of two photonic crystal fibre laser amplifiers with very different properties, reporting higher combined powers and combination efficiency than previously shown.

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Session Classification: WG7

Track Classification: WG7 - High brightness power sources: from Laser Technology to beam drivers

Contribution ID: **219** Type: **talk**

Full-scale modeling of plasma-based accelerators using ponderomotive guiding center solver in OSIRIS

Wednesday, September 18, 2019 6:20 PM (20 minutes)

Full 3D modeling of plasma-based accelerators using particle-in-cell (PIC) simulations is very computationally demanding. The use of a reduced model such as the ponderomotive guiding center algorithm (PGC) [1] allows us to bridge the large-scale disparity between the shortest (laser) wavelengths, which is in µm range, and the acceleration distance, which can exceed the meter range. Here, we present our implementation of a 3D PGC solver [2] into OSIRIS [3] which includes cylindrical, 3D cartesian coordinates and full ionization support. We discuss the potential of using PGC for parametric studies for down ramp injection and magnetic injection. Furthermore, we present the full 10 m modeling of the AWAKE experiment [4], detailing the laser ionization seeding of the self-modulation of the driving proton beam.

References:

[1] D. F. Gordon et al., IEEE Trans. Plasma Scii., 28(4), 1135 (2000)
[2] A. Helm et al. to be submitted J. Comput. Phys.
[3] R. A. Fonseca et. al., Lect. Notes Comp. Sci., 2331, 343 (2002)
[4] E. Adli et. al., Nature 561, 363–367 (2018)

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Session Classification: WG6 - Proposed solution(s) to physical problem, Envelope PGC model

Track Classification: WG6 - Theory and simulations

Contribution ID: **220** Type: **talk**

ELIMED: the first Users beamline dedicated to the irradiation studies with laser-driven ion beams

Monday, September 16, 2019 6:20 PM (20 minutes)

The main direction proposed by the community in the field of laser-driven ion acceleration is to improve particle beam features in order to demonstrate reliable approaches to be used for multidisciplinary applications. The mission of the laser-driven ion target area at ELI-Beamlines (Extreme Light Infrastructure) in Czech Republic, called ELI-Multidisciplinary Applications of laser-Ion Acceleration (ELIMAIA), is to provide stable, fully characterized and tunable beams of particles accelerated by Petawatt-class lasers and to offer them to the user community for multidisciplinary applications. The focusing, selecting, measuring and irradiating parts of ELIMAIA, constitutes the so-called ELIMED (ELI-MEDical and multidisciplinary applications) portion. At ELIMED, very high-dose-rate (not less than 10^5Gy/min) controlled proton and ion beams, with energy ranging from 5 to 250 MeV, will be transported up to the in-air section where absolute dosimetry will be carried out with a maximum expected error within 5%. First radiobiological campaign for in-vitro cells irradiation is scheduled for 2020. In this work, the beamline status will be reported along with a complete description of the dosimetric systems and the first calibrations. The expected final beam characteristics, in terms of dose per-pulse, dose-rate, beam spot size, directly derived by Monte Carlo simulations, will be reported, as well.

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Session Classification: WG2-WG4 Joint Session

Track Classification: WG2-WG4 Joint Session

Contribution ID: **221** Type: **poster**

Update on ALEGRO activities

Wednesday, September 18, 2019 7:00 PM (1 hour)

ALEGRO, the Advanced LinEar collider study GROup is an international study group promoting advanced and novel accelerators (ANAs) for high-energy physics applications. ALEGRO organizes one workshop each year as well as meetings at prominent ANAs conferences (EAAC, AAC, etc.). ALEGRO also submitted an input to the European Strategy for Particle Physics Update (ESPPU) process and was represented at the ESPPU meeting in Grenada. We will present a summary of the last workshop (CERN, March 26-29, 2019), as well as of the ESPPU meeting in order to inform the EAAC audience and encourage it to contribute to the important goals of ALEGRO.

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Presenter: ALEGRO, A. (ALEGRO)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG8 - Advanced and novel accelerators for High Energy Physics

Contribution ID: **222** Type: **talk**

Acceleration of electrons in the plasma wakefield of a self-modulated proton bunch

Wednesday, September 18, 2019 9:40 AM (30 minutes)

AWAKE is a proof-of-principle experiment to study proton driven plasma wakefield acceleration at CERN. Highly relativistic proton bunches (e.g. available at CERN) carry large amounts of energy (>20 kJ). They have the potential to excite ~GV/m plasma wakefields that can accelerate a witness bunch to TeV energies in a single plasma stage. The proton bunch length is on the order of 10 cm; much longer than the plasma electron wavelength at the densities needed to achieve GV/m field amplitudes. Thus, AWAKE relies on the transverse seeded self-modulation to modulate the long bunch into a train of microbunches. This microbunch train then resonantly drives high amplitude wakefields. In this contribution, we discuss the experimental results of AWAKE Run 1 (2016-2018) including: acceleration of externally injected 18.6 MeV electrons to GeV energies in 10m of plasma.

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Co-author: AWAKE COLLABORATION

Presenter: TURNER, Marlene (CERN)

Session Classification: Plenary Session 5

Track Classification: Invited Plenary Talk

Contribution ID: **223** Type: **talk**

Physics plans for AWAKE Run 2

Thursday, September 19, 2019 6:40 PM (20 minutes)

During its Run 1, AWAKE has very successfully demonstrated the self-modulation of long SPS proton bunches in plasma, as well as the acceleration of externally injected, 19MeV electrons up to 2GeV. The goal of Run 2 is to accelerate an externally injected electron bunch, i.e. charge >100pC to GeV energy with a narrow final energy spread and preservation of its incoming emittance. To achieve this goal, two plasmas will be used, the first one for self-modulation of the proton bunch and the second one for acceleration of the electron bunch. The plan is to include a plasma density step in the first source since numerical simulation results indicate that this allows for the wakefields to be maintained at near their peak value after theirs growth saturation. The parameters of the 165MeV electron bunch will be set to allow for plasma electrons blow-out within the wakefields driven by the proton bunch, matching to the pure ion column focusing, and loading of the wakefields. New plasma and beam diagnostics are also investigated. At the same time, plasma sources allowing for generating very long plasmas (10s to 100s of meter) are also actively developed. Physics plans and challenges will be presented.

Primary authors: MUGGLI, Patric (Max-Planck-Institut für Physik); AWAKE COLLABORATION

Presenter: MUGGLI, Patric (Max-Planck-Institut für Physik)

Session Classification: WG1 - Hybrid staging and future PWFA experiments

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **224** Type: **poster**

The AWAKE Run 2 Facility

Wednesday, September 18, 2019 7:00 PM (1 hour)

The AWAKE Run 1 experiment finished successfully its proof-of-concept program in 2018 by demonstrating the seeded self-modulation of a long proton bunch in plasma and accelerating externally injected electrons to GeV energies in 10m plasma.
AWAKE is now preparing for Run 2 planned to start in 2021 with the aim to achieve high-charge bunches of electrons accelerated to high energy, about 10 GeV, while maintaining beam quality through the plasma and showing that the process is scalable. By the end of Run 2 AWAKE should be in the position to use that scheme for first particle physics applications. To achieve this goal, two plasma sources will be installed, the first one used to self-modulate the proton beam and the second one to accelerate a high intensity, high energy electron bunch coming from a new electron source and beam line system. In addition new plasma and new beam diagnostics will be installed. An overview of the AWAKE Run 2 experiment will be given. The technical challenges of this new facility as well as the proposed schedule will be shown.

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Presenter: GSCHWENDTNER, Edda (CERN)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **225** Type: **talk**

Investigating extreme conditions using laser-wakefield accelerator sources

Thursday, September 19, 2019 4:20 PM (20 minutes)

High-intensity laser facilities can now routinely generate GeV electron bunches and broadband multi-keV X-rays using laser-driven wakefield accelerators. These energetic sources are ultra-short in duration (femtoseconds) with a small source size (microns) and low divergence (miliradians). They are also inherently synchronised to the drive laser itself, making pump-probe setups possible.

The TeX-Mex project aims to utilise these unique capabilities to perform experimental measurements of various physical phenomena in extreme conditions. This includes X-ray absorption measurements of high-energy-density samples which mirror the interior of large astrophysical objects, and the study of high-density photon interactions that give rise to QED and high-field processes such as Breit-Wheeler pair production and radiation reaction effects.

An overview of the project is given and a summary of recent results from experimental campaigns conducted by our group and on-going collaborations is presented.

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Presenter: KETTLE, Brendan (Imperial College London)

Session Classification: WG4

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **228** Type: **talk**

Spatial autocorrelation study for laser beam quality estimation

Tuesday, September 17, 2019 4:20 PM (20 minutes)

High brightness electron beam is required by several applications in the accelerator physics field, e.g., Plasma Wake Field Acceleration (PWFA) experiments and Free electron Laser (FEL) radiation sources. In order to have a high brightness beam, that means a high current and a low emittance beam, it is important to study, among other things, the beam's non uniformity due to the non perfect transverse laser beam uniformity. Regarding the transverse analysis of the beam, statistical tools as mean and standard deviation are usually used. In this contribution we will show how the autocorrelation function of a photocathode laser can be used for monitoring the spatial distribution of the beam non-uniformity, strictly connected with high the electron beam emittance: we will apply our analysis on the SPARC_LAB data.

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Presenter: SCIFO, Jessica (LNF)

Session Classification: WG3 - Particle Sources

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **229** Type: **poster**

The Effects of Tape-Based Plasma Mirrors on GeV Electron Beams, with a View to Staging Laser Wakefield Accelerators

Monday, September 16, 2019 7:00 PM (1 hour)

To overcome dephasing and pulse depletion while maintaining a high average accelerating gradient, staging multiple 10 GeV level Laser Wakefield Accelerators has been proposed. To minimise the total length of a staged accelerator laser beams must be introduced at an angle to the beamline. A convenient solution to reflect the intense laser pulse on to the beamline is to use a thin, moveable tape as a plasma mirror. Tapes can also be used to block depleted laser pulses from damaging later stages or beam optics.
We will present experimental results of the effects of tape-based plasma mirrors on 1-2 GeV electron beams. While the divergence increase of the electron bunch passing through 'cold'tape material was small, when the tape was used as a plasma mirror the laser-produced plasma caused a large increase in the beam divergence integrated over electron energy. Spectrally dispersed measurements of the electron beam indicate that the transverse momentum gain was correlated with longitudinal momentum. Consequent limitations of staging schemes will be discussed.

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Presenter: WOOD, Jonathan (Imperial College London)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG8 - Advanced and novel accelerators for High Energy Physics

Contribution ID: **230** Type: **talk**

High Flux X-ray Emission from a Large Radius Electron Bunch that was Injected after Significant Pulse Compression in a Laser Wakefield Accelerator

Thursday, September 19, 2019 6:00 PM (20 minutes)

A Laser Wakefield Accelerator producing two distinct electron populations: a 2 GeV component that was self-injected early in the interaction, and a sub-GeV component injected close to the laser depletion length, was shown to be an intense source of betatron x-rays. The x-rays were predominantly generated by the sub-GeV bunch.
Simultaneous measurements of the electron and x-ray spectra demonstrated that the larger oscillation radius of the sub-GeV beam was the main driver of the increased flux of emitted radiation, while the lower energy gain ensured moderate photon energies of 10-20 keV.
As many as 5×10^{10} x-ray photons with energies > 1 keV were recorded per laser shot, which has led to a significant improvement in the signal to noise ratio of betatron radiography images.
3D particle-in-cell simulations demonstrate that the first bunch was injected after the initially oversized laser spot underwent rapid self-focussing to the matched spot size. Continuous temporal compression and power amplification of the drive pulse in the wakefield increased the width and length of the wakefield bubble through increased a_0, leading to the injection of a second electron bunch with higher transverse momentum.

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Presenter: WOOD, Jonathan (Imperial College London)

Session Classification: WG4-WG6

Track Classification: WG4-WG6 Joint Session

Contribution ID: **231** Type: **talk**

Focusing of laser-accelerated proton beams with active plasma lens

Wednesday, September 18, 2019 4:40 PM (20 minutes)

We report on the first experimental demonstration of radially symmetric focusing of laser-accelerated proton beams with an active plasma lens which provides tunable field gradients of the order of kT/m. MeV level proton beams generated from micrometer solid density targets interacting with a relativistically intense laser were used to examine the focusability and robustness of this new approach. By varying field gradients of the active plasma lens, proton beams with mm focus spot size at selected energies were achieved at a distance of 1.5 meters behind the source. Results were supported by simple numerical calculations. Work towards retrieval of the proton beam source properties (source size, emittance) by combining these methods with dipole magnetic dispersion will be discussed as well.

The work was supported by Laboratory Directed Research and Development (LDRD) funding from Lawrence Berkeley National Laboratory provided by the Director, and the U.S. Department of Energy Office of Science Offices of High Energy Physics and Fusion Energy Sciences, under Contract No. DE-AC02-05CH11231. Work at BELLA was also supported by LaserNetUS (https://www.lasernetus.org/). J.H.Bin acknowledges financial support from the Alexander von Humboldt Foundation.

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Presenter: BIN, Jianhui (Lawrence Berkeley National Laboratory)

Session Classification: WG2 - WG5 (Joint Session)

Track Classification: WG2-WG5 Joint Session

Contribution ID: **232** Type: **poster**

Mitigating a large energy spread in the laser plasma driven FEL using FEL beam conditioning

Wednesday, September 18, 2019 7:00 PM (1 hour)

The FEL beam conditioning has been proposed 30 years ago as a method to mitigate an excessive electron beam emittance, which at that time was considered the principal limiting factors for the SASE FEL development at short wavelengths. In essence, the beam conditioning implies artificially inducing at the undulator entrance a correlation in the electrons'energies and intra-undulator betatron oscillations amplitudes. In the ideally conditioned beam, the off-axis electrons undergoing larger amplitude betatron oscillations are also faster, and thus on average better phase-matched to the slower on-axis electrons, resulting in an overall FEL gain length reduction, and improved performance. We propose to use this approach to mitigate the characteristically large output energy spreads in the laser-plasma or wakefield accelerators, and thus enable their use as drivers for FEL applications. In this case, we will use the matching section after the plasma exit to induce artificially the transverse distribution at the FEL entrance, such that places faster electrons further away from the axis, and slower electrons closer to the axis, improving the FEL gain. In this paper we illustrate this effect with the numerical models and discuss wavelength scaling and the applicability limits of the proposed approach.

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Presenter: MUROKH, Alex (RadiaBeam Technologies, LLC.)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **233** Type: **talk**

Recent progress on laser-plasma acceleration at kHz repetition rate

Monday, September 16, 2019 12:00 PM (30 minutes)

We will review our recent research activities on high-repetition rate laser-wakefield acceleration. In a recent series of experiments, we have used millijoule near-single-cycle laser pulses of 3.5 fs duration at kHz repetition rate to accelerate electrons to 5 MeV energies. The single-cycle laser pulses were able to excite nonlinear plasma wakefields and accelerate electrons to MeV energies in few tens of microns only. We will discuss the various acceleration mechanisms that allowed us to accelerate high beam-loads of tens of picoCoulomb per pulse at a kHz repetition rate.
Using near-sincle cycle laser pulses has allowed us to enter a new regime of laser plasma acceleration where carrier-envelope phase (CEP) and group velocity dispersion effects (GVD) become important. We will show the first clear experimental evidence of CEP effects on electron injection and acceleration. We will also show unique results where we compare the physics of laser-plasma interaction using laser pulses with different spectral widths (i.e. different Fourier Transform limits). These results outline the fact that for extremely short pulses < 4-fs, dispersion effects complicate the interaction and might become detrimental to electron acceleration in certain cases.

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Session Classification: Plenary Session 2

Track Classification: Invited Plenary Talk

Contribution ID: **234** Type: **talk**

Experimental Signatures of the Quantum Nature of Radiation Reaction in the Field of an Ultraintense Laser

Thursday, September 19, 2019 12:10 PM (30 minutes)

Quantum Electrodynamics (QED) represents one of the greatest theoretical achievements in modern physics, able to elegantly combine electromagnetism, quantum mechanics, and special relativity into a unified theory. Its predictions have been tested to a high degree of precision in relatively low fields but, thus far, little is experimentally known about the behaviour of quantum systems in fields comparable to the QED critical field (E_S ~ 1.3×10^{18} V/m). At these field intensities, exotic phenomena are predicted to occur, such as stochastic photon emission, electron-positron pair production in vacuum, and strong radiation reaction.
The fast-paced development of high-power laser technology is now opening up the possibility of studying high-field QED in the focus of a laser. For instance, a 1 GeV electron propagating through a laser field with a realistic intensity of 10^{21} W/cm^2, already experiences a field of the order of $0.2E_S$.
In this talk, we will discuss experimental campaigns carried out at the Central Laser Facility on quantum effects in radiation reaction and on pair production via linear Breit-Wheeler, together with future campaigns currently under preparation at the Eu-XFEL and FACET-II.The implications of these experiments for the next generation of ultra-high power laser facilities will also be discussed.

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Presenter: SARRI, Gianluca (Queen's University Belfast)

Session Classification: Plenary Session 8

Track Classification: Invited Plenary Talk

Contribution ID: **235** Type: **talk**

A positron source for applications using the TARANIS laser

Thursday, September 19, 2019 4:40 PM (20 minutes)

The realization of compact positron source is of great importance for a wide range of applications such as positron annihilation spectroscopy for material science. Moreover, a number of applications could benefit from short pulse duration (sub-100 ps) positron beams.
The interaction of a high-intensity laser with high-Z solid targets can be used to produce a population of relativistic electrons which, in turn, initiate an electromagnetic cascade in the target emitting a positron beam together with electrons and X-rays. This technique can be used to produce high-current mildly relativistic to relativistic positron beams suitable for applications in a compact setup.
Preliminary experiments using the TARANIS laser facility at Queen's University providing intensities $\sim 10^{19}\ W/cm^2$ on target and simulations using the Monte-Carlo scattering code FLUKA were performed to design a compact and high-quality positron source at the Queen's University of Belfast. Results of preliminary experiments, simulations and plans to optimize the positron source will be presented.

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Presenter: AUDET, Thomas (The Queen's University of Belfast)

Session Classification: WG4

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **236** Type: **talk**

Near-100 MeV protons via a laser-driven transparency-enhanced hybrid acceleration

Wednesday, September 18, 2019 12:10 PM (30 minutes)

The range of potential applications of compact laser-plasma ion sources motivates the development of new acceleration schemes to increase achievable ion energies and conversion efficiencies. Whilst the evolving nature of laser-plasma interactions can limit the effectiveness of individual acceleration mechanisms, it can also enable the development of hybrid schemes, allowing additional degrees of control on the properties of the resulting ion beam. We report on the experimental demonstration of efficient proton acceleration to energies exceeding 94 MeV via a hybrid scheme of radiation pressure-sheath acceleration in an ultrathin foil irradiated by a linearly polarised laser pulse. This occurs via a double-peaked electrostatic field structure, which, at an optimum foil thickness, is significantly enhanced by relativistic transparency and an associated jet of super-thermal electrons. The range of parameters over which this hybrid scenario occurs is reported, as are new routes to its optimisation and control.

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Presenter: GRAY, Ross (University of Strathclyde)

Session Classification: Plenary Session 6

Track Classification: Invited Plenary Talk

Contribution ID: **238** Type: **poster**

Resonant electron acceleration with laser-irradiated microstructured targets

Wednesday, September 18, 2019 7:00 PM (1 hour)

We theorerically demonstrate a possibility to resonantly accelerate electrons by a moderately relativistic laser pulse (from $\sim 10^{19} - 10^{20}$ W/cm^2) interacting with the surface of a microstructured target with periodic grooves. If the structure period is equal to the laser wavelength, a resonant acceleration may occur and electron bunches can be accelerated up to high energies by the laser electric field component in the direction of grooves. Due to the presence of the microstructure, the relativistic electrons feel only the forward component of the field during the acceleration process, which allows for achieving energies up to hundreds of MeVs even for moderately relativistic field amplitudes $a_0 \sim 10$.
A one-dimensional model allows for determining the condition for electron capture by the field structure and infinite acceleration.
Also, three-dimensional PIC simulations demonstrate the feasibility of the considered acceleration process in more realistic situations. The effects of oblique incidence and the laser polarization direction with respect to the groove direction on the acceleration process are also studied.
Also, it is shown that with increasing laser intensity, the structured target also becomes an efficient source of synchrotron gamma-rays.

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Presenter: SEREBRYAKOV, Dmitry (Institute of Applied Physics RAS)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG6 - Theory and simulations

Contribution ID: **239** Type: **poster**

Near-surface electron acceleration by grazingly incident laser pulses

Monday, September 16, 2019 7:00 PM (1 hour)

With the help of 3D numerical simulations, we demonstrate the possibility to accelerate a high number of electrons (tens of nC) to tens or even hundreds of MeVs using relativistic laser pulses ($\sim 10^{22}$ W/cm^2) grazingly incident on solid targets. It is shown that in this regime, the electrons are accelerated mostly efficiently at some distance from the target, and the key factor in that is the field structure in which the longitudinal electric field becomes dominant at a certain distance. Also the presence of the dense plasma surface allows for efficient electron injection into the field structure. We also study the effect of the plasma surface shape on the electron acceleration efficiency. It turns out that the presence of the target density gradient can significantly increase the radiation power due to more efficient electron injection into the accelerating field. The optimal preplasma properties for efficient electron acceleration are determined as well. A model of electron acceleration in this regime is also developed, that allows one to estimate some of the characteristics, and the key results agree with the simulations.

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Presenter: SEREBRYAKOV, Dmitry (Institute of Applied Physics RAS)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG6 - Theory and simulations

Contribution ID: **240** Type: **talk**

Effect of the plasma scale length variation on the extraction of electron beams from a GeV-class wakefield accelerator

Tuesday, September 17, 2019 4:40 PM (20 minutes)

The extraction of a laser driven electron beam from the plasma accelerating structure plays an important role in determining the final beam quality. If properly matched, the extraction mechanism can mitigate beam degradation and minimize emittance growth. Controlling this process poses a challenge for multi-stage acceleration schemes aiming to generate TeV level beams for particle collider applications and for the coupling of laser wakefield accelerated beams into insertion devices such as FELs. Here we present results from experiments at the Astra-Gemini facility investigating how the variation in plasma scale length at the exit of a GeV class wakefield accelerator affects the quality of the accelerated electrons.

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Presenter: SHALLOO, Rob (Imperial College London)

Session Classification: WG1 - Plasma acceleration physics I

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **241** Type: **poster**

Investigating linear Breit-Wheeler pair production at Gemini

Monday, September 16, 2019 7:00 PM (1 hour)

The two-photon (linear) Breit-Wheeler mechanism is the simplest process through which light can be converted into matter. Despite its simplicity only the multi-photon (non-linear) process has yet been measured definitively. The linear process remains elusive as the production threshold of $2m_ec^2 \approx 1\,\mathrm{MeV}$ is comparatively high for two photons and requires two bright sources of gamma- and X-rays housed at the same facility. In addition, competing non-vacuum processes producing electron-positron pairs, such as Bethe-Heitler and Trident, make measuring the linear Breit-Wheeler process in isolation even more challenging. In an experiment performed at the Gemini laser in 2018 we collided ~ 100 MeV gamma rays produced using a laser wakefield accelerator with multi-keV X-rays emitted from a hot plasma with the aim of detecting positrons from the linear Breit-Wheeler process.
We report on the success of the individual components of the setup, including the gamma and X-ray sources, as well as the single particle detectors coupled to a magnetic chicane, and provide an update on the ongoing data analysis.

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Presenter: KETTLE, Brendan (Imperial College London)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **242** Type: **poster**

Single-shot multi-keV X-ray absorption spectroscopy using an ultrashort laser wakefield accelerator source

Wednesday, September 18, 2019 7:00 PM (1 hour)

X-ray absorption spectroscopy can provide a wealth of information about a sample, including a simultaneous measurement of the temperature and structure of both the electrons and ions, via techniques such as XANES (X-ray Absorption Near Edge Structure). If these measurements can be made using a single ultrashort probe pulse at multi-keV energies, they provide a powerful tool for investigating ultrafast processes and laboratory-based high energy-density (HED) samples. States which are notoriously difficult to probe due to their extreme conditions and transient nature.

The X-rays generated by a laser wakefield driven electron beam are uniquely suited for such measurements. The pulse duration is on the order of 10's of femtoseconds, the photon flux and energy available ($E_{crit} \approx 25$ keV) can penetrate relatively large samples, and the smooth broadband spectrum is ideal for absorption measurements.

We present single-shot XANES measurements of the K-edge of a cold titanium sample from a recent experiment at the Gemini laser facility. Quantitative measurements of the slope and pre-edge absorption features are made. With appropriate experiment setup improvements the post-edge features should be resolvable, providing access to the ion component of the sample.

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Presenter: KETTLE, Brendan (Imperial College London)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **243** Type: **poster**

Control of electron injection in laser wakefield acceleration with external magnetic fields

Wednesday, September 18, 2019 7:00 PM (1 hour)

It is shown that external magnetic fields at tens of tesla can provide additional control of electron injection in laser wakefield acceleration (LWFA). In the first case, we consider ionization injection assisted by a transverse magnetic field. Both the electron trapping condition and the wakefield structure are changed significantly by the magnetic field such that injection occurs over a shorter distance and at an enhanced rate. Furthermore, beam loading is compensated for as a result of the trapezoidal-shaped longitudinal charge density profile of injected electrons. These lead to a reduction in the energy spread and an enhancement of both the charge and final peak energy of the electron beam.

In the second case, we consider density downramp injection assisted by a longitudinal magnetic field. The magnetic field dynamically induces an expanding hole in the electron density distribution at the rear of the wake bubble, which reduces the peak electron velocity in its vicinity. Electron injection is suppressed when the electron velocity drops below the phase velocity. This enables the start and end of electron injection to be independently controlled, allowing the generation of sub-femtosecond electron bunches with peak currents of a few kilo-Ampere.

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Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG6 - Theory and simulations

Contribution ID: **244** Type: **poster**

A photon beam line for the water window FEL at EuPRAXIA@SPARC_LAB

Monday, September 16, 2019 7:00 PM (1 hour)

A proposal for building a Free Electron Laser, EuPRAXIA@SPARC_LAB, at the Laboratori Nazionali di Frascati, is at present under consideration [1]. This FEL facility will exploit plasma acceleration to produce ultra-bright photon pulses with durations of few femtoseconds down to a wavelength between 2 and 4 nm, in the so called "water window".
The photon beamline we designed will deliver the photon beam from the undulators to the experimental area, optimizing the beam for the running experiment to allow a fine tune of the beam characteristics. The FEL radiation will be in SASE regime, at least for the first phase of the project, so it will present shot-to-shot fluctuations in intensity, spectrum and position. The radiation diagnostics are therefore chosen to be single-shot and not-intercepting whenever possible. The beam will be characterized by measuring its dimensions, coherence and positions both in transverse and longitudinal directions, its spectrum and its intensity. The main class of experiments that will be performed at the EuPRAXIA@SPARC_LAB FEL will include coherent diffraction imaging, soft X-ray absorption spectroscopy, Raman and photofragmentation measurements [2].

[1] M. Ferrario et al., Nucl. Instr. Met. Phys. A, 2018, 909, 134.
[2] A. Balerna et al., Cond. Matt., 2019, 4, 30.

Primary author: VILLA, Fabio (INFN / LNF)

Presenter: VILLA, Fabio (INFN / LNF)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **245** Type: **poster**

Optimization towards the demonstration of high-quality electron-beam generation from density downramp injection in a beam driven PWFA at FLASHForward

Wednesday, September 18, 2019 7:00 PM (1 hour)

Beam-driven plasma wakefield accelerators allow for the generation and subsequent acceleration of electron beams inside the plasma
with substantially lower emittance than the driving electron beam, eventually providing technology for final-focus brightness converters for versatile applications. Among a variety of internal injection techniques, density downramp injection has the potential to reliably produce submicrometer emittance electron beams. The FLASHForward TW laser system allows for the ionization of wide plasma columns in a gas capillary and controlled density spikes, by selectively ionizing gas constitutes. This allows for shaping the plasma density profiles in order to control beam parameters.
We report on the recent progress in preparation and commissioning efforts for the optimization and realization of the generated electron beams.

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Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **246** Type: **talk**

Recent developments in dielectric laser acceleration

Wednesday, September 18, 2019 11:00 AM (40 minutes)

Dielectric laser acceleration has made tremendous progress. We will give an overview of recent results, most of them obtained in the Gordon and Betty Moore Foundation-funded Accelerator on a Chip International Program, ACHIP. Highlight results include: acceleration gradients of around 1 GeV/m; the generation of electron pulse trains with attosecond bunchlet duration via optical near field or via free space ponderomotive interaction; acceleration powered by on-chip photonic waveguides; laser-driven electron lensing using dielectric structures; electron guiding by alternating phase focusing, allowing continued acceleration of electrons over, in principle, infinitely long structures with little particle loss. The current status on the way to a particle accelerator on a photonic chip will be given, as well as the status of dielectric laser acceleration experiments at the high energy beam facilities.

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Presenter: HOMMELHOFF, Peter (University of Erlangen (FAU))

Session Classification: Plenary Session 6

Track Classification: Invited Plenary Talk

Contribution ID: **247** Type: **talk**

High average power laser drivers for particle acceleration

Monday, September 16, 2019 5:00 PM (20 minutes)

High peak power lasers have been succesfully used to accelerate particles, for example producing a 8 GeV record for electron acceleration with a PetaWatt laser. However laser repetition rate is quite limited, to 1 Hz maximum and this prevents use of lasers in applications requiring significantly higher repetition rate. To be able to build the next generation of laser-based machines such as Eupraxia, we will need a new generation of lasers combining a high peak power and a high average power. We will present designs and development results of a new generation of Titanium Sapphire lasers being able to operate between 100 Hz and 500 Hz repetition rate. We will present results of development of a new generation of Nd:YAG pump lasers as well as results obtained to improve the thermal management of Titanium Sapphire crystals. We will also review the challenges of high average power pulse compression and derive the requirements for the development of the relevant compression gratings sustaining in the same time high peak power and high average power.

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Presenter: SIMON-BOISSON, Christophe (Thales LAS)

Session Classification: WG7

Track Classification: WG7 - High brightness power sources: from Laser Technology to beam drivers

Contribution ID: **249** Type: **talk**

Key physics study of high quality laser driven ion acceleration

Wednesday, September 18, 2019 11:40 AM (30 minutes)

For the past two decades, the interaction of ultra-intense lasers with over-critical plasma has been motivated by acceleration of proton/ions for radiobiological applications. Despite some progress, the realization of a stable high-charge narrow-energy-spread protons of hundreds MeV remains a challenge. One promising scheme is the "light sail"acceleration, where laser pressure directly pushes the whole target, providing a strong accelerating force. A major showstopper of such scheme is that it will suffer significant transverse instabilities that can break up the target, but the underlying mechanism has still not been clarified. Here we present a full three-dimensional theoretical model that clarifies the origin of this long-standing problem, and support it with 2/3D PIC simulations for a wide range of parameters. Based on this understanding, we propose several new concepts of high quality ion acceleration, which provide better scalings and indicate several hundreds of MeV protons can be produced by 100s TW to PW laser systems.

Primary authors: WAN, Yang (Weizmann Institute of Science); ANDRIYASH, Igor (Weizmann Institute of Science); LU, Wei (Tsinghua University of Beijing, China); Prof. MORI, Warren Bicknell (University of California Los Angeles); Prof. JOSHI, Chan (University of California Los Angeles); MALKA, Victor (LOA)

Presenter: WAN, Yang (Weizmann Institute of Science)

Session Classification: Plenary Session 6

Track Classification: Invited Plenary Talk

Contribution ID: **253** Type: **talk**

The road to very high energies

Thursday, September 19, 2019 9:00 AM (40 minutes)

A number of accelerator projects are on-going or studied for implementation in Europe and elsewhere, with primary goal pushing towards higher energies and higher beam intensities, as needed for future experimental studies within particle physics. This talk will provide an overview of the status and challenges ahead for on-going and potential future projects aiming for very high accelerator energies, as currently discussed in European and international roadmaps.

Primary author: STAPNES, Steinar (CERN)

Presenter: STAPNES, Steinar (CERN)

Session Classification: Plenary Session 7

Track Classification: Invited Plenary Talk

Contribution ID: **254** Type: **talk**

Applications of machine learning and active feedback in laser-plasma wakefield accelerators

Tuesday, September 17, 2019 10:10 AM (30 minutes)

Performing high intensity laser-plasma interactions at high repetition rate (>1 Hz) allows for a fundamental change in the way these phenomena are explored. The large quantity of data collected allows for statistical modelling and fine scans of parameter space. In addition, multi-dimensional optimisation becomes possible, which is of great importance when individual parameters are coupled in a complex manner. In this talk, I will describe how machine learning techniques can be applied to improve experimental outcomes and physical understanding in laser wakefield experiments. A series of experiments will be discussed, in which the laser and plasma parameters were autonomously controlled by an algorithm designed to optimise a user defined goal function, such as the charge of the electron beam in a particular energy band. I will also report on experiments aiming to combine feedback algorithms with controlled injection techniques. Combining these techniques with a new generation of high-power high-rep rate facilities promises to vastly accelerate progress in the field of the laser-plasma accelerators.

Primary author: STREETER, Matthew (Imperial College London)

Presenter: STREETER, Matthew (Imperial College London)

Session Classification: Plenary Session 3

Track Classification: Invited Plenary Talk

Contribution ID: **255** Type: **talk**

High gradient ultra-high brightness C-band photoinjector

Thursday, September 19, 2019 6:40 PM (20 minutes)

Recent studies and investigations show the possibility to increase the cathode peak field, using normal conducting structures with a reduced RF pulse duration or using copper structures operated at cryogenic temperatures. In this context we studied the beam dynamics advantages using a 1.6 cells C-band gun operated at the gradient of 240 MV/m, in order to set the photo-injector layout for the XLS design study. The higher gradient combined with a shorter RF gun structure, pushes the beam to a relativistic energies faster and in less space compared to the 1.6 cells S-band case operated at 120 MV/m. In order to use only one frequency in the entire injector and to save longitudinal space, we used in the simulations two TW C-band structures operated at the accelerating gradient of 40 MV/m. Scaling the beam parameters from the S-band scenario and re-optimizing the solenoid magnetic field and all the device positions, it is possible to increase the beam brightness at least of an order of magnitude. The beam exiting the C-band gun completely match the requests of the XLS design study, also saving a factor two in the longitudinal photo-injector size compared to the S-band scenario.

Primary authors: VANNOZZI, Alessandro (ROMA1); GIRIBONO, Anna (LNF); VACCAREZZA, Cristina (LNF); ALESINI, David (LNF); CARDELLI, Fabio (LNF); DIOMEDE, Marco (LNF); FERRARIO, Massimo (LNF); CROIA, Michele (INFN / LNF)

Presenter: CROIA, Michele (INFN / LNF)

Session Classification: WG3 - High Gradient RF Technology

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **256** Type: **talk**

Recent Developments and Future Applications for Laser-Driven Neutron Sources

Thursday, September 19, 2019 11:40 AM (30 minutes)

Laser-driven accelerators drive ultra-short pulse beams of MeV ions and photons that can be utilised as deployable neutron sources for science and industry. This talk will summarise recent results from groups around the world focusing on the optimisation of laser-driven neutron sources for applications relevant to security, industry and science. Topics covered include neutron beam characterisation in flux, energy and divergence, neutron energy moderation, and applications in imaging and active interrogation. With the recent delivery of multi-Hz PW-class laser systems, high flux laser-driven based neutron beamlines for applications can now be envisioned with this advanced accelerator innovation
An extreme photon intensity (> 10^18 W/cm^2) interaction with a solid target seeds the acceleration of a dense bunch of suprathermal electrons which give rise to a bright picosecond-pulse beam of ions via the establishment of a TV/m charge-separation electrostatic sheath field. The MeV-temperature of these beams makes them suitable for driving neutron emission via a number of nuclear reactions, depending on the primary target material or the use of a secondary foil that the ions are directed into (a 'catcher'target). The most commonly used materials are deuterated plastic, lithium, beryllium, and copper.

Primary author: BRENNER, Ceri (STFC Central Laser Facility)

Presenter: BRENNER, Ceri (STFC Central Laser Facility)

Session Classification: Plenary Session 8

Track Classification: Invited Plenary Talk

Contribution ID: **257** Type: **talk**

Gas-foil target for laser-plasma ion acceleration

Thursday, September 19, 2019 6:20 PM (20 minutes)

The gas-foil target combines two domains in laser-plasma acceleration which are normally separate: gas targets are usually used for electron acceleration and solid targets for ion acceleration. The combination of the two thus provides a system of rich physics to explore. We are experimentally investigating this type of target with a focus on ion acceleration. The experiment is done under WHELMI, a collaboration between the labs at the Weizmann Institute of Science in Israel and the HZDR institute in Germany. I will present the main results we have obtained so far.

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Presenter: LEVY, Dan (Weizmann Institute of Science)

Session Classification: WG2

Track Classification: WG2 - Ion beams from plasmas

Contribution ID: **258** Type: **talk**

Prediction and control of electron beams using machine learning based diagnostics: proof-of-principle studies in support of applications at FACET-II

Tuesday, September 17, 2019 4:40 PM (20 minutes)

We report on the application of machine learning (ML) methods for predicting and optimizing the e-beam distribution of particle accelerators, with a focus on proof-of-principle studies aimed at future applications in the FACET-II linac (including longitudinal phase space prediction and round-to-flat beam transforms). The approach consists of training ML-based virtual diagnostics to predict the e-beam distribution using only nondestructive linac and beam measurements as inputs. We study this approach in start-to-end simulations for the FACET-II linac and show its feasibility in a proof of principle experiment at the LCLS. The e-beam longitudinal phase space images at LCLS are obtained with a transverse deflecting cavity and used as training data for our ML model. We also present initial results obtained at the UCLA Pegasus beamline, where ML models were used to predict and optimize the e-beam spot size ratios in a round-to-flat beam transformation set up. We discuss the sensitivity of these ML models to input uncertainties, drift and noise and comment on opportunities for integrating such diagnostics in existing and future accelerator facilities.

Primary authors: EMMA, Claudio (SLAC National Accelerator Laboratory); Dr EDELEN, Auralee (SLAC); Mr CROPP, Eric (UCLA); Dr LUTMAN, Alberto (SLAC); HOGAN, Mark J. (SLAC); Prof. MUSUMECI, Pietro (UCLA); Dr WHITE, Glen (SLAC); Dr YAKIMENKO, Vitaly (SLAC); Dr SCHEINKER, Alex (LANL)

Presenter: HOGAN, Mark J. (SLAC)

Session Classification: WG5 - Beam Transport

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **259** Type: **talk**

Toward the modeling of chains of plasma accelerator stages with WarpX

Tuesday, September 17, 2019 4:00 PM (20 minutes)

One of the most challenging application of plasma accelerators is the development of a plasma-based collider for high-energy physics studies. Fast and accurate simulation tools are essential to study the physics toward configurations that enable the production and acceleration of very small beams with low energy spread and emittance preservation over long distances, as required for a collider. The Particle-In-Cell code WarpX is being developed by a team of the U.S. DOE Exascale Computing Project (with non-U.S. collaborators on part of the code) to enable the modeling of chains of tens of plasma accelerators on exascale supercomputers, for collider designs. The code combines the latest algorithmic advances (e.g., boosted frame, pseudo-spectral Maxwell solvers) with mesh refinement and runs on the latest CPU and GPU architectures. The application to the modeling of up to three successive muti-GeV stages will be discussed. The latest implementation on GPU architectures will also be reported, as well as novel algorithmic developments.

Supported by the Exascale Computing Project (17-SC-20-SC), a collaborative effort of two U.S. Department of Energy organizations (Office of Science and the National Nuclear Security Administration).

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Presenter: VAY, Jean-Luc (Berkeley Lab)

Session Classification: WG6

Track Classification: WG6 - Theory and simulations

Contribution ID: **260** Type: **poster**

Study of the plasma plume effects on the beam quality for plasma based accelerators

Wednesday, September 18, 2019 7:00 PM (1 hour)

The development of compact accelerator machines is leading towards plasma-based devices able to produce high accelerating gradients in the GV/m scale but, at the same time, with the aim of preserving the electron beam quality. The latter topic, for plasma-based accelerators, is strictly related to the plasma properties as stability, uniformity and reproducibility, which in turn depend on the geometric characteristics of the plasma device. In this context, the activity of the SPARC_LAB test-facility, where a gas-filled capillary plasma source is used to confine and characterize plasmas, is currently focused on the development of new plasma sources to minimize the beam quality degradation. The plasma ramps produced at the ends of the capillary during the gas ionization represent a critical point for the beam quality preservation, because of the plasma parameters in these areas strongly change as a function of the capillary shape and, consequently, the beam emittance could undergo a drastic degradation. In this work, we present a study on the plasma plumes formation and their effects on the beam, then we propose a possible solution based on the capillary shape modifications that are able to optimize the density profile at its extremities.

Primary authors: BIAGIONI, Angelo (LNF); ANANIA, Maria Pia (LNF); BELLAVEGLIA, Marco (LNF); CHIADRONI, Enrica (LNF); CIANCHI, Alessandro (ROMA2); COSTA, Gemma (LNF); DI GIOVENALE, Domenico (LNF); DI PIRRO, Giampiero (LNF); FERRARIO, Massimo (LNF); MOSTACCI, Andrea (Sapienza); POMPILI, Riccardo (LNF); SHPAKOV, Vladimir (LNF); STELLA, Angelo (LNF); VACCAREZZA, Cristina (LNF); VILLA, Fabio (LNF); ZIGLER, Arie (LNF)

Presenter: BIAGIONI, Angelo (LNF)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **261** Type: **talk**

A new advanced facility for applications of laser-driven accelerators

Monday, September 16, 2019 11:00 AM (30 minutes)

The Central Laser Facility at the STFC Rutherford Appleton Laboratory in the UK is now building a new laser application centre. This £81.2 M facility will use STFC's patented diode-pumped laser technology (DiPOLE) to drive plasma accelerators, producing novel particle and x-ray beams for imaging critical industrial components and biomedical systems. This application centre will build a unique innovation ecosystem with academia, industry and security communities. I will discuss the concept and design specifications of this new centre.

Primary author: PATTATHIL, Rajeev (Central Laser Facility,)

Presenter: PATTATHIL, Rajeev (Central Laser Facility,)

Session Classification: Plenary Session 2

Track Classification: Invited Plenary Talk

Contribution ID: **263** Type: **talk**

Seeded Self-Modulation of a Relativistic Proton Drive Bunch in Plasma

Wednesday, September 18, 2019 4:00 PM (20 minutes)

Plasma wakefield accelerators using a long particle bunch as driver rely on a self-modulation process transversely modulating the long bunch into micro bunches that resonantly drive the wakefields [1]. Seeding the self-modulation at a level exceeding the noise level suppresses possible competing instabilities such as the hosing instability and leads to a phase reproducible modulation, needed for a high capture efficiency and quality preservation of the externally injected witness bunch.
We will present experimental results obtained with two seeding methods at AWAKE: Seeding with a relativistic ionization front, routinely used and seeding with an externally injected electron bunch, which was briefly tested.
We will quantitatively characterize the modulation of the proton bunch observed at AWAKE using time resolved transverse profiles recorded by a streak camera, analysing the charge per micro bunch and the strength of defocusing of protons within a few wakefields periods from the ionization front.
We attempt to infer the wakefield amplitude growth along the plasma and along the bunch from experimental results of defocused protons (time resolved and time integrated [2]) as well as from the energy gain of a probe electron witness bunch injected at various positions along the wakefield.

Primary authors: BACHMANN, Anna-Maria (CERN); MUGGLI, Patric (Max-Planck-Institut für Physik); AWAKE COLLABORATION

Presenter: BACHMANN, Anna-Maria (CERN)

Session Classification: WG1 - PWFA experimental results

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **265** Type: **talk**

Simultaneous temporal resolved measurements of protons and fast electrons in TNSA experiments

Wednesday, September 18, 2019 5:00 PM (20 minutes)

The interaction of ultra-intense high power lasers with solid state targets have been largely studying for twenty years as future compact proton and ion source. Indeed, the huge potential established on the target surface by the escaping electrons provides accelerating gradients of ~TV/m. This process, called TNSA, involves a large number of phenomena and is very difficult to study because of the picosecond scale dynamics.
At SPARC_LAB Test Facility the high power laser FLAME is employed in experiments with solid targets aiming to study possible correlations between ballistic fast electrons and accelerated protons. In detail, we have installed in the interaction chamber two different diagnostics, each one devoted to characterize one beam. The first relies on Electro-Optic Sampling and has been used to perform temporally resolved electron charge measurements with a resolution of the order of 100fs. On the other hand, a Time-Of-Flight detector, based on a Chemical-Vapor-Deposited (CVD) diamond, has allowed to retrieve the proton energy spectrum.
In this work we report on simultaneous temporal resolved measurements of both escaping electrons and accelerated protons made for different laser energies to provide a more complete scenario of the interaction.

Primary authors: BISESTO, Fabrizio Giuseppe (LNF); GALLETTI, Mario (Instituto Superior Tecnico); ANANIA, Maria Pia (LNF); COSTA, Gemma (LNF); FERRARIO, Massimo (LNF); POMPILI, Riccardo (LNF); ZIGLER, Arie (LNF); CONSOLI, Fabrizio (ENEA - Centro Ricerche Frascati); SALVADORI, Martina (Roma1); ANDREOLI, pierluigi (ENEA - Centro Ricerche Frascati); VERONA, claudio (University of Rome "Tor Vergata", Industrial Engineering Department)

Presenter: BISESTO, Fabrizio Giuseppe (LNF)

Session Classification: WG2 - WG5 (Joint Session)

Track Classification: WG2-WG5 Joint Session

Contribution ID: **266** Type: **talk**

Hybrid LWFA-PWFA staging: from concept to proof-of-principle experiments

Friday, September 20, 2019 10:10 AM (30 minutes)

Beam-driven plasma-wakefield accelerators(PWFAs) offer a unique regime for the generation and acceleration of high-quality electron beams to multi-GeV energies. Here we present an innovative hybrid staging approach, deploying electron beams generated from a compact laser-driven wakefield-accelerator(LWFA) as drivers for a PWFA. This scenario exploits the capability of LWFAs to deliver shortest, high peak-current electron bunches[1] with the prospects for high-quality witness beam generation in PWFAs[2]. The feasibility of the concept is presented through exemplary particle-in-cell simulations, followed by experimental results from extensive campaigns performed at high-power laser facilities; ATLAS (LMU, Munich), SALLE-JAUNE (LOA, Paris) and DRACO (HZDR, Dresden). Using few-cycle optical probing we captured clear images of beam-driven plasma waves in a dedicated plasma stage, allowing us to identify a non-linear plasma-wave excitation regime. Trailing the plasma waves, the impact of ion motion to the transverse modulation of the plasma density was observed over many picoseconds[3]. Furthermore, we demonstrate for the first time the acceleration of distinct witness beams in such LWFA-driven PWFA(LPWFA) setup, showcasing an accelerating gradient on the order of 100 GV/m. These milestones pave the way towards compact sources of energetic ultra-high brightness electron beams as well as a miniature model for large scale PWFA facilities.

Primary authors: KURZ, T. (Helmholtz-Zentrum Dresden-Rossendorf, Institute of Radiation Physics); HEINEMANN, T. (Deutsches Elektronen-Synchrotron DESY; Scottish Universities Physics Alliance, Department of Physics, University of Strathclyde); GILLJOHANN, M. F. (Ludwig-Maximilians-Universität München; Max Planck Institut für Quantenoptik); COUPERUS CABADAĞ, J. P. (Helmholtz-Zentrum Dresden -Rossendorf, Institute of Radiation Physics); SCHOEBEL, Susanne (Helmholtz-Zentrum Dresden-Rossendorf); Dr KONONENKO, olena (LOA, École polytechnique, ENSTA ParisTech, CNRS); CHANG, Y.-Y. (Helmholtz-Zentrum Dresden-Rossendorf, Institute of Radiation Physics); PAUSCH, R. (Helmholtz-Zentrum Dresden-Rossendorf, Institute of Radiation Physics); DEBUS, A. (Helmholtz-Zentrum Dresden -Rossendorf, Institute of Radiation Physics); Dr ASSMANN, Ralph (Deutsches Elektronen-Synchrotron DESY, Germany); BUSSMANN, Michael (Helmholtz-Zentrum Dresden-Rossendorf); DING, Hao (LMU München); GÖTZFRIED, Johannes (LMU Munich); KÖHLER, Alexander (HZDR); RAJ, G. (LOA, ENSTA ParisTech, CNRS, Ecole Polytechnique, Institut Polytechnique de Paris); ZARINI, Omid (Helmholtz-Zentrum Dresden - Rossendorf e.V.); CORDE, Sébastien (Ecole Polytechnique); DÖPP, Andreas (LMU Munich); HIDDING, B. (Scottish Universities Physics Alliance, Department of Physics, University of Strathclyde; Cockcroft Institute, Sci-Tech Daresbury); KARSCH, Stefan (LMU Munich); SCHRAMM, Ulrich (Helmholtz-Zentrum Dresden-Rossendorf); MARTINEZ DE LA OSSA, A. (Deutsches Elektronen-Synchrotron DESY); IRMAN, Arie (Helmholtz Zentrum Dresden Rossendorf)

Presenter: IRMAN, Arie (Helmholtz Zentrum Dresden Rossendorf)

Session Classification: Plenary Session 9

Track Classification: Invited Plenary Talk

Contribution ID: **267** Type: **talk**

Narrow energy spread, GeV electron beams from shock injection in a laser wakefield accelerator

Wednesday, September 18, 2019 6:40 PM (20 minutes)

Laser wakefield accelerators (LWFAs) using self- or ionisation-injection techniques have been demonstrated to produce GeV electron beams, but typically suffer from large energy spreads when operating in this regime. One promising alternative scheme is shock injection, where abrupt changes in the local density of a LWFA gas target can induce the injection of electrons into the wakefield. This technique has been shown to produce few-$\%$ energy spread, sub-GeV beams, at values of a_0 close to unity.

We present results on shock injection using the Gemini laser ($a_0 = 2.5$), producing $\Delta E_{\mathrm{FWHM}}/E \sim 5\%$ electron beams at > 1 GeV. Low energy spread electron bunches are a vital tool in precision radiation-reaction studies, where the distinction between competing semi-classical and fully-stochastic QED models is highly sensitive to initial bunch energy spread. Additionally these compact, low emittance electron beams could eventually provide sources for Thomson scattering, sources for free electron lasers or part of a staged acceleration scheme to reach multi-GeV electron energies.

Primary author: COLGAN, Cary

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Presenter: STREETER, Matthew (Imperial College London)

Session Classification: WG1 - Injection control

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **269** Type: **talk**

e-SYLOS: a kHz laser wakefield driven beamline for radiobiological and imaging applications at ELI-ALPS

Tuesday, September 17, 2019 6:20 PM (20 minutes)

The ELI Attosecond Light Pulse Source (ELI-ALPS) facility is the Hungarian pillar of the Extreme Light Infrastructure (ELI) project aimed at high-repetition rate, ultrafast science driven by ultra-short few-cycle laser pulses. ELI-ALPS aims to provide ultrashort light pulses from the THz to the x-ray regime as well as high-energy particle sources, all at high repetition rates for developers and end-users. This talk presents an overview of the development of the e-SYLOS beamline; a laser wakefield driven kilohertz electron beamline at ELI-ALPS aimed at producing ultrafast electron bunches and x-rays. Currently transitioning to the implementation phase, the beamline takes advantage of the Single Cycle Laser (SYLOS); a 1 kHz, 37 mJ, 6.4 fs NOPCPA laser system. Once completed, the beamline will be well suited to experiments in radiobiology, x-ray imaging and attosecond science as well as high repetition-rate wakefield development.

Primary authors: SHALLOO, Rob (Imperial College London); NAJMUDIN, Zulfikar (Imperial College London); HAFZ, Nasr (ELI-ALPS); Dr LI, Song (ELI-ALPS); PAPP, Daniel (ELI-ALPS); Dr KAMPERIDIS, Christos (ELI-ALPS, HU)

Presenter: SHALLOO, Rob (Imperial College London)

Session Classification: WG4

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **270** Type: **poster**

Plasma density profile measurements for ultra-short high power laser beam guiding experiments at SPARC_LAB

Wednesday, September 18, 2019 7:00 PM (1 hour)

External injection is a promising method to achieve high accelerating gradients and to control the beam properties. The energy gain of an electron via the wakefield is proportional to the product of the accelerating field multiplied by the effective propagation distance of the laser. Therefore, in order to bring the electron energy to the order of the GeV, a longer propagation length is required, which can be obtained by guiding the laser pulse in a wave-guide. In the case of SPARC_LAB, a $500\ \mu m$ diameter hydrogen-filled capillary discharge is used; to guide the laser beam it is necessary to act on the refractive index of the plasma, depending on its density.
In this work measurements of the trend over time of longitudinal and transverse profiles of plasma density within the capillary are presented, compared with the results of MHD simulations based on initial gas profiles obtained in openFOAM and on the real discharge profile. The gas emission line enlargement produced by the Stark effect was detected by a spectrometer. Preliminary test of laser guiding are also shown, detecting the behavior of the laser beam at the exit of the capillary with respect to the discharge current value.

Primary authors: COSTA, Gemma (INFN / LNF); ANANIA, Maria Pia (LNF); BIAGIONI, Angelo (LNF); BISESTO, Fabrizio Giuseppe (LNF); BRENTEGANI, Emanuele (La Sapienza, INFN-LNF); CIANCHI, Alessandro (ROMA2); FERRARIO, Massimo (LNF); POMPILI, Riccardo (LNF); ROMEO, Stefano (LNF); ROSSI, Andrea Renato (MI); ZIGLER, Arie (LNF)

Presenter: COSTA, Gemma (INFN / LNF)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **271** Type: **talk**

Multi Spectral CTR Imaging and Interferometry of Laser Wakefield Accelerated Electron Bunches

Monday, September 16, 2019 5:00 PM (20 minutes)

The low emittance of electron bunches from laser wakefield accelerators (LWFAs) makes them attractive for compact FELs and colliders. Single-shot, direct, non-intercepting diagnostics of this emittance outside the LWFA are, however, needed. Here we present single-shot coherent transition radiation (CTR) imaging and interferometry data from electron bunches ~2 mm after emerging from a 300 MeV LWFA. We combine near field (NF) and far field (FF) imaging of CTR from a foil just outside the accelerator. We also employ a multi-octave CTR spectrometer to diagnose the longitudinal structure of the beam. The NF system images the foil with high resolution at many narrow visible bandwidths. This measurement elucidates the transverse structure of micro-bunched portions of the beam. We find typical transverse radii of 2 ≤ σ_{perp} ≤ 3 μm . The FF system collects CTR from a double Wartski interferometer to diagnose sub-bunch divergences as low as $\sigma_\theta \approx 0.5$ mrad. We have determined sub mm mrad emittance of a micro-bunched portion of the beam. Using multi-spectral NF images and CTR spectrum, we produce 3D reconstructions of the bunch. We will present data and analysis on bunch size, divergence and substructure revealed by the FF and NF imaging systems.

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Presenter: LABERGE, Maxwell (University of Texas - Austin)

Session Classification: WG1-WG5 Joint Session - Advanced Beam Metrology

Track Classification: WG1-WG5 Joint Session

Contribution ID: **272** Type: **poster**

High repetition rate and coherent Free-Electron Laser in the X-rays range tailored for linear spectroscopy

Wednesday, September 18, 2019 7:00 PM (1 hour)

Fine time-resolved analysis of matter - i.e. spectroscopy and photon scattering - in the linear response regime requires fs-scale pulsed, high repetition rate, fully coherent X-ray sources. A seeded FEL driven by a Linac based on Super Conducting cavities, generating 10^8-10^{10} coherent photons at 2-5 keV with 0.2-1 MHz of repetition rate, can address this need. Three different seeding schemes, reaching the X-ray range. are described hereafter.

The first two are multi-stage cascades upshifting the radiation frequency by a factor 10-30 starting from a seed represented by a coherent flash of extreme ultraviolet light. This radiation can be provided either by the High Harmonic Generation of an optical laser or by a FEL Oscillator operating at 12-14 nm. The third scheme is a regenerative amplifier working with X-ray mirrors. The whole chain of the X-ray generation is here described by means of start-to-end simulations.

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Presenter: OPROMOLLA, Michele (Università Statale degli Studi di Milano, INFN Sezione di Milano)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **273** Type: **talk**

Dual energy electron beams from two independent injection events

Wednesday, September 18, 2019 6:00 PM (20 minutes)

LWFA electron beams have evolved from their rather random performance of the early days to a well-controlled, tunable electron source able to serve real-world applications. The key ingredient for this evolution was the realization of various controlled injection schemes. Here we show that by combination of shock-front and colliding pulse injection it is possible to generate two independently energy-tuneable electron beams from a single LWFA. Such dual beams may be used to drive a Thomson source in order to produce a two-color X-ray pulse. By the nature of the injection process, the temporal separation of both pulses in the current scheme is of the order of only few femtoseconds. We will discuss how this separation can be enhanced or even controlled to produce a two-color source for X-ray pump / X-ray probe studies. Such dual beams may also be used as driver-witness pairs for hybrid wakefield acceleration. We will present a scheme based solely on shock-front injection for generating such double bunches with large temporal saturation. Finally, we will show first electron acceleration resutls from the new ATLAS-3000 laser at CALA.

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Session Classification: WG1 - Injection control

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **274** Type: **talk**

Plasma Wakefield Acceleration Science at FACET-II

Thursday, September 19, 2019 10:10 AM (30 minutes)

FACET-II is a new National User Facility at SLAC National Accelerator Laboratory scheduled to begin operating in 2020. The PWFA collaboration has proposed an ambitious series of experiments consistent with the US DOE Advanced Accelerator R&D Roadmap. A photoinjector in a configuration similar to that of LCLS will enable FACET-II to investigate acceleration and beam quality preservation utilizing beams with an emittance two-orders of magnitude lower than what was routinely available at FACET. The resulting improvement in beam density will enable FACET-II to study new effects like the motion of plasma ions and unintended beam ionization in the plasma sources. Additional plasma-based experiments have been proposed for generating bunches with orders of magnitude lower emittance that will ultimately be needed for both an early application of a PWFA and for a plasma-based future linear collider. Phased upgrades to FACET-II are expected to provide high-intensity positron bunches, a capability unique in the world, to experimentally investigate the optimal technique for high-gradient positron acceleration in plasma.The high-intensity beams open the door to an even broader experimental program including dielectric wakefield acceleration (DWA). The status of the facility and expected initial experimental program will be discussed.

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Presenter: HOGAN, Mark (SLAC National Accelerator Laboratory)

Session Classification: Plenary Session 7

Track Classification: Invited Plenary Talk

Contribution ID: **275** Type: **talk**

Future perspectives on short wavelength FELs

Friday, September 20, 2019 11:00 AM (40 minutes)

X-ray free-electron lasers are the brightest sources of X-rays, with a peak power that is several orders of magnitude larger than synchrotron radiation facilities and table-top high-harmonic sources. From the development of of high-repetition rate machines to the advent of femtosecond and attosecond pulse shaping, XFELs are the subject of a vigorous research effort worldwide.
At the same time, research on advanced accelerators promises to shrink the size of these high-energy machines to university-scale laboratories.
In my presentation I will talk about current trends in X-ray free-electron laser research and discuss my view on future directions for large scale FEL facilities as well as compact machines.

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Session Classification: Plenary Session 10

Track Classification: Invited Plenary Talk

Contribution ID: **277** Type: **poster**

Design Studies for Permenant Magnetic Quadrupole Triplet for Matching into Laser Driven Wake Field Acceleration Experiment with External Injection at SINBAD

Monday, September 16, 2019 7:00 PM (1 hour)

The ARES (Accelerator Research experiment at SINBAD) Linac at SINBAD (Short and INnovative Bunches and Accelerators at DESY) facility at DESY aims to produce high brightness ultrashort electron bunches (sub fs to few fs) at around 100 MeV, suitable for injection into novel accelerators e.g. dielectric Laser acceleration (DLA) and Laser Driven Wakefield acceleration (LWFA). The external injection experiment planned at ARES aims for stable LWFA by combining the reproducible conventional RF-based accelerator technology, with high-power plasma wake field dynamics. The LWFA experiment demands Twiss parameter β to be of the order of few mm, in order to avoid emittance growth because of high accelerating gradient in the plasma. The ARES Linac produces ultra-short bunches at around 100 MeV, so the effect of space charge is significantly high. To match such a space charge dominated beam, strong transverse focusing is required. A Permanent Magnetic Quadrupole (PMQ) triplet is one promising focusing strategy. In this paper, we report the technical design constraints and findings for stable settings for PMQ triplet to match the requirements of the electron beam properties, study of phase spaces for final focus into LWFA experiment.

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Presenter: YAMIN, Sumera (DESY)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG7 - High brightness power sources: from Laser Technology to beam drivers

Contribution ID: **278** Type: **talk**

Progress towards laser plasma electron based free electron laser on COXINEL

Tuesday, September 17, 2019 4:40 PM (20 minutes)

The Free Electron Laser (FEL) application of Laser plasma acceleration (LPA) requires the handling of energy spread and divergence. The COXINEL (ERC340015) manipulation line designed and built at SOLEIL [1, 2] consists of variable permanent magnet quadrupoles [3] for divergence mitigation and a decompression chicane for energy sorting, enabling FEL amplification. The COXINEL line, installed at Laboratoire d'Optique Appliquée, uses electrons generated and accelerated by ionization injection for robustness using a 30 TW laser. The electron position and dispersion are independently adjusted [4]. The undulator radiation emitted presents a wavelength stability of 2.6 %, a gap driven tuneability and a linewidth control. However, the electron used for the first experiments deviated from the baseline reference case, because of the rather simple LPA configuration and the limited laser energy. With currently achieved performance on different LPA experiments, FEL effect is within reach. Further calculations indicate that in the seeded configuration, the FEL radiation is red shifted with respect to the seed wavelength and present an interference fringe pattern. Those behaviours can be interpreted with simple theoretical models, which can further enable a full temporal reconstruction of the FEL pulse temporal amplitude and phase distributions.

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Session Classification: WG4 - FEL

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **279** Type: **poster**

Estimates of the radioisotope production from laser driven proton acceleration

Wednesday, September 18, 2019 7:00 PM (1 hour)

Laser-driven ion acceleration is an attractive way to realize compact and affordable ion sources for many exciting applications including cancer therapy. Many of these applications require high energy ion beams with narrow
energy spread as well as high flux. When a near critical (or rather overdense) target is irradiated by a laser pulse, ions are compressed to form a density spike, which in turn launches electrostatic shocks in the target. These shocks can reflect upstream ions and yield ion beams with monoenergetic peaks of a few MeV [1]. In this study, we propose to estimate the use of protons to induce reactions in secondary targets to produce radioisotopes of relevance to the nuclear medecine community (b + emitters), like 11C , 13N or 18F via (p,n) or (p,a) reactions. Indeed, these radioisotopes can be produced with lower proton energy, below 35MeV, energy achievable by laser acceleration. Laser ion acceleration is therefore promising to replace cyclotrons by a more flexible devices : laser systems.
In this work, we present the numerical chain formed by PIC [2] and MONTE CARLO [3] codes. First results of radiosiotope production are analysed, as a function of ion acceleration mechanisms and of targets properties.

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Presenter: BONVALET, Julien (CELIA (CNRS))

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG2 - Ion beams from plasmas

Contribution ID: **281** Type: **poster**

Plans for a Transverse Gradient Undulator Experiment at SINBAD-ARES

Wednesday, September 18, 2019 7:00 PM (1 hour)

Free Electron Lasers (FEL) are commonly regarded as the potential key application
of laser wakefield accelerators (LWFA), but up to now the relatively high energy spread has prohibited FEL lasing. In order to overcome this limitation, modified undulator schemes, so-called transverse gradient undulators (TGUs), were proposed and a first superconducting TGU was built at Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany. A collaboration between KIT, HI Jena and DESY was formed to prepare a first experimental test at the ARES Linac at SINBAD at DESY.

This contribution presents the beam optics, integration studies and simulation results. The current status and the timeline will be described in detail.

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Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **282** Type: **poster**

Emittance Reduction by Density Tapering in Laser-Plasma Electron Acceleration

Monday, September 16, 2019 7:00 PM (1 hour)

Laser-plasma accelerators [1] may become a compact, affordable and powerful alternative for delivering relativistic electron beams of relevance for medical treatment and imaging [2] to fundamental researches related to high-energy physics [3]. However, a main obstacle for this approach to fulfill its promise, for some of the applications, is the beam quality with large divergence and emittance [4]. Tapering the plasma density with which the high-power laser interacts is one of the possible ways to affect and mitigate the beam quality degradation upon its extraction from the plasma [5]. The physical phenomena and the ways to implement the density tapering and improve beam extraction are the topics of this work. Theory and simulations support the feasibility of this method to improve the beam's quality, possibly qualifying the laser-plasma concept as the next generation of electron accelerators.

1. T. Tajima, J. M. Dawson, Phys. Rev. Lett., vol. 43, pp. 267 (1979)
2. Y. Glinec et al., Med. Phys. 33, 155–162 (2006)
3. C. B. Schroeder et al., 13th Advanced Accelerator Concepts Workshop (2008)
4. M. Migliorati et al., Phys. Rev. ST Accel. Beams 16, 011302 (2013)
5. I. Dornmair et al., Phys. Rev. ST Accel. Beams 18, 041302 (2015)

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Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **284** Type: **poster**

A compact UHV-compatible high-voltage supply for a small dielectric laser accelerator

Wednesday, September 18, 2019 7:00 PM (1 hour)

High voltage sources are used in a variety of applications including X-ray tubes, electron microscopes and particle accelerators. One of the most common methods of high voltage generation is the Full-Wave Cockcroft-Walton voltage multiplier (FWCW), where each stage consists of three capacitors and four diodes. The aim of this work is to introduce a circuit design that provides a high voltage (60keV) with low ripple (<1V) and a small footprint, while being fully ultrahigh vacuum (UHV) compatible. By placing this HV generator inside the UHV, we can avoid bulky HV feedthrough and the isolation requirements. Such an in-vacuo unit could be used to operate an electron gun to provide a small sized self-contained electron source, which will be utilized for compact future dielectric laser accelerator experiments. Recent experimental results and simulations will be presented.

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Presenter: KRAUS, Stefanie

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **285** Type: **talk**

CHALLENGES IN THE DESIGN OF A LASER DRIVER FOR A PLASMA ACCELERATOR

Monday, September 16, 2019 6:20 PM (20 minutes)

Novel optical, plasma based accelerators require high peak-power laser drivers at high repetition rate and kW-scale average power for their operation. Significant progress has been made in laser performance during the past decades, mainly concerning peak-power, now in the 10 PW range, well beyond what needed for driving laser-wakefied acceleration. Enhancement of other parameters, like repetition rate, average power, efficiency and footprint is needed to make these systems attractive are you for novel accelerators.
Most of the existing systems rely on chirped pulse amplification in titanium sapphire (Ti:Sa), pumped by frequency doubled conventional (flashlamp-pumped) Neodymium lasers. Recent developments include a range of different architectures, ranging from fiber lasers to systems using other gain materials, in place of Ti:Sa, that can be pumped directly with high efficiency diode lasers.
Here we discuss laser driver requirements for the most advanced accelerator schemes, examine pros and cons of emerging technologies and introduce a viable laser driver concept for a first generation of plasma accelerators.

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Presenter: GIZZI, Leonida Antonio (CNR-INO and INFN)

Session Classification: WG7

Track Classification: WG7 - High brightness power sources: from Laser Technology to beam drivers

Contribution ID: **286** Type: **poster**

Plasma Mirror Reflectivity Measurements on Gemini in a Staged Laser Plasma Wakefield Acceleration Set-Up

Wednesday, September 18, 2019 7:00 PM (1 hour)

The acceleration of electrons with ultra-short, high-intensity laser pulses has a successful method. Although, the maximum accelerated electron energy is limited mostly due to de-phasing of the electrons with the driving laser pulse and the depletion of the laser pulse. Staging two laser wakefield accelerators with two laser beams can overcome these limitations. Using the first plasma cell for electron-trapping and acceleration and a secondary plasma cell for further acceleration. The space-constraints and the high intensity of the laser pulse does not allow conventional reflective optics. One way to solve this issue are plasma mirrors. In this case composed of ultra-thin foil, it can inject the second laser pulse into the second gas cell, minimally disturbing an electron beam as it passes through. The reflectivity and subsequent focus spot in such a compact two stage set-up has been measured and is presented as well as it guiding characteristic in a 18 mm plasma cell.

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Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **287** Type: **poster**

Multi-objective Optimization of the Matching Beamline for External Injection into a Laser-driven Plasma Accelerator

Monday, September 16, 2019 7:00 PM (1 hour)

Accelerators based on LWFA are of great interest for a new generation of compact machines. Choosing external injection of the probe beam in LWFA has the advantage that a well-controlled and fully characterized beam can be injected. The matching of electron bunches into an accelerating wakefield makes high demands on the electron beam quality. The electron beam size must be extremely small to match the tiny plasma channel. The short period of accelerating field in the plasma requires a bunch length in the (sub-)fs range. These electron beam properties result in a high electron density and strongly space charge (sc) dominated bunches. The beamline before the plasma must enable to control the significant effect of sc on the bunch and to transversely match the beam to the plasma. Further constraints to the beamline design are given by the in-cloupling of the high power laser and the implementation of diagnostic tools. Choosing suitable settings for the beamline elements in order to match the beam, poses a great challenge for the beamline design. Using multi-objective optimization, optimum settings for the beamline elements can be extracted from Pareto optimum solutions. The development of a universal multi-objective optimization algorithm for beamline matching is presented.

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Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **288** Type: **poster**

Towards single-shot spatio-temporal characterisation of a multi-PW laser

Wednesday, September 18, 2019 7:00 PM (1 hour)

Full characterisation of ultra-intense laser pulses not only requires their separate characterisation in space and time, but also measurement of the entire spatio-temporal field distribution $E(x, y, t)$. While a variety of techniques has been developed for this purpose (e.g. STARFISH, TERMITES or INSIGHT), most of them rely on spatial or temporal scanning and thus require some thousand shots for a single measurement. An exception to this rule is STRIPED-FISH, which uses interferometry combined with hyperspectral imaging. We present a variation of STRIPED-FISH for implementation at the ATLAS-3000 multi-PW laser system in Garching. Providing the spatio-temporal distribution in a single shot, the setup is particularly suitable for experiments with low-repetition rate lasers aiming for highest focal intensities.

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Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG7 - High brightness power sources: from Laser Technology to beam drivers

Contribution ID: **290** Type: **poster**

FEL-quality 5GeV e-bunches with the Resonant Multi Pulse Ionization injection scheme.

Wednesday, September 18, 2019 7:00 PM (1 hour)

The production of high-quality electron bunches in LWFA relies on the possibilities of both injecting ultra-low emittance bunches in the plasma wave and preserving their quality during the acceleration. Among the recently proposed ultra-low emittance LWFA schemes, the Resonant Multi-Pulse Ionization injection (ReMPI) [1] is flexible and relies on commercially available laser technology. In ReMPI a train of pulses excites, through a MP-LWFA [2], a large amplitude plasma wave that traps electrons extracted from field-ionization. The ionization occurs by means of a dedicated second/third harmonics pulse, focused behind the train.

Here we will show, by means of s2e simulations, that high-quality 5GeV bunches can be generated by using a 800TW-Ti:Sa laser system.
The train of pulses can be generated by using the TeMPI scheme [3], whose exact simulated time-shape has been incorporated in the LWFA simulation. Results show that FEL-quality, 30pC/3kA beams can be obtained, being the slice energy spread close to the peak current $\sigma(E_s)/E_s \simeq 7 \cdot 10^{-4}$, with a slice normalized emittance of $\epsilon_{n,s} \simeq 70\, nm \cdot rad$.

[1] P. Tomassini et al, Phys. Plasmas 24 103120 (2017).

[2] D. Umstadter et al., PRL 72, 1224 (1994).

[3] L. Labate et al., Quasi-Lossless Pulse Train generation by Early-Amplitude division (submitted).

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Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG6 - Theory and simulations

Contribution ID: **291** Type: **poster**

Progress of the L3IA ion beamline at ILIL-PW

Wednesday, September 18, 2019 7:00 PM (1 hour)

In the poster we will describe the most recent experimental results obtained at the Laser Light Ion beam-Line using both flat and nanostructured thin foil targets, where accelerated ions were characterized using a wide range of detection techniques, optimized for the severe conditions typical of a laser-plasma acceleration environment.
Advanced targets are also being explored to enhance beamline performance, with special attention to nanostructured targets, including nano-pillars and porous materials that are used for their role in modifying the electron distribution function of fast electrons. This is mainly investigated via characterization the properties of the fast electron and the ions escaping from the target. Preliminary results and detailed numerical simulations show that a key role is played in these measurements by the level of interstitial plasma filling gaps and cavities in the target, before the ultrashort laser pulse hits the target.
In view of the applications, we also focus on the shot by shot fluctuations of the ion source, investigating the possible role of target imperfections, laser-beam energy, focal spot intensity, pulse duration and pointing stability.

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Presenter: GIZZI, Leonida Antonio (CNR-INO and INFN)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG2 - Ion beams from plasmas

Contribution ID: **292** Type: **talk**

Gamma Factory for CERN: concept and progress report

Tuesday, September 17, 2019 4:50 PM (20 minutes)

The Gamma Factory (GF) proposal is based on the use of partially stripped ion (PSI) beams as drivers of a novel high intensity and high energy (0.1-400 MeV) photon source. We describe the GF concept, the results of the initial beam tests carried out in 2017-2018 at the SPS and LHC with partially stripped xenon and lead beams and we discuss the preparation for proof-of-principle experiment at the SPS to study collisions of PSI beams with the laser pulses.

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Session Classification: WG8

Track Classification: WG8 - Advanced and novel accelerators for High Energy Physics

Contribution ID: **293** Type: **talk**

Compact spectral characterization of 10-500 MeV γ-rays from the Texas Petawatt Laser-Driven Plasma Accelerator

Wednesday, September 18, 2019 4:00 PM (20 minutes)

GeV (γ_e > 2000) electron bunches from petawatt-laser-driven plasma accelerators can be converted to tunable, narrowband or to broadband continuum γ-ray ($h\nu$ > 10 MeV) pulses by Thomson backscattering (TBS) or bremsstrahlung, respectively. Inserting a plasma mirror (PM) near the accelerator exit converts electrons to γ-rays compactly and inexpensively [1], in a TBS/bremsstrahlung mixture determined by PM thickness, material and location. Characterizing the γ-ray spectra accurately is a challenge, usually addressed with bulky pair production/Compton spectrometers. Here, we spectrally characterize PM-generated TBS/bremsstrahlung γ-rays from 1-2 GeV Texas-Petawatt-Laser-accelerated electron bunches using a compact stack calorimeter, consisting of alternating absorbers and imaging plates, to record energy-dependent particle showers generated by incoming γ-rays. An iterative Bayesian algorithm, based on a calorimeter response matrix built from GEANT4 simulations, reconstructs TBS and bremsstrahlung contributions for each shot, as PM and electron parameters vary. The method should be widely applicable to plasma-accelerator-based radiation with MeV photon energies.

[1] H.E. Tsai et al., Phys. Plasmas 22, 023106 (2015); T. Phuoc et al., Nat. Phot. 6, 308–311 (2012); A. Döpp et al., Plasma Phys. Control. Fusion 58, 034005 (2016); C. Yu et al., Sci. Rpts. 6, 29518 (2016)

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Session Classification: WG4 - Thomson

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **294** Type: **poster**

Tunable laser plasma acceleration based on ionization injection

Wednesday, September 18, 2019 7:00 PM (1 hour)

Laser-plasma accelerators generate ultrarelativistic electron beams over only a few centimeters, making them particularly interesting as drivers for compact next-generation light sources. In order to become applicable for these applications, control of electron beam properties, enhanced stability and reproducibility are crucial.
Here, we demonstrate dedicated tuning of electron beam parameters based on the ionization injection scheme. Using a 200 TW laser system we generate electron beams from a nitrogen-doped hydrogen plasma. Precisely adjusting laser and plasma parameters, we control beam loading, the electron peak energy, the bunch charge, beam divergence and emittance. Carfully optimizing these parameters allows us to reproducibly operate our plasma accelerator with percent-level electron energy stability between 200-400 MeV, an FWHM energy spread below 20% and a bunch charge between 100 and 300 pC.

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Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **295** Type: **talk**

Collisionless shock acceleration in near-critical and underdense plasmas

Tuesday, September 17, 2019 6:40 PM (20 minutes)

Laser-driven electrostatic shocks have shown the potential to accelerate ions to very high energy with low energy spread and divergence and thus, they constitute a very promising ion acceleration mechanism [1,2,3]. Leveraging multi-dimensional realistic particle-in-cell simulations, this work explores how intense shocks can be excited in near-critical and underdense plasma targets. The importance of the plasma density profile in reducing the energy spread is analysed and conditions leading to high-quality beams are individuated. New engineered target configurations are proposed [4]. It will be shown that this approach guarantees low energy spread ions with a high level of controllability. The dependence of the beam quality on the laser transverse profile will be also addressed and conditions to obtain low divergence beams will be derived. Finally, simulation results will be connected with recent experimental outcomes [1,3].

[1] Haberberger et al, Nat Phys 8, 95 (2012). Fiúza et al, Phys Rev Lett 109, 215001 (2012). Fiúza et al., Phys. Plasmas 20, 56304 (2013).
[2] Tresca et al, Phys Rev Lett 115, 094802 (2015). Pak et al, Phys Rev Accel Beams 21, 103401 (2018).
[3] Antici et al, Sci Rep 7, 16463 (2017).
[4] Boella et al, Plasma Phys Contr F 60, 035010 (2018).

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Session Classification: WG6

Track Classification: WG6 - Theory and simulations

Contribution ID: **296** Type: **talk**

Progress towards BELLA Center's Laser-Plasma Accelerator based Free Electron Laser

Tuesday, September 17, 2019 4:00 PM (20 minutes)

At the BELLA Center at LBNL, we are pursuing the demonstration of a high gain free electron laser (FEL) using an electron beam generated by a laser plasma accelerator (LPA) with an ultimate goal of developing a compact, high brightness VUV/x-ray source. A new dedicated 100TW-class laser system now delivers pulses of 2.5J and 40 fs duration (at 5 Hz repetition). After an upgrade with a deformable mirror, we are now routinely producing electron beams at the 100-200 MeV level. In this presentation we will describe our LPA FEL facility, including the advanced electron beam transport line to the 4-meter-long strong-focusing VISA undulator. Transport and manipulation devices include a permanent quadrupole triplet, several steering magnets, an electro-magnetic triplet, a magnetic chicane to decompress the electron beam, a mid-line magnetic spectrometer, and a diagnostic chamber. Our simulations indicate that FEL gain should be observed by decompressing the few-femtesecond few-% energy spread beams with the chicane. Diagnostics and recent results towards FEL research will be presented, including phase-space optimization of the electron beams.

This work was supported by the U.S. Department of Energy (DOE) under Contract No. DE-AC02-05CH11231, and by the Gordon & Betty Moore Foundation under Grant ID GBMF4898.

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Session Classification: WG4 - FEL

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **297** Type: **poster**

Design of an experiment to measure the decay rate of laser-driven linear wakefields

Wednesday, September 18, 2019 7:00 PM (1 hour)

Multi-pulse laser wakefield acceleration (MP-LWFA) is a promising scheme for increasing the repetition rate of LWFAs to to the kHz range [1-2] In this approach the laser wakefield is driven by a train of laser pulses spaced by the plasma wavelength such that the wakefields driven by each pulse interfere coherently.

A major consideration for MP-LWFA and related schemes is the decay time of the wakefield, since this determines the maximum number of laser pulses that can be used. The decay time is determined by the motion of the plasma ions, which is usually neglected for short pulse drivers.

We will present the design of the experiment presented in the talk "Measurement of the decay rate of laser-driven linear wakefields". The amplitude of a wakefield was measured up to 4 ps after excitation by a 44 fs long single laser pulse of laser parameter a0 ~ 0.5. The target consisted of a gas cell backed with 20 mbar of either hydrogen or deuterium gas, and the Temporally Encoded Spectral Shifting (TESS) method [3-4] was used to measure the wakefield amplitude. The experimental layout, wakefield diagnostic, data analysis, and target design will be covered in this poster presentation.

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Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **298** Type: **talk**

Single-cycle THz signal accompanying laser wake in photo-ionized plasmas and plasma channels

Thursday, September 19, 2019 6:40 PM (20 minutes)

Photoionization by a femtosecond TW laser pulse generates a plasma column in a neutral ambient gas.The 3D laser wake wave extends through the column surface, generating an azimuthally polarized rotational current within a micron-thin shell. This current supports a broad-band, evanescent THz signal accompanying the wake, detectable at a distance orders of magnitude larger than the column radius. Frequency spectrum of the signal bears an imprint of the radial density profile, helping evaluate the ionization state of the gas and thus the efficiency of laser coupling to the plasma. A few millimeters away from the column, rapid evanescence of its high-frequency components turns the signal into a radially polarized, single-cycle pulse. The THz rotational current may be similarly generated in a leaky plasma channel, via coupling the wake electron velocity to the radial density gradient. Also, applying external voltage to the channel induces a slowly-varying, radially non-uniform electron flow (DC). Coupling velocity of this flow to electron density perturbations in the laser wake adds another term to the rotational current. The efficiency of coupling depends on the radial structure of the DC and the plasma wake.
Supported by AFRL through contract FA9451-17-F-0011, and by AFOSR grants FA9550-16RDCOR325, FA9550-19RDCOR023, and FA9550-19RDCOR027.

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Session Classification: WG6

Track Classification: WG6 - Theory and simulations

Contribution ID: **299** Type: **talk**

Laser-driven Ion Acceleration and Societal Applications at the Extreme Light Infrastructure (ELI)

Monday, September 16, 2019 6:00 PM (20 minutes)

The ELIMAIA (ELI Multidisciplinary Applications of laser-Ion Acceleration) beamline has been recently installed at ELI-Beamlines in the Czech Republic. The main goal of ELIMAIA is to offer short ion bunches accelerated by lasers with high repetition rate to users from different fields (physics, biology, material science, medicine, chemistry, archaeology) and, at the same time, to demonstrate that this source can be delivered through innovative and compact approaches. In fact, ELIMAIA will provide stable, fully characterized and tunable particle beams accelerated by PW-class lasers and will offer them to a broad community of users for multidisciplinary applied research, as well as fundamental science investigations.

An international scientific network, called ELIMED (ELI MEDical applications), particularly interested in future applications of laser-driven ions for hadrontherapy, has already been established. In such a perspective ELIMAIA will enable to use laser-driven proton/ion beams for medical research thanks to the reliability and accuracy of its particle beam transport and dose monitoring devices.

An overview of the ELI-Beamlines international facility in the Czech Republic, along with the ELIMAIA user beamline and ELIMED objectives will be given.

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Session Classification: WG2-WG4 Joint Session

Track Classification: WG2-WG4 Joint Session

Contribution ID: **300** Type: **poster**

Electron Beam Matching Strategies for External Injection in LWFA for SINBAD-ARES

Wednesday, September 18, 2019 7:00 PM (1 hour)

Laser-driven plasma wakefield acceleration (LWFA) provides an innovative and compact alternative to conventional RF accelerators. The electron beam can be injected to a plasma accelerator using different techniques. The advantage of external injection from an RF accelerator is given by the possibility to inject fully characterized bunches with a well-controlled beam quality. In addition, the consideration of a staged approach in the plasma accelerator always requires the use of an externally injected beam. The matching of the electron bunches to the accelerating wakefield in the plasma makes high demands on the electron beam properties at the plasma entrance and the timing. Further requirements and constraints for the design of the matching beamline are given by the incoupling of the high-power laser and the implementation of diagnostic tools.
This conference contribution presents different strategies and a first layout proposal to externally match a low-energy, high-charge electron beam to an accelerating plasma cell. The shown studies are done for SINBAD-ARES (Accelerator Research Experiment at SINBAD) at the Deutsches Elektronen-Synchrotron (DESY), a linac under construction that will be a test facility for the generation of high brightness probes for LWFA and their external injection to a plasma cell.

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Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **301** Type: **talk**

THz streaking of ultrashort electron bunches

Wednesday, September 18, 2019 6:00 PM (20 minutes)

Recently, we proposed to use building blocks of THz metamaterials for streaking of ultrashort electron bunches. Such building blocks allow for a precise control of the electric and magnetic near-field distribution in a volume that is defined by the geometry of the structure. THz radiation with wavelengths on the order of a hundred micron is well matched to the transverse and longitudinal size of typical electron bunches in advanced accelerators. Moreover, today's pulsed THz sources provide field strengths up to hundreds of MV/m and thus become competitive with standard microwave sources. When combined with structures featuring high values of either electric or magnetic field enhancement, the maximum field strength can even be ten to a hundred fold higher.

Here, the streaking device is a split ring resonator loaded by a single cycle THz pulse. Electron bunches passing through the resonator's gap experience a transverse momentum kick which sign and magnitude depends on the longitudinal bunch position. Thus, the longitudinal bunch density is mapped onto the transverse axis and can be measured with a spatially resolved electron detector. Detailed simulations and experimental results are presented for the 3 MeV ultrafast electron diffraction facility at KAERI.

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Session Classification: WG3 - Thz acceleration

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **302** Type: **poster**

Progress on the Commissioning of a Terahertz-Driven Velocity Bunching Experiment

Wednesday, September 18, 2019 7:00 PM (1 hour)

Terahertz-driven electron beam manipulation promises femtosecond control of bunches with femtosecond timing jitter. A compact, terahertz-driven velocity bunched electron beam demonstration is under development at the Cockcroft Institute. A lithium niobate terahertz radiation source using the tilted pulse front scheme has been established experimentally and its interaction with a 100 keV electron bunch, generated from a previously characterised photoemission gun, has been simulated. This is part of a larger group effort which hopes to demonstrate an apparatus capable of generating, deflecting and accelerating a high quality, ultra-short electron bunch, using one laser system to guarantee synchronisation between stages. Such a short bunch accelerator can be readily applied to ultrafast electron diffraction application, and has potential for solving long-standing challenges of external injection into high-gradient accelerators, such as laser wakefield accelerators.

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Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **303** Type: **poster**

Experimental results from a two-color laser wakefield accelerator and its application to positron beam generation

Wednesday, September 18, 2019 7:00 PM (1 hour)

A typical laser-plasma accelerator (LPA) is driven by single, relativistic laser pulse from terawatt or petawatt-class lasers. Recently, there have been simulation studies on the use of two synchronized ultrashort relativistic co-propagating two-color laser pulses (CTLP) for LPA research. Here, we present experimental results from the first LPA driven by CTLP where we observed a significant distinction in the electron energy spectra as compared with the results from a standard LWFA driven by a single laser pulse of equivalent power. Those results have been further confirmed in a real-application experiment, where the electrons from the CTLP scheme were used in a bremsstrahlung-based positron generation configuration which led to a distinctive spectrum for the positron beam energy spectra as well. Numerical simulations suggest that the trailing Second Harmonic (SH) relativistic laser pulse is capable of sustaining the acceleration process for a much longer distance after the preceding fundamental laser pulse has been depleted in the plasma. Therefore, our experimental work demonstrates significant advances in driving LPAs by two-color laser pulses.

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Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **304** Type: **talk**

Acceleration of relativistic beams using laser-generated terahertz pulses

Wednesday, September 18, 2019 6:20 PM (20 minutes)

Here we present the first demonstration of THz-driven acceleration of a fully relativistic electron beams. The experiments were carried out with the 35MeV bunches of the CLARA research facility at Daresbury Laboratory. The electrons were injected into a dielectric-lined waveguide simultaneously with a quasi-monochromatic laser-generated THz pulse with a longitudinal electric field containing mode. Interaction with long-duration chirped electron bunches gives rise to an enegy spectrum modulation with 90% visibility, demonstrating potential for THz-driven bunching of relativistic beams. Single-bucket injection and acceleration of short duration bunches is observed. We further demonstrate time-energy phase-space characterization of the electron beam thorough its interaction with the THz pulse. These results pave the way to unprecedented control over relativistic electron beams, providing bunch compression for ultrafast electron diffraction, synchronized and compressed bunches for injection into alternative novel accelerator schemes, energy manipulation for bunch diagnostics, and ultimately delivering high-field gradients for compact THz-driven particle acceleration.

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Session Classification: WG3 - Thz acceleration

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **305** Type: **poster**

High transformer ratio resonant PWFA working point design for EuPRAXIA@SPARC_LAB

Wednesday, September 18, 2019 7:00 PM (1 hour)

In the context of plasma wakefield acceleration beam driven, we design and numerically test an ideal working point that exploits the resonant behavior of a train of driving bunches with ramped charge in order to accelerate a trailing bunch to high energy. The working point consists in a train of four bunches generated by an RF X-band photo-injector with the energy of 1.2 GeV. The bunch current profile is shaped by means of hybrid compression stage exploiting the combination of velocity bunching and magnetic chicane. The charges are properly calibrated in order to maximize the transformer ratio up to RT=8. The trailing bunch has a triangular shape and a peak current I=3kA. By means of a 2.4m long plasma channel we simulated the acceleration of the trailing bunch up to 5GeV mainly preserving the quality of the accelerated beam. The simulations were performed in cylindrical symmetry with the hybrid kinetic-fluid code Architect

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Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG6 - Theory and simulations

Contribution ID: **307** Type: **talk**

Alternating phase focusing in dielectric laser acceleration

Monday, September 16, 2019 5:00 PM (20 minutes)

Utilizing photonic nanostructures and ultra-short laser pulses, dielectric laser acceleration (DLA) provides a scheme for high gradient particle accelerators. In the past, this concept was limited by insufficient beam transport through longer structures and the inability to stage multiple structures without particle loss. The concept of alternating phase focusing (APF) provides a way to transport and accelerate electrons over, in principle, infinitely long structures with little particle loss. By alternating between the phases longitudinally focusing –transversely defocusing and longitudinally defocusing –transversely focusing, the particle beam can be confined both longitudinally and in one transverse direction [1]. We have experimentally demonstrated APF transport in a well-suited nanostructure. The particle beam used consists of 30 keV electrons of an ultrafast SEM. The APF structure used in the experiment shows a boost in electron throughput of up to 100% when illuminated by laser pulses. Preliminary data indicate good agreement with theory simulations.
[1] U. Niedermayer, Thilo Egenolf, Oliver Boine-Frankenheim, and Peter Hommelhoff, Phys. Rev. Lett. 121, 214801 (2018)

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Session Classification: WG3 - Dielectric Acceleration

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **308** Type: **poster**

Electron bunch length in laser-plasma acceleration.

Wednesday, September 18, 2019 7:00 PM (1 hour)

Many experiments have been conducted in recent years in which electron bunches have been accelerated during the interaction of ultra-short and ultra-intense laser pulses with thin solid targets. Several causes can be taken into consideration which contribute to the determination of the measured bunch length at the exit of the targets. These include the velocity distribution of the electrons accelerated at the plasma critical surface and, eventually, the extension of the pre-plasma in which other acceleration processes can develop as well.
The understanding of these mechanisms will allow, in the future, for controlling the duration of an electron bunch generated with these techniques, which is necessary for several applications as, for example, multi-stage laser-plasma acceleration systems.

Primary authors: GIULIETTI, Danilo (PI); CURCIO, Alessandro (CERN)

Presenter: GIULIETTI, Danilo (PI)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **309** Type: **poster**

Enhanced proton acceleration from ultra-thin foils with non-periodic nano-holes

Wednesday, September 18, 2019 7:00 PM (1 hour)

The interaction of high-power, high-contrast laser pulses with nanostructured targets has largely been explored as a possible way to increase energy absorption and aim to more efficient proton acceleration. In these studies, the costs of target manufacturing and handling are a key factor to establish the soundness of each approach, and while advance of laser technologies now allow preserving the target structures until the interaction with the ultra-intense pulse peak, stringent requirements on target geometries and shapes may hinder their applicability to high repetition rate schemes.

Here we present promising results on the energy enhancement of TNSA-driven proton beams achieved when irradiating sub-μm foils perforated with a non-periodic distribution of nm-size holes. Particle-In-Cell simulations highlight how hot electrons travelling across the nano-holes benefit from a longer interaction with the laser pulse and result in a more efficient sheath field for accelerating the proton beams. The numerical investigation demonstrates the robustness of the mechanisms within a variety of foil thicknesses and hole diameters. Recent experiments performed at the Lund High-Power Laser facility are consistent with the simulation results and confirm the favourable manageability of this target configuration.

Primary author: CANTONO, Giada (Lund University)

Co-authors: PERMOGOROV, Alexander (Lund University); SVENDSEN, Kristoffer (Lund university); WAHLSTRÖM, Claes-Göran (Lund University); Dr THIELE, Illia (Chalmers University of Technology); FERRI, Julien (Chalmers University of Technology); Dr SIMINOS, Evangelos (University of Gothenburg); Dr GREMILLET, Laurent (CEA); Mr DMITRIEV, Alexander (Gothenburg University); Mrs SMETANINA, Evgeniya (Gothenburg University); Prof. FÜLÖP, Tünde (Chalmers University of Technology)

Presenter: CANTONO, Giada (Lund University)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG2 - Ion beams from plasmas

Contribution ID: **310** Type: **poster**

Spectral phase effects on laser-accelerated proton beams

Monday, September 16, 2019 7:00 PM (1 hour)

The recent installation of a double plasma mirror in the experimental area of the Lund High-Power Laser facility now allows the study of laser-plasma interactions with stable, pre-pulse and pedestal-free laser pulses. Such a regime of high contrast (10e-8 at 1 ps before the pulse peak) ensures that targets with nm-scale thicknesses can be irradiated without forming a pre-plasma at their surface, resulting in more reproducible and controlled experimental conditions, and thus opening the possibility to investigate finer processes involved in laser-driven proton acceleration.

Here we present our recent experimental study on the effect of the spectral properties of the laser pulse on the cutoff energy of TNSA-driven proton beams. We manipulated the laser spectral phase to deliver chirped and skewed pulses to sub-μm carbon foils, observing a 30% enhancement of the proton energies with positively-chirped pulses. Effects of third order dispersion appear to play a minor role with respect to the chirp.
Our results suggest that positively-chirped pulses bring about a more efficient absorption mechanism that may be related to piling up of hot electrons at the front surface of the target on a sub-ps time scale. Details of the acceleration process are currently being explored with Particle-In-Cell simulations.

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Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG2 - Ion beams from plasmas

Contribution ID: **311** Type: **talk**

Application of laser-accelerated particles (protons and electrons) to radiation biology.

Monday, September 16, 2019 4:00 PM (20 minutes)

Laser-accelerated particles (protons and electrons alike) feature very short duration (often below 1 ps) and high peak current (~ kA). These characteristics makes them suitable for depositing dose in living tissues over a timescale at the heterogeneous chemistry level, at peak doserates exceeding several 10^9 Gy/min. The effect of fractionated dose deposition and ultra-high dose rate has recently gained much attention due to the discovery of the FLASH effect, showing that high doses delivered in short times would produce less secondary effects in healthy tissues, while keeping intact their therapeutic potential on cancerous cells. The construction of laser-driven pre-clinical irradiation line could represent a perfectly adapted tool for the exploration on fundamental effects in radiation biology and chemistry towards the definition of new therapeutic strategies.
During recent experimental activities in LOA a fully characterized proton transport line with on-line dosimetry was setup, enabling two successful experimental campaigns in radiation biology. Recent results will be presented, and their pertinence for the transition towards application of laser-driven particle sources to medicine will be discussed. Perspectives for the extension to the use of laser-accelerated protons and electrons for in-vitro and in-vivo experiments will also be presented.

Primary authors: FLACCO, Alessandro (LOA/ENSTA); Dr BAYART, Emilie (LOA/ENSTA); CAVALLONE, Marco (École Polytechnique Paris); Dr DELMAS, Olivier (LOA/ENSTA)

Presenter: FLACCO, Alessandro (LOA/ENSTA)

Session Classification: WG4

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **312** Type: **talk**

An update on the Radiobiology experiments at ultra -high dose rate employing laser-driven ion accelerators

Tuesday, September 17, 2019 12:10 PM (30 minutes)

The use of particle accelerators in radiotherapy has significantly changed therapeutic outcomes for many types of solid tumours. While protons are well known for sparing normal tissues surrounding the tumour and increasing the overall therapeutic index, carbon ions have been suggested to be particularly effective in the treatment of radioresistant hypoxic tumour due to the higher Relative Biological Effectiveness and Linear Energy Transfer. The large and expensive infrastructure currently required for delivering these forms of therapy has stimulated interest in alternative approaches of ion acceleration and delivery. Among these, laser-driven methods demonstrate the potential of delivering therapeutic doses at ultra-high dose rates, with compact irradiation systems. An extensive investigation of the radiobiological effectiveness of laser driven ion pulses is necessary in view of any future clinical application, but also offers the opportunity of accessing yet untested regimes of radiobiology where the dose is delivered to biological samples at dose rates exceeding by many orders of magnitude what normally possible with conventional RF accelerators.

This talk will provide a review of recent results globally obtained in the field, as well as details of experiments carried out by the UK-wide A-SAIL consortium at the Central Laser Facilities of the Rutherford Appleton Laboratory.

Primary author: CHAUDHARY, Pankaj (Centre for Cancer Research and Cell Biology, Queen's University Belfast)

Presenter: CHAUDHARY, Pankaj (Centre for Cancer Research and Cell Biology, Queen's University Belfast)

Session Classification: Plenary Session 4

Track Classification: Invited Plenary Talk

Contribution ID: **313** Type: **talk**

Heat-induced deformation of compressor gratings and resulting spatio-temporal couplings

Thursday, September 19, 2019 4:20 PM (20 minutes)

Today's laser-plasma accelerators are driven by terawatt-class laser systems at a few-Hz repetition rates and few-Joule pulse energies. Typically, the architecture of these systems includes a compressor based on in-vacuum gold-coated gratings, which absorb a percent-level fraction of the incident laser energy. However, as laser technology pushes the limit towards higher repetition rates and operation at higher average power, the energy absorbed in the compressor becomes a severe issue: the heat-induced deformation of the gratings changes the spatial and temporal properties of the laser beam during high-power operation, which can in turn drastically decrease the peak intensity on target, as well as degrade the quality of the accelerated electron beams. Here, we present experimental studies on the impact of heat-induced grating deformation and report on the wavefront and pulse degradation on target.

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Presenter: EICHNER, Timo (University of Hamburg/Center for Free-Electron Laser Science)

Session Classification: WG7

Track Classification: WG7 - High brightness power sources: from Laser Technology to beam drivers

Contribution ID: **314** Type: **poster**

Conventionally accelerated and plasma-accelerated particles for studying destructive pigment darkening in artworks

Wednesday, September 18, 2019 7:00 PM (1 hour)

The strong focusing down of intense laser pulses in air leads to the production of plasma-accelerated low-energy electrons. These particles are emitted almost isotropically and travel with an intense photon emission, which –when impacting matter –stimulate cathodo- and luminescence. This contemporaneous luminescence emission provoked by both electrons and photon has recently been referred to as In-Air Plasma-Induced-Luminescence (In-Air-PIL). In this paper we study the In-Air-PIL spectroscopy as alternative to classical chemical and crystallographic methods employed in materials science using conventional accelerated (e.g. the Particle Induced X-Ray Emission – PIXE), and in particular in the field of Cultural Heritage. We evaluate the suitability of the suggested technique on a case study related to investigating the effect of the light aging on the darkening of five pristine yellow pigments commonly employed in Cultural Heritage artworks. Using different accelerator techniques we show that the darkening is not associated to changes in the chemical composition, neither the oxidation nor absorption of impurities, or rearranging of the morphology, but to a strong loss in crystallinity.

Primary authors: Prof. BARBERIO, Marianna (INRS); Dr SKANTZAKIS, Emmanouil (FORTH); SORIEUL, Stéphanie (CNRS-IN2P3/CENBG); ANTICI, Patrizio (INRS)

Presenter: ANTICI, Patrizio (INRS)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **315** Type: **talk**

Challenges and tolerances for a compact and hybrid ultrafast X-ray pulse source based on RF and THz technologies

Wednesday, September 18, 2019 6:40 PM (20 minutes)

A hybrid concept for an Inverse Compton Scattering (ICS) based compact ultrafast X-ray pulse source, relying on the combination of a conventional S-band electron gun with a dielectric-loaded waveguide driven by a multicycle THz pulse (THz linac), is under investigation by the authors. The target of this hybrid concept is to generate pC-class ultrashort electron bunches (≤ 1 fs rms), at moderate energies (15 to 20 MeV) and focused to a transverse size below 10 µm rms while keeping a compact beamline (≤ 2 m). This contribution first presents the optimization of the concept through beam dynamics simulations and the simulation of the properties of the X-rays generated via ICS. The main part is then dedicated to two aspects. First, a description of the main technical requirements for the concept and the associated challenges is given. Finally, a tolerance study deals with the influence of various jitters and beamline imperfections on the achievable electron bunch properties.

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Presenter: VINATIER, Thomas (DESY)

Session Classification: WG3 - Thz acceleration

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **316** Type: **poster**

Feasibility study for a THz acceleration experiment on the PHIL facility at LAL

Wednesday, September 18, 2019 7:00 PM (1 hour)

Particle acceleration beyond the few-MeV level currently requires large infrastructures, due to the low frequencies (a few GHz) and relatively low field amplitudes (a few tens of MV/m in the meter-long structures) used in conventional accelerating structures. One of the scheme currently investigated to reduce the footprint of particle accelerators by several orders of magnitude is to use dielectric-loaded circular waveguides (DLW) driven by multicycle THz pulses, for which the operating frequency (100 GHz to a few THz) and field amplitude (up to a few GV/m) are expected to be much higher. A demonstration experiment of this acceleration scheme is currently investigated. The basic experimental principle would be to inject the 3-4 MeV electron beam from the S-band gun of the PHIL photoinjector into a DLW driven by a multicycle THz pulse, the Joule-class infrared laser from the LASERIX facility being a potential candidate for its generation. We study the feasibility of this experiment, especially looking at the design of the DLW, the requirements in terms of THz pulse properties, the integration into the PHIL beamline and evaluate the expected results through start-to-end beam dynamics simulations along the PHIL beamline with the DLW included.

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Presenter: VINATIER, Thomas (DESY)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **317** Type: **talk**

Science Applications for the European Accelerator Research Infrastructure EuPRAXIA

Wednesday, September 18, 2019 6:00 PM (20 minutes)

The Horizon2020-funded project EuPRAXIA is a conceptual design study aiming to develop a multi-GeV electron accelerator test facility based on plasma acceleration. With particular emphasis on compactness and cost-effectiveness, the project focuses on achieving high beam quality, stability and robustness, unprecedented for plasma accelerators and essential for their development towards user readiness. While the entire project will be summarised in a conceptual design report in October 2019, one particular topic of importance is the science case of EuPRAXIA. Several highlight user applications are foreseen for the baseline design of the machine, including, among others, free-electron laser pilot experiments, radiation- and positron-beam-based imaging for materials and life sciences as well as high-energy physics detector testing and accelerator R&D. This paper will highlight some of these applications and more generally potential future uses of plasma accelerators. We will also discuss the layout of the facility and touch on the role of EuPRAXIA within the current and future research infrastructure landscape in Europe.

Primary authors: WEIKUM, Maria Katharina (DESY); WALKER, Paul Andreas (DESY); Dr ASSMANN, Ralph (Deutsches Elektronen-Synchrotron DESY, Germany); CLARKE, Jim (STFC); COUPRIE, Marie Emmanuelle (Synchrotron SOLEIL); FERRARIO, Massimo (LNF); NGUYEN, Federico (ENEA); MURPHY, Chris (York University); NAJMUDIN, Zulfikar (Imperial College London); SARRI, Gianluca (Queen's University Belfast); SPECKA, Arnd (LLR - Ecole Polytechnique - CNRS/IN2P3); Dr STREETER, Matthew (Imperial College London); WALCZAK, Roman (University of Oxford)

Presenter: WEIKUM, Maria Katharina (DESY)

Session Classification: WG4 - New Facilities, laser wakefield betatron for QED and HED

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **318** Type: **poster**

Alternating phase focusing in dielectric laser acceleration

Wednesday, September 18, 2019 7:00 PM (1 hour)

Utilizing photonic nanostructures and ultra-short laser pulses, dielectric laser acceleration (DLA) provides a scheme for high gradient particle accelerators. In the past, this concept was limited by insufficient beam transport through longer structures and the inability to stage multiple structures without particle loss. The concept of alternating phase focusing (APF) provides a way to transport and accelerate electrons over, in principle, infinitely long structures with little particle loss. By alternating between the phases longitudinally focusing –transversely defocusing and longitudinally defocusing –transversely focusing, the particle beam can be confined both longitudinally and in one transverse direction [1]. We have experimentally demonstrated APF transport in a well-suited nanostructure. The particle beam used consists of 30 keV electrons of an ultrafast SEM. The APF structure used in the experiment shows a boost in electron throughput of up to 100% when illuminated by laser pulses. Preliminary data indicate good agreement with theory simulations.
[1] U. Niedermayer, Thilo Egenolf, Oliver Boine-Frankenheim, and Peter Hommelhoff, Phys. Rev. Lett. 121, 214801 (2018)

Primary author: ILLMER, Johannes (Chair for Laserphysics, FAU)

Co-authors: Mrs MITTELBACH, Anna (Chair for Laserphysics, FAU); NIEDERMAYER, Uwe (TU--Darmstadt); SCHÖNENBERGER, Norbert (Friedrich-Alexander-Universität Erlangen-Nürnberg); SHILOH, Roy (Chair of Laserphysics (FAU)); HOMMELHOFF, Peter (University of Erlangen and Max Planck Institute of Quantum Optics)

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Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **321** Type: **talk**

Ultra-High Intensity Laser Research at BELLA

Wednesday, September 18, 2019 6:20 PM (20 minutes)

This presentation will review the status of ion acceleration at the BELLA petawatt (PW) facility with a large laser spot (f\65) and give an outlook on science enabled by a short-focal length (f\2.5) laser beamline, currently under construction.
Proton beams from the long-focal length beam line exhibit a strongly reduced divergence and increased ion numbers and are hence, ideally suited for subsequent capture and transport with an active plasma lens (APL).
As part of our development of an experimental platform for investigating radiobiological effects of laser-accelerated ions, we were able to irradiate normal and radioresistant prostate cancer tumor cell samples with over 1500 PW shots using the APL.
The new the short-focal length beamline will be equipped with a re-collimating double-plasma mirror to study laser-plasma interactions at ultra-high temporal contrast. BELLA is now part of LaserNetUS, providing international user access.

The work was supported by Laboratory Directed Research and Development (LDRD) funding from LBNL provided by the Director, and the U.S. Department of Energy Office of Science Offices of High Energy Physics and Fusion Energy Sciences, under Contract No. DE-AC02-05CH11231. Work at BELLA was also supported by LaserNetUS (https://www.lasernetus.org/). JHB acknowledges financial support from the Alexander von Humboldt Foundation.

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Presenter: STEINKE, Sven (Lawrence Berkeley National Laboratory)

Session Classification: WG2

Track Classification: WG2 - Ion beams from plasmas

Contribution ID: **324** Type: **poster**

Quantitative reconstruction of wakefield electron density distribution

Wednesday, September 18, 2019 7:00 PM (1 hour)

Few-cycle shadowgraphy is a common tool to qualitatively investigate the longitudinal and transverse structure of laser generated wakefields. However the measured intensity distribution provides hardly any information about the wake amplitude since the wakefield itself is a pure phase object and the measured intensity distribution is a function of the imaging plane. Commonly this plane is not precisely known due to the pointing jitter of the driver laser. One possible approach to investigate the phase object constituted by the electron distribution inside the wake is to image multiple planes around the wakefield. From these multiple intensity distributions it is possible to reconstruct the phase that defines the propagation between the imaged planes and therefore represents the original phase object.
We report on the successful reconstruction of the phase accumulated by the probe beam and subsequent extraction of the plasma refractive index. From that the electron density distribution of the wakefield is calculated.
We experimentally observe wakefields in He-gasjets driven by a 100TW-class laser. The gas density is in the range of $5 \cdot 10^{18} cm^{-3}$. We find linear and quasi-linear plasma wakes with a modulation depth comparable to that expected from theory and simulations.

Primary author: FOERSTER, Moritz (LMU Munich)

Co-authors: DING, Hao (LMU München); DÖPP, A. (Ludwig-Maximilians-Universität München; Max Planck Institut für Quantenoptik); KARSCH, S. (Ludwig-Maximilians-Universität München; Max Planck Institut für Quantenoptik); KONONENKO, Lena (Ecole Polytechnique); CORDE, Sébastien (Ecole Polytechnique); CHANG, Yen-Yu (Helmholtz-Zentrum Dresden - Rossendorf); IRMAN, Arie (Helmholtz Zentrum Dresden Rossendorf)

Presenter: FOERSTER, Moritz (LMU Munich)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **325** Type: **talk**

Progress on the Vorpal exascale transition

Tuesday, September 17, 2019 4:20 PM (20 minutes)

Vorpal was designed nearly 20 years ago, with its first applications roughly four years later, as a highly performant, flexible plasma simulation code. Using object oriented methods, Vorpal was designed to allow runtime selection from multiple field solvers, particle dynamics, and reactions. It has been successful in modeling for many areas of accelerator physics, including RF structures, laser-plasma and beam-plasma acceleration, and dielectric-based accelerators. Now it is critical to move to exascale systems, with their compute accelerator architectures, massive threading, and advanced instruction sets. Previous revolutionary changes, such as the move to distributed memory computing (MPI), led to entirely new applications, as the extensive required restructuring made new application development from scratch the more efficient process. Here we discuss how we have moved this complex, multiphysics computational application to the new computing paradigm, and how it was done in a way that kept the application producing physics during the move. We present performance results showing significant speedups in all parts of the PIC loop, including field updates, particle pushes, and reactions.

Primary authors: COWAN, Benjamin (Tech-X Corporation); AVERKIN, Sergey (Tech-X Corporation); CARY, John (Tech-X Corporation); LEDDY, Jarrod (Tech-X Corporation); SIDES, Scott (Tech-X Corporation); ZILBERTER, Ilya (Tech-X Corporation)

Presenter: COWAN, Benjamin (Tech-X Corporation)

Session Classification: WG6

Track Classification: WG6 - Theory and simulations

Contribution ID: **326** Type: **talk**

Characterization of the Electron Beam in the ACHIP Chamber in SwissFEL

Monday, September 16, 2019 4:20 PM (20 minutes)

We have installed an interaction chamber in the electron beam line of SwissFEL. Electrons with a particle energy of 3 GeV are focused into the sample, which can be aligned to electron and laser beam with a hexapod. The goal of this installation is to demonstrate laser-driven acceleration inside dielectric structures. We present here the layout of this chamber, as well as first measurements of the electron beam.

Primary authors: ISCHEBECK, Rasmus (PSI); Dr BETTONI, Simona (Paul Scherrer Institut); Ms BORRELLI, Simona (Università di Pisa); Dr CALVI, Marco (Paul Scherrer Institut); Dr FREI, Franziska (Paul Scherrer Institut); Mr HAUENSTEIN, Dominique (Paul Scherrer Institut); HERMANN, Benedikt (Paul Scherrer Institut); Mr HÜRZELER, Orell (Paul Scherrer Institut); Dr LOMBOSI, Csaba (Paul Scherrer Institut); Dr PRAT, Costa Eduard (Paul Scherrer Institut); Dr REICHE, Sven (Paul Scherrer Institut); RIVKIN, Leonid (PSI, Villigen)

Presenter: ISCHEBECK, Rasmus (PSI)

Session Classification: WG3 - Dielectric Acceleration

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **327** Type: **poster**

Transverse wakefield effects in dielectric slab symmetric structures

Wednesday, September 18, 2019 7:00 PM (1 hour)

Dielectric wakefield structures driven by relativistic beams have been employed to generate high-gradients for collinear acceleration schemes, as well as for applications in beam phase space manipulations. In simple cylindrical dielectric structures, the longitudinal wakefields are also accompanied by transverse fields. The growth of the transverse fields can severely limit the acceleration gain of the interaction due to the generation of forces that can lead to beam break up. One proposed method to mitigate the growth of these instabilities is the use of alternate geometries to reduce beam coupling to deleterious modes. In this paper, we will present recent experimental work that employs dielectric wakefield acceleration in slab planar and woodpile geometries to mitigate effects of transverse forces.

Primary authors: ANDONIAN, Gerard (UCLA); O'SHEA, Brendan (SLAC National Accelerator Laboratory); WILLIAMS, Oliver (UCLA Department of Physics and Astronomy); Prof. ROSENZWEIG, James (UCLA Dept. of Physics and Astronomy); HOGAN, Mark (SLAC National Accelerator Laboratory); Dr YAKIMENKO, Vitaly (SLAC); CLARKE, Christine; Dr HOANG, Phuc (UCLA); Dr BATURIN, Stanislav (University of Chicago)

Presenter: ANDONIAN, Gerard (UCLA)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **328** Type: **talk**

Numerical implementation of a hybrid PIC-fluid framework in laser-envelope approximation

Wednesday, September 18, 2019 6:40 PM (20 minutes)

In Laser WakeField Acceleration, when relevant scale lengths of the laser envelope and of the plasma waves are well separated from the wavelength of the laser fast oscillating component, the time-averaged particles trajectories can be computed by means of a set of more efficient, properly modified equations of motion [1,2]. Besides, in regimes well described by the Lorentz-Maxwell fluid system, solving Euler equations can be significantly more convenient than the Particle-in-Cell approach. We describe the new solvers for laser-plasma dynamics in envelope approximation and Euler equations that have been recently implemented in ALaDyn [3]. Both the explicit envelope solver and the one step upwind solver for Euler equations in non-conservative form are integrated with the standard PIC framework allowing hybrid PIC-fluid and envelope description and favouring ease of implementation for any PIC code relying on the FDTD Maxwell's equation solver. The speedup obtained with the hybrid scheme is consistent and allows for short time 3D simulations of the ongoing experiments with the 200-TW class laser at the ILIL group of INO-CNR.

[1] P. Mora et al., Phys. Plasmas 4, (1997)
[2] B. Cowan et al., J. Comput. Phys. 230 (2011)
[3] D. Terzani et al., Comp. Phys. Comm. 242 (2019)

Primary author: TERZANI, Davide (INO - CNR)

Co-authors: LABATE, Luca (Istituto Nazionale di Ottica - Consiglio Nazionale delle Ricerche); TOMASSINI, Paolo (INO-CNR); GIZZI, Leonida Antonio (PI)

Presenter: TERZANI, Davide (INO - CNR)

Session Classification: WG6 - Proposed solution(s) to physical problem, Envelope PGC model

Track Classification: WG6 - Theory and simulations

Contribution ID: **330** Type: **talk**

Generation and characterization of attosecond micro-bunched electron pulse trains via dielectric laser acceleration

Monday, September 16, 2019 6:00 PM (20 minutes)

Dielectric laser acceleration is a versatile scheme to accelerate and control electrons with femtosecond laser pulses in nanophotonic structures. We show recent results of the generation of a train of electron pulses with individual pulse durations as short as 270 +/- 80 attoseconds. We achieve these attosecond micro-bunch trains based on two subsequent dielectric laser interaction regions connected by a free-space electron drift section, all on a single photonic chip. In the first interaction region (the modulator), an energy modulation is imprinted on the electron pulse. During free propagation, this energy modulation evolves into a charge density modulation, called ballistic bunching. The resulting density modulation is probed in the second interaction region (the analyzer). This work represents a crucial step for dielectric laser accelerators, namely to enable phase synchronous acceleration of a significant fraction of electrons injected into the device. In addition, ultrafast experiments with these attosecond electron pulse trains come to mind.

Primary authors: SCHÖNENBERGER, Norbert (Friedrich-Alexander-Universität Erlangen-Nürnberg); Mrs MITTELBACH, Anna (Chair for Laserphysics, FAU); YOUSEFI, Peyman (Friedrich Alexander University of Erlangen Nürnberg); MCNEUR, Joshua (Friedrich Alexander University); NIEDERMAYER, Uwe (TU-Darmstadt); HOMMELHOFF, Peter (University of Erlangen and Max Planck Institute of Quantum Optics)

Presenter: SCHÖNENBERGER, Norbert (Friedrich-Alexander-Universität Erlangen-Nürnberg)

Session Classification: WG3 - Dielectric Acceleration

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **331** Type: **poster**

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Primary authors: SCHÖNENBERGER, Norbert (Friedrich-Alexander-Universität Erlangen-Nürnberg); Mrs MITTELBACH, Anna (Chair for Laserphysics, FAU); YOUSEFI, Peyman (Friedrich Alexander University of Erlangen Nürnberg); MCNEUR, Joshua (Friedrich Alexander University); NIEDERMAYER, Uwe (TU-Darmstadt); HOMMELHOFF, Peter (University of Erlangen and Max Planck Institute of Quantum Optics)

Presenter: SCHÖNENBERGER, Norbert (Friedrich-Alexander-Universität Erlangen-Nürnberg)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **333** Type: **poster**

Recent results at SPARC_LAB

Wednesday, September 18, 2019 7:00 PM (1 hour)

The recent activities of the SPARC_LAB test-facility (LNF-INFN) are focused on the study of the interaction of high-brightness electron beams with plasmas and on tests on new advanced diagnostics. Here we report the latest results, showing the progress toward plasma acceleration and demonstrating the use of plasmas to shape the beam longitudinal and transverse profiles.

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Presenter: POMPILI, Riccardo (INFN / LNF)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **334** Type: **talk**

Toward effective applications of laser-driven VHEE in radiotherapy: dosimetry, multiple-field irradiation and intensity-modulated fields

Monday, September 16, 2019 4:40 PM (20 minutes)

Laser WakeField Acceleration allows electron bunches with energy in the range of several tens to hundreds of MeV to be delivered by compact, table-top devices, thus holding the promise for a possible widespread deployment of such machines into medium scale clinical environments. This has spurred the study of the properties of the so-called very high energy electrons (VHEE) which could be beneficial in the field of radiotherapy, possibly paving the way to novel treatment protocols. In particular, numerical simulations have mostly been employed to study the dosimetric features of VHEE in advanced, complex irradiation geometries.
Here we present the results of a recent experimental campaign, carried out at the Intense Laser Irradiation Laboratory of the CNR-INO in Pisa, Italy, aimed at assessing the possible enhancement of the dose deposition pattern using a multiple-field irradiation with isocentric technique. The capability to get 2D intensity-modulated irradiation fields were also investigated, which would allow an even better dose deposition tailoring. Issues related to the electron bunch features and dosimetry will also be discussed. Results of both the experimental campaign and numerical (Monte Carlo) simulations will be presented.

Primary author: LABATE, Luca (CNR - INO and INFN - Pisa)

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Presenter: LABATE, Luca (CNR - INO and INFN - Pisa)

Session Classification: WG4

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **335** Type: **poster**

Towards additive manufacturing of dielectric accelerating structures

Monday, September 16, 2019 7:00 PM (1 hour)

Additive manufacturing techniques such as stereolithography can simplify prototyping of novel accelerator components.
A precise knowledge of the permittivity of the material is essential to the design of dielectric accelerating structures.
We present here measurements of the permittivity of commercially available polymers, as well as tests for vacuum compatibility.

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Presenter: KELLERMEIER, Max (DESY)

Session Classification: Cheese and Wine Poster Session 1

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **336** Type: **poster**

Plasma afterglow metrology at CLARA

Wednesday, September 18, 2019 7:00 PM (1 hour)

The field of plasma acceleration has undergone rapid advancement in recent years, with significant progress being made towards the production of stable high quality electron beams. With this progression comes new avenues of research into potential applications, facilitating the need for precise understanding and control of the femtosecond-micrometer scale interaction process. Experimental results from the Stanford linear accelerator FACET I facility have demonstrated the potential for plasma afterglow as a novel diagnostic for the spatiotemporal synchronisation of laser and electron beam. Recent work at the Daresbury laboratory CLARA facility continues this investigation into plasma afterglow, utilising a low energy relativistic electron beam interacting with a partially ionised Argon plasma. Analysis of features within the plasma afterglow and electron-beam spectrometer data is presented, along with discussion of potential sources such as gas dynamics and partial plasma lensing. Further discussion will address upcoming experiments at the FACET II facility (E315 & E316) and at Helmholtz-Zentrum Dresden-Rossendorf, which seek to examine this diagnostic for application in both PWFA and hybrid acceleration schemes.

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Presenter: NUTTER, Alastair James (University of Strathclyde)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG5 - Plasma devices, plasma and beam diagnostics

Contribution ID: **337** Type: **talk**

E-310 Trojan Horse-II at FACET-II and the STFC PWFA-FEL programme

Thursday, September 19, 2019 7:00 PM (20 minutes)

The beam-driven plasma photocathode wakefield acceleration concept [1] allows decoupled laser injection of electron bunches with emittance and brightness reach many orders of magnitude better than state-of-the-art [2]. After successful proof-of-concept demonstration at SLAC FACET in the "E-210: Trojan Horse"project [3], we now embark on the next experimental phase around the "E-310: Trojan-II"flagship and five related experiments at FACET-II, where better incoming beams and improved setup may unleash the full potential of the scheme. Plans for FACET-II experiments and complementary progress and plans on hybrid LWFA->PWFA with automatically synchronized plasma photocathodes will be presented. Looking further ahead, the UK STFC has initiated the UK-US "PWFA-FEL"programme, which aims to push exploitation of the ultralow emittance and ultrahigh brightness of beams which may be obtainable from upcoming installations of plasma photocathodes. This project will explore the benefits of ultrahigh brightness beams and will also be used to assist experimental programmes on PWFA and plasma photocathodes at Daresbury's CLARA facility and at FACET-II, and at future hybrid LWFA->PWFA systems.

[1] PRL 108, 035001 (2012)
[2] Nat. Comm. 8,15705 (2017)
[3] Generation and acceleration of electron bunches from a plasma photocathode, Nat. Phys., accepted (2019)

Primary authors: ROSENZWEIG, James (UCLA); HOGAN, Mark (SLAC National Accelerator Laboratory); KARGER, Oliver (University of Hamburg, Institute for Experimental Physics); HEINEMANN, T. (Deutsches Elektronen-Synchrotron DESY; Scottish Universities Physics Alliance, Department of Physics, University of Strathclyde); HABIB, Ahmad Fahim (SUPA, Department of Physics, University of Strathclyde, Glasgow, UK and Cockcroft Institute, Sci-Tech, Daresbury, UK.); YAKIMENKO, Vitaly (SLAC); LITOS, Michael (University of Colorado Boulder); CARY, John (Tech-X Corporation); CLARKE, Jim (STFC); SUTHERLAND, Andrew (University of Strathclyde); Prof. RAUBENHEIMER, Tor O. (Stanford University); HEMSING, Erik (SLAC); SCHERKL, Paul (University of Strathclyde); ULLMANN, Daniel (University of Strathclyde); BEATON, Andrew (University of Strathclyde); NUTTER, Alastair (University of Strathclyde); BOULTON, Lewis (University Of Strathclyde / DESY); Dr WILLIAMS, Peter (STFC Daresbury Lab.); ANGAL-KALININ, Deepa (STFC, Daresbury Laboratory); Dr MCNEIL, Brian (University of Strathclyd & Cockcroft Institute); ANDONIAN, Gerard (UCLA); Dr MANAHAN, Grace Gloria (University of Strathclyde); KNETSCH, Alexander (Deutsches Elektronen-Synchrotron DESY); O'SHEA, Brendan (SLAC National Accelerator Laboratory); BRUHWILER, David; HIDDING, Bernhard (Scottish Universities Physics Alliance, Department of Physics, University of Strathclyde; Cockcroft Institute, Sci-Tech Daresbury)

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Session Classification: WG1 - Hybrid staging and future PWFA experiments

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **338** Type: **talk**

Generation and acceleration of electron bunches from a plasma photocathode

Wednesday, September 18, 2019 5:00 PM (20 minutes)

Fundamental improvements of the quality, and stability of the electron output of plasma wakefield accelerators are required to realize key applications such as hard X-ray FELs and lepton colliders [1]. Here we report on the first realization of a plasma photocathode [2], in which a spatiotemporally synchronized laser beam is used to release tunnel-ionized electrons inside an electron beam driven wakefield. This concept decouples injection from wakefield excitation and opens a regime of ultralow emittance and ultrahigh brightness [3] due to localized injection. Details of the experimental SLAC FACET "E-210: Trojan Horse PWFA"programme are presented, including innovations which allow to successfully address key challenges of spatiotemporal injection and plasma control. This proof-of-concept milestone [4] has been realized in 90° geometry and under significant experimental constraints. Improvements of setup and experimental boundary conditions allow exploring the full range and quality of electron output, and its stability. An analysis of stability and quality reach expected from upcoming realizations of the scheme are presented.

[1] https://arxiv.org/abs/1904.09205 UK PWASC Roadmap
[2] PRL 108, 035001 (2012)
[3] Nat. Comm. 8,15705 (2017)
[4] Generation and acceleration of electron bunches from a plasma photocathode, Nat. Phys., accepted (2019)

Primary authors: HABIB, Fahim A. (SUPA, Department of Physics, University of Strathclyde, Glasgow, UK and Cockcroft Institute, Sci-Tech, Daresbury, UK.); HEINEMANN, Thomas (Univ. Strathclyde / DESY); DENG, Aihua; KARGER, Oliver (University of Hamburg, Institute for Experimental Physics)

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Presenters: HABIB, Fahim A. (SUPA, Department of Physics, University of Strathclyde, Glasgow, UK and Cockcroft Institute, Sci-Tech, Daresbury, UK.); HEINEMANN, Thomas (Univ. Strathclyde / DESY)

Session Classification: WG1 - PWFA experimental results

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **340** Type: **poster**

Nuclear activation of copper isotopes in a γ-ray beamline based on Texas Petawatt Laser-Plasma Accelerated Electrons

Wednesday, September 18, 2019 7:00 PM (1 hour)

The advent of laser wakefield acceleration of electrons to GeV energies and charges up to nanocoulombs offer a unique tool to generate high intensity bremsstrahlung with characteristics similar to conventional accelerators, but in a more compact setup. Future facilities like the ELI pillars will use laser-generated bremsstrahlung at high repetition rates to study nuclear physics phenomena. However, for this scheme to be successful, proper characterization of the generated beam and the acceleration process is required.
In this poster we show the application of such a beamline in an experiment conducted at the Texas Petawatt facility. Electrons accelerated to GeV energies generated high intensity MeV gamma rays by means of a bremsstrahlung radiator and by Thomson backscattering. The radiation was used to activate copper isotopes via (γ, n) and (γ, 2n) producing 64Cu, 62Cu and 61Cu whose decay times were measured via a coincidence detector. At the same time, the acceleration process was diagnosed with an electron spectrometer and the gamma-ray beam with a differential calorimeter. We will report measurements of gamma-ray photon number and spectrum based on this suite of detectors.

Primary authors: HANNASCH, Andrea (University of Texas at Austin); LASO GARCIA, Alejandro (Helmholtz Zentrum Dresden Rossendorf); WAGNER, Andreas (Helmholtz-Zentrum Dresden-Rossendorf); DOWNER, Michael (The University of Texas at Austin)

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Presenter: HANNASCH, Andrea (University of Texas at Austin)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **341** Type: **talk**

Efficiency and beam quality in a loaded quasilinear plasma wakefield positron accelerator

Tuesday, September 17, 2019 6:20 PM (20 minutes)

Being promising alternatives to conventional accelerators and for application to high-energy physics also linear colliders, it is crucial for plasma accelerators to accelerate positrons, which is much more challenging than electron acceleration that most current researches focus on.

Plasma electron motion is one main source of beam quality degradation for positron acceleration in quasi-linear regime of plasma wakefield acceleration. We study the evolution of a positron witness bunch starting from matched condition in wakefield generated by a drive bunch. For relatively high witness charge, the witness projected emittance can initially grow and rapidly saturate due to non-linear transverse focusing force of loaded wakefield. But it is found that the relative emittance growth stays moderate and that negligible emittance growth occur after equilibrium reached. However, beam loading creates a longitudinal accelerating field that varies both longitudinally and transversely, and generates significant slice correlated energy spread, which grows continuously over propagation distance. The degradation of longitudinal phase space sets a limit on the witness charge that can be accelerated in quasilinear plasma wakefield, which also limits the efficiency of the accelerator. It is found that efficiencies of up to 20% can be obtained for a positron plasma wakefield accelerator in quasi-linear regime.

Primary author: YU, Siyi (Ecole Polytechnique)

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Presenter: YU, Siyi (Ecole Polytechnique)

Session Classification: WG8 - Positrons

Track Classification: WG8 - Advanced and novel accelerators for High Energy Physics

Contribution ID: **342** Type: **talk**

KALDERA – High average power laser plasma accelerator project at DESY

Monday, September 16, 2019 11:30 AM (30 minutes)

A key next step in advancing the technology of laser plasma accelerators (LPA) is to show that they can be operated at high average power, i.e., high repetition rate of kHz and higher. Previous workshop reports on laser technology for accelerators and national and international roadmaps have all advocated for the need for such systems. The rapid advances in laser technology are now making it possible to develop high peak power (>100 TW), high average power (>1 kW) lasers. Building
on the significant progress that has been achieved in improving the reliability of LPAs with 1-5 Hz repetition rate lasers, such repetition rates will enable feedback control to reach even higher levels of stability and reliability. We will discuss technology requirements and plans for developing the multi-kW KALDERA laser at DESY, its integration into the SINBAD facility and the ATHENA project, as well as on the plasma source technology that will be required.

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Presenter: LEEMANS, Wim (DESY)

Session Classification: Plenary Session 2

Track Classification: Invited Plenary Talk

Contribution ID: **343** Type: **poster**

THz acceleration and phase space manipulation: ponderomotive interactive vs slow wave structure

Wednesday, September 18, 2019 7:00 PM (1 hour)

We discuss the use of high power laser-generated THz waves for acceleration and electron beam phase space manipulation. These find application both as a compact alternative for radiofrequency-based accelerators as well for high frequency manipulation of electron beam longitudinal phase spaces and beam compression. We'll present our different approaches to reach next goal in THz acceleration which is to demonstrate MeV energy gain from laser-driven THz waves.

Primary author: MUSUMECI, Pietro (UCLA)

Presenter: MUSUMECI, Pietro (UCLA)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **344** Type: **talk**

Towards MeV energy gains in dielectric laser accelerators

Monday, September 16, 2019 4:00 PM (20 minutes)

We report on the status of the next generation DLA experiments at the UCLA Pegasus laboratory. These experiments, carried out in the framework of the ACHIP collaboration will use a newly commissioned 40 mJ laser system and take full advantage of the capabilities to manipulate nearly arbitrarily the phase and amplitude of a laser wave with liquid crystal phase mask technology. We show how injecting a high brightness relativistic beam from the UCLA Pegasus laboratory into a cm-long dielectric double-grating dielectric structure, it could be possible to shape the drive laser to obtain stable focusing and acceleration of the electrons in the channel with a net energy gain exceeding 1 MeV.

Primary author: MUSUMECI, Pietro (UCLA)

Co-authors: ENGLAND, Joel (SLAC); Mr ODY, Alexander (Stanford University); CRISP, S.

Presenter: MUSUMECI, Pietro (UCLA)

Session Classification: WG3 - Dielectric Acceleration

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **345** Type: **talk**

Frontiers of Inverse Free Electron Laser acceleration

Tuesday, September 17, 2019 4:20 PM (20 minutes)

Here we review the status of Inverse Free Electron Laser as a high gradient advanced accelerator presenting recent results on applications of IFEL beams for X-ray generation and the demonstration of high repetition rate laser acceleration using this efficient advanced accelerator scheme. We will then discuss the next steps in the development of IFEL. In particular we analyze the possibility of lowering the injection beam energy using short period undulators and of using waveguides to limit diffraction effects, increase the interaction length and control the output longitudinal phase space.

Primary author: MUSUMECI, Pietro (UCLA)

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Presenter: MUSUMECI, Pietro (UCLA)

Session Classification: WG4 - FEL

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **346** Type: **talk**

Status of ELI projects

Thursday, September 19, 2019 11:00 AM (40 minutes)

We will be summarizing the status of the major parts of the ELI pillars including high intensity laser sources, experimental areas with beamlines and end-stations. Special emphasis will be given to the availability of equipment for the first calls for users and user policy. The next steps of the transformation of ELI–DC (delivery consortium) to ELI-ERIC (European Research Infrastructure Consortium) will be described with the anticipated time lines for the completion of this process. Currently calls for commissioning users have been published and corresponding user actions have started.

Primary author: KORN, Georg (ELIBeamLines)

Presenter: KORN, Georg (ELIBeamLines)

Session Classification: Plenary Session 8

Track Classification: Invited Plenary Talk

Contribution ID: **347** Type: **poster**

Advanced Acceleration by Dielectric Based Structures, and Dielectric Materials for Accelerator Applications.

Wednesday, September 18, 2019 7:00 PM (1 hour)

Relativistic, high intensity and small emittance electron bunches are the basis of linear collider and FEL projects. With this talk, our interest focused on wakefields generated by using dielectric based structures. We consider Dielectric Disk Accelerating (DDA) and other dielectric structure designs. The electrical properties of low loss ceramic, fused silica and diamond like materials will be discussed for the wakefield beam-driven high repetition rate and high gradient structures applications. With this talk, we present recent results in the development and experimental testing of advanced dielectric materials for accelerators. The ceramic material, commonly used for the dielectric based accelerating structures, have to withstand high gradient accelerating fields, and prevent potential charging. We report here first experimental testing of a ceramic material with a finite DC electrical conductivity and low loss tangent ta GHz frequency ranges. The finite electrical conductivity will drain away the field-emission and halo induced charge. The low loss tangent will allow the realization of high efficiency wakefield acceleration. With this talk, we also present our recent experimental results of the fast (<100 ns) BST ferroelectric based 400 MHz tuner developed and tested by the CERN/Euclid Techlabs collaboration.

Presenter: KANAREYKIN, Alexei (Euclid Techlabs LLC/ANL)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **348** Type: **talk**

A Gatling-Gun Target Delivery System for High-Intensity Laser Irradiation Experiments

Thursday, September 19, 2019 6:40 PM (20 minutes)

Intense laser irradiation experiments of sub-micrometer scale targets are currently performed at slow shot rates. This limitation is the result of the inability to place such targets quickly and accurately in the focus of the laser. I will present a target setup that enables irradiation at a high rate and sub-wavelength positioning accuracy. Three hundred targets were micro machined and mounted on a single Si wafer. The system implements a closed feedback loop between a triangulation displacement sensor and a motorized manipulator. Using this setup, we demonstrate repeatable stable proton acceleration from 600 nm thick Au foils at a rate of 0.2 Hz. This system will enable studies that require a large overall dose, high statistical significance, or a fine scan of target geometric attributes. Gershuni, D, et. al, A gatling-gun target delivery system for high-intensity laser irradiation
experiments, Nucl. Instruments Methods Phys. Res. Sect. A Accel. Spectrometers, Detect. Assoc. Equip. 934 (2019) 58–62. doi:10.1016/J.NIMA.2019.04.071.

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Presenter: POMERANTZ, Ishay (Tel-Aviv University)

Session Classification: WG2

Track Classification: WG2 - Ion beams from plasmas

Contribution ID: **349** Type: **poster**

New Tunable High Gradient Permanent Magnet Quadrupole for Plasma Wake Field Acceleration at SPARC_LAB

Wednesday, September 18, 2019 7:00 PM (1 hour)

Applications such as colliders and plasma wake field acceleration require high gradient quadrupoles, in the range of 400-500 T/m and with a bore of few millimeters in diameter.
The design of a tunable high gradient permanent magnet quadrupole, based on the QUAPEVA design developed for the SOLEIL synchrotron, is presented. The quadrupole has a fixed part made of a Halbach quadrupole surrounded by four permanent magnet cylinders with a radial orientation of the magnetic momentum. The gradient is regulated by rotating the cylinders, reaching a tunability greater than the 25%. The main improvements with respect to the SOLEIL configuration are the gradient increasing from 200 T/m to more than 500 T/m, and a near vanishing of undesirable skew quadrupole components.
The quadrupole has been designed for the COMB plasma wake field experiment for the SPARC_LAB test-facility at INFN-LNF, one of the candidates to host the EuPRAXIA project. The present layout foresees two triplets where the focusing strength tuning is performed by moving two quadrupoles of each triplet along the beam axis. The new quadrupoles have bigger gradient and less multipolar content than actual ones, moreover a tuning system that does not need any shift of the magnet.

Primary authors: VANNOZZI, Alessandro (ROMA1); VACCAREZZA, Cristina (LNF); SANELLI, Claudio (LNF); ALESINI, David (LNF)

Presenter: ALESINI, David (LNF)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG3 - Electron beams from electromagnetic structures, including dielectric and laser-driven structures

Contribution ID: **350** Type: **poster**

Experimental study of the unmatched regime for laser-driven wakefield acceleration

Wednesday, September 18, 2019 7:00 PM (1 hour)

The report is devoted to the latest experimental results on the laser-driven acceleration of electrons obtained at the laser-plasma setup PEARL (IAP RAS, Russia). The main goal of the experimental campaign was to demonstrate in the laboratory an unmatched LPA regime, leading to higher acceleration gradients. Electrons with energies exceeding GeV were demonstrated for ~ 10 J, 50 fs laser pulses focused with an f/40 focusing mirror into a two-section gas cell with controlled interaction length. The gas concentration was chosen so that the plasma wavelength was several times smaller than the scale of the focal spot. Particular attention was paid to possible ambiguity of the spectrum reconstruction procedure.

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Presenter: SOLOVIEV, Alexander (Institute of Applied Physics of RAS)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG1 - Electron beams from plasmas

Contribution ID: **351** Type: **poster**

Characterisation of LWFA with realistic laser profiles for ESCULAP project

Wednesday, September 18, 2019 7:00 PM (1 hour)

A goal of ESCULAP [1,2] experiment is the external injection of photo-injector electrons bunch with consequent LWFA acceleration in the moderate density plasma cell.
In our configuration small fraction of LASERIX laser is send to the photocathode, and the rest is delivered to the plasma cell for the wake excitation.
Stability of the laser beam, its shape, "flatness", duration, intensity etc. are crucial parameters for the reproducible shot-to-shot acceleration. In current paper we study numerically LWFA and evolution/propagation of flattened Gaussian profile of the laser approximating the experimental one. The study is performed for 10, 20 and 50 MeV externally injected electron beam.

[1] E. Baynard, et al., Nucl. Instrum. Meth. Phys. Res. A 909, 46 (2018).
[2] K. Wang, et al., "A Start to End Simulation of the Laser Plasma Wakefield Acceleration Experiment at ESCULAP", in
Proc. 9th Int. Particle Accelerator Conf. (IPAC'18), pp. 1731–1734 (2018).

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Presenter: KUBYTSKYI, Viacheslav (Postdoctoral Fellow)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG6 - Theory and simulations

Contribution ID: **352** Type: **poster**

Using existing laser facilities to probe quantum radiation reaction –optimal parameters and expected results

Wednesday, September 18, 2019 7:00 PM (1 hour)

High power laser facilities currently under construction will open up new accelerator applications, which will encounter quantum processes. Experiments such as Compton backscatter sources will require a thorough experimental understanding of non-classical behaviour. Recently, experiments have started to measure these effects in isolation by studying radiation reaction, using the collision between a PW-scale laser pulse and GeV electron beams from a laser wakefield accelerator. However, for these experiments to conclusively identify and understand these quantum effects, high quality electron beams and laser pulses are required.

`We describe simulations of radiation reaction experiments using realistic parameters, already d`

Primary authors: ARRAN, Christopher (University of York); COLE, Jason (Imperial College London); GERSTMAYR, Elias (Imperial College London); Dr BLACKBURN, Tom (Chalmers University of Technology); MANGLES, Stuart (Imperial College London); Dr RIDGERS, Christopher (University of York)

Presenter: ARRAN, Christopher (University of York)

Session Classification: Cheese and Wine Poster Session 2

Track Classification: WG4 - Application of compact and high-gradient accelerators

Contribution ID: **356** Type: **not specified**

Opening remarks

Monday, September 16, 2019 9:00 AM (20 minutes)

Presenters: FERRARIO, Massimo (INFN / LNF); ASSMANN, Ralph (DESY)

Session Classification: Plenary Session 1

Contribution ID: **357** Type: **not specified**

Special Talk

Contribution ID: **358** Type: **not specified**

Van der Meer Award

Contribution ID: **359** Type: **not specified**

WG 1 Summary

Friday, September 20, 2019 4:00 PM (20 minutes)

Presenters: IRMAN, Arie (Helmholtz Zentrum Dresden Rossendorf); TURNER, Marlene (CERN/TU Graz); CORDE, Sébastien (Ecole Polytechnique)

Contribution ID: **360** Type: **not specified**

WG 6 Summary

Friday, September 20, 2019 6:10 PM (20 minutes)

Presenters: MASSIMO, Francesco (LLR - CNRS); VIEIRA, Jorge (Instituto Superior Tecnico)

Contribution ID: **361** Type: **not specified**

Summary Preparation

Thursday, September 19, 2019 5:00 PM (20 minutes)

Session Classification: WG4

Contribution ID: **362** Type: **talk**

Status and future perspectives of the EuPRAXIA project

Thursday, September 19, 2019 9:40 AM (30 minutes)

The Horizon2020 design study EuPRAXIA was started in 2015. The EuPRAXIA consortium is formed by 41 institutes from Europe, Asia and US and has the goal of developing the conceptual design of a plasma accelerator with superior beam quality and with pilot applications. The conceptual design report will be published in October 2019 when the design study is completed. Improvements in the understanding of beam quality in plasma accelerators and the EuPRAXIA solutions towards improved quality are discussed. The conceptual design of the proposed future large research infrastructure EuPRAXIA is presented and a possible distributed implementation model in Europe is explained. Future perspectives of the proposed EuPRAXIA infrastructure and the possible next steps are discussed.

Primary author: ASSMANN, Ralph (DESY)

Presenter: ASSMANN, Ralph (DESY)

Session Classification: Plenary Session 7

Track Classification: Invited Plenary Talk

Contribution ID: **363** Type: **talk**

Advanced Crystal Assisted Techniques for EuPRAXIA

Thursday, September 19, 2019 4:00 PM (30 minutes)

Channeling of charged particles is well known technique to handle beams shaped in specified ways. Having proposed more than 40 years ago this technique has been utilized for beam both collimation and focusing at many famous research centers. Channeling of light charged particles is of a special interest as novel powerful and compact radiation source.
Effective approach for a positron source is to use a sub-GeV or GeV electron beam for production of channeling radiation in a crystal with its subsequent conversion into electron-positron pairs in amorphous. On the contrary, coherent bremsstrahlung (for aligned crystals) is characterized by higher radiation frequencies and intensities at lower energies of charged particles. This feature can be also utilized for getting an effective positron source at much lower electron energies.
In this report the possibility for a new technique of particles acceleration based on channeling of charged beams in solids will be also discussed. The research in this field is of strong interests due to the fact that the field gradients that could be obtained in solids are of the order of 0.1-1 TeV/m or even higher.

Primary author: DABAGOV, Sultan (LNF)

Co-authors: ABDRASHITOV, Sergei (National Research Tomsk Polytechnic University); KUNASHENKO, Yuri (National Research Tomsk Polytechnic University; Tomsk State Pedagogical University); PIVOVAROV, Yury (National Research Tomsk Polytechnic University); FERRARIO, Massimo (LNF)

Presenter: DABAGOV, Sultan (LNF)

Session Classification: WG8

Track Classification: WG8 - Advanced and novel accelerators for High Energy Physics

Contribution ID: **366** Type: **not specified**

WG 2 Summary

Friday, September 20, 2019 4:20 PM (20 minutes)

Presenters: MARGARONE, Daniele (ELI-Beamlines, IoP-ASCR); LANCIA, Livia (LULI Ecole Polytechnique & Dip.to Energetica Sapienza); ROTH, Markus (Technische Universität Darmstadt)

Contribution ID: **367** Type: **not specified**

WG 3 Summary

Friday, September 20, 2019 4:40 PM (20 minutes)

Presenters: ALESINI, David (LNF); BRINKMANN, Reinhard (DESY)

Contribution ID: **368** Type: **not specified**

WG 4 Summary

Friday, September 20, 2019 5:00 PM (20 minutes)

Presenters: BRENNER, Ceri (STFC Central Laser Facility); SARRI, Gianluca (Queen's University Belfast)

Contribution ID: **369** Type: **not specified**

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Contribution ID: **370** Type: **not specified**

WG 5 Summary

Friday, September 20, 2019 5:50 PM (20 minutes)

Presenters: DELERUE, Nicolas (LAL, CNRS and Université Paris-Sud 11); D'ARCY, Richard (DESY)

Contribution ID: **371** Type: **not specified**

WG 7 Summary

Friday, September 20, 2019 6:30 PM (20 minutes)

Presenters: MICHEL, Knut (TRUMPF Scientific Lasers GmbH + Co. KG); CORNER, Laura (Cockcroft Institute, University of Liverpool)

Contribution ID: **372** Type: **not specified**

WG 8 Summary

Friday, September 20, 2019 6:50 PM (20 minutes)

Presenters: CARLSTEN, Bruce (Los Alamos National Laboratory); SCHULTE, Daniel (CERN); LU, Wei (Tsinghua University of Beijing, China)

Contribution ID: **373** Type: **not specified**

Closing remarks

Friday, September 20, 2019 7:10 PM (10 minutes)