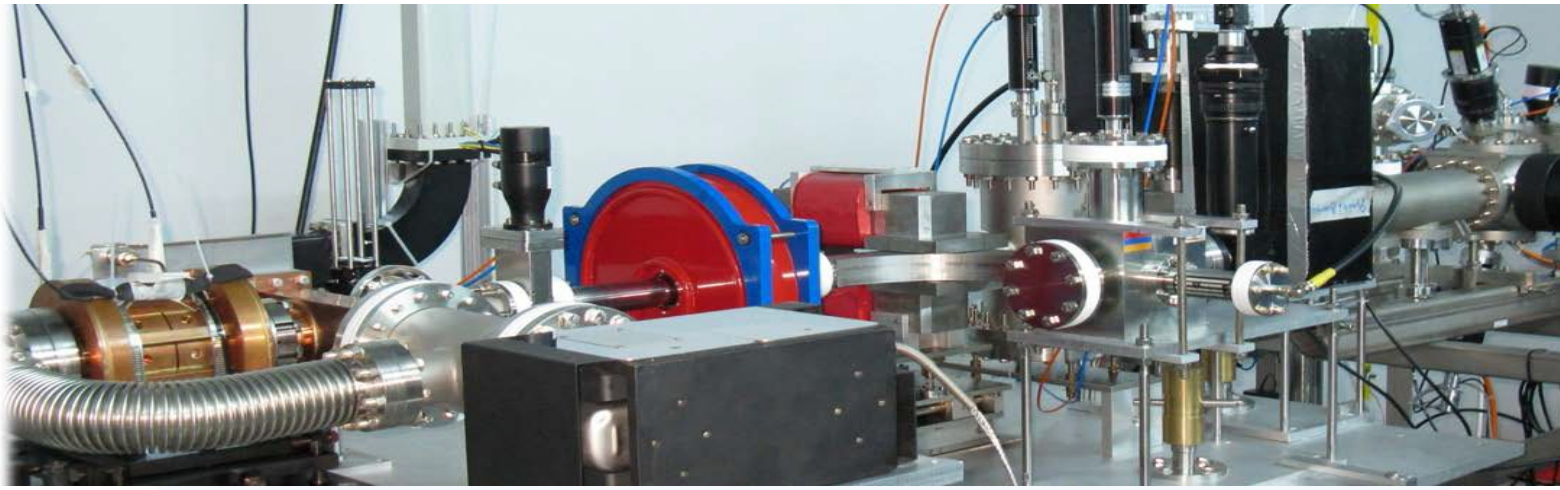
Ultrafast Beams and Applications

International Workshop



02-05 July 2019, CANDLE, Armenia

Abstracts

DESY

CANDLE

State Committee of Science RA

Preface

The tremendous progress in the generation of ultrafast electron and photon beams during the last decade has opened new horizons for dynamic process studies at cell, molecular and atomic levels. The aim of the workshop is to organize a forum for the scientists from diverse fields of accelerator physics, laser physics, life and materials sciences to discuss the highlights of physics and applications of ultrafast electron and photon beams, with an emphasis on low energy relativistic electron and Infrared–THz photon beams.

The main topics of the workshop are:

- Ultrashort electron beams
- Radiation sources and FELs
- Advanced accelerator concepts
- Instrumentation and experimental techniques
- Applications in life and materials sciences

Workshop coordinators:
Klaus Floettmann (DESY, Germany)
Vasili Tsakanov (CANDLE, Armenia)

International Workshop

Ultrafast Beams and Applications

Date

02-05 July 2019

Venue

CANDLE SRI
Str. 31 Hr. Acharyan
Yerevan, Republic of Armenia

Program

1 July Monday	
18:00 – 19:30	***17:45 Bus from Ani Hotel*** ***Registration and Reception (CANDLE SRI)***
2 July Tuesday	
8:45 Bus from Ani Hotel	
9:00 – 9:20	***Registration***
Session 1: Facilities and New Projects (Chairman: Klaus Floettmann)	
9:20 – 9:30	***Workshop Opening***
9:30 – 10:00	***Radiobiological Effects of Ultrashort Pulsed Electron Beam Irradiation In Vitro and In Vivo*** Rouben Aroutiounian (Yerevan State University/NAS RA, Armenia)
10:00 – 10:30	***The Southern Europe Thomson Backscattering Source STAR: Beam Dynamics, Project Status and Foreseen Applications*** Alberto Bacci (INFN Milan, Italy)
10:30 – 11:00	***Status and Plans at SINBAD-ARES*** Ulrich Dorda (DESY, Germany)
11:00 – 11:20	**Coffee Break**
11:20 – 11:50	

	THz Generation and Ultrafast Electron Diffraction at PITZ Mikhail Krasilnikov (DESY, Germany)
11:50 – 12:10	***Iranian Test Stand Electron Linear Accelerator*** Sasan Ahmadiannamin (IPM, Iran)
12:10 – 12:30	***AREAL - Facility: Status and Highlights*** Vasili Tsakanov (CANDLE SRI, Armenia)
12:30 – 14:30	**Lunch**
Session 2: Photon Beams (Chairman: Erion Gjonaj)	
14:30 – 14:55	***Generation of Few-Cycle Terahertz Pulses in Domain-Engineered Lithium Niobate Crystals*** Yuri Avetisyan (Yerevan State University, Armenia)
14:55 – 15:20	***Toward the Cherenkov FEL Experiment at CANDLE*** Francois Lemery (DESY, Germany)
15:20 – 15:45	***Solitonic and Resembling Processes for Ultrafast Laser Pulse Registration and Spectral Self –Compression*** Minas Sukiasyan (Yerevan State University, Armenia)
15:45 – 16:10	***Precision Laser Processing for Beam Shaping and Guiding Applications*** Arsham Yeremyan (CANDLE SRI, Armenia)
16:10 – 16:25	***Smith-Purcell Radiations for a Cylindrical Grating*** Anna Kotanjyan (Yerevan State University, Armenia)
3 July Wednesday	
8:30 Bus from Ani Hotel	
Session 3: Wakefield and Impedances, Beam Dynamics (Chairman: Alberto Bacci)	
9:00 – 9:30	***Impedance Calculation in the Frequency Domain*** Erion Gjonaj (Technische Universitat Darmstadt, Germany)
9:30 – 9:50	***Wakefield of Structured Dense e+/- Bunches in a One-Dimensional Plasma Model*** Suren Arutunian (Yerevan Physics Institute, Armenia)

9:50 – 10:15	***The Resonant Impedance of Metal-Dielectric Structures in THz Region*** Michael Ivanyan (CANDLE SRI, Armenia)
10:15 – 10:40	***Transient Wave in a Dielectric Pipe*** Martin Dohlus (DESY, Germany)
10:40 – 11:00	***Geometrical Interpretation of Transition Radiation in a Waveguide*** Lusine Aslyan (CANDLE SRI, Armenia)
11:00 – 11:20	**Coffee Break**
11:20 – 11:40	***Matching Measured Beam Dynamics with ASTRA Simulations at REGAE*** Max Hachmann (DESY, Germany)
11:40 – 12:00	***Electron Beam Dynamics in Marix, a Two-Pass Two-Way Super Conducting Accelerator for Ultrafast, High Repetition Rate X-Ray FEL*** Marcello Rossetti Conti (INFN Milan, Italy)
12:00-12:15	***Stability of shear rotational viscose dusty plasma systems merged in the helical background magnetic field by Multi-fluid model*** Marjan Mahdavi-Gharavi (Kharazmi university, Iran)
12:15 – 12:30	***Nonlinear Dynamics Optimization with Multi-Objective PSO Algorithm*** Artsrun Sargsyan (CANDLE SRI, Armenia)
12:30 – 14:30	**Lunch**
Session 4: Applications and Experimental Techniques (Chairman: Bagrat Grigoryan)	
14:30 – 14:50	***Differences in DNA Damage and Repair in Human Cancer and Normal Cells after Ultrashort Pulsed Electron Beam Irradiation*** Nelly Babayan (Institute of Molecular Biology NAS RA, Armenia)
14:50 – 15:10	***Electron Beam Irradiation Applications for the Improvement of Biofilm Formation by Probiotics*** Astghik Pepoyan (Armenian National Agrarian University, Armenia)
15:10 – 15:25	***Ultrafast Beam Effects on Some E.coli Strains*** Garnik Khachatryan (Yerevan Physics Institute, Armenia)
15:25 – 15:40	***Two-Photon Microscopy Imaging of Cerebral Blood Flow after Ischemic Stroke*** Senik Matinyan (Yerevan State Medical University, Armenia)

15:40 – 16:00	**Coffee Break**
16:00 – 16:30	***Low-Energy Nuclear Physics: Problems and Solutions*** Amur Margaryan (Yerevan Physics Institute, Armenia)
16:30 – 16:45	***Imaging Strain in Semiconductor Nanowires by Means of Coherent X-Ray Diffraction Imaging*** Arman Davtyan (University of Siegen, Germany)
16:45– 17:00	***Experimental Station for the Materials Study under Near the Earth Space Conditions*** Vika Arzumanyan (Yerevan Physics Institute, Armenia)
4 July Thursday	
8:30 Bus from Ani Hotel	
Session 5: Advanced Concepts and Technology, Tour to AREAL (Chairman: Ulrich Dorda)	
9:00 – 9:30	***Synchronous Acceleration with Tapered Dielectric-Lined Waveguides*** Klaus Floettmann (DESY, Germany)
9:30 – 10:00	***Introduction to the MicroTCA.4 Standard*** Patrick Nonn (DESY, Germany)
10:00 – 10:30	***Rohde & Schwarz Solutions for Accelerator's Techniques Applications*** Alexander Beresnev and Sergey Rybinskiy (Rohde & Schwarz, Germany)
10:30 – 11:15	***Opening of the Rohde&Schwarz-CANDLE Training Laboratory***
11:15 – 11:30	**Coffee break**
11:30 – 12:30	***Tour to AREAL Facility and Laboratories***
12:30 – 14:50	**Lunch – Hotel**
15:00-18:00	**Tour to Garni and Geghard Monasteries**
19:00	**Workshop Dinner**
5 July Friday	
8:30 Bus from Ani Hotel	
Session 6: Instrumentation & Diagnostics (Chairman: Vasili Tsakanov)	

9:00 – 9:20	***Overview of the REGAE Beamline Upgrade*** Benno Zeitler (University of Hamburg & CFEL, Germany)
9:20 – 9:40	***Synthesis of Advanced Solid Solution Ceramics as Promising Materials for Accelerator Applications*** Norair Martirosyan (CANDLE SRI, Armenia)
9:40 – 9:55	***A Picosecond Resolution Optical Sensor for TCSPC Applications at CANDLE*** Simon Zhamkochyan (Yerevan Physics Institute, Armenia)
9:55 – 10:10	***Ultrafast Laser-Induced Modification of Glass and Fabrication of Buried Phase Structures*** Maksim Sargsyan (Yerevan State University, Armenia)
10:10 – 10:30	***Development of RF Structures and Diagnostic Tools for Ultrashort Bunches*** Vahe Danielyan (CANDLE SRI, Armenia)
10:30 – 10:45	**Coffee Break**
10:45-11:10	***Immuno-Cytochemical Detection of Radiation-Induced DNA Damage*** Andreyan Osipov (Semenov Institute of Chemical Physics RAS, Russia)
11:10- 11:30	***The socio-economic implications of ultrafast beams and applications*** Mariam Yeghyan (CANDLE SRI, Armenia)
11:30 – 12:30	***Workshop Summary & Closing***
12:30 – 14:30	**Lunch**

Radiobiological Effects of Ultrashort Pulsed Electron Beam Irradiation In Vitro and In Vivo

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The rapidly evolving laser technologies lead to the development of laser-generated particle accelerators as an alternative to conventional particle therapy facilities. However, the radiobiological characteristics need to be determined to enhance the application of new generation particle beams in clinical practice. The aim of the work was to study the molecular-genetic effects of ultrashort pulsed electron beam (UPEB) radiation in vitro and in vivo. The X-ray radiation was used a reference. It was shown, that in case of UPEB radiation the average yield of γH2AX foci (as a marker of DNA double strand breaks) per unit of absorbed dose was approximately similar to X-ray radiation, however, the level of residual foci detected after UPEB irradiation was 2-fold higher, suggesting the differences in activated repair mechanisms and thereby the different nature of induced DNA damages. The faster elimination of X-ray-induced DSBs shown in our experiments also support this suggestion, since the 60% decrease in the number of γH2AX foci was observed 4 h post-irradiation, whereas only 7% UPEB-induced damages was repaired at the same time point. The activity of p-DNA-PK, a key protein in the non-homologous end joining (NHEJ) DNA repair pathway, was shown to be higher in response to UPEB radiation, compared to X-ray radiation. Based on CBMN assay, which is a valuable biodosimetric tool for quantifying radiation-induced chromosomal damages, the lower level of mutagenic capacity in case of UPEB irradiation was shown, compared to X-ray radiation (RBE=0.06). As it was expected, no significant changes in cell viability were found after 24h of X-ray radiated, whereas at the 1 Gy of UPEB radiation the 60±3.4 % of viability was accompanied with the 22±1.4 % of apoptotic cells. It was also shown, that UPEB radiation induces changes in global DNA methylation 24 h post-irradiation and the level of methylated CpG islands increases by 40-50%. The in vivo experiments revealed that spleen is more sensitive to UPEB radiation, compared to bone marrow and thymus. So, it can be concluded, that UPEB-induced DNA DSBs are characterized by slow repair kinetics, suggesting the formation of complex DNA damages. The p-DNA-PK, responsible for activation of NHEJ repair pathway, is partially participates in recruitment of repair factors to DSBs induced by UPEB radiation. The level of p-DNA-PK activity after UPEB irradiation is higher, compared to X-ray radiation, which can be due to the

activation of apoptotic cell death pathway induced by UPEB radiation. The low level of genomic abnormalities passing through generations of cells accompanied with faster elimination of damaged cells, shown in our experiments after UPEB radiation, is of great interest for improvement of radiotherapy efficiency associated with reduction of early and late side effects of exposure.

The Southern Europe Thomson Backscattering Source STAR: Beam Dynamics, Project Status and Foreseen Applications

Alberto Bacci, INFN Milan, Italy

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The STAR Project, Southern Europe Thomson backscattering source for Applied Research, is in its advanced stage of completion, aiming at commissioning a user facility based on a Thomson source of monochromatic, tunable, ps-long and polarized X-ray beams. The STAR site is located in Calabria (Italy) at the University of Calabria. The operating photon energy range will be from 40 up to 80 keV in its initial phase, driven by a high phase space density 65 MeV electron beam. The research infrastructure was recently approved by the Italian government for a second phase upgrade program, spanning the next 3 years, aiming at increasing the maximum electron beam energy up to 150 MeV, with maximum photon energy up to 350 keV, and implementing a second beam line for the high energy range of X-ray beams. The STAR Project status, the beam dynamic simulations on which the project is based and the foreseen applications in the archaeological heritage field are presented.

Status and Plans at SINBAD-ARES

Ulrich Dorda, DESY, Germany

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At the dedicated accelerator R&D facility SINBAD at DESY, the gun-stage of the 100MeV linac is just being commissioned. In this presentation, the linac optics design, its objectives and the future plans are presented.

THz Generation and Ultrafast Electron Diffraction at PITZ

Mikhail Krasilnikov, DESY, Germany
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The Photo Injector Test Facility at DESY in Zeuthen (PITZ) develops high brightness electron sources for modern Free Electron Lasers (FELs), like FLASH and the European X-ray FEL in Hamburg. In addition, PITZ has been proposed as a suitable facility for research and development on an accelerator-based THz source prototype for pump-probe experiments at the European XFEL. A proof-of-principle experiment of generating THz SASE FEL radiation by using an LCLS-I undulator driven by an electron bunch from the PITZ accelerator has been planned and studied in simulations. Preliminary electron beam experimental characterization has been performed as well. Additionally, the PITZ facility can also support femtosecond electron diffraction at the same beam repetition rate as the European XFEL, which brings XFEL users more flexibility for different experiments. In this contribution, an overview of THz-related activities and femtosecond electron diffraction studies based on the PITZ accelerator setup will be presented.

Iranian Test Stand Electron Linear Accelerator

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Iranian low energy electron linear accelerator (IReLinac) is a 8 MeV electron linac with 10 mA beam current and 255 Hz repetition rate. The main purposes of its development are the training of MSc and PhD students and applications as a test stand for the development of different components of linear accelerators. This setup will be used for the development of different types of electron guns, RF cavities, detectors and dosimeters. In addition, this facility can be upgraded for researches in the area of medical and industrial radiography and as a test pilot for developing different types of diagnostic instruments and ideas. At the moment, the output energy of this facility increased from 1.5 MeV to 5 MeV. The progress of this project and measurement of different parameters of electron beam in the machine are represented in this presentation.

AREAL – Facility: Status and Highlights

Vasili Tsakanov, CANDLE SRI, Armenia

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Advanced Research Electron Accelerator Laboratory - AREAL – is a laser driven RF gun based electron linear accelerator aimed for producing ultrashort electron and photon pulses. After the successful operation of the 5 MeV energy RF photogun, the facility upgrade with beam energy increase to 20-50 MeV to be delivered to ALPHA (Amplified Light Pulse for High-end Applications) and BETA (Booster for Emerging Technology Accelerators) experimental stations is foreseen. ALPHA station is designated for the free electron laser in far-infrared region and BETA station is designated as a test stand for advanced accelerator and radiation source concepts. The current status and upgrading plans of the facility, along with experimental program, are presented.

Session 2: Photon Beams

Chairman: Erion Gjonaj

Generation of Few-Cycle Terahertz Pulses in Domain-Engineered Lithium Niobate Crystals

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In recent years, the application areas requiring intense terahertz (THz) pulses have been rapidly increasing. The high field strength of few-cycle THz pulses in combination with relatively large wavelength offers unique opportunities to manipulate the motion of charged particles. In this report the generation of few-cycle THz pulses by optical rectification in the periodically and aperiodically poled lithium niobate (PPLN and APPLN) crystals is analyzed. The experimental realization of THz generation by using former crystal is easier, whereas in the latter case the estimated THz power is significantly higher. The THz electric field strength an order of few MV/cm (in focus) is predicted for chirped APPLN crystal pumped by a sequence of fs-laser pulses with chirped delay between adjacent pulses and peak intensities of about 20 GW/cm2.

Toward the Cherenkov FEL Experiment at CANDLE

Francois Lemery, DESY, Germany

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The Cherenkov FEL is an interesting mechanism developed some decades ago. Accelerator technology has made great strides since and we discuss the application of a CFEL with a modern photo injector source like AREAL. We discuss a path forward toward an experiment.

Solitonic and Resembling Processes for Ultrafast Laser Pulse Registration and Spectral Self –Compression

Minas Sukiasyan, YSU, Armenia
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In this work we developed and experimentally examined a real-time single-shot technique of femtosecond pulse duration measurement based on similariton spectrotemporal imaging and measuring temporal profile via electrical oscilloscope. Also the pulse spectral phase is measured by transferring the information from the spectral to the temporal domain by stretching the pulse to reach the far field of dispersion. We have implemented the technique through sum-frequency generation by using the laser pulse as a reference and have experimentally demonstrated the direct spectral phase measurement of various amplitude-modulated pulses.

Precision Laser Processing for Beam Shaping and Guiding Applications

Arsham Yeremyan, CANDLE SRI, Armenia
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Material processing by ultrashort-pulse lasers has nowadays found a widespread usage as an efficient and versatile microfabrication tool with an ever growing potential of applications (in almost all areas of science and industry). The high level of tunability of laser parameters available with current laser technologies allows one to choose among a variety of modes of laser-matter interactions and provides a wider choice of materials and design approaches for fabrication of specific devices and components. In this talk, the latter flexibility will be demonstrated by presenting some results of studies directed towards the fabrication of specific devices and components for laser and electron beam shaping and guiding such as diffraction optical elements, waveguides, special masks and apertures, etc. The advantages and limitation of the technique will be discussed from the point of view of the potential of using new design approaches and improvement of fabrication quality of such devices.

Smith-Purcell Radiations for a Cylindrical Grating

Anna Kotanjyan,YSU, Armenia

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We have investigated the spectral-angular distribution for the radiation emitted by a point charge moving around/inside a cylindrical grating with perfectly conducting strips parallel to the cylinder axis. The effect of the grating on the radiation intensity is approximated by the surface currents induced on the strips by the field of the rotating charge. The expressions are derived for the electric and magnetic fields and for the angular density of the radiation intensity on a given harmonic. We show that the interference between the synchrotron and Smith-Purcell radiations may lead to interesting features. In particular, the behavior of the radiation intensity on large harmonics can be essentially different from that of a charge rotating in the vacuum. For the geometry of diffraction grating the radiation intensity on higher harmonics does not vanish for small angles with respect to the cylinder axis. For given characteristics of the charge, by the choice of the parameters of the diffraction grating, one can have highly directional radiation near the normal to the plane of the charge rotation. With decreasing energy, the relative contribution of the synchrotron radiation decreases and the Smith-Purcell part is dominant. By using a grating with the radius of the order of cm, electromagnetic radiation up to terahertz range can be generated.

Session 3: Wakefield and Impedances, Beam Dynamics

Chairman: Alberto Bacci

Impedance Calculation in the Frequency Domain

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Wake potentials and coupling impedances can be calculated analytically only for simple structures and for special limiting cases. For the calculation of wake fields in “real-world” 3D accelerator structures, one has to rely on numerical field simulations. In the talk, we will discuss a novel method for the calculation of impedances in the frequency domain. It will be shown that the method can effectively be applied in the simulation of THz-structures that are otherwise not accessible to conventional wakefield simulations in the time domain.

Wakefield of Structured Dense e+/- Bunches in a One-Dimensional Plasma Model

Suren Arutunian, Yerevan Physics Institute, Armenia

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A model of 1D cold plasma whit external train of rigid structured e+/- bunches is introduced. In this model a solution cancelled wakefield after the train is found. Density of the bunches in this case can be much greater than the density of the plasma and a high amplitude electrical field arising inside the train can be used for charged particles acceleration.

The Resonant Impedance of Metal-Dielectric Structures in THz Region

Michael Ivanyan, CANDLE SRI, Armenia

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The report provides some considerations regarding the optimization of cylindrical two-layer metal-dielectric structures in the sense of monochromatization of wake radiation of an ultra-relativistic charged particle flying along its axis.

Transient Wave in a Dielectric Pipe

Martin Dohlus, DESY, Germany

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When a charged particle travels through a metallic pipe with a dielectric layer, it excites a wave with the phase velocity identical to the particle velocity. The steady state condition in an infinite pipe (after infinite time) can be calculated easily by field matching. A qualitative picture for a particle that traveled a finite time in the pipe is a wave-train of the length given by the difference of phase and group velocity multiplied with time of flight. A more quantitative analysis of this process is given.

Geometrical Interpretation of Transition Radiation in a Waveguide

Lusine Aslyan, CANDLE SRI, Armenia

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The report demonstrates the geometric properties of transition radiation (TR) of an ultrarelativistic point-like charged particle crossing the transverse wall of a circular semi-infinite waveguide with ideally conducting walls. The particle trajectory is parallel to the waveguide axis. An explicit expression is obtained for the components of the TR field in the space-time representation as an expansion in the space-time harmonics of an ideal circular waveguide with analytically determined weighting coefficients.

Matching Measured Beam Dynamics with ASTRA Simulations at REGAE

Max Hachmann, DESY, Germany

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In order to fully understand a LINAC like REGAE it is highly demanded to match the measured beam parameters with beam dynamical simulations yielded e.g. with a particle tracking code like ASTRA. Results on this issue are presented and an online tracking tool, called ASTREG, for the REGAE accelerator is introduced.

Electron Beam Dynamics in Marix, a Two-Pass Two-Way Super Conducting Accelerator for Ultrafast, High Repetition Rate X-Ray FEL

Marcello Rossetti, INFN Milan, Italy

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We present a study of an innovative scheme to generate high repetition rate (MHz-class) GeV electron beams by adopting a two-pass two-way acceleration in a Super-Conducting Linac operated in Continuous Wave (CW) mode. The beam is accelerated twice in the Linac by being re-injected, after the first pass, in opposite direction of propagation. The task of recirculating the electron beam is performed by an arc compressor based on Double Bend Achromatic (DBA) cells. We study the main issues of the two-fold acceleration scheme, the electron beam quality parameters preservation (emittance, energy spread), together with the bunch compression performance of the arc compressor, aiming to operate an X-ray Free Electron Laser.

Stability of Shear Rotational Viscose Dusty Plasma Systems Merged inthe Helical Background Magnetic Field by Multi-Fluid Model

Marjan Mahdavi-Gharavi, Kharazmi University, Iran

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The instability of magneto rotational systems is important because of its ubiquity both in space as well as in recent laboratory experiments set to examine the scenarios where a magnetized Talor-Couette flow in a current-free helical background magnetic field can be triggered [R. Hollerbach, G. Rüdiger, Phys. Rev. Lett. 95 (2005) 124501; G. Rüdiger, R. Hollerbach, M. Schultz, D.A. Shalybkov, Astron. Nachr. 326 (2005) 409]. We would like to point out that the MRI by considering the background helical magnetic field has not yet been discussed by multi-fluid approach. So, it should be emphasized that the typical astrophysical parameters considered for the magneto rotational viscose collisional shear system to illustrate the physics of such scenarios. In this regard, the influence of an azimuthal magnetic field on the instability of shear viscose dusty plasma systems has been investigated by employing the multi-fluid approach coupled with Maxwell equations. The main results of analytical and numerical solution of the obtained dispersion relation demonstrate the stabilization role of the magnetic field helicity and the viscosity effect on the system. Moreover, for both axial and helical magnetic field structures, the maximum growth rate of instability increases the dust particles concentration while the maximum wave number decreases.

Nonlinear Dynamics Optimization with Multi-Objective PSO Algorithm

Artsrun Sargsyan, CANDLE SRI, Armenia

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Recently developed low emittance/low alpha lattice of CANDLE storage ring was suffering from the typical issue of complicated nonlinear beam dynamics resulting in lowered dynamic and momentum apertures. In order to improve these characteristics of the new lattice, an optimization of nonlinear dynamics, by the usage of multi-objective particle swarm algorithm, was performed. The main aspects and results of the conducted optimization procedure are presented.

Session 4: Applications and Experimental Techniques

Chairman: Bagrat Grigoryan

Differences in DNA Damage and Repair in Human Cancer and Normal Cells after Ultrashort Pulsed Electron Beam Irradiation

Nelly Babayan, Institute of Molecular Biology NAS RA, Armenia
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DNA damage response (DDR) is a network of cellular pathways to detect DNA damages, realize signal transduction and promote their repair. In contrast to normal cells, most cancer cells lost one or more DDR pathway during their generation, resulting in stronger dependency on the remaining pathways. The approach of specifically targeted treatment of DNA repair-defective tumours has been described as synthetic lethality. Two genes are synthetic lethal when silencing one of them can support cell viability, whereas inhibiting both leads to cell death. Thus, it is important to identify DNA repair genes and/or proteins whose expression differs in cancer and normal cells. The aim of the work was to study the differences in DDR in human blood cancer and normal cells after ultrashort pulsed electron beam (UPEB) radiation. It was shown, that the viability of cancer cells can be retained at a higher level of UPEB-induced DNA damages in comparison to normal cells. The DNA double strand break repair, which is crucial for cell viability, is more effective in cancer cells than in normal ones. The analysis of activation of DNA repair pathways (BER, NHEJ, HRR) at different levels of DNA damages revealed, that cancer cells exhibit higher level of repair potential in comparison to normal cells. The activation of certain DNA repair pathway depends on the level of DNA damages, suggesting the involvement of epigenetic regulation during the activation of those processes. Based on the data obtained, it was suggested that the inhibition of APEX1 protein (responsible for BER pathway) may reduce the repair potential in cancer cells, without having effect on normal cells' repair systems. It was shown that the Ref-1 gene silencing (APEX1 protein) increases the radiosensitivity of cancer cells, leading to the 80% cell death (64% apoptotic cells). At the same time, the viability of normal cells was not affected after Ref-1 gene silencing. So, it can be concluded, that Ref-1 can be considered as target gene for synthetic lethality and recommended for further studies on combined effects with radiation therapy.

Electron Beam Irradiation Applications for the Improvement of Biofilm Formation by Probiotics

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Taking into account the importance of biofilm-formation ability and cell surface hydrophobicity for the probiotic characteristics of lactobacilli, as well as the possible impact of radiation on its physical and chemical characteristics, the effects of 50 - 150 Gray electron-beam irradiation on the biofilm-formation ability and cell surface hydrophobicity of the commercial strain, Lactobacillus acidophilus DDS®-1 from Lacto-G (a marketed symbiotic formulation) and the putative probiotic, L. rhamnosus Vahe, were evaluated. The AREAL electron accelerator was used to investigate the impact of low dose electron-beam irradiation on the biophysical characteristics of lactobacilli membranes. No significant changes in cell surface hydrophobicity were found after irradiation, while strain-specific increases in biofilm-formation abilities were documented for both investigated microorganisms. Our results indicate that the electron-beam irradiation (50 -100 GY) treatment of probiotic lactobacilli strains may improve their biofilm-formation ability without influencing hydrophobicity. Therefore, this technique may be considered as a useful approach for product processing/packaging in the personal/healthcare and food industries.

Ultrafast Beam Effects on Some E.coli Strains

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The survival of few strains of bacteria E.coli with different radiosensitivity was investigated on AREAL electron accelerator, and value of D0 for each curve was received using different bunch frequency.

Two-Photon Microscopy Imaging of Cerebral Blood Flow after Ischemic Stroke

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The aim of this research is to provide updated information about using two-photon microscopy to understand blood flow changes during the chronic phase of ischemic stroke.

Low-Energy Nuclear Physics: Problems and Solutions

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Methodic studies related to the low-energy nuclear physics and precise measurements in hypernuclear physics by using electron-photon beams of CANDLE are discussed.

Imaging Strain in Semiconductor Nanowires by Means of Coherent X-Ray Diffraction Imaging

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The combination of coherent x-ray diffraction imaging (CXDI) and ptychograpy in Bragg geometry was used in order to characterize single core-shell-shell heterostructure nanowires (NWs) grown on (111) silicon substrate with 140nm GaAs core-10nm In0.10Ga0.90As inner shell and 30nm GaAs outer shell and 2-3 micron length. The experiment has been performed at the beamline ID01 of the ESRF, Grenoble using coherent x-rays with energy of 9keV and a beam size of 150x200nm^2 full width at half maximum (FWHM). CXDI was applied to record 3D reciprocal space maps of the symmetric GaAs (111) reflection at different positions along the NW growth axis for two different NWs. In case of NW1 projection of these 3D RSMs a plane parallel to the growth axis shows that, except the bottom part, the NW structure is uniform, whereas for NW2 the RSMs are changing as a function of NW height. In addition to CXDI measurements the very same NWs were investigated with 2D ptychography at the GaAs (111) Bragg reflection. In agreement with our RSM analysis ptychography reconstruction also shows the homogeneous structure (reconstructed homogeneous phase) of the NW1 and phase change along the growth axis in NW2.

Experimental Station for the Materials Study under Near the Earth Space Conditions

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Study of effects in materials and electronic equipment under the influence of ionizing radiation is of great importance for the creation of radiation-resistant elements and devices for space, military and other special applications. At present, when space exploration moved to a stage of intensive development, these tasks become relevant. Spacecrafts, during the period of their existence in space, are exposed to various factors of space. According to modern concepts, the main factors capable of damaging the electronic equipment of spacecraft are the following: ionizing radiation (electrons with energies of 0.1-10 MeV, protons with energies of 1-104 MeV); radiation of the sun and planets; vacuum 10-5 and high; temperature range from -100 0C to +100 0C;

The nature and extent of the radiation effect on the physical parameters of materials strongly depend on the:

- type and energy of radiation,
- intensity,
- irradiation conditions

The aim of this work is the development of experimental setup simulating some near the Earth space environment conditions for study materials and devices at AREAL Facility with the following parameters:

- Electron beam with energy up to 4MeV, pulse duration 4x10-13 sec
- Solar ultraviolet radiation
- Measurement temperature range from -100 0C to +100 0C
- Vacuum - 10-5 Torr. (1.33x10-3 Pa),

Besides, experimental results on the study of non-equilibrium processes in a silicon crystal under exposure to a 3.5 MeV pico-second electron beam at the usual conditions (including room temperatures) are given.

Session 5: Advanced Concepts and Technology, Tour to AREAL

Chairman: Ulrich Dorda

Synchronous Acceleration with Tapered Dielectric-Lined Waveguides

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A concept to accelerate non-relativistic particles in a tapered dielectric lined waveguide working in the THz range is presented. Problems regarding the transverse and longitudinal beam dynamics will be highlighted. The aim of the study is to develop a compact electron source with beam parameters suitable for ultrafast electron diffraction, advance accelerators and other applications.

Introduction to the MicroTCA.4 Standard

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The MicroTCA standard was developed as an alternative to Advanced TCA, with a smaller volume, for application in the telecommunication industry. This standard has been extended to MicroTCA.4 for using in scientific instrumentation, especially particle accelerators. This talk will introduce the MicroTCA.4 standard and highlight its use in small machines.

Rohde & Schwarz Solutions for Accelerator's Techniques Applications

Alexander Beresnev and Sergey Rybinskiy, Rohde & Schwarz, Germany
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High-end telecommunications, RF and microwave components for advanced accelerators.

Session 6: Instrumentation & Diagnostics

Chairman: Vasili Tsakanov

Overview of the REGAE Beamline Upgrade

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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.

Synthesis of Advanced Solid Solution Ceramics as Promising Materials for Accelerator Applications

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The self-propagating high-temperature synthesis (SHS) technologies were developed for obtaining high-quality ceramic materials based on Ba1-xSrxTiO3 and (1-x)BiFeO3–xBaTiO3 compositions with various dopmant (MgO, MnO, etc.). From the obtained ceramics it is foreseen to produce equipment with coaxial and coaxial/planar structures with 40 mm diameter designated for RF wave phase and amplitude regulation.

A Picosecond Resolution Optical Sensor for TCSPC Applications at CANDLE

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The Radio Frequency Photomultiplier Tube (RFPMT) as an ultra-high time resolution photon detector for Time Correlated Single Photon Counting (TCSPC) is proposed. The RFPMT operational principles and its TCSPC applications, such as time-correlated Stimulated Emission Depletion (STED) microscopy and time-correlated Diffuse Optical Tomography (DOT), are described. Advantages of CANDLE laser system for testing and application of the RFPMT are outlined along with the proposed experimental setup.

Ultrafast Laser-Induced Modification of Glass and Fabrication of Buried Phase Structures

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Extremely high peak powers available with the state-of-the-art ultrafast lasers significantly extended the area of their applications as a tool for fabrication of micro and nanoscale structures. Processing of transparent glasses and crystals is a particular field of interest in view of the potential applications in photonics, integrated optics, microfluidics among many others. An advantage of the sub-picosecond lasers is that extremely high peak intensities can be achieved at a localized area of the surface or in the volume of a transparent sample. As a result, permanent modifications can be induced in glasses or crystals through nonlinear absorption and photoionization mechanisms. In this talk, the results of our studies on the refractive index change (RIC) induced in BK7 glasses by ultrashort laser pulses are presented. It is shown that traces with smooth RIC can be obtained at moderate pulse energies in a space-selective manner, which allows to produce 3D patterns of buried structures in layer-by-layer mode. Taking the advantage of the ability to fabricate large structures, a method is suggested and exploited for qualitative estimation of the sign and the value of the RIC, as well as measurement of the scattering losses from laser-modified regions in a particular fabrication regime.

Development of RF Structures and Diagnostic Tools for Ultrashort Bunches

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The presentation is devoted to the R&D of precision technologies developed at CANDLE SRI - RF structures, diagnostic systems and accelerator magnets production technologies.

Immuno-Cytochemical Detection of Radiation-Induced DNA Damage

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The Socio-economic Implications of Lasers and Accelerator Facilities

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Ultra-fast lasers have been proven for their applications at micro and macro level industry, starting from fabrication of functional medical stents, medical treatment, such as LASYKC – a refractive surgery used to correct myopia, hyperopia and astigmatism to automotive industry and advanced energy sources. The applications of ultrafast beams in different life and material sciences can stimulate development of novel technologies for a variety of business and industrial sectors including micromachining, optics, pharmaceutics, mining industry, food processing, medical instruments processing, etc. Thus, many advanced business companies and developed country governments invest in R&D (namely in ultrafast sciences) a lot of money expecting to increase the efficiency of manufacturing process, reduce cost expenditures and gain more net benefit as a final result. E.g. Panasonic USA used picosecond lasers for the first time in mass production to produce funnel-shaped ink-jet nozzles, US Department of Energy (DOE) issued a $3.7 million grant to a consortium of companies to develop nascent ultrafast-pulse laser technology to build a next generation manufacturing process for automotive fuel injectors. The main objective of this report is to outline the industrial applications of ultra-fast beams (lasers) and assess/predict their overall impact of economies at micro and macro level.