Extreme Light's Modernistic Applications

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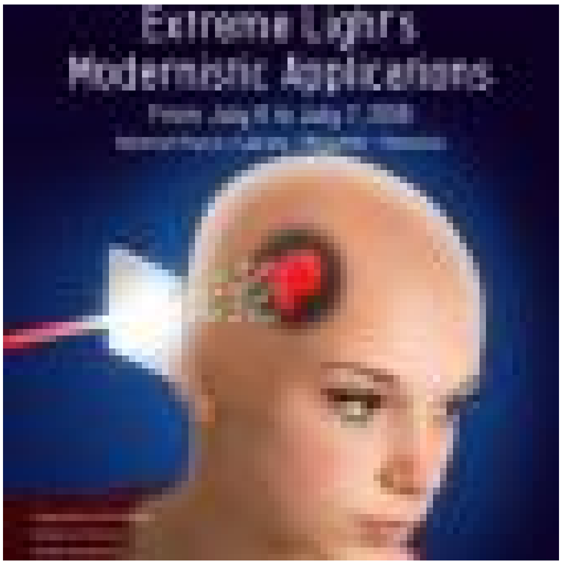
ELI-NP Magurele - Romania



Book of Abstracts

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Temporal recompression and intensity contrast ratio enhancement of high energy femtosecond laser pulses

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A possibility of implementation nonlinear optical effects to pulse shortening and temporal intensity contrast ratio enhancement of high energy (˜kJ) femtosecond laser pulses will be discussed. Experimental results on temporal recompression from 57fs to 22 fs in a part of a petawatt level laser beam at laser system PEARL will be presented. Theoretical analyze of an influence of a residual spectral phase on Thin Film Compression technique will be concidered.

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Prospective Studies for Combining Multi-PW Pulses

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Extreme Light Infrastructure – Nuclear Physics (ELI-NP) under construction in Romania will host a laser system with two parallel 10PW arms make possible power powers in excess of 10PW, once the synchronization of the two beams is demonstrated at a jitter level below the pulse duration.
A short review of ELI-NP laser specifications is presented. The rough monitoring of the synchronization can be performed using the plasma mirror technique reported in [1], with temporal resolution down to 2 ps. The overlap of the pulses can be achieved using nonlinear processes such as second order autocorrelation. In order to reach coherent combination of the pulses, the jitter of the two pulses shall drop below a quarter of period of the pulse, which is ˜0.5fs in the ELI-NP case. Further, the proposed path to follow for the pulse duration reduction and peak power boost is spectral combination of ultrashort laser pulses. A collinear combination method was proposed, based on the spectral combination of parallel laser pulses, with complementary spectra, in chirped pulse amplification (CPA) laser systems. In a proof-of-principle experiment, it was demonstrated that two long pulses of 330 fs can be overlapped in a collinear way, to produce a shorter pulse, of 190 fs. As a consequence, it is shown that the power for the combined pulse obtained is up to a factor of 1.7 larger than the sum of the peak powers of each individual pulse. The spectral phase of the combined pulse was characterized with lambda/10 accuracy, using spectral interferometry. A way to implement the method at parallel CPA laser facilities, such as ELI-NP, using no transmission optics, was indicated [2].
However, the collinear spectral coherent combination method proposed is complex in terms of hardware use, using 6 large gratings. An alternative way towards a simpler combination is to synthesise the ultrashort pulse directly in the interaction point.
Hence, non-collinear spectral coherent combining (NCSCC) of ultrashort pulses is analyzed 2D modeling of the electromagnetic field is performed in case of NCSCC using two or three pulses with different wavelengths. In the case of two pulses, a potentially unwanted spatio-temporal structure of the field appears, corresponding to spatial and temporal modulation of the pulse. By using NCSCC of three 62 fs long pulses with different spectral composition, such spatial-temporal coupling is

eliminated and the combined pulse duration in the focal region drops to less than half. The method is scalable to a large number of ultrashort pulses. Increasing the number of beams, the pulse duration drops accordingly [3]. The results are relevant for projects such as ICAN [4].
The research leading to these results has received funding from the UEFISCDI project PN2 – Parteneriate - 1/2012 and is supported by Extreme Light Infrastructure Nuclear Physics (ELI-NP), a project co-financed by the Romanian Government and European Union through the European Regional Development Fund.

[1] R. Ungureanu, G. Cojocaru, R. Banici, D. Ursescu, Optics Express Vol. 22, Issue 13, pp. 15918-15923 (2014)
[2] R. Banici and D. Ursescu, EPL (Europhysics Letters) 94, 44002 (2011).
[3] L. Ionel and D. Ursescu, Optics Express, Vol. 24, Issue 7, pp. 7046-7054 (2016)
[4] G. Mourou, B. Brocklesby, T. Tajima, and J. Limpert, Nature Photonics 7, 258–261 (2013)

High Energy Single Cycle Pulse (next) / **30**

Single-cycle Pulses

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The efficient, post-compression of high-energy Petawatt (PW) scale laser pulses toward the fundamental limit of a single-cycle pulse duration offers a path to extreme peak intensities without the need for adding additional costly energy amplification. Instead the existing pulse energy is redistributed in the generation of additional spectral bandwidth and further compressed through subsequent spectral phase compensation to produce the increased intensities. The proposed Thin Film Compressor (TFC) promises to offer an efficient and affordable method to boost the peak pulse achievable with existing facilities. Recent measurements at the CETAL PW laser based at the National Institute for Lasers, Plasma and Radiation Physics (INFLPR) show the spectra from a small-scale TFC configuration to be recompressible to shorter than the original measured pulse duration (near the limit of the available diagnostic tool) using films of both cellulose acetate and PMMA. These early experimental results show great promise for pulse compression but suggest that additional diagnostics and sampling methods must be implemented at the facilities that will allow for continued studies of single-cycle pulses.

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Introduction to Extreme Light's Modernistic Applications

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As the three ELI pillars in Romania, Czech Republic and Hungary and other large scale facilities like the Apollon system are becoming a reality, unfathomable possibilities not envisaged in the original proposal are coming up. They stem from the combination of peak power, flattop and low beam divergence. The most intriguing one is the capacity to compress petawatt pulses to the single cycle regime. It gives access to exawatt pulse, efficient generation of high energy particle and radiation as well as attosecond-zepto second pulse. Their shortness in the atto and sub attosecond regimes makes their spectrum in the X-ray domain. These high field X-ray pulses could for the first time be used to generate wake field acceleration in solid with a behemoth accelerating gradient of TeV/cm. This new intensity regime will make possible the laser to penetrate into the field of Nonlinear Quantum Electro-dynamic, to fulfill a fifty years old dream.

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EXTREME LİGHT INFRASTRUCTURE – NUCLEAR PHYSİCS (ELI-NP): STATUS AND PERSPECTİVES

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Extreme Light Infrastructure – Nuclear Physics (ELI-NP), the new Research Center under construction in Bucharest-Magurele, will use extreme electromagnetic fields, produced by a high power laser system (2x10PW) and by a very brilliant gamma beam (up to 20 MeV), for nuclear physics research. The status of the Project implementation, which started in 2013, will be presented. The new Center, valued approx. 300 Meuros, will be operational in 2019. The scientific program under implementation, especially the main directions of the envisioned applied research will be presented.

Medical practitioners / **37**

Lasers in ophtalmology - a physician story for the physicist -

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The aim of the presentation is to describe actual lasers applications in ophtalmology, for therapy and diagnostic. Different eye diseases are explained physipatologically and therefore the use of lasers based on their specific laser-tissue interaction. The goal is for the audience to have an idea about the importance of lasers for our vision.

Protontherapy & Nuclear Pharmacology / **15**

Laser-driven Medical Therapy

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Status of Proton Therapy using Conventional Proton Sources

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Proton radiation therapy for patients started in 1954. Until today more than 150000 patients have been treated. First decades of proton therapy were focused on treatments of skull base and (para)spinal tumors, e.g. chordomas, chondrosarcomas and sarcomas. Choroidal melanomas and prostate cancer built the largest groups of entities during the past 20 years.
Nowadays proton radiation therapy is now widely accepted as the best radiation treatment in the management of rare complex tumors as well as in pediatric oncology with curative intent if available.

Since technology and IT capacity rapidly developed in photon radiation therapy also proton therapy progressed.
New tools in proton therapy as gantry rooms, pencil beam scanning, intensity-modulated proton radiotherapy, multileaf collimators, fast re-scanning etc. and an increasing number of running new facilities mainly at leading cancer centers in the world will offer new opportunities in the future treatment of tumor patients. Roughly 100 centers will be in operation in 2020.

That promises innovative scientific work. Especially in the U.S.A. several studies are being designed for new indications. Recruiting of patients has started. So far more than 200 trials are registered for nearly all kinds of oncologic entities incl. pediatric oncology (23 prospective clinical trials). Higher treatment capacity offers studies of thoracic (48) and abdominal/ pelvic tumors (75) as well as head and neck (22) and CNS tumors (28). Results will be evaluated in the next couple of years.
Questions of quality of life, hypofractionation and cost-effectiveness, combinations of protons and systemic treatments are in the focus of interest. Comparisons of protons vs carbon ions as well as re-irradiation and palliative radiotherapy will be evaluated.

In early proton radiation times mostly single institution study results were published. Nowadays multicenter studies are fortunately increasing. This will result in comparable high numbers of evaluated patients in analogy to photon radiation trials. Evidence based medicine with particles will not any longer be a hypothesis.

It is only a question of time when proton radiation therapy will be proven for all accepted indications in photon radiation therapy as well as in brachytherapy.
With regards to economic limitations and a low number of facilities (multicenter), trials will help to define future indications for particles in comparison to modern highly conformal photon irradiation.
It might be too early to state a shift from photons to protons. Nevertheless this will be the next logic step with regards to the evolution in radiation oncology, if cost-effectiveness will be reached and if one believes in the advantage of 60% lower integral doses to the patient.

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Proposal for a new type of accelerator for electrons and protons

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Abstract
The idea we propose is based on avoiding the direct interaction between the laser and the atomic/molecular components of the thin film which the laser interacts with, in the purpose of saving the energy of the emergent laser. For this purpose the emergent laser interacts with free electrons generated by an electron source, then the laser accelerated electrons by the laser attract pulsed protons emitted by a source of ions.
The clouds of protons and electrons are stripped by an electrostatic or magnetostatic field. The resulted electrons are brought back into the cycle; the protons can be used in medical or industrial purposes.
The advantages of this equipment are the very small sizes and a small mass. This kind of acceleration is a very compact, which takes place on the meter scale.

Round Table "Innovation and Technological transfer : from science to the medical industry" / 28

ELAP: the Extreme Light Applications Park of the ELI-NP facility

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ELAP is the Extreme Light Applications Park of the ELI-NP facility in Magurele (RO).
The Extreme Light physics is a novel approach to laser-matter interaction, made possible by the groundbreaking works of Prof T. Tajima (UCI, CA, USA) and Prof. G. Mourou (IZEST-Ecole Polytechnique, FR). The unique characteristic of the extreme light laser is to produce enormous amounts of energy and pressure; enough to rip matter apart, releasing sub-atomic particles such as protons, moving close to the speed of light. The core activities of ELAP are based on the breakthroughs in the field of the nuclear physics made possible by extreme light, especially in the field of nuclear medicine, but also to other real life applications like nuclear waste disposal.
Since the preparation of the ELI-NP white book, the project team identified the need of an application park to transform the scientific results into real-life applications. ELAP is the natural outcome of such an ambitious and unique project. The present project for an Extreme Light Applications Park was defined by the brainstorming activity of the IZEST laboratory team (Ecole Polytechnique, France) and the ELI-NP (Magurele, Romania) scientific team.
ELAP answers, on the short term, to the need of building applications on the scientific novelties discovered at the ELI-NP facility. On the long term, the creation of an innovation activity in the environment of Magurele will represent a unique advantage for the development of the ELI-NP project and of Romania in general.

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Generation of an ultrashort GeV proton bunch in an instability-free regime by a single-cycle laser pulse

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Prompted by the possibility to produce high energy, single-cycle laser pulses with tens of Petawatt (PW) power, we have investigated laser-matter interactions in the few optical cycle and ultra relativistic intensity regimes. A particularly interesting instability-free regime for ion production was revealed leading to the efficient coherent generation of short (femtosecond) monoenergetic ion bunches with a peak energy greater than GeV. Of paramount importance, the interaction is absent of the Rayleigh Taylor Instabilities and hole boring that plague techniques such as target normal sheath acceleration and radiation pressure acceleration.

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Extreme light at CoReLS and its application to single-cycle pulse generation

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Extreme light at Center for Relativistic Laser Science (CoReLS) in Korea has been developed and currently its' output power reaches 4 PW. The output energy and the pulse duration are 83 J and 19.6 fs, respectively after the pulse compression. In addition, we have carried out the pulse compression experiment with thin fused silica plates using a 30 fs, 100 TW laser pulse. After compensating the group delay dispersion (GDD) induced during the supercontinuum generation, the laser pulse was compressed to 12.3 fs. Here the development of a 4 PW Ti:sapphire laser and the pulse compression toward single-cycle generation will be presented.

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Fs-Laser driven secondary sources of x-rays and particles within ELI-Beamlines and their applications

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ELI-Beamlines will be the high-energy, repetition-rate laser pillar of the ELI (Extreme Light Infrastructure) project. It will be an international facility for both academic and applied research, slated to provide first user capability since the beginning of 2018. The main objective of the ELI-Beamlines Project is delivery of ultra-short high-energy pulses for the generation and applications of high-brightness X-ray sources and accelerated particles. The laser system will be delivering pulses with

length ranging between 15 and 150 fs and will provide high-energy Petawatt and 10-PW peak powers. For high-field physics experiments it will be able to provide focused intensities attaining 1024 Wcm-2, while this value can be increased in a later phase without the need to upgrade the building infrastructure to go to the ultra-relativistic interaction regime in which protons are accelerated to energies comparable to their rest mass energy on the length of one wavelength of the driving laser. In this talk we will concentrate on the development of short wavelength (20 eV-100 keV) short pulse high intensity laser driven sources of x-rays and particles (few MeV - 200 MeV) and their practical implementation in the ELI-beamline user facility. The short pulse x-ray sources are either based on direct interaction of the laser beam with gaseous or solid targets (High order harmonics or plasma sources) or will first accelerate electrons which then will interact with laser produced wigglers (Betatron radiation) or directly injected into undulators (laser driven LUX or later X-FEL). The direct interaction (collision) of laser accelerated electrons with the laser again will lead to short pulse high energy radiation via Compton or Thomson scattering. The main planned short pulse laser driven x-ray sources and particles their parameters will be presented, together with the date of commissioning.
We discuss new approaches for efficient proton acceleration with higher repetition rate targets based on a solid Hydrogen ribbon for possible medical applications in the energy range above 60 MeV. The ion acceleration beamline ELIMAIA and the ELIMED concepts will be highlighted for their use in different fields including medicine.

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Medical applications development using laser-driven protons generated at the high-power PEARL facility

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An experimental platform is presented, aimed at studying the impact of laser-driven high-energy protons on biological objects. The platform has been developed using the PW-class PEARL laser facility (IAP RAS Nizhny Novgorod, Russia). Pilot experiments were performed using laser-accelerated protons having up to 25 MeV energy, and we demonstrated the possibility of transferring doses up to 10 Gy to bio-objects in a single shot. Magnetic separation was used in order to expose the bio-objects solely to protons, which were free from parasitic X-ray radiation and fast electrons. During the test experiments, cells from the culture HeLa Kyoto was irradiated and the fraction of survived cells was measured. In the talk, we will discuss ways of optimizing the parameters of proton beams and suitable methods for controlling the proton energy distribution as well as transport the protons onto the bio-objects. Future plans include upgraded laser capabilities in order to address hadron therapy of malignant neoplasms.

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Intense Laser Plasma Interactions at UCI

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At the newly formed Laser Plasma Interactions group at UCI, a wide variety of unique laser capabilities is becoming available for use. The 3000 square foot lab is equipped with HEPA filtering and temperature/humidity stability to ensure robust laser operation. A 30 fs Ti:Sapphire regenerative amplifier is at the heart of the laser facility, operating at high repetition rates of 1 kHz and peak powers up to 230 GW. A power amplifier can boost the peak power to 3 TW. Modules for increased laser contrast and decreased pulse duration exist. Nonlinear and parametric amplifiers will enable wavelength tuning from 267 to 2100 nm central wavelengths maintaining short pulse durations. The flexible laser parameters provide a unique complement to laser plasma investigations at ELI.

The present and the future of ultra-fast lasers medical applications / 19

Creation of a start up

Author: Tibor JUHASZ TBC[None]

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PREPARATION FOR RADIOBIOLOGY RESEARCH AT ELI-ALPS WITH SECONDARY IONIZING RADIATION SOURCES

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Introduction: ELI-ALPS will provide laser accelerated electron and ion beams with unique, ultra-short pulses and ultra high dose rate parameters to examine the effects of different ionizing radiations on cells, zebrafish and rodent models.
Aims: Our aims are to develop the appropriate dosimetry system and to validate preclinical models for Relative Biological Effectivity (RBE) investigations, in order to prepare future radiobiological experiments focused on healthy tissue reactions. After the establishment of an accurate control and verification of the delivered radiation dose, cancer and normal cell lines, zebrafish embryos and rodents will be exposed to escalated doses of accelerator based photons, electrons, protons, carbon ions, photon-neutron mixed beam of a nuclear research reactor and laser driven very high energy electron-, and hadron beam.
Materials and methods: In our previous and ongoing investigations we used different cell lines to measure the dose-dependent cell survival by clonogenic, colorimetric assays, and by impedance-based label-free technology. We irradiated zebrafish embryos of wild type-, and different tissue-specific transgenic lines in the presence of radiation modifier agents and by different radiation qualities (photon, neutron). In addition, we set up two rodent models (rat and mouse) to investigate the acute and late consequences of focal brain irradiation.
Results: We observed higher sensitivity at earlier stages of the zebrafish embryogenesis and dose-, and radiation type-dependent organ damages macroscopically (e.g. shortening of the body length, spine curvature, microcephaly) and microscopically (marked cellular changes in skin, cardiac, gastrointestinal system) as well. Furthermore, we detected the irradiation-caused overexpression of

proinflammatory cytokines (IL-1β, IL-6, NF-κB) in this protocol. Regarding the rat model, we found evidence for acute inflammatory activation in the peripheral circulation, and significant memory deficits and histological damages after irradiation.
Conclusion: Our vertebrate models proved to be appropriate models for preclinical examinations on different radiation quality, and especially, to test possible protective agents that can theoretically increase the therapeutic index, and provides the prospect of an improved outcome of radiation, and consequently to an improved quality of life of patients who undergo radiotherapy.
The ELI-ALPS project (GOP-1.1.1-12/B-2012-000, GINOP-2.3.6-15-2015-00001) is supported by the European Union and co-financed by the European Regional Development Fund.

The present and the future of ultra-fast lasers medical applications / 32

Radioisotopes for nuclear medicine: molecular imaging, targeted therapy and theranostic

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Radioisotopes applications in nuclear medicine are in the field of both diagnosis (oncology, cardiology and neurology) and therapy (oncology). Molecular imaging probes, a special class of radiopharmaceuticals, targets specific biochemical signatures associated with disease and allow for non-invasive imaging on the molecular level. Because changes in biochemistry occur before diseases reach the advanced stage, molecular imaging probes make it possible to locate and stage disease, track the effectiveness of drug, treat disease, monitor response, and select patients to allow for more personalized diagnosis and treatment of disease. Based on the same biochemical processes, radionuclide systemic therapy is a powerful method to eradicate disseminated tumour cells and small metastases.
Thus, to improve the differential diagnosis, prognosis, planning and monitoring of cancer treatment, new functional radiopharmaceuticals based on relevant bioactive molecules and promising medical radioisotopes have to be developed and evaluated. The potential interest of a given radio-isotope in medicine depends on a number of factors: the specific decay properties of the radio-isotope to be used; physical and biological half-life (which must be long enough to reach the target but short enough to avoid unnecessary radiation exposure); elemental/chemical properties (purification, post-processing and radiolabelling of bioactive molecules); pharmaceutical formulation constrains; and the ease of production (specific activity, cost effectiveness, availability).
As one of the alternative route for production of emerging/promising radioisotopes for nuclear medicine, ELI-NP will employ (g, n) nuclear reaction to produce such radioisotopes, with relevant quantity and quality.

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High peak power lasers and their medical applications

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The field of high peak power lasers have seen considerable developments over the past years. Several lasers delivering more than 1 PetaWatt peak power at significant pulse rates have become available and there are several 10 PW lasers in construction worldwide.
In addition to the improvement of performance (higher peak power, shorter pulse duration, higher

repetition rate), there are also tremendous evolutions in the ease of use of such lasers which are more compact and more reliable.
In parallel significant research results have confirmed the emergence of new acceleration schemes for electrons, protons and ions such as laser wakefield acceleration and target normal sheath acceleration which may in turn generate medical applications like protontherapy.
High intensity lasers allow also the generation of X-rays which can be used for example in medical imagery.
We present the recent evolutions of laser technology which will generate in the near future new medical applications of high peak power lasers.