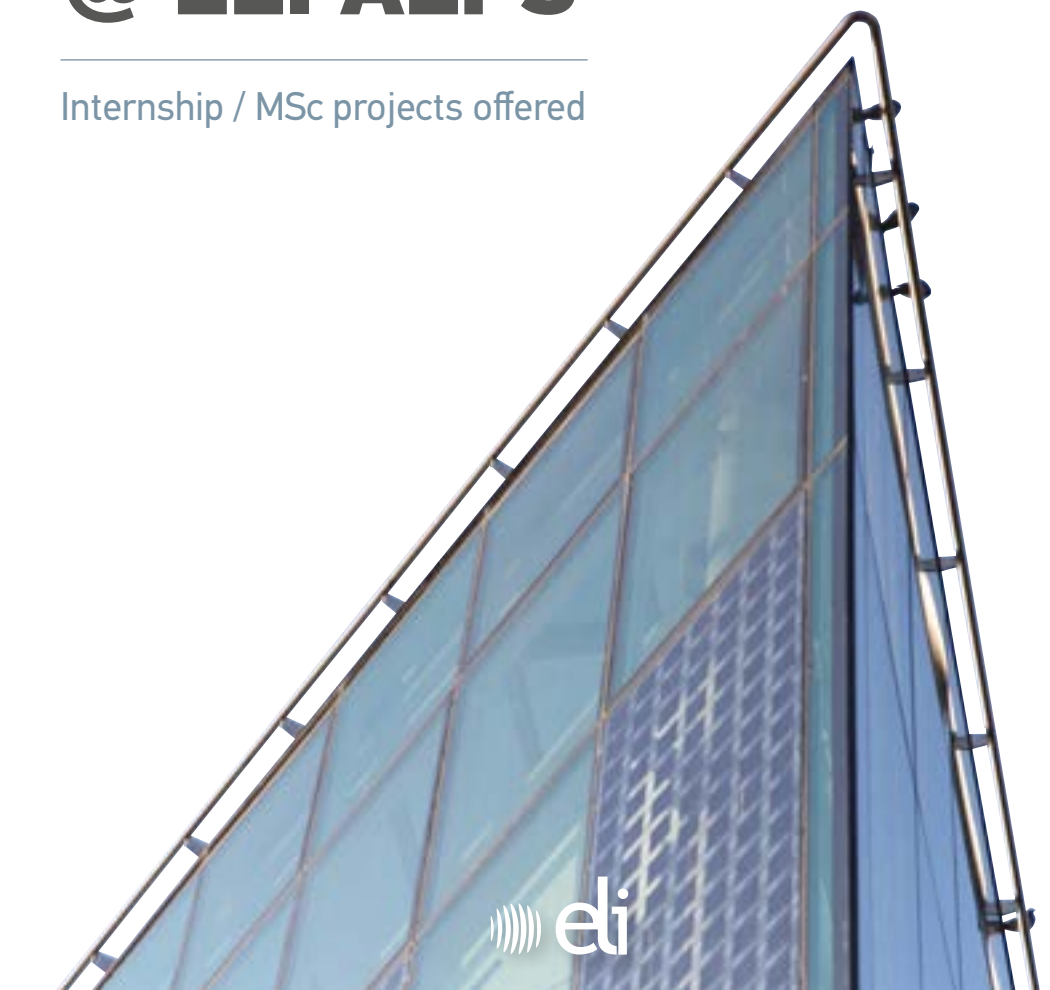
STUDENT PROGRAM @ ELI ALPS

Internship / MSc projects offered



ELI ALPS internships are aimed at university students both from Hungary and abroad. They represent a unique opportunity to turn theory into practice in an international environment where real-world problems are researched.

Students can actively participate in state-of-the-art scientific projects and test their interdisciplinary skills.

What do we offer?

- Unique opportunities to turn theory into practice at an international research institution in the field of laser technology
- Specific topic scope – possibility to work on exciting projects within a team
- Dedicated mentor
- Completion certificate
- Chance to meet fellow interns and make new friends
- Participation in the ELI Summer School
- We do not cover expenses for accommodation, travel and meals
- Duration of internship: 2 to 6 months, based on an agreement
- Don't be shy, apply!

We provide unique opportunities to work within an international research environment on state-of-the-art topics with dedicated mentors. We expect students will have the potential to be part of a publication at the end of the internship.

Please send your application containing your Resume/CV and the topic you are applying for with a brief motivation letter to the HR and Communications Department.

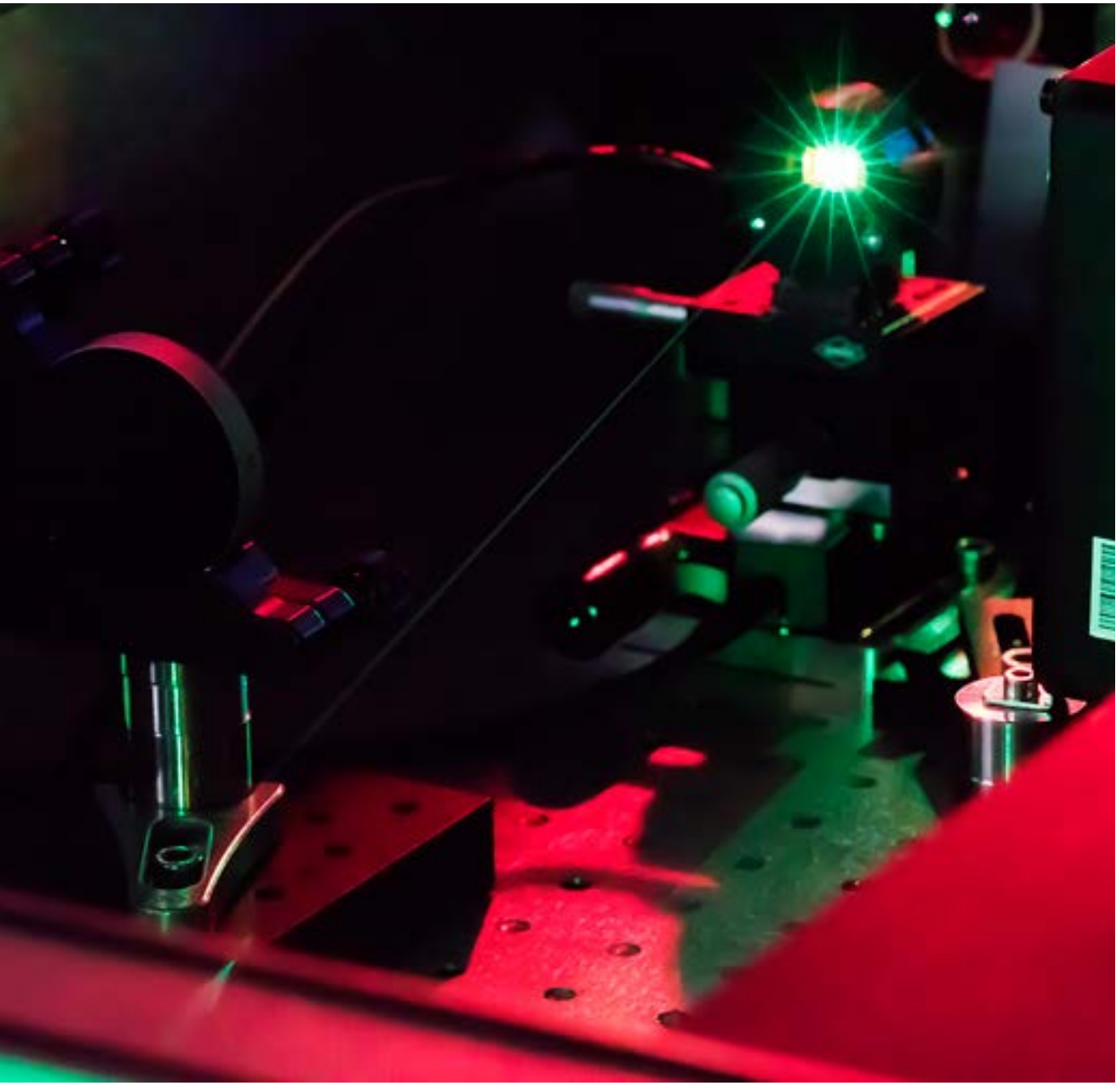
LASER SOURCES DIVISION

Sylos2 post-compression (Janos Csontos)

During this work we would like to further improve the current performance of the Sylos2 laser system of ELI ALPS. In these experiments the goal is to reduce the current pulse duration of the laser towards the single-cycle regime. To this end, we would like to use a known post-compression technique. Our aim is to involve the student in the experimental work, in building the setup, and in the optimization process. The student is expected to have experience with ultrashort laser physics and guiding of high energy laser pulses.

Sylos2 burst mode and single-shot operation upgrade (Janos Csontos)

The repetition rate of the Sylos2 laser system of ELI ALPS is 1kHz. In some of the experiments it would be useful if the laser could be operated in burst mode. For this, we would like to upgrade the system with a special controlling unit between the optomechanic components. The tasks of the candidate would include the programming of the controller, and some experimental lab work. The student is expected to have experience with the programming of PLCs, ultrashort laser physics and guiding of high energy laser pulses.



ULTRAFAST SCIENCE AND APPLICATIONS DIVISION

NanoESCA (László Óvári)

The NanoESCA end station of ELI ALPS is a complex surface science/ condensed matter instrument, equipped with various in-situ sample preparation techniques (argon ion sputtering, metal evaporation, gas dosing), and characterization methods, such as electron diffraction, and X-ray photoelectron spectroscopy. The core of the end station is the NanoESCA itself, which is a spectroscopic imaging instrument, providing energy, spin, and spatial resolution both in real and reciprocal space, to obtain detailed knowledge of the electronic structure of the studied solid sample. The aim of the work is to involve the intern in experimental work around the end station, which may include both time resolved and "static" studies. The student is expected to have some experience with ultrahigh vacuum systems. Previous surface science experience is an advantage.

In-situ transient absorption spectroscopy to study the formation of defects in colloidal particles (Viktor Chikán)

This work explores the combination of an ultrafast spectroscopic tool with traditional colloidal kinetics to investigate the formation of defects in colloidal quantum dots. Our goal is to investigate the effective integration of various dopants into colloidal quantum dots to find conditions necessary to create functional doped quantum dots.

Coulomb explosion of small molecules by FTVIS spectroscopy (Viktor Chikán)

Ultrafast lasers have the potential to apply electric fields that are comparable to the forces that hold molecules together. During a Coulomb explosion, a large number of charged molecules is produced, however the fate of neutral species produced is largely unknown. This work aims at the development of a methodology that mainly focuses on the observation of neutral species via a high-resolution spectroscopic tool, Fourier transform visible spectroscopy by detecting the chemiluminescence of the products.

Combined electrochemical/ultrafast transient absorption studies of semiconductor particles (Viktor Chikán)

The effective extraction of charge carriers from colloidal quantum dots is important to produce efficient solar cells based on colloidal quantum dots. This work uses a transient absorption spectroscopic tool combined with electrochemical measurements to investigate conditions necessary to produce optimal conditions for charge extraction.

Theory and simulation of electrons, atoms and molecules interacting with strong laser fields (Attila Czirják)

Our group works on various research projects in attosecond and strong-field physics. The student is expected to have a strong background and interest in theoretical physics, mathematics or numerical simulations. He/she will first receive a broad perspective and introduction into the research area and will then participate in one of our ongoing projects supported by a supervisor.

Nanofabrication (Judit Budai)

During the project, the student will participate in the preparation of plasmonic nanostructures using electron beam lithography or focused beam ion technique. He/she will take part in all steps of sample preparation from spin-coating to metallization. He/she will participate in the characterization of the nanostructure samples by scanning electron beam microscopy and by measuring extinction spectra.

Dosimetry of laser driven ionizing radiation sources (Katalin Hideghéty) (Róbert Polanek)

Laser wakefield acceleration (LWFA) offers a promising compact solution to produce high and very high energy electron (VHEE) beams, which have an ultrashort pulse duration with a high instantaneous dose rate and small source size. These unique properties are of radiobiological as well as clinical interest, and proper dosimetric characterization is essential for successful applications. The work includes contribution to the development and evaluation of Monte Carlo simulations (Geant4 and Fluka based) as well as contribution to the development of experimental irradiation and dosimetric setup. For this internship basic programming knowledge is a prerequisite (at least C++, Python, Fortran is an advantage). Furthermore, the work includes experimental activities with standard and non-standard dosimetric equipment. The student is also expected to contribute to the development of novel dosimetric methods.

The radiation protection of laser-driven particle sources (Róbert Polanek)

ELI ALPS Research Institute is a unique user facility dedicated to serve international research groups by offering equipment which produces very short electromagnetic pulses and laser driven relativistic particle beams. The unique characteristics of these relativistic particle beams pose exciting challenges for applications and radiation protection alike. Students interested in the safe application of ionizing radiation, in general, and especially in radiation protection can be involved in the work of the radiation protection officer as well as in the development and application of a new radiation protection monitoring system.

Studying the effects of laser-driven ionizing radiation on biological systems (Katalin Hideghéty)

Students interested in biomedical applications will be introduced to radiation biology and to work in biological laboratories through lectures and training. Thereafter they can participate in the X-ray irradiation of different cell lines with different doses and can perform a colony forming assay. The students can analyse IH-stained cells and evaluate the results on photographed images. Another group of students can work with our in vivo, vertebrate model, detecting dose dependent macro, micro and molecular lesions of irradiated embryos in the zebrafish laboratory. They can practise the microscopic survival calculation and quantitative measurement of dose dependent developmental deteriorations and morphological changes of the zebrafish embryos.

SECONDARY SOURCES DIVISION

Automated optimization of attosecond pulse parameters by few-cycle laser field shaping (Subhendu Kahaly)

Tasks: Computer simulation using Machine Learning and/or Genetic Algorithm, data visualization, virtual experiments with realistic parameters.

Requirements: Python / Windows / Linux and good English communication skills

Vectorial tight focussing of few cycle laser pulses for specialized interaction (Subhendu Kahaly)

Tasks: Computer simulation of the nonparaxial focussing of the laser pulse / Diffraction of broadband light field / 3d Data visualization / Virtual experiments with light field machining

Requirements: Python / Windows/Linux / Good English communication skills

Phase sensitive diagnosis of ultrashort laser exposed optical surfaces for damage detection (Subhendu Kahaly)

Tasks: Computer simulation with application of Machine Learning for image classification/ Usage of state of the art wave-front sensor for damage detection / Wavefront Data visualization and analysis/ Experiments and data analysis, participating in the building up of the set up.

Requirements: Python / Windows/Linux / Good English communication skills

Algorithm development for analysis of raw data from spectrally resolved imaging for laser matter interaction (Subhendu Kahaly)

Tasks: Participate in a pilot project that utilizes spectrally resolved imaging / Usage of state of the art single shot spectral-cameras / Algorithm development for 3 dimensional Data saving and Data visualization / Experimental Data analysis, participating in the building up of the pilot imaging set up.

Requirements: Python / Windows/Linux / Good English communication skills

Development of a THz pump–optical probe system (József Fülöp)

The work includes the optimization of a THz pump–white light probe setup, the development of the measurement control software, and measurements on selected samples, for example biological materials.

Simulation of strong-field high-average-power THz sources (József Fülöp)

The work includes contribution to the development of numerical simulation tools for the investigation of various effects influencing the performance of strong-field high-average-power THz sources, as well as performing simulations to optimize such sources.

Materials in disruptive THz-frequency fields (József Fülöp)

The work includes the experimental study of the response of selected materials and structures to extremely strong, MV/cm-scale THz pulses. Such strong fields can cause nonlinear responses, electron emission, molecular orientation, phase transitions, and other structural changes.

Algorithm development for the evaluation of raw data resulting from attophysics experiments (Balázs Major)

In the framework of this project the student(s) will participate in ongoing attophysics experiments at the HR GHHG beamlines and AMO end stations and contribute to them, e.g. by the development and/or upgrade of data processing algorithms and by evaluating measurement data.

Characterization of gas density from gas jets with/without cylindrical symmetry (physics, application control, data acquisition, data analysis) (Balázs Nagyillés)

In-vacuum laser position sensor (electronics engineering, building and testing; electronics, lasers, optics, data processing)

Preparation for future remote laser beam stabilization

MIR homodyne detection (electronics, lasers/thermal sources, optics, optomechanics, photonics, statistics, data analysis)

Preparation for future quantum optics experiments. Development of quantum optics know-how at ELI.

Pump-probe setup for MIR-HHG Rabbitt (MIR optics, nonlinear optics, experiment, data analysis)

Preparation of crystal HHG Rabbitt without a photoelectron spectrometer. We can use the fundamental and its second harmonic to do a cross-correlation in a mixing crystal.

SYLOS Electron and PW Electron Beamlines-Machine Learning Optimization (Nasr AM Hafz)

At ELI ALPS, the Particle Acceleration Group is responsible for the implementation and operation of two distinct laser-driven electron beam accelerators employing under-dense gaseous plasmas as the acceleration media. These accelerators are based on a mechanism known as “laser wakefield acceleration”, which was proposed in 1979. This process is complicated and multi-parametric and, therefore, requires efficient way(s) to achieve the desired accelerator performance. The parameters include: laser pulse energy, pulse duration, laser axis direction, plasma parameters such as the electron density profile and plasma length. Recently, there has been a growing interest in employing machine learning (AI) techniques, particularly, Bayesian Optimization of the mentioned laser and plasma parameters. The goal of optimization is to reach the best performances of the two accelerators especially with the laser operation at high repetition rates which is unique to ELI ALPS lasers. The best quality electron beam is defined as one that has a minimal divergence angle, is monochromatic/monoenergetic, has maximal current (i.e. charge/pulse duration), which is the goal of applying the machine learning optimization. SYLOS Electron and PW Electron beamlines accelerate electrons to energies in the range of 10 MeV-100 MeV and 1 GeV -2 GeV, respectively.

Biological effects of THz radiation (József Fülöp) (Katalin Hideghéty)

Our Biomedical Application Group performs research to detect biological processes induced by high intensity THz radiation in *in vitro* and *in vivo* systems. We study the regeneration enhancement in the zebrafish embryo model and reveal the molecular background to improved wound healing on human keratinocyte fibroblast cells and on fish tissues using different omics. The students should have interest in radiobiology and should have basic skills in biological laboratory work. The students will receive theoretical material to read and prepare themselves, and they can join our cell culture experiments (survival analysis, colony forming assays) and the evaluation of the THz effects on zebrafish embryos.

SOFTWARE ENGINEERING

Application deployment and lifecycle management in Kubernetes clusters (Lajos Schrettner)

The goal is to develop, test, apply and document automated methods related to application deployment and lifecycle management in Kubernetes clusters. Areas of interest include configuration management tools, rollback methods, application health status analysis, real time cluster monitoring, graphical and command line interfaces for automation, webhook integration, access token management, audit trails management.

Real time monitoring and alert management in control systems (Lajos Schrettner)

The goal is to survey, develop and apply real time monitoring and alerting solutions in a control system context. Focus areas are: data ingestion from heterogenous data sources, alert rules formulation, maintenance, efficiency measurement, management interfaces both for administrators and for end users.

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