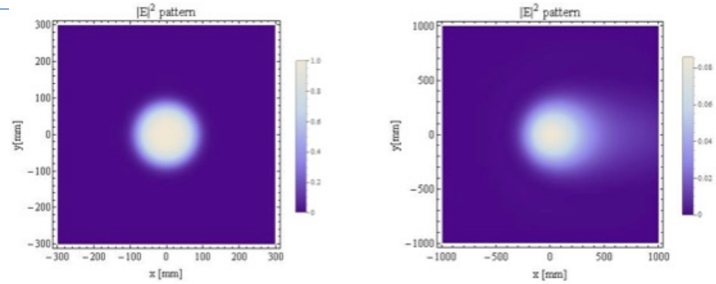
Towards Simulating Laser Beams with Spatio-Temporal Couplings

A. M. Talposi*[1,2], D. Ursescu[1,2]

1. Extreme Light Infrastructure – Nuclear Physics (ELI-NP) Magurele, Romania
2. University of Bucharest, Physics Department, Bucharest, Romania

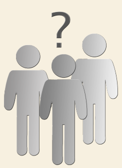
Laser-matter interaction experiments require to focus the full beam energy in a smooth spatial and temporal region. Spatio-temporal couplings (STC) can decrease the peak intensity on target and they cannot be detected and/or corrected with the usual measurement devices. In this work, several effects of STCs have been simulated by introducing a Gaussian decomposition propagation method: the initial laser field is considered as a superposition wavelets of Gaussian shape in space and time.

for pulses with spatial chirp   mm/ THz on the x-axis. Left: . Right: .



Strategies for Target Debris Characterization and Mitigation

S. Pietzsch, G. Schaumann, M. Roth
Institut für Kernphysik, Technische Universität Darmstadt, Germany



What is Debris?

- Induced by laser-target interaction
- Target fragments: Shrapnel, gas …

What are the Problems?

- Damaged optics and diagnostics
- Contamination

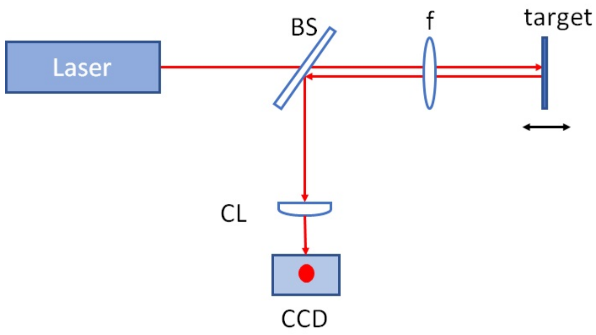
Strategies

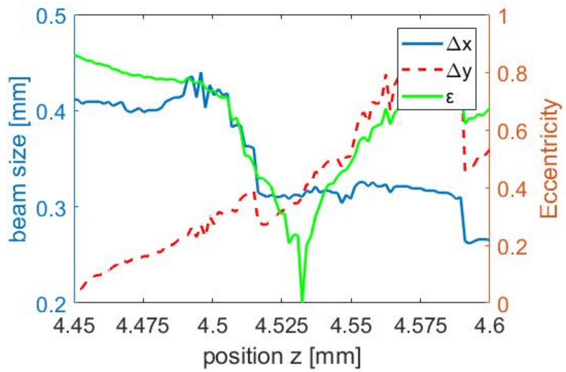
Characterization – use high-speed camera and witness plates
Mitigation - specific target design, shields and debris deflection

Design and development of an astigmatic auto-focus system based on a Si-CMOS image sensor for femtosecond laser pulses

J. Delgado, M. Rosete, C.J. Román, C. Ruiz*, J. Garduño
Instituto de Ciencias Aplicadas y Tecnología,UNAM, Mexico
*Universidad de Salamanca, Salamanca, Spain

We implemented a Si-CMOS image sensor on an astigmatic confocal setup for an auto-focus system. The wide range of the spectral response from the Si-CMOS (400-1100 nm) makes it a good option for auto-focus for several lasers in specific for femtosecond laser pulses.

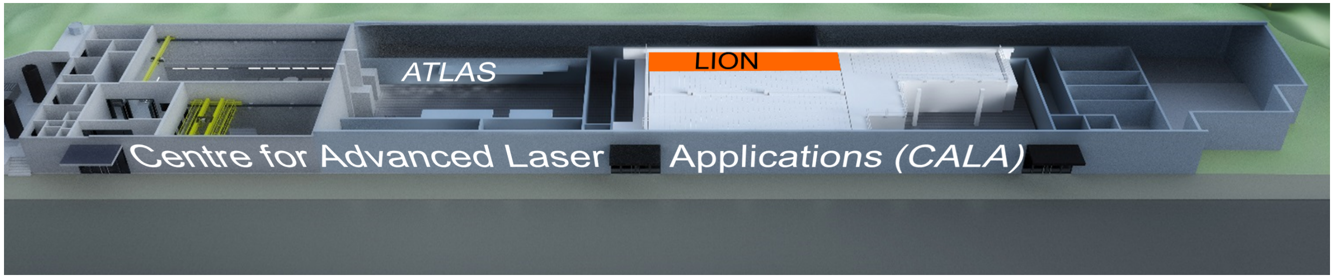




Laser ION Acceleration at the Centre for Advanced Laser Applications (CALA)

Luisa Tischendorf
Ludwig-Maximilians-Universität München

The experimental station "laser-driven Ion (LION) Acceleration" at CALA serves research on this novel particle accelerator technology. The major goal is to establish a reliable platform that can serve biomedical and radiobiological studies in cells and tumor models.



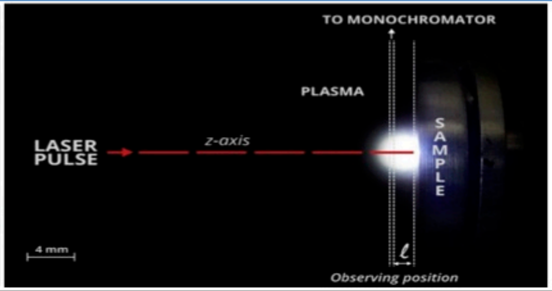
Feasibility of LIBS based on TEA CO_2 laser for atomic and molecular analysis of solid materials

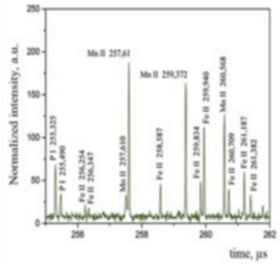
Jelena Petrovich

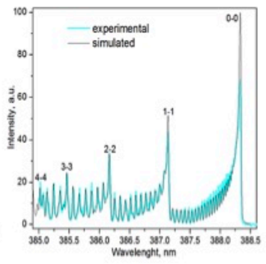
Institute of Nuclear Sciences Vinca, University of Belgrade, Serbia

Laser Induced Breakdown Spectroscopy (LIBS) has been well recognized as a modern, fast and direct analytical tool. LIBS utilizes powerful laser beams in order to create localized plasma on the sample surface. Resulting optical emission from laser induced plasma can be detected and used for both quantitative and qualitative determination of elemental sample composition.

In our work we used a unique LIBS setup based on Transversely Excited Atmospheric (TEA) CO_2 laser that has been successfully applied for different types of samples.







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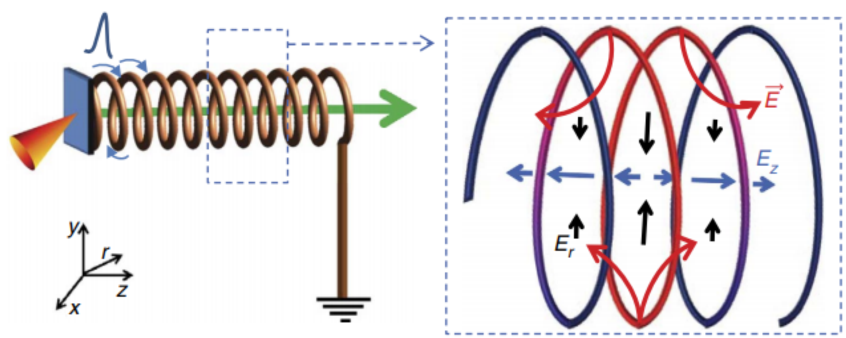
16-20 September 2019, Salamanca (Spain)

Controlling Angular and Spectral Properties of Laser Accelerated Proton Beams

Orla McCusker – Queen's University, Belfast

When an intense laser pulse (~10^{18}W cm^{-2}) interacts with a thin (μm) flat foil target, protons are emitted from the target's surfaces, with energies reaching the multi-MeV range. These protons possess unique properties such as ultra-short duration, high brilliance and low emittance. However, despite these promising observations, laser-accelerated protons have their downfalls; they have a naturally large divergence and a broad energy spectrum. This poster will discuss the use of a miniature linear accelerating module, which can simultaneously tackle both these problems. Through thorough studies of laser-target interactions, it is observed that EM pulses are generated. A helical coil is attached to the rear target surface, to direct these EM pulses in a helical path around the laser-accelerated protons (generating electric fields). It is observed that these electric fields act to successfully focus and accelerate the proton beams.

S. Kar et al. (2016, Nature)
https://www.nature.com/articles/ncomms10792



Study of EUV laser ablation for fusion applications

Eduardo Solis Meza

University of York

Fusion reactions combine lighter atoms, such as hydrogen, together to form larger ones and release significant amounts of energy. Fusion energy aims to use such reactions for the production of renewable energy. Inertial Confinement Fusion is one of the approaches to achieve fusion energy and this project sits in this area. The main concept is to achieve fusion by heating and compressing a fuel target using high-power lasers. Laser ablation, i.e. a high-power laser interacts with a target, turning it into a plasma, is one of the key processes in Inertial Confinement Fusion.

This project aims to study the fundamental physics behind laser ablation of solid materials, in particular focusing on the differences as a function of wavelength, from IR to EUV. It will involve both experimental as well as computational modelling investigations. Plasma diagnostics such as optical emission spectroscopy, time-resolved imaging, shadow-graphy and interferometry will be used the study the properties of the ablation process.

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Levine-Louie's dielectric function to describe the gain of thermal energy in a nuclear fusion fuel

Manuela María Alberola Herrero, Manuel D. Barriga Carrasco, José Vázquez

E.T.S.I. INDUSTRIALES, UCLM, E-13071 CIUDAD REAL, SPAIN

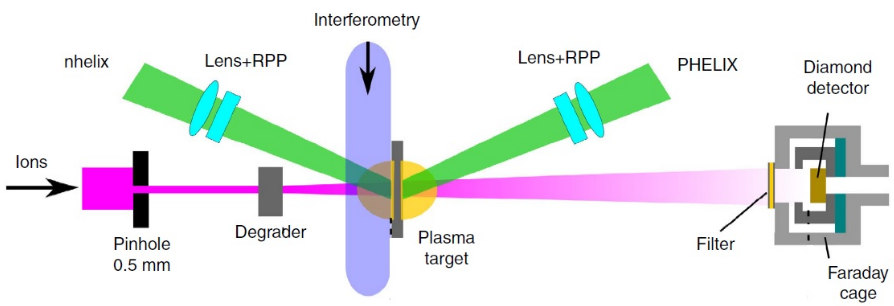
LEVINE-LOUIE'S DIELECTRIC FUNCTION

Stopping Power

Thermal energy

Energy extraction

Electrical Energy



Transition to different proton acceleration regimes by optical control and plasma tailoring

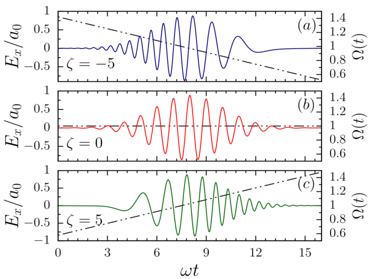
Shivani Choudhary and Subhendu Kahaly*
ELI-APLS, ELI-HU, Non-Profit Ltd., Dugonics ter 13, Szeged 6720, Hungary

Laser driven protons from thin foil targets can have different spectral features depending on the associated acceleration mechanisms.

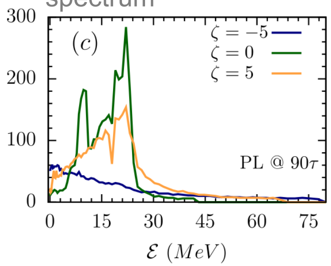
Here, we investigate the influence of laser pulse chirp and foil plasma density gradient on proton acceleration.

We observe that different mechanisms can be selectively accessed, allowing a control over the resultant energy spectra.

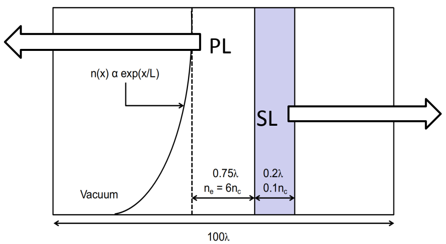
Frequency chirped laser pulse



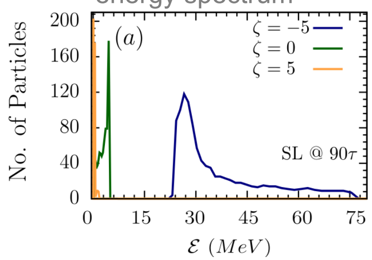
Primary layer proton energy spectrum



Plasma Target configuration



Secondary layer proton energy spectrum



Graphite Calorimetry for Dosimetry of Laser-Driven Ions

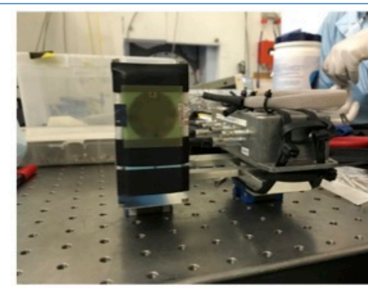
[1,2]Sean McCallum

[1]Centre for Plasma Physics, Queen's University Belfast, BT7 1NN

[2]Medical Radiation Science, National Physical Laboratory, Teddington, TW11 0LW

Laser-driven particle acceleration based on the use of intense, ultra-short laser pulses is emerging as a novel technique for the compact generation and delivery of beams of energetic ions, particularly in the interest of a potential future driver for particle therapy of cancer. Precise quantification of the dose delivered to a given volume is a necessary requirement to ensure optimal treatment outcomes.

Therefore, associated dosimetric techniques must be implemented to diagnose the properties of such energetic beams before offering the possibility for use within hadron therapy treatments and clinical practice. Absolute dosimetry of laser-driven ion beams using the NPL small portable graphite calorimeter is presented, with a first proof of principle experiment demonstrating measurement of the absorbed dose of ionizing radiation through calorimetry.



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Laser driven ion acceleration of heavy ion species towards a fission-fusion reaction mechanism

E.G. Fitzpatrick, F.H. Lindner, P.G. Thirolf

Ludwig-Maximilians Universität, Center for Advanced Laser Applications (CALA)

Providing a realistic opportunity to generate neutron-rich isotopes close to the magic neutron number N = 126 in the rapid neutron capture astrophysical nucleosynthesis process (r-process), the fission-fusion reaction mechanism [1] is one of the forefront experiments able to exploit unique features of CALA's potential in the laser-driven nuclear physics domain. Major prerequisite for the realization of this reaction mechanism is the availability of heavy ion bunches at energies right above their fission barriers (≈ 7 MeV/u for 232Th) with densities orders of magnitude higher than achievable with conventional acceleration schemes. The still-to-be-shown laser-driven acceleration of heavy ions in the radiation pressure acceleration (RPA) regime could pave the way for achieving such high-density ion bunches around the required energy.

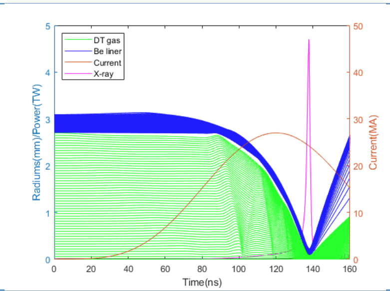
[1] D. Habs et al., "Introducing the fission–fusion reaction process: using a laser-accelerated Th beam to produce neutron-rich nuclei towards the N=126 waiting point of the r-process, " Applied Physics B 103(2), 471–484 (2011).

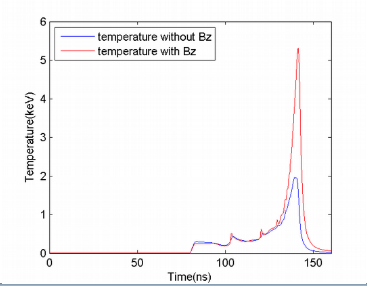
Simulation of MagLIF with Nernst Effect

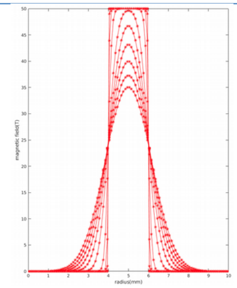
Shijia Chen, Fuyuan Wu, Rafael Ramis

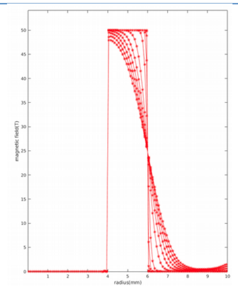
E.T.S.I. Aeronáuticos y del Espacio, Universidad Politécnica de Madrid, España

Magnetized linear inertial fusion (MagLIF) [1] has become an attractive path for Z-pinch driven fusion owing to the introduce of fuel magnetization and laser preheat, which significantly lower the radial convergence for ignition. In previous, the overall implosion dynamics of MagLIF [2] has been studied using the one-dimensional radiation magneto-hydrodynamic code MULTIIFE [3,4]. Recently, the MHD modeling and further simulation of MagLIF with Nernst effect have been finished, where the evolution of magnetic field and energy equation are self-consistent modeling according to the theory of Braginskii [5]. From Ohm's law, the interplay between the magnetic field and electron energy is significant. On the one hand, the electron heat flux will transport the magnetic field from the fuel center to the edge, decreasing the desired fuel magnetization. On the other hand, the exist of magnetic field will modify the electron heat flux, apart from the Joule heating. We present the derivation and a full implicit solving method for the MHD model of MagLIF, as well as some basic tests and integrated calculations.









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Numerical investigations about the self-generated magnetic field in the plasma produced by laser

Fuyuan Wu

E.T.S.I. Aeronáuticos y del Espacio, Universidad Politécnica de Madrid, España

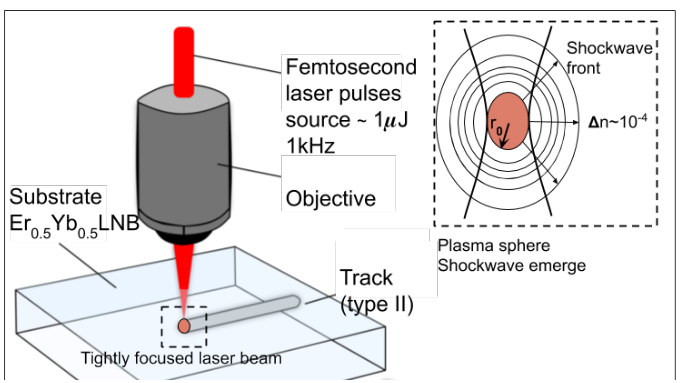
According to the generalized Ohm's law, self-generated magnetic fields will be spontaneously generated, when the temperature gradient and the density gradient in the plasma are not parallel. For example, in a planar target irradiated by a laser, toroidal magnetic fields will be generated due to the Non-parallel temperature gradients and density gradients. In this report, we will present a new algorithm for introducing the self-generated magnetic field into the MHD package of code MULTI-2D. The self-generated magnetic field around a planar target and laser hohlraum will be analyzed.

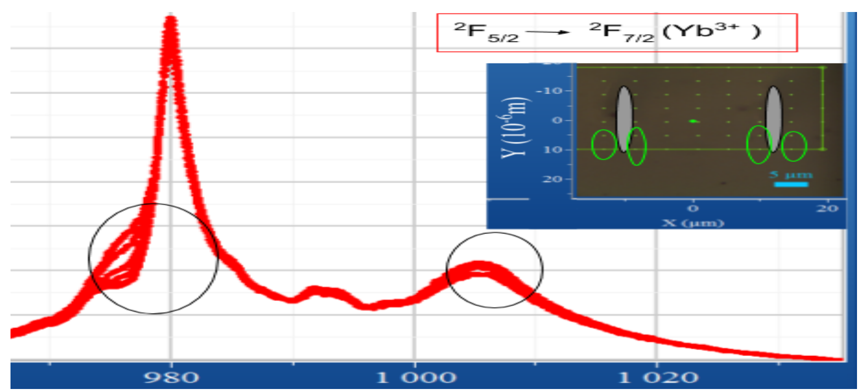
It is well known from the generalized Ohm's law that a self-generated magnetic field is spontaneously generated, when the temperature gradient and the density gradient in the plasma are not parallel. For example, in a planar target irradiated by a laser, a toroidal magnetic field will be generated due to the Non-parallel temperature gradients and density gradients produce. In this report, we present a new algorithm for introducing the self-generated magnetic field into the MHD package of code MULTI-2D. The self-generated magnetic field around a planar target and laser driven hohlraum will be analyzed.

Optical materials modified by plasma-induced shock waves generated using bulk-focused femtosecond laser pulses

D.A.Biasetti[1,2,3], G.A Torchia[1,2,4]
[1]Centro de Investigaciones Ópticas de La Plata (CIOp), [2]CONICET,
[3]National University of La Plata; [4]National University of Quilmes

In this work we present a new experimental analysis of shock-waves in polarized laser written optical waveguides. Double-track type II optical waveguides were fabricated in Er/Yb Lithium Niobate crystalline samples using Ultrafast Laser Inscription. The plasma induced in the focal volume of focused femtosecond laser pulses through highly nonlinear processes, generate an anisotropic shockwave which is damped due to the acoustic impedance some micrometers from the filament. Along its propagation, the shock front wave compresses the material leading to a soft variation of the local refractive index. From micro-Luminescence spectroscopy scanning new hints about microstructural modification can be suggested. The crystalline field of rare Er/Yb ions are weakly modified by the compression so that the spatial extent of the shockwave are manifested through spectroscopic shifts or broadening of particular emission bands. This sensitive variation can be taken as spatial traces of shockwave propagation from the plasma sphere and it was shown that depends on the laser polarization.





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