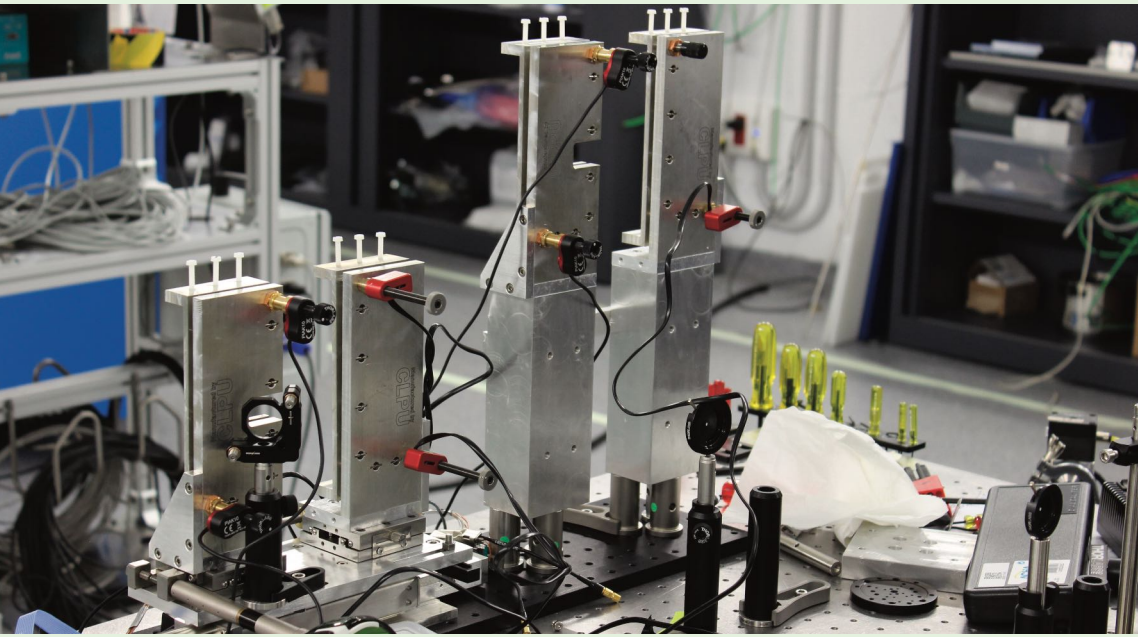
CLPU

CENTRO DE LÁSERES PULSADOS

Activities Report

2022



GOBIERNO DE ESPAÑA · MINISTERIO DE CIENCIA E INNOVACIÓN

Junta de Castilla y León

VNiVERSiDAD D SALAMANCA

CAMPUS DE EXCELENCIA INTERNACIONAL

UNIÓN EUROPEA

Una manera de hacer Europa

"Fondo Europeo de Desarrollo Regional"

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CLPU: Javier Sastre
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Salamanca, 2023

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MESSAGE FROM THE DIRECTOR

Dear readers,

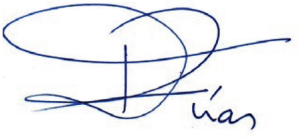
It is my pleasure to address you for the first time as director of this consortium to share the goals accomplished last year, not only as a user center but also as a research center. Heading the infrastructure is a professional achievement that I am increasingly proud of as I become familiar with the everyday tasks of the human team that makes it up. While it might be true that the center's uniqueness lies in its exceptional cutting-edge technology equipment, the VEGA petawatt laser system, it would be of little use without the high degree of specialization of the professionals who work on and with it. I would like these to be the keys you consider when reading all the details gathered in this Activities Report: the impressive ultra-intense laser equipment that has allowed Spain to become a player on the global laser technology stage; and the human team behind its operation and service to the international community.

The CLPU's facilities are a fundamental pillar in carrying out our projects and those of our users, achieving high-quality results. This is why we keep working on updating them, as shown by the actions conducted under the framework of the FEDER national project 'Reorganization of the lines of the laser system VEGA for Pump & Probe experiments' by the Ministry and Science and Innovation; or, also by the same Ministry, the launching of the project for building and equipping a new experimental area alongside the current one. The value of our laser lies in it being a versatile, ultra-intense, high-repetition-rate system, which ranks it among the three most powerful in the world. The statistics it provides its users with allow a new step to be taken in research in this specialized field and the opening of new challenges that the Center's scientists face in collaboration with other institutions in support of development. Indeed, as well as being a

user center, the consortium is also a research center with its own strategic lines of action. The new project, TULIPAN, by the Regional Government of Castile and León, focused on the analysis of solid and gaseous targets for use in high-repetition-rate systems, is one such example; or the one granted in late December under a call issued by the Nuclear Safety Council, focused on the study and optimization of CMOS technology for dosimetry.

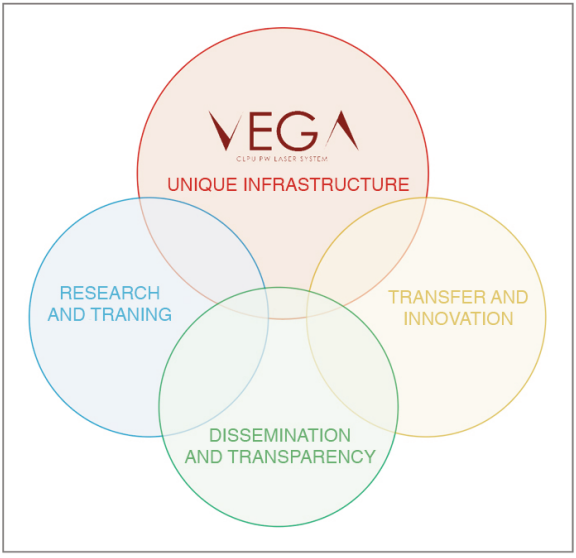
At the same, we continue our commitment to reinforcing the CLPU's presence at the global level through new European projects such as EuPRAXIA and Remade@ARI, under the Horizon Europe call, which add to the H2020 RADNEXT and IMPULSE/ELI; collaboration agreements, participation in international committees, or in the Laserlab Europe association that coordinates the European laser centers.

This year we faced several challenges, decisively overcame several hurdles, and devoted our efforts to seeking national and international cooperation so that the Center for Pulsed Lasers may continue to be a worldwide reference. We have an exceptional team of researchers, technicians, engineers, administration staff, and collaborators. Their devotion and skill have been crucial to the success of all the activities that are addressed in this Activities Report. Their passion for science and their commitment to excellence have been the driving force behind each accomplishment. New challenges and opportunities emerge every year, shaping the near future. Our goal is to continue to promote pioneering research using cutting-edge technology to generate knowledge that may contribute to social progress. Interdisciplinary collaboration, innovation in research, strategic alliances, and participation in projects of international relevance will continue to set our pace. Together and always moving in pursuance of a more prosperous and sustainable world. Let's keep going!



1. INTRODUCTION

The Center for Pulsed Lasers is a public consortium that was conceived in 2007 by the Ministry of Science and Innovation, the Regional Government of Castile and Leon, and the University of Salamanca. Since 2016, it has been attached to the Spanish General State Administration. The three mentioned institutions joined forces to create a new unique scientific and technical infrastructure (ICTS) that would from then on become part of the Spanish ICTS Map as a single-location facility, located in the Science Park of the University of Salamanca and specialized in ultra-intense lasers. Its uniqueness relies on the petawatt class laser system, VEGA. A system that includes three different synchronized outputs with different powers (20 TW, 200 TW, and 1 PW) with ultra-fast complementary sources such as the CEP laser system, whose ultra-short 6-femtosecond pulses allow an extraordinarily ac-



curate time estimate, as well as a set of primary and secondary beam detectors, and another series of complementary laboratories such as the one for micromaterial processing (ULAMP), the SEM microscopy service, or the mechatronics workshop. The Center's activity is divided into four strategic and cross-cutting Functional Units to achieve enhanced smoothness in our actions, development, and service to users.

Although the first open access competition call was launched in 2017 (focused on VEGA-2), the infrastructure did not become fully operational (with the activation of the petawatt output) until the end of 2018, when it was inaugurated by Their Majesties the King and Queen.

During 2022, the CLPU achieved full normalization of its activities after the pandemic. In this regard, the 5 experiments belonging to the third open access competition call took place as expected. Besides, it was possible to schedule our strategic experimental activities, which were either linked to service optimization or developed as part of national and European projects in which the CLPU is involved.
This year has also been characterized by an important change in the Consortium's management, which took place in late September. Its founding director and science promoter, Luis Roso, left office after 14 professional years devoted to the unique infrastructure. Thus, on 1 October, the function of new director was officially assumed by María Dolores Rodríguez Frías, Chair of Atomic, Molecular and Nuclear Physics at the University of Alcalá (Madrid).

2. VEGA UNIQUE INFRASTRUCTURE

The CLPU is a user facility where the laser beam is placed at the service of the international scientific and industrial community for the development of different experimental campaigns in pursuance of scientific-technical progress, innovation, and growth. Hence, open access competition calls are launched so that research groups can submit their requests for beam time, and an external panel made up of leading experts in the area assesses the applications, selecting those that best meet scientific quality, potential impact of the research goal, and talent attraction criteria.

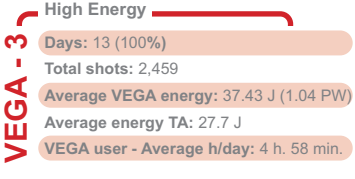
a) Experimental Campaigns

As part of the third open access competition call, in 2022, five out of the seven experimental campaigns selected by the Access Committee were scheduled. These campaigns accounted for almost 40% of the time the laser system was in operation throughout the year, reaching an approximate total of 15,800 shots, without the need to cancel any session because of system malfunction.

High Harmonic Hot Spot

Led by Robert Fedosejevs, a researcher of the University of Alberta (Canada), the main goal of this experiment was to generate a photon hot spot in the extreme ultraviolet radiation (XUV) spectrum through the interaction of VEGA-3 out of focus on a gas jet of special dimensions. The goal was to increase the interaction area. The results obtained are still under analysis.

The campaign, which was co-funded by the Laserlab-Europe European consortium as part of its a Transnational Access program, ran from 7 to 23 February, with an average use of VEGA-3 in the experimental area of almost 5 hours a day, reaching an average energy in the area of 27.7 J.



Direct comparison of non-linear, relativistic Thomson scattering radiation, ejected electrons & parent ion charge state

The second open access competition experimental campaign that was carried out in 2022 was also co-funded by Laserlab-Europe. From 21 March to 4 April, the principal investigator, Wendell T. Hill III, from the University of Maryland (USA) led this experiment with VEGA-3, as a continuation of previous campaigns. The main goal was to measure the intensity of light at values of 10^{18} W/cm^2. Current techniques measure intensity at low values and indirectly. This line of research proposes direct measurement based on relativistic Thomson scattering. The average use of VEGA-3 in the experimentation area was 4 hours and 22 minutes a day, yielding an average energy of 27.48 joules.

VEGA - 3 — High Energy

- **Days:** 11 (110%)
- **Total shots:** 7,130
- **Average VEGA energy:** 37.14 J (1.03 PW)
- **Average energy TA:** 27.48 J
- **VEGA user - Average h/day:** 4 h. 22 min.

Plasma Undulators based on laser-plasma interactions: towards an ion channel free-electron laser

The third experiment using VEGA-3 ran from 3 to 23 May and was led by the researcher from the University of Strathclyde (UK), Dino Jaroszynski, with an average daily use of the system in the experimentation area of 3 hours and 51 minutes. The goal was to optimize the electron-generation process via laser-plasma interaction using Laser Wakefield Acceleration (LWFA). For this purpose, a double-pulse laser was successfully implemented by the CLPU's specialized technologists who operate with VEGA.

VEGA - 3 — High Energy

- **Days:** 15 (100%)
- **Total shots:** 1,735
- **Average VEGA energy:** 36.52 J (0.99 PW)
- **Average energy TA:** 27.03 J
- **VEGA user - Average h/day:** 3 h. 51 min.

The system was used at high energies throughout all the sessions of the campaign, reaching an average energy of 27.03 joules in the experimental area. This experiment was also co-funded by the Laserlab-Europe European consortium.

Laser-driven neutrons for nuclear physics experiments and applications at CLPU

VEGA - 3
High Energy
Days: 15 (100%)
Total shots: 3,924
Average VEGA energy: 36.66 J (1.05 PW)
Average energy TA: 27.13 J
VEGA user - Average h/day: 3 h. 07 min.

In this fourth campaign, the Spanish researcher Carlos Guerrero, from the National Center of Accelerators (CAN) Unique Scientific and Technical Infrastructure (ICTS), led a large team of scientists from almost a dozen Spanish and European universities for this experiment. The VEGA-3 system was used at high energy during each of the sessions. The campaign has been of vital importance for the Center and the scientific community since it is the first time that laser-driven neutron generation has been accomplished in Spain. The research objective was neutron generation and the study of the response of a variety of neutron detectors, both traditional and new generation ones. A new type of rotary target in synchrony with the laser beam was also successfully tested to maximize VEGA's repetition rate. The average use of the system in the experimentation area was 3 hours and 7 minutes, reaching an average energy of 27.13 joules.

For further information, we suggest that you watch our interview with him upon completion of the experiment, which was uploaded to our YouTube channel (https://youtu.be/s_hQZAbU8Ks)

Laser. initiated 11B (p,alpha)2alpha fusion reactions in energetic, intense and high-rate laser facilities

The fifth experiment, co-funded by the Laserlab-Europe European consortium, was led by the Italian researcher Fabrizio Consoli, from ENEA, with the objective of inducing the proton-boron reaction through protons generated by Target Normal Sheath Acceleration (TNSA), which involved focusing the VEGA-3 laser on a micrometer thick solid target. The results obtained are under analysis.

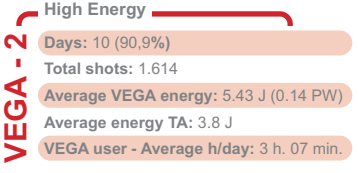
It was a highly collaborative experiment, with more than 25 researchers at the CLPU from almost a dozen European and American facilities. VEGA-3 was used at high-energy in 100% of the sessions, reaching an

VEGA - 3
High Energy
Days: 11 (110%)
Total shots: 633
Average VEGA energy: 36.92 J (1.05 PW)
Average energy TA: 27.32 J
VEGA user - Average h/day: 5 h. 18 min.

average of 27.32 in the experimental area and an average daily use of 5 hours and 18 minutes.

Besides these campaigns led by external users, there are a series of experiments carried out by scientists and technologists from the Center as part of the infrastructure's own research, which pursues research projects granted in national, European and autonomous-community level competitive calls. These campaigns provide the staff with increased know-how while optimizing the systems for a more versatile and higher quality service.

Electron source development and advanced user station



The year 2022 started with a first experiment led by the CLPU for the analysis and operationalization of a high-energy electron source installed in VEGA-2. In this context, the emission mechanisms via Wakefield laser and high-energy electrons were studied. Specifically, the focus was placed on the interaction between electrons and crystal structures, measuring parametric X-ray radiation using an angle of 90 degrees to the direction of propagation in constructive interference, in the direction where the virtual photon waves' vector and the crystal lattice's vector converge. The results were reported in the open access article Observation of tunable parametric x-ray radiation emitted by laser-plasma electron beams interacting with crystalline structures, published in the Physics Review Accelerators and Beams journal, in June 2022.

The average energy reached in the experimental area during the ten days of the campaign was 3.8 joules, with a total of more than 1,600 shots.

Development and characterization of a quasi-monoenergetic short time duration compact proton source for probing high energy density states of matter

This campaign, led by the CLPU scientist Jon Apiñaniz, ran from 7 to 11 March and was aimed at assessing and testing an optimized version of the proton-energy selection platform for probing warm dense

VEGA - 2
High Energy
Days: 4 (80%)
Total shots: 371
Average VEGA energy: 6.09 J (0.16 PW)
Average energy TA: 4.26 J
VEGA user - Average h/day: 2 h. 37 min.

matter states using protons. The results are under analysis. For this experiment, the VEGA-2 system's 200-terawatt output was used for 4 days at high energy, with a total of 371 shots.

Protons characterization, transport and applications, towards experimental stations

VEGA - 3
High Energy
Days: 28 (71%)
Total shots: 805
Average VEGA energy: 35.33 J (0.99 PW)
Average energy TA: 26.14 J
VEGA user - Average h/day: 1 h. 31 min.

This experimental campaign was developed as part of the project promoted by the Regional Government of Castile and Leon 'Transport and handling of particles in laser-accelerators: new scenarios in FLASH radiotherapy'. It was led by Giancarlo Gatti, head of the Scientific Area of the CLPU and ran from 24 May to 1 July. This experimental stage of the project was successfully completed with the implementation of a proton transportation beam based on the use of a quadrupole triplet whose main task was to focus and collect the ultra-fast proton energy pulses. This is a relevant preliminary result for the Flash radiotherapy field of research and analysis. In addition to this, a new diagnostic tool was successfully assessed: a multi-pinhole Thomson parabola for measuring the transverse space of the different types of ions.

Measurement of betatron radiation for EuPRAXIA

VEGA - 2
High Energy
Days: 4 (80%)
Total shots: 1,072
Average VEGA energy: 6.13 J (0.99 PW)
Average energy TA: 4.29 J
VEGA user - Average h/day: 3 h. 00 min.

This experiment was carried out in early June, led by the CLPU researcher Alessandro Curcio, as one of the objectives set by the EuPRAXIA European project, which the Center for Pulsed Lasers participates in. The goal was to carry out the diagnosis of accelerated electron beams (using the LWFA technique) by measuring both incoherent (X-rays) and coherent (infrared and THz) betatron radiation. In the case of X-rays, a mask that allows the measurement of the spectral part as an angle was also used.

Commissioning Experiment of the high-pressure system at CLPU

VEGA - 3
High Energy
Days: 8 (80%)
Total shots: 90
Average VEGA energy: 36.2 J (1.03 PW)
Average energy TA: 26.78 J
VEGA user - Average h/day: 1 h. 14 min.

High-density gaseous targets are an interesting alternative to standard solid targets because they are continuous and allow the laser beam to work at high repetition rates. Besides, they are inherently residue-free and can be optically tested under certain conditions. These advantages are development values in the field of laser-driven ion and proton acceleration. As part of the ministry's national project for the Generation of Knowledge 2021, 'High-repetition rate targets in ultra-intense laser interactions. Production of particles and applications (TULIPÁN)', this campaign was carried out in late July. Led by the CLPU scientist José Luis Henares, the aim was to implement and test a new high-pressure gas system in the VEGA-3 experimentation chamber. The average power delivered by VEGA in this campaign was 1.04 petawatts, reaching an energy of 26.17 joules in the experimental area.

Online high-power measurement and characterization of the pulse profile of the PW line in TA of CLPU

VEGA - 3
High Energy
Days: 4 (80%)
Total shots: 10
Average VEGA energy: 35.37 J (1.04 PW)
Average energy TA: 26.17 J

The ultimate goal of this campaign was to design an online diagnosis for pulse-characterization, operating at peak power. This was done by testing and optimizing the metrology line of VEGA-3 (petawatt output) in the experimental area at peak power and high-repetition rate (1Hz), carrying out an online measurement of pulse duration using different devices: autocorrelator, Wizzler and d-scan. This campaign took place in the beginning of August and relied on the participation of two trainee students from the University of Salamanca, under the supervision of the principal investigator of the experiment, the CLPU scientist José Antonio Pérez. The students completed their experimental training in high-intensity laser metrology techniques. This experiment is a first phase that is to be continued until the line is fully developed.

Debris material characterization during laser particle generation using solid targets

The main aim of the campaign, led by the Head of the Center's Technical Area, Cruz Méndez, and carried out in mid-September, was to measure the debris resulting from the interaction between intense lasers and thick solid targets, where the volume of particles generated during ablation and the risk of exposure to them was higher. The conclusion reached at this point was that the number of suspended nanometric particles around the experimentation chamber was very small, near the back of the laboratory. This led to the suggestion of a change in the chamber's opening protocol. The week of irradiation that the experiment involved was also used so that he Radioprotection Unit of the Center could irradiate the reference dosimeters to measure the occupational doses that workers in the vicinity of the accelerator would receive with energy values close to the safety value established for the facilities. The results show that there is no need to classify the staff as 'occupationally exposed workers'. Nevertheless, inconsistencies were observed between the measures of the ionization chambers and the TLDs. Finally, it should be noted that the campaign was also used to carry out a measurement using silicon wafers of the nanoparticles expelled in different directions by the irradiated solid. These measurements are being studied and gathered for a future publication.

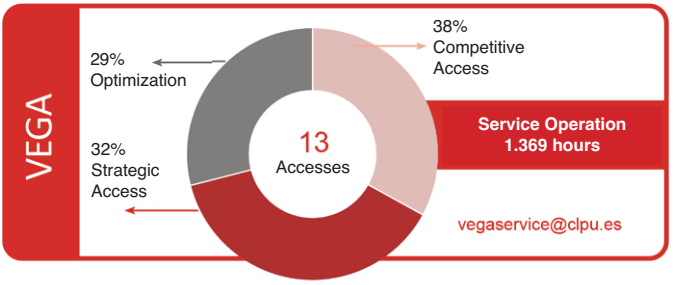
VEGA - 3
High Energy
Days: 4 (100%)
Total shots: 697
Average VEGA energy: 37.11 J (1.06 PW)
Average energy TA: 27.47 J
VEGA user - Average h/day: 1 h. 40 min.

Enhancement of tape-targets at VEGA through the characterization of evaporation craters

This experimental campaign was approached in late September with the purpose of assessing some of the developments implemented in the tape-target designed by the CLPU engineer Diego de Luis within the framework of the IMPULSE and TULIPÁN projects. Under the guidance of the researcher Michael Ehret, the investigating scientific team tested different strategies at different energy levels, obtaining sa-

VEGA - 3
High Energy
Days: 3 (60%)
Total shots: 225
Average VEGA energy: 37.53 J (1.10 PW)
Average energy TA: 27.78 J
VEGA user - Average h/day: 2 h. 24 min.

tisfactory data for this configuration. The results are being analyzed for future publication.



In addition to all these competitive and non-competitive accesses, the CLPU takes part in a series of European projects that facilitate researchers' mobility for experimental access.

Laserlab Europe V (LL-V)

Aim It is a European consortium of international laser laboratories that make up a highly experienced interdisciplinary network that is aimed at reinforcing the leadership of lasers in science and technology, promoting joint research activities in areas of scientific-social interest, and contributing to make access to cutting-edge laser infrastructures easier.

Actions The most relevant aspect for the Center for Pulsed Lasers in 2022 has been the support of this consortium in the cofounding of a large number of competitive campaigns carried out in the facilities thanks to its Transnational Access program.

Radiation Facility Network for the Exploration of effects industry (RADNEXT)

Aim It is a European project belonging to the H2020 INFRAIA call of transnational access that includes a network of facilities, among which is the CLPU, that offer

services that range from the use of X-rays and energetic electrons to protons and heavy ions. Its main goal is to promote research on space radiation effects on electronic equipment.

Actions — During 2022, this network launched three transnational access calls, one with a proposal linked to the CLPU, which is pending analysis for experimental access confirmation in 2023.

Recyclable Materials Development at Analytical Research Infrastructures(Remade@ARI)

Aim — It is a European project funded under the H2020-INFRADEV call aimed at promoting new possibilities of access to facilities by researchers who are working on the design of new recyclable materials. The objective is to provide them with analytical tools so that they can explore the properties and structures of their material from the finest details to their atomic resolution. ReMade@ARI is committed to the circular economy model by fostering the development of innovative and sustainable materials for key components in the most diverse sectors (electronics, batteries, vehicles, construction, packaging, plastics, textile, food) at unprecedented levels. The CLPU takes part in it through Laserlab-Europe.

Actions — In 2022, no requests to use the CLPU facilities were made through this network.

b. Infrastructure Optimization

The value and mission of the ICTS not only relies on having and operating a petawatt-class, high-repetition rate laser, but in assessing the constant optimization of the system to always be at the forefront of the expected cutting-edge technological progress; this means working for VEGA to continue being not only the best ultra-intense, ultra-

fast laser system in Spain, but also the leading scientific-technological site at the international level, which it has already been since it became fully operational in 2018. To pursue this goal, the Center received a grant from an important project of the FEDER Multiregional Operational Program 2014-2020 by the Ministry of Science and Innovation in the ICTS line:

Reorganization of the VEGA laser lines for Pump & Probe experiments

Aim

To increase the setting modes to operate the laser system adding value to VEGA's capacities. These proposed new lines, alongside the Pump & Probe system, are based on synchronizing VEGA with the ultra-short duration (6 femtoseconds) CEP laser system, as well as adding uncompressed output lines.

Actions

As part of this project, in 2022, the cryogenic system of VEGA-2's main amplifier was upgraded to reduce vibration and maintain a high stability of 10 Hz. Besides, VEGA-1's uncompressed line was set up, and the delay between VEGA-2 and VEGA-3 was characterized on the metrology table so that both outputs could be used in a synchronized manner. The beam synchronization achieved is better than the 20-femtosecond resolution threshold of the second-order autocorrelator used for this characterization. Finally, a public-private collaboration was initiated to develop an intelligent beam pointing system for the uncompressed petawatt line.

Although the tender processes, acquisition, setup, and commissioning of all the equipment involved in this project are the main actions performed towards the system's optimization, the CLPU's team of specialized technologists have carried out a variety of activities that add to the project's goal, providing the system with new functionalities and improving the service. Noteworthy among them is the setup of a system that split the beam of VEGA-3 into two pulses in the experi-

mentation area, with a variable inter-pulse delay of 0 to 1 nanosecond. This function was key to the experimental development of the campaign led by the researcher from the University of Strathclyde, Dino Jaroszynski. Also noteworthy is the design and operationalization of simulation programs of each and all the front-end pump lasers and the oscillator to enable the assessment of the system's remote start prototype, a virtual prototype that was finally used in real tests. A final mention must be made to the huge task undertaken in 2022 to design and launch a database with the structure of a data library for the intelligent analysis of all the information generated by VEGA. This involved the development of R tools for intelligent uploading of stored data and for trend searching and analysis. The database was also used to study the historical evolution of the system's activity and reliability since it became operational.

In 2022, the **experimental area** also optimized its equipment and processes, which is essential added value since it is ultimately where researchers carry out their experiments. The following should be mentioned:

- Facilities: as part of the Recovery and Resilience Plan, within the specific call for ICTS, the Center for Pulsed Lasers received substantial support from the Ministry of Science and Innovation to build and equip a new experimental area that will allow the Center to increase its capacities.

Construction and equipping of experimental area 2 (AREX2)	
Aim	To design, build and equip a new experimentation area to increase the flow of users and experimental campaigns (in number and fields of research); to maximize the laser system's high-repetition rate; to enable the implementation of simultaneous campaigns in the different experimentation areas; to install secondary sources that can be accessed by the non-laser-expert community; to allow advanced remote access; and to generate a stable experimental data storage system to immerse the infrastructure in the world of open data.

Actions

After completing the initial study of the project's feasibility, both the detail analysis of the plot and the projected planning of the area had to be modified from being designed as an underground area continuing on from the original one, to becoming an outbuilding. Thus, 2022 involved a series of procedures along which the planning meetings with the Technical Unit for Infrastructures of the University of Salamanca began, as provided for in the collaboration agreement between both entities, and the first recruitment call associated with the project was issued (out of the two that are scheduled).

- Equipement:
  - Design, implementation, and start-up of the Thomson parabola diagnostic equipment to characterize heavy proton/ion beams at different angles with the purpose of performing spatial-quality measurements of the particle beams.
  - Installation of a new compressor for high-pressure experiments, including pneumatic networks and new electrical connections.
  - Faraday cage setup to prevent high-frequency interferences in measurement instruments.
  - Support and extension of the vacuum systems, including the design of a differential vacuum-control system in the auxiliary chamber for experiments using VEGA-3, and development and setup of the rough pump automatic control valve.
  - Taking advantage of the experimental campaigns led by the Spanish researcher Carlos Guerrero, from the National Center of Accelerators Unique Science and Technology Infrastructure, preoperational testing of a new neutron source was carried out to obtain the authorization of the Nuclear Safety Council for its final commissioning.

- Target development:
  - Collaboration with the University of Seville for improvements in the different configurations of the liquid target developed by the Center.

- Acquisition of the ANSYS program for multi-physics simulation of the development of high-density targets, as well as for the assessment of the laser-generated electromagnetic pulse.

- Processes: Generation of THz and X-ray radiation through innovating methods involving laser-gas interaction and interaction between electron beams and crystal

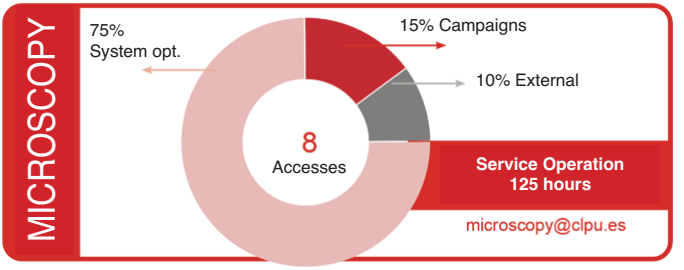
c. Complementary Laboratories/Workstations

In addition to the mentioned optimizations are the closure of new work areas and the transfer of part of the equipment that the CLPU had been storing until then in the neighboring building of the Science Park, M3. The CLPU took advantage of the summer months to engage in a new distribution of the spaces attached to VEGA's laboratory and the experimental control room through versatile divisions that have delimited new work areas. Assembly areas have been designed for pre-experimental target testing, diagnostic tools, and other equipment. And, most important, the equipment belonging to the complementary microscopy service has been transferred and the area has been conditioned for eventual transfer of the systems belonging to the ULAMP microprocessor laboratory. Precisely, the infrastructure's versatile nature is reflected in these complementary services that the CLPU has implemented over the years. Services that, pursuing a new strategic line, will be centralized to increase user-friendliness and thus provide different added values to the Center's uniqueness:

Microscopy

This laboratory's main piece of equipment is a scanning electron microscope (SEM) whose use can be requested, as is the case with the VEGA system, through the Center's access platform, FARO. The microscope is a Carl Zeiss SEM EVO HD25 with six detectors:

- SE – Everhart-Thornley Secondary Electron Detector: work can be carried out in a broad voltage range (1kV - 30 kV) to obtain topographic and structural information from a sample's surface.

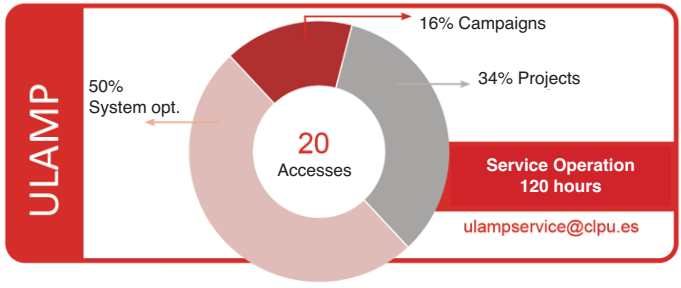


- VPSE – Variable Pressure Secondary Electron Detector: suitable to prevent charge-up effects in non-conductive samples. The gas neutralizes the electrons trapped on the surface, stabilizing the emission of secondary electrons.
- BSD – 5-segment Backscattered Electron Detector: a sample's emission of backscattered electrons is related to the atomic number of the material it is made of, which makes this technique useful in fields such as Geology, Metallurgy, Physics of Materials, etc. Besides, its topographic mode can produce high-quality images of surface details.
- STEM – Scanning Transmission Electron Microscopy Detector: the detector in this type of microscope is placed below the sample, which must therefore be thin enough for the electrons to be able to pass through it. The setup allows the diode-type detector to be placed very close to the sample, thus improving resolution, which is comparable to that provided by a BFTEM. It can work in variable pressure mode.
- EDS – Energy Dispersive X-Ray Spectroscopy Detector: this device reveals the chemical characterization of a sample through the analysis of X-ray emissions. It is widely used in Materials Science since, apart from information about the elements contained in the sample, it can provide information about its distribution and even its concentrations. The detector is a 20 mm2 SDD by Oxford Instruments and is controlled using the AZtec® program.
- EBSD – Electron Backscattered Diffraction Detector: this technique is used to define the crystallographic orientation of crystalline and semi-crystalline materials. The HKL Nordlys detector by Oxford Instruments is controlled using the AZtec® program and includes the CHANNEL 5 ® analysis program.

After closing the divisions and, taking advantage of the need to move it, a large part of the SEM usage time has been devoted to a thorough analysis of the system and its improvement. Even so, it has also been possible to provide services to meet both internal requests, linked to experimental campaigns (competitive and non-competitive) and external requests for use from other organizations.

Ultrashort Laser Applications and Micromaterial Processing – ULAMP

This laboratory offers a high-quality specialized service for laser materials processing. To this end, it relies on a high-repetition rate, femtosecond system and four workstations. The laser equipment offers a



top-quality beam and excellent shot stability (shot-to-shot), and the pulse's short duration enables ultra-fast laser ablation. This is a selective process that allows the removal of submicrometric layers of material with minimum thermal effect since this happens at larger temporal scales than the duration of the pulse itself. Besides, this type of ultra-short laser makes it possible to observe and control changes in certain material properties: refractive index, reflectivity… both on the surface and at the bottom of transparent materials. The laser can be used in three out of the four experimental workstations, each of which has been designed to serve different purposes:

- High-precision workstation with two microprocessors and an auxiliary imaging system where the laser beam can be focused on a specific area of the target and sample processing can be monitored in real time. Besides, it has another micropositioning system with galvanometers for more effective control of the laser beam,

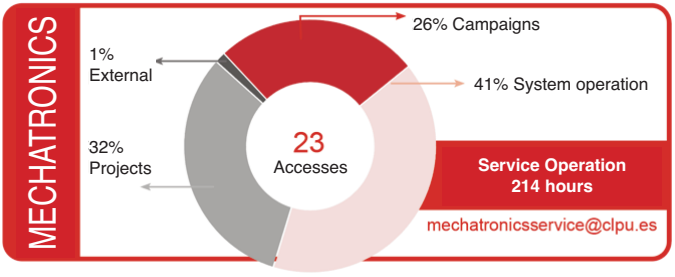
faster processing, and higher-quality reproducibility close the industrial environment.

- Trephine and automation workstation: a robust optical work surface designed for use with large-dimension specimens and for processing larger-scale microstructures. The trephine allows the generation of circular structures with conicity and dimensional control.
- General processing workstation with a versatile design that makes it suitable for other types of microprocessing work such as laser filamentation or single shot for LIDT applications.

Alongside these, the ULAMP laboratory has a CO_2 processing workstation, a complementary area with a CO_2 laser system that is connected to a galvanometric system. It is ideal for processing plastic and other materials with a low laser damage threshold and high absorption at 10 µms.

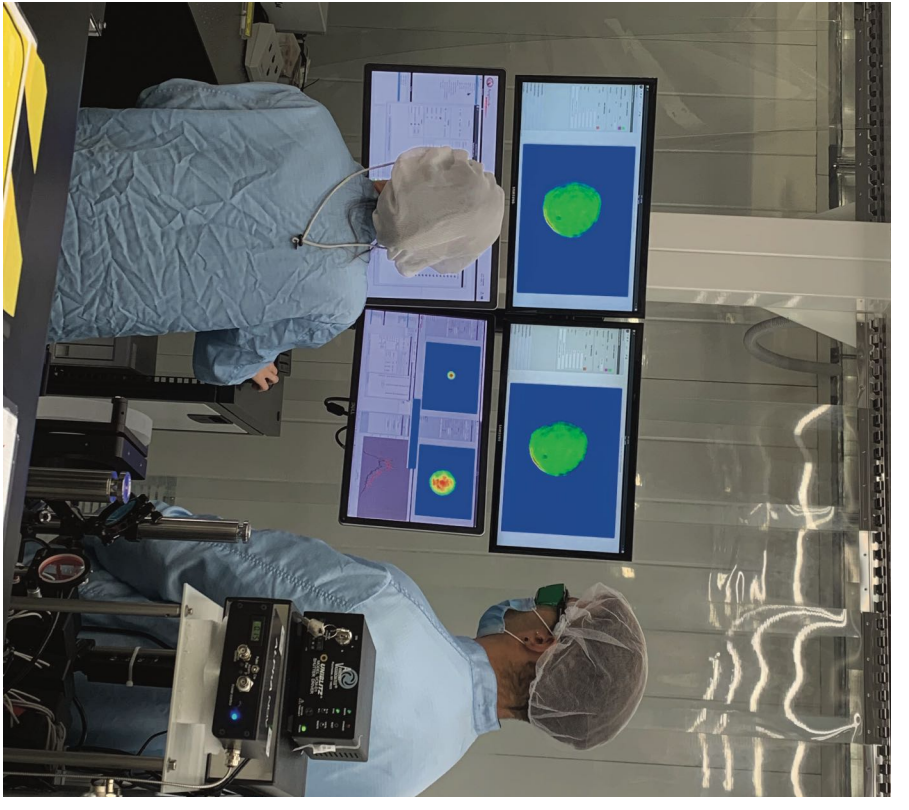
Mechatronics Workstation

From the very beginning, this workstation has been one of the infrastructure's strategic commitments. It is aimed at offering a machining and electronics service for full adaptation of our equipment to users'



needs, eliminating dependence on external services (usually foreign), cutting time, and improving the quality of the service. The main equipment in the machining area is a continuous five-axis milling machine, one of the few in Spain that is not linked to the aeronautical or automotive sectors. The area is also equipped with other auxiliary machines such as a reciprocating saw, a vertical drilling machine, a lathe,

and other tools for customized manufacturing of complex pieces. The electronics workstation allows the repair and development of devices that involve a certain degree of complexity thanks to its high-class professional tools. There are two workstations for soldering and reworking: one for manual welding and one with a stand for hot-air soldering with infrared preheating.



3. RESEARCH AND TRAINING

As well as a user center, the CLPU is a research center where technologists, scientists, and engineers, each in their field of expertise, collaboratively contribute to the optimization of the ultra-intense systems and to the scientific progress associated with them. Among the main lines of action, attention should be drawn to the study for the development of new laser-plasma particle accelerators and advanced photon sources, the astrophysics laboratory, the analysis of matter under extreme conditions, the development of biomedical and defense applications, etc.

a. Scientific Contributions

Throughout 2022, our specialized staff has made important contributions, both in the form of scientific articles in high-impact international journals and by participating in different international conferences.

Articles

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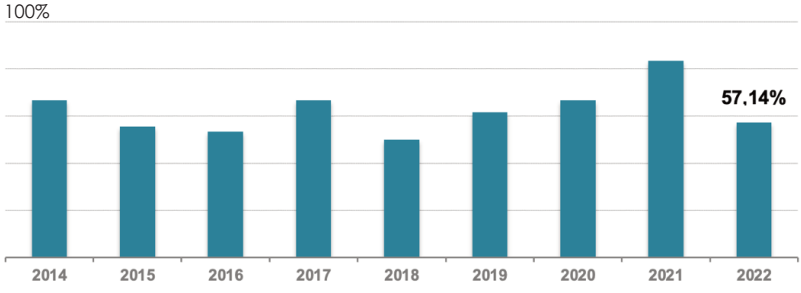
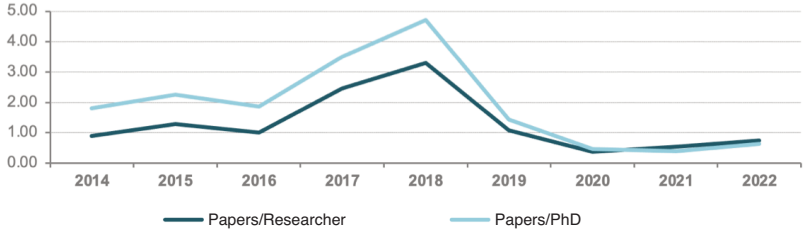
Curcio, A.; Apiñaniz, I.; Cebriano Ramírez, T.; Ehret, M.; Kebladj, B.; Morabito, A.; Pérez Delgado, A.; Salgado López, C.; Volpe, L. and Gatti, G. Liouville Theory for Fully Analytic Studies of Transverse Beam Dynamics in Laser-Plasma Ion Accelerators, Symmetry 2022, 14 (9), 1875

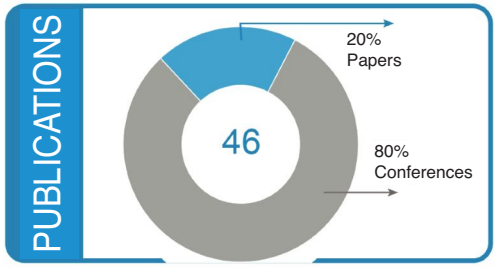
Evolution of publications in journals by year Q1+Q2

Total Publications / Year



Evolution of publications according to number of researchers and PhDs





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Pisarczyk, T.; Renner, O.; Dudzak, R.; Chodukowski, T.; Rusiniak, Z.; Dostal, J.; Krupka, M.; Ehret, M. et al. Influence of magnetic fields on characteristics of electron and ion emission from ablative plasma produced at laser irradiated disc-coil targets, 17th Direct Drive and Fast Ignition Workshop, Madrid 3-5 May 2022 [Presentation]

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Roso, L., Breathrough Ideas Panel Discussion, II ELI-ERIC Iberian Information Day, Madrid 01 June 2022 [Round table]

Gatti, G., II. Pillar of HE and Excellence, Mission oriented, research on high repetition/high energy lasers, II ELI-ERIC Iberian Information Day, Madrid 01 June 2022 [Round table]

Ehret, M., Future electron sources and secondary radiation for use applications - T2.2 Global Status, Laserlab Joint Research Activities Workshop 2022, Darmstadt 13-15 June 2022 [Presentation]

Ehret, M., High repetition rate energy selected ion sources for applications - T2.4 Global Status, Laserlab Joint Research Activities Workshop 2022, Darmstadt 13-15 June 2022 [Presentation]

Ehret, M., Ion spectrum measurements - T2.6 Status at CLPU, Laserlab Joint Research Activities Workshop 2022, Darmstadt 13-15 June 2022 [Presentation]

Curcio, A., Introduction to accelerators and plasma-Wakefield acceleration, 47th International Nathiagali Summer School, 20 June - 02 July 2022 [Guest lecturer]

Curcio, A., Relativistic laser-matter interaction, 47th International Nathiagali Summer School, 20 June - 02 July 2022 [Guest lecturer]

Curcio, A., Laser Wakefield acceleration and production of betatron radiation, 47th International Nathiagali Summer School, 20 June - 02 July 2022 [Guest lecturer]

Curcio, A., Applications of betatron radiation, 47th International Nathiagali Summer School, 20 June - 02 July 2022 [Guest lecturer]

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Salgado, C. Angular-Resolved Thomson Parabola Spectrometer for Laser-Driven Ion Accelerators, 11th International Beam Instrumentation Conference (IBIC 2022), 11 - 15 September 2022 [Presentation]

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Ehret, M., Optical Generation of transient magnetic fields of high energy density under short laser pulse irradiation, 36th European Conference on Laser Interaction with Matter (ECLIM), 19 - 23 September 2022 [Presentation]

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Ehret, M., Controlled EMP sources, L4n Round Table of the ELI Beamlines Section of the Joint ELI User Meeting, 02 - 04 November 2022 [Guest presentation]

Rico, M., Laser technology for innovation in Space and Astrophysical Applications, Forum de Universidad-Industria de Aplicaciones

Espaciales y de Astrofísica AIRBUS, 06-07 November 2022 [Guest presentation]

Morabito, A., WP 7 - Promote the IMPULSE project and ELI through activities aiming at attracting new members & strategic partners within ELI, ELI Users Meeting, 09 - 10 November 2022 [Presentation]

Ehret, M., WP 3 & 4 - Excellent Operations and Key Technologies, ELI Users Meeting, 09 - 10 November 2022 [Presentation]

Puyuelo-Valdés, P.; de Luis, D.; Hernández, J.; Apiñaniz, J.I.; Curcio, A.; Henares, J.L.; Huault, M.; Pçerez-Hernández, J.A.; Roso, L.; Gatti, G.; and Volpe, L, Thin, flat water capable of high-repetition-rate MeV-range proton acceleration in a high-power laser, Ultrafast Science & Technology Spain (USTS 2022) 16-18 November 2022 [Guest presentation]

Rico, M.; Lera, R.; and Roso, L., Laser industrial applications and transfer technology from CLPU, Ultrafast Science & Technology Spain (USTS 2022) 16-18 November 2022 [Presentation]

Curcio, A.; Ehret, M.; Pérez-Hernández, J.A.; and Gatti, G., Observation of tunable parametric X-ray radiation emitted by laser-plasma electron beams interacting with crystalline structures, Ultrafast Science & Technology Spain (USTS 2022) 16-18 November 2022 [Guest presentation]

Ehret, M., IMPULSE Project Working Package 3 - Standardization and Metrology in Task 3.2, Spanish Workshop on HEDP Opportunities at FAIR 2022, 18 November 2022 [Presentation]

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b. Projects

Although, as the ICTS it is, the Center for Pulsed Lasers is characterized by being a user center, it is, above all and according to its statutes, a research center where the cutting-edge technology and quality of its services involves sustained upgrading work. This is why different projects in various areas and scopes are being carried out, all of them directly linked to the infrastructure's strategic lines. In 2022, there were some involving applied research and many in the area of training, highlighting the value that the Center places on human resources, which are what maintain and promote the facility as an international reference. The value of knowledge in the world of specialization.

Integrated management & reliable operations for user-based laser scientific excellence (IMPULSE)	
Aim	After being built, the European Extreme Light Infrastructure (ELI) entered into a new phase. This project provides crucial supply the resources and experience of the main European laser installations to accelerate the transition into the operative phase and improve sustainability of the ELI.
Actions	Several activities were carried out in 2022 as part of the research work and the task of standardization of the high-intensity laser operation processes, particularly: establishment of a work standard for characterization and simulation of the laser-generated electromagnetic pulse; development of diagnostics and high-repetition targets (assessed within an internal campaign using VEGA-3); development of equipment for proton spectrometry; and acceptance of an experimental proposal in the ELI-NP. As for dissemination and promotion, emphasis should be placed on the organization of the ELI-ERIC Iberian Information Day meeting, and participation in different specialized events such as the ECLIM 2022.

EuPRAXIA

Aim

EuPRAXIA is a consortium that encompasses 51 institutes and industrial partners whose aim is the construction of an electron-beam-driven plasma accelerator in the metropolitan area of Rome. Its second phase includes the construction of another laser technology accelerator in a location that is yet to be defined. Thus, EuPRAXIA intends to become a distributed, compact, and innovating facility for plasma acceleration.

Actions

The kick-off meeting took place in November and the project was launched at the end of 2022.

Targets in ultra-intense laser interaction, particle production & applications (TULIPAN)

Aim

The main objective of this project by the Ministry of Science and Innovation is to operationalize and make effective use of particle acceleration via high-repetition rate laser-plasma interaction through the development, assessment, and comparison of different target arrangements. There are also plans to study the likely new lines of research that may arise from it, as well as its application in Physics and Materials Science and, specifically, possible investigations aimed at achieving inertial confinement fusion.

Actions

In 2022, two important actions were carried out within the framework of this project. On the one hand, the first solid tape target prototype was designed and tested in an experimental campaign carried out in the Center using VEGA-3 in collaboration with different institutions; on the other hand, a high-density gas target prototype was developed and subjected to initial assessment on a test bench.

Transport and handling of particles in laser accelerators: new scenarios in Flash radiotherapy (TYMPAL)

Aim

The main purpose of this project, co-funded by the Regional Government of Castile and Lion, is the design and building of loaded particle transportation tools adapted to secondary laser-generated radiation sources. The use of this type of laser accelerator requires considering relevant parameters such as shot-to-shot instability, emission angles, spectrums, etc.

Actions

In 2022, the design, implementation, and commissioning of a permanent magnet quadrupole proton transport line, assessed in an experimental campaign whose results are under analysis for future publications.

PTA - Commissioning of the advanced characterization and management of data for the reorganization of VEGA's lines

Aim

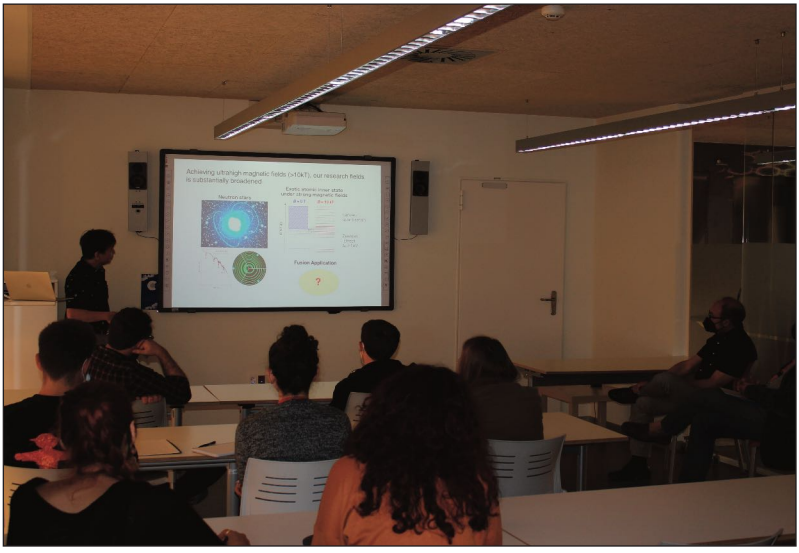
This project pursues three main goals: the commissioning of tools for the statistical analysis of VEGA's functioning data; the commissioning of an automatic storage prototype to control the beam pointing of each of VEGA's three outputs; and the development of advanced characterization systems.

Actions

The project started in November 2022; therefore, the main actions carried out in its early stages have involved training and an analysis of the state-of-the-art: training in the use of the infrastructure and procedures associated with VEGA; study and proposal of appropriate tools for the processing of existing data; and study and initial proposal for the development of the automatic storage system.

c. Training

In the framework of its agreement with the University of Salamanca, the Center for Pulsed Lasers participates as host facility for possible curricular and extracurricular activities that are carried out by the academic establishment's students. Thus, in 2022, two students completed their curricular practices between July and September; two arrived to develop projects as part of extracurricular practices; and there were three pre-doctoral students who were drafting their PhD. In addition to these young researchers, training practices were carried out by two students from the Venancio Blanco Secondary Education School, who were selected in a decision taken jointly by the two institutions to collaborate in the Department of Systems of the Center. Likewise, the CLPU participates in some of the master's degrees designed by the USAL. In this regard, the researcher José Antonio Pérez delivered the 'Physics in Intense Fields' subject within the Master's Degree in Physics and Laser Technology. Moreover, this scientist also co-directed the Final Master's Degree Project of the student Alejandro Huerta, titled 'Acceleration and characterization of electrons via laser-plasma interaction in the relativistic regime'.



4. TRANSFER AND INNOVATION

a. Laboratory of Innovation and Technology in Lasers – LITeL

This laboratory was designed to generate new laser-light sources, advanced photon technology, laser components and, in general, new laser platforms based on solid-state media and their associated frequency conversion techniques, in order to promote the digitalization of different industrial sectors by using laser technology to boost development and innovation. Our scientists are constantly analyzing the state-of-the-art so that each user can be provided with the best and most advanced solution. New research in areas such as Materials Science, applied science, and the production of innovating designs are essential for work and applications of solid-state lasers. Knowledge of such advances allows a better understanding of the needs that arise in the industry, biomedicine, life sciences, telecommunications, space science, military systems… or applications where solid-state lasers play an essential role. In this laboratory, laser resonators are of particular importance since they define the output quality of any laser's beam. Its adapted design makes it a potential solution for many scientific-technical problems, since being able to control beam parameters (power, shape, pulse duration, etc.) is relevant to all laser applications, as well as a factor that contributes to the development of new technologies and applications. Likewise, research carried out alongside users on innovative approaches in the study of laser-beam radiation using low and high energy is particularly interesting.

As in the previous year, in 2022 the focus of the laboratory was to finish the laser demonstrator developed for the Ministry of Defense as part of the SIGILAR project (further details can be found in this section under 'Projects').

b. Collaborations

In pursuance of its strategic line for the support of innovation, the Center for Pulsed Lasers Consortium continues to be involved with the main industrial platforms in the sector, both at the national and at the regional levels, seeking areas of collaboration and synergy to foster progress:

Ineustar, Spanish Science Industry Association

A nonprofit private organization whose goal is to contribute to scientific and technological progress and the reinforcement of innovation. Its plan is to build an efficient collaboration network among enterprises, research centers, and support organizations and institutions. It is in constant collaboration with the CLPU, and both entities participate in different industrial events and meetings. In 2022, we should mention their collaboration in the II ELI-ERIC Iberian Information Day European event, held in Madrid on 1 June.

Fotónica 21

A platform born to coordinate the activities of the main national actors in the photonics sector in an equivalent manner to those carried out through the European Technology Platform Photonics21. Its main aim is to provide an efficient backbone for the industrial innovation process in photonics technology and its applications in four key sectors: information and communication, industrial manufacturing processes, life sciences, and lighting and displays.

Enterprise European Network

The main purpose of this European platform is to help companies innovate and grow at the international scale. It gathers experts in the areas of technology, innovation support organizations, universities and research institutes, development agencies at the regional level, and chambers of commerce and industry. The Center for Pulsed Lasers is attached to the network through the ENN-GalacteaPlus consortium, which is the point of contact in the northeast of the Peninsula for this platform that was

launched in 2008 by the European Commission under the Single Market Program.

PEPRI

It is the National Radiological Protection Research and Development Platform. Its main goals are to encourage scientific-technologic growth in the area of radiological protection and include suggestions from the sector in the State Plan for Scientific and Technical Research and Innovation, as well as forming an advisory and coordination entity at the national level to foster collaboration among the different actors while facilitating Spain's participation in international R&D&I programs in the field.

c. Contributions

In the area of innovation and knowledge transfer, the Center for Pulsed Lasers has also participated and shown its capacities in industrial events:

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Roso, L. El Centro de Láseres Pulsados, Bloque I. Oportunidades de inversión de las infraestructuras nacionales de física de partículas, Jornada Industria de la Ciencia – ICTS Infraestructuras Científicas y Técnicas Singulares: Oportunidades de colaboración y suministro para la industria española en las áreas de física de partículas, fusión y astronomía, 26 April [Guest presentation]

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Rico, M., Spanish Center for Pulsed Lasers, IV Pannel Discussion: Focus on Industry Involment, II ELI-ERIC Iberian Information Day, 1 June [Guest presentation]

d. Innovation projects

In 2022, the Center's specialized scientists fostered knowledge transfer in the form of three important projects: one was being completed, another was starting, and a third was in full development under an experimental campaign.

High-power pulsed laser-guided system for the military field SIGILAR	
Aim	This project, belonging to the Ministry of Defense, is aimed at developing a more than 15 kW peak-power laser that can fire in a stable way and be fitted on a platform with a system to control and guide the laser beam for functionality tests in field trials.
Actions	During 2022, the laser system was optimized and improved so that it could surpass the peak power required, reaching values of 30-40 kW. Besides, the different subsystems were integrated with the laser-beam pointing platform. The testing of laser application on materials, both in the laboratory and as field tests (in the defense facilities of La Marañosa), at the required distances was successfully carried out and validated. Finally, all the technical documentation required at the end of the agreement was delivered to the Ministry of Defense on 26 October 2022

Hybrid prototype based on laser boost of a Linac to obtain a ultrahigh high dose rate in radiotherapy – Hybrilin	
Aim	The development of this project promoted by the Ministry of Science and Innovation relies on the outcomes of previous projects carried out by the CLPU, such as PALMA (Particles accelerated by laser for medical applications), as well as on the outstanding scientific and technological level of radiology and oncology in Salamanca, to go one step further on the road of Flash radiotherapy research. Specifically,

the purpose of this project is to modify an existing conventional accelerator to assemble the first Flash-RT device.

Actions

By the end of 2022, the project had mainly advanced in the phase of design and adaptation to the new conditions (unavailability of the LINAC 2100). The design of the new source is finished as regards its main components, although there is still a margin of uncertainty (laser target) that requires further testing for a lack of references in the existing literature. Meanwhile, reference work points at high energy that are scalable to the project's aims have been isolated, characterizing the beam under such conditions as a future reference.

Development and testing of new compact and low-cost CMOS technology systems for dosimetry of neutrons, ionizing radiation, and charged particles

Aim

Th ultimate goal of this project, which belongs to the call issued by the Nuclear Safety Council, is to offer proof of concept on the feasibility of using CMOS detectors for recording the spatial distribution of pulsed doses of thermal neutrons. Besides, an attempt will also be made to prove the viability of such systems for fast neutron measurement with polyethylene converters.

Actions

Launched in November 2022, this project started with a thorough bibliographic review and an analysis of the state-of-the-art of commercial CMOS image sensors.

5. DISSEMINATION AND TRANSPARENCY

a. Scientific Culture and Innovation Unit – UCC+i

In 2022, after years of working on this strategic line, the Center's communication managers succeed in achieving the distinction of Scientific Culture and Innovation Unit (UCC+i) for the Consortium, which is awarded by the Spanish Foundation for Science and Technology (FECYT). As gathered in the white book of Scientific Culture and Innovation Units, these entities "are regarded as one of the main actors in the dissemination and popularization of science and innovation in Spain and are a key service in improving and increasing citizens' scientific training, culture, and knowledge". Thus, the Center for Pulsed Lasers becomes part of the Spanish Network of Scientific Culture Units, whose most important tasks are the following: to act as an intermediary between researchers and journalists (in this regard, the inclusion, in June, of the CLPU in the Science Media Center promoted by the FECYT should be noted); to bring society closer to science and researchers to society, giving greater visibility to scientific results, increasing the general public's rigorous scientific culture, and fostering scientific vocations among the youngest. Some of the most outstanding actions carried out are the conclusion of a project belonging to the call for aid to promote scientific, technological, and innovation culture issued by the FECYT, and the approval and launch of a new one:

Luciérnagas
podcast científico

Aim

Luciérnagas is a science podcast to support citizens in the learning and understanding of the reality of the scientific method so that the knowledge acquired allows them to interpret scientific news related to lasers, plasma, optics… It is also aimed at promoting critical thought in society so that together we can

stop fake news and infodemics. It should also be noted that, in collaboration with the Federation of Associations for the Deaf of Castile and Lion, several videos have been made with Spanish sign language translations and subtitles.

Actions

When it ended in June 2022, this project had published, as established in its Technical Report, a total of eight episodes, all of them available on the project's website (*www.luciernagas.clpu.es*), and downloadable from Google Podcast, Spreaker, Spotify, and iVoox. The program achieved over 10,000 subscriptions on the main podcast platform, Ivoox, in only ten months after its beginning.

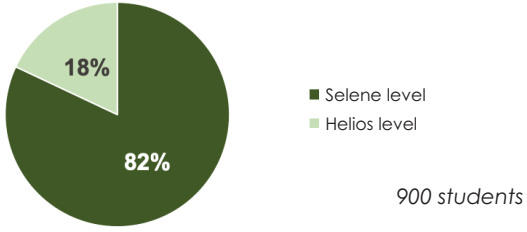
Teia
Un taller científico sobre la luz y la radiación

Aim

It is a dissemination project aimed at promoting scientific vocation at early ages ranging between 4 and 14. The action is divided into three different adaptation levels to understand concepts such as light, colors, and radiation. The novelty of the project, which includes carrying out different types of experiments and, as is usual in the activities designed by the CLPU, requires the student's continuous interaction, is the use of XR technologies: augmented reality for children aged 4 to 6, and virtual reality for those aged 7 to 14.

Actions

The project started in July 2022 with the launch of the recruitment call associated with the action, the acquisition of equipment, and the creation of the digital contents to be used for the XR technology. The vacancy was filled in early September and the project started to be promoted through the regular channels, including the activity in the proposals made through the Fundación Salamanca Ciudad de Cultura y Saberes, as well as making it known through radio clips on the main regional broadcasting stations. As planned in the Technical Report, the workshops began in mid-October, and by the end of the year, almost 40 groups of students between 4 and 11 years old from 16 schools in the province of Salamanca had been scheduled for participation.



Alongside these two relevant dissemination actions, the Center engaged in other activities linked to providing information and promoting the infrastructure, its science, and its scientific outcomes. Among the most outstanding are the guided tours of the Center for different groups such as the students from the University of Salamanca participating in the Interuniversity Program for Older Students; students from the Master's Degree in Materials of the Polytechnical University of Madrid; students from the University of Salamanca's School of Engineering of Béjar; or participants in the II ELI-ERIC Iberian Information Day; other more specialized visitors such as teachers from the department of Materials Physics of the Complutense University of Madrid; or a group of technologists from the Nuclear Safety Council. Likewise, there were also activities of a more informative nature such

as the visit of a group of people with intellectual disabilities from the Insolamis Association. During 2022, the series of informative videos on the experimental campaigns has continued, one of the outstanding ones being the interview with the researcher of the National Center of Accelerators, Carlos Guerrero, who carried out a neutron generation experiment alongside a large international group of collaborators (*https://youtu.be/s_hQZAbU8Ks*).

Finally, the Center organized the following activities on the occasion of special events:

- International Day of Women and Girls in Science (11 February): in the framework of the Luciérnagas podcast project, a special episode was published where interviews were carried out with the head of the Women and Science Unit of the Ministry of Science and Innovation, Zulema Altamirano; and with the scientist who won one of the 'L'Oréal-Unesco Awards for Women in Science', Ángela Nieto, PhD in Biochemistry and Molecular Biology (you can listen to and/or download it from the project's website: *https://luciernagas.clpu.es/*).

- International Day of Light and Light-based Technologies (16 May): the infrastructure scheduled two actions for this special day: on the one hand, a new special episode of the Luciérnagas podcast project, addressing the science behind technologies that are widely used by the general public, such as microwaves, radars, 5G… with Guillermo Sánchez León as spokesperson (you can listen to and/or download it from the project's website: *https://luciernagas.clpu.es/*); and, on the other hand, the Center launched the second edition of the 'Garabalux' provincial drawing competition, whose decision was published on 16 May, delivering the prizes to its winners and finalists during a special visit to the Center in early June.

- Castile and Lion Science Week: on the occasion of its twentieth edition, the manager of the Center's Radioprotection Unit, José Manuel Álvarez, took part in a 'Coffee with Science' arranged in the 'El Retiro del Campus' café with the talk 'Radiation: our daily dose'.

b. Transparency

As a consortium that is part of the Spanish public institutional sector, linked to the General Administration of the State, for years, the CLPU has been pursuing a good governance policy implemented through the creation of a Transparency Portal that is on public display and can be accessed from its website (*https://www.clpu.es/PT_Home*). Towards the middle of the year, an Anti-fraud Measures Plan was published in the mentioned transparency portal and has been in force since its adoption. The plan includes: anti-fraud policy, code of ethics, protocol for managing conflicts of interest, protocol for action when there is suspicion of fraud and disciplinary regime, and guidelines for using and managing the complaints channel.

6. PROJECTS SUMMARY

FU - VEGA Infrastructure — € 3,841,663.36

Entity	Title	PI CLPU	Duration	Amount
MCI	*Reorganization of the VEGA laser lines for Pump & Probe experiments*	MD Rodríguez Frías	01/01/20 - 31/12/22	€ 480,000.00
MCI	*Experimental Area 2*	MD Rodríguez Frías	01/09/21 - 31/12/25	€ 3,018,000.00
UE/H2020	*RADNEXT*	Giancarlo Gatti	01/06/21 - 31/05/25	€ 89,687.50
UE/H.Europe	*ReMade at ARI*	Giancarlo Gatti	01/09/22 - 31/08/26	€ 46,872.00
UE/H2020	*Laserlab Europe V*	Giancarlo Gatti	01/12/19 - 30/11/24	€ 207,150.00

FU - Research and Training — € 1,233,247.04

Entity	Title	PI CLPU	Duration	Amount
UE/H2020	*IMPULSE*	Giancarlo Gatti	01/11/20 - 30/04/24	€ 450,690.00
JCyL	*TYMPAL*	Giancarlo Gatti	01/11/20 - 31/10/23	€ 264,000.00
MCI	HRR - TULIPAN	J. Luis Henares y J. Antonio Hernández	01/09/22 - 31/08/25	€ 78,650.00
MCI	*Support Technical Personnel (PTA)*	Cruz Méndez	03/10/22 - 31/10/25	€ 42,600.00
MCI / SEPE	*Research Programme*	Roberto Lera	24 months	€ 66,217.84
MCI / SEPE	*Research Programme*	Diego de Luis	24 months	€ 66,217.84
JCyL / ecyl	*Research Programme (2)*	Cruz Méndez	12 months	€ 66,217.84
JCyL / ecyl	*Research Programme (2)*	Miguel A. Carmona	12 months	€ 66,217.84
JCyL / ecyl	*Research Programme (3)*	Giancarlo Gatti	12 months	€ 99,326.76
JCyL / ecyl	*Research Programme (1)*	Diego de Luis	12 months	€ 33,108.92

FU - Transfer and Innovation — € 196,707.34

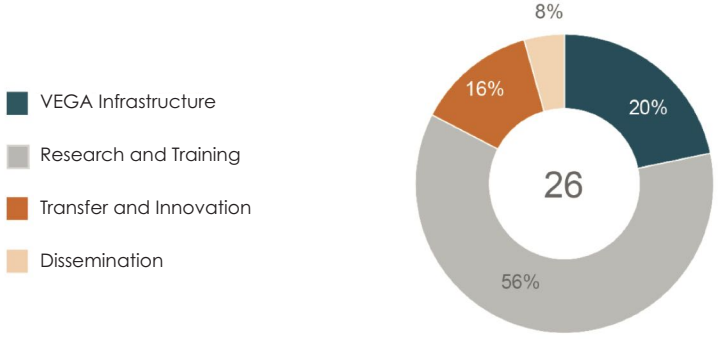
Entity	Title	PI CLPU	Duration	Amount
MCI	*HYBRILIN*	Giancarlo Gatti	01/12/21 - 30/11/23	€ 97,750.00
EU/H.Europe	*EuPRAXIA*	Giancarlo Gatti	01/11/22 - 30/10/26	€ 10,000.00
CSN	*Development and testing of new compact and low-cost CMOS technology systems for dosimetry of neutrons, ionizing radiation, and charged particles*	Jon I. Apiñániz	01/01/23 - 31/12/25	€ 88,957.34

FU - Dissemination and Transparency — € 20,000.00

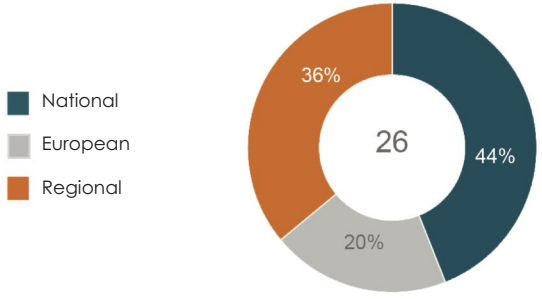
Entity	Title	PI CLPU	Duration	Amount
FECYT	*Teia*	Pilar Puyuelo	01/07/22 - 30/06/23	€ 20,000.00

€ 5,291,617,74

According to nature (linked to Functional Unit)



According to geographic scope of the call



7. HUMAN RESOURCES

Although VEGA is what makes us unique, we are aware that our main asset is our highly specialized human team that works daily at the Center. We have already noted a significant landmark for the infrastructure: the incorporation of PhD María Dolores Rodríguez Frías, Chair of Atomic, Molecular and Nuclear Physics at the University of Alcala (Madrid), as director of the infrastructure after the office was left by PhD Luis Roso, science promoter of the CLPU.

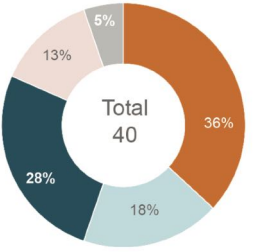
Direction

Luis Roso Franco
(January-October)

María D. Rodríguez Frías
(October-December)

Management

Pedro García García



Scientific Area

- *Giancarlo Gatti*
- Jon I. Apiñániz Aginako
- Teresa Cebriano Ramírez
- Diego de Luis Blanco
- Michael Ehret
- Eduardo Flores González
- José L. Henares González
- Alejandro Huerta Sánchez
- Roberto Lera Matellanes
- Antonia Morabito
- José A. Pérez Hernández
- Pilar Puyuelo Valdés
- Mauricio Rico Hernández
- Carlos Salgado López

Technical Area

- *Cruz Méndez Valverde*
- Javier García Ajates
- Enrique García García
- Irene Hernández Palmero
- Marta Olivar Ruiz
- José D. Pisonero Carabias
- Óscar Varela Baquero

Engineering Unit

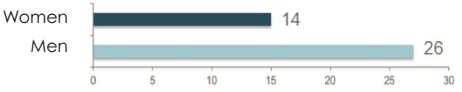
- *César Ayllón Castillo*
- José Miguel García Mata
- Rubén Hernández Martín

Management Area

- Alberto Berrocal Macías
- Miguel A. Carmona Moreno
- María J. Cortés de Dios
- Yaiza Cortés Gómez
- Elena García Martín
- Marisol Iglesias Sánchez
- Carlos Navarro Laporta
- Sara Sánchez Hernández
- Ana Santa Cruz Marcos
- Javier Sastre Porcherie
- María J. Torrens Bermejo

Radioprotection Unit

- *José M. Álvarez Pastor*
- Ana María Cives Fernández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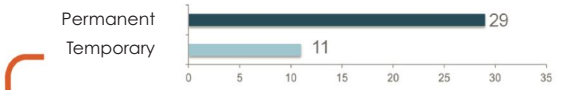
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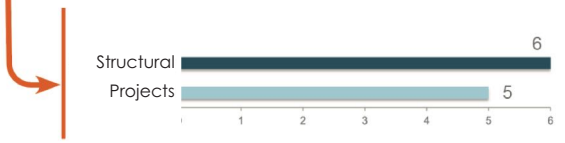
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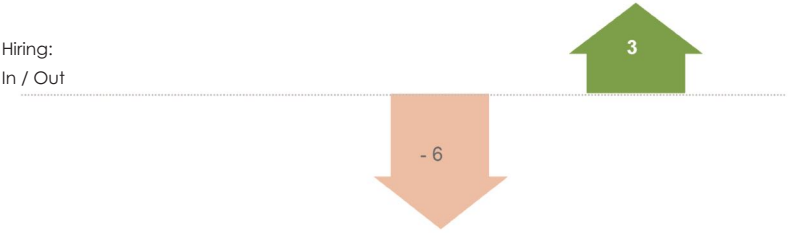
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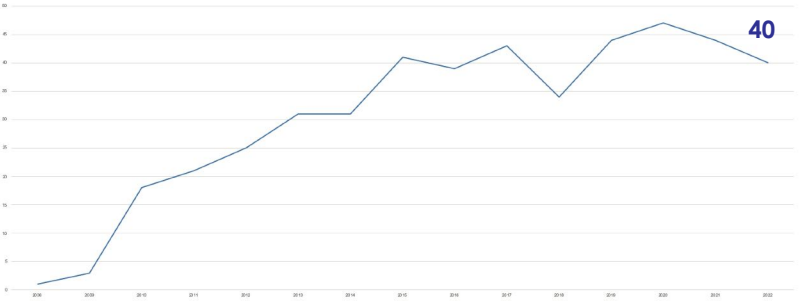
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