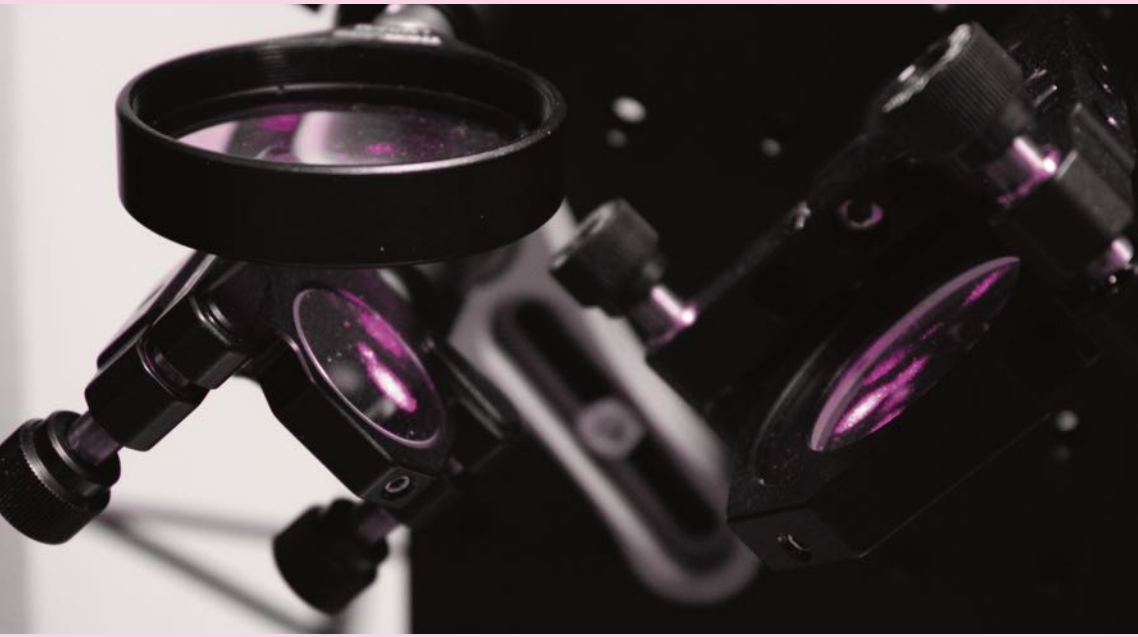
CLPU

CENTRO DE LÁSERES PULSADOS

Activities Report

2021



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"


SALIDA
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Design: Javier Sastre
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Salamanca, 2022

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MESSAGE FROM THE DIRECTOR

I arrived at the Chair of the University of Salamanca with the dream to install an ultra-intense laser, along the lines of what I was familiar with from my Rochester time. I can now retire fully satisfied, since the dream has become a reality with the Spanish Center for Pulsed Lasers.

For almost 20 years, I have been in charge of the most powerful laser in Spain, first at the University of Salamanca, and then at the CLPU. This would not have been possible without the help, support and good work of the human team, both from the university, first, and from the CLPU, now. It has been a pleasure and an honor to head these groups that have led Salamanca to become a reference in the area of ultra-intense lasers at the national and international levels.

The memory of being the founding director of the CLPU will forever remain with me. When I promoted the CLPU, accomplishing the goal was a challenge that seemed to have limited chances of success; and this is why it was planned with a timeline that ended in 2021. The Center's foundational stage gave rise to many questions: would we be capable of having a petawatt laser in Salamanca? would we be able to operate an experimental area adequate enough to attract international users? would we be able to manage it correctly?... Well, thanks to the competent and dedicated work of a large percentage of the Center's staff, the CLPU is now an unquestionable and unquestioned reality. Proof of this is, on the one hand, the extraordinary overdemand of our facilities by scientific teams from all over the world, and, on the other hand, the renewal of the consortium. I would like to

thank those of you who have made this possible, and also the Spanish citizens, who have contributed to pay for the Center's development with part of their taxes.

In particular, I would like to take this opportunity to express my deepest gratitude to two extraordinary people whom I have had the great fortune to meet and who have been instrumental in making the CLPU a reality: thanks, on the one hand, to Pedro García, a wonderful manager who has succeeded in surrounding himself by a dedicated and efficient team whose work has been key to the stability of the Center; thanks, on the other hand, to Ángela Fernández Curto who, from the ministry that is in charge of science, whose name keeps changing, has succeeded in guiding the CLPU in and extraordinarily efficient manner, leading to the consolidation of the Center as a Unique Scientific-Technical Infrastructure. I know that both of them will continue to purposefully ensure the proper functioning of the CLPU, supporting the new director, to whom I wish luck and every success.

As strange as it may seem, centers like the CLPU are made by people who regard overtime hours as ordinary office hours. Thanks to those of you who have done that and who have always been ready regardless

Visit to the CLPU of the 2018 Nobel Prize in Physics, Gérard Mourou.

of the time to solve and work out likely problems and also those that have unexpectedly overwhelmed us. To those who have chosen other pathways seeking personal gain above the collective good at any cost, I would like to remind that the CLPU is made and will be made greater by the people who are part of it. I believe that I am leaving the tools for a bright future, but what is to come is up to all of you.

As a physicist, I am deeply aware that every particle has its corresponding antiparticle —interestingly, even the neutrino —, which is why I do not wish to end these lines without my most heartfelt 'anti-thanks': to the Ministry of Finance, under the different governments, which has been uncapable of understanding that to make a unique facility, the petawatt laser, available to users every morning, requires many years of training and singular work tools. This has forced us to work at the limits of our planning possibilities and has prevented us from optimizing the use of the public resources allocated to us.

I also leave with a thorn in my side for failing to forge a stronger and more beneficial relationship with the University of Salamanca or, rather, with certain groups of it. Having a unique scientific-technical infrastructure in the city is an asset whose importance should be maximized by all social agents, but especially by the university community, for the sake of scientific progress and training quality, issues that have sometimes been disregarded because of private interests.

Nonetheless, the overall balance is very positive indeed. I leave the CLPU director post extraordinarily satisfied because of the point at which the Center is. The agreement has been established for an indefinite period, we have a good basic funding commitment for the coming years, we are involved in important international projects with the Extreme Light Infrastructure (ELI), with EUPRAXIA and with the CERN. We are also a Laserlab Europe node. And, above all, I leave the Center with an extraordinary international reputation thanks to the good overall work of the CLPU team. We are creating a series of new units, among them one for research, one for transference and another for dissemination. Likewise, a project for the building of a second bunker to develop more extreme accelerators has been granted and funded.

Therefore, I think it is the right time for looking at the calendar and reminding myself of my age and that I should start thinking about slowing down. On 2 November I informed of my intention of leaving my position as director of the Center and I hope that the CLPU will soon have a new director who, I am sure, will know how to successfully lead this new stage of the Center. Indeed, I will fully support him/her, and I hope the entire human team of the CLPU will do so too.

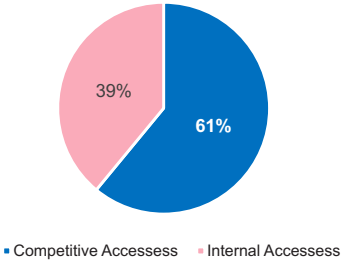
Luis Roso

CLPU Director

VEGA UNIQUENESS INFRASTRUCTURE

a) Accesses

i. Experimental campaigns



Three open access competition campaigns corresponding to the second call and postponed in 2020 due to the international health crisis caused by the COVID-19 pandemic could be carried out in 2021. While the first of them was a second phase of the remote experiment that began at the end of 2020, the other two, once again, involved the presence of international researchers, this return to normal being crucial for scientific progress. There are also three further additional internal campaigns, some of them involving various accesses, for the development of new targets and the design of new experimental work areas for users.

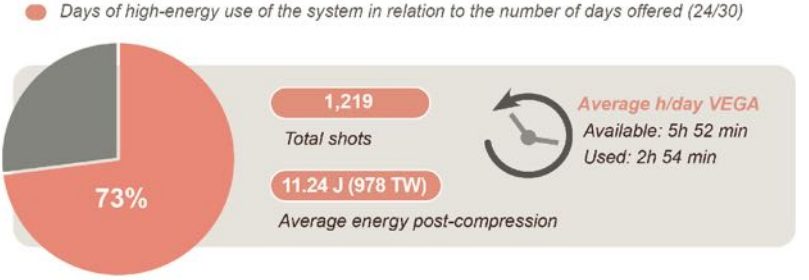
Experimental competitive campaigns have accounted for over 60% of the total accesses for the use of the unique system's beam. Below is the main information corresponding to each of them:

VEGA-3 Commissioning: characterization of ion acceleration [18/01 - 19/02]

This experiment was headed by Alessio Morace, a researcher from Osaka University in Japan. It has become the first remotely developed experiment at the Spanish Center for Pulsed Lasers. The campaign met four goals: on the one hand, it involved the launching of the VEGA-3 system, which was first fired repetitively at different energies and pulse durations, including its maximum energy (30 joules) and compression (30 femtoseconds). This has been a success because of the achievement of proton acceleration at energies above 20 MeV and it has been possible to perfectly characterize all the laser's para-

meters (stability, energy, beam focus and temporal duration) as well as the particle acceleration mechanism. On the other hand, the basis of the experiment was an analytical study on the influence of solid target thickness on the particle acceleration mechanism, along with other parameters such as energy and laser pulse duration. The aim was to capitalize on VEGA's high repetition rate to gather a large number of data to be used by the researcher in a study on the laws of particle acceleration scaling using machine learning techniques.

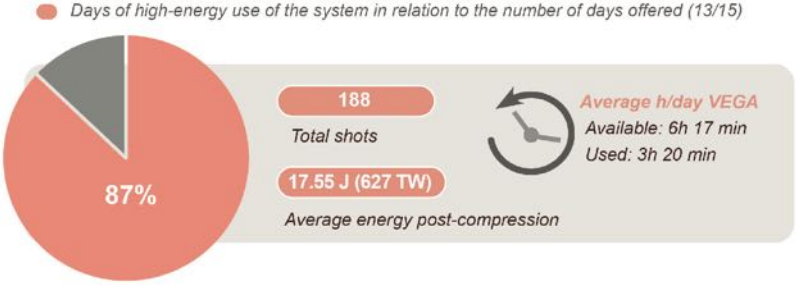
Operational data of the system during the experiment:



Ion acceleration by ultra-intense laser interaction with high-density gas jet – towards PW power regime [07/06 - 02/07]

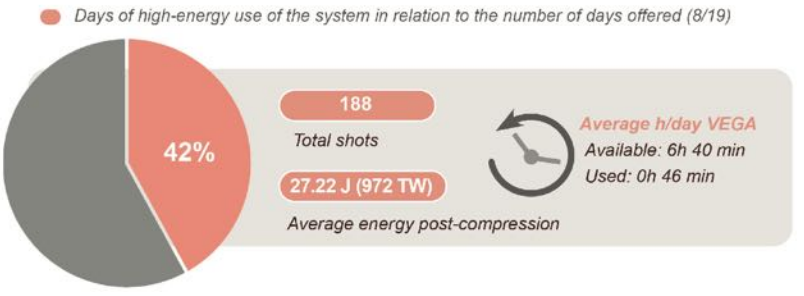
Whereas the leader of this experimental campaign was the University of Bordeaux researcher Joao J. Santos, it has relied on a large team of collaborators from different organizations: Institute of Plasma Physics and Laser Microfusion, Centre d'Etudes Nucléaires de Bordeaux-Gradignan, Princeton Plasma Physic Laboratory, and the Czech Institue of Plasma Physics. The novelty of the project consisted in the use of high-density gaseous targets to interact with ultrashort and ultra-intense laser pulses at the petawatt level (VEGA-3) with the purpose of achieving ion acceleration in the multi-MeV energy range. Accomplishing this experimental evidence paves the way for industrial and medical applications using this type of accelerated beams where the

average particle flux required is high, as is the case with radiochemistry or radiopharmacy. The campaign proved successful inasmuch as it was possible to characterize and optimize the high-pressure gas system, ions above one MeV were obtained, accelerated and detected, as well as very high-load electron beams of up to 50 MeV. However, because of the large deployment of diagnoses used, the research team is still analyzing the large amount of data obtained.



Investigation of laser-based neutron sources with a high-repetition rate laser system [18/10 - 26/11]

The team of young researchers of the Technical University of Darmstad (Germany), directed by the scientist of such institution, Markus Roth, sought to use at high speed a distilled water liquid target, designed and constructed by them, to gather a relevant number of data to be able to, for the first time, characterize a neutron beam obtained using a short laser pulse at a high repetition rate. Another goal was to use such neutron beam to perform resonance spectrometry. However, problems arising from the target prevented good experimental development. Once the target could be used correctly and VEGA-3 could be fired on it, it was proved that it could be used at high-repetition rates for energies under 200 J since otherwise the target would freeze. Because of this, the decision was made to finally use the system in single-shot mode.

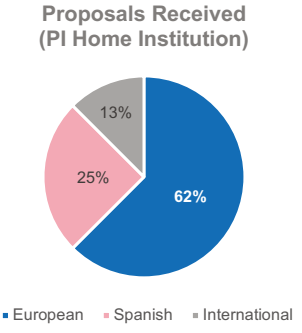


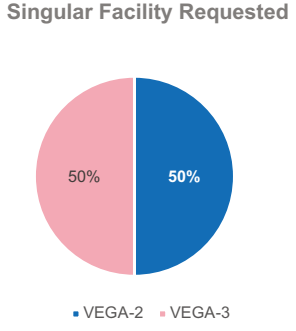
As can be observed, the three competitive access campaigns correspond to the strategic area of laser acceleration of particles. For their part, the three internal experiments that were also carried out in 2021 were directly linked to the goal of increasing the infrastructure's added value by optimizing the Center's experimental area, both as regards the development of new targets to capitalize on VEGA's high-repetition rate (let us recall that it is one of the three petawatt class laser systems in the world that can fire one shot per second) and in the design and implementation for users of work spaces with the secondary sources that are offered.

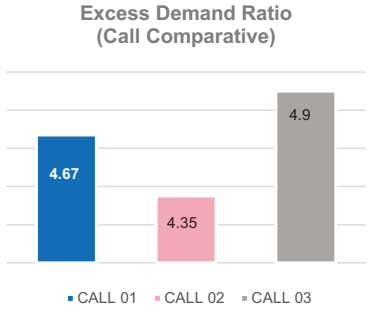
ii. Third call for access to VEGA

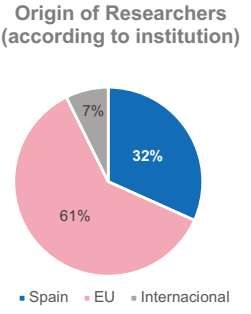
The worldwide situation brought about by the arrival of SARS-CoV2 not only had an impact on putting into practice the scheduled experiments, but also on those to come, since the publication of the regulatory bases for a third call also had to be postponed. The call was finally launched on 31 July 2020 with an application submission deadline that was extended until 12 December of said year, once again as a result of the situation of recent 'return to normal' that was taking place, which was uneven across the different countries. After the information gathering process and the meeting of the Access Committee, its members selected 7 out of the 16 proposals. In fact, considering the quality of the requested experiments, the Access Committee proposed to select a larger number, so the 50 sessions that had been originally offered were redefined as 78, most of which have already been scheduled for 2022. The most significant aspect of the call is its launching for the first time as part of a co-funding scheme. The requirements of such scheme involved defraying a minimum of the access costs, which varied according to whether it was VEGA-2 or VEGA-3 that was used. The price could be cofounded either through direct payment by the institution to which the applicant researcher belonged, or through national or transnational access programs, and even through contributions in kind. At the end of 2021, almost 90% of the selected campaigns had succeeded in being approved by the *Laserlab-Europe* transnational access program.

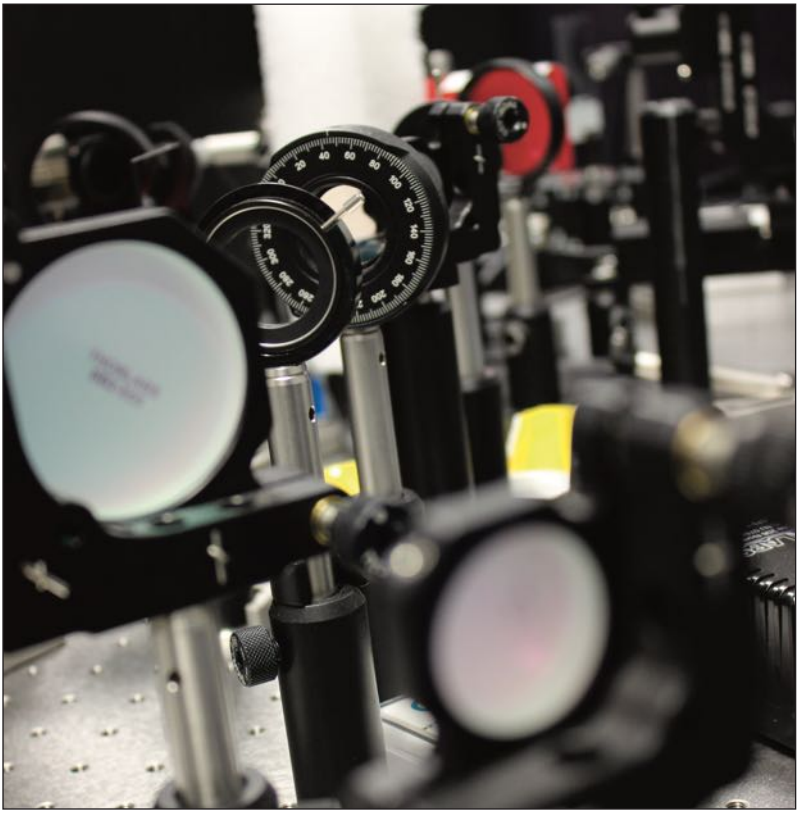
Data corresponding to the call:






Excess Demand Ratio
(Call Comparative)
4.67
4.35
4.9
CALL 01
CALL 02
CALL 03


Origin of Researchers
(according to institution)
7%
32%
61%
Spain
EU
Internacional



b) Added value actions in the Infrastructure

i. VEGA laser system

The optimization of the laser system's singularity has been mainly linked to the project of reorganizing the lines of the VEGA laser system for the accomplishment of Pump and Probe experiments, which are those where two laser beams are used, one of which is fired on the target while another, synchronized with the former, analyzes what happens, one of the greatest technological challenges being the capacity to analyze phenomena that can happen in subnanoseconds. To achieve this, the Spanish Center for Pulsed Lasers has been implementing this project that involves the synchronization of VEGA's singular features with the CEP laser system, a laser beam system with lower intensity but ultrashort duration (6 femtoseconds) that allows extraordinarily accurate time discrimination. For further details, see this functional unit's Projects section. All this has led to new combinations of laser beams that the users may find interesting, including the synchronization of VEGA-2 and VEGA-3 with an under 200-picosecond resolution. Hence, the operational modes available to users are:

In addition to these actions, there have been other improvements in 2021, mainly affecting the systems of online control and interactions with users. Among them, we would like to emphasize the following:

- Set up and operationalization of the system for remote firing from the experimentation zone, which allows users to fire the shot or series of shots that they require at each moment, only having constant supervision by the associated laser technicians to confirm availability of the system.
- Development of the remote start control prototype of VEGA's oscillator and pumping lasers. This improvement allows the optimization of activation times favoring the increase of the time of use of the system.
- Creation of online users and passwords to access the infrastructure's 'Click & Shot' platform so that users may consult and download the data corresponding to each shot fired in their experiment, each labelled with its time tracking.

ii. Experimentation area

The service to access the unique infrastructure is based on VEGA's platform, which includes the laser equipment, on the one hand, and, equal in relevance, the experimental area, on the other, where users *de facto* carry out their experimental setups and where the research campaign is carried out. Therefore, it is essential to improve this section to offer a top-quality comprehensive service. In this regard, the following improvement actions were implemented in 2021:

- Development of a high-density gaseous target as an alternative for the acceleration of ions driven by high-power and high-repetition rate laser beams like the ones obtained using VEGA.
- The following improvements were installed as a result of the last calls for tenders of the 'Multi-shot with high repetition rate experimental campaigns' project framed in the Support for Scientific-Technical Infrastructures and Equipment 2018: ultrafast laser device for real time measurements based on the spectral phase interferometry for direct field reconstruction (SPIDER) technique; group of devices to measure ultrashort laser pulses using the d-scan dispersion scanning technique; and a closed adaptive optics

system to improve the focus of the high-intensity beam of the VEGA laser.

- Design and implementation of a new work area for VEGA-2, integrating VEGA-1 to be able to easily and clearly integrate the use of probe beams and the workstations to operate with secondary sources.

However, the most important occasion arrived in September 2021 when the Spanish Center for Pulsed Lasers was granted more than 3 million euros in funding for the design and creation of a new experimental area to make the facility more attractive to users and broaden the system's scope of applicability, to enable campaigns to be conducted simultaneously in both experimental areas, to install secondary sources available to the non-laser-expert national community, to allow advanced remote access, and to open a stable experimental data storage system to efficiently accomplish 'open' data procedures. This is unquestionably the most important project of the facility in the new period that starts after the facility was granted its indefinite nature. For further information, see the forthcoming 'Projects' section.

iii. Radioprotection Unit

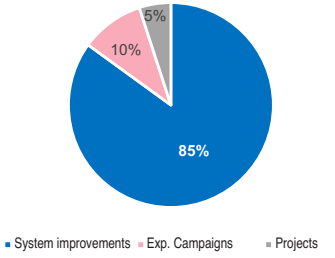
The Spanish Center for Pulsed Lasers is a second category radioactive facility, which is why it has a specialized unit for radioprotection. The CLPU was where laser-produced ionizing radiation was first obtained in Spain. For this reason, and always in collaboration with the Spanish Nuclear Safety Council (CSN), the Spanish Center for Pulsed Lasers works towards establishing safety standards linked to this new type of facilities. In 2021, work to include a new neutron source in the radioactive facility es undertaken, which is very interesting for users. In this regard, pre-operational testing before the entry into operation of the facility in 2022 was performed. Likewise, the process for converting the unit into the Service for Radioprotection, a change that had been requested by the Nuclear Safety Council in July 2020, continued. Several requests for additional information were answered and, in December 2021, the first technical inspection prior to its authorization was carried out, which is expected to be completed next year.

iv. Complementary services

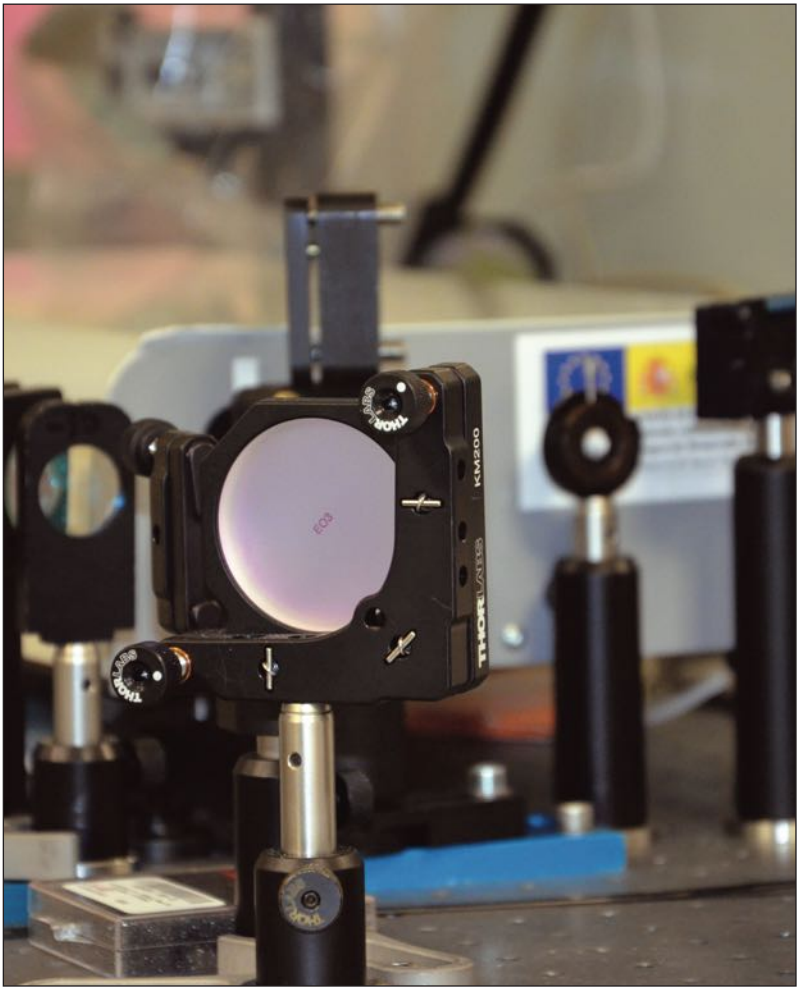
The users of the facility have the added benefit of access to other complementary services that allow them to customize the experimental setup and/or targets required. In this regard, two essential facilities stand out:

- Mechatronics workstation, which is the machining and electronics workstation of the Spanish Center for Pulsed Lasers that users can count on for the adaptation of any piece and/or system that their experiment may require. It is also a useful service for the new implementations that the facility plans for the improvement of its integral service to users, since it does not rely on external services and the production and adjustment of pieces can be monitored from their design to the material used. For further information:

  https://www.clpu.es/Mecatronica_Introduccion



- ULAMP, Ultrashort Laser Applications and Micromaterial Processing, groups the workstations that are linked to the Spitfire high-repetition rate laser system. In 2021, it has been operational for more than 700 hours, mainly for the creation of pinholes in experimental setups and for target design. Additional information is available at:
  https://www.clpu.es/ULAMP_Caracteristicas_Tecnicas



c) Projects

Multi-shot with high-repetition-rate experimental campaigns

Ministry of Science Innovation and Universities/Support for scientific-technical infrastructures and equipment 2018

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Aim:

To adapt the Center's first experimental area so that users can make effective, relevant and safe use of VEGA's technology.

Actions:

All the devices acquired and set up in 2020 were set in motion in 2021 and the tenders proposed for the project were concluded. Specifically, equipment for laser time measurements, as well as devices for the measurement and correction of VEGA-2 using wavefront sensors and a deformable mirror were purchased.

477.680,00 € (100 % used)	From 01/01/2018 to 31/03/2021 (100 % completed)

Reorganization of the lines of the laser system VEGA for Pump & Probe experiments

Ministry of Science and Innovation/FEDER Multiregional Operational Program for Spain 2014-2020

Aim:

Presentation of the design to restructure the unique system's lines, increasing its operating modes and adding value to VEGA's capacities. The aim is to have new lines and a pump & probe system, based on the synchronization of VEGA with the CEP, a system with lower intensity but ultrashort duration (6 femtoseconds) beams that allows an extraordinarily accurate time discrimination.

Actions:

All the material corresponding to the bidding for this action was received and most of this equipment was installed, set up and put into operation: optical table for the delay line, adaptive optics system, spatio-spectral characterization system to improve the metrology of VEGA-2 and VEGA-3, two new fused silica windows for the cryogenic system of VEGA-2, a set of ultraviolet lamps to clean the compressors' elements and a high-speed long-travel linear motor to allow the transition in VEGA-3 between single-shot and 1 Hz without quality characteristic changes. Also, the first prototype of beampointing maintenance system was implemented for use in the additional propagation of VEGA-2 in the delay line and of VEGA-3 without compressing, and the vacuum system required for the uncompressed propagation to the experimentation area of VEGA-1 was tested. It has been possible to synchronize VEGA-2 and VEGA-3 with a resolution below 200 picoseconds, and the synchronization of VEGA with the CEP has also been achieved.

480.000,00 € (89,80 % used)	From 01/01/2020 to 31/12/2022 (66,67 % completed)

Construction and equipping of experimental area 2 (AREX2)

Ministry of Science and Innovation/ICTS 2021
Recovery and Resilience Plan

Aim:

To design, build and equip a new experimentation area to increase user capacity and the number of experimental campaigns per year, to capitalize on the high-repetition shot rate offered by the VEGA system, to enable the implementation of simultaneous campaigns in both experimental areas, to install permanent secondary sources so that the non-laser-expert national community may have access, to allow advanced remote access and open a stable experimental data storage system so that the infrastructure can become a source of open data.

Actions:

Granted in September 2011, the first scientific-technical meetings to design the area were held.

3.018.000,00 € (0 % used)	From 01/09/2021 to 31/12/2025 (7,69 % completed)

Laserlab-Europe V

UNIÓN EUROPEA

H2020/INFRAIA 2018

Laserlab Europe

Aim:

It is an interdisciplinary network of national laser laboratories across Europe whose aim is to strengthen the leading role in research on and with laser by fostering joint research activities and offering calls for access to state-of-the-art laser equipment boosting cutting-edge research.

Actions:

One of the most outstanding is the inclusion of VEGA's laboratory among the Laserlab facilities that can be accessed, allowing this network to be activated as a co-financing route for the competitive accesses that were offered in the third call that was launched at the end of 2020 and resolved in the middle of 2021. Of the 7 experiments that were selected by the Access Committee, 6 were approved for Laserlab's transational access program, which allows their cofounding. On the other hand, the Network on Extreme Intensity Laser Systems (NEILS) took place on 24 and 25 November, still in virtual conference form. Additionally, the Spanish Center for Pulsed Lasers has continued collaborating in the five joint research activities (JRA) that it participates in:

- Spatio-temporal metrology of advanced laser sources. Actions in this area have consisted of a work of correlation to measure pulse duration in the experimentation area during the competitive campaign led by Alesio Morace at the beginning of the year. Its publication is being prepared.
- Future electron and secondary radiation sources for user applications. This research project includes the preliminary work carried out by researchers of the Spanish Center for Pulsed Lasers for the setting up of a laser-induced betatron X-ray source.

- Ion sources with high-repetition rate selected energies for applications. Here we should emphasize the collaborations of the Spanish Center for Pulsed Lasers in the experimental campaigns of the researchers Alessio Morace (January 2021) and Joao Santos (June 2021) [For further information see section 'Experimental Campaigns' under VEGA Unique Infrastructure Functional Unit].
- Standardization and automation of the ion spectrum measurement process. In this task we must once again highlight the Center's collaboration with the experimental campaigns undertaken by Alessio Morace (Osaka Univ., Japan) and Joao Santos (Univ. Bordeaux, France). In addition to these studies is the assessment test and commissioning of the scintillation detector developed by the infrastructure.
- Development of phase-contrast images based on high-repetition rate laser-driven X-ray sources that may allow temporal resolution measurements of materials, biological samples and Warm Dense Matter (WDM) plasmas. The Spanish Center for Pulsed Lasers has contributed to the research carried out at the end of the year for the setting up of a laser-induced betatron X-ray source.

207.150,00 € (3,41 % used)	From 01/12/2019 to 30/11/2023 (52,08 % completed)

Radiation facility network for the exploration of effects industry (RADNEXT)

UNIÓN EUROPEA

H2020/INFRAIA 2020

RAD NEXT

Aim:

The purpose of this project is to create a diverse network of facilities with equipment to carry out tests for the study of the effects of spatial radiation on electronic products. The available beams that are offered to users through a transactional access process range from X-rays and energetic electrons to protons and heavy ions.

Actions:

During 2021, up to 2 calls for access have been launched, in none of which have viable proposals been presented for the CLPU.

89.687,50 € (0 % used)	From 01/06/2021 to 31/05/2025 (14,58 % completed)

Integrated management & reliable operations of user-based laser scientific (IMPULSE)

H2020/INFRADEV 2018

IMPULSE

Aim:

This project addresses the analysis of the scientific, technical, organizational and management requirements needed for efficient functioning of the pan European infrastructure ELI (Extreme Light Infrastructure) alongside the creation and consolidation of national user communities and the expansion of the consortium of ELI members.

Actions:

The Spanish Center for Pulsed Lasers takes part in this European project in two work packages:

- Progress towards excellent procedures in operability with laser systems – Its main goal is to establish and implement detailed procedures for the working of the experimental systems offered by ELI, and analogous associated facilities. In this regard, a study of electromagnetic pulse metrology capturing and recording them to optimize user access to the infrastructure has begun. Electromagnetic pulses not only contain information about interaction, but also about the experimental environment that define unique parameters, such as fingerprints. These data have great scientific relevance and added value for users. Additionally, work on the development of a new type of metrology based on the implementation of a spectral-spatial resolution detector for laser-accelerated ion beams that can work at high-repetition rates has been undertaken. Improved documentation on diagnostics, equipment, consumables and existing software applications has been drawn up and made available to the center and its users by means of a Wiki application, thus contributing to standardization. Finally, in accordance with the mentioned work, control programs

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 871161

for standard diagnostics have been developed, such as those designed for the ion and electron spectrometer line.

- Promotion of ELI and disclosure – The aim of this work team is to boost the promotion and disclosure of the scientific-technical area of expertise linked to ELI-ERIC and its partners, including areas such as training and scientific diplomacy. This year, the collaboration of the Spanish Center for Pulsed Lasers through its hired person has involved organizing and/or participating in several events such as: European Conference on Plasma Diagnostics, EPS Satellite Meeting, LaPlaSS Summer School, Laserlab User Meeting, First Annual IMPULSE Meeting and First ELI-ERIC Iberian Information Day. Additionally, work has been dedicated to preparing a brochure focused on new applications of laser technology in the cultural heritage domain.

450.689,79 € (15,78 % used)	**From 01/11/2020 to 31/04/2024 (33,33 % completed)**

RESEARCH AND TRAINING

This functional unit has an essential pillar, not only in the area of research, but mainly in that of specialized training. It is the CLPU Laser-Plasma Chair of the University of Salamanca, created in 2014 at the request of the Advisory Committee and as a result of the collaboration between both entities: Spanish Center for Pulsed Lasers and University of Salamanca. Many actions have been carried out since then, the most outstanding that took place in the year addressed in this report being the following: organization of the open day for students of the Faculty of Sciences and related sciences; talks on plasma-laser specialization at the University of Salamanca; presentation of a European project framed in the MSCA calls; organization of different international events such as the European Conference on Plasma Diagnostics, the EPS Satellite Meeting; and, of course, the LaPlaSS international summer school, this time in its fourth edition.

a) Publications

During this year, the scientists of the infrastructure, in addition to collaborating with the experimental campaigns carried out by users on the premises, have taken part in the publication of relevant results, among which are different publications in high-impact journals and the editing of one of the chapters of the Progress in Ultrafast Intense Laser Science XVI specialized book:

> Mirani, F.; Maffini, A.; Casamichiela, F.; Pazzaglia, A.; Formenti, A.; Dellasega, D.; Russo, V.; Vavassori, D.;Bortot, D.; Huault, M.; Zeraouli, G.; Ospina, V.; Malko, S.; Apiñaniz, J.I.; Pérez-Hernández, J.A.; de Luis, D.; Gatti, G.; Volpe, L.; Pola, A. and Passoni, M., Integrated quantitative PIXE analysis and EDX spectrocopy using a laser-driven particle source, Science Advances vol. 7, 03 (2021)[1].

1 Results associated with the Laser-driven secondary sources for material science application experimental campaign carried out at the Spanish Center for Pulsed Lasers in May 2019.

> Apiñaniz, J.I.; Malko, S.; Fedosejevs, R.; Cayzac, W.; Vaisseau, X.; de Luis, D.; Gatti, G.; McGuffey, C.; Bailly-Grandvaux, M.; Bhutwala, K.; Ospina-Bohorquez, V.; Balboa, J.; Santos, J.J.; Batani, D.; Beg, F.; Roso, L.; Perez-Hernandez, J.A. and Volpe, L. A quasi-monoenergetic short time duration compact proton source for probing high energy density states of matter, Scientific Reports 11, 6881 (2021).

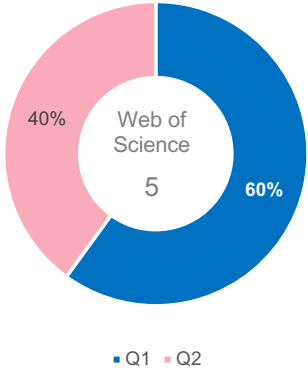
> Pastor, I.; Álvarez-Estrada, R.F.; Roso, L.; Guasp, J. and Castejón, F., Electron Dynamics and Thomson Scattering for Ultra-Intense Lasers: Elliptically Polarized and OAM Beams, Photonics 8,182 (2021).

> Azteni, S.; Batani, D.; Danson, C.N.; Gizzi, L.A.; Perlado, M.; Tatarakis, M.; Tikhonchuk, V. and Volpe, L., An evaluation of sustainability & societal impact of high power laser & fusion technologies: a case for a new European research infrastructure, High Power Laser Science & Engineering, e52 (2021).

> Curcio, A. Recirculated wave undulators for compact FELs, Applied Science-Based, vol.11, nº13 (2021)

> Roso, L.; Pérez-Hernández, J.A; Lera, R. and Fedosejevs, R., The role of the ponderamotive force in high field experiments, Progress in Ultrafast Intense Laser Science XVI, Vol. 141, Chapter Book (pp.149-177).

Quartiles (JCR 2020)



b) Scientific contributions

i. Conferences

In 2021, the researchers at the infrastructure made several scientific contributions addressing different areas of expertise in different events at the international level, many of them still held online:

> Volpe, L., High power lasers for studying proton stopping power in extreme state of matter, International School of Physics & Allied Disciplines, ISPAD, 9-11 march 2021, Online [Guest presentation].

> Huault, M., A 2D scintillator-based proton detector for high repetition rate experiments, ECPD2021, 7-11 june 2021, Online [Presentation].

> Puyuelo, P., Laser-driven ion acceleration with a liquid sheet at HRR at CLPU, ECPD2021, 7-11 june 2021, Online [Presentation].

> Volpe, L., Near-Bragg peak ion stopping power measurement in WDM experiment in ultrahigh and short repetition rate laser facilities, 47th Conference on Plasma Physics 2021, 21-25 june, Online [Guest presentation].

> Touati, M., Relativistic collisionless shocks: microphysics & long-time dynamics, 47th Conference on Plasma Physics 2021, 21-25 june, Online [Presentation].

> Roso, L., The Spanish Petawatt Laser, EPS Satellite Meeting 2021, 28-29 june, Online [Guest presentation].

> Roso, L., Future scattering experiments between infrared photons using big lasers as a QED test, XFEL Workshop, 10-11 june 2021, Online [Presentation].

> Malko, S., Experimental campaign performed at CLPU where proton stopping power in WDM was measured at HRR, ECPD2021, 7-11 june 2021, Online [Guest presentation].

> Roso, L., Review of fs lasers and their capacities in different sectors, Laser Technology in Archaeology and Cultural Heritage Material Science, Specific Targeted Workshop (STW2), ED-ARCH-MAT, 15 july, Online [Guest presentation].

> Puyuelo, P., Faisceaux d'ions accélérés par interaction d'un laser intense avec un jet de gas dense, 11ème Forum Laser et Plasmas, from 27 september to 1 october, Bastia (France) [Guest presentation].

> Roso, L., Towards the measurement of the quantum--vacuum Lagrangian coupling coefficients using two counter propagating super-intense laser pulses, Extremely High Intensity Laser Physics Conference (ExHILP 2021), 13-17 september, Online [Presentation].

> Ehret, M.et al., Working Package 3 – Ramping-up Towards Excellent Steady-State Operations, IMPULSE First Annual Meeting, 19 october, 2021, Online [Presentation].

> Morabito, A., Working package 7 (WP7)- Promote the IMPULSE project and ELI through activities aiming at attracting new members and strategic partners within ELI, IMPULSE First Annual Meeting, 19 october, 2021, Online [Presentation].

> Ehret, M.; Volpe, L., et al., Working Package 3.2 – Sources and metrology devices at CLPU, IMPULSE Expert Meeting, 21 october, 2021, Online [Presentation].

> Ospina-Bohorquez, V.; Salgado, C.; Ehret, M.; Consoli, F. et al, Experimental & numerical investigations of ion acceleration by ultraintense laser pulses in near-critical transparent gas jets, 63rd Annual Meeting of the APS Division of Plasma Physics, 8-12 november 2021 [Presentation].

> Apiñaniz, J.; Malko, S., Salgado, C., et al., A quasi-monoenergetic compact proton source for probing high energy density states of matter at high repetition rate, 63rd Annual Meeting of the APS Division of Plasma Physics, 8-12 november 2021. Online [Presentation].

> Roso, L., Spanish involvement and research, First Introductory ELI-ERIC Iberian Day, 12 november, 2021, Online [Guest presentation].

> Volpe, L., Education and Training – Spanish experience, plans, courses, summer schools, First Introductory ELI-ERIC Iberian Day, 12 november, 2021, Online [Guest presentation].

> Ehret, M. et al., Compact laser-driven wire-loops as ion beam shaping and guiding elements, The 30th International Toki Conference on Plasma and Fusion Research, 16-19 november, 2021, Online [Guest presentation].

> Roso, L., CLPU, Laserlab Europe User Meeting, 22-23 november, 2021, Online [Guest presentation].

> Pérez-Hernández, J.A., Facility Updates, CLPU, NEILS Meeting 2021, 24 november, 2021, Online [Presentation].

> Pérez-Hernández, J.A., Henares, J.L., Remote access / Staff assisted experiments, NEILS Meeting 2021, 24 november, 2021, Online [Presentation].

> He, C.; Longman, A.; Ravichandran, S.; Apiñaniz, J., et al., Characterizing relativistic Thomson scattering angular distribution as a function of laser intensity, Mid-Atlantic Section Meeting 2021, 3-5 december, 2021 [Poster presentation].

ii. Other events – Specialized training

In the context of specialized training, as already indicated, one of the most important events is the fourth edition of the LaPlaSS international summer school, delivered still online, organized by the Center via the Laser-Plasma Chair of the Spanish Center for Pulsed Lasers. Laser-induced plasma is a key area of research in modern intense laser research facilities. The main purpose of the LaPlaSS summer school is to train students in the emerging field of laser-induced plasma physics and laser acceleration of particles, both research fields being closely linked to ultra-intense and ultrafast lasers like VEGA. The fourth edition of the school, under the title "Experimental methods in plasma generation processes using high-intensity lasers" was supported by the IMPULSE European project. The contributions made to the school by the Center's expert staff were as follows:

Curcio, A., Radiation mechanisms in ultra-short laser-plasma interactions, LaPlaSS2021, 27 September to 1 October, Online [Guest presentation].

Roso, L., Extreme Intensity Measurement, LaPlaSS2021, 27 September to 1 October, Online [Guest presentation].

Volpe, L., Measurements of Particle and plasma parameters in extreme state of matter, LaPlaSS2021, 27 September to 1 October, Online [Guest presentation].

Pérez-Hernández, J.A., Experimental activities at CLPU, LaPlaSS2021, 27 September to 1 October, Online [Presentation].

Henares, J.L., Laser-driven ion acceleration by supersonic gas jet targets, LaPlaSS2021, 27 September to 1 October, Online [Presentation].

Apiñániz, J., Introduction of laser ion diagnostics, LaPlaSS2021, 27 September to 1 October, Online [Presentation].

Morabito, A., Transport & manipulation of laser-driven proton beams for diagnostics and applications, LaPlaSS2021, 27 September to 1 October, Online [Presentation].

Volpe, L., Scintillator-based proton detector at HRR, LaPlaSS2021, 27 September to 1 October, Online [Presentation].

Lera, R., Spatio-temporal diagnostics in ultra-short lasers, LaPlaSS2021, 27 September to 1 October, Online [Presentation].

Ehret, M. et al., Measurements of rapid electromagnetic phenomena, LaPlaSS2021, 27 September to 1 October, Online [Presentation].

García, E., VEGA, CPA laser chain, LaPlaSS2021, 27 September to 1 October, Online [Presentation]

In addition to this activity, two specialized training seminars were delivered online:

Roso, L., All-optical studies of the quantum vacuum & other fundamental questions enable by multi-petawatt lasers, ISUILS VII Online Seminar, 16 November 2021 [Guest presentation - Seminar].

Ehret, M.; Apiñaniz, J.; Malko, S.; Sopina-Bohorquez, V.; Salgado, C.; Volpe, L. et al., Ion acceleration by an ultrashort laser pulse interacting with a near-critical-density gas jet and perspectives to micro-compression, GSI Plasma Physics Seminar, 22 June 2021, Online [Guest presentation - Seminar].

c) Projects

Research on pathways to inertial fusion energy at Centro de Láseres Pulsados

IAEA

International Atomic Energy Agency – IAEA

Aim:

The infrastructure collaborates with the agency in a project that seeks to achieve progress in three crucial lines of research: progress in all science underlying fusion energy, development of suitable technology for this aim with high-repetition rate systems such as VEGA, and development of next generation diagnostics.

Actions:

During this annuity, the Spanish Center for Pulsed Laser participated in two virtually organized specialized events that addressed issues related to the project:

- Technical Meeting on Advances in Laser Driven Neutron and X-Ray Sources and their applications (8 - 11 February)
- Technical Meeting on Main current problems and feasibility of IFE (7 – 11 June)

From 25/08/2020 to 31/12/2024
(30,76 % completed)

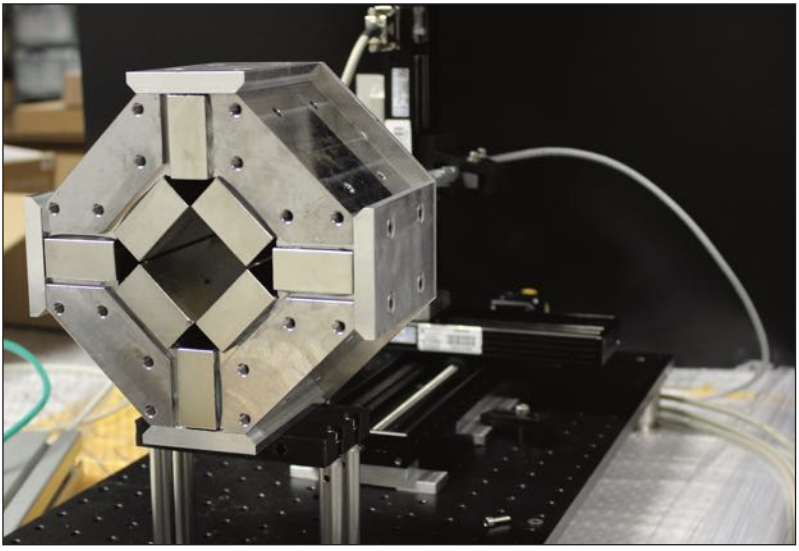
Transport and handling of particles in laser accelerators: new scenarios in FLASH (TYMPAL)

Junta de Castilla y León

Regional Government of Castile and León / Support program for research projects co-funded by European Regional Development Fund

Aim:

To design and build loaded particle transportation tools that are adapted to secondary laser-generated radiation sources. This entails considering parameters such as shot-to-shot instability, emission angles, spectrums, etc. in this type of accelerators.



Actions:

In 2021, a proton transportation line with two main elements was designed. First, work was carried out on a three-quadrupole system aimed at driving and concentrating the proton beam. This involved several experimental and dummy tests aimed at achieving the best

configuration according to project requirements. In this case, since the proton beams generated by laser interaction have very specific angular spread and energetic characteristics that are not common in other types of laser accelerators, the option of developing a tool in Phyton to simulate the evolution of the proton pulse along the transport line was chosen. The position of the quadrupoles that best fit the requirements of each test can be defined by using this script. These simulations have been tested against other programs that are commonly used in this field such as MCNP6 (Monte Carlo N-Particle transport) y ASTRA (A Space Charge Tracking Algorithm, DESY, Hamburg 1997), thus corroborating the tool's validity.

The second main aspect was the beginning of a study of a vacuum-air interface to run tests without the constrictions associated with vacuum. In 2021, the MCNP6 program was used for several studies, not yet concluded, involving the analysis of the proton stopping power in these windows, the doses that are transmitted through them (Bragg peak), or the critical parameters in terms of choosing the thickness of these materials.

264.000,00 € (56,07 % used)	**From 01/11/2020 to 31/10/2023 (38,88 % completed)**

European Network for Innovative Training Programme

Ministry of Science and Innovation/National Plan for R+D+I)– Research Europe

Aim:

To hire an expert for advice in the drafting and improvement of the European project submitted by the entity for the creation of a specialized training network to support predoctoral students in research and innovation areas.

Actions:

In 2021, in the framework of this program, the 'Ultrafast Laser-Plasma processes at high-intensities and applications (ULPHIA)' proposal was prepared for the Horizon Europe MSCA-DN call. For this purpose, the appropriate meetings were held with all the partners involved to define each task and responsibility, also collaborating with a consulting firm that contributed to the definitive approach and drafting of a proposal that was finally submitted in November.

15.000,00 € (44,59 % used)	**From 01/11/2020 to 31/10/2022 (58,33 % completed)**

Technological developments for the optimization and extension of the VEGA petawatt laser system

Ministry of Science and Innovation/State Program for the promotion of Skills and Employability in R+D+I

Aim:

The project proposes the hired technician's participation in the design and implementation of new developments, improvements and modifications to the system that might be required to improve quality of service to VEGA users. Specifically, the project agreement focuses on the development of additional elements that optimize the use and maintenance of VEGA and on the improvement and extension of other already existing ones.

Actions:

During this year, the project was completed by executing the following relevant items: commissioning of the automatic leak detector of the technical corridor; commissioning of the VEGA metrology data automatic system, which enables the collection of information from the computers that are connected to VEGA's metrology systems and makes it possible to upload them to the Center's server in a structured manner so that they can be conveniently consulted by users; VEGA functioning detection system, which picks up the signal that comes from the laser system's amplifiers to discriminate its status and send the corresponding signal to the Center's display elements.

39.500,00 € (100,00 % used)	From 01/09/2019 to 31/10/2021 (100,00 % completed)

Radiological protection plan in the CLPUS authorized radioactive facility

Ministry of Science and Innovation/State Program for the promotion of Skills and Employability in R+D+I

Aim:

To develop a radiological protection plan for the entity including procedures and drafting of the necessary reports in collaboration with the regulatory body.

Actions:

In 2021, the fundamental tasks of the project continued: supervision of the authorized radioactive facility (IRA 3254), radiation monitoring (which includes detection equipment, verifying the proper functioning of the network, RVR entries, natural events entries, personal dosimetry, and the PSS system), as well as the drafting of the required documentation for the authorized radioactive facility (documentation about the radiological protection unit, documentation required by the Nuclear Safety Council, information requested for the setup of the radioprotection service, radiological protection training and dissemination and Monte Carlo simulations).

39.500,00 € (100,00 % used)	From 01/09/2019 to 31/10/2021 (100,00 % completed)	

Synchronization of beam outputs of VEGA-3 petawatt laser system

Ministry of Science and Innovation/State Program for the promotion of Skills and Employability in R+D+I

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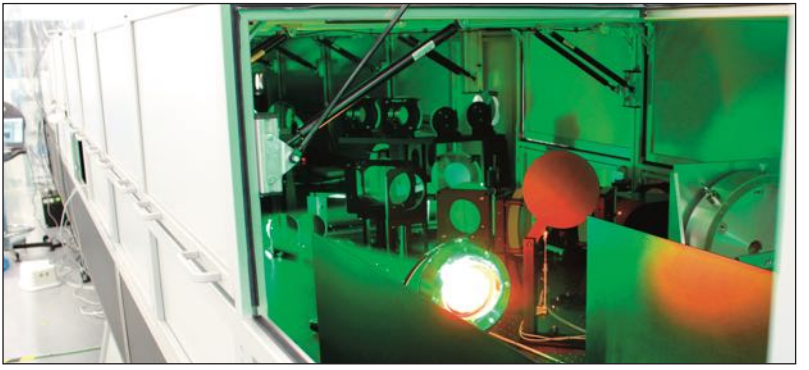
Aim:

To collaborate in the implementation in the experimentation area of the installation of the systems required for the synchronization of the petawatt laser beam outputs.

Actions:

During 2021, work on the commissioning of the ABB IRB 120 Robot and the specification of its applications in the experimentation area has continued. Likewise, the Center has participated in the study, design and implementation of loop systems to achieve stability of the laser's parameters, and has continued to study slow, medium and high-speed synchronization systems, including the analysis of optical/electronic subsystems.



47.308,49 € (93,30 % used)	From 01/10/2019 to 28/02/2022 (93,10 % completed)

TRANSFERENCE AND INNOVATION

a) Innovation services

ULAMP – Ultrashort Laser Applications & Micromaterial Processing

The ULAMP laboratory offers a high-quality specialized service for laser material processing both for scientific research and for industrial innovation. Its main bastion is a Spitfire high-repetition rate laser system, a femtosecond commercial equipment that offers a high-quality laser beam with excellent shot stability (shot-to-shot).

Its characteristics are ideal for the study of the interaction of ultrashort pulses with solid targets and for use in materials processing. The pulse's short time duration affords the possibility of eliminating submicrometric layers of material with minimum thermal effect since they take place at larger temporal scales. This selective material removal process is known as ultrafast laser ablation.

Also, this type of ultrashort laser allows the observation and control of changes in certain material properties (refractive index, reflectivity…) both on the surface and at the bottom of transparent materials. The laboratory includes different experimentation areas: a high precision processing area, an experimental workstation for automation processes and where the trephine can be used, a CO_2 processing workstation, and a general processing area. Further information is available at:

https://www.clpu.es/en/ULAMP_TechnicalFeatures

LITeL – Laboratory of Innovation and Technology in Lasers

This laboratory was designed to offer solutions and assistance for industrial and scientific users in the development of their applications in the field of solid-state laser, optics and photonics areas, as well as to promote new system designs and optimization studies.

The main purpose of the LITeL is to develop new sources of laser light, advanced photonic technology, laser components and new laser system designs that may benefit the development, promotion and marketing of new laser platforms based on solid state media and their associated frequency conversion techniques.

In 2021, the laboratory focused on the development of the SIGILAR project, whose details are provided in the "Projects" section of this functional unit. For further information on this laboratory:

https://www.clpu.es/en/LITeL_TechnicalFeatures

b) Conferences

In accordance with the infrastructure's strategic line for the promotion of innovation in the areas of smart and sustainable growth, the Center has collaborated on several platforms through industry-oriented specialized seminars and conferences:

Roso, L., García, P. and Lera, R., Cryogenics, vacuum and extreme lasers, Large Scientific Facilities Conference: Center for the Development of Industrial Technology (CDTI)-Industry and Science Technology Platform (INDUCIENCIA) 'The Industry of Science at the Forefront of Recovery 2021', 26 January 2021, Online [Guest presentation]

Roso, L., Laser technology as a crosscutting tool for innovation, Public-Private collaboration opportunities in Castile and León in the area of Unique Scientific and Technical Infrastructures (ICTS), 20 May 2021, Online [Guest presentation]

Roso, L., Introduction to large facilities: the Spanish Center for Pulsed Lasers, bilateral conference Extreme Meeting II: Fusion-a2, 23 September 2021, Salamanca [Guest presentation]

Roso, L., participation in the 'Innovation and Research: how to make the seed of high-tech centers grow', Round Table in the frame of the II 'White Book for the Development of Salamanca' Conference organized by La Gaceta, 18 October 2021 [Guest presentation]

c) Collaborations

In the area of collaboration with companies for the boosting of knowledge transfer and for the sake of innovation, the Center for Pulse Lasers continues to participate on several platforms and fosters the

development of new agreements that emphasize this strategic action.

As regards platforms, an important accomplishment has been the incorporation of the infrastructure into the Enterprise Europe Network (EEN) European network, which it has joined through its national contact point, the Institute for Business Competitiveness of Castile and León. The EEN is the most important international support network for small and medium-sized enterprises that seek to extend beyond their borders. In this area, the Center has been included as an expert body and has launched the patented utility model together with the Alba unique scientific and technical infrastructure as a technological novelty available over the network.

In addition, the Spanish Center for Pulsed Lasers continues to closely collaborate with the Induciencia innovation platform, which it has worked with at several scientific-technical events such as the second edition of the Spanish Center for Pulsed Lasers' Extreme Meeting, which this year focused on nuclear fusion with Fusion-a2 (jointly organized with the IFMIF-DONES Consortium).

Likewise, the infrastructure has remained active on the Digital Innovation Hub platform of Castile and León (focused on training and support for the adoption of IoT systems and other disruptive technologies), Fotónica 21 (whose main goal is to efficiently promote photonics in the process of industrial innovation), and PEPRI (national forum aimed at encouraging research and development in the area of radiological protection).

ENN Induciencia DIH Fotonica 21 PEPRI

Regarding specific knowledge transfer actions, the most important have been the confidentiality agreements established with the Tecnobit and S.I.T. Sordina IOT companies, in addition to other agreements of a scientific nature such as the one signed with the Complutense University of Madrid for the transfer of equipment or the collaboration agreement with the University of Alberta (Canada).

d) Projects

High-power pulsed laser guided system in the military field (SIGILAR)

Ministry of Defense/Program for Cooperation in Scientific Research and Development of Strategic Technologies (COINCIDENTE)

Aim:

To develop a laser demonstrator with a peak power greater than 15 kW that can fire in a stable way and can be fitted on a platform with a beam control and operation system to perform tests in field trials.

Actions:

First phase completion of the integration of the laser subsystem into the demonstrator and testing of materials that has allowed both the verification of its capacity and the improvement of its technical specifications; the second period involved collaboration with the subcontracted company EM&E in the development of the subsystem's directing platform and its integration into the aiming subsystem developed by the Spanish Center for Pulsed Lasers. Finally, the integration of all the subsystems to put together the SIGILAR demonstrator that was delivered to the Ministry of Defense at the end of the year was carried out.

450.000,00 € (90,58% used)	From 01/01/2019 to 30/06/2022 (80,64 % completed)

Hybrid prototype base on laser boost of a Linac to obtain a ultrahigh high dose rate in radiotherapy (HYBRILIN)

Ministry of Science and Innovation/R+D+I Projects/Proof of Concept

Aim:

Based on the knowledge acquired during the previous project, PALMA, and the broad experience and high level of research that Salamanca has in the field of oncology, this project proposes the modification of a conventional accelerator of an existing Linac device to turn it into the first flash radiotherapy equipment based on laser technology.

Actions:

The project was launched in December 2021, which means that its implementation in the year analyzed has been only one month, this time being used to establish the initial contacts for the launching of the project.

97.750,00 € (0,00% used)	**From 01/12/2021 to 30/11/2023 (4,16 % completed)**

DISSEMINATION AND TRANSPARENCY

a) Dissemination activities

Given the added value they bring to the area of transparency, dissemination and promotion of science and the image of this entity, all the scientific-technical activities organized by the infrastructure are linked to this functional unit:

- ICTS-ICE Conference – organized in collaboration with the other two unique infrastructures of Castile and León (CENIEH and SCAYLE), held on 25 May.
- European Conference on Plasma Diagnostics – ECPD- biennial event that brings together scientists working on diagnostics for magnetic confinement fusion, plasmas and inertial fusion, industrial and low-temperature plasmas, and astrophysical plasmas. It was held online in June (https://www.clpu.es/en/ECPD2021).
- EPS Satellite Meeting, focused on High Field laser-plasma interaction (HIFI) & Laser-driven particle and radiation sources for application (LASA). Held online at the end of June (https://www.clpu.es/en/47ConferencePlasmaPhysics_Satellite_Meeting).
- II Extreme Meeting 'Fusion-a2 towards the future', a scientific-industrial conference co-organized in collaboration with the IFMIF-DONES and held in September to discuss the future of fusion in Spain (https://www.clpu.es/extreme_meeting_fusion-a2).
- LaPlaSS Summer School, the Spanish Center for Pulsed Lasers' specialized training event that was held online at the end of September (https://www.clpu.es/LAPLASS2021_Home)
- Laserlab User Meeting, organized by the CLPU and other representatives of the European project itself and held in mid-November as a closed online event.
- ELI-ERIC Iberian Information Day, an online conference organized in collaboration with the Extreme Light Infrastructure (ELI-ERIC) and the Technical Institute of Lisbon (IST) in the framework

of the IMPULSE project (see section of projects of the Unique Infrastructure's functional unit)
(https://www.clpu.es/ELI-ERIC_IberianDay)

Additionally, other dissemination activities have been promoted, such as:

- I Edition of the Garabalux Drawing Contest for primary education students of the province of Salamanca on the occasion of the International Day of Light, on 16 May.
- Guest participation at the Open School of the Fray Luis de León Secondary Education Center in Salamanca with the 'Laser: the light of innovation and its relevance in our daily life' workshop, 16 November 2021.
- Article 'A new step towards fusion energy thanks to lasers', written by Luca Volpe and José Antonio Pérez-Hernández for the local newspaper La Gaceta, on the occasion of the experimental results in the area of fusion obtained by the Livermore laboratory of the USA. Published on 25 September 2021.
- Organization of the 'Light Cycle' on the occasion of the Science Week of Castile and León held from 8 to 14 November with guest presentations on light by experts in different areas. For more information: https://www.clpu.es/Ciclo_Luz

b) Transparency and good practices

In 2021, much effort has been devoted to preparing an Equality Plan by its Negotiation Committee, using the equality policy approved by the entity's director as a basis. Thus, the Center falls into line with all the national and European movements whose aim is to make gender equality a reality in science and in society: basic research, the development of technologies, or decision making are some of the scopes of work.

Alongside this main objective, the fostering of transparency actions has continued through the improvement of the web portal by including information regarding electronic invoicing, which is currently part of the infrastructure's accounting procedure. Also, a new link has

been added to give greater visibility to all the activities reports published by the entity, as well as to the annual action plans and projects.

Also, the Spanish Center for Pulsed Lasers has continued to work for the adjustment and subsequent certification in the National Security Plan, a plan created for the safe management of electronic administration in keeping with the European regulatory context and mainly designed to strengthen cybersecurity. As a public consortium linked to the General State Administration, the Spanish Center for Pulsed lasers falls within its scope of application. The project included a first phase where the unique scientific and technological infrastructures involved were to work jointly with the National Cryptologic Center (CCN) to ensure the adequacy of the first measures: implementation of basic principles, establishment of minimum requirements… This action was coordinated by RedIRIS, which is the unique scientific and technological infrastructure in charge of providing the national scientific and university community with advanced technology and communications services.

As a result of this effort, last November, the team in charge of the computer systems of the ICT (Information and Communication Technologies) Center passed an audit based on the regulatory framework, and the operational steps envisaged for the facility started in mid-December. These measures include the modification of the communication policies for firewall navigation, use of electronic resources, documentary measures, training and awareness raising, etc. To ensure correct implementation, work this year revolved around the Center's systems, also training and raising awareness among its workers.

c) Projects

Luciérnagas

Ministry of Science and Innovation/Spanish Foundation for Science and Technology

Aim:

The project involved the design of a radio program consisting of a series of podcasts to support citizens in the learning and understanding of the reality of the scientific method and science linked to the physics promoted at the Unique Scientific and Technical Institution.

Actions:

The kickoff of the project took place in June with the recruitment of the person linked to the project and the first chapter was broadcast at the end of September, in compliance with the project's schedule. The following chapters were broadcast in 2021:

Of gods and masters of light, with the participation of José Joaquín Caerols, professor of Classical Philology at the Complutense University of Madrid, and Luis Roso, director of the Spanish Center for Pulsed Lasers. This first episode provides an introduction on the importance of light in culture and science.

Laser. From comic to science. On this occasion, Marvel's Spanish illustrator Salvador Larroca, and Carlos Albarrán, a laser technologist at the Spanish Center for Pulsed Lasers, were interviewed. Are technologies first heard of through cultural phenomena such as movies or comics? Are they faithful to reality? Should they be so?

Radiated by earthling. A third special episode that involved the guest collaboration of the commissioner of the Nuclear Safety Council, Francisco Castejón, alongside the physicist Guillermo Sánchez León, and the radioprotection expert technologist of the Spanish Center for Pulsed Lasers Ana María Cives. Radiation seems to always have harmful effects, but this is not so…

Movies, science fiction and fantasy, fourth episode that includes a relaxed conversation with scientist Jon I. Apiñaniz, of the Spanish Center for Pulsed Lasers. Where can we draw the line between fantasy and science fiction? The impossible in films such as the 'Star Wars' of 'Star Trek' sagas is dissected.

All the episodes can be downloaded from the main podcast platforms: iVoox, Spotify, Spreaker, Youtube and Google Podcast. Moreover, the Center created its own page to offer the opportunity of enjoying and downloading the contents, and even to comment on them and make suggestions using the 'Comments' section. Likewise, continuing with the special relationship between the infrastructure and the locality of Villamayor, where it has its headquarters, an agreement was established between the local radio station 'Arenisca' and the project so that the episodes were broadcast the first Sunday after their launching, thus increasing the project's quantitative impact. Finally, it is worth noting that, in line with its nature, one of the entity's goals has been to break down the barriers that audio content could involve for certain population groups affected by hearing impairments; hence, it has collaborated with the Federation of Associations for the Deaf of Castile and León which each month undertakes the translation of the contents into Spanish Sign Language producing subtitled videos that are uploaded to the Luciérnagas website and to the YouTube channel of the Spanish Center for Pulsed Lasers, in addition to their promotion on the Federation's Facebook channel.

20.000,00 € (44,37% used)	**From 01/07/2021 to 30/06/2022 (50,00 % completed)**