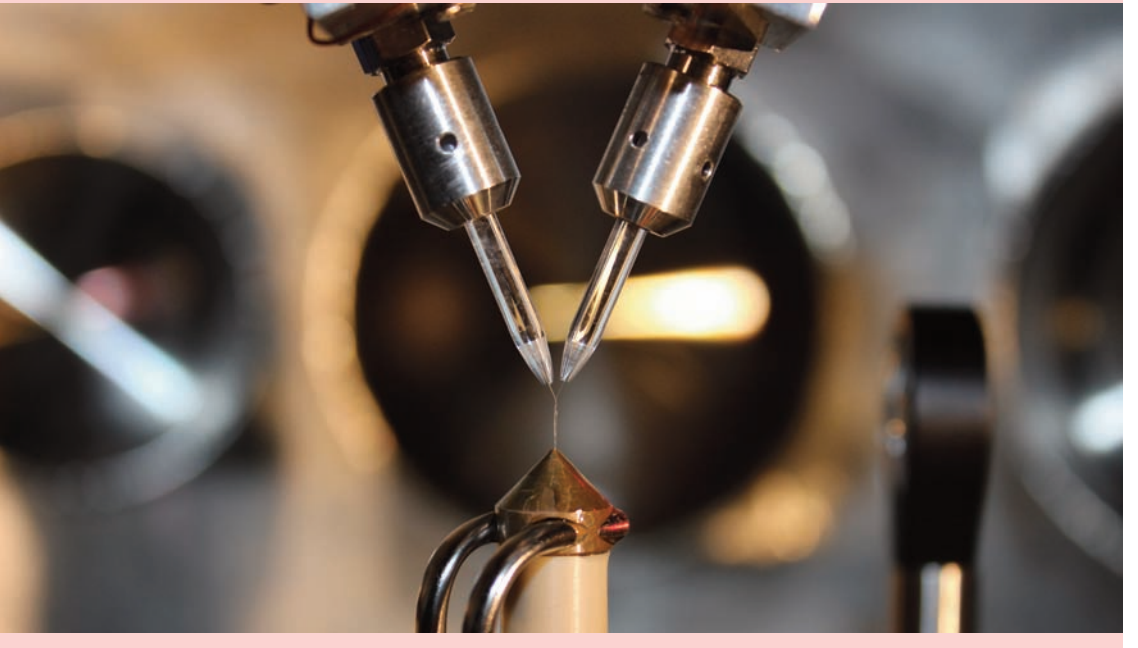
CLPU CENTRO DE LÁSERES PULSADOS

Activities report

2017



GOBIERNO DE ESPAÑA · MINISTERIO DE CIENCIA, INNOVACIÓN Y UNIVERSIDADES

Junta de Castilla y León

VNIVERSIDAD D SALAMANCA

UNIÓN EUROPEA

Una manera de hacer Europa

"Fondo Europeo de Desarrollo Regional"

welcome to clpu !

Picture obtained by proton radiography

Cover pircure: Continuous system laser target
Salamanca, 2018

MESSAGE FROM THE DIRECTOR

Each year, I face the challenge to approach this blank paper in order to mention the relevant events in the year and especially to try to express all the effort, the support and the constant work that the team of the Consortium of the Pulsed Lasers Centre has carried out in each of the initiatives included in this report. It has always been difficult to try to emphasize specific events among all our activities, because every detail is important for our final goal, no matter how small.

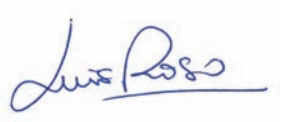
However, this year I can write these lines rapidly and without hesitation, and I feel even more hopeful than other years, because the main branch of our unique laser system, VEGA-2, is now open to users, and at the same time the construction of the experimental area of the VEGA-3 section has been completed. As a Unique Scientific and Technical Infrastructure (ICTS), the objective of the Centre is to offer international users unique and state-of-the-art equipment: VEGA, a system that stands out because of its power, which is relevant because of its high repetition rate, and which is unique because of its structure. This has been the year in which the unique nature of the CLPU has evolved as a true user's centre.

After receiving the notification from the Spanish Nuclear Safety Council that they had certified the 200 TW output for VEGA (VEGA-2), the first international call for competitive open access was announced. The uniqueness of this system was reflected on the results of a very successful call in which 29 applications were received that requested over 400 sessions (one session represents 8 hours of beam/laboratory use) out of the 100 sessions that were offered. A high percentage of these requests came from international institutions, 82% of which

came from Europe, and the rest from the United States, Canada and Japan. After a perfectly defined evaluation process with the participation of the Access Committee, made up of renowned national and international researchers, 7 proposals were selected for the development of state-of-the-art experiments in 2018. The partial operating capacity of the CLPU as an ICTS will be completed during 2018, because that is the moment when the Petawatt output of VEGA (VEGA-3) will be open for competitive international access.

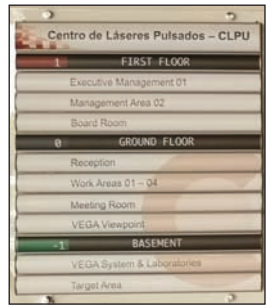
Together with this significant milestone, we must highlight again the progress made in all the areas of our infrastructure: our specialized technicians have made an immense effort to offer a 200-TW beam of great quality and stability; the necessary metrology and detection systems have been installed; industrial projects have been initiated; our scientists have worked painstakingly to start operations as a unique laboratory and they were the hosts of the different international events organized in 2017; and the management work has focused this year on the implementation of the Electronic Administration systems.

Thank you.



STATE-OF-THE-ART INFRASTRUCTURE

The Consortium of the Pulsed Lasers Centre is a specialized dynamization agent of the National System of Science and Technology. Its strategic mission is the promotion of fundamental and applied research and, of course, of innovation in ultrashort laser pulses.



As a unique scientific and technical infrastructure (ICTS), the CLPU has installed one of the ten most powerful lasers in the world, VEGA, with three synchronized outputs that provide versatility without any quality loss in the beam: VEGA-1, with 20 TW; VEGA-2, with 200 TW; and VEGA-3, with 1 PW of peak power. This has been a key year in the evolution of the Centre because its VEGA-2 beam has been announced for the first time in a call for competitive open access. With this initiative, the CLPU has moved from being an infrastructure under construction to being partially operative. In its next step, the start of activities of VEGA-3 will be the culmination of this long process in which the Consortium has promoted world-class state-of-the-art technology.

This report is merely a testimony of the activity that the staff in our Centre has carried out in 2017. In the following pages, the reader can see how the Centre acts according to the European standards for smart specialization of the territory, and how it contributes to RIS3 with the following strategies: reinforcing a more competitive and sustainable economic model through business innovation and the efficient use of its resources; advancing towards scientific and technological leadership; improving internationalization; and promoting multidisciplinary cooperation and the culture of innovation and creativity.

This cornerstone of smart growth is sustained by the CLPU on the basis of its state-of-the-art infrastructure, its user's centre for research and its structure as an agent that promotes knowledge transfer.

The first fundamental point is latest-generation technology. As a scientific and technological structure, the Pulsed Lasers Centre must cons-

tantly update its equipment to offer its users reliable, safe and advanced technology in optimal working conditions. This technology is mainly divided into two categories:

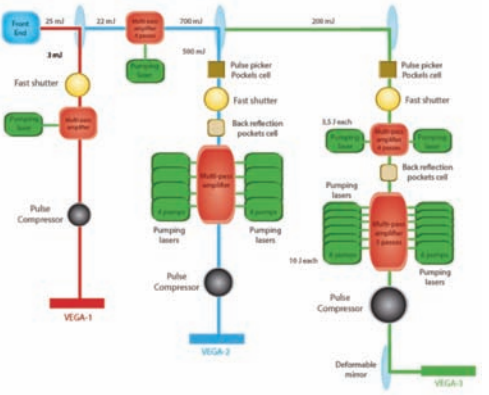
1. VEGA system, an extreme light beam that establishes the CLPU as a unique infrastructure which is mainly oriented to research in the frontiers of knowledge.
2. Primary sources and complementary units, with which the Centre expands and consolidates its community of users by promoting public-private collaboration and the development of applied research projects.

Unique system: VEGA

Equipment

In order to comprehend the VEGA system it is necessary to understand that the use of a laser with these characteristics does not only involve the installation and use of a complex and sensitive technology, but also the versatile design of an experimentation area and a beam transport system from its output point in VEGA to the area of interaction.

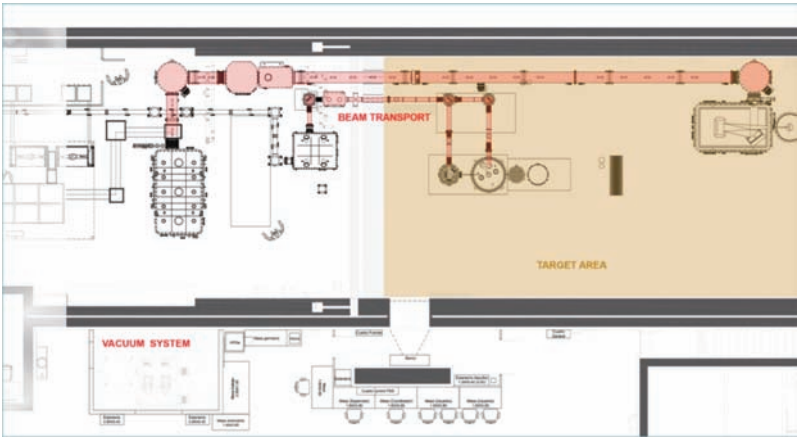
The VEGA system has a unique architecture with three outputs with different powers that are synchronized by a single front-end. It is a double Chirped Pulse Amplification (CPA) system based on Titanium-Sapphire technology which can reach a peak power of terawatts and/or Petawatts with an initial energy of a few millijoules.



Access to the laser system area is restricted for users, because it can only be operated by highly specialized CLPU staff.

However, the experimentation area has been designed, bu0ilt and equipped so that users can develop their experiments there.

The experimentation area is located inside a bunker. Until the CLPU was created, the Spanish Nuclear Safety Council had not considered the possibility that a laser might generate radiation, but the truth is that high-intensity laser systems like VEGA do generate radiation when they interact with matter. Thanks to the collaboration of both institutions, this new context of scientific and technological progress has been analysed and the Centre has developed a customized and specialized safety system that has become a reference for other laser installations. Inside this specially protected area, secured with physical barriers as well as with specific action protocols, users can prepare their experiments, always accompanied by researchers from the Centre. They have access to vacuum interaction chambers, since these high-intensity lasers cannot travel through air because they would ionize it and the beam would lose its quality. This has made it necessary to promote the development of a vacuum transport system for the beam that the CLPU has created thanks to an innovative public tender won by the Spanish company Added Value System – AVS. With this new system, the VEGA-2 and VEGA-3 beams travel in a vacuum from their respective compressors in the laser room until they get into the bunker and reach the interaction chamber when required by the different experiments.



The development and start of activities in the experimentation area with the VEGA-2 beam has been one of the main objectives of the Centre in 2017.

Services

	Peak Power	Energy/pulse	Duration/pulse	Repetition rate	Central wavelength
VEGA 1	20 TW	600 mJ	30 fs	10 Hz	800 nm
VEGA 2	200 TW	6 J	30 fs	10 Hz	800 nm
VEGA 3	1 PW	30 J	30 fs	1 Hz	800 nm

Apart from the fact that the duration of the ultrashort pulse is only 30 femtoseconds, VEGA stands out for its high repetition rate. In fact, it is one of the three only lasers in the world that can offer a beam with 1 petawatt of peak power with only 1 hertz (that is, one pulse per second).

All these high capacities of the laser system would not be so useful if the experimentation area were not versatile enough to take advantage of all its features.

Primary Sources and Complementary Units

High Repetition Rate Laser System (HRR)

Femtosecond laser system Spitfire (Spectra Physics) that can emit pulses of 7 mJ with a repetition rate of up to 1 kHz. It is based on CPA technology which is characterized by the high quality of its laser beam and the excellent shot-to-shot stability it provides. It operates with a wavelength of 800 nm, close to the infrared region of the spectrum, right at the border of visible range for the human eye.

HRR Laser System	
Energy/pulse	7 mJ
Peak power	60 GW
Duration/pulse	< 120 fs
Repetition rate	1 kHz
Pre-pulse contrast	> 1000:1
Wavelength	750 – 840 nm
Polarization	Linear

The characteristics of Spitfire make it a very adequate system for the study of the interaction of ultrashort pulses with solid targets and its application in material processing. In this regard, the CLPU has designed a microprocessing laboratory with three workstations plus a general workstation for the development of innovative laser applications and for increased versatility that expands its community of users. This laboratory is completed with the X-ray station for characterization purposes. When it was built, it became the first experimental station with laser-generated X-rays in Spain. The knowledge derived from this first source of soft X-rays was used to implement and improve new systems in VEGA. After these first objectives were reached, the laboratory was transformed into a conventional X-ray station which does no longer belong to the HRR laser system but which remains located in the same laboratory.

	Services provided by HRR	
WS01	High precision processing	It has a large optical table close to the laser room to avoid beam instabilities. Two micro-positioning systems have been installed, each of which is based on three axes connected to a programmable multi-axis controlled by a mechanical shutter and an optical attenuator, respectively. Another microprocessing system with a galvanometer is then added for better control of the laser beam, faster processing and greater reproducibility, similar to that of an industrial environment.
WS02	General microprocessing purposes	It is a very versatile experimental area with a large optical table for other processing tasks such as LITD application, single-shot micromachining with laser filamentation or other more basic types of processing.
WS03	Trepanning and automatization processes	This experimental station is isolated from other areas in a room with a robust optical table. The setup has been designed to operate with samples of large dimensions and to produce microstructures at a scale of 10-100 um. It can also produce circular structures with controlled conicity and dimensions.
	X-Ray Laboratory	
WS04	X-ray laboratory	For this laboratory, the Centre acquired in 2017 a new 50KV X-ray tube source that received authorization from the Spanish Nuclear Safety Council to start working at the end of September, and it has been active and available for users from that moment on.
	General Purposes Station	
WS05	General purposes	This is an optical table in which users can set up the experiments required in their research and which require a laser system like the HRR laser of our Centre.

Carrier Envelope Phase Laser System (CEP)

This 4th-generation femtopower laser system is a unique facility in Spain. It can emit ultrashort pulses with few cycles and stabilized carrier envelope phase. It operates at a wavelength in the near-infrared range with a spectral band of 50 nm FWHM after amplification and > 200 nm in the oscillator after compression. The unique characteristics of this system will become integrated in the unique VEGA infrastructure in 2018 to allow users to carry out synchronized pump-probe experiments at 5 femtoseconds.

CEP Laser System	
Energy/pulse	> 2 mJ (amplifier) ♦ < 0.6 mJ (post-compressed)
CEP stabilization	< 200 mrad rms (3 hours)
Duration/pulse	< 25 fs ♦ < 5 fs (post-compressed)
Repetition rate	80 MHz (oscillator) ♦ 1 kHz (amp., post-compres.)
Pre-pulse contrast	> 10^8:1
Central wavelength	790 nm
Polarization	Linear, p
Beam diameter (1/e^2)	20 mm amplifier
Energy stability	< 1.5% rms (1.000 shots)
Pointing stability	< 10 µrad rms
M^2 parameter	< 1,6

Oscilators Unit

The Oscillators Unit was designed to promote laser technology in an industrial environment. It is one of the units that have contributed the most to the strategy of promotion of knowledge transfer; it has facilitated the shift from analysis to implementation, from research to innovation.

With this unit, the CLPU wants to explore with its users new approaches in the development of laser technology, both with regard to the analysis of laser radiation of the beam and in the production of laser resonators with different nonstandard systems and optical elements; as well as to look for new criteria for the characterization of laser beams, of diagnostic systems or of amplifiers.

This service is located in the same laboratory as the high repetition rate laser system, although it is in an area where the beam cannot reach, since it is not necessary for the purposes of this Unit.

Microscopy Unit

It was the first service that was operational in the Centre. It represents a relevant support to research in different fields such as Chemistry, Geology, Biology or Engineering. It includes two different pieces of equipment:

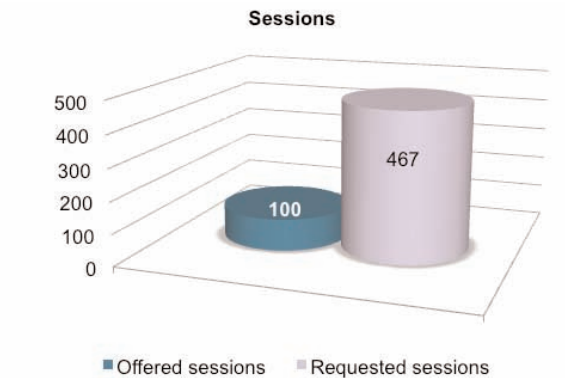
- Atomic Force Microscope (AFM): it is an opto-mechanical instrument that provides three-dimensional images (topographic) by scanning the surfaces of the analysed samples using a metallic sharp point of small dimensions. It makes it possible to characterize and see samples at a nanometric or even atomic scale. The maximum scanning area is 80 x 80 μm.
- Scanning Electron Microscope: the working methodology of this instrument involves scanning the surface of the sample by focusing an electron beam. It is an EVO HD25 device manufactured by the Carl Zeiss company which has been fitted with three additional detectors, apart from those included in the original piece: a STEM microscope, which is a kind of transmission electron microscope in which electrons pass through the sample; an EDS, which makes it possible to obtain the chemical composition of the sample; and an EBSD that measures the crystallographic orientation of the element that is being analysed.

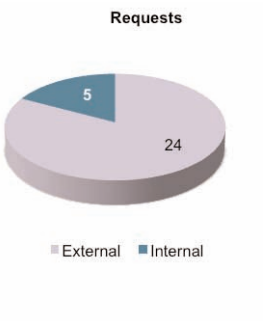
USER'S CENTRE

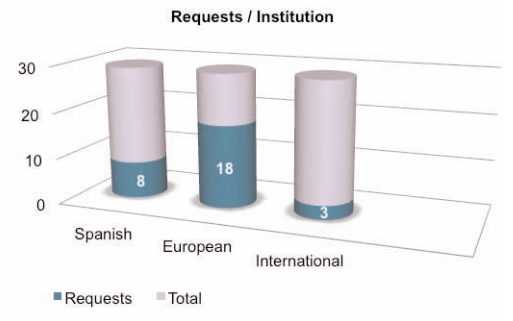
As a unique scientific and technical infrastructure, the Consortium of the Pulsed Lasers Centre has been defined, since its foundation, as a user's centre. For this reason, all the pieces of equipment that have been described in the previous sections are linked to their own specialized service that users can request online thanks to the digital tool FARO (Facilities Access Request On-line). This is an application developed by the Centre according to European and national regulations which allows users to interact with the different members of the staff of the CLPU who are responsible for each part of the process. This application is used both for competitive access (linked to VEGA) and for non-competitive access (mainly linked to all the other facilities).

Considering this, and since it represents a large percentage of the activity of the Centre, it is important to mention here the different research initiatives that have taken place in these services.

The first relevant element is the fact that 2017 was the year in which the first call for competitive open access was announced for the VEGA-2 output (200 terawatts). From April 1st to 31st, researchers from all over the world submitted their requests to perform their experiments in our facilities. The call offered 90% of all the beam time (with 10% for non-competitive access), that is, 100 sessions between October 2017 and October 2018. The calculation of the beam time that was offered was made after considering the time to carry out maintenance work of the equipment, updating, and operational tests that the specialized staff from the CLPU will carry out in 2018. Finally, the call received 29 applications that requested 467 experimental sessions, with the participation of 150 researchers from 51 institutions (see charts). These data clearly show the success of this first call.







After the period for submissions of proposals ended, the Internal Committee assessed the feasibility of the proposals with a final report that was sent to the Access Committee. This is the main organism that assesses the process of competitive open access. The members of this Committee are replaced every four years and are approved by the Executive Commission from a list submitted by the Director of the Centre that includes renowned international researchers.

Accesos

Unique equipment: VEGA-2

User: University of Alberta, Canada
Service: VEGA-2
Line of research: Plasma physics
Type of access: Agreement

Action objectives: Betraton Measurement of the ionization state of Warm Dense Aluminium

Duration: 320 sessions

The experiment aimed to study the time resolved evolution of thin aluminium foil targets with a thickness of ~50nm in two configurations. The first was thin aluminium films on thin 100 nm Si_3N_4 films on a semiconductor wafer which worked as a continuous foil target and the second was a free standing aluminium film supported on a grid substrate and advanced at a repetition of around 0.5 Hz. The VEGA-2 laser pulse was used to generate 400 MeV weakfield pulses of electrons which in turn will generate Betatron radiation. A small part of the laser pulse, on the order of 50 mJ, was split off as a heater beam to heat the free standing aluminium foil to create the warm dense matter system. Beside this first step, the experiment was carried out in 4 more stages: imaging the Betatron radiation onto the heated foil with a Kirckpatrick-Baez microscope; heating and characterization of the warm dense aluminium; synchronization and overlap of the X-ray probe and heater beams and finally acquisition of the absorption spectra for heated foil temperatures of 20 to 35 eV and probe times of 0.5 to 2.0 picoseconds.

Primary Sources: HRR

User: Deneb Medical, S.L.

Service: HRR

Project: RTF Laser - Design and development of a laser-guided surgery system with selective tissue discrimination

Type of Access: Contract (Project)

Action objectives: Laser ablation on soft tissue

Duration: 24.5 sessions

Experimental development: The experimental setup is similar to the one that was used for hard tissue, with different laser parameters applied during the laser-tissue interaction.

Results: Ablation tests were made on soft tissue (pig skin) so that tests to cut skin can be made in the future. The threshold values for laser ablation on soft tissues were measured.

User: Deneb Medical, S.L.

Service: HRR

Project: RTF Laser - Design and development of a laser-guided surgery system with selective tissue discrimination

Type of Access: Contract (Project)

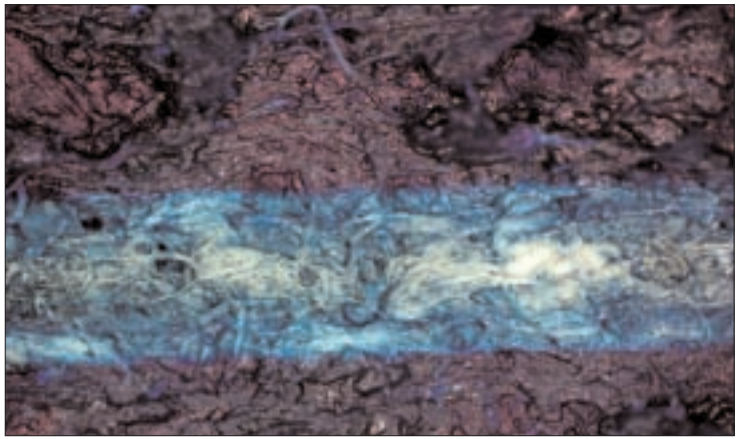
Action objectives: Removal of ink and/or tattoos on the skin

Duration: 16 sessions

Experimental development: The experimental setup is similar to the one that was used for hard and for soft tissue, with different laser parameters applied during the laser-tissue interaction. In this experiment,

nonprofessional tattoos were performed with lines and rectangles filled with ink of different colours.

Results: Ablation tests were performed on soft tissue (pig skin), both in the tattooed area and on the area without ink. The threshold values for laser ablation on those soft tissues were measured. We assessed the capacity and type of process that would allow ink to be removed. The results are included in the reports of the RTF Laser project.



Sample with ink removed with femtosecond laser

User: Deneb Medical, S.L.

Service: HRR

Project: RTF Laser - Design and development of a laser-guided surgery system with selective tissue discrimination

Type of Access: Contract (Project)

Action objectives: Ablation on bone. Comparison with the results obtained with the Carbide laser

Duration: 2 sessions

Experimental development: In the year 2016, different experiments were carried out with the Carbide laser (1027 nm, variable energy, repetition rate, and pulse duration). This time, measurements were repeated with a titanium laser amplifier with higher energy per pulse and low repetition rate (athermal) to compare the different types of laser ablation and ablation rhythms over time.

Results: The results were positive. It was possible to assess the efficiency of the ablation techniques and protocols that were used. The results are included in the reports of the RTF Laser project.

User: Deneb Medical, S.L.

Service: HRR

Project: RTF Laser - Design and development of a laser-guided surgery system with selective tissue discrimination

Type of Access: Contract (Project)

Action objectives: LIBS measurement to detect Ca ions in biological tissue with nanosecond pulses

Duration: 3 sessions

Experimental development: The experimental setup and samples were provided by Deneb Medical. The CLPU provided technical assistance for precise laser parameters in the LIBS tests. An Empower30 laser system (Spectra Physics) was used.

Results: As part of the activities of the RTF Laser project, different LIBS measurements were repeated. These measurements were different from the ones that Deneb Medical had carried out in their facilities, and were carried out with parameters that were not available in their laboratories. The tests assessed the power and improvement of the processes, and the results were recorded as part of the progress of their project.

User: Deneb Medical, S.L.

Service: HRR

Project: RTF Laser - Design and development of a laser-guided surgery system with selective tissue discrimination

Type of Access: Contract (Project)

Action objectives: Improvement of the system for the processing and quality of laser focalization

Duration: 5 sessions

Experimental development: Tests were performed to implement improvements in the final quality of the laser beam, as well as to obtain a higher depth of field with larger Rayleigh regions.

Results: The systems were updated and improved in the experimental stations of laser material microprocessing. A smaller focus for the light beam was optimized, with larger and smoother Rayleigh regions. These improvements will be used in the remaining experiments carried out as part of the RTF Laser project.

User: Deneb Medical, S.L.

Service: HRR

Project: RTF Laser - Design and development of a laser-guided surgery system with selective tissue discrimination

Type of Access: Contract (Project)

Action objectives: Filamentation with cylindrical lenses

Duration: 6 sessions

Experimental development: The experiment consists in the focalization of the laser beam with cylindrical lenses with different focal length (although some spherical lenses may be used too) to estimate an energy threshold for multiple filamentation. A CCD camera was used to take images of the process.

Results: A laser filament with a cylindrical lens has different applications (medicine, materials processing, etc.). The results and reports are part of the RTF Laser project.

User: Deneb Medical, S.L.

Service: HRR

Project: RTF Laser - Design and development of a laser-guided surgery system with selective tissue discrimination

Type of Access: Contract (Project)

Action objectives: Electric switch through the creation of an AC/DC plasma laser

Duration: 36 sessions

Experimental development: The electrical part of the experimental setup was prepared by Deneb, whereas the laser elements were designed by the CLPU. The objective was to create plasma with ultrafast laser, and to study its electrical properties.

Results: The results and reports are part of the RTF Laser project.

User: Jeanología

Service: HRR

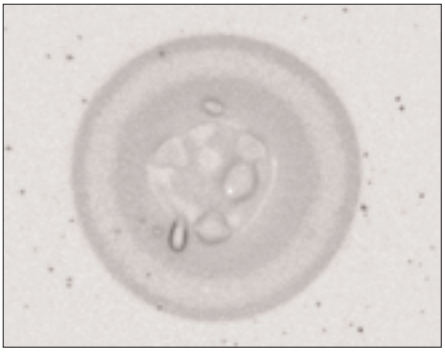
Project: ULTRALASER - Development of ultrashort pulse lasers with advanced features at low cost for their application in new industries

Type of Access: Contract (Project)

Action objectives: Development of experimental LIDT testing with laser crystals (with patterns)

Duration: 28 sessions

Experimental development: A new line of work has been developed based on the study of the damage induced by lasers in laser crystals. The system makes it possible to control the amount of pulses, control the energy, synchronize the measurements, etc. Its activity was verified with calibrated samples and a pattern. The damage observed in the study was always superficial.



Optical damage with laser induced with ultrafast laser (100 pulses)

Results: We have determined the thresholds for optical damage with laser under different conditions and laser parameters, and in tests with 1 pulse, 10, 100, 1,000 and 10,000 pulses under controlled and synchronized conditions. The ablation thresholds have been estimated and a detailed analysis of the spot in the material has been carried out. The different procedures involved in the process that damages the materials have been assessed. The results are part of the ULTRALASER project and they will be used to assess the introduction of new improvements in laser crystals that will be implemented within this same project.

User: Spanish National Research Council -CSIC-

Service: HRR

Line of research: Improvements in the function of new materials

Type of Access: Other (Collaboration)

Action objectives: Laser processing in eutectic ceramics for applications in solid oxide fuel cells

Duration: 7 sessions

Experimental development: The goals were: creating a patterned structure with hexagonal holes made with laser; analysing the ablation thresholds for that material; creating structures with holes with an egg box pattern; and analysing the ablation thresholds for that material. Tests were carried out at 100 Hz and 1 kHz to assess the thermal effect.

Results: Different tests were performed, focusing on ablations with diameters of 10-20 µm. Different results were observed depending on the separation between the holes. The engines used limited the tests because not all the required movements could be performed. In this regard, this campaign will be continued when the system is improved with the installation of galvo lasers.

User: Autonomous University of Madrid

Service: HRR

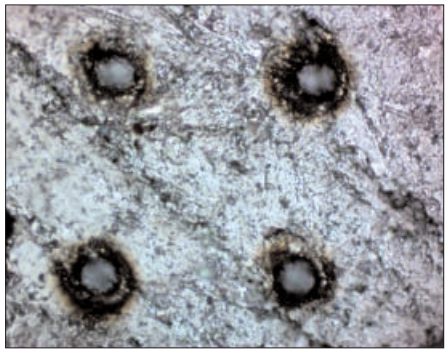
Line of research: Systems for the reduction of secondary electron emission in spatial applications.

Type of Access: Other (Collaboration)

Action objectives: Perforated metal sheets with femtosecond laser

Duration: 9 sessions

Experimental development: Patterns of microperforations with a high aspect ratio created with metals such as Cu, Ag, Au, etc., can be applied to advanced anti-multipactor coatings; that is, engineering surfaces with reduced secondary electron emission (SEE-SEY) to supress the discharge of multipactor electrons that damage the operations of telecommunications and observation satellites as well as other advanced technological systems. With femtosecond irradiations, the absorption mechanism of the material is the same as with other nanosecond lasers, but the time scale involved in the ablation process is much shorter. Therefore, the area which is affected by the heat can be disregarded, and the energy can be focused on a much more controlled volume that creates a deeper and cleaner ablation. The automatization of the irradiation process makes it possible to create areas of 10 x 10 nm with a mesh parameter of 100 μm (10,000 holes). In order to research the way to obtain a high aspect ratio, each irradiation has been performed with different pulse energies and a different number of pulses. Aspect ratio is defined as depth divided by the radius of the hole.



Pattern of microperforations in silver.

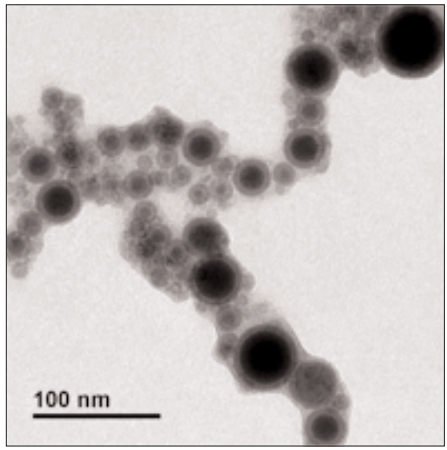
Results: It is necessary to create a mesh with holes separated by 100 microns and with edges of at least 1 mm in thin sheets of silver, copper, aluminium and graphite. It is necessary to obtain the damage thresholds and the efficiency of the material ablation. The holes need to be deeper than the dimensions of the diameter of the laser beam. Patterns of microperforations with a high aspect ratio (of approximately 1) through ablation with femtosecond laser. An irradiation of femtoseconds produces cleaner and sharper holes. The resulting patterns are a promising surface for the reduction of secondary electron emission, which is relevant to improve telecommunications and Earth observation satellites.

User: Spanish National Research Council (CSIC)
Service: HRR
Line of research: Production of nanoparticles with laser
Type of Access: Other (Collaboration)

Action objectives: Nanoparticles with femtosecond laser
Duration: 2 sessions

Experimental development: Femtosecond laser pulses were used to study the production of nanoparticles that avoid the thermal effects observed in the nanosecond range or even in the femtosecond range, when high frequency laser pulses or pulses with a high duration are used. With the help of galvanometric mirrors, the laser scans a circular area of 10 mm in diameter which is filled with parallel lines that have a 100 µm separation.

Results: The iron nanoparticles have been created with femtosecond laser irradiation. A new irradiation method that uses galvanometric mirrors makes it possible to scan large areas and produce high ablation rates. The particles of any size have a nucleus structure of Fe/Fe_2O_3. The size of the particles that have been created ranges from 5 to 100 nm.



Iron nanoparticles created with ultrafast irradiation.

User: Instituto Superior Técnico of the University of Lisbon
Service: HRR
Line of research: LaserLab Europe Staff Exchange Programme
Type of Access: Other (Collaboration)

Action objectives: Study of laser parameters during ablation processes in metals and organic samples. Effects on the surface of the beam and thermal effects of the pulses

Duration: 10 sessions

Experimental development: The objective was to research the mechanisms of ultrafast laser ablation for biological applications using the simultaneous spatial and temporal configuration of the laser beam. This technique has the potential to significantly improve the efficiency of the process and to contribute to a better understanding of the methods for material processing in extreme time scales.

Results: The main results of this work were the determination of the yield at the thermal threshold —the density of laser energy in which the target is vaporized— for two significantly different types of materials (organic and metallic), in the pulsed femtosecond range. The conditions for the creation of micro-fissures and severe damage to the surrounding material were also established. Apart from these achievements, the depth profiles of the holes and the lines that were ablated were studied, as well as their dependency on yield. The next objectives include the development of a configuration of temporal pulse to assess the ablation rate and compare the results with analytical calculations.

User: Consortium of the Pulsed Lasers Centre (CLPU)
Service: HRR
Project: Barium Tagging
Type of Access: Contract (Project)

Action objectives: Trying the new barium evaporation source
Duration: 9 sessions

Experimental development: We needed to try and characterize the new system of barium evaporation to reach the vapour pressure of barium based on a heated filament and an effusive molecular beam. In this campaign, we wanted to verify the suitability of the system of barium evaporation and the efficiency of the electron impact ionization system to generate barium ions.

Results: The heating filament was characterized based on the intensity of the final experimental conditions. Barium was introduced in the camera and several mass spectrometry measures were obtained when the barium was heated. Unfortunately, in the first campaign no traces of barium were found in the spectrum that was required to repeat the campaign. In the following experimental campaign, the residual barium oxide was removed and pure barium was introduced in the crucible. Then, the mass spectrometry analysis was performed again on the diffusion beam, and the lines observed in the spectrum matched the pattern for barium. No quantified measurements were obtained for barium production.

User: CARTIF Foundation
Service: HRR
Line of research: Laser microprocessing of materials
Type of Access: Free

Action objectives: Laser cuts of rubber and plastic sections
Duration: 3 sessions

Experimental development: Rubber and plastic sections are found in many applications, particularly in vehicles, where they are used to prevent dust and water from entering the cabin through the grooves of doors and hatches. In the manufacture process, pieces must be cut accurately through complex trajectories, and lasers can be used to achieve more flexible results. One of the main requirements is that the edges obtained with the cutting process must be clean. However, some types of laser create a black dust or soot that must be avoided.

Results: The service that was requested consisted in the execution of some cuts on the surface of a sample with a short or ultrashort laser beam to verify whether soot appears in the process. The cut must be deep, down to some millimetres, and the shape may be a 10 x 5 mm rectangle, and also more complex forms. The final pieces that were cut showed relatively good quality, and with only a minimal effect of black dust generated in the process of laser cutting of the samples.

User: Deneb Medical, S.L.

Service: HRR

Project: RTF Laser - Design and development of a laser-guided surgery system with selective tissue discrimination

Type of Access: Contract (Project)

Action objectives: Femtosecond laser cleaning of copper discs

Duration: 2 sessions

Experimental development: A system was implemented for surface cleaning with femtosecond laser that removed unnecessary material and provided low surface roughness in the rest of the sample.

Results: The surface of the copper discs was polished after the tests were performed and the necessary laser parameters were determined. In the first samples, the surface was blackened, and in other samples a superficial treatment was induced. The disadvantage of this method is the laser time required per sample. In discs with a diameter of 25 mm, the time is acceptable, but in 10-cm discs it requires an excessive amount of time.

User: Consortium of the Pulsed Lasers Centre (CLPU)

Service: HRR

Line of research: Preparation of targets for VEGA experiments

Type of Access: Other (Internal research)

Action objectives: RFC preparation. Experimental setup for research on protons in VEGA-2

Duration: 12 sessions

Experimental development: Preparation of a series of cylindrical microholes that make it possible to apply controlled stopping power in

one of the parts of the experiment with protons with Thomson parabola.

Results: Different tests were carried out with copper (material required by the applicant) to obtain the microholes (100-200 microns), with a thickness of 1.5-2 mm. Due to the requirements of the final experimental application, 2 techniques were tried: standard laser microprocessing and microprocessing with laser filamentation. Both techniques show very different results for such large thickness. The best results were obtained with laser filamentation during microhole processing. The ratio between the entry and the exit holes was virtually the same. All the holes were measured with microscopy (optical and electron-scanning microscope).

User: Consortium of the Pulsed Lasers Centre (CLPU)

Service: HRR

Line of research: Preparation of targets for VEGA experiments

Type of Access: Other (Internal research)

Action objectives: RFC preparation. Experimental setup for research on protons in VEGA-2

Duration: 9 sessions

Experimental development: Preparation of microholes in X-ray, electron or proton-absorbing materials, such as radiochromic materials. The thickness of the samples ranged from less than 200 microns to 100 microns. It was necessary to create microholes in specific positions to filter part of the energy of the beam (radiation or particles).

Results: After many tests and different problems related with the thermal load created by the laser in the radiochromic materials, it was possible to implement a protocol in the microprocessing system with the galvo that added precision to the movement of the beam and the control of the amount of pulses to perform cuts, pinholes, etc. on those materials. Removing the thermal load on the radiochromic ma-

terials was essential, because these materials become blackened when radiation or particles with high energy impact on them. Finally, reproducible samples were obtained with different microhole patterns for the different experiments designed for VEGA. Reproducibility was important because part of those samples would be stacked up and the microholes needed to match.

User: Consortium of the Pulsed Lasers Centre (CLPU)

Service: HRR

Line of research: Preparation of targets for VEGA experiments

Type of Access: Other (Internal research)

Action objectives: Masks for the generation of proton radiographs.

Duration: 7 sessions

Experimental development: Standard experimental setup for micro-processing.

Results: Micro-cuts have been performed with the femtosecond laser, creating a high-precision athermal microprocessing of the edges of several pieces of aluminium and copper (sheets of 3 and 6 microns in different days for proton targets). In addition, microprocessed samples have been obtained from 6-micron aluminium sheets with the femto-second laser for their use as contrast sections with X-ray or proton ab-sorption radiography. The samples were obtained in the experiments performed with VEGA-2. We have observed that they work properly, and future initiatives will create more complex structures to meet the requirements of further VEGA experiments.

User: Consortium of the Pulsed Lasers Centre (CLPU)
Service: HRR
Line of research: Optimization of equipment
Type of Access: Other (Internal research)

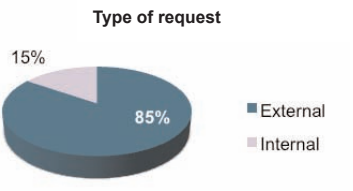
Action objectives: Improvement of equipment and systems associated to the laser.

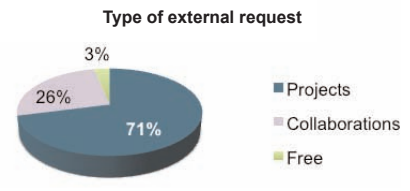
Duration: 28 sessions

Experimental development: The actions were structured in three stages: tests and verification of the single-shot system of the HRR; first stage to start the trepanning system; and assembly of a scanning laser system with galvanometer crystals.

Results: We successfully managed to reduce the number of pulses of the femtosecond laser with a (nominal) repetition rate of 1 kHz until we achieved control with a single pulse or several synchronized pulses. We studied the transport of the beam from the laser system to the isolated compartment where the trephine is installed in order to continue the process of activation of the system in the next year. With regard to the galvanometer system, it significantly improved the microprocessing service that was offered to our users.

Analysis of requests[1]





1 Requests related to system maintenance have not been included in the count, and requests linked to projects —with users that may include the CLPU— have been classified as external.

Primary Sources: Carrier Envelope Phase Laser System (CEP)

User: University of the Basque Country (EHU)
Service: CEP
Line of research: Femtochemistry
Type of Access: Agreement

Action objectives: Nonadiabatic coupling of excited states La/Lb of indole.

Duration: 4 sessions (8 h/session)

Experimental development: Third campaign for the development of this experimental line in which time-resolved pump-probe ionization has been measured to monitor the relaxation dynamics of the molecule indole. The work plan included five development stages: alignment of the pump-probe beams through the equipment and spatial overlapping of the ionization area; time synchronization of the pump-probe pulses; detection of the parameters of the spectrometer that had to be optimized; and execution of the experiment through the propagation of the pump-probe beams through the transfer chamber in vacuum conditions.

Results: The experiment was successful, and the ultrarapid relaxation dynamics of naphthalene could be recorded with a resolution of approximately 25 femtoseconds. The results pave the way for new experimental goals.

User: Consortium of the Pulsed Lasers Centre (CLPU)
Service: CEP
Project: Barium Tagging
Type of Access: Contract (Project)

Action objectives: Characterization of a barium jet
Duration: 4 sessions

Experimental development: The objective of the experimental campaign was the characterization of the ion source built as part of the Barium Tagging project.

Results: Although no positive results were obtained, we concluded that it was necessary to shift to a barium evaporation system made up of a crucible and an electrical resistance heater.

User: Consortium of the Pulsed Lasers Centre (CLPU)
Service: CEP
Line of research: Optimization of technology
Type of Access: Other (Internal research)

Action objectives: Replacement of the translation stage of the experimental setup for ultrafast dynamics
Duration: 8 sessions

Experimental development: The objective of this campaign was to implement a new tool that may assist users in their research. In the first stage, a zero-delay line was installed in order to achieve pumping synchronization with the pump probe for this kind of experiments (a naphthalene signal was used as a reference). When this stage was completed, a Labview program was designed for data collection.

Results: The tool was successfully implemented and two initiatives for improvement have been initiated, without positive results so far: two-photon-induced transition in the ultraviolet spectrum (in CO_2) and the use of a post-compressed CEP beam to reach 5 femtoseconds.

User: Consortium of the Pulsed Lasers Centre (CLPU)
Service: CEP
Project: Barium Tagging
Type of Access: Contract (Project)

Action objectives: Start of the new barium heat source
Duration: 5 sessions

Experimental development: During this campaign, different experiments were carried out with the time-of-flight spectrometer of the ion. These first experiments were used to characterize the background polluting elements that were present in the vacuum chamber and to optimize the equipment itself. After they were completed, a second objective was the detection of the barium ions signal. In order to achieve this, the naphthalene signal was used as a reference because both barium and naphthalene have a similar mass and, consequently, they decay in the same region of the mass spectrometer.

Results: The search did not yield positive results. We believe that this could be due to the rapid oxidation of barium. Therefore, in view of these new findings, new campaigns will be designed.

User: Consortium of the Pulsed Lasers Centre (CLPU)
Service: CEP
Line of research: Optimization of technology
Type of Access: Other (Internal research)

Action objectives: Calibration of optical elements according to polarization changes. The objective is to test the optical elements and their chromatic behaviour under conditions similar to the ones present while using the VEGA laser
Duration: 5 sessions

Experimental development: For the development of this experiment, broadband polarizers and wave plates were used (Lambda/4 and Lambda/2), as well as a spectrometer that acted as a conventional analyser of polarization. First, the stability of the source was tested regarding polarization and spectral structure, and then the behaviour of polarization was measured with reflecting optical elements in the entire spectrum.
Results: The results are being analysed for their implementation in the VEGA laser system.

User: CELIA – University of Bordeaux
Service: CEP
Line of research: Development of critical-density laser targets
Type of Access: Other (Collaboration)

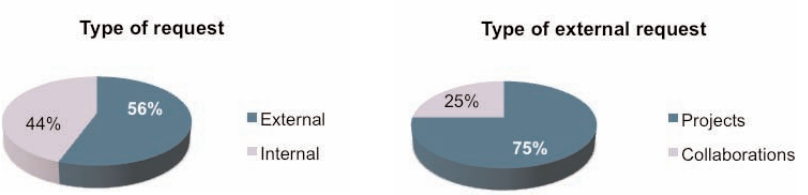
Action objectives: Characterization of a high-density gas jet
Duration: 14 sessions

Experimental development: The objective of this experiment was the characterization of the density profiles of the gas under experimental

conditions similar to the ones of a future experiment with VEGA-2. This information is vital, because the density and initial structure of the targets is one of the most important parameters that can be controlled in laser-plasma experiments. More specifically, critical-density targets are a candidate for laser acceleration of protons with high repetition rate. The process of characterization has been carried out through interferometry, using both the CEP laser and a helium-neon continuous wave laser.

Results: The results were used to prepare a future experiment with the VEGA-2 system.

Analysis of requests by type of access[2]



2 Requests related to system maintenance have not been included in the count, and requests linked to projects —with users that may include the CLPU— have been classified as external.

Complementary Units: Oscillators Unit

User: Deneb Medical

Service: Oscillators

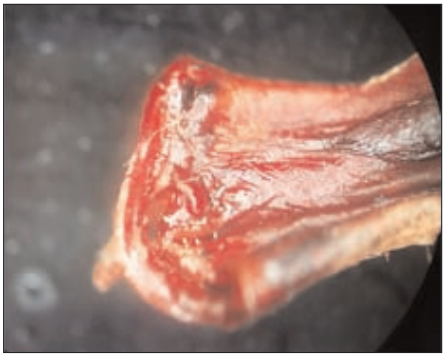
Project: RTF Laser - Design and development of a laser-guided surgery system with selective tissue discrimination

Type of Access: Contract (Project)

Action objectives: Experiments on coagulation and cauterization of blood vessels

Duration: 9 sessions

Experimental development: Tests have been carried out on ex-vivo material (mainly arteries and blood) from animals (rats, rabbits and pigs) to study the effects of laser parameters with different laser systems on the cut and cauterization of different types of blood vessels, as well as on blood coagulation with ablative and/or thermal laser effect.



Experiment on cutting and cauterization of a pig's artery

Results: The results will be used to secure improvements in a new system of laser surgery.

User: Deneb Medical

Service: Oscillators

Project: RTF Laser - Design and development of a laser-guided surgery system with selective tissue discrimination

Type of Access: Contract (Project)

Action objectives: Experiments on cutting, coagulation and cauterization with in-vivo blood vessels and vascularized tissue.

Duration: 1 session

Experimental development: After the ex-vivo experiments carried out previously, a specific request was accepted for an in-vivo research project in collaboration with the Service of Animal Experimentation of the University of Salamanca. Once that the request was authorized by the bioethical committee for animal experimentation in research, a pre-prototype of laser surgery tool was designed for the experiment. The results that had been previously obtained with ex-vivo tissue were assessed this time in several vascularized tissue samples under real conditions of blood pressure and pumping. The different tests that were carried out included experiments on cutting and cauterization of vascularized tissue (both soft and hard), arteries and veins. Also, different coagulation and/or cauterization processes were assessed in the vascularized tissue.

Results: The results will be used to secure improvements in a new system of laser surgery.

User: Deneb Medical

Service: Oscillators

Project: RTF Laser - Design and development of a laser-guided surgery system with selective tissue discrimination

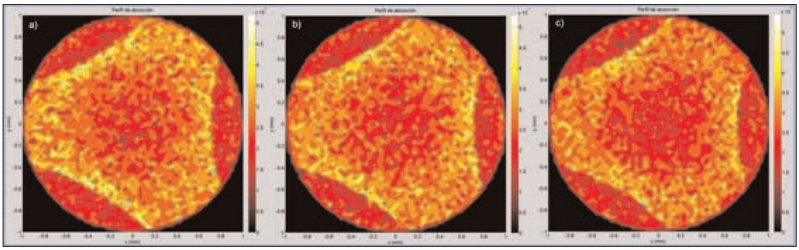
Type of Access: Contract (Project)

Action objectives: Design and development of an erbium-based mid-infrared laser

Duration: Approximately 100 sessions

Experimental development: Study of different models and simulations to approach a conceptual design for a laser in the mid-infrared region. Several architectures for a laser system have been assessed and characterized for their application in the initiatives related to this project. The most adequate components and elements for the potential development of a laser have been assessed and selected. Finally, a simulation program of the laser system and of the behaviour of the laser active medium has been developed.

Results: The results will be used to secure improvements and further develop the laser systems that will be included in potential applications for laser surgery.



Absorption profile of an Yb-YAG bar with different refrigeration systems

User: Jeanología

Service: Oscillators

Project: ULTRALASER - Development of ultrashort pulse lasers with advanced features at low cost for their application in new industries

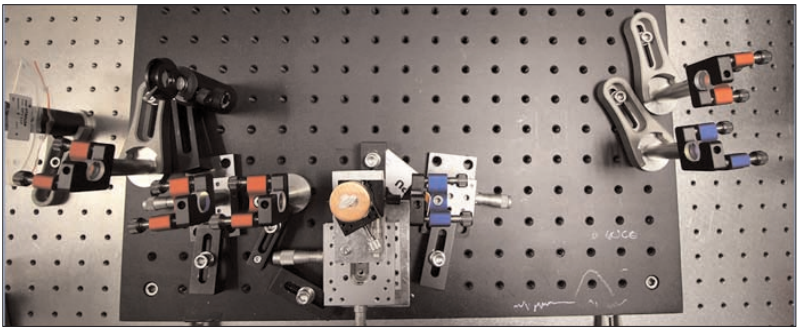
Type of Access: Contract (Project)

Action objectives: Tests with new laser materials for the development of laser oscillators

Duration: 29 sessions

Experimental development: After assessing the different designs of a conceptual pulsed laser system, some of those designs were executed on an optical board. The laser cavities were installed to assess their function and the improvements that were required. In order to do so, and once that relatively simple oscillators had been installed, the laser function was assessed for Yb-doped crystals with a laser emission in the 1030-1050 nm region. The tests included commercially available crystals and crystals developed as part of the project itself.

Results: The results were positive and they will be used to apply improvements and further develop the laser systems of our project.



Setup of an Yb oscillator for a high repetition rate

User: Jeanología

Service: Oscillators

Project: ULTRALASER - Development of ultrashort pulse lasers with advanced features at low cost for their application in new industries

Type of Access: Contract (Project)

Action objectives: Tests for the setup of solid-state oscillators with ytterbium-doped crystals

Duration: 36 sessions

Experimental development: Once that the different designs had been assessed, efforts were focused on 3 designs of cavities for the execution of the most stable tests for the development of oscillators. The options included a compact oscillator with high repetition rate (200-300 MHz), a standard oscillator with Z/X configuration and a repetition rate of 100 MHz and a compact oscillator with a repetition rate of 80-100 MHz. This last configuration has been one of the best designs for the goals of this project: a relatively stable laser emission was obtained with optimal results for both modes of laser operation (continuous and pulsed), with TEM00 laser modes. Improvements still need to be made in the pulsed mode, which are already being analysed.

Results: The results will be used to add improvements and further develop the laser systems of the project.

User: Jeanología

Service: Oscillators

Project: ULTRALASER - Development of ultrashort pulse lasers with advanced features at low cost for their application in new industries

Type of Access: Contract (Project)

Action objectives: Setup of the diode pumping system in the solid-state oscillator with ytterbium-doped crystals

Duration: 40 sessions

Experimental development: The next stage in the project was the implementation of a laser pumping system that resulted in a laser oscillator that was more compact and economical. A > 15 W system was acquired for a more efficient pumping of Yb-doped crystals. This pumping system was guided with coupled laser fibre, and the system of collimation and focus of the pump beam had to be optimized. In turn, a new system of active refrigeration had to be designed in the platform of the active laser medium.

Results: Good results were obtained, and a controlled laser emission was generated in different operating modes (continuous and pulsed), in some cases with powers and energies within the range required for laser amplification afterwards. These results will be used to add improvements and further develop the laser systems of the project.

Complementary Units: Microscopy Unit

User: University of Salamanca [Dept. Organic Chemistry –GIR QUESCAT

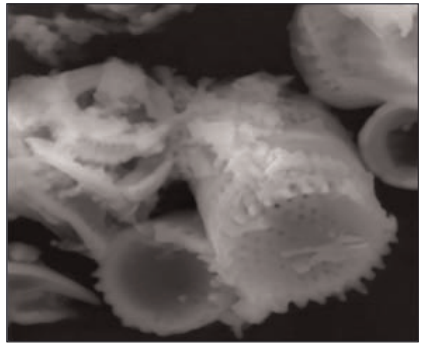
Service: SEM

Projects: Development of more effective materials for processes of advanced oxidation and adsorption applied to surface water [MAT2013-47811-C2-R]; development of materials for processes of advanced oxidation and adsorption applied to water treatment [Spanish Ministry of Education, Culture and Sport – Spanish-Brazilian Program of Inter-University Collaboration PHBP14/00003]. Line of research focused on the study of the modification of clay-like materials through different methods and new applications of the resulting solid materials, particularly with regard to the elimination of contaminants in water.

Type of Access: Agreement

Action objectives: The starting materials and the solids were studied in order to verify the alterations caused by the different treatments. The main samples analysed were laponite functionalized with biuret and melamine, used for the adsorption of the antibiotic Trimethoprim in water; a montmorillonite that had been pillared with titanium polycations doped with different transition elements, which has later been used to remove methylene blue and the antibiotic trimethoprim; and a diatomaceous earth (silica derived from single-cell algae) treated with acid that has later been used as support for ferric porphyrin to prepare oxidation catalysts.

Duration: 4 h



Diatomaceous earth treated with HCl and functionalized with APTES used as support for ferric porphyrin FETCPP.

User: University of Salamanca

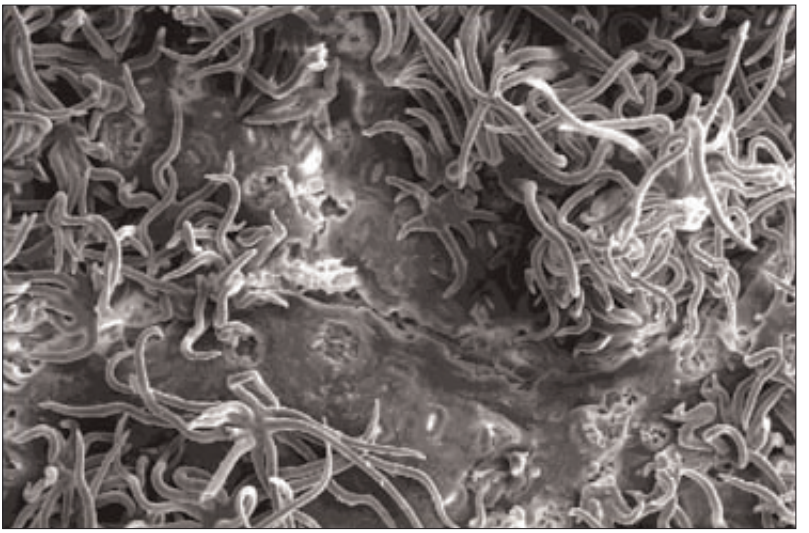
Service: SEM

Project: Architecture of the branches of tree species and its effects on light absorption and photosynthesis [CGL2016-79861-P]

Type of Access: Agreement

Action objectives: Study of stomata. Differences have been observed in the patterns of gas exchange and water potential among the leaves in different positions on the top of different specimens of *Quercus*. In order to understand whether the differences are due to the chemical composition of the leaves that occupy different positions or rather to differences in their anatomical and/or morphological differences, the study included, among other features, the analysis of the leave surface to detect possible changes in the density of stomata and pubescence among leaves with different orientations.

Duration: 2 actions that involved 5 hours of observation in total.

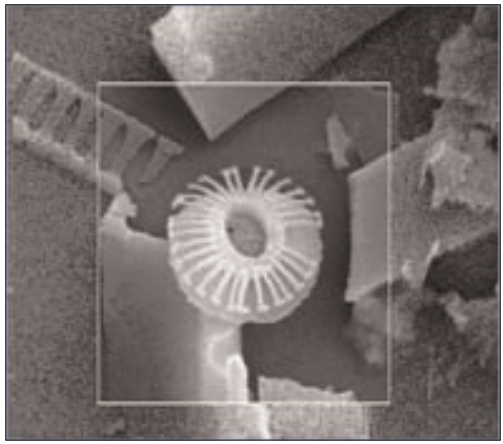


Adaxial surface of a leaf of Quercus suber (detail of trichomes and stomata)

User: University of Salamanca
Service: SEM
Project: SONAR-CO2 [MSCA-IF-EF-ST 748690]
Type of Access: Agreement

Action objectives: Analysis of the morphological variability and chemical composition of associations of coccoliths recorded in a sediment trap in the Antarctic region of the Southern Ocean. The SEM was used to clarify the taxonomic identifications that had been established with the optical microscope and to determine the morphotype of Emiliania huxleyi.

Duration: 4 actions with a total of 17 hours of observation.



Calcium carbonate coccolith of Emiliania huxleyi *(single-cell algae) captured by a sediment trap in the Southern Ocean.*

User: University of Salamanca

Service: SEM

Line of research: Pharmaceutical technology: use of cells and derivatives as drug carriers.

Type of Access: Agreement

Action objectives: Preliminary tests of a new line of research promoted by the Department of Pharmaceutical Sciences of the Faculty of Pharmacy of the University of Salamanca. These observations tried to characterize vesicles from human cells.

Duration: 3 actions which represented a total of 6.5 hours of observation in the SEM

User: University of Salamanca

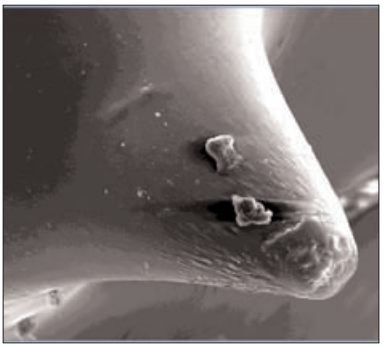
Service: SEM

Projects: VULCANO I [CTM2012-36317], FEDER; VULCANA [vulcana-IEO-2015-2017]; EXPLORA CIENCIA [CGL2014-61775-EXP]; José Castillo [CAS14-00189]

Type of Access: Agreement

Action objectives: Analysis of a coral sample for the study of signs of magmatic helium (3He). A theoretical growth rate was used to estimate the time of capture of the 3He from the time of release of the magmatic source and the subsequent volcanic activity. The results suggest that the emission of magmatic helium takes place months before the subaquatic seismic activity.

Duration: 1 h



Detail of a skeletal spicule of black coral

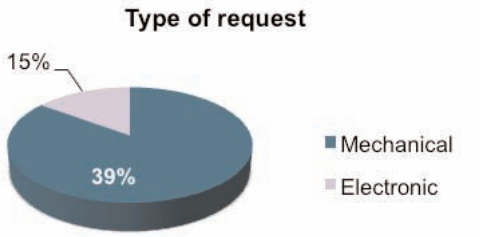
User: Nuclear Physics Institute
Service: SEM
Projects: GACR No. 16-05167S; MSMT No. 20-SVV/2017.
Type of Access: Agreement

Action objectives: Morphological assessment and alterations in the composition of a sheet of graphene oxide irradiated with helium ions at 1.2 MeV. Comparison with other analysis techniques. The results were presented during the 17th International Conference on Ion Sources.

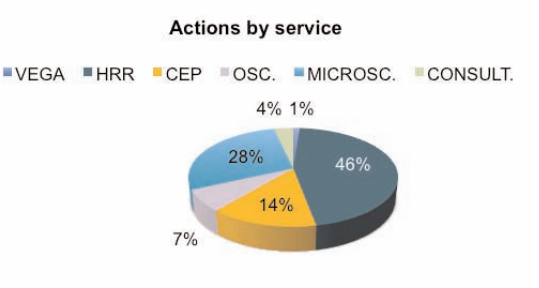
Duration: 7 h (1 action)

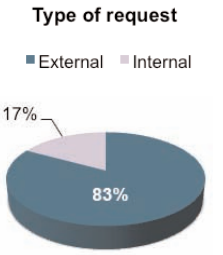
Complementary Units: Mechatronics Workshop

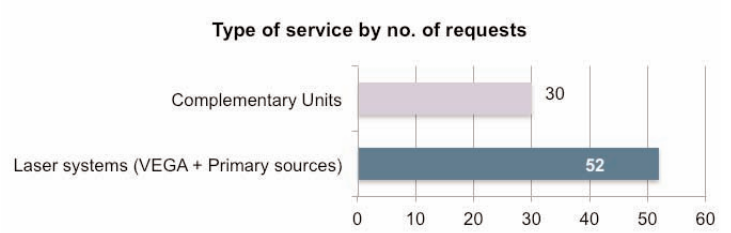
These two services of the Centre, the mechanical and electronic workshops, have contributed in 2017 not only to the improvement of the infrastructures of the CLPU, but also to the optimized development of their own lines of research and user experiments with 47 requested actions:



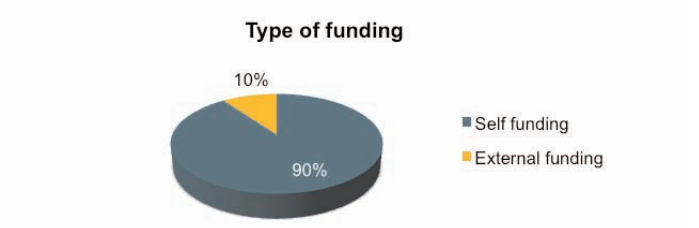
Actions Summary







The total cost of the services provided was **499.502,58 €**



Services Scheme

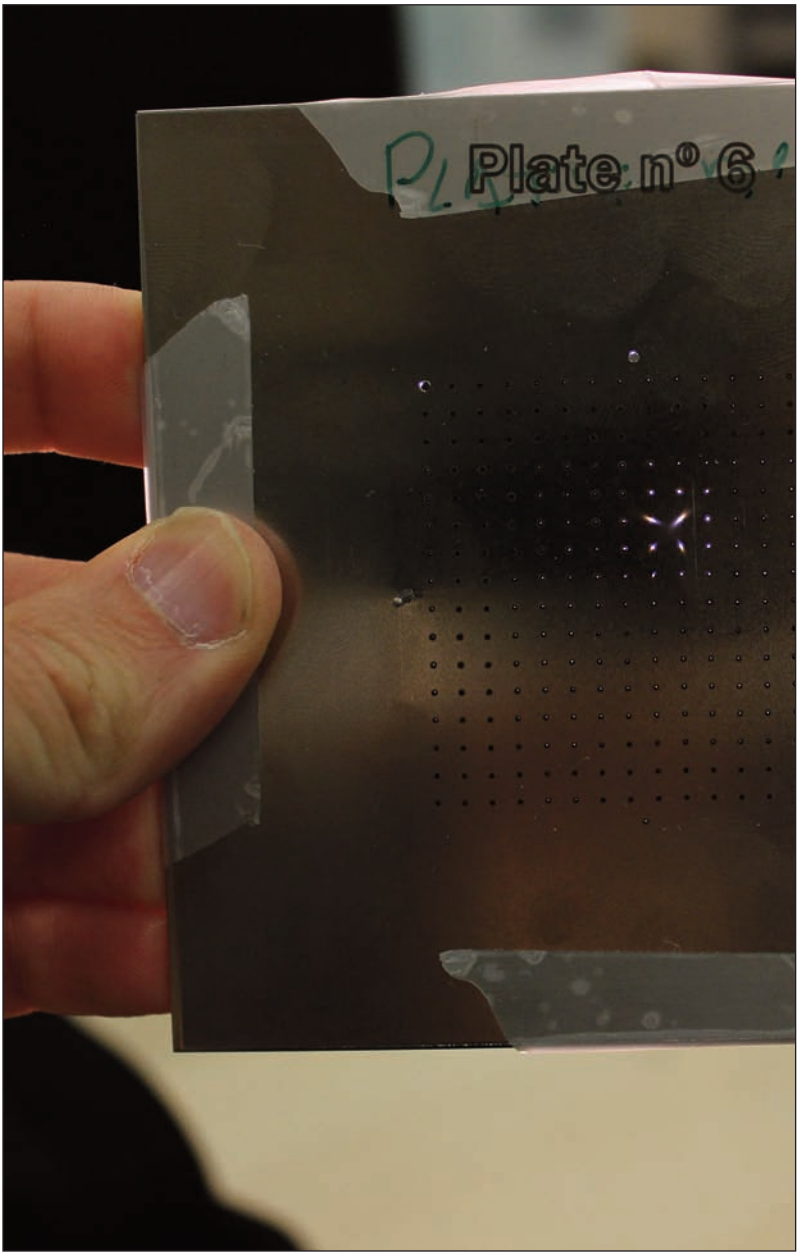


Plate nº 6

SCIENTIFIC LEADERSHIP

Research lines - VEGA

The construction, operation, maintenance and development of the laser systems of the Centre are, by themselves, one of the most important scientific and technological challenges of the CLPU. When approaching this strategic line, we are aware of our responsibility in contributing to the promotion of Spain's competitiveness in the field of laser science. In this regard, two main lines of action have been designed:

- Technological development: This element is essential to always offer our users the best tools for research and scientific progress. During the year 2017, the updates and improvements in the system have focused mainly on the study of a prototype-mount based on the design of a delay line that offers our users the spatial and temporal synchronization of VEGA-2 and VEGA-3; the analysis of an uncompressed output for the petawatt beam of VEGA-3 that can reach the experimentation area without affecting the characteristics of the beam routing; the study of the transport of the CEP system to improve the unique system of the CLPU by giving VEGA-2 the possibility to interact with pulses of less than 6 femtoseconds; and the addition of a metrology bench to the system.
- Applications: The main advantage of using high intensity lasers is that we are able to induce interaction between electromagnetic waves and matter in levels that had never been reached before. In fact, by reducing the laser-matter interaction area to its diffraction limit, we can obtain high intensities (from 10^{16} W/cm^2 to 10^{22} W/cm^2). Under these conditions, matter is instantly ionized and becomes plasma. Therefore, one of the main lines of research linked to VEGA is Plasma Physics, with plasma induced by ultrafast and ultraintense lasers. This allows us to carry out experiments on laser acceleration of protons/ions; high harmonic generation; design of laser-powered electron sources; X-ray *bremsstrahlung*; high-energy laser filamentation and what is known as *Warm Dense Matter*. Apart

from this line of action, the characteristics of VEGA make it possible to carry out research in Atomic, Molecular and Nuclear Physics based on lasers, such as atomic and molecular photoionization of laser-induced nuclear physics; and the development of laser-based Particle Physics, including the study of polarization in a vacuum or the analysis of beta decay.

Research lines: Primary Sources and Complementary Units

Apart from the unique nature of VEGA and the experimentation that the first call for requests for the use of VEGA-2 will bring to Spain in 2018, research in the CLPU is largely based on its "satellite" laboratories, where most of the research of the Centre has been carried out so far. For this reason, as in the case of our unique equipment, two main lines of action have been defined here:

- Technological Development: The CLPU, promoted by the Oscillators Unit and the optimization of the high-repetition-rate and CEP laser systems, makes a constant effort as a guide to show all the possibilities of this technology and its potential applications. In this regard, in 2017 the following lines of research on laser technology in laser technology have stood out, not including the initiatives related to VEGA that have been described before: designed and development of a laser-guided surgery system, development of ultrashort pulse lasers with advanced features at low cost for new industries, interferometry for the characterization of surfaces and characterization of a high-density gas jet.
- Applications: By promoting a constant search for new applications for this rapidly evolving technology, in 2017 research has been developed mainly in the fields of study of ultrafast dynamics, laser material processing and analysis of laser ablation.

Results

Scientific Contributions of Users		
Reference	**Type of Contribution**	**CLPU Service**
I. Lamas, R. Montero, A. Peralta Conde, M. Sánchez Albaneda, L. Roso y A. Longrate, Tracking electronic coupling in polyatomic molecules by sub-25 fs UU pulses. Ultrafast Science & Technology 2017	Conference paper	CEP
A.Longarte, Ultrafast photoactivated molecular processes: from fundamentantals to applications. Ultrafast Science & Technology 2017	Conference paper	CEP
M.A. Moreira, K.J. Ciuffi, V. Rives, M.A. Vicente, R. Trujillano, A. Gil, S. Korili and E.H. de Faria, Effect of chemical modification of palygorskite and sepiolite by 3-aminopropyl triethoxisilane on adsorption of cationic and anionic dyes, Applied Clay Science, 135, 394–404 (2017).	Publication	SEM
B. González, T.H. da Silva, K.J. Ciuffi, M.A. Vicente, R. Trujillano, V. Rives, E.H. de Faria, S.A. Korili and A. Gil, Laponite Functionalized with Biuret and Melamine - Application to Adsorption of Antibiotic Trimethoprim, Microporous and Mesoporous Materials, 253 (2017) 112–122.	Publication	SEM
B. González, R. Trujillano, M.A. Vicente, V. Rives, E.H. de Faria, K.J. Ciuffi, S.A. Korili and A. Gil, Doped Ti-pillared clays as effective adsorbents – Application to Methylene Blue and Trimethoprim removal, Environmental Chemistry, 14, 267–278 (2017).	Publicación	SEM
M.V. do Prado, E.J. Nassar, E.H. de Faria, K.J. Ciuffi, B. González, M.A. Vicente, R. Trujillano and V. Rives, Ironporphyrin heterogeneous catalysts supported on Diatomaceous Earth, 5th International Conference on Multifunctional, Hybrid and Nanomaterials, Lisboa (Portugal), March 2017.	Conference paper	SEM
B. González, T.H. da Silva, K.J. Ciuffi, M.A. Vicente, R. Trujillano, V. Rives, E. Pérez-Bernal, E.H. de Faria, Laponite functionalized with Biuret and Melamine – Application to adsorption of Trimethoprim antibiotic, 16th International Clay Conference, Granada, July 2017.	Conference paper	SEM

Scientific Contributions of Users *(cont.)*		
Reference	**Type of Contribution**	**CLPU Service**
Álvarez-Valero, A.M., Burgess, R., Recio, C., de Matos, V., Sánchez-Guillamón, O., Gómez-Ballesteros, M., Recio, G., Fraile-Nuezc, E., Sumino, H., Flores, J.A., Ban, M., Geyer, A., Bárcenas, M.A., Borrajo, J., Compaña, J.M., 2017. Noble gas signals in corals predict submarine volcanic eruptions. Chemical Geology 2017	Publication	SEM
San Román, J., Conejero-Jarque, E., Silva, F., Romero, R., Holgado W., González-Galicia, M.A., Sola, I.J. and Crespo, H., Intuitive identification of optimal few-cycle pulse-compression dynamics in hollow-core fibers using dispersión-scan, Lasers and Electro-Ooptics Europe & European Quantum Electronics Conference (CLEO/Europe-EQEC, 2017 Conference)	Conference paper	CEP
Silva, F., Sola, I.J., Crespo, H., Romero, R., Miranda, M., Cord, A.L., L'Huiller, A., Trull, J. and Cojocaru, C., Monolithic single-shot dispersion-scan: A new tool for real time measurement and optimization of femtosecond pulses, Lasers and Electro-Optics Europe & European Quantum Electronics Conference (CLEO/Europe-EQEC, 2017 Conference)	Conference paper	CEP
Cutroneo, M.; Havranek, V., Mackova, A., Malinsky, P., Torrisi, L., Pérez-Hernández, J.A., Roso, L., Luxa, J. and Sofer, Z. Ion-beam lithography: a promising technique for the patterning of graphene oxide foil, 17th International Conference on Ion Source(ICIS 2017)	Conference paper	SEM

Scientific Publications from the Centre - 2017

Suárez, N.; Chacón, A.; Pérez-Hernández, J.A.; Biegert, J.; Lewenstein, M. and Ciappina, M.F., High-order harmonic generation in atomic and molecular systems, Physical Review A, 95 (2017)

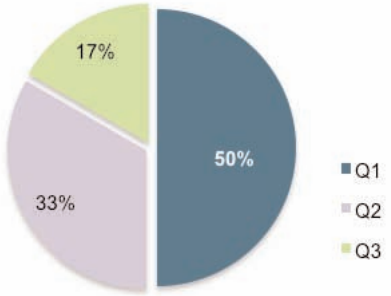
Ciappina, M.F.; Pérez-Hernández, J.A.; Landsman, A.S et al., Attosecond physics at the nanoscale, Reports on Progress in Physics (2017)

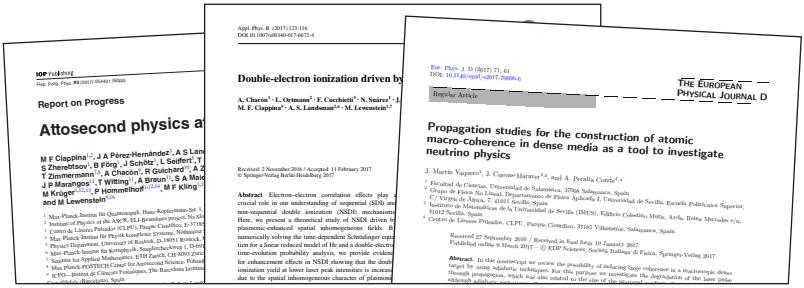
Ciappina, M.F.; Pérez-Hernández, J.A.; Landsman, A.S. et al., Double-electron ionization driven by inhomogeneous fields, Applied Physics B, 123 (2017)

Osika, E.N.; Chacón, A.; Ortmann, L.; Suarez, N.; Pérez-Hernández, J.A. at al., Wannier-Bloch apporach to localization in high-harmonic generation in solids, Applied Physics B, 7 (2017)

Valle Brozas, F.; Papp, D.; Escudero, L.M.; Roso, L. and Peralta Conde, A., X-ray emission from a liquid curtain jet when irradiated by femtosecond laser pulses, Applied Physics B, 123 (2017)

Ortmann, L.; Pérez-Hernández, J.A.; Ciappina, M.F.; Schötz, J.; Chacón, A.; Zeraouli, G.; Kling, M.F.; Roso, L.; Lewenstein, M. and Landsman A.S., Emergence of a Higher Energy Structure in strong field ionization with inhomogeneous electric fields, Physical Review Letters, 119 (2017)

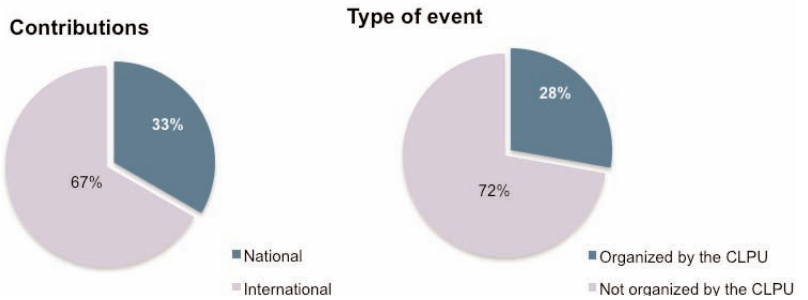




Specialized Events	
Event	**Contribution**
Presentation of ELI-Beamlines to the Spanish scientific community specialized in ultraintense lasers [Spain]	Organization, moderation of the meeting and presentations
13rd Direct Drive & Fast Ignition Workshop [Spain]	• *VEGA presentation [Ponencia]* • *Non collisional Hot electron transport in the femtosecond regime: analytic calculations of magnetic fields [Póster]* • *Initial research of EMP generated by VEGA system [Póster]* • *Study of ionization states dyanmics of Warm Dense Aluminion [Póster]* • *Picosecond-laser driven EM discharges and application to proton tailoring [Póster]* • *Adjustable KB microscope as a diagnostic for laser-driven x-ray sources [Póster]* • *VEGA laser operation [Póster]* • *Strong Magnetic field generation for electron and ion beam tailoring as a prospective for the fast ignition scheme [Póster]* • *Laser driven electrons and x-ray Betatron radiation generation at VEGA [Póster]*
2nd EMP Working Day [Poland]	Colaboration
e-ASTROGAM [Italy]	A laser driven source for radiation damage studies [Póster]
IZEST Spring Meeting [France]	Colaboration
Encuentro de Directores de las grandes instalaciones láser europeas [Germany]	Colaboration
2nd Conference on Plasma Diagnostics [France]	Adjustable KB microscope as a diagnostic for laser-drive x-ray sources [Póster]
Neutron and Ion Dosimetry Symposium – NEUDOS-13 [Poland]	Evaluation of Cadmium Telluride (CdTe) for Neutron Detection in High Intensity Laser Facilities [Póster]

Specialized Events *(cont.)*	
Event	**Contribution**
Joint conference 21 SEFM and 16 SEPR "Radiation, progress and health". [Spain]	Active dosimeters for PR in fields of pulsed radiation generated by femtosecond lasers [Presentation]
3rd Targetry for HRR Laser-Driven Sources [Spain]	• VEGA-2 comissioning experiment: WDM study using X-ray Betatron radiation [Presentation] • VEGA presentation [Presentation] • Adjustable KB microscope as a diagnostic for laser-driven x-ray sources [Poster] • Strong Magnetic field generation for electron and ion beam tailoring as a prospective for the fast ignition scheme [Poster] • Laser driven electrons and x-ray Betatron radiation generation at VEGA [Poster] • Laser material processing facility for targetry applications [Poster] • Study of ionization states dyanmics of Warm Dense Aluminion [Poster] • VEGA laser operation [Poster]
NEILS 2017 Target Area Operator at HRR for Peta/femto Laser Systems [Spain]	Organization, moderation of the meeting and presentations
Spanish Meeting of Optoelectronics – OPTOEL 2017 [Spain]	• Preliminary research on femtosecond laser tatto removal [Poster] • Ablation of bone tissue by fs laser: threshold, productivity and termal damage [Poster] • VEGA laser operation [Poster]
Plasma Physics by laser and applications - PPLA 2017 [Italy]	Laser acceleration with high repetition rate petawatt lasers [Invited Presentation]
EURADOS WG11 – High energy radiation fields Meeting [Switzerland]	Consortium of the Pulsed Lasers Centre [in the panel Instrument response in pulse photon fields] [Presentation]
43th Annual Meeting of the Spanish Nuclear Society [Spain]	Applications and approaches of neutron sources generated with ultraintense lasers [Presentation]

Specialized Events *(cont.)*	
Event	**Contribution**
IMPhocus'17 [Spain]	The petawatt (and femtosecond) laser, a unique public Spanish facility open to the scientific community [Presentation]
International Committee on Intense Laser Sciences _ ICILS 2017 [China]	Development and diagnostics of ultra-high power lasers [Invited Presentation]
Ultrafast Science and Technology Spain 2017 – USTS 2017 [Spain]	• Femtosecond laser drilling on Cu for high energy particle spectrometry applications [Poster] • Metal nanoparticles generated by femtosecond laser ablation [Poster] • Wavefront optimization of VEGA's main output [Poster] • VEGA Laser [Poster] • Visualizing material expansión in dielectrics after fs-laser surface irradation using fs-resolved microscopy [Poster] • High-harmonic generation tunability bu chromatic focusing of few-cycle laser pulses [Poster] • Ablation threshold of Yb-doped CaNbGa garnet single crysstals under femtosecond laser irradiation [Poster] • High aspect ratio micro holes patterns in metals by temtoecond laser ablation [Poster]



The participants of the TARG3 congress pose in a family photo during their visit to CLPU facilities.

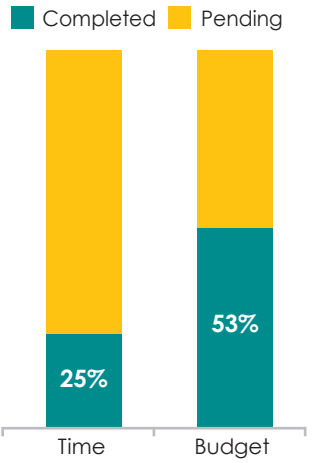
Generation of Knowledge – R&D

Projects – Applied Research

Laser-accelerated particles for medical applications – PALMA

Name of call: R&D+I Projects – Research Challenges
Budget: 242,000 €
Participation of CLPU: Coordinator
Duration: 48 months (30/12/2016 - 29/12/2020)

Description: Its objective is the development of a controlled X-ray source (of tens of KeV) in which the flow from the source guarantees that two or more photons per cell can be obtained with each pulse. In addition, it envisages a second source of protons with high and low dose rate versions. The aim is to generate a source that can verify the effectiveness of laser-driven proton therapy compared to the conventional approach.



A way to make Europe

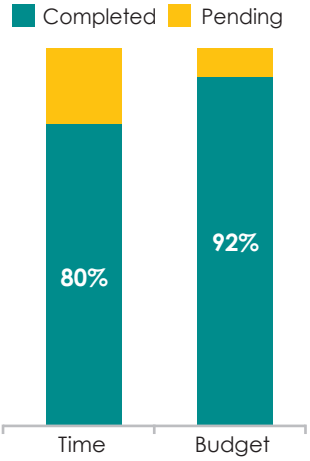
Actions:

- Concept and code simulations of the ultrafast Betatron radiation source. Generation of harmonics to be used in this context. Tests for alternative geometries.
- Development of the concept of the laser-guided proton beam for the TNSA proton source.
- Numerical simulations for the analysis of the operation of the proton source.
- Development of the solid- and gas-state targets.
- Basic design and construction of a neutron source for the study of plasma conditions to generate DD fusion reactions.
- We initiated contacts with the CIEMAT and the University of Aveiro to work on the design and development of the neutron spectrometer based on scintillation detectors.

Development of a system for continuous over-critical density laser targets

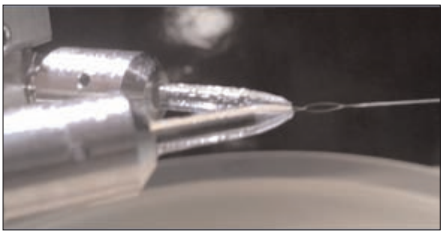
Name of call: Incentives for Infrastructures and Scientific-Technical Equipment.
Budget: 184,376.40 €
Participation of CLPU: Coordinator
Duration: 30 months (01/01/2016 – 30/06/2018)

Description: The PW line of the VEGA laser is one of the laser systems with the highest repetition rate in the world. The objective of this initiative is to have efficient target systems on which VEGA can be projected.



Actions:

- Purchase of a system of micro-liquids that can generate three types of target with great stability and precision:
  - > Micro-droplets that can be synchronized with VEGA thanks to a complex piezoelectric system.
  - > High-precision micro-columns where the beams can impact.
  - > Liquid micro-sheets formed by the controlled collision of two micro-columns.



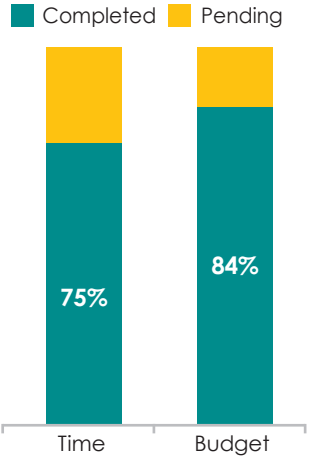
Jet liquid, curtain detail.

Investing in your future

Barium Tagging

Name of call: MINECO – R&D+I Projects – Research Challenges
Budget: 78,650 €
Participation of CLPU: Partner
Duration: 48 months (01/01/2015 – 31/12/2018)

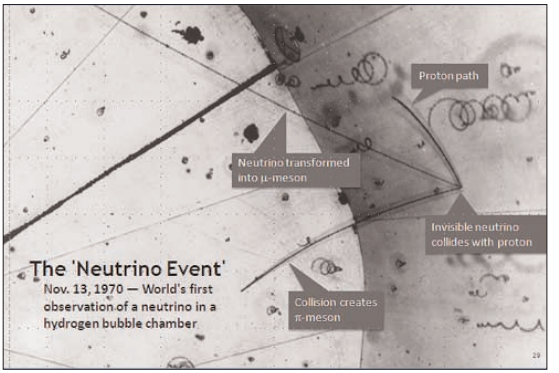
Description: This activity is part of the European project NEXT and its objective is to prove that it is possible to tag and detect Ba++ ions produced by xenon double beta decay.



Actions:

- Construction of a device to generate barium vapour through a system of ionization by electronic impact.
- Study of the optimal experimental conditions to improve the fluorescence performance between the P and D states of barium ion.
- Publication of an article in European Physical Journal D (see scientific publications).

Investing in your future



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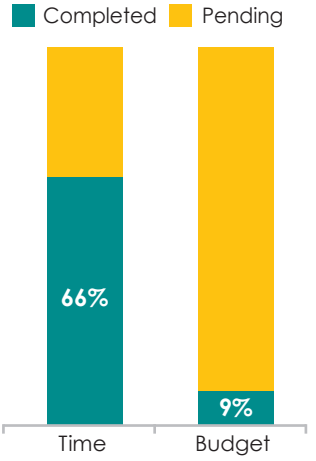
Extreme Diagnosis

Name of call: Regional Government of Castile and León – Support for Research Projects 2016
Budget: 68,460 €
Participation of CLPU: Coordinator
Duration: 36 months (01/01/2016 – 31/12/2018)

Description: With a biomedical approach, the goal of this project is to move forward in the area of detection of different procedures of light-matter interaction in the femtosecond range, and to generate new tools for extreme diagnosis with high intensity and high pulse repetition rate.



Actions:

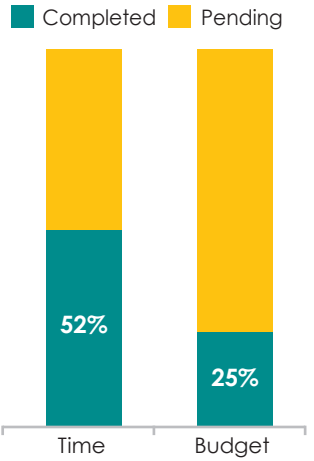
- Study of scattering in metallic and dielectric mirrors. Start of the construction of proton detectors and simulations with the beam profile.
- Intensity detector: Tests have been carried out in the 200 TW system focus, and tests have also started with the PW focus.
- Proton detector: The construction works have finished and tests have started with a laser mirror.
- Validation of radiation detectors: The design has been finished and the scintillation detector has been encapsulated. Development of an electronic system for readings and tests with the electronic acquisition system that will validate the electronic reading from the detectors.
- Hiring of a new researcher (08/2017).

Projects - Research and Development Networks

Laserlab Europe IV

Name of call: UE – H2020 – INFRAIA 2014-2015
Budget: 66,250 €
Participation of CLPU: Partner
Duration: 48 months (01/12/2015 – 30/11/2019)

Description: European Consortium with 33 laboratories and associated companies which work on basic and applied research in the field of intense lasers. The CLPU works in three different areas: development and applications of compact light sources; radiotherapy and imaging based on laser-accelerated proton beams and advanced instruments; and development of interaction targets for high-energy photons and laser-generated particle sources.



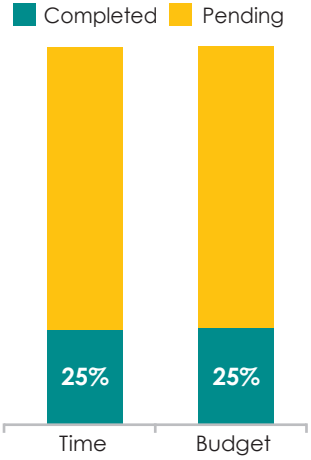
Actions:

- Betatron radiation has been produced in VEGA-2, and the source was used to study the plasma through spectroscopic analysis in the target ionization process. Its radiation has been used to radiograph small low-density objects with phase-contrast scanning.
- Protons were obtained in the 1-2 MeV range through VEGA-2 pulses in long focal configuration within a thin plastic-aluminium sheet.
- End of the construction of the X-ray microscope.
- X-ray spectroscopy has been used with Bragg/Bent Bragg crystals coupled with an X-ray camera.

RedLUR - Spanish Network of Ultrafast Lasers

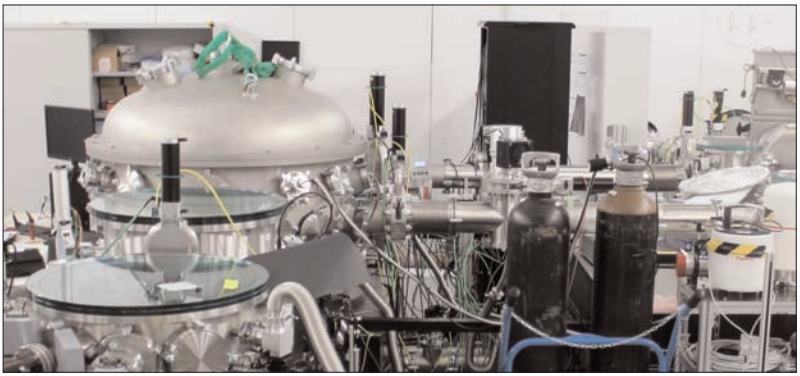
Name of call: MINECO – Excellence Networks
Budget: 41,500 €
Participation of CLPU: Coordinator
Duration: 24 months (01/07/2017 – 31/06/2019)

Description: This project gathers the most relevant Spanish research groups specialized in ultrafast lasers in order to promote activities for the spreading, collaboration and establishment of this specialized scientific community.



Actions:

- Hiring of staff to manage the project.
- Contact with groups and knowhow acquisition from the previous project, CATLUR.
- The Conference Ultrafast Science & Technology Spain 2017 was organized and held.
- Review of the catalogue of services of the group.



Projects – Promotion of Research (HR)

Hiring of predoctoral researchers

Name of call: Regional Government of Castile and León – Grants for the hiring of predoctoral researchers
Budget: 74,000 €
Participation of CLPU: Coordinator
Duration: 48 months (01/09/2017 – 31/08/2021)

Description: Preparation of the doctoral thesis "Development of a streak camera for extreme x-rays", related to the line of research of the Centre and its participation in the European project Laserlab IV.

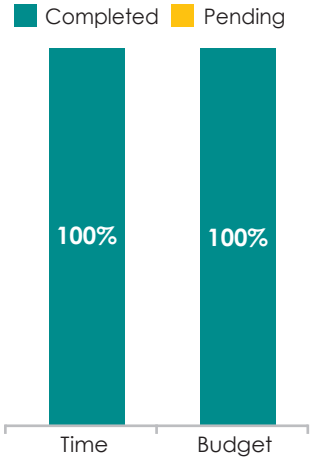
Actions:

- Hiring of a researcher.
- Literature review of streak techniques in the picosecond range and their physical applications.
- First numerical simulations.
- Experimental training.

Promotion of Youth Employment and Implantation of Youth Guarantee

Name of call: MINECO – Promotion of Talent and Employability
Budget: 39,200 €
Participation of CLPU: Coordinator
Duration: 24 months (30/11/2015 – 29/11/2017)

Description: The objective of the project was hiring support staff for the technical area of the Centre.



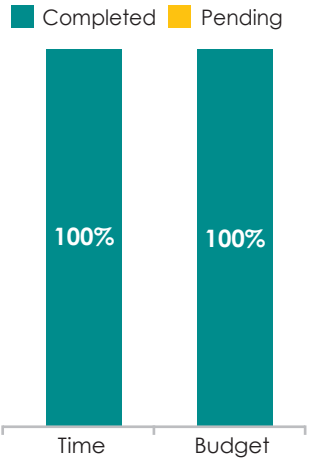
Actions:

- Development of a prototype of a web application to consult and modify the inventory related to the VEGA system in real time.
- Training related to the HRR lased based on the CPA technique. Collaboration in the maintenance of the laser infrastructure and the cooling units, and replacement of filters and damaged parts.
- Management of the purchase of electric, electronic and mechanical elements, and acquisition of optical materials.
- Measuring vibration in the VEGA system and the experimentation area.
- Assessment study for the creation of a portable laminar flow to protect diffraction networks in the VEGA-2 and VEGA-3 compressors.
- Monitoring of the system of air conditioning and cooling systems of the building regarding their interaction with the laser system.

FPU2012

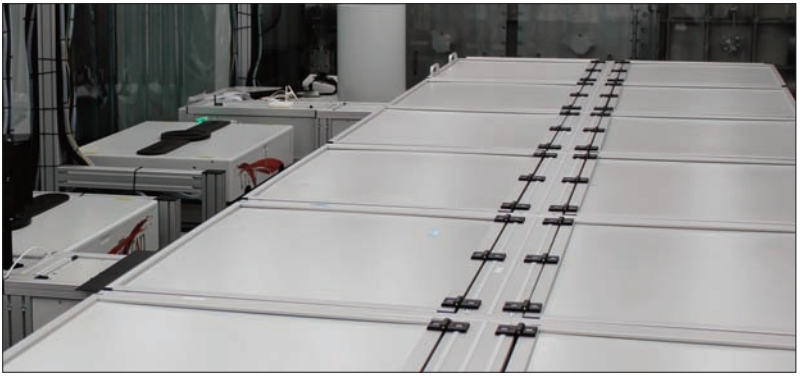
Name of call: MECD – Grants for the Training of University Lecturers
Budget: 71,234.16 €
Participation of CLPU: Coordinator
Duration: 48 months (01/04/2013 – 31/03/2017)

Description: The work proposal is a doctoral thesis focused on the study and design of a proton source which can cause nonlinear damage of materials.



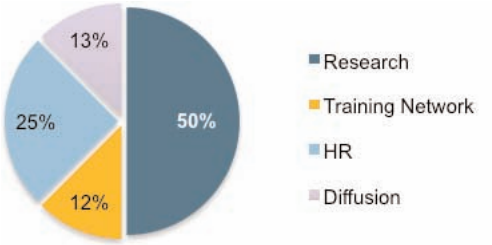
Actions:

- The doctoral thesis was written and defended with the title Design and Construction of a Radiation Source of Extreme Flux (11/09/2017)

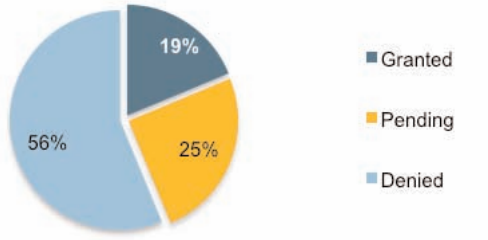


Projects – Applications for new grants			
Type	**Name (CLPU Activity)**	**Date**	**Status**
H2020-INFRAIA 2014-2015	AHEAD. WP09: PACT, Pair and Compton Telescope (Consultancy)	19/10/2016	Granted
COST- AP OC-2016-2-21750	Towards understanding and modelling intense electronic excitation (Colaboration)	12/07/2017	Pending
AVS – ESA	Powering rovers by High Intensity Laser Induction on Planets (Colaboration)	30/05/2017	Denied
AERTEC/EDA	Study on critical components for military lasers and advantages and use of wide area sensor technologies on UAVs (Colaboration)	20/09/2017	Granted
H2020-ERC AdG	InsideOut	29/08/2017	Denied
H2020 – MSCA-ITN-2017	ULPHIA	10/01/2017	Denied
H2020 – MSCA-ITN-2017	NOVA	01/2017	Denied
H2020-ERC/CoG	LIRA: Laser driven ionizing radiation towards new radiotherpay strategies	02/2017	Denied
Salamanca Ciudad de Cultura y Saberes Foundation	Talent attraction – Laser-Driven Proton Sources	30/09/2017	Denied
MINECO – Promotion of Talent & Employability	Technical Support Staff	02/02/2017	Denied
MINECO – Promotion of Talent & Employability	Juan de la Cierva Scholarship	27/01/2017	Denied
MINECO – Promotion of Talent & Employability	Ramón y Cajal Scholarship	19/01/2017	Unfilled
MINECO – Scientific & Technical Research	EXPLORA 2017: Beta-Femto-Phase-contrast	21/11/2017	Pending
MINECO – Scientific & Technical Research	EXPLORA 2017: LAS4SPACE	21/11/2017	Pending
FECYT – Promotion of Scientific Culture	The Black Room. Laboratory of Light.	31/10/2017	Granted
FECYT – Promotion of Scientific Culture	International Diffusion of Excellence in Research of the CLPU	31/10/2017	Pending

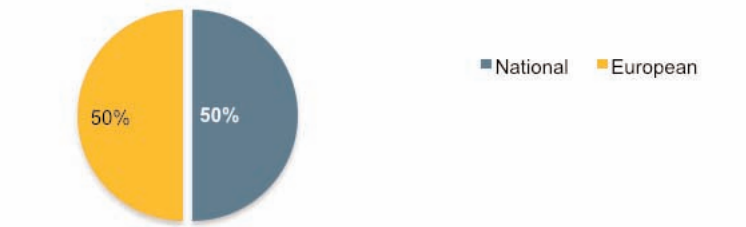
Topics of the project applications



Status of the project applications



Funding of project applications



Visits – Scientific Collaboration

From the CLPU to other facilities

Type of visit	Destination
Scientific collaboration	ICFO [Spain]
Search of strategies for HRR targets	Meeting with directors of several European facilities with large laser systems [Germany]
Execution of experiments (2)	CELIA [France]
Execution of experiments	GSI [Germany]
Scientific collaboration	CIEMAT [Spain]

From other facilities to the CLPU

Type of visit	Origin
Scientific collaboration PALMS Project	Univ. Maryland [USA]
Execution of experiments	Univ. Alberta [Canada]
Execution of experiments	Inst. Técnico of Lisbon [Portugal]
Execution of experiments	ELI-ALPS [Hungary]
Scientific collaboration	DER-IZEST
Scientific collaboration	ILE-Osaka [Japan]
Scientific collaboration	LULI [France]
Scientific collaboration	ENEA-Frascati [Italy]
Scientific collaboration	CNBG-Bordeaux [France]

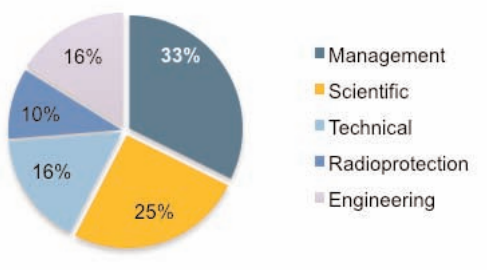
Institutional Collaboration – New Agreements

Organization	Type	Date of Signature
University of Strathclyde	Memorandum of Understanding	20 March 2017

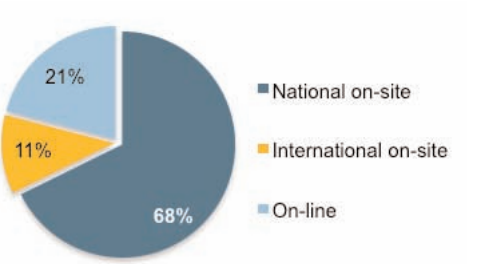
Generation of Knowledge: Training

Many training initiatives have been developed this year, with a total of 62 courses, many of which were attended to by staff from different areas and/or units. In absolute terms, we can say that 90.5% of our staff has received some kind of training throughout 2017. To this, we have to add the seminars taught by specialists in different areas that have taken place in the Centre, as well as the support activities offered by the CLPU for the academic specialization of several studies from the province of Salamanca, both in university levels and in the field of vocational training.

Training by Area and Units



Type of Training



Support to Academic Specialization

Institution	Area	# Students
USAL	Master's and Doctorate Degree in the field of Laser Physics and Technology	5
USAL	External work placement (curricular or extracurricular)	7 (2 with double stay)
CIFP Río Tormes	Training courses	1 (2 with stay)
IES Venancio Blanco	Training courses	1

Seminars taught in the Centre

Institution	Speaker	Title (date)
Lasing, S.A	Pablo Quintana	Innovating in Laser Technology (30/01)
DER-IZEST	Gerard Mourou / Jonathan Wheeler	Petawatt thin film pulse compression looking beyond today's limits (01/02)
USAL-CLPU	Valeria Ospina	Automatization of the high vacuum VEGA laser support system (15/03)
CNBG-Bordeaux	Mehdi Tarisien	Nuclear Excitation by laser at CNBG (26/04)
ILE – Osaka	Hioraki Nishimura	Advanced scheme laser driven neutron sources (19/05)
LULI	Michelle Koening	High energy density physics with laser (24/05)
CLPU	Juan Hernández	Working with vacuum: concepts, standards and good practice (21/11)
ENEA-Frascati	Danilo Pacella	New X-Ray 2D imaging digital detectors and techniques for laser plasma experiments (28/11)

A bridge to innovation
Patents

The most important milestone in the portfolio of patents of the Consortium was the granting of a national patent co-signed by the company Tecnivial. This is a new technology related to road safety published in the Spanish Official Industrial Property Gazette of June 2nd, 2017.

Patent Portfolio

Reference: ES2582236:
Road signalling system through laser lighting
Owners: Tecnivial (50%) y CLPU (50%)
State: Granted (13/06/2017)
Notes: The CLPU has received an authorization from the Ministry to license its percentage of ownership to the other co-owner of the patent through a direct grant.

Reference: ES1133731:
Window with interchangeable glass for pressure chambers
Owners: Sincrotrón ALBA (50%) y CLPU (50%)
State: Granted (03/02/2015)
Notes: The PCT procedure has been started. Technological offer published in: www.clpu.es - www.cells.es

Reference: ES2492365: System and procedure to recover gas substances from gas currents
Owners: Iberdrola Ingeniería y Construcción (80%) CLPU (10%) and Universidad de Salamanca (10%)
State: Granted (08/07/2015)
Notes: Licensing in process

Reference: EP14382080.1: Vacuum vessel & a part of the bounding thereof
Owners: CLPU (100%)
Application date: 06/03/2014
State: Test requested on 08/03/2016

Reference: JP5867758: Optical Pulse Generator
Owners: Proton Laser Applications
State: Granted (15/01/2016)

Industrial Projects

Study of critical components for military lasers and advantages and use of sensor technology in broad areas applicable to UAVs

Name of call: European Defence Agency
Budget: 67,000 €
Participation of CLPU: Subcontracted by AERTEC Solutions
Duration: 15 months (21/11/2017 – 20/02/2019)

Description: The goal of this project is the development of a miniature prototype for a system of counter-measures that includes a laser emitter with a wavelength close to the infrared region that can be installed in unmanned aerial vehicles from the European Defence Agency, which is responsible for the study of the viability of the prototype. This project aims to increase the capacity of these European aircraft thanks to the development by Spanish engineers that will work on this incipient type of technology.

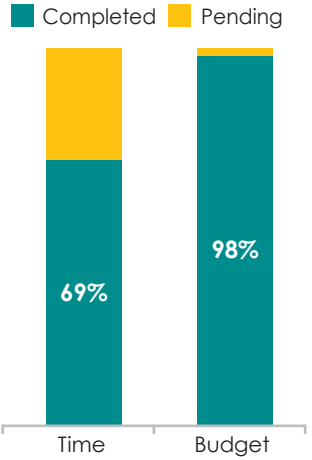
Actions:

- Initial meeting to launch the project
- Call for hiring staff associated to this project

EUROPEAN DEFENCE AGENCY

RTF Laser / Design and development of a laser-guided surgery system with selective tissue discrimination

Name of call: MINECO | Collaboration Challenges 2015
Budget: 158,616 €
Participation of CLPU: Partner
Duration: 30 months (01/10/2015 – 31/03/2018)



Description: The objective is developing a unique surgical device that acts as a modular platform equipped with functions that can discriminate tissue in real time.

Actions:

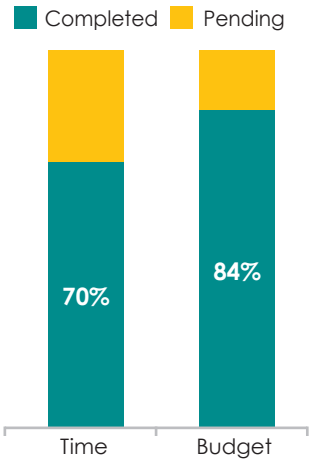
- Development of a prototype for a modular surgical platform to operate with laser ablation on different types of biological tissue (bone tissue, soft tissue, etc.)
- Support has been provided and the necessary tests requested by Deneb Medical with regard to the measurement of the depth of cut or the detection and control of burning in real time have been performed.
- End of ablation tests on biological material (hard and soft) with laser in different commercial systems: femtosecond, picosecond, microsecond and continuous laser (Ti-sapphire, Yb:KYW, Er: YAG and diodes).
- Creation of a confidential report. Some of the results have been published in conferences and scientific journals.
- Implementation of galvanometric systems to automatize the process and gain greater control of the laser during the tests of cut on bones and other tissue, with optimization of time and configurations.
- Ex-vivo experiments: Tests were performed, preferentially on bone material for hard tissue and skin, veins and arteries for soft tissue. In this type of essays, cauterization, coagulation and material removal (ink) tests on skin have been carried out.

Una manera de hacer Europa

- In-vivo experiments: in collaboration with the animal laboratory of the University of Salamanca, laser surgery tools have been assessed in tests for the coagulation, cauterization and cut of hard biological material.
- Support for other tasks: study of the depth of cut during laser processing in tests with hard materials, discrimination of hard/soft material for LIBS experiments in the Centre.
- Analysis of experimental results and creation of reports.

ULTRALASER / Development of ultrashort laser pulses with advanced features at a low cost for application in new industries

Name of call: MINECO | Collaboration Challenges 2015
Budget: 318,666.20 €
Participation of CLPU: Partner
Duration: 40 months (01/09/2015 – 31/12/2018)



Una manera de hacer Europa

Description: The objective is to produce a range of lasers of ultrashort pulses with advanced features and at a low cost which provide high versatility for new emerging industrial applications.

Actions:

- In the year 2017, the CLPU has focused, together with the ICMM-CSIC, on the tasks related to solid-state laser systems. In this regard, the systems have been tested and optimized with different operating configurations in CW (>1W). Also, pulsed-mode lasers were tested with different SESAM designs, and the ps regime was reached with diodes and some instability in the mode-locked form. Optical pumping

systems with laser diodes and active refrigeration systems for laser crystals were optimized.

- Detailed study of laser-induced damage threshold (LIDT) in grown laser systems by the ICMM-CSIC, which may be a key element in an oscillator or an amplifier.
- The processing of laser pulses has been assessed, and it has revealed a simple model that makes it possible to double or triple the frequency, although it will be necessary to optimize this system and to assess possible ways to integrate it.
- Technological transfer of fibre laser to the partners in the project (Jeanología, FYLA and the University of the Basque Country).
- A custom system has been designed to diagnose the quality of the laser beam, and laser prototypes can now be validated through a testbed that is constantly being updated.

Industrial Contracts

Throughout 2017, thanks to the constant relationship between the Centre and companies from different sectors, some relevant agreements have been signed that reveal the commitment of the CLPU to promoting, strengthening and consolidating public-private relations as a means of innovation.

Entity	Type	Entry into force
OEPM – Spanish Patent & Trademark Of.	Collaboration agreement	3 april 2017
AVS – Added Value Solutions, S.L.U.	Confidentiality agreement	27 april 2017
AERTEC Solutions	Contract for Laseron UAVs Project	30 dec. 2017

Technological Platforms

One of the strategic goals of the Centre is based on knowledge transfer. Therefore, the main line of action of the CLPU to implement this strategy is its collaboration, with varying degrees of involvement, with different technological platforms where science and industry look for synergies.

Ineustar

It is a structured forum, led by agents in the Industry of Science which wish to define research and technological development in Spain, with a clear market orientation. Their work and activity make it possible to guide and focus all efforts towards a more committed, planned and structured scenario of innovation in the field of the Industry of Science. More information: www.induciencia.es

Fotónica21

Like other European technological platforms, the main goal of Fotónica 21 is to efficiently guide the process of industrial innovation of photonic technology and its application in the four economic fields that have been described as key areas: Information and Communications Technology, Industrial Manufacture Processes, Life Sciences, and Lighting and Displays. More information: www.fotonica21.org

PEPRI

Spanish National R&D Platform of Radiological Protection. It was born in 2004, and its main goal is the promotion of R&D+I activities to promote protection against radiation. To do so, it establishes different specific measures, such as promoting the growth of scientific and technological knowledge, creating coordination group for national R&D+I initiatives by promoting collaboration between the different actors, or coordinating the Spanish participation in international R&D programmes, and particularly in the Horizon 2020 program of the European Union on radiological protection.

Consultancy Services

The Consultancy Service is a key element of the Consortium because it is proof of the efforts made by the CLPU to offer laser technology as a possible solution to some of the problems faced by progress.

Applicant	Request
ELI-HU Non-Profit Ltd.	Advice on research technology integration and laser radiation protection [The call was won by a different entity]
University of Strathclyde	Design and mechanical implementation of the main constituent of a Kirkpatrick Microscope for X-ray transport and focusing
Spanish Nuclear Safety Council	Specialization seminar on laser installations and radiological protection

Communication

Communication is one of the strategic lines that are constantly being developed by the Centre because, as a public scientific and technological infrastructure, it has assumed the need, virtually from its beginnings, to implement the activities directly linked to the social responsibility associated to the fact that it is a revitalizing agent of intelligent growth. During this year, apart from its habitual participation in the Science Week of Castile and León, the Consortium has focused on promoting knowledge about the technology of ultraintense lasers and on promoting the Centre itself through visits from different institutions:

Communication initiatives

Action	Typo of Event	Date
Specialization in ultraintense lasers. Group of students from the Polytechnic University of Madrid in the course "Structure of Matter", taught by the scientist P. Velarde.	Visit	13/03
Specialization in radioprotection. Group of technicians from the Spanish Nuclear Society.	Visit	24/07
Demonstration of the Microscopy Unit. Use of the SEM. Group of students from the University of Salamanca.	Visit	18/10
Awaking the scientific calling. Group of students from the French Secondary School Val de Durance, partnered with the Spanish Secondary School Tomás Bretón from Villamayor.	Visit	07/11
Forum "Science in Cinema". Primary School Ciudad de los Niños, Villamayor.	Science Week	15/11
Diffusion of laser technology and its applications. Group of alumni from the University of Salamanca.	Visit	15/12

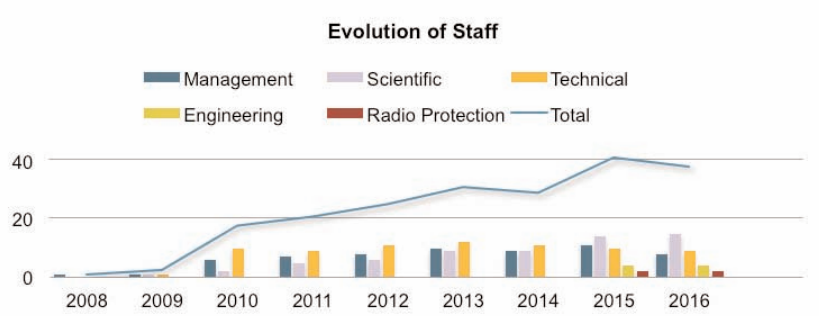
Institutional Collaboration – New Agreements

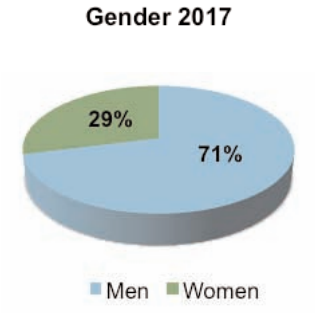
Entity	Type	Date
OSAL Student Chapter	Framework Collaboration Agreement	13/03/2017

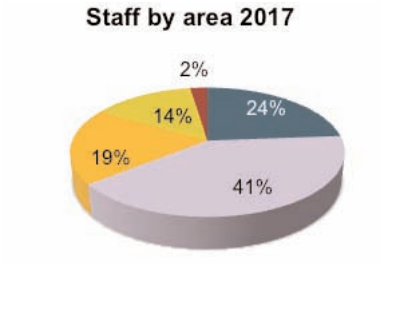
OTHER RELEVANT INFORMATION

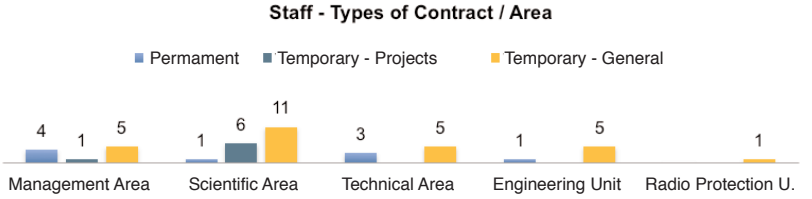
Knowledge management in an intelligent growth system requires the implementation of tools and management procedures that are efficient, effective and dynamic. Therefore, each year, the Infrastructure Management Area optimizes its efforts to improve each of these aspects.

Efficient Management - Human Resources

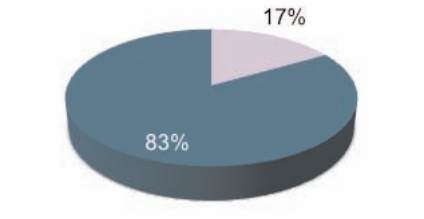




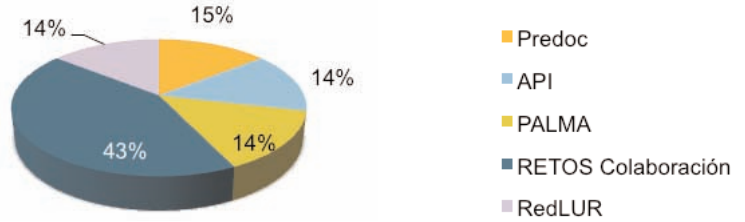




Division of Budget for Temporary Staff 2017

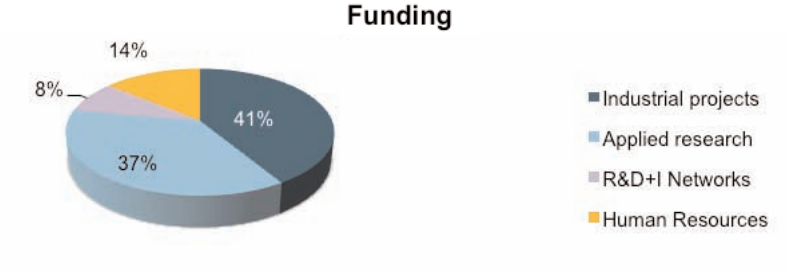


Temporary Staff by Projects



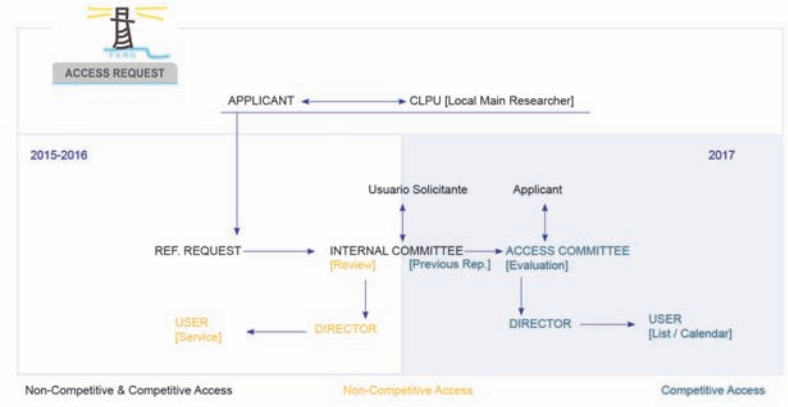
External Funding

INDUSTRIAL PROJECTS	RTF Laser	158.616,00 €
	Study of critical components for Military lasers (...)	67.000,00 €
	ULTRALASER	318.666,20 €
APPLIED RESEARCH	Barium Tagging	78.650,00 €
	Laser Accelerated Particles for Medical Applications –PALMA–	242.000,00 €
	Development of a system for continuous over-critial density targets	92.188,20 €
	Extreme Diagnosis	68.460,00 €
R&H NETWORKS	Laserlab Europe IV	66.250,00 €
	RedLUR	41.500,00 €
HR-PROMOTION OF RESEARCH	Hiring of Predoctoral Research Staff	75.200,00 €
	Promotion of Youth Employment and Implantation of Youth Guarantee	39.200,00 €
	FPU 2012	71.234,16 €



Total funding was € 1,318,964.56, which represents an increase of 3.04%, compared to the previous year. To this amount we must include the earnings from our services. The annual turnover this year was € 12,750.44 €. Therefore, the global sum of external funding in 2017 was € 1,331,714.56.

Electronic Administration

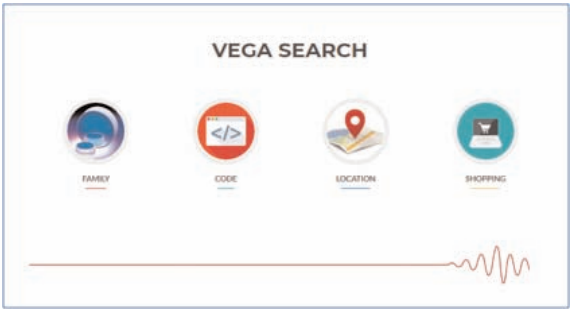


As a User's Centre, the Consortium has been committed for years to optimizing its resources for a comprehensive support of its users. In this regard, it has progressively designed procedures and tools to streamline the steps that go from the call for proposals to the arrival of users, the execution of the experiment and its conclusion. In the section "User's Centre" we already referred to FARO, the digital application

with which the CLPU can efficiently manage the interaction of potential users with the staff of the Centre. 2017 has been a key year for its use, for the first time, in competitive access requests.

With regard to the process of access to the Centre, the Management Area has also launched in 2017 the digital platform of distance training, CLPU-Learning. It is a complementary and necessary tool with which users and staff from the Centre will receive relevant information about the different aspects of the infrastructure in order to ensure a correct development of their tasks and of the experiments. This platform started operating in the last trimester of the year with a total of 7 courses, some of which include assessment tests to certify their completion and to allow, if necessary, access to restricted areas of the building.
Both in the case of competitive and non-competitive access, whenever the service involves training (laser safety, risk prevention ,radioprotection, etc.), potential users whose request has been accepted and whose budget has been approved will automatically receive a message with a list of the courses they have to complete and the time they have to do so.

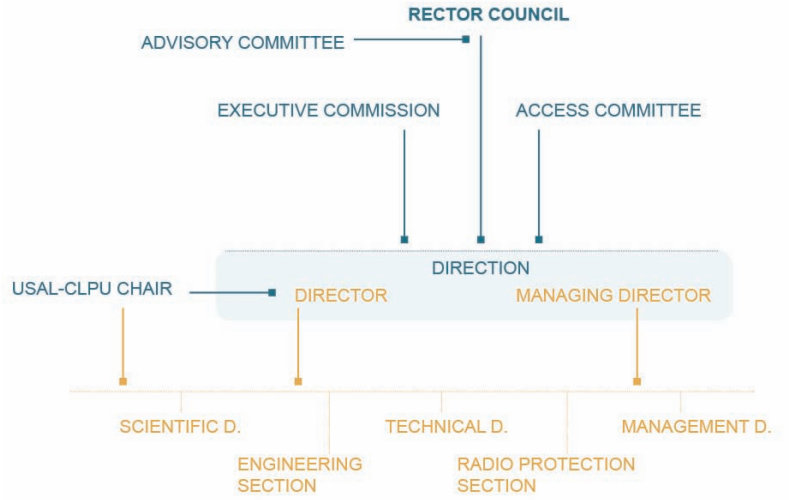
On the other hand, we have launched an important digital inventory system for the technical maintenance of VEGA material (a tool that has been implemented by the specialized technicians of the Centre). The importance of this tool lies in the complexity of the laser systems, the need to look for elements and the planning of preventive maintenance for that technology. It is a complete php-mysql tool that makes it possible to track all specialized material and its search in the system according to its family, sub-family, location, code and supplier data.



Finally, and according to the plan to join the electronic administration system, in 2017 we completed the configuration of the GEISER system (an

acronym in Spanish for "Integrated Management of Register Services"), which will allow us to work as an office that can send and receive registers as processing units or organizations from January 2018 onwards. The CONECTA system has already implemented (the electronic central for centralized contracting), and it has been active from the end of the year. In mid-2017 we adhered to AUDInet, a tool that allows managing centres in the field of the Public Sector to carry out electronic processing of documents within the framework of the auditing and financing control initiatives of the different units of the IGAE.

Structure of the Centre



As we can see in this organization chart, the Consortium of the Pulsed Lasers Centre has two governing bodies, two auxiliary committees and the USAL-CLPU Chair of Plasma with which the Centre, located in the city of Salamanca, has built a direct bridge between training and professional specialization.

Rector Council: It is the main governing organism of the Centre. It is made up of nine members who belong to the three founding institu-

tions. It has an annual rotation system for the positions of President and Vice-President, which are appointed by the Ministry of Economy and Competitiveness and by the Regional Government of Castile and León. In 2017 the Presidency was occupied by Ms. Pilar Garcés García, General Director of Universities and Research of the Regional Government of Castile and León, and the Vice-presidency was occupied by Juan Mª. Vázquez Rojas, from the General Secretary Office of Science and Innovation of the Ministry of Economy, Industry and Competitiveness, who replaced, on February 16th, Ms. María Luisa Castaño Marín, General Director of Innovation and Competitiveness of that same Ministry.

Executive Commission: It is made up of two members from each founding entity, and it is in charge of overviewing the implementation of the activities of the Centre. As in the case of the Rector Council, it follows a rotation system for its main positions, and both organisms cannot be presided over by the same institution at the same time. In 2017 these positions were held by Ms. Ángela Fernandez Curto, General Deputy Assistant Director of Major Scientific and Technological Infrastructures of the Ministry of Economy, Industry and Competitiveness, as President; and by Ms. Pilar Garcés García, General Director of Universities and Research of the Regional Government of Castile and León, as Vice-president.

Advisory Scientific-Technical Committee: It is made up of 8 researchers of international renown who are in charge of advising the Rector Council about the current scientific programmes of the Centre or the ones that are being planned for the future.

Access Committee: It is a vitally important element in the competitive open access process. This committee was created in 2017 as a fundamental part of the first open call for access to VEGA-2. It is mainly made up of renowned external researchers. The director of the CLPU invites them to be part of the Committee, and the Executive Commission is in charge of approving these appointments for renewable periods of four years.

Plasma USAL-CLPU Chair: This chair was created as part of the founding relationship between the Pulsed Lasers Centre and the University

of Salamanca. Its objective is the development of activities of common interest in the scientific and technological field of ultraintense and ultrashort lasers. More specifically, it focuses on Plasma Physics, because this is one of the main research areas associated to the unique equipment of VEGA.

For more information about the structure of the Center...