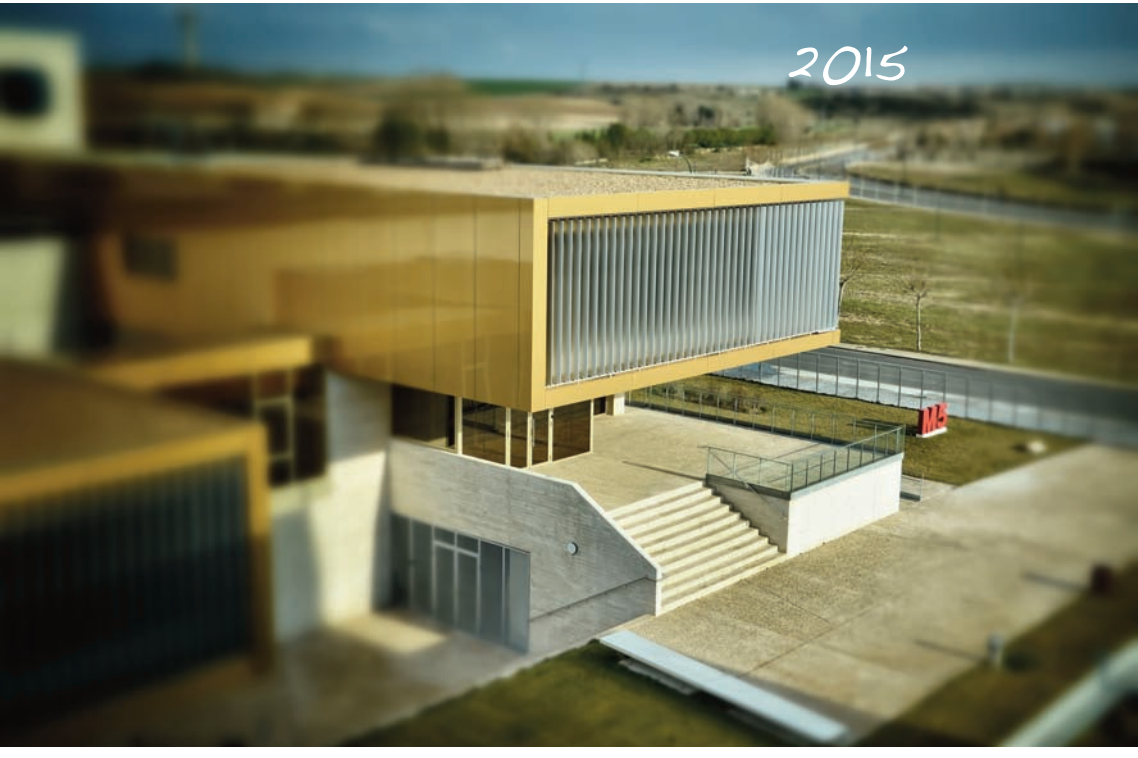
CLPU CENTRO DE LÁSERES PULSADOS

Activities Report

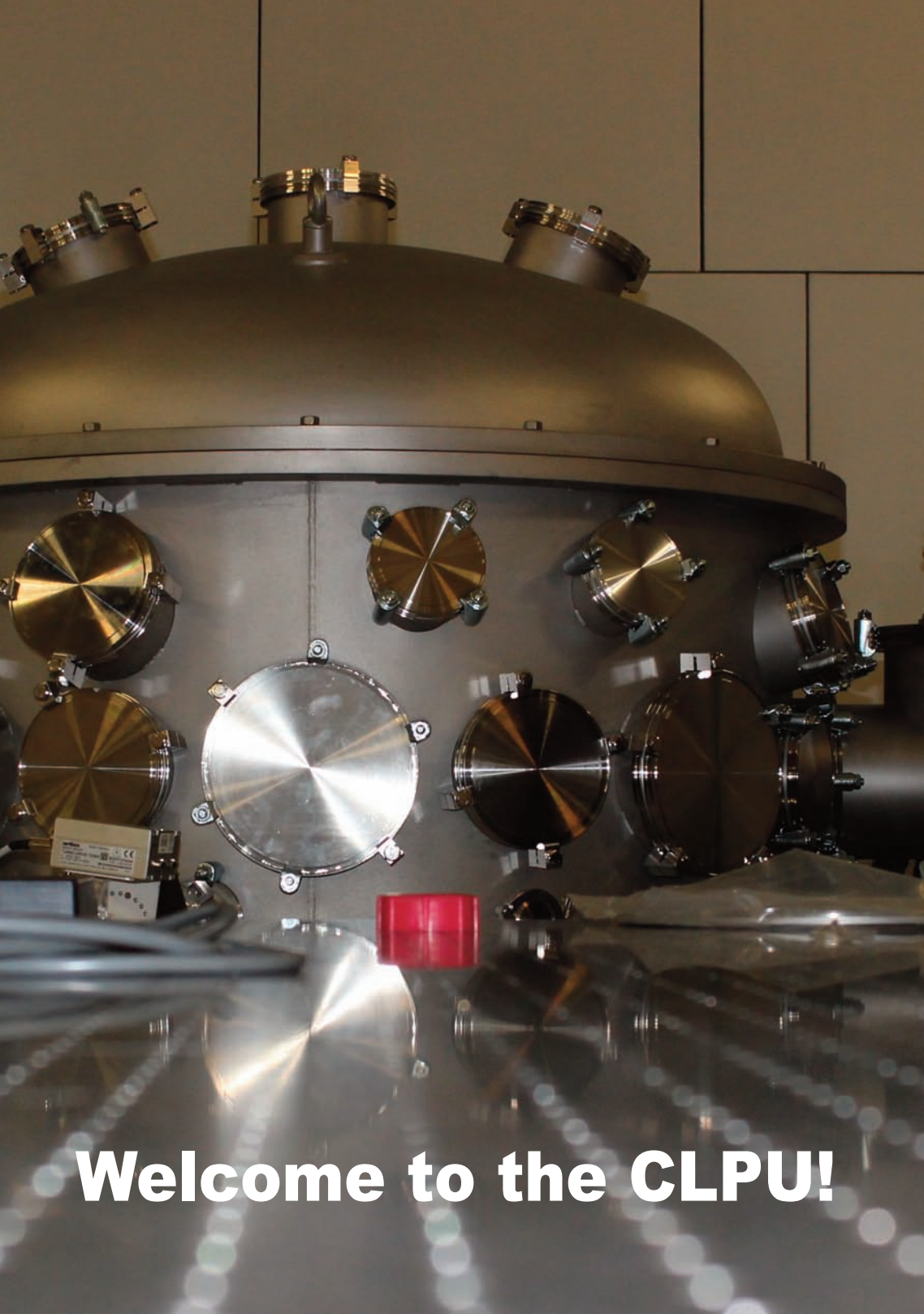


UNIÓN EUROPEA
FONDO EUROPEO DE DESARROLLO REGIONAL
"Una manera de hacer Europa"

GOBIERNO DE ESPAÑA
MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD

Junta de Castilla y León

VNIVERSIDAD D SALAMANCA



Welcome to the CLPU!

Message from the Director

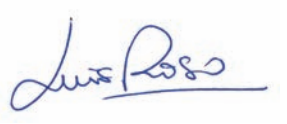
Message from the Director

Welcome to the Pulsed Lasers Centre. It is once again my pleasure to meet you in this public forum in which its infrastructure is presented as it has been all along the past year. 2015 has been essential in the development of the CLPU's uniqueness, since most of the efforts of our specialized technical staff have been devoted to initializing the third output of our main laser system, VEGA. This is the equipment to which we owe our existence and it is the focus of our staff's activity every single day. As you shall see while reading this report, our system, which will be one of the ten most powerful lasers in the world, is now ready to start its test phase in the year 2016, a period in which we hope to be able to report that the only laser in Spain which can reach a peak power of 1 petawatt has been set in motion. The different measures implemented in 2015 in the Pulsed Lasers Centre will finally give shape to the equipment which defines its essence and which is the reason why it has been labelled as a Unique Scientific and Technical Infrastructure. The CLPU is, above all else, VEGA, and VEGA is CLPU.

However, this Centre has travelled a long way to get to this point, and it has done so by displaying a unique versatility which made it possible for it to become a User's Centre even before VEGA was operational. These efforts had two clear objectives: promoting Spanish laser technology and consolidating a community of users who would not only provide stability to our infrastructures, but also move forward in the

specialized scientific area, both in the public and in the private sector. In this regard, this report begins by focusing on those two essential facets of the CLPU: its singularity, VEGA; and its main aspect as an infrastructure designed for a scientific and industrial community; and then to focus on the bustling activity of a centre which carries out its own research in order to offer the highest quality to its users.

One more year, the Pulsed Lasers Centre shows, with its initiatives, a constant effort to efficiently contribute to the economy of knowledge and to the progress of Spanish science and technology for social development.



Unique Scientific and Technological Infrastructure (ICTS)

UNIQUE SCIENTIFIC AND TECHNICAL INFRASTRUCTURE (ICTS)

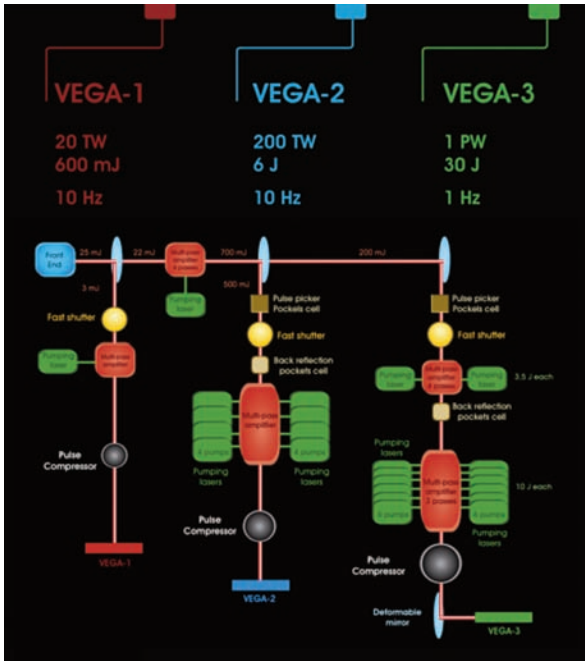
Introduction

The Consortium for the Pulsed Lasers Centre is a Unique Scientific and Technical Infrastructure (ICTS by its Spanish initials) specialized in ultraintense and ultrashort lasers. ICTS are defined as avant-garde experimental tools which unique capabilities in Spain, which are open to the entire system of research, development and innovation and which are essential for the scientific community in order to carry out certain research and/or technological development. All these installations are part of the national ICTS Roadmap. The appointment of the first ICTS was decided in the 3rd Conference of Autonomous Presidents held on the 11th of January 2007. In 2012, the Science, Technology and Innovation Policy Council was created, and one of its main tasks was the approval of the updated ICTS Roadmap. To do so, the different facilities submitted their Strategic Plans, which were analysed and assessed to evaluate whether they should be included in the new Roadmap, which was finally approved on the 7th of October 2014. The Pulsed Lasers Centre featured in the map as a facility under construction.

Roadmap of Unique Scientific and Technical Infrastructures, published in 2015 by the Spanish Ministry of Economy and Competitiveness.

In the new map, ICTS can have a single location, they can belong to a network of infrastructures or they can appear as a Distributed Infrastructure, depending on the level of integration and coordination of its different functions. With regard to the specialized areas, 8 categories have been defined: Astronomy and Astrophysics; Sea, Life and Earth Sciences; Health Sciences and Biotechnology; Information and Communications Technology; Energy; Engineering; Materials; and Socioeconomic Sciences and Humanities. According to these two classifications, the Pulsed Lasers Centre is a Single-Location ICTS (Science Park of the University of Salamanca) in the area of 'Materials'.

The Pulsed Lasers Centre is publicly owned (50% by the Ministry of Economy and Competitiveness, 45% by the Regional Government of Castile and León, and 5% by the University of Salamanca), and it has a unique equipment in Spain: VEGA, a system which can reach a peak intensity of one petawatt. 2015 has been a key year for this piece of equipment which is set to start operating immediately (since the Centre houses some additional services which are already active), because it is in this year when the three outputs of the system have been put together and adjusted. VEGA is not only relevant because of the power it can reach, which places it as one of the nine most powerful lasers in the world, but because of its design: a system with three outputs with different power which are synchronized with the same pulse generator.



Actions on VEGA

All along this year, the installation of the VEGA petawatt system has continued.

During the first four-month period, the main work was done on the amplification equipment of the third output of the system (VEGA-3), the petawatt laser: the 2.5 J amplifier was aligned, and so was the Twin Amplifier, which also started operating this year. Similarly, the front-end was tested with measurement of duration and beam contrast, and the software of the control system was implemented.

Starting in June, and all through the summer, the two main outputs of the system (VEGA-1 and VEGA-2) were integrated in their new location and transferred from another laboratory of the Pulsed Lasers Centre in an adjoining building.

In September, the VEGA-1 and VEGA-2 systems were aligned in free-running and seeded regimes. The control system for these two outputs was updated.

At the end of the year, the optics equipment was installed in the pre-compression stage and in the compressor of VEGA-2 and VEGA-3. Also, the portable metrology table was installed at the entrance of the main amplifier of VEGA-2, thus finishing the equipment installation stage for the VEGA laser system and starting the operation check stage.

Actions / Services 2015

As has already been noted, the Pulsed Lasers Centre is in its installation stage for the petawatt system. However, from its beginning, the Centre promoted the development of services linked to ultraintense lasers which could act as a complement to VEGA and created a user's community. During the year 2015, these have been the initiatives which have been developed and the characteristics of the services in which they have taken place:

VEGA LASER SYSTEM

Contact: vegaservice@clpu.es

TECHNICAL SPECIFICATIONS		
	VEGA 1	**VEGA 2**
Energy / pulse	600 mJ	6J
Peak Power	20 TW	200 TW
Duration / pulse	30 fs	30 fs
Repetition rate	10 Hz	10 Hz
Central Wavelength	800 nm	800 nm

Actions:

Experimental Station: VEGA 1

User: EMPA. Material Science & Technology (Zurich, Switzerland)

Project/Line of research: Obtaining coherent X radiation through stimulated emission in plasma mediums

Action objectives: Studying the dynamics of formation and expansion of laser-generated plasmas

Experimental development: The diagnosis of plasmas was carried out through interferometry. The experiment used targets with different geometric profiles: planes, angles and cylinders.

Duration: Three months

Results: Inconclusive. The line of research is open to new experiments

Experimental Station: VEGA 2

User: Institute for Molecular Imaging Technologies (I3M)

Project/Line of Research: INNPRONTA 'LIFE: Breast cancer integral challenge'. One of its objectives is the development of medical applications for proton acceleration.

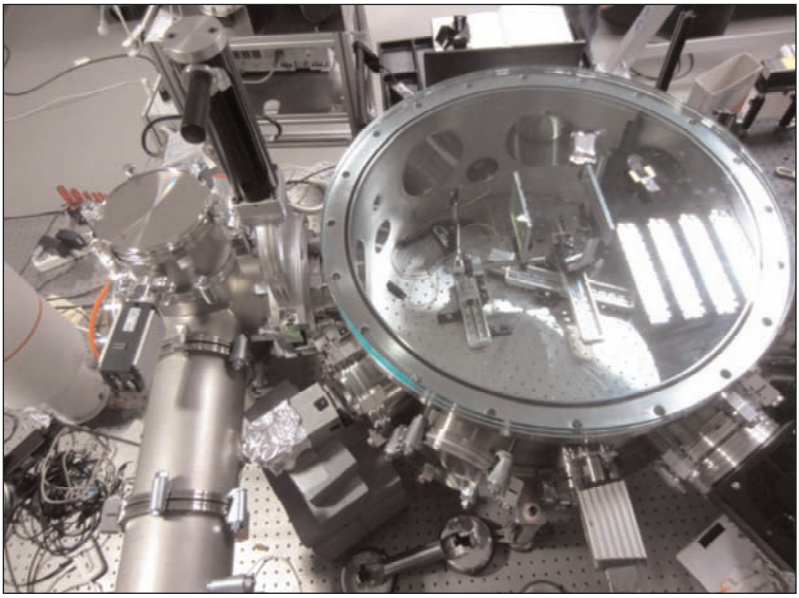
Action objectives: Obtaining accelerated proton beams for the creation of radiopharmaceuticals for nuclear medicine through ultrashort ultraintense laser.

Experimental development: The experiments were carried out with the VEGA-2 laser, with 6J pulse energy and a pulse duration of 30 fs focused on an area of 30 microns in diameter. The experimental system included a vacuum chamber which contained the

optic equipment which focused the laser. The chamber was connected to another one in which the target and the proton diagnosis elements were placed. Radiochromic films with dose calibration and scintillation detectors were used to detect the generated protons and to measure their energy.

Duration: 6 months.

Results: Inconclusive. The line of research remains open.



Target and diagnosis chamber.

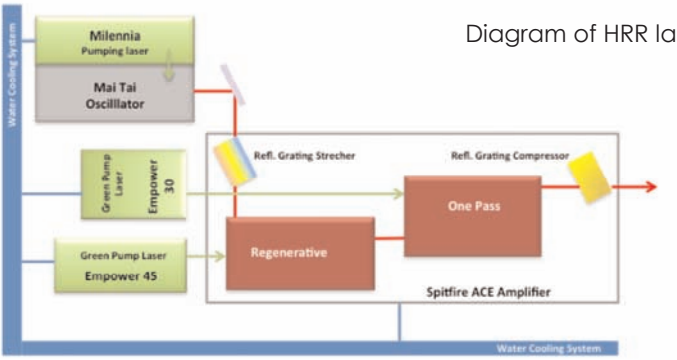
HIGH REPETITION RATE LASER SYSTEM

Contact: highrepservice@clpu.es

TECHNICAL SPECIFICATIONS	
Commercial model	Spitfire (Spectra Physics)
Energy / pulse	7 mJ
Peak Power	60 GW
Duration / pulse	120 fs
Repetition Rate	1 kHz
Central Wavelength	800 nm
Pre-pulse contrast	> 1.000:1
Polarization	Linear

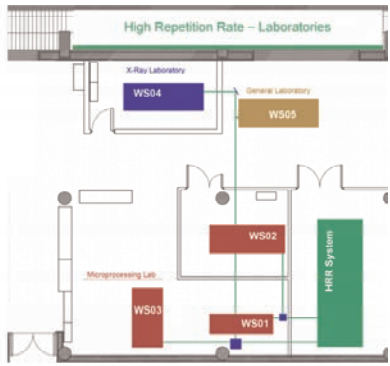
Diagram of HRR experimental area (Laboratory 2)

Diagram of HRR laser system



The High Repetition Rate (HRR) laser system involves three experimental areas:

1. The microprocessing laboratory, which has three workstations:
   - WS01: specific area for high-precision microprocessing.
   - WS02: trepanning area.
   - WS03: versatile area. General microprocessing.



2. The X-Ray Laboratory (WS04) has a single work table with a source of laser soft X-rays. This is the first equipment which has been classified as a Category

3 radioactive installation by the Spanish Nuclear Safety Council (authorization IRA 3254).

3. General laboratory WS05.

Actions:

Experimental Station: Microprocessing laboratory WS01

User: Research Groups in Laser Microprocessing Materials (GIMM-LASER) and Extreme Optics (GIOE) of the University of Salamanca[1].

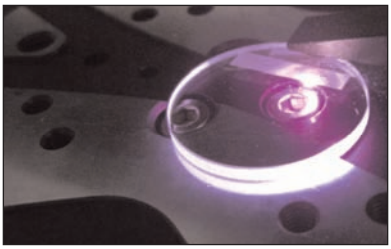
Project/Line of Research: FIS2013-44174-P, item 'Interaction between ultrashort pulses and solids. Manufacture of non-linear optic devices and material nanostructuring'.

Action objectives: Developing and implementing an experimental device for high-precision 3-dimensional microprocessing. The objective of this line of work is creating an integrated system which makes it possible to approach the microstructuring process of samples with any geometric profile.

Experimental development: The experimental device includes a computer-controlled 5-axis micropositioning system connected to a laser microprocessing station and an additional holographic conoscope to scan three-dimensional surfaces.

Duration: 1 month

Results: No direct results were obtained with the experiments carried out in the Centre.



Surface micromachining on CaF_2 glass

Three-dimensional texturing of metals

1 All these actions have been promoted by researchers from the University of Salamanca according to the agreement between both entities and, more particularly, to the annex "Development of joint activities in material microprocessing and extreme optics through laser USAL-CLPU".

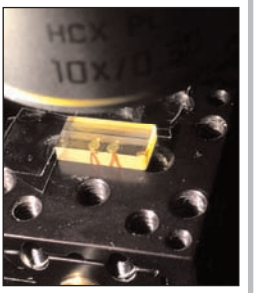
Experimental Station: Microprocessing laboratory WS01.

User: Research Groups in Laser Microprocessing Materials (GIMM-LASER) and Extreme Optics (GIOE) of the University of Salamanca.

Project/Line of Research: FIS2013-44174-P, item 'Interaction between ultrashort pulses and solids. Manufacture of non-linear optic devices and material nanostructuring'.

Action objectives: Designing and manufacturing new waveguide-type structures on optic crystals for the development of three-dimensional photonic devices. The aim of this line of work is the creation of compact detectors (such as stellar interferometers or miniature spectrometers) which are particularly in demand in the sector of spatial and telecommunications research.

Experimental development: The experimental device includes a microprocessing station with 3-axis motors and systems for focalization and laser beam control. Particular emphasis has been placed on crystals with active ion doping such as NdYAG and non-linear crystals such as LiNbO.



Manufacture of waveguides in crystals.

Duration: 2 months.

Results: Scientific publication in a high-impact journal:

- Y. Cheng, J. Lv, Sh. Akhmadaliev, I. Hernández-Palmero, C. Romero, J. R. Vázquez de Aldana, Sh. Zhou, F. Chen, Optical ridge waveguides in Yb:YAG laser crystal produced by combination of swift carbon ion irradiation and femtosecond laser ablation, Optics and Laser Technology 72, 100 (2015).

Experimental Station: General laboratory WS05.

User: VALEO Iluminación S.A.U.

Project/Line of Research: Established as per agreement.

Action objectives: Analysis of improvements in the soldering of plastic materials and their combinations.

Experimental development: Confidential.

Duration: 5 weeks.

Results: Confidential.

Experimental Station: General laboratory WS05.

User: Centre's own research.

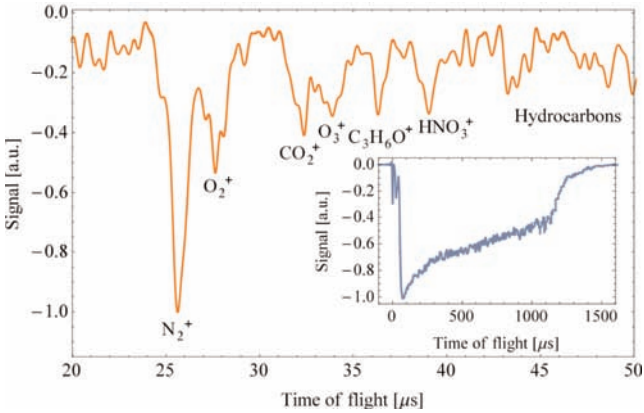
Project/Line of Research: Design and characterization of a compact mass spectrometer for the detection and analysis of laser-ionized species at atmospheric pressure.

Action objectives: Implementing more efficient laser techniques for ionization in mass spectrometers. Partially selective ionization improves the resolution of these devices for the analysis of traces of elements in complex samples.

Experimental development: Design and development of the prototype with the first evaluation tests. For this initiative, collaboration from the department of electronics was required, and they carried out a technical assessment for the selection and use of intensity and high voltage probes.

Duration: 2 weeks.

Results: Inconclusive. The line of research will remain open so that in 2016 the potential of the spectrometer may be explored.



Mass spectrometry of an air-generated laser filament at atmospheric pressure

Experimental Station: General Laboratory WS05.

User: Deneb Medical.

Project/Line of Research: Established as per agreement.

Action objectives: Generating laser filaments with kHz to investigate the viability of plasma generation and its use in HV electrical applications.

Experimental development: Confidential.

Duration: 3 weeks.

Results: Confidential. Possible patent. The line of research remains open.

Experimental Station: X-Ray Laboratory (WS04).

User: Centre's own research.

Project/Line of Research: Generation of X-rays through laser.

Action objectives: Analysis and assessment of the X-ray source.

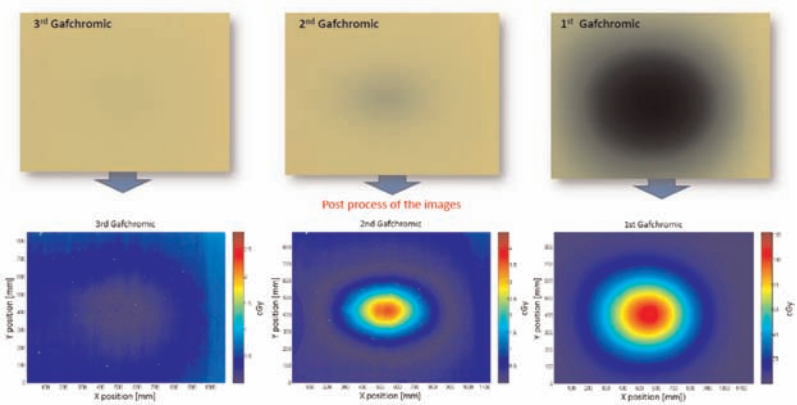
Experimental development: Several campaigns were implemented:

- Study of the divergence and energy of electrons produced in an X-ray source through a radiochromic film stack (EBT2).
- Analysis of the usability of thermoluminescent detectors (TLD) to check whether their calibration can be applied to low-energy photons. To do so, an array of TLD was placed on previously calibrated radiochromic EBT2 stacks. The recorded doses in both detectors were compared and we verified that the doses registered by TLDs which had been calibrated for high energies were several orders of magnitude higher than in the radiochromic stacks. Consequently, we concluded that the calibration of TLDs cannot be extrapolated to low-energy contexts.

Duration: 2 months

Results:

- Laser based x-Ray source at the Pulsed Lasers Centre, two pieces of research were created with this title, an oral communication and a poster which were presented in three international events.
- Final degree dissertation: 'Characterization of an X-ray source generated by ultrashort, ultraintense pulses'.



Doses registered in the radiochromic stack.

Experimental Station: X-Ray Laboratory (WS04).

User: Centre's own research in collaboration with the Radio Protection Unit.

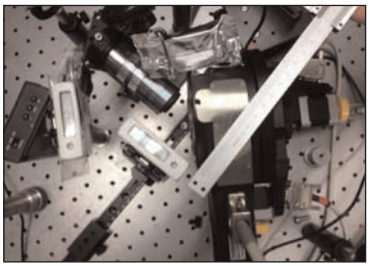
Project/Line of Research: Study and development of personal dosimeters adapted to the radiation fields generated in a high-intensity laser station.

Action objectives: Study of the response of commercial electronic personal dosimeters (EPDs) after exposure to the radiation field generated by the laser-sodium interaction with high repetition rate.

Experimental development: An experimental set was prepared with two EPDs located at different distances and angles from the source generated when the kHz laser beam is focused on a target. Dosimeters from the National Centre of Dosimetry were also used.

Duration: 1 month.

Results: Accepted as a specialized contribution to the 18th International Conference on Solid State Dosimetry (SSD18).



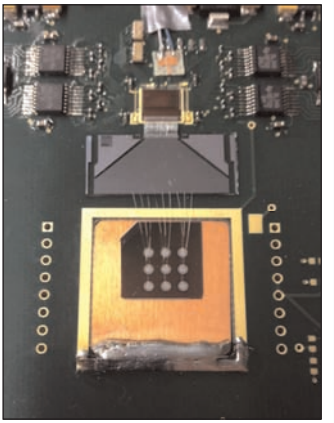
Experimental set-up.

Experimental Station: X-Ray Laboratory (WS04).

User: Centre's own research in collaboration with the Unit of Radioprotection.

Project/Line of Research: Study and development of personal dosimeters adapted to the radiation fields generated in a high-intensity laser station.

Action objectives: Development of solid state detectors adapted to laser-generated ultrashort, ultraintense fields.



Silicon detector connected to beetle chip through pitch adapter

Experimental development: A silicon detector was integrated in a commercial reading system developed as part of the collaboration work with ALIBAVA (manufacturer of devices and detection systems). The system uses a beetle chip for the reading of the silicon detector which has been subject to the radiation generated by the laser-sodium interaction with a high repetition rate. Due to the scope of the research, this project involved the participation of two ICTS centres: The White Room at the National Microelectronics Centre (IMB-CNM-CSIC) which manufactures the silicon detector, and the CLPU, which provides its facilities and services for the research.

Duration: 2 weeks.

Results: Accepted as a specialized contribution to the 18th International Conference on Solid State Dosimetry (SSD18). New experiments in this same line of research are planned.

Experimental Station: X-Ray Laboratory (WS04).

User: Centre's own research in collaboration with the University of Aveiro and the Unit of Radioprotection.

Project/Line of Research: Study and development of personal dosimeters adapted to the radiation fields generated in a high-intensity laser station, based on gas detectors.

Action objectives: Development of gas detectors adapted to laser-generated pulsed ultrashort fields.
Experimental development: Study of the response of a gas detector (mixture of gases and Xe) developed by the Portuguese organization. The results of this first measurement campaign are preliminary and were used as the basis to know the potential of this type of detectors for their use in high-intensity laser facilities, and particularly in the CLPU.
Duration: 3 days.
Results: The experiments have revealed that this line of research may be of interest, and further research will be carried out.

LASER SYSTEM WITH CARRIER-ENVELOPE PHASE (CEP) STABILIZATION

Contact: cepservice@clpu.es

TECHNICAL SPECIFICATIONS	
Commercial Model	Femtopower PRO - HE CEP 4
Energy / pulse	2 mJ | < 0,6 mJ (post-compression)
Duration / pulseo	< 25 fs | < 5 fs (post-compression)
Repetition Rate	80 MHz (oscillator) | 1 kHz (amplification | post-compression)
Central Wavelength	790 nm
Pre-pulse contrast	10^8:1
Polarization	Linear, p

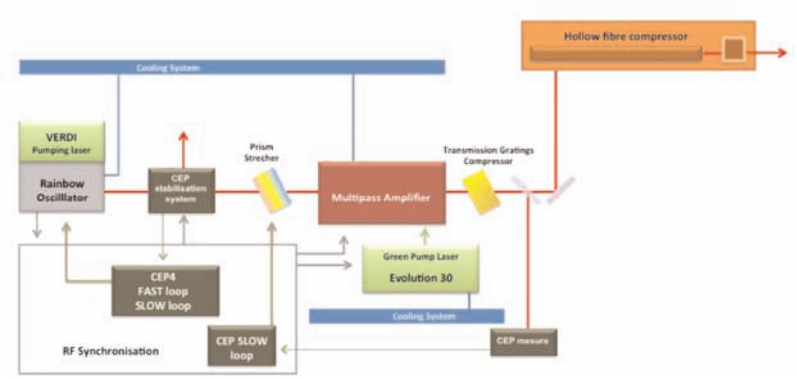


Diagram of CEP laser system.

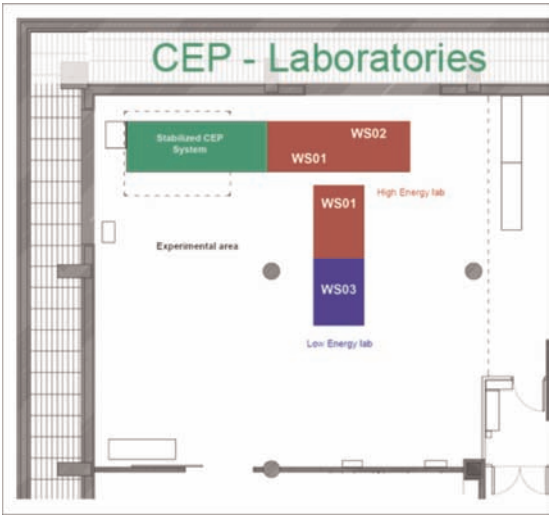


Diagram of CEP Experimental Area (Laboratory 3).

The CEP laser system involves two experimental areas:

1. High Energy Laboratory, with two workstations:
   - WS01. High Energy
   - WS02. XUV secondary source
2. Low Energy Laboratory, with WS03.

Experimental Station: High Energy Laboratory WS01.

User: Research Group in Extreme Optics (GIOE) of the University of Salamanca.

Project/Line of Research: FIS2013-44174-P, item 'Generation and characterization of ultrashort pulses in different spectral ranges'.

Action objectives: Development of a prototype of d-scan.

Experimental development: Post-compressed pulses were measured and satisfactorily compared with the results obtained with a commercial d-scan manufactured by Sphere Ultrafast Photonics.

Duration: 5 days.

Results: The system works correctly and the CEP laser has been optimized.

Experimental Station: High Energy Laboratory WS01.

User: Research Group in Extreme Optics (GIOE) of the University of Salamanca.

Project/Line of Research: FIS2013-44174-P, item 'Generation and characterization of ultrashort pulses in different spectral ranges'.

Action objectives: Development of a self-diagnosis system for the laser in collaboration with the Research Group in Optics of the Jaume I University.

Experimental development: In this experiment, the 'pulse shaping' feature of the laser system was used to obtain d-scan measurements of the emitted pulses. That is, the system which had to be measured was used as part of its own diagnosis.

Duration: 2 days.

Results: The results were satisfactory, with similar values to those obtained through other methods. The initial hypotheses have been verified and the analysis of results is pending publication.

Experimental Station: High Energy Laboratory WS01.

User: Research Group in Extreme Optics (GIOE) of the University of Salamanca.

Project/Line of Research: FIS2013-44174-P, item 'Generation and characterization of ultrashort pulses in different spectral ranges'.

Action objectives: Control of the compression of laser pulses. This experiment is the result of public-private collaboration with the University of Porto (Portugal) and the company Sphere Ultrafast Photonics.

Experimental development: Study of the impact of the shape of initial pulses before the post-compression stage, in order to achieve the highest possible compression. The Dazzler system of the laser chain was used together with measurement systems for d-scan pulses. In line with the simulations carried out by the GIOE, the effects of the initial spectral phase on post-compression could be observed. A post-compression of up to 3.2 fs has been reported.

Duration: 4 days.

Results: Currently, scientific articles on the subject are being prepared.

Experimental Station: High Energy Laboratory WS01.

User: Research Group in Extreme Optics (GIOE) of the University of Salamanca.

Project/Line of Research: FIS2013-44174-P, item 'Generation and characterization of ultrashort pulses in different spectral ranges'.

Action objectives: The University of Santiago and its Laser Laboratory for Acceleration and Applications (L2A2) are collaborating with the GIOE in a study of devices based on the XPW effect.

Experimental development: Systematic study of the effects of the spectral phase of laser pulses on non-linear XPW processes with Dazzler to introduced known and controlled phases. During the experiment, some dependence was observed, and it is being studied by comparing it with simulations.

Duration: 10 days.

Results: Data are currently being analysed for their publication.

Experimental Station: High Energy Laboratory WS01.

User: Research Group in Extreme Optics (GIOE) of the University of Salamanca.

Project/Line of Research: FIS2013-44174-P, item 'Generation and characterization of ultrashort pulses in different spectral ranges'.

Action objectives: Study of optical vortices in collaboration with the Group of Optical and Laser Technologies of the University of Zaragoza.

Experimental development: An analysis of the optical vortices generated by holographic systems implemented in previous joint projects was performed. In order to study their properties, a space-time characterization of the vortices was carried out with the STARFISH technique.

Duration: 7 days.

Results: Part of the results will be included in a monographic issue which is under preparation.

Experimental Station: XUV Secondary Source Laboratory WS02.

User: Research Group in Extreme Optics (GIOE) of the University of Salamanca.

Project/Line of Research: FIS2013-44174-P, item 'Generation and characterization of ultrashort pulses in different spectral ranges'.

Action objectives: Generation of high harmonics with alternative schemes.

Experimental development: Light is focused on the HHG system with different schemes than the usual ones. Altered space-time configurations are used which, according to the theoretical hypotheses, may lead to changes in the resulting harmonics.

Duration: 12 days.

Results: Stage of assessment of results and comparison with theoretical simulations.

Experimental Station: High Energy Laboratory WS01.

User: THz Laboratory of the University of Salamanca.

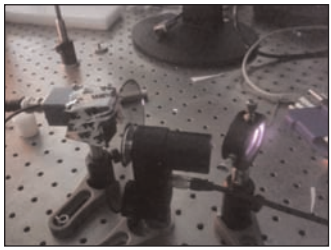
Project/Line of Research: Creating a THz radiation source through laser in collaboration with the GIOE.

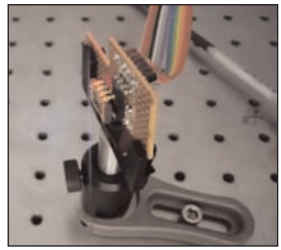
Action objectives: Generation of THz radiation through the creation of a plasma filament in air with a femtosecond laser.

Experimental development: The designed experiment used SiGe transistors for the detection of THz. In spite of the fact that the detectors worked properly, there were problems to filter the signal from the optical range (both visible and infrared).

Duration: 2 days.

Results: Results are inconclusive. The line of research remains open pending the design of experiments based on the new requirements.





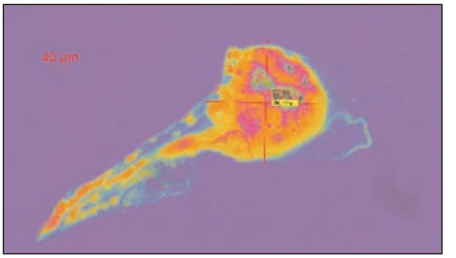
Experimental set-up.

Experimental Station: XUV Secondary Source Laboratory WS02.

User: Laboratory of Fundamental Physics of the University of Salamanca.

Project/Line of Research: MAT2013-46308-C2-1-C 'Design, manufacture and characterization of bi-dimensional electronic nanodevices'.

Action objectives: Application of XUV radiation obtained through generation of high harmonics for the resin curing process. Particularly, XUV radiation through high harmonics was supposed to offer high spatial resolution and a fast method for XUV lithography thanks to its short wavelength.



Circular mark on the resistance placed on a Si/SiO_2 substrate.

Experimental development: In the experiment, two different commercial positive electrical resistances were used: ARP679.04 and ARP617.03, on substrates of different dimensions. After the design of the experimental set-up and the treatment of the samples, they were subject to different periods of XUV radiation. After developing and fixing the images with commercial devices, we observed that one of the samples did not reveal signs of exposure, but the other showed a circular mark in the middle.

Duration: 1 day.

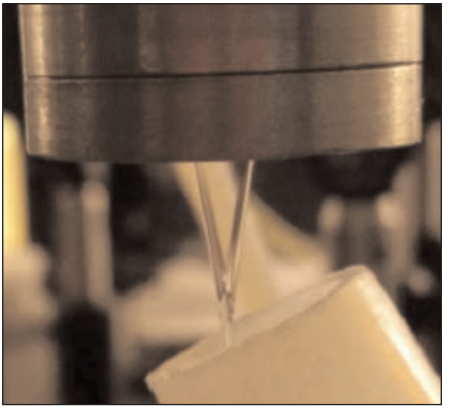
Results: The line of research remains open. It is probable that further work will be carried out on the overexposed sample or that the experiment will use resistances which are more sensitive to the type of radiation used.

Experimental Station: High Energy Laboratory WS01.

User: ELI - ALPS.

Project/Line of Research: Collaboration with the CLPU.

Action objectives: Research the generation of ultrashort X-ray pulses (50-100 fs) with a liquid jet made up of an aqueous solution with a dissolved salt as a target.



Liquid jet emerging from the nozzle.

Experimental development: The duration of the laser was 22 fs, with a central wavelength of 790 nm, pulse energy of 2 mJ and a repetition rate of 1 kHz. This laser was focused through an off-axis parabolic mirror of 30 cm focal length, with focus diameters of a few microns. The experiment was carried out in a vacuum and an AMPTEK X-100 CR Si PIN detector was used. The targets were a liquid jet with a known concentration of KCl, and then a metallic sheet. Measurements were obtained with a pump-probe setup in order to generate a pre-plasma to promote X-ray emission.

Duration: 6 weeks.

Results: The results of this experimental campaign were inconclusive. The line of research remains open and in 2016, different high repetition targets will be explored, such as liquid targets or droplets.

OSCILLATORS SERVICE

Contact: oscillatorsservice@clpu.es

Experimental Station: Oscillators.

User: Institute of Material Sciences of Madrid, in collaboration with the CLPU.

Project/Line of Research: INNPACTO 'Development of a "low-cost" femtolaser for industry'.

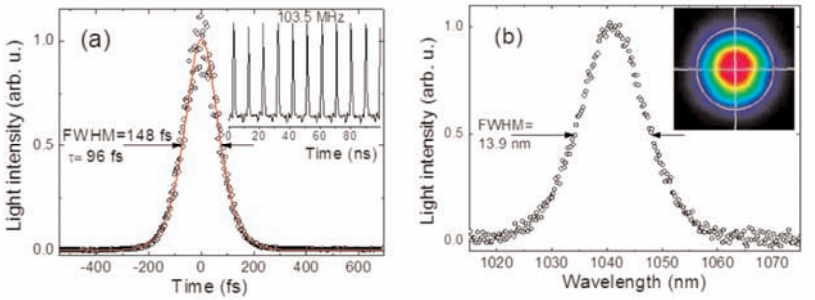
Action objectives: Verification of operation of the prototype.

Experimental development: Verification of the correct operation of the prototype of a solid-state laser on an optic table based on disorganized tungstate laser crystals. Also, values below 100 femtoseconds were obtained with energies which made it possible to reach pulses of 12 nJ with a repetition rate of 100 MHz. These values are considered optimal for implementation in integrated prototypes, which represents a step up in TRL (technology readiness level).

Duration: 3 months.

Results:

- Castellano-Hernández, E; Han, X; Rico, M; Roso, L; Cascales, C and Zaldo, C, Mode-locked laser operation of Indium-modified Yb:KY$(WO_4)_2$ single cristal, Optics Express, 23, 9, 11135 (2015)
- Scientific communication: Sub-100 fs mode-locked laser opera-



Characteristics of laser pulses obtained through passive mode-locking $KY_{0.8}In_{0.07}Yb_{0.13}(WO_4)_2$ crystals. (a) Autocorrelation trace (circles) adjusted through a sech2 function (red line). The upper part shows the laser pulse train. (b) Spectral distribution of the laser pulses. The inserted graph shows the effective section of the intensity of the laser beam.

tion of new disordered Yb:KInY$(WO_4)_2$ crystal, presented in the CLEO Europe 2015 conference, 21-25/06 Munich, Germany.
- Scientific communication: SESAM mode-locked laser base on Yb doped crystals: effects on laser wavelength, poster presented in OPTOEL 2015, 13-15 July 2015, Salamanca, Spain.
- Scientific Communication: Development and enhancements in new laser sources for commercial and scientific applications: SESAM mode-locked laser base on YB doped gain media, poster presented in USTS2015, 24-25 November 2015, Madrid, Spain.

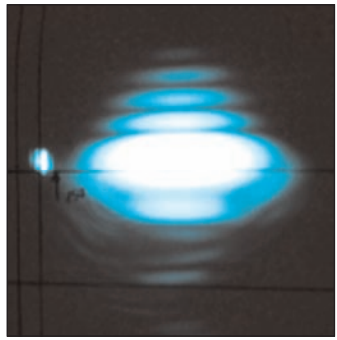
Experimental Station: Oscillators.

User: University of Stuttgart (Germany) in collaboration with the CLPU through the European Mobility Erasmus+ Programme.

Project/Line of Research: Barium Tagging.

Action objectives: Obtaining a laser light with continuous wave through the generation of a second harmonic. This light will be then used to excite barium ions and to study the optic spectroscopy of the radioactive decay of those ions under different conditions.

Experimental development: After several assessments, we decided to generate the second harmonic of a Ti:sapphire laser at a continuous wavelength of 987 nm, because it makes it possible to tune the wavelength to induce a resonant excitation of the barium ions and also to control the width of the blue excitation line in the spectroscopy experiments.



Profile of the laser beam when it leaves the frequency doubling module in continuous mode. The wavelength is 493.5 nm.

Duration: 6 months.

Results:
- Weber, J.H; Garcia-Garcia, E; Roso, L and Rico, M. Theoretical study of CW SHG at 494 nm with bow-tie enhancement cavity for Barium Tagging, poster presented in OPTOEL 2015, 13-15 July 2015, Salamanca, Spain.

MICROSCOPY SERVICE

Contact: microscopyservice@clpu.es

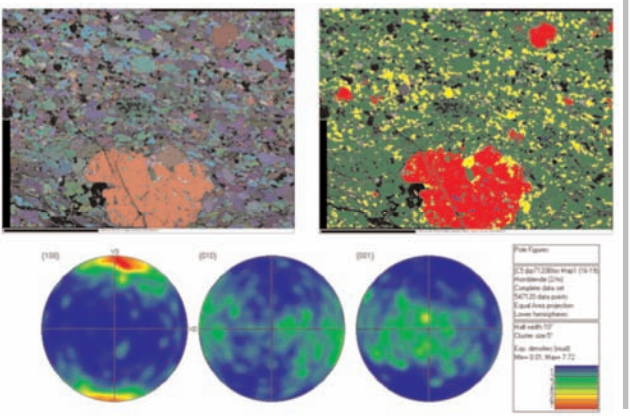
The microscopy service has two different pieces of equipment, an Atomic Force Microscope (AFM) and a Scanning Electron Microscope (SEM), which is the most commonly used device. We have not received all the scientific reports from the observations analysed in this service, and consequently only part of them will be included here. It may be noted that the microscopy service was the first one in operation and it has the most stable community of users and receives the highest number of applications, also thanks to the agreement between the CLPU and the Nucleus Platform of the University of Salamanca.

Experimental Station: SEM (EBSD).

User: Doctoral candidate of the University of Salamanca.

Project/Line of Research: Doctoral research work on the amphibolites of the Sobrado unit (NW Iberia) as a good example of deformation in the lower crust.

Action objectives: Processing the EBSD measurements carried out in the University of Liverpool (United Kingdom) with the Channel 5 software of the SEM. A satisfactory assessment of the texture components of the different mineral phases of the eight samples was carried out. Also, different diagrams and misorientation maps were drawn to estimate the distribution of angles and axes. Part of the time in this service was used to implement and opti-



Images from the analysis carried out in the SEM of the CLPU.

mize the procedure of microstructural and texture analysis within the software, which will represent an improvement for the rest of the users.

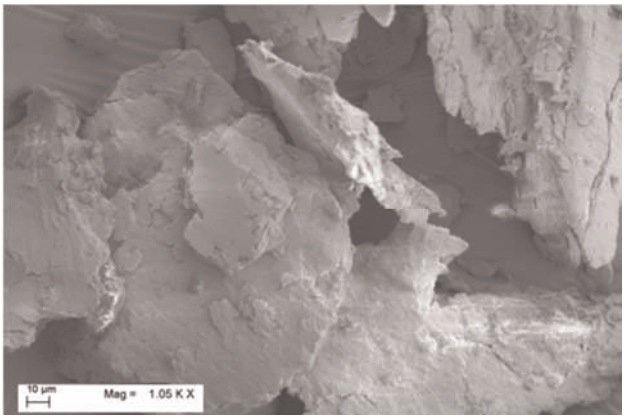
Results: Included in the doctoral thesis which has not been defended yet.

Experimental Station: SEM.

User: Department of Organic Chemistry of the University of Salamanca.

Project/Line of Research: Society Challenges MAT2013–47811–C2–R, 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. Spanish-Brazilian Programme of Inter-University Cooperation, reference no. PHBP14/00003, in collaboration with researchers from the Universidade de Franca (Brazil).

Action objectives: The preliminary stage analysed the initial clay and the treated samples in an attempt to study the variation in texture caused by treatments with organic agents on the clay particles. More specifically, the analysed samples were saponite (magnesium clay from the smectite group) organophilized with the organic agents n-hexadecyltrimethylammonium bromide (CTAB) and (3-Aminopropyl)triethoxysilane (APTES).



Saponite treated with n-hexadecyltrimethylammonium bromide (CTAB).

Results:

- Scientific article: Organically Modified Saponites: SAXS Study of Swelling and Application in Caffeine Removal, L. Marçal, E.H. de Faria, E.J. Nassar, R. Trujillano, N. Martín, M.A. Vicente, V. Rives, A. Gil, S.A. Korili, K.J. Ciuffi. ACS Applied Materials & Interfaces, 7, 10853–10862 (2015);
- Scientific communication: Hybrid materials based on saponite with APTES and CTAB applied to the removal of emerging organic pollutants, L. Marçal, E.H. de Faria, E.J. Nassar, N. Martín, M.A. Vicente, R. Trujillano, V. Rives, A. Gil, S. Korili, K.J. Ciuffi. para el congreso Fourth International Conference on Multifunctional, Hybrid and Nanomaterials (Hybrid Materials 2015). Sitges, Marzo 2015.
- Doctoral thesis: Preparação de híbridos orgânico-inorgânicos aplicados em adsorção de poluente orgânico emergente e oxidação de hidrocarbonetos, defendida por Liziane Marçal da Silva, Universidade de Franca (Brasil), 20 de Mayo de 2015.

Experimental Station: SEM and EDX.

User: VALEO Iluminación, S.A.U.

Project/Line of Research: Company's own line of research.

Action objectives: Studies of reverse engineering in semiconductor laser materials.

Results: Confidential.

Experimental Station: SEM.

User: Department of Pharmaceutical Sciences of the University of Salamanca.

Project/Line of Research: Research group's own line of research.

Action objectives: Characterization of liposomes and albumin micro/nanoparticles.

Results:

- Scientific article: Valle, M.J, and Sánchez Navarro, A. Liposomes Prepared in Absence of Organic Solvents: Sonication Versus Lipid Film Hydration Method, Current Pharmaceutical Analysis, 11, 2, 86-91 (2015).
- Scientific Communication: Valle, M.J; Delgado Rubio, O; López Díaz, D; Velázquez Salicio, M, and Sánchez Navarro, A. Cationic liposomes encapsulated with bovine serum albumin as a phar-

maceutical vehicle for vaccine formulation, presentado en el IX International Forum on Advances in Pharmaceutical Technology CISDEM, Santiago de Compostela 5- 6 Noviembre 2015.
- National patent application (P201530974).

Experimental Station: SEM.
User: Department of Inorganic Chemistry of the University of Salamanca.
Project/Line of Research: Research group's own line of research.
Action objectives: Observation and analysis of texture of materials and estimates for particle measurement.
Results: The results have not been published yet.

MECHATRONICS UNIT

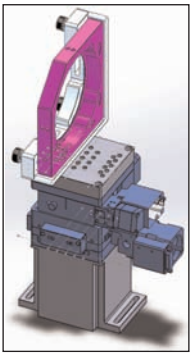
Contact: machiningservice@clpu.es | electronicservice@clpu.es

The Mechatronics workshop receives, as part of its services, applications for the use of the machining service and the electronic service: Most of the actions in these services complement other actions which have already been mentioned. However, there have been some initiatives exclusively linked to this service, which are detailed here:

Experimental Station: Machining workshop.
User: Pulsed Lasers Centre.
Project/Line of Research: Centre's own line of research: VEGA 2 beam transport system.
Action objectives: Designing and manufacturing pieces to create a mechanically stable transport system for the VEGA 2 beam, because the critical point in most of the experiments which will be carried out with this system will be how to achieve a proper and accurate focus on the target.
Experimental development: In order to achieve the required accuracy, a five-axis milling machine installed in the Machining Service of the CLPU was used to manufacture the pieces according

to a three-dimensional design. The elements of aluminium, in red, are set on the vacuum chambers, which involved a strict cleaning procedure which included an ultrasonic bath.

Duration: 8 days.



Three-dimensional design of one of the pieces.

Aluminum stands for the translation lines and optical mountings, and steel (red) for the vacuum chambers.

Experimental Station: Machining workshop.

User: Pulsed Lasers Centre.

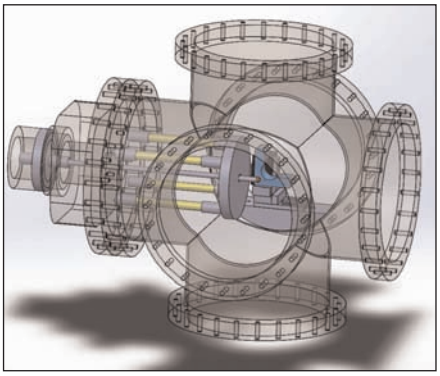
Project/Line of Research: Centre's own line of research related to ultra-rapid molecular spectroscopy.

Action objectives: Modification of a time-of-flight device to adapt it to an experiment in which the mechanism will be able to obtain ultra-rapid dynamic measurements of physical-chemical processes.

Experimental development: A repulsion plate was designed with insulating fixing points to attach it to a vacuum lid. The lid will be connected to a high voltage to repel positively charged particles and divert them to a detector. Inside one of the cylindrical vacuum tubes, it is necessary to place a mechanized mounting with a certain space for movement and stability on which a mirror will be installed to align and focus the laser beam. To do so, a vacuum-compatible support was designed together with an adaptor plate.

Duration: 1 hour and a half.

The designed pieces are shown in this three-dimensional diagram inside a six-way port cross vacuum chamber. In the middle of the repulsion plate there is a pipe through which gas may be introduced. The pieces were designed and delivered to the machining workshop of the CLPU, where they were manufactured with the continuous five-axis milling machine. For this experiment, the electronics service also produced a voltage divider to feed a new Micro Channel Plate.



Three-dimensional design of the TOF (Time of Flight)

Experimental Station: Machining workshop.
User: Laboratory of Stable Isotopes of the University of Salamanca.
Project/Line of Research: Optimization of the laboratory.
Action objectives: Producing a tailor-made piece for the collector noble gas spectrometer in a clean environment appropriate for the laboratory.
Experimental development: Manufacture of pieces of the extraction line of a spectrometer designed to separate noble gases, purify them and collect them sequentially and separately for an individual isotope analysis.
Duration: 1 day.

Experimental Station: Electronic Workshop.
User: Pulsed Lasers Centre.
Project/Line of Research: Optimization of systems linked to VEGA.
Action objectives: Optimization of systems linked to VEGA.
Experimental development: Design and manufacture of a shutter laser safety system with a mechanical actuator connected to the access signalling device.
Duration: 1 month.

Experimental Station: Electronic Workshop.
User: Pulsed Lasers Centre.
Project/Line of Research: Optimization of systems linked to VEGA.
Action objectives: Optimization of systems linked to VEGA.
Experimental development: Improvement of the corridor to adapt it to the new requirements of the laser power supplies, installation of an independent uninterruptible power supply (UPS) for the VEGA oscillator and improvement of the light control systems. Also, some work has been done on the equipment of the technical installations of the bunker regarding the electric supply, experimentation signals and experiment control.
Duration: 2 months.

Experimental Station: Electronic Workshop.
User: Pulsed Lasers Centre.
Project/Line of Research: Optimization of systems linked to VEGA.
Action objectives: Optimization of systems linked to VEGA.
Experimental development: Work in PLC S71200 systems with a PROFIBUS network for the distributed control of the vacuum system. This centralized system is an essential element for an optimal operation of the VEGA laser and its experiments, because it affects the compressor chambers of the three VEGA outputs and the beam transport system from the laser bay to the experimental area in the bunker.
Duration: 1 month.

Experimental Station: Electronic Workshop.
User: Pulsed Lasers Centre.
Project/Line of Research: Internal radioprotection project 'Personnel Safety System (PSS).
Action objectives: Design and development of a personal safety system that meets the requirements for a SIL-2 certification.
Experimental development: Creation of a set of agreed guidelines and protocols on personal safety; risk analysis according to the ISO 123100 norm; definition of requirements regarding safety according to the ISO 13849 norm; detailed analysis and development of the engineering elements of the PSS system;

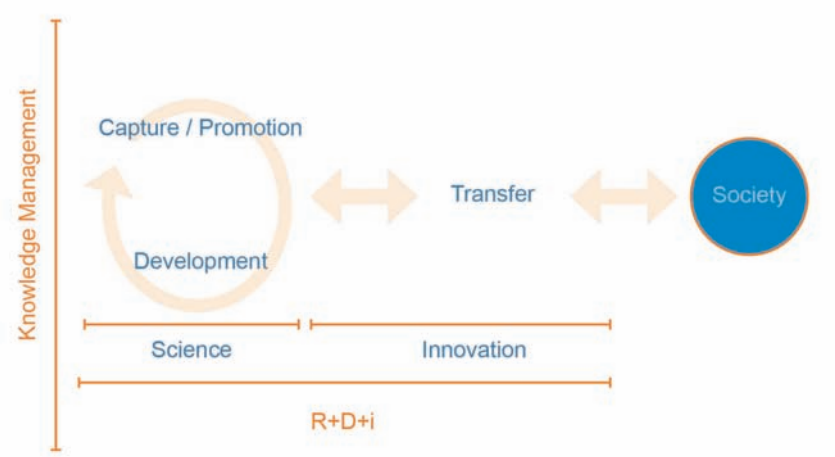
development of control software and an interface for users; integration of the stations for area dosimetry (model 6020ª) as part of the PSS (in total there are 7 stations in the building, two of which have their own light signalling devices), and installation of all the remaining components of the PSS system: electrical conduits, wiring and connection of all the field devices with the control and operation panel.

Duration: 12 months.

Knowledge Management

KNOWLEDGE MANAGEMENT

The Pulsed Lasers Centre, either indirectly through its users or directly through its own research projects, generates knowledge related to optics, photonics and vacuum, among other areas, which contribute to the development of science and technology of ultraintense lasers. In order to adequately manage this knowledge, the CLPU works in basic research, applied research and innovation. Therefore, it becomes a key agent for a smart specialisation of the area, one of the objectives included in the RIS3 (Research and Innovation Strategies for Smart Specialization, part of the Integrated Agenda for Regional Economic Transformation of the Europe 2020 Strategy).



This knowledge management involves the development of an effective process with three essential steps: the capture and promotion of knowledge; the development or creation of knowledge; and its transfer. This last element connects the public and private areas and directly affects the economic progress of a region. Therefore, we shall analyse it first:

Transfer

Patents

As a result of the constant exchange between the public and private areas, research, application and know-how, on the 31st of December 2015, the CLPU owns 2 patents which were granted nationally and 4 patents which are currently pending approval.

PATENT 1 > Utility model

Window with interchangeable glass for pressure chambers.

Co-owner: ALBA CELLS – CLPU.

CPA (chirped pulse amplification) technology involves the compression of the laser that is going to be amplified. This compression must be carried out in a vacuum to prevent any negative effects which may alter the quality of the laser (ionization, scattering, etc.). Therefore, it is necessary to use a system which makes it possible for a beam to access the vacuum chamber from a 'normal' environment. This utility model uses a 126 mm diameter viewport with an integrated BK7 glass which does not interfere with the beam. The glass is independent from the structure of the viewport and the structure has been designed to not introduce any local distortion or punctual stress which may alter the optical properties of the glass. It also includes a centring mechanism and a mechanism to replace the glass, both of them easy to use, which reduces the economic and time costs.

PATENT 2 > Invention

System and procedure to recover gas substances from gas currents.

Co-owner: IBERDROLA INGENIERÍA Y CONSTRUCCIÓN, S.A – UNIVERSITY OF SALAMANCA – CLPU.

This is a new system to obtain the CO_2 which results from gas combustion with a significant cost reduction, compared with other systems. The equipment includes an input and an output, a laser generator for the ionization of gas jets and several electrodes to create an electromagnetic field to attract the ions of the gas it wants to separate. If more than one system is required, several units may be connected in series.

Industrial projects

In innovation-oriented knowledge management, the industrial or research and transfer projects promoted and developed by the Pulsed Lasers Centre in 2015 are particularly important. They represent more than 21% of all the projects developed in the Centre:

TRANSFER PROJECTS

Equipment of the petawatt laser system. Phase 3

Project Type: MICINN - ICTS co-funded by ERDF. Technological Fund Operative Program.
CLPU Principal Investigator: Luis Roso

Description: The objective is to install a laser system which can reach one petawatt of peak energy, (phase 3), which will be connected to phase 1 (20 TW) and to phase 2 (200 TW). It is the cornerstone of the CLPU and it defines it as an ICTS.

Actions: All the actions are described in the section 'Unique Scientific and Technical Infrastructure > Actions on VEGA'.

Completed: budget (80%), time (100%)

TRANSFER PROJECTS

Design and development of a laser-guided surgery system with selective tissue discrimination (Real Time Feedback Laser)

Project Type: MINECO - Collaboration Challenges.
Leader company: DENEB MEDICAL, s.l.
CLPU Principal Investigators: Luis Roso and Mauricio Rico.

Description: The objective of the project is to develop a single surgical medical device, designed as a modular platform and equipped with a real-time tissue discrimination function, in order to overcome the limitations of minimally invasive surgery and to spread its large-scale

use. This device will make it possible to discriminate tissue in real time in order to prevent damage, diagnose problems in real time and treat them in the same operation.

Actions:

- The project started provisionally in October 2015. The final granting agreement was issued in December 2015.
- Analysis of the state of the art in the project field of research and technology. Study of the advances in the field of biological tissue processing.
- Planning and effective distribution of tasks, which are divided into different workgroups including the following: development of ablation and depth of cut function; development of a function to distinguish between soft and hard tissue and between different soft tissues; electromechanical design of the platform.
- Selection of a commercial femtosecond laser by Deneb Medical. Advice and input from the Pulsed Lasers Centre was received for the purchase.
- Hiring process for the recruitment of a researcher associated to the project by the CLPU.

Completed: budget (2.12%), time (10%).

TRANSFER PROJECTS

Development of ultrashort pulse lasers with advanced features at low cost for its application in new industries (ULTRALASER)

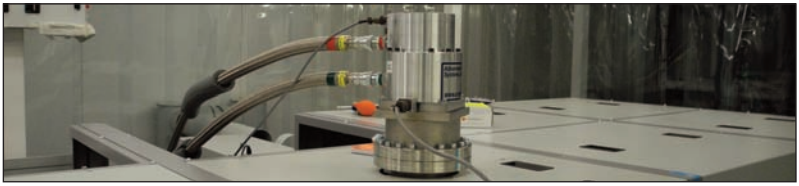
Project Type: MINECO - Collaboration Challenges.
Leader company: Jeanologia, s.l.
CLPU Principal Investigators: Luis Roso and Mauricio Rico.

Description: The objective is to produce a range of lasers of ultrashort pulses with advanced features and at low cost which provide high versatility in order to meet the requirements of the new emerging applications. It represents an attempt to develop lasers as a 'green technology' at an industrial level with high efficiency in the use of resources and raw materials.

Actions:

- The project started provisionally in October 2015. The final granting agreement was issued in December 2015. It is led by the company Jeanología, which is in charge of starting tasks of technological surveillance and prototype validation.
- The Pulsed Lasers Centre will be in charge of coordinating the studies and work to produce a low-cost solid-state femtosecond laser prototype.
- Studies and analysis for the improvement of some of the advanced features of the laser fibre prototypes, in collaboration with Jeanología and FYLA
- Hiring process for the recruitment of a researcher associated to the project by the CLPU.

Completed: budget (3.83 %), time (10%).



Industrial Contracts

In its constant endeavour to interact with the business sector and to promote innovation, the Pulsed Lasers Centre has made contact with different companies and signed different agreements depending on the stage of the collaboration. All along 2015, the CLPU has signed agreements with companies in different areas. Most of these industrial contracts have been signed as confidentiality agreements.

COMPANY	TYPE OF COLLABORATION	ENTRY INTO FORCE
TECNATOM	Confidentiality Agreement	14/01/2015
TECNIVIAL	Collaboration Agreement	09/10/2015
ABENGOA	Confidentiality Agreement	29/10/2015

The origin of some of these agreements traces back to the use of the consulting services (consultingservice@clpu.es) which the Pulsed Lasers Centre offers since the middle of 2014.

Technological Platforms

The Pulsed Lasers Centre has increased and consolidated its participation in different industrial platforms in the fields of optics, photonics and other related areas, as a key element in the process of knowledge transfer:

SECPhO. Southern European Cluster in Photonics and Optics

It is a cluster which includes companies, technological centres and research groups in the field of optics and photonics. Its main objectives are creating business opportunities for companies, providing avant-garde technology for the research centres with access to projects, and promoting innovation in this specialized field. The Pulsed Lasers Centre is a founding partner and also responsible for the main work team created around laser technology.

http://www.secpho.org/

FOTÓNICA 21

It aims to efficiently coordinate the process of industrial innovation of photonic technology and its applications in four key economic sectors: Information and Communications Technology, industrial manufacture processes, life sciences, and lighting and displays. It includes the main agents in the sector of photonics in Spain. It aims to coordinate the national activities in the field of photonics in the same way to those carried out by the European Technology Platform Photonics21.

http://www.fotonica21.org/

INDUCIENCIA. Spanish technological platform of Industry of Science.

The relationship between the Pulsed Lasers Centre and this platform has grown stronger during this year. INEUSTAR is a professional association of Spanish companies which develop high technology pro-

ducts and systems for large scientific installations (LSI) all over the world. It includes five different workgroups: fusion, particle physics, energy and ICTs, astrophysics and spatial sciences, and engineering and TSI infrastructures.

http://www.ineustar.com/

PEPRI. Spanish National R+D
Platform of Radiological Protection.

The Pulsed Lasers Centre has been a member of this platform since October 2014, three months after it was created, and it participates in one of its work groups. The general objective of PEPRI is the promotion of R+D+I activities aimed at the protection against radiation through different strategies: promoting the growth of the scientific and technological knowledge, creating a coordination group for national R+D+i initiatives by promoting collaboration between the different actors, creating a Strategic R+D Plan for Radiological Protection and promoting and coordinating Spanish participation in international R+D programs, and particularly in the Horizon 2020 program of the European Union on radiological protection.

http://www.sepr.es/html/plataforma/plataforma.php

Development

In order to effectively carry out the process of transfer, which is the last step in knowledge management, it is essential to implement certain previous steps which contribute to the generation of said knowledge and to its exchange in specialized areas.

Development Projects: Research

Industrial projects are not the only type of initiatives undertaken by the Pulsed Lasers Centre. Precisely in 2015, the CLPU was awarded with the title of Consolidating Research Unit of Castile and León, because apart from being a User's Centre, it has endeavoured for over more than 10 years to become a qualified actor in the process of re-

search in Optics and Photonics. All the projects carried out by the CLPU both in applied and basic research try to further deepen knowledge in the different lines of research of this specialized field in order to become a reliable support for its users.

RESEARCH PROJECTS

National Research

FURIAM (Ultrafast Sources of Ionizing Radiation for Medical Applications).

Project Type: Ministry of Economy and Competitiveness - Challenges.
CLPU Principal Investigator: Luis Roso

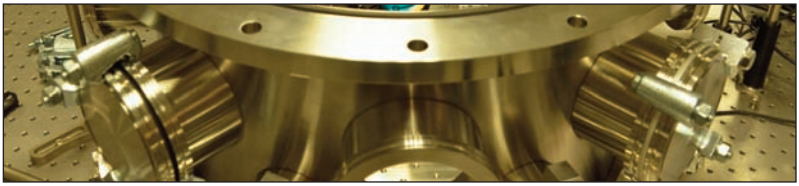
Description: The goal of this project is to obtain two ultrafast sources of ionizing radiation (femtoseconds) which can be used by the biomedical community. In order to establish the values corresponding to the ultrafast ultraintense domain, a threshold value of one gigagray/second has been established. It is necessary to obtain a proton source in the range of 5 KeV-10 MeV which can reach that level and an X-ray source with the same dose rate.

Actions:

- Numerical and analytical modelling of the proton source.
- Work for concept tests with thin solid targets, and analysis of several systems of gas targets with high-pressure gas jets.
- Application of the theoretical-numerical model of TDSE (time-dependent Schrödinger equation) to different atoms and ions for the analysis of situations of maximum X-ray generation.
- Analysis of the X-ray spectrum and the inverse Bremsstrahlung generated in air with energies beyond 1 GW.
- Study of the possibility of intensifying harmonics with a nano-tip. New collaborations.
- Study of the range of energies of protons emitted through the use of radiochromic plates.
- Work in VEGA 2 with a three-chamber system and the use of a long focal length.

- Analysis of other detectors in similar centres. First simulations with FLUKA in order to correlate the measures with the proton energies.

Completed: budget (63.58%), time (66.6%).



RESEARCH PROJECTS

National Research
Barium Tagging
(Barium tagging with NEXT).

Project Type: Ministry of Economy and Competitiveness - Challenges.
CLPU Principal Investigator: Alicia Vázquez Carpentier.

Description: The BATA programme is divided into different test experiments in order to prove that it is possible to tag and detect barium ions (Ba^{++}) produced by xenon double beta decay. The programme also includes the development of a 4.1 micron laser which is necessary to depopulate the metastable D state of Ba^{+}. One of the attractive characteristics of this laser is its wide range of scientific and technological applications, because its wavelength is in a transparent region of the atmosphere.

Actions:
- Design of a blue laser for Barium ion spectroscopy.
- Selection and purchase of laser components.
- Construction, assessment and optimization of a first prototype.
- First experimental campaign based on spectroscopy with Ba+ produced through electrical discharge.

Completed: budget (50%), time (25%).

RESEARCH PROJECTS

Regional Research

Design and characterization of a compact mass spectrometer for the detection and analysis of ionized species with atmospheric pressure laser.

Project Type: Regional Government of Castile and León
Support for Research Projects.
CLPU Principal Investigator: Álvaro Peralta Conde.

Description: As the title suggests, the main objective of the project is the design and characterization of a compact mass spectrometer for the analysis and detection of ionized particles with atmospheric pressure laser. Its development may have applications for the detection of explosive traces and other volatile substances, the diagnosis of diseases through the detection of certain substances in human exhalation or the analysis of filamentation-generated plasma dynamics.

Actions:

- Preliminary theoretical study which included simulations of vacuum conditions and ion guidance, as well as a study of the laser-matter interaction regime which would later be applied.
- Design of a first version of the spectrometer.
- Manufacture and optimization of the prototype.
- First experimental measurements. The testbed was the study through mass spectrometry of laser filamentation-generated plasma in air.
- Draft of a first-level scientific article, already published in 2016, as well as a patent application.

Completed: budget (100%), time (100%).

Institutional collaboration in research:

INSTITUTION	TYPE OF COLLABORATION	ENTRY INTO FORCE
EMPA – Swiss Federal Laboratories for Material	Framework Agreement	09/02/2015
Science & Technology di Frascati – Istituto Nazionale di Fisica Nucleare	Framework Agreement	31/02/2015
University of Stuttgart	Funding Agreement Erasmus +	26/03/2015
Autonomous University of Barcelona	Framework Agreement	10/04/2015
CONICET (Argentina)	Framework Agreement	22/04/2015
ELI-Beamlines (FZU)	Agreement of Understanding	10/06/2015
General Foundation of the University of Salamanca	Specific Collaboration Agreement	10/06/2015
Photon Pioneer Center (Osaka Univ)	Agreement of Understanding	22/06/2015
Institut National de la Recherche Scientifique (Univ. Québec, Canadá)	Confidentiality Agreement	18/12/2015

Development Projects: Training

The CLPU does not forget its social responsibility to train new specialists as a way to improve quality scientific development. In this specific area, the following projects have been developed along 2015:

TRAINING PROJECTS LA3NET
Lasers for Applications at Accelerators:
A Marie Curie Initial Training NETwork.

Project Type: UE - FP7 - ITN Marie Curie.
CLPU Principal Investigator: Luis Roso.

Description: This project involves a consortium of over 30 organizations including universities, research centres and companies which work on the scientific-technological development of laser-based applications for acceleration. Nearly 20 young researchers work in specific projects as part of this initiative. The project includes a large training programme with schools, workshops and international conferences.

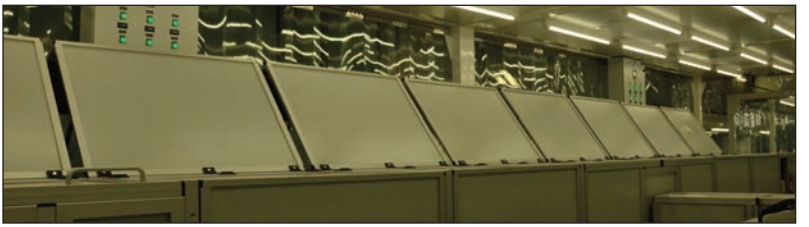
Actions:

- End of the research studies related to the project carried out by the two researchers associated to it: 'Investigation into particle acceleration towards hadron therapy' (Luca C. Stockhausen); 'Femtosecond X-ray sources from laser-driven electron accelerators' (Andreas Döpp). In both cases, and independently from the project itself, these studies have become doctoral theses and have been defended at the end of 2015.
- Participation and/or attendance to different conferences and international conferences, both those part of the network and those not associated to it:

    - Laser Applications at Accelerators Conference 2015, Majorca (Spain), 25-27 March 2015 (LA3NET event).
    - Symposium on lasers and accelerators for Science and Society, Liverpool (United Kingdom), 26 June 2015 (LA3NET closing session).
    - SPIE OPtics + Optoelectronics, Prague (Czech Republic), April 2015.
    - Laser Plasma Acceleration Workshop, Guadeloupe (France), 10-15 May 2015 (A. Döpp).
    - II European Advanced Accelerator Concepts Workshop, Elba (Italy), 13-19 September 2015.
    - National Optics Meeting, Salamanca (Spain), 1-4 September 2015 (A. Döpp).

    It is worth mentioning that one of the researchers from the CLPU, Andreas Döpp, received the LA3NET award for his contributions as a young researcher.

Completed: budget (100%), time (100%).



TRAINING PROJECTS

MECD - FPU
Grants for the Training of University Lecturers 2012

Project Type: MECD - FPU
CLPU Principal Investigator: Luis Roso.

Description: The final goal of this project is the defence of the thesis entitled "Design and construction of an extreme instantaneous flux proton source", which seeks to obtain a source model with which to achieve maximum flow at moderate energy.

Actions:

- Work in the laser-generated X-ray station along the line of research of the grant beneficiary, which led to different scientific papers presented in different events [See Contributions to Specialized International Events].
- Experiments in IRA 3254 (radioactive facility) to characterize the beam.
- Supervision of a final degree dissertation on the work for beam characterization in the X-ray laboratory.
- Supervision of a final master's degree dissertation on a gas jet.
- Publication of two scientific articles, one of which was featured in the front page of the Spanish Physics Journal (Revista Española de Física) [See Scientific Publications].
- Participation in different experimental campaigns (CLPU, CELIA).
- Study of new models of laser acceleration and data analysis of the radiation created when an ultraintense laser is focused in a vacuum.
- Scientific Director of the Communication Project "Unveiling Shadows", detailed in the Section Knowledge Management > Promotion/Capture > Promotion Projects.

Completed: budget (60.23%), time (68.75%).

TRAINING PROJECTS

MINECO
Youth Employment 2015

Project Type: MINECO – National Plan for Youth Employment 2015. Youth Guarantee in R+D+i.
CLPU Principal Investigator: Luis Roso

Description: This project is aimed at the hiring of technical staff and staff for R+D management in order to improve their employability and training. At the same time, the activities of the institutions and the performance of their infrastructures are improved. Particularly, the CLPU requested one person for the development of a training plan which was directly linked to the CPA technology laser systems of the Centre, and mainly with regard to VEGA 3, the petawatt laser system which defines the singularity of the CLPU.

Actions:

- Hiring of a worker associated to the project in November 2015.
- Attendance to specialized events.
- Familiarization with the operation of systems like the high-repetition rate Spitfire, the VEGA system and the SAMURAI TM software.

Completed: budget (4.2%), time (4.2%).

Institutional collaboration in training

In order to promote this field of knowledge management, both with regard to research and to training, the CLPU has signed along this year several agreements which detail the collaboration which exists *de facto* between the signatories:

INSTITUTION	TYPE OF COLLABORATION	ENTRY INTO FORCE
IES Vasco de la Zarza (Ávila)	CICERON (JCyL) Programme	03/02/2015
IES Venancio Blanco (Salamanca)	CICERON (JCyL) Programme	20/02/2015
University of Salamanca	Annexes to the Training Project	*Several agreements are signed regarding the external practice programme (3 for 2015 and 9 for the next year), apart from 6 agreements regarding final degree dissertations.*

Scientific Publications

With regard to the published scientific articles, most of them in journals with a high impact, we report those created thanks to the services offered by the CLPU and those published by the Centre's own technicians and researchers. The publications derived from the use of the Centre's services can be seen in the initial section on the Services of the CLPU. Here is a list of the publications with a direct participation of the staff of the Centre which are not directly related to the services provided:

- Teichmann, S.M.; Rácz, P.; Ciappina, M.F., **Pérez-Hernández, J.A.**; Thai, A.; Fekete, J.; Elezzabi, A.Y.; Veisz, L.; Biegert, J.; Dombi, P., Strong-field plasmonic photoemission in the mid-IR at ,1 GW/cm^2 intensity. Sci. Rep. 5, 7584 (2015).
- Ciappina, M.F.; **Pérez-Hernández, J.A.**; Landsman, A.S.; Zimmermann, T.; Lewenstein, M.; **Roso, L.**; Krausz, F., Carrier-Wave Rabi-Flopping Signatures in High-Order Harmonic Generation for Alkali Atoms, Physical Review Letters 114, 143902 (2015).
- Ciappina, M.F.; **Pérez-Hernández, J.A.**; **Roso, L.**; Zaïr, A.; Lewenstein, M., High-order harmonic generation driven by plasmonic fields: a

new route towards the generation of UV and XUV photons?, Journal of Physics: Conference Series, 601, 012001 (2015).

- Castellano-Hernández, E.; Han, X.; **Rico, M.**; **Roso, L.**; Cascales, C.; Zaldo, C., Mode-locked laser operation of Indium-modified Yb:KY$(WO_4)_2$ single crystal. Optics Express 23, 9, 11135-11140 (2015).
- Hilliard, A.J.; Fung, Y.H.; Sompet, P.; **Carpentier, A.V.**; Andersen, M.F., In-trap fluorescence detection of atoms in a microscopic dipole trap, Physical Review A, 91, 053414 (2015).
- Antonelli, L; Forestier-Colleoni, P; Folpini, G; Bouillaud, R; Faenov, A; Fedeli, L; Fourment, C; Giuffrida, L; Hulin, S; Pikuz, S; Santos, J.J; **Volpe, L.** and Batani, D. Measurement of reflectivity of spherically bent crystals using Kα signal from hot electrons produced by laser-matter interaction, Review of Scientific Instruments 86 (7), 073507 (2015).
- Chacón, A; Ciappina, M.F and **Peralta, A.** High-order harmonic generation enhanced by coherent population return, The European Physical Journal D 69, 133 (2015).
- Ciappina, M.F.; **Pérez-Hernández, J.A.**; Landsman, A.S.; Zimmermann, T.; Lewenstein, M.; **Roso, L.** and Krausz, F., Carrier-Wave Rabi-Flopping Signatures in High-Order Harmonic Generation, Journal of Physics: Conference Series Vol. 635, 092032 (2015).
- Castillo, G.C.; Romero, C.; Lifante, G.; Jaque, D.; Chen, F.; **Varela, Ó.**; **García-García, E.**; **Méndez, C.**; Camacho-López, S. and R. Vázquez de Aldana, J., Stress-induced waveguides in Nd:YAG by simultaneous double-beam irradiation with femtosecond pulses. Optical Materials 51, 84-88 (2015).
- **Apiñaniz, J.I.**; **Peralta, A.** and Martínez, R., Experimental observation of the ion energy spectra of Al, Co, and Cu laser produced plasmas. The European Physical Journal D 69, 265-272 (2015).
- **Stockhausen, L.C.**; Torres, R. and Conejero, E., Simulations of ion acceleration from ultrathin targets with the VEGA petawatt laser, Proc. SPIE 9514 (2015).
- Guillaume, E.; **Döpp, A.**; Thaury, C.; Phuoc, K.T.; Lifschitz, A.; Grittani, G.; Goddet, J.P.; Tafzi, A.; Chou, S.W.; Veisz, L. and Malka, V., Electron Rephasing in a Laser-Wakefield Accelerator. Physical Review Letters 115, 15, 155002 (2015)

- Guillaume, E.; **Döpp, A.**; Thaury, C.; Lifschitz, A.; Goddet, J.P.; Tafzi, A.; Sylla, F.; Iaquanello, G.; Lefrou, T.; Rousseau, P.; Phuoc, K.T. and Malka, V., Physics of fully-loaded laser-plasma accelerators, Physical Review Special Topics-Accelerator and Beams 18, 6, 61301 (2015).
- Powell, H.W.; King, M.; Gray, R.J.; MacLellan, D.A.; Gonzalez-Izquierdo, B.; **Stockhausen, L.C.**; Hicks, G.; Dover, N.P.; Rusby, D.R.; Carroll, D.C.; Padda, H.; Torres, R.; Kar, S.; Clarke, R.J.; Musgrave, I.O.; Najmudin, Z.; Borghesi, M.; Neely, D. and McKenna, P., Proton acceleration enhanced by a plasma jet in expanding foils undergoing relativistic transparency, New Journal of Physics 17, 103033 (2015).
- **Valle Brozas, F.**; **Carpentier, A.V.**; **Salgado, C.**; **Apiñaniz, J.I.**; **Rico, M.**; **Sánchez Albaneda, M.**; **Álvarez, J.M.**; **Peralta Conde A.** and **Roso, L.** Fuente de rayos X mediante láseres intensos: características y aplicaciones, Revista Española de Física, 29, 3 (2015).
- Popmintchev, D; Hernandez-Garcia, C; Dollar, F; Mancuso, C; **Pérez-Hernandez, J.A.**; Chen, M.C.; Hankla, A.; Gao, X.H.; Shim, B; Gaeta, A.L.; Tarazkar, M.; Romanov, D.A.; Levis, R.J.; Gaffney, J.A.; Foord, M.; Libby, S.B.; Jaron-Becker, A.; Becker, A.; Plaja, L.; Murnane, M.M.; Kapteyn, H.C. and Popmintchev, T. Ultraviolet surprise: Efficient soft x-ray high-harmonic generation in multiply ionized plasmas. Science 350, 6265, 1225-1231 (2015).
- Thaury, C; Guillaume, E; **Döpp, A.** et al, Demonstration of relativistic electron beam focusing by a laser-plasma lens, Nature Communications 6, 6860 (2015).
- **Döpp, A.** et al, Single Shot Radiography Using an all-optical Compton backscattering source, Physics Procedia, Vol. 77, 9-14 (2015).

Scientific visits and collaboration in experiments

In this section of knowledge management we include the visits of our scientists and technicians to other facilities, as well as the visits received from other scientists. These exchanges partly belong to training (acquisition of experience) and to research, and they contribute to the advances in specialization:

SCIENTIFIC VISITS TO THE CLPU

RESEARCHER	INSTITUTION OF ORIGIN	DATES	OBJECTIVE
Jordi Mompart	Autonomous University of Barcelona, España	4-6/02	Search of synergies with his research group on conical refraction. Organization of a seminar.
Marcelo Ciappina	CONICET, Argentina	20-22/05	Collaboration as part of the FURIAM project and preparation of a future scientific stay in the Centre.
Robert Fedosejevs	University of Alberta, Canada	28-30/06	Collaboration as part of the FURIAM project and preparation of a future scientific stay in the Centre.
Ramon Vilaseca	Autonomous University of Barcelona, España	15-17/07	Debate on the latest report on scientific policy as president of the Scientific and Technical Advisory Committee of the CLPU.
Marcelo Ciappina	CONICET, Argentina	01/09 a 31/10	Scientific Stay

SCIENTIFIC VISITS AND EXPERIMENTATION STAYS FROM THE CLPU STAFF

RESEARCHER	INSTITUTION OF ORIGIN	DATES	OBJECTIVE
Luca C. Stockhausen	University of Strathclyde, Glasgow, Scotland (United Kingdom)	02-07/02	Collaboration with the research group Strathclyde Intense Laser Interaction (SILIS). (LA3NET)
Alicia Vázquez / Mauricio Rico	University of Valencia, Spain	23-25/02	Collaboration meeting of the Centre with the European Project NEXT (ERC Advanced Grant)
Alicia Vázquez	École Polytechnique, Paris, France	23-24/04	Search for collaboration as part of the FURIAM Project.
Pablo Bellido	National Accelerator Centre, Seville, Spain	25-29/05	Experimental collaboration for detector calibration as part of the INNPRONTA 'LIFE' Project.
Enrique García	CELIA, Bordeaux, France	31/05-13/06	Experimental collaboration as part of the staff exchanges of the Laserlab III Project.
Andreas Döpp	LOA, Palaiseau, France	7-21/06	Experimental collaboration with the Laboratoire d'Optique Appliquée (LOA) as part of the LA3NET project.
Francisco Valle	CELIA, Bordeaux, France	5-27/07	Experimental visit for a training campaign as part of the FURIAM project.
Enrique García	CELIA, Bordeaux, France	12-25/07	Experimental collaboration as part of the staff exchanges of the Laserlab III Project.
Luca Volpe	CELIA, Bordeaux, France	8-31/07	Experimental campaign with the ECLIPSE system.
Sophia Malko	CERN, Switzerland	18-24/08	Campaign of activities for the management of the Montecarlo FLUKA system.
Irene Hernández	Lund, Sweden	16-30/08	Experimental collaboration as part of the staff exchanges of the Laserlab III Project.
Javier Lozano	Munich, Germany	9-13/11	Scientific collaboration for the management of the Montecarlo FLUKA simulation system for radioprotection.

Contributions to specialized international events:

The technicians, engineers and scientists of the Centre have also contributed to the international community through their participation in different first-rate conferences, symposiums and workshops:

EVENT	CONTRIBUTION	AUTHORS
VEGA Laser	ELI-Tango Workshop, 24-25/02, Szeged (Hungary).	Javier Santamaría Juan Manuel Sánchez
Ultrafast and ultraintense laser based disruptive applications	Advanced course 'Light Sciences & Technologies for a new world, 15-19/06, Univ. Int. Menéndez Pelayo, Santander, Spain	Luis Roso
Sub-100 fs mode-locked laser operation of new disordered Yb:KInY$(WO_4)_2$ crystal	CLEO/EUROPE-EQEC 2015, 21-25/06, Munich, Germany.	E. Castellano Mauricio Rico
Carrier-wave Rabi flopping signatures in high-order harmonic generation	CLEO/EUROPE-EQEC 2015, 21-25/06, Munich, Germany.	M. F. Ciappina José A. Pérez Hernández A.S. Landsman T. Zimmermann M. Lewenstein Luis Roso F. Krausz
Strong filed nanoplasmonic photoemission in the mid-IR at <1 GW/cm^2 intensity	CLEO/EUROPE-EQEC 2015, 21-25/06, Munich, Germany.	S.M. Teichmann P. Rácz M. F. Ciappina José A. Pérez Hernández A. Thai J. Fekete A. Y. Elezzabi L. Veisz J. Biegert P. Dombi
Laser-driven ion acceleration	Symposium on lasers and accelerators for Science and Society, 26/06, Liverpool, United Kingdom.	Luca C. Stockhausen Ricardo Torres Enrique Conejero
Synchroton radiation from Thomson back-scattering of laser-accelerated electron beams.	Symposium on lasers and accelerators for Science and Society, 26/06, Liverpool, United Kingdom.	Andreas Döpp Enrique Conejero Camilo Ruiz E. Guillaume C. Thaury I. Andriyash K. Ta Phuoc

EVENT	CONTRIBUTION	AUTHORS
High-order harmonic generation in resonant atomic systems	INREX-Laserlab Europe, 26/06, Munich, Germany	José Antonio Pérez
Generando luz: de la bombilla a los láseres ultraintensos (Generating light: from the lightbulb to ultraintense lasers)	Campamento científico 'La luz: fuente de ciencia, tecnología y progreso', 29/06, Univ. Murcia, Spain	Luis Roso
SESAM mode-locked laser base don Yb doped crystals: effects on laser wavelength	OPTOEL2015. Reunión Española de Optoelectrónica, 11-13/07, Salamanca, Spain	Enrique García Luis Roso Mauricio Rico
Theoretical study of CW SHG at 494 nm with bow-tie enhancement cavity for Barium Tagging	OPTOEL2015. Reunión Española de Optoelectrónica, 11-13/07, Salamanca, Spain	Jonas H. Weber Enrique García Luis Roso Mauricio Rico
Time and spatial-resolved measurements of plasma structures in laser produced plasmas at CLPU	Atoms & Plasmas in Super-Intense Laser Fields – International School of Quantum Electronics, 12-22/07, Erice, Italy.	Ghassan Zeraouli Álvaro Peralta Francisco Valle Jon I. Apiñaniz Alicia Vázquez Giancarlo Gatti Sophia Malko Davide Bleiner Leile Masoudnia Luca Volpe Luis Roso
Laser based x-Ray source at the Pulsed Lasers Centre	Atoms & Plasmas in Super-Intense Laser Fields – International School of Quantum Electronics, 12-22/07, Erice, Italy.	Marine Huault Francisco Valle José L. Sagredo Álvaro Peralta Luca Volpe Luis Roso
Carrier-wave Rabi flopping signatures in high-order harmonic generation	XXIX International Conference on Photonic, electronic and Atomic Colllisions (ICPEAC), 22-28/07, Toledo, Spain	M. F. Ciappina José A. Pérez Hernández A.S. Landsman T. Zimmermann M. Lewenstein Luis Roso F. Krausz
Laser Particle Acceleration at the Pulsed Lasers Centre	ELI_Beamlines and Hilase, Summer School, 23-29/08, Praga, Czech Rep.	Francisco Valle Jon I. Apiñaniz Alicia Vázquez Mauricio Rico Carlos Salgado Marina Sánchez

EVENT	CONTRIBUTION	AUTHORS
		Álvaro Peralta Luis Roso
Beyond carbon k-edge harmonic emission using a spatially and temporally synthesized laser field.	ELI_Beamlines and Hilase Summer School, 23-29/08, Praga, Czech Rep.	José A. Pérez Hernández M. F. Ciappina M. Lewnstein L. Roso A. Zair
Time and spatial-resolved measurements of plasma structures in laser produced plasmas at CLPU	ELI_Beamlines and Hilase Summer School, 23-29/08, Praga, Czech Rep.	Ghassan Zeraouli Álvaro Peralta Francisco Valle Jon I. Apiñaniz Alicia Vázquez Giancarlo Gatti Sophia Malko Davide Bleiner Leile Masoudnia Luca Volpe Luis Roso
VEGA, a unique Petawatt laser for Science and Innovation	Colloquium Spectroscopicum Internationale XXXIX, Portugal. 30/08-03/09	Álvaro Peralta
High Intensity Lasers for Science and Innovation	Colloque sur la lumière et ses applications, 13-15/09, Algeria	Alicia Vázquez
High repetition rate laser-driven particles at CLPU	Conference on Plasma Physics by Laser Application (PPLA), 5-7/10, Frascati, Italy.	Luca Volpe
Laser based x-ray source at the CLPU	Workshop 'Optical Technologies for society', 4-6/10, Madrid, Spain	Francisco Valle
Extreme Lasers	Workshop 'Optical Technologies for society', 4-6/10, Madrid, Spain	Luis Roso
Extreme Lasers	Ponencia invitada Universitat Rovira i Virgili, 30/10, Tarragona, Spain.	Luis Roso
Development and enhancements in new laser sources for comercial and scientific applications: SESAM mode-locked laser base don Yb doped gain media.	Ultrafast Science & Technology Spain (USTS2015), 24-25/11, Madrid, Spain	Enrique Garcia Luis Roso Mauricio Rico

EVENT	CONTRIBUTION	AUTHORS
The VEGA laser system	Ultrafast Science & Technology Spain (USTS2015), 24-25/11, Madrid, Spain	Estrella Fernández Mauricio Rico Luis Roso
Laser based x-Ray source at the Pulsed Lasers Centre	Ultrafast Science & Technology Spain (USTS2015), 24-25/11, Madrid, Spain	Marine Huault Francisco Valle José L. Sagredo Álvaro Peralta Luca Volpe Luis Roso
Possibilities in next future scenario for VEGA lasers at CLPU	V User Meeting of the Pulsed Lasers Centre, 1-2/12, Salamanca, Spain	Giancarlo Gatti
VEGA lasers: performances, diagnostics and optic issues	V User Meeting of the Pulsed Lasers Centre, 1-2/12, Salamanca, Spain	Cruz Méndez
Intense & fast laser-matter interaction at CLPU	V User Meeting of the Pulsed Lasers Centre, 1-2/12, Salamanca, Spain	Luca Volpe
CLPU: the laser user facility and the Spanish Road Map	V User Meeting of the Pulsed Lasers Centre, 1-2/12, Salamanca, Spain	Luis Roso
The CLPU	International Symposium on Ultrafast Intense Laser Science (ISUILS'14), 9-13/12, Hawaii, United States of America	Luis Roso

Promotion/Capture

The Pulsed Lasers Centre has also contributed to the capture of knowledge and its promotion in different fields through its participation in specialized networks and its collaboration in the field of scientific communication.

Promotion Projects:
Promotion of Research, Networks, Communication

RESEARCH PROJECTS
Promotion of research
ELI4SPAIN
Promotion of the Spanish participation in ELI through the CLPU

Project Type: MINECO - FCCI - ACI Promociona
CLPU Principal Investigator: Luis Roso

Description:
Consolidation of a scientific and technological community specialized in ultraintense lasers which provides the necessary support for the Spanish participation in the ELI pan-European structure.

Actions:
- Creation of a Spanish network on science, applications and technology of ultrafast lasers through the consolidation of a specialized group in ultrafast lasers of the Spanish Royal Society of Physics (RSEF).
- Creation of a socioeconomic study commissioned to the General Foundation of the University of Salamanca for the analysis of the three ELI infrastructures and its possible synergies with the CLPU in an attempt to promote the establishment of the fourth ELI facility in Spain.
- Design and implementation of joint experiments with different ELI facilities [for more information, please see section: Actions/Services 2015].
- Start of scientific-technical collaboration with the ELI facility in Magurele (Romania) for cooperation between both organisms and

the development of an optical line which makes it possible to optimize the synchronization of the petawatt and the terawatt laser lines.
- Organization of events for the consolidation of the ELI community [See Promotion > Event Organization].

Completed: budget (100%), time (100%)

NETWORK PROJECTS

LaserLab Europe III: The integrated initiative of European Laser Research Infrastructures III

Project Type: UE - FP7 - Infrastructures
CLPU Principal Investigator: Luis Roso

Description: Third stage of a European consortium network which includes more than 30 organizations with leading infrastructures in laser research and technology.

Actions:
- Initiatives related to the work package "Scientific-Technological Exchange": organization of the Third Meeting of Ultrashort Ultraintense Lasers (NAUUL) [See Event Organization] and two experimental visits, one to CELIA, in Bordeaux (France) and one to Lundt (Sweden) [for more information, see Scientific Visits and Collaboration in Experiments.
- Initiatives related to the work package "International relations": experimental visit from a pre-doctoral researcher of the University of La Plata (Argentina) who developed a theoretical work and numerical calculations on High Harmonic Generation for two months. He also completed his training and acquired experience with the CEP laser of the CLPU.

Completed: budget (100%), time (100%)

NETWORK PROJECTS

LaserLab Europe IV: The integrated initiative of European Laser Research Infrastructures IV

Project Type: H2020 - INFRAIA 2014
CLPU Principal Investigator: Luis Roso

Description:
Fourth stage of a European consortium network which includes more than 30 organizations with leading infrastructures in laser research and technology.

Actions:

- Meeting for the coordination and planning of activities of the different work packages.
- Tasks assigned to the Pulsed Lasers Centre:
  - WP (Work package) Scientific and Technological Exchanges, by networks of extreme intensity laser systems, through a regular forum of laser science.
  - WP of International Relations. The CLPU will lead the relations of non-European research centres with Laserlab.

- Participation in two joint research activities (JRA):
  - ILAT - Innovative Laser Technologies, on the development of laser technologies with high average peak power: the CLPU will participate in the development of laser technologies based on sources in the mid-infrared region.
  - LEPP - Laser-driven high Energy Photon & Particle sources towards industrial and societal applications, on the acceleration of protons and X-Ray Generation: the CLPU will participate in the search of societal and industrial applications (capture of images and proton therapy based on laser sources).

Completed: budget (0%), time (2.8%)

NETWORK PROJECTS

CATLUR - Spanish Network on Science, Applications and Technology of Ultrafast Lasers.

Project Type: MINECO - Excellence Networks
CLPU Principal Investigator: Luis Roso

Description:
The main goal of this project is to generate a tool to maintain the cohesion of the group of members who were part of the CONSOLIDER SAUUL project (Science and Applications on Ultraintense Ultrafast Lasers), in order to prevent all the know-how created in it from disappearing.

Actions:

- Design and construction of a website of the network, coordinated by the Pulsed Lasers Centre.
- Initial meeting of the network with the attendance of the main researchers from the member laboratories in order to detail the functions of the group and to decide its relation with the Spanish Royal Society of Physics.
- Organization of the meeting 'Ultraprecisión láser - Aplicaciones en Medicina, Industria y Telecomunicaciones' [Laser ultra-precision: Applications in Medicine, Industry and Telecommunications], as part of the conference Ultrafast Science and Technology - Spain (USTS 2015), which was held in Madrid.
- Design and creation of a digital service catalogue.
- Promotion of the group in different events: OPTOEL2015 and the V User Meeting [See Event Organization].

Completed: budget (64%), time (54.1%)

COMMUNICATION PROJECTS

Unveiling Shadows

Project Type: MINECO – FECYT 2014
CLPU Principal Investigator: Francisco Valle Rozas

Description:
This is a project of informal education which promotes science as the basis of the socio-economic development of the region, and which was designed by the CLPU to mark the International Year of Light and Light-Based Technologies (declared by UNESCO in 2015 according to resolution A/RES/68/221). This programme is aimed at the promotion of creativity and scientific vocation, and at the promotion of scientific culture in society. It is made up of a main action and a complementary one. The main action is called "Classroom of Light", and it involves different activities developed by the educational centres, as well as an exhibition located in one of the laboratories of the Pulsed Lasers Centre. The complementary initiative is the design, development and promotion of a 2.0 website for the communication of results in which the participants in the other initiatives will provide contents and structure as collaborators in the spreading of knowledge on optics and photonics.

Actions:

- Massive viewing of the solar eclipse on May 20. The activity was coordinated by the OSAL Student Chapter of the Universidad de Salamanca.
- Development of activities in the educational centres as part of the initiative "The classroom of light":
  - Workshops "The Optics of your world": "The light of the rainbow" and "From daguerreotypes to digital cameras".
  - Debates: "The mad scientist", "Lasers in cinema".
  - Communications "Not one talk without you": "The optics of the human eye", "Lasers in medicine".
- Creation, development and maintenance of the 2.0 website "Sparkling Light".
- Design, installation and promotion of the interactive exhibition "The Science of Light", as part of the initiative "The classroom of light".
- In total, more than 90 initiatives for over 4,000 people were carried out.

Completed: budget (100%), time (100%)

Grant applications for projects:

As a consolidated research unit of Castile and León, and with the strategic goal of promoting research excellence and offering quality support for its users, the Pulsed Lasers Centre has applied for grants for 15 different projects which initiate or continue with the main lines of research in its field of specialization. Out of all the projects currently active, grants for five of them have been requested this year.

Pending resolution

ENTITY	CALL FOR GRANTS	DATE of APPLICATION
MINECO	Society Challenges – EXPLORA	24/09/2015
MINECO	Society Challenges – EXPLORA	24/09/2015
Unión Europea	H2020/ERC/Starting Grant	16/11/2015
MECD	Training of University Lecturers	19/12/2015

Denied

ENTITY	CALL FOR GRANTS	DATE of APPLICATION
UE	H2020/ITN (Novacc)	12/01/2015
UE	H2020/ITN (OPTe)	12/01/2015
MINECO	Ramón y Cajal 2014	20/01/2015
UE	UE/LASHARE	13/03/2015
MECD	Training of University Lecturers	15/06/2015
MINECO	Conference Promotion	17/06/2015

Event Organization

One of the tasks that the CLPU carries out every year with regularity is the organization of specialized events to attract the community of scientists, technicians and entrepreneurs in this sector to the Centre, so that direct collaborations may emerge after the presentation of the equipment with which the CLPU offers its services.

OPTOEL2015

The Spanish Meeting of Optoelectronics (OPTOEL) is the most important biannual forum in which the latest scientific and technological advances in the fields of Photonics and Optoelectronics are discussed and presented. The objective of this meeting is not only the exhibition of research results, but the creation of an adequate space for inter-

action between researchers and the industry in this sector. The scope of interests of OPTOEL ranges from basic research in new systems and concepts to photonic applications.
The edition organized by the CLPU (11-13 July) included the presence of 8 guest speakers from different universities and research centres of the United States, Australia, the United Kingdom, Germany, Belgium, Italy and Israel. Together with these invited talks, a Conference was held to present ordinary communications in poster format. In total, 105 submissions were accepted, and 38 external reviewers were required for their selection. There were 3 poster sessions with an average of 35 communications in each of them. Out of all the accepted submissions, 87% were by national authors, whereas 13% were by international authors. This represents a relevant increase compared to previous editions. During the conference, participants could also visit the commercial exhibition with the presence of 13 companies which also had a session of talks to present their innovative products.
Finally, this is the edition in which the Carlos Gómez Reino Award was first granted to promote quality activities in young researchers and to reward the results obtained in their research.

3rd NAUUL Meeting. Target area diagnostics with ultrafast ultraintense laser

The Pulsed Lasers Centre is a member of the Laserlab European consortium, one of whose tasks is the promotion of specific initiatives for scientific exchange in the field of ultrashort ultraintense lasers among the different leading facilities of Europe. In its role as coordinator of the Networking Activity on Ultra high intensity Ultrashort Lasers (NAUUL) in 2015, the CLPU organized, on the 30th of November, the third and last specialized meeting of this work group as part of the Laserlab III project. The unique combination of high intensity, short duration and high repetition rate means that the scientific community is focusing its efforts on the development of diagnosis systems, which is the main subject of this edition. To this end, this edition included the participation of 9 international researchers from different centres and institutions in Europe and the United States. It also included the participation of three companies of this sector which showed their innovations to those present.

V User Meeting of the Pulsed Lasers Centre. Toward an ultraintense ultrafast laser European community

As at the end of every year, the Pulsed Lasers Centre organized in 2015 its traditional User Meeting in which current and future users of the services of the Centre exchanged their experiences in the field of ultraintense lasers. Since the ultimate goal of these meetings is to consolidate an international community of ultraintense laser users, the programme focused on the facilities of the pan-European project Extreme Light Infrastructures (ELI), and it was included in the framework of the ACI-PROMOCIONA project [See Knowledge Management > Promotion/Capture > Promotion Projects]. There were 13 invited speakers from the following institutions: ELI-Attosecond Light Pulse Source (ELI-ALPS); Centre for advanced laser technologies (CETAL); Laboratori Nazionali di Frascati (LNF); ELI- Nuclear Physics; Pulsed Lasers Centre (CLPU); ELI-Beamlines; Instituto de Plasmas e Fusão Nuclear (IPFN). The meeting lasted one day and a half (December 1st and 2nd) and it included a visit to the CLPU facilities, where the participants could observe the design and scientific and technical characteristics of the VEGA system.

Organization of the INEUSTAR Board of Directors

As a member of the INEUSTAR (Spanish Association of the Science Industry) technological platform, the Pulsed Lasers Centre agreed to hold the meeting of the Board of Directors of INEUSTAR at the end of September. The objective behind holding the meeting was the search for synergies between both institutions in a later meeting. Through its presence, its work and its collaboration with the Pulsed Lasers Centre, this business group attempts to get closer to the main European infrastructures related to lasers, and its members acquire specialized experience in an expanding scientific and technological field. This will give these Spanish companies an opportunity to improve their internationalization capabilities in a highly specialized area.

Attendance to Specialized Events

Apart from their contributions to international conferences, the staff of the Centre has attended other scientific events in the search for joint initiatives and future collaborations:

SPECIALIZED EVENT	DATE	PLACE
The International laser Plasma Targetry Workshop	20-22/04	Paris (France)
SPIE Optics & Photonics + Optoelectronic Conference	09-13/08	California, (USA)
SuperIntense laser-atom Physics	07-10/09	Bordeaux (France)
European Advanced Accelerator Concepts Workshop	13-19/09	Elba (Italy)
Simulated Raman Adiabatic Passage in Physics, Chemistry and Technology	22-25/09	Kaiserlauten (Germany)
Frontiers of Quantum Physics	22-23/10	Barcelona (Spain)
Laserlab Meeting	24/11	Milan (Italy)

Infrastructure Management

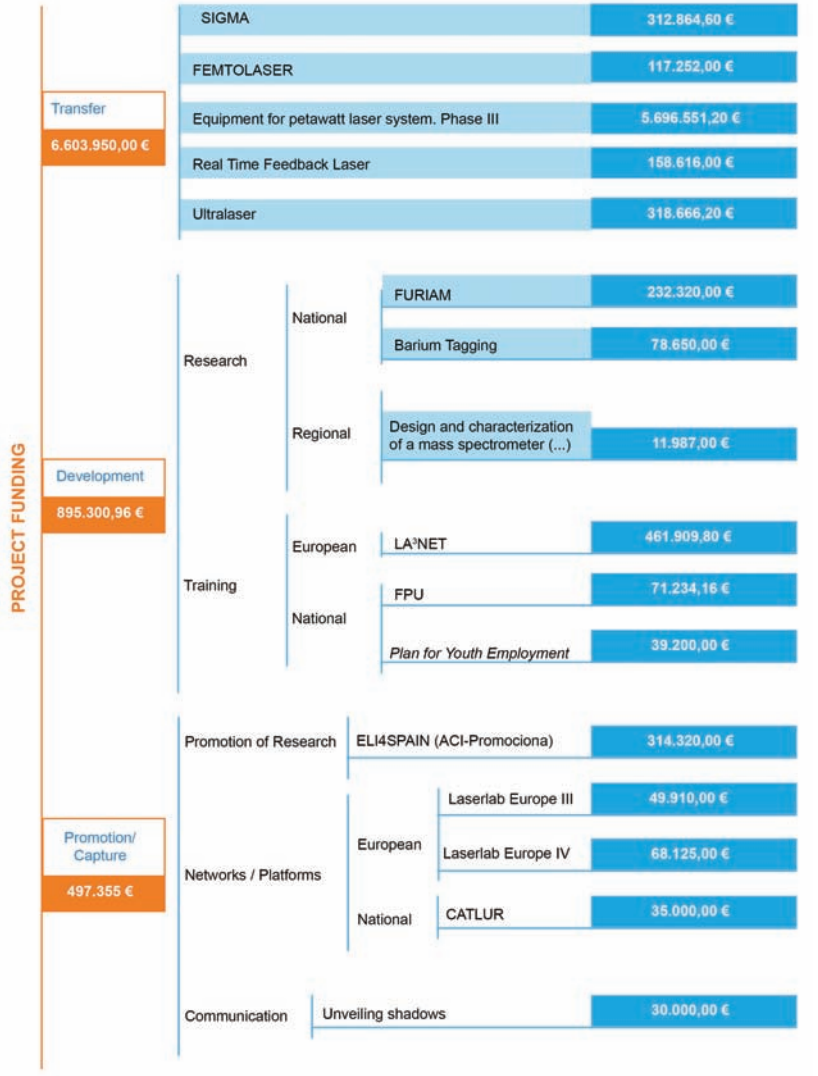
INFRASTRUCTURE MANAGEMENT

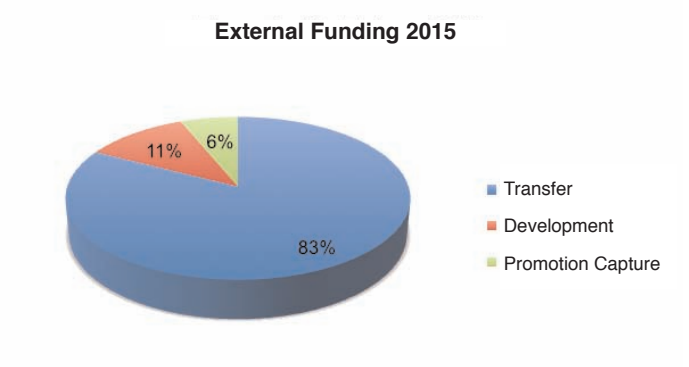
The Pulsed Lasers Centre is a public consortium created in December 2007 by three institutions which, from their respective areas, decided to implement in Salamanca the Roadmap of Unique Scientific and Technical Infrastructures (ICTS): The Ministry of Economy and Competitiveness (MINECO) (back then the Ministry of Education and Science); the Regional Government of Castile and León; and the University of Salamanca (USAL). This is, therefore, a public scientific and technological entity which is open to the national and international research and industrial community.

As we have already mentioned, this does not prevent the Centre, in its role as a consolidated research unit of Castile and León, and in an attempt to provide its users with the highest work quality, from promoting the design, development and funding of lines of research which are directly related to the uniqueness of the Centre or with the areas of interest of its users. This makes it possible to receive external funding, which is essential for the long-term maintenance of its infrastructures.

External Funding (divided into projects):

The figures represent the total amount granted to the CLPU in each project:





Efficient Management

The Managing Division has also endeavoured to implement services and processes which facilitate access to the facilities and has generated digital procedures which increase the effectiveness in access management and control.
More specifically, in 2015 it has implemented a digital access request to the operational services of the Centre: high repetition and CEP laser systems, microscopy, oscillators and mechatronics workshop.
On the other hand, the Managing Division has worked intensely in the development of the second stage of the FARO software (Facilities Access Request Only). It has included exclusive functions for VEGA, such as the classification of access into competitive and not competitive, functions for the Internal Committee, the Access Committee and its assessors, functions for the assessment of different requests according to their stage in the process, confirmation from the Director, classification of proposals or a system for automatic communication with applicants.
Also, and in order to facilitate the processing of requests for the use of any of our services, a new user registration system has been created in which users will be given a personal identification code with which the person who completes the application will no longer be in charge of personally adding all the information of their collaborators.
Finally, the third phase of the FARO implementation was drafted an analysed in order to include additional information on the develop-

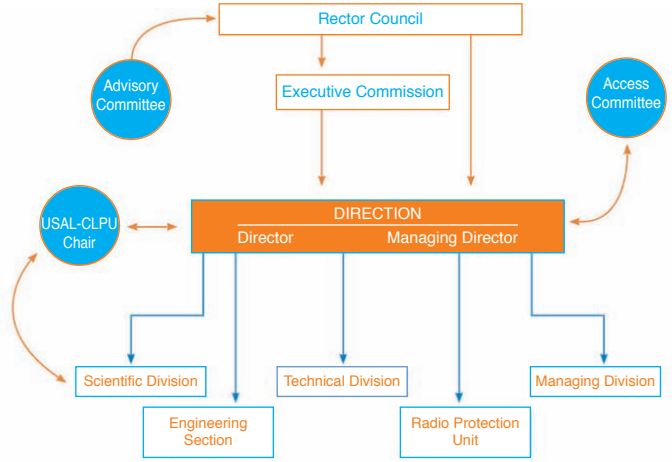
ment of each of the experimental proposals into the application. Parallel to this, the inclusion of an e-learning platform into the website is being considered so that applicants for access to VEGA may complete and prove their training in risk prevention —including radiological risks— before their arrival at the Centre.
Apart from these innovations, an electronic purchase system has been developed in order to allow purchase proposals through the managing computer system, which automates the process of authorization, reception and accounting. This leads to higher efficiency in purchases, their control and budgetary monitoring.

Structure of the Centre

The Pulsed Lasers Centre is structured around a Direction Section which is overviewed by the Executive Commission, which supervises the correct implementation of the activities of the Centre, and by the Rector Council, which is the main governing body of this infrastructure. According to the organization chart below, there are 5 specialized areas which depend from the Direction.
This structure is complemented with three more elements:

1. Advisory Scientific-Technical Committee. Currently made up of 8 researchers of international renown who are in charge of advising the Rector Council about the current and future scientific programmes of the Centre in order to optimize the quality of the Centre and its scientific and technical scope.
2. USAL-CLPU Chair. As part of the founding relationship between both entities, this Chair was created for the development of common objectives and interests in the field of scientific and technological experimentation and research in all the aspects related to ultrashort and ultraintense lasers.
3. Access Committee. This organism, which has not been yet established, is linked to the singular equipment of the Centre and will be in charge of the competitive access to the VEGA laser system.

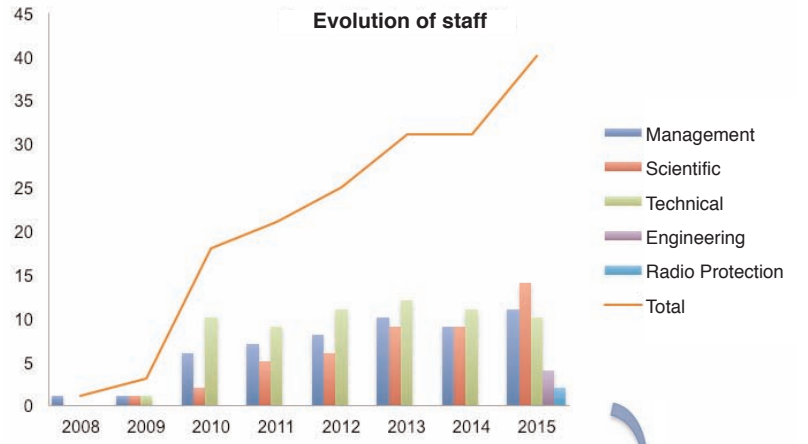
The Rector Council, made up of nine members, has an annual rotation system for the positions of President and Vice-President, which are appointed by the Ministry of Economy and Competitiveness and by the Regional Government of Castile and León. In 2015, the Presidency

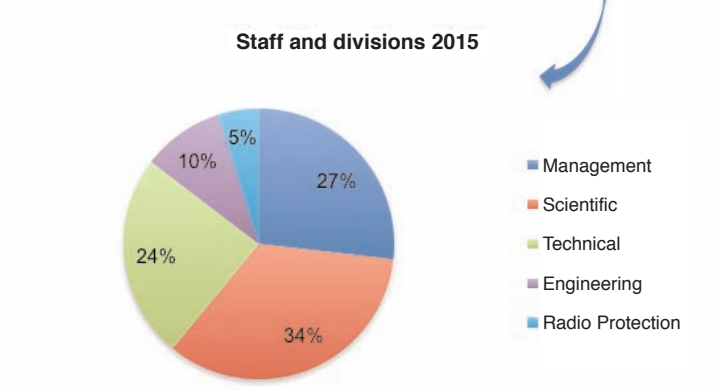


was occupied by Mr. Ángel de los Ríos Rodicio, General Director of Universities and Research of the Department of Education of the Regional Government of Castile and León, who was replaced on 25 September 2015 by Ms. María Luisa Castaño Marín, General Director of Innovation and Competitiveness of the Ministry of Economy and Competitiveness.
For more information, see:
http://www.clpu.es/about-us/clpu-structure/rector-council

For its part, the Executive Commission is made up of two members from each founding entity. The presidency and vice-presidency follow the same system of annual rotation, and the same institution cannot occupy the presidency of the Council and the Commission at the same time. In 2015 these positions were held as follows: President: Ms. Ángela Fernández Curto, General Deputy Assistant Director of Scientific and Technical Infrastructures Planning of the Ministry of Economy and Competitiveness; Vice-president: Mr. Ángel de los Ríos Rodicio, General Director of Universities and Research of the Department of Education of the Regional Government of Castile and León, who was replaced on 25 September 2015 by Ms. Pilar Garcés García, General Director of Universities and Research of the Department of Education of Castile and León.
For more information, see:
http://www.clpu.es/about-us/clpu-structure/executive-commission

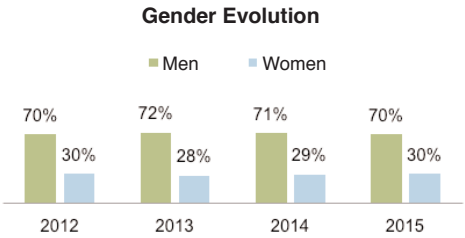
Human Resources (Analysis of Staff)

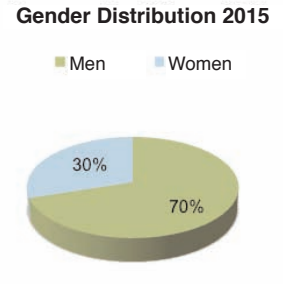


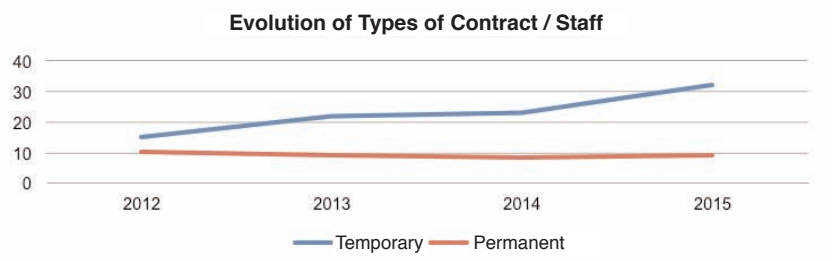


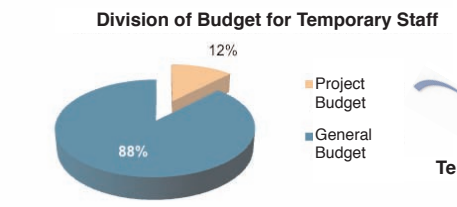
As it can be seen in the figures, the staff figures have grown significantly in 2015, with an increase of about 29% which is mainly reflected on the scientific division. This is relevant, because this is the first time that this happens in the history of the CLPU. The number of projects of transfer and development is directly linked to this factor, and so is the Centre promotion of quality support for its users. Also, the split of the Engineering and Radio Protection Units from the Technical Division has

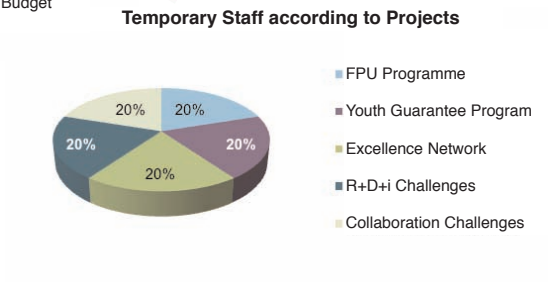
contributed to this difference, which explains why the Scientific Division has more employees than any other division for the first time. This increase, however, has not contributed to higher gender equality among the staff, which maintains virtually the same relative percentages, with barely any changes since the year 2012.

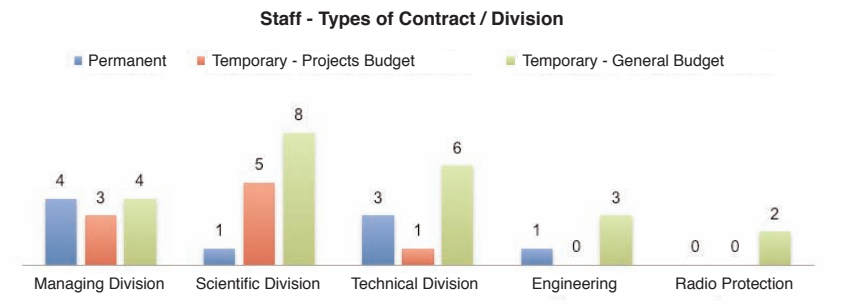








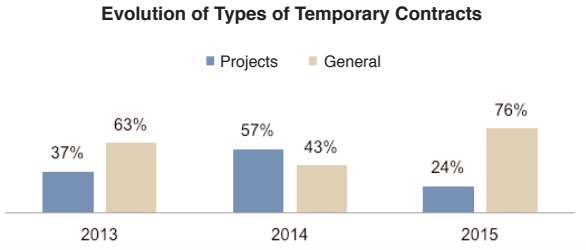


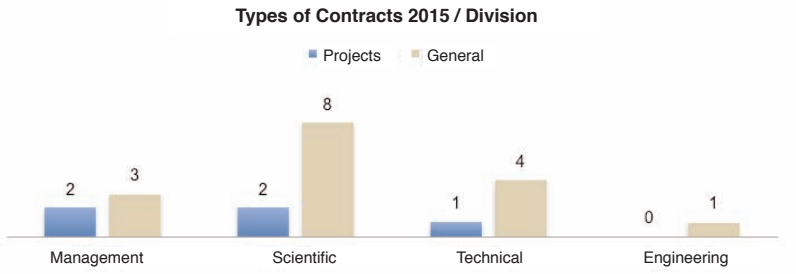


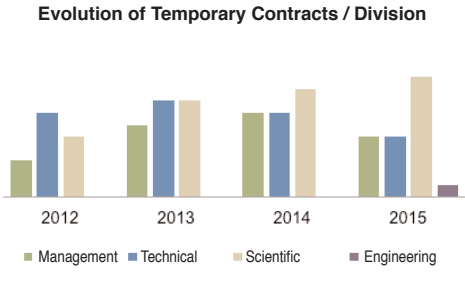
On the other hand, and as it can be seen in the charts, the number of employees with a permanent contract remains stable, and most of the members of the staff have temporary contracts which are no longer linked to specific projects, but to the general budget.

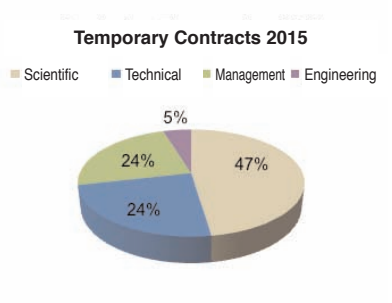
Analysis of Contracts

In the year 2015 only one permanent contract has been signed, linked to the Direction of the Scientific Division, according to the replacement rate of the Centre. All other contracts have been temporary, and their distribution is shown in the graphs below.









Staff Training

In total, 25 courses have been offered by workers in different divisions. The following chart shows all the training initiatives and their percentages in the different areas. The Managing Division, which includes very diverse professional profiles, is the area in which the highest proportion of training resources has been developed.