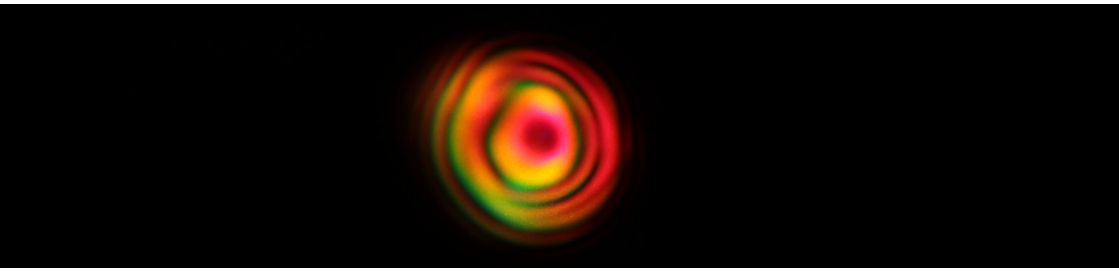
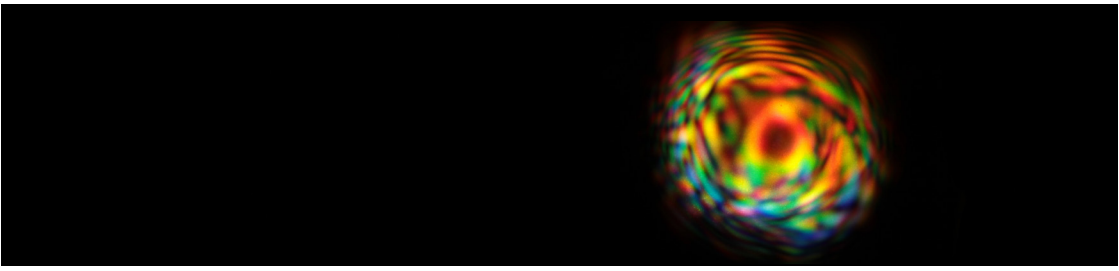
CLPU CENTRO DE LÁSERES PULSADOS

Activities Report

2013





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

Salamanca, April 2014

Index

Letter from the Director

I am contacting you again this year to send the CLPU Activities Report, a report in which we detail the activities carried out during 2013 with a view to consolidating our project.

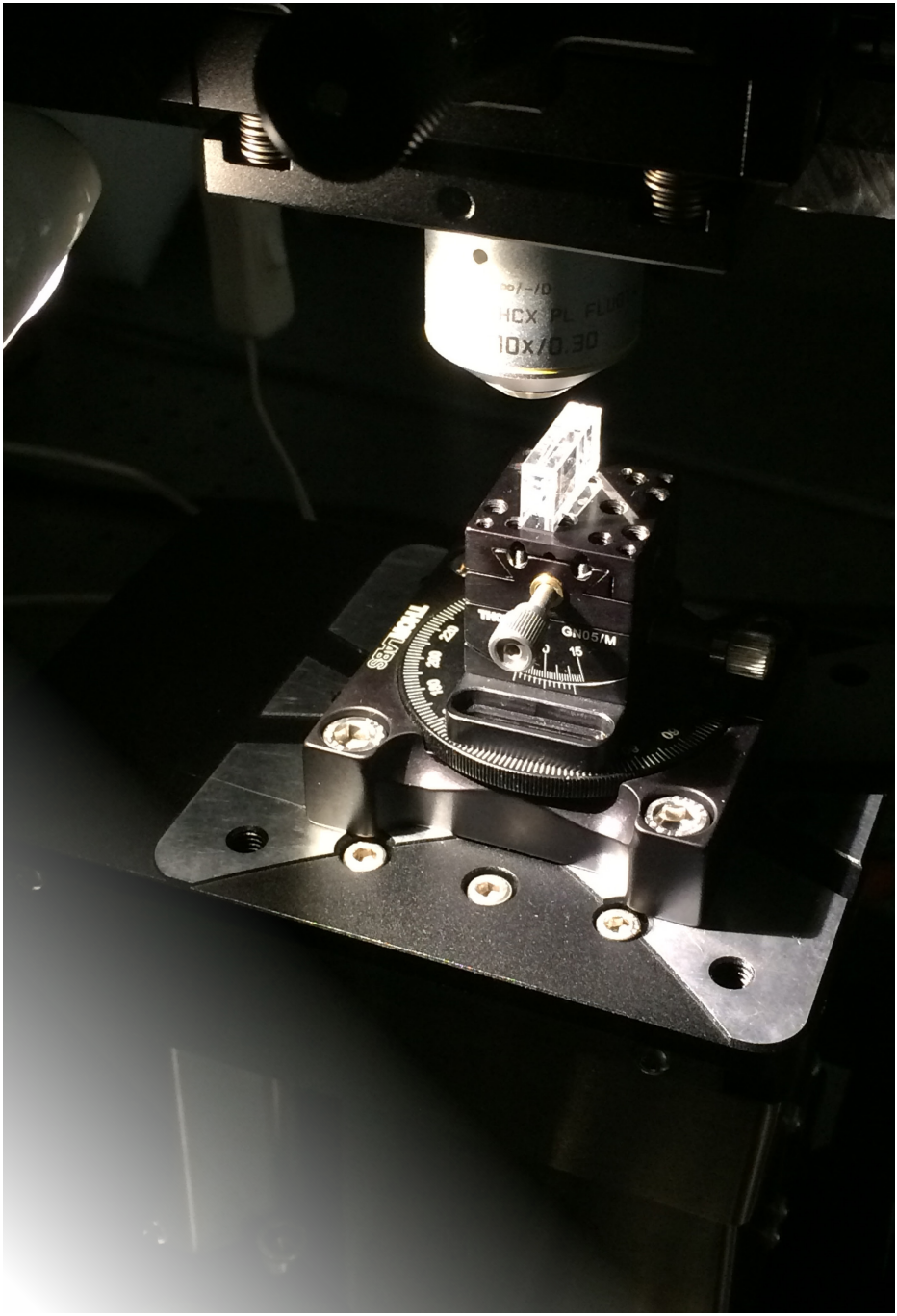
Even though Spain remains in a very tricky socio-economic position, in each of its actions the CLPU has attempted to provide the added value of representing a singular scientific-technological infrastructure (SSTI). This distinction has led the Installation to become a user centre able to generate knowledge and boost innovation. With this foundational responsibility, and thanks to its strategic position in the Science Park of the University of Salamanca, during 2013 we continued our quest to seek and develop public-private agreements and constant support for the transfer of knowledge. As you will see in the text of the report, from within the CLPU we have worked under the European impulse to develop regional strategies aimed at intelligent specialization of the territory. This year was crucial for our infrastructure since the "hub" building of the Centre was completed and the administrative offices were moved there. The building, co-financed by European Funds for Regional Development, will house one of the most powerful laser systems in the world, VEGA. With this we will have taken a leap forwards to bringing our project to fruition. Towards the end of the year, theoretical studies and specialized consultations were made to discuss the adaptation of the VEGA platform to the singular characteristics of this petawatt system. The design and construction of VEGA are currently being completed in France, where the system has been partially accepted.However, as an SSTI the CLPU would be nothing without its users: hence the need to generate fruitful dialogue with them. Aware of this, in December the Centre transformed its Users' Meeting into a specialist debate on petawatt systems. The aim of this was to define user's needs, adapt to them, and consolidate a potential users' community.

Together with VEGA, the apparatus that underpins the very singular nature of the Centre, the CLPU has shown great versatility in adapting to the times by setting up new services. With these, the Centre seeks to create

a modest basis for self-funding that will allow it to cover the costs of operating and maintaining VEGA as soon as it reaches a stabilized position with a consolidated group of domestic and international users. Additionally, the complementary light systems, the support units and the mechatronics workshop have been designed to make the CLPU not only a singular installation (owing to its petawatt laser system) but also one that is specialized in the field of ultraintense pulsed lasers. Thus, and beyond the frontiers of knowledge in which our SSTI moves, the CLPU wishes to contribute to the socio-economic development of the region, providing specialized instruments and becoming, from within the Villamayor Science Park, a true driver of the user companies who will eventually facilitate public-private collaboration.

Finally, I should like to end by referring to one of the greatest difficulties our Centre encountered during 2013: employee insecurity. Current public policies regarding contracting in research centres, derived from the domestic economic problems, shrink the possibilities of staff consolidation and new contracts, and this means that staff training has unfortunately become an investment with no foreseeable returns. I thus take advantage of this report to urge, once again, the public administration to take a hard look at the possibilities of increasing R&D+i funding, the driving force underlying the social and economic growth of our country.
Nevertheless, beyond these issues and other obstacles, I do hope that readers of this report will be able to appreciate the effort and work that has been put into the endeavour by all those involved, especially the researchers, the technicians and administrative staff participating in the project. A large part of the progress of the Centre can be attributed directly to them. Thank you all.

Finally, I should like to express my gratitude to all the social agents who, directly or indirectly, have placed their faith in the Centre for the joint development of research and innovative activities aimed at promoting social development.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Introduction

Intelligent specialization in the field

1

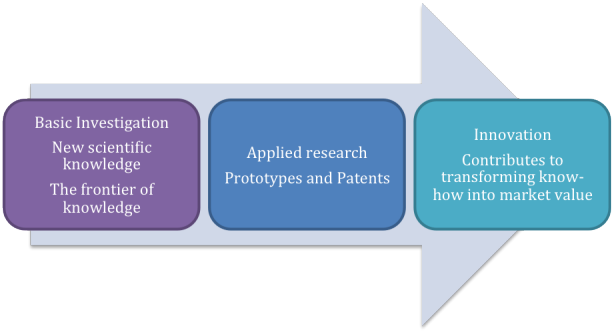
The Pulsed Lasers Centre (Spanish acronym: CLPU) is one of the two singular scientific-technological infrastructures (ICTS) located in the Region of Castile & Leon. Devoted to the science of ultraintense lasers, by definition this installation is a specialized, differentiating asset, whose aim is to increase Spanish competitiveness within the fields of Optics and Photonics. To achieve its aims, the CLPU will offer the international scientific community a Titanium-saphire laser system, VEGA, with which CPA[1] technology will be able to operate with a pulse duration of 30 femtoseconds and reach a peak power of one petawatt. Towards the end of 2015, this technology will make Salamanca the first Spanish city to house one of the 10 most powerful lasers in the world. With this on the horizon, the CLPU has set up a series of complete and very powerful complementary instruments that at the same time as the design, installation and test phase of the petawatt system have allowed it to offer services already, enhancing its user community year by year. With these assets, and thanks to the versatility of the installations, 2013 witnessed the endeavours of the CLPU to contribute to the regional and domestic economy through the development of knowledge.

As a singular scientific-technological infrastructure, the CLPU can be defined as a unique installation of its kind (thanks to VEGA) that requires hefty investments both for its construction and its upkeep. Its aims are as follows: to advance in experimental science and technological development; to facilitate the industrial and technological growth of the Region, and to raise the international competitiveness of Big Science in Spain. With such commitments, the CLPU pursues specialization of the Region by activating the economy through concentration and innovation[2].

To achieve the above goals, the CLPU has been designed as a users' centre and as a research centre aimed at catalyzing knowledge about ultraintense lasers. In this sense, and as may be seen from this report, the CLPU offers all the acumen necessary to activate the mechanism of knowledge transfer, participating in basic and applied research and innovation.

[1] CPA: Chirped Pulsed Amplification, a technology that allows the amplification of the power of a laser by means of temporal manipulation of the beam

[2] Definition of ICTS extracted from the *Mapa de Instalaciones Científicas Singulares*. Ministry of science and Innovation (2010)



In 2007 three public agencies (the Ministry of Economy and Competitiveness –then the Ministry of Education and Science–, the Regional Government of Castile & Leon and the University of Salamanca) joined forces to create the Consortium that underpins and provides the legal support for the CLPU. This initiative has allowed Spain to jump into the limelight of Laser Physics and has given it the opportunity to continue its work along the guidelines set forth by Europe for experimental research. Within this sphere, photonics is of course one of the six Key Enabling Technologies (KET), recognized, supported and encouraged by the European Union. This report demonstrates the role that ICTS, and in particular the CLPU, must play in the definition of European policy in regional strategies aimed at intelligent specialization (RIS3). Its strategic location in the Science Park of the University of Salamanca, on the Villamayor campus, is another example of the contributions offered by the CLPU to the regional economy and highlights its deep-seated desire to contribute to the creation of an innovative ecosystem. Science Parks can be thought of as clusters of knowledge and they contribute the private part, that of companies, to the CLPU. Thus, the installation is a living example of the triple helix model proposed by Henry Etzkowitz and Loet Leyersdorff. This model proposes the development of knowledge societies through permanent relationships between universities, companies and government.

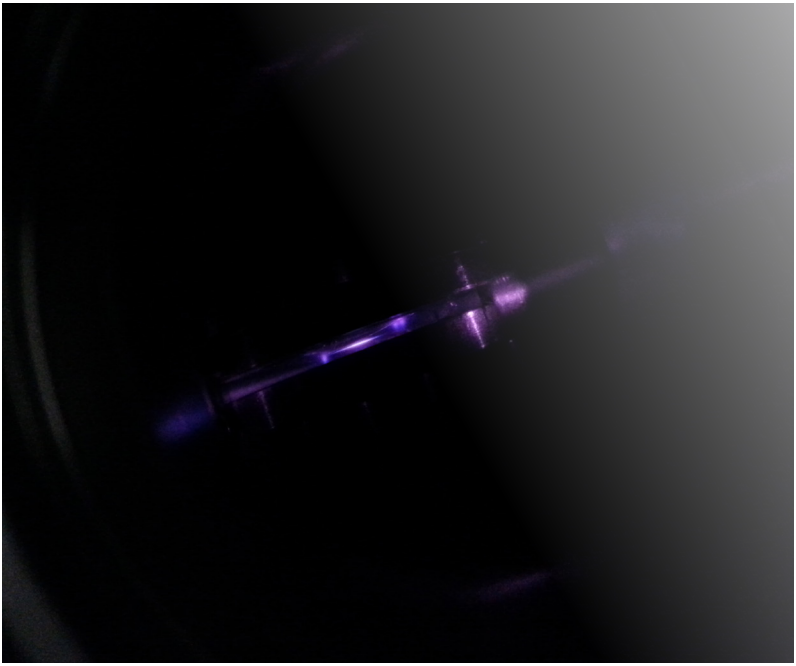
The CLPU is a scientific & technological impulse that seeks specialization in the region.

In the present year, 2013, and owing to evolution in both the scientific technological sphere and the general state of the country, the Ministry of Economy and Competitiveness initiated the updating of the Domestic Map

of Singular Scientific-Technological Infrastructures, consisting of the assessment of a Strategic Plan for the 2013-2016 period, a report on the state of progress of the construction and implementation of the installation, and an analysis of its indicators regarding development, yield and results. Such progress continues as this report is being drafted.

With this theoretical-foundational basis, in a response to the current economic crisis the CLPU has decided to break down each step it made in 2013 into small initiatives aimed at intelligent specialization in the field. This report addresses the culmination of the activities in which the CLPU has been involved that are indicative of the implementation of a strategy based on two pillars: research and innovation. The most salient milestones concerning the operative process of the CLPU are the completion of its construction and the formal acceptance of phase 2 of VEGA.

This report focuses on the efforts made in 2013 by each of the technicians, scientists and administrative staff at the CLPU aimed at generating a project in which specialization, public-private sector cooperation and innovation are key elements.



Knowledge management

2

2.1 Research and Innovation Instruments

2.1.1 Technical resources

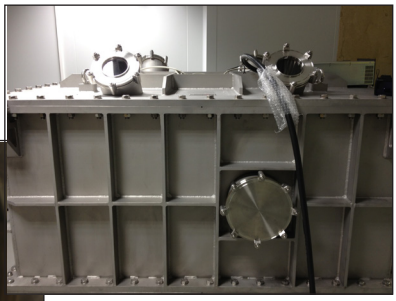
VEGA

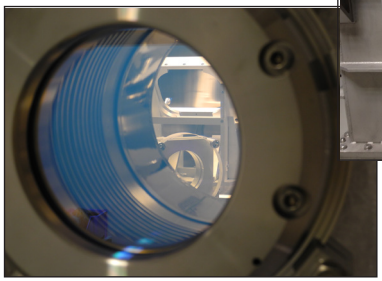
What makes the CLPU a singular scientific-technological infrastructure is VEGA, a laser system able attain one petawatt of power. It is an assemblage designed for investigation at the frontier of knowledge and aims to promote laser science and technology and help this to become a fundamental tool in industrial innovation. Like the other systems of the CLPU, VEGA is a CPA system based on Titanium-sapphire (Ti:sa) technology. Its design is unique, since starting out from a moderate energy (30 J) it can deliver very short pulses (30/25 fs) of high power, high contrast and a repetition rate (1 Hz) that also make it one of a kind at international level. The high spatial quality of the beam means that it can be focused on very small areas, achieving pulses with intensities of 10^{21} W/cm^2.
Another important characteristic is that the set-up has three amplification lines, synchronized by a single front-end, which permits not only the possibility of working in parallel, using the different beams, but also the development of pump-probe experiments. The following table shows the characteristics of the various outputs of VEGA:

Output	Energy/ Shot	Duration/ Pulse	Central wavelength	Peak Power	Repetition Rate
VEGA-1	600 mJ	30 fs	800 nm	20 TW	10 Hz
VEGA-2	6 J	30 fs	800 nm	200 TW	10 Hz
VEGA-3	30 J	30 fs	800 nm	1 PW	1 Hz

This singular design was developed in phases, corresponding to each of the outputs. The first two were coupled at the end of 2012, but it was in 2013 when the acceptance tests were carried out, once it had been checked that the pulse energy before compression, its duration and the repetition frequency coincided with what had been specified. Later, the vacuum chamber of VEGA-2 was received, designed and installed in collaboration with ICTS CELLS. This is a crucial element for the operation of this output from the system because it must be taken into account that owing to its

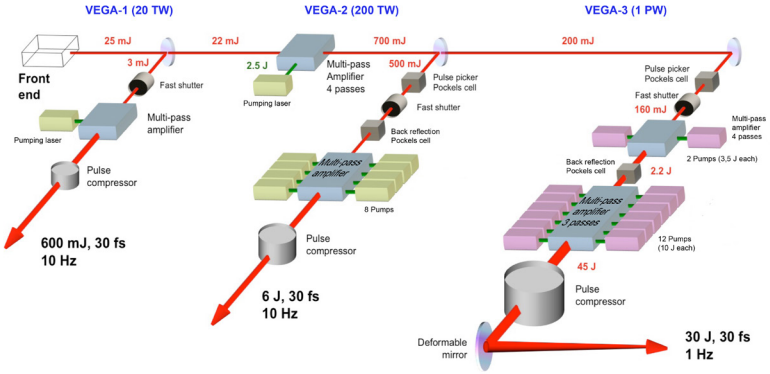
power this type of laser must propagate through a vacuum to prevent non-linear effects.



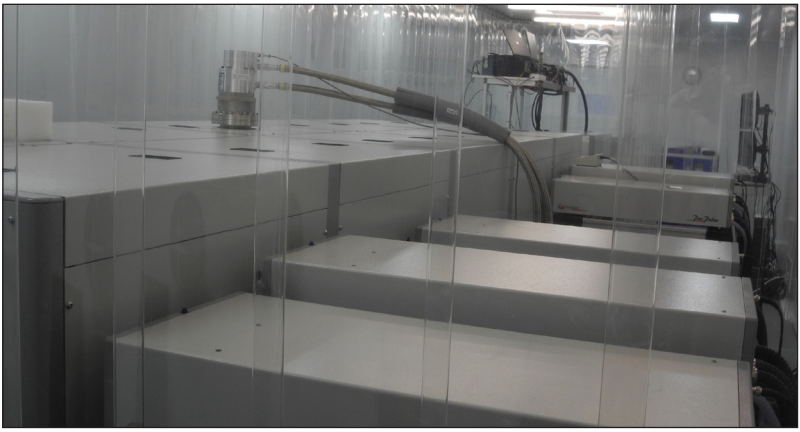


Compressor of the VEGA-2 system, general and detail of interior.

Scheme of VEGA



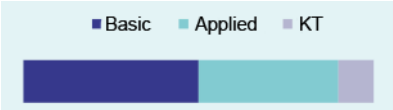
VEGA-2 seen from outside the clean room where it is installed



Part of the VEGA-2 system inside the clean room where it is housed

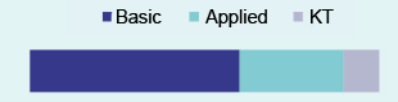
R&D+i Estimation of the devices
(Basic and applied research and knowledge transfer –KT–)

- VEGA-1
  Scientific-technological interest: Filamentation, generation of high harmonics, attoscience...



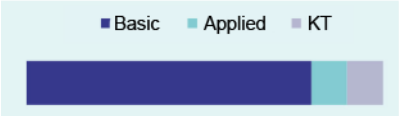
VEGA-2

- Scientific-technological interest: Particle acceleration, applications in radiopharmacy, generation of coherent X-rays...



VEGA-3

- Scientific-technological interest: Laboratory astrophysics, nuclear energy, relativistic microphotonics, protontherapy...



Complementary systems

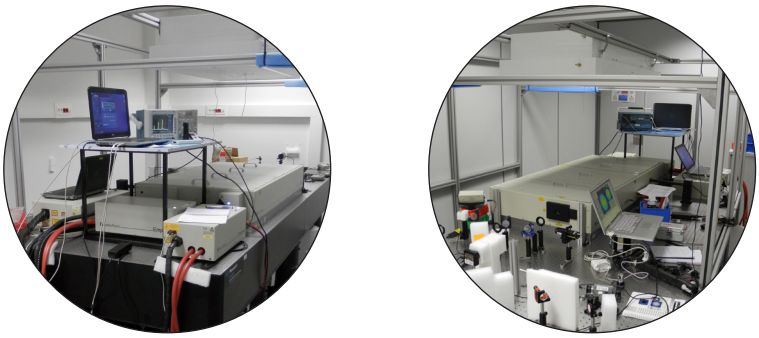
Apart from its main functional value, during the economic crisis the CLPU has decided to broaden its offer of laser technology. Thus, while offering greater technological support to the research of its users it has had a noteworthy impact on a broader sector of the regional economy.

High Repetition Rate (HRR) laser system

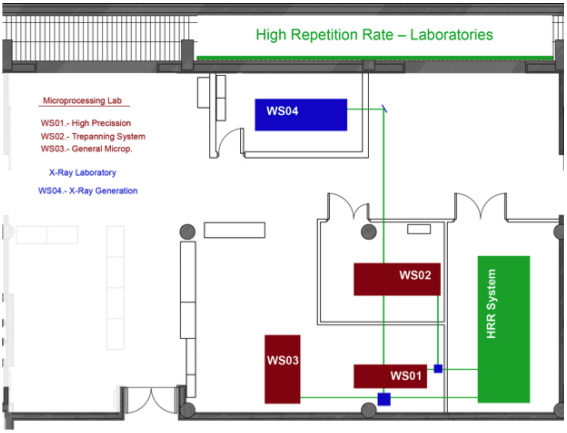
This femtosecond laser system is a commercial Spitfire from Spectra Physics. It is able to emit pulses at 7 mJ with a high repetition rate of up to one kilohertz. It operates at 800 nanometres, close to the Infra-Red and just outside the region visible to the human eye.

Spitfire ACE-7W	
Energy/Shot	7 mJ
Peak Power	60 GW
Duration/Pulse	< 120 fs
Repetition Rate	1 kHz
Pre-Pulse Contrast	> 1000:1
Central wavelength	750-840 nm
Polarization	Lineal

The most important aspect of this system is not the high quality of it beam or its stability but the two laboratories it feeds, which were designed to study laser/matter interactions (microprocessing laboratory) and to promote investigation into X/gamma rays via laser/plasma acceleration (X-Ray generation laboratory).



High Repetition Rate (HRR) laser system



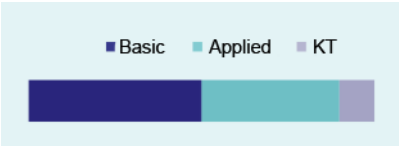
Microprocessing Laboratory

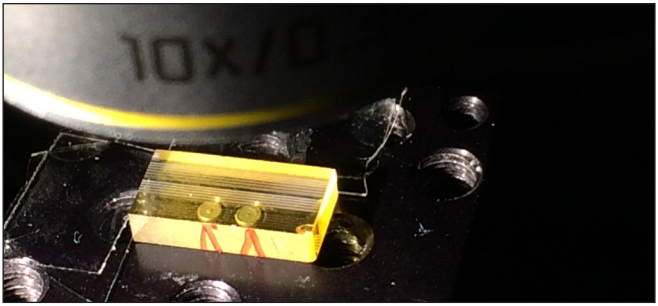
This has three work stations. One is versatile (WS03) and the other two are specific: high-precision processing (WS01) and trepanning and automation processes (WS02).

X-Ray Generation Laboratory

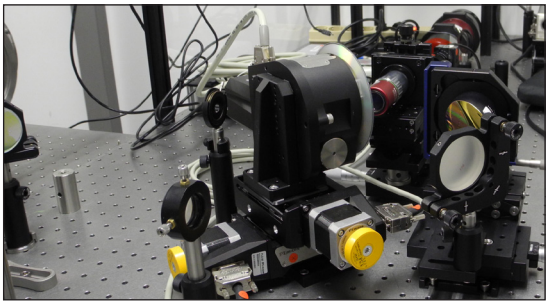
This has an optics bench prepared for the investigation of new sources of incoherent X-rays and the study and characterization of energetic electron beams. As a Category 2 radioactive installation, permission for its use was requested from the Regional Government of Castile & Leon (the competences for such decisions have been granted). Towards the end of 2013, it had the authorization and awaited the inspection that would finally endorse the actual start-up of the installation.

R&D+i estimate of the system
(Basic and applied investigation and knowledge transfer –KT–)

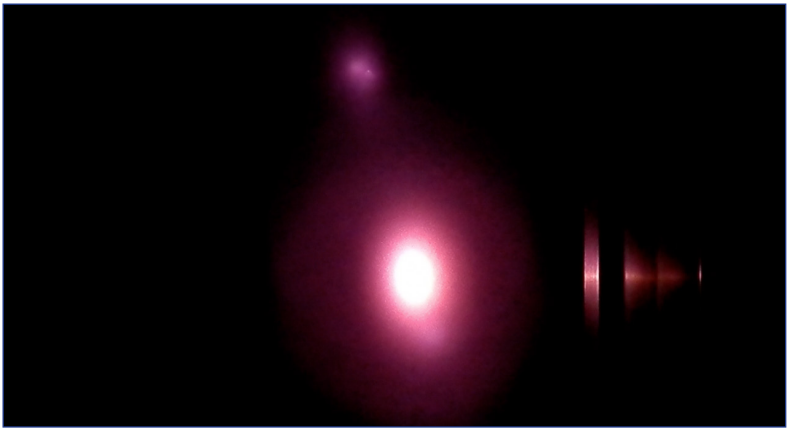




Detail of a piece during microprocessing

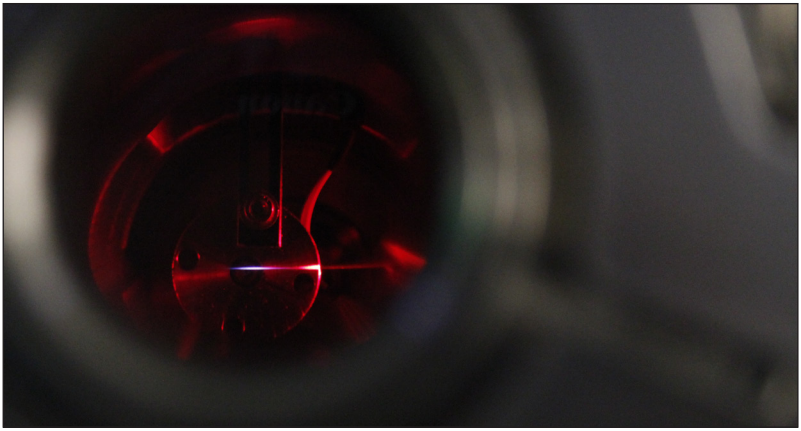


Detail of the experimental bench of the X-Ray Generation Laboratory



The High Repetition Rate (HRR) laser system during one of the experiments perfomed at the CLPU

The CEP (Carrier Envelope Phase) system



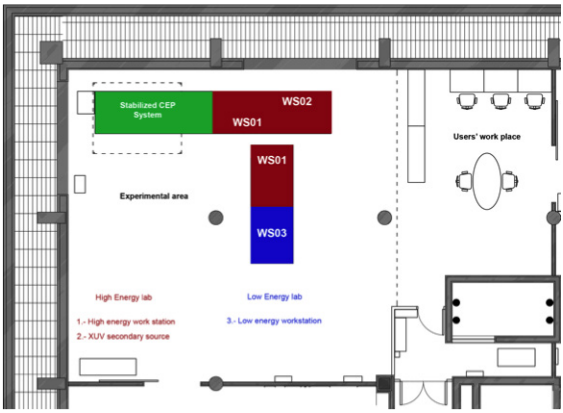
Plasma in a zone of harmonics generation created with the CEP laser

This laser is a Femtopower device able to generate ultrashort pulses (23 femtoseconds or less after post-compression) and with just a few cycles (5 femtoseconds or less after post-compression). It is able to work with a stabilized CEP and at a central wavelength of some 800 nanometres, in the Near Infra-Red range. The He Pro CEP has a fourth-generation stabilizing system, which enables complete control of the relative phase value in all the pulses emitted by the laser.

Among its applications, spectrometry and real-time measurements, broad-band photonics, attoscience and XUV radiation are especially important.

Femtopower HE Pro CEP	
Energy/Shot	> 2 mJ > 0,6 mJ (post-compression)
Duration/Pulse	< 25 fs < 5 fs (post-compression)
Repetition Rate	80 MHz (oscillator) 1 kHz (amplifier, post-compression)
CEP stabilization	< 200 mrad rms (3 hours)
Beam diameter ($1/e^2$)	20 mm (amplifier)
Parameter M^2	< 1,6
Pre-Pulse Contrast (ps)	> 10^8:1
Energy stability	< 1,5% rms (1000 shots)
Pointing stability	< 10 µrad rms
Central wavelength	790 nm
Polarization	Lineal (p)

The characteristics of the system, together with the design of its laboratory, offer reliable and highly stable experimental conditions as well as a very precise degree of control over the particularities of the radiation.



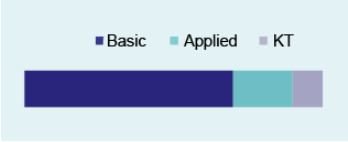
High-energy Laboratory

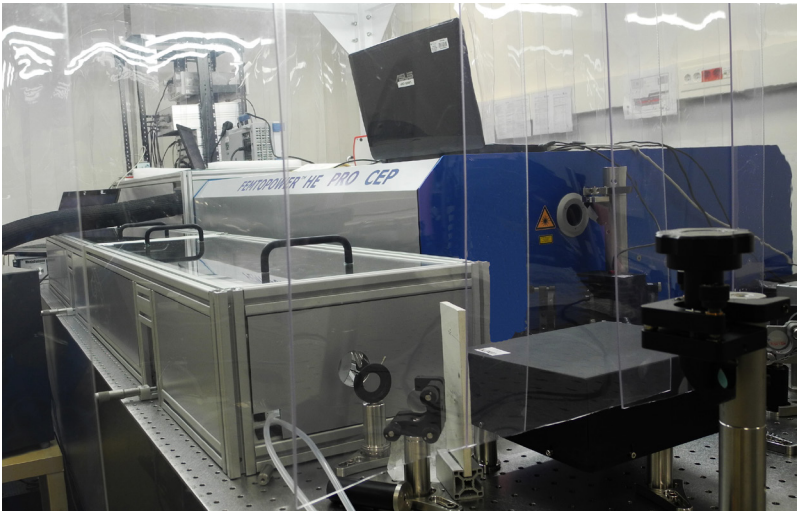
This laboratory has two work stations. In one, the amplified beam (primary source) is used at power levels of dozens of GW or even 100 GW for studies in non-linear optics, femtochemistry or time-resolved spectroscopy. At the other work station, the amplified beam is focused (before or after post-compression) on a gas inside a vacuum chamber, generating coherent radiation in the ultraviolet ray region (XUV). This radiation can be used both in attoscience and in XUV applications.

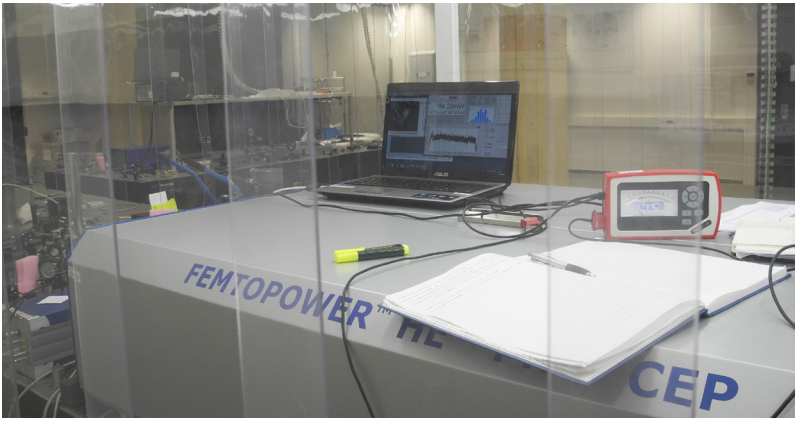
Low-energy Laboratory

This has a work station fed from the beam from the oscillator or from a leak from the CEP stabilization module. It was designed for applications using high-repetition rates, photonics, broad-band experiments, etc.

R&D+i estimate
(Basic and applied research and knowledge transfer –KT–)







Detail of the CEP system installed at the Spanish Pulsed Laser Centre

Mechatronics Laboratory

The Mechatronics Laboratory was born from a fusion of the mechanical and electronics workshops. In operation since the beginning of 2013, it was created to provide service to both the users of the CLPU and other users from the industrial sector. One of its functions is to produce custom-built parts for the CLPU and its needs so that there will not be a constant demand of parts from foreign countries or the need to modify commercially available parts that do not always match the desired purposes.
The key element at the workshop is a continuous five-axis milling machine able to manufacture highly complex parts, ranging from optomechanical mountings to personalized prototypes custom-built for users. The production process begins with a detailed 3D design of each of the elements to be made. Once checked and rechecked, these models are coded into correct instructions for the milling machine via a computer program. The material is prepared and the parts are adjusted by means of other equipment available at the laboratory: a Pinacho lathe, a saw, a vertical drilling machine and other “more mundane” tools.

The laboratory produces exclusive parts for the Centre

Additionally, the CLPU has an electronics section prepared for the design and production of custom-built circuits capable of integrating different types of sensors or actuators. To achieve this, there are oscilloscopes and generators of functions and delays, all of them digital and last-generation.

Continuous five-axis milling machine, detail of photos of the milling machine and drill.

Support Units

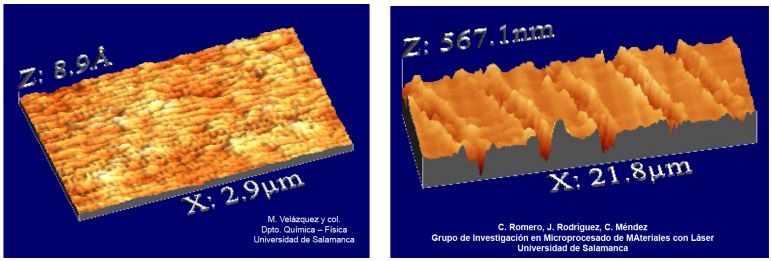
The CLPU is strengthening its strategy of innovation by setting up systems complementary to VEGA. Among them, the most important are the support units with which the CLPU helps to increase the spillover from the knowledge-economics axis.

Microscopy

Microscopy encompasses a set of techniques and methods that allow objects to be seen that, owing to their size, would otherwise be invisible to the human eye. The CLPU contributes to this technological support area in research into chemistry, geology and mining with two devices: an atomic-force microscope and a scanning electron microscope.

Atomic Force Microscope (AFM)

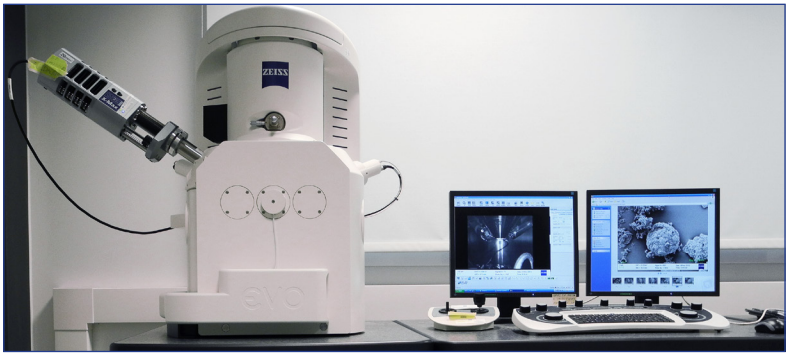
The AFM is a mechanical-optical instrument to allows 3D (topographic) images of the surface of a sample to be acquired via a probe shaped like a pyramid.
This is a NANOTEC microscope that permits the characterization and visualization of samples at nanometric scale and even at atomic scale, with a scanned area of 80 x 80 microns.
The main working method is topographic in contact mode in air (measurement of terraces or how objects are distributed in the surface).



Real examples of images that can be obtained with the AFM

Scanning Electron Microscope (SEM)

The EVO HD25 is a last-generation device able to analyze samples with a resolution of 20 nm. The SEM methodology consists of scanning the sample surface with accelerated electrons. An electromagnet detector measures the amounts and intensity of the electrons interacting with the sample, generating images of its surface in black and white. The sample must be metalized to prevent electric charges from forming on the surface.

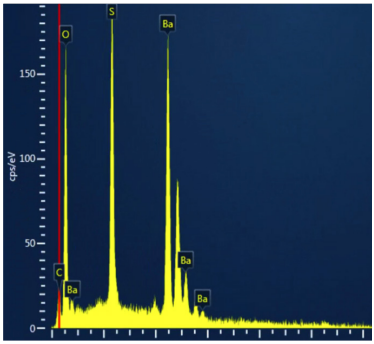


General view of the SEM at the CLPU

- Technical details:
  - A thermo-ionic electron gun with an LaB6 filament
  - Clean vacuum, turbomolecular pump
  - Variable pressure (10 – 400 Pa)
  - Three different types of detector for results optimization:
    - SED (secondary electrons), which allows image capture in real time
    - VPSE, this eliminates charge effects by a gas that ionizes the molecules, neutralizing the electrons trapped on the surface. Accordingly the SE emission is stabilized
    - BSD, detection of electrons by backscattering

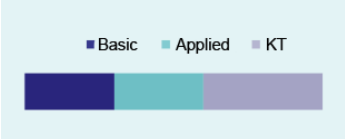
- Large sample holder (a rotating carousel with 9-12 mm diameter bases)
- Eleven ports for detector accessories and possible amplification to 3000 Pa.

Furthermore, the SEM of the CLPU has been equipped to deal with semiquantitative EDS (energy-dispersive spectroscopy) microanalysis to obtain the composition of the sample, which must be polished for such work to be successful. Towards the end of 2013, the pertinent training course was completed prior to starting up service for the next year.



EDS microanalysis results example

R&D+i estimate of instrumentation
(Basic and applied research and knowledge transfer –KT–)



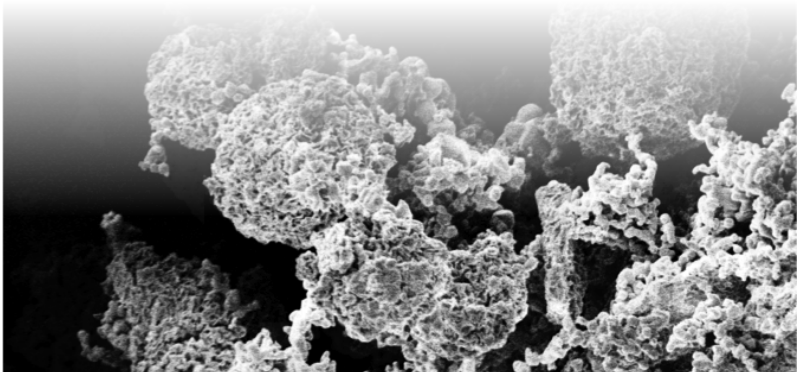


Image captured with the SEM microscope of the Centre

Oscillators

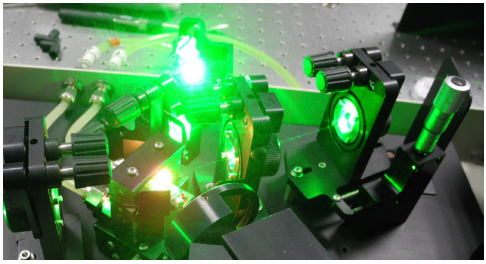
The Laser Oscillator Unit was created with a view to promoting laser technology for professionals working in the industrial sector. The unit contributes strategically to the transfer of know-how, fostering the passage from research to application and from application to innovation.

Currently, this Laser Oscillator Unit is available for use by all users at the CLPU who request its services. Users can find information ranging from consultations about laser equipment to its use or integration in different applications. In 2013, activities were performed upon request for Spanish Universities, CSIC agencies and Spanish companies working in the laser sector.

This Unit has the following elements:

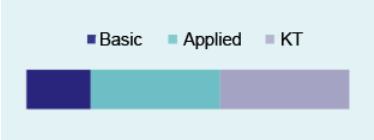
- *Coherent Verdi*-G20 continuous laser at 532 nm and up to 20 W.
- A Ti:sapphire laser in continuous wave mode and tunable from ~ 700 up to 1000 nm with an output power of the order of 2 to 3 W.
- An He-Ne laser (CW, 632 nm, 7 mW) and a low-power NdYAG laser.
- Two femtosecond laser oscillators, under construction, with Ti-sapphire and Ytterbium.
- Measuring equipment for laser pulse times (APE- Berlin Pulse Check 60 fs -150 ps).
- Power meters (Gentec, from μW to hundreds of W), laser beam profile meters (Gentec Beamage 3.0) and spectrometers (APE and Mightex of 300-2600 nm)
- Photodiodes from 40 ps to a few ns (Alphalas, Hamamatsu and Thorlabs)
- A Tektronix 4-channel oscilloscope (500 MHz) with RF (3 GHz)
- Specialized software: LASCAD, Zemax, etc.

The oscillator unit fosters the passage from research to innovation



Pump test at the oscillator unit

R&D+i estimate of the instrumentation
(Basic and applied research and knowledge transfer –KT–)



2.1.2 Services

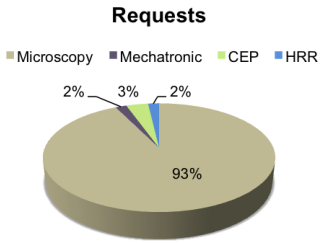
Along 2013 the CLPU processed 54 external requests and 9 internal requests for the use of equipment already in operation. The internal requests were directly linked to the development of projects in which the Centre is involved.

As may be seen from the graphics, the Microscopy Service received the highest number of external petitions. Several of the users have recognized collaboration from the CLPU and from the technicians responsible for the unit in different publications and PhD theses (see section on Results/publications).

Additionally, the kilohertz laser system (high repetition rate or HRR) was the system most sought in the external requests. In particular, it has been used for the tests carried out the prototype of the INNPACTO SIGMA Project (see section on R&D+i activities/scientific-technological projects)

It is a tested and stabilized system that functions at 100% of its capacity. However, its service has not been publicized officially since the work areas where the beam is to reach are still being completed.

In this sense, it should be noted that a complete processing bench has been assembled with bases monitored in XYZ and an attenuator; beam splitters



and mirrors have been fitted to make this processing bench serviceable, for trepanning and for the radiation laboratory (see section on Research and innovation instruments/Technical resources). The X-ray station has also been completed and license for use as a Category 3 installation has been obtained.

The mechatronics workshop began functioning in the first trimester of 2013 and has mainly developed its activities around the design and production of parts for the CLPU itself (protective structures, adapters for the coupling of optomechanic elements, assemblies for the positioning of targets and tools for laser alignment, among others). Nevertheless, evaluation tasks have been performed and the workshop has collaborated in the manufacture of odontological pieces, clamping structures and mechanized parts for other laboratories.

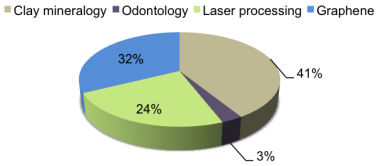
In the case of the CEP system, 2013 was devoted to completing the design of a laboratory: equipment for the development of two experimental lines, the Infra-Red -IR- line at MHz and at 1 KHz, and the extreme Ultra-Violet –XUV- line. The IR study line was started up after the installation of the Phazzler system and laser pulse characterization. The system was adapted for pulses of 20 femtoseconds, and experiments involving diffractive optics with femtosecond pulses and spatio-temporal reconstruction were carried out. In the case of the XUV line, the harmonics system and its spectrometer were installed. Fruit of this progress, the CEP was started up at the end of 2013 with the first two users from different Spanish Universities.

Regarding VEGA-2, (see section on R&D+i activities/scientific-technological projects), the new acquisitions and controls have allowed this second phase of the petawatt system to be up and running, although so far only in test mode. Accordingly, it cannot strictly be considered equipment for service. Despite this, it is now being used for the development of very-high-harmonics generation, proton and electron acceleration, intense-beam and X-ray propagation. All these are present in a multivalent assembly which is now functioning.

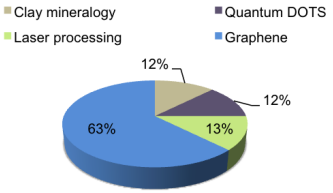
The Oscillator unit can be seen as an operative service in so far that it is aimed at a public-private sector collaborative program (see section on R&D+i activities/Scientific-technological projects). In 2013 it was endowed with a continuous-wave (CW) laser as a multiuse pump system, providing it with greater versatility in its aims.

The most important aspect in the field of microscopy is the fact that most of the research areas of the requests are in the fields of nanochemistry, applied physics and pharmacology. This underscores which fields should become promotional objectives of the microscopy service at both research and industrial level.

Lines of SEM research

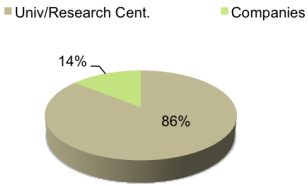


Lines of AFM research



While the Petawatt system is being installed and tested the CLPU must continue promoting the complementary services so that a users community will be generated, consolidating already existing clientele and strengthening strategic innovation through collaboration between the Centre and industrial research.

Origin of use of Services



Together with these services linked to the Centre's equipment, the team of technologists of the CLPU have also carried out maintenance work and have set up the laser systems located in the School of Physics of the University of Salamanca.

2.2 Results

2.2.1 Patents

- Filed Successfully

System and procedures for the recovery of gaseous substances from gaseous flows.
Co-ownership: Iberdrola Ingeniería y Construcción. Centro de Láseres Pulsados, University of Salamanca
Area: Domestic
Date: 23/12/2013
No.: P201330318

- Pending (awaiting concession)

Optical Pulse Generator
Co-ownership: Proton Laser Applications, Centro de Láseres Pulsados and Universitat Politècnica de València
Area: European
Date: 05/04/2013
No.: EP13162434

Intra-operatory carbon ion radiation therapy system
Co-ownership: Proton Laser Applications, Centro de Láseres Pulsados, Universitat Politècnica de València, and Centro Superior de Investigaciones Científicas
Area: European
Date: 23/12/2013
No.: EP87794PM259

2.2.2 Publications

Own

1. **J.A. Pérez-Hernández**, M.F. Ciappina, M. Lewenstein, **L. Roso** and A. Zäir, Beyond Carbon K-Edge Harmonic Emission using a spatial and temporal synthesized laser field, Physical Review Letters 110, 053001 (2013). [FI2012: 7.943]

2. C. Hernández-García, **J. A. Pérez-Hernández** et al., Zeptosecond High harmonic keV X-Ray Waveforms driven by midinfrared laser pulses, Physical Review Letters 111, 033002 (2013) [FI2012: 7.943]

3. H. Han, **M. Rico**, M. D. Serrano, C. Cascales and C. Zaldo, Efficient infrared (≈1.9–2.0 μm) laser operation in color-defect-free Tm:NaGd(MoO4)2 crystal, Laser Physics Letters 10, 045808 (2013) [FI2012: 7.714]

4. M.F. Ciappina, T. Shaaran, R. Guichard, **J.A. Pérez-Hernández**, **L. Roso** et al., High energy photoelectron emission from gases using plasmonic enhanced near-fields, Laser Physics Letters 10, 105302 (2013). [FI2012: 7.714]

5. **A. Peralta Conde** et al., Ultrafast dynamics of the ns(n=3,4) and 3rd Rydberg states of O2, Phys. Chem. Chem. Phys. 15, 4914-4920 (2013). [FI2012: 3.829]

6. A. Chacón, M. Lein and **C. Ruiz**, Retrieval of the amplitude and phase of the dipole matrix element by Attosecond electron-wave-packet interferometry, Physical Review A 87, 023408 (2013). [FI2012: 3.042]

7. T. Shaaran, M.F. Ciappina, R. Guichard, **J.A. Pérez-Hernández, L. Roso** et al., High-order-harmonic generation by enhanced plasmonic near-fields in metal nanoparticles, Physical Review A 87, 041402 (R) (2013). [FI2012: 3.042]

8. M. F. Ciappina, **J. A. Pérez-Hernández**, T. Shaaran, L. Roso and M. Lewenstein, Electron-momentum distributions and photoelectron spectra of atoms driven by an intense spatially inhomogeneous field, Physical Review A 87, 063833 (2013). [FI2012: 3.042]

9. V. A. Brazhnyi, **D. Novoa**, C. P. Jisha, Dynamical generation of interwoven soliton trains by nonlinear emission in binary Bose-Einstein condensates, Physical Review A 88, 013629 (2013). [FI2012: 3.042]

10. T. Alejo, M.D. Merchán, M.M. Velázquez and **J.A. Pérez-Hernández**, Polymer/surfactant self-assembly of nanoparticles into Langmuir-Blodgett films, Materials Chemistry and Physics 138, 286 (2013). [FI2012: 2.072]

11. D. Biasetti, E. Neyra, J.R. Vázquez de Aldana, **L. Roso** and G. Torchia, Buried waveguides in Nd:YLF crystals obtained by femtosecond laser writting under double line approach, Applied Physics A 110, 595-599 (2013). [FI2012: 1.545]

- From Users (Acknowledgements to the CLPU)

1. C. Hernández-García, I.J. Sola and L. Plaja, Signature of the transversal coherence length in high-order harmonic generation, Physical Review A, 88, 043848 (2013).

2. B. Alonso, et al., Characterization of sub-two-cycle pulses from a hollow-core fiber compressor in the spatiotemporal and spatiospectral domains, Applied Physics B –Lasers and Optics, 112: 105-114(2013).

3. A.L. Gomes, J. C. Ramos, S. Santos-del Riego, J. Montero and A. Albaladejo, Thermocycling effect on microshear bond stregth to Zirconia ceramic using Er:YAG and tribochemical silica coating as surface conditioning, Lasers in Medical Science 28, 5 (2013)

4. A. M. Álvarez-Valero, et al. Vesicle evolution in magma conduits implications for the processes of silic magma ascent (Poster), IAUV-CEI2013 Scientific Assembly, 20-24th July, Kagoshima (Japan).

5. Beatriz Martín García. Trabajo de Tesis. Universidad de Salamanca. Self-assembled systems of nanomaterials on Langmuir-Blodgett films.

6. T. Alejo, B. Martín-García, M.D. Merchán and M. M. Velázquez, QDs supported on Langmuir-Blodgett films of polymers and Gemini surfactant, Journal of Nanomaterials, 287094, 2013.

7. B. Martín-García and M. M. Velázquez, Blocks copolymer assisted self-assembly of nanoparticles into Langmuir-Blodgett films: effect of polymer concentration. Materials Chemistry & Physics, 14, 324-332 (2013).

8. M. Portillo, et al. Influence of Er:YAG & Ti:sapphire laser irradiation on the microtensile bond strength of several adhesives to dentin, Lasers in Medical Science, 28,3 (2013).

9. Juan Miguel Caballero Valdizán. Trabajo Fin de Máster. Universidad de Salamanca. Ensayos de desgaste sobre cerámicos técnicos texturizados con pulsos ultracortos.

2.2.3 Contributions at Congresses

- Scientific Committees

1. L. Roso, Steering Committee Conference on Lasers & Electro-optics. International Electronics Conference (CLEO®/Europe IQEC 2013)

2. L. Roso, International Scientific Committee of RIAO/OPTILAS 2013

- Oral/written presentations

1. **L. Roso**, High Order Harmonic Generation: how to get coherent x-Rays, VIII Jornadas de Recerca del Departament de Fisica i Enginyeria Nuclear, 31st January, Barcelona (Spain).

2. **J. A. Pérez-Hernández**, M.F. Ciappina, M. Lewenstein, **L. Roso** and A. Zäir, Beyond Carbom K-edge harmonic emission using spatially and temporally synthesized laser field. Ultrafast Optics 2013, 4-8th March, Davos (Switzerland).

3. **L. Roso**, Short Pulse Intensity Lasers: The key for new advanced scientific & technological applications, 4th International Conference on Laser Peening & Related Phenomena, 6-10th May, ETS Ingenieros Industriales UPM, Madrid (Spain).

4. **M.Rico** and X. Han, Tunability and efficient CW laser operation in KLa(XO4):Nd3+(X=W or MO), disordered single crystals (poster), CLEO/Europe –IEQ 2013, 12-16th May, Munich (Germany).

5. R. Borrego-Varillas, **C. Romero**, B. Alonso, **I. Gallardo-Gonzalez** et al., Generation of spectrally shaped UV-vis supercontinuum femto-

second pulses by means of diffractive lenses (poster), CLEO/Europe –IEQ 2013, 12-16th May, Munich (Germany).

6. **J. A, Pérez-Hernández**, M. F. Ciappina, M. Lewenstein, **L. Roso** and A. Zäir, Beyond Carbon K-edge harmonic emission using spatially & temporally synthesized laser field, CLEO/Europe –IEQ 2013, 12-16th May, Munich (Germany).

7. **L. Roso** and D. Tommasini, Quantum vacuum driven by Extreme CPA lasers, The short Pulse Strong Field Laser Physics International Symposium Honouring S. L. Chin, 21-24th May, Laval (Canada).

8. **Andreas Doepp**, Preliminary studies &design for laser-driven electron & x-ray sources at the Salamanca High Power laser facility (poster), First European Advanced Accelerator Concepts Workshop, 2-7th June, Elba Island (Italy).

9. **A. Doepp** and **C. Ruiz** Femtosecond X-Ray sources from laser-driven electron acceleration: development & applications, LA3NET mid-term review, 16th June, Copenhagen (Denmark).

10. **L. Roso**, Fundamentos de la aceleración de partículas cargadas por medio de radiación láser infraroja, III Congreso Conjunto de las Sociedades Científico Médica y Protección Radiológica, XIX Congreso de la SEFM y XIV Congreso de la SEPR, 19 Junio, Cáceres (España).

11. **M. Rico** and **M. Sánchez**, The Spanish Petawatt Laser Facility (poster), ELI Beamlines Summer School, 23-28th June, Prague (Czech Republic).

12. M. F. Ciappina, **J. A, Pérez-Hernández**, , M. Lewenstein, **L. Roso** and A. Zäir, Beyond Carbon K-edge harmonic emission using spatially & temporally synthesized laser field, European Conference on Atoms, Molecules and Photons ECAMP11, 24-28th June, Lisbon (Portugal).

13. **L. Roso**, Laser Acceleration – Enabling unparalled accelerating gradients, First oPAC Topical Workshop: Grand Challenges in Accelerator Optimisation, 26-27th June, CERN, Meyrin (Switzerland)

14. **L. Roso**, The Spanish BIG laser, EuroRisnet + Workshop: Research Infrastructure towards 2020, 5th July, Lisbon (Portugal).

15. **J. A, Pérez-Hernández**, M. F. Ciappina, M. Lewenstein, **L. Roso** and A. Zäir, Beyond Carbon K-edge harmonic emission using spatially

& temporally synthesized laser field (poster), VIII Reunión Española de Optoelectrónica, 10-12 Junio, Alcalá de Henares, Madrid (España).

16. A. Chacón, M. Lein and **C. Ruiz**, Retrieval of the amplitude and phase of the dipole matrix element by Attosecond electron-wavepacket interferometry (poster), 4th International Conference on Attosecond Physics, 8-12nd July, Paris (France).

17. **C. Ruiz** and A. Chacón, The role of CEP in the double ionization of Helium in the RESI process (poster), 4th International Conference on Attosecond Physics, 8-12nd July, Paris (France).

18. **J. A. Pérez-Hernández**, M. F. Ciappina, M. Lewenstein, **L. Roso** and A. Zäir, Beyond Carbon K-edge harmonic emission in He using a spatially & temporally synthesized laser field (poster), 4th International Conference on Attosecond Physics, 8-12nd July, Paris (France).

19. **G. Hernández González** y F. Fernández, Cálculo de los blindajes de una instalación de rayos X generados por láseres intensos (poster), XXXIV Reunión Bienal de la Real Sociedad Española de Física, 15-19 Julio, Valencia (España).

20. **L. Roso**, The Salamanca Petawatt: emerging applications of compact ultrafast Ultraintense lasers, VIII Iberoamerican Optics Meeting & XI Latinamerican Meeting on Optics, Lasers and Applications (RIAO/OPTILAS), 22-26th July, Porto (Portugal)

21. W. Holgado, C. Hernández-García, L. Plaja, **O. Varela**, **J. Hernández-Toro**, et al., High harmonic tunability and XUV supercontinuum generation, VIII Iberoamerican Optics Meeting & XI Latinamerican Meeting on Optics, Lasers and Applications (RIAO/OPTILAS), 22-26th July, Porto (Portugal)

22. A. Chacón, M. Lein and **C. Ruiz**, QSPIDER: A new technique for phase retrieval of electron wavepackets by Attosecond interferometry, XXVII International Conference on Photonic, Electronic & Atomic Collisions, 24-30th July, Lanzhou (China)

23. M. Seimetz, P- Bellido, **J.I. Apiñániz**, P. Conde, E. Crespo, M. Galán, A. J. González, J. Hernández, A. Iborra, R. Lera, F. Martos, L. Moliner, **A. Peralta Conde**, **M. Rico**, J.P. Riga, M.J. Rodríguez-Álvarez, L. Roso, F. Sánchez, **M. Sánchez Albaneda**, A. Soriano, **F. Valle Brozas**, L. F. Vidal and J. M. Benlloch, Laser Acceleration of Protons and Ions at Salamanca, Targetry for laser-driven Proton (ion) accelerator sources, 9-11th October, LMU Munich (Germany).

24. **C. Ruiz,** QSPIDER: Retrieval of the dipole matrix element phase with attosecond pulses (Poster), Correlated Multielectron Dynamics in intense laser fields (CORINF), 13-15th November, Madrid (Spain)

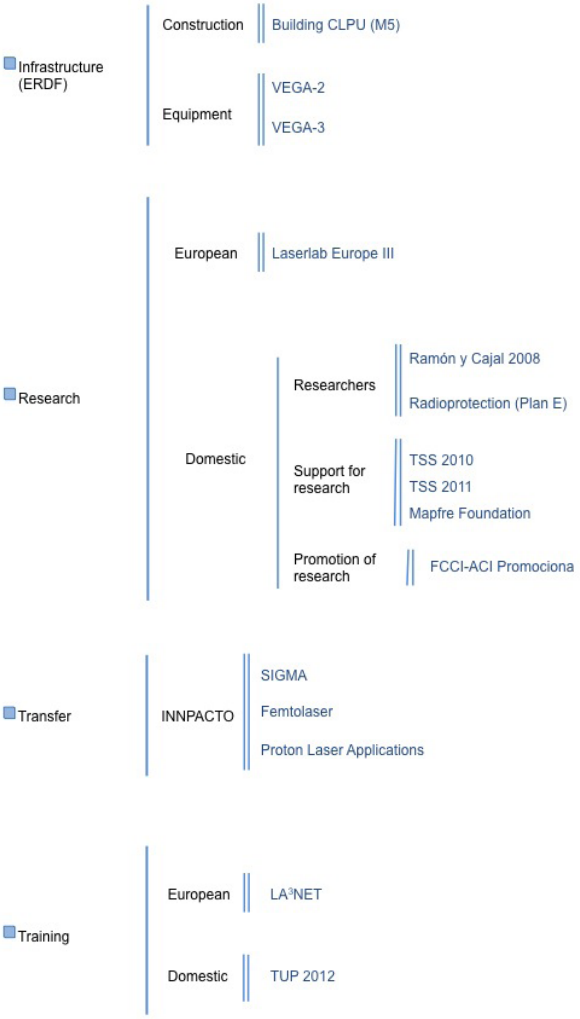
25. **L. Roso**, The VEGA laser system, 3rd Users Meeting CLPU, 2-3rd December, Salamanca (Spain)

Moreover, as the agency from Laserlab responsible for relations with Latin-America the CLPU participated as a sponsor at the VII Latin-American Conference of Optics and the XI Latin-American Meeting on Optics, Lasers and Applications (RIAO / OPTILAS), which was held in Porto from 22 to 26 July 2013. Within this context, the CLPU set up a stand at the Fair of the event, where it offered promotional information about Laserlab to the attendees.

Participation of Laserlab at RIAO/OPTILAS under the CLPU

2.3. R&D+i activities

2.3.1 Scientific–Technological Projects



Infrastructure |Construction

Public Works construction of the Pulsed Laser Centre (Phase I: ERDF)

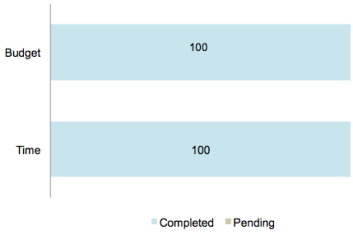
29/11/2010 31/12/2013

Description: Application of investments associated with the action enti tled “Drafting of the Project and Execution of the Work for the Construction of the CLPU-Petwatt laser at the Villamayor de la Armuña Campus”.

Actions 2013: Completion of the Public Works Construction

- The project was extended after the detection of problems outside the responsibility of the centre in the electricity supply that affected the M5 Building. A solution was found by redistributing the power contracted for the different buildings of the Science Park.
- Completion of the installation of false ceilings and other construction details, together with tiling and pavement work.
- The metal work pending and interior carpentry were completed.
- Completion of the plumbing system with full installation of sanitary elements, as well as fire-protection systems and air-conditioning and extraction systems.
- Painting completed, together with decoration. Security systems and health and waste management systems completed.
- During the first months, tests were performed on the acclimatization, electricity, plumbing, fire protection and control systems.
- The final tests were performed between May and June and the building was officially “received” on 21 July. The final budget of the work was approved on 25 July.

Statistics:



Infrastructure |Equipment

Phase II of the petawatt laser (ERDF)

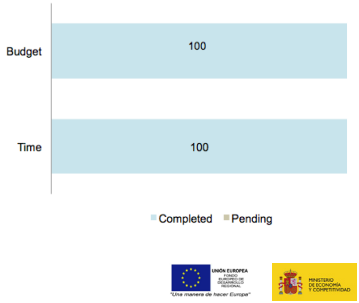
01/01/2008 15/09/2013

Description: Co-funding of a laser device to upgrade the 20 TW laser in Salamanca to 200 TW. Coupling of VEGA-1 and VEGA-2.

Actions 2013: Conclusion of the project

- In March, the contracted company, Amplitude Technologies, visited the Centre to check the front-end, the movement of the metrology bench and the pump lasers of the main system. A training course on the front-end was given.
- April saw the installation of the 200 TW device and the set-up for the acceptance tests was prepared. These took place at the end of the month. After checking that the energy supplied before compression coincided with the specified value of 5.8 J and that the other characteristics of the pulse met the specifications, the formal acceptance of the system was approved.
- In May, the vacuum chamber for the compressor of VEGA-2 was received. It was installed in the laboratory and was validated by Amplitude Technologies in June. Finally, the optical elements of the system were incorporated.

Statistics:



Infrastructure |Equipment

Phase III of the petawatt laser (ERDF)

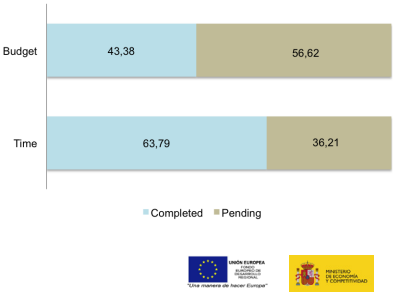
29/11/2010 30/09/2015

Description: Co-funding of a petawatt laser device to be coupled to VEGA-2 (200 TW) and VEGA-1 (20 TW). Key device of the CLPU as a singular scientific-technological infrastructure.

Actions 2013: Continuation of the project

- In February, the contracted company, Amplitude Technologies specified the technical settings and requirements of the vacuum chamber of the petawatt system.
- In March, both parties met to comment on the progress in the control systems of the installation. They discussed its components and the interface that might be used for its synchronization with other subsystems.
- In May, the execution deadline of the project was extended.
- In July, partial reception of the system was carried out in France: crystals of Ti-Sa with their mountings and pump systems.
- A new meeting was held in November to pinpoint the metrology, the installation equipment and the final approval of the chamber of the compressor. A further aim was to check the state of assembly of VEGA-3.

Statistics:



Research |European

Laserlab Europe III

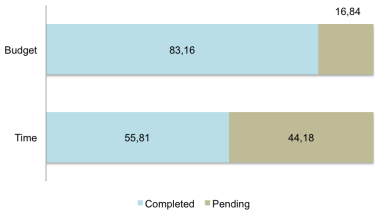
01/06/2012 10/01/2015

Description: Third phase of a highly successful European network that is developing a project belonging to the Seventh Framework Program, Capacities subprogram. This is a consortium of more than 30 European organizations that have front-line laser infrastructures in research.

Actions 2013: Continuation of Project

- Start of the activities of the Joint Research Activity (JRA) in which the scientists and technicians of the Centre are involved: Innovative Radiation Sources at Extremes (INREX)
- In the framework of work package 4 (WP4) and in the development of Networking Activity on Ultrahigh Intensity Ultrashort Lasers, a thematic call was made for the development of specialist meetings being developed at the FORO NAUUL, published on the official web site of the Project. Finally the participants decided on, designed, and held the I Annual Meeting of NAUUL- Second Congress on Operation of PW lasers, 13-14 July in Jena, Germany.
- As the party responsible for the relations between LASERLAB and Latin America, via a two-way communications plan the CPLU informed about the main activities in the field of lasers and optics carried out on Latin-American lasers and optics and the counterpart activities being conducted in Europe. Also, as a visible member, it participated as a sponsor in RIAO/OPTILAS in the summer of 2013 in Porto to open the doors of the network to Latin America.
- As National Contact Point, information was offered about Laserlab at each congress organized by CLPU. A database of potential users was set up.

Statistics:



Research |Domestic | Investigators

Ramón y Cajal 2008

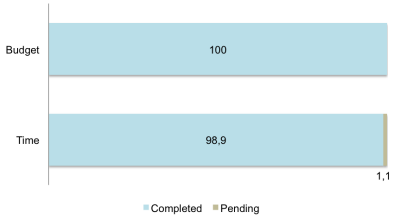
21/01/2009 — 20/01/2014

Description: A project promoted by the Ministry of Economy and Competitiveness aimed at strengthening the professional careers of PhD researchers in Spain. In particular, this Project develops three lines of work: Strong fields in molecules and atoms; attoseconds and non-linear and high-intensity propagation.

Actions 2013: Continuation of the project

- X-ray station; X-rays generated by the interaction of an intense laser and a solid target: completion of design, the radioprotection system, the sealing off of the radioprotection system, and a report requesting authorization for operation from the National Security Council (CSN).
- Installation of a characterization system for gaseous targets by means of an interferometer for the characterization of jets of gases made at the Centre.
- Certification 13 from ANECA, with the award of Pass with Honours in the execution of the Ramón y Cajal project by the investigator involved.
- Training activities: Classes in the Master's degree in Laser Physics and Technology (USAL/UV), development of projects of academic innovation, tutoring of PhD candidates, the Ramón y Cajal project being responsible for one of the beneficiaries of the LA^{3}NET European project and tutor of a woman Erasmus student.
- Participation in the development of other projects developed at the CLPU.

Statistics:



Research |Domestic | Investigators

Radioprotection (Plan E)

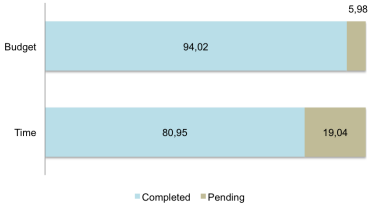
18/10/2009 31/12/2014

Description: Ultraintense laser systems are able to ionize atoms and accelerate particles (ions and electrons) to very relevant energies that must be considered with the greatest of caution within the framework of radioprotection. In this sense, with this project the aim of the CLPU is to lay down, for the first time in Spain, the bases of the radiological protection for a laser installation such as the one housed at the CLPU.

Actions 2013: Continuation of the project

- Once the main laser system of the Centre had been tendered, the design and development of a specific plan for radioprotection was begun: simulations were made with FLUKA code to estimate the doses in the laser-matter target area. Regarding the sealing of the bunker, simulations were performed with different configurations of the target area, designed according to the criterion of maximizing the scientific profitability of the installation. Work continues in the drafting of a report on the Category 2 radiological installations located in building M5.
- In collaboration with Professor Francisco Fernández of the University of Salamanca, the report on the request for authorization to operate as a Category 3 radioactive laboratory for X-ray generation, located in building M3. The authorization was obtained and awaits the requisite inspection by the Nuclear Security Council to be able to start serving users.

Statistics:



Research |Domestic |Support for research

Technical Support Staff (TSS) 2010

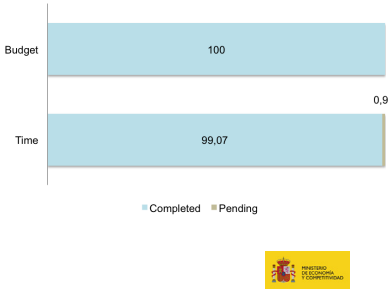
11/01/2011 20/01/2014

Description: An action encompassed within the Instrumental Lines of Actions of the National Program of Contracting and Incorporation of Human Resources, promoted by the Ministry of Science and Innovation, tendered in Feb 2010. In particular, this Project includes the following: the design and setting up of a mechatronic workshop, the generation of CAD/CAM designs of optomechanical elements and the manufacture modification of repair of parts for the Centre.

Actions 2013: Conclusion of the project

- Once the workshop was functioning, 2013 was a year devoted to strengthening its potential by means of the design, creation and manufacture of parts for the Centre, as well as for other external users, who are becoming increasingly interested in the additional equipment of the CLPU. At the same time, the technician responsible for this has continued in training with the company that supplies the main equipment parts to the workshop.

Statistics:



Research |Domestic |Support for research

Technical Support Staff (TSS) 2011

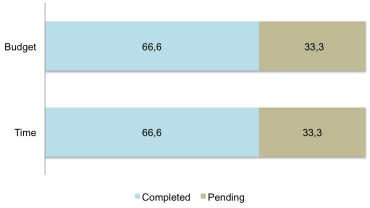
01/01/2012 31/12/2014

Description: Among the goals to be to be carried out by the contracted technician, this project aims at the following: training in the use and maintenance of the laser system of the Centre; participation in the experimental work relating to radioprotection, and the characterization of laser pulses. In particular: the measurement of the laser propagation factor and the design and development of a wave-front sensor.

Actions 2013: Continuation of the project

- Follow-up of the laser systems: work involving the use, maintenance, alignment and adjustments of the laser system in its first tests were carried out. Participation in the selection of the cooling systems, electrical connections, low-pollution spaces, hydraulic and pneumatic systems, sealings and safety measures.
- Dissemination of information about the equipment at different events organized or attended by the CLPU.
- Planning of the transfer of the laser systems from building M3 to building M5
- Disposition of the VEGA system with respect to its final emplacement, its electrical demands, refrigeration, acclimatization, the vacuum system, etc. Monitoring of the system's components during the test phase at the origin (in France).
- Adaptation of spaces for the users of the Centre: negotiation and purchase of optics benches, protective sealing mechanisms, optomechanical equipment, etc.

Statistics:



Research |Domestic |Support for research

Protocols for radioprotection in installations housing intense lasers (MAPFRE Foundation: Research Aid, 2012)

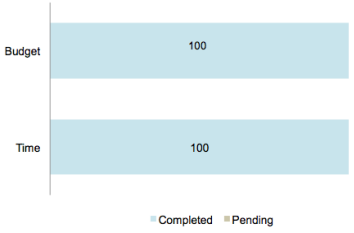
01/01/2013 31/12/2013

Description: This aim of this Project was to draft and compile the protocols for radioprotection, which are obligatory for installations housing intense lasers such as the Centre in Salamanca. It should be recalled that when an intense laser beam is focused, the electromagnetic field of the laser is able to ionize the atoms of the material, producing a plasma that in turn, through interaction with the target material, can –by bremsstrahlung- produce protons, neutrons and gamma/X radiation, which demand the definition of protocols for radioprotection.

Actions 2013: Conclusion of the project

- A review of the background literature, investigation of similar installations, a review of the current legislation and review of the source term.
- Monte Carlo-based simulation.
- Characterization of the radiation emitted. Analysis of the available detectors and assessment of risk in different areas, staff individuals and equipment that might be affected.
- Energy characterization: calculation of the dose rates and requisite consultation at the Nuclear Security Council.
- Design of radioprotection shields: prevention and detection measures. Dosimeter studies.
- Elaboration of a procedural manual oriented towards safety.

Statistics:



FUNDACIÓNMAPFRE

Research |Domestic | Research Promotion

FCCI – ACI PROMOCIONA

15/12/2009 15/12/2015

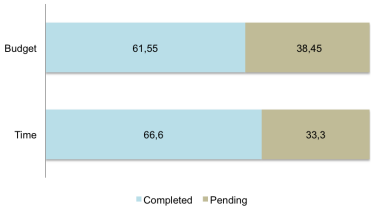
Description: This project aims to boost Spanish participation in the Pan-European Project entitled Extreme Light Infrastructure (ELI). This proactive attitude involves the consideration of four specific goals: the creation of an ELI scientific community, the training of Spanish scientists and technologists specialized in ultra-intense lasers and the promotion of Spanish outreach in the ELI.

Actions 2013: Continuation of the project

- The Pulsed Laser Centre as a key bastion in Spain of the ELI project is fully aware of its public relations, promotion and the dissemination of results within the different forums in which it moves. This has been seen in 2013. Thus, each event organized by or involving the CLPU has included a section relating to ELI (ISUILS, Final Meeting SAUUL), III CLPU Users Meeting…), thereby attaining goals such as promotion of the ESFRI High-Power Roadmap and the dissemination of extreme laser technology, its possibilities, and the types of application of sources of radiation. Of special relevance is the continuation of the Consolider- SAUUL Project of the University of Salamanca in a future National Femtolaser Community, created, designed and endorsed by the CLPU. Considering that the Pulsed Laser Centre is the Spanish representative in the ELI Delivery Consortium, the infrastructure thus becomes the main bridge for promoting collaborative work between Spanish groups and those participating in ELI.

- The training activities associated with the project have been encapsulated in the form of specialized seminars, courses, workshops, symposia and visits to laser installations (see section on training)

Statistics:



Transfer |INNPACTO

Atmospheric separation by electric/photonic ionization in magnetic fields (SIGMA)

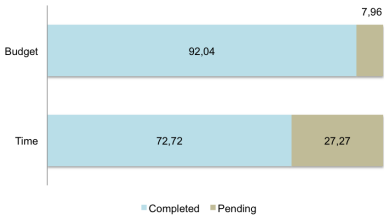
03/05/2011 31/12/2014

Description: The aim of this project is to develop a novel advanced system of separation of atmospheric gases by ionization and magnetism that will allow the capture and concentration of CO_2 in a viable way, both economically and technically for any type of industrial work involving the emission of pollution.

Actions 2013: Continuation of the project

- Completion of the prototype begun the previous year and application for a national patent together with Iberdrola Ingeniería and the University of Salamanca.
- Theoretical and experimental calculation of the prototype and of the photoionization processes desired. It should be noted that owing to the intensity required for efficient photoionization and the duration in time of the laser pulse, in the order of femtoseconds, the physical-chemical processes induced are highly complex, such that it is necessary to study, from an interdisciplinary perspective, the phenomena for a correct understanding of the results.

Statistics:



Transfer |INNPACTO

Development of a “low-cost” femtolaser for industry

03/05/2011 31/12/2014

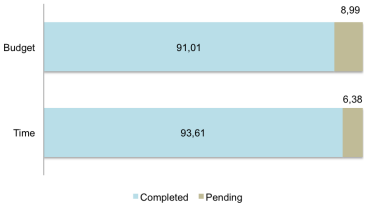
Description: This project aims to design and build a small low-power femtosecond laser at a reasonable cost for industrial purposes. This is to overcome the technological risk involved in the use in the industry sector of a type of laser mainly used in experimental science.

Actions 2013: Continuation of the project

- The review of the literature has been continued: different oscillators, the optimization of laser compression, and improvement in laser diagnostics. An industrial laser systems market survey, including trade fairs, has been performed jointly with the coordinating company.
- The equipment for the Project has been designed and developed.
- At the Autonomous University in Madrid, the laser system has been set up in pulsed mode, and in the stabilization of the mode-locking regime of the Yb:YAG prototype, with positive results.
- The spatial and power characterization of a laser system at the University of Valencia and a study of the system as a pump for lasers doped with Yb have been performed.

- Continuation of the technical study for the construction of a compressor based on prisms.
- Work continues in the construction of a scanning autocorrelator designed according to the needs of the project by the Pulsed Laser Centre.

Statistics:



Transfer |INNPACTO

Design and development of technological elements for particle acceleration by means of ultrashort and ultraintense lasers

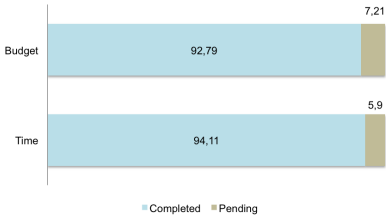
03/05/2011 28/02/2014

Description: This projects aims at designing and producing a particle generator based on ultrashort ultraintense pulsed laser technology for mainly biomedical applications, for both diagnosis and therapy. It also seeks future applications in the field of energy and diverse industrial processes.

Actions 2013: Continuation of the project

- Continuation of the tasks relating to the milestones stipulated in the project. Work has mainly focused on new-generation optical pump systems and amplifiers by simulation and preliminary laser designs.
- Proton Laser Applications, the coordinating company, presented the optical pump system at CLEO, a world laser fair.
- Continuation of the development of the prototypes of laser amplification on an optics bench
- Collaboration in the study of I3M, one of the participating companies, for the detection of large numbers of accelerated protons with sufficiently high energies (10 MeV)
- Application for two patents.

Statistics:



Training |European

Laser for applications at accelerators. A Marie Curie Initial Training Network (LA^{3}NET)

01/10/2011 30/09/2015

Description: This is a European consortium interested in the development of laser applications for particle accelerators within a training network. The aim is to set up collaboration long-term and create links between the parties involved to improve research and training in this field. To accomplish this, the network gathers together research centres, Universities and industrial partners with the new generations of researchers. Within the sphere of its participation in this project, the CLPU has two research students: Luca C. Stockhausen and Andreas Doepp.

Actions 2013: Continuation of the project

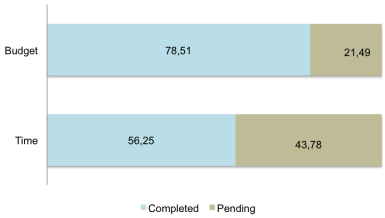
Luca Stockhausen:

- Participation at events: SPIE Optics + Optoelectronics (Czech Republic), II LA^{3}NET School (U.K), International Particle Accelerator Conference (China); Mid Term Review LA^{3}NET (Denmark), III LA^{3}NET School (Germany), and the Christmas Meeting of the Rutherford Appleton Laboratory –RAL– (U.K).
- Scientific Experimentation/visits: Collaboration with the team of Prof Paul McKenna (University of Strathclyde) in experiments in the VULCAN, TAP and GEMINI of the RAL (UK). Analysis of the results of the experiments. Stay in Glasgow. Preparation of a paper with the University of Strathclyde (forthcoming publication in Physical Review Letters).
- Drafting of the report: State-of-the-art of laser-driven acceleration.
- Graphical User Interface for the analysis of Thompson parabolas-Poster for the LA^{3}NET School.
- Video on a project for the LA^{3}NET network.

Andreas Doepp:

- Participation in events: SPIE Optics + Optoelectronics (Czech Rep.), II LA^{3}NET School (U.K), First European Advanced Accelerator Concepts Workshop (Italy), III LA^{3}NET School (Germany) and MidTerm Review LA^{3}NET (Denmark).
- Experiments/scientific visits: RWTH Aachen University (Prof. H.J. Kull); *Laboratoire d'Optique Appliquée* –LOA– (Prof. Kim Ta Phuoc); Imperial College London (Prof. Zulfikar Najmudin and Dr. Stuart Mangles); scientific meeting with LA^{3}NET partners (Prof. Victor Malka and Prof. Paul McKenna); experiments in LOA.

Statistics:



Training |Domestic

Training of University Professors (TUP 2012)

01/04/2013 31/03/2017

Description: The thesis entitled “Design and Construction of an extreme instantaneous flux proton source”, associated with this project, seeks to obtain a model with which to achieve maximum flow at moderate energy. Thus, there would be an exceptional source for the study of the non-linear damage to materials caused by protons. The final goal is to focus VEGA (petawatt laser) far from the diffraction limit and, with this, obtain a proton source able to cause non-linear damage to materials.

Action 2013: Continuation of the project

- Analysis of literature addressing laser-driven particle acceleration, a compilation of the different laser-driven acceleration mechanisms and a review of the detection systems usually employed in such experiments (radiochromic layers), Thompson parabolas, time-of-flight detectors…).
- Specification of an experimental set-up to perform experiments involving proton acceleration, laser focusing, focus diagnosis, target-positioning system. Proposal of particle detectors.
- Analysis of the requirements necessary for simulating the experimental situation and first round of simulations. The goodness of single-dimension techniques has been analyzed.

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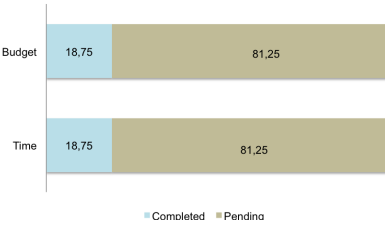
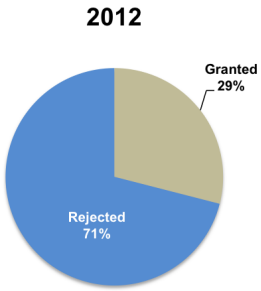
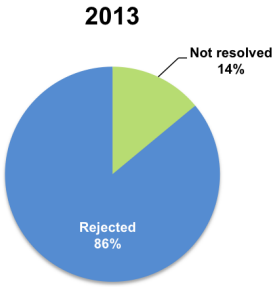


Participation in other projects			
Area/Duration	**Type**	**Name**	**Coordination**
Domestic 2011-2014	INNPRONTA	LIFE: "Desafío integral al cáncer de mama"	Exploraciones Radiológicas Especiales, S.A.
Regional 2012-2014	API 2012	3D microstructuring with femtosecond laser pulses	Univ. of Salamanca (Dr. Pablo Moreno)
Regional 2012-2014	API 2012	Material for the non-linear processing of photonic signals based on newly-synthesized lanthanide complexes	Univ. of Valladolid (Dr. Pedro Chamorro)
Regional 2012-2014	Xunta Galicia	LaserPET	Univ. Santiago of Compostela (Dr. José Benlliure / Dr. Maite Flores)
Local 2013-2014	USAL/Innovation and improvement in teaching	Guided tours of a laser laboratory for students of ESO 4th year and BACH 2nd year	Univ. Salamanca (Dr. Isabel Arias)

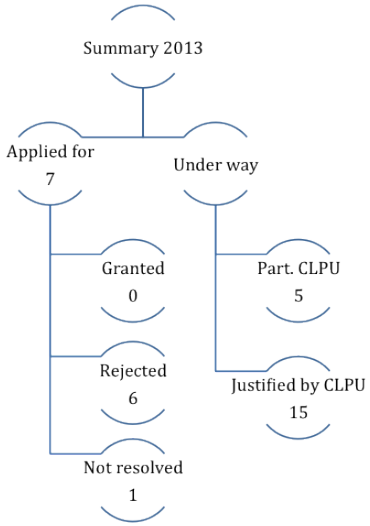
State of projects applied for in 2012 and still unresolved in 2012			
Domestic			
Type	**Name**	**Date Req.**	**State Req.**
Ramón y Cajal (MINECO)	RYC 2012 (2 plazas)	11/2012	No candidates (2013)
Juan de la Cierva (MINECO)	JDC 2012 (3 plazas)	11/2012	Rejected (2013)
Technical Support Staff (MINECO)	PTA 2012 (1 plaza)	12/2012	Rejected (2013)
International			
European FP7-ENERGY	Advanced system for CO_2 capture by ionization and electrostatic separation	10/2012	Rejected (2013)
Latin-American CYTED	MILATEC–Laser microprocessing: an emerging technology for optical communications	03/2012	Rejected (2013)

Projects applied for 2013			
Regional			
Type	**Name**	**Date of applic.**	**State of applic.**
API 2013 – JCyL	Design and characterization of a compact mass spectrometer for the detection and analysis of ionized species by laser at atmospheric pressure.	04/2013	Denied (2013)
API 2013 – JCyL	Generation of extreme intensities for laser-plasma interaction experiments	04/2013	Denied (2013)
API 2013 – JCyL	Prospective study of the use of a laser-driven pulsed X-ray source for mammography	04/2013	Denied (2013)
Domestic			
Scientific culture and Innovation (FECYT)	Light workshops. Itinerant experiments	06/2013	Denied (2013)
Scientific culture and Innovation (FECYT)	Discovering lasers. Audio-visual material	06/2013	Denied (2013)
Research challenges (MINECO)	Ultra-fast sources of ionizing radiation for medical applications.	11/2013	Not resolved
International			
United States Air Force	Quantum vacuum driven by extreme lasers	04/2013	Denied (2013)





While in 2012, 8 projects were requested, of which 71% were rejected; in 2013 7 projects were resquested but 86% of them were rejected.



2.3.2 Collaborative experimental activities

Investigator: Ricardo Torres
Stay: 10/05 – 02/06
Facility: *Rutherford Appleton Laboratory* (Vulcan)

Investigator: Luca C. Stockhausen
Stay: 21/05 – 22/06
Facility: *Rutherford Appleton Laboratory* (Vulcan)

Investigator: Andreas Doepp
Stay: 02/07 – 31/07
Facility: *Laboratoire d'Optique Appliquée (Salle Jaune)*

Investigator: Camilo Ruiz
Stay: 24/11 – 14/12
Facility: *Laboratoire d'Optique Appliquée*

2.3.3 Scientific visits

24/05/2013.- Professor Sadao Nakai from the University of Osaka, President of Laser Society Engineering and an expert in laser-plasma interactions visited the Centre. He was interested in seeing the VEGA installations.

12-14/10/2013.- During his stay in Salamanca to attend the International Symposium on Ultrafast Intense Laser Science (ISUILS), Professor See Leang Chin from the University of Laval paid a short visit to see the installations and projects associated with them. He also offered a seminar for the investigators and technicians of the Centre.

27/11/2013.- The Electricity and Electronics Group from the University of the Basque Country (EHU/UPV) visited the CLPU to negotiate the possibility of launching a joint project related to the control system of the Centre.

2.3.4 Technological platforms

In its mission to increas the added value of the Centre, the CLPU has opted for being present not only in the key European networks in the field of lasers (see Project section–Laserlab Europe, La^{3}NET…–) but also for participating in the main technological platforms currently existing in the fields of Optics and Photonics:

SECPhO

Southern European Cluster in Photonics and Optics, of which the CLPU is a founding partner and in which it is also responsible for the main work team created around laser technology.

FOTONICA

This comprises more than 180 members distributed in different work teams, thereby optimizing the results. The aim of this platform is to set up an efficient process of industrial innovation of photonics technology and its applications in specific sectors of the economy.

Furthermore, in 2013 the Centre began conversation with Induciencia, a Spanish platform devoted to the Science Industry and interested in maintaining open contact with infrastructures working at the frontiers of knowledge.

2.4 The pursuit of knowledge and its transfer

2.4.1 Organization of events

In 2013, the Pulsed Laser centre focused its interest on the co-organization of relevant international events relating to the science of ultraintense lasers:

Annual Meeting of NAUUL – 2nd Workshop Operation of PW- class lasers

- Date: 13 – 14 June
- Venue: Dornburg Castles, Jena (Germany)

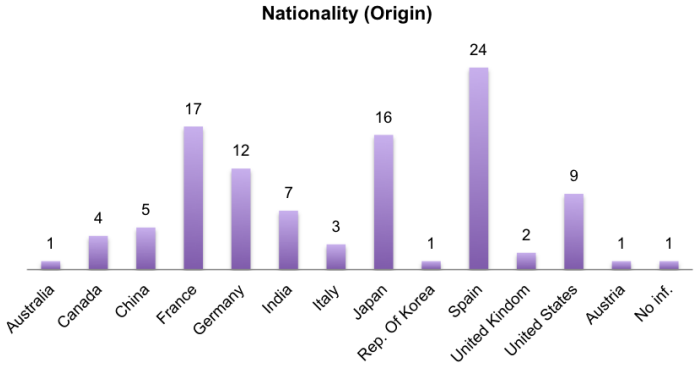
Within the framework of the role played by the Pulsed Laser Centre in the European Laserlab Project as coordinator of the Networking activity on ultrahigh intensity ultrashort lasers (NAUUL), the CLPU is responsible for promoting specific actions involving scientific exchange in the field of ultra-intense ultra-short lasers among the new emerging installations in France, the United Kingdom and Germany. In this sense, during 2013 it sought to strengthen personal contacts between the scientists involved in this field and designed and launched an open forum of proposals for the setting up of small meetings among specialists. As a result of this idea, the second specialist Congress on petawatt lasers was organized by three institutions: the CLPU in Salamanca (Spain), the University & HI Jena (Germany) and CEA-Saclay (France), with the University of Jena responsible, commendably so, for most of the logistics of the organization. The meeting focused on debates about the hottest topics in the day-to-day use of high-intensity lasers and gathered an important European group of experts in the different themes proposed: intensity measurements, detection and correction of aberrations in the laser beam, the detection of secondary radiation, new targets and target manipulation, and laser designs.

Two moments at the Congress organized within the NAUUL framework.

International Symposium on Ultrafast Intense Laser Science (ISUILS12)

- Date: 6 – 11 October
- Venue: Colegio Arzobispo Fonseca, Salamanca (Spain)

The ISUILS is a relevant international Congress series with a history of more than 10 years. It was begun in Tokyo in 2002 with the aim of promoting the science of ultra-short ultra-intense lasers and exploring their frontiers by sparking interdisciplinary debates (physicists, chemists, laser technicians…). It is held twice a year and alternates among different continents. In 2011 the Director of the CLPU, Luis Roso, was responsible for Salamanca winning the candidacy as the host of the 12th Meeting, which was held in 2103. The Congress saw the attendance of more than a hundred specialists from 45 institutions and 13 different countries (see chart).



This Congress boosted the regional economy, with 16 companies involved in the logistic development of a relatively small event but a very relevant one in terms of the scientific acumen it gathered together (16 countries that equally shared a total cost of more than 60,000 euros). The Pulsed Laser Centre participated not only as a local organizer in constant collaboration with the promoter of the Symposium, the University of Tokyo, but also became a sponsor of the Congress, together with the University of Salamanca, Caja Duero, the Japan Intense Laser Science (JILS) and the University of Tokyo itself.

Panel at the Opening Session of the Congress

3rd Users Meeting: VEGA, a Unique Petawatt for Science and Innovation

- Date: 2 – 3 December
- Venue: Hospedería Fonseca, Salamanca (Spain)

Within the framework of the pan-European project Extreme Light Infrastructure (ELI), the CLPU calls for an annual users meeting to consolidate, create and potentiate the awareness of the domestic and international community about the scientific-technological relevance of the Centre and its role in the goals of ELI in the advance of the science of ultraintense lasers. At the third meeting, the CLPU focused on its petawatt laser system, the system that makes the Centre a highly singular entity, in order to develop an atmosphere of debate about this type of installation. With a panoply of relevant Spanish and International scientists, this meeting (one and a half days) gathered about 50 scientists and technologists, most of them

from the University world. The two Congresses organized by the CLPU in Salamanca offered a visit to its installations, showing the visitors the complementary equipment, the building to house VEGA and the current VEGA-2 system.

Public attending the event

Material offered

2.4.2 Training

- Teaching/Research Work

Type of work: PhD thesis
Co-superviser: Camilo Ruiz Méndez
Student: Alexis Chacón Salazar
Title of work: Applications of attosecond pulses
Status: Ongoing

Type of work: PhD thesis
Co-superviser: Camilo Ruiz Méndez
Student: Andreas Doepp
Title of work: X-ray sources from laser plasma accelerators
Status: Ongoing

Type of work: PhD thesis
Co-superviser: Ricardo Torres
Student: Luca C. Stockhausen
Title of work: Conceptual implementation of Laser-Driven Proton Acceleration with the VEGA laser
Status: Ongoing

Type of work: PhD thesis
Tribunal: Luis Roso (President), Ricardo Torres (Member)
Student: Carlos Hernández
Title of work: Coherent Attosecond light sources based on high-order harmonic generation: influence of the propagation effects

Type of work: PhD thesis
Tribunal member: Álvaro Peralta Conde
Student: Sara Ibáñez
Title of work: Control & dynamics of two-level quantum systems: the limits

Type of work: Master's thesis
Co-supervisor: Luis Roso, Mauricio Rico
Student: Roberto Lera
Title of work: Modelling of a regenerative amplifier

Type of work: Master's thesis
Co-supervisor: Ramón Vilaseca, José Manuel Álvarez
Student: Karla Patricia Reyes Sánchez
Title of work: Radiation environment over the WFM detector in LOFT's ESA space mission

Type of work: Master's thesis
Co-supervisor: Ramón Vilaseca, José Manuel Álvarez
Student: James Perénguez López
Title of work: Laue lens simulations for gamma radiation in the energy range of 1 MeV

Type of work: Master's thesis
Co-supervisor: Iñigo J. Sola, Álvaro Peralta Conde
Student: Hugo Dacasa Pereira
Title of work: Molecular alignment in gases by ultrashort pulses and its application in the select ionization of species

Type of work: Master's thesis
Co-supervisor: Camilo Ruiz
Student: Mara Oswald
Title of work: Polarization effects in strong laser fields
Status: Ongoing

Seminars (given)

Camilo Ruiz
Wilhem und Else Heraeus Seminar – High Harmonic Spectroscopy
Leibnitz Universität –Austria–
28/02/2013

Seminars (Organization)

24/01/2013
Philippe Zeitoun
Laboratoire d'Optique Appliquée. Palaiseau, Paris –France–
Achievement and prospectives of laser-diven femtosecond X-ray sources at LOA

22/02/2013
Javier Sanz & Arnauld Debayle
(Dpt. Physics of plasma and inertial fusion. ETSI. Polytechnic University of Madrid –Spain–)
Towards a self-consistent analytical model of the interaction between an ultraintense laser and overdense plasma

22/02/2013
Víctor Malka
Laboratoire d'Optique Appliquée. Palaiseau, París –France–
High Quality electron & x-ray beams produced in laser-plasma accelerator

11/04/2013
Pedro Corredera
'Daza Valdés' Advanced Optics Institute. CSIC, Madrid –Spain–
Optical synchronization of clocks by fibre optics

11/04/2013
Pedro Corredera
FOCUS, S.L. An experiment in entrepreneurship

16/10/2013
See Leang Chin
Université Laval, Québec –Canada–
Filament-induced precipitation in a cloud chamber

27/11/2013
Lukas Medisaukas
Imperial College London, London –United Kingdom–
Electronic control of molecular dissociation with sub-femtosecond precision

04/12/2013
Marta Castillejo
Rocasolano Institute of Chemistry-Physics, CSIC, Madrid –Spain–
High-quality electron & x-ray beams produced in laser-plasma accelerator

10/12/2013
Max Lederer
European XFEL GmbH, Hamburg –Germany–
Status of laser developments for the European XFEL project

10/12/2013
Carlos Zaldo
Madrid Material Science Institute (ICMM), Madrid –Spain–
Disordered monocrystals for ultrafast lasers

Courses

1. Advanced course in the use of SEM. Imparted by Zeiss. 29-31/01/2013
2. Course on safety: gases and cryogeny. Imparted by Air Liquide. 26/07/2013
3. Handling and use of the bridge crane. Imparted by Homanber Cranes. 13/11/2013
4. Course on training on the SAP platform.
   10/12/2013; 02/12/2013; 22/11/13

Journal Club

This year, the Pulsed Laser Centre has continued to maintain the activities of the Journal Club, a training activity whose aim is to improve and enhance the communications skills of the participants. In these activities, stress is placed not only on the choice and structuring of the information at presentations but also on how the speaker must be able to transmit those data to the audience. Seven contributions were made in 2013:

1. R. Torres (22/02/2013) Laser acceleration of quasi-monoenergetic proton and ion beams.
2. A. Chacón (8/03/2013) Attosecond lighthouses from plasma mirrors.
3. C. Ruiz (25/03/2013) All-optical Compton gamma-ray source.
4. J. Apiñaniz (10/05/2013) Interferometric techniques for plasma diagnostics.
5. J.H. Toro (24/05/2013) Practical aspects in vacuum.
6. F. Valle (31/05/2013) Enhanced proton flux in the MeV range by defocused irradiation.
7. A. Peralta (21/06/2013) Evanescent phenomena in Quantum mechanics or how to get crazy about a half-an-hour experiment.

2.4.3 Popularization

Along 2013, several members of the scientific area of the Centre participated in activities aimed at popularization, in support of one of the strategic communications lines of the centre:

1. L. Roso, *El láser, donde la realidad parece ficción*. Cultural Room of Casino de Salamanca. 3 June 2013, Salamanca (Spain).
2. J. Apiñaniz, *Y tú…¿en qué trabajas?* Colegio San Prudencio Ikastetxea. 13 December 2013, Álava (Spain)
3. A. Peralta, *VEGA: a unique Petawatt laser for Science and Innovation*. EHU/UPV, 17 December 2013, Bilbao (Sapin).
4. F. Valle Brozas. Laboratorio de Láseres *The Optics Adventure*. Fundación Salamanca Ciudad de Saberes. (2012-2013)

2.5 Scientific-Technological Agreements

14/02/2013
The Pulsed Laser centre subscribed for one year to an action protocol with the MAPFRE Foundation for the development of the Project entitled “Protocols for radioprotection in installations housing intense lasers”, within the funding call by the Foundation for research.

01/04/2013
Second annex to the agreement signed together with the Centre by the company Proton Laser Applications (PLA) and the Polytechnic University of Valencia (through the I3M) for the development of a project within the INNPACTO subprogram, 2011 call. This annex includes a specific agreement between the CLPU and PLA for optimizing collaboration among the human resources of both institutions involved in research into the above project. The agreement was signed on 31/02/2013 and is programmable by consensus.

30/05/2013

Addendum to an agreement for specific collaboration signed in 2011 between the University of Salamanca and the Pulsed Laser Centre. This addendum includes an agreement for educational cooperation via external practical work between both parties. Although the date of the agreement was 25/05/2014, this is tacitly deferrable for the same amount of time, unless there are objections. Starting out from this agreement and according to the model established in Annex I, the following practical work for students of the University of Salamanca at the Pulsed Laser Centre was stipulated:

- 21/06/2013. An engineering student from the EPS in Zamora joined the Centre to do practical work at the Mechatronics Workshop.
- 19/09/2013. A student from the Physics Degree Course joined the centre to carry out practical work together with the technicians responsible for the development of arrangements and the characterization of pumps for petawatt lasers.
- 19/09/2013. A student from the Physics Degree Course joined to centre for the updating of a program for data acquisition in LabView.

03/06/2013

Collaborative agreement with the Rio Tormes Integrated Centre for Professional Training (CIFP) stipulating general frameworks for action and cooperation between both agencies. Any joint activity must be defined by means of a specific agreement. Although it is valid until 02/06/2014, it can be extended tacitly for the same period of time unless there are objections.

18/07/2013

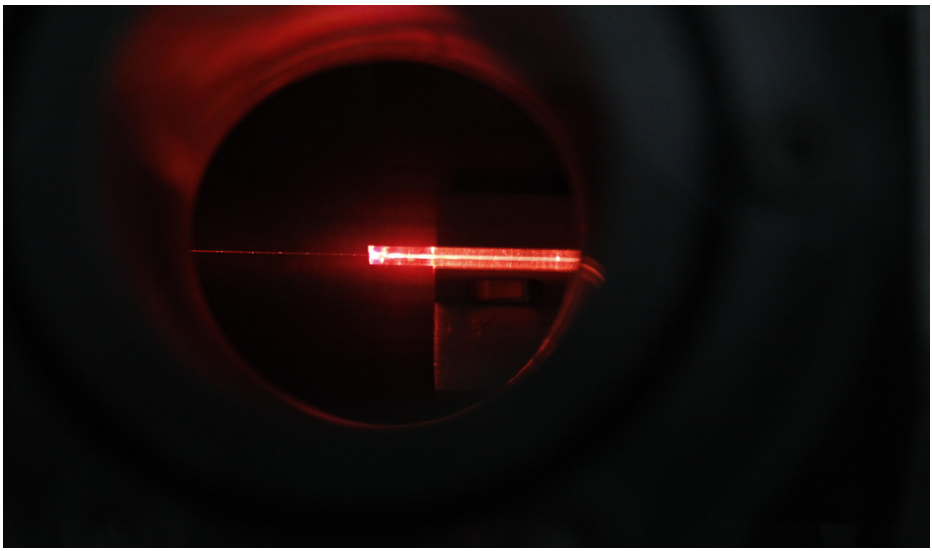
The Ministry of Education, Culture and Sports signed an agreement with the CLPU for collaboration aimed at optimizing the management of the funds derived from calls from the Ministry. The aims were as follows: to promote the training of University professors to facilitate future incorporation into the Spanish system of Higher Education and scientific research, and to foster post-doctoral specialization by means of mobility stays. This is a 4-year program, extendible for a further two years if both parties agree.

02/09/2013
At the beginning of September the Centre signed a framework agreement of collaboration with the National Research Centre on Human Evolution. Its duration is 3 years and this can be extended tacitly for the same time if there are no objections.

01/10/2013
The CLPU signed a 3-year agreement with the National Accelerator Centre (CNA) to define to framework of the lines of cooperation between both parties. This agreement can be extended tacitly if there are no objections.

30/10/2013
The CLPU signed a collaborative agreement with the University of the Basque Country (EHU) to foster scientific-technological cooperation between both institutions. This agreement can be extended tacitly if there are no objections.

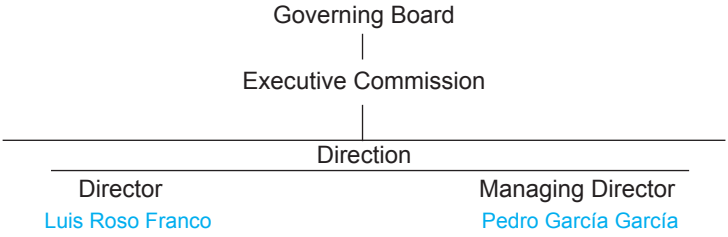
09/12/2013
The CLPU signed a framework agreement with the University of Santiago de Compostela (USC) to foster scientific-technological cooperation between both institutions. This agreement can be extended tacitly if there are no objections.



Infrastructure Management

3

3.1 Managing bodies



Governing Board

Composition

President

Mr. Ángel de los Ríos Rodicio
General Director of Universities and Research of the Education Board of Castile & Leon.

Vice-President

Ms. María Luisa Castaño Marín[3]
General Director of Innovation and Competitiveness. MINECO

Secretary

Mr. Gerardo Arévalo Vicente
Chief of the Economic Affairs Unit of the University of Salamanca

Members

Mr. José Ignacio Doncel Morales
General Sub-Director of Planning of Scientific and Technological Infrastructures. MINECO

[3] She replaced Ms. María Luisa Ponce García on 23 April 2013

Mr. José Ramón Naranjo Orovio[4]
Adjoint Vice-President of the Scientific Programming of the CSIC.

Ms. Ángela Fernández Curto
Adjoint General Sub-Director of the Planning of Scientific and Technological Infrastructures. MINECO

Mr. Benedicto González Vereda
Coordinator of Services of the General Council of Education and Research of the Education Board of the Government of Castile & Leon.

Mr. Luis Ángel González Bueno
Chief of the Service of Scientific Research, Knowledge Transfer and University Infrastructure in Castile & Leon.

Mr. Agustín Carrillo Franco
Technical Adviser to the General Secretariat of the Education Board of Castile & Leon.

Mr. Ricardo López Fernández
Vice-Rector of Economy of the University of Salamanca.

Ms. Mª Ángeles Serrano García
Vice-Rector of Research of the University of Salamanca

Mr. Luis Mediero Oslé
Financial Manager of the University of Salamanca

[4] Replaced Mr. Eusebio Carlos Jiménez Arroyo on 29 October 2013

Executive Commission

Composition

President

Ms. Ángela Fernández Curto
Adjoint General Submanager of the Planning of Scientific and Technological Infrastructures. MINECO

Vice-President

Mr. Ángel de los Ríos Rodicio
General Manager of Universities and Research of the Education Board of Castile & Leon.

Secretary

Mr. Gerardo Arévalo Vicente
Chief of the Economic Affairs Unit of the University of Salamanca.

Members

Mr. Benedicto González Vereda
Coordinator of Services of the General Council of Education and Research of the Education Board of the Junta of Castile & Leon.

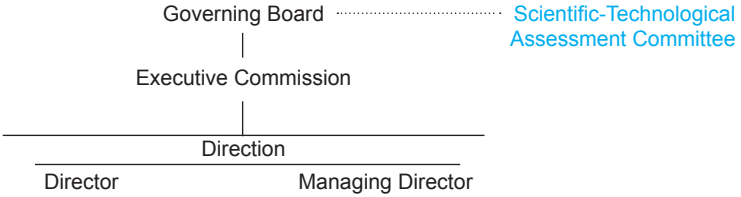
Ms. Beatriz Albella Rodríguez
Chief of the Area of Biotechnology and Materials of the General Sub-Directorship of the Planning of Scientific and Technological Infrastructures. MINECO

Ms. Mª Ángeles Serrano García
Vice-Rector of Research of the University of Salamanca.

Mr. Ricardo López Fernández
Vice-Rector of Economy of the University of Salamanca.

The Governing Board and the Executive Commission are formed by members of the three foundational institutions of the Consortium

Scientific-Technological Assessment Committee



The scientific-technological commission of the CLPU is formed by ten members from outside the institution. These are relevant scientists from the international arena who have worked on intense lasers. Their mission is to counsel the Governing Board about programs, plans, activities and future scientific-technological proposals that will help to enhance the quality of the Centre. On 3rd June, the President of the Committee, Jon Marangos (Imperial College, London), visited the centre to prepare the second CACT Meeting, which was finally held on 25-26 November. This meeting addressed the progress of the Centre and the development of the scientific planning.

CACT members next to the Director of the CLPU (L) during the visit to the Centre

3.2 Infrastructure

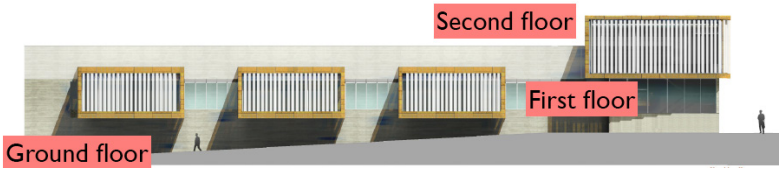
General view of the M5 building, the hub of the CLPU

As a scientific-technological infrastructure, the CLPU is defined by the particularity of the laser system it will offer its users from across the world. However, in turn VEGA has made it necessary to have a highly specific work space available.

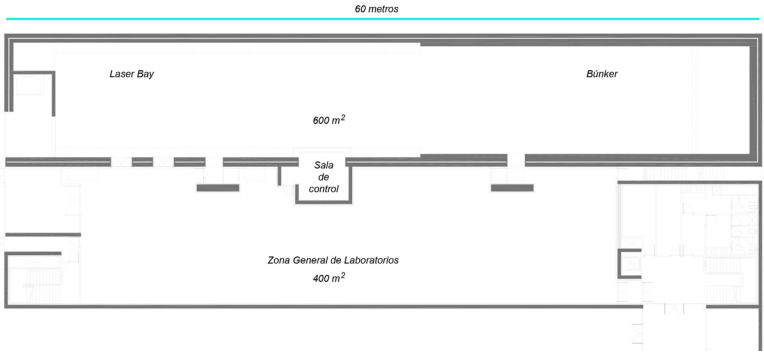
2013 was a key year for the opening of the host building, M5, which is to house one of the most potent laser systems in the world. It was finally occupied in October after obtaining the corresponding technical-inspection license for buildings.

The correlation between the equipment and the laboratories reveals the unique profile of the CLPU, so the key aspects of the building should be detailed further, as done previously with the laser system.

The M5 building comprises three levels: the ground floor, which houses the offices of the researchers and technicians; the first floor, that is occupied by administration and management, and the basement, which houses VEGA. All floors have been specially treated to prevent vibrations that might negatively affect the equipment.



The basement is the true hub of the building. It is divided into two corridors with a control area between them: the general complementary laboratory zone and the experimental zone, and the laser bay, measuring 60 metres in length.



The floor of the laser platform comprises two layers of reinforced concrete (30 and 60 cm thick) with a layer of sand (15 cm) between them. The protection is increased with a bunker-like wall built as a preventive measure against possible radiation generated by the interaction of the laser with the targets. This bunker has two concrete walls of reinforced concrete: the inner one is 65 cm and the outer one is 35 cm thick, both separated by a 4+4-cm thickness thermal-acoustic insulation layer.

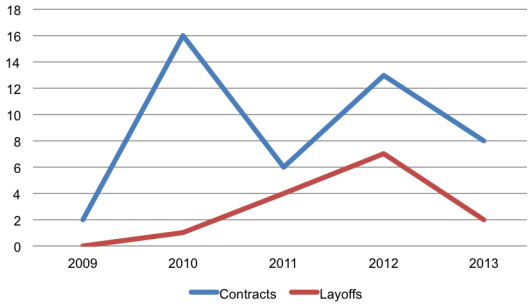
This singular building is located in the Innovatec zone of the Science Park of the University of Salamanca. Since its inception, the Pulsed Laser Centre has followed a strategy based on the development and transfer of knowledge. An example of this is that this Science Park was built on the Villamayor Campus in Salamanca. This choice aimed to contribute efficiently to the ecosystem of investigation, development and innovation arising from the cluster of companies (tipically present) in a Science Park.

Map of the Science Park . The zone in standard pink is Innovatec.

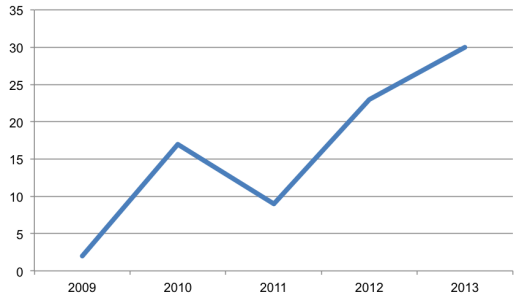
3.3 Human resources

Since 2011, like other public research institutions, the Spanish Pulsed Laser Centre has found itself in a difficult situation as regards human resources since it has been impossible to contract researchers on a permanent basis, which directly affects scientific-technological development. The direct effects of this impediment were very apparent in 2013 and will be further exacerbated in the future. To this should be added the fact that contracting with funding from a general budget must be strongly justified, such that the need for more human resources is crucial for the proper evolution of the infrastructure. This means that an important number of staff members at the CLPU are contracted via projects, which in many instances are nearing their end. This, together with the increasing fewer calls for funding from the competent authorities, and above all the ferocious competition to access such funds, reveals the sort of crisis that affects all socio-economic environments of a large part of the country environments, from which the CLPU in particular is unable to escape. All this should be borne in mind when attempting to interpret figures and numerical and statistical data concerning the human resources situation we are now witnessing.

- Comparison of contracts/layoffs with time

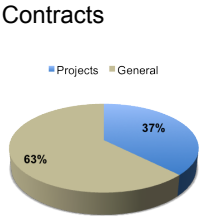


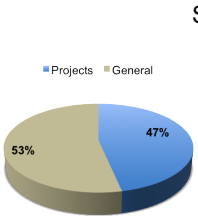
Evolution of staff

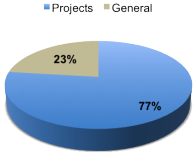


As may be seen in the above plots, the number of contracts decreased significantly in 2013. However, since the number of layoffs has also decreased (as indicated previously, many contracts are from projects that finish some years later) this has meant that in global terms the CLPU can still reflect a slight growth in staff numbers in its statistics. A glance at the distribution of new contracts shows that a large part of them were taken on the basis of the general budgets (owing to the fewer calls for funding), which has meant that at staff level the total numbers become equal. In fact, in a comparison the change in the sign of the distribution of contracts is significant.

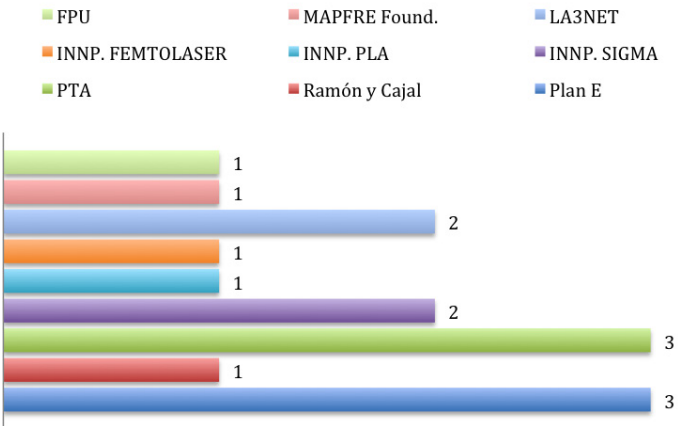
Allocations in staff expenditure





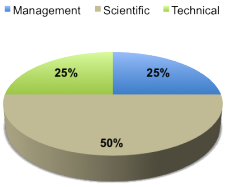


Projects with funding for staff



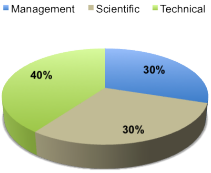
The new contracts in 2013 were from the Mapfre projects, the FPU and the fellowships of LA^{3}NET. Of the others, only ACI Promociona has funds for contracting and at the end of December the person contracted through this project left the Consortium.

Contracts by area



These new recruitments have mainly been in the scientific area, which has seen the most growth thanks to one of the European projects in which the CLPU is involved in the area of training: LA^{3}NET (see section on projects). However, despite these efforts towards the end of 2013, one finds the following division of staff by areas:

Staff by divisions

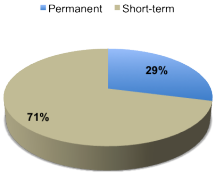


As can be seen, the technical area maintains a higher number of employees, which is logical in an infrastructure that at present is moving between the installation, maintenance and start of operation of its services. Moreover, the slight growth of the scientific area has merely made the number of employees equal to the staff numbers in the administrative area, again pointing to the difficulties involving in maintaining high-level research at a users Centre of technology and scientific support in the evolution of studies at the frontier of knowledge.

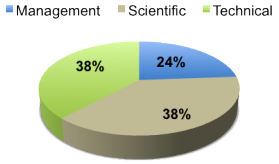
On comparing the above with the statistics about this issue for the last year, it may be seen that contracting in one area indirectly means difficulties in contracting in another one, suggesting that the total number of contracts, and not their significant distribution by areas, is what is most important.

All this means, as may be seen below, that the number of permanent contracts remains static against the significant increase in short-term contracts, since this is the only way of contracting people.

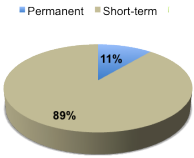
Types of contract

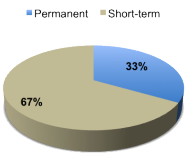


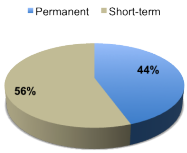
Short-term by divisions



Type of contract by divisions (Scientific, Technical and Management)



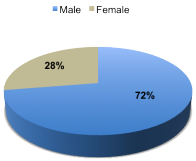




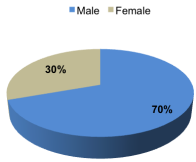
Of all of them, the most significant is again that of the scientific area, where the low percentage of permanent contracts refers area leaders, no other permanent staff being present in this section. In any case, these statistics corroborate what has been said up to now.
Having arrived at this point, a pause is in order: up to what point can we speak of return from investment in staff training? What should we do to reach the degree of specialization required by a scientific-technological infrastructure such as the CLPU so that its users can receive the very best services? How else can it be converted into an international reference? A magnificent installation does not become a quality service without specialized staff to master, use and maintain it. An ICTS cannot be defined, nor should be, by the mere presence of a first-class installation but by the entirety of its expert staff, who daily ensure that the elements of the installation are top-quality and that the science developed through their use will be of excellence.

Other data

Comparison by gender (male/female)



2013

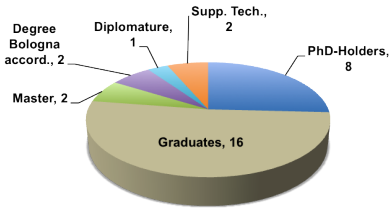


2012

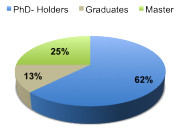
From 2012 to 2013 there was a slight increase in men over women, diverging from parity in the staff roster of the CLPU. Nevertheless, this is merely another collateral piece of information concerning the present situation, since we are speaking here of the short-term contracting of staff who are already required to have a high level of specialization. Finding someone willing who meets all the requirements to apply for an opening at the Centre is extremely difficult, such that positive discrimination for women is out of the question.

Training

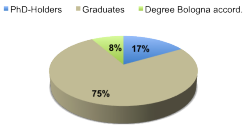
Staff



By divisions



Scientific



Technical

Management

As is logical, and as appears in earlier reports, the greatest number of PhD-holders is concentrated in the scientific areas, whereas the highest number of staff with intermediate studies is seen in the management area, although, overall, graduate degree-holders are the most numerous among the employees at the Centre.

3.4 Efficiency in management

The services offered by the CLPU during 2013 had repercussions on the NUCLEUS platform of the University of Salamanca, with which an agreement about the joint use of the services included in the platform was reached.

Another important milestone regarding management was the implementation of the informatics platform in its new building, M5, and above all the connection with the fibre-optic network of the RED IRIS, which will lead to higher-quality access to other scientific-technological networks, including that of the University of Salamanca itself, which in the future will form the Regional Science and Technology Network of Castile and Leon.

The ERDF agreements subscribed with the Ministry of Economics and Competitiveness are currently being analyzed for their proposal as models of good practice with respect to their processing and, in particular, aspects related to the dissemination of such agreements.

Finally, it should be noted that a new informatics tool, SAP Business One, has been implemented. This will afford better integration of all processes with economic implications and centralization of the information. This will facilitate the use of the tool by all the CLPU staff. This introduction has been recognized as successful by the partner who collaborated in setting it up.

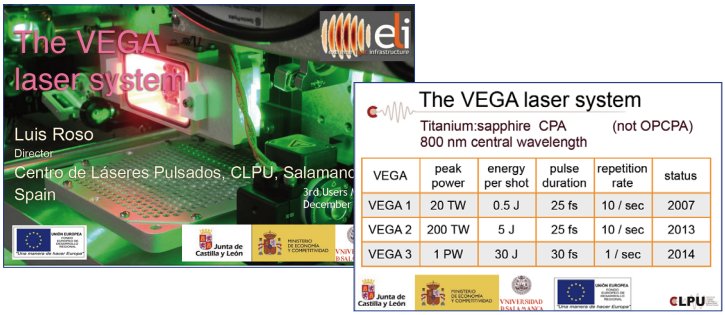
3.5 Communication

As one of the basic pillars of its activities, the Pulsed Laser Centre has continued to engage in a constant dialogue with its surrounding environment. Aware of the social role played by a scientific-technological infrastructure of such singular nature, the CLPU has maintained activities involving visibility, publicity, promotion and popularization, both of the centre itself and of the laser technology available there. With this type of activity, the CLPU has achieved a dual aim: dissemination and the capture of users for the socio-economic activation of the region. Although dissemination as such has been addressed in the part of this report corresponding to boosting knowledge, it should not be forgotten that the constant effort in intervent-

ions directed towards the public in general is made by the scientists and technicians of the Centre in order to bring science closer to society. It is here that we should recognize the intense efforts made to popularize the information implicit in each news item, journalistic report or interview given.

Within the framework of the outreach of the Centre towards the international arena, in 2013 the Director sparked 6 interventions aimed at increasing the visibility of the CLPU in Spain and internationally.

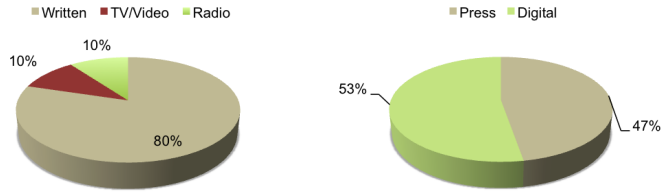
1. High Order Harmonic Generation: how to get coherent x-Rays. VIII Jornadas de Recerca del Departament de Fisica i Enginyeria Nuclear, 31 January, Barcelona (Spain).
2. Quantum vacuum driven by Extreme CPA-lasers, Pulsed Strong Field Laser Physics International Symposium, 21-24 May, Laval (Canada).
3. Bases for the Acceleration of Charged Particles by Infrared Laser Radiation, III Congreso conjunto de las sociedades científico-médica y radiológica, 19 June, Cáceres (Spain).
4. The Spanish BIG Laser, EuroRisNet+Workshop. Research infrastructures towards 2020. 5 July, Lisboa (Portugal).
5. The Salamanca Petawatt: emerging applications of compact ultrafast ultraintense lasers, VIII Iberoamerican Optics Meeting & XI Latinamerican Meeting on Optics, Lasers and Applications (RIAO / OPTILAS), 22-26 July, Porto (Portugal).
6. The VEGA laser system, 3rd Users Meeting CLPU, 2-3 December, Salamanca (Spain).



This year, 2013, has been characterized by the outreach of the Centre at domestic and international level, and this has reached an important number of regional media outside the Community of Castile & Leon, indeed at national level. All this has been possible thanks to the link between the Centre and the multinational company Iberdrola, which in this case has acted as a "projector", allowing the CLPU to attain, for the first time in its history, an unparalleled impact in the various media. An analysis of this indicates that several aims have been achieved:

- Making a broader sector of the public aware of the existence of the Spanish Pulsed Lasers Centre.
- Publicizing the commitment of the Centre to innovation and social challenges.
- Popularization of the existence of singular scientific-technological infrastructures
- A broadening of the media agenda and hence the contacts that help both to provide information about the Centre and its novelties and also to broadcast the science developed at the CLPU.

Together with this -which involved the presentation of a prototype for the capture of pollutant gases in collaboration not only with the domestic company (Iberdrola) but also with the University of Salamanca, the third member of the SIGMA innovation project- it may be seen that most of the news has been linked to the scientific-technological development of the Centre. However, its presence in the media regarding the events it has organized should not be overlooked (see section on "Optimization of events"), together with activities aimed at dissemination. On the web site of the Centre (www.clpu.es) it is possible to follow the press releases and press reviews together with news, reports and interviews conceded to Press officers, the television, and radio linked to the CLPU in 2013.

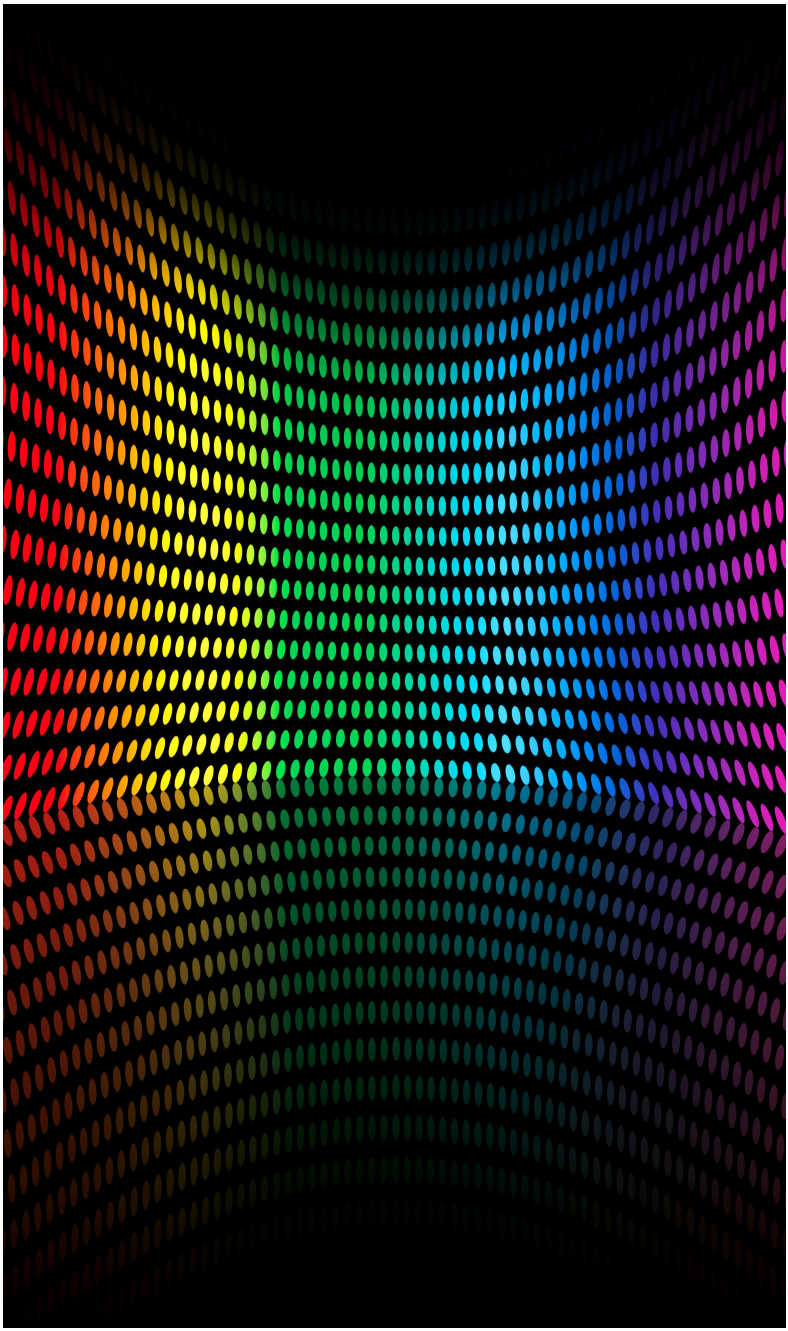


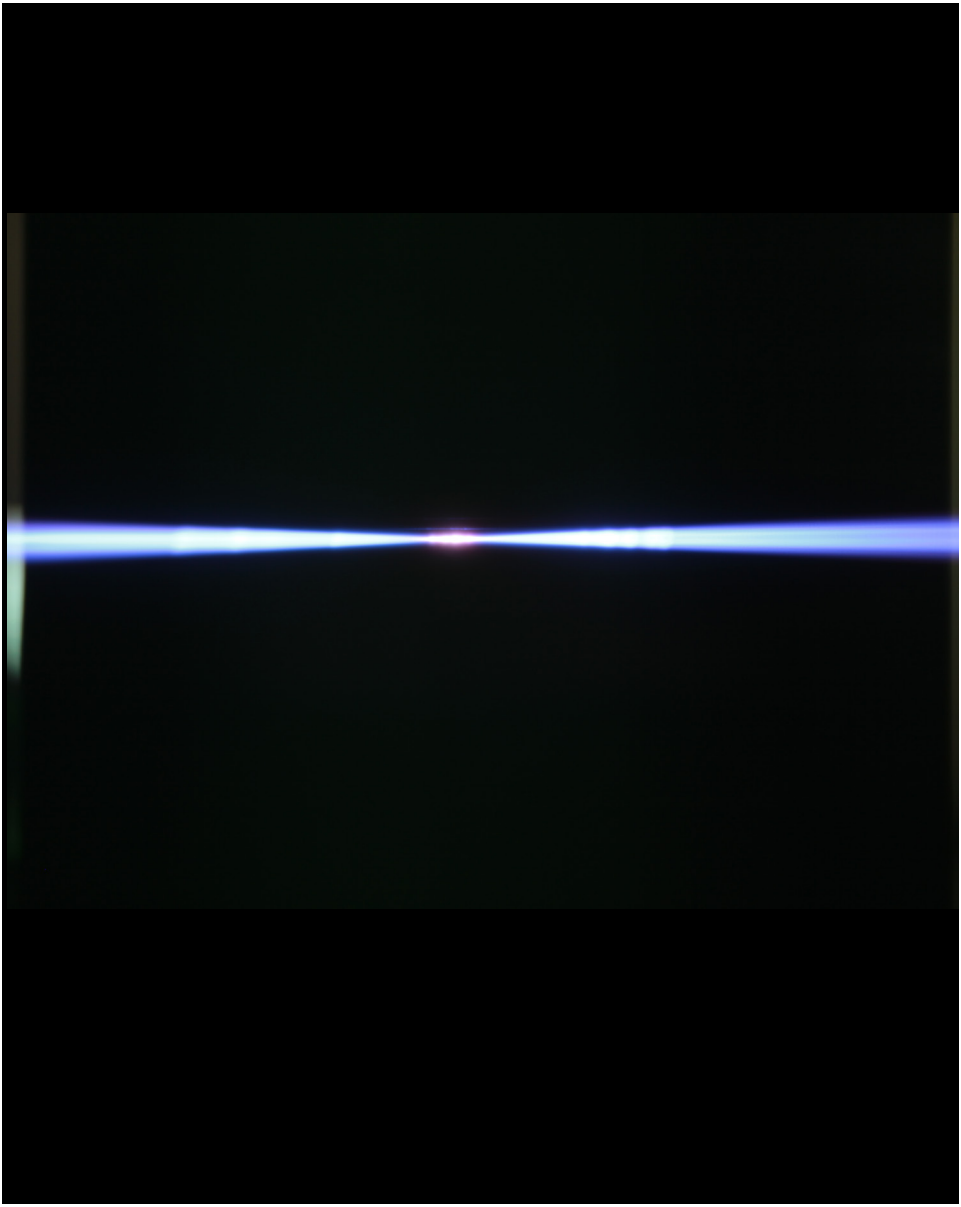
The above pie-charts show that the Centre has reached important percentages regarding its visibility in the audiovisual media, since there is not always sufficient informative power available to find a niche there. These figures indicate that there has been an increase in the appreciation of the Centre as an element of social interest. Fruit of this is the increase in the presence of the CLPU in the digital press as compared with traditional newscasting such that, as seen in the charts, the numbers are almost the same. In previous years, a conventional newspaper, whose chief representative was the “Gaceta de Salamanca”, was almost the only medium to reflect news relating to the CLPU, offering spaces ranging from half a column to reports of 2 or 3 pages in length. From this it may be concluded that along its evolution the Pulsed Laser Centre has gradually been expanding the sphere of its impact, a crucial issue even though all this took place before the installation of VEGA. It should not be forgotten that, as an ICTS, the CLPU always considers its domestic nature in its international outreach, and this is how it should be considered at communications level.

Finally, note that the CLPU continues to publish its own news bulletins: the CLPU bulletin, which is sent out every three months and informs about the most important events at the Centre, and also the European Research News, with the main European news of interest to researchers.

Photographs from the image bank of the Spanish Pulsed Lasers Centre (credits to photographers):

Front conver	Íñigo J. Sola
Pag. 4	Carolina Romero
Pag. 11-12	Yaiza Cortés
Pag. 13	CLPU
Pag. 15	Carolina Romero
(up-down)	Yaiza Cortés
	Álvaro Peralta
Pag. 16	Íñigo J. Sola
Pag. 18-19	Yaiza Cortés
Pag. 24	Yaiza Cortés
Pag. 33	Yaiza Cortés
(left-right)	Yaiza Cortés
	Javier R. Vázquez de Aldana
Pag. 56	Ricardo Torres
Pag. 57-58	Yaiza Cortés
Pag. 66	Álvaro Peralta
Pag. 72	CLPU
Pag. 73/87	Yaiza Cortés
Back cover	Íñigo J. Sola





CLPU CENTRO DE LÁSERES PULSADOS