LASERLAB-EUROPE

The Integrated Initiative of European Laser Research Infrastructures IV

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Work package 5 – Training and Development of User Communities

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Final Report on “User Training Schools”

Lead Beneficiary: 11 – ILC

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Deliverable Type	
R = Report DEM = Demonstrator, pilot, prototype, plan designs DEC = Websites, patents filing, press & media actions, videos, etc. OTHER = Software, technical diagram, etc.	R
Dissemination Level	
PU = Public, fully open, e.g. web CO = Confidential, restricted under conditions set out in Model Grant Agreement CI = Classified, information as referred to in Commission Decision 2001/844/EC	PU

1 Introduction

The training of new generations of future users is considered as one of the main tasks of Laserlab-Europe. The objectives of Work Package 5 “Training and Development of User Communities” are:

- Train a new generation of researchers and technical staff to enable them to make optimum use of laser facilities, to exploit new experimental and theoretical approaches in photonics and laser-related science and to use them in novel applications with high industrial and societal impact;
- Develop new laser user communities in domains of science such as bio photonics, medicine, pharmacy, ICT, material research, environment, in industry, and in European regions where laser user communities are still less developed;
- Increase efficiency in these activities through cooperation with externally funded activities, aiming at a similar development of human resources, and in close collaboration with other European facilities, networks, projects and industry, such as FELs of Europe, ELI, EuroBioImaging, Photonics21, EOS, etc.

2 Objectives of Task 1

In order to make optimum use of the potential and opportunities of Laserlab-Europe’s access programme, dedicated activities are pursued to train new users from scientific communities with little experience in laser research, but with high socio-economic potential such as (bio)material analyses, (bio)medical diagnosis and treatment, communication and data processing, or new emerging interdisciplinary fields like nano/biophotonics, nano/biotechnology, etc. Training schools focus on specific topics and provide hands-on training in experimental techniques on research installations in laboratories.

Lead partner: ILC

3 Laserlab-Europe Training Schools

For the selection of Laserlab-Europe user training schools, the Networking Board has developed a procedure based on calls for proposals, issued once a year. Selection is made by the Networking Board. From the proposals submitted to the two calls for 2018 and 2019, the following training schools were selected and organised:

Training Workshop on Time-Resolved Techniques (TReT), 20-22 June 2018, Vestec/Prague, Czech Republic

The Training School on Time-Resolved Techniques (TReT) was organised jointly by the International Laser Centre (ILC), Bratislava, and BIOCEV - Biotechnoloy and Biomedicine Centre of Academy of Sciences and Charles University, in the framework of the Laserlab-Europe User Community Training schools.

Background

After successful workshops on Time-correlated single photon counting techniques held at BioCev in 2016 and 2017, the new format organized together with ILC under the framework of Laserlab Europe was designed. For the first time of the infrastructure existence we invoked collaboration between BioCEV and ELI Beamlines (Dolni Brezany are in very close vicinity to Vestec) with tight connections to EuroBioImaging since ILC and BioCev are both partners in this pan-European ESFRI project.

Training goals and topics

The workshop was focused at the promotion of time-resolved technologies and their applications in medicine, biology, chemistry, material and sensoric sciences, with focus given

particularly at time-resolved spectroscopy, imaging, advanced microscopy and tomography, as well as data analysis and practical implementations. In practical training we used extensive instrumental infrastructure for time-resolved imaging and spectroscopy available at BioCev and ELI Beamlines.

Time-resolved technologies are emerging, highly sensitive methods that have revolutionized biomedical research, e.g. in the fields of non-invasive multi-modal fluorescence recordings, multi-photon microscopy and tomography. Time-resolved techniques also invoked many applications in material sciences, sensorics and others technical disciplines. Various approaches, such as fluorescence lifetime imaging (FLIM), phosphorescence lifetime imaging (PLIM), Foster resonance energy transfer (FRET), time-resolved spectroscopy (TRES) and others were discussed and practically demonstrated during the TReT workshop.

Audience

Students, engineers, researchers, companies

Objectives of the workshop were:

- To attract new European users and train a new generation of researchers to employ time-resolved technologies in their professional studies
- To gather the general basics on concepts of time-resolution in biomedical photonics applications, including time-resolved spectroscopy and imaging, multiphoton microscopy and optical coherent tomography
- To aquire an overview on the state-of the art of time-resolved technologies and their applications in medicine, biology, chemistry and materials sciences.
- To learn how to design optical experiment, how to employ appropriate laser light sources for time-resolved techniques, as well as to comprehend how to record and analyze complex data
- To build a network of new potential users within the European laser community, to exchange knowledge among participants and initiate collaborations.

Results

The workshop put together an interesting international group of more than 20 students, scientists and professionals, who participated in a Laserlab Training School for the first time. The workshop featured 3 main blocks and hands-on training sessions. Block I - Introduction to time-resolved spectroscopy and imaging - gave basic introduction to modern time-resolved detection techniques and their applications. Block II on Time-resolved technologies in biology, medicine and chemistry was focused on various applications. Block III introduced analysis of complex data, time-resolved and multi-modal imaging. In addition to these main theoretical blocks, hands-on sessions provided users with direct work on imaging and spectroscopy instrumentation. A round-table "Careers in light-based technologies" has been organized as an open platform for discussion of users, speakers, infrastructure and company representatives. Detailed program of the Workshop is attached at the end of this document.

Hands-on exercises:

1. FLCS / Importance of proper timing in STED microscopy
2. FLIM-FRET / Lipid membrane order sensing by Laurdan
3. NAD(P)H quantification in live cells / Autofluorescence of plants and algae
4. FLIM data analysis
5. External visit to ELI Beamlines – spectroscopy lab

Statistics:

Number of participants (users): 22, including 3 industrial users

Number of speakers: 13, including 4 representatives from 3 companies

Countries represented: 6 - Czech Republic, Slovakia, Romania, Portugal, Germany, Russia

Supported by:

The TReT Workshop was supported by in-kind contribution of:

- Student Chapter of SPIE, International Laser Centre, Bratislava
- Becker-Hickl, GmbH Berlin
- Carl Zeiss sro, Praha
- Pragolab sro, Praha

Feedback from the participants

User questionnaire was distributed to the participants who evaluated the event and its organization positively. Users acknowledged well organized event, good lectures and discussion opportunities. Suggestions for the future Users' training events was more time for hands-on training exercises and optimal duration between 3 days - 1 week; with overall interest for future training.

Laserlab involvement and benefit

Laserlab-Europe access opportunities have been described to all participants in the form of a lecture "Laserlab Europe overview - concepts and working modes". Thanks to Laserlab-Europe support, we utilized an opportunity to get together experts and professionals in the field of laser physics, time-resolved detection and biomedical research from leading pan-European infrastructures. Broad range of expertise present in Laserlab Europe network, together with ELI and BIOCEV was a key factor to successful implementation of the workshop. We also highly appreciated good location and high standard of local services.

One of the most important outcomes of the TReT workshop was related to collaboration with industry. We appreciated support from representatives of industrial sector (namely manufacturers and distributors of systems for time-resolved detection, involving 4 lecturers from 3 companies), as well as the interest from the industrial sector to delegate users of the workshop (3 representatives of 2 companies).

Participants in the lectures and hands-on training

Laser Plasma Summer School at CLPU, 17-21 September 2018, Salamanca, Spain

The first Laser Plasma Summer School (LaPlaSS) has been organised by the Centro de Laser Pulsados (CLPU) and the University of Salamanca (USAL) during the third week of September 2018 at the USAL Scientific Park of Salamanca where CLPU is located.

The school was organised for 5 days from Monday to Friday with theoretical sections in the morning, experimental activities and a visit of the VEGA system in the afternoon.

25 Undergraduate and graduate students (13 male and 12 female) from the EU and abroad attended the school, namely from Greece (4), Poland (2), Germany (2), Mexico (3), Hungary (2), Ukraine (3), Romania (3), Scotland (1), Italy (2), Japan (1), Spain (2). The main goal was to train a new generation of researchers from Spain and from the EU to enable them to make optimum use of laser facilities, in novel applications. The estimated cost exceeded the funding through the project and the difference was provided by CLPU with an in-kind contribution.

The topic of the school was focused on the diagnostic methods for HRR high power systems and lecturers from EU and abroad contributed to the school.

The school started Monday 17/09 with a formal inauguration from the Director of the physics department of University of Salamanca Jose Miguel Roco, the Director of the CLPU Luis Roso, the manager of CLPU Pedro Garcia and the director of the School Luca Volpe (see fig.1). Luca Volpe gave a first introductory lecture on diagnostic techniques for HRR high power systems (see fig2).

All lectures of the school were prepared with a basic introductory part to account for the different levels and degrees of the students' formations. Each professor of the school was having three hours to develop his topic, distinguishing the school from a conference.

The most relevant topics have been discussed to give a homogeneous overview of the status of the art of plasma and particle diagnostic techniques. Plasma temperature and density measurement techniques, charged particle beams detectors and measurements, spatial and temporal resolved as well as high rep rate acquisition techniques have been extensively discussed.

Experimental activities have been organised and totally supported by the CLPU team. Two relevant topics have been developed:

i) the measurement of Plasma density by interferometry techniques and ii) the fast phenomena measurement by streak techniques. The plasma density laboratory was organised in a satellite laboratory of CLPU with an underdense conventional gas jet, and the main parameters and problems related to the interferometry measurements have been discussed interacting with the students that were also able to manipulate and modify the main parameters. The second experience was performed by a private company, Optronics, that prepared a demonstration of the main working mechanisms of a sup-ps (~ 1-5 ps) time resolved streak camera working in the optical domain. This experience was performed in the VEGA 2 target area where the duration of the stretched VEGA 2 pulses was measured (see fig.3 and fig.4).

Two poster sessions have been organised to increase the level of student participation and considering that most of the PhD students are already involved in some laboratories. Each of the poster sessions was organised in the afternoon from 16.00 to 18.00 with all the school professors involved in evaluating the posters. At the end three of the total 19 posters were awarded with a prize of 100 € each (fig.6). The Poster prizes were sponsored and financially supported through the scientific journal Applied Science (see fig.5).

The organization of the school was designed in order to preserve a given amount of common "time spaces" to favour as much as possible interchanges between students and between teachers and students. In addition, the time schedule was organised not too tight and with

many breaks to reduce the level of organizational stress and to leave the final focus to the contents more then on the time schedule itself.

Final exams:

A final exam has been arranged in order to evaluate the level of knowledge transfer during the school. The exam was in form of multiple choices with on average one question per hour of lesson. The results of the exam are excellent showing an overall good performance of the training school.

Students' Satisfaction Questionnaire:

A final satisfaction questionnaire has been distributed to the students to better evaluate the training school performance and prepare an improvement strategy according to the questionnaire result. The questionnaire has been prepared by our collaborator from the knowledge society group at the University of Salamanca which also made the final collection and analysis of the results.

The school was sponsored by Photon lines Company offering training on the topic of the analysis of fast phenomena by means of imaging in the time domain covering from picosecond to millisecond. An introduction to the specific constraints of image acquisition was proposed, as well as a presentation of the existing means and their implementation. Eye-motion real-time image processing platform were introduced. Photon lines Company was offering also to bring one of the experts from detection, streak or x-ray imaging.

Applied Science Journal contributed 3 prizes (100 € x 3 = 300 €) for the poster session competition. The Scientific Park of Salamanca supported the school by providing the infrastructure for the class for the students. CLPU supported the school by providing teachers from the internal team, teaching material and by covering meals expenses for students and professors.

Fig1: Inauguration of LaPlaSS

Fig2: First Introduction

Fig3: Streak camera lab

Fig4: Gas jet interferometry lab

Fig5: Poster session

Fig6: Poster prize

Laserlab Training school in luminescence dynamics: analysing relaxation processes, 10-12 April 2019, Riga, Latvia

- Brief description of the training goals and topics and the targeted audience:

Training goals:

- Familiarizing participants with the basic design of a table-top confocal microscope
- Acquiring basic concepts involved in designing a synchronized, pulsed experiment
- Demonstrating how efficient experiment and code design can increase the sensitivity of an experimental apparatus
- Introducing participants to excitation spectroscopy by performing measurements at low (~ 15 K) and room temperature
- Demonstrating time resolved luminescence spectroscopy under direct and up-conversion excitation
- Bringing together young scientists specialising in laser physics and promoting new possibilities of cooperation under the auspices of Laserlab network
- Providing practical information about the network and opportunities to get involved

Topics: The training school focussed on studying fluorescent defects and their practical applications both as light sources and quantum probes. Particular attention was given to the study of magnetic and optical relaxation processes and what information about the material can be obtained thereby.

The targeted audience was students / engineers and laboratory operators / young researchers

- Training format and schedule:

Synergy: Based on the previous experience, the training school was organized in collaboration with the annual Developments in Optics and Communications (DOC) conference for young scientists, and Laserlab IV Networking activities were actively supported by the local student chapters of the Optical Society of America (OSA) and SPIE. This combined format yielded excellent results in 2010 and 2014. Therefore, we took advantage of the synergy between these two events again in 2019. The conference, open to all Training School participants, took place on April 11-12 and featured six invited talks and 17 contributed talks plus posters in the fields of laser physics and spectroscopy, optics in communication, optical materials and phenomena, biophotonics, and vision science.

The training format: The training school was run in parallel with the DOC conference. All experiments were available both days based on participant interest and availability. Efforts were made to accommodate all participants' first choices. Many also chose to participate in a second or even a third experiment. The schedules were adjusted so that as far as possible, the experiments took place during conference sessions less directly related to the experiment. Experiments on nitrogen-vacancy (NV) centres in diamond at UL Laser Centre

at Jelgavas Street 3. The time-resolved fluorescence studies of human skin took place at the Institute of Atomic Physics and Spectroscopy at Jelgavas Street 3 in Riga. The studies of rare-earth doped materials took place at the Institute of Solid State Physics UL in the Kengarags neighbourhood of Riga.

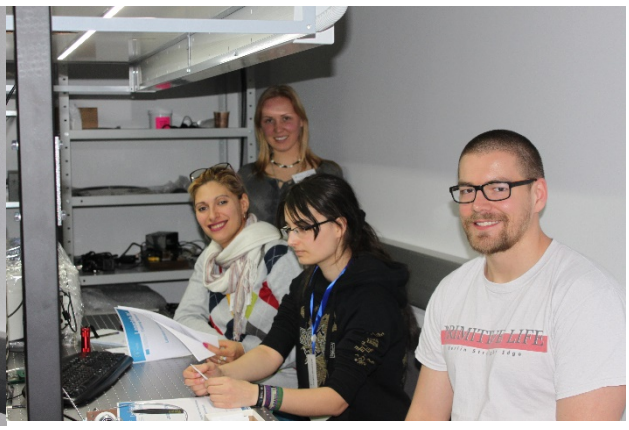
Participants: Altogether 20 students participated in the training school. Many of them also attended some of the conference sessions and participated in networking events together with the conference participants.

Registration Table

Guided tour of the new building at Jelgavas Street 3.

Organisational meeting

Participants explore NV centres.



Time-of-flight spectroscopy exercise.

DOC Conference

Brief description and statistics

The event comprised a large and very international group of young scientists, who participated in the Laserlab VI Training School for Potential Users. The training school was organized in collaboration with the tenth annual Developments in Optics and Communications (DOC) conference for young scientists, and Laserlab VI Networking activities were actively supported by the local student chapters of the Optical Society of America (OSA) and SPIE. This combined format had been tried first in 2010 and 2014 with good results, so it was logical to take advantage of the synergy between the two events again in 2019.

Statistics:

- Total number of participants 81
- Participants in the Laserlab laboratory work 20
- Countries represented by conference and training school participants – 10 (Lithuania, Latvia, Russia, Belarus, Ireland, Poland, Greece, Romania, Germany, and Sweden).
- Institutes hosting the laboratory exercises:
    - University of Latvia Laser Centre
    - Institute of Atomic Physics and Spectroscopy, Biophotonics Laboratory
    - University of Latvia Institute for Solid State Physics
- Laboratory exercises:
    - “Relaxation measurements in nitrogen-vacancy (NV) centres in diamond” (LU Laser Centre)
    - “Propagation time of photons through tissues (photon time-of-flight)” (Institute of Atomic Physics and Spectroscopy)
    - ”Time-resolved luminescence spectroscopy under direct and up-conversion excitation” (LU Institute for Solid State Physics)
    - “Luminescence excitation spectra and up-conversion luminescence measurements: what’s common and what different” (LU Institute for Solid State Physics)
- Presenters and topics of invited talks:
    - Prof. Stefan Anderson-Engels (Lund University, Sweden), “Development of monitoring of infant lung function based on NIR infrared spectroscopy of oxygen gas and water vapour”
    - Dr. Dmitrijs Bliznuks (Riga Technical University, Latvia), “Non-contact skin cancer diagnostic system: Results and challenges running cloud based diagnostics”
    - M.Sc. Arturs Bundulis (Institute of Solid State Physics, Latvia), “Asymmetrical all-organic waveguide gas sensor”
    - M. Sc. Tatjana Pladere, “Imaging the eye: structure, function and window to the body”
    - Prof. Antonio M. Morgado (University of Coimbra, Portugal), “Femtosecond pulses in micromachining of transparent materials"

  - o Dr. Kristina Fomina (Latvian American Eye Center, Latvia), “Glaucoma: diagnosis and treatment options”
- Overall conference statistics:

  The conference featured 6 invited talks and 17 contributed talks in addition to posters in the fields of laser physics and spectroscopy, optics in communication, optical materials and phenomena, biophotonics, and vision science.

- Publicity

  4 press releases

In the afternoons of April 10 and 11 laboratory exercises were offered at three locations.

The Laser Centre of the University of Latvia, located at the Faculty for Physics and Mathematics in its new location at Jelgavas Street 3, offered a session on nitrogen vacancy (NV) centres in synthetic diamond. These have a triplet ground state (s=1) that can be pumped optically into the ms=0 state. The ms=±1 state can be split by applying a magnetic field, and the system can be manipulated by pulses of laser radiation and microwaves. The participants observed Rabi oscillations between the ms=0 and ms=1 states, and to measure the spin-lattice decay constant (T1 time).

At the Institute for Solid State Physics, students had the opportunity to perform luminescence kinetic measurements under direct excitation, when excitation radiation photon energy is greater than luminescence photon energy, and under up-conversion excitation, when excitation radiation photon energy is smaller than luminescence photon energy. The second process is possible due to excited state absorption of several excitation photons or/and energy transfer between excited ions.

Luminescence kinetics were measured with two different devices: iCCD camera and photomultiplier tube. Students will be able to compare pros and cons for those two devices.

To obtain luminescence kinetics, students had to position sample in sample holder and adjust all optical components to obtain optimal signal intensity. After the experiments students compared:

- the luminescence decay kinetics measured by iCCD camera and photomultiplier tube
- the luminescence decay for direct excitation and up-conversion excitation and calculate the luminescence decay time and excited level lifetime.

In another exercise, participants were offered the opportunity to perform up-conversion luminescence spectra of Er^{3+} in different host materials and using different excitation techniques. This rare earth element is important in telecommunications applications where it appears in the erbium doped fibre amplifier. Time resolved luminescence spectra yield insights into the relaxation processes and luminescence mechanisms. Participants learned how to prepare the sample, adjust the apparatus, and optimize the signals.

The main goal of these laboratory works was to give students first concepts, knowledge and practical skills in time resolved spectroscopy. In the end students gained a general understanding about luminescence kinetics measuring processes, luminescence decay and excited state lifetime. Students learned to perform basic luminescence kinetics measurements and analyse the obtained results.

The Biophotonics Laboratory of the Institute of Atomic Physics and Spectroscopy, now also located at Jelgavas Street 3, offered to implement the measurements of the propagation time of light pulses through tissues. An optical fibre conducted laser radiation to the skin and collected fluorescence light. The skin could be excited with picosecond pulses (60 ps half-width) to measure pulse propagation times. Analysis of the propagation times can distinguish between malignant and benign skin lesions.

- Event assessment by participants: survey results

From the evaluation of the survey, one can see that in general, the students considered the event to be well organised and useful for networking. Future events might consider giving more attention to the actual content of the exercises and to the background of the participants so that the learning experience for new insights both inside and outside each participant's main laser physics specialisation is better.

Laser Plasma Summer School – LaPlaSS, 16-20 September 2019, Salamanca, Spain

The Second Laser Plasma Summer School (LaPlaSS) has been organised by the Spanish Center for Pulsed Lasers (CLPU) and the University of Salamanca (USAL) during the third week of September 2019 at the USAL Science Park of Salamanca where CLPU is placed.

The school was organised in five days from Monday to Friday with theoretical sessions in the morning, experimental activities and poster sessions in the afternoon. A full visit of the system VEGA has been organised, coupled with special presentations from the scientific team of CLPU. In addition a visit of the City has been organised the last afternoon.

The school was organised in three parts, called i) Theory, ii) Practice and iii) Exchange

i) Theory: 4 full mornings with 4 hours/day of lectures (16 hours)

ii) Practice: a series of 30 minutes talks from CLPU team members related to diagnostics and targetry techniques and two afternoons of laboratory training

iii) Exchange: 2 poster sessions with short presentation of the topics and final discussion

20 Undergraduate and Graduate Students (~ 50% male and females) from EU and abroad attended the school, in particular from Spain (6), Serbia (1), Germany (3), Hungary (1), UK (3), Romania (2), Italy (2), Argentina (1) and USA (1). The main goal was to train a new generation of researchers to enable them to make optimum use of laser facilities in novel applications. The estimated cost exceeded the available funding from Laserlab-Europe and the difference was provided by CLPU as in-kind contribution.

The topic of the school focused on the Experimental methods for HRR High power systems, and lectures from speakers from the EU and abroad contributed to the school.

The school started on Monday 16/09 with a formal inauguration from:

- Ángela Fernández Curto, General Deputy Assistant Director of Major Scientific and Technological Infrastructures, Ministry of Science, Innovation and Universities.
- Blanca Ares González, General Director of Universities. Junta de Castilla y León
- Jose Miguel Roco Director of the physics department of University of Salamanca
- Luis Roso, Director of the CLPU
- Luca Volpe, Director of the Plasma USAL–CLPU Chair and Director of the School

Professor Luca Volpe gave a first introductory lecture on diagnostic techniques for HRR high power systems.

All lectures of the school started with a basic introductory part to account for the different levels and degrees of the students' formations. Each professor of the school was having from one to two three hours to develop his topic and to make the school different from a conference.

The most relevant topics were discussed to give a homogeneous overview of the status of the art of laser-plasma experimental techniques in the EU and abroad.

1. Overview of diagnostic techniques in Magnetic Confinement Fusion (D. Mazon) and Inertial Confinement fusion (A. Casener)

2. Overview of targetry problems in HRR systems and target fabrication (G. Schaumann)
3. Special diagnostic methods for ultra short and ultra high power laser pulses (G. Gatti L. Roso)
4. Ultra short laser pulse synchronization (Ursescu)
5. Laser-plasma applications (L. Volpe, C. Gutierez)
6. Numerical simulations for experimental results verifications (M. Touati, R. Florido)
7. ThZ radiation and disgnostics (Y. Meziani)
8. Fpulses and Diagnostic targetry for HRR system have been described by experts on the fields.

Also two poster sessions have been organised to increase the level of student participation and considering that most of the PhD students are already involved in some laboratories. Each of the poster sessions was organised in the afternoon from 16.00 to 18.00 with all the school professors involved in evaluating the posters. At the end two of the total 16 posters were awarded with a prize of 100 € each to be spent on books from Cambridge press. The Poster prizes were sponsored by the scientific journal “High Power Laser Science and Engineering”.

Programme

LaPlaSS Laser Plasma Summer School — Experimental methods for Laser-Plasma Physics

Time	Monday 16		Tuesday 17	Wed. 18	Thursday 19		Friday 20
9.15 – 9.30	Opening		Giancarlo Gatti	Ricardo Florido	Daniel Ursescu		Exams
9.30 – 10.15	Introduction to the School (Luca Volpe)						
10.15 – 11.15	Luca Volpe		Gabriel Schaumann	Carolina Gutiérrez	Michael Touati		Exams
11.15 – 11.45	Break		Break	Break	Break		Break
11.45 – 12.45	Didier Mazon		Alexis Casner	Subhendu Kahaly	Yahya M. Meziani		Questionaries
12.45 – 14.30	Lunch		Lunch	Lunch	Lunch		End of School
14.30 – 15.30	Luca Volpe		Alexis Casner	Luis Roso	José A. Pérez		
15:30 – ...	15:30 – 17:00	Snaptalks (30 min): M. de Marco J. Apiñaniz J.M. Álvarez	Poster Presentation P.1 –P.8 (10 min.)	Poster Presentation P.9 –P.17 (10 min.)	15:30 – 17:00	Snaptalks (30 min): J.L. Salgado M. Huault G. Zeraouli	*Departure*
	17:00 – 17:50	Visit CLPU	Poster Session (with coffee)	Poster Session (with coffee)	17:00 – 17:30	Poster Prizes	
18:30 – 19:30/20:00					Visit Salamanca *'Legends Tour'*		

Photos of the training event

University of Salamanca

Inauguration

Poster session

Lecture

Group picture in front of the CLPU building