LASERLAB-EUROPE

The Integrated Initiative of European Laser Research Infrastructures V

Grant Agreement number: 871124

Work package 4 – NA3 – Training and Development of User Communities

Deliverable D4.2
Final report on “User Training”

Lead Beneficiary: 13 – ILC

Due date: Month 60

Date of delivery: Month 60

Project webpage: www.laserlab-europe.eu

Deliverable Type		
R	Document, report	R
DEM	Demonstrator, pilot, prototype	
DEC	Websites, patent fillings, videos, etc.	
OTHER		
ETHICS	Ethics requirement	
ORDP	Open Research Data Pilot	
DATA	data sets, microdata, etc.	
Dissemination Level		
PU	Public, fully open, e.g. web	PU
CO	Confidential, restricted under conditions set out in Model Grant Agreement	

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement no. 871124.

1 Objectives

Engagement and stimulation of growth of future generations of users is one of the main tasks of Laserlab-Europe. This work package is dedicated to the development and coordination of user training activities as well as to the development of future user communities. The objectives are:

- to create a sustainable training platform for a new generation of researchers and technical staff, by increasing scientific excellence of the users in the field of photonics and laser-related research and its applications;
- to address professionals in geographic areas in Europe which display an under-representation of participation in the Laserlab-Europe access programme;
- to develop new laser user communities in domains of emerging and interdisciplinary science such as nano/biophotonics, ICT, materials research, biomedicine and biotechnology, environmental sciences, etc.;
- to create a virtual framework for information sharing related to education and training of users, exploiting available and newly developed multimedia content and e-learning materials.

Lead beneficiary: ILC

2 Task 1: User Training Schools

Task leader: ILC

The activity is focused on the development of a series of training schools with high quality standards, which shall provide a recognisable and sustainable Laserlab-Europe brand identifier, contribute to attract new users and build new generations of researchers and engineers. It addresses the optimum use of top-scale access-providing laser facilities and builds on past experience of Laserlab-Europe hands-on training activities in both advanced experimental techniques and theoretical approaches of data analysis. Following annual calls for proposals, the Laserlab-Europe user training schools are selected by the Networking Board.

As this activity was planned to be based on access to laboratories for hands-on training, it was significantly affected by the COVID-19 restrictions during the first two years of the project. Therefore, online training events have been tested and found suitable for specific topics, e.g. data analysis and computational modelling. Nevertheless, most training events after the end of the pandemic took place in person to allow for hands-on training in the lab, which met with huge demand from students and young scientists.

During the entire project, Laserlab-Europe organised 12 training events, three online and nine in person. In addition, bursaries were paid to young scientists to attend a summer school of relevance in particular for topics addressed in the JRA PRISES.

User Training Workshop on Data Analysis in Time-Resolved Imaging and Spectroscopy, 27 May 2021, online event

To cope with the COVID-19-related pandemic situation, a new format was designed in order to continue the user training activities. For the first time, a User Training Workshop on Data Analysis in Time-Resolved Imaging and Spectroscopy (TRIS) was organised fully online by the International Laser Centre of CSTI SR (ILC), Bratislava.

For details, see deliverable D4.1 Intermediate report on “User Training”

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement no. 871124.

Training event on "Modelling of ultra-intense laser propagation in plasmas and laser-plasma accelerators: fundamentals", 26-29 April 2022, online event

An online training event has been organized on "Modelling of ultra-intense laser propagation in plasmas and laser-plasma accelerators: fundamentals" on 26 to 29 April 2022, by Laserlab-Europe partner IST, Lisbon, Portugal, in close collaboration between the projects Laserlab-Europe and EURIZON.

The training event was dedicated to the fundamentals of computational modelling of intense laser pulse propagation in plasma, and applications to compact laser plasma based accelerators. Laser plasma accelerators are one of the most exciting applications of intense lasers, and computational modelling plays a critical role in the design and optimization of laser plasma accelerators.

The target group were PhD students, post-docs as well as researchers in laser-plasma interactions, with both experimental and theoretical backgrounds, aiming to develop their know-how on computational techniques commonly used in laser propagation in plasmas and intense laser-plasma interactions. In total 27 applications were received and accepted. Overall, 23 attendees actively participated throughout the full 4 days of the training. The majority of the participants were affiliated with Laserlab-Europe and ELI facilities, but also participants from other European laboratories, from Israel and a participant from the University of Khartoum, Sudan, took part. The group consisted of three Master students, 15 PhD students and 6 postdoctoral researchers. Six participants (25%) were female.

The event took place over the course of 4 days, with a 2 hour lecture per day where participants learned the basics of pulse propagation in plasma, the principles of state of the art laser-plasma computational tools, how to use these tools and perform data analysis. The computational tool that was used was the open-source ZPIC code (https://ricardo-fonseca.github.io/zpic/) developed by the instructors. ZPIC is a fully relativistic, electromagnetic particle-in-cell code that is specifically designed for plasma physics education. ZPIC builds on the state-of-the-art particle-in-cell OSIRIS, featuring all the main ingredients of that code, and allowing for use in a Jupyter (Python) notebook environment.

The PIC scheme is a standard tool in laser-plasma research today, and in particular in laser-plasma accelerators. Participants learned the fundamentals of the PIC algorithm, as well as basic skills in using these codes for their research and for laser-plasma/accelerator applications. Ideally participants were expected to have some experience/programming skills in C and Python but the training event could also be followed with beginners' expertise.

The lectures and hands-on sessions were entirely remote, with remote support/discussion over a Slack channel. Participants needed to have their own laptop or desktop computers and good internet connection. Instructions for software installation have been provided during class. Background and training material for each day was provided through the event's webpage.

User Training Workshop on Data Analysis in Charged Particle Imaging and Spectroscopy, 27-29 June 2022, online event

A training workshop on "Data Analysis in Charged Particle Imaging and Spectroscopy" has been organised in June 2022 by the University College London, United Kingdom, and the International Laser Centre of the Slovak Centre of Scientific and Technical Information, Slovakia, with support from Laserlab-Europe partners.

The three-day workshop consisted of online lectures, followed by sessions dedicated to hands-on training. Participants also had the opportunity to give a three-minute flash presentation on their own research. There were two hands-on training sessions with real experimental data provided by the workshop leaders that participants could access and use.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 871124.

The workshop focused on data analysis methods broadly in the area of spectroscopy and imaging with a focus on several charged particle imaging and spectroscopy methods (in particular time-resolved X-ray absorption and photoelectron spectroscopy, scattering and velocity map imaging). The goals were to introduce participants to some of the statistical considerations when evaluating data quality and data treatment options available, to think about integrating data management plans into their experimental planning and work, learn how to write proposals for facilities and deal specifically with the types of data obtained from the aforementioned techniques.

There were five main topics in the school

1) General introduction to signal capture and statistical analysis in experiments
2) Data management and analysis of big datasets (focusing on scattering)
3) Statistical methods for treating noisy datasets and machine learning methods
4) Experiment design and planning with a focus on facility work and free-electron laser experiments
5) Fundamentals and applications of velocity map imaging.

In addition to these lectures, hands-on sessions provided users with a chance to work with .hdf5 files – a commonly used data format for free-electron laser measurements – and velocity map imaging data.

One of the hands-on workshops was run as a group programming exercise using breakout rooms in Zoom to try and encourage engagement between participants, which overall worked well though it was challenging to balance the experience levels in the groups online. Both workshops made use of Jupyter notebooks and Python to give participants an awareness of relevant packages for data analysis

The workshop was restricted to 20 participants due to the hands-on training sessions and research presentation being an integrated part of the school. Participants came from 12 countries: Croatia, Czech Republic France, Germany, India, Israel, Japan, Netherlands, Slovenia, Spain, United Kingdom, Italy.

Lecture – Rebecca Ingle (UCL, UK)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 871124.

Training Weeks on Experimental Laser-Plasma Physics, 25 July - 5 August 2022 and 1-12 August 2022, Rutherford Appleton Laboratories, UK

The Central Laser Facility, based at the UK's Rutherford Appleton Laboratory provides a training platform for new PhD students to learn the key skills to participate in high power laser experiments. The event provides an opportunity to network with other students from across Europe whilst taking part in the training. The course covers the basic skills required for experimental laser-plasma physics – everything from optical alignment and target manufacturing through to setting up an experimental geometry, taking shots and analysing data.

With life getting back more to normal, the Central Laser Facility (CLF) once again hosted its training weeks program for new PhD students in summer 2022. Following the Covid pandemic the course saw a few changes in delivery but maintained the overall aim to train up inexperienced PhD students in the practical elements of fielding laser-plasma experiments. Twelve individual courses were held, each containing up to four students, with the last 2 courses, taking place from 25 July to 5 August and 1 to 12 August 2022, dedicated to attendees from the Laserlab-Europe and the EURIZON project.

Each two-week course was broken into two distinct weeks. Week 1 was dedicated towards the basic elements of experiments, covering a wide range of topics including:

- Basic optics and optomechanics
- Imaging systems
- Parabola alignment
- Spectrometers
- Particle diagnostics, e.g. Thomson Spectrometer, electron spectrometer, radiochromic film (RCF) pack design
- Optics handling
- Target fabrication

This first week ensured each student was provided with the knowledge required for the second week – bringing these skills into the laboratory for a mini-experiment. This took place in Vulcan's Target Area West (TAW) facility. The experimental week challenged the students to build an experiment from scratch, with only the primary beamline optics in place. The students checked the main beam alignment, built imaging lines to reference target position, optimised the focus and installed diagnostics including:

- Focal spot imaging camera
- Dual target reference imaging lines
- Active x-ray pinhole camera
- Passive x-ray pinhole camera
- Optical spectrometer
- Radiochromic film pack.

The groups were challenged in the experimental design and strategy, highlighting common issues and ways to avoid them. The CLF tutors guided the students through the best approach in building the experiment to avoid conflicts of diagnostics and tackling the everyday problems of space constraints, as well as organising themselves to optimise their work and record their work with good lab processes.

The second week finished with shots to target on thin foils to generate proton beams and basic analyses of their results. The group also had the opportunity to observe the impacts of electromagnetic pulses (EMP) on active diagnostics. The practical skills developed through the course were backed with development of "soft skills", encouraging good communication, teamwork and leadership, with regular catch-up sessions – key skills which form the basis for a successful experimental campaign.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 871124.

The second group started a week later than the first group and copied the program. By offsetting the start dates the groups had a week overlap to network and learn about what everyone is doing.

The participants in this year's training courses came from the UK, Romania, France, Sweden, Poland and Germany. The majority were 1st year and 2nd year PhD students, but also a number of industrial / non-academic attendees participated.

Images from the Experimental Laser-Plasma Physics course

Jyväskylä Summer School course on Ultrafast Spectroscopy, 7-11 August 2023, Jyväskylä, Finland

The 32nd edition of the Jyväskylä Summer School (JSS32, www.jyu.fi/jss) was organized on 7-18 August 2023 at the University of Jyväskylä (JYU), Finland. Local staff of the Laserlab-NSC (Nanoscience Center) organized a one-week course on 7-11 August entitled *"Ultrafast Spectroscopy: phenomena, experiments and data analysis methods*". The course was coordinated by Senior Lecturer Tatu Kumpulainen, University of Jyväskylä, Finland, and featured two expert lecturers, Prof. Eric Vauthey from University of Geneva, Switzerland, and Assoc. Prof. Jens Uhlig from Lund University, Sweden. In addition to the lectures, the course featured four workshops organized mostly by the local staff that were aimed at introducing the participants to the practical aspects of steady-state and time-resolved spectroscopies as well as the data analysis methods. The course schedule is summarized in Figure 1.

Time	Mon	Tue	Wed	Thu	Fri
9–10	Lecture 1 (EV)	Lecture 4 (EV)	Lecture 7 (EV)	Lecture 10 (JU)	Lecture 13 (JU)
10–11	Lecture 2 (EV)	Lecture 5 (EV)	Lecture 8 (JU)	Lecture 11 (JU)	Lecture 14 (JU)
11–12	Lecture 3 (EV)	Lecture 6 (EV)	Lecture 9 (JU)	Lecture 12 (JU)	Closing (TK)
12–13	Lunch	Lunch	Lunch	Lunch	Lunch
13–14	**Workshop 1** (steady-state / anisotropy decay)	**Workshop 2** (steady-state / anisotropy decay)	**Workshop 3** (fs-spectroscopy / data analysis)	**Workshop 4** (fs-spectroscopy / data analysis)	**Departure**
14–15					
15–16					
16–17					

Figure 1. The course schedule. Abbreviations indicate the lecturers Eric Vauthey (EV), Jens Uhlig (JU) and Tatu Kumpulainen (TK). Duration of all workshops was 3 h but multiple groups were staggered in the 4 h time slot to maintain small (8-9 participants) group sizes.

The aim of the course was to provide the participants with a good understanding of several photophysical and photochemical processes in organic molecules and transition metal complexes and how such processes are manifested in spectroscopic data with a particular focus on time-resolved femtosecond spectroscopies. The main processes covered were vibrational, rotational and solvent relaxation, intersystem crossing and energy and electron transfer. Several ultrafast techniques, including both optical (EV) and x-ray based (JU)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 871124.

methods, were introduced during the lectures along with case studies on each of the methods showing real experimental data together with data analysis and interpretation.

The workshops provided practical information on steady-state spectroscopy, TCSPC, broadband femtosecond spectroscopy (transient absorption and fluorescence) and global analysis of broadband data with KiMoPack (organized by Prof. Jens Uhlig). The experimental workshops included a brief introductory lecture on the working principles and experimental design followed by a hands-on measurement and data analysis demos. The steady-state workshop was organized in the format of an escape room, during which participants could bond in problem solving: finding the code to unlock the cuvettes necessary for the experiment; using a UV lamp to discover the molecular weight of the compound; and exploring the lab to find hidden clues as to the necessary equations and variables.

The course was targeted to MSc/PhD students and postdocs whose research was related to ultrafast spectroscopies. The aim was to provide a strong background for newcomers in the field but offer also an ample of in-depth information for more experienced participants. The course was advertised through several channels and received over 70 applications. Due to the in-person workshops, the number of participants was limited to 32. In the selection process, the benefit of the course to the applicants' career was evaluated and a balance between previous experience, gender and geographical origin of the selected applicants was maintained. In addition, only one person per research group was admitted to course. In the end, 33 applicants were selected for the course (+5 joining for lectures only) representing 15 different countries and a total of 19 different nationalities. Majority of the students were from reputable spectroscopy labs around the Europe. Backgrounds of the participants ranged from MSc students to experienced postdocs. Geographic and demographic distribution of the participants is presented in Figure 2.

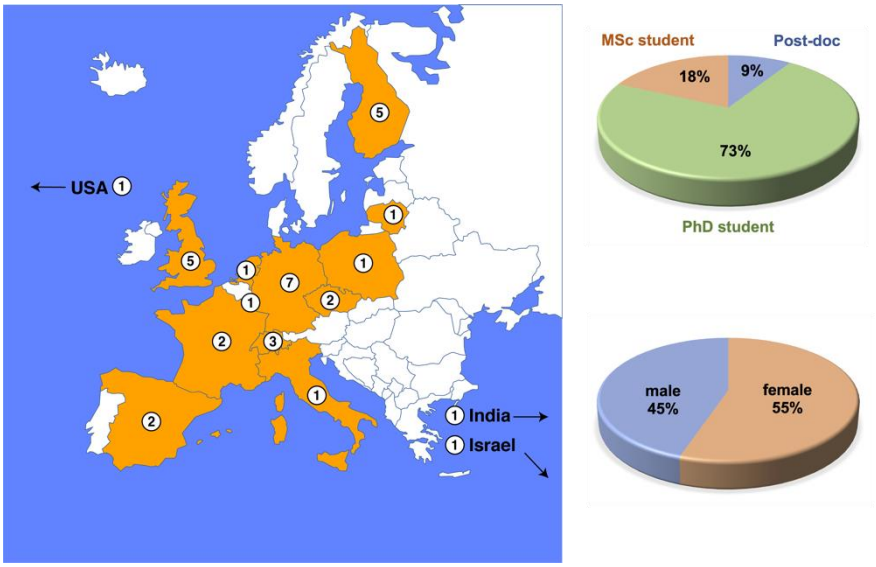


Figure 2. Geographic distribution of participants based on their home institutions. Number of participants from each country is represented by the number in the left figure. Distributions based on the experience and gender of the participants is given in the right figure.

The course was very well received by the participants. Out of the 17 respondents, 14 rated the course very good (5) and three good (4) with an average of 4.8 on a scale from 1 to 5. Half of the respondents found the difficulty of the course suitable and the other half found it demanding (40%) or very demanding (10%). The course met the expectations of 44% and exceeded the expectations of 28% of the respondents. Roughly half of respondents highlighted the lectures as the best part of the course while another half highlighted the workshops. The open comments were mostly positive giving compliments to the organization, lectures, and workshops. Few selected comments are highlighted below. Negative feedback focused on smaller individual aspects of the course.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 871124.

Figure 3. Group photo taken at the end of the summer school course.

CLF training weeks for high-power laser experiments, 4-15 and 11-22 September 2023, Rutherford Appleton Laboratories, UK

The CLF Training Weeks is a course designed to teach PhD students and early career researchers the fundamentals of conducting experiments using high-power laser systems, such as the CLF-based Vulcan and Gemini, as well as other such facilities around the world. We aim to provide students with the technical skills and knowledge required to conduct cutting-edge research.

Each course runs for two weeks, and students are taught in groups of 6. The course consists of a series of practical modules, which teach students a range of skills such as optical alignment, diagnostic setup and calibration, experimental best practice, and data analysis techniques. We also cover critical safety procedures to enable students to work safely with class 4 lasers, high-pressure gases, and vacuum systems, all of which are commonly encountered during high-power laser experiments.

The target audience for the CLF Training Weeks is students near the start of their PhD (i.e. 1st / 2nd year), however we offer training to those at any stage of their PhD, and to early stage postdoctoral researchers who require it. The 2023 edition of the course has been organised on behalf of the projects EURIZON and Laserlab-Europe.

In 2023, we had 20 applications for training from institutions in the Czech Republic, France, Germany, Poland, Portugal, Romania, Spain, Sweden, Ukraine. Twelve participants were chosen, but unfortunately, two of the students from Ukraine withdrew their applications at short notice (one cited issues obtaining a visa in time). Due to the short notice, it was not possible to fill remaining slots. Therefore, there were 10 participants in total, 3 female and 7 male.

The course starts with a safety briefing, followed by a lecture on optics used in high power laser experiments. This lecture is designed to extend the students' existing knowledge of optics from university into a more experimental context. Key topics include, focussing properties of optical elements, optical materials and coatings, aberrations, and nonlinear effects, all of which are important considerations in any experiment involving lasers.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 871124.

This is followed by a series of motivating lectures on the scientific applications, and some of the key challenges, associated with high repetition-rate laser facilities.

In the practical sessions, students are given hands-on training in a variety of techniques which are essential for conducting successful experiments. These sessions were conducted in one of several lab spaces within the facility. The general format is an introductory demonstration by a CLF staff member, followed by a series of problem-solving tasks to be completed by the students. Each session is prepared and tested prior to the start of the course to ensure the students attain the maximum benefit.

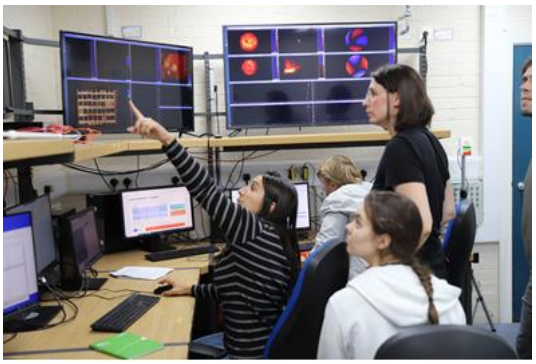
The focus of the course is a short experimental practical in one of our target areas, Gemini TA2, where the students participate in a short, but realistic experimental campaign to optimise an X-ray source produced from a laser interaction with copper. The experiment was designed at the CLF and gives the students the opportunity to guide the experimental process, ultimately collecting sets of data from various diagnostics which they can analyse during the data analysis sessions.

The practical sessions for this year were as follows:

Optics handling	Teaches the correct approach for handling large and delicate optics in order to prevent damage, as well as techniques for inspecting and cleaning optical elements.
Optics & Optomechanics	Students learn the basic techniques of optical alignment, including how to build rudimentary imaging systems using optical components.
Parabola Optimisation	Principles of alignment and optimisation of parabolic mirrors used to focus lasers to high intensity.
Adaptive Optics	Measurement and mitigation of wavefront aberrations. Adaptive optics are used to reduce aberrations and improve focal spot quality.
Beam Timing	Techniques used to temporally overlap laser pulses to femtosecond precision.
Particle and X-ray diagnostics	Students learn about the types of diagnostics used to detect particle and X-ray emission, as well as techniques for calibration and analysis.
Simulations and High-Performance Computing	An overview of the simulation techniques used to complement experimental campaigns. Students are also introduced to high-performance computing using our on-site computing cluster, SCARF.
Experimental Practical	Students spend two days in one of our laser target areas and learn how to set up an experiment and collect data at high-repetition rate. The students conduct a basic laser-solid experiment to produce hard X-rays from copper tape.
Data Analysis Techniques	A three-day workshop on basic analysis techniques using Python, during which the students analyse the data collected from their experiment.

On the final day of the course, the students give a short presentation on the results of their experiment to an audience comprised of CLF staff. Following the presentation there is a question-and-answer session to allow further discussion of the results.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 871124.

Images from the CLF training weeks

Training Course on Intense Lasers, 16-20 October 2023, Talence (Bordeaux), France

The PYLA training center provides training courses in the field of lasers, optics and photonics since 2005. Located within the Institute of Optics of Aquitaine, the PYLA training center has premises entirely dedicated to the organization of training courses for professionals, including 500sqm of labwork facilities.

This 5-day training course on intense lasers, organised jointly by Laserlab-Europe and the EURIZON project, provides participants with the necessary skills to design and efficiently use intense laser systems. The course addresses the theoretical background as well as practice and lab work including computation and simulations, covering laser architecture; laser sources (oscillators); amplification, beam handling and focusing; non-linear optics: frequency conversion and laser tenability; laser diagnostics and beam management; and labs-simulations and codes. The course consists of 12 sessions of tutorials or lab works by more than ten expert trainers in the field.

Attendance is limited to 12 participants. A call for applications was published on the webpages of Laserlab-Europe and EURIZON and distributed through several email distribution lists.

In total, 32 candidates from all over Europe applied, of which 25 male and 7 female. Applicants were selected according to their level of training with respect to the contents of the course to allow successful participation in the high-level course. In addition, the aim was to include applicants from different institutions. Twelve participants were chosen from the applications, three female and nine male, coming from Austria, Czech Republic, France, Germany, Hungary, Italy, Spain, Sweden, UK

The training course instructors and coaches for the hands-on sessions are experts from universities, laboratories and partner companies, mainly in the Bordeaux area.

In their feedback, the participants unanimously appreciated the quality and high standard of the course regarding topics, the state-of-the-art experience of the experts, as well as the good ratio of theory and practice.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 871124.

Schedule – Sessions

LASER INTENSES TRAINING COURSE, 16 Oct; - 20 Oct. 2023, Talence
PYLA TRAINING CENTER– Bordeaux France

SCHEDULE

PYLA TRAINING CENTER – Laser, Optics, Photonics RF & Microwaves

	Monday 16/10/2023		Tuesday 17/10/2023		Wednesday 18/10/2023
	LASER ARCHITECTURE		NON LINEAR OPTICS		LASER SOURCE (OSCILLATORS)
09:00	**WELCOME 9h00 - 9h15** **LASER BEAMS - 9h15 - 10h45** **Physical quantities** - Wavelength - Power, Energy, Fluence, Intensity, Brightness - Peak power, average power **Linear propagation:** - Complex electric field - Time-frequency duality - Spatial modes - Beam quality M^2, wavefront	09:00	**BASICS OF NON LINEAR OPTICS 9h00 - 10h00** Concept and definition - conservation laws, phase matching, $\chi 2$,$\chi 3$ **NON LINEAR OPTICS APPLICATION 10h00-10h45** Frequency conversion and parametric sources Crystal with $\chi 2$	09:00	**9h00 – 11h00 OSCILLATOR PRINCIPLES** Laser operation: CW, Q-switch, mode-locking (active, passive) Cavities and gain mediua (3 et 4 levels) Optical pumping (Laser de pompe, diodes lasers) **FEMTOSECOND SOLID-STATE OSCILLATORS** Gain media for modelocking Modelocked sources (Picoseconde Femtoseconde, Non linearisés/dispersion, performances/state of the art)
10:45	BREAK - 10h45 - 11h00	10:45	BREAK - 10h45 - 11h00	11:00	BREAK - 11h - 11h15
11:00	**LASER ARCHITECTURE - 11h00 - 12h30** **Hih intensity lasers** Components: Oscillator, pulse picker, amplifiers, compressor, beam shaping, ,... Specific architectures (ns, ps, fs, CPA, OPA) **Related issues:** Damage , Thermal, Propagation (Linear, Non-lineaire, Kerr/Brillouin/Raman), ...		**NON LINEAR PROPAGATION - 11h00 - 12h30** Impact in the spectral/temporal domain Impact in the spatial domain Self focusing, SPM, SRS, AM-FM, SBS, cascaded processes,, B- integral, ...		AMPLIFICATION **SOLID STATE AMPLIFICATION - 11h15 - 12h30** Optical Pumping, Single and multipass amplifier (illustrationNd:glass)
12:30	LUNCH 12h30 - 13h30	12:30	LUNCH 12h30 - 13h30	12:30	LUNCH 12h30 - 13h30
13:30	**LABWORKS 13h30 - 17h00** **Rotation - 4 groups 3 Pers., 50' /TP** Fibre injection, Helium - Neon Cavity, VR Alignement / telescope / parabola, Basic metrology (Power, energy, spectrum)	13:30	**LABWORKS 13h30 - 17h00** **Rotation - 4 groups 3 Pers., 50' /TP** Frequency doubling, Raman. , S-pulse HR, super continuum, SNLO, designing and selecting non-linear cristal for frequency conversion, OPA, OPO, SPM, dispersion, solitons in fibres (Fiberdesk, GNLSE code Python)	13:30	**AMPLIFICATION (suite) - 13h30 - 15h30** Regenerative amplifier (illustration with Ti :Sapph) Chirped pulse amplification Constraints **+ TUTORIAL** BREAK - 15h30 - 15h45 **FIBER OSCILLATORS 15h45 - 17h00** Waveguide and fibers , gain media femto secondes fiber Oscillators
17:30	Feedback and round table	17:30	Feedback and round table	17:30	Feedback and round table

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 871124.

LASER INTENSES TRAINING COURSE, 16 Oct; - 20 Oct. 2023, Talence
PYLA TRAINING CENTER– Bordeaux France

SCHEDULE

	Thursday 19/10/2023		Friday 20/10/2023
	AMPLIFICATION (continuation)		**LASER DIAGNOSTICS ET BEAM SHAPING**
09:00	**FIBER AMPLIFIERS - 9h00 - 10h00** Er, Yb, Quasi 2 ou quasi 3 level Design, geometry Specific constraints Performances / State of the art	09:00	**DIAGNOSTICS - 9h00 - 10h00** Energy, power, spectrum Temporal characterization (Autoco, FROG, SPIDER,...) Spatial characterization, wavefront measurement (HASO, ...) M2, Strehl ratio, Encircled energy
10:00	BREAK - 10h00-10h15	10:00	**TEMPORAL AND SPECTRAL SHAPING - 10h - 11h00** Amplitude and phase Dazzler, SLM and zero dispersion line
11:00	**CONSTRAINTS - 10h15 - 11h45** Gain managment Damage Birefringence Environment Thermal issues Contrast (ASE, prepulse)	11:00	BREAK 11h00-11h15 **SPATIAL CONTROL - 11h15-12h00** Measurements Correction and protection techniques
12:00	**TUTORIAL** **11h45 - 12h30**	12:00	**TUTORIAL 12h - 12h45** Influence of the spectral phase on the pulse duration and diagnostics simulation (TF, autoco, FROG and SPIDER traces)
12:30	LUNCH 12h30 - 13h30	12:45	LUNCH 12h45- 13h30
13:30	**LABWORKS 13h30 - 17h00** **Rotation - 4 groups 3 Pers., 50' /TP** Neodyme:Glass Oscillator,Regen, S-Pulse, Fiber laser kit, Fiber amplifier	13:30	**LABWORKS 13h30 - 17h00** **Rotation - 4 groups 3 Pers., 50' /TP** Temporal measurement: commercial Autoco, FROG, Manual autoco, Spatial control and measure, Spatio-temporal measurement
17:30	<u>Feedback and round table</u>	17:30	<u>Feedback and round table/Evaluation</u>

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 871124.


Images from the PYLA training event

ALPHANOV-PYLA Training Course on Intense Lasers, 27-31 May 2024, Talence, France

Following the high demand for the first ALPHANOV PYLA training course, a second edition was organised in May 2024.

This 5-day training course on intense lasers, organised by Laserlab-Europe, provides participants with the necessary skills to design and efficiently use intense laser systems. The course addresses the theoretical background as well as practice and lab work including computation and simulations, covering laser architecture; laser sources (oscillators); non-linear optics: frequency conversion and laser tunability; laser diagnostics and beam management; amplification, beam handling and focusing; and lab simulations and codes. The course consists of 12 sessions of tutorials and lab works by 14 expert trainers in the field.

Attendance is limited to 12 participants. A call for applications was published on the Laserlab-Europe webpage and distributed through several email distribution lists.

In total, 59 candidates from 20 countries all over the world applied, of which 42 were male, 16 female and 1 did not want to say. Applicants were selected according to their level of training with respect to the contents of the course to allow successful participation in the high-level course. In addition, the aim was to include applicants from different institutions. Twelve participants were chosen from the applications, five female and seven male, coming from Czech Republic, Croatia, France, Germany, Hungary, Italy, Spain, Ukraine, UK

The training course instructors and coaches for the hands-on sessions are experts from universities, laboratories and partner companies, mainly in the Bordeaux area.

The feedback from the participants again was very positive regarding the quality and high standard of the course, the selection of topics, the state-of-the-art experience of the experts, as well as the good ratio of theory and practice.



Images from the 2024 ALPHANOV PYLA training event

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 871124.

Summer School on Hands-on Design of Metasurfaces for Ultrafast Lasers, 24-26 July 2024, Graz, Austria

The Summer School Hands-On Design of Metasurfaces for Ultrafast Laser Pulses was a great success. We received 33 applications and aimed for about 15 participants. In response to our invitations, we received 16 acceptances; unfortunately, Austria rejected the visas of 3 candidates despite invitation letters.

The remaining group consisted of 50% women and 50% men from Finland, Greece, Italy, Portugal, Scotland, Spain, Sweden, Ukraine, and Germany.

The participants learned in 6 lectures and 5 applied exercises about the basics of metasurface design, about the generation and characterization of ultrashort pulses, and about the opportunities of combining these two topics.

Furthermore, we attracted 5 international, well-known speakers to the Summer School. Their highlight lectures on the application of metasurfaces in ultrafast laser physics and the poster session were attended additionally by around 20 students from Graz's universities, which led to a lively international exchange.

The Summer School was also well received academically by the participants, as documented by an excellent evaluation after its end. All participants attended the entire Summer School and groups of newly acquainted participants continued to meet, discuss, and explore the city even after the Summer School ended for the day.

To summarise, the Summer School Hands-On Design of Metasurfaces for Ultrafast Laser Pulses was a success, scientifically, for young talent promotion, and international exchange. We are very grateful that Laserlab-Europe made our Summer School possible.

Summer School Graz Group picture

Summer School: Advanced Experimental Training in Laser Physics and Ultrashort Pulse Characterization, 19-23 August 2024, Vilnius, Lithuania

The VU LRC Summer School: Advanced Experimental Training in Laser Physics and Ultrashort Pulse Characterization took place from 19th to 23rd August 2024 at the Vilnius University Laser Research Center (VULRC) in Vilnius, Lithuania. The event offered a comprehensive and intensive program focused on key topics in laser physics and ultrashort pulse characterization, aimed at equipping participants with both theoretical knowledge and practical skills. The training sessions catered to varying levels of expertise, allowing attendees

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 871124.

to directly engage in experimental work in a laboratory setting. The event was organized under the leadership of Dr. D. Kaškelytė, Director of the VULRC.

Keynote Lectures

The summer school featured three keynote lectures delivered by experts from VULRC, addressing advancements in laser technologies:

- Dr. R. Budriūnas presented "OPCPA: Latest Advances in High-power Facilities and Research Highlights," sharing the latest developments in Optical Parametric Chirped Pulse Amplification (OPCPA) and its high-power laser system applications.
- Prof. D. Paipulas delivered a lecture on "Mastering Complex-shaped Laser Beams: Practical Insights into Advanced Laser Micromachining," where he discussed innovative approaches to manipulating complex laser beam shapes for precision micromachining using femtosecond lasers.
- Prof. A. Dubietis concluded the keynote series with "All-solid-state Spectral Broadening, Supercontinuum Generation, and Pulse Post-compression," explaining the theory and applications of pulse compression and supercontinuum generation in ultrafast laser systems.

Experimental Sessions

Alongside theoretical presentations, participants were immersed in experimental sessions led by leading researchers, focusing on advanced ultrafast laser techniques:

1. Measurement of Few-cycle Pulse Temporal Characteristics using the Dispersion Scan Technique
   Led by Dr. R. Budriūnas and PhD student G. Jansonas, this session introduced the dispersion scan (d-scan) method for accurately characterizing few-cycle pulses. Participants learned to assemble chirp-scan setups, handle software, and measure ultrashort pulse profiles, using ~10 fs pulses from OPCPA systems and an acousto-optic programmable dispersive filter ("Dazzler").
2. Ultrashort Laser Pulse Characterization Techniques
   Guided by Dr. J. Vengelis, participants explored the methods used to characterize ultrashort laser pulses, including intensity autocorrelation, second harmonic frequency-resolved optical gating (FROG), and cross-correlation frequency-resolved optical gating (XFROG). The session involved constructing setups and conducting experiments to retrieve the temporal and spectral characteristics of ultrashort pulses.
3. Optical Damage Morphology and Threshold Measurements
   Led by Dr. B. Momgaudis, this session focused on investigating optical damage in materials and determining damage thresholds at various laser intensities. Participants tested international standard optical damage procedures on samples such as metallic and dielectric coatings. In situ imaging and DIC microscopy were used to analyze damage morphology, concluding with an evaluation of the optical damage threshold.
4. Laser Beam Shaping Techniques for Femtosecond Laser Pulses
   Prof. D. Paipulas and Dr. D. Gailevičius demonstrated techniques for shaping femtosecond laser beams, emphasizing applications in laser micromachining. Participants learned about Gaussian-Bessel and Airy beams, doughnut-shaped beams, and top-hat beams, using tools like spatial light modulators (SLM), axicons, and CANUNDA beam-shaper units from Cailabs.
5. Femtosecond Supercontinuum Generation in Bulk Solid-state Materials
   Led by Dr. V. Jukna and Dr. G. Tamošauskas, this session explored supercontinuum light generation in solid-state materials. Participants observed self-focusing, pulse splitting, and spectral broadening, analyzing conical emission and coherent spectra for practical applications. The session also covered material degradation and the effects of high laser pulse repetition rates.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 871124.

Participants and Institutions

The summer school attracted 12 participants, including 2 postdoctoral researchers, 8 PhD students, and 2 MSc students, from eight scientific institutions across Europe and beyond:

- National Institute for Nuclear Physics, Catania, Italy
- Charles University, Prague, Czech Republic
- Friedrich Schiller University, Jena, Germany
- Wroclaw University of Science and Technology, Poland
- King Abdullah University of Science and Technology (KAUST), Saudi Arabia
- Leibniz Institute for Photonics Technology, Jena, Germany
- University of Tartu, Estonia
- Rezekne Academy of Technologies, Latvia

Conclusion

The VU LRC Summer School provided a valuable platform for young researchers to engage with cutting-edge topics in laser physics and ultrashort pulse characterization. Supported by Laserlab-Europe, the event enabled participants to develop both theoretical and practical expertise through direct involvement in experimental activities. It also fostered international collaboration and advanced knowledge exchange in the field of ultrafast optics.

Impressions of the VULRC Summer School

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 871124.

ICFO-NAIS Frontiers Research School on Advanced data processing methods, 9-11 October 2024, Castelldefels/Barcelona, Spain

Data analysis and treatment is a key skill for experimental science. Beyond determination of the signal to noise of the detection scheme and applying an error analysis, there exist a plethora of methods to extract meaningful information from the measurement. Independent on the physical origin, the statistical significance of data determines which methods produce the most meaningful representation of the physics. Machine learning methods are just one example, others are nonlinear hypersurfaces for singular value decomposition methods.

The goal of this 3-day training school was to introduce various methods, develop an understanding of when to use each method, and provide hands-on practice with examples. These methods are applicable to both spectroscopy and imaging.

The school was primarily aimed at PhD students. Postdoctoral researchers and local master's students working on relevant projects are also invited to join.

The 24 participants (14 male, 10 female and 1 preferring not to disclose) came from Spain (14 participants) and Germany (3 participants), with representation from Croatia, the United Kingdom, Latvia, Italy, and Iran. Participants consisted of 6 Master's students, 12 PhD students, 5 Postdoctoral researchers, and 1 in a different category. The group included primarily young scientists with a mix of graduate and early-career researchers.

The selection criteria focused on evaluating applicants' academic and research backgrounds, alignment with program goals, and commitment to scientific growth. CVs were reviewed for relevant qualifications and experiences, while motivation statements helped assess enthusiasm and clarity of purpose.

The workshop included lectures, delivered by experts who provided in-depth sessions on key topics, allowing time for thorough explanations and participant questions. Hands-on Tutorials followed each lecture where participants applied concepts in interactive scenarios, reinforcing theoretical knowledge. Shorter sessions and seminars focused on specialized topics, giving participants quick insights into current research trends and advancements. Networking Sessions provided opportunities for participants to connect with peers and faculty (school dinners). In addition, guided visits to research labs were organised, giving participants insight into real-world applications.

Participants rated the event highly, with average scores of 4.75 out of 5 for lectures and seminars, 4.50 for tutorials, and a perfect 5.0 for lab tours, indicating strong satisfaction with the content and organization. The networking opportunities to engage with speakers during breaks and the diversity and quality of tutorials were particularly appreciated. The sessions were noted for their accessibility, with participants able to extract valuable insights even when the topics were outside their direct research field.

The event was successful in delivering high-quality content and fostering professional connections among early-career scientists. Feedback suggests that the structure of combining lectures, practical tutorials, networking, and lab tours created a well-rounded educational experience. Minor adjustments to session organization and content breadth would enhance clarity and applicability.

List of lecturers/speakers

- Martino Trassinelli (CNRS & Institute of Nanoscience de Paris, CNRS)
- Josh Kas (Stanford University)
- Ahmad Hosseinizadeh (University of Wisconsin-Milwaukee)
- Oleg Ryabchykov, Leibniz Institute of Photonic Technology (IPHT)
- Ivo H.M. van Stokkum (Vrije Universiteit Amsterdam)
- Chorvát Dusan (Slovak Centre of Scientific and Technical Information)
- Jens Uhlig (Lund University)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 871124.

Group picture at the Frontiers Research School

Hands-on Course on MINDLAB: Manipulating and Investigating Neural Dynamics for Learning and Ageing in the Brain, 12-15 November 2024, Castelldefels/Barcelona, Spain

MINDLAB stands for “Manipulating and Investigating Neural Dynamics for Learning and Ageing in the Brain” and is an interdisciplinary creative playground rooted squarely in academic rigor, comprising of research groups from ICFO and beyond. We focus on advancing fundamental knowledge on how the mind emerges from the behavior of individual molecules, neurons and brain networks but also creating and commercializing transformational future technologies with outstanding potential to impact our society for good.

Hence, this course exposed participants to the state-of-the-art of photonics-based technologies tailored to monitor a hierarchy of scales in the study of the brain: i.e. from single molecules up to the whole organism.

The MINDLAB faculty included world leading experts in their fields. The expertise of the core faculty was complemented by a diverse set of affiliated adjunct faculty from various research centres in Barcelona but also through clinical and corporate partners. The course was supplemented by invited lecturers covering topics related to two Horizon 2020 Projects, LowLiteScope (with GA number: 101138041) and TinyBrains (https://tinybrains.eu). TinyBrains has developed a tomographic, non-invasive imager of brain function for newborns with severe congenital heart defects.

In this context, TinyBrains organized a dedicated session with Prof. Jennifer M. Lynch (a pediatric cardiothoracic anesthesiology at the Children’s Hospital of Philadelphia and an assistant professor of bioengineering at the University of Pennsylvania) and Prof. Martin Lauritzen (Professor of Translational Neurobiology at the University of Copenhagen).

The school was primarily aimed at PhD students and young post-docs. Master's students working on relevant projects were also invited to join.

There were 100 participants in the plenary sessions and 31 in the lab sessions (11 female, 7 male and 13 whose pronouns were not disclosed). Participants in the lab sessions came from

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement no. 871124.

Spain, Italy, Germany, Turkey and the Czech Republic. The group was primarily composed of young scientists, including a mix of graduate, undergraduate, and early-career researchers.

The workshop included 6 shorter sessions focused on specialized topics, giving participants quick insights into current research trends and advancements, 8 Lectures on key topics, allowing time for thorough explanations and participant questions, and full-day Hands-on Lab-sessions. Students were divided in 5 different groups and had the opportunity to be guided by expert instructors from ICFO.

The sessions took place in the following labs:

- Super resolution Light microscopy and Nanoscopy (ICFO experts: Maria Marsal, Gustavo Castro, Eric Catalayud and Nicolás Mateo)
- Neurophotonics and Mechanical Systems Biology (ICFO experts: Montserrat Porta and Luis-Felipe Morales-Curiel)
- Medical Optics (ICFO experts: Lorenzo Cortese and M. Atif Yaqub)
- Photon Harvesting in Plants and Biomolecules (ICFO experts: Antonio Sampaoli and Chunyu Li)
- Single Molecules Biophotonics (ICFO experts: Félix Campelo and Roger Pons)

These practical, immersive sessions took place in state-of-the-art laboratories, providing participants with the opportunity to apply theoretical knowledge in a real-world setting. During these sessions, participants were guided by expert instructors to master advanced techniques, refine their technical skills, and gain valuable experience with specialized equipment and methodologies relevant to their field of study.

A Student project preparation and presentation session focused on consolidating and showcasing the knowledge and skills acquired during the hands-on laboratory sessions. Students worked collaboratively to prepare structured presentations summarizing their key learnings, practical insights, and outcomes from their lab experiences. These presentations aimed to facilitate peer-to-peer learning by allowing participants to share their findings and techniques with the group, fostering an environment of mutual growth and exchange of ideas. Additionally, this session encouraged students to reflect on their learning journey, identify significant takeaways, and articulate their understanding in a clear and impactful manner. By presenting their work to their peers and instructors, students also developed critical communication and presentation skills, further enriching their overall learning experience.

Participants were also in contact with industry, looking at instruments or listening talks form industry. Participating companies were pioNIRS, Hamamatsu, Lasing, Abberior and IZASA. In addition, the Barcelona Medical Photonics Network, an initiative based in Catalonia between ICFO, biomedical and clinical partners, also had the opportunity to deliver a talk.

Networking Sessions provided opportunities for participants to connect with peers and faculty.

MINDLAB School impressions

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 871124.

Networking opportunities and the variety of topics were appreciated. Participants noted the value of the sessions, even for topics outside their direct research fields, emphasizing the accessibility and broad appeal of the content.

Conclusions: The event successfully delivered engaging content and provided networking opportunities for early-career scientists. Feedback suggests that optimizing session timing and providing additional resources like slides could further enhance the experience.

THRILL Summer School on laser technology for high-energy lasers, 7-11 October 2024, Hyères, France

Thirty students from eight European countries participated in the first summer school organized by the THRILL project. The goal of the school was to increase the awareness and offer training on the technologies related to high-energy high-repetition-rate laser facilities.

Topics:

The following topics were covered by the school by expert lecturers in the respective fields:

- Laser architecture and laser amplification
  Erhard Gaul (University of Texas, Marvel Fusion)
- Optical coating technologies
  Jim Oliver (Vacuum Innovations, UoR)
- Diagnostics and beam quality control
  Nicolas Forget (Université Côte d'Azur, Nice)
  Jonas Ohland (GSI)
- AI in optimization and control
  Steve Schmerler, Sebastian Starke (Helmholtz AI)
  Ritz Aguilar (HZDR)

In addition to content delivered in the form of lectures, directed work and hand-on training was offered to each topic. This included python-based coding of laser-design aspects such as laser amplification and ghost-focus analysis, as well as the introduction to the optical coating design software OTF Studio in its demo version. The students had the opportunity to learn about wavefront measurement and control with experimental setups using equipment and software, which is applied in many laser laboratories worldwide. Finally, the basics of machine learning were introduced via python-based coding.

Twelve of the students were those directly involved in THRILL work, while 18 students were external. Six of these external students received bursaries via Laserlab Europe. The level of training of the students was diverse, 58% were PhD students, 15% post-docs, 15% undergraduate students and 12% technical and scientific staff. 21% of the participants were female.

The organizers obtained detailed feedback of the school from the participants. Overall, the school was very well received and participants of all levels of education benefited from the courses by broadening and/or widening their knowledge. In addition to the technical sessions, the social events (meals at the resort, excursion) were appreciated and useful for networking among the participants. Some valuable comments were given by the participants on teaching pace and method, which will be taken into account for the second THRILL summer school planned for 2026.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 871124.

Group picture of the THRILL Summer School

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 871124.

3 Task 2: E-learning and Education

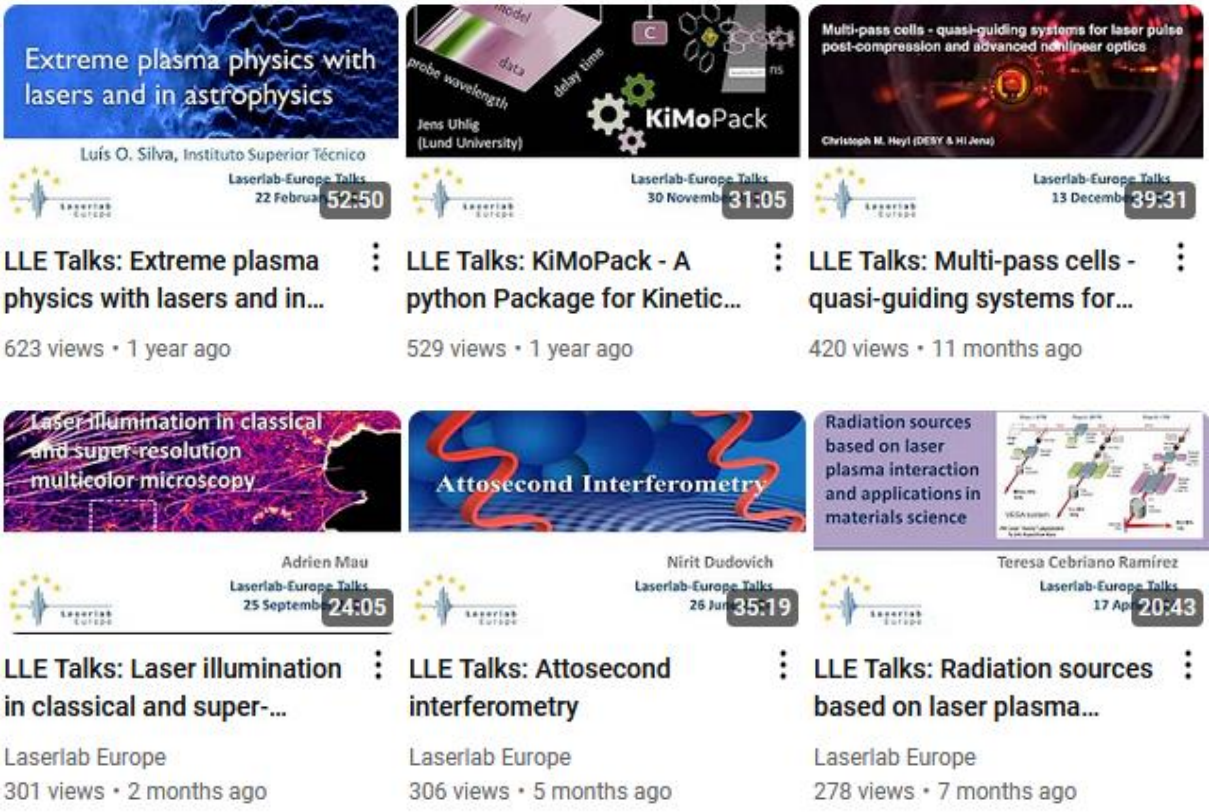
Task leader: FVB-MBI

The task aims at broadening the impact of the Laserlab-Europe human resources development activities through the creation of training videos from the user training schools and through the identification of relevant existing e-learning materials in collaboration with “NA2 – Scientific and Technological Exchanges, Task 5 Thematic Networks”. This initiative permits reaching the entire community, irrespective of geographical or thematical focus of training events, thus increasing effectiveness.

The lectures from the User-Training Workshop on Data Analysis in Time-Resolved Imaging and Spectroscopy (TRIS) are available online in the Laserlab-Europe cloud, for internal use of Laserlab-Europe members and participants in the training event.

A collection of links to existing e-learning materials of interest or use to Laserlab Europe users has been put on the Laserlab webpage.

Recordings of the “Laserlab-Europe Talks” in WP2, a series of online events presenting scientific and technical achievements of the Laserlab-Europe partners and targeting an audience from PhD students to experts in the field and industrial partners, are uploaded to the Laserlab-Europe YouTube channel.



Examples from the Laserlab-Europe YouTube channel

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement no. 871124.