



European Laser Research Infrastructures serving Science and Industry

Grant Agreement N° 101131771

WP 4

D4.4: Intermediate report on the “Cross-facility services” activities

Lead Beneficiary: Helmholtz-Institute Jena (HIJ)

Due date of deliverable: 30.09.2026

Type and dissemination level: Report, Public

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About Lasers4EU

Lasers4EU incorporates the major laser research infrastructures, in a large number of European member states, into a comprehensive virtual distributed laser research infrastructure that offers to a broad user community, from academia and industry, access to an exceptional portfolio of technical and scientific capabilities. This unique set of instruments together with the specific scientific expertise at the host facilities allows Lasers4EU users to carry out high-level research in an extremely wide range of high-impact topics in life sciences, materials nano-processing, etc.

Laser technology has experienced remarkable advances and breakthroughs in the last 60 years and is now a key innovation driver for highly diversified societal applications and products, thereby substantially contributing to economic growth and to solving challenges in the areas of health, environment and energy. Through its strategic approach, Lasers4EU aims to strengthen Europe’s leading position and competitiveness. It facilitates long-term coordination of the laser research activities within the European Research Area and provides concerted and efficient services to scientific, industrial and medical researchers. The main objectives of Lasers4EU are to:

- provide coordinated access to high-quality services based on a coherent and comprehensive consortium of 27 leading European laser installations offering to users from academia and from industry cutting-edge performances at the forefront of the laser technologies,
- structure the European landscape of laser Research Infrastructure through enhanced access, extended geographical coverage, novel science diplomacy activities, improved synergies with other European networks and projects,
- increase European human resources in the field of laser science by implementing training activities towards researchers from new domains of science and technology and from geographical regions where laser communities are still less developed.

1 Introduction

Work Package 4 (WP4) comprises five complementary tasks aimed at developing, harmonising and continuously improving scientific, technical, organisational and data-management capabilities across the Lasers4EU consortium: Task 4.1 – Short-term R&D Projects, Task 4.2 – Joint Experiments, Task 4.3 – Staff Exchanges, Task 4.4 – Standardised Performance Assessment, and Task 4.5 – FAIRness.

These five tasks are implemented within the framework established in *Deliverable 4.2, Concept and Initial Implementation of Cross-Facility Services*, which sets out their objectives, scope and selection criteria. As these elements remain unchanged, they are not repeated in this intermediate report. Likewise, calls launched during the first year of the project (Oct. 2024 – Sept. 2025) are referenced where relevant to ensure continuity, but are not described again in detail, as the corresponding information was already provided in D4.2.

Against this background, this report provides an overview of the work and progress achieved during the first 24 months of the project, with particular emphasis on developments during the second project year. Where individual activities are covered in dedicated deliverables, the corresponding sections are kept concise and highlight only the key developments and outcomes relevant to this intermediate report. This applies in particular to Task 4.4, for which the detailed work on standardised performance assessment is documented in Deliverable 4.3, *Commonly agreed shared protocols for performance assessment, routine quality check and automated acquisition in at least 3 different research fields*.

Overall, WP4 continues to strengthen the integration and harmonisation of services across the Lasers4EU consortium. Through its complementary activities, it supports high-quality, reliable and reproducible user access while fostering cross-facility collaboration, knowledge exchange, capacity building and the sharing of good practices among consortium members.

2 Task 4.1: Short-term R&D projects

This task supports time-limited joint developments aimed at expanding the instruments, methods and digital solutions available within Lasers4EU. The projects are intended to improve user-friendliness and reproducibility and to develop new capabilities that can strengthen the Lasers4EU service portfolio.

During the reporting period, two calls for Short-term R&D Projects were launched. A total of 11 proposals were submitted and five projects selected for funding. The first call, with a deadline of 28 February 2025, resulted in two selected projects. The second call closed on 28 November 2025 and three further projects were selected by the Activity Board in January 2026.

For the second call, cooperation with the wider Laserlab-Europe network was strengthened. The call was launched jointly by Lasers4EU and Laserlab-Europe AISBL, with the aim of facilitating broader participation and collaboration beyond the Lasers4EU consortium. While each proposal was required to involve at least two partners, including at least one Lasers4EU access provider, projects involving an eligible Laserlab-Europe AISBL partner outside Lasers4EU could receive additional financial support from Laserlab-Europe AISBL. This approach created additional opportunities for joint developments across the broader Laserlab-Europe community.

The other core implementation principles remained unchanged. Projects are expected to be completed within two years of approval, with co-funding covering eligible consumables and travel, while personnel costs are borne by the participating laser laboratories.

Table 1 - Proposals received in the second call for short-term R&D projects

Title of proposal	Lead partner(s)	Estimated duration	Result
Development of high-repetition-rate optical parametric amplifier systems for time-resolved optical spectroscopy in the mid-IR spectral range	CUSBO & LENS	15 months	approved
(HIPER-DOS) HYbrid Performance and Equivalence in Reproducible DOS systems	POLIMI & ICFO	4 months	rejected
Attosecond vortices from scissor mirrors	CELIA & LIDYL	6 months	approved
Unravelling non-equilibrium plasma chemistry in ammonia conversion using ultrafast laser diagnostics	LLC & TU Darmstadt	1,5 months	rejected

Title of proposal	Lead partner(s)	Estimated duration	Result
Setup for simultaneous frequency doubling and nonlinear pulse compression of ultrashort TiSa and Yb lasers	LIDYL-LULI-HI Jena-ISMO-LLC	23 months	approved
High POver multi-pass cell Post-compression Ytterbium based laser in the Green spectral range HIPOPYG	LIDYL & CELIA	12 months	rejected
THUNDER - THz Ultrafast Nonlinear Dynamics & Emission Regulation	LIDYL & FERMI	not indicated	rejected

2.1 Progress of the co-funded projects

The five projects address complementary areas of technology development, ranging from microscopy instrumentation and soft-X-ray/attosecond spectroscopy to mid-infrared source development and ultrafast frequency conversion and pulse compression.

- **Open-source laser-based autofocus system for microscopy – Leibniz IPHT**

D4.2 reported the demonstration of the basic astigmatism-based autofocus principle and initial evaluation of its drift performance. Since then, the work has progressed from proof of principle towards an integrated prototype. A compact, fibre-coupled infrared laser unit has been developed, combining a beam splitter, astigmatic optical system and CMOS camera. The design allows the astigmatism to be introduced or removed through the cylindrical lens.

The autofocus functionality has also been integrated into ImSwitch, an open-source microscopy control platform, enabling configurable autofocus scans in terms of scanning range, resolution and focus-detection algorithm. The prototype has subsequently been integrated into the openUC2 FRAME microscope and used for large-area imaging across a wellplate-sized field. These tests demonstrated stable focus tracking over extended imaging sequences and represent an important step towards a transferable autofocus solution for microscopy platforms.

- **Birefringent interferometer for Fourier Transform Spectroscopy in the soft X-ray domain – DESY / CUSBO**

At the time of D4.2, the required components had been procured, the prototype assembled and calibrated using infrared light, and initial high-harmonic-generation experiments had been performed. Since then, the setup has been adapted for operation with few-cycle driving pulses for

the high-order harmonic source.

Progress was temporarily affected by an extended period of laser downtime at DESY and subsequent troubleshooting. Following restoration of the laser system, experimental testing of the new configuration resumed. Initial indications of spectral interference have been observed in the harmonic spectrum around the aluminium edge at approximately 73 eV. Further measurements are underway to confirm and characterise the interference signal.

- **High-repetition-rate OPA systems for mid-IR spectroscopy – CUSBO / LENS**

The project develops tunable femtosecond sources in the mid-infrared for time-resolved optical spectroscopy. The optical design of the mid-IR Optical Parametric Amplifier (OPA) has been completed. Work currently focuses on selecting suitable nonlinear crystals based on the required spectral bandwidth, pulse duration and nonlinear properties, as well as identifying suppliers for the crystals and optical components required for construction of the sources.

- **Attosecond vortices from scissor mirrors – CELIA / LIDYL**

The project aims to demonstrate the generation of XUV beams carrying orbital angular momentum using a two-mirror “scissor” configuration. The proposed device controls the relative angle between two planar mirrors at grazing incidence with microradian precision and is designed to be compatible with attosecond pulses. The work is planned as a joint experiment between CELIA and LIDYL at CELIA, using the high-energy harmonic beamline and EUV wavefront sensor to generate and characterise the spatial mode and azimuthal phase of the XUV beam. The original work plan foresees instrumental development and beamline-geometry tests, followed by interferometric testing of the bi-mirror control and a proof-of-concept experiment with the scissor mirrors. The proposed approach is intended to provide a simple and potentially transferable solution that could later be adapted by other Lasers4EU partners.

- **Simultaneous frequency doubling and nonlinear pulse compression of ultrashort Ti:Sa and Yb lasers – LIDYL / LULI / HI Jena / ISMO / LLC**

Since approval of the project in January 2026, LIDYL has demonstrated a first LBO-based frequency-doubling scheme for Yb lasers, converting 36 fs pulses at 1050 nm to a 22 nm-wide spectrum centred at 525 nm, compatible with sub-19 fs pulse durations. The results were presented at Photonics West in January 2026. Preliminary tests were also carried out on LULI’s XCAN system, where frequency doubling at 1032 nm achieved conversion efficiencies of up to 30% at 100 W average power, with further optimisation required.

In parallel, LIDYL is developing transportable diagnostics for simultaneous characterisation of beam

and pulse parameters at the fundamental and second-harmonic wavelengths. The system is currently being benchmarked against existing FROG and SPIDER diagnostics and prepared for use at partner facilities. Further experiments on XCAN are planned for November 2026, while a LIDYL SPIDER system has already been installed at ISMO. Subsequent joint experiments at partner facilities in Jena and Stockholm are planned for the second quarter of 2027.

2.2 Transferability and integration into user services

At this intermediate stage, the projects are moving from initial concepts and component-level developments towards prototypes and systems suitable for implementation across partner facilities. The remaining work will focus on completing the technical developments, validating them in different facility environments and documenting the resulting methods, procedures and software.

Where generated, technical drawings, procedures and software will be made freely available in line with the conditions of the calls. The final assessment of Task 4.1 will therefore consider both the completion of the planned developments and their uptake within the Lasers4EU service portfolio and wider user community.

3 Task 4.2: Joint experiments

Task 4.2 supports collaborative experiments between Lasers4EU partner facilities through two complementary types of activity. **Curiosity-driven joint experiments** bring together partners to address scientific questions by combining complementary expertise and can be submitted on a continuous basis. **Joint experiments for standard procedures and instrument calibration** focus on conducting comparable experiments across facilities in order to develop and validate common procedures, improve instrument calibration and strengthen the reproducibility and comparability of experimental results.

3.1 Projects and progress

3.1.1 Curiosity-driven joint experiments

Proposals for curiosity-driven joint experiments can be submitted on a continuous basis through the standard proposal-management procedure, with applicants identifying the proposal as a “Joint Experiment”.

During the first project year, nine curiosity-driven joint experiments were received, eight of which

were completed. Further proposals were received and implemented during the second project year, demonstrating sustained interest in this cross-facility activity.

The experiments cover a broad range of topics, including ultrafast and attosecond science, magneto-optical phenomena, nonlinear optics, high-harmonic generation, biomaterials and high-energy laser pulse compression. This thematic diversity reflects the role of the activity in bringing together complementary expertise and capabilities across Lasers4EU facilities.

As the overview of joint experiments is continuously updated, a complete and consolidated table of the curiosity-driven joint experiments implemented during the reporting period will be provided in the forthcoming Lasers4EU access report.

3.1.2 Joint experiments for standard procedures and instrument calibration

In parallel with the curiosity-driven experiments, two proposals have so far been selected under the dedicated calls for joint experiments on standard procedures and instrument calibration.

- **Standardising Field Intensity Determination in Optical Microcavities**

The project aims to establish a reproducible approach for determining optical field intensity in microcavities and thereby improve the comparability of measurements between participating laboratories. D4.2 reported the planned preparation and characterisation of perovskite nanocrystal films and microcavities, followed by subsequent intensity-dependent transient absorption measurements.

Since then, the experimental programme has been largely completed. Optical cavities and thin films of perovskite nanocrystals were fabricated in Lund, followed by transient absorption measurements in Milan at several excitation powers on both film and cavity samples. Measurements planned in Florence were initially affected by laser instability; however, after the replacement of several laser components, the system became operational again. To complete the experimental dataset, the transient absorption measurements were also repeated in Lund. The resulting data have been analysed and the partners are currently preparing a manuscript based on the results.

- **HYPER-DOS – HYbrid Performance and Equivalence in Reproducible DOS systems**

The project aims to develop and validate standardised procedures for the calibration, quality control and performance assessment of hybrid time-domain near-infrared spectroscopy (TD-NIRS) and diffuse correlation spectroscopy (DCS) systems. The experimental characterisation phase has been completed on five instruments, including selected performance tests and cross-device

measurements under comparable conditions. Analysis of the resulting datasets using standard analysis protocols is also close to completion.

The remaining work focuses on consolidating the analysis and translating the results into standardised procedures and practical recommendations for hybrid TD-NIRS/DCS measurements. Based on the final analysis, the partners will also assess whether additional measurements or more advanced modelling are required and whether the results provide the basis for a scientific publication.

Overall, the activities implemented under Task 4.2 show continued use of the joint-experiment mechanism across a broad range of scientific fields and facilities.

The continued submission and implementation of new experiments in 2026 provide a basis for further scientific collaboration, knowledge exchange and the development of common experimental approaches during the remaining project period.

4 Task 4.3: Staff exchange

This task supports short-term staff exchanges between Lasers4EU partner facilities to strengthen the professional development of scientific and technical staff through hands-on training and the exchange of expertise. In addition to developing individual skills and competences, these exchanges facilitate knowledge transfer, the sharing of operational practices and experience with complementary equipment and experimental approaches, thereby contributing to the further harmonisation of procedures across the network.

During the reporting period, two calls for staff exchanges were launched. A total of 13 proposals were submitted, of which ten were approved. The first call, with a deadline of 27 April 2025, resulted in five approved exchanges. The second call closed on 27 February 2026; eight proposals were submitted, of which five were approved and three rejected. One of the exchanges approved under the first call, between CLUR and MBI, was subsequently cancelled after the CLUR staff member selected for the visit assumed new responsibilities at the university and was no longer able to undertake the exchange.

The core implementation principles remained unchanged during the reporting period. Exchanges are designed as short-term visits of one to two weeks and can focus on practical training and hands-on experience with laser equipment, experimental setups, data-acquisition systems and experimental data-analysis methods. The established reporting and feedback mechanisms continue to provide an

appropriate basis for documenting the activities undertaken and capturing the knowledge and experience gained by participating staff.

Table 2 - Proposals received in the 2026 call for staff exchanges

Sending partner	Hosting partner	Result
ENEA	LULII	approved
LIDYL	FERMI	approved
CNR-INO	CNRS-LASERIX	rejected
CNRS-LASERIX	CNR-INO	rejected
MBI	HZDR	approved
VULRC	FORTH	rejected
HZDR	LLC	approved
CLUR	CUSBO	approved

4.1 Achievements of the staff exchanges

The completed exchanges covered complementary areas of scientific and technical expertise, ranging from super-resolution microscopy and ultrafast laser development to high-order harmonic generation and beamline integration.

- **Super-resolution microscopy and nanoscopy – CUSBO / ISMO**

The CUSBO–ISMO exchange focused on training in single-molecule localisation and super-resolution microscopy. Activities included sample preparation, optical alignment, calibration procedures and validation experiments using ISMO’s microscopy setups. CUSBO photonic devices were also tested with the host instrumentation to assess their performance for single-molecule imaging. The exchange resulted in shared experimental protocols and follow-up activities, while the acquired know-how will support improved calibration and acquisition procedures, as well as the further development of super-resolution imaging capabilities at CUSBO.

- **THG chip implementation and ultrafast UV generation – DESY / FERMI**

The DESY–FERMI exchange focused on the implementation and testing of a Third Harmonic Generation (THG) chip in a vacuum environment. Activities included the optimisation of gas and vacuum conditions, positioning of the chip, testing with different laser sources and characterisation of the generated UV radiation. Simulation tools were also exchanged and applied to the experimental

conditions. The knowledge gained will support the future implementation of the system at FERMI’s LDM beamline, helping DESY adapt future UV-generation configurations to the technical conditions at FERMI.

- **High-energy ultrafast laser development – HiLASE / Rutherford Appleton Laboratory**

The HiLASE–Rutherford Appleton Laboratory exchange focused on high-energy ultrafast laser systems and frequency conversion. Activities included work on Ti:Sapphire amplifier development, the DiPOLE100 pump laser, LBO-based second-harmonic generation and the handling of large-aperture optics. The acquired know-how is directly applicable to related systems at HiLASE and will support improvements in frequency-conversion performance, system stability and the further development of high-energy laser technologies.

4.2 Knowledge transfer and added value for the participating facilities

The completed exchanges demonstrate that the activity generates benefits beyond the immediate training of individual staff members. Knowledge acquired at the host facilities is being transferred to ongoing or planned activities at the sending institutions, for example through improved calibration and acquisition procedures, the adaptation of experimental setups, the optimisation of frequency-conversion systems and preparation for future beamline integration. At the same time, joint experimental work and the exchange of tools and protocols have strengthened technical interaction between partner facilities and created a basis for follow-up activities and longer-term collaboration.

At this intermediate stage, the completed exchanges show how staff mobility can contribute simultaneously to individual skills development, institutional capacity building and the wider integration of expertise across Lasers4EU. As further exchanges are completed, the assessment of Task 4.3 will consider not only participation and training delivered, but also how the acquired know-how is applied within the participating facilities and whether the exchanges lead to sustained technical collaborations, shared practices or improvements in services offered to users.

5 Task 4.4: Standardised performance assessment

Task 4.4 aims to improve the quality, reproducibility and comparability of Lasers4EU services through commonly agreed approaches to performance assessment and routine quality checks. It also addresses the systematic acquisition and documentation of relevant system parameters in line

with FAIR principles.

During the first project year, a working group was established with one representative from each laser laboratory. A series of online meetings, an in-person workshop and a consortium-wide survey were used to map existing practices in performance assessment, automated acquisition and routine quality checks across Lasers4EU facilities. The resulting analysis provided the basis for identifying common features and selecting research areas in which shared protocols could be developed.

During the second project year, the work focused on three areas: Diffuse Correlation Spectroscopy, Transient Absorption Spectroscopy and Characterisation of Ultrashort Pulses. Dedicated subgroups exchanged experience, reviewed existing practices and developed field-specific approaches to performance assessment and standardisation. Their progress was also discussed at a dedicated Performance Assessment workshop held in Prague on 26 May 2026.

The resulting work is documented in Deliverable 4.3. *Standardised performance assessment: Commonly agreed shared protocols for performance assessment, routine quality check and automated acquisition in at least 3 different research fields.* The three approaches reflect the different requirements of the respective research communities: agreed figures of merit for Diffuse Correlation Spectroscopy, reference compounds and measurement approaches for Transient Absorption Spectroscopy, and a structured validation pathway for the characterisation of ultrashort pulses.

The next phase will focus on testing relevant aspects of these protocols in routine user access and refining them on the basis of practical implementation. Where appropriate, the resulting protocols may also be disseminated through scientific publications or open repositories.

6 Task 4.5: FAIRness

Task 4.5 aims to establish a sustainable framework for data management and FAIR (Findable, Accessible, Interoperable and Reusable) practices across the Lasers4EU network. Its activities include the development of a simplified Lasers4EU-wide Data Management Plan (DMP) template based on Horizon Europe requirements, the collection and analysis of existing DMPs and institutional data policies, the establishment of a network of FAIR representatives across the access-providing facilities, and the provision of guidance and support through a FAIR helpdesk.

6.1 Progress

During the second project year, activities focused on further developing and testing the data-

management framework established during Year 1 and on gathering additional information on current practices across the consortium.

A second questionnaire was circulated to partners, covering institutional data policies and their implementation, data repositories, metadata and DOI practices, and the practical management of research data. Responses were received from approximately half of the consortium and analysed to identify common practices, remaining gaps and areas requiring further harmonisation.

Work also progressed towards the practical implementation of a Lasers4EU DMP planning tool. HZDR's Research Data Management Organiser (RDMO) was tested in the context of a joint experiment, using the Horizon Europe DMP template as a starting point. Based on this experience, the questions are being reviewed, prioritised and adapted to the specific requirements of Lasers4EU in preparation for use in future experiments.

Progress was also made on data publication and findability. The FAIR network agreed to use Zenodo as a default alternative repository for Lasers4EU data. As Zenodo is harvested by OpenAIRE, this supports the visibility of project outputs within the wider European research-data environment. In parallel, the potential use of the PaNOSC metadata catalogue is being explored as a means of improving scientific findability through richer metadata.

The online [Data Management Day](#), held on 11 November 2025, provided a forum for exchange on DMPs, metadata, research-data tools, electronic laboratory notebooks and FAIR principles, bringing together Lasers4EU partners and representatives from related research communities.

6.2 Next Steps

The next phase will focus on further developing the RDMO-based DMP workflow and testing it in upcoming experiments. The Horizon Europe DMP questions will be adapted to the Lasers4EU context, with DMPs to be completed jointly by users and access-providing facilities after an experiment has been approved. This approach is intended to ensure that the resulting plans reflect the actual experimental setup and data-management requirements.

The findings from the partner questionnaire will inform further harmonisation of data management practices and help identify areas where additional guidance is needed. A follow-up meeting of the FAIR network is planned to discuss these results, as well as the further development of the common DMP framework.

Work will also continue on integrating data publication and metadata practices into the emerging workflow, including the use of Zenodo and the exploration of options for improving the scientific findability of Lasers4EU data.

In the longer term, the aim is to integrate RDMO-based DMP functionality into the Lasers4EU user access platform during 2027, enabling experiment-specific DMPs to be generated as part of the access process.

Together, these activities are intended to move Task 4.5 from framework development towards the routine implementation of FAIR data-management practices across Lasers4EU.

7 Conclusion

Over the first 24 months of the project, WP4 has translated the framework established in D4.2 into concrete activity under all five tasks, moving progressively from the design and piloting of shared mechanisms towards their practical implementation within Lasers4EU.

Under Task 4.1, five short-term R&D projects are advancing from initial concepts towards prototypes and technical solutions with potential for transfer between facilities and integration into the Lasers4EU service portfolio. Task 4.2 has maintained a strong level of joint experimental activity, both through curiosity-driven experiments and work on standard procedures and instrument calibration, demonstrating the continued value of collaboration between partner facilities in a broad range of scientific fields. Task 4.3 has approved ten staff exchanges, one of which was subsequently cancelled. The exchanges implemented to date have combined individual skills development with the transfer of practical know-how back to the participating institutions and created opportunities for follow-up collaboration. Task 4.4 has resulted in field-specific, commonly agreed approaches to performance assessment in three research areas, which will now be tested and refined through practical application. Task 4.5 has established the structures needed for a more coherent approach to FAIR data management and is progressing towards the practical implementation of shared DMP workflows and data publication practices.

Taken together, these developments show that WP4 is increasingly linking activities that would otherwise remain facility-specific and using them to strengthen the wider Lasers4EU network. The remaining project period will therefore focus on consolidating and validating the work already underway: completing and assessing the transferability of R&D developments, further implementing common experimental and performance assessment procedures, embedding FAIR data-management practices into user access and continuing to capture the longer-term effects of joint experiments and staff exchanges on collaboration, knowledge transfer and service development.

In this way, WP4 continues to strengthen the integration, harmonisation, quality and reproducibility of Lasers4EU services and to support a more coherent and sustainable service portfolio for the user community.