

Deliverable D6.1: Intermediate Report on Access to LiCal

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Introduction:

The Lidar Calibration Centre (LiCal) started to provide a wide set of services to various users from the beginning of ACTRIS2. The LiCal facilities are set to provide specific services based on the received applications from the scientific community (within and outside ACTRIS) but also to the external community (user communities and private sector). The infrastructures provided by LiCal are designed to meet the lidar user needs by offering dedicated installations for specific applications involving both the equipment and the operators. Infrastructures like the LiCal: LiCoTest, POLIS fixed, MUSA mobile and fixed are designed to offer services like inter-comparison with operational instrumentation and characterization of different lidar modules. Coordinated check-up procedures to examine both the instruments and data (LiReQA and LiCheckUnit) allow a better exploitation of the data due to the common way to determine important lidar parameters.

During this first period of ACTRIS2, LiCal launched specific calls to help the users apply for dedicated topics: 1st LiCalTrain workshop for intensive training in ACTRIS-EARLINET quality assurance (QA) programme, the 1st LiCoTest call for the characterization and testing of the lidar optical components, the first call for the LiReQA test analysis and the 2nd LiCalTrain workshop focused on data processing with emphasis on depolarization measurements, calibration and use of SCC to automatically perform lidar processing tasks. The TNA activities carried out in WP6 are designed to use the advanced lidar calibration facility for various aspects of lidar calibration: good practices → components testing → lidar block testing → system characterization. These activities target not only the scientific community but also external users like SMEs or users involved in operational use of lidar based instruments. During the LiCal calls, external applicants like research groups from non-EU developing countries, lidar integrators and developers were also encouraged to apply for the TNA. Continuous feedback from LiCal applicants is encouraged since support must be provided after the access is finalized. The feedback will also help the infrastructure tune the services to the needs of the applicants offering more reliable products and services for the future.

LiCalTrain is design to answer to the needs of the lidar user community (also including non-EU developing countries) by constantly applying the latest measurement and QA procedures available within ACTRIS. LiCalTrain had and will open dedicated calls for basic and advanced instrument operation and together with LiReQA and LiCheckUnit, will analyze and offer the required knowledge transfer to enhance the quality of the instrument and operator knowledge.

Access to LiCal TNA

The first part of the LiCal setup was dedicated to the preparatory phase. The workload carried out by the beneficiaries was focused on the format and selection criteria for the LiCal application forms. All beneficiaries in WP6 (CNR, INOE, LMU) have worked on this task. The *request application forms*, *evaluation forms* and the *confirmation of access forms* were developed based on the preparatory phase (CNR, INOE, LMU). Evaluation of the LiCal applications was performed by the LiCal User Selection Panel (USP). The USP members are international experts selected to provide recommendations and evaluate the TNA applications. The USP was established based on

the expertise and availability of the considered external and internal members (CNR, INOE, LMU).

Next task was the development of the LiCal official website: lical.inoe.ro (INOE). The site provides information on each installation provided by LiCal, services offered, news, how to apply to LiCal and LiCal TNA calls. News on the latest developments and calls will also be available on the LiCal website in the second part of the project. The optimization of LiCal services and information provided for the TNA access was first iterated by addressing the target user community considered to further access the infrastructure.

A questionnaire was send to the EARLINET community as the expected main users of LiCal. The main focus was to collect feedback on the basic needs of the ACTRIS-2 user community: what prevents the user for submitting data to the database and what are the user training needs (CNR, INOE, LMU). The feedback showed a keen interest on:

- Lidar instrument basics: measurement principle, blocks and components, common problems and solutions
- Lidar operation: alignment, signal linearity, maintenance
- Lidar testing: telescope cover tests, depolarization calibration tests, Rayleigh fit, dark measurement
- Data processing: algorithms, SCC data format
- Data products check-up: backscatter calibration, ratio parameters, integrated parameters

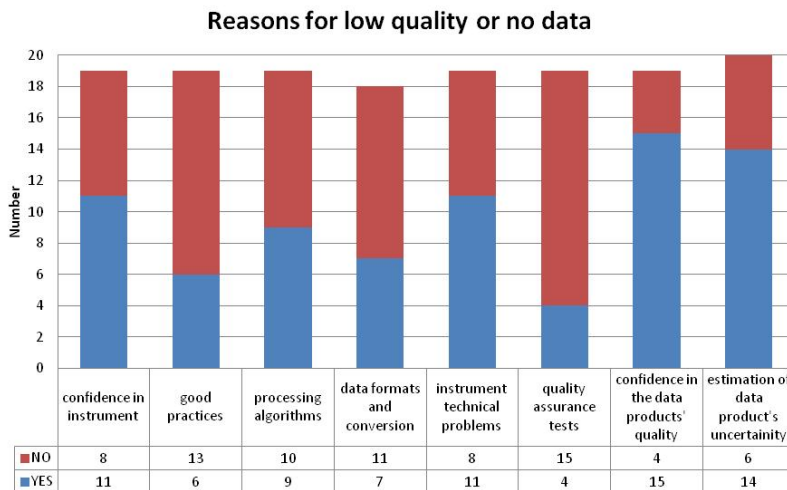


Figure WP6.1: LiCal survey: Reasons for low quality or no data in the ACTRIS database

Additional suggestions were also welcomed:

- Checking of the polarization state of the emitted beam (LiCoTest)
- Raytracing of the individual systems (LiCheckUnit)
- Training on the added value for implementing the 3 channels depolarization measurement (total, cross, parallel) (LiCalTrain).
- Uncertainties of different assumptions used in the lidar processing (LiCalTrain)

Support offered under LiCal TNA

Second, a draft timetable with future calls on the LiCalTrain was realized. All interests for specific LiCal training were included in the timetable (Figure WP6.2): lidar operation, data processing, instrument basics, lidar testing, data products check-up.

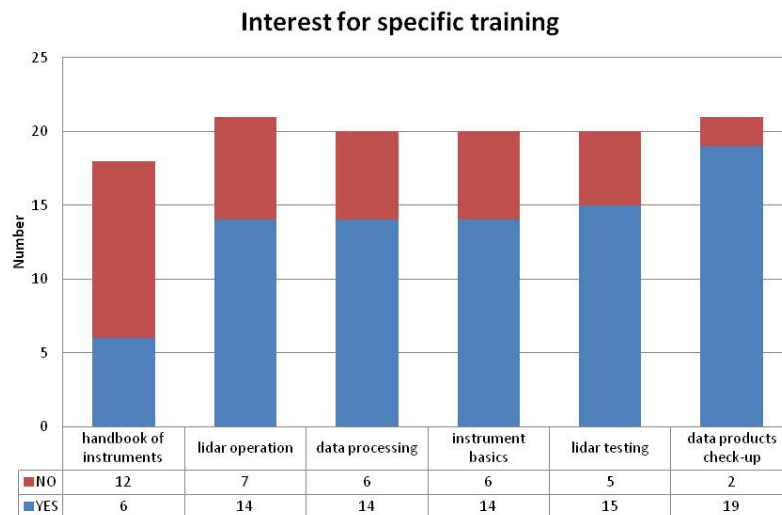


Figure WP6.2: LiCal survey: Interest for specific training

The LiCalTrain calls were divided in two major sections: basics and advanced trainings.

Basics: related to the instrument

- Introduction: measurement principle, blocks and components, common problems & solutions
- Operation: alignment, signal linearity, maintenance
- Testing: telescope cover tests, polarization calibration tests, Rayleigh fit, dark measurement

Basics: related to the data products

- Data submission: EARLINET and SCC netCDF format, definition of variables, conversion tools
- Data processing: algorithms, assumptions, statistical uncertainties

Advanced: related to the instrument

- Testing (coupling with LiCoTest): checking polarization state of emitted beam, checking the effects of emission optics on the polarization state, assess the diattenuation of different optical components, assess the polarization parameters needed for the SCC,
- Simulation: polarimetric lidar simulations for the linear depolarization ratio uncertainty assessment

Advanced: related to the data products

- Data checking: integrated parameters, ratio parameters
- Data synergy: POLIPHON, LIRIC, GARRLIC, satellite, models

Outreach to new users (ongoing)

The **first LiCalTrain training workshop** was scheduled between 23rd and 27th of May 2016. In parallel to the first LiCalTrain call, the **first components testing session (LiCoTest)** was announced (INOE). The call was focused on:

- **interference filters** center wavelength, homogeneity, bandwidth fwhm with an accuracy <0.1nm at 0 degrees;
- spatial homogeneity of the **linear polarization filters** used in the polarization channels: extinction ratio (1mm spots), overall extinction ratio
- **emission optics** transmittance and reflectance parameters (Rp, Rs, Tp, Ts), retardation at 45 degrees incidence angle ± 5 degree (accuracy 0.1 degrees and resolution 0.5 degrees).

The regular **QA test analysis by LiReQA** for the ACTRIS community was also launched on the official website. The users were asked to submit the QA tests up to 31st of May 2016 (LMU, INOE).

The **2nd LiCalTrain workshop** was announced on the official website at the beginning of 2017. The users were requested to fill in the TNA form until 31st Jan 2017. The workshop is scheduled to take place during 27th February to 3rd March 2017.

In addition, a continuous TNA call was launched on the official LiCal website. Since the LiCheckUnit, POLIS fixed, MUSA fixed and mobile are mostly based on specific user needs for testing and validating different instruments, no specific calls are required for these infrastructures. During the first half of the project LiCal covered 435.5 access days out of a total of 810 access days during the first half of the project (M22). The LiCal statistics shows the TNAs provided by each installation and the access days used by each installation during the first reporting period (Figure WP6.3).

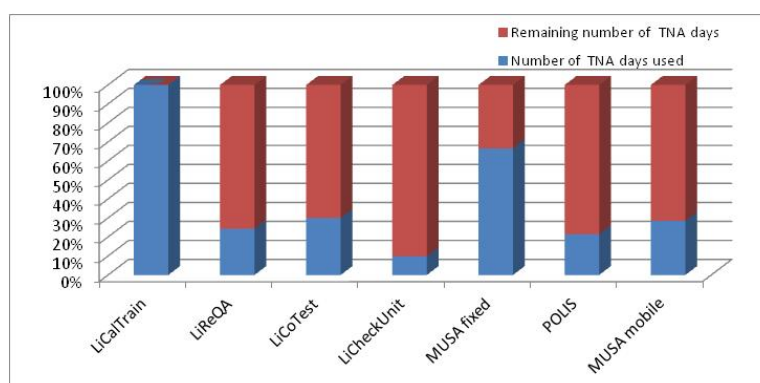


Figure WP6.3: Intermediate assessment of LiCal access provision up to M22.

The TNA access applications received during the first part of the project show that:

- External users (users from outside the ACTRIS community) are focused on services provided by MUSA and POLIS reference instruments since the main goal is to validate instrumentation (in this case for commercial use).
- The scientific community within ACTRIS is mainly focused on the LiCalTrain, LiCoTest, LiReQA and the LiCheckUnit services.

Individual LiCal facilities description

LiCalTrain was involved in the 1st LiCalTrain workshop for intensive training in ACTRIS-EARLINET quality assurance (QA) programme. The hands-on training was hosted by the LiCalTrain facility in Bucharest during 23-27 May 2016. The workshop was dedicated to beginner users that are unfamiliar with instrument operation and need to implement measurement and QA procedures available within the network. The main focus of the workshop aimed the basics of the instrument, common instrument problems and solutions, ACTRIS-EARLINET QA tests, good practices in operation and maintenance of the lidar, problem identification for individual cases and introduction to data check-up procedures (<http://lical.inoe.ro/apply-for-access/>). **The 2nd LiCalTrain workshop** was announced on the official website and is scheduled during 27th of February to 3rd of March 2017. The workshop is focused on data processing with emphasis on depolarization measurements and their calibration. The specific topics covered will include: a) Pre-processing and optical processing of lidar signals b) Correction of polarization effect on lidar signals c) Calibration of depolarization measurements d) Use of SCC to automatically perform these tasks. The workshop will give emphasis on hands-on training, and participants are expected to bring and analyses their own data.

- After the 2nd LiCalTrain workshop, LiCalTrain will provide **34 TNAs** for **44 users** covering a total of **275.5 access days** from a total of 200 covered by Actris2.

LiCoTest organized the first call for the characterization and testing of the lidar optical components in parallel with the LiCalTrain workshop. The call was focused on interference filters characterization: homogeneity, bandwidth fwhm, neutral density filter characterization, spatial homogeneity of linear polarization filters used for measurement and calibration in the depolarization channels: extinction ratio and overall extinction, optics emission, transmittance and reflectance parameters, retardation at 45° incidence angle, characterization of optical components (beam expanders and mirrors) by assessing the Mueller matrix for several wavelengths. LiCoTest provided access to five research institutions during this call. In order to accommodate these experiments, the LiCoTest team had to optimize the available instrumentation to fit the mechanical and optical constraints of each component. After the measurements, the LiCoTest team was in contact with all applicants for feedback and support. The measurements performed at LiCoTest will help the applicants to further optimize their lidar instruments and better assess the uncertainties related to the considered parameters. The measurements will generally lead to the improvement of long-term lidar observational data relevant to climate and air-quality research within ACTRIS-2. During the beginning of 2017 the LiCoTest laboratory is under continuous upgrade. The

improvements are mainly related to the number of equipments and services to better meet the lidar community needs.

- LiCoTest provided **5 TNAs** for **8 users** covering a total of **30 access days** out of a total of 100. All access to LiCoTest was provided during the first LiCoTest workshop in May 2016.

LiReQA provides the analysis and feedback during the internal quality check-up tests required by EARLINET-ACTRIS for validation of the long-term observational data. During the first period of ACTRIS-2, LiReQA provided continuous access offering support and feedback based on the collected test files submitted by each station. The regular QA are required from all EARLINET-ACTRIS stations for the homogeneous characterization of all instruments that usually provide observational data to the ACTRIS database. The LiReQA providers organized periodic online meetings during the reporting period. The meetings were designed to analyze particular cases and try to find possible solutions together with the LiReQA applicants. This type of virtual access is aiming to optimize the QA testing process performed by each user. The feedback provided by LiReQA will help lidar groups to optimize the instruments and, if necessary, advise the user to apply for other facilities within LiCal.

- LiReQA provided **22 TNAs** for **23 users** covering a total of **39 access days** out of a total of 160. The access was mostly provided during the first call for QA test analysis. LiReQA also provided several online meetings for analyzing the QA tests together with the LiReQA users. During the meetings feedback to improve and optimize the implementation of the QA procedures within and outside ACTRIS was provided.

LiCheckUnit is designed to offer expert evaluation to inspect and debug lidar instruments. Since one important parameter for aerosol typing and mass concentration retrieval is the linear particle depolarization ratio, the calibration module used in the lidar system must provide stable and reliable results. The TNA requests were focused on the evaluation of the depolarization channels performance and optimization of the calibration modules used by the instruments. The activities carried out by the LiCheckUnit aim to improve the quality of observational data for climate and air-quality research by providing reliable data for aerosol typing and mass concentration retrievals.

- LiCheckUnit provided **2 TNAs** for **2 users** covering a total of **11 access days** from a total of 112. The LiCheckUnit requests were related to the advanced debugging of the lidar instruments. The requests applicants were experienced lidar users that required specific tests to improve the performance of the instruments.

MUSA fixed and mobile, POLIS: the reference lidar instruments are able to provide side-by-side inter-comparisons for instrument validation not only for research lidars (scientific community) but also for commercial lidars and ceilometers (the user community and the private sector). During the first period of the project, *MUSA fixed* was involved in two inter-comparisons campaigns involving two commercial instruments: the mini-MPL commercial lidar provided by Sigma Space Corporation and the Campbell CS135 ceilometer. Both instruments were sent to Potenza for inter-comparison with the reference *MUSA fixed* lidar instrument. These instruments (commercial lidars and ceilometers) are able to provide an extended spatial and temporal coverage for long-term observations in scientific and operational networks. Without higher specification reference

instrumentation, it is not possible to assess in great detail the sensitivity and stability of commercial instruments. For this, the performance of the instrument has to be assessed in different environmental conditions by direct comparison to the reference MUSA instrument.

- *MUSA fixed*: provided **2 TNAs** for **2 users** (2 inter-comparison campaigns) for operational instruments, covering a total of **28 access days** from a total of 42.
- *MUSA mobile*: provided **1 TNAs** for **2 users** (1 inter-comparison campaigns) for operational instruments, covering a total of **24 access days** from a total of 84
- *POLIS fixed*: provided **1 TNAs** for **2 users** (1 inter-comparison campaigns) for operational instruments, covering a total of **24 access days** from a total of 112

Other indicators:

- The quantity of access provided by LiCal to **non-EU users** is **16.99%** out of the total access days used (corresponding to 74 access days to non-EU members).
- LiCal provided access to 29 women users from a total of 111 users (covering **26.13%** of the total LiCal access).
- During the first reporting period LiCal provided **5.4%** of the total access TNA days to the **private sector** (CIMEL, Sigma Space Corporation) and **7%** to **public services** (national weather service: Finnish Meteorological Institute, Meteorological Observatory Hohenpeissenberg, KNMI).

Figure WP6.4 a-c shows the TNA statistics for above TNA latter indicators for each LiCal installation.

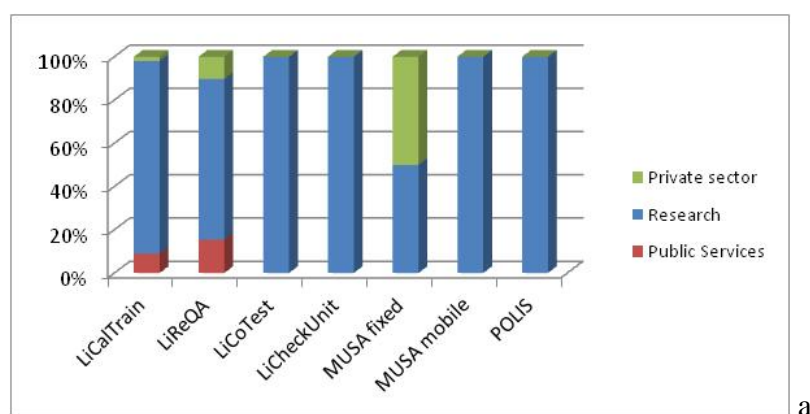
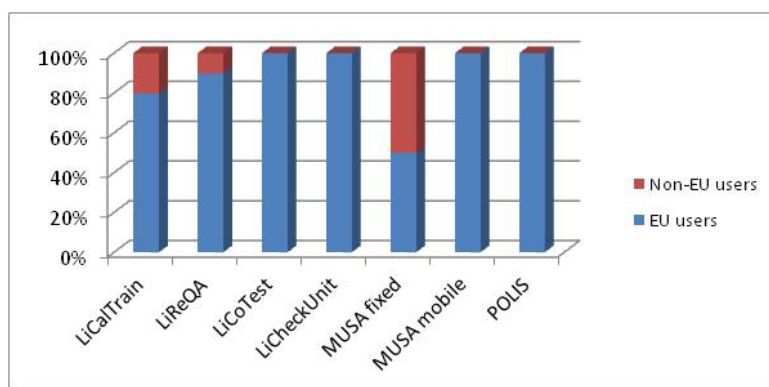
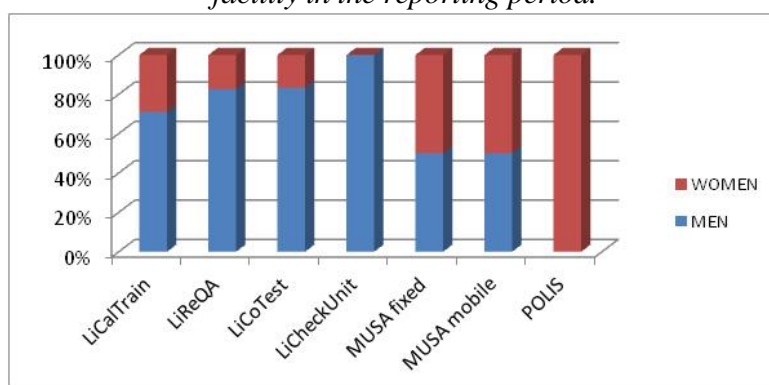


Figure WP6.4a: LiCal indicators for the quantity of access provided to private sector and public services at each the LiCal facility in the reporting period.



b

Figure WP6.4b: LiCal indicators for quantity of access to EU/non EU members at each LiCal facility in the reporting period.



c

Figure WP6.4c: LiCal indicators related to gender equality at each LiCal facility in the reporting period.

Review procedure

During this reporting period, the LiCal infrastructure was continuously open to any users via open call and specific targeted calls. All proposals were submitted by email to the Project Management Team (PMT) in the form of a short proposal. The proposals included information about the users (the applicant details, short profile, individual users and any support requested by the user) and description of the work to be performed (project information and project description: scientific relevance, instrument description and problem to be addressed). After receiving the request and verification for formal compliance with EU regulations, the PMT send all requests to the USP for evaluation. The evaluation process is based on clearly defined selection criteria, carefully chosen during the first phase of the reporting. After evaluation, all users are provided with an official answer from the PMT regardless of the evaluation result. During RP1, all TNA requests were accepted during the entire period for all eligible users accessing LiCal.

Impact:


The LiCal infrastructure is the result of the extended experience developed within the European lidar research community through several joint research projects like ACTRIS-2 and predecessor projects (ACTRIS, EARLINET-ASSOS and EARLINET). The lidar research community continues to sustain a joined effort to build a quantitative comprehensive unbiased database of the aerosol distribution on the continental scale. The level of confidence required by this approach needs dedicated measurement and data quality assurance procedures that can only be achieved in a centralized effort. The LiCal infrastructure is intended to meet the needs of the lidar research community for the harmonization of observational protocols for near-surface and remote-sensing atmospheric species.

All standard and measurement protocols are promoted continuously by all LiCal TNA activities within the ACTRIS community but also to external users like the external scientific community, the user community and the private sector. The role of this effort is to ensure that standards and measurement protocols are used in other exploratory projects to provide harmonized data to the direct benefit of the scientific community. All LiCal services provided in ACTRIS-2 are based on knowledge transfer within and outside the project by training (LiCalTrain), continuous feedback with the users after the TNA completion (LiCoTest, LiCheckUnit, LiReQA) and also by direct inter-comparisons with reference instruments (MUSA, POLIS).

By addressing directly to the private sector, LiCal is continuously facilitating a direct connection between the scientific community and SMEs that provide environmental services, instrumentation, optical components and opto-electronic modules. The SMEs awareness of LiCal activities will lead towards new opportunities for knowledge transfer, procedures and new commercial standards for emerging technologies in future remote sensing products available on the market.

Promotion of the LiCal services:

Promotion of LiCal services was realized via ACTRIS website, EARLINET website, the ITaRS portal and the official LiCal website. The LiCal infrastructure was also promoted during invited talks, conferences, workshops and project meetings (Figure WP6.5-6). Each beneficiary used its own relevant mailing list to promote the infrastructure (CNR, INOE, and LMU). LiCal promotional material is already under development at INOE and CNR (Figure WP6.7).




The Lidar Calibration Centre

a recently established ACTRIS calibration facility

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2nd ACTRIS-2
General Meeting
Feb. 29 – Mar. 4, 2016
Frascati, Italy



What is LiCal?

The Lidar Calibration Center (LiCal) is a multi-installation facility part of the ACTRIS2 project, offering a wide range of services to test and calibrate lidars and ceilometers.

Lidar calibration is a complex process, relying on the quantitative assessment of the instrument's performance (systematic errors) and its continuous control. LiCal combines a series of direct and remote techniques, involving both the equipment and the operators, to ensure a proper evaluation, maintenance, calibration and operation of the lidar. Each of the seven installations has a specific role in this process, offering together a complete characterization and optimization of lidar instruments:

LiCal Facilities:

- Lidar Calibration Training Laboratory (LiCalTrain)** operates a multiwavelength depolarization Raman lidar, a scanning depolarization UV lidar, a tropospheric ozone lidar and complementary instrumentation as well as dedicated software tools to test, characterize, calibrate and validate lidar measurements.
- Lidar Components Testing Laboratory (LiCoTest)** has a long expertise in characterizing laser beams and optical components. This lab also covers spectroscopic ellipsometry measurements and spectral characterization of interferential filters, beam splitters and dichroic mirrors.
- Mobile reference lidar POLIS** measures at two elastic wavelengths - 355 nm and 532 nm and their Raman shifted wavelengths - 387 nm and 607 nm, and linear depolarization ratio at 532 nm.
- Reference lidar MUSA** (in fixed or mobile configuration) is a multi-wavelength depolarization Raman with 3 elastic - 1064, 532, 355 nm, 2 Raman - 607, 387 nm, and linear depolarization ratio at 532 nm. It is the only reference instrument operating simultaneously 3 elastic (including the infrared) and 2 Raman channels.
- Lidar Remote Quality Assurance (LiReQA)** operates dedicated software tools (raytracing for analyzing the transmitter and receiver optics, lidar polarization analysis software, lidar radiation power budget analysis software, analysis of test measurements specialized for individual lidar setups) to perform fault diagnosis of any lidar system.
- Lidar Check-up Unit (LiCheckUnit)** is a portable unit (polarization analysis instruments for inspection of transmitter and receiver optics, adapted instruments for checking the alignment of the lidar systems, lidar pulse simulator for inspection of the detection electronics) which can be used at the user site to inspect and debug the instrument.

Provided services

- Characterization of basic components (LiCoTest)**
 - laser beam characterization, optical and spectral characterization of lenses, filters, mirrors and fiber optics
 - spectroscopic ellipsometry measurements, polarization measurements
 - paraxial analysis of optical systems
 - electronic modules synchronization, stability, response timespeed.
- Assessment of overall system's performance**
 - made by side-by-side comparison with POLIS or MUSA. These systems can be used as reference for scientific lidars
- Systematic quality assurance of the optical and electronic chains and fault diagnosis** is performed at LiReQA.
 - ensures a homogeneous characterization of the instruments
 - identifies possible biases or instrumental problems.
- Inspection, debugging and optimization of lidars** is performed by LiCheckUnit.
- Intensive training to maintain and check the calibration** is provided at LiCalTrain
 - focusing on good practices in lidar measurements and correct application of QA tests

Past experience

Up to now:

LiCal had offered a significant number of accesses within EARLINET, ACTRIS, ESA-GEOS, ITaRS, as well as for the master and doctoral programs at the Romanian, Italian and German Universities and national research programs.

LiCal installations have hosted about 48 projects (intercomparisons, sample analysis, training, system inspection) and 1260 access days per year, for a number of 51 external users per year, out of which 30 international users.

Within the frame of EARLINET and ACTRIS, LiCal has been serving the scientific community (about 20 active lidar stations, regular access), the user community (several lidar/ceilometer operators belonging to weather services and aviation) and the private sector (about 3 companies / developers and integrators).

LiCal was also involved in several intercomparison (SLICE2000, EARL09, SPAL10, SOL10, ROL10, AQUIL12, NAL13, LEL13) and scientific campaigns (ACTRIS SUMMER 2012 Campaign, Charnes EARLINET 7th exercise - Jul. 2012, EMEP summer and winter campaign - Jun-Jul. 2012 and Jan-Feb. 2013, Charnes 2013)

While regular users (e.g. EARLINET stations) are accessing LiCal installations systematically in order to fulfil the agreed standards and ensure homogeneous data quality, it is expected that the number of new users will increase considerably during the project. These are weather services and aviation safety administrations, which are now in the process of implementing such systems for warning or monitoring purposes, as well as lidar/ceilometer developers.

LiCal will also be used within the research community: new lidar stations will be soon operational in countries which have recently joined EU or are now in the process (Serbia, Croatia, Republic of Moldova, etc.).

Who can access LiCal?

Up to now LiCal was mainly used by research networks. Being unique in Europe and in the world, LiCal is now able to offer to the external community access to the QA tools, procedures and standards developed by EARLINET, implemented and tested at network level during ACTRIS. Moreover, the new developments foreseen in NA2, will be picked-up by LiCal as soon as they will be fully tested and documented.

How to access LiCal?

Access will be provided to one or more LiCal installations, based on the user's request and identified needs. The user has to shortly describe the system to be calibrated and the problems identified / suspected. Facts such as "test calibration date", "major upgrades", "expertise of the operators", "application and recommended measurement accuracy" will be taken into consideration by the LiCal User Selection Panel when recommending and granting access to (a) specific LiCal installation(s).


Physical access will be provided by LiCalTrain, LiCheckUnit, POLIS and MUSA.
 Remote access will be provided by LiCoTest and LiReQA.

website: lcal.inoe.ro www.actris.eu/DataServices/InstrumentCalibration/LIDAR.aspx

Support

Support is offered to the external and international users in terms of travel assistance and fiscal authority. Within the available budget, selected proposals can be provided with support money for travel.

- For all activities involving training, users are provided with documentation, training material, and have access to lecture rooms, internet, instruments and software.
- For scientific and technical support, the LiCal experts are directly involved and at the disposal of the users for explanations and clarifications.
- Access to the characterization, testing and check-up installations helps the users to properly assess the instrumental errors, optimize the systems and quantify the data uncertainty.
- Access to the hands-on training installations (including during intercomparisons) provides the user with the necessary expertise to properly operate, maintain and calibrate their systems on long term, therefore to allow quantitative measurement of relevant aerosol parameters (Angstrom coefficients, lidar ratio, linear particle depolarization ratio, microphysics).



ACTRIS (www.actris.eu) is supported by the European Commission under the Horizon 2020 - Research and Innovation Framework Programme, H2020-INFRAIA-2014-2015, Grant Agreement number: 654109

Figure WP6.5: LiCal advertising at the 2nd ACTRIS-2 General Assembly Meeting ESA/ESFRIN Frascati, Italy, March 3, 2016



ACTRIS Lidar Calibration Centre

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3rd ACTRIS-2 General and MTR Meeting
Jan. 30 – Feb. 3, 2017
Granada, Spain



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LiCal Facilities

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Lidar Components Testing Laboratory (LiCoTest) has a long expertise in characterizing laser beams and optical components. The lab covers spectroscopic ellipsometry measurements and spectral characterization of interferential filters, beam splitters and dichroic mirrors.

Mobile reference lidar POLIS measures at two elastic wavelengths - 355 and 532nm and their N2-Raman shifted wavelengths and the linear depolarization ratio at 532 nm and 355 nm.

Reference lidar MUSA is a multi-wavelength depolarization Raman with 3 elastic, 2 Raman, and one linear depolarization ratio at 532 nm. It is the only reference instrument operating simultaneously 3 elastic (including the infrared) and 2 Raman channels.

Lidar Remote Quality Assurance (LiReQA) operates dedicated software tools (raytracing for analyzing the optics, lidar polarization analysis software, lidar radiation power budget analysis software, analysis of test measurements specialized for individual lidar setups) to perform fault diagnosis of any lidar system.

Lidar Check-up Unit (LiCheckUnit) is a portable unit (analysis instruments for inspection of transmitter and receiver optics, adapted instruments for checking the alignment of the system, pulse generator for inspection of the detection electronics) to be used at the user site to debug the lidar.



Provided services

Characterization of basic components (LiCoTest)

- laser beam characterization, optical and spectral characterization of lenses, filters, mirrors and fiber optics
- spectroscopic ellipsometry measurements, polarization measurements
- paraxial analysis of optical systems

Assessment of overall system's performance

- made by side-by-side comparison with POLIS or MUSA.

Systematic quality assurance of the optical and electronic chains and fault diagnosis is performed at LiReQA.

- ensures a homogeneous characterization of the instruments
- identifies possible biases or instrumental problems.

Debugging and optimization of lidars is performed by LiCheckUnit.

Intensive training to maintain and check the instrument at LiCalTrain

- focusing on good practices and correct application of QA tests

LiCal can provide characterization of components, blocks and channels, debugging and optimization, intensive training and direct comparison with a reference system. The services are not restricted to research lidars. Commercial systems and ceilometers can also be evaluated, including parts and sub-systems. Many LiCal tools and procedures have already been developed (e.g. QA tests, depolarization calibration, tests for different optics, comparison with a reference instrument, training with focus on EARLINET requirements) towards the concepts for ACTRIS RI.

Up to now

1st LiCoTest workshop (23-27 May 2016):
Main focus: a) interference filters center wavelength, homogeneity, bandwidth within an accuracy <0.1nm at 0 degrees; b) spatial homogeneity of the linear polarization filters used in the depolarization channels: extinction ratio (1mm spots), overall extinction ratio; c) emission optics transmittance and reflectance parameters (Rp, Rs, Tp, Ts), retardation at 45 degrees incidence angle +5-degree (accuracy 0.1 degree and resolution 0.5 degrees)

1st LiCalTrain workshop (23-27 May 2016):
Main focus: a) basics of the instrument; b) common problems and solutions; c) ACTRIS-EARLINET QA tests (theory, tools, hands-on, analysis); d) good practices in operation and maintenance; e) problem identification; f) introduction to data check-up procedures.

1st LiReQA test analysis (March 2016):
Main focus: analysis of the ACTRIS-EARLINET QA tests

2nd LiCalTrain workshop (27th February – 3d March 2017):
Main focus: data processing with emphasis on depolarization measurements and their calibration. The specific topics covered will include: a) Pre-processing and optical processing of lidar signals b) Correction of polarization effect on lidar signals c) Calibration of depolarization measurements d) Use of SCG to automatically perform these tasks. The workshop will give emphasis on hands-on training, and participants are expected to bring and analyse their own data

• General (continuous) call:

LiCalTrain ➡ 2 workshops (1 pending)
➡ 19 finalized projects

LiCoTest ➡ 1 workshop (continuous call)
➡ 6 finalized projects

LiReQA ➡ 1 call (continuous call)
➡ 21 finalized projects

LiCheckUnit ➡ 2 finalized projects

MUSA Fixed ➡ 3 finalized projects + 1 pending

MUSA Mobile

POLIS

(for debugging of the lidar instruments)

Figure WP6.6: LiCal advertising at the ACTRIS-2 MTR and General Assembly Meeting, Science Museum, Granada, Spain, 30 Jan – 04 Feb, 2017

Lidar Calibration Centre - LiCal

- characterization of basic lidar components
- assessment of the overall system's performance
- systematic quality assurance
- inspection, debugging and optimization
- intensive training to maintain and check the calibration

The Lidar Remote Quality Assurance (LiReQA) operates dedicated tools to perform diagnosis of any lidar system

The Lidar Calibration Training Laboratory (LiCalTrain) operates lidar instruments and complementary instrumentation to train on testing, characterize, calibrate and validate lidar measurements

The mobile reference lidar POLIS can be easily moved to the user's site to perform side-by-side intercomparison.

The reference lidar MUSA can be moved at the user site or can be operated at the host for longer intercomparisons.

The Lidar Components Testing Laboratory (LiCoTest) has a long expertise in characterizing laser beams and optical components which are part of the transmitter and receiver.

The Lidar Check-up Unit (LiCheckUnit) is a portable unit which can be used at the user site to inspect and debug the instrument

Contact:

Access to the Lidar calibration Centre is open. Applicants are required to download the access request form, fill in the corresponding information and send it to: opical@inoe.ro

For more information please visit: lcal.inoe.ro www.actris.eu

ACTRIS-2 grant agreement No 654109

Figure WP6.7: LiCal rollout for advertisement – first draft

LiCal advertising was performed by several channels:

- Websites
 - LiCal website (<http://lcal.inoe.ro>)
 - ACTRIS (www.actris.eu/Outreach/News/CallsforTNA/LiCalcall2016.aspx)
 - ITaRS portal (<http://itars.uni-koeln.de/static/index.php.1.html>)
 - https://twitter.com/ecars_project/status/821269434237153280

website

- ECARS website (<http://ecars.inoe.ro>)
- Outreach activities
 - Invited talks (*Planned training activities* at Lical, Doina Nicolae, 2nd ACTRIS-2 General Assembly Meeting ESA/ESFRIN Frascati, Italy, March 3, 2016; *The Lidar calibration centre, a recently established ACTRIS calibration facility*, Belegante Livio, 2nd ACTRIS-2 General Assembly Meeting ESA/ESFRIN Frascati, Italy, March 3, 2016)
 - Conferences (EGU 2016, April, Vienna, Austria. EAC 2015, Milan, Italy <http://www.eac2015.it/>. DUST 2016, Castellaneta Marina, Italy, <https://www.scientevents.com/dust2016/>)
 - Workshops (ECARS workshop, May 2016, Magurele, Romania)
 - Project meetings (MULTIPLY - <http://environment.inoe.ro/article/172/multiply-about>, ECARS - <http://ecars.inoe.ro/>)
 - ILRC 2015 (“Lidar Calibration Centre” Gelsomina Pappalardo, Volker Freudenthaler, Doina Nicolae, Lucia Mona, Livio Belegante, Giuseppe D’Amico, ILRC 27, July 5 - July 10, 2015 New York, USA)
 - ILRC28 2017 – submitted paper
- Mailing lists (each beneficiary was responsible to distribute promotional information about LiCal via email)

Future plans to promote the LiCal infrastructure and services are under development: the first draft of the LiCal roll-up is finalized and future LiCal flyers designed to promote the LiCal activities are also considered.