Workshop on Photometer Calibration: Utilizing LED Lights in Accordance with CIE 251:2023 Standard

Summary Report

APEC Sub-Committee on Standards and Conformance

November 2026

Asia-Pacific
Economic Cooperation

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Workshop on Photometer Calibration: Utilizing LED Lights in Accordance with CIE 251:2023 Standard (Reference Spectrum L41 Domestic Metrology Institutes)

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Produced by
Mr. Tony Bergen (Consultant)
Mr. Billy Berino Quispe Cusipuma (Project Overseer)
National Institute of Quality (INACAL) - Peru
Email: bquispe@inacal.gob.pe

Reviewed by
Mr. José Ramírez (Alternate Project Overseer)
Ms. Marianella Domen
National Institute of Quality (INACAL) - Peru
Email: jramirez@inacal.gob.pe

For
Asia Pacific Economic Cooperation Secretariat
35 Heng Mui Keng Terrace
Singapore 119616
Tel: (65) 68919 600
Fax: (65) 68919 690
Email: info@apec.org
Website: www.apec.org

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Glossary and Acronym List

Term	Definition
APEC	Asia-Pacific Economic Cooperation
CCT	Correlated colour temperature
CIE	International Commission on Illumination (Commission Internationale de l'Éclairage), the leading international authority on light and lighting
CMC	Calibration and measurement capability
DMI	Domestic metrology institute
L41	White LED reference spectrum defined in CIE 251:2023, with a CCT of approximately 4 100 K, intended as an ideal reference spectrum for sources used to calibrate photometers
L41 source	A source with a spectral distribution intended to closely match L41
LED	Light-emitting diode
NIM	National Institute of Metrology, China
Photometer	An instrument for measuring photometric quantities, such as an illuminance meter, luminance meter or goniophotometer
Spectral mismatch	An error that arises when the spectral composition of the measured source differs from that of the calibration source and the broadband photometer's responsivity differs from the ideal V(λ) function
V(λ) function	Spectral responsivity of the human eye under photopic lighting conditions, where the level of adaptation is greater than 5 $cd \cdot m^{-2}$, such as daylight and most indoor lighting conditions

For brevity, the phrase "implemented L41" is used in this report to mean the implementation of an L41 source for photometer calibration.

APEC Nomenclature

AUS	Australia
BD	Brunei Darussalam
CDA	Canada
CHL	Chile
PRC	People's Republic of China (China also acceptable)
HKC	Hong Kong, China
INA	Indonesia
JPN	Japan
ROK	Republic of Korea (Korea also acceptable)
MAS	Malaysia
MEX	Mexico
NZ	New Zealand
PNG	Papua New Guinea
PE	Peru
PH or PHL	The Republic of the Philippines (the Philippines also acceptable)
RUS	The Russian Federation*
SGP	Singapore
CT	Chinese Taipei
THA	Thailand
US or USA	United States
VN	Viet Nam

1. Executive summary

In 2023, the International Commission on Illumination (CIE) published CIE 251:2023, LED Reference Spectrum for Photometer Calibration [1]. The publication introduces the CIE reference spectrum L41, which is intended to replace incandescent sources in the calibration of photometers, including illuminance and luminance meters. Using an L41 source enables more accurate calibration for measurements of LED sources, which are now predominant in commercial, industrial and residential settings. More accurate measurements can support the uptake of higher-efficiency light sources, contributing to energy savings and improvements in the quality and reliability of lighting products.

The project had two objectives:

1. Conduct a survey to determine the uptake of L41 among domestic metrology institutes in the two years following the publication of CIE 251:2023.
2. Hold a four-day workshop through which participants from APEC domestic metrology institutes could develop theoretical and practical knowledge of calibration using L41 sources, thereby enhancing their expertise and capabilities.

This report summarises the survey findings and provides details of workshop participation, activities, outputs and outcomes. The full survey report and supporting files are provided as attachments.

2. Introduction and project overview

The project consisted of two main activities designed to support the implementation of CIE 251:2023 reference spectrum L41 across APEC economies.

The first activity was a survey of primary laboratories to assess the uptake of L41-based calibration practices and related photometric activities, such as, (i) the level of implementation of calibration standards based on the CIE reference spectrum L41; (ii) the nature of photometer and source calibrations performed by the laboratories; and (iii) the transition from traditional sources to LED sources within the participating economies.

The second activity was a capacity-building workshop held in Beijing, China, focusing on the practical and theoretical aspects of photometer calibration using LED reference sources. This activity involved participants from China; Hong Kong, China; Indonesia; Malaysia; Mexico; Peru; the Philippines; Thailand; and Viet Nam.

3. Background and objectives

Over the past two decades, LED light sources have increasingly replaced traditional sources, including incandescent, fluorescent and high-intensity discharge lamps, in interior and exterior lighting applications. LED sources have become more efficient and longer-lasting and therefore provide a robust, energy-efficient alternative to traditional sources. Test methods for photometric and colorimetric measurements of LED lighting devices include CIE S 025 [2] and IES LM-79 [3].

Illuminance meters, also called luxmeters, and luminance meters are two types of instruments which measure light and are collectively known as photometers. Illuminance meters measure the amount of light (illuminance) incident on a surface, such as the light illuminating a desk for an office worker to achieve a given task or the amount of light on a sports pitch for players to compete and for observers in the crowd to see or for television cameras to record. Luminance meters measure the luminance (brightness) of surfaces that are intended to be viewed by an observer, such as the brightness of computer monitors, the visibility and readability of emergency exit signs, etc.

Photometers measure light which is visible to an average human eye. Their spectral responsivity, i.e. their sensitivity to different wavelengths of light, is designed to match a spectral distribution called the $V(\lambda)$ function, which is published by the CIE, and which represents the typical spectral response of the human vision in photopic (daytime) conditions [4]. Photometers have traditionally been calibrated using light sources based on CIE standard illuminant A: an incandescent lamp run at a particular lamp filament current so that their light output has a prescribed correlated colour temperature.

A key issue in the photometry of LED lighting devices is spectral mismatch. Errors arise when a photometer's spectral responsivity does not perfectly match the $V(\lambda)$ function and the spectral distribution of the source being measured differs significantly from that of the calibration source. This could be encountered in practice when a photometer is calibrated using an incandescent lamp corresponding to CIE standard illuminant A but then measuring light sources with significantly different spectrum such as LED light sources. This error can be minimised by using a calibration source whose spectral composition more closely resembles that of the sources the instrument will measure.

Given the increasing use of LED light sources as the predominant light source for new lighting installations and becoming the dominant source in use throughout the world, the CIE developed an artificially designed reference spectrum, known as CIE reference spectrum L41, which was published in CIE 251:2023 [2]. This spectrum represents a broad range of phosphor-pumped white LED sources but is not based on any existing product. The spectrum is designed to minimise overall measurement error across LED sources with a range of correlated colour temperatures and most traditional light sources. The name L41 refers to its correlated colour temperature of approximately 4 100 K.

Laboratories and manufacturers are expected to develop calibration sources whose spectral distributions match L41 as closely as possible. For photometer calibration, matching the spectral distribution is more important than matching CCT alone, because sources with the same CCT may have substantially different spectral distributions.

The survey which was conducted as part of this project provided a snapshot of the uptake of CIE 251:2023 and L41 during the two years following its publication. It also gathered information on the uptake of LED light sources and the implementation of minimum energy performance standards (MEPS) across the participating APEC economies.

The workshop was intended to enable participants from APEC domestic metrology institutes to develop theoretical and practical knowledge of calibration using L41 sources. Additional topics included the fundamentals and history of photometry, human visual response, the effects of light on people, and basic and advanced approaches to measurement uncertainty.

4. Survey results

To complete the objectives of the survey, a survey was created using SurveyMonkey. It was intended to establish the degree of take-up and use of sources based on CIE reference spectrum L41 in the two years since it was published, whether those sources were commercially available or in-house developed, and also which types of calibration and testing services they were used for. In addition, the survey also asked questions regarding the scope of testing and calibration services performed by the laboratory, and also the take-up of LED lighting products within the commercial and domestic lighting sectors of the laboratory's economy as well as the implementation or planned implementation of MEPS within the economy.

The survey was sent to 19 primary laboratories in early May 2025 with a response expiry date of 29th May. There were 17 credible responses, representing a response rate of 89 %. A second survey was also created to be sent to secondary laboratories, however there seemed to be some confusion with the survey and it was not considered to be an accurate assessment.

The survey found that 29% of the primary laboratories surveyed, representing five of 17 credible responses, had implemented CIE reference spectrum L41, as shown in Figure 1. Roughly half of these were commercially available sources and half were developed in-house.

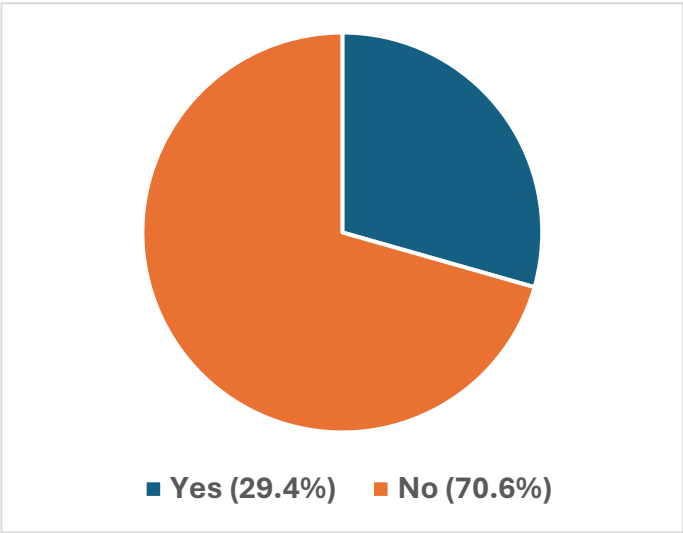


Figure 1: Proportion of primary labs which have implemented CIE reference spectrum L41 (as of May 2025)

Of the 12 laboratories that had not implemented an L41 source, 10 intended to do so in the future within the timelines shown in Figure 2. Eight laboratories planned to implement an L41 source for both illuminance meter and luminance meter calibrations, while two planned to implement an L41 source for illuminance meter calibrations only.

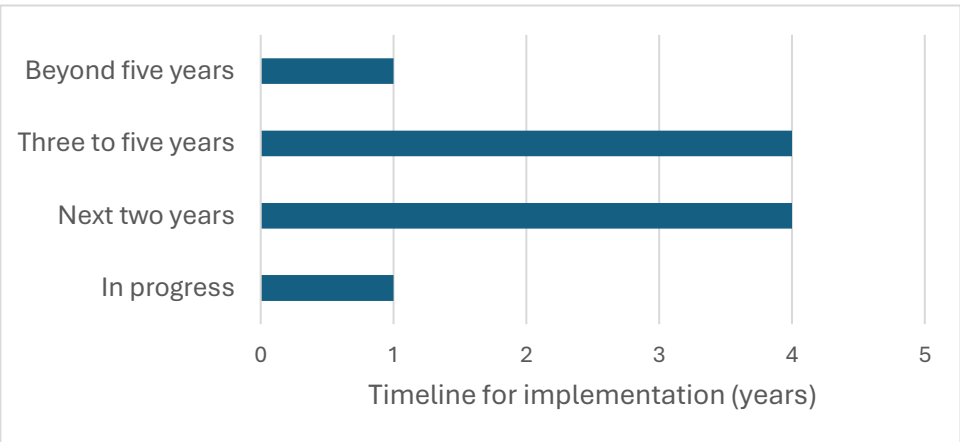


Figure 2: Timeline for implementation of L41 calibration source(s)

The complete findings of the 2025 survey, including the supplementary questions relating to the scopes of testing and the take-up of LED lighting products in the economy, are contained in report C250409-06, dated 6 July 2025, and its supporting attachments.

- C250409-06 - APEC - Survey.pdf
- C250409-06A - APEC - Survey - Primary Labs - All individual responses.pdf
- Survey results - Primary labs.xlsx
- C250409-06B - APEC - Survey - Secondary Labs - All individual responses.pdf
- Survey results - Secondary labs.xlsx

5. DMI specialists involved in the workshop

The workshop was held at two campuses of China's National Institute of Metrology (NIM) from 1 to 4 June 2026. It consisted of 28 participants from a range of domestic metrology institutes and standardisation organisations from the following APEC economies:

- China
- Hong Kong, China
- Indonesia
- Malaysia
- Mexico
- Peru
- The Philippines
- Thailand
- Viet Nam

The workshop participants were mainly metrologists from the participating laboratories, but were also technical officers, engineers, researchers, laboratory directors/managers and other staff roles. Also attending the workshop were Project Consultant Mr Tony Bergen, Australia; NIM contact Dr Zhao Weiqiang, China; as well as Dr Liu Hui and Dr Yan Jinyun from NIM, China.

Additionally, an Expert Speaker session on L41 and related topics was held on the afternoon of the third day, which included online speakers from Australia and the United States, and which was attended by additional online participants.

The workshop topics and structure, as well as the content of the lectures, were provided by the Project Consultant, Mr Tony Bergen. Local support and organisation of NIM's laboratories for the practical part of the workshop was provided by the NIM Contact Dr Zhao Weiqiang. Overall project coordination and interaction with APEC secretariat was handled by staff at INACAL, Peru, led by the Project Overseer Dr Billy Berino Quispe Cusipuma.

6. Workshop programme

As defined in the Project Proposal, the workshop was intended to be divided equally between theory and practice. Accordingly, the workshop was structured so that the theory and practical parts were mixed, so that there was not too much of a demand for concentration in intensive lectures as they were interspersed with practical demonstrations and hands-on sessions.

The workshop commenced with an introduction to the fundamentals of photometry and radiometry, including the principles of optical radiation, photometric measurements, spectroradiometry, and the historical development of photometric standards. Particular attention was given to the challenges associated with the measurement of LED lighting products and the limitations of traditional calibration approaches based on incandescent sources. Discussions focused on the development of the CIE reference spectrum L41, the rationale for its adoption, and its role in reducing spectral mismatch errors in photometer calibration.

Building on these foundations, participants explored calibration methodologies for illuminance meters and luminance meters. Discussions examined both source-based and detector-based calibration approaches, the advantages and limitations of different calibration sources, and practical considerations for implementing L41-based calibration systems. Through presentations and technical exchanges, participants gained a clearer understanding of the standards, equipment, and laboratory conditions required to establish and maintain reliable photometric calibration capabilities.

A significant component of the workshop consisted of practical laboratory activities hosted by Dr Zhao Weiqiang and the team at National Institute of Metrology (NIM). Participants observed demonstrations of fixed-output and variable-output L41 calibration sources and toured NIM's photometric facilities, including illuminance meter calibration systems, goniophotometers, integrating spheres, spectroradiometric equipment, and temporal light modulation measurement systems. These demonstrations provided participants with direct exposure to advanced laboratory infrastructure and operational practices used in photometric metrology.

Hands-on exercises formed a central part of the workshop. Participants were able to observe and take part in the calibration of illuminance meters and luminance meters, with several attendees bringing instruments from their own laboratories. These practical sessions facilitated discussion on alignment techniques, measurement procedures, stray-light control, instrument positioning, and the factors influencing measurement uncertainty. The opportunity to compare approaches and equipment from different economies further enhanced the exchange of technical knowledge among participants.

An expert speaker session provided additional perspectives on regional developments related to photometer calibration, implementation of the L41 reference spectrum, and energy-efficiency policy. Presentations covered the results of the project survey on L41 implementation, experiences in developing and evaluating L41 sources, and the role of minimum energy performance standards in promoting high-quality and energy-efficient lighting products. The session encouraged participants to discuss common technical challenges and opportunities for future regional cooperation.

The final section of the workshop focused on measurement uncertainty, an area identified by many participants as critical for strengthening laboratory capability. Presentations examined the principles of uncertainty evaluation, statistical analysis, uncertainty budgets, and advanced approaches such as Monte Carlo methods. Participants discussed practical examples relevant to photometric calibrations and explored methods for improving confidence in measurement results.

Throughout the workshop, discussions consistently highlighted the growing importance of LED-based calibration methods, the benefits of adopting the CIE L41 reference spectrum, and the need for continued technical cooperation among APEC economies. Participants expressed strong interest in future training activities, interlaboratory comparisons, and knowledge-sharing initiatives to support the ongoing development of photometric measurement capabilities across the region.

The detailed workshop agenda is provided in Annex 1, an outline of the expert speaker session is given in Annex 2, and pictures taken during the workshop, including some pictures of the practical demonstrations, are given in Annex 3.

7. Outcomes for participants

7.1 Expected outcomes and evidence of achievement

During the opening of the workshop on Day 1, one participant from each of the participating organisations was invited to introduce themselves and their facility. They were also encouraged to outline what outcome they were hoping to get out of the workshop.

A selected summary of the expected outcomes stated by the participants is shown in Table 1, along with comments on evidence of the completion of these objectives during the workshop.

Table 1. Expected outcomes and evidence of achievement of those outcomes

Expected outcome	Evidence of achievement
Acquire practical insights into photometer calibration using LED sources.	This was addressed through the technical lectures, laboratory demonstrations and hands-on calibration exercises.
Observe good practices and laboratory setups.	Participants observed NIM equipment, facilities and procedures.

Table 1. Expected outcomes and evidence of achievement of those outcomes

Expected outcome	Evidence of achievement
Exchange technical knowledge and experience.	This was facilitated through the presentations, practical sessions and technical discussions. Participants also mingled and interacted well with each other during breaks.
Identify opportunities for capability enhancement.	Participants reviewed equipment, procedures and approaches that could inform development within their institutions, as well as experiencing the theoretical presentations which they could take back to their own workplaces to inform others.
Understand source-based and detector-based calibration methods.	These topics were covered in the theory sessions and practical demonstrations.
Understand the standards and equipment required to implement L41-based calibration.	These topics were covered in the theory sessions and practical demonstrations.
Strengthen knowledge of measurement uncertainty.	This was addressed through basic and advanced lectures and example uncertainty budgets, with a whole morning session dedicated to this topic.
Learn from other domestic metrology institutes.	This was enabled through cross-economy exchange and participant presentations.
Explore future collaboration on LED measurement and L41 implementation.	Participants identified regional exchanges, training and interlaboratory comparisons as potential follow-up activities.
Explore an Asia-Pacific interlaboratory comparison system.	No comparison system was established during the project; however, participants recommended this as a future activity.

The evidence presented in Table 1, together with the workshop discussions and presentations described in Section 6 and the findings reported in Sections 7.2 and 7.3, demonstrates that the workshop successfully achieved the outcomes identified by participants at the beginning of the event. Participants were exposed to both theoretical and practical aspects of L41-based photometer calibration, including calibration methodologies, measurement uncertainty, laboratory practices, and regional experiences. The knowledge and skills self-assessment increased from an average of 2.81 out of 5 before the workshop to 4.29 out of 5 after the workshop, while 19 of the 21 survey respondents strongly agreed that the project achieved its intended objectives and the remaining two respondents agreed. These results indicate that the workshop effectively met participants' expectations and delivered the intended capacity-building outcomes.

7.2 Key takeaways reported at the end of the workshop

During the Round Table in the closing of the workshop, participants reported that the workshop had provided both practical and strategic insights that could be applied in their laboratories. Discussions showed that participants particularly valued the hands-on calibrations activities, the opportunity to observe advanced facilities at NIM, and the exchange of experiences with specialists from other APEC economies. Key takeaways included:

- Greater understanding of alignment methods for lamps and detectors.
- Improved understanding of NIM's LED lamp with a planar filament.
- Recognition of the importance of adapting calibration methods to LED spectra to reduce spectral mismatch.
- Exposure to automated optical-rail, luminance meter and high-illuminance calibration setups.
- Stronger understanding of measurement uncertainty, terminology and practical calibration methods.
- Increased confidence in implementing L41-based calibration.

- New professional connections across participating APEC economies.

7.3 Outcomes reported in the written survey

During the final session, participants completed a post-event survey. Twenty-one completed surveys were received, and the complete set of responses are provided as an external attachment. A summary of the survey outcomes is given in Tables 2, 3 and 4.

Table 2. Agreement with statements about the workshop

Statement	Strongly agree (3)	Agree (2)	Disagree (1)	Average
The objectives of the training were clearly defined	20	1	0	2.95
The project achieved its intended objectives	19	2	0	2.90
The agenda items and topics covered were relevant	20	1	0	2.95
The content was well organised and easy to follow	19	2	0	2.90
Gender issues were sufficiently addressed during implementation	16	4	1	2.71
The trainers, experts and facilitators were well prepared and knowledgeable	21	0	0	3.00
The materials distributed were useful	19	2	0	2.90
The time allocated for the training was sufficient	15	5	1	2.67

Table 3. Relevance of the project

Question	Very (5)	Mostly (4)	Somewhat (3)	A little (2)	Not much (1)	Average
How relevant was this project to you and your economy?	18	3	0	0	0	4.86

Table 4. Knowledge and skills before and after the workshop

Question	Very high (5)	High (4)	Medium (3)	Low (2)	Very low (1)	Average
Before participating in the event	2	0	12	6	1	2.81
After participating in the event	9	9	3	0	0	4.29

The results indicate that participants considered the project highly relevant to their economies. The average self-reported knowledge and skills rating increased from 2.81 before the workshop to 4.29 afterwards, an increase of 1.48 points. This substantial reported increase, together with the other evaluation results, indicates that the workshop met its principal learning objectives.

Participants reported that they had gained knowledge of alignment systems, L41 standard lamps, source-based and detector-based calibration methods, measurement uncertainty, goniophotometry and laboratory setup. They expressed that they intended to use the knowledge to develop or improve calibration procedures and facilities within their institutions.

7.4 Recommendations for future activities

The written survey had opportunity for the participants to write their recommendations on what needs to be done next by APEC. Recommended follow-up activities reported by the survey responders included:

- Regular virtual technical exchanges on L41 implementation.
- Further hands-on workshops with smaller groups or longer practical sessions.
- Interlaboratory comparisons using L41 sources.
- Bilateral or hybrid comparisons to support the development of new calibration and measurement capabilities.
- Knowledge-sharing and technical cooperation among domestic metrology institutes, particularly to support developing economies.
- Regional technical exchanges on testing luminaires and implementing LED-based calibration.

8. Overall impact and lessons learned

The project strengthened technical knowledge of L41-based photometer calibration among specialists from participating APEC economies. Combining lectures, demonstrations and hands-on activities was particularly valuable because it enabled participants to connect theoretical concepts with laboratory practice.

The participation of specialists from multiple economies supported cross-economy exchange and created a foundation for continued technical cooperation. Survey feedback also showed that participants considered the project relevant to their economies and expected to apply the knowledge in their workplaces.

The principal lessons learned were that practical sessions require sufficient time; smaller groups can improve access to equipment; and sustained regional exchange is important for economies at different stages of implementing L41. Future activities should therefore allocate more time to hands-on work and consider structured follow-up mechanisms.

9. Next steps and future activities

The project objectives were achieved, with participants engaging in theoretical and practical training on the implementation of CIE reference spectrum L41 for photometer calibration. Participants received PDF copies of the theory-session presentations for review and internal knowledge-sharing within their domestic metrology institutes.

Potential follow-up activities include:

- Further hands-on workshops and technical training.
- Regular online meetings to maintain and strengthen connections among metrologists from APEC economies.
- Round-robin or interlaboratory comparison activities involving photometer calibration with L41 sources.
- Regional exchanges on the measurement of LED-based sources and the development of calibration and measurement capabilities.

10. Conclusions

The project objective was to strengthen the metrological capabilities of APEC economies regarding the use of LED lamps in photometric measurements, both in the manufacture of photometers and in their subsequent calibration. The survey provided a snapshot of the implementation of CIE reference spectrum L41 for photometer calibration in mid-2025.

LED lighting products are now widely used in industrial, commercial and residential sectors. The use of L41 in calibration laboratories is expected to increase over the next three to five years. L41-based calibration can improve the accuracy of LED lighting measurements, and, in turn, the quality of on-site and field measurements performed by lighting consultants, surveyors and installers, among others.

The workshop provided a strong foundation for implementing L41-based calibration sources among domestic metrology institutes in APEC economies. Participant feedback demonstrated demand for additional training and for APEC-supported interlaboratory comparisons that can consolidate and extend the knowledge gained. This

will help to facilitate more accurate measurement of LED lighting products and more accurate calibration of instruments used in field measurement of LED lighting installations.

11. References

[1] International Commission on Illumination. CIE 251:2023, LED Reference Spectrum for Photometer Calibration. Vienna: CIE, 2023. https://cie.co.at/publications/led-reference-spectrum-photometer-calibration

[2] International Commission on Illumination. CIE S 025, Test Method for LED Lamps, LED Luminaires and LED Modules.

[3] Illuminating Engineering Society. IES LM-79, Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products.

[4] International Commission on Illumination. CIE 018:2019 The Basis of Physical Photometry, 3rd Edition. Vienna: CIE, 2019. https://www.cie.co.at/publications/basis-physical-photometry-3rd-edition

Annex 1. Workshop Agenda

Workshop on Photometer Calibration: Utilizing LED Lights in Accordance with CIE 251:2023 Standard (Reference Spectrum L41 Domestic Metrology Institutes)
National Institute of Metrology (NIM), Beijing, China

Time	Activity
Morning, Day 1 (1 June 2026)	Opening remarks and welcome Participant introductions Group photograph Tour of NIM Hepingli campus and photometric primary standards
Afternoon, Day 1 (1 June 2026)	Theory session 1: Fundamentals of light and photometry History of photometry and introduction to CIE reference spectrum L41 LED lighting measurement standards and test methods Human vision and the effects of light Workshop dinner
Morning, Day 2 (2 June 2026)	Theory session 2: Photometer calibration principles Source-based and detector-based calibration methods Spectral mismatch and calibration considerations Practical session 1: Demonstration of L41 calibration sources
Afternoon, Day 2 (2 June 2026)	Practical session 2: Tour of NIM Changping Campus photometric measurement facilities Demonstrations of illuminance meter calibration, goniophotometry, integrating-sphere photometry, spectroradiometry, and temporal light modulation measurement
Morning, Day 3 (3 June 2026)	Practical session 3: Hands-on photometer calibration exercises In-depth demonstration of and participation in illuminance meter and luminance meter calibration
Afternoon, Day 3 (3 June 2026)	Expert speaker session Technical presentations and regional experience sharing Discussion and question session
Morning, Day 4 (4 June 2026)	Theory session 3: Measurement uncertainty in photometry Uncertainty budgets and statistical methods Monte Carlo methods and practical examples
Afternoon, Day 4 (4 June 2026)	Roundtable discussion Participant feedback and workshop evaluation Certificates presentation ceremony Closing remarks and group photograph

An outline of the expert speaker session which was held on the afternoon of the third day is given in Annex 2

Annex 2 Expert speaker session

Speaker	Presentation
Billy Quispe	Welcome and introduction
Tony Bergen	The CIE reference spectrum L41 for photometer calibrations
Tony Bergen	Outcomes of the 2025 survey on implementation of L41 for photometer calibration
Steve Coyne	Implementation of MEPS, HEPS and labelling for product efficiency and quality improvements
Zhao Weiqiang	Introduction to NIM laboratory capabilities and development of its in-house L41 source
Yuqin Zong	Getting ready for calibration of photometers based on the new CIE L41 source
Tony Bergen	Final discussion and wrap-up session

Annex 3. Selected photographs from the workshop



Figure 1. Roundtable introductions during the opening session.



Figure 2. From left: Project Consultant Mr Tony Bergen and representative of the Alternate Project Overseer Mr José Ramírez.



Figure 3. Participants in the opening session, including NIM Vice Director General Dr Fang Fang (front row, centre).



Figure 4. Workshop lecture room.



Figure 5. NIM staff member Dr Zhao Weiqiang demonstrating integrating-sphere equipment.



Figure 6. NIM staff member Dr Liu Hui demonstrating illuminance meter calibration.



Figure 7. Trainees undertaking a hands-on illuminance meter calibration exercise.

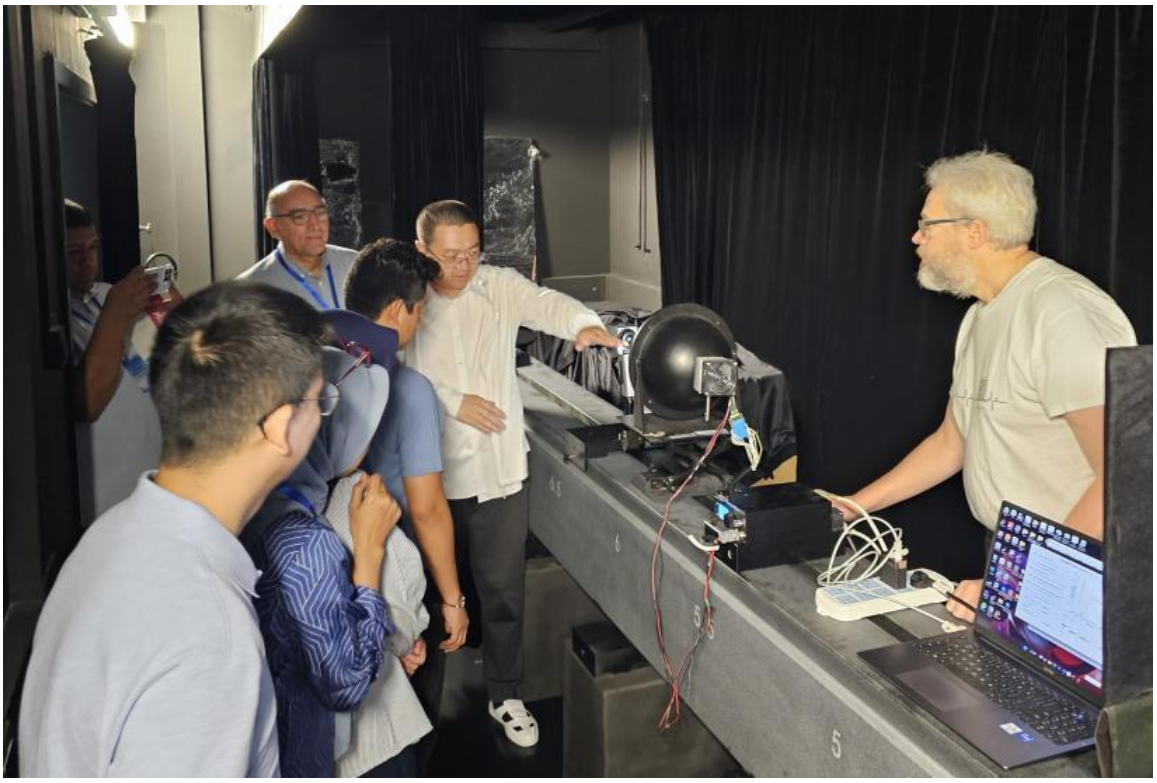


Figure 8. NIM staff member Dr Yan Jinyun demonstrating the luminance meter calibration setup.



Figure 9. Trainees with their certificates of attendance.