

COUNCIL FOR OPTICAL RADIATION MEASUREMENTS



Tenth Report:

Pressing Problems and Projected International Needs in Optical Radiation Measurements

AUGUST 2023

www.cormusa.org

INTRODUCTION

The Council for Optical Radiation Measurements (CORM, www.cormusa.org) is a not-for-profit, international organization consisting of members from industry, academia and government who are interested in the measurement of optical radiation (light, ultraviolet and infrared energy), color and optical properties of materials. CORM began as a subcommittee of the Commission Internationale de l'Éclairage (CIE) for the purpose of advising national metrology institutes (NMIs) working in photometry, radiometry and colorimetry about the needs within these communities for standardization, calibration sources, and measurement procedures and techniques.

Periodically, CORM has published reports containing the results of surveys of its members (excluding those individuals from NMIs) and summarized the results of those surveys to assist NMIs including the National Institute for Standards and Technology (NIST) in the U.S., National Research Council Canada (NRCC), Centro Nacional de Metrología (CENAM) in Mexico, the National Physical Laboratory (NPL) in the U.K., and others in developing programs to best assist industry, academia and practitioners in the measurement of optical radiation.

The previous report, the CORM Ninth Report, was published in 2020. It was a briefer report than earlier CORM Reports, and given rapid evolution and acceleration in light source technology and applications, CORM decided to prepare similarly shorter, and more frequent reports than have been published in the past. A survey was developed by CORM and circulated to members of the light and optical radiation measurement and application communities in 2021-2022. The survey consisted of several short questions:

- What type of organization are you from?
- What type(s) of products are you measuring?
- For what application(s) are your measurements relevant?
- What is your wavelength range(s) of interest?
- What light source(s) do you work with?
- What type(s) of measurements do you make?
- What kind(s) of detectors/sensors do you use?
- If/for optical properties measurements, what type(s) of materials are measured?
- What challenges do you face or anticipate?
- What accreditation requirements do you have?
- What documentary standards or guidelines do you use?
- What calibration or other services do you need from your national metrology institute (NMI)?
- What NMI service(s) are you currently using?
- What are your specialized training or educational needs?

Fifty-two individuals completed the survey. The following sections of this report address the responses to each question. Some questions had a specified list of possible responses (with “other” responses permitted), and responses to those questions are summarized with a bar chart. Other questions had a free-form text box for responses. For those questions, word clouds summarizing the collective responses were generated with the sizes of words proportional to their frequency among the answers as a guide in interpreting the responses.

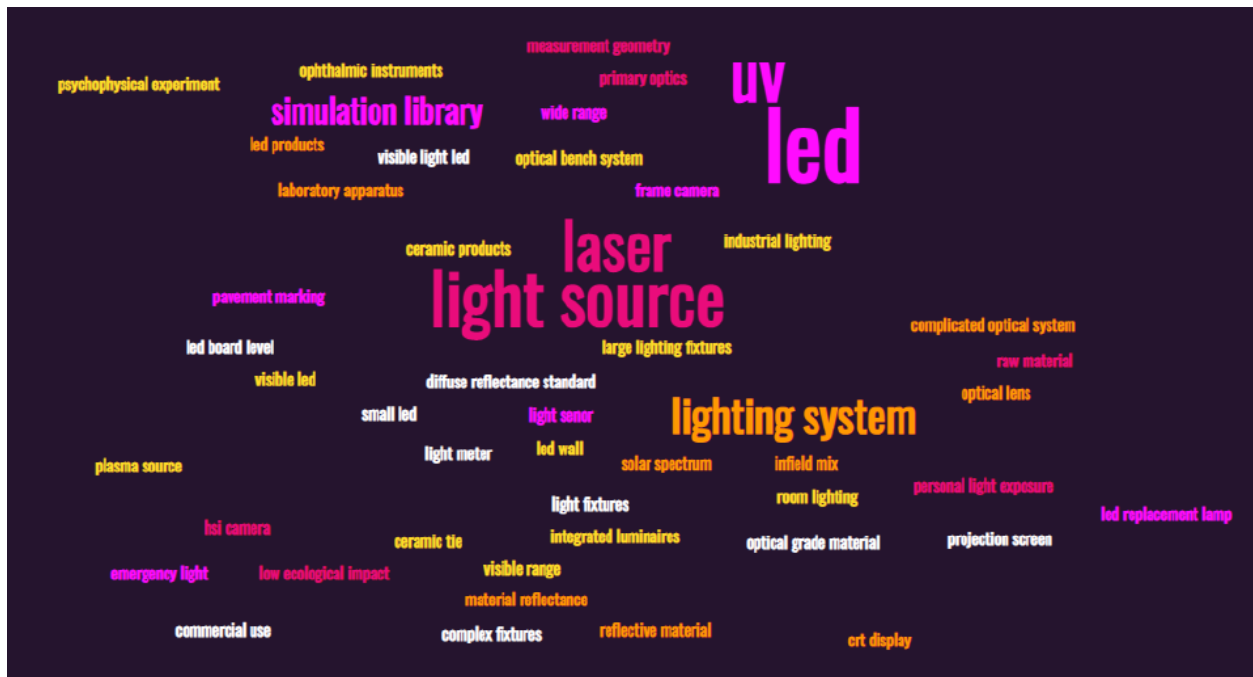
QUESTION 1: RESPONDENT ORGANIZATIONS

In response to the question ‘‘What type of organization do you work for?’’ the most frequently selected response as shown below was ‘‘academic institution,’’ followed by ‘‘instrumentation manufacturer,’’ ‘‘calibration or independent testing laboratory,’’ and ‘‘local, state/provincial or national government agency.’’ Together, these four categories represented over half of all participants. Other individuals were largely from other manufacturers or were in various consulting, research or engineering organizations.



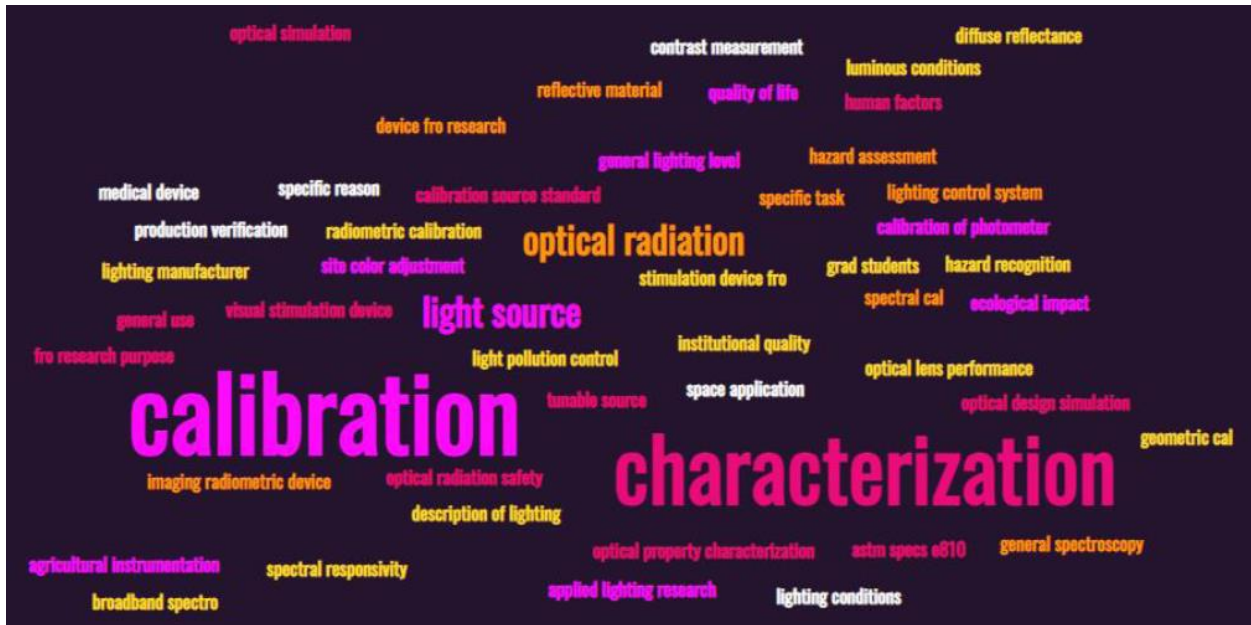
QUESTION 2: PRODUCT MEASUREMENT TYPES

In response to the question ‘‘What type(s) of products are you measuring?’’ the word cloud below suggests that most measurements among respondents are performed at the source or component level, with ‘‘LED,’’ ‘‘light source,’’ ‘‘laser’’ and ‘‘UV’’ mentioned most frequently. Nonetheless, the term ‘‘lighting system’’ was mentioned multiple times, as was ‘‘simulation library,’’ the latter suggesting that some respondents are interested in using or developing optical simulation software.



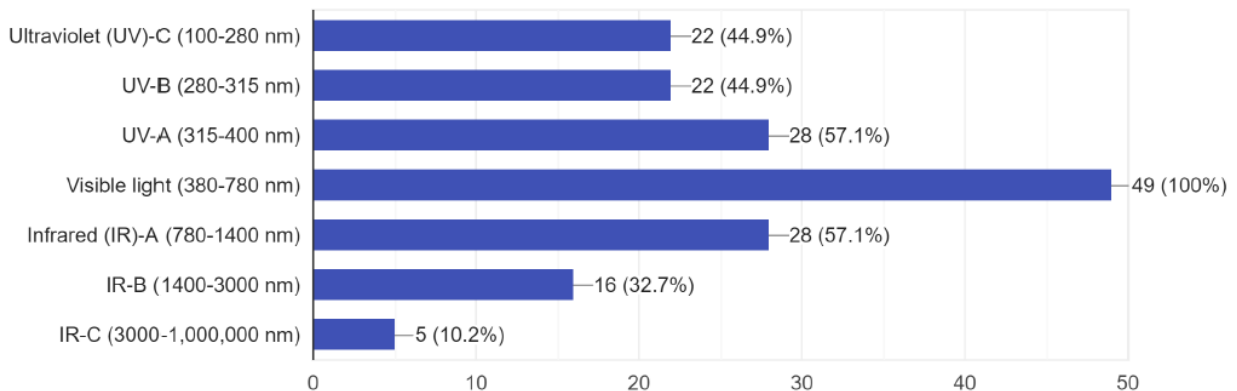
QUESTION 3: RELEVANT APPLICATIONS

For the question “For what application(s) are your measurements relevant?” two terms were prominent among the responses: calibration and characterization. This suggests that respondents need to ensure that the products and systems they work with are properly calibrated and that their performance is correctly and accurately defined. The specific applications (e.g., agriculture, transportation, medicine) are highly varied.



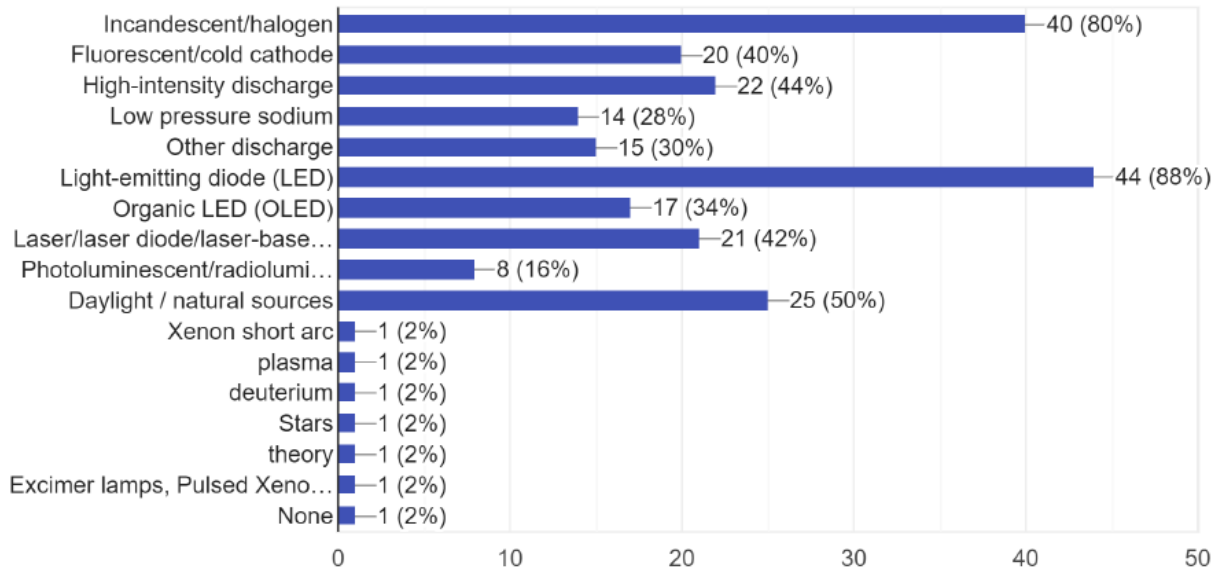
QUESTION 4: WAVELENGTH RANGES

In response to the question “What is your wavelength range(s) of interest?” all respondents included visible light (380-780 nm) among the range(s) they work with. Just over half responded that the near-ultraviolet (UV) or near-infrared (IR) ranges were among the wavelength bands of interest. UV-B and UV-C, as well as IR-B bands each were also selected by about a third or more of respondents, and 10% selected the IR-C band out to 1,000,000 nm.



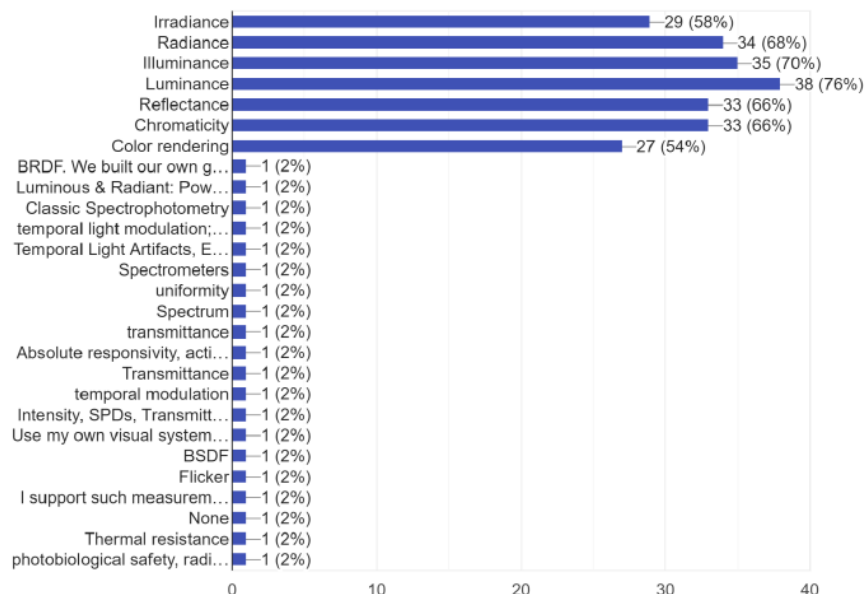
QUESTION 5: LIGHT SOURCES

In response to the question “What light source(s) do you work with?” two types of sources were selected by large majorities of respondents: light-emitting diodes (LEDs) and incandescent/halogen lamps. About half also selected daylight/natural light, and discharge and other solid-state sources were represented by sizable pluralities.



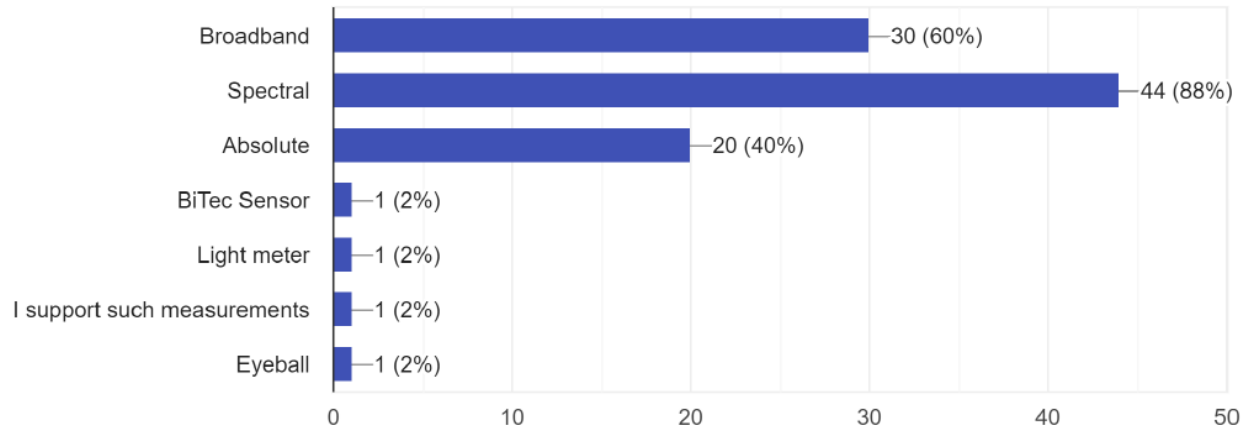
QUESTION 6: MEASUREMENT TYPES

In response to the question “What type(s) of measurements do you make?” luminance was the most commonly selected (76%) response. More than half of all respondents reported that they also made illuminance (70%), radiance (68%), reflectance (66%), chromaticity (66%), irradiance (58%) and color rendering (54%) measurements. The highest response rates to luminance and illuminance suggests that conventional lighting measurements continue to have importance among respondents.



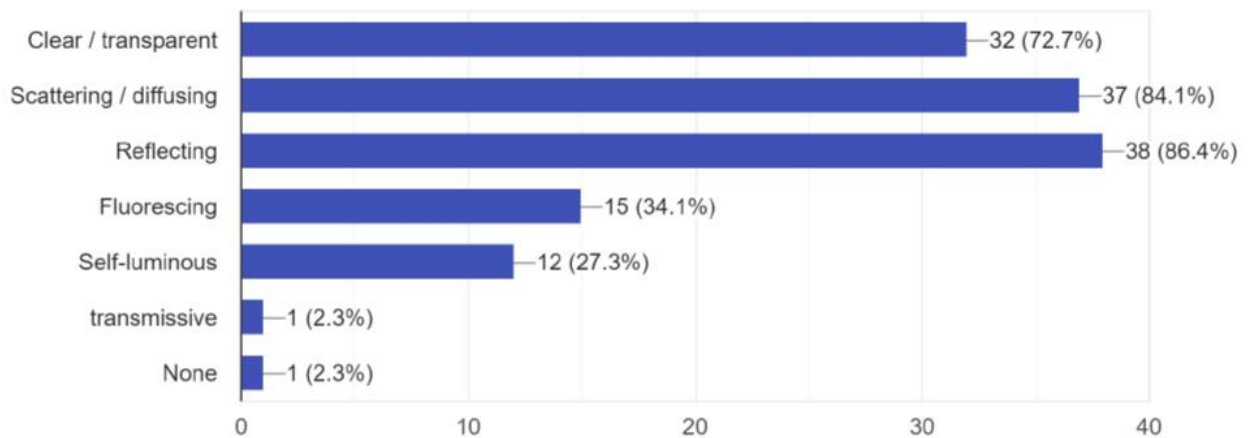
QUESTION 7: DETECTORS AND SENSORS

In response to the question “What kind(s) of detectors/sensors do you use?” the most frequently selected answer was “spectral” (by 88%), followed by “broadband” (60%) and “absolute” (40%). It is interesting that despite luminance and illuminance being the most commonly measured quantities (see Question 6), spectral measurement systems are most common.



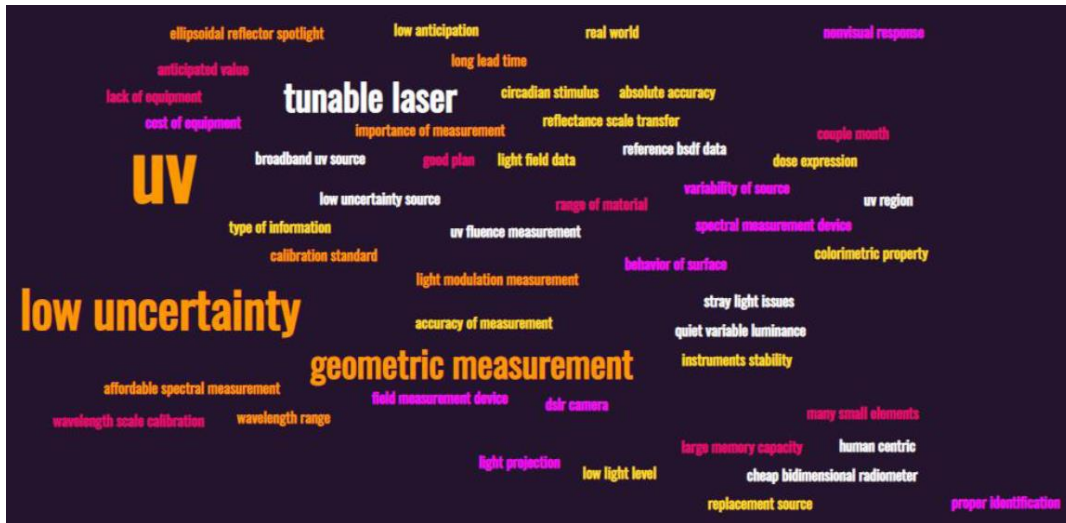
QUESTION 8: MATERIALS FOR OPTICAL PROPERTIES MEASUREMENTS

In response to the question “If/for optical properties measurements, what type(s) of materials are measured?” materials that reflect (86%), scatter/diffuse (84%), or transmit (73%) light were selected most commonly. Materials that generate light through fluorescence (34%) or direct generation of light (27%) were less commonly selected.



QUESTION 9: CURRENT AND ANTICIPATED CHALLENGES

In response to the question “What challenges do you face or anticipate?” the most commonly mentioned response was “UV.” Having “low uncertainty” was also mentioned multiple times, followed by responses such as “geometric measurement” and “tunable lasers.” The recent coronavirus pandemic may have enhanced interest in UV measurements, but the challenges facing the respondents are clearly diverse.



QUESTION 10: ACCREDITATION REQUIREMENTS

In response to the question “What accreditation requirements do you have?” the most commonly mentioned responses included “ISO”/“ISO17025,” “NVLAP,” “time” and “instruments.” There is clearly interest among respondents in International Standards Organizations (ISO) standards and in the National Voluntary Laboratory Accreditation Program (NVLAP). The mention of instruments may reflect interest in ensuring that laboratory instruments are properly calibrated to a traceable source.



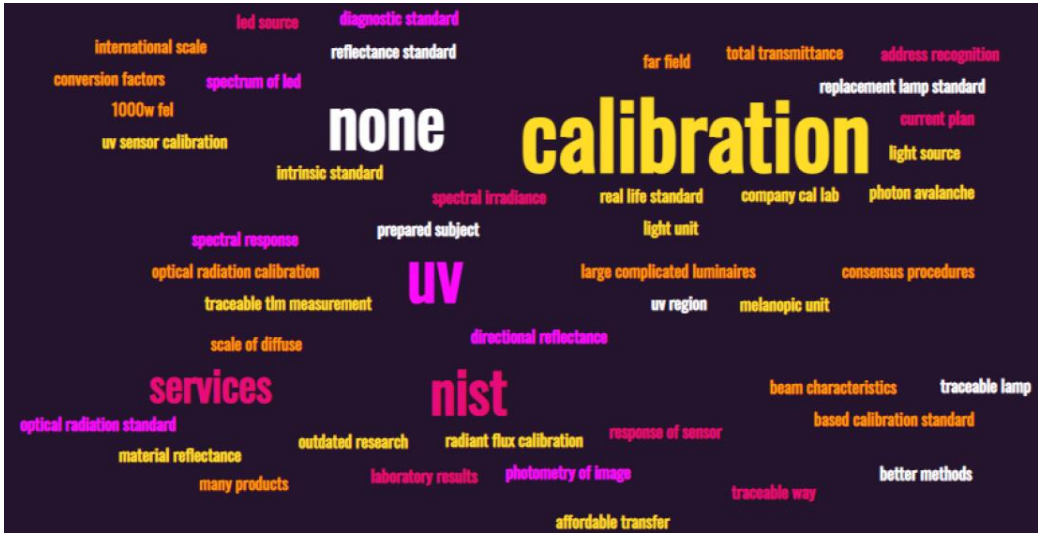
QUESTION 11: DOCUMENTARY STANDARDS OR GUIDELINES

In response to the question “What documentary standards or guidelines do you use?” many common responses included names of relevant organizations including “ISO,” “CIE,” “ANSI,” “ASTM,” “NIST” and “ACGIH.” These include application standards used in lighting practice like many Commission Internationale de l’Eclairage (CIE) standards, as well as standards for measurement practice. “LM” likely refers to Lighting Measurement standards published by the Illuminating Engineering Society (IES).



QUESTION 12: SERVICES NEEDED FROM NMIS

In response to the question “What calibration or other services do you need from your national metrology institute (NMI)?” the term “calibration” was most frequently mentioned, suggesting that this is the most important type of service that organizations like the National Institute of Standards and Technology (NIST) and the National Research Council of Canada (NRCC) should provide. Of note, “UV” was also relatively frequently mentioned and indicates a good amount of interest.



DISCUSSION

The results of the survey are indicative of several potential trends:

- “Basic” measurement types such as luminance and illuminance seem to have the greatest level of importance among the survey respondents. This is consistent with responses that visible light is the primary wavelength band of interest.
- Despite the strong interest in basic photometric measurements, a growing area, especially in comparison to responses to CORM’s Ninth Report, is that of UV measurement. This may be a response to growing interest in germicidal applications following the coronavirus pandemic experienced worldwide in recent years.
- Although filament sources are still commonly measured by many survey respondents, the primary interest is among solid state sources including LEDs, OLEDs and laser/laser diode sources. It is possible that the interest in filament source measurements is more related to the use of this source as a calibration artifact (stable and repeatable) more than its end use in lighting and other applications of optical radiation.

Among the issues frequently mentioned by survey respondents were calibration and calibrated standards for use when calibrating. Such sources from NMIs are very expensive and this may limit their use by many laboratories. Programs such as NIST’s Measurement Assurance Program (MAP) involve NIST conducting a proficiency test with laboratories in an effort to point out common sources of excess measurement uncertainty in the laboratory’s equipment and procedures. The MAP program is not a substitute for the use of a calibration standard, however, meeting the pre-determined acceptable tolerance in a MAP exercise confirms that the laboratory meets certain expected limits of acceptable proficiency. Costs for the MAP program include review and analysis by technical staff in reporting back to the customer after sending results to NIST, so participation in the MAP program is not substantially less expensive than purchasing calibrated standard lamps. Perhaps NIST and other NMIs could explore costs of lending calibrated standard lamps to customers who have demonstrated proficiency in measurements (through MAP or other programs) at reduced costs to help facilitate improved calibrations among their constituent photometric measurement communities.

CORM will continue to evaluate the frequency and scope of CORM Reports in the future. CORM is grateful to its members and to other survey respondents who participated in the survey for this report. CORM is very interested in your input regarding the most useful frequency and scope of its reports and the surveys and questions used to inform them, as well as any specific topics that should be addressed with more detailed survey questions. You are welcome to submit your feedback online at: <http://cormusa.org/contact-us>.