

**Consultative Committee for Photometry and Radiometry (CCPR)**  
25th Meeting (on-line 10-11 May 2022)

**CCPR member report on activities in radiometry and photometry since the last  
CCPR meeting (2019)**

**Reply from: NIM**

**Delegate: LIN Yandong**

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1. Summarize the recent progress in your laboratory with respect to measurement standards, research projects, and metrology services to fulfill the demands of customers in:
    - (a) **broad-band radiometric quantities:**

Established broad-band irradiance scale for LED in UV spectral range and the combined standard uncertainty can reach  $u_{rel}=1.1\%$ .

Optical radiation power measurement based on QCL laser and Y-type cryogenic radiometer, and spectral responsivity measurement based on MCT detector have been carried out in the mid-infrared band from  $7.35\mu\text{m}$  to  $10.6\mu\text{m}$ .

A laser power measurement facility based on the principle of light pressure was established. The laser power range covers 1kW to 6kW, and the measurement uncertainty is 1.3% at 3kW.
    - (b) **spectral radiometric quantities:**

NIM established measurement facility for spectral radiant flux between 200 nm and 450 nm. A double monochromators were used for UV spectral radiant flux measurement to reduce the stray light effect. The combined standard uncertainty for 200 nm~450 nm spectral radiant flux is  $u_{rel}=3.4\%\sim 0.8\%$ .

An LED-based miniaturized integrating sphere light source was developed for instant radiance responsivity calibration of optical microscopes, with measurement uncertainty of 1.3%.

A laser diode based collimated light source was developed for power responsivity calibration of photodetectors from miliWatt level to nanoWatt level, with measurement uncertainty of 0.7%.
    - (c) **photometric quantities:**

LED filament standard lamps were developed and improved, which are as stable as incandescent lamps during the last two years' characterization, and the socket is E27, the same as that of incandescent lamps. Both luminous intensity lamp and luminous flux lamp have been used as transfer standard for CCPR WG-KC-TG4 pilot comparison.

(d) other area(s) relevant to CCPR:

A gonio-colorimeter was developed to fulfill the traceability needs from industry. A fluorescent colorimeter was developed to meet the paper industry's demand for measuring whiteness and color for fluorescent paper.

In order to meet the calibration requirements for the area of irregular apertures in the field of radiometry, an aperture area measurement facility was established based on the radiant flux comparison method.

A single photon source characterization facility based on femtosecond multiphoton microscope was developed. A novel method for photon flux responsivity calibration of the multiphoton microscope was proposed based on the combination of LED-based miniaturized integrating sphere light source and a standard aperture. The measurement uncertainty was about 2%. Absolute photon flux measurement for single photon sources is under investigation based on this multiphoton microscope setup.

2. What work in PR has been/will be terminated in your laboratory, if any, in the past /future few years? Please explain the reasons and provide the name of the institution if it has been/will be substituted by a DI or accredited laboratory.

The calibration of tube type fluorescent lamps will be terminated as this kind of lamp is gradually replaced of by LED luminaire.

3. Summarize the Capacity Building and Knowledge Transfer activities undertaken by your institute in photometry and radiometry (courses, training, ...):

We translated CIE S 026/E:2018 "CIE System for Metrology of Optical Radiation for ipRGC-Influenced Responses to Light" Authorized by CIE, and published the Chinese version, which promotes the application of non-visual illuminating technology in China.

4. Summarize the research projects currently performed within a collaboration with one or more NMIs or Dis (name of the project, participants):

None.

5. Are there any other research projects where you might be looking for collaborators from other NMIs or are there studies that might be suitable for collaboration or coordination between NMIs?

None.

6. Have you got any other information to place before the CCPR in advance of its next meeting?

None.

7. Bibliography of radiometry and photometry papers of your laboratory since the last CCPR (September 2019):

- [1] Zhao Weiqiang et al, Temperature dependence correction method of LED filament lamp for total luminous flux calibration based on voltage measurement, 2021 *Metrologia* 58 045003
- [2] Caihong Dai, Yanfei Wang\*, Ling Li, Zhifeng Wu, Yihang Xie, Boris Khlevnoy\*, Irina Grigoryeva, Shufang He and Yandong Lin. Spectral irradiance scale realization and uncertainty analysis based on a 14 mm diameter WC-C fixed point blackbody from 250 nm to 2500 nm. *Metrologia*. 59 (2022) 024001 (12pp). <https://doi.org/10.1088/1681-7575/ac4a40>
- [3] Caihong Dai\*, Zhifeng Wu, Yanfei Wang, Ling Li, Shufang He and Yihang Xie. Spectral irradiance primary scale realization and characterization of deuterium lamps from 200 to 400 nm. *Applied Optics*, 2020.9. 59(27),8494-8504
- [4] Ling Li, Zhifeng Wu, E R Woolliams, Caihong Dai and Yanfei Wang. A simple method of UV stray light correction for field spectrometers in Ground Validation Sites. *Journal of Physics: Conference Series*. 2149 (2022) 012004. doi:10.1088/1742-6596/2149/1/012004
- [5] Zhifeng Wu, Ling Li, Caihong Dai, Yanfei wang, Qiutong Cheng, Yihang Xie. Adjustable light source for low light level with nearly constant correlated color temperature. *Journal of Physics: Conference Series*. 2149 (2022) 012016. doi:10.1088/1742-6596/2149/1/012016.
- [6] Fu, Yangting, Xiangliang Liu, Yingce Wang, Yingwei He, Guojin Feng, Houping Wu, Chundi Zheng, Ping Li, and Haiyong Gan. "Miniaturized integrating sphere light sources based on LEDs for radiance responsivity calibration of optical imaging microscopes." *Optics Express* 28, no. 21 (2020): 32199-32213.
- [7] Fu, Yangting, Yike Xiao, Haiyong Gan, Xiangliang Liu, Yingwei He, Nan Xu, Wende Liu, and Changyu Shen. "A spectrally tunable monochromatic integrating sphere photon source for spectral photon radiance responsivity calibration." In 2019 International Conference on Optical Instruments and Technology: Optoelectronic Measurement Technology and Systems, vol. 11439, p. 114391G. International Society for Optics and Photonics, 2020.
- [8] Feng, G. et al. "Realization of diffuse reflectance in 3um-14um based on auxiliary integrating sphere method." International Conference on Optical Instruments and Technology 2019: Optical Systems and Modern Optoelectronic Instruments 2020.
- [9] High-power laser measuring device based on light pressure principle, *Chinese Journal of Lasers*, 2021, 48(3), 0315002.
- [10] Research on variable angle fiber-type terahertz time-domain spectrometer, *Spectroscopy and spectral analysis*, 2020, 40(11), 3379-3383.
- [11] High-precision laser power scale transfer based on shape detection, *Optical Engineering* 60(5), 054103 (2021).
- [12] Wende Liu, Nan Xu, Yingwei He, Haiyong Gan, Guojin Feng, Yanfei Wang, Xiangliang Liu, Yangting Fu, Yingce Wang, and Yandong Lin, Mid-infrared spectral

responsivity scale based on an absolute cryogenic radiometer and a tunable quantum cascade laser, Metrologia, Vol. 58(2), 025003, 2021

- [13] Wende Liu, Nan Xu, Yingwei He, Yandong Lin, Haiyong Gan, Xiangliang Liu, Yangting Fu, "Recent advances in measurement of radiometric aperture area using optical method at NIM," Proc. SPIE 11552, Optical Metrology and Inspection for Industrial Applications VII, 115521U (10 October 2020);
- [14] Yingwei He, Haiyong Gan, et.al. "A New Spectral Responsivity Calibration Comparator of InGaAs photodiode Based on Cryogenic Radiometer Fundamental at the National Institute of Metrology of China", Proc. of SPIE, Optical Metrology and Inspection for Industrial Applications VII, 115521V, 2020.