Questionnaire on activities in radiometry and photometry

1. Summarize the progress in your laboratory in realizing top-level standards of:

(a) broad-band radiometric quantities :

None.

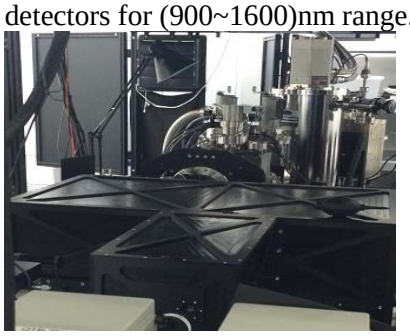
(b) spectral radiometric quantities:

A laser-based facility for spectral irradiance responsivity is established. Using a tunable laser and standard trap detectors, the spectral irradiance responsivity of detectors under test can be traced back to cryogenic radiometer. The uncertainty is reduced compared to source based realization.

Total spectral radiant flux is realized for incandescent or tungsten lamp. Calibration service is provided, which covers the spectra range of 380 nm to 830 nm with a measurement uncertainty of 3.6% ~ 1.8% (k=2).

Research on laser power realization has been carried out between 0.1W to 100 W based on the disc substrate thermopile sensor by electrical calibration method. The nonequivalence between optical and electrical heating has been characterized. The uncertainty component induced by nonequivalence can be reduced.

A monochromator-based absolute cryogenic radiometer (ACR) system was built to measure absolute spectral responsivities of photodetectors. Using supercontinuum white source and double monochromator, recent work includes spectral responsivitity calibration of silicon trap detectors for (400~1100)nm range and InGaAs trap detectors for (900~1600)nm range.



(c) photometric quantities :

The prototype of LED filament standard lamps for luminous flux and luminous intensity are being developed. The development will be finished soon.

A photometer spectral responsivity measurement facility was set up using an OPO tunable laser in2018. Compared to traditional method for measuring S(λ) of the photometer, it has a the low noise and strong signal. The measurement uncertainty at 450 nm is Urel = 0.2% (k=2) .

2. What other work has taken place in your laboratory in scientific or technological areas relevant to the CCPR?

Photosynthetic Photon Flux Density (PPFD) is widely used in the field of plant science for assessing the photosynthesis active radiation (PAR). We developed the ability to calibrate PPFD for PAR meter which trace to spectral irradiance standard, as well as the related software to calculate the spectral mismathch correction factor for light source with known relative spectral power distribution.

NIM collaborated with a Chinese company to begin the reproduction of luminous intensity standard lamp of China (BDP type) and total luminous flux standard lamp of China(BDP type) that were developed in the 1970s .

Realization of spectral diffuse reflectance standard

Updated and realized the spectral diffuse reflectance with homemade 150mm and 200mm auxilary sphere and white standard in Van Den Akker method. The spectral range is 350nm to 900nm, the uncertainty is between 0.3%~0.5% (k=2)

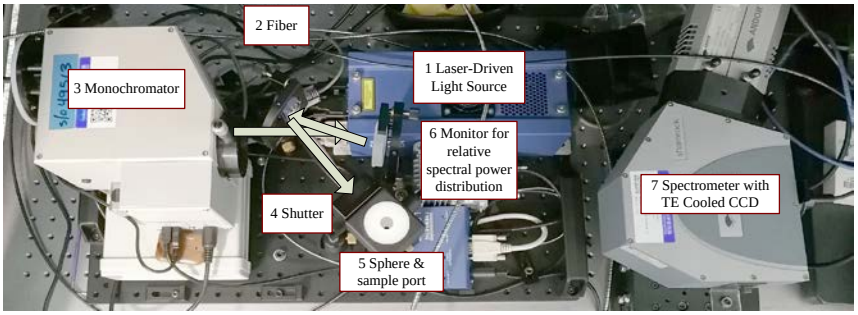
APMP. TCPR. S7 comparison

12 sets of grey scale samples are selected and prepared for the APMP. TCPR. S7 comparison “grey scale diffuse reflectance”. The protocol is prepared and hope to start the measurement at the end of 2020.

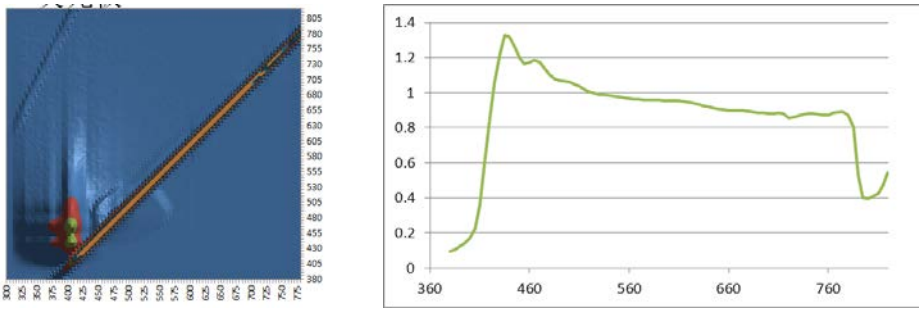
99%, 50%, 20% grey scale samples

Surface color and whiteness of fluorescent sample

A white light source and a monochromator are used to generate monochromatic light from 300nm to 900 nm, an integrated sphere is used to illuminate the sample to be measured, and then a spectrometer is used to measure the spectral radiance factor of DUT.



Device diagram



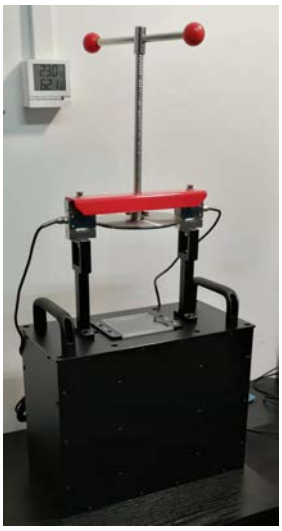
Excitation and emission data matrix Spectral radiance factor

The measurement is traced to spectral diffuse reflectance and spectral responsivity through a white standard and a photodiode. Spectral radiance factor measurement

repeatability is 0.1%~0.8%, and the tristimulus value and whiteness repeatability is 0.05%~0.12%.

Cotton color traced to SI

The cotton color measurement setup is under developed, with a good stability and repeatability, and the color value could trace to SI by color ceramic plates.



The cotton color measurement setup

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

   None.

4. What are present, new or emerging needs of users of your services that are not being supported sufficiently by current CCPR activities or initiatives? In the light of this information please suggest desirable changes in the future working program of the CCPR.

   None.

5. What priorities do you suggest for new research and development programmes at NMIs in the area of Photometry and Radiometry?

The influence of using CIE new illuminant LED-B3 instead of CIE illuminant A in the field of photometry need to be researched.

6. Are there any 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.

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

   None.

8. Bibliography of radiometry and photometry papers of your laboratory since the last CCPR (September 2016)?

(1) Zhao weiqiang, Liu Hui, Liu Jian, The Realization of 380 nm ~ 780 nm Total Spectral Radiant Flux and the Measurement Uncertainty Evaluation, Acta Metrologica Sinica, Vol39 No1:24-27 (2018)

(2) Liu Jian, Liu Hui, Zhao Weiqiang, Li Cheng, Zhang Xiaoying, Zhang Baozhou, The Evaluation of Uncertainty about the Shape of Aperture on Measurement of Averaged LED Intensity, SPIE OMTI 2016, Proc. of SPIE Vol. 10155 101552U-2-6

(3) Zhifeng Wu, Caihong Dai, Yanfei Wang and Ling Li. Stray light correction of array spectroradiometer measurement in ultraviolet, Journal of Physics: Conf. Series 972, 012022 (2018)

(4) Zhifeng Wu, Caihong Dai, Yanfei Wang and Juhong Zou. Measurement of optical parameters for array spectroradiometers, Opt. Precision Eng., 24, 1902-1907(2016)

(5) Tao Xu, Haiyong Gan, Jing Yu, et al. Temporal response of laser power standards with natural convective cooling. Optics Express, 2016, 24(2): 935-944.

(6) Spectral responsivity calibration of silicon photodetectors using monochromator-based cryogenic radiometer', Xu N. et. al., Proc. of SPIE Vol. 10155 1015513-1,2016.