

Consultative Committee for Photometry and Radiometry (CCPR)
24th Meeting (19 - 20 September 2019)

Questionnaire on activities in radiometry and photometry

Reply from: Physikalisch-Technische Bundesanstalt (PTB), Germany

Delegate: Stefan Kück

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1. Summarize the progress in your laboratory in realizing top-level standards of:
 - (a) broad-band radiometric quantities:

New setup for calibration of broad-band UV-radiometers

A new setup has been completed at PTB for calibration of broad-band UV-radiometers that are used to monitor UV-curing processes in various industrial applications. The setup includes different UV sources commonly used for the UV-curing: low- and medium-pressure Hg lamps without doping, Hg-lamps with Fe as well as Ga doping and, finally, LED sources with peak wavelengths at 365 nm and 395 nm that are also increasingly used in the UV-curing applications. Up to five UV-sources can be operated in parallel. The spectral irradiance of a source measured by a spectroradiometer can be numerically weighted with the actinic action spectrum that the UV-radiometer is designed for. Comparison of the resulting integral value and the readout of the UV-radiometer provides then the responsivity of the broad-band radiometer with respect to the weighted actinic irradiance.

- (b) spectral radiometric quantities:

The Metrology Light Source (MLS) — PTB's electron storage ring dedicated to metrology

- The announcement by the major semiconductor manufacturers Samsung and TSMC in autumn 2018 to use extreme-UV (EUV) lithography for the production of high-end processors marks the commercial breakthrough of this technology after a long development phase. PTB has made a major contribution to this development through its unique EUV radiometry capabilities at the MLS (and the electron storage ring BESSY II) in Berlin-Adlershof. Based on a beamtime of currently more than 6,000 hours per year at several beamlines, this field of activity opens excellent perspectives for EUV radiometry.
- Several studies refer in this context to the development of stable detector standards in the EUV and vacuum-UV (Reichel et al. 2016, Gottwald et al. 2018, Gottwald and Scholze 2018).

- In the same spectral range, a room temperature radiometer, developed at the Japanese NMIJ/AIST for EUV lasers, was successfully compared with the primary detector standard SYRES II and the Metrology Light Source as primary source standard.
- In cooperation with the Fraunhofer IPM in Freiburg, gas photoionization chambers were characterized as absolute VUV detectors for the quantitative evaluation of solar radiation data from the SolACES instrument on board of the International Space Station (ISS). In this context, photoionization cross-sections of noble gases with a solid traceability were newly determined for applications also in the characterization of EUV lasers and the analysis of combustion gases (Schäfer et al. 2018).
- The radiometric characterization of the EUI and SPICE spectrographs of ESA's Solar Orbiter mission could be completed.
- Various single photon detectors have been calibrated using a new operation mode that automatically lowers and counts the number of electrons stored in the MLS.

Metrology for Terahertz Radiation

PTB continues to extend its capabilities of metrology for THz radiation. The pilot comparison of THz power measurement using PTB's THz laser was carried out between NIST, NIM and PTB and published in IEEE transactions on terahertz science and technology **6**, 664-669 (2016). A reference material for characterization of transmission and reflection measurements was developed in a joint research project with an industrial partner (Optics Express **26**, 34002-34006 (2018)). A comparison of the high-frequency power measurement in rectangular waveguides on the one hand and the free-space power measurement of a Gaussian beam on the other hand is carried out at PTB in the frequency range between 80 GHz and 110 GHz. Both methods are completely independent in terms of metrological tracing back absolute power measurements because the radiant power in the quasi-optical measurement setup is measured by means of a special pyroelectric THz detector which is designed to yield a constant spectral responsivity in the range 100 GHz to 5 THz (Technisches Messen **83**, 386-389 (2016)). Therefore, it is calibrated using optical methods at frequencies above 1 THz with PTB's THz laser.

Metrology for single photon sources and detectors

The single-photon source based on the nitrogen vacancy center in a nanodiamond with a traceable spectral photon flux was realized and fully metrologically characterized (B Rodiek, et. al., Journal of Physics: Conf. Series 972 (2018)). The total output power of this source is adjustable between 55 fW and 75 fW, between a total photon flux of 190 000 photons per second and 260 000 photons per second, respectively. The relative standard uncertainty of the spectral photon flux was determined to be 4.0 %. Furthermore, the angular distribution of the emission of an NV center in a nanodiamond was also investigated. New single-photon sources with a calculable photon emission rate and high purity will be developed within the frame

the EMPIR Project 17FUN06 SIQUST: Single-photon sources as new quantum standards. In addition, the calibration of the detection efficiency calibration of a gated fiber-coupled InGaAs/InP single-photon avalanche diode detector was reported (Marco López, et. al., Proceedings of NEWRAD 2017, Tokyo 13 - 16 (2017)). The calibration was performed against a low-noise traceable InGaAs photodiode at a wavelength of 1550 nm. The detection efficiency was determined for different photon flux rates between 600 photons/s and 20000 photons/s. The standard uncertainty achieved is < 1 %.

Differential Spectral Responsivity facility (DSR and Laser-DSR)

The laser-based Differential Spectral Responsivity (DSR) facility is used for high precision calibrations of the spectral irradiance responsivity of large area detectors like solar cells with an uncertainty of 0.4%. With current activities, the uncertainty shall be reduced to 0,35%. The traditional, lamp-based DSR-facility is used for routine operation for the calibration of the absolute spectral irradiance responsivity of solar cells, photometric detectors and UV detectors, traceable to the PTB's cryogenic radiometer.

Using the current, obtained by the (Laser-) DSR measurements, an accurate IV-characteristics under STC can be determined.

Competence Centre for PV-Metrology

The PTB is establishing a competence center for PV metrology. It will offer a unique infrastructure of laboratory and free-field calibration procedures with the lowest measurement uncertainties worldwide and it will serve the metrological support of the energy transition. With the PV Metrology Competence Centre, PTB is extending their activities from the area of solar cells to solar modules. It will cover all required parameters for a comprehensive calibration regarding all yield-relevant quantities and the energy rating according to IEC 61853.

Diffuse Reflectance

The goniometric primary set-up as well as the sphere-based facility are constantly asked for calibration tasks on a high level. Unfortunately, this work was severely impaired in 2018 by a long-time drop-out of climate controls with impact like calibration postponement still in 2019.

The wavelength range of the gonio-setup will be enhanced to cover the NIR range >1700 nm to 2500 nm by implementing new measurement schemes and radiation sources.

Investigations on the influence of polarization in directed-directed diffuse geometry raised great attention in the field. Special activities on this subject were introduced to the research projects described below.

The European Metrology Research Program (EMRP) project "xD-Reflect, Multidimensional Reflectometry for Industry" was successfully finalized. The smaller follow-up project "BiRD, Bidirectional Reflection Definition", was started in the pre-normative call of EMPIR and is currently in its second half. In this project the gained knowledge from xD-Reflect as well as further investigations will result in

recommendations on measurements of BRDF, Sparkle and Gloss. These which will be published as TRs of the specially founded CIE TCs 2-85 (BRDF), JTC 12 (Sparkle & Graininess), and JTC 17 (Gloss).

In May 2019 the EMPIR program BxDiff (“Bi-directional measurements in extra dimensions of diffusing materials”, call SI broader scope) was started in which the European measurements capabilities for BRDF-measurements will be improved, first NMI reference set-ups for BSSRF will be created, and dedicated BTDF primary facilities will be implemented at Aalto and PTB. This EMPIR project found an overwhelming support by stakeholders (>30 from diversified fields of applications).

Regular spectral transmittance and reflectance

Following the CCPR-K6 comparison on regular transmittance the facility served as link laboratory for the local European comparison on regular transmittance.

The primary facility is constantly booked out by calibrations, not few being performed on special items from optical industry, research institutions or industry. Therefore, a continual effort is made especially in adding new radiation sources. E.g. a quantum cascade laser for measurements in the MIR was successfully integrated as well as small spot laser sources to supply calibrations in the growing field of micro-samples.

(c) photometric quantities:

Luminous flux and LED measurement facility

The robot-based goniophotometer, where lamps or luminaires are not moved during measurement, and the versatile LED measurement setup for gonio-photometric measurements, which can be used for sources which are insensitive with respect to position and movement, are permanently improved to satisfy customer needs also with respect to gonio-spectral measurements. Cost-efficient fisheye camera assisted integrating sphere measurements provide additional information to the customers about the distribution of the partial luminous flux of sources. The robot-based goniophotometer and the integrating sphere of PTB were successfully used for the measurements of the group of PTB luminous flux travelling standard lamps within the CCPR-K4.2017, piloted by NMIJ/AIST.

Luminous intensity

The Photometric Bench System of PTB was successfully used for the measurements of the group of PTB luminous intensity travelling standard lamps within the CCPR-K3.2014, piloted by NRC (Draft A completed, review by participants ongoing). To improve and shorten the traceability chain from the cryogenic radiometer to the luminous intensity lamps for the realization of the unit of the quantity luminous intensity, PTB built a special transition-trap-based photometer ($V(\lambda)$ -Trap) which can be calibrated using the coherent light beams of PTBs Lasers based setups, as well as incoherent incandescent light sources. The $V(\lambda)$ -Trap device is currently calibrated against the cryogenic radiometer. It will be used to determine the temperature of a

black body to subsequently calibrate a luminous intensity standard lamp by the determination of its distribution temperature traceable to the black body and its luminous intensity traceable to the cryogenic radiometer by the $V(\lambda)$ -Trap taking all correlations into account.

Within the framework of the EMPIR Project PhotoLED a special LED luminous intensity transfer standard was developed at PTB which is to be used as a transfer standard for a specific LED illuminant and which is currently being discussed as a complementing standard illuminant for Illuminant A.

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

Traceability for ground-based monitoring of total column ozone (TOC)

Within the recently accomplished EMRP ENV59 project ATMOZ “Traceability for the total column ozone” PTB characterized different reference and network instruments from the global TOC monitoring networks with respect to their spectroradiometric properties and thermal coefficients. The results allowed to estimate the respective uncertainty contributions and to improve the consistency of the TOC determinations among the instruments.

Moreover, in a cooperation with an industrial partner Gigahertz-Optik GmbH, a novel array spectroradiometer was adapted for measuring direct solar irradiance, radiometrically characterized, calibrated and operated by PTB during a TOC comparison measurement campaign organized within the EMRP ATMOZ project at Izaña observatory in Tenerife in September 2016. The results of the determined TOC values showed a good agreement to those yielded by the Dobson and Brewer instruments.

Compact ns-OPO based setup for radiometric applications

A new setup based on an optical parametrical oscillator (OPO) operating at 1 kHz pulse repetition rate was recently taken into use at PTB. It is an upgrade for the Pulsed Laser for Advanced Characterization of Spectroradiometers (PLACOS) facility that has been in operation at PTB for over ten years. The new setup offers an advantage of significantly shorter measurement times, a broader dynamic range and an improved stability. It enables characterization and calibration of array spectroradiometers with respect to stray light, bandpass characteristics as well as wavelength scale over the spectral range from 210 nm to 2600 nm. The ns-OPO setup has been also used for spectral responsivity calibrations of UV-radiometers.

LED-based UV source for monitoring spectroradiometer properties

Within the EMRP ENV59 project ATMOZ “Traceability for total column ozone”, a compact and stable UV monitoring source based on state-of-the-art commercially available ultraviolet light emitting diodes (UV-LEDs) has been developed by PTB. It is designed to trace the radiometric stability — both responsivity and wavelength scale — of array spectroradiometers measuring direct solar irradiance in the wavelength range between 300 nm and 400 nm. The UV-LED source was used together with an

array spectroradiometer developed by Physikalisch-Meteorologisches Observatorium Davos, World Radiation Center (PMOD/WRC) during an international TOC comparison campaign organized within the EMRP ATMOZ project at Izaña observatory in Tenerife in September 2016. In-field measurements of the source with an array spectroradiometer indicated the stability of the source to be within the standard uncertainty of the spectroradiometer calibration, which was within 1% to 2%.

Radiometry for remote sensing

The new Reduced Background Calibration Facility 2 (RBCF2) of PTB was brought into operation as the successor of the Reduced Background Calibration Facility (RBCF). It provides traceable calibrations of space based infrared remote sensing experiments in terms of radiation temperature and spectral radiance under cryogenic and / or vacuum conditions. The integration of the instruments under test into the RBCF2 can be done under ISO 5 clean room conditions.

Reference sources for comparisons are several dedicated vacuum variable temperature blackbodies, ranging from -196 °C to 430 °C, a large area heatpipe blackbody operable from -60 °C to 50 °C featuring a radiating diameter of 250 mm and calibrated vacuum integrating sphere radiators for UV-VIS and SWIR applications. The radiation temperatures of the blackbodies and the radiance of the integrating sphere radiators are traceable to the ITS-90 via the primary standards of PTB. Using the calibrated vacuum infrared standard radiation thermometer (VIRST) direct calibrations of sources in terms of radiation temperature in the wavelength range from 8 µm to 14 µm can also be performed.

The radiation of the reference sources and the sources under test can also be imaged on a vacuum Fourier-Transform Spectrometer (FTS) to allow spectrally resolved measurements. The FTS covers the wavelength range from 0.4 µm to 1000 µm. Sources can be also spatially mapped and characterized for the lateral distribution of their spectral radiance. The flexible design of the facility allows also large aperture camera characterizations and modifications for customer needs and the measurement of directional spectral emissivities over a wide temperature and wavelength range.

Recently the On-Board Calibration Assembly (OBCA) of the hyperspectral satellite EnMAP was fully characterized in the spectral range from 400 nm to 2500 nm with a spectral resolution of 0.1 nm under application conditions. Another recent task was the spectral characterization of critical components like beamsplitter and candidates for blackbody coatings of the of the planned ESA Earth Explorer 9 FORUM in the spectral range from 4 µm to 100 µm during phase A of the mission.

Spectral and total emissivity

PTB continues to extend its capabilities to determine the directional spectral emissivity, total directional and total hemispherical emissivity of surfaces. Additionally, to the existing capabilities to measure directional spectral emissivities from 1.1 µm to 200 µm under variable angles of observation in a temperature range from -40 °C to 1000 °C under air and vacuum it is now possible to characterize semi-transparent and foil samples as well.

Fourier transform spectroradiometers for solar UV and IR irradiance measurements

A Fourier transform spectroradiometer has been calibrated against different standard lamps and in parallel radiation against other spectroradiometer. The Fourier transform spectroradiometer is used for outdoor measurements of the direct sun light with a high wavelength resolution of 0.05 nm. The facility will complement an array spectroradiometer with lower wavelength resolution and a smaller wavelength range when performing primary solar cell calibration with the Direct-Sunlight-Method (DSM).

Status of the CCPR-K1.a

PTB participates in comparison CCPR-K1.a Spectral Irradiance 250 nm - 2500 nm piloted by VNIIOFI. PTB measurements were completed. Pre-draft A is in preparation.

Status of the CCPR-K1.b

PTB participates in second-round CCPR key comparison K1.b spectral irradiance 200 nm to 400 nm, piloted by NIST. The technical protocol is in preparation.

Status of the CCPR-K2.a.2015

PTB participates in the comparison CCPR-K2.a.2015. "Spectral Responsivity" (wavelength range 900 nm to 1600 nm). PTB has finished its measurements.

Status of the CCPR-K2.b.2016

PTB participates in the comparison CCPR-K2.b.2016. "Spectral Responsivity" (wavelength range 300 nm to 1000 nm). PTB has finished its measurements and has sent the result report and the technical to the pilot.

Status of the CCPR K3

The measurements campaign for the CCPR K3.2014 "Luminous Intensity" at PTB has been finished. The final result for all 6 WI41/G lamps of PTB was sent to the pilot laboratory (NRC) in July 2015. In the meantime, the pilot distributed Draft A for review to the participants.

Status of the CCPR K4

The measurements campaign for the CCPR K4.2017 "Luminous Flux" at PTB has been finished. The final results for all lamps of PTB were sent to the pilot laboratory (NMIJ/AIST) in 2018. In the meantime, the measurement of all participant lamps finished at the pilot.

Status of the CCPR K6.2010

The comparison was successfully finalized and the final report can be downloaded from the CIPM webpage.

Status of CCPR-K5.2018

The comparison on “Spectral Diffuse Reflectance” was started in early 2019. Samples were acquired and measurements by the pilot (Aalto) are in progress.

Status of the CCPR pilot comparison “Spectral Responsivity in the Terahertz Spectral Range”

In 2015 the CCPR pilot comparison “Spectral Responsivity in the Terahertz Spectral Range” between NIST, NIM, and PTB took place at PTB at two frequencies, namely 2.52 THz and 0.762 THz. The results are published in IEEE transactions on terahertz science and technology, 6, 664-669 (2016); doi: 10.1109/TTHZ.2016.2590260.

Status of the CCPR “Pilot study on the detection efficiency of single-photon detectors – Si-SPAD”

The “pilot study on the detection efficiency of single-photon detectors – Si-SPAD” started in May 2016 at PTB with the first measurements. This pilot study is carried out within the frame of the CCPR-WG-SP Task Group 11. There are 11 participants in this pilot study, from which 7 have already carried out their measurements. It is planned that the study ends in 2020 with the final report.

Status of COOMET.PR-K1.b.1: Bilateral comparison of spectral irradiance of deuterium lamps between PTB and VNIIOFI

A bilateral comparison of spectral irradiance measurements of deuterium lamps in the spectral range between 200 nm and 350 nm was completed between PTB and VNIIOFI. The comparison was accomplished within the framework of RMO COOMET intercomparison, where VNIIOFI acts as a pilot laboratory. PTB acted as link laboratory to the CCPR-K1.b.

Status of COOMET.PR-K1a.2018 spectral irradiance 250 nm - 2500 nm

PTB participates in COOMET.PR-K1a.2018 spectral irradiance 250 nm - 2500 nm as link to CCPR-K1.a Spectral Irradiance 250 nm - 2500 nm. Measurements at PTB were completed.

Status of EURAMET.PR-S5

The measurements of EURAMET Supplementary Comparison S5 about the short circuit current under Standard-Test-Conditions of reference solar cells are finished. The confirmation of the data of the participants and the evaluation has been succeeded. The Pre-Draft A is completed, and the Draft A is planned for 2019.

CCT NCTherm "Absolute radiometry for re-defined kelvin"

The re-definition of the kelvin in terms of the Boltzmann constant in May 2019 strengthens the role of primary thermometry methods such as the temperature measurement of a blackbody radiator by absolute radiometry and Planck's law of thermal radiation in order to directly measure and disseminate the thermodynamic temperature.

Robust data of T-T90 is required for ongoing improvements of the Mise-en-pratique of the kelvin and to facilitate the transition towards the re-defined unit. Within the

EMPIR project “Implementing the new kelvin – 2” PTB together with NIST, NPL, LNE-CNAM, CEM and NIM investigated the difference between the thermodynamic temperature T and T_{90} in the temperature range between 550 °C and 962 °C using absolutely calibrated Si and InGaAs filter radiometers.

In the temperature between 1086 °C and 2474 °C PTB together with the VNIIOFI developed and realized a two-wavelength ratio technique which by comparing two primary radiometric sources, synchrotron radiation and blackbody radiation, allows to determine the unknown temperature of a blackbody. Compared to absolute single wavelength filter radiometry the ratio technique promises to benefit from a nearly identical measurement geometry for both radiometers and thus reduced measurement uncertainties. In a first practical realization the estimated measurement uncertainties were enlarged by a factor of 4 instead, partly due to a higher sensitivity to small variations of the observed photocurrent, and partly due to the drift in spectral transmission of the storage rings exit window.

Short Course in Photometry

In November 2019, PTB will organize the 2019 short course in photometry for German speaking participants. This 11th short course comprises the most relevant topics of metrology and traceability in the field of photometry and colorimetry and targets lighting engineers and scientists working in the field of metrology.

Traceability of the detection efficiency of fiber-coupled single photon detectors to national standards

PTB and the “Sources and Detectors” group at NIST Boulder are working in a joint effort to validate the traceability of the detection efficiency of fiber-coupled single photon detectors to national standards, i.e. the cryogenic radiometer. Two calibration campaigns have been performed at NIST Boulder laboratories and PTBs Metrology Light Source. The aim was to identify suitable corrections that have to be applied when fiber-coupled detectors are calibrated against free-space standards, such as the reflection at the fibre end which occurs only during free-space measurements. The results have been published (Müller, Ingmar; Horansky, R. D.; Lehmann, J. H.; Nam, S. W.; Vayshenker, I.; Werner, Lutz; Wübbeler, Gerd; White, M.: Verification of calibration methods for determining photon-counting detection efficiency using superconducting nano-wire single photon detectors. *Optics Express*, 25 (2017), 18, 21483-21495, dx.doi.org/10.1364/OE.25.021483OSA Publishing. ISSN 1094-4087).

Status of COOMET.PR-S2

VNIIOFI, PTB, Ukrmetrteststandard and GUM performed a supplementary comparison of the material property “Angle of rotation of plane of polarization” (CCPR service number 4.17.0). The final report has been published in 2019: Vishnyakov *et al.* “Report on supplementary comparison COOMET.PR-S2: angle of rotation of plane of polarization”, *Metrologia*, 56 (2019), 1A, Techn. Supl., 02002. The report contains also an alternative evaluation based on the publication [1] which resulted in slightly different values.

[1] Elster, C. and Toman, B. (2010). Analysis of key comparisons: estimating laboratories' biases by a fixed effects model using Bayesian model averaging. *Metrologia*, 47(3):113-119.

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.
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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.
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5. What priorities do you suggest for new research and development programmes at NMIs in the area of Photometry and Radiometry?
 - The development of transfer standard detectors and calibration procedures for (high-power) UV spectral responsivity.
 - The development of stable transfer standard detectors for VUV and EUV spectral responsivity
 - The development of transfer standard sources and spectral irradiance calibration procedures for high-power UV spectral irradiance.
 - Near-field gonio-photometry, imaging photometry (ILMDs) and imaging radiometry are important technologies for the future. True traceability of measured sources or plots cannot be provided currently. Although European NMIs tried to establish joint projects in the framework of the European Metrology Research program more than once, these JRPs were rejected by the reviewers and the attempts failed.
 - The development of transfer standards sources for LEDs and OLEDs to be used as secondary standards in photometry.
 - The development transfer standards for BSSRD and BTDF (tackled currently in EMPIR BxDiff)
 - The development of single photon standard sources to be used as standards for single photon and low photon flux radiometry.
 - The development of a method for the accurate measurement of angular dependency of solar modules to fit the needs of the energy rating standards.
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?

Within Europe this is currently almost completely covered by the EMPIR research programs and projects.

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

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

2016

Bohmeyer, Werner; Lange, Karsten; Müller, Ralf; Steiger, Andreas: Calibrated detectors for broad-band terahertz power measurements. *Laser and Photonics*, (2016), 66-67, <http://www.photonik.de/calibrated-detectors-for-broad-band-terahertz-power-measurements/150/21404/320987Hanser>. ISSN 1865-5475 (online)

Dhoska, Klodian; Hofer, Helmuth; Rodiek, Beatrice; Lopez, Marco; Kübarsepp, Toomas; Kück, Stefan; "Improvement of the detection efficiency calibration and homogeneity measurement of Si-SPAD detectors"; SpringerPlus (2016)

Follert, Roman; Taubert, Richard Dieter; Hollandt, Jörg; Monte, Christian; Oliva, E.; Seemann, U.; Löwinger, T.; Anwand-Heerwart, H.; Schmidt, C.; Dorn, R. J.; Bristow, P.; Hatzes, A.; Reiners, A.; Piskunov, N.; Heiter, U.; Stempels, E.; Marquart, T.; Lavail, A.; Cumani, C.; Grunhut, J.; Haimerl, A.; Hinterschuster, R.; Ives, D.; Jung, Y.; Kerber, F.; Klein, B.; Lizon, J.-L.; Molina-Conde, I.; Nicholson, B.; Origlia, L.; Pasquini, L.; Paufigue, J.; Stegmeier, J.; Tordo, S.: Characterizing the cross dispersion reflection gratings of CRIRES+. *Advances in Optical and Mechanical Technologies for Telescopes and Instrumentation II*; (Proceedings of SPIE: 9912), (2016), 99122B-1-99122B-11, [dx.doi.org/10.1117/12.2232569](https://doi.org/10.1117/12.2232569), Bellingham, Wash.: SPIE. ISSN 0277-786X

Gower, Mike; Lodeiro, Maria; Aktas, Alper; Shaw, Richard; Maierhofer, Christiane; Krankenhagen, Rainer; Augustin, Sven; Röllig, Mathias; Knazovicka, Lenka; Blahut, Ales; Monte, Christian; Judaschke, Rolf; Segur, Damien: Design and manufacture of reference and natural defect artefacts for the evaluation of NDE techniques for fibre reinforced plastic (FRP) composites in energy applications. 19th WCNDT 2016 in Munich, Germany; (DGZfP-Proceedings BB: 158), (2016), 10 S. München

Kleinert, Anne; Adibekyan, Albert; Ebersoldt, Andreas; Gutschwager, Berndt; Monte, Christian; Olschewski, Friedhelm; Schulz, Marco; Wroblowski, Oliver: Characterization of large area calibration blackbodies for the imaging FTS GLORIA. *Conference papers*, (2016), [online only], 2 S., [dx.doi.org/10.1364/FTS.2016.FM3E.4](https://doi.org/10.1364/FTS.2016.FM3E.4)

Maierhofer, Christiane; Krankenhagen, Rainer; Röllig, Mathias; Riemer, Stefanie; Gower, Mike; Baker, Graham; Lodeiro, Maria; Knazovicka, Lenka; Blahut, Ales; Monte,

Christian; Adibekyan, Albert; Gutschwager, Berndt: Characterisation of artificial and natural defects in fibre reinforced plastics designed for energy applications using active thermography. 19th WCNDT 2016 in Munich, Germany; (DGZfP-Proceedings BB: 158), (2016), 9 S. München

Lehman, John; Steiger, Andreas; Tomlin, Nathan; White, Malcolm; Kehrt, Mathias; Ryger, Ivan; Stephens, Michelle; Monte, Christian; Müller, Ingmar; Hollandt, Jörg; Dowell, Marla: Planar hyperblack absolute radiometer. Optics Express, 24 (2016), 23, 11 S., [dx.doi.org/10.1364/OE.24.025911OSA](https://doi.org/10.1364/OE.24.025911OSA). ISSN 1094-4087

T. Reichel, A. Gottwald, U. Kroth, C. Laubis, F. Scholze: „Developments in calibration of EUV and VUV detectors for solar orbiter instrumentation using synchrotron radiation“, Proc. SPIE 9905, 990547-6 (2016)

Salim, Saber G. R.; Anhalt, Klaus; Taubert, Dieter R.; Hollandt, Jörg: Three-element trap filter radiometer based on large active area silicon photodiodes. Applied Optics, 55 (2016), 15, 3958-3965, [dx.doi.org/10.1364/AO.55.003958OSA](https://doi.org/10.1364/AO.55.003958OSA) Publishing. ISSN 0003-6935 (print); ISSN 1539-4522 (online)

Steiger, Andreas; Müller, Ralf; Remesal Oliva, Alberto; Deng, Yuqiang; Sun, Qing; White, Malcolm; Lehman, John; “Terahertz laser power measurement comparison”; IEEE transactions on terahertz science and technology, 6, 664-669 (2016); doi: 10.1109/TTHZ.2016.2590260

Steiger, Andreas; Bohmeyer, Werner; Lange, Karsten; Müller, Ralf: Novel pyroelectric detectors for accurate THz power measurements = Neuartige pyroelektrische Detektoren für genaue THz-Leistungsmessungen. Technisches Messen, 83 (2016), 6, 386-389, [dx.doi.org/10.1515/teme-2015-0083](https://doi.org/10.1515/teme-2015-0083), De Gruyter. ISSN 0171-8096 (print); ISSN 2196-7113 (online)

2017

Adibekyan, Albert; Kononogova, Elena; Monte, Christian; Hollandt, Jörg: High-accuracy emissivity data on aeroglaze Z306, nextel 811-21, herberts 1534 and acktar fractal black. TEMPMEKO 2016: Selected Papers of the 12th International Symposium on Temperature, Humidity, Moisture and Thermal Measurements in Industry and Science; In: International Journal of Thermophysics, , 38 (2017), 6, 89-1-89-14, [dx.doi.org/10.1007/s10765-017-2212-z](https://doi.org/10.1007/s10765-017-2212-z) Springer. ISSN 0195-928X (print); ISSN 1572-9567 (online)

Bünger, Lars; Taubert, Richard Dieter; Gutschwager, Berndt; Anhalt, Klaus; Briaudeau, Stephan; Sadli, Mohamed: Absolute radiation thermometry in the NIR. International Journal of Thermophysics, , 38 (2017), 4, Artikel 61-1-Artikel 61-18, [dx.doi.org/10.1007/s10765-017-2199-5](https://doi.org/10.1007/s10765-017-2199-5) Springer. ISSN 0195-928X (print); ISSN 1572-9567 (online)

Dönsberg, Timo; Manoocheri, Farshid; Sildoja, Meelis; Juntunen, Mikko; Savin, Hele; Tuovinen, Esa; Ronkainen, Hannu; Prunnila, Mika; Merimaa, Mikko; Tang, Chi Kwong; Gran, Jarle; Müller, Ingmar; Werner, Lutz; Rougie, Bernard; Pons, Alicia; Smid, Marek; Gal, Peter; Lolli, Lapo; Brida, Giorgio; Rastello, Maria Luisa; Ikonen, Erkki: Predictable quantum efficient detector based on n-type silicon photodiodes. *Metrologia*, 54 (2017), 6, 821-836, <https://doi.org/10.1088/1681-7575/aa85ed>, BIPM & IOP Publishing Ltd. ISSN 0026-1394 (print); ISSN 1681-7575 (online)

Dönsberg, Timo; Manoocheri, Farshid; Sildoja, Meelis; Juntunen, Mikko; Tuovinen, Esa; Ronkainen, Hannu; Prunnila, Mika; Merimaa, Mikko; Tang, Chi Kwong; Gran, Jarle; Müller, Ingmar; Werner, Lutz; Rougie, Bernard; Pons, Alicia; Smid, Marek; Gal, Peter; Lolli, Lapo; Brida, Giorgio; Rastello, Maria Luisa; Ikonen, Erkki: Predictable quantum efficient detector based on n-type silicon photodiodes. 13th International Conference on New Developments and Applications in Optical Radiometry (NEWRAD 2017): Proceedings (2017), 132-133

Gieseler, Julian; Monte, Christian; Adibekyan, Albert; Hollandt, Jörg; Kersting, R.: Entwicklung und Aufbau eines Probenhalters für die Emissionsgradmessung an semitransparenten Materialien. *Temperatur 2017: Fachtagung PTB Institut Berlin*, 17.-18. Mai 2017, (2017), 279-286, Braunschweig [u.a.]: Physikalisch-Technische Bundesanstalt.

Gutschwager, Berndt; Hollandt, Jörg: Nonuniformity correction of infrared cameras by reading radiance temperatures with a spatially nonhomogeneous radiation source. *Measurement Science and Technology*, 28 (2017), 1, 1-14, [dx.doi.org/10.1088/1361-6501/28/1/015401](https://doi.org/10.1088/1361-6501/28/1/015401), IOP Publishing. ISSN 0957-0233 (print); ISSN 1361-6501 (online)

Gutschwager, Bernd; König, Sebastian; Hollandt, Jörg: Novel recording and calculation method for fast and simultaneous determination of the nonuniformity of blackbody radiators and of IR camera systems. *Temperatur 2017: Fachtagung PTB Institut Berlin*, 17.-18. Mai 2017, (2017), 63-69, Braunschweig [u.a.]: Physikalisch-Technische Bundesanstalt.

G. Hülsen, J. Gröbner, S. Nevas, P. Sperfeld, L. Egli, G. Porrovecchio, M. Smid, "Traceability of solar UV measurements using the QASUME reference spectroradiometer"; 13th International Conference on New Developments and Applications in Optical Radiometry (NEWRAD 2017), Proceedings: (2017), 215 – 217

Kück, Stefan; López, Marco; Rodiek, Beatrice; Hofer, Helmuth; Porrovecchio, P.; mid, M.; Brida, G.; Traina, P.; Degiovanni, I.P.; Pokatilov, A.; Kübarsepp, T.; Manninen, A.; Vaigu, A.; Chunnillall, C.; Szwed, D.; Polyakov, S.; Claudon, J.; Gregersen, N.; Mørk, J.; Chu, X.-L.; Götzinger, S.; Lindner, S.; Bock, M.; Becher, C.; Reitzenstein, "Single-photon sources for quantum technologies - Results of the joint research project SIQUTE"; 13th International Conference on New Developments and Applications in

Optical Radiometry (NEWRAD 2017): Proceedings (2017), NewRad2017: 13th International Conference on New Developments and Applications in Optical Radiometry, Tokyo, 13-16, June, 2017

M. López, H. Hofer, B. Rodiek, S. Kück, "Traceable calibration of the detection efficiency of InGaAs/InP single-photon avalanche diode detectors"; Proceedings of the 13th International Conference on New Developments and Applications in Optical Radiometry (NEWRAD 20167), Miraikan Hall, in Odaiba, Tokyo 13 - 16 June, 2017

Maierhofer, C.; Krankenhagen, R.; Röllig, M.; Unnikrishnakurup, S.; Monte, Christian; Adibekyan, Albert; Gutschwager, Bernd; Knazowicka, L.; Blahut, A.; Gower, M.; Lodeiro, M; Baker, G.; Aktas, A.: Einfluss thermischer und optischer Materialeigenschaften auf die Charakterisierung von Fehlstellen in Faserverbundwerkstoffen mit aktiven Thermografieverfahren. Temperatur 2017: Fachtagung PTB Institut Berlin, 17.-18. Mai 2017, (2017), 15-20, Braunschweig [u.a.]: Physikalisch-Technische Bundesanstalt.

Müller, Ingmar; Horansky, R. D.; Lehmann, J. H.; Nam, S. W.; Vayshenker, I.; Werner, Lutz; Wübbeler, Gerd; White, M.: Verification of calibration methods for determining photon-counting detection efficiency using superconducting nano-wire single photon detectors. Optics Express, 25 (2017), 18, 21483-21495, dx.doi.org/10.1364/OE.25.021483OSA Publishing. ISSN 1094-4087

S. Nevas; U. Köhler, F. Schönenborn, G. McConville; "Characterisation of Dobson spectrophotometers using a tuneable pulsed laser"; 13th International Conference on New Developments and Applications in Optical Radiometry (NEWRAD 2017), Proceedings: (2017), 173 - 175

Oberto, Luca; Bisi, Marco; Kazemipour, Alireza; Steiger, Andreas; Kleine-Ostmann, Thomas; Schrader, Thorsten: Measurement comparison among time-domain, FTIR and VNA-based spectrometers in the THz frequency range. Metrologia, 54 (2017), 1, 77-84, dx.doi.org/10.1088/1681-7575/aa54c2, BIPM & IOP Publishing Ltd., ISSN 1866-6892 (print); ISSN 1866-6906 (online)

Olschewski, F.; Monte, Christian; Gutschwager, Bernd; Adibekyan, Albert; Hollandt, Jörg: Ein Schwarzkörper-Flächenstrahler für die Influg-Kalibrierung eines Interferometers auf einem Stratosphärenballon. Temperatur 2017: Fachtagung PTB Institut Berlin, 17.-18. Mai 2017, (2017), 49-56, Braunschweig [u.a.]: Physikalisch-Technische Bundesanstalt.

T. Pulli, S. Nevas, O. El Gawhary, S. Van den Berg, J. Askola, P. Kärhä, F. Manoocheri, E. Ikonen, "Nonlinearity characterization of array spectroradiometers for the solar UV measurements", Applied Optics **56** (2017), 11, 3077 – 3086, <https://doi.org/10.1364/AO.56.003077>

T. Pulli, S. Nevas, P. Kärhä, T. Karppinen, J. Karhu, K. Lakkala, A. Vaskuri, M. Shpak, F. Manoocheri, L. Doppler, S. Gross, J. Mes, E. Ikonen, "Stray light characterization of Brewer MKII spectrophotometers", 13th International Conference on New Developments and Applications in Optical Radiometry (NEWRAD 2017), Proceedings: (2017), 59 –60

B. Rodiek, M. López, H. Hofer, S. Kück, "The absolutely characterized nitrogen-vacancy center based single-photon source - measurement uncertainty of photon flux and angular emission properties", 13th International Conference on New Developments and Applications in Optical Radiometry; in: Journal of Physics: Conference Series (2018)
NEWRAD 2017, Tokyo, 13-16, June 2017

T. Quast, A. Schirmacher, K.-O. Hauer, A. Koo, "Polarization properties and microfacet-based modelling of white, grey and coloured matte diffuse reflection standards," NEWRAD 2017, Journal of Physics: Conf. Series 972 (2018) 012024, doi :10.1088/1742-6596/972/1/012024

Schumacher, Christian; Möhlmann, Carsten; Monte, Christian; Oeffling, Bianca; Plitzko, Sabine: Expositionsbewertung einer Tätigkeit mit mehrlagigen Kohlenstoffnanoröhren. sicher ist sicher, , 68 (2017), 6, 283-287, <https://www.sisdigital.de/sis.06.2017.283>, Erich Schmidt Verlag GmbH & Co. KG. ISSN 2199-7330

Schumacher, Christian; Oeffling, Bianca; Möhlmann, Carsten; Monte, Christian; Plitzko, Sabine: Risk assessment of handling rigid carbon nanotubes at a technical centre in Berlin. Gefahrstoffe - Reinhaltung der Luft, , 77 (2017), 10, 416-420, [https://www.gefahrstoffe.de/gest/article.php?data\[article_id\]=88301&keep_alive=yes&pos=](https://www.gefahrstoffe.de/gest/article.php?data[article_id]=88301&keep_alive=yes&pos=), Springer-VDI-Verlag GmbH & Co. KG. ISSN 0949-8036 (print); ISSN 1436-4891 (online)

Sametoglu, F.; Celikel, O.; Witt, F.: "A differential spectral responsivity measurement system constructed for determining of the spectral responsivity of a single- and triple-junction photovoltaic cells", European Physical Journal: Applied Physics: 80 (2017), 2, 21001-1 – 21001-10, <https://doi.org/10.1051/epjap/2017170162>

M. Sildoja, S. Nevas, S. Pape, S. Pendsa, P. Sperfeld, F. Kemus, "LED-based UV monitoring source", 13th International Conference on New Developments and Applications in Optical Radiometry (NEWRAD 2017), Proceedings: (2017), 92 –93

C. Strothkämper, A. Ferrero, A. Koo, P. Jaanson, G. Ged, G. Obein, S. Källberg, J. Audenaert, F. B. Leloup, F. M. Martínez-Verdú, E. Perales, A. Schirmacher, and J. Campos, "Multilateral spectral radiance factor scale comparison," Applied Optics 1996 Vol. 56, No. 7, March 1 2017

Taubert, Richard Dieter; Monte, Christian; Baltruschat, Christoph; Schulz, Marco; Hollandt, Jörg: Development and specification of an accurate cosine-behaviour responsivity radiometer head for infrared temperature radiation = Entwicklung und Spezifizierung eines Radiometer-Messkopfes mit cosinusgetreuen Ansprechverhalten für Infrarot-Temperaturstrahlung. *Technisches Messen*, 84 (2017), 12, 769-778, [dx.doi.org/10.1515/teme-2017-0095](https://doi.org/10.1515/teme-2017-0095) De Gruyter. ISSN 0171-8096 (print); ISSN 2196-7113 (online)

Taubert, Richard Dieter; Monte, Christian; Baltruschat, Christoph; Schulz, Marco; Hollandt, Jörg: Development and specification of an accurate cosine-behaviour responsivity radiometer head for infrared temperature radiation. *Temperatur 2017: Fachtagung PTB Institut Berlin, 17.-18. Mai 2017*, (2017), 77-88, Braunschweig [u.a.]: Physikalisch-Techn. Bundesanstalt.

Urban, David; Anhalt, Klaus: Dynamisches Messverfahren für den gerichteten spektralen Emissionsgrad im Temperaturbereich bis 2000 °C. *Temperatur 2017: Fachtagung PTB Institut Berlin, 17./18. Mai 2017*, (2017), 287-293, Braunschweig [u.a.], Physikalisch-Technische Bundesanstalt.

van den Berg, Steven; Dekker, Paul; Reiniger, Max; Gutschwager, Berndt; Monte, Christian; Hollandt, Jörg: Traceability of the Network for Detection of the Mesospheric Change (NDMC) to radiometric standards via a near infrared filter radiometer. *13th International Conference on New Developments and Applications in Optical Radiometry*, 1316 June 2017, Tokyo, Japan; *Proceedings*, (2017), 18-19 Bristol, IOP Publishing.

R. Zuber, P. Sperfeld, S. Nevas, M. Sildoja, “A stray light corrected array spectroradiometer for complex high dynamic range measurements in the UV spectral range”, *13th International Conference on New Developments and Applications in Optical Radiometry (NEWRAD 2017)*, *Proceedings*: (2017), 65 –66

2018

A. Berjón, A. Redondas, M. Sildoja, S Nevas, K. Wilson, S. León-Luis, O. El Gawhary, I. Fountoulakis “Sensitivity study of the instrumental temperature corrections on Brewer total ozone column measurements”, *Atmospheric Measurement Techniques*: 11 (2018), 3323 – 3337, <https://doi.org/10.5194/amt-11-3323-2018>

A. Gottwald, F. Scholze: “Advanced silicon radiation detectors in the vacuum ultraviolet and the extreme ultraviolet spectral range”, *Smart sensors and MEMS, Intelligent devices and microsystems for industrial applications*, 2nd edition, 151-170 (2018)

A. Gottwald, U. Kroth, E. Kalinina, V. Zabrodskii: “Optical properties of a Cr/4H-SiC photodetector in the spectral range from ultraviolet to extreme ultraviolet”, *Appl. Opt.* **57**, 8431 (2018)

R. Klein, S. Kroth, W. Paustian, M. Richter, R. Thornagel: „PTB’s radiometric scales for UV and VUV source calibration based on synchrotron radiation”, *Metrologia* **55**, 386 (2018)

U. Köhler, S. Nevas, G. McConville, R. Evans, M. Smid, M. Stanek, A. Redondas, F. Schönenborn, “Optical characterisation of three reference Dobsons in the ATMOZ Project – verification of G. M. B. Dobson's original specifications”; *Atmospheric Measurement Techniques*: 11 (2018), 1989 – 1999, <https://doi.org/10.5194/amt-11-1989-2018>

Kröger, I.; Friedrich, D.; Winter, S.; Salis, E.; Müllejans, H.; Pavanello, D.; Hohl-Ebinger, J.; Bothe, K.; Hinken, D.; Dittmann, S.; Friesen, G.; Bliss, M.; Betts, T.; Gottschalg, R.; Rimmelpacher, L.; Stang, J.; Herrmann, W.; Dubard, J.: “Results of the round robin calibration of reference solar cells within the PhotoClass project”, *International Journal of Metrology and Quality Engineering*: 9 (2018), 8, 1 - 6 (2018), <https://doi.org/10.1051/ijmqe/2018006>

N. Pereira, D. Bolsée, P. Sperfeld, S. Pape, D. Sluse, G. Cessateur, “Metrology of solar spectral irradiance at the top of the atmosphere in the near infrared measured at Mauna Loa Observatory: the PYR-ILIOS campaign”, *Atmospheric Measurement Techniques*, 11 (2018), 12, 6605-6615, <https://doi.org/10.5194/amt-11-6605-2018>

Plag, F.; Kröger, I.; Fey, T.; Witt, F.; Winter, S. : “Angular-dependent spectral responsivity - traceable measurements on optical losses in PV devices”, *Progress in Photovoltaics*: 26 (2018), 8, 565 – 578, <https://doi.org/10.1002/pip.2957>

Plag, F.; Kröger, I.; Riechelmann, S.; Winter, S.: “Multidimensional model to correct PV device performance measurements taken under diffuse irradiation to reference conditions”, *Solar Energy*: 174 (2018), 431 – 444, <https://doi.org/10.1016/j.solener.2018.08.072>

T. Pulli, T. Karpinen, S. Nevas, P. Kärhä, K. Lakkala, J. Karhu, M. Sildoja, A. Vaskuri, M. Shpak, F. Manoocheri, L. Doppler, S. Gross, J. Mes, E. Ikonen, “Out-of-range stray light characterization of single-monochromator brewer spectrophotometers”, *Atmosphere-Ocean*: 56 (2018), 1, 1 – 11, <https://doi.org/10.1080/07055900.2017.1419335>

A. Redondas, S. Nevas, A. Berjón, M. Sildoja, S. León-Luis, V. Carreno, D. Santana-Díaz, “Wavelength calibration of Brewer spectrophotometer using a tunable pulsed laser and implications to the Brewer ozone retrieval”, *Atmospheric Measurement Techniques*: 11 (2018), 3759 – 3768, <https://doi.org/10.5194/amt-11-3759-2018>

K. Salfner, T. Dönsberg, G. Porrovecchio, M. Smid, K. Nield, S. Nevas, “Characterization of a room temperature predictable quantum efficient detector for

applications in radiometry and photometry”, *Metrologia*, 55 (2018), 5, 654-661,
<https://doi.org/10.1088/1681-7575/aad19d>

R. Schaefer, A. Gottwald, M. Richter: „Traceable measurements of He, Ne, Ar, Kr, and Xe photoionization cross sections in the EUV spectral range”, *J. Phys. B: At. Mol. Opt. Phys.* **51**, 135004 (2018)

A. Schirmacher, M. Pastuschek, “Zur Messung von Sparkle Eigenschaften”, Oral presentation Dfwg Annual Meeting 2018, Bönningheim, 10. Okt. 2018, Dfwg-Report 2019/1, ISSN 1860-2835

F. Schmähling, G. Wuebbeler, U Krueger, B. Ruggaber, F. Schmidt, R. D. Taubert, A. Sperling, C. Elster, “Uncertainty evaluation and propagation for spectral measurements”, *Color Research & Application* (2018), Vol 43, Issue 1, 6-16,
<https://doi.org/10.1002/col.22185>

Schmidt, Marco; Helversen; López, Marco; Gericke, F.; Schlottmann, E.; Heindel, T.; Kück, Stefan; Reitzenstein, S.; Beyer, Jörn; “Photon-number-resolving transition-edge sensors for the Metrology of Quantum Light Sources”; *Journal of Low Temperature Physics* (2018), <https://doi.org/10.1007/s10909-018-1932-1>

P. Schneider, K. Salfner, A. Sperling, S. Nevas, I. Kröger, T. Reiners, “Improved calibration strategy for luminous intensity”, *Journal of Physics: Conference Series* (2018), Volume 972, Conference 1, doi :10.1088/1742-6596/972/1/012016

F. Scholze, A. Fischer, C. Tagbo, C. Buchholz, V. Soltwisch, C. Laubis: „Spatially resolved reflectometry for EUV optical components”, *Proc. SPIE* **10809**, 108091U-1 (2018)

M. Sildoja, S. Nevas, N. Kouremeti, J. Gröbner, S. Pape, S. Pendsa, P. Sperfeld, F. Kemus, “LED-based UV source for monitoring spectroradiometer properties”, *Metrologia*, 55 (2018), 3, 97-103, <https://doi.org/10.1088/1681-7575/aab639>

A. Sperling, M. Meyer, S. Pendsa, w. Jordan, E. Revtova, T. Poikonen, D. Renaux, P. Blattner, “Multiple Transfer Standard for calibration and characterisation of the setups for LED lamps and luminaires in industry”, *Metrologia*, 55 (2018), S37-S42,
<https://doi.org/10.1088/1681-7575/aaa173>

R. Zuber, P. Sperfeld, S. Riechelmann, S. Nevas, M. Sildoja, G. Seckmeyer, “Adaption of an array spectroradiometer for total ozone column retrieval using direct solar irradiance measurements in the UV spectral range”, *Atmospheric Measurement Techniques*, 11 (2018), 4, 2477-2484, <https://doi.org/10.5194/amt-11-2477-2018>

Adibekyan, Albert; Kononogova, Elena; Monte, Christian; Gutschwager, Berndt; Hollandt, Jörg: Emissivity, reflectivity and transmissivity of semitransparent fibre reinforced plastic composites. DGfZP IRT-2017; in: Journal of Nondestructive Testing and Ultrasonics, (2018), 5, 1-7, <https://www.ndt.net/article/dgzfp-irt-2017/papers/17.pdf> NDT Internet Publishing. ISSN 1435-4934 (online)

Adibekyan, Albert; Kononogova, Elena; Monte, Christian; Hollandt, Jörg: Review of PTB measurements on emissivity, reflectivity and transmissivity of semitransparent fibre-reinforced plastic composites. International Journal of Thermophysics, , 40 (2019), 14 S.,
<https://link.springer.com/content/pdf/10.1007%2Fs10765-019-2498-0.pdf>,
<https://doi.org/10.1007/s10765-019-2498-0> Springer. ISSN 0195-928X (print); ISSN 1572-9567 (online)

Bliss, M.; Betts, T.; Gottschalg, R.; Salis, E.; Müllejans, H.; Winter, S.; Kröger, I.; Bothe, K.; Hinken, D.; Hohl-Ebinger, J. : Interlaboratory comparison of short-circuit current versus irradiance linearity measurements of photovoltaic devices, Solar Energy: 182 (2019), 256 – 263, <https://doi.org/10.1016/j.solener.2019.02.031>

Gieseler, Julian; Monte, Christian; Adibekyan, Albert; Hollandt, Jörg; Kersting, R.: Entwicklung und Aufbau eines Probenhalters für die Emissionsgradmessung an semitransparenten Materialien. Technisches Messen, 85 (2018), 1, 40-48, [dx.doi.org/10.1515/teme-2017-0089](https://doi.org/10.1515/teme-2017-0089) De Gruyter. ISSN 0171-8096 (print); ISSN 2196-7113 (online)

A. Gottwald, H. Kaser, M. Kolbe: „The U125 insertion device beamline at the Metrology Light Source“, J. Synchrotron Rad. **26**, 535 (2019)

Kehrt, Mathias; Monte, Christian; Steiger, Andreas; Hoehl, Arne; Hollandt, Jörg; Gemünd, H.-P.; Brömel, A.; Hänschke, F.; May, T.; Deßmann, N.; Hübers, H.-W.; Mientus, R.; Reck, E.: Intercomparison of far-infrared transmittance measurements. Optics Express, 26 (2018), 26, 34484-34496, <https://doi.org/10.1364/OE.26.034484>, OSA Publishing. ISSN 1094-4087

Kehrt, Mathias; Monte, Christian; Steiger, Andreas; Hollandt, Jörg: Background corrected measurements of optical quantities in the far-infrared spectral range. Optics Express, 26 (2018), 26, 34002-34006, <https://doi.org/10.1364/OE.26.034002> OSA Publishing. ISSN 1094-4087

Khlevnoy, Boris; Grigoryeva, Irina; Anhalt, Klaus; Wähmer, Martin; Ivashin, Evgeniy; Otryaskin, Denis; Solodilov, Maxim; Gavrilov, Valery; Sapritsky, Victor: Development of large-area high-temperature fixed-point blackbodies for photometry and radiometry. Metrologia, , 55 (2018), 2, S43-S51, <https://doi.org/10.1088/1681-7575/aaa16a> IOP Publishing. ISSN 0026-1394 (print); ISSN 1681-7575 (online)

Kleinert, Anne; Krisch, Isabell; Ungermann, Jörn; Adibekyan, Albert; Gutschwager, Berndt; Monte, Christian: Characterization of blackbody inhomogeneity and its effect on the retrieval results of the GLORIA instrument. *Atmospheric Measurement Techniques*, 11 (2018), 3871-3882, [dx.doi.org/10.5194/amt-2018-59](https://doi.org/10.5194/amt-2018-59) Copernicus GmbH (Copernicus Publications). ISSN 1867-1381 (print); ISSN 1867-8548 (online)

König, Sebastian; Gutschwager, Berndt; Hollandt, Jörg: A large-area plate radiator with in situ temperature homogenization for thermographic imager calibration. *Review of Scientific Instruments*, 89 (2018), 1-6, <https://doi.org/10.1063/1.5027874> American Institute of Physics. ISSN 0034-6748 (print); ISSN 1089-7623 (online)

König, Sebastian; Gutschwager, Berndt; Hollandt, Jörg: Nonuniformity correction of infrared camera systems by reading radiance temperatures in theory and practice. 14th Quantitative InfraRed Thermography Conference (QIRT 2018); (DGZfP-Berichtsband BB:167), (2018), 1-2, <http://qirt.org/dynamique/index.php?idD=81&Lang=0> Berlin: ISSN 2371-4085 (online)

König, Sebastian; Gutschwager, Berndt; Hollandt, Jörg: Nonuniformity determination of infrared imagers by detecting radiance temperatures with the Data Reference Method. *Image and Signal Processing for Remote Sensing XXIV*; (Proceedings of SPIE: 10789), (2018), 1078904-1-1078904-11, <https://doi.org/10.1117/12.2325598>, Bellingham, Wash.: SPIE.

Maierhofer, Christiane; Krankenhagen, Rainer; Röllig, Mathias; Unnikrishnakurup, S.; Monte, Christian; Adibekyan, Albert; Gutschwager, Bernd; Knazowicka, Lenka; Blahut, Ales; Gower, Mike; Lodeiro, Maria; Baker, Graham; Aktas, Alper: Einfluss thermischer und optischer Materialeigenschaften auf die Charakterisierung von Fehlstellen in Faserverbundwerkstoffen mit aktiven Thermografieverfahren. *Technisches Messen*, 85 (2018), 1, 13-27, [dx.doi.org/10.1515/teme-2017-0078](https://doi.org/10.1515/teme-2017-0078) de Gruyter. ISSN 0171-8096 (print); ISSN 2196-7113 (online)

Maierhofer, Christiane; Röllig, Mathias; Gower, Mike; Lodeiro, Maria; Baker, Graham; Monte, Christian; Adibekyan, Albert; Gutschwager, Bernd; Knazowicka, Lenka; Blahut, Ales: Evaluation of different techniques of active thermography for quantification of artificial defects in fiber-reinforced composites using thermal and phase contrast data analysis. *International Journal of Thermophysics*, , 39 (2018), 61, 37 S., [dx.doi.org/10.1007/s10765-018-2378-z](https://doi.org/10.1007/s10765-018-2378-z) Springer. ISSN 0195-928X (print); ISSN 1572-9567 (online)

McEvoy, Helen C.; Martin, Maria-Jose; Steiner, Anton; Schreiber, Ekkehard; Girard, Ferruccio; Battuello, Mauro; Sadli, Mohamed; Ridoux, Pascal; Gutschwager, Berndt; Hollandt, Jörg; Diril, Ahmet; Pehlivan, Özlem: Report on the measurement results for the EURAMET 658 extension: project to examine underlying parameters in radiance scale realisation. *Metrologia*, , 55 (2018), Tech. Suppl., 120 S.,

<https://doi.org/10.1088/0026-1394/55/1A/03001> IOP Science. ISSN 0026-1394 (print); ISSN 1681-7575 (online)

Meindl, Peter; Johannsen, Uwe; Pohl, Tobias; Kosubek, Elzbieta; Taubert, Richard Dieter; Werner, Lutz: SI traceable measurement of the spectral responsivity of thermal detectors in the wavelength range from 1.5 μm to 10.6 μm by using a cryogenic radiometer at PTB. 14th Quantitative InfraRed Thermography Conference (QIRT 2018); (DGZfP-Berichtsband BB:167), (2018), 1-2, <http://qirt.org/dynamique/index.php?idD=81&Lang=0> Berlin: ISSN 2371-4085 (online)

Müller, Ingmar; Adibekyan, Albert; Gutschwager, Berndt; Kononogova, Elena; König, Sebastian; Monte, Christian; Reiniger, Max; Hollandt, Jörg: Calibration capabilities at PTB for radiation thermometry, quantitative thermography and emissivity. 14th Quantitative InfraRed Thermography Conference (QIRT 2018); (DGZfP-Berichtsband BB:167), (2018), 329-333, <http://qirt.org/archives/qirt2018/papers/015.pdf>, <https://doi.org/10.21611/qirt.2018.015>, Berlin: ISSN 2371-4085 (online)

Olschewski, Friedhelm; Monte, Christian; Adibekyan, Albert; Reiniger, Max; Gutschwager, Berndt; Hollandt, Jörg; Koppmann, R.: A large-area blackbody for inflight calibration of an infrared interferometer deployed on board a long-duration balloon for stratospheric research. Atmospheric Measurement Techniques, 11 (2018), 8, 4757-4763, <https://doi.org/10.5194/amt-11-4757-2018> Copernicus Publications. ISSN 1867-8548

Pohl, Tobias; Meindl, Peter; Johannsen, Uwe; Taubert, Dieter; Werner, Lutz: Measurement of the absolute spectral responsivity in the mid-infrared based on the cryogenic electrical substitution radiometer and an optimized thermopile detector. Journal of Sensors and Sensor Systems (JSSS), (2019), 8, 195-205, <https://doi.org/10.5194/jsss-8-195-2019> Copernicus Gesellschaft mbH. ISSN 2194-8771 (print); ISSN 2194-878X (online)

Porrovecchio, Geiland; Smid, Marek; Werner, Lutz; Johannsen, Uwe; Linke, Ulrike: Long-term spectral responsivity stability of predictable quantum detectors. Proceedings of 29th CIE Session 2019, (2019), 417-420, http://files.cie.co.at/x046_2019/x046-OP58.pdf, <https://doi.org/10.25039/x46.2019.OP58>

Salis, E.; Pavanello, D.; Kröger, I.; Winter, S.; Bothe, K.; Hinken, D.; Gandy, T.; Hohl-Ebinger, J.; Friesen, G.; Dittmann, S.; Dubard, J.; Müllejans, H.: Results of four European round-robins on short-circuit current temperature coefficient measurements of photovoltaic devices of different size; Solar Energy: 179 (2019), 424 – 436, <https://doi.org/10.1016/j.solener.2018.10.051>

Schmähling, Franko; Wübbeler, Gerd; Krüger, Udo; Ruggaber, Benjamin; Schmidt, Franz; Taubert, Richard D.; Sperling, Armin; Elster, Clemens: Uncertainty evaluation and propagation for spectral measurements. *Color Research & Application*, , 43 (2018), 1, 1-11, [dx.doi.org/10.1002/col.22185](https://doi.org/10.1002/col.22185) Wiley. ISSN 0361-2317 (print); ISSN 1520-6378 (online)

Marco Schmidt; Martin von Helversen; Elisabeth Schlottmann; Marco López; Fabian Gericke; Jan-Hindrik Schulze; André Strittmatter; Christian Schneider; Stefan Kück; Sven Höfling; Tobias Heindel; Jörn Beyer; Stephan Reitzenstein; "Photon-number-resolving transition-edge sensors for the metrology of photonic microstructures based on semiconductor quantum dots"; *Proc. SPIE 10933, Advances in Photonics of Quantum Computing, Memory, and Communication XII*; 1093305 (4 March 2019); doi: 10.1117/12.251408

Steiger, Andreas; Kehrt, Mathias; Deninger, Anselm: A reference material for accurate THz measurements. 2018 43rd International Conference on Infrared, Millimeter, and Terahertz Waves (IRMMW-THz) IEEE Xplore (2018), <https://doi.org/10.1109/IRMMW-THz.2018.8510011>, Piscataway, NJ: IEEE. ISSN 2162-2035 (online); ISSN 2162-2027 (PoD)

Urban, David; Krenek, Stephan; Anhalt, Klaus; Taubert, Richard Dieter: Improving the dynamic emissivity measurement above 1000K by extending the spectral range. *TEMPMEKO 2016: Selected Papers of the 12th International Symposium on Temperature, Humidity, Moisture and Thermal Measurements in Industry and Science*: In: *International Journal of Thermophysics*, , 39 (2018), 1, 11 S., [dx.doi.org/10.1007/s10765-017-2339-y](https://doi.org/10.1007/s10765-017-2339-y) Springer. ISSN 0195-928X (print); ISSN 1572-9567 (online)

van den Berg, Steven; Dekker, Paul; Reiniger, Max; Gutschwager, Berndt; Monte, Christian; Hollandt, Jörg: Traceability of the Network for Detection of the Mesospheric Change (NDMC) to radiometric standards via a near infrared filter radiometer. *Journal of Physics: Conference Series*, 972 (2018), 01, 1-6, <https://doi.org/10.1088/1742-6596/972/1/012006> IOP Publishing. ISSN 1742-6588 (print); ISSN 1742-6596 (online)