THE REDUCED BACKGROUND CALIBRATION FACILITY 2 FOR INFRARED DETECTORS, CAMERAS AND SOURCES

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The Reduced Background Calibration Facility 2 (RBCF2) as the successor of the Reduced Background Calibration Facility (RBCF) was recently brought into operation at PTB. 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.

INTRODUCTION

The Physikalisch-Technische Bundesanstalt (PTB) designed a new calibration facility, the Reduced Background Calibration Facility 2 (RBCF2) as the successor of the Reduced Background Calibration Facility (RBCF) [1], and brought it recently into operation. It provides traceable calibrations of air born and space based infrared remote sensing experiments in terms of radiance temperature and spectral radiance. Traceable remote measurements require the use of calibrated stable detector systems and/or source-based calibration standards on board of the instrumentation. In any case they should be calibrated under operational conditions to ensure traceability with the smallest possible uncertainty. The RBCF2 enables therefore the calibration of radiators and detectors and cameras under cryogenic and/or vacuum conditions. The integration of the instrument under test into the RBCF2 can be done under ISO 5 clean room conditions.

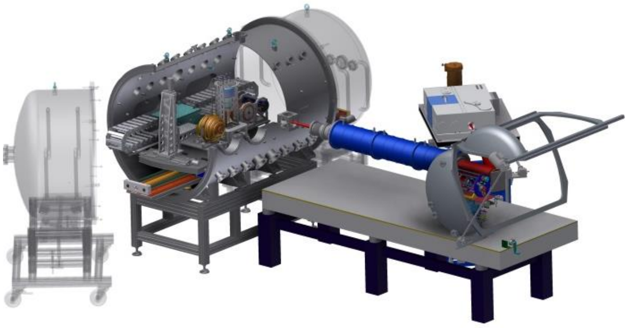

Figure 1 The Reduced Background Calibration Facility 2 (RBCF2) of PTB with source- (left) and detector (right) chamber.

CONCEPT OF THE RBCF2

The general concept of the RBCF2, shown in Figure 1, is to connect different sources in the source chamber and detectors in the detector chamber via a liquid nitrogen cooled beam line. Source- and detector chamber also incorporate cooling facilities. Translation units in both chambers enable the RBCF2 to automatically compare and calibrate different sources and detectors with stable comparison instruments at cryogenic ambient temperatures and under a common vacuum.

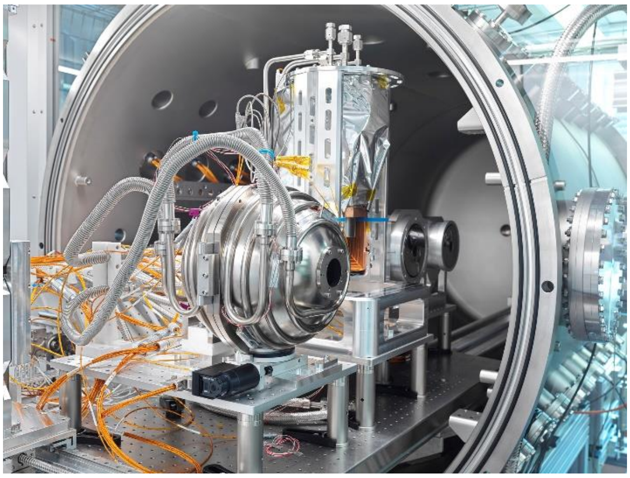

Figure 2 View into the source chamber of the RBCF2: emissivity sample holder, LN2-blackbody, VLTBB and VMTBB from left to right.

Reference sources for comparisons are dedicated vacuum variable temperature blackbodies (compare Figure 2), for example the vacuum medium temperature blackbody (VMTBB, 150 °C to 430 °C) [2], the vacuum low temperature blackbody (VLTBB, -173 °C to 177 °C) [3], the large area heatpipe blackbody (LAHBB, -60 °C to 50 °C) featuring a radiating diameter of 250 mm, the liquid nitrogen blackbody (LNBB, -196 °C) and calibrated vacuum integrating sphere radiators for UV-VIS and SWIR applications (Figure 3). The radiation temperatures of the reference blackbodies and the spectral 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) [4] direct calibrations of sources in terms of radiance temperature in the wavelength range from 8 µm to 14 µm can be performed.

For spectrally resolved measurements the radiation of the reference sources and the sources under test is imaged on a vacuum Fourier-Transform Spectrometer (FTS). The FTS covers the wavelength range from 0.4 µm to 1000 µm by employing detectors ranging from photomultipliers to liquid helium cooled bolometers. The different reference blackbodies enable measurements with respect to at least two reference temperatures, simultaneously. Hereby disturbances in the infrared by background radiation resulting from inside the FTS can be effectively compensated. Sources can be also spatially mapped and characterized for the lateral distribution of their spectral radiance. The flexible design of the facility also allows large aperture camera characterizations and modifications for customer needs and the measurement of directional spectral emissivities over a wide temperature and wavelength range.

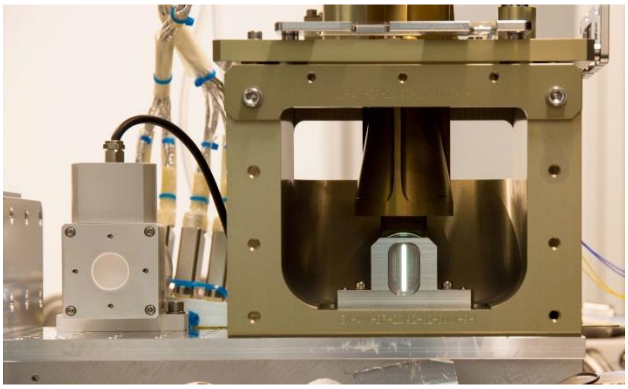

Figure 3 PTB's vacuum integrated sphere radiance transfer standard (RTS) (left) and EnMAP's onboard calibration assembly (OBCA) with illuminated exit aperture (right) inside the source chamber of the RBCF2.

EXEMPLARY APPLICATIONS

As a critical consistency check to the former RBCF vacuum emissivity measurements were performed at the RBCF2. For example, the results of the directional spectral emissivity of SiC depicted in Figure 4 show no deviation between past and current measurements within the standard uncertainty. Additionally, comparison measurements performed with the emissivity measurement facility in air (EMAF) show no significant deviation.

Recent calibrations of the large aperture on-board blackbodies of the airborne GLORIA limbsounder [5] in the MIR spectral range and of the on-board calibrations assembly (OBCA) of the EnMAP satellite [6] in the VIS-NIR spectral range will be shown during the presentation to illustrate the capabilities of the RBCF2.

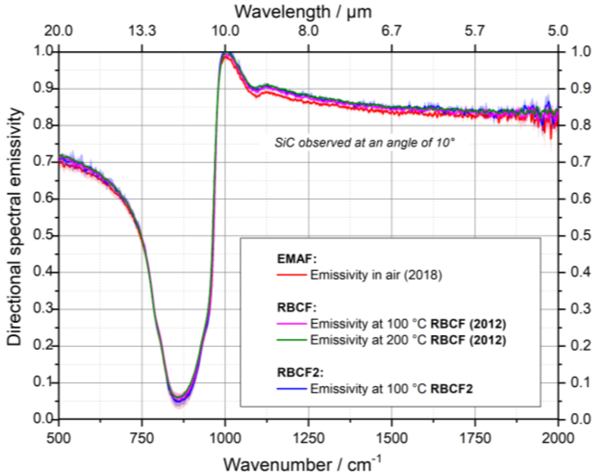

Figure 4 Directional spectral emissivity of SiC recorded 2012 at the RBCF in vacuum, 2018 at the EMAF and 2019 at the RBCF2 show no significant deviation.

REFERENCES

1. C. Monte et al., The Reduced Background Calibration Facility for Detectors and Radiators at the Physikalisch-Technische Bundesanstalt, in: Sensors, Systems,and Next-Generation Satellites XIII, edited by: Meynart, R.,Neeck, S. P., and Shimoda, H., Vol. 7474, Proceedings of SPIE/,747414, Berlin, 2009a..
2. S. P. Morozova et al., Vacuum Variable Medium Temperature Blackbody (VMTBB), Int. J. Thermophys, 31, 1809-1820, 20103.
3. S. P. Morozova et al., Vacuum Variable Temperature Blackbody VLTBB100, Int. J. Thermophys., 29, 341-351, 2008.
4. B. Gutschwager et al., An Infrared Precision Radiation Thermometer for the Calibration of Remote Sensing Instrumentations under Vacuum, in: Image and Signal Processing for Remote Sensing XV, edited by: Bruzzone, L., Notar-nicola, C., and Posa, F., Vol. 7477, Proceedings of SPIE, 747719, Berlin, 2009.
5. C. Monte et al., Radiometric calibration of the in-flight blackbody calibration system of the GLORIA interferometer, Atmos. Meas. Tech., 7, 13-27, 2014.
6. L. Guanter et al., The EnMAP Spaceborne Imaging Spectroscopy Mission for Earth Observation. Remote Sens., 7, 8830-8857, 2015.