**Introduction:** The MERTIS instrument onboard BepiColombo is a thermal infrared spectrometer and radiometer that is designed to investigate the surface mineralogy of Mercury in the wavelength region from 7 µm to 14 µm [1]. Mercury’s daytime surface temperatures reach more than 400°C [2]. Therefore, the studied wavelength range is dominated by thermal emission. Although emissivity and reflectance can be converted via Kirchhoff’s law (1-Reflectance=Emission), this correlation is only entirely correct for directional-hemispherical reflectance [3]. Especially band intensities may vary when directional-directional reflectance is measured (like in the standard IRIS (Infrared & Raman for Interplanetary Spectroscopy) laboratory measurement campaigns) and emissivity is calculated. However, reflectance measurements are much faster and easier to perform compared to emissivity measurements. Therefore, it is necessary to compare the results of reflectance measurements from the IRIS laboratory with corresponding emissivity measurements.

**Setup and Methods:** To gain genuine emissivity spectra, we built a new emissivity setup using a Harrick Emission Accessory connected to the Bruker Vertex 70v FTIR spectrometer in the IRIS laboratory. The emission accessory is equipped with a high temperature reaction chamber by Harrick covered by a ZnS window. Within this chamber we generate a high vacuum with a Pfeiffer High Cube turbo pump down to a minimal pressure of 10⁻⁴ Pa. The beam path between the chamber and the spectrometer is purged with zero air to suppress atmospheric water and CO₂ bands. The chamber outer walls are cooled with water. The sample holder inside the chamber, which is not in direct contact with the outer chamber walls, has a diameter of 6 mm and a depth of 5 mm. The sample holder is directly heated from outside the chamber. The heating and setpoint temperatures are automatically controlled and held stable. This enables also long term heating cycles. The built in temperature control is located outside the chamber with a thermocouple located above the heating cartridge. We added a second thermocouple, which we inserted through one of the gas inlet/outlet ports directly into the sample holder as we recognized that a correct as possible temperature measurement for the calibration is indispensable. This thermocouple reaches through the powdered samples. The tip of this thermocouple is directly located at the sample’s surface to determine the surface temperature as exact as possible. For the calibration of the measurements we used the method proposed by [4] and the trivial relation that sample and background are at the same temperature (S/R). For comparison reasons we used the same blackbody material as [5], however, the chamber also provides a plate with a small hole to convert the sample holder into a cavity radiator for calibration purposes. The calibration method uses two measurements of the blackbody at two temperatures and a measurement of the empty sample chamber to measure the reflected signal of the complete setup [4]. Together with the theoretical blackbody spectra at the same temperatures and the two blackbody measurements and the chamber reflectivity measurement a spectrometer response function (Fig. 1) and the instrument energy (Fig. 2) is calculated. Those two values are used to calibrate the samples emission measurements at varying temperatures to derive the emissivity (Fig. 3). To guarantee stable and reproducible results, we allowed the blackbody to equilibrate for 1.5 hours prior to the measurements used for the method of [4]. The sample was first over-heated and then cooled down to the desired temperature.

![Response function](image)

**Fig 1:** Instrument response function. At the short wavelength side are some artifacts visible which are due to water vapor in the beam path.
For the S/R measurement the blackbody was measured between 190°C and 210°C in 5 K steps. Then the most suitable BB-measurement was used for the calibration.

**Discussion:** The response function as well as the instrument energy reveal that there is minor residual water vapor and CO₂ (especially at the 14.99 µm band) in the beam path of the emission chamber (Figs 1 and 2). However, this has only a very small effect on the emission spectra in the wavelength region around 7 µm (Fig 3). The instrument energy is very stable over a wide temperature range indicating very stable measurement conditions during a measurement campaign (Fig 2).

All emission spectra show a clear Christiansen feature (emission maximum) at the wavelength expected from the reflectance measurement value (Fig. 3). The emission calculated with the method proposed by [4] led to emission-values well below the 1-R-spectrum and the sample/background-spectrum. Therefore, we applied an offset to these two spectra to match approximately the value of the 1-R-measurement. The need for the offset might be an artifact caused of inhomogeneous sample heating or unstable temperatures during the measurements. The measured sample temperature at the inner thermocouple was 199°C to 200°C during the measurement. Using [4] to calculate the temperature lead to a value of 218°C, which was then used to calculate the emission. The measured temperature for the low-temperature measurement was 96°C, whereas the calculation led to a value of 118°C. We attribute those deviations to the non-ideal sample surface temperature variations. In turn, the used blackbody measurement used in the sample/background calculation was at 195°C to achieve the spectrum because the 200°C measurement yield a larger deviation from the 1-R measurement.

**Conclusion:** The new emissivity chamber setup is a powerful extension of the IR-measurement capabilities at the IRIS laboratory. It will allow us to directly compare the reflectance and emission spectra of the same samples without longer sample transportation and under similar conditions. This addition improves our capabilities in the preparation and investigations of the expected MERTIS Mercury data.

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**References:**

**Additional Information:** All spectra measured in the IRIS laboratory and published in a peer-reviewed journal are made available together with electron microprobe data of the samples and potential additional data like raman spectra or scanning electron microscope images are available in the IRIS MERTIS spectral database at http://bc-mertis-pi.uni-muenster.de/.

**Fig 2:** Instrument energy derived from two blackbody measurements, that are not distinguishable at this scale.

**Fig 3:** Emissivity measurements of the same diopside sample ID 134 [6] at two different temperatures with two different methods to derive the emissivity compared with the reflectance measurement turned into emission (blue). The values derived with the method proposed by [4] are offset to match approximately the 1-R-value.