LABORATORY MEASURMENTS OF LUNAR SAMPLES TO CONSTRAIN MERTIS OBSERVATIONS FROM BEPICOLOMBO EARTH/MOON FLYBY. O. Barraud[1], A. Maturilli[1], A. Van den Neucker[1], J. Helbert[1], M. D'Amore[1] and H. Hiesinger[2], [1]German Aerospace Center (DLR) - Institute of Planetary Research, Rutherfordstrasse 2, 12489 Berlin (Oceane.Barraud@dlr.de), [2]Institut für Planetologie (IfP), Westfälische Wilhelms-Universität Münster, Wilhelm-Klemm-Str. 10, 48149 Münster, Germany.

Introduction: The Mercury Radiometer and Thermal Infrared Spectrometer (MERTIS) [1] is part of the ESA BepiColombo Mercury Planetary Orbiter (MPO) payload and consists of a push-broom IR-spectrometer (-TIS) and a radiometer (-TIR) which operate in the wavelength regions of 7-14 µm and 7-40 µm, respectively. During the long cruise to Mercury, BepiColombo have been flyby the Earth on April 10th, 2020. Due to the flight configuration, not all the instruments onboard BepiColombo are able to operate during cruise and flybys. However, MERTIS is able to acquire data through its space baffle and had the opportunity to observed the Moon during the Earth flyby [1,2].

Sample returned mission and orbital spectroscopic observations in the ultraviolet (UV), visible (VIS) and near-infrared (NIR) domains have greatly advanced our understanding of the mineralogical and chemical composition of the lunar surface. However, MERTIS provided the first hyperspectral observation of the Moon in the thermal infrared (TIR) wavelengths from space and laboratory measurements are needed to interpret this dataset. Here, we present the preliminary results about laboratory measurements of lunar analog rocks under simulated Moon conditions in the spectral range of the spectral imager of MERTIS.

Laboratory measurements:

Lunar Samples. Laboratory measurements are performed on lunar sample, terrestrial sands and regolith simulants produced using the Planetary Spectroscopy Laboratory (PSL) [eg., 2, 3] facilities:

- Apollo 16 sample (62231.44)
- Mojave desert sands (two types of grain size)
- Eifelsand simulant (a mix of crushed basalt and volcanic pumice sand)
- DLR Lunar mixture (with four different grain sizes).
- Lunar highland simulant (provided by NASA/USGS)
- Lunar mare simulant (JSC-A1).

Experimental setup. The Planetary Spectroscopy Laboratory (PSL) at Deutsches Zentrum für Luft- und Raumfahrt (DLR) offers the capability to measure emissivity of solid and powder materials, in air or in vacuum, at very high temperatures (100-1000°C), over an extended spectral range (0.7-200 µm) in a range of planetary simulation chambers. Here, emissivity measurements are complimented by hemispherical reflectance. Both measurements are made by using same model of spectrometers, the Bruker Vertex 80V. The instruments obtain measurements under vacuum and are equipped with a liquid-nitrogen cooled HgCdTe (MCT) detector for MIR spectroscopy. For this study, emissivity measurements are performed on samples heated to 130°C inside steel cups (Fig.1) inside the vacuum chamber. Black-body measurements from 105 to 140°C with 5°C steps are performed and used for the calibration.

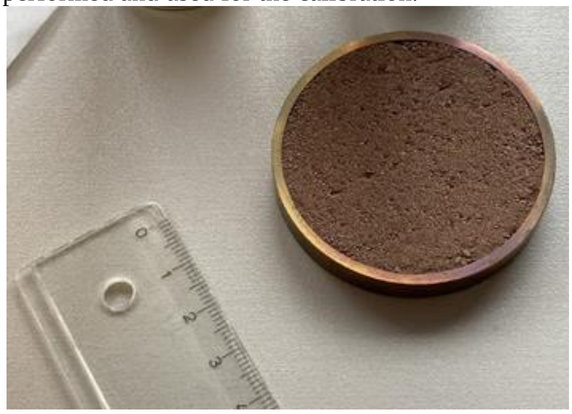

Fig 1: Mojave desert sand (larger grains) inside the steel cup before emissivity measurements inside the vacuum chamber.

Calibration and spectral analysis. Emissivity measurements are calibrated following the one-temperature method described in [5] and [6]. Using this method, the sample emissivity is computed as the ratio between the sample radiance and a calculated black-body radiance at the sample temperature. Hemispherical measurements are calibrated using the spectrum of a gold sandpaper as a reference. Hemispherical reflectance is converted to emissivity following the Kirchhoff's law (emissivity = 1 – reflectance).

Spectral characteristics: Emissivity retrieved from hemispherical reflectance are shown in Fig 2. DLR Lunar mixture shows a strong decrease of emissivity before 8.8 µm and the intensity of this decrease seems corraleted to the grain size of the sample. The same observations could be done with the Mojave samples before 8.0 µm. Lunar mixture exhibits a broad spectral band between 8 and 12 µm with to different peaks around 9 and 10.8 µm. The spectral contrast of this extended feature decrease with decreasing grain size.

MERTIS/BepiColombo implications: As already mentioned, MERTIS provided the first hyperspectral observations of the Moon's surface between 7 to 14 µm. Laboratory measurements performed in this study will be compared with MERTIS data obtained during the Earth flyby. This comparison will allow a better understanding of the MERTIS data of the Moon but also prepare the observations of the

Mercury surface, the main objective of MERTIS [1]. The surface composition of the Moon and Mercury have been frequently compared in the literature even if the mineralogical composition of Mercury is unknown since the MESSENGER observations lack of absorption bands in the UV-VIS-NIR [7]. MERTIS spectral domain will therefore be crucial to determine the compostion of the Mercury's surface and a good interpretation of its dataset is needed.

References:

[1] Hiesinger H. et al. (2020). *Space Science Reviews*, *216*, 1-37. [2] Maturilli A. et al. (2020) *EPSC2020-271. Copernicus Meetings*, 2020. [3] Maturilli A. et al. (2008). *Planet. Space Sci*.56, 420–425. [4] Maturilli A. and Helbert.J. (2009). *Earth Planet. Sci. Lett.*285, 347–354. [5] Ruff S.W. et al. (1997). *J. Geophys. Res*. 102, 14899–14913. [6] Maturilli A. et al. (2006). *Space Sci. 54 (11)*, 1057–1064. [7] Izenberg. R. N. et al. (2014). *Icarus*, *228*, 364-374.

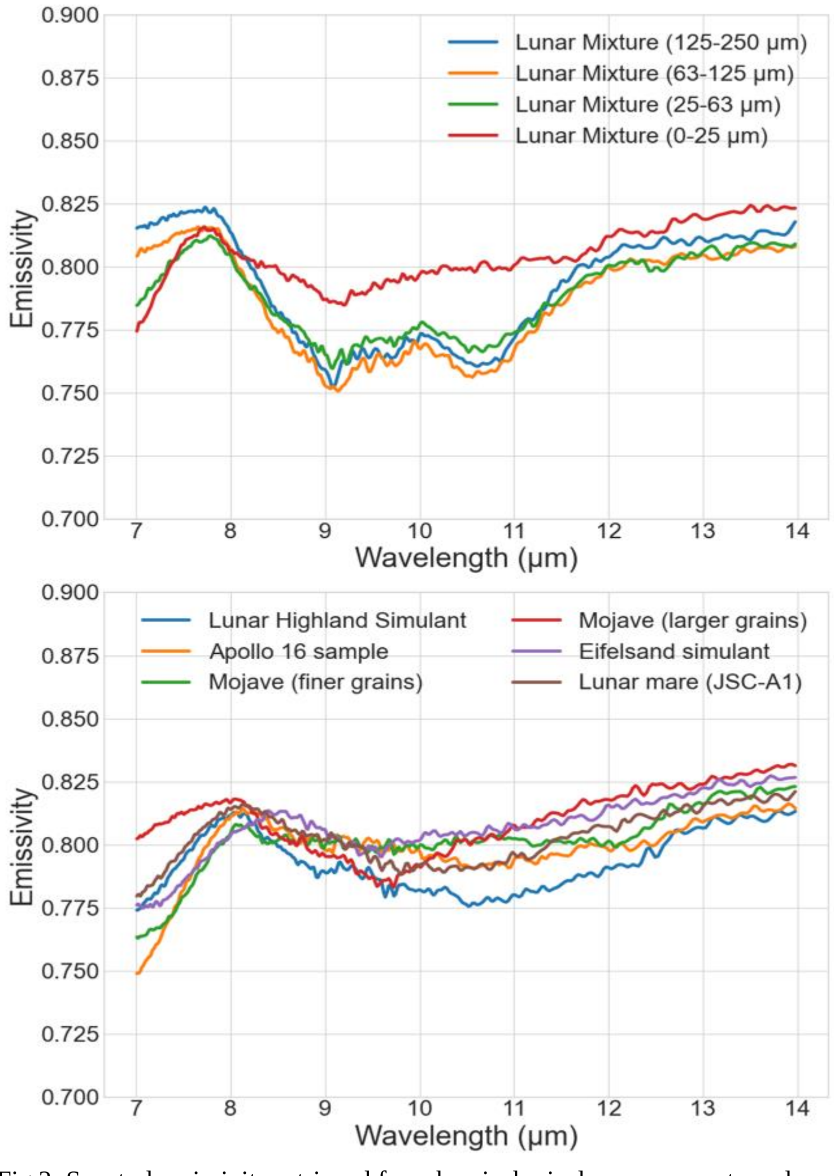

Fig 2: Spectral emissivity retrieved from hemispherical measurements on lunar sample and simulants across the MERTIS (TIS) wavelength range.