EPSC Abstracts
Vol. 5, EPSC2010-268, 2010
European Planetary Science Congress 2010

Science requirements for MERTIS on BepiColombo revisited

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Abstract

The first concepts for the **Mercury Radiometer and Thermal Infrared Spectrometer (**MERTIS**)** instrument were developed almost 10years ago. At this time the NASA mission MESSENGER had just been approved and there were almost no laboratory data available on the infrared spectra of minerals at high temperatures. For this reason, the definition of the requirements and the derived design for MERTIS was driven by the idea of "prepare for the unexpected".

1. Introduction

Today the situation has changed significantly. We had three flybys of Mercury by the MESSENGER mission and with the Planetary Emissivity Laboratory at DLR in Berlin we can routinely obtain infrared emission spectra at high temperatures. At the same time MERTIS has grown from a concept to a fully functional development model that allows realistic performance measurements. Hence, it is the perfect time to review the MERTIS science requirements and the performance in perspective of our new knowledge of Mercury.

2. The MERTIS instrument

The Mercury Radiometer and Thermal infrared Imaging Spectrometer MERTIS on the joint ESA-JAXA mission BepiColombo to Mercury is combining a spectrometer using an uncooled microbolometer in a pushbroom mode with a highly miniaturized radiometer. The imaging spectrometer will map the surface of Mercury with a typical spatial resolution of better than 500m in the spectral range from 7-14µm with a wavelength resolution of 200nm. The radiometer extends the spectral range to 40µm allowing measurements of Mercury's nightside temperatures with high accuracy. All this is combined in an instrument with a mass of 3.3kg and an average power consumption of 13W.

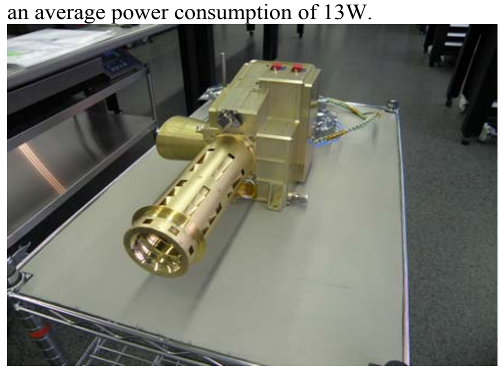

Figure 1 MERTIS structural and thermal model

3. MERTIS science goals

The scientific objective of MERTIS is to provide detailed information about the mineralogical composition of Mercury's surface layer by measuring the spectral emittance in the spectral range from 7-14µm. The knowledge of the mineralogical composition is crucial for testing several competing theories, and thus for selecting the most likely model for the origin and evolution of the planet. Furthermore, MERTIS will constrain parameters for the thermophysical properties of the surface, mainly the thermal inertia and the roughness of the surface. Summarized, MERTIS has four main science goals, building on the general science objectives of the Bepi-Colombo mission.

1. Study of Mercury's surface composition
2. Identification of rock-forming minerals
3. Global mapping of the surface mineralogy
4. Study of surface temperature and thermal inertia

MERTIS will globally map the planet at unprecedented high spatial resolution (~500m) and a S/N of at least 100. For a typical dayside observation the S/N ratio can exceed 300 even for a fine grained and partly glassy surface. MERTIS will map 5-10% of the surface with a spatial resolution higher than 500m. The flexibility of the instrumental setup will allow us to study the composition of the radar bright polar deposits with a S/N ratio of >50 for an assumed surface temperature of 200K.

MERTIS will produce classification maps of the global distribution of surface types on Mercury. The deconvolution algorithms will be developed based on existing methods and drawing from the experience gained in laboratory measurements.

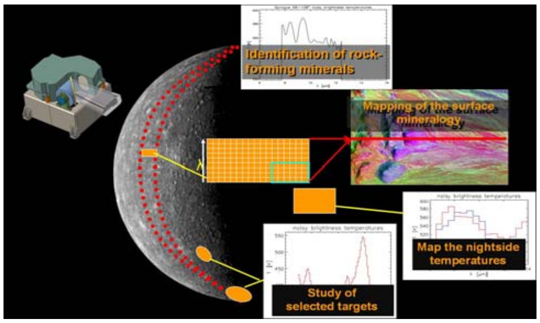

Figure 2 MERTIS science goals

4. Planetary Emissivity Laboratory

To facilitate the data analysis of MERTIS, the Planetary Emissivity Laboratory (PEL) has been recently upgraded to allow measurement of the emissivity of Mercury-analogue materials at grain sizes smaller than 25 µm and at temperatures of more than 400°C, typical for Mercury's low-latitude dayside. The PEL development follows a multi-step approach. We have already obtained emissivity data at mid-infrared wavelengths that show significant changes in spectral behavior with temperature, indicative of changes in the crystal structure of the samples. We have tested new calibration targets that will allow the acquisition of emissivity data over the full wavelength range from 1 to 50 µm with a signal-to-noise ratio exceeding 1000 for most of the spectral range. Currently we are in the final verification steps of the full setup.


Figure 3 Laboratory setup at the PEL

6. Summary and Conclusions

The science requirements of MERTIS have been defined based on very limited knowledge of Mercury. In the light of all the new data provided by MESSENGER and the recent laboratory data, they are more valid than ever.

The development of MERTIS is on track and the instrument fulfils all of its performance requirements. Therefore we are very optimistic that MERTIS will allow us to see Mercury as it was never seen before.

Acknowledgements

The MERTIS development is funded by the German Space Agency (DLR) under grant number 50QW0901

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