Emissivity vs. emergence angles for asteroid analogues

A. Maturilli, J. Helbert, M. D‘Amore, S. Ferrari
Institute for Planetary Research, DLR, Berlin, Germany

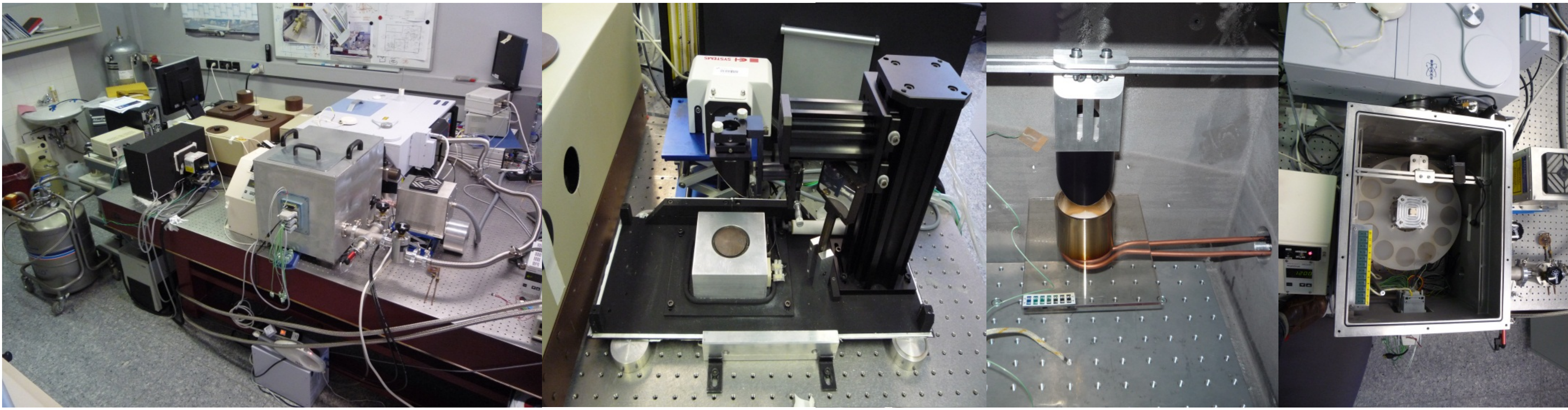
(alessandro.maturilli@dlr.de)

Planetary Emissivity Laboratory

Planetary Emissivity Laboratory

DLR

The PEL complete set-up



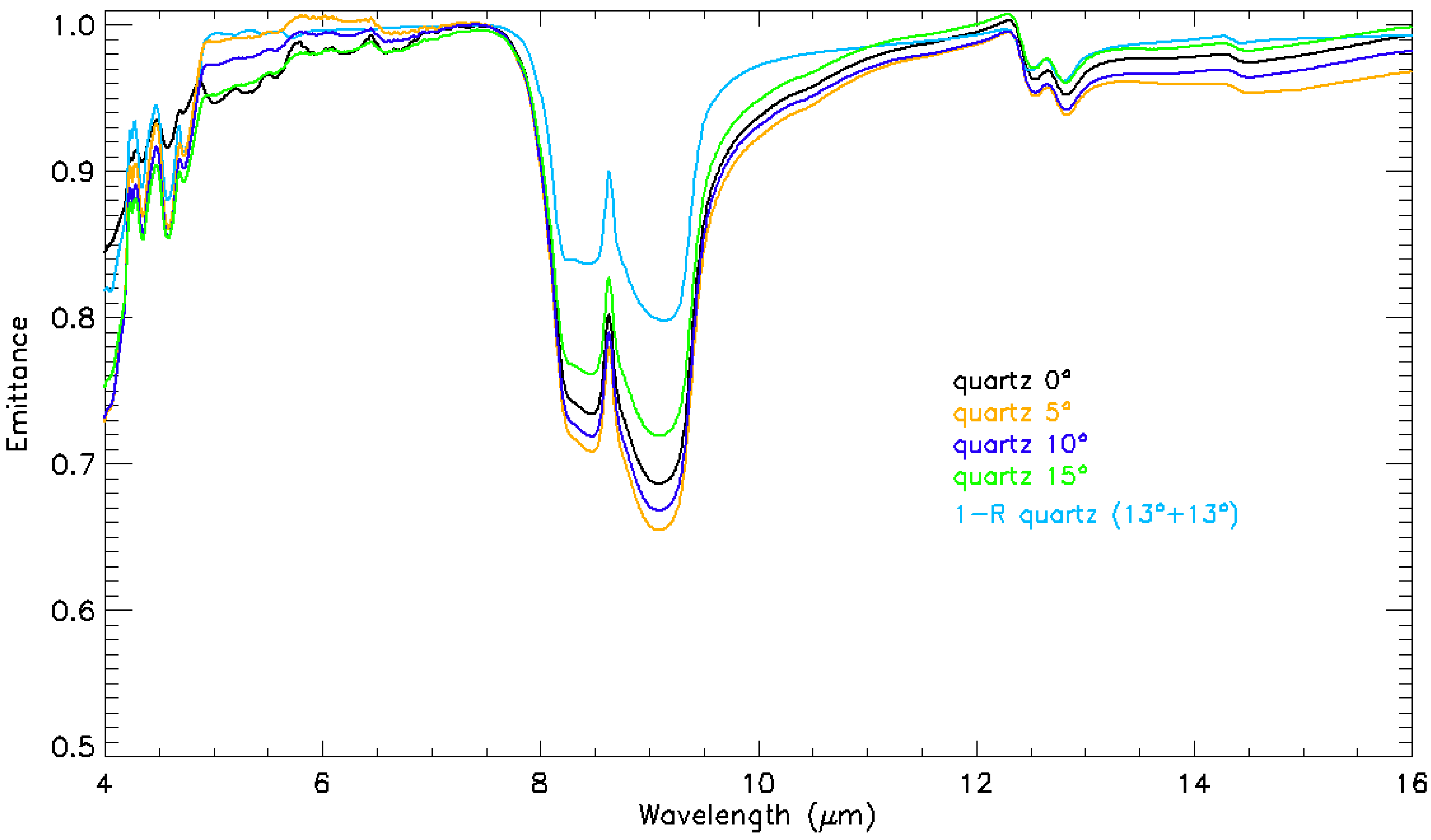
- Instrument Bruker VERTEX 80V coupled via a shutter with evacuated emissivity chamber containing blackbody, stepper motor, sample holder carousel, webcam, and an induction system to heat the samples to high T
- Instrument Bruker IFS 88 coupled with purged emissivity chamber, calibration blackbody, sample heater, and moving mirror
- Full set of detectors and beamsplitter to cover from 0.4 to above 100 μm in emissivity, reflectance and transmission measurements
- Four standard mineral grain sizes: <25, 25-63, 63-125, 125-250 μm

The Previous Experiment

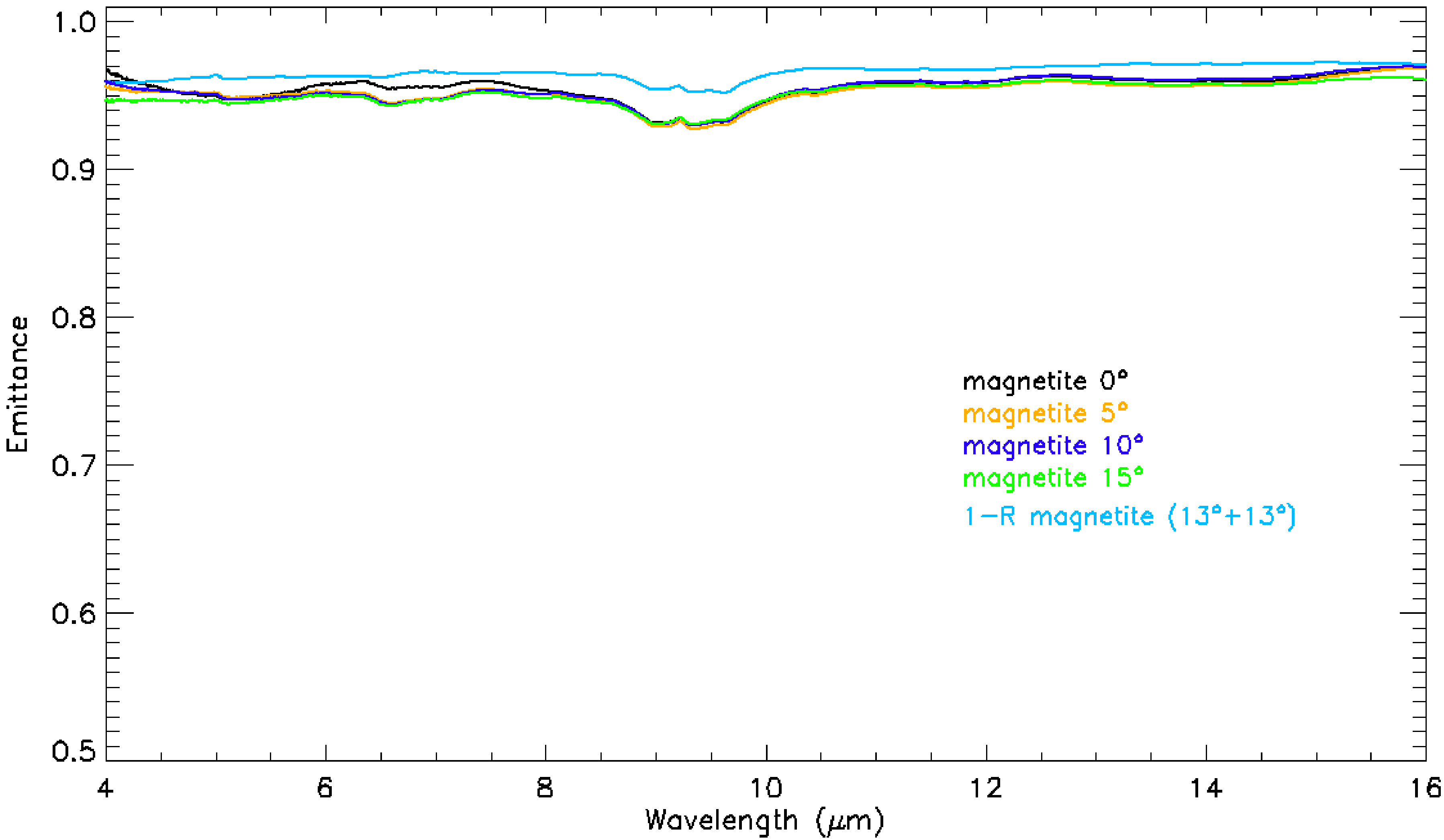
- Emissivity measurements of 2 very different endmembers: quartz 250-355 µm and a magnetite < 500 µm grain size, plus a binary mixture (50%+50% in volume) of the 2 endmembers
- Measurements in vacuum (100 Pa) at asteroid typical temperature (373 K)
- Measurements for plane (0° inclination), 5°, 10° and 15 ° inclination for all the samples
- Calibration body measured in the same conditions of pressure, surface temperature and inclination of the samples

Samples and wedges

Quartz

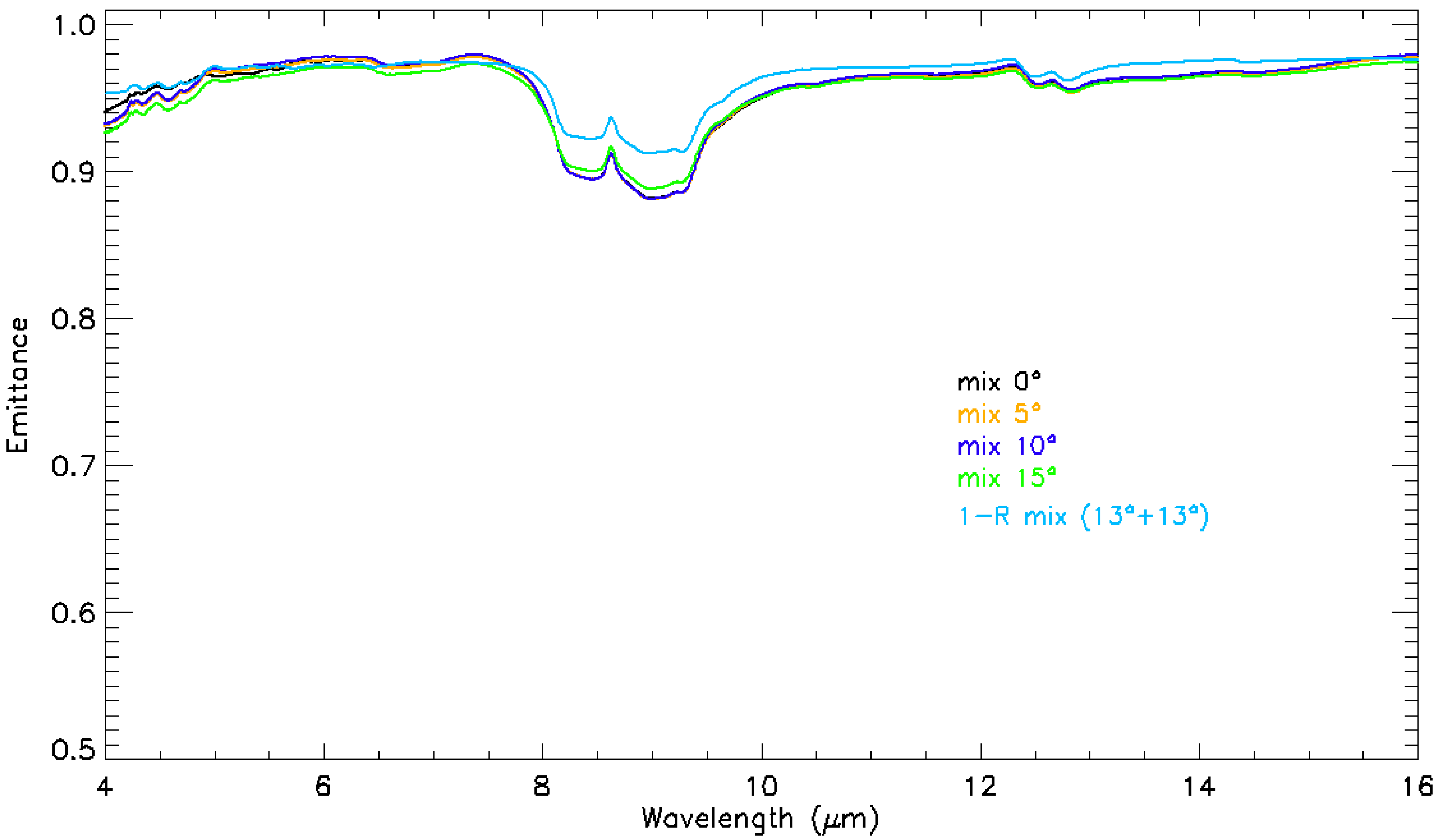

1.0
0.9
0.8
0.7
0.6
0.5
Emittance
4
6
8
10
12
14
16
Wavelength (µm)
quartz 0°
quartz 5°
quartz 10°
quartz 15°
1-R quartz (13°+13°)

Magnetite

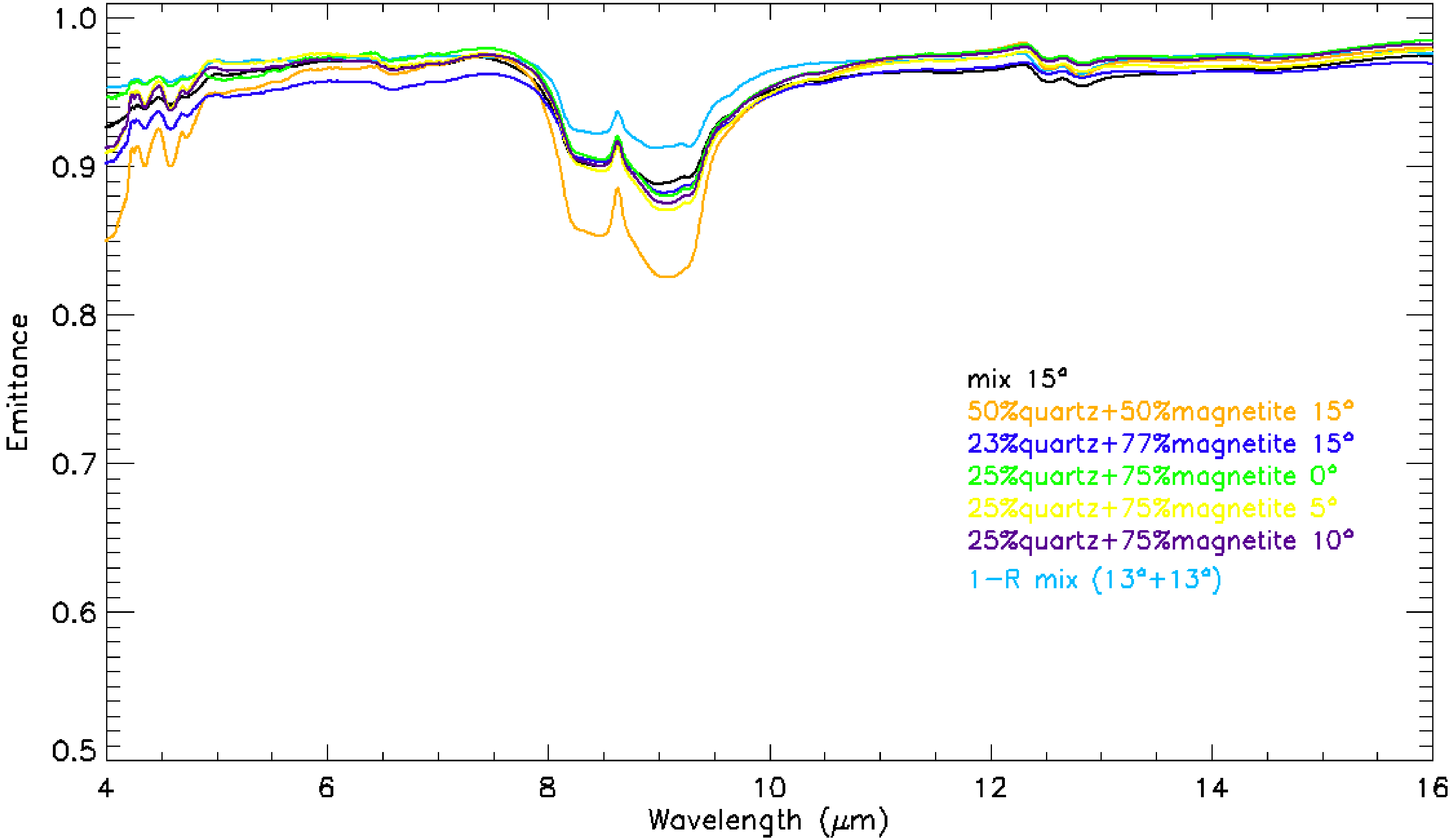

1.0
0.9
0.8
0.7
0.6
0.5
Emittance
4
6
8
10
12
14
16
Wavelength (µm)
magnetite 0°
magnetite 5°
magnetite 10°
magnetite 15°
1-R magnetite (13°+13°)

PEL Planetary Emissivity Laboratory

Mixture all



Mixture 18


1.0
0.9
0.8
0.7
0.6
0.5
Emittance
4
6
8
10
12
14
16
Wavelength (µm)
mix 15°
50%quartz+50%magnetite 15°
23%quartz+77%magnetite 15°
25%quartz+75%magnetite 0°
25%quartz+75%magnetite 5°
25%quartz+75%magnetite 10°
1-R mix (13°+13°)

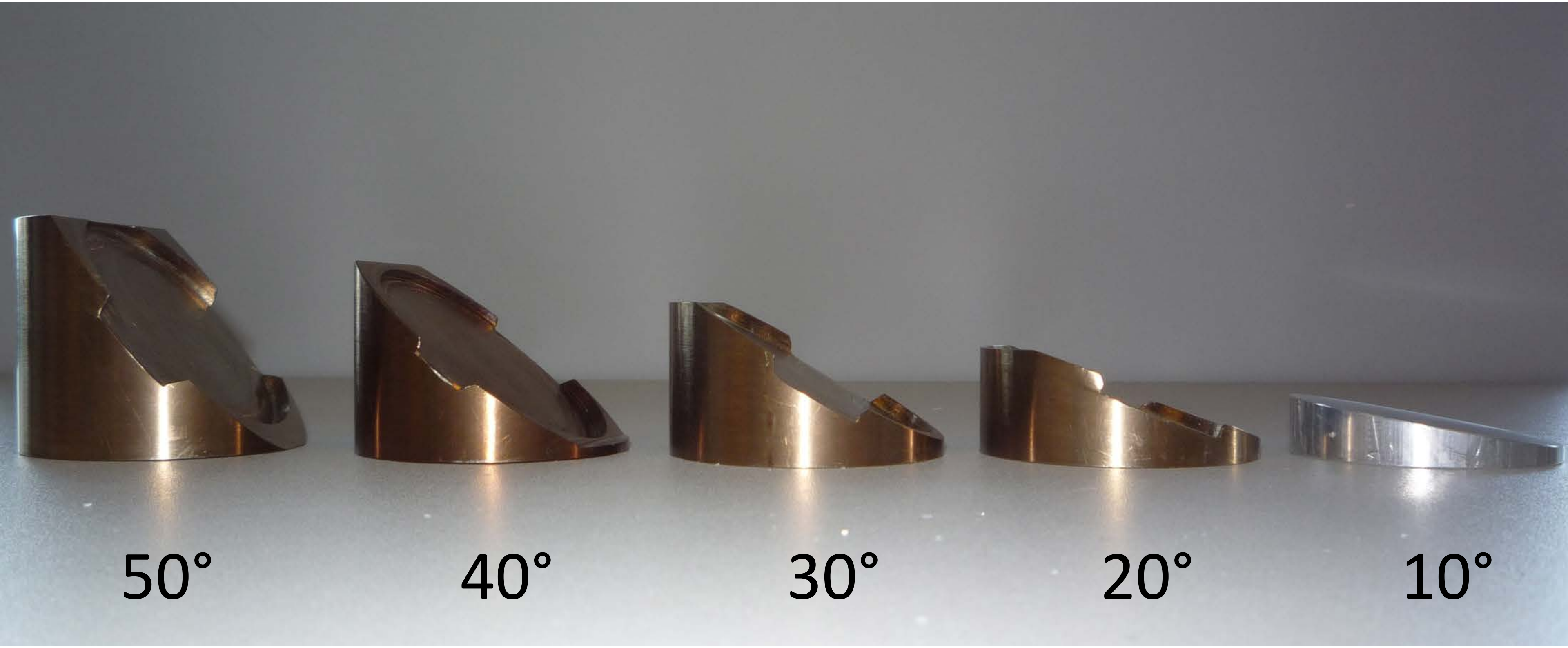
Conclusions on first experiment

- Emerging angles up to 15° seems <u>not to be the</u> major driver of differences observed in measured emissivity
- Dark material is masking the brighter one: problems for linear deconvolution methods
- Test the experiment again with endmembers having the same grain size fractions (very fine and a larger as optimum)
- Extend angle of inclination to 25° (feasible) or even 35° (difficult)
- Calibration respect to a flat blackbody, like in space

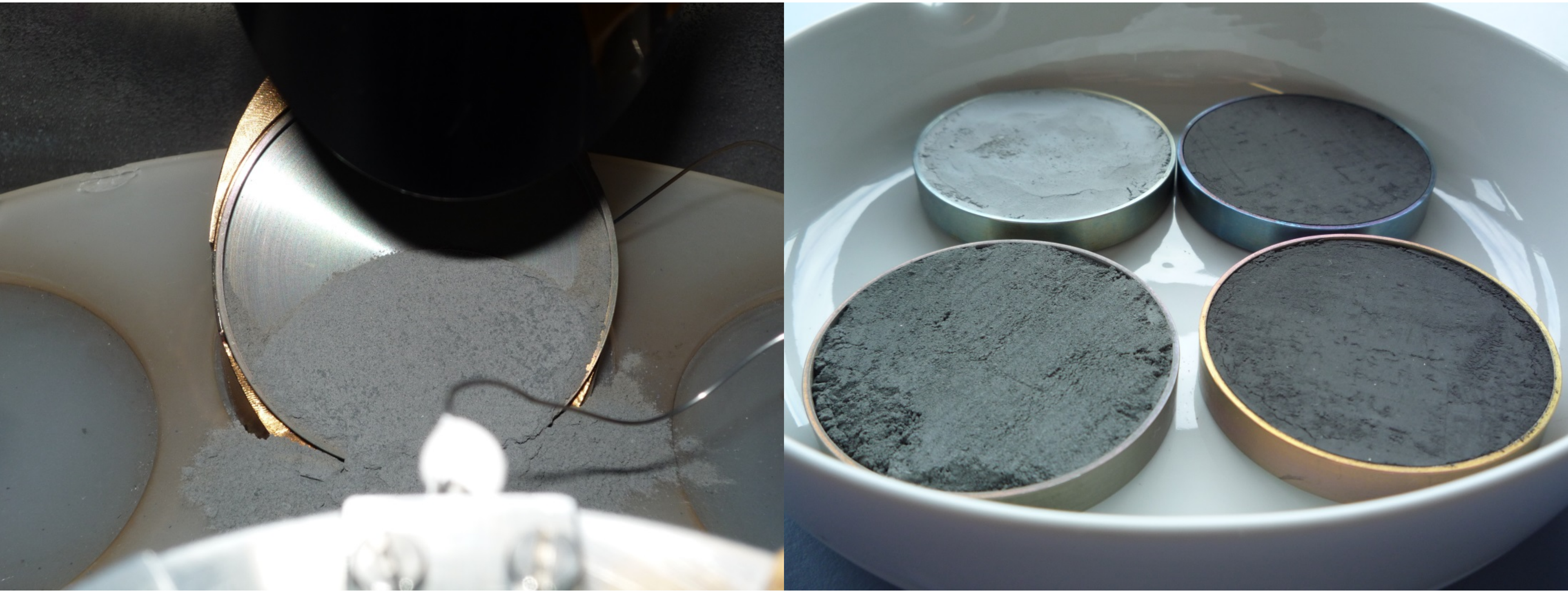
New Experiments

- Emissivity measurements of 2 asteroid analogues: synthetic enstatite <25 µm and meteorite millbillillie (fine)
- Emissivity measured in air and in vacuum (100 Pa) at asteroid typical temperature (373 K)
- Measurements for plane (0° inclination), 5°, 10° 20°, 30°, 40°, 50°, 60° inclination for all the samples (had to encrust them) !!
- Calibration body measured in the same conditions of pressure, surface temperature and inclination of the samples (flat also)

Some of the Wedges

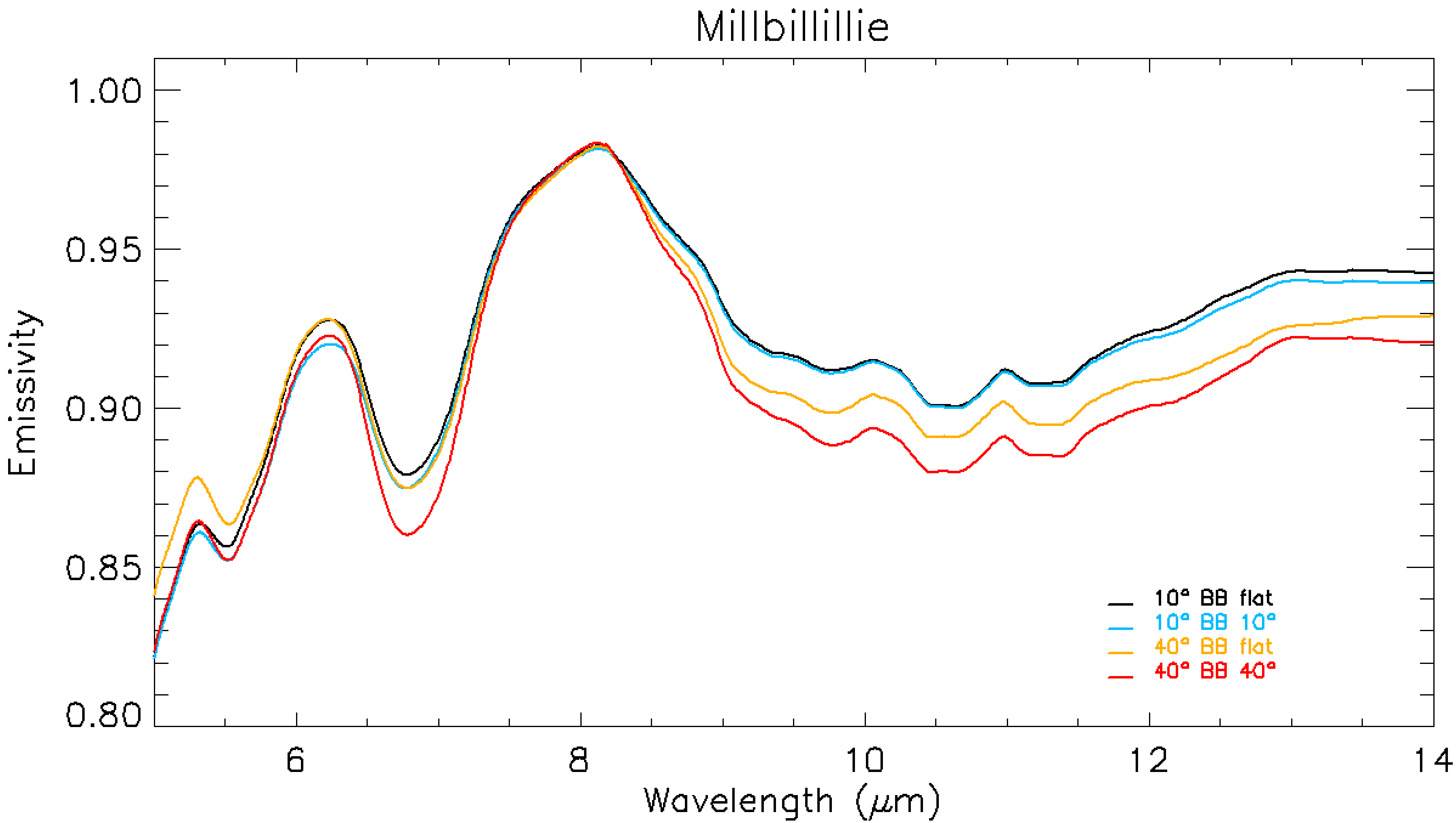


Samples preparation

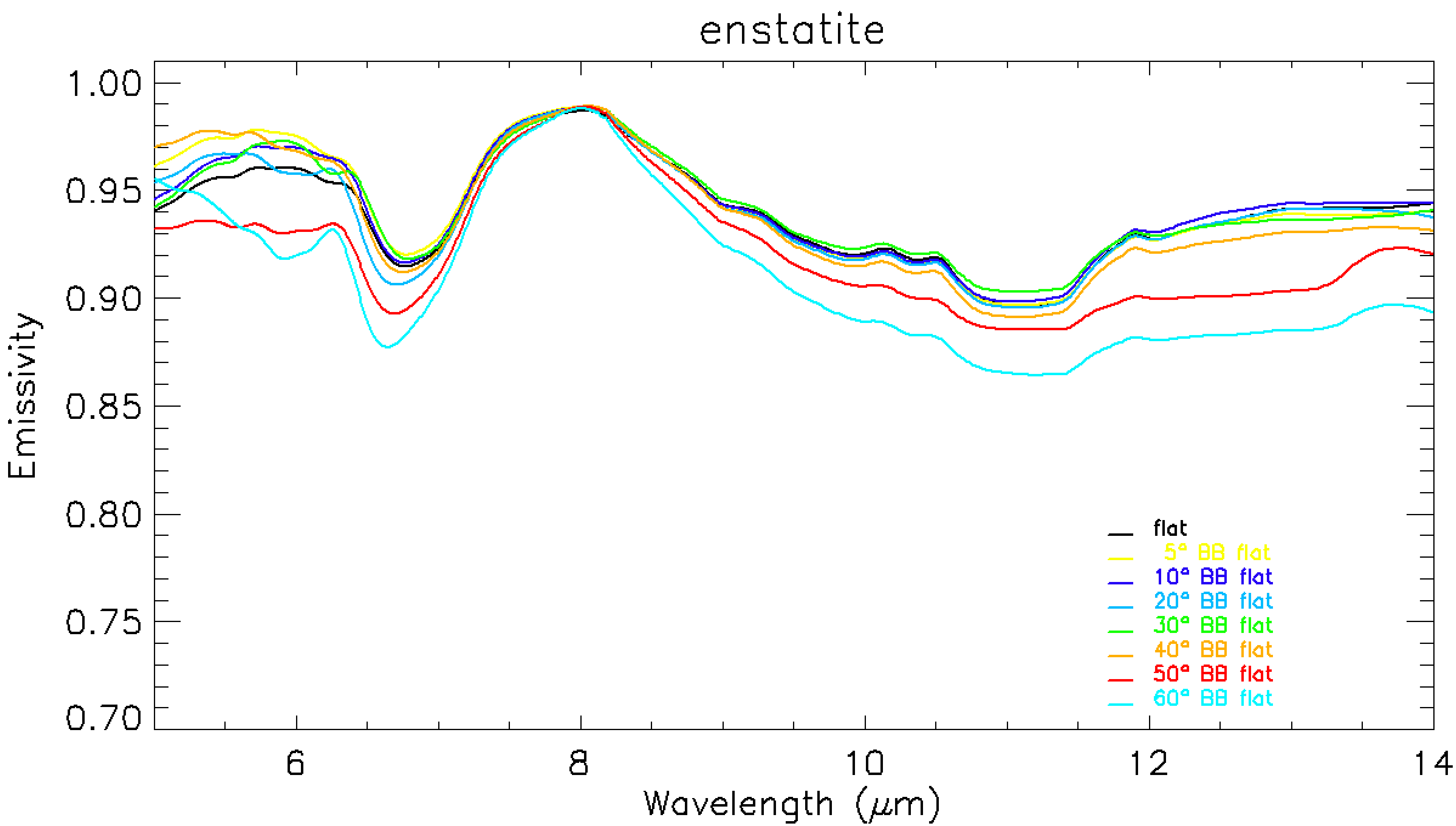


- To avoid samples slipping away from the cups, we had to encrust them: mixing with ethanol, preparing the cups gently packing the moistured powder, letting dry at 30° C for one day.

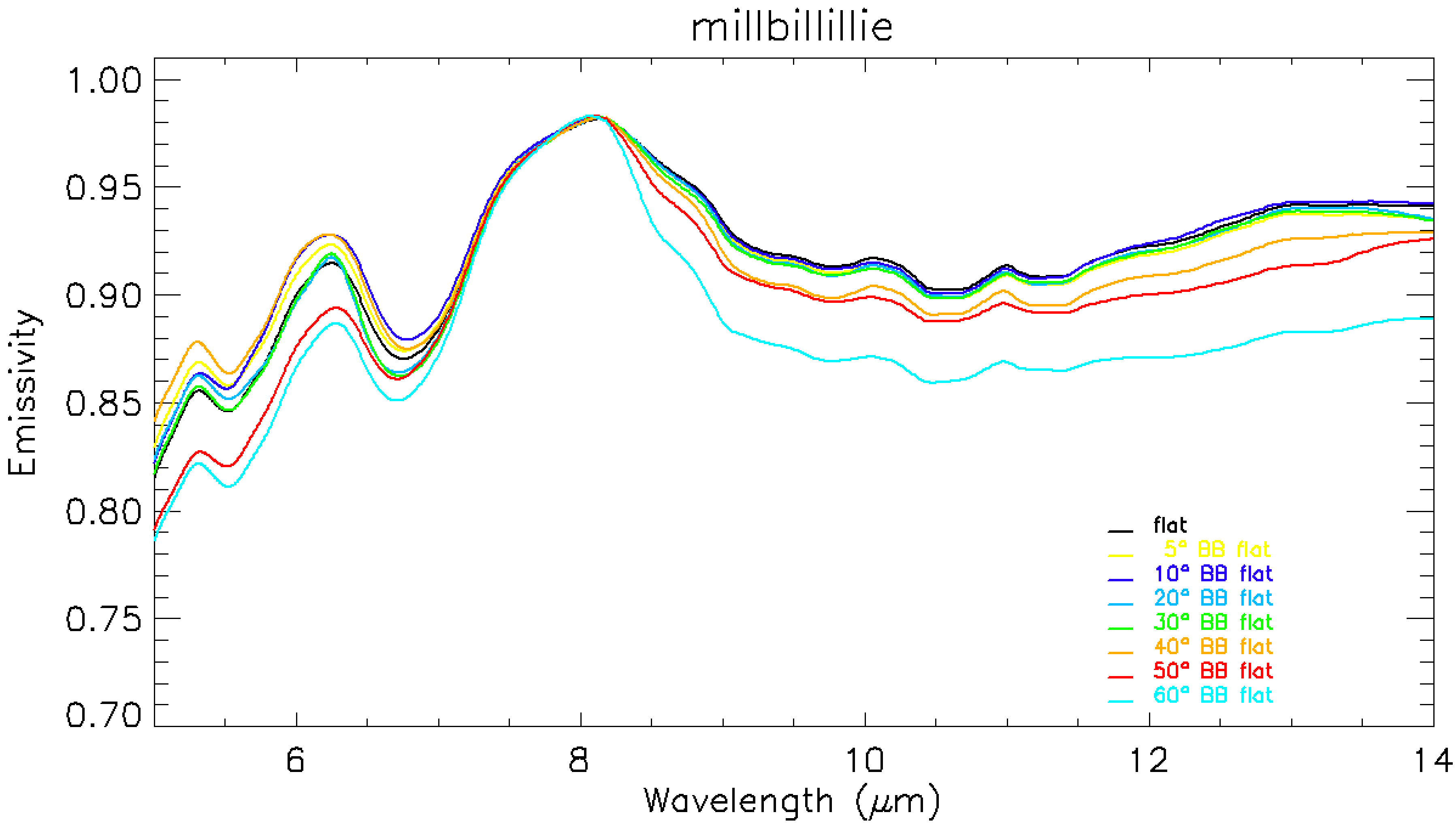
Flat vs. Inclined blackbody - Air



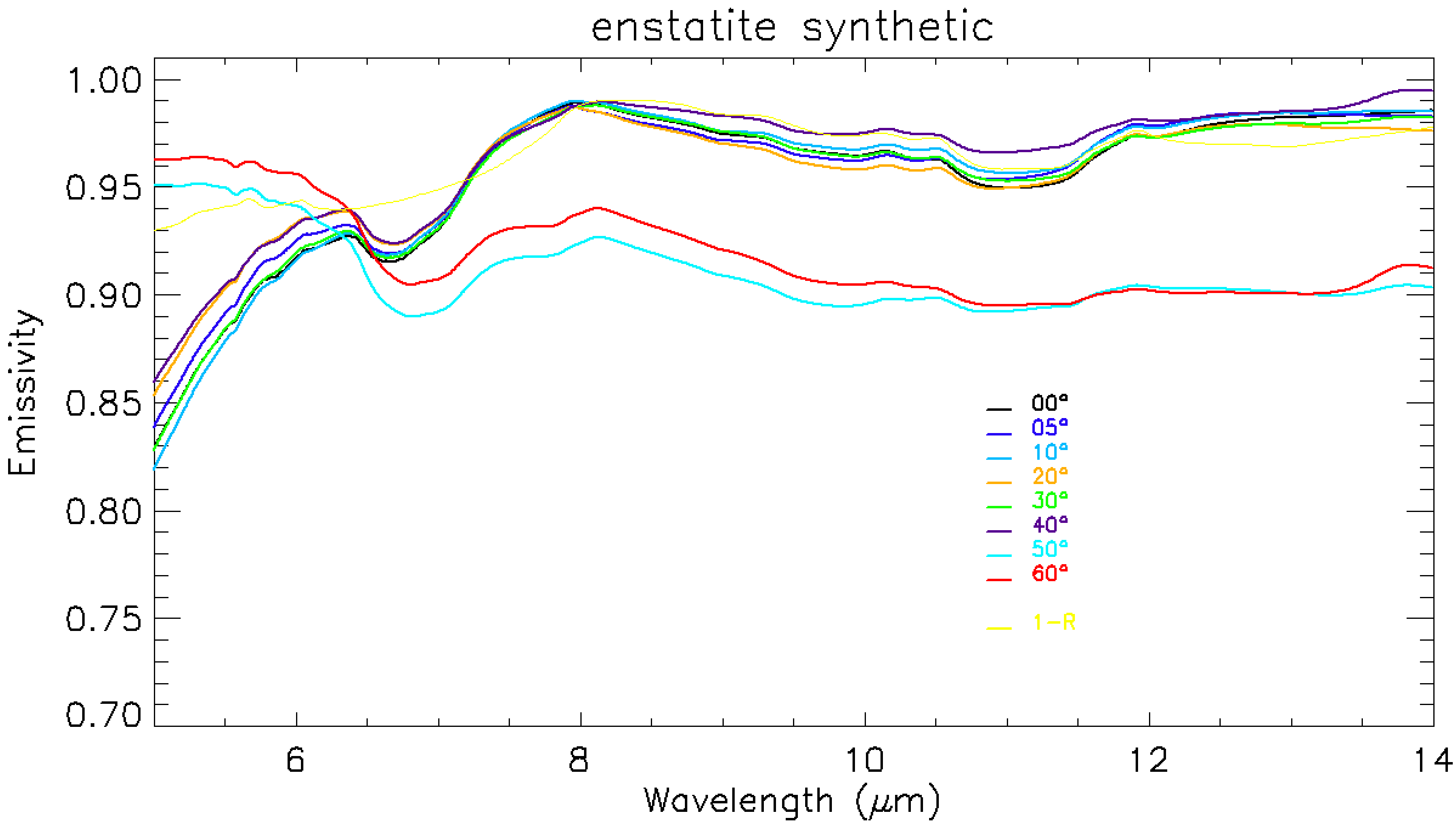
Enstatite (flat BB) - Air



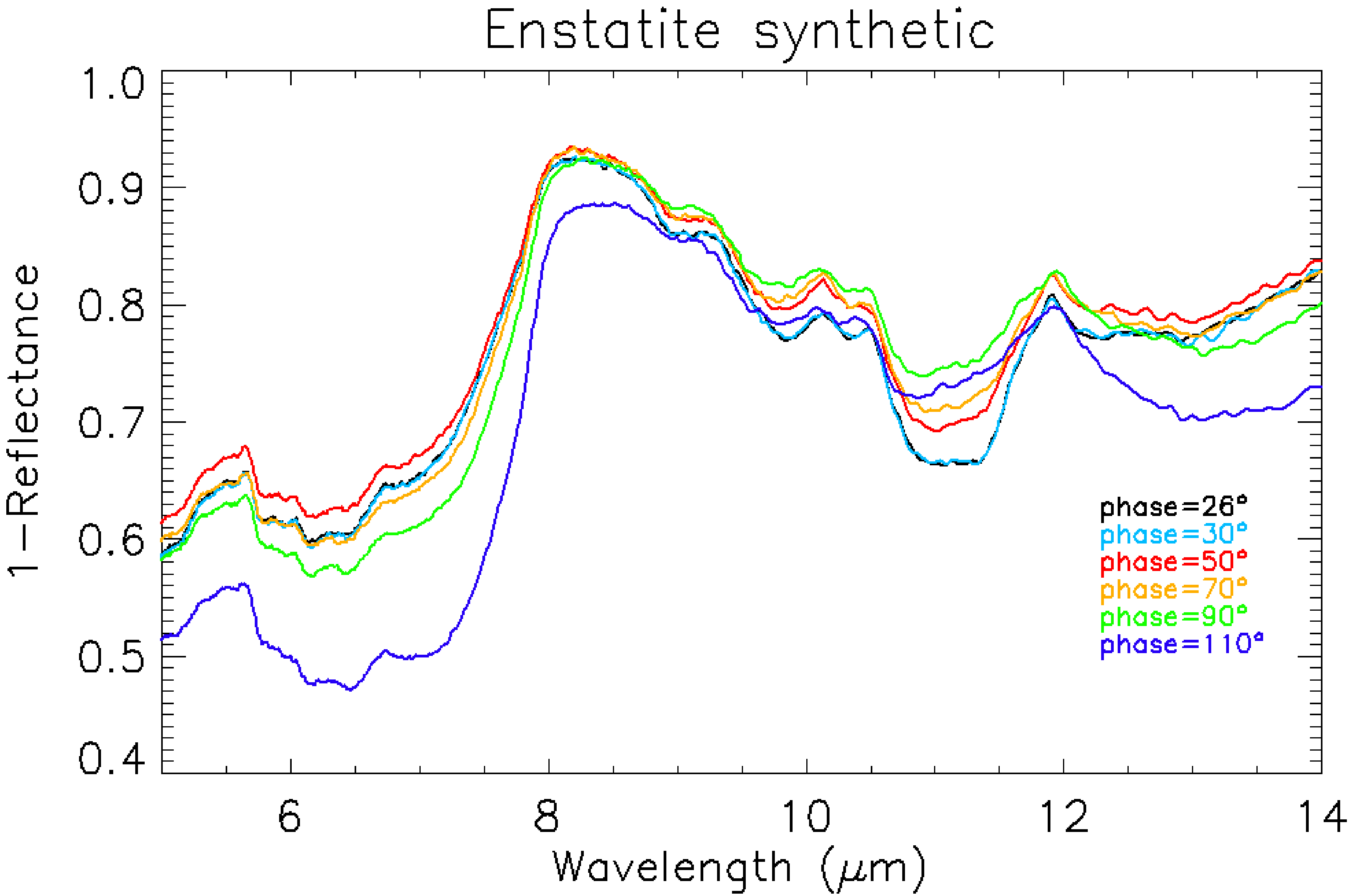
Millbillillie (flat BB) - Air



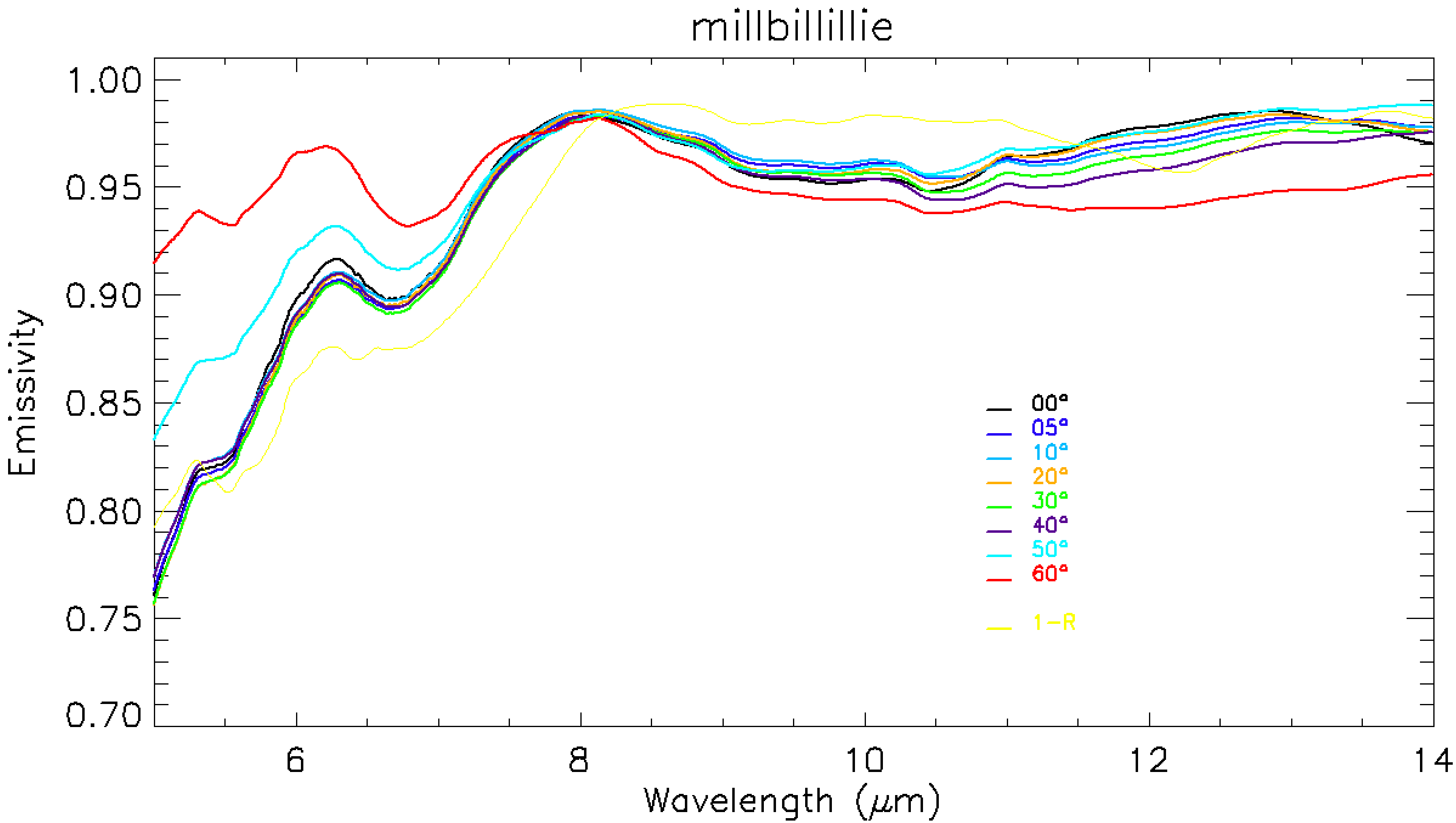
Enstatite (flat BB) - Vacuum



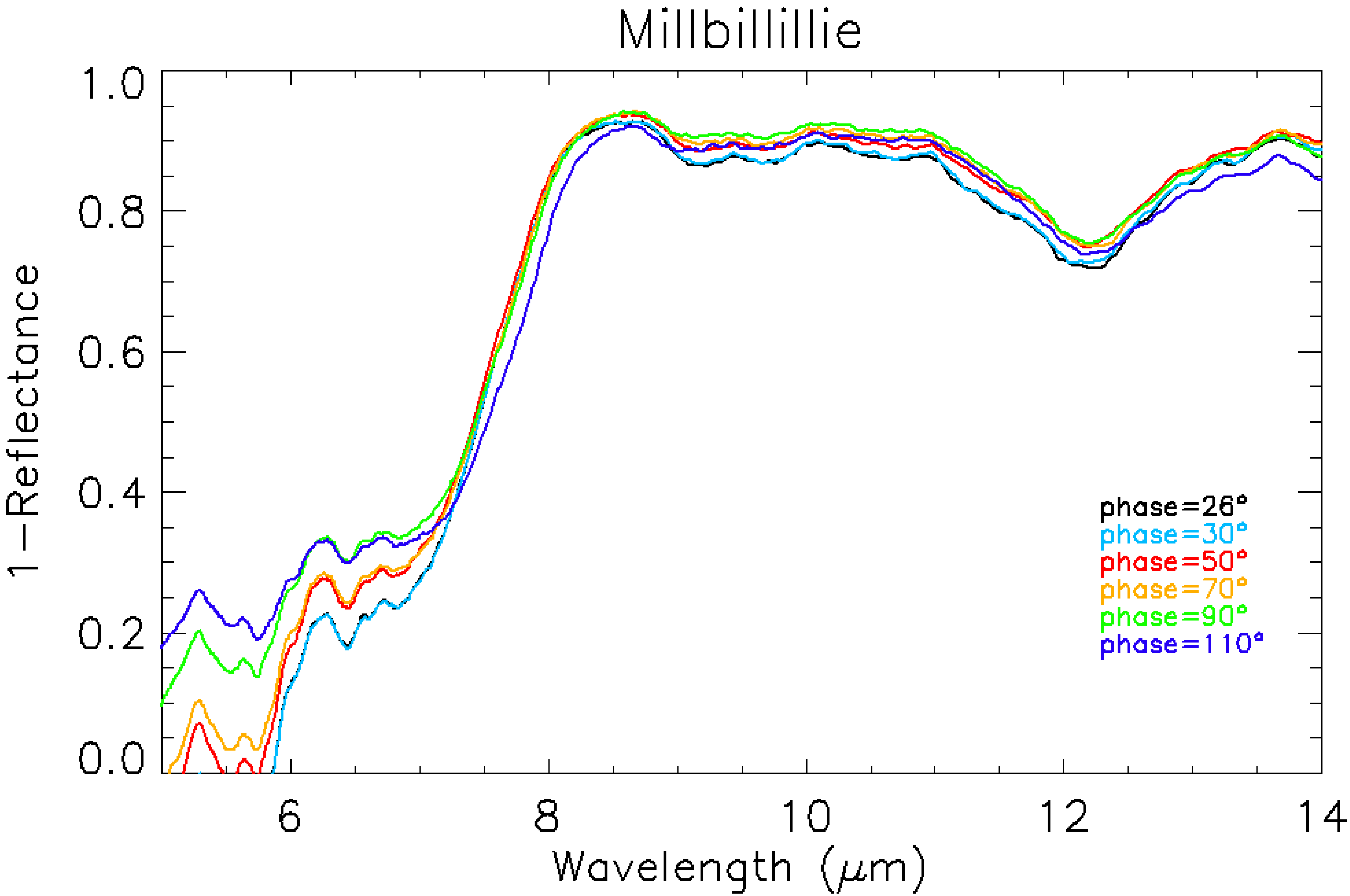
1-R Enstatite - Vacuum



Millbillillie (flat BB) - Vacuum



1-R Millbillillie - Vacuum



Conclusions

- Calibration vs. flat blackbody does not alter the nature of experiment and best reproduces orbiter conditions
- For both samples, calibrated emissivity in air show remarkable variations for e ≥ 40°
- Measure in vacuum (more complicated) confirm the same trends
- 1-R for both samples shows large differences occurring for phase angles > 70°
- With increasing e we note trends in band shifts and band shapes
- Reflectance with minimum incidence and increasing emission angles