Ryugu as observed by MASCOT:
Preliminary Results of the MARA Instrument

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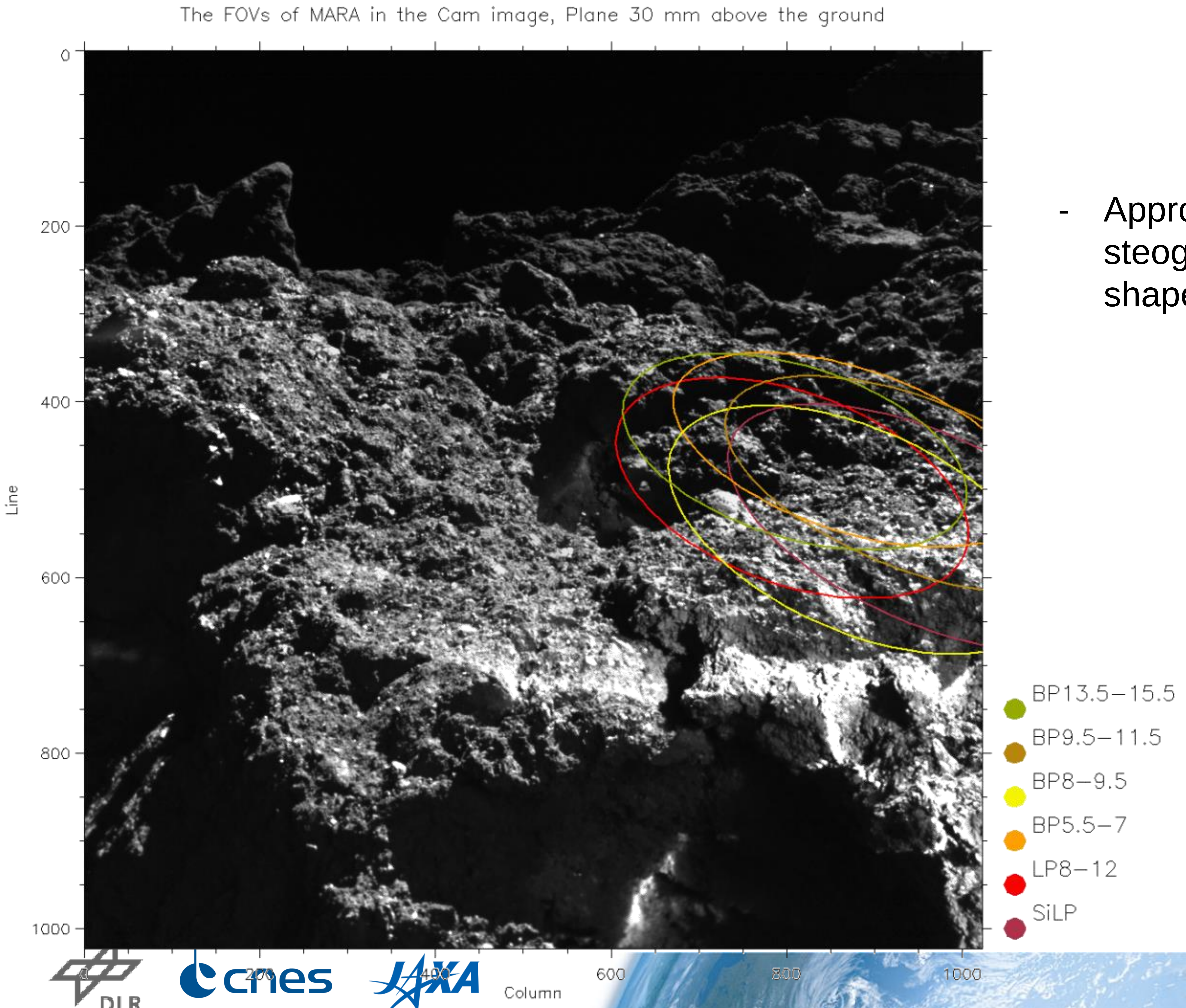
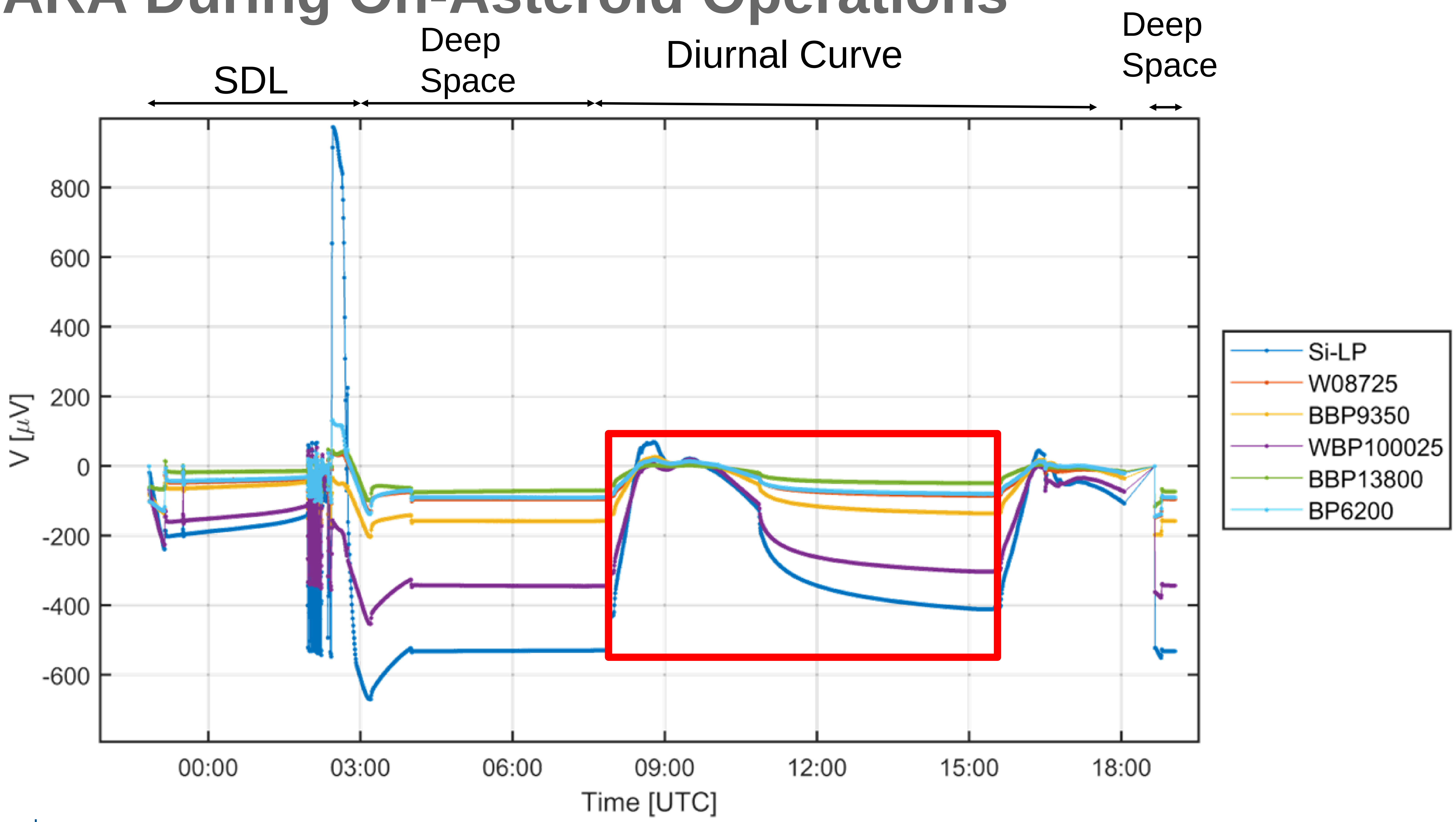
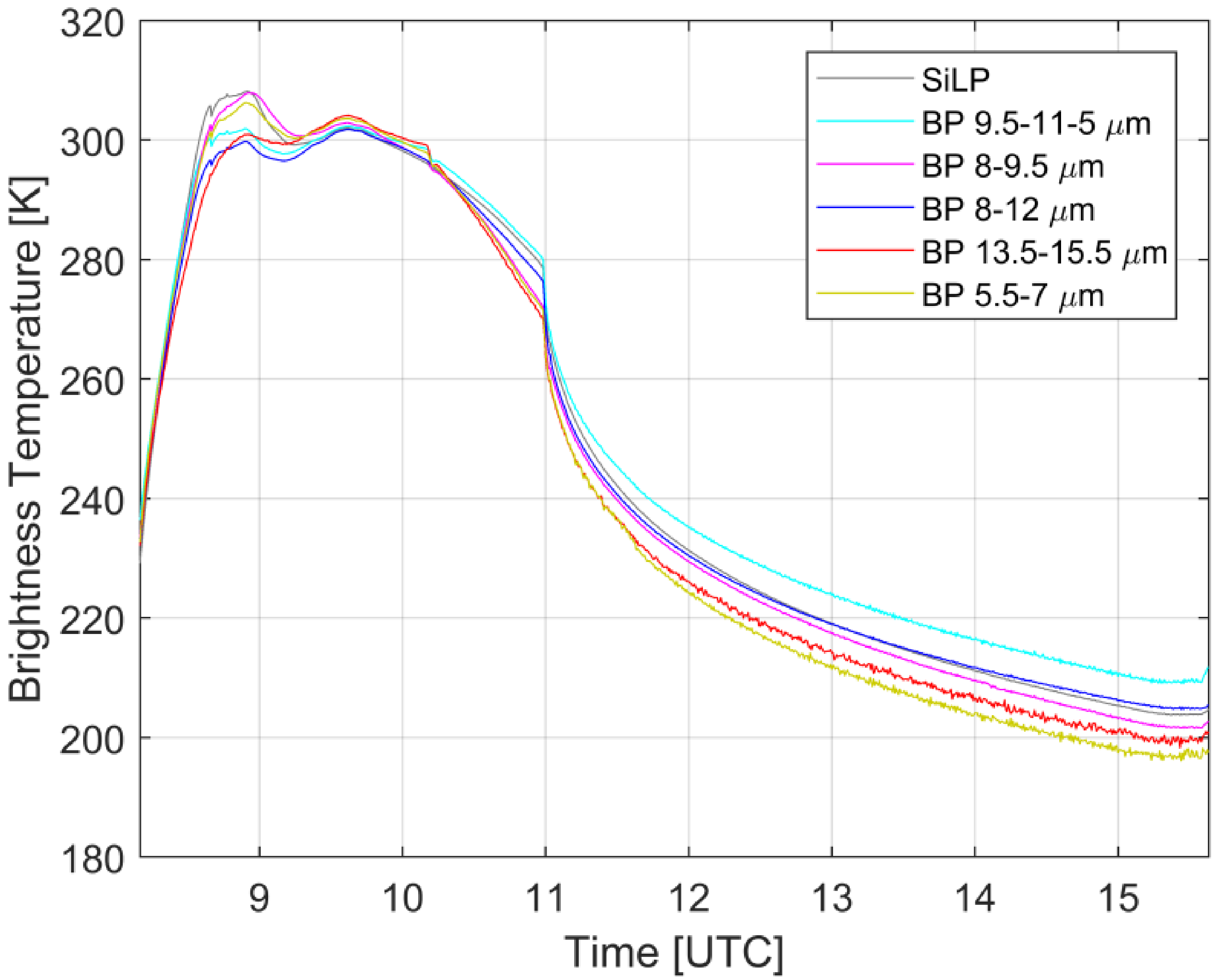


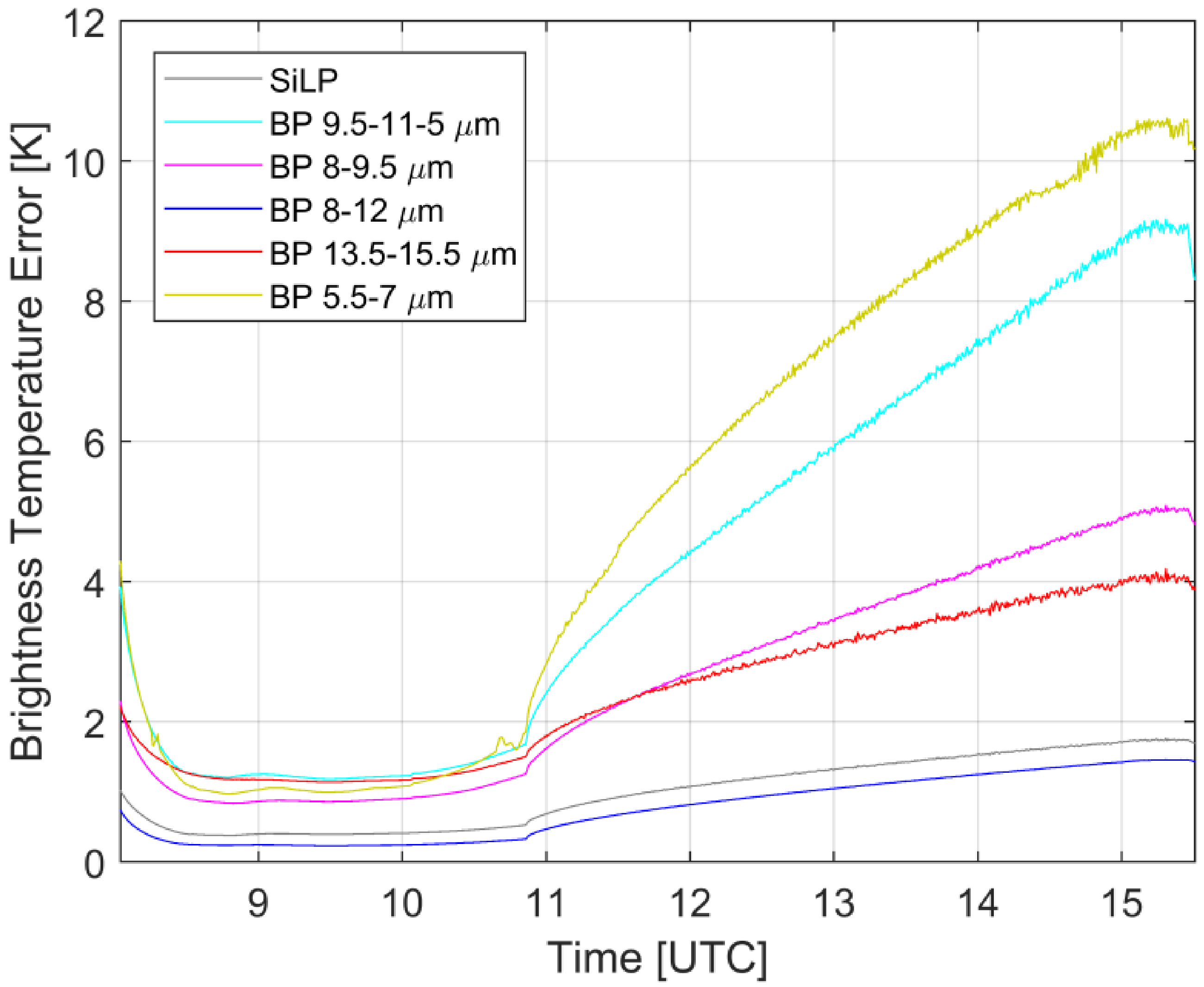
- Approximate field of view of MARA, steographic reconstruction of the 3D shape of the boulder is in progress

MARA During On-Asteroid Operations



Temperature Measurement Uncertainty





- Brightness temperatures have bee calibrated using all in-flight data during cruise as well as the deep space views during on-asteroid operations.
- The 8-12 µm filter was found to be the best performing filter
- In general, brightness temperature errors are <1 K during daytime, but grow large for the narrow bandpasses during nighttime.

Illumination Model

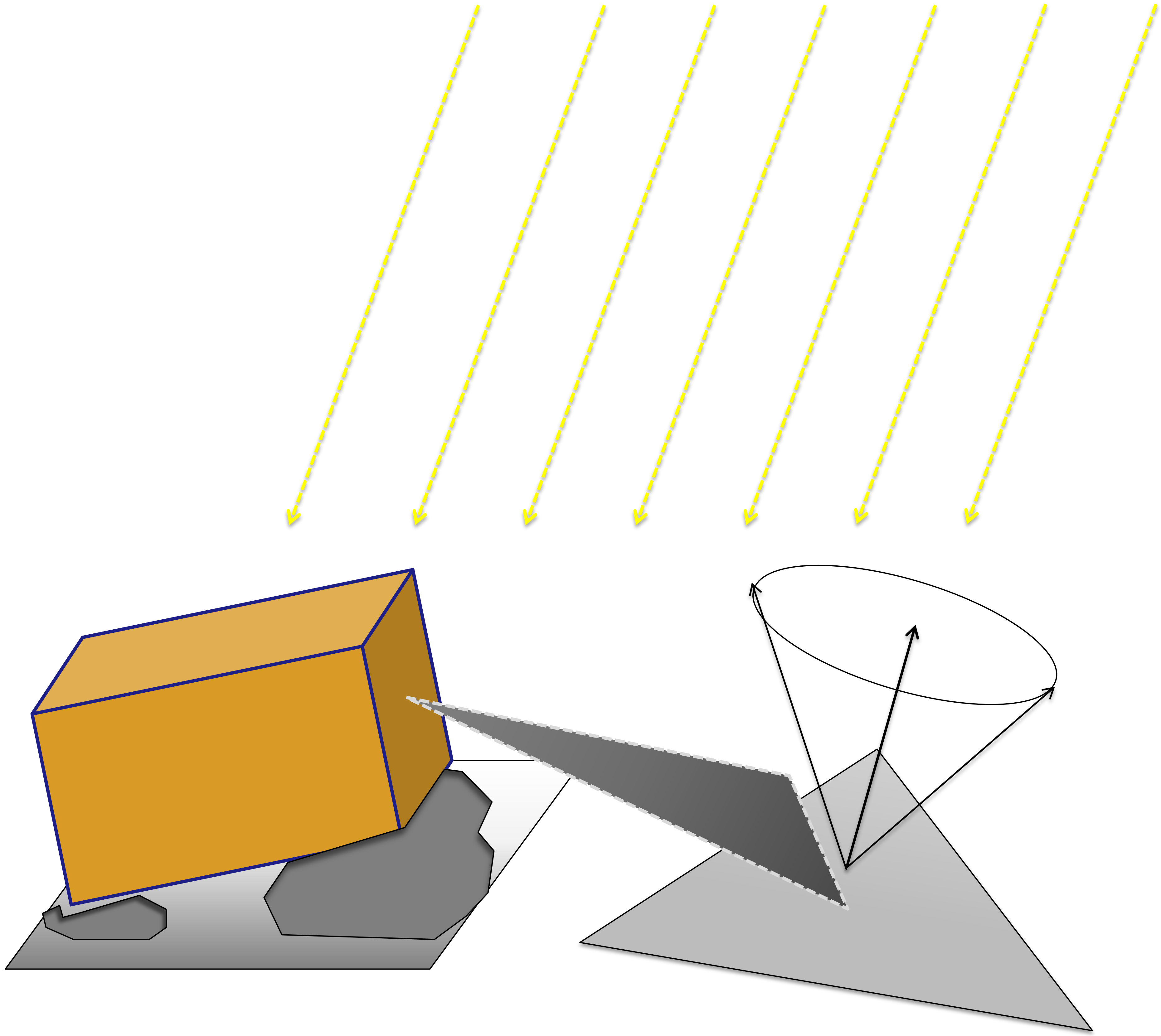
- The illumination model has been calculated based on the location of MASCOT at -22.30° N, 317.13° E

- The orientation of the observed surface with respect to the local landing site orientation is unknown

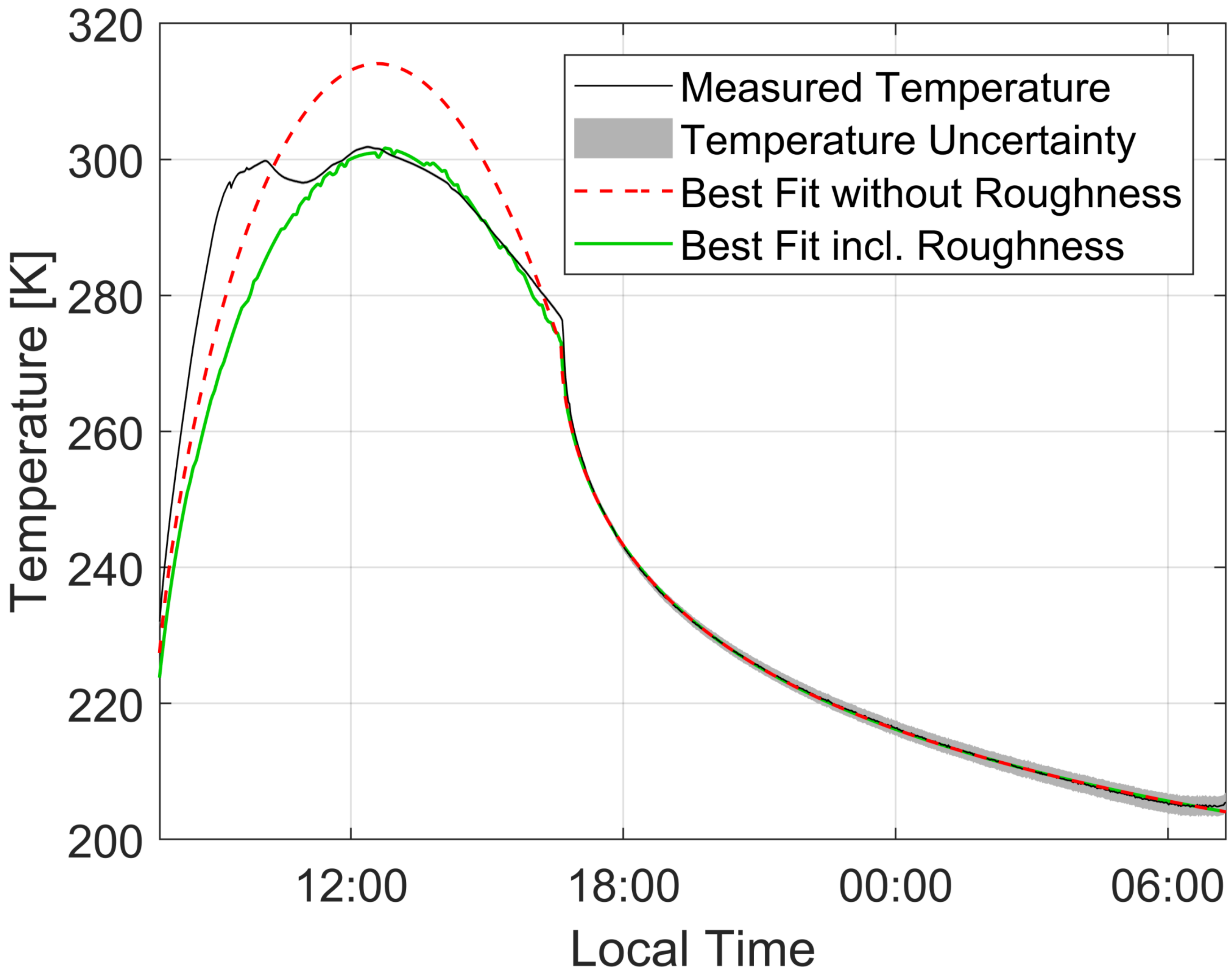
- Orientation of the surface normal is varied by ±25° around the nominal surface normal.

- Illumination is calculated by $I_{max} \cdot \vec{n}_{facet} \cdot \vec{v}_{sun}$

- Sunrise and sunset have been adapted to fit the GNC sensors and the temperature data

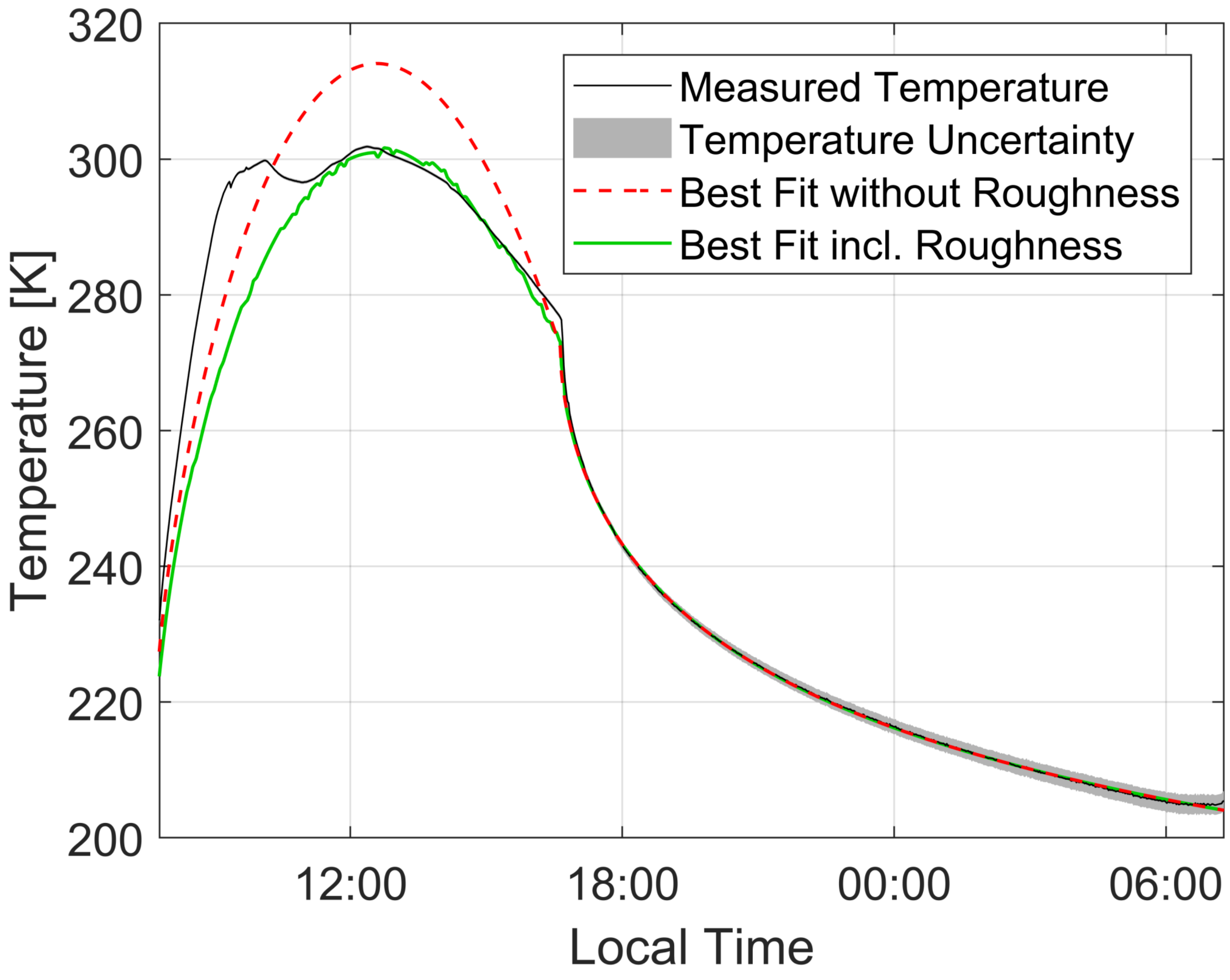


Thermal Inertia - Best Fit



- Data is fitted for nighttime temperatures after 11:00 UTC
- Excellent fit during nighttime
- Modelled daytime temperatures are higher than the observed ones
- This can be a roughness effect

Thermal Inertia - Roughness

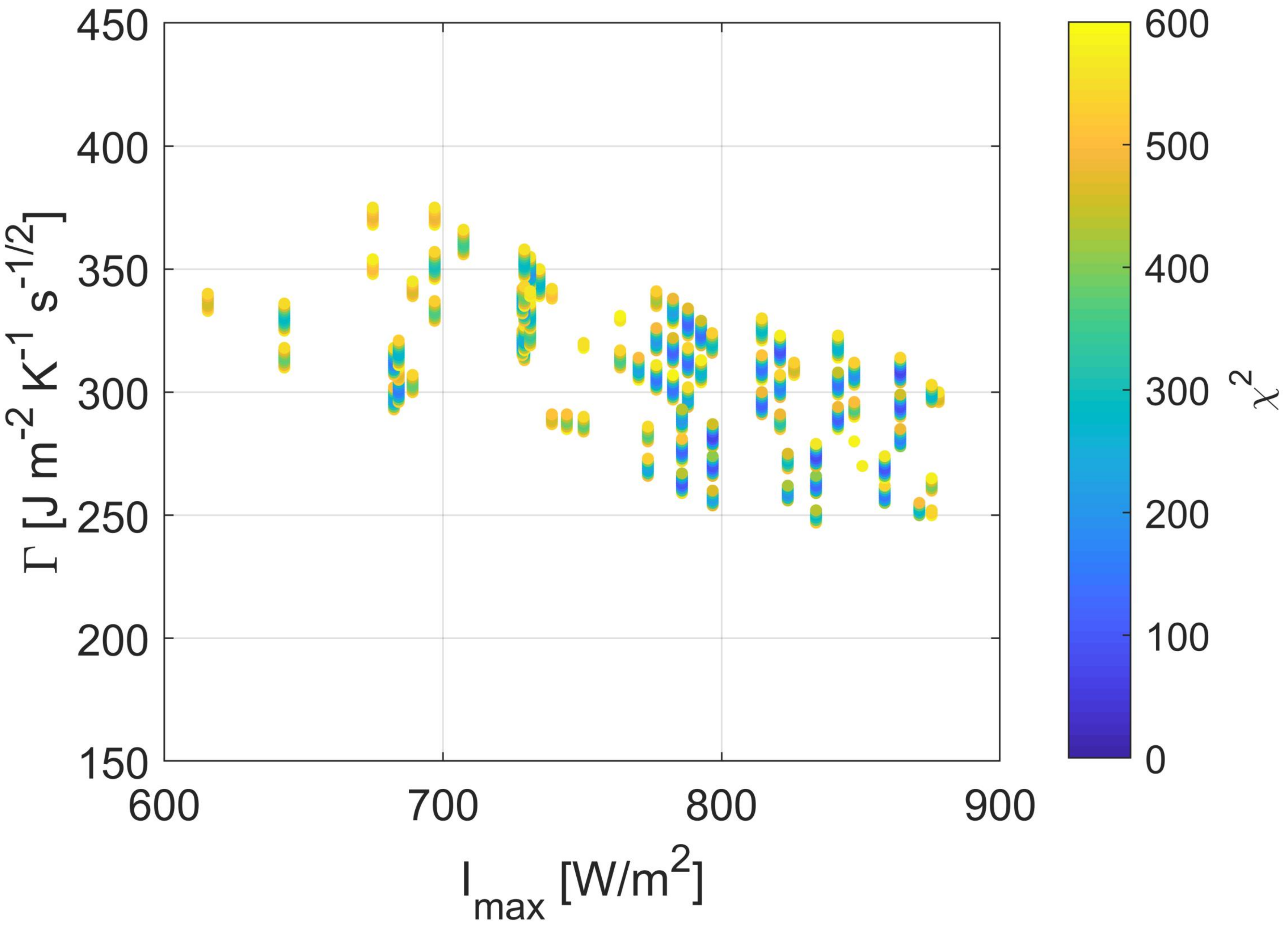


- Roughness reduces the daytime fluxes for the MARA viewing geometries

- We use a simple roughness model using spherical cavities

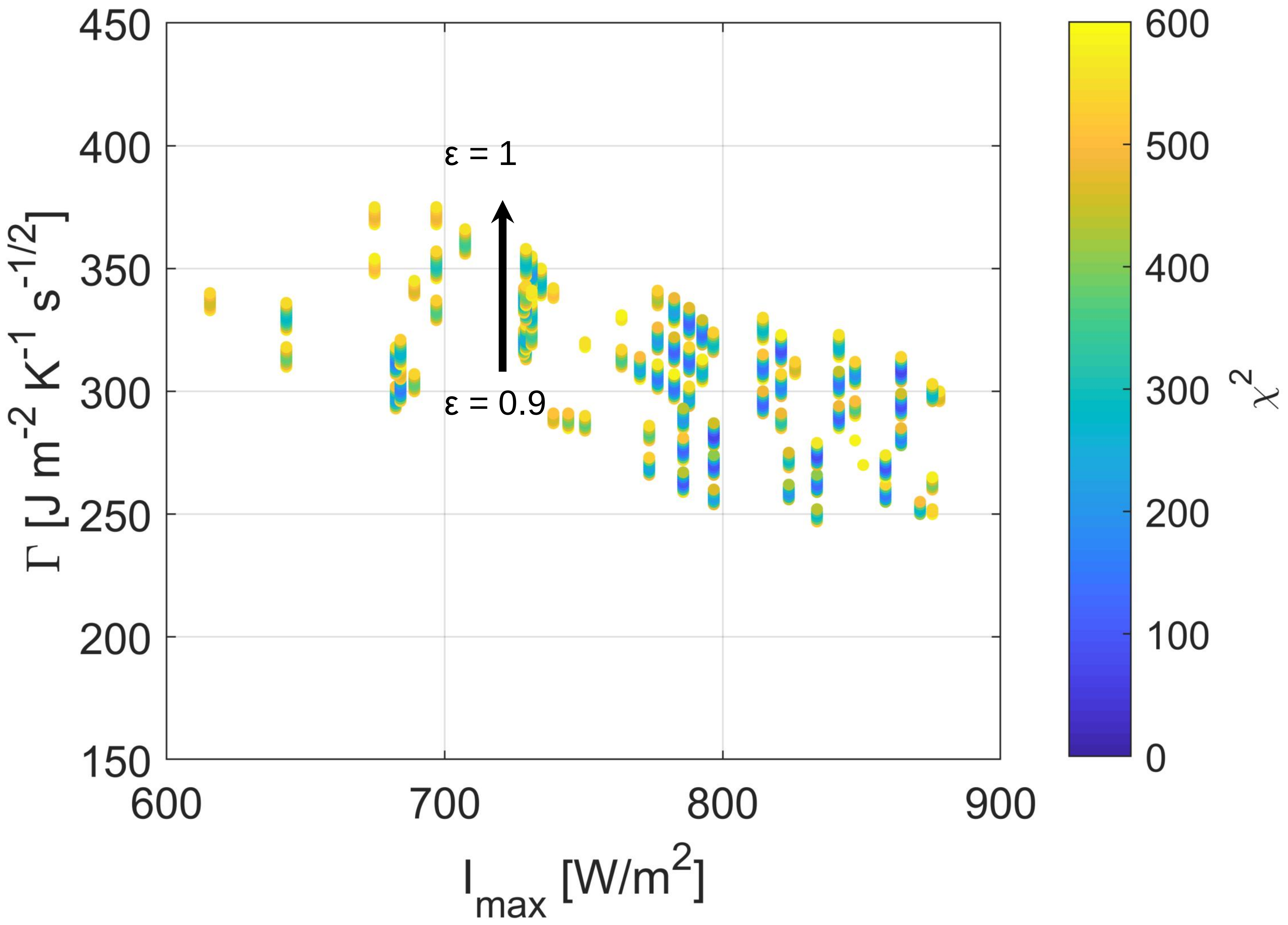
- The model takes the viewing geometry into account but not vertical heat conduction

Thermal Inertia Estimate



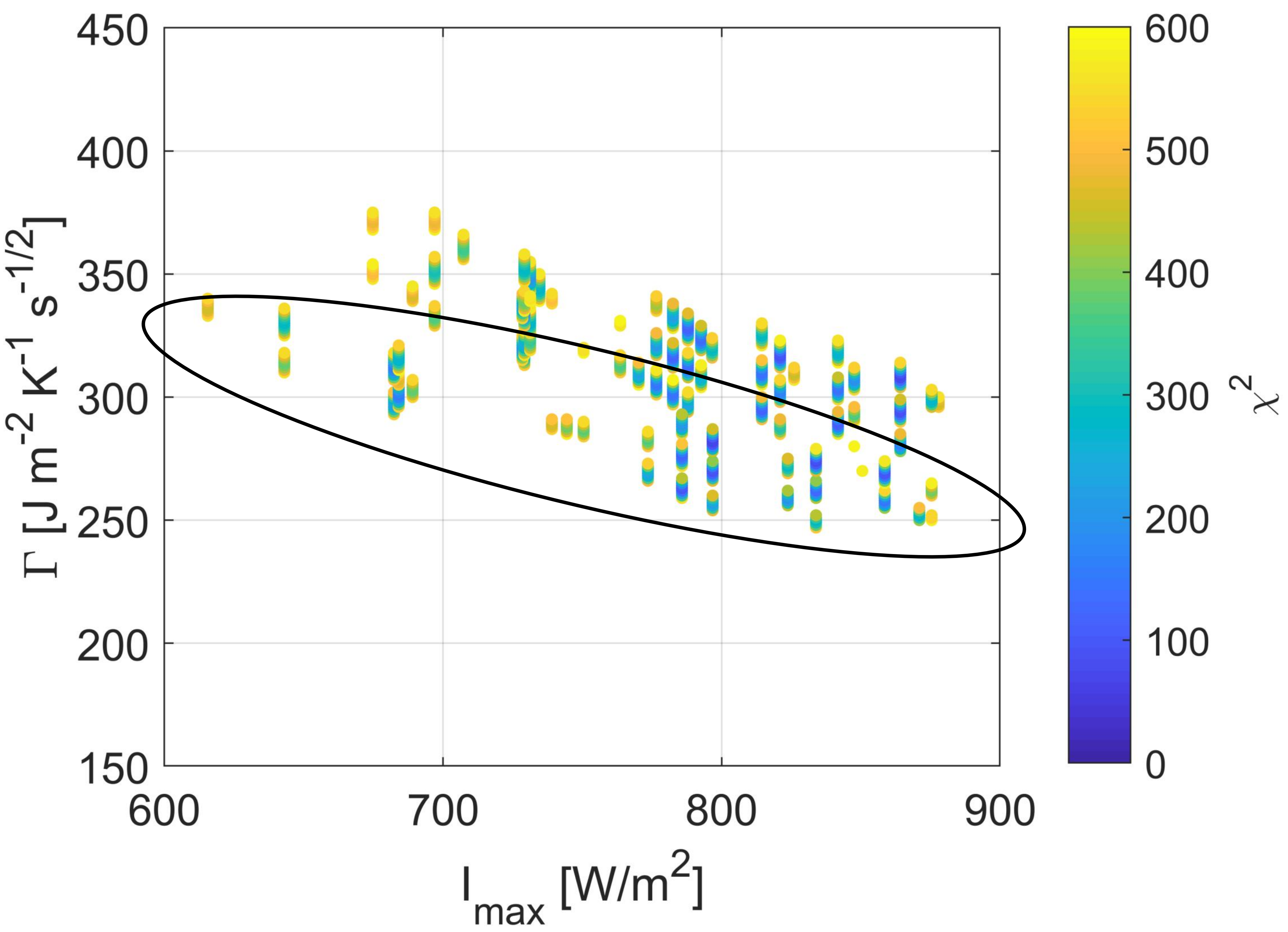
- Besides the various possible surface orientations, emissivity was varied from 0.9 to 1 and thermal radiation from the was modeled or ignored
- for each of the above cases thermal inertia is fitted to the data, shown are those combinations with a sufficiently low χ^2

Thermal Inertia Estimate



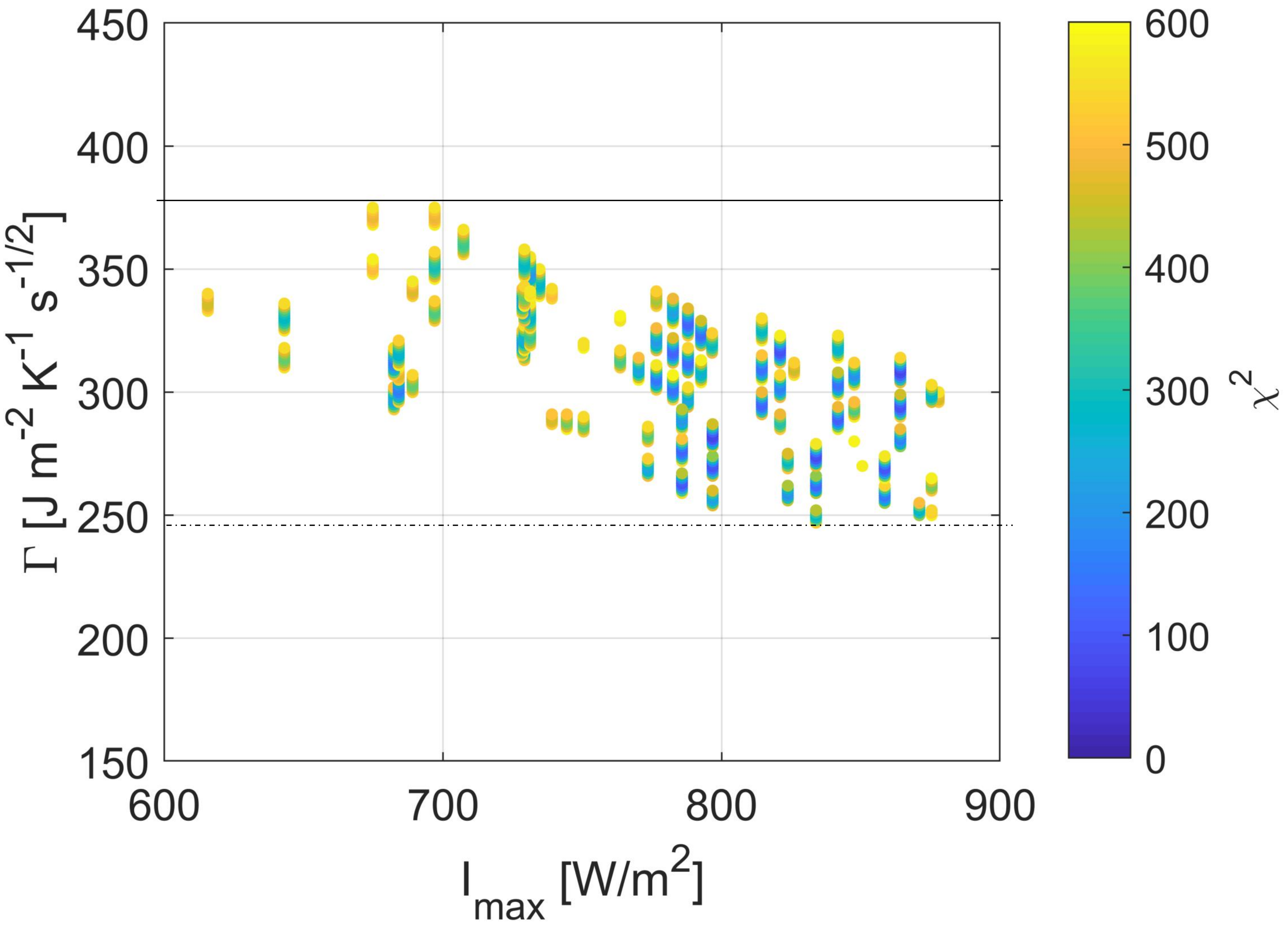
- The assumed emissivity has a small influence on the obtained results
- Acceptable fits result in thermal inertia ranging from 247to 375 J m^{-2} K^{-1} $s^{-1/2}$ with a best fit for 282 J m^{-2} K^{-1} $s^{-1/2}$ and an emissivity of 1

Thermal Inertia Estimate



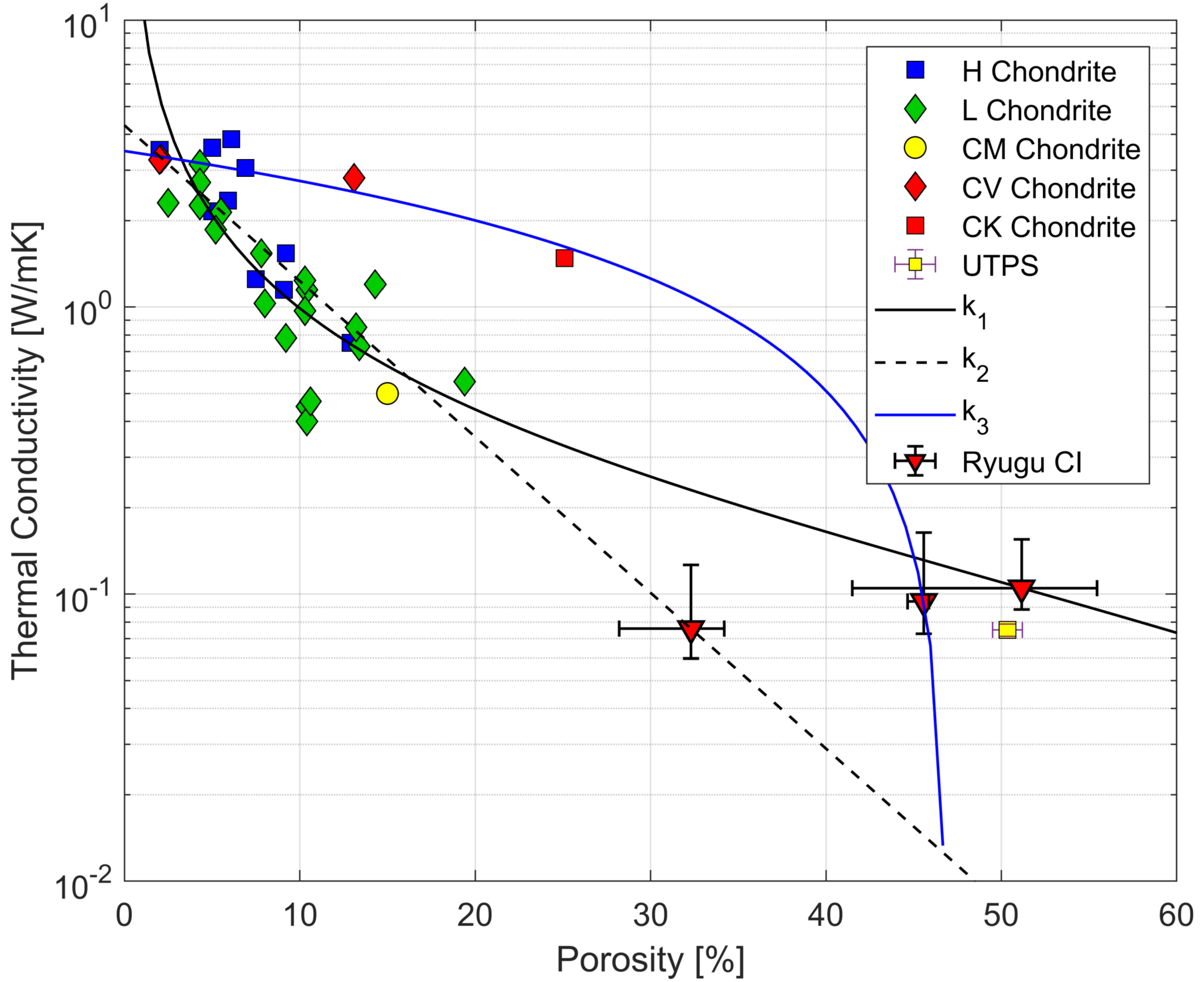
- Thermal radiation of the surrounding terrain will systematically increase temperatures throughout the day
- Assuming 8% view factor to surrounding, ambient temperature same as observed brightness temperature, retrieved thermal intertia decreases down to 247 J m^{-2} K^{-1} $s^{-1/2}$

Thermal Inertia Estimate



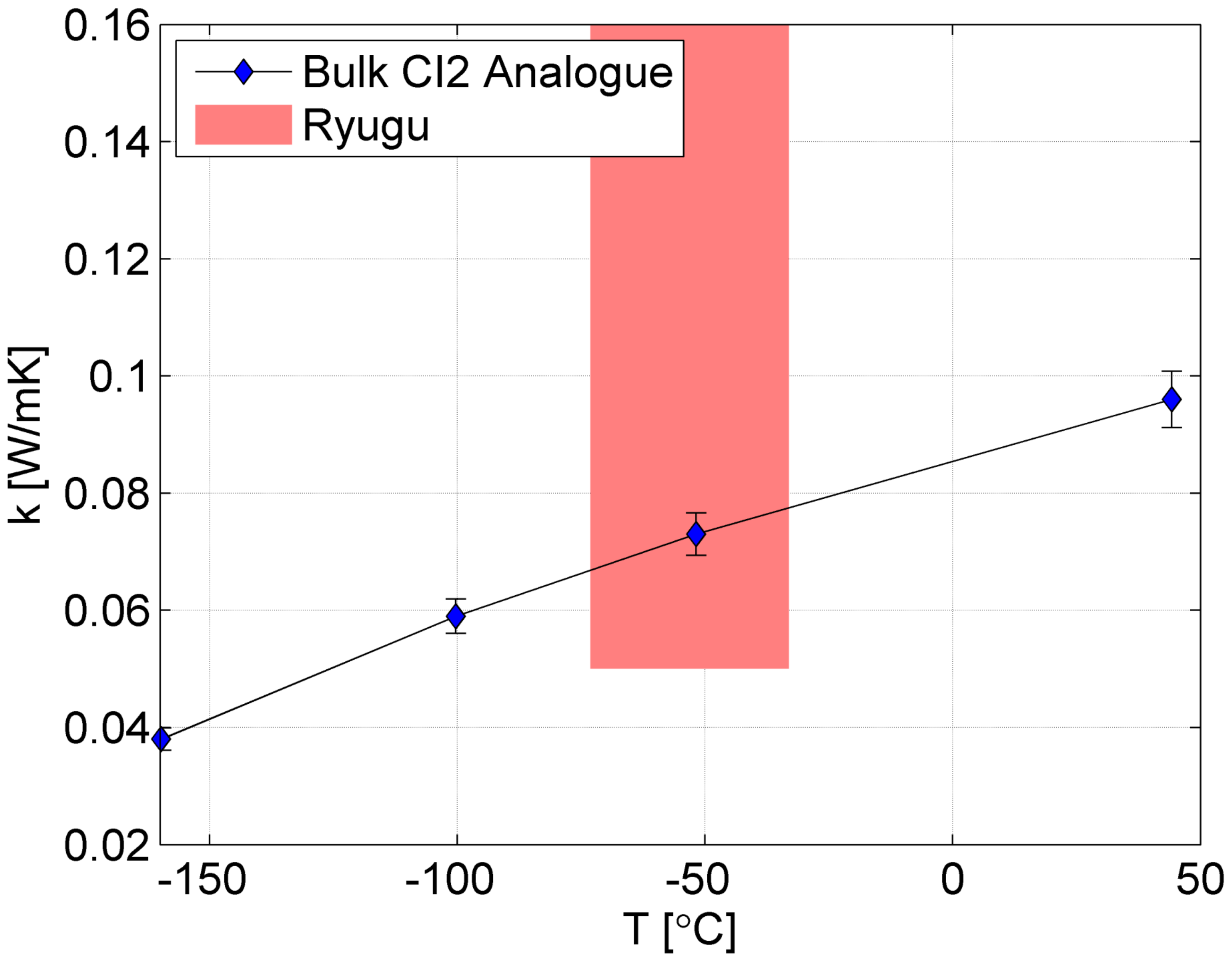
- Thermal radiation of the surrounding terrain will systematically increase temperatures throughout the day
- Assuming 8% view factor to surrounding, ambient temperature same as observed brightness temperature, retrieved thermal intertia decreases down to 247 J m^{-2} K^{-1} $s^{-1/2}$
- Estimated thermal inertia range is a upper limit, stronger thermal radiation from the evironment would decrease the estimate

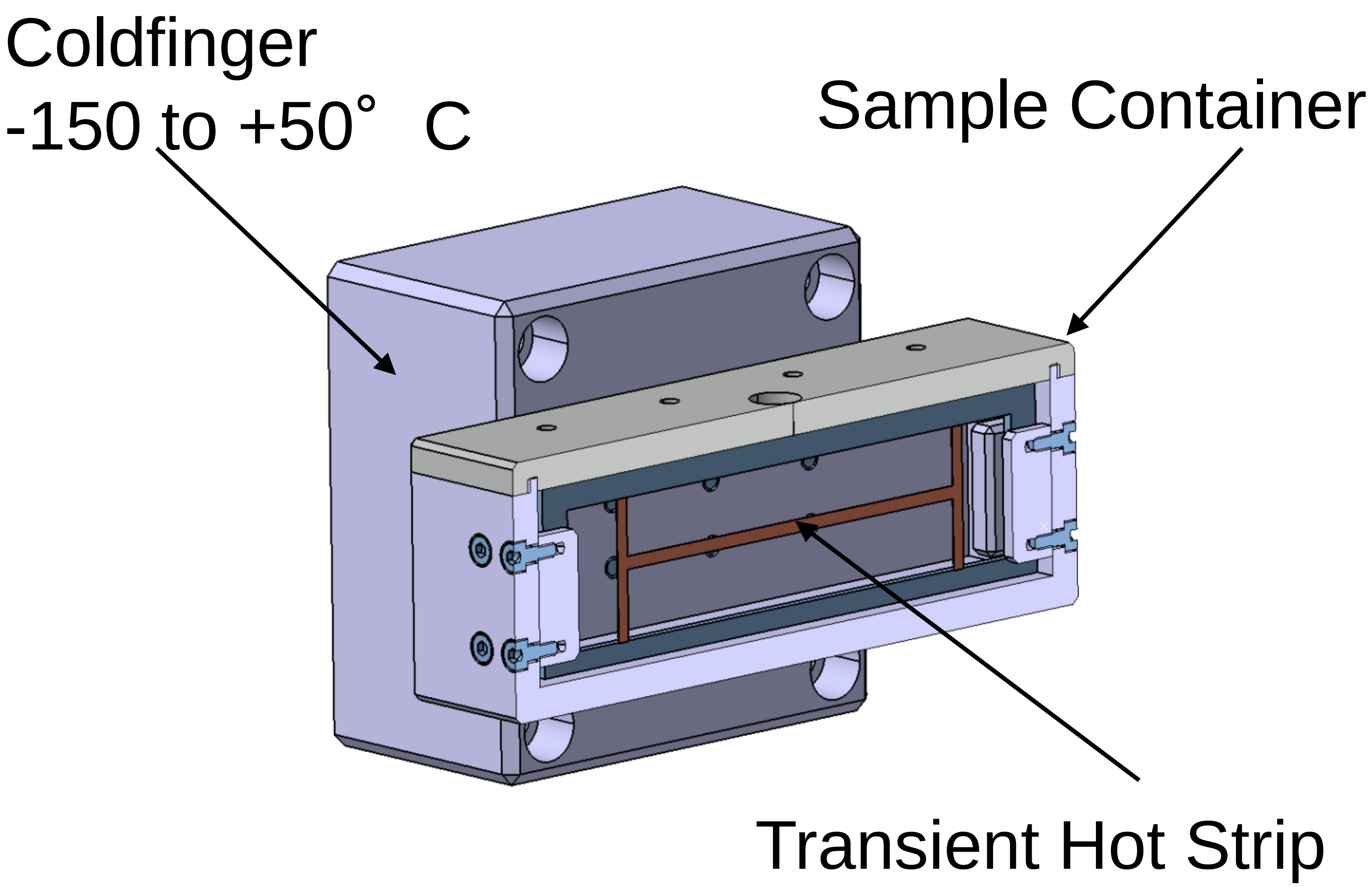
Estimated Thermal Conductivity and Porosity



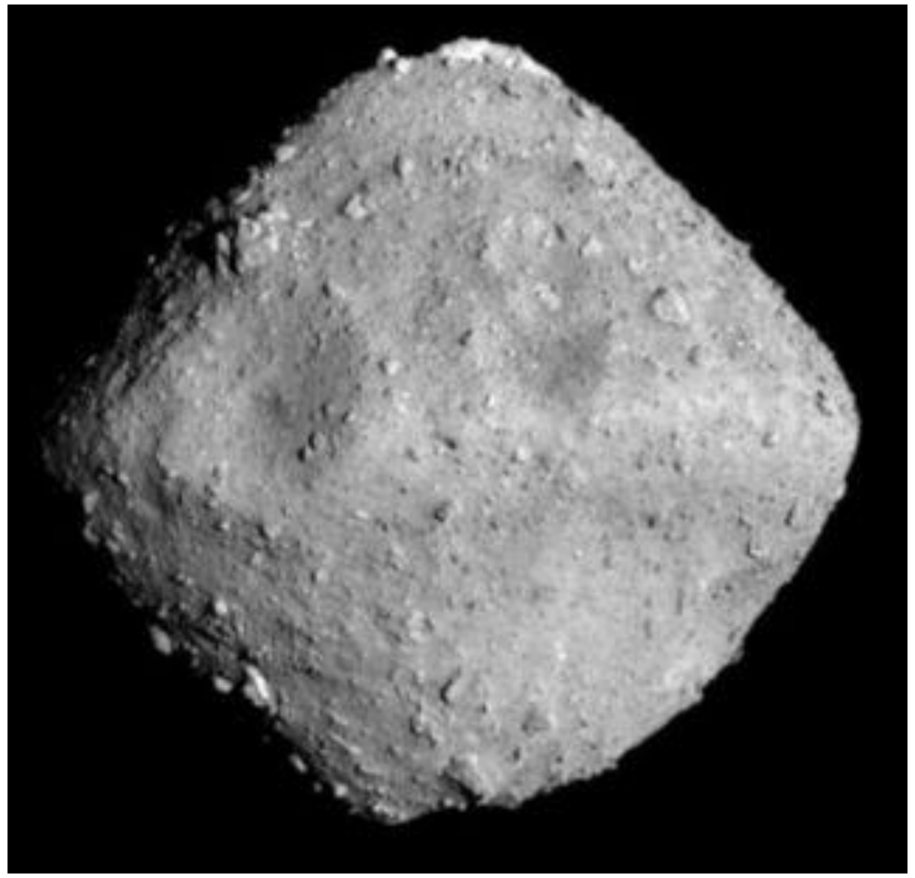
- Assuming a grain density typical for CI meteorites, ρ_s = 2420 kg m^{-3}, and a model of c_p we derive thermal conductivity $k(\phi)$ from thermal inertia
- Comparison to three models of thermal conductivity based on meteorite samples to derive thermal conductivity and porosity of Ryugu
- Large gap in the data for C chondrites

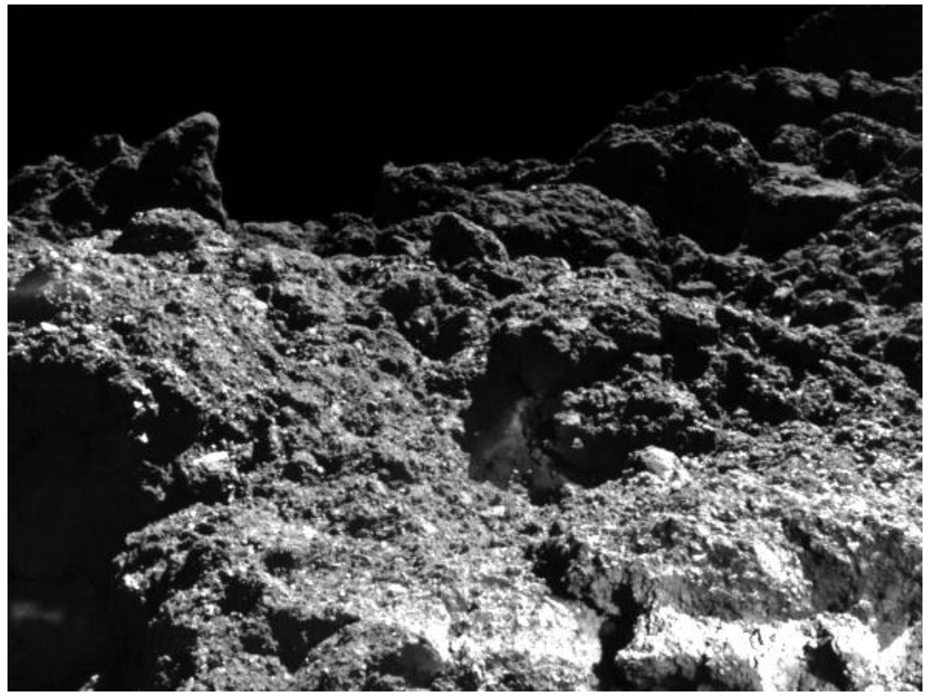
Lab Work -Thermal Conductivity Measurement Setup





Summary and Conclusions





- MARA observed a full day-night at MASCOT site 2, looking at a boulder in its field of view
- The best fitting thermal inertia of the boulder as derived from nighttime data is 282^{+93}_{-35} J K^{-1} m^{-2} s$^{-1/2}$
- The estimate will be refined considering thermal re-radiation, probably extending the lower errorbar
- Current TI estimates indicate a highly porous boulder with ϕ = 28 - 46%
- The low TI of small bodies may be unrelated to regolith cover. Rather, it could reflect the high porosity of surface boulders
- We still need thoroughly investigate re-radiation and roughness when more 3D data is available from MASCAM