

## **In-flight alignment calibration between a laser altimeter and an imaging system – Application to the BepiColombo mission**

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BepiColombo, the upcoming ESA mission to Mercury will be equipped with an imaging system (SIMBIO-SYS) and a laser altimeter (BELA). While the post-launch orientation of the imaging system can be determined by observations of bright stars, the in-flight alignment calibration of the laser altimeter to the reference frame of the spacecraft is a challenging task. The effect of launch load, zero-gravity offloading and thermal distortion in Mercury orbit can lead to an uncertainty in the knowledge of direction of the emitted laser pulse. Especially, at large ranging distances poor knowledge of the instrument orientation leads to large uncertainties in the coordinates of the laser footprints on the surface. Consequently, this results in a co-registration error when a laser profile is compared to an image or to other laser profiles. We propose the co-registration of laser profiles with images or digital terrain models derived from stereo images (stereo DTMs) for co-alignment calibration of the instruments. Previous studies have shown that laser profiles and stereo DTMs can be co-registered with high accuracy, on the order of the DTM grid size. Moreover, we propose to analyze simultaneous measurements by the laser altimeter and the imaging system, as the uncertainty of the spacecraft orientation and position becomes negligible in this case. Provided that simultaneous high-resolution images and laser altimeter measurements are available, such results warrant precise calibration of the co-alignment of the instruments.