In Flight Calibration Results of Hayabusa2 Multi-Band Camera

1. ONC

The optical navigation camera (ONC) system of HAYABUSA2 consists of three framing cameras (T, W1, and W2) with 2-dimensional (1024x1024) charge-coupled devices (CCDs).

Left panel: The estimated FWHM as a function of the distance from the center of the image. The PSF outside this area was slightly higher than 2 pixels, and this was due to the vignetting by the extended hood attached to the camera after the pre-flight calibration to 280 pixels of areas are binned together.

1. ONC-T Distortion and PSF measurement with star field

Star image captures with ONC-T on Dec 11, 2014 with the wide-band filter used in measurements of PSF and a distortion. (Left top) An image with a reference gray scale level. (Left bottom) The location and number of known stars. (Right) The estimated FWHM as a function of the distance from the center of the image. The FWHM of ONC-T (wide band) was less than 2 pixels in most fields of view (r < 580 pixels), indicating no evidence for degradations of PSF after the launch. The PSF outside this area was slightly higher than 2 pixels, and this was due to the vignetting by the extended hood attached to the camera after the pre-flight calibration to 280 pixels of areas are binned together.

3. Albedo maps based on W1 and W2 Earth Images

An image composed using images #1, #13, and #17 captured by the W1 camera. W1 image covers Arabian peninsula to India with a lot of clouds. Similarly to W1 image, appropriate albedo values are obtained.

4. Multi-band Observations of Mars

(Top) Reflectance spectra of Mars obtained by ONC-T at different dates. (Bottom left) 1cm/pix and 390, 480, 550, 700, 800, 950, 589.5nm, wide-focus distance: 100m – 1x1m. Global coverage of 280 pixels from 20km altitude to 100x100m. (Bottom right) Temperature dependences of CCD sensitivity for various wavelengths provided by E2V.

5. Flat field calibration for ONC-T

Normalized sensitivity and ratio of this data with that for a simple model described below for each wavelength band. Left panel shows the normalized image at the light panel captured on Dec. 21st at Tanegashima (launching site). The image was captured only at the v-band, and the flat distribution appeared similar to that reported by Kameda et al., 2016. Right panel shows ratio between the normalized flat (Figure 18 (a)) and that shown in K2016. This clearly shows a deviation of the flat distribution, especially in the corners of the image. In a corner of small (large) X and Y, approximately +10% (+5%) increase (decrease) in the flat was evident.

6. Moon image by ONC-T two days after Earth Swing-by

Left: Moon image (550m) obtained by ONC-T on Dec. 5, 2015. Middle: Albedo map of the Moon based on Spectral Profiller on KAGUYA. Right: Difference in spectral irradiance of the Moon between ONC-T observation and KAGUYA spectral model prediction. Furthermore, when 40x30 pixels of areas are binned together for the Moon, the spectrum based on pre-flight calibration agrees with that predicted from the spectral model based on JAXA’s KAGUYA measurements (Koyama et al. 2016, 2017). In particular, the discrepancy in the band ratios (r/v and v/s bands) used for quantifying the 0.7mm absorption for iron-rich serpentine is 0.4 and 0.8%, respectively. Details of the comparison are given by Koyama et al. 2017.

7. Summary of Initial InFlight Calibration

Inflight calibration observations of Hayabusa2 indicate that the camera system is in a good condition without any noticeable damage or major change since the pre-flight calibrations. From our detailed analyses of the in-flight spectral data strongly suggest that ONC-T can achieve visible spectroscopic observation of C-type asteroid Ryugu with high enough accuracy to detect signature of hydrated minerals, such as 0.7mm absorption, particularly when ~ a few tens by few tens of area is binned. More thorough discussions on the in-flight calibration results will be given by Suzuki et al. Submitted to Icarus.