INFLIGHT CALIBRATION OF ASTEROID MULTIBAND IMAGING CAMERA ONBOARD HAYABUSA: PRELIMINARY RESULTS. R. Nakamura[1] , M. Ishiguro[1,2], A. M. Nakamura[3], N. Hirata[3], J. Terazono[1], A. Yamamoto[4], M. Abe[1], T. Hashimoto[1] and J. Saito[5], [1]Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency, 2-1-1 Sengen, Tsukuba, Ibaraki, 305-8505, Japan (ryosuke@selene.tksc.jaxa.jp) , [2]Univ. of Hawaii, [3]Kobe Univ., [4]Remote sensing technology center of JAPAN, [5]Nishimatsu construction Co.

Introduction: HAYABUSA is a Japanese sample return mission from a S-type near-Earth asteroid Itokawa and Asteroid Multiband Imaging Camera (AMICA) is one of the remote-sensing instruments. The field of view of 5.7 degree square is covered by a CCD chip consisting of 1024x1024 pixels with the 12 bit dynamic range. AMICA has a filter set similar, but not identical to the Eight Color Asteroids Survey (ECAS), which is the standard system for the ground-based asteroid taxonomy[1]. In addition, four polarizers are attached on the surface of the CCD. Further descriptions can be found in [2]. While the imaging performance is a critical factor to investigate the surface topography, contaminants may blur the images as MSI on Near/ Shoemaker [3]. The ground-based measurements of a integrating sphere provided us with the radiometric calibration coefficients, which convert the output DN of AMICA to the input radiance. The preflight radiometric calibration, however, were conducted under the much higher temperature compared with the inflight operational environments. With the absolute radiometric calibration, we can estimate the Hapke parameters of Itokawa, which could be associated with the regolith properties. In addition, the local variations of the color and iron absorptions can be directly compared with the previous studies on Eros [4]. In this article, we present some preliminary results of inflight observations of AMICA to check the imaging performance and the absolute sensitivity in space.

Observations: Table 1 gives a summary of inflight observations in 2004. Since the pointing direction of AMICA is limited to the anti-sun region, we selected bright stars near the ecliptic plane to derive the point-spread function of AMICA.

Dates	Objects	Filter
Jan 6th	α Ori (M1)	ALL
	α Aur (G5)	ALL
	Saturn	ALL
Jan 13th	β Tau (B7)	ALL
May 16th	Moon	ALL
May 17th	Moon,Earth	ALL,*bvw*
May 18,19th	Earth	*bvw*

Table 1 The log of AMICA observation in 2004

The Moon and Earth were imaged during the Earth swingby around May 19th, 2004. The corresponding smear frames with the minimum exposure of 1 microsec were subtracted to correct the frame transfer component. The frames for flat-fielding was taken by observing an integrating sphere just before the launch.

Results: In order to reduce the total data amount of star images, we have extracted 256x256 partial images between (401,437) and (585,621) and applied reversible data compression with the onboard data processor. Then, we examined the downlinked images (e.g., Figure 1) to derive the full width at the half maximum (FWHM), but Saturn images were not employed because the apparent extent of the ring exceeded the spatial resolution of AMICA. The FWHM values for β Tau are 1.75(*ul*), 1.90(*b*), 1.76(*v*), 1.42(*w*), 1.52(*x*), 2.12(*p*), 2.10(*zs*) pixels, respectively. The values for *p* and *zs* bands are possibly degraded by the nearby hot pixels because the same procedures for the redder α Ori and α Aur give better values. We can conclude that AMICA will provide us with very clear images in all the seven bands upon the arrival on Itokawa.

Figure 1: A *p*-band image of βTau with the exposure time of 89.1 seconds. The bright dots are hot pixels with the high dark current.

For the radiometric calibration, airless moon is a better target than the Earth owing to the stability. However, we observed the farside (Figure 2), for which the reliable ground-based telescopic data is lacking. Clementine/UVVIS provided the global dataset, but the radiometric calibration based on the Apollo 16 sample would yield too high albedo compared with the nearside ground-based observations [5] possibly due to the different compaction state [6]. We picked up the averaged albedo at the sub-spacecraft region in the UVVIS mosaic (Figure 3) and then multiplied it by the correction factor derived in [5]. The effect of photometric function can be neglected for the sub-spacecraft point because the illumination and observing condition occasionally mimic the standard geometry, i.e., phase and incident angle ~ 30 degree and emission angle ~ 0 degree. The central wavelength and width of UVVIS filters are (415/40), (750/10), (900/20), (950/30) and (1000/30) nm. Assuming that UVVIS 950nm band corresponds to the *p* band of AMICA, we obtained a radiometric calibration coefficient as 1.89e-3 (W/m^2/um/str) /(DN/sec). The temporal variation will be monitored by future observations of the stars listed in Table 1. Alternatively, absolute radiometric calibration can be made based on the ground-based observations of Itokawa. Once we establish the accurate models for the shape, rotation and photometric function of Itokawa, the disk-resolved radiance could be adjusted to the ground-based measurements of the irradiance.

Murchie et al. [4] found that the plot of 950/760 (nm) VS 760 (nm) reflectance for Eros falls on a single line.

Figure 2: Lunar farside image in the *v* band taken on May 17th, 2004. Mare orientale and moscoviense can be seen. The exposure time is 65.5 millisecond and the spatial resolution at the sub-spacecraft point (21N,133W) is roughly 35km per pixel.

The spread along the line can be explained by space weathering. The similar plot of *p/w* VS *w* by AMICA would show variations not only in the degree of space weathering but also in the composition and/or the regolith properties. Furthermore, if we find a different line for Itokawa from that of Eros, it may reflect the degree of differentiation experienced by their parent bodies.

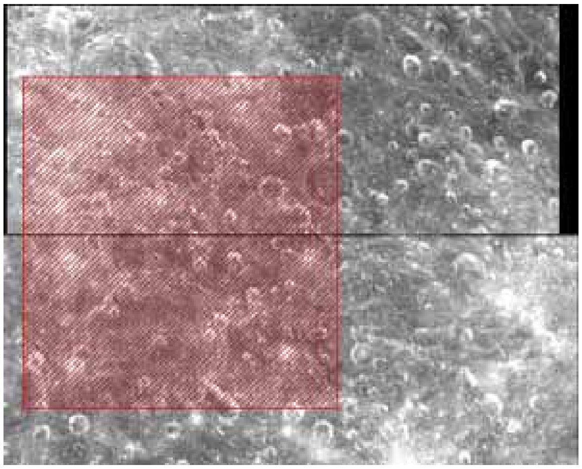

Figure 3: Close up of the sub-spacecraft region taken from the 950nm UVVIS mosaic. The hatched area corresponds to the sub-spacecraft 5x5 pixels in figure 2.

Summary: Asteroid Multi-band Imaging CAmera (AMICA) is an imaging instrument onboard HAYABUSA spacecraft to examine the surface topography and composition of the target S-type asteroid Itokawa. We have performed inflight observations of AMICA since the launch of HAYABUSA in May, 2003. The point-spreading functions have been estimated from the star images and radiometric calibration was made by using the lunar farside images taken before the Earth swingby in May, 2004. AMICA is in very good condition and ready for the arrival on Itokawa in 2005.

References: [1] Zellner B. et al. (1985) *Icarus, 61*, 355-416 [2] Nakamura T. et al. (2001) *Earth, Planets and Space, 53*, 1047-1063 [3] Li J. et al. (2002) *Icarus, 155*, 244-252 [4] Murchie S. et al. (2002), *Icarus, 155*, 145-168 [5] Hillier, J. K. et al. (1999) *Icarus, 141*, 205-225[6] Sakai T. and Nakamura A. M. (2004) *LPS XXXV*, Abstract #1731