IN-FLIGHT PERFORMANCE OF THE HAYABUSA-2 NEAR-INFRARED SPECTROMETER (NIRS3). K. Kitazato, T. Iwata, M. Abe, M. Ohtake, S. Matsuura, T. Arai, Y. Nakauchi, K. Tsumura, N. Hirata, H. Senshu, S. Watanabe and the Hayabusa-2 NIRS3 Team, 1University of Aizu, Fukushima, Japan (kitazato@u-aizu.ac.jp), 2JAXA ISAS, Kanagawa, Japan, 3Graduate University for Advanced Studies, Kanagawa, Japan, 4Tohoku University, Miyagi, Japan, 5Chiba Institute of Technology, Chiba, Japan, 6Nagoya University, Aichi, Japan.

Introduction: JAXA’s Hayabusa-2 mission is planning to explore the near-Earth asteroid (162173) 1999 JU3 and bring back its surface sample to the Earth. The target asteroid 1999 JU3 is a sub-km-sized C-type asteroid, which has low albedo and spectral signature consistent with carbonaceous chondrites. In a part of its surface a shallow absorption feature associated with the presence of hydrated mineral had been observed from the ground [1]. This implies that 1999 JU3 would be formed from the collisional disruption of a larger parent body that had experienced aqueous alteration. Thus, it is important to reveal the distribution of water and hydrated minerals on the asteroid surface not only as information for sampling site selection but also for understanding the asteroid formation and evolution.

NIRS3, the near-infrared spectrometer onboard the Hayabusa-2 spacecraft, is a remote-sensing instrument to measure the spectral radiance of reflected sunlight from the asteroid surface. Since its spectral coverage is 1.8-3.2 μm (Δλ = 20 nm), NIRS3 enables to examine the shape and strength of 3-μm absorption features due to structural OH ions and H2O molecules from the reflectance spectra. To complete the flight model in short period of ~3 years, we developed NIRS3 as a point spectrometer inheriting the design concept of the Hayabusa/NIRS [2]. The detector was changed to a linear array sensor of Indium-Arsenic (InAs) photodiode having high responsivity in 3-μm wavelength region. Resulting from this, it was required to cool down the detector around -80°C, and the spectrometer unit became external mounting and installing a radiator [3].

On December 3, 2014 at 4:22 UTC, Hayabusa-2 spacecraft was successfully launched from Tanegashima Space Center. After that we confirmed NIRS3 functions correctly. We present the results for on-ground calibration tests of NIRS3 and its actual performance estimated from the observing data after the launch.

On-ground Calibration Tests: The manufacturing of the NIRS3 flight model was finished in July 2013 and then we performed its on-ground calibration tests during about 1 month. We obtained the spectral and radiometric calibration data with the spectrometer unit cooled in a vacuum chamber. Also we measured the dark current and noise characteristics.

As for the relationship between pixel and wavelength, almost no change was seen within the temperature range from -70°C to -90°C. On the other hand, the spectral responsivity depends on the detector temperature. In addition, we found that the responsivity is non-linear with respect to both the integration time and the intensity of incidence light. Since the dark output also shows a similar trend, we consider that the shift in bias voltage of InAs photodiode would cause it. Thereby, it is necessary to derive the spectral response coefficients depending on those factors for accurate radiometric calibration. Moreover, it was found that sporadically a ripple pattern occurs in the spectrum data due to the grounding condition of the electric circuit, and we decided to remove such a pattern by the on-ground data processing using the Fourier transform.

From the results of on-ground calibration tests, we finally confirmed that NIRS3 would be able to accomplish the signal-to-noise ratio of greater than 300 at the nominal observing altitude (even in the case of low altitude, that would be greater than 50), which is good performance enough to distinguish the corresponding type of carbonaceous chondrites from 3-μm absorption features [4].

Operational Plan: In the cruise phase of ~3.5 years until arrival at the asteroid, we perform the calibration data acquisition at the frequency of about once a month. NIRS3 has two types of small lamp unit so as to obtain the calibration data even in flight. Also these data had been obtained in the on-ground calibration tests. Therefore, we can evaluate the effect of degradation for the spectrometer performance, such as by shock and vibration during the launch, contamination of outgass, and space radiation, by comparing between the on-ground and in-flight data. In addition, we are planning to observe Mars and Jupiter as a point source to check the direction of field of view.

At the Earth swing-by of December 2015, the Hayabusa-2 spacecraft will make its closest approach to the Moon at 360,000 km. Though the solar phase angle is quite high as sunlight doesn’t incident on the solar array panel. If the disk-resolved observation of the Moon is achieved, we will be able to use the data for checking the absolute radiometric calibration.