INITIAL CALIBRATION OF SPECTRAL PROFILER AND EXAMPLES OF THE OBSERVED LUNAR SURFACE SPECTRAL SIGNATURES.
Y. Ogawa[1], T. Matsunaga[1], M. Ohtake[2], J. Haruyama[2], Y. Yokota[2], T. Morota[2], C. Honda[2], M. Torii[2], R. Nakamura[3], S. Kodama[3], and LISM Working Group, [1]National Institute for Environmental Studies, 16-2 Onogawa, Tsukuba, Ibaraki, 305-8506, Japan, [2]Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency, 3-1-1 Yoshinodai, Sagamihara, Kanagawa 229-8510, Japan, [3]National Institute of Advanced Industrial Science and Technology, AIST Tsukuba Central 2, Tsukuba, Ibaraki, 305-8562, Japan.

Introduction: SELENE (KAGUYA) was launched off to the Moon on 2007/9/14. It mainly observes the lunar surface in polar orbits about 1 year as a nominal mission. An instrumental unit onboard the spacecraft specializes in passive optical observation of the lunar surface and is called LISM (Lunar Imager / SpectroMeter). The Spectral Profiler, hereafter we write SP, is one of the components of LISM [1] [2].

SP is a visible and near infrared spectrometer, which covers 500-2600 nm in wavelength with spectral resolutions of 6-8 nm and high SNRs of ~2300@810-860 nm, accompanying three detectors (VIS: 513-1010 nm, NIR1: 884-1676 nm and NIR2: 1702-2588 nm). Compared with other spectrometers targeting the Moon in the past, SP is superior in its broader spectral coverage with high spectral resolution and high SNR, which could identify the mineralogical compositions of the lunar surface with unprecedented accuracy and contributes to the completion of the global map of the mineral distribution [3].

Procedures to Calibrate SP data: SP observes lunar surface during all day-time basically, and night-time, too, for calibration (see below). The calibration of SP data is essential for evaluation of the spectral signatures observed and critical for their scientific interpretations [4]. Many factors would affect observed spectral features; observational conditions (phase angles and solar altitude), thermal conditions of the instrument, and surface conditions (including space weathering, compaction, degradation) other than the surface composition itself, which should be considered carefully [ex. 5].

SP data calibration consists of radiometric and spectral calibration. We apply following sequential process to radiometric calibration: (a) Evaluation and removal of dark signals, (b) Conversion of digital signal (DN value) into radiance, (c) Conversion of radiance into reflectance. As for spectral calibration, we apply: (d) Evaluation and adjustment of sensitive wavelength of each element of the detectors. We should also take care of their changes with time, which may require frequent modification of calibration coefficients. For those calibrations, we plan the following methods: (i) Ground-truth comparison / Observation of the "standard" site (Apollo 16 landing site) [6], (ii) In-flight calibration with onboard halogen lamps, (iii) Preflight calibration comparison of the radiometric measurement with integrating spheres, (iv) Comparison of repeated observation over same sites , (v) Cross calibration with other instruments, especially MI (Multi-band Imager, other components of LISM).

Data processing of SP currently focuses on evaluation of halogen lamp data. We show examples of spectral data of calibration lamp obtained in the initial operation around the Moon, comparing with the preflight data in Fig. 1. We see no significant difference between preflight and inflight data, which guarantees performance of SP. We can use the lamp data for independent calibration of SP as planned.

Examples of the Observed Lunar Surface Spectral Signatures: SELENE (KAGUYA) completed its initial check-out phase on 2007/12/21 and moved to the nominal phase. Up to now (2008/1/7), we've got data for about 150 orbits and SP L2A products processed amounts to more than 200 in total. Here we show a few examples of SP raw data in Fig. 2. The values are DN (Digital Numbers) and the signatures clearly exceed the noise level. Even though the data has not been executed any calibration, we can see the characteristic features along geological surface variations, distinguishing a crater rim and shadowed floor. After processing some appropriate calibrations, we can discuss these signatures quantitatively. Finishing initial calibration, SP L2B products (converted into spectral radiance) will be generated.

Final Goals: New SP data for the day-lighted area is acquired continuously. New halogen lamp data are to be added 4 times a week to monitor changes of calibration coefficients. Our final goal is to get mineral maps of the lunar surface, using well calibrated SP data covering several absorption bands of pyroxene, plagioclase, and olivine, succeeding to Lucey et al., 2006 [7].

References: [1] M. Ohtake et al. (2008) *LPS XXXVIV,* in this volume, [2] J. Haruyama et al. (2008) *LPS XXXVIV,* in this volume. [3] T. Matsunaga et al. (2008) *LPS XXXVIV,* in this volume. [4] T. Matsunaga et al. (2001) *SPIE, 4151,* 32-39, [5] T. Hiroi et al. (2006) *Nature, 443,* 56-58, [6] S. Tompkins and C. M. Pieters (1999) *Meteorit. Planet. Sci., 34,* 25-41, [7] P. Lucey et al. (2006) *New Views of the Moon,* 83-202.

(a) — DN value vs Element Nu# of VIS sensor: 1-84 (corresponding 513-1010 nm)

(b) — DN value vs Element Nu# of N1 sensor: 1-100 (corresponding 884-1676 nm)

(c) — DN value vs Element Nu# of N2 sensor: 1-112 (corresponding 2588-1702 nm)

The elements of #1-60 (2588-2177 nm in wavelengths) catch no signals because the light emitted for the range of these wavelengths doesn't reach due to the intrinsic characteristics of the
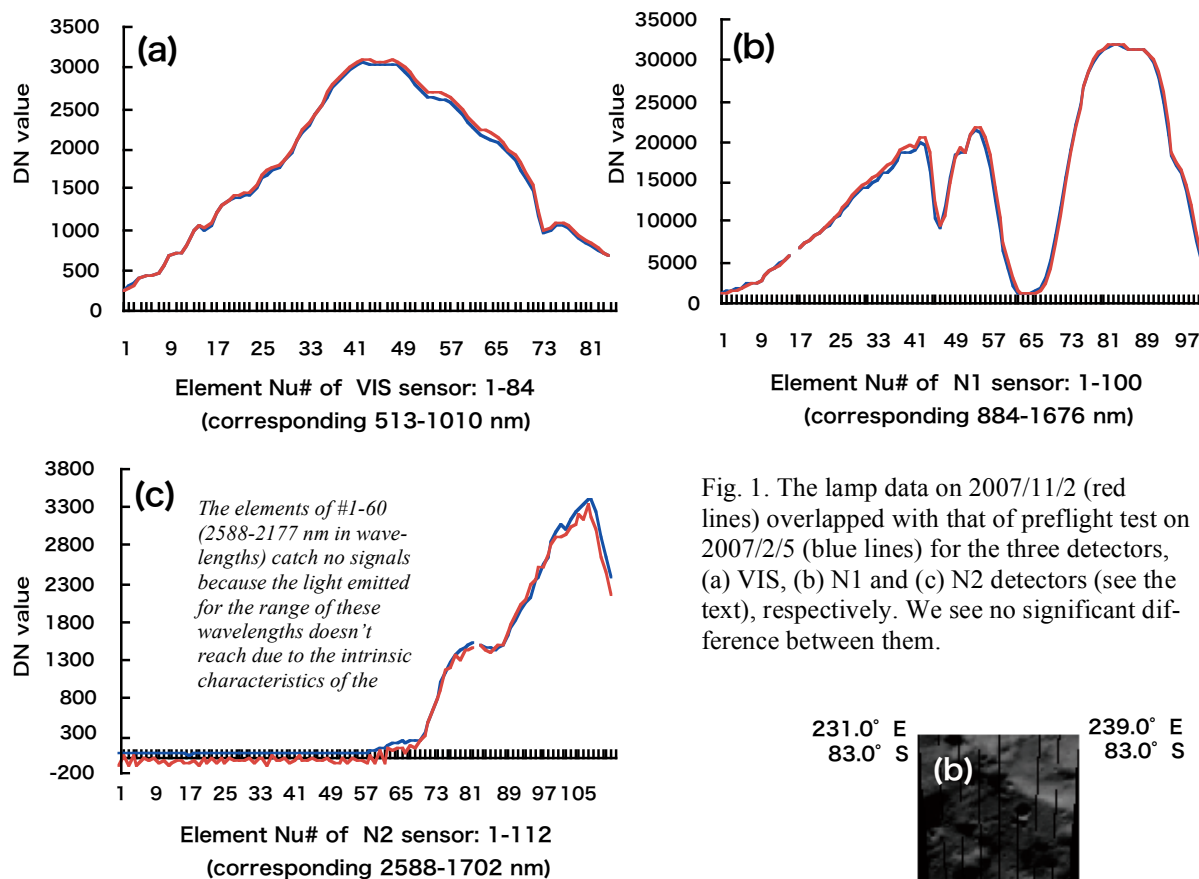
Fig. 1. The lamp data on 2007/11/2 (red lines) overlapped with that of preflight test on 2007/2/5 (blue lines) for the three detectors, (a) VIS, (b) N1 and (c) N2 detectors (see the text), respectively. We see no significant difference between them.
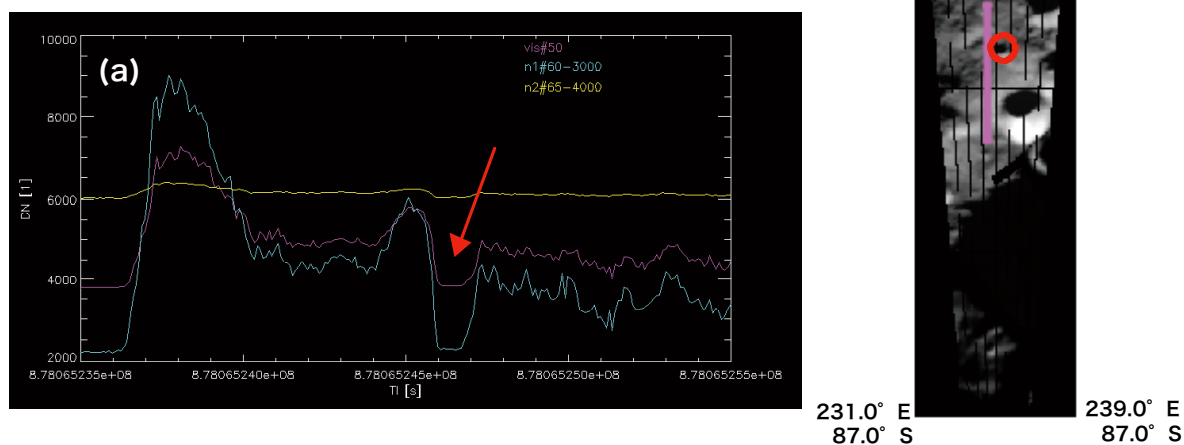
Fig. 2. (a) Examples of SP raw data, showing variation of DN along with time and (b) SP footprint (measurement line) during this time window embedded in Clementine UVVIS mosaic image (purple line). The fixed wavelengths are 807, 1356 and 2077 nm for VIS#50, N1#60, N2#65, respectively. We can see the common depression of surface reflectance (red arrow) to match a small crater (red circle, not scaled, a few km in diameter to locate around -84.8 in latitude, 234.5 in longitude, now the size is exaggerated;). The decrease of reflectance potentially suggests shadows within the crater. TI represents relative time (sec). The data is acquired 2007/11/2 18:47-19:22 UT.