Overview of candidate instruments on board the Lunar Lander Project SELENE-2. S. Tanaka[1], T. Mitani[1], Y. Iijima[1], H. Otake[1], K. Ogawa[1], N. Kobayashi[1], T. Hashimoto[1], T. Hoshino[1], M. Otsuki[1], J. Kimura[2], K. Kuramoto[2], [1]JAXA (3-1-1 Yoshinodai, Chuo-ku, Sagamihara-shi, Kanagawa 252-5210, JAPAN, tanaka@planeta.sci.isas.jaxa.jp), [2]CPS/Hokkaido Univ. (Kita 8, Nishi, 5, Kita-ku, Sapporo, 060-0808, JAPAN).

Introduction: SELENE-2 lunar landing mission is one of the series of Japanese lunar exploration program of the next two decades[1](Fig.1). A pre-project team was established in 2007 (Phase-A) and the launch is scheduled in the mid-2010s. We report up-dated status of investigation and development of candidate instruments.

Basic concept and strategy of deployment of the instruments on board the SELENE-2: The main prior object of the SELENE-2 mission is to develop safe and precise landing system on middle to large planets and satellites such as the Moon, Mars for the future Moon and planetary exploration. Although, in addition to the landing system, the SELENE-2 system is under consideration of deployment of a rover and a relay orbiter system respectively. This enables us flexible idea and selection of instruments on board.

As for the science regime, the basic concept of observation strategy is as the following three items;

a) Investigating radial variation(s) of structure and chemical composition , hopefully, to the center of the Moon by the combination of in-situ Geophysical and Geological measurements,
b) Detailed geological observations which are motivated by the recent progress of the lunar remote sensing observations, and
c) Proceeding the first step of astronomical observations by using lunar (unique) environment.

On the other hand, the basic concept of future utilization and other purposes are;

a) Supplying useful information for the future manned mission to the Moon, and
b) promoting outreach activity following the successful result of the Kaguya mission which deployed High Definition TV (HDTV) .

Overview of candidate instruments: At present, 14 candidate instruments are under investigation and promoting development by the pre-project budget. We introduce an outline of these candidate instruments.

-Geological observations;

We have recognized an importance of in-situ observations following high precision remote-sensing observations which were realized by Kaguya, LRO and other missions. Using the lander and rover system, we consider some candidate instruments;

a) Three multiband cameras with having different resolution on board the lander and the rover, one of them have also sample processing (polishing) tool . We expect to obtain further information about the composition of Lunar Magma Ocean (LMO), and mantle minerals.
b) Gamma ray and Neutron Spectrometer(GNS), which will inform us quantitative analysis of radioactive elements such as U, and Th, which are considered to be the representative elements of refractory elements. We also expect that the data will become a ground truth of remote sensing data obtained by Kaguya GRS or Lunar Prospector.

Recently, we included chemical analysis system on board the Rover using Active X-ray (AXS) and Laser induced breakdown spectroscopy (LIBS) . Both of them are now under development and expect to obtain within several percent precision of the major elements.

Selection of the instruments and their specification are obviously dependent on the landing site. The landing site selection board was established in 2010, and it has worked aggressively so far. The result of its activity is reported in the near future.

-Geophysical observations;

In order to investigate internal structure of the Moon by geophysical method, four candidate instruments are now under consideration.

a) The most vital tool for the investigation of the internal structure of the planet is a seismic observation. Four stations nework observations were conducted by the Apollo missions. For the SELENE-2 mission, we are considering the deployment of the combination of Very Broad Band seismometry system (VBB) which was mainly developed by the European team and Short period seismometers (SP) developed by the Japanese team. Despite one landing system which can not consist of network observations, we expect to obtain information of crustal structure and thickness, and hopefully core radius by the detection of core reflection wave (ScS) by using higher resolution and wider area of bandwidth compared to the Apollo seismometers.
b) Geodetic observations are also under consideration by deployment of radio transmitters on board the lander and the orbiter. Advanced VLBI tech-

nology based on the Kaguya heritage will be applied and expect high precision measurement of k2 (second order potential Love's number) which is an important information of core radius and density distribution. In addition, deployment of laser reflector (LLR) is also under development to measure the vertical component in line of sight motion which is complementary with the VLBI measurement.

c) Electromagnetic field observation on board both the Lander and the orbiter will give us precise information of structure of the electrical conductivity which can translate thermal structure of the Moon. This observation was also conducted by the Apollo missions but large uncertainty could not infer the state of the core (solid or liquid).
d) Heat flow observation is planned by the deploymentof the HP^3 which was developed by DLR (German aerospace center) [2]. This system is expected to penetrate as deep as three meters and to obtain heat flow value at the landing site within 10% in precision.

In order to achieve these objectives described above, all geophysical observations require long term observation duration, at least three month or longer. In order to do this, night survival system is also under development by the pre-project team.

-Astronomy from the Moon;

Lunar environment may provide us particular condition which does not realize on and around the Earth. For example, lunar orbit could avoid any radiowave noise from the Earth by shading of the Moon, and extremely low ground noise on the Moon. Long duration of insolation (and night time) would be also beneficial for astronomical observations. We are considering following two observations;

a) Low frequency (20-25MHz) astronomical telescope: frequency range enable us for a precise observation of mechanism of Jupiter-Io Decameter wave as the first step.
b) Dust counter on board the orbiter. High velocity Impaction of micrometer size dust generates plasma which will be detected by this instrument. This is also expected to detect cosmic and lunar dust with 1 -100km/s, and 10^{-14} to 10^{-11} g ,which may contribute to understand evolution of the lunar regolith.

Futuer utilization and outreach : In order to obtain useful information for the future manned mission(s) and human activities on the Moon, following two instruments are under consideration;

a) Lunar Soil Mechanics Investigation System (LSM) on the lander will give us basic information for construction of Lunar base or lunar telescope system.
b) Real-time Radiation Monitoring Device (RRMD) on the Orbiter, which is originally developed by International Space Station (ISS) project.

And lastly, for the outreach purpose,

c) High Definition TeleVision (HDTV), which was successfully operated by Kaguya mission.

Future activity plan: We have promoted technological development of the candidate instruments so far. Especially, we have obtained an aspect of the thermal design of each instrument under severe temperature condition on the Moon. In the near future, further selection board will be held before the system requirement review board(SRR). We still have in mind further announcement calling for candidate instruments as the framework of international collaboration (International AO). As of now, SELENE-2 mission team is elaborating a "realistic" proposal from the viewpoints of both technological readiness and severe financial condition.

References:

[1] Hashimoto T. et al., (2011) Proc. IAC meeting -10.A3.2B.1. ; [2] Grott M. et al.,(2009) *LPS XXXX*, Abstract #1107.

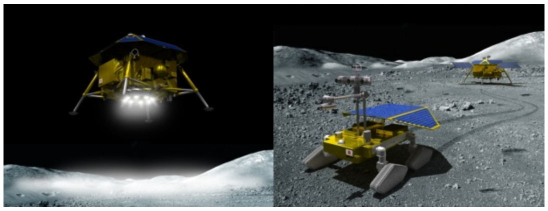

Fig. 1 Image view of SELENE-2 lander and rover.