KMAG: THE MAGNETOMETER OF THE KOREA PATHFINDER LUNAR ORBITER (KPLO) MISSION

J. Shin[1], H. Jin[1], H. Lee[1], S. Lee[2], S. Lee[1], M. Lee[1], B. Jeong[1], J.-K. Lee[4], D. Lee[5], D. Son[3], K-H. Kim[1], I. Garrick-Bethell[1,6] and E. Kim[7]

[1]School of Space Research, Kyung Hee University (1732, Deogyeong-daero, Yongin, 446701, Republic of Korea), (E-mail: jhshin@khu.ac.kr), [2]Intorule Inc. (306, Sinwon-ro, Suwon, 16675, Republic of Korea), [3]Sensorpia Co. (64, Yuseong-daero, Daejeon, 34054 , Republic of Korea), [4]Soletop Inc. (409, Expo-ro, Daejeon, 34051, Republic of Korea), [5]Department of Earth and Space Science and Engineering, York University (4700 Keele St, Toronto, ON M3J 1P3 Canada), [6]Earth and Planetary Science, University of California, Santa Cruz (1156 High Street Santa Cruz, CA, 95064, USA), [7]Korea Aerospace Research Institute (169-84, Gwahak-ro, Daejeon, 34133, Republic of Korea)

Introduction: Korea Pathfinder Lunar Orbiter (KPLO) is the first lunar exploration mission in Korea. Its development started in 2016 and is scheduled for launch in 2020. The mission objectives are demonstration of lunar exploration technologies, construction of a ground station for deep space communication, and scientific investigation of the lunar environment. KPLO is equipped with five science payloads: Lunar Terrain Imager (LUTI), Disruption Tolerant Networking Payload (DTNPL), Wide-Angle Polarimetric Camera (Polcam), KPLO Gamma Ray Spectrometer (KGRS), ShadowCam, and KPLO MAGnetometer (KMAG). The main objective of the KMAG instrument is to provide measurement data of the magnetic field of the Moon using three fluxgate sensors [1].

Mission Objective: Localized magnetic fields (magnetic anomaly) of the lunar surface have been examined by previous lunar exploration missions such as Lunar Prospector (LP) and KAGUYA (SELENE). Even though past lunar missions have derived reasonable results for the lunar magnetism, many puzzles still remain [2]. Magnetic field maps have already been obtained but more data are required to understand the origins of lunar magnetism and swirl formation [3, 4, 5].

KMAG System: KMAG consists of the Magnetometer (MAG) unit and the Fluxgate magnetometer Control Electronics (FCE) unit (Figure 1). The MAG unit is composed of the boom Assembly, actuator Assembly and hinge Assembly. The three MAGs are located inside a 1.2 m-long tube of the Boom Assembly and the tube is made from Carbon Fiber Reinforced Plastic (CFRP), which has high strength to weight ratio. The FCE is composed of a housing structure and four electrical boards: Low Voltage Power Supply (LVPS), On-Board Computer (OBC), Digital board and Analog board. The OBC communicates with Spacecraft BUS Management Unit (SBMU). The housekeeping and science data will be generated at about 295.31 Mbit/day. KMAG has a mass of 3.5 kg and power consumption of 4.6 W [6].

Magnetometer: The magnetometer of the KMAG is a tri-axial fluxgate designed to measure ±1000 nT range of DC magnetic fields with lower than 0.2 nT resolution. The magnetometer has a temperature coefficient of less than 0.1 %/°C and noise of less than 50 $\mathrm{pT}/\sqrt{\mathrm{Hz}}$. The dimensions of fluxgate magnetometer are Φ45 × 45 mm and it has a 3-axis configuration. The mass is 0.15 kg and power consumption is about 0.28 W. The MAG unit is designed to deploy with a 135° angle on the central top floor of spacecraft (S/C) to minimize an effect of magnetic disturbance from the S/C. For this deployment mechanism, a non-explosive actuator is equipped on the MAG unit with torsion springs. The three fluxgate magnetometers are installed between the edge and middle of the boom to eliminate the S/C's induced fields effectively [7]. In addition, a three-axis magnetoresistive (MR) sensor is located inside the FCE unit to detect the internal magnetic condition of S/C. The MR sensor will also provide useful information for in-flight calibration and data processing.

Operation Scenario: KMAG has two operation categories. Deployment mode: MAG unit will be deployed right after the S/C deployment process of solar panels and antennas. Normal operation mode: KMAG will operate on a 100 % duty cycle in nominal phase and extended phase. Measurements will continue and data will be transferred to the Earth until KPLO impacts on the surface of the Moon.

Future Works: KMAG Flight Model (FM) will be delivered to the Korea Aerospace Research Institute (KARI) by 1Q, 2019. After FM delivery, we will perform long-term testing using QM and EQM KMAG to develop the calibration process and pre-processing software.

Acknowledgement: This paper has been supported by BK21 plus through grant to Kyung Hee University and NRF-2016M1A3A9913306 program the National Research Foundation (NRF) funded by the Ministry of and the Ministry of Science, ICT of South Korea.

References: [1] Jin et al., (2017), SST-2017, [2] Weiss and Tikoo (2014), Science, Vol 346, page 1246753, [3] Baek et al., (2017), JGR, Vol 122, p 411-430, [4] Baek et al., (2019), JGR, in press, [5] Lee et al., (2019), ICARUS, Vol 319, p 869-884, [6] Shin et al., (2017) COSPAR symposium 2017, P1-17, [7] Lee et al., (2016) 2016 AGU Fall Meeting, GP23C-1340

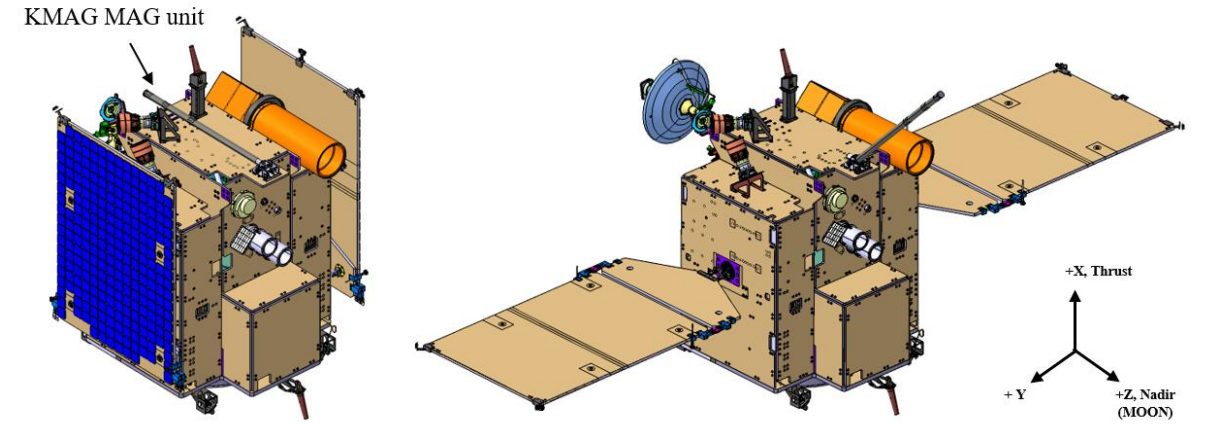

Figure 1 KPLO S/C with KMAG MAG unit (Left: stowed version, Right: deployed version)

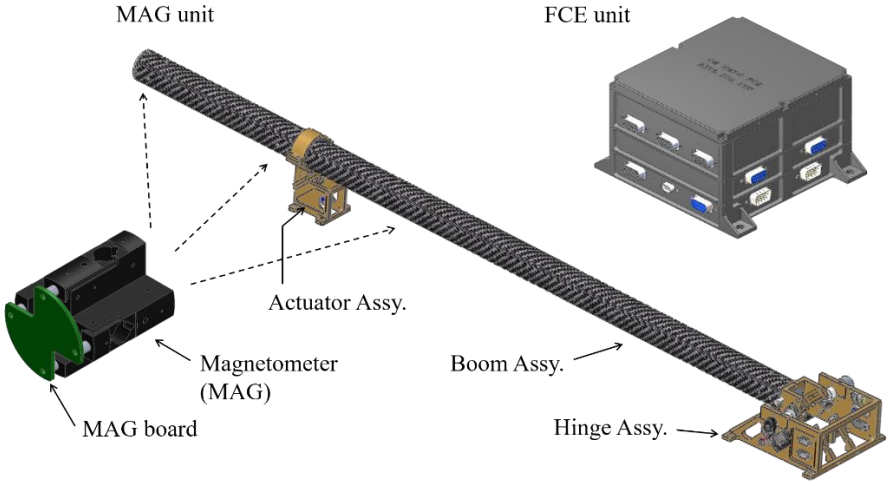

Figure 2. KMAG configuration