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Moon Exploration – Part 1 (2A)

Author: Mr. SEBASTIEN DE RAUCOURT
IPGP, France

Prof. Philippe Lognonné
Université Paris Diderot (Paris 7), France
Mrs. Gabrielle Chabaud
IPGP, France
Mr. Taoufik Gabsi
IPGP, France
Mr. Frederic Guattari
iXblue Photonics, France
Mr. Taichi Kawamura
IPGP, France
Mr. Tanguy Nebut
Institut de Physique du Globe de Paris, France
Mr. Gabriel Pont
Centre National d'Etudes Spatiales (CNES), France
Mr. Olivier Robert
IPGP, France
Mr. Sylvain Tillier
IPGP, France
Mr. Charles Yana
Centre National d'Etudes Spatiales (CNES), France
Dr. William Bruce Banerdt
National Aeronautics and Space Administration (NASA), Jet Propulsion Laboratory, United States
Mr. Raphael Garcia
ISAE - Institut Supérieur de l'Aéronautique et de l'Espace, France
Prof. Clive Neal
University, United States
Dr. Mark Panning
Jet Propulsion Laboratory - California Institute of Technology, United States

TECHNOLOGICAL EVOLUTION OF THE VERY BROAD BAND SEISMOMETER: INSIGHT, FAR SIDE SEISMIC SUITE AND FUTURE MISSIONS WITH OPTICAL VBB

Abstract

The Insight mission is in operation since November 2018. Its very broad band seismometer (VBB) has monitored the Mars seismicity for more than 1100 sols and provided during the night the lowest seismic noise monitored on a planet including the Earth in the 0.1-1 Hz bandwidth. The sensor architecture is based on an inverted pendulum with a capacitive displacement sensor operated with force feedback. Mars data show the compliance of the VBB to the expected performances and to scientific goals of Martian seismology, whereas the Earth environmental noise prevent such a demonstration prior to flight.

In the frame of the NASA's CLPS (Commercial Lunar Payload Services) initiative, the FSS (Farside SeismicSuite) geophysical package, has been selected to fly to the Moon in late 2024/early 2025. It will be equipped with a spare model from InSight's VBB with minor modifications. Gravity adaptation and performances improvements requires changes. Additional proof mass, spring change, sensor attitude were the trade-off between the various possible adaptations, the two later enabling to maintain a high technological maturity. Despite these constraints and the FSS short schedule, it will be possible to improve the displacement sensor self-noise and benefits from new low noise amplifiers available for space applications.

To achieve more demanding science goal on Moon, including deep interior structures and long period surface waves detections, performances breakthroughs are required. A prototype of optical broad band seismometer is in development in the frame of the EC H2020 PIONEERS project. Its goals are better performances and more simplicity to operate than the lunar version of InSigh's VBB. For this goal, the capacitive displacement sensor is replaced by a Michelson interferometer. The high dynamic range allows to operate the pendulum in open loop and remove the recentering mechanism. The mechanical oscillator has been designed with the InSight development lesson learned and the optical phase readout electronic is inherited from FOG technology.

With the InSight experience and feedback on seismic sensor design, the FSS demonstration of a geophysical autonomous package and an optical VBB prototype, Moon seismic network with very high performances will be achievable at short term in the frame of NASA Artemis program, Lunar Geophysical Network or ESA EL3.