

Subject offered for a contract starting October 2019

SUBJECT TITLE: Design and development of a new generation of planetary seismometers with extremely high performances based on the use of an interferometric readout.

Advisor: **Lognonné Philippe (Pr), lognonne@ipgp.fr**

Second Advisor/ Supervisor:
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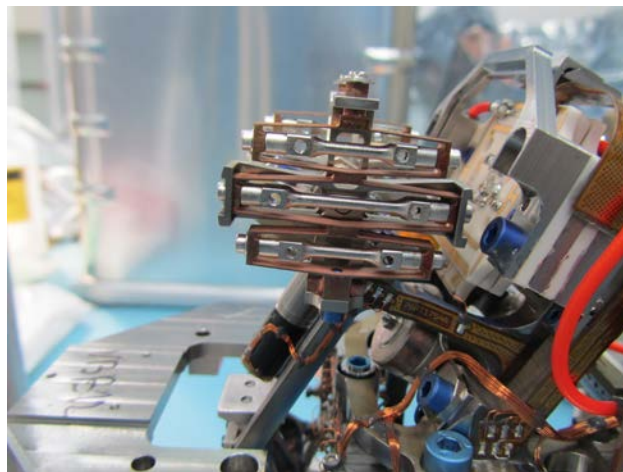
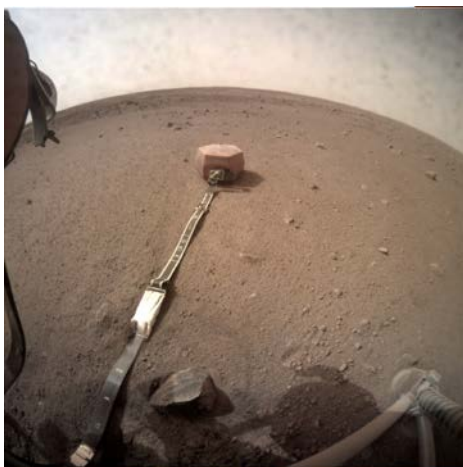
Host lab/ Team : *please fill in and leave out meaningless information*
IPGP- Team « Planetology & Space Sciences » – UMR7154

Financing: Doctoral contract without teaching assignment

For more information go to <http://ed560.ipgp.fr>, section: Offres de these (PhD offer). You must apply on the Doctoral School website.

Presentation of the subject:

Since the 90's IPGP has developed a worldwide expertise in the development of ultrasensitive seismometers to study the internal structure of telluric planets (especially the Moon and Mars). IPGP was responsible for the delivery of the long-period sensors (or VBB for Very Broad Band) of the SEIS (Seismic Experiment for Interior Structure) experiment of the NASA InSight mission.



Pictures: Left: SEIS on Mars on sol 66. Right: one the flight long period sensor in IPGP tests facilities.

In parallel of the InSight technology optimisation, IPGP is willing to develop a new

generation of seismometers targeting very high performances (self-noise of a few 10^{-12} m.s⁻²/sqrt(Hz)) to address the Moon seismology science objective.

Pioneers (**P**lanetary **I**nstruments based on **O**ptical technologies for an **i**nnovative **E**uropean **E**xploration using **R**otational **S**eismology) is a project funded by the European Union in the frame of the H2020 program. Within this project, IPGP is responsible for the development of a translation seismic sensor, in partnership with iXBlue (a French company specialized in optronics and Fiber Optics Gyroscopes), who will develop its optical readout.

A seismometer with an optical displacement transducer operated in open loop would get rid of intrinsic limitation of classical VBBs whose noise sources are due to the feedback or electrostatic forces of their displacement transducers.

The objective of this thesis is to develop such a seismometer from scratch up to a TRL 4/5 prototype and to demonstrate the performances potential of this technology. The PhD will be focus on the sensor architecture trade-off, sensor modelling, performances budget and tests.

iXBlue is in charge of the optical part, i.e. the interferometric displacement sensor and IPGP is responsible for the mechanical oscillators and the whole sensor as a system. The PhD will be involved mainly in the global system study: specification of the sensors, specification flow down to the 2 mains components (optical readout and mechanical oscillator), architecture trades-off, sizing, performances budget, sensor integration, functional and performances tests.

The student will work at IPGP, in the Planetary and Space Sciences lab located on the Paris Rive Gauche Campus of the Université de Paris (close to the French National Library, in the 13th district of Paris). Frequent displacements at iXblue (St Germain en Laye) are foreseen.

The candidate should have some experience in experimental physics and instrument engineering. Knowledge in interferometry/optical development and / or space instrumentation is a plus.

The PIONEERS project will fully fund this PhD position. It will also provide procurement and engineering support to built and test the prototype.

For any further information, please contact:

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References:

- [1] – website of IPGP laboratory : <http://www.ipgp.fr> <http://www.ipgp.fr/fr/pss/planetologie-sciences-spatiales>
- [2] – website of iXBlue <https://www.ixblue.com> <http://www.blueseis.com/>
- [3] –website of InSight/SEIS : <https://www.seis-insight.eu>
- [4] – Lognonné, P., Banerdt, W.B., Giardini, D. et al. Space Sci Rev (2019) 215: 12.
<https://rdcu.be/bwond>
- [5] –http://www.univearths.fr/wp-content/uploads/2018/07/UnivEarthS_These-Lucile-Fayon.pdf