SEIS EXPERIMENT FOR THE INSIGHT MISSION: TOWARDS 2018 LAUNCH

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Introduction: The InSight NASA Discovery mission will provide unprecedented data on Mars' deep interior structure and more generally on the mechanisms that shaped telluric planets in our solar system. The French contribution to InSight, the SEIS seismometer, will perform essential measurements of Mars' tectonic activity that will enable us to characterize the nature and size of its core and the thickness of its crust.

After giving an outline of the InSight mission, with a focus on SEIS activities on Mars, we will describe the SEIS instrument and its performances, and provide a status of its development at the time of the workshop.

Insight mission [1]: Insight is led by the Jet Propulsion Laboratory. It will deploy at the surface of Mars on November 26th, 2018 a set of seismometers called SEIS (Seismic Experiment for Interior Structure), and a suite of complementary instruments, such as a precision temperature sensor, a micro-barometer, a magnetometer and a wind sensor, making it the first broadband seismic broadband station on another planet. A heat flow sensor and geodetic measurements, HP^3, will provide additional science measurements, in order to constrain the internal structure of Mars.

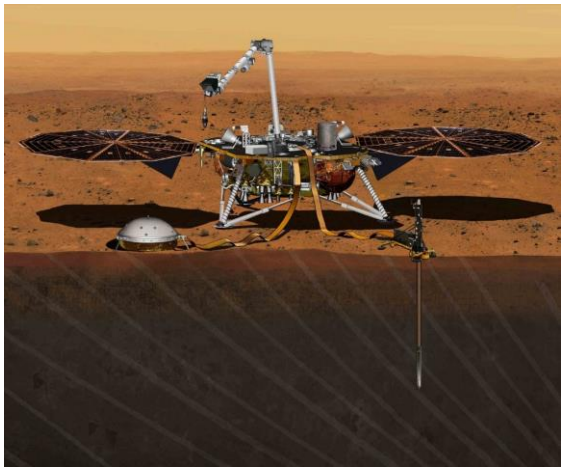

Figure 1 : Insight's lander on the surface of Mars, with SEIS on the left and HP^3 on the right

The INSIGHT lander reuses extensively the cruise bus and the Entry-Descent and Landing System of PHOENIX, which performed a successful mission on Mars Northern terrains in 2008.

SEIS instrument [2]: SEIS is provided by CNES, the French Space Agency, which manages a wide consortium including IPGP of Paris, Imperial College of London, Oxford University, MPS of Gottingen, ETH of Zürich, ISAE from Toulouse and the Jet Propulsion Laboratory of Pasadena.

SEIS accommodates two independent, 3 axis seismometers: an ultra-sensitive Very Broad Band (VBB) oblique seismometer and a miniature, Short Period (SP) seismometer. Both seismometers, and their respective signal preamplifier stages, are mounted on a common structure which can be precisely leveled through 3 legs with adjustable legs. They are thermally insulated, and protected from the Martian wind, by an aerogel thermal blanket and WTS (wind shield) and connected by a flexible cable tether to the E-box, a set of electronic cards located inside the Lander thermal enclosure.

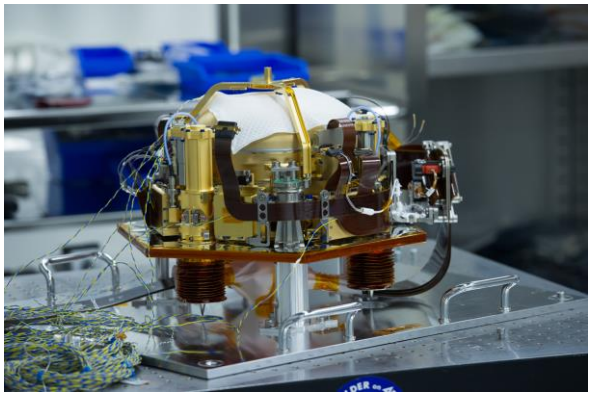

Figure 2 : SEIS flight model in 2015 during environmental test

Several challenges have been overcome to design and realize the planetary seismometer, which exhibits a self-noise of about 10-9 m/s2/sqrt(Hz) in the seismic

bandwidth for its very broadband component. These challenges implied a very complex hardware, both from a mechanical point of view and from an electronic point of view. In particular, keeping the VBBs in vacuum is essential in order to achieve the noise target.

Insight was originally planned for a launch in March 2016. Accordingly, in August 2015, the SEIS Flight Model was fully functional. Unfortunately, it was affected during thermal qualification testing by a leak in the evacuated container that keeps its three seismometers in a vacuum. This led to a loss of performance that was soon judged unacceptable by both the InSight and SEIS Principal Investigators. A joint JPL-CNES Tiger Team worked very hard during the fall of 2015 to locate and fix that leak, but the schedule pressure the team to opt for a repair of the existing Flight Model, which limited the range of solutions. This could however not be achieved in time, and the launch had to be postponed to the next Mars window, in May 2018. In that new time frame, some redesign of the evacuated container has taken place after the root cause of the leak has been identified in one of the feed through electrical connectors. The 2nd phase of SEIS development plan with this new evacuated container will be presented at the workshop.

References :

[1] W. B. Banerdt et al, "INSIGHT: a Discovery mission to explore the interior of Mars", 44th Lunar and Planetary Science Conference (2013)

[2] Ph. Laudet et al, "The SEIS Experiment for the Insight Mission: Development and management plan", EPSC2015-726, 201