The SEIS InSight VBB Experiment. P-A. Dandonneau[1], P. Lognonné[1], W. B. Banerdt[2], S. Deraucourt[1], T. Gabsi[1], J. Gagnepain-Beyneix[1], T. Nébut[1], O. Robert[1], S. Tillier[1], K. Hurst[2], D. Mimoun[3], U. Christenssen[4], M. Bierwirth[4], R. Roll[4], T. Pike[8], S. Calcutt[5], D. Giardini[6], D. Mance[6], P. Zweifel[6], P. Laudet[7], L. Kerjean[7], R. Perez[7] and the SEIS Team[1].
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Introduction: The SEIS experiment is the primary payload of the Interior Structure Investigation using Seismology and Heat Transport (InSight) [1] mission selected by NASA in August 2012 to be the next Mars mission. The objective of the InSight SEIS experiment is the determination of the deep internal structure of Mars. In particular, geophysical parameters of first importance, such as the state (liquid/solid) and size of the core, structure of the mantle, shape of discontinuities and thickness of the crust will be determined by the experiment. It will measure seismic activity over a very broad frequency band, from tidal frequencies (0.05 mHz) up to high frequencies (50 Hz), to address a wide range of scientific questions, from the state of the core to the meteoritic impact rate, marsquake rate and the response of the planet to the Phobos tide.

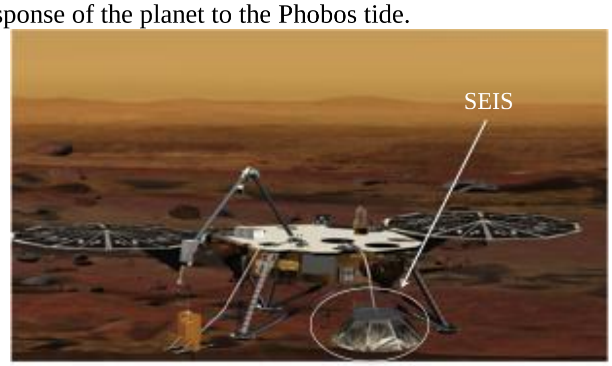

Figure 1 : SEIS deployed on the ground next to the lander

Description of the instrument: The instrument includes notably a Very Broad Band (VBB) 3 axis seismometer which is developed by the 'Institut du Globe de Paris' (IPGP) under the funding of CNES. The sensor assembly, which also contains a MEMS short-period seismometer, will be deployed on the Martian ground by a robotic arm from a Phoenix-type lander platform and will be protected by a wind and thermal shield. The wind and thermal shield,together with a vacuum sphere and a passive compensation system will achieve a very high protection of the VBB against temperature and pressure variations, allowing the sensor to operate in the rough Martian thermal environment while reaching a detection threshold below 10^{-9} ms^{-2} $Hz^{-1/2}$ in the VBB bandwidth. A deployment structure/leveling system will allow the seismometer to get the best possible mechanical coupling with the ground motion.

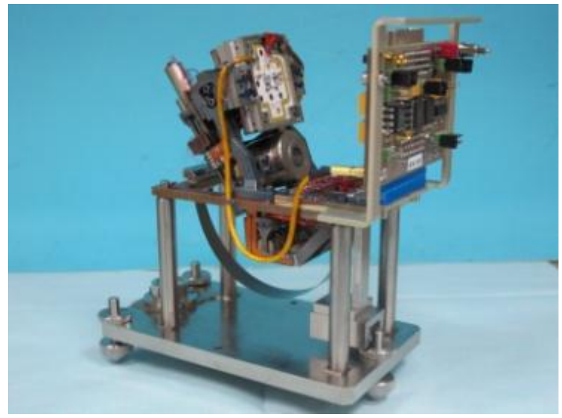

Figure 2 : Single-axis VBB-prototype with proximity electronics

VBB heritage: The implementation requires several specific capabilities to reach the sensitivity goals imposed by the science requirements of a Mars mission. These capabilities have been developed at IPGP [2] starting in 1993 with the Optimism instrument on the Russian Mars96 mission to Mars, followed by the Netlander [3] CNES program in 2003. From 2006 to 2009, the program was funded by the EXOMARS ESA mission.
During those 20 years, expertise on the mechanical pendulum as well as the high-gain capacitive sensor and the low-noise analog front-end and feedback electronic were developed, and the robustness of the seismic sensor to the space mission environment was strongly improved.

VBB performance: Most testing is conducted at IPGP in a suburb of Paris. In order to test the VBB performance as well as possible, some tests were also conducted at the Black Forest Observatory, a very low noise site in Germarny, on a VBB breadboard. This has allowed us to verify our instrument noise model.

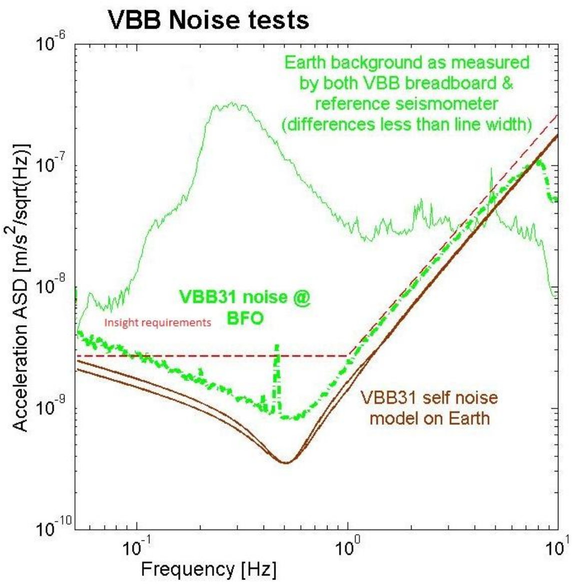

Figure 3 : Earth performance validation

Conclusion: Performance has been demonstrated with previous prototypes and all the electronical and mechanical aspects of the presented VBB are controlled and reproductible in the many tests performed in the past years of development. The SEIS experiment of the InSight mission will therefore provide high-quality seismic signal acquisition and associated seismic information during one martian year, i.e. the nominal mission duration.

The delivery of the payload is planned for the end of 2014 and the launch is in March 2016.

References:

[1] Banerdt, et al., The Rationale for a Long-lived Geophysical Network Mission to Mars, white paper submitted to the National Academy of Sciences Decadal Survey, 2010. [2] Tillier and al, A Martian and Lunar Very Broad Band Seismometer, ESMATS Symposium, 2011. [3] Lognonné, et al., The NetLander very broad band seismometer, Planet. Space Sci., 48, 1289-1302, 2000.