GEP-ExoMars: a Geophysics and Environment observatory on Mars : Philippe Lognonné[1], Tilman Spohn[2], David Mimoun[1,*], Stephan Ulamec[3], Jens Biele[3], the ML2SP team and the Aurora Environment team
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Scientific objective:
The goal of the Long-Lived Geoscience Observatory on Mars, GEP (Geophysics Package) is to initiate the setup of a permanent network of fixed stations on the planet, with the objective to operate for several years. These stations will monitor with high resolution the seismic activity and the rotation of the planet, the magnetic field and its variations. It will measure the heat flux and monitor and study the environmental conditions (meteorology and atmospheric electric fields) and subsurface (ice/water table, subsurface porosity and volatiles). By providing new geophysical models of Mars interior as well as the actual geologic activity of the surface (heat flow, seismic activity), GEP will provide a major step in our understanding of the geological evolution of the planet and the habitability conditions during the first billion years. In addition, GEP will monitor the present Martian climate and meteorology, will provide a unique data set on potential hazards for future human exploration missions (radiation, atmospheric electricity, dust storms) and will perform high resolution characterization of the Martian surface.

Payload
The payload is composed of the following instrument suite (All model payload characteristics are based on state of the art in Europe)

- Network/geophysical : Core payload is based on network instruments with phase B+ maturity
- Geophysical : Full payload includes experiments working in conjunction with the Aurora Rover or drilling system, or experiments needing some lander elements or significant R&D activities
- Environmental AURORA payload : ESA recommended the inclusion of the Pasteur environment suite (ATM and UV-VIS already listed in the Network payload plus a Dust analyzer and Ionising Radiation Monitor) for a total of 1.9 kg of environmental instruments, excluding the boom.

System
Two system options are considered depending on deployment: a 'Semihard' option that can be deployed before landing, and a 'Soft' option (same load as the lander). For ExoMairs, 'Soft' option is currently favoured.

Instrument	Heritage	Mass / kg	average power, W	Description	Network science	Comments	
SEIS	Netlander (Phase B)	1,615	0,28	Seismic suite: 2 VBB oblique seismometers plus one Short period horizontal MEMS (Micro-Electro Mechanical System) sensor completing the tribedron. Target sensitivity <	x	Needs soil contact, wind and sun protection and decoupling from	CORE
ATM	Beagle-2 (flown)	0,685	0,095	Meteo suite: wind, temperature, pressure, humidity, OD, UV spectra, dust impact. Modes: low/nominal/campaign/dust devil rates	x	partly to be replaced by similar Pasteur instruments, see below	CORE
AEP	Netlander (Phase B)	0,147	0,105	Atmospheric electricity probe to measure electric conductivity, quasi DC electric field (up to 300 V/m), ELF/VLF radio-electric emissions (10 Hz to 4 kHz)	x		CORE
HP3	Beagle-2 (flown)	1,195	0,003	Heat flow and physical properties package. Deployed by a mole up to 5 m deep in Martian regolith: TEM, a thermal measurement suite (thermal conductivity, heat capacity, thermal gradient [heat flux]); DACTIL, a set of accelerometers (orientation, depth, so			CORE
MAG	Champ, Astrid-2 satellites (flown)	0,255	0,03	Tri-axial vector magnetic field sensor including t and attitude sensors. Range +/- 1E4 nT, resol. 0.02 nT, offset accuracy <0.1 nT and <30 ppm, noise 12 pT (0.01 to 10 Hz)	x	"MSMO"	CORE
GPR	Netlander NEIGE (Phase B)	0,395	0,142	Mono resp. bi-static ground-penetrating radar, 2 to 6 Mhz. Seach for water reservoirs, either in the form of ground ice or liquid water; morphology and structure of the underground. In the bi-static version, a GPR2 on the rover		"EISS"	FULL
Radio Science	TRL2	0,500	0,2	Geodesy (high precision nutation, polar motion, LOD, ionospheric properties) with S/X-band transponder by measuring doppler shifts. Two frequencies allow elimination of	x		FULL
SEIS-SP	Netlander (Phase B)	0,064	0,14	Short period seismometer, complement to SEIS: 2 more SP MEMS sensors	x		FULL
HUM		0,006	0,02	Humidity microsensor, coulometric (Keidel) cell ; Mixing ratio 1e-7 .. 1E-3 with 5% accuracy absolute	x	Alternative for humidity sensor on Meteo suite	FULL
MEDUSA	GIADA (Rosetta)	1,015	0,065	dust flux, physical properties and size distribution of particles as well as water vapour detection. 5 stages cascade impactor with optical and piezoelectric detectors and micro-balance.			selected PASTEUR instruments to be inc
IRAS	ISS	0,500	0,1	Ionising Radiation Sensor; several segmented planar silicon PIN-detectors around segmented organic scintillator (BC430) in telescope configuration. Neutron and gamma count and dose rates, LET		Influence of RHU neutron radiation to be assessed	selected PASTEUR instruments to be inc
UV-VIS spectro + sun sensor	Beagle-2	0,305	0,081	Spectro: 200-720 nm, resolution 2 nm. Sun sensor: continuous UV/VIS monitoring (photodiode)	x	may be used for transit timing of Phobos and possibly Deimos shadows in	selected PASTEUR instruments to be inc
Meteo boom	Netlander (Phase B)	0,410				to Meteo suite	
TOTALS		**7**	**1,261**				
all data without margins							

Power concept
Although the mean power consumption of GEP is of the order of 4 W, a solar generator is not feasible under the given constraints (±45° latitude, all seasons including global dust storms, > 6 a operational life). An RTG solution is foreseen with off-shelf heater elements from Russia and a highly efficient European thermoelectric generator. A 40 Wh Li-Ion secondary battery is used to buffer peak power demands (mainly for telecommunications)

Programmatics
The GEP is currently onboard the baseline EXOMARS 2011 mission of ESA's AURORA program. Other opportunities might be considered for the deployment of GEP package, such as the 2016 AURORA mission, NASA 2011 SCOUT and possibly all other NASA mission later than 2011. The GEP stations are a unique contribution to the International Mars exploration in the next decade and will complement the Pasteur-EXOMARS and MSL payloads, more focused on exobiology, surface mineralogy and atmosphere composition. (Figure: credits Alcatel Alenia Space)