EXOMARS 2018 LANDING SITE PROPOSAL GUIDE & TEMPLATE

Ref: EXM-SCI-LSS-ESA/IKI-002
Version 1.0, 17 December 2013

Introduction:

Proposals are required to contain the following sections: 1) An abstract summarising the key features of the proposed site. 2) A discussion of the suitability of the proposed landing site to address the ExoMars 2018 science objectives—in particular the search for signs of life. 3) Detailed location information (latitude and longitude of centre of candidate landing ellipse pattern), including a figure with the proposed ellipses (see below). Within the ellipse pattern, please identify areas of prime science interest for sample acquisition and analysis, establish their priority and justify. Please show available high-resolution data footprints superimposed on the landing site and provide the relative references. Include footprints of additional remote sensing observations that could be obtained by instruments on orbiting spacecraft to improve the understanding of the landing site. 4) References.

The proposal should not exceed six pages (A4 format, 11-pt character size) and must be submitted in PDF format. The Landing Site Selection Working Group (LSSWG) will contact proposers to arrange for the electronic submission of additional information (e.g. detailed imagery) in support of their application.

ExoMars 2018 Mission:

The 2018 mission includes two science elements: a Rover and a Surface Platform. The ExoMars Rover will carry a comprehensive suite of instruments dedicated to geology and exobiology research named after Louis Pasteur. The Pasteur payload contains: panoramic instruments (wide-angle and high-resolution cameras, an infrared spectrometer, a ground-penetrating radar, and a neutron detector); a subsurface drill capable of reaching a depth of 2 m to collect specimens; contact instruments for studying rocks and collected samples (a close-up imager and an infrared spectrometer in the drill head); a Sample Preparation and Distribution System (SPDS); and the analytical laboratory, the latter including a visual and infrared imaging spectrometer, a Raman spectrometer, and a Laser-Desorption, Thermal-Volatilisation, Derivatisation, Gas Chromatograph Mass Spectrometer (LD + Der-TV GCMS). The Rover will be able to travel several kilometres searching for traces of past and present signs of life. It will do this by collecting and analysing samples from outcrops, and from the subsurface—down to 2-m depth. The very powerful combination of mobility with the ability to access locations where organic molecules can be well preserved is unique to this mission. After the Rover has egressed, the ExoMars Surface Platform will begin its science mission to study the surface environment at the landing location.

Landing Site's Scientific Requirements:

The ExoMars 2018 mission must target a geologically diverse, ancient site interpreted to have strong potential for past habitability, and for preserving the physical and chemical signs of life and organic matter (including abiotic/prebiotic organics).

The rover will 1) analyse the local geology at km- to sub-mm scales and down to ~2 m depth; 2) search for and evaluate the nature of past habitable environments at the landing site; 3) investigate favourable geological materials for preserving biosignatures; and 4) analyse them to search for physical and chemical signs of life—as well as seek evidence of abiotic, or prebiotic carbon chemistry—in the 0–2-m depth range.

For the ExoMars Rover to achieve results regarding the possible existence of signs of life, the mission has to land in a scientifically appropriate setting:

1. The site must be **ancient** (older than 3.6 Ga)—from Mars' early, habitable period: Pre- to late-Noachian (Phyllosian), possibly extending into the Hesperian;
2. The site must show abundant morphological and mineralogical evidence for long-duration, or frequently reoccurring, **aqueous activity**;
3. The site must include numerous **sedimentary rock outcrops**;
4. The outcrops must be **distributed** over the landing ellipse to ensure that the rover can get to some of them (the expected rover traverse range is a few km—during the mission's 218-sol nominal duration);
5. The site must have **little dust** coverage.

Regarding the search for molecular biosignatures, the LSSWG would consider favourably sites providing easy access to locations with reduced radiation accumulation in the subsurface. The presence of fine-grained sediments (on Earth, organic molecules are better preserved in fine-grained sediments than in coarse materials) in units of recent exposure age would be very desirable. Young craters can provide the means to access deeper sediments, and studies on Earth suggest that fossil biomarkers can survive moderate impact heating. Additionally, impact related hydrothermal fractures may have contributed to creating habitats for microbial life in the past. However, for landing safety reasons it is better not to have many craters in the ellipse, so sites exposed by high erosion rates would appear preferable.

Landing Site's Engineering Constraints:

The entry, descent, and landing method is similar to that of the 2016 ExoMars EDM and Phoenix missions: ballistic entry with heat shield and parachute deceleration, followed by a powered descent terminal phase to achieve a soft touchdown. The constraints reported hereafter may evolve during the ExoMars 2018 project lifecycle. Proposers should nevertheless indicate and justify if their site violates any of these requirements.

Latitude: 5° S to 25° N.

Elevation: ≤ –2 km elevation with respect to the MOLA geoid.

Landing Ellipse: 104 km x 19 km.

Landing Ellipse Azimuth: 88° to 127° (clockwise from the North direction)

- For a 2018 launch, the landing ellipse azimuth can be between 90° and 102°.
- For a 2020 (backup) launch, the landing ellipse azimuth can vary from 113°–127° (at the beginning of the launch window) to 88°–103° (at the end of the launch window).
- Proposed sites must comply with both launch opportunities (i.e. 88° to 127°).

Terrain Relief and Slopes:
≤ 3.0° slopes for length scales 2–10 km.
≤ 8.6° at 330-m length scale.
≤ 12.5° at 7-m length scale.
≤ 15.0° slopes at 2-m length scale.

Rocks:
≤ 7 % rock abundance.

Surface Thermal Inertia:
Surfaces must have thermal inertias ≥ 150 J m^{-2} $s^{-0.5}$ K^{-1}.

Surface Albedo
0.1 ≤ albedo ≤ 0.26.

Radar Reflectivity:
–15 dB ≤ Ka-band backscatter cross section at nadir ≤ 27.5 dB.

Horizontal Wind:
≤ 25 m/s from 10 km to 1 m above ground level (during landing).
≤ 30 m/s at 1 m above ground level (during surface operations).

Landing Site's Planetary Protection Constraints:

The ExoMars 2018 mission is not compatible with landing in a Mars Special Region. A Mars Special Region is defined as any area providing an environment (even if for just a few hours a year) where both the following threshold levels are exceeded: temperature (> –25°C) and water activity (> 0.5). A proposed landing site must not contain features currently considered as Mars Special Regions: gullies, bright streaks associated with gullies, and pasted-on terrain. Any evidence of dark streaks or recurrent slope lineae (RSL) in a proposed landing site must be identified (please indicate if the resolution of the available data is insufficient to perform this task). The determination of whether any such features would constitute a Mars Special Region would be the subject of a case-by-case evaluation.

EXOMARS 2018 LANDING SITE: SITE NAME

X Y Name, *Affiliation, Address,* x.name@institution1.edu (main contact)
Y Z Name, *Affiliation, Address,* y.name@institution2.edu
Etc.

1 Abstract (up to half a page)

Please provide a summary of the key features of the proposed landing site.

2 Suitability of the Proposed Site to Address the ExoMars 2018 Scientific Objectives (up to 4 pages)

Please discuss how the proposed landing site can satisfy the ExoMars 2018 science objectives. Address (as far as possible) the expected geologic framework, chronology of the site (please provide estimates for the depositional age and surface exposure age of the various units), and describe the nature of the targeted materials. Any mineralogical, volatile, or geomorphic evidence important for the site's interpretation should also be included, with the appropriate references.

3 Landing Site Information (up to 1.5 pages)

A visual image or map showing the landing site is required. Fig. 1 shows an example of a Mars Express High Resolution Stereo Camera (HRSC) image. The basemap could be any easily obtainable image, such as MOLA shaded relief, THEMIS-IR (thermal), HRSC, CTX or other image base. Proposers are requested to indicate whether they have ArcGIS files available for the LSSWG to use in evaluating the site.

Ellipses spanning both launch opportunities must be shown on the map, with the ellipse pattern's size, centre latitude and longitude provided (in MOLA planetocentric coordinates). Areas of science interest for both launch opportunities must be designated on the image and justified in the text.

In the case where there are only a few locations containing mineral signatures of relevance within the landing ellipse pattern, as mapped from orbit, the proposers should provide other supporting information (e.g. geomorphological context, structural features, etc.) suggesting that the landing site (likely) includes other areas of interest within the rover's travelling range, wherever the landing may occur within the ellipse pattern.

For producing their image, proposers can assume a 90° ellipse for a 2018 launch, but must also consider and indicate the site's interest for a potential backup, 2020 launch. For the latter, depending on the launch date, the ellipse azimuth can vary between 88° (early launch) and 127° (late launch). As an approximation proposers can consider 120° as an average inclination for a 2020 launch date. As a minimum, example ellipses with azimuth 90° (2018) and 120° (2020) should be illustrated on the basemap of the proposed landing site to demonstrate its feasibility for both launch dates.

The location of any existing high-resolution image and spectroscopic data (e.g. MOC, HiRISE, CTX, CRISM, HRSC, OMEGA) in or near the ellipse should be indicated (as in Fig. 1). For additional images being requested, their location should also be shown in priority order, with due consideration given to typical image sizes.

In general, the surface of any proposed landing site must appear smooth and flat throughout the ellipse in available images and topographic maps. While it is not expected that proposers will undertake a detailed analysis of potential hazards in the ellipse, the Landing Site Selection Working Group (LSSWG) would like to be made aware of any potential hazards known to be present. Please cite which data sources have been used to estimate the landing site's rock abundance, thermal inertia, and albedo values.

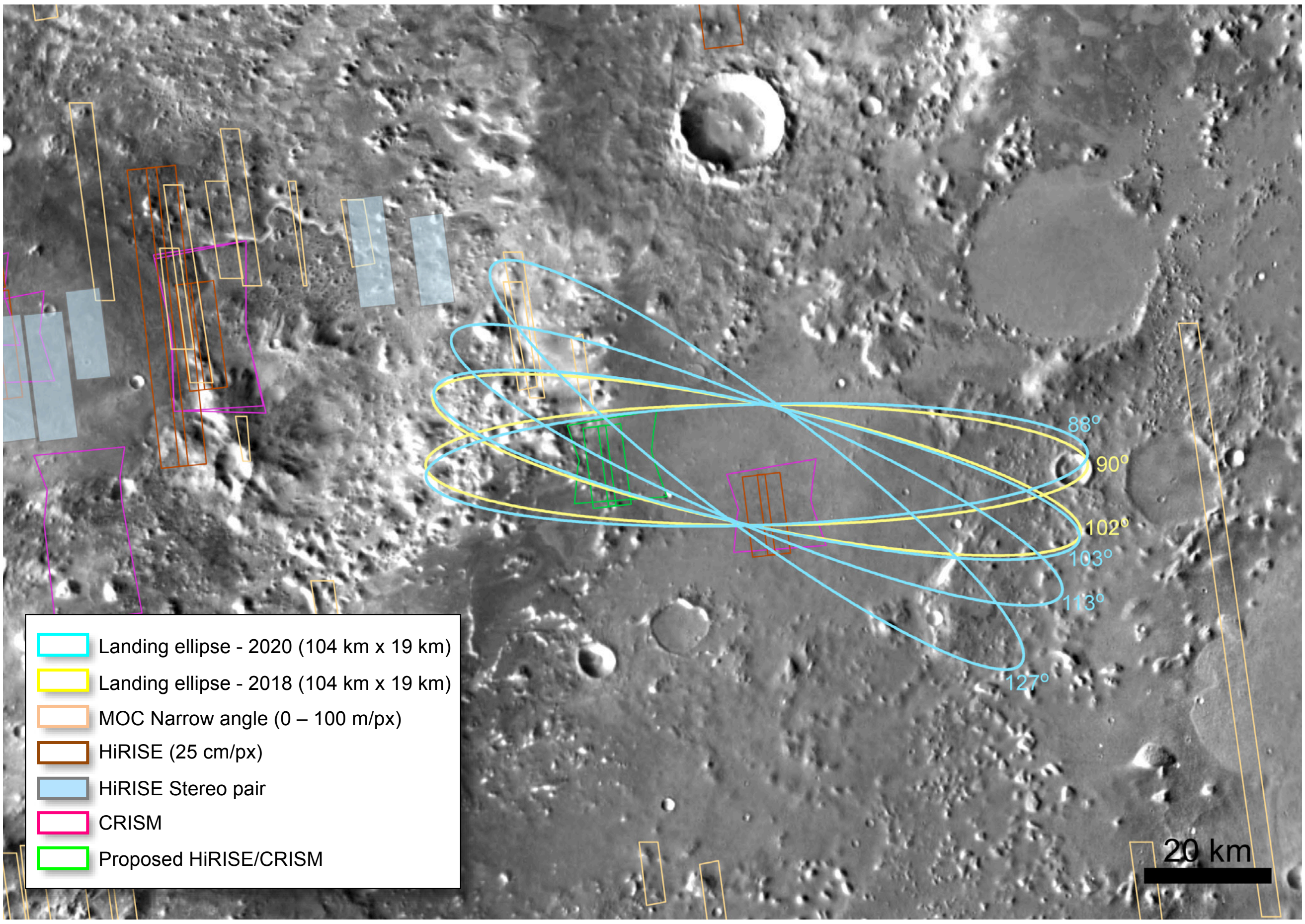

Fig. 1: Example of an ExoMars (104 km x 19 km) landing ellipse pattern. For a 2018 launch (in yellow), the orientation of the landing ellipse can vary between 90° and 102° azimuth (computed clockwise from the North direction). For a 2020 launch (in light-blue), the landing ellipse azimuth can span the 88°–127° range, depending on the launch date within the 2020 launch window opportunity. The ellipse pattern is centred at 18.36° N, 77.59° E, at an elevation of –2.66 km with respect to the MOLA geoid in planetocentric coordinates. The prime science targets are phyllosilicates (not shown). The footprints of existing HiRISE, CRISM (in purple), and MOC (orange) images are shown. In green are depicted a new, requested HiRISE image (rectangle) and a CRISM image (hourglass shape) centred at 18.365° N, 77.719° E. Please include a scale bar in the image[1].

Please note that since it is required that landing sites be complaint with both launch opportunities, the adequacy of candidate landing sites against the applicable constraints will be verified over the entire landing ellipse pattern. The call's *ExoMars 2018 Landing Site Selection User's Manual* includes additional information on scientific, engineering, and planetary protection constraints that landing sites must satisfy. Proposers are requested to take these into account.

1 Image adapted from NASA's "Template for Acquiring Images of Prospective Landing Sites for Proposed Future Mars Missions."

Proposers must also provide a table (Table 1) including the name of the site, the ellipse centre coordinates, the site's elevation, the characteristics of the prime science targets, the distance and priority of the prime science targets from the centre of the ellipse, and the distance and priority of any other science targets. Proposers should also indicate to what extent suitable science targets are distributed throughout the landing ellipse area.

Targets outside the predicted landing ellipse pattern would not be accessible to the rover.

Site Name	Ares
Ellipse pattern centre's latitude, longitude, and size	XX°N or XX°S, YY°E 104 km x 19 km (spanning 88° to 127° azimuth range)
Elevation (for centre, max, min)	XX.X km MOLA centre YY.Y km MOLA max ZZ.Z km MOLA min
Prime science targets	Smectites [Highest Priority], Layered materials, Channels [Lowest Priority]
Distance of prime science targets from ellipse centre	Smectites: 3 km to W Layers: 4 km to NW Channels: 2 km to E
Distance of other science targets from ellipse centre	Sulphates: 3 km to S Layers: 4 km to NW Channels: 1.5 km to NE
Overall distribution of science targets in ellipse	Everywhere; In X main areas; Very localised; etc.
Occurrences of dark streaks	No/Yes (coordinates/extension) or Resolution insufficient to determine
Occurrences of RSL	No/Yes (coordinates/extension) or Resolution insufficient to determine

Table 1: Summary table of site characteristics, required for any landing site proposed (please note that the landing ellipse area covers an 88° to 127° azimuth range).

Rationale for New Data:

Please explain in detail how any proposed new images, spectra, or other data (MEX, Odyssey, MRO, MAVEN) would improve the understanding of the geologic setting, history, and environment of the landing site. Imaging/data requests will be evaluated on the basis of how the new information would better define the science that could be accomplished at the landing site.

4 References

Please provide references in the following format (references do not count towards the six-page limit of the proposal):

[1] Murchie, S., et al., *J. Geophys. Res.*, 112, E05S03, 2007.
[2] Gorelick, N.S., et al., Abstract #2057, *34th Lunar and Planetary Science Conference,* 2003.
[3] MRO/CRISM Data Users' Workshop 2012, *43rd Lunar and Planetary Science Conference.*
[4] Pelkey, S. M., et al., *J. Geophys. Res.*, 112, E08S14, 2007.
[5] Miliken, R. E. and D. L. Bish, *Philosophical Magazine*, 90:17-18, 2293-2308, 2010.
[6] Bishop, J. L. et al., *Clay Minerals*, 48, 35-54, 2008