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## **PhoDEx — a low-cost mission to explore the Martian satellite system**

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For ESA's M4 Medium Mission Call, we proposed a low-cost mission to explore the Martian satellite system. PhoDEx (Phobos Deimos Explorer) will carry out investigations on the origin and evolution of the Martian satellites, as well as their interactions with the environments. The mission will shed light on the formation of the satellites by using a variety of complementary techniques to study interior structures, as well as chemical and mineralogical compositions.

We foresee that a Soyuz-Fregat launch vehicle will insert PhoDEx into a Mars transfer orbit in 2024. Upon arrival at the Martian system the spacecraft will begin with a Deimos phase consisting of two distinct Quasi-Satellite Orbit (QSO's) phases about the satellite. Afterwards PhoDEx will rendezvous with Phobos and enter two distinct QSO's again before deploying a small Lander on the surface. The foreseen landing area is the North Pole region of Phobos during the summer season in 2027, allowing lander operations in daylight for approximately 3 months.

For both Martian satellites, comprehensive characterization for morphology and gravity field, and studies of their spectral and thermal soil characteristics will be carried out. Crater statistics will be used to determine the ages of surface units and time scales of geological processes. Sensors onboard the orbiter will monitor the interaction of solar wind with the surfaces to help understand the evolution and weathering of the regolith. A powerful short-wave-radar will explore the deep regolith structures. Finally, using impact detectors, we will identify sources and sinks of the micrometeoroid population and address the question of Phobos/Deimos dust rings.

The landing package will be equipped with a powerful LIBS/Raman spectrometer to obtain precise data on the chemistry and mineralogy of Phobos soils at the landing site. A seismometer will capture seismic signals from impacts and thermal quakes. A radio science experiment will provide accurate measurements of Phobos orbital motion and rotational librations to determine the time scales of Phobos' orbital decay.

As M4 missions have a ceiling to mission's cost to ESA of 450 M€ we have discussed various cost saving options. Among other options, we plan to use a modernized design of Mars Express, built "fast-track" to catch the narrow launch window and design a custom-made small-sized lander of approximately 45 kg. By this the PhoDEx mission costs (including 30% margin) are estimated to be at ~530 M€ consisting of 425 M€ESA costs (launch, operations, s/c, lander) and 105 M€payload costs. PhoDEx will give us a new picture of the Martian satellites and also improve our understanding of other planetary systems.