EPSC Abstracts,
Vol. 4, EPSC2009-757, 2009
European Planetary Science Congress,

Enabling ambitious interplanetary missions thanks to precision landing and autonomous hazard avoidance

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Abstract

ESA's Moon-NEXT Lunar Lander mission represents the opportunity for Europe to develop precision landing with autonomous hazard avoidance. This generic capacity is critical both to enable missions on airless bodies and to increase the payload mass delivered on bodies with an atmosphere, as demonstrated by the successful landing of Phoenix on Mars.

Thales Alenia Space and NGC assess in this paper where the technology to be acquired by this lunar mission might be used in the Solar System. Most planetary targets, with diameters above 500 km, are airless bodies. But they still have a significant gravity that makes landing technologies distinct from the ones used for asteroids. The surface gravity of the potential target bodies determines the applicability of the technology at first order. The gravity is made vary from its lunar value (1.6 m/s^2) up to the one of Mars and Mercury (3.7 m/s^2) and down to the one of Ceres (0.27 m/s^2) or Enceladus (0.11 m/s^2). The consequences on the sizing of the mission, and on the braking, descent and landing (BDL) are discussed.

But other criteria such as illumination, terrain topology or soil properties, spin velocity… must be taken into account. These latter are highly variable. Smooth plains can be found on most bodies, as well as highly chaotic terrain. Rocky soils present variation in grain size, from boulders on Mars to the very fine regolith at Ceres equator. Icy soils also display grain variability, with fields of ice boulders, or ice plates and chasms on Europa or potentially snowy fields close to Enceladus South Pole.

In some cases such properties will be mixed, with big unknowns on the presence of ice in the potential ever-shadowed polar terrains of Mercury or Ceres, or on the extreme small-scale heterogeneities of the terrain of Callisto. The spin can vary from a nine hour rotation period in the case of Ceres to a near zero value in the case of Mercury. All this influences the capacity to reuse Lunar Lander techniques and architecture.

Then we conclude by discussing the application field and the multi-mission return on investment for the on going developments, which enable multiple valuable Lander missions.