Paper ID: 48249
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IAF SPACE EXPLORATION SYMPOSIUM (A3)
Moon Exploration – Part 2 (2B)

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A MODULAR ASCENDER CONCEPT FOR SAMPLE RETURN MISSIONS

Abstract

Historically, lunar landing missions have been focussing on the lunar near side. After the confirmation of water at the poles, most recent scenarios are focusing on polar regions. In particular the Aitken basin allows addressing both - high priority science goals as well as in-situ resource utilization demonstration needs. In this context, several missions including ESA's cooperation with Roscosmos on robotic lunar polar sample return (LPSR) and with JAXA and CSA on a human assisted (lunar) sample return (HERACLES) are aiming at returning samples either robotically to an earth return vehicle in low lunar orbit or to a mantended habitation module. In parallel, significant steps towards the first successful robotic mars sample return (MSR) have been undertaken by ESA and NASA. While some elements of the MSR architecture (e.g. the transfer module, the entry capsule or the sky crane) do have flight heritage, some other elements (e.g. the MSR lander, the sample fetch rover, the ascent vehicle, and the earth return vehicle) require substantial development. A common development approach for moon and mars would avoid unnecessary and expensive competition between both programs and could ultimately reduce cost and risk if a viable technical solution exists. While the high level objective – to lift a payload from the surface into orbit – is identical for all scenarios, significant differences exist regarding the environmental conditions. It is obvious that in particular the different gravitational environment and the absence of atmospheric pressure on the moon lead usually to different concepts. However, while atmospheric drag does play effectively no role on the moon, an aerodynamic shape optimized for martian atmosphere does not necessarily lead to drawbacks on a lunar ascender. Further, gravitational differences can be compensated by strap on boosters or kick-stages, utilizing the mass saving effects of staging for a martian ascent vehicle whilst allow using a single stage to orbit lunar ascent vehicle as upper stage. In the frame of the German national GAMMa study, a modular ascender family has been derived. The concept is complying with all considered reference mission scenarios. Comparative analyses show only minor mass growth with respect to a single mission design concept, making the concept a viable option for several sample return missions. GAMMa (Gemeinsamkeiten von Aufstiegsstufen für Mond und Mars) has been supported by Federal Ministry for Economic Affairs and Energy on the basis of a decision by the German Bundestag (50JR1706).