Paper ID: 44394
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IAF SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Interactive Presentations - IAF SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (IP)

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LOW-COST PROTOTYPE DEVELOPMENT OF A LUNAR MASSDRIVER

Abstract

In this paper the results of an ongoing low-cost prototyping efforts for a suitable lunar massdriver concept are presented. A massdriver is an electromagnetic acceleration device to propel a payload to launch velocity. Such lunar application is of manifold interest. As the Moon is lacking any significant atmosphere velocities relevant for spaceflight can be achieved without having issues with aerothermodynamics. The relatively low mass of the Moon requires launch velocities for escaping the Moon system that can already be achieved with current Lorentz rail accelerator type massdrivers. The Moon is furthermore rich in minerals and elements relevant for spaceflight such as silicon, aluminium, titanium, oxygen and potentially water. Making these elements available in Earth and cislunar orbit on a large scale will significantly enhance the future opportunities of spaceflight. A facility of this type will be of large scale, when moderate accelerations on the payload are permitted and significant masses are to be transported from the lunar surface into space. Hence, construction from lunar resources is advised. A scalable lunar massdriver concept has already been developed and now initial development for a small-scale model with functional hardware is presented. As aluminium is the electrical conductor of choice for lunar application rails and armatures of the massdriver are manufactured from it. As a direct current power supply COTS super capacitors with a capacity of 500 F each are utilized to be able to generated currents on the order of several hundreds amperes for a short amount of time. Conventional secondary batteries are utilized to charge the capacitors over time. A Raspberry Pi 3 Model B microcomputer is used as a control unit, handle power transfer and set the state of the massdriver prototype. The objectives of the prototype are to demonstrate that building a massdriver from commercially available components and the scaling concept of stacking multiple Lorentz rail accelerator modules to form a single accelerator are both feasible. Performance parameters of the massdriver like launch velocity and energy efficiency are analysed in different stacking modes (i.e. electrical switching) and operating conditions. The data are used to validate and refine models for future planned lunar massdriver designs. The prototype hardware will be investigated after each launch for damages caused by local overheating caused by strong operational currents. The stacking concepts allows for the reduction of these currents and a significant reduction of degradation is expected.