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Ground testing of a critical mechanism for object injection into geodesic orbit

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Mechanisms often constitute critical spacecraft subsystems, since they are subjected to environmental conditions which may affect their functionality and performance. Among the possible criticalities, tribological issues constitute a relevant source of mechanism malfunction, with relevant impact on the mission. Typical conditions which can enhance tribological phenomena (friction, wear, adhesion) are related to launch vibration, extreme temperatures, fretting and vacuum environment. In the framework of the development of the ESA (European Space Agency) LISA Pathfinder (LPF) mission, the need arose to understand if an extended object can be injected into a perfect free-fall state (geodesic orbit) by a mechanism with a minimal residual velocity with respect to the satellite. Most of the uncertainty in the expected velocity at the release is related to the behavior of adhesion forces between the metallic surfaces of the object to be released and its holding/releasing devices. In particular, the impulse developed by adhesion forces under the abrupt rupture of adhesive bonds, produced by quick separation of the holding devices, needs to be characterized and tested. In the ground testing activities of the Grabbing Positioning and Release Mechanism (GPRM) a facility was developed to test the behavior of adhesive bonds between metallic surfaces under quick separation. The transferred momentum measurement facility was designed and developed to characterize the impulse produced by the GPRM in releasing a suspended mock-up of the flight proof mass. The results of the ground testing activities are presented and discussed here.



Figure 1: Picture of the transferred momentum measurement facility

Recent Publications

1. D. Bortoluzzi et al., 2017 “On-ground testing of the role of adhesion in the LISA-Pathfinder test mass injection phase”, *Advances in Space Research* Volume 59 (issue 10) pages 2572-2582.
2. C. Zanoni et al., 2015 “Summary of the results of the LISA-Pathfinder Test Mass release”, *Journal of Physics: Conference series*, Volume 610 (issue 1) article no. 012022.
3. C. Zanoni, D. Bortoluzzi, 2015 “Experimental-analytical qualification of a piezoelectric mechanism for a critical space application”, *IEEE/ASME Transactions on Mechatronics*, Volume 20 (issue 1) pages 427-437.
4. D. Bortoluzzi, C. Zanoni, S. Vitale 2015 “Improvements in the measurement of metallic adhesion dynamics”, *Mechanical Systems and Signal Processing* Volume 52-53 (issue 1) pages 600-613.

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Biography

Daniele Bortoluzzi graduated in Mechanical Engineering at the University of Padova (Italy) in 1998. He earned the Ph.D. in Mechanics of machines in 2002 at the University of Brescia (Italy). He joined the Department of Physics of the University of Trento (Italy) in 2002 with a Post-doc grant on the development of drag-free technologies for space missions. Currently he has a position as Associate Professor of Mechanics of Machines in the Department of Industrial Engineering of the University of Trento. He collaborates with the European Space Agency and several industrial partners in the design of payloads for scientific missions, with particular emphasis on mechanisms. He is responsible for the qualification of the release mechanism for the LISA Pathfinder mission, where tribological, dynamics and control issues are involved. His research interest lies in mechanisms for space applications.

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