

Challenges of the development of a compliant Focus Mechanism submitted to the harsh Martian environment for the ExoMars Rover mission.

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In the frame of the development of the CLUPI instrument for the ExoMars rover, CSEM developed a frictionless compliant focus mechanism. An EQM and a FM model were delivered to Thales Alenia Space Switzerland who is the instrument industrial prime. An additional model will soon be provided for the on-ground science related activities performed by the Space Exploration Institute which assumes the PI activities.

The CLUPI Focus Mechanism (CFM) design utilizes flexure guides to allow the frictionless adjustment of the focal distance of the imager and takes into account the high mechanical launch loads and the harsh Mars environment. The main challenges are the low mass requirement, the development of a new launch lock device and the use of off-the-shelf components such as the positioning sensor (LVDT) and the actuator (Voice Coil).

During this development various challenges were tackled, issues were met and resolved. The design was improved to meet the mission's needs within the constrained budget and schedule. Among these challenges the following aspects are discussed:

- The compliant structure design was improved to survive important vibration and shock loads. Despite the very efficient launch lock mechanism, resilience to vibration and shock loads remained a very challenging aspect of the development. As a matter of fact the intermediate stages of the compliant structure are only carried by flexible blades. Thus the compliant structure internal modes needed to be adjusted to remove any damaging effects. Additionally the flexible blades buckling limit needed to be improved to survive the high loads observed inside the mechanism under shock.
- Despite careful inspections, experience acquired on breadboard models and an assembly procedure tested successfully on the EQM, a number of unexpected issues were encountered during the FM assembly. These led to additional costs for CSEM and delays which further constrained the already tight schedule for the qualification test campaign.
- In spite of the use of flight proven technology and early testing on the Pin Puller and launch locking system, the first firing test of the launch lock in the qualification campaign failed. The resulting investigation reviewed many root causes and found a solution improving the unlocking performance.

In fine, all the issues encountered challenged us to find new solutions and to learn from this experience. The solutions presented describes how we mitigated and resolved arising issues in the constrained schedule of the ExoMars mission. However, many lessons were learnt and some more elegant solutions would be implemented in an eventual new development of a similar mechanism.

