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The Mode Selector Mechanism (MSM): a bi-stable cryo-actuator operated at 4.2K

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A cryogenic environment implies a lot of constraints and uncertainties when it comes to the use of mechanical parts since the material properties are thermally dependent. This is even more true when the mechanical part ensures the motion of a mechanism. In that context, the Centre Spatial de Liège (CSL) has developed a specific mechanism with 3D printed parts. The Mode Selector Mechanism (MSM) is a bi-stable cryo-actuator operated at 4.2 K developed by Centre Spatial de Liège. The MSM development started as part of the far-infrared spectrometer SAFARI on the ESA/JAXA SPICA space telescope. It is taking place now in the preparation and anticipation of next generation cryogenic missions.
The MSM is characterized by its ability to switch between two stable positions an optical part, such as a mirror, at ambient as well as at cryogenic temperature (4.2 K). The particularity of this bi-stable actuator is a passive locking at both positions, to prevent electromagnetic interference sources. The actuator is also optimized regarding the energy dissipated during actuation. For that reason, specific elements such as magnets, copper coils, and flexible pivots, designed and 3D printed by CSEM, are included in the actuator.
In this talk, we present first the setup and results for the characterization of the main components at cryogenic temperature. We highlight the challenges and solutions implemented during the development of dedicated test benches for magnetic field, electrical resistance, and mechanical torque measurements adapted to cryogenic temperature. For instance, conduction was minimized between ambient and cold areas, and molecular conduction from Helium at low pressure was added during transients to improve test dynamics. We conclude with the characterization of the MSM mechanism at 4.2 K, including the time of commutation between both positions and the power consumption.

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