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Lessons Learned in Space Systems: Achievements, Challenges, Best Practices, Standards. (5)

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FELDS EXPERIMENT: LESSONS LEARNED FROM A NEW TETHERED SYSTEM FOR SPACECRAFT DOCKING

Abstract

Flexible Electromagnetic Leash Docking system (FELDs) is an educational experiment, whose main objective is to test an electromagnetic soft docking technology that guarantees a mechanical connection between two spacecraft through the use of a flexible cable. Soft docking is performed launching a ferromagnetic probe towards the target vehicle, which attracts it with a static magnetic field.

The FELDs experiment consists of a prototype of the proposed docking system, which comprises two main subsystems, the launcher (GUN) and the receiving interface (SEC).

The experiment was tested in microgravity at the ZARM Drop Tower in Bremen in the framework of ESA Educational Drop your thesis! Programme. Five drops were performed, with different system parameters to measure the probe dynamics evaluating the effects of magnetic field and tether friction on the GUN, to verify the effectiveness of the proposed docking solution. For the first three drops the docking attempts were successful. In the last two drops the probe did not reach the target due to snags in the tether release system.

This paper describes the design and building process of the experiment as an important learning experience; the progression from the first preliminary design to the complete experiment was long and full of challenges, but most of them were met with a systematic approach and overcome.

The attention to all details, even the most minute, and the ability to think in terms of all possible negative outcomes are part of the standard toolbox of an engineer, but actual experience with complicated systems that can fail in unexpected ways is the best way to develop and grow these skills.

Despite all the problems, the success of the experiment turned out to be the most educational part: the good results obtained had to be analysed carefully, distinguishing the relevant data from the measurement noise and spotting the trends and their physical causes. Thanks to the theoretical work in the design phase, few factors were fundamental to fit the model of the system to the empirical data; the knowledge of the system acquired, both analytical and intuitive, will be very helpful in the design of future developments.

The experimental results also proved very encouraging: the three successful drops demonstrated the technology capability, and the data agreed with the theoretical model. This experiment was the first test of the FELDs technology, and its success is the first step towards a full space-viable implementation of the system.