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Author: Ms. Pauline Faure
LaSEINE, Kyushu Institute of Technology, Japan

Mr. Atomu Tanaka
Kyushu Institue of Technology, Japan
Prof. Mengu Cho
Kyushu Institute of Technology, Japan
Ms. HORYU-IV Team
Japan

# TOWARD THE IMPROVEMENT OF LEAN SATELLITES RELIABILITY THROUGH TESTING – THE HORYU-IV (AEGIS) NANO-SATELLITE CASE STUDY

**Abstract**

What comes to your mind when small satellites are mentioned? For a part of the space community, they represent the possibility of building a satellite despite lack of resources; and hope, through successful achievement, to be recognized as a positive contributor to space science, technology, and engineering. For another part, small satellites represent the black sheep of satellites engineering in the sense that they have the highest rate of infant mortality and mission failure, and a non-functional satellite is another space debris. High rate of infant mortality and mission failure of small satellites tend to point out that ground based testing is not carried out optimally or sufficiently. Moreover, small satellites, especially micro- to pico-satellite are relatively new comers on the space scene and documentation on their development philosophy, testing strategy, and on-orbit operations is scarce. Currently, work to define an adapted testing strategy for small satellites is undergoing through the ISO on "Design Qualification and Acceptance Tests of Small Spacecraft and Units" (ISO/CD 19683). Based on this framework, HORYU-IV testing strategy was established. Experimental data show that most failures are discovered during the early stage of testing. Moreover, experimental data show the importance of interfaces verifications. Overall, a failure was detected on average every 20h of testing. HORYU-IV failures taxonomy is also presented. In addition to testing data, simulations were carried out. The plots of the number of detected defects versus time are in good correlation with the testing data. Moreover, impact of failure criticality on overall project schedule and cost was evaluated. Simulations results show that drastically increasing the initial testing time does not drastically increase reliability, but does drastically increase cost by more than 80%. Through this paper and the presented results, the authors intend to serve as a reference and help each lean satellite program developer deciding how much time should be invested in the testing phase based on a trade-off between the desired reliability after launch for a given time and reasonable project development time and cost.