# Mission Testing for Improved Reliability of CubeSats

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## CubeSats

- Satellites measuring in units (U) of 10×10×10 $cm^3$.
- To date >1000 CubeSats have been launched.
  ↳ ~30% of which were university-class missions.

- *Pro:* Small-scale design reduces typical barriers to space, increasing accessibility and enabling a wide range of sciences.
- *Con:* shorter development times, less resource investment and lower requirements on experience and expertise lead to high levels of risk and low levels of reliability (i.e. likelihood of mission success).
  ↳ *The failure rate of CubeSats is high.*

| *Research Topic* | *CubeSat Mission* | *Mission Details* |
|---|---|---|
| *Solar Physics* | MinXSS CubeSat | *3U, Student-led (University of Colorado), Deployed into Low Earth Orbit (LEO) on 05/2016, Operational until 05/2017* |
| *Earth Science* | HARP | *3U, Student-led (University of Maryland), Deployed into LEO on 02/2020, Operations on-going* |
| *Interplanetary Science* | MARCO | *Two 6U CubeSats (MarCO-A and B), NASA, Launched on 05/2018, Mars flyby on 11/2018, Operational until 12/2018 (A) and 01/2019 (B)* |
| *High Energy & Multi-messenger Astrophysics* | HERMES | *3U CubeSat constellation, Future mission concept, Scientific pathfinder (HERMES-SP) currently under development as part of the EU's Horizon 2020 Research and Innovation programme* |

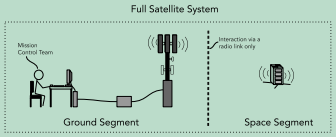
## EIRSAT-1: Ireland's 1st Satellite

- The Educational Irish Research Satellite is a 2U CubeSat being developed by a student-led team at UCD as part of the 2nd edition of ESA's Fly Your Satellite! programme.
- Aims: *education*, *technology demonstration* and *science*.
  ↳ The Gamma-ray Module (*GMOD*) is a miniaturised, scintillator-based γ-ray detector that will be used to detect Gamma-Ray Bursts (GRBs).

  GMOD will act as a technology pathfinder for future scientific missions and show the capabilities of CubeSats, as well as constellations of CubeSats, for conducting GRB research.

- *Challenge:* given the high failure rate of CubeSats, how do we improve the reliability of EIRSAT-1?

***Mission Testing***, where the performance of the *full-system* is tested and evaluated during scenarios that are expected to occur over the mission's lifetime and which are simulated with in-flight representative conditions.




- Do CubeSat teams view Mission Testing as a key step to reduce risk and improve reliability?
  ↳ *To answer this, a survey was developed.*

## Do CubeSat teams Perform Mission Tests?

- Most respondents to the survey indicated that Mission Testing was performed for their CubeSat project.
  ↳ *However,* further details provided show that the scope of testing performed varies widely across teams, e.g:

| *Participant ID* | *Number of Mission Tests Performed* | *Duration of Each Test* |
|---|---|---|
| *1* | *2* | *1-2 weeks* |
| *2* | *5* | *12 hours* |
| *3* | *1* | *Couple of hours* |

- Early loss of the mission where only ~hours of Mission Testing were performed demonstrates the potential impacts of poor quality testing on mission reliability.

*Concluding points:*

- This work highlights that, for improved mission reliability:
  ↳ *Mission Testing should be considered an essential part of a CubeSat development project.*
  ↳ *There is a need for clearer guidance and standards on the quality of Mission Tests that should be performed by CubeSat teams.*
- More information as well as details on the Mission Test plans developed for EIRSAT-1 are available in the accompanying conference paper.

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