CanSat 21/22 Luxembourg Competition – Teams Manual

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LE GOUVERNEMENT
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Ministère de l'Éducation nationale,
de l'Enfance et de la Jeunesse

esa

LSA LUXEMBOURG SPACE AGENCY

LUXEMBOURG SCIENCE CENTER

SCRIPT

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1. Introduction

Welcome to the 2021-2022 Luxembourg CanSat Competition!

1.1 What is CanSat?

CanSat is an initiative of the European Space Agency that challenges students from all over Europe to build and launch a mini satellite the size of a soda can.

The challenge for the students is to fit all the major subsystems found in a satellite, such as power, sensors and a communication system, into the volume and shape of soft drinks can. The CanSat is then launched by a rocket up to an altitude of approximately one kilometer, or dropped from a platform, drone or captive balloon. Then its mission begins. This involves carrying out a scientific experiment and/or a technology demonstration, achieving a safe landing, and analyzing the data collected.

The winning team will be allowed to participate to the European CanSat competition to represent Luxembourg!

A CanSat example

1.2 Educational and pedagogical values

The CanSat competition gives students the opportunity to experience the different stages of a space project: mission selection, satellite design, component integration, systems testing, launch preparation and scientific data analysis.

Throughout this process, students will learn on their own, become familiar with the specific approach to scientific and technical work in a practical way, will reinforce notions of mathematics, physics and engineering, will discover the importance of teamwork and coordination, and will also develop communication skills.

1.3 Adaptation to COVID-19

The teacher trainings and the support sessions could be done either in person or online depending on the recommendations of the Ministry of Health.

2. The CanSat Competition 2021/22

The task of the participating teams is to develop and build a mini-satellite the size of a beverage can. This includes, among other things, the selection of the components needed to accomplish a given mission, the development of the electronic circuitry, the soldering of the individual components and the programming of microprocessors.

The completed CanSats will be launched on a solid-propellant rocket and will reach the ground on a recovery system while fulfilling the mission described in section 2.2.

In addition, the teams will be required to prepare project and financial planning. Through creative public relation work, the participants are also expected to present their project to an audience as broad as possible.

A time schedule, a design report and a final report must be submitted on fixed dates. In addition, they have to write an instruction manual for the CanSat and present their results in a presentation to the jury at the end of the project.

2.1 Conditions of participation

The following conditions must be met in order for a team's registration to be accepted:

- Teams must be made up of 4 to 6 students, aged between 14 and 20 years old.
- Teams must be made up of students attending a secondary school in Luxembourg on a full-time basis.
- Each team must be supervised by an adult in the role of mentor.
- The registration form must be submitted by November 5th 2021 at the latest.

Team members do not necessarily have to attend the same school.
The mentor must be able to accompany the pupils throughout the competition, participate in the introductory workshop as well as the launch campaign.

2.2 Primary and secondary missions

Teams can choose to perform the primary mission only, or both primary and secondary missions.

2.2.1 Primary mission

The team must build a CanSat and program it to accomplish the following mission:

After launch and during descent, the CanSat shall measure the following parameters and transmit the data once per second to the ground station:

- Air temperature
- Air pressure

It should be possible for the team to analyze the data obtained (e.g., to do an altitude calculation) and visualize

them in graphs (for example, altitude vs. time and temperature vs. altitude).
These analyses can be performed after the flight.

2.2.2 Secondary mission

The secondary mission for CanSat is in fact an open mission which must be defined by the team itself.

This secondary mission could be based on: other satellite missions, a need for specific scientific data for a specific project, a technological demonstration for a component that has been designed by a student or any other mission that corresponds to the CanSat capabilities.

Some examples of missions are listed below but teams are free to design the secondary mission of their choice, as long as it demonstrates a certain degree of scientific, technological or innovative value.

Teams will also need to be aware of the limitations of the CanSat mission and will need to focus on the feasibility of the chosen mission.

Some examples of secondary missions:

- *Advanced telemetry:* during launch and descent, the CanSat measures and transmits additional telemetry to that required in the primary mission.
  For example: acceleration, GPS location, radiation level...
- *The remote control:* during the descent, commands are sent from the ground to the CanSat to perform an action such as changing the frequency of measurements, connecting or disconnecting a sensor...
- *The planetary probe*: the CanSat simulates an exploration flight to a new planet, taking measurements on the ground after landing. Teams should define their exploration mission and identify the parameters needed to accomplish it (e.g. pressure, temperature, field samples, humidity, etc.).

2.3 Time schedule and documentation

2021-2022: Timeline	
Phase 1: Call for projects and team selection	
End of registrations	November 12th
Announcement of selected teams	November 15th
Phase 2: Introductory meetings	
Teachers workshop	October 21th and 28th
Kick-off meeting for students on Microsoft Teams	November 16th 17:00 -> 18:00
Phase 3: CanSat construction and testing	
1st design report submission	January 28th
Software testing sessions with university	February 15th until March 31st
Jury feedback on the 1st design report	February 23rd
Optional technical support session	March 4th
2nd design report submission and jury feedback on Microsoft Teams	March 24th and 25th
Drones drop to test & structure YAGI antenna testing	March 26th
Mandatory technical support session Final teams' selection	April 7st
Phase 4: Competition	
Execution of the launches	April 23rd
Final reports presentation & awards ceremony	May 7th
Phase 5: European Competition for Luxembourg winner	
See full timeline on CanSat European website	June-July 2022

2.3.1 Mentors workshop and teams kick-off meeting

Two meeting will be organized:

1- During the mentors workshop, teams mentors will receive a CanSat kit, containing all the components needed to build the basic mini satellite and a complete set of training resources on various topics such as: sensors and signal analysis, signal management, and data and data transmission, software installation and programming, etc.

The objective of this workshop is to ensure that all teams have the necessary equipment and expertise to implement their CanSat project.

2- A virtual kick-off meeting will also be organized for the participants. Here, the students will be able to get to know each other and exchange information, and their questions will be answered.

2.3.2 Planning

The first task of the teams is to develop a planning for their project.

In doing so, the participants should think through in as much detail as possible which steps and tasks are necessary to build their satellite and how much time they require.

The planning must be described in section 4.2 of the report.

2.3.3 Design reports

Two design reports will have to be submitted by email to contact@esero.lu by the dates specified in the timeline in section 2.3. CanSat Luxembourg provides the teams with design template for the reports on the CanSat website. In these reports the teams will present their design ideas. The jury will evaluate the teams' work and makes suggestions for improvement.

2.3.4 Primary mission integration testing

The Luxembourg University CubeSat Lab has assembled a testing platform for your CanSat!

When your CanSat is able to run the primary mission sensor software, you have the opportunity to test it at the University.

The testing platform will:

- run your software
- automatically judge the execution success for the nominal run based on data:
    - a. obtained over-the-air
    - b. saved on the SD card
- simulate:
    - a. faulty code execution initiation
    - b. execution interruption, e.g. temporary power loss
    - c. faulty peripheral interaction (e.g. pressure and temperature sensor removal and reconnection)
- provide an automatically generated ASCII based report on the execution success

Two testing sessions are organized beginning of February and beginning of March

2.4 Design requirements

The following design requirements **must be met** when building the CanSat:

Number	Requirements
#	Explanation of the requirements
Mass/weight	
01	All CanSat components may not exceed the size of a standard can (115mm in length and 66mm in diameter). An exception can be made for radio and GPS antennas, which can be mounted outdoors. The payload area of the rocket usually has 4.5cm of additional space per CanSat available, in the axial direction of the CanSat (i.e. height), which must allow for the placement of external elements, including: parachute, equipment of fixing of the parachute and possible antennas.
02	The CanSat, including the parachute, must weight at least 300 grams. If it is lighter, it must be loaded with weights like sand or lead.
Material restrictions	
03	The use of projectiles, fireworks or other explosive materials, as well as easily flammable and hazardous materials are not permitted.
Power supply	
04	The CanSat must have an independent power supply (e.g. battery, accumulators, solar panels, etc.). The power supply must be easily accessible in case it has to be replaced/recharged. The battery capacity must be sized so that the CanSat can be operated for at least 4 hours continuously.
05	The satellite must have an easily accessible main switch.
Recovery system	
06	The CanSat must have a recovery system, such as a parachute. It must use coloured or bright material to facilitate the recovery of the CanSat after landing.
07	The parachute must be solidly attached to the CanSat to withstand high loads.
08	A descent rate around **10m/s** is highly recommended for recovery reasons. In any case, the CanSat's descent speed must not be lower than 5 m/s or higher than 12 m/s for safety reasons.

Number	Requirements
#	Explanation of the requirements
Statics and dynamics	
10	The CanSat must be able to withstand an acceleration of up to 20g.
Cost	
11	The total budget of the final CanSat model should not exceed 500€, including the cost of the CanSat kit provided during the mentors workshop. Ground stations and any related non-flying item will not be considered in the budget.
12	In the case of sponsorship, all sponsored items should be specified in the budget with the actual corresponding costs on the market.
Mission requirements	
13	The CanSat must at least measure temperature and air pressure, as described in the primary mission
14	The radio frequency must be easily modified to avoid radio communication interference with other teams. The assigned frequency must be respected by all teams during the launch campaign.
15	During the CanSat descent, the data must be transmitted both to the ground station and to the onboard SSD card
16	To avoid surprises with the battery being empty or any other malfunction, a green LED must indicate if the CanSat is up and running. The green LED must be visible outside the CanSat case.

2.4.1 Important notes

The team must check and document in advance whether the design requirements have been met.

All the above-mentioned requirements must be verified in the reports and will be checked by the jury upon acceptance.

2.5 The rocket launch

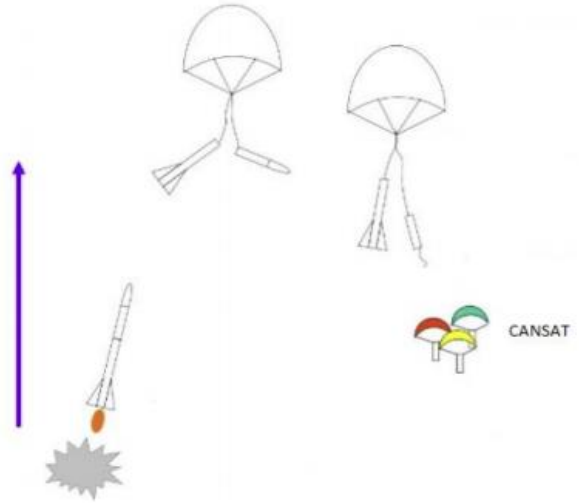
The climax of the competition will be the launch of the best CanSats.
This event will take place in April 2022.
The CanSats will be launched via a rocket at an altitude of approximately 1 kilometre.

At the apogee, the rocket will deploy their parachute and release the CanSats.

They will then begin their descent using a parachute to conduct their missions and land safely on the ground in order to be recovered by the CanSat teams.

During the flight, the rocket can reach a maximum acceleration of 8g in the vertical direction and a maximum speed of 1000 km/h.

At the end of the launch, each team will present the results obtained in front of the other teams and the jury.



3. Jury and evaluation criteria

3.1 Jury

The jury is composed of experts from the following participating scientific institutes, space companies and scientific institutions.

Eric Smit	Eric Smit has a Master's degree in Electrical engineering, with a specialization in aerospace systems. He was introduced with space systems during his bachelor's study, where he worked on the transmitter for the Delfi-C3 satellite.	T-Minus	
Ana Baltazar	Mechatronics engineer with a MSc. in Space Studies. Involved in the design and implementation of Electrical Power Subsystems, where she designs the components needed to operate prototypes and the later system that will integrate all of them.	MaanaElectric	
Jan Thoemel	Expert in very small satellites also known as CubeSats, he works at the University of Luxembourg where he researches how to improve small satellites and how to use them for scientific and business purposes	Uni Luxembourg	

3.2 Evaluation criteria

Teams will be evaluated on an ongoing basis, taking into consideration the following points:

- Scientific/educational value: 35%
- Technical performance: 35%
- Professional skills: 15%
- Awareness of the project: 15%

3.2.1 Scientific/educational value

The jury will take into consideration the quality of the progress reports, the scientific relevance, the team's efforts and the learning of the team through the project.

3.2.2 Technical performance

The jury will take into account the way in which the teams have obtained the results, the reliability and the solidity of the CanSat at the time of the launch, but also the innovative aspects (from the secondary mission, software used, methodology, etc.). The analysis of the results is essential.

In the event that a CanSat has not been able to accomplish its missions, but the team can explain the reasons for the failure and suggest improvements, the jury will be magnanimous.

3.2.3 Professional skills

The jury will assess the team spirit in the accomplishment of the mission, the distribution of tasks, the planning and execution of the project, but also the work done in order to find additional support and advice. On top of that, the quality of the presentation and the competence to communicate the results achieved will be taken into account.

3.2.4 Raising awareness of the project

The team will be evaluated for its communication of the project to the school and the general public (press, Facebook or Instagram page...).

4. Financing

4.1 Teachers workshop

All costs related to the teaches workshop in October will be covered by the organizers.

These costs include catering, training equipment and the provision of a CanSat kit for each team.

4.2 CanSat realization

In addition to the basic CanSat kit provided to mentors during the workshops, the organizers may grant, on the basis of supporting invoices, an amount necessary for the realization of the secondary mission for a maximum amount of 500 €.

4.3 Launch campaign

The organizers are responsible for the costs of the launch:

- Round trip to the launch site
- Accommodation
- Meals
- Transport on site
- All costs related to the launch of the rockets and flight-related activities

5. Contact

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6. Sponsors

CanSat Luxembourg is supported by