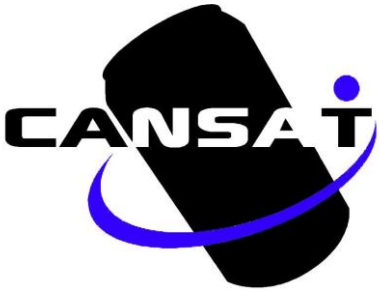
2nd International CanSat Competition LEEM-UPM

All You CAN Fly



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List of Acronyms

CDR	Critical Design Review
COIAE	Colegio Oficial de Ingenieros Aeronáuticos de España
COITAE	Colegio Oficial de Ingenieros Técnicos Aeronáuticos de España
CONOPS	Concept of Operations
INTA	Instituto Nacional de Técnica Aeroespacial
LCO	Launch Control Officer
LEEM	Laboratorio para Experimentación en Espacio y Microgravedad
MSDS	Material Safety Data Sheet
NAR	National Association of Rocketry
PDR	Preliminary Design Review
RSO	Range Security Officer
TRA	Tripoli Rocketry Association
UPM	Universidad Politécnica de Madrid

1. Introduction to CanSat

A CanSat consists in autonomous device that can perform certain missions, implemented inside of the volume of a refreshment can (with the size of a common can of 330ml). This system represents an exceptional learning platform for the students that are interested in the design, manufacture and satellite operations. The CanSat must incorporate all the satellite basic functions to be able to operate by an autonomous way: power supply, attitude control, communications, etc.

The participants (students or professionals), alone or with the help of a tutor, have to create a "satellite" in a structure with a refreshment size. This will be introduced in one of the LEEM rockets, and it will be released at 1.500 meters (except in the Planetary probe and Experimentation categories), beginning then its descent and operations stage. The CanSat operations stage starts when it is released from the rocket, however, the data collection can begin before.

2. CanSat categories

The 2010 Competition cover the following categories:

1. **ComeBack**
2. **Rocket Subsystem: Telemetry**
3. **Planetary Probe**
4. **Scientific Experimentation**

The jury will evaluate the actions of every CanSat at the launch field; although the points for originality and design of the device will be awarded on the basis of the documentation the teams will present in the Critical Design Review (CDR).

The success in the achievement of the objectives that every team has proposed (presented in the documentation) will be evaluated in the results presentation ceremony, the day after of the launch journey.

The jury will value the academic level of the members of every team, the external help received, the hours of work and the project budget, in order to deliver a verdict that values the personal effort of students and/or professionals.

2.1 ComeBack

The CanSat must navigate by an autonomous way until stopping as nearly as possible of a target located on the launch field. The main parameter of evaluation will be the final distance to the target; also other parameters will be value, for example, the originality and the design of the subsystems as well as the navigation algorithm.

The CanSats navigation in the Comeback category will have to be performed by an autonomous way. The teams are authorized to download telemetry from the device but it's strictly forbidden to send navigation signals from the ground station.

The target where CanSats will have to be bounded consists is a 3 meter diameter red coloured plastic skin. Teams will be allowed to approach to the target before integrating the CanSat in the rocket to take their own measurements of the coordinates of the target and to memorize them in the device. The Organization will not announce the coordinates of the target.

2.1.1 CanSat Navigation Methods

CanSats will be able to move by air and land. The recommended methods to be used are the following: Optical: the CanSat can be guided to the target by recognizing its color, red.

Satellite navigation: the CanSat can be guided to the target by a Global Navigation Satellite System (GNSS).To achieve that, GPS system and its' improves could be used, such as GBAS *(*Ground Based Augmentation System*) or SBAS (*Satellite Based Augmentation System*).*

It's necessary to consider several important points inside these GPS system improvements:

- GBAS. It's based in the application of the DGPS (Differential GPS concept). The reference GPS receiver can place inside the made up area for the competition (the airfield). The data link between DGPS and the GPS receiver installed onboard the CanSat can perform through a radiofrequency signal (see the frequency restrictions in the corresponding paragraph) like by Wi-Fi, in case that reference data are obtained by Internet. In this last case, the organization won't provide with Internet connection the team will have to provide itself.

- SBAS. EGNOS (European Geostationary Navigation Overlay Service) system can be used because it's the only SBAS system which's system area includes the whole Europe. Its utilization will be valued positively by the jury since it's a European system.

Note: The utilization of any type of equipment of electric beacon or active signposting that sends signs to the CanSat is forbidden.

2.2 Rocket subsystem category: Telemetry

In this edition we propose the communication and telemetry subsystems.

The CanSat must send certain minimum information about the flight conditions to a Ground Station (GS) in real time (see at the specific paragraph).

In this category, the precision with which the initial objectives declared in the CDR, and the originality of the design of the telemetry subsystem is achieved will be valued. This category also is used to make the selection of the team that will design the subsystem for the different series of rockets that will be developed by the division of exploration rockets of LEEM.

CanSats competing in this category will have to design taking into account the possibility to integrate them in future as a telemetry subsystem in a sounding rocket.

The minimum data that the CanSat must send in real time to its Ground Station are:

1. 4 bits Identifying code
2. Barometric altitude
3. External temperature
4. Acceleration (at least in the longitudinal axis of the CanSat)
5. GPS position
6. Three digital signals logic level (to be simulated by the CanSat)
7. Detection of two events:
    1. Launch of the rocket
    2. Parachute release

2.3 Planetary probe

The perfect category for the lovers of robotics. In this category, participants will have to create a robot that will have to accomplish some exploration mission in some scenery called *"Ayllón Planet"*.

2.3.1 Precedents

It's the year 3024. The destruction of the Earth Planet is imminent. There is the possibility to shelter the humanity at *Ayllón* planet. However, currently the scientific community doesn't know many things about this planet, the *Ayllón* Planet. Nevertheless immediately after the studies and observations made in previous missions, they believe that water and live (intelligent?) could be existing there. Science relies in your discoveries to save the humanity of its final destiny.

2.3.2 Rules of the Planetary Probe category

Only the robots with the same or less mass and dimensions than the ones of "OpenClasss" will be able to participate. The mass have to be less than 1050 grams and a maximum of 240mm length and 146mm diameter.

The robot will be released from 20 meters high over the planet. All the released robots will land in the planet *Ayllón* so that the participant team will just have to worry about the brake system, not the auto pilot one.

The team that obtain more points will be the winner, according with the following **score criteria**:

- CanSat: **20 points**
    - The robot must have the same or less mass and dimensions from a standard CanSat: 66mm of diameter x 115mm of length and a maximum mass of 350 grams.
- Exploration:
    - Find water: **20 points** for each water area founded.
        - The scenery may have one or more small areas with water. There is no risk for the robot to land over an area covered by water, but there is a risk that the robot enter that area itself after landing.
    - Find life: **20 points** per life kind founded
        - Every team will get 20 points per each different life kind that finds. The organisation won't give more details.
    - Find the *Ayllón-lander-III*: **10 points**
        - *Ayllón-lander-III* was lost some months ago in an *ayllonic* reconnaissance mission. Non space agency was able to find it since its loss. Mission engineers declare that there is a high possibility that the emergency radio beacon is still active (the frequency of this radio beacon will be announced in the Competition Website).
    - Soil samples: **5 points** per each collected sample that is later carried to the base.
        - The robot will be able to collect any kind of soil sample. For each sample placed in the base, the team will get five more points. There won't be a limited number of samples. The base is recognizable for its fluorescent rose colour and its periodical audio emission.
- Mission end: **30 points**
    - The mission time limit is 10 minutes. After this time, the robot must be in the *Alpha-Ayllonis* base, recognizable for its fluorescent rose colour and its periodical audio emission.

- Autonomous movement: **100 points**
    - The robot must move automatically in the *Ayllón* planet.
    - The team will have to carry out manual movements, but they will be sanctioned.
        - For each telematic movement the team carries out, 5 points will be subtracted (**-5 points**).
        - For each physical movement the team makes, 10 points will be subtracted (**-10 points**). Teams will only be able to make this operation i case the jury authorise it.

Final punctuation can be negative.

No team can previously see the scenery. Only one person per team can be observing directly the movements of its robot in case it needs physical help; however, this person will not be able to communicate with the rest of the team during the 10 minutes of the robot mission.

Robot can send live video or photography to the team tracking station, which could be located at a maximum range of 100 horizontal meters. Every team must carry out these communications. The organisation will check that the used frequencies' are inside the range of the allowed radio strips, that can be found in the competition rules and will be given the previous day if the competition.

Time starts when the robot is released in the planet atmosphere, which means 20 meters over the surface.

The organisation won't provide the teams with the details of the terrain conditions. However, they will be published in the website. Moreover, the organisation will answer questions about the terrain in the website forum.

2.4 Scientific Experimentation – CanSat

This category has been created with no restrictions, for those teams that want to test certain subsystems for the design of a future CanSat or to carry out any kind of scientific/ technological experiments.

The success of the CanSat mission, in its aims, will be valued. Also the originality, the design and the scientific relevance of the measurements will be valued.

To be able to launch, they will have to carry out at least the 80% of the declared design objectives in the CDR. The organisation will value the relevance of the scientific experiment or the originality of the technological system to be tested.

3. Types of CanSat

3.1 CanSat (Standard)

All the teams participating in the "Telemetry" and "Scientific Experimentation" will have to create a CanSat that verifies with the following specifications. The use of the standard size will be optional, but positively valuated, in the rest of the categories.

1. All the components must be integrated in a structure of the standard size of a European refreshment can (115mm height and 66mm diameter).

2. The mass of the complete CanSat, including the recovery system, can't exceed from 350 grams.

3. The recovery system anchorage must support 20G's in the moment of opening. It must be united directly to the main structure.

4. Nothing can stick out from the diameter of the refreshment can (antennas, sensors, etc) until the CanSat leaves the payload bay of the rocket.

5. The total length available in the payload bay is 230mm. The device can't exceed 115mm of height, leaving the other 115mm for the parachute folding, antennas or other folding devices.

6. The use of explosives, detonators, flammable or dangerous materials, pyrotechnic charges and biological payloads are strictly forbidden. All materials must be mild for the staff, equipments and environment. In case of doubt, the organisation will ask for MSDS.

7. The CanSat will have to detect autonomously the separation from the rocket. For this reason, the use of timers or photoelectric sensors for this aim, are strictly forbidden. The organisation recommends the use of mechanical devices, such as pressure sensors or "*Kill-switch*"

8. The energy supply of the CanSat must allow a waiting time of 30 minutes between the integration in the payload bay and its ejection from the rocket.

9. The total cost of the CanSat can't exceed from 500 Euros.

3.2 OpenClass

Also there is a Helium balloon available to release "OpenClass" size CanSats. In this edition these kinds of CaSats will just be able to compete in the "Planetary Probe" and "ComeBack" category. The requirements for the "OpenClass" CanSats will be the same as for the standard size ones, with the exception of:

1. Total maximum scale: 240mm length and 146mm diameter.

2. Maximum total mass: 1050 grams

The "OpenClass" CanSats will be released at an altitude of 100 meters over the terrain.

4. CanSats acceptance revision

It will be organised by shifts the first afternoon of the Competition. During the Briefing a time for revision will be assigned to every group. Then the following will be checked:

- The mass of the whole system as it will be integrated in the rocket (including parachute and folding devices)
- Size (diameter and length)
- Compatibility with the interface launcher, including the activation sequence after the rocket division.
- Verification of the used frequencies (a device to measure frequencies will be used).
- Functional test to ensure that, at least, the 80% of the objectives presented in the CDR are going to be carried out.
- Verificate that the CanSat will remain operative without interfering with the rocket operations.

No device will be launched in case it is not able to remain certain time in the launching ramp (up to 30 minutes in standby mode) and that won't be able to detect its own ejection from the rocket.