

2018

**EUROPEAN CANSAT COMPETITION
GUIDELINES**

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1 INTRODUCTION

The European Space Agency (ESA) endorses and supports a range of CanSat activities across its Member States. The CanSat project, aimed at secondary school students, mainly addresses technology, physics, and programming curricular subjects. CanSat provides students with the opportunity to have a practical experience working on a small-scale space project and promotes teamwork.

What is a CanSat?

A CanSat is a simulation of a real satellite, integrated within the volume and shape of a soft drink 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 this minimal volume. The CanSat is then launched by a rocket to an altitude of about one kilometre, or dropped from a platform, drone or captive balloon. Then its mission begins. This involves carrying out a scientific experiment, achieving a safe landing, and analysing the data collected.



Participants of the 2017 European CanSat Competition at ZARM in Bremen

Educational value of the CanSat project

Taking part in a CanSat project gives the participating student teams the opportunity to go through all the phases of a real space project, from selecting the mission objectives, designing the CanSat, integrating the components, testing the system, preparing for launch, and analysing the scientific data obtained. Through this process the students:

- learn by doing,
- get acquainted with the enquiry-based methodology typical of real-life scientific and technical professions,
- acquire and/or reinforce fundamental technology, physics, and programming curricular concepts,
- understand the importance of coordination and teamwork,
- enhance their communication skills.

2 COMPETITION OVERVIEW

The 2018 European CanSat Competition consists of five phases:

- Phase 1 – Launch of the European CanSat Competition
- Phase 2 – National competitions
- Phase 3 – Preparation of the European CanSat Competition launch campaign
- Phase 4 – European CanSat Competition launch campaign
- Phase 5 – Post-launch campaign activities

Phase 1 - Launch of the European CanSat Competition

The 2018 European CanSat Competition will be launched in autumn 2017 with an article on ESA's Education website at www.esa.int/education and www.esa.int/Education/CanSat. The location of the European CanSat competition finals will be known and announced at the beginning of 2018.

Only one team per ESA Member State will be admitted to the European competition.

Case 1. The winning team of the national CanSat competitions which are recognised by ESA (see 2.2.) will automatically be granted participation in the European competition. The national organisers will be invited to confirm they want to 'reserve' a slot for their winning team in the European CanSat Competition by emailing the dedicated registration template to ESA (cansat@esa.int) no later than 10 December 2017 at 22:00 Central European Time (CET), although earlier applications are encouraged.

The national organisers who have registered will be requested to send ESA the name of their national winning teams via email (cansat@esa.int) indicating "2018 European CanSat Competition National Winner" in the subject line, no later than May 6 2018, 22:00 Central European Time (CET). Exceptions to this deadline may be authorised by ESA for specific situations and only after receiving a justified request from the national organiser.

Case 2. For the countries where a national CanSat competition does not exist, student teams can apply/register and submit their CanSat proposal by filling and emailing the dedicated proposal form to ESA (cansat@esa.int) by 10 December 2017, 22:00 (CET).

Based on the quality of the submitted proposals, one team per country will be selected by an Evaluation Committee nominated by ESA. On 20 December 2017 ESA will let the selected teams know that they have been accepted to participate in the European competition.

Student team eligibility conditions

In order for a student team to be accepted in the European competition the following conditions should be fulfilled:

- 1) Each student **team** shall comprise a minimum of 4 (required¹) to a maximum of 6 students (aged 14 - 20) resident in an ESA Member State or Associate State², respecting one of the following conditions:
 - a) Team of students enrolled full-time in a **secondary** school.
 - b) Team of students in home schooling condition (certified by the National Ministry of Education or delegated authority).
 - c) Team of members of a social club enrolled full-time in a secondary school.
- 2) At least 50% of the students included in a team must be nationals of an ESA Member or Associate State.
- 3) University/higher education students cannot participate in this competition.
- 4) Each team needs to be supervised by a teacher or mentor (Team Leader) responsible for monitoring the team's technical progress, offering help and advice, and acting as the team's point of contact with ESA's Education Office. The Team Leader must be available to accompany the team to the competition launch campaign.
- 5) One teacher/mentor can be responsible for one team per year only. One teacher/mentor cannot present the same team more than once.
- 6) Student teams participation in the European CanSat Competition more than once is not allowed (no individual student can participate more than once).

¹ A minimum of **4** students per team is required in order to guarantee proper team interaction and collaboration processes.

² **ESA Member States in 2017:**

Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Portugal, Romania, Spain, Sweden, Switzerland, United Kingdom.

ESA Associate States in 2017: Canada, Slovenia.

Phase 2 – National competitions

In order for a national CanSat competition to be recognised by ESA (and, as a consequence, for the national winning team to be automatically accepted in the European competition):

- 1) Student teams must comply with the following eligibility criteria:
 - a) Each **team** shall comprise a minimum of 4 (required)³ students, aged 14 – 20 and resident in an ESA Member State or Associate State⁴, respecting one of the following three conditions:
 - i) Team of students enrolled full-time in a **secondary** school.
 - ii) Team of students in home schooling condition (certified by the National Ministry of Education or delegated authority).
 - iii) Team of members of a social club enrolled full-time in a secondary school.
 - b) At least 50% of the students included in a team must be nationals of the ESA Member or Associate State concerned.
 - c) University/higher education students cannot participate in this competition.
 - d) Each team needs to be supervised by a teacher or mentor (Team Leader) responsible for monitoring the team's technical progress, offering help and advice, and acting as the team's point of contact with ESA's Education Office. The Team Leader must be available to accompany the team to the European competition launch campaign.
 - e) One teacher/mentor cannot present the same student team more than once.
- 2) The national teams must perform all of the following tasks:
 - (a) Selection of mission objectives;
 - (b) Definition of technical requirements necessary to achieve the objectives;
 - (c) Design of CanSat hardware and software;
 - (d) Design of ground station/ground telecommunication system;
 - (e) Documented design reviews, leading to design refinement;
 - (f) Integration and testing of the CanSat;
 - (g) National launch campaign.
- 3) The national organisers have to guarantee a fair geographical distribution and participation from teams from across their country.
- 4) The national organisers are encouraged to run their national competitions between summer 2017 and the first week of May 2018.

³ A minimum of **4** students per team is required in order to guarantee proper team interaction and collaboration processes. Only up to 6 students per team will be allowed to participate in the European CanSat competition.

⁴ **ESA Member States in 2017:**

Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Portugal, Romania, Spain, Sweden, Switzerland, United Kingdom.

ESA Associate States in 2017: Canada, Slovenia.

- 5) The national organisers should have the intention of continuing the CanSat national activity in the future, and try to guarantee editions on a yearly basis.
- 6) It is the obligation of the National organiser to make sure that the winning team(or, in case of unavailability for exceptional reasons, second ranked team) are able to attend the European Competition. The organisers have to ensure as well that all the organisational and administrative aspects of the participation of the winning team in the European CanSat competition are properly sorted out in due time (such as: insurance coverage, etc).

Phase 3 - Preparation of the European CanSat Competition

Under the supervision of the team's teacher/mentor, all the teams participating in the European CanSat competition will have to carry out technical work on their CanSats applying the procedures used in the typical lifecycle of a real space project, which are:

- Selection of mission objectives;
- Definition of technical requirements necessary to achieve these objectives;
- Design of hardware and software;
- Submission of a **Pre-launch Report** of a maximum of 30 pages to ESA by 10 June 2018, 22:00 CET, summarising all the work done (progress report), providing a full description of the CanSat mission, system and functionalities, and indicating the steps, rationale and trouble-shooting which was needed to get to the CanSat refined design, as well as a detailed budget. This document should accurately record all the details of the completed CanSat prototype. This will be the main document provided to the **Jury** members during the launch campaign, who will then be tasked to evaluate the work and performance of each team as described in Chapter 4;
- Integration and testing of the CanSat before the launch campaign starts.

The Pre-Launch Report must be submitted to ESA at cansat@esa.int with the name of the team and of the document submitted written in the subject line (e.g. "*Team A Pre-launch report*"). The document attached should be in a pdf format, with the following file name format: *teamA_prelaunch report.pdf*.

Important note: In order to ensure that the national competition winners and the teams with no national competition selected directly by ESA have a fairly homogeneous level of preparation, the teams selected directly by ESA will have to submit an additional report prior to the Pre-Launch Report: the Critical Design Review report (CDR):

What is the Critical Design Review (CDR) report?

The CDR report is a technical document that ensures that the design can meet the stated performance requirements, taking into account all the system constraints. Compiling the CDR report allows student teams to evaluate the detailed design effort, determine readiness for hardware fabrication and for software coding, and establish the final configuration of the secondary mission.

The CanSat CDR report must contain:

- A demonstration that all the requirements stated in the guidelines for the European CanSat Competition have been fulfilled
- The design specifications needed to fulfil the secondary mission (see 3.2)
- Results of the requirements verification tests completed
- Overview of mission operations
- Detailed budget

Outline of project schedule

The CDR report must be submitted to ESA via email (cansat@esa.int) no later than 1 April 2018, 22:00 CET, with the the name of the team and of the document submitted clearly written in the subject line (e.g. "TeamA_ cansat CDR report"). The document should be attached in a pdf format with the following file name format: teamA_ cansat CDR report.pdf.

ESA will provide guidelines as well as templates for the required reports to each participating team.

Phase 4 - European CanSat Competition launch campaign

The highlight of the competition will be the launch campaign which will take place from 27 June until 1 July 2018, when each CanSat will be launched by a rocket up to an altitude of 1 km. The CanSats will then separate from the rocket, conduct their missions, and land on the ground to be recovered by the teams.

The CanSats must be flight-ready on time for the launch campaign.

Outline of the launch campaign:

Day 1	Teams arrive by 12:30 maximum Opening ceremony Presentations of projects by CanSat teams (~10 teams)
Day 2	Presentations of projects by CanSat teams (~10 teams) First technical inspection of CanSats Drop tests of CanSats
Day 3	Launch of CanSats
Day 4	Presentation of results by CanSat teams Work on the CanSat final paper Evaluation & Closing
Day 5	Teams depart

A **Jury** panel in charge of evaluating the teams and their work will be nominated by ESA. The Jury will select the winning teams based on the criteria listed in chapter 4.

Phase 5 - Post-flight activities

After the launch campaign the teams will be requested to prepare and submit the **CanSat Final Report (CFR)**, which follows the standards of a scientific paper that includes an abstract and the details of the whole project. The report must summarise the work done before, during, and after the launch campaign, with a special focus on the results obtained and the (scientific/engineering) conclusions. Only after submission of the CFR will the members of the teams receive an **ESA certificate** recognising their participation in the 2018 European CanSat Competition.

The CanSat Final Report has to be submitted to ESA at cansat@esa.int by 15 July 2018, 22:00 CET, stating the name of the team and of the document submitted in the subject line (e.g. "TeamA_cansat final report"). The document should be sent in a pdf format, using the following file name format: *teamA_cansat final report.pdf*.

ESA will provide guidelines as well as templates for the required reports to each participating team.

Overview of the competition timeline

Phase 1: Launch of the European CanSat Competition	
Activity	Date
Competition announcement and ESA call for proposals for countries with no national competition	October 2017
Deadline for national competition organisers to confirm to ESA they want to 'reserve' a slot for their winning team in the European competition	10 December 2017
Deadline for submission of proposals from countries with no national competition	10 December 2017
ESA announcement of the teams selected from countries with no national competitions	20 December 2017
Critical Design Review report is submitted to ESA (only by teams from countries with no national competitions)	1 April 2018
ESA sends feedback of Critical Design Review report to teams from countries with no national competitions	20 April 2018

Phase 2: National competitions	
Activity	Date
National competition campaigns take place	Summer 2017 – 6 May 2018
Deadline for national competition organisers to communicate name of winning teams to ESA	7 May 2018

Phase 3: Preparation of the European Competition campaign	
Activity	Date
Student teams submit their Pre-launch Report to ESA	10 June 2018

Phase 4: European competition launch campaign	
Activity	Date
European competition launch campaign	27 Jun-1 Jul 2018

Phase 5: Post-flight activities	
Activity	Date
Student teams submit their final report to ESA ESA posts the participation certificates to the teams	15 July 2018



3 MISSION OVERVIEW

The CanSat competition is designed to simulate all aspects of a real satellite mission, including design, development, testing, launch, operations, and data analysis.

3.1 The rocket launch

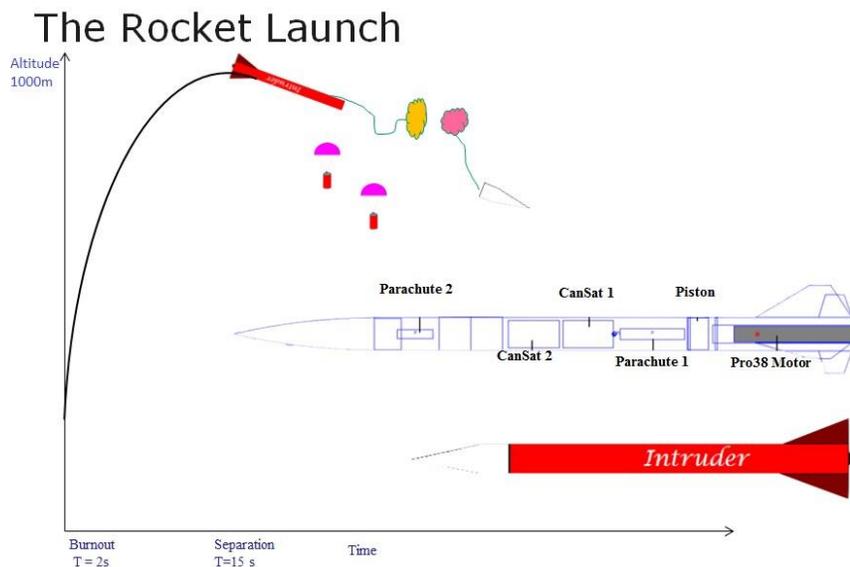
An example of a rocket launch is given below and could differ from the one finally used in the launch campaign.

A commercial model rocket kit, such as the Intruder, could launch the CanSats. Each rocket could host 2/3 CanSats with the following characteristics:

Mass:	3 kg
Length:	1.5 m
Diameter:	79.4 mm
Span:	232 mm
Apogee:	approx. 1000 m
Flight time:	approx. 140 s
Propellant mass:	280 g

The rocket would deploy its parachute at apogee, reached around 15 seconds after take-off, together with the two CanSats. Just after the apogee (0-2 seconds later), the CanSats would separate from the rocket and descend in separate parachutes. The CanSats are usually found within 1 km of the launch site. However, recovery of the CanSats cannot be guaranteed.

During flight, the rocket can reach a maximum acceleration of 20g in the vertical direction, and a maximum velocity of 550 km/h.



3.2 Primary and secondary CanSat missions

1) Primary mission

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

After release and during descent, the CanSat must measure the following parameters and transmit the following data as telemetry to the ground station at least once every second:

- **Air temperature**
- **Air pressure**

It must be possible for the team to analyse the data obtained (for example, make a calculation of altitude) and display it in graphs (for example, altitude vs. time and temperature vs. altitude). This analysis can be done in a post-flight analysis.

2) Secondary mission

The secondary mission of the CanSat must be selected by the team. It can be based on other satellite missions, a perceived need for scientific data for a specific project, a technology demonstration for a student-designed component, or any other mission that would fit the CanSat's capabilities.

Some examples of missions are listed below, but teams are free to design a mission of their choice, as long as they can demonstrate to have some scientific, technological or innovative value. Teams should also keep in mind the limitations of the CanSat mission profile, and focus on the feasibility (both technical and administrative) of their chosen mission.

Some secondary mission examples:

1. Advanced telemetry

After release and during descent, the CanSat measures and transmits additional telemetry to that required for the primary mission, for example:

- Acceleration
- GPS location
- Radiation levels

2. Telecommand

During descent, commands are sent from the ground to the CanSat to perform an action, such as switching a sensor on and off, changing the frequency of measurements, etc.

3. Targeted landing

The CanSat navigates autonomously with a control mechanism such as a parafoil. The objective is for the CanSat to land as close as possible to a fixed target point on the ground after it has been released from the rocket. This mission is an advanced telemetry/telecommand mission - navigation data is exchanged between the CanSat and a ground station throughout the descent.

4. Landing system

For this mission, an alternative safe landing system for the CanSat would be deployed, such as a bespoke parachute or airbag.

5. Planetary probe

A CanSat can simulate an exploration flight to a new planet, taking measurements on the ground after landing. Teams should define their exploration mission and identify the parameters necessary to accomplish it (e.g. pressure, temperature, samples of the terrain, humidity, etc.).



Students with their CanSats ready for launch during the 2017 European CanSat Competition

3.3 CanSat requirements

The CanSat hardware and mission must be designed following these requirements and constraints:

- [1] All the components of the CanSat must fit inside a standard soda can (115 mm height and 66 mm diameter), with the exception of the parachute. Radio antennas and GPS antennas can be mounted externally (on the top or bottom of the can, but not on the sides), depending on the design.

N.B. The rocket payload area usually has 4.5 cm of space per CanSat available, along the can's axial dimension (i.e. height), which must accommodate all external elements including: parachute, parachute attachment hardware, and any antennas.

- [2] The antennas, transducers and other elements of the CanSat cannot extend beyond the can's diameter until it has left the launch vehicle.
- [3] The mass of the CanSat must be between 300 and 350 grams. CanSats that are lighter must take additional ballast with them to reach the 300 grams minimum mass limit required.
- [4] Explosives, detonators, pyrotechnics, and inflammable or dangerous materials are strictly forbidden. All materials used must be safe for the personnel, the equipment, and the environment. In case of doubt, Material Safety Data Sheets (MSDS) will be requested.
- [5] The CanSat must be powered by a battery and/or solar panels. It must be possible for the systems to be switched on for four continuous hours.
- [6] The battery must be easily accessible in case it has to be replaced/recharged.
- [7] The CanSat must have an easily accessible master power switch.
- [8] Inclusion of a retrieval system (beeper, radio beacon, GPS, etc.) is recommended.
- [9] The CanSat should have a recovery system, such as a parachute, capable of being reused after launch. It is recommended to use bright coloured fabric, which will facilitate recovery of the CanSat after landing.
- [10] The parachute connection must be able to withstand up to 1000 N of force. The strength of the parachute must be tested to ensure that the system will operate nominally.
- [11] For recovery reasons, a maximum flight time of 120 seconds is recommended. If attempting a directed landing, then a maximum of 170 seconds flight time is recommended.

[12] A descent rate between 8 and 11 m/s is recommended for recovery reasons. In case of a directed landing, a lower descent rate of 6m/s is recommended. However, the airfield might determine additional mandatory restrictions on the velocity. In this case, the information will be provided to the teams well in advance so that they can adapt their secondary missions to these restrictions.

[13]The CanSat must be able to withstand an acceleration of up to 20 g.

[14]The total budget of the final CanSat model should not exceed 500€. Ground Stations (GS) and any related non-flying item will not be considered in the budget. More information regarding the penalties in case the teams exceed the stated budget can be found in the next section.

[15]In the case of sponsorship, all items obtained should be specified in the budget with the actual corresponding costs on the market.

[16]The CanSat must be flight-ready upon arrival at the launch campaign. A final technical inspection of the CanSats will be done by authorised personnel before launch.

4 EVALUATION AND SCORING

During 'Phase 3: Preparation of the European CanSat Competition', the teams' progress will be evaluated on an ongoing basis by an **Evaluation Committee** nominated by ESA. The **Jury** will be comprised of members of the **Evaluation Committee**, CanSat experts, and other special appointed ESA specialists that will evaluate the team's performance during 'Phase 5: European CanSat Competition launch campaign', taking into consideration the **CanSat Pre-launch Report**. Experts from ESA will provide feedback on 'Phase 6: Post-flight activities' upon request.

4.1 Phase 3: Preparation of the European CanSat Competition

During this phase, the Evaluation Committee will monitor and evaluate the development progress of each team based on their submission of the Pre-Launch Report.

During Phase 3, the following items will be taken into account:

- Team organisation and roles
- Mission objectives
- Mission overview
- Mechanical/ structural design
- Electrical design
- Software design
- Recovery system
- Ground support equipment
- Project planning
- Time schedule of the CanSat preparation
- Resource estimation



- Budget
- External support
- Test plan
- Outreach programme

Bonus

Bonus points will be awarded for:

- **Performance and consistency** in the completion of the CanSat Pre-launch Report (PLR). Each team will be rewarded with a specific percentage for the Pre-Launch Report. This percentage will then be translated into a multiplier factor that will increase the final score given by the Jury in the launch campaign.

The multiplier factor has a final minimum value of 1 and a maximum value of 1.3, depending on the quality of the CanSat Pre-launch Report. Here are the minimum and maximum multiplier factors that can be obtained in the Design Review:

Design Review	Percentage	Multiplier Factor
PLR	0-30%	1-1.3

Teams	PLR	Final Multiplier Factor
	(mark) %	
Team A	(0)	1 (0%)
Team B	(5)	1.15 (15%)
Team C	(10)	1.30 (30%)

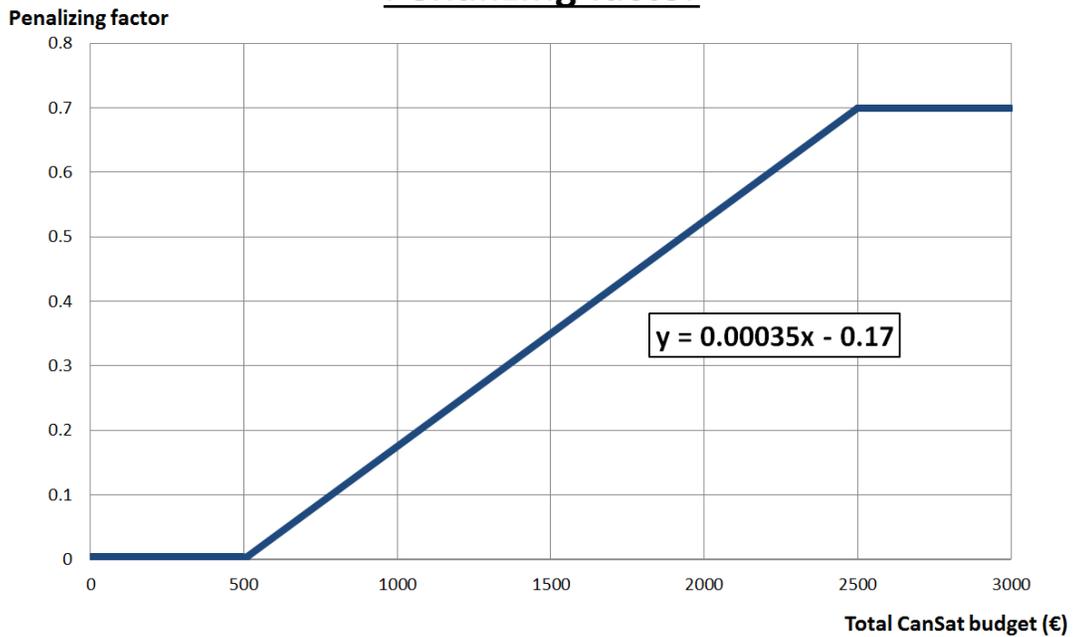
In the examples given above, we can see that Team A obtained the lowest score possible, Team B received good scores, and Team C got the best possible performance, obtaining the best final multiplier factor possible.

Penalties

Should teams exceed the budget limit specified in the requirements, a penalising factor will be implemented according to the following graphic:



Penalizing factor



This factor will be subtracted from the final bonus awarded, establishing a final multiplying factor that can then take a minimum value of 0.3 and maximum value of 1.3. Note that the maximum value that can be subtracted from the multiplying bonus factor is a factor of 0.7 (70%).

This penalising factor will always have a negative effect on the final score and only if the total budget of the final CanSat (500€) is exceeded.

In case of delay in the submission of any of the documents, an extra penalisation of 1% deduction per day of delay will be applied according to the deadlines specified in the present guidelines (Chapter 2.7). Therefore, a deduction of 1.01 per day of delay will be applied to the final multiplier bonus factor. As an example, a team with a total delay of one week (7 days) during Phase 4 will get a 7% deduction (1.07).

4.2 Phase 4: Competition launch campaign

Before and during this phase, the **Jury** will evaluate the **CanSat Pre-Launch Report** and the overall performance of the team during the launch campaign.

The following points will be taken into account:

Educational value

For this item, the Jury will consider the quality of the Pre-launch Report and the team presentations, the level of effort made by the team, and how much the team appears to have learned throughout the project.

Technical achievement

Innovative aspects of the project will be judged (e.g. the mission selected and the hardware/software used). The jury will also take into account how the teams obtained the results, how reliable and robust the CanSat was, and how the CanSat performed. If the CanSat did not succeed in accomplishing its mission, but the team is able to explain the reasons why and suggest improvements, it will be taken into account positively.

Teamwork

The Jury will assess how well the team worked together on the assignment, the distribution of tasks, the planning and execution of the project, and the team's success in obtaining the necessary funding, support, and advice.

Outreach

The team will be awarded points on how well the project was communicated to the school and the local community, taking into account web pages, blogs, presentations, promotional material, media coverage, etc.

Marking scheme

The overall balance between the items to be evaluated is as follows:

1. Educational value	20%
2. Technical achievement	50%
3. Teamwork	15%
4. Outreach	15%
TOTAL	100%

The final score of each team will be made up by the points gathered from the evaluation of the Jury and the accumulated bonus percentages during Phase 4.

5 FUNDING & SPONSORSHIP

For the competition launch campaign, ESA will sponsor the accommodation, meals and local transportation expenses for one teacher and six students per national team, as well as all costs for the rocket launches and related flight activities.

All teams are responsible for their travel booking and expenses from their hometowns to and from the main airport/train station to the launch campaign location, and for the costs of their CanSat hardware and tools.

6 CONTACT

All questions and expressions of interest should be directed to:

Email: cansat@esa.int

Address:

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Noordwijk

The Netherlands

More information

CanSats in Europe Portal www.esa.int/Education/CanSat