

**2015**

**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, is mainly addressing technology, physics and programming curricular subjects. The CanSat activity provides the students with practical experience 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 to an altitude of about one kilometre by a rocket, dropped from a platform or captive balloon and its mission begins: to carry out a scientific experiment, achieve a safe landing and analyse the data collected.



*Participants to the 2014 European CanSat Competition at Andøya Rocket Range, Norway*

### Educational value of the CanSat experience

The CanSat experience provides the participating student teams the opportunity to go through all the phases typical of a real space project, from selecting the mission objectives, designing the CanSat, integrating the components, testing the system,

preparing for launch and then 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 work,
- acquire and/or reinforce fundamental technology, physics and programming curricular concepts,
- understand the importance of coordination and team work,
- enhance their communication skills.

## 2 COMPETITION OVERVIEW

The 2015 European CanSat Competition will consist of five phases:

1. Call for proposals and team selection
2. Teachers Workshop
3. CanSat construction and test activities
4. Competition Launch Campaign
5. Submission of CanSat final paper

### 2.1 Call for proposals and team selection

The call for proposals is published on the ESA Education Portal at [www.esa.int/education](http://www.esa.int/education) and on the CanSats in Europe website at [www.cansat.eu](http://www.cansat.eu). The deadline for proposals is Sunday 7 December 2014 at 24:00 CET. A complete proposal form ([download here](#)) must be emailed to ESA before the deadline at [cansat@esa.int](mailto:cansat@esa.int) with the subject: "2015 European CanSat Competition Call for Proposals".

#### **Eligibility**

The following conditions should be fulfilled, in order for a proposal to be considered as eligible:

- The **team** should comprise between **4** and a **maximum** of **10** (aged 14+) full-time enrolled secondary school students in an ESA Member State\*, assisted by a teacher. Teams of 4/5 students are advisable to maximise the learning process.
- The majority of team members must hold the nationality of an ESA Member State.
- A complete application must be submitted to ESA before 24:00 CET on Sunday 7 December 2014.

#### **\*ESA Member States in 2015:**

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

## **Responsibility for leading the team**

Each team must have a teacher (Team Leader) responsible for monitoring the team's technical progress, available to offer help and advice, and acting as the point-of-contact between the ESA Education Office and the student team. The Team Leader must be available to attend the Teacher Workshop and to accompany the team to the competition Launch Campaign.

## **Team selection**

The competition will have 18 CanSat launch slots available, divided into two categories: Beginners and Advanced. Teams can choose which category to apply for, but the **Review Board** reserves the right to change the category, depending on the applications received. The **Review Board** nominated by ESA will be responsible for evaluating and revising the Design Reviews, provide feedback and advice to the teams in a timely manner. Their decision regarding the placement will be communicated during Phase 3.

- The **Beginners category** is intended for teams with no prior experience in designing and building a CanSat or a similar project.
- The **Advanced category** is intended for teams that already have some practical experience or come from a technical background and are therefore able to undertake a more complex project.

It is possible for a launch slot to be reserved by the organisers of a national CanSat activity (see below).

The remaining slots will be filled through a central selection process, organised by ESA's Education Office. A Selection Panel of experts will consider all proposals on the basis of their scientific merit, team organisation and outreach plans. The final selection will be communicated to the teams and published on the CanSats in Europe website and on ESA portal in December 2014.

## **Reserving a launch slot by the organisers of a national CanSat activity**

ESA has secured a total of 18 launch slots for the 2015 European CanSat Competition. Organisers of a national CanSat activity can apply to reserve one of the slots for the winning team of their event. Please note that only one team per ESA Member State will be admitted to the European competition this way.

The following aspects will be considered by ESA when evaluating the requests from national CanSat organisers:

- The nature and schedule of the activity
- The number of schools and students involved in the activity
- The outreach value of the activity
- The prospects for continuation of the activity in future
- The nature of the CanSat that is proposed for the requested launch slot (how and when the team will be chosen, which CanSat activities will have already been completed, information available about the team or mission, etc.)

National organisers should send their applications to [cansat@esa.int](mailto:cansat@esa.int) no later than Sunday 7 December 2014 at 24:00 CET, although early applications are encouraged. A complete proposal form ([download here](#)) must be emailed to ESA before the deadline at [cansat@esa.int](mailto:cansat@esa.int) with the subject: "2015 European CanSat Competition National Winner". The final selection will be communicated to the teams and published on the CanSats in Europe website and on

ESA portal in December 2014.

National Winners of a CanSat competition will automatically be enrolled in the competition following similar requirements, criteria and deadlines as the Selected Teams.

## 2.2 Teacher Workshop

Teachers of the ESA Selected Teams will be invited by ESA to attend an introductory workshop at ESA's ESTEC centre in The Netherlands which will take place on 28-30 January 2015.

The aim of the workshop is to ensure that the Team Leaders gain the knowledge and expertise needed to mentor their students during the CanSat development phase. Participation in the workshop is mandatory for the Team Leaders of all ESA Selected Teams.

During the workshop, a series of lectures covering all aspects of CanSats will be given. This will be followed by hands-on training sessions on topics such as sensors and signal analysis; data handling and data transmission; software installation and programming, etc.

By the end of the workshop each Team Leader will have gained the experience needed to successfully mentor their students. Before departure the Team Leaders will be given one CanSat kit per team to be used by their students.

All costs related to the Teachers Workshop will be borne by ESA. This includes travel expenses, accommodation, meals, training material, and the provision of the CanSat kit.

## 2.3 CanSat construction and test activities

Between February and June 2015, under the supervision of the Team Leader, the teams will 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;
- Documented Design Reviews, leading to design refinement;
- Integration and testing of the CanSat;

### **Reporting to ESA during the project**

In order to monitor the development progress of each CanSat, there are **three Design Reviews: Preliminary Design Review (PDR), Critical Design Review (CDR) and Final Design Review (FDR)**. Each of them includes a progress report and a design document section and have to be submitted at regular intervals. Deadlines, guidelines as well as templates for the required reports, will be provided to each selected team by the time of the Teacher Workshop and are indicated in the Guideline of Reviews 2015. A **Review Board** nominated by ESA will be responsible to review the Design Reviews and to provide feedback and advice to the teams in a timely manner.

Before the Launch Campaign the teams are expected to submit the **Final Design Review (FDR)** which summarises all the work done to date and which provides a full description of



their CanSats system and its functionalities. This will be the main document provided to the **Jury** members who will be tasked to evaluate the work and performance of each team.

After launch and data analysis, the teams are expected to produce the **CanSat Final Paper** summarising the work before, during and after the Launch Campaign with a special focus on obtained results and (scientific/engineering) conclusions.

## **Preliminary Design Review (PDR)**

The PDR is a multi-oriented technical review to ensure that the current design can proceed into detailed design and can meet the stated performance requirements taking into account all the system constraints.

The CanSat PDR shall contain:

- A demonstration that all the requirements stated in the guidelines for the European CanSat Competition have been fulfilled
- The stating of the secondary mission
- The design specifications in order to fulfil the secondary mission
- The preliminary budget
- The detailed development budget
- An outline of the project schedule

## **Critical Design Review (CDR)**

The CDR is a multi-oriented technical review to ensure that design can meet the stated performance requirements taking into account all the system constraints. The Critical Design Review evaluates the detailed design effort, determines readiness for hardware fabrication and for software coding and establishes the final configuration of the secondary mission.

The CDR is an altered version of the PDR, it shall include all the discrepancies from the Preliminary Design Review and will assess the progress of technical performance measures. All major documentation and plans are reviewed.

The CanSat CDR shall contain:

- The progress from the PDR
- Results of requirements verification tests completed to date
- Overview of mission operation
- Revised budget
- Revised outline of the project schedule

## **Final Design Review (FDR)**

The Final Design Review is the final report that should be submitted before the Launch. This report will contain all the alterations made to the CDR design and their implementation. 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 be tasked to evaluate the work and performance of each team as described in chapter 4.

## **2.4 Competition Launch Campaign and selection of winning team**

The highlight of the competition will be the Launch Campaign at the Santa Cruz Air Field near Lisbon in Portugal between 24 and 28 June 2015, where each CanSat will be launched in a rocket up to an altitude of 1 km. The CanSats will then separate from the rocket, conduct their missions, and land safely on the ground to be recovered by the teams.

The CanSats must be flight-ready upon arrival at the Santa Cruz Air Field before the Launch Campaign.

An outline of the Launch Campaign is as follows:

24 June 2015	Teams arrive
25 June 2015	Opening ceremony Presentations of projects by CanSat teams (Briefing) Final technical inspection of the CanSats
26 June 2015	Launch and recovery operations Analysis of the mission results
27 June 2015	Presentation of results by CanSat teams (Debriefing) Jury evaluation and winners selection
28 June 2015	Prize ceremony Optional cultural activities 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 below.

## 2.5 Submission of CanSat Final Paper

After the Launch Campaign the teams are requested to submit the **CanSat Final Paper (CFP)**, which follows the standards of a scientific paper including an abstract and a manuscript of the project. Only after submission of the CFP will the members of the teams will receive an ESA certificate in recognition of their participation in the 2015 European CanSat Competition.



## 2.6 Overview of the competition timeline

Phase 1: Call for proposals and team selection	
Activity	Date
Call for proposals opens	05 November 2014
Deadline for proposals	07 December 2014*
Announcement of Selected Teams	December 2014

Phase 2: Teacher Workshop	
Activity	Date
Teacher Workshop	28-30 January 2015

Phase 3: CanSat construction and test activities	
Activity	Date
Preliminary Design Review (PDR)	15 March 2015*
Critical Design Review (CDR)	26 April 2015*
Final Design Review (FDR)	7 June 2015*

Phase 4: Competition Launch Campaign	
Activity	Date
Competition Launch Campaign	24-28 June 2015

Phase 5: Submission of CanSat Final Paper	
Activity	Date
CanSat Final Paper (CFP)	26 July 2015*

- \* Notice that all deadlines are on Sunday with a final submission time at 23:59 CET. All the required documents are requested to be submitted at [cansat@esa.int](mailto:cansat@esa.int) with the subject stating the name of the team and the name of the document submitted, e.g. Team A CDR, Team B FDR. The documents should be attached in the email in a pdf format with the following format: team\_document, e.g. TeamA\_CDR, TeamB\_FDR.



## 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

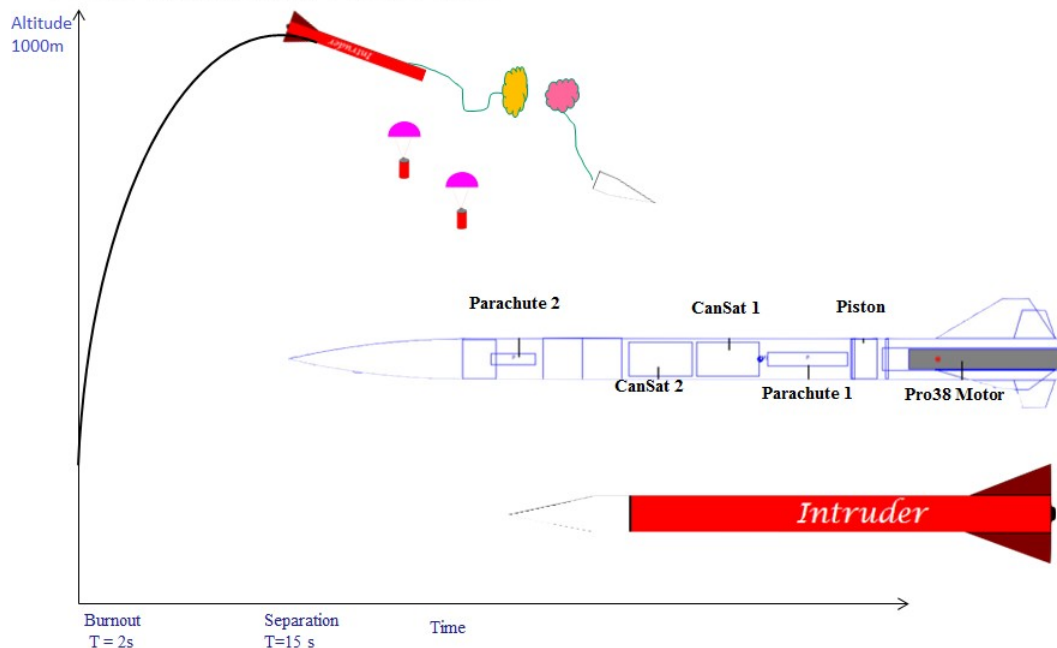
A commercial model rocket kit, the Intruder, will be used to launch the CanSats. Nine rockets will be launched, each with 2 CanSats on board. The rocket has the following characteristics:

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

During the flight, the rocket can reach a maximum acceleration of 12g in the vertical direction and a maximum velocity of 550 km/h.

### The Rocket Launch



## 3.2 Primary and secondary CanSat missions

### Primary mission

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

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

- 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.

### Secondary mission

The secondary mission for 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 it can be demonstrated 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.

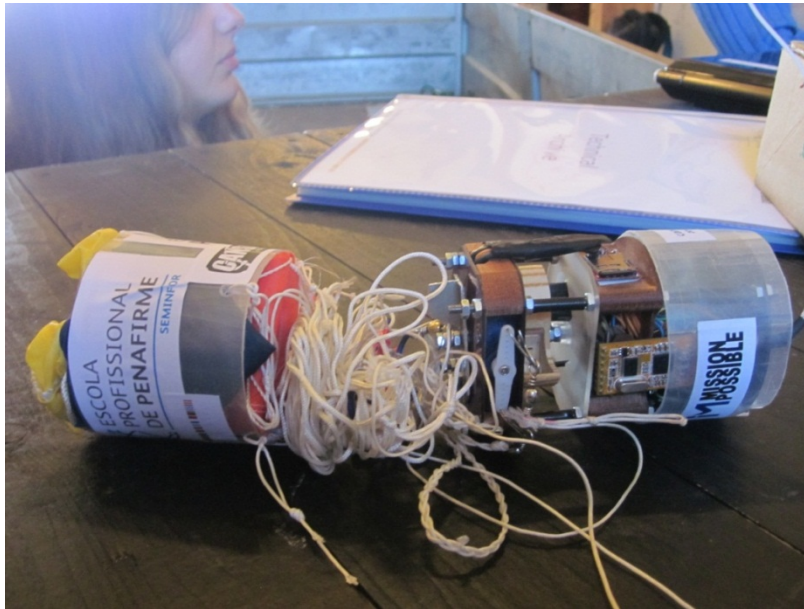


## 4. Landing system

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.).



The Mission Impossible CanSat (PT) ready for launch, Andoya 2014 European CanSat Competition Launch Campaign

## 3.3 CanSat requirements

The CanSat hardware and missions must be designed to the following 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. An exemption can be made for radio antennas and GPS antennas, which can be mounted externally (on the top or bottom of the can, not on the sides), based on the design.

N.B. The rocket payload area has 4.5 cm of space available per CanSat, 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 grams 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 flammable or dangerous materials are strictly forbidden. All materials used must be safe for the personnel, the equipment and the environment. Material Safety Data Sheets (MSDS) will be requested in case of doubt.
- [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 give confidence 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 m/s and 11 m/s is recommended for recovery reasons. In case of attempting a directed landing, a lower descent rate of 6m/s is recommended.
- [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€ for the Beginners category and 600€ for the Advanced category. Ground Stations (GS) and any related non-flying item will not be considered in the budget. More information regarding the penalties in case of exceeding the stated budget can be found in the next section.
- [15] In case of sponsorship, all the items obtained should be specified in the budget with the corresponding costs on the market at that moment.
- [16] The CanSat must be flight-ready upon arrival at Santa Cruz Airfield. A final technical inspection of the CanSats will be done by authorised personnel before launch.

## 4 EVALUATION AND SCORING

The teams' progress will be evaluated on an on-going basis during Phase 3: CanSat construction and test activities, by a **Review Board** nominated by ESA. The **Jury** will be comprised of members of the Review Board, CanSat experts and other special appointed ESA specialists that will evaluate the team's performance during Phase 4: Competition Launch Campaign, taking into consideration the Final Design Review (FDR). Experts from ESA will provide feedback on Phase 5: Submission of CanSat Final Paper, upon request.

### 4.1 Phase 3: CanSat construction and test activities

During this phase the Review Board will monitor and evaluate the development progress of each team based on their submission of the three Design Reviews (PDR, CDR and FDR). In case of a late incorporation of a National Winner, the team will have to submit the next Design Review possible.

The following items are being taken into account during Phase 3:

- 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 are to be awarded for performance and consistency in the completion of the **three Design Reviews (PDR, CDR and FDR)**. Each team can be rewarded with a specific percentage for every Design Review submitted. This percentage is translated then in 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 1.35, according to the quality of the Design Reviews submitted. Here are shown the maximum and minimum multiplier factors that can be obtained in each Design Review phase:

Design Review	Percentage	
PDR	0-5%	
CDR	0-10%	
FDR	0-20%	<b>Multiplier Factor</b>
<b>TOTAL</b>	<b>0-35%</b>	<b>1-1.35</b>



The final multiplier factor is the result of adding the percentage obtained in each of the three Design Reviews to be submitted. As an example, find below some possible multiplier factor scenarios:

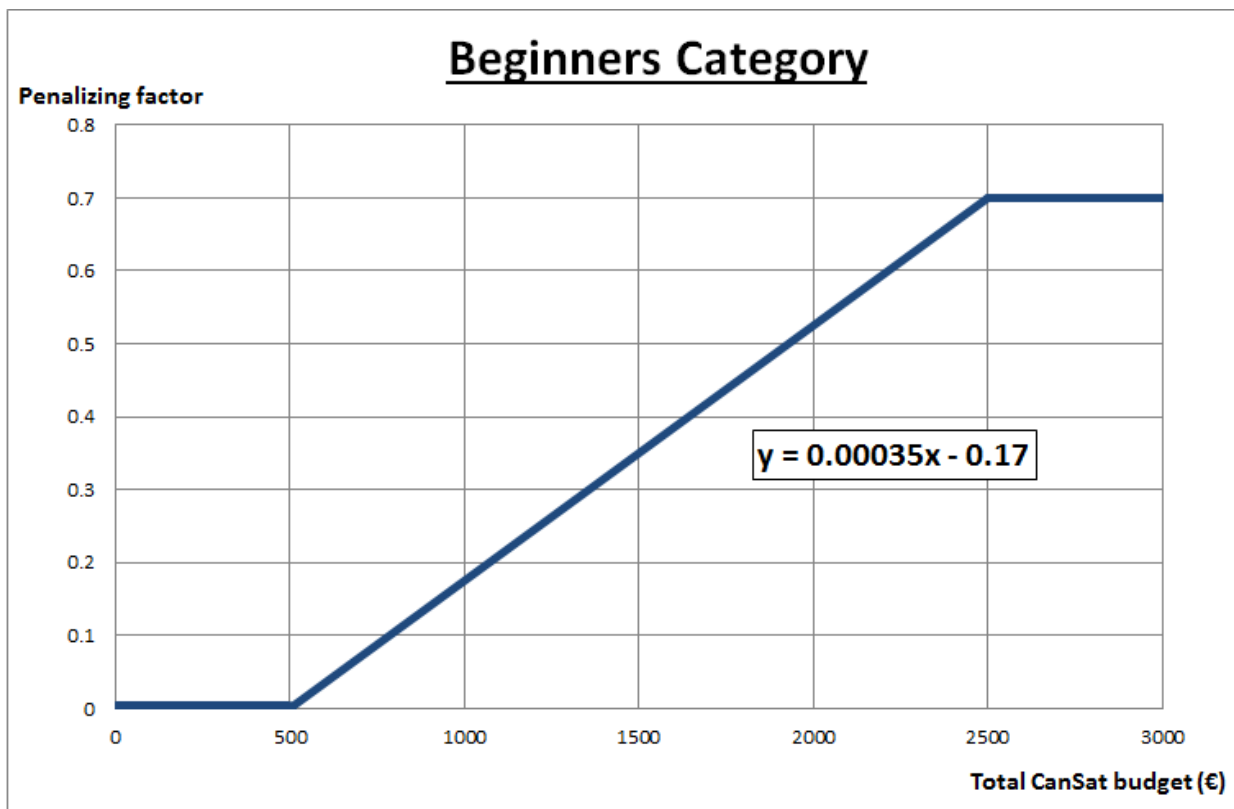
Teams	PDR	CDR	FDR	Final Multiplier Factor
	(mark) %	(mark) %	(mark) %	
Team A	(0) 0%	(0) 0%	(0) 0%	1 (0%)
Team B	(8) 4%	(7) 7%	(9) 18%	1.29 (29%)
Team C	(10) 5%	(10) 10%	(10) 20%	1.35 (35%)

In the above given examples we can see Team A obtaining the lowest scores possible, while Team B has good scores and Team C has the best possible performance, obtaining the best final multiplier factor possible.

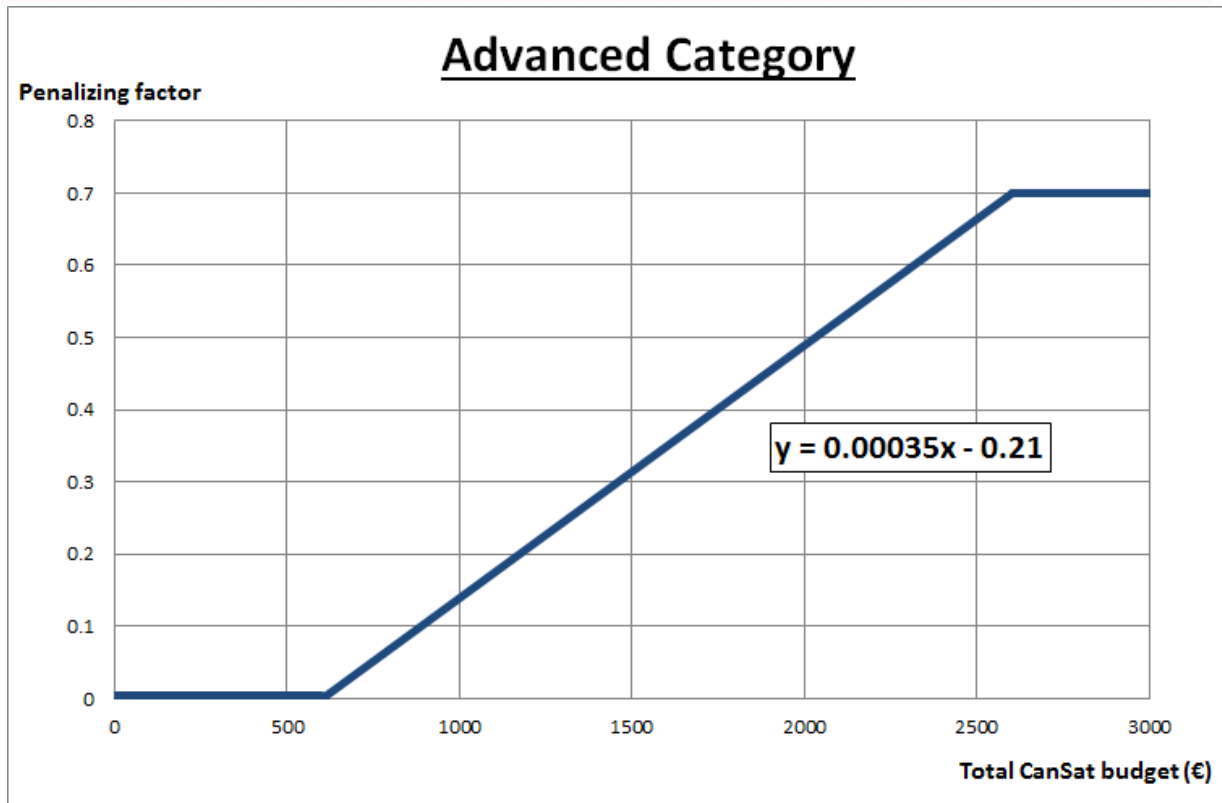
With a late incorporation of a National Winner, the team will have to submit the next Design Review possible and will be evaluated with a total score weighted according to the previous Design Reviews not submitted. For instance, a National Winner incorporated before the CDR deadline, will have to submit the CDR that will be evaluated with a maximum bonus of 15%. For the following Design Reviews the procedure will be the same as for the other participating teams.

## Penalties

Should the budget limit specified in the requirements be exceeded, a penalizing factor will be implemented according to the following graphics:







This factor will be subtracted from the final bonus awarded, establishing a final multiplying factor that can then take a minimum and maximum value of 0.3 and 1.35. Notice that the maximum value that can be subtracted from the multiplying bonus factor is a factor of 0.7 (70%).

This penalizing factor will always apply with a negative effect in the final score and only if the total budget of the final CanSat is exceeded; that is 500€ for the Beginners Category and 600€ for the Advanced Category according to the previous exposed requirements.

In case of delay in the submission of any of the Design Reviews, an extra penalization will apply with a 1% deduction per day of delay according to the deadlines specified in the present guidelines, Chapter 2.6. Therefore a deduction of 1.01 in the final multiplier bonus factor is applied per day of delay. As an example, a team with a total delay of one week (7 days) during Phase 3, will get a 7% deduction (1.07).

**Note:** In case of using the T-Minus CanSat kit, the budget will have to include each of the used parts as follows:

Structure: Metallic parts + top and bottom shields	15€
Transmitter board: Only one, as ground stations will not be considered in the budget	25€
Controller board	40€
Sensor board: Including all the provided sensors and electronic components to be soldered	15€

*(This are not T-Minus sales prices)*

Notice that a part will be considered as soon as one of its components is used.

## 4.2 Phase 4: Competition Launch Campaign.

During this phase the **Jury** will evaluate the **Final Design Review (FDR)** and the overall performance of the team during the Launch Campaign.

The following items are being taken into account:

### **Educational value**

For this item, the Jury will consider the quality of the Final Design 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, for example: the mission selected and the hardware/software used. It will be also taken into account how the teams obtained results, how reliable and robust the CanSat was and how the CanSat performed. If the CanSat did not succeed in accomplishing the missions but the team is able to explain the reasons why and suggest improvements, it will be also taken into account positively.

### **Team work**

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 scored on how well the project was communicated to the school and the local community, taking into account any webpages, blogs, presentations, promotional materials, media coverage, etc.

### **Marking scheme**

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

<b>1. Educational value</b>	20%
<b>2. Technical achievement</b>	50%
<b>3. Team work</b>	15%
<b>4. Outreach</b>	15%
<b>TOTAL</b>	<b>100%</b>

The final score of each team will be made up by the points gathered from the evaluation of the Jury and the adding of the accumulated bonus percentages during Phase 3.

## 5 FUNDING

All costs related to the Teacher Workshop at ESA/ESTEC on 28-30 January 2015 will be sponsored by ESA. This includes travel expenses, accommodation, meals, training material and the provision of a CanSat kit for each team.

For the competition Launch Campaign, ESA will sponsor the accommodation, meals and local transportation expenses of one teacher and up to four pupils, as well as all costs for the rocket launches and related flight activities. The rest of the team is welcome to attend the launch day but they will need to find alternative funding for their accommodation, meals and local transportation.

Teams are responsible for obtaining alternative sponsorship for any additional CanSat hardware (beyond the kit supplied), as well as the team's travel expenses to and from the competition Launch Campaign.

## 6 CONTACT

All questions and expressions of interest should be directed to:

Email: [cansat@esa.int](mailto:cansat@esa.int)

Address:  
ESA Education Office (DGC-DE)  
ESTEC  
Postbus 299  
2200 AG  
Noordwijk  
The Netherlands

### **More information**

CanSats in Europe Portal <http://www.cansat.eu>



Team Alpha's CanSat - winner of the 2012 European CanSat Competition