# ZR-SAT Description

# Introduction

## Abstract

ZR-SAT Competition is a competition between Teams of High School Students to develop Scientific/Technological Experiments to be carried on in Zero Gravity and flown either aboard ISS or small satellites. Successful Teams need to master skills in Science, Technology, Engineering and Mathematics (STEM), as well as show originality, innovative ideas and good communication to present their work. The ZR-SAT Competition consists of several successive phases, at national and international levels, and at each step only the best Teams are selected to enter the next phases. Juries, composed by eminent people in the science fields, make the selection and the winning Teams are awarded a prize. Depending on the availability of funds, the best satellites could be considered for launch.

## Introduction and Short Description

The ZR-SAT Competition is organized at national and international levels to promote the study of technological and scientific subjects among high school students. The participating teams are required to envision a space mission and develop a scientific experiment to be flown aboard a small satellite (namely, a CubeSat) to complete it. Only the experiment has to be developed and not the whole CubeSat.

The ZR-SAT Competition follows a number of phases, starting from the conceptual idea up to the (partial) realization of a prototype, where each phase refines the design going through successive levels of abstraction. At the end of each phase, teams should produce a deliverable which is evaluated by the other teams and by a national/international jury, and through a voting system only the best teams are allowed to continue the competition.

All Teams have to participate to the National Competition and only the winner(s) will be accepted to the International Competition.

Competitions can be different every year, according to a set of rules which are defined by the organization committee. As an example, a short description of a competition is given in the following, by outlining possible phases.

1. Team Creation: a Team is composed of 5 to 10 High School Students, one of them being the Team Leader, guided by a Mentor (a teacher or staff of the same High School). A team may also have an external Coadjutor, if desired.

   The Team enrolls in the ZR-SAT Competition by providing all required information to the National Committee using the Registration Form.

2. Phase I - Idea Presentation (National Competition): the first step consists in proposing a Scientific/Technological Experiment for a Space Mission to be flown on a CubeSat and briefly describe its objectives and the methods that the Team intends to use to accomplish it.

   The team shall prepare an Idea Presentation Document containing a preliminary description of the proposed Scientific/Technological Experiment, possibly making use of a simple Optional Pre-totype. The description should clearly identify a relevant problem that the Scientific/Technological Experiment contributes to solve, its relevance, the innovative aspects of the proposal, and what is already available. The document should also briefly address the possibility for the experiment to satisfy the given requirements.

   The team shall then prepare a First Elevator Pitch, that is, a 3 minutes video aimed at convincing the jury about the characteristics and relevance of the proposed Scientific/Technological Experiment. All documents shall be written and recorded in English.

Deliverables: the Idea Presentation Document and the First Elevator Pitch, made available to all participants on the Competition Web Site. The two deliverables will be uploaded by Deadline Submission Elevator Pitch I and made visible to the others only after all Teams have uploaded their documents. They will also be made publicly visible through appropriate Social Media.

Evaluation Phase I: based on the videos, each Team draws up a ranking of the other Team proposals and points are assigned to Teams. A Phase I Jury also evaluates the proposals, adding additional points to Teams. The relative weights of the points given by the other Teams and by the Phase I Jury are specified every year in the rules.

Selection Phase I: only the best 25 teams are admitted to the next phase.

3. Phase II - Prototyping (National Competition): in the second phase, Teams shall produce a (partial) Simple Prototype of the scientific experiment.

   The Simple Prototype shall be closer than the Pre-totype to the real Scientific/Technological Experiment in terms of implementation, yet the Simple Prototype need not adhere to space mission standards regarding materials, reliability, robustness, and so on, but the design should take those aspects into consideration as much as possible.

   The team shall then prepare a Second Elevator Pitch, an improved version of the former, which makes use of the Simple Prototype developed and aims at convincing the National Jury about the characteristics and relevance of the proposed Scientific/Technological Experiment

   Deliverable: the Second Elevator Pitch, made available to all participants on a dedicated Social Media. The deliverable will be uploaded by Deadline Submission Elevator Pitch II and made visible to the others only after all Teams have uploaded their videos. The video shall be recorded in English.

   At that point each Team will have to declare its willingness or not to participate in the International Phase, should the Team be selected. The choice is binding.

   Evaluation Phase II: similarly to the first phase, teams draw up a ranking of the other teams, and a National Jury (possibly composed of different people with respect to the Phase I Jury) adds additional points.

   Selection Phase II: The best six Teams (TBD) are admitted to the National Final, plus as many other as required to have at least three Teams in the final which declared interest in proceeding to the International Phase.

4. National Final: Selected Teams may further develop the Simple Prototype and are then called to a final meeting with the National Jury.

   During the event, Teams should present live the mission and their satellite, possibly using the Simple Prototype they developed and any other multimedia systems, and go show some Testing of the experiment.

   Evaluation: the National Jury alone evaluates the presentations and the quality of the Simple Prototype and the presentation and establishes the winners of the ZR-SAT Competition (1st, 2nd, 3rd, 4th places).

   Selection International Finalists: in parallel, the three Teams with the highest score among those who declared their interest in proceeding to the International Phase, are selected for the International Phase.

5. International Phase (details still to be confirmed!): the three selected Teams from each Participating Nation are allowed to optionally extend their team by either adding other students or get allied with another Team (not among the international finalists), either an existing Team or possibly a new one with the same characteristics of other Teams, but potentially with capabilities of manufacturing prototypes.

   The extended Teams shall then produce a fully functional Scientific/Technological Experiment compatible with the given Size and Constraints and with the hosting CubeSat.

6. International Final (details still to be confirmed!): all teams of the International Phase are called to participate at an international event, similar to the National Final, where an International Jury will select the winners.

## Motivations

The ZR-SAT Competition aims to attract young students at the secondary level to study scientific subjects in the STEM (Science, Technology, Engineering and Mathematics) area. During the competition, students are required to develop multidisciplinary skills, in science, physics, mathematics, as well as in communication, information processing, engineering and to apply them in an actual project.

To be successful, students need to form a team and learn how to work together to reach a common goal, following a set of rules and comparing with the other teams. They need to be imaginative and innovative, finding intelligent solutions to relevant problems, while at the same time promoting their ideas in fascinating and clear ways.

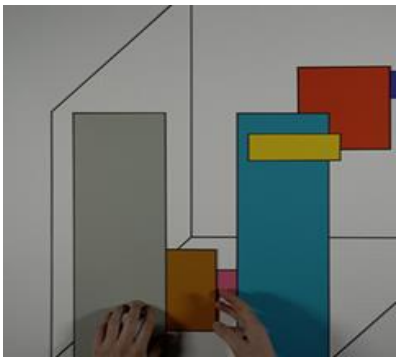
The focus is on space science, inviting students to think about the future in an iconic place like the International Space Station, but keeping a practical view of their work that is intended to be implemented as a Scientific/Technological Experiment inside CubeSat. The activities during the ZR-SAT Competition will also aid students in understanding the kind of studies they really want to undertake and the university level and ultimately in their professional life.

## Competition Organization

The practical organization of the Scientific/Technological Experiment will be as follows:

1. During national phases, each team shall produce:

   1.1. during Phase I - Idea Presentation: an Idea Presentation Document, a Optional Pre-totype and a First Elevator Pitch; this will be evaluated both by the other teams and by a Phase I Jury to select a number of teams proceeding further, by the Deadline Selection Phase I):



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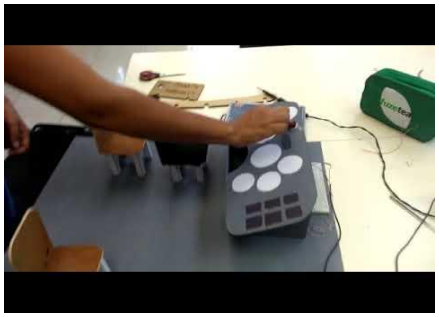
Optional Pre-totype

Idea Presentation Document and First Elevator Pitch

   1.2. Teams admitted to Phase II - Prototyping shall then produce a Simple Prototype of the proposed Scientific/Technological Experiment, plus a Second Elevator Pitch aimed at describing the Simple Prototype; the latter will be evaluated both by the other teams and by a National Jury to select a number of teams proceeding further, by the Deadline Selection Phase II):



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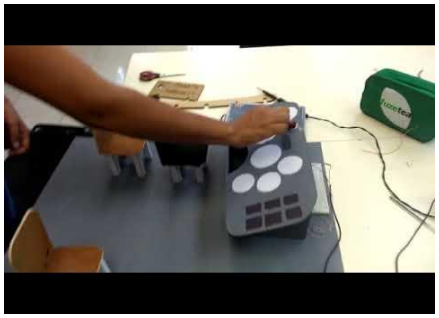
Simple Prototype

Second Elevator Pitch

1.3. Finalists will have time to improve their Simple Prototype and show it to the National Jury



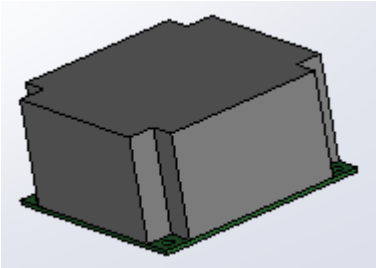

Simple Prototype → National Jury

which will decide for the National Champions and International Finalists.

2. [More details on international phase will follow later]

Preliminarily, International Finalists can extend their Team and ally with another non-finalist Team with more competence on prototyping.

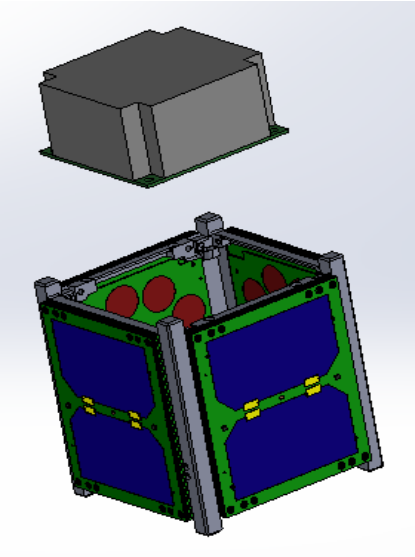
The two together shall then produce the real Scientific/Technological Experiment compatible with the Size and Constraints given by the Competition Rules:



Real Scientific/Technological Experiment

The Scientific/Technological Experiment is expected to be hosted inside a CubeSat.

Teams shall only produce the Scientific/Technological Experiment, not the hosting CubeSat. Teams interested may purchase one CubeSat to have the Scientific/Technological Experiment more realistic, but that will not be part of the evaluation. Yet the Organizing Committee will provide a simple PC interface providing power supply and communication capabilities to test their Scientific/Technological Experiment using a normal PC.



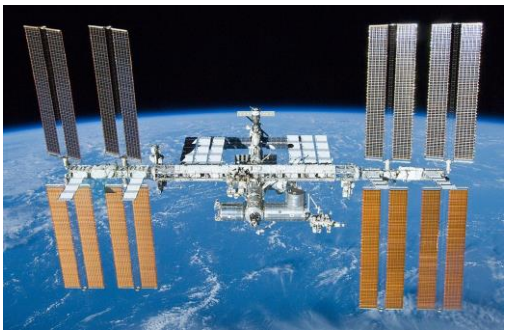
The real Scientific/Technological Experiment inserted into a CubeSat (the latter not to be produced by the Teams).

# 1. The Environment

The competition aims at developing Scientific/Technological Experiments to be hosted on a CubeSat which either orbits in space in Low Earth Orbit or inside the ISS, which in turns orbits around Earth in a Low Earth Orbit.

## ISS

The International Space Station (ISS) is a space station, or a habitable artificial satellite, in low Earth orbit. Its first component was launched into orbit in 1998, with the first long-term residents arriving in November 2000. It has been inhabited continuously since that date. The last pressurised module was fitted in 2011, and an experimental inflatable space habitat was added in 2016. The station is expected to operate until 2030. Development and assembly of the station continues, with several new elements scheduled for launch in 2020. The ISS is the largest human-made body in low Earth orbit and can often be seen with the naked eye from Earth. The ISS consists of pressurised habitation modules, structural trusses, solar arrays, radiators, docking ports, experiment bays and robotic arms. ISS components have been launched by Russian Proton and Soyuz rockets and American Space Shuttles.



The ISS serves as a microgravity and space environment research laboratory in which crew members conduct experiments in biology, human biology, physics, astronomy, meteorology, and other fields. The station is suited for the testing of spacecraft systems and equipment required for missions to the Moon and Mars. The ISS maintains an orbit with an average altitude of 400 kilometers (250 mi) by means of reboost maneuvers using the engines of the Zvezda module or visiting spacecraft. It circles the Earth in roughly 92 minutes and completes 15.5 orbits per day.

## Low Earth Orbit

A Low Earth Orbit (LEO) is an Earth-centered orbit with an altitude of 2,000 km or less (approximately one-third of the radius of Earth) or with at least 11.25 periods per day (an orbital period of 128 minutes or less) and an eccentricity less than 0.25. Most of the manmade objects in outer space are in LEO.

## CubeSat

A CubeSat (U-class spacecraft) is a type of miniaturized satellite for space research that is made up of multiples of 10 cm × 10 cm × 11.35 cm (~ 4 in × 4 in × 4.5 in) cubic units. CubeSats have a mass of no more than 1.33 kilograms (2.9 lb) per unit, and often use commercial off-the-shelf (COTS) components for their electronics and structure. CubeSats are commonly put in orbit by deployers on the International Space Station, or launched as secondary payloads on a launch vehicle. Over 1000 CubeSats have been launched as of January 2019. Over 900 have been successfully deployed in orbit and over 80 have been destroyed in launch failures.

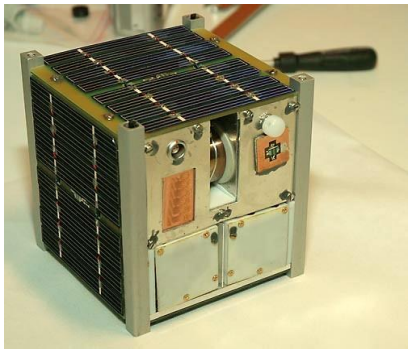
In 1999, California Polytechnic State University (Cal Poly) and Stanford University developed the CubeSat specifications to promote and develop the skills necessary for the design, manufacture, and testing of small satellites intended for low Earth orbit (LEO) that perform a number of scientific research functions and explore new space technologies. Academia accounted for the majority of CubeSat launches until 2013, when more than half of launches were for non-academic purposes, and by 2014 most newly deployed CubeSats were for commercial or amateur projects.

Uses typically involve experiments that can be miniaturized or serve purposes such as Earth observation or amateur radio. CubeSats are employed to demonstrate spacecraft technologies intended for small satellites or that present questionable feasibility and are unlikely to justify the cost of a larger satellite. Scientific experiments with unproven underlying theory may also find themselves aboard CubeSats because their low cost can justify higher risks. Biological research payloads have been flown on several missions, with more planned. Several missions to the Moon and Mars are planning to use CubeSats. In May 2018, the two MarCO CubeSats became the first CubeSats to leave Earth orbit, on their way to Mars alongside the successful InSight mission.

Some CubeSats became the first national satellites of their countries, being launched by universities, state, or private companies. The searchable Nanosatellite and CubeSat Database lists over 2,000 CubeSats that have been and are planned to be launched since 1998.

## Ncube-2

As an example, the Ncube-2, a Norwegian CubeSat (10 cm cube)



# 2. Teams

The core element if the ZR-SAT Competition competition are the Teams, which are made of a number of High School Students plus a Mentor.

## Team

A Team is composed of 5 to 10 High School Students, one of whom acts as Team Leader, supported by a Mentor and, optionally, by a Coadjutor.

Alternatively, a Team may be composed of a Pair of High Schools of the same nationality (one of the two schools is the Leading School), provided that the total number of students is between 5 to 10. The team will have a unique leader plus a Mentor from each High School.

High School Students should be nonprofessionals and be between 14 and 20 years old. In each Team, no more than 80% of the students can be of the same sex, except for some motivated exception. One of the students is the Team Leader and is the reference person for interaction with the National Committee and International Committees.

The school designates, for each Team, a Mentor, i.e. a professor or technical staff that helps the Team in the organization. If a High School has more than one Team, the Mentors of each Team should be different.

The Team may be helped by a Coadjutor - possibly not part of the school - which has to be a nonprofessional in the fields of the ZR-SAT Competition.

## High School Student

A 14 to 20 years old high school student, not professional in the field of the ZR-SAT Competition.

## Team Leader

The Team Leader is a student who acts as the referent of the Team. He/she shall provide all his/her contacts to the Organizing Committee and shall be the one, together with the Mentor, to be contacted by the Organizing Committee during each phase of the ZR-SAT Competition.

## Mentor

A teacher or staff of the High School or of each High School, in case of two schools making up the Team. The Mentor must be distinguished for each Team.

The Mentor is expected to supervise and advise the team but not to actively design and manufacture more than a small fraction of the experiment!

## Coadjutor

The Coadjutor is an adult who is not necessarily structured, as long as he is not a professional in the field related to the topics of the ZR-SAT Competition. The Coadjutor will not have to develop significant parts of the experiment, but only be supportive or advise the students of the team.

As an example, a Coadjutor can also be a former student of the same school, a University student or teacher.

The Coadjutor is expected to supervise and advise the team but not to actively design and manufacture more than a small fraction of the experiment!

## Pair of High Schools

When a High School does not have enough students to create a Team or when it wants to promote interschool cooperation, two High Schools (preferably close to each other) can participate together and share the same Team, which will be composed of students from both schools. One of the schools must be declared as the Leading School. Each Team must have its own Mentor.

# ZR-SAT Phases

## 3. Team Creation

### Team Creation

Team Creation provides, in the order:

- Team Formation
- Team Registration

### Team Registration

Each team shall submit a Registration Form to the National Committee by the Deadline for Registration. The registration form is available from the Competition Web Site (https://zerorobotics.polito.it/).

The form shall be submitted (as an excel file) to leonardo.reyneri@polito.it, claudio.passerone@polito.it, enrico.lorenzini@unipd.it .

## 4. Phase I - Idea Presentation

### Phase I - Idea Presentation

Phase I - Idea Presentation should address, in the order:

- Mission Definition, which identifies a Scientific/Technological Experiment and produces a Idea Presentation Document to be submitted to the Competition Web Site;
- Preliminary Development of the Optional Pre-totype;
- Brief description of the Operation Procedures once the Scientific/Technological Experiment is in orbit.
- Pre-totyping
- Video Production, at the end of which an First Elevator Pitch is produced and submitted to the Competition Web Site; the First Elevator Pitch shall not be published on Social Media by the Teams before the end of the National Competition;
- Video Publishing (by the National Committee);
- Evaluation Phase I (by the other Teams and a Phase I Jury).

### Mission Definition

Each Team must select or define a specific "Space Mission" and identify a specific Scientific/Technological Experiment that is fundamental for the selected Space Mission.

The Scientific/Technological Experiment will be chosen among the Mission Objectives proposed by a Proposing Company or a Team can choose its own, compatible with the Mission Constraints, different each year.

### Preliminary Development

This step consists in the development of conceptual ideas for the proposed Scientific/Technological Experiment, in order to clarify its Scientific/Technological Aspects. Some preliminary analyses will also be carried out and all these aspects will be reported inside a written Idea Presentation Document (a Word document).

### Pre-totyping

Pre-totyping is a way to test a product idea quickly and inexpensively by creating extremely simplified versions of that product to help validate the proposed idea.

During Phase I - Idea Presentation, Teams may use, for instance, cardboard, plastic boxes, 3D printing and any other cheap material and technique to make the idea clear to the Phase I Jury during the First Elevator Pitch;

### Pre-totype

An Optional Pre-totype made of simple and cheap materials.

### Video Production

Development of the First Elevator Pitch, making use of any appropriate tool.

### First Elevator Pitch

A 3 minutes video presentation of the idea, the team, the motivations, the possible implementation.

### Video Publishing

The First Elevator Pitch shall first be uploaded by the Team on the Competition Web Site by the Deadline Submission Elevator Pitch I, then it will be transferred to the ZR-SAT Competition's Social Media by the National Committee right after that date.

### Voting Phase I

Each Team ranks from 1 to N-1 of all OTHER Teams, from the best to the worst, without ex-aequo.

### Evaluation Phase I

The Phase I Jury will also give its own vote.

Final score will be a combination (TBD) of other Teams' and the Phase I Jury's scores

At the end of the evaluation, all the votes given are public.

### Selection Phase I

**National Committee**, based on results of Voting Phase I and Evaluation Phase I (Ranking Phase I) selects a number of teams (25 teams) to proceed to phase II.

# 5. Idea Presentation

### Idea Presentation Document

An Idea Presentation Document of the Scientific/Technological Experiment selected by the Team, under the form of a Word or PDF document of max 3 pages.

It shall contain at least:

- Mission Objectives;
- Experiment Description

- Proposed Method;
- Scientific/Technological Aspects;
- Operation Procedures
- Bibliography

The Idea Presentation Document shall be uploaded to the Competition Web Site by the Deadline Submission Elevator Pitch I.

| | |
|---|---|
| 3 pages | Max length of the Idea Presentation Document |

### Mission Objectives

What are the aims of the proposed Space Mission?

What is it expected to do during its lifetime?

What is the expected mission duration?

### Experiment Description

A short description of the proposed Scientific/Technological Experiment - part of the Space Mission - which will be prototyped or developed in the course of the ZR-SAT Competition.

### Proposed Method

Which method is used to carry out the Scientific/Technological Experiment?

### Scientific/Technological Aspects

What are the physical, mathematical, technological and scientific aspects that need to be addressed to complete the experiment?

# 6. First Elevator Pitch

### First Elevator Pitch

A short description of the proposed Scientific/Technological Experiment that explains the concept in a way such that any listener can understand it in a short period of time (max 3 minutes). This description shall explain what the proposed Scientific/Technological Experiment is for, what it does, why it is needed, and how it will get done. It should also contain Mission Objective. It shall at least explain what the Scientific/Technological Experiment is and its value. The First Elevator Pitch may also show the Optional Pre-totype, for a better comprehension and should also contain a brief Team and School Description and possibly show all the members of the Team.

It is advised - although not compulsory - that the First Elevator Pitch contains the same elements of the Idea Presentation Document: Mission Objectives, Experiment Description, Proposed Method, Scientific/Technological Aspects, Operation Procedures.

The First Elevator Pitch, together with the associated Idea Presentation Document will be used to convince the Phase I Jury that the proposed Scientific/Technological Experiment is the one which deserves the first prize. The goal is simply to convey the overall concept or topic in an exciting way.

The name —elevator pitch— reflects the idea that it should be possible to deliver the summary in the time span of an elevator ride, or approximately a few minutes.

The First Elevator Pitch shall be uploaded to the Competition Web Site by the Deadline Submission Elevator Pitch I.

| | |
|---|---|
| 3 minutes | Max duration of the First Elevator Pitch |

### Team and School Description

A brief description of the Team and the school

### Mission Objectives

What are the aims of the proposed Space Mission?

What is it expected to do during its lifetime?

What is the expected mission duration?

### Optional Pre-totype

**Pretotyping** is a way to test a product or an experiment idea quickly and inexpensively by creating an extremely simplified version of that product or experiment to help validate the idea.

A Optional Pre-totype is a partial mock-up of the intended idea that can be built in minutes, hours or days instead of weeks, months or years. It can be made with simple and cheap materials, such as: plastic, cardboard, paper, wires, etc.

In the specific context, pretotyping is aimed to help Teams to clarify to the Phase I Jury the basic concepts of the proposed Scientific/Technological Experiment, its implementation and its potential applications.

The Optional Pre-totype is optional.

### Proposed Method

Which method is used to carry out the Scientific/Technological Experiment?

### Scientific/Technological Aspects

What are the physical, mathematical, technological and scientific aspects that need to be addressed to complete the experiment?

### Experiment Description

A short description of the proposed Scientific/Technological Experiment - part of the Space Mission - which will be prototyped or developed in the course of the ZR-SAT Competition.

# 7. Phase II - Prototyping

### Declaration Interest International

Teams which are willing to proceed to the International Phase, if their project will be among the selected ones, shall declare it during this phase, prior to Video Publishing.

This is mandatory as this information may affect the results of Selection Phase II. The selection made is binding, in the sense that a Team which declares its intention to proceed to the International Phase, if selected, shall then take all necessary steps to actively participate in the International Phase.

### Prototype Development

Development of a simplified Simple Prototype for the proposed Scientific/Technological Experiment, in order to prove and/or show the ideas behind the selected Scientific/Technological Experiment. It is clear that the Simple Prototype will be presented and explained on the Earth, where gravity is not zero, therefore the prototype shall somehow mimic the absence of gravity in some simplified manner.

### Presentation Development

Development of the Second Elevator Pitch, which will describe the idea and demonstrate the Simple Prototype, within the constraints posed by the presence of gravity on the Earth.

### Video Publishing

The Second Elevator Pitch shall first be uploaded by the Team on the Competition Web Site by the Deadline Submission Elevator Pitch II, then transferred to the ZR-SAT Competition's Social Media by the National Committee right after that date.

### Voting Phase II

Each Team ranks from 1 to N-1 of all OTHER Team.s, from the best to the worst, without ex-aequo.

### Evaluation Phase II

The National Jury will also give its own vote.

Final score will be a combination (TBD) of other Teams' and the National Jury's scores

At the end of the evaluation, all the votes given are public.

### Selection Phase II

The best 6 teams are admitted to the National Final, plus as many other as required to have at least three Teams in the National Final which declared interest in proceeding to the International Phase.

### Prototype Improvement

The Teams selected for the National Final will be given some time to improve their Simple Prototype according to the outcome of Evaluation Phase II, before the National Final event.

# 8. Second Elevator Pitch

### Second Elevator Pitch

An improved and longer version of the First Elevator Pitch with more details and which necessarily shows the Simple Prototype developed. Max Second Elevator Pitch duration is 5 minutes

The Second Elevator Pitch will be used to convince the National Jury that the proposed Scientific/Technological Experiment is the one which deserves the first prize. The goal is simply to convey the overall concept or topic in an exciting way.

The Second Elevator Pitch shall be uploaded to the Competition Web Site by the Deadline Submission Elevator Pitch II.

| | |
|---|---|
| 5 minutes | Max duration of the Second Elevator Pitch. |

### Team and School Description

A brief description of the Team and the school

### Mission Objectives

What are the aims of the proposed Space Mission?

What is it expected to do during its lifetime?

What is the expected mission duration?

### Simple Prototype

A Simple Prototype is a partial mock-up of the intended idea that shows in practice the key concepts of the Scientific/Technological Experiment.

The difference w.r.t. the Optional Pre-totype is that the latter is typically a very simple mock-up made of poor materials and need not be functional, while the Simple Prototype has to be functional, even in a simplified way (e.g. automatic controls can be substituted by manual operations, absence of gravity can be emulated by rubber bands or springs, power supply can be generated by batteries, etc.)

The Simple Prototype need not be compliant with space and CubeSat constraints despite it should preferably be developed such as to be later easily adapted to a CubeSat.

In the specific context, Simple Prototype is aimed to help Teams to clarify to the National Jury the concepts and potential implementation of the proposed Scientific/Technological Experiment, its implementation and its applications.

### Proposed Method

Which method is used to carry out the Scientific/Technological Experiment?

### Scientific/Technological Aspects

What are the physical, mathematical, technological and scientific aspects that need to be addressed to complete the experiment?

### Experiment Description

A short description of the proposed Scientific/Technological Experiment - part of the Space Mission - which will be prototyped or developed in the course of the ZR-SAT Competition.

## 9. National Final

### Public Presentation

Participation to the National Final is mandatory as judgement is based on the physical presentation of the Simple Prototype to the National Jury.

Presentation can be with any means, as long as it shows the prototype. For instance:

- Video + prototype
- Prototype + demo

More details on the National Final will follow later.

### Evaluation

The National Jury alone will give its own vote. Teams will not vote during this phase.

At the end of the evaluation, all the votes given are public.

### Selection International Finalists

International finalists will be chosen as the three teams with the highest scores among the national finalists who have declared their willingness to proceed to the International Phase.

### Prize Giving

Awards will be given at the end of the National Final event.

# 10. International Phase (Preliminary)

Details of international phase are preliminary !!!

### Team Extension

The three selected Teams from each Participating Nation are allowed to optionally extend their team by either adding other students or getting allied with another Team (not among the other international finalists); either an existing Team or possibly a new one with the same characteristics of other Teams, but potentially with capabilities of manufacturing prototypes.

### Experiment Development

The extended Teams shall produce a fully functional Scientific/Technological Experiment compatible with the given Size and Constraints and with the hosting CubeSat.

### Integration

The Scientific/Technological Experiment will be integrated with either a hosting CubeSat which can be purchased separately or with the PC interface which will be obtained by the Organizing Committee.

What type of integration will be selected will NOT affect the final evaluation at all.

### Team Testing

The Team will perform some functional testing with either the hosting CubeSat or the PC interface.

### Public Presentation

TBD

Presentation can be with any means, as long as it shows the Scientific/Technological Experiment. For instance:

- Video + Scientific/Technological Experiment + demo
- Scientific/Technological Experiment + demo

# 11. International Final (Preliminary)

### Committee Testing

The Organizing Committee will perform some functional testing with either the hosting CubeSat or the PC interface.

### Public Presentation

TBD

Presentation can be with any means, as long as it shows the Scientific/Technological Experiment. For instance:

- Video + Scientific/Technological Experiment + demo
- Scientific/Technological Experiment + demo

### Evaluation

The International Jury alone will give its own vote, based on testing results and on the team's Public Presentation. Teams will not vote during this phase.

At the end of the evaluation, all the votes given are public.

### Prize Giving

Awards will be given at the end of the International Final event.

## 12. Deliverables

### Idea Presentation Document

### First Elevator Pitch

### Optional Pre-totype

### Simple Prototype

### Second Elevator Pitch

# 2019 Competition Rules

## Competition Rules

The rules, different for each year, describe in detail all the phases of the ZR-SAT Competition, the calendar, the requirements and deliverables, as well as the evaluation criteria. In particular they include:

- The Mission Objectives, which can either be freely decided by each team, or can be chosen among those proposed by a Proposing Company working in the space field but within the Size and Constraints given each year by the International Committee
- The Scientific/Technological Experiment dimensions and constraints: it should be hosted by a CubeSat (of a single or multiple units), with a maximum mass, using a certain voltage in a given range and consuming a maximum power or energy, it should be accessible from the outside for testing, it should be designed for a terrestrial, lunar or deep space orbit, depending on the mission specifications. These constraints do NOT apply to Optional Pre-totype and the Simple Prototype.
- The competition phases: for each phase a deliverable is specified, and a deadline to provide the deliverable is given.
- The Evaluation Criteria: for each Deliverables, a number of aspects that the jury should consider for evaluation are listed. For instance they might include vision, usefulness, originality, feasibility, costs, communication, clarity, technical aspects, and so on.

## Proposing Company

An external Company, Agency or University proposing a challenging Mission Objectives compatible with the capabilities of Teams of High School Students.

## Size and Constraints

Every year, the rules will define at least:

- Physical Dimensions
- Mass
- Available electric power
- Any requirement to access the exterior of the CubeSat (e.g. for a camera)
- Orbit (likely aboard ISS)
- Communication protocol with the CubeSat

Size, mass, electric power and communication protocol constraints do not apply to the Optional Pre-totype and the Simple Prototype but only to the Scientific/Technological Experiment in the International Phase. All other constraints apply to each phase of the ZR-SAT Competition.

| | |
|---|---|
| Maximum size | Maximum size of the Scientific/Technological Experiment shall be 80x80x80 mm.<br>This constraint does not apply to Optional Pre-totype and Simple Prototype. |
| Maximum mass | Maximum mass of the Scientific/Technological Experiment shall be 800 g.<br>This constraint does not apply to Optional Pre-totype and Simple Prototype. |
| Average electrical power | Average electrical power consumed by the Scientific/Technological Experiment shall be less than 0,5W. Power is averaged over 24h.<br>This constraint does not apply to Optional Pre-totype and Simple Prototype. |

| | |
|---|---|
| Peak electrical power | Peak electrical power consumed by the Scientific/Technological Experiment shall be 10W. for not more than 1min every 2h.<br>This constraint does not apply to Optional Pre-totype and Simple Prototype. |
| External accessibility | The Scientific/Technological Experiment is allowed to have an access (optical or radio) to the exterior of the CubeSat on only one side, less than 50 mm diameter. |
| Orbit | The orbit of the CubeSat (or ISS) hosting the Scientific/Technological Experiment is Low Earth Orbit between 200 km and 1000 km of altitude. |
| Communication | The Scientific/Technological Experiment shall only communicate with the hosting CubeSat by means of a TBD interface and protocol (e.g. I2C or SPI or RS232).<br>This constraint does not apply to Optional Pre-totype and Simple Prototype. |
| Outgassing | The Scientific/Technological Experiment shall not eject any liquid or solid object of any type or mass<br>The Scientific/Technological Experiment shall not emit gases more than 1% of the experiment mass.<br>This constraint does not apply to Optional Pre-totype and Simple Prototype. |

## Evaluation Criteria Phase I

Only the First Elevator Pitch will be evaluated and the end of Phase I - Idea Presentation (possibly with the help of the Idea Presentation Document). The following criteria will be considered during evaluation:

- the vision, that is the capability to see at the future;
- the usefulness, that is what problem is solved by the proposed Scientific/Technological Experiment;
- the originality, that is how original is the proposed Scientific/Technological Experiment w.r.t. existing space experiments;
- the feasibility, that is how simple is to build the Scientific/Technological Experiment;
- the technical aspects, if any;
- the Operation Procedures to operate it while in space;
- the communication and clarity of the presentation, including the language;

## Evaluation Criteria Phase II

Only the Second Elevator Pitch will be evaluated and the end of Phase II - Prototyping (possibly with the help of the Idea Presentation Document). The following criteria will be considered during evaluation:

- the vision, the usefulness, the originality and the feasibility, as in the First Elevator Pitch;
- the implementation of the Simple Prototype;
- the quality of its realization;
- the performance of the Simple Prototype;
- the key technical aspects faced;
- the coherence w.r.t. the original idea presented in the Experiment Description section of the Idea Presentation Document;

- the Operation Procedures to operate it while in space;
- the communication and clarity of the presentation, including the language;

## Evaluation Criteria Final

TBD

## Calendar

| | |
|---|---|
| Deadline for Registration | November 30th, 2019 |
| Deadline for Presentation Submission | December 15th, 2019 |
| Deadline Submission Elevator Pitch I | January 26th, 2020 |
| Deadline Voting Phase I | February 2nd, 2020 |
| Deadline Evaluation Phase I | February 8th, 2020 |
| Deadline Selection Phase I | February 12th, 2020 |
| Deadline Submission Elevator Pitch II | April 5th, 2020 |
| Deadline Voting Phase II | April 12th, 2020 |
| Deadline Evaluation Phase II | April 19th, 2020 |
| Deadline Selection Phase II | April 22th, 2020 |
| National Final Date | Tentative date week May 4th to May 8th, 2020 |
| International Final Date | Tentative date October to December 2020 |