

**Fly Your Satellite! 3**

**CubeSat Proposal**

**-CubeSat Name-**

|  |  |
| --- | --- |
| CubeSat Name |  |
| Form factor (1U, 2U, 3U) |  |
| Expected entry level (Phase C/ D) |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **Proposing university/ institute** | | **Team leader** | |
| Name |  | Name |  |
| Department  If applicable |  | Corresponding address |  |
| City |  | Telephone number |  |
| Country |  | E-mail address |  |

The team leader herewith declares that all the information provided in this proposal is true and correct to the best of his/her knowledge and undertakes to inform ESA of any changes therein immediately.

|  |  |  |
| --- | --- | --- |
|  |  |  |
| Name | Date | Signature |

CubeSat Proposal Submission

This proposal template is for teams applying to enter the Fly Your Satellite! programme. Please refer to the website for more information on the programme, phases, entry levels, how to apply, and conditions to apply.

<http://www.esa.int/Education/CubeSats_-_Fly_Your_Satellite>.

**Proposal technical content**

Note that the proposal might seem demanding in terms of technical content. Candidate teams might not be familiar with the terminology used or they might be not ready to submit all the requested technical data in each section. One of the goals of the Fly Your Satellite! programme is to teach these aspects related to space mission design and project documentation but teams are invited to do their best to complete the proposal.

* Teams are encouraged to fill the proposal with as much information as possible, which will certainly benefit them during the proposal evaluation.
* If selected to participate in the programme, all the information reflected in the proposal will be reused during the course of the programme.
* The content of each section can be tailored according to the maturity of the CubeSat design. For example, when applying to Entry Level 2 (Phase D), teams are expected to provide the necessary additional information that demonstrates that the team is ready, or almost ready, to start the integrated system tests, e.g. results of AIV, test reports.

***Additional Information***

*Additional information that may be provided is highlighted within the template in a box. It contains suggestions to complement the (sub)sections, in case the information is available. For the purpose of demonstrating readiness for Entry Level 2, it is recommended to provide the additional information.*

**Proposal general formatting**

* The proposal should be targeted to be below 50 pages for the main body and below 150 pages including appendices. There is no minimum number of pages.
* For the sake of good readability, additional lower level headings can be added to better structure text and paragraphs throughout the document.
* The overall structure of the proposal template should be maintained. Sections shall not be deleted, whereas, a short sentence shall be written if the section is not applicable to the proposal under submission.
* Detailed information that does not fit in the body of the proposal should be added in the Appendices. Briefly report in dedicated subsection(s) what information can be found and the reference(s) to the Appendices in the body of the text.
* Before submitting, please ensure that the proposal is complete and that all the grey comments have been removed.
* Please ensure that the CubeSat proposal and all attachments are legible.

The information provided in the proposals will only be distributed to and reviewed by the ESA CubeSat Evaluation Panel for the purpose of the evaluation.

**The proposal shall be uploaded in one PDF file to the online submission form no later than 13 October, 2019 23:59pm CEST.**

Checklist

|  |  |
| --- | --- |
| **Checklist** of the “**Fly Your Satellite!3**” programme | |
| The CubeSat is 1U, 2U or 3U |  |
| The detailed design of the system is finalized |  |
| The team is ready to proceed to the satellite integration/ integrated satellite verification campaign |  |
| The CubeSat project is an educational project |  |
| The CubeSat team is from a university based in an ESA Member State, Canada or Slovenia |  |
| The CubeSat project is endorsed by the university with the signed endorsement letter attached to the online submission form |  |
| The resume of the team leader is attached to the online submission form |  |
| A core team of at least 8 university student team members are participating in the project and comply with the eligibility criteria |  |
| Of these 8 a minimum of 4 university student team members are at master or PhD level |  |
| In addition to the 8, a minimum of 2 supervisors are covering the following three functions for the CubeSat team:  Professor, Team leader, System engineer |  |
| The CubeSat team will rely on their own funding/sponsorship for the development of their CubeSat |  |
| A letter from authorities of the university confirming that the funds necessary to build and operate the CubeSat (if selected to FYS) will be available is attached to the online submission form |  |
| No more than one proposal from the same university faculty/department has been submitted for the application to Fly Your Satellite! |  |
| The university has carefully read the general Terms and Conditions before submitting an application to Fly Your Satellite! |  |

Status Overview

*Provide a short description of the current status of the CubeSat project including on-going current activities and activities planned for the near future. Activities in the table below may serve as a reference.*

*Please complete as well the following table; additional rows can* be *added.*

| **Phase** | **Started** | | **Concluded** | | **Comments** |
| --- | --- | --- | --- | --- | --- |
| **[Y/N]** | **Date (mm/yy)** | **[Y/N]** | **Date (mm/yy)** |  |
| Mission analysis/ need identification |  |  |  |  |  |
| Concept definition / Feasibility study | Y | 01/17 | Y | 01/18 |  |
| Preliminary design phase |  |  |  |  |  |
| Detailed design |  |  |  |  |  |
| Thermal model / analysis performed |  |  |  |  |  |
| Structural model / analysis performed | Y | 01/18 | N |  | - CAD design finalised  - FEA ongoing |
| Other model/ analysis performed (if yes, specify which) |  |  |  |  |  |
| CubeSat components/ subsystems/ payload procured or manufactured  (if yes, specify which component/ subsystems/ payloads) | Y | 01/15 | N |  | - EM structures available  - all other EM subsystems to be procured/ manufactured |
| Subsystem / payload / ground station tests performed (if yes, specify which tests and on which subsystem(s) and/or payload(s)) |  |  |  |  |  |
| Flatsat testing performed |  |  |  |  |  |
| CubeSat Integration on System level |  |  |  |  |  |
| CubeSat fully integrated |  |  |  |  |  |
| Ground station installed |  |  |  |  |  |
| System level tests performed (if yes, specify which tests e.g. functional, vibration, thermal vacuum, etc.) |  |  |  |  |  |
| Flight ready |  |  |  |  |  |
| Ground station operational |  |  |  |  |  |
| Launch opportunity secured |  |  |  |  |  |
| Other (please specify) |  |  |  |  |  |

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# Abstract

Briefly summarize the project including: information of the team, the mission objectives, basic description of the CubeSat, the expected outcome and its possible future applications. The abstract shall be self-explanatory and not contain figures nor references.

# Abbreviations and Acronyms

*List all the abbreviations and acronyms used in the text, in alphabetical order.*

# Mission Description

## Mission Context

Formulate the mission statement.

Give a description of where the idea of the CubeSat project originates and what the motivation for the CubeSat project is.

Provide the context in which the mission will be executed, highlighting possible knowledge gaps that can be fulfilled by the mission (e.g. technological enhancement, scientific return, educational return etc.).

Explain whether the subject has been investigated in the past and give existing literature on the subject.

*Provide a justification to implement this mission on a CubeSat as opposed to other ground, air- or space-based platforms.*

## Mission Objectives

Formulate and give a description of the main objectives of the project, including the educational objectives and the mission objectives (technological experiment, scientific research, etc.).

*Give a description of the identified mission success criteria (e.g. measurement of performance or effectiveness, minimum objectives to be achieved, etc.).*

Give a description of the methodology in which the mission success criteria are meant to be achieved.

## Mission Analysis

*Indicate the acceptable range of orbits and the general mission constraints.*

*Specify the nominal / ideal orbit (or orbit range) as well as the flexibility to other orbits, i.e. the range of orbits where the system may suffer a reduction in performance, but can still function with some operational adaptations, and obtain enough scientific/ engineering data to accomplish the mission objectives. Information may include altitude range, inclination, orbital lifetime requirements, other constraints such as SSO, eccentricity, RAAN, launch window, etc.*

Explain if the ISS orbit is acceptable for your mission and complement with the results of the mission analysis.

## Mission Phases and Mission Timeline

Identify and briefly describe the mission timeline, including all mission phases and durations (Launch preparation, Launch and Early Operations Phase, In-orbit commissioning, Operational phase, End of Life and Post mission phase).

*Provide a detailed description of the various mission phases. For each phase this could include for example information about top level objectives of the phase, initial condition (e.g. after detumbling) and final condition, required interfaces with other systems (e.g. ground station), duration, constraints, potential off-nominal events.*

## CubeSat Operational modes

Give a description of all CubeSat operational modes (e.g. detumbling mode, safe mode, experiment mode, etc.) within each mission phase, including their purpose (i.e. circumstances under which they shall be used), which subsystems are active and any operational constraints (for example whether a particular attitude is required).

Include a clear diagram of all modes and the transitions between them (automatic / by command).

## Concept of Operations

Give a description of how the mission will work in practice to meet mission objectives and the system characteristics from an operational perspective.

This could include, for example, information about on-board autonomy, mission planning, scheduling (e.g. payload activation and data recollection scheduled or activated by telecommand, etc.), and the strategy for on-board data generation, storage and downlink.

# Design Definition

## System Description

### Physical Architecture

Provide a block diagram of the physical architecture of the system showing the subsystems breakdown into hardware products or elements and their interconnection and interfaces.

Provide an exploded view of the system labelling all the key components/parts.

Show in a figure the envelope size dimensions of the spacecraft in stowed configuration (e.g. when inside a deployer) including labels to the location of key features such as the RBF pin, umbilical connectors, separation springs, deployment switches, etc.

Show in a figure the envelope size dimensions of the spacecraft in deployed configuration (e.g. during operations) labelling the used deployable parts (such as antennas or other deployable mechanisms).

### Mass budget

Report the mass budget and explicitly indicate the margins that are applied, with a rationale for each applied margin.

## Payload & Subsystems Design Definition

### Payload(s)

Give a description of the payload architecture, operating modes, key features, and interfaces; include figures and schematics where needed. Provide a short justification for the chosen design.

***Additional information***

*Additional information may be added such as budgets, performed analyses and/or simulations, test reports, interaction with ground support equipment, operational constraints, or any other.*

### Attitude & Orbit Control Subsystem (AOCS)

*Give a description of the AOCS physical architecture, operating modes, key features, and interfaces (including interfaces among equipment); include figures and where needed. Provide a short justification for the chosen design.*

***Additional information***

*Additional information may be added such as momentum budgets (including pointing requirements (if any), momentum budget concerning slew manoeuvres (i.e. required momentum storage and control authority), pointing error budgets, attitude determination and control strategies and algorithms, timelines and/or modes in which each algorithm is executed, results of sensitivity analyses, interaction with ground support equipment, operational constraints, test reports, or any other.*

### Electrical Power Subsystem (EPS)

Give a description of the EPS physical architecture (e.g. solar array architecture and dimension, battery parameters), system power regulation and management, key features, and interfaces; include figures and schematics where needed. Provide a short justification for the chosen design.

Give a description and graphical representation of the circuit of independent inhibits (e.g. kill switch, Remove Before Flight pin, etc.), which ensure that the spacecraft is off during ground processing, launch and, if applicable, storage onboard ISS.

Include additional information on the selected batteries and their power management circuitry including the presence of protections (e.g. current interrupting device, overpressure venting valves, circuit for over discharge limitation, undervoltage protection, etc.).

Indicate whether the supplier declares the batteries have any significant heritage of usage in space application and whether the batteries are compatible with ISS requirements and/or already certified for ISS safety.

Include a power budget and energy budget for each operating mode. Include details on how it was calculated (e.g. efficiencies/ loss values used).

***Additional information***

*Additional information may be added such as depth of discharge for each mode, description of loading cycles, performed analyses/ simulations, test reports, or any other.*

### On-board Data Handling (OBDH) and On-board Software architecture (OBSW)

Give a description of the OBDH physical architecture, key features, and interfaces; include figures and schematics where needed. Provide a short justification for the chosen design.

Provide a Memory and CPU budget concerning payload and housekeeping data rates, how this data is processed, how the OBC can process this amount of data, or how the generated data can be stored on-board and downloaded.

*Provide the high level architecture of the On Board Software (e.g. Operating System)*

***Additional information***

*Additional information may be added to the* On Board Software architecture (with processes and/or threads, building blocks, etc.). On Board Software architecture re-configurability (patching procedure), sampling frequencies, description of FDIR approach, means implemented to limit sensitivity to radiation, *performed analyses and/or simulations, test reports, or any other.*

### Telemetry, Tracking and Communications (TT&C) subsystem

Give a description of the TT&C physical architecture (antennas, transmitter, receiver, etc.), key features and interfaces; include figures and schematics where needed. Provide a short justification for the chosen design.

Specify the uplink and downlink frequencies. Provide a link budget with foreseen frequencies, data rates and modulation for communications uplink & downlink, including the *definition of worst and nominal communication cases.*

Provide a list of the telemetry and telecommands needed to operate the CubeSat, including its name, description and units.

***Additional information***

*Additional information may be added such as performed analyses or simulations, test reports, or any other.*

### Structures and Mechanisms

Give a description of the satellite structure and any mechanisms, key features and interfaces; include figures and schematics where needed. Provide a short justification for the chosen design.

Provide details of the implemented separation springs, and indicate if there is a possibility to change separation springs if needed.

***Additional information***

*Additional information may be added such as definition of resonance frequencies and modes, moments of inertia for each satellite configuration, explanation of each mechanism and the resulting disturbances, performed analyses and/or, test reports, or any other.*

### Thermal control

Give a description of the thermal control system including architecture, key features, interfaces, and description and specification of sensors, heaters or other parts contributing to the thermal control (if any); use figures and schematics where needed. Provide a short justification for the chosen design.

Provide a table with the temperature ranges for each subsystem/component (operational and non-operational).

***Additional information***

*Additional information may be added such as performed thermal analyses and or simulations, identification of worst-case environment, test reports, or any other.*

### Propulsion (when applicable)

In case the CubeSat is equipped with a propulsion system, provide a description of the propulsion system physical architecture (propulsion type, propellant type, vessels, propellant reservoirs, tubes, nozzles, valves), key features and interfaces; include figures and schematics where needed. Provide a short justification for the chosen design.

***Additional information***

*Additional information may be added such as performed such as tank structural analyses,* *performance limits, hazards, inhibits, inhibit controls, etc.*

### Grounding Scheme (EMC/EMI)

*Give a brief description of the grounding approach and its scheme.*

*Give a description of the EMC Control plan (if any).*

### Ground Segment

Give a description of the ground segment physical architecture, key features and location; include figures and schematics where needed.

***Additional information***

*Additional information may be added such as satellite accesses analysis, antenna tracking design, software architecture and protocols, operator graphical user interface design, ground station design parameters such as transmitting power, signal amplification, line loss, performed analyses and/or simulations, test reports, or any other.*

## Technical Requirements Specification

Fill in Appendix A.1 Technical Requirements Specification.

## Technical challenges

Give a description of the main challenges and potential events that have or might have negative impacts (risks) to the project e.g. technical performance, safety of the system, an assessment of the follow-up actions.

*This could include for example system safety and reliability analysis, possible mission off-nominal events, Fault tree analysis, Failure Mode Effect & Criticality Analysis (FMECA), etc.*

# Assembly, Integration and Verification

## Model Philosophy

Give a description of the selected model philosophy and describe which models will be used (Development Model, Engineering Model, Qualification Model, Flight Model, Protoflight Model, any other model of the satellite or of some of its subassemblies).

*Give a description of the main differences between the models and what tests are planned to be performed on which model.*

**Additional Information**

A flowchart could be provided that indicates, how each subsystem evolves through its model philosophy, from subsystem-level to system-level. As an example, this diagram could show how the payload would start as a development model, then become a protoflight model that is finally integrated in the system-level protoflight model.

## AIV Activities

Give a description of the planned main activities in the assembly, integration and verification process of the different models used.

**Additional Information**

In case assembly, integration and test activities have been performed on subsystem level and on integrated system level, more details should be provided for each test activity including when the test has been performed, its objective, duration and the results.

List of procedures and obtained results can be added in the dedicated appendices .

## Processes applied

Give a description of the treatments the CubeSat or some of its parts will undergo/ underwent (e.g. surface treatments, conformal coating, whether thermal bake-out is planned/ has been performed, etc.).

## Development Status Overview

Summary of the current status of subsystems, payload(s) and ground segment, according to the example given in the table below. For each subsystem/ element include the development status (procurement/ manufacturing/ integration status) and, where applicable, the subsystem level tests that have been performed and specifying which tests.

| **Subsystem/ element** | **Manufacturer (in-house/COTS)** | **Current available model (if any)** | **Status** |
| --- | --- | --- | --- |
| Payload 1 | In-house | EM | *- Manufactured and assembled.*  *- Performance test performed.*  *- Vibration test ongoing.* |
| FM | - To be manufactured |
| TT&C | In-house | EM | *- Ready to be manufactured. Expected delivery Dec 2019.* |
| FM | - To be manufactured. |
| *Structure* | *<Company name>* | *FM* | *- CAD design finalised*  *- Structural analysis ongoing*  *- To be ordered.* |
| *Ground Segment* |  |  |  |

## Facilities and Ground Support Equipment

List the support facilities (cleanroom, test facilities, etc.) available to the team and provide a short description. When applicable include the names of the organisations, departments or companies that provide in-kind support, if any.

Give a description of the test software and test tools to be utilized, and the electrical and mechanical Ground Support Equipment (EGSE + MGSE) foreseen to be used for handling on ground and tests.

## CubeSat Testing

Give a description of how the CubeSat will be prepared for testing in environmental testing facilities (shaker and thermal vacuum chamber) using the table below.

*Additional rows can* be *added.*

|  |  |  |
| --- | --- | --- |
|  | [Y/N] | Describe **what**, **how** and to **what level** |
| Recharging during testing |  |  |
| Switching on/ off during testing  (also inside the thermal vacuum chamber) |  |  |
| Send and receive telecommands to/ from your CubeSat (also inside the thermal vacuum chamber). |  |  |
| Test sensors installed | Y | The CubeSat will have X thermocouples installed, which will be cut after the TVAC testing |
| Software updates are possible on-ground/ in orbit after testing |  |  |
| Accessibility to the internal part of the satellite for executing repairs or change components |  |  |
| Screws and nuts secured inside/ outside the CubeSat |  |  |
| Other (please specify) |  |  |

## Fly Your Satellite! Design Specification – Compliance Matrix

Attach the filled in ‘Fly Your Satellite! Design Specification – Compliance Matrix’ in Appendix A.2

# Project Organisation

## Team Information

Team Leader

|  |  |
| --- | --- |
| *Title, Name* |  |
| *Nationality* |  |
| *University* |  |
| *Department* |  |
| *Country* |  |
| *Email* |  |

Endorsing Professor

|  |  |
| --- | --- |
| *Title, Name* |  |
| *Nationality* |  |
| *University* |  |
| *Department* |  |
| *Country* |  |
| *Email* |  |

System Engineer

|  |  |
| --- | --- |
| *Title, Name* |  |
| *Nationality* |  |
| *University* |  |
| *Department* |  |
| *Country* |  |
| *Email* |  |

List of Students

Provide an overview of the key student team members currently involved in the programme.

|  |  |  |  |
| --- | --- | --- | --- |
| (1) | **First name** | (7) | **# of years** being at University so far (e.g. BSc + MSc) |
| (2) | **Last name** | (8) | **Field of study** (e.g. aerospace engineering) **& Specialisation** (e.g. Space Systems, Materials and Structures, etc.) |
| (3) | **Birth date** dd/mm/yyyy | (9) | **Function** in the project(e.g. outreach, power subsystem) |
| (4) | **Nationality** country code | (10) | Expected date of **Graduation** mm/yyyy |
| (5) | **University** of enrolment | (11) | Preparing graduation **Thesis** within project (Y/N)+topic |
| (6) | Current **Level** of study(BSc/MSc/PhD) |  |  |

| **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** | **(8)** | **(9)** | **(10)** | **(11)** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **First name** | **Last name** | **Birth date** | **Nationality** | **University** | **Level** | **# of years** | **Field of study & specialisation** | **Function** | **Graduation** | **Thesis (if any)** |
| Jon | Doe | 24/12/1988 | IT | University of Great Knowledge | MSc | 5 | Aerospace engineering  Space Systems | AOCS | 01/2020 | Y - AOCS design for a cubesat |
|  |  |  |  |  |  |  |  | System Engineer |  |  |
|  |  |  |  |  |  |  |  | Power |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |

## Organigram

Show in an organigram the work distribution and the responsible team members per area (e.g. in a project Work Breakdown Structure (WBS), Organizational Breakdown Structure (OBS), Responsibility assignment matrix (RAM) and/or Work Package Descriptions (WPD), etc.). Indicate who are students, professors/ experts of the university and the external parties that provide support.

Give a description of the responsibilities of the team members and the available manpower (e.g. weekly dedication to the project by the students).

In case the development of the project is shared with another party explain how the collaborations with other organisations or institutions will be practically arranged. Include how you will tackle the challenges that may arise and include a description of the mutual agreements.

## Project Planning

Present the planning of your project (e.g. in a Gantt chart), showing when the project started and all major activities with planned milestones and tasks expected duration. The planning should include those activities for each planned model (e.g. engineering model, flight model), both at subsystem and system level.

*Include a detailed description of the on-going and upcoming activities (including documentation and review statuses) in the current phase of the CubeSat team.*

## Cost Budget

Provide the cost breakdown of the whole project; indicate who the funding organisations (sponsors) are, what part they will sponsor and for which part you still need to identify funding organisations.

## Outreach

Give a description of all outreach and communication activities. Define how the team will promote the CubeSat project in different media, including written media, radio, television and the internet.

The section shall include:

* A description of how it is planned to promote the CubeSat (Facebook, web, etc.);
* The planned contact with media and the planned presentations at universities, local schools, events, fairs etc.;
* Plans for the production of promotional materials (videos, animations, posters, stickers, goodies, etc.);
* The URLs/addresses for the team’s web-based accounts;
* Any other matter the team believes is important for the outreach & communication campaign.

## Main Challenges to the Project

Give a description of the main challenges and potential events that have or might have negative impacts (risks) to the project e.g. lack of funding, project schedule, procurement delays, manpower, student turnovers and an assessment of the follow-up actions.

# Academic Return

Give a brief description of the background of the university. The proposing organisation shall report concisely their experience in building educational satellites, if any, or in running other sorts of educational space-related hands-on projects.

Give a description of how the CubeSat is used for educational purposes in the university and how the project will be included in the syllabus of students (e.g. part of master or PhD thesis, a research programme, or any form of project supported by the applicant’s university, etc.).

Give a description of the main motivations for applying to the Fly Your Satellite! programme and what kind of support the team is seeking for in the programme.

# References

# Appendix A: Technical specification

## A.1 Technical Requirements Specification

*List all the technical requirements. The following table may be used. If the team has available a Technical Specification, it may be attached in any format (also in case it includes more information beyond the Requirement text, such as verification strategy, parent/child relations, etc.).*

|  |
| --- |
| **Requirement Identification**  All requirements should be identified with a unique identifier |
| **Requirement Text**  Definition of the requirement |

| **Req ID** | **Requirement text** |
| --- | --- |
|  |  |
|  |  |
|  |  |

## A.2 Fly Your Satellite! Design Specification – Compliance Matrix

Attach the filled in ‘Fly Your Satellite! Design Specification – Compliance Matrix’ in this appendix.

To receive a copy of the Fly Your Satellite! Design Specification (FDS) document and the FDS - Compliance Matrix, please send an email to cubesats@esa.int.

# Appendix B Additional Pictures of satellite subsystems / components, antennas and ground station



Figure 1: <Engineering model> Insert caption

# Appendix C Analysis/ Modelisation reports (if Applicable)

# Appendix D Test reports (if applicable)

# Appendix E Assembly and integration reports (if applicable)

# any other appendix