



→ **EUROPEAN ASTRO PI
CHALLENGE 2018/19**

**MISSION SPACE LAB
GUIDELINES**

→ INTRODUCTION

The European Astro Pi Challenge is an ESA Education project run in collaboration with the Raspberry Pi Foundation. It offers students and young people the amazing opportunity to conduct scientific investigations in space by writing computer programs that run on Raspberry Pi computers aboard the International Space Station (ISS).

The Astro Pi challenge is divided in two separate missions featuring different levels of complexity: Mission Zero and Mission Space Lab. This document is a guide to participate in Mission Zero.

Mission Space Lab offers participants people the chance to have their scientific experiments run on the ISS. The challenge is to design and program an experiment to be run on an Astro Pi computer. The best experiments will be deployed to the ISS, and teams will have the opportunity to analyse and report on the results. The ten teams that author the best reports will be selected as the Astro Pi Mission Space Lab winners!

In the first section of the document, you will find an overview of the challenge structure, and rules for entering. The other sections will take you through each phase of the challenge, with useful resources and tools you can use along the way. program rules are guaranteed to have their program run in space!

→ OVERVIEW

Teams will have to come up with an idea for an experiment that fits one of the following two themes:

→ THEME A - LIFE IN SPACE

Teams that choose to investigate 'Life in space' will use the Astro Pi computer called Ed to investigate life inside the Columbus module of the ISS.

→ THEME B - LIFE ON EARTH

Teams that choose to investigate 'Life on Earth' will use the Astro Pi computer called Izzy, including its sensors and its near-infrared camera facing out of an ISS window pointing at Earth, to investigate life on the planet's surface.

Mission Space Lab consists of four phases:

**Phase
1**

Design

Come up with an idea for an experiment.

**Phase
2**

Create

Code your program and test your experiment on Earth.

**Phase
3**

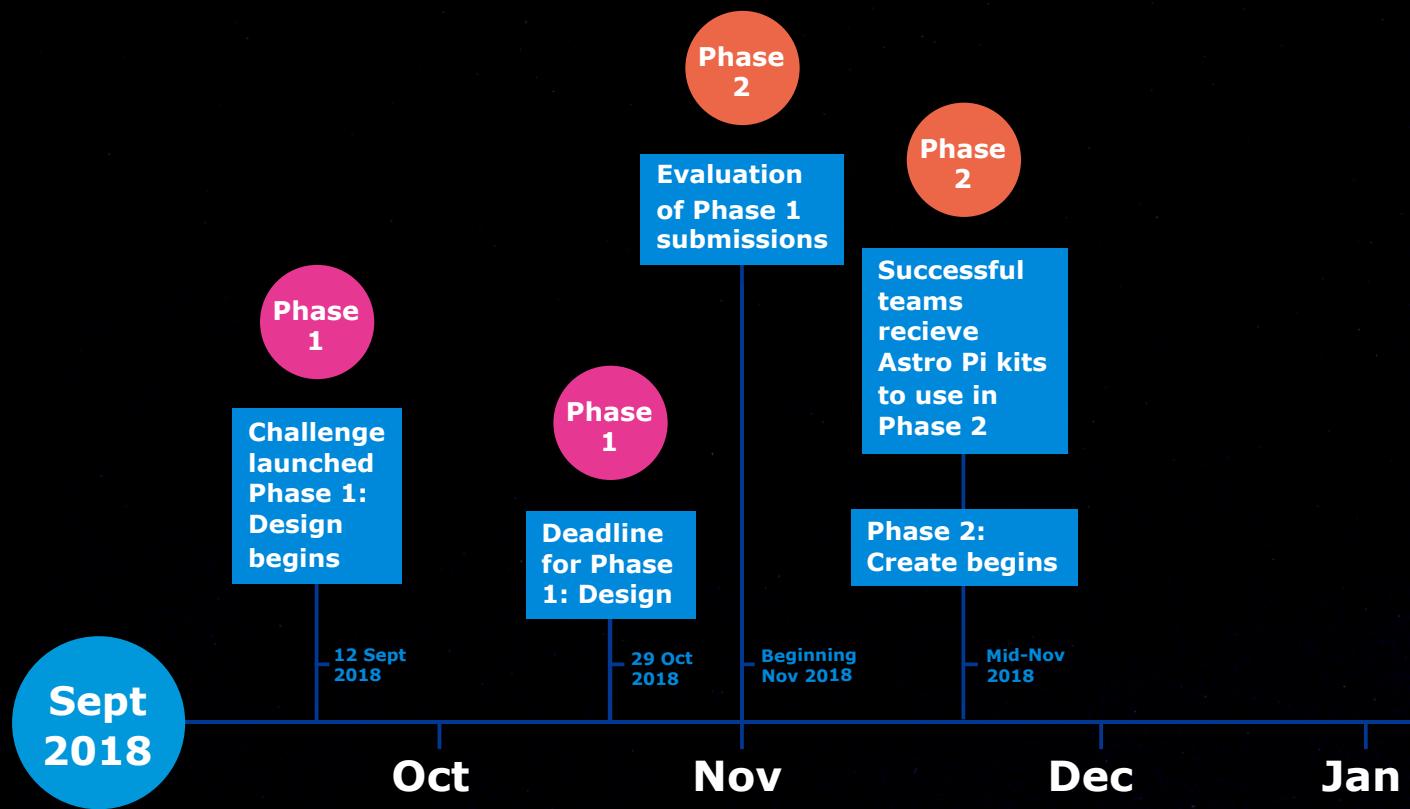
Deploy

Your program is deployed on the ISS.

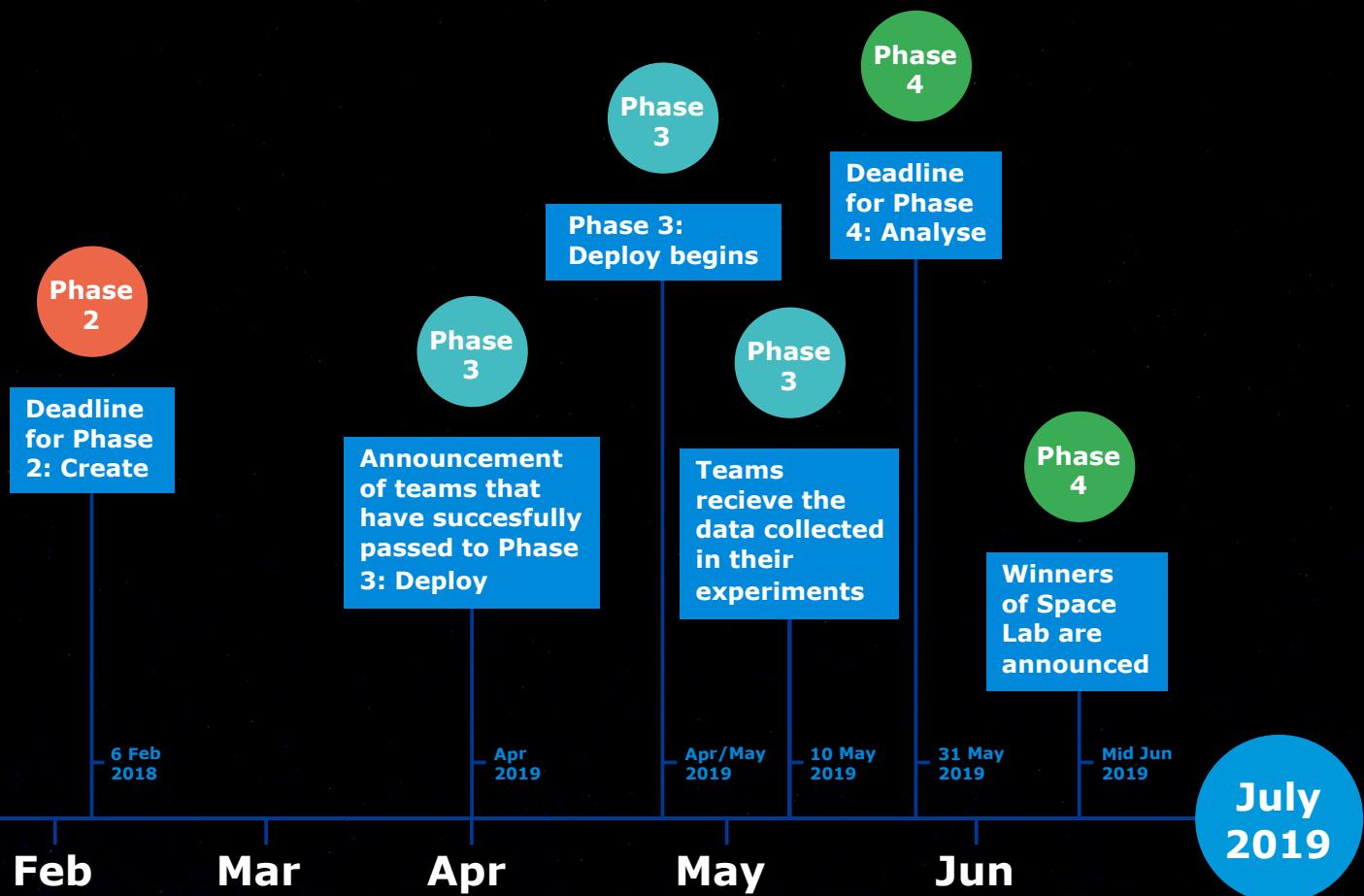
**Phase
4**

Analyse

Use the data from your experiment to prepare your report.



→ OVERVIEW



→ CHALLENGE OVERVIEW

Phase 1

Design

(12 September – 29 October 2018)

In this phase, you just need an idea for an experiment! You don't need to do any coding yet, but you should think about how you might write the program for your experiment to make sure you don't set yourself an unachievable goal. Teams have until 29 October 2018 to register and submit their idea on the Astro Pi website.

We will notify the selected teams of their acceptance to Phase 2 by mid-November 2018.

Phase 2

Create

(Mid-November 2018 – 6 February 2019)

In Phase 2, which will take place between mid-November 2018 and 6 February 2019, selected teams will design and write the computer program necessary to perform the experiment they suggested in Phase 1.

Astronauts are always very busy, so the Phase 2 experiments will be run on the ISS Astro Pis as part of an automated deployment schedule. Therefore your program needs to conform to some simple requirements so that it can be controlled automatically. Any programs that do not meet these requirements will not progress to Phase 3.

Teams selected to participate in Phase 2 of the challenge will receive an ESA-branded Astro Pi kit directly to their school or club (unless the team's teacher or mentor already received a kit during a previous Astro Pi Challenge). The kit contains the core equipment necessary for teams to test their program; teams will need to provide their own monitor, USB keyboard, and mouse.

The deadline for submissions (via the Astro Pi website) is 6 February 2019.

Phase 3

Deploy (April – May 2019)

In this phase, the best experiments will be selected to receive 'Flight status', and we will notify the teams that created these in April 2019. The selected entries will be uplinked to the ISS and deployed on the Astro Pi computers. The programs will run on the ISS from mid-April to the beginning of May 2018 (depending on ISS operational constraints). Then the experimental data collected in orbit will be downlinked and distributed to the participating teams.

Phase 4

Analyse (10 May – 31 May)

We challenge all teams that have made it this far to analyse their data collected on the ISS and submit a short final report about the results of their experiment. We provide a report template for this.

Only teams that submit their final report will receive the official Astro Pi Challenge participation certificate. The ten teams that submit the best reports will be announced as Mission Space Lab winners, and they'll receive special winners' certificates.

The deadline to submit your final report is 31 May 2019.



→ RULES FOR PARTICIPATION

To take part, teams must:

- Be made up of students/young people who each are no older than 19 years
- Have at least two and at most six students/young people as members
- Be supervised by a teacher, mentor, or educator, who will be the point of contact with the Astro Pi team
- Be made up of at least 50% team members who are citizens of an ESA Member/Associate Member State¹

In addition, **each team member** must be at least **one** of the following:

- Enrolled full-time in a primary or secondary school located in an ESA Member/Associate Member State, or a state with a special collaboration agreement with ESA²
- Home-schooled (certified by the National Ministry of Education or delegated authority in an ESA Member or Associate Member State)
- A member of a club or after-school group, such as Code Club, CoderDojo, or Scouts

One teacher/mentor may supervise a maximum of five teams per year and will only receive one Astro Pi kit (provided they have not already received one during a previous Astro Pi Challenge). There is no limit to the number of teams a school or club can enter. Each team can only submit one entry, and each student can only be part of one team.

¹ **ESA Member States in 2018:**

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

ESA Associate States in 2018: Canada, Slovenia

² In the framework of the current collaboration agreement between ESA and the Republic of Malta, teams from **Malta** can also participate in the European Astro Pi Challenge. ESA will also accept entries from primary or secondary schools located outside an ESA Member or Associate State only if such schools are officially authorised and/or certified by the official Education authorities of an ESA Member or Associate State (for instance, French school outside Europe officially recognised by the French Ministry of Education or delegated authority).

Phase 1

→ DESIGN

12 SEPTEMBER – 29 OCTOBER

Phase 1 is all about your team coming up with an idea for an experiment you want to run on the Astro Pis aboard the ISS.

To do this, you will need to do the following:

1 Organise your team

As mentioned in the requirements section above, a team must consist of two to four students or young people, aged 19 years or younger, and half must be from an eligible country.

Each team needs a teacher or mentor. This person will support the team during the challenge, and will be the main point of contact for us.

2 Choose your theme

There are two Mission Space Lab themes you can choose between, depending on what you would like your experiment to investigate.

Theme A – Life in space

An experiment in this theme will use the Astro Pi called Ed to investigate life in the Columbus module. If you choose this theme, you will need to submit **an experiment idea that makes use of Astro Pi Ed's LED matrix and at least one of its sensors**, which include a visible-light camera. Note that the Astro Pi Ed will be deployed inside the Columbus Module, and that you may use its camera only as a sensor and not to take photos or videos.

Theme B – Life on Earth

An experiment in this theme will investigate life on the planet's surface using the Astro Pi called Izzy, including its sensors and its near-infrared camera facing out of a window in an ISS module pointing at Earth. If you choose this theme, you will need to submit **an experiment idea that makes use of**

Astro Pi Izzy's near-infrared camera (with optional blue optical filter) and its LED matrix; use of sensors is optional. Note that Astro Pi Izzy will be deployed in front of an Earth-facing window on the ISS, for example inside Node 2.

3 Design your experiment together

A. Preparation

i. Essential: understanding the hardware

It is crucial that your team understands the limitations of the Astro Pi hardware. We recommend that you have a look at

our classroom resources to better understand the hardware

limitations so that you can avoid making common mistakes (e.g. planning to use the near-infrared camera as a thermal imaging camera — this is not possible, as near-infrared and thermal infrared are not the same). Remember to take into account the different hardware available for each theme (see point 2).

ii. Recommended: considerations regarding your program. You should make yourself familiar with the coding requirements that you will be using to code your program during Phase 2 to that ensure your experiment idea is feasible. This can be found in our

Phase 2 guide here.

B. Brainstorm

This step is all about coming up with experiment ideas within your chosen theme. You can do this in any way you like. This is our suggestion for a brainstorming session:

- i. Start by writing your ideas down on post-it notes and sticking them to a board or wall, one idea per note. The ideas don't have to be fully formed research questions, so you can write down topics or things that inspire you. Make sure each team member adds some ideas.



- ii. Once everyone has had an input, it's time to group the ideas according to themes or categories: sort the post-it notes to cluster similar ones together. While you do this, talk through the ideas as a team. Once you've sorted everything, you may wish to vote on which idea your team wants to pursue: have each team member place an X on their top three post-it notes.
- iii. You should end up with one or two ideas that have received the most votes. Now it's time to do some research! To settle on your final experiment idea, spend a short amount of time researching your topics and also checking the hardware and Phase 2 resources we listed above. You might need to revise your idea a little, or maybe combine several things in one experiment.

4

Tell us about your idea

Head to the [Mission Space Lab web page](#) to submit your experiment idea. You will need to give us some details about the people in your team, and answer these two questions:

- A.** What is your experiment idea?
- B.** How will you use the Astro Pi computers to perform your experiment?

Your answers to these questions will help us assess whether your experiment for its feasibility, scientific value, and creativity.

You will also need to decide on a unique team name. This name must have eight or fewer characters and contain no spaces.

5

Wait for our email

We will notify all teams about whether their experiment idea has been accepted for the next phase of the challenge by mid-November.

Phase 2

→ CREATE

5 NOVEMBER – 6 FEBRUARY

In Phase 2, your team will write the program for the experiment you have proposed, and then test and submit it. These are the steps involved:

1 Be accepted to Phase 2

You will receive an email confirming your acceptance to Phase 2 of the challenge by mid-November.

2 Receive your kit

We will send an Astro Pi kit for your school or club to the address provided in your Phase 1 submission, provided you have not previously received one. This kit contains the same hardware that is used on the Astro Pis aboard the ISS (apart from the special space-hardened case).

3 Create your experiment

Read our comprehensive **Mission Space Lab Phase 2 guide** for information on assembling your kit, coding your experiment, and testing your program. This guide also includes essential information on what is and isn't possible with the Astro Pi hardware and software. You can also have a look at **our resources** that go into more detail about the Astro Pi hardware and using it to write the program for your experiment.

4 Submit your program

To submit your program, head to the **Astro Pi website**. You will need to:

- A.** Upload your program
- B.** Answer the following:
 - i.** What are the main objectives of your experiment?

- ii.** Describe how you will achieve these objectives.
- iii.** What do you think the results of your experiment will be?
- iv.** If you are submitting a 'Life on Earth' experiment, does it require the blue camera filter?
- v.** Please estimate how much disk space (in megabytes) your experimental results will use on the Astro Pi computer.



Phase 3

→ DEPLOY

6 FEBRUARY – 10 MAY 2019

Once you have submitted your program, it will be judged by our expert panel. They will be assessing your program according to its:

- **Scientific value**
 - Is your experiment investigating a scientific concept or principle?
- **Program readability and quality**
 - Is your program easily understandable?
 - Is it using comments and/or docstrings?
 - Is it structured well, does it include rigorous error checking?
 - Is re-used code from other sources/authors correctly attributed?
- **Feasibility of the experiment in the ISS environment**
 - Can your experiment run according to the environment and hardware limitations aboard the ISS?
 - Is it likely to produce meaningful data?
- **Clarity and comprehensiveness**
 - Are your experiment's objectives clear based on the program you have written and the answers you have submitted?
 - Could the experiment be easily reproduced? ISS, for example inside Node 2.

If your program passes the expert panel of judges, we will test it on ground to ensure that it runs without errors and that it doesn't violate any of the security rules, including:

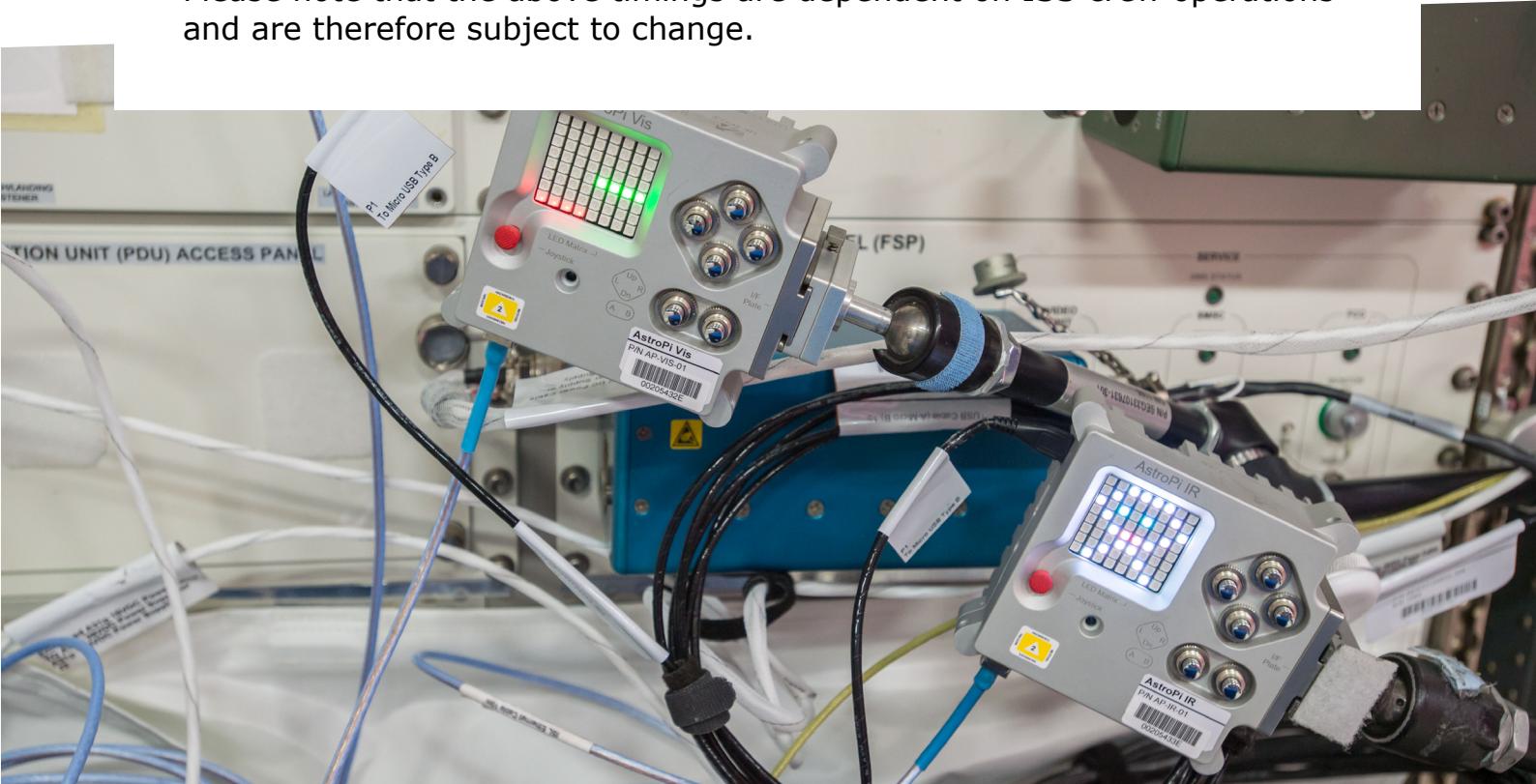
- Programs are not permitted to save photo or video files from within the ISS (applies to 'Life in space' theme only).

- Programs should record data in log files as outlined in the coding requirements. Files should not be opened in other areas of the SD card directory structure.
- Programs should not attempt to open a network connection or to communicate across a network interface.
- Programs should not contain obfuscated code.
- Programs should not attempt to spawn other programs or to start, or interfere with, system processes.
- Programs should run for a maximum of three hours and terminate cleanly.

Once the programs have been tested, we will email you about whether your team's experiment has achieved flight status (mid- to late April). We'll then prepare and upload the successful programs to the ISS, and we will notify you once your experiment has been deployed.

You will receive the results of your experiment via email once these have been downlinked from the ISS. This will be around mid-May.

Please note that the above timings are dependent on ISS crew operations and are therefore subject to change.



Phase 4

→ ANALYSE

MAY 2019

Once you receive your results back from the Astro Pi team, it is time to analyse them and write your report. Only teams that submit a report will receive participation certificates. The ten teams with the best reports will be selected as the Astro Pi Mission Space Lab winners!

Your report needs to:

- Use this **Astro Pi official report template**
- Not be longer than three pages
- Be uploaded as a PDF

We cannot accept reports that do not follow these rules.

A couple of things to remember:

- If your program does not produce the results you were hoping for, we still encourage you to submit a report. You are still eligible for a prize, and you will receive participation certificates.
- Your report does not need to be long or expertly written. We are looking for simple and clear explanations of what you did, what you discovered, and what you learned.

To analyse your data and produce your report, you could use the following process:

1

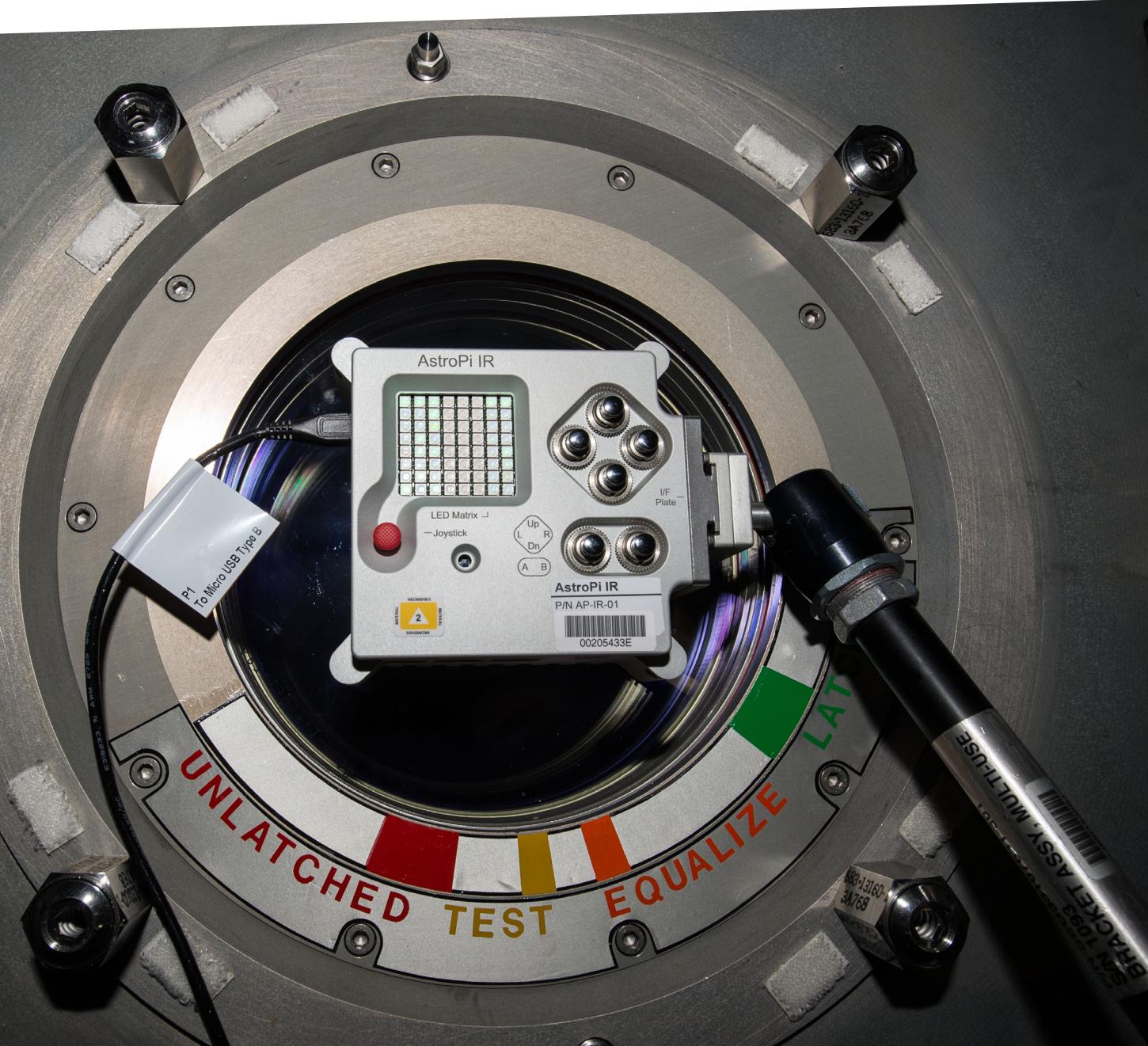
Data analysis

a. For tips on analysing data in CSV file format, see our **handy resource**

2**Report writing**

- a. Share the report template with your team, read through each section, and discuss what should go into each one
- b. Divide the report up and allocate each section to one or two team members; write the sections
- c. Put the sections together and read through the complete report as a team to ensure that it makes sense as a whole

The deadline for submitting your report is 31 May 2019. Winners will be announced in mid-June.



→ QUESTIONS

**Thank you for your interest in the European Astro Pi Challenge:
Mission Space Lab!**

If you'd like more information, or updates on the challenge, head to
the [Astro Pi website.](#)

For resources and project ideas, head to resource page of the Astro Pi
website.

If you have any questions, you can reach the Astro Pi team at
astropi@esa.int or follow us on Twitter [@astro_pi](#)

The European Astro Pi Challenge is an ESA Education programme run in
collaboration with the Raspberry Pi Foundation.

For more information on ESA Education programmes, head to:
www.esa.int/Education

For more information on the Raspberry Pi Foundation, head to:
www.raspberrypi.org

