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Association for
Vertical Farming

Get involved, let’s chat after th

BORDER SESSIONS

INTERNATIONAL FESTIVAL ON TECHNOLOGY & SOCIETY

**6 & 7 JULY 2016**
**THE HAGUE**

# WHO CARES ABOUT GROWING TOMATOES ON THE MOON OR MARS?

MELISSA


**IN OUR OPEN DESIGN SESSION THE 7TH OF JULY AT BORDER SSIONS FESTIVAL THE HAGUE, THE NETHERLANDS**

n space farmers unite! Be part of an emerging open-source movement help build the next generation galactic farming systems. Join our open n session on the intersection of high-tech space and urban farming for inventive urban farmers, bio-hackers, IoT techies, and any creative with an interest in making our planets habitable for future generations.

isruptive innovations have their origins in spacetech. It took the effort y smart entrepreneurs, designers and creative minds to make these ogies accessible for the wider public. Do you have green fingers? Or her make stuff? ESA and Border Sessions offer you the opportunity with the people who feed our astronauts and find solutions for the hallenges on earth, including unsustainable food practices, food nd the corporatization of agriculture.

Join us by sending your morse code to our operator in the I
thieme@bordersessions.org

WWW.BORDERSESSIONS.ORG

BORDER LABS

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# THREE OBJECTIVES

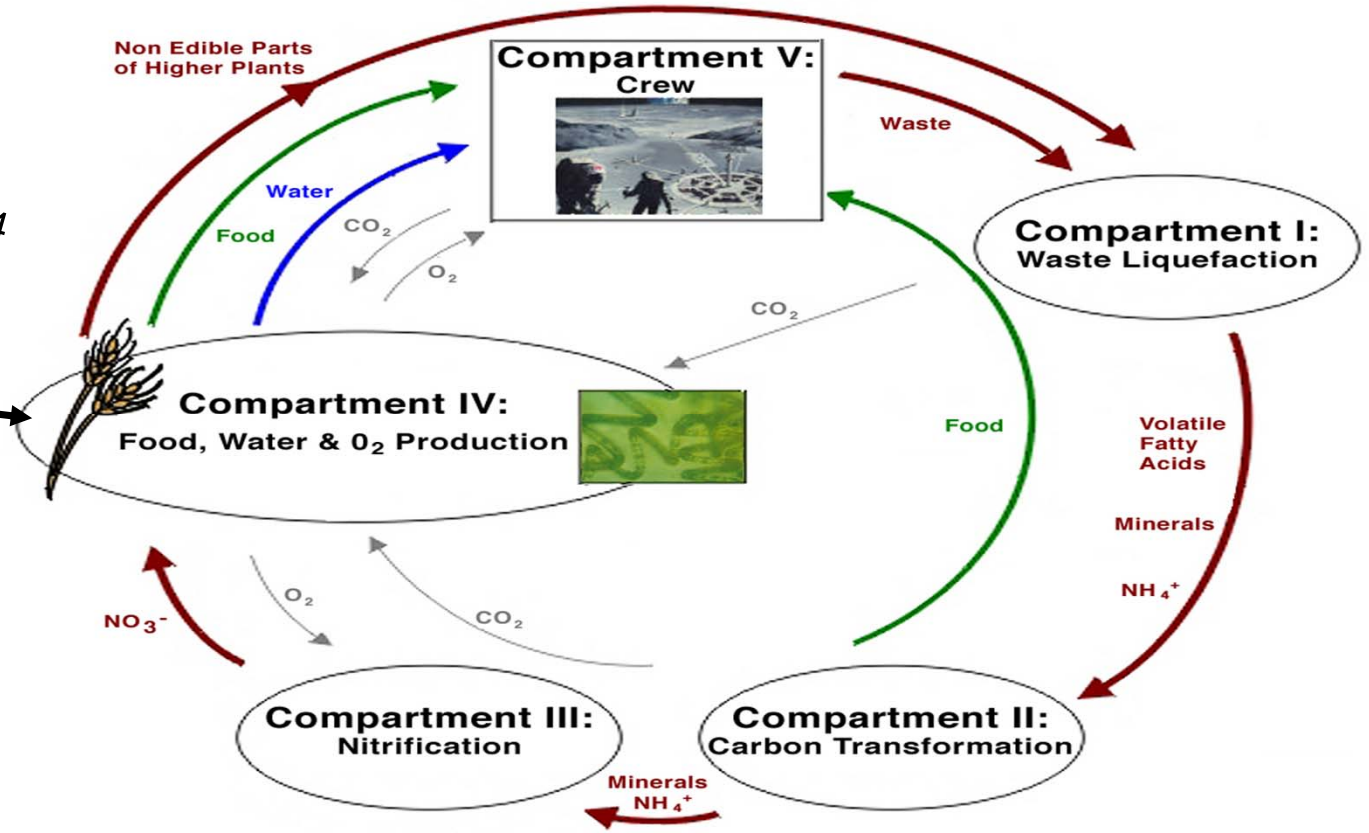
1. RESEARCH: Public data sets about plant growth
2. EDUCATE: Engaging a New Genaration of Urban and Space Farmers
3. INNOVATE: Open Source hydroponics plant lab infrastructure

AstroPlant v3

ASTROPLANT

# I. RESEARCH → MELiSSA and wider community

AstroPlant v4

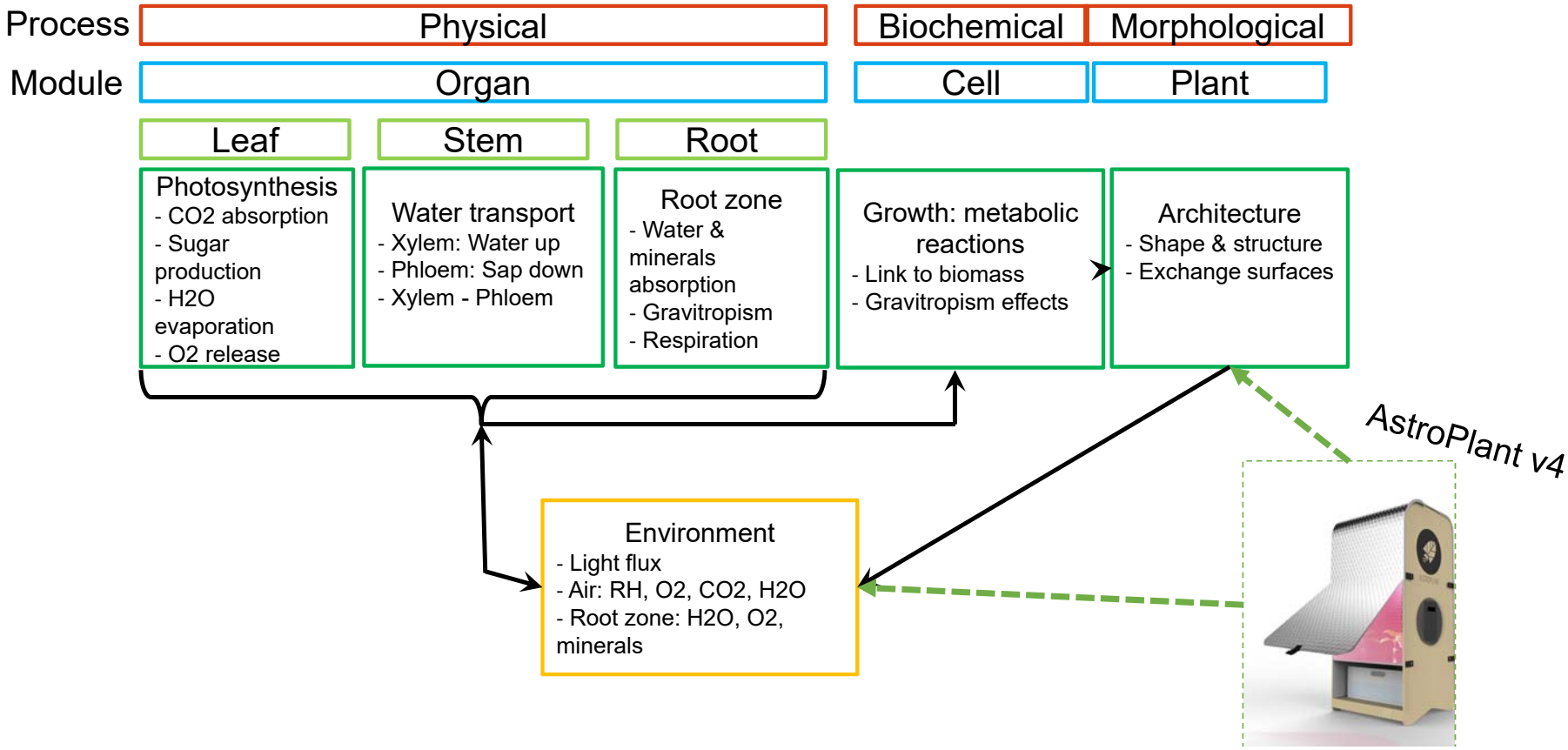


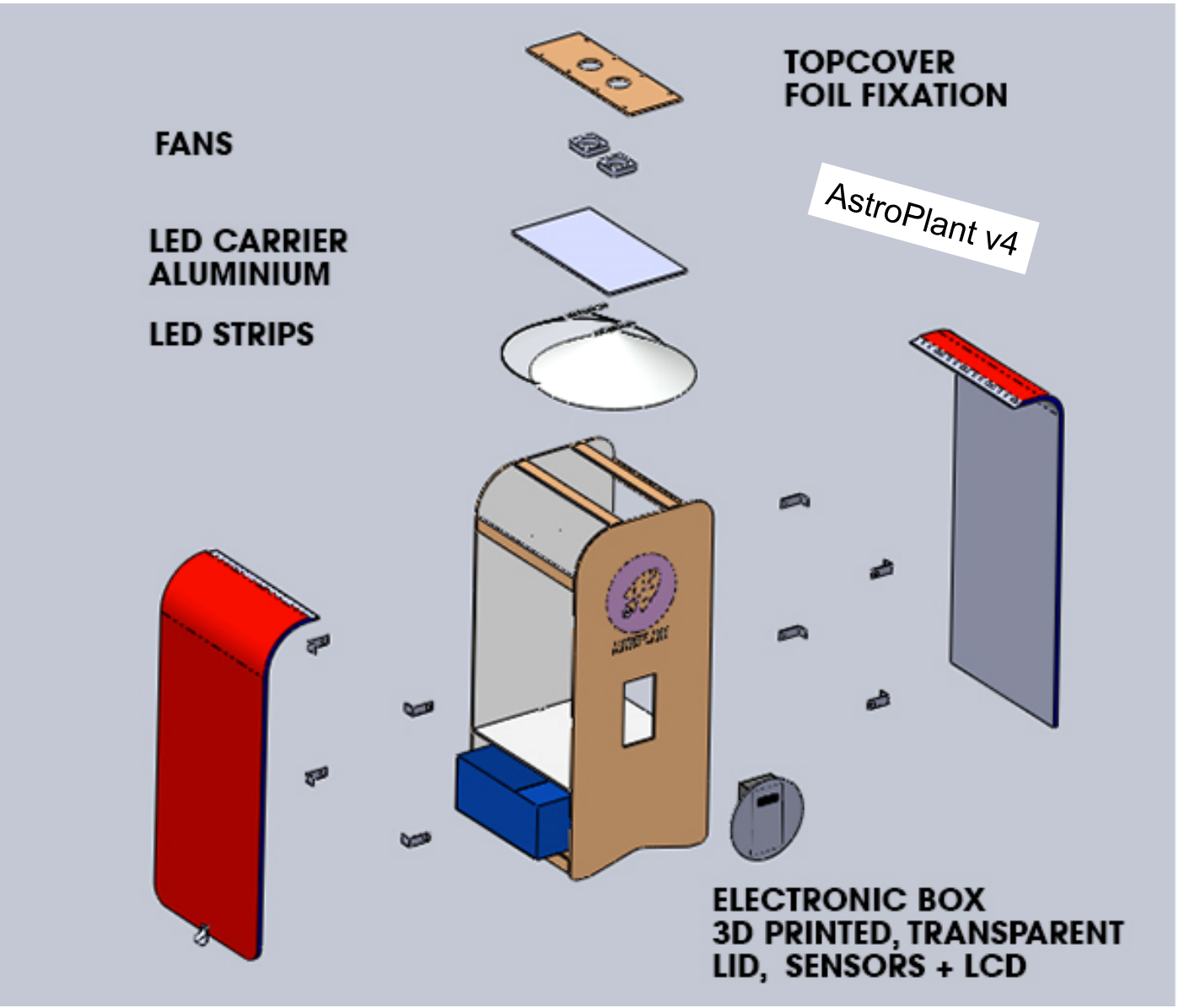

AstroPlant: part of the research into the Higher Plant Compartment

- Characterise plant growth
- Evaluating how plants grow in different environments

.. for many plants and cultivars

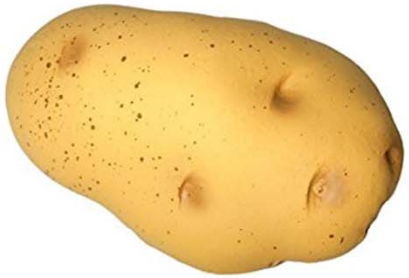
# Model Preliminary Structure






## Semi-controlled growbox

- RaspberryPi + custom PCB
- Fully controllable custom growLED system (intensity + spectrum)
- Two or three fans
- Simple hydroponics system
- Sensors:
  - Temperature (air, water)
  - Humidity
  - CO2
  - Light
  - EC and pH
  - Regular camera + multispectral camera*
- Manual input by citizen scientist:
  - Size of leaves
  - Weight of the plants
  - Root length
  - etcetera



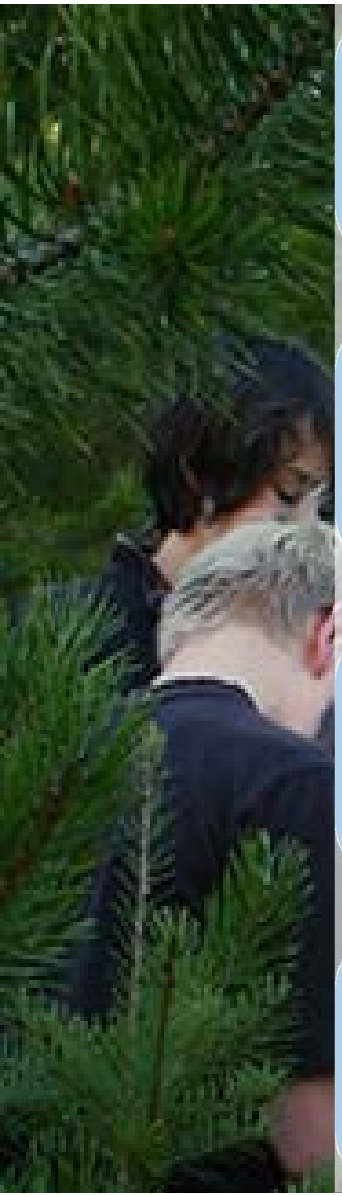








# II. EDUCATE → Citizen Science, Science Education, Creative Learning, Interdisciplinary



## Level 4 - Extreme Citizen Science

- Collaborative science - problem definition, data collection and analysis

## Level 3 - Participatory Science

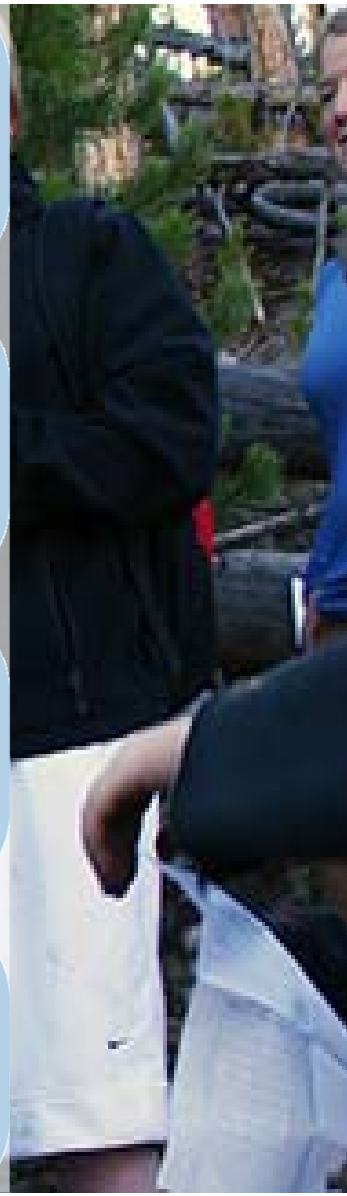
- Participation in problem definition and data collection

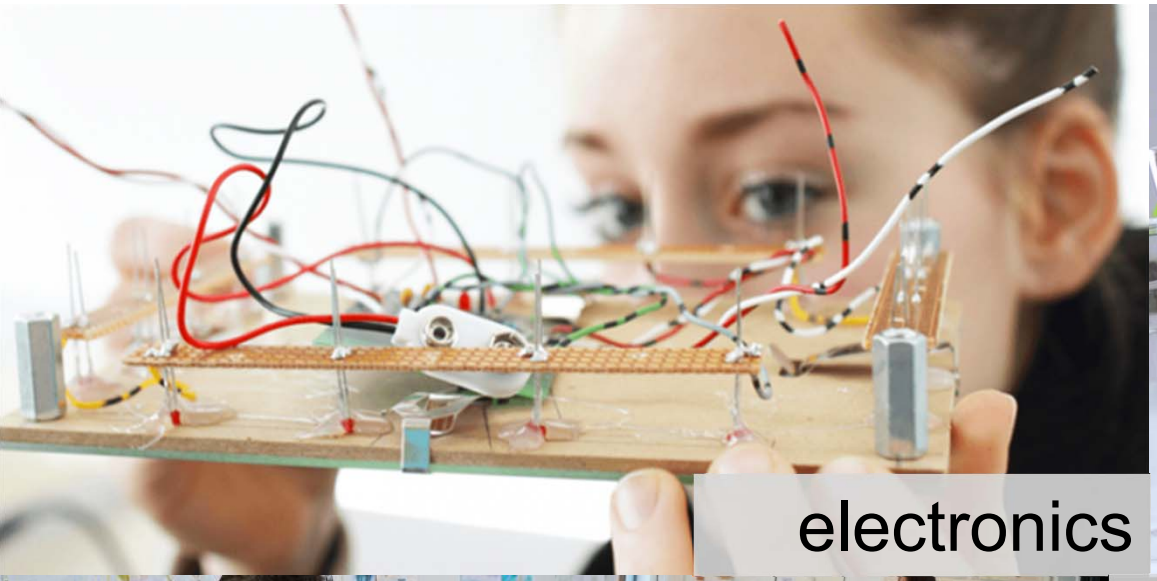
## Level 2 - Distributed Intelligence

- Citizens as basic interpreters
- Volunteered thinking

## Level 1 - Crowdsourcing

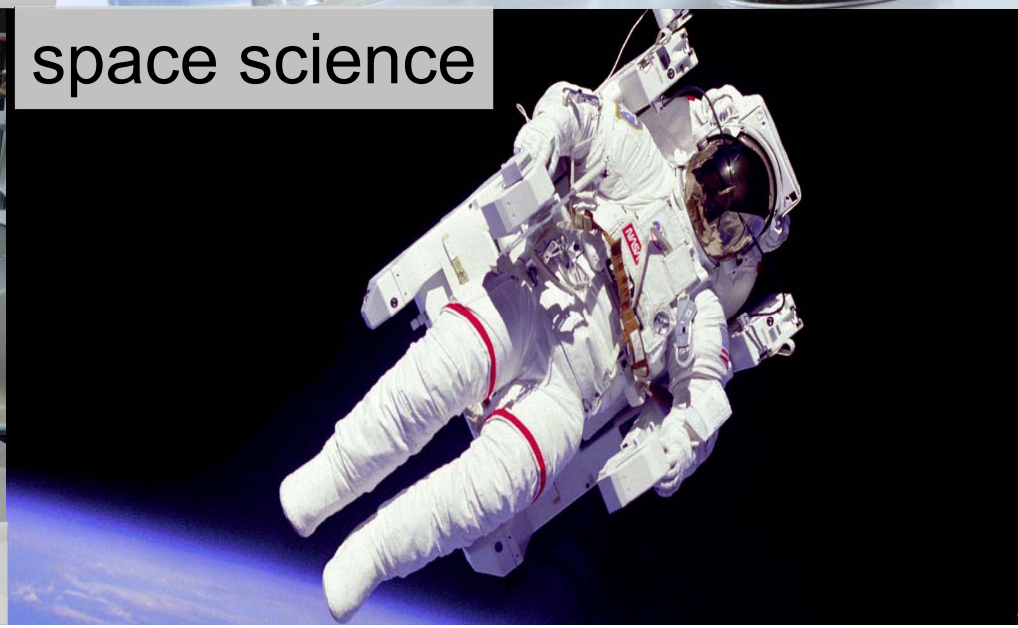
- Citizens as sensors
- Volunteered computing




electronics


plant science

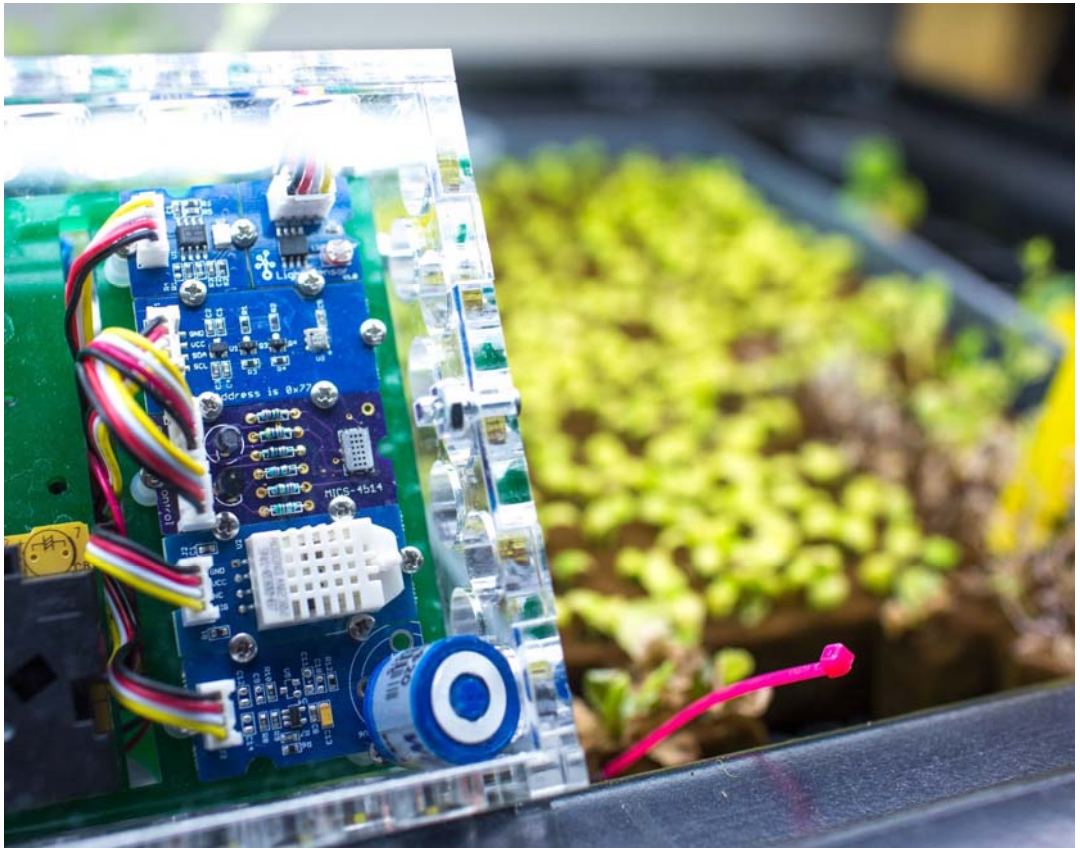

digital fabrication


space science

# Educational projects

- First one in Ghent (high school)
- AVANS (vocational education)
- ESA Education is building a program for 10-12 year olds

- Sept-Dec: pilot with 10 schools



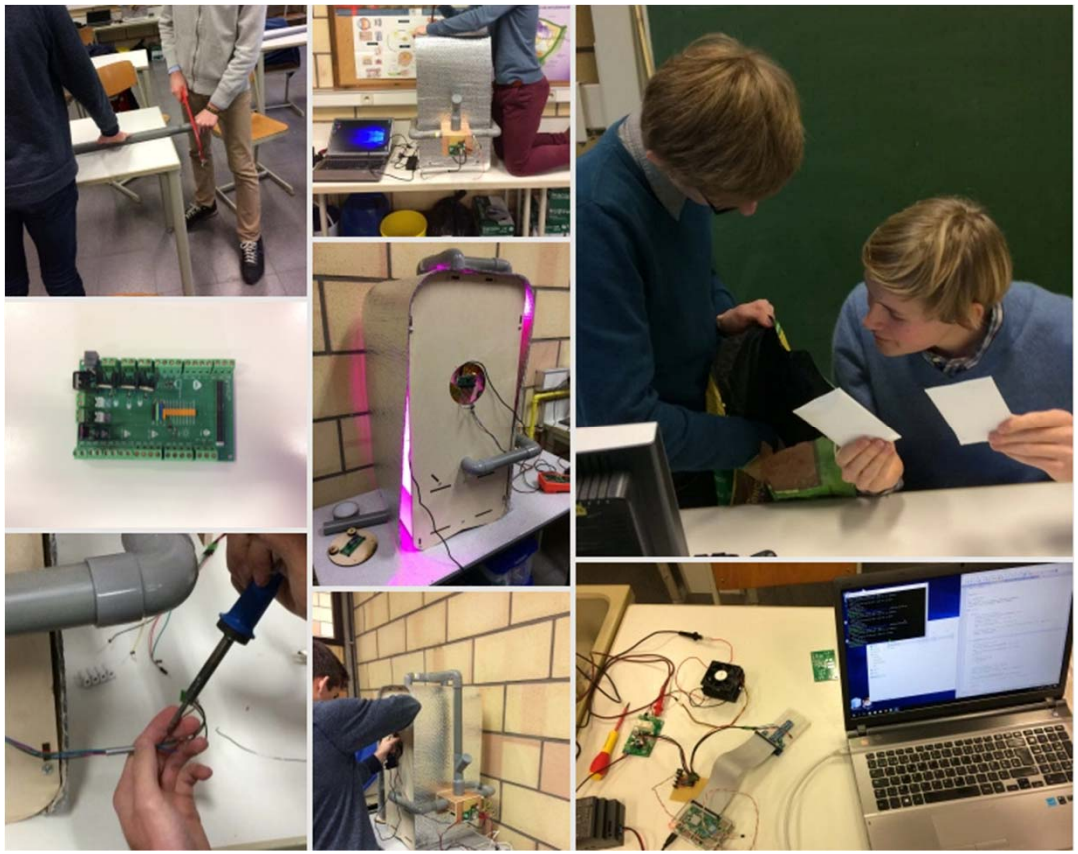
# Ghent

Project based learning

- 2 months preparation: research design
- 4 months executing research (January – April)

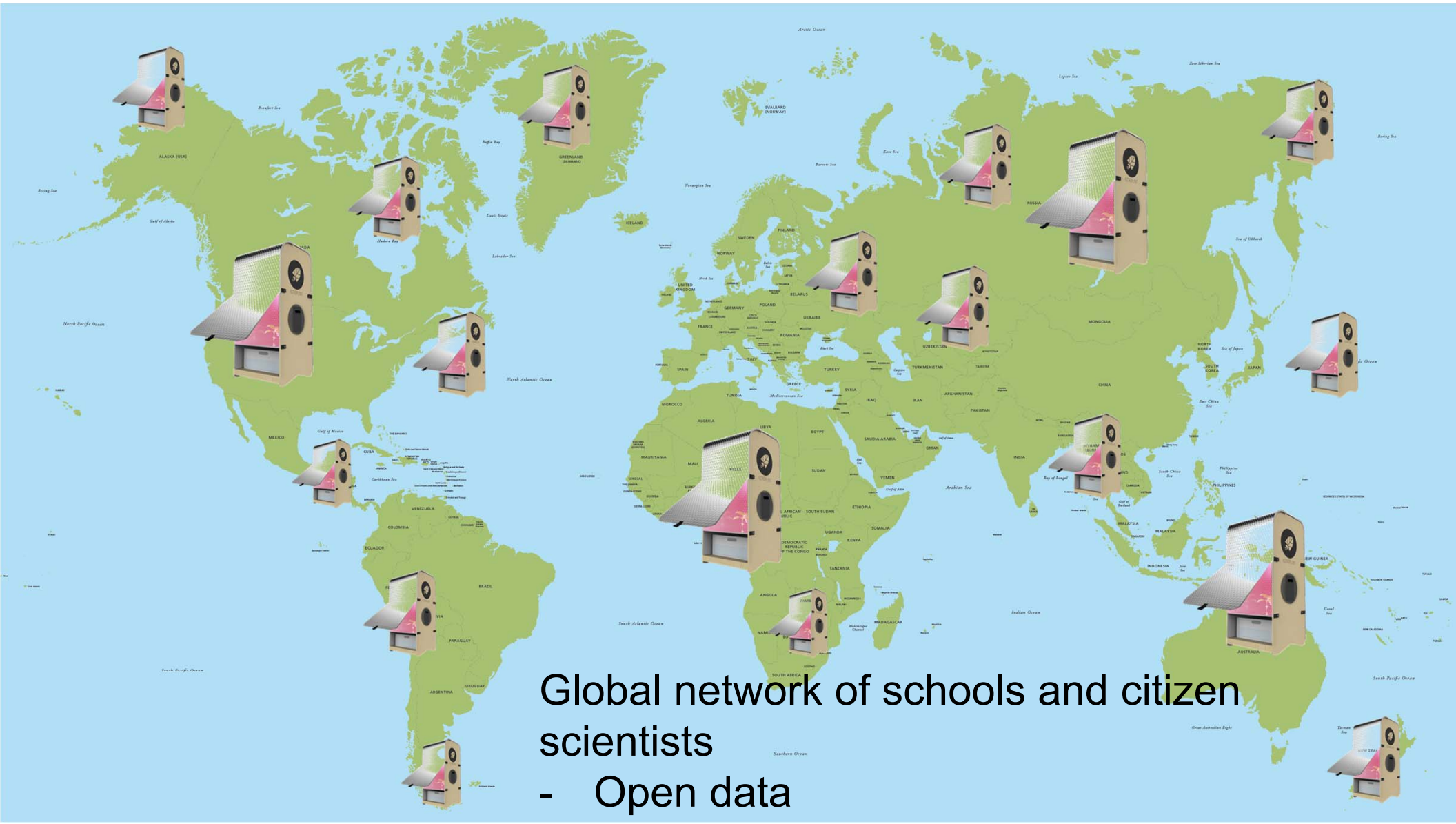
Topics:

- Effects of IR on plant growth (soy bean)
- Tech development: controlling temperature
- Science communication



# Strategy

- Sept-Dec – AstroPlant pilot (~ 10 high schools) EU
- 2019 – rollout to 100+ schools and institutes
  - AstroPlant part of Moon Camp (ESA Education/ESEROs)
  - Global crowdfunding campaign (makers, schools, researchers)
  - *Novo Nordisk LIFE program (DK), other national programmes*
- 2020 – 1000+ schools, spinoff technologies


Global network of schools and citizen scientists
- Open data

# ESA Education Activities on the Astroplant Citizen Science Project

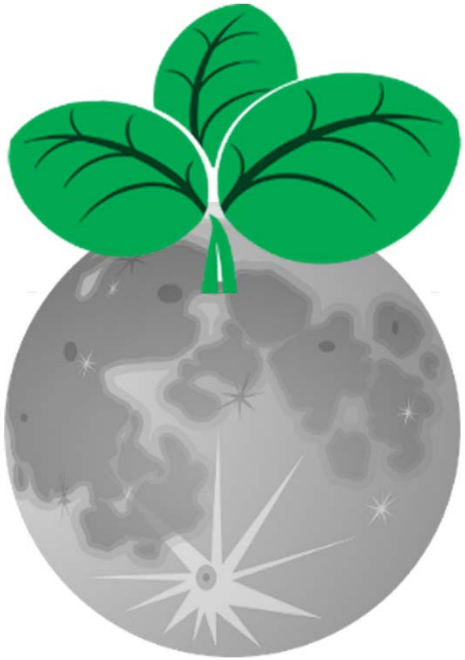
ESA Education Office

# ESA Education support to Astroplant

- *Plants, Food, Space and Technology* – the Astroplant topics integrate well with the school curricula across Europe.

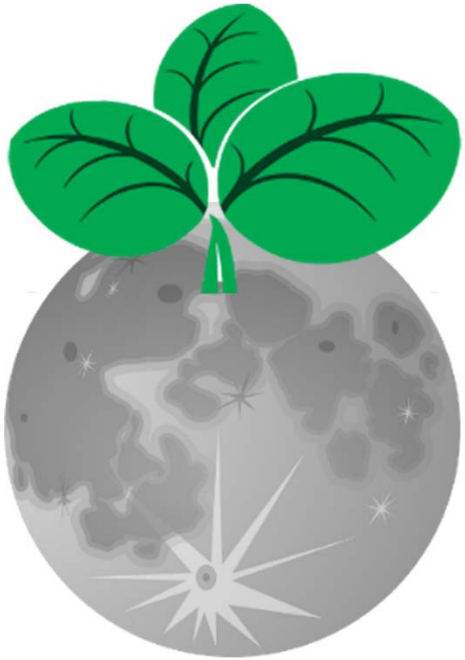
- Space Food and plant growth is one of the topics covered in the new ESA school challenge: ***Moon Camp***, to be launched in October 2018.

- A set of classroom activities inspired by the Astroplant kit has been created for first use in the **Moon Camp challenge**, and that will prepare the students to later participate in the AstroPlant citizen science project.



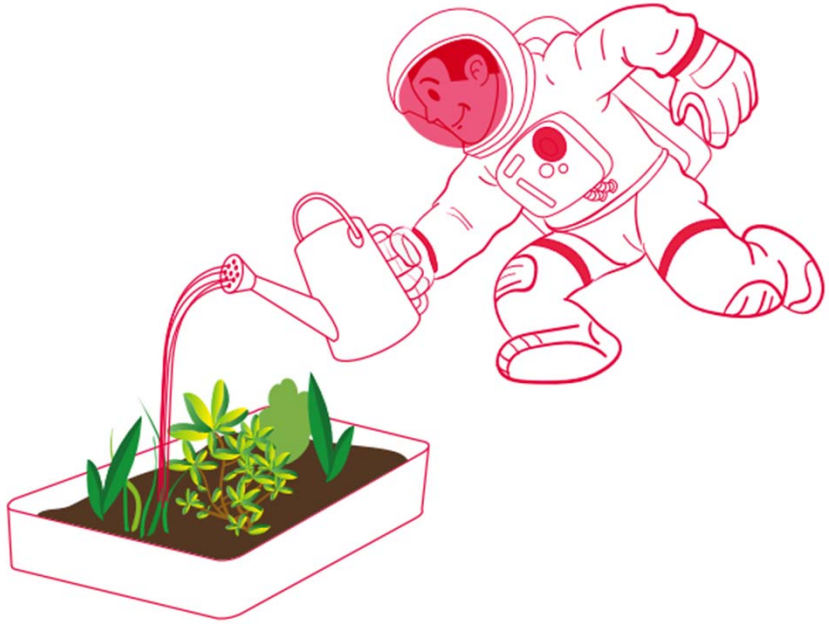
# ESA Education support to Astroplant

- ESA Education will procure 3 prototypes Astroplant kits for school testing (during Astroplant development/test phase)
- After the official launch of Astroplant, **ESA Education will launch an educational call for schools, integrated with the second edition of the Moon Camp in school year 2019-2020**, to be part of the citizen science project.
- ESA Education can procure a limited number of final Astroplant kits (when cost/kit has reached affordable price) to support the citizen science project, through a European school loan scheme coordinated nationally by the participating European Space Education Resource Offices (ESEROs).



# Moon Camp/Astroplant: ESA Education classroom resources

- ESA Education is developing a set of hands-on classroom resources and interdisciplinary classroom projects to support the citizen science project: Astroplant
- Students will investigate the conditions in which plants develop and identify plants suited for space travel
- **Learning objectives:** Plants, Food, Biology, Physics, Geology, Chemistry (TBC)
- **Themes:** Space Environment, Space Exploration
- **Target Group:** 6 to 16 years old



# Astroplant: ESA Education classroom resources

## Primary

**AstroFood**
Edible plants in Space

**AstroFarmer**
Growing plants for future space missions

**AstroCrops**
Growing plants in a biodome

**AstroHub**
Sharing your results

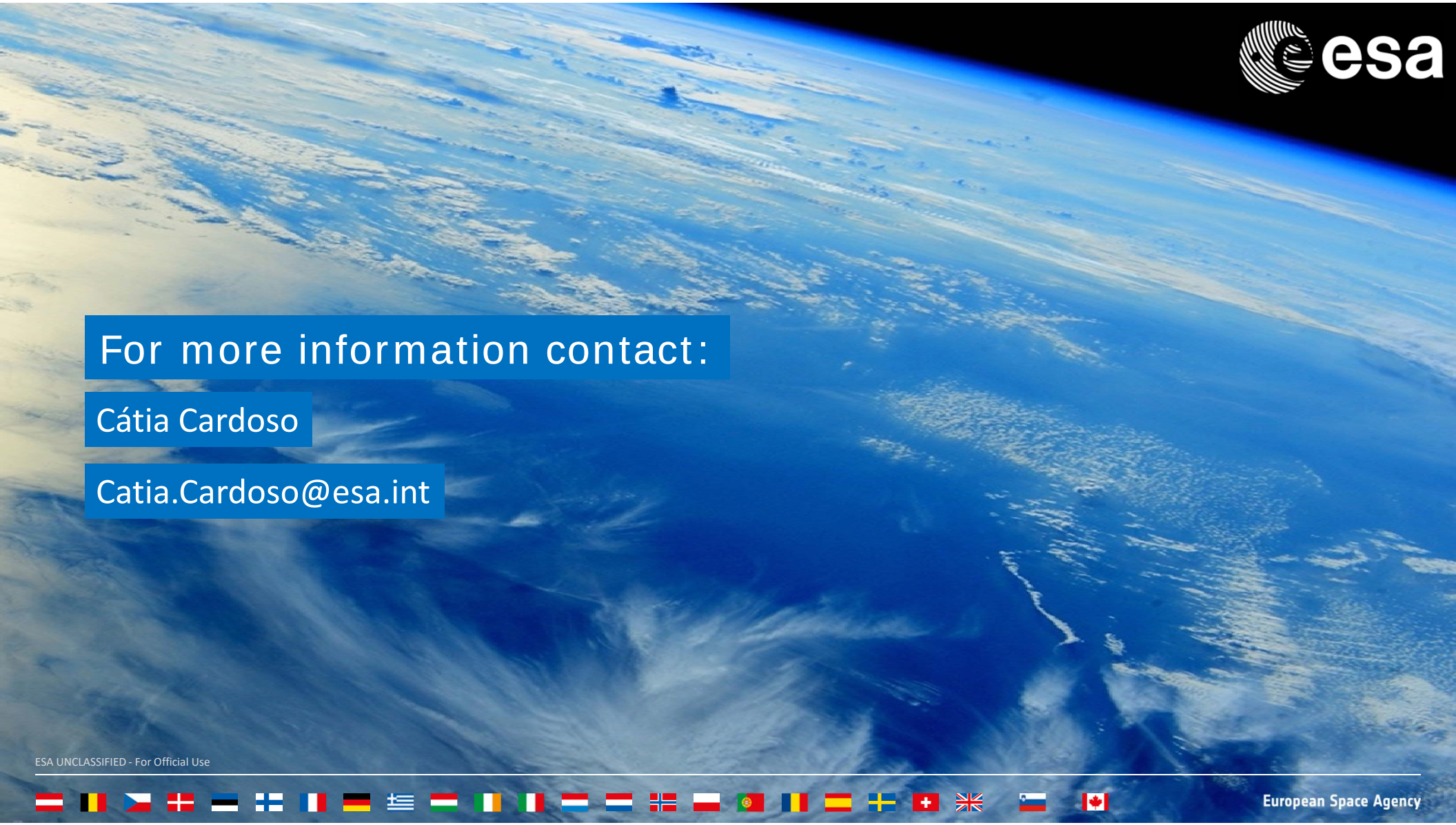
## Secondary

**Classroom Projects**
Interdisciplinary projects about plants in space

**Biology**
Which plants would survive in space?

**Physics**
Danger! Radiation overload

**Geology**
Are the soils all the same?



## For more information contact: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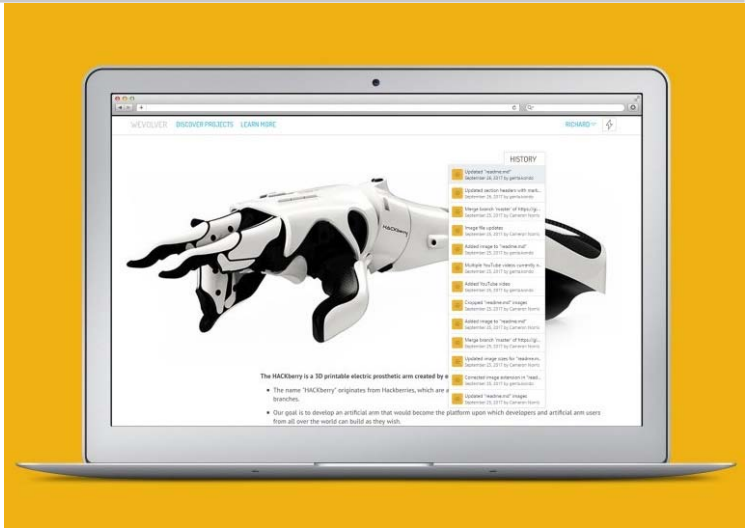
Catia.Cardoso@esa.int

# III. INNOVATE → Open Source Technology, Open Data, Open Education

# Being Open

WEVOLVER OPEN SOURCE HARDWAR

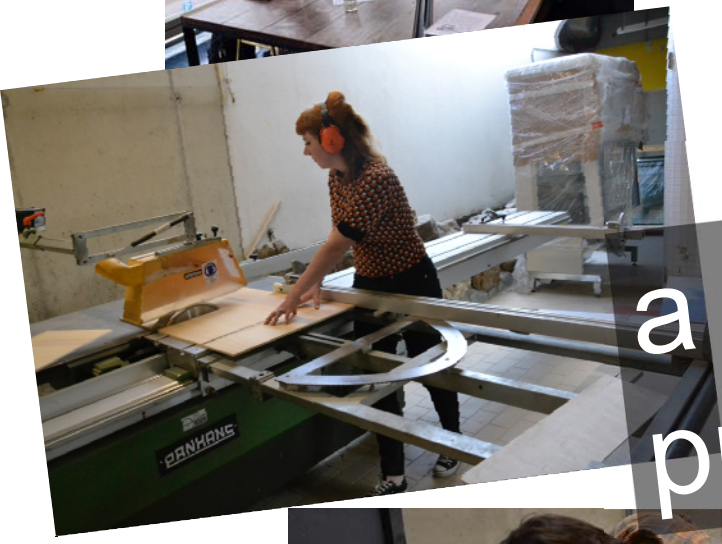


Open Source Software (GNU LGPL)
Open API for plant data (under construction)
Open Source Hardware (CERN OHL)
Online Collaboration (WeVolver/git, Slack)

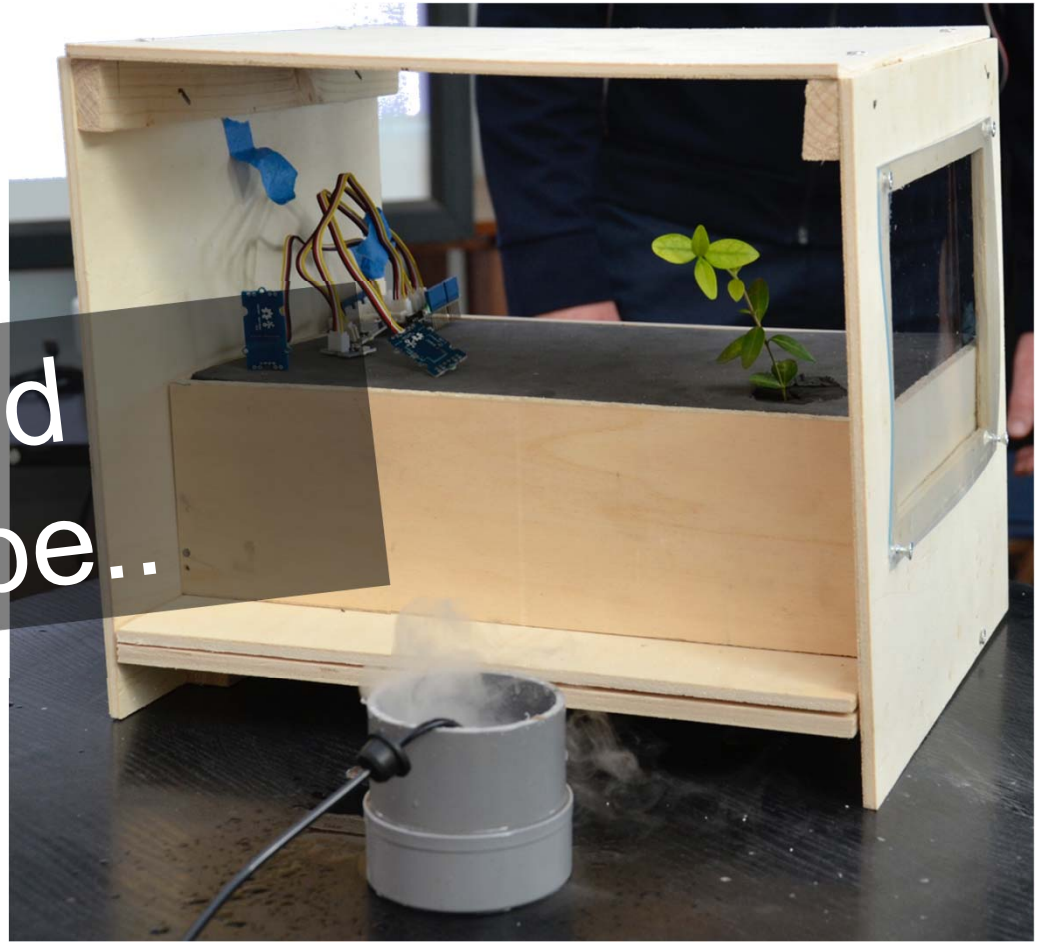
→ core team of 5 volunteers working on AstroPlant
→ new electronics board developed by volunteer electronics engineer in Switzerland
→ Collaboration with OpenAg on standardisation of plant data models
→ Open source EC and pH sensors developed by engineer in USA
→ More upcoming collaborations: Greek Agri University (plant analysis and tech dev), Kiev University, Plant Geek, Kapelice.. etc.

All because of the open nature of the project


a first
prototype..
esa
MELiSSA
BORDER
LABS
follow us on
borderlabs.org



a second prototype..



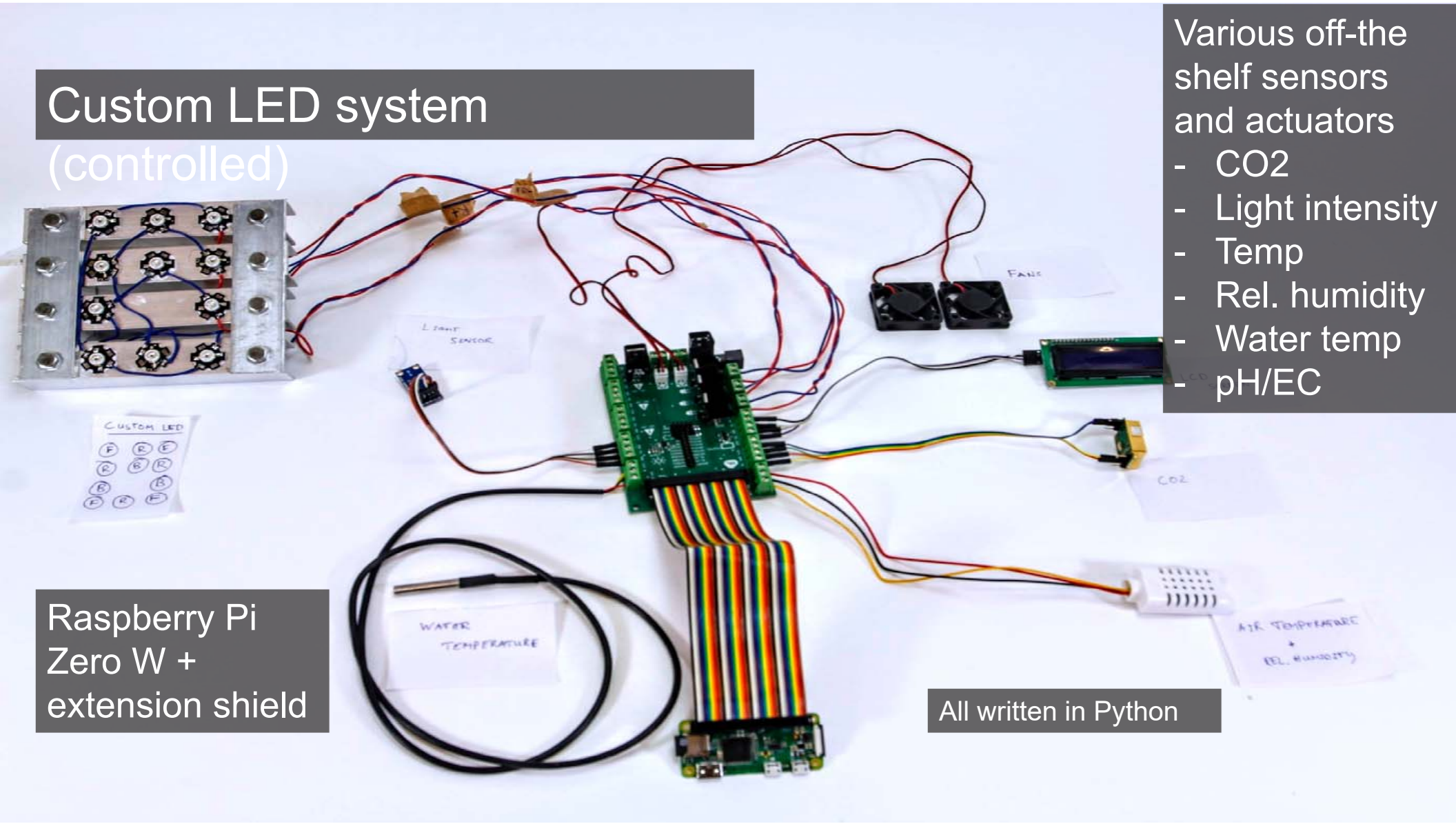
# a third prototype..

(operating perfectly for nearly 5 months: first ‘space peppers’ eaten)

## 4.1...


## 4.2...

# Custom LED system (controlled)

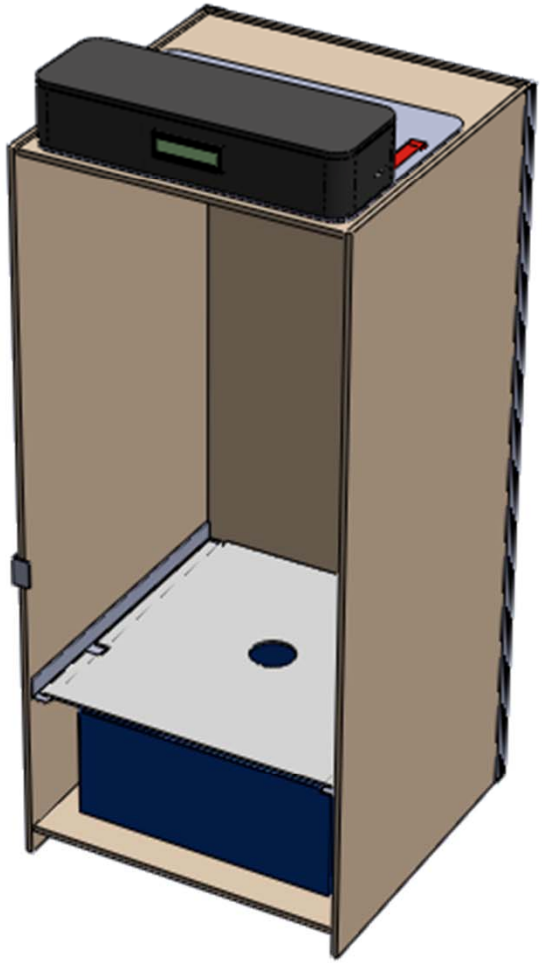


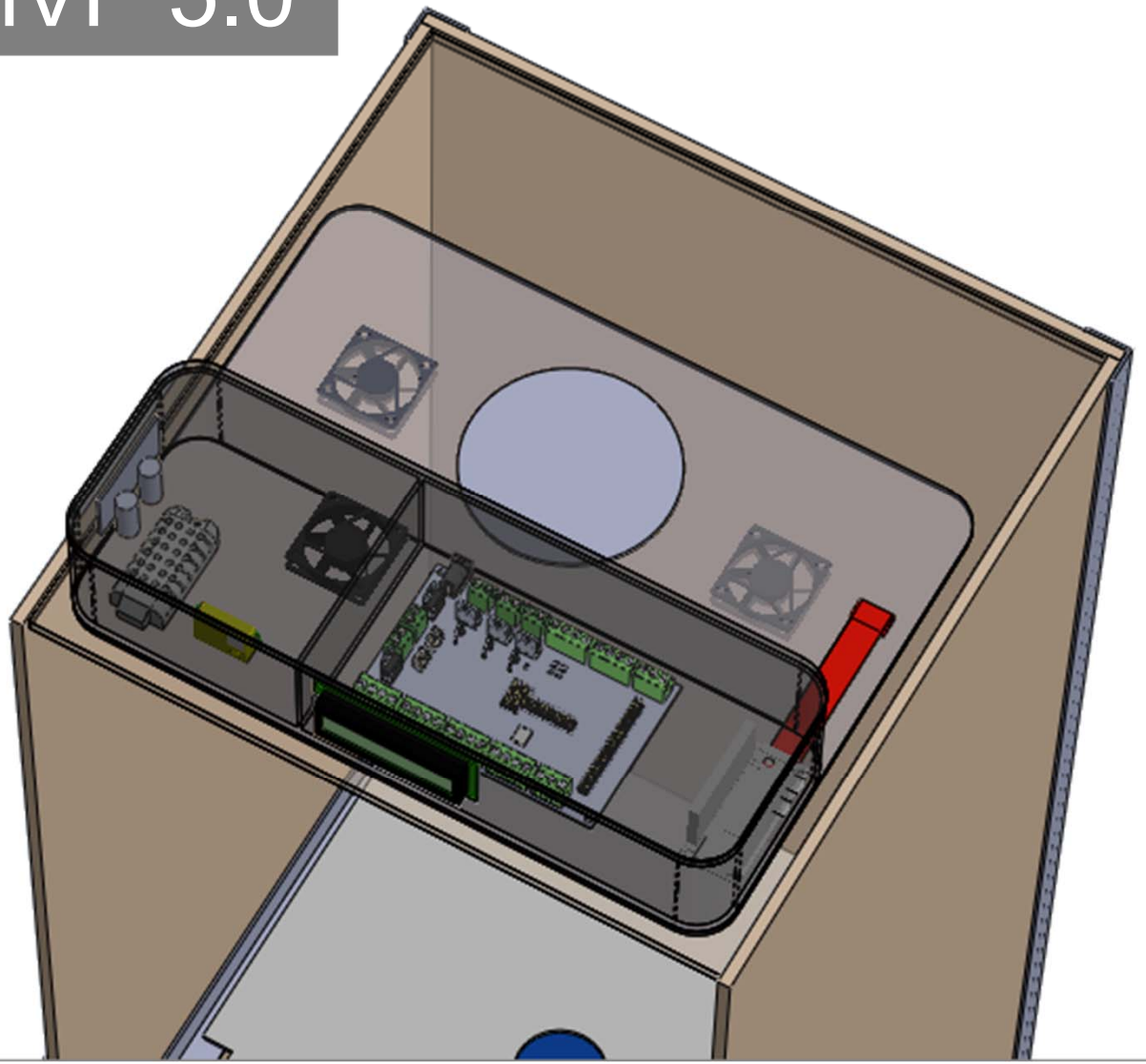

Various off-the shelf sensors and actuators
- $CO_2$
- Light intensity
- Temp
- Rel. humidity
- Water temp
- pH/EC

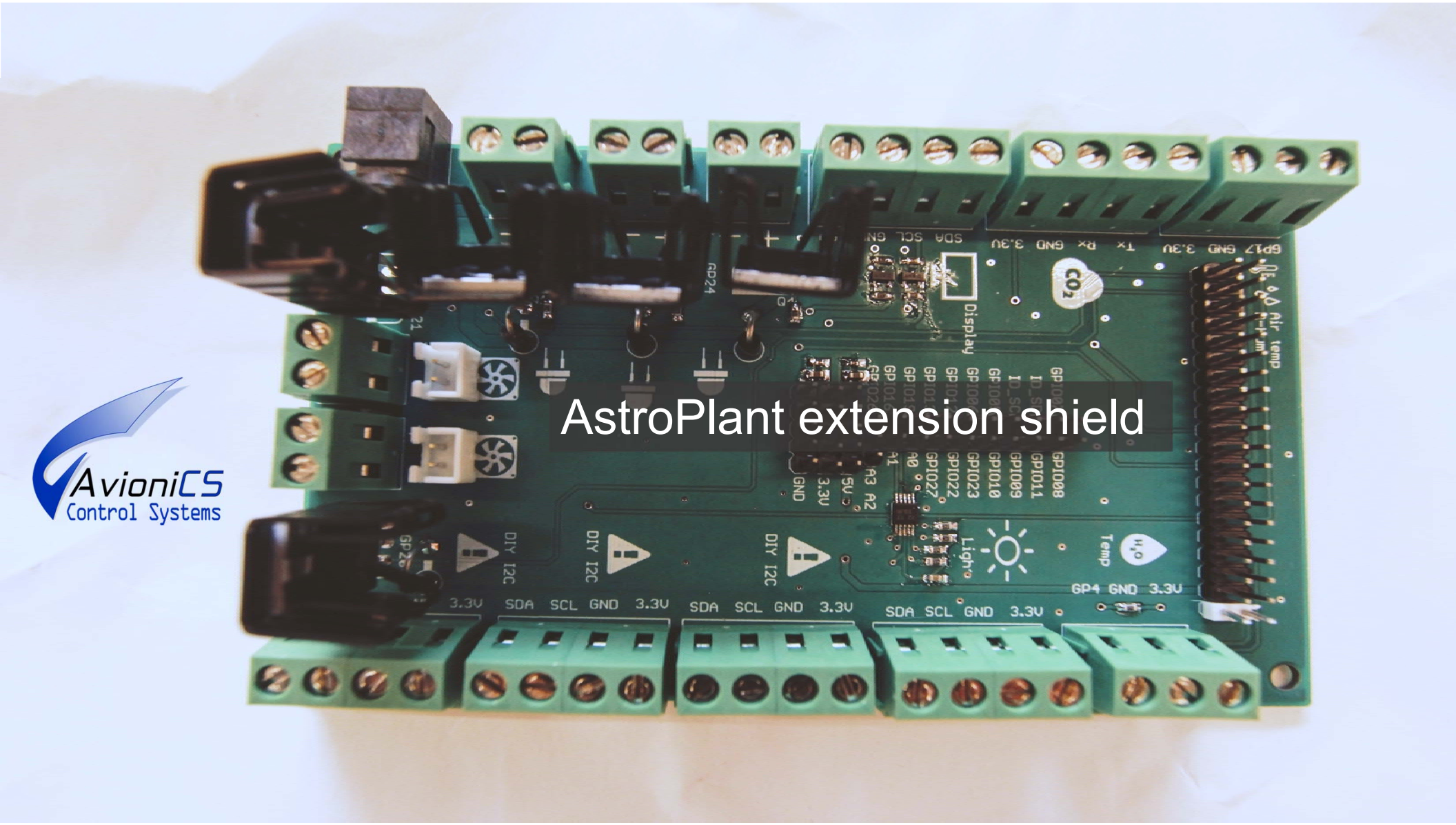
Raspberry Pi Zero W + extension shield

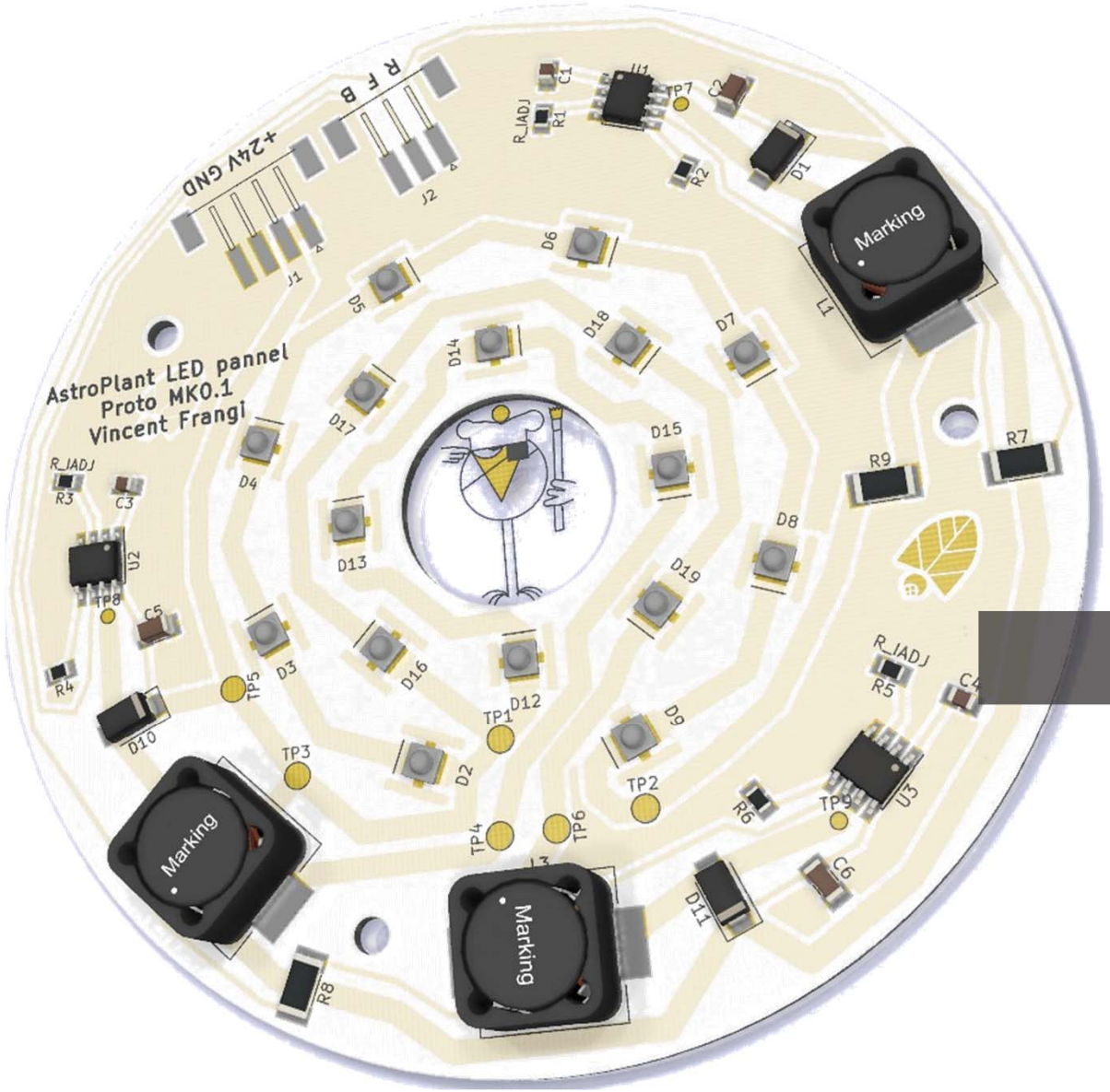
All written in Python

# MVP 5.0






AvioniCS
Control Systems
AstroPlant extension shield
DIY I2C
DIY I2C
DIY I2C
3.3V SDA SCL GND 3.3V
SDA SCL GND 3.3V
SDA SCL GND 3.3V
GP4 GND 3.3V
Display
Light
Temp
Air temp
GPIO8
GPIO11
GPIO9
GPIO10
GPIO23
GPIO22
GPIO27
A0
A1
A2
A3
GND
3.3V
5V

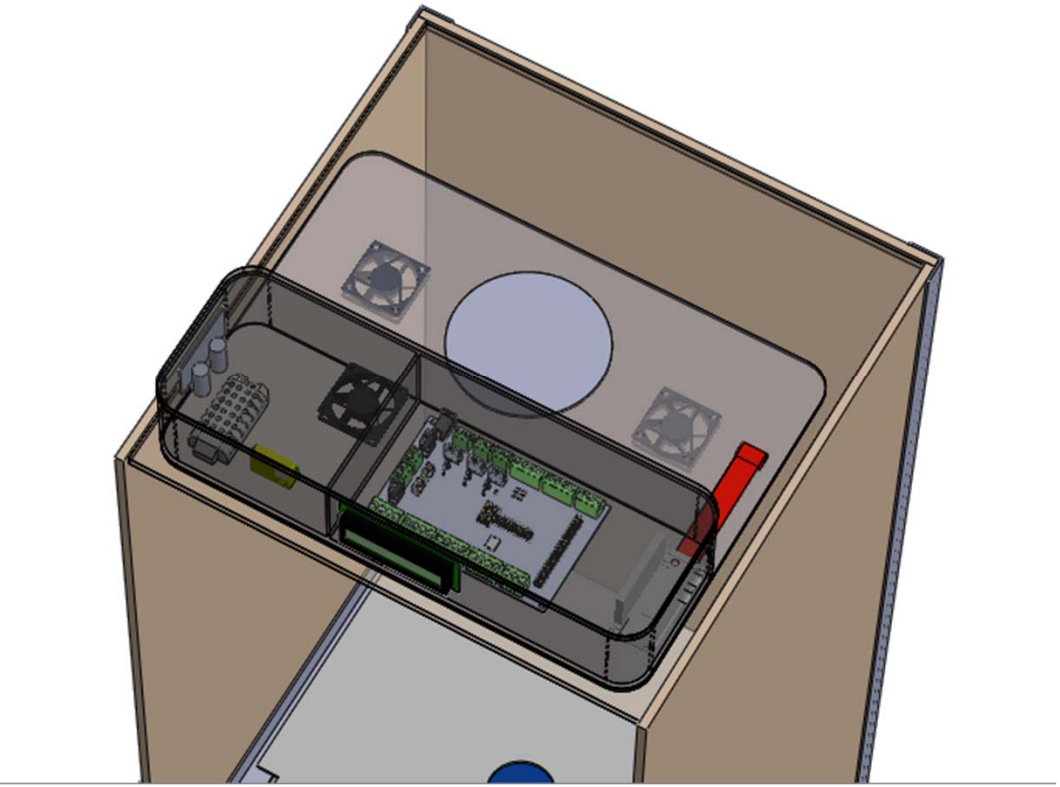


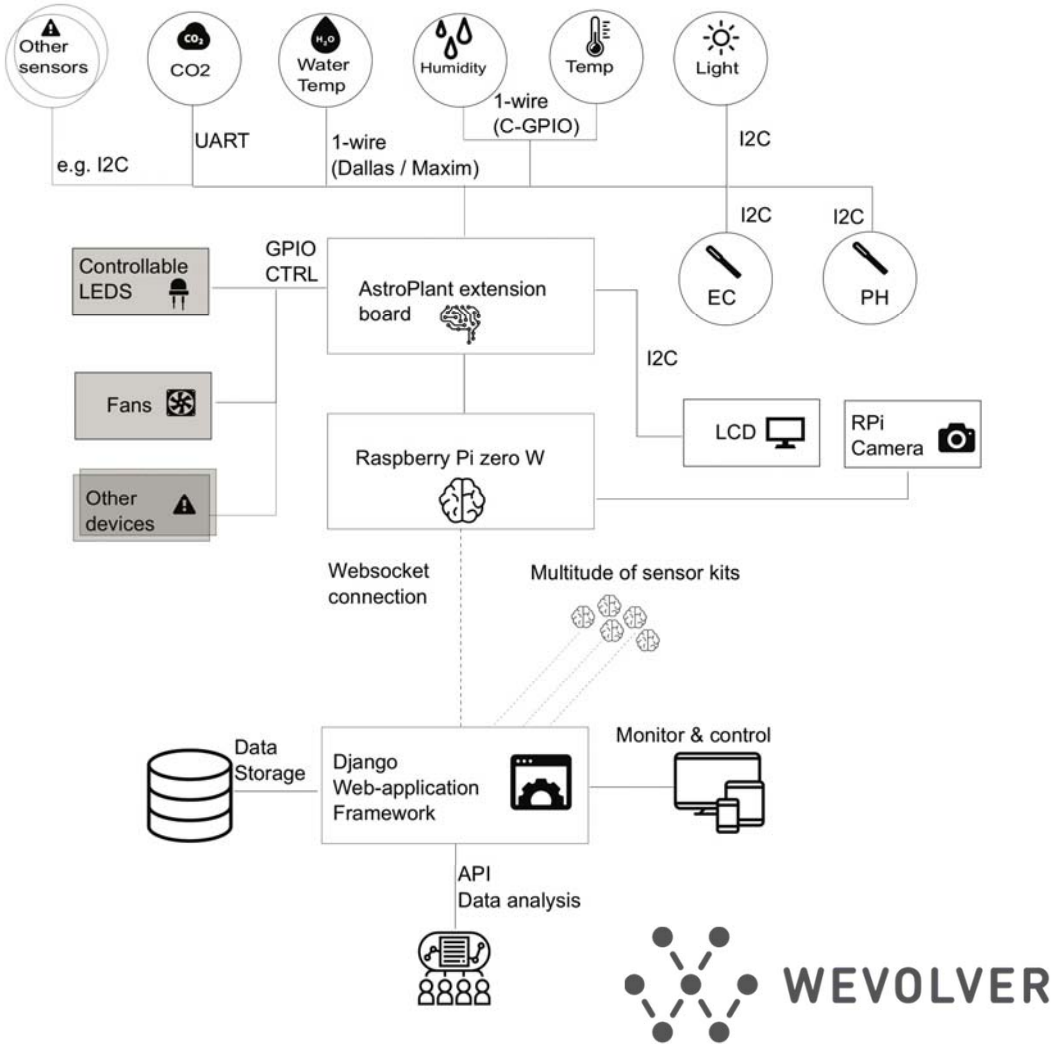

# LED control system

pH/EC board and probes

Next: multispectral / hyperspectral imaging

# You want to hack AstroPlant? You can.





PLEASE DO GET IN TOUCH!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AstroPlant@ESA.int

(or Catia.Cardoso@ESA.int for the educational program)


esa European Space Agency

Association for Vertical Farming

AvioniCS Control Systems

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DUTCH COAST

# Some additional slides


# Advisers and partners

Christel Paille, Christophe Lasseur – MELiSSA, ESA

Raffaella Pappalardo – ESA

GJ van t Veen – Dutch Coast, Jungle Works

Michel Behre – Border Sessions

Angelo Vermeulen – SEAD, TU Delft

WeVolver – open source hardware

Avionics – electronics company

Association for Vertical Farming – plant science & vertical farming

# Q&A

# Your input and involvement needed – 5 MINUTES

How would you like to be involved? – some ideas

- OPEN SCIENCE
  - **Draft a research design appropriate for the project AND your research**
- OPEN EDUCATION
  - **Propose / sketch an engaging educational activity**
    - e.g. How does light influence plant growth?
- OPEN INNOVATION
  - Help us improve the kit! Build it, test it, improve it.

# Thieme: Design challenge, ideation, and brainstorming

I. Design Challenge “Design a Design Challenge”
   - Mixing expertise

II. Hack AstroPlant – using SCAMPER approach
   - Substitute, combine, adapt, maximize…

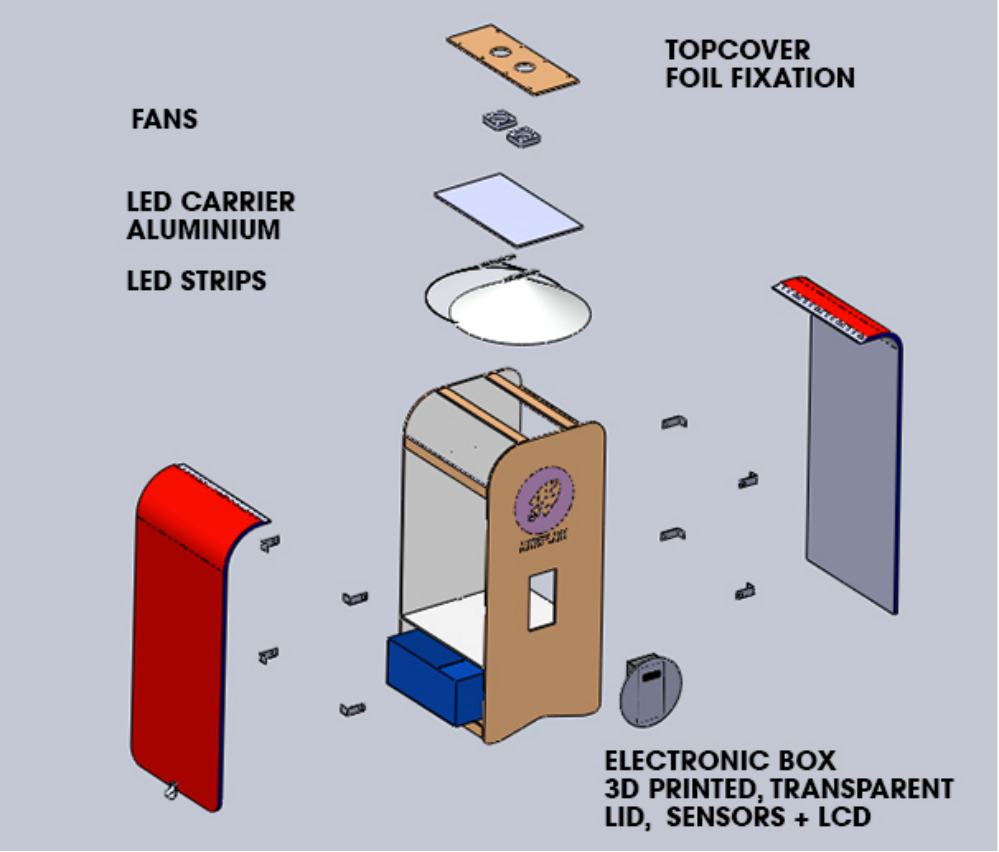
III. AstroPlant Ideation using COCD Box

# I. Design Challenge: Design a Design Challenge

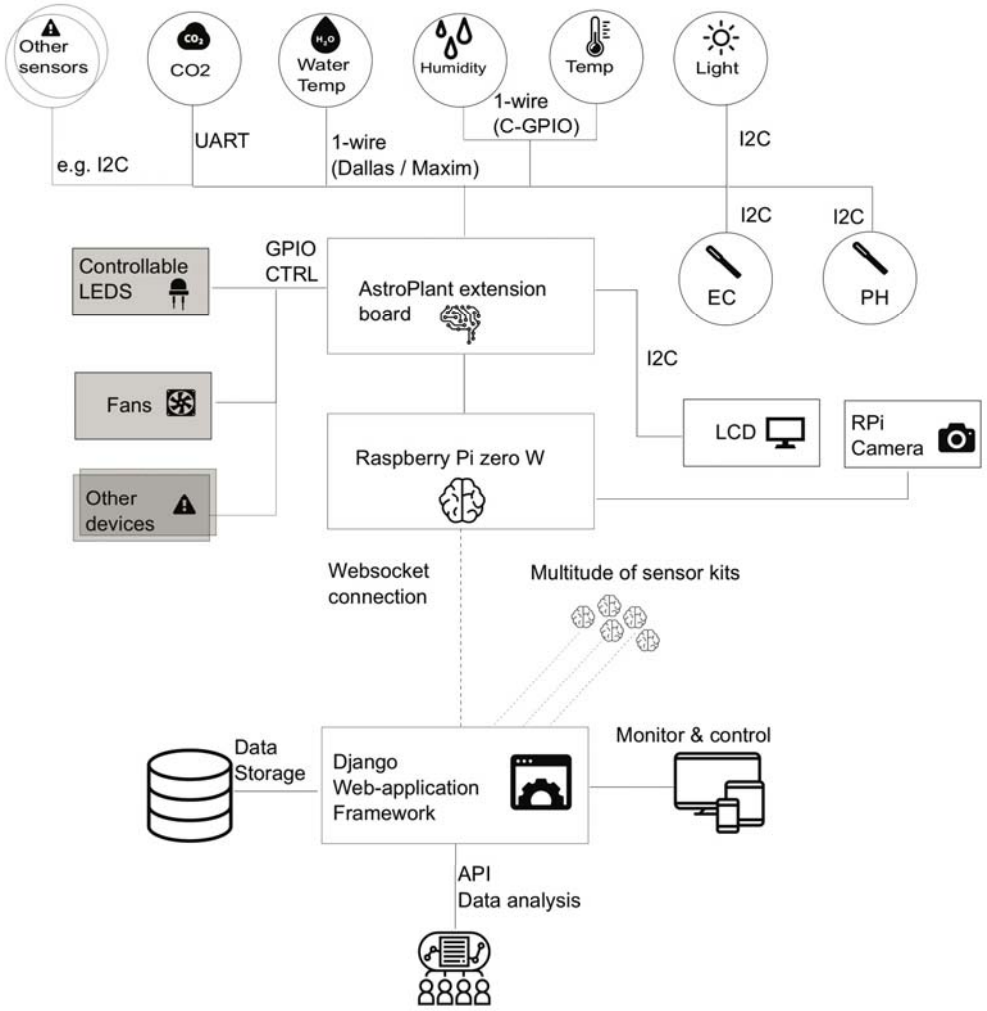
- Suppose you're a…
  - Entrepreneur → e.g. design challenge on business modeling for AstroPlant
  - Biologist → e.g. design challenge to develop a plant-science research design
  - Maker → e.g. design challenge "make an AstroPlant from waste materials"
- Adding to the template
  - Questions, challenges, resources, links, target group + your email if you want to be involved in co-developing the challenge
- I will turn it into short online challenges that will be provided to young explorers using AstroPlant

# IIa. Hack AstroPlant

- SUBSTITUTE: parts, the whole, material…
- COMBINE: functions, material, just different…
- ADAPT: other color, place, use, form, timing…
- MAXIMIZE: bigger, stronger, longer, more time, macro level, use more often…
- MINIMIZE: smaller, lighter, shorter, micro level, less important…
- PUT TO OTHER USES: other context…
- ELIMINATE: parts, functions, material…
- REVERSE: sequence, upside down, inside out…

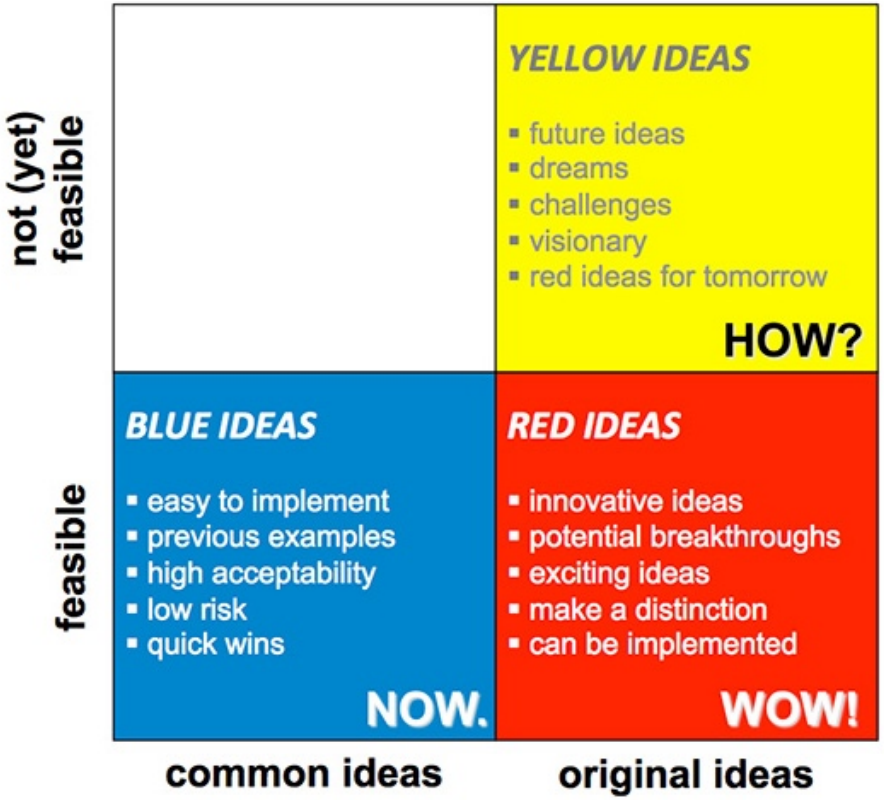


# IIb. Hack AstroPlant



# III. Ideation challenge

- Where to go with AstroPlant: now, next, and in 5 years?
- Example: building a Moon Lander demonstrator (actually…)
- Start individually with just writing down lots of ideas for AstroPlant… then boil down your grand list of ideas down to about 15 really good ones (5 in each color – blue, red and yellow).
- Process
  - Brainstorm lots of ideas
  - Boil down to max 3-5 favs per colour



**30 minutes !**