

MUSA

An ISS experiment for the research of a dual culture for Panama disease

Valeria Dittel Tortós
Fiorella Arias Bonilla
Instituto Tecnológico de Costa Rica

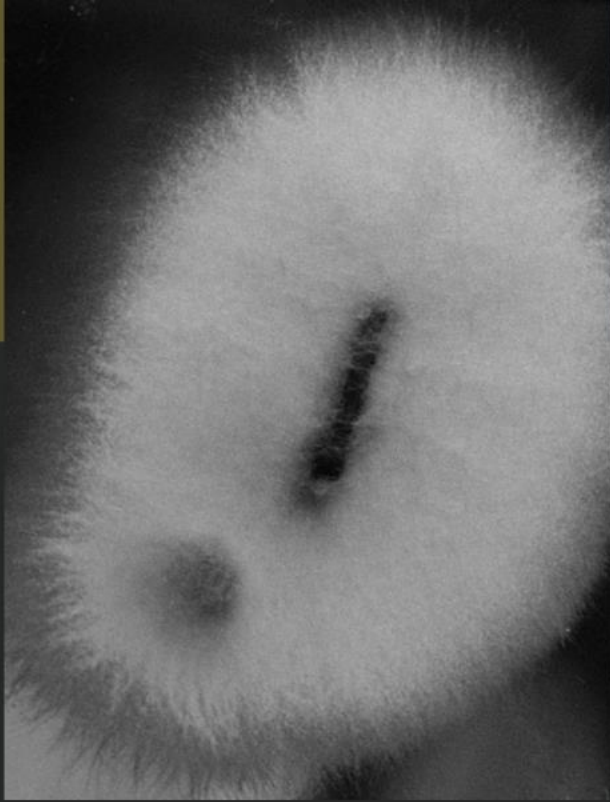
Importance of Banana



40 thousand direct jobs in Costa Rica

Basic Diet of 400 million people

1 million bananas imported in Japan annually



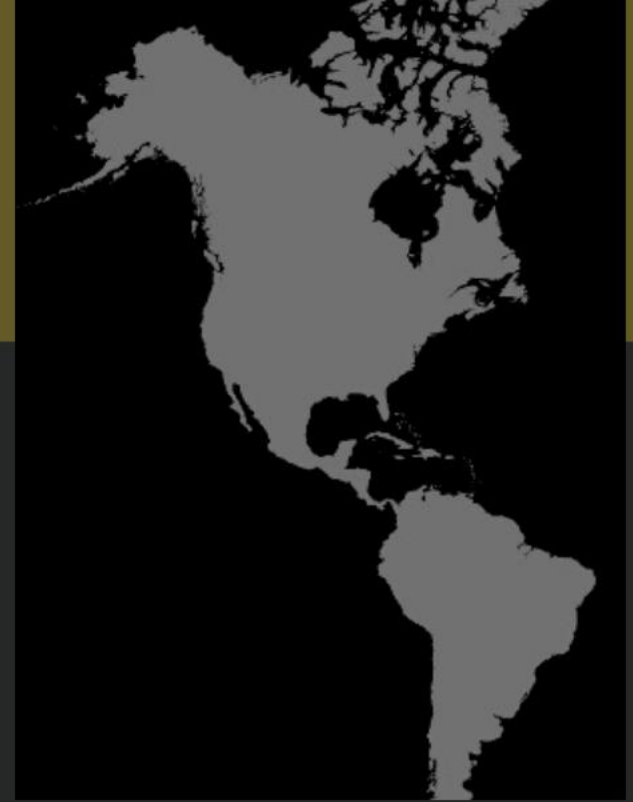
FUSARIUM OXYSPORUM RACE 4.

Produced the denominated
Panama Disease



AROUND 80%

Of the Banana crops are at
risk.



LATIN AMERICA

Under alert as a primary
source



Our Project MUSA

A DUAL CULTURE

of two antagonist fungi at the International Space Station. We will use *Trichoderma harzianum* and *Fusarium* race 1.

GENERAL OBJECTIVE

Determine gene expression changes in *Trichoderma harzianum* and *Fusarium oxysporum* f. sp. cubense tropical race 1; via a dual culture exposed to constant microgravity, compared to on-Earth controls.

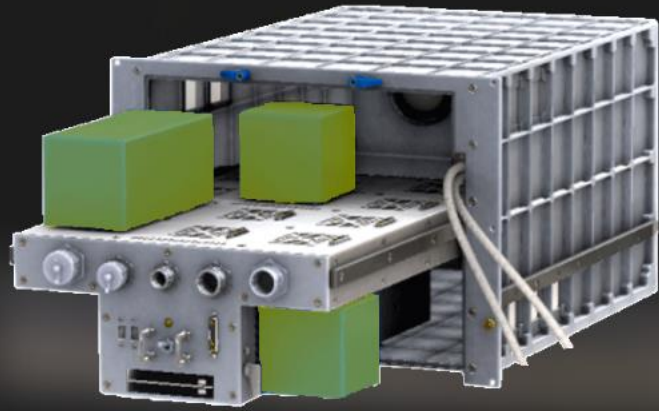
SPECIFIC OBJECTIVES

Return in a safe condition the mission's scientific payload for in-lab analysis.

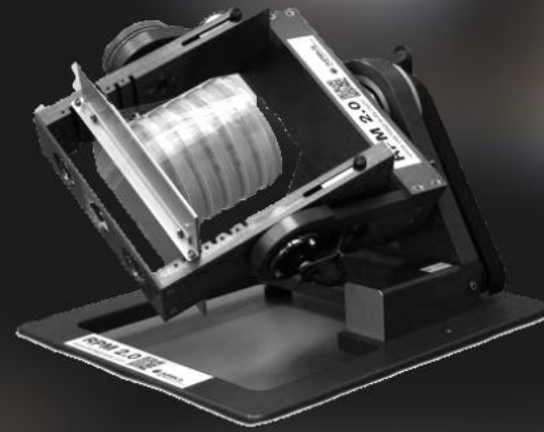
Acquire panoramic and millimetric resolution image data from the mission's scientific payload during the on-orbit operation cycle.

Provide infrastructure and experiment setup to study dual culture interactions in microgravity.

CONCEPT OF OPERATIONS



Space Segment



Clinostat



Earth - Lab
Experiments

PETRI DISHES

9 samples on rectangular petri dishes
(60 x 30 x 7) mm

PDA

pH 5.5 & Concentration 1.5%

TEMPERATURE

$(25 \pm 5) ^\circ\text{C}$

HUMIDITY

Between 60% and 80%

OXYGEN CONCENTRATION

Must be kept at 22% to prevent oxygen deficit
caused by the fungi metabolism

GROWTH ADVANCEMENT

$\text{GAF} = 100 * (D1 - D2) / D1$

STATISTICAL ANALYSIS

9 SAMPLES ANALYZED
THROUGH ANOVA F TEST

Parametric variance with 95% confidence intervals

Power up to 99%

Differences detection of 50%

VALIDATION

Minimum of 6 samples

GROWTH ADVANCEMENT FRONT

The experiment has to measure growth rates
with millimetric resolution

RISK AT MINIMUM

Experiment should keep risk factors at a
minimum

MINIMAL MICROGRAVITY EXPOSURE TIME

The experiment has to be exposed for at least 6
days microgravity conditions (60 mm x 30 mm
x 7 mm sample)

The substrate (agar) must maintain useful conditions during transport.

Samples will be kept at 4-8 °C before the start of the experiment, and (-22) °C after its execution.

Key Performance Parameters

Key Performance Parameters

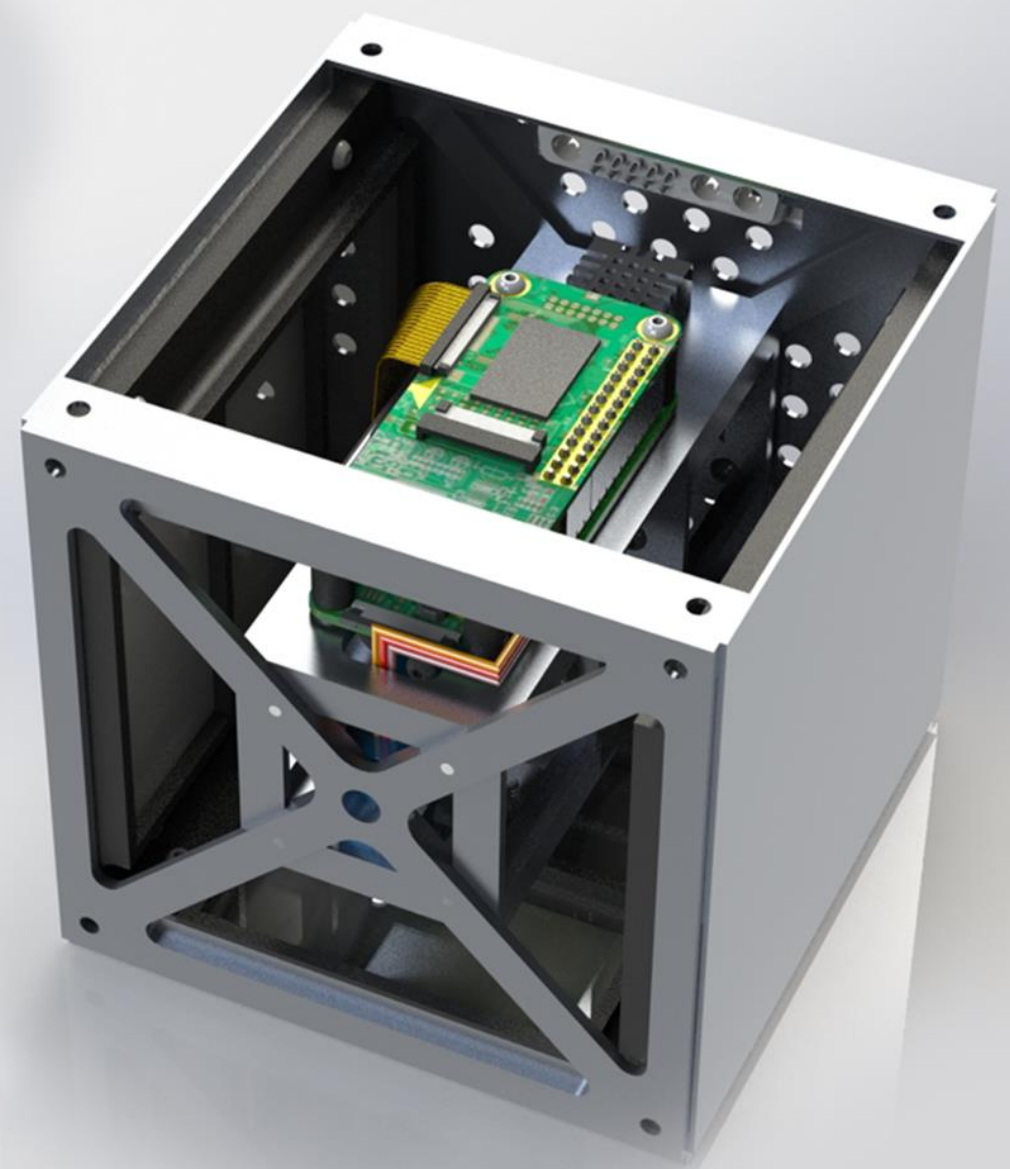
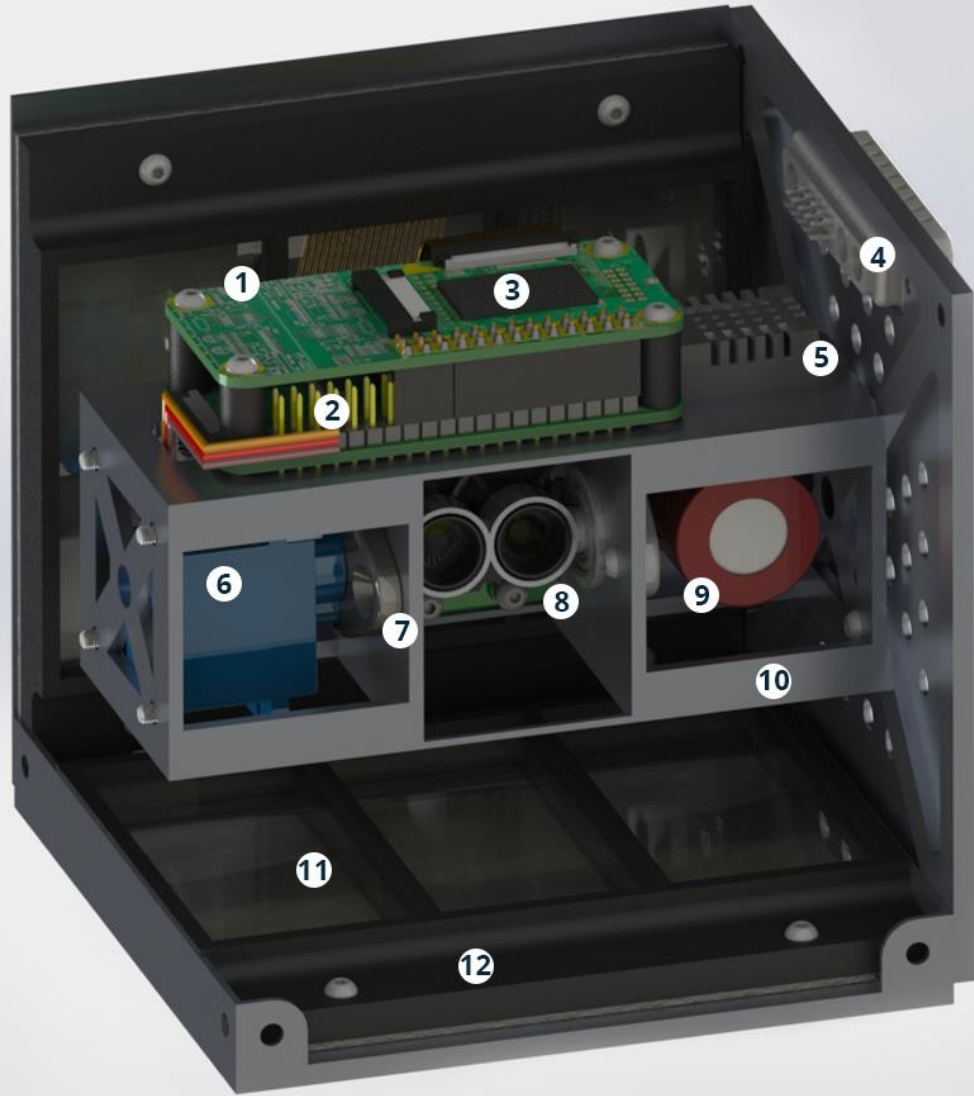
The spores must arrive in safe condition for the execution of the experiment.

Earth return must be successful for mission objectives to be completed.

The camera must capture millimetric resolution images of the samples.



SPACE SEGMENT DESIGN



1- Printed Circuit Board
2- Microprocessor
3- Multiplexer
4- DB13W3P Male Plug

5- DHT22 Sensor
6- Servomotor
7- Bearing
8- Cameras

9 - CO2 Sensor
10- Inner Structure
11- Sample Container
12- Sample Holder

POWER SUBSYSTEM

TOTAL CONSUMPTION: 2.029 W

Servomotor 0.5 W

DHT22 0.005 W

O2 Sensor 0.005 W

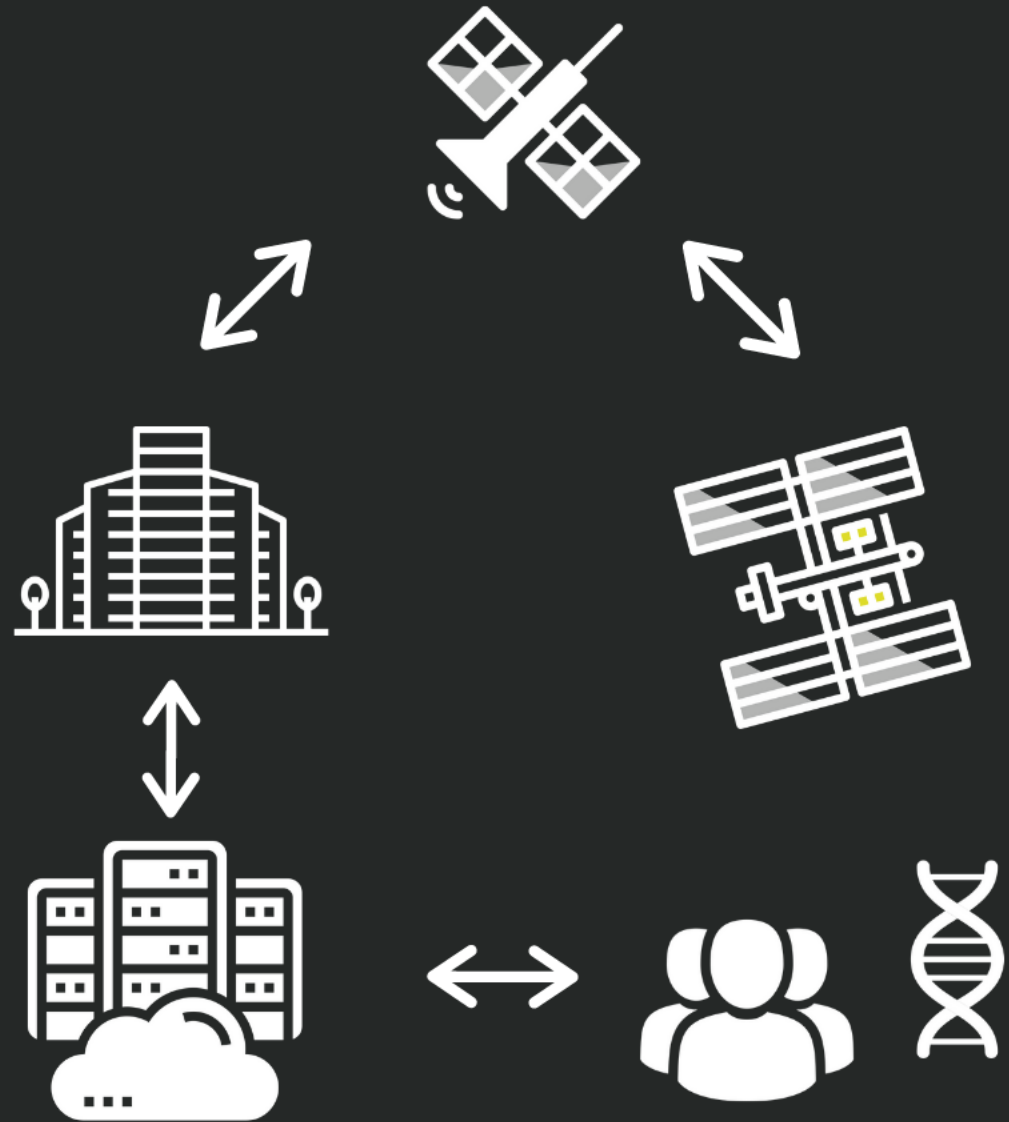
LEDs 0.066 W

SN74LVC1G123 0.053 W

Raspberry Pi Zero & Cameras 1.5 W

COMMS AND DATA HANDLING

Data will be downlinked and
synchronized with home base using
ICECubes Facility

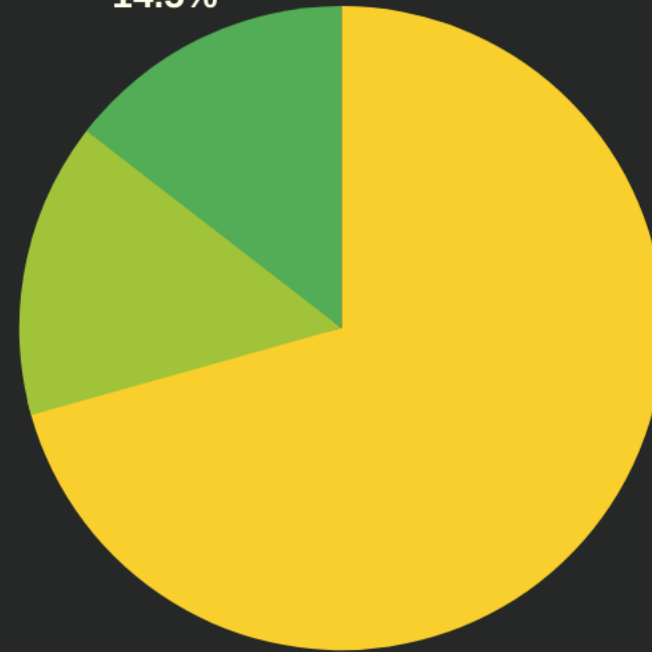


MASS BUDGET

TOTAL MASS: 0.564 KG

Electronics
14.8%

Samples
14.5%



Mechanical structures
70.6%

A photograph of a SpaceX Dragon capsule in space, oriented vertically. The capsule is white with blue accents and the word "SPACEX" is visible on its side. It is attached to a service structure. The background is a dark, starry space.

LENIENT STATE

Phase 1: Launch + 14 days



DEFROSTING OF THE SAMPLES

Phase 2: + 1 day

A photograph of a space station in orbit above the Earth. The station's complex structure, including multiple solar panel arrays, is visible against the blue and white horizon of the planet. The text 'NOMINAL OPERATIONS' is overlaid in white, sans-serif font across the center of the image.

NOMINAL OPERATIONS

Phase 3: + 6 days



ISS FREEZERS

Phase 4: + 1 day

A woman with dark hair, wearing glasses and a white lab coat over a grey turtleneck, is focused on her work in a laboratory. She is holding a petri dish and looking towards a microscope. The background shows a cluttered lab desk with various equipment, including another microscope, a pen holder, and some papers. A window with a view of the outdoors is visible on the right side of the frame. The overall scene is dimly lit, with a soft glow from the window.

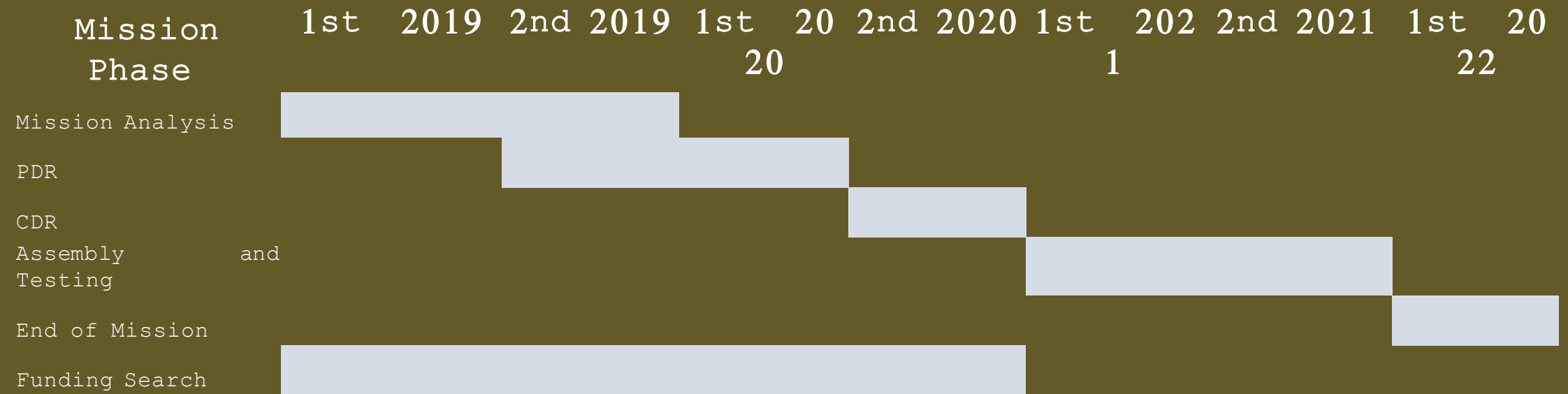
TRANSPORT ON THE
SPACE X DRAGON
CAPSULE TO EARTH

Phase 5: Return + 14 days

IMPLEMENTATION PLAN



GANTT CHART



Lack of sufficient funding.

MEDIUM

Spores get damaged in
transport.

LOW

Internal mechanisms failure
due to vibrations.

MEDIUM

MISSION RISKS

MISSION RISKS

Defreezing of samples
during transport.

MEDIUM

Electronics failure.

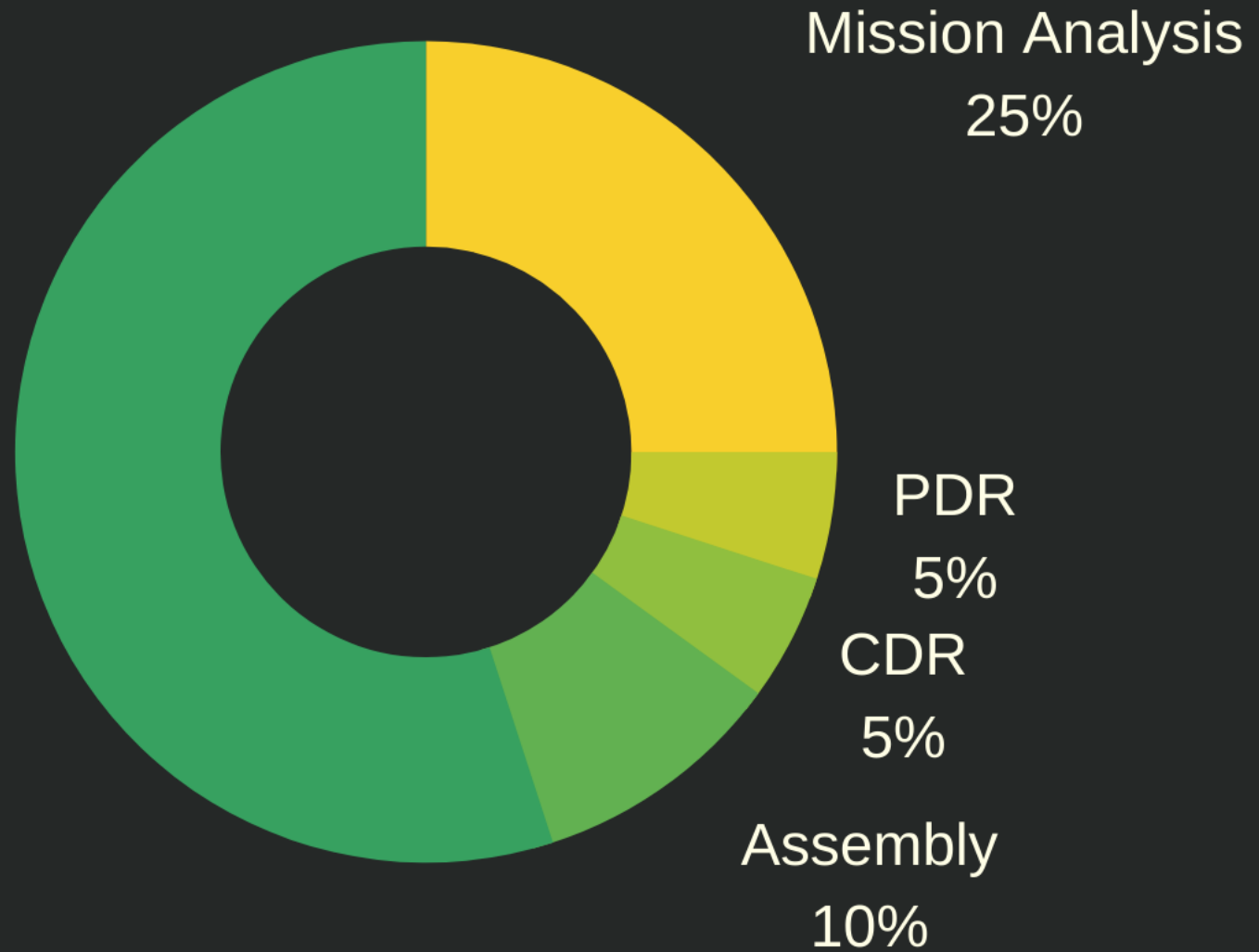
LOW

FINAL COST

TOTAL
ESTIMATE
COST:

\$100.000

Operations
55%



8 DECENT WORK AND
ECONOMIC GROWTH



Decent work
and economic
growth

12 RESPONSIBLE
CONSUMPTION
AND PRODUCTION



Responsible
consumption
and production

15 LIFE
ON LAND



Life on Land



Questions?