How to take advantage of biodiversity for human spaceflight:

the Costa Rica case

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Electronic Engineering School
Costa Rica Institute of Technology

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National Laboratory of Nanotechnology (LANOTEC)
National Center for High Technology (CeNAT)

United Nations Expert Meeting on Human Space Technology
"Providing Access to Space"

Vienna International Centre, Vienna, Austria
4-6 December 2018

UNITED NATIONS
Office for Outer Space Affairs

Where is Costa Rica?

- Independent since 1821
- No army since 1949 (70 years last December 1st)
- Percentage of protected areas is 25 %, forest areas around 50 %
- Intends to be the first carbon neutral country on Earth
- Most biodiverse country per area in the world by some standards

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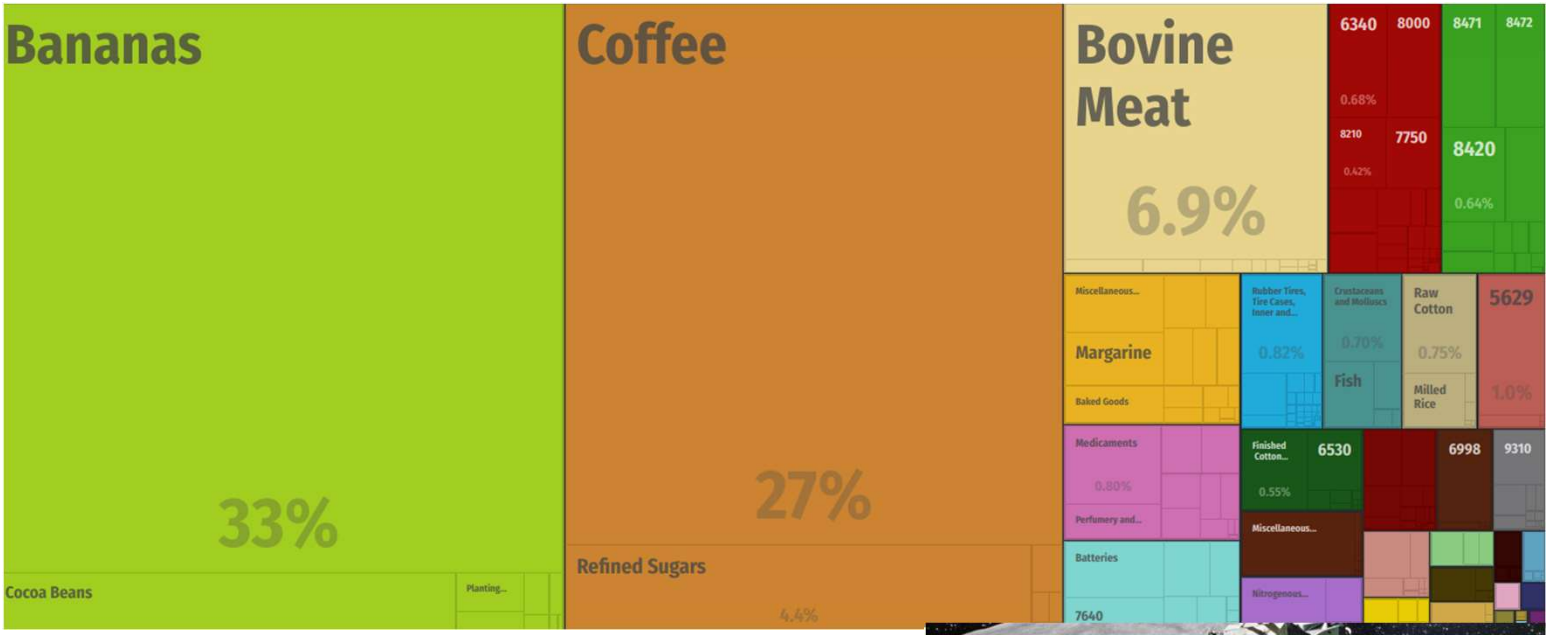
What does Costa Rica export in 1969?

Same year as lunar landing by Apollo 11



Source: The Observatory of Economic Complexity
https://atlas.media.mit.edu

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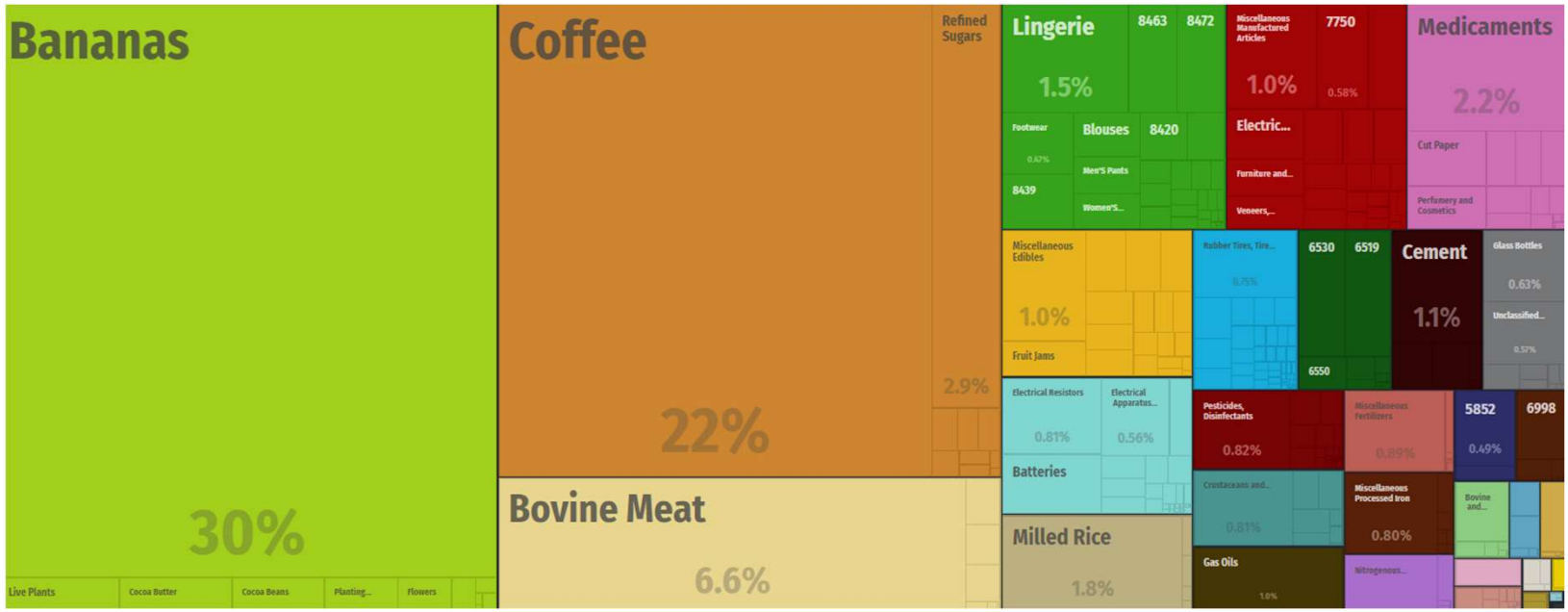
What does Costa Rica export in 1980?

Same year as shuttle first flight



Source: The Observatory of Economic Complexity
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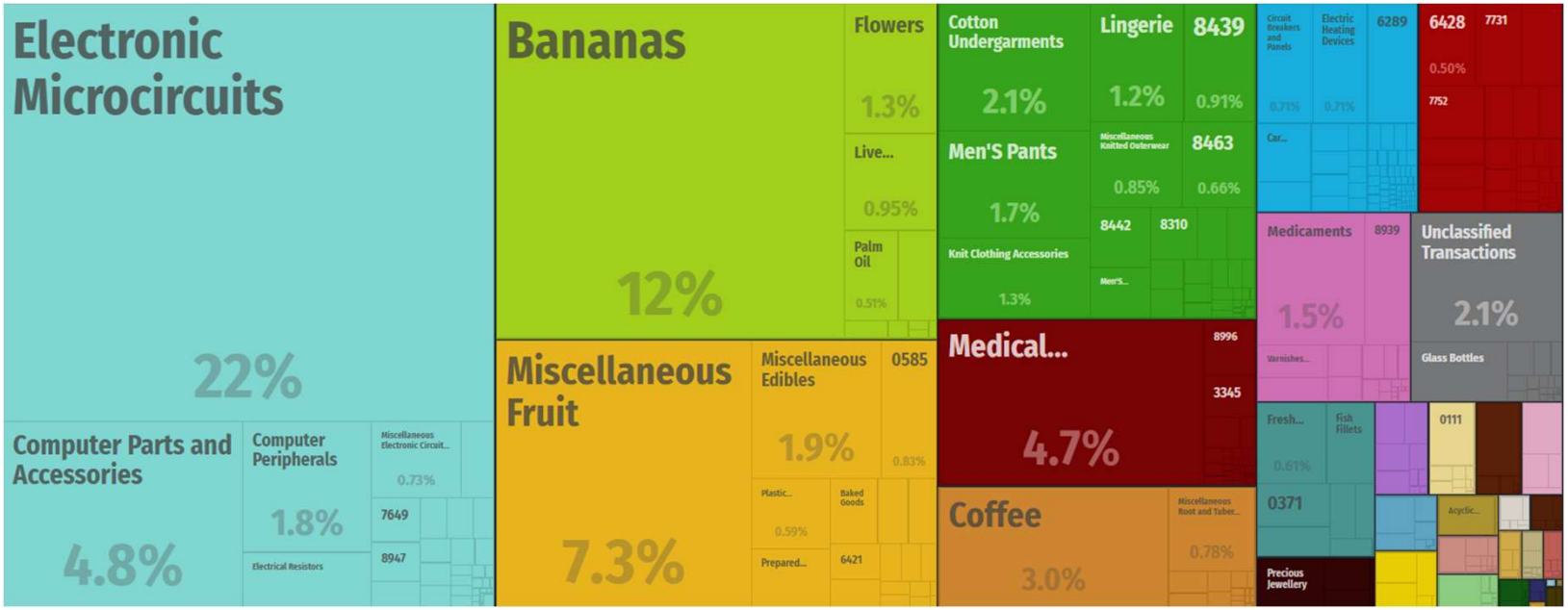
What does Costa Rica export in 2002?

Same year as Dr. Chang last flight!



Source: The Observatory of Economic Complexity
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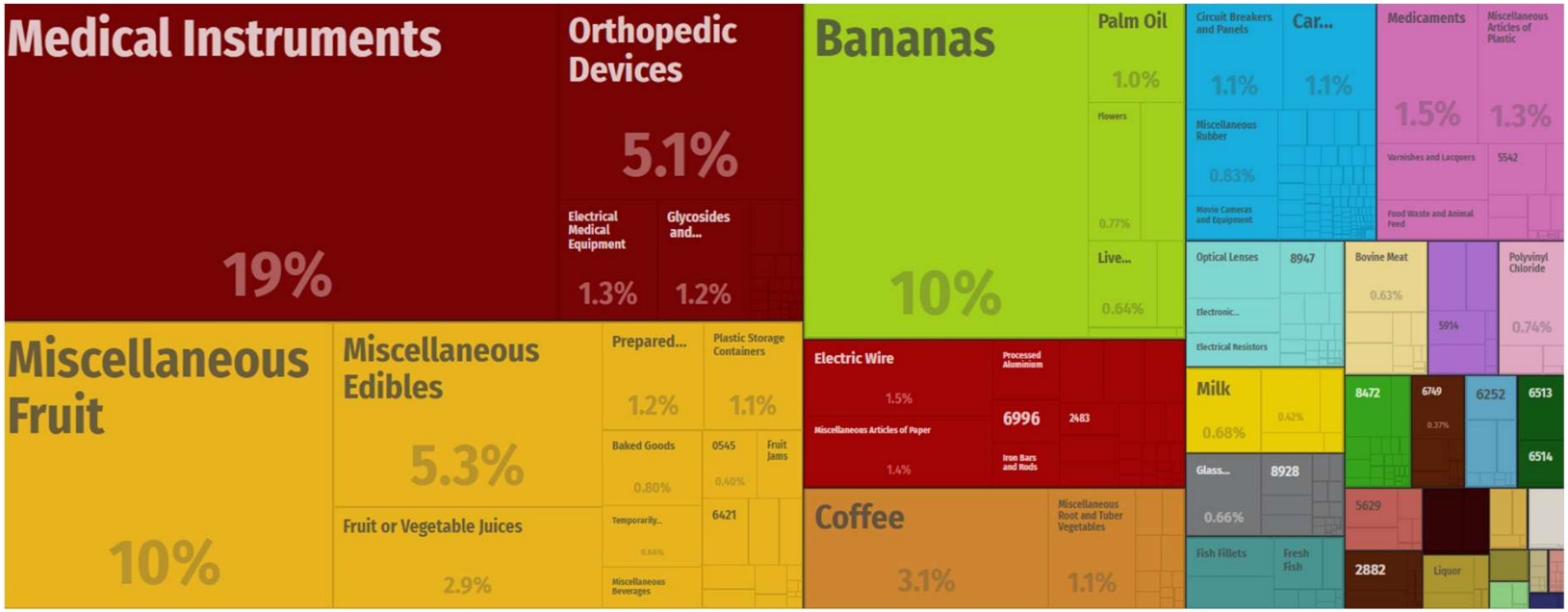
What does Costa Rica export in 2016?

Creation of the Costa Rica Aerospace Cluster



Source: The Observatory of Economic Complexity
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COSTA RICA AEROSPACE CLUSTER

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Ok, Costa Rica economy is evolving… how about space?

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Evolution of the space sector in Costa Rica

Franklin Chang Missions

COSTA RICA AEROSPACE CLUSTER

90's

2013

2016

2018

1995 2000 2012 2015 2017

Project IRAZÚ

IRAZÚ In orbit

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Chagas disease experiment: biological space experiment with Costa Rican Participation

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CubeSat project (ACAE/TEC)

PROYECTO IRAZÚ

https://www.tec.ac.cr/proyectos/proyecto-irazu

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Drop Tower Experiment (TEC)

DropTES, Series III: Experiment by Costa Rican Team at ZARM Microgravity Tower

Team during experiment integration in Bremen: (from left to right) Moacir Fonseca, Dr. Renato Rímolo, Carlos Mayorga, Nicole Chaves y Ernesto Corrales. Courtesy of T. Könemann, ZARM.

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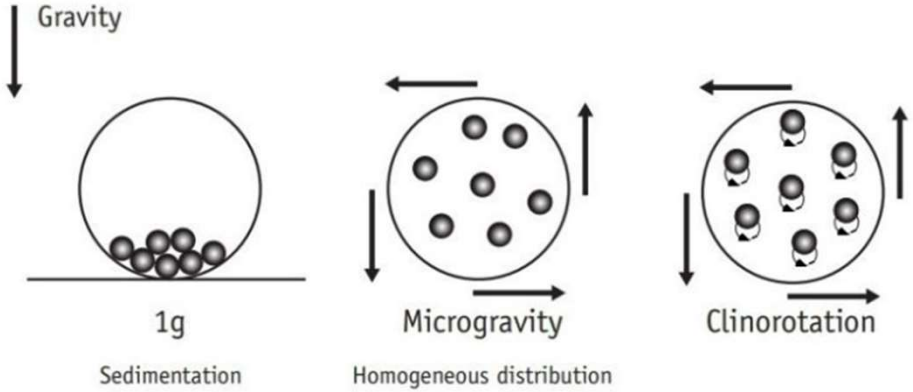
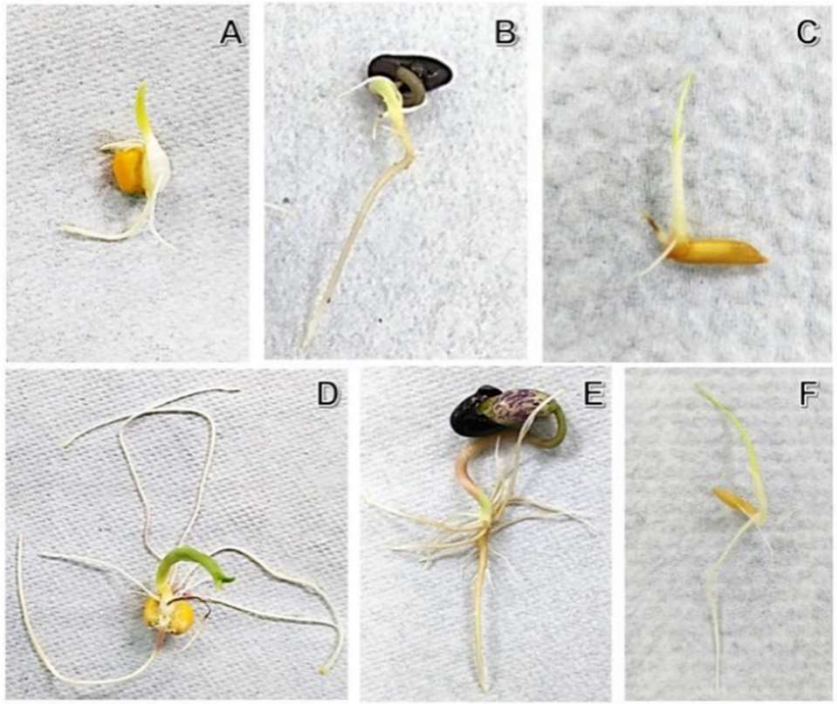
Clinostat results (LANOTEC)



Representation of the rotational movement of a 2-D Clinostat. Modified from UNOOSA



Seeds of maize (*Zea mays*), beans (*Phaseolus vulgaris*) and rice (*Oryza sativa*), exposed to two different conditions of rotation and their respective control. **A. B** and **C**. Micro-g. **D. E** and **F.** Control. A two-dimensional clinostat (2-D) was used. Next conditions were considered: temperature at 23°C, humidity at 80% and 15 rpm. Plants were grown up until the 8th day

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What has been done in Costa Rica?

	Provided by UNOOSA	Organization	Comments	Next steps
Clinostat	Yes	LANOTEC-CeNAT	Maize, rice and beans experiments done	Test in space
Drop Tower	Yes	TEC	Sucessful experiment	No further planning
CubeSat Mission 1	In part (help from Kyutech Study program)	ACAE/TEC	One CubeSat mission in operation	-GWSat misión -Central American CubeSat -BiodiverSat

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Ok, Costa Rica has some projects in space. Where are we pointing?

TEC Space Program philosophy

- Cooperation to achieve high impact goals
- Use the competitive advantages of Costa Rica
- Be at the service of the country and Sustainable Development Goals
- Be a world class laboratory, not a follower

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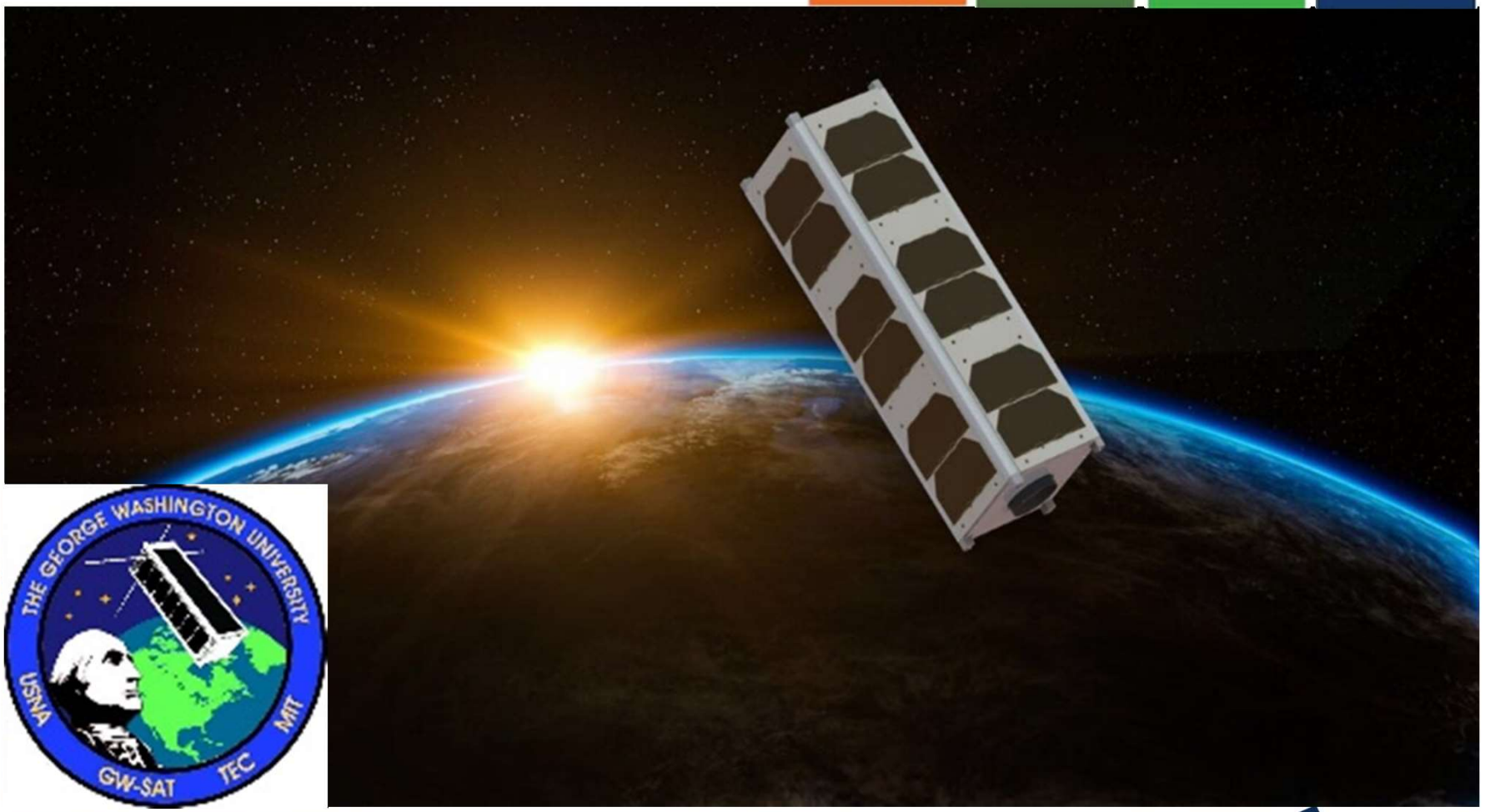
Project #2: GW-Sat



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TEC | Tecnológico de Costa Rica

Project 3: Central America Satellite

UVG UNIVERSIDAD DEL VALLE DE GUATEMALA

TEC | Tecnológico de Costa Rica

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Proyecto #4: BIRDS

TEC | Tecnológico de Costa Rica

Bangladesh 

Nigeria 

Mongolia 

Ghana 

Japan 

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Academic cluster! What is that?

CeNAT
Centro Nacional de Alta Tecnología

TEC
CONARE
UNED
UTN
Universidad Técnica Nacional

17 PARTNERSHIPS FOR THE GOALS

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Latinamericans in Space: How it works?

INTERNATIONAL ASTRONAUTICAL FEDERATION

GRULAC
Latin America and Caribbean

SINGLE-STAGE SUBORBITAL ROCKET

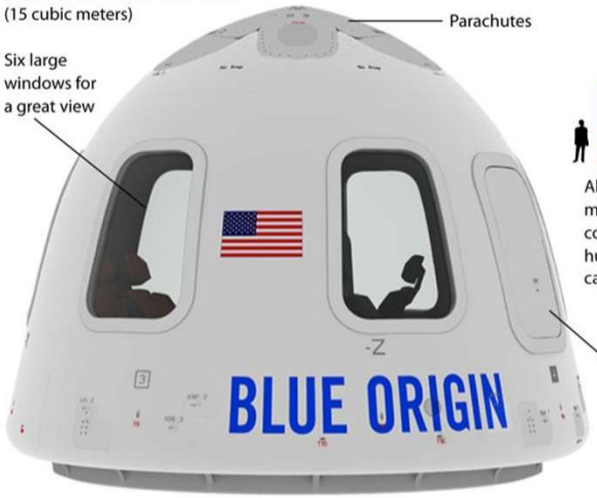
New Shepard, named after Mercury astronaut and Apollo moonwalker Alan Shepard, is Jeff Bezos' scheme for high-altitude, near-space tourism. A propulsion module (rocket) lobs the crew to an altitude of 307,000 feet (93,573 meters) – well above the height required to earn NASA astronaut wings. The rocket returns to its launch site and lands, while the crew capsule descends on a parachute.

SIX-PERSON CREW CAPSULE

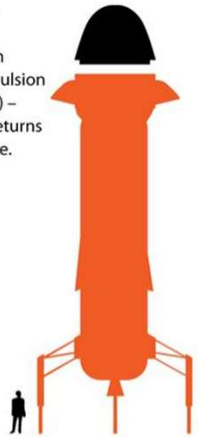
Interior volume: 530 cubic feet (15 cubic meters)

Parachutes

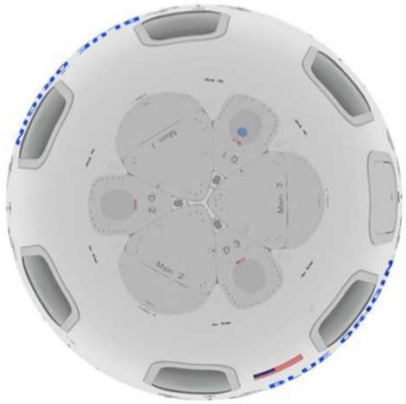
Six large windows for a great view



Entry/exit hatch



Above: The propulsion module in landed configuration, with a human figure and crew capsule to scale.



SOURCE: BLUE ORIGIN

SPACE.COM

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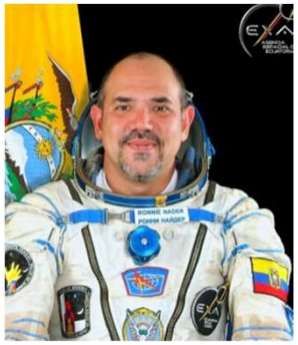
LATCOSMOS-C : Latinamericans in Space



Name: Cdr. Ronnie Nader
Function: Mission Commander
Agency: EXA
Country: Ecuador

Name: Phd. Alberto Ramirez
Function: Payload Specialist
Institution: UNAM
Country: Mexico

Name: Msc/MdS Jonna Ocampo
Function: Payload Specialist
Agency: EXA/ICC
Country: USA

Name: Phd Cdt. Adolfo Chaves
Function: Payload Specialist
Institution: TEC-CR
Country: Costa Rica

Name:
Function: Payload Specialist
Institution: AEC
Country: Colombia

2020 ESAA-01 Mission Crew Candidate Pre-Selection

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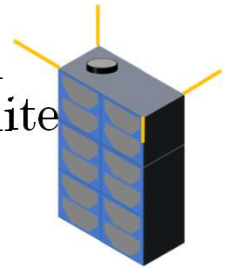
Costa Rica's past and future in this decade

Project IRAZÚ (TEC/ACAE)

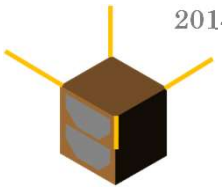
Drop tower experiment (TEC) & Clinostat results (LANOTEC)

MDR Central American Satellite (3rd satellite) (TEC/UVG)

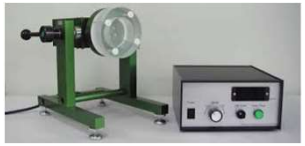


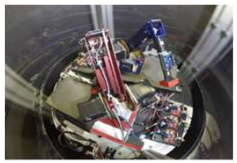
COSTA RICA AEROSPACE CLUSTER

2013 2014 2015 2016 2017 2018 2019 2020

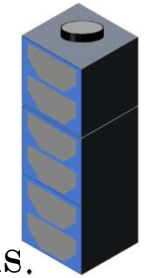


Aerospace Cluster created





IRAZÚ In orbit & GWSat begins. 2nd satellite GWU/TEC



-GWSat in orbit -Latcosmos (human space flight)

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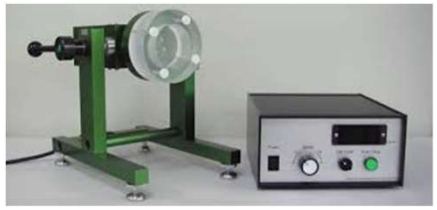
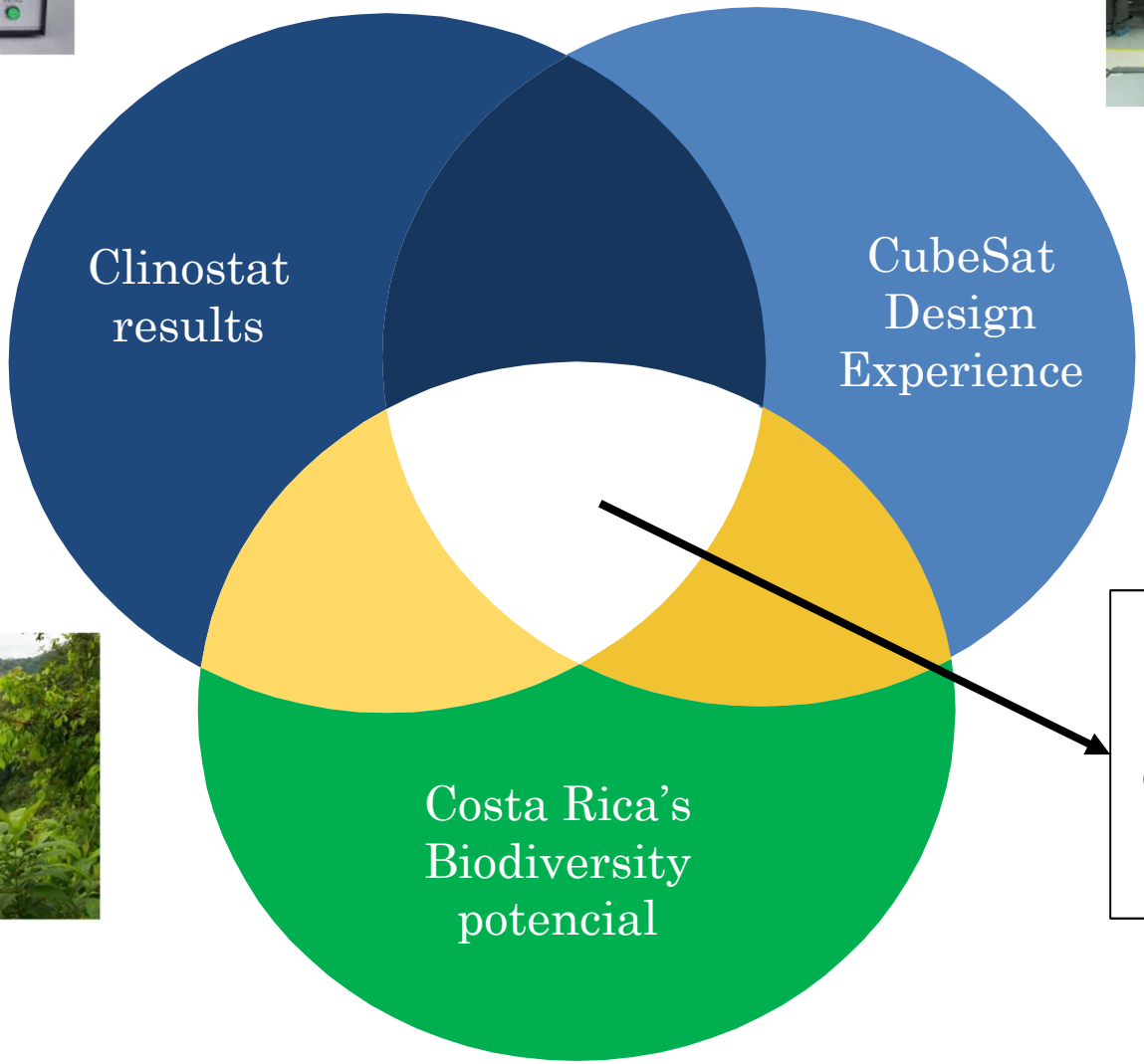
How does a country do first class space research?





Make the best out of what we have!
Combine it with a competitive advantage!

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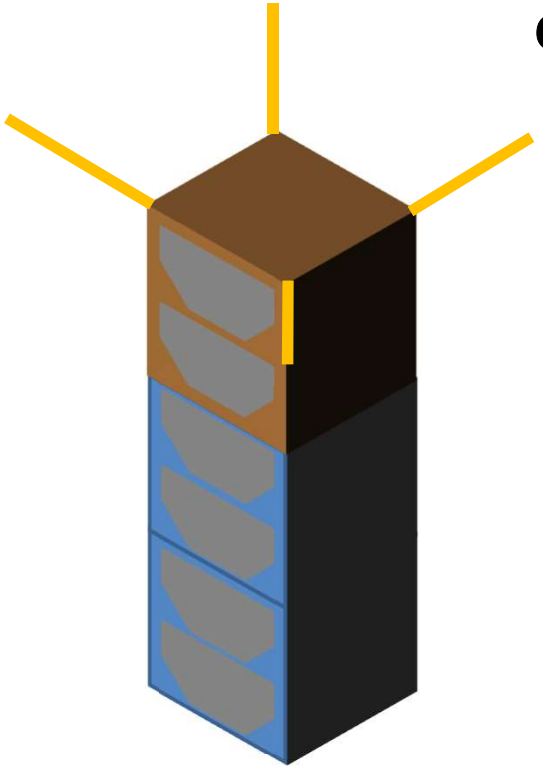
Project proposal: BiodiverSat

the biodiversity space program: Is time for Costa Rica to propose!
A path for world class space research from any country!



- Use the heritage of two to three space missions
- Use the experience from Lanotec, and pre-tested plants with the clinostat

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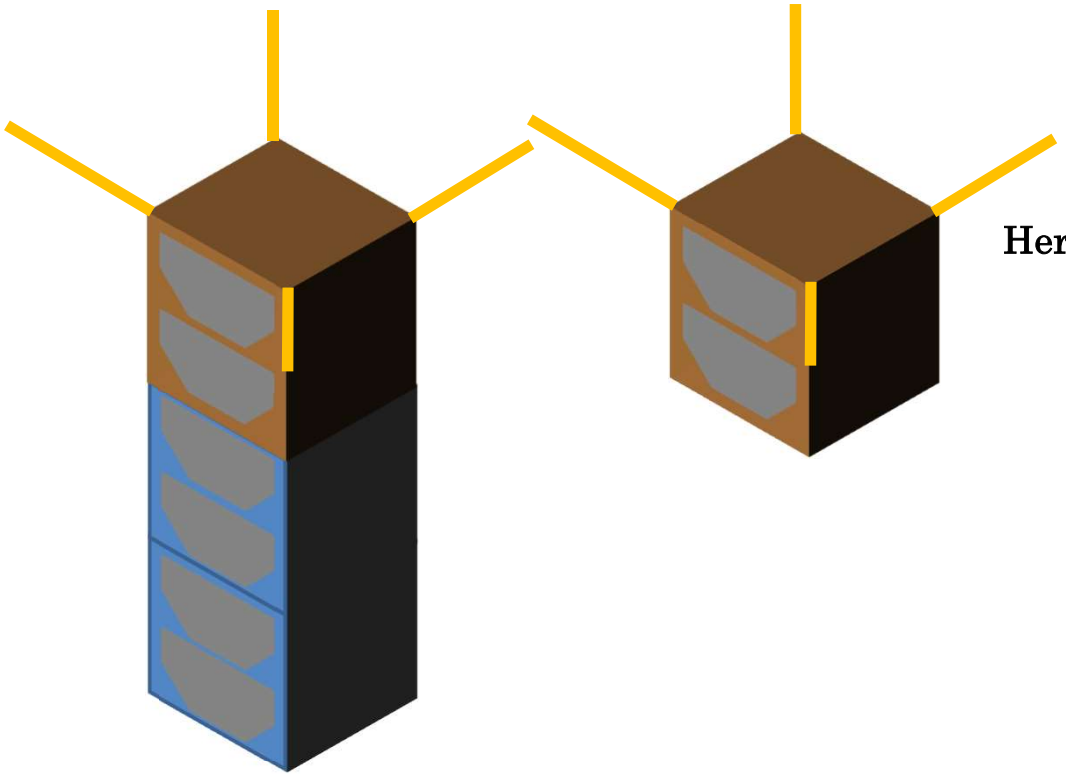
Project proposal: BiodiverSat

A path for world class space research from any country!



Service module

Heritage from two space missions at SETEC Lab

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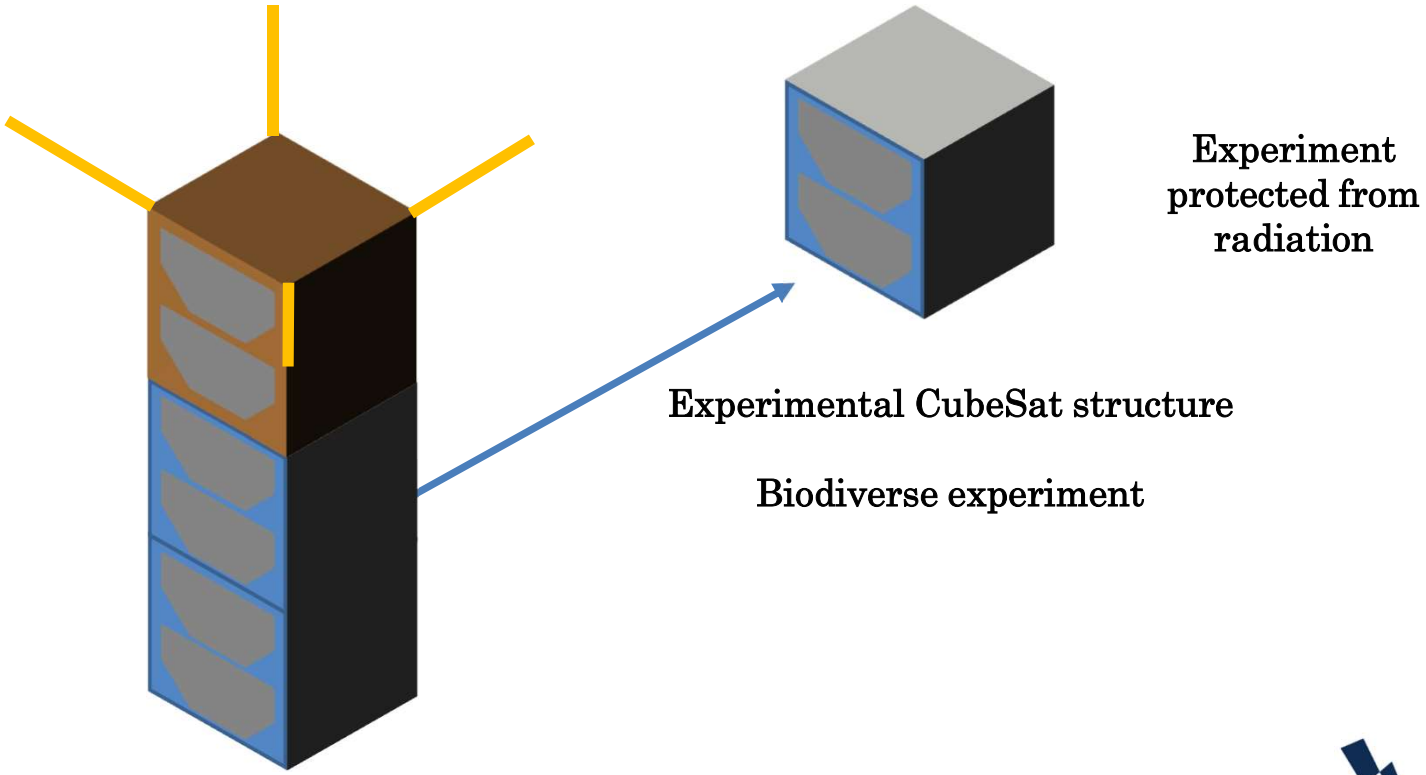
Project proposal: BiodiverSat

A path for world class space research from any country!



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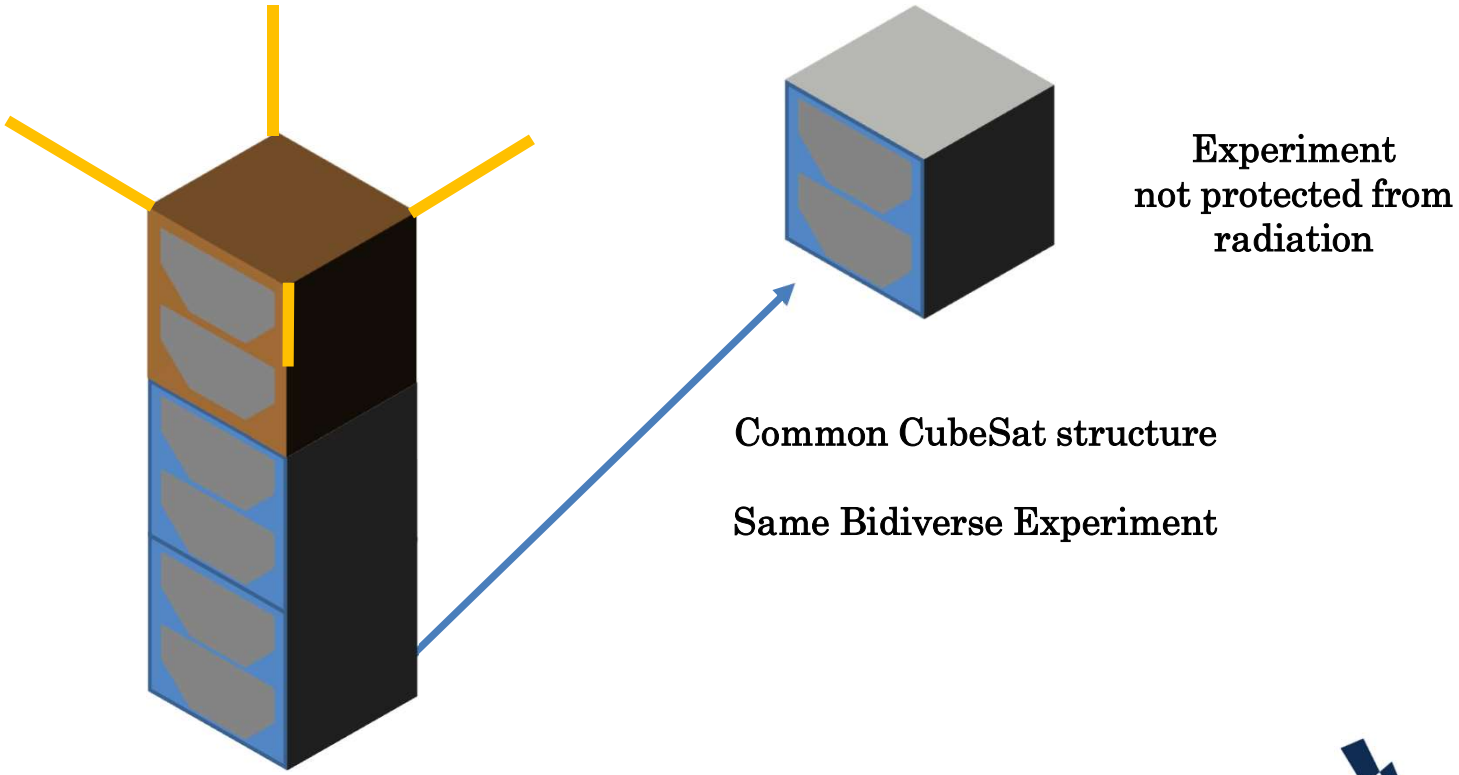
A path for world class space research from any country!



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How biodiversity experimentation fits in the space research program?

	Provided by UNOOSA	Advantages	Disadvantages	Plants growing experiments feasible?	Cosmic radiation experiments	
Clinostat	Yes	Cheap Long duration experiments Helps select promising experiments	Is not possible to know for certain if results are due to low gravity	Yes	No	Earth
Drop Tower	Yes	Real microgravity	Very low duration	No	No	
Zero Gravity aircraft	Not yet	Manipulation by user	Very low duration	No	No	
Suborbital missions	Not yet	Reach space	Very low duration	No	No	Suborbital
Orbital Mission (Dream Chaser)	Yes	Space mission Return to Earth	Only LEO conditions may be applied	Yes	No	LEO
CubeSat	Yes (launch)	Relative cheap Long duration experiments Not restricted to LEO (test radiation effects)	Expensive launch	Yes	Yes	LEO / Interplanetary

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Conclusions

- We think all countries have something to add to human space exploration
- How to find it? Think what makes your country unique
- What makes Costa Rica unique? Biodiversity!
- Use what you already have:
  - Results from clinostat
  - Small spacecraft heritage
  - Use UNOOSA opportunities
- After the use of current opportunities, come and propose new ideas!
- Come to international meetings and discuss! today very good ideas on how to make this feasible may come!

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Thank you!

https://www.tec.ac.cr/unidades/laboratorio-sistemas-espaciales

https://www.researchgate.net/project/SETec-Laboratory

https://www.facebook.com/SETECLab/

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