agro-nutrition &health

WEBINAR

Choose Space for your Agro-nutrition & Health R&D!

JULY, 8TH 2021 – 3PM

DURATION 90’

ORGANIZERS

cnes

connect by cnes

MEDES

PARTNERS

CLUBSTER NSL Nutrition Santé Longévité

SCM

Agenda

- Overview (15’)
  - MEDES and Connect by CNES
  - Announcement new market opportunity
  - Introduction of Clubster NSL and Role in Program
- Agro-Nutrition & Health Opportunities in Space (30’)
  - Why Space?
  - Scientific Overview
  - Case Studies
  - Relevant Applications and Propositions
  - How Can You Engage?
  - Service Providers
- Panel Discussion (25’)
- Q&A (20’)

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Introduction of Connect by CNES and Medes

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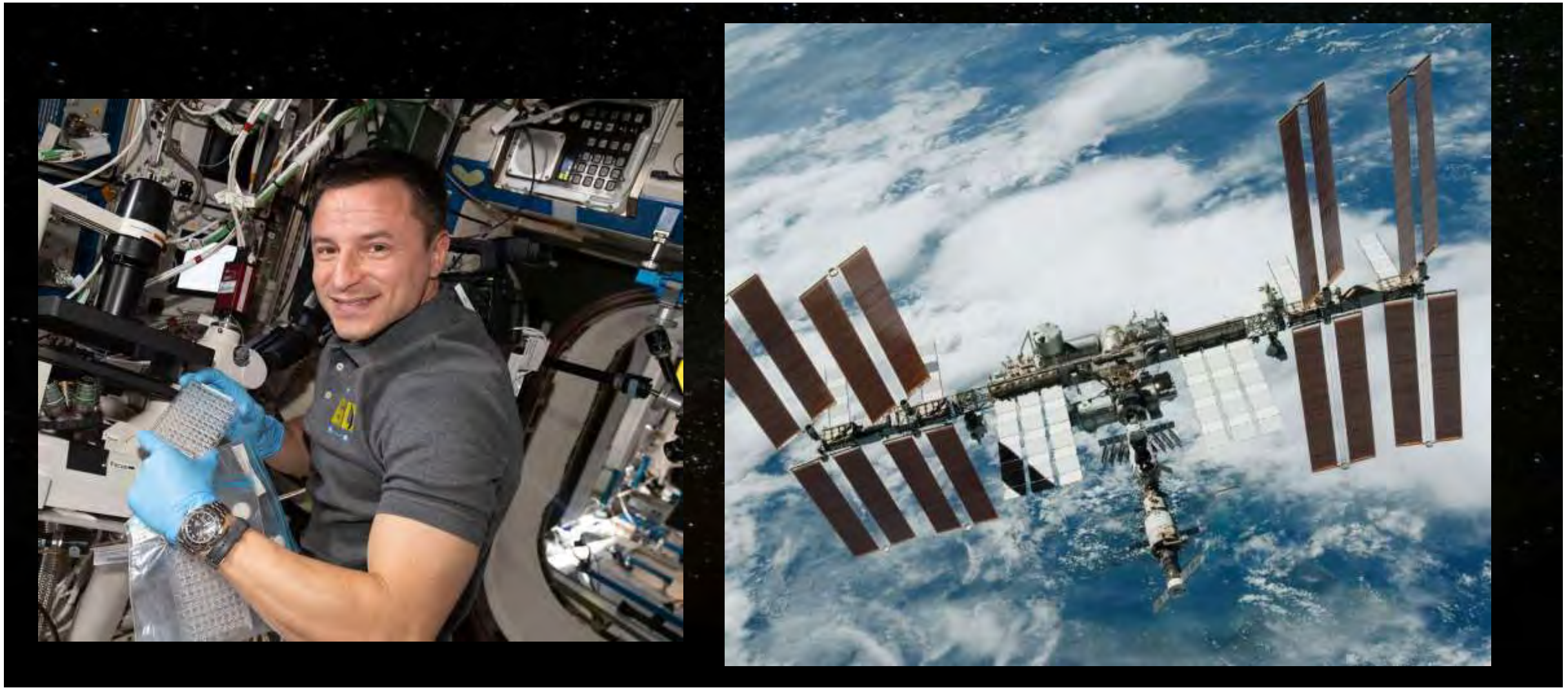

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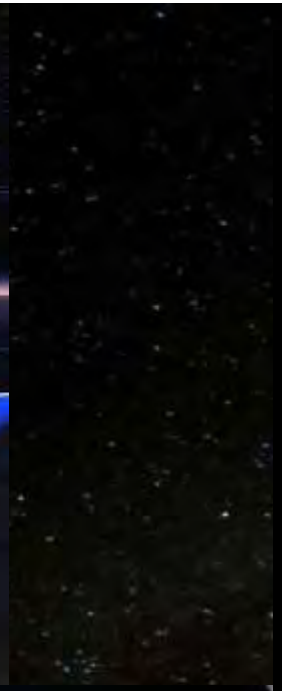

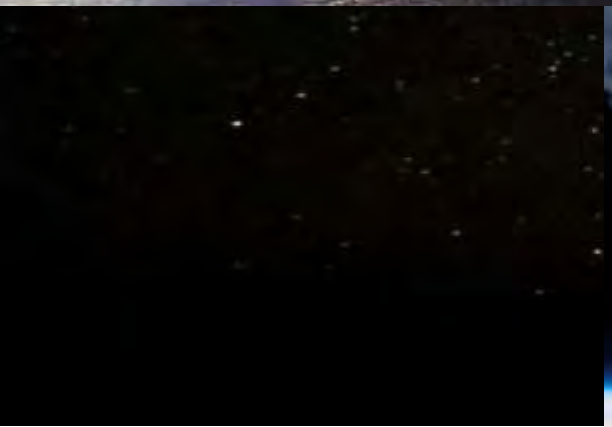

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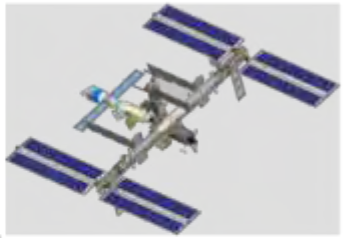
Space Exploration



Unique LEO Environnement

Disruptive innovation

Terrestrial Market

esa

Life Science Industry

Planned Innovation

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Medes

A hybrid organization – for space and health

cnes
CENTRE NATIONAL D'ÉTUDES SPATIALES

Hôpitaux de Toulouse

Economic Group of Interest – Private but public members

Main members – CNES / Toulouse University Hospital, other French universities and hospitals

Our missions

- Provide **expertise & operational support in the field of space physiology and medicine** for space agencies for manned spaceflight
- Support ground based **clinical research**
- Promote **societal applications and innovations** for space and health

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A multidisciplinary team with various health professionals & IT and biomedical engineers

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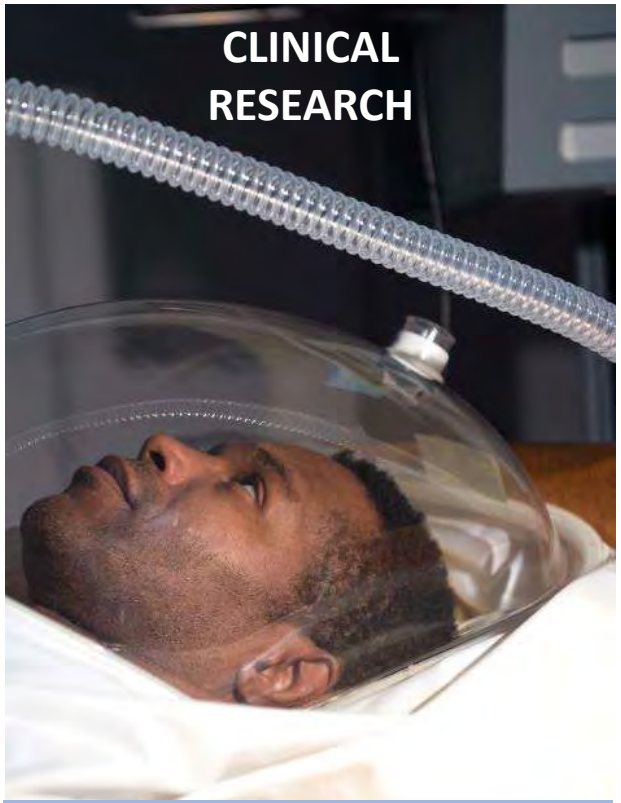
Expertise for space medicine related aspects for manned spaceflights



Expertise & clinical research infrastructure
Access to a large network of top-level medical experts at international level

Bridging space (satellite-based services / space data and technologies & knowledge from space exploration) and health

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Connect by CNES Goals

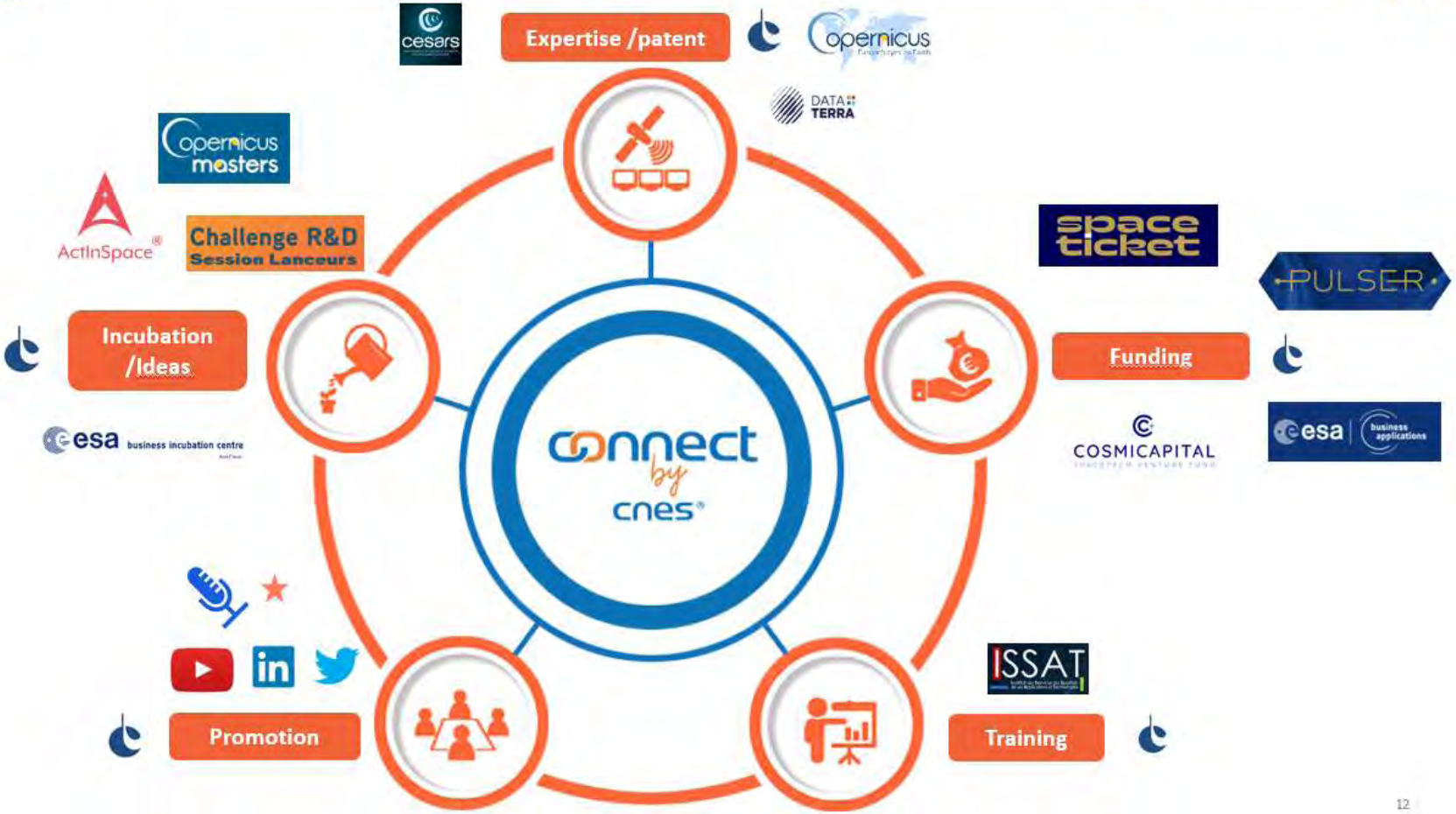
Develop a new community of users

- In order to boost economic, societal and environmental development in France in particular by adding value through the use of satellite data and innovative services for the healthcare, environment and mobility sectors.






Our OFFER



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Introduction of Clubster NSL

CLUBSTER NSL
Nutrition Santé Longévité

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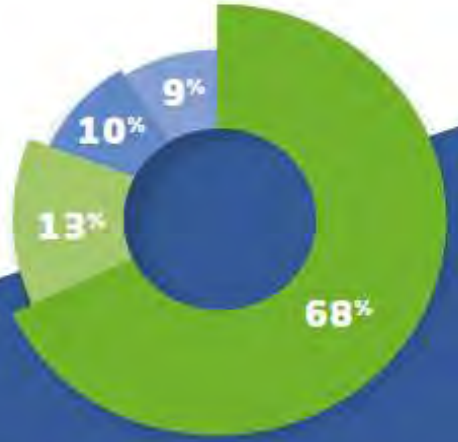
CLUBSTER NHL : WHERE THE HEALTH AND FOOD SECTORS CONVERGE

CLUBSTER NHL
Nutrition Health Longevity

THE 1ST PROFESSIONAL NETWORK

Of industrials, academics, healthcare and nutrition professionals in Hauts-de-France.

Clubster NHL includes a group of stakeholders with complementary profiles in the fields of **nutrition** and **human**, **animal** and **plant health**.



TYPOLOGY OF MEMBERS:

- Companies 68%
- Innovation partners 13%
- Academic, technical centers and training bodies 10%
- Care institutions 9%

MEMBER ACTIVITY SECTORS:

- Agro-nutrition 30%
- MedTech-hospitech 25%
- Biotech-pharma 22%
- Healthy ageing 13%
- Digital health 10%

+300 MEMBERS

OUR MISSION

Federate and stimulate health and nutrition actors in the conception, the development and the funding of innovation.

INNOVATION

NETWORKING

DEVELOPEMENT

KEY PROJECTS AND TOPICS

AGRO-NUTRITION & HEALTH KEY TOPICS

- One Health : link between Plant , animal and human health
- Microbiota and associated research fields
- Omics technologies, personalized nutrition & health
- Food, feed, functional ingredients and formulation
- Chronic diseases : prevention and treatment (obesity, diabetes…)

…

CLUBSTER NHL AS CO-ORGANISER OF INTERNATIONAL EVENTS

- The leading European partnering event for early-stage innovation deals and investment rounds in the field of **Life Sciences**

- NutrEvent is dedicated to **innovation in Food, Feed, Nutrition and Health**. It aims at identifying industrial, scientific, commercial and financial partners for your R&D projects and innovations

- AgeingFit is the European event fostering innovation for **well-being in older-age.**

- With 700 international participants from 25+ countries, MedFIT is your opportunity to connect with international key innovators in the **MedTech, diagnostic and digital health sectors.**

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Overview of LEO

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SPACE COMMERCE MATTERS

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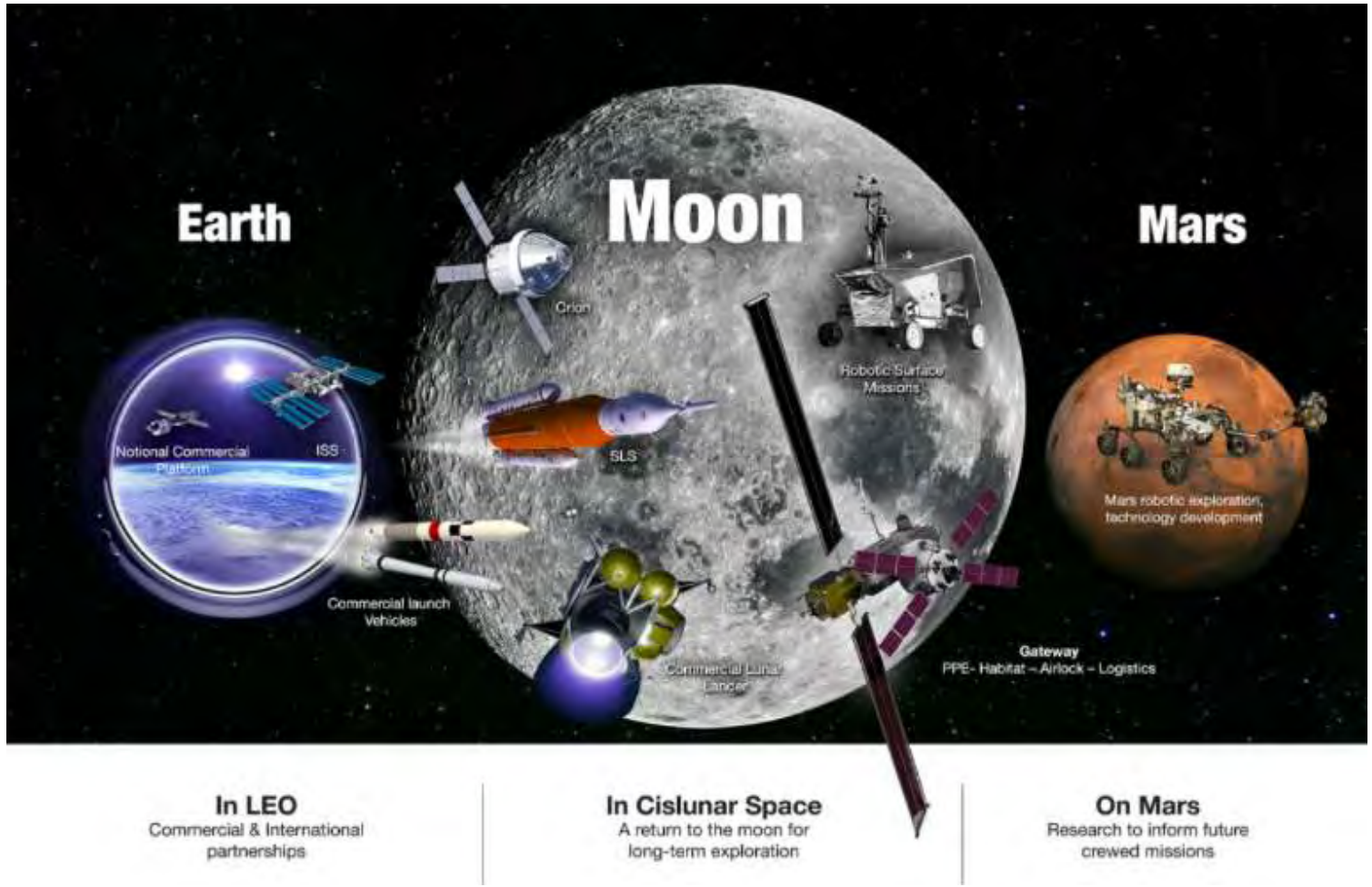
The Opportunity: International Space Station and Low Earth Orbit is Open for Business

- **New Science and Innovation** – Higher Quality R&D and Manufactured Products
- **Commercial Opportunity** – Incremental Revenue, New Product Offerings, Attract Funding
- **Marketing and Branding** – Capitalize on the PR Opportunities

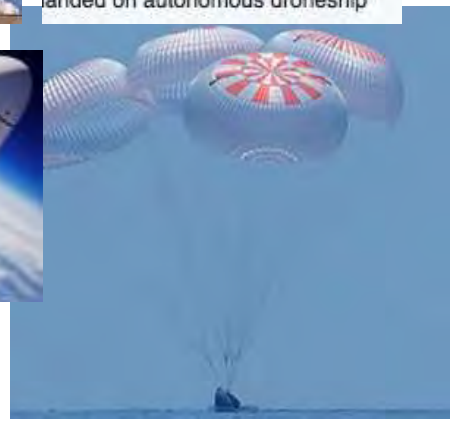
Space Continuum



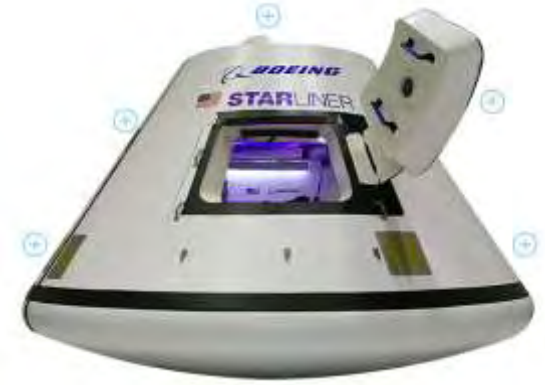
Traditional Focus on Supply Side

SpaceX

First stage of Falcon 9 Flight 23 landed on autonomous droneship

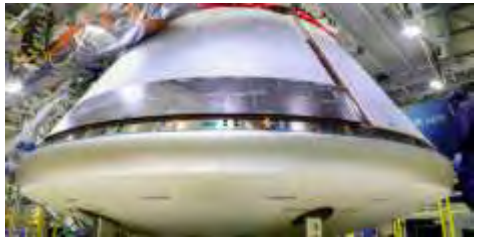


Boeing



Sierra Nevada

Sierra Nevada Corp's Dream Chaser

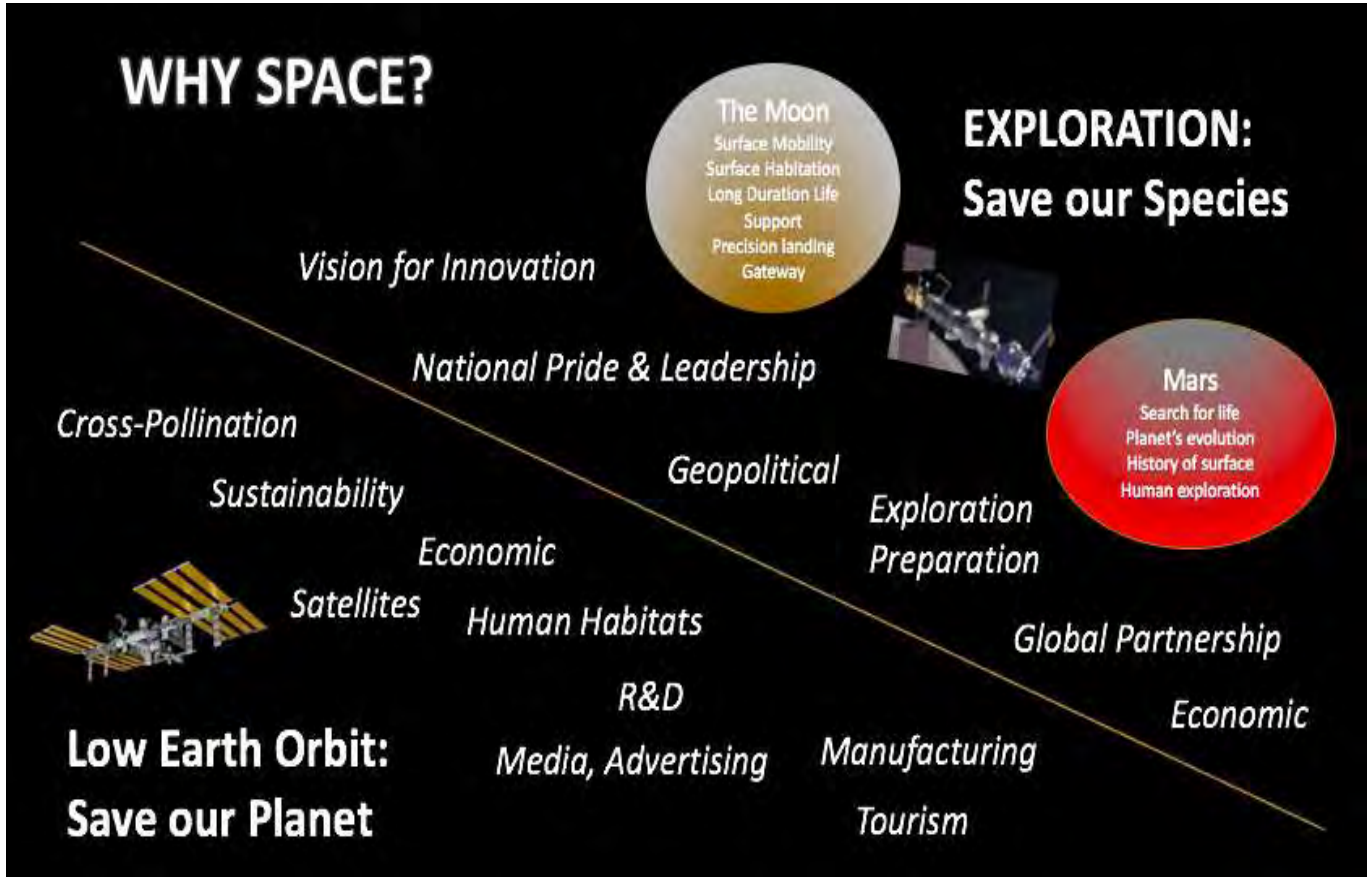


Axiom

Axiom announces crew for first private ISS mission

But What About Demand? Why Space?

- Formulation of **novel materials and better manufacturing** processes
- Broad-based **sustainability programs** focused on: climate change, plastics in the ocean, water scarcity, sustainable crop production, and energy conservation.
- Better **drug delivery systems**: increased access of therapies
- **Accelerated disease modeling**: aging and chronic disease
- Regenerative medicine: repaid, restore, or replace **damaged tissues and organs**
- **Crop science**: indoor/vertical agriculture, water management, and beneficial bacteria
- **Remote sensing and satellite technology** capability: maritime security, weather monitoring, agriculture monitoring, energy, urban development, and national security



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Broader Benefits from Space-Based Activity

Economic

- ✓ New Job Creation
- ✓ New Revenue
- ✓ Accelerated Time to Market
- ✓ Cost Saving

Innovation/Science

- ✓ Innovation Pathways
- ✓ Published Papers and Citations
- ✓ Patents
- ✓ Ideation Volume

Humankind/Social

- ✓ Quality of Life
- ✓ Environmental Impact
- ✓ Sustainability
- ✓ Lives Saved

Currently there is Extensive Commercial and Scientific LEO Activity

SANOFI · AstraZeneca · Lilly · TARGET · GOODYEAR · P&G · Honeywell · hp · IBM · MOREHEAD STATE UNIVERSITY · NALCO Champion An Ecolab Company · MERCK Be well · BAYER · Baylor College of Medicine · BASF We create chemistry · HOUSTON Methodist LEADING MEDICINE · DELTA · VISIDYNE · Microsoft · Google

Life Science & Crop Science

- Drug Discovery & Development
- Cellular Biology
- Regenerative Medicine
- Accelerated Disease Models
- Manufacturing & Optimization

Consumer Products & Industrial

- In Orbit Manufacturing
- Accelerated Degradation
- Material Synthesis
- Combustion
- Transport Phenomena
- Interfacial Phenomena

Technology & Communications

- VR/AR/AI
- Optics/Photonics
- Robotics
- Autonomous Systems
- Data Imagery
- IOT

Sustainability

- Climate Change
- CO_2 Sequestration
- Ocean Health
- Water Efficiency
- Energy
- Mobility

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Benefitting Research Areas and Industries

Research:

- Plant Science
- Materials Science
- Chemistry
- Fluid Dynamics
- Earth Science
- Remote Sensing
- Technology Demonstration
- Disease Modeling
- Cell Biology
- Genomics

Industries:

- Food & Beverage
- Raw Materials
- Consumer Products
- High Tech
- Industrial Materials
- Pharmaceuticals
- Aerospace
- BioTech
- CleanTech
- Energy

Coalition Support for Social Responsibility and Sustainability Programs

Coalition Management and Support

Focused on Large Issues like Climate Change & Sustainability

Using X-Prize type Open Innovation Competitions

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Scientific Benefits of LEO

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Microgravity

Microgravity, weightlessness, alters observable phenomenon within the physical and life sciences. Microgravity influences cell behavior, organism health, fluid physics, combustion, and various processes across the physical and life science.

Extreme Conditions

Extreme Environmental Conditions of space include extreme thermal cycling, atomic oxygen, ultra-high vacuum, debris impacts and high energy radiation.

Vantage Point

The ISS offers a unique vantage point at about 400km overhead in Low Earth Orbit (LEO). The orbital path of the ISS covers about 90% of the Earth's population every few days and provides unique spatial resolution and variable light conditions.

Crystallization

Larger more ordered structures can be obtained in microgravity

- Microgravity Molecular Crystal Growth (MMCG)
- New targets for significant diseases
- Drug discovery, formulation and delivery
- Biomarker discovery

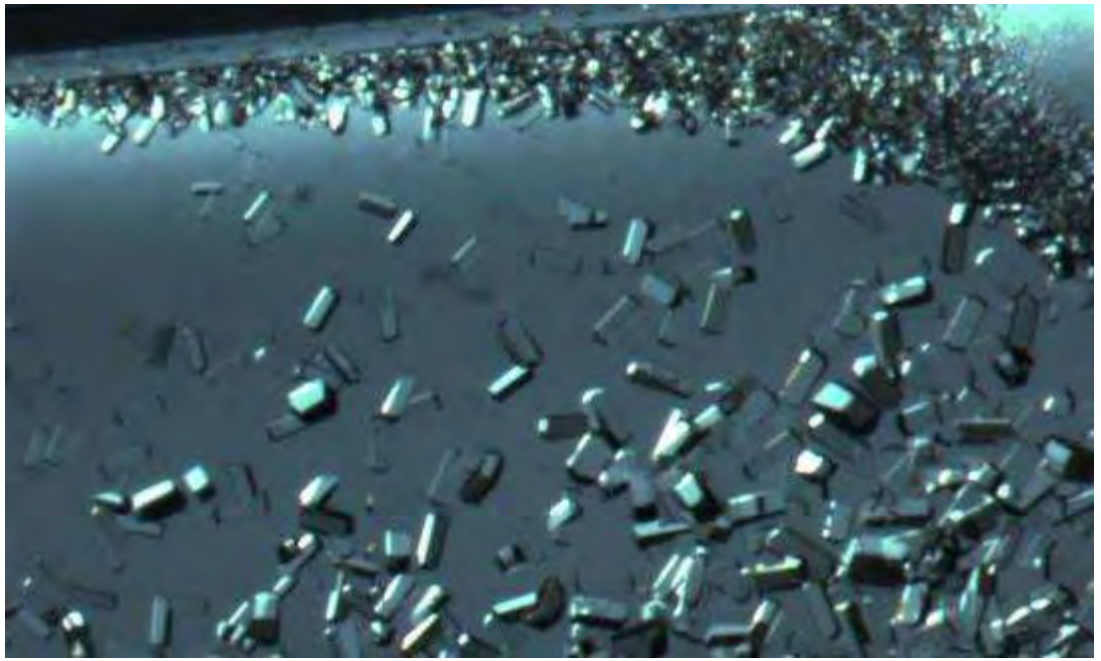


Image courtesy of phys.gov and Lawerence DeLuca.

Cell Biology

Microgravity effects cell's behavior, gene expression, and allows 3D structures to form without the use of a scaffolding or matrix

- Tissue-on-Chips
- 3D Cell Culture
- 3D Bio-printing
- Stem Cells
- Regenerative Medicine

Image courtesy of Science.

Microorganisms

The diffusion driven environment of space induces changes in the behavior and virulence of microorganisms

- Bacteria
- Fungus
- Viruses
- Biofilms

Disease Models

Microgravity induces changes in the human body and cells that mimic age related diseases

- Muscle & bone loss
- Immune dysfunction
- Cancer Tumors
- Organoids
- Model organisms - rodents

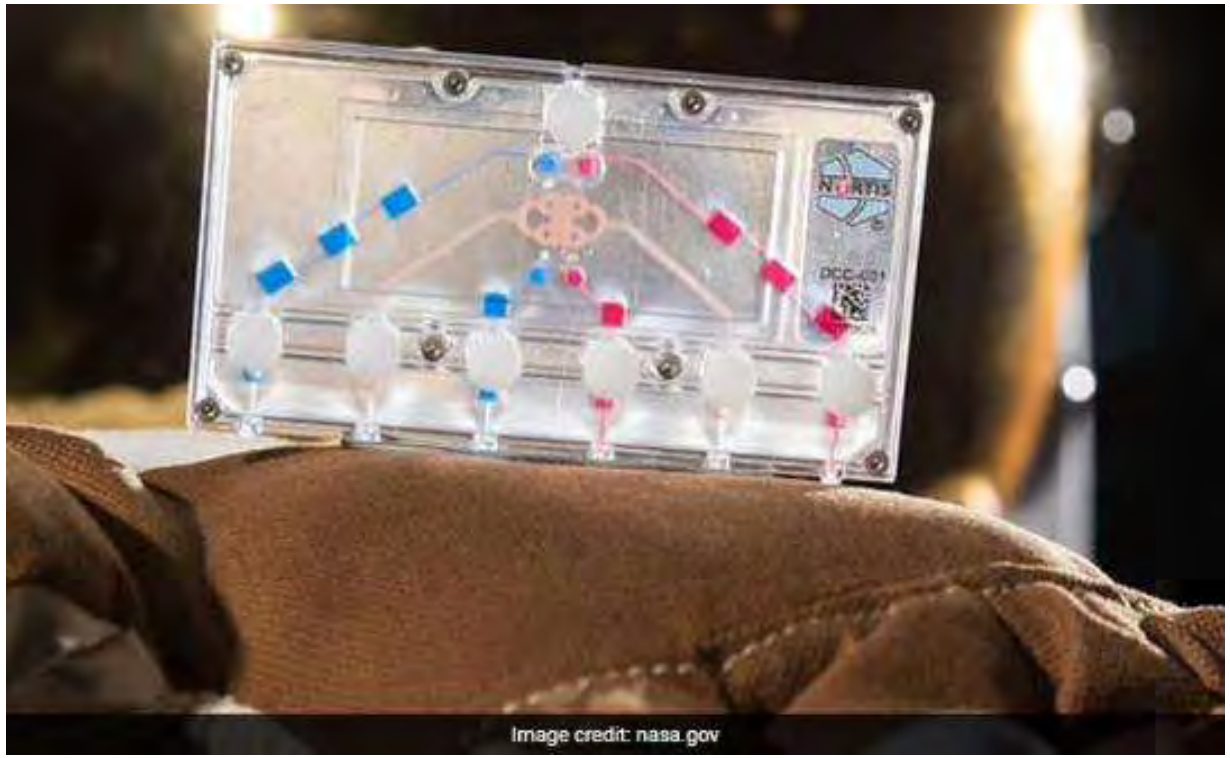


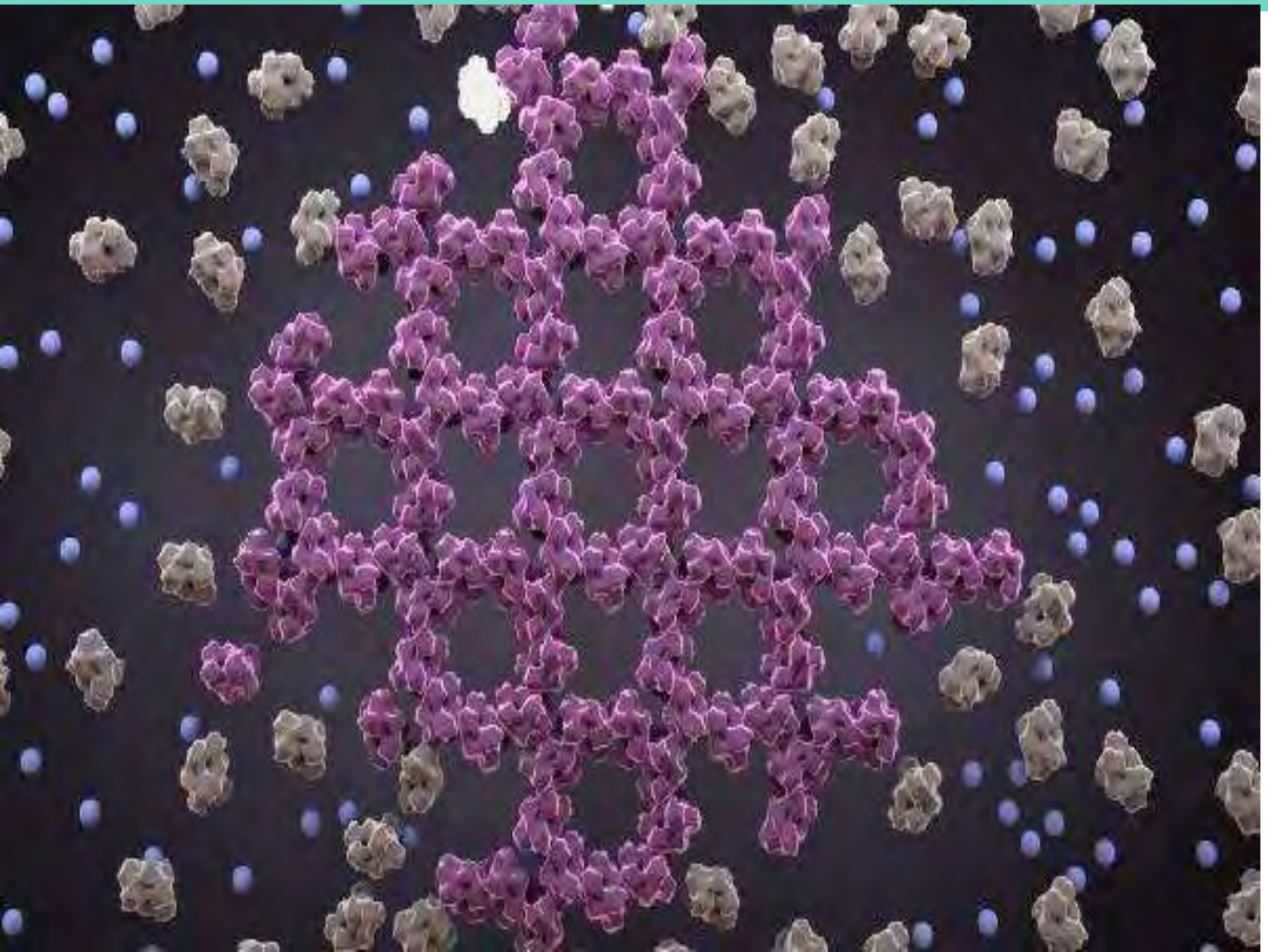
Image courtesy of NASA.gov

Plant Science

Microgravity can be used to probe mechanisms to understand how terrestrial plants respond to gravity and activates stress response in plants

- Plant growth
- Plant Stress
- Plant/microbe interaction
- Crop monitoring
- Water monitoring

Image courtesy of NASA.gov



Materials Synthesis

More ordered material structures can be developed in microgravity

- Polymers
- Biomaterials
- Composites
- Ceramics
- Metals
- Semiconductors

Property Measurements & Behavior

Critical properties of materials and systems can be measured more accurately in microgravity leading to more exact design models

- Thermophysical Properties
- Transport & Modeling Coefficients
- Phase Transitions

Fluid Dynamics & Transport Phenomena

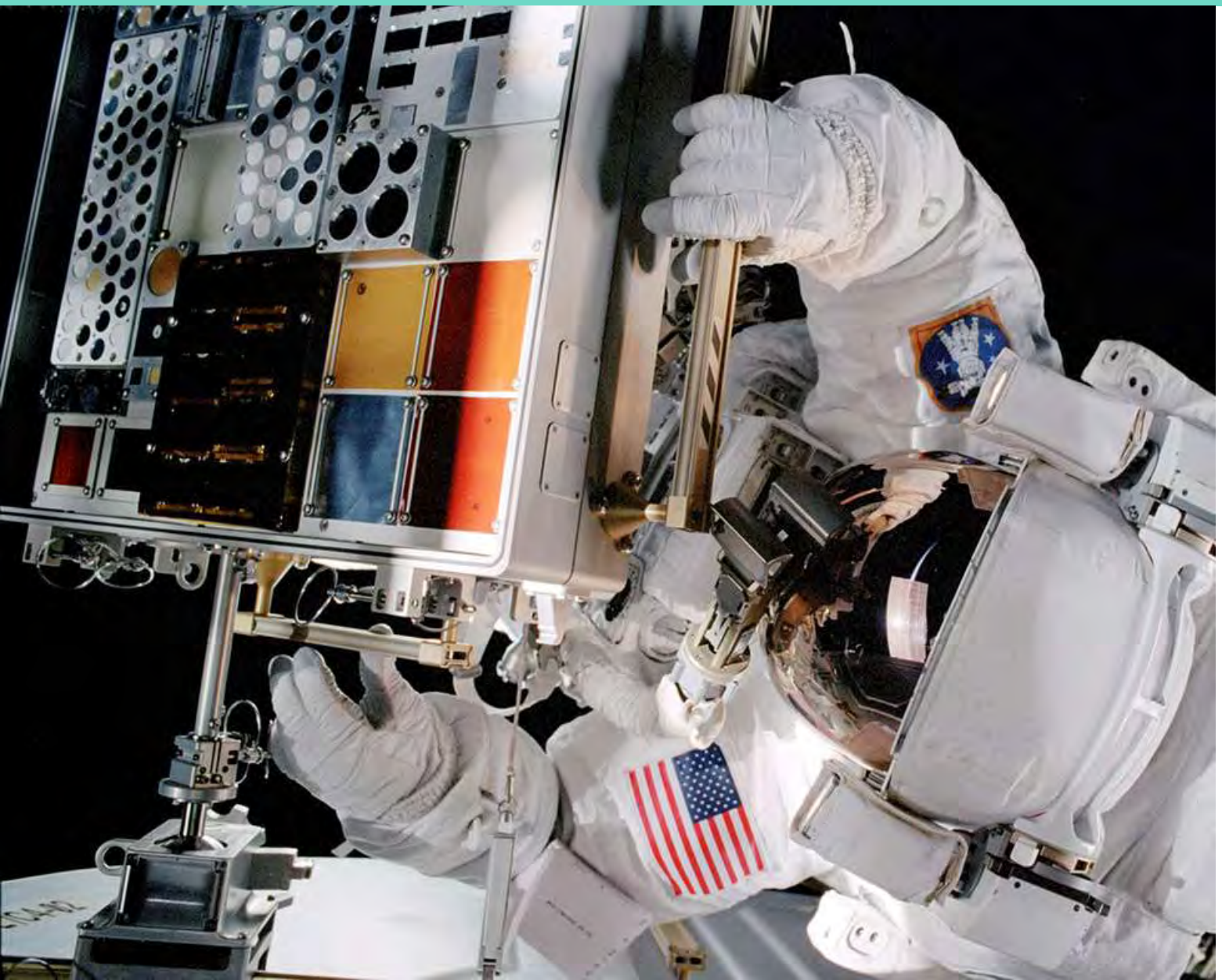
Unique fluid behavior in microgravity can allow for easier studies of:

- Multiphase Flows
- Capillary Flow
- Diffusion
- Surface Tension
- Separation and Agglomeration
- Interfacial Behavior

Reaction Chemistry

Lack of gravitational forces can influence:

- Chemical Product Formulation
  - Flow
  - Batch
- Mixing Behavior
- Combustion



External Materials Testing

- The extreme conditions of space provide the ultimate platform for materials testing:
  - Degradation
  - Corrosion
  - Other Failure Modes
- Degradation process occurs orders of magnitude faster than on Earth

Remote Sensing

- Vantage point of ISS provides opportunity to collect important data sets (regional, continental, global)

- Sensing Options:
  - Visible/Hyperspectral
  - Infrared
  - RADAR
  - RF

- Data Applications:
  - Sustainability
  - Climate Change
  - Planet Health
  - Raw Materials
  - Mapping

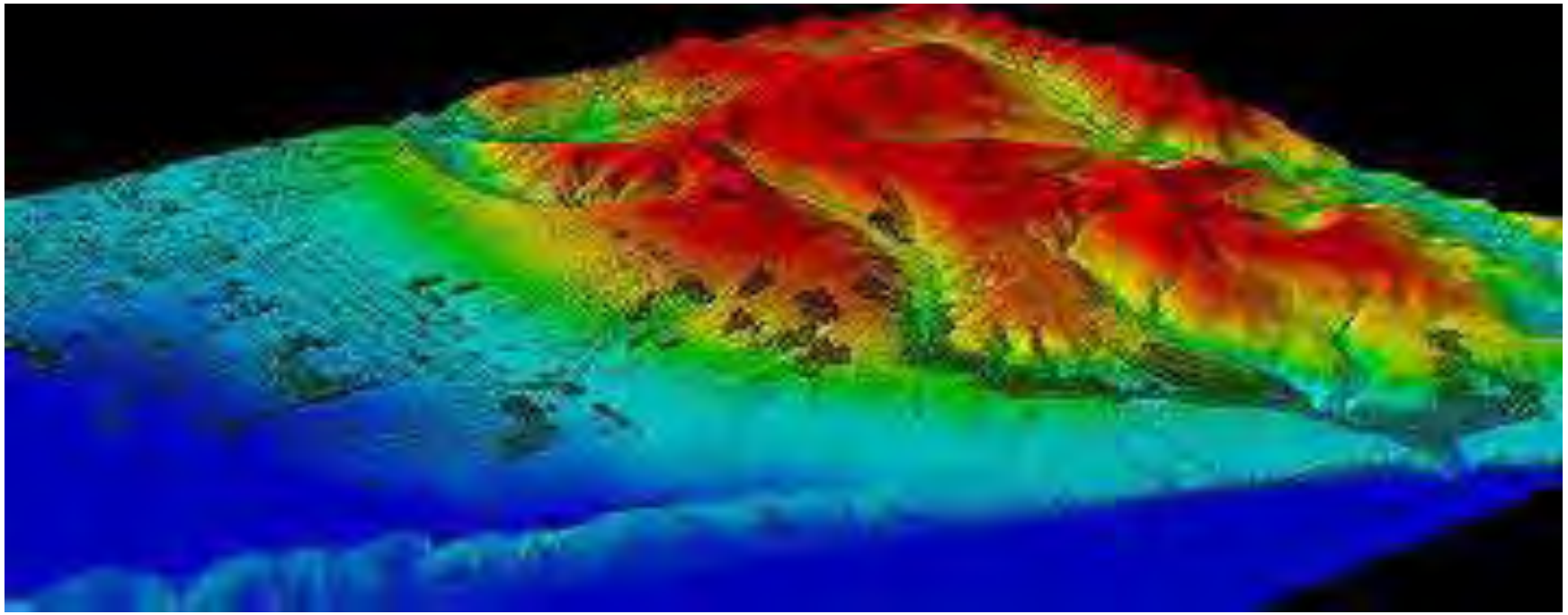


Image courtesy of NOAA

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Examples of Flight Projects

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Biofilm Thickness & Corrosion – ChampionX

- Microbiologically Influenced Corrosion (MIC) causes $0.5-1.5T in damages and lost revenue annually, mostly in oil & gas industries
- Driving forces behind MIC risk: number of cells, total mass, and thickness of film
- The microgravity environment enables these factors to increase in biofilms
- Can determine if these thicker films lead to more corrosion in carbon steel

Why Space: *Biofilms grow significantly faster and larger in microgravity, compared to what can be grown on Earth. This provides a much better platform to determine the extent of biofilm growth on surfaces*

Value Impact: *Reduction of damaged oil & gas pipelines, lessening the risk of leaks/spills, potentially saving billions of dollars in damages*

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Colloidal Stability – Procter & Gamble

- Phase separation is significant issue in the reduction of shelf life for consumer products (foods, cleansers, etc.)
- Sedimentation, driven by gravity, is not the only driver of phase separation

Why Space: *Non-gravitational factors contribute to phase separation of colloids, but these factors can only be clearly studied in microgravity since sedimentation is nullfied*

Value Impact: *Increased shelf life and formula stability of numerous, everyday household products*

Lyophilization – Eli Lilly

- Freeze-drying may create layering or other textures in the presence of gravity
- Eli Lilly-Lyophilization freeze-dries a range of samples under microgravity conditions onboard the ISS and then returns the samples to Earth for comparison with control samples

Why Space: *Microgravity prevents the sedimentation of particles by weight and the near-perfect vacuum of space provides an excellent solution for drying*

Value Impact: *Improved shelf life of sensitive medications. Improved ability to store medications without refrigeration. Increased access to medications*

Images courtesy of NASA.gov

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Barley Seed Germination - Budweiser

- Plant growth in microgravity provides clues towards plant growth under various stresses on Earth
- The lack of gravitational forces influences growth mechanisms and could lead to a better structured strand of barley, which can be used not only in products for human consumption, but also livestock feed

Why Space: *Plants grown in microgravity experience changes in their gene expression, root structure, shoot growth, and more*

Value Impact: *Influence how barley and other raw materials should be grown/developed on the ground and aid in creating more stress resistant strains of core crops. Increased crop production to feed a growing population*

Images courtesy of Space Tango.

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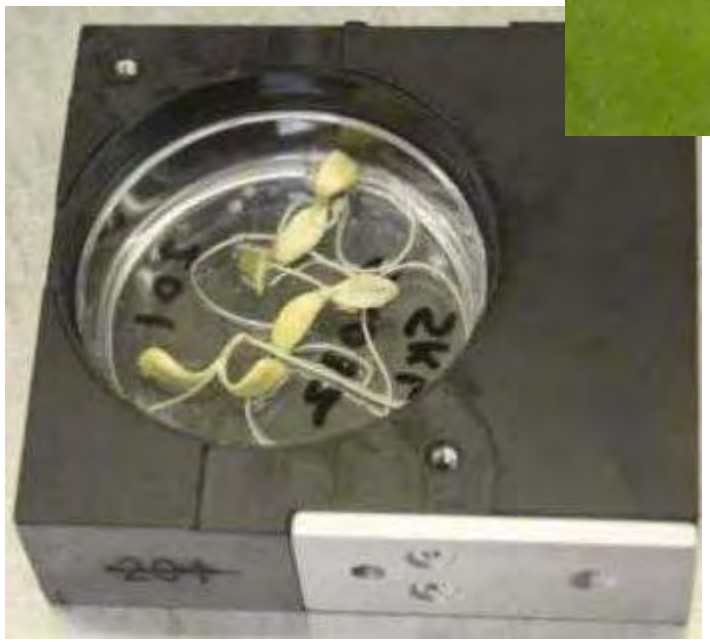
Plant-Microbe Interactions - SyNRGE

- Foods like soybeans, peas, beans, and more rely on bacteria when grown in nitrogen depleted soil
- Bacteria in microgravity can become more virulent and see other physiological changes
  - Leading to a change in the plant-microbe relationship

Why Space: *Changes in the behavior of bacteria and plants due to microgravity and changes in gene expression*

Value Impact : *Understanding how changes in bacterial physiology increase the symbiotic nature of plant-microbe interactions for agricultural biologics. Fewer chemicals used in large-scale farming leading to improved water and soil health*



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Possible LEO Topics for the Agro-Nutrition Sector

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Possible LEO Topics for the Agro-Nutrition Sector

- Formulations
  - Synthesis
  - Mixing
- Product Stability
  - Phase Separations
  - Active Agents
- Raw Materials
  - Sustainability
  - Global Material Sources
- Packaging
  - Sustainable Packaging
  - Flow Profiles
  - Degradation
- Microbiome
  - Nutrient Encapsulation
  - Bacteria Physiology
  - Self-assembled Peptides
- Biofilms
  - Rapid Growth
  - Product Degradation

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How Do You Engage?

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Where to start?

- Talk to us! Lucie.campagnolo@medes.fr Marie-Laure.gouzy@medes.fr
- You have an idea / project?
  - We work with you to consolidate your project and build a proposal
- You are not sure but are interested?
  - Secure a Keynote and Workshop at your headquarters / facility to work hands-on with your innovation team

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Hardware – Service Providers

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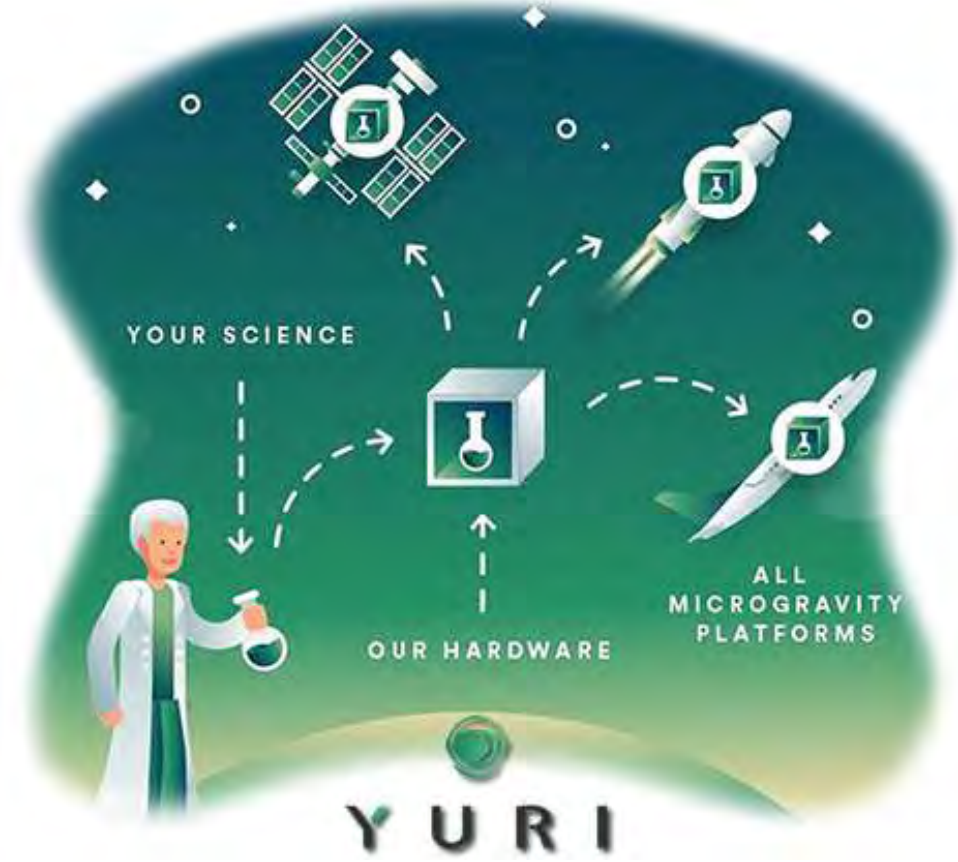
Yuri (Germany)

- General microgravity facility focused on life and material sciences
- Partners with ICE Cubes and LaMont
- Support projects focused on:
  - Crystallization
  - Shelf Life & Product Stability
  - Mixing & Emulsifying
  - Fluid Dynamics
  - Medical Devices



ICE Cubes (Belgium)

- Hardware designed for use by life sciences, food & beverage, material sciences, and Technology Readiness Level (TRL) demonstrations using their experiment cube
- Partner with yuri and Bioreactor
- Support projects focused on:
  - Microorganisms
  - Shelf Life & Product Stability
  - Mixing & Emulsifying
  - Interfacial Studies
  - Fluid Dynamics
  - Separations
  - Medical Devices

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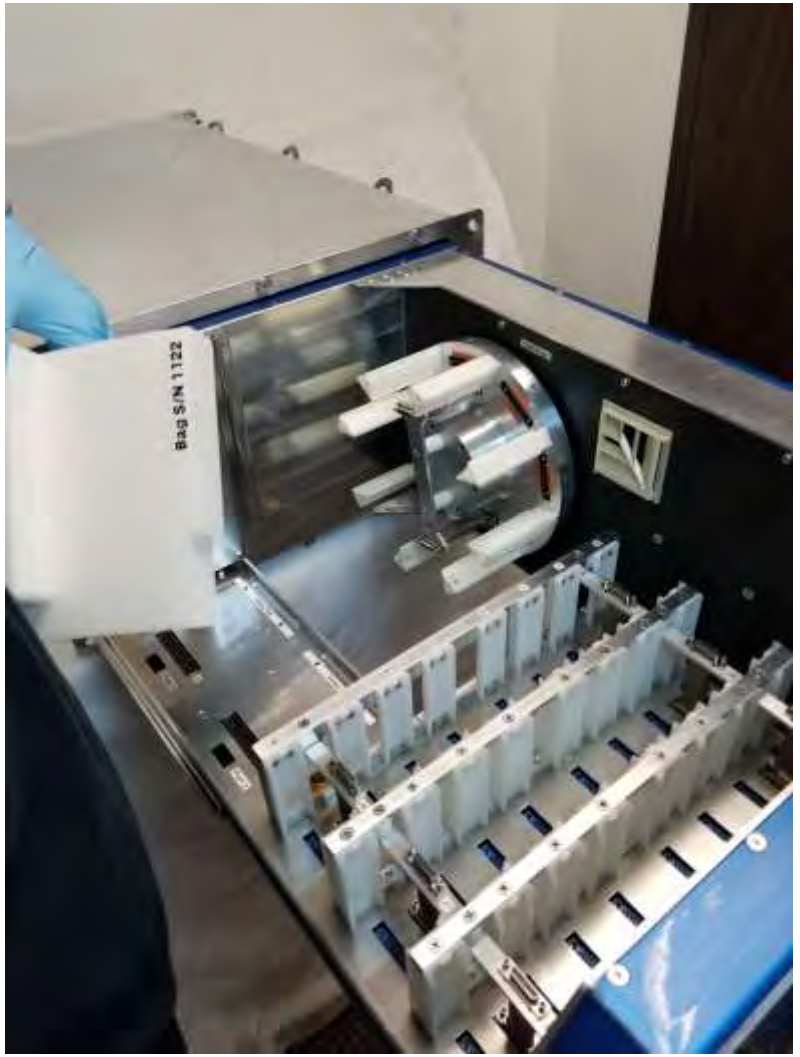
Bioreactor Express (Italy)

- Primarily life sciences based using miniaturized bioreactors for biotechnology, food & beverage, and fluids applications
- Support projects focused on:
  - Microorganisms
  - Shelf Life & Product Stability
  - Mixing & Emulsifying
  - Medical Devices

LaMont Aerospace (USA)

- Life and materials science research centered on their LaMont BioResearch Facility and centrifuge and now moving into more complex project work in the cell culture arena
- Partners with yuri and Bioreactor Express
- Supports projects focused on:
  - Crystallization
  - Microorganisms
  - Mixing & Emulsifying
  - Interfacial Studies
  - Shelf Life & Product Stability
  - Separations
  - Medical Devices



Techshot (USA)

- Primarily life science focused on complex payloads, with capability in 3D Bioprinting, tissue chip, cell culturing and stimulation, microorganisms, and bone densitometry
- Support projects focused on:
  - Crystallization
  - Shelf Life & Product Stability
  - Interfacial Studies
  - Mixing & Emulsifying
  - Fluid Dynamics
  - Separations
  - Medical Devices

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panel discussion

DURATION 25’

Lucie Campagnolo

CNES / MEDES

Cynthia Bouthot

Space Commerce Matters

Anne-Charlotte Pupin

Clubster NSL

Mark Kugel

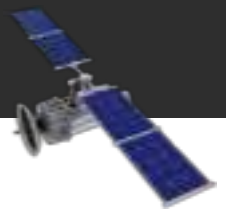
Yuri Gravity

Vic Keasler

ChampionX

Hilde Stenuit

Space Application Services



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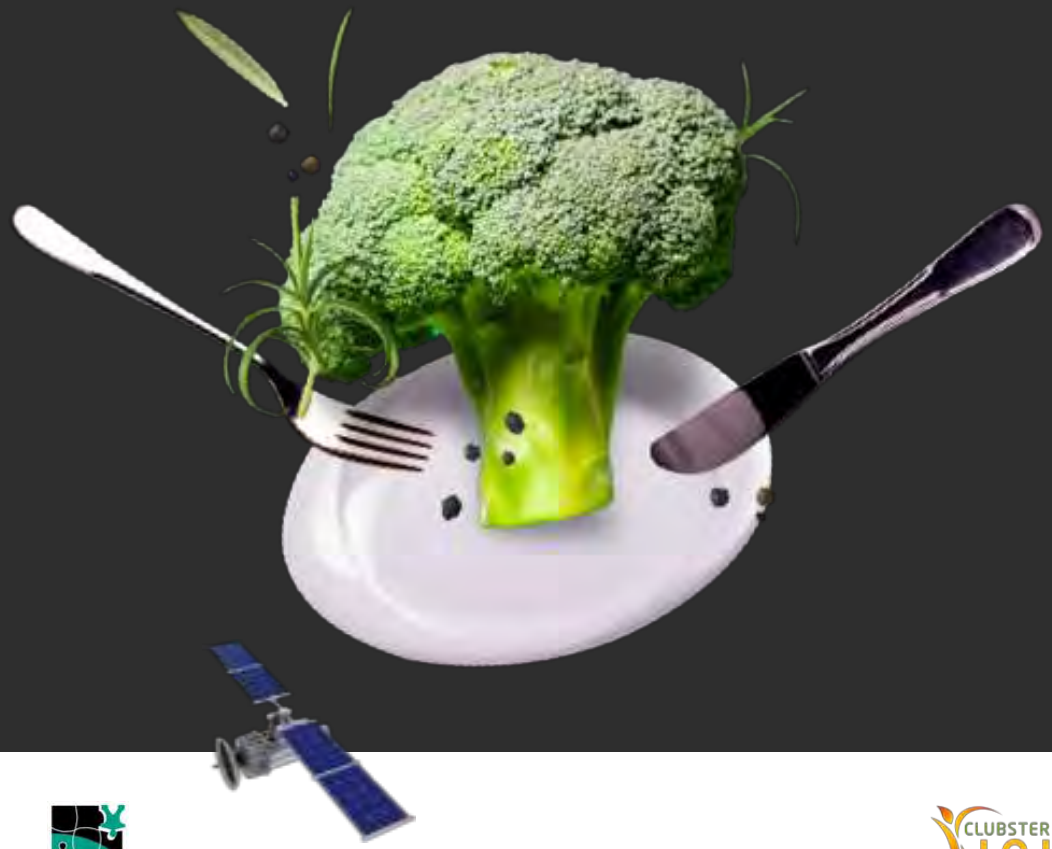
Q&A

DURATION 20’




thank you

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Appendix

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Program Timeline

Mentors & Partners acquisition & onboarding

Proposal scoring & selection

Pitching week

10-week « Ready to fly » program

April 2022 — M1 — M2 — June 2022 — M4 — September 2022 — M6 — M7

Outline Proposals

Full Proposals

Final selection of inaugural cohort of projects Co-Funded by Program fund

1st Week: Mentoring + Keynotes

2nd Week: IP selection Final project

3rd Week: Projects + IP consolidation Mentoring

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Possible LEO Topics for the Agro-Nutrition Sector

- Formulations
  - What does the lack of convection, buoyancy, and sedimentation have on the synthesis of:
    - Active agents
    - Emulsions (sauces, dressings, etc.)
    - Other Colloids
    - Additives
  - How do ingredients mix differently in microgravity?
    - Can apply to various phases
      - Solid/Liquid/Gases
      - Singular and multiphase mixtures

Possible LEO Topics for the Agro-Nutrition Sector

- Product Stability
  - In addition to sedimentation, are there any other forces at play that contribute to phase separation of products? On both a macro and microscale?
  - How do these forces affect the performance of active agents?
- Manufacturing
  - Can optimal crystalline structures & multilayered materials be manufactured with gravitational forces being suppressed?
  - How does a surface tension dominant environment (microgravity) affect the application of coatings to products or products to a surface (flavorings or seasonings on food)?
  - Can a better separation process be developed to purify a liquid with the knowledge of how things behave without sedimentation, convection, and buoyancy?

Possible LEO Topics for the Agro-Nutrition Sector

- Raw Materials
  - Use the vantage point of LEO to develop remote sensing opportunities that help better identify sources of raw materials on ground used for food & beverage products
    - Vegetables
    - Fruits
    - Grains
  - What are other areas that could possibly contain or produce these raw materials based on soil characteristics, climate, etc.?

Possible LEO Topics for the Agro-Nutrition Sector

- Packaging
  - Sustainable Packaging
    - Formulate novel packaging materials for food products in microgravity that are more sustainable and less harmful to the environment (i.e. plastics polluting the oceans)
  - Flow Profiles
    - What are the differences in flow profiles within liquid dispensers in microgravity?
  - Degradation
    - Rapidly accelerate degradation of packaging material to learn about failure modes

Possible LEO Topics for the Agro-Nutrition Sector

- Microbiome
  - Investigate nutrient encapsulation methods for improved nutrient diffusion and targeting, nutrient uptake via new methods of nutrient delivery, diffusion based nutrient scavenging of bacteria leading to a better understanding of gut microbiome
  - How do changes in bacteria physiology and virulence leading to changes in behavior that provide new insights into gut microbiome?
  - How can changes in self-assembled peptides in microgravity aid in understanding disease causing mechanisms?
- Biofilms
  - How does significantly accelerated biofilm growth in microgravity compared to ground help determine the severity that biofilms have on the surfaces they impact?