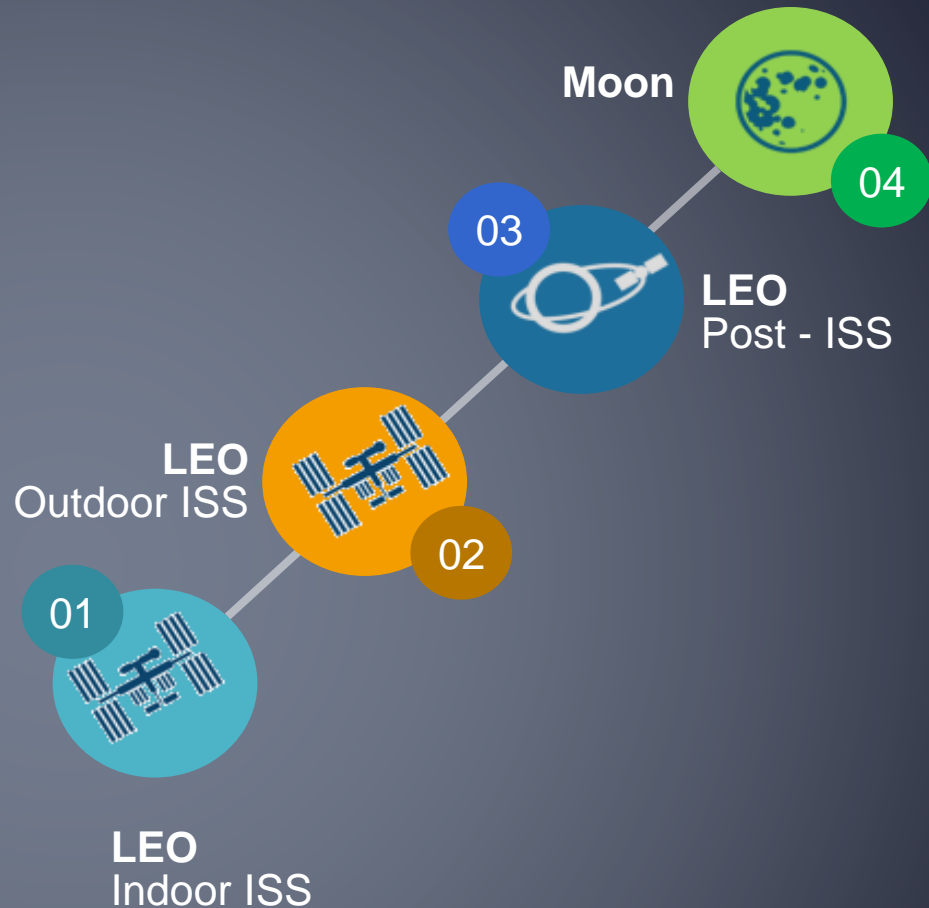




International Commercial Experiments Service

Making access for space experiments fast, simple, attractive and affordable



www.ICECubesservice.com
ICECubes@spaceapplications.com
Hilde.Stenuit@spaceapplications.com
[@ICECubesService](https://twitter.com/ICECubesService)

Introduction ICE Cubes

With the signature of the partnership agreement with ESA, the **International Commercial Experiment Cubes (ICE Cubes) service** is now providing for **the first European commercial access service** to ISS.

ICE Cubes provides

Fast

Simple

Affordable

access for research and technology on the ISS.



The launch of the ICE Cubes internal facility is planned in **early 2018** and the first batch of 5 experiments cubes will be operated soon after.

The PPP **agreement with ESA** allows to ensure access to committed & recurring launches, which is an important asset for the potential (commercial) users of the LEO market being developed.

This project has received funding from the European Commission's H2020 Framework Programme for research, technological development and demonstration under grant agreement No. 666815.

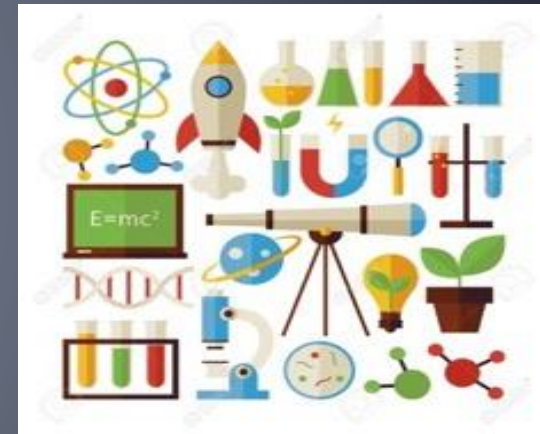




Introduction ICE Cubes

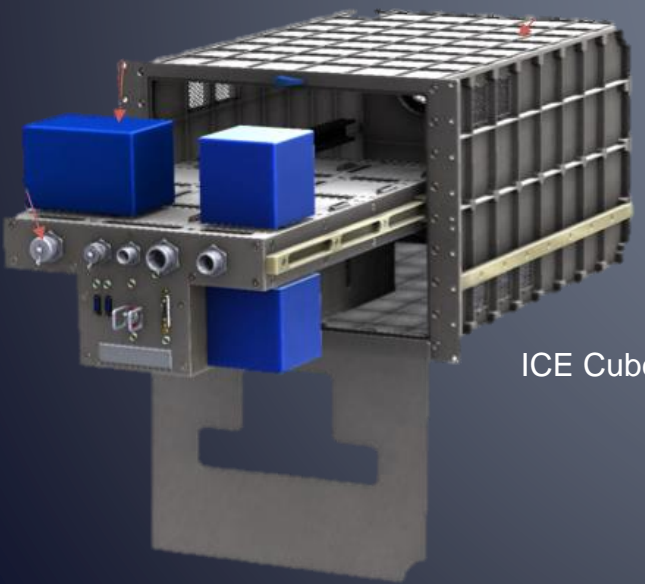
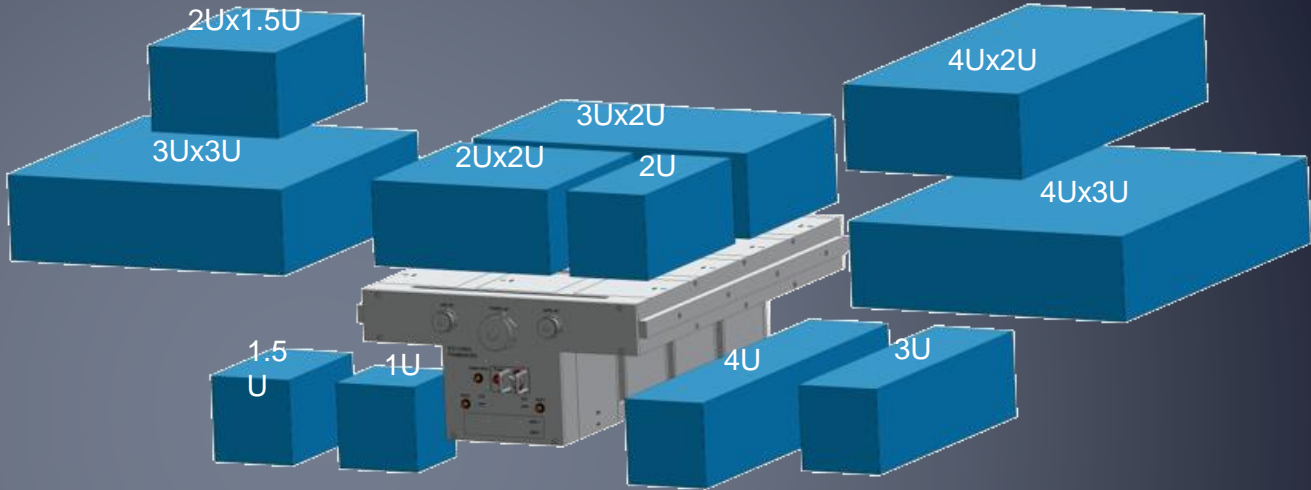
The ICE Cubes service is suitable for:

- Fundamental and applied **research / university** studies (Bachelor, Master and Doctoral theses)
- In-orbit testing and validation of **technologies** and processes
- **Industrial** and commercial R&D activity
- Accommodation for (future) **on-orbit manufacturing** capabilities
- **Educational** experiments and demonstrations in the science, technology, engineering and mathematics (STEM) areas





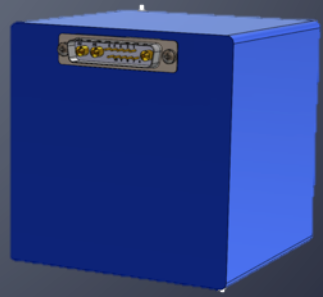
ICE Cubes Facility and Experiment Cubes



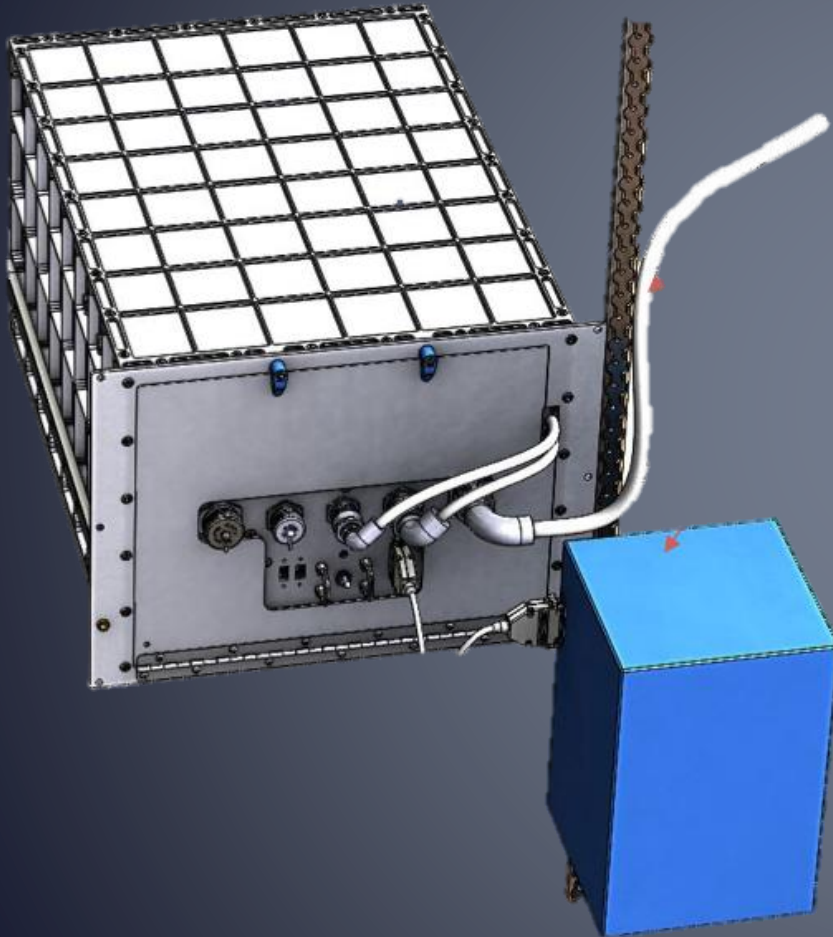
ICE Cubes Facility (ICF)

Sizes from 10x10x10cm up to **max of ~45 x ~35 x ~11cm.**

Experiment Cubes using a single connector for both power and data.



ICE Cubes Facility and Experiment Cubes



External Wired Experiment Cubes



Credits: NASA Spheres

Credits: NASA Astrobee



External Wireless Experiment Cubes
(images courtesy ESA-NASA)

ICE Cubes Facility and Experiment Cubes



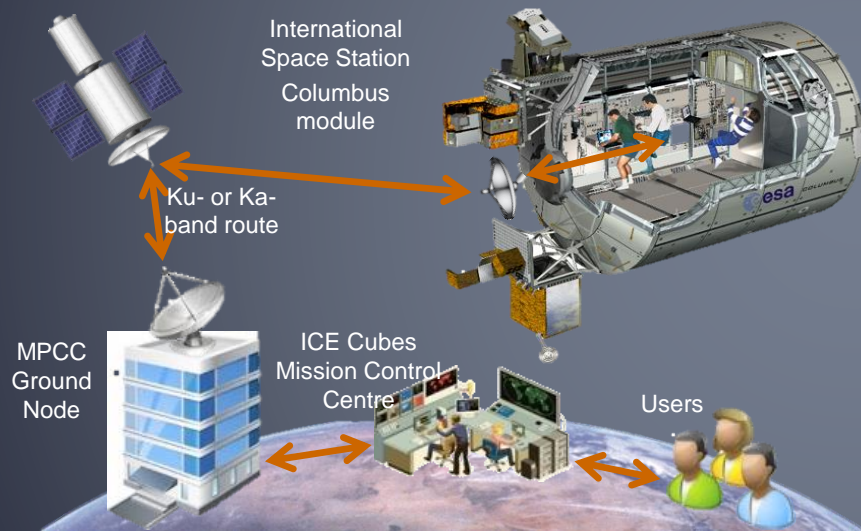
Experiment Cubes characteristics

- **Power** profiles: 5V and 12 V, 10W per liter, up to 40.5 W max per Cube
- **Thermal** cooling: Forced air ventilation
- Operations: **Real-time** telemetry/telecommand to/from ground
- **Data**: Downlink up to 4 Mbps
Uplink up to 0.5 Mbps
- Communications: standard **internet protocols (IPs)**



ICE Cubes Operations and communications

- Payload operations from ground, i.e. near real-time telemetry and telecommand
- Data reception and distribution directly to the various user home bases



To control their Experiment Cubes, users are provided with an out-of-the-box software suite composed of: VPN client, FTP client, Web browser, Mission Control System client, User manual.



ICE Cubes Service Characteristics

Complete 'end-to-end service':

Launch dates, Experiment Cube development guidance, interface testing, arranging experiment certification, launch and on-orbit installation, operation as well as disposal after operation.

Time from contract signature to launch	12 Month (typ)
Cubes delivery to launcher authority	Late access possible (days before launch)
Launch / return frequency	Every 4 months from beg 2018
Data transfer to ground	<ul style="list-style-type: none">• Near real-time• Postponed downlink• Physical download (e.g. via USB flash drive)
Post-mission download of experiments	Possible (optional)

Ownership:

The customer remains the owner of his Experiment Cube and of the results of his experiment.



ICE Cubes Service Characteristics

Standard Service:

Primary / Secondary Education: 35 K€ (reference)

University / Non Education: 50 K€ (reference)



Standard Service includes:

- 1U cube of max 1 kg for location for 4 months,
- basic Experiment Cube development guidance,
- interface testing,
- arranging experiment certification,
- launch ,
- on-orbit installation,
- standard type operations support,
- as well as disposal after operation.

Additional Service can include:

- engineering support for development
- conditioned stowage
- late access to launch vehicle
- additional mass per U
- return of the hardware
- early access to return vehicle
- dedicated crew activities
-



ICE Cubes and funding

Given the relatively new nature of a commercial approach for research, questions are asked related to funding possibilities. ICE Cubes to be placed in the context of

- the gradual transition of institutionally funded ISS utilization to commercial research & technological exploitation of LEO ,
- the global **NewSpace / Space 4.0 / LEO ecosystem** of academia / industry / startups / agencies, ...

Distinction can be made according to 2 dimensions:

- High vs lower research factor,
- “market” / applications potential (high / mature vs low).

In addition to **continued (“traditional”?) possibilities** through:

- ESA (science / technologies IOD & IOV),
- National Agencies, regional and others.

Also **possible opportunities** in terms of:

- Research consortia grouping academia and industry (including SME funding),
- Innovation clusters around microgravity R&D value propositions,
- As such expanding and broadening the user community.



ICE Cubes Service impact beyond research

Affected areas	With ICE Cubes	Without ICE Cubes
Socio-Economics	Spin-in opportunities	Oligopoly Space market
	Spin-offs generations	Isolated Space club
Industry – Space	De-risk innovation and accelerate development	Lower inception of innovation
Industry – Non Space	Prompt access to μg	High barrier to μg
Future Exploration	Enabling private endeavour to explore space business	Business as usual

Since the related LEO market is not yet mature, similar or related services and technologies are being envisaged as collaboration opportunities rather than as competition at this stage.



ICE Cubes special diagnostic cubes

In the frame of the ICE Cubes Service special purpose Cubes will be developed provided with **diagnostics to support different areas or research**. The special cubes will remain on board the ISS and will temporarily host **replaceable experiment containers/cartridges**. This approach aims at providing solutions for Cube level mini-facilities that may reduce cost of the development and launch of the various branches of experiments.

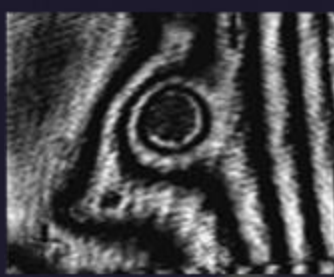
Currently undergoing a survey of the possible interests/requests by the potential users or at start of development are:

- Fluorescent microscope
- X-Ray diffractometer
- Organ-on-a-chip technology testbed
- Others under investigation

We are interested to receive feedback from the user community on which diagnostics are key / valuable and to look into possible collaborations.

Credits: NASA

Scientific Opportunities and Possible Areas of Usage - Fluids

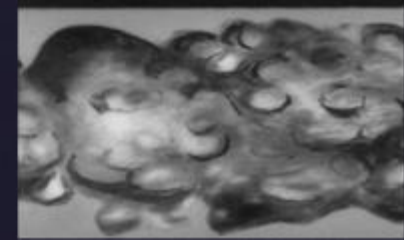
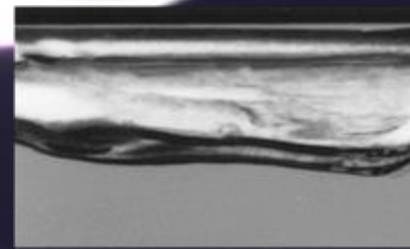


Credits: ALTECSPACE

Credits: ULISSE / Medes



Credits: ULISSE / Medes



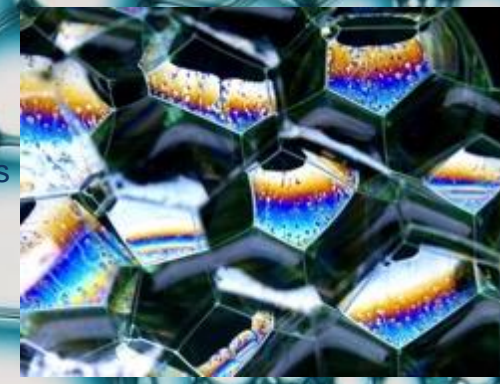
Credits: ULISSE / Medes

Scientific Opportunities and Possible Areas of Usage Foams

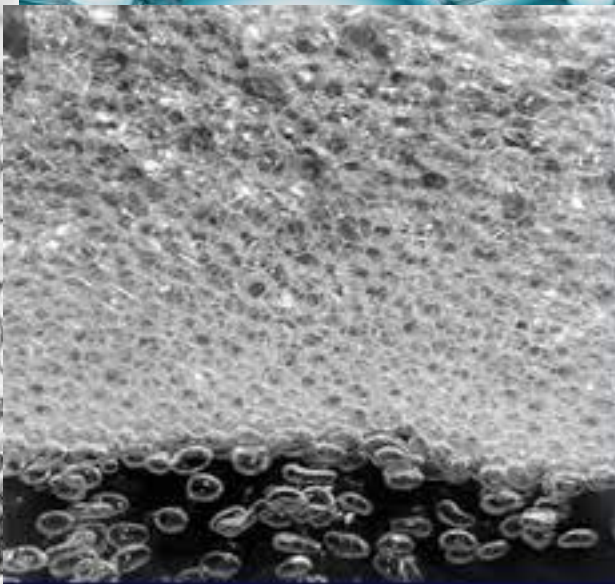
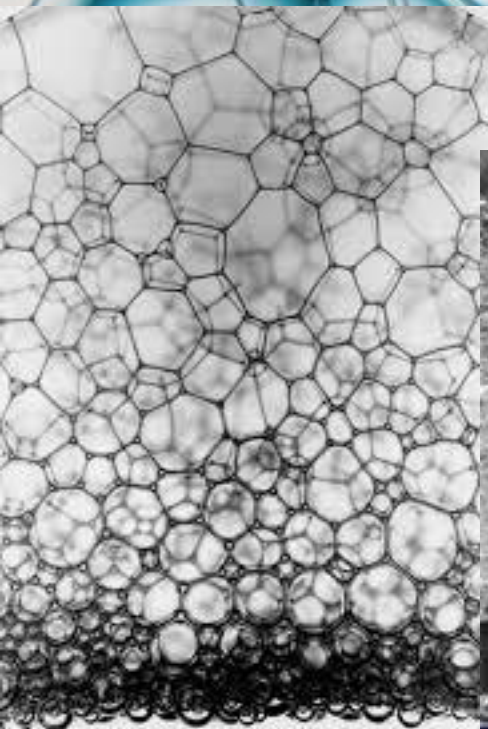
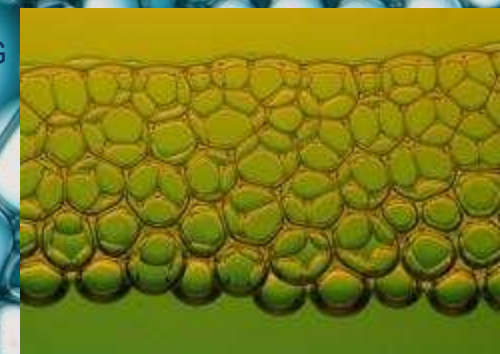


Credits: NASA/ ESA

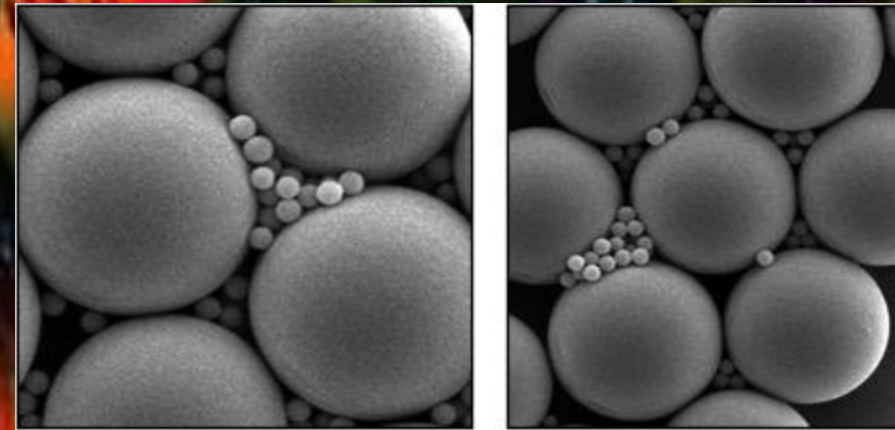
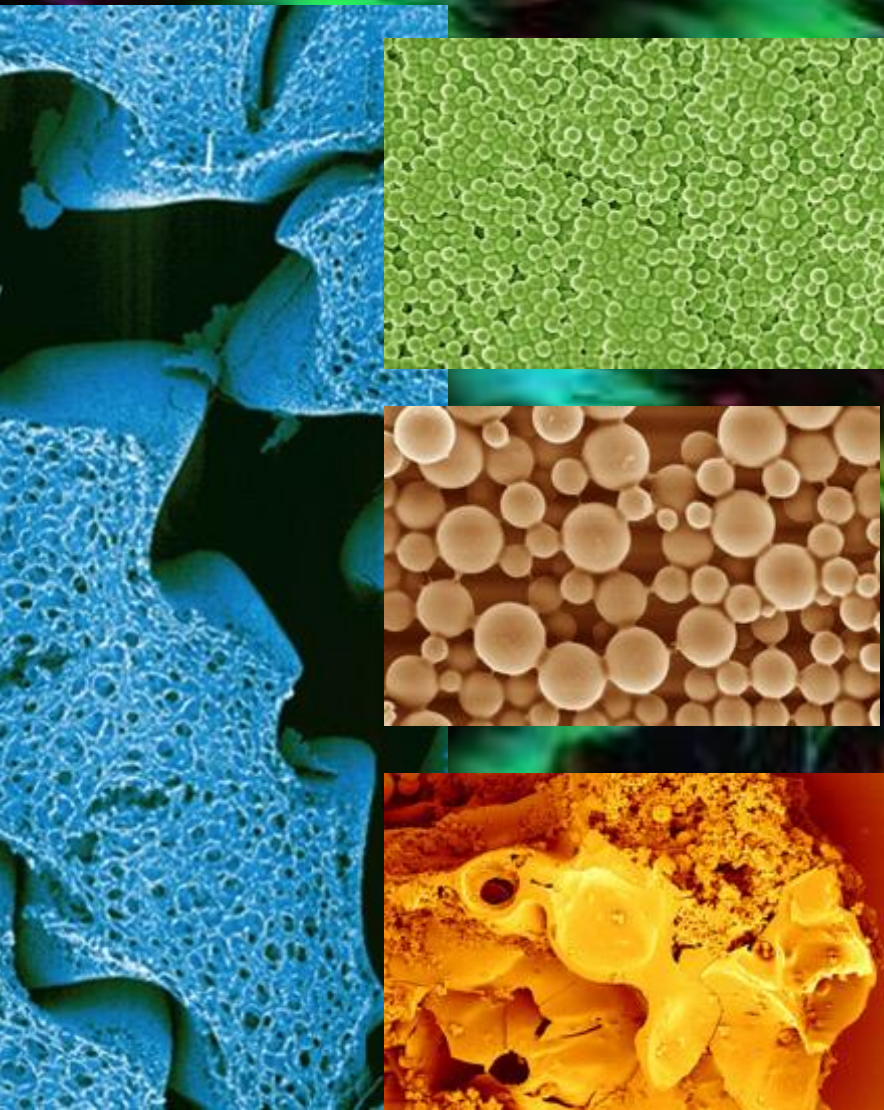
Credits: LPS
Universite de Paris



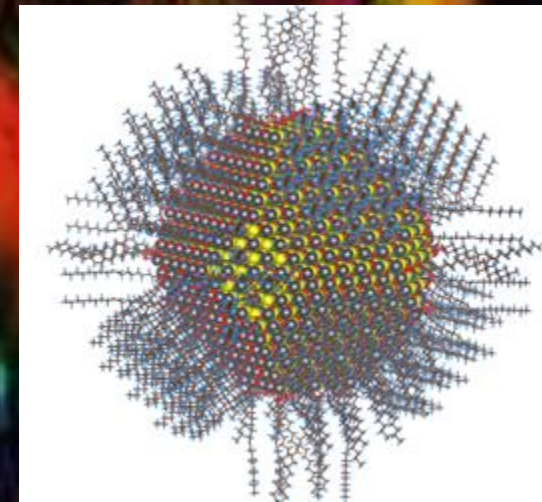
Credits: GRASP, ULG



Scientific Opportunities and Possible Areas of Usage Colloidal chemistry / Nanoparticles

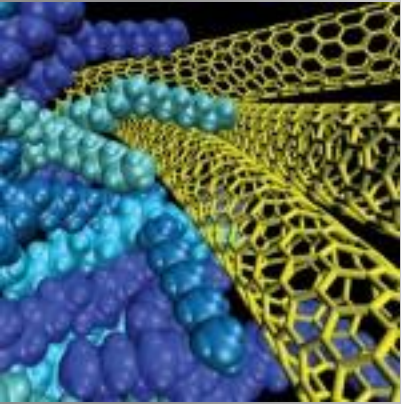


Credits: P.M. Chaikin and A.D. Hollingsworth, New York University

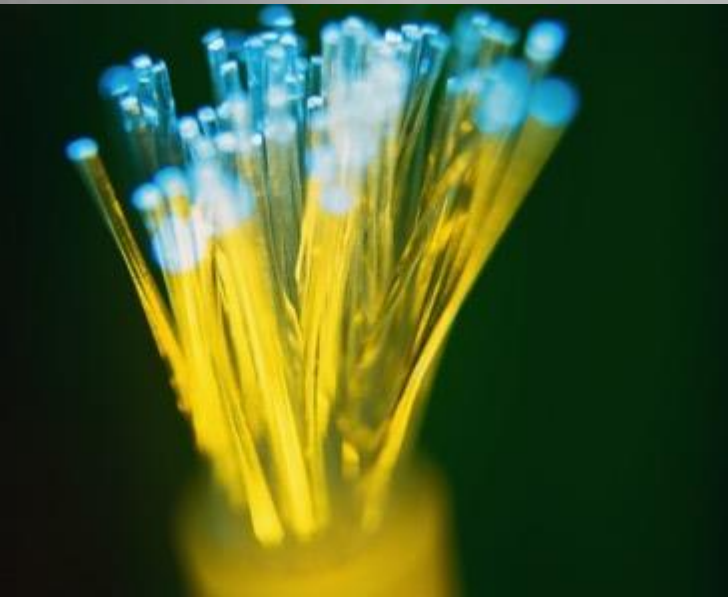


Scientific Opportunities and Possible Areas of Usage Materials

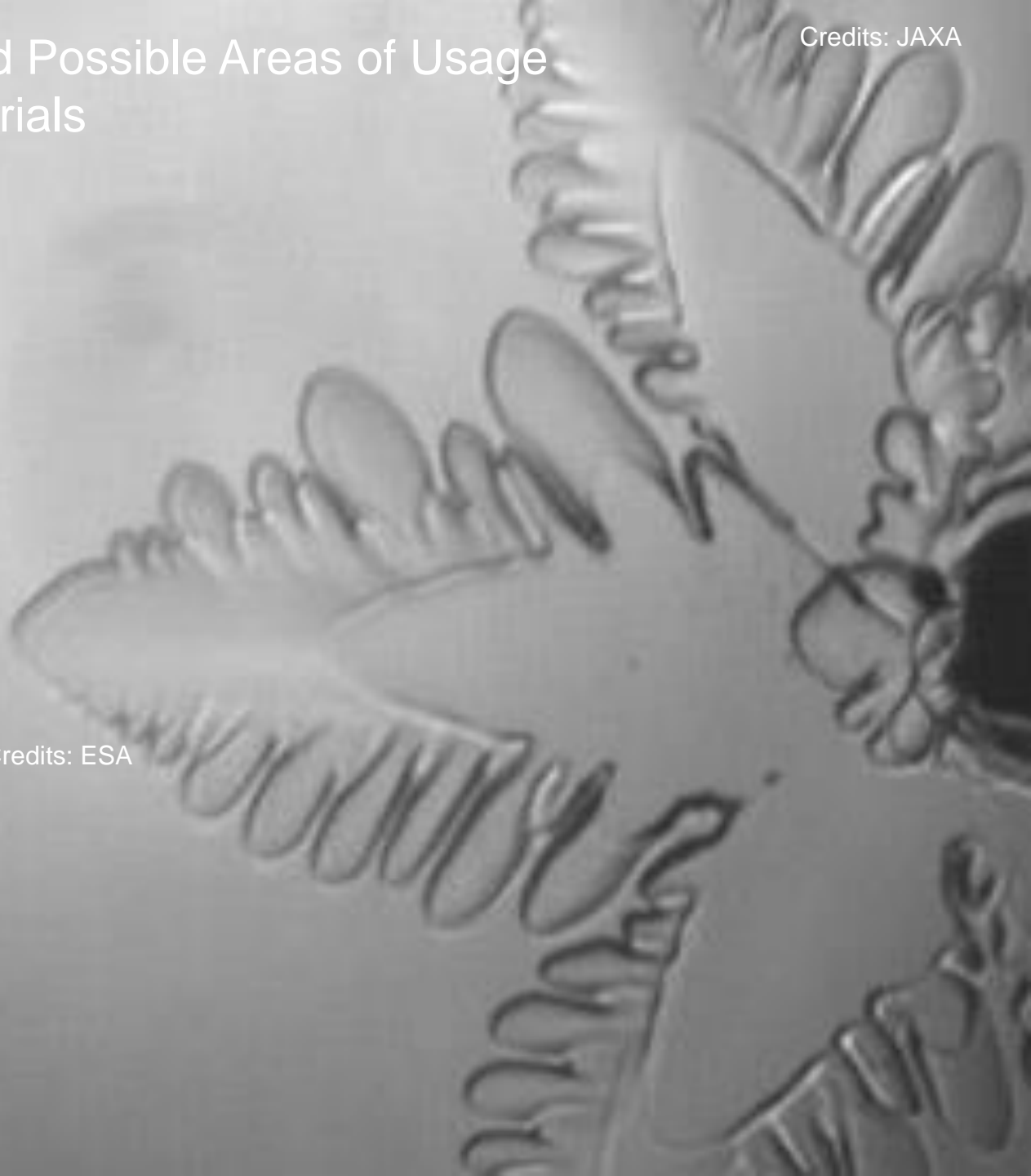
Credits: JAXA



Credits: ALTECSPACE



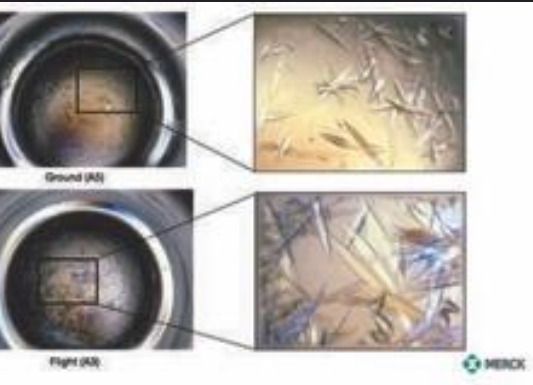
Credits: ESA



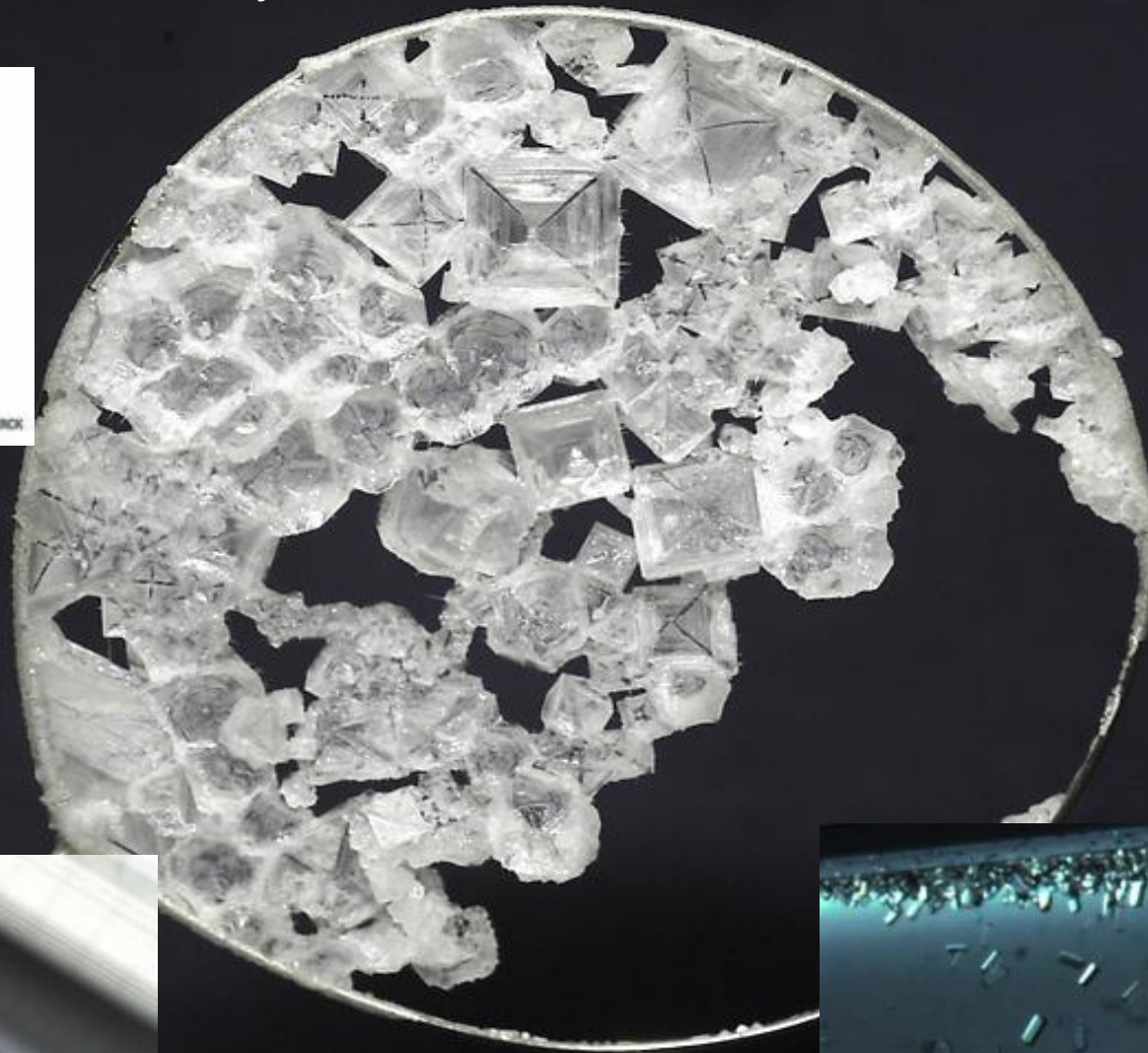
Scientific Opportunities and Possible Areas of Usage

Proteins crystallization

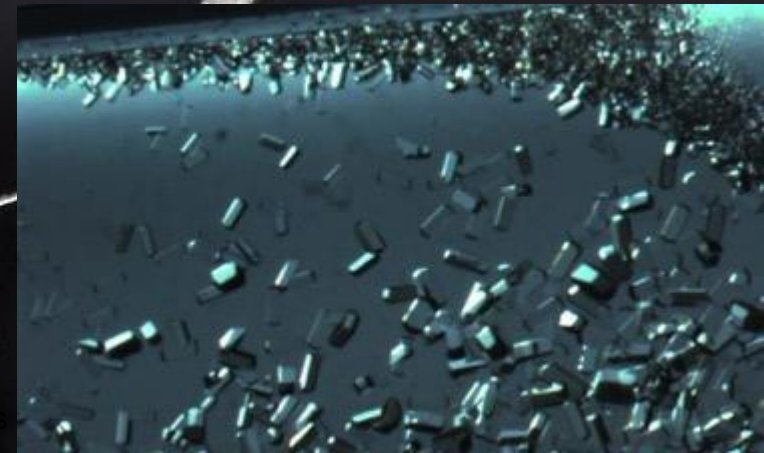
Credits: NASA@aber



Credits: MERCK



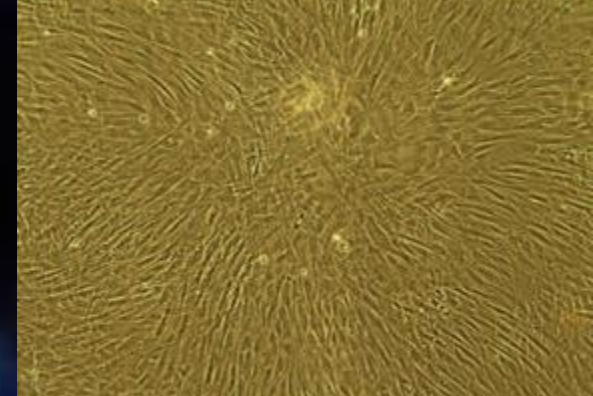
Credits: NASA



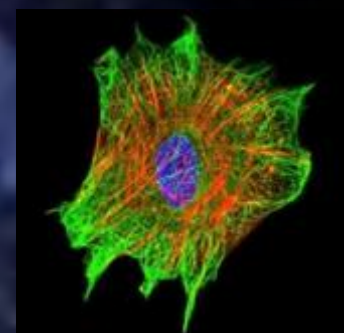
Credits: Lawrence DeLucas



Scientific Opportunities and Possible Areas of Usage Radiation / Radiation Biology



Credits: BIOANALYTICAL CORE LABORATORY



Credits: NASA/Jiashan Wang



Credits: NASA



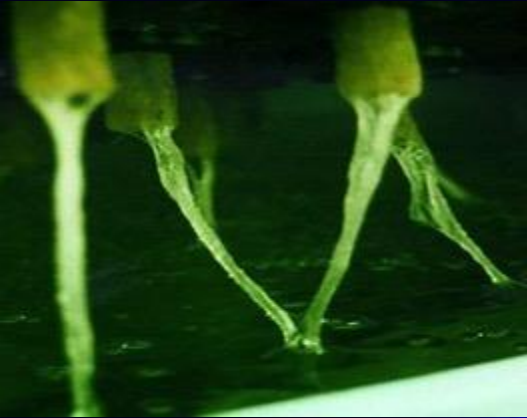
Credits: NASA@aber

Scientific Opportunities and Possible Areas of Usage

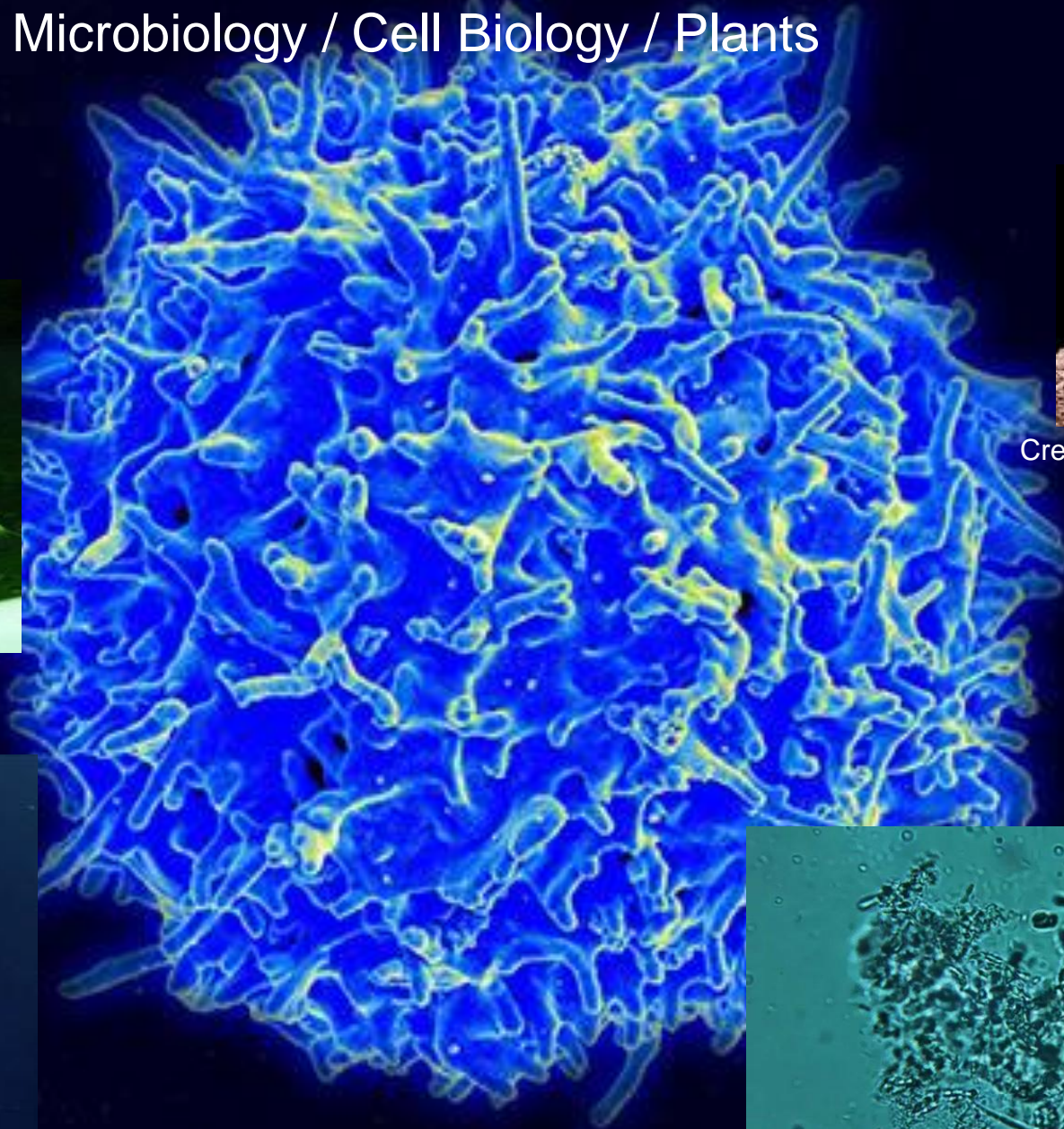
Space Biology / Microbiology / Cell Biology / Plants



Credits: ESA

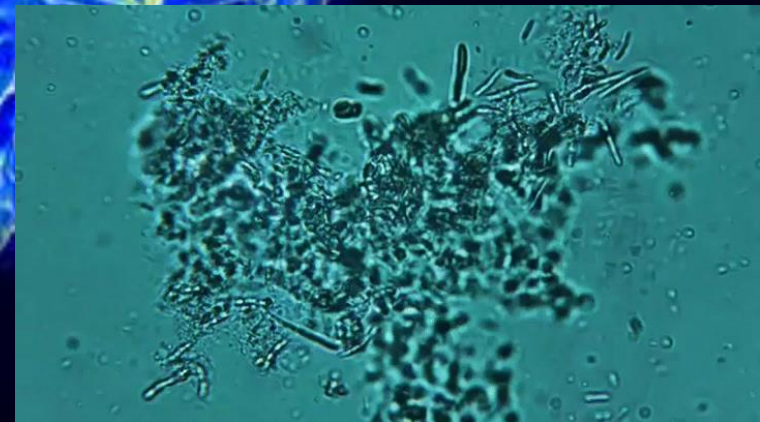


Credits: NASA Genelab



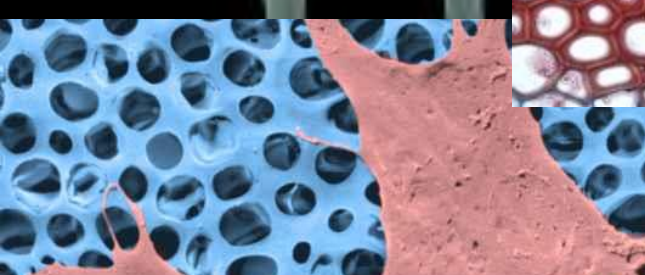
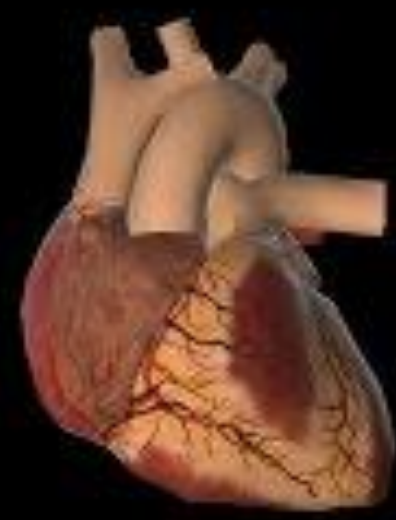
Credits: Eric Erbe, Wikimedia

Credits: NASA





Scientific Opportunities and Possible Areas of Usage Stem Cell Research / Regenerative Medicine / 3D tissue Engineering

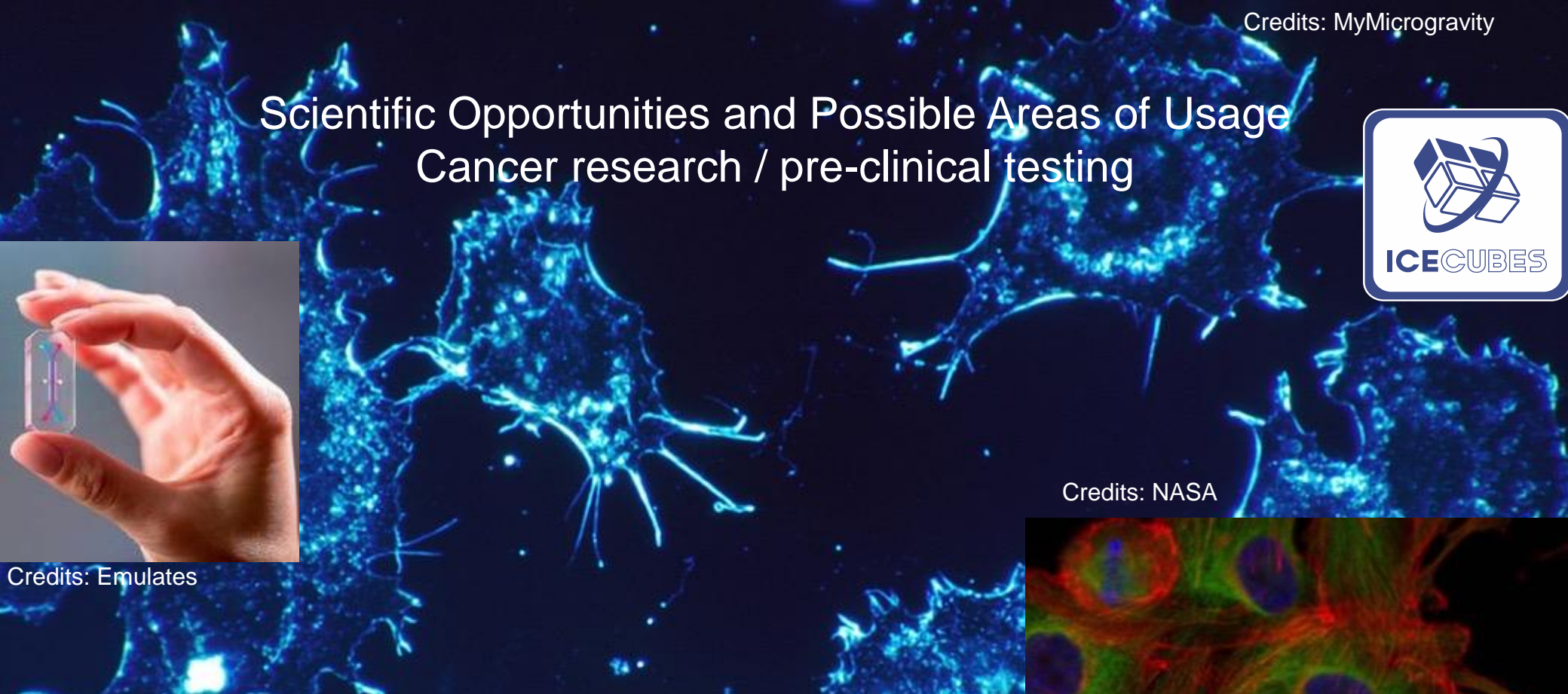


Scientific Opportunities and Possible Areas of Usage

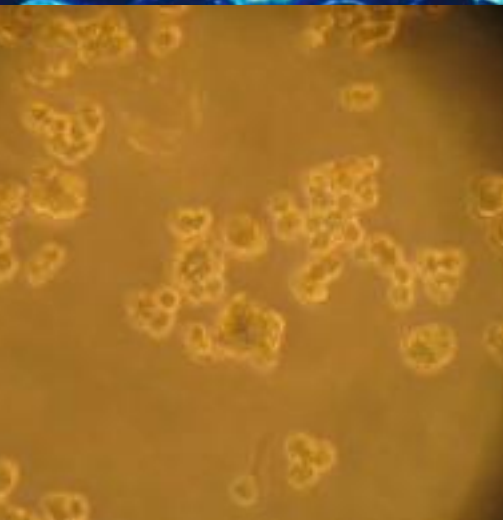
Cancer research / pre-clinical testing



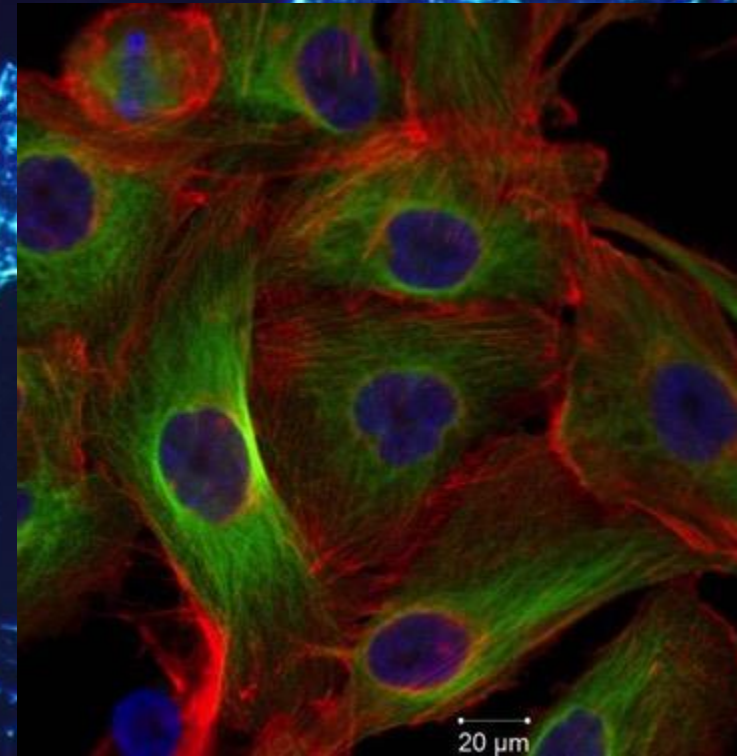
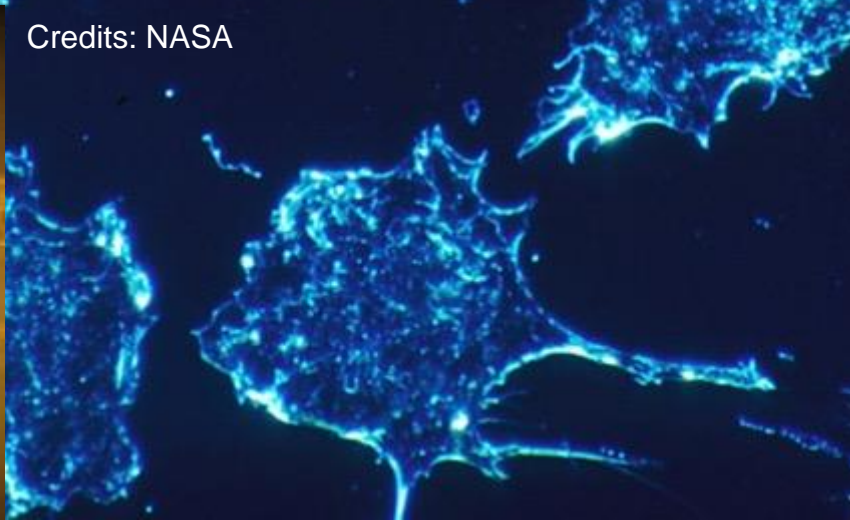
Credits: Emulates



Credits: NASA



Credits: NASA

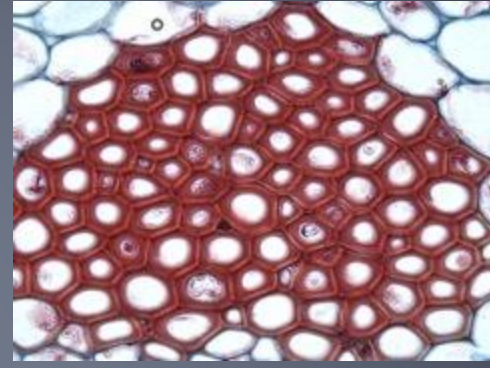


20 μm

ICE Cubes potential usage areas for R&D

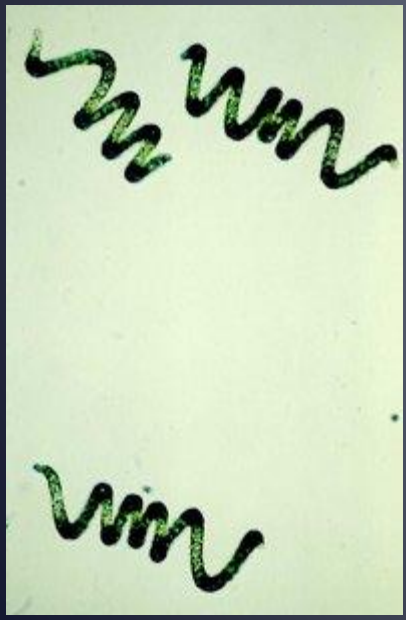
Pharmaceutical industry:

- Drugs' R&D optimization and testing
- Pharmacodynamics and pharmacokinetics research
- Toxicology research



Credits: Swansea Univ

Biotech / Agriculture / Food industry:



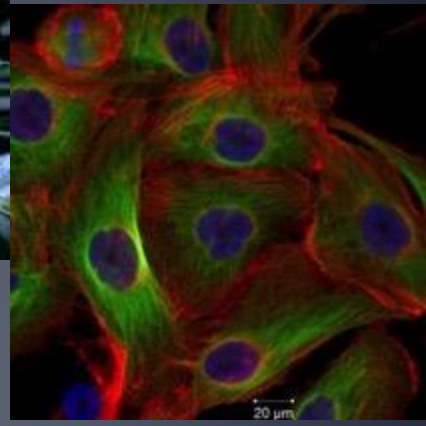
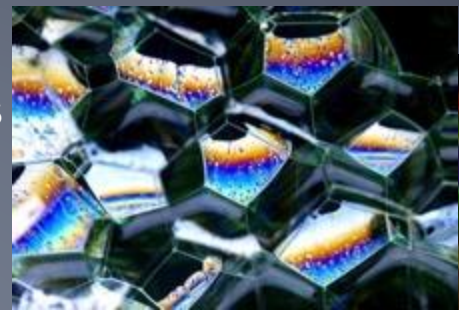
- Investigations to further understand the diseases' etiology and mechanisms
- Generation of biotech products & processes for diseases countermeasures / therapies & eco-environmental interventions (e.g. waste recycling, pollution control & abatement)
- Study and testing of pesticides
- Study and testing for food safety: ingredients formulations and stability - preservatives, colourants and other food components
- Food / drinks formulations



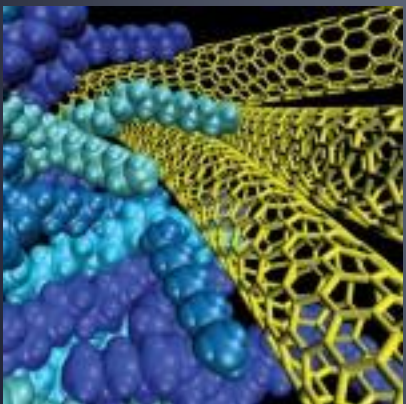
ICE Cubes potential usage areas for R&D

Petroleum / Cosmetics industry:

- Optimisation of combustibles R&D: formulations
- Optimisation of cosmetics R&D: formulations
- Soft matter (e.g. nanoparticles, polymers, nanocomposites)
- Coatings / Catalysts



Credits: NASA



Credits: ALTECSPACE

Technologies IOD / IOV:

Testing and validating any technologies or components in a relevant space environment and raising TRL levels

Additive Manufacturing



ICE Cubes Service Future Evolution

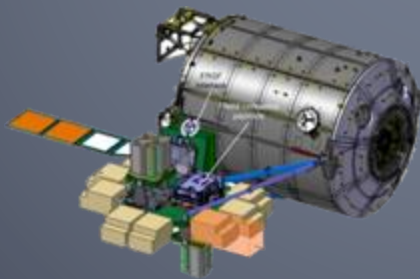
Internal ISS Experiments

- Specialized sub-facility labs with diagnostic capabilities
- Crew interaction applications



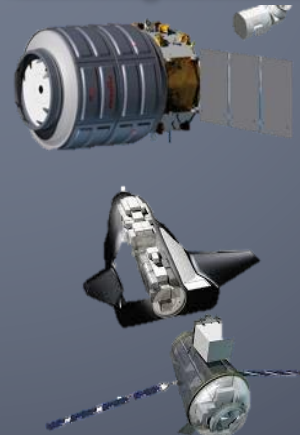
External ISS Experiments

- Facility for deployment of external payloads through ISS Airlock(s) (e.g. KIBO Platform and Bartolomeo)



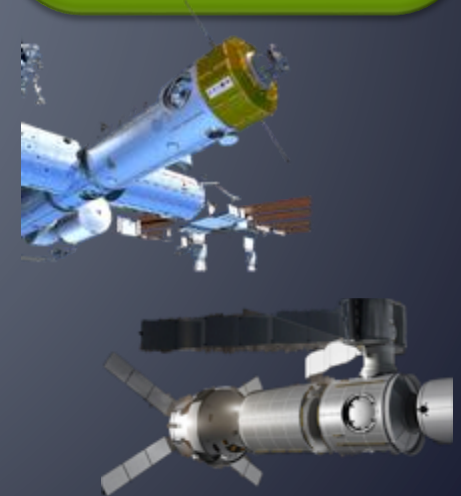
Free flying and sub-orbital Experiments

- Facility for pressurized payloads in e.g. Orbital Cygnus, Dream Chaser, Space Rider,...
- Facility for utilization in balloons and/or Sounding Rockets



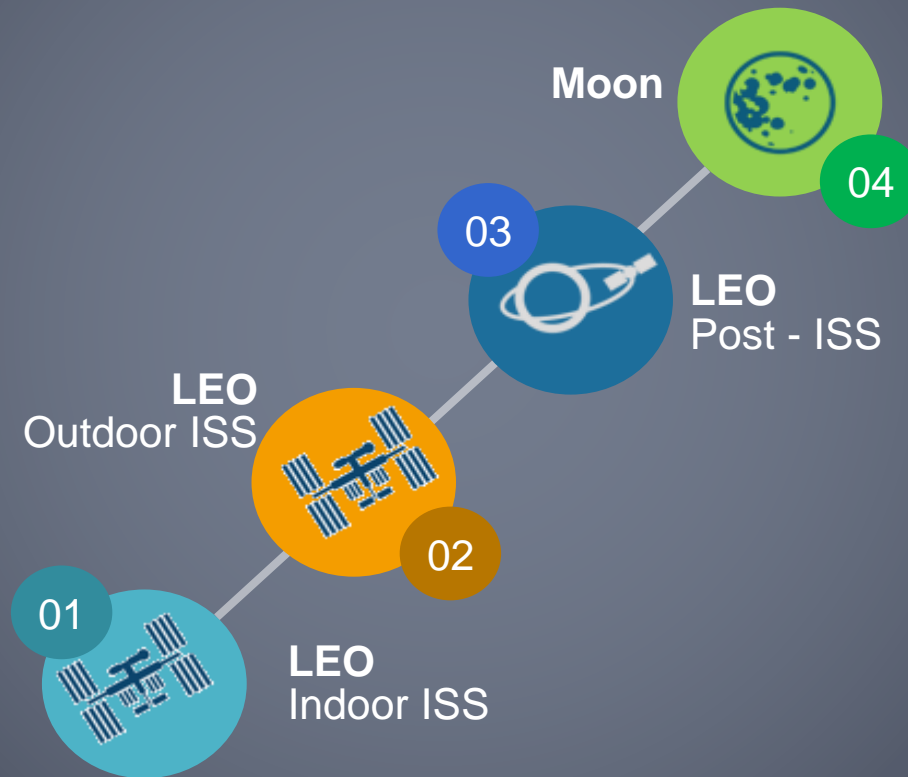
Post ISS and beyond LEO

- Possible collaborations with commercial platforms
- Possible commercial exploitation of the Cis-lunar Station / Moon





ICE Cubes Service Future Evolution





Back-up



About Space Applications Services

Space Applications Services NV/SA is an independent Belgian company founded in 1987, with a subsidiary in Houston, USA and an office in The Netherlands. Staff of 90, and growing.

Our aim is to research and develop innovative technology, solutions and services for the aerospace and security markets and related industries:

- Research and develop technologies for specific domains or subsystems which may be used stand alone or integrated within an overall system.
- Services to design, develop and integrate scientific and technology payloads, mission critical systems, facilities and command and control centres. Including laboratory, workshop and clean room.
- Services to operate facilities and command and control centres and to train persons to perform operations.

The company capabilities cover system, software and operations engineering and our activities include manned and unmanned spacecraft, launch/re-entry vehicles, monitor and control, robotics and information systems.



www.spaceapplications.com



European Space Research and Technology Centre
Noordwijk, The Netherlands



Space Applications Services
Noordwijk Office, The Netherlands



European Astronaut Centre
Cologne, Germany



Aerospace Applications North America Inc., Houston, USA



spaceapplications SERVICES

Space Applications Services NV HQ,
Zaventem, Belgium



Belgian Institute for Space Aeronomy
Brussels, Belgium

