

Space as a Cradle for Development & Innovation Builder

International Commercial Experiment Cubes Service – ICE Cubes



Overview

The 2018 discussion paper on Future Global Value Networks¹ identifies space as a vast resource of materials, as a location for infrastructures, an energy source, a source of valuable knowledge and a new opportunity for the entire humanity (Finland Future Research Centre/Fraunhofer Institute of Systems and Innovation Research).

Research & Innovation

Research implies creativity – the will to find new ways to improve our world. Research conducted in space – such as on-board the International Space Station – has unique advantages. The space environment can provide properties of micro-gravity², exposure to extreme environmental conditions, vacuum, radiation, and for human research subjects: real isolation and confinement.

µGravity

These features allow us to gain knowledge in many fields of science and technological research, which

¹ <https://www.utu.fi/en/units/ffrc/research/projects/Pages/ribri.aspx>

would otherwise not be possible if limited to the Earth.

Opportunities

In biology and pharmaceutical studies, micro-gravity allows for three-dimensional aggregation of cells into tissue-like architectures, faster cellular growth and increased virulence for biological dynamics.

Also changes in human physiological functions are induced, such as alterations in body fluids and the circadian rhythm, muscle-skeletal and immune system adaptations, neurocognitive alterations. The study of related mechanisms will speed up the research about a number of diseases, on Earth.

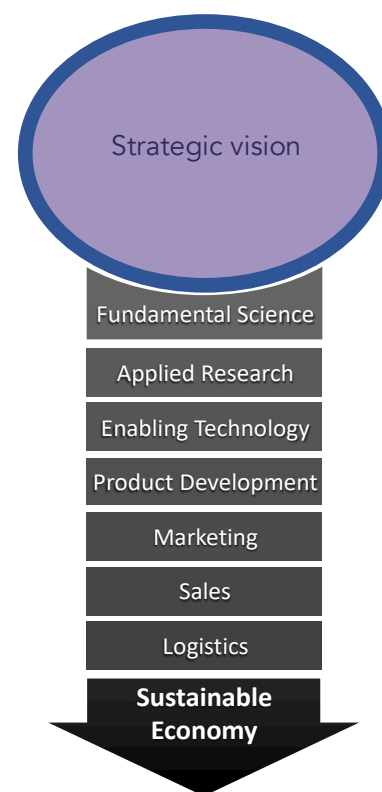
The lack of sedimentation phenomena in microgravity allows for creating new or significantly improved materials characterized by absence of defects, homogeneity and higher resolution and symmetric growth control. The absence of drainage and convection affect systems and processes including surface wetting and interfacial

² Micro-gravity is the term used for describing the typical condition in orbit, where the objects and bodies fluctuate because not gravity force.

Strategic Value

- µGravity
- Extreme environments
- Space radiation
- Isolation & confinement
- Life support systems
- Education
- Unique capabilities

Global Value Chains



Scientific Domains

- Biology
- Pharmaceutical
- Physiological
- Materials

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tension, multiphase flow and heat transfer, multiphase system dynamics, solidification, fire and combustion.

These microgravity-driven effects allow the study of phenomena, mechanisms and processes that simply cannot be observed on Earth, hidden by the gravity vector factor.

United Arab Emirates

The United Arab Emirates, the UAE Space Agency and the UAE space sector have made significant leaps to establish a national space program and to be part of the space-faring nations.

The ambitious strategy as set out by the UAE covers scientific innovation, technological advancement and sustainable development. All is aimed at establishing a sustainable knowledge-based economy, through the promotion of economic diversification and encouragement of innovation including the establishment of a strong knowledge core in space science and the setting up of educational programs as inspiration for the future generations.

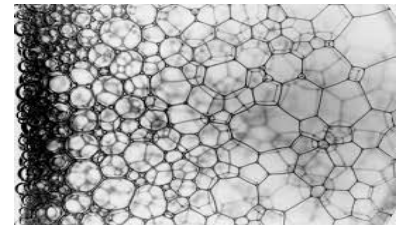
The UAE space programmes and endeavors are significantly ambitious and very inspiring. The target is not only the achievement of those ambitious objectives, but also the establishment of a UAE sustainable and innovative space science & technology ecosystem, through the network of UAE universities & academia, schools, industries and entrepreneurs and possibly through knowledge transfer agreements with international partners.

ICE Cubes Vision

Recognizing that μ gravity, Low Earth Orbit and the exploration of space provide many benefits but that it has been too costly and unnecessarily complex to go to space, we have established the ICE Cubes service which makes access to space possible for anyone and at a low price. ICE Cubes starts operation with the International Space Station (ISS) and will provide access to other vehicles as well as the moon and eventually Mars.

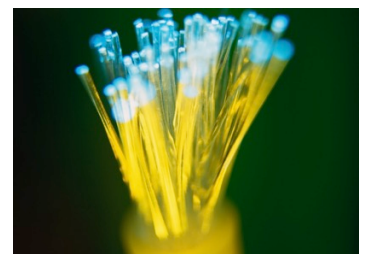
Research

- Micro & macroscopic effects
- Dynamic systems
- Crystalization
- Melting
- Nano-particles and fluidics
- Synthetic biology
- Closed loop environmental management



Industrial Applications

- Novel materials
- Health care & innovative medicines
- Bio-technology
- Foods
- Cosmetics
- Scientific instrumentation



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ICE Cubes Service

ICE Cubes provides:

- regular launches every 4 months
- 9-12 months from flight reservation to launch
- on-orbit duration of 4 months or more
- accommodation and installation of small and medium sized payloads
- fixed prices for launch / return
- fast track approach agreed with the European Space Agency
- all necessary for customers to communicate directly with their payload from their own location.

The ICE Cubes service is suitable for many uses:

- Fundamental and applied research / university studies
- Industrial / enterprises Research & Development
- In-orbit testing and validation of technologies and processes for Earth and Space applications
- Educational demonstrations in Science, Technology, Engineering and Mathematics.

The payloads will be accommodated in the ICE Cubes facility, on board the European Columbus module of the ISS, and will be operated directly by the development organization - company or university - from the UAE, via Internet.

ICE Cubes offers a real end-to-end service from the first assessment of the payload concept to the final delivery of the data back to the developer. The access to space becomes fast, simple and affordable.

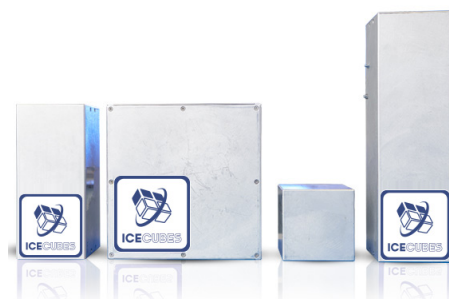
The service is the only interface for the customers and takes care of booking the launch, the crew activity for installation of the payload on board the ISS, and the necessary resources. The service also takes care of all the certifications for flight readiness and safety.

Supporting Services

Space Applications Services and the ICE Cubes team has decades of experience in making use of μ Gravty, providing ESA with mission science and payload system engineering support, astronaut training as well as operations of payloads on the International Space

Features

- **Standard**
 - Launch to ISS every four months
 - Launch, installation by astronaut included
 - Many different sizes of payload possible
 - High data rates



- **Additional**
 - Return to your laboratory each 4 months
 - 8, 12 months or longer periods on orbit
 - Stowage of cold items, such as biological samples



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Station. We provide inspirational support in workshops:

- “What are the benefits of μ Gravity”
- “What is the state of the art in μ Gravity Experimentation at the ISS”

and we provide engineering training:

- “Engineering familiarization for building a μ Gravity Payload”
- “Advanced Training in μ Gravity Payload Development”

Benefits for Society

ICE Cubes benefits its customers in many ways, not only that access to space can be an “every day” activity but through the consequences of accessing space, as illustrated below.

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 μ g	High barrier to μ g
Future Exploration	Enabling private endeavour to explore space business	Business as usual

Opportunities for American University of Sharjah (AUS) Enterprises

The American University of Sharjah (AUS) Enterprises is created with the target to enable commercial opportunities from the results of world-class research.

Supporting Services

- Education and Training
 - Student workshops
 - Student and Engineer Training
 - ICE Cube Users Information Events



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This catalytic synergy between academic research and innovative industrial R&D is exactly where the ICE Cubes service can provide a unique benefit.

The Sharjah Research, Technology and Innovation Park (SRTIP) is aiming at knowledge-intensive businesses related to the following areas

[\(http://www.ause.ae/initiatives/\)](http://www.ause.ae/initiatives/):

- Water technology,
- Renewable energy,
- Environmental technology,
- Digitization,
- Production, design & architecture,
- Transport & Logistics.

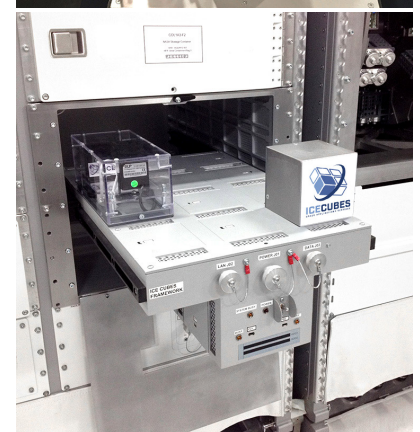
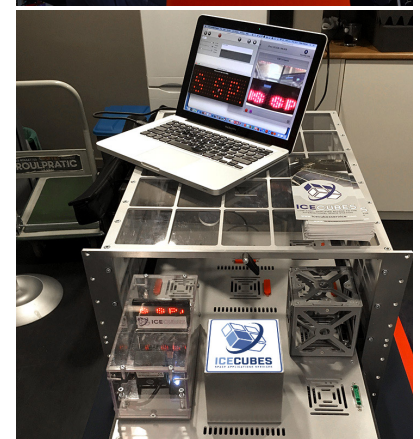
From the SRTIP areas and the research topics of interest for the AUS, the ICE Cubes service and μ Gravity are relevant for a significant number of topics. To name a few:

- Performance materials / material science / new materials
- Generation of biotech products & processes for eco-environmental interventions (e.g. waste recycling, pollution control & abatement)

- Closed circular environments / artificial ecosystem for bio-regenerative life support systems
- Enhancement of biofuel
- Additive Manufacturing / 3D printing / 3D bioprinting
- Space Manufacturing
- Applied fluid science
- Colloidal and nanoparticle self-assemblies and its applications (+ Electro-rheological fluids
- Zeolite crystals with potential applications
- Coatings
- Sensor technologies
- Robotics

All of these topical areas can benefit from performing R&D and technology testing in microgravity in a space for commercial benefits on Earth.

A proposal has been made to AUS to achieve this with options for using webinars and training to raise knowledge and expertise about space with special reference to human spaceflight.



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