



ICE CUBES SERVICE
EDUCATIONAL
February, 2024



ICEcubes@spaceapplications.com
<https://www.icecubesservice.com/>



ICE CUBES SERVICE WHO ARE WE?

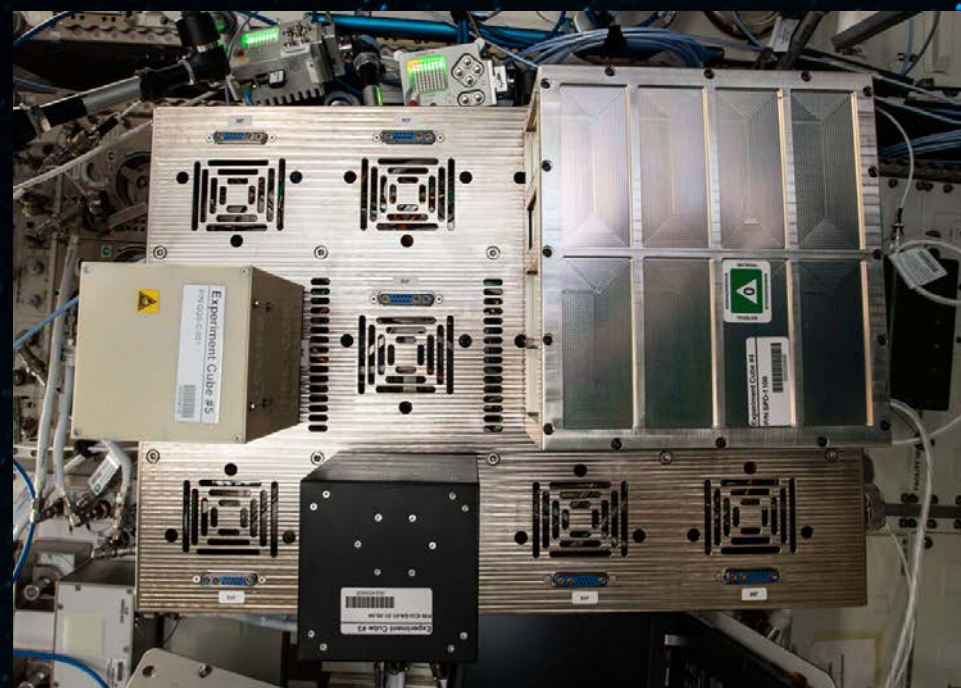
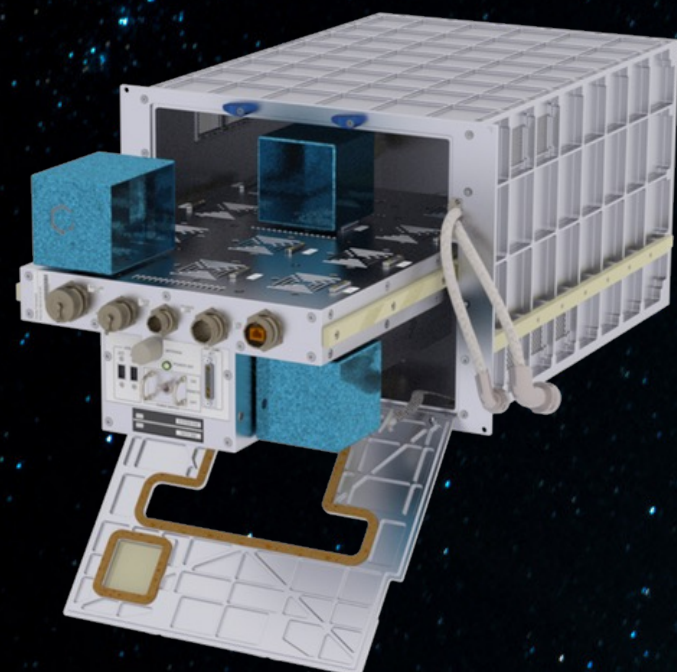


ICE CUBES SERVICE

Cost effective end-to-end service to fly your research and technology to the International Space Station (ISS)

WE OFFER

- Fast-track regular access to space
- Access to our facility onboard the ISS
- Engineering support and payload development capabilities
- Unique real-time interaction
- IP rights owned by customer



Credit: NASA / ESA



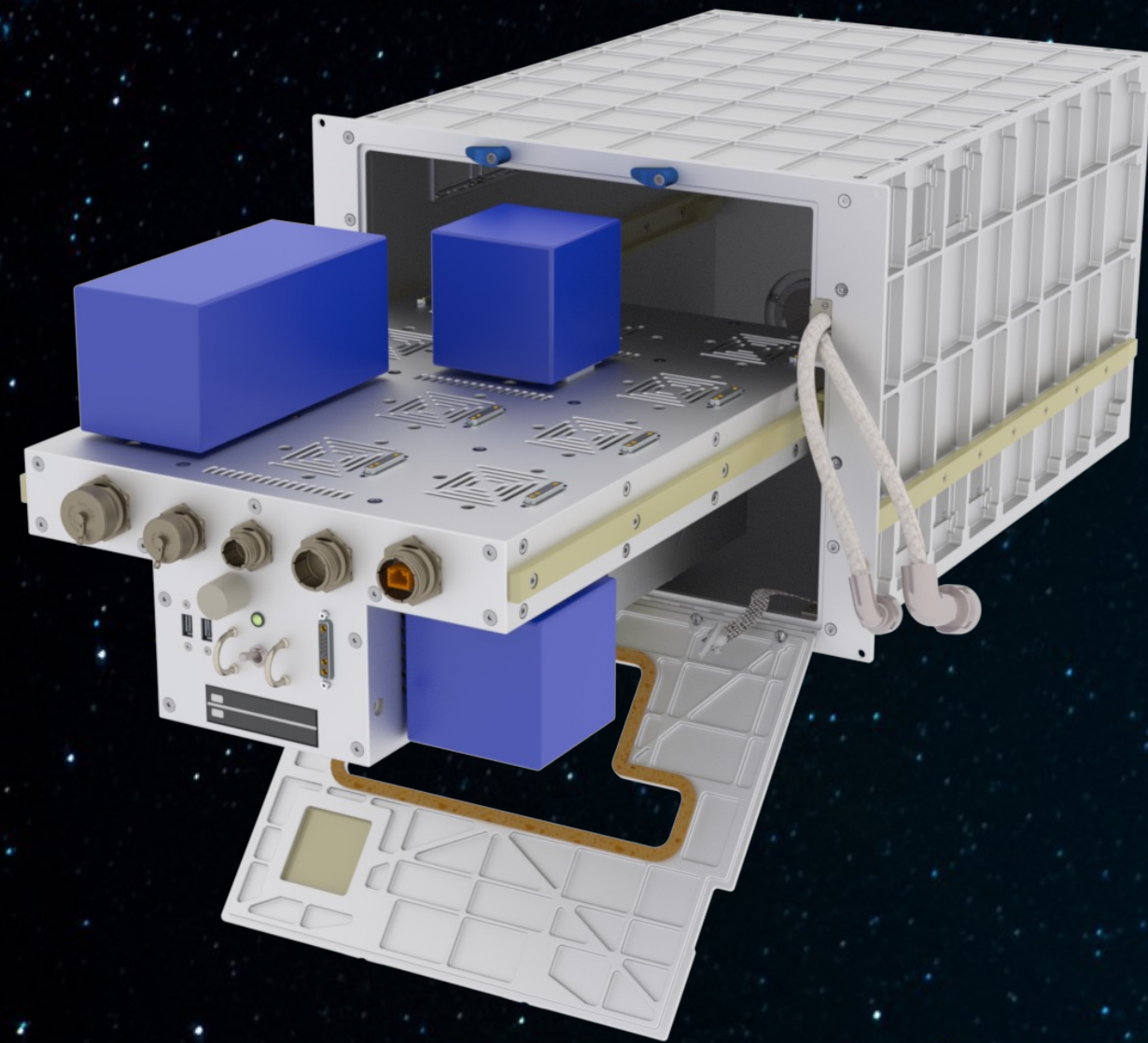
ICE CUBES SERVICE

WHO ARE WE?



ICECUBES
BY SPACE APPLICATIONS SERVICES

ICE CUBES Models

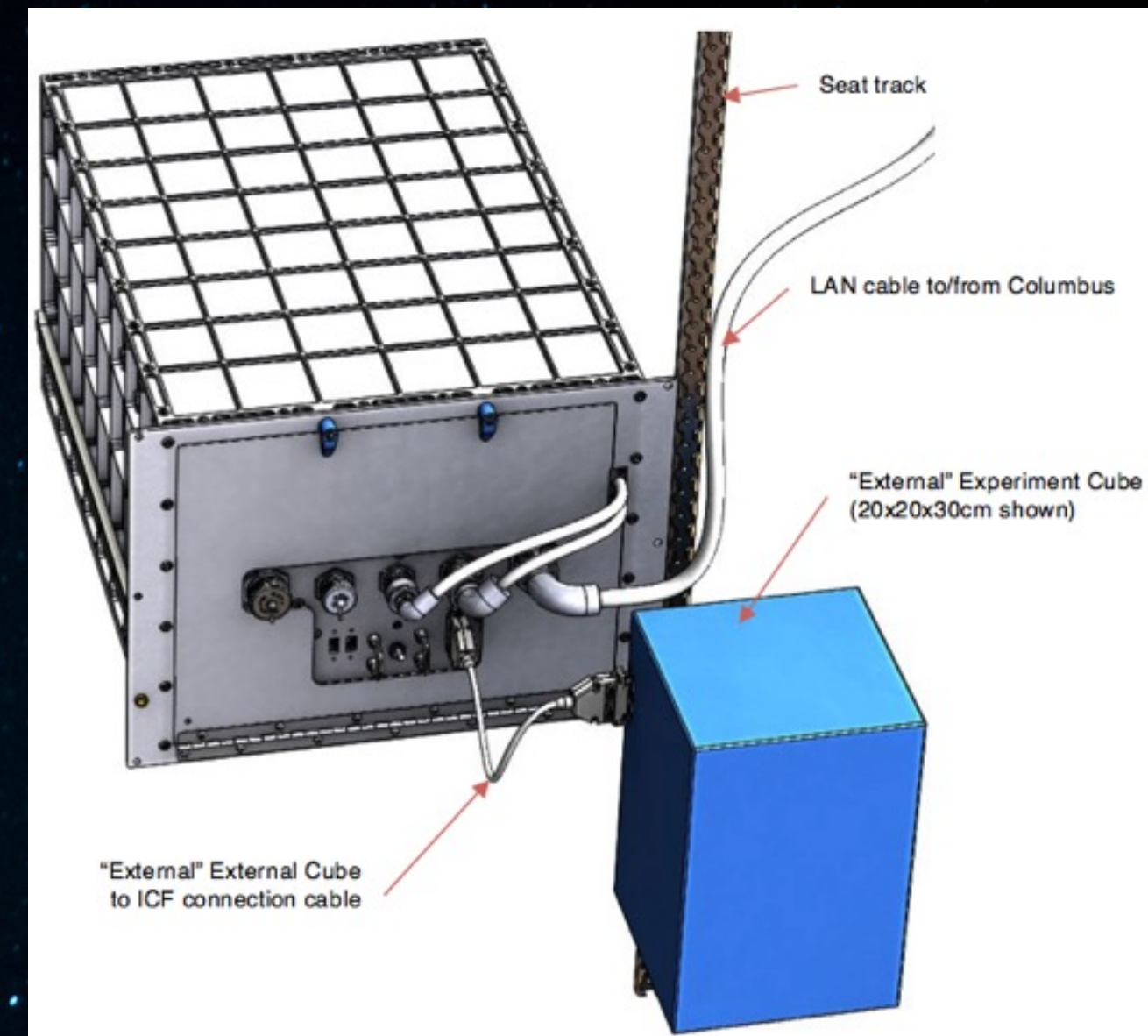


Wired Cubes
(plug&play)

Wireless
Cubes

Aisle payloads

... and crew interaction
applications





ICE CUBES SERVICE CHARACTERISTICS

- Unique real-time interaction capability
 - Live stream
 - Via internet / IP protocols
 - From your home location ~24/7
 - Data down/uplink at high speed
- Power / data
- Form Factor flexibility
- Mission durations choice

Link to Interface Requirements document:

https://www.icecubesservice.com/wp-content/uploads/2020/04/ICU-SA-RQ-004_1.6.0-ICE-Cubes-Facility-to-Experiment-Cube-IRD.pdf





ICECUBES
BY SPACE APPLICATIONS SERVICES

A photograph of an astronaut in a white spacesuit with a clear helmet, standing on the moon's surface. The astronaut is positioned in the lower right quadrant of the frame. The moon's surface is dark and covered in craters and rocks. The sky is a deep, dark blue with numerous stars. The overall lighting is dim, with some highlights on the astronaut's suit and the moon's surface.

ICE CUBES SERVICE EDUCATION



EDUCATIONAL

- Educational **challenges or competitions**:
 - ESA Orbit Your Thesis – tertiary
 - AI in Space Challenge – secondary or tertiary
 - Code4Space – primary or secondary
 - Global Sustainability Space Challenge

Support in:

- Selection process
- Feasibility assessment
- Teams mentoring & workshops

- **MediaSet** interactive / inspirational events
- A “lesson from space” (show & tell)
- Interactive art in space

Variety of options

- Use a **cube “off-the-shelf”** & focus on **science**
 - Science Cube
 - Greenhouse
 - BioCube
 - Protein Crystallization Cube
- **Develop your own** & focus on space **engineering**
- **Demonstrate / validate technology**

- Executive **courses** / Space Academy
 - Through JV Metaspaces
- Your own **Space Innovation Lab** at your university



EDUCATIONAL

- Educational **challenges or competitions**:
 - ESA Orbit Your Thesis – tertiary
 - AI in Space Challenge – secondary or tertiary
 - Code4Space – primary or secondary
 - Global Sustainability Space Challenge

Support in:

- Selection process
- Feasibility assessment
- Teams mentoring & workshops

- **MediaSet** interactive / inspirational events
- A “lesson from space” (show & tell)
- Interactive art in space

Variety of options

- Use a **cube “off-the-shelf”** & focus on **science**
 - Science Cube
 - Greenhouse
 - BioCube
 - Protein Crystallization Cube
- Develop your own & focus on space **engineering**
- Demonstrate / validate **technology**

- Executive **courses** / Space Academy
 - Through JV Metaspaces
- Your own **Space Innovation Lab** at your university

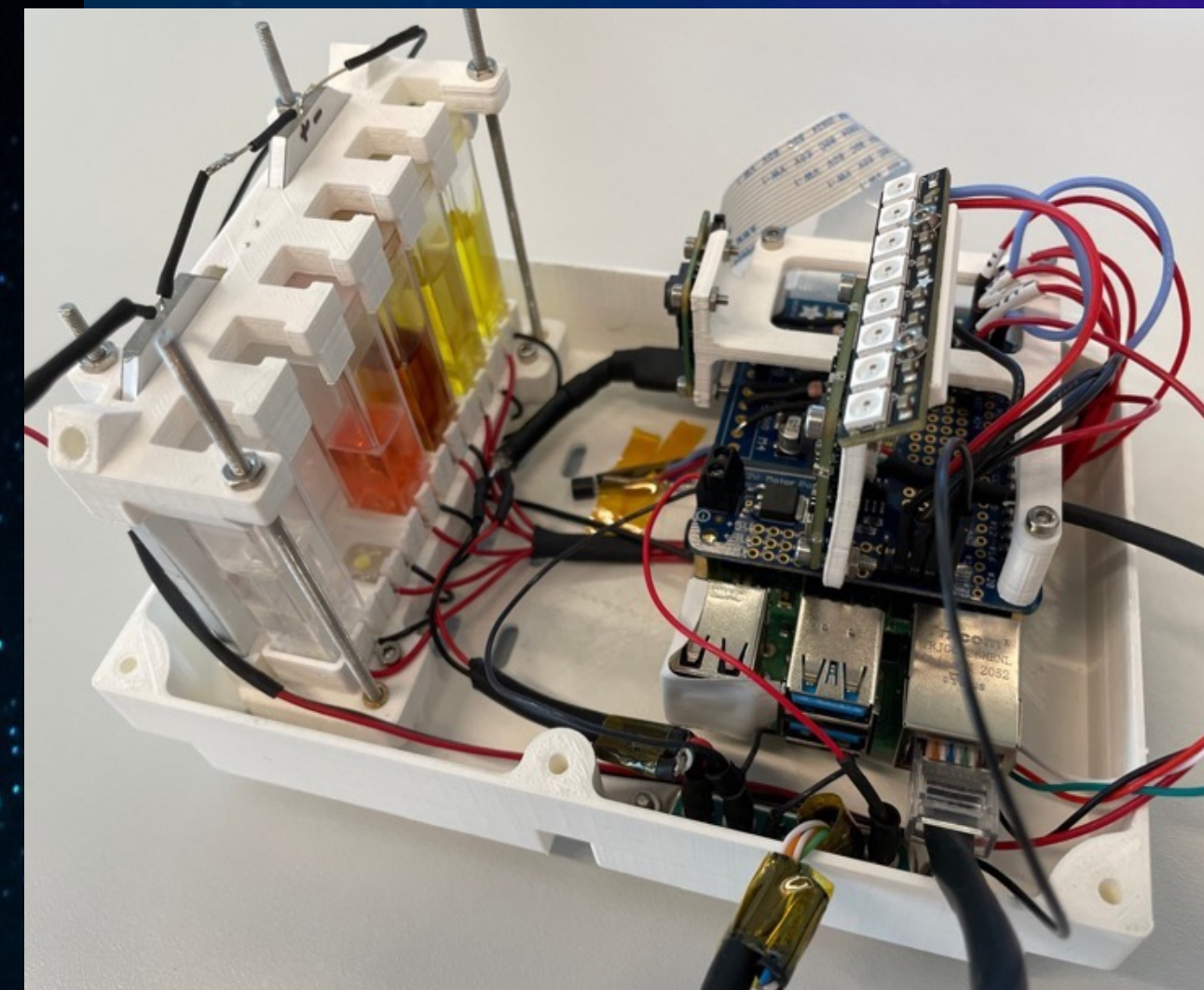
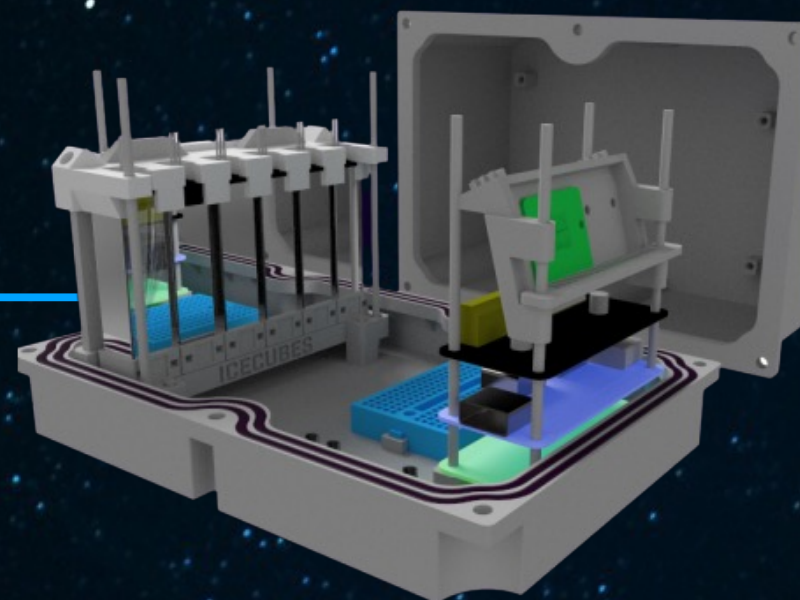


ICE CUBES SERVICE
MEET CUBES “OFF-THE-SHELF”



MEET THE **SCIENCE CUBE**

- 6 or 12 or 18 standard tubes
- Fluids, bacteria, particles, cells, plants, fungi...
- Raspberry Pi based command and control
- Multiple cameras and illumination
- Sample stimulation (e.g. light, heat)
- Real-time commanding & monitoring
- Is being enhanced to have temperature conditioning
- Possibility to connect with AI-Box for real time AI-ML analysis
- Missions so far: Maleth I, II, III



- <https://www.icecubesservice.com/journal/first-maltese-space-mission/>



MEET THE GREENHOUSE



The Greenhouse has been flown in 2018 for plants growth study by ISU and NASA AMES.
<https://www.icecubesservice.com/journal/plants-engineered-to-bio-manufacture-specific-proteins/>

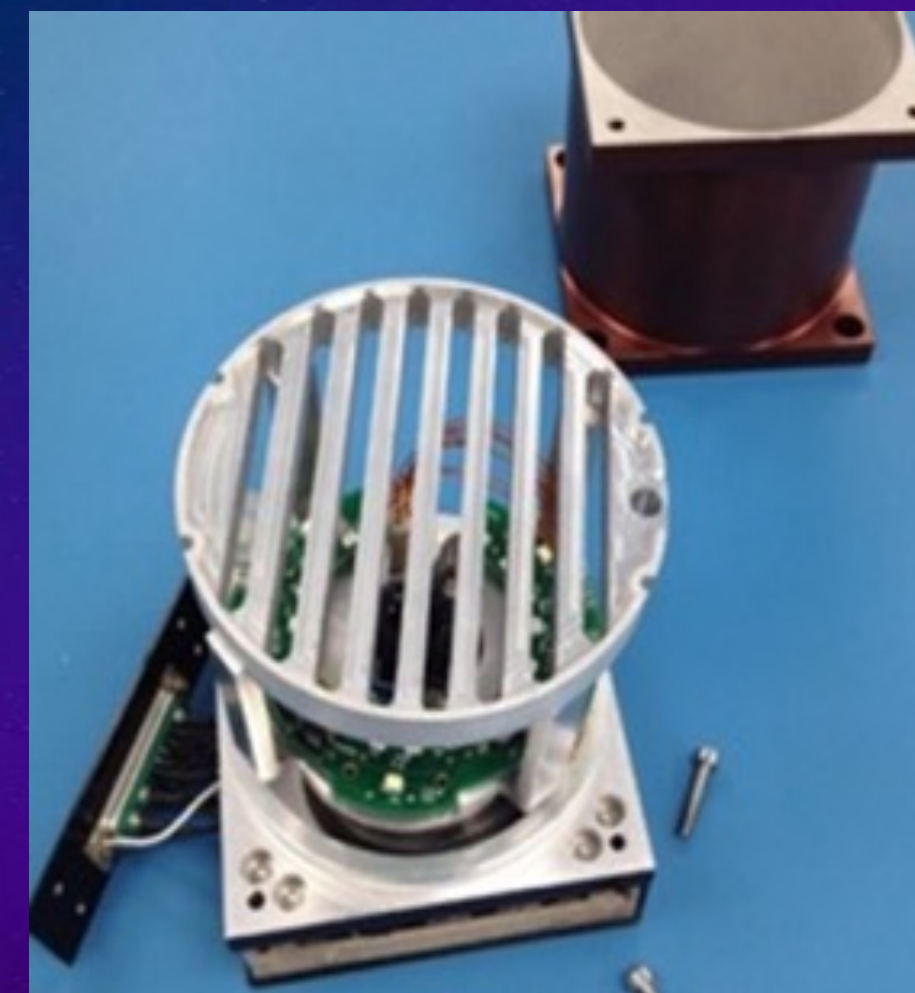
Used for:

- Absence of gravity allows for the study of plant development and growth
- Studying plants' response to space environment for use in long missions.
- Examining the growth of seedlings in microgravity

Characteristics:

- Consists of one reservoir, one containing only water, estradiol and MS Salts
- White, blue and red LEDs
- Thermistor
- DC Converter
- Camera
- Feed-Through Connector

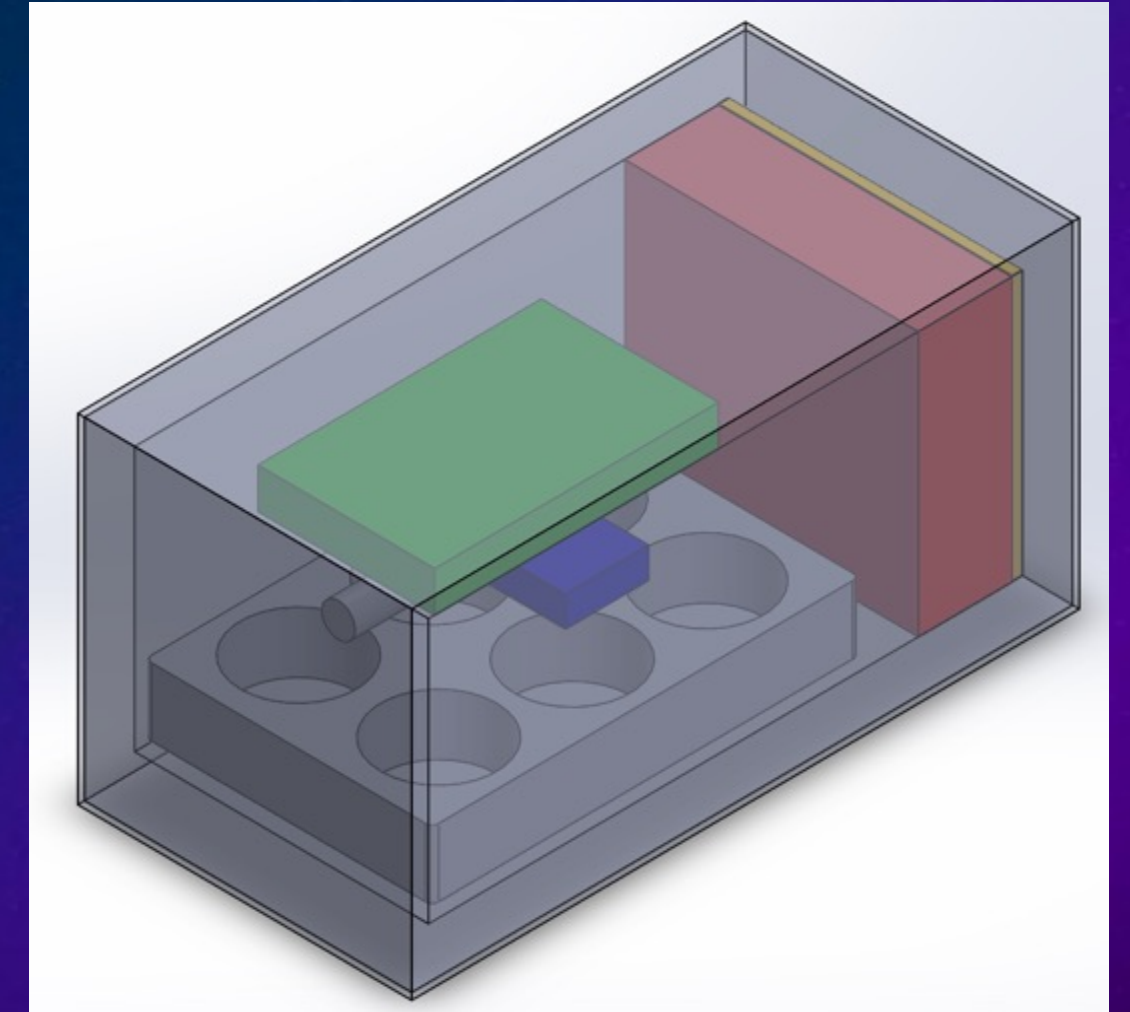
ICE CUBES SERVICE





MEET THE **BIO CUBE**

- 6 large cell culture chambers / 6-well plate (or 24-well or...)
- Temperature control at $37 \pm 1^\circ\text{C}$
- Provide media refreshment capability
- Provide fixation capability for all chambers
- Provide air with 5% CO₂ to the samples
- Provide washing with PBS for all chambers
- Provide photo/video 2x Raspberry Pi cameras
- Possibility to connect with AI-Box for real time AI-ML analysis





MEET KIRARA. EDUCATION

KIRARA protein crystallization incubator

Used for educational purposes:

Theory programme including **lectures** about:

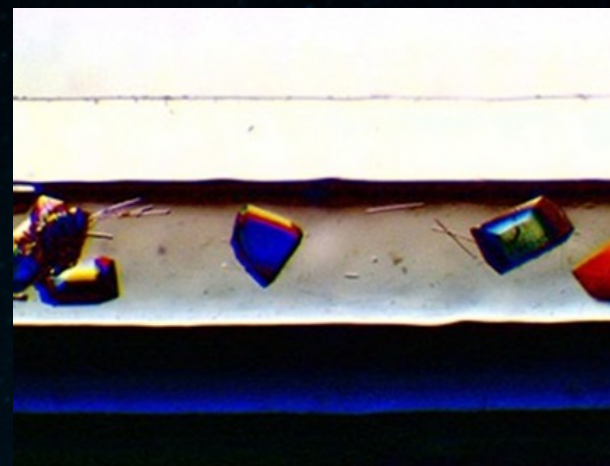
- Space missions and space sciences
- Crystallisation processes and techniques on Earth and in space

Protein crystallisation kit to be distributed to schools

- Kit developed in collaboration with JAMSS and Confocal Science Inc for Educational programme
- Students test the best conditions on ground before mission to space

Opportunity to participate in a **real space mission**

- Samples from multiple student teams in Kirara mission



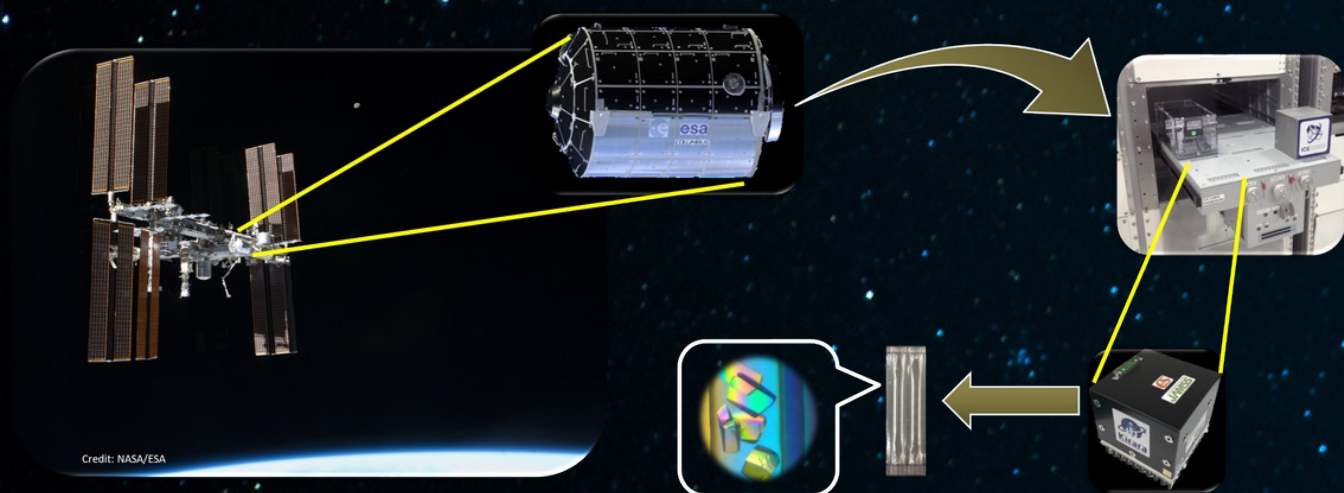
KIRARA EDUCATION USE CASE

Extracurricular program for middle to Taiwan high school students

- Focus on protein crystal production for drug discovery

Series of events held over a period of about six months

- First and second events to conduct preliminary experiments (condition studies) for space experiments,
- During the third event, each team presented the results of their preliminary experiments and prepared samples for space experiments.



Credit: NASA/ESA



Group photo of event participants. Credit: JAMSS



Left: Preparing samples for a space Mission.

Right: Samples installed in Kirara device. Credit: JAMSS



ICE CUBES SERVICE
OTHER ASSETS & CHALLENGES



EDUCATIONAL

- Educational **challenges or competitions**:
 - ESA Orbit Your Thesis – tertiary
 - AI in Space Challenge – secondary or tertiary
 - Code4Space – primary or secondary
 - Global Sustainability Space Challenge Qatar

Support in:

- Selection process
- Feasibility assessment
- Teams mentoring & workshops

- **MediaSet** interactive / inspirational events
- A “lesson from space” (show & tell)
- Interactive art in space

Assets, Challenges & Competitions

- Use a **cube “off-the-shelf”** & focus on **science**
 - Science Cube
 - Greenhouse
 - BioCube
 - Protein Crystallization Cube
- **Develop your own** & focus on space **engineering**
- **Demonstrate / validate technology**

- Executive **courses** / Space Academy
 - Through JV Metaspace
- Your own **Space Innovation Lab** at your university



MEET THE AI BOX

The AI-Box is permanently hosted inside the ICE Cubes Facility and offered on loan to users, who can upload their models and run AI-ML tasks in support of their payloads/equipment.

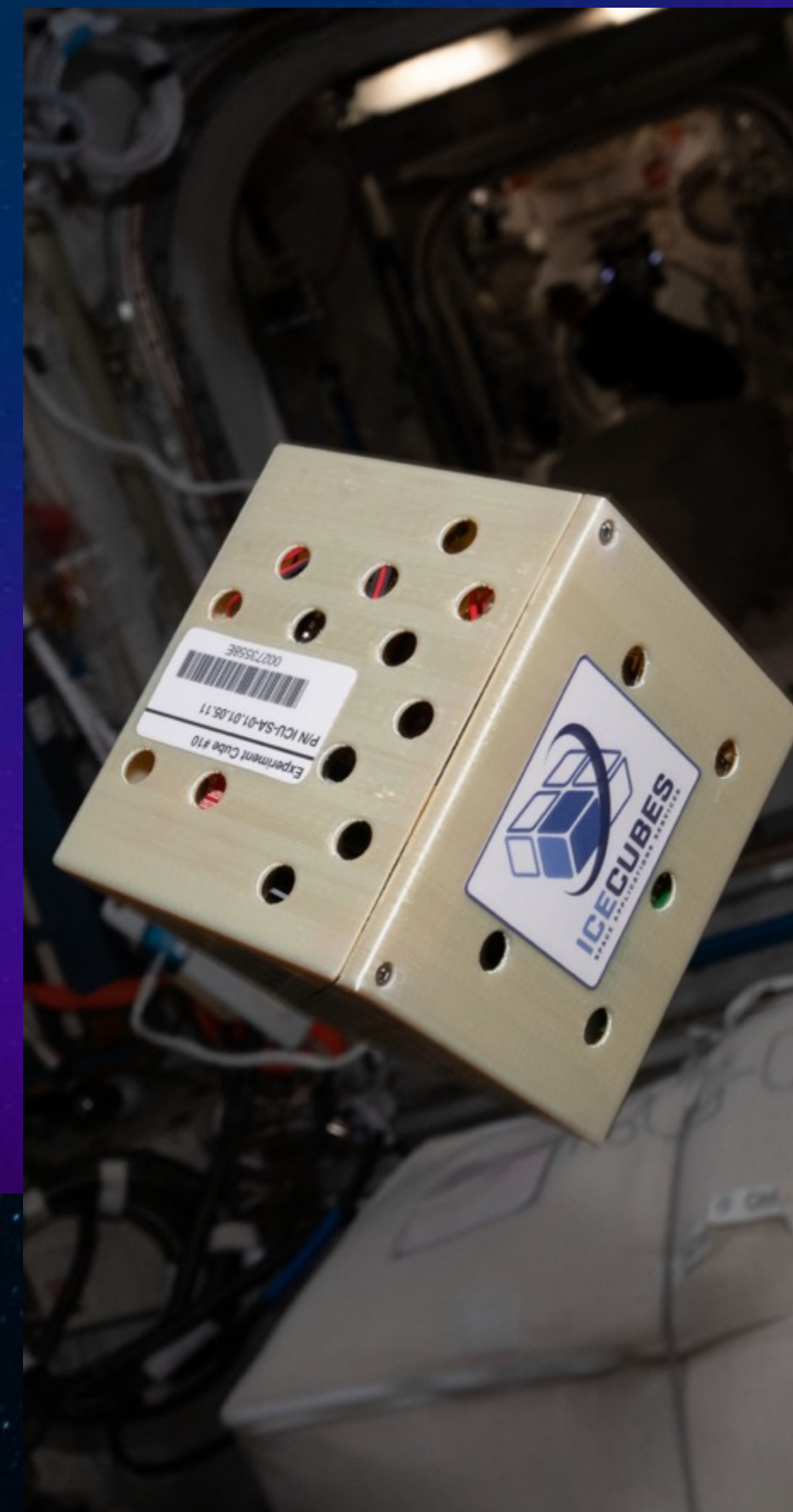
Used to:

- Upload and run AI (neural networks) previously trained on ground, or
- Train the AI models directly on board
- Real-time commanding & monitoring
- Link to cubes or MediaSet

Cases of use:

- S/W demo & validation
- In-situ analysis
- Embedded & Edge computing
- Image classification, object detection, segmentation, speech processing
- Fault analysis & prediction
- <https://www.icecubesservice.com/journal/ai-applications-in-space-operations-examples/>

ICE CUBES AI-Box



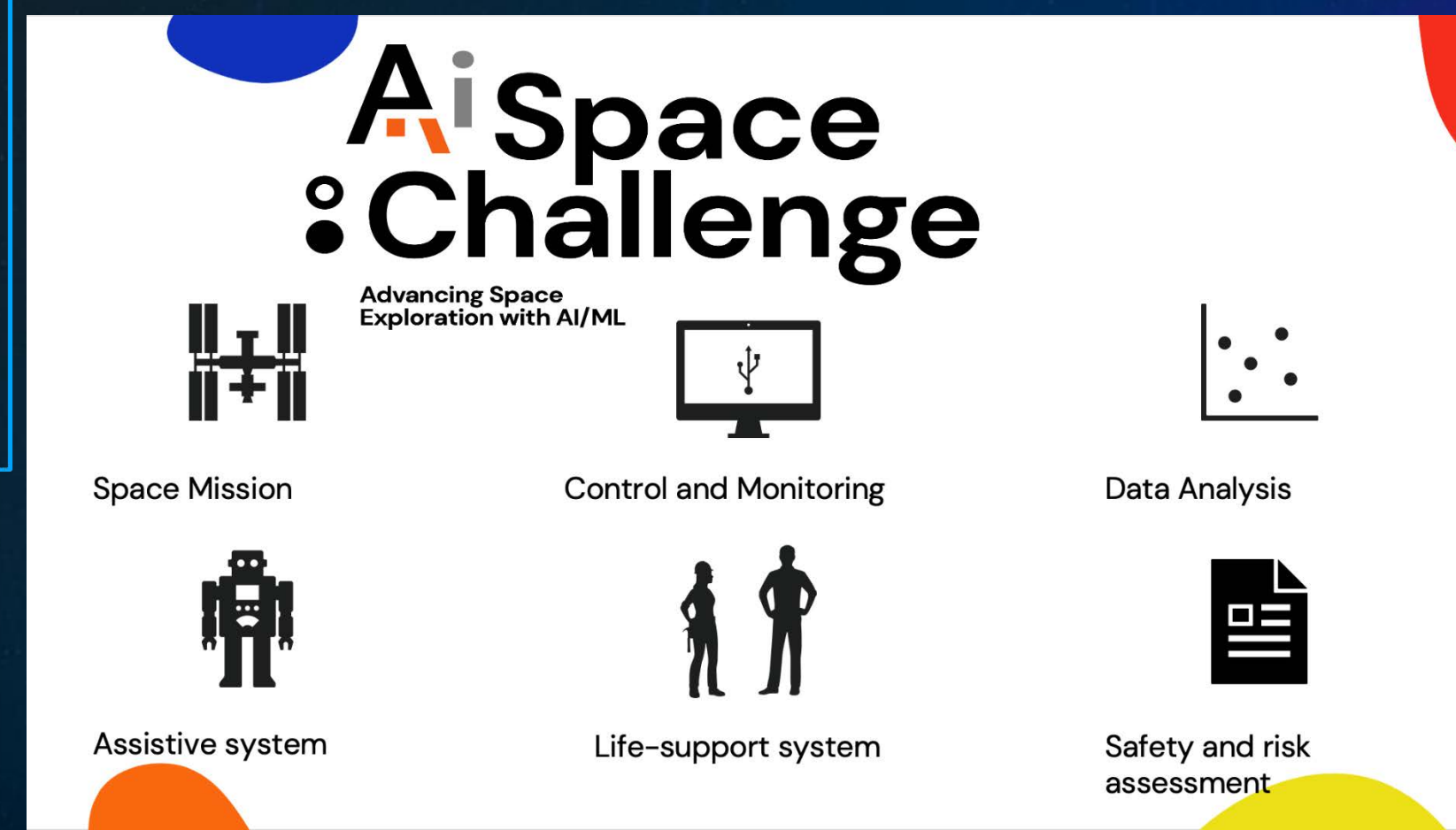


AI BOX EDUCATION USE CASE

- University level AI challenge - South-East Asia
- <https://www.icecubesservice.com/journal/ai-space-challenge-south-east-asia/>

Built-in sensors:

- Relative humidity
- Atmospheric pressure
- Temperature
- Acceleration (on X, Y, Z axes)
- Rotation (on Z, Y, Z axes)
- Magnetic field (on X, Y, Z axes)
- CO2 concentration, particulate matter
- Advacam's MiniPIX TPX3 sensor, which is a miniaturized and low power radiation camera with the state of art Timepix3 chip





MEET THE **MINI-CALLIOPE**

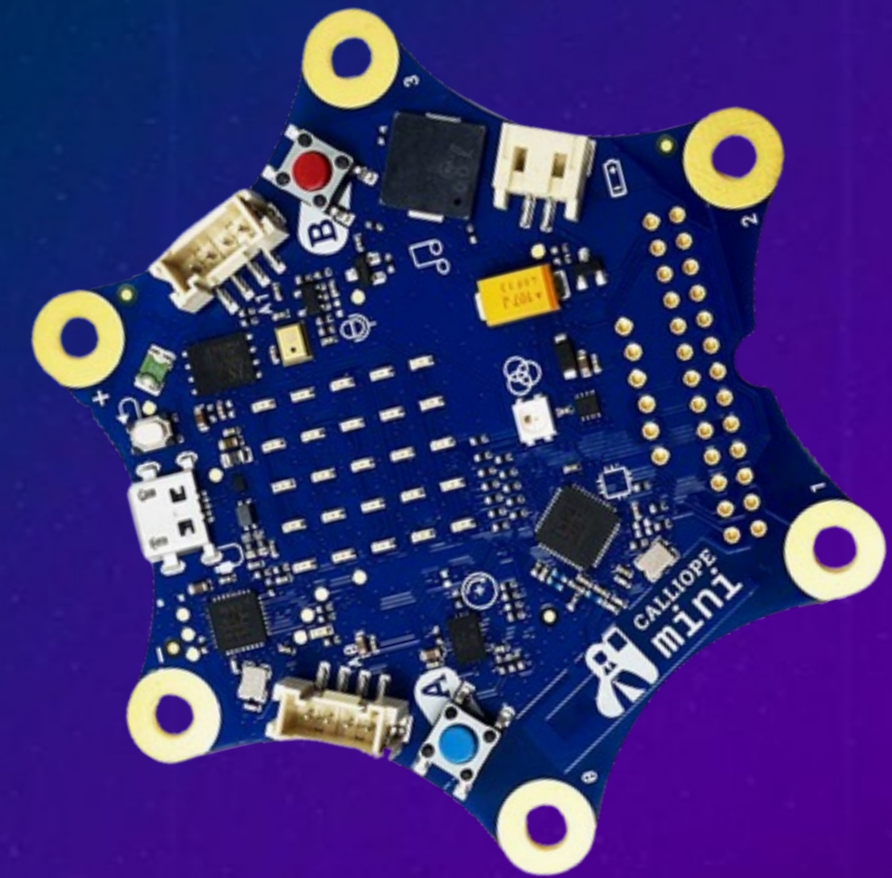
The mini-Calliope is a tiny controller which you can program in a easy and fun way. It has previously been used in a competition called Code4Space (<https://code4space.org>).

Used for:

- Easy programming
- STE(A)M activities
- Testbed
- Adaptable for all ages
- Crew interaction in Columbus

Cases of use:

- 5x5 LED / RGB LED
- Speaker
- Light sensors
- Microphone
- Location sensor
- Temperature sensor
- Accelerometer
- Infrared camera
- Standard spectrum camera
- And more...





MINI-CALLIOPE EDUCATION USE CASE

<https://code4space.org>



- Code4Space Calliope activity onboard the ISS conducted by ESA Astronaut Samantha Cristoforetti
- 'Space Bounce Ball' experiment designed and programmed by a group of 6th graders from Switzerland, winners of the Code4Space competition
- <https://www.youtube.com/watch?v=qy7qqzxe5Gc>





ICE CUBES SERVICE
MEDIASET EVENTS

EDUCATIONAL

- Educational **challenges or competitions**:
 - ESA Orbit Your Thesis – tertiary
 - AI in Space Challenge – secondary or tertiary
 - Code4Space – primary or secondary
 - Global Sustainability Space Challenge

Support in:

- Selection process
- Feasibility assessment
- Teams mentoring & workshops

- **MediaSet** interactive / inspirational events
- A “lesson from space” (show & tell)
- Interactive art in space

- Use a **cube “off-the-shelf”** & focus on **science**
 - Science Cube
 - Greenhouse
 - BioCube
 - Protein Crystallization Cube
- **Develop your own** & focus on space **engineering**
- **Demonstrate / validate technology**

- Executive **courses** / Space Academy
 - Through JV Metaspace
- Your own **Space Innovation Lab** at your university



ICECUBES
BY SPACE APPLICATIONS SERVICES

MEET THE MEDIA SET (ON-ORBIT)

The Media Set can be used as a Webcam for outreach with the crew, but also in connection with the AI-Box

Main missions:

- Support and monitoring of experiments
- Facilitate communication with the ground
- Astronaut interaction and assistance

Provides:

- Live or recorded events utilization
- Availability on demand
- Secure 'on-demand' private conversations capability

ICE CUBES Media Set





ICECUBES
BY SPACE APPLICATIONS SERVICES


ICE CUBES SERVICE

MEDIA SET EDUCATION USE CASE



Check out recordings:

- <https://youtu.be/qy7qqzxe5Gc>
- <https://vimeo.com/724817538>
- <https://www.youtube.com/watch?v=Xlpfl62UyDA>
- <https://www.icecubesservice.com/journal/ice-cubes-media-set-for-iss-interaction/>



ICE CUBES SERVICE
METASPACE
SPACE INNOVATION LABS
COURSES



EDUCATIONAL

- Educational **challenges or competitions**:
 - ESA Orbit Your Thesis – tertiary
 - AI in Space Challenge – secondary or tertiary
 - Code4Space – primary or secondary
 - Global Sustainability Space Challenge

Support in:

- Selection process
- Feasibility assessment
- Teams mentoring & workshops

- **MediaSet** interactive / inspirational events
- A “lesson from space” (show & tell)
- Interactive art in space

Space Innovation Courses

- Use a **cube “off-the-shelf”** & focus on **science**
 - Science Cube
 - Greenhouse
 - BioCube
 - Protein Crystallization Cube
- **Develop your own** & focus on space **engineering**
- **Demonstrate / validate technology**

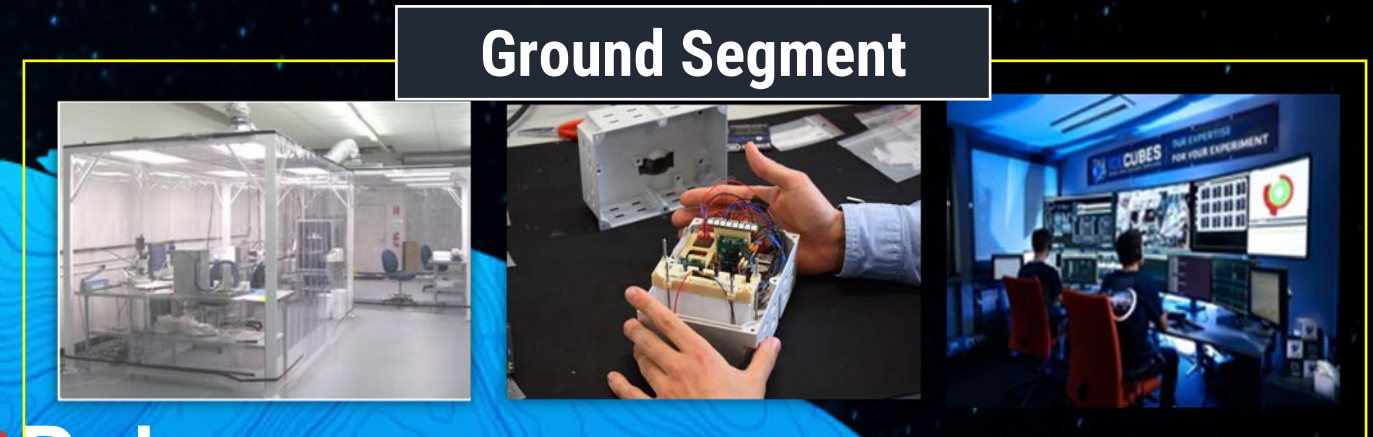
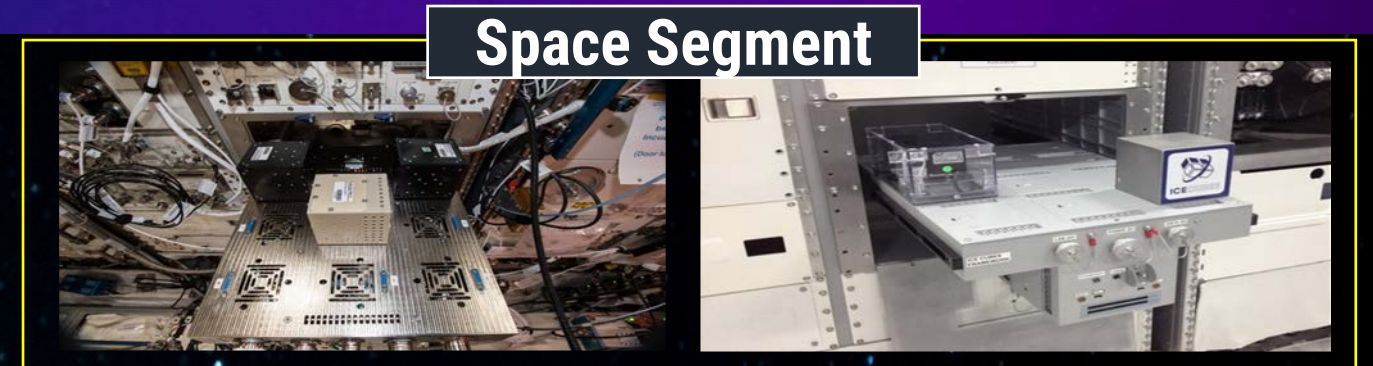
- Executive **courses** / Space Academy
 - Through JV Metaspaces
- Your own **Space Innovation Lab** at your university



SPACE INNOVATION LABS GLOBAL NETWORK

The global network of Space Innovation Labs (SILs) will benefit space exploration by sharing resources and expertise, collaborating on research and development, and pooling talent from different countries using the metaverse as ground tool.

SYNERGY:
Space Infrastructure
Ground infrastructure
Metaverse access



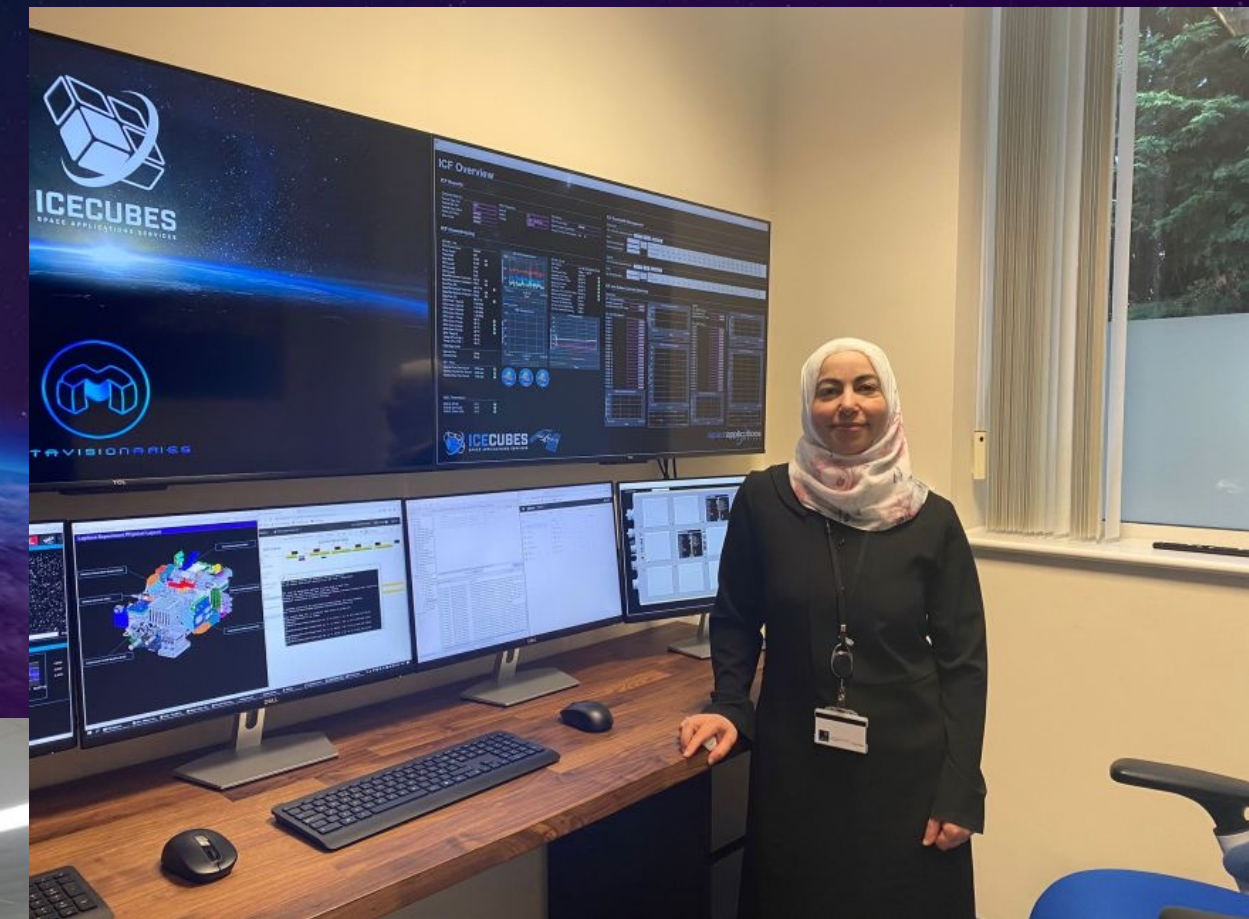
As of today, **10 Space Innovation Labs** initiated.
Our mission is to have by the year 2025, **25 SIL's** in every continent on Earth

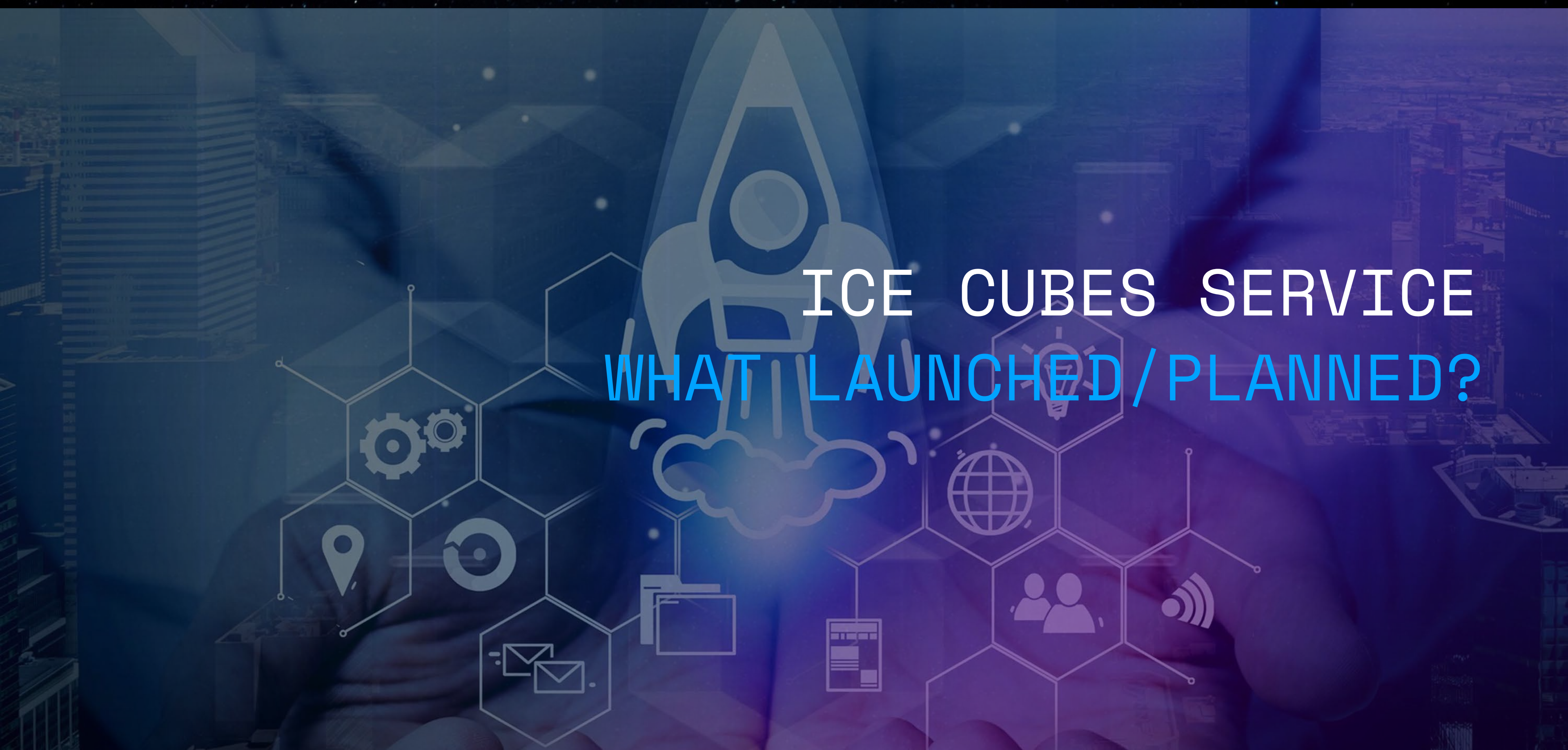
MALTA SPACE INNOVATION LAB:

- Malta I-II-III missions to ISS
- Diabetes
- Genetic study on Human Skin Microbiome samples

OXFORD SPACE INNOVATION LAB:

- Ageing
- Organoids
- Treatments

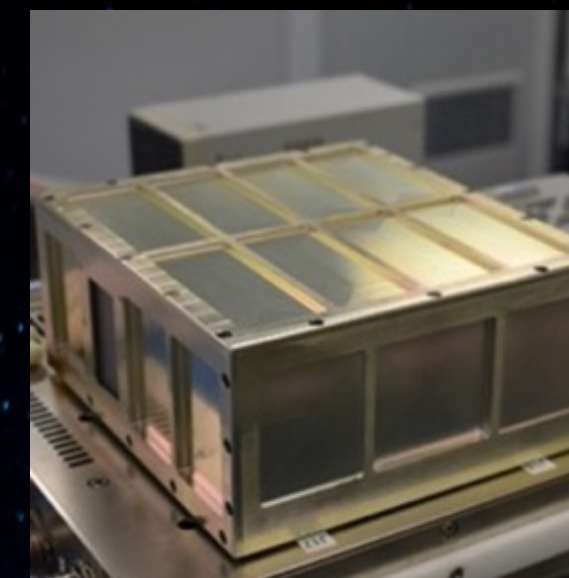




ICE CUBES SERVICE WHAT LAUNCHED / PLANNED?



ICE CUBES SERVICE WHAT LAUNCHED/PLANNED?



Greenhouse

<https://www.icecubeservice.com/journal/plants-engineered-to-bio-manufacture-specific-proteins/>

Art interactive

<https://www.icecubeservice.com/journal/interactive-kaleidoscopic-art/>

Biomining

Protein Crystallization

<https://www.icecubeservice.com/journal/service-kirara-high-quality-protein-crystallisation/>

Cybersecurity

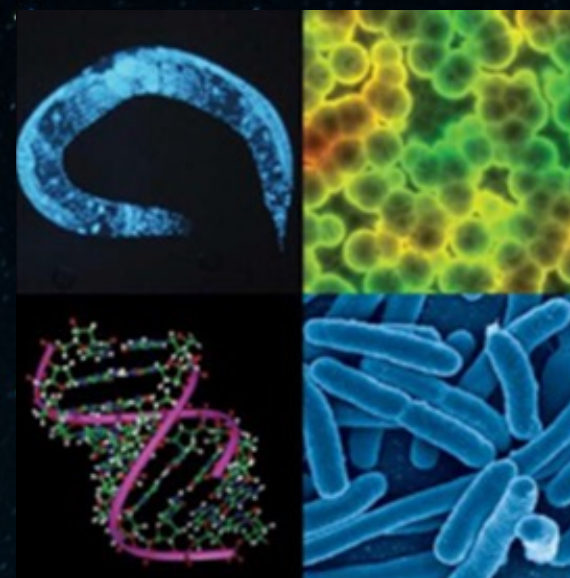
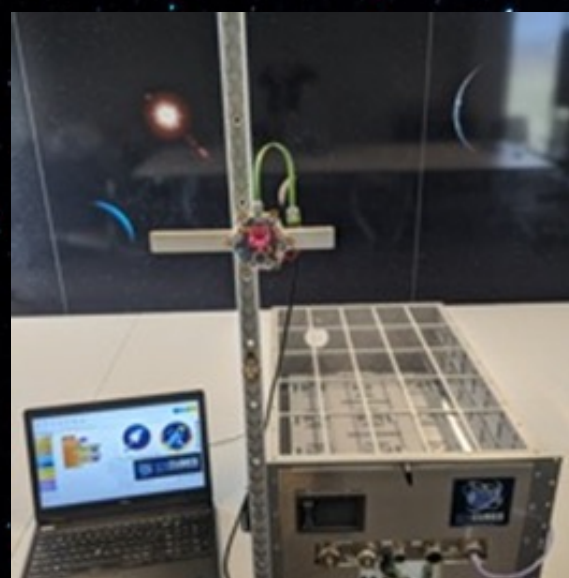
<https://www.icecubeservice.com/journal/cryptography-ice-cubes-esa/>

Spectrometer

<https://www.icecubeservice.com/journal/validating-uv-vis-spectrometer-for-exobiology/>



ICE CUBES SERVICE WHAT LAUNCHED/PLANNED?



Code4Space

<https://youtu.be/qy7q-qzxe5Gc>

MicroAlgae

<https://www.icecubes-service.com/journal/ax-3-stem-cells-microalgae-live-events/>

Genetic Study Diabetes

<https://www.icecubes-service.com/journal/gr-and-finale-to-the-maleth-trilogy/>

Banana disease

Fluid Physics in Microgravity

<https://www.icecubes-service.com/journal/gator-gatsby-fluid-physics-in-microgravity/>

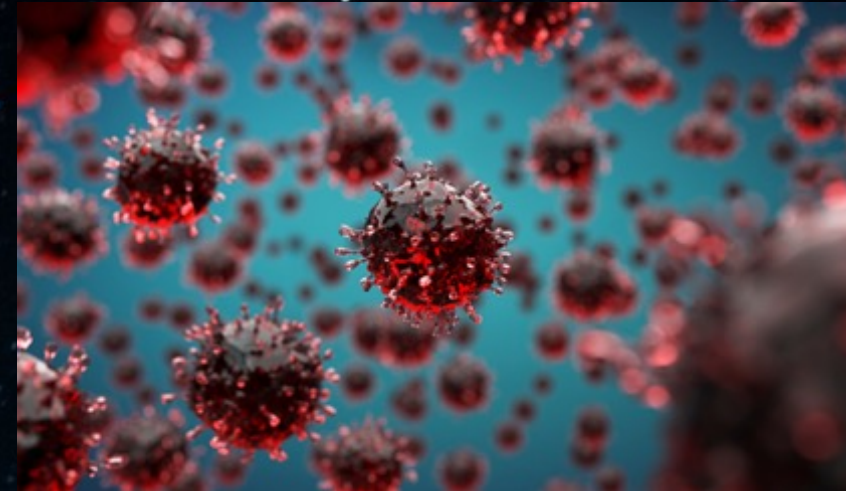
OscarQube diamond magnetometer

<https://www.icecubes-service.com/journal/journey-diamonds-to-space/>



ICE CUBES SERVICE WHAT LAUNCHED/PLANNED?

ICE CUBES SERVICE SUCCESS STORIES



First ever COVID drug research in space
Through protein crystallization service

<https://www.icecubesservice.com/journal/first-ever-covid-19-drug-research-in-space/>



Cow cells orbit Earth for high steaks
Through microfluidic Lab-on-chip

<https://www.icecubesservice.com/journal/cow-cells-orbit-earth-for-high-steaks/>



Genetics study on human skin microbiome
analyzing diabetic foot ulcer samples

<https://www.icecubesservice.com/journal/first-maltese-space-mission/>



ICECUBES
BY SPACE APPLICATIONS SERVICES

ICE CUBES SERVICE WHAT LAUNCHED/PLANNED?



New health monitoring apps for human spaceflight

Axiom-1 RAKIA

<https://www.icecubesservice.com/journal/axiom-1-rakia-new-health-monitoring-apps-for-human-spaceflight/>



First ever Cellulose Synthesis in Space

Through protein crystallization service

<https://www.icecubesservice.com/journal/cellulose-synthesis-in-space/>



Stress and DNA damage response during Spaceflight

Through microfluidic Lab-on-chip

<https://www.icecubesservice.com/journal/axiom-1-rakia-stress-and-dna-damage-response-during-spaceflight/>

**ICE CUBES
SERVICE
SUCCESS
STORIES**



ICECUBES
BY SPACE APPLICATIONS SERVICES

Space Applications Services NV/SA
Leuvensesteenweg 325
1932 Sint-Stevens-Woluwe
(Brussels area)
BELGIUM

WWW.ICECUBESSERVICE.COM
ICECubes@spaceapplications.com
[@ICECubesService](https://www.instagram.com/ICECubesService)

WWW.SPACEAPPLICATIONS.COM
WWW.AEROSPACEAPPLICATIONS-NA.COM



ICE CUBES SERVICE
WHAT CAN WE ACCOMMODATE?

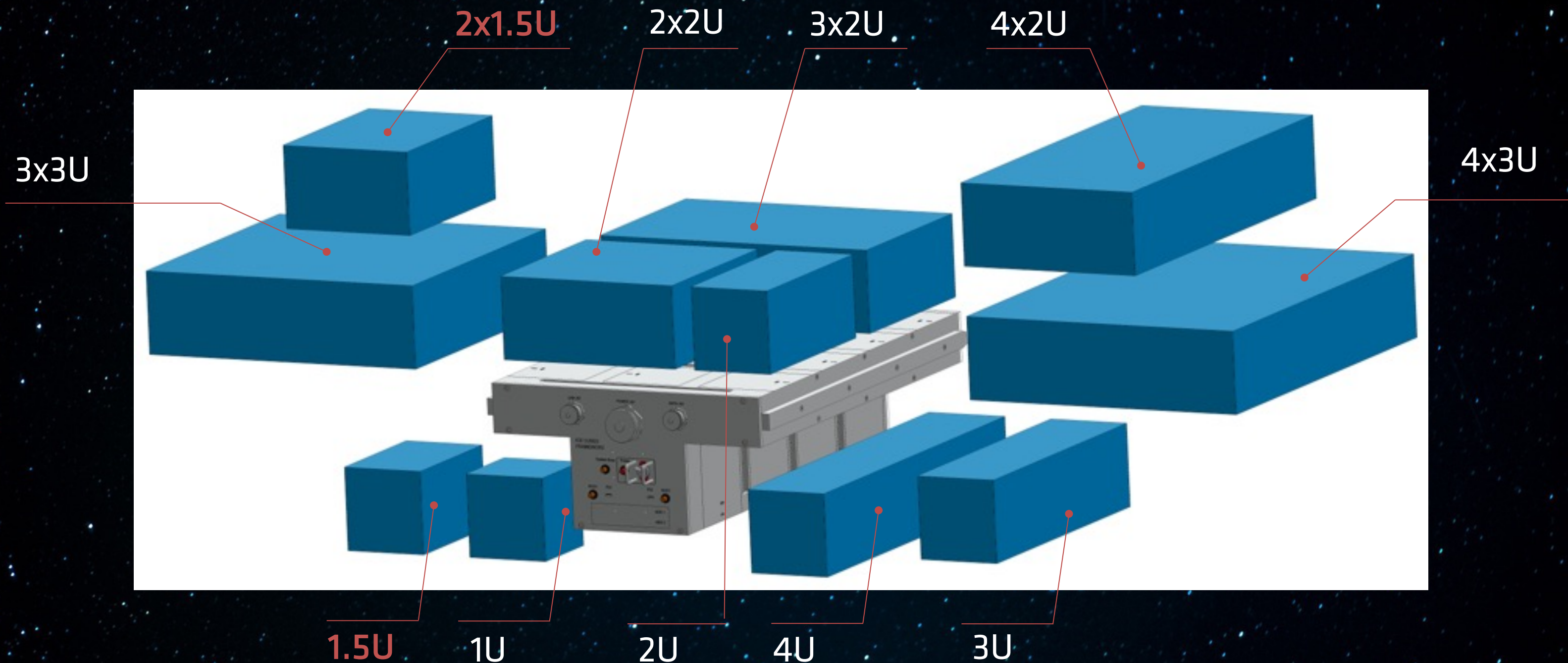
ICE CUBES SERVICE

WHO ARE WE?



ICECUBES
BY SPACE APPLICATIONS SERVICES

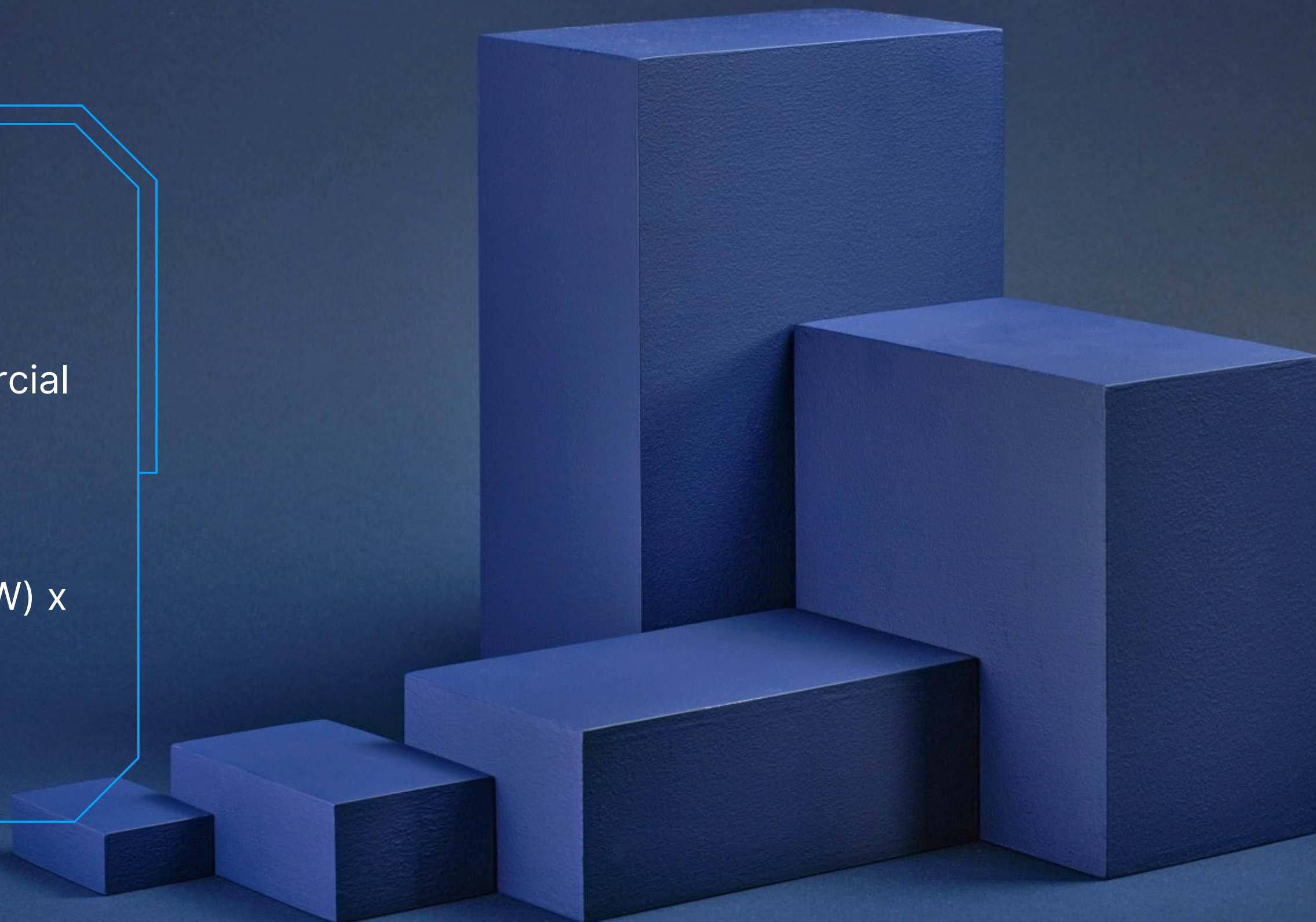
The Experiment Cubes are standardized plug-and-play research modules
Basic size: U=10x10x10 cm ... but **11x12x6 cm or a cylinder!**





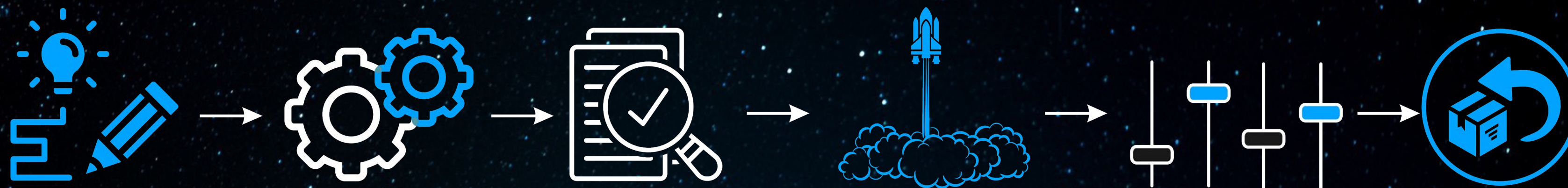
EXPERIMENT CUBES

- Cubes or modules
- "Plug & Play" experiment cubes
- Possibility to be built with commercial off-the-shelf components
- Easy installation
- Automation
- Volume in the facility: ~up to 38 (W) x 28 (H) x 58 (D) cm





ICE CUBES SERVICE EDUCATIONAL



- Scientific Ideation
- Feasibility study (business & technical)

- Experiment H/W selection & development

- Safety review
- Transportation documents
- Operations
- Testing
- Integration

- Transport to launch site
- Launch preparation & launch
- Late delivery to launch site

- On-board operations
- Ground control - real-time command & control

- Samples retrieval
- Transport to customer's site

End-to-end service menu or a la carte

ICE CUBES SERVICE

Typical mission profile



ICECUBES
BY SPACE APPLICATIONS SERVICES

6 weeks to 4 months

