



# ICE CUBES SERVICE

## US EDUCATIONAL

March, 2024



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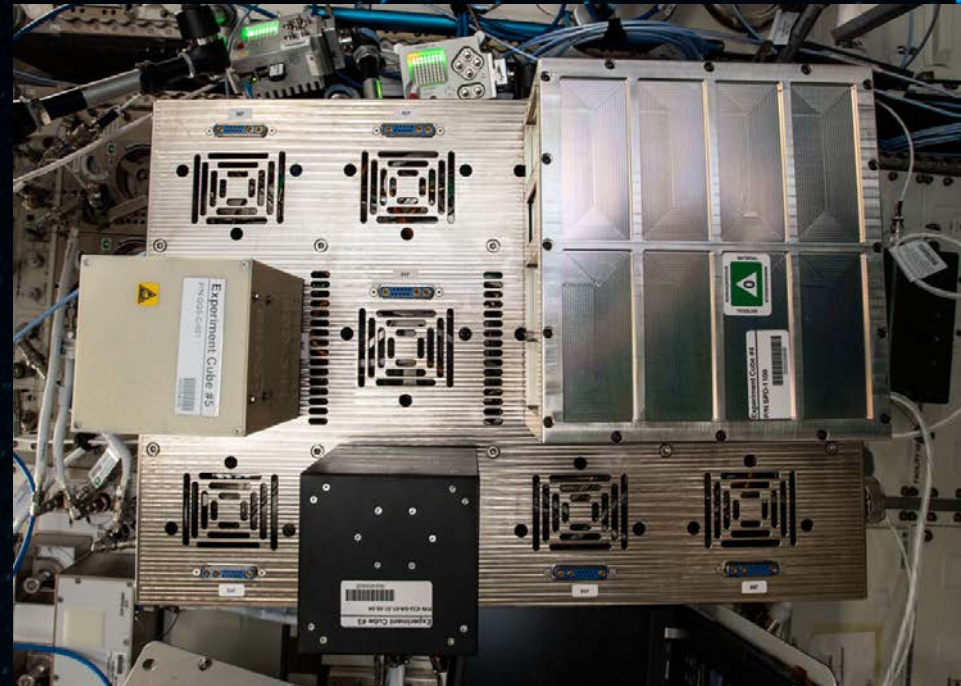
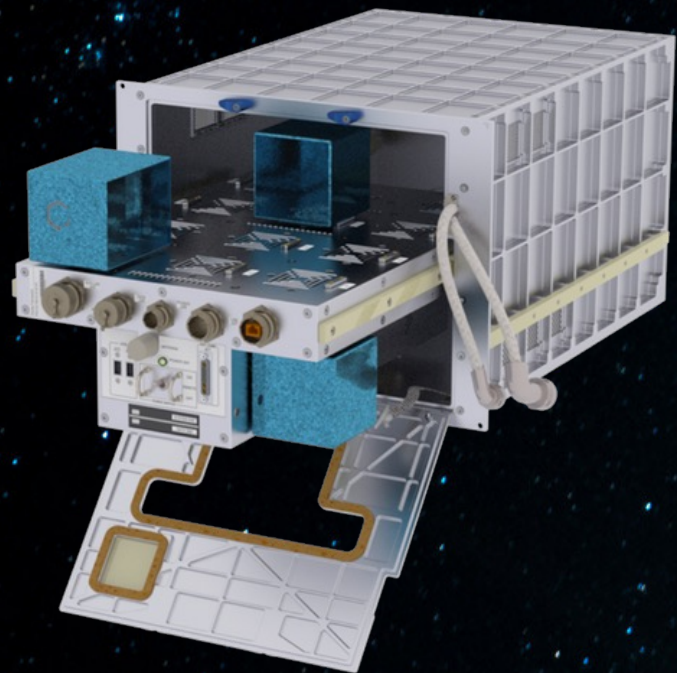
# ICE CUBES SERVICE WHO ARE WE?

## ICE CUBES SERVICE

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

### 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

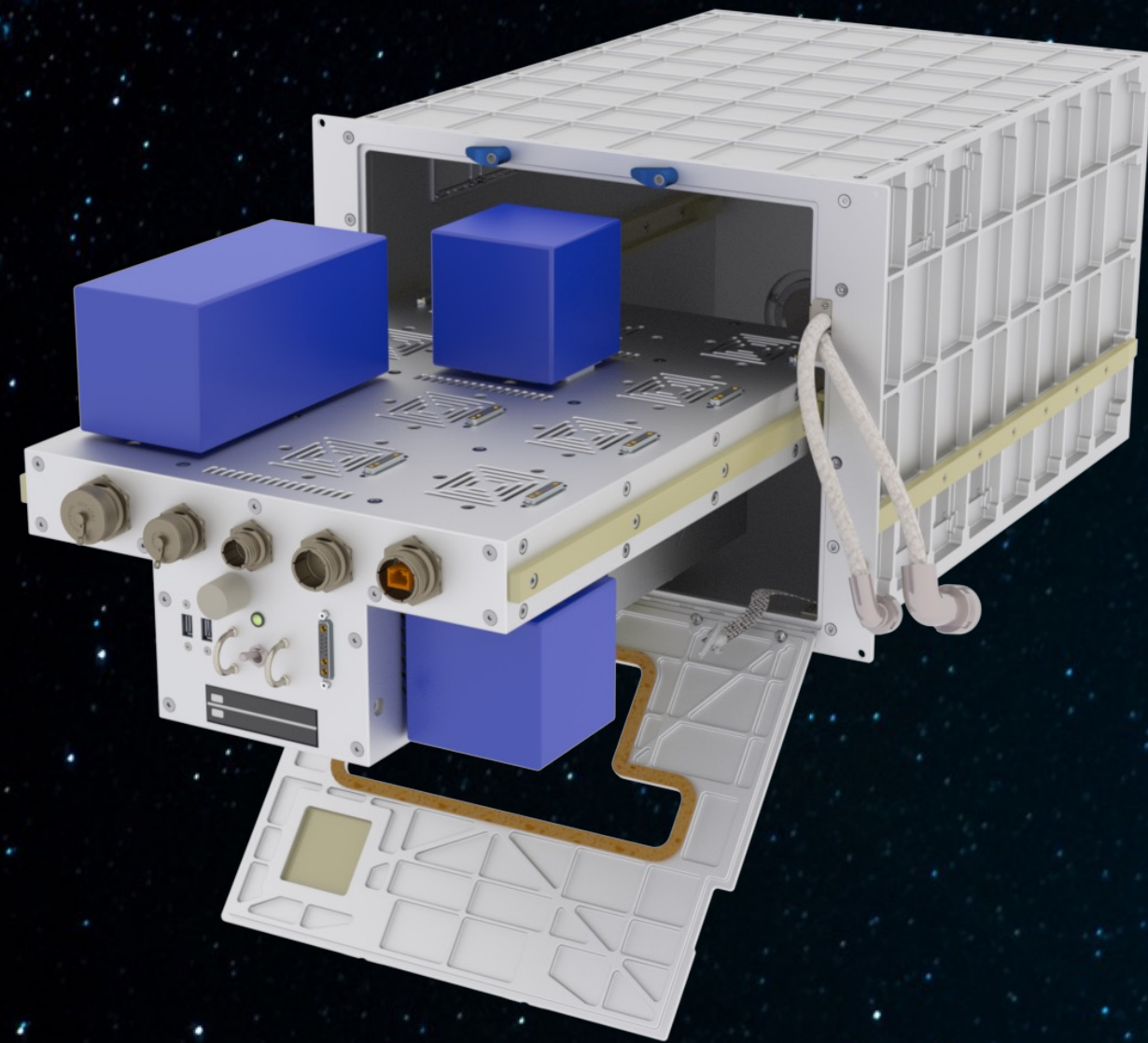


# ICE CUBES SERVICE

## WHO ARE WE?



## ICE CUBES Models

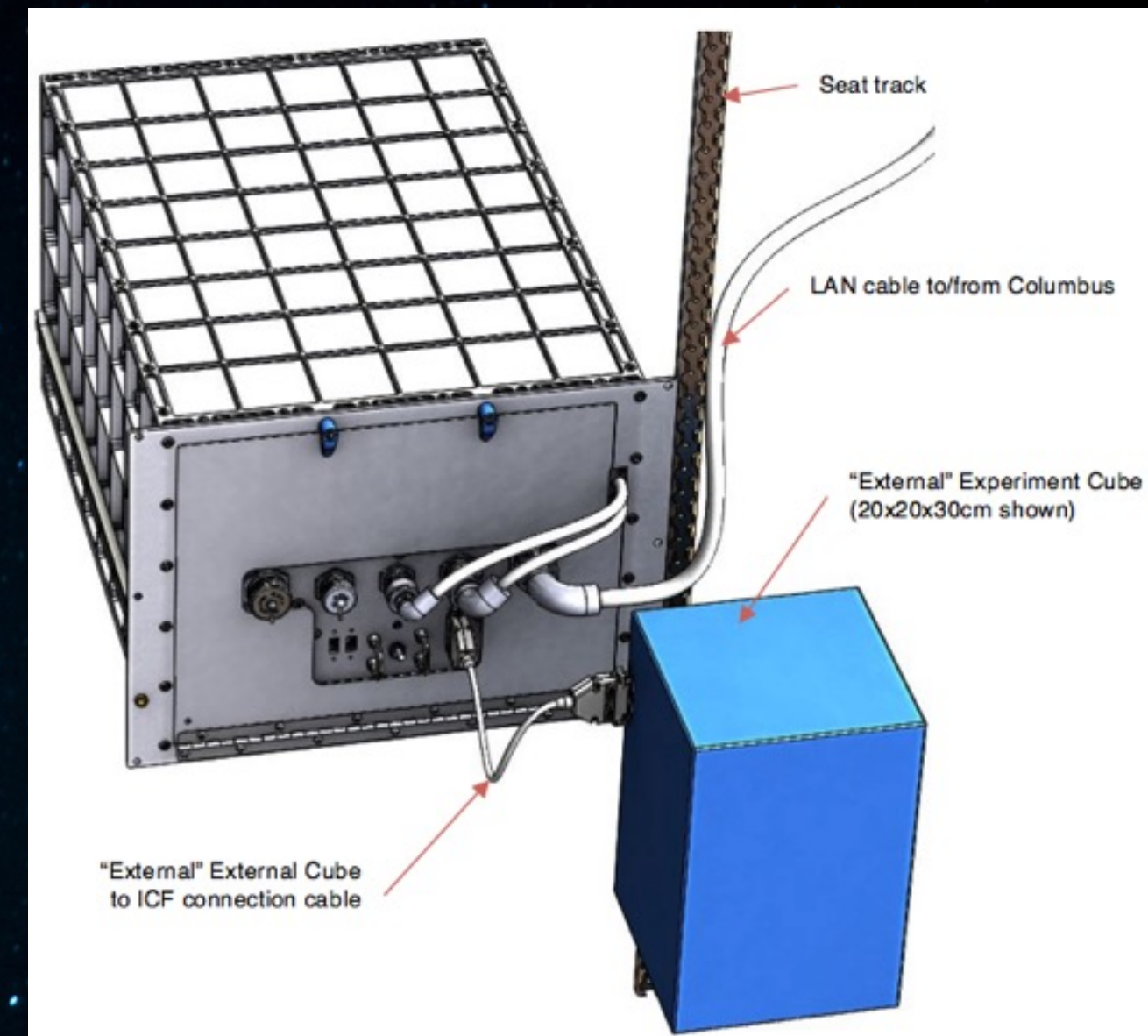


Wired Cubes  
(plug&play)

Wireless  
Cubes

Aisle payloads

... and crew interaction  
applications





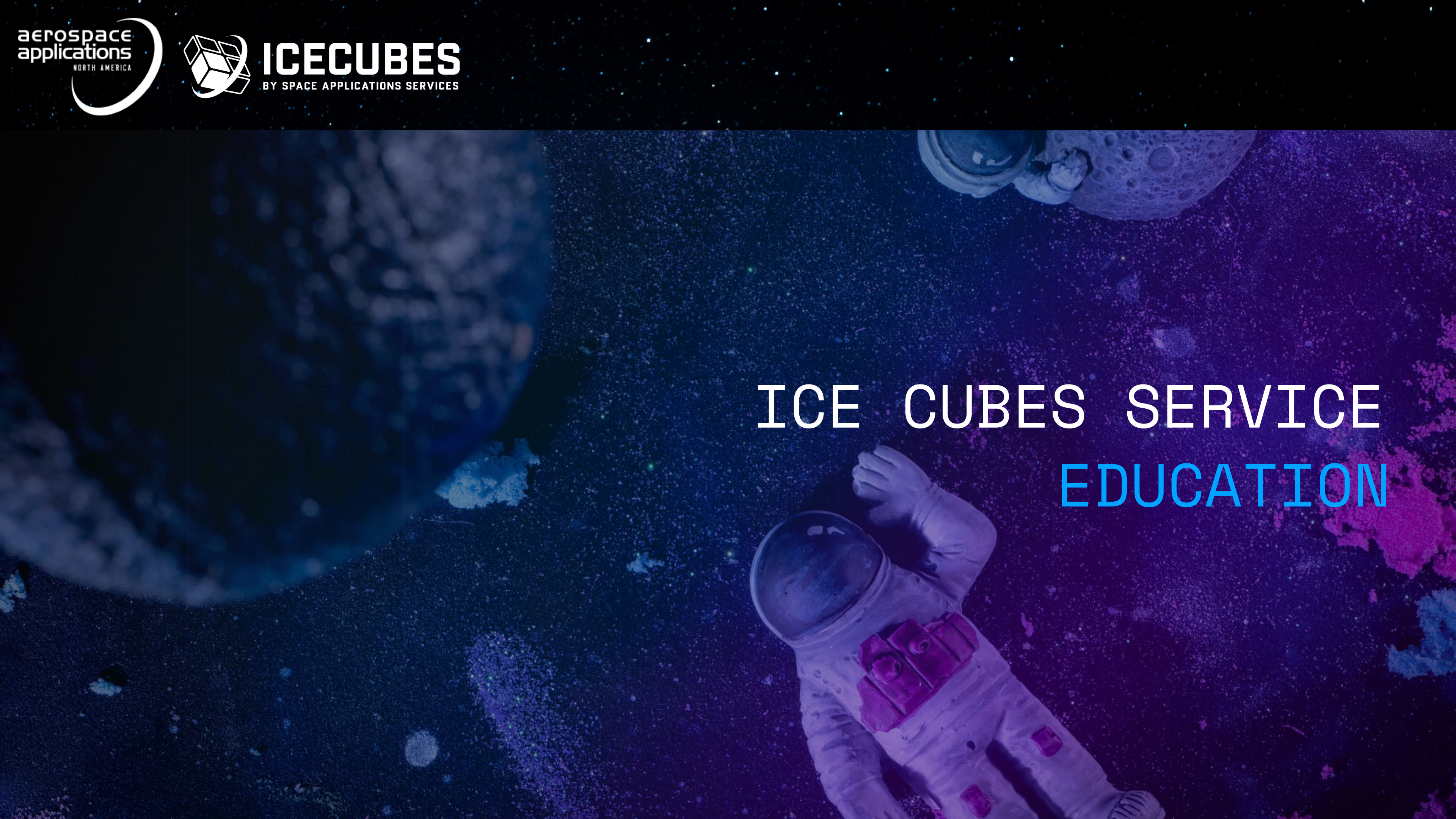
## ICE CUBES SERVICE CHARACTERISTICS

- 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](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

# 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





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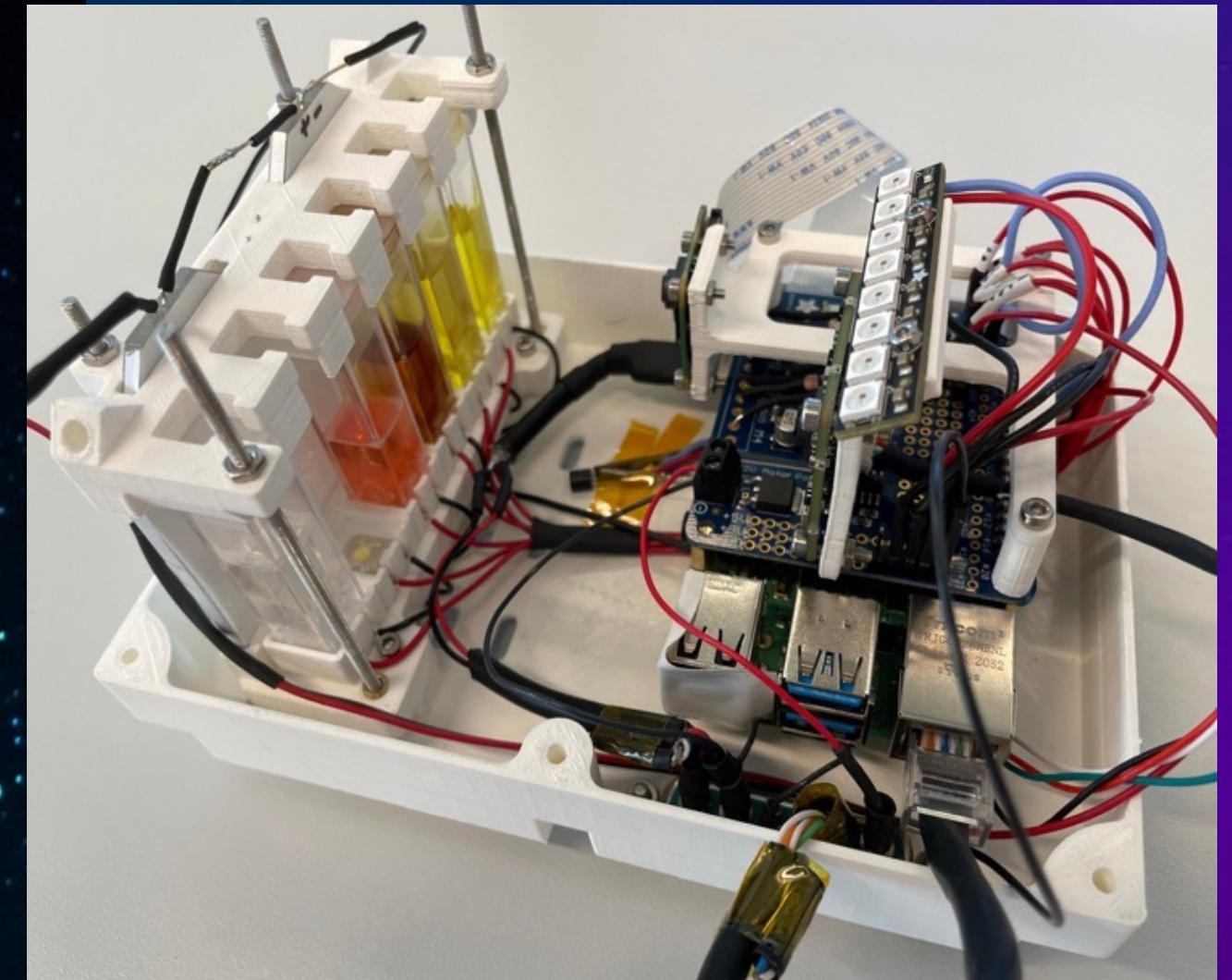
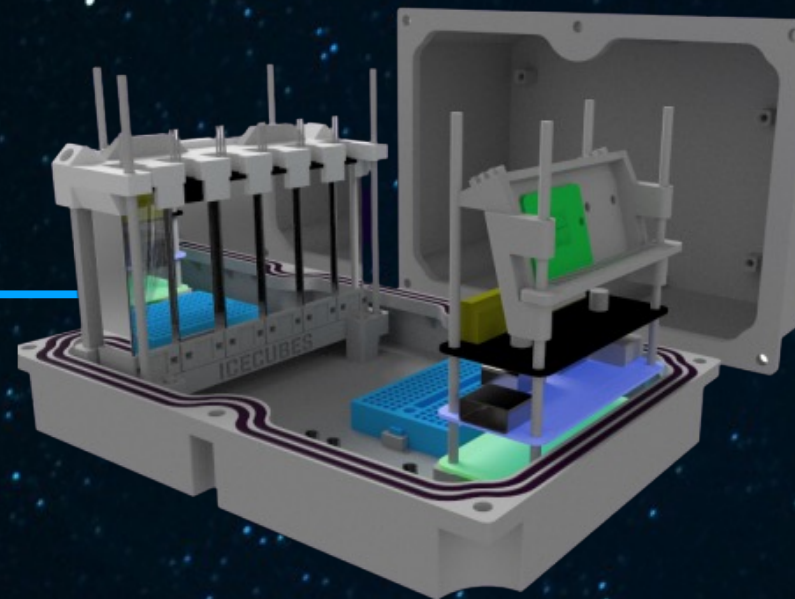


**ICE CUBES SERVICE**  
**MEET CUBES “OFF-THE-SHELF”**



# 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:

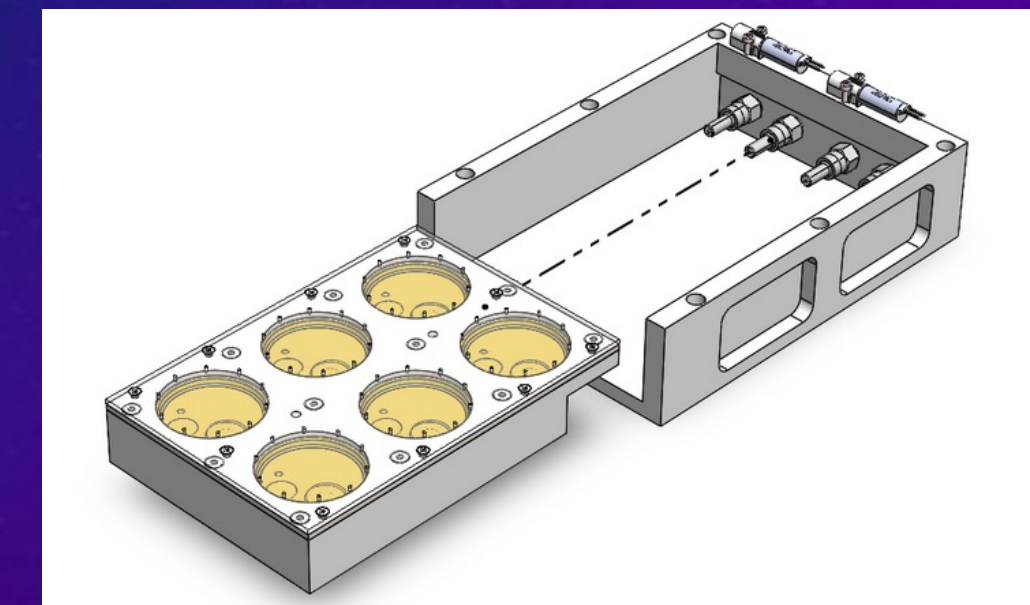
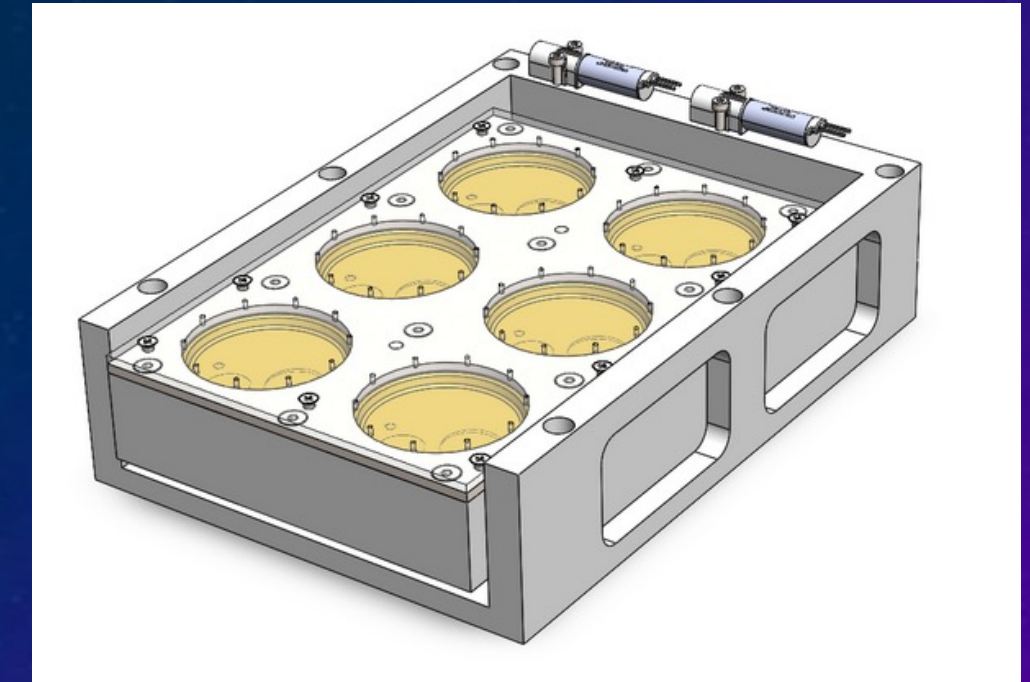
- Consists of one reservoir, one containing only water, estradiol and MS Salts
- White, blue and red LEDs
- Thermistor
- DC Converter
- Camera
- Feed-Through Connector





## MEET THE **BIO CUBE**

- 6-well plate (or 24-well or chips-plate)
- Temperature control at  $37 \pm 1^\circ\text{C}$  samples
- Temperature control at  $+4^\circ\text{C}$  for medium / fixative
- Regular Medium refreshments
- Fixation capability
- Exhausted medium collection in different bags
- Medical test compounds (soluble in the medium)
- Diagnostics (Optical observation, pH, temperature)
- 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:

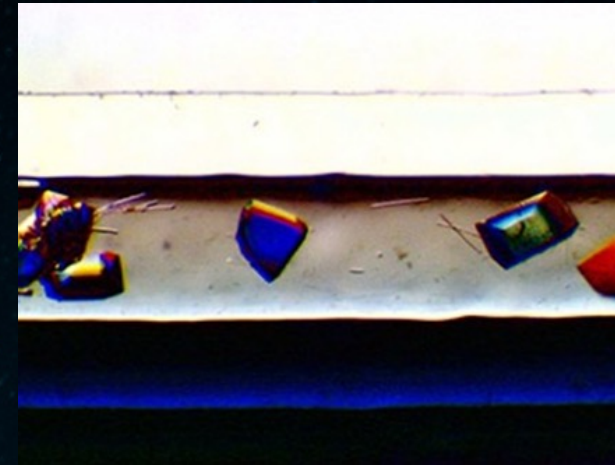
- Space missions and space sciences
- Crystallisation processes and techniques on Earth and in space

**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





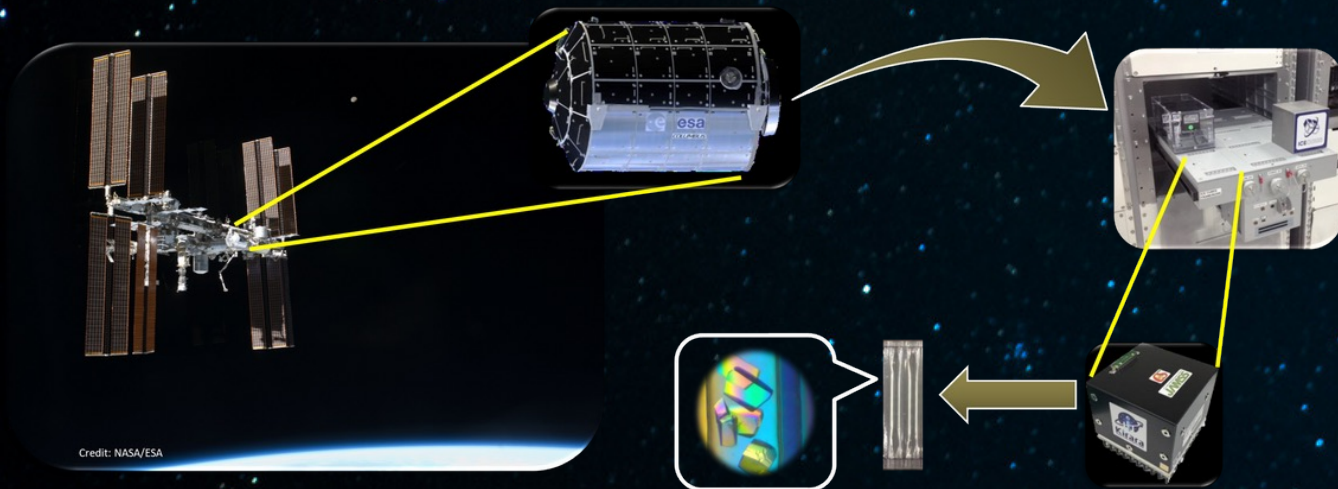
# KIRARA EDUCATION USE CASE

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**:
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## Support in:

- Selection process
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# Assets, Challenges & Competitions

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- **Develop your own** & focus on space **engineering**
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# 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.

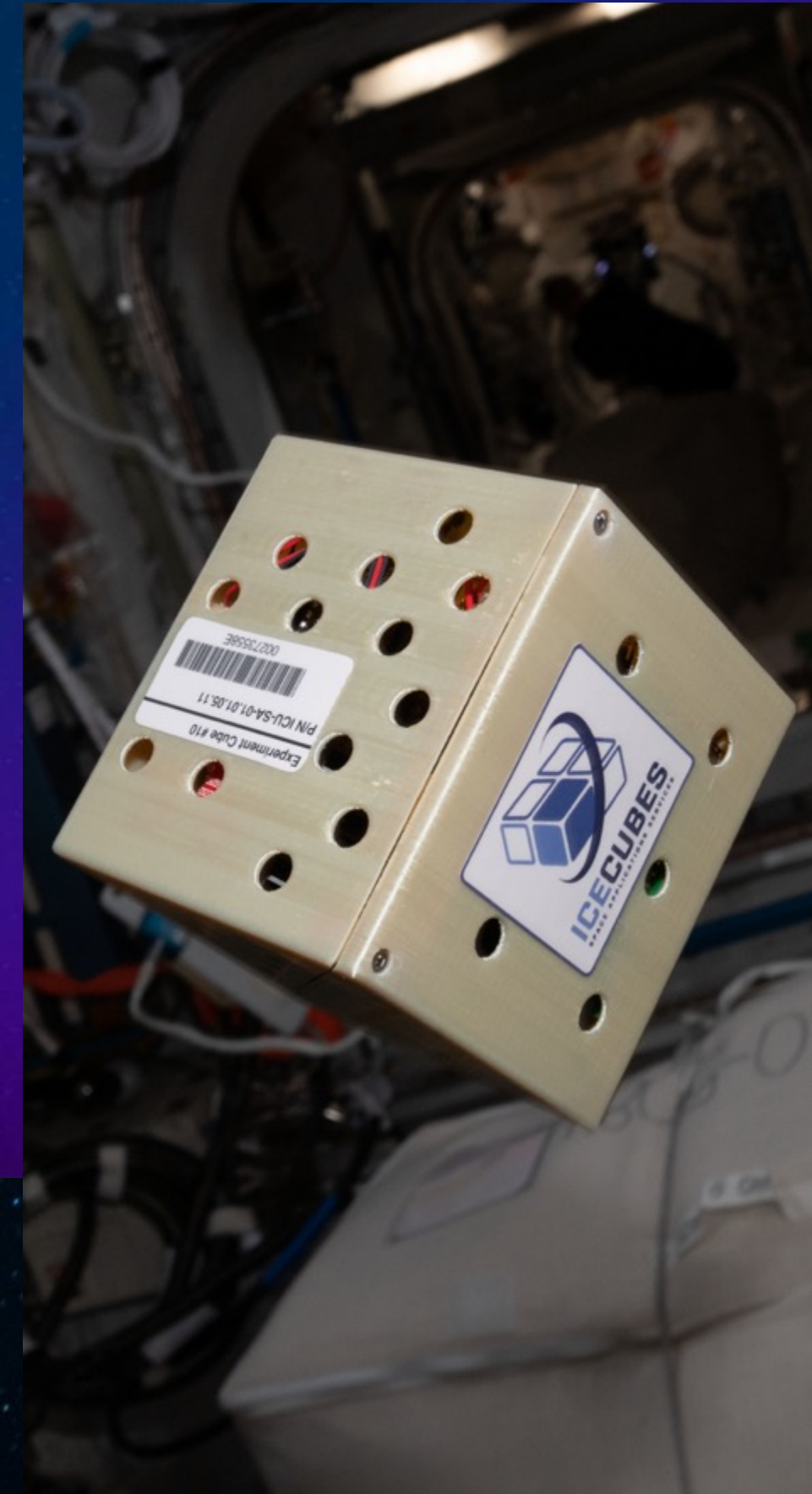
## Used to:

- 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



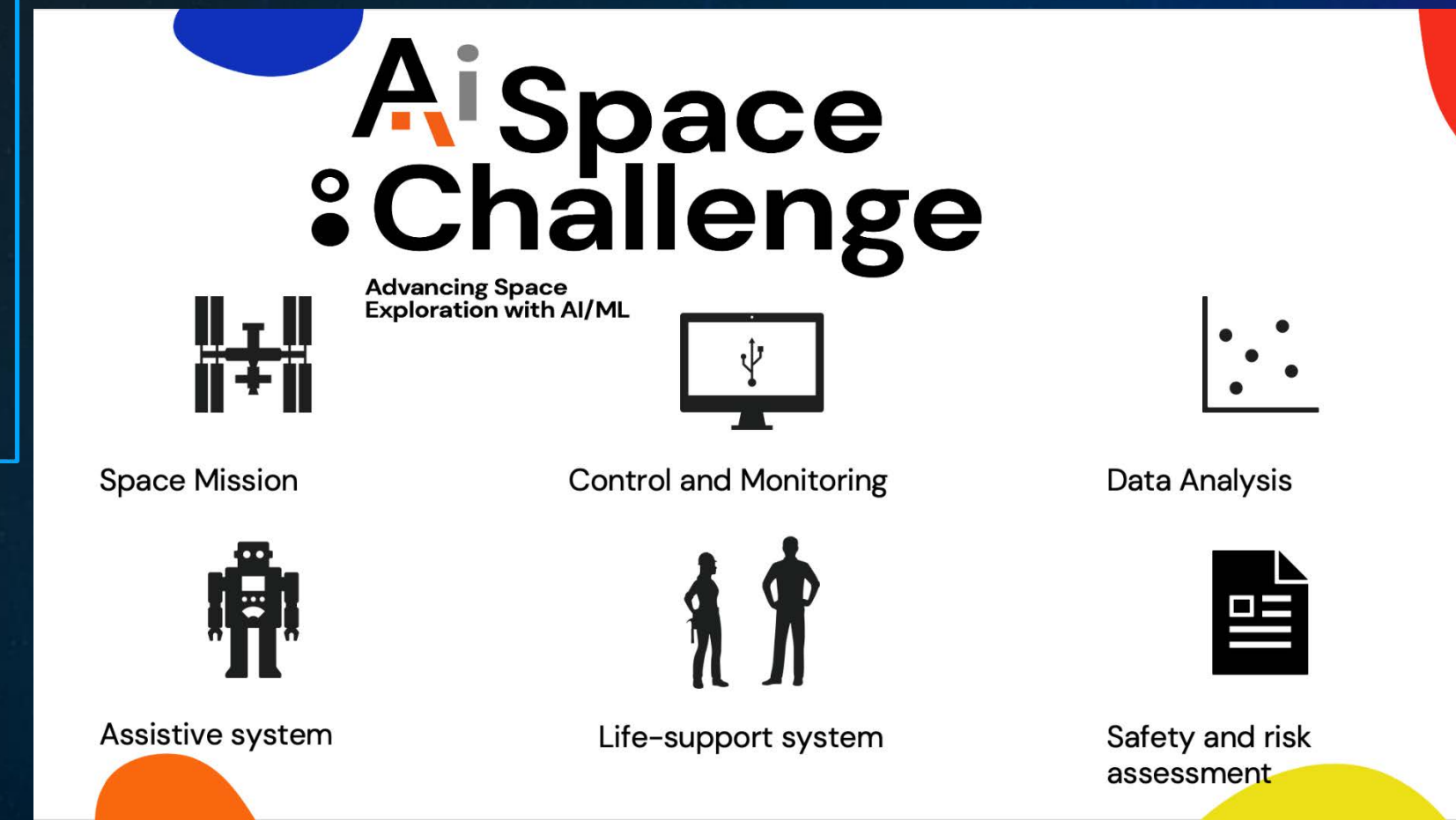


## AI BOX EDUCATION USE CASE

- 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**

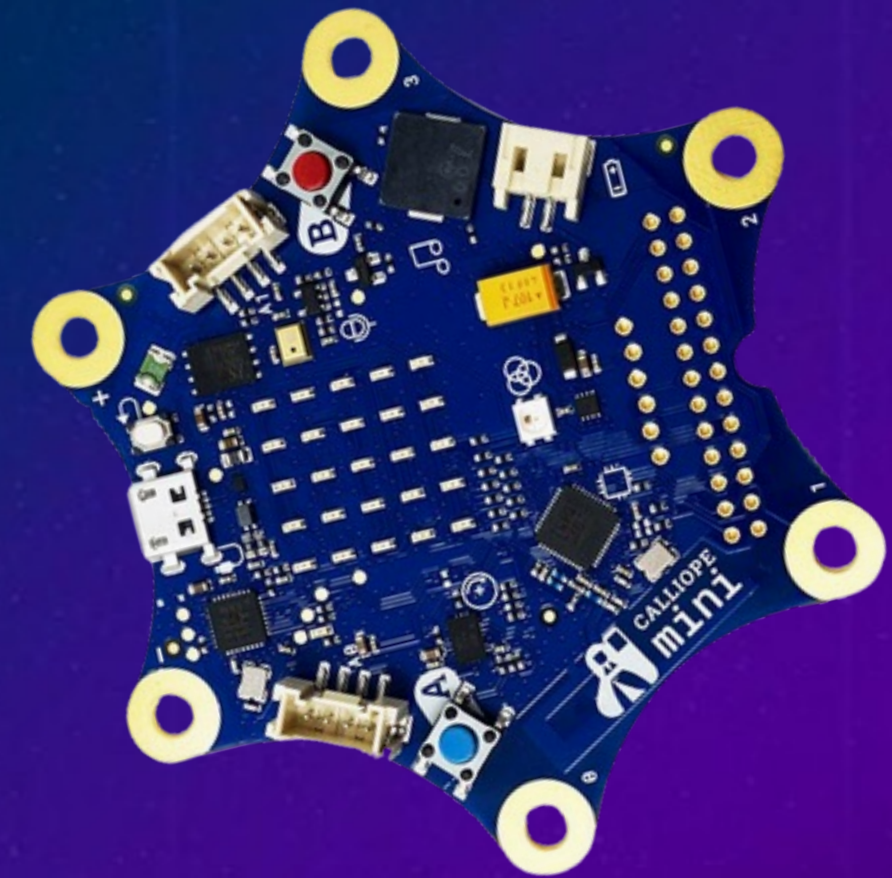
The mini-Calliope is a tiny controller which you can program in a easy and fun way. It has previously been used in a competition called Code4Space (<https://code4space.org>).

## Used for:

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

## Cases of use:

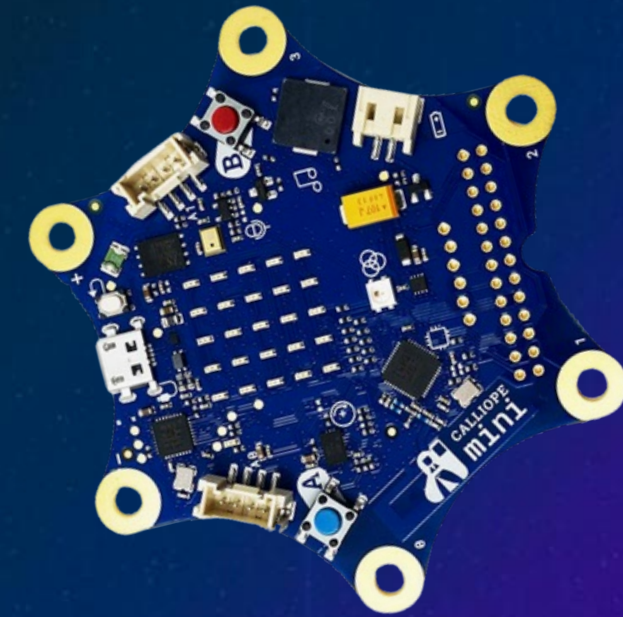
- 5x5 LED / RGB LED
- Speaker
- Light sensors
- Microphone
- Location sensor
- Temperature sensor
- Accelerometer
- Infrared camera
- Standard spectrum camera
- And more...





## 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**:
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### Support in:

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# 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







## 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





**ICE CUBES SERVICE**  
**METASPACE**  
**SPACE INNOVATION LABS**  
**COURSES**



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## Support in:

- Selection process
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- **MediaSet** interactive / inspirational events
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# Space Innovation Courses

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- **Develop your own** & focus on space **engineering**
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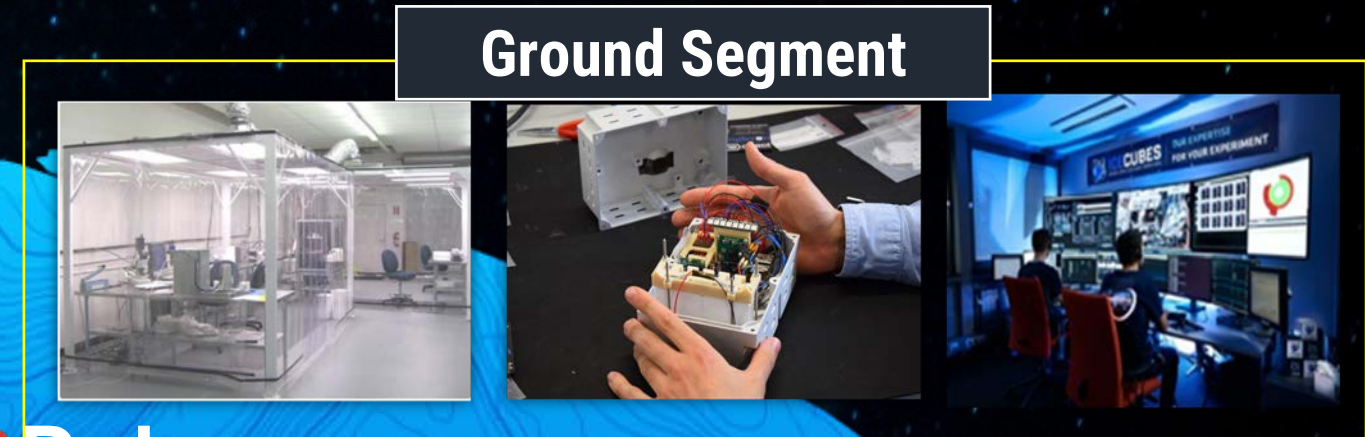
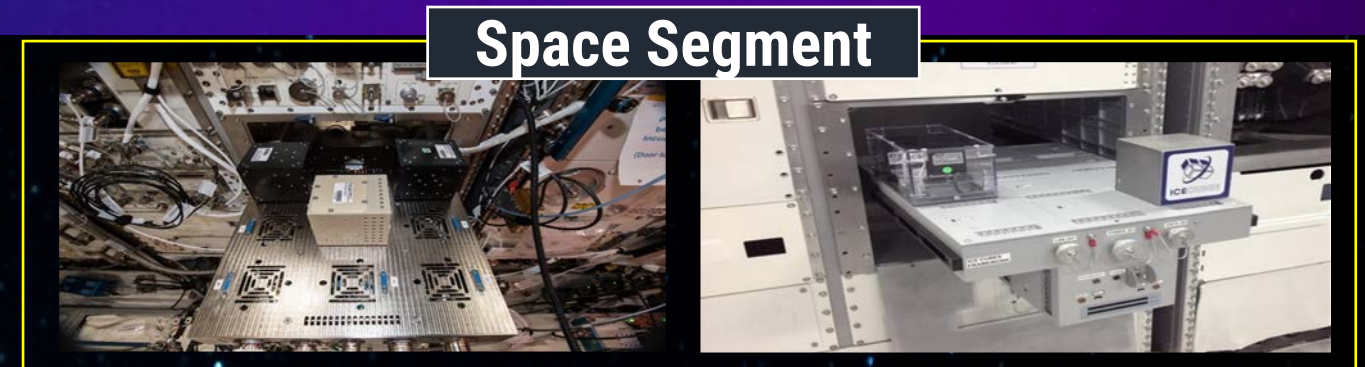
- Executive **courses** / Space Academy
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# SPACE INNOVATION LABS GLOBAL NETWORK

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



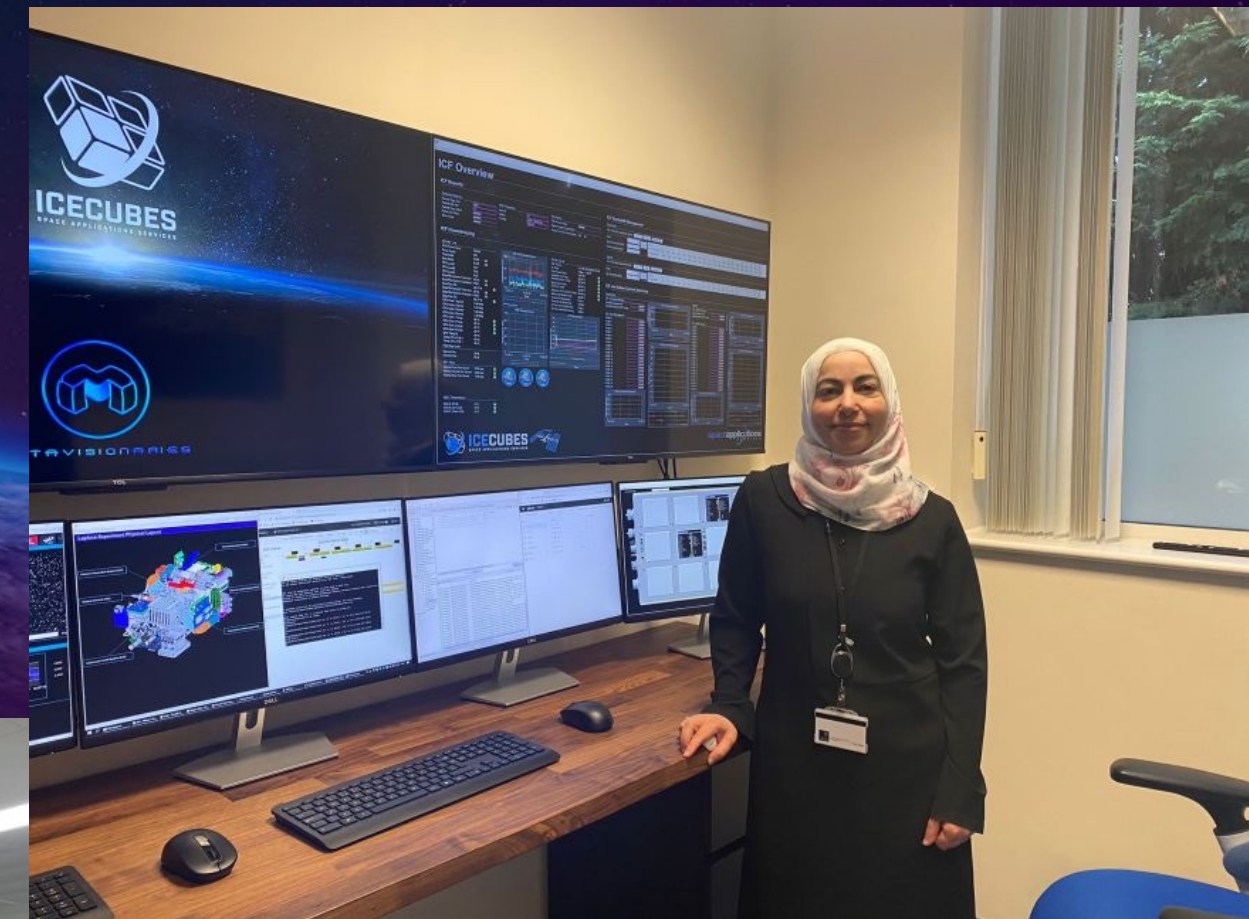
As of today, 10 Space Innovation Labs initiated. Our mission is to have by the year 2025, 25 SIL's in every continent on Earth


**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

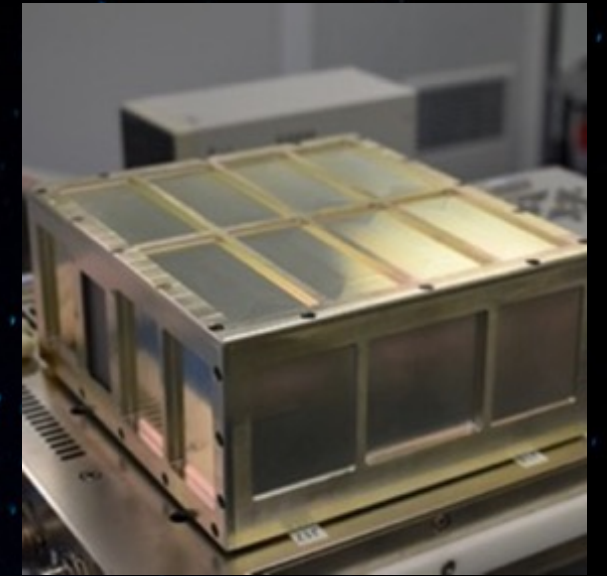
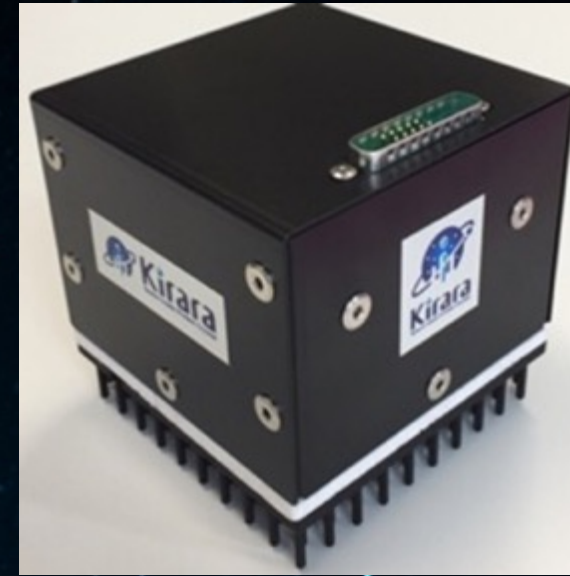
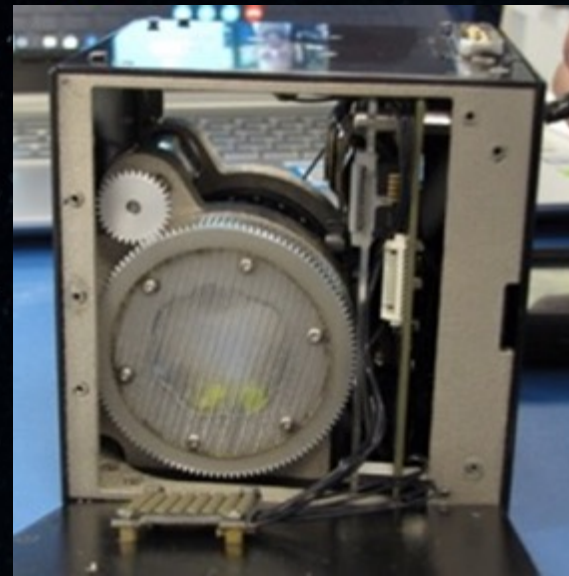




# ICE CUBES SERVICE WHAT LAUNCHED / PLANNED?



# 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

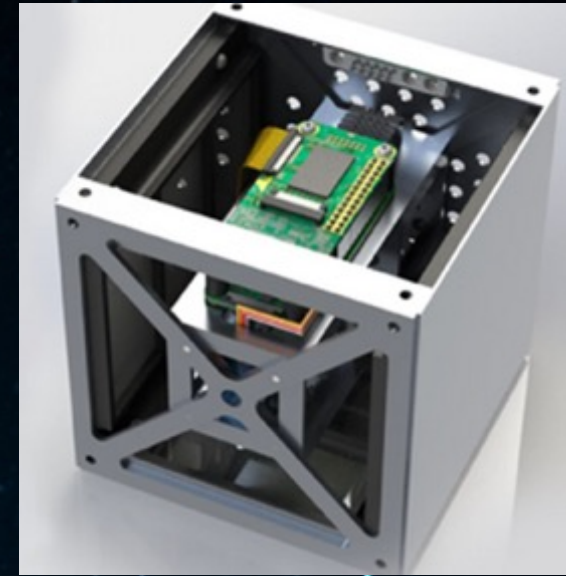
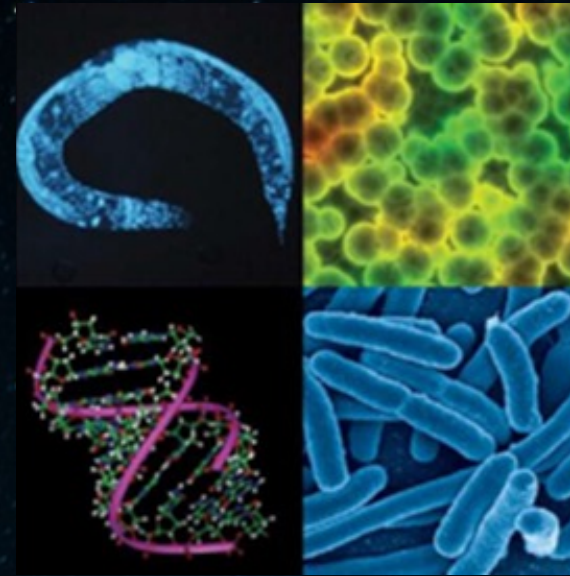
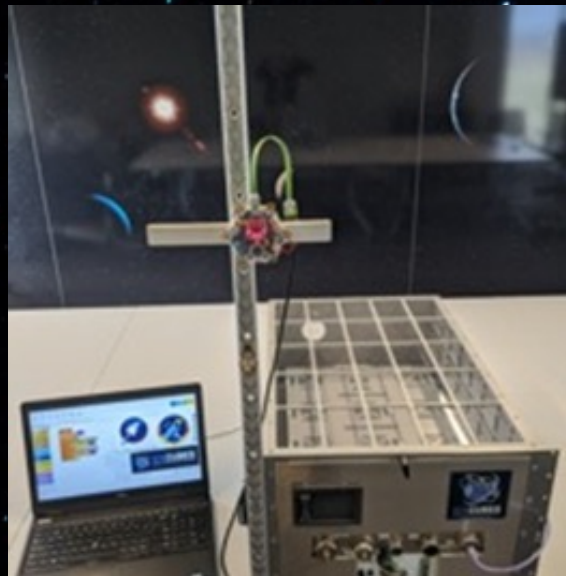
<https://www.icecubeservice.com/journal/cryptography-ice-cubes-esa/>

## 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.icecubeservice.com/journal/ax-3-stem-cells-microalgae-live-events/>

## Genetic Study Diabetes

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

## Banana disease

## Fluid Physics in Microgravity

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

## OscarQube diamond magnetometer

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

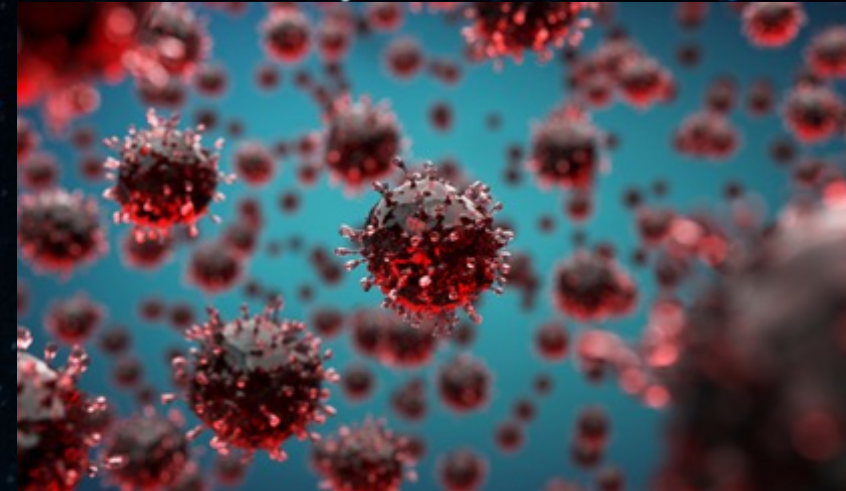




**ICECUBES**  
BY SPACE APPLICATIONS SERVICES

# 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



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[@ICECubesService](https://www.instagram.com/ICECubesService)

[WWW.AEROSPACEAPPLICATIONS-NA.COM](http://WWW.AEROSPACEAPPLICATIONS-NA.COM)  
[WWW.SPACEAPPLICATIONS.COM](http://WWW.SPACEAPPLICATIONS.COM)



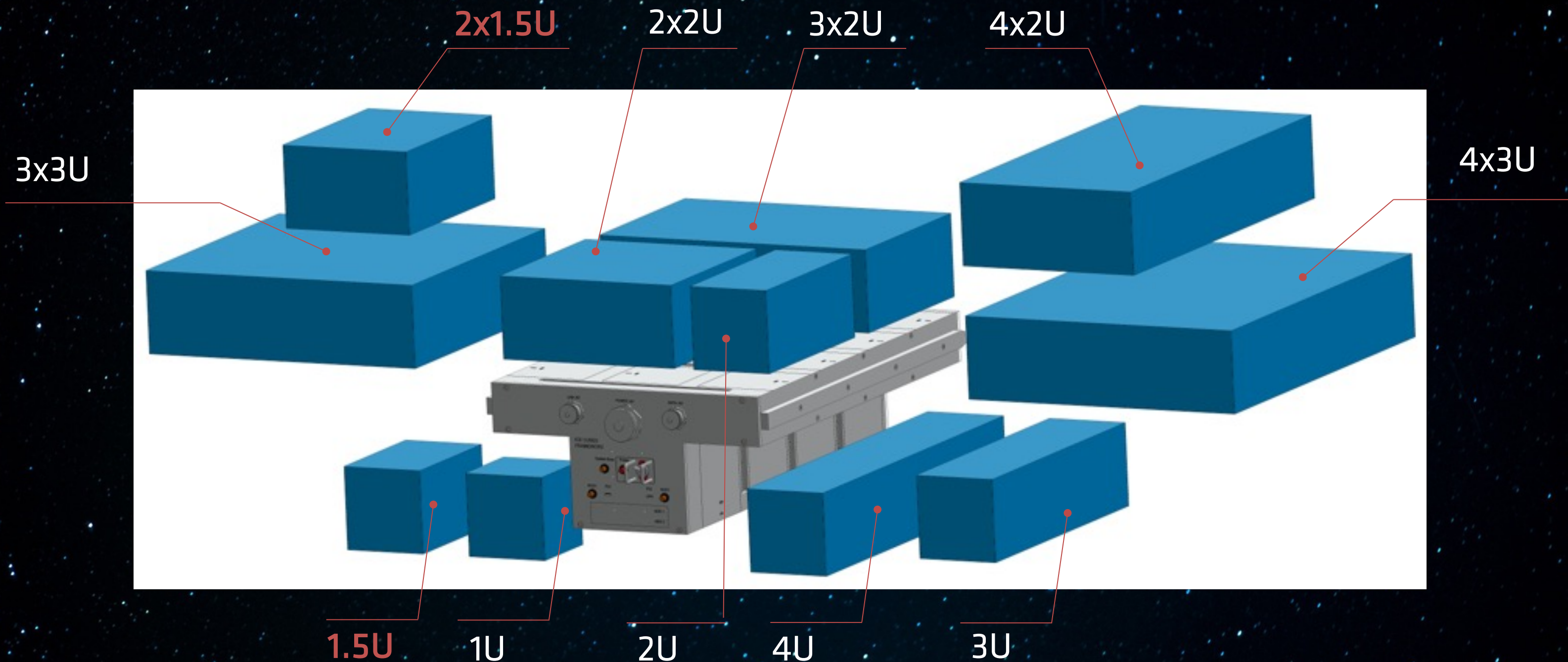
**ICE CUBES SERVICE**  
**WHAT CAN WE ACCOMMODATE?**

# ICE CUBES SERVICE

## WHO ARE WE?



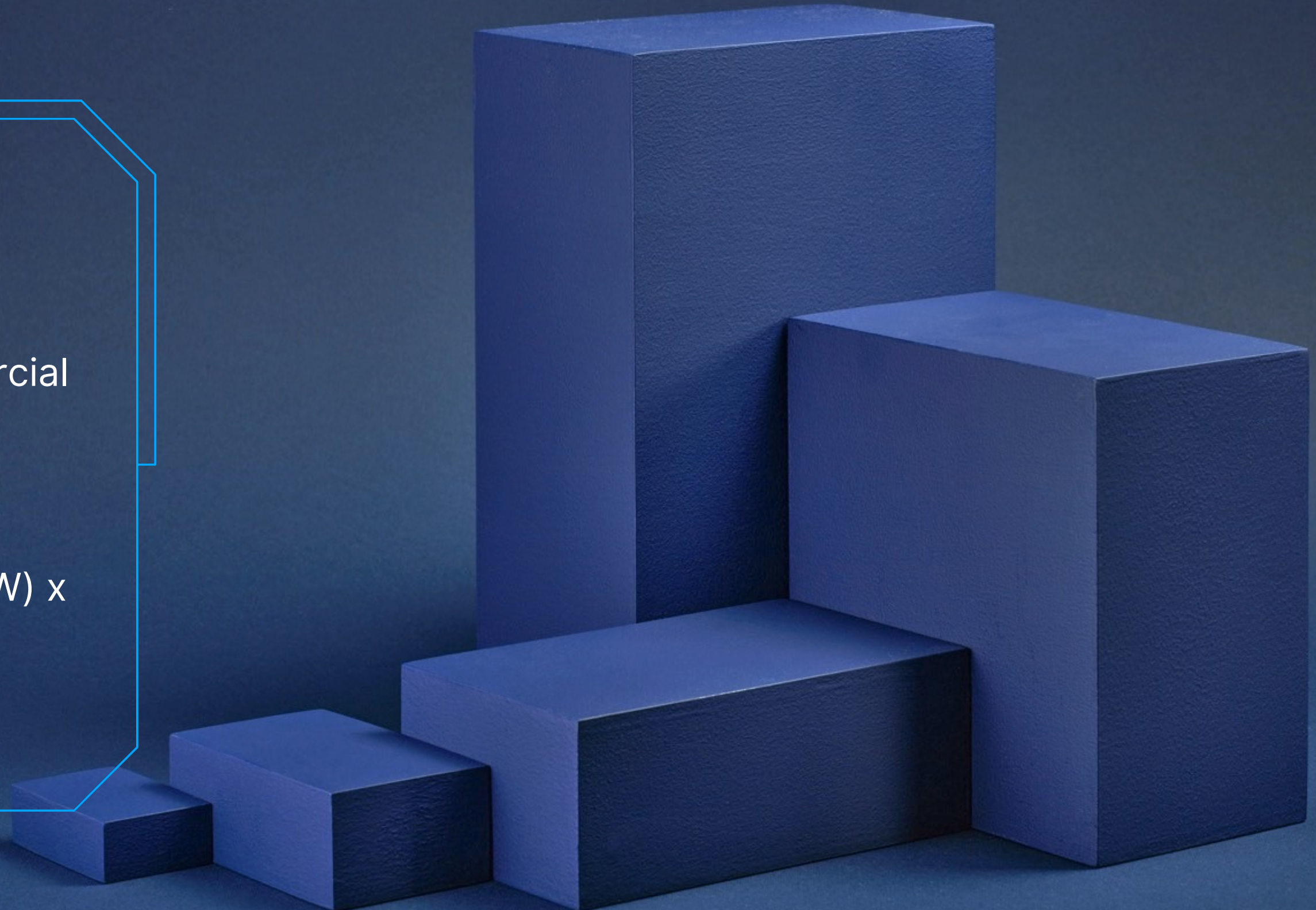
The Experiment Cubes are standardized plug-and-play research modules  
Basic size: U=10x10x10 cm ... but **11x12x6 cm or a cylinder!**





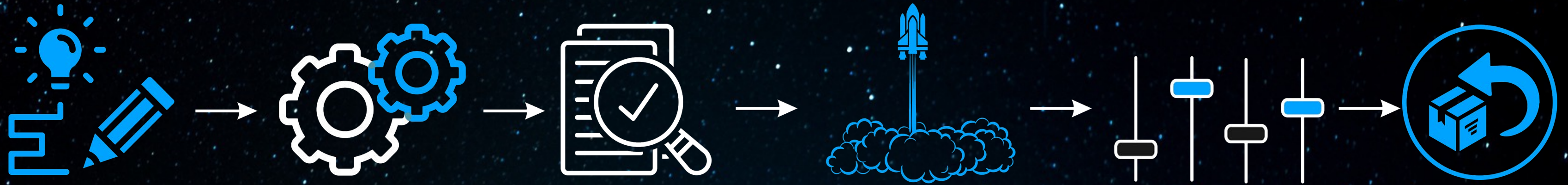
## EXPERIMENT CUBES

- 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



6 weeks to 4 months

