



ICECUBES
SPACE APPLICATIONS SERVICES

ACCESS TO SPACE FOR STEM EDUCATION AND INSPIRATION THROUGH ICE CUBES

NEW PERSPECTIVES IN SCIENCE AND EDUCATION



Co- authors: Geraldine Mariën, Hilde Stenuit, Manuela Aguzzi, Mauro Ricci



SPACE APPLICATIONS SERVICES HUMAN SPACEFLIGHT MISSION HERITAGE

6 HUMAN SPACECRAFT SYSTEMS - 30 YEARS INVOLVEMENT IN HUMAN SPACEFLIGHT



MIR



SOYUZ



ISS



ATV



SPACE SHUTTLE



SPACELAB



1992 Spacelab Atmospheric Laboratory for Applications (ATLAS) & Spacelab Science & International Microgravity Laboratory (IML)



ESA ISS Payload System Engineering Service for European Life & Physical Sciences in Space (ELIPS) since 2002



Maintenance & Repair Skills Training



Mission Independent Training



Basic Training



Automated Transfer Vehicle Ground Segment Specification



European Astronaut Centre Specification & Design



ESA's Columbus Payloads User Support & Operations Centre Development



Belgian Columbus Payloads User Support & Operations Centre Development



Atomic Clock Ensemble in Space Global Payload Ground Segment Development



Exploration Analogue Simulation System Moonwalk



ISS Payload Training



European Astronaut Centre Specification & Design of Extensions for Lunar Exploration



Mission Simulations



European Astronaut Centre Development of Concept for Extra Vehicular Operations Training Facility



Lunar & Mars Exploration Analogue Mission Simulations

> 6 Microgravity Domains
 > 15 Years of Continuous ESA Science Operations
 > 35 Qualified Scientists, Engineers & Operations personnel
 System Engineering on 45 ISS Payloads
 > 1,000 Operations Procedures Validated

Science & Operations

> 8 Qualified ISS instructors
 > 100 Astronauts & Cosmonauts Trained from NASA, JAXA, RKA, CSA, ESA
 > 400 Ground Personnel Trained
 > 600 Hours of Training Developed
 > 2,500 Hours of Training Implemented

Training

Ground Segment Facilities

> 100,000 HOURS OF CONTINUOUS ISS SCIENCE & HUMAN SPACEFLIGHT OPERATIONS

1993

1996

1999

2000

2014

2015

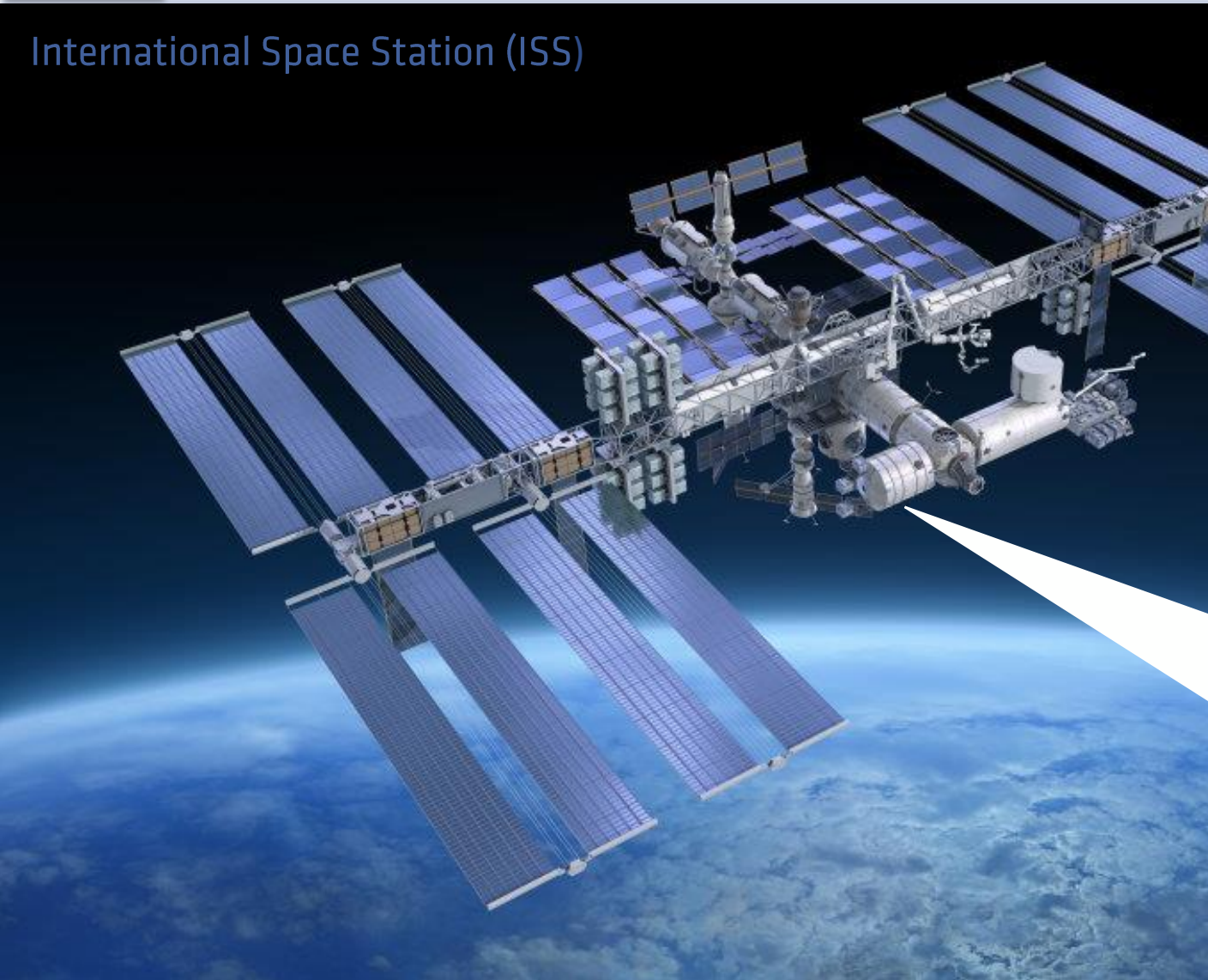
2017

SCIENCE & OPERATIONS

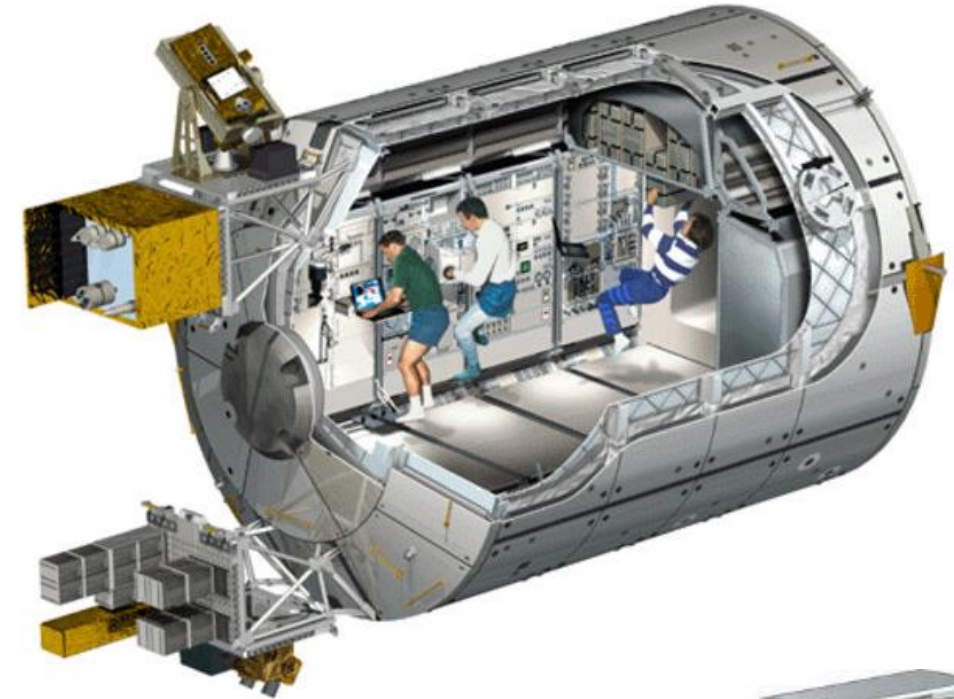
TRAINING

GROUND SEGMENT FACILITY

International Space Station (ISS)



Columbus Module



Human Physiology

Fluid science

Materials

Biology ...

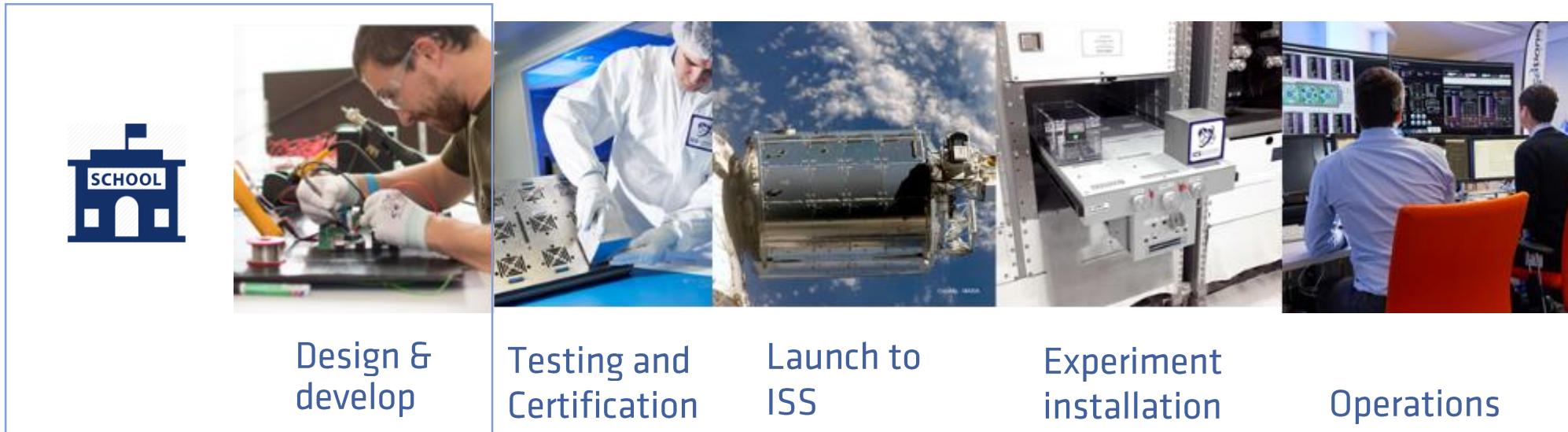


Human Space Flight is considered as the ultimate summum of inspiration for topics in Science, Technology, Engineering and Mathematics (STEM) education.

At every age

Inside and outside the classroom





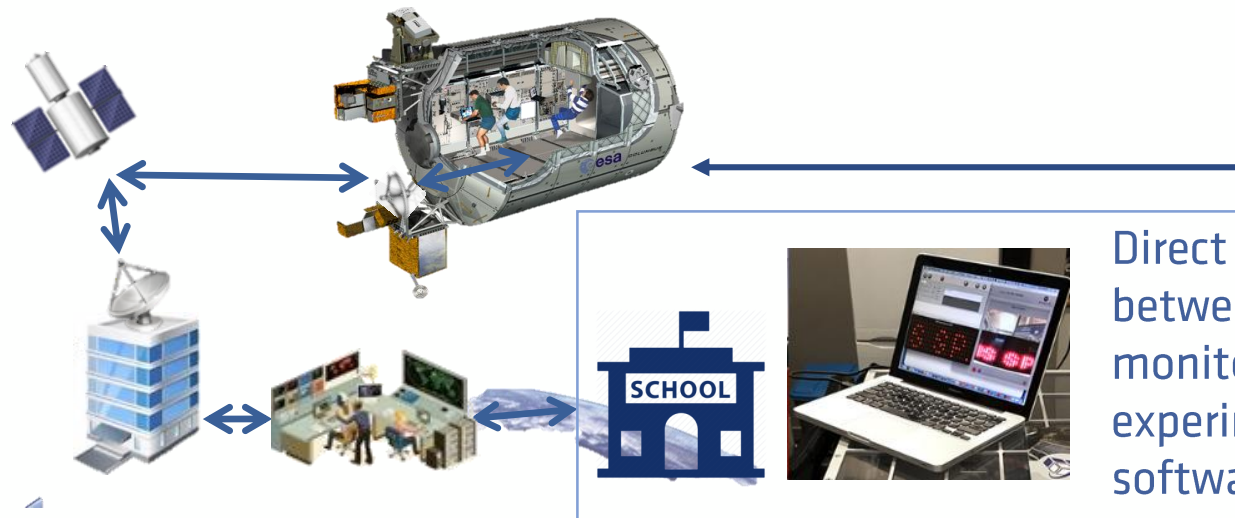
Design & develop

Testing and Certification

Launch to ISS

Experiment installation

Operations



Direct real-time connection between Cube and users to monitor and control the experiment via dedicated software.

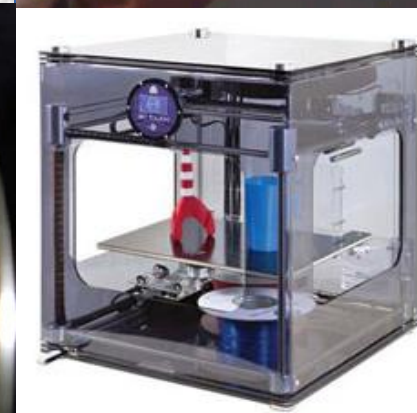
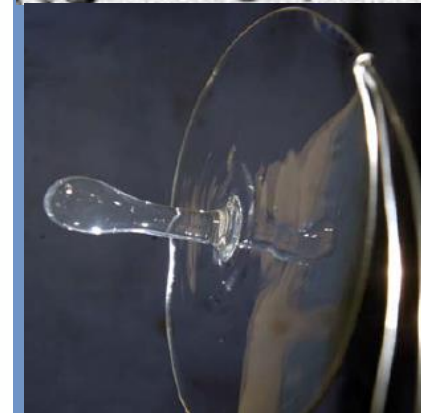
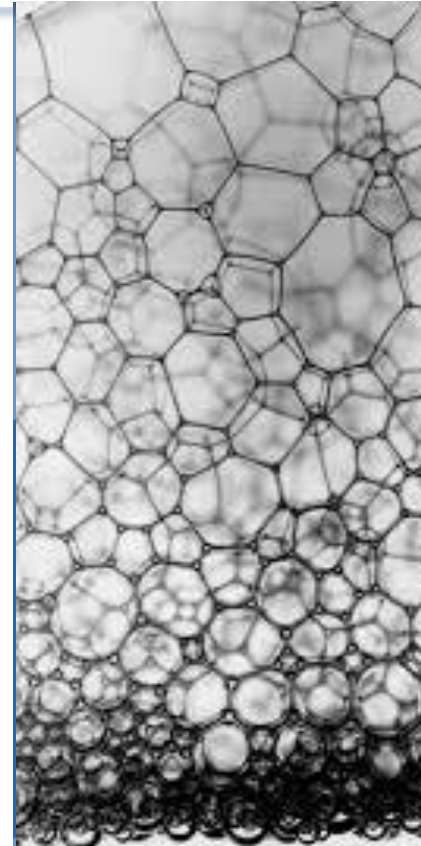
- 1U: 10 x 10 x 10 cm
- Weight: ~1kg
- Power: 5V and 12 V, up to 40.5 W max per Cube
- Thermal cooling: Forced air ventilation
- Data: Downlink up to 4 Mbps; Uplink up to 0.5 Mbps
- Communications: standard internet protocols (IPs)

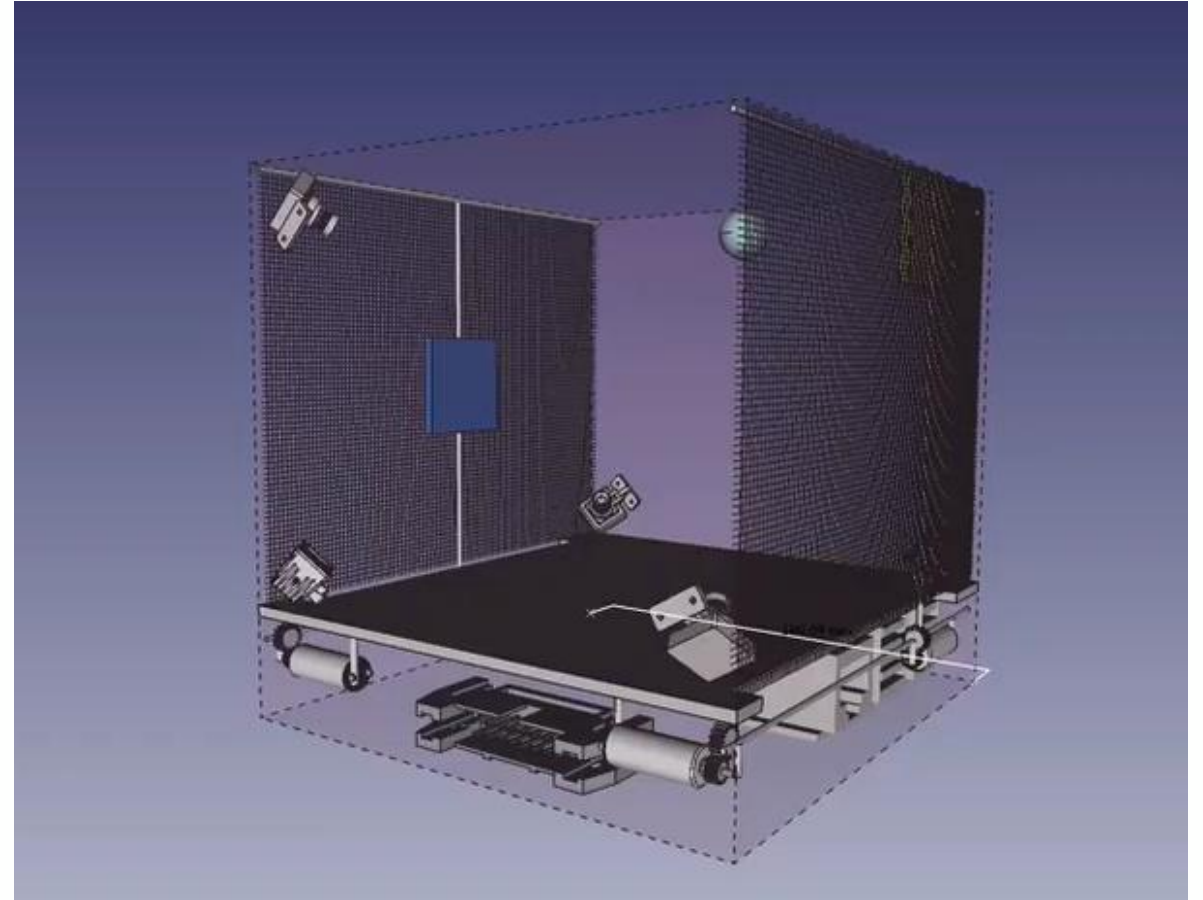


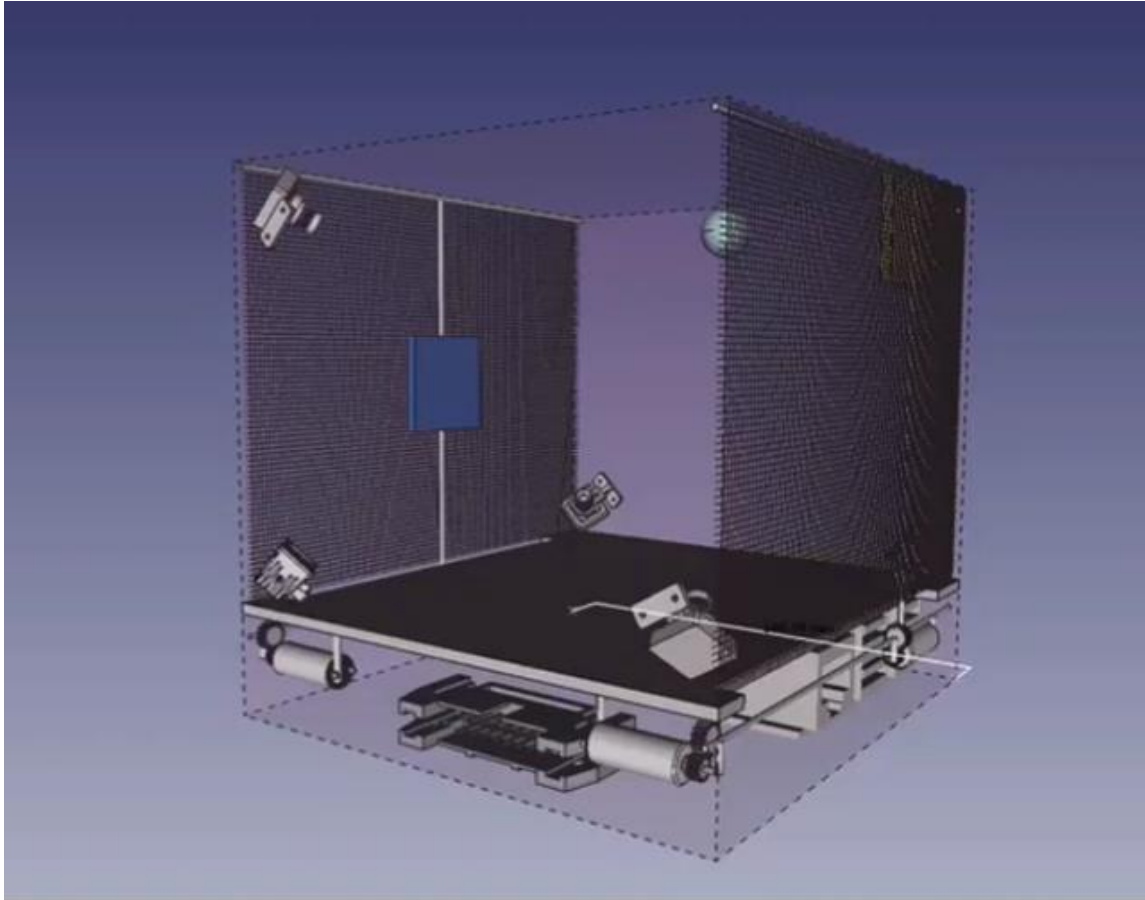
- FOR STUDENTS: Stimulate creative and autonomous thinking, cooperation, teamwork and inclusion;
- FOR TEACHERS: Support to the teachers to teach students to learn about the exciting aspects of space research and careers;
- FOR SCHOOLS: Encourage the “knowledge triangle” and closing the gap between academic, industry and educational entities



- Fluid science: liquid behaviour, foams, capillarity, surface tension
- Biology: fungi, plants, ruts...
- Close loop system: waste product recycle
- Food: production and conservation
- Human Physiology: parameter monitoring, energy consumption, circadian rhythms...
- 3D printing of prototypes or parts
- Robotic: remote controlling and coding



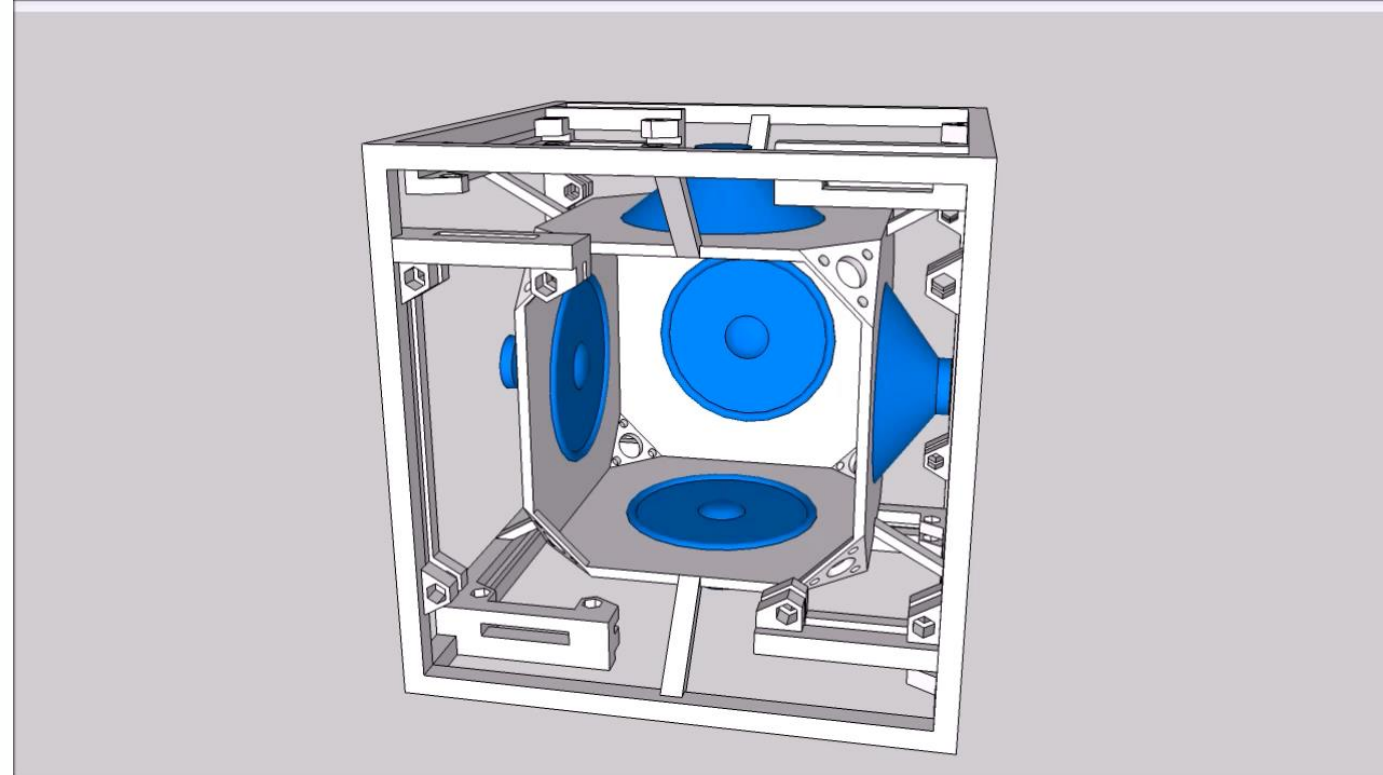
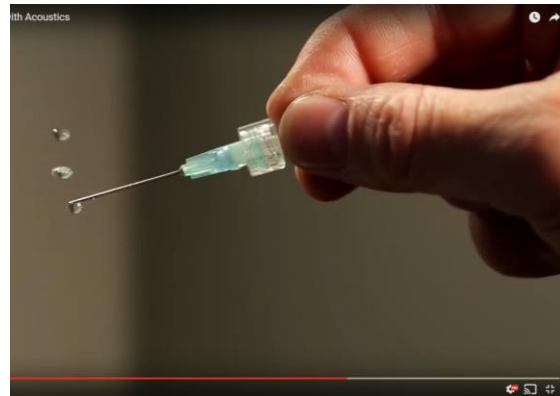






Jonathan (15)

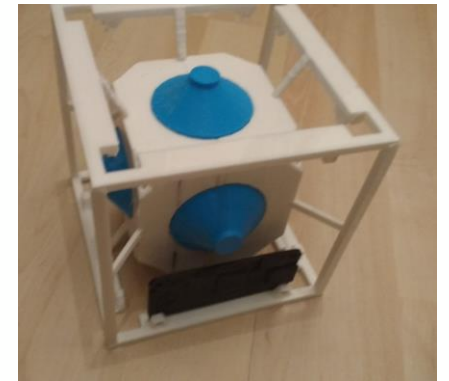
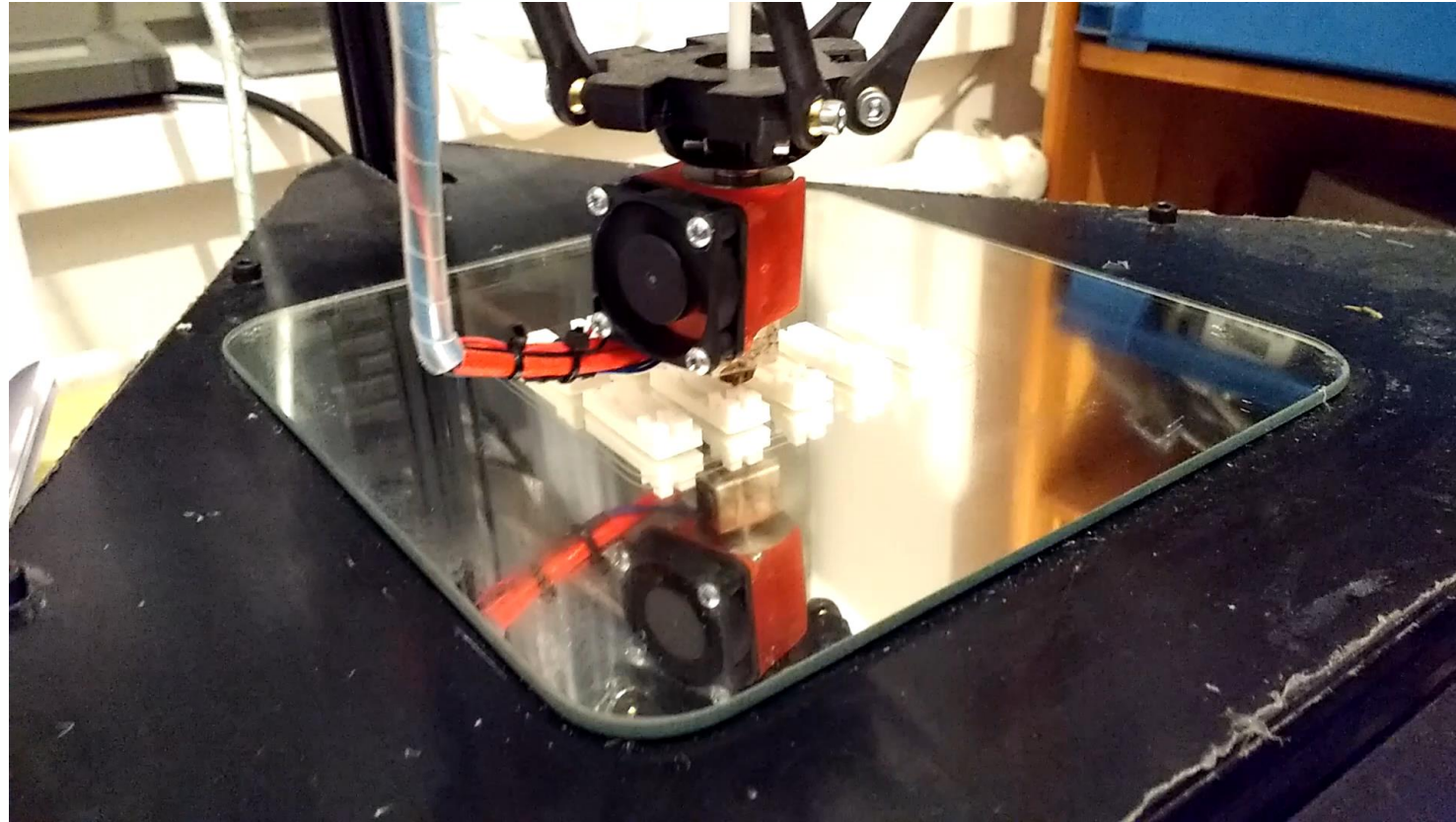
Rani (>15)



TEAM

SCIENCE
Moving water by sound waves

DESIGN
Cage, support, speakers, Raspberry



3D Printer “Home-made” PROTOTYPING

MODEL



TEST in Parabolic Flight

SCIENCE

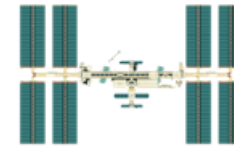
- STEM in Microgravity
- Careers in Space
- Educational material for teachers and students
- European Contest



ENGINEERING

- Careers in Engineering
- Multimedia Educational material Building a payload
- Broadcast of Cube building phases

Design – Build - Test – Certification



OPERATIONS

- Careers in Operations
- Monitoring and commanding in real time from schools



Operation support

Different Languages
 Different Educational Programs
 Costs

International

National Level:

Governmental Institutions
 National Space Agencies
 National STEM Platform
 ESERO

European Level:

European Commission
 ESA Educational
 EU STEM Platform
 EU SCHOOL NET

Crowdfunding
 Partnership
 Multilanguage



Europe seen from Space

General Information

Please complete the following as far as possible.
We can help to determine missing information later.

Organisation*

Name*

Email*

Telephone Number*

Type of experiment
 Fluid science
 Biology
 Technological Demonstration
 Crystallography
 Education
 Other

Physical Properties

Indicative volume of experiments in U: U (1U = 10cm x 10cm x 10cm)

Indicative mass:

Transport to the ISS

Do you need late access to the launcher?
 Yes
 No

Do you need for launch in refrigerated or frozen conditions
 Yes
 No

Do you need for early retrieval from spacecraft (after docking with the ISS)
 Yes
 No

Return to Ground

Do you need the experiment to be returned to ground?
 Yes
 No
 Nice to have

Need for launch in refrigerated or frozen conditions
 Yes
 No

Data Delivery

Amount of overall generated data:

Mbytes

Minimum data rate needed:

kbit / sec

Do you need a near real-time data downlink during the experiment?
 Yes
 No

Do you need deferred data downlink after each experiment session?
 Yes
 No



Contact

Questions about ICE Cubes Service?
Do not hesitate to contact:



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**THANK YOU FOR YOUR ATTENTION
QUESTIONS?**