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Access to Space for All Initiative: opportunities, achievements and way forward beyond 2020

I. Background

1. The Office for Outer Space Affairs of the Secretariat manages and implements the programme on the peaceful uses of outer space, which is aimed at strengthening international cooperation in space activities and in the use of space science and technology for achieving sustainable development, and represents the United Nations in promoting international cooperation in the exploration and peaceful uses of outer space for economic, social and scientific development, in particular for the benefit of developing countries[1]. The Office discharges these responsibilities by, among other duties, implementing the Programme on Space Applications, which has been created in 1971. The programme was created to increase awareness about the benefits to be derived from the applications of space technology and today provides capacity-building in the form of conferences, training courses, advisory services, fellowships and hands-on opportunities.[2]

2. The Office launched the Access to Space for All Initiative in 2018, providing opportunities in space research and space science data services. Under the Initiative, the Office has been collaborating with spacefaring governmental, intergovernmental and private sector entities to open ground- and space-based facilities to all Member States of the United Nations for micro- and hypergravity experiments, space missions, and human spaceflight-related activities.

3. The Access to Space for All Initiative evolved from the Human Space Technology Initiative, which was launched in 2010 by the Office. The first opportunity was the "Zero-Gravity Instrument Project" (ZGIP) in which about 50 clinostats, microgravity-simulating instruments, were distributed to selected schools and institutions worldwide. The objectives of the project were to provide unique opportunities for students and researchers to observe natural phenomena of samples under simulated microgravity conditions on the ground, and to inspire the students and researchers to undertake further studies in the fields of space science and

[1] Secretary-General's bulletin: Organization of the Office for Outer Space Affairs, ST/SGB/2020/1 13 January 2020, https://cms.unov.org/dcpms2/api/finaldocuments?Language=en&Symbol=ST/SGB/2020/1.

[2] Office for Outer Space Affairs, History of the United Nations Programme on Space Applications, https://www.unoosa.org/oosa/en/ourwork/psa/history.html.

technology. The project was also aimed at creating datasets of plant species with their gravity response, which would contribute to the design of future space experiments and to the advancement of microgravity research. A "Teacher's Guide to Plant Experiments in Microgravity" (ST/SPACE/63), providing step-by-step instructions was also published.[3]

4. This report presents the objective of the Initiative and the specific achievements of its different opportunities as of end of 2020 and first quarter of 2021. Lessons learned also guide the development of new actions for future cycles of opportunities and new partnerships.

II. Access to Space for All Initiative

5. The goal of the Access to Space for All Initiative is to provide research and orbital opportunities for United Nations Member States to access space and to ensure that the benefits of space, in particular for sustainable development, are truly accessible to all. To fulfill this goal, the opportunities have been organized in three different tracks, which enable progressive capacity development:

(a) Hypergravity and Microgravity Track;

(b) Small Satellite Development Track; and

(c) Exploration Track.

6. The Tracks have been created to deliver capacity in specific aspects of space technology development and data acquisition, from start to the end, by grouping existing opportunities and identifying gaps that the Office is striving to close.

7. Partnership is a distinctive feature of the Initiative. The Access to Space for All Initiative is only possible owing to partnerships with various public and private actors, who are contributing to the Initiative in various manners. New contributions to the Initiative are possible and encouraged.

8. The number of opportunities is different from track to track. The Hypergravity and Microgravity Track currently has the highest number of opportunities available, with five programmes. The requirements for applicants vary from opportunity to opportunity, although, in general terms, the Initiative is mainly addressed to developing countries, rendering accessible opportunities that otherwise would be difficult to access or too costly, and providing the building blocks to start building capacity towards more complex experimentations in a structured manner. To that effect, the Hypergravity and Microgravity Track has been designed to provide a full range of facilities, from ground to orbit, to help participants acquire the skills and knowledge to develop experiments in orbit.

9. The Satellite Development Track currently provides two opportunities, which require a different degree of expertise and enable the deployment of different sizes of CubeSats.

10. Further information on the Exploration Track may be found in chapter VI of the present report.

11. The Office for Outer Space Affairs strives to support the monitoring and achievement of the 17 Sustainable Development Goals, part of the 2030 Agenda for Sustainable Development, and requires that applicants to the opportunities provided for through the Initiative make the link between what they try to achieve and the Sustainable Development Goals. In the years that the Initiative has been active, the Office has received applications relevant to many of the targets of the Sustainable Development Goals, including, inter alia, developments for improving communications in areas subject to disasters using CubeSats, cancer prevention and

[3] Office for Outer Space Affairs, Zero-Gravity Instrument Project (ZGIP), https://www.unoosa.org/oosa/en/ourwork/psa/hsti/capacity-building/zgip.html.

treatment and the development of high efficiency solar cells. The importance of the Access to Space for All Initiative transcends the development of space capabilities, as the skills that are acquired through the participation in the opportunities are multi-purpose and can be used in a wide range of other fields.

III. Areas of research conducted under the Initiative

12. The Office has offered opportunities in space research and space science data services since 2010, with the Access to Space for All Initiative launched in 2018. Including the opportunities provided under programmes that are still active, and now the additional opportunities under the Initiative, there have been winners from 28 different countries, and one organization that represented eight countries. This information is presented, together with the respective projects, in the opportunity-specific tables in the annex.

13. The areas of interest explored by the researchers are varied, covering many different aspects of space science and technology, such as:

- Three projects in biology, microbiology, biotechnology and biophysics have direct or indirect application in food supply for space exploration, agriculture and food security on Earth, medicine, epidemiology and public health;
- Eight projects are innovative in physics and chemistry studies, including in material science, fluid dynamics, thermodynamics or nuclear physics;
- Ten engineering and technology experiments have application in space exploration, satellite development and operations such as Earth observation and telecommunication, 3D printing in space and others;
- Two projects were in astronomy; and
- Five have applications to monitor climate change impacts and other indicators of development.

Many of the winning projects are cross-sectorial and can deliver results of interest in other areas of applications.

14. Scientific selection committees for each opportunity approved projects from high schools, colleges and universities, national and regional research and development institutes and agencies, space agencies, societies and research councils in all three Tracks.

15. The following sections provide an overview of the highlights for each Track and associated opportunities during 2020 and the first quarter of 2021.

IV. Hypergravity and Microgravity Track

16. The objective of this Track is the development of hands-on capacity to develop experiments under different gravity conditions.

17. Hypergravity is when the acceleration force is larger than the gravitational force equivalent of 1g, while microgravity is when the acceleration forces are of the order of 1 millionths of the Earth gravity (mg). Experiments under varying gravity can help to prove theories, reveal unexplained phenomena and develop new technology.

18. Through the opportunities offered in the Hypergravity and Microgravity Track, in partnership with different entities, teams from all regions of the world have been able to run experiments in engineering, such as the development of mechanisms to dump oscillations of tethers in satellites or understanding the behaviour of a reduced-scale robotic arm manipulator. There have also been experiments in material science, such as the analysis of the mechanical features of nitinol alloy, a biocompatible material, super elastic and intelligent material with “shape-memory” and experiments related to medicine and microbiology, such as the one focused on a

method to develop increased antimicrobial activity in medicine droplets. To complement the experiments, the Office provides theoretical knowledge to assist countries with no previous capacity related to hypergravity/microgravity experimentation.

A. The Drop Tower Experiment Series (DropTES)[4]

Project Outline

19. The Drop Tower Experiment Series programme is done in partnership with the Centre of Applied Space Technology and Microgravity (ZARM) and the German Aerospace Centre (DLR). The Drop Tower Experiment Series allows student teams from non-spacefaring countries to learn and study microgravity science first-hand by performing experiments at the Bremen Drop Tower in Germany. This drop tower is a ground-based laboratory with a drop tube of a height of 146 meters, which can enable short microgravity experiments to be performed in various scientific fields, such as fluid physics, combustion, thermodynamics and material science. Each experiment consists of four drops or catapult launches within a one-week period. The entire programme is aimed at contributing to the promotion of space education and research in microgravity.

Implementation

20. Six rounds have been successfully implemented and the winning teams between 2013 and 2019 were from Jordan, Bolivia, Costa Rica, Poland, Romania and Italy respectively. The experiments conducted range from technology demonstration to medical science and material science. The seventh-round winning team selected in April 2020 is from Universidad Católica de Bolivia, with an experiment to analyse the feasibility of a new 3D printing extruding technique in microgravity. The series of experiments has been postponed to 2021 due to the coronavirus disease (COVID-19) pandemic. A list of the past experiments is found in Table 1 of the annex to the present report. The announcement of opportunity for the 8th round of DropTES has been announced on 2021 and the number of drops or catapult launches has been extended to five.

B. China Space Station[5]

Project Outline

21. The Cooperation on the Utilization of the China Space Station (CSS) is done in partnership with the China Manned Space Agency (CMSA). This programme provides scientists from around the world with an opportunity to conduct their own experiments on board the China Space Station. There are three ways to conduct experiments in this programme: the first is conducting experiments inside the China Space Station by utilizing experiment payloads to be designed and developed by the selected applicants; the second is conducting experiments inside the China Space Station by utilizing experiment payloads already provided by CSS; and the third is conducting exposed experiments outside the China Space Station by utilizing exposed experiment payloads. It is an innovative and future-focused programme to open up space exploration to all nations and to create a new paradigm in building capabilities in space science and technology.

[4] Office for Outer Space Affairs, Fellowship Programme for “Drop Tower Experiment Series” (DropTES), https://www.unoosa.org/oosa/en/ourwork/psa/hsti/capacity-building/droptes.html.

[5] Office for Outer Space Affairs, The United Nations/China Cooperation on the Utilization of the China Space Station (CSS), https://www.unoosa.org/oosa/en/ourwork/psa/hsti/chinaspacestation/ao_main.html.

Implementation

22. A total of forty-two applications from organizations in twenty-seven countries were received and nine experiment projects were selected in June 2019 in the first round of this opportunity. This programme was innovative in that many projects were submitted by multi-national teams. The Office for Outer Space Affairs and the China Manned Space Agency are working together to organize a second round for this opportunity. A list of the nine selected experiments are attached in Table 2 of the annex to the present report.

C. Large Diameter Centrifuge Hypergravity Experiment Series (HyperGES)[6]

Project Outline

23. The Fellowship Programme on the Large Diameter Centrifuge Hypergravity Experiment Series (HyperGES) is done in partnership with the European Space Agency (ESA). The fellowship programme aims at providing opportunities for scientists and researchers, with particular emphasis on supporting participants from developing countries. Teams of students are afforded the opportunity to conduct their own hypergravity experiment series at the large diameter centrifuge facility located at the European Space Research and Technology Centre (ESTEC) of ESA in Noordwijk, the Netherlands. It is a part of the Life and Physical Sciences Instrumentation and Life Support Laboratory in ESTEC, dedicated to serve the science and technology user communities. The entire programme is aimed at contributing to the promotion of space education and research to understand and describe the influence of gravity systems.

Implementation

24. The first cycle of the Large Diameter Centrifuge Hypergravity Experiment Series opened in the second half of 2019 with the selection of the winner taking place in the beginning of 2020. The winner of this cycle is a team from the Faculty of Science of the Mahidol University, Thailand, with a proposal to study the effect of hypergravity on wolffia, commonly known as watermeal or duckweed, a type of aquatic plant, with the aim at using it as a source of food an oxygen for space exploration. The experiment has been postponed to 2021 due to the coronavirus disease (COVID-19) pandemic.

D. Bartolomeo[7]

Project Outline

25. The opportunity to accommodate a payload on the Airbus Bartolomeo external platform aboard the International Space Station (ISS) and to have the All-in-One Mission Service is opened in partnership with Airbus Defence and Space GmbH. Bartolomeo is an external platform on the International Space Station's European module. It allows the hosting of small and medium size payloads, with different viewing conditions, offering hosting that can point to Earth or to space. It provides the highest data downlink rate on the International Space Station and the payloads can be controlled and data retrieved through the Airbus Cloud.

[6] Office for Outer Space Affairs, United Nations/European Space Agency (ESA) Fellowship Programme on the Large Diameter Centrifuge Hypergravity Experiment Series (HyperGES), https://www.unoosa.org/oosa/en/ourwork/psa/hsti/ldc_hyperges/ao_main.html.

[7] Office for Outer Space Affairs, Accessing Space with the ISS Bartolomeo Platform, https://www.unoosa.org/oosa/en/ourwork/psa/hsti/orbitalmission/bartolomeo/index.html.

Implementation

26. The opportunity opened in 2019 and was closed in April 2020 with the reception of proposals from 18 countries and 29 institutions. The selection process is ongoing. The winner of the first round will be selected from the three higher-ranked proposals and will be announced in 2021.

E. Dream Chaser[8]

Project Outline

27. The opportunity to participate in an orbital space mission utilizing the Dream Chaser® space vehicle of Sierra Nevada Corporation (SNC) is under preparation. The Dream Chaser is the only runway landing space vehicle actively in development that is designed to launch on a variety of launch vehicles. It can carry experiments, payloads, or satellites provided by institutions in the participating countries.

Implementation

28. In 2017, a call for interest was launched to assess the feasibility of a free-flight mission and have a preliminary understanding of the types of payload for which to plan. The results exceeded the expectations with 150 responses from 75 countries. At the International Astronautical Congress of 2019 in Washington, D.C., a call for interest for landing sites was launched. The call was open until the end of April 2020. Applications from seven countries have been received. This marks a milestone in the effort of the Office and the Sierra Nevada Corporation towards opening the announcement of opportunity for the utilization of the Dream Chaser.

V. Satellite Development Track

29. The objective of this Track is the building of hands-on capacity for satellite development.

30. Despite being as small as 10 cm x 10 cm x 10 cm, CubeSats have a large variety of uses. They can capture images of Earth; they can be used as testbeds for new technologies; and can help us understand the space environment, among their many applications. They may also allow and encourage a country to establish the essential mechanisms for a larger space programme in compliance with international law and regulations. They may develop engineering and human capacity in space systems engineering processes and the necessary tools within the development cycle.

31. As many of their components are readily available, CubeSats are affordable to develop, and therefore a very accessible entry point to space activities. In this regard, the Committee on Space Research (COSPAR) has identified several recommendations concerning small satellites, noting that scientific communities from small countries in particular may benefit from investing their budgets in small satellites.

32. To complement the experiments, the Office provides, through webinars, symposiums and fellowship programmes, theoretical knowledge to assist countries with no previous capacity related to developing CubeSats. In 2018, the Office co-organized with the Government of Brazil the “United Nations/Brazil Symposium on Basic Space Technology: Creating Novel Opportunities with Small Satellite Space Missions”. The Symposium reviewed the status of capacity-building for small satellites, examined issues relevant to the implementation of small satellite programmes, and elaborated on regulatory and legal issues for space technology development programmes.

[8] Office for Outer Space Affairs, Orbital Space Mission, https://www.unoosa.org/oosa/en/ourwork/psa/hsti/FreeFlyer_Orbital_Mission.html.

33. The Office and the Government of Japan, in cooperation with the Kyushu Institute of Technology (Kyutech), have established a United Nations/Japan Long-term Fellowship Programme on Nano-Satellite Technologies for nationals of developing countries or non-spacefaring nations. The Programme provides extensive research opportunities in nano-satellite systems through the use of the nano-satellite development and testing facilities available at Kyutech.

34. The following section provides a list of the opportunities available under this track and the progress in 2020 and the first quarter of 2021.

A. KiboCUBE[9]

Project Outline

35. The Cooperation Programme on CubeSat Deployment from the International Space Station (ISS) Japanese Experiment Module (Kibo) "KiboCUBE" is offered in partnership with the Japan Aerospace Exploration Agency (JAXA). KiboCUBE provides educational and research institutions from developing countries with the opportunity to develop a CubeSat and have it deployed from the Japanese module "Kibo" of the International Space Station. Thanks to the lower vibration and more benign environment during launch, KiboCUBE lowers the threshold for countries to enter space activities and contributes to national capacity development in spacecraft engineering, design and construction, inspiring new generations of scientists and engineers.

Implementation

36. The Central American Integration System (SICA) was selected as the winner of the fifth round of the Programme, with a proposal of a communications satellite for emergency situations. Besides Central American Integration System, there are three CubeSats, from Indonesia, Mauritius and Moldova respectively, that are currently in development. In April 2020, the second-round winner Guatemala deployed Quetzal-1, the first satellite of the country, into orbit. The deployment ceremony was conducted online on 28 April due to the coronavirus disease (COVID-19) pandemic and was covered by national and international media. In addition, during the first quarter of 2021, the first satellite of Mauritius, MIRSAT-1 has been successfully handed over to JAXA.

37. The first satellite deployed thanks to KiboCUBE, from Kenya, 1KUNS-PF, re-entered the atmosphere in June 2020 after having successfully completed more than 10,000 orbits. A note verbal was addressed to the Secretary General to update the information of the Register of Objects Launched into Outer Space. During its lifetime, it acquired images from the Earth and monitored data such as temperature and voltage data of on-board components.

38. During the first quarter of 2021, The Office and JAXA worked together with the support of UNISEC-Global to offer the "KiboCUBE Academy" a series of webinars geared towards building capacity on small satellite development, operation and utilization. This series of webinars complemented, at theoretical level, the opportunities offered under the Satellite Development Track.

39. The list of winners since KiboCUBE was launched may be found in Table 4 of the annex to the present report.

[9] United Nations Office for Outer Space Affairs, The United Nations/Japan Cooperation Programme on CubeSat Deployment from the International Space Station (ISS) Japanese Experiment Module (Kibo) "KiboCUBE", https://www.unoosa.org/oosa/en/ourwork/psa/hsti/kibocube.html.

B. Vega C[10]

Project Outline

40. The Cooperation Programme on Access to Space by utilization of the Vega C launcher is offered in partnership with Avio S.p.A. This opportunity will put into orbit a CubeSat or aggregates of CubeSats of maximum 3U developed at educational or research institutions from developing countries.

Implementation

41. The Office and Avio S.p.A conducted a webinar in July 2020 to raise awareness of the opportunity and another webinar in October 2020 to announce the opening of the Announcement of Opportunity. To ease the process of partnership development, the Office made available an innovative matchmaking tool so interested institutions can advertise their interest in partnering and the type of partner they are looking for in the context of this opportunity.

VI. Exploration Track

42. The Office is interested in developing capacity related to exploration missions, both on the ground through opening access to analogue facilities and in exploration missions beyond the geostationary orbit, with the objective of developing hands-on capacity in these areas.

43. This Track also covers data acquisition and hands-on research related to celestial bodies.

A. ISONscope[11]

Project Outline

44. ISONscope, the opportunity offered by the United Nations Office for Outer Space Affairs (UNOOSA) and Keldysh Institute of Applied Mathematics (Russian Academy of Sciences) (KIAM RAS) aims at providing small telescopes and associated capacity-building on astronomy to academic and research institutions in developing countries. In addition, this opportunity also offers assistance for the establishment of the telescope-related facilities and training of specialists on the use of the telescope.

Implementation

45. The opportunity was announced on January 2021, and closes on May 2021, with the final selection taking place in 2021. Two webinars, with two sessions each, to accommodate different time zones, have been conducted to support this opportunity and provide additional information to potential applicants.

VII. Gaps

46. It is worth noting that the Tracks, in addition to providing a structured learning path, also allow for the identification of areas where the Initiative should expand in order to offer a gradual learning curve:

(a) Hyper and Microgravity Track: As an intermediate step to acquire experience in orbit experimentation, the Office is interested in developing capacity in

[10] United Nations Office for Outer Space Affairs, Accessing Space with VEGA-C, https://www.unoosa.org/oosa/en/ourwork/psa/hsti/vegac.html.

[11] United Nations Office for Outer Space Affairs, Telescope provision in cooperation with Keldysh Institute of Applied Mathematics “ISONscope”, https://www.unoosa.org/oosa/en/ourwork/psa/bssi/isonscope.html.

parabolic and suborbital experimentation, to increase the experience of applicants before applying to an opportunity for developing an in-orbit experiment, as well as, in increasing access to facilities on the ground, such as clinostats.

(b) Satellite Development Track: the Office would like to develop capabilities related to CanSats as a starting point that will enable countries to advance their capabilities in space systems engineering. In addition, facilitating access to test facilities on the ground, would be beneficial for participants.

(c) Exploration Track: the Office is interested in developing capacity related to exploration missions, both on the ground through opening access to analogue facilities and in exploration missions beyond the geostationary orbit.

47. The Office encourages Member States, as well as private and public entities, to join the Initiative through in-kind or extrabudgetary contributions.

VIII. Conclusion and lessons learned

48. The opportunities under the Access to Space for All Initiative continue to attract the interest of institutions from around the world. This year new applications on a wide number of topics have been received. Although the pandemic situation has created delays for the development of some of the activities, due to the difficulty in importing components or due to the impact on the winning teams such as their access to their respective research facilities or because of travel restrictions, the different opportunities continue to move forward.

49. In 2020, through the Initiative, the Office achieved the following;

(a) Selected a winner for the seventh-round for DropTES;

(b) Deployed the second-round KiboCUBE winner Guatemala’s first satellite into space and opened an announcement of opportunity for another round in December;

(c) Opened an announcement of opportunity for the first-round for Avio; and.

(d) Twelve webinars related to the Initiative were conducted.

50. During the first quarter of 2021, through the Initiative, the Office achieved the following;

(a) Announcement of opportunity for DropTES 8th round and ISONscope;

(b) Seven webinars related to the Initiative were conducted. Including KiboCUBE Academy, covering aspects related to the Satellite Development Track.

51. The Office complements the opportunities with other learning activities, such as webinars. A series of webinars were offered to further the work on the Access to Space for All Initiative and continue to offer space-related opportunities as a source of inspiration and to attract students and professionals from different areas, fostering science, technology and innovation and preparing them for the jobs of the future. A total of 19 webinars related to Access to Space for All have been organized during 2020 and the first quarter of 2021. Whenever possible, two sessions of the same webinar were organized to accommodate different time zones (annex, table 5).

52. The Office continues to work with partners to maintain and enhance the Access to Space for All Initiative, providing opportunities for universities and research institutions, and promoting international cooperation in the peaceful uses of outer space. Member States and private and public entities are encouraged to join the Access to Space for All Initiative.

Annex

Table 1. Past results of DropTES

Round/Year	Implementing Organization	Objective	Country
1st Round/2014	German Jordanian University	Stabilizing the Electrodynamic Tether by using Tilger: to investigate the stability of tether dynamics for satellites with electromagnetic tether systems using a Tilger, a mass damper	Jordan
2nd Round/2015	Universidad Católica Boliviana “San Pablo”	To examine and evaluate the property of an alloy of Nickel and Titanium “Nitinol” under the microgravity environment	Plurinational State of Bolivia
3rd Round/2016	Instituto Tecnológico de Costa Rica (TEC) Universidad de Costa Rica (UCR)	Behaviour of a reduced-scale robotic arm manipulator under microgravity conditions: to expand the technical knowledge and information, through drop series in DropTES, on the behaviour of a reduced-scale robotic arm manipulator such as dynamics, motion, and control under microgravity conditions	Costa Rica
4th Round/2017	Warsaw University of Technology	To verify, in vacuum and microgravity conditions, the deployment of the deorbit sail system on their two-unit CubeSat called “PW-Sat2”	Poland
5th Round/2018	University of Bucharest Politehnica University of Bucharest	To expose medicine droplets containing aqueous chlorpromazine (CPZ) solution to both laser radiation and microgravity conditions	Romania
6th Round/2019	Politecnico di Milano (Polimi)	To analyse the lateral sloshing of a ferrofluid solution in low gravity with the aim of measuring its oscillation frequency while subjected to different magnetic field intensities	Italy
7th Round/2020	Universidad Católica Boliviana “San Pablo”	To determine the 3D printing feasibility under microgravity conditions, measure intra-structure remaining liquid resin after light exposure and compare manufacturing time, amount of used material, while processing the same piece between 2 different approaches (Fused Deposition Modelling (FDM) and Digital Light Processing (DLP))	Plurinational State of Bolivia

Table 2. Results of the First Round for the China Space Station

Implementing Organization	Objective	Country
The University of Geneva National Center for Nuclear Research Max Planck Institute for Extra-terrestrial Physics of Germany Institute of High Energy Physics of Chinese Academy of Sciences	POLAR-2: Gamma-Ray Burst Polarimetry on the China Space Station: to answer the most important open questions in astrophysics regarding the nature of Gamma-Ray Bursts (GRBs) by using the most promising investigation approach of polarization measurements allowing to observe even the weakest gamma-ray transients, such as those connected to gravitational waves	Switzerland Poland Germany China
The Indian Institute of Astrophysics The Institute of Astronomy of the Russian Academy of Sciences	Spectroscopic Investigations of Nebular Gas (SING): to map the sky using an ultraviolet long-slit spectrograph by taking advantage of the CSS. It is targeted to the extended nebulae in our own Galaxy, star formation in nearby galaxies and on an even larger scale, the cosmic web	India Russian Federation
Indian Institute of Technology (BHU) Université Libre de Bruxelles (ULB)	Behaviour of Partially Miscible Fluid in Microgravity: to study the concentration diffusion phenomenon during local mixing of unmixed liquid caused by temperature change under microgravity, including droplet migration, accumulation and thermal diffusion caused by Marangoni effect in local mixing area. The theory obtained will guide the industrial process of foundation and understand the complex interface process	India Belgium
Tsinghua University University of Tokyo	Flame Instabilities Affected by Vortices and Acoustic Waves (FIAVAW): to investigate the instabilities of edge flames in the absence of gravity, as well as the potential control and effects from external flow oscillations taking advantage of the long-duration and buoyancy-free environment onboard the CSS. The research looks at the most fundamental problems of flame stabilization in a convective flow that is related to aircraft and rocket engine combustion, as well as fire safety problems in	China Japan
Norwegian University of Science and Technology International Space University Vrije University Amsterdam in the Netherlands Belgium Nuclear Research Centre	Tumours in Space: Signatures of early mutational events due to space-flight conditions on 3D organoid cultures derived from intra-individual healthy and tumour tissue: to thoroughly test the two important hypotheses: The gravitational force and the galactic cosmic radiation (GCR), respectively, causes a unique mutational signature in the DNA of 3D human organoids derived from intra-individual healthy and colorectal cancer tissue. The results could have a major scientific impact	Norway France Netherlands Belgium

Implementing Organization	Objective	Country
	on the current understanding of cancer aetiology and offer new perspectives on prevention and treatment of cancer, including on crew health on long-term deep-space missions	
Mars Society – Peru Chapter Mars Society – Spain Chapter	Effect of Microgravity on the Growth and Biofilm Production of Disease-Causing Bacteria: This project studies the differences between the growth and biofilm production of bacterial colonies grown on Earth and those on board of the China Space Station. It will contribute to understanding how disease-causing bacteria behave on an altered/reduced gravitational environments	Peru Spain
National Institute of Astrophysics Optics and Electronics (INAOE) Benemérita Universidad Autónoma de Puebla (BUAP)	Mid infrared platform for Earth observations: With this project, two infra-red (MIR) cameras will be installed on the CSS to observe the Earth. It is used to monitor the land and the atmosphere of the Earth. The results could give clue information for a better knowledge of humidity flows and improve forecasting of heavy precipitations and hurricanes for early preventing civil population. It could also obtain experience in the development of payloads for nanosatellites, in order to develop a MIR solar space telescope that could fit in a 3U CubeSat among other scientific projects	Mexico
National Centre for Nanotechnology and Advanced Materials King Abdulaziz City for Science and Technology (KACST)	Development of Multi-Junction GaAs Solar Cells for Space Applications: to design and manufacture high-efficiency solar cells. After exposing the solar cells on the outside of the CSS, the comprehensive properties of the solar cell will be investigated and quantitatively measured. The data will support the redesign to mitigate these effects	Saudi Arabia
Sapienza University of Rome In Quattro s.r.l. Machakos University	BARIDI SANA – High Performance Micro 2-Phase Cooling System for Space Applications: to conduct research and testing of the next generation of cooling systems for space applications by replacing ordinary liquid cooling loops with two-phase cooling system, taking advantage of the CSS. The cooling agent will be organic and non-toxic, which is a new concept and in particular of high value for human space exploration systems. Thanks to the lower power required to operate the system, it has a strong impact on carbon footprint in ground applications	Italy Kenya

Table 3. Results of the first round for HyperGES

Round/Year	Implementing Organization	Objective	Country
1st Round/2020	Mahidol University, Thailand	Watermeal, the future food source for space: To study watermeal, the smallest and fastest growing flowering plant on earth, under an extended period under hypergravity	Thailand

Table 4. Past results of KiboCUBE

Round/Year	Implementing Organization	Objective	Country
1st Round/2016	University of Nairobi	1KUNS-PF: To verify the performance of the on-board subsystems, by receiving telemetry data from the satellite	Kenya
2nd Round/2017	Universidad del Valle de Guatemala	Quetzal-1: To test a multispectral sensor prototype to monitor the concentration of harmful cyanobacteria (algae blooms) over inland bodies of water	Guatemala
3rd Round/2018	Mauritius Research Innovation Council	MIR-SAT1: To collect images of Mauritius and surrounding regions using longwave infrared (LWIR) thermal camera, technology demonstration of S-band high speed data transmission and reaction wheel, and capacity building detailed spatial and temporal data for land and ocean studies of Mauritius. The nanosatellite will also be used as a test platform to test inter-island connectivity by broadcasting updates to remote islands of the Republic of Mauritius	Mauritius
3rd Round/2018	Surya University	SS-1: Capacity-building, technology demonstration of remote communication and Automatic Packet Reporting System that works on amateur radio frequency	Indonesia
4th Round/2019	National Centre of Space Technologies/ Technical University of Moldova	TUMnanoSAT: Educational outreach capacity-building and technology demonstration (nano/micro wire sensor, magnetometer, micro-gyroscope, sun sensor, communication protocol, power source)	Moldova
5th Round/2020	Central American Integration System (SICA)	MORAZAN-SAT: The development of early warning system for floods and landslides, which can operate in remote zones with little to no access to communications, and additionally the use of the same system for post emergency communications will be tested. The satellite will test the use of packet radio communications protocol for both the monitoring of environmental variables and the communications for emergency response	Central America Region

Table 5. Webinars conducted under Access to Space for All

Webinar Title	Date	Learners were able to
AVIO and UNOOSA description of the collaboration	16 July 2020	- Describe the collaboration between UNOOSA and AVIO - Describe technical details of the Vega rocket
Access to Space 4 All (two sessions)	30 September 2020	- Describe the Access to Space 4 All Initiative and why it is important - Describe the objectives of the Access to Space 4 All Initiative - List the tracks - List the opportunities - List the partners of the Access to Space 4 All Initiative
AVIO: Announcement of Opportunity (one session)	8 October 2020	- Describe state of the art - Describe the timeline of the opportunity - Describe the documentation needed - Describe the technical aspects of this opportunity
Enabling more countries to access space through the KiboCUBE opportunity *part of World Space week (one session)	9 October 2020	- Describe state of the art - Describe the timeline of the opportunity - Describe the documentation needed - Describe the technical aspects of this opportunity - Integrate experiences from previous winners
How to raise awareness and engage the audience about your project (two sessions)	28 October 2020	- Prepare a successful communications plan - Approach media and permanent missions to raise awareness
Space Law and Regulations (two sessions)	11 November 2020	- To enhance understanding of fundamental principles of space law - To understand the importance of space object registration - Describe the steps for frequency registration
DropTES – series (two sessions)	18 November	- Describe state of the art - Describe the timeline of the opportunity - Describe the documentation needed - Describe the technical aspects of this opportunity - Integrate experiences from previous winners
Ask a winner (two session)	25 November 2020	- Incorporate lessons learned from previous winners for example solutions and difficulties when undertaking their projects
Artificial Intelligence and Access to Space (one session)	2 December 2020	- Describe some of the tools that have been made possible by artificial intelligence and how they can be used in the context of Access to Space 4 All
Announcement of Opportunity on the 6th round of KiboCUBE (two sessions) *part of World Space Forum	10 December 2020	- Describe what KiboCUBE is and how participating countries can benefit from it

Webinar Title	Date	Learners were able to
KiboCUBE: How to build a great Application Form (two sessions)	16 December 2020	- Understand the requirements set out in the Announcement of Opportunity - Fill in the application form for this opportunity
Announcement of Opportunity on the donation of telescopes in partnership with Keldysh Institute of Applied Mathematics (two sessions)	28 January 2021	- Understand the requirements set out in the Announcement of Opportunity - Fill in the application form for this opportunity
KiboCUBE Academy – Day 1 – (one session)	14 January 2021	- Enumerate the principles and steps of the technical aspects of satellite development and the applications of CubeSats
KiboCUBE Academy – Day 2 – (one session)	21 January 2021	- Enumerate the principles and steps of the technical aspects of satellite development
KiboCUBE Academy – Day 3 – (one session)	28 January 2021	- Enumerate the principles and steps of the technical aspects of satellite testing and capacity-building
KiboCUBE Academy – Day 4 – (one session)	4 February 2021	- Enumerate the principles and steps of the technical aspects of satellite operation and related regulations
Announcement of Opportunity on the new round of DropTES (two sessions)	11 February 2021	- Understand the requirements set out in the Announcement of Opportunity - Fill in the application form for this opportunity
Brownbag webinar on Access to Space for All	10 March 2021	- Raise awareness on Access to Space for All and its possible future evolutions
ISONscope Questions and Answers (two sessions)	25 March 2021	- Answer questions related to the opportunity and application process from potential applicants related to the application