INTERNATIONAL
ASTRONAUTICAL
FEDERATION

IAF HIGHLIGHTS 2018

Connecting @ll Space People

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Welcome Message

2019 has already begun, but we can look back at 2018 as a very impressive and successful year. This publication, the IAF Highlights, is summarizing the main IAF events and activities that took place. The theme of IAC 2018, *#InvolvingEveryone*, is an approach that has been seen throughout the year in IAF's activities. The importance of including everyone in the space sector and to collaborate on a global level is essential. This concept is also strongly visualized in our 3G concept, Generation, Gender and Geography, which aims to encourage and improve diversity.

GLAC 2018, the Global Space Applications Conference, was co-organized together with Centro de Investigación y Difusión Aeronáutico Espacial (CIDA-E) in Montevideo, Uruguay. This was the first time that the IAF took one of its Global Conferences to South America and also the first time that the IAF organized an event in Uruguay. For three days, experts gathered in Montevideo to discuss space applications with a specific focus on emerging space nations and Latin America.

The 69th International Astronautical Congress returned to Europe and was organized together with The Center of Applied Space Technology and Microgravity (ZARM) in Bremen, Germany. IAC 2018 was an extraordinary event that managed to break many records! The Technical Programme received a record number of abstracts with 4349 submissions, and during the IAC week the congress center welcomed 6,458 delegates from 81 countries. The programme was more packed than ever, with many interesting Plenaries, GNF sessions and the Technical Programme, that included as new format Special Sessions. In addition, a dedicated Public Day programme had been organized that involved a live session with Alexander Gerst from the International Space Station (ISS). More than 10,000 attendees came to witness this exceptional event.

The majority of IAF publications and for the first time, the IAC Final Programmes, have been printed in recycled paper this year. This is an important step towards more eco-friendly events and a mission we aim to continue in the years to come.

IAF looks forward to yet another exciting year, in following its mission to encourage cooperation, promote international development and share knowledge. This year, in 2019, the 70th International Astronautical Congress will take place in Washington DC as well as the celebration of the Apollo 50th Anniversary. We look forward to share these important events and much more with the whole IAF Community in 2019!

Jean-Yves Le Gall

President,
International Astronautical Federation (IAF)

Pascale Ehrenfreund

Incoming President & VP for Communications,
Publications and Global Conferences,
International Astronautical Federation (IAF)

IAF 2018

Events Overview

IAF General Assembly

The International Astronautical Federation General Assembly has gathered during the International Astronautical Congress, IAC 2018 in Bremen, Germany, in two sessions (Monday, 1 October 2018, and Friday, 5 October 2018). Several important decisions have been taken.

2018 Elections of IAF Officers

The Incoming President and 4 new Vice-Presidents have been elected by the General Assembly:

- **Pascale EHRENFREUND**, Chair of Executive Board, German Aerospace Center (DLR), Germany, has been appointed as IAF Incoming President

- **Mohammed Nasser AL AHBABI**, Director General, United Arab Emirates Space Agency, United Arab Emirates (UAE), has been appointed as IAF VP for Global Membership Development

- **Bruce CHESLEY**, Senior Director of Strategy, Space and Missile Systems, The Boeing Company, United States has been appointed as IAF VP for Industry Relations

- **Minoo RATHNASABAPATHY**, Research Engineer, Space Enabled Research Group, MIT, United States, has been appointed as IAF VP Education and Workforce Development

- **S. SOMANATH**, Director of the Liquid Propulsion System Center (LPSC) – Indian Space Research Organisation (ISRO), India, has been appointed as IAF VP for Technical Activities

Selection of Host City for IAC 2021

The IAF General Assembly at its second session on 5 October 2019, selected Paris, France, as Host City for IAC 2021. The Hosting Organization is the Centre National d'Études Spatiales (CNES), a member of IAF since 1981.

Upcoming IAF Events

During the IAF General Assembly sessions, reports were given on the advancement of preparation for the IAC 2019 in Washington D.C., USA, and for the IAC 2020 in Dubai, UAE.

Also, a detailed presentation was offered on the progress made in the organization of the Global Conference on Space for Emerging Countries 2019 (GLEC 2019) that will take place in Marrakech, Morocco on 24-26 April 2019 in cooperation with the Centre Royal de Télédétection Spatiale (CRTS).

IAF Finance

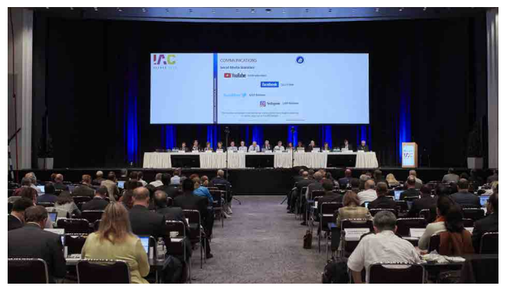
The IAF has also approved the **final accounts 2017 and Auditor's Statement 2017** and the **revised budget and preliminary accounts 2018** and the **Proposed Budget 2019**.

New IAF Members

The IAF General Assembly also approved the applications of 29 new Member Organizations. With this, the IAF Membership comprises 366 Member Organizations from 68 countries, confirming IAF's position as a truly global Federation.

The New IAF Members are:

Company	Category	Region	Country
Adriatic Aerospace Association	Association & Professional Society	Europe	Croatia
Azercosmos	Space Agency	Asia	Azerbaijan
bavAIRia e.V.	Association & Professional Society	Europe	Germany
Beijing SpaceD Aerospace Application and Science Education Co. Ltd.	Association & Professional Society	Asia	China
Black Engine Aerospace UG	Industry	Europe	Germany
European Organization for Nuclear Research (CERN)	Research and Development	Europe	Germany
Columbian Space Agency	Space Agency	Latin America	Colombia
European GNSS Agency (GSA)	Space Agency	Europe	Czech Republic
Firefly Aeropspace Inc.	Industry	North America	United States
Fraunhofer INT	Research and Development	Europe	Germany
Hermes Engineering	Research and Development	Europe	Bulgaria
High Technology Unit (UAT) Faculty of Engineering - UNAM	University	Latin America	Mexico
Infostellar	Industry	Asia	Japan
LandSpace Technology Corporaqtion Ltd.	Industry	Asia	China
Mars Planet	Association and Professional Society	Europe	Italy
MEDES - IMPS	Research and Development	Europe	France
Moon Village Association (MVA)	Association and Professional Society	Europe	Austria
Northrop Grumman Corporation	Industry	North America	United States
Paraguayan Space Agency	Space Agency	Latin America	Paraguay
PTScientists	Industry	Europe	Germany
Polish Space Agency (POLSA)	Space Agency	Europe	Poland
Space Flight Laboratory (SFL)	University	North America	Canada
SpaceExcess LLC	Industry	North America	United States
SpaceForest	Industry	Europe	Poland
Tsinghua University	University	Asia	China
University of Bologna	University	Europe	Italy
Valispace	Industry	Europe	Germany
WEPA - Technologies GmbH	Industry	Europe	Germany
Zhuhai Orbita Aeropspace Science & Technology Co. Ltd.	Industry	Asia	China



ISF 2017

Second International Space Forum at Ministerial Level – The African Chapter (ISF 2017)

ISF 2017 INTERNATIONAL SPACE FORUM AT MINISTERIAL LEVEL THE AFRICAN CHAPTER

14 FEBRUARY 2018 | NAIROBI, KENYA

The 2nd International Space Forum at Ministerial Level – The African Chapter, was initially scheduled to take place in Nairobi, Kenya in November 2017, but it was moved to February 2018, due to the time conflict with the Kenyan presidential elections. The Forum was co-organized by the IAF, the Italian Space Agency (ASI) and the Kenya Space Agency (KSA), and took place at the Radisson Blu Hotel in Nairobi on 14th February 2018.

42 governmental delegations, composed by Ministers, Ambassadors, Heads of space agencies, representatives of International Intergovernmental Organizations and universities, gathered to contribute to this unique Forum dedicated to *Space Science and Academia for Sustainable Development in Africa*. The result of the Nairobi event was the adoption by consensus of the Nairobi Page to be added to the Trento Space Statement.

Raúl Kulichevsky, Executive and Technical Director of the Argentinian National Commission of Space Activities (CONAE) announced that the new regional chapter of the ISF focusing on Latin America would be hosted by Argentina in November 2018.

The day after the Forum, a technical visit was organized for the delegations to the Broglio Space Centre in Malindi.

IAF Spring Meetings 2018

27 - 29 MARCH 2018 | PARIS, FRANCE

Spring Meetings 2018

On 27th – 29th March the IAF hosted its traditional Spring Meetings 2018 in Paris. Various events took place during the three days, SM including the selection of abstracts for IAC 2018; an IAF Diversity Day, comprising of an IDEA "3G" Diversity Breakfast, Luncheon and Afterwork gathering; committees' meetings including 2 sessions of the IAF Bureau.

The IAF Global Networking Forum featured sessions on various topics such as the *International Space Exploration – Report on ISEF2 and Beyond*, a presentation on the Space Ops organization and signature of the cooperation agreement with the IAF, and a presentation by the Moon Village Association on its contribution to Moon Settlement. Of course, the traditional IAF cocktail took place on Wednesday evening.

On Thursday the IPC General Meeting was held followed by the IAC 2018 Abstract Selection. This year a record number of abstracts had been received, with 4,349 submissions!

IAF Global Conference

Global Space Applications Conference, GLAC 2018

GLAC 2018 Global Space Applications Conference

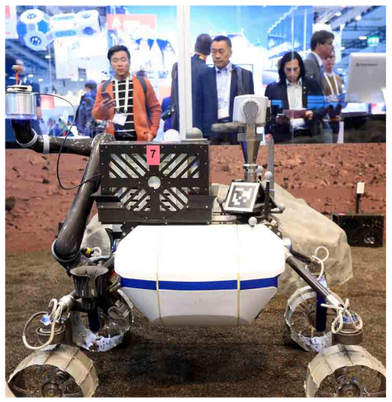
21 - 23 MAY 2018 | MONTEVIDEO, URUGUAY

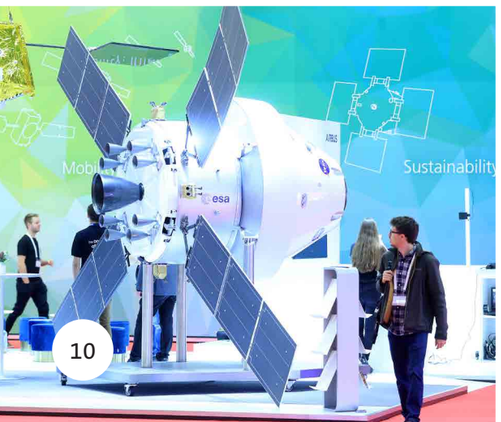
This year the IAF continued its series of Global Conferences with the Global Space Applications Conference (GLAC 2018), which took place in Montevideo, Uruguay from 21st to 23rd May 2018, in cooperation with the Centro de Investigación y Difusión Aeronáutico Espacial (CIDA-E). The Conference was a great success, with a participation of over 200 participants from more than 20 countries.

The GLAC 2018 Plenary Programme showcased 6 Plenary Events and 6 corresponding high-level Keynotes giving all participants the opportunity to be updated on recent developments and future endeavours in Space Applications.

In the spirit of the IAF "3G" activities, a very successful SGAC/IAF Seminar on Space Applications was organized right before the Conference, as well as a kick-off IDEA Luncheon before the GLAC Opening Ceremony. Both events attracted a fantastic participation from local students and young professionals.

International Astronautical Congress





IAC

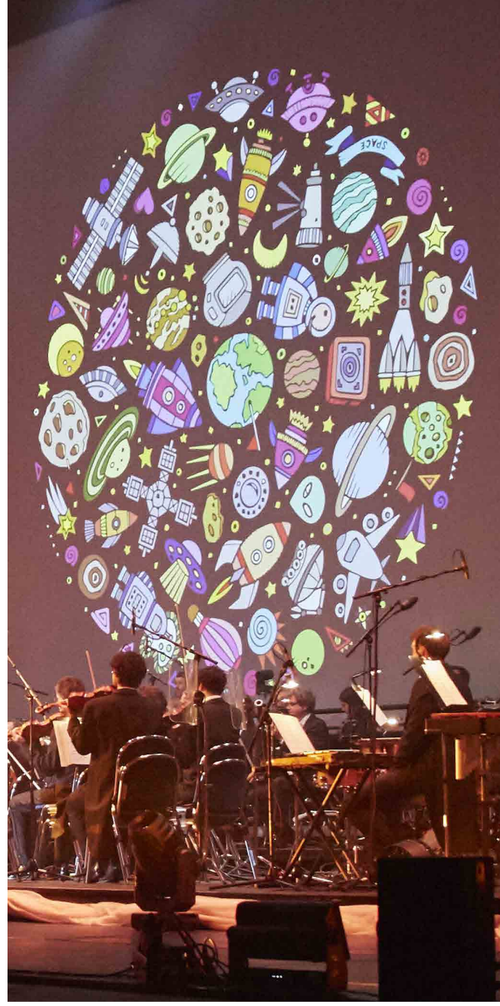
BREMEN 2018

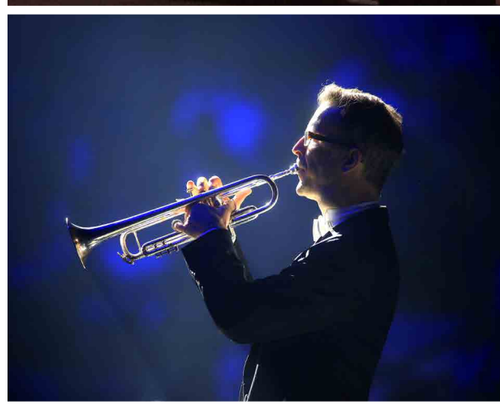
1 - 5 OCTOBER 2018 | BREMEN, GERMANY

Overview

The 69th International Astronautical Congress was an impressive IAC that broke many records! It truly lived up to its motto #InvolvingEveryone by bringing together the record number of 6,548 delegates from 81 countries in Bremen. This year a special programme had been created for the public day, which saw more than 10,000 participants who witnessed the exceptional live session with Alexander Gerst from the International Space Station (ISS).

IAC 2018 proved to be the most intense yet, with a full-packed schedule for the whole five days. The Plenary Programme saw many interesting panels, including a Highlight Lecture on business opportunities in space by Tom Enders from Airbus and a Late Breaking News session on the space missions HAYABUSA2, MASCOT, MINERVA II. The Technical Programme received a record number of abstracts with 3,439 submissions and authors from all over the world came to present their research in 179 Technical Sessions and in the Interactive Presentation Session. Over 360 Interactive Presentations were conducted at IAC 2018. The IAC Special Issue was also published for the first time, presenting a sample of those IP manuscripts to give a flavour of the presentations made this year. As part of the Technical Programme, the new format Special Sessions (SpS) was introduced for the first time including panel and group discussions, workshops, design sprints and campfires. The IAF Global Networking Forum (GNF) offered participants a record-breaking number of sessions, 46 in total, on a variety of topics, such as Lunar Exploration, Society, & Education, Sustainable Development, New Technologies and Reusability.





7 Plenaries

3 Highlight Lectures

179 Technical Sessions

1 Late Breaking News

+2,000 Technical Papers

46 GNF Events

2,500 Authors

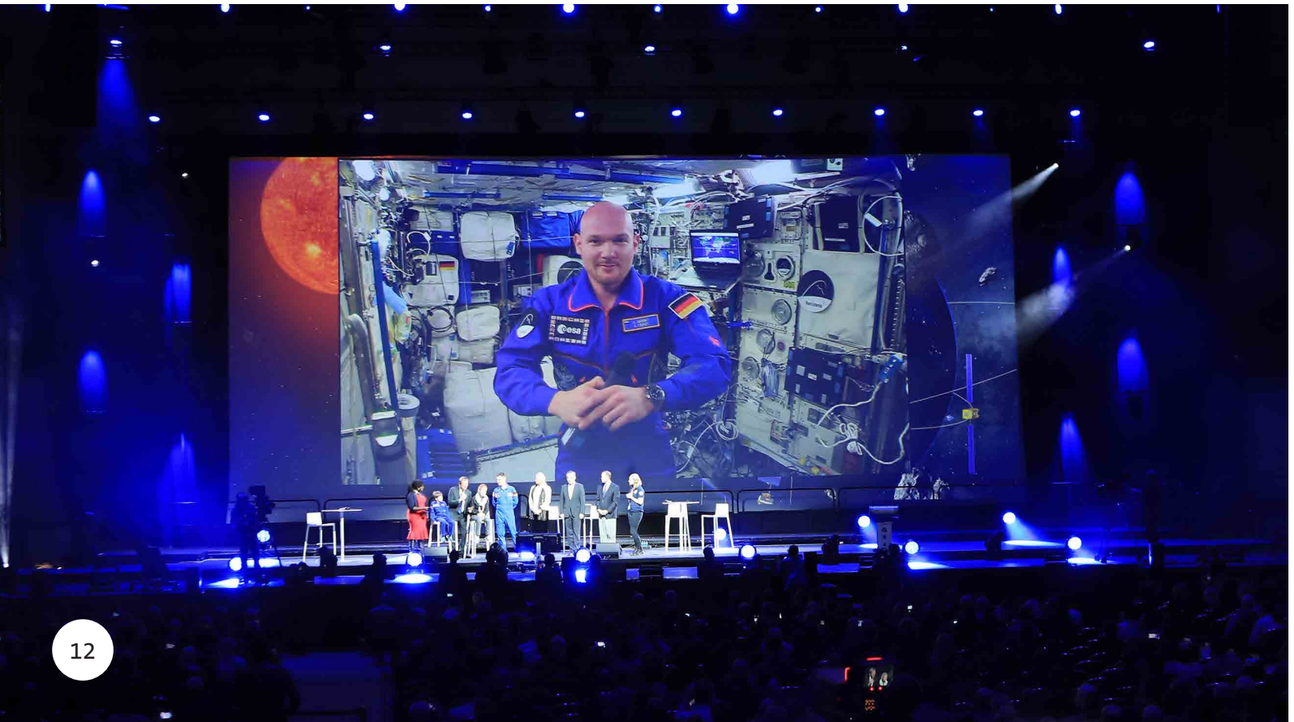
31 Special Sessions

400 Interactive Presentations

12 Press Conferences

192 Exhibitors

Numerous Networking & Social Events



IAC 2018 Plenaries

Plenary 1: **Heads of Agencies**

The IAC 2018 plenary programme had a great start with the Heads of Agencies plenary, offering an overview of how the main space agencies are reacting to a changing space environment with new actors getting involved and how they are successfully involving the broader spectrum of space and non-space actors.

Jan Woerner, Director General of the European Space Agency (ESA), K. Sivan, Chairman of the Indian Space Research Organisation (ISRO), Kejian Zhang, Administrator of the China National Space Administration (CNSA), Hiroshi Yamakawa, President of the Japan Aerospace Exploration Agency (JAXA), Dmitry Loskutov, Head of International Cooperation Department at ROSCOSMOS, Sylvain Laporte, President of the Canadian Space Agency (CSA) and Jim Bridenstine, Administrator of the National Aeronautics and Space Administration (NASA) presented, one after another, the latest achievements of their agencies and the upcoming projects. A focus was put on the "*shift of paradigm in instruments*" as Woerner said, with different types of activities coming from the traditional way using new methods even more commercialization, but it's the same time participation by involving everyone. International collaboration is key to the success of the space sector and the agencies showed their will to promote such initiatives. It was well demonstrated by CNSA by inviting the other nations to participate in future missions involving their future space station which will be completed in 2022 and by NASA promoting the international effort to land once again on the Moon sustainably as the cost of access to space goes down and it improves everybody's ability to participate in space activities, enabling more space missions than possible before, as pointed out by both ROSCOSMOS and NASA. CSA also presented the efforts on space outreach, involving Canadian citizens into the astronauts' selection with a social media campaign as never seen before for this kind of event. The agencies insisted on the importance of the younger generation to carry the values of the space sector, to bring the needed motivation and innovation to develop new thrilling space missions.

Following the agencies presentations, the audience asked many questions to the speakers, showing a genuine interest in the challenges they currently meet. There was a discussion about the possibility of a global space agency, what would its role be compared to national agencies, how would it be different from the current international cooperation in space missions and so on. The Moon and the Gateway were tackled, calling to the previous question with the necessity of international cooperation. The issue of space debris appeared to be taken very seriously by all the agencies, once again focusing on an international effort, as Woerner said: "*we better clean it together*", talking about space. The session was concluded with a question on how to involve the young generation in space, making a link to the IAC motto *#InvolvingEveryone*. The agencies insisted that it is a global effort. Everyone is needed.

As a conclusion, the space sector is evolving and the national agencies are literally trying to involve everyone to make the best out of those changes.

Plenary 2: **Host Plenary – How to Live and Work on ISS, Moon and Mars**

One of the most fascinating aspect of space is human exploration. Sending humans to the Moon or Mars is not scheduled in a distant future. This plenary session focused on the research under space conditions and the requirements for living and working in space. Three speakers, from various backgrounds, presented their life experiences and their work to give a better idea on the importance and the challenges of space research.

Takuya Onishi, Astronaut from the Japan Aerospace Exploration Agency (JAXA), presented the astronauts life on the ISS and the science performed on board. He explained what it takes and how long it takes to get used to the microgravity environment before presenting many types of experiments done during his mission. He also presented shortly the effects of space flight on the astronauts, like the fluid shift and the bone loss. He insisted on the relationship with his colleagues in the station, how strong are the bonds between astronauts, and on the psychological effects of long-distance space flight since, thanks to the Soyouz capsules, he was always in reach of [his] home planet. He noticed that it might differ for a Moon mission and even more for a Mars mission. Will the connection be lost?

In a second time, Hanns-Christian Gunga, Head of Work Group at the Center for Space Medicine and Extreme Environments presented in more details the effects of living in space on astronauts. He took the example of the body temperature and how slight variations (a few degrees) can alter the mental capacity. In space, the astronauts' temperature was measured above 39°C, compared to 37°C for a normal temperature on Earth. This implies thorough measurement and calculation of the astronauts' workload to avoid damages as well as mitigation measures. These researches on the body temperature have had many spin-offs such as sensors for firefighters, treatments for patients not able to regulate properly their own temperature and for baby care.

Christiane Heinicke, Team Lead – Moon and Mars Base Analog (MAMBA) at the Center of Applied Space Technology and Microgravity (ZARM) presented her own work on analog missions. She took the audience to a journey to the highest volcano on Earth from base to top where an experiment to simulate life on Mars was held, the Hawaii Space Exploration Analog Simulation (HiSEAS). The crew of six astronauts were isolated for a full year in a habitat with a delay of 20 minutes for any communication mean. The goal was to understand how humans behave and change with long distance isolation. In order to send people to Mars, you need to make sure that the crew does not sabotage the mission on the way. This life changing experience gives a new view on how we live on Earth. Having eight minutes to shower per week for one year makes you reconsider how you use water on Earth. Those analog experiments bring valuable knowledge: "*If we can live on Mars, we can live on Earth sustainably*".

Beyond the Earth, there are many opportunities for humankind to explore. This plenary session showed how important space research is and what it can bring to people on Earth.

Plenary 3: **High Tech Entanglement: How the diverse global space industry and other high-tech sectors are becoming more entwined and interdependent**

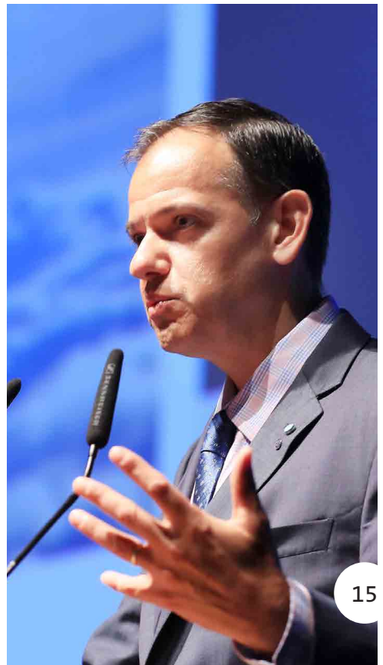
The plenary of the industry day kicked off with the acknowledgment that the industry relations committee adds a fourth "G" to the "3G Diversity" of IAF: Genre. IAF recognizes the genre mix of industry partners - from the largest multinational to the smallest startup.

James Brayshaw, Vice President of Sales at Planet, started off by mentioning that satellite constellation operates as a nexus point for the industry. From earth observation to telecommunications, satellites operate on all orbits to gather data. Brayshaw emphasized that integration with advanced technologies such as artificial intelligence and machine learning allow more efficient use of bandwidth availability and real-time data processing. Collaboration with technology partners enables Planet to do multi-spectral analyses to make data accessible to customers in hours' time for the strategic allocation of satellite resources. Standardization of data allows inter-agency collaboration and connections between constellations. With data being increasingly involved in decision-making processes, accuracy and data governance is paramount, an ecosystem that Planet and partners are working to create.

Antonio Abad Martin, Chief Technical and Operations Officer at Hispasat, provided insights from the satellite telecommunications industry (satcom). Satcom technologies are now shifting from providing broadcasts to providing multiple one-to-one connections, with new infrastructure being able to provide multi-altitude connections between multiple parties. The three product groups of Hispasat: GEO (geosynchronous orbit), LEO (low-Earth orbit), and HAPs (high-altitude platforms) aim to supply a reliable platform. He commented that HAPs will be able to provide mobile infrastructures with high granularity and low latency that is redundant and upgradable. Martin also quoted that while the technology is almost ready, the legal and insurance infrastructure for their use is still in process.

Herve Clauss, Director of MAPS Global Sourcing at TomTom, spoke of real-life applications such as location services, navigation software, and autonomous driving. With downstreams by customers and upstreams from cars and IOT (internet of things), data usage is reaching new heights, and TomTom is developing new AI algorithms that can analyze data real-time. Machine-human interfacing is crucial in ensuring data accuracy, with TomTom utilizing an agile approach to data to create new ways that consumers can use data.

Alison Lowndes, AI Developer Relations at NVIDIA, presented a more fundamental observation of space technology. NVIDIA's GPUs are used in spacecraft and satellites worldwide, with Lowndes' Frontier Developing Lab providing tools to process/visualize data, operate cloud-based GPUs, and integrate blockchain technology. NVIDIA also heavily invests in AI technology that is used for multi-spectral analysis, swarm constellations, and integration between hardware and software. Fully connected cars and equipment can bring an age where data can be used to minimize accidents and support humans make informed decisions.



Plenary 4: **The Game Changers: For a Joint Future in Space**

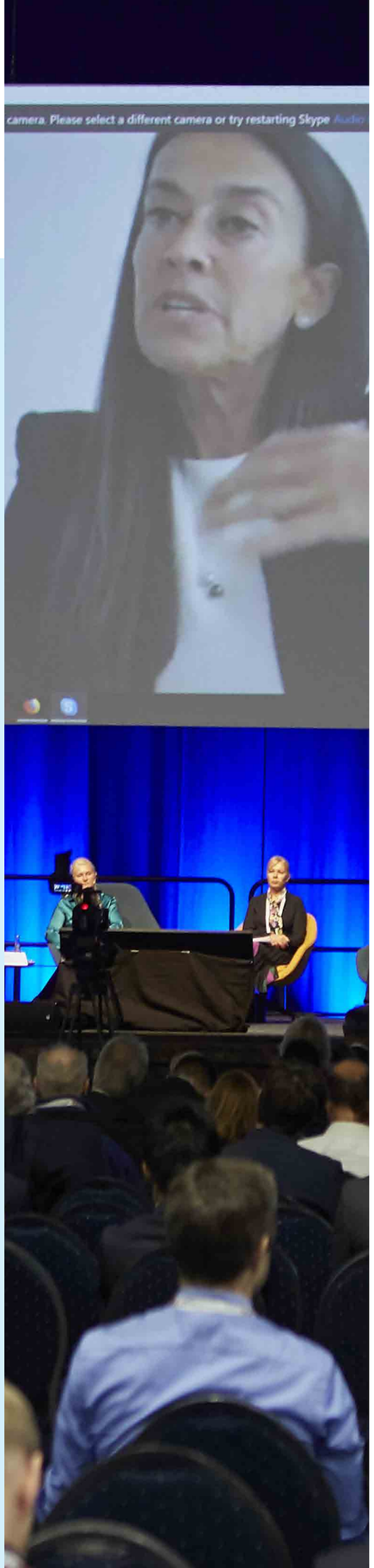
The fourth plenary featured the first women-only panel at IAC 2018.

Pascale Ehrenfreund, Chair of the Executive Board at DLR pointed out that the all-female panel symbolizes that there is existing female presence in the space arena - which must be recognized alongside a socio-economic ecosystem that provides personnel to the space sector. To better the pipeline Ehrenfreund said that agencies must collaborate with institutions and universities to ensure sustained competitiveness in the 21st century. DLR is hosting approximately 500 visiting scientists from over 100 countries every year, with diverse teams showing greater innovative capacity and rethinking existing solutions. Ehrenfreund concluded that talent management and diversity is the building block for future development.

Elzbieta Bienkowska, European Commissioner for Internal Market, Industry, Entrepreneurship, and SMEs at the European Commission (EC), started off by noting that EC has adopted the European Space Strategy in 2016 to compensate the private and public funds in the European space sector. The budget boosted the development and usage of the Galileo and Copernicus initiative, which cemented European leadership in fighting climate change. An increased budget proposal is planned for the EC that will target increased public utilization of satellite data, increased collaboration within and beyond EU member states, and cooperation agreements with partner nations in Asia and Latin America for use of Copernicus data.

Simonetta Di Pippo, Director of UN Office for Outer Space Affairs (UNOOSA), showed how space has become a cornerstone for modern society, with the UN Committee on the Peaceful Uses of Outer Space (UNCOPUOS) seeing a 25% increase in membership over the last four years. Developing countries are recognizing that space capability is the next step in getting international recognition, with many nations adopting principles held within the UN Space 2030 Agenda released shortly after the SDGs. The 3S': safety, security, and sustainability, were the principles that must be upheld to conserve space as a global commons for future generations.

Lisa Callahan, Vice President and General Manager of Commercial Civil Space at Lockheed Martin Space, and Grazia Vittadini, Chief Technology Officer at Airbus Defence and Space, agreed that partnerships among space companies were integral in achieving the more demanding missions of the coming decades. The larger space companies with a wide range of products and systems have the opportunity of being the nexus point for NewSpace actors. Vittadini recognized (1) digitalization, (2) private capital and entrepreneurship, and (3) personalization as the driving force for the next wave of space exploration. These forces will allow greater automation, paradigm shifts for data-driven manufacturing, tapping of the 20 billion USD NewSpace market, and adoption of new business models.



Plenary 5: **The Next Generation Plenary – Small Sats – Involving Everyone through Their Applications**

The next generation plenary on small satellites and how they enable to involve everyone, gathered actors from many different backgrounds to talk about innovative ways to access and use space. The six panellists who participated in the round table presented how small satellites helped them achieve what would have never been possible without them.

Alec Courtright, Research Assistant at Global Science & Technology, Inc., presented the opportunities for students offered through three different programmes. Given the rapid development of technologies, using small satellites has become a very efficient way for learning. Despite some inequalities in the spread of resources for students, using affordable technologies enables them to hone their skills.

Ana-Mia Swardt, Chief Project Officer of Simera Sense, explain how the small satellites industry gave her company the opportunity to develop rapidly compared to before, when it was difficult for small companies and developing nations to make progress due to the custom nature of satellites. Today, her company develop 3 to 6U cubesats and was involved with some of the 17 satellites launch by African countries.

Ekaterina Timakova, Final-year student at the Aerospace department of Bauman State Technical University (BMSTU), presented a University project held by students to help the space weather forecast to protect assets by predicting solar events more efficiently. They use a group of nanosatellites performing X-rays monitoring at high altitude. This choice was made to reduce the cost of the mission, showing how students can get their hands-on actual space objects.

David Henri, CEO of Exotrail, develops new propulsion modules for cubesats and explained how the electric propulsion can change the small satellites market, comparing dedicated launches with piggy back ones. Adding propulsion to small satellites increases coverage, enables lower orbits and helps mitigating space debris. The challenge is to obtain a combination of high impulse and high trust to minimize the time to reach the operating orbit and bring more agility to spacecrafts. This can also be seen as a serious precursor for on-orbit servicing.

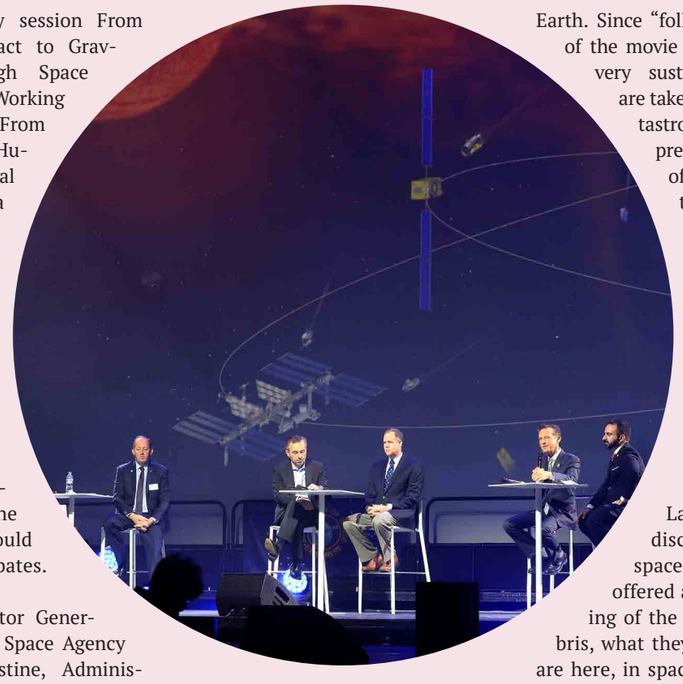
Marco Goméz, Research Engineer at the Costa Rica Institute of Technology, presented the development of a satellite project by a non-space faring nation, aiming at launching the first satellite of Central America. He presented the many challenges encountered during the project and, in particular, the financing issues. Not being a space faring nation turns out to be an obstacle to raise funds for satellite developments, hence, small satellites are a relevant solution. He pointed out that they resorted to crowdfunding to get the proper financing in the end, successfully launching the project.

Anastasia Volkova, Aeronautical Engineer at the University of Sydney, gave an overview of the activities of her recently founded start-up, focusing on precision agriculture. The goal is to use space technologies such as GPS and Earth observation, to strengthen them with adequate decision support and to offer a service through an application to monitor the crop health and plan the daily cares.

This panel clearly showed how the small satellite development enables more and more to involve everyone with space, independently of the environment and the resources.

Public Day

Plenary 6: From Deep Impact to Gravity through Space Weather: Working Together to Protect From Space Hazards, Human-made or Natural

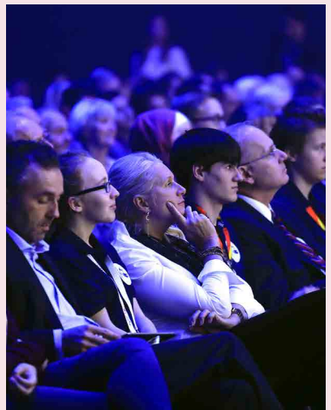


The plenary session From Deep Impact to Gravity through Space Weather: Working Together to Protect From Space Hazards, Human-made or Natural held in the Arena during the public day has been attended by several thousands of people familiar or not with space. The topic of space safety has been decomposed into multiple subtopics and simply explained so that the general public could easily follow the debates.

Jan Woerner, Director General of the European Space Agency (ESA), Jim Bridenstine, Administrator of the National Aeronautics and Space Administration (NASA), Thomas Jarzombek, Federal Government Coordinator for the German Aerospace Policy, Nicolas Chamussy, Executive Vice President Space Systems at Airbus Defence and Space, Patrick Michel, Director of Research at the Centre National de la Recherche Scientifique (CNRS), and Matteo Emanuelli, Co-Chair of the Space Generation Advisory Council (SGAC) shared their view on space safety. They provided different insight given their very different backgrounds, from science to politics and from engineering to management and strategy.

The first topic to be discussed was space weather. They presented the sun activities; how dangerous it can be to us and to spacecraft and in what limits the Earth magnetic field protect us. They explained how the solar activity is monitored, the actions that can be taken in case of a dangerous event and where we can still improve.

The second topic was about Near Earth Objects (NEOs), meaning comets and asteroids passing by at a relatively short distance from the Earth. Since "following the scenario of the movie Armageddon is not very sustainable", measures are taken to prevent any catastrophe. The speakers presented the means of observation to detect those objects and the possibilities of detection. They also showed interesting concepts developed by agencies to deviate the course of an impacting object to prevent a major catastrophe.



Last but not least, the discussion tackled the space debris issue. They offered a good understanding of the origin of space debris, what they are and why they are here, in space. Interesting view of Earth orbits filled with debris were shown to mark the point. The speakers presented also the threat that they represent and the necessity to clean space "before it is too late". They particularly insisted on the need to focus on space traffic management to mitigate beforehand. Some innovating solutions for cleaning were presented, as well as actual projects developed by agencies, taking very seriously this threat to the space assets and our life comfort.

To conclude the panel, three people from the audience came on stage to ask their questions directly to the speakers, involving everyone in the discussion.

Plenary 7: Greenhouse Gas Measurements from Space – Difficult Challenges, Emerging Success, and Plans for the Future

The plenary session on the greenhouse gas measurement from space gathered an impressive number of participants. The four speakers presented how space can help measure the greenhouse gas in the atmosphere and the challenges related to the different technologies.

Josef Aschbacher, Head of ESRIN and Director of Earth Observation Programmes at the European Space Agency (ESA), started with a video of the French President Emmanuel Macron saying: "There is no planet B". So, he presented how "ESA is monitoring planet A". With the Sentinel series and the ESA Climate Change Initiative, the combination of parameters that is important to understand the climate change, is monitored. Sentinel 5P provides daily measurements of greenhouse gas, like methane for example, with a accuracy of 7.5x7.5km per pixel. Sentinel CO2 is a future mission that will focus on the measurement of CO2 with an accuracy of 2x2km. Lots of progress are made in the Earth monitoring and future programmes will bring more tools to cope with the climate change.

Michael Freilich, Director of the Earth Science Division at the National Aeronautics and Space Administration (NASA), explained the pumping phenomenon of CO2. The measurements show that "half of the anthropogenic CO2 put in the atmosphere stays in the atmosphere" and NASA investigates thoroughly this phenomenon sending space missions. OCO-2, OCO-3 and GeoCarb are giving valuable information to understand it.

Alain Ratier, Director General of EUMETSAT, presented the Copernicus programme since EUMETSAT is part of the Copernicus team. He raised the question about why measuring from space. Space enables to have a global view of the carbon cycle, which would not be possible with only terrestrial measurements. Measuring the carbon emission is not enough, it is mandatory to also measure the flux, hence the importance of space.

Naoto Matsuura, Senior Chief Officer of Satellite Applications and Director of Earth Observation Research Center (EORC) at the Japan Aerospace Exploration Agency (JAXA), showed GOSAT results. This mission observes methane and carbon dioxide. He also presented a full roadmap from JAXA to monitor Earth, including the successors of GOSAT, GOSAT-2 and GOSAT-3. Japan is very dedicated to monitoring the atmosphere and has many future missions planned already.

The question session offered a very interesting discussion about the validation of the measurements. Since the modelling is a very tricky part due to some lack of maturity of some segments, making decision maker accept the data is not always easy. The focus has to be put on the conversion of the measurements into tangible and reliable information. We still have a lot to learn on climate change and atmosphere monitoring. It is clearly a group effort and it definitely involves everyone.

IAC 2018 Highlight Lectures

Highlight Lecture 1: **The Growing Role of Artificial Intelligence in Space Exploration**

Steve Ankuo Chien is the Senior Research Scientist at the Jet Propulsion Laboratory in CalTech.

Chien started off by recognizing the success of implementing AI to the EO-1 Hyperion satellite. The Autonomous Sciencecraft Experiment (ASE) software implemented on EO-1 analyzes images onboard and control the acceptance and rejection of images according to policies defined by scientists. Future EO satellites with AI capacities embedded since launch will have greater potential for redirecting satellite sensors for high-importance locations, and efficient use of limited data storage and communication equipment.

ASE's potential can be further enhanced when implemented in entire constellation of satellites - where the output from one satellite can inform the positioning of other satellites in the constellation. This will allow the real-time data provisions for natural disasters such as forest fires and volcanoes. ASE on EO-1 has already provided 100 times more data for volcanic events compared to baseline systems. For Thailand, ASE has doubled the temporal density of water information in events such as flooding.

Machine Learning (ML) techniques excel in analyzing data beyond human senses. Multidimensional data such as hyperspectral data, or hyperspectral analyses that can reach up to a few hundreds of spectrums, can be conducted with relative ease compared to humans whose senses are limited to three dimensions and visual spectrums. ML can process super pixel segmentation to decrease noise and reduce data, while pattern recognition allows finding sub-pixel signatures of chemicals. ML can also "create" derivative sensors from raw data, such as the texture-cam classifier that successfully differentiated plume, shadow, and land from the Eyjafjallajokull volcanic eruption in 2010.

Model-based AI systems allowed human scientists to input operational constraints and focus resources on high-level goal requests. The Mars Science Laboratory (MSL; Curiosity rover), when equipped with AI could autonomously perform low-level planning tasks such as target detection, feature extraction, and prioritization. MSL was more effective in conducting experiments with AI-aided systems than in 100% human-guided situations.

The planned adaptation of AI includes the Rosetta OSIRIS plume detection model, where "broad sweep" processes acquire topographic data and expectation levels for plumes, with "targeted sweeps" with focused instruments conduct detailed scans for high-interest areas. Multi-spacecraft operations will also be heavily guided by AI. The RELICS (Reionization Lensing Cluster Survey) mission concept includes observing target galaxies via 128 spacecrafts, with the AI-assisted search expected to provide up to 20% better results. Martian cave exploration missions using multiple rovers for signal relay and redundancy systems is also under investigation.

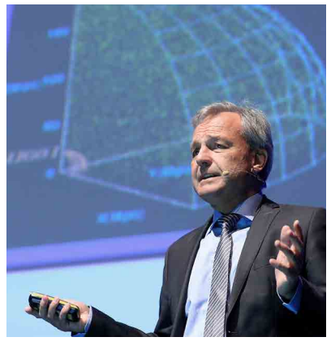
Lastly, Chien mentioned how AI lead to the democratization of space as institutions without space background could directly receive customized analysis products.

Highlight Lecture 2: **Gravitational Wave Detection on Ground and in Space – The New Window to The Universe**

Karsten Danzmann, Director of the Max Planck Institute for Gravitational Physics (Albert Einstein Institute) and the Institute for Gravitational Physics of the Leibniz Universität Hannover, gave a fascinating talk about quantum physics and space research trying to understand the gravitational waves. He gave a short history of the LIGO, a tool to detect gravitational waves, explained its functioning and showed some astounding results.

This topic currently involves more than a thousand of authors, 133 institutions and was even the reason for a Nobel prize in physics in 2017 for Rainer Weiss, Barry C. Barish and Kip S. Thorne "for decisive contributions to the LIGO detector and the observation of gravitational waves."

LIGO stands for Laser Interferometer Gravitational-Wave Observatory. It is a tool to detect distance changes. The expected event rate of the observatory is around once per year, to compare with once a millennium before the modifications of 2011. From 2011 to 2015, the LIGO was improved to a factor 10 but it was still no enough in regard to the initial goal where a factor 3 was still missing. The 14th of September 2015, while LIGO was still in commissioning, an alert is given by the coherent wave burst data analysis online pipeline. There was no match in the database with mundane events: They were listening to a black hole!



Karsten presented the actual research on gravitational waves. There are currently two LIGO deployed, one at Hanford, Washington, and the second one at Livingston, Louisiana. They enabled to observe the merging of two black holes where three solar masses where consumed in a matter of seconds and converted into gravitational waves.

By their intrinsic nature, black holes are extremely difficult to observe. As Karsten said "*black holes do not have hair*", illustrating that they do not have any other property than a mass and an angular momentum, limiting greatly the means of detection. The electromagnetic radiation detection showed that the event was not detectable by any other instrument despite being the brighter than the rest of the universe combined. This difficulty to observe raised also questions like are black holes made of dark matter?

On the 17th of August 2017 the LIGO had the opportunity to observe a neutron star merger, inducing a gamma ray burst. It enabled to get valuable data on the dynamics of the universe.

The last part of Karsten presentation referred to the current and future missions for gravitational wave detection. He mentioned the LISA mission and its precursor mission, LISA Pathfinder launched in 2015. LISA consists in three satellites with 3 million km between them to detect galaxy collisions. By 2030 more ground based observation missions will be developed (LNC, LSST, SKA, ALMA, EHT) and space telescopes should join the fleet (JWST, EUCLID, Gaia, WFIRST, eROSITA, GRAVITY).

Karsten made it clear that space will still contribute greatly to the science of gravitational waves as there is still a lot to discover and understand.

Highlight Lecture 3: **The Sky is not the Limit – Paving the Way for an Orbital Society**

Tom Enders, CEO of the aerospace company Airbus, discussed about business opportunities in space when facing the current transformation of the sector. The increasing number of private ventures investing into space capabilities is a good indicator of the reality of an orbital economy, especially at low Earth orbit. However, the push for space exploration, and even manned space exploration expands this economy to the Moon and beyond.

The challenge that the Airbus group is facing today consists in understanding how to keep the momentum of exploring space and the place that Europe can take in these changes. "Will Europe end up being the former gateway to the world or will it turn out to become the new gateway to space?" At this level of difficulty, going alone is not possible anymore, cooperation is mandatory. The US gives an excellent example of cooperation between the government, the NASA and the Industry resulting in spectacular developments. In comparison, the collaborations in Europe are to weak. Tom encouraged vigorously more cooperation between France and Germany, the two heavy weights of Europe, to show the way and to boost the developments in space. He unfortunately deplored *"too much talk, not enough walk"*, dragging down considerably the efficiency of European projects, making them unable to face the competition.

On the bright side, Enders does not estimate the Europe to be done, since the potential of excellency and know-how is there. He strongly suggested that Europe should not just watch but be an active partner with three main axes. First, a restructuration of the European governance is needed. The current system is too heavy, adding difficulty in space projects for no reason. Second, the repartition of the geo-return should be reconsidered in case of international competition. Having a more global geo-return instead of a split by project would help maintaining a better competitivity by lowering the costs and delays due to the work being done in different countries. Last, we should not be shy and push for European preference, exactly like the US is doing. It is clearly unbalanced.

Enders also insisted on the need for inspiration. The people working in the space industry do that by passion. It is important to imagine visionary projects that capture human creativity. The industry has its role to play and need more public support, hence a strong need to reinforce the space outreach.

He suggested many projects to boost the European economy like the 3D-printing of an entire platform in space feasible within 2 to 3 years, a full on-orbit servicing mission or a worldwide quantum data transmission network.

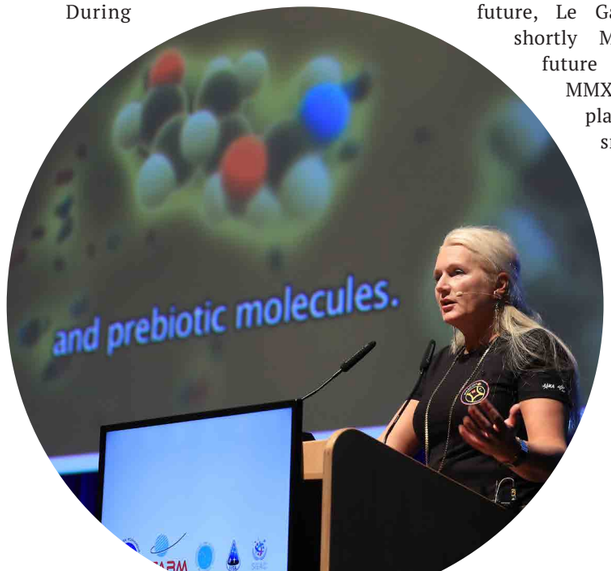
Europe is full of opportunity to be explored and it needs to embrace the changes to stay competitive. ArianeGroup is, for example, a first step towards efficiency.

IAC 2018 Late Breaking News

HAYABUSA2, MASCOT, MINERVA II

The morning of the last day of the IAC, Pascale Ehrenfreund, Chair of the Executive Board of the German Aerospace Center (DLR), Jean-Yves Le Gall, President of the Centre National d'Etudés Spatiales (CNES) and Masaki Fujimoto, Professor of Space Plasma Physics at the Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency (JAXA), presented, with the support of experts, the Hayabusa2 mission on the Ryugu asteroid and its last developments.

After giving a description of the mission and its instruments, Ehrenfreund was very proud to announce the successful landing of MASCOT from 60 meters. The small lander had a few bounces and given that Ryugu's surface is extremely rough, it was a very difficult landing. At the time of the conference, MASCOT had already spent three nights on the asteroid since a single day lasts 7 hours.
During the descent, the lander was upside down. It took 20 images before reaching the surface. The 21st photo should have been the first when landed. However, the telemetry stopped at the 19th image. Without images, determining the position of MASCOT was a difficult job and the instruments were giving weird results. The control team took then the tough decision of interrupting the nominal sequence and move the lander to put it in the correct position before resuming its activities on Ryugu. It was a thrilling experience to follow this little lander's adventure on a foreign world.

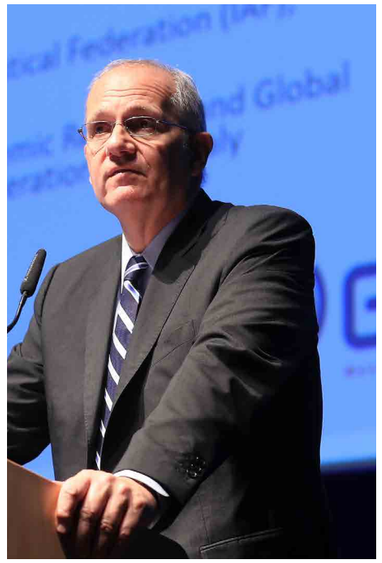


Jean-Yves Le Gall presented the French contribution in the project. He pointed out that, even if it was not always smooth, MASCOT is an excellent example of international cooperation. France brought its know-how acquired at CNES with the Philae instrument developed for the Rosetta mission that landed 4 years ago. Orienting towards the future, Le Gall presented shortly MMX as the future of MASCOT. MMX is a mission planning to send small rover on Phobos in 2024. As Hayabusa2, it is from Japan with instruments and systems developed by France and Germany. It will be the same model of cooperation. He gave shortly the floor to Aurélie Moussi who worked on the CNES side of MASCOT, she explained the challenges that was faced during the development phase. Having no propulsion, no anchor system but a mobility system and having a very short time for development pushed the teams to their limit to deliver this masterpiece that is MASCOT.

Masaki Fujimoto presented JAXA's Small Body Exploration Program. Given that these small bodies might have brought the water to our planet, the objective of this program is "going after the Big Question". It shows that, despite its unquestionable success, Hayabusa2 is just a small element in JAXA's program with much more to come. He also gave a feedback on the challenges met for the operation of the mission. He gave the example of the landing surface. Some hasty assumption was made that part of the surface would be smooth, which was not the case. The target was categorized "unfriendly" and the decision centre needed more information. Fortunately, The Minerva system gave amazing images enabling a better planning for the mission.

What the actor of the project described as the keys for the success of this international cooperation were trust, respect and courage.

IAF Global Networking Forum (GNF)



GNF Sessions: Monday 1 October

Opening Day

The GNF Sessions at IAC2018 opened with the IAF President, Jean-Yves Le Gall emphasizing the increased role of GNF in integrating different sectors and disciplines. The Vice President for Science & Academic Relations and Global Networking Forum, Gabriella Arrigo, encouraged audience members to actively participate in sharing and exchange of ideas and opinions, under the spirit of *"Meet, Share, and Connect."*

Roberto Battiston, President of the Italian Space Agency (ASI), reported on how the Alpha Magnetic Spectrometer (AMS) on the ISS has advanced our understanding of dark matter and cosmic ray particles. AMS is an international collaborative research effort that utilizes the ISS-board particle detector (AMS-02), CERN (European Organization for Nuclear Research) laboratories, and stratospheric balloon experiments. AMS-02 can directly observe cosmic rays of which the positron (e^+) and helium fluxes have generated results that cannot be explained by single rigidity models. AMS' continued study of 4-He (an isotope of Helium) will provide new insight into the existence of anti-helium, and consequently, of the properties of antimatter.

Simonetta Di Pippo, Director at the United Nations Office for Outer Space Affairs (UNOOSA), moderated the panel on the Results of the 26th Workshop on Space Technology for Socio-Economic Benefits: Industry, Innovation, and Infrastructure for Development (3Is4D). Cenan Al-Ekabi, Project Manager at the IAF, reported on the growing number of delegates from emerging space nations, and the representation of youth at IAC. Mr.Al-Ekabi also noted on the growth potential for gender representation (only 23% of IAC 2018 attendees were female), and the role of Global Conferences on Space for Emerging Countries (GLEC) in connecting emerging space nations to the global ecosystem. Shirish Ravan, Senior Programm Officer at UNOOSA, talked about the role of UN SDG[1] #9: Industry, Innovation, and Infrastructure in linking space applications to the socio-economic benefits. The workshop discussions showed how industry and startups from emerging countries can benefit from increased access to space by means of broadband accessibility, Earth observation, and international cooperation for innovation. Joachim Post, International Relations at the German Aerospace Center (DLR), remarked that developing countries have gaps of understanding of space technologies between the providers and beneficiaries. Raising awareness in all levels and across sectors is especially important for countries challenged in utilizing space technologies. To this, both Ravan and Post commented on the importance of enablers: academic environment, governmental support programs, and enthusiasm for entrepreneurship.

Lena De Winne, Deputy Head of Administration at Asgardia, moderated the panel on using ISS as a launchpad for future astronautics. The panel consisted of experts from government and industry at the United States and Russia. Evgeny Mirkin, General Designer at RSC Energia, remarked ISS' unique efforts in the past two decades of international collaboration, with 56 expeditions and 232 cosmonauts and astronauts to date. Dmitri Loskutov, Head of International Cooperation Department at Roscosmos, commented that ISS utilization will continue through 2030, with the open architecture platform allowing for industry participation as well as government. Mark Mulqueen, ISS Program Manager at Boeing, described how private technologies developed on the ISS is now being used for beyond-ISS missions such as the Lunar Gateway, with spin-off technologies benefitting lives back on Earth and human spaceflight capabilities beyond Earth orbit. William Gerstenmaier, Associate Administrator for Human Spaceflight at NASA, lastly commented on how inter-governmental and private partnerships fostered through ISS is informing decisions for a post-ISS cooperation of multiple space stations and development of cis-lunar infrastructure.

Robert T. Richards, Vice President of Strategy and Business Development, Advanced Programs Division at Northrop Grumman, continued on the topic of beyond-Earth exploration. With the recent acquisition of Orbital ATK (now Northrop Grumman Innovation Systems), the Cygnus spacecraft has been added to Northrop Grumman's growing portfolio of space systems. Cygnus' autonomous capture and docking capabilities and "free-flyer" capabilities allow the ISS to be the hub of higher-orbit missions, with "Cygnus Labs" being mini-stations that will undertake shorter-term experiments. The Lunar Gateway Architecture, being built collaboratively with other commercial space module providers, add flexibility and autonomy to lunar exploration by enabling frequent lunar lander missions and real-time control of lunar rovers.

[1] United Nations Sustainable Development Goals.

GNF Sessions: Tuesday 2 October

Industry Stream

The second day of GNF at the Industry Stream consisted of an inter-party panel on lunar exploration, the newly-formed Australian space agency, a startup pitch session, and three industry deep dives.

The GNF sessions started with an international panel on lunar exploration, moderated by Eric Stallmer, President of the Commercial Spaceflight Federation in the USA. Nicolas Faber, COO at Blue Horizon in Luxembourg, quoted the Advanced Student Team Research in Space (ASTRI) program in Luxembourg that nurtures lunar engineers. Ahsan Choudhuri, Director at NASA MIRO Center for Space Exploration & Tech Research, noted that the current aerospace workforce does not represent the 21st-century demographic, and sustainable education and mentorship is required. The discussion moved to lunar infrastructures, with Maria Antonietta Perino, Director of Relations with Space Associations of Thales Alena Space in Italy, emphasizing the role of flexible, configurative architecture with immersive virtual-reality environments for lunar missions. Comments from other major private parties, includ-

ing Peter McGrath from the Boeing Company in the U.S., Dominic "Tony" A. Antonelli from Lockheed Martin Space Systems in the U.S., and Juergen Ackerman from ArianeGroup in France, reinforced the role of next-generation technology in lunar exploration, whose development is influenced by government partnership and VC[1] funding. Speakers from startups, including Karsten Becker of PT Scientists in Germany, and Kyle Acierno of iSpace Europe in Luxembourg, spoke of autonomous systems and AI-led data analytics that allows smaller companies to have lunar capabilities. Oliver Juckenhoefel, Vice President of On-Orbit Services at Exploration at Airbus Defence and Space, closed off by remarking new initiatives for lunar exploration such as the Moon Race by Airbus.

At IAC 2017, the Australian government announced the approval for the Australian Space Agency (ASA). The head of the Australian Space Agency, Megan Clark, was interviewed by moderator Pamela Melroy, Director of Space Technology and Policy at Nova Systems of Australia on the future prospects of the Agency. Clark first mentioned the growing collaboration among agencies, noting new cooperation's between the Australian Space Agency and the Centre National d'Etudes Spatiales (CNES) and the UK Space Agency (UKSA). Australia's geographic location for connecting orbital space and Earth has also attracted deep space communication stations from ESA and NASA. The Australian Space Agency is investing heavily in commercial infrastructure, with a 1 billion dollars (AUD) capital target for the next term. The highly developed automation and robotic industry of Australia, as well as the growing startup ecosystem, would strongly position Australia in the global space supply chain.

The first edition of the *IAF Startup Pitch Session*, saw 10 startups give 5-minute pitches followed by 2-minute Q&A sessions. Four startups presented airborne/spaceborne hardware: AlphaLink that manufactures unmanned multi-body aircraft for ultra-long duration airborne capabilities; Insitek, whose tethered balloon infrastructure bring telecommunication services to places where landline internet services are difficult to implement; Dawn Aerospace, whose rocket-powered high-speed UAV could launch satellites to low-earth orbit; and Space Walker Inc. whose suborbital spaceplane can act as a platform for research or smallsat launches. There were also platform service providers such as Precious Payload Inc., whose rideshare platform aggregate launch provider information to contract for the optimal payload space; and Valispace, whose data management integration platform facilitates an integrated design process. There were also mid-product providers, where Space Products and Innovation (SpiN) provides plug&play satellite components and Manastu Space Technologies Pvt Ltd whose Hydrogen Peroxide based propellent is cheaper and safer than Hydrazine. Lastly, there were application startups such as Virtual Space Systems with a virtual reality platform with a treadmill and Sensovo GmbH whose watch-like product provide tactical navigation.

Valispace was both the judge's and audience's choice winner, to receive coaching sessions from Airbus Bizlab and Boeing Horizon X Ventures, as well as three tickets to IAC 2019 sponsored by Lockheed Martin.

The first Industry Deep Dive session that followed featured Chris Moran, Vice President of Corporate Development and Executive Director and General Manager of Lockheed Martin Ventures (LMV). Moran described how factors of prior partnerships, government relations, and financial soundness are all important for startups looking to get investments from LMV. LMV work with multiple accelerators and partners and designate a single point of contacts for all acquired companies to expedite communication and ensure the independence of the startup.

The second Industry Deep Dive session was from Kyle Acierno, the Managing Director for iSpace Europe. Acierno said key partnerships are essential in advancing startups to the next stage. For iSpace, technology partnership with Suzuki for wheel development, and partnership with commercial developers for lunar landers were crucial for the efficient acquisition of knowledge and investor validation. iSpace Europe has received 500 million dollars in funding, which will be utilized for the first two missions to be launched by SpaceX.

The third Industry Deep Dive session was from Agnieszka Lukaszczyk, Senior Director for European Affairs at Planet. Lukaszczyk described how Planet (previously Planet Labs) bootstraps by insourcing every development process: R&D, manufacture, operation, and data management. The insourcing and control allow Planet to iterate rapidly while managing three constellations (300 CubeSats, 5 RapidEye satellites, and 10+ SkySats) and integrating within verticals. Planet's new direction is in data management where Planet donates Earth Observation data for humanitarian purposes.

The last Industry Deep Dive session came from Jim Bell, Director at the ASU Space Technology and Science ("NewSpace") Initiative, Lisa Callahan, Vice President and General Manager of Commercial Civil Space at Lockheed Martin, and Lon Levin, President and CEO at GEOshare, about the MILO Space Science Institute. The MILO Institute serves as a nexus point for organizations around the world on identifying promising missions, gathering funding, and collaboration for mission operations. Currently, the institute has acquired 200 million dollars in funding for the development and operations of six smallsats that will locate near-Earth asteroids.

[1] Venture Capital

Society & Education Stream

The GNF Sessions of the Society and Education stream, covered many different aspects of space like arts, outreach, space debris, parabolic flights, capacity building in emerging countries and New Space in Earth observation.

In a session on Orbits, Arts & Culture, Nelly Ben Hayoun, Director of NBH Studios, working at the SETI Institute presented her work on critical design, reflecting on what it means to develop new technologies and the motivation behind innovation. Melanie King, Director of the Lumen Institute, showed amazing astronomy shots to trigger

a discussion on the understanding of the human existence. Nahum Romero Zamora, Director of the KOSMICA Institute, works on "being able to formulate and to ask some of the issues we have on our planet". Using letters of rejections of women application for astronaut positions from NASA in the 60s, he emphasized the changes and innovative views the space sector has been through and what it brings to the public. He worked with refugees, "suffering from those artificial lines we created" to promote the benefits of the overview effect, to see the Earth as the home of all. Aoife Van Linden, Tol Artist, presented her performance at ESTEC on chaos and made a parallel with the research mindset of scientists. Bernard Foing, chairing the session gave an overview of the Moon Village workshop activities before Rob La Frenais, curator, who explained the Republic of the Moon exhibition on a video message.

The following session focused on Bridging Space and Society: Strategies of Space Agencies to Foster the Uptake of Satellite-Based Services, and Isabelle Duvaux-Béchon, Head of the Member States Relations and Partnerships Office at the European Space Agency (ESA), demonstrated the ESA catalogue for sustainable development initiatives, insisting that "space can support non-space policies". Carlo Des Dorides, Executive Director of the European GNSS Agency (GSA), presented the Galileo services, how the benefits can justify the costs and promoted that making the signal free is a good way to make people involved. Simonetta Di Pippo, Director of the United Nations Office for Outer Space Affairs (UNOOSA), offered the opportunity to build unique capabilities in space for sustainable development with a specific focus on emerging countries by presenting the UN-SPIDER programme. Everyone should be involved because "we cannot do it alone". During the session, Dr. Di Pippo received the Hubert Curien Award from Eurisy for her achievements.

Nikolai Khlystov, Lead, Aerospace Industry, at the World Economic Forum, presented during the session on Space Sustainability Rating – New Way of Addressing the Orbital Debris Challenge, an innovative approach to bring motivation to deal with space debris. When many talks about punishing the polluters, he suggested a reward system for the cleaners with a systematic rating of the sustainability of space missions. It would be first focused on orbital sustainability and extend further to Earth sustainability.

During the following session on Aircraft Parabolic Flight Campaigns for Microgravity and Student Experiments, Derek Gawanlock, Test Flight Engineer at the National Research Council (Canada), Jean-Baptiste Renard, Scientist at The National Center for Scientific Research (CNRS), Hanns Selig, Project Manager MIGROP Parabolic Flight at GERADTS GMBH and Nigel Savage, Programme Coordinator for Gravity-Related University Student Experiments at the European Space Agency (ESA) presented the benefits of parabolic flights where scientists and students can be onboard with their own experiments, which is an extremely important parameter.

In the GNF session titled "The Role of Education in Support of Emerging Countries", Simonetta Di Pippo, Director of the UNOOSA, Francisco Javier Mendieta Jiménez, Director General of the Mexican Space Agency (AEM), Driss El Hadani, Director of the Centre Royal de Télédétection Spatiale (CRTS), Kai-Uwe Schrogl, International Institute of Space Law (IISL) President and Chief Strategy Officer at the European Space Agency (ESA), Roberto Battiston, President of the Italian Space Agency (ASI), Seishiro Kibe, Senior Advisor of International Relations and Research Department at the Japan Aerospace Exploration Agency (JAXA) and Jörg Feustel-Büechl, Advisor, at the Bavarian State Ministry for Economic Affairs and Media, Energy and Technology (MWMET), reflected on the role of education to support emerging countries and the utilization of space technologies, following the UN sustainable development goals.

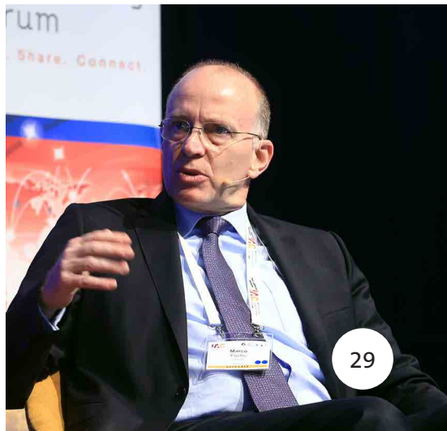
In the last session of this stream on New Space – Rocking Earth Observation, Peter Platzer, CEO of Spire Global, Yasu Yamazaki, Brand Manager at Axelspace, Rafał Modrzewski, CEO of Iceye and Grega Milcinski, CEO of Sinergise, presented how their companies are participating in the changes that the space sector is undergoing. They showed that start-ups have become major actors in the development of space.

GNF Sessions: Wednesday 3 October

Public Stream

The Global Networking Event Public stream, happening during the IAC 2018 Public Day in Bremen, was an occasion to get an insight on the industrial contribution in the space sector and for the public, to get the once-in-a-lifetime opportunity to discuss with Alexander Gerst, the German ESA astronaut, live form the International Space Station, and to meet a panel gathering seven astronauts on stage.

During the first session of the day, titled *What Will Shape the Future of European Launchers*, stakeholders in the launchers industry, discussed about the upcoming Ariane 6, its development and its challenges. Thomas Jarzombek, Member of German Parliament and Federal Government Coordinator of German Aerospace Policy, Martin Guenthner, Senator of Economic Affairs, Labour and Ports, Jan Woerner, Director General at the European Space Agency (ESA), Matthias Maurer, the latest Astronaut of the European Space Agency (ESA), Luce Fabreguettes, Executive Vice



President of Arianespace, Pierre Godart, CEO of ArianeGroup Gmbh and Marco Fuchs, CEO of OHB SE / OHB System AG, shared their different perceptions of this new launcher, what it can do and how it can face the competition with the objective of having a product 40% cheaper than the Ariane 5. Like Luce Fabreguettes pointed out: "We are at an exciting turning point now" and the entire European space sector is having great expectation for this new model. The competition is harsh, so talking about Ariane 6, the question is, according to Marco Fuchs: "How can we be the innovation leader?". And to those who ask about the challenges to face, Jan Woerner has a simple answer: "No risk, no fun".

Later on, Hans Koenigsmann, Vice President of Build and Flight Reliability at SpaceX, presented the challenges of using reusable launchers. The policy of SpaceX is to be as reusable as possible, meaning minimising the refurbishment after each recovery. It has become the main pivot of SpaceX strategy, it will increase the launch rate, reduce the launch cost and ultimately enable more reliable vehicles.

During the session *Space Spin-Ins from the Underground – CERN's Aerospace Applications*, Enrico Chesta, Aerospace Applications Coordinator of the Knowledge Transfer Group at the European Organization for Nuclear Research (CERN), explained how the research at CERN has, on top of synergies with space, participated in some missions like the AMS experiment, LISA Pathfinder, Euclid and others. The common ground here is the Big Data, one of the trendiest topics across industries and space could use the example of CERN to optimise how it handles it.

In the following session on *European Industry Contribution to a Lunar Orbital Platform*, Detlef Wilde, Program Manager for Suborbital Missions at Airbus Defence and Space, presented Airbus Defence and Space work of the Lunar Orbiter Platform - Gateway (LOP-G). He detailed the progress of the Orion capsule and the future plans for the exploitation of the LOP-G, showing that the European industry is deeply involved in reaching the Moon again.

Finally, in the OVB Arena took place the public day, where the audience assisted to a live In-Flight Call with the International Space Station (ISS), seeing Alexander Gerst live from 400km above their heads. Some audience members even had the opportunity to go on stage and ask directly their questions to the German astronaut who was extremely pleased to take part in this event. This unique and exciting event was followed by an IAF-ASE Astronauts Panel where seven astronauts took part in a discussion describing to the public the challenges of life in space. Reinhold Ewald, Thomas Reiter, Pamela A. Melroy, Matthias Maurer, Koichi Wakata, Michael Lopez-Alegria and Ernst Messerschmid discussed and answered questions from the audience about living in space, becoming an astronaut and as well, what is life after being in space.

During this open day, the public had the occasion to witness many fascinating events and meet space personalities. Space enthusiasts could share their passion and show that, in space, it is not that difficult to involve everyone.

Development Stream

The GNF Development Stream, divided in six sessions, covered a wide array of topics, from small satellites applications to the Italian Space Economy, passing by ESA's new proposed "Safety Envelope Programme".

Organized by China HEAD Aerospace and moderated by Steve Bochinger, Euroconsult COO, the first session was titled *Small Satellite Applications Development Leveraging Socio-Economic Benefits*. Bochinger introduced the 2017 smallsats market, followed by an overview of China HEAD by Kammy Brun, China HEAD Head of Global Business Development. Valanathan Munsami, CEO of the South African National Space Agency, described the process that the Agency undertook to identify priorities for its space programme, underlining that satellites are means to socio-economic benefits. Similarly, Driss El Hadani, Director of the Moroccan Centre Royal de Télédétection Spatiale (CRTS), highlighted the Centre's mission and approach in supporting national strategies. Finally, Jorge Del Rio Vera from the United Nations Office for Outer Space Affairs (UNOOSA) underlined how space can contribute up to 65% of the UN Sustainable Development Goals.

The second session, *Introduction of the System and Current Development on Aerospace Components in China*, was introduced by Li Ming, Vice President of China Academy of Space Technology (CAST), and followed by Zhang Lei, Assistant of the Director of CAST, focusing the discussion on the China Aerospace Components Engineering Center (CACEC), the Quality Assurance Agency affiliated to CAST, giving an overview of the agency, its Quality Assurance systems, calling for international cooperation topped by the possibility to access the future Chinese Space Station.

The ESA's Jam Session on *Space Safety* was an incredibly interactive session, with only two speakers – ESA Director General, Jan Woerner and Chiara Manfletti, Programme Advisor to the Director General – leaving the floor to the audience, allowed to participate and comment at any point of the discussion. Main topics discussed were Space Debris removal, Space Weather, Asteroid and Meteorites, and the various technologies, actors, and budgetary needs to tackle such issues. Eventually, Jan Woerner announced the plan to propose a "Safety Envelope Programme" to ESA Member States in the upcoming 2019 Ministerial Council, before the discussion moved back to potential issues, technological and commercial requirements for the endeavours implied by the programme.

During the session *The Need for a Solid SME Base within the Industrial Chain on Space and Defence Programmes* agencies, large industries and SMEs exchanged views on how SMEs are contributing and can contribute to space missions. With a first panel on public procurement and how to favour SMEs in specific circumstances, the session was rich of suggestions for public actors to support SMEs and for SMEs to thrive with public procurement contracts and partnerships with prime contractors. The second panel highlighted the reasons for which SMEs are great partners both for agencies and larger contractors: they can specialize much more than large companies and they are agile in what they do, enabling outside-of-the-box solutions.

Organized by the *Italian Space Agency (ASI), the workshop Italian Space Economy for the Sustainable Development Goals* gathered together Italian Space stakeholders to discuss the country's contribution to the SDGs via space. The session was launched with presentations by the President of ASI Roberto Battiston and by UNOOSA Director, Simonetta di Pippo, speaking respectively of the Italian space assets and programmes and the vitality of space in the pursuit of the SDGs. The discussion moved then to the status of the Italian space industry, its segments and needs, with a focus on the shift of paradigm from large to small satellites and the ongoing democratization of space.

The final session for the Development stream, *The UK Space Agency – Towards 2030*, was held by Graham Turnock, Chief Executive of UKSA. Turnock made an overview of the British history as spacefaring nation, moving then on current governmental plans to catch the 10% of the Space Market by 2030, a goal which will require serious commitment in R&D, higher education, fostering innovation, technological spill-overs and Intellectual Property. Turnock concluded reassuring that the UK will still thrive as space actor despite Brexit, given the large number of international partnerships, a new spaceport, and a reinforced ESA membership.

GNF Sessions: Thursday 4 October

Future Stream

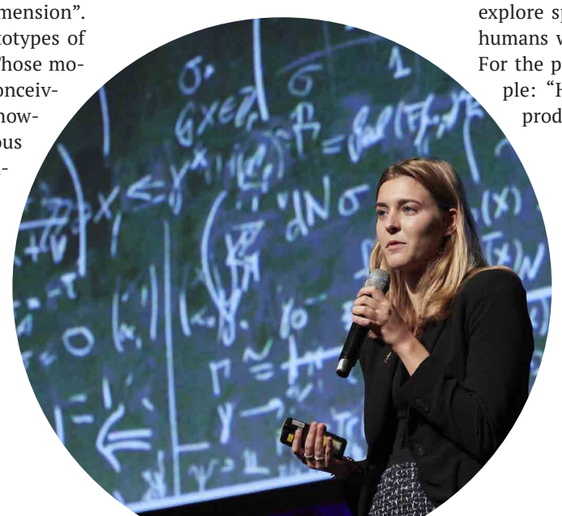
The GNF sessions part of the future stream, were a good occasion for the audience to be updated and discover the upcoming projects and technologies for space activities. The discussions ranged from the launchers of tomorrow sustaining a low Earth orbit ecosystem, to taxi-drones on Earth, 3D-printing a Moon base, the future Chinese space station, quantum technologies and the search for habitable places in the universe.

The first session *Space Station and the Next Generation: Launching the LEO Ecosystem,* organized by Boeing, presented the company's views on commercialization opportunities in low Earth orbit. Mark Mulqueen, ISS Program Manager, John Mulholland, CST-100 Starliner Program Manager and Chris Ferguson, Boeing Starliner Astronaut, presented three different aspects: the motivation to do science in space, the design of the Starliner and the strategy of the Starliner.

During the *Space & Mobility session*, organized by the Ministry of Economic Affairs, Labours and Ports of Bremen, Stefan Klocke, Chairman of the Advisory Board of Volocopter GmbH and Hansjörg Dittus, Executive Member for Space Research and Technology at the German Aerospace Center (DLR), presented the future of urban air mobility: "it is time to use the third dimension". The speakers showed prototypes of drones used as air taxis. Those mobility concepts are not conceivable without the space know-how with the tremendous challenges of traffic management and safety.

3D-printing is one of the key technologies in the future of space exploration. Advenit Makaya, Materials and Processes Section TEC-MSP at the European Space Agency (ESA) and Matthias Sperl, Group Leader Granular Matter at the German Aerospace Center (DLR) presented, during the session on *URBAN: Conceiving a Lunar Base Using 3D Printing Technologies*, the recent advances in this field at their respective agencies. A fused deposition modelling printer has already been used on the International Space Station as a first step for on-orbit manufacturing. The 3D-printing using Moon regolith shows very promising results with structures as strong as concrete on Earth. In a second part the audience was asked what would be printed first on the Moon. Various answered were given from very interdisciplinary backgrounds ranging from operations, survivability and sustainability to arts.

Yang Hong, Chief Designer at the China Academy of Space Technology (CAST), gave a full presentation on the upcoming Chinese Space Station, as an *Introduction to Manned Environment and Scientific Experimental Resources of Chinese Space Station*. The purpose of Tiangong, meaning "Heavenly Palace", is to give the opportunity to improve the know-how of space experimentation. Yang Hong made a clear call for everyone: "the China Space Station is not only for Chinese but also for international partners".



On a different topic, the rise of quantum technology might have a highly disruptive impact on the space sector. In a session organized by OHB, Hansjörg Dittus, Executive Member for Space Research and Technology at the German Aerospace Center (DLR), Harald Hauschildt, Programme Manager, Scylight Programme at the European Space Agency (ESA) and Christoph Marquardt, Group Leader Quantum Information Processing Group at the Max Planck Institute of Light (MPL) presented the implication of this technology on space. Communication, cybersecurity, sensors, clocks for GNSS and science will be greatly influenced and "a global cooperation is necessary to make the revolution happen".

During the last session on *Life in Space: the Science, the Challenges, and the Broad Horizon*, Pascale Ehrenfreund, Chair of Executive Board of the German Aerospace Center (DLR), Chiaki Mukai, Senior Advisor, Astronaut at the Japan Aerospace Exploration Agency (JAXA), John C. Mankins, President of the Mankins Space Technology, Inc. and Dava J. Newman, Apollo Program Professor at the Massachusetts Institute of Technology, presented the current understanding of life in space: the search for extra-terrestrial life, how to put humans in space and keep them there and how to explore space. But why considering humans when we can send robots? For the panel, the answer was simple: "Humans are, by far, more productive than robots".

Challenges Stream

The first GNF session of the Challenges stream was on climate change. Space spectroscopy allows the tracking of carbon dioxide (CO_2) and greenhouse gases (GHG). Charlotte Bewick, Systems Engineer at OHB Systems, commented how, unlike land-based systems, space-borne applications can identify types and causes of climate change source elements. John Burrows, Director of the Institute of Environmental Physics at the University of Bremen, and Michael Freilich, Director of Earth Science Division at NASA, commented that climate change is a "nonlinearity" in data that is hard to predict. As Audrey Berquand, NPI-PhD student at the Intelligent Computational Engineering Lab remarked, nonlinearity-driven challenges require human insight as AI can only learn from past data. The political challenges of human-led collaboration, Timo Stuffler, Director of Business Development at OHB Systems, mentioned, can be alleviated by the inclusion of non-political entities (such as corporations) in the research and solution acquisition process.

The second GNF Challenges session introduced China's New Generation Recoverable Satellite (NGRS) service. With the discontinuation of the space shuttle programme, delivery, and retrieval of large (35-50 pound) experiments are not feasible. US-led private carriers or Russia's Soyuz launcher can bring back a small amount of cargo, but its cargo is still subject to high-g launch/landing that is unsuitable for many biological experiments. NGRS offers a self-contained chamber with up to 1-year experiment duration 200kg payload capacity that is undisturbed by human activities (such as ones on the ISS). As a commercial platform, NGRS is subject to less regulatory/political issues and can be more flexible to client demand. NGRS aims to open up the next era of biological long-term experiments in space.

The following session focused on the young generation's perspective on space and security. The conversation between the ten panelists mainly revolved around the three topics: security from space, security of space, and security in space. The panel comprised of young professionals from 6 countries, with backgrounds in military, entrepreneurship, government, and intergovernmental agencies. Security from space relied on greater geoinformatics collaboration. Security of space touched on space situational awareness, space surveillance and tracking, and space weather. Security in space described the safety of space assets, space traffic management, space debris mitigation, and cybersecurity. The dual use of technology was a chief roadblock in the international collaboration that was echoed in all age groups, with the social responsibility of sustainable engagement being the underlying commonality between all parties.

The fourth GNF Challenges session was the *SpaceGen Entrepreneurs Forum*. Robert Boehme, Founder and CEO of PT Scientists, emphasized how space is a cross-over industry for other industries, where frontline innovations can have many spin-off benefits. Chris Boshuizen, Operating Partner at Data Collective VC, talked about how prototyping and proof of hardware are critical in the high-stakes space investment board. 2015 marked a turning point for NewSpace actors with the year alone seeing more VC funding for space than in the previous 15 years combined. Adnan Al Rais, Director of the Remote Sensing Department at the Mohammed Bin Rashid Space Center of UAE, mentioned how governments are increasingly trying to build sustainable financial ecosystems that can take on risks posed by space startups.

The last GNF Challenges session was presented the industry focus to the developing space workforce. Government experts, such as Yuguang Yang from CASIC and Olga Zhdanovich and Andrew Herd from ESA, talked of long-term infrastructure development centered around STEM capabilities. Building knowledge containers and developing standards were also mentioned as retaining expertise from the retiring workforce. Corporate experts, such as Maria Antonietta Perino from Thales Alena Space, talked of developing system engineering training programs at partner institutions. Institution representatives such as Lisa La Bonte from Arab Youth Venture Foundation, and Vera Mayorova from the Youth Space Centre of Bauman Moscow State University, gave examples of medium-term engagement platforms that allows STEM-educated students to acquire hands-on experiences that expedites workforce integration to the corporate environment.

GNF Sessions: Friday 5 October

Exploration Stream

The last day of the GNF, focused on the theme of space exploration.

The first session shed insight on the commercial strategies for lunar exploration and beyond, featuring four representatives from Lockheed Martin Space Systems. In last year's IAC, Lockheed had revealed how its lunar gateway infrastructure can be used for deep space prospecting missions and support Mars basecamp missions. This year, Lockheed representatives talked of greater commercial and governmental opportunities with the Lunar Gateway, including partnering up with ISS-borne smallsat deployment service provider Nanoracks. Lockheed is now soliciting public interest in payload opportunities onboard Orion modules - either internal or externally attached - that can be manually deployed from the far side of the moon.

The following session on *Monitoring Asteroids: Defending our Planet* featured planetary defence from asteroids. Patrick Michel, Director of Research at CNRS, France, mentioned how the Hayabusa-2 mission presented new insights on asteroid composites, as well as new challenges in identifying Near-Earth Asteroids (NEA) and approaching them. Ian Carnelli, General Studies Program Manager at ESA, talked about the danger of having non-validated approaches of planetary defence, and how the Asteroid Impact and Deflection Assessment (AIDA) mission from ESA, to be completed on 2022, would provide answers. Fritz Merkle, Representative of the Executive Board of OHB Systems, said how in-situ resource acquisition companies, including asteroid mining firms, would be key technology partners.

The third GNF Exploration session was on international engagement for space exploration. Agency representatives such as Barbara Zelon from NASA and Thomas Reiter and Rosita Suenson from ESA presented how government communication strategies, which is the first-hand medium to many, should diversify: noting NASA's success of Curiosity's "7 minutes of terror" video that received nearly 2.5 million views on NASA TV, Youtube, and Twitter accounts. Siegfried Monser from Airbus Space Systems mentioned how private engagement have had tangible results, such as Google's Lunar X Prize, and revealed how Airbus' Moon Race mission hopes to achieve private engagement. Lastly, Linda Singleton from Lockheed Martin showed how the Lockheed was soliciting public opinion for payloads for Orion's first three missions (EM-1, EM-2, EM-3).

The fourth GNF Exploration session was on involving everyone in the "EarthMoonMars" journey. Maria Grulich from SGAC commented that EarthMoonMars should be "involving everyone", and highlighted SGAC's efforts on involving emerging space nations. Hank Rogers from the International Moonbase Alliance recalled how multidisciplinary analogue missions such as HI-SEAS allows for tangible cooperation among parties. Agata Kolodziejczyk from Space Garden pointed out the importance of understanding biology for lunar and Mars missions, which Athiye Jawad from Planet expanded by commenting that all exploratory endeavors should incorporate the SDGs. The panel ended with Andrea Jaime from OHB Systems urging the audience members to go back to their home cities and give one presentation about space exploration to their communities.

The fifth GNF Exploration session was about *Digitization in the Space Sector*. Robert Axmann from DLR set the stage with the three reasons for software's growing importance in the space sector: (1) increase in the amount of data (2) increase in the transfer of data (previous S- and X-band communications being replaced with optical protocols) and (3) digitization of the production chain. Representatives from academia commented that operating technology is as important as developing technology, which is done in academia. Dietmar Ratzsch from Jena-Optronik remarked that industry is more than ready to embrace software by incorporating high-end manufacture systems such as 3D printing into their processes. Other agency representatives such as Christina Giannopapa from ESA and Frank Dannemann from DLR mentioned that software integration in project management is the first and last step of the evolution.

The last GNF session featured the Moon Village Association (MVA), with panelists from industry (PT Scientists, OffWorld), agency (JAXA), and non-government organizations (Secure World Foundation). MVA is the current nexus for the industry, academia, and governments wanting to establish a permanent mission to the moon. Parallels were drawn between MVA and Antarctic settlements, with disruption in orbital access costs playing a pivotal role in resource delivery. A discussion of the extent of roles automation will perform was followed by a more extensive discussion on the legalities and regulations that will govern the construction and operation of the village. The session wrapped up with consideration of human culture representation, and protection of existing human artefacts on extraterrestrial surfaces.

Special Sessions: **Monday 1 October**

SpS

For the year 2018, a new format of the IAC Technical programme was introduced: the Special Sessions. This new format envisioned to be innovative, instructive and inclusive, favouring interaction between audience and panellists, for a better engaging experience. During the first day of the International Astronautical Congress, two Special Sessions took place in the Congress: *New Challenges for Planetary Protection*, organized by David H. Smith and Mia A. Brown, respectively Senior Study Director and Research Associate of the Space Studies Board of the U.S. National Academies of Sciences, Engineering, and Medicine; and an *Open Source Space Workshop,* organized by Claas Ziemke, Research Engineer at the German Aerospace Center (DLR).

With NASA Chief Scientist James Green as facilitator, the *SpS New Challenges for Planetary Protection* immediately started by covering the issue of the topic's lack of appeal, and in particular to policy makers. With the potential surge of space exploration missions pushed by private actors, Planetary Protection will face more challenges, John Green suggested. John D. Rummel, Senior Scientist at the SETI institute, remarked that the risk is not only to interfere or damage other planets' ecosystems, but also to contaminate and damage our own planetary ecosystem by introducing alien forms of life. This is something that was already considered by the Committee on Space Research (COSPAR) before the draft of the Outer Space Treaty, and the reason for COSPAR to be still motivated in developing guidelines on the subject. Athena Coustenis, Chair of the COSPAR Panel on Planetary Protection, added that COSPAR guidelines do not inhibit or prohibit space exploration, but rather enable it, offering constantly updated guidelines and expertise to governments, agencies and inexperienced private actors. The session unfolded with further presentations on the Chinese Lunar Programme and its compliance with planetary protection provisions and a look forward to Martian missions, followed by a call to prioritize the avoidance of contamination from terrestrial biological forms, with the ISS already providing a great testbed to measure impact of radiation and the evolution of microbes, DNA, RNA, and so on during long-term spaceflight. Finally, the President of the Commercial Spaceflight Federation Eric Stallmer commented the topic from the industry side, calling for further governmental, commercial and scientific cooperation on the issue which is growingly relevant also for commercial actors, welcoming expertise and guidelines from scientific partners. The roundtable concluded with a series of questions and intervention from the audience, ranging from the commercial cost of Planetary Protection to the Outer Space Treaty.

The second SpS for the day, *Open Source Space Workshop,* was organized as very interactive, with panellists introducing themselves before starting asking questions and for contributions to the audience. Compared to others, open source space is still not a united community, and this first special session was an attempt to start building bridges among various initiatives. Claas Ziemke, Research Engineer at DLR and organizer of the session, introduced the concept of open source, bringing as example companies as Instagram and Linux, which have become successful because using open software and architectures, relying on users and developers worldwide to improve them. Andreas Horning, from Aerospaceresearch. net, introduced his current work on building open source ground stations for cubesats, a way to enable universities worldwide to launch cubesats without the need to build their own ground station, a costly, and often overlooked aspect. Domink Marszk, Ground Systems Engineer at the European Space Agency, told the audience how he tries to rely and push as much as possible on open source software inside ESA itself. Marcin Stolarski, Software Developer and Manager, involved the audience to understand the reasons behind writing open software, included easing access to space, as also agreed by the public. The last panellist, Artur Scholz from the LibreCube initiative, explained that open source is important to learn from accumulated and shared knowledge, avoiding commonly made mistakes. This might be vital for space missions, in particular for small satellites, which can be expensive while often developed by inexperience and scarcely funded actors. The session concluded with discussions from the role of Space Agencies to the relation between open source and ITAR restrictions. The attendants showed enthusiasm in repeating the session with future follow-ups.

Special Sessions: **Tuesday 2 October**

During the second day of the IAC, Special Sessions covered a wide range of topics. These were: *A Global Space Partnership towards 2030 – Addressing the Needs of Member States of the United Nations to Achieve the Sustainable Development Goals*, organized by members of the UN Office for Outer Space Affairs (UNOOSA); The Nexus of Blockchain and Space, divided in two different sessions; and *Swarm Systems for Future Space Exploration*.

A Global Partnership towards 2030, the first session, was introduced by UNOOSA Director Simonetta Di Pippo, who underlined that space is vital to achieve roughly 65% of the targets proposed by the SDGs, explaining the reasoning

behind the Space2030 Agenda and the UNOOSA's Space4SDGs initiatives. Jean-Pascal Le Franc, director of Planning, International Relations and Quality at CNES, continued the session focusing on the use for space to pursue global goals, as the UN 2030 SDGs, providing an overview on the role that space played and plays in tackling Climate Change, and presenting the agencies-level Space Climate Observatory, proposed by CNES during the 2017 One Planet Summit. The discussion followed by John Njoroge Kimani, Lead Scientist and CEO of the new-born Kenya Space Agency, who presented the activities that Kenya has been conducting to address the SDGs via space applications, showing that space can be vital to developing countries. Ming Li, Vice President of China Academy of Space Technology (CAST), went on with an overview on CAST activities, its long-lasting history and heritage, and its initiatives related to education, training, and overall cooperation with international partners, showing CAST's efforts to contribute to the pursuit of the SDGs. Finally, the session was concluded by Vincenzo Aquaro, Chief for Public Institutions and Digital Governments, UN Department of Economic and Social Affairs (DESA), who highlighted the role that space technologies are playing in fostering digital government, welcomed the Space2030 Agenda and encouraged UNOOSA in keeping leading such initiative, also with DESA's cooperation.

The second and third SpS were a panel and workshop on *The Nexus of Blockchain and Space*, organized by Timiebi Aganaba-Jeanty, Assistant Professor at the School for the Future of Innovation in Society, Arizona State University. Started with an introduction on blockchain and its potential applications, as to enable a more transparent tracking of satellites, the discussion moved on issues related to its governance, with Julie Maupin, Head of Social Impact and Public Regulatory Affairs at the IOTA Foundation, and Joe Ladon, CFO at Planetary Resources and Chairman of Space Angels, discussing the possibility to tokenize satellites and other space assets, enabling "self-ownership" of satellites, and their automatic use, manoeuvring, and interactions via smart contracts and applications of Distributed Ledger Technology. This would have many implications, paving the way to a potential "legal nightmare", with an innovation not related to the decentralization itself, but rather on a newer, more open ownership of space assets via their tokenization.

The final SpS of the day, *Swarm System for Future Space Exploration*, covered the attempts at developing swarms of spacecraft, be them in orbit or on ground, to operate more efficiently in space missions. Armin Dammann, Head of the Mobile Radio Transmission Research Group at DLR, explained such systems: instead of having a single element, analysing a single area at time, space exploration missions could be developed with a series of many, identical or complementary spacecraft or rover, which coordinate and cooperate, constantly communicating and learning together. The rationale for this system, discussed Fred Hadaegh, Chief Technologist at NASA JPL, is that spacecraft in swarms can be fractionated, "incomplete" elements with limited single capabilities, but once combined could achieve what monolithic missions could not. Self-organizing and flexible architectures could be developed both on ground and in orbit, paving the way for applications as co-observation, contemporaneous spatial sampling, sensor webs, large and flexible synthetic apertures, among other things. Leon Alkalai, Manager at the Office of Strategic Planning at NASA JPL, suggested that it is the right time to develop such architectures, as there is a converge between the strategic interest toward them and the maturity of the technology to make them real. The session concluded with Dmitriy Shutin, Team Leader Swarm Exploration at DLR, showcasing undergoing successful test experiments on swarm systems, reaching a peak of efficiency with 10 to 12 elements involved, and showing the feasibility of the architecture.

Special Sessions: **Wednesday 3 October**

The Special Session, *Earth Observation and Sustainable Development Goals – Views from a Decade with the Group on Earth Observations. Panel Discussion on Readiness for a Terrestrial Forecasting System* for Wednesday kicked off with a wide panel of Earth Observation (EO) experts. Of new importance was Sustainable Development Goals (SDGs), which was introduced as the aspirations and objectives of humans as a species by the United Nations. While EO influences many of the 17 SDGs, SDGs regarding health and food security demonstrated the power of EO in benefiting societies on Earth. Stephen Volz, Assistant Administrator for Satellite and Information Services at NOAA mentioned how EO capacity for air and water has improved global best-practices for information-sharing. Michael Freilich, Director of Earth Science Division at NASA, emphasized how multi-spectral terrestrial imaging provides anthrome (anthropogenic biome) information that provides insight on biology and human life. Josef Aschbacher, Director of EO Programmes at ESA, pointed out that EO data have been crucial in tracking migration patterns and climate change in Europe. To audience questions of the human factor in data processing, James Graf, Deputy Director for Earth Science and Technology from JPL commented that the AI-led data processing and redirection onboard satellites have led to increasing mission efficiencies previously unseen.

The Special Session, *Landsat-Copernicus Sentinel 2 Collaboration: Integrated Operational Land Imaging to Meet User Needs Worldwide*, talked about the collaboration between Landsat-Copernicus and Sentinel 2 satellites. The session had a big panel, composed of 10 experts from Europe and US, representing both government, agency, and industry. The collaboration marks the first time the entire Earth was covered by a moderate-resolution multi-spectral land imaging satellites. The US-EU Copernicus Cooperation Arrangement, signed in 2015, has been providing analysis-ready data to the public, which triggered the formation of Landsat-data usage communities. Community members - present in both panel and audience - noted the growing need for data harmonization across platforms for a more consistent, characterized, and appropriate dataset. Interoperability and normalization of data were identified as a key hurdle, alongside increased training programs on data usage.

The session, *New Approaches to Space for a Better World: Space for Sustainable Development*, continued the discussion of EO from the European perspective. The Copernicus satellite constellation has provided the "golden age" of EO data. At the same time, the introduction of big data have confined data usage to major institutions that had proprietary algorithms for data analysis, and the issues of data interpretation and public training were recalled. The ESA collaboration with the African Union in providing data cubes, data infrastructure, and training have been brought up as a prime example. Comments from industry representatives, such as Agnieszka Lukaszczyk and Will Marshall from Planet, and Rafal Modrzewski from ICEYE highlighted the role of private institutions in filling in data gaps of public EO constellations. Increased public-private partnerships (PPP) would provide higher spatiotemporal resolution in EO data and analytics capabilities.

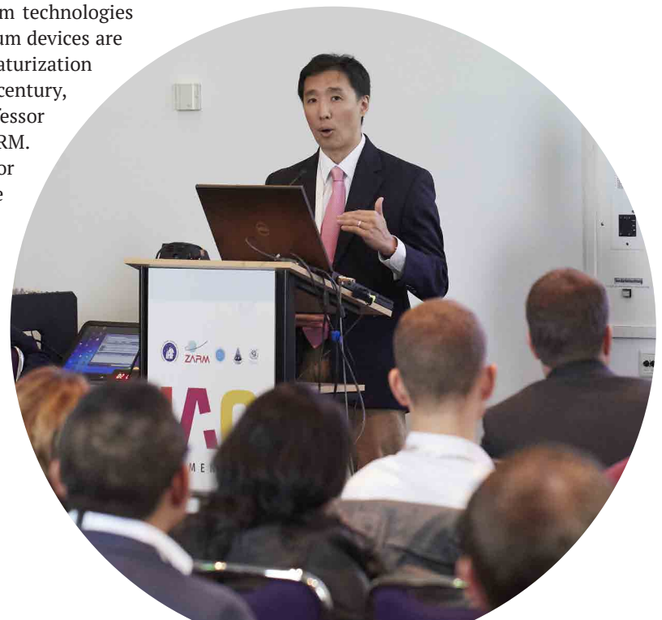
The session, *New Approaches to Space for a Better World: Space for Sustainable Development*, was a highly interactive session that pulled in information from prior panels: namely EO, SDGs, and PPP. With more than 50% of UN SDG indicators relying on EO data, solving new challenges of EO directly affect SDG completion. These challenges include: (1) greater complexity in data points and partners (there has been 20-70 EO satellite launches /year) (2) big-data inflexion point (daily EO data flow is now transitioning to the petabyte range) (3) integrating local decision-making and AI-powered in-situ data analytics (4) integration across different orbits, service, resolutions, and spectrums, and (5) sustainable use of orbits and management of space debris. The roundtable talks allowed audience members to meet with one of the eight panellists to pose further questions in the member's interest area.

Special Sessions: **Thursday 4 October**

The fourth day of the IAC 2018 hosted four Special Sessions and a workshop on Space Journalism. The SpS were: *Twenty Years of the International Space Station: Shaping the Future of Human Space Exploration; Quantum Technologies for Space: Development and Applications; Global Space Exploration: Increasing Benefits through International and Commercial Partnerships*; and *Quantum Key Distribution: The Future of Cryptography.*

The first SpS, *Twenty Years of the International Space Station*, was a celebration of the 20th anniversary of the orbiting of the ISS since its first module. CNES and ESA astronaut Jean-François Clervoy started the session together with a video by NASA astronaut Scott Kelly, who could not participate in person, and an introduction by Justin St. P. Walsh, Associate Professor of Art History and Archaeology and Chair of the Department of Art, Chapman University. The SpS revolved around three roundtables. The first one focused on the experience gained in terms of International partnership thanks to the ISS, with speakers as Jean-Jacques Dordain, former ESA DG, agreeing on the fact that the partnership itself, as well as the industrial experience gained by cooperating, is the most durable and important asset of the ISS. The second panel developed the lessons learned as human beings living and working in the ISS, with a recorded video intervention by Scott Kelly followed by debates by panellists, focusing on habits lost and gained in space, international companionship, and the change of perspective that living in space brings to both people in space and those left on the ground. The third and final panel focused on Science on the Station and Outreach, as the ISS has resulted a great platform enabling unprecedent science, while astronauts have been involving and inspiring the younger generations.

During the second SpS, *Quantum Technologies for Space*, the development and applications of quantum technologies in and from space were discussed. Quantum devices are today already used and with their miniaturization represent the technology of the 21st century, highlighted Claus Laemmerzahl, Professor and Director of Space Science at the ZARM. Alexander Ling, Principal Investigator for Space-Grade Quantum Optics at the Centre for Quantum Technologies, National University of Singapore, introduced the audience to Quantum Key Distribution (QKD) and to the efforts his team is doing in developing a space-based QKD architecture, which would solve the seatbacks related to operating via optical fibre. The discussion continued on quantum applications in space, such as to improve accuracy of clocks on board GNSS satellites, and therefore their precision, as well as the development of Bose-Einstein Condensates, which might be key to a second quantum revolution.



Organized by the International Space Exploration Coordination Group (ISECG), the SpS *Global Space Exploration: Increasing Benefits through International and Commercial Partnerships* focused on building a dialogue between agencies and industries toward the next space exploration missions. Naoki Sato, current Chair of the ISECG, introduced the Coordination Group and its activities, and its current recommendation to focus on the Lunar Gateway as first step for lunar human exploration. The first panel followed, with agencies and industry debating on how they can each contribute to a lunar mission and on how eventually partnerships between industries could be enabled by – and replace – agencies-to-industry partnerships, with the agencies helping to shape the market at first, stepping aside later on. The second panel focused on the industry and how the ISECG Space Exploration Roadmap could help nations and companies in catching up with technological gaps. The Roadmap, in particular, emerged as very useful for new actors in space.

The final SpS of the day, *Quantum Key Distribution: The Future of Cryptography*, saw panellists recalling the previous SpS on Quantum Technologies and debating on the state of QKD. Despite being demonstrated on ground and in space, there is still no clear market for such technology, as infrastructures need still to be developed to make QKD, and QKD from space in particular, affordable and integrated with other architectures. Nevertheless, both industries and agencies are exploring potential uses and integrations for secure communications, as the benefits might be many.

Special Sessions: **Friday 5 October**

Despite being the final day of the IAC 2018, Friday 5th October was incredibly rich of events, included eleven SpS, covering topics from the emerging opportunities for On-Orbit Servicing to the launch of the joint Colombian-Ecuadorian Lunar Programme.

#HiddenNoMore: Empowering Young Women in the Space Sector covered the topic of women and STEM. The discussion started from the reasons that convinced the panellists to pursue a STEM career, moving to the importance of having and being a mentor, also covering the issues of discrimination in a male-dominated field. The panel discussion concluded by speaking about involving and motivating young girls in studying and working in STEM-related sectors, by keeping their curiosity fed, showing them that everyone can contribute to science, and most importantly providing them role models to follow. Speakers and audience agreed to repeat the meeting in future fora, trying to involve more men in it, as this should be a bipartisan discussion.

Commercial Suborbital: Opening the Aperture for Space Utilization was the session to introduce the audience to the great opportunities provided by Suborbital Spaceflight. Speakers from the ZARM, Blue Origin, PLD Space, and others discussed how today there are more and more opportunities to access to microgravity, with suborbital flights potentially playing a role to allow universities and companies to test technologies cheaply enough. However, companies "selling microgravity" should be more aggressive in their outreach, as few are aware of such opportunities, in particular outside the space community.

During *Innovative Spacecraft Concepts and Servicing*, speakers discussed the near-term maturity for On-Orbit Servicing (OOS), modularity and standardization of spacecraft components. A relevant aspect of OOS would be enabling a greater space sustainability, but refuelling, manoeuvring and de-orbiting are just few of the potential applications of OOS. Modularity could also enable and ease in-orbit assembly and manufacturing, paving the way for still unimagined applications and business cases for operators and agencies worldwide.

Covering a usually overlooked, albeit very relevant topic, the session *RF Spectrum for TT&C – Regulatory Framework VS Needs of Operators* tried to address the emerging challenges and trends in the Frequency Spectrum allocation and management, given the surge in applications for satellites and an increasing number of inexperienced operators, which does not have the resources nor the expertise to dig into the regulatory framework for transmitting to and from space. These inexperienced actors, together with those who would like to leverage Amateur-destined frequencies for commercial purposes, could face, in fact, very high fines, often being unaware of such risk.

The session *The European Research Council – Finding Opportunities for Bright Minds*, introduced the audience to the European Research Council (ERC), its activities and the opportunities it provides for researchers. Professor Michael Kramer opened the discussion explaining the overall organization of the 11 years old ERC, underlining its independence and its goal of funding excellence and breakthroughs, from fundamental physics to social sciences. Isabelle Ortmans, head of Sector "Computer Science, Engineering and Earth System Science" at the ERC, provided an overview on the application procedures, the requirements to apply to grants and to conduct the research once funded. Finally, two grantees shared their experience and opinions on their application and ongoing projects.

During *Latin America Beyond LEO: Securing Regional Participation in the Moon Village*, Ronnie Nader, Space Operation Director of the NGO Ecuadorian Civilian Space Agency (EXA) led speakers and audience to analyse the reasons for which Latin America should step up its space efforts and try to sit on the discussion table of the ESA-proposed Moon Village. Nader, together with Pilar Zamora from the NGO Colombian Civil Space Agency, announced the launch of the initiative Latin America and Caribbean Moon Programme, introducing, as precursor to this, the joint Ecuadorian-Colombia Lunar Programme, to together reach the moon and explore there the application of laser communications technologies, leveraging these as a way to contribute to the Moon Village.

For the special session *Adoption of Space Technologies and Applications in Emerging/NewSpace Actors*, Narayan Prasad Nagendra, Co-Founder of satsearch.co, organized a discussion with panelists from emerging space faring nations like the United Arab Emirates, South Africa and young start-ups. The participants had in common the feeling that space is an excellent opportunity for development even in a non-space environment meaning that the space sector can become a key to the development of emerging countries or start-up nations.

Christiane Heinicke, Researcher at the ZARM, organized a special session on "A Scientific *Wish List" for Research Facilities on the Moon*. To help the participants gaining knowledge on the topic, she invited, to give the foundations of the Moon exploration basic knowledge, four speakers: Miranda Fateri, Researcher at the German Aerospace Center (DLR), Bram de Winter, Student at VU Amsterdam, Lucie Poulet from the European Space Agency (ESA) and Hanns-Christian Gunga, Head of Work Group at the Center for Space Medicine and Extreme Environments, gave presentations on the respective topics: Material Science, Geology, Biology and Medicine. Following that, the participants shared ideas on the necessities for establishing a first base on the Moon.

Markus Jäger, System Engineer at Airbus Defence and Space, organized a special session about the European contribution to human-rated space exploration entitled *2018: 10 years Columbus in Space and Delivery of Orion European Service Module*. Bas Theelen, Orion ESM Program Manager at Airbus Defence and Space, Jens Lassmann, Head of Site Bremen ArianeGroup, Nico Dettmann, HRE Development Projects Group Leader at the European Space Agency (ESA) and William Hartwell, Project Manager at the National Aeronautics and Space Administration (NASA), shared their view on the past, present and future contribution of Europe in space exploration. They discussed the success of the Columbus module for 10 years providing the sound foundation for space exploration and the current cooperation for the development of the Orion capsule.

The special session *Space Needs Everyone's Ideas! Prizes and Challenges in the Space*, organized by Ademir Vrolijk, PhD Candidate at The George Washington University and Zoe Szajnfarber, Associate Professor at The George Washington University, gave an insight on the agencies strategies to gather ideas and provided the audience with a clear understanding of ideas management mechanisms. Jason Crusan, Advanced Exploration Systems Division Director at the National Aeronautics and Space Administration (NASA), gave many examples of prizes by NASA. Leopold Summerer, Advanced Concepts Team Head at the European Space Agency (ESA) presented the ESA Open Space Innovation Platform gathering ideas from anyone who is willing to share. Jennifer Gustetic, Small Business Innovation Research (SBIR/STTR) Program Executive at the National Aeronautics and Space Administration (NASA), demonstrated a toolkit to enable anyone to organize prizes and challenges- Ademir completed those presentation by introducing ideas management strategy, how to choose the proper the target and scale the prize depending on the expected results.

Marc C. Lange, Founder / Google Expert & Head Mentor at Challengers, organized a very interactive workshop *The Design Sprint: How to Solve Almost Any Challenge in Less Than a Week* where the participants iterated on a technical solution using Design Thinking. Armed with stickers, giant sheets of paper and markers and under Marc's guidance they followed a simulation until reaching very creative solutions to the problem they were facing.

IAF IDEA "3G" Diversity Day

During Wednesday 3 October, it was celebrated the IAF IDEA "3G" Diversity Day, with the 3Gs standing for Generation, Gender and Geography, an initiative launched by the IAF under the presidency of Jean-Yves Le Gall. Developed along three main events during the day – a breakfast, a luncheon, and an afternoon event – the 3G Diversity Day hosted keynotes, awards and a speed-mentoring session.

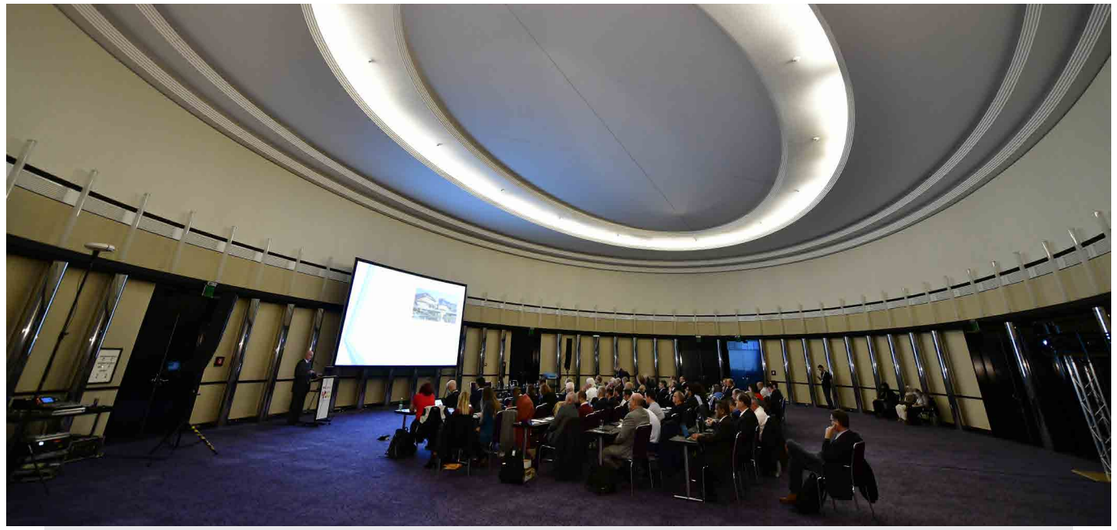
The Breakfast session, taking place from 7:00 am, was launched by Mary Snitch, Senior Manager at Lockheed Martin Space Systems and IAF VP for Global Membership Development and Diversity Initiatives, followed by the Welcome of IAF President Jean-Yves Le Gall, which underlined the importance of the event within the IAF Mission to create and diverse and vary workforce for space. Following the welcoming introduction, the session was divided in four main parts. Firstly Pascale Ehrenfreund (Chair of the DLR Executive Board), Hiroshi Yamakawa (President of JAXA) and Jean-Yves Le Gall (as President of CNES) announced the successful deployment of the lander MASCOT, a German-French cooperation, from the JAXA Sample Return Mission Hayabusa-2, a great example of successful international cooperation. Secondly, ESA DG Jan Woerner, together with the ESA Astronaut Thomas Reiter and kid Paula Monfeld, introduced the ESA's Kids' Weightless Dreams Campaign, which involved parabolic flights and weightlessness experience, and in which Paula participated. Thirdly, UNOOSA Director Simonetta Di Pippo introduced the audience to UNOOSA's Space for Women, a project to boost presence of women in STEM studies and careers, and tackle UN SDGs number 4 and 5. Finally, the Breakfast session concluded with two keynote speeches by Lockheed Martin Early Career Role Models Danielle Richey (Space Exploration Architect at Lockheed Martin) and Kat Coderre (Systems Engineer, Lockheed Martin), which called for more personal involvement in supporting diversity, underlining that building the international aerospace community in diversity is for the best future to come.

The Luncheon, introduced once again by IAF President La Gall and IAF VP Mary Snitch, hosted the award ceremony of the 2018 IAF Excellence in "3G" Diversity Award, assigned to the Space Generation Advisory Council (SGAC). SGAC Executive Director, Clementine Decoopman, presented the organization's activities and efforts, highlighting how much SGAC consider diversity a vital part of its strategy. After the award assignation, the hosts introduced the IAF/SGAC video "Fostering Generational Diversity".

The Afternoon session, divided in three parts, was introduced again by IAF President Le Gall and IAF VP for Diversity Initiatives Mary Snitch. For the first part of the session, Luisella Giulicchi, President and Interim Chair of Women in Aerospace - Europe (WIA-E) introduced the organization, its activities, its support programmes, and its purpose, which is to create an inclusive and diverse aerospace sector, as today while 30% of STEM students are women but only 10% of the Aerospace workforce is. Chris Welch, IAF VP for Education and Workforce Development, introduced to WIA-E Grant programmes and announced the winners of the WIA-E Student and Young Professional Awardees. Following the update on WIA-E, Young ESA Moderator Christopher Vasko, ESA DG Jan Woerner and SGAC Executive Director Clementine Decoopman introduced and announced the winners of the Young ESA / SGAC Diversity Award.

The Afternoon meeting concluded with the IAF IDEA Mentoring Session with Young ESA, SGAC, and WIA-E: five-minute long sessions, for a total of 45 minutes, in which mentors switched tables to meet and discuss with different young professionals.

IAC Hosts Summit



Right before the start of the congress, the IAC Hosts Summits, sponsored by the UAE Space Agency, is the occasion to get an insight on and to discuss the past, present and future organization of the IAC. The focus is put on the strong point of the previous editions, the potential improvement for the coming years and the natural evolution of the congress.

The IAF Vice-President for Finance and IAC Evolution, and Vice-President for Global Sales, Marketing & Customer Experience at Blue Origin, Clay Mowry insisted on the growing momentum of IAC and encouraged keeping it that way for the future sessions. Khaled Al Hashmi, from the UAE Space Agency, strengthened this point by quickly introducing the IAC 2020 in Dubai. The UAE will have, at this date, reached many of its milestones like the first Emirati astronaut in the International Space Station in April 2019, Emirates Mars Mission launch in July 2020, the construction of new testing facilities for small satellite testing and the development of Cubesat programmes.

Michael Davis, chair of the Space Industry Association of Australia and the IAC 2017 Local Organization committee, presented the astounding results of the previous year's congress. The statistics of the attendees are well above the previous editions. To be noted, 24% of female attendees in total, 700 school children attending activities during the congress and more than 300 volunteers to support the organization. The IAC 2017 had a major impact on the government, the media and the general public. It gave birth to industry and educational initiatives and saw a significant growth in the number of IAF members.

The Executive Director of IAF, Christian Feichtinger, went further by presenting a retrospective view on IAC evolution. First, he established simple criteria to assess the success of an IAC: attendance, application download, participants satisfaction through surveys, positive social media sentiment recorded, cost reduction and financial balance. The focus shall be put on how to foster this networking and how to help people meet. In the same way, to improve the technical sessions, bringing more interactivity is one of the objectives that IAF has set. Christian said it himself: *"We need to see the interaction"* when speaking about the presentations. IAF is on very good tracks and there are even more challenges to take on like increasing sustainability, raising young generation involvement, tailoring activities to bring people together, everything towards a more social and measurable IAC.

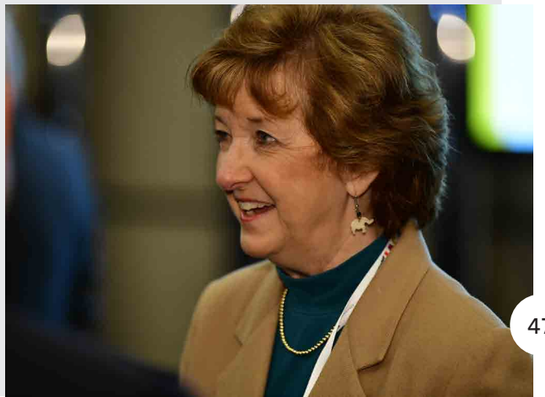
The Local Organization Committee, represented by Claus Lämmerzhal (Director of Space Science at ZARM), Christiane Schmullius (Chair at Friedrich-Schiller Universität Jena and IAC 2018 IPC Co-Chair), Nicolas Peter (Head of International Relations at DLR) and Fritz Merkle (former member of the Management Board of OHB System AG-Bremen), presented the views for this year edition of the IAC. A major focus was put on the 3G (Generation, Gender, Geography) and involving the space community in general. More than 150 events were planned with the essential support from the city of Bremen.

Comparing the IAC to other space conferences, Steve Eisenhart, Senior Vice-President – Strategic & International Affairs at the Space Foundation, focused on what made IAC unique. Being the 69th edition is already a good proof of success of the event. IAC is enabling the participants to bring back with them the three following assets: professional growth, personal growth and value.

Making IAC more accessible and affordable is a challenge that IAF faces constantly. Many improvements have been seen already and more are to come. Valanathan Munsami, CEO of the South African National Space Agency and IAF VP for Developing Countries and Emerging Nations, presented suggestions. He strongly insisted on two main aspects. First, applying the 3G concept should not be the topic of a single session but applied all along the congress and, second, IAC should be more accessible to emerging countries (less than 5% of accepted papers) by, for example, having an edition in one of them.

To conclude the summit, Christian Feichtinger, Michel Arnaud (Special advisor to IPC Co-Chair), Mary Snitch (Senior staff at Global S&T Organizations, Lockheed Martin and IAF VP for Global Membership Development and Diversity Initiatives), Chris Welch (Professor of Space Engineering at ISU and IAF VP for Education and Workforce Development) and Vicoria Alonsoperez (Founder of Chipsafer, IAF 2016 Young Space Leader and Special Advisor to IAF President) presented their comparative perspective on the IAC challenges presented. The global agreement was that increasing gender participation and from emerging country is among the priorities and still more can be done to improve the outreach and what IAC brings to the participants. The two following quotes, from respectively Chris and Mary, sum up very well their challenges: "[IAC] got to be about all space people and not only about all space people that come to the IAC" and, thanks to the sponsorship, IAC gives "the great value of networking with thousands of leaders around the world".

IAC is an unquestionable success so, as Clay says, *"keep this wave rising"*.



9th IAF International Meeting for Members of Parliaments

The Seamless Chain of Innovation: from Space Science to Business

The International Meeting for Members of Parliaments (MoP) is an annual event held by the IAF in conjunction with the International Astronautical Congress. Members of Parliaments from all over the world meet to discuss relevant space-related topics, with the participation of experts from space agencies, industry and academia.

Titled *The Seamless Chain of Innovation: from Space Science to Business*, the 9th IAF International MoP Meeting was held the 30th of September 2018 in the Bremen State Parliament, as a side event to kickstart the 69th IAC.

The day was organized around a series of keynote speeches and three themed discussion sessions, with wide space left to Parliamentarians to intervene. Kai-Uwe Schrogl, moderator for the day and ESA Chief Strategy Officer, opened the welcoming remarks, followed by, among others, local authorities; Jean-Yves Le Gall, IAF President; Jan Woerner, ESA DG and IAF VP for Agencies, Parliamentarians and Ministerial Relations; and Chris Schacht, former Senator of Australia – IAC 2017 host country. Schrogl explained that the reasoning behind the MoP meetings is to benefit the attending parliamentarians, to inspire them to carry space-related activities in their nations. Woerner added to these remarks that space is not there for space itself, but rather for citizens, industries and society.

Pascale Ehrenfreund, Chair of the German Aerospace Center (DLR) Executive Board and first keynote speaker for the day, introduced the Parliamentarians to DLR's organization and overall German space-related activities, underlining the relevance of NewSpace and the paradigm shift that the world is witnessing. The second keynote speech was addressed by Jan Woerner, ESA DG, covering the topic of Space Safety and Security, as well as the need for the space sector to exploit any potential field of study, moving from STEM to STEAM, with A standing of Art and any other useful subject, underlining the vitality of outreach and cooperation. Valanathan Munsami, CEO of the South African National Space Agency and IAF VP for Developing Countries and Emerging Nations, gave an overview on why space is important to Africa, and on the 2016 common African Space Strategy and African Space Policy, highlighting the importance of space application for policy making. The last keynote speaker for the morning, Mohammed Nasser Al Ahbabi, DG of the United Arab Emirates Space Agency, introduced the audience to the Emirates' strategy for space, with an overview on the UAE history in space, its space industry, space-related regulations, and current space programmes.

The first discussion session, *Education to Business*, included three speakers. Andres Jaadla, coordinator of the Commission for the Environment, Climate change and Energy (ENVE) at the European Committee of the Regions, introduced the audience to the possibility and opportunity for regions and small nations to benefit from space, accompanied by the necessity to clarify to the citizenry the importance of space, bringing the example of Estonia and ESTCUBE-1. Thorsten Rudolph, CEO of AZO, the Application Centre for Satellite Navigation, showed to the MoPs the impact that incubation can have in linking scientists and innovators to concrete business opportunities, with the success stories coming from the creation of a Business Incubator in 2003, which then evolved in today's ESA BIC Bavaria and its 148 incubatees. Finally, Oliver Juckenhoefel, Airbus Defence and Space Vice President for On-Orbit Services and Exploration, stressed the necessity to move the discussion from how to bring space to the economy to how can everyone contribute in achieving that, as we are at the dawn of an orbital society.

Following the first discussion, the audience was addressed by Parliamentarians from France, Iceland, Australia, Norway and Germany, calling fellow MoPs to increase their focus on space activities, as space is about inspiration, education, innovation and business.

Kai-Uwe Schrogl concluded the morning session with a lecture on the new legal challenges for space utilizations, underlining the need to keep promoting the rule of law, also in space, despite the challenges faced by the current international regime.

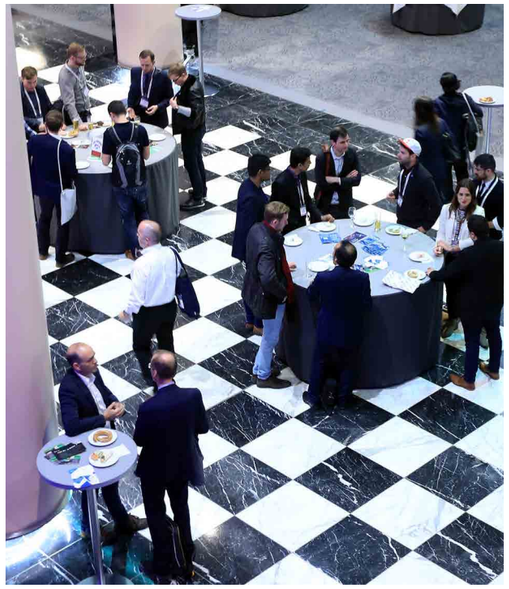
The afternoon session was opened with a keynote speech by Simonetta di Pippo, Director of the UN Office for Outer Space Affairs, who introduced the audience to the Office's roles, activities and future agenda, the outcomes of the UNISPACE+50, and overall stressing the vital contribution that space applications have in pursuing the UN 2030 Sustainable Development Goals.

Four speakers took part in the second discussion session, *Science to Research and Development*. Günther Hasinger, ESA Director of Science, gave an overview to the time of discoveries we are living in, underlining that as discoveries from a century ago are a major pillar for today's economy, today's discoveries will shape and enable the world's future wealth, and that is a farsighted reason to keep investing in science. Gilles Rabin, the Director of Innovation, Applications and Sciences at the Centre National d'Études Spatiales (CNES), made a presentation on Science and Competitiveness, on the current re-booming of the Space Industry, and the new role for the public sector: establishing a base for further industrial development, breaking the traditional public monopoly typical of space businesses. Hansjoerg Dittus, DLR Executive Board Member for Space Research and Technology, presented the impact that Space Science has on the development of novel technologies, with examples ranging from the Apollo on-board computer or Pioneer 1 cameras to today's first steps on quantum telecommunication technologies. Finally, Shoji Yoshikazu, Director of the International Relations and Research Department at the Japanese Aerospace Exploration Agency (JAXA), overviewed JAXA's organization and activities, with a special attention to 2020 – an important year for Japan and its space endeavours, due to the Olympic Games in Tokyo, the first launch of a H-III launch vehicle, and the conclusion of the Hayabusa-2 sample return mission.

Between the second and the third discussion sessions, NASA Administrator Jim Bridenstine addressed the MoPs with the final keynote speech of the day: an overview of NASA's Exploration Campaign, setting the tone on the future of Human Spaceflight in Low Earth Orbit and beyond, with a special focus on the future international lunar Deep Space Gateway, which will enable unprecedent exploration of the Moon, while being a necessary testbed to safely reach Mars.

The third and final discussion session, *Innovation and Regulation*, developed around five presentations. Marc Avila, Executive Director of the Centre of Applied Space Technology and Microgravity (ZARM) of the University of Bremen, introduced the MPs to the activities of the ZARM and its famous drop tower, stressing the relevance of Microgravity Research as enabler of innovation. Lionel Suchet, CNES Chief Operating Officer, highlighted the current strong evolution taking place in the space sector and the challenges that this poses to the Outer Space Treaty, suggesting the need for smarter, and not less, regulations, as deregulation is a recipe for disaster. Fritz Merkle, Representative of the Executive Board of OHB System AG-Bremen, intervened on the regulatory issue stressing the necessity for regulations to be not too strict to impede innovation and competition. Sergio Marchisio, Full Professor of International Law at University Sapienza of Rome and Chairman of the European Centre for Space Law, gave an overview on European developments related to the implementation of new space legislations, noting a shift from comprehensive legislations – addressing the compliance with international obligations – to nationally-focused, specific regulations – enforced as enablers and facilitators for national space industries. Finally, Gabriel Swiney, Attorney Advisor to the U.S. Department of State and Head of the U.S. delegation at the UN COPUOS legal subcommittee, concluded the session and the day with practical suggestions on how to draft and implement national space legislations that are tailor-made a country's needs, industry and experiences, underling the necessity of flexibility for future legislations, as space is more and more subject to fast-paced innovation.

YPP Networking Reception



The second Young Professionals Programme Networking reception hosted few but relevant panellists: Bob Smith, CEO of Blue Origin; Lisa Callahan, VP and General manager of Commercial Civil Space at Lockheed Martin Space Systems; and Jim Bridenstine, NASA Administrator.

Bob Smith opened the session by saying that "If you are not excited about this space era, you are not paying attention". He outlined Blue Origin's vision of having millions of people living and working in space, introducing the company's strategy to develop the New Glenn heavy launcher by first learning with the New Shepard, aiming at extreme reusability combined with high payload capacity. Smith also took the time to stress out that Blue Origin's activities would not be possible without the passionate work of young professionals and interns, highlighting that the company's employees' average age is below 30.

Lisa Callahan brought Lockheed Martin's plans to the discussion, introducing Orion, the capsule that is being built by American and European partners, and which will allow astronauts to go back to the moon and to NASA's planned Deep Space Gateway. Callahan highlighted her company's vision – to bring space benefits down to earth, protecting the planet while discovering the solar system – adding that it is to the younger generations to have a bolder, energized vision for the future, as it is the younger generation that will make the next leap in space exploration. She concluded with advice for the young professionals in the audience: to keep building relationships, keep learning, have many different experiences and be agile, as jobs will constantly evolve.

The last speaker, Jim Bridenstine, started by pointing out the reasons for going back to the Moon, and in particular to inspire the younger generations, as they were not present during the years of the first Moon landing. He then outlined NASA's plans for commercializing the low earth orbit, hoping to enable companies as Blue Origin to succeed in creating a sustainable economy in space. With the commercialization of LEO, he added, NASA would be able to use the free resources to focus on the Moon, paving the way for an international Gateway in lunar orbit, which would be a sustainable and long-term mission, and a testbed to reduce risks and improve technologies for the journey to Mars. The Administrator concluded wishing all the young professionals in the room to be successful, as it is their generation that has the role to establish a new Apollo-like moment in history, an inspiring milestone for generations to come.

The session concluded with a wide space for questions, covering technical aspects of Blue Origin's rockets, the Deep Space Gateway, the status of Astronauts as commercial spaceflight becomes a reality, and the role of young professionals in the space sector.

Emerging Space Leaders Grant Programme (ESL Grants)

Started in 2008, the former Youth Grant Programme, now called Emerging Space Leaders Grant Programme (ESL Grants) celebrates this year its 10th anniversary. In the frame of the YP Networking Events, it was the occasion for hundreds of Young Professional attending the IAC to learn more about the program and meet representatives of the sponsors.

Jean-Yves Le Gall introduced the history of the ESL Grant Programme, explaining that "IAF bring new initiative to inspire and support the young gen to be the future leaders of the space community". He was then followed by EUMETSAT, Boeing, Blue Origin, HE Space among others who presented their activities and opportunities for young professionals in the space sector.

Chris Welch, IAF Vice-President for Education and Workforce Development (WD/YPP) Committee, presented the changes brought to the IAC with an increasing participation of the younger generation with more than a hundred grantees from the IAF since its beginning.

In a second part, recent ESL grantees shared their experiences in a round table, explaining their motivations and how attending the IAC changed their life. Minoo, Ali, Sanat, Merve and Manisha all agreed on the fact that the ESL grant gave them an amazing opportunity to meet passionate people, to boost their careers and to get tools to increase the outreach in their home countries.

Press Conference – upcoming Global Conference on Space for Emerging Countries, GLEC 2019

24 - 26 APRIL 2019 | MARRAKECH, MOROCCO

GLEC2019
GLOBAL CONFERENCE ON SPACE FOR EMERGING COUNTRIES

Valanathan Munsami, VP for Developing Countries and Emerging Nations at IAF, presented at IAC 2018 the upcoming Global Conference on Space for Emerging Countries, GLEC 2019, to be held in Marrakech, Morocco, on 24-26 April 2019.

This conference is motivated by the different inspirations that emerging countries have about space. The main focus is put on the main benefits of space applications for those actors with the following key aspects: understanding the value proposition of space applications, analysing the financial constraints, assessing the technology maturity level and the capacity building needed to bring the countries up and evaluating the need for new infrastructures.

The draft of new agencies by many emerging countries demonstrates a need to emphasis the policy and regulatory issues. GLEC is a clear start of a longer-term initiative, answering the need of the new space actors to gain more visibility and to set up a framework for collaboration. As Valanathan said: "[in Africa], space is becoming a question to be discussed".

GLEC2019 is one of a series of action deriving from the IAF Global Innovation Agenda, in particular concerning the engagement of the IAF in promoting and involving new communities and emerging countries, as well as reinforcing the 3Gs: Geography, Generation and Gender.

ISF 2018

Third International Space Forum at Ministerial Level – The Latin American and Caribbean Chapter (ISF 2018)

1 NOVEMBER 2018 | BUENOS AIRES, ARGENTINA

The successful series of International Space Forums at Ministerial Level (ISF), started in Trento in 2016, thanks to the cooperation of the International Astronautical Federation (IAF) and the Italian Space Agency (ASI), continued this year with a new regional chapter. In 2018, the ISF moved to Latin America and the Caribbean. Representative from the region's countries engaged in an interesting discussion about the role space technologies could play in facing some of the challenges in the area, and the opportunities that the development of the space sector could bring for the socio-economic development.

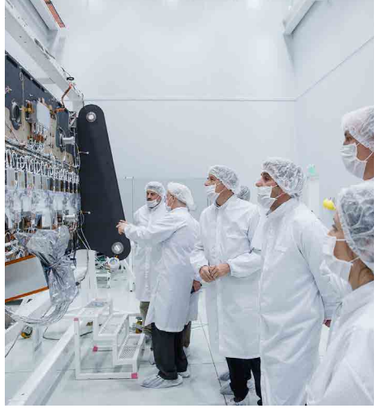
This year's Forum was jointly organized by the IAF, ASI and the Comisión Nacional de Actividades Espaciales (CONAE), and took place in Buenos Aires on 1st November 2018. As in previous years, the ISF 2018 brought together representatives from Governments, Space Agencies Universities, and other Institutions involved in the Space Programmes. In total, 17 delegations from Latin American and the Caribbean and 11 from International Organizations and Space Agencies from all over the world got together in Buenos Aires to discuss about space development and to report on the experience of their own countries.

The Forum was opened by Lino Barañao, Secretary of Government for Science, Technology and Productive Innovation of Argentina, who welcomed the participants and emphasized the importance of international cooperation to achieve regional goals. On behalf of the Federation, Pascale Ehrenfreund, recently elected IAF Incoming President, greeted the delegations and launched the discussion on space for a better solution of Latin American and Caribbean Challenges.

Three prominent keynote speakers were carefully selected to present pivotal topics for the region's space development and to stimulate a positive and disruptive discussion within the Forum.

The first keynote, by Jan Woerner, Director General of the European Space Agency, underlined the important role of space assets in the *"Management of Natural Resources and the Prevention of Disasters"*. Climate extremes have become more and more frequent in Latin America and the Caribbean and space-based Earth observation could support not only in an early phase of monitoring and prevention, but can also be used as an effective tool to assess damages and support reconstruction plans after disasters such as hurricanes, earthquakes, and floods. Nicaragua and Honduras delegations corroborated these statements with examples of past natural disaster and extreme weather conditions causing deaths that could have been easily avoided with the use of space technologies. On a different note, Uruguay, highlighted the important role that space has also in the daily management of agriculture, which is also particularly sensitive to climate.

To effectively use space technologies, it is vital for emerging space countries to rely on the more experienced ones. This important aspect was presented by the Chair of the 2018 – 2019 UNCOPUOS, Rosa Maria Ramírez de Arellano y Haro, in her keynote speech on *"Space Partnerships"*. Latin American and Caribbean countries should cooperate within the region and with the rest of the world to maintain or develop the knowledge required to properly exploit space assets and further improve the well-being of the whole region. Knowledge development should not be pursued solely through international cooperation, but also by further promoting the synergies between local academia and other local space actors such as companies, governments and agencies. These thesis were strongly endorsed by the delegations present; Paraguay reported on the need for strengthening international coordination to truly achieve all the beneficial effects that space can have for one country's economy; while the representative from the Korea Aerospace Research Institute (KARI) reminded the Forum about its recent agreement with the Peruvian National Commission for Aerospace Research and Development (CONIDA). The importance of intersectoral partnerships, was emphasized by Brazil, which mentioned the creation of governmental programmes aimed at encouraging cooperation between Research and Development institutions and companies.



The significant role of education in the development of the space sector was highlighted by Raúl Kulichevsky, Executive and Technical Director of CONAE, during his keynote speech on *"Education and Capacity Building"*. In his presentation, the host underlined that in order to obtain the advantages that space technologies and earth observation can bring, it is necessary to have technicians and communities who are capable of transferring scientific knowledge into everyday life, for example by supporting the decision process of policy makers. In addition, the representative of Mexico, called the attention to the fact that the space sector is rapidly changing, opening up to new actors who, if integrated in an efficient network, could contribute even more to the growth and development of Latin America and the Caribbean.

All the topics addressed during the ISF 2018 were included in the Buenos Aires Page, the final ISF2018 document endorsed by the delegations at the end of the Forum, which was then added to the Trento Space Statement (ISF 2016) together with the Nairobi Page (ISF 2017).

The ISF 2018 was officially closed by Alejandro Finocchiaro, Minister of Education, Culture, Science and Technology of Argentina, who thanked the delegations for their participation. Gabriella Arrigo, IAF Vice President for Science and Academic Relations, announced that next year's International Space Forum at Ministerial Level will be dedicated to the Mediterranean Region, focusing on the role that space plays in the management of maritime transport and security. The academic community together with local and regional Authorities will be involved during the ISF 2019 – The Mediterranean Chapter.

On the 2nd of November, delegates were offered the opportunity to visit the Teofilo Tabanera Space Center (CETT) in Córdoba. The Center hosts the Mission Operations and Control Center of SAOCOM 1A, CONAE's recently launched L-Band SAR satellite, as well as the Córdoba Ground Station, used for several international missions. Participants were also introduced to the Instituto Gulich, located in the same area, which embodies the importance of cooperation for capacity building: the technicians that are formed at the Instituto count on the unique and joint support of the University of Córdoba, CONAE and ASI.

Technical Committees

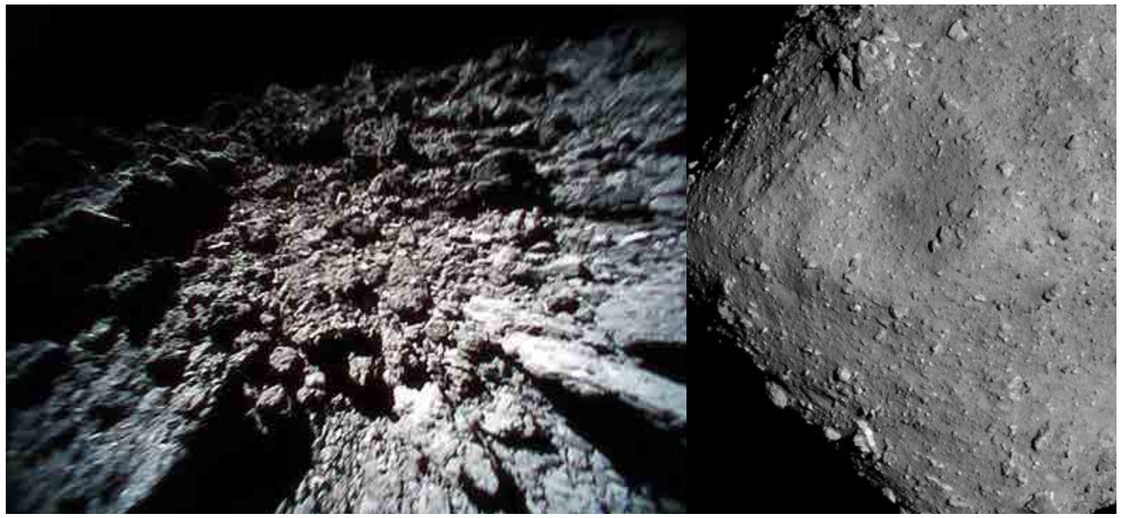
Astrodynamics Committee

The Astrodynamics Committee had a busy and successful year. The call for abstracts generated 326 responses. This number alone kept the committee busy during the IPC as we strived to select the highest quality abstracts for the Astrodynamics Symposium's 9 Technical Sessions and 1 Interactive Presentation Session. In addition, the Astrodynamics Symposium and Space Debris Symposium organized, for the first time, a joint session entitled "Orbital Safety and Optimal Operations in an Increasingly Congested Environment." This also required extra coordination effort with the second committee.

When all the delegates arrived on September 30, the Committee elected the new Chair and Vice-Chair. Prof. Anna Guerman (University of Beira Interior, Portugal) and Prof. Daniel Scheeres (University of Colorado Boulder, USA) were elected as Chair and Vice-Chair, respectively. They will lead the committee into the next decade. IAC 2018 was also the occasion to say farewell to 8 members and 1 expert. In return, we welcomed 6 new members and 1 new expert. The committee now has 26 members and 1 expert, with members from industry, academia and government organizations in 14 countries. With the support from the IAF, the committee also created an inventory of back-up papers for the first time. With 5 late cancellations and withdrawals, we were at least successful in bringing in one back-up paper to the podium. This is a small success but we are convinced that with better planning (e.g. informing authors of back-up papers sooner), we can start to approach 100% utilization of the presentation slots in technical sessions. The joint session achieved the goal of bringing in an audience outside of the usual astrodynamics community. We look forward to discussing possible joint sessions with other technical committees in future IACs. The 24th John V. Breakwell Memorial Lecture "How to Sense Gravity?" was a huge draw with over 200 in the audience. It was given by Prof. Eberhard Gill from TU Delft. With a minimal use of equations and formulas, Prof. Gill disseminated this subject eloquently and with fascination.

The Astrodynamics Committee now looks forward to adding new committee members in the coming year, and has a diverse list of new candi-

Prof. Eberhard Gill (TU Delft) delivers the 24th John V. Breakwell Memorial Lecture, entitled "How to Sense Gravity?"



Images (courtesy of JAXA) from the Hayabusa2 mission. Left, the surface of the asteroid Ryugu from the Minerva rover. Right, an image of the asteroid Ryugu from orbit.

dates who are the top in their fields, with both former experience on the committee and newcomers to the IAF.

The field of Astrodynamics has continued to expand and find new relevance and application over the last year. In the area of space exploration and science missions, the last year has seen the first ever fully successful deployment of rovers onto a small-body surface, with the Hayabusa2 mission's deployment of the Japanese Minerva rover and the European Mascot rover. The design and implementation of the deployment trajectories, and the dynamics of the rovers on the asteroid surfaces have required the involvement of astrodynamics at every level. Presentations at the Astrodynamics Symposium in previous years have discussed and shared the necessary technological analyses and steps required for these achievements. Also significant are the rendezvous and close proximity operations of the Hayabusa2 spacecraft at its target asteroid Ryugu. By the end of the 2018 year the NASA OSIRIS-REx spacecraft will have also finished its encounter with the asteroid Bennu. Both of these missions will acquire surface samples from these different asteroids and bring them back to Earth in the coming years.

In Earth orbit, the Magnetospheric Multiscale Mission (MMS) mission continues to operate in its unique and challenging formation of 4 satellites that must position themselves precisely relative to each other once per orbit. The design and control of these complex trajectories is a continuing area where advanced Astrodynamics research has been crucial to this mission's continued success.

This year also saw the end of mission of two significant space missions, the NASA Kepler and Dawn missions. Kepler distinguished itself by discovering hundreds of exo-planets about other star systems. The techniques used in the study of these solar system dynamics are related to the core science and mathematical discussions that occur in the Astrodynamics Symposium. The Dawn mission was distinguished in many ways, being the first scientific low-thrust inter-planetary mission and exploring for the first time the largest asteroids in the solar system.
Closer to Earth, the field of Astrodynamics continues to be highly influenced by the topic area of Space Situational Awareness. The maintenance of space catalogs, the understanding of debris dynamics and the best way to address potential collisions in the Earth's orbital sphere remain profound topics of study that must be addressed, in part, by continued advances in the field of Astrodynamics.

The growth of small satellite technology and the decreasing cost of accessing space also has had a large impact on Astrodynamics research. The feasibility of launching multiple low-cost satellites opens the door to on-orbit experiments to develop space technology and test out ideas for the control of satellite formations in close-proximity to each other. Research activity in these areas has also grown considerably over the last few years and continues to expand.

Figure: Images (courtesy of JAXA) from the Hayabusa2 mission. Left, the surface of the asteroid Ryugu from the Minerva rover. Right, an image of the asteroid Ryugu from orbit.

Commercial Spaceflight Safety Committee

Considering the evolution of the space market towards commercial approaches and new space economy, the Commercial Spaceflight Safety Committee (CSSC) captures all emerging aspects relevant to the development of Commercial Spaceflight, with special emphasis to the safety aspects relevant to the new generation transportation systems and ground infrastructures and spaceports.

Activities during 2018 IAF Spring Meetings

To prepare for the coming International Astronautical Congress (IAC) in Bremen, the Commercial Spaceflight Safety Committee held a meeting on 28th March 2018 in Paris, France during the IAF Spring Meetings. Presentations were given by Jean-Bruno Marciacq of JBM Aerospace on initial efforts to develop new European space safety standards. The European Committee for Standardization (CEN), the European Committee for Electrotechnical Standardization (CENELEC) and the European Telecommunications Standards Institute (ETSI) have been requested by the European Commission to develop European Standards for the space industry.

Di Reimold of the Federal Aviation Administration (FAA) Office of Commercial Space Transportation gave a presentation on three new Aviation Rulemaking Committees in the US. Those three committees are: Airspace Access, Spaceport Categorization, and Regulatory Reform (also known as 21st Century Licensing). The rulemaking committees provide advice and recommendations to the FAA.

During abstract selection, the CSSC determined that the new "no transfer after 11am" rule worked against the Committee since the number of abstracts received overall is smaller in comparison to other IAF Committees and additional papers could have been added. The online selection at the IAF website is easy to use during abstract selection and proved to be a good support system for organizing each session.

Because of high interest in papers for Bremen, the CSSC did select a healthy number of abstracts to provide for good sessions in October for D6.1, D6.2/D2.9 and D6.3 sessions. Only two abstracts were rejected, one on UAVs and one on fire safety which was a close version of one it was accepted by the same author. The CSSC met with the IAF Space Transportation Committee about the joint D6.2/D2.9 session and agreed on an Apollo anniversary Special Topic Session in the IAC 2019. Another Special Topic Session was considered on the new NASA Commercial Crew program for 2020 provided that there are flights by then.

Activities during 2018 IAC Congress in Bremen

The Commercial Spaceflight Safety Committee held a coordination meeting on Sunday September 30th 2018. The CSSC re-elected John Sloan of the US Federal Aviation Administration for another term as Chairperson. The Committee also voted to elect Francesco Santoro of ALTEC S.p.A. Torino Italy as new Vice-Chair to replace the retiring Christophe Chavagnac.

Presentations were given by Richard DalBello of Virgin Orbit and Virgin Galactic on new developments and international site locations under consideration as well as safety issues. Mr. Koichi Yonemoto of the Space Walker company also gave a presentation on a new Japanese vehicle under development. Each of the 15 Members of the CSSC in attendance provided highlights of space activity from their home organizations in France, Japan, United States, Italy, and China.

During the paper sessions, the CSSC noted that in some cases, presentations uploaded in the Speakers Preparation Room did not properly show in the sessions but this may only require a minor fix.

The D6.1 and D6.3 had 8 papers each with good audience attendance and good questions for speakers. The joint D6.2/D2.9 session also had good attendance. Many countries are interested in spaceports. Safety remains a paramount aspect and a major driver to the development of commercial spaceflight activities. The paper on Italian spaceport in Grottaglie was proposed for publication in Acta Astronautica.

The CSSC was pleased to find that a research project which it had proposed for outside research – with the encouragement of the TAC and IAF – was presented as a paper during the D6.1 session. The paper, "Cost Reduction Solutions in Regard to Planetary Protection for Commercial Companies" was presented by Diane Howard of Embry Riddle Aeronautical University. The paper surveyed several companies familiar with missions to the Moon and asteroids and concluded that while Planetary Protection is an important consideration in all space missions, it is not a cost driver. In addition, since government requirements through COSPAR may not apply to commercial missions, individual companies are looking at internal protection guidelines to preserve their business case.

The CSSC has 59 people on its e-mail distribution list from 13 countries.

Cultural Utilisation of Space Technical Committee (ITACCUS)

[R]evolution

Imagination is our window into the future. Led by each generation of artists, engineers and scientists, it is through their explorations and inventions that we push towards the edges of possibility. Aerospace developments are no exception and like other areas of human endeavor we are witnessing the increased creative utilisation of space as the technological tools for humans to make our visions of the future a reality.

In 2018, the Cultural Utilisation of Space Technical Committee (ITACCUS) celebrated ten years with the IAF. Launched at the 59th International Astronautical Congress, Less Remote symposium in Glasgow in 2008, ITACCUS was set up to promote and facilitate the innovative utilisation of space by cultural sectors of society internationally. In a cultural context, the term 'utilisation' may include cultural production, cultural preservation, cultural representation, cultural education and cultural development. In astronautics, 'culture' may include communities of technical operation, architecture, policy, business, education, outreach and community. In other words, for ITACCUS members and partners, cultural utilisation promotes a lively two-way transfer of cultural and technical benefits.

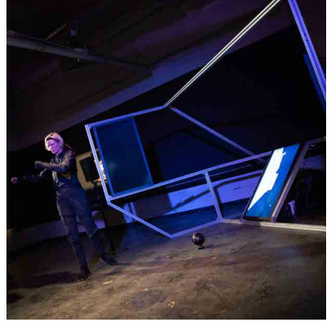
Looking to the future, the task of ITACCUS is the continued promotion of world-class creative research and cultural engagement in astronautics. We aim to engage with the latest technological achievements in the design, development, verification and utilization of space across all phases of mission architectures for commercial and cultural benefits. Additionally, we will work strategically to build sustainable partnerships and aligning across industries on mutual sector goals for increased geographic, generational, and gender diversity and cross disciplinary engagement in space.

Over the last ten years the topics addressed by the Committee have evolved following cultural, political, societal and technological progresses and innovations both in the use of commercial space actors and in the increased accessibility and engagement through new open-source assets and ubiquitous social media platforms. The rapid evolution in space engineering, environment and shifting global economics requires us to develop new non-conventional design processes and creative partnerships. ITACCUS follows this evolution and through technical sessions in the IAA Space and Society symposium, and the IAF Space Education and Outreach symposium which annually sees the submissions of more than 400 abstracts; and by hosting a Global Networking Forum, ITACCUS reveals itself as an inspirational knowledge hub within the IAC, and makes a virtual bridge among the space and cultural specialists around the world for a better integration of the new technological and cultural challenges for mutual benefit and inspiration.

Other activities throughout the year include facilitated collaborations, workshops and meetings around the world for critical conversation and exchange; advocacy and networking promoting, developing and raising the profile and quality of 'cultural utilisation of space' within the space community, the cultural community, and general public; and delivering and endorsing quality cultural products including policies, publications, and partnerships.

2018 Activities

IAC Technical Sessions: ITACCUS embraced the theme "IAC 2018 - involving everyone", and the vision of a more diverse space sector. Technical Sessions included: E1.9 **Public Engagement in Space Through Culture:** A technical session co-sponsored by ITACCUS and the IAA Search for Extraterrestrial Intelligence (SETI) with the focus on current activities of institutions such as museums, space agencies and non-profit organizations involving space that engage the cultural sector. Topics include the process, critical thinking and methodologies underlying space education and outreach events. E5.3 **Contemporary Arts Practice and Outer Space: A Multi-Disciplinary Approach:** A technical session on the practice of contemporary artists who have developed new ways to appropriate space for their work, the conceptual and practical foundations of their engagement, and the implications of this emerging aesthetic paradigm for both the fields of space and art.



Artists and art historians, space industry and space agency representatives as well as from the cultural sector facilitating or programming related projects crossing over the increasingly blurred boundaries of creative practice.

Since the late 1970s a number of artists have been negotiating access to space facilities and organizations, critiquing or making experiential the exploration and utilisation of space, or re-purposing space technology, materials or data independently or in direct exchange with the space sector. Today this practice is branching into a several directions, ranging from performance, installation, video, or conceptual work situated in the space or space analog environments themselves, to commercial gallery contexts and the realm of participation and public engagement with science. As "space artists" (r)evolve and the impact and significance of technical and cultural utilisation of space expands, we note an increase in cultural utilisation papers in non-typical ITACCUS sessions for example, other IAF Symposiums, Global Technical Sessions, Interactive Presentations and Global Networking Forum panels.

IAF Global Networking Forum: Chairperson Bernard Foing moderated a lively conversation for the **GNF: Orbits, Arts & Culture**. ITACCUS member representatives Nahum, Niamh Shaw, Nelly Ben Hayoun, Melanie Kathryn King, Rob La Frenais, and Aoife van Linden Tol were selected as GNF panelists to challenge the traditional view that space activities are owned by national space agencies and the private sector. They presented a series of performative presentations to show how artists and cultural practitioners have always shaped the way we envision our future on Earth and beyond.

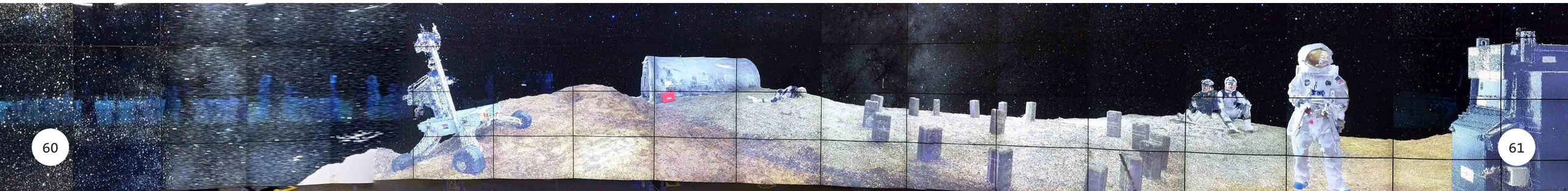
Highlighted ITACCUS Endorsed projects: developing and raising the profile and quality of 'cultural utilisation of space' including:

SciArt: ***Ethereal Things*** 14-15 April 2018: An evening of performance, film, talks and music that aimed to make the physics of the universe intimate and inspiring. The Arts Catalyst hosted convener Nahum, artists Annie Carpenter and Aoife van Linden Tol, film-makers Semiconductor, dark matter physicist Chamkaur Ghag, cosmologist Richard Bower, and band Spacegong. Spectacular cosmological visuals by the Institute for Computational Cosmology, Durham University.

Payload: ***The Contour of Presence*** artwork for the SpaceX CRS-15 mission, was launched on 29 June 2018 from Cape Canaveral, FL, on board a Falcon 9 rocket and a Dragon cargo module supplying the ISS. Hydra-3/Pulse is a collaboration between the International Space University, Space Applications Services' ICE Cubes Service and Nahum Studios through a partnership with the European Space Agency. The interactive performance installation and payload design addresses both scientific and artistic concerns related to space. Fostering open technology innovation and public engagement is not only about promoting broader use (including cultural utilisation) of the International Space Station (ISS) but could also have a positive impact on future missions.

Analogue Missions: ***SPECTRA Mission***, Lunares MoonMars Station, Pila Poland 14-29 July 2018. A simulated Lunar mission for the dedicated testing of integrated technical, cultural and biological systems, and application of interdisciplinary cooperation and innovative experimental approaches for future performance in lunar settlement scenarios, and in communication with Earth systems.

Platforms: ***KOSMICA Parliament*** 6-9 Sep 2018: A series of performative events featuring the artistic community of Ars Electronica and their views about human activities in outer space. Inside a media space capsule, artists were welcome to give a performative statement about the errors of space exploration. At Ars we actively reflect on these issues in order to envision novel ways of exploring and inhabiting space through emerging understanding of relations between humanity, non-terrestrial environments and



technologies. Artistic Director Miha Turšič, and Nahum invited ITACCUS' Sarah Jane Pell, Anna Nazo, YaTang-Hsu, Changyeob Ok, Nicola Triscott, Florian Voggeneder, Chris Welsh, Egle Pernare, Nicole L'Huillier, Eric Dahlstrom, Rob la Frenais to name a few.

munity engagement platforms such as the KOSMICA Institute; and presented recommendations to UNESCO. He also fostered close working relationships with space agencies, space companies, and space and cultural institutions including The Arts Catalyst, IAA, Leonardo/OLATS, ESA, NASA, JAXA, CNES, MIT Media Lab, SETI, ISU, COPOUS, the International Lunar Exploration Working Group and Lockheed to name a few. Nahum will remain a member of the committee and continue in global activities. The committee thanked Nahum and Vice-Chairs Bernard Foing and Carol Christian for their service and engagement.

Membership updates

At the 2018 Committee Meeting, ITACCUS Chair Nahum Mantra submitted his final annual report and called for a new leadership. The committee recognised the many contributions of Nahum's legacy. He initiated over 20 "space arts" and related public events; developed com-

The committee elected the following Technical Committee Chairpersons and Vice-Chairs for 2018-2021:
Chair - Bernard Foing (DE) - Professor, European Space Agency.
Vice-Chair - (Academic) Nelly Ben Hayoun (UK) - SETI, Designer of Experiences.
Vice-Chair - (Community) Aoife van Linden Tol (UK) - European Space Agency, Artist-in-Residence.
Vice-Chair - (Partnerships) Sarah Jane Pell (AU) - Adj. A/Professor, Monash University, Artist-Astronaut.

Through our continued work with the IAF, the ITACUSS Chairperson and Vice-Chairs will place special emphasis on the new generation of space experts, the expansion of equal opportunities, and the integration of new countries and start-up companies into the global space network. They seek new commercial partners, cross-cultural communities and creative collaborations for increasing the public participation in space though novel, innovative, informed and daring outreach, engagement, advocacy, arts and creative medias.

Membership comprises individuals acting as liaisons for many global cultural and space organizations including representatives from the public and private sector. The committee is also supported by active associates building a critical a community of passionate arts and cultural professionals working in astronautics and related space fields. ITACCUS welcomes all new members and associates as enthusiastic and capable activators and advocates.

Earth Observation Committee (EO)

The Earth Observation (EO) Committee brings together technologists on Systems, Technologies, and Applications for Earth Observations. In 2018, there was the 'three yearly' renewal of most members, and while there were some retirements of longstanding members, we also welcomed several new members so that overall the membership of the committee and subcommittee has remained stable.

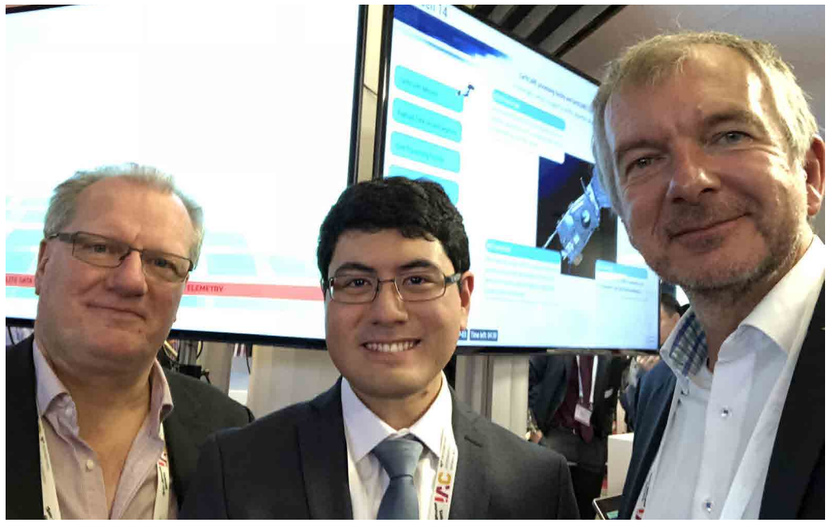
The EO committee has also analyzed its 3G profile and has concluded that currently the committee has a strong bias to male members (but greatly improving with new female members joining this year), and that there are many European members, partly due to strong participation of European companies. From an age perspective the committee (without too many enquiries on age) is quite well balanced between older and younger members with a majority in the 'middle' period of their careers.
The EO committee also thanks DLR for the Earth globe in the exhibition area displaying sets of remote sensing data during the entire week of the IAC.

It was also a great pleasure to the committee that Barbara Ryan, former director of the Group on Earth Observation (GEO) and member of the GEOSS Subgroup was welcomed into the IAF Hall of fame for her outstanding service throughout her career to earth observation, but especially her role in establishing a free and open data exchange for Earth Observation data.

The committee also addressed the changes of the Chairs, electing three members as Chair (Andy Court), and two vice Chairs (Harry Cikanek and Masami Onoda) and re-elected members wishing to serve over the 2018-21 period. Two new members were elected (from China and Italy) and two potential new members were introduced at the committee meeting.

Many papers were submitted to the six EO sessions held during the IAC in Bremen. In addition, EO events were held at IAC throughout the week beginning on Tuesday with a keynote address on the 2018 Activities of the International Committee on Earth Observation Satellites (CEOS) by Astrid-Christina Koch, European Commission. This was followed by a GNF session on New Space exploring how the concept of Space 4.0 is changing the face of EO and data analytics, with a panel led by Josef Aschbacher (ESA) and panelists from SPIRE and Axelspace. A second GNF also took place on the Planet company who have a reputation for building and launching EO satellites faster than any company or government in history. Agnieszka Lukaszczyk, Planet's Senior Director for European Affairs, gave an address on the agile space that Planet operates by and the game changer that small satellites have become in the Earth observation ecosystem.

On Wednesday there were two GNF and four Special Sessions devoted to EO topics, starting with Small Satellite Applications Development Leveraging Socio-Economic Benefits with a panel exploring the exchanges of data and service requirements based on small satellite technology, and the second on the Italian Space Economy for Sustainable Development Goals which explored the tools that the Italian space economy is providing in support of the goals of the UN Agenda 2030 for sustainable development. The first of the Special Sessions also covered Earth Observation and Sustainable Development Goals covering the broad, open data policies and practices for the U.S. Landsat Program, and the European suite of Sentinel satellites in the Copernicus Programme, and how these can help to achieve the United Nation's SDGs as well as the advancement of Earth observations towards a terrestrial forecasting system. The next Special Session covered the Landsat-Copernicus sen-



From left to right: Committee chair Andy Court, IAC 2018 IP winner Ahmed Kiyoshi Sugihara El Maghraby and outgoing chair Gunter Schreier

tinel 2 integrated operational land imaging and its access to the global user community. The third Special Session was a panel discussion on the 'The Golden Age of European Earth Observation' looking at how the Copernicus program is delivering data and how this should lead from the current Institutionalized use of data towards commercial services. The final Special Session was an interactive workshop on new approaches to Space for a better world focusing on new approaches in space science, technology and economy to achieve a better and more sustainable world.

Thursday at the conference started with a Plenary session on greenhouse gas measurements from space, in which leaders of space and meteorological agencies from around the world discussed the difficult challenges of making GHG measurements from space and highlighting the successes from efforts already underway, and the plans for the future of these critical observations. This was followed by a final GNF building on the plenary session with Young Professionals discussing with senior experts on climate change how space based measurements can be used to understand the changing human impact on the sources and sinks of greenhouse gases and global climate change.

Thursday was also the day on which the B.1.6 Technical Session on Citizen Science in Global Earth Observation Systems took place, which is the second event in a three-year series focusing on the role of Citizen Science and crowd sourcing in Global Earth Observation science investigations. It follows the IAC Global Networking Forum kick-off event at the 2017 IAC, Adelaide. This session includes scientific methodology and results, technical challenges and pitfalls, guidelines for success, policy and educational aspects, and benefits of Citizen Science and crowd sourcing in Global Earth Observation science investigations. This joint session is organized through a continuing partnership between IAF Subcommittee on Global Earth Observation System of Systems (GEOSS) and IAF's Workforce Development and Young Professional Programme (WD/YPP) in collaboration with the Bremen IAC Local Organizing Committee.

The EO committee was also happy to recognize that the winner for the overall Category B. "Applications and Operations" interactive presentation award, Mr. Ahmed Kiyoshi Sugihara El Maghraby from University of Southampton has submitted his paper for the Earth Observation Symposium. His interactive presentation was titled: "Coupled Orbital and Radiometric Performance Simulation of the Formation Flight Interferometric Radiometer for Geostationary Atmospheric Sounding". This is the second overall category B winner in Earth observation after Adelaide.

Away from the IAC itself there was also the Global Space Applications Conference (GLAC 2018) held in Montevideo 21 – 23 May 2018, MONTEVIDEO, URUGUAY. GLAC 2018 was coorganised by IAF together with the Centro de Investigacion y Difuson Aeronautico-Espacial (CIDA-E), a member of the IAF since 1985 and one of ten IAF members from South America. GLAC 2018 was to focus on collaborative solutions, challenges, lessons learnt, and paths forward primarily on Earth observation and Earth observation applications. Gunter Schreier, then Chair of the IAF Earth Observation Committee, gave a keynote on "The Preservation of Natural Resources through Space".

Finally, the EO committee looks forward to the 70th IAC in Washington next year with another full program of technical sessions, GNF's and other events.

Enterprise Risk Management Committee (ERMC)

Last year was quite an active year for the IAF Enterprise Risk Management Committee (ERMC):
A real questioning on the direction the Committee wanted to take took place among the Members and the decision was taken to embrace a larger audience/topic range by moving towards a symposium closer to Enterprise issues.

Indeed, Members expressed the wish to invite as well newly implemented startups to express their views on how they assess their risks, with a focus on innovation topics and New Space. One of the areas of interest would concentrate on how entrepreneurs particularly in NewSpace understand and tackle risks linked to soft skills, managing people, resources and relationships. Therefore, the E.6 Business Innovation Symposium was contacted and together the decision to move to such a symposium was taken during the IAF Spring Meetings in March 2018 in Paris, France.

This year the Technical Session in Bremen welcomed some new space businesses (Spire, Valispace) and also a key note speaker Prof. Reinhold Ewald, former ESA astronaut sharing his view on human risks within the ISS, shedding light on a more anthropologic approach to risk management.

The committee held its elections as well:

- M-G Sarah, from ESA, was elected as the ERMC Chairperson;
- R. Suess, from DLR was elected as Vice-Chair; and
- Helen Tung, founder of the « NewSpace2060 » startup, recently elected a Member.

Global Workforce Development Subcommittee

Overview of the past year

10th Anniversary of the Global Workforce Development Subcommittee

The year 2018 marked the tenth anniversary of the Global Workforce Development Subcommittee and its relevant technical session. Ten years ago, in 2008, the need of establishing a forum to discuss the challenges and opportunities to build the future aerospace workforce drove to the International Astronautical Federation's Space Education & Outreach Committee (SEOC) and the Workforce Development & Young Professionals Programme (YPP) Committee to organize jointly the Global Workforce Development Subcommitee and dedicated Technical Session. The Workforce Development Technical Session, as the part of the Education and Outreach Symposium of the International Astronautical Congress (IAC), has been held ten times since 2009. Every two years, this Technical Session is organized in collaboration with the International Project/Programme Management Committee (IPMC). In total during last ten years, more than 100 papers from 63 organizations all around the world have presented their achievements, experiences and best practices in the area of Workforce development. The evolution of the workforce challenges was addressed in the study performed by A. Monzon and O. Zhdanovich entitled "IAC Workforce Development Technical session – 10 years addressing the challenges of the future global workforce". The study was presented at IAC2018 in Bremen.

Below are important findings:

- The interest on the Workforce Development Technical Session has grown significantly, being today one of
- the sessions with the most abstracts received within the Education and Outreach Symposium. In 2009, the session started with 13 abstracts submitted, whereas in 2018 the number of abstract has increased to 33 and represents close to 1% of the total abstracts of the IAC2018.
- Likewise, the percentage of authors which have presented more than once in the Technical Session (13%) is remarkable, showing a maintained interest along the time in this forum.
- The geographical diversity of the Technical Session has continued to increase since its start. All major regions of the world are represented. Representatives of 30 countries shared their views on space workforce training.
- In terms of gender distribution, a near to parity situation is present; despite a difference of 14% between male (57%) and female (43%) authors in the latest session.
- During the period analyzed (2009 – 2018) most major organizations of the sector have • participated in the Technical Session, including space agencies (29%), academia (27%), industry (15%), institutions (14%) and non-governmental organizations (18 %).

This IAC in Bremen Global Workforce Development Subcommittee organized the GNF panel entitled "Developing Space Workforce – Industry Focus".

Attracting a skilled workforce in the space industry is always a challenge. There are few important issues to consider: lack of motivation of young people in engineering subjects; an aging of workforce in the space industry (especially in Europe); and a scarcity of certain professions as for example system engineering and product assurance.

The panellists discussed the specific problems faced by the space industry today in various regions of the world - Russia, United Arab Emirates/Middle East region, China and Europe - in terms of training the future space workforce; the scarcity of certain professions in space industry; addressing an aging workforce and capturing the knowledge accumulated; and discussing the way forward. The panel started with Prof. Vera Mayorova from Bauman Moscow State University, Russia and Ms Lisa La Bonté, Founder and CEO of Arab Youth Venture Foundation describing hands on projects in which students in Russia and UAE participate before they graduate from the university. Russian students perform hands on projects on-site of space industrial enterprises that give the possibility to get experience with industrial engineering processes. It is interesting to know that partnership/ sponsorship programs with NASA, Boeing and Lockheed Martin give unique space experience and training of young people not only in UAE but also to young people from Middle East region. Prof. Yang Yuguang from China Aerospace Science and Industry Corporation and Ms Maria Antonietta Perino Director of Relations with Space Associations from Thales Alenia Space shared their experience in training engineers with skillsets needed by their industrial companies. In China, engineers receive additional training in quality management and standardisation; while in Europe, a lack of system engineering skills has resulted in the organisation of a Master course together with Politechnico of Turin, Italy, University of Bremen Germany and Grande Ecole Aerospatial Supaero, France, on space exploration and development systems with special emphasis of system engineering skills. The retiring wave of space engineers is also a problem that the space industry in Europe is facing. Mr Andrew Herd, senior knowledge management engineer shared the experience and efforts made by the European Space Agency (ESA) to capture the knowledge of experts to be retired very soon. The panel members had a very interesting discussion with the audience, covering all age groups of space workforce beginning with future engineers; then discussing the luck of specific skills of engineers in industrial companies; and finally, capturing the knowledge of senior experienced space experts to be retired from space industry soon.

Changes of the Subcommittee

Before October 2018

Amalio Monzon (Airbus SD, YPP Committee, Spain) - Chair
Olga Zhdanovich (Modis for ESA, SEOC, Russia) Vice-Chair

Since October 2018

Olga Zhdanovich (Modis for ESA, Russia, SEOC) Chair
Kathleen Coderre (Lockheed Martin, US, YPP) Vice-Chair

Space Astronomy Technical Committee (SATC)

Committee Meetings

The IAF Space Astronomy Technical Committee (SATC, 2015-2018) held a face-to-face committee meeting on Tuesday, 2 October 2018, at the Bremen Conference Centre, during the 69th International Astronautical Congress (IAC).

The agenda included key topics:

- Election of SATC members and chairs
- Review and planning of annual activities and committee objectives
- Reporting and fostering of cooperation between the SATC and COSPAR and IAU
- Current events in space astronomy, particularly in the areas of small satellites for space research and cooperation between space and ground-based astronomy

Committee Participation in the 69th IAC

The SATC organizes and hosts Symposium A7, the **Symposium on Future Space Astronomy and Solar-System Science Missions**.

This symposium invites leaders throughout the science, space industry, and space-agencies communities to share with each other their respective activities, insights, and planning for future space missions in space physics, fundamental physics, astronomy, exoplanets, and planetary science on extreme frontiers in our solar system like Venus, Mercury, and the outer solar system including the Ocean Worlds.

Our symposia comprise both invited talks and contributed papers in these five areas: space physics, fundamental physics, astronomy, exoplanets, and planetary science on extreme frontiers. We solicit discussion of phenomena coming within our reach in the next half-century:

- Enabling measurement and system technologies, including significant progress made by research laboratories within industry and agencies,
- Mission concepts to implement such investigations,
- Corporate and space agency strategies for prioritizing and investing to make them real.

We trace this thread, from strategy to emergent technologies, throughout the week at each IAC, typically in three Oral Sessions plus Interactive Presentations, co-chaired and reported by Committee Members.

The Highlight Lecture "Gravitational Wave Detection on Ground and in Space" proposed by the SATC was given by Prof. Karsten Danzmann; it was an outstanding lecture and attracted a full audience. Gravitational waves have first been observed in 2015, leading to the award of the 2017 Nobel Prize in Physics. They provide a new and very clean way to observe the dynamics of Black Holes, stars, and the whole universe.

SATC membership status

During the SATC meeting at the 69th IAC, the new composition of the Committee was decided. Pietro Ubertini (INAF, Italy) was re-elected as Committee Chairperson and Eric Wille (ESA/ESTEC, The Netherlands) was elected as Vice-Chair. The efforts in increasing the number of active Members of the Committee have been successful, demonstrated by a large presence in Bremen and the election of four new Members. The complete list of Members can be found on the IAF Committees page at www.iafastro.org. The Committee thanks all outgoing Members for their efforts and welcomes the new Members.

The chairing and reporting of the three A7 sessions was shared among the following Committee Members:

Ms. Colleen N. Hartman, NASEM, United States

Mr. Brent Sherwood, JPL, NASA, United States

Mr. Leopold Summerer, ESTEC, ESA, The Netherlands

Mr. Pietro Ubertini, INAF, Italy

Mr. Jakob van Zyl, JPL, NASA, United States

Mr. Eric Wille, ESTEC, ESA, The Netherlands

Session descriptions in the call for papers

A7.1: Space Agency Strategies and Plans

Invited talks by international space-agency division directors about their long-term views, priorities, and plans to implement developments and missions for the five fields (space astronomy, space physics, fundamental physics, exoplanets, and extreme planetary science). Mission scope includes flagship-class, large-class, medium class, small-class, and smallsat platforms. Program scope includes status updates on current programs, near-term investment priorities, and long-range directions, including the relationship to community and guiding research panels.

A7.2: Science Goals and Drivers for Future Exoplanet, Space Astronomy, Physics, and Outer Solar System Science Missions

Invited and contributed talks about scientific motivations, goals, opportunities, and needs in the five fields (exoplanets, space astronomy, space physics, fundamental physics, and outer solar system planetary science). New directions for measurements that are being opened by emergent results and newly understood phenomena will be explored, and science roadmaps to pursue them will be discussed.

A7.3: Technology Needs for Future Missions, Systems, and Instruments

Invited and contributed talks about the technology challenges and plans required to enable breakthrough science objectives in: exoplanet detection and characterization; astronomy throughout the electromagnetic spectrum and using gravitational waves; space physics including fractional gravity regimes and heliophysics; fundamental physics including relativity; and outer solar system planetary science including gas giants, ice giants, complex planetary systems, primordial body populations, and ocean worlds. Topical focus includes measurement techniques, data types, performance requirements, instrument designs, mission concepts and systems, and associated technology developments.

Scientific Progress in the SATC's Area

Space astronomy

Astrophysics and fundamental physics investigations have changed profoundly over the past few years. Even if the importance of observing the gamma-ray, X-ray, UV-optical, and near-IR spectral ranges from space was already clear, combined observations by multiple space observatories and large ground-based facilities have profoundly changed the way to study the cosmos physics. Scientifically, the so-called new astronomies (Gravitational Waves, and High-Energy Neutrinos) are expanding our access to astrophysical information. One of the most important observational challenges of our time is linking discoveries made by the new astronomies with observations of the electromagnetic universe. Last year, such a window opened, through which we should be able to study fundamental events such as binary neutron-star system collapse. The LIGO-VIRGO consortia detected for the first time a gravitational wave signal hypothesized for a neutron-star merger, GW170817. Then just 1.7 seconds later, the INTEGRAL and FERMI space telescopes detected and located the gamma-ray burst source GRB170817a., though triggering the most extensive multi-wavelength observation ever. This was humanity's first "multimode" observation of a stellar cataclysm. Also, the 2017 Nobel Prize in Physics was awarded to Reiner Weiss and to Barry Barish and Kip Thorne, "for decisive contributions to the LIGO detector and the observation of gravitational waves."

On 22 September 2017, a second "multimessenger" observation followed, which combined observation of a flaring gamma-ray blazar coincident with a high-energy neutrino event detected by the cubic-kilometer IceCube Neutrino Observatory.

Exoplanets

To date, almost 3800 exoplanets have been discovered using multiple techniques, in a wide range of planetary-system configurations. Ice Giants (like Uranus and Neptune) appear to be the most common type of planet in the galaxy. Many "hot Jupiters" are found: very large gas giants orbiting very close to their host stars. Rocky planets in their stars' "habitable zones", where liquid water could exist on their surfaces, are found in increasing numbers. While the Kepler spacecraft is now done, NASA launched and commissioned TESS, which seeks to find Earth-like planets in our stellar neighborhood, for spectroscopic follow-up by JWST. And the ALMA microwave observatory continues to image circumstellar material, revealing evidence for protoplanetary disk behavior including the clearing of dust gaps by accreting planets.

Ocean Worlds

The JUICE and Europa Clipper missions continue in development. The Clipper launch date is still in flux, partly dependent on NASA's choice of launch vehicle: conventional (with 6-year trip time) or the SLS (with 2-year trip time). The Dragonfly New Frontiers concept (octocopter drone for surface exploration of Titan) is in a competitive Phase A, with selection decision planned for June 2019. NASA also developed a concept for a Europa Lander that would conduct geophysics, geochemistry, and biomarker science at the surface of Europa. NASA continues funding potential in situ instruments and life-detection suites for Europa and Enceladus.

Extreme Solar System Environments

ESA launched BepiColombo on its multi-year trajectory to attain orbit around Mercury, a unique rocky planet that is 80% metal core. The US science community is working with NASA to establish a new Assessment Group specific to Mercury. Despite Akatsuki and Venus Express, our understanding of Venus continues to lag because it is such a challenging exploration target; yet Venus can help us understand how Earthlike planets in their stars' habitable zones nonetheless can evolve to be inhospitable. Venus missions continue to be proposed into available mission opportunities; the ones currently in play are EnVision in the Cosmic Vision program, and Venera-D in Russia. NASA has committed significant support to both.

Space Education and Outreach Committee (SEOC)

Overview of the Past Year

The Space Education Outreach Committee (SEOC) worked throughout 2017 and 2018 to ensure excellent support was provided to the 69th International Astronautical Congress (IAC), which was held in Bremen, Germany on October 1-5, 2018. This pre-work enabled the SEOC to plan and facilitate excellent technical sessions, professional development opportunities, as well as networking and educational outreach for students and educators. Below are highlights from some of our activities:

E1 Symposium – Lisa Antoniadis, Vice Chair

The E1 Symposium on Space Education and Outreach included nine technical sessions and one interactive presentation session, which were very successful. The quality of papers and presentations were very high and each session was well attended. The best interactive presentation in Category E - Space & Society was attributed to Kristine Dannenberg from Sweden. Her presentation was entitled, "Hands-on space education with REXUS/BEXUS - Rocket and Balloon Experiments for University Students."

E2 Symposium – Marco Schmidt, Vice Chair

The E2 Symposium included four technical sessions. The E.2.1 and E.2.2 were associated with the undergraduate and graduate student competition. The team competition was held in the scope of the E.2.3 session. All sessions were well attended, especially the team competition, which attracted many congress people. The following winners of the student competition were awarded at the closing ceremony:

Undergraduate Category
1st prize (Hermann Oberth Gold):
Mr. Shaun Andrews, University of Bristol
Title of the paper: *Modelling and Characterisation of Plasmadynamic Drag on Gridded Ion Engine Propelled Spacecraft in Very Low Earth Orbit*

Graduate Category
1st prize (3AF Gold):
Mr. Marcello Sciarra, Politecnico di Milano
Title of the paper: *Impact probability computation for NEO resonant returns through a polynomial representation of the Line of Variations*

2nd prize (3AF Silver):
Mr. Jürgen Lüdemann, Stellenbosch University
Title of the paper: ***Sub-pixel image registration on an embedded satellite platform***

2nd prize (Hermann Oberth Silver):
Mr. David Jimenez-Lluva, TU Delft
Title of the paper: *Hybrid Optimization of Low-Thrust Many-Revolutions Trajectories with Coasting Arcs and Longitude Targeting for Propellant Minimization*

British Interplanetary Society Prize for best technical paper
Mr. Gabriël Roux, Stellenbosch University
Title of the paper: *A Novel High-Performance Nanosatellite Attitude and Rate Sensor*

Hans von Muldau Team Award for the Best Team Project (Representative): Mr. Hunter Hall, NASA Jet Propulsion Laboratory
Title of the paper: *Project Zephyrus: An autonomous and economical high-altitude testing system*

Awards and Honors – JR Edwards, Vice Chair

Malina Medal
The Malina Medal recognizes an outstanding educator. Thirteen applications were received and a small committee reviewed and ranked them. David Spencer, Professor, Department of Aerospace Engineering at The Pennsylvania State University was selected and his medal was presented at the IAC Closing Ceremony.

Napolitano Award
The Napolitano Award recognizes a space researcher under the age of 35. Twenty-five applications were received and reviewed. Peter Schulte, Earth/Moon/Mars Guidance, Navigation, & Control Engineer at Draper was selected and his award was presented at the IAC Closing Ceremony.

Outreach – Carolyn Knowles, Vice Chair

Student Program

The SEOC worked with the International Space Education Board (ISEB) to support the IAC Student Program. The Student Program was a big success, with a range of activities for ISEB students, as well as local students and educators. The ISEB accepted the United Arab Emirates as a new partner, increasing its membership to ten agencies - Canadian Space Agency (CSA); European Space Agency (ESA); Japan Aerospace Exploration Agency (JAXA); National Aeronautics and Space Administration, NASA; Centre National d'Etudes Spatiales (CNES); Korea Aerospace Research Institute (KARI); South African National Space Agency (SANSA); Victorian Space Science Education Centre (VSSEC); Mexican Space Agency (AEM), and United Arab Emirates, (UAE). The CSA served as ISEB lead and together with its partners sponsored 75 students, who had the opportunity to present technical papers and interactive presentations throughout the week. They were also able to hear from leaders in the space world, network with colleagues from around the globe, and participate in outreach to local middle school students. For the first time, the International Student Zone (ISZ) was co-located in the middle of the exhibit hall, along with the European Space Agency and the German Aerospace Center (DLR). This arrangement provided greater visibility and was appropriate for the 2018 IAC.

Educator Professional Development Workshop (EPDW)

The SEOC collaborated with the International Space Education Board (ISEB) to support a successful Educator Professional Development Workshop (EPDW), which was held as a pre-congress activity on Saturday, September 29 at the University of Bremen. The SEOC and IAC enable teachers to see the full life cycle of student development. Staff from VSSEC, CSA, and DLR Labs worked well together to conduct excellent training. There were 28 local teachers who participated in a full day of programming, including the latest pedagogy research. They experienced a good mix of theory and hands-on training. They provided positive feedback, indicating they would be able to implement what they learned in their classrooms.

Outreach to Local Middle School Students

Approximately 50 local middle school students participated in outreach activities on September 29 in the International Student Zone. Staff from the VSSEC facilitated the training activity entitled, "Tickle My Droid," which focused on coding and robotics. The ISZ was a place of "orderly chaos," as students and staff spent time together learning and having fun. Members from the ISEB and Space Education Outreach Committee (SEOC) worked together to promote a very successful student program.

Global Workforce Development

Separate Report Submitted. See p. 66

General Changes to the Committee

The members below were elected at the 2018 IAC for a three-year term:

- Carolyn Knowles, Chair, SEOC
- Ali Nasser, Vice Chair, E1 Symposium
- Marco Schmidt, Vice Chair, E2 Symposium
- JR Edwards, Vice Chair, Honors and Awards
- Olga Zhdanovich, Vice Chair, Work Force Development
- Camille Alleyne, Vice Chair, Outreach
- Carol Christian, Vice Chair, Communications
- Carol Carnette, Secretary
- New Developments in the Field of the Committee

For the first time, the SEOC engaged our Malina Award winner to serve as the E1 Symposium Keynote Speaker. For 2018, it was David Spencer, The Pennsylvania State University.

Space Propulsion Committee

The Space Propulsion Committee addresses sub-orbital, Earth to orbit and in-space propulsion. The general areas considered include both chemical and non-chemical rocket propulsion, air-breathing propulsion, and combined air-breathing and rocket systems. Typical specific propulsion categories of interest are liquid, solid and hybrid rocket systems, ramjet, scramjet, and various combinations of air-breathing and rocket propulsion and nuclear, electric, solar and other advanced rocket systems. The Committee is concerned by component technologies, the operation and application to missions of overall propulsion systems and unique propulsion test facilities.

Overview of the past year

The IAF Spring Meeting was the occasion for the Space Propulsion Committee members to gather together and prepare for the IAC 2018; at that meeting, over 361 abstracts had been submitted, and 196 abstracts were accepted including 57 Interactive Presentations.

The Space Propulsion Symposium, C4, ran very successfully in Bremen. In addition to the classical presentations during the 10 sessions and the Interactive Presentations Session, where a prize was won by a propulsion presentation on "Regulation of LE-9 Japanese Engine", 5 keynotes have been presented covering topics of Large Liquid Propulsion, Solid Propulsion, Space Propulsion for small satellite, Air Breathing Scramjet Propulsion and Green Propellants.

General Changes to the committee

2018 was the year of the election of a new Chairperson and Vice-Chairs. This was a good opportunity to warmly thank our Chairperson, Dr. Toru Shimada (JAXA, Japan), for the huge work he has performed over the past 3 years, and to thank also our Vice-Chairs who help a lot in the dynamic activities of our Committee.

Following the election, Mr Christophe Bonhomme (CNES, France) is the new Chairperson, along with Dr. Vanessa Vial (Safran Aircraft Engines, France), Dr Elena Toson (T4i, Italy), Dr. George Schmidt (NASA, United States), Mr. Giorgio Saccoccia (ESA, The Netherlands), Dr. Riheng Zheng (CASIC, China) who are the Vice-Chairs.

The Committee also welcomed 5 new Members: Mr. Jean-Claude Traineau (ONERA, France), Dr. Ashley Karp (JPL, United States), Mr Simon Feast (Reaction Engines, United Kingdom), Dr. Arif Karabeyoglu (AIAA, Turkey) and Mr. Jacob Herscovitz (RAFAEL Ltd, Israel).

New developments in the Field of the Committee

The IAF Space Propulsion Technical Committee is always looking to expand its membership toward a better representation encompassing the whole range of age, countries, skills and a good balance between women and men and between Academy, Agencies and Private Companies.

This year, we also intend to propose a better representation of propulsion topics between our C4 sessions with application expected at 71th IAC in 2020. For this purpose, a dedicated working group has been defined to work on the subject and give a proposal to the Space Propulsion Committee at the IAF Spring Meeting in 2019.

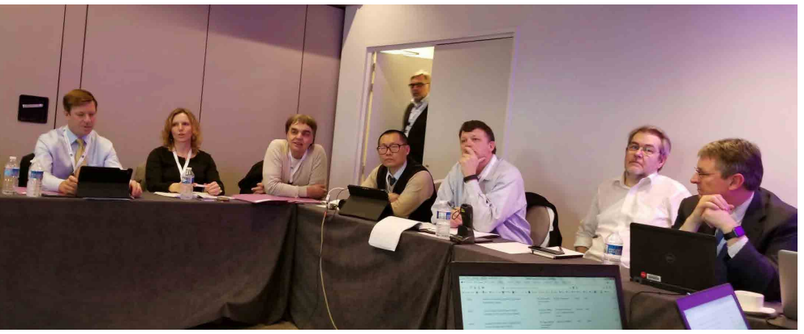
Space Transportation Committee (STC)

Space Transportation Committee (STC) Activities during 2018 IAF Spring Meetings

To prepare for the D2 Symposium of the International Astronautical Congress (IAC) in Bremen, the Space Transportation Committee held our meeting during the IAF 2018 Spring Meeting in Paris. This year Ms. Christie Alisa Maddock from the UK became a new Member following the meeting.

After attending International Program Committee (IPC) General Meeting, the Space Transportation Committee conducted our paper selection tasks. As the submission system had improved from last year, we accomplished our tasks with very high efficiency. We also changed the topic of D2.9 session to 'The Apollo program and the rockets that took humanity to the moon'. This session will describe the development and operations of critical systems in rockets of the Apollo program as well as the heritage the Saturn 5 Rocket's systems on modern rockets. The intention is to invite keynote papers from the developers of the 1960's. We hope to have a successful session during IAC2019.

Our committee member Daniel Dumbacher attend our meeting and we heard from him that he has just become the executive director of AIAA, congratulations to Dan!



STC Meeting in Paris, 2018

Paper selection after IPC General Meeting

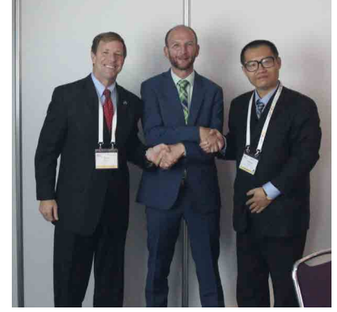
Daniel Dumbacher in STC meeting in Paris

STC Meeting before IAC2018

Activities during the STC meeting in Bremen

In line with tradition, the Space Transportation Committee held our meeting on Sunday 30 September, just before the opening ceremony of the IAC2018. This is a very important preparation of the 9 Technical Sessions we are in charge of. Our new Chairperson, Mr. Markus Jaeger from Airbus, and Secretary, Mr. Yang Yuguang from CASIC, hosted the meeting.

During our STC Meeting, we carefully prepared every session and confirmed the Co-Chairs and Rapporteurs of each session. With care and due diligence, every session was a success. We also received requirements from the Technical Activities Committee (TAC) meeting and discussed the preparation of new Terms of Reference (TOR) for the STC. During this meeting we elected three new Members, and appointed them as Co-Chairs of D2 Sessions.



New leadership of STC

During IAC2015 in Jerusalem, Israel, Steve Creech and Yuguang Yang were elected as Chairperson and Secretary of the STC; this year was the end of their turn. From 2015 to 2018, Steve Creech has done a great job as Chairperson of STC and has done great contribution to the IAF Technical Committee. Being the project manager of SLS, every year he always gave the newest development of the 'superstar SLS' during D2.8 session.

Our Vice-Chair, Markus Jaeger from Airbus now takes the role as Chairperson of the IAF Space Transportation Committee. Randy L. Kendall from Aerospace corporation and Yuguang Yang from CASIC were elected as the new Vice-Chairs of the Committee.

Our New Members, Mathieu Chaize, Florian Ruhhammer and Josef Wiedemann

A "STC Seminar" on Space Transportation Technology

A "STC Seminar" on Space Transportation Technology

Another tradition of the STC since its meeting in Adelaide, we continue to organize a special STC Seminar before the end of our Committee meeting. Members introduced the space transportation technologies, products, missions and future development of their companies and their countries. We all agree that the committee should enhance this kind of discussion in the future.

Activities during IAC2018 in Bremen

This year in Bremen, we held 9 successful Sessions during IAC2018. 153 papers were presented orally or as Interactive Presentations. With more than 6,000 delegates attending the Congress this year, there was also a larger audience during each D2 session. Usually more than 50 persons were listening to the presentations.

A glance of D2 Symposium

D2 Dinner during the IAC2018

In every IAC, the Space Transportation Committee has a dinner on the fourth day of the Congress. This year we choose STAENDIGE VERTRETUNG! of Bremen. Members all over the world came together, tasted the delicious German food and enjoyed the happy night!

STC Dinner!

STC Members in the IAF Community

During the IAC2018, our Member S. Somonath was elected as a new Vice President: Technical Activities of the IAF Bureau. Congratulations to him! Next, the Chair of D2.8 Session, Prof. Ernst Messerschmid went into space by Shuttle Challenger in 1980s. Before hosting Session D2.8, he attended the traditional astronaut event, and shared his experience in space and vision of the future. And our Member, Carina Dorbath gave birth to a baby this year! She is the 'supergirl' of STC and has done a great job during every Spring meeting and every IAC. Good luck to Carina and her angel!!!

S. Somonath

Carina Dorbath

Ernst Messerschmid

Above Dr. John Horack, Dr Andrew Aldrin and below Dr Yang Yuguang on China Central Television

STC Members on China Central Television

In 2018, China Central Televison's CGTN Channel continues to invite our committee members to the studio and give comments to the space activities of the whole world.

When the Trump Administration in the United States announced its plan of going back to the Moon, our Member, Dr. John Horack and Yuguang Yang were invited to the studios in Columbus and in Beijing, to give their view and analysis of the space transportation event.

When Landspace's inaugural orbital launch attempt failed, China Central Television invited Dr. Andrew Aldrin and Dr. Yang Yuguang from IAF Space Transportation Committee to give comments on this event, we also talked a lot about commercial orbital transportation during the program.

Administrative Committees

International Project Programme Management Committee (IPMC)

It is my great pleasure as Chairman of the IAF International Project/Programme Management Committee (IPMC) to provide highlights of our activities focused on an exchange of information, mutually beneficial activities and sharing best practices for enhancing the management of space programs and projects through training and curriculum development, knowledge sharing, lessons learned, and related research activities.

IAC 2018 IPMC Elections (Bremen, Germany)

The IPMC elections (2019-2021) were held at the IAC 2018 and unanimously re-elected Mr. Roger Forsgren (NASA) as IPMC Chair and Ms. Petra Georgi, (DLR) and Mr. Federico Massabrio (TAS) were re-elected as IPMC Vice-Chairs. Mr. Robert Clairmont Jr. (NASA) continues to serves as IPMC Secretariat. Members and Friends were re-appointed and new members welcomed. The IPMC list has been updated for the 2019-2021 period.

IPMC Standing Space Agency Subcommittee (SSASC)

Mr. Takashi Ohtani (JAXA), Chair and Mr. Ruediger Suess (DLR), Vice-Chair completed their study on Project Management and Systems Engineering to promote common space agency interests regarding governance structures (program/project), relationships with line organizations, and decision-making processes. Mr. Takashi Ohtani completed their 2015-2018 objectives and the SSASC was officially disbanded.

2018 IPMC Young Professionals Workshop at IAC 2018

Ms. Brigit Hartman (ESA) facilitated the workshop with 38 delegates, with an average age of 30-years from 15 different organizations and 16+ countries:

- **Topic 2:** Fostering Project Management in the world of Diversity
- **Topic 3:** Space 4.0 and the evolution of the (aero) space Sector
- **Topic 4:** Challenges faced by multi-disciplinary teams working on space projects between emerging space economies and legacy space economies
- **Topic 5:** Knowledge Management Best Practices in today's aerospace sector

2018 IPMC Young Professional Workshop (Bremen, Germany) Schedule:

- January – June 2018: Call for Delegates
- July – August 2018: Literature Review and Research
- November 2018: Draft Report/ Presentation and Workshop
- December 2018: Final Report to IPMC

International Project Management (IPM) Course managed by NASA in collaboration with IPMC

This course provides project practitioners with an understanding of cultural challenges, legal concerns, and teaming issues that are likely to be encountered when working with international partners. Two distinct facets of successful international project management are addressed: technical knowledge and cultural understanding. Participants gain insights into the characteristics of international teaming that have the potential to make or break a project through the use of lectures, small group discussion, hands-on practical exercises, and case studies.

IPM #20 (15-20 July, 2018)

The course was held at the Kennedy Space Center Visitor's Complex, Center for Space Education. 43 participants attended the course from 9 countries with presentations from NASA, ESA, JAXA, CNES, CSA, DLR, KARI, and Boeing. The overall course rating was a 4.29 /5.00.

2019 IPM Courses Dates:

- IPM #21: 24 February – 1 March 2019, Kennedy Space Center Visitor's Complex, Center for Space Education
- IPM #22: 14-19 July, 2019, Kennedy Space Center Visitor's Complex, Center for Space Education

IAF 2018 Activities

Other Events

IAF New Offices

Following the decision of ESA to vacate their premises in rue Mario Nikis for necessary renovations, the IAF Secretariat has also left its previous headquarters in rue Mario Nikis and has relocated to 100 Avenue Suffren, 75015, Paris, since mid-June 2018.

Preparation for IAC 2018 in Bremen

The IAF Secretariat team has been closely interacting with the LOC of IAC 2018 through telecons as well as e-mail exchanges for the past months.

Members of the IAF Secretariat travelled to Bremen from 15th to 17th January 2018, to conduct the traditional IAC2018 Site Visit in Bremen. Important requirements for the Congress, including establishing a baseline room allocation and a communication structure were successfully clarified, the congress venue and social events venues were inspected and important contacts were established guaranteeing a smooth interaction during the upcoming months.

The IAF Secretariat delegation left the site visit with a very positive impression on the overall status of the work done by the German counterparts and the location itself.

10th Annual Conference on European Space Policy

The IAF President and Secretariat attended the 10th Annual Conference on European Space Policy taking place in Brussels, Belgium. On 23rd January 2018, the IAF hosted a lunch, with the participation of IAF President Le Gall, EU Commission Vice-President Šefčovič, Commissioner Bienkowska and many other representatives of the EU Commission and various European Space Agencies.

UN COPUOS STSC

On 1st February 2017, the IAF took part in the 55th Scientific and Technical Subcommittee of the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS), held in Vienna.

IAF Vice President Sergey Krikalev delivered the statement on behalf of the Federation.

Satellite 2018

The IAF Secretariat was also present at the Satellite Show 2018 in Washington D.C., from 12th to 15th March 2018.

34th International Space Symposium

The IAF was again present at the 34th International Space Symposium on 16th to 19th April 2018 in Colorado Springs and attended the IISL Board Meeting and participated

in various bilaterals and meetings in preparation for IAC 2018 and IAC 2019 and to attract potential new IAF members.

SpaceOps Conference 2018, Marseille

From 28th May to 1st June 2018, the IAF attended the SpaceOps Conference in Marseille, to get a better understanding on the programme and inside process of the SpaceOps Conferences' organization.

During the week, many meetings were held between the SpaceOps leadership and the IAF Secretariat to ensure a smooth transition of process from AIAA who was previously acting as the SpaceOps Secretariat to the IAF.

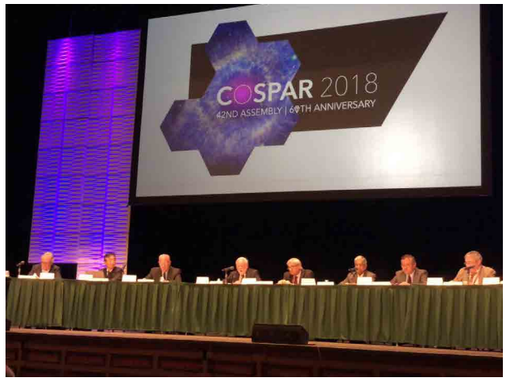
UNISPACE +50

The IAF was also present in June at the UNISPACE+50 and the **61st session of the UN Committee on the Peaceful Uses of Outer Space (UNCOPUOS)** which took place from 18th – 21st June 2018 in Vienna.

IAF Vice President Sergey Krikalev gave a statement during the session on behalf of the Federation.

COSPAR 42nd Scientific Assembly

On 14th to 22nd July 2018, the IAF was in Pasadena to support the Committee on Space Research with the organization of their 42nd Scientific Assembly and to strengthen the relationship with the COSPAR. While in Pasadena, the IAF also heavily promoted the IAC 2018 and IAC 2019.



Additional Site Visits to Bremen for IAC2018 preparations

The IAF Secretariat returned to Bremen twice during the summer (in June and again July) to follow preparation on the IAC and to coordinate parts of the programme with different stakeholders. In particular, it was very important the visit to Bremen paid by the IAF on 23rd July to discuss the status of preparations for the IAF Members of Parliaments Meeting.

31st Planetary Congress of the Association of Space Explorers

To further strengthen the IAF and ASE cooperation, the IAF Executive Director participated in the ASE Conference in Minsk from 9th to 12th September.

At this occasion IAF and ASE discussed the details of the joint ASE/IAF Astronauts session at the Global Networking Forum at the IAC2018 during the Public Day.

APRSAF-25

Again this year, the IAF participated in the 25th Session of the Asia-Pacific Regional Space Agency Forum (APRSAF-25) in Singapore, from 6th to 9th November 2018.

SpaceOps Fall Meeting

Following the signing of the SpaceOps and IAF MoU, the IAF Secretariat was in Tokyo from 26th to 29th of November to support the organization of the SpaceOps fall meeting and to initiate the planning of the upcoming SpaceOps Conference in Cape Town, South Africa in 2020.

Galaxy Forum, Beijing 2018

On December 7, 2018, just a few hours before the Chinese Chang'e 4 launch to the Moon, the IAF participated in the Galaxy Forum 2018 in Beijing, China.

The forum was co-organized by the International Lunar Observatory Association (ILOA), the Chinese Society of Astronautics (CSA), and the National Astronomical Observatories of the Chinese Academy of Sciences (NOAC) and saw the participation of about 200 people among which many young people including school classes were present.

Mr. Liwei YANG, first Chinese astronaut and Deputy Director of China Manned Space Agency (CMSA), gave an inspiring speech on his vision for Moon exploration. IAF Executive Director Dr. Christian Feichtinger presented the IAF, its history, its missions, its members as well as the events it organizes. He also gave an overview of international Moon missions and the concrete actions the Federation is undertaking to support and discuss Moon missions at the International Astronautical Congresses and at the Global Conferences.

THE INTERNATIONAL ASTRONAUTICAL FEDERATION

Connecting @ll Space People

WHO WE ARE

Founded in 1951, the International Astronautical Federation (IAF) is the world's leading space advocacy body with over 366 members from 68 countries on six continents including all leading agencies, space companies, societies, associations, universities and institutes worldwide.

Following its theme *"A space-faring world cooperating for the benefit of humanity"*, the Federation advances knowledge about space, fostering the development and application of space assets by advancing global cooperation. As organizer of the annual International Astronautical Congress (IAC) as well as other thematic conferences and workshops, the IAF actively encourages the development of astronautics for peaceful purposes and supports the dissemination of scientific and technical information related to space.

WHAT WE DO

Promoting cooperation

The IAF's International Astronautical Congress and various IAF committees provide unique collaborative platforms for experts from space agencies, industry and research.

Advancing international development

The IAF is building a future of cooperation, development and international friendship, bringing together experts from experienced and emerging space nations alike.

Sharing knowledge

The Federation has many well-established channels to disseminate information within its global network and the wider space community.

Recognizing achievements

The Federation's prestigious awards are presented annually to individuals and groups who have distinguished themselves in the global space community.

Preparing the workforce of tomorrow

To nurture new talent, the Federation has many activities targeting students and young professionals.

Raising awareness

The global network of the IAF, and IAF publications, help promote the public appreciation of space activities worldwide.

BECOME A MEMBER

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