



IAF President's Welcome

Dear IAF Members, Friends, Volunteers,

On behalf of the International Astronautical Federation, let me express my sincere thanks for your continued support to our Federation. We have come through a year that was filled with both challenges and success. In March, in light of the continuing worldwide COVID-19 situation, the IAF successfully held its **Spring Meetings 2021** virtually. Then, in June, the third edition of the **IAF Global Space Exploration Conference (GLEC 2021)** was organized in Saint Petersburg in cooperation with ROSCOSMOS as the first in-person conference since the beginning of the pandemic. At the end of October, the IAF community gathered in Dubai for the **72nd International Astronautical Congress – IAC 2021**, organized by the IAF and hosted by the Mohammed Bin Rashid Space Center (MBRSC). The congress was a resounding success and, as the first IAC in the Arab region, will certainly leave a lasting legacy.



This year the IAF established a new record by welcoming **50 new members** bringing its membership to **433 organizations from 72 countries**, including 2 new countries, Egypt and Angola. In addition, **Lisa Campbell**, President of the Canadian Space Agency, **Steven Eisenhart**, Senior Vice President of the Space Foundation, **Davide Petrillo**, Executive Director of the Space Generation Advisory Council (SGAC) and **Lionel Suchet**, Chief Operating Officer at the Centre National d'Études Spatiales (CNES) were elected as new IAF Vice Presidents. **Clay Mowry**, Vice President of Global Sales, Marketing & Customer Experience at Blue Origin was elected IAF Incoming President; he will join me during the next year before taking up the President position at the end of next year's IAC in Paris.

Our activities will progress throughout 2022 and I would like to invite you already to our main events for the year to come: the Federation's **70th Anniversary** on Saturday 26 March 2022, the **IAF Spring Meetings 2022** at the New CAP Conference Centre, 28-30 March 2022, in Paris, the **IAF Global Conference on Space for Emerging Countries - GLEC 2022** to be held in Quito, Ecuador, from 16 to 20 May 2022 and the **73rd International Astronautical Congress, IAC 2022** hosted by the Centre National d'Études Spatiales (CNES) in Paris, France, the IAC 2022 will exceptionally start on **Sunday 18 September 2022 until Thursday 22 September 2022**.

The IAF is dedicated to providing a continuously high-level service to its members, and I am grateful for your involvement and engagement in our activities.

I wish you all the best for 2022 and I look forward to welcoming you and other representatives from your organization at the IAF SM 2022, IAF GLEC 2022 and IAC 2022.

With my very best personal regards,

Pascale EHRENFREUND
IAF President

Connecting @ll Space People

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- GLEC 2022
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IAF MEMBERS' CORNER

INTERVIEW WITH:

- VP Lisa Campbell
- VP Steven Eisenhart
- VP Davide Petrillo
- VP Lionel Suchet

IMPORTANT DATES:

- IAF Launchpad Mentorship Programme Mentee Applications: **24 December 2021**
- IAF Abstract Mentor Programme (AMP): **5 February 2022**
- IAF Emerging Space Leaders Grant Programme Applications: **11 February 2022**
- IAF Young Space Leaders Nominations: **11 February 2022**
- Submit proposal for IAC 2022 Plenary or Highlight Lecture: **11 February 2022**
- IAF Excellence in International Cooperation Award: **18 February 2022**
- IAF World Space Award: **18 February 2022**
- IAF Excellence in Industry Award: **18 February 2022**
- IAF Excellence in "3G" Diversity Award: **18 February 2022**
- Frank J. Malina Astronautics Medal: **18 February 2022**
- IAF Hall of Fame: **18 February 2022**
- Call for Hosting IAC 2025 - Deadline for notices of intent to submit proposals: **18 February 2022**
- IAC 2022 Call for Abstracts: **28 February 2022**
- IAF Spring Meetings: **28 – 30 March 2022**
- GLEC 2022: **16 – 20 May 2022**
- IAC 2022: **18 – 22 September 2022**





Thank you for your continuous support of our Federation and looking forward to welcoming you at GLEC 2022 in Quito, Ecuador and IAC 2022 in Paris, France!

*With Kind Regards,
The IAF Secretariat*



In 2022 do not miss the following events:

- 14th European Space Conference, **25-26 January 2022**, in Brussels
- COPUOS Scientific and Technical Subcommittee, 59th session, **7-18 February 2022**, in Vienna
- IAF 70th Anniversary Celebration Event, **26 March 2022**, in Paris
- IAF Spring Meetings, **28-30 March 2022**, in Paris
- 37th Space Symposium, **4-7 April 2022**, in Colorado Springs
- Global Conference on Space for Emerging Countries - GLEC 2022, **16-20 May 2022**, in Quito
- Space Tech Expo USA 2022, **23-25 May 2022**, in Long Beach
- COPUOS, 65th session, **1-10 June 2022**, in Vienna
- Innovation and Leadership in Aerospace - ILA, **22-26 June 2022**, in Berlin
- COSPAR 44th Scientific Assembly, **16-24 July 2022** in Athens



THE IAF 70-YEAR ANNIVERSARY CELEBRATORY EVENT POSTPONED

New date: Saturday 26 March 2022

It was with great sadness that the IAF was forced to announce the postponement of the IAF 70-year anniversary celebratory event, that was supposed to take place in Paris on 10 December 2021.

Due to the rise, once again, of the Covid cases worldwide and several recent government announcement around the world imposing travel restrictions leading to many cancellations of participants, the IAF was forced to postpone the event. As you know, hosting safe events it is always a priority for the Federation and it was felt this was the best course of action at that point in time.

Please do **SAVE THE NEW DATE** for the event, now planned to take place in Paris on **Saturday 26 March 2022**, in conjunction with the IAF Spring Meetings which are now planned to take place from **Monday 28 to Wednesday 30 March 2022**.



As each year, the IAF is pleased to invite you to its Spring Meetings taking place in Paris, France where the IAF community will get together for three days, from **28 – 30 March 2022** in New CAP Conference Centre.

The programme will shortly be available [here](#)





SAVE THE DATE FOR THE IAF GLOBAL CONFERENCE ON SPACE FOR EMERGING COUNTRIES – GLEC 2022

15 December 2021, Quito, Ecuador – The International Astronautical Federation (IAF) and its members the [Sideralis Foundation](#) and the [Ecuadorian Civilian Space Agency \(EXA\)](#) have signed the agreement to co-organize the [IAF Global Conference on Space for Emerging Countries \(GLEC 2022\)](#) from **16 to 20 May 2022** in the **Hotel Hilton Colon Quito**, Quito, Ecuador.

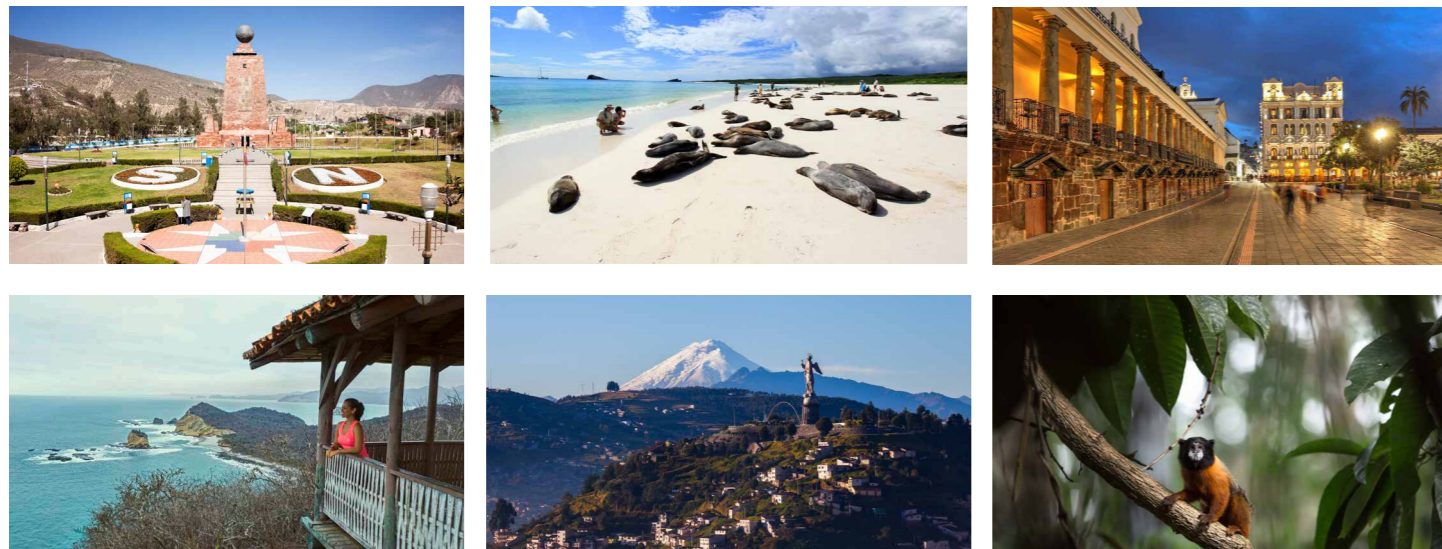
Following its mission to promote international development and share knowledge, the IAF and its members Sideralis Foundation and EXA are committed to fostering and supporting the international relations that allow space faring nations and space developing nations to share practices and data about space activities and their concrete social benefits.

Second Conference of its kind after [GLEC 2019](#) in Marrakech, Morocco (in cooperation with [CRTS](#)), GLEC 2022 is designed to:

- **Creating awareness on the essential legislative and policy elements that must be considered in establishing a firm foundation for national or regional space programs;**
- **Promoting the creation and development of a local space industry that is innovative, responsive, robust, commercially viable, and connected and integrated to the global space industry;**
- **Highlighting the socio-economic benefits of space applications so that high-level citizen support can be secured for advancing national or regional space programs.**

GLEC 2022 will address various topics of interest for space developing and emerging nations and regions, with a specific focus on the a) **Benefits of Space Technology and Applications to Socio-Economic Development**, b) **Financial Models and Resourcing**, c) **Technology and Skills Development**, d) **Base Infrastructure Requirements**, e) **Space Industry Development and Support**, f) **Legal and Policy**.

The Conference programme is designed to bring together the international community, including senior representatives of the major space agencies, industry, governments, policy makers, academia and NGOs. These leaders in the field will converge in Quito, Ecuador, to present results, exchange ideas, debate roadmaps, and discuss the future opportunities provided by space activities to emerging nations.



IAC 2022

The IAF's International Astronautical Congress embraces an inclusive approach that is community-driven, engaged, and accessible for everyone. We support the diversity that our congress participants bring by providing a variety of ways for people to engage. You are all invited to contribute to the programme of the IAC 2022 which will be held in Paris from 18 to 22 September 2022 under the theme "Space for @ll"!



Submit your Plenary or Highlight Lecture for the next IAC 2022 in Paris!

THE IAC 2022 CALL FOR PLENARIES AND HIGHLIGHT LECTURES IS OPEN!

Do you want to present a topic of general, scientific or technological interest? Are you a scientific or a technical expert with a solid knowledge of the latest space-related topics? Submit your proposal for a Plenary or Highlight Lecture, you can be selected to present in front of a large audience during the five days of the IAC.

Deadline for submitting proposals for Plenaries, Highlight Lectures, and Special Sessions is **Friday 11 February 2022 at 23:59 CET**.

The IAF Global Networking Forum (IAF GNF) call will be opened separately on 11 March 2022 and will close on 27 May 2022. Please note that the GNF will not accept as submissions any rejected Special Sessions, Plenary or Highlight lectures formats. Proposal must be original and submitted to fit the Global Networking Forum format.

To avoid the allocation of several numbers for the same proposal, each proposal can be submitted only once. If you have any doubts or need confirmation about the most appropriate format type for your proposal (Plenary, HLL, IAF GNF or Special Session), please contact us at support@iafastro.org.

Bear in mind that it is possible that you may be requested to modify one or several aspects of your proposal in order to fit it into the framework of IAC's Programme.

Proposal Formats

Plenaries and Highlight Lectures



Do you want to present a topic of general scientific or technological interest? Are you a scientific or a technical expert with a solid knowledge of the latest space-related topics? Submit your proposal for a Plenary or Highlight Lecture, and you can be selected to present in front of a large audience during the five days of the IAC.



The Plenary and Highlight Lecture events are selected by the IPC Steering Group in a well-defined competitive selection process. You can find all necessary information on the selection criteria and the submission form on the IAF Website at the following link: <https://www.iafastro.org/events/iac/iac-2022/plenary-programme.html>

Plenaries and Highlight Lectures proposals must be submitted to the IAF Secretariat at iacplenary@iafastro.org.



The IAF GNF offers a unique opportunity to all IAF Members and future Members to participate actively and showcase their latest developments in front of a widely engaged audience. The aim of the IAF GNF is to provide Congress participants with a varied programme throughout the week, touching upon the most recent and hot topics in space, and to provide a one-of-a kind visibility experience for the organizers.

IAF GNF sessions will be selected and placed thematically within the overall programme, and will be divided in three timeslots: 30 minutes, 45 minutes and 60 minutes. Additionally, do not forget that you can actively support the GNF by sponsoring your session!

Should you have any questions concerning the IAF GNF Programme, please contact the IAF Secretariat at gnf@iafastro.org.



IAC 2022 Technical Programme

The IAC provides a unique platform to showcase your research and projects, and gain **visibility** among leading space professionals from around the world! There are many ways you can **get involved** in the IAC 2022 Technical Programme!



Call for Abstracts

Submit an abstract for an oral or interactive presentation by **28 February 2022**.

Questions?
support@iafastro.org

Call for abstracts



Call for Special Sessions

Submit a Special Session proposal with an interactive format by **11 February 2022**

Questions?
sps@iafastro.org

Call for SpS



IAF Abstract Mentor Programme

Become a Mentor or Mentee and submit your application by **28 January 2022**.

Questions?
amp@iafastro.org

IAF AMP



Get involved with the IAF Abstract Mentor Programme!



Need some help with your IAC 2022 abstract?

The **International Astronautical Federation (IAF)** is continuing the successful **Abstract Mentor Programme (AMP)**, which was introduced in 2018, with the objective of helping young or less experienced researchers improve their abstracts before submitting them, to increase the chance of their work being accepted for presentation at International Astronautical Congress.

The programme is **open to anyone** and is completely independent of **the abstract review and selection process**. **The IAF AMP especially targets researchers and new authors from** resource-limited settings, who lack access to opportunities for rigorous **mentoring** in research and writing. The aim is to build capacity for a new generation of researchers and **increase the diversity** of speakers at the IAC.

Mentors will be paired with early career mentees based on their common field of interests (Science & Exploration, Applications & Operations, Technology, Infrastructure, Space & Society).

Submit Your Draft Abstract For Mentoring

If you do not have a lot of experience in writing abstracts, a mentor can help you. We have a pool of expert mentors who can provide advice and feedback on how to write successful abstracts for each of the Technical Programme categories.

Experienced abstract submitters can offer you feedback on your draft IAC 2022 abstract and answer your questions on practical issues, such as formal requirements on abstract writing and the quality of the data collected. The deadline for submitting your abstract for the IAF AMP is **28 January 2022**.

Become a Mentor

Mentors can apply for the programme until **14 January 2022**. Mentors must have had at least two abstracts accepted at an IAC and/or should be a member of the International Programme Committee. Becoming a mentor presents an excellent opportunity for **enhancement of leadership and coaching skills**.

Questions? Contact us at amp@iafastro.org

Mentee Application Form

Mentor Application Form

Contact

AMP Success Stories





Call for Nominations for the 2022 IAF Young Space Leaders Recognition Programme

The International Astronautical Federation (IAF) is pleased to announce its **2022 IAF Young Space Leaders Recognition Programme** that will provide opportunities to recognise students and young professionals who are demonstrating exceptional leadership in their academics or early careers. The IAF is soliciting nominations for the 2022 IAF Young Space Leaders Recognition Programme from IAF Members, Regional groups and Technical and Administrative Committees on students and young professionals between the ages of 21 to 35 years on 1 January 2022 who are:

- Contributing to astronautics through their academic and/or professional activities,
- Reaching out to other young people and to their community to share knowledge and experience,
- Engaging colleagues in the international space community,
- Contributing to the work of IAF committees and/or volunteering in support of other Federation activities such as physical or virtual participation on selection activities related to IAF grants, Next Generation Plenary and awards; participation in organization of IAC technical sessions and other activities; and participation on local organizing committees for GLEC, GLAC and other IAF meetings. (Note: Attendance at International Astronautical Congress does not in itself qualify).

Nominations should contain:

- A nomination letter from an IAF member organization, an IAF Technical Committee or an IAF Administrative Committee summarising the nominee's qualifications and specifying how the nominee meets the criteria (please download the template on [Nomination Letter Template](#))
- Two letters of recommendation addressing the contributions and engagement of the nominee.

The 2022 IAF Young Space Leaders will be selected by the Federation's Young Space Leaders Selection Subcommittee in consultation with the IAF President during March 2022. The Federation will notify the nominating organizations of those selected and subsequently the selectees themselves no later than 1 May 2022.

IAF Young Space Leaders will be inducted at the 73rd International Astronautical Congress (IAC), 18 – 22 October 2022 in Paris, France at the Closing Ceremony. They will attend the IAC Gala Dinner as guests of the IAF President. Although travel expenses to attend the IAC will not be provided by the IAF, the IAC registration fee will be waived. Nominators are encouraged to help identify sources of funding for their nominee if he/she is selected.

Up to five IAF Young Space Leaders will be selected in 2022. IAF Young Space Leaders will help increase knowledge among and broaden the involvement of students and young professionals worldwide in astronautics activities and the IAF.

In the year following their induction, IAF Young Space Leaders will:

- Be featured in an IAF newsletter and on the IAF website, contributing a short summary of their experience and achievements and their perspectives on space and international cooperation, including the role of the IAF.
- Mentor the Emerging Space Leaders who receive IAF grants to attend the IAC in Dubai.

Please send the nomination material before **11 February 2022 15:00 CET (Paris time)** to the IAF Secretariat, preferably by email at award@iafastro.org (Subject line: NOMINEE'S LAST NAME Nominee's First Name-2022 YSL).

If email is not available, the reference can be sent by postal mail to:

IAF Secretariat
Attention: 2022 IAF Young Space Leaders Recognition Programme
100 Avenue de Suffren
75015 Paris
France



Apply Now for the 2022 IAF Emerging Space Leaders Grant Programme

Apply now and get the exclusive opportunity to be fully funded by the IAF for the IAC 2022 in Paris, France next September!

The International Astronautical Federation (IAF) is pleased to announce its **2022 IAF Emerging Space Leaders (ESL) Grant Programme** that provides opportunities for students and young professionals to participate in the annual International Astronautical Congress.

The young people selected to take part in the 2022 IAF Emerging Space Leaders Grant Programme will participate in the **73rd International Astronautical Congress (IAC)** scheduled to take place in **Paris, France** from **18 – 22 September 2022**. The individuals selected will also participate in other activities held the week prior to and during the Congress such as the UN/IAF Workshop or the Space Generation Congress (SGC) and the Cross-Cultural Communications and Presentation Workshop.

Students and Young Professionals between the ages of 21 and 35 on 1 January 2022 with space-related career interests are encouraged to apply for the programme. Up to twenty-five students and young professionals will be selected by the IAF to participate in the 2022 programme.

Who should consider applying?

- Individuals interested in pursuing careers involving the development, application and use of space systems, space science research, the policy, legal, social and cultural aspects of space activities, international cooperation on space programmes and other similar subjects.
- Persons who - for financial, sponsorship or other reasons - would not otherwise be able to attend an International Astronautical Congress.

Note: Candidates may apply regardless of their home country or current residence. While all applications will be considered, through this programme the IAF seeks to encourage the participation of young people in nations with emerging space capabilities and interests who would otherwise not be able to attend an International Astronautical Congress.

- Young people who wish to meet and interact with other colleagues from around the world with similar interests.
- Individuals who hope to utilise the knowledge and experiences they gain during the IAC in their own careers and in enhancing space and related activities in their home countries.

What does the grant include?

- Round trip air fare between the candidate's home/residence country and Paris, France
- Support (in kind-services or funding) for local transportation, lodging and meals during the candidate's stay in Paris, France
- Assistance with visa arrangements provided by the IAC Local Organizing Committee and the Government of France
- Registration to the 73rd International Astronautical Congress as well as the 2022 Space Generation Congress or the 2022 UN/IAF Workshop.
- Mentors will provide advice on presentations at the IAC and on activities before and during the IAC to help grant recipients benefit fully from the Congress and related meetings and meet with the grant recipients during the IAC.

Application Deadline: **11 February 2022 15:00 Paris Time / UTC + 1:00**

To apply, [click here](#).

For detailed information, application process and requirements please download our **"2022 IAF Emerging Space Leaders Grant Programme Handbook"**.



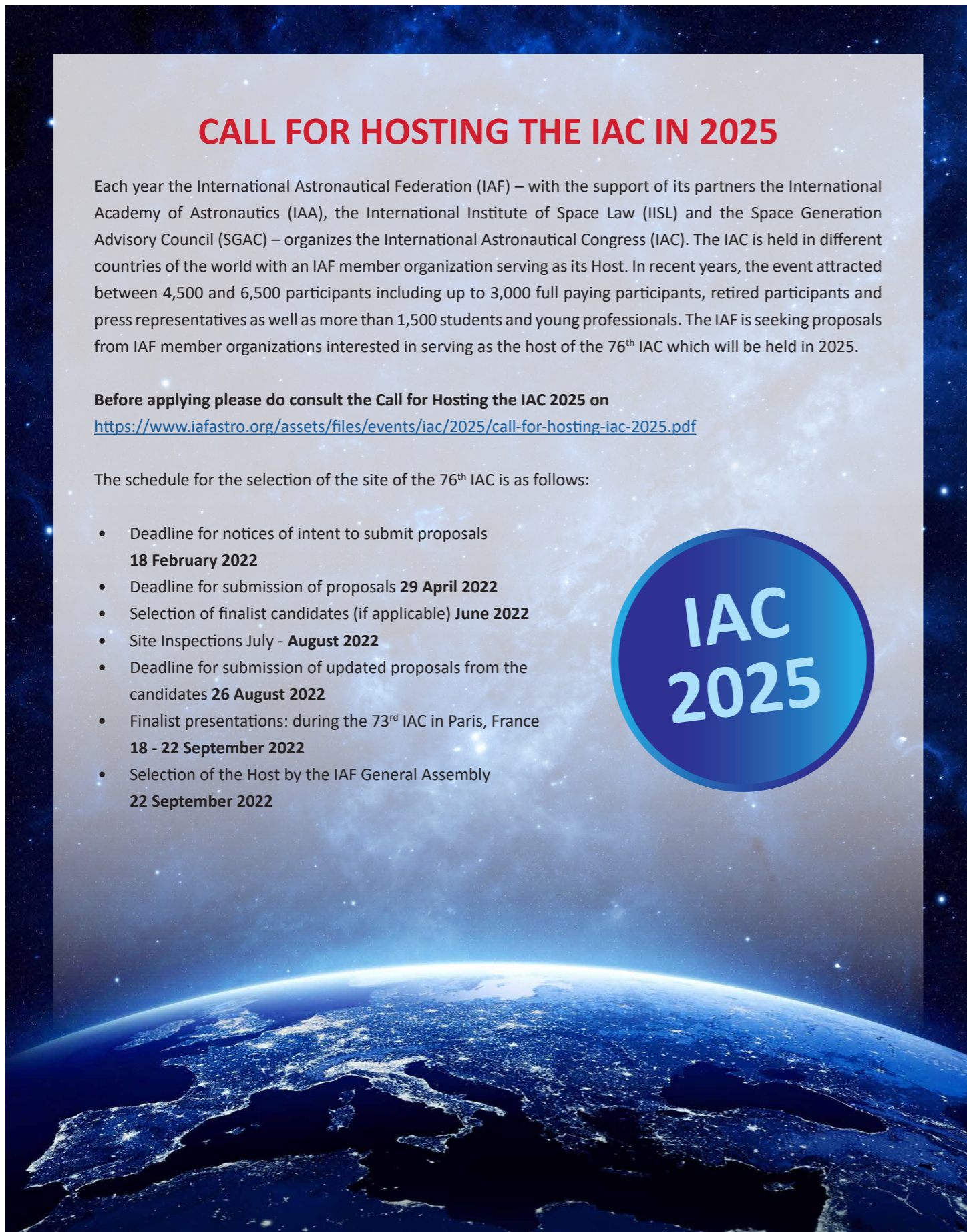
CALL FOR HOSTING THE IAC IN 2025

Each year the International Astronautical Federation (IAF) – with the support of its partners the International Academy of Astronautics (IAA), the International Institute of Space Law (IISL) and the Space Generation Advisory Council (SGAC) – organizes the International Astronautical Congress (IAC). The IAC is held in different countries of the world with an IAF member organization serving as its Host. In recent years, the event attracted between 4,500 and 6,500 participants including up to 3,000 full paying participants, retired participants and press representatives as well as more than 1,500 students and young professionals. The IAF is seeking proposals from IAF member organizations interested in serving as the host of the 76th IAC which will be held in 2025.

Before applying please do consult the Call for Hosting the IAC 2025 on <https://www.iafastro.org/assets/files/events/iac/2025/call-for-hosting-iac-2025.pdf>

The schedule for the selection of the site of the 76th IAC is as follows:

- Deadline for notices of intent to submit proposals **18 February 2022**
- Deadline for submission of proposals **29 April 2022**
- Selection of finalist candidates (if applicable) **June 2022**
- Site Inspections July - **August 2022**
- Deadline for submission of updated proposals from the candidates **26 August 2022**
- Finalist presentations: during the 73rd IAC in Paris, France **18 - 22 September 2022**
- Selection of the Host by the IAF General Assembly **22 September 2022**



WELCOME

TO THE INTERNATIONAL ASTRONAUTICAL FEDERATION

Dear New Members,

We are delighted you have joined this Federation. We look forward to your active participation in all programmes, activities, and events!



AAKA SPACE STUDIO CORP



ALE Co., Ltd.



Angolan National Space Program Management Office (GGPEN)



Asia-Pacific Space Cooperation Organization (APSCO)



Astralintu Space Technologies



Astrax, Inc.



Beijing Minospace Technologies Co., Ltd



C-Astra Technologies



Centre for the development of Industrial Technology (CDTI)



COMSPOC Corp.



DcubeD (Deployables Cubed GmbH)



Dragonfly Aerospace Pty (Ltd)





Egyptian Space Agency



EngineRoom.io Pty Ltd



European Space Foundation



Fachhochschule Wiener Neustadt GmbH



Felix & Paul Studios



Global Defence for Industrial Transformation

Global Defence for Industrial Transformation



Gokmen Space and Aviation Training Center (GUHEM)



Hebrew University of Jerusalem



INNOSPACE Co. Ltd.



Institut d'Estudis Espacials de Catalunya

Institut d'Estudis Espacials de Catalunya



Institute of Mechanics, Chinese Academy of Sciences

Institute of Mechanics, Chinese Academy of Sciences



Karman Project



Saudi Space Commission (SSC)



Shaanxi XingYi Space technologies Co. Ltd.



Simera Sense



Slovak Investment and Trade Development Agency (SARIO) - Slovak Space Office



Spade



Spartan Space



Starburst Aerospace Ltd

Starburst Aerospace Ltd



Stardust Technologies Inc.



Teaching Science and Technology, Inc (TSTI)



Tensor Tech CO., LTD.



ФГУП «Центр Келдыша»

Keldysh Research Center



MicroDrive Space Ltd.



Mudd Law



The University of Winnipeg



Turkish Space Agency (TUA)



University of Strathclyde



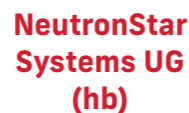
Voyager Space Holdings



NanoAvionika UAB (NanoAvionics LLC)



National Space Science Agency (NSSA)



NeutronStar Systems UG (hb)



Office for Space Technology & Industry, Singapore



Pacific West Data Pty Ltd - Trading as ACME SpaceTek



Portugal Space Agency



Reaction Engines



Saint Petersburg State University of Aerospace Instrumentation

Connecting @ll Space People

IAF Committee Briefs



November 2021

IAF ASTRODYNAMICS COMMITTEE

1. Introduction

The IAF Astrodynamics Committee was established more than four decades ago and is currently made up of about 30 members. The Astrodynamics Symposium, coordinated by the Committee and conducted at annually IAC, is an international forum for recent advancements in the areas of guidance, navigation & control, mission design, optimization and operations, orbital and attitude dynamics.

2. Summary

In the area of Guidance, Navigation & Control (GNC), theoretical as well as applied contributions have appeared in the domains of landing and in-orbit maintenance. As in various other scientific fields, there is a confirmed trend in the research to investigate the benefit of artificial intelligence (neural networks) for the definition of open-loop guidance (also on-board). In parallel, more realistic modelling of the equipment used in GNC (in particular, pulse thrusters) continue to be investigated in terms of impact versus a more simple approach. Two main recurrent themes are:

- autonomy: shift of the guidance & control planning and computations from the ground station to the on-board computer,
- GNC techniques: machine learning, reinforcement learning, potential function, sliding-mode control,

whereas the main applications are:

- reconnaissance and landing on small bodies: autonomous reconnaissance, trajectory optimization, landmark navigation,
- formation flight and swarms: decentralized control of swarms, reconfiguration control, optimal collision avoidance,
- orbital debris : uncertainty propagation, collision prediction, debris removal,
- Earth-Moon system: data-driven model predictive control, low-thrust station keeping and attitude control in Halo orbit.

In the context of mission design, operations and optimization, emphasis is on lunar missions, including satellites in NRHOs and deployment of microsatellite constellations. Missions to the Martian moons have gained interest, most likely in response to the role that Phobos and Deimos have been assigned in support to the Mars exploration program in the areas of telecommunications, radiation protection and infrastructure for transportation and operations. Trajectories to the asteroids and the outer solar system are also in the focus of recent research. From the methodology point of view, multi-objective trajectory optimization approaches have been developed which address system and operations uncertainty (even severe). The use of neural networks and tree-search like heuristics is more and more common.

The main topics and applications in the context of orbital dynamics can be summarized as follow:

- Multi-body dynamics: uncertainty prediction, data-driven analysis and identification of dynamical structures, optimal orbit transfers between invariant manifolds, Keplerian map theory for third-body effects, adiabatic invariant theory applied to capture dynamics,
- Earth orbit dynamics: efficient orbit propagation methods, deorbiting with the use of solar radiation pressure and J2 perturbation,
- Orbit dynamics in the Earth-Sun system: formation flying control using solar radiation pressure,
- Orbit dynamics in the Earth-Moon system: machine learning for orbit predictions, ballistic escape using lobe dynamics.

Studies in the area of attitude dynamics have developed along traditional as well as highly-challenging paths, such as with magnetic control and control moment gyros. Novel techniques are being investigated, including visual serving based on tracking features identified in onboard captured images. Artificial intelligence techniques are a trend also for attitude control. The a-posteriori analysis of some attitude-related issues during the re-entry of Hayabusa-2 is remarkable and intriguing as all actual operation results can be.

3. The Breakwell Lecture – Prof. Martin Lara (Universidad de la Rioja, Logroño, Spain)



Prof. Martin Lara from Universidad de la Rioja, Logroño, Spain (in the photo with Prof. Daniel Scheeres and Prof. Anna Guerman) received the Breakwell Award from the International

Astronautical Federation for his dedication and outstanding research on perturbation methods. Prof. Lara gave a keynote speech on the application of perturbation methods to Quasi Satellite Orbits and Libration Point Orbits.

4. Highlights

- Autonomy: shift of the orbital and attitude guidance & control planning and computations from the ground station to the on-board computer,
- GNC techniques: machine learning, reinforcement learning, potential function, sliding-mode control,
- Multi-body dynamics: decentralized control of swarms, reconfiguration control in formation flying
- Interplanetary missions: to the Moon, Mars with optimal orbit transfers between invariant manifolds and the four-body problem technique

IAF Committee Briefs



November 2021

IAF COMMERCIAL SPACEFLIGHT SAFETY COMMITTEE (CSSC)

Fostering Safe Commercial Access To Space

1. Introduction

The present brief has been prepared to provide an outlook of the major areas onto which the CSSC focused over the year.

2. Summary

SPACEPORTS: In Europe there is high interest in Spaceports Development and in general in the new Space Economy. This was in particular remarked during the Conference ‘Mediterranean Aerospace Matching’, held in Grottaglie in September 2021; this site was designated in 2018 by the Italian Minister of

Infrastructures and Transportation as the future spaceport for suborbital flights. The 2nd National conference of Space Geopolitics was held in Caserta, Italy in October 2021, with the participation of the Italian Space Agency (ASI) and reps from different organizations, including ALTEC. In the regulatory area, following the European Concept for Higher Airspace Operations (ECHO) an EU-driven initiative, a working group for High Altitude Operations and Access to Space led by the Italian Civil Aviation Authority (ENAC) was established to start drafting its national regulatory framework covering suborbital flights, air-launch and reentry activities.



Japan has four spaceports in development: Hokkaido, Kii, Oita and Okinawa. Oita Spaceport is based on a commercial aviation airport from which All Nippon Airways (ANA) has signed an agreement with Virgin Orbit to operate the air-launched rocket carrier Launcher One.

DEBRIS REMOVAL: Japan has now five commercial space debris mitigation companies, namely Astroscale (ADR/magnet), Ale (Electrical Tether), Axelspace (Membrane structure), Skyperfect/JSAT(Laser) as well as KHI (ADR/robot).

SUBORBITAL AND ORBITAL SPACEFLIGHT: The UK and Italy are pursuing initiatives for direct access to space from their respective territories. In the UK, the Government has published its Space Industry Regulations in July 2020, aiming at Commercial Launches from Scotland from 2023 onwards. In Italy, ALTEC is coordinating suborbital spaceflight capabilities, aiming at carrying out Ground Segment and Operations activities. This is targeting markets such as space tourism, microgravity science, and astronauts/pilots training. Other European countries (i.a. the Netherlands through the DAWN company currently testing rocket-powered drones from New Zealand) are also interested in developing infrastructures for vertical and horizontal operations.

FLIGHT AND GROUND FACILITIES: In Italy, the SpaceLand group is accelerating the development of ad-hoc-designed ground and flight facilities to fulfill the need of low-cost, user-friendly low-gravity and zero-gravity environments in support to microgravity STEM (Science, Technology, Engineering, Math, Medicine). Operations are predicted to start from mid-2022 onwards.

SPACE TRANSPORTATION COMPANIES IN JAPAN: there are seven commercial space transportation companies in Japan including Honda which newly announced in September 2021 a small launcher development. Interstellar Technologies have already gotten into suborbital launch service. Planned operations are manned and unmanned by horizontal, vertical, sea and air launch.

3. Highlights

US NEW SAFETY REGULATIONS: New launch and reentry safety regulations (Part 450) issued by the US Federal Aviation Administration's Office of Commercial Space Transportation (FAA-AST) went into effect in 2021. Part 450 regulations may be useful to countries that are considering new national frameworks for commercial space transportation, including hosting U.S. vehicles in their country that would be licensed by the FAA. In parallel, the FAA through its Center of Excellence continues pushing medical guidelines both for Crew Members and for Spaceflight Participants (SFP).

COMMERCIAL SPACE TECHNOLOGIES: In Japan, initiatives are focusing on a pulse-destination engine development, next-gen composite high-pressure tanks and Artificial Intelligence-

driven operations. The Space Liner Association (SLA) was established in Japan in May 2021 to develop reusable space vehicles for human suborbital spaceflight, LEO space tourism, and P2P space flight. SLJ is the platform formed by users, operators and manufacturers to encourage LEO and beyond space economic activities under Private-Public Partnerships (PPP).

GROUND & FLIGHT SEGMENTS: 1) Spaceports: design of the first set of SpaceLand Centers is ongoing, configured as prototypes of Mars Habitats, showcasing novel Near-Zero-Energy-Building (NZE) and In-Situ-Resources-Utilization (ISRU) technologies, construction methods and mixed materials; such multi-facilities will be open to both users and the general public, with three target locations in Switzerland, Mauritius and central-eastern Asia 2) Flight: following on a License granted to SpaceLand by the US-Government for Spaceport development studies in Africa, an exclusive agreement has been signed with US partners to support the above mentioned projects with a novel large aircraft accessible to SpaceLand affiliates and partners for long-duration parabolic flights.

IAASS ESTABLISHES A SPACE SAFETY INSTITUTE (SSI) as an independent safety vericator for New Space, checking compliance with relevant Industry Standards using a "Safety Case" approach.

SAFETY AND PSYCHOLOGY: When safety is at stake, it is not only a question of technical advances, psychology is also an important question, especially concerning the evaluation of risks. With this point of view, the flight of SpaceX in outer space with only "amateur" astronauts is an important milestone; For some, it shows that non-professional astronauts could be considered as "payload" or "passengers" rather than an integrated component of the safety of the system, what shall impact future designs.

4. Future Outlook

POINT TO POINT (P2P) TRANSPORTATION: From the perspective of the Global Spaceport Alliance, one of the most interesting projects in the coming years will be the effort to accomplish point-to-point transportation through space. Multiple companies are looking at developing similar systems. Successfully achieving this type of capability will require partnerships between government, industry, and academia, and will involve not only advances in engineering and technology, but also work in policy, law, regulations, customs and security, flight and ground operations, market analysis, and economics. We believe that the Commercial Spaceflight Safety Committee could play an important role in helping to bring about these transformational capabilities.

Japan is establishing and developing its hydrogen network both for ground and space transportation.



REGULATORY AND LEGAL: An adequate and harmonized regulatory framework has to be developed and refined. Exchange of information among participating countries has to be fostered.

ACCESS TO LOW-COST FACILITIES: SpaceLand Flight and Ground segments aims to help planetary exploration industry and low-G / microgravity STEM stakeholders in all continents, facilitating access to low-cost facilities for hand-on R&D, Education and Test programs.

5. Committee activities

The CSSC will focus on fostering the interactions and mutual knowledge of the committee participants. An intensive effort shall be performed in attracting more papers stimulating the sharing of information and discussing among a diverse community the various challenges of common interest. Primary focus has to be put on how Safety affects the various activities and processes. Focus on Space Traffic Management (STM) will also be given by the Committee.



November 2021

IAF EARTH OBSERVATIONS COMMITTEE (EO)

1. Introduction

Earth Observations has entered an era of high importance on international political and social agendas due to the twin threats of global climate change and biodiversity reduction. They have also demonstrated their business value for a wide variety of commercially important applications and are attracting new business from both established industry and entrepreneurial firms across all points of the value chain. These developments are underpinned by dramatic advance-ments in technologies, business models, and science. They result in providing accelerating value to society as threats and impact along with opportunities to provide actionable information for societal decisions all increase. The most noteworthy developments from June 2021 through November 2021 are highlighted.

2. Summary

Capella Space announced it will begin installing optical terminals on its SAR imaging satellites to increase volume and speed of data delivery. The US National Reconnaissance Office released a request for bids for commercial imagery from US providers. PlanetIQ Launched its Global Navigation and Occultation Satellite (GNOMES-2) on June 30th and is raising money to build out a 20-satellite constellation. IceEye officially joined the Copernicus Earth Observation Program after winning a contract to provide data from its SAR satellites. Planet unveiled its Pelican Earth-imaging satellites and infusing SAR data from Sentinel 1 in

its Planet Fusion Monitoring Project. The 38th Institute of China Electronics Technology Group (CETC) announced it is partnering with Spacety to construct an C and X band SAR constellation of 96 satellites launched into various orbits. Tomorrow.io won a contract from the US Air Force to support a planned constellation of 32 weather satellites with a 1-hour revisit time. NASA's Landsat 9 was launched on September 27th. South Korea announced the Satrec Initiative to build a constellation of high-resolution Earth observation satellites. EUMETSAT made its first commercial data acquisition. NASA and ESA signed a cooperation agreement on climate science cooperation.

3. Highlights

The major breakthroughs in the field are primarily coming as a result of industry and Agency application of new technologies developed in other industries and supported by Agency technology programs to adapt them to Space application. Two primary technologies to highlight are optical communications allowing satellite to satellite links that enable reduced data latency, and Machine Learning / Artificial Intelligence which is greatly expanding utility and efficiency of analyzing and producing value added information products from earth observations

4. Future Outlook

The main focus in the following years will be three-fold. First,



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the major driver from society will be climate change monitoring and mitigation, along with associated improvement in weather, ocean, and land forecasting on all time scales. Second, is value added commercial applications across a wide variety of industries that need precision earth information, and third is security spanning national defense, illegal activity, and major societal issues such as disease, famine, oppression etc. We are seeing the emergence of many developing constellations to address these three topics and many more being announced. The World's Spacefaring Agencies are also obtaining increased resources to expand their science and public benefit observations and applications.

5. Committee activities

The Earth Observations committee had a very successful IAC 2021 in Dubai with its six technical sessions and one interactive presentations' session. For the third year in a row, a presenter in the EO IP session won the award for top IP presentation in the B Category on Applications and Operations. Highlights included a session dedicated to celebrating 20 years of one of the most noteworthy international collaborations: The Disaster Charter. Several prominent members of the Charter Agencies provided presentations on past successes, status and future plans. The committee plans to combine the papers along with a summary of the Disaster Charter Highlight Lecture into a special section of Acta Astronautica.

The committee also elected new Officers and recon-firmed members per IAF rules and updated its an-nouncements in the call for papers for IAC 2022 to highlight Green House Gas Monitoring and elicit papers addressing the emerging transformation technologies of Machine Learning and Commercial Ground Services, cloud networking and data analytics. The EOC is working closely with GEOSS to foster new partnerships with Young Professionals, offer a new slate of Plenary and Special Session proposals and other cooperative activities.

Highlight Lecture by the Heads of the Three Founding Agencies – ESA, CNES and CSA at IAC 2021 Celebrating the 20th Anniversary of the Disaster Charter



IAF Committee Briefs

have been tackled relate to space debris and to the monitoring and prevention of risks especially considering the developments of space traffic management regulations.air launch.

3. Future Outlook

In the next year the focus will be on building resilience after having faced risks such as the pandemic and in several areas, such as:

1. automation of risk surveillance, to ensure "full coverage" of risks identification
2. cybersecurity risks and associated regulatory framework
3. risk management in new space technology assets
4. STM for the future in the time of ever increasing constellations
5. strategies for risk management and lessons learned from industries and institutions outside the Space world

4. Committee activities

The focus was on analyzing the role played by a robust Risk Management system post COVID pandemic and draw some lessons learned. How were the Risk Managers solicited during and after the pandemic and what was their involvement in the business continuity plan?

The ERM committee has held two meetings this year.

The first meeting took place during the Spring IAF meetings (cyber edition) in March 2021 and every member was able to report on their business continuity plans within their organizations.

The second meeting was during the IAC 2021 hybrid-edition (half of the participants online and half were in the room at the Dubai World Trade Center) with a keynote speech from Christopher Geiger, (Lockheed Martin) - internal audit Director-on integrating enterprise risk management and sustainability processes.



At the Dubai meeting the members and officers of the committee were renewed for another three-year term. Christopher Geiger (Lockheed Martin) and Nancy Wolfson (Disrupting Space) were also elected as new members committee. Two experts were also nominated: Antonio Carlo from NATO and Francesca Casamassima from Deloitte, both specialists in cybersecurity, an area of interest for the ERM committee.

Apart from the IAF Spring meeting and IAC in 2022, the committee will also plan intermediate meetings early in 2022 to agree plans for sessions at the IAC, and before the IAC in Paris to review the program at the Congress.



November 2021

IAF ENTERPRISE RISK MANAGEMENT COMMITTEE (ERM)

Pushing the Boundaries of Risks for a Successful Organization

1. Introduction/Summary

In 2021 the ERM committee has held two meetings, at the IAF Spring session (virtual) and IAC (F2F/virtual). A focus on how to assess opportunities linked to every risk were at the core of the discussions this year, especially considering the ongoing pandemic and its impact on Space activities throughout the world. The major developments and trends that have shaped

the year in our ERM field are the relationship between opportunity and risk management.

2. Highlights

Linking Sustainability of an organization with its risk management process, especially of interest for Risk and Corporate Social Responsibility Officers. Other themes that



November 2021

IAF GLOBAL EARTH OBSERVATION SYSTEM OF SYSTEMS (GEOSS) SUBCOMMITTEE

1. Introduction

The Global Earth Observing System of Systems has entered an era of high importance on international political and business

agendas due to the twin threats of global climate change and biodiversity reduction, and due to the tremendous shift in cost vs benefit profile of commercial and public / private partnership applications. The most noteworthy developments

in partnerships, applications, GEOSS cooperation from May 2021 through November 2021 are highlighted. The IAF GEOSS Subcommittee promotes cooperation between space agencies and Earth focused organizations to address the changing climate, its impact on biota, and applications for sustainable development. The Subcommittee coordinates between the IAF and many of these organizations like the Group on Earth Observations (GEO), and works to highlight the latest advances in Satellite based Earth science to the IAC by conducting highlight lectures, plenary events and special sessions at the Congresses.

2. Summary

Dramatic advancements in technologies, business models, and science are providing the opportunity provide accelerating value to society as threats and impact along with opportunities to provide actionable information for societal and business decisions all increase. Satellite based earth observations are having more and more impact on applications that address environmental conditions, human activity, protection of the environment, and climate change mitigation.

3. Highlights

The biggest event of the year in Earth science was COP 26 in Glasgow Scotland. The Group on Earth Observations (GEO) community presented through the negotiations, side events and engagements outside the official COP26 events over the two weeks to promote the role of Earth observations in providing actionable information for climate adaptation and mitigation. NOAA highlighted using space assts for monitoring and described the importance of in situ measurements.

GEO week starts in Nov 22, 2021. GEO is a partnership of more than 100 national governments and in excess of 100 Participating Organizations that envisions a future where decisions and actions for the benefit of humankind are informed by coordinated, comprehensive and sustained Earth observations. GEOSS provides the linkage between GEO and the IAF.

There is a major celebration planned for July 2022 to honor the 50th Anniversary of the launch of the first Landsat mission. At the same time, plans are underway to celebrate the 30th Anniversary of the launch of the first spacecraft dedicated to measuring sea surface height and the continuous measurements since that date. Sentinel 6 Michael Freilich was the recent member of this continuous chain of spacecraft.

Key present and upcoming events are as follows:

- November 2, 2021, U.K. Pavilion COP-26, WGIC, GEO and Climate Trace discuss GHG Monitoring from Space Report (virtual)
- October 24-27, 2022, [Pecora-22](#), Denver, Colorado (see attached Hold-the-Date and Call-for-Abstracts)

- October 26, 2022, Landsat 50th Celebration at Pecora Conference
- November 14-18, 2022, [ISRSE-39](#), Hanoi, Vietnam

4. Future Outlook

Public private partnerships both in observations (such as for greenhouse gas monitoring) and in applications (such as machine learning, data access, services) are coming to fruition and are expected to make major contributions that go beyond the traditional Government provided services and commercially offered services. One example is the Carbon Plume Mapper effort within the USA.

5. Committee activities

GEOSS conducted several major activities during the IAC in Dubai including a Highlight Lecture celebrating the 20th Anniversary of the Disaster Charter (speakers included the heads of the three founding agencies - ESA, CNES, CSA), a Special Session on monitoring Ocean's health from Space to coincide with the UN Decade of Ocean Science (speakers include Heads of Earth science in several leading space agencies), an IAF Global Networking Forum session in conjunction with Young Professionals on Tuesday night at the Congress, and further discussion to support greater integration with GEO, Emerging Countries, and development of a new three year partnership with YPP. The GEOSS is identifying several new themes for events for the next IAC in Paris. GEOSS also supported GEO management by organizing and supporting a meeting of MENA members and GEO management at the IAC.

The committee also elected new Officers and re-confirmed members per IAF rules, and updated its announcements in the call for papers for IAC 2022 to highlight Green House Gas Monitoring. The GEOSS Subcommittee is working closely with the IAF SEOC Committee to foster new partnerships with Young Professionals, offer a new slate of Plenary and Special Session proposals and other cooperative activities. The GEOSS SC is shown below while meeting in Dubai.



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November 2021

IAF COMMITTEE ON INTEGRATED APPLICATIONS

1. Introduction

Space systems are more and more involved in the delivery of global utilitarian services to end-users. The concept of Integrated Applications encompasses the simultaneous use of basic space services and technologies. The IAF Committee on Integrated Applications focuses on various aspects of integrated applications, which combine different space systems (Earth observation, navigation, telecommunications, etc) with airborne and ground-based systems, in addition to other technologies as big data, analytics, IOT, 5G and others to deliver solutions responding to users' needs.

The applications exploit the synergies between different data sources to provide the right information at the right time to the right user in a cost-effective manner and deliver the data to users in a readily usable form. The objective of the Committee is to enable the development of end-to-end solutions by connecting the user communities that are driving toward end-to-end solutions with those that are developing enabling technologies for integrated applications. Other aspects pertinent to the committee are the commercial satellite applications including the commercial space and space culture, the commercial space model for public users and some case analysis of satellite commercial applications

2. Summary

Key topics addressed are the specific systems, tools and technologies in support of integrated applications solving the various issues associated with applications development, the kind of data to be collected, how are data collected and how the data are integrated and distributed to address key user needs.

3. Highlights

Emerging technologies, such as Machine Learning, Artificial Intelligence, Internet of Things, and other advanced technologies are rapidly revolutionizing and reshaping infrastructure and global-local economies. Leveraging these new transformative developments and understanding their

disruptive potential with respect to technology, shifting demographics and global connectivity is essential for space technologies.

Possible topics include: ground-truthing of data collected from space platforms; innovative, low-cost tools for data distribution and access that focus on the space segment; new ways of distributing integrated data products; data fusion and visualization tools; managing integrated applications programmes and public outreach efforts to connect the public to these applications.

Examples of case studies of particular interest include end-to-end solutions, case studies, proof-of-concept applications and current projects that aim to provide innovative user-driven solutions and applications that combine ground- and space-based data sources with models to address specific user requirements.

These examples can cover a variety of domains, like disaster/crisis monitoring and management, energy, food security, space situational awareness, transportation, health, etc. The user needs, the structure of the user communities, the value chain, the business case and the sustainability of the solutions are among the many aspects that can be considered. Examples of projects with established partnerships and fluent working relationships between space and non-space stakeholders are also discussed.

4. Future Outlook

The concept of digitizing and connecting everything forms the basis of how the Fourth Industrial Revolution, Industry 4.0, is influencing and impacting the world. Emerging technologies, as Machine learning, Artificial Intelligence, Internet of Things, and other advanced technologies are rapidly revolutionizing and reshaping infrastructure and global-local economies. Leveraging these new transformations and understanding their disruption potential with respect to technology, shifting demographics and global connectivity is essential for the space technologies.

The ability of satellite technology to provide ubiquitous and



increasingly fast connectivity to billions of people globally is at the core of the Fourth Industrial Revolution. Connectivity is not the only element in the Fourth Industrial Revolution that can be harnessed by the satellite industry. Innovative technologies will open the door to new opportunities incorporating multiple disciplines and industries to create new markets and growth. New business models (eg. the impact of AI on satellite data processing) and the evolving economic/trade landscape, for example related to the autonomous technologies, will lower barriers to entrepreneurs with new ideas to access the markets. Space systems are more and more involved in the delivery of global utilitarian services to end-users.

5. Committee activities

The plan for spring next year is to undertake a global Air Quality project. The project has already started in Los Angeles funded

by NASA. The aim is to integrate data from many other cities around the globe as part of a global effort to use satellite data and ground data to provide predictive analytics using machine learning. See more at <http://airquality.lacity.org>.

Next year's proposal from the Committee is to organize a special session workshop on "Space Applications for Social Justice". Environmental justice (air quality), food justice (food insecurity), and digital justice (cybersecurity), and educational justice (African school support).



scale optimization and manufacturing of, for example, ultra-lightweight structures consisting of optimized macro geometries and tailored lattices on a meso level. Combined with smart materials and deployables, such innovative concepts and designs are currently being investigated for upcoming robotic landers and rovers.

All of these new developments have been widely presented and discussed in this year's IAF Materials and Structures symposium confirming their high importance to the space community.

3. Future Outlook

Looking ahead, several topics in the field of materials and structures are on the horizon and about to drastically change some of the design and manufacturing approaches of classical space systems. From a technological point of view, the topic of in-space manufacturing is expected to open up unparalleled possibilities with respect to a sustained human space exploration. To enable off-Earth manufacturing, innovative additive manufacturing techniques are combined with in-situ resource utilization, which providing the fundamental ingredients from a materials perspective. In-space manufacturing is also of high importance for upcoming exploration missions to Moon and Mars and will therefore be

heavily investigated and matured in the near future.

Another very promising but yet underdeveloped field is structural health monitoring. Understanding the health status of structures and systems while in use, unlocks unprecedented opportunities in terms of operation, prediction and design optimization of space systems. Only with the availability of increased computational power on-board of spacecraft (i.e. edge computing), real-time processing of structural health data of a satellite is possible. This revolutionary technology will enable significant autonomy and smartness of future space systems.

Finally, the paradigm of design-to-cost will gain more and more importance throughout all subsystems of a spacecraft. Therefore, the design and manufacturing of future space structures and materials will increasingly be driven by cost, schedule and the potential for large-scale serial production, especially for large-scale commercial space applications.

4. Committee activities

For next year, the committee plans to reorganize some sessions of its symposium to better respond to new developments taking place in the field of space technologies, materials and structures.



November 2021

IAF MATERIALS AND STRUCTURES COMMITTEE

Recent trends and achievements in high-performance, lightweight and innovative materials and structures for space applications.

1. Summary

As the whole space sector, the field of materials and structures is undergoing constant evolution and advancements. In particular over the last 12 months, an increasing trend towards further miniaturization of satellites and launchers has been observed. This is mainly driven by a large number of startups and private entities venturing into the commercial space market, for which SmallSats and MicroLaunchers significantly lower the entry barrier in terms of cost, schedule and risk. Another ongoing trend has been the increased use of lightweight design and optimization via computational approaches. Continuous advancements in the field of computational methods, readily available computational resources and novel manufacturing techniques enable the use of advanced designs even for

most challenging, multidisciplinary space applications. The advancement of additive manufacturing techniques furthermore enables the utilization of custom-tailored composites and engineered materials in order to maximize the performance of future materials and structures in an unprecedented manner.

2. Highlights

One of the highlights in the field of materials and structures is the unlimited possibilities enabled by serial additive manufacturing. While additive manufacturing techniques do not only provide almost unlimited geometrical design freedom, they also greatly reduce the complexity, cost and schedule of space systems by minimizing the number of parts and enhancing their capabilities by design. This, for example, enables multi-



November 2021

IAF COMMITTEE ON PLANETARY DEFENSE AND NEAR-EARTH OBJECTS (NEOS)

1. Introduction

Planetary defense is the term used to encompass all the capabilities needed to detect and warn of potential asteroid or comet impacts with Earth, and to prevent and mitigate their possible effects.

A Near-Earth object (NEO) is an asteroid or comet whose orbit brings it within about 50 million kilometers of Earth's orbit.

The primary objective of the IAF Technical Committee (TC) on Planetary Defense and Near-Earth Objects (NEOs) is to raise awareness among the global space community, in particular the IAC audience, about the ongoing work within the planetary defense community and to get more people, especially students and young professionals, interested and actively participating in the field.

2. Summary

The biennial IAA Planetary Defense Conference was held in April this year, hosted by the United Nations Office of Outer Space Affairs (UNOOSA). Over 700 individuals from 50 countries attended the virtual event. Highlights of the conference included a realistic but fictitious Asteroid Threat Exercise, as well as a panel that featured representatives of seven national space agencies, demonstrating awareness and support of planetary defense activities. A primary outcome of the conference was unanimous attendee support for an International Year of Planetary Defense (IYOPD) similar to like the 2009 International Year of Astronomy. The 2029 close passage of asteroid Apophis is a natural opportunity to hold the event, raise awareness about the hazard, demystify the topic, and connect current and future communities.

3. Highlights

Recent highlights include the two asteroid sample return missions. JAXA's Hayabusa2 mission to asteroid Ryugu yielded 5.4 grams of material when it returned the sample on 5 December 2020, while NASA's OSIRIS-REx took a sample from asteroid Bennu on 20 October 2020, which is expected back on Earth on 24 September 2023. While primarily science missions, knowledge about the physical properties and composition of asteroids is critical for designing and implementing a deflection mission when needed. In fact, scientists were surprised by the size of the crater that was created when Hayabusa2 fired a small projectile into the surface on the asteroid in order to take a subsurface sample, as it was bigger than expected, proving that there is still much to learn about asteroids and their characteristics.



Figure 1- left: sample site on Bennu, right: sample from Ryugu

4. Future Outlook

On 24 November 2021, the launch period for NASA's Double Asteroid Redirect Test (DART) spacecraft will open. DART will journey to the non-hazardous, binary asteroid system

Didymos to demonstrate the viability of the kinetic impactor – an asteroid deflection technology that works by colliding a spacecraft into an asteroid to give it a push years before it would impact Earth in order to move it sufficiently out of the way. In this case, DART will hit Didymos' moon, Dimorphos, on 2 October 2022 and will allow scientists to compare the actual outcome with the expected one. Two years later, ESA's Hera mission will launch to the same binary asteroid system to measure in detail the effect the impact had on Dimorphos after it arrives in December 2026.

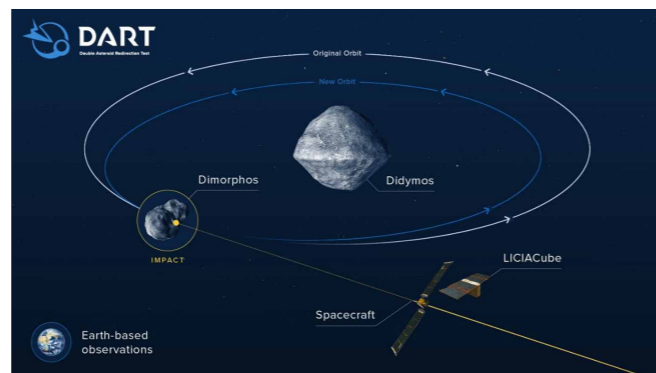


Figure 2- DART kinetic impactor schematic

As we can only deflect what we know, finding objects before “they find us” is of paramount importance. NASA plans to launch an infrared space telescope called NEO Surveyor in 2026 that is dedicated to finding asteroids that are potentially hazardous to Earth. In combination with the ground-based Vera C. Rubin Observatory, which is expected to start observing in 2022/2023, an exponential increase in the number of asteroid discoveries is expected, reducing the uncertainty of asteroid impacts with Earth.

5. Committee activities

The committee has been renamed to stress its focus on planetary defense and to help clarify the topics covered as the committee will have for the first time a dedicated technical session at the IAC 2022. After successful Special Sessions in 2019 and 2021, the committee intends to continue submitting quality proposals for the IAC programme.

IAF Committee Briefs



November 2021

IAF SPACE ASTRONOMY TECHNICAL COMMITTEE (SATC)

1. Introduction/Summary

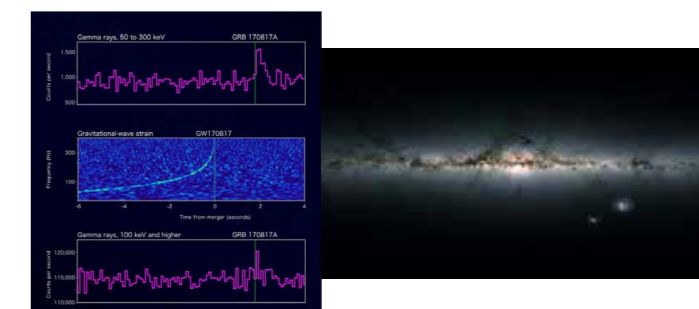
Ground and Space Astronomy synergy has recently permitted a phase of remarkable discovery and growth. Public recognition is the several Nobel physics prizes gained in (observational) cosmology, exoplanets, gravitational waves, X-ray astronomy, and astrophysical neutrinos. Although the field of astrophysics is vast, the the IAF Space Astronomy Technical Committee (SATC) concentrates its work in the area of space astronomy and in particular, serve as a forum for the exchange of information and interaction between the scientific community, space industry, and space agencies involved in the preparation and the future development of new astronomy missions. Therefore, the SATC action covers the very early phases of mission conception before missions are proposed to the Agencies for assessment. As such, the SATC role comes up-front and is largely complementary to the current work that the Agencies achieve. Its principal intended role is to enable or improve the emergence of new science mission concept.

2. Highlights

Astronomy is currently in a phase of remarkable discovery and growth. A public recognition of this impact are the Nobel physics prizes in 2021, Giorgio Parisi, “for the discovery of the interplay of disorder and fluctuations in physical systems from atomic to planetary scales”; Roger Penrose, Reinhard Genzel and Andrea Ghez “for the discovery of a supermassive compact object at the centre of our galaxy” in 2020; Jim Peebles - cosmology, Michel Mayor and Didier Queloz – exoplanets in 2019; Rainer Weiss, Kip Thorne and Barry Barish in 2017– gravitational waves; Saul Perlmutter, Brian Schmidt and Adam Reiss in 20211 – observational cosmology; John Mather and George Smootin 2006 – observational cosmology, Riccardo Giacconi – X-ray astronomy, and Ray Davis Jr and Masatoshi Koshiba – astrophysical neutrinos in 2002. The impressive range of progress is manifest. Just few examples among others:

- Gravitational waves and Astrophysical counter-part search of BH-BH Mergers
- NS-NS Mergers: first Gravitational Wave counter-part detection

On August 17, 2017, after a long quest, Fermi and INTEGRAL detected a short γ -ray burst (GRB 170817A) linked to GW70817 caused by the merger of two neutron stars. The time lag (1.7 s) between the merger of the GW event and the prompt γ -ray observation after 120My travel time, imposed constraints on the difference between the speeds of light and gravity, placed new bounds on the violation of Lorentz invariance, and presented a new test of the equivalence principle. The observations also constrained the size and bulk Lorentz factor of the γ -ray emitting region. To date, this observation remains the only firm detection of the so-called Kilonova generated by the NS-NS merging process with spill-over of nuclear dense matter.



Joint, multi-messenger, detection of GW170817 and GRB 170817A (left) and Gaia's view of the sky. Credit: Abbott et al. 2017, ApJ 848, L13 and ESA/Gaia/DPAC, CC BY-SA 3.0 IGO.

- Protoplanetary disks and exoplanets
- Fast Radio Bursts
- GRB detected at TeV
- Origins of a Cosmic Neutrino
- Gaia
- Asteroseismology



3. Future Outlook

The increasing size and complexity of large space-based observatory missions place a growing emphasis on international collaboration. The increasing range of joint missions involving space agencies in Europe (ESA), United States (NASA), Japan (JAXA), the Russian Federation (RKA) and China (CNSA), India (ISRO), and more recently, the United Arab Emirates (UAESA), and others. The Astronomy and Astrophysics Decadal Survey (US: Astro2020) and the ESA Cosmic Vision (EU) outline a comprehensive research strategy and vision for a transformative science at the frontiers of astronomy and astrophysics in the next decades. Similar plans, though at a lower level, are on-going under other major national space agencies mentioned before. In particular, large scale flagship missions like the Athena X-ray Observatory, LISA GW explorer, the Jupiter icy moons Explorer (JUICE) (ESA), NASA technological studies for LUNAR, Nancy Roman Space Telescope (NASA), and medium size missions like Euclid, PLATO, and TESS, and Starburst are already operative, approved, or in the realization phase. This impressive fleet of space observatories will be complemented during this decade by large-scale ground based facilities like TMT, ELT (ESO), SKA, CTA, and others, spanning from radio to optical/IR to high energy gamma rays. The new observational window opened by the GW interferometers and Neutrino detectors are under upgrade and optimized to be inter-operative with other ground-based infrastructure and space-based missions.

4. Committee activities

The main SATC activity for the current year have been focused on:

1. Long-term analysis of the technical, scientific and programmatic areas of space astronomy. Serve as a *forum for exchange of information and interaction between the scientific community, space industry and agencies* involved in the preparation and future development of new astronomy missions. Particular emphasis is on technological breakthroughs for future space applications (e.g. space cryogenics systems, cubesat constellations, space-ground synergy).
2. Of particular importance are the recent developments and actions to preserve the "Dark Sky" against the optical and radio interference between 1.000-10.000 small-sat for TLC and ground and space astronomical observatories. The strong interaction with STM-TC26 Committee has been finalized during the Dubai IAC 2021 meeting with cross participation of members of TC23 and TC26 meetings. As such, the SATC role will be complementary to the current work carried out by the Agencies, industries, Academia and space and ground-based stakeholders;
3. Organization of the A7 symposium at IAC 2021 and IAC 2022, for the discussion and publication of ideas and relevant results and issues to the impact and needs of future astronomical missions.
4. Provide a point of contact for national and international bodies.

The Action plan foresees: IAC 2021 sessions with active participation (done), IAU Las Palma UNOOSA, ISSI Forum 2021 (done), participation to "Ground and Space Astronomy: Challenges and Synergies", November 2021, to COSPAR 2022 (Athens) and 2023 Space science with small satellites (Singapore), IAU Busan 2022 etc.



November 2021

IAF SPACE COMMUNICATION AND NAVIGATION COMMITTEE (SCAN)

1. Introduction

The IAF Space Communications and Navigation Committee (SCAN) addresses all aspects of space-based systems, services,

applications, and technologies for fixed, broadcast, high-throughput, and mobile communication services as well as position determination, navigation and timing services.



2. Summary

Space-based communication and space-based navigation continue to be significant drivers for new applications and new technology.

The satellite communications market was estimated to be worth \$62.19 billion in 2019 and is predicted to grow by about 9.2 % in the period from 2020 to 2027. There is still a high need of very high throughput satellites (VHTS) and a growing capacity need for Internet of Things (IoT) services.

The international Global Navigation Satellite Systems (GNSS) infrastructure continues to expand, with global [Beidou (China), Galileo (EU), GLONASS (Russia), GPS (USA)] as well as the regional [EGNOS (EU), IRNSS (India), QZSS (Japan), WAAS (USA)] systems. The economic benefit of GPS alone has been estimated at \$1.4 Trillion (2017\$) since it went operational in 1995. The impact of the loss of GPS is estimated at \$1 billion per day.

3. Highlights

In 2020 about 22 commercial communication satellites were ordered to be manufactured: six by Space Systems Loral (US), four by Northrop Grumman (US), two by Boeing Satellite Systems (US), six by Airbus Defense and Space (F), three by Thales Alenia Space (F), and one by China Great Wall Industries (CGWIC).

As of 5 Nov 2021, six commercial communication satellite manufacturing orders have been placed: two for Maxar (US), two for Airbus Defense and Space (F), one for Thales Alenia Space (F) and one micro-GEO for Astranis (US).

SpaceLink, a US company formed by Australia's Electro Optic Systems (EOS) in 2020, awarded a contract to OHB System AG (Germany) to manufacture four satellites for its commercial space data relay constellation. SpaceLink plans to establish a relay network in medium Earth orbit to connect commercial and government satellites with customer mission operations centers. This is a remarkable move. Until now, all data relay networks have been established in geostationary orbits.

SpaceLink won a contract to demonstrate a 10 Gbit/s optical communication service for the ISS. SpaceLink plans to provide data-relay services in Ka-band at about 600 Mbit/s (as currently provided by TDRSS), and in the optical domain for 1 to 10 Gbit/s data rate with its now contracted MEO data relay constellation.

In the area of mega-constellations, 2021 saw a substantial increase of the constellation sizes of OneWeb and Starlink. From July 2021 until October 2021 OneWeb has launched 240 satellites using four launchers. Starlink launched 51 spacecrafts in September 2021.

On 20 January 2021, the European Commission signed a contract with Airbus and Thales for the second generation of Galileo

satellites. These new satellites, due to be launched in 2024, will have the latest in highly innovative technologies (e.g., digitally configurable antennas, inter-satellite links, new atomic clock technologies, use of fully electric propulsion systems), that will allow these satellites to improve the accuracy of Galileo as well as the robustness and resilience of its signal.

In March 2021, EGNOS, the European Geostationary Navigation Overlay Service, celebrated 10 years of operation. This European regional navigation system provides services primarily to airlines, and provides an accuracy and integrity improvement to all GNSS service providers. EGNOS, like the US-based Wide Area Augmentation System (WAAS), can pinpoint positions to within 1.5 m! Such accuracy facilitates automated landing of aircraft thus allowing operations in the worst visibility conditions.

RUAG Space signed an agreement in October 2021 with the UAE's Mohammed Bin Rashid Space Centre (MBRSC) to deliver their LEORIX space-based GNSS receivers. These latest receivers allow satellite operators to locate their satellites with unprecedented accuracy. RUAG's LEORIX, GEORIX, and PODRIX line of products leverage the latest in technology development from the European Space Agency and with 80 receivers already on order, space operations will be getting increasingly more reliable – something that is of the utmost importance as the issue of space debris continues to haunt those that are on the operational front lines.

The US Global Positioning System launched the fifth GPS III satellite, nicknamed Neil Armstrong, on 17 June 2021, and it is now operational. The five operational GPS III satellites, manufactured by Lockheed Martin, are an integral part of the GPS constellation, and continue to advance the capabilities of GPS, with a 15-year design life, 3X better accuracy, and a new internationally coordinated signal, L1C.

The Japanese Quasi-Zenith Satellite System (QZSS) launched its first successor satellite, QZS-1R, on 26 October 2021. It has a 15-year design life, and replaces QZS-1 (Michibiki-1). QZSS began service in 2018 with four satellites. The Japan Aerospace Exploration Agency (JAXA) plans to have seven satellites launched by 2023.

4. Future outlook

The first ViaSat-3 VHTS satellite launch, originally foreseen for 2021, has been moved to 2022 at the earliest, due to the effects of COVID-19. ViaSat-3 is the highest capacity geostationary satellite system under development in the world, providing a capacity of more than one Terrabit/s (=10¹² bit/s) with one satellite. The ViaSat-3 Americas satellite must be brought into use (BIU) by 31 December 2021 OR it must receive a waiver from the FCC's deployment milestone. The originally planned launch date was 29 March 2021 and operational service was expected by 31 December 2021. The launch date has now shifted to 2022.



The success of EGNOS and WAAS to airlines has attracted the attention of those wishing to operate unmanned drones in the same commercial airspace. As the number of remotely piloted vehicles quickly outpace the number of commercial aircraft, safety-of-life services is seen as essential to safely managing the skies.

5. Committee activities

The SCAN committee had a very active year. The IAC 2021 symposium was organized, abstracts evaluated and selected, and sessions conducted in Dubai. This was the first use of a restructure of the symposium session descriptions, which now has several sessions with the same name but shown as Part 1, Part 2, etc. The new structure required more coordination between session chairs, but also allowed grouping of specific topics into each session, for more cohesive discussion. The committee will continue with this approach for a few more years, to further evaluate the benefits versus effort. As a result of pandemic-related absents in Dubai, substitute session chairs were arranged to support all nine sessions that the committee sponsors.

In addition to organizing and running the B2 symposium, the SCAN committee Terms of Reference was updated. The previous version from 2005 did not include space-based navigation. This has been added, the overall ToR updated, and it now conforms to the new IAF template.

Virtual meetings were held in March 2021 and October 2021. Elections were conducted for Chair and Vice-Chair. All affiliations and contact information were updated in the SCAN committee roster. Reviewing the roster for inactivity (no committee participation for more than 3 years), several "members" and one "friend" were removed. Four new members and one expert were added. All other members were re-elected. After two years of successful virtual meetings, the committee is exploring the opportunity to conduct more frequent virtual meetings to improve cohesion of all activities. The goal is to conduct meetings quarterly, adding virtual meetings in winter and summer, with in-person meetings at the IAF Spring Meetings and the annual IAC.



November 2021

IAF SPACE EDUCATION AND OUTREACH COMMITTEE (SEOC)

1. Introduction

The IAF Space Education and Outreach Committee (SEOC) promotes the development and delivery of quality learning and outreach opportunities for students, educators, and members of the IAF so that space, science, and technology become better known and are more accessible to the global community. We also help recognize activities by students and educators at the IAC through our competitions and Honours and Awards programme.

2. Highlights

New approaches to outreach and science communication within the space sector are growing, particularly with engagements

involving artists and strong emphasis in the use of social media. As part of these initiatives, mentorship focused programs are also on the rise, the IAF Launchpad Mentorship Programme and SGAC's Mentorship Programme being among the successful ones. Outside of the IAF and its partners, several industrial mentorship programs have been developed in the US and Canada to help students enter the industry in an easier manner. The implications of these trends on the work of the committee is one of the focuses of the committee's 2022 activities.

3. Future Outlook

SEOC welcomed its new leadership this month, and the new vice-chairs are currently scoping their vision for the next 3 years. In the meantime, we are continuing preparations for the 73rd



IAC, which will be held in Paris in 2022. Our call for papers for the Space Education and Outreach Symposium and the Student Competition have been updated with lessons learned from this year's IAC and are now available online. SEOC also plans to continue its honours and awards programme, contributions to the Next Generation Plenary and mentorship programmes at the IAF.

One of the trends that the committee is interested in exploring and bringing into its programmes include the rise of novel science communication techniques through arts and social media. These trends, while somewhat covered by our technical symposia, could be engaged within the context of other platforms within the IAF. In addition, we have observed that most speakers at SEOC activities are scientists and engineers that are active in education; K-12 educators and teachers have not engaged with the committee as much. SEOC wishes to engage with these communities more, either by inviting them as keynote speakers at the IAC, or as part of special sessions and other online activities to be planned in the coming year.

4. Committee Activities

The SEOC worked throughout 2021 to plan for excellent support to the 72nd International Astronautical Congress (IAC), where we hosted two symposia:

- The Space Education and Outreach Symposium (E1) showcased over 90 papers (selected from over 180 submissions) in 10 sessions around various topics in space education and outreach, workforce development and culture
- The 29th Student Competition Symposium (E2) showcased 45 papers from around the world in 4 sessions, one of which was broadcast online as part of the Global Technical Symposium
- While both symposia were impacted by the uncertainties of the COVID-19 pandemic, the end result was comparable to past years.
- SEOC Honours and Awards continued its great work this year, by awarding the following three titles:
- The Frank J. Malina Astronautics Medal was awarded to Filippo Graziani, President of the Italian company Group of Astrodynamics for the Use of Space Systems (G.A.U.S.S. srl), and Senior Professor of Astrodynamics at University of Roma "La Sapienza". This award recognizes an educator who has demonstrated excellence in taking the fullest advantage of the resources available to him/her to promote the student of astronautics and related space sciences. Professor Graziani was also a keynote speaker at the SEOC E1 Symposium.
- The Luigi G. Napolitano Award was awarded to Federica Angeletti, School of Aerospace Engineering (SIA), Sapienza University of Rome. This award is presented annually to a young scientist (below 30 years of age) who contributed significantly to the advancement of aerospace sciences and

presents a paper on this contribution at the IAC.

- The IAF Student Awards were presented to Sam Bunka, Hugo Lévy, Harika Pothina, Nadia Weronika Brzostowicz and Jaroslav Hruby. These awards recognize the best papers presented by students at the IAC in the undergraduate, graduate and student team categories.

SEOC members contributed to the selection of the IAF Emerging space Leaders Grantees and the IAF Young Space Leaders Award programme as well. We are happy to see two SEOC members and contributors (Kat Robinson and Elizabeth Barrios) among the awardees of the YSL this year.

SEOC members (alongside the IAF WD-YPP and other committees) also supported the Next Generation Plenary (NGP) program as steering committee members. The NGP this year focused on Next Generation Impact on Social Responsibility in Space and was a great success, while the program also planned an additional plenary this year focused on the role of space in combating climate change.

Throughout 2021, SEOC also supported other in-itatives, such as the IAF Abstract Mentor Programme and IAF Launchpad Mentorship programme, with SEOC members acting as mentors in both programmes. We also revamped its webpage this year, providing a broad description of its activities and highlighting the new procedure for joining the committee in a clear manner. We have also created a new means for those interested to reach out to SEOC vice chairs directly, and have updated our terms of reference to reflect new definitions and election procedures used by the committee.

IAF Committee Briefs



November 2021

IAF SPACE HABITATS COMMITTEE (SHC)

1. Introduction

The IAF Space Habitats Committee (SHC) aims, in cooperation with other IAF committees and symposia, to foster interest in the importance of building an international and interdisciplinary understanding of the issues and stakes raised by future space habitats (e.g., settlements on celestial bodies and orbital infrastructures). Besides diversity in terms of generation and geography, the SHC gathers one of the most diverse interdisciplinary teams of experts among IAF members (engineers, architects, designers, crewmembers, social scientists, policymakers and space explorers) to consider the various dimensions of space habitation for innovative and inclusive initiatives.

2. Summary

Plans are continuously under development for future lunar and Martian exploration, which include, within the current decade, habitats concepts for Moon missions – e.g., the circumlunar station “Gateway” and some landers concepts –, all designed for scientific missions performed by professional crews. Newly developed spacecrafts which will serve as habitats in the coming years include the Orion capsule and the Chinese space station.

Meanwhile, we also observe fast-growing development of private missions involving a wide range of habitation configurations, such as:

- The Crew Dragon capsule in autonomous flight for 4 people for 3 days;
- After 10 years without non space professionals on board, the ISS is currently serving again as habitat for private residents, benefiting from recent additions to the station such as the Russian Nauka module launched during the Summer 2021 (a Russian film crew and a Japanese crew using a Soyuz, an international private crew and an American film crew launching on SpaceX’s Crew Dragon);
- Private crews orbiting the Earth with the Blue Origin’s New Shepard;

- NASA and Axiom Space have also signed an order for the first private astronaut mission to the International Space Station to take place no earlier than January 2022;
- The massive and voluminous StarShip will take 9 private passengers [around the Moon](#) within a few years, while [private space stations](#) will become operational.

These missions present a variety of configurations in terms of crew size, crew qualification, training, available volume, duration of the mission, type of mission and tasks. This implies mobilization of multiple actors involved in the design, engineering, operability, training concepts and space analogs, all related to habitability, including also universities where teaching space architecture and design evolves accordingly fast.

3. Highlights

Habitat design requirements include the design integration of technology for life support, designing for strict limitations in habitable volume, while providing maximum safety and strategies for future expansions and optimizations for possible variables in mission objectives. Complying with such needs also pushes the technological and scientific advancements on Earth challenges related to the design of sustainable living environments on Earth. Lessons learned from more than 20 years of permanent human presence on board the ISS constitute a strong contribution to further space habitability development. Future habitats beyond LEO will also need to address the problem of radiation protection of the crew. The past years have seen the development and exhibition of various ways to address the issues raised by future long-duration spaceflights, either professional or private, including via inflatable and modifiable structures. Analog missions around the world, either commissioned and organized by space agencies or private actors, are more than ever important to test and analyze different habitability options.

4. Future Outlook

Until recently, humans in space were mostly professional

astronauts and cosmonauts, from STEM, pilot or military backgrounds whose missions are determined by scientific and technological experiments. However, the commercial sector is now transporting civilians to space and space habitats will also increasingly include commercial astronauts and cosmonauts, as illustrated by the ‘Summary’ section. This raises questions on the status of civilians in space (including the rights and obligations of those civilians and appropriate governance mechanisms) and consequent updates in space law, but furthermore on the definition and design of space habitats in terms of life quality beyond the safety and operational aspects of professional crews’ flights. Another important aspect of space habitats in the near future, especially for orbital habitats, will be the organization of their end of life considering space debris management.

5. Committee activities

The SHC held its elections for the 2021-2024 term during its IAC meeting in Dubai (29 October 2021). New members have been voted on in addition to several ‘observers’ interested in joining the Committee in the future, and Chair (Julie Patarin-Jossec) and Vice-Chairs (Olga Bannova and Sandra Häuplik-Meusburger) have been elected. In terms of scientific and political dialogue related to space habitats, SHC members have actively contributed to the IAC 2021 in Dubai either via technical papers and the organization of symposia, the participation in, and organization of Special Sessions, the participation in GNFs, and the participation in plenary events like astronaut panels. Some SHC members have also been actively part of the exhibition, for instance presenting prototypes of surface space habitats for future analog, Moon and Mars missions. Several new projects have been discussed among SHC members for the coming year, including:

- The creation of a working group/task force on governance issues related to space habitats (introduced by E. Tepper), to further discuss new governance models better suited to future space habitats than the ISS’ framework, including regarding the increasing commercial and long-term nature of human spaceflight.
- The organization of a dedicated session for SHC members’ presentations as part of the ‘Mars to Earth’ 2022 conference (January 2022), organized by the Mars Planet organization (part of SHC membership).
- The organization of joint session(s) for the IAC 2022 in Paris with symposia in space architecture, space and society and system engineering — in addition to a keynote lecture in space architecture and eventual Special Sessions and/ or GNFs.
- The development of a new technical session for the IAC 2023 in Baku.
- The creation of an analog habitats group within the SHC to further work on analog-based habitability solutions, completing analog space habitats projects in partnerships with the UNOOSA.

- The development of a partnership with Padova University which, for its eighth centenary celebrations, will designate May 2022 as ‘Space Month’.
- The organization of (side) events during the IAF Spring Meetings in March 2022 around space habitats.
- The discussion, and eventually the creation, of a hybrid architectural investigation of the concept of an ‘orbital university’ reflecting on what would be minimum necessary requirements for a habitat people would want to live in space.
- A collective and long-term reflection on best practices and processes benefiting an increasingly diverse membership, including (but not limited to) forms of participation in SHC and IAF activities for marginalized space actors (NGO representatives, artists, etc.).

All these initiatives are aimed to be undertaken by, or open to, members, experts and friends from a wide range of disciplines representing the multidisciplinary expertise of the IAF Space Habitats Committee. New memberships allow, and will allow in the coming year, new partnerships completing the above-mentioned projects.



November 2021

IAF TECHNICAL COMMITTEE ON SPACE TRAFFIC MANAGEMENT (STM)

1. Introduction

The IAF Technical Committee on Space Traffic Management aims at providing a contribution to the joint Reference Paper prepared together with IISL and IAA, following the MOU signed between the three organizations in Bremen in 2018, with the objective to “develop comprehensive approaches and proposals for STM to be addressed to decision-makers on national and international level”.

2. Summary

The work of the Committee has been initially subdivided into 29 thematic Working Groups. The first phase of the work, led in 2021, focused on the first 9 subjects; the second phase, started in Dubai in October 2021, added 5 subjects. One additional one has been merged with existing one, 4 have been postponed probably to end of 2022, and 4 are not yet started, but could turn out to be merged with ongoing topics.

The following table describes the Working Groups currently ongoing.

	1st Phase	2nd Phase	Merged	Postponed	Not yet started
1	Terminology - Common understanding and Definitions				
2.1	Improving the knowledge - New technical means of space objects monitoring				
2.2	Improving the knowledge - Improve trackability and identification of small objects				
2.3	Improving the knowledge - Data fusion - Merging of information - Shared catalog				
2.4	Improving the knowledge - Improvement of orbital data precision and accuracy				
2.5	Improving the knowledge - Improvement of the UN registration				
2.6	Improving the knowledge - Shared Catalog (merged with 2-3)				
2.7	Improving the knowledge - Hazards associated with reentry				
3.1	Space capacity management				
3.2	Management of RF interferences				
3.3	Improvement of the collision avoidance process				
3.4.1	Future operations - Spacetrags, IOS, IOM, IOR				
3.4.2	Future operations - Large constellations				
3.4.3	Future operations - Sub-orbital activities				
3.4.4	Future operations - Ground support activities such as spaceports				
3.4.5	Future operations - Transits through airspace				
3.4.6	Future operations - Impact of constellations on Astronomical observations				
3.5	Future operations - Preparation of future activities				
3.6	Future operations - Traffic from orbit to Moon (and Mars)				
4.1	Technical regulations - Current references				
4.2	Technical regulations - New activities				
4.3	Technical regulations - Effective compliance to Technical Regulations				
5	Outreach				

The aim of each Working Group is to provide a 10 pages report + Annexes + 1 page Executive Summary. The collection of all these inputs, merged by the coordinators, completed by a couple of pages introduction, will constitute the Final Report, expected for IAC 2022 in Paris.

The work of TC26 is structured following the dedicated web zone on the IAF web site <https://iafaastro.directory/iac/folder/tc/spacetraffic/#file.5090>

3. Highlights

The Technical Committee currently regroups 134 Members, Friends, Experts, coming from 24 different countries, following very well the 3G motto from IAF, Gender, Generation, Geography.

Each Working Group followed its own agenda, meeting regularly to prepare their draft Final Report for IAC 2021. The 9 initial Working Groups have globally been very efficient and in line with the objective planning. A general review of the progress has been done on Oct. 24th in Dubai, followed by a Special Session on Oct. 26th, recalling the general frame of the effort, presenting the progress of each Working Groups and recalling the perspectives for the following periods. This progress can be seen on the dedicated page set in place by IAF secretariat: [Space Traffic Management Committee \(iafaastro.org\)](https://iafaastro.org)

4. Future Outlook

As explained, 5 new Working Groups have been kicked-off in Dubai, involving 54 members, each WG being co-chaired by 2 coordinators. We currently witness the setting in place of these groups, the first meetings, and can be very optimistic on the progress that should take place in the coming 6 months. We expect all the draft Reports by May 2022, followed by general merging and polishing of the complete file, cross-read, comments, amendments... and final issue by September

2022 under a form which is still TBD (White Paper; Special Publication...).

One point nevertheless remains open and source of worry: the progress made by the “parallel” entities involved in the MOU (IAA and IISL) is unknown, and we hope their contributions will arrive in due time for the finalization of the common report.

5. Committee activities

The IAF TC26 Coordinators, Darren Mc Knight and Christophe Bonnal, the TC Secretary Serge Platard, and the IAA-IISL Liaison Officer Didier Alary wish to warmly thank the IAF secretariat for the wonderful job done in assisting our Technical Committee; thanks to this support, we are very confident in the success of the initiative.



November 2021

IAF SPACE PROPULSION TECHNICAL COMMITTEE

1. Introduction

The Space Propulsion Committee addresses sub-orbital, Earth-to-orbit, and in-space propulsion. All types of propulsion are of interest to the committee: chemical and non-chemical/ electric propulsion, but also advanced, unconventional, or air-breathing propulsion. The symposium sessions organized by the committee during the yearly International Astronautical Congress include: liquid systems (2 sessions); solid and hybrid systems (2 sessions); electric propulsion (2 sessions); small satellite propulsion; nuclear propulsion and power systems; air-breathing rocket propulsion; innovative propulsion systems enabling new/visionary space missions.

The committee deals with component technologies as well as complete propulsion systems and their implementation in missions and spacecraft, but also welcomes discussions on dedicated test facilities for space propulsion testing. Special attention is given to New Space developments, including miniaturized propulsion systems for small spacecraft/ launchers, or how combined technologies, such as chemical and electric propulsion, can be optimized for extending the range of feasible space missions.

2. Summary - Space Propulsion Highlights in 2021

In the **United States**, SpaceX is continuing the development of its Starship launch system, powered by a cluster of **Raptor** engines (LOX-methane, full-flow staged combustion, 2 MN

thrust). In May, a Starship prototype powered by three Raptor engines achieved an apogee altitude of 10 km and successfully performed a rocket-powered landing maneuver.

Other US large rocket engines under development include Blue Origin’s **BE-4** engine (LOX-methane, 2.4 MN thrust) for the Vulcan and New Glenn launch vehicles, and Aerojet Rocketdyne’s RS-25 (upgrade of the Space Shuttle Main Engine) for the Space Launch System program.



Raptor engine (courtesy. Wikipedia)

In **Europe**, the development of the **Vulcain 2.1** engine for the first stage of the Ariane 6 launcher is being completed (LOX-LH₂, gas generator, 1.3 MN thrust), in parallel with the upper-stage **Vinci** engine and the P120C solid rocket boosters (one-piece, composite case, 4 MN thrust).



Test of the Vulcain 2.1 engine (cour. ESA)

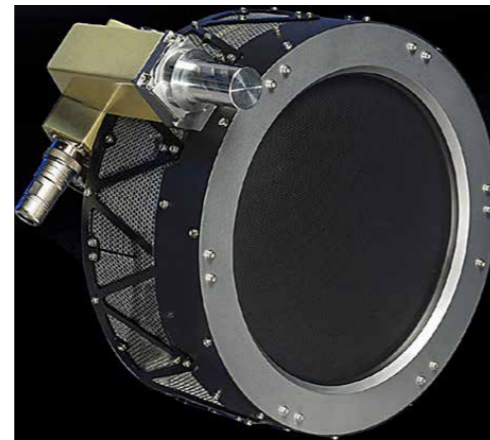
In the meanwhile, the 3 stage-solid rocket motors and liquid upper module launcher **Vega** has successfully completed its 20th launch, confirming its versatility for the launch of small orbital payloads.

In **Asia**, China has successfully started the manufacturing and component-level hot fire testing of a **5 MN-thrust class LOX/kerosene rocket engine** for a future heavy-lift launch vehicle, intended for deep space exploration and manned landing on the Moon. The engine is based on an oxidizer-rich staged combustion cycle system and after-pump gimbal configuration.

Japan is preparing for the maiden flight of its new H3 launch vehicle, based on the **LE-9** engine (LOX-LH₂, expander bleed cycle, 1.4 MN thrust) and the **LE-5B-3** engine (LOX-LH₂, new and updated version in the LE-5 family of upper-stage engines).

In the **Electric Propulsion** scenario, Maxar Technologies and Busek Co. have successfully completed in March an end-to-end hot fire test campaign for their 6 kW system **SEP** (Solar Electric Propulsion), featuring four Busek's **BHT-600** Hall Effect thrusters using Xenon propellant. The final goal is to develop a 50 kW electric propulsion system for the Power and Propulsion Element of the NASA Gateway, which will be the most powerful electric propulsion system ever flown in space.

Ariane Group is continuing the development of its RIT-2X series of radiofrequency ion thrusters (Xenon propellant, thrust ranging from 80 to 205 mN), intended to be used on the Earth Return Orbiter of the Mars Sample Return Program.



RIT-2X thruster (cour. Ariane Group)

In 2021, using a RAFAEL developed propulsion system comprising two **IHET-300** thrusters, the Venus satellite, a joint CNES-ISA mission, successfully completed a significant orbit transfer from 720 to 410 km, and is currently maneuvering back to a new 560 km orbit.



IHET-300 thruster (cour. Rafael)

The **micro-propulsion** scenario has been very dynamic this year, with a number of innovative systems under development to meet the needs of ambitious deep space small satellite missions. Examples are: the 8-thrusters high performance mono-propellant system for the NASA CAPSTONE CubeSat and the 4-thrusters green mono-propellant for the NASA Lunar Flashlight CubeSat; the miniaturized ion thruster for the ESA M-ARGO CubeSat; and the AQUARIUS water micro-resistojet for the JAXA EQUULEUS CubeSat.

3. Future Outlook

This year, one of the most active rocket launcher sectors has been in the field of **micro-launchers**, with a multitude of start-ups and other companies currently developing their own launcher to address the 100-1000 kg payload market. The development and qualification of new, low-cost, reliable rocket engines in the 100 kN-thrust class or below will be crucial for the success of this category of micro-launchers.

Another very promising and fast developing sector for rocket propulsion is **Additive Layer Manufacturing**, a technology with enormous potential in terms of simplification and reduction of lead times. As an example, the team at NASA Marshall Space Flight Center has recently demonstrated a 90-days manufacturing cycle for a 5 ft diameter, 6 ft height metallic nozzle with fully integral cooling channels.

Significant developments are expected in the short-term for **air-breathing rocket engines**, where the recent successes of Reaction Engines Limited in the validation of the precooler technology for their SABRE engine are particularly remarkable. Several research groups are currently working at the development of engines based on **aerospike nozzles**, for which a significant milestone has recently been achieved by Pangea Aerospace, with the demonstration in a 2.5 min hot fire test of a 20 kN regeneratively cooled engine. Finally, the continuous **Rotating Detonation Engine** is a concept that is receiving great attention in recent years, with a number of numerical and experimental activities that have allowed to greatly improve our understanding of the detonation process and its mechanisms. As an example, Nagoya University (Japan) and their team have successfully completed in August the world-first flight demonstration of a Rotating Detonation Engine.

4. Committee Activities

The new committee management structure (chair and vice chairs) for the period 2022-24 has been defined through elections involving all committee members. The new chairperson will be Angelo Cervone (Delft University of Technology, the Netherlands), supported by three vice chairs: Christophe Bonhomme (CNES, France), Elena Toson (T4I – Technology for Propulsion and Innovation, Italy), Riheng Zheng (China Aerospace Science and Industry Corporation).

The committee is currently made of 47 members, with good distribution among geographical areas and categories (industry, Academia, agencies). One of the main committee's goals for the period 2022-24 will be to significantly increase the percentage of female members (currently 8) and young professionals (currently 6). Another goal is to renew the committee area on the IAF website, including continuously updated information on the committee activities and on the recent developments in the field of space propulsion.

The committee is not only active in the organization of the International Astronautical Congress, but also fosters synergies with other relevant space propulsion conferences, such as the EUCASS (European Conference for Aeronautical and Space Sciences) and the biennial 3AF/ESA Space Propulsion conference.



November 2021

IAF SPACE TRANSPORTATION COMMITTEE

1. Introduction

The objective of the IAF Space Transportation Committee is to address worldwide space transportation solutions and innovations. In particular the goals are:

- To foster understanding and cooperation amongst space business academicians and practitioners, through the creation, diffusion, and adoption of new knowledge and lessons learned

- To build a world-wide network of communication and relationships
- To encourage, promote, and assist the development of newer members of the space community through IAC participation

The corresponding activities are devoted to different types of space transportation missions, systems (launch vehicle system and/or the propulsion stages, expendable or reusable, manned or unmanned) and to their safety and support operations.

2. Summary

The major highlight in 2021 was the achievements in commercial human space transportation with successful flights of Virgin Galactic, Blue Origin and SpaceX.

Another interesting development is the race between tenths of companies related to the development of a cheap launch service based on a small launch vehicle with a high launch rate

3. Highlights

HORIZON 2020

Air-breathing hypersonic vehicle concepts may act both as first stage of future reusable two stage to orbit vehicles, able to take-off and land horizontally, and as high-speed civil passengers transport aircraft. Within the framework of the Horizon 2020 Project STRATOFly (Stratospheric Flying Opportunities for High-Speed Propulsion Concepts), significant results have been achieved at mission, system and subsystems level for a vehicle concept that flies at Mach 8 at 35 km of altitude exploiting liquid hydrogen as propellant. At mission and system level the following achievements can be highlighted:

- Complete aero-propulsive characterization for all speed regimes through high-fidelity simulations for wave rider configurations
- Enhancement of the scientific understanding of atmospheric processes has revealed that the higher is the stratospheric altitude of the water vapour emissions, the longer is the perturbation lifetime of the emitted water vapour, thus resulting in higher climate impact
- Jet-noise test campaigns coupled with high-fidelity simulations have allowed to get reliable acoustic data to make observations about the noise mechanism and to derive an adapted semi-empirical noise prediction tool for the nozzle of air-breathing high-speed engines. Strategies for noise reduction potentials have thus been defined.

At subsystems level the following achievements can be highlighted:

- Redesign of the dual mode ramjet combustor guarantees a reduction of the 80% in NOx levels emissions in cruise at Mach 8, with respect to the initial baseline
- Validation of LES high-fidelity models of high-speed combustion through combustion test campaign
- Performance assessment of the multidisciplinary and multi-functional Thermal and Energy Management System that exploits liquid hydrogen for multiple integrated purposes: heat rejection, thermal control (as coolant mean of heat exchangers) and high electric power generation through turbine expansion for on-board subsystems

NASA Update

NASA's Commercial Crew Program safely returned their second crew from the International Space Station after 199 days in orbit in November 2021. The next crewed launch, Crew-3, is preparing for launch aboard a SpaceX Crew Dragon in November.

NASA has completed stacking of the Artemis I Space Launch System rocket and Orion spacecraft in the Vehicle Assembly Building (VAB) at the Kennedy Space Center in Florida. The ground team also recently completed their Underway Recovery Test 9 (URT-9) certifying that NASA's Landing and Recovery team is ready for the Artemis I recovery. A series of tests are now underway in the VAB before the wet dress rehearsal in January and a targeted launch in February 2022. This first test flight paves the way for NASA's first crewed flight of Orion and the SLS, planned for 2024 on Artemis II.



A view of the fully stacked Orion and SLS in the Vehicle Assembly Building



U.S. Navy divers from Explosive Ordnance Disposal (EOD) Expeditionary Support Unit 1, attach tending lines to a mock Orion capsule during Day 2 of Underway Recovery Test 9 (URT-9) aboard the USS John P. Murtha. During the weeklong test, NASA's Landing and Recovery team completed their final mission certification ahead of Artemis I.

Newest Development of China's Space Transportation

Chang'e-5 has accomplished China's first Lunar sample return mission. Chang'e-5's mission profile is very similar to Apollo program, although it is unmanned. The probe is consisted of an Ascender, a lander, a return capsule and an orbiter. The Ascender/Lander combination is similar to Apollo's Lunar Module and return capsule/Orbiter is similar to CSM. During the mission, the world's first unmanned Lunar orbit rendezvous and docking with an orbiter was conducted.

After a test launch in 2020, China used its Long March-5B rocket to take its space station into orbit. This version is the world's only one and a half stage launch vehicle in service. It has four boosters with two YF-100 kerosene/liquid oxygen engines each. The total thrust of the boosters are more than 960 tons. It took Tianhe-1 core module of China's space station to a 41.5 degree inclined orbit. The core module is the first of the world that adopted hall effect engines to raise its orbit.

China tested its new launch vehicle, Long March-8 on 22 December 2020. This launch vehicle has a similar first stage like Long March-7 but with only two boosters. The second stage of this rocket is a derivative of the third stage of Long March-3A, which uses liquid hydrogen/liquid oxygen engines. Long March-8 rocket is developed for commercial market and hope to test recover and reusable technologies in the future.

After a failure on its maiden flight of Long March-7A in March 2020, the second flight was a success in March 2021. The rocket is based on Long March-7, which is a two and a half stage mid-sized launch vehicle. Long March-7A added a third stage, which is based on the third stage of Long March-3A. With this improvement, the GTO capability can reach to 7 tons.

Beijing Interstellar Glory Co. Ltd, which is the first private company in China that achieved an orbital launch in 2019, suffered two failures in its second and third orbital launch attempt. Galactic Energy, another private company accomplished its first orbital launch in November 2020. Both company's launchers are small four-stage solid-rocket boosters.

4. Future Outlook

As an outlook into the future, it will be interesting to see in the next years, which company will be able to successfully develop, qualify and operate a small launch vehicle out of the many currently running projects.

Also, one must watch carefully how the commercial human space flight will develop after the first successful missions this year into low earth orbit with a short visit to a space station respectively into suborbital altitude.

Finally, 2022 will hopefully mark the return to human lunar missions with the first flight of the SLS launch vehicle and the Orion spacecraft.

5. Committee activities

Two new activities are planned by the IAF Space Transportation Committee up to the next committee meeting in March 2022:

- To organize a virtual session on small launch vehicles latest developments
- To propose special sessions and keynotes for the IAC 2022 in Paris. For example, a special session on the climate impact of future launchers (either reusable or not), imagining a higher launch rate for large constellations

NEWS!

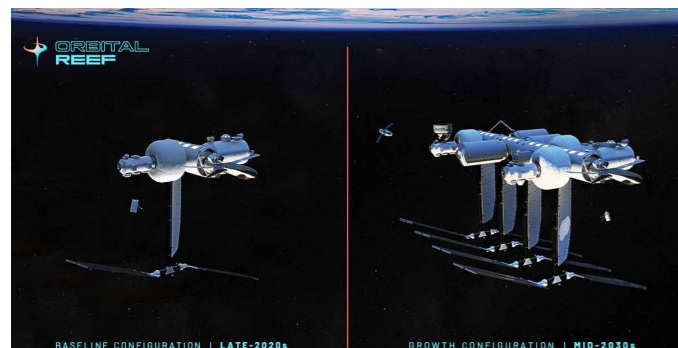


Orbital Reef Unlocks Low Earth Orbit with Open Architecture

Governments and companies around the world are beginning to prioritize commercializing low Earth orbit, and [Orbital Reef](#) answers the call as the premier mixed-use space station for commerce, research, and tourism, with plans to be operational before the end of this decade. Selected by NASA for their Commercial LEO Destinations (CLD) program, [Blue Origin](#) and [Sierra Space](#) lead an expert team including [Boeing](#), [Redwire Space](#), [Genesis Engineering Solutions](#), and [Arizona State University](#). Designed to utilize existing technologies and ideas never before possible, Orbital Reef unlocks LEO by reducing cost and complexity for both traditional and emerging customers.

Orbital Reef will provide end-to-end services, standard interfaces, and technical support needed by space flight novices: planning, payload development, training, transportation, data analysis, and security for people or payloads (or both). Commercially developed, owned, and operated, Orbital Reef opens doors to new markets and catalyzes the growth of a vibrant space ecosystem. It provides an "address on orbit" for use, lease, or ownership that is international and open to all.

This is more than a vision... Key elements of this open and sustainable architecture are already in development, including four transportation elements and six destination elements. Orbital Reef is the next logical step towards a future of millions of people living and working in space to benefit Earth. To learn more, visit www.orbitalreef.com.



Cyclone-4M joint project between Ukraine and Canada starts to unfold

On November 18, Volodymyr Taftai, Head of the State Space Agency of Ukraine and Lisa Campbell, President of the Canadian Space Agency, met in Halifax to sign the Joint Statement, recognizing the partnership in the space industry between Ukrainian companies Yuzhnoye State Design Office (Yuzhnoye SDO), SE Production Association Yuzhny Machine-Building Plant (Yuzhmash) and Canadian Maritime Launch Services Ltd. The partnership is initiated to create a Launch Vehicle Space System to provide commercial launch services for the payload to be launched aboard the medium-lift Cyclone-4M rocket. Spaceport will be located in Canada nearby Canso, Nova Scotia.

For this joint commercial project of Ukraine and Canada, Yuzhnoye SDO is contributing engineering and design solutions that will allow Cyclone-4M, a new Ukrainian medium-lift rocket, to enter the world market of space launch services within a short period of time, offering a high level of quality and reliability at a competitive price.

Yuzhnoye's area of responsibility in this project will include development, testing and operation of the launch vehicle; Yuzhmash will manufacture and provide Cyclone-4M launch vehicles for Maritime Launch Services that will be the launch system operator.

On November 19, Maritime Launch Services hosted in Halifax a presentation to unveil the design of Spaceport Nova Scotia's Launch Control Centre and to announce the first launch customer who signed the contract with MLS. Texas-based Nanoracks became the first customer to provide satellites and special buses to extend the spacecraft stay in orbit. In addition, Stephen Matier, the President and CEO of Maritime Launch Services, announced that his company also signed a letter of intent to launch small satellites aboard Cyclone-4M for Nova Scotia-based GALAXIA Mission Systems. Launch control center of the future spaceport will be named after Alexander Degtyarev, former Yuzhnoye SDO General Designer – General Director (2010 - 2020). Launch Control Centre will manage not only all the launch activities but also include the visitor and educational center to showcase space science as well as the Nova Scotia's Guysborough County diverse culture and environment. The LCC will also provide space accessible for students to study space science.

The forum was attended by Volodymyr Taftai, Head of the Ukraine's State Space Agency, François-Philippe Champagne, Minister of Innovation, Science and Industry, Sean Fraser, Member of Parliament for Nova Scotia, Minister of Immigration,



Astroscale's New Docking Plate and Collaborative Agreements to Advance Space Sustainability.

Astroscale is launching their first commercial [Docking Plate](#) to prepare satellites in low Earth orbit for servicing or removal. The Docking Plate is a lightweight solution which enables magnetic or robotic capture, with flexibility to minimize mass and size either as a flush mount or with different height truss legs. With a robust design and in-space lifetime of over 15 years, the first-generation plate was tested during a magnetic capture demonstration in August this year as part of multiple planned captures in [ELSA-d mission](#). Astroscale is urging all operators to futureproof their satellites for unexpected failures in orbit.

Astroscale recently announced a partnership agreement with the [New Zealand Government](#) to support long-term space sustainability goals. To initiate these efforts, a project in collaboration with Rocket Lab and Te Pūnaha Ātea–Auckland Space Institute will define the engineering requirements, policy challenges and associated costs for multi-active debris removal missions with clients that require direct re-entry due to survivability of components.

Astroscale and [Virgin Orbit](#) will also explore areas of cooperation on policy and regulatory efforts in the fields of space sustainability, space debris removal, government partnerships, launch and on-orbit servicing spectrum allocation. The agreement includes a partnership to study the business potential of a joint Global Responsive Satellite Servicing capability, pre-encapsulating Astroscale payloads and storing them at LauncherOne spaceports. Both companies will promote U.S.-Japan and U.S.-UK bilateral cooperation with a responsive launch capability from Virgin Orbit's launch sites in Oita, Japan, and Spaceport Cornwall, UK.

Visit astroscale.com



Refugees and Citizenship, Susan Corkum-Greek, Minister of Economic Development for Nova Scotia, Lisa Campbell, President of Canadian Space Agency, Larisa Galadza, Ambassador of Canada to Ukraine, Jeffrey Manber, Co-Founder and CEO of Nanoracks, and other Canadian and Ukrainian state officials and business representatives.



United Launch Alliance (ULA) completed the initial round of Vulcan pathfinder activities at Cape Canaveral by successfully performing a countdown test to rehearse all aspects of launch day operations.

The flight-configuration Vulcan core stage, named the Pathfinder Tanking Test (PTT) booster, was transported 2.7 miles (4.3 km) from the Spaceflight Processing Operations Center to Space Launch Complex-41 aboard the Vulcan Launch Platform. At the pad, the rocket systems were powered up and tested while a separate team of technicians at SLC-41 configured the pad for cryogenic fueling operations.

The Vulcan rocket was loaded with 254,000 pounds (115,200 kg) of LNG, chilled to -260 degrees F (-162 deg C) and 808,000 pounds (366,500 kg) of liquid oxygen, chilled to -297 degrees F (-183 deg C), marking the first time Vulcan has been loaded with both liquid oxygen and liquified natural gas.

The dual commodity test provided Vulcan engineers with real-life data on conditioning the core stage, the timelines to accomplish chill down and tank filling to reach topping mode, calibrating the propellant flow rates through the pad's upgraded systems and the fill/drain and topping valves, and bringing the engines into their prescribed start parameters.

The tanking tests utilized the significant modifications made to SLC-41 that transformed the site into a dual-use pad to seamlessly handle both Atlas V and Vulcan overlapping manifests. The work included a newly installed LNG storage area featuring three reservoirs and upgrades made to the booster liquid oxygen transfer lines for more efficient loading.



Micro Drive 微动

MicroDrive Space (MDS)

MicroDrive Space (MDS), a Chinese space mechanism company, recently announced its first round financing completed. One of the investors is MiraclePlus, founded by former Microsoft global VP, Dr. Qi Lu. MDS is a new space company in China focused on space mechanisms: Solar Array Drive Mechanism(SADM), Antenna Deployment and Pointing Mechanism(ADPM), Thruster Orientation Mechanism(TOM), etc.. MDS has an experts team of 15 years average experience in space mechanism. The first SADM of 300W-500W power transfer capacity has been qualified and will be verified in orbit by Aug. 2022. In the meantime, 1.3kW 2-axis SADM is being developed, and MDS is also working on development of 3kW SADM, electrical propulsion TOM and SAR satellite ADPM. MDS is accessing new space projects with in total more than 650 satellites to be launched in the coming 3-4 years. In parallel to new space projects, the company is proud of participating a scientific mission of comet exploration by developing compact high precision actuators.



and Economics and MANT, is approaching soon. The call for papers is already out, the submission deadline is December 20, 2021. The H-SPACE 2022 conference will be held in Budapest on February 8-9, 2022. Registrations will be open from January 10. Since the conference is planned as a hybrid event, there is a unique opportunity to participate from anywhere in the world, without the need for traveling. Contributions could be published as conference papers in the on-line proceedings to appear a few months after the event. The motto of the next H-SPACE conference is "New trends in the space sector". All the details can be found on its website, <https://space.bme.hu>.



Splendid space book and the H-SPACE 2022 conference

Coordinated by the Hungarian Astronautical Society (MANT) and supported by the Ministry of Foreign Affairs and Trade, a major effort arrived to a successful end: the representative publication titled "Hungary and Space – Our Role in the Space Activities of the World" is already available in the bookstores. The work of nearly 80 authors presents the Hungarian space heritage and a vast collection of current research and application activities in more than 200 colourful pages. What is even more, detailed background material is accessible on the web via QR codes printed in each pair of thematic pages.

The next edition of the H-SPACE international space conference series, jointly organised by the Budapest University of Technology



Space in Africa is a media, analytics, and consulting company focusing on the African Space and Satellite Industry. We produce authoritative business and market analysis reports for the African Space and Satellite Industry segments. Our domain focus enables us to offer our clients cutting-edge expertise and data from the African space industry.

Some of the projects we undertook in 2021 include:

- **Space in Africa Portal:** This resource is a daily-updated portal to aid business intelligence and policy decisions. It provides real-time data on the African space and satellite industry value chain—access portal.
- **Reports:**
 - a. **African Space Industry Report; 2021 Edition:** This report provides information and analyses on projects, policies, and opportunities that nuance the African

space scene. The report comes with complimentary access to the Space in Africa Portal.

- a. **NewSpace Africa Industry Report; 2021 Edition:** The African NewSpace industry has seen tremendous growth in the last decade, especially in the past year. With a clientele across the globe and a presence in every market, this sub-industry is one to watch out for.
- b. **Global Space Budgets 2021:** This is an open-source analysis of the space budgets of 106 governments. The analysis recorded space investments based on country and continent to draw inferences on market fluctuations. Purchase reports.



- **AUC Baseline Studies:** Furthermore, the African Union Commission delegated the implementation of baseline studies on EO, Astronomy, Satellite Communication and the socio-economic benefits of space to Space in Africa. The aim is to use the information gathered from these studies to roll out a robust space programme.



Space in Africa represented at the IAC 2021



Space in Africa represented at the 28th UN/IAF workshop:



Managing Director Space in Africa Speaking at Expo 2020 Dubai

For more Information
www.spacein africa.com
 IG/Twitter/Facebook: @spacein africa1
 LinkedIn: Space in Africa

The All-Russian CosmoStart Forum held in St. Petersburg

On 2nd and 3rd of December, the VI All-Russian Cosmonautics and Aviation CosmoStart Forum was held at the State University of Aerospace Instrumentation (SUAI), St. Petersburg, Russia. The Forum brought together cosmonauts and aerospace industry specialists, as well as participants and spectators from all over the country.

This annual large-scale space industry event is organized by SUAI together with the North-West Interregional Public Organization of the Russian Federation of Cosmonautics and with the support of the Roscosmos State Corporation. The main information partner is the VKontakte social network

In 2021, the Forum was held in a hybrid format – online and offline educational platforms were organized for participants. The broadcast of CosmoStart was conducted from the regional collective work space "Boiling Point - St. Petersburg. GUAP", where a virtual studio for speakers and an offline platform for experts were created.

The opening ceremony of the Forum was attended by distinguished guests, including Alexey Levchenko, Deputy Director of the Department of State Policy in Higher Education, Vladimir Knyagin, Vice-Governor of St. Petersburg, Dmitry Shishkin, Director of the Administrative Department of Roscosmos State Corporation, Bogdan Zastavny, Chairman of the St. Petersburg Youth Policy Committee, and Yulia Antokhina, Rector of SUAI.

The central event of the CosmoStart Forum was a dialogue with astronauts Ivan Wagner and Alexander Kaleri. The Forum was also attended by members of the backup crew of the Challenge scientific and educational project - cameraman Alexey Dudin and actress Alyona Mordovina. The speakers answered the questions of the participants in the studio and the audience of the broadcast.

The two days of the Forum also included discussions with experts, lectures and workshops from scientists, video tours, quizzes and much more.



2022 will bring unprecedented opportunities to IAF members: a brand new flight platform will provide up to 50 people per mission with the largest-ever Mars-gravity and Moon-gravity lab for 20 to 30 minutes of cumulative low-G time, at the cheapest price ever for parabolic flights, for Africa in Mauritius and for Europe taking off from alpine airports.

This will be the flight segment of the SpaceLand program, in synergy with its ground segment "SpaceLand City": this latter will be a novel Space-themed mixed-use holistic business & residential green settlement, welcoming laypersons and space program stakeholders interested to work and live in a clean-energy-powered urban marvel featuring a unique "Space-immersive" business & life-style.

In Mauritius, the envisaged palm-tree-beach-facing smog-free urban ambience is set near tropical lagoons and will also generate extra benefits such as low-taxation and fiscal residence permits for smart-working and living in FATF-white-listed breath-taking paradise country, near state-of-the-art micro-G R&D facilities within a Mars-inspired techno-park.

The City's breakthrough Near-Zero-Energy-Buildings (NZEB) will feature eco-sustainable systems derived from Mars-bound housing solutions being developed by SpaceLand and showcased in the nearby SpaceLand Center; here, Space STEAMM business (Science, Technology, Engineering, Arts, Math and Medicine) will be facilitated through Research, Education and Training programs hinging on ad-hoc designed low-gravity ground and underwater facilities, labs, emulators and infrastructures at the edge of science-fiction.

Such elements will be hosted inside Mars Habitat technology demonstrators erected using building methods and local materials as per circular economy & ISRU policies (In Situ Resources Utilization): this will also kick-start both a new housing construction industry and a new *cult architecture* maximising the healing power of nature as well as almost zeroing city maintenance costs, pollution and unhealthy electromagnetic radiation levels, while showcasing what Space-spun-off alternatives might do to replace squalid metallic-plastic bidonvilles world-wide.

All this will be synchronized with operational flight campaigns twice per year on the *world's largest narrowbody aircraft* taking off from the local airport, exclusively utilized by SpaceLand to democratize access to microgravity, thanks to flight systems providing the *best quality of zero-G levels* in the *longest cabin* and with the *cheapest price tag ever*.

SpaceLand senior engineering team, including structures, aerospace experts and architects teaching at prestigious

universities, in synergy with reknown construction companies, will master such a disruptive flight & ground endeavour, capitalizing on the group's long-term expertise: this latter ranges from developing top-level real estate and restructuring most valuable high-tech buildings (such as the Chapel hosting Christ's Holy Shroud) to designing Olympic Games' facilities and technically managing European, Russian and International Space Station programs, correlated astronaut training activities and microgravity R&D flights involving kids, elderly and disabled for the first time, since the year 2005.

Such a multi-faceted endeavour, providing in 5 years a ROI more than 10 times the investment, will boost a post-COVID-19 *socio-economic renaissance* in the respective regions, onsetting a new Microgravity Economy which can benefit all social layers, generating respectively the first *tropical Island of Space* and the *first Alpine Space Village*. Stakeholders and investors can get involved through www.SpaceLand.it



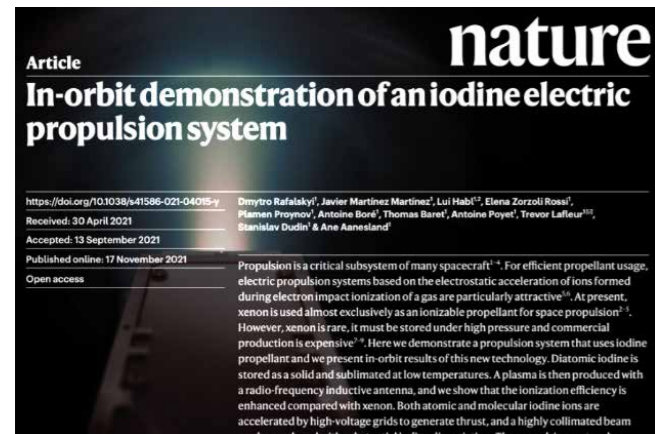
THRUSTME

ThrustMe has successfully tested the first iodine-fuelled electric propulsion system in space and results of this historic demonstration have been published in one of the leading scientific journals, Nature. These results confirm for the first time that iodine is not only a viable alternative to conventional xenon propellant, but that it also enables extreme propulsion system miniaturization. This provides small satellites with new maneuvering and space exploration potential, and critical new collision avoidance and deorbiting capabilities that will prove vital for the long-term sustainability of the space industry.

"Iodine is significantly more abundant and cheaper than xenon, and has the added advantage that it can be stored unpressurized as a solid", says Dmytro Rafalskyi, CTO and co-founder of ThrustMe. This enables significant simplification and

miniaturization of propulsion systems. “ThrustMe has developed a revolutionary propulsion system, the NPT30-I2, which includes all needed subsystems and fits within a 1U single package” says Dmytro. Comparison with xenon shows that iodine gives an almost 50% performance enhancement.

“Publication of these historic results is not only important for ThrustMe, but also for the space industry in general” says Ane Aanesland CEO and co-founder of ThrustMe. “Many new companies have entered the market in recent years but demonstrated evidence of flight heritage and performance transparency are missing. Having our results peer-reviewed and publically accessible provides the community with further confidence and helps to create a benchmark within the industry”. The article is currently in the top 5% of all research outputs ever tracked by Altmetric, leading provider of research metrics to scholarly publishers, funders and institutions as Nature Publishing Group and Elsevier.



ISRO established a dedicated Control Centre for SSA activities

The Indian space programme always has placed high importance on spaceflight safety in all its endeavours. ISRO has been in the forefront in preserving the long term sustainability of outer space through well-defined Space Situational Awareness (SSA) activities. Recognising the importance of SSA in ever growing space sector and reliance on space applications for national development, a dedicated Control Centre is established at Bangalore, India to coordinate all SSA activities. The control centre houses state-of-the-art facilities to conduct R&D activities pertaining to modelling and analysis of space debris, near Earth objects, space weather and space environment.



ISRO SSA Control Centre is envisioned to function as a hub of activities to safeguard Indian space assets and to effect dedicated efforts to comply with the International guidelines on space debris mitigation. The activities include close approach alert services; design, planning, and execution of collision avoidance manoeuvre; analysis of the impacts of growing space objects environment and the large constellations in LEO. It serves as the nodal data centre for the observational data from ISRO's space object tracking facilities and optical devices. The control centre has provisions to process and fuse observation data from space object tracking facilities for orbit determination, object correlation and catalogue generation. ISRO has plans to setup network of observational facilities for carrying out more accurate SSA analysis for collision avoidance and mitigation procedures. As an initial attempt in this direction, Network of space object and TRacking (NETRA) project undertakes the establishment of a multi object tracking radar for LEO object tracking and an optical telescope for GEO object observations.

ISRO SSA Control Centre is also engaged in framing space debris mitigation policies and procedures for India; collaboration with other space agencies including coordination of spacecraft operators towards effective close approach risk mitigation; engaging with national and international bodies on various aspects of Space traffic management; and active participation in Inter Agency Space Debris Coordination Committee.



SPACE WEEK was held at Expo 2020 Dubai from October 17-23 as part of the thematic weeks dedicated to the global challenges of humanity. Within the framework of EXPO 2020 Space Week the The State Space Agency of Ukraine organized a presentation event “Space Activities of Ukraine”. The event took place in Ukraine Pavilion, EXPO 2020 Opportunity District, Dubai, UAE. The agenda included speech of Volodymyr Taftai, State Space Agency of Ukraine Head, and a series of thematic presentations of Ukrainian space sphere enterprises. There was great interest in the presentation of the Serhii Korolyov National Museum of Cosmonautics. Irina Dyachuk, General Director of the museum, presented the museum's strategy for international partnership. The participation in SPACE WEEK EXPO2020 became the basis for the future joint programs, projects and agreements in the field of cultural diplomacy, innovative exhibition technologies, popularization of space exploration.



AIRBUS

Bartolomeo serves as observation platform for African climate project 'ClimCam'

Airbus and UNOOSA offer a free ride on the ISS

In the near future, 'ClimCam', a three-country African project, will be able to observe the continent's environment and climate from the Bartolomeo platform on the International Space Station (ISS), thanks to UNOOSA and Airbus.

Mid-October UNOOSA, the United Nations Office for Outer Space Affairs and Airbus Defence and Space announced the winner of their joint opportunity during IAC Dubai for a free one year mission aboard the ISS. The winning 'ClimCam' team consists of specialists from three nations: Egypt, Kenya and Uganda have partnered to observe climate change effects in East Africa.

Jointly, the 'ClimCam' team will develop a remote sensing camera system, to monitor weather, floods, and impacts of climate change in East Africa. The three nations have agreed to an open data policy, sharing information and images acquired from the project to guide climate change mitigation efforts across the entire region. In addition to its direct goals, the project will also

demonstrate space technology developments made in Africa, inspiring African engineers and scientists.

The climate mission supporting the UN's Sustainable Development Goals will fly on Bartolomeo, the Airbus external payload hosting platform on-board the ISS. Bartolomeo enables the hosting of external payloads in low-Earth orbit. Application areas include Earth observation, robotics, material science or astrophysics. Payloads can be hosted for institutional and commercial organisations alike. Operated in a 400-km orbit the Bartolomeo platform offers unobstructed view towards Earth as well as into outer space.



Societies have to be engaged at large, at layperson's level, in microgravity STEMM (Science, Technology, Engineering, Math, Medicine) to facilitate people's understanding of the cultural and socio-economic importance of standing at the vanguard of the Space Economy, which in turn helps to safeguard our Earth. A centralized multi-disciplinary, immersive location open to all citizens to prepare for this can best cater for such needs: thereby, people and hardware can also be readied for actual low-gravity STEMM projects to fully grasp correlated implications benefitting humankind's daily lives: users' engagement by hand-

on emulation of astronauts' weightless activities, for instance, might ease the comprehension of the outstanding relevance of microgravity STEMM and planetary exploration for the future of humankind.

In this light, the SpaceLand group's program is being expanded in Switzerland, in synergy with a similar development in Africa (ref. speech given by the former Head of State of Mauritius at previous IAF/UNOOSA events, on <https://youtu.be/2RthuFMcdfg>). Focused on low-gravity R&D and edutainment programs for the general public, the SpaceLand's "virtuous system" is getting unfolded to benefit all social layers of population in Canton Ticino, thanks to newly designed ground, underwater and flight facilities being utilized also for the SpaceLand Center being developed in Africa.

The program triggers highly-skilled careers, discoveries and spin-offs, inspiring the elderly and all young generations for a novel post-COVID approach to life: the former, appreciating how Space can help fundamental R&D projects on, e.g., regenerative biomedicine and nutrition (this also entails understanding the need for weightless three-dimensional pharmacodynamics related to macro-molecular compounds e.g. large proteins otherwise flattened by gravity in normal laboratories, also to best study long-term effects of drugs and vaccines on human cells); the latter, pursuing long-term jobs in cutting-edge STEMM within such synesthetic "space-station-like" destinations. The SpaceLand Centers will enable the general public to experience the Space "real thing" even without being the "right stuff": in the respective territories, such microgravity hubs will also become a reference site for eco-friendly high-tech industry, research institutions, academia and schools. Differently from recent billionaires-funded sub-orbital joyrides, SpaceLand's ground, underwater and flight infrastructures are not confined to the high-end VIP's entertainment world, rather they target at opening Space really to everybody. Near the beautiful lakes in the cradle of the Italian Swiss mountains, this game-changing program is being conceived with local authorities to create the 1st Alpine Valley of Space Economy.

Differently from the Mars Habitat designed in Mauritius to serve as a unique construction technology demonstrator to host some of the SpaceLand facilities, the Swiss version of the Center matches the features of a prestigious historical Palace provided by public entities, where gravity will remain a factor: from G-induced hydro-electric power generation, which the chosen site was built for in the early 1900's, to G-reduction thanks to proprietary systems and environments. Adjacent to runways for the flight segment of the program and served by the Lugano-Zurich highway and railways, such a transformative cluster of ground and flight low-G STEMM research and educational facilities de facto also jump-starts low-cost Aerospace tourism: people will get to know, hand-on learn about, discover and even participate to first series of Mars-G & Moon-G STEMM R&D and educational flight missions, starting next year, on the world's largest narrowbody flight vehicle. The program enshrines 20 years of activities with records set at NASA:

thereby, SpaceLand converges all its assets, know-how, global brand and design solutions in such breathtaking locations, namely its tropical version in Mauritius and the alpine one in Ticino, to best follow on its own legacy at NASA (www.spaceref.com/news/viewpr.html?pid=22537): practising within own microgravity training camps world-wide, since 2002 the SpaceLand engineering team selects, prepares on ground and underwater, and flies STEMM payloads and people as young as 11, as old as 93 years of age, including the first 100% disabled woman (first flight back in 2005, with the first group of non-U.S. individuals flying weightless from the U.S. Space Shuttle landing site). Experiments will follow on research conducted also for teams led by a Nobel Prize winner (https://en.spaceland.it/media-amp-events/mass-media-on-stem/a-kid-in-weightlessnessfor-alzheimer/c_19): the payload manifest will include healthy-lifetime-extension biomed R&D, hand-free ICT technology testing for both astronauts and disabled persons, as well as investigations showcasing novel housing construction methods & materials for Mars-bound ISRU (In Situ Resources Utilization) which also address the need for more saluber alternatives to plastic-metallic bidonvilles world-wide.



Such "novel knowledge hubs" in Europe and in Africa can indeed democratize Space-STEMM for societies and citizens, striving to ameliorate our planet while also preparing to explore others. International stakeholders are welcome ! More info on www.SpaceLand.it



Europe's first polar-orbiting weather satellite successfully deorbited

On 30 November, Europe's first meteorological satellite in polar orbit, [Metop-A](#), was successfully deorbited by Europe's meteorological satellite agency, EUMETSAT, with support from Airbus.

The satellite will now spiral downward in progressively lower orbits until it disintegrates upon re-entering the Earth's

atmosphere, a process that is expected to end within the next 25 years, in accordance with international standards on space debris mitigation.

During the deorbiting process, an original experiment was run: the satellite performed a manoeuvre in which it flipped upside-down so that the instruments that normally scanned the Earth instead scanned deep space.

The data acquired during this manoeuvre will lead to an improved calibration of the monitored environment, providing a new baseline for data processing which can be applied retrospectively to all Metop data already received, as well as to new data from the entire lifetimes of the two remaining satellites in the [EUMETSAT Polar System](#), Metop-B and Metop-C

When Metop-A was launched, it was loaded with significantly more fuel than ended up being necessary to power the satellite for its expected lifetime of five years. Because of this, the satellite was able to continue to collect and transmit crucial weather data for fifteen years, three times longer than initially anticipated.



Astralintu Space Technologies is a pioneer Latin American startup founded in 2020 with the support of the Ecuadorian Civilian Space Agency (EXA). Astralintu specializes in in-orbit satellite mission services with the goal of facilitating access to space without the need of developing missions from scratch or having an in-house space program.

Astralintu offers two main services: FullSat missions and SharedSat missions. Both services include planning, payload integration, testing, certification, launch procurement, frequency allocation, and more.



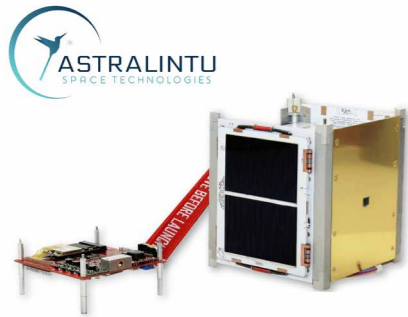
IAF Members' Corner

Astralintu is on track to deploying its pilot mission in Q2 2023 flying our in-house developed and customer-provided payloads. Official mission announcement will happen during the Joint 3rd IAA Latin American Symposium on Small Satellites and the 5th IAA Latin American CubeSat Workshop in Quito, Ecuador in March 2022.

With state-of-the-art technology and personalized support, Astralintu will ensure the clients' payloads will achieve the required mission objectives.



Orbital Deployment SERVICE



SharedSat SERVICE



FullSat SERVICE



IAF Members' Corner

INTERNATIONAL ASTRONAUTICAL FEDERATION

PROUD MEMBER

Plans and Expectations by IAF Vice President for Agency Relations and Global Membership Development: Lisa Campbell



Building on the IAF's theme of a space-faring world cooperating for the benefit of humanity, and its unique ability to bring government, industry, academia and non-profit sectors together, Ms. Campbell will work to increase membership by 10%. The diversity of the international space community makes us stronger and she will focus on enhancing the participation of newer and emerging space agencies from around the world. Beginning with the Western Hemisphere, including North America, Latin America and the Caribbean, Ms. Campbell will recruit members globally. As President of the Canadian Space Agency, she will heighten awareness of the IAF in the rapidly growing Canadian space sector.

Ms. Campbell is President of the Canadian Space Agency (CSA). With the brilliant CSA team, she promotes the sustainable and peaceful exploration of space, advancing space science and technology for the benefit of humanity. Previously, Ms. Campbell was Associate Deputy Minister, Veterans Affairs, supporting the wellness of veterans and promoting recognition of those who served Canada. She was Assistant Deputy Minister, Defence and Marine Procurement, leading the organization procuring Canada's military and marine equipment. Ms. Campbell was Senior Deputy Commissioner at Canada's competition authority, responsible for reviewing mergers and business conduct. She also enforced civil and criminal laws for truth in advertising. Ms. Campbell has done extensive regulatory work on the collection and trade in data, particularly in emerging business models. She worked as a litigator in the areas of criminal, employment and constitutional law. Ms. Campbell holds a B.A in political science from McGill University (1988) and an LL.B. from Dalhousie Law School (1991).

Plans and Expectations by IAF Vice President for the IAF Global Networking Forum: Steve Eisenhart



Steve Eisenhart is Senior Vice President – Strategic & International Affairs for Space Foundation, a U.S. based non-profit, non-governmental organization offering a gateway to education, information and collaboration. He is principally responsible for the Space Foundation's global strategy, as well as the organization's relationships with international space agencies and organizations, foreign embassies, and other bodies involved with global space programs. He is directly responsible for the program development and integration of key Space Foundation activities including the annual Space Symposium. Steve and his wife Pam are avid travelers when not enjoying the outdoor Colorado lifestyle.

I am excited to join the IAF Bureau and to assume the portfolio of the Global Networking Forum. This program provides a vital platform to share knowledge and networking. I see the GNF as serving a particularly important role for organizations of all sizes to meet, share and connect. I hope to continue to evolve the GNF to serve all of our space community in advancing our '3G Diversity' with a strong emphasis on young professionals and emerging space participants. As a complement to IAC Plenary and Technical Sessions, the GNF offers a unique opportunity to provide varied and 'up to the minute' programming for all of our stakeholders.

Plans and Expectations by IAF Vice President for the Education and Workforce Development: Davide Petrillo



Davide has currently been appointed as Executive Director of the Space Generation Advisory Council (SGAC). Davide holds a M.Sc. in Aerospace Engineering from the University of Padova (Italy). His professional experience brought him to London (UK) as a Business Manager for Alten Ltd and previously in Milano (Italy) as a Business Analyst for Accenture, global management consulting company that provides strategy, consulting, technology and operations services. Previously, he was the Team Leader of FELDs Experiment selected by the European Space Agency (ESA) for the Drop Your Thesis! 2014 programme. FELDs tested a tethered electromagnetic soft docking technology in microgravity conditions at the Drop Tower of the Centre of Applied Space Technology and Microgravity (ZARM) in Bremen, Germany. In 2015, he won the "Hans Von Muldau Team Award" for the best team project that took place in Jerusalem at the 66th International Astronautical Congress (IAC). Davide joined SGAC in 2016 and has been appointed as part of the 3rd E-SGW organizing team, the SGC 2018 organizing team specifically focused on the organization and management of the Special Track "Bridging the Space Divide" Working Group, Space Generation Congress 2019 Deputy Manager (Washington D.C., USA) and Space Generation United Manager.

Plans and Expectations by IAF Vice President for the Technical Activities: Lionel Suchet



Early in his career Lionel Suchet focused on human spaceflight, first in charge of safety and human factors and then as Project Leader for five human spaceflight missions, during which time he also worked to set up the CADMOS centre for the development of microgravity applications and space operations at CNES.

He subsequently oversaw all of CNES's orbital systems projects before being appointed Deputy Director of the Toulouse Space Centre (CST). At the start of 2016, he created the agency's Directorate of Innovation, Applications and Science, which he headed. Mid-2017, he was appointed Chief Operating Officer of CNES.

Technical activities are a core component of what the Federation does. IAF congresses have earned world renown for the quality of their technical sessions, and this degree of technical excellence absolutely must be preserved.

At the same time, domains of expertise are diversifying and increasing numbers of new players are emerging. This is excellent news, but it is also compelling us to find the best trade-off between addressing new topics, the growing number of submissions and the time needed for those selected to present their papers adequately. Thanks to the excellent work accomplished within the TAC, I am putting myself forward to help resolve this complex and exciting equation.



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The next IAF newsletter will be issued in March 2022