

# 68<sup>th</sup> IAC

International Astronautical Congress

ADELAIDE, AUSTRALIA

25 - 29 SEPTEMBER 2017

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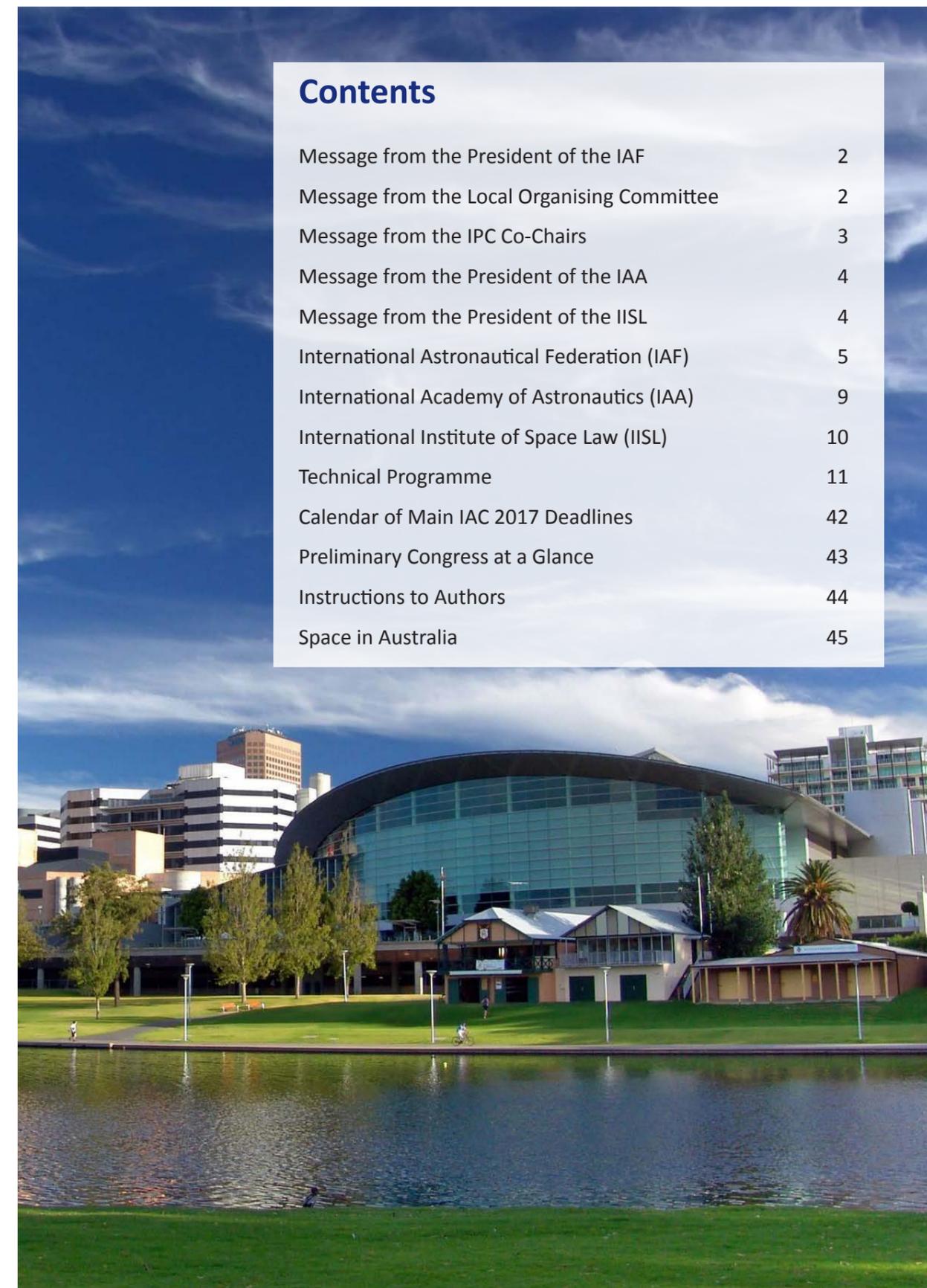


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## Message from the President of the IAF

It is with great pleasure that we invite you to attend the 68<sup>th</sup> International Astronautical Congress in Adelaide, Australia.

The IAC is returning to Australia for the second time, previously in year 1998 the 49<sup>th</sup> IAC was held in Melbourne.

Our Australian host, the Space Industry Association of Australia (SIAA) is already working hard to prepare an excellent programme with a variety of events and activities which we are sure will impress you. Adelaide is the capital city of South Australia, which is a region that has a lot to offer. Besides the rich culture and spectacular landscapes, it is growing as an international hub of innovation and Adelaide is proving to be a vibrant city with a strong entrepreneurial spirit.

We are confident that, together with the dedicated work of the Local Organising Committee and partner organisations, the IISL and the IAA, the 68<sup>th</sup> IAC will be a great success and one to long remember!

We look forward to seeing you in Australia, the land down under!



**Kiyoshi Higuchi**  
*President*  
*Former Senior Vice President,*  
*Japan Space Exploration*  
*Agency (JAXA),*  
*Japan*



**Jean-Yves Le Gall**  
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*Centre National d'Etudes Spatiales*  
*(CNES),*  
*France*

## Message from the Local Organising Committee

IAC2017 in Adelaide Australia is structured around the theme *Unlocking Imagination, Fostering Innovation and Strengthening Security*. These three ideas capture the essence of human involvement with the space environment in the 21<sup>st</sup> Century. The space environment is harsh and near earth space is fragile. The interests of all nations and people with respect to access to space can only be met if that access is safe and assured. Technical political and policy challenges must be overcome for this end state to be achieved. Technological innovations, notably the increasing reach of the internet and miniaturization, are combining to reduce barriers of entry to space and to encourage entrepreneurs to develop space-based businesses that could not be contemplated even a decade ago.

Australia has responsibilities for land and ocean areas that account for nearly 15% of the world's surface. We make extensive use of satellite communications, global timing and navigation systems and earth observation data to meet our sovereign prerogatives and to fulfill our obligations under international law. Space cooperation with regional nations is increasing and we continue to value our long-standing relationships with partners in North America and Europe. Australia is making substantial investments in developing capabilities in space-based communications, space situational awareness, and space-based remote sensing. Industry is expected to play an increasingly important role in these developments. Your hosts, the Space Industry Association of Australia are determined to place further emphasis on B2B interactions at IAC2017 in Adelaide. We also plan to showcase the importance of Science, Technology, Engineering and Mathematics (STEM) education as pathways to careers that are essential to the modern global economy. We invite all members of the space community to attend only the third IAC to be held south of the Equator and only the second to be held in Australia from 25-29 September next year.



**Brett Biddington**  
*Chief Executive Officer*  
*Local Organising Committee*

## Message from the IPC Co-Chairs

It is with great pleasure that we invite you to submit an abstract for the 68<sup>th</sup> International Astronautical Congress to be held in Adelaide, Australia.

The IAC brings together the leaders and innovators of the space industry and the technical program is a platform to showcase the latest research. There are few conferences where you will find such diversity and quality, covering space science, engineering, economics, policy, law, education and history. All abstracts are peer reviewed and a limited number of papers will be selected for publication in Acta Astronautica.

Australia has a long involvement in the space industry. In 2017 it will be 50 years since Australia launched its first satellite from Woomera in South Australia. Since then Australia has been active in space research, developed a sophisticated user community for space-derived products and services, launched its own satellites, developed instruments and components that have flown on international missions, and supported international missions through the Canberra Deep Space Communication Complex and other ground stations. The Australian Geoscience Data Cube represents a new paradigm in analysing and providing public access to space-based crucial datasets: for the first time internationally an entire continent's environmental attributes have been made available through the Australian Space Research Program.

IAC2017 will look to the future of the industry. Under the theme of "Unlocking Imagination, Fostering Innovation and Strengthening Security" the congress will present excellence in research and the translation of this research into commercial products and services through traditional methods and expanding entrepreneurial activity. It will consider the development of a skilled future workforce and the importance of preserving the space environment. Most importantly it will be an opportunity to expand existing international collaboration and explore new opportunities.

We hope that with more than 180 technical sessions to choose from you will find the perfect platform to present your research and network with your peers. We encourage you to use everything the IAC in Adelaide has to offer to develop new collaborative relationships and stimulate future projects that you can then share with the community the following year when the IAC is held in Bremen.



**Naomi Mathers**  
*IPC Co-Chair*  
*Advanced Instrumentation and*  
*Technology Centre (AITC),*  
*Australia*



**Christiane Schmillius**  
*IPC Co-Chair*  
*Friedrich-Schiller-University (FSU),*  
*Germany*



### Message from the President of the International Academy of Astronautics



The International Academy of Astronautics (IAA) is pleased to invite you to attend the IAA Academy Day on Sunday and the IAA symposia throughout the week.

In addition to organizing around 20 conferences a year, worldwide, the Academy is organizing 13 symposia at this year's IAC in Adelaide, Australia, representing one third of the IAC program, and will co-host some thrilling sessions with the IAF and the IISL.

**Peter Jankowitsch**  
*President of the International Academy of Astronautics*



### Message from the President of the International Institute of Space Law



On behalf of the International Institute of Space Law, I am pleased to invite you to attend our 60<sup>th</sup> Colloquium on the Law of Outer Space in Adelaide. This year's Colloquium places a special focus on the 50<sup>th</sup> anniversary of the Outer Space Treaty, and discusses its main principles in the context of each individual dedicated IISL session.

Relevant legal questions raised by current public and private space activities will be addressed and debated by the world's finest space lawyers as well as students and young professionals.

IISL will also co-host sessions with the IAF and the IAA, and the 32<sup>nd</sup> IAA-IISL 'Scientific-Legal Roundtable' will provide an opportunity for lawyers, scientists and engineers to jointly tackle a subject in an interdisciplinary setting.

The World Finals of the 26<sup>th</sup> Manfred Lachs Space Law Moot Court Competition will take place in Adelaide, welcoming university students from Africa, the Asia Pacific, Europe and North America, and will as always be judged by sitting members of the International Court of Justice.

The IISL is proud to contribute in a significant way to the success of the IAC, and we are greatly looking forward to welcoming you in Adelaide!

**Kai-Uwe Schrogel**  
*President of the International Institute of Space Law*



## International Astronautical Federation (IAF)

Founded in 1951, the International Astronautical Federation is the world's leading space advocacy body. The IAF has over 300 members in over 66 countries, including all leading space agencies, companies, societies, associations and institutes worldwide.

Following its theme - "A space-faring world cooperating for the benefit of humanity" - the Federation advances knowledge about space and fosters the development and application of space assets by advancing global cooperation.

As organiser of the annual International Astronautical Congress (IAC), and other meetings on specific subjects, the IAF actively

encourages the development of astronautics for peaceful purposes and supports the dissemination of scientific and technical information related to space.



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SSC	Sweden	World Space Week Association	United States
Starsem	France	Wyle	United States
State Enterprise Production Association Kyivprylad	Ukraine	X PRIZE Foundation	United States
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## International Academy of Astronautics (IAA)

The international community of leading experts committed to expanding the frontiers of space, the newest realm of human activity. To foster the development of astronautics, the Academy undertakes a number of activities, including the recognition of outstanding contributors through elections and awards. It also facilitates professional communication, develops and promotes new ideas and initiatives, engages the public and fosters a sense of community among the members. The IAA is a unique non-governmental organisation established in 1960 and recognized by the United Nations in 1996.

It is an honorary society with an action agenda. With 1200 elected members and corresponding members from 87 nations, it works closely with space agencies, industry, the academic community and the national science and engineering academies to determine needs and objectives and to help shape policy and forge cooperation by means of studies, position papers, conferences and publications. The IAA has published nearly 60 studies to date and is engaged in the preparation of 40 others. The Academy also publishes the journal Acta Astronautica containing refereed papers.

The Academy now organizes 20 conferences per year and regional meetings focused on the development and promotion of new

initiatives. This activity also includes, in cooperation with the International Astronautical Federation and the International Institute of Space Law, the traditional contribution to the International Astronautical Congress (IAC), where the Academy sponsors 13 Symposia. The Academy also continues to enjoy its participation in the COSPAR Assemblies by sponsoring and co-sponsoring symposia and the International Society for Photogrammetry and Remote Sensing (ISPRS) congress this year in Prague. Although the IAA has many connections to these and other similar organizations, it is distinctive as the only international Academy of elected members in the broad area of astronautics and space.



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## International Institute of Space Law

Founded in 1960, the International Institute of Space Law (IISL) is an independent non-governmental organisation dedicated to fostering the development of space law. The membership of the Institute is composed of individuals and institutions from more than forty countries, elected on the basis of their contributions to the field of space law or other social sciences related to space activities. Additionally, prospective membership is open to students and young professionals with a demonstrated interest in space law.

Since 1992, the IISL has organized the annual Manfred Lachs Space Law Moot Court Competition. The competition is based on a hypothetical space law case, and is written by IISL members. Approximately sixty student teams from universities in Africa, the Asia Pacific, Europe, and North America participate. The competition is an important part of the organisation's outreach programme, and is its principal mechanism for engaging future generations of space law experts. The regional champions compete in the World Finals, which take place at the IAC and are judged each year by judges of the International Court of Justice. This unique feature makes the Manfred Lachs Moot Court one of the most prestigious moot court competitions in the world.

The IISL is an officially recognized observer at sessions of the United Nations Committee on the Peaceful Uses of Outer Space, and its Scientific & Technical and Legal Subcommittees. In cooperation with the European Centre for Space Law (ECSL), the IISL organizes an annual space law symposium for the delegates and staff attending the sessions of the UNCOPUOS Legal Subcommittee. In addition the Institute organises a variety of conferences on space law throughout the year in locations all over the world. It publishes an annual volume of IISL Proceedings with papers and reports of all these activities during the year.



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## Introduction to the Technical Programme

Dear Colleagues,

It is with great pleasure that I share with you the opening Call for Papers to fill the technical program of the 68<sup>th</sup> International Astronautical Congress in Adelaide, Australia. Our colleagues "Down Under" are preparing a Congress to match any we have experienced before. I encourage you, your students, and your peers to submit abstracts for consideration by the various technical committees, to build a robust, high-quality, and relevant set of technical papers for our Congress.

We succeed on the basis of our exceptional technical depth, our breadth of subject matter related to space, and our ability to meet and exchange ideas with professionals from all over the globe. Returning to meet again under the beautiful sky of the southern hemisphere, not only do we have a chance to re-acquaint ourselves with some of the most fascinating parts of our local universe - the Southern Cross, the Magellanic Clouds, and more - we also have a chance to re-acquaint ourselves with each other, as we move forward together in the exploration of space, and its use for the benefit of all peoples everywhere.

I look forward to your abstract and participation in the IAC 2017!



**John Horack**  
*IAF Vice-President, Technical Activities And IAC Evolution*

## Technical Programme



### SCIENCE AND EXPLORATION

Systems sustaining missions, including life, microgravity, space exploration, space debris and SETI

- A1 SPACE LIFE SCIENCES SYMPOSIUM
- A2 MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM
- A3 IAA SPACE EXPLORATION SYMPOSIUM
- A4 46<sup>TH</sup> IAA SYMPOSIUM ON THE SEARCH FOR EXTRATERRESTRIAL INTELLIGENCE (SETI) - THE NEXT STEPS
- A5 20<sup>TH</sup> IAA SYMPOSIUM ON HUMAN EXPLORATION OF THE SOLAR SYSTEM
- A6 15<sup>TH</sup> IAA SYMPOSIUM ON SPACE DEBRIS
- A7 SYMPOSIUM ON FUTURE SPACE ASTRONOMY AND SOLAR-SYSTEM SCIENCE MISSIONS

Category coordinated by Maria Antonietta Perino, *Thales Alenia Space Italia, Italy*

#### A1

##### SPACE LIFE SCIENCES SYMPOSIUM

This symposium jointly organised by the International Academy of Astronautics (IAA) and the International Astronautical Federation (IAF) addresses all aspects of space life sciences research and practice in human and robotic spaceflight, from Low Earth Orbit (LEO) to the universe beyond, and from the Big Bang to the lives of future explorers on other planets of our solar system.

##### Coordinators

**Oleg Orlov**  
*SSC RF-Institute of Biomedical Problems RAS — RUSSIAN FEDERATION*

**Peter Graef**  
*Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) — GERMANY*

#### A1.1

##### Behaviour, Performance and Psychosocial Issues in Space

This session considers psychosocial, interpersonal, cultural, cognitive, sleep, circadian rhythm and human factors issues and countermeasures related to human spaceflight and space exploration.

##### Co-Chairs

**Nick Kanas**  
*University of California, San Francisco — UNITED STATES*

**Peter Suedfeld**  
*University of British Columbia — CANADA*

##### Rapporteur

**Gro M. Sandal**  
*University of Bergen — NORWAY*

#### A1.2

##### Human Physiology in Space

This session focuses on physiological effects of short- and long-duration spaceflight, and how this affects general health. Research into mitigation (countermeasures) of space effects are also included.

##### Co-Chairs

**Inessa Kozlovskaya**  
*State Scientific Center of the Russian Federation - Institute of Biomedical Problems of the Russian Academy of Sciences — RUSSIAN FEDERATION*

**Rupert Gerzer**  
*Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) — GERMANY*

##### Rapporteur

**Thais Russomano**  
*Microgravity Centre — BRAZIL*

#### A1.3

##### Medical Care for Humans in Space

This session focuses on medical care for astronauts including operational medicine aspects, countermeasure development and applications as well as needs for future care for astronauts during long term stays in space and missions to and on the Moon and Mars. A further focus will lie on medical care for passengers and operators of commercial suborbital and orbital space flights.

**Co-Chairs**

**Oleg Orlov**  
SSC RF-Institute of Biomedical Problems RAS —  
RUSSIAN FEDERATION

**Satoshi Iwase**  
Aichi Medical University — JAPAN

**Rapporteur**

**Hanns-Christian Gunga**  
Charité - University Medicine Berlin — GERMANY

**A1.4 The International Space Station in LEO and the Deep Space Habitat in Cis-Lunar Space as platforms for simulated Mars voyages**  
This session will discuss the sequential use of the ISS and DSH as platforms for preparation of future human flight to Mars. It will include discussions about all the possibilities to perform a preliminary dry run on the ISS to fully exploit the ISS features and flexibilities and to prepare for a natural progression into the DSH where a final dry run will be envisaged. It will also consider tests to be performed either at a lunar Lagrange point or in a distant retrograde lunar orbit with a lunar surface sortie after 6 months in weightlessness.

**Co-Chairs**

**John Charles**  
NASA Human Research Program — UNITED STATES

**Livio Narici**  
University of Rome - Tor Vergata — ITALY

**Rapporteur**

**Guenther Reitz**  
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) — GERMANY

**A1.5 Radiation Fields, Effects and Risks in Human Space Missions**  
The major topics of this session are the characterisation of the radiation environment by theoretical modelling and experimental data, radiation effects on physical and biological systems, countermeasures to radiation and radiation risk assessment.

**Co-Chairs**

**Guenther Reitz**  
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) — GERMANY

**Yai-Ping Mimi Shao**  
Florida Hospital Cancer Institute — UNITED STATES

**Rapporteur**

**Nicole Buckley**  
Canadian Space Agency — CANADA

**A1.6 Astrobiology and Exploration**  
A new era of space exploration will soon expand into a global endeavour to achieve highly ambitious goals such as establishing human bases on the Moon, journeys to Mars and the construction of new infrastructures in space. Astrobiology plays a key role in the strategic search for organic compounds and life on Mars and other planetary objects in our solar system and can provide support in the preparation of human exploration endeavours. The session invites papers of astrobiological content supporting future robotic and human exploration missions.

**Co-Chairs**

**Nicolas Walter**  
European Science Foundation — FRANCE

**Petra Rettberg**  
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) — GERMANY

**Rapporteur**

**Elizabeth Richard**  
Wyle — UNITED STATES

**A1.7 Life Support, habitats and EVA Systems**  
This session will address strategies, solutions and technologies in providing Life Support for finally human requirements during future deep space and planetary/lunar surface exploration as well as extreme environments in general. An important task of Life Support is the use of in situ resources. This research and technology development is of utmost interest also for Earth application.

**Co-Chairs**

**Klaus Slenzka**  
OHB System AG — GERMANY

**Liu Hong**  
Xi'an Aerospace Propulsion Institute — CHINA

**Rapporteur**

**Chiaki Mukai**  
Japan Aerospace Exploration Agency (JAXA) — JAPAN

**A1.8 Biology in Space**  
This session focuses on all aspects of biology and biological systems related to gravity in ground-based and space flight experiments as well as on topics not covered by other sessions of this symposium.

**Co-Chairs**

**Fengyuan Zhuang**  
Beihang University — CHINA

**Nicole Buckley**  
Canadian Space Agency — CANADA

**Rapporteur**

**Cora Thiel**  
University of Zurich — SWITZERLAND

**A1.1P Interactive Presentations**  
Authors with an abstract accepted for an interactive presentation will be asked to prepare slides and display them for the duration of the congress on plasma screens. Authors will be assigned to interactive sessions in which they must be near the plasma screens to engage in interactive discussions with other congress attendees.

**A2 MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM**

The objective of the Microgravity Science and Processes Symposium is to highlight and discuss the state of the art in microgravity (reduced-gravity) physical sciences and processes, as well as to prepare for future orbital infrastructure. Session topics cover all microgravity science disciplines (material science, fluid physics, combustion science, fundamental physics), current results and research perspectives, together with relevant technology developments.

**Coordinator**

**Nickolay N. Smirnov**  
Moscow Lomonosov State University — RUSSIAN FEDERATION

**Secretary**

**Anastassia Nikonova**  
Russian Academy of Sciences — RUSSIAN FEDERATION

**Vice-Coordinator**

**Gabriel Pont**  
Centre National d'Etudes Spatiales (CNES) — FRANCE

**A2.1 Gravity and Fundamental Physics**  
This session is devoted to the search of new fields of research in condensed matter physics and gravitational physics including cryogenic fluids, critical fluids, equivalence principle, atomic clock and plasma crystals.

**Co-Chairs**

**Antonio Viviani**  
Seconda Università di Napoli — ITALY

**Hanns Selig**  
ZARM - University of Bremen — GERMANY

**Rapporteur**

**Qi KANG**  
National Microgravity Laboratory, Institute of Mechanics, Chinese Academy of Sciences. — CHINA

**A2.2 Fluid and Materials Sciences**  
The main focus of the session is on perspective research fields in fluid and materials sciences, multi-phase and chemically reacting flows including theoretical modelling, numerical simulations, and results of pathfinder laboratory and space experiments..

**Co-Chairs**

**Nickolay N. Smirnov**  
Moscow Lomonosov State University — RUSSIAN FEDERATION

**Satoshi Matsumoto**  
Japan Aerospace Exploration Agency (JAXA) — JAPAN

**Rapporteur**

**Jean-Claude Legros**  
Université Libre de Bruxelles — BELGIUM

**A2.3 Microgravity Experiments from Sub-Orbital to Orbital Platforms**  
This session presents recent results of microgravity experiments from all disciplines using different microgravity platforms, including drop towers, parabolic aircraft, sounding rockets and capsules.

**Co-Chairs**

**Raffaele Savino**  
— ITALY

**Rainer Willnecker**  
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) — GERMANY

**Rapporteur**

**Peter Hofmann**  
OHB System AG - Munich — GERMANY

**A2.4 Science Results from Ground Based Research**

This session is focused on the results of ground based preparatory experiments from all disciplines.

**Co-Chairs**

**Antonio Viviani**  
Seconda Università di Napoli — ITALY

**Valentina Shevtsova**  
Université Libre de Bruxelles — BELGIUM

**Rapporteur**

**Nickolay N. Smirnov**  
Moscow Lomonosov State University — RUSSIAN FEDERATION

**A2.5 Facilities and Operations of Microgravity Experiments**

This session is devoted to new diagnosis developments, new instruments definition and concepts for the future, ground and flight operation (telescience, robotics, hardware & software).

**Co-Chairs**

**Gabriel Pont**  
Centre National d'Etudes Spatiales (CNES) — FRANCE

**Rainer Willnecker**  
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) — GERMANY

**Rapporteur**

**Satoshi Matsumoto**  
Japan Aerospace Exploration Agency (JAXA) — JAPAN

**A2.6 Microgravity Sciences Onboard the International Space Station and Beyond - Part 1**

Aimed at the presentation of results obtained from large orbital platforms, in particular the ISS, as well as preparation scenarios for further long term flight opportunities, this session includes description and performance of ground and in-orbit infrastructures.

**Co-Chairs**

**Bernard Zappoli**  
Centre National d'Etudes Spatiales (CNES) — FRANCE

**Peter Hofmann**  
OHB System AG - Munich — GERMANY

**Rapporteur**

**Angelika Diefenbach**  
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) — GERMANY

**A2.7 Microgravity Sciences Onboard the International Space Station and Beyond - Part 2**

Aimed at the presentation of results obtained from large orbital platforms, in particular the ISS, as well as preparation scenarios for further long term flight opportunities, this session includes description and performance of ground and in-orbit infrastructures.

**Co-Chairs**

**Angelika Diefenbach**  
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) — GERMANY

**Satoshi Matsumoto**  
Japan Aerospace Exploration Agency (JAXA) — JAPAN

**Rapporteur**

**Gabriel Pont**  
Centre National d'Etudes Spatiales (CNES) — FRANCE

**A2.IP Interactive Presentations**

Authors with an abstract accepted for an interactive presentation will be asked to prepare slides and display them for the duration of the congress on plasma screens. Authors will be assigned to interactive sessions in which they must be near the plasma screens to engage in interactive discussions with other congress attendees.

**Coordinators**

**Gabriel Pont**  
Centre National d'Etudes Spatiales (CNES) — FRANCE

**Qi KANG**  
National Microgravity Laboratory, Institute of Mechanics, Chinese Academy of Sciences — CHINA

**A3 SPACE EXPLORATION SYMPOSIUM**

This symposium covers the current and future robotic missions and material plans for initiatives in the exploration of the Solar System.

**Coordinators**

**Bernard Foing**  
ESA/ESTEC — The Netherlands

**Christian Sallaberger**  
Canadensys Aerospace Corporation — CANADA

**A3.1 Space Exploration Overview**

This Session covers Space Exploration strategies and architectures, as well as technology roadmaps. Papers of both national and international perspectives are invited, as are papers dealing with the emerging area of commercial space exploration activities.

**Co-Chairs**

**Christian Sallaberger**  
Canadensys Aerospace Corporation — CANADA

**Kathy Laurini**  
National Aeronautics and Space Administration (NASA) — UNITED STATES

**Rapporteurs**

**Keyur Patel**  
National Aeronautics and Space Administration (NASA)/ Jet Propulsion Laboratory — UNITED STATES

**Norbert Frischauf**  
— AUSTRIA

**A3.2A Moon Exploration – Part 1**

This session will address current and future lunar missions. The session will address orbital missions, robotic surface missions, as well as life sciences on the Moon, resource utilisation and preparatory activities for future solar system exploration.

**Co-Chairs**

**Bernard Foing**  
ESA/ESTEC — THE NETHERLANDS

**David Korsmeyer**  
National Aeronautics and Space Administration (NASA) — UNITED STATES

**Rapporteur**

**Nadeem Ghafoor**  
Canadensys Aerospace Corporation — CANADA

**Sylvie Espinasse**  
European Space Agency (ESA) — THE NETHERLANDS

**A3.2B Moon Exploration – Part 2**

This session will address current and future lunar missions. The session will address orbital missions, robotic surface missions, as well as life sciences on the Moon, resource utilisation and preparatory activities for future solar system exploration.

**Co-Chairs**

**Bernard Foing**  
ESA/ESTEC — THE NETHERLANDS

**David Korsmeyer**  
National Aeronautics and Space Administration (NASA) — UNITED STATES

**Rapporteurs**

**Nadeem Ghafoor**  
Canadensys Aerospace Corporation — CANADA

**Sylvie Espinasse**  
European Space Agency (ESA) — THE NETHERLANDS

**A3.2C**

**Moon Exploration – Part 3**

This session will address current and future lunar missions. The session will address orbital missions, robotic surface missions, as well as life sciences on the Moon, resource utilisation and preparatory activities for future solar system exploration.

**Co-Chairs**

**Bernard Foing**  
ESA/ESTEC — THE NETHERLANDS

**David Kormsmeier**  
National Aeronautics and Space Administration (NASA) — UNITED STATES

**Rapporteurs**

**Nadeem Ghafoor**  
Canadensys Aerospace Corporation — CANADA

**Sylvie Espinasse**  
European Space Agency (ESA) — THE NETHERLANDS

**A3.3A**

**Mars Exploration – missions current and future**

The planet Mars is being explored now and in the coming years with multiple robotic missions from a variety of nations. This session will cover current results from ongoing Mars missions and the designs for proposed Mars missions.

**Co-Chairs**

**Pierre W. Bousquet**  
Centre National d'Etudes Spatiales (CNES) — FRANCE

**Vincenzo Giorgio**  
Thales Alenia Space Italia — ITALY

**Rapporteurs**

**Amalia Ercoli Finzi**  
Politecnico di Milano — ITALY

**Cheryl Reed**  
The Johns Hopkins University Applied Physics Laboratory — UNITED STATES

**A3.3B**

**Mars Exploration – Science, Instruments and Technologies**

The planet Mars is being explored now and in the coming years with multiple robotic missions from a variety of nations. This session will cover science, instruments and technologies for Mars missions including expected experiments. Papers on any aspects of the search for evidence or extinct Martian life, and forward and backward contamination are particularly welcome.

**Co-Chairs**

**Pierre W. Bousquet**  
Centre National d'Etudes Spatiales (CNES) — FRANCE

**Vincenzo Giorgio**  
Thales Alenia Space Italia — ITALY

**Rapporteurs**

**Amalia Ercoli Finzi**  
Politecnico di Milano — ITALY

**Cheryl Reed**  
The Johns Hopkins University Applied Physics Laboratory — UNITED STATES

**A3.4**

**Small Bodies Missions and Technologies**

This session will present the missions and technological aspects related to the exploration of small bodies including a search for pre-biotic signatures.

**Co-Chairs**

**Stephan Ulamec**  
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) — GERMANY

**Susan McKenna-Lawlor**  
Space Technology (Ireland) Ltd. — IRELAND

**Rapporteurs**

**Marc D. Rayman**  
Jet Propulsion Laboratory - California Institute of Technology — UNITED STATES

**Norbert Frischauf**  
— AUSTRIA

**A3.5**

**Solar System Exploration**

This session covers robotic missions for Solar System exploration (inner and outer planets and their satellites, and space plasma physics) except the Earth, Moon, Mars, and small bodies covered in other sessions of this symposium. Papers covering both new mission concepts as well as the associated specific technologies are invited.

**Co-Chairs**

**Junichiro Kawaguchi**  
Japan Aerospace Exploration Agency (JAXA) — JAPAN

**Mariella Graziano**  
GMV Aerospace & Defence SAU — SPAIN

**Rapporteurs**

**Alain Ouellet**  
Canadian Space Agency — CANADA

**Charles E. Cockrell Jr**  
National Aeronautics and Space Administration (NASA) — UNITED STATES

**A3.1P**

**Interactive Presentations**

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**Coordinators**

**Bernard Foing**  
ESA/ESTEC — THE NETHERLANDS

**Christian Sallaberger**  
Canadensys Aerospace Corporation — CANADA

**A4**

**46<sup>TH</sup> IAA SYMPOSIUM ON THE SEARCH FOR EXTRATERRESTRIAL INTELLIGENCE (SETI) – THE NEXT STEPS**

This symposium organised by the International Academy of Astronautics (IAA) deals with the scientific, technical and interdisciplinary aspects of the search for extra-terrestrial intelligence (SETI) including a discussion of all kinds of contacts. The technical side is not limited to the microwave window, but includes also optical and any kinds of radiation. The interdisciplinary aspects include all societal implications, risk communication and philosophical considerations of any kind of discovery or contact.

**Coordinator**

**Claudio Maccone**  
International Academy of Astronautics (IAA) and Istituto Nazionale di Astrofisica (INAF) — ITALY

**A4.1**

**SETI 1: SETI Science and Technology**

All technical aspects involved in the search for extraterrestrial intelligence, including current and future search strategies.

**Co-Chair**

**Ian Morrison**  
Swinburne University of Technology — AUSTRALIA

**Michael Albert Garrett**  
University of Manchester — UNITED KINGDOM

**Rapporteur**

**Andrew Siemion**  
University of California / ASTRON / Radboud University — UNITED STATES

**A4.2**

**SETI 2: SETI and Society**

All aspects concerning the societal implications of extraterrestrial intelligence are considered, including public reaction to a discovery, risk communication and the possible.

**Co-Chair**

**Carol Oliver**  
University of New South Wales — AUSTRALIA

**Paul Davies**  
Arizona State University — UNITED STATES

**Rapporteur**

**Morris Jones**  
Independent Space Analyst — AUSTRALIA

**A4.1P**

**Interactive Presentations**

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**Coordinator**

**Claudio Maccone**  
International Academy of Astronautics (IAA) and Istituto Nazionale di Astrofisica (INAF) — ITALY

**A5**

**20<sup>TH</sup> IAA SYMPOSIUM ON HUMAN EXPLORATION OF THE SOLAR SYSTEM SYMPOSIUM**

This Symposium, organised by the International Academy of Astronautics (IAA), covers the strategic plans, architectural concepts and technology development for future human exploration of the Moon, Mars, Lagrangian Points and NEO's.

**Coordinators**

**Christian Sallaberger**  
Canadensys Aerospace Corporation — CANADA

**Maria Antonietta Perino**  
Thales Alenia Space Italia — ITALY

**A5.1**

**Human Exploration of the Moon and Cislunar Space**

This session will examine the scenarios and infrastructure required to support human exploration of the Moon and Cislunar space. Papers are invited to discuss technology roadmaps as well as interfaces to allow international cooperation.

**Co-Chairs**

**Michael Raftery**  
Boeing Defense Space & Security — UNITED STATES

**Nadeem Ghafoor**  
Canadensys Aerospace Corporation — CANADA

**Rapporteur**

**Marc Haese**  
DLR, German Aerospace Center — GERMANY

**A5.2**

**Human Exploration of Mars**

This session will examine the scenarios and infrastructure required to support human exploration of Mars and the moons of Mars. Papers are invited to discuss technology roadmaps as well as interfaces to allow international cooperation.

**Co-Chairs**

**Kathy Laurini**  
National Aeronautics and Space Administration (NASA) — UNITED STATES

**Maria Antonietta Perino**  
Thales Alenia Space Italia — ITALY

**Rapporteur**

**Norbert Frischauf**  
— AUSTRIA

**A5.3**

**Human and Robotic Partnerships in Exploration - Joint session of the Human Spaceflight and Exploration Symposia**

This session seeks papers on new systems and technologies for current human spaceflight and exploration programmes, and the role of human and robotic partnerships in areas such as onboard robotic assistants, habitat / infrastructure construction support, human mobility support systems (e.g. EVA mobility aids, rovers); and robotic precursor activities to human spaceflights for test, validation, and demonstration of systems. This session also welcomes papers considering how the roles of humans, machines and intelligent systems are likely to evolve in the coming years and the corresponding impact on complex mission design, implementation, and operations.

**Co-Chairs**

**Christian Sallaberger**  
Canadensys Aerospace Corporation — CANADA

**Juergen Schlutz**  
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) — GERMANY

**Rapporteur**

**M. Hempell**  
Hempell Astronautics Limited — UNITED KINGDOM

**A5.4**

**Joint-session: Space Transportation Solutions for Deep Space Missions**

This joint session will explore space transportation capabilities, existing or under study, for human space exploration missions, new science, programme architectures, technology demonstrations as well as the issues of scientific and political motivations and international cooperation. The session will also deal with worldwide needs, requirements and potential missions enabled by deep space transportation system.

**Co-Chairs**

**Charles E. Cockrell Jr.**  
National Aeronautics and Space Administration (NASA) — UNITED STATES

**Ernst Messerschmid**  
University of Stuttgart — GERMANY

**K. Bruce Morris**  
RUAG SPACE — SWEDEN

**Co-Chair**

**Yuguang Yang**  
China Aerospace Science & Industry Corporation (CASIC) — CHINA

**Gerhard Schwehm**  
European Space Agency (ESA) — SPAIN

**Steve Creech**  
National Aeronautics and Space Administration (NASA) — UNITED STATES

**A5.1P**

**Interactive Presentations**

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**Coordinators**

**Christian Sallaberger**  
Canadensys Aerospace Corporation — CANADA

**Maria Antonietta Perino**  
Thales Alenia Space Italia — ITALY

**A6**

**15<sup>TH</sup> IAA SYMPOSIUM ON SPACE DEBRIS**

This symposium organised by the International Academy of Astronautics (IAA) will address the complete spectrum of technical issues of space debris: measurements, modelling, risk assessment in space and on the ground, reentry, hypervelocity impacts and protection, mitigation and standards, and Space Surveillance.

**Coordinators**

**Christophe Bonnal**  
Centre National d'Etudes Spatiales (CNES) — FRANCE

**J.-C. Liou**  
National Aeronautics and Space Administration (NASA) — UNITED STATES

- A6.1 Measurements**  
This session will address advanced ground and space-based measurement techniques, related processing methods, and results characterization of orbital and physical properties of space debris.
- Co-Chairs**  
**Frank Di Pentino**  
*Integrity Applications Incorporated (IAI) — UNITED STATES*
- Thomas Schildknecht**  
*Astronomical Institute University of Bern (AIUB) / SwissSpace Association — SWITZERLAND*
- Rapporteur**  
**Heather Cowardin**  
*Jacobs Technology, ESCG — UNITED STATES*
- A6.2 Modelling and Risk Analysis**  
This session will address the characterization of the current and future debris population and methods for in-orbit and on-ground assessments. The in-orbit analysis will cover collision risk estimates based on statistical population models and deterministic catalogues, and active avoidance
- Co-Chairs**  
**Carmen Pardini**  
*ISTI-CNR — ITALY*
- Daniel Oltrogge**  
*Analytical Graphics, Inc. — UNITED STATES*
- Rapporteur**  
**Marlon Sorge**  
*— UNITED STATES*
- A6.3 Hypervelocity Impacts and Protection**  
The session will address passive protection, shielding and damage predictions. Shielding aspects will be supported by experimental and computational results of HVI tests. Use of HVI techniques for debris mitigation.
- Co-Chairs**  
**Frank Schaefer**  
*Fraunhofer - Institut für Kurzezeitdynamik, Ernst-Mach-Institut (EMI) — GERMANY*
- Norman Fitz-Coy**  
*University of Florida — UNITED STATES*
- Rapporteur**  
**Alessandro Francesconi**  
*University of Padova - DII/CISAS — ITALY*
- A6.4 Mitigation and Standards**  
This session will focus on the definition and implementation of debris prevention and reduction measures and vehicle passive protection. The session will also address space debris mitigation guidelines and standards that exist already or are in preparation at the national or international level.
- Co-Chairs**  
**Christian Cazaux**  
*Centre National d'Etudes Spatiales (CNES) — FRANCE*
- David Finkleman**  
*International Academy of Astronautics — UNITED STATES*
- Rapporteur**  
**Holger Krag**  
*European Space Agency (ESA) — GERMANY*
- A6.5 Space Debris Removal Issues**  
This session will address active removal techniques "ground and space based" and identify implementation difficulties and maturity of proposed technologies.
- Co-Chairs**  
**Fabio Santoni**  
*University of Rome "La Sapienza" — ITALY*
- Fabrizio Piergentili**  
*University of Rome "La Sapienza" — ITALY*
- Rapporteur**  
**Benjamin Bastida Virgili**  
*European Space Agency (ESA) — GERMANY*
- A6.6 Space Debris Removal Concepts**  
This session will address active removal techniques "ground and space based", review potential solutions and identify implementation difficulties.
- Co-Chairs**  
**Louisa Innocenti**  
*European Space Agency (ESA) — FRANCE*
- Nicolas Bérend**  
*Office National d'Etudes et de Recherches Aéropatiales (ONERA) — FRANCE*
- Rapporteur**  
**Gerrit Hausmann**  
*OHB System AG - Munich — GERMANY*
- A6.7 Operations in Space Debris Environment, Situational Awareness**  
This session will address the multiple aspects associated to safe operations in Space dealing with Space Debris, including operational assessment from observations, catalogue build-up and maintenance, data aggregation from different sources, relevant data exchanges standards and conjunctions analyses.
- Co-Chairs**  
**Juan Carlos Dolado Perez**  
*Centre National d'Etudes Spatiales (CNES) — FRANCE*
- T.S. Kelso**  
*Center for Space Standards and Innovation — UNITED STATES*
- Rapporteur**  
**Carsten Wiedemann**  
*Technische Universität Braunschweig — GERMANY*
- A6.8 (Joint session with Space Security Committee): Policy, Legal, Institutional and Economic Aspects of Space Debris Detection, Mitigation and Removal**  
This session will deal with the non-technical aspects of space debris detection, mitigation and removal. Policy, legal and institutional aspects includes role of IADC and UNCOPIUS and other multilateral bodies. Economic issues including insurance, financial incentives and funding for space debris mitigation and removal. The role of international cooperation in addressing these issues will be considered.
- Co-Chairs**  
**Serge Plattard**  
*European Space Policy Institute (ESPI) — AUSTRIA*
- Alexander Soucek**  
*Austrian Space Forum — AUSTRIA*
- Rapporteur**  
**Darren McKnight**  
*Integrity Applications Incorporated (IAI) — UNITED STATES*
- A6.9 Orbit Determination and Propagation**  
This session will address aspects of space debris orbit determination related to assessment of raw and derived data accuracy, optical measurements processing and modelling and risk analysis of space debris.
- Co-Chairs**  
**Heiner Klunkrad**  
*European Space Agency (ESA) — GERMANY*
- Moriba Jah**  
*Air Force Research Laboratory (AFRL) — UNITED STATES*
- Rapporteur**  
**Hugh G. Lewis**  
*University of Southampton — UNITED KINGDOM*
- A6.1P Interactive Presentations**  
Authors with an abstract accepted for an interactive presentation will be asked to prepare slides and display them for the duration of the congress on plasma screens. Authors will be assigned to interactive sessions in which they must be near the plasma screens to engage in interactive discussions with other congress attendees.
- Coordinators**  
**Christophe Bonnal**  
*Centre National d'Etudes Spatiales (CNES) — FRANCE*
- Darren McKnight**  
*Integrity Applications Incorporated (IAI) — UNITED STATES*
- Tetsuo Yasaka**  
*QPS Institute — JAPAN*

- A7 SYMPOSIUM ON FUTURE SPACE ASTRONOMY AND SOLAR-SYSTEM SCIENCE MISSIONS**  
The Symposium invites leaders from the science, space industry, and space-agencies community to share information, insights, and planning for future space missions in exoplanets, astronomy, space physics, fundamental physics, and outer-solar-system planetary science. The Symposium will comprise both invited talks and contributed papers in these four areas of scientific endeavor. For each, the Symposium solicits discussion of phenomena coming within our reach over the next decades; their enabling measurement and system technologies, including significant progress made by industry and research laboratories; mission concepts to implement such investigations, and corporate and space agency strategies to prioritize and invest in bringing them into reality.
- Coordinator**  
**Jakob van Zyl**  
*National Aeronautics and Space Administration (NASA) — UNITED STATES*
- A7.1 Space Agency Strategies and Plans**  
The first session includes invited talks by international space-agency division directors about their long-term views, priorities, and plans to implement developments and missions for the five fields (exoplanets, space astronomy, space physics, fundamental physics, and outer solar system planetary science). The mission scope ranges from flagship-class, large-class, medium-class, and small-class to smallsat platforms. The program scope includes status updates on current programs, near-term investment priorities, and long-range directions, including the relationship to community and guiding research panels.
- Co-Chairs**  
**Jakob van Zyl**  
*National Aeronautics and Space Administration (NASA) — UNITED STATES*
- Pietro Ubertini**  
*INAF — ITALY*
- Rapporteur**  
**Brent Sherwood**  
*Caltech/JPL — UNITED STATES*
- A7.2 Science Goals and Drivers for Future Exoplanet, Space Astronomy, Physics, and Outer Solar System Science Missions**  
The second session includes invited and contributed talks about scientific motivations, goals, opportunities, and needs in the five fields (exoplanets, space astronomy, space physics, fundamental physics, and outer solar system planetary science). New directions for measurements that are being opened by emergent results and newly understood phenomena will be explored, and science roadmaps to pursue them will be discussed.
- Co-Chair**  
**Brent Sherwood**  
*Caltech/JPL — UNITED STATES*
- Pietro Ubertini**  
*INAF — ITALY*
- Rapporteur**  
**Eric Wille**  
*ESA — THE NETHERLANDS*
- A7.3 Technology Needs for Future Missions, Systems, and Instruments**  
The third session includes invited and contributed talks about the technology challenges and plans required to enable breakthrough science objectives in: exoplanet detection and characterization; astronomy throughout the electromagnetic spectrum and using gravitational waves; space physics including fractional gravity regimes and heliophysics; fundamental physics including relativity; and outer solar system planetary science including gas giants, ice giants, complex planetary systems, primordial body populations, and ocean worlds. Topical focus includes measurement techniques, data types, performance requirements, instrument designs, mission concepts and systems, and associated technology developments.
- Co-Chairs**  
**Eric Wille**  
*ESA — THE NETHERLANDS*
- Jakob van Zyl**  
*National Aeronautics and Space Administration (NASA) — UNITED STATES*
- Rapporteur**  
**Brent Sherwood**  
*Caltech/JPL — UNITED STATES*



## APPLICATIONS AND OPERATIONS

On-going and future operational applications, including Earth observation, communication, navigation, human space endeavours and small satellites

**B1 EARTH OBSERVATION SYMPOSIUM**  
**B2 SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM**  
**B3 HUMAN SPACEFLIGHT SYMPOSIUM**  
**B4 24<sup>TH</sup> IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS**  
**B5 SYMPOSIUM ON INTEGRATED APPLICATIONS**  
**B6 SPACE OPERATIONS SYMPOSIUM**

Category coordinated by Otto Koudelka, Graz University of Technology (TU Graz), AUSTRIA

- B1 EARTH OBSERVATION SYMPOSIUM**  
The Earth Observation Committee covers all aspects of Earth observations from space, especially observations related to the Earth's environment and including mission planning, microwave and optical sensors and technologies, systems for land, oceanographic, and atmospheric applications, ground data-processing.
- Coordinators**  
**Andrew Court**  
*TNO — THE NETHERLANDS*
- Gunter Schreier**  
*Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) — Germany Eumetsat — GERMANY*
- B1.1 International Cooperation in Earth Observation Missions**  
Focus is on efforts being made by governments, agencies and society to achieve coordination, cooperation and compatibility in the development of space-based Earth observation systems. Presentations are encouraged which involve cooperative efforts with developing countries. Papers on current and ongoing missions involving coordination among commercial, government and other entities are especially encouraged.
- Co-Chairs**  
**John Hussey**  
*Consultant — UNITED STATES*
- Pierre Ranzoli**  
*Eumetsat — GERMANY*
- Rapporteur**  
**David Brent Smith**  
*National Oceanic and Atmospheric Administration (NOAA) — UNITED STATES*
- B1.2 Future Earth Observation Systems**  
Emphasis is on technical descriptions of planned and new space systems and missions for experimental and operational Earth observation. Descriptions of new concepts and innovative Earth observation systems are encouraged.
- Co-Chairs**  
**Alain GLEYZES**  
*Centre National d'Etudes Spatiales (CNES) — FRANCE*
- Timo Stuffer**  
*OHB System AG - Munich — GERMANY*
- Rapporteur**  
**Gunter Schreier**  
*Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) — GERMANY*



<b>B1.3</b>	<p><b>Earth Observation Sensors and Technology</b> Focus is on sensors now being developed or tested for all aspects of Earth observation. Particular emphasis is on new sensors, technologies, instruments or techniques that can provide either new measurements or improved data for science, operational or commercial applications.</p> <p><b>Co-Chairs</b> <b>Andrew Court</b> <i>TNO — THE NETHERLANDS</i></p> <p><b>Ralph Girard</b> <i>Canadian Space Agency — CANADA</i></p> <p><b>Rapporteur</b> <b>Yean Joo Chong</b> <i>National University of Singapore — SINGAPORE, REPUBLIC OF</i></p>
<b>B1.4</b>	<p><b>Earth Observation Data Management Systems</b> Focus is on Earth Observation Data Acquisition, Communication, Processing, Dissemination and Archiving systems and concepts. Presentation of International coordination and programmes - on data management-related systems - is also encouraged.</p> <p><b>Co-Chairs</b> <b>Gunter Schreier</b> <i>Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) — GERMANY</i></p> <p><b>James E. Graf</b> <i>National Aeronautics and Space Administration (NASA)/Jet Propulsion Laboratory — UNITED STATES</i></p> <p><b>Rapporteur</b> <b>Na Yao</b> <i>China Academy of Space Technology (CAST) — CHINA</i></p>
<b>B1.5</b>	<p><b>Earth Observation Applications and Economic Benefits</b> Focus is on using Earth Observation data to generate value-added products and services. Presentation of algorithms, processing software, value chains for science applications and commercial users are encouraged.</p> <p><b>Co-Chairs</b> <b>Luigi Bussolino</b> <i>Bussolino and Associates — ITALY</i></p> <p><b>Paul Kamoun</b> <i>Thales Alenia Space France — FRANCE</i></p> <p><b>Rapporteur</b> <b>Yean Joo Chong</b> <i>National University of Singapore — SINGAPORE, REPUBLIC OF</i></p>
<b>B1.6</b>	<p><b>Big Data, Data Cubes and new platforms to exploit large-scale, multi-temporal EO Data</b> Focus is on the new cloud and GIS-inspired software platforms and new operational/business models that allow users to exploit more the large datasets provided by the new generation of EO sensors more effectively. Around the world, space agencies and companies have launched or are developing missions with new, highly calibrated instruments that produce orders of magnitude increases in data volume and data quality. Coupled with this increase in volume is the need for rapid processing for current and emerging diverse applications like weather forecasting, wildfire incident command, coral reef and fisheries management. These vast new data sources need to be transformed and delivered in an affordable manner when existing approaches do not scale. How do we archive these valuable resources, how do we make them accessible and usable, how do we extract maximum value? How do we deal with the increasing burden of IT security? How do we grow this evolving economic sector of information suppliers? This session is asking for contributions on the latest trends in “big data” as it applies to Earth observations and innovations from leading thinkers and players across the value chain, producers and archivists to users and value-added suppliers.</p> <p><b>Co-Chairs</b> <b>Harry A. Cikanek</b> <i>National Oceanic and Atmospheric Administration (NOAA) — UNITED STATES</i></p> <p><b>Ralph Girard</b> <i>Canadian Space Agency — CANADA</i></p> <p><b>Rapporteur</b> <b>Wolfgang Rathgeber</b> <i>European Space Agency (ESA) — ITALY</i></p>
<b>B1.IP</b>	<p><b>Interactive Presentations</b> Authors with an abstract accepted for an interactive presentation will be asked to prepare slides and display them for the duration of the congress on plasma screens. Authors will be assigned to interactive sessions in which they must be near the plasma screens to engage in interactive discussions with other congress attendees.</p> <p><b>Coordinators</b> <b>Andrew Court</b> <i>TNO — THE NETHERLANDS</i></p> <p><b>Gunter Schreier</b> <i>Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) — GERMANY</i></p>
<b>B2</b>	<p><b>SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM</b> This symposium examines development in technology, applications and systems as they relate to fixed and mobile communication services, satellite broadcasting, position determination, navigation and timing, and interactive multimedia provisioning.</p> <p><b>Coordinator</b> <b>Manfred Wittig</b> <i>European Space Agency (ESA) retired — THE NETHERLANDS</i></p> <p><b>Otto Koudelka</b> <i>Joanneum Research — AUSTRIA</i></p>
<b>B2.1</b>	<p><b>Advanced Space Communications and Navigation Systems</b> Advanced satellite-based communication and navigation systems, including their architectures, infrastructure and applications are presented.</p> <p><b>Co-Chairs</b> <b>Amane Miura</b> <i>National Institute of Information and Communications Technology — JAPAN</i></p> <p><b>Morio Toyoshima</b> <i>National Institute of Information and Communications Technology — JAPAN</i></p> <p><b>Rapporteur</b> <b>Giovanni B. Palmerini</b> <i>Universita' di Roma 'La Sapienza' — ITALY</i></p>
<b>B2.2</b>	<p><b>Fixed and Broadcast Communications</b> Advances in Fixed and Broadcast Satellite Systems will be presented including Ku and Ka band multi-beam high throughput systems, VSAT and radio/television direct to users applications.</p> <p><b>Co-Chairs</b> <b>Desaraju Venugopal</b> <i>Devas Multimedia Pvt. Ltd. — INDIA</i></p> <p><b>Robert D. Briskman</b> <i>Sirius XM Radio — UNITED STATES</i></p> <p><b>Rapporteur</b> <b>Laszlo Bacsardi</b> <i>Hungarian Astronautical Society (MANT) — HUNGARY</i></p>
<b>B2.3</b>	<p><b>Mobile Satellite Communications and Navigation Technology</b> New and emerging technologies for land-mobile, aeronautical and maritime applications (covering different frequency bands), for personal satellite communications and for navigation will be presented.</p> <p><b>Co-Chairs</b> <b>Giovanni B. Palmerini</b> <i>Universita' di Roma 'La Sapienza' — ITALY</i></p> <p><b>Joe M. Straus</b> <i>The Aerospace Corporation — UNITED STATES</i></p> <p><b>Rapporteur</b> <b>Peter Buijs</b> <i>Netherlands Space Society (NVR) — THE NETHERLANDS</i></p>
<b>B2.4</b>	<p><b>Advanced Satellite Services</b> The communications, broadcast and navigation transmissions from satellites are used to provide services to users. Advanced services and applications will be presented including global internet, 4K and 3D video, data file compression, autonomous vehicle navigation and rural tele-education as well as tele-medicine.</p> <p><b>Co-Chairs</b> <b>Eva Maria Aicher</b> <i>Tesat-Spacecom GmbH &amp; Co. KG — GERMANY</i></p> <p><b>K.R. Sridhara Murthi</b> <i>NIAS — INDIA</i></p> <p><b>Rapporteur</b> <b>Enrique Pacheco Cabrera</b> <i>Agencia Espacial Mexicana (AEM) — MEXICO</i></p>

<b>B2.5</b>	<p><b>Space-Based Navigation Systems and Services</b> New and emerging systems for satellite-based position, navigation and timing will be presented, including end user applications.</p> <p><b>Co-Chairs</b> <b>Kristian Pauly</b> <i>OHB System — GERMANY</i></p> <p><b>Rita Lollock</b> <i>The Aerospace Corporation — UNITED STATES</i></p> <p><b>Rapporteur</b> <b>Norbert Frischauf</b> <i>QASAR Technologie(s) GmbH — AUSTRIA</i></p>
<b>B2.6</b>	<p><b>Near-Earth and Interplanetary Communications</b> Systems with relative motion between space and ground systems, in both near-Earth and interplanetary environments, will be discussed with particular emphasis on unique concepts, techniques and technologies.</p> <p><b>Co-Chairs</b> <b>Manfred Wittig</b> <i>European Space Agency (ESA), retired — THE NETHERLANDS</i></p> <p><b>Ramon P. De Paula</b> <i>National Aeronautics and Space Administration (NASA) — UNITED STATES</i></p> <p><b>Rapporteur</b> <b>Dipak Srinivasan</b> <i>The Johns Hopkins University Applied Physics Laboratory — UNITED STATES</i></p>
<b>B2.7</b>	<p><b>Advanced Technologies for Space Communications and Navigation</b> Promising payload and bus technologies for space communications, navigation and data relay systems will be presented, as applied to both existing and future systems. The technologies discussed in this Session cover the whole range of those applicable to micro- or nano- satellites and constellations, all the way up to those earmarked for large high throughput satellites.</p> <p><b>Co-Chairs</b> <b>Edward W. Ashford</b> <i>Graz University of Technology (TU Graz) — AUSTRIA</i></p> <p><b>Elemer Bertenyi</b> <i>Canadian Aeronautics and Space Institute — CANADA</i></p> <p><b>Rapporteur</b> <b>Nader Alagha</b> <i>ESA — THE NETHERLANDS</i></p>
<b>B2.8</b> <b>GTS.3</b>	<p><b>Space Communications and Navigation Young Professionals Virtual Forum</b> A Global session to present and discuss developments in a wide range of satellite communication topics, including fixed, mobile, broadcasting, and data relay technologies and services, as well as those for satellite based position determination, navigation, and timing. Both Earth orbital and interplanetary space communications topics can be addressed. This session is co-sponsored by the Space Communications and Navigation Committee and the Workforce Development/Young Professionals Programme Committee.</p> <p><b>Co-Chairs</b> <b>Edward W. Ashford</b> <i>Graz University of Technology — AUSTRIA</i></p> <p><b>Kevin Shortt</b> <i>Canadian Space Society — CANADA</i></p> <p><b>Rapporteur</b> <b>Stephanie Wan</b> <i>Space Generation Advisory Council (SGAC) — UNITED STATES</i></p>
<b>B2.IP</b>	<p><b>Interactive Presentations</b> Authors with an abstract accepted for an interactive presentation will be asked to prepare slides and display them for the duration of the congress on plasma screens. Authors will be assigned to interactive sessions in which they must be near the plasma screens to engage in interactive discussions with other congress attendees.</p> <p><b>Coordinators</b> <b>Manfred Wittig</b> <i>European Space Agency (ESA), retired — THE NETHERLANDS</i></p> <p><b>Otto Koudelka</b> <i>Joanneum Research — AUSTRIA</i></p>
<b>B3</b>	<p><b>HUMAN SPACEFLIGHT SYMPOSIUM</b> The symposium addresses all practical aspects of human spaceflight including the design, development, operations, utilization and future plans of space missions involving humans. The scope covers actual past, present and future space missions and programmes in LEO and beyond, both governmental and private.</p> <p><b>Coordinators</b> <b>Cristian Bank</b> <i>ROVSING A/S — DENMARK</i></p> <p><b>Martin Zell</b> <i>European Space Agency (ESA) — THE NETHERLANDS</i></p> <p><b>Support</b> <b>Guillaume Girard</b> <i>INSYEN AG — GERMANY</i></p>
<b>B3.1</b>	<p><b>Governmental Human Spaceflight Programs (Overview)</b> The session provides the forum for “Overview” presentations on present and evolving governmental Human Spaceflight programmes. This session will include the latest status of human spaceflight programmes and the spacecraft being developed to support them, including the International Space Station and the Chinese Space Station. Emerging nations’ manned spaceflight programmes, evolution concepts (e.g. ISS, MPCV, Tjanganong) and governmental manned exploration initiatives are also addressed in this session.</p> <p><b>Co-Chairs</b> <b>Carlo Mirra</b> <i>Airbus Defence &amp; Space — THE NETHERLANDS</i></p> <p><b>Kevin D. Foley</b> <i>The Boeing Company — UNITED STATES</i></p> <p><b>Rapporteur</b> <b>Rainer Willnecker</b> <i>Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) — GERMANY</i></p>
<b>B3.2</b>	<p><b>Commercial Human Spaceflight Programs</b> This session provides a forum for papers describing commercial human orbital and sub-orbital spacecraft and stations in development, as well as human-rated launch vehicles and human-tended modules. Topics include the status of development, testing, and operations; the architecture and performance of various systems; launch infrastructure development; and other pertinent areas of commercial human spaceflight development. Programmes such as Atlas 5, B330, CST-100, Cygnus, Dream Chaser, Dragon, Falcon 9, Lynx, New Shepard, Spaceplane, SpaceShipTwo, WhiteKnightTwo, and others are appropriate for this session.</p> <p><b>Co-Chairs</b> <b>Michael E. Lopex Alegria</b> <i>MLA Space, LLC — UNITED STATES</i></p> <p><b>Michael W. Hawes</b> <i>Lockheed Martin Corporation — UNITED STATES</i></p> <p><b>Sergey K. Shaevich</b> <i>Khrunichev State Research &amp; Production Space Center — RUSSIAN FEDERATION</i></p>
<b>B3.3</b>	<p><b>Utilization &amp; Exploitation of Human Spaceflight Systems</b> This session addresses the utilization and exploitation of space stations and human spacecraft and provides the opportunity to discuss achievements, plans and outlooks. Topics for discussion include proposed or available payload facilities, experiments, research, manufacturing, and other on-orbit activity and its related planning, accommodation, and implementation. Additional items appropriate for discussion include scientific and industrial utilization applications and engineering research and technology demonstrations, as well as uses of space stations (i.e. International Space Station and Tjanganong) and other manned vehicles as test beds for exploration.</p> <p><b>Co-Chairs</b> <b>Kevin D. Foley</b> <i>The Boeing Company — UNITED STATES</i></p> <p><b>Maria Stella Lavitola</b> <i>Thales Alenia Space Italia — ITALY</i></p> <p><b>Rapporteur</b> <b>Shannon Ryan</b> <i>Defence Science and Technology Organisation (DSTO) — AUSTRALIA</i></p>
<b>B3.4</b> <b>B6.5</b>	<p><b>Flight &amp; Ground Operations of HSF Systems — Joint Session of the Human Spaceflight and Space Operations Symposia</b> This session addresses key challenges and their solutions related to flight and ground operations in governmental and commercial human spaceflight, their systems and elements. Topics include operational problems and solutions, cost reduction, new and proposed ground facilities or infrastructure, and ground segment operations and planning. Also included are logistics and mission planning, ground transportation, and sustainment.</p> <p><b>Co-Chairs</b> <b>Dieter Sabath</b> <i>Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) — GERMANY</i></p> <p><b>Helmut Luttmann</b> <i>Airbus Defence and Space - Space Systems — GERMANY</i></p> <p><b>Rapporteur</b> <b>Rachid Amekrane</b> <i>Airbus DS GmbH — GERMANY</i></p>



## B3.5

### Astronaut Training, Accommodation, and Operations in Space

This session concentrates on all aspects of spaceflight that are unique to the presence of astronauts. It encompasses astronaut activities such as selection, training, workload management, and task division between flight and ground segments. It includes spacecraft systems and robotic tools; interfaces; international command, control and communications; payloads; research; and utilization. It addresses the unique spacecraft systems required to safely accommodate astronauts during intravehicular and extravehicular activities. The session includes astronaut pre-mission, mission, and post mission support of technological and scientific space based research and utilization of human space complexes and the space environment.

#### Co-Chairs

**Alan T. DeLuna**  
*ATDL Inc. — UNITED STATES*

**Igor V. Sorokin**  
*S.P. Korolev Rocket and Space Corporation Energia — RUSSIAN FEDERATION*

#### Rapporteur

**Tai Nakamura**  
*Japan Aerospace Exploration Agency (JAXA) — JAPAN*

## B3.6

### A5.3

### Human and Robotic Partnerships in Exploration - Joint session of the Human Spaceflight and Exploration Symposia

This session seeks papers on new systems and technologies for current human spaceflight and exploration programmes, and the role of human and robotic partnerships in areas such as on-board robotic assistants, habitat / infrastructure construction support, human mobility support systems (e.g. EVA mobility aids, rovers); and robotic precursor activities to human spaceflights for test, validation, and demonstration of systems. This session also welcomes papers considering how the roles of humans, machines and intelligent systems are likely to evolve in the coming years and the corresponding impact on complex mission design, implementation, and operations.

#### Co-Chairs

**Christian Sallaberger**  
*Canadensys Aerospace Corporation — CANADA*

**M. Hempzell**  
*Hempzell Astronautics Limited — UNITED KINGDOM*

#### Rapporteur

**Juergen Schlutz**  
*Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) — GERMANY*

## B3.7

### Advanced Systems, Technologies, and Innovations for Human Spaceflight

This session is designed to examine and identify the potential evolution of key elements of Human Spaceflight missions, especially those driven by advanced technologies and innovations. Papers are solicited that address how to shape the future subsystems, technologies, innovations, logistics, processes, procedures, etc. to enable or significantly improve future human space mission objectives that will include exploration, commercial initiatives, tourism, and industrial undertakings. Also, lessons learned from past missions and their application to future missions are essential topics in this session.

#### Co-Chairs

**Lionel Suchet**  
*Centre National d'Etudes Spatiales (CNES) — FRANCE*

**Martin Zell**  
*European Space Agency (ESA) — THE NETHERLANDS*

#### Rapporteur

**Gi-Hyuk Choi**  
*Korean Aerospace Research Institute — KOREA, REPUBLIC OF*

## B3.8

### E7.7

### Joint IAF-IISL Session on the Legal Framework for Collaborative Space Activities

Outer Space Treaty principles of international cooperation. This session hosts papers on topics related to the legal framework governing collaborative space programmes, in particular governmental Exploration programmes and their preparations. It includes a focus on future collaborative efforts in relation to human space flight.

#### Co-Chairs

**Elina Morozova**  
*Intersputnik International Organization of Space Communications — RUSSIAN FEDERATION*

**Mark Sundahl**  
*Cleveland State University — UNITED STATES*

#### Rapporteur

**Maria Pozza**  
*Helmore Ayers Lawyers — NEW ZEALAND*

## B3.9

### GTS.2

### Human Spaceflight Global Technical Session

The Human Space Endeavours Global Technical Session is targeting individuals and organisations with the objective of sharing best practices, future projects, research and issues for the future of Human Space Endeavours. This is a Global session co-sponsored by the Human Space Endeavours Committee and the Workforce Development/Young Professionals Programme Committee.

#### Co-Chairs

**Cristian Bank**  
*Rovsing A/S — DENMARK*

**Guillaume Girard**  
*INSYEN AG — GERMANY*

## B3.IP

### Interactive Presentations

Authors with an abstract accepted for an interactive presentation will be asked to prepare slides and display them for the duration of the congress on plasma screens. Authors will be assigned to interactive sessions in which they must be near the plasma screens to engage in interactive discussions with other congress attendees.

#### Coordinators

**Cristian Bank**  
*Rovsing A/S — DENMARK*

**Martin Zell**  
*European Space Agency (ESA) — THE NETHERLANDS*

## B4

### 24<sup>TH</sup> IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS

"Small Satellite Missions" refers to the class of missions conducted using satellites weighing less than 1000 kg. For clarity, we further classify small satellites as microsats if they weigh less than 100 kg; nanosats or cubesats if they weigh less than 10 kg; and picosats if they weigh less than 1 kg. This Symposium, organised by the International Academy of Astronautics (IAA), addresses Small Satellite missions and projects in Science, Exploration, and Technology for government, industry, and academic programmes. The Symposium scope encompasses space science (B4.2), earth observation (B4.4), and exploration (B4.8) missions, as well as the cross-cutting topics of small satellite programmes in developing countries (B4.1), cost-effective operations (B4.3), affordable and reliable space access (B4.5), emerging and promising technologies (B4.6A and B4.6B), and cross-platform compatibility applications and standards (B4.7). Abstracts highlighting ingenuity or innovation are preferred. Where possible, abstracts should have a wide interest in the community and include transferable knowledge or lessons learned. This is in keeping with our commitment to meeting the needs of the small satellite community. This Symposium will be accepting submissions for oral presentations only.

#### Coordinator

**Alex da Silva Curiel**  
*Surrey Satellite Technology Ltd (SSTL) — UNITED KINGDOM*

**Rhoda Shaller Hornstein**  
*— UNITED STATES*

## B4.1

### 18<sup>th</sup> Workshop on Small Satellite Programmes at the Service of Developing Countries

This workshop is organized jointly by the United Nations Office for Outer Space Affairs (UNOOSA) and the International Academy of Astronautics (IAA). It shall review the needs that could be satisfied and results achieved by developing nations through using small satellites. National space plans and examples of application results and benefits shall be included. Small satellite programmes in the Americas would be of particular interest to the session. The workshop shall also review the results of international cooperation, technology transfer, lessons learned and the extent to which these efforts have contributed to the space maturity of developing countries.

#### Co-Chairs

**Sias Mostert**  
*Space Commercial Services Holdings (Pty) Ltd — SOUTH AFRICA*

**Werner R. Balogh**  
*United Nations Office for Outer Space Affairs — AUSTRIA*

#### Rapporteurs

**Danielle Wood**  
*National Aeronautics and Space Administration (NASA) — UNITED STATES*

**Pierre Molette**  
*— FRANCE*

**Sergei Chernikov**  
*— AUSTRIA*

## B4.2

### Small Space Science Missions

This session will address the current and near-term approved small/micro/nano missions whose objective is to achieve returns in the fields of Earth science, solar, interplanetary, planetary, astronomy/astrophysics observations, and fundamental physics. Emphasis will be given to results achieved, new technologies and concepts, and novel management techniques.

#### Co-Chairs

**Larry Paxton**  
*The Johns Hopkins University Applied Physics Laboratory — UNITED STATES*

**Stamatios Krimigis**  
*The Johns Hopkins University Applied Physics Laboratory — UNITED STATES*

## B4.3

### Small Satellite Operations

This session covers the planning for, and execution of, cost-effective approaches for Small Satellite Operations, with emphasis on new missions with new models of operation to reduce mission lifecycle costs and to minimize the cost impact of mission extensions. Papers addressing innovation, an entrepreneurial approach to new business opportunities, novel finance and business models, management techniques, and international cooperation in support of Small Satellite Operations are particularly encouraged. Papers that discuss the application of novel technology to mission operations, such as automation and autonomy, constraint resolution, and timeline planning, as well as reports on missions recently accomplished and lessons learned, are also welcome. For papers not addressing small satellites, please refer to Symposium B6.

#### Co-Chairs

**Andreas Hornig**  
*University of Stuttgart — GERMANY*

**Helen Walker**  
*STFC — UNITED KINGDOM*

#### Rapporteur

**Norbert Lemke**  
*OHB System AG - Munich — Germany*

## B4.4

### Small Earth Observation Missions

We call for papers that will present information to decision makers, scientists, engineers, and managers about cost-effective small satellite missions, instruments, technologies, and designs of both current and planned Earth- and near-Earth missions. This session addresses the technologies, applications and missions achieved through the use of small, cost-effective satellites to observe the Earth and near-Earth space. Innovative cost-effective solutions to the needs of the science and applications communities are sought. Satellite technologies suited for use on small satellites including those in the single to multiple cubesat range are particularly encouraged. Satellite or technology development efforts that make use of innovative launch opportunities, such as the developing space tourism market and commercial launch capability, hold significant promise for low-cost access to space make Earth observation missions attainable to non-governmental organizations as well as traditional users: papers addressing these evolving opportunities would be welcomed.

#### Co-Chairs

**Amnon Ginati**  
*European Space Agency (ESA) — THE NETHERLANDS*

**Larry Paxton**  
*The Johns Hopkins University Applied Physics Laboratory — UNITED STATES*

#### Rapporteur

**Carsten Tobehn**  
*European Space Agency (ESA) — THE NETHERLANDS*

## B4.5

### Access to Space for Small Satellite Missions

A key challenge facing the viability and growth of the small satellite community is affordable and reliable space access. Topics of interest for this session include utilization of dedicated launches; development of ride-share systems, auxiliary payload systems, and separation and dispenser systems; and responsive integration approaches that will enable efficient small satellite access to space. Includes lessons learned from users on technical and programmatic approaches. For a dedicated discussion of small satellite propulsion systems, please refer to session B4.5A-C4.8. For a discussion of small launchers concepts and operations, please refer to session D2.7.

#### Co-Chairs

**Alex da Silva Curiel**  
*Surrey Satellite Technology Ltd (SSTL) — UNITED KINGDOM*

**Philip Davies**  
*Deimos Space UK Ltd — United Kingdom*

#### Rapporteur

**Jeffery Emdee**  
*The Aerospace Corporation — UNITED STATES*

## B4.5A

### C4.8

### Joint Session between IAA and IAF for Small Satellite Propulsion Systems

This session will pay particular attention to propulsion systems and associated technologies as an enabler to efficient small satellite access to space and orbit change. Papers are invited discussing the particular challenges of design, manufacture, testing, operations and technological developments of small satellite propulsion systems, and the challenges of obtaining high performance within a small volume and mass. The scope includes chemical and electrical propulsion systems for major orbit changes, fine orbit control and maintenance, and end-of-life disposal. For papers with an emphasis on the small satellite and its system design, refer to other B4 sessions. For focus on other propulsion system and technologies, refer to other C4 sessions.

#### Co-Chairs

**Arnau Pons Lorente**  
*Space Generation Advisory Council (SGAC) — SPAIN*

**Jeffery Emdee**  
*The Aerospace Corporation — UNITED STATES*

## B4.6A

### Generic Technologies for Small/Micro Platforms

This session covers emerging and promising generic technologies for small and micro platforms. Real-life examples are particularly encouraged, both recently launched and shortly to be launched (next 3 years).

#### Co-Chairs

**Jian Guo**  
*Delft University of Technology (TU Delft) — THE NETHERLANDS*

**Philip Davies**  
*Deimos Space UK Ltd — UNITED KINGDOM*

## B4.6B

### Generic Technologies for Nano/Pico Platforms

This session covers emerging and promising generic technologies for nano and pico platforms. Real-life examples are particularly encouraged, both recently launched and shortly to be launched (next 3 years).

#### Co-Chairs

**Joost Elstak**  
*Airbus Defence and Space Netherlands — THE NETHERLANDS*

**Zeger de Groot**  
*Innovative Solutions in Space BV — THE NETHERLANDS*

#### Rapporteur

**Andy Vick**  
*— UNITED KINGDOM*

## B4.7

### Highly Integrated Distributed Systems

Small satellites offer important advantages for creating new opportunities for integrated sensor systems. In this session we focus on the new, emerging, enabling technologies that can be used or are being used to create networked data collection systems via small satellites. Session B4.7 focuses on distributed architectures and sensor systems and how this low cost and rapidly delivered technology offers the potential to fulfil complex user needs, working in coordination with other small or large space infrastructures as well as with airborne or terrestrial assets. This hardware system implementation is a key issue and crucial for the success of these systems, featuring for instance, cross-platform compatibility to achieve mission objectives. Papers to be solicited should show how cross-platform compatibility is carried out, the standards that are proposed or adopted, design techniques and standards that enable this cross-platform compatibility, etc. We are particularly interested in the technologies that enable small spacecraft to play an important role in upcoming applications, such as (but not limited to) civil security, telecommunications in remote areas, navigation support (e.g., along the new foreseen routes in the Arctic), natural disaster management (e.g., damage assessment and first responders support). The integrated applications of these sensor systems are covered in Symposium Session B5.2, and the broader view of tools and technologies to enable integrated applications are covered in B5.1. In B4.7 authors are also invited to analyze technological enhancements and new developments to guarantee small satellite integration with existing and scheduled assets from both the bus and payload perspectives. Also analysis of inter-operability within integrated systems can be addressed, like payload data management, spacecraft operation.

#### Co-Chairs

**Michele Grassi**  
*University of Naples "Federico II" — ITALY*

**Rainer Sandau**  
*International Academy of Astronautics — GERMANY*



## Rapporteurs

**Jaime Esper**  
National Aeronautics and Space Administration (NASA)  
— UNITED STATES

**Marco D'Errico**  
Seconda Università di Napoli — ITALY

## B4.8 Small Spacecraft for Deep-Space Exploration

This session focuses on innovative small spacecraft designs, systems, missions and technologies for the exploration of space beyond Earth orbit. Target destinations for these miniaturized space probes include the Earth's Moon, Mars, small bodies and other deep-space destinations, as well as near Earth vicinity for necessary development and technology demonstration missions. Small exploration probes covered by this session may come in many different forms, including special-purpose miniature spacecraft, standard format small platforms such as cubesats, or other microsats, nanosats, picosats, etc. Topics include new and emerging technologies in miniaturized subsystems including propulsion, avionics, guidance navigation & control, power supply, communication, thermal management, and sensors and instruments. Main aspect on this session is on new and emerging systems and mission applications for deep-space exploration using small spacecraft.

### Co-Chairs

**Leon Alkalai**  
National Aeronautics and Space Administration (NASA)/Jet Propulsion Laboratory — UNITED STATES

**Rene Laufer**  
Baylor University — UNITED STATES

### Rapporteur

**Amanda Stiles**  
SpaceX — UNITED STATES

## B4.9 GTS.5

### Small Satellite Missions Global Technical Session

The Small Satellite Missions Global Technical Session (GTS) is collaboration between the International Academy of Astronautics (IAA) Small Satellite Missions Symposium and the International Astronautical Federation (IAF) Workforce Development/Young Professionals Programme Committee. This session is unique in that it allows for sharing of information on a global scale with presenters and audience both at the IAC venue and online at their home/work/university locations. Abstracts are solicited regarding operational missions or mature proposals for small satellite systems and related topics. These must have clear relevance on an international scale or at a business level, and must also provide young professionals a taste of what the space sector has to offer. Where possible, abstracts should have a wide interest in the community and should include transferable knowledge or lessons learned. Abstracts highlighting ingenuity or innovation are preferred. Examples include space missions utilizing small satellites that address specific new societal, scientific or commercial challenges, or novel technologies that have the potential to revolutionize space missions and/or enable their access to space. Papers are to describe the specific need, the small satellite approach that addresses this need, the benefits of this approach and the use of space technology, and demonstrate that other non-space approaches provide inferior solutions. Papers from, or directed at the young professional community are preferred. This session will be accepting submissions for oral presentations only.

### Co-Chairs

**Alex da Silva Curiel**  
Surrey Satellite Technology Ltd (SSTL) — UNITED KINGDOM

**Rhoda Shaller Hornstein**  
— UNITED STATES

## B5 SYMPOSIUM ON INTEGRATED APPLICATIONS

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. This symposium will address various aspects of integrated applications. Integrated applications combine different space systems (Earth observation, navigation, telecommunications, etc) with airborne and ground-based systems to deliver solutions to local, national and global needs. They 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 goal of the symposium is to enable the development of end-to-end solutions by connecting the communities that are driving toward end-to-end solutions with those that are developing enabling technologies for integrated applications. For the purposes related to the small satellites, please refer also to the session B4.4. For issues related to integrated sensor systems featuring for instance cross-platform compatibility, please direct contributions to session B4.7..

### Coordinators

**Amnon Ginati**  
European Space Agency (ESA) — THE NETHERLANDS

**Larry Paxton**  
The John Hopkins University Applied Physics Laboratory — UNITED STATES

## B5.1 Tools and Technology in Support of Integrated Applications

The session will focus on specific systems, tools and technology in support of integrated applications and address the various issues associated with the design of space and ground systems, the kind of data they collect, how they collect data, and how the data are integrated and distributed to address key user needs. Possible topics include: ground-truthing of space data; innovative, low-cost tools for space data distribution and access; new ways of distributing integrated data products; data fusion and visualisation tools especially those using COTS systems; managing integrated applications programmes; education and outreach for integrated programmes, etc...

### Co-Chairs

**Carsten Tobehn**  
European Space Agency (ESA) — THE NETHERLANDS

**Larry Paxton**  
The John Hopkins University Applied Physics Laboratory — UNITED STATES

**David Y. Kusnierkiewicz**  
The John Hopkins University — UNITED STATES

## B5.2 Integrated Applications End-to-End Solutions

The session will be a forum for end-to-end solutions, including case studies, proof-of-concept missions, and current projects that provide, or could provide, innovative user-driven solutions. Applications that combine ground- and space-based data sources with models to address specific user requirements will be presented. 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

### Co-Chairs

**Amnon Ginati**  
European Space Agency (ESA) — THE NETHERLANDS

**Boris Penne**  
OHB System AG-Bremen — GERMANY

**Yuval Brodsky**  
tinTree International eHealth — SOUTH AFRICA

## B6 SPACE OPERATIONS SYMPOSIUM

The Space Operations Symposium addresses all aspects of spaceflight operations. The sessions address both manned and un-manned space operations, from low-Earth and geosynchronous orbit, to lunar, planetary, and exploration missions. The symposium covers both flight and ground systems, and included mission planning, training, and real time operations. Particular focus is provided for commercial space operations, advanced systems, new operations concepts, and small satellite operations.

### Coordinators

**John Auburn**  
Consultant — ITALY

**Pierre Jean**  
Canadian Space Agency — CANADA

## B6.1 Human Spaceflight Operations

This session focuses on all aspects of operations unique to human spaceflight. Papers may address any phase in the mission lifecycle including concept development, mission planning, ground operations, ascent, on-orbit and entry operations, as well as recovery and post mission analysis.

### Co-Chairs

**Mario Cardano**  
Thales Alenia Space France — ITALY

**Michael McKay**  
European Space Agency (ESA) — GERMANY

### Rapporteur

**Helmut Luttmann**  
Airbus Defence and Space - Space Systems — GERMANY

## B6.2

### New Operations Concepts, Advanced Systems and Commercial Space Operations

This session included commercial and new space operations, and addressed advanced concepts, systems and tools for operating new types of missions, improving mission output in quality and quantity, and reducing costs in both commercial and governmental space enterprises.

### Co-Chairs

**Pierre Lods**  
Centre National d'Etudes Spatiales (CNES) — FRANCE

**Thomas Kuch**  
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) — GERMANY

### Rapporteur

**Keiichiro Sakagami**  
Japan Aerospace Exploration Agency (JAXA) — JAPAN

## B6.3

### Mission Operations, Validation, Simulation and Training

This session addresses the broad topic of operations, from preparation through validation, simulation and training, including operations execution and lessons learned. It included concepts, methods and tools, as well as experience gained.

### Co-Chairs

**Paolo Ferri**  
European Space Agency (ESA) — GERMANY

**Zeina Mounzer**  
Telespazio Vega Deutschland GmbH — GERMANY

### Rapporteur

**Thomas Uhlig**  
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) — GERMANY

## B6.4 GTS.1

### Spaceflight Operations Global Technical Session

This session is a technical session co-sponsored by the Space Operations Committee and the Workforce Development/Young Professionals Program Committee. The forum targets hands-on flight control/operations personnel from multiple international organisations with objectives of sharing best practices, lessons learned, and issues.

### Co-Chairs

**Ahmed Farid**  
Telespazio VEGA Deutschland GmbH — GERMAN

**Andrea Boyd**  
European Space Agency (ESA) — AUSTRIA

## B6.5 B3.4

### Flight & Ground Operations of HSF Systems – Joint Session of the Human Spaceflight and Space Operations Symposia

This session addresses key challenges and their solutions related to flight and ground operations in governmental and commercial human spaceflight, their systems and elements. Topics include operational problems and solutions, cost reduction, new and proposed ground facilities or infrastructure, and ground segment operations and planning. Also included are logistics and mission planning, ground transportation, and sustainment.

### Co-Chairs

**Dieter Sabath**  
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) — GERMANY

**Helmut Luttmann**  
Airbus Defence and Space - Space Systems — GERMANY

### Rapporteur

**Rachid Amekrane**  
Airbus DS GmbH — GERMANY

## B6.IP

### Interactive Presentations

Authors with an abstract accepted for an interactive presentation will be asked to prepare slides and display them for the duration of the congress on plasma screens. Authors will be assigned to interactive sessions in which they must be near the plasma screens to engage in interactive discussions with other congress attendees.

### Coordinators

**John Auburn**  
Consultant — ITALY

**Pierre Jean**  
Canadian Space Agency — CANADA

## Category



## C1

## TECHNOLOGY

Common technologies to space systems, including astrodynamics, structures, power and propulsion

- C1 ASTRODYNAMICS SYMPOSIUM
- C2 MATERIALS AND STRUCTURES SYMPOSIUM
- C3 SPACE POWER SYMPOSIUM
- C4 SPACE PROPULSION SYMPOSIUM

Category coordinated by *Li Ming, China Academy of Space Technology (CAST), China*

## ASTRODYNAMICS SYMPOSIUM

This symposium addresses advances in orbital mechanics, attitude dynamics, guidance, navigation and control of space systems.

### Coordinators

**Alfred Ng**  
Canadian Space Agency — CANADA

**Anna Guerman**  
Centre for Mechanical and Aerospace Science and Technologies (C-MAST) — PORTUGAL

## C1.1

### Attitude Dynamics (1)

This theme discusses advances in spacecraft attitude dynamics and control, as well as design, testing and performance of novel attitude sensors and actuators. This theme also covers dynamics and control of multiple interconnected rigid and flexible bodies, including tethered systems, and in-orbit assembly.

### Co-Chairs

**James O'Donnell**  
National Aeronautics and Space Administration (NASA)/Goddard Space Flight Center — UNITED STATES

**Shinji Hokamoto**  
Kyushu University — JAPAN

### Rapporteur

**Gianmarco Radice**  
University of Glasgow — UNITED KINGDOM

## C1.2

### Attitude Dynamics (2)

This theme discusses advances in spacecraft attitude dynamics and control, as well as design, testing and performance of novel attitude sensors and actuators. This theme also covers dynamics and control of multiple interconnected rigid and flexible bodies, including tethered systems, and in-orbit assembly.

### Co-Chairs

**Michael Yu Ovchinnikov**  
Keldysh Institute of Applied Mathematics, RAS — RUSSIAN FEDERATION

**Paolo Teofilatto**  
University of Rome "La Sapienza" — ITALY

### Rapporteur

**Hao-Chi Chang**  
National Space Organization — TAIWAN, CHINA



## C1.3

### Guidance, Navigation & Control (1)

The emphasis of this theme is on the studies and application related to the guidance, navigation and control of Earth-orbiting and interplanetary spacecraft and rockets, including formation flying, rendezvous and docking.

#### Co-Chairs

**Stephan Theil**  
*Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) — GERMANY*

**Yong Chun Xie**  
*Beijing Institute of Control Engineering — CHINA*

#### Rapporteur

**Fuyuto Terui**  
*Japan Aerospace Exploration Agency (JAXA) — JAPAN*

## C1.4

### Guidance, Navigation & Control (2)

The emphasis of this theme is on the studies and application related to the guidance, navigation and control of Earth-orbiting and interplanetary spacecraft and rockets, including formation flying, rendezvous and docking.

#### Co-Chairs

**Anton de Ruiter**  
*Ryerson University — CANADA*

**Bernard Lübke-Ossenbeck**  
*OHB System AG-Bremen — GERMANY*

#### Rapporteur

**Igor V. Belokonov**  
*Samara State Aerospace University — RUSSIAN FEDERATION*

## C1.5

### Guidance, Navigation & Control (3)

The emphasis of this theme is on the studies and application related to the guidance, navigation and control of Earth-orbiting and interplanetary spacecraft and rockets, including formation flying, rendezvous and docking.

#### Co-Chairs

**Arun Misra**  
*Mc Gill Institute for Aerospace Engineering (MIAE) — CANADA*

**Moriba Jah**  
*University of Arizona — UNITED STATES*

#### Rapporteur

**Shoji Yoshikawa**  
*Mitsubishi Electric Corporation — JAPAN*

## C1.6

### Mission Design, Operations & Optimization (1)

The theme covers design, operations and optimization of Earth-orbiting and interplanetary missions, with emphasis on studies and experiences related to current and future missions.

#### Co-Chairs

**Michèle Lavagna**  
*Politecnico di Milano — ITALY*

**Stéphanie Lizy-Destrez**  
*SUPAERO- Ecole Nationale Supérieure de l'Aéronautique et de l'Espace — FRANCE*

#### Rapporteurs

**Johannes Schoenmaekers**  
*European Space Operations Centre — GERMANY*

**Vincent Martinot**  
*Thales Alenia Space France — FRANCE*

## C1.7

### Mission Design, Operations & Optimization (2)

The theme covers design, operations and optimization of Earth-orbiting and interplanetary missions, with emphasis on studies and experiences related to current and future missions.

#### Co-Chairs

**Kathleen Howell**  
*Purdue University — UNITED STATES*

**Massimiliano Vasile**  
*University of Strathclyde — UNITED KINGDOM*

#### Rapporteurs

**Richard Epenoy**  
*Centre National d'Etudes Spatiales (CNES) — FRANCE*

**Xiao Qian Chen**  
*National University of Defense Technology — CHINA*

## C1.8

### Orbital Dynamics (1)

This theme discusses advances in the knowledge of natural motions of objects in orbit around the Earth, planets, minor bodies, Lagrangian points and more generally natural orbital dynamics of spacecraft in the Solar System. It also covers advances in orbit determination.

#### Co-Chairs

**Laureano Cangahuala**  
*Jet Propulsion Laboratory — UNITED STATES*

**Simei Ji**  
*Beijing Institute of Technology — CHINA*

#### Rapporteurs

**Filippo Graziani**  
*G.A.U.S.S. Srl — ITALY*

**Josep J. Masdemont**  
*Universitat Politècnica de Catalunya (UPC) — SPAIN*

## C1.9

### Orbital Dynamics (2)

This theme discusses advances in the knowledge of natural motions of objects in orbit around the Earth, planets, minor bodies, Lagrangian points and more generally natural orbital dynamics of spacecraft in the Solar System. It also covers advances in orbit determination.

#### Co-Chairs

**Daniel Scheeres**  
*University of Colorado, Colorado Center for Astrodynamics Research — UNITED STATES*

**Gerard Gomez**  
*University of Barcelona — SPAIN*

#### Rapporteur

**Antonio Prado**  
*National Institute for Space Research - INPE — BRAZIL*

## C1.IP

### Interactive Presentations

Authors with an abstract accepted for an interactive presentation will be asked to prepare slides and display them for the duration of the congress on plasma screens. Authors will be assigned to interactive sessions in which they must be near the plasma screens to engage in interactive discussions with other congress attendees.

#### Coordinators

**Alfred Ng**  
*Canadian Space Agency — CANADA*

**Anna Guerman**  
*Centre for Mechanical and Aerospace Science and Technologies (C-MAST) — PORTUGAL*

## C2

### MATERIALS AND STRUCTURES SYMPOSIUM

This symposium provides an international forum for recent advancements in assessment of the latest technology achievements in space structures, structural dynamics and materials. The Symposium addresses the design and development of space vehicle structures and mechanical/thermal/fluidic systems. Future advances in a number of space systems applications for space power, space transportation, astrodynamics, space exploration, space propulsion and space station will depend increasingly on the successful application of innovative materials and the development of structural concepts - particularly those relating to very large deployable (and assembled) space structures. For these applications to occur, increased interaction between these technology communities, and collaboration among technologists and mission planners needs to be pursued. Substantial improvements are essential in a wide range of current technologies, including nanotechnologies, to reduce projected costs and increase potential scientific returns from respective mission system applications. Papers in this symposium will review the projected advances in materials and space structures in this domain for advanced space systems applications.

#### Coordinator

**Constantinos P. Stavrinidis**  
*European Space Agency (ESA) — THE NETHERLANDS*

## C2.1

### Space Structures I - Development and Verification (Space Vehicles and Components)

The topics to be addressed include evaluation of analysis versus test results, spacecraft and launch vehicles system and subsystems, e.g. pressurised structures, tanks, loads introduction, primary structures, fluidic equipment, control surfaces; examination of both on-ground and in-orbit testing, launch dynamic environment as related to structural design, space vehicle development and launch verification such as sine, random and acoustic vibration testing, and lessons learned.

#### Co-Chairs

**Alwin Eisenmann**  
*IABG Industrieanlagen - Betriebsgesellschaft mbH — GERMANY*

**Andreas Rittweger**  
*DLR (German Aerospace Center) — GERMANY*

#### Rapporteur

**Jochen Albus**  
*Airbus DS GmbH — GERMANY*

## C2.2

### Space Structures II - Development and Verification (Deployable and Dimensionally Stable Structures)

The topics to be addressed include evaluation of analysis versus test results for deployable and dimensionally stable structures, e.g. reflectors, telescopes, antennas; examination of both on-ground and in-orbit testing, thermal distortion and shape control, structural design, development and verification; lessons learned.

#### Co-Chairs

**Jean-Alain Massoni**  
*Thales Alenia Space France — FRANCE*

**Paolo Gasbarri**  
*Universita di Roma "La Sapienza" — ITALY*

#### Rapporteur

**Pierre Rochus**  
*CSL (Centre Spatial de Liège) — BELGIUM*

## C2.3

### Space Structures - Dynamics and Microdynamics

The topics to be addressed include dynamics analysis and testing, modal identification, landing and impact dynamics, pyroshock, test facilities, vibration suppression techniques, damping, micro-dynamics, in-orbit dynamic environment, wave structural propagation, excitation sources and in-orbit dynamic testing.

#### Co-Chairs

**Harijono Djojodihardjo**  
*— INDONESIA*

**Ijar M. Da Fonseca**  
*ITA-DCTA — BRAZIL*

#### Rapporteur

**Luigi Scatteia**  
*PricewaterhouseCoopers Advisory — FRANCE*

## C2.4

### Advanced Materials and Structures for High Temperature Applications

The topics to be addressed include advanced materials and structures for high temperature applications in space related domains. This includes carbon-carbon and ceramic matrix composites, ultra high temperature ceramics, ablative materials, ceramic tiles and insulations, together with innovative structural concepts making use of the above, for propulsion systems, launchers, hypersonic vehicles, entry vehicles, aero capture, power generation. The session covers the full spectrum of material, design, manufacturing and testing aspects.

#### Co-Chairs

**David E. Glass**  
*National Aeronautics and Space Administration (NASA) — UNITED STATES*

**Marc Lacoste**  
*Herakles (Safran group) — FRANCE*

#### Rapporteur

**Zijun Hu**  
*China Academy of Launch Vehicle Technology — CHINA*

## C2.5

### Smart Materials and Adaptive Structures

The focus of the session will be on application of smart materials to spacecraft and launch vehicle systems, novel sensor and actuator concepts and new concepts for multi-functional and intelligent structural systems. Also included in the session will be new control methods for vibration suppression and shape control using adaptive structures as well as comparisons of predicted performance with data from ground and in-orbit testing.

#### Co-Chairs

**Hiroshi Furuya**  
*Tokyo Institute of Technology — JAPAN*

**Pavel M. Trivailo**  
*RMIT University, Australia — AUSTRALIA*

#### Rapporteur

**Paolo Gaudenzi**  
*Sapienza University of Rome — ITALY*

## C2.6

### Space Environmental Effects and Spacecraft Protection

The focus of the session will be on space environmental effects and spacecraft protection. The effects of vacuum, radiation, atomic oxygen, spacecraft charging, thermal cycling, dissociation, meteoroids and space debris impact on space systems, materials and structures, and microelectronics will be addressed. Protective and shielding technologies, including analysis simulation and testing of debris impact, and susceptibility of Commercial-Off-The-Shelf (COTS) micro-electronics to space radiation will be covered.

#### Co-Chairs

**Anatolii Lohvynenko**  
*Yuzhnoye State Design Office — UKRAINE*

**Giuliano Marino**  
*CIRA Italian Aerospace Research Centre — ITALY*

#### Rapporteur

**Kyeum-rae Cho**  
*Pusan National University — KOREA, REPUBLIC OF*

## C2.7

### Space Vehicles – Mechanical/Thermal/Fluidic Systems

The topics to be addressed include novel technical concepts for mechanical/thermal/fluidic systems and subsystems of launchers, manned and unmanned spacecraft, re-entry vehicles and small satellites. Advanced subsystems and design of future exploration missions will be covered, considering issues arising from material selection, cost efficiency and reliability, and advancements in space vehicle development with respect to engineering analysis, manufacturing, and test verification.

#### Co-Chairs

**Brij Agrawal**  
*Naval Postgraduate School — UNITED STATES*

**Oleg Alifanov**  
*Moscow Aviation Institute — RUSSIAN FEDERATION*

#### Rapporteur

**Guoliang Mao**  
*Beijing Institute of Aerodynamics — CHINA*

## C2.8

### Specialised Technologies, Including Nanotechnology

Specialised material and structures technologies are explored in a large variety of space applications both to enable advanced exploration, and science/observation mission scenarios to perform test verifications relying on utmost miniaturisation of devices and highest capabilities in structural, thermal, electrical, electromechanical/ optical performances offered by the progress in nanotechnology. Examples are the exceptional performances at nano-scale in strength, electrical, thermal conduction of Carbon nanotubes which are experiencing first applications at macro-scale such as nano-composite structures, high efficiency energy storage wheels, MEMS and MOEMS devices. Molecular nanotechnology and advances in manipulation at nano-scale offer the road to molecular machines, ultra compact sensors for science applications and mass storage devices. The Session encourages presentations of specialised technologies, in particular of nanomaterial related techniques and their application in devices offering unprecedented performances for space applications.

#### Co-Chairs

**Mario Marchetti**  
*Associazione Italiana di Aeronautica e Astronautica (AIDAA) — ITALY*

**Pierre Rochus**  
*CSL (Centre Spatial de Liège) — BELGIUM*

#### Rapporteur

**Bangcheng Ai**  
*China Aerospace Science and Industry Corporation — CHINA*

## C2.9

### Advancements in Materials Applications and Rapid Prototyping

The topics to be addressed include advancements in materials applications, and novel technical concepts in the rapid prototyping of mechanical systems.

#### Co-Chairs

**Giuliano Marino**  
*CIRA Italian Aerospace Research Centre — ITALY*

**Sylvie Béland**  
*National Research Council — CANADA*

#### Rapporteur

**John R. Koenig**  
*Southern Research Institute — UNITED STATES*



## C2.IP

### Interactive Presentations

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#### Coordinators

**Constantinos P. Stavrinidis**  
*European Space Agency (ESA) — THE NETHERLANDS*

**Pavel M. Trivailo**  
*RMIT University, Australia — AUSTRALIA*

## C3

### SPACE POWER SYMPOSIUM

Reliable energy systems continue to be key for all space missions. The future exploration and development of space depends on new, more affordable and more reliable energy sources of diverse types ranging from the very small to the extraordinarily large. Moreover, the continuing support for space activities by the public requires that these activities are increasingly inserted into the global challenge to transition current terrestrial energy systems into more environmentally friendly, sustainable ones. The space sector has traditionally served as cutting edge precursor for the development of some renewable power systems. These activities are now put into a much larger space & energy perspective. These range from joint technology development up to visionary concepts such as space solar power plants. The Space Power Symposium addresses all these aspects, covering the whole range from power generation, energy conversion & storage, power management, power transmission & distribution at system and sub-system levels including commercial considerations. It will include, but not be restricted, to topics such as advanced solar and nuclear systems for spacecraft power and propulsion, novel power generation and energy harvesting, and examine the prospects for using space-based power plants to provide energy remotely to the Earth or other planets.

#### Coordinator

**Koji Tanaka**  
*ISAS, JAXA — JAPAN*

**Ming Li**  
*China Academy of Space Technology (CAST) — CHINA*

## C3.1

### Space-Based Solar Power Architectures / Space & Energy Concepts

This session deals with all aspects of architectures and concepts for space-based solar power plants and concepts integrating space and terrestrial energy activities. It will be structured in two half-sessions, one focusing on advances in the field of space solar power plant architectures and one on activities in the field of space & energy, including all types of conceptual, technical and organisational progress to better integrate space and terrestrial energy activities. It is the primary international forum for scientific and technical exchanges on this topic and thus provides a unique common platform for discussions. Typically it will include all system-level, architectural, organisational and commercial aspects, including modelling and optimisation as well as related non-technical aspects.

#### Co-Chairs

**John C. Mankins**  
*ARTEMIS Innovation Management Solutions, LLC — UNITED STATES*

**Leopold Summerer**  
*European Space Agency (ESA) — THE NETHERLANDS*

#### Rapporteurs

**Koji Tanaka**  
*ISAS, JAXA — JAPAN*

**Nobuyuki Kaya**  
*Kobe University — JAPAN*

## C3.2

### Wireless Power Transmission Technologies, Experiments and Demonstrations

This session focuses on all aspects of wireless power transmission systems. It covers wireless power transmission technologies, including laser, microwave-based as well as novel wireless power transmission technologies from the short ranges (e.g. within spacecraft or between two surface installations) up the very large distances for space exploration and power transmission from space to ground. The session covers theoretical as well as applied and experimental results, including emitter/receiver antenna architectures and deployment.

#### Co-Chairs

**Ming Li**  
*China Academy of Space Technology (CAST) — CHINA*

**Nobuyuki Kaya**  
*Kobe University — JAPAN*

#### Rapporteurs

**Massimiliano Vasile**  
*University of Strathclyde — UNITED KINGDOM*

## C3.3

### Advanced Space Power Technologies and Concepts

This session covers all type of advanced space power technologies and concepts. These include technologies and concepts related to power generation (solar, nuclear, other) and harvesting, power conditioning, management and distribution, energy storage, and energy generation. This session focuses on the power systems in the hundreds of watts and above, including large power systems for telecom spacecraft and novel power architectures for planetary, asteroid and lunar exploration scenarios up to MW size nuclear reactor systems.

#### Co-Chairs

**Gary Pearce Barnhard**  
*National Space Society — UNITED STATES*

**Lee Mason**  
*National Aeronautics and Space Administration (NASA)/ Glenn Research Center — UNITED STATES*

#### Rapporteurs

**Koji Tanaka**  
*ISAS/JAXA — JAPAN*

**Matthew Perren**  
*ASTRIUM EADS — FRANCE*

## C3.4

### Small and Very Small Advanced Space Power Systems

This session is devoted to emerging concepts of very small power systems typically below the tens of watts but including micro- and milli-watt power harvesting technologies. While the space power market is still dominated by increasing power systems for large platforms, essentially telecom platforms, a dynamic market is emerging on the low power and low performance fringes of space in the form of nano, micro and mini spacecraft. This session is dedicated to power systems for such applications as well as for very low power, long-duration exploration probes and sensors.

#### Co-Chairs

**Massimiliano Vasile**  
*University of Strathclyde — UNITED KINGDOM*

**Shoichiro Mihara**  
*Japan Space Systems (J-spacesystems) — JAPAN*

#### Rapporteur

**Tanaka Koji**  
*ISAS/JAXA — JAPAN*

## C3.5

### Joint Session on Advanced and Nuclear Power and Propulsion Systems

This session, organised jointly between the Space Power and the Space Propulsion Symposium, includes papers addressing all aspects related to nuclear power and propulsion for space applications.

## C4.7

#### Co-Chairs

**Leopold Summerer**  
*European Space Agency (ESA) — THE NETHERLANDS*

**Koji Tanaka**  
*ISAS/JAXA — JAPAN*

#### Rapporteur

**Koji Tanaka**  
*ISAS/JAXA — JAPAN*

## C3.IP

### Interactive Presentations

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#### Coordinators

**Koji Tanaka**  
*ISAS, JAXA — JAPAN*

**Ming Li**  
*China Academy of Space Technology (CAST) — CHINA*

## C4

### SPACE PROPULSION SYMPOSIUM

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

#### Coordinators

**Christophe Bonhomme**  
*Centre National d'Etudes Spatiales (CNES) — FRANCE*

**Giorgio Saccoccia**  
*European Space Agency (ESA) — THE NETHERLANDS*

**Helen Webber**  
*Reaction Engines Ltd. — UNITED KINGDOM*

#### Riheng Zheng

*China Aerospace Science & Industry Corporation (CASIC) — CHINA*

#### Toru Shimada

*Institute of Space and Astronautical Science (ISAS), Japan Aerospace Exploration Agency — JAPAN*

## C4.1

### Propulsion System (1)

This session is dedicated to all aspects of Liquid Rocket Engines.

#### Co-Chairs

**Christophe Bonhomme**  
*Centre National d'Etudes Spatiales (CNES) — FRANCE*

**Patrick Danous**  
*Snecma — FRANCE*

#### Rapporteurs

**Arnau Pons Lorente**  
*Space Generation Advisory Council (SGAC) — SPAIN*

**Vanniyaperumal Narayanan**  
*Indian Space Research Organization (ISRO) — INDIA*

## C4.2

### Propulsion System (2)

This session is dedicated to all aspects of Solid and Hybrid Propulsion.

#### Co-Chairs

**Stéphane Henry**  
*Herakles (Safran group) — FRANCE*

**Toru Shimada**  
*Japan Aerospace Exploration Agency (JAXA) — JAPAN*

#### Rapporteurs

**M. Badrinayarana Murthy**  
*Indian Space Research Organization (ISRO) — INDIA*

**Yen-Sen Chen**  
*American Institute of Aeronautics and Astronautics (AIAA) — TAIWAN, CHINA*

## C4.3

### Propulsion Technology (1)

This session includes all science and technologies supporting all aspects of space propulsion. The emphasis in this session is placed in particular on components for propulsion.

#### Co-Chairs

**Angelo Cervone**  
*Delft University of Technology (TU Delft) — THE NETHERLANDS*

**Didier Boury**  
*Herakles (Safran group) — FRANCE*

#### Rapporteurs

**Elizabeth Driscoll**  
*Aerjet Rocketdyne — UNITED KINGDOM*

**John Harlow**  
*Aerjet Rocketdyne — UNITED KINGDOM*

## C4.4

### Electric Propulsion

This session is dedicated to all aspects of electric propulsion technologies, systems and applications.

#### Co-Chairs

**Garri A. Popov**  
*Research Institute of Applied Mechanics and Electrodynamics — RUSSIA*

**Vanessa Vial**  
*Snecma — FRANCE*

#### Rapporteurs

**Nicoletta Wagner**  
*Airbus DS GmbH — GERMANY*

**Norbert Puettmann**  
*Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) — GERMANY*

## C4.5

### Propulsion Technology (2)

This session includes all science and technologies supporting all aspects of space propulsion. An objective is to attract papers from students and young professionals with a more technical rather than programmatic or organisational focus.

#### Co-Chairs

**Jacques Gigou**  
*European Space Agency (ESA) — FRANCE*

**Walter Zinner**  
*Airbus Safran Launchers — GERMANY*

#### Rapporteurs

**Max Calabro**  
*The Inner Arch — FRANCE*

**Zvika Zuckerman**  
*Rafael Advanced Defense Systems Ltd. — ISRAEL*

## C4.6

### New Missions Enabled by New Propulsion Technology and Systems

The session will explore concepts for new missions that can be enabled by specific advancements in propulsion and/or integration of various propulsion technologies and systems.

#### Co-Chairs

**Giorgio Saccoccia**  
*European Space Agency (ESA) — THE NETHERLANDS*

**Jerrold Little**  
*Aerjet Rocketdyne — UNITED STATES*

#### Rapporteurs

**Elena Toson**  
*Space Generation Advisory Council (SGAC) — ITALY*

**Mariano Andrenucci**  
*Sitala Spa — ITALY*

#### Rapporteur



**C4.7 C3.5** **Joint Session on Advanced and Nuclear Power and Propulsion Systems**  
This session, organised jointly between the Space Power and the Space Propulsion Symposiums, includes papers addressing all aspects related to advanced and nuclear power and propulsion systems for space applications.

**Co-Chair**

**Jerome Breteau** *European Space Agency (ESA) — FRANCE*      **Leopold Summerer** *European Space Agency (ESA) — THE NETHERLANDS*

**Rapporteurs**

**Constanze Syring** *Euro Engineering AG — GERMANY*      **Elizabeth Driscoll** *Aerojet Rocketdyne — UNITED STATES*      **Koji Tanaka** *Japan Aerospace Exploration Agency (JAXA) — JAPAN*

**Vito Salvatore** *CIRA Italian Aerospace Research Center, Capua — ITALY*      **Youngbin Yoon** *Seoul National University — KOREA, REPUBLIC OF*

**C4.8 B4.5A** **Joint Session between IAA and IAF for Small Satellite Propulsion Systems**  
This session will pay particular attention to propulsion systems and associated technologies as an enabler to efficient small satellite access to space and orbit change. Papers are invited discussing the particular challenges of design, manufacture, testing, operations and technological developments of small satellite propulsion systems, and the challenges of obtaining high performance within a small volume and mass. The scope includes chemical and electrical propulsion systems for major orbit changes, fine orbit control and maintenance, and end-of-life disposal. For papers with an emphasis on the small satellite and its system design, refer to other B4 sessions. For focus on other propulsion systems and technologies, refer to other C4 sessions.

**Co-Chairs**

**Arnaud Pons Lorente** *Space Generation Advisory Council (SGAC) — SPAIN*      **Jeffery Emdee** *The Aerospace Corporation — UNITED STATES*

**Rapporteurs**

**Elena Toson** *Space Generation Advisory Council (SGAC) — ITALY*      **Elizabeth Jens** *NASA Jet Propulsion Laboratory — UNITED STATES*

**C4.9** **Hypersonic and Combined Cycle Propulsion**  
This session covers papers on Hypersonic and Combined Cycle Propulsion for space applications.

**Co-Chairs**

**Helen Webber** *Reaction Engines Ltd. — UNITED KINGDOM*      **Riheng Zheng** *China Aerospace Science & Industry Corporation (CASIC) — CHINA*      **Salvatore Borrelli** *CIRA Italian Aerospace Research Centre — ITALY*

**Rapporteur**

**C4.1P** **Interactive Presentations**  
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**Coordinators**

**Christophe Bonhomme** *Centre National d'Etudes Spatiales (CNES) — FRANCE*      **Elizabeth Driscoll** *Aerojet Rocketdyne — UNITED STATES*      **Elizabeth Jens** *NASA Jet Propulsion Laboratory — UNITED STATES*  
**Jerrold Little** *Pratt & Whitney Rocketdyne — UNITED STATES*      **Yen-Sen Chen** *American Institute of Aeronautics and Astronautics (AIAA) — TAIWAN, CHINA*

**Category D**

## INFRASTRUCTURE

Systems sustaining space missions, including space system transportation, future systems and safety

- D1 SPACE SYSTEMS SYMPOSIUM
- D2 SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM
- D3 15<sup>TH</sup> IAA SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT
- D4 15<sup>TH</sup> IAA SYMPOSIUM ON VISIONS AND STRATEGIES FOR THE FUTURE
- D5 50<sup>TH</sup> IAA SYMPOSIUM ON SAFETY, QUALITY AND KNOWLEDGE MANAGEMENT IN SPACE ACTIVITIES
- D6 SYMPOSIUM ON COMMERCIAL SPACEFLIGHT SAFETY ISSUES

Category coordinated by John-David F. Bartoe, *National Aeronautics and Space Administration (NASA) — UNITED STATES*

**D1** **SPACE SYSTEMS SYMPOSIUM**  
This symposium addresses the present and future development of space systems and technologies, with sessions on System Engineering Methods, Processes, and Tools; Enabling Technologies for Space Systems; Significant Achievements in space systems with implications for Lessons Learned and future Training and Practice; Advanced System Architectures; and Innovative and Visionary Space Systems of the future. A special session addresses the emerging technologies and potential applications in the area of supplementary payloads "hosted" on spacecraft and constellations, where the mission of the hosted payload can be unrelated to the primary mission of the hosting system.

**Coordinators**

**Jill Prince** *National Aeronautics and Space Administration (NASA) — UNITED STATES*      **Reinhold Bertrand** *European Space Agency (ESA) — GERMANY*

**D1.1** **Innovative and Visionary Space Systems Concepts**  
This session will explore innovative concepts, and services for space applications in future scenarios. The aim is to broaden the perimeter of the opinion-makers in order to foster the involvement of people, from researchers and subject matter experts to other appropriate stakeholders, in building up and advancing the future vision of novel and transformational space systems and relevant applications. In this perspective, the dreams of yesterday are the hope of today and the reality of tomorrow. By proposing novel concepts of space systems, and applications, we can broaden today's paradigm towards preferred outcomes beyond incremental advancements.

**Co-Chairs**

**Peter Dieleman** *National Aerospace Laboratory (NLR) — THE NETHERLANDS*      **Tibor Balint** *Royal College of Art — UNITED KINGDOM*      **Camillo Richiello** *CIRA Italian Aerospace Research Centre — ITALY*

**Rapporteur**

**D1.2** **Enabling Technologies for Space Systems**  
This session addresses current and future space systems architectures designed to realize promising concepts for Earth orbiting or exploration missions, both manned and unmanned. These architectures and their elements and building blocks should aim at an increase in functionality, performance, efficiency, reliability and flexibility of operations, while building on state-of-the-art, innovative or even disruptive technologies. The scope of the session includes architectures for single satellite systems, multiple satellite systems, such as constellations, formations, swarms, distributed systems, and system-of-systems (including hybridization with terrestrial systems). Ground-versus-space allocation of functionality and aspects of autonomy, both on-board and on-ground, may be addressed during the session, together with potential spin-offs. Examples include instrumentation, biotechnology, components, micro- and nano-technology, MEMs, advanced new structures.

**Co-Chairs**

**Steven Arnold** *The Johns Hopkins University Applied Physics Laboratory — UNITED STATES*      **Xavier Roser** *Thales Alenia Space France — FRANCE*

**Rapporteur**

**Eiichi Tomita** *Japan Aerospace Exploration Agency (JAXA) — JAPAN*

**D1.3** **Technologies to Enable Space Systems**  
This session will focus on innovative, technological developments that are usually high risk, but which have the potential to significantly enhance the performance of existing and new space systems. Enabling innovative technologies for space applications often result from spin-ins which will be discussed during the session, together with potential spin-offs. Examples include instrumentation, biotechnology, components, micro- and nano-technology, MEMs, advanced new structures and software techniques.

**Co-Chairs**

**DAPEG WANG** *China Academy of Space Technology (CAST) — CHINA*      **Dmitry Payson** *United Rocket and Space Corporation — RUSSIAN FEDERATION*

**Rapporteur**

**Franck Durand-Carrier** *Centre National d'Etudes Spatiales (CNES) — FRANCE*

**D1.4.A** **Space Systems Engineering - Methods, Processes and Tools (1)**  
This session will focus on state-of-the-art systems engineering methodologies that reduce the time and cost, and improve the quality of space system design. Of special interest are multi-disciplinary methods, processes, and tools used for System Design, Product Realization, Technical Management, Operations, and Retirement of space systems to improve risk management, safety, reliability, testability, and quality of life cycle cost estimates, namely: - state of organizational structures, practice methods, processes, tools, training that benefit space system design, development and operations - state of the art systems engineering methodologies for space systems, including space system(s) of systems (SoS) - engineering design methods, modelling and simulation tools applied to space system design and optimization - methodologies and processes for technical planning, control, assessment and decision analysis of space system design - advancement in space system development environments, such as concurrent engineering design facilities - novel methods to improve risk management, earned value management, configuration management, data management, availability, safety, reliability, testability and quality of life cycle cost estimates.

**Co-Chairs**

**Franck Durand-Carrier** *Centre National d'Etudes Spatiales (CNES) — FRANCE*      **Peter Dieleman** *National Aerospace Laboratory (NLR) — THE NETHERLANDS*

**Rapporteur**

**Jill Prince** *National Aeronautics and Space Administration (NASA) — UNITED STATES*

**D1.4.B** **Space Systems Engineering - Methods, Processes and Tools (2)**  
This session will focus on state-of-the-art systems engineering methodologies that reduce the time and cost, and improve the quality of space system design. Of special interest are multi-disciplinary methods, processes, and tools used for System Design, Product Realization, Technical Management, Operations, and Retirement of space systems to improve risk management, safety, reliability, testability, and quality of life cycle cost estimates, namely: - state of organizational structures, practice methods, processes, tools, training that benefit space system design, development and operations - state of the art systems engineering methodologies for space systems, including space system(s) of systems (SoS) - engineering design methods, modelling and simulation tools applied to space system design and optimization - methodologies and processes for technical planning, control, assessment and decision analysis of space system design - advancement in space system development environments, such as concurrent engineering design facilities - novel methods to improve risk management, earned value management, configuration management, data management, availability, safety, reliability, testability and quality of life cycle cost estimates.

**Co-Chairs**

**Eiichi Tomita** *Japan Aerospace Exploration Agency (JAXA) — JAPAN*      **Klaus Schilling** *University Wuerzburg — GERMANY*

**Rapporteur**

**Otfrid Liepack** *National Aeronautics and Space Administration (NASA)/Jet Propulsion Laboratory — UNITED STATES*

**D1.5** **Lessons Learned in Space Systems: Achievements, Challenges, Best Practices, Standards.**  
This session addresses Lessons Learned in Space Systems on all aspects of life cycle. The learning from the past is the necessary way to ensure mission success of future missions. This retrospective perspective includes the achievement of mission accomplishments, the challenges to overcome the difficulties and the best practices to lead the mission success, as well as to document Lessons Learned. The scope of the session also includes the standards in design, development and operation. - lessons learned in design, development and operation - achievement from development, project management - achievement from mission success and on-orbit operation - best practices of project management and systems engineering - challenges on development - challenges to overcome the difficulties on orbit - discussion to improve the Space system from former system development and operation - discussion of standards to assure the mission - documentation of learned lessons to preserve and make them available to future missions

**Co-Chairs**

**Geilson Loureiro** *National Institute for Space Research - INPE — BRAZIL*      **Norbert Frischauf** *— AUSTRIA*

**Rapporteur**

**Otfrid Liepack** *National Aeronautics and Space Administration (NASA)/Jet Propulsion Laboratory — UNITED STATES*

**D1.6** **Cooperative and Robotic Space Systems**  
This session will focus on cooperative and robotic systems as they apply to the space domain. This emerging topic includes concepts such as constellations, multi-satellite architectures, and on-orbit servicing of space systems and technologies. Hosted payloads, where their objectives may be unrelated to the principal mission, are also addressed. Additional areas of interest include collaborative robotic systems, such as space robotic systems and manipulators, robotic/human interactions and distributed multi-agent technologies. Papers in this session will look at current missions and future opportunities, while addressing both benefits and challenges as the world-wide space community moves into these exciting areas.

**Co-Chairs**

**DAPEG WANG** *China Academy of Space Technology (CAST) — CHINA*      **Igor V. Belokonov** *Samara State Aerospace University — RUSSIAN FEDERATION*

**Rapporteur**

**Steven Arnold** *The Johns Hopkins University Applied Physics Laboratory — UNITED STATES*

**D1.IP** **Interactive Presentations**  
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**Coordinators**

**Jill Prince** *National Aeronautics and Space Administration (NASA) — UNITED STATES*      **Reinhold Bertrand** *European Space Agency (ESA) — GERMANY*

**D2** **SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM**  
Topics should address worldwide space transportation solutions and innovations. The goal is to foster understanding and cooperation amongst the world's space-faring organisations.



## Coordinators

**Emmanuelle David**  
*German Aerospace Center (DLR) — GERMANY*

**Steve Creech**  
*National Aeronautics and Space Administration (NASA) — UNITED STATES*

## Secretary

**Yuguang Yang**  
*China Aerospace Science & Industry Corporation (CASIC) — CHINA*

## D2.1 Launch Vehicles in Service or in Development

Review of up to date status of launch vehicles currently in use in the world or under short term development.

### Co-Chairs

**Giorgio Tumino**  
*European Space Agency (ESA) — FRANCE*

**Iwao Igarashi**  
*Mitsubishi Heavy Industries Ltd. - Nagoya Aerospace Systems — JAPAN*

### Rapporteur

**Randolph Kendall**  
*The Aerospace Corporation — UNITED STATES*

## D2.2 Launch Services, Missions, Operations and Facilities

Review of the current and planned launch services and support, including economics of space transportation systems, financing, insurance, licensing. Advancements in ground infrastructure, ground operations, mission planning and mission control for both expendable and reusable launch services.

### Co-Chairs

**Francesco Santoro**  
*Altec S.p.A. — ITALY*

**Yves Gérard**  
*Airbus Defence & Space — FRANCE*

### Rapporteur

**Igor V. Belokonov**  
*Samara State Aerospace University (SSAU) — RUSSIAN FEDERATION*

## D2.3 Upper Stages, Space Transfer, Entry and Landing Systems

Discussion of existing, planned or new advanced concepts for cargo and human orbital transfer. Includes current and near term transfer, entry and landing systems, sub-systems and technologies for accommodating crew and cargo transfer in space.

### Co-Chairs

**Chiara Manfretti**  
*ESA — FRANCE*

**Oliver Kunz**  
*RUAG Space AG — SWITZERLAND*

### Rapporteur

**Oleg Ventskovskiy**  
*— UKRAINE*

## D2.4 Future Space Transportation Systems

Discussion of future system designs and operational concepts for both expendable and reusable systems for Earth-to orbit transportation and exploration missions.

### Co-Chairs

**Charles E. Cockrell Jr**  
*National Aeronautics and Space Administration (NASA) — UNITED STATES*

**José Gavira Izquierdo**  
*European Space Agency (ESA) — THE NETHERLANDS*

### Rapporteur

**Philippa Davies**  
*Reaction Engines Ltd. — UNITED KINGDOM*

## D2.5 Technologies for Future Space Transportation Systems

Discussion of technologies enabling new reusable or expendable launch vehicles and in-space transportation systems. Emphasis is on TRL hardware development and verification prior to flight, including ground testing and/or innovative technology prototype demonstrations not yet involving flight.

### Co-Chairs

**Patrick M. McKenzie**  
*RUAG Space — UNITED STATES*

**Sylvain Guéron**  
*ESA - APT — FRANCE*

### Rapporteur

**Giuseppe Rufolo**  
*CIRA Italian Aerospace Research Centre — FRANCE*

## D2.6 Future Space Transportation Systems Verification and In-Flight Experimentation

Discussion of atmospheric and in-space flight testing and qualification of system, sub-system, and advanced technologies for future launch vehicles and in-space transportation systems. Emphasis is on higher TRL in-flight experimentation, demonstration, and qualification, including test plans and innovative technology prototype demonstrations involving or leading to flight as well as new and unique test platforms and capabilities.

### Co-Chairs

**David E. Glass**  
*National Aeronautics and Space Administration (NASA) — UNITED STATES*

**S Somanath**  
*ISRO — INDIA*

### Rapporteur

**Tetsuo Hiraiwa**  
*Japan Aerospace Exploration Agency (JAXA) — JAPAN*

## D2.7 Small Launchers: Concepts and Operations

Discussion of existing, planned and future Launchers for small payloads ranging from 1500 kg to as low as 1 kg into Low Earth Orbit. Includes innovative solutions such as airborne systems, evolutions from sub-orbital concepts, combinations of existing / emerging elements and new elements, reusable, partially reusable and expendable concepts, and flexible, highly responsive concepts. Includes mission operations, design, development, and specific constraints. For discussion on small satellite missions not focused on launchers and their operations, please refer to session B4.5.

### Co-Chairs

**Harry A. Cikanek**  
*National Oceanic and Atmospheric Administration (NOAA) — UNITED STATES*

**Nicolas Bérend**  
*Office National d'Etudes et de Recherches Aérospatiales (ONERA) — FRANCE*

### Rapporteur

**Steve Cook**  
*Dynetics — UNITED STATES*

## D2.8 Space Transportation Solutions for Deep Space Missions

**A5.4** This joint session will explore space transportation capabilities, existing or under study, for human space exploration missions, new science, programme architectures, technology demonstrations as well as the issues of scientific and political motivations and international cooperation. The session will also deal with worldwide needs, requirements and potential missions enabled by deep space transportation system.

### Co-Chairs

**Charles E. Cockrell Jr.**  
*National Aeronautics and Space Administration (NASA) — UNITED STATES*

**Ernst Messerschmid**  
*University of Stuttgart — GERMANY*

**K. Bruce Morris**  
*Teledyne Brown Engineering — UNITED STATES*

### Co-Chair

**Yuguang Yang**  
*China Aerospace Science & Industry Corporation (CASIC) — CHINA*

### Rapporteurs

**Gerhard Schwehm**  
*European Space Agency (ESA) — SPAIN*

**Steve Creech**  
*National Aeronautics and Space Administration (NASA) — UNITED STATES*

## D2.9 Joint-Session Creating Safe Transportation Systems for Sustainable Commercial Human Spaceflight

**D.6.2** Commercial human space transportation systems must account for technical, economic and policy factors in order to be sustainable. This session will explore both this technical design solutions for reliability and safety, as well as the related economics, policy and regulatory issues involved in producing a human space transportation ecosystem that is sustainable. The discussion can include both suborbital and orbital transportation systems, as well as spaceports and infrastructure.

### Co-Chairs

**Markus Jäger**  
*Airbus Defence & Space, Space Systems — GERMANY*

### Rapporteur

**Martin Sippel**  
*Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) — GERMANY*

## D2.IP

### Interactive Presentations

Authors with an abstract accepted for an interactive presentation will be asked to prepare slides and display them for the duration of the congress on plasma screens. Authors will be assigned to interactive sessions in which they must be near the plasma screens to engage in interactive discussions with other congress attendees.

### Coordinators

**Christophe Bonnal**  
*Centre National d'Etudes Spatiales (CNES) — FRANCE*

**Daniel L. Dumbacher**  
*Purdue University — UNITED STATES*

## D3

### 15<sup>TH</sup> IAA SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT

This symposium organised by the International Academy of Astronautics (IAA) will involve papers and discussion that traverse a wide range of highly valuable future space capabilities (FSC) – in other words “building blocks” for future space exploration, development and discovery – that could enable dramatic advances in global space goals and objectives. The international discussion of future directions for space exploration and utilisation is fully underway, including activities involving all major space-faring nations. Decisions are now being made that will set the course for space activities for many years to come. New approaches are needed that establish strategies, architectures, concepts and technologies that will lead to sustainable human and robotic space exploration and utilisation during the coming decades. The symposium will examine the possible paths, beginning with current capabilities such as the International Space Station, which may lead to ambitious future opportunities for space exploration, discovery and benefits. The sessions that comprise this symposium are key elements of current or planned International Academy of Astronautics (IAA) studies.

### Coordinators

**Alain Pradier**  
*European Space Agency (ESA) — THE NETHERLANDS*

**John C. Mankins**  
*ARTEMIS Innovation Management Solutions, LLC — UNITED STATES*

## D3.1

### Strategies & Architectures as the Framework for Future Building Blocks in Space Exploration and Development

Future scenarios for sustainable exploration and development in space will unfold in the context of global conditions that vary greatly from those of the 1950s-1970s (the first generation of space programmes, driven by international competition), or those of the 1980s-2000s (the second generation of space programmes, enabled by international cooperation). Looking to the future, it is likely that space-faring countries will pursue their goals and objectives in a more building-block fashion focused on developing high-value future space capabilities, rather than through massive, geo-politically driven programmes. Increasingly, these developments may also reflect future commercial space opportunities. As a result, it is important that the international community should engage in an ongoing discussion of strategies and architectures to frame a “building block” approach to our future in space. Such a discussion should involve sustainable budgets and multiple-purpose system-of-systems capabilities that lead to a diverse range of future activities of broad benefit to humanity. This session, which is related to a prospective new International Academy of Astronautics (IAA) study group, will address strategies and architectural approaches that may allow a new paradigm, a “building block” approach, to be established among the space-faring countries. Papers are solicited in these and related areas.

### Co-Chairs

**John C. Mankins**  
*ARTEMIS Innovation Management Solutions, LLC — UNITED STATES*

**Maria Antonietta Perino**  
*Thales Alenia Space Italia — ITALY*

### Rapporteur

**Anouck Girard**  
*University of Michigan — UNITED STATES*

## D3.2

### Systems and Infrastructures to Implement Future Building Blocks in Space Exploration and Development

The emergence of novel systems and infrastructures will be needed to enable ambitious scenarios for sustainable future space exploration and utilisation. New, reusable space infrastructures must emerge in various areas include the following: (1) infrastructures that enable affordable and reliable access to space for both exploration systems and logistics; (2) infrastructures for affordable and reliable transportation in space, including access to/from lunar and planetary surfaces for crews, robotic and supporting systems and logistics; (3) infrastructures that allow sustained, affordable and highly effective operations on the Moon, Mars and other destinations; and, (4) supporting in space infrastructures that provide key services (such as communications, navigation, etc.). Papers are solicited in these and related areas.

### Co-Chairs

**Paivi Jukola**  
*Aalto University — FINLAND*

**Scott Hovland**  
*European Space Agency (ESA) — THE NETHERLANDS*

### Rapporteur

**William H. Siegfried**  
*The Boeing Company — UNITED STATES*

## D3.3

### Novel Concepts and Technologies to Enable Future Building Blocks in Space Exploration and Development

In order to realise future, sustainable programmes of space exploration, utilisation and commercial development, a focused suite of transformational new concepts and supporting technologies must be advanced during the coming years. The technical objectives to be pursued should be drawn from a broad, forward looking view of the technologies and systems needed, but must be sufficiently well focused to allow tangible progression—and dramatic improvements over current capabilities—to be realised in the foreseeable future. This session will address cross cutting research topics and/or technologies to enable future building blocks in Space Exploration and Development. Papers are solicited in these and related areas.

### Co-Chairs

**Alain Pradier**  
*European Space Agency (ESA) — THE NETHERLANDS*

**Christopher Moore**  
*National Aeronautics and Space Administration (NASA) — UNITED STATES*

### Rapporteurs

**Alain Dupas**  
*European Bank for Reconstruction and Development — FRANCE*

**Junjiro Onoda**  
*Japan Society for Aeronautics and Space Sciences (JSASS) — JAPAN*

## D3.4

### Space Technology and System Management Practices and Tools

The effective management of space technology and systems development is critical to future success in space exploration, development and discovery. This session is the next in an ongoing series at the International Astronautical Congress that provides a unique international forum to further the development of a family of ‘best practices and tools’ in this important field. Specific areas of potential interest include: (1) Technology Management Methodologies and Best Practices; (2) R&D Management Software Tools and Databases; and (3) Systems Analysis Methods and Tools. The full range of R&D activities are appropriate for discussion, ranging from technology development long-term planning, through technology R&D programmes, to system development projects, with special emphasis on the transition of new technologies from one stage to the next. Particular topics could include: Technology Readiness Levels (TRLs) and Technology Readiness Assessments, Technology R&D Risk Assessments and Management, Advanced Concepts Modeling Approaches and Tools, etc. Either more theoretical discussions, or examples of applications of R&D management techniques and/or tools to specific R&D programmes and projects are of interest for the session..

### Co-Chairs

**John C. Mankins**  
*ARTEMIS Innovation Management Solutions, LLC — UNITED STATES*

**Paivi Jukola**  
*Aalto University — FINLAND*

### Rapporteur

**Maria Antonietta Perino**  
*Thales Alenia Space Italia — ITALY*

## D3.IP

### Interactive Presentations

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### Coordinators

**Alain Pradier**  
*European Space Agency (ESA) — THE NETHERLANDS*

**John C. Mankins**  
*ARTEMIS Innovation Management Solutions, LLC — UNITED STATES*



D4

## 15<sup>TH</sup> IAA SYMPOSIUM ON VISIONS AND STRATEGIES FOR THE FUTURE

This 15<sup>th</sup> Symposium is organized by the International Academy of Astronautics (IAA). In Space Activities the focus is usually kept on the short term developments, at the expense of future goals. The Symposium will discuss topics with at least 20 to 30 years prospective lead time and identify technologies and strategies that need to be developed. These developments will be examined with the goal to support also short/medium term projects and to identify priorities required for their development. The Sessions in the Symposium will address innovative technologies and Strategies to develop Space Elevator as well as Interstellar Precursor Missions. A session will address also how Space activities can contribute to the resolution of World Societal Changes as well as to increasing the countries engaged in space activities.

### Coordinator

**Giuseppe Reibaldi**  
*International Academy of Astronautics (IAA) — FRANCE*

D4.1

## Innovative Concepts and Technologies

In order to realize future, sustainable programmes of space exploration and utilisation, a focused suite of transformational new system concept and supporting technologies must be developed during the coming decade. The technical objectives to be pursued should be drawn from a broad, forward looking view of the technologies and system needed, but must be sufficiently focused, to allow tangible progression and dramatic improvements over current capabilities. This session will address cross cutting considerations in which a number of discipline research topics and/or technologies may be successful developed to support transformational new system concept. Papers are solicited in these and related areas.

### Co-Chairs

**Giorgio Saccoccia**  
*European Space Agency (ESA) — THE NETHERLANDS*

**Roger X. Lenard**  
*LPS — UNITED STATES*

### Rapporteur

**Paivi Jukola**  
*Aalto University — FINLAND*

D4.2

## Contribution of Space Activities to Solving Global Societal Issues

The session will discuss the contributions, in the future, of space exploration and utilisation to the solution of global challenges (e.g. energy, population, sustainable development) and how the space systems will support the understanding of the global societal issues. The session will include also the identification of the related technologies that needs to be developed. The definition of a roadmap will be encouraged. Environmental issues including global climate change will not be covered in this particular session.

### Co-Chairs

**Giuseppe Reibaldi**  
*International Academy of Astronautics (IAA) — FRANCE*

**John C. Mankins**  
*ARTEMIS Innovation Management Solutions, LLC — UNITED STATES*

D4.3

## Conceptualizing Space Elevators and Tethered Satellites

The development of a system concept for space elevators [and tethered satellites] requires systems engineering and architecture approaches. IAA study (3-24) entitled "Road to Space Elevator Era" is pulling together initial steps for a new look at space elevators. This study will show how to approach mega-projects with engineering discipline leading to the initial phase of a program - Concept Development. The members of the study are all focusing on the early engineering and operational steps towards an operational capability, such as defining the missions and laying out the top-level requirements. This session will suggest strategies to illustrate the space elevator development leading to a phenomenal low cost to space infrastructure. In addition, the session can accept the strategies to leverage space tethers as a viable tool for space systems.

### Co-Chairs

**Akira Tsuchida**  
*Earth-Track Corporation — JAPAN*

**Peter Swan**  
*International Space Elevator Consortium — UNITED STATES*

### Rapporteur

**Robert E Penny**  
*Cholla Space Systems — UNITED STATES*

D4.4

## Strategies for Rapid Implementation of Interstellar Missions: Precursors and Beyond

Knowledge about space beyond our solar system and between the stars—that is interstellar space —is lacking data. Even as IBEX, NASA's Interstellar Background Explorer, studies the edge of our solar system, it still is confined to earth orbit. Arguably, some of the most compelling data to understand the universe we live in will come from sampling the actual environment beyond our solar system as Voyager 1 and Voyager 2 spacecraft are on the threshold of doing. In the 36 years since the Voyager probes' launches, significant advances in materials science, analytical chemistry, information technologies, imaging capabilities, communications and propulsion systems have been made. The recently released IAA study: "Key Technologies to Enable Near-Term Interstellar Scientific Precursor Missions" along with significant initiatives like the DARPA seed-funded 100 Year Starship, signal the need, readiness and benefits to aggressively undertaking interstellar space missions. This session seeks to define specific strategies and key enabling steps to implement interstellar precursor missions within the next 10-15 years. Suggestions for defined projects, payloads, teams, spacecraft and mission profiles that leverage existing technological capacities, yet will yield probes that generate new information about deep space, rapidly exit the solar system and which can be launched before 2030 are sought.

### Co-Chairs

**Giancarlo Genta**  
*Politecnico di Torino — ITALY*

**Mae Jemison**  
*100 Year Starship — UNITED STATES*

### Rapporteur

**Louis Friedman**  
*The Planetary Society — UNITED STATES*

D4.5

## Space Mineral Resources, Asteroid Mining and Lunar/Mars insitu

Exploitation of space mineral resources is becoming a commercial space endeavour for the benefit of humanity and profit. In 2012, the IAA approved a broad study of the technology, economics, legal and policy aspects of identifying, obtaining, and using these resources. The question on the table is not "how" to leverage space minerals resources, but "how best" to leverage them. The purpose of this session is to provide the current state of the art of the technology, economics, law & policy related to Space Mineral Resource (SMR) opportunities. Our objective will be to put a developmental roadmap anchored in realities of engineering, economics and legal/policy.

### Co-Chairs

**Peter Swan**  
*International Space Elevator Consortium — UNITED STATES*

**Roger X. Lenard**  
*LPS — UNITED STATES*

### Rapporteur

**Susan McKenna-Lawlor**  
*Space Technology (Ireland) Ltd. — IRELAND*

D4.IP

## Interactive Presentations

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### Coordinator

**Giuseppe Reibaldi**  
*International Academy of Astronautics (IAA) — FRANCE*

D5

## 50<sup>TH</sup> IAA SYMPOSIUM ON SAFETY, QUALITY AND KNOWLEDGE MANAGEMENT IN SPACE ACTIVITIES

Quality, safety, security... These domains reflect a same concern: how a complex space system can be developed and be operated in order to give its best with the proper robustness. In that environment, where radiations are not the least stress and possible ill-intentioned actions may occur, decreasing the level of failures in space activities is a must. Knowledge management, meaning proper capturing, capitalising, protecting and sharing the knowledge, and application of lessons learned and experience, are key factors. This Symposium organized by the International Academy of Astronautics aims at arousing the discussion between professionals, and raising the awareness of the new generation on the various approaches to obtain and run reliable, and safe space systems: design solutions, validation and tests, software development, validation and security, methods, management approaches, regulations to improve the quality, efficiency, and collaborative ability of space programs and space operations. All aspects are considered: risk management, complexity of systems and operations, knowledge and information management, human factors, economical constraints, international cooperation, norms, and standards.

### Coordinator

**Jeanne Holm**  
*University of California — UNITED STATES*

**Roberta Mugellesi-Dow**  
*European Space Agency (ESA) — UNITED KINGDOM*

D5.1

## Safety and Quality for "Low Cost" Space Programs

A constant ambition in space activities is running faster and cheaper programs ! It is often a sine qua non conditions for new stakeholders to enter the race. Short developments may also be a must, for instance for pedagogic purposes with the now numerous students satellites. What are the keys ? More recurrent space technologies ? More identical models ? On the opposite, more innovation ? New development and validation approaches ? Too many space missions do not meet success, the worse being when there are safety problems. This session provides an opportunity for exchanges on all aspects of the development philosophy, risk management, norms and cost index of development of novel transportation systems, orbital systems, exploration vehicles, test procedures, and operations to meet this challenge for every kind of aerospace missions including space tourism. It deals with the methods, tests, lessons learned, standards for analysis and mitigation of risks in space missions development and operations.

### Co-Chairs

**Alexander S. Filatyev**  
*Central Aero-HydroDynamic Institute — RUSSIAN FEDERATION*

**Manola Romero**  
*3AF — FRANCE*

### Rapporteur

**David Finkleman**  
*International Academy of Astronautics — UNITED STATES*

D5.2

## Knowledge Management and Collaboration in Space Activities

Working on complex space missions requires collaboration, learning lessons from the past, transferring knowledge from experts to younger generations, and developing deep expertise within an organization. Typical questions addressed during the session are: how are aerospace organisations managing the sharing of the knowledge to develop new missions, what solutions are in place to work securely across corporate and international boundaries, how is knowledge captured, shared, and used to drive innovation and create value to the organization. This session focuses on the processes and technologies that organisations are using to sustain, energise and invigorate their ability to learn, innovate, and share knowledge within and amongst organisations for a sustainable, peaceful exploration of space. Examples of case studies and approaches of particular interest include successful projects and innovations in the application of knowledge management, grounded research in knowledge and risk management, methods that allow data, information or knowledge exchange within or amongst organisations in support of actual programmes.

### Co-Chairs

**Lionel Baize**  
*Centre National d'Etudes Spatiales (CNES) — FRANCE*

**Roberta Mugellesi-Dow**  
*European Space Agency (ESA) — UNITED KINGDOM*

### Rapporteurs

**Jeanne Holm**  
*University of California — UNITED STATES*

**Patrick Hambloch**  
*University of Alabama in Huntsville — UNITED STATES*

D5.3

## Prediction, Measurement and Effects of space environment on space missions

Space environment characterized by various factors such as radiation, plasma, atomic oxygen, planetary dusts, extreme temperature, vacuum, micro-gravity, micrometeoroid and debris, etc. and its fluctuations strongly affects quality of space missions. Environmental conditions yield constraints at design phase, and important risks in the course of the mission. The evaluation of the average and worst case conditions to be met, and of their impact on missions and sub-systems are thus of prime importance. This session will encompass the following topics: Space Weather, Plasma, Spacecraft Charging, Radiation, Atomic Oxygen, Planetary Dusts, Combined Environments - flight measurements; - physical processes; - prediction of average or worst case condition; - ground testing; - flight experiments and lessons learnt; - modelling and prediction.

### Co-Chairs

**Jean-Francois Roussel**  
*Office National d'Etudes et de Recherches Aérospatiales (ONERA) — FRANCE*

**Mengu Cho**  
*Kyushu Institute of Technology — JAPAN*

### Rapporteur

**Justin Likar**  
*UTC Aerospace Systems — UNITED STATES*

D5.4

## Cyber-security threats to space missions and countermeasures to address them

The increasingly pervasive network connectivity following the Internet explosion introduces a whole new families of cyber-security threats to space missions. To send commands to a spacecraft now you would not need to build a ground station, but you can penetrate from your home or office the existing ground infrastructures, challenging and bypassing their protection measures. These questions will have to be addressed in the session: - What is the interest of cyber-crime and cyber-activism with respect to space activities? - How are aerospace organisations managing the ability to introduce the right level of security measures in the process to develop new missions? - What solutions are in place to work securely across corporate and international boundaries? - How is knowledge about security threats captured, shared, and used to follow the evolution of cyber threats? - Which ones of these specific threats are to be expected to target space missions, from the ground and from space? - What is particularly to be expected from the cyber-space to target outer space? Case studies will focus for example on cryptography, processes, operational security, and other aspects of space missions that are all constituting the technical components to keep a mission "cyber secure".

### Co-Chairs

**Deganit Paikowsky**  
*Tel Aviv University — ISRAEL*

**Stefano Zatti**  
*ESA — ITALY*

### Rapporteur

**Luca del Monte**  
*European Space Agency (ESA) — FRANCE*

D5.IP

## Interactive Presentations

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### Coordinator

**Jeanne Holm**  
*University of California — UNITED STATES*

**Roberta Mugellesi-Dow**  
*European Space Agency (ESA) — UNITED KINGDOM*

D6

## SYMPOSIUM ON COMMERCIAL SPACEFLIGHT SAFETY ISSUES

Topics should address commercial safety and regulatory policy issues for orbital and suborbital space transportation and spaceports. The goal is to identify issues common to commercial operators of both human and robotic space vehicles to increase international safety and interoperability.

### Coordinator

**Christophe Chavagnac**  
*Airbus Defence and Space SAS — FRANCE*

**John Sloan**  
*Federal Aviation Administration Office of Commercial Space Transportation (FAA/AST) — UNITED STATES*

D6.1

## Commercial Space Flight Safety and Emerging Issues

Topics for this session cover commercial space transportation and safety issues including human and robotic vehicles, spaceports, re-entry vehicles, in-space transportation vehicles, and regulations. Papers related to commercial space transportation are also encouraged on: policy and law; operations and training; best practices and standards; pilot, crew and participant safety; and ground operations and launch site safety.

### Co-Chairs

**Christophe Chavagnac**  
*Airbus Defence and Space SAS — FRANCE*

**John Sloan**  
*Federal Aviation Administration Office of Commercial Space Transportation (FAA/AST) — UNITED STATES*

### Rapporteur

**Gennaro Russo**  
*Associazione Italiana di Aeronautica e Astronautica (AIDAA) — ITALY*

D6.2

D2.9

## Joint-Session Creating Safe Transportation Systems for Sustainable Commercial Human Spaceflight

Commercial human space transportation systems must account for technical, economic and policy factors in order to be sustainable. This session will explore both this technical design solutions for reliability and safety, as well as the related economics, policy and regulatory issues involved in producing a human space transportation ecosystem that is sustainable. The discussion can include both suborbital and orbital transportation systems, as well as spaceports and infrastructure.



D6.3

**Co-Chairs**

**Markus Jäger**  
*Airbus Defence & Space, Space Systems — GERMANY*

**Rapporteur**

**Martin Sippel**  
*Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) — GERMANY*

**Enabling safe commercial spaceflight: vehicles and spaceports**

This session addresses new and existing spaceports and factors that launch vehicle and spaceplane operators may use in evaluating the selection of a launch and/or landing location. Topics include: safety, air and spaceport facilities, runways, geography, air and space traffic, weather, population density, access to workforce and technical support, customer needs, regulations, and other areas. Papers are welcome from spaceports, airports, space transportation providers, support equipment providers, academia, commercial companies and governments.

**Co-Chairs**

**Christophe Chavagnac**  
*Airbus Defence and Space SAS — FRANCE*

**John Sloan**

*Federal Aviation Administration Office of Commercial Space Transportation (FAA/AST) — UNITED STATES*

**Rapporteur**

**Francesco Santoro**  
*Altec S.p.A. — ITALY*

Category



**SPACE AND SOCIETY**

Interaction of space with society, including education, policy and economics, history and law

- E1 SPACE EDUCATION AND OUTREACH SYMPOSIUM
- E2 45<sup>TH</sup> STUDENT CONFERENCE
- E3 30<sup>TH</sup> IAA SYMPOSIUM ON SPACE POLICY, REGULATIONS AND ECONOMICS
- E4 51<sup>ST</sup> IAA HISTORY OF ASTRONAUTICS SYMPOSIUM
- E5 27<sup>TH</sup> IAA SYMPOSIUM ON SPACE ACTIVITY AND SOCIETY
- E6 BUSINESS INNOVATION SYMPOSIUM
- E7 60<sup>TH</sup> IISL COLLOQUIUM ON THE LAW OF OUTER SPACE
- E8 IAA MULTILINGUAL ASTRONAUTICAL TERMINOLOGY SYMPOSIUM

Category coordinated by Lyn Wigbels, *American Astronautical Society (AAS) — UNITED STATES*

E1

**SPACE EDUCATION AND OUTREACH SYMPOSIUM**

This symposium explores best practice and innovative approaches to space education at all levels. It also considers activities, methods and techniques for informal education, outreach to the general public and workforce development. Each year the symposium will commence with a key note address by the winner of the IAF Frank J. Malina Astronautics Medal. This award recognizes the outstanding contribution to space education by an educator who promotes the study of astronautics and space science. When submitting abstracts for consideration, please note that: • Papers should have clear education or outreach content. • Emphasis should be placed on evaluating the learning outcomes of a project, and how these learning outcomes were achieved and evaluated. • Authors are encouraged to clearly identify target groups, benefits, lessons-learned, good practice and include measures of critical assessment • Technical details of projects, even if carried out in an educational context, will not usually qualify. • Papers reporting on programmes/activities that have already taken place will be given preference over papers dealing with concepts and plans for the future. • Papers covering topics/activities which have been reported at a prior IAC must state this explicitly and detail both the additional information to be presented and the added value that this represents.

**Coordinators**

**Lisa Antoniadis**  
*— SWITZERLAND*

**Naomi Mathers**  
*Advanced Instrumentation and Technology Centre (AITC) — AUSTRALIA*

E1.1

**Ignition - Primary Space Education**

This session will explore innovative programs for students up to the age of 11 conducted within the formal education system. Emphasis will be placed on programs that effectively engage primary school students in STEM, develop key skills, and foster a long-term passion for space. This session will also consider programs and activities that develop effective and inspirational primary school teachers.

**Co-Chairs**

**David Cook**  
*University of Alabama in Huntsville — UNITED STATES*

**Kaori Sasaki**  
*Japan Aerospace Exploration Agency (JAXA) — JAPAN*

**Rapporteurs**

**Christopher Vasko**  
*Space Generation Advisory Council (SGAC) — THE NETHERLANDS*

**Ian Christie**  
*Victorian Space Science Education Centre — AUSTRALIA*

E1.2

**Lift Off - Secondary Space Education**

This session will explore innovative programs for students aged 11 to 18, conducted within the formal education system. Emphasis will be placed on programs that effectively engage secondary school students in STEM, develop key skills, and foster a long-term passion for space. This session will also consider programs and activities that develop effective and inspirational secondary school teachers.

**Co-Chairs**

**Andrea Jaime**  
*OHB System AG - Munich — GERMANY*

**Ian Christie**  
*Victorian Space Science Education Centre — AUSTRALIA*

**Rapporteurs**

**Christopher Vasko**  
*Space Generation Advisory Council (SGAC) — THE NETHERLANDS*

**David Cook**  
*University of Alabama in Huntsville — UNITED STATES*

E1.3

**On Track - Undergraduate Space Education**

This session will explore innovative programs for undergraduate students. This can include the development and delivery of innovative courses, project-based work, and work placements. Emphasis should be placed on how the program is structured for maximum impact, how the impact is measured and how the lessons learned are being applied to other courses.

**Co-Chairs**

**Hubert Diez**  
*CNES — FRANCE*

**Lisa Antoniadis**  
*— SWITZERLAND*

**Rapporteur**

**Michal Kunes**  
*Czech Space Office — CZECH REPUBLIC*

E1.4

**In Orbit - Postgraduate Space Education**

This session will explore innovative programs for postgraduate students. This can include the development and delivery of innovative courses, project-based work, and work placements. Emphasis should be placed on how the program is structured for maximum impact, how the impact is measured and how the lessons learned are being applied to other courses.

**Co-Chairs**

**Emmanuel Zenou**  
*SUPAERO- Ecole Nationale Supérieure de l'Aéronautique et de l'Espace — FRANCE*

**Franco Bernelli-Zazzera**  
*Politecnico di Milano — ITALY*

**Rapporteurs**

**David B. Spencer**  
*The Pennsylvania State University — UNITED STATES*

**Thierry Dana-Picard**  
*Jerusalem College of Technology (JCT) — ISRAEL*

E1.5

**Enabling the Future - Developing the Space Workforce**

This session will focus on the challenges, opportunities and innovative approaches to developing the current and future global space workforce.

**Co-Chairs**

**Bettina Boehm**  
*European Space Agency (ESA) — FRANCE*

**Edward J. Hoffman**  
*National Aeronautics and Space Administration (NASA) — UNITED STATES*

**Rapporteurs**

**Amalio Monzon**  
*Airbus Group — UNITED KINGDOM*

**Olga Zhdanovich**  
*European Space Agency (ESA) — THE NETHERLANDS*

E1.6

**Calling Planet Earth - Space Outreach to the General Public**

This session will focus on activities, programs and strategies for engaging the general public. This session does not include programs that are conducted within the formal education system.

**Co-Chairs**

**Kerrie Dougherty**  
*— AUSTRALIA*

**Thierry Dana-Picard**  
*Jerusalem College of Technology (JCT) — ISRAEL*

**Rapporteur**

**Frank Friedlaender**  
*Lockheed Martin Space Systems Company — UNITED STATES*

E1.7

**New Worlds - Non-Traditional Space Education and Outreach**

This session will focus on novel and non-standard methods of space education and outreach in non-traditional areas and to non-traditional target groups. This session does not include programs that are conducted within the formal education system.

**Co-Chairs**

**Olga Zhdanovich**  
*European Space Agency (ESA) — THE NETHERLANDS*

**Vera Mayorova**  
*Bauman Moscow State Technical University — RUSSIAN FEDERATION*

**Rapporteur**

**Carol Christian**  
*STScl — UNITED STATES*

E1.8

**Open Space: Participatory Space Education and Outreach**

This session will focus on the involvement and participation of target groups in space education and outreach-related activities which are internet - or digitally mediated or reply on an "open source" approach, e.g. hackathons, unconferences, barcamps, etc. This session does not include programs that are conducted within the formal education system

**Co-Chairs**

**Kerrie Dougherty**  
*— AUSTRALIA*

**Valerie Anne Casasanto**  
*NASA Goddard/University of Maryland, Baltimore County (UMBC) — UNITED STATES*

**Rapporteur**

**Andrea Jaime**  
*OHB System AG - Munich — GERMANY*

E1.9

**Space Culture –Public Engagement in Space through Culture**

This Session is co-sponsored by the IAF Technical Committee on the Cultural Utilization of Space (ITACCUS) and will focus the activities of institutions such as museums, space agencies and non-profit organizations involving space that engage the cultural sector. This session does not include programs that are conducted within the formal education system.

**Co-Chairs**

**Nahum Mantra**  
*Laboratorio Arte Alameda — MEXICO*

**Nelly Ben Hayoun**  
*Royal Holloway, University of London — UNITED KINGDOM*

**Rapporteur**

**Lisa Antoniadis**  
*— SWITZERLAND*

E1.1P

**Interactive Presentations**

Authors with an abstract accepted for an interactive presentation will be asked to prepare slides and display them for the duration of the congress on plasma screens. Authors will be assigned to interactive sessions in which they must be near the plasma screens to engage in interactive discussions with other congress attendees.

**Coordinators**

**Chris Welch**  
*International Space University (ISU) — FRANCE*

**Lisa Antoniadis**  
*— SWITZERLAND*

E2

**45<sup>TH</sup> STUDENT CONFERENCE**

Presentation of space-related papers by undergraduate and graduate students who participate in an international student competition.

**Coordinators**

**Marco Schmidt**  
*Bochum University of Applied Sciences — GERMANY*

**Stephen Brock**  
*American Institute of Aeronautics and Astronautics (AIAA) — UNITED STATES*

E2.1

**Student Conference – Part 1**

Undergraduate and graduate level students (no more than 28 years of age) present technical papers on any project in space sciences, industry or technology. These papers will represent the specific work of the author(s) (no more than two students). The students presenting in this session will compete in the 44th International Student Competition. This session is NOT for team projects. Team project papers should be submitted to session E2.3. French, German, US, British and Canadian students submitting abstracts for the sessions E2.1 and E2.2 should apply via the national coordinators: - for France: Benedicte.Escudier@supaero.fr - for Germany: Marco Schmidt at: schmidt.marco@informatik.uni-wuerzburg.de - for USA: Stephen Brock at: stephen@aiaa.org - for Great Britain: Chris Welch at: Welch@isu.isunet.edu - for Canada: Jason Clement: Jason.Clement@asc-csa.gc.ca The guidelines for the student competition will be distributed from the session chairs to the authors after abstract acceptance.

**Co-Chairs**

**Benedicte Escudier**  
*Institut Supérieur de l'Aéronautique et de l'Espace (ISAE) — FRANCE*

**Franco Bernelli-Zazzera**  
*Politecnico di Milano — ITALY*

**Rapporteurs**

**Emmanuel Zenou**  
*SUPAERO- Ecole Nationale Supérieure de l'Aéronautique et de l'Espace — FRANCE*

**Jeong-Won Lee**  
*Korea Aerospace Research Institute — KOREA, REPUBLIC OF*

## E2.2

### Student Conference – Part 2

Undergraduate and graduate level students (no more than 28 years of age) present technical papers on any project in space sciences, industry or technology. These papers will represent the specific work of the author(s) (no more than two students). The students presenting in this session will compete in the 44th International Student Competition. This session is NOT for team projects. Team project papers should be submitted to session E2.3. French, German, US, British and Canadian students submitting abstracts for the sessions E2.1 and E2.2 should apply via the national coordinators: - for France: Benedicte Escudier at: benedicte.escudier@supaero.fr - for Germany: Marco Schmidt at: schmidt.marco@informatik.uni-wuerzburg.de - for USA: Stephen Brock at: stephenb@aiaa.org - for Great Britain: Chris Welch at: Welch@isu.isunet.edu - for Canada: Jason Clement: Jason.Clement@asc-csa.gc.ca The guidelines for the student competition will be distributed from the session chairs to the authors after abstract acceptance.

#### Co-Chairs

##### Jeong-Won Lee

Korea Aerospace Research Institute — KOREA, REPUBLIC OF

##### Marco Schmidt

Bochum University of Applied Sciences — GERMANY

#### Rapporteurs

##### Benedicte Escudier

Institut Supérieur de l'Aéronautique et de l'Espace (ISAE) — FRANCE

##### Carlos Duarte

Agencia Espacial Mexicana (AEM) — MEXICO

## E2.3

## GTS.4

### Student Team Competition

Undergraduate and graduate level student teams present papers on any subject related to space sciences, industry or technology. These papers will represent the work of the authors (three or more students). Students presenting in this session will compete for the Hans von Muldau Team Award. The guidelines for the student competition will be distributed from the session chairs to the authors after abstract acceptance.

#### Co-Chairs

##### Andrea Jaime

OHB System AG - Munich — GERMANY

##### Carolyn Knowles

National Aeronautics and Space Administration (NASA) — UNITED STATES

#### Rapporteur

##### Michelle Mendes

World Space Week Association — UNITED STATES

## E2.4

### Educational Pico and Nano Satellites

Proposed session with SUAC.

#### Co-Chair

##### Xiaozhou Yu

Northwestern Polytechnical University — CHINA

#### Rapporteur

##### Franco Bernelli-Zazzera

Politecnico di Milano — ITALY

## E3

### 30<sup>th</sup> IAA SYMPOSIUM ON SPACE POLICY, REGULATIONS AND ECONOMICS

This symposium, organized by the International Academy of Astronautics (IAA), will provide a systematic overview of the current trends in space policy, regulation and economics, by covering national as well as multilateral space policies and plans. The symposium also integrates the 32<sup>nd</sup> IAA/IISL Scientific-Legal roundtable.

#### Coordinators

##### Bernard Schmidt-Tedd

Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) — GERMANY

##### Jacques Masson

European Space Agency (ESA) — THE NETHERLANDS

## E3.1

### International Cooperation - a cornerstone of 50 years UN Space Law and space diplomacy

International Mechanisms of Cooperation in the Peaceful Exploration and Use of Outer Space is a subject of the Legal Subcommittee of UNCOPOUS, where a dedicated report is expected for 2017, the jubilee event of 50 years of the outer space treaty. The session gives the opportunity to evaluate and highlight the different mechanisms of international cooperation in space, as develop during the past decades and to highlight its value for cooperation among nations for the future.

#### Co-Chairs

##### Ciro Arevalo Yepes

— COLOMBIA

##### Elisabeth Back Impallomeni

University of Padova — ITALY

## E3.2

### Private Endeavour in Space Exploration

Space exploration is a domain in evolution like most of the space sector. There is in particular an increasing role of the private sector with new privately financed and led endeavours to many destinations from LEO, to the Moon, Mars and Asteroids. This paradigm shift with the emergence of new private space capabilities has however revealed gaps in current national and international law and regulations. In particular, the 50 years old Outer Space Treaty (OST) requires all signatories to provide "authorisation and continuing supervision" for all of their space activities, including the ones of private actors. This session will thus aim to reflect on the current evolution of the space exploration domain and its impacts on the legal framework in place and in particular the OST and identify potential evolution to consider for future national legislations and the preparation of the next UNISPACE.

#### Co-Chairs

##### Marc Haese

DLR, German Aerospace Center — GERMANY

##### Nicolas Peter

European Space Agency (ESA) — FRANCE

## E3.3

### The Demand Side of the Space Economic Equation: Understanding and Evaluating the Changing Market Dynamics in Space Activities

This session will focus on space business sectors such as telecommunications, navigation, and remote sensing as their markets become saturated and rapid growth slows. What will be the role of the new industrial actors in space? Can the demand for new small satellites, big data, satellite servicing, and space resource utilization, remain sufficient to encourage additional investment growth in the basic terrestrial supporting infrastructure (launch vehicles, space hardware, and consumer products)? Or, will the eventual saturation of the current "big ticket" space applications lead to a fundamental change in financing and investing in private space activities and affect large-scale government missions as well?

#### Co-Chairs

##### Claire Jolly

Organisation for Economic Co-operation and Development (OECD) — FRANCE

##### Max Grimard

Airbus Defence and Space — FRANCE

## E3.4

### Assuring a Safe, Secure and Sustainable Space Environment for Space Activities

Space Activities provide a wealth of increasing benefits for people on Earth. However, space actors have come to realize that the benefits of the space infrastructure for the world community depend on technical, legal, policy and political means to keep a safe, secure and sustainable space environment. This session will explore the progress being made within multilateral fora, the private sector and individual countries in supporting the goal of a safe, secure and sustainable space environment. It will especially focus on trends and inputs in the context of the UNISPACE+50 process

#### Co-Chairs

##### Chen Shenyang

Beihang University — CHINA

##### Ray Williamson

Secure World Foundation — UNITED STATES

#### Rapporteur

##### Peter Stubbe

German Aerospace Center (DLR) — GERMANY

## E3.5

## E7.6

### 32<sup>nd</sup> Joint IAA/IISL Round Table: Technological and legal challenges for on-orbit servicing

Invited speakers only; not open for paper submission Outer Space Treaty Principles of international collaboration and sustainability of outer space affairs. It is beyond question that satellite servicing holds huge benefits for future scientific missions, application satellites, new commercial programmes and further steps in space exploration. Several technical solutions have been developed in the past decades and proven that they are fit for service (i.e. Hubble and ISS). This development accelerates and goes along with the need for a strong international collaboration, particularly for running the systems cost-effectively and reliably. These new partnerships raise plenty of legal questions (i.e. in case that one repairs the satellite of another operator or the operator of a system is supposed to lift a system to another orbit – who is responsible for the consequences?). So we are not only faced with the need to better use already launched systems but also to ensure firm legislation for future missions. In this Scientific-Legal Roundtable we will first listen to different experts who will present technical and legal challenges of on-orbit servicing. Afterwards the experts discuss in a panel and finally the audience is welcome to discuss with the panelists.

#### Co-Chairs

##### Tommaso Sgobba

International Association for the Advancement of Space Safety — THE NETHERLANDS

##### Richard Crowther

UK Space Agency — UNITED KINGDOM

#### Rapporteurs

##### Marc Haese

DLR, German Aerospace Center — GERMANY

##### Nicola Rohner-Willsch

Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) — GERMANY

## E3.6

### Strategic Risk Management for successful space programmes

Considering today's global economic and industrial challenges, more and more organisations have implemented a Corporate Risk Management (also called Enterprise Risk Management - ERM) framework in order to align their strategy with their risk appetite and available resources. In the space sector, and in particular for organisations dealing with large-scale space projects, this cross-organisational process, applies when setting goals across the whole organisation. The process is designed to identify and mitigate potential threats and exploit opportunities in the achievement of the organisation's goals and objectives, and helps support the decision making of senior management. This session, organised by the ERM Technical Committee, will offer a forum to reflect on the recent trends in strategic risk management and exchange validated practices and lessons learned from organisations that already implement such a framework.

#### Co-Chairs

##### Maria-Gabriella Sarah

European Space Agency (ESA) — FRANCE

##### Ruediger Suess

Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) — GERMANY

#### Rapporteurs

##### David M. Lengyel

David M. Lengyel  
George Washington University — UNITED STATES

## E3.1P

### Interactive Presentations

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#### Coordinators

##### Bernhard Schmidt-Tedd

Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) — GERMANY

##### Jacques Masson

European Space Agency (ESA) — THE NETHERLANDS

## E4

### 51<sup>st</sup> IAA HISTORY OF ASTRONAUTICS SYMPOSIUM

History of space science, technology & development, rocketry, personal memoirs. The entire spectrum of space history, at least 25 years old, is covered, as well as history of rocketry and astronautics in Australia. History of preparation and developments for the first Moon landing in 1969.

#### Coordinators

##### Ake Ingemar Skoog

— GERMANY

##### Christophe Rothmund

Airbus Safran Launchers — FRANCE

##### Kerrie Dougherty

— AUSTRALIA

#### Otfrid Liepack

National Aeronautics and Space Administration (NASA)/Jet Propulsion Laboratory — UNITED STATES

## E4.1

### Memoirs and Organisational Histories

Autobiographical & biographical memoirs of individuals who have made original contributions to the development & application of astronautics & rocketry. History of government, industrial, academic & professional societies & organisations long engaged in astronautical endeavours.

#### Co-Chairs

##### Marsha Freeman

21<sup>st</sup> Century Science & Technology — UNITED STATES

##### Niklas Reinke

Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) — GERMANY

#### Rapporteurs

##### John Charles

NASA Human Research Program — UNITED STATES

##### Karlheinz Rohrwild

Hermann-Oberth-Raumfahrt Museum e.V. — GERMANY

## E4.2

### Scientific and Technical Histories

Historical summaries of rocket & space programs, and the corresponding technical & scientific achievements.

#### Co-Chairs

##### Christophe Rothmund

Airbus Safran Launchers — FRANCE

##### Radu Rugescu

Association Dedicated to Development in Astronautics (A.D.D.A) — ROMANIA

#### Rapporteurs

##### Paivi Jukola

Aalto University — FINLAND

##### William Jones

— UNITED STATES

## E4.3A

### History of Australia's Contribution to Astronautics

Special session with invited & proposed speakers. Origin (technical & political aspects) of the space activities & programs in Australia.

#### Co-Chairs

##### Kerrie Dougherty

— AUSTRALIA

##### Otfrid Liepack

National Aeronautics and Space Administration (NASA)/Jet Propulsion Laboratory — UNITED STATES

#### Rapporteurs

##### Charles Lundquist

University of Alabama in Huntsville — UNITED STATES

##### John Harlow

Aerojet Rocketdyne — UNITED KINGDOM

**E4.3B “Can you believe they put a man on the Moon?”**  
This special session welcomes papers focusing on all aspects of the development and preparation for the man arrival on the Moon in 1969. The session seeks papers on topics including but not limited to: technology & scientific aspects (developments, results, spin-offs, etc); reflection on the impacts (political, cultural and societal); contributions from non-US countries and Russia Moon program.

**Co-Chairs**  
**John Charles**  
NASA Human Research Program — UNITED STATES  
**Vera Pinto Gomes**  
— BELGIUM  
**Rapporteur**  
**Otfrid Liepack**  
National Aeronautics and Space Administration (NASA)/Jet Propulsion Laboratory — UNITED STATES

**E5 28<sup>TH</sup> IAA SYMPOSIUM ON SPACE AND SOCIETY**  
This 28<sup>th</sup> symposium, organised by the International Academy of Astronautics (IAA), will review the impact and benefits of space activities on the quality of life on Earth, including arts and culture, society’s expectations from space, life in space, as well as technology and knowledge transfer.

**Coordinators**  
**Geoffrey Languedoc**  
Canadian Aeronautics & Space Institute (CASI) — CANADA  
**Olga Bannova**  
University of Houston — UNITED STATES

**E5.1 Architecture for humans in space: design, engineering, concepts and mission planning**  
The session welcomes papers on all aspects of the challenges of emplacing, sustaining, and growing accommodations for space habitation throughout the inner solar system: Earth orbits, Lagrange points, the Moon’s surface, interplanetary space, Near Earth Objects, the moons of Mars, the surface of Mars and the asteroid Main Belt. These places share a need for basic protection against space radiation, vacuum and thermal extremes, but vary widely in remoteness, proximity to gravity wells and resources, and socio-psychological impact. Architectural solutions, including pressurized volume, shielding, life support, food production, transportation access and social accommodation will stretch concepts and technologies for space architecture. The session seeks papers on topics including but not limited to: integration of architecture, structures, space systems, life-support systems, man-machine interfaces and new technologies.

**Co-Chairs**  
**Brent Sherwood**  
Caltech/JPL — UNITED STATES  
**Olga Bannova**  
University of Houston — UNITED STATES  
**Rapporteur**  
**Anna Barbara Imhof**  
Liquifer Systems Group (LSG) — AUSTRIA

**E5.2 Models for Successfully Applying Space Technology Beyond Its Original Intent**  
Many R&D organizations look for ways to demonstrate the value of their technology portfolio to educate as well as to accommodate a broad community of onlookers and users. Academia- and government-sponsored space programs need to depict how their science and technology activities are relevant to knowledge sharing, technology commercialization and technology transfer. Papers will explore a variety of approaches that organizations can adopt for the successful transfer of technologies that impact new products and services for space and non-space applications. Relevant legislation, business structures, models, metrics, and alternative technology transfer models will be discussed. Papers will provide examples of successful models with descriptions of the approach and tools used, results to date, issues addressed, and ongoing changes made.

**Co-Chairs**  
**Nona Minnifield Cheeks**  
National Aeronautics and Space Administration (NASA)/Goddard Space Flight Center — UNITED STATES  
**Olga Bannova**  
University of Houston — UNITED STATES  
**Rapporteur**  
**Anna Barbara Imhof**  
Liquifer Systems Group (LSG) — AUSTRIA

**E5.3 Contemporary Arts Practice and Outer Space: A Multi-Disciplinary Approach**  
Since the late 1970s, a number of artists have been negotiating access to space facilities and organisations and organisations, critiquing or making experiential the exploration and utilisation of space, or re-purposing space technology, materials or data independently or in direct exchange with the space sector. Today, this practice is branching into a several directions, ranging from performance, installation, video, or conceptual work situated in the space or space analogous environments themselves, to commercial gallery contexts, and the realm of participation and public engagement with science. This session addresses the practice of contemporary artists who have developed new ways to appropriate space for their work, the conceptual and practical foundations of their engagement, and the implications of this emerging aesthetic paradigm for both the fields of space and art. Submissions are welcome from artists and art historians; representatives from space industry, space agencies and the cultural sector facilitating or programming related projects crossing over the increasingly blurred boundaries of creative practice.

**Co-Chairs**  
**Richard Clar**  
Art Technologies — UNITED STATES  
**Nahum Romero**  
Equilibrio. Medio ambiente y responsabilidad social — MEXICO  
**Rapporteur**  
**Daniela De Paulis**  
Rietveld Academy/ASCA-University of Amsterdam — THE NETHERLANDS

**E5.4 Space Assets and Disaster Management**  
This session will explore the role space assets can play in situations requiring disaster management and emergency response. Papers will discuss how space assets and applications can be brought to bear to assist with situation monitoring and assessment, shortening response times and mitigating impact on affected populations.

**Co-Chairs**  
**Geoffrey Languedoc**  
Canadian Aeronautics & Space Institute (CASI) — CANADA  
**Jillianne Pierce**  
SPACE FLORIDA — UNITED STATES

**E5.5 Space Societies, Professional Associations and Museums**  
Space societies, professional associations and museums form a special and important group of IAF members - nearly one quarter of the membership and, as a sector, second in size after space industries. They include professional societies, space museums, space associations, non-profit organisations and other organisations interested in space activities. Some have a large membership of 10 000 or more, others can be small; a few are already a century old, others are just being created. They exist in traditional and emerging space nations. Together they champion the interests of an impressive number of individuals and organizations connected to space. This symposium offers a podium for ideas and proposals to enhance the interaction between the organisations, their members and the Federation. Papers may address proposals to exchange experiences and best practices; sharing articles, exhibitions or educational material; novel ideas to help outreach to the general public, etc. Of particular interest are papers exploring ways to foster communication and collaboration and to develop mutual benefits amongst young societies, representatives of emerging space nations and museums within and outside the IAF family.

**Co-Chair**  
**Jean-Baptiste Desbois**  
SEMECEL Cité de l’Espace — FRANCE  
**Scott Hatton**  
The British Interplanetary Society — UNITED KINGDOM  
**Rapporteur**  
**Minoo Rathnasabapathy**  
Space Generation Advisory Council (SGAC) — AUSTRIA

**E5.IP Interactive Presentations**  
Authors with an abstract accepted for an interactive presentation will be asked to prepare slides and display them for the duration of the congress on plasma screens. Authors will be assigned to interactive sessions in which they must be near the plasma screens to engage in interactive discussions with other congress attendees.

**Coordinator**  
**Geoffrey Languedoc**  
Canadian Aeronautics & Space Institute (CASI) — CANADA  
**Olga Bannova**  
University of Houston — UNITED STATES

**E6 BUSINESS INNOVATION SYMPOSIUM**  
The Business Innovation Symposium is designed to offer papers that observe, study, analyse, describe, and/or propose any topic related to space activities that have commercial objectives, whether from an academic and/or practitioner perspective.

**Coordinator**

**Ken Davidian**  
Federal Aviation Administration Office of Commercial Space Transportation (FAA/AST) — UNITED STATES

**E6.1 New Space Individuals, Projects, Programs, or Business Units: Innovation, Entrepreneurship & Investment at The Microscopic Level of Analysis**

Included in this session are topics of innovation, entrepreneurship, and investment at the microscopic level of analysis and conducted by any sector (e.g., public or private, government or industry, etc.). Subjects of interest can include analyses, narrative descriptions, or current practices regarding individual projects, programs, business units (within a firm, regardless of the firm size). Example topics may include specific business plan ideas, descriptions of particular fund raising techniques, performance of a specific division within a company, etc.

**Co-Chair**  
**Ken Davidian**  
Federal Aviation Administration Office of Commercial Space Transportation (FAA/AST) — UNITED STATES

**E6.2. New Space Industry Segments, Firms, Actor Groups, and Multiple Programs: Innovation, Entrepreneurship, & Investment at The Mesoscopic Level of Analysis**

Included in this session are topics of innovation, entrepreneurship, and investment at the mesoscopic level of analysis, (between the microscopic and macroscopic levels of analysis) and conducted by any sector (e.g., public or private, government or industry, etc.). Subjects of interest can include analyses, narrative descriptions, or current practice of entire firms (regardless of firm size), groups of actors (e.g., the government sector, the financial sector, etc.), and systems of programs. Example subjects may include industry-segment analyses or descriptions (within a specific country), perspectives of investment community of the industry, descriptions of public-private partnership arrangements, etc. It should be noted that the boundary definitions between the mesoscopic level and the micro- and macro-level perspectives are not particularly clear.

**Co-Chair**  
**Ken Davidian**  
Federal Aviation Administration Office of Commercial Space Transportation (FAA/AST) — UNITED STATES

**E6.3 New Space at The National, International, and Overall Industry Levels: Innovation, Entrepreneurship, & Investment at The Macroscopic Level of Analysis**

Topics of innovation, entrepreneurship and investment from the macroscopic perspective may include theory-based analyses or narrative descriptions of current practice or programs at the national, regional, and/or international levels of analysis. Examples could include descriptions of public-private partnership arrangements, industry-specific structure or change analyses (across multiple countries), etc.

**Co-Chairs**  
**Ken Davidian**  
Federal Aviation Administration Office of Commercial Space Transportation (FAA/AST) — UNITED STATES

**E6.IP Interactive Presentations**  
Included in this session are topics of innovation, entrepreneurship, and investment from the macroscopic level of analysis and conducted by any sector (e.g., public or private, government or industry, etc.). Subjects of interest can include analyses, narrative descriptions, or current practice of topics at a national, international, or comprehensive industry level. Example subjects may include descriptions of private or government incubators or technology transfer programs, multi-national analyses, entrepreneurial environment studies, etc.

**Coordinator**  
**Ken Davidian**  
Federal Aviation Administration Office of Commercial Space Transportation (FAA/AST) — UNITED STATES

**E7 60<sup>TH</sup> IISL COLLOQUIUM ON THE LAW OF OUTER SPACE**  
This year’s Colloquium places a special focus on the fiftieth anniversary of the Outer Space Treaty, and discusses its main principles in the context of each individual dedicated IISL panel session

**Coordinators**  
**Catherine Doldirina**  
Joint Research Centre (JRC) of the European Commission — ITALY  
**Lesley Jane Smith**  
Leuphana University of Lüneburg/Weber-Steinhaus & Smith — GERMANY  
**Publication officers**  
**Rafael Moro-Aguilar**  
OrbSpace — AUSTRIA  
**PJ Blount**  
University of Mississippi School of Law — UNITED STATES

**E7.1 9<sup>th</sup> Nandasiri Jasentuliyana Keynote Lecture on Space Law and Young Scholars Session**  
The session examines the terms of the Outer Space Treaty in a prospective light, lending thought to how such a treaty, were it drafted today, would seek to regulate outer space activities as they are to develop further.

**Co-Chairs**  
**Kai-Uwe Schrogl**  
European Space Agency (ESA) — FRANCE  
**Michael Davis**  
Space Industry Association of Australia — AUSTRALIA  
**Rapporteur**  
**Michael Dodge**  
Institute of Air and Space Law, McGill University — CANADA

**E7.2 ‘NewSpace’, New Laws/ How governments can foster new space activities**  
Outer Space Treaty principles of freedom of use, non-appropriation and state responsibility. A range of new entrant financial investors is attracted to space activities, developing spacecraft constellations, introducing new practices, changing the conditions of access and use of Outer space, promoting what is now commonly called "NewSpace" initiatives. This session explores how new business already influences the development of space law and how governments are reacting or regulating new space activities. Papers are invited to analyze emerging trends in "NewSpace" and address the open question: Will "NewSpace" necessarily mean New Laws?

**Co-Chairs**  
**Marco Ferrazzani**  
European Space Agency (ESA) — FRANCE  
**PJ Blount**  
University of Mississippi School of Law — UNITED STATES  
**Rapporteur**  
**Kamlesh Brocard**  
Swiss Space Office (SSO) — SWITZERLAND

**E7.3 Refugees and the role of space communications/Status and Practice of Charter for Man-made Disasters**  
Outer Space Treaty principles of peaceful use of outer space in accordance with international law, international cooperation, and the environment of outer space. One of the central tasks of the international communications framework dating from the early days of radio communications has been to serve humanitarian purposes. This is clearly reflected in the ‘space benefits’ approach of the treaty. Currently, one of its major tasks is to support international refugees who rely on space communication, are also supported by diverse institutions using space communication and, in cases of distress, can be more easily saved by the means of space communication. The legal character and form of international networks supporting the refugees are varied: The UN, its specialised organizations like the ITU and the IMO, ESA, singular States, alongside numerous non-state actors are Parties to arrangements supporting the refugees. One of the - non-binding - bases of these activities is the 2016 Charter on Major Disasters and Migration initiated by ESA, following the 1999 Charter on Space and Major Disasters. This session analyses the legal framework of these initiatives focusing on their use by and on behalf of the refugees. It raises the question whether, and which of these regulations could serve as a model for future initiatives.

E7.4	<p><b>Co-Chairs</b></p> <p><b>Mahulena Hofmann</b> <i>University of Luxembourg — LUXEMBOURG</i></p> <p><b>Ranjana Kaul</b> <i>Duo Associates — INDIA</i></p>	<p><b>Rapporteur</b></p> <p><b>Andrea Harrington</b> <i>University of Mississippi — UNITED STATES</i></p>
<p><b>Space law Developments in Asia-Pacific: Diverging national space legislation with regard to the applicability of space law to suborbital flights</b></p> <p>Outer Space Treaty principles of state responsibility and liability, as well as duty to register spacecraft, while respecting the status of astronauts as envoys of mankind. The last 10-15 years have seen the emergence of a growing body of national space law, as States increasingly recognise the need to have in place appropriate domestic regulatory frameworks for their national space activities. This trend has been matched by the exponential growth in space-related technology, which opens the possibilities for a vast array of new space and high altitude activities, including proposed sub-orbital and low orbit activities. Many of these may be based on 'non-traditional' technology. This is a worldwide phenomenon, and includes the Asia-Pacific region. This session seeks to encourage discussion and analysis of how these factors are shaping the content and scope of national space law, both in terms of a re-evaluation of those existing national laws that largely pre-dated 'NewSpace' technology, as well as the development of new laws that seek to most appropriately address the respective needs of each country.</p>		
<p><b>Co-Chairs</b></p> <p><b>Steven Freeland</b> <i>Western Sydney University — AUSTRALIA</i></p> <p><b>Zhenjun Zhang</b> <i>China Institute of Space Law — CHINA</i></p>		
<p><b>Rapporteur</b></p> <p><b>Anja Nakarada Pecujlic</b> <i>University of Vienna — AUSTRIA</i></p>		
E7.5	<p><b>Current Developments in Space Law</b></p> <p>Outer Space Treaty principles of supervision and control over non-governmental space activities in a peaceful and non-military, yet sustainable context. In this session, papers are invited to address the most recent legal developments of space activities since the last congress with particular relevance to the practice of states and the space community in managing its operations. One such field is that of export control and control of dual-use goods. This has undergone some reform in the recent past, and remains a concern in the context of ensuring the sustainability of space when it comes to matters space traffic management and debris removal. This session looks at developments in the field of peaceful use of outer space in the context of export and international trade in dual use goods, and invites papers to consider the responses to common technology brought about by the call for sustainability.</p>	
<p><b>Co-Chairs</b></p> <p><b>Setsuko Aoki</b> <i>Keio University — JAPAN</i></p> <p><b>Yun Zhao</b> <i>The University of Hong Kong — HONG KONG</i></p>		
<p><b>Rapporteur</b></p> <p><b>Olga Volynskaya</b> <i>ROSCOSMOS — RUSSIAN FEDERATION</i></p>		
E7.6 E3.5	<p><b>32<sup>nd</sup> Joint IAA/IISL Round Table: Technological and legal challenges for on-orbit servicing.</b></p> <p><b>Invited speakers only; not open for paper submission.</b></p> <p>Outer Space Treaty Principles of international collaboration and sustainability of outer space affairs. It is beyond question that satellite servicing holds huge benefits for future scientific missions, application satellites, new commercial programmes and further steps in space exploration. Several technical solutions have been developed in the past decades and proven that they are fit for service (i.e. Hubble and ISS). This development accelerates and goes along with the need for a strong international collaboration, particularly for running the systems cost-effectively and reliably. These new partnerships raise plenty of legal questions (i.e. in case that one repairs the satellite of another operator or the operator of a system is supposed to lift a system to another orbit – who is responsible for the consequences?). So we are not only faced with the need to better use already launched systems but also to ensure firm legislation for future missions. In this Scientific-Legal Roundtable we will first listen to different experts who will present technical and legal challenges of on-orbit servicing. Afterwards the experts discuss in a panel and finally the audience is welcome to discuss with the panelists.</p>	
<p><b>Co-Chairs</b></p> <p><b>Tommaso Sgobba</b> <i>International Association for the Advancement of Space Safety — THE NETHERLANDS</i></p> <p><b>Richard Crowther</b> <i>UK Space Agency — UNITED KINGDOM</i></p>		
<p><b>Rapporteurs</b></p> <p><b>Marc Haese</b> <i>Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) — GERMANY</i></p> <p><b>Nicola Rohner-Willsch</b> <i>Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) — GERMANY</i></p>		
E7.7 B3.8	<p><b>Joint IAF-IISL Session on the Legal Framework for Collaborative Space Activities</b></p> <p>Outer Space Treaty principles of international cooperation. This session hosts papers on topics related to the legal framework governing collaborative space programmes, in particular governmental Exploration programmes and their preparations. It includes a focus on future collaborative efforts in relation to human space flight.</p>	
<p><b>Co-Chairs</b></p> <p><b>Elina Morozova</b> <i>Intersputnik International Organization of Space Communications — RUSSIAN FEDERATION</i></p> <p><b>Mark Sundahl</b> <i>Cleveland State University — UNITED STATES</i></p>		
<p><b>Rapporteur</b></p> <p><b>Maria Pozza</b> <i>Helmere Ayers Lawyers — NEW ZEALAND</i></p>		
E7.1P	<p><b>Interactive Presentations</b></p> <p>Authors with an abstract accepted for an interactive presentation will be asked to prepare slides and display them for the duration of the congress on plasma screens. Authors will be assigned to interactive sessions in which they must be near the plasma screens to engage in interactive discussions with other congress attendees.</p>	
<p><b>Coordinators</b></p> <p><b>Catherine Doldirina</b> <i>Joint Research Centre (JRC) of the European Commission — ITALY</i></p> <p><b>Lesley Jane Smith</b> <i>Leuphana University of Lüneburg/Weber-Steinhaus &amp; Smith — GERMANY</i></p>		
E8	<p><b>IAA MULTILINGUAL ASTRONAUTICAL TERMINOLOGY SYMPOSIUM</b></p> <p>This symposium, organised by the International Academy of Astronautics (IAA), will review the progress made in multilingual space terminology and its impact on international cooperation in space. Terminology is a key issue for a better understanding among people using various languages and dialects. Consecutive or simultaneous translation does not remove the risk of ambiguity during technical meetings and accuracy in terminology is essential during all phases of cooperation. The session will address issues such as standardisation of definitions in space science and technology. The specific character of emerging space countries will also be discussed.</p>	
<p><b>Coordinators</b></p> <p><b>Susan McKenna-Lawlor</b> <i>Space Technology (Ireland) Ltd. — IRELAND</i></p> <p><b>Tetsuo Yoshimitsu</b> <i>Institute of Space and Astronautical Science (ISAS), Japan Aerospace Exploration Agency — JAPAN</i></p>		
E8.1	<p><b>IAA MULTILINGUAL ASTRONAUTICAL TERMINOLOGY</b></p> <p>This symposium, organised by the International Academy of Astronautics (IAA), will review the progress made in multilingual space terminology and its impact on international cooperation in space. Terminology is a key issue for a better understanding among people using various languages and dialects. Consecutive or simultaneous translation does not remove the risk of ambiguity during technical meetings and accuracy in terminology is essential during all phases of cooperation. The session will address issues such as standardisation of definitions in space science and technology. The specific character of emerging space countries will also be discussed.</p>	
<p><b>Co-Chairs</b></p> <p><b>Susan McKenna-Lawlor</b> <i>Space Technology (Ireland) Ltd. — IRELAND</i></p> <p><b>Tetsuo Yoshimitsu</b> <i>Institute of Space and Astronautical Science (ISAS), Japan Aerospace Exploration Agency — JAPAN</i></p>		
<p><b>Rapporteur</b></p> <p><b>Fabrice Dennemont</b> <i>International Academy of Astronautics (IAA) — FRANCE</i></p>		

## Category

# G

### GTS. GLOBAL TECHNICAL SYMPOSIUM (GTS)

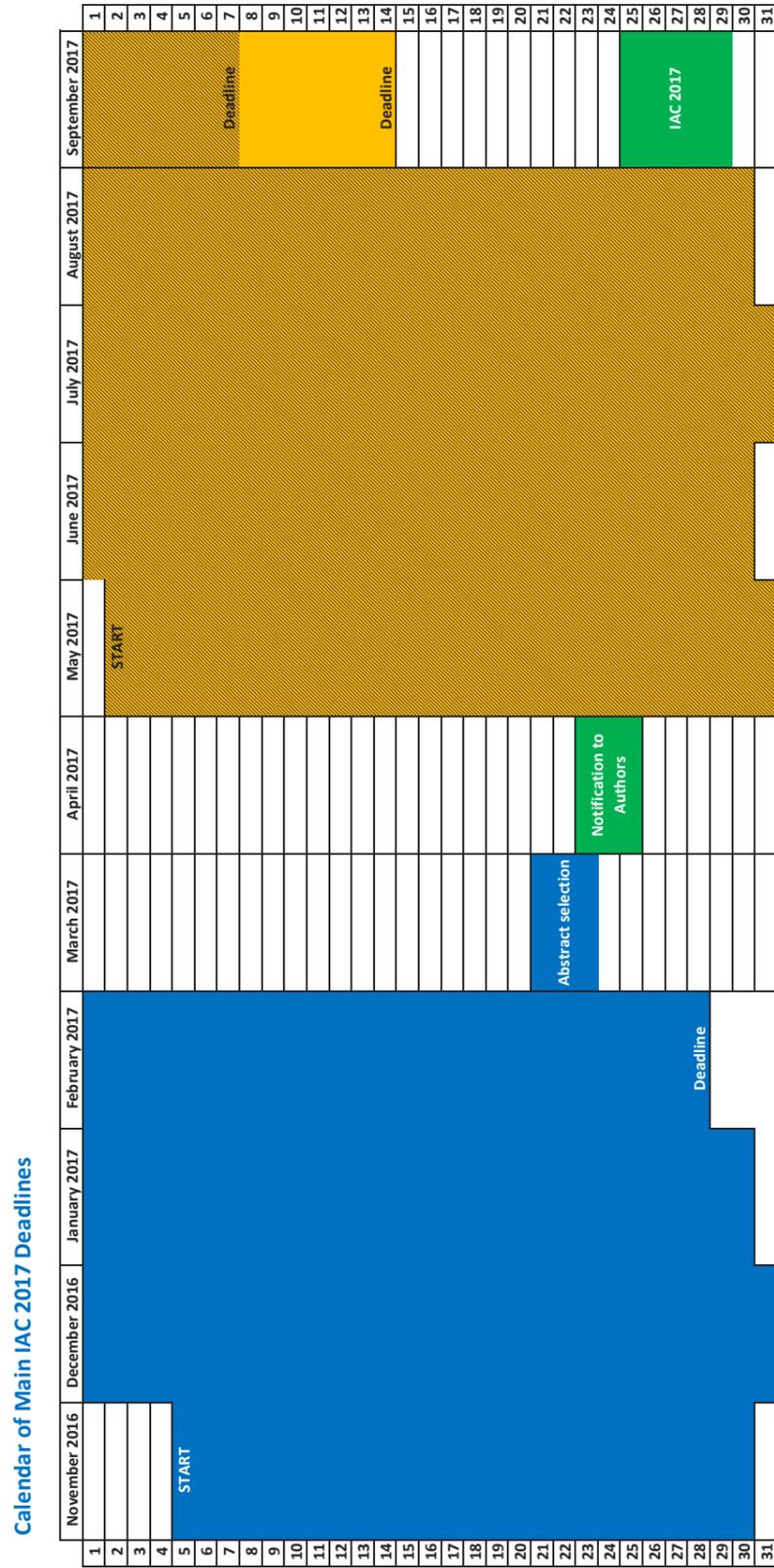
The Global Technical Symposium (GTS) is designed to offer a modern and eclectic platform at the IAC for sharing technical content to an open minded audience on-site but also online! Oriented towards young and talented space professionals, it allows for sharing of information on a global scale with presenters and audience both at the IAC venue and online at their home/work/university locations. The Global Technical Sessions are similar to the conventional technical sessions with abstract selection and paper submissions. They are jointly organized by associated technical committees and co-chaired by seasoned experts and young professionals in order to stimulate the interaction with the authors. The Global Technical Sessions are the IAC cradle for future talents and a modern session to speak with a larger audience thanks to the real-time broadcast online. It can also allow the authors who can't come to IAC to present their paper to the onsite audience at the IAC and is recorded for further use and personal branding by the presenter.

**GTS.1 SPACEFLIGHT OPERATIONS GLOBAL TECHNICAL SESSION**  
**GTS.2 HUMAN SPACE FLIGHT GLOBAL TECHNICAL SESSION**  
**GTS.3 SPACE COMMUNICATIONS AND NAVIGATION GLOBAL TECHNICAL SESSION**  
**GTS.4 STUDENT TEAM COMPETITION**  
**GTS.5 SMALL SATELLITE MISSIONS GLOBAL TECHNICAL SESSION**

Coordinated by Guillaume Girard, *INSYEN AG — GERMANY* and Kathleen Coderre, *Lockheed Martin Corporation — UNITED STATES*

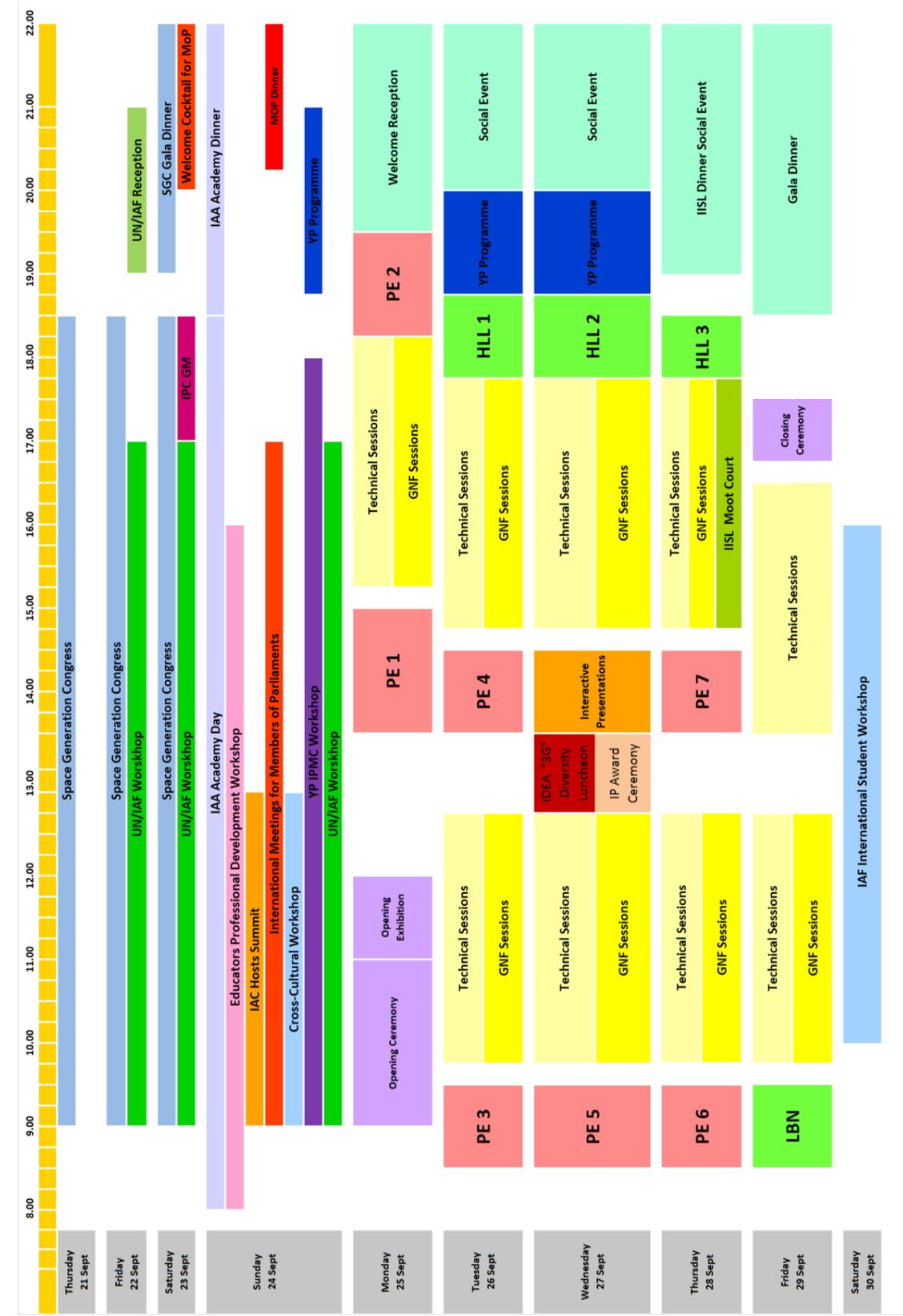
GTS.1 B6.4	<p><b>Spaceflight Operations Global Technical Session</b></p> <p>This session is a technical session co-sponsored by the Space Operations Committee and the Workforce Development/Young Professionals Programme Committee. The session targets hands-on flight control/operations personnel from multiple international organizations with objectives of sharing best practices, lessons learned, and issues. This is a joint session with session B6.4.</p>	
<p><b>Co-Chairs</b></p> <p><b>Ahmed Farid</b> <i>Telespazio VEGA Deutschland GmbH — GERMANY</i></p> <p><b>Andrea Boyd</b> <i>European Space Agency (ESA) — AUSTRIA</i></p>		
GTS.2 B3.9	<p><b>Human Space Flight Global Technical Session</b></p> <p>The Human Space Flight Global Technical Session is targeting individuals and organisations with the objective of sharing best practices, future projects, research and issues for the future of Human Space Flights. This is a technical session co-sponsored by the Human Space Flight Committee and the Workforce Development/Young Professionals Programme Committee.</p>	
<p><b>Co-Chairs</b></p> <p><b>Cristian Bank</b> <i>EADS Astrium Space Transportation GmbH — GERMANY</i></p> <p><b>Guillaume Girard</b> <i>INSYEN AG — GERMANY</i></p>		
GTS.3 B2.8	<p><b>Space Communications and Navigation Global Technical Session</b></p> <p>A Global session to present and discuss developments in a wide range of satellite communication topics, including fixed, mobile, broadcasting, and data relay technologies and services, as well as those for satellite based position determination, navigation, and timing. Both Earth orbital and interplanetary space communications topics can be addressed. This session is co-sponsored by the Space Communications and Navigation Committee and the Workforce Development/Young Professionals Programme Committee.</p>	
<p><b>Co-Chairs</b></p> <p><b>Edward W. Ashford</b> <i>Graz University of Technology — AUSTRIA</i></p> <p><b>Kevin Shortt</b> <i>Canadian Space Society — CANADA</i></p>		
<p><b>Rapporteur</b></p> <p><b>Stephanie Wan</b> <i>Space Generation Advisory Council (SGAC) — UNITED STATES</i></p>		
GTS.4 E2.3	<p><b>Student Team Competition</b></p> <p>Undergraduate and graduate level students teams present papers on any subject related to space sciences, industry or technology. These papers will represent the work of the authors (three or more students). Students presenting in this session will compete for the Hans von Muldau Team Award. The guidelines for the student competition will be distributed from the session chairs to the authors after abstract acceptance.</p>	
<p><b>Co-Chairs</b></p> <p><b>Andrea Jaime</b> <i>OHB System AG - Munich — GERMANY</i></p> <p><b>Carolyn Knowles</b> <i>National Aeronautics and Space Administration (NASA) — UNITED STATES</i></p>		
<p><b>Rapporteur</b></p> <p><b>Michelle Mendes</b> <i>World Space Week Association — UNITED STATES</i></p>		
GTS.5 B4.9	<p><b>Small Satellite Missions Global Technical Session</b></p> <p>The Small Satellite Missions Global Technical Session (GTS) is collaboration between the International Academy of Astronautics (IAA) Small Satellite Missions Symposium and the International Astronautical Federation (IAF) Workforce Development/Young Professionals Programme Committee. This session is unique in that it allows for sharing of information on a global scale with presenters and audience both at the IAC venue and online at their home/work/university locations. Abstracts are solicited regarding operational missions or mature proposals for small satellite systems and related topics. These must have clear relevance on an international scale or at a business level, and must also provide young professionals a taste of what the space sector has to offer. Where possible, abstracts should have a wide interest in the community and should include transferable knowledge or lessons learned. Abstracts highlighting ingenuity or innovation are preferred. Examples include space missions utilizing small satellites that address specific new societal, scientific or commercial challenges, or novel technologies that have the potential to revolutionize space missions and/or enable their access to space. Papers are to describe the specific need, the small satellite approach that addresses this need, the benefits of this approach and the use of space technology, and demonstrate that other non-space approaches provide inferior solutions. Papers from, or directed at the young professional community are preferred. This session will be accepting submissions for oral presentations only.</p>	
<p><b>Co-Chairs</b></p> <p><b>Alex da Silva Curiel</b> <i>Surrey Satellite Technology Ltd (SSTL) — UNITED KINGDOM</i></p> <p><b>Rhoda Shaller Hornstein</b> <i>— UNITED STATES</i></p>		

## Calendar of Main IAC 2017 Deadlines



- Abstracts Submission Period
  - Papers Submission Period
  - Presentations Submission Period
- Abstracts Submission Deadline -> 28 February 2017  
Abstracts Selection -> 21-23 March 2017
- Papers Submission Deadline -> 7 September 2017
- Presentation Submission Deadline -> 14 September 2017

## Preliminary Congress at a Glance Chart



## Instructions to Authors

### Abstract Preparation

#### Format

- Abstracts must be written in English.
- Abstract length should not exceed 400 words.

#### Content

- Tables or drawings are not allowed in the abstract.
- Formulas can be included using the toolbox provided on the abstract submission web page.
- Abstracts should specify: purpose, methodology, results and conclusions.
- Abstracts should indicate that substantive technical and/or programmatic content is included.

#### Co-authors

All your co-authors should be added at the time you submit your abstract using the tool provided online. You should register all of them online indicating their name, affiliation, full postal address, phone and email address.

### Abstract Submission

#### Signing in

- The submission of abstracts must be done exclusively on the IAF website restricted area [www.iafastro.net](http://www.iafastro.net)
- If you are submitting an abstract on our website for the first time, you will need to register.
- In case you have forgotten your password, please use the password recovery utility.

#### Submission

- Go to the new abstract submission page.
- Browse the technical programme and choose the symposium and technical session for which you want to submit your abstract.
- Type the title and content of your abstract into the related fields.
- Choose your presentation preference: oral presentation only, poster presentation only, oral or poster.
- Confirm that the material is new and original and that it has not been presented at a previous meeting.
- Confirm that your attendance at IAC 2017 to deliver and present the paper is assured.

**Note: An abstract can be submitted to only one Technical Session**

### Abstract Selection

Submitted abstracts will be evaluated by the Session Chairs on the basis of technical quality and relevance to the session topics. Selected abstracts may be chosen for eventual oral or poster presentation – any such choice is not an indication of quality of the submitted abstract. Their evaluation will be submitted to the Symposium Coordinators, who will make acceptance recommendations to the International Programme Committee which will make the final decision. Please note that any relevance to the Congress' main theme will be considered as an advantage.

### Paper and Presentation Submission

- Details on how to prepare and submit your final paper as well as your presentation material will be available on [www.iafastro.org](http://www.iafastro.org) by mid-April.
- Authors with an abstract accepted for oral presentation will be offered a presentation slot of 10 to 20 minutes.
- Authors with an abstract accepted for interactive presentation will be offered a presentation slot of 5 to 10 minutes.
- Authors with an abstract accepted for an interactive presentation will be asked to prepare slides and display them for the duration of the congress on plasma screens. Authors will be assigned to interactive sessions in which they must be near the plasma screens to engage in interactive discussions with other congress attendees.

### International Astronautical Federation (IAF)

Preliminary versions of the IAC proceedings will be available to participants at the congress electronically. More information about the IAC paper archive is available on [www.iafastro.org](http://www.iafastro.org)

### International Academy of Astronautics (IAA)

Authors should follow the above general procedure. An additional suitability requirement is that the proposed topic must be related to a potential or on-going IAA Study Group activity.

### International Institute of Space Law (IISL)

Authors should follow the above instructions for the submission of their abstracts. In addition to the IAC Proceedings, the papers of the Colloquium, along with other materials, will be published in the Proceedings of IISL. Authors who qualify may ask to be considered for the Dr I.H. Ph. Diederiks-Verschoor Award for Best Paper. Please contact the IISL secretary for the regulations at [secretary@iislweb.org](mailto:secretary@iislweb.org).

### DEADLINES

Abstract Submission	28 February 2017
Paper Submission	7 September 2017
Presentation Submission	14 September 2017

**Please make sure to check the IAF website ([www.iafastro.org](http://www.iafastro.org)) regularly to get the latest updates on the Technical Programme!**

## AUSTRALIAN SPACE HERITAGE and PROSPECTS

Australia has an unusual and often misunderstood space heritage. Our principal commitments have been in support of our allies, initially the United Kingdom and, since the 1960s, the United States. We do mark, however, some important national milestones and achievements. Australia was the third or fourth nation (depending on the definition of sovereign territory) to launch a locally designed and manufactured satellite from its own territory. This was the Weapons Research Establishment satellite (WRESAT) in 1967. Australian diplomats played an active role in the negotiations that led to the signing of the Outer Space Treaty in 1967 and an Australian chaired the technical sub-committee of the Committee on the Peaceful Uses of Outer Space (COPUOS) for the first three decades of the sub-committee's existence.

Two astronauts are Australian born and the television images of Neil Armstrong stepping onto the moon were first received by stations in SE Australia before they were broadcast to the world.

The location of the Australian continent, equidistant in longitude from Europe and North America and the radio quietness of much of the landmass, means that it is very well suited to host ground

stations such as those for ESA in Western Australia and the NASA ground station at Tidbinbilla near Canberra. Radio astronomy is a national strength and the national space narrative incorporates and acknowledges the importance of astronomy.

Beyond providing real estate for the use of others, to this point Australian government and industry investment in space has been focused on satellite communications (including satellites) and data processing from satellites owned and operated by others. Technology is reducing the cost and other barriers of entry to space and various Australian organisations are presently building cubesats as a first step to the development of a 21<sup>st</sup> Century space industry that builds on entrepreneurship, agility, speed to market and profound collaboration. Of necessity new approaches to regulation, investment and priority and goal setting will be needed to best capitalise on these developments. The Space Industry Association of Australia invites all delegates to contribute to the discussion and the debate about the emergent Australian space sector at IAC2017 in Adelaide from 25-29 September 2017.



Students investigating the geology of Mars at the Victorian Space Science Education Centre (VSSEC), Melbourne, Australia



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