

## EXECUTIVE SUMMARY

2021



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## INTRODUCTION

#### Dear Members, Partners and Friends of Space Innovation

Although 2021 did not bring all the relief from the sanitary situation we hoped for, Space Innovation was able to step boldly into its activities, thanks to a dedicated team and the trust received from its valued members and partners.

Space evolved extremely fast in the past year. Commercial actors such as SpaceX took an even more prominent role in the media as well as in the occupation of orbits to the point of becoming a concern to scientists as trains of satellites could be observed with the naked eye on some summer evenings.

In collaboration with the Steering Committee, the update of the Strategic Plan was put in place and is now available to members. Although we became experts in visio-conferences and webinars, I am glad we could meet in person at the Annual Assembly in December. Established partners are strengthening their ties, new members are joining us, the younger generation is pushing to have an active part in space related innovation.

Thank you for your continued trust, and we look forward to actively shaping the future with you.

Vhass Prof. Volker Gass, Director

## O1 MISSION

### FOSTERING SPACE TECHNOLOGIES

With the evolution of our activities, we have re-formulated our mission statement:

### Space Innovation builds on the multi-domain relevance of space technologies to support the development of disruptive innovation projects in the space sector.

#### Our focuses are:

- Strengthening Switzerland's space capabilities
- Offering opportunities to involve players in space innovation
- Enabling space technologies to contribute to sustainable development

#### Our core capabilities are:

- An established network in Switzerland
- A solid national and international recognition and reputation
- Access to cutting edge technologies (from academia, RTOs and industrial partners)

#### Our value propositions are:

- Pro-active advancing of members' goals
- Establishing & supporting innovative projects with partners
- To be your voice in national and international activities

### **STEERING** COMMITTEE

Tasked with the approval of new members and organization of working groups, the members of the Steering Committee met regularly under the chair of Prof. Markus Rothacher.

In 2021, the Steering Committee was composed of the following representatives:

- Prof. Markus Rothacher (ETHZ), chair
- Dr. Julia Binder and Prof. Jamie Paik (EPFL), chair
- Prof. Marcel Egli (Academy representative)
- Dr. Gerrit Kuhlmann (RTO representative)
- Mrs. Elisabetta Rugi Grond (Industry representative)
- Dr. Fabrice Rottmeier (Industry representative)

## O2 MEMBERS

## A NETWORK IN EXPANSION

In 2021, Space Innovation welcomed 5 new members (Syderal Swiss, CompPair, Kistler, the Swiss Armed Forces, Coactum). Apart from the founding members which constitute the BoD (EPFL, ETH Zürich), 40 members from each region of Switzerland, representing all the types of companies (large-sized, medium and start-up), academies (Swiss Federal Institutes, Universities, Universities of Applied Sciences) and RTO (CSEM, EMPA, PMOD/WRC, EAWAG) are part of the network.



A new version of our "Members' Profiles" was edited in December 2021. This document is available electronically on the Space Innovation website.

## **03** IGLUNA 2021



IGLUNA is part of the ESA\_Lab@ initiative launched by ESA to create a hub for innovation between universities, research organizations and industry. More than 500 international students have already taken part in the platform. Based on the heritage of IGLUNA 2019 and 2020, the third edition of the project started in September 2020 and concluded with a Field Campaign in Lucerne in the summer of 2021.

This last academic year, 12 different teams coming from 9 countries worked on their technologies focusing on the challenge of remote operations and pushing their business applications further. During the Field Campaign held from 16-25 July, the students communicated from the VERKEHRSHAUS – Swiss Museum of Transport with their projects located on the Pilatus, more precisely on the terrace of the Pilatus Kulm and at the intermediate station of Krienseregg. The operations were carried out thanks to an infrastructure installed for the occasion by the Lucerne University of Applied Sciences and Arts and the RheinTec company.

After successfully completing the Critical Design Review in February 2021, participating in the Mid-term Event in March and passing the Readiness Review in May and June, the student





teams were invited to take part in the Field Campaign in a hybrid way. Some student teams travelled to Switzerland and met in Lucerne to test their technologies, while the others joined online from their respective countries due to the COVID-19 situation. The Project Shows were broadcast live on the Space Innovation YouTube channel, along with several other events that punctuated the IGLUNA campaign, including the Inauguration, the online meeting with ESA DG Josef Aschbacher, the public presentation of Astronaut Thomas Reiter, as well as the Closing Ceremony.



# 04 ESA Astronaut Selection

ESA's plan to launch an astronaut selection campaign in 2021 was revealed in September 2020. Preliminary discussions were initiated during that period between the Swiss Space Office and Space Innovation, to promote the astronaut selection to potential Swiss candidates. For this purpose, the Swiss Space Office mandated Space Innovation to create a video teaser and a master class in 3 languages, French, German and Italian, which can now be viewed on YouTube under the SBFI SEFRI SERI channel.

These activities contributed to the success of the astronaut selection campaign among the Swiss community. By the deadline, 670 Swiss citizens had submitted their applications, with a total of 22'600 candidates applying from all the ESA member states. The astronaut selection will continue in 2022 and we hope that one of the finalists will be a Swiss citizen.

## 05 EDUCATION



## SPACE INNOVATION WEBINARS

As part of the continuing education services that Space Innovation offers to its members, since 2020 a webinar series covering additive manufacturing for space mechanisms and structures was organized involving presentations of experts in this domain. Two successful online webinars were coordinated in 2020, and the series continued into 2021 with the webinar entitled "In-Space Manufacturing: Challenges and Opportunities for Building our 21st Century Future" given by Olivier De Weck, MIT in February.

In September, Space Innovation organized another webinar entitled "Experience and Outlook on In-Orbit Demonstration (IOD) in Switzerland". The target of the webinar was to initiate the reflection regarding a Swiss IOD mission and to get a first insight into the potential interest of Space Innovation members related to IOD. The agenda followed the presentations below:

- Fabien Droz, Head of Instrumentation Activity at CSEM SA, "Why Invest in an IOD?"
- Reto Muff, Chief Technical Officer at Thales Alenia Space Switzerland Ltd, "IOD of an Optical Freespace Communication System for Small Satellites"
- Veronica La Regina, CEO Nanoracks Space Outpost Europe srl, "Affordable and Valuable IoD/IoV for your Business: How to Work with Nanoracks Europe"

The participation from Space Innovation members in these webinars series was outstanding, demonstrating the interest in the events and courses organized by Space Innovation.



## HIGHER LEVEL EDUCATION

#### Massive Online Open Course on Space Mission Design and Operations

Claude Nicollier's Massive Online Open Course (MOOC) on Space Mission Design and Operations was switched to a self-paced mode at the beginning of 2021. This means that now the students can connect to the course when they want and do not have to follow the pace imposed by the instructor. This feature was often requested by the students, who wanted more flexibility to attend the various lectures and take the quizzes and tests, accommodating their professional or student life to the pace of the course. The follow-up of the students and the answering of the questions has however also been limited. Since its first edition in 2016, the MOOC has matured and has been adapted several times in order to take into account the evolution of the space business and technologies, but also to create a sound base course that covers space mission design and operations that will not become obsolete as time passes.

More than 30'000 students from all over the world (over 137 countries) and various horizons (from young students to experienced professionals who intend to boost their career or pursue a personal interest) registered for the course. More than 1'500 registered for the graded course in order to get a certificate (the course is free of charge but a small fee applies for the certificate track). From the beginning, more than 950 students received the certificate, successfully passing the graded tests. All of these numbers are increasing regularly.

The course is now self-standing, with limited support from the instructors and will probably not be further updated.

#### **Claude Nicollier**

Claude Nicollier was a member of the first group of ESA astronauts selected in 1978. He joined Group 9 of NASA astronauts in 1980 for Space Shuttle training at the Johnson Space Center, Houston, Texas, where he was stationed until September 2005. From 1996 to 1998, he was Head of the Astronaut Office Robotics Branch. From 2000 on, he was a member of the Astronaut Office Extravehicular Activity Branch, while maintaining a position as Lead ESA Astronaut in Houston. Claude Nicollier is Honorary Professor of EPFL and joined the Swiss Space Center, supporting the Swiss space activities.

The course is still a unique way to get a comprehensive introduction to human space activities, with much information covering various aspects of space environment and constraints. It is recommended as an introduction to all students wanting to work for space agencies and for those who are passionate or simply curious.

Basic registration for the course is free of charge on https://www.edx.org/course/space-missiondesign-and-operations. Students must, however, pay a reasonable fee for acquisition of the graded tests and to get a certificate if they successfully pass the assignments.

#### Course on Fundamentals of Systems Engineering (ENG-421)

The Course on Fundamentals of Systems Engineering was given to EPFL students by Prof. Olivier de Weck from MIT during fall semester 2021. This course, which is fully supported locally by the Space Innovation team, allowed 39 students to receive a comprehensive introduction to systems engineering.

The course is based on both the classical V-model of systems engineering and new agile approaches. The topics of the lectures ranged from stakeholder analysis to commissioning and operations, including all the steps required to successfully complete a project such as requirements definition and system architecture, as well as system safety, verification and validation.

During the course, trade-offs between performance, lifecycle cost and system operability have been discussed. The course was oriented towards practice, readings about systems engineering

standards and research papers were required from the students. The students also had to apply the concepts of systems engineering to a cyber-electro-mechanical system, which could subsequently be entered into a design competition.

#### Introduction to the Design of Space Mechanisms (EE-580)

An introductory course on the design of space mechanisms was given by Dr. Gilles Feusier from Space Innovation to the students of EPFL during the spring semester 2021.

The course gave a general overview of the space environment, including vacuum, radiations, thermal, micro-gravity and vibrations constraints. The course tackled the various aspects required to develop a space mechanism, including the selection of the materials, structural calculation and testing definition, as well as the selection and definition of components, like actuators, sensors and bearings. An introduction to space system reliability and space project management, including quality management, were also addressed during the course. Some invited speakers participated in the course, bringing their own hands-on experience to the students, on topics such as additive manufacturing and flexible elements. A total of 35 master level students followed the one-semester course, some of them complementing their acquired learning with internships in Space Innovation member companies.

#### Workshop on Antenna Design and Satellite Communication

This year, Space Innovation organized a Workshop on Antenna Design and Satellite Communication with Celestial GmbH, a reliable partner acquainted through the ESA\_Lab@CH activity coordinated by Space Innovation. The workshop was designed for bachelor students at the ETHZ Institute of Electromagnetic Field (IEF) following a course by Prof. Leuthold. With the participation of students from different departments, the workshop was held online where a high level of motivation and enthusiasm from the students enabled a deeper insight into the content.

#### Lecture Series: Space Research and Exploration

In collaboration with ARIS and ETHZ Prof Sascha Quanz, Space Innovation supported the coordination of the Lecture Series on Space Research and Exploration offered to students in their master's program during the Fall semester of 2021. With 120 students enrolled, the lecture aimed to shed light on key questions engaged by leading scientists and engineers today. It consisted in a weekly lecture given by different speakers with vast experience in their respective field (e.g., Human Spaceflight, System Engineering of Spacecraft, Space Life Sciences, Spacebased astrophysics). Subsequent to the talk, the students had the opportunity to deepen their understanding by asking questions to the presenter in a moderated Q&A.

Volker Gass presented an overview of the space actors in the Swiss ecosystem during the lecture on 19 October, and Tatiana Benavides gave a lecture on the effects of microgravity on the human body during the lecture on 26 October. Claude Nicollier also presented two lectures towards the end of the semester.

## SPACE FOR THE NEXT GENERATION

Along with Claude Nicollier, Space Innovation participated in many events to provide inspiration in space careers to the younger generation, from primary and secondary schools to university level.

We strongly believe that outreach activities in the space domain are extremely important to trigger interest in the STEM careers at an early age. Demand far exceeds the amount of time that can be granted to this activity.



#### **TecDays in High Schools**

Space Innovation also participates in the TecDays organized by SATW (Swiss Academy of Engineering Sciences) to support technology education at secondary schools. In these events, students spend a day attending different modules which offer insight into technology and research and facilitate exciting discussions with specialists. In the Space Innovation module, the staff teaches the students diverse aspects of space technologies, supplementing the explanation with an interactive activity consisting of a Moon mission carried out remotely by drones from a simulated control center. Due to the COVID situation in 2021, only 4 TecDays were hosted in physical form featuring 12 modules, while 5 TecDays took place in a virtual setting, featuring an additional 20 modules where more than 800 students were reached. According to the MINT's report, 43% of high school graduates chose to pursue these topics following a TecDay.

#### **Primary School Vivalys Mission**

In 2020-2021 the pilot project, Vivalys Mission, was implemented in Vivalys Elementary School at Ecublens, in partnership with EPFL Space@yourService (S@yS). This project was led by a student, Chloé Carrière, under the supervision of Space Innovation. The goal was to adapt an analogous space mission to the program of a class of 16 children, aged 7 to 8. As a result, the

entire class curriculum was set up around the mission. Not only did the children learn to read, write and calculate with a purpose, but they also integrated typical mission terms such as "SWOT analysis", "Standard Operating Procedure" or "Preliminary Design Review". The first mission was concluded

by a field trip in which the young analogous astronauts performed all tasks required for the mission with great enthusiasm.

With such a success, Vivalys Elementary School asked for a follow-up for 2021 – 2022 exploring the concept of "The Little Prince" by Antoine de St-Exupéry.

This school year the scenario is as follows: the children are warned of the dangers of overexploitation of the Earth's resources. To help them, a geographer suggests that they harvest minerals from an asteroid passing close to the earth.

The 15 young analogous astronauts aged 8 to 9 will be learning about the fundamentals of systems engineering and project management. They will have had a robotics workshop in partnership with EPFL Xplore Association, have followed a course on rockets with the EPFL Rocket Team, have analyzed rocks and minerals with UNIL SwissSIMS, and addressed a letter to the United Nations on the ethical right to claim and harvest a celestial object. Space Innovation serves as experts for the PDR, CDR and QDR.

The project will be concluded by a small analogue mission or expedition in the field, in March 2022, at the Fort Champex (Valais, Switzerland) where the children will be able to put into practice their knowledge and skills developed throughout the year. One of the objectives of the mission is to make the children aware of team spirit, mutual aid and autonomy. The Mission is mainly led by an EPFL student, Lucas Braud of the Space @ Your Service Association. We warmly thank him for his dedication.

Globis Astronautenschule

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- June 2021- Inauguration
- Claude Nicollier participated to this special event at ETHZ
- Science instead of fiction a nature trail for children
- Now open to receive groups of children

7-12 years ideally

# 06 STUDENT Achievements



### SPACE FOR THE NEXT GENERATION

In October 2021, the second edition of EuRoC (European Rocketry Challenge), the European student rocket building and launching competition, took place in Ponte de Sor (Portugal). A small number of teams from the continent's top universities were selected by the jury to take part in the 2021 edition. Among this small group were **two Swiss teams:** the *EPFL Rocket Team* and *ARIS* (ETH Zürich).

The *EPFL Rocket Team* **efforts were rewarded** as the team won the competition and was thus crowned European **champion in rocket construction and launch**. It also **won the award for reaching the target altitude of 3000 meters** as precisely as possible. While the EPFL Rocket Team had already achieved excellent results at the competition in the United States in June (notably 2<sup>nd</sup> place in its category and 2<sup>nd</sup> place in the ranking of the most innovative team), this trophy is a real confirmation of the quality of its know-how.

The second Swiss team, *ARIS* from the ETH Zürich, also did very well, **winning the title in its category**. This set of awards shows the hope that Swiss students have for the future of European space and the development of this industry in Switzerland. It was on the initiative (among others) of one of the members of the EPFL Rocket Team that this European competition was created in 2020, with the aim of contributing to the development and promotion of European space talent.

From now on, the EPFL Rocket Team competition will focus on moving to a **supersonic rocket for the next edition of EuRoC**. The association has set the goal of developing the necessary technologies (including a bi-liquid engine) to design a rocket capable of **reaching space within five years**.

# 07 NATIONAL Trainee Program

Since 2014 young graduates with Swiss citizenship have been given the opportunity to spend 2 years at the European Space Agency. The objective of this special initiative is to increase the number of Swiss staff at ESA. Simona Richard, Francesco Garrone and Aurélien Verdier have now begun their final year at ESA with the following activities:

- Simona Richard, Associate Strategy Analysis, ESRIN
- Francesco Garrone, System Engineering Support for ExoMars 2022, ESTEC
- Aurélien Verdier, Euclid Survey Detection of solar system object, ESAC

Simona Richard was happy to share a few words about her experience during an interview.

Scientific Assistant at Space Innovation and specializing in Political Science, Simona Richard is currently based at the ESA Centre for Earth Observation (ESRIN) in Frascati, Italy.

I am working in the Strategy and Development Office within DG Services at ESRIN in Frascati, Italy. Initially my main task was to support the Member States Relations team in analyzing national space policies and maintaining a comprehensive overview of the space landscape in the 22 ESA Member States. For a few months I have been supporting the preparation of the ESA Council at Ministerial Level (CM22) which will take place towards the end of 2022, and during which the ESA Programmes and financial commitments for the coming years will be decided. I am further involved in several initiatives that are coordinated within my office such as the ESA\_Lab@ initiative aimed at fostering partnerships with academia or research institutions and the ESA SDG Catalogue, a platform showcasing ESA projects in support of the UN *Sustainable Development Goals* (SDG).

#### What are the most interesting tasks or events you participated in?

Participating in the CM22 preparation allows me to acquire a thorough understanding of the European space sector's priorities, the challenges it faces, as well as where ESA and its Member States will be headed in the future. Being able to work on these topics in my daily job is most interesting to me and a privilege. Working on the ESA\_Lab@ initiative further allows me to collaborate with experts across the Agency and learn about a wide range of research topics.

A more specific task that made an impression concerned ESA's contribution to an exhibition called "Space for our Planet", highlighting how space technologies and applications support the achievement of the 17 SDGs. Together with my colleagues I proposed ESA projects to be featured in the exhibition and worked closely with Communications until its launch.

#### How will this experience be useful to your career?

The traineeship at ESA is a unique opportunity to kick-off a career in the space sector. Apart from gaining extensive knowledge of the European space sector – on a political as well as programmatic level – I appreciate that through my work I get to interact with people across all ESA Directorates. These exchanges allow me to strengthen my technical knowledge and add to a global understanding of how the Agency functions while also serving as a networking opportunity which will prove beneficial in the future.

The added value of space in our everyday lives and for tackling global challenges is a recurring topic in my work. Witnessing how space touches upon nearly every policy field makes me feel confident to pursue a career in space and put this experience into practice.

Lastly, I value the opportunity to gain firsthand experience in an intergovernmental organization and to grow professionally by successively taking on more responsibility within the team.

#### What are your projects for the future?

An exciting decade lies ahead of the European space sector and I would like to continue to be part of this journey beyond my traineeship at ESA which I will complete towards the end of 2022. If not in space, I see myself working at the intersection of science/technology and policy to combine my interest for both.

## O8 EVENTS



### **SCIENTIFICA**

On September 3-5, Space Innovation hosted a stand at the Zurich Science Days Scientifica 2021 event organized by ETH Zurich and the University of Zurich. Aligned with this year's edition, the topic of "Science Naturally" was the focus of the stand, and presented examples from the Space Innovation members related to enabling human survival on other planets, particularly on the subject of bioreactors. EAWAG, RUAG, Hochschule Luzern, amongst other members were featured. As an activity for the public awareness of space, children were encouraged to draw what they would need to feel at home on the Moon or Mars and how they would bring nature into space. Additionally, Prof. Volker Gass took part on a panel discussion at the Science Cafés on "How Space Tourism Could Become a Reality - Liftoff in 3..2..1".



## EXPO 2020 DUBAI -EPFL HOSTS THE SPACE WEEKS AT THE SWISS PAVILION

From October 17<sup>th</sup> to 30<sup>th</sup> 2021, the exhibition "Switzerland, a Space Nation" showcased our country's active international participation in the space field for over 50 years. It was an opportunity to raise awareness on research and innovation and space sustainability. Claude Nicollier was invited to represent Switzerland and hold a series of presentations.

## IAC - SPACE INNOVATION INVOLVEMENT

The 72<sup>nd</sup> International Astronautical Congress, IAC 2021, took place in Dubai, U.A.E., from 25-29 October 2021. Claude Nicollier attended the congress to represent Swiss interests. The IGLUNA Concurrent Design Facility study was presented during the IAF Space Exploration Symposium at the Moon Exploration session on Tuesday 26 October by former graduate trainee Gabriela Ligeza and IGLUNA alumni with a paper entitled:

SCALE: A Collaborative Payload to Demonstrate Multiple Technologies for a Lunar Habitat and Infrastructure

The team received positive feedback on the presentation and established valuable contacts to explore potential collaboration towards future IGLUNA-related activities.

Gaetan Petit and former employee Manuel Gerold also attended IAC to expand their network concerning the Space4Impact international accelerator program to connect space startups and new customers across industries and outside of the space sector.





## ANNUAL ASSEMBLY - ANNUAL ASSEMBLY ON DECEMBER 8<sup>TH</sup>, 2021

If the Annual Assembly had been a few days later, the pandemic measures would have constrained us to set up a virtual platform. Fortunately, with protective masks and Covid pass checks we were allowed to hold the session in person at EPFL. With over 70 people present during the entire assembly we can say that the networking objective was attained.

Prof. Volker Gass opened the session with a review of the projects and activities carried out during the year at Space Innovation. Prof. Markus Rothacher (ETH Zürich) presented the work of the Steering Committee that he chairs. Ursula Oesterle (Vice-Presidency for Innovation, EPFL), Chair of the Board of Directors, expressed her thoughts on new space activities for Switzerland, from maturing upstream technologies to emerging downstream opportunities. It is fundamental to find a way to bridge the gap between laboratory concepts hatched in universities and new products development in the private sector.

Three of our members were given the opportunity to present their companies to the audience, including two of our five new 2021 members: the renowned Kistler and the young start-up Coactum. Marcel Egli from the Hochschule Luzern gave a fascinating presentation on the impact of microgravity on astronauts, in particular on lower back pain.



We were able to witness the success of two student associations active in the field of space and collaborating wonderfully across the Röstigraben: the EPFL Rocket Team and Aris from ETH Zürich. With their brilliant results in international competitions, these students show us that the next generation is confident and motivated.

Finally, Daniel Neuenschwander from the European Space Agency gave a final word on the subject of the agency's launchers. After a conclusion and outlook for 2022 by Volker Gass, the audience gathered for networking purposes.

## 09 EXPERT'S Words



Let's recall a few recent successes. On the 4th of December we launched two Galileo satellites from the Guiana Space Center with a Russian Soyuz rocket; in mid-November we had VV20, which was the 20<sup>th</sup> flight of Vega rocket, which is very important as we had a failure on the 17<sup>th</sup> flight, so we have now three successes in a row. That's absolutely fundamental in terms of positioning on the market and now we head towards the main fight of legacy. A bit earlier at the end of October we had Ariane 5, our workhorse, which launched the Syracuse 4A and SES-17. In summary, all three missions took place for the freedom of action of Europe if you look at the payloads.

You are prepared to shape the future as long as you deliver in the present. We have a number of challenges ahead. Let's think about what's happening around us. First of all, there is the sustainability crisis in space. We are facing a huge issue with space debris, so it is important that Europe takes initiative and leapfrogs in response to this situation. We will make sure that all our upper stages in the future are deorbited, but that's not sufficient. In the future, we propose that each time we launch a satellite, we will also bring one down. It is clear that with the decision taken in the last consultation, Switzerland is in a very good position on this topic, but there's much more to do.

Going to the game changers, the connectivity constellations, we have the question of secured connectivity in Europe. Europe has to increase its investment in this field; this will definitely bring about change in the market.

We have an excellent position on the market with Ariane 5. As a matter of fact, the last 20 years were extremely successful but with a big risk of falling behind if we are not taking resolute actions. It is important to push for competition, and to assure that European institutional missions which are launched on European vehicles are robustly competitive.

We shall be ready for higher risk-taking, while also developing a real culture of tolerance towards failure. It is not about purposeful failure, it is about rapid testing, rapid re-flying and the readiness to encounter some difficulties. The key point is how you stand up and how you run even faster afterwards.

We have excellent talent in Europe. Switzerland is absolutely at the top in skilled workforce, so let's really capitalize much more on this skilled workforce and also be bold in placing priorities on hot spots we want to focus on in the future.

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