



Executive summary

2018

Cover: photograph from on board the International Space Station by NASA astronaut Jeff Williams, Commander of the Space Station for the Expedition 48 crew.
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2018

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INTRODUCTION



Markus Rothacher (Steering Committee/ETHZ), Renato Krpoun (Board of Directors/SSO), Volker Gass.

2018 started at a very high pace with a first time ever crowd ideation initiative, where the worldwide community was invited to give their ideas about future space activities. Within one month, after more than 70'000 views, 200 likes and 80 comments, 18 new ideas were generated and voted on. This confirmed the importance of the topics presented in April at the starting event of the International Student Project, IGLUNA, that is described later in this report.

Based on the new edition of the Swiss Space Implementation Plan, the Center's steering committee, led by Prof. Markus Rothacher, took on the task of updating our strategic plan by adding, among other things, emerging themes such as the handling of Big Data, cyber security and Industrialization 4.0 to our scope of activities. We look forward to discussing and working on these issues with you in the coming years through working groups or bilateral activities.

Space remains an exciting domain for education, research and industry. We particularly appreciate the involvement of

the younger generation in our activities and could reach more than 1000 youth through our outreach programs spanning from primary schools to universities.

Again, none of this would have been possible without the trust and support of our members and partners, and we always appreciate your input and engagement. The team of the Swiss Space Center thanks you and looks forward to a bright and challenging future working together.

A handwritten signature in black ink, appearing to read 'V. Gass', with a long, sweeping underline.

Prof. Volker Gass, Director

MISSION

A Link Between Institutions, Academia and Industry

In 2018 the steering committee took on the task of revising the strategic plan of the Swiss Space Center. Based on the second edition of the Swiss Space Implementation Plan (SSIP) released at the end of 2017 by the Swiss Space Office, the strategic plan was re-written, focusing primarily on “strategy” rather than on “operations”. The mission of the Swiss Space Center remains:

“To provide a service supporting institutions, academia and industry to access space missions and related applications and promote interaction between these stakeholders.”

Roles

- To network Swiss research institutions and industries on national and international levels, in establishing focused areas of excellence, internationally recognized for both space R&D and applications;
- To facilitate access to and implementation of space projects for Swiss research institutions and industries;
- To provide education and training;
- To promote public awareness of space.

Steering Committee

Tasked with the approval of new members, organization of working groups and preparation of the workplan, the members of the steering committee met regularly under the chairmanship of Prof. Markus Rothacher.

The Steering Committee is composed of the following representatives:

- Prof. Markus Rothacher (ETHZ), chairman
- Dr. Mickaël Thémans (EPFL)
- Dr. Urs Frei (SSO)
- Prof. Samuel Krucker (Academy representative)
- Dr. Antonia Neels (RTO representative)
- Mr. Urs Meier (Industry representative)
- Mr. Christian Schori (Industry representative)

MEMBERS

A Network in Expansion

In 2018, the Swiss Space Center welcomed three new industrial members (GF Preci-cast Additive, SCHURTER and Swissapollo). Apart from the founding members which constitute the BoD (SSO, EPFL, ETH Zürich), 33 members from each region of Switzerland representing all 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 all part of the network.

Board of Directors



Partner



- Institution
- Academic Member
- ▲ RTO
- Industrial Member



Members of the Swiss Space Center (status December 2018)

A new version of our “Members’ Profiles” was edited in December 2018. This document is available electronically on the SSC website, as well as a limited number of printed hardcopies which are available upon request.

WORKING GROUPS

PLATFORM TO SHARE COMPETENCES

Four working groups are currently in operation within the SSC network on the following topics:

- Education,
- Miniaturization and Mini- or Micro- Systems (M3S),
- Earth Observation & Remote Sensing,
- Software for Operations

Each member can send representatives to one or several of these working groups and additional working groups may be established at the request of SSC members, pending the approval of the steering committee.

In addition to these working groups, a group focusing on mechanisms and

structures organizes a yearly roundtable on a specific topic. This event is summarized below.

Second Round Table on Swiss Space Mechanisms Components

The second roundtable event on Swiss space mechanisms and components organized by the Swiss Space Center was held in Bern in the Swiss Space Office premises on June 18, 2018.

The nearly 4-hour event was primarily dedicated to mechanical components for space mechanisms. The term “building blocks” was used by several speakers in the five technical presentations proposed during the event. This shows the trend toward more and more modularity for building space mechanisms, with the target of reducing the cost and lead time. The development of space systems and sub-systems is indeed under pressure related to the developments of large satellite constellations. There is also clearly a trend toward frictionless mechanisms (using flexible elements and contactless sensors, power and signal transmission joints as well as actuators) and the use of additive manufacturing techniques for the manufacturing of the structures.

The feedback given by the participants in the roundtable was very positive. The roundtable presents a great opportunity to meet most of the Swiss community dedicated to space mechanisms.



IGLUNA

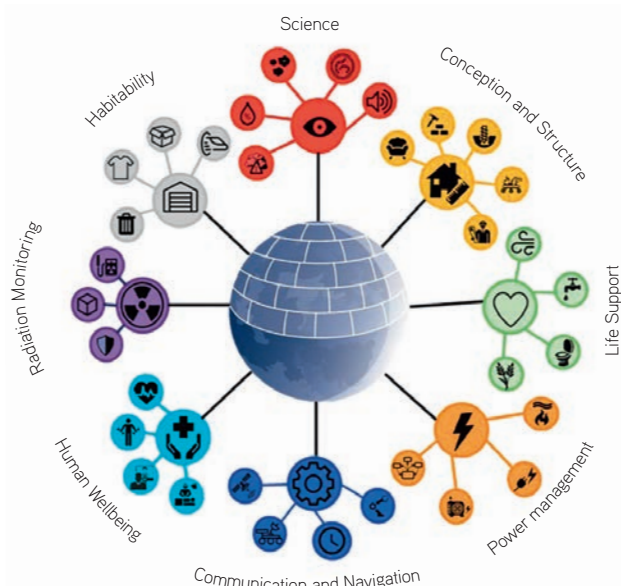
STUDENTS ACROSS EUROPE LAY THE FOUNDATIONS OF A MOON VILLAGE



IGLUNA, as a demonstrator pilot project, is aimed at supporting and accelerating the ESA_Lab initiative. The lessons learned from IGLUNA will help in the implementation of future ESA_Labs. The Swiss Space Center leads the project and the main systems engineering activities, mentors the students, coordinates the events, and communicates with the general public to increase the outreach.

The nature of the project is to stimulate student education and exchange through an international, interdisciplinary, and collaborative project on the topic: "A Human Habitat in Ice: Demonstrating Key Enabling Technologies for Life Support in Frozen Worlds." The topics covered in the project go from the habitat conception

and construction to life support systems, power management, communication and navigation, as well as human wellbeing and science. Students apply their knowledge to solve a technological challenge, increasing in parallel the maturity of technologies relevant to the space domain.



The purpose of this mission is to investigate an approach for constructing a human habitat on the moon, directly in the ice craters near the poles. 19 student teams from 13 universities from 9 European countries, with 7 student teams from 5 Swiss universities, including Swiss

Federal Institutes of Technology (EPFL and ETHZ) are working together during two academic semesters in 2018/2019 to build this habitat, which will be tested in a similar extreme environment inside a glacier cave in Zermatt, Switzerland, in June 2019.



The student teams met at ETH Zürich from September 12-14, 2018 for the IGLUNA kick-off event to mark the start of the student projects. During the event the students

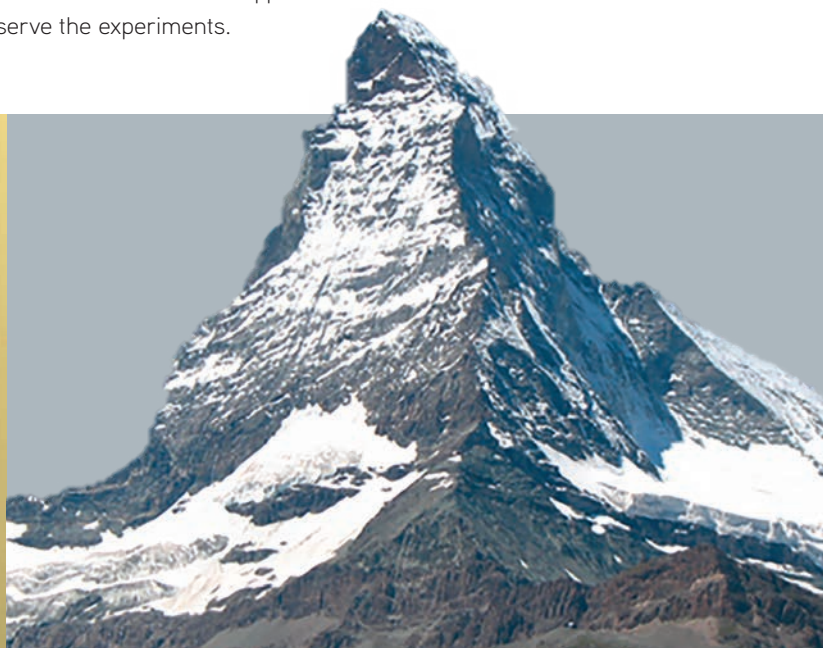
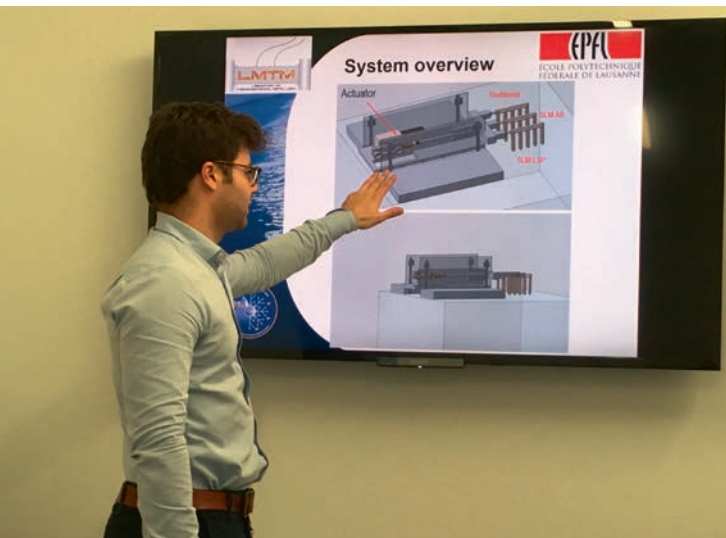
got to know each other, worked together, learned about design thinking tools, developed their project descriptions and requirements, and presented their projects.





For the Preliminary Design Review, the SSC visited the teams at their universities where the students presented the progress of their projects during the last two weeks of November 2018. The Critical Design Review will take place during the mid-term event planned for mid-January 2019 to mark the halfway point of the student projects.

The field campaign will take place at the Glacier Palace in Zermatt during the last two weeks June 2019. During this time, all the teams will meet, bring together their technologies, and present their demonstrations. Inside the glacier cave, the teams will build a 36m^2 human habitat. The Glacier Palace will be open to the public, and visitors will have the opportunity to observe the experiments.



NATIONAL ACTIVITIES

“Mesures de Positionnement” (MdP) Call 2016



The twelve studies selected under the MdP Call 2016 came to an end in January. Each of the consortia shared the results achieved in a final review and highlighted the roadmap for further development.

The traditional public event “Space Technologies Studies 2016 – Results” was held at EPFL on February 13, 2018. Once again, more than 100 participants from the Swiss space community and from

ESA gathered at the EPFL auditorium to know more about the results of these national activities, establish new links for future projects and learn about the next call for proposals.

In addition to the MdP consortium, the floor was given to the seven studies funded under the Call for Ideas 2017. Four of them took this opportunity to give a two-minute “elevator pitch” before the break.



“Mesures de Positionnement” (MdP) Call 2018

For the fifth time a Call for Proposals was opened for February 2019. Eleven studies were selected by the SERI/SSO at the end of an evaluation process implemented by the Swiss Space Center during the second quarter of 2018. These studies will be conducted for 15 months, culminating in January 2020. The goal is to better position Swiss industrial and academic entities with respect to competition, particularly in the realm of ESA activities and other international programs such as the EU Research Framework Programs.

The main objective of this Call for Proposals is to foster and promote Swiss technological and scientific competences that have a clear potential for space products and services/applications.

As usual, a public event will be organized in February 2020 at EPFL where the consortium will have the opportunity to present their main achievements.



Space Technologies Studies 2016: results

BE A STAR IN ESA'S UNIVERSE

The “Be a Star in ESA's Universe” roadshow stopped at Hepia/HES-SO in Geneva on November 7 and at ETH Zurich on November 8, 2018. Over 350 students participated in both events. The students heard inspirational talks regarding space careers from ESA, SSO, Hepia/HES-SO, CERN, Picterra, Apco, ETH Zurich, ARIS, RUAG Space, University of Zurich, Gamma Remote Sensing and Fixposition.

Students could direct their questions to the space professionals during the panel discussion which led to a vivid dialog on what it takes to launch your own career in space. The discussion between students and space professionals continued during the networking apéro.

We also took the opportunity to introduce the ESA initiative #spacetalk and invited the students to do a rocket-selfie. As the event was officially registered as a space talk, we proposed to the students to take selfies during the event and share them on social media under the hashtag #SpaceSelfie. During the month of November 2018, participants had the opportunity to attend a registered space talk all around Europe, take a selfie, post it with

the hashtag on social media and, with a bit of luck, win a trip to Kourou to the ESA launch site.



#SpaceSelfie at ETH Zurich



#SpaceSelfie at hepia/HES-SO



NATIONAL TRAINEE PROGRAM

Following the success of the first Calls since 2014, thirteen new positions were proposed to young graduates with Swiss citizenship. This special initiative, aimed at increasing the number of Swiss staff at ESA, is similar to other national trainee programs operating in Germany, Portugal and Belgium. At the end of the process, four candidates were selected and began on December 1st:

- Héloïse Boross, Prodex Office Support, ESTEC in the Netherlands
- Maude Maréchal, Additive Manufacturing, ESTEC in the Netherlands
- Miro Voellmy, Automation and Robotic, ESTEC in the Netherlands
- Valère Girardin, Future Launcher Preparatory Program, ESA HG in Paris



Grégoire Bourban – SSC • Valère Girardin – NTP • Héloïse Boross – NTP • Miro Voellmy – NTP • Maude Maréchal – NTP • Fernando Maura – ESA.



"On any given day, I may be talking to astronaut instructors, eurocoms, astronauts or flight surgeons."

Scientific Assistant at the Swiss Space Center and specializing in Biology, Corinne Hänggi is currently based at the European Astronaut Center (EAC) in Cologne. She explains what her tasks are...

During the course of my traineeship, I am a member of the 'Spaceship EAC' team at the European Astronaut Centre (EAC) in Cologne, Germany. The Centre's main purpose is the training of astronauts and the operation of the International Space Station. In anticipation of the decommissioning of ISS in the 2020's, the innovation team 'Spaceship EAC' was founded in 2012 with the goal to ensure the Centre's serviceableness post-ISS. My task within the team is to promote all biology related projects; the two major ones at this moment are a bio-regenerative life support system and the production of bactericidal surfaces. Besides this, I regularly get opportunities to assist with projects in a variety of areas and also with the supervision and management of student interns.

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

EAC is a small Centre with only about a hundred people. This, however, does not mean that nothing is happening here. Because we are not so many people, it's easy to get to know the staff working in all different areas related to human space flight. On any given day, I may be talking to astronaut instructors, eurocoms, astronauts or flight surgeons. I had some truly unique opportunities in my first year here

at EAC: I received a partial robotics training, I am part of a simulation mimicking extravehicular activities on the moon, and I was an extra in the filming of the movie *Proxima* by French director Alice Winocour, starring Eva Green and Matt Dillon, set to premiere in Cannes next year.

- **How will this experience be useful to your career?**

The traineeship at ESA is certainly an important steppingstone for me to get into the space sector. It's not only instructive in regard to how the space industry and human space exploration work, but it also shows me that possibilities in space exploration are ubiquitous. Besides this, I have been very lucky so far to meet numerous very interesting people who truly inspire me to keep aiming high in life and be persistent about my goals.

- **What are your projects for the future?**

I have one more year here in 'Spaceship EAC'. For the following summer, I plan to thru-hike the Pacific Crest Trail in the USA. After this, I would like to do a PhD in astrobiology and maybe apply for a temporary job with CNES at the Space Port in French Guiana.

DOCTORAL THESIS IN THE SPACE DOMAIN

Two major achievements in the ESA Networking/Partnering Initiative (ESA NPI) took place at SSC

2018 was a very special year for the two first PhD students at SSC, Florian Gallien and Camille Pirat. After more than four years at SSC, the time came to defend their thesis work, first in front of an experts' jury and finally publicly in front of their family, friends and colleagues. Both passed these important steps successfully and were awarded with a doctoral degree from EPFL. These two PhD works were carried out under the co-funding of the European Space Agency (ESA) and its program, Networking/Partnering Initiative (NPI). With this program, the two candidates had the opportunity to spend 3 months per year at the ESA Technical Center (ESTEC) in the Netherlands. This provided a unique experience and opportunity to access ESA laboratories and expertise.¹

Florian Gallien's research entitled "Periodic

Cellular Aluminum Structures for Space Applications: From Casting to Additive Manufacturing" was under the academic co-direction of Prof. Andreas Mortensen (EPFL-LMM) and Prof. Volker Gass (SSC). He was hosted by the section of Materials Technology at ESTEC under the supervision of Dr. Andrew Norman.

Camille Pirat's research focused on "Guidance, Navigation and Control for Autonomous Rendezvous and Docking of Nano-Satellites". He was under the academic direction of Prof. Volker Gass and supervised by Dr. Roger Walker, responsible for ESA CubeSat missions and in-orbit demonstrations, as well as Dr. Finn Ankensen, ESA GNC expert.

¹ Interview in Executive Summary 2015 (Florian) and 2016 (Camille)

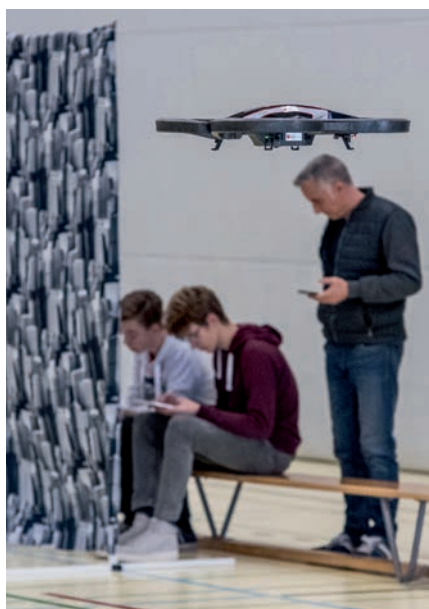


EDUCATION

School Visits and Open Days

To raise public awareness about space, particularly youth, the Swiss Space Center provides educational activities in a variety of contexts such as open days and class visits to the EPFL campus and the “TecDay” events, organized in schools all over Switzerland by the National Academy for the Promotion of Engineering Sciences and New Technologies (SATW¹).

A particularly appreciated educational activity is engaging participants in the concern of space debris as both a scientific and societal problem. The attached photo captures a typical moment of the activity, where school students face the challenge of a debris de-orbiting mission through maneuvering a drone toward its target. In 2018, more than 500 students from 7 secondary schools followed the module provided during the SATW TecDays. The presentations were done by the SSC staff members in the local language (French, German and Italian).



¹ http://www.satw.ch/index_EN



FocusTerra

From March 28, 2018 to June 16, 2018, focusTerra at ETH Zurich dedicates an exhibition to space: Expedition Solar System – Join ETH Zurich on a Journey into Space.



In addition to the exhibition, focusTerra published a brochure with illustrations and augmented reality elements to explain the solar system.

Claude Nicollier, who is also featured in this brochure, attended the opening ceremony and gave a short speech.

To increase dissemination among the Swiss population, the SSC took on the task to have the brochure also translated into French and Italian. This action serves to promote interest in the solar system to the younger generations during our outreach campaigns.

4th Swiss Space Summer Camp at ETH Zürich

The Swiss Space Summer Camp 2018 was held at ETH Zürich around the topic of Extreme Habitats.

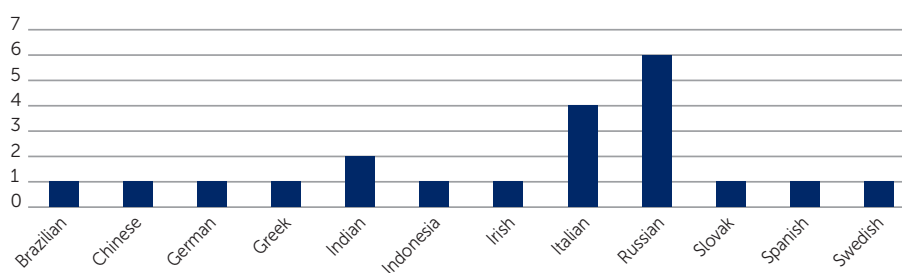


There were 21 students from Russia, Italy, the UK, Greece, The Netherlands, Spain, Sweden, India, Switzerland, and Brazil. The topics addressed were life support, structures, power generation and management, human well-being. The program

included a design thinking session at the ETH student project house, lectures given by external experts (EPFL, ZHAW, HSLU, FixPosition, Claude Nicollier) and social events.



Count of nationality



PUBLIC ACTIVITIES

Thomas Pesquet in Bulle

At the 20th anniversary of the Espace Gruyère Convention Center, Thomas Pesquet, a French ESA astronaut, came to Bulle on May 17th to make two presentations. The first presentation was for local schools and gathered 2000 teenage students and their teachers. The evening presentation was open to the public. All 2400 tickets were sold.

Th. Pesquet eloquently described his experience in the ISS, where he spent 196 days. Swiss “adventurers” Raphaël Domjan (SolarStratos), Laurent Sciboz and Nicolas Tièche (gas balloonists who broke the world record of the longest distance in a balloon) came on stage to share experiences and answer questions. Thomas Pesquet graciously signed autographs until late at night.

Upon recommendation of the Swiss Space Office, Espace Gruyère approached

the Swiss Space Center to seek advice in organizing a conference with so many young people and an astronaut. The Swiss Space Center participated by gathering a group of 14 volunteers to help with organizing this event. The Swiss Space Center was also visible with a booth to hand out information about ESA, Swiss Space, ISS posters etc. Organizers were dressed in SSC t-shirts and caps.



ESA astronaut, Thomas Pesquet, and the support team.

The Moonwalker Charlie Duke visited SSC

On December 12th, the youngest man to walk on the moon during the Apollo 16 mission, American astronaut, Charlie Duke, and his wife, Dotty, inspired young and more mature space enthusiasts in a small get-together organized at the EPFL by our member SwissApollo and the Swiss Space Center.

In April 1972, with only a few minutes left on the moon during their mission, Charlie and his commander, John Young, decided to do a few high-jump exercises in what they called the “Lunar Olympics” to celebrate the Olympic year. Before coming to visit us, they received an Olympic award in Lausanne for this achieve-

ment... 46 years after it had taken place! Charlie reminded us that even if the moon landings are important, Apollo 8, in December of 1968, dared to send people extremely far from home, behind the moon. It is inspiring to see the trust and courage these people had.



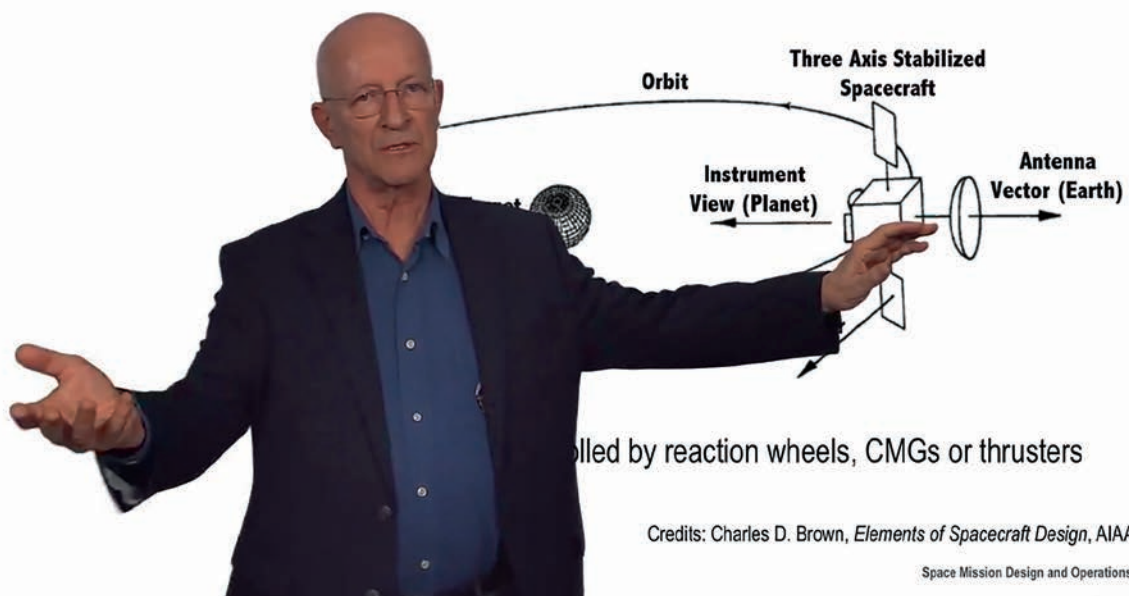
Massive Online Open Course on Space Mission Design and Operations

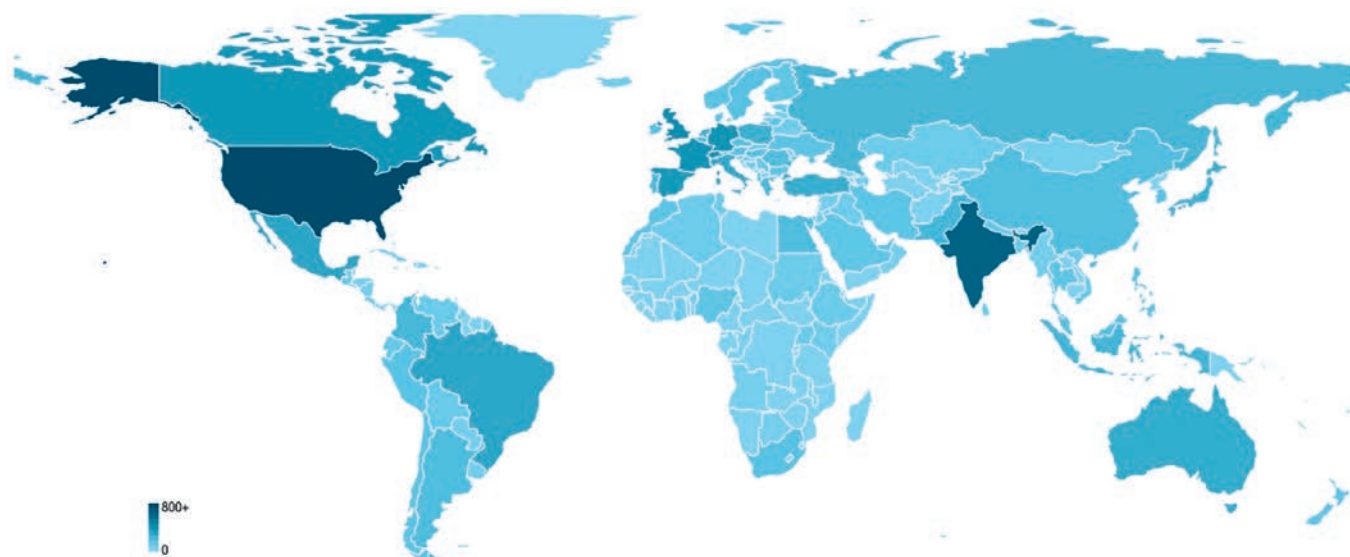
Claude Nicollier's Massive Online Open Course (MOOC) on Space Mission Design and Operations, which began in 2016, is updated on a yearly basis in order to improve learning experiences for students, to correct inaccuracies, and to take into account the latest news related to space activities. New videos are recorded, and the content of the website is reorganized and re-worded.

The third 8-week edition of the course, released in February 2018, was, like the first ones, a great success. A total of 15,810 students enrolled in the three editions. Over 30% of them hold a master's degree (or above) and 18% are women. More than 530 students successfully passed the ex-

ams. According to the survey and comments, the satisfaction level of the students was high. The course is indeed a unique way to get a comprehensive introduction to space missions and travels, with much information about the various aspects of space environment and constraints.

Three axis stabilized spacecraft





Claude Nicollier's MOOC also showcases Swiss expertise and knowledge. Students attending the course are coming from all around the world, from USA (20% of the students), India (13%), UK, France, Ger-

many ... Only 5% of the students attending the course are from Switzerland.

Next edition will start by the end of February 2019 and registration is free of charge on the www.edx.org platform.

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.

Reviews

I learned way more than I expected to. [...] I learned more in this course about orbital mechanics and the other topics than I did in my undergrad Aerospace program.

I would like to express my gratitude for a fantastic course! Really appreciated, useful, and good refresher of a course taken a long time ago in my case. I will definitely recommend this MOOC to anyone with an engineering background!

I liked the overall structure of the course. I think, however, that there was too much focus on the Space Shuttle. [...] I believe that the explanation of basic concepts related to this course could also be based on future plans and challenges regarding space exploration.

MEMBERS' WORDS



Claudia Rössli
Research Associate
Remote Sensing Laboratories
University of Zurich

The year of 2018 was an exciting year for the University of Zurich (UZH), with the diverse activities in the areas of Space Life Sciences, Astro-physics and Earth Observations that form the three main pillars of space-activities at UZH. Within the Space Life Sciences pillar, the third Swiss parabolic flight campaign was organised, taking off from Dübendorf airport, allowing guests to experience a zero-gravity adventure and scientists a platform to test their experiments in zero-g conditions. The summer of 2018 also included multi-spectral flight campaigns flown again from Dübendorf from different platforms such as a zeppelin or aircraft. The airborne campaign included the data collection over Europe with APEX (Switzerland's Earth observation instrument built under ESA's PRODEX program) and NASA's AVIRIS-NG. Data was collected for ESA and other research institutes in Europe for different projects. With the zeppelin mission, first experiments on the detection of the

plastic pollution in Earth's water bodies using remote sensing have been accomplished. Other activities at the UZH included radar remote sensing for (wet) snow cover detection and ESA's GlobDiversity project on the design of Essential Biodiversity Variables observed with Sentinel-2 satellite data.

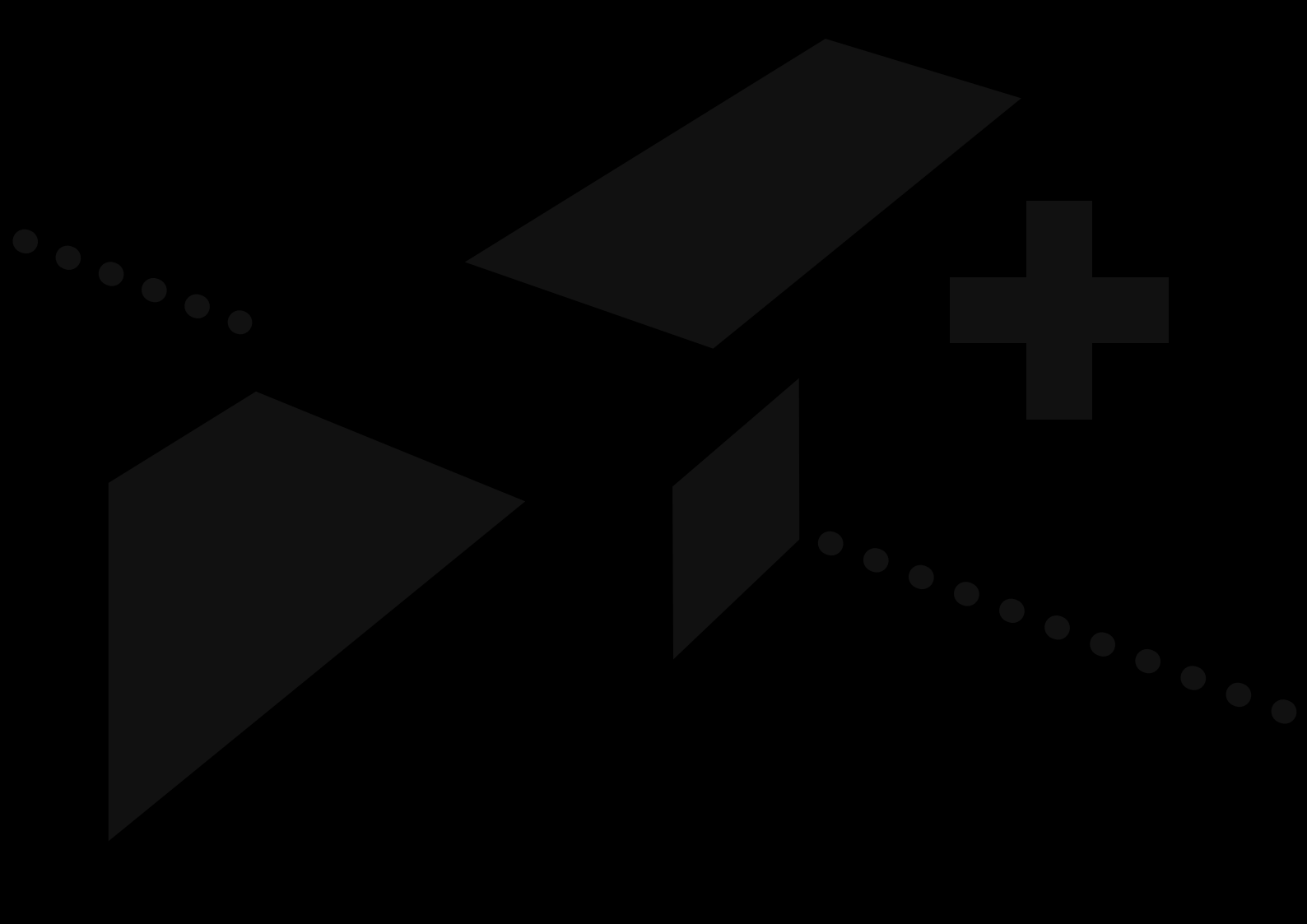
For two years, UZH has been a member of the Swiss Space Center and highly appreciated for their activities and promotion of the space domain. The UZH is involved in the working group of Earth Observation and Remote Sensing, the space promoting event of "Be a Star in ESA's Universe". They also participated at the event "Remote Sensing 4.0" and were able to present the UZH's activities during the Annual Assembly in Zurich. We appreciate the platform for exchange and networking and are looking forward to an exciting year in 2019 and also to intensify the collaboration and exchange with the SSC.



Bruno Zemp
Head Advanced Engineering
Schurter AG

In the past decade, an intensive research and development cooperation between SCHURTER and the European Space Agency (ESA) has led to new technologies and products for protecting electronic modules in space applications. This cooperation has created outstanding circuit protection devices which are the only full ESA ESCC qualified parts of this kind on the world market. The aerospace market is one of SCHURTER's strategic focus segments. SCHURTER is a competent, sustainable and innovative partner for circuit protection solutions in space application worldwide. It was a logical consequence for SCHURTER to become a member of the Swiss Space Center (SSC) in 2018, due to its strong position in the space market. The space industry in Switzerland might be small compared to others such as in France or Germany. However, Switzerland is home to many excellent research institutions and highly specialized and even hidden world class compa-

nies. SSC brings all these entities together, makes them visible and facilitates access to projects involving international stakeholders and organizations such as ESA. It strengthens the role of both, Switzerland's academy and industry in this rising competitive and very international market. The network of the SSC's national members facilitates innovation and enables prospering partnerships between academia and industry. These valuable benefits make SCHURTER an esteemed contributor to the SSC. SCHURTER actively participates in the community as a highly qualified manufacturer and innovator of electrical components for space applications, including up-screen testing and ESA ESCC qualifying of passive components. Therefore, SCHURTER intends to further reinforce its strong tie with SSC in the future. SCHURTER is pleased to be a member of the SSC family and is looking forward to exciting meetings and collaboration in the up-coming years.



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