



Executive summary 2014



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Introduction



*The Swiss Space Center Director, Prof. Volker Gass, with **Charlie Duke**, the 10th astronaut out of 12 to have walked on the Moon (Apollo 16 mission). Visiting Switzerland in April 2014, Charlie kindly accepted to share his fantastic experience with the Swiss Space Center.*

Dear members, partners and friends of the Swiss Space Center,

The year 2014 was filled with many events, opportunities and challenges, which have served to confirm our role and mission as technology network partner for the Swiss space community. The number of industrial and non-industrial members has increased, we have been asked to participate in international committees, allowing a representation of Swiss excellence abroad and, with the establishment of a Swiss Space Center hub at the ETHZ, the proximity to all national stakeholders has been enhanced.

The spin-off of the academic & project activities of the EPFL Space Center (eSpace) is in full progress and will be completed by the end of 2015. ESA's mandate for EPFL laboratory support activities is in full swing and has allowed Swiss industrial companies to become acquainted with the space sector whilst demonstrating the high competences of our industry to the European Space Agency.

Our staff has remained stable with a slight change in orientation towards service to our members as scientific projects are gradually being moved to the eSpace team. Our year-long public awareness campaign is starting to bear fruit, as more than 50 students have registered in the Space Technology Minor in the fall of 2014 at EPFL and we are enlarging our activities with the Swiss Academy of Science and Technology in high schools to motivate young people to consider technical careers through hands-on workshops and classes.

We will pursue our goals and remain committed to our mission in the coming year and are glad to have received new facilities to do so on both campuses at EPFL and ETHZ. I look forward to new challenges, the enlargement of membership and the strengthening of space actors in Switzerland as well as our reputation on the international scene.

Prof. Volker Gass, Director

Mission

A link between institutions, academia and industry

The mission of the Swiss Space Center, as declared in the “Terms of Reference” issued on October 31st, 2013 by the Board of Directors composed of the SERI/SSO Director, Daniel Neuenschwander, the EPFL Vice-President, Prof. Philippe Gillet and the ETHZ Vice-President, Prof. Roland Siegwart, is:

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

Role

- To network Swiss research institutions and industries on national and international levels in order to establish 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

The Steering Committee provided guidance to the Swiss Space Center through the establishment of essential documents, such as the Strategic Plan or the set-up of Working Groups.

After the first two-year period, the Swiss Space Center members were asked to re-elect their representatives at the Steering Committee. During the Annual Assembly held in December 2014, Ms. Nathalie Pichard and Prof. Zeno Stössel were warmly thanked for their hard work during the two years. The new composition of the Steering Committee is as follows:

- Prof. Nico de Rooij (EPFL), Chairman
- Prof. Markus Rothacher (ETHZ)
- Dr. Urs Frei (SSO)
- Prof. Samuel Krucker (non-industry representative)
- Mr. Fabien Droz (industry representative).



Members

A network in expansion

During the year 2014, the Swiss Space Center welcomed three new members : TSS Innovation projects, ZHAW and PMOD / WRC.

At the end of the year, the Swiss Space Center had 23 members from every region of Switzerland and representing all types of companies (large size, medium and start-up), academies (Swiss federal institutes, universities, universities of applied sciences), research and technology organizations and institutions. Discussions are on-going with other entities from the Swiss space community to include more members in 2015.

In 2014, three working groups were implemented, in which the members have the opportunity to present their activities and express their opinion. These working groups were defined in the Strategic Plan elaborated by the Steering Committee and approved by the Board of Directors in September. They address the following domains: education, miniaturization & mini- or micro-systems, high precision mechanisms & structures.

Members



Status: Q14 2014

Swiss Space Center Members.

Projects

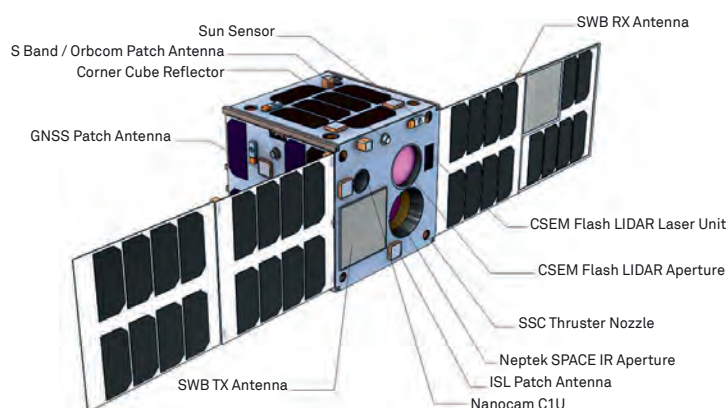
In-orbit demonstrations for large debris removal

The collision between the American satellite Iridium and the Russian Cosmos, in 2009, brought a new emphasis on the orbital debris problem. With its Clean Space initiative, the European Space Agency (ESA) is devoting increasing attention to the environmental impact of its activities. One of the branches of this program started the development and demonstration of the key technologies required for the capture and controlled atmospheric re-entry of an ESA owned uncooperative target, in the > 1000 kg class and orbiting in the LEO protected region. It is recognized that Active Debris Removal (ADR) involves risky manoeuvres and operations, and calls for new technologies. It is also recognized that it will require an expensive development phase.

In 2014, the Swiss Space Center performed an analysis in the frame of the ESA study “CubeSat Technology Pre-Developments, QB-50- Active Debris Removal”. The question that was raised in this activity was : can we reduce the risk of large debris removal missions with CubeSat In-Orbit-Demonstrations (IODs)? Two mission scenarios utilizing CubeSat technologies for the main satellite subsystems have been investigated. These two missions are called “CADRE”, for CubeSat Active Debris Removal Experiment. The first CADRE mission scenario involves the demonstration of rendezvous sensor technologies and operations. The second CADRE mission scenario is targeted toward the demonstration of net deployments and flexible link (tether dynamics). Both CADRE missions assume the use of an 8U chaser CubeSat and a 4U target CubeSat, launched together in a 12U deployer.

The study first addressed the scalability and applicability of CubeSat demonstration missions to the problem of large debris removal. These aspects are developed for the rendezvous sensors, for the guidance, navigation and control, for the net capture system and its dynamics, and for the mission design and operations. Once the rationale is established, the next part of the analysis highlighted the technical and system level challenges, and the solutions found to design the missions and CubeSats.

ADR Technology trade-offs were performed in the areas of rendezvous sensors, both vision and radar-based, and on the net capture. It was found that several types of rendezvous sensor would be necessary to fill all functions required for a non-cooperative rendezvous. In addition, CubeSat micropropulsion technologies and high-performance processors were evaluated. These technologies would require tailoring to the mission, integration and system level developments (and tests). While the selected rendezvous sensor and mission scenario fit the technology demonstrations of interest, all the analyses performed also showed a capability enabled by CubeSats that could be extended to other applications.



A small satellite that knows its way around immensity

CubETH, the youngest member of the Swiss cubsats family takes a lot from its predecessor, SwissCube, from an architectural point of view. The most innovative and significant design elements of SwissCube have been kept, such as the use of cell phone batteries packaged in a waterproof and thermally controlled casing. Another preserved feature is the use of the innovative system of copper pads that provide a better attachment of the solar cells on the satellite's walls. However, the scientific mission of CubETH, is more ambitious, as the spacecraft will be capable of calculating its own altitude and position in space with unprecedented precision, thus paving the way for nano-satellite constellations with inter-satellite communication capabilities.

This project is the result of a partnership between EPFL Swiss Space Center and the Federal Institute of Technology at Zurich (ETH Zurich). The launch of the satellite is scheduled for the end of 2015 at the earliest. The prototype is currently going through the "flat sat" stage, in order to test all its electronic components.

"We aim at making CubETH a high performance orbitographic tool capable of calculating its position, altitude and orientation in space with high accuracy," said Prof. Markus Rothacher, Director of the Geodesy and Geodynamics Lab at ETH Zurich, and main investigator for the scientific part of the project. The idea is to design a stable satellite in order to prevent it from spinning, as it happened to the SwissCube. "But most importantly, added the specialist, we want to create conditions for future cubsat constellations so that, for example, we could carry out thorough observations of Earth at a given time. For that reason, it is essential to know the satellites' exact orbits so as to coordinate their trajectories and scientific equipment."

Proven on earth, unprecedented in space

To achieve a more accurate measurement of the satellite's orbit, the researchers opted for GPS receivers designed by the Swiss company u-blox. "These sensors caught our interest because they are small, cheap and their performance is well proven," said Dr. Anton Ivanov, in charge of the satellite's entire technical design. The u-blox receivers are very common, particularly in mobile phones, but they have never been used in space. We want to prove that, by adapting its software, this low cost piece of hardware originally developed for terrestrial purposes can be used in space applications."

In addition, these sensors are compatible with other navigational systems like the Russian GLONASS or the European Galileo. Hence, researchers are envisaging the use of all of these GPS technologies, not only for the cubsat constellations but also in the context of the "cleaner" satellite project CleanSpace One. They could certainly provide the high precision necessary for carrying out the delicate maneuvers to approach and capture space debris.



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Finally, CubETH will also have an antenna on its side to study the atmosphere's composition and nature. The idea is yet again to verify the efficiency of less expensive components than those traditionally used in space. In such a way, the CubETH project remains faithful to the spirit behind cubsats in general: a platform for testing and demonstrating the applicability of standard electronic components in space.

An educational role

The cubsats format was devised by the California and Stanford universities, to allow scholars to conduct their own scientific experiments in space at a reduced cost.

CubETH is a federating project, in the sense that it generates links and collaborations between the two Swiss Federal Institutes of Technology, providing exciting hands-on study opportunities in space technologies to undergraduate and doctoral students.

Other Project Partners :

Academic : Hochschule Zentralschweiz (Luzern), Hochschule Rapperswil Technik

Industrial : u- blox, RUAG, Saphyrion.

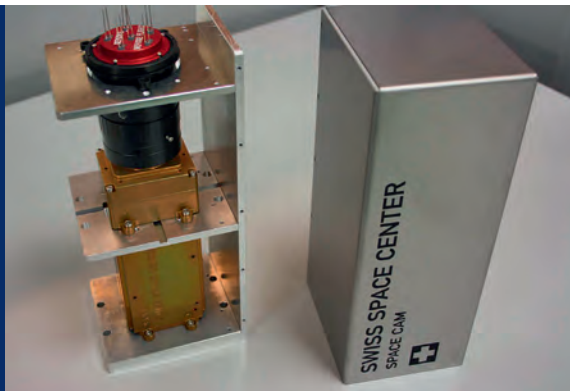
SpaceCam

The EPFL and Swiss Space Center started collaboration with the Beihang University of Aeronautics and Astronautics (BUAA) in Beijing, China in 2013. A common project was initiated as a stepping-stone towards this collaboration when BUAA gave the opportunity to the Swiss Space Center to fly a camera on the BUAA-SAT academic satellite that is planned to be launched in 2015/2016.

The Swiss Space Center identified a Swiss commercial off-the-shelf (COTS) industrial smart camera manufacturer and is adapting one of its camera models to space requirements and to the specific BUAA-SAT mission. The project has been called SpaceCam. The main objectives of the project are:

- to establish a positive collaboration momentum between Swiss and Chinese engineers, on a technical as well as a cultural level,
- to gain experience on the adaptation of COTS industrial components for space requirements that can be shared with the Swiss community,
- to train young engineers and students on space projects.

This activity also has synergy with the Active Debris Removal (ADR) activities initiated by the Swiss Space Center. Indeed, ADR requires the in-flight identification of debris and the determination of their attitude. Vision system is a key element of this goal. An ADR mission will therefore require autonomous vision system, making use of smart cameras and the SpaceCam may be adapted in the future for that purpose.



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Pre-assembly of SpaceCam QM. The SpaceCam is based on a COTS industrial camera produced by a Swiss company.

Interfaces, communication protocol between SpaceCam and BUAA-SAT, as well as the mission and technical requirements have been defined and agreed between both teams. SpaceCam Critical Design Review (CDR) has been successfully completed and the assembly of the Qualification and Flight Models is on-going. Some difficulties related to the adaptation of the embedded COTS software lead to a slippage of the schedule. Qualification testing is now planned beginning 2015 and has been kept inline with the BUAA-SAT mission schedule.

Structural and Thermal as well as Electrical Models of the camera have already been developed by the Swiss Space Center, delivered to BUAA and tested on BUAA-SAT test platform.

Collaboration between the Swiss Space Center and HES-SO has also started on the SpaceCam software, allowing HES-SO to improve its skills on embedded flight software.

National Activities

Mesures de Positionnement

“To foster and promote Swiss scientific and technological competences related to space activities”

2014 was a very important year for the national activities “Mesures de Positionnement” funded by the SERI/SSO and implemented by the Swiss Space Center. Indeed, the second cycle initiated in 2012 with twelve studies selected came to an end in January with the final reviews. A special event was organised at EPFL on February 11th, in which the project managers had the opportunity to present the main results before an audience of more than 120 people coming from the Swiss space community and from the European Space Agency. In the introduction, Mr. Alberto Tobias, Head of the Systems, Software and In-orbit Demonstration Department at ESA, highlighted the necessity of such national initiatives to support ESA developments and maintain the excellence of Switzerland for high-quality, innovative and reliable products.

Based on the success and the quality of the two first cycles, the SERI/SSO has decided to launch a third “Call for Proposals”, officially opened on February 24th. 30 proposals were received among which 10 were selected for funding over a period of 15 months. The kick-off meetings were held in October and the final reviews should take place in January 2016.

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Alberto Tobias, Head of the Systems, Software and In-Orbit Demonstration Department at ESA.

Events

9th ESA Round Table on Micro and Nano Technologies for Space Applications

From June 10 to 13, the Swiss Space Center hosted the “9th ESA Round Table on Micro and Nano Technologies” at EPFL, organised by the Component Technology Section of the European Space Agency. For the first time in almost 20 years of existence, this conference was organised outside the technical center of ESA located in Noordwijk, The Netherlands. In order to celebrate this event, more than 100 participants, from all over the world, were welcomed at the new Swiss Tech Convention Center for the 54 presentations selected. All the different fields of the micro and nano technologies were covered, from the RF-MEMS to nanotechnology, through the sensors and actuators which are of high interest for the determination and control of attitude and orbit of a spacecraft. Although they are well represented in our everyday life, micro and nano technologies are not yet standard in space applications despite very interesting possibilities. The low volume of the market and the long qualification process are probably the main reasons that explain this situation, obliging actors to find very specific applications where microtechnology is a necessity. This was the case for the Silicon-based microseismometer for planetary deployment, which was developed by the Imperial College of London, Oxford University and the company Kinemetrics.

Hosting this round table in Switzerland was also the occasion to show to the community the competences of Switzerland in this domain through several presentations done by Swiss stakeholders. At the end of the first day, a welcome cocktail was sponsored by the CSEM, during which ESA astronaut Claude Nicollier (also Professor at EPFL and Chairman of the CSEM) gave an outlook of the immensity of the Universe to a public usually focused on the extremely small. On Thursday, a special dinner was organised at the Olympic Museum where the participants had the opportunity to visit this symbol of Lausanne and enjoyed an apero with an amazing view of the lake and the Alps.

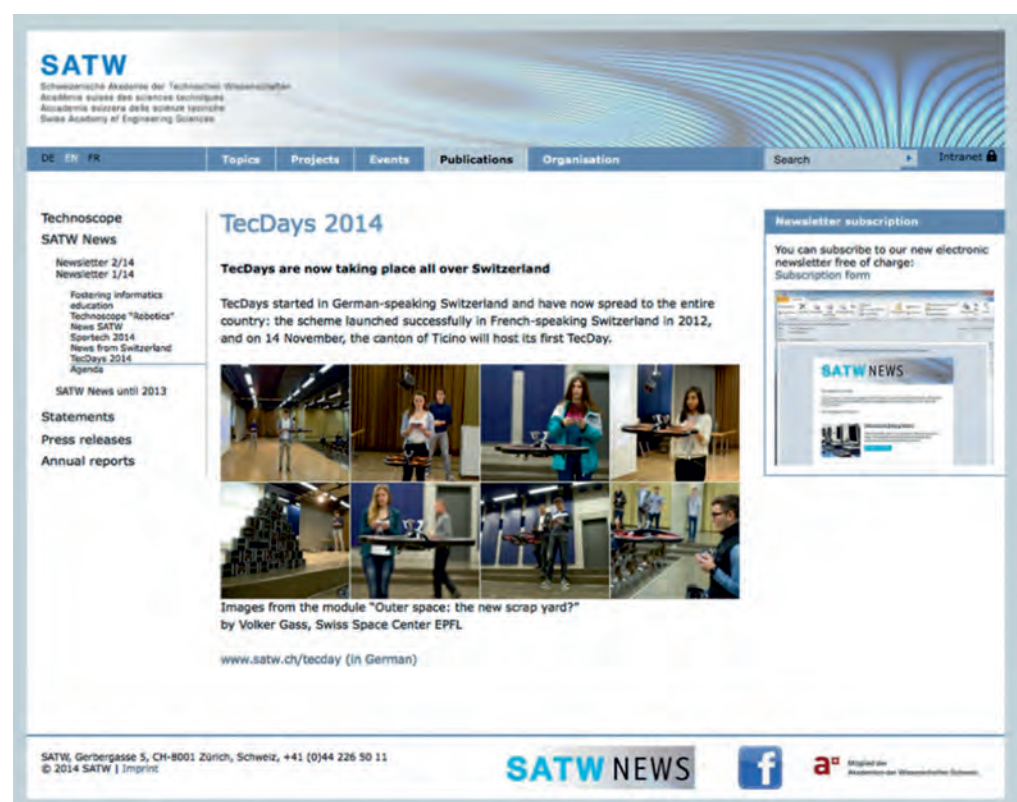
The conference was closed on Friday 13th with the participation of Mr. Franco Ongaro, ESA Director – Technical and Quality Management, who reminded the audience of the importance of high-level technology research and development for space applications.



SATW TecDays

Every year, the Swiss Academy of Engineering Sciences (SATW) organizes special days in Swiss highschools during which scientists have the opportunity to present their work to students. In 2014, the Swiss Space Center participated in three events in the different linguistic areas of Switzerland (Zofingen, Lausanne and Locarno). The objective was to raise the awareness of the youngsters for in-orbit debris through a presentation entitled "Space: the new junkyard".

A game under the form of a quadricopter competition was organized to catch satellite mock-ups. Six sessions were carried out, more than 100 young students attended them and the feedback given at the end was very positive, encouraging the Swiss Space Center to pursue its action in 2015. Our module was relayed in the media and on the main page of SATW TecDays 2014.



National Trainee Programme

The SERI/SSO announced the launch of a National Trainee Programme in order to foster the education of young graduates in space business. Within this programme, ESA provided the Swiss Space Office with job descriptions addressing technology areas jointly determined. The Swiss Space Center was entrusted to organise the selection of the candidates and all the administrative support linked to it.

The selection of the applications took place from August to early September. 18 applications were received from EPFL, ETHZ, USI, HES-SO, University of Fribourg and BUAA.

Three Swiss trainees were selected addressing the following areas: “Space Automation and Robotics”, “Time and Frequency” and “Space Debris”. They will start working at the ESA sites ESTEC in the Netherlands and ESOC in Germany in 2015.

The second edition of this programme will start in May/June 2015 to allow future trainees to start in fall 2015.



Space Career Day 2014

The promotion of careers in the space sector to students in Switzerland is one of the key roles of the Swiss Space Center. After a successful edition in 2013, the Swiss Space Center organised another edition on 9 October 2014 at the SwissTech Convention Center in the frame of “Forum EPFL”.

Several Swiss industries (APCO, RUAG, S3 and Almatech) presented their company and gave an overview of their space programme and career opportunities. Young engineers shared their experience about the minor in space technology at EPFL and the ESA Young Graduate Trainee Programme. The SERI/SSO participated and presented the Swiss Space Programme and the National Trainee Programme. About 50 students from Swiss universities attended this workshop and had the opportunity to network with the invited speakers.

Similar workshops will be organized by the Swiss Space Center in 2015 in ETH Zürich or other parts of Switzerland to reach a bigger student community and include the main Swiss space actors.

ECSS Training, continuing education course

In September, the Swiss Space Center organised a training course entitled “ECSS Training”. The purpose of the seminar was to give an introduction to the set of standards established in the frame of the European Cooperation for Space Standardisation (ECSS). The aim of the ECSS initiative is to improve industrial efficiency and competitiveness in the space industry by standardisation of project management, product assurance and engineering activities.

The lectures were given by specialists from the European Space Agency. The course was organized in the frame of the Hub of the Swiss Space Center at the ETH Zürich and was held in the Hönggerberg campus. 27 people from academia and industry attended this 3-day course, open to all the Swiss space community.



Group photo with A. Santovincenzo (left), E. Gonzalez-Conde (first row, right), two of the ESA-experts giving the course.



Chinese Swiss Space Science Workshop

The Chinese Swiss Space Science Workshop was organized by the Swiss Space Center on behalf of SERI/SSO, in cooperation with the National Space Science Centre (China). It was held from 10 to 11 September 2014 in Lenk im Simmental, Switzerland, with the participation of 14 Chinese and 21 Swiss scientists.

The objectives of this workshop were to introduce the Strategic Priority Programme on Space Science, present the current missions, identify opportunities, expertise, potential stakeholders and relevant framework conditions for a mutually beneficial collaboration of Chinese and Swiss space research communities. The main topics addressed were astrophysics, planetary science, fundamental physics, solar and space physics, microgravity and space environment, earth observation.

SERI/SSO, the Swiss Space Center and the Swiss Embassy in China concluded the workshop by expressing their willingness to support scientists from both countries in order to develop existing and new collaborations. The Chinese Academy of Science has decided to establish a new institution dedicated to space sciences, where most of the Chinese delegates attending the workshop will be involved. This institution will create new missions and secure background studies for the next 5 years.

Prof. Wu Ji, Director of the NSSC, has kindly proposed to organize the second Chinese Swiss Space Science Workshop in Beijing in 2016 and has invited all participants of this first workshop.



ESA Celebration: 50 Years of European Cooperation in Space

On 12 September 2014, ESA commemorated 50 years of European cooperation in space at the Centre International de Conférences de Genève (CICG). This event brought together many major academic, political and institutional partners from Europe and beyond. Many students from Europe including 20 Swiss students, interested in this promising field were also invited to attend the event and were given the opportunity to interact with professionals from various space-related fields in the form of “speed-dating” rounds. The results were later reported to all the participants by a group of selected representatives.

During this day, the latest news and breathtaking images from the ambitious 67P/Churyumov-Gerasimenko-bound Rosetta mission were shared with the audience, as well as other recent scientific highlights. The audience was furthermore given the chance to follow a discussion between high level representatives of some of the most important national and supra-national space organisations (ESA, NASA, JAXA, IKI and NSSC), mainly on the future of space and collaborations with Europe. Beyond those more programmatic aspects, important scientific players also recollected major achievements and successes of the European space efforts, and projected themselves into the future, before Jean-Jacques Dordain’s closing remarks.

2014 BUAA / EPFL Summer Camp

For the second year, a delegation of professors and students from Beihang University (BUAA) in Beijing was hosted at EPFL for a week from 25 to 30 August. The Chinese delegation that attended this EPFL summer school was composed of 5 students at master / PhD level and 4 Professors, coming mainly from the Robotics, Image Processing and Satellite Engineering fields (see table below). The summer school, specialized in space technologies, included theoretical courses, project design sessions but also practical training. The first day was dedicated to technical exchanges between both schools. A practical training was proposed with the mechanical assembly of a ball bearing system. The first phase of the training included a theoretical part, with applications, and engineering elements related to ball bearings. The second phase was composed of the assembly of the ball bearing system, its pre-load and mechanical tests. Another training exercise was provided by the Swiss Welding Institute. The purpose was to introduce students to the standards and main aspects of welding for space applications. In parallel, project design activities were proposed with topics linked to Active Debris Removal. BUAA had expressed interest in this domain, thus the design project was centered on the design of a nano / micro-satellite that would remove a launch vehicle interface adapter (150 kg) from 700 km altitude in space. In the end, the Chinese delegation was very appreciative of the proposed activities and would like the duration of the Summer School be extended to 10-15 days.

Name	Position	Research Field
Niu Jianwei	Prof./Vice-dean of School of Computer Science and Engineering, BUAA	Computer Science
Wang Xinsheng	Assistant Professor / School of Astronautics, BUAA, BUAA-SAT Project Manager	Micro / Nano-satellite System Engineering
Zhan Qiang	Prof. / School of Mechanical Engineering & Automation, BUAA	Robotics
Wang Wenguang	Associate Prof. / School of Electronic and Information Engineering, BUAA	Image Processing, Target detection and recognition
Zhou Kaixing	Ph.D candidate / School of Astronautics, BUAA	System Engineering, embedded system
Zhang Hao	Master student / School of Astronautics, BUAA	OBDH system / Hardware design
Hu Shengman	Master student / School of Astronautics, BUAA	Spacecraft attitude control
Wang Lei	Master student / School of Computer Science and Engineering, BUAA	Computer Science
Zhang Yin	Ph.D candidate / School of Mechanical Engineering & Automation, BUAA	Robotics

BUAA attendees list.

Communication strategy

In order to promote space activities, the Swiss Space Center is implementing a communication strategy with the use of a new mailing systems and through social media. The Swiss Space Center is also looking to reach and involve the young space community using Facebook and LinkedIn. Space amateurs and professionals are now able to subscribe to the regular news sent by the Swiss Space Center or follow them on both social media.

The Swiss Space Center has moved

The Swiss Space Center (SSC) has moved from EPFL... to EPFL. In order to continue to improve its support to the Swiss space community and to its members, the Swiss Space Center has moved into another building on the EPFL site, gaining space, improving its organisation and permitting a clear separation between the EPFL Space Center (eSpace) and the Swiss Space Center activities.

For the education and training activities, as well as for supporting the Swiss space community and its members, the Swiss Space Center possesses and continuously improves its own facilities related to space activities, and has access to the many facilities available amongst the various EPFL laboratories. The Swiss Space Center facilities include: a thermal vacuum chamber, a cleanroom, a concurrent design facility (CDF), a student laboratory, and a one-axis motion simulator.



SSC is located on the third floor of the PPH building (Photos Alain Herzog / EPFL).

Members' Word



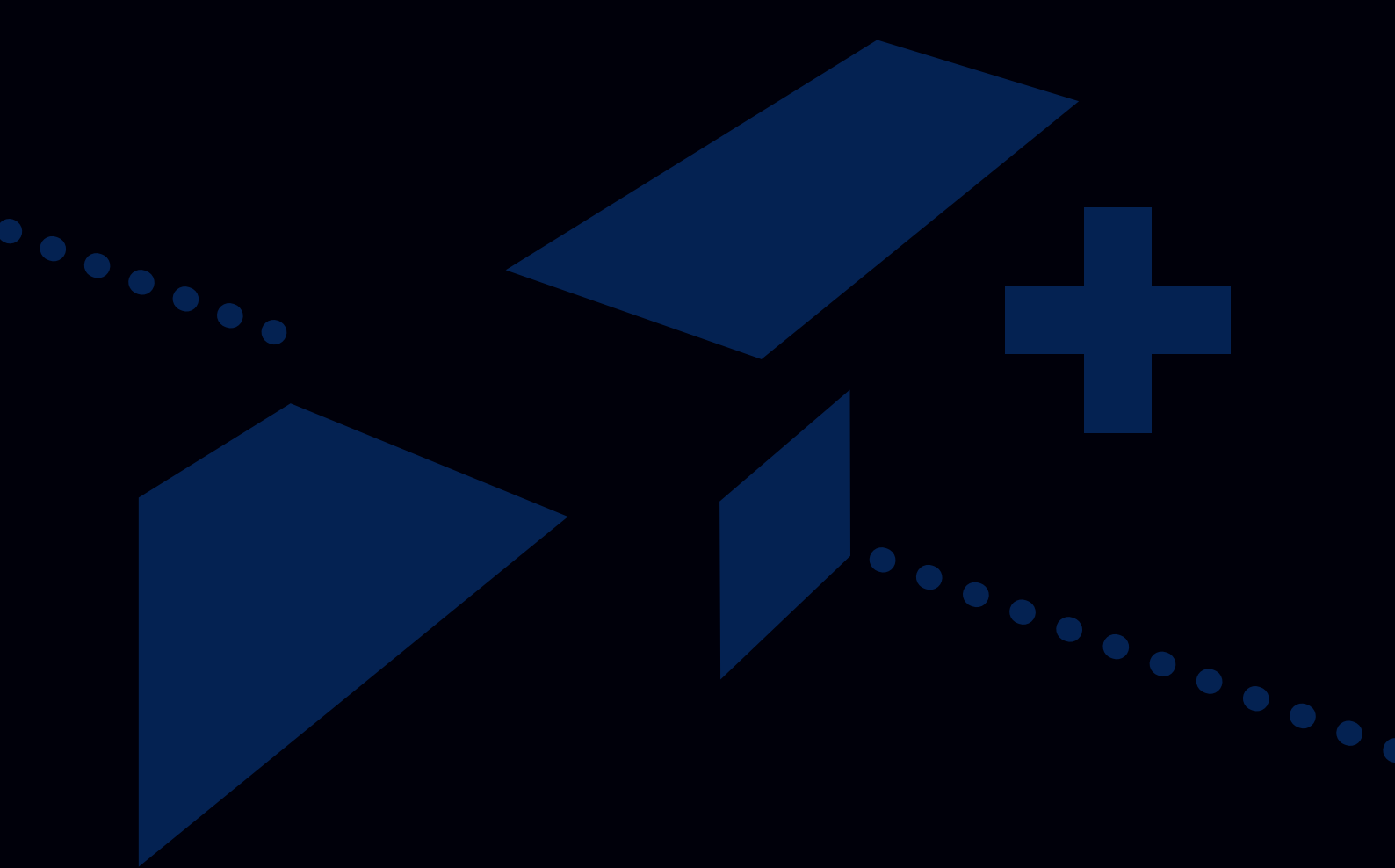
Fabien Droz

Vice-President Space Activities, Orolia Switzerland (Spectratime)

The space market is complex. The customers are not so numerous; few space agencies and major companies. The rules are different depending on satellite missions or projects and the same entity could be your partner, your competitor, your supplier or your customer. This is true for the majority of the industries working in the space domain even with well established products as the Spectra-time atomic clocks or oscillators.

Due to this complexity, the anticipation of the contextual frame is crucial. Selection of the most adequate technologies, of reliable partners or evaluation of efforts to be well positioned for the capture of a market are keys of success. The Swiss Space Center can play a significant role in those efforts. Effectively, through the management of innovative projects (MdP, call for ideas, introduction of new TRP) or via the networking, the Swiss Space Center is an additional tool at the disposal of the Swiss space actors. The Swiss Space Center has already helped us to evaluate the real potential of a technology or its associated risk and to select the most suitable Swiss partner.

We also appreciate the involvement of the Swiss Space Center to manage the teaching of graduate engineers and its contribution to the reconnaissance of the Swiss space community's strong capability to provide worldwide products and services in such a particular domain.



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