Summary

Introduction
2013: Broadening the Scope

Mission
A link between institutions, academia and industry

Role

Members
A network in expansion

Projects
Clean-mE / Active Debris Removal
Toward solutions for an efficient debris removal
ClearSpace One in orbit with Swiss Space Systems (S3)

SpaceCam
An eye in space to identify debris

CubETH
A tool for precise orbit determination

Call for ideas 2013
To foster disruptive space innovations based on ideas and concepts

Swisscube
Twenty-two thousand trips around the planet

Events
Space Career Day 2013
To grow the “rocket scientists” of tomorrow!

ESR International Summer School
A comprehensive overview of satellite navigation

Space technology summer camps
Moscow
Beihang University

International Astronautical Congress
When all space actors come together

6th EPFL robotic festival

Members’ Word
The reputation of the Swiss Space Center is steadily growing among the national and international actors. This allowed us to participate in important conferences such as the RAST in Istanbul and the IAF/IAC in Beijing as invited speakers or as session chair persons and gave us the opportunity to inform the international space community about activities in Switzerland.

The first summer school with Beihang University as well as the now established summer school with Baumann University of Moscow were a great success and will be enhanced and repeated in the future.

The Swiss Space Center has equally been busy at a national level. Projects such as CubETH and the ESA GSTP study provide positive synergies between large and small industrial members as well as universities of applied sciences and the two federal institutes of technology. Continuing education has found strong interest with the prototype of a week-long systems engineering course that will be opened to all members from 2014 onwards.

The new initiative “call for ideas” launched in 2013 showed a strong resonance in the country with more than 30 proposals submitted, a third of which could be funded. We are confident that more than one of these studies will result in a project under the upcoming “Mesures de Positionnement” or other international funding measures.

It is thanks to the support and trust of our members and partners, as well our thoroughly dedicated staff that we are able to accomplish the activities presented in this executive summary and we are looking forward to the challenges that lie ahead of us.

Volker Gass, Director
Swiss Space Center Members.

Mission

A link between institutions, academia and industry

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

Members

A network in expansion

During the year 2013, the Swiss Space Center welcomed seven new Swiss industries within its members: Almatech, Clemessy, DLTECH, Meggitt, Sarmap, Spectratime and Swiss Space Systems (S3).

Therefore, the Swiss Space Center currently counts 20 members from each region of Switzerland and representing all types of companies (large size, medium and start-up), academies (Swiss Federal Institutes, Universities, Universities of applied sciences) and Institutions (Swiss Space Office, CSEM). Discussions are on-going with other entities from the Swiss space community to include more members in 2014.
Projects

Clean-mE / Active Debris Removal

Toward solutions for an efficient debris removal

China’s demonstration of its capability to destroy an aging satellite in 2007, and the collision between the American satellite Iridium and the Russian Cosmos in 2009 brought a new emphasis on the orbital debris problem. Although most of the work had been concentrated on avoidance prediction and debris monitoring, all major space agencies are now claiming the need for active removal of debris. About 16'000 debris above 10 cm are catalogued. Roughly 2'000 of these are remains of launch vehicles, 3'000 belong to defunct satellites and the rest are either mission generated or fragmentation debris.

In addition, over the years, many studies have been performed to actively remove debris from LEO and GEO, and there is a vast pool of information on this topic. However, all solutions known at this point for removing debris are difficult to implement and require non-trivial resources (cost, mass,…). Furthermore, all these solutions need new technology developments for efficient debris removal. Based on these observations, the Swiss Space Center has been involved in active debris removal research activities over the last 4 years in a program called “Clean-mE”. Three major activities involving students were pursued in 2014 in this field. The first activity was funded by EADS Astrium under a CNES contract. It had for purpose the evaluation of the most cost-effective way to remove 5-10 large debris (the ones with the most debris creation potential) per year. The Swiss Space Center in collaboration with Prof. O. De Weck, MIT (USA), created a mission and campaign analysis tool to feed the technical analysis. The tool optimizes the launch date and the debris selection path, the number of remover satellites per launch; it provides a conceptual design of the remover satellite and kits, and allows for technology trade-offs (see Figures XX1 and XX2). The results of this activity were published at the 6th ESA Conference on Space Debris in Darmstadt, Germany. A second activity started under ESA funding, which purpose is to evaluate if and which ADR technologies could be demonstrated in space using CubeSats (ranging from 2 units up to 6 units in size/mass). This activity involves academic and industrial partners of the Swiss Space Center. It is expected to finish late 2014.

Figure XX1
Example of 3 mission architectures for removing 4 target debris [1].
CleanSpace One in orbit with Swiss Space Systems (S3)

The third activity of the Clean-mE program was the continuation of the CleanSpace One (CSO) project, which purpose will be to demonstrate the removal and de-orbiting of SwissCube. A first funding partner, Swiss Space Systems (S3), joined the project late 2014. Project management and mission scenario evaluations are on-going. A press conference took place in Payerne on September 10, 2013, to announce this new partnership and present the satellite’s new design. A large media coverage resulted from this event.

CleanSpace One Will De-Orbit Space Junk in 2018

CleanSpace One is to be the first satellite to clean up a cloud of dangerous debris. Developed at EPFL in Lausanne, Switzerland, the satellite will function as an orbital sweep for the S3 family of small space satellites. The S3 team is the launch technology that produces no orbital debris.

The third activity of the Clean-mE program was the continuation of the CleanSpace One (CSO) project, which purpose will be to demonstrate the removal and de-orbiting of SwissCube. A first funding partner, Swiss Space Systems (S3), joined the project late 2014. Project management and mission scenario evaluations are on-going. A press conference took place in Payerne on September 10, 2013, to announce this new partnership and present the satellite’s new design. A large media coverage resulted from this event.

SpaceCam

An eye in space to identify debris

In the frame of the Active Debris Removal (ADR) activities, the Swiss Space Center is seeking for solutions permitting 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.

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. In the frame of collaboration with the Beihang University of Aeronautics and Astronautics (BUAA) in Beijing, China, BUAA gave an opportunity to the Swiss Space Center to fly a camera on the BUAA-SAT academic satellite that will be launched in 2014.

The objective of the Swiss Space Center is therefore to test a modified COTS industrial smart camera in flight and to verify the camera computing power in space environment. A Structural and Thermal Model of the camera has already been developed by the Swiss Space Center and sent to BUAA for implementation into the BUAA-SAT test platform. In parallel, the Swiss Space Center developed a communication protocol between the camera and the satellite as well as the on-board software that will be tested with the Electrical Model, delivered by end of December 2014 to BUAA. The Critical Design Review of the camera was successfully performed in December 2013 and the manufacturing of the Qualification Model and Flight Model has been released. The qualification of the camera will be performed at EPFL in Spring 2014.

Figure 1- Artist view of the SpaceCam.
Call for Ideas 2013

To foster disruptive space innovations based on ideas and concepts

For the first time, the Swiss Space Center initiated in 2013, under its mandate from the SERI/SSO, a “Call for Ideas” to identify and demonstrate disruptive space innovations based on ideas and concepts. The main objective was to foster low Technology Readiness Level (typically TRL 1) research and development studies related to space activities. Four different topics were identified coming from the Development Plan of the Strategic Committee and the needs of the European Space Agency (ESA):

- Micro-Nano Technologies (MNT)
- Materials, Parts and Processes (MPP)
- Optics
- Pico/Nano Sat technology and components

The call was opened on May 2nd and at the end of the four weeks submission phase, no less than 31 ideas and concepts were received among which 10 were selected and funded for six months.

CubETH

A tool for precise orbit determination

CubETH is a project to evaluate low-cost GNSS sensors on a nano-satellite by following the Cubesat standard. GNSS sensors will be used for precise orbit determination and validation of attitude determination of the cube. The project shall verify in-space use of COTS GNSS detectors and novel algorithms for on-board data processing.

The main scientific goal of CubETH satellite is precision orbit determination using COTS GNSS sensors. Additionally, we aim at characterizing attitude determination using GNSS sensors. Programmatic goal is to implement this project in cooperation between ETHZ and EPFL schools, involving engineers and students from federal schools as well from HES / FH domain. This project will serve for education of new generations of highly qualified engineers. The Geodesy and Geodynamics Lab of the ETH is responsible for this scientific instrument (payload). GNSS sensors are provided by Swiss company u-blox. The Swiss Space Center is working on the satellite bus (1U-Cubesat). In order to accelerate the development process and reduce the cost, the goal is to reuse as much as possible of the SwissCube design. Both main responsible entities [ETHZ and EPFL] work closely together with the different “Fachhochschulen” and industry partners of Switzerland. Final integration and testing will be performed at the Swiss Space Center. Science operations will be driven by ETHZ in close collaboration with ground stations for mission operations located at HS Luzern and HS Rapperswil.

Collaboration with industry is very important for this project. u-blox is supplying GNSS chips and knowledge on chip algorithms; RUAG Space is helping with testing procedures and analysis of test data; Sapphire is helping with expertise in electrical system and beacon design.

PRR review was held in April 2013 and the project was in Phase B at the end of the year. The focus in 2013 was to examine options for CubETH implementation and qualifying individual components to validate design choices. The goal of phase B is to deliver an operational FlatSat model (electrical model), where all electrical and data interfaces will be verified. Payload, Control and Data Management, Electrical Power and Communication subsystems are now ready for integration on FlatSat. PDR is planned for 2014. The goal is to demonstrate functioning FlatSat at the PDR.

In 2013 30 people were involved in the project across 5 different schools and more than 20 students worked on the project.
Swisscube

Twenty-two thousand trips around the planet

The mission was supposed to last three months to one year. Four years later, Swisscube is still orbiting the Earth and working! This small Cubesat-type satellite, entirely designed in Switzerland, was launched on September 23, 2009. After more than 22,000 trips around the planet, all its functions are still operational. Only one of its six solar sensors has been irreversibly damaged.

Set your calendar for 2018

In four years, Swisscube has narrowly avoided impact with space debris several times. As soon as it was launched, it was quickly caught up in the train of debris created by the February 2009 collision between the commercial satellite Iridium-33 and the Russian satellite Cosmos-2251. In 2013, US Air Force alerted the Swiss Space Center no less than 12 times for predicted conjunction between SwissCube and a secondary object. On September 2013 the distance between SwissCube and SCC# 35386 was only 63 meters. This is one of the 15,000 pieces of space debris more than 10cm in diameter that have been identified and are monitored from the ground by the U.S. But it appears that Swisscube’s time has not yet come. Barring an unforeseen event, Swisscube’s demise has been programmed for 2018. It will be the first object captured and destroyed by CleanSpace One, the space debris clean-up satellite currently under development at the Swiss Space Center.

Events

Space Career Day 2013

To grow the “rocket scientists” of tomorrow!

The promotion of careers in the space business to students in Switzerland is one of the key roles of the Swiss Space Center. After six years of absence, it was decided to organize again a special event directly focused on the presentation of career opportunities in Switzerland and at the European Space Agency on November 11th.

This first new edition of a “Space Career Day” was held at EPFL with the participation of RUAG Space, APCO Technologies, Spectratime for the industrial point of view and the Swiss Space Office for the institutional side. It is part of different actions taken to promote careers in the space business pursued all along the year with the participation in various public events, and also with the minor in space technology at EPFL, the student projects (bachelor and master) and the summer camps (in Russia and China). An interesting presentation of a former EPFL student who has just completed his Young Graduate Trainee (YGT) at the ESA technical center (ESTEC) in the Netherlands was highlighted by the unique personal experience of our “guest-star”, colleague Prof. Claude Nicollier. This was also the occasion for the SSO to announce the implementation of a National Trainee Programme in Switzerland for the placement of young graduate Swiss citizen at ESA in 2014. More information on this new programme will be given in the first quarter of 2014.

Thanks to the success encountered by this event with more than 60 students attending the presentations, the Swiss Space Center has decided to organize it on a yearly basis.

The satellite’s mission was to photograph airglow. In four years, some 230 images were produced. Even though these data are not precise enough to be studied scientifically, the Swiss space community still considers Swisscube a success.

Its goal was above all educational, as more than 200 students from EPFL and the Universities of Applied Science learned about space technology. Today, the documentation on SwissCube gives valuable information to current students as it allows movements and altitude verification for instance, as well as testing of ground-based algorithms.

The fact that it has lasted this long proves that the satellite is robust and confirms the wisdom of certain technological choices. For example, it was decided that instead of components that were certified space-quality, standard electronic components would be used: they were thus much less expensive, such as mobile phone batteries bundled into a thermally controlled, waterproof housing. An innovative system of copper mountings was developed that both secured the solar cells to the external walls, ensuring stowage during the violent shakings of launch. “The first week is decisive,” explains Richard. “If the satellite gets through it without a hitch, it’s because it was truly well built, and there’s a high likelihood that it will operate for years to come.”
ESA International Summer School

A comprehensive overview of satellite navigation

The GNSS Summer School 2013 was held from 15th to 25th July 2013 at Hotel Schatzalp in Davos, a former Sanatorium for Tuberculosis patients in an Art Nouveau style ideally situated on the heights of Davos at about 1600 m. Among a dozen other hotels prospected throughout Switzerland in 2012, it was definitely the one providing the best deal.

The objective of the GNSS Summer School was to provide a comprehensive overview of satellite navigation: GNSS system, signals, processing of observations in a receiver, and position-navigation-time determination. A few workshops were carried out for “hands-on” experiences, and lectures on intellectual property rights, patents and business were given. The future of satellite systems was also discussed with emphasis on the development of a group project using innovative ideas and covering all aspects of start-up development: brainstorming, business plan, technical realization, and marketing.

The participants included a large range of educational backgrounds: graduate students with more than 3 years studies, PhDs, Postdoctoral researchers under 35, students with more than 3 years studies, any young professionals from industry and agencies. Participants included 52 young people from 20 different nationalities: Argentina, Australia, Austria, China, Czech Republic, France, Germany, Ghana, Hungary, Italy, Mexico, Netherlands, United States, Poland, Portugal, Republic of Korea, Slovenia, Spain, Switzerland, Trinidad and Tobago and the United Kingdom. Their nationalities were rarely related to their working places, clearly demonstrating globalization of economy and research in the domain. There was for instance a French working in the UK, an Italian and a Hungarian in Switzerland, an Argentinian and a Spaniard in Germany, an American working in Austria, a Pole in Czech Republic, etc.

The group included 15 young women.

The Swiss Space Center was in charge of the co-organization of this summer school with ESA. It began with the selection of the best place, which appeared to be Davos. Then, several teleconferences and a meeting at ESTEC in May were held in order to allow a perfect welcome of the participants in Switzerland.

During the two weeks in Davos, Mrs Marion Harmel, administrative assistant at SSC, was present and ensured the quality of all administrative and organizational tasks. In addition, two scientific assistants (Federico Belloni and Reto Wiesendanger) followed the complete school program and issued a report on this experience. The first feedback from ESA based on previous GNSS summer school was very positive and this Swiss edition is considered as successful.

Space technology summer camps

Moscow

For the sixth times since 2008, the Swiss Space Center welcomed a group of 11 students and professors from Bauman Moscow State University (BMSTU) in May for various lectures and laboratory activities. An employee of the Swiss Welding Institute in Yverdon-les-Bains was invited to set-up a short experiment on welding reliability and another experiment on bearing assembly for space mechanism was created for the occasion.

As usual, a group of 12 Swiss students (11 from EPFL and 1 from HES-SO) participated in the space technology summer camp organized by BMSTU in July. It was the opportunity to carry out interesting space projects in international teams and visit some famous sites of the Russian space activity.

Belihang University

For the very first time, the Swiss Space Center organized an exchange summer school with Beihang University in Beijing. Beihang University is the new name for the former Beijing University of Aeronautics and Astronautics (BUAA). It was founded in 1952 and was China’s first university focused on aeronautical and astronautical engineering and academic research. Nowadays, it holds 26 schools in many disciplines such as sciences, engineering, economics, management, humanities, law, philosophy, education, medicine and art.

This exchange began with the venue of 9 students and professors of Beihang University in April at EPFL. During the visit, the students, supervised by SSC engineers, performed a project linked to the deorbiting of an object. In addition, they did a practical work in clean room based on welding reliability issues (with the participation of the Swiss Welding Institute).

In July, 8 people (4 young engineers from the SSC, one EPFL student, two young engineers from the HES-SO and Mrs Muriel Richard, SSC Deputy Director) took part to the international summer school organized in Beijing, where more than 130 students and young engineers coming from 27 countries were involved. This was a great opportunity to reinforce the already existing link between Beihang University and the Swiss Space Center.
International Astronautical Congress

When all space actors come together

The International Astronautical Congress is the one place and time of the year when all space actors come together. Global, multidisciplinary and covering all space sectors and topics, it offers everyone the latest space information, developments but above all contacts and potential partnerships. It is affiliated to the IAF (International Astronautical Federation), created in 1951 to foster dialogue between scientists around the world, and to support international cooperation in all space-related activities.

The Federation is the world’s leading space advocacy body with 246 members, including all key space agencies, companies, societies, associations and institutes across 6 continents and 62 countries. Its annual International Astronautical Congress (IAC) changes country, theme and local organizer.

In 2013, the 64th edition took place in Beijing on the theme “Promoting Space Development for the Benefit of Mankind”.

It was hosted by the Chinese Society of Astronautics (CSA 23-27 September 2013 with more than 3000 attendees, 180 technical sessions, 8 plenary events, 3 highlight lectures and 3 late breaking news, and appearances by elites. With a local organizing committee (LOC) comprising high-level representatives of all key space actors in China, ranging from government to industry and academia, IAC 2013 has been one of the most thorough introductions to the Chinese space world to date.

For four days, the main space programs of major agencies have been presented and discussed with the audience from all over the world, followed by 30 space-related themes divided into 180 technical sections. The Swiss Space Center presented three papers in the technical sections between student and scientific projects and one of its experts attended as chairman in one of the technical sections.

6th EPFL robotic festival

On April 20th, the 6th robotic festival took place at EPFL. This one-day event is organized once a year at EPFL and pursues the objective to open the world of robotics to general public. For the first time this year, the organizers decided to give a theme to the festival: “In the Stars!” which was dedicated to the robots and Space.

The Swiss Space Center was asked to participate and build a stand to present its projects (such as CleanSpace One), and offered very successful games where the children could grasp a small SwissCube with a gripper.

17,000 people came to the festival which included exhibitions from EPFL laboratories, HES, professional schools, associations and start-ups. This was a perfect opportunity to raise public awareness of space, which one of the roles of the Swiss Space Center.
**Members’ word**

To help find talents and promote space awareness

“APCO Technologies is a Swiss company active in the design, manufacturing, integration, and testing of space, nuclear and other special industrial equipment. For the space industry, we develop flight structures, instruments and precision mechanisms as well as complex optical, mechanical, thermal integration and testing systems for on ground activities. These challenging developments are performed mainly for Earth Observation and Science applications for the European Space Agency missions.

System engineering including design and analysis of flight and ground support equipment is one of the key assets of APCO Technologies. It is important for us that this core competence is maintained and further developed to support the heavy proposal and development phases of our projects. In the context of our space activities, the availability of highly qualified resources is a major factor of our success. Therefore, the support of the Swiss Space Center is important to help finding these talents among Swiss students and to promote space and industrial awareness in the Swiss institutions. The ‘Space Career’s Day’ organized in November perfectly illustrates our expectations. We initiated contacts and students were selected to perform training periods.

APCO Technologies is also part of the Space harmonization process and we consider the coordination work performed by the Swiss Space Center as essential in order to federate and defend a common and coherent Swiss position towards the European competition. We thank the Swiss Space Center for their work and congratulate them for their achievements in 2013.”

Didier Manzoni
APCO Technologies
General Manager Space

**S3 and the Swiss Space Center: a natural fit in 2013 and beyond**

“2013 was a special year for S3. As it saw our official launch, we communicated for the first time about our company and space program, this after a couple years of work hidden from public view. One of the inspirations behind S3 comes from the K-1000 suborbital shuttle project I had the pleasure of working on under the supervision of Professor Claude Nicollier between 2005 and 2009. From 2009 to 2012, we then refined our technical project and developed our business model. This period also gave us time to work on the hard task of developing our network of international industrial partners and institutional technical advisors. This network keeps growing to this day and constitutes a strong asset for S3. Among these technical advisors coming from Europe, the US and Russia, who all help us in the current R&D phase, the Swiss Space Center naturally fits in, since its mission is to support industries in the field of aerospace. During the course of 2013 we have established a fruitful collaboration manifested in our partnership on CleanSpace One announced in September. This innovative satellite project will be launched by our reusable launching system; itself characterized by its efficiency and safety.

As future launcher, we feel it is our responsibility to make our part in order to solve this space debris issue, which represents an environmental issue as much as a safety issue.

CS 1 will demonstrate its technology thanks to the in-orbit delivery we will provide in 2018. On the other hand, we will demonstrate our launching system during this challenging mission. A definitive Win-Win collaboration we look forward to continuing in the coming years.”

Pascal Jaussi
founder and CEO of Swiss Space Systems (S3)

For more information contact:

Swiss Space Center
EPFL, Station 11
1015 Lausanne

Tel.: +41 (0)21 693 69 48
http://space.epfl.ch