swiss space center

Executive summary 2012

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

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Summary

Foreword

2012: an eventful year

The Swiss Space Center experienced significant changes in 2012. In January it's status grew from regional to national significance. The objectives of the Center thus expanded with the advent of new projects and exciting mandates.

At the heart of the Swiss Space Center since its creation in 2003 is the objective to reinforce the position of Swiss Space stakeholders, whether institutional, academic, or industrial players.

With the evolution in January 2012 from a regional Center to an organization of national significance, the Swiss Space Center stays true to its initial mandate 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. Not only that, but the role to facilitate access to and implement space projects for Swiss research institutions and industries has been greatly strengthened by strategic positioning.

2012 was an exciting and challenging year starting with the launch of the CleanSpace One study that had a very positive echo in the media worldwide, placing Switzerland once again on the international stage. The steady increase of members, the support of hosts and partners allowed the Center to refurbish its Concurrent Design Facility, build up a clean-room for educational purposes and contribute to the advancement of space interest through events and coordination of specific activities such as the very successful " Mesures de Postionement ".

Most members participated in the Strategic Committee, the advisory body that in 2012 helped in the orientation of the Center and whose major output was a recommendation for new Terms of Reference that will govern the Center in the future.

During the last quarter of 2012, Switzerland was appointed to the co-presidency of the ESA ministerial conference, and in parallel won the ESA Small-sat call for tenders with the CHEOPS proposal. These elements, among others, ensure that the eyes of the international space community are turned towards Switzerland. With its members and partners, the Swiss Space Center will contribute in the next years to the excellence of Swiss contribution to space through innovative technological advances, reliable product developments in our industry as well as international collaborations in Europe and beyond.

Daniel Neuenschwander, SERI Swiss Space Office Director and Prof. Volker Gass, Swiss Space Center Director.

Mission

A link between institutions, academia and industry

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

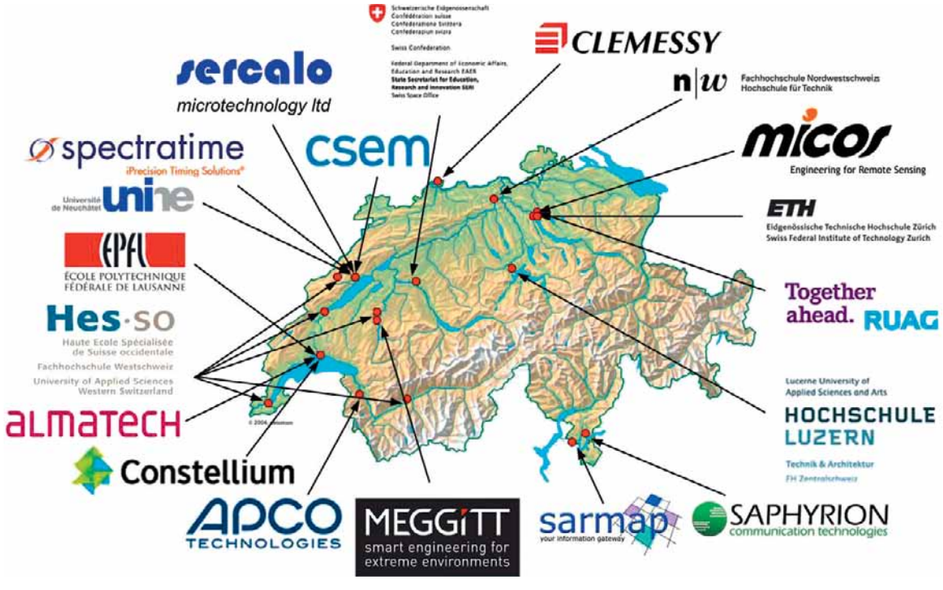
- To network Swiss research institutions and industries on national and international levels in order to establish focused areas of excellence internationally recognized for both space R&D and applications;
- To facilitate access to and implementation of space projects for Swiss research institutions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

Members

A network in expansion

During the year 2012, the Swiss Space Center welcomed seven new Swiss entities within its members : the ETHZ, two universities of applied sciences (HES-SO and Hochschule Luzern), two industries (Constellium and APCO) and two start-up (Micos Engineering and Saphyrion) joined the network. This trend continues in the first quarter 2013 with 6 new industrial members (Almatech, Clemessy, Meggitt, Sarmap, Sercalo and Spectratime).

Therefore, the Swiss Space Center currently counts 19 members from each region of Switzerland and representing all the 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 ongoing with other entities from the Swiss space community to include more members in 2013.

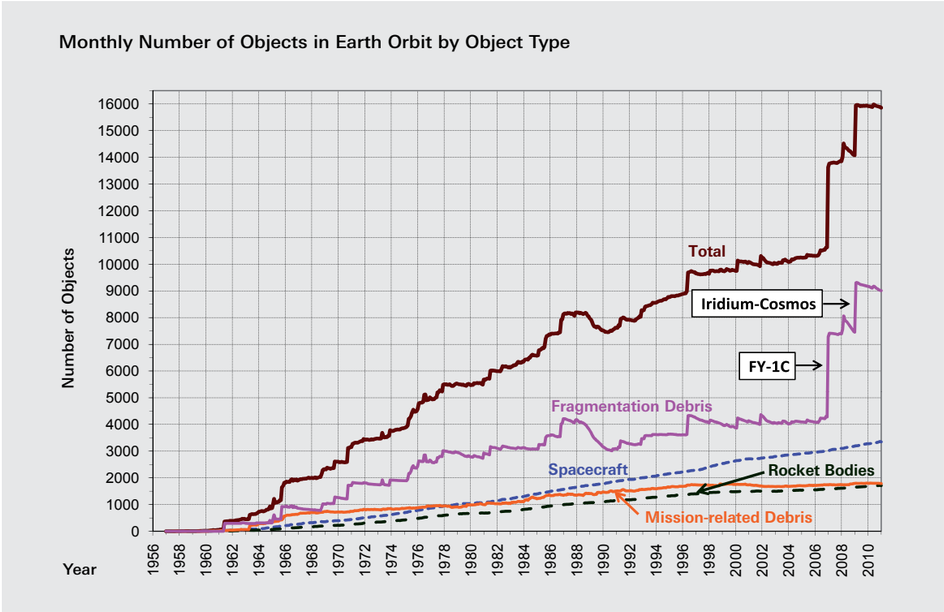


Swiss Space Center Members.

CleanSpace One

A Swiss solution to tackle space debris

The destruction of an aging satellites in 2007 by a Chinese anti-satellite missile test, and the accidental collision between the American satellite Iridium and the Russian Cosmos in 2009 brought a new emphasis on the orbital debris problem. Although in the past, satellite traffic monitoring was only based on debris monitoring and collision avoidance, all major space agencies now agree upon the need for active debris removal. In 2011, about 14'000 debris above 10 cm were catalogued. About 2'000 of these are remains of launch vehicles and 10'000 originate from non-operational satellites (see the figure 10 below).



Credit: NASA, J.C. Liou, *An active debris removal parametric study for LEO environment remediation*. Advances in Space Research, 2011.

Over the years, many studies have been conducted 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 date are difficult to implement and require non-trivial resources (cost, mass….). Furthermore, all these solutions need new technology developments for efficient debris removal.

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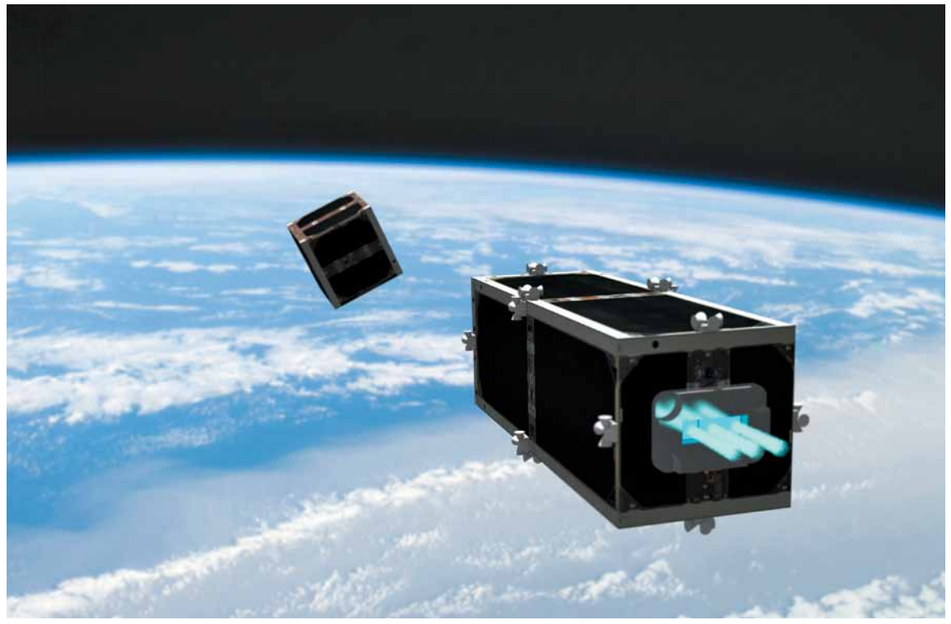
Based on these observations, the Swiss Space Center has been involved in research activities over the last 3 years, preliminary debris removal designs, and Swiss technology surveys in a program called "Clean-mE". This program has brought the basis for today's CleanSpace One (CSO) project, which purpose will be to demonstrate Active Debris Removal (ADR). The main motivation behind the CleanSpace One project is to increase awareness and start mitigating the impact on the space environment by acting responsibly and removing our "debris" from orbit thus proving that it is feasible.

During 2012, a conceptual design of the CleanSpace One nanosatellite was done, and several student projects continued the technology developments in the area of the grasping and vision systems.



CleanSpace One chasing SwissCube (artist view).

CHEOPS

A satellite to analyse exoplanets

The CHaracterizing ExoPlanet Satellite (CHEOPS) will be the first mission dedicated to search for transits by means of ultrahigh precision photometry on bright stars already known to host planets in the super-Earth to Neptune mass range ($1 < M_{planet} / M_{Earth} < 20$). By being able to point at nearly any location on the sky, it will provide the unique capability of determining accurate radii for a subset of those planets for which the mass has already been estimated from ground-based spectroscopic surveys. The mission will also provide precision radii for new planets discovered by the next generation ground-based transits surveys (Neptune-size and smaller).

The Swiss Space Center was responsible for the flight segment work package in the project. Activities in 2012 started with Preliminary Requirements Review. Based on the preliminary study the team has responded to ESA's S-mission call (June 2012). CHEOPS proposal was the only one recommended for further study out of 26 proposals from the short list (out of more than 50 submitted). After the selection the project was evaluated at the ESA's Concurrent Design Facility and the Swiss Space Center has provided active support. No major issues were found during the CDF study and project have moved towards Phases A and B in 2013/2014.

CHEOPS project is led by University of Bern (PI: Prof. W. Benz). ESA will contribute part of the costs of the project (spacecraft bus and launch costs among others). Switzerland will partner with other countries to provide the instrument. Swiss partners include the Swiss Space Center, University of Genève, ETHZ and RUAG. On the instrument side, various subsystems will be contributed by Italy, Belgium, Austria, France, UK, Hungary, Portugal and Sweden. UK will actively participate in Mission operations.

The mission will fly a single payload on a small satellite platform and the total mass of the S/C will be on the order of 200 kg. To obtain high photometric stability, thermal stability of the instrument and stray light suppression from the Earth are design drivers. At the same time, the observable sky should be maximized.

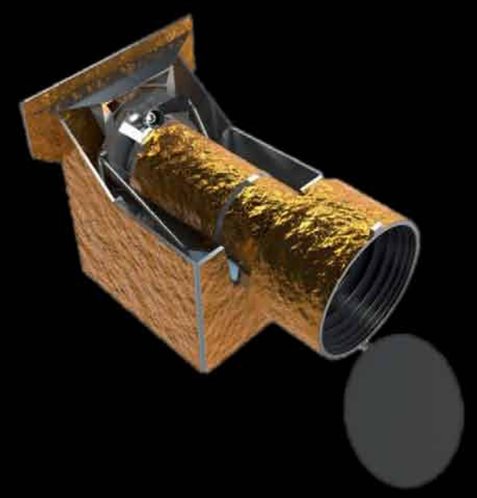
To meet the above requirements, the telescope will be orbiting in a Sun Synchronous Low Earth Orbit having a LTAN of 6 a.m. and an altitude of 620 to 800 km. This orbit minimizes eclipses and therefore provides a thermally stable environment. To allow the stringent thermal control of the detector, the S/C will be 3-axis stabilized but nadir locked. Payload radiators shall always face away from Earth to cold space. A small sun shield prevents illumination of these radiators by the Sun, therefore providing a thermally stable environment for the payload radiators. This orbit allows science requirement fulfilment.

In addition to a thermally stable environment, the instrument requires high pointing stability: the telescope line-of-sight must remain stable to 8 arcsec RMS over a 10-hour observing period. This precision can be achieved on a small platform by including the instrument data in the attitude control loop.

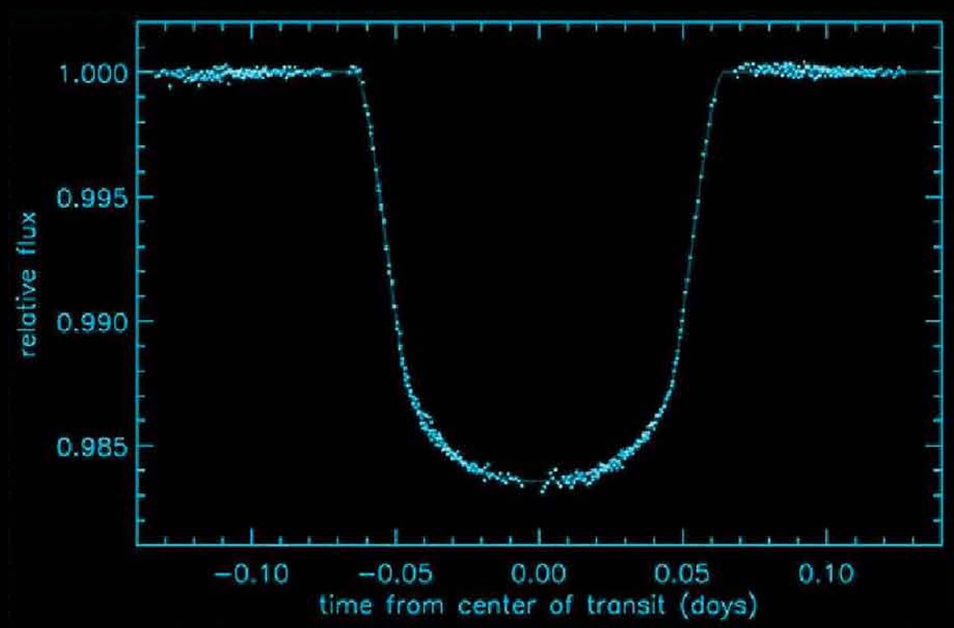
The CHEOPS satellite will observe individual target stars in a track and stare mode. Following target acquisition of a single star - which will take less than a minute - the telescope will continuously point at the target for typically 6-12 hours but up to a few weeks if the phase modulation of the planet is measured. The telescope operation will be dominated by many such short pointings, typically only observing a star when the transit is expected to occur. So, from a data point of view, CHEOPS is a simple instrument. The team baselines an S-band system for TM/TC and data downlink. The S/C will provide 50 W continuous power for instrument operations and allow for at least 1GBit/day downlink (see Figure 3, left, for a rendering of the s/c).

Parameter	Value
Name	CHEOPS (CHaracterizing ExOPlanet Satellite)
Primary science goal	Measure the radius of planets transiting bright stars to 10% accuracy (Earth-like: 15 ppm)
Targets	Known exoplanet host stars with a V-magnitude < 12.5 anywhere on the sky
Instrument	33 cm reflective on-axis telescope
Detector	13 µm pixel 1k x 1k CCD (baseline: e2v CCD47-20 AIMO)
Orbit type	LEO sun-synchronous 6am-6pm, 800 km
Mission Duration	3.5 years
ESA Program	S-class mission
Expected Launch date	2017
Total dry mass	198 kg
Total instrument mass	65 kg

Main goals of the CHEOPS project and characteristics of the spacecraft



3D artist rendering of the CHEOPS satellite, based on the 2012 study at the ESA's Concurrent Design Facility.



Example of an observed transit.

Education

A new tool to calculate the orientation of a satellite

Each year, tens of students carry out projects at the Swiss Space Center. 2012 was marked by the launched of an experiment developed at EPFL on-board an ESA sounding rocket.

The Gravity Gradient Earth Sensor (GGES) experiment is a project supported by the EPFL LMTS (Microsystems for Space Technologies Laboratory) and the Swiss Space Center, which aims to test the operation of the Earth Sensors in microgravity conditions. The project was initiated in October 2010 and culminated with the launch of the experiment on the REXUS11 sounding rocket from Esrange Space Center, Sweden, in November 2012 as part of the REXUS/BEXUS programme. The GGES experiment is the first test of a novel attitude determination sensor in freefall, which utilizes the Earth's gravity gradient as a reference.

The sensor principle is based on the use of a device that can measure the Gravity Gradient Torque (GGT) [3]. The MEMS sensor consists of an elongated proof mass suspended by two very compliant springs. In Earth orbit, the GGT on the proof mass depends on the angle between the longitudinal axis of the proof mass and the nadir. By measuring the displacement of the proof mass due to GGT, the angle, and therefore attitude, can be determined for LEO orbits.

The experiment is constructed within a cubesat-sized frame. It includes a total of four Micro Electro Mechanical System (MEMS) independent Earth sensors, providing redundant pitch and roll measurements. A single power and communications board provides the interface between the two boards and the external rocket power and telemetry service module. In its current design, the experiment has no batteries and relies on external power to operate. It has a mass of approximately 830 g, and consumes 2.8 W of power for a 28 V supply and has an output data rate of 12 Kbit/s.

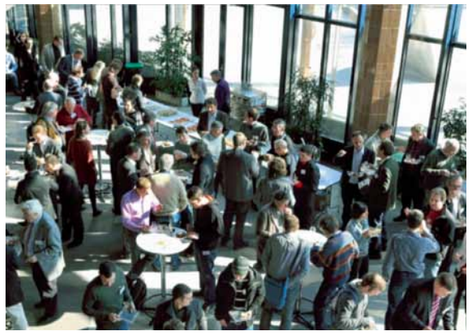
Courtesy K.Ghose, EPFL-LMTS.

Of the four MEMS sensors, three survived launch and one functioned nominally during freefall. Analysis is on-going to determine the displacement due to GGT, since the motion of the MEMS proof mass is a sum of the effect of GGT and payload tumble. We observe that the predicted displacement of the proof mass due to acceleration and angular velocity of the payload in freefall shows a correlation to the recorded change in capacitance due to motion of the MEMS proof mass.

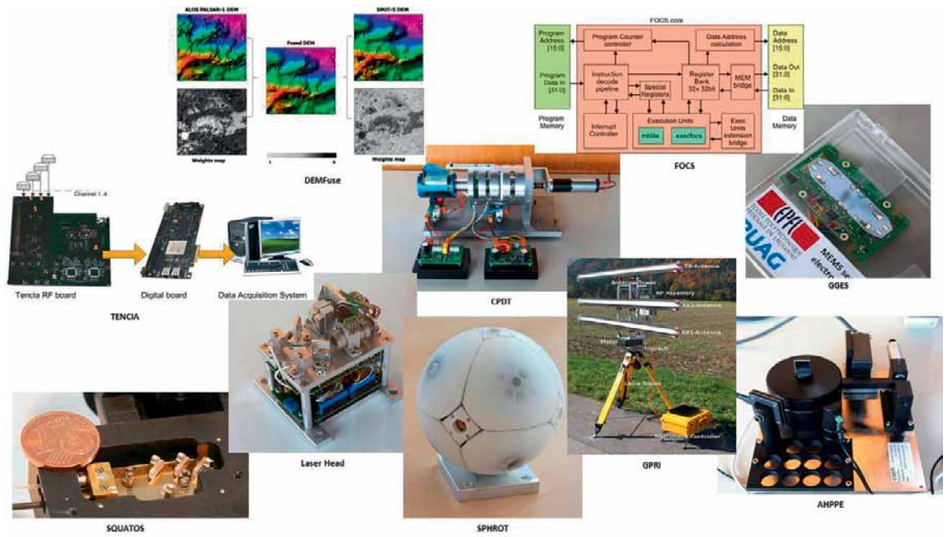
"Mesure de Positionnement"

To promote innovative ideas and new products related to the space sector

The first call for proposals "To foster and promote Swiss scientific and technical competences related to space activities" issued by the Swiss Space Office of the State secretariat for Education, Research and Innovation SERI/SSO in 2010 under the programme "Mesure de Positionnement" was concluded in February 2012 with the public presentation of the studies funded. This event was held at EPFL on February 24th with more than 100 participants from the Swiss space community, the European Space Agency and the industrial primes (Astrium and Thales Alenia Space).



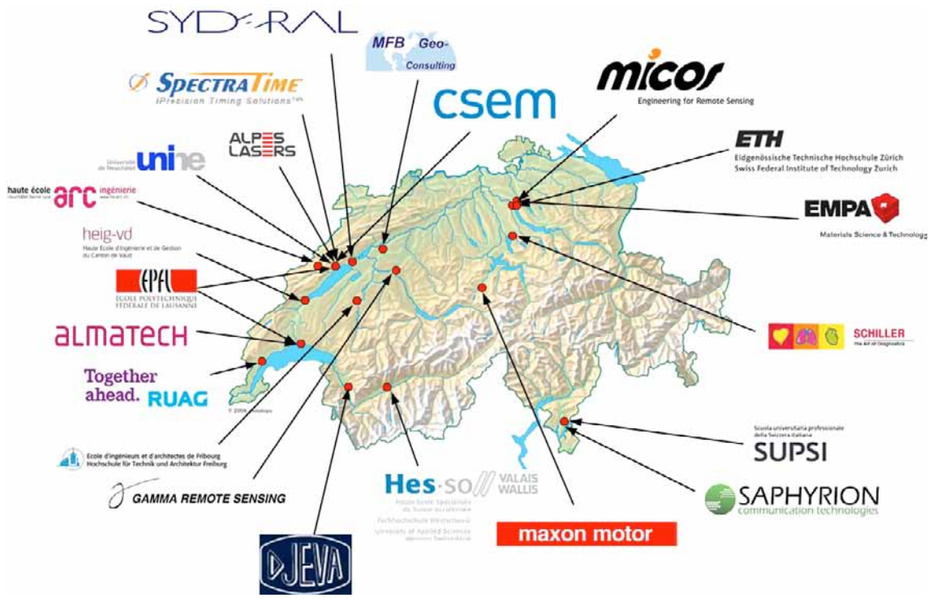
Space Technologies Studies 2010 at EPFL with the participation of Franco Ongaro (ESA D/TEC).



MdP 2010 activities.

Following this first call, the Swiss Space Center has been entrust-
Following this first call, the Swiss Space Center has been entrust-
ed again by the SERI/SSO to implement a second call for proposals based on the same rules, with the same objective: "To foster and promote Swiss scientific and technological competences related to space activities". On April 30th, 24 new proposals were received and went through the technical evaluation as defined in the "Guidelines on positioning measure proposals for space programme".

At the end of September, the SERI/SSO communicated its decision to fund 12 studies involving 22 Swiss entities.



Entities involved in the "Mesure de positionnement" call 2012.

Promotion of space

Space Technology Summer Camp in Moscow

In the framework of agreement between Baumann Moscow State University (BMSTU) and the EPFL, the Swiss Space Center hosted a group of 10 students and professors in May 2012 for a workshop on technical speaking, organised jointly with EPFL human resources. As usual now since 2008, a group of Swiss students (8 from EPFL and 2 from ETHZ) visited the Space Technology Summer Camp organised by BMSTU in July.

BMSTU 2012 participants.

Odyssée exhibition at "Foire du Valais"

In October, the Swiss Space Center participated in the exhibition "Odyssée" organised during the "Foire du Valais" in Martigny. It was estimated that one third of 200'000 visitors went to the exhibition dedicated to Space. Therefore, about 70'000 people saw the Swiss Space Center animations, and were made aware of the space debris problematic, the projects of the Center and its missions alongside other Swiss space stakeholders such as University of Bern and RUAG Space and prestigious space objects from NASA and ESA. Special guests included Prof. Claude Nicollier and Charlie Duke, respectively ESA and NASA Astronauts.

Swiss Space Center exhibition at "Foire du Valais".

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Concurrent design training course

In September, the Swiss Space Center organised a training course entitled "Introduction to Concurrent design and engineering". This 2-day course, open to all the Swiss space community, was attended by ten people. The objectives were:

"Attendees will learn what Concurrent Design (CD) is and what its benefits are for their company. This course will also emphasize where this technology fits in the overall product development. Through hands-on exercises, the attendee will experience the CD process and the CD supporting tools. This hands-on tutorial will help the attendees to translate the theoretical description of CD in a practical example, using a subject easily translatable to their own field of interest and their company products."

Concurrent design training course.

IAF conference in Naples

The Swiss Space Center represented EPFL at IAF (International Astronautical Federation) congress in Naples (Italy) from October 1st to 5th. Prof. Gass was nominated member of the Space University Advisory Committee (SUAC). This event was attended by 3300 people from all over the world. 160 technical sessions were presented, 8 plenary events, 3 highlight lectures and 3 late breaking news.

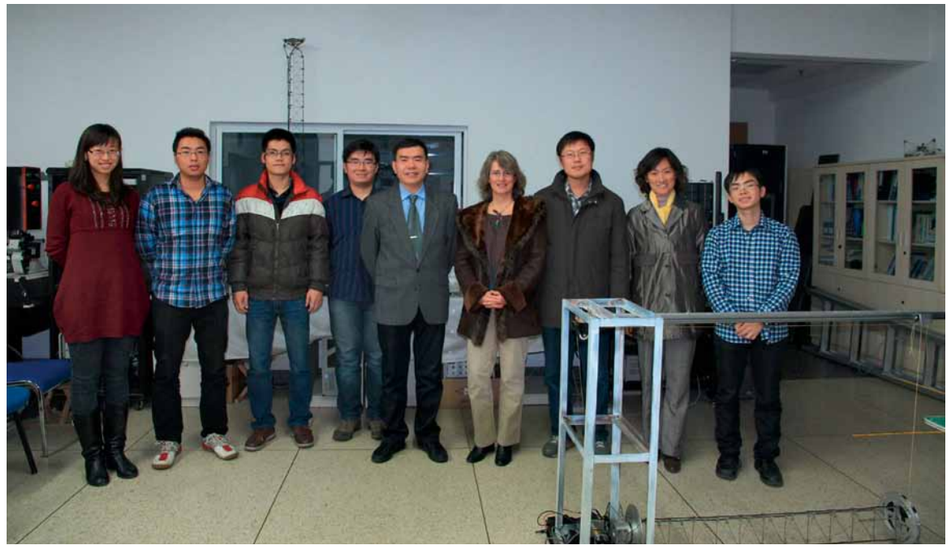
Volker Gass receiving the commemorative flag having flown 444 days in space celebrating the 60th anniversary of IAF.

Visit to Beihang University in Beijing

The Swiss Space Center attended from November 6, till November 9, a series of meeting with professors from Beihang University (Beijing), as well as the "2012 Beijing Space Sustainability Conference". The objectives of the meetings at Beihang University were to start exchanges at a technical level and discuss the possibilities for a summer school exchange.

The Beihang Universtiy (BUAA) 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. Out of the 26 schools, laboratories from two schools were visited: the School of Astronautics and the School of Instrument Science and Optoelectronics Engineering.

The Swiss Space Center was invited to present the CleanSpace One project at the "2012 Beijing Space Sustainability Conference". This conference was co-organised by Beihang University, Secure World Foundation and the International Space University. It belongs to a series of Space Sustainability Conferences, mostly funded by the Secure World Foundation. This conference covered both technical and legal/political aspects related to space debris.



Prof. Huang's group from the School of Astronautics with Muriel Richard, Senior engineer and Deputy Director or the Swiss Space Center

2012 Space Sustainability Conference in Beijing, organised by Beihang University.

Members' word

Lucerne University of Applied Sciences and Arts, Engineering & Architecture (HSLU T&A) signed a two-year cooperation agreement as an academic partner in the network of the Swiss Space Centre (SSC) of the EPFL. The technically challenging projects conducted by the SSC together with students are well in line with the practical Bachelor Engineering education at HSLU T&A. The successful participation in the on-going project CubETH is an excellent example which is being used as a fascinating showcase for potential future students. We are also convinced that the various centres of excellence at HSLU T&A will be able to bring skills which are complementary to the other academic institutions and which will prove valuable to industrial partners in future joint projects.

Marcel Joss
Professor
HES-Luzern

"At Constellium innovation has always been at the core of our business. And amongst many markets where advanced technology is critical, Space has always been amongst the leading sectors.

Therefore Space is and will continue to be an important field for us, where we can push the boundaries of our aluminium solutions to perhaps the most demanding environment.

As we expand our aerospace manufacturing capabilities to our plant in Sierre, Valais, it is paramount for us to interact as much as possible with the Swiss space industry. In this context, the Swiss Space Center is an excellent platform for Constellium."

Bruno Mucciolo
Global Marketing Manager
Constellium

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