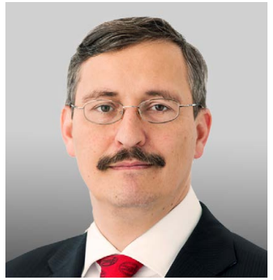
SWISS PARABOLIC FLIGHTS

Science for Tomorrow

University of Zurich[UZH]

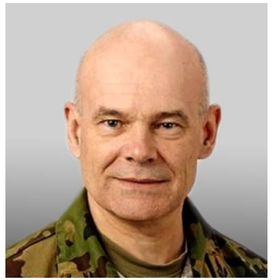
Microgravity flights serving Swiss **science and technology**

Contents



Research in microgravity is breaking through boundaries and significantly enriches and advances medicine, technology and physics. The University of Zurich, as one of the leading European research institutions, represents an excellent environment for the realization of highly innovative projects, for the science for tomorrow.

Prof. Dr. Michael Hengartner
President of the University of Zurich



Military aviation has always been closely linked to a pioneering spirit, research and technological development. Parabolic flights from Dubendorf airport exemplify the innovative potential of the birthplace of Swiss military aviation, specifically with regards to the future mixed utilization as federal military base, civilian airfield and national innovation park.

Major General Bernhard Müller
Chief Air Force Operations

CONTENTS

THE TEAM

Prof. Dr. Dr. Oliver Ullrich - Project Director and Chairman

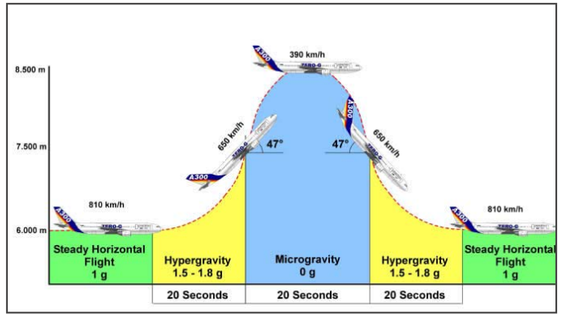
- Full Professor and Chair, University Zurich (Switzerland) and Professor of Space Biotechnology, University of Magdeburg (Germany), Academician of the International Academy of Astronautics, Head of Space Medicine / Life Sciences and Member of the Council of the German Society for Aerospace Medicine
- Active investigator for the German and European space life sciences research program, 10 years of experience as scientific leader of 15 parabolic flight projects, 4 suborbital and 4 orbital missions, including experiments on the International Space Station (ISS); flight log: 932 parabolas (5 1/2 hours in microgravity).

Capt. Dr. Marc Studer - Project Director

- Member of the Professional Pilot Corps of the Swiss Air Force, jet fighter pilot and flight instructor (F/A-18 and F-5)
- Commercial Pilot Licence, Swiss Aviation Training
- Physician (MD, University of Zurich), Research on “Parabolic maneuvers of the Swiss Air Force fighter jet F-5E as a research platform for cell culture experiments in microgravity“
- Active researcher, Aeromedical Institute (AMI), Dubendorf and University of Zurich (UZH)

The only manned research platform in weigthlessness on Earth

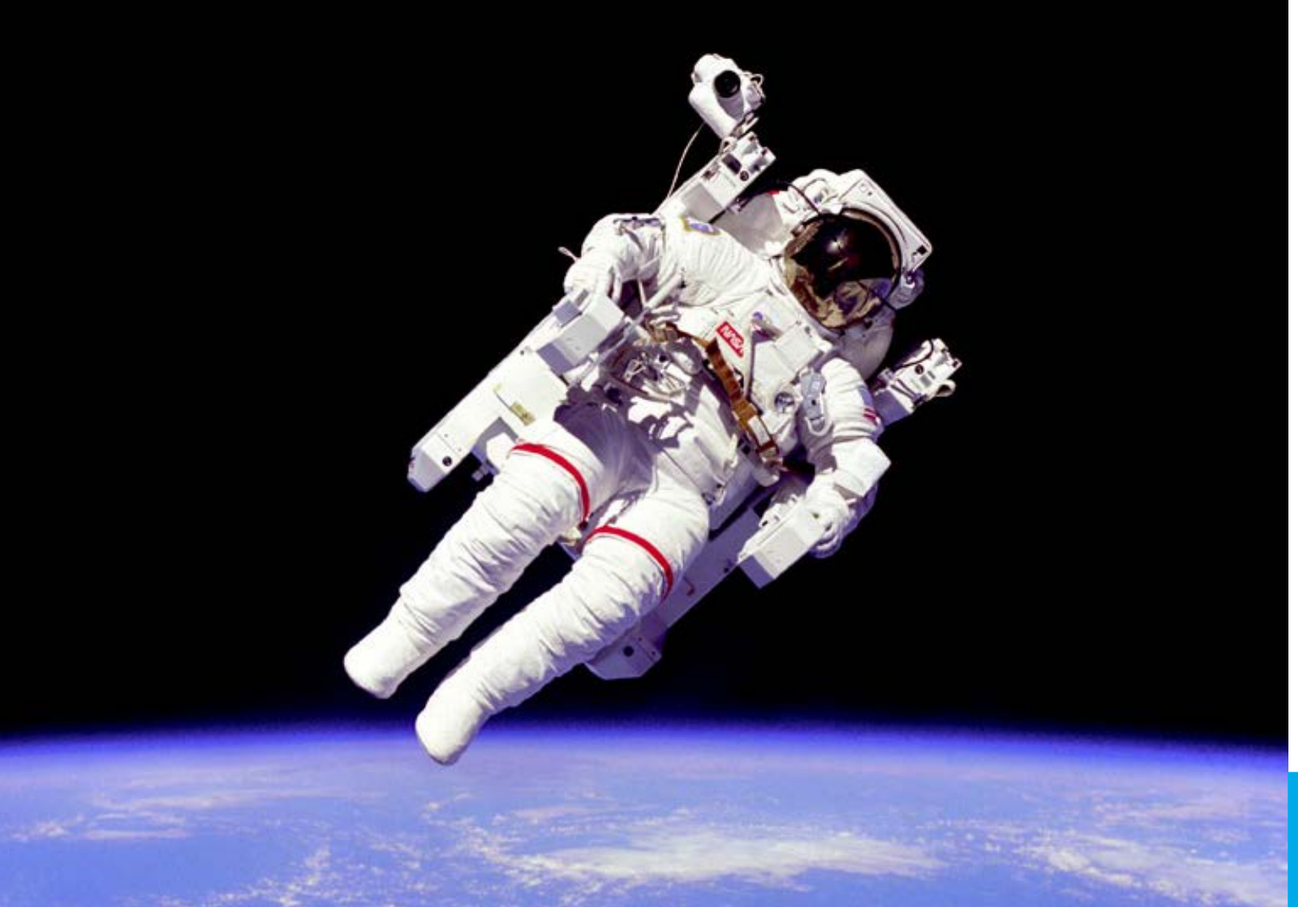
During the past 50 years aircrafts flying parabolic trajectories have provided an important milestone in space exploration and research. Parabolic flights are the only manned research platform in weightlessness, through which scientists are able to conduct their experiments by themselves. After thousands of experiments in the last decades, parabolic flights are the backbone of microgravity and spaceflight research and technology development. To date, parabolic flights are the basis for every manned spaceflight program.



The parabolic maneuver

Research in microgravity is the driving force for manned spaceflight and exploration beyond our home planet. During a parabolic flight maneuver, an aircraft is weightless by flying on a “Keplerian trajectory”, which is described as an unpropelled body in an ideally frictionless space subjected to a centrally symmetric gravitational field. During this free-fall trajectory, the resultant of all forces acting on the aircraft other than gravity is nulled. An entire scientific parabolic flight campaign usually consists of three individual parabolic flights with 31 respective parabolas in sequence (93 parabolas in total).

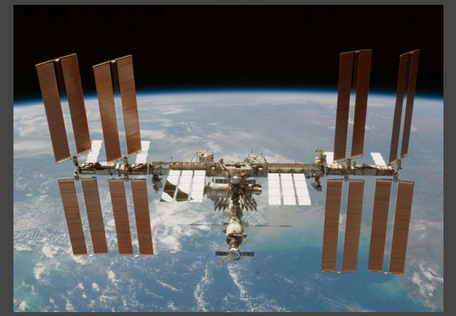
PARABOLIC FLIGHTS



Breakthrough Research

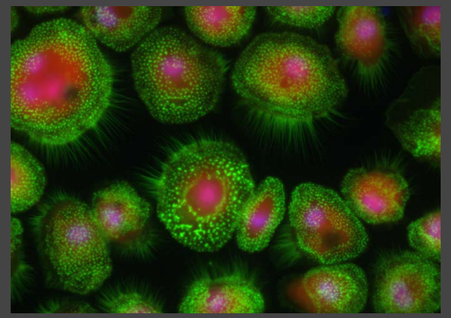
Parabolic flights allow for the study of biological, physical and other processes during weightless conditions (microgravity). As such, they are an indispensable tool for the study of fundamental principles, which are often masked by gravity.

Microgravity research has led to breakthroughs in fundamental research and in industrial applications in physics. Finally, medical research in space has significantly enriched and advanced modern medicine and medical technology.



WHY MICROGRAVITY?

WHY **MICRO** GRAVITY?



Tissue engineering and regenerative medicine

Treatment for organ- and tissue-loss problems due to diseases and accidents create up to 400 billion CHFs of excess costs per year worldwide. Because of tremendous shortages of the various tissues and organs for transplantation, researchers are looking for alternative tissue sources.
In vitro tissue engineering technologies are very promising sources. 3D cell growth is achieved in microgravity cultures, in which cells are able to form complex structures in a much faster manner. This has already been successfully demonstrated for heart cells, cartilage and nerve regeneration.

Results from fundamental and applied research in microgravity can be applied to on ground 3D cell culture bioreactors.

Medical research and alternatives to animal experiments

Further application fields of 3D in vitro tissue models are research on disease pathology, pharmacological research and research on alternative systems to animal experiments.

The 3D cell culture is a promising new technology for research and replacement of animal experiments, because the 3D architecture does not only allow for direct contact between cells via cell-cell junctions but also enables communication through the exchange of nutrients and signaling molecules, thereby resembling key characteristics of a natural organism.

The implementation of 3D techniques as alternatives to animal testing is currently advanced in fields such as toxicology, eye irritation, skin corrosion/irritation and vaccine development.

3D CELL AND **TISSUE** CULTURES

Plasma crystals and plasma medicine

Due to the effects of gravity, plasma particles are deposited in a strictly two-dimensional layer when processed in a laboratory on Earth. Consequently, a weightless environment is better suited for plasma crystal research, and substantial discoveries have already been made in microgravity conditions.

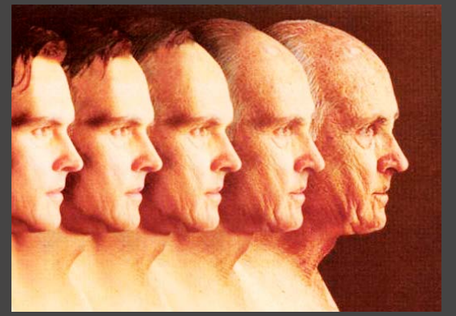
The practical application of plasmas is the innovative and newly emerging field of plasma medicine, which combines plasma physics, life sciences and clinical medicine. Physical plasmas are implemented in novel therapeutic applications. They are capable of killing bacteria without damage to the surrounding tissue and they furthermore stimulate tissue regeneration.

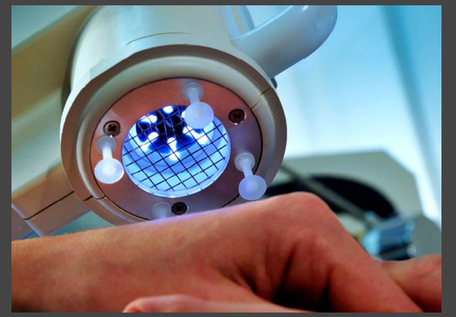
Antimicrobial resistance is an increasingly serious threat to global public health which requires action across all government sectors and society. This serious global threat may be overcome by plasma medicine and this novel field may also support the developement of future antimicrobial therapies.

Aging

Certain physiological changes which occur in microgravity conditions also arise with aging: bone and muscle degeneration, cardiovascular deconditioning, balance disorders, disturbed circadian rhythms and a reduced immune response.

Research platforms in microgravity further the understanding of aging mechanisms, aid the maintenance and improvement of health and the performance of the aging human.





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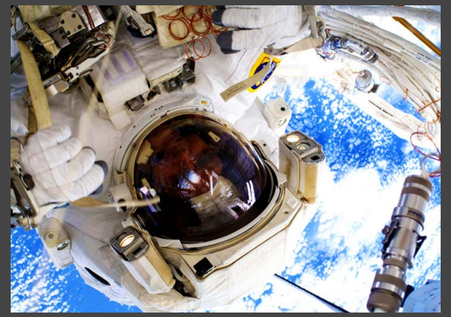


WHY MICROGRAVITY?

Medical research for long-term space missions

Astronautics has entered the era of long-term space missions. Several limiting factors for human health and performance in microgravity have been clearly identified, e.g. for the musculoskeletal system and the immune system.

It is for this reason that there is an urgent need to understand the cellular and molecular mechanisms by which altered gravity influences and changes cell function. In particular, bone loss during long duration stays in weightlessness still remains an unacceptable risk for long-term and interplanetary flights. Furthermore, serious concerns arose as to whether spaceflight-associated immune system weakening ultimately precludes the expansion of human presence beyond Earth‘s orbit.

It follows that research is necessary for appropriate risk assessment, development of in vitro tests for medical monitoring and for the identification of targets for preventive interventions – and to provide all the necessary knowledge for long-term space flights and the exploration of new worlds.

To understand life on Earth

Gravity has been a constant force throughout evolutionary history on Earth. The architecture of all life on Earth – including the human body – is adapted to the gravitational force. Thus, it is one of the fundamental biological questions, whether and how life on Earth requires and responds to gravity at a functional cellular and molecular level. Is gravity a condition for complex life? Is gravity a condition for the existence of mankind? Ultimately, research in microgravity helps to comprehend one of the biggest questions - to understand life on Earth.

17 years of reliable service

After 17 years of loyal service, the European workhorse for microgravity research on parabolic flights, the Airbus A300 ZERO-G operated by Novespace (France), was retired at the end of October 2014. Its successor, an Airbus A310, is already being prepared for the first microgravity flight campaigns in spring 2015.
The Airbus A300 was the world´s largest airplane used for gravity research. The success of this aircraft is supported by the long list of customers which includes ESA, CNES, DLR, JAXA, industrial customers and private commercial flights.

The new Airbus ZERO-G

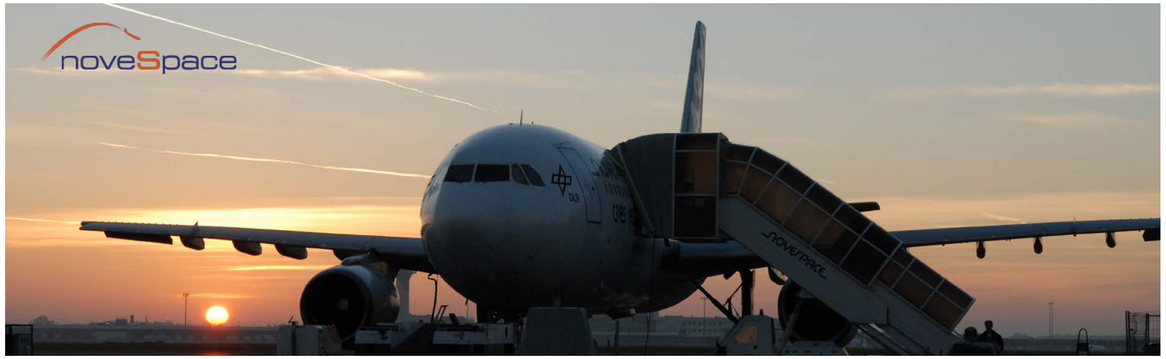
The A300 offered hundreds of international researchers access to weightlessness and reduced-gravity for experiments and investigations in simulated lunar and martian gravity. The successor aircraft is the Airbus A310 “Konrad Adenauer” from the German Air Force, previously used by the German government for official travel and diplomatic business. In summer 2014, the new A310 (Airbus ZERO-G) successfully flew its qualification flights from Bordeaux-Mérignac airport.

Highest safety standards

The A310 was modified by Lufthansa Technik and will undergo final qualification in March 2015 with the European Aviation Safety Agency and the French Civil Aviation Authority. CNES, the ESA and the DLR are the main partners and users of the parabolic flight program. Benefits generated by other flights help to fund European microgravity research. Novespace relies on recognized European maintenance organizations and on experienced crew.

Novespace - Our partner for strong science

Novespace, subsidiary of the CNES, founded in 1986, owns and operates the Airbus ZERO-G. Novespace organizes in-flight tests and research activities for worldwide customers mainly on parabolic flights. For more than 15 years, Novespace has been organizing over 110 parabolic flight campaigns on board the A300 ZERO-G for international space agencies (CNES, ESA, DLR, JAXA), for technological investigations and scientific research.



THE AIRCRAFT

THE **AIRPORT**

The airport: Dubendorf - 100 years of aviation

The airfield between Dubendorf and Wangen built in 1910 is internationally known as the birthplace of the civilian and military aviation of Switzerland. After 1948, civil aviation moved to the newly built Zurich Airport and Dubendorf was solely used for military purposes.

Dubendorf today and tomorrow

Today Dubendorf Air Force Base hosts Air Transport squadron 3 and 4, the Swiss Air Force Command, the Air Defense and Direction Center, Skyguide national for military air traffic control and Skyguide for Swiss civil air traffic control. The planned mixed civil and military use of the Air Force Base was approved by the Swiss government. The plans for the future use of the Air Force Base include an “innovation park“ for industry, spin-off companies and science.

The Aeromedical Institute (AMI)

The Aeromedical Institute (AMI) is the Swiss center of competence for medical and psychological assessment with regard to security and performance in military aviation, transport and management. For the air force the AMI examines pilots and parachutists, prospective General Staff course applicants as well as members of the special forces. The AMI offers an excellent medical support before, during and after the Parabolic Flight Campaign.

University of Zurich[UZH]

The University of Zurich (UZH) is Switzerland's largest university. It is Europe's first university to be established by a democratic political system and has seven faculties covering some 100 subject areas. UZH is a member of the "League of European Research Universities" (LERU) and one of Europe's most prestigious research institutions. The UZH is internationaly renown in the fields of medicine, immunology, genetics, neuroscience and structural biology as well as economics. To date, the Nobel Prize has been conferred on twelve UZH scholars. The University of Zurich promotes the transfer of knowledge and technology, supports cooperation with private enterprises and the realization of innovative projects. http://www.uzh.ch

THE **UNIVERSITY** OF **ZURICH**

The advantages

Zurich as a European location of parabolic flight campaigns

- The well established military airport Zurich-Dubendorf
- Swiss Air Force will give full support of parabolic flight campaigns
- Excellent scientific ground support through the very close laboratories of the University of Zurich: Quick and easy transportation of equipment to the airport, superb state-of-the-art laboratories to support complex and demanding scientific experiments
- Located in an ESA member state at the center of Europe, proximity to Germany and France
- Superior infrastructure of the Zurich area
- Very attractive environment and a potentially strong local market

ZURICH AS **EUROPEAN LOCATION** OF **PARABOLIC FLIGHT** CAMPAIGNS

THE **FIRST** SWISS **PARABOLIC FLIGHT** CAMPAIGN

Flights into microgravity

In order to present the Swiss Parabolic Flight platform to the public, a two-day kick-off campaign will be held on September 21-22, 2015 (reserve date: September 23, 2015) on the premises of the Dubendorf Airport, Switzerland. Day one will be dedicated to scientific microgravity research experiments, day two is the Microgravity Flight Participant flight day.

A new era of science

The first Swiss Parabolic Flight campaign is the foundation for the development of scientific, logistic and operational processes and it will advance the establishment of high-quality standard operational procedures for future Swiss campaigns. The Swiss Parabolic Flight campaign will host a full range of events and a lot of complementary information will be delivered.

An event for pioneers

It is a unique opportunity to gain more knowledge about the latest space science and microgravity research, to meet renowned international researchers and senior personnel of the Swiss Airforce in person. Foremost, it is a unique opportunity to experience the state of weightlessness above the Swiss Alps or the Mediterranean Sea.

Be a Pioneer !

Swiss Parabolic Flight Science Pioneer Pass

How can you participate in this exciting kick-off campaign? You can purchase a Swiss Parabolic Flight Science Pioneer Pass, which includes full participation in a flight day. The flight day includes a briefing session conducted by the Airbus ZERO-G flight captain, the 90 minute microgravity flight in the Airbus ZERO-G (15 parabolas with 22 seconds of total microgravity during each parabola and a short scenic flight above the Swiss Alps) and a debriefing. The day is completed by an award ceremony for all pioneer flight participants.

Swiss Parabolic Flight Founders Club

And/or you may join the exclusive Swiss Parabolic Flight Founders Club by a donation to the science program. As a member of the Swiss Parabolic Flight Founders Clubs you will be acknowledged personally in scientific presentations and publications arising from the 1st Swiss Parabolic Flight Campaign and awarded during a VIP cocktail event on September 21, 2015. You will qualify to be selected to conduct a scientific experiment during a science flight (if qualified and after training). For more information regarding the Swiss Parabolic Flight Science Pioneer Pass and the Swiss Parabolic Flight Founders Club please contact Mrs. Pascale Wyss (pascale.wyss@uzh.ch or phone +41 44 63 54060).

THE **FLIGHT** PIONEER **PROGRAM**

From left to right: Cora Thiel, Marc Studer, Oliver Ullrich, Tina Graf, Liliana Layer

A **STRONG** TEAM

Prof. Dr. Dr. Oliver Ullrich
Full Professor and Chair of Anatomy,
Professor of Space Biotechnology,
Project Director and Chairman

Dr. Cora Thiel
Senior Scientist and
Parabolic Flight Project Leader

Prof. Dr. Max Gassmann
Full Professor and Director,
Chairman of the Zurich Center for
Integrative Human Physiology (ZIHP),
Parabolic Flight Project Leader,
Specialist for high altitudes

Capt. Dr. Marc Studer
Professional Pilot Corps,
Swiss Air Force
Physician, Project Director

FOR STRONG **SCIENCE**

Colonel Martin Erb
Commander Dubendorf Air Base

Dr. Svantje Tauber
Project Scientist

Tina Graf, M.Sc.
Finance and Strategic Partnerships

Pascale Wyss
Project Administration and Management

Liliana Layer, Dipl.-Biol.
Project Scientist

Colonel Dr. Andres Kunz
Director Aeromedical Institute

Jennifer Polzer, B.Med.
Project Scientist

Naomi Shepherd, M.A., B.Med.
Project Scientist

Natalie Dové
Project Management

Corinna Gomm
Designer

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Science for Tomorrow

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IMPRESSUM

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Responsible for the contents:
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Full Professor, Chair of Anatomy
Professor of Space Biotechnology

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