

REXUS/BEXUS - ROCKET AND BALLOON EXPERIMENTS FOR UNIVERSITY STUDENTS

M. Inga

SSC, Science Services, P.O. Box 4207, SE-171 04 Solna, Sweden, Mikael.inga@sscspace.com

The REXUS/BEXUS programme allows students from universities and higher education colleges across Europe to carry out scientific and technological experiments on research rockets and balloons. Each year, two rockets and two balloons are launched, carrying up to 20 experiments designed and built by student teams. REXUS experiments are launched on a rocket powered by an Improved Orion motor with 290 kg of solid propellant. It is capable of taking 40 kg of student experiment modules to an altitude of approximately 90 km. BEXUS experiments are lifted by a balloon with a volume of 12000 m³ to a maximum altitude of 30 km, depending on total experiment mass (40-100 kg). The flight duration is 2-5 hours. The REXUS/BEXUS programme is realised under a bilateral Agency Agreement between the German Aerospace Center (DLR) and the Swedish National Space Board (SNSB). The Swedish share of the payload has been made available to students from other European countries through collaboration with the European Space Agency (ESA). EuroLaunch, a co-operation between the Esrange Space Center of SSC and the Mobile Rocket Base (MORABA) of DLR, is responsible for the campaign management and operations of the launch vehicles. Experts from ESA, SSC and DLR provide technical support to the student teams throughout the project.

I. Introduction



THE REXUS/BEXUS Programme in its current form was started with a vision:

- To promote sounding rocket and balloon activities and attract young people in Space activities
- The intention is to give European students the opportunity to gain valuable experience in planning for and carrying out experiments in association with a professional environment

The programme is now in its fifth year, 56 Experiment teams involving over 400 European students have already had the chance to fly their own experiments to the edge of space.

The programme offers opportunities for students to carry out scientific and technological experiments on sounding rockets and stratospheric balloons. Each year, two rockets and two balloons are launched, carrying up to 20 experiments designed and built by student teams.

Students experience the full life-cycle of a space project, beginning with researching the idea and defining the design, continuing with building and testing, participating in the flight campaign and completing with data analysis and reporting. Throughout the project, the students develop a valuable understanding of space project methods and gain confidence in the practical skills necessary for the assembly, integration and testing of flight hardware and software.

The possibility to participate in a launch campaign with teams from across Europe is a unique and unforgettable opportunity. Many students choose to base their university projects or theses on their REXUS/BEXUS experiments.

Students are also encouraged to document their progress, to develop an outreach programme and to present their experiment to experts in conferences and to the public through media such as the internet or their local press.

II. REXUS/BEXUS Organization

The REXUS/BEXUS programme is realised under a bilateral Agency Agreement between the German Aerospace Center (DLR) and the Swedish National Space Board (SNSB). The Swedish share of the payload has been made available to students from other European countries through collaboration with the European Space Agency (ESA).

EuroLaunch, a co-operation between the Esrange Space Center of SSC and the Mobile Rocket Base (MORABA) of DLR, is responsible for the campaign management and operations of the launch vehicles. Experts from ESA, SSC and DLR provide technical support to the student teams throughout the project.

REXUS and BEXUS are launched from SSC's facility Esrange Space Center in northern Sweden.

III. Programme outline

The REXUS/BEXUS programme is targeted at student teams from universities and higher education colleges across Europe. Each year, two rockets and two balloons are launched in March and October respectively, carrying up to 20 student experiments.

The application process for participation opens in September each year, with the experiment selection being finalized before Christmas. From that point, the students' projects take about nine months for BEXUS and 14 months for REXUS to be ready for launch.

Sponsorship is available for the student teams to attend a training week, project reviews and the launch campaigns, with expert guidance available throughout the project. Dedicated lectures and workshops are offered throughout the project on topics relevant to the project stages.

Since the students themselves are responsible for designing, building and operating their experiment, they are advised to form an interdisciplinary team that includes knowledge of mechanics, electronics and experimental methods, alongside scientific expertise. Guidance from a professor or an institute is highly recommended.

IV. Timetable

Following are a typical timetable for REXUS (Table 1) the timetable for BEXUS is similar:

Table 1: REXUS Timetable.

T-18 m	Call for experiment proposals
T-16 m	Proposal submission deadline
T-15 m	Proposal shortlisting
T-14 m	Workshop in ESTEC (ESA) / Bonn (DLR), presentation of proposals
T-13.5 m	Final experiment selection
T-12 m	Student Training Week (STW) at SSC, Esrange Space Center or DLR, MORABA facilities. Preliminary Design Review (PDR)
T-9 m	Critical Design Review (CDR)
T-6 m	Mid Term Report (MTR)
T-3 m	Delivery of Experiments, Experiment Acceptance Review (EAR)
T	Campaign at Esrange
T+1 m	Distribution of the REXUS post flight Report
T+3 m	Submission of Student Experiment Reports
T+4 m	Publication of Final Report

V. Vehicles

REXUS experiments are launched on an unguided, spin-stabilised rocket (Figure 1) powered by an Improved Orion motor with 290 kg of solid propellant. It is capable of taking 40 kg of student experiment modules to an altitude of approximately 90 km. The vehicle has a length of approx. 5.6 m and a body diameter of 35.6 cm.

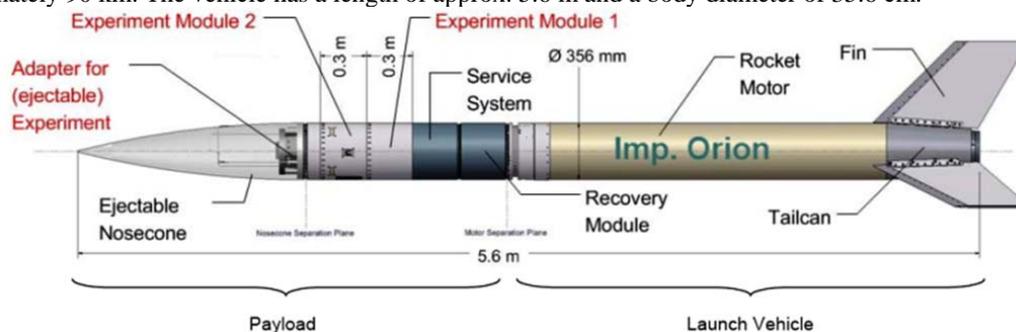


Figure 1: REXUS.

BEXUS experiments (Figure 2) are lifted by a balloon with a volume of 12 000 m³ (Figure 3) to a maximum altitude of 30 km, depending on total experiment mass (40-100 kg). The flight duration is 2-5 hours.

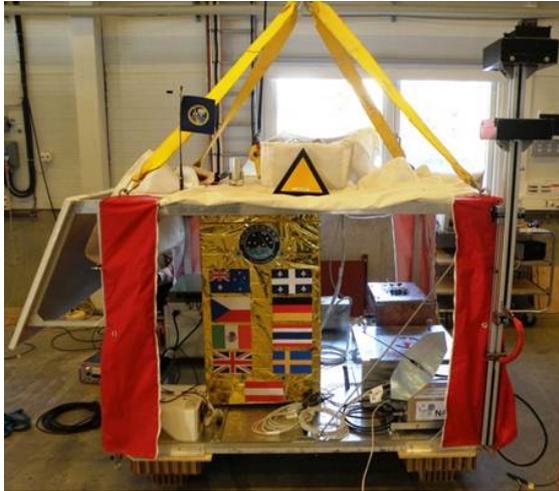


Figure 2: BEXUS Gondola with experiments.



Figure 3: BEXUS Launch.

VI. The Experiments

56 Experiments have been flying on REXUS/BEXUS and there are currently 14 new experiments that are being designed and built. Many of the experiments have a scientific focus, in research fields such as atmospheric physics, radiation, magnetic fields, fluid physics, microgravity and materials science. Other teams have flown technology demonstrations investigating aspects of aerodynamics, propulsion, communications, deployment systems and more.

VII. One Experiment

RAIN (Rocket deployed Atmospheric probes conducting Independent measurements in Northern Sweden) - KTH Royal Institute of Technology, Sweden, <http://rainexperiment.se>

The scientific objective of the REXUS experiment RAIN is to develop a proof of concept of a technique to conduct high-resolution vertical multiple point measurements of middle atmospheric aerosols. An increasingly important topic in meteorological sciences has been the monitoring of aerosol particles in the middle atmosphere. Middle atmosphere aerosols play an important role in determining the chemical composition and radiation balances of the whole atmosphere. As of yet there have been no measurement techniques that can gather high resolution distribution profiles of these aerosols. Through the use of multiple measurement probes (2 Free-Flying Units), each fitted with a selection of collection materials that are exposed to aerosol particles at varying altitudes, it is hoped that such a distribution can be collected. Resolution of horizontal structures at probe separations on the order of hundreds of meters is an additional novelty of the experiment. Scanning electron microscope post-flight analysis will be conducted to observe the particles collected.

VIII. Conclusion

The REXUS/BEXUS programme has so far been a success with more than 400 Students involved in space related activities, from which they have gained valuable experience and confidence.

The great breadth and volume of outreach carried out for the programme and the space community is hard to quantify but it has made a significant impact. Hopefully, in the future, further increased interest in sounding rocket and balloon activities is seen and that the programme continues to promote space activities for the upcoming scientists and engineers.

Many of the former REXUS/BEXUS students are now involved in the space science and technology community as professionals, which is a clear indicator of success when looking back on our vision.

More Information

More information about the REXUS/BEXUS Programme can be found at: <http://www.rexusbexus.net>