

NATIONAL REPORT ON SWEDISH SPACE ACTIVITIES – GENERAL OVERVIEW WITH A FOCUS ON BALLOONS AND ROCKETS

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ABSTRACT

The paper gives an overview of major Swedish space activities within the field of balloons and rockets, recently launched or scheduled for launch in a near future from Esrange Space Centre. Several research projects, including the nationally led experiments PoGOLite and PHOCUS, are described in brief. Sweden is also a major player in sounding rocket activities within the ESA Elips programme as provider of launch services and developer of microgravity experiment modules. Last but not least, the education programme Rexus and Bexus, jointly performed with DLR with a participation of ESA is described. It should be noted that a number of other balloons and rockets have been launched from Esrange Space Centre during the reporting period. The present paper concentrates, however, on the projects led by Swedish Principal Investigators and activities with a major involvement of Swedish scientists and engineers.

INTRODUCTION

Swedish space research comprises many different fields, such as astronomy, space physics, astrobiology, earth observation, atmospheric research, as well as microgravity research, including space physiology. The major part of Swedish space research activities is supported by the Swedish National Space Board (SNSB), within its national programme for space research and remote sensing. The annual budget available for these activities is around 6 M€ enabling support to ~65 research projects at Swedish universities and research institutes. Most projects utilise flights offered by ESA programmes and/or data provided by ESA satellites and other missions.

Experiments utilising balloons and rockets currently constitute a minor part of the national programme. Nevertheless, these national activities are of high relevance as they provide unique opportunity of combining basic science with instrument development as well as possibility to use a custom-made platform for the experiment. In addition, the smaller scale of the balloon and rocket projects allows close cooperation between the research groups, technicians and industry. Another advantage is the fact that the time-frame from the start of the project to publishing the results is relatively short, which is especially attractive for young researchers and PhD students.

The balloons and rockets are launched from Esrange Space Centre, a unique Swedish and European facility situated above the polar circle at lat. 67° 53'N, long. 21° 04'E, with a rocket impact area of 5600 km². Landing sites for short duration balloons includes northern Scandinavia whereas long duration balloons usually land in northwest Canada.



Fig. 1. Surroundings of Esrange in early spring (photo K. Dannenberg).

1. SWEDISH EXPERIMENTS ON BALLOONS AND ROCKETS

Currently, two nationally led balloon and rocket research projects are ongoing within the national space science programme. The balloon project PoGOLite, the Polarized Gamma-ray Observer, is a downscaled instrument for measurements of the polarisation of gamma-rays from extreme astrophysical objects. PoGOLite is led by Prof. Mark Pearce, KTH, in cooperation with scientists from USA, Japan and France. On its maiden flight on a balloon in 2010, PoGOLite will concentrate on a well-known target, the Crab Nebula. The experience from PoGOLite will hopefully pave the way for a new branch of astrophysics, involving measurements with larger instruments in future. The PoGOLite balloon will be the largest balloon ever launched from Esrange under Swedish leadership.

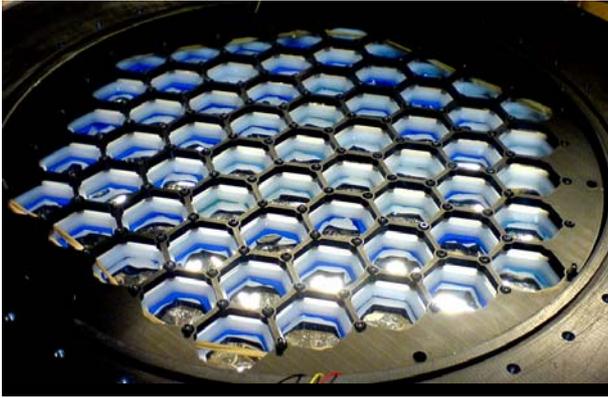


Fig. 2. Top-view of the PoGOLite detector (courtesy of Prof. Mark Pearce, KTH).

The rocket project PHOCUS (Particles, Hydrogen and Oxygen Chemistry in the Upper Summer mesosphere) will study mesospheric particles and their interaction with their neutral and charged environment. The experiment is planned for launch in 2011. PHOCUS will carry 17 instruments from 8 scientific groups in Sweden, Norway, Germany, Austria and the USA, and characterise the atmospheric processes at altitudes up to 100 km. PHOCUS brings together technologies tested on a number of previous rocket flights, such as MAGIC.

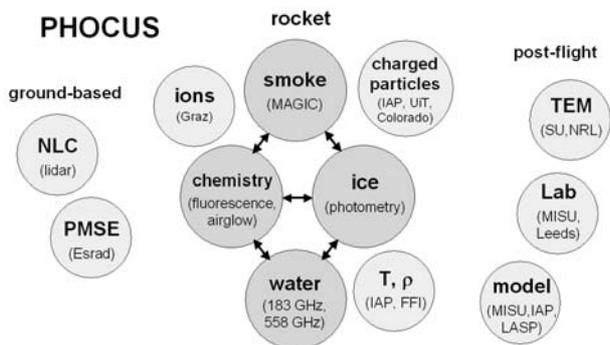


Fig. 3. Schematic overview of the measurements, techniques and collaborators involved in the PHOCUS project (courtesy of Dr. Jörg Gumbel, SU)

Another science mission, already flown from ESRANGE on a stratospheric balloon, is MEAP (Mars Environment Analogue Platform). The MEAP project was led by scientists from University of Bern, Switzerland, with an active participation of researchers from IRF, Swedish Institute of Space Physics under leadership of Prof. Stas Barabash. The aim of this balloon experiment was to test scientific instrumentation (high resolution neutral gas mass spectrometer P-BACE, Polar Balloon Atmospheric Composition Experiment) in a Mars analogue environment. The balloon experiment was successfully flown from Kiruna to Canada during the period June 28 - July 3, 2008.



Fig. 4. The trajectory of MEAP balloon flight (courtesy of Prof. Stas Barabash, IRF).

Mars-like environment with respect to pressure and temperature was achieved at 33-38 km latitude, and more than 4500 mass spectra were recorded during the 116 hour long flight.

2. PARTICIPATION IN ESA ELIPS PROGRAMME

Besides national activities, Sweden contributes to several of ESA programmes. ELIPS is one of the major optional programmes with Swedish participation, and Swedish industrial activities are mainly focused on MASER and MAXUS sounding rockets.

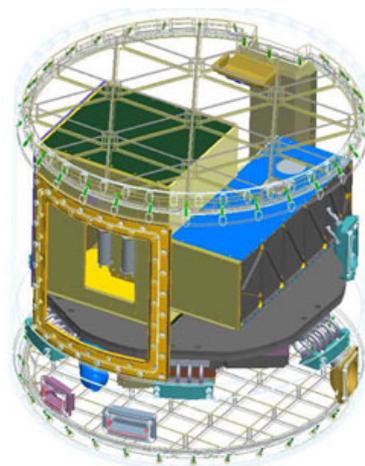


Fig. 5. Schematic view of the XRMON experiment module to be launched on Maxus-8 (courtesy of SSC).

The MASER-11 rocket was successfully launched from Esrange in May 2008, carrying onboard several experiment modules developed by Swedish Space Cooperation, SSC. The launch of the largest ESA sounding rocket MAXUS-8 is currently planned in spring 2010. A number of Texus rockets are also being launched from Esrange, within the framework of German national sounding rocket programme and in cooperation with ESA.

Engineers at SSC possess broad expertise and long experience within the development of the experiment modules for microgravity studies. One of the most interesting modules recently developed by SSC is the XRMON facility, X-ray monitoring on sounding rockets. Metal foam is being generated in situ at temperatures up to 700-900 °C. The samples are then studied by means of X-ray technique. Various scientific objectives are being addressed by XRMON such as in situ investigations on metallic foam formation, measurements of metallic melt diffusion as well as fundamental studies of solidification of metals including columnar and dendritic growth of crystals, morphological instabilities, forming of casting defects etc.

The XRMON-1 facility has been flown on Maser-11 and an improved XRMON-2 facility offering X-ray measurements of higher resolution is currently under development to be finished by the end of 2010.

3. REXUS AND BEXUS PROGRAMME

Sweden takes an active part in the student rocket and balloon programme Rexus & Bexus (Balloon and Rocket Experiments for University Students) The project is a joint undertaking of DLR and SNSB with an active participation of ESA. An annual call for proposals is being issued, offering an opportunity to carry out European student experiments on real rockets and balloons. The two first balloon flights within the joint programme, BEXUS 6 and 7, were successfully launched from Esrange in October 2008 and the two rockets, REXUS 5 and 6, were launched in March 2009. The duration of the balloon flights was 2-3 hours at 26-

30 km altitude. The Rexus rockets reached altitudes of around 100 km. Students from more than ten European countries are currently being involved in the experiments on Rexus and Bexus.

The next call for new proposals will open in September 2009 and students from ESA member states and cooperating states are invited to submit their proposals.

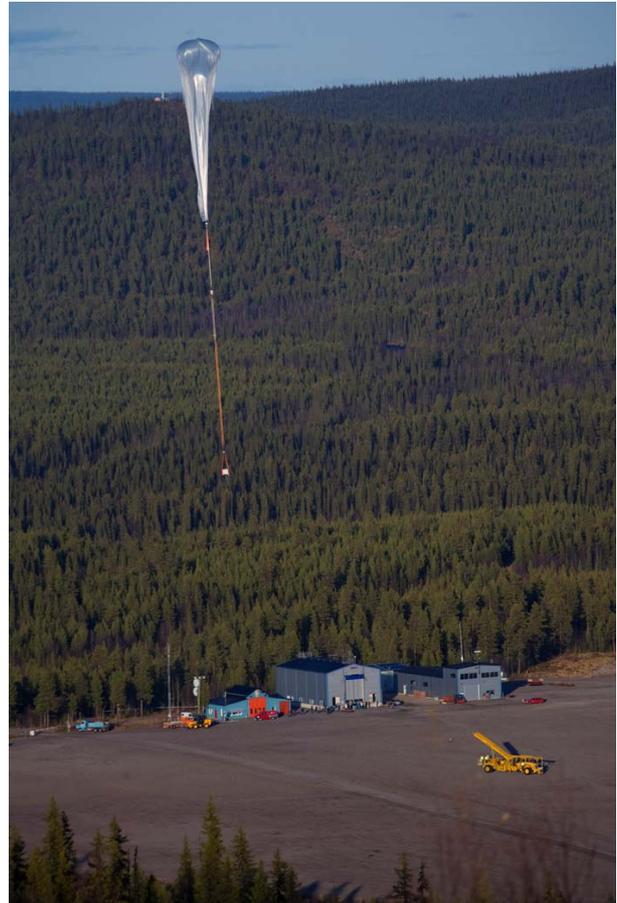


Fig. 6. Bexus-7 launch from Esrange in October 2008 (© SNSB, photo R. Schederin).