SWEDISH SPACE CORPORATION ACTIVITIES WITHIN NATIONAL AND INTERNATIONAL BALLOON AND ROCKET PROJECTS

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ABSTRACT

Swedish space research comprises a large variety of research projects utilising different platforms such as balloons, sounding rockets and satellites. Current and future scientific projects, aim at investigating Earth's atmosphere, the aurora and its origin, sub-millimetre observations of interstellar medium, gamma rays and many other topics. These studies require advanced technical capabilities with respect to payload and spacecraft design, as well as ground based equipment to fulfil the scientific goals. Swedish Space Corporation is executing and takes an active part in many of the space projects, especially in the fields of atmospheric research, space physics, astrophysics, material- and fluid-science, biology and physiology in microgravity, as well as space technology in general.
The ongoing rocket and balloon research projects executed by SSC or with participation from SSC that also will be launched from the SSC launch site Esrange Space Centre are described in this paper.

1. REXUS and BEXUS

Figure 1. BEXUS launch

REXUS and BEXUS is a joint ESA/SNSB/DLR student program that is executed by SSC and DLR. It gives university students an opportunity to carry out experiments on sounding rockets, REXUS and balloons, BEXUS.

1.1. BEXUS

The typical BEXUS configuration consists of a 12.000 m^3 balloon, a cutter, a parachute system, the Esrange Balloon Service System (EBASS), the flight train Argos GPS and ATC Transponder (AGT), a radar reflector and an experiment gondola. The total length of this system is up to 75 m.

Ascent velocity	5 m/s
Acceleration during parachute deployment	10 g
Mission Duration	2-5 hours
Altitude	20-35 km
Landing Velocity	8 m/s
Data Uplink	two channels 9.6 kbps
Data Downlink	one channel 4.8 kbps
Total Experiment Mass	40-100 kg
Gondola	40-100 kg
Payload Volume	1.4 m · 1.4 m · 1.2 m
Experiment Length (max.)	0.5 m

Table 1: BEXUS characteristics

1.2. REXUS

The student experiments are launched on unguided spin-stabilized solid-propellant single stage rockets. The launch vehicle is composed of an Improved Orion motor. The total mass of the rocket is around 515 kg comprising a propellant mass of 290 kg, motor and vehicle hardware of around 125 kg and a payload mass of around 100 kg. The total rocket vehicle has a length of 5.6 m and the diameter is 356 mm. The standard configuration of this payload comprises the recovery module, the service system, an ejectable nosecone and two experiment modules. The mass of each experiment module structure and bulkhead is approximately 5 kg.

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The total available mass for the student experiments is normally about 30 kg.

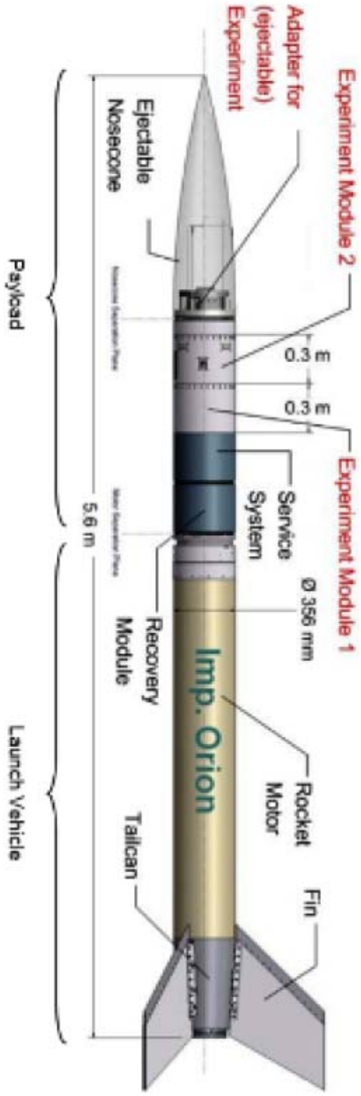

Figure 2: REXUS Standard configuration

2. PoGOLite

The light-weight Polarized Gamma-ray Observer (PoGOLite) will measure the polarization of soft gamma rays in the 25 keV- 80 keV energy range. The principal investigator of the project is Prof. Mark Pearce, KTH. The experiment is planed to be launched on a large balloon from Esrange Space Centre in August 2010. SSC is supporting the project with the following task:

- Power system
- Telemetry and telecommand
- Launch
- Flight operation
- Recovery

In the future a larger telescope is foreseen

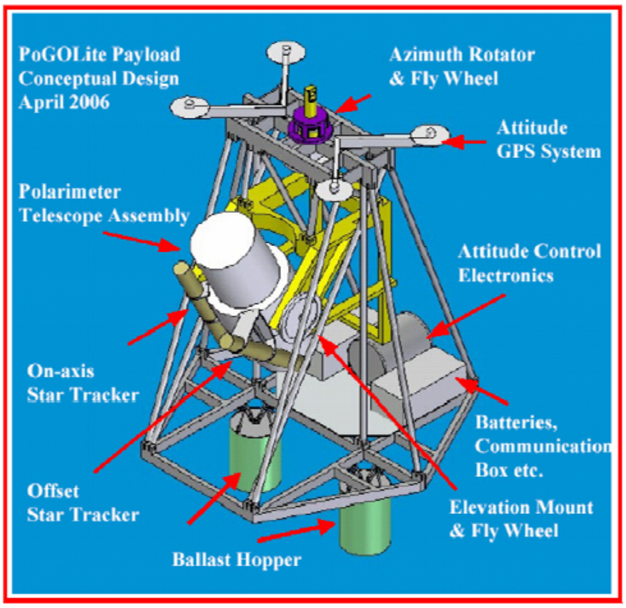

Figure 3:PoGOLite payload

3. PHOCUS

With the PHOCUS (Particles, Hydrogen and Oxygen Chemistry in the Upper Summer Mesosphere) sounding rocket the complex interaction between the different particles and substances in the Mesosphere will be studied with comprehensive simultaneously measurements. The principal investigator of the project is Dr. Jörg Gumbel, Stockholm University. The rocket will carry 17 different instrument for the different simultaneously measurements during flight. The launch is currently planned for summer 2011 from Esrange Space Center.

Figure 4: Noctilucent clouds

SSC is responsible for the overall project, integration and test, rocket system, service system, launch, operation, recovery. A new service module will be developed by SSC for this project and future 14” sounding rockets that can fulfill the increasing experiment demands.

A 2-stage Nike-Improved Orion rocket motor will be used for launching the rocket to the required 110 km apogee.

4. MASER

The MASER microgravity rocket program is conducted by SSC since 1987, with the purpose of providing flight opportunities to the scientific community for performance of experiment under microgravity conditions. SSC offers with the MASER program a complete concept from experiment payload development, testing and verification to flight preparation, operation and recovery. The program is also available on a flight ticket basis, were the user can fly their own payload or part of payload. The rockets are launched from the SSC rocket launch site Esrange Space Center in northern part of Sweden. The payload is recovered from the land impact area and returned by helicopter in approximately 2 hours. Biological samples or other sensitive samples can be retrieved directly at the impact site for fast and environmental controlled return to the launch site in approximately 1 hour.

Figure 5: MASER11 launch from Esrange Space Center

The latest rocket, MASER 11 was successfully launched in May 2009 and MASER 12 is currently planned for launch in end of 2010 beginning of 2011.

Figure 6 : Recovery of MASER11 motor

The MASER system uses a two stage solid fuel rocket motor. For MASER 10 a Skylark 7 was used, it was the last remaining Skylark. For MASER 11 the newly developed Brazilian motor VSB-30 was used, the diameter of the motor is 22" (559 mm). The total microgravity time is 6 – 7 minutes depending on the payload mass. The microgravity level is guaranteed to be below $1x10^{-4}$ g but is normally in the order of some $1x10^{-6}$ g.
The service system comprises the recovery and the service module, MASM, which includes the rate control system and the Digital Video System. It provides necessary support functions for the experiment facilities to perform their experiments during the mission. The service system also provides the payload functions for tracking and recovery of the MASER payload. The MASM is also providing the communication between the ground operators and the payload. The MASER system has the following technical characteristics:

payload mass:	up to 400 kg
scientific payload mass:	up to 300 kg
payload diameter:	438 mm
microgravity time:	6-7 minutes
microgravity levels:	$1x10^{-5}$g
apogee:	250-320 km

5. MAXUS

The MAXUS microgravity rocket program provides regular flight opportunities for microgravity research. It provides 12-14 minutes of microgravity. 7 successful launches have been conducted and the next rocket MAXUS 8 is currently planned to be launched from Esrange Space Centre in end of 2009. The MAXUS program is a joint venture between SSC and EADS Astrium Germany since 1991. ESA is the major customer with the ELIPS program..

Thrust Vector controlled system	
Overall length:	~15.5 m
Payload length:	~ 6.5 m
Overall mass:	12 400 kg
Payload mass:	up to 785 kg (experiment part approx. 480 kg)
Payload diameter:	640 mm
Max. velocity:	3500 m/sec
Max. acceleration:	15 g
Propellant mass:	10 042 kg
Motor burn time:	63 sec
Microgravity:	up to 14 minutes
Apogee:	> 700 km
Thrust(max. in vacuum):	500 kN
Motor:	single stage Castor IVB

6. Acknowledgment

All these projects have been made possible by financing from ESA and Swedish National Space Board.

Figure 8 : MAXUS launch from Esrange Space Cente

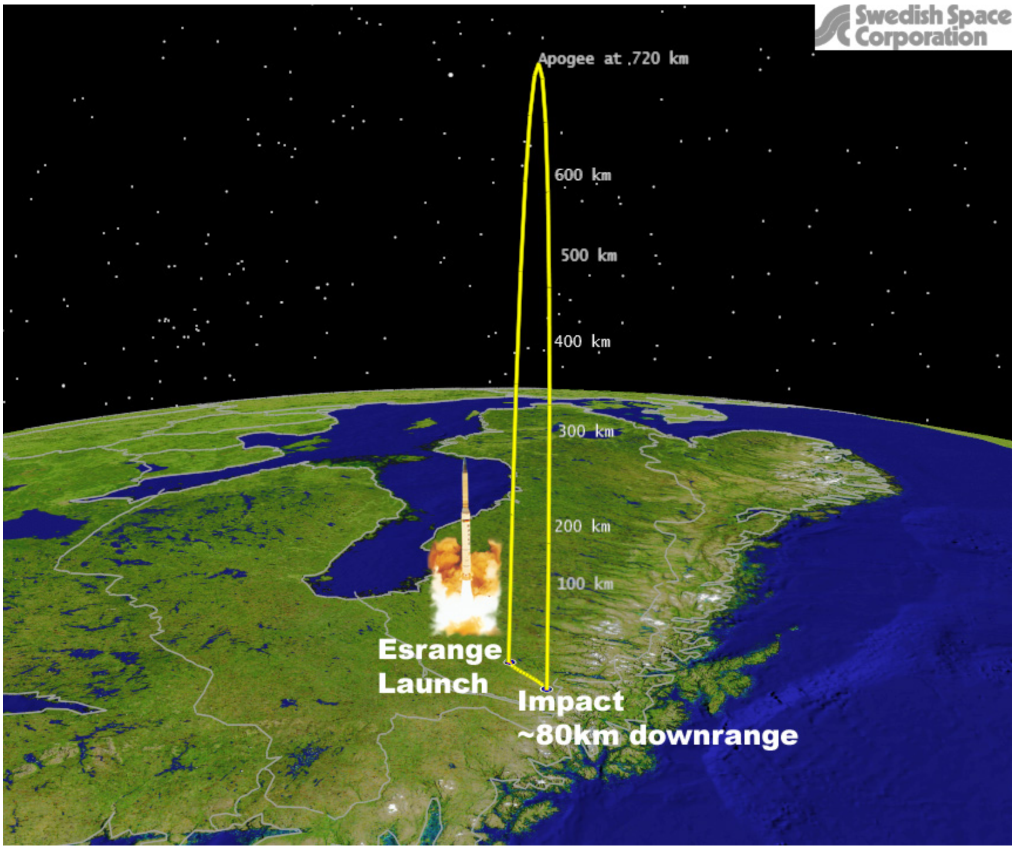

Figure 9 : MAXUS trajectory