BEXUS – *Balloon Experiments for University Students* Technical Overview:

This overview provides the technical basis to write a proposal for a BEXUS experiment.
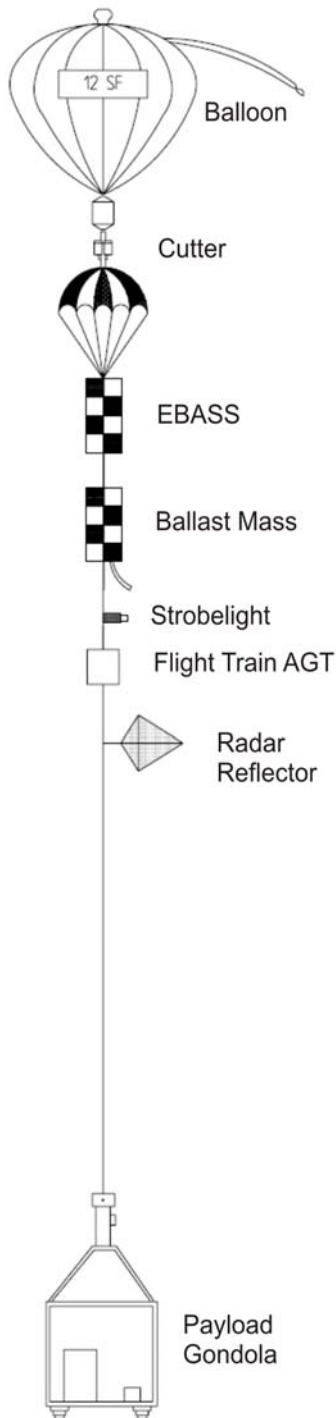

Fig. 1: BEXUS Vehicle

1. Launch Vehicle:

A typical BEXUS vehicle consists of a balloon, a piloting system and an experiment gondola (Fig. 1). The performance of the BEXUS balloon may be adapted to the respective experiment requirements.

a) Balloon System

The launch vehicle is a ZODIAC 12SF plastic balloon filled with Helium gas. The balloon has a volume of 12,000 m³ and the diameter of the filled balloon is 14 m. The total length of the balloon system may vary between 65 - 100 m. The total lifting capacity is 117 kg up to a maximum altitude of 35 km.

b) EBASS Service System

The ESRANGE Balloon Service System EBASS provides functions for altitude control, flight termination, load cell controlled termination, GPS, housekeeping and three serial channels for experiment data and control. The service system is enclosed in a glass-fibre armed insulation box. Load cell termination means that if the balloon bursts, the flight train is automatically disconnected from the balloon envelope when it senses a loss of lift tension to avoid entangling of the flight train.

Fig. 2: Hercules launch truck with Payload Gondola

c) Payload Gondola (see Fig. 2)

The experiments are placed in the payload gondola, which measures 1.45 m x 1.45 m x 1.2 m. The total mass of the experiments can be between 40 and 100 kg. The mass influences the maximum altitude.

2. Flight Profile and Conditions

The BEXUS balloon is launched from ESRANGE, Sweden.

a) Launch Requirements

The most important launch requirements are the trajectory and the winds. If higher altitude winds are strong, then the flight time will be reduced. Ground winds have to be lower than 5 m/s and preferably around 2 m/s.

b) Flight Profile

After the ascent phase, the balloon floats in the stratosphere at an altitude between 20 – 35 km. A valve and ballast function for altitude control is optional and normally not flown on BEXUS. After a flight duration of 2 – 5 hours the payload gondola is cut down from the balloon and recovered with a parachute system (Figure 3).
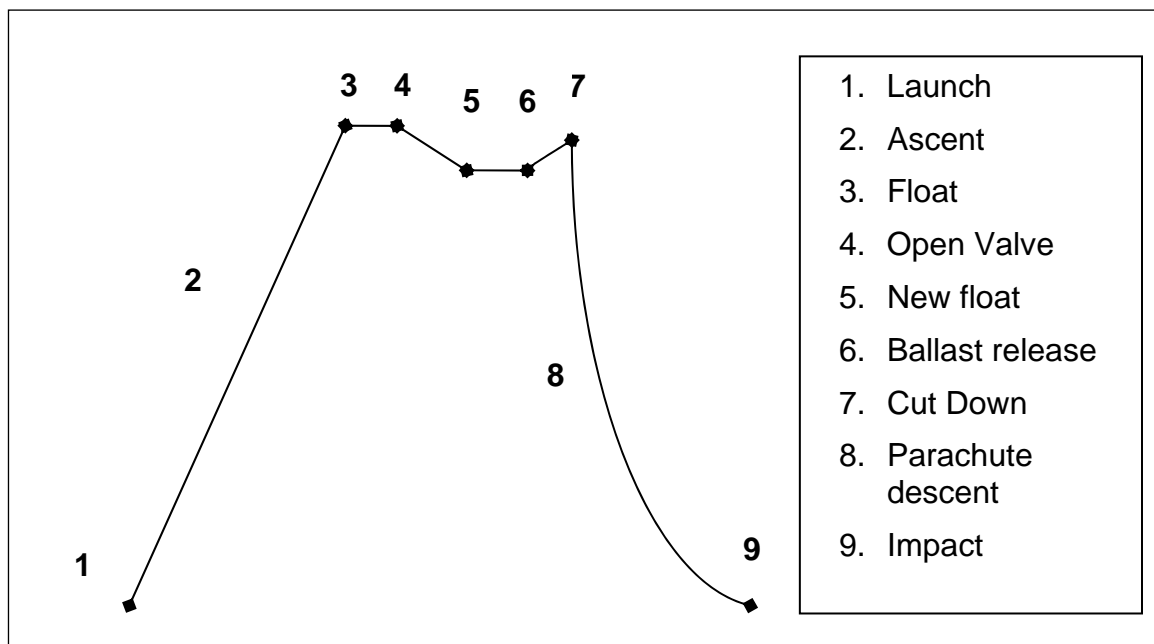

1.	Launch
2.	Ascent
3.	Float
4.	Open Valve
5.	New float
6.	Ballast release
7.	Cut Down
8.	Parachute descent
9.	Impact

Figure 3: BEXUS Flight Profile

Flight duration and cut down will be based on calculations for a safe landing within the Swedish border. The gondola will be picked up by a helicopter (Figure). The payload is normally brought back to ESRANGE within a day or two after launch.

c) Environmental Conditions

The environmental conditions of the balloon flight are temperatures as low as -70 °C and an air pressure of 10 mbar.

The temperature during the transport to the launch pad and after landing can be -20 °C with an exposure time of up to several hours at launch and typically one to two days after landing. It is recommended that heat sensitive experiments that create high temperatures within the gondola include temperature regulation in the experiment design. Due to vacuum conditions, it should be verified that systems, especially electrical ones, have nominal performance in the absence of convective cooling.

Figure 4: BEXUS Recovery

d) Loads during Launch and Flight
Experiments should be able to withstand certain loads. The acceleration loads during the launch, flight and descent phases will be below 10 g vertically and 5 g horizontally. The landing velocity is approximately 8 m/s. The shock at impact depends on the nature of the ground surface. Nominally, the landing is gentle, causing no damage to the experiments.

The flight parameters are summarized in Table 1.

Table 1: BEXUS Flight Parameters

Flight Parameter	
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

3. Experiment Interfaces:

Depending on the mass of each experiment and the required altitude, about 8 Experiments can be accommodated in the Gondola (Figure).
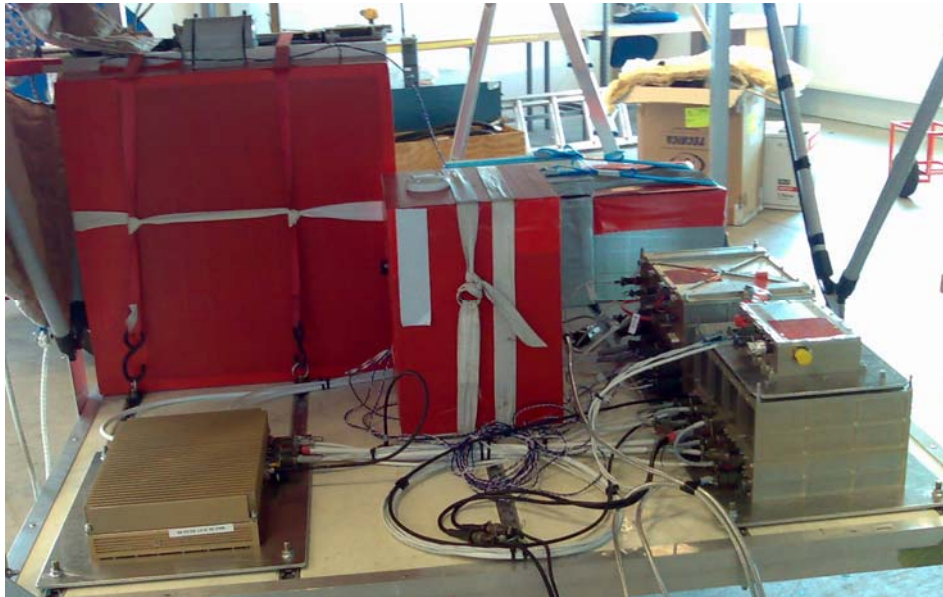
Figure 5: Experiment Accommodation within the Gondola

The electrical interfaces comprise data, command and power wires. The experimenters have to provide their own battery power. Batteries must be certified to handle low pressure and temperatures. 28 V is common.

Each experiment is connected to the EBASS (Service System) or the E-Link. The E-Link is a telemetry system with a standard Ethernet interface. It can handle TCP/IP and UDP/IP communication and other types of synchronous and asynchronous user interfaces. Details are described in the BEXUS user manual.

Table 2: BEXUS Experiment Data

Experiment Data	
Data uplink	two channels 9.6 kbps
Data downlink	one channel 4.8 kbps
Total experiment mass	40 – 100 kg
Payload Volume	1.45 m x 1.45 m x 1.2 m
Experiment length (max)	0.5 m

4. Abbreviations

AGT — Argos GPS receiver/transmitter (box on the flight-train also containing an air traffic transponder with altitude reporting)

BEXUS — Balloon Experiments for University Students

EBASS — ESRANGE BAlloon Service System (control and piloting system)

E-Link — Ethernet up & downlink

ESRANGE — European Sounding Rocket Launching Range

GPS — Global Positioning System