# HIGH ALTITUDE BALLON - FIRST LAUNCH FROM REPUBLIC OF MOLDOVA

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***Abstract:*** *High-altitude balloons (HABs) are conventionally used to collect flight data, weather data, including pressure, inside and outside temperature,humidity,wind speeds and a lot of data needed by developers up to an altitude of at least 40 km. The scope of this project is to test the ground station systems developed at NCST, create and launch an electronic system for real-time tracking and data monitoring for a HAB. GPS data, inside and outside temperature, pressure, battery status and images caputered during the flight are saved to an on-board SD card and sent via 10mWatt transmitter to NCST Ground Stations System. Also was installed an GPS tracker thus, users are able to track the position for balloon recovery. One onboard camera capture still images throughout the three hour flight.*

***Key words:*** *balloon, ground, station, education, client, software*

## 1. Introduction

A HAB consists of two systems. The balloon provides the necessary lift using the buoyancy force of hydrogen or helium. The payload is tied below the balloon, and contains the electronics necessary for taking measurements and communicating with users on the ground.

Our primary contribution to HABs is the development of the payload. The project goals were to provide real-time tracking, accurately calculate altitude, and capture photos of the flight. GPS was the clear choice for determining position and altitude, though several possibilities exist for communication. Radio transmitters, such as RadioMetrix MTX2-434.650-10, are frequently used with HABs. The MTX2 is an FM radio transmitter that features a TCXO (Temperature Compensated Crystal Oscillator) that means that the output frequency is very stable despite temperature changes. This means that once you tune in to the transmission, you won't need to retune during flight even if the tracker gets very cold.

The scope of the project mainly was to test the ground statation system developed at National Center for Space Technologies at Technical University of Moldova.

## 2. Hardware and Software

The hardware and software requirements for the HAB were decomposed into five tasks: power supply board, communication, localization, sensors, and image collection. We used a Raspberry system to perform all.

The power supply allows the PITS and Pi to be powered from a 3S lipo battery. The battery voltage is converted to 5V and then fed to the Pi (via the GPIO connector) which down-converts to 3.3V and other voltages for the processor. The 3.3V is fed by the Pi to the GPIO connector where it then powers the rest of the electronics on the PITS board.

We supply a GPS antenna which screws into the SMA socket next to the GPS module. The combination is very sensitive however use indoors will give varied results depending on proximity to a window.


Figure 1  PITS+ Board for model A+, B+, V2 B

Basic operation of the MTX2 is very simple; we just connect the output of the Pi serial port to the data input on the MTX2.  This results in 2 different frequencies being emitted; a lower frequency for a "0" (low voltage - about 0V) from the port, and a slightly higher frequency for a "1" (high voltage - about 3.3V) from the port.  The difference between these frequencies is 600Hz - 910Hz depending on the PITS version. The MTX2 a 10mW transmitter preset to a frequency in the 434MHz European ISM (Industrial, Scientific and Medical) band which allows for airborne operation.

PITS includes a DS18B20 so it can report on the board temperature.  It would of course be possible to get an approximate reading by measuring the CPU temperature, but since we also bring the DS18B20 "one wire" bus out to a connector for you to add a second DS18B20 to measure the external (to the payload) air temperature, having a DS18B20 on the board means that the software can easily confirm that the bus is configured and working.

An ADC senses battery voltage and board current consumtion. Finally, the I2C bus is brought out to a connector, to which you can add any I2C sensor.  Our software supports the BMP085/180 pressure/temperature sensors

The software consists of camera script and the tracker program.

Both are started automatically when the Pi boots. The camera script is very simple loop where each time round the loop it takes an image for the SSDV system (to send to the ground) and a large image for storage only.

### 3. Communication

In order to solve the problem of communication with the HAB, we had to write a program to our ground station system that will track the balloon using the data from the on-board GPS. For first information to be received we've developed a mobile station installed on our car, that was the chase car used in our project. the name of the chase car was ER1OR.

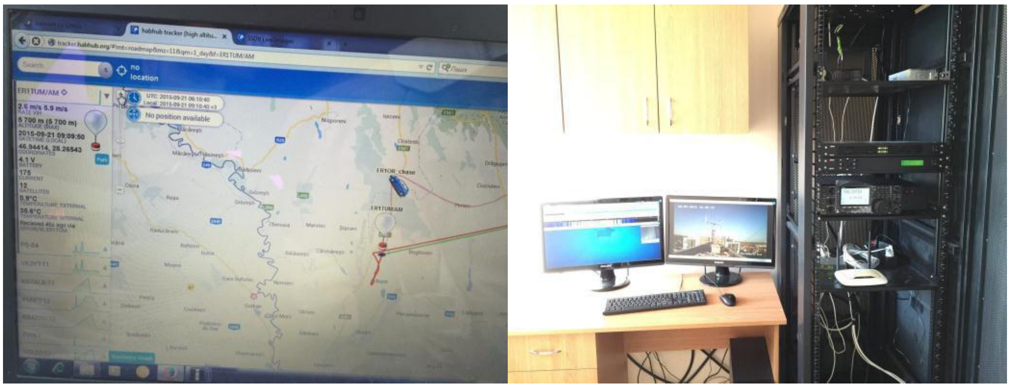

Figure 2  The chase car on the map and NCST Ground Station

The mobile station was equipped with a 3G modem and first data were sent to server so the ground station took these data and started to track the balloon.

The ground station was named and is still named ER1TUM, it is our official name that gave authorities.

### 4. Image collection

Images are saved on the SD card, and at the same time transmitted to ground station, every image is compressed and the sent. Were developed a loop, when one transmission is finished another one begines with a new picture.

When the payload was captured, the high resolution pictures were downloaded from the the SD card, so here we have all pictures from high altitude at high resolution.

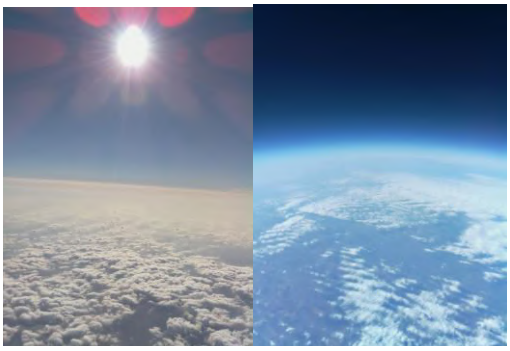

Figure 3 The best image from stratosphere captured by our payload

### 5. Prediction

The prediction of the balloon flight in the atmosphere is very important for taking the balloon home after its flight, and is important for authorities to give a NOTAM and to get the permissions for this flight.

Our team made everything right, this was the first launched balloon in our country, and all the authorities were helping us, it is about MOLDATSA, CNFR, CAA, SIS, MAE.

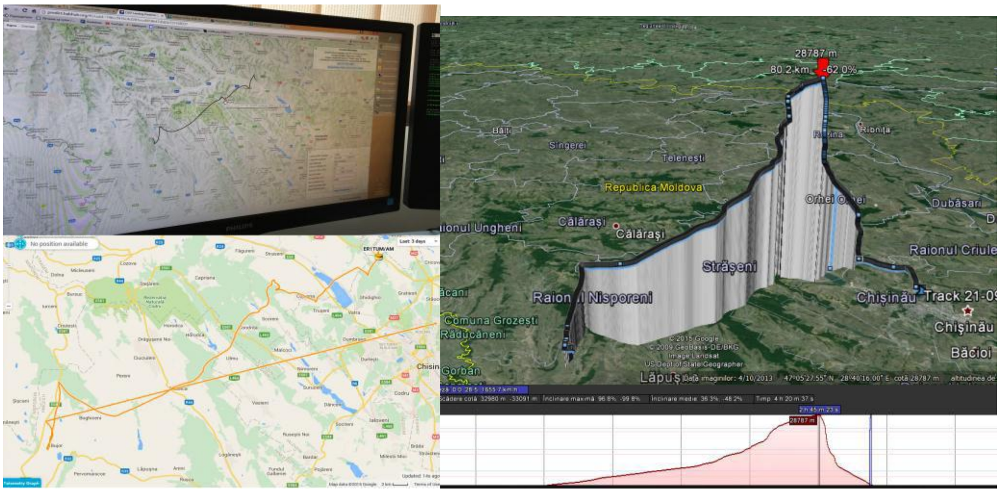


Figure 4 Prediction and the real trajectory

### 6. Balloon System

Our team used a 500g professional latex weather balloon capable of inflating to 5.8meters in diameter. When inflated to 2meters diameter at ground level, the balloon provides 1 kg of lift, and continues to expand before bursting at around 30km. About the parachute, we've bought a simple 36” diameter parachute made from nylon rope. The dimmensions of the parachute were provided by our calculations of the vertical landing speed. at 1kg of weight the vertical speed must be 5m/s and with this information our calculations gave a result of 36 inch parachute.

**7. Conclusion**

The launch of a HAB(High Altitude Balloon) only seems to be a simple step in order to take some pictures or flight data from stratosphere, indeed this was a hard work, our team was doing all this work during one month, and we were ready on the last day, doing last tests.

Finally this was a success to all of us, I mean the authorities, our team, the Technical University of Moldova and The Center for Space Technologies.

Based on our experience, we would make the following changes to the payload. To change the system that will cut the wire. To insert an gyroscope inside to see how it will stay in the air.

As a presentation was made a movie, the link is here:
https://www.youtube.com/watch?v=ul8FsSo787A

Figure 5 The team

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