BALLOON RESEARCH IN ANTARCTIC REGION

Antonov R.A., Sysoeva T.I., Titov V.Yu., Chernikov S.P.
Lebedev state Physics Institute, Moscow, Russia

Captive balloons are used extensively worldwide primarily for applied tasks, such as advertisement, ecological research, photography, etc. In the Soviet Union during World War II captive balloons was used for military purposes like obstruct balloons against German air strikes. For the first in history a program of scientific research with intensive using of balloons was developed in Russia. This program is being realized at present time.

Important part of this program is Antarctic balloon expedition at the Novolazarevskaya base station. Research program of this expedition includes the following:

1. A studying of energetic spectrum and nuclear structure of primary cosmic rays in hi-energy range over 10^{15} eV.
2. Measurements of solar neutrons spectrum
3. Measurements of ozone variation in frequency range from 1 second to 10^7 seconds. The goal of this research is collection of information on ozone photochemistry in troposphere lower layers and determination dynamical characteristics of the following: gravitation waves, tides, seasonal variations of turbulence on edge of circuit-polar vortex.
4. Research on influence of industrial emission into atmosphere
5. Studying of radiation background
6. Gamma-astronomy research
7. Obtaining landscape holograms from different altitudes

The Balloon Committee of Academy of Sciences coordinates the research project from Lebedev State Physics Institute, Moscow, while actual main start base and training ground is in Volsk in Volga region.

The committee staff consists of leading faculty members of Academy of Sciences institutes as well as representatives from other involved organizations.

Creation of start-base near Moscow in Puschino is in further plans. The Arctic expedition of the Lebedev State Physics Institute in Antarctic region is working since 2002.

For the current phase of research it was important to organize launching base for captive balloons in extreme conditions. Successful launches of captive balloons require the following conditions to be met: wind near the ground less than 10 m/s, flat launching surface, and ground connection for neutralization of electrostatic charge. Launches from ice and stone surfaces, which pose additional problems, and therefore have to be handled on case by case basis. For ordinary launches, the most important launch base equipment components are:

1. Winch
2. Rope
3. Ground connection
4. Holding dowels
5. Handy gas filling device
6. Wind block wall
7. Well-trained start crew

For safety reasons first time launches will be carried out with helium-filled balloons. All of the expedition staff has necessary skills for balloon launching to allow for necessary interchangeability of the team members.

Training of expedition staff is conducted at balloon center in Volsk, Dolgoprudniy stratospheric station near Moscow, and by Augur Company, the primary designer of captive balloons used in conducted research.

There are four types of captive balloons used by the Science Center of Lebedev State Physics Institute:

Balloon	Volume, m^3	Working Altitude, m	Payload mass, kg	Start crew, persons
MPA	5	300–500	1	1
PAK-60	60 (or 80)	1200–1500	10	3
APA-1	250	1500	90	8
AZ-55	850	4500	120	12

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Recently, a collaborative study of ecology of Arctic region was conducted in conjunction with Canadian Institute of Ecology, Toronto and Finnish Academy of Sciences, using PAK-60 captive balloon. Past collaborative research projects were conducted with colleagues from France, Canada, Brazil, Bulgaria, China, and Japan.

At this moment a balloon start base in Antarctic region is operating. A specially designed by Augur Company for Antarctic ambient circumstances captive balloon APA-1 is used there. This new captive balloon has 250 m^3 volume and polymeric rope. It can carry up to 80 kg of useful load up to 1200 m and can stay at this height during 15 days. Contracting system of rubber shock absorbers in the bottom part of balloon shell is used for compensation of the atmospheric pressure during ascents and descends of the balloon.

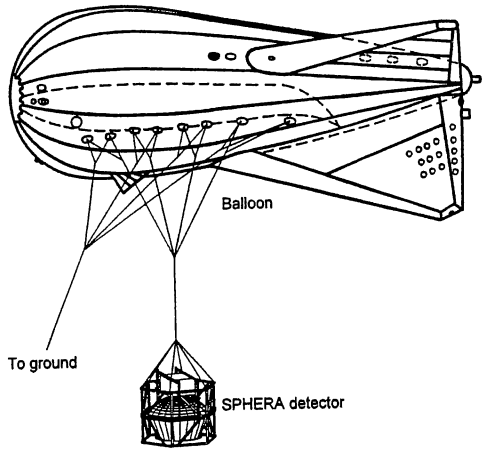
Empennage of our balloon consists of three stabilizers: one upper and two on sides that are placed on the shell in rear area of the balloon. Upper stabilizer is set vertically in the symmetry plane of the shell. Side stabilizers lies in the bottom area at angle of 108° one to another. All of these three stabilizers are the same size and have hard-frame sail design.

For connecting container to balloon, a lifting gear, consisting of six straps, attached to the bindings on the shell and container. Strap configuration allows for change of coordinates of container's center of gravity to achieve optimal pitch angle of the balloon if we need to change strap length on firing pad.

There is gas safety valve on the shell to avoid high gas pressure on the inside of the balloon. Kinematics scheme of the valve keep it fully open on extra pressure of 750÷800 Pa and momentary close on 650÷700 Pa.

In 48th Russian Antarctic expedition this specially designed APA-1 captive balloon for SPHERE equipment will be used during Antarctic night.

In the past, as part of more extensive program of energy spectrum of highest-energy cosmic rays with SPHERE detector study was conducted in Volga region. The AZ-55 captive balloon was used. These successfully completed measurements were amongst the most famous fundamental scientific project with captive balloons.



Ozone measurements are carried out during the entire year. Other parts of the program are planned for Antarctic day.

In the SPHERE project, a lot of original solutions were realized. To measure the fine structure of the spectrum calorimetric method is provided, which consists of measurements of integral flux of Cherenkov light from extensive air shower (EAS) has to be applied. It is an original and never before used method invented by academician Chudakov XX in 1940.

This device takes photometry of these snow fields and can measure energy of primary cosmic ray particles very precisely.

New captive balloon for further scientific investigations with specifications up to 7000m altitudes now is in process of development.

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