SIRIUS

ASGARDIA
THE SPACE NATION

ИМБП

ASGARDIA IN ISOLATION EXPERIMENTS

SIRIUS-23
A SPACE RESEARCHER'S DIARY

ASGARDIA IS THE FIRST DIGITAL SPACE NATION IN THE HISTORY OF HUMANKIND

Space Phones

Launchers

SPACE NETWORK

Space Ports

Mission Control Centre

Asgardia National Ark (ANA)

Protective Space Platform

Asgardia's motto is:
"One Humanity – One Unity!"

Manufacturing

Asgardia's mission is: to provide for infinite continuity of humans as a biological species in the universe by achieving the birth of the first human child in space

ASGARDIA
THE SPACE NATION

We are steadily moving towards our main goal – the birth of the first human child in space!

Igor Ashurbeyli,
the Founder and Head of Asgardia the Space Nation,
Doctor of Engineering:

In applied space science, the path to great discoveries has always started with ground-based research. At this stage, they have a key role in Asgardia's scientific programme aimed at achieving our primary goal: the first childbirth in space. That is why we decided to cooperate with one of the world's oldest space medicine institutes, the Institute of Biomedical Problems, which has been conducting isolation experiments since 1967. Our partnership started the year that marked the 60th anniversary of the first human space flight, and we find this symbolic.

Between 4 November 2021 and 14 November 2024, we conducted two ground-based isolation experiments at IBMP, SIRIUS-21 and SIRIUS-23, lasting 240 and 366 days respectively.

These two experiments are two stages of Asgardia's scientific programme studying female health under the impact of isolation and some other spaceflight factors. This is not only a major step towards the primary mission of the Space Nation I founded, but it is also our contribution to global space science, to the development of medications and techniques needed to adjust the female body to being in space, considering all of its psychophysiological peculiarities.

The next stage would probably be the planet's first isolation experiment involving married couples on the premises of Asgardia's own ground-based experimental complex. The potential construction of this kind of facility is currently being considered.

In parallel, jointly with our other partners, we started research on developing artificial gravity technologies. Artificial gravity and protection from space radiation are paramount to make fertilisation and childbirth in space possible. This is the starting point of our journey into deep space, the full-fledged exploration of our universe, which will finally allow humankind to actually grow, to enter a new stage of civilisation development, becoming independent from its terrestrial “cradle”.

Oleg Orlov,
Director of the Institute of Biomedical Problems of the Russian Academy of Sciences, Doctor of Medicine:

SIRIUS is an international programme running since 2017. And what is important, it is a creative one. That means that every research team entering the experiment invests not only its resources, but also its intellectual potential in the form of ideas and projects that can bring people together.

Asgardia's contribution cannot be overstated. The Space Nation joined the SIRIUS programme having a highly intelligent scientific project and ideological message wherein we can see great prospects. In the SIRIUS-23 experiment, it became our key international partner.

Within the SIRIUS scientific agenda and many other IBMP-based experiments, we are facing the global task of creating a system of medical support for long-distance interplanetary space missions. And this is a completely different ideology than the one related to orbital conquest, which is in demand here and now. That is why Asgardia's involvement is so important.

Childbirth in space and the human race expansion in the universe is a super strategic and super complex challenge. In the absence of a solution, human access into the universe and its exploration are simply out of the question. In deep space, it is necessary to cover such temporal and physical distances that humanity will really have to master reproduction in flight. And we are moving towards this goal — sitting at a lab microscope, conducting certain experiments on board the International Space Station and in our sealed facility, where the year-long SIRIUS-23 isolation project ended on 14 November 2024.

Igor Ashurbeyli and Oleg Orlov at the observation point monitoring SIRIUS-23 test researchers. Head of the Space Nation visiting IBMP RAS, December of 2023


Asgardia's scientific programme in the
SIRIUS-21 and SIRIUS-23 isolation experiments

Two experiments. Two Asgardian test researchers

Space Nation test researchers at the Asgardia booth during the International Astronautical Congress in Baku, 5 October 2023

The Asgardia scientific programme "Assessment of the Effects of Isolation as a Spaceflight Factor on Immunological, Biological Status, and Mineral-Bone Metabolism in the Female Body" included two large-scale isolation experiments, SIRIUS-21 and SIRIUS-23, lasting 240 and 366 days respectively.

In the SIRIUS-21 experiment, which took place in the Ground Experimental Complex of the IBMP RAS from 4 November 2021 to 3 July 2022, the crew physician, surgeon Victoria Kirichenko, was in charge of the Asgardia scientific programme.

The isolation stage of the SIRIUS-23 experiment started on 14 November 2023 and ended exactly one year later, on 14 November 2024. In this experiment, the crew physician, allergist and immunologist Ksenia Orlova, proceeded with implementing Asgardia's scientific programme. The outcome related to studying the biomaterials in the course of SIRIUS-23 and analysing the results will be summarised in the autumn of 2025.

Victoria and Ksenia took part in the experiments as both scientists and test subjects. Thanks to them, additional statistics on the adjustment of the female body to certain spaceflight conditions were generated. These statistics are essential for developing medications and techniques to support cosmonauts during long-term space missions. In addition, the research conducted in isolation experiments helps to bring closer the possibility of long-distance missions, when space explorers will have to stay away from their home planet for more than a year or two. For Asgardia, it's part of the preparation work to accomplish its primary mission: the first childbirth in space.

Ksenia Orlova with the Certificate of Recognition of the Head of the Space Nation. 28 December 2024

Awarding Victoria Kirichenko with the Certificate of Recognition of the Head of the Space Nation. 6 July 2022

Both test researchers, Victoria Kirichenko and Ksenia Orlova, were honoured with a special award for their contribution to Asgardia's scientific progress: the Certificate of Recognition of the Head of the Space Nation, established by Decree No. 61 dated 18 Leo 0006 (5 July 2022).

ASGARDIA
THE SPACE NATION

Space Nation and IBMP RAS joint project supervisors representing Asgardia:

Prime Minister
Lena De Winne

Minister of Science, Head of the University of Antwerp Space Laboratory
Prof. Floris Wuyts

Supervisors representing IBMP:

Head of Department of Implementation and Propagation of Scientific Achievements, Chief Manager of the SIRIUS international research project (Scientific International Research In Unique terrestrial Station), Cand. Sc. (Medicine)
Mark Belakovsky

Senior Researcher, Head of the Environmental and Hygienic Aspects of Habitability Laboratory, Cand. Sc. (Biology)
Daria Komissarova

Senior Researcher, Head of Department of Immunity and Metabolism, Head of Physiology of the Immune System Laboratory, Dr. Sci. (Medicine), SIRIUS International Project Executive Director
Sergey Ponomarev

Senior Researcher, Deputy Head of Department at SSC of Russia-IBMP RAS, Cand. Sc. (Biology)
Anna Kussmaul

Senior Researcher, Head of Bone & Metabolic Effects of Microgravity Research Laboratory, Cand. Sc. (Medicine)
Galina Vassilieva

Cyberphysician, test researcher and participant of a number of Institute's experiments, Head of the IBMP RAS Press Office
Oleg Voloshin

Ground-based isolation experiments are the path to deep space

Sergey Ponomarev,
SIRIUS International Project Executive Director, Senior Researcher, Head of Department of Immunity and Metabolism, Head of Physiology of the Immune System Laboratory at IBMP RAS, Dr. Sci. (Medicine):

The SIRIUS-21 and SIRIUS-23 experimental programmes focus on studying the adaptive processes that occur in the human body when a range of space flight factors are simulated in isolation conditions of a sealed facility with an artificial habitat. In particular, the psychophysiological state of crew members and the efficiency of intergroup interaction are assessed. Establishing connections between psychophysiological state and neuroimmunoendocrine status, homeostasis and metabolism regulation mechanisms, their dynamics and interactions in an altered habitat is a starting point for choosing a strategy that will make it possible to come closer to resolving the problem of long-term human living and working in space flight conditions or planetary station stays. Isolation experiments help to identify “hotspots” of human exposure to an artificial ecosystem.

The data on joint IBMP-Asgardia research, obtained during the SIRIUS-21 experiment, is now available. The results turned out to be quite interesting. In particular, studying the biological material collected from the female participants of the experiment revealed that in isolation, the amount of opportunistic pathogenic female microflora increases. Such microorganisms can cause various diseases and lead to dysbacteriosis. This is a risk factor, particularly for conception in space, that is to say, the results are important as a step towards the main scientific experiment of Asgardia in the future. And the primary goal of our joint experiment as an intermediate stage is precisely to assess the risks associated with certain kinds of space activities and to develop countermeasures.

We also detected a decrease in the ability of B-cells to produce antibodies, especially towards the end of the 240-day isolation. That implies decreased immune function, and the person becomes susceptible to various kinds of diseases. This is one of the risks cosmonauts may face. At the same time, it has been confirmed that upon exiting the sealed facility, one's recovery goes quite fast. Within seven days, everything is back to normal.

SIRIUS-23 crew commander Yuri Chebotarev during his extravehicular activity (EVA) on the "lunar" gravity stand

The human body is a complex system capable of adjusting to living in a variety of extreme conditions, nevertheless, up to the present moment, the limits of adaptive capacity, beyond which pathology begins, have not been clearly defined. A series of alterations can lead to changes in the physiological systems' functional activity and be of critical importance, including for fulfilling the reproductive function. This is exactly what calls for a comprehensive approach to studying the impact of space flight factors on the body for the purpose of potentially expanding the human habitat beyond our planet.

Galina Vassilieva,
Cand. Sc. (Medicine), Senior Researcher, Head of Bone & Metabolic Effects of Microgravity Research Laboratory at IBMP, one of the Asgardia programme supervisors in both SIRIUS-21 and SIRIUS-23:

The problem of negative changes in bone tissue under the impact of space flight factors has been comprehensively studied for decades, and the possibility of long and thus more distant flights depends on finding the solution. The relative rarity of female space flights means that we cannot investigate all medical aspects of the effect of space factors on their bodies.

Needless to say, research in mineral metabolism and morphofunctional bone disorders conducted on Earth gives us an opportunity to obtain unique medical and biological data. We get a chance to conduct comprehensive assessments of systems involved in regulating calcium homeostasis, to study various osteogenesis stages and adaptive bone remodeling mechanisms, and to identify predictors of osteodeficiency states specific to extreme conditions.

The results of ground-based studies will be further used to develop effective countermeasures and to correct osteodeficiency states developing during space flights in order to minimise the risks of bone fractures while landing on space objects and/or during prolonged extravehicular activity in hypogravity.

What factors affect human reproductive function in space?

Irina Ogneva, Head of the Cell Biophysics Laboratory at IBMP RAS, Dr. Sci. (Physics and Mathematics):

The key spaceflight factors affecting human biology and physiology, including reproductive function, are zero gravity, changes in radiation background (space radiation), changes in electromagnetic field (hypomagnetism), altered gas composition of the atmosphere, microbiological environment inside the spacecraft, limited room for moving around, confined space, and other causes of psychological tension leading to physiological stress and hormonal state changes.

SIRIUS-21 crew during a maximum physical exertion test. Crew physician Victoria Kirichenko monitoring physiological parameters

Asgardia–IBMP scientific programme interim results based on the SIRIUS-21 experiment

Studying the Effects of Simulated Spaceflight on Female Body in SIRIUS Ground-Based Experiment

Human deep space exploration requires solving a number of complex problems in various fields of science and technology, including medical support. Human spaceflight is associated with the restructuring of a whole range of processes in the body's physiological systems. These changes have been monitored and analysed for many years, and preventive countermeasures have been developed. However, specific changes in the female body under such conditions have not been studied in sufficient detail, since most studies have involved male participants. Nevertheless, the participation of women in space flights is increasing every year and the exploration of deep space would be unthinkable without the participation of women.

Scientific projects like the SIRIUS International Project that provide the opportunity to collect and study biological material from the participants of experiments that imitate real spaceflight give researchers a unique opportunity to study shifts in the functioning of different body systems, to outline the range of risks that may await humans in space, and to develop timely preventive methods for the possible adverse effects on the body's physiological systems. The results of such studies make it possible to develop recommendations for the biomedical support of women during space flights.

During the eight months stage of the SIRIUS project, the IBMP scientists, supported by Asgardia the Space Nation, studied the changes in the microbiological, immunological and bone status, body composition, electrolyte and hormone concentration dynamics, mineral and bone exchange in female volunteers staying in long-term isolation in a sealed facility.

Immune system changes

It is extremely important to study the female immune system changes during the spaceflight. When the immune system is out of balance, such pathological phenomena as infectious diseases and cancer in case of immunological surveillance weakening, on the one hand, and allergic and autoimmune conditions with excessive, inadequate and uncontrolled immune response, on the other hand, can appear. Cells and humoral factors of the immune system are distributed in almost all organs and tissues of the body in a special way, participating in the operation of many physiological systems and affecting vital functions of the body.

One of the most important evaluation parameters are the parameters of the B-cell link of immunity, which provides a point-specific humoral immune response against a certain antigen.

It turned out that during the period of adaptation to the isolation conditions, some of the immune system parameters show changes characteristic of the stress state and adaptation shift in the immune system. In the recovery period, seven days later, the value of all the analysed parameters in-

creased and practically did not differ from the background values, indicating a fairly rapid and complete replenishment of the B-cell functions after "landing".

Changes in the bone system

One of the important aspects of preserving the performance and quality of life of cosmonauts in spaceflight is the development of a system of comprehensive preventive interventions aimed at reducing the risk of developing disorders of bone mineral density, its structure and strength. Currently, on the threshold of long-distance and long-term space flights, the problem of studying the state of the musculoskeletal system of cosmonauts becomes particularly relevant. During lunar and extraterrestrial expeditions the human musculoskeletal system will have to function in new conditions, different from orbital flights, when the daily gravitational load is lower than on Earth, but the physical efforts during activities on other space objects may be more significant and prolonged than during orbital flights.

The relative rarity of female space flights means that we cannot investigate all medical aspects of the effect of space factors on their bodies. This is why experiments in mineral metabolism and morphofunctional bone disorders conducted on Earth give us an opportunity to obtain unique medical and biological data.

One of the first significant experiments involving eight women was a long-term, 120-day anti-orthostatic hypokinesia (-6° angle bed rest) conducted in the early 1990s at IBMP. The pharmacological corrections for changes in calcium metabolism and bone tissue condition that were tested in the experiment were promising. The method of two-photon X-ray gamma absorptiometry directly investigated the reactions of the female bone skeleton to a long-term deficit of mechanical load, as well as the state of electrolyte exchange and hormonal regulation of bone metabolism at different stages of the experiment. Scientists found interesting features of mineral redistribution in the female participants, which could indicate some differences in the processes of bone tissue adaptation to simulated weightlessness in women and men.

Another relevant and bone-related research objective is to assess the effect of extreme factors on the component composition (content and ratio of fat and lean mass) of both the entire human body and its individual regions. It is no coincidence that the FRAX® algorithm (fracture risk assessment tool), developed by the WHO to determine the 10-year risk of bone fractures, uses a close relationship between bone mineral density and body mass index, indicating the influence of modifications in fat metabolism on bone metabolic processes. Of practical importance for space medicine is also the assessment of nutritional status, which is necessary to analyse the adequacy of energy intake with food and the complex of key nutrients during prolonged exposure of the body to SF factors in order to timely correct the nutrition of cosmonauts. These studies allow us to understand the processes of metabolic adaptation of the body to new conditions.

When a person is isolated in a hermetically closed facility, a number of spaceflight factors are simulated, such as an artificial environment without natural light and seasonal changes, hypodynamia, chronic stress and change of habitual diet. They have significant influence on metabolism regulation in a body and affect processes of bone remodelling.

The comprehensive approach to studying the condition of the

bone system that we developed earlier included bone X-ray densitometry ("the gold standard" of osteoporosis diagnosis, the dual-energy X-ray absorptiometry, DXA), blood and urine analysis of neuroimmunoendocrine regulation of physiological processes, including thyroid and sex hormones, bone markers and electrolytes, and some noninvasive methods of screening observation of the bone condition and body composition.

After 240 days in isolation, participants in the SIRIUS-21 experiment had an increased proportion of lean mass while decreasing the fat component. That said, there were no critical changes in bone mineral content and bone density in the expert skeletal areas (lumbar vertebrae L1-L4 and proximal femur). Osteodensitometry of the heel bone, performed monthly, provided information on the biomechanical characteristics of the bone directly under isolation conditions and showed multidirectional changes, presumably associated with different modes of physical training in the female participants. The results of the instrumental measurements and biomaterial analysis will be included in the database for further statistical studies when a sufficient number of observations is accumulated.

Changes in the microflora

Microflora plays an important role in the prevention of inflammatory diseases of all biotopes of the human body and creates a barrier to opportunistic microorganisms that can cause dysbiotic conditions, and in a neglected state — inflammatory processes.

Factors of a space mission, such as work in stressful conditions, altered diets and hygienic procedures, constant microbial exchange between crew members in a confined space (spacecraft or hypothetical lunar station) cause formation of negative changes in the microflora of various biotopes. In many model experiments simulating certain factors of a space flight an increase in the number of opportunistic microorganisms and a decrease in the number of protective ones in the intestinal and upper respiratory tract microflora were observed. However, in these earlier model experiments the test subjects were mostly males, so the effect of simulated factors of space flight on the vaginal microbiome has not been studied before, although the microflora of this biotope plays an important part not only in creating a barrier to opportunistic microorganisms, but also, ultimately, affects the fertility functions of women and, in particular the success of fertilisation.

The main component of the normal vaginal microbiota is Lactobacillus spp. Maintaining a high number of lactobacilli in the vaginal microflora is an important condition for maintaining the health of female participants of long-term space missions and is directly related to the chances of getting pregnant.

It turned out that the number of almost all anaerobic and facultative anaerobic opportunistic pathogens in the vaginal and cervical canal biomaterial of the 8-month isolation participants after the experiment increased, while the number of protective lactobacilli decreased and became lower than normal. Such changes may lead to the development of inflammatory conditions and indicate the need for the development and use of preventive means.

Conclusions

In the conditions of long-term spaceflight, the human body faces a spectrum of adverse influences affecting a number of

physiological systems of the body. Ground-based isolation experiments simulating the conditions of a real long-term space flight provide invaluable factual material which helps to approach the understanding of the processes underlying the functional transformations of the body systems under the action of spaceflight factors.

During the SIRIUS-21 experiment, we obtained data on the dynamics of parameters describing changes in the microbiological, immunological and bone status, body composition, electrolyte and hormone concentration dynamics, mineral and bone exchange in female volunteers staying in a long-term isolation condition in a pressurised facility.

The study revealed a complex of changes in the systems studied, apparently of an adaptive nature. Due to the small group size the data obtained is not sufficient, further studies are required for a deeper understanding of the processes occurring in the female body under the effect of space flight factors. Work on studying these processes will continue.

Contributors:

Anna Kussmaul, Senior Researcher, Deputy Head of Department at SSC of Russia-IBMP RAS, Cand. Sc. (Biology), Member of the Tsiolkovsky Russian Academy of Cosmonautics, Full Member of the International Academy of Astronautics.

Galina Vassilieva, Head of Bone & Metabolic Effects of Microgravity Research Laboratory at SSC of Russia-IBMP RAS, Cand. Sc. (Medicine), Full Member of the International Academy of Astronautics.

Daria Komissarova, Senior Researcher, Head of the Environmental and Hygienic Aspects of Habitability Laboratory at IBMP RAS, Cand. Sc. (Biology).

Victoria Kirichenko, Asgardia resident, SIRIUS-21 crew physician, Junior Researcher at the Department of Operational Management of Spaceflight Medical Support at IBMP RAS, surgeon..

Sergey Ponomarev, SIRIUS International Project Executive Director, Senior Researcher, Head of Department of Immunity and Metabolism, Head of Physiology of the Immune System Laboratory at IBMP RAS, Dr. Sci. (Medicine), Corresponding Member of the International Academy of Astronautics.

Habitat parameters in the sealed facility of the IBMP RAS Ground Experimental Complex, where the SIRIUS-23 experiment test researchers spent 366 days

Gas medium temperature: 21-25 degrees Celsius;

Temperature fluctuations: 4 degrees Celsius maximum;

Relative air humidity: 40%;

Total gas medium pressure: 660-860 mm Hg;

Partial oxygen pressure: 140-200 mm Hg;

Partial carbon dioxide pressure: up to 7 mm Hg;

Nitrogen content: 78-79% by volume;

Habitable area gas medium velocity: 0,08-0,2 m/s;

Habitable area noise level: within 60 dB;

Working area luminosity: 400 lux minimum;

Microbial content shall not exceed 500 microbial cells (MC) per 1 m^3 in the experimental modules' atmosphere, and 100 MC per 1 m^3 on surfaces.

GEC technical equipment allows to

- automatically maintain the gas medium temperature and be able to adjust it within the specified temperature range at the crew's discretion;
- automatically maintain the gas medium optimal relative humidity within the specified range and remove excess moisture from the gas medium.

SIRIUS-23 science and technology programme

Research area	Test projects
Psychological and psychophysiological research	18
Physiological research	15
Immunity research	2
Metabolic, biochemical, and molecular biological research	4
Medical research	2
Sanitary-hygienic and microbiological research	11
Operational and technical experiments	15
Total:	**67**

5 modules of the IBMP RAS Ground Experimental Complex (GEC) where the experiment took place

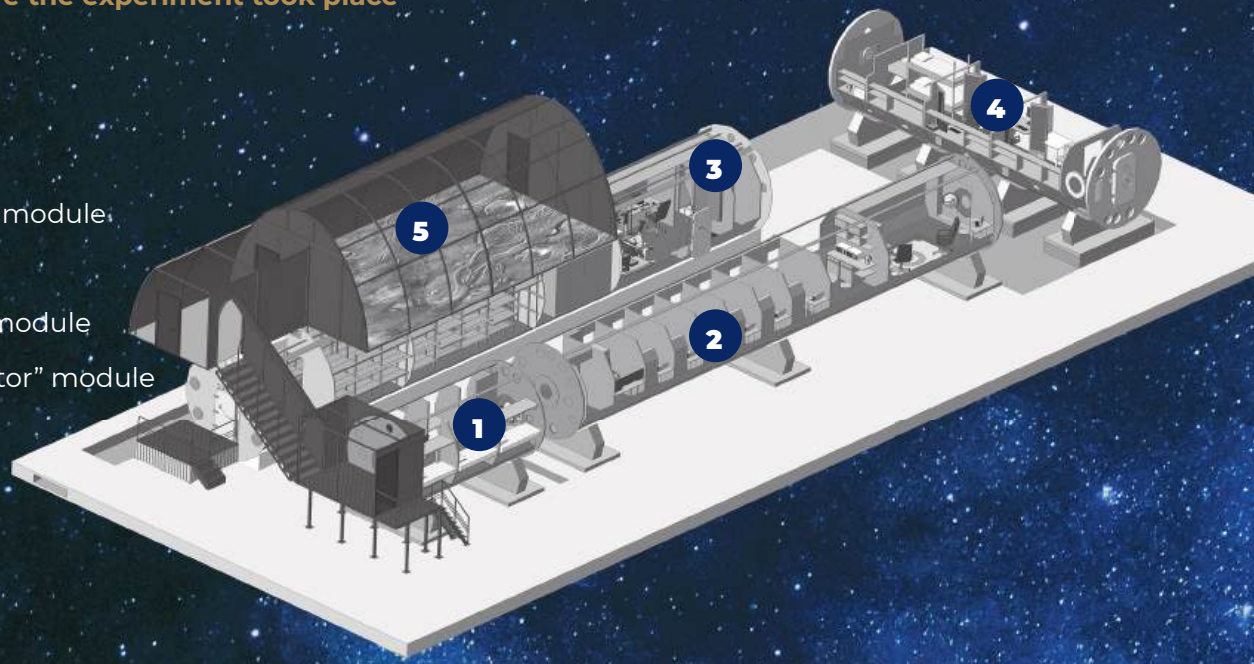
1 "Landing" module

2 Crew accommodation module

3 Food storage module

4 Medical experiments module

5 "Planet surface simulator" module



SIRIUS-23 conditions

6 crew members

5 kg of personal items taken by each crew member into isolation

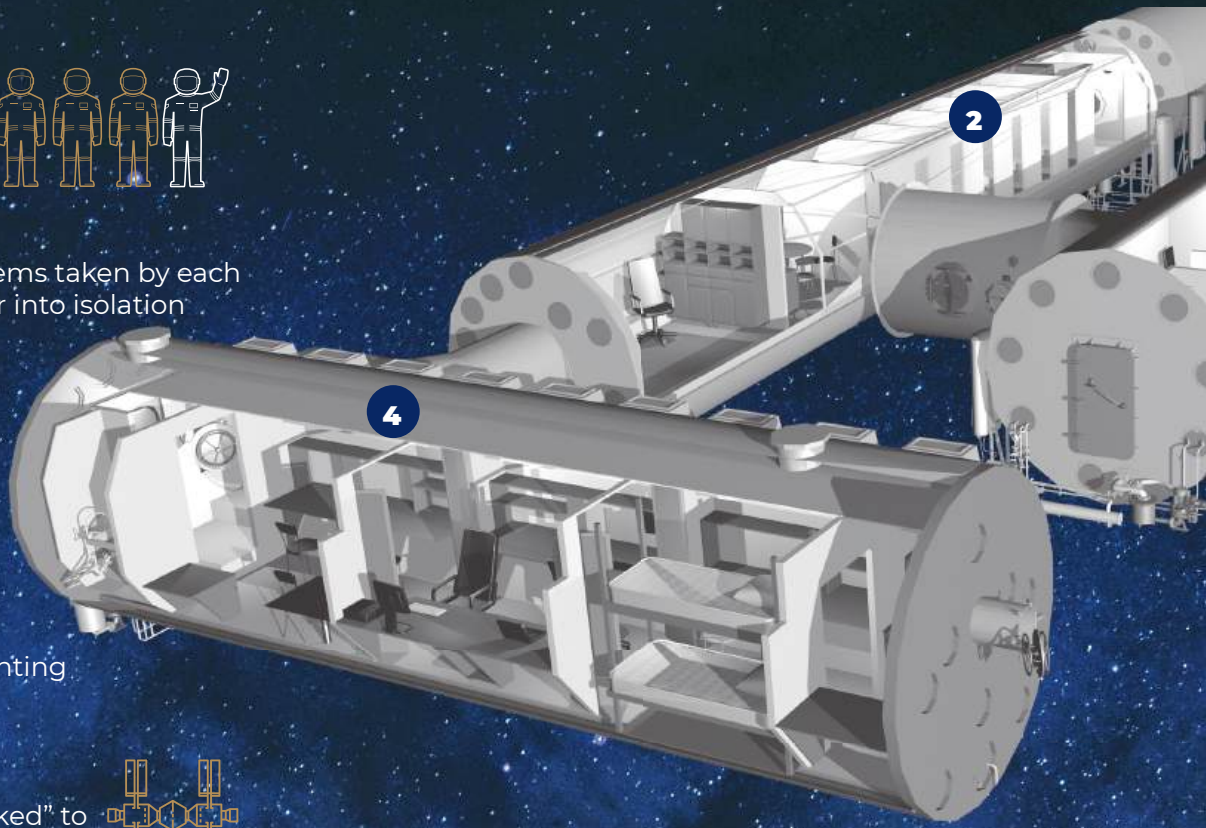
366 days of isolation

5 kinds of artificial lighting installed in the GEC

4 cargo vehicles “docked” to the GEC over the year

5 test researchers' EVAs as part of their simulated flight to the Moon

100 video cameras installed to monitor test researchers 24/7

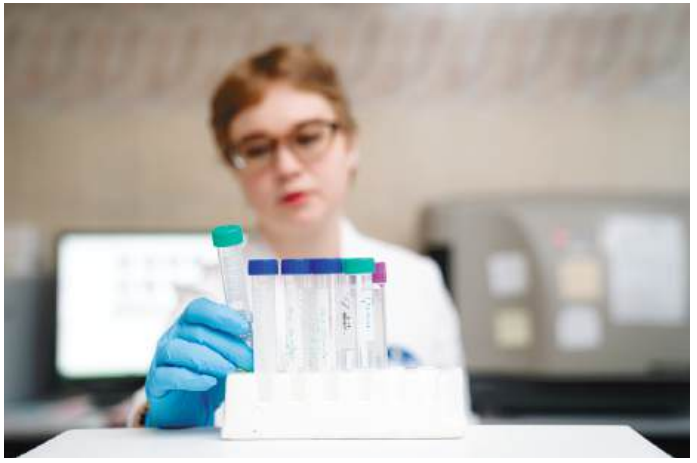


ИМБП

Ksenia Orlova, Asgardian test researcher in the SIRIUS-23 experiment

Ksenia graduated from the Medical School of the Moscow State Medical University named after A. I. Evdokimov (as a general practitioner), completed a residency in allergology and immunology at the Federal Clinical Research Centre of Russia's Federal Biomedical Agency and a course in aviation and space medicine at the Russian Academy of Postgraduate Education. Since 2018, she has been working at the Institute of Biomedical Problems of the Russian Academy of Sciences as a junior researcher at the Physiology of the Immune System Laboratory. She is a postgraduate student at IBMP and a physician in aviation and space medicine. She is also a member of the Tsiolkovsky Russian Academy of Cosmonautics.

As a physician on duty, she took part in experiments with anti-orthostatic hypokinesia, 7-day dry immersion, 5-day female immersion, the ARFA-23 experiment on the influence of hypomagnetic conditions, and the SIRIUS-21 isolation experiment. She participated in the experiment as a volunteer test researcher for the first time.



Ksenia Orlova at work in the Physiology of the Immune System Laboratory at IBMP RAS

The crew entering the isolation facility

Research conducted in the SIRIUS-23 experiment as part of the Asgardia scientific programme

“Implementing this programme, we considered the strategic importance of the primary goal of Asgardia — the birth of the first human child in Earth orbit — for the entire space science. The research conducted during the SIRIUS-23 experiment continues what was done in SIRIUS-21 by crew physician and Asgardia resident Victoria Kirichenko," explains Ksenia Orlova. "There are a number of challenging questions to be addressed on our way to achieving this goal. In a sealed facility here on Earth, we were unable to recreate the factors that are most hazardous to the body: zero gravity and the impact of space radiation. But women's health, to the extent of its susceptibility, can also be significantly affected by the stress experienced in a confined space, the psychological atmosphere in the team, increased physical stress, poor nutrition, and other factors.

While in the sealed facility, we had several episodes of taking venous blood samples every month. IBMP physiologists monitored the dynamics of female sex hormones, stress hormones, and changes in mineral and bone metabolism. During fetal development, the woman "shares" all of her calcium reserves and other micronutrients with the baby. Insufficient compensation of these in the female body can lead to higher bone fragility and increased risk of fractures. That requires overly complex medical care, and thus should not be tolerated in long-term space missions.

It has been established that both space flight and even just prolonged isolation in terrestrial conditions adversely affect all of the above parameters.

"Participating in a year-long isolation programme as a volunteer test researcher is extremely challenging. When I was offered the position of crew physician, I had my doubts for a long time," shares Ksenia. "But the meeting with Dr Igor Ashurbeyli in Baku, at the International Astronautical Congress, and the conversations I had there completely dispelled my doubts. I realised that I could become a part of the programme that opens horizons for humankind to get to know the depths of the universe. We have successfully completed the research proposed by Asgardia, and we continue to work on processing the data and making the goals and results of the programme widely available to the international community. I am proud of being a resident of Asgardia, a large international team of like-minded people. I am ready to keep on following the high ideals of the Space Nation!"

The SIRIUS-21 and SIRIUS-23 results confirmed this, while the data processing for our experiment is still in progress, and we can get additional inputs to the facts we already know.

For the same purpose, we performed monthly heel ultrasound as the most convenient model for diagnosing bone density in a speedy way. This is needed to be able to calculate and compensate for the required amount of micronutrients with the diet. As we already know, this diet will be significantly different from the regular "terrestrial" standards, especially in preparation for childbearing, pregnancy.

In addition, together with our microbiologists, a lot of work has been done on tracking changes in the female microflora composition and developing autoprobiotic medications to maintain its optimal composition.

The point of the study was that during the preparation period for the experiment, microflora samples were collected from the female part of the crew (each person always has their own unique composition and amount). These samples were taken as "reference" samples under normal terrestrial conditions for each female test researcher. Then, based on these samples, probiotic capsules were developed: they were periodically taken by the ladies and followed up.

It is anticipated that long-term space flights will require the continuous use of such capsules, hence it is crucial to develop and test the most optimal administration formula now, so that women do not experience additional discomfort in flight. This is what we did in isolation, and our observations and suggestions in this study were taken into account by the managers."

SIRIUS-23 Asgardian Test Researcher's DIARY

14 November 2023 –
14 November 2024

Isolation Zero Day

All This Is for the Whole Year!

Commander Yuri Chebotarev prepares video recording text. The very first photo in isolation, taken on 14.11.23

After the hatch locked behind us, we had to stay in official spacesuits for some time for filming. So, we tried to set up computers for our local network. There was also a task to shoot a video greeting for the conference in the CPC, and already here our team skills acquired during the preparation started to show.

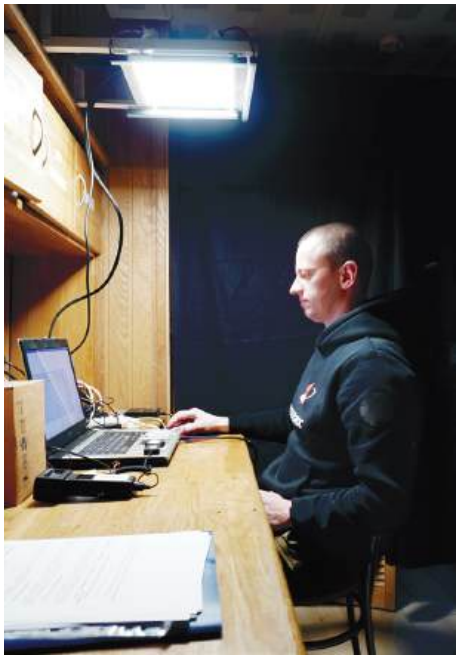
It was really amazing to watch: one of us identified a challenge, the second proposed an idea, the third started to implement it, the fourth adjusted it, the fifth added yet another idea, the sixth brought everything to perfection — and so it is with everything, whether it's finding an algorithm for computer questions or the task of how to hang a welcome poster.

We started to sort out the barcoding and to get the necessary things from the warehouse, to sort out our own belongings. In the transition tunnel between the modules, I suddenly caught myself thinking: 'All of this is for a whole year.' It was a very unusual sensation. A sting of fear, a mite of realisation of the limited space, and an acceptance of the fact that there was definitely no turning back now. Something inside me was cut off. The life 'before' had suddenly become a bounded and recollected past, and something completely new and unexplored was opening up.

Days 8–19
Entries
of 22.11.23–03.12.23

Adjusting to New Realities

The commander while implementing SPR technique under the red and white lighting



Regular techniques have begun. Each of the managers wants to see their equipment in action within the framework of such a large-scale experiment. Therefore, regular photo and video reporting work is necessary. We have decided to do it together.

Spatial Frequency Response of the Visual Organ

The week starting SPR technique deals with assessing visual information sensitivity threshold under the artificial lighting exposure. It is quite time consuming, you have to sit in the dark for two hours, so that there is no distraction by other stimuli than the computer screen displaying various tests and colours.

Being in headphones during this test is not a good idea — you may fall asleep or miss something. That is why an assistant is assigned to watch the test subject to keep awake and help navigate the instructions and equipment in the dark. Moreover, the assistant helps with conversation. I think this is an amazing team-building practice in general. After all, we are constantly in a group setting, and one-on-one communication is rarely possible.

I started regular medical duties, which include taking venous and capillary blood samples, which requires due preparation. In this experiment, unlike the previous ones, the crew physician independently collects and signs the tubes and prepares all consumables for the procedure.

According to the psychological operator's activity technique, Ksenia Shishenina hangs posters with bifractal images in our cabins once every three days to fight monotony and humdrum. We are surprised that the images are black and white: we would rather see colour images of nature, reminding us of 'home'.

The crew physician during the ABM technique collecting Olga Mastitskaya's capillary blood

The crew at weekly food collection and distribution from the stockroom to the kitchen, each performs their task

As usual, we devoted Sunday morning to menu preparations for the week. This time the guys were able to find surprises in the boxes. For example, we accidentally found out that, after all, we have not just one kind of bread but also three! We immediately opened the packs and pounced on tasting new flavours, because it's some variety at least.

Days 22–24
Entries
of 06–08.12.23

Training Begins

Ksenia Orlova provides with a maximum exercise load test on active treadmill for Rustam Zaripov

Rustam Zaripov while studying environment microbiological composition as part of monthly monitoring

I was engaged in collecting venous and capillary blood for several days in a row. It is surprising how quickly we get used to our duties: at first I couldn't do anything without consulting the manual, constantly referring to it so as not to mess up anything. But after a few repetitions, you do all the manipulations by memory.

Maximum Physical Activity Tests as Part of the Physical Efficiency Experiment

It was my first time working with the Cosmed unit, which makes it possible to read metabolic processes during physical activity by capturing exhaled air through a special mask, tracking blood pressure, heart rate and other metrics.

The physician's role is to set up the equipment (and install cardiac electrodes when necessary), regulate the safety of the test, which the test subject should pass, taking into account the maximum individual exertion.

It is necessary to timely warn him or her about the increasing test difficulty, monitor the heart rate of the test subject and assess their condition, as a person can overestimate their strength to the detriment of health, and stop at the right time. And after that — save the records, disinfect all individual elements and put them away for drying, then reassemble the unit,

Rustam Zaripov secures SOT equipment as part of the Basic Metabolism technique

calibrate and invite the next test subject. And this routine is to be repeated 5 times (Rustam Zaripov does it for me).

I perform such tests on an active treadmill, a passive treadmill and a cycle ergometer, each on a separate day after a day of rest, performed once a month. This is probably the longest technique I will do in isolation.

The exercise sessions were eagerly awaited by everyone. During the observation period and the first weeks of isolation, they were not scheduled, so that the difference in condition before and after the start of exercise could be recorded and an optimal exercise plan could be selected for everyone.

So, after the tests, most of us experienced pronounced muscle pain from the sudden maximal exertion. But that's the upside — it's a pleasant pain that allows us to judge the effectiveness of the exercise.

Basic Metabolism Technique

Dinner before the Basic Metabolism is a difficult test. Lacking special food offered for the technique, we ourselves chose the most protein-free products. Rustam Zaripov takes things seriously. In order to accurately calculate the time after eating, I had to have dinner no later than 19:30 and then miss eating anything else. The most you can afford is to drink clean water, making entry in the questionnaire for recording food and liquids.

Some time after dinner, Rustam applies the SOT (portable somnology device) equipment to two test subjects who will undergo the metabolism study tomorrow morning. Today, it is the crew commander, Yura Chebotarev, and me. The sensor is attached to the left hand, as is an additional volumetric watch with a large screen, while the actigraph should be moved to the right hand, recording the time of removal for the actigraph technique manager.

The somnology device is hardwired for measuring ECG, blood pressure through electrodes and a pulse oximeter fingertip.

Rustam secures all sensors and electrodes with special tape to prevent them from coming off during sleep. The device allows you to monitor sleep and thereby control the technique performance requirements. The regular blood pressure cuff is used for double pressure control — before installation and right before bed, one needs to state it in a special form and pass it to Rustam in the morning. In my case, after all other regular procedures before sleeping, I may go to bed, but no

Performing the Basic Metabolism technique in the morning. The second one is a view from inside under the dome

later than 23:00, so as to meet the Basic Metabolism requirements of 8-hour sleep. Sleeping with SOT equipment is not very comfortable: the pulse oximeter fingertip interferes the most, since it is made of rubber material and becomes uncomfortable for the skin when worn for a long time.

This is not the first time we go to bed with this equipment, so I do not pay attention to the wires anymore. We got used to sleeping with watches on both hands back in October. I remember the first preparation days; everyone shared their impressions, saying that they failed to sleep normally because of the bulky watches on their forearms. Now we do not notice them anymore. Even when you have a lot of wires and you sleep in all this gear. Personally, I am more worried for the electrodes to come off, and for the manager to have good data. Therefore, I periodically turn on the SOT screen and check for writing down the readings or whether I need to adjust the electrodes tighter.

Rustam woke me up around 7 a.m. I had to move from the cabin to the sports module as calmly as possible, avoiding unnecessary movements and talking to anyone. Then 20 minutes in the semi-darkness on an air mattress in an aquarium made of a plastic cap.

Day 31
Entry
of 15.12.23

First Sleep Deprivation

It was a long-awaited day: the arrival of the cargo vehicle. But, at the same time, it was the most difficult one. According to the experiment scenario, sleep deprivation is planned to study human capabilities in a stressful environment. A situation may well arise on the space station that requires prolonged incessant wakefulness. For example, urgent repairs. We also have to go through it so that scientists could obtain more data on the impact of forced insomnia on the body and be able to help cosmonauts more effectively with their developments.

In our deprivation scenario, the staging team tried to think of a maximum of physical and challenging activities so that we could go without sleep for about 38 hours. It is exactly for this period that the arrival of the cargo vehicle is scheduled, so that we are busy unloading it, as well as doing major cleanup and physical training. Of course, everyone was looking forward to this day with excitement, since no one had ever been in similar situations and it was difficult to predict our behavior and reactions.

The only thing we could do in advance was to come up with and agree on activities that would cheer us up. For example, we made up our own crew game. Its purpose was to maximise the activity.

The day went on as usual, and only at 20:00 on the cyclogram we had a 'docking' with the cargo vehicle. We could finally go to the coveted hatch of module 50 of the Ground-Based Test Facility, which had been hidden from us until now (experimental setup with a volume of 50 m3).

Having crossed a short passage in the form of a pipe, we found ourselves in a new location, as if in a computer game.

Then and there, the commander assigned roles. All packages

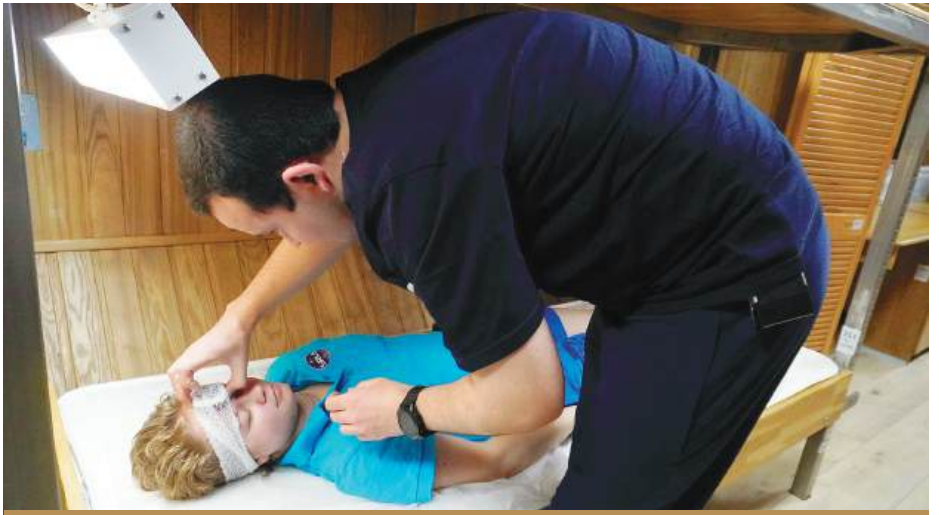
Placing supplies from the 'cargo ship' into the stock room. Pictured are the crew members, Rustam Zaripov and Anzhelika Parfenova

contained a new supply of food for the adjusted menu (the adjustments were made after our 'isolation food' tasting), additional personal hygiene items, some clothes, equipment for performing procedures, consumables, medical supplies and, of course, New Year gifts from our colleagues and relatives.

We were especially happy to get the food items. For instance, a pleasant surprise was a package with tea, sweets and the like with a postcard signed 'From the SIRIUS-21 crew to help celebrate the New Year'. Later, we recorded a video with words of gratitude for Victoria Kirichenko (SIRIUS-21 crew physician and physician-on-duty in our experiment at Mission Control Centre).

About 1:00 a.m., my brain was ready to shut down and my head started to ache from the long and hard physical work. But the sausage sandwich from among the presents definitely saved the day for a while.

We are not allowed to store food in opened packages in refrigerators, as refrigerators are intended for biomaterials and reagents used in experiments. Therefore, our task was to eat perishable food as quickly as possible. It was a long-awaited opportunity for everyone to treat our taste buds to something familiar and tasty and earthy, not sublimated and tasteless as in our daily monotonous menu.



Rustam Zaripov conducts a microcirculation technique for Ksenia Orlova

After having a snack, we started cleaning and then sat down to watch the show. The deprivation rules forbid us to stay in our cabins for more than 15 minutes, so no one would not fall asleep. At one point, there was a call from the Ground Control Centre that acted as an alarm clock. We got such calls should the duty crew notice that any of the crew members were falling asleep.

Microcirculation Studies

At 5 a.m., Yura (Yuri Chebotarev) and I had one of the series of microcirculation experiments and neurovisceral control titled VSR-LDF-FS (heart rate variability — laser doppler fluorimetry — fluorescence spectroscopy). Taking into account the time of the activity, it began to turn into a torture for all the participants, since it lasts half an hour, for ten minutes you have to lie still with the equipment on but not sleep. They attached electrodes from a portable ECG sensor to me. I lie on the couch for 10 minutes, oral thermometry. They put LDF and FS sensors (laser doppler fluorimetry and fluorescence spectroscopy) on my forehead, hand, lower leg and big toe of my left foot. After five minutes of the parameter background recording, a fixed breathing rate testing begins — to study the autonomic nervous system response. The person responsible for the technique, dictating when

Olga Mastitskaya during EEG

to inhale and when to exhale, sets the rate.

After a short rest, measuring pressure in a lying position prior to the next test. I perform an orthostatic test: stand tall, removing the sensor from my big toe. I stand in this position for six minutes, during which they continue to measure my pressure, and then I have to lie back down — the pressure measurements again. Rest for six minutes. Then the occlusion test — now I have the second tonometer cuff on, pumped up to 60 mm Hg and held in this state for three minutes. After releasing pressure, three minutes of recovery follow.

When I was free, there were still a couple of hours left before breakfast. That is where the game we invented came in handy. Laughter, as usual, cheered everyone up.

After that, the most usual day started, if it were not for one 'but'. We had been doing without sleep for 24 hours already. Probably, it seemed to the on-duty teams that we were really working as if nothing had happened. However, I admit, it was incredibly challenging.

In the afternoon, we had psychological tests and EEGs. I assisted. Despite a severe headache, I was somehow able to pull myself together and monitor the correct execution of the experiment, to wake somebody up if he or she fell asleep. Nevertheless, for the EEG, I was alone in the medical module, and it was a dangerous moment: no one was controlling whether I would fall asleep or not. Eventually, I caught myself in a position when 'the roll to the left began to portend the ship was going down.' There were no calls from the Ground Control Centre, but I still managed to wake myself up.

In the afternoon, I even managed to draw a little. Time would go incredibly slow. It was early, and it felt like late night.

We are not allowed to consume any energisers during sleep deprivation: no coffee, no tea, and no chocolate. It was Saturday, a day when half the crew, including me, has a weekly shower. The shower invigorated me and get through until 9 p.m.

All this time despite the tense atmosphere and challenges, no one was disruptive, irritated or confrontational. I believe that this is also a significant victory. Doing puzzles together during sleep deprivation is the best way to fight sleepiness

Collecting puzzles together during sleep deprivation is the best way to combat drowsiness

Day 36
Entry
of 20.12.23

First Emergency

Flowering hippeastrum (Christmas star), grown by test researchers in the SIRIUS-23 experiment greenhouse

On that day, the Ground Control Centre informed us of a failure in the air purification system, and the flight engineer (Anzhelika Parfenova) should leverage a special device to measure CO2 level in the air. If it exceeded certain values, everyone would have to move to another module until the system was restored from the outside.

We turned on all our air purifiers to the maximum just in case and dispersed to different locations so as not to create high CO2 levels when we were all in the same area at the same time. I went to the sports module 250 and spent time on plants there. We agreed with Olya Mastitskaya (researcher from the Republic of Belarus) that she would pass the care of flowers to me. In my case, this was another surprising effect of isolation: I had no special interest in gardening in my life. Here I realised that the greenhouse contains the only living things besides ourselves. I began to take note of abnormalities in the development of plants more often, worry about them and try to help.

After lunch, it became clear that the carbon dioxide levels continued to rise. As a physician, I was given the task to monitor the condition of the crew members and report any abnormal symptoms immediately. Fortunately, nothing life-threatening or very disturbing was detected. My personal sensations were a feeling of shortness of breath and slight dizziness. I just wanted to inhale deeper, but in general it did not interfere much with following the cyclogram.

Gradually, the CO2 level began to go off the charts in each module, forcing the crew to leave one location after another until we were all in module 250. According to Lika Parfenova, the stuffiness created in the Isolation Facility could be compared to the stuffiness in a crowded subway car during rush hours.

In the sports module, everyone found a place where they could continue working or amuse leisure. We had dinner here. We decided not to go to the kitchen for now, not to take risks, despite the permission received from the Mission Control Centre, and the commander brought us snacks.

The association with our survival course, taken during the period of preparation for isolation, came to mind. I came to the conclusion that even in isolation there is room for "adventure". It turned out later that the entire emergency was designed and organised by the experiment managers to practice behavior in emergency situations and for psychological observations of crew interactions.

Days 40
Entry
of 24.12.23

There Is Room for Celebration in Isolation

SIRIUS-23 crew with homemade New Year decorations

We all prepared for the New Year, even the guys made decorations from kits. We hung a hand-drawn poster, New Year banners, and flags with pictures. We transformed the walls with the help of 50 New Year cards. Yura Chebotarev shared interior stickers received with the cargo. Lika Parfenova decorated the mirrors with stained glass stickers, Ksyusha Shishenina hung a Christmas tree felt applique opposite the exit from the cabins taken along in the isolation. Olya Mastitskaya and I made snowflakes from Alyonka chocolate foil. The snowflakes decorated the corridor and cabins on hooks that Yura prepared from aluminum wire. The airflow made them rotate beautifully and sparkle festively.

Preparing New Year balls for decorating Christmas tree

We placed the tree on the table in the common room (rest room). We decided to play Secret Santa in advance. We put all our gifts in a bag; I mixed them up and put them under the tree. Everyone should guess who gave a gift. WE also put all gifts from the institute employees under the tree. It turned out to be a truly festive corner. We filmed congratulatory videos for our colleagues and friends, dressed in our official suites. Well, it seems that the SIRIUS-23 crew meets the New Year head-on. Happy New Year 2024 to all of us!

Days 75–79
Entries
of 28.01–01.02.24

Daily Routine of Test Researches

Rustam Zaripov in his cabin ('A week in the life of a test researcher' photo project)

As an amateur photographer, I took on one of the large-scale photo-video projects for the crew members — 'A week in the life of a test researcher'. The cameraman will have to follow the heroes through their cyclograms, all the techniques, to show the inside of everyone's working week, because everyone has a different schedule and tasks. The 'Week' also includes the stories 'Test Researcher's Cabin', 'Books and Leisure'.

The first hero is Rustam Zaripov. We had pre-planned the filming schedule by days and hours. Today we started shooting from the moment of awakening. In the evening, I took photos and videos of Rustam recording the DPC (Daily Planning Conference — a standard morning and evening report for the Mission Control Centre, being a psychological technique as well). Everyone already has one's own individual tricks. Rustam speaks smoothly and steadily. And my DPCs began to resemble a tongue twister — I learned our standard lines by heart, which allows me to report in a minute. I hope it makes life easier for the lab technicians on duty, who are required to take down all the videos in shorthand: retype our words for reporting.

Remote Monitoring of Psycho-Emotional State

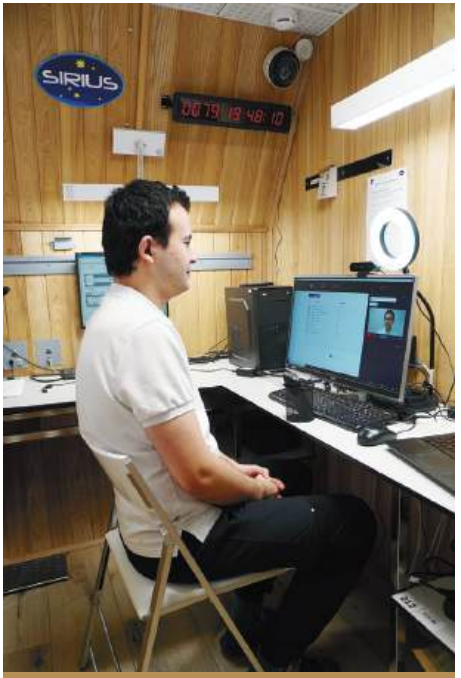
Once every two weeks we have a psychological technique with video interviews. We need to record answers to 33 questions. The question wording does not suggest a detailed answer — in the format 'Was it? Did you feel it?', and I say either 'yes' or 'no'.

Only a few require a description. For example — 'What food or drink do you miss the most?' Mostly I answer — 'None.' Why tease yourself with memories or something unavailable for a long time. Moreover, there is no need to think about it. However, if something pops into my head, then I relate.

For example, I have already dreamed twice about a vegetable salad of fresh cucumbers, tomatoes, onions and greens with sour cream. Before isolation, I had never dreamed about food. However, here it is so vivid, with a sense of taste! Everything I love, right down to the bread soaked in salad dressing. Once I suddenly remembered dumplings. Although I ate them very rarely before isolation.

The same technique includes completing a questionnaire of 48 questions and writing an essay on the topic 'Me, others, the world.'

Rustam assists to Olga Mastitskaya at the beginning of training on the treadmill (photo project 'A week in the life of a test researcher')



Rustam Zaripov records evening DPC (photo project 'A week in the life of a test researcher')

Requirement is that the text contain at least 1,500 characters. This is the most difficult thing for me because of the assignment's peculiar wording. Moreover, I am responsible for this technique in the experiment, so my task is to archive my answers with a password, remind everyone about it, and wait for everyone's archives to upload to the local server for the managers in the evening.

By the evening, the main tasks are completed, and I am busy writing my PhD thesis. Sometimes I may sit for a long time trying to formulate a specific thought or thinking about the process. At such moments, calm background music helps. I asked our media service to download an album with soundtracks containing all sounds of nature (birds singing, the sound of the wind, surf noise, sound, peals of thunder, rain whisper, the howl of a snowstorm) accompanied by ethnic instruments. Just the sounds that we lack in isolation.

Days 85–87
Entry
of 07–09.02.24

Variety of Techniques

Ksenia Shishenina collects hair samples for analysis from Olga Mastitskaya

I gradually gave up listening to the music radio stations, uploaded to us by the press media service on behalf of the crew. All these ads, promotions, news... I do not want to know anything about it even after coming out of isolation.

I started perceiving the GEC walls (ground experimental complex) as a protective environment, saving from oversaturation with all and sundry. Perhaps, by the end of isolation, some will not even want to leave. I recall cases from our previous isolation experiments at the Institute of Biomedical Problems. For example, after 520 days of isolation, the MARS-500 crew was in no hurry to leave the GEC on the last day, regretting that they would have to miss their usual lunch in the sealed facility.

Osteology Technique

Ksyusha Shishenina carries out an additional physiological technique — collecting hair samples. She carefully cuts out bunches of about 10 hairs at the root from different parts of the head, removes the excess long part and places the root (the one that has grown since the last collection) in test tubes. It is necessary for a more accurate analysis of some types of microelements and vitamins.

This study is one of those being conducted jointly with Asgardia to study the effects of isolation on women's health.

After taking crew members' blood and undocking all biomaterials through the airlock, I start training. On this day, my favorite, on a stationary bike. I found an important psychological aspect in it for myself. Indeed, I want to improve my performance, and I like this kind of physical activity more than running. This means that I should make every effort: not give myself any slack and endure what the managers prescribed. An intensive microcycle implies almost the limit of your capabilities, taking into account the power indicators from the previous test. First, a gradual warm-up, then 20 seconds — maximum, 10 seconds — recovery, and so on about

10 times. You need to overcome yourself if you want to improve the result.

Morpheus Technique

In the evening, Rustam Zaripov, as part of the Morpheus technique, placed individual Cardioson ballistocardiographs in all cabins. These are metal plates placed under the test subject's mattress.

The device records motor activity during sleep. Such a study is conducted regularly once a month. A switch-on sensor is connected to the plate via wires, to be turned on before falling asleep and turned off immediately upon waking up in the morning.

You do not feel the presence of the plate in any way, but the activated sensor on the wires flashes a bright yellow light every second, and I try to place it on the floor so that it does not interfere with falling asleep.

Thermohomeostasis Technique

The morning began with the arrival of Rustam to conduct a thermohomeostasis technique with sensors for measuring skin blood flow. In total, about 15 minutes are allocated for everything. Then follows video recording of the face via a thermal imaging camera within a minute.

Next, I have the second stage of the physiological technique with thermohomeostasis and LDF sensors (laser doppler flowmetry) - the afternoon session takes place in the medical module. After that, a one-minute face video recording again.

Rustam Zaripov performs thermohomeostasis and microcirculation techniques

Before going to bed, there is the third session on thermohomeostasis - thermal imaging camera records a face for 1 minute, then 15 minutes in my bed with LDF sensors on, thermometry of skin surfaces and filling out the shortest questionnaire on subjective thermoregulation consisting of just one question.

.

Rustam Zaripov conducts research on thermohomeostasis for Yuri Chebotarev

Part of the Osteology and InBody Technique

Olya Mastitskaya and Lika Parfenova give me bioimpedance and body composition measurements on the InBody machine in the medical module.

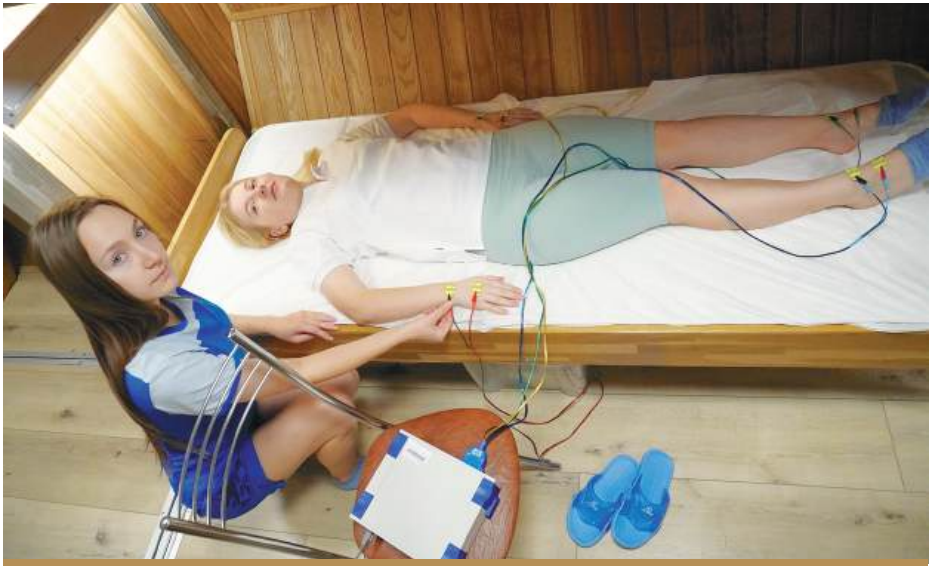
During the bioimpedance measurements, it is necessary to lie on the bed without touching the body with your hands, with all metal things removed. The person in charge of the procedure places two electrodes on the hands and feet, the measurements are taken for one minute of body composition, the percentage of muscle and fat mass.

n order to take measurements via InBody device, one must stand on a platform and hold special handles in the palms of their hands, the grooves with sensors being located under the thumbs. One stands still for a minute, while the body is automatically scanned for similar parameters as in the bioelectrical impedance analysis.

Pursuant to the technique, Olga performed anthropometry for me. The technique includes measurements of the subject's body in different areas, height, weight, measurement of fat folds with a calliper tool (which feels like biting the very fat folds off). There is also dynamometry of the leading arm.

According to the cyclogram, I have to prepare for the Basic Metabolism technique. According to another physiological technique, I also have to collect saliva samples every two hours today, and daily urine. In order not to miss the time, I set myself an alarm on my wrist actigraphy watch.

Anzhelika Parfenova conducts anthropometry for Olga Mastitskaya



Anzhelika Parfenova conducts bioimpedancemetry research for Olga Mastitskaya

Lunch on such days turns out to be quite heavy, since afterwards, because of the Basic Metabolism technique, it is no longer allowed to consume proteins and caffeine-containing drinks until 7 a.m. In addition, for the last two days and today especially, we are completing an additional questionnaire about the foods we consume, weighing everything accurately. Rustam will count these data

later, so he is strictly making sure that no one forgets to weigh everything.

Osteology Technique – Heel Bone Ultrasound

Ksyusha Shishenina performed an ultrasound of the heel bone under the scientific programme of Asgradia, 'Study of mineral-bone metabolism in the female body in isolation.' The procedure is quite pleasant: from a sitting position, one needs to put the bare left foot with gel on it into the apparatus bed. When turned on, membranes on both sides are filled with warm water to gently compress the heel bone. The bone density is measured by ultrasound. The membranes are then deflated. The same sequence has to be repeated 10 times to get more accurate results. It takes a lot of time, so I took my laptop and continued working on it simultaneously.

Anzhelika Parfenova performs the heel bone ultrasound

Rustam Zaripov and Anzhelika Parfenova perform Sail technique (as part of 'A week in the life of a test researcher' photo project)

Sail Technique

In the recreation room of the residential module, Olya and I started the Sail psychological technique — neurogames. We made ourselves comfortable on our bean bag chairs, covered the door to the kitchen to eliminate distracting extraneous sounds, and armed ourselves with notebooks and stopwatches. There are two tests to be completed in pairs. The first is to memorise 30 words for two minutes. One person memorises, the other tracks time and makes sure everything is accurate.

When the stopwatch reaches the point, the test taker moves on to the second part — in two minutes one has to write down all the words one has memorised. This exercise is interesting since everyone comes up with their own way of memorising. I tried different methods until I chose the most effective one for me. As the words are arranged in rows of five, I try to mentally link them into an overall picture or story. If my imagination allows, I also connect the lines with each other. Thanks to this approach, I manage to memorise almost all

the words, especially when I am not distracted by anything else. Of course, the sentences or stories are quite strange, because every two weeks we repeat this method with new unrelated words, but it is quite entertaining.

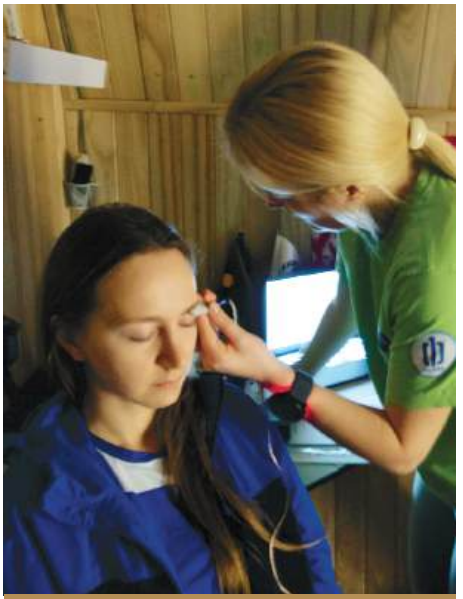
The next test is tracking the speed of articulating the colour of written words. For example, the word ‘red’ is written in yellow, so one has to call it ‘yellow’. On the screen, the whole page is filled with such words, the second person counts the time and makes sure that there are no mistakes. All this data is then recorded. And then again, the roles are reversed. Such an exercise definitely trains reaction speed and attentiveness. In the crew we agreed to alternate pairs each time for a change.

Ophthalmology Technique

After breakfast (I can finally have a normal meal with proteins) and the standard daily procedures, I move on to the ophthalmology technique.

I need to sit for a couple of minutes in the lounge room with the lights off to let the visual analyser relax. Olya Mastitskaya and Ksyusha Shishenina conduct the study with an ophthalmic electrical stimulator.

Olga hands me a passive electrode wrapped in a wet napkin. And she puts the active one, with wet absorbent cotton, on the corner of my eye. My eyelids are closed. All of this takes place in total darkness. In the first part of the study, I should say "stop" when I see flickers, and then — when I see frequent flickers merging into a single continuous one. Then the same sequence for the second eye is performed. The method is absolutely safe and allows us to estimate the threshold of electrical sensitivity of the retina and the lability of the optic nerve. The girls will perform the same study with everyone before dinner.



Olga Mastitskaya conducts ophthalmological research for Anzhelika Parfenova

Proteom Technique

In the afternoon, I conduct a capillary blood technique with Yura and Rustam — now for metabolic research. I make a puncture in the finger with a scarificator (as for the acid-base metabolism technique), but this time I wait for a drop to form on the pad, from which I take 20 microlitres of capillary blood with a laboratory pipette with disposable tips and put it on a special paper applicator with an area dedicated for the drop. I do it again with the second drop. These papers will be left for two hours in the air to dry and then put in a zip-lock bag to go through the airlock. These samples will help to determine the quality and quantity of protein composition.

Day 90
Entry
of 02.12.24

First Isolation Birthday

Crew physician Ksenia Orlova takes microbiological samples from Anzhelika Parfenova

The 12th February is Rustam's birthday — our first birthday together in isolation for which we carefully prepared in advance in order to please the hero of the day with surprises. We started celebrating in the morning, but before that, as a physician, I had to perform a number of medical procedures for the crew.

Medical Check with Microbiological Samples

I arm myself with special swabbing tubes, tongue spatulas and gloves. I go to each person's cabin immediately after waking up, before any hygienic procedures. It is necessary to take samples from the surface of the skin on different parts of the body, as well as swabs from the nose, pharynx and ears. At the end, I perform all the same manipulations for myself, mostly doing everything on my own, but when I need help, I address Rustam as the second person in the crew who has a medical background.

After the technique, I immediately conduct the dental one — Paradont. Two techniques follow each other on the same day to be performed once a month.

The study is completed, and I return to the living module to fill out the questionnaires. Today I have a monthly test consisting of 206 questions.

Veloergometer Tests

After that, I run to the sports module: before lunch, I have to conduct a physical test for two researchers on a bicycle ergometer. In preparation, I perform gas calibration and calibration of the individual turbines for the masks through which the subject breathes during the test, when the Cosmed machine records the volume of gases consumed and exhaled.

I stick electrodes for ECG recording on each person — they will stay on a test subject until the end of the study. I also put a cardiac sensor and a cuff for automatic blood pressure measurement. I start recording with the Cosmed programme, and simultaneously

on the test researcher's tablet in the application for HR recording using a portable Belarusian cardiac monitor. The test subject sits in the mask, wires, sensor and cuff for five minutes at rest, then at my command starts pedalling the ergometer.

Every minute, the intensity builds up. My job as a physician is to monitor heart rate, blood pressure, and physical condition to stop everything at the right moment when the test researcher's subjective maximum physical capacity is reached, or when it is medically indicated. I also keep the test subject informed of all the steps: 30 and 10 seconds before the next load step, I inform them of the upcoming transition.

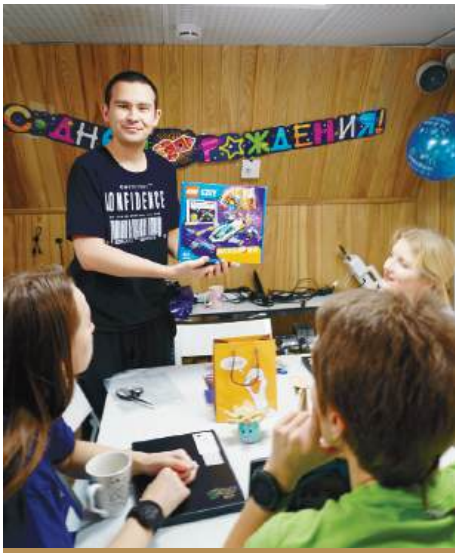
This is the third such test since the isolation started, and I know roughly everyone's capabilities, keeping statistics on past sessions in my notebook. When the test subject is approaching the performance of the last test, I keep asking if he (she) is ready to continue gaining the load, or we should stop. I also refer to the medical data on the monitors.

At the subjective maximum, the test subject shows me a signal that he or she is not ready to continue (talking in the mask is not allowed, so we agreed on non-verbal signals).

Crew commander Yuri Chebotarev during a maximum physical load test on a veloergometer

I press the 'Recovery' mode in the programme, then the test researcher has to pedal at low power for a minute, and only after that, he/she gets five minutes of rest while sitting on the ergometer to record the data. Then I save all the results, release the test subject from the shackles and the rubber mask with tubing, detach the ECG electrodes, and carry out other procedures. It is necessary to soak an individual mask and turbine in a special disinfectant solution for 15 minutes.

Rustam's holiday continues throughout the day. The day before, we signed a big postcard and put our SIRIUS seal on it. We designed and ordered the seal even before the isolation. Asgardian Prime Minister Lena De Winne advised me to make it similar to the ones that every expedition to the ISS has. Astronauts use them to mark their letters and other materials they send back to Earth. And after their return, the seal is destroyed so that everything marked with it becomes unique. We liked that idea. We will probably do the same thing when we get out of isolation. The seal has the name and surname of each crew member, and the background is a circle symbolising the Moon.



Rustam Zaripov with a gift from psychological support for his birthday

Day 94
Entry
of 02.16.2024

Once Again — No Sleep! Asgardian Test Researcher's Recipes for Fighting Against Sleep

Olga Mastitskaya and Rustam Zaripov perform counts of products in the stockroom

The 94th day of isolation for us began without night sleep, as it was the second day of sleep deprivation. Unlike the first one, it took place without missing cargo shipment. As we were told, the 'docking' had to be postponed due to technical reasons — another test in the experiment scenario. When this was announced, crew mates who expected 'goodies' from their relatives got upset.

The peculiarity of this deprivation was a scheduled inventory of absolutely everything in the sealed facility: food, personal hygiene products, clothing, equipment, first aid kit. We had to count everything manually and compare it with the barcode database. And general cleaning of the complex is also on the agenda.

As during deprivation, we are forbidden to consume any caffeine-containing products we selected herbal teas in advance. Around three o'clock in the morning, everyone gathered for a snack. Just by that time, the aromatic bread with raisins was baked — a means of 'survival' in sleep deprivation. Flavours in isolation in general play a huge role. For example, we have three kinds of granola bars, including strawberry and cherry. When I open the package, the first thing I do is hold it up to my nose and enjoy the marvellous berry flavouring until the smell is completely gone. In normal life, this would seem strange. I guess everyone eats such bars without paying much attention to the smell. But in isolation, where perfume and products with fragrances are forbidden because of the closed sealed environment, any source of pleasant smell is already a gift, and one can feel this smell keenly.

During the cleaning, we had an emergency situation: the electrical outlets in the residential module went out. While the commander and the engineer were figuring out what was

wrong, I continued my anti-dust work. Later, everything was restored, and we went on with the cyclogram.

It is 4:30, and I cannot eat any more — in a couple of hours, saliva will be collected and blood will be sampled, and this is supposed to be done on an empty stomach.

The guys went to assemble the foosball given to Rustam Zaripov for his birthday. Olya Mastitskaya started putting a puzzle together on the floor in the recreation room. The others were watching a TV series. Armed with a Lego set and my laptop, I went to the desk in the sports module, where it was spacious enough to work. The brain was already working lazily and confusedly. I used to watch a series of How the Universe Works space documentaries as a background for such an activity, to combine the pleasant and the useful. But now it was very difficult to perceive the information. So I turned on "The Big Bang Theory", a sitcom about young scientists. And now it was just a salvation: 20-minute-long series do not stress me, and I enjoy their common and scientific humour. In other words, to stay awake, I engaged several stimuli at once: the visual and auditory analysers were occupied by the series. The sitcom evoked positive emotions, laughter is also an effective tool against sleep. At the same time, the taction and thoughts were engaged in Lego assembling: it is necessary to follow the instructions.

Moving household equipment during cleaning from the medical to the residential module, the image taken in the passage. Rustam Zaripov has an audio dosimetry microphone attached to his T-shirt

How do I describe the way my brain works after 24 hours of uninterrupted work? It is as if I am under a veil. Reactions are slowed down, the blurred gaze glides more slowly over the objects around me. There is a pressing feeling because of the inability to perceive reality and work as usual.

When the time came for cognitive tests, the moving object test predictably showed that our reactions slowed down and our accuracy decreased. As a means to stay conscious, Ksyusha Shishenina suggested ice for facial massage. It's almost painful. But instantly wakes one up, refreshes and therefore is insanely pleasant. The main thing is not to pull one's hand away and not to feel sorry for oneself, and hold the ice on the face until it melts. This is a magical remedy, but the effect, much to our regret, lasts only for about 15 minutes.

As a former on-duty physician observing the SIRIUS-21 crew, I know that people are looking

at us from the ground station and thinking, 'The crew is still OK, they hold up well, the legs do not give way, everyone walks evenly'. However, the physician on duty can nowhere near understand our real condition. It seems to me that only the same former test researchers and cosmonauts, spending 72 hours sleepless in sleep deprivation chambers, are able to understand us.

You slow down so much that you're ready to collapse and fall asleep right as you walk or even stand up. Some of the crew members did just that, one just has to catch them in time. Victoria Kirichenko, the SIRIUS-21 crew physician, described in her Asgardian Space Researcher's Diary that one of the crew members did fall asleep while standing up. He dozed off leaning against a shelf in the warehouse. Our guys were able to outdo him: some fell asleep standing up without any support at all. Thankfully, they were not alone in the room at the time, so they were prevented from falling.

Right now, in the morning the zombie state kicks in: sclerae are decorated with a pattern of blood vessels, eyelids are trying to protect the eyes from hostile bright light. I go somewhere and forget why and where I was going. In order not to forget again, I strain my brain, frowning my eyebrows, trying to hold on to the escaping thoughts, thus provoking a tension headache. I am slower to answer questions. It takes longer to choose words in conversation because I simply forget the most basic ones. Movements lose precision and coordination.

Hyper-responsibility forces me to secure other crew members by saying, 'Stay awake!' Other means do not work any more. A "wake-up" lamp with a cold bright light, held in front of the face for 15 minutes (recommendation from the Stress Control technique managers), is just another interior accessory these days.

Commander Yuri Chebotarev in search of an effective method to combat drowsiness during sleep deprivation

Physical activity is risky for two reasons. Firstly, if I attempt to do push-ups, I might stay on the floor for a while. Secondly, physical effort would make me even more tired, and I will use up the last of your body's resources, which are already worth their weight in gold. The only hope was the ice massage and food.

During the last deprivation, a shower helped me out, as the sleepless day was set to be a Saturday. But this time, things didn't add up: this deprivation is happening Thursday through Friday, and my shower this week was postponed due to a technique with the EEG measurement during running.

Toward the end of the 36-hour deprivation, the perception of time begins to change: what happened yesterday afternoon seems to happen two days ago or even a long time ago.

Last time, we noticed that everyone was in a depressed and aggressive mood after deprivation and the 10-hour sleep that followed. I wonder how the morning would go this time.

Days 101–111
Entry
of 23.02–4.03.24

When You Feel Alone on Your Home Planet

I caught myself on an interesting thought: for a little more than 100 days, we have been in isolation, and outside, “on Earth”, such unusual events are happening, and it seems something from the realm of fantasy. Maybe when we come out in 265+7 days, we will be greeted by a completely different amazing world with new possibilities. A world where time and events rush even faster than before, and we, hopelessly lagging behind, will feel like savages or tourists on this planet.

Day 104 was notable for an unusual event — my move to another cabin. We swapped places with Lika Parfenova, as she likes variety, and I decided to support the idea.

At the beginning of the experiment, I had a clear conviction that I would not go for such an exchange. But now the attachment to material things doesn't matter that much anymore. ‘My cabin’, ‘my place’ — this is all superfluous, as our cabins are basically the same and there is no difference where exactly to sleep.

It was a great opportunity to review my belongings and throw out all the unnecessary things, of which there were already a lot. It's amazing that so many different items can fit in such a small space.

Really, the cabin is exactly the same, there are no differences in it. Except for the added realisation that I used to live in the cabin where a year and a half before me, during the SIRIUS-21 experiment, a test researcher from the USA, William Brown, lived, and now I have moved to the cabin of a researcher from the UAE, Saleh Omar al Ameri.

I immediately noticed that the audibility is just as good here, but the sounds are completely different: I can now hear what is being recorded and switched on in the radio room, even though it is across the cabin from me. The nearest lavatory is also more audible. But there is less sound coming from the kitchen, where there are often lively conversations and board game duels. Another positive bonus is that there is a radio room nearby, and you can charge your gadgets at any time, as we don't have sockets in our cabins.

On Monday, I also had to do the traditional active treadmill workout. I was contemplating my rare communication with personal contacts in the process. Overall, it seems as if "earthlings" don't fully realise what happens to people in isolation. I've thought a lot about this topic and I'll try to describe what it looks like.

Probably, when we get out, the world outside will indeed seem alien to us. We, who are used to stability and monotony, the same sounds, the same faces and voices, the same or similar sensations, smells and tastes, and unchanging interiors, will be overwhelmed by an avalanche of emotions from the diverse outside world.

I miss the meals from my family: ordinary pasta or porridge cooked by loved ones become especially coveted. I can imagine what a blast it would be for taste

buds that are not even used to the usual salt and pepper (they just don't exist in the sealed facility). Not to mention the exquisite combinations and spices.

It is about satiety, which we experience day in and day out in ordinary life, having access to almost everything we want. One stops distinguishing between flavours, and constantly needs new additives and enhancers to feel anything at all. And when you zero in on that, even foods with simple salt become a delicacy.

As the saying goes: we don't appreciate what we have. And only when we lose it do we learn to appreciate it. In isolation, this is more relevant than anywhere else. We most often do not notice everything described above in our everyday "mundane" life. Moreover, we get so used to it that we take it for granted and do not take care of it at all. And only with the long absence of all this we begin to feel the real lack, uniqueness and importance of each moment of life in this wonderful huge world of planet Earth.

Not so long ago we found and decided to revisit our videos on the computer in the radio room — the very first ones made during the Dry Run test isolation mode. October 2023. Looking at it now is quite strange. I wondered mentally, — 'Was I really like that?'

I think that just as we have adapted to isolation, so too will we need to adapt to earthly conditions. I noted for myself that it took me three months to adjust to life in a containment facility. How long would it take me to readjust on Earth? It is even difficult to imagine...

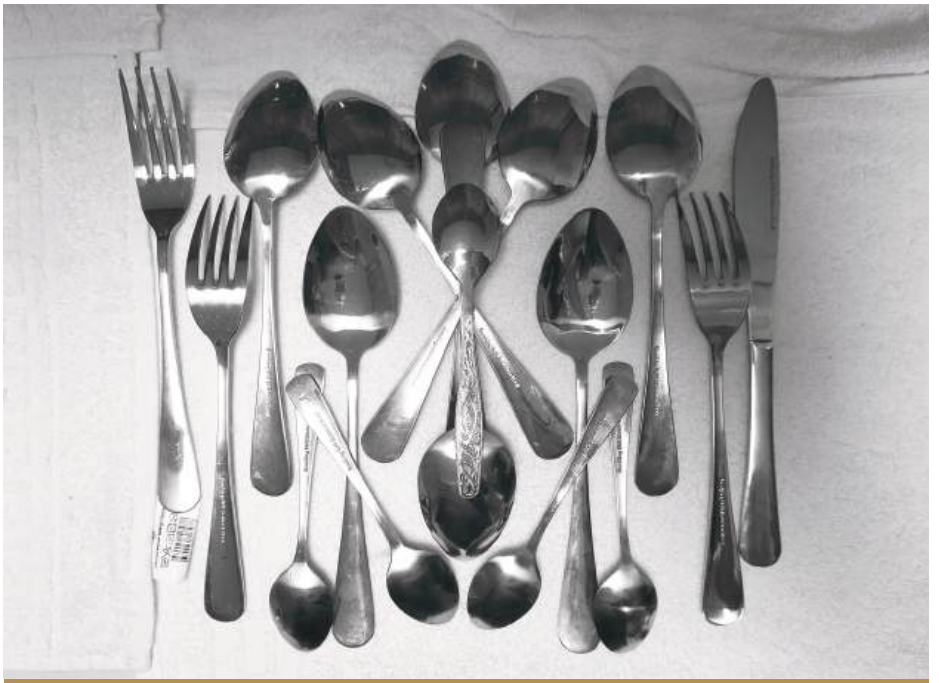


Photo project "Isolation aesthetics" based on the cutlery artistic arrangement after washing by Yuri Chebotarev

Day 113
Entry
of 06.03.24

I Seem to Be Changing Not Only in Appearance

A way to intellectually combat monotony in isolation is to play chess

Now, an output list is about to shape up, i. e., my knowledge that I am able to share with future participants of long-term isolation experiments and, perhaps, even space missions.

The first forewarning is to avoid trying to predict your behaviour in isolation. This is the wrong strategy, implying many expectations that will not materialise. It is simply impossible to predict what will happen to your consciousness and view of life. The 'earthly' common laws of behaviour patterns do not apply here. You will definitely encounter something you have never encountered before. You will definitely discover something completely new in yourself. One way or another, you will go over something that you wanted to forget, that seemed gone the way of a dodo bird.

It is amazing what just four months of isolation may result in. Compared to the total lifespan, this period is a moment. Anyway, it may turn everything upside down. You prove able to mentally run back your whole life, reflect on every step, at long recognising your actions and behaviour, giving due weight to everything while thinking about it through a different lens.

Conflict Diary Technique

The Conflict Diary is another psychological technique for today. It consists of several parts. The first describes the conflict itself outlining the background. Next, using several scales, you need to characterise your emotional state and the state of your opponent during the conflict. In the final part, you need to think of potential change in situation at the very beginning and prevent opposition.

It seems to be a very useful tool for ordinary life, work-a-day and personal communication. It serves to understand the mishappening in the context of inner monitoring. Whether you

take note of your feelings and those of your opponent in the time of conflict. Alternatively, you may have missed something and, merely by means of subsequent self-reflection, have discovered some detail or a major problem?

When considering a situation in black and white, you have a chance of telling everything down and debating with a wave of a magic wand about navigating a similar situation in the future. It even turns out to be a kind of auto-training, when you may act as your own psychologist. It is a very useful skill in isolation or a space environment. We fill the data once a month.

During the evening routine, I am reviewing the day results in the medical surveillance journal of a crew surgeon. I may observe an amazing fact even omitting special analyses and research: the crew, in my opinion, becomes synchronous in large part. For example, for two days, everyone has been complaining of headache. Moreover, each of us has different weather sensitivity levels, different circulatory system state, and different age.

Ksenia Orlova assists Olga Mastitskaya with a technique using a sensor from Turkish colleagues to record EEG changes during cognitive tests after physical exertion

As far as I know, environmental conditions (such as the sealed facility pressure) have not changed during these days. How could you explain the common headache? I am not able to answer.

Creativity brings variety and saves during sleep deprivation in isolation

Day 122
Entry
of 15.03.24

Virtual Reality – EVA Helper

Crew physician Ksenia Orlova signs test tubes the day before taking venous blood

On this day, we had a rich cyclogram. Firstly, the probiotic spray technique again. The 'cargo ship' had supplied us with new vials. For three days, we have to fill in a new nutrition questionnaire, this time for metabolic studies. In general, it is similar to the Basic Metabolism technique questionnaire. In addition, we need to indicate the grams of food consumed and the amount of fluid drunk. I had to prepare and sign the tubes for taking blood for the same metabolic studies.

Cosmobot Technique

And at the same time, something very interesting was about to start, I mean one of the important techniques of the operational and technical programme, Cosmobot and Interaction from the Yuri Gagarin Cosmonaut Training Centre. Yura Chebotarev, crew commander, was responsible for it as a CTC representative.

Unfortunately, I do not participate in this programme: I turned out to be too miniature for a device resembling an exoskeleton for the shoulder girdle and arms of a test researcher. My off-size body would have made it difficult to work in virtual reality. But, having finished with the test tubes, I went to conduct a photo report on how the guys were doing.

The commander and the crew members involved in the technique needed to clearly plan the order of their actions, assign roles, make brief protocols for clarity and hang them on the wall to save time for technical training.

Each of the technique participants put on the already mentioned device at a certain time, with the help of others — the construction is bulky, heavy, with many elements, repeating each joint of the shoulder girdle and arms. Numerous straps and fasteners ensured a reliable fixation.

Additionally, electrodes were glued to the test researcher's skin, and a device for monitoring physiological parameters was suspended from the belt. Then the

colleagues helped to put on virtual reality glasses and connected all the devices of the so-called suit with two computers. In this way, the test researcher entered the virtual space and followed the operators' commands.

At first glance, the tasks were not difficult: to lift a virtual cube and place it in the centre of the table, to take a fire extinguisher from the table and activate it, to open the control panel and press certain buttons and levers, to connect a springhook. Some of the tasks were performed on a fixed virtual model, and some on a moving construction. That is, you also had to 'drive up' to a certain point of space. Outside the sealed facility, a delegation from the Cosmonaut Training Centre observed our work; a robot located on the territory of the IBMP repeated the actions of the crew members.

So in fact the work was difficult, but it helps to test the system, which in the future will make it possible to perform complex manipulations of extravehicular activities to repair space stations without the direct participation of the cosmonaut, but rather with a special robot manipulator. This will greatly reduce the risks to human life and ensure higher efficiency of piloted missions.

During the period of preparation for isolation, I had a chance to test this system on myself once; at that time we worked with the famous FEDOR (Fyodor) robot. It was an interesting and memorable experience. It's hard to combine your physical hands and virtual ones in your perceptions: in virtual space, the action you perform is displayed at a different distance. You still have to adapt to this perspective. Still, this outstanding technology is amazing, especially when you realise how much it will facilitate human life and EVA in space.

Our guys had to repeat all the tasks over and over again. With each attempt, the adaptation to the virtual space and, consequently, the process itself accelerated significantly.

During dinner, we exchanged comments on the fact that today is the 122nd day, which means that we have overcome one of the isolation milestones of the past years. The crew of the four-month-long SIRIUS-19 had already completed its mission at about this milestone. The consensus was that four months is a period that flies by very quickly.

The crew performs Cosmobot technique

It is extremely difficult, albeit interesting, to work in the Cosmobot technique munition

Day 124
Entry
of 17.03.24

The Most Unusual Birthday

The SIRIUS-23 crew celebrates their physician's birthday

The morning of the day I was born 31 years ago began with collecting saliva for metabolic research. There is no time to make a festive look yet; you have to hurry straightway to the techniques, give immunology blood tests, and take others' blood testing.

Sprut Technique

Next follows body composition indication by the Sprut (octopus) method. It is similar to the BIA (bioelectrical impedance analysis) physiological experiment, yet involves different electrodes in a growing number. The test subject is to lie on a couch in the medical module so that the arms and legs do not touch each other and the body.

In general, BIA is a safe technique for assessing body fluids, body composition and metabolism. It is performed by means of integral multi-frequency measurement of tissue electrical conductivity during low and high frequency alternating voltage scanning.

Also today, the assistant measured the waist and hip circumference and the body mass, entering indicators into paper forms.

It was not until after completing these priority tasks that I allowed myself to look around — the guys decorated the interior for my birthday. A4 sheets painted by the commander's hand were immensely impressive, each denoting a separate letter. Together they formed a Happy Birthday garland in the kitchen.

At breakfast, the guys presented a new cake recipe — the chocolate meringue layer cake known as Ruins of a Count's Castle, based on baked bread, decorated with 3D red plastic toppers of commander's design. All that was amazing and absolutely nice.

A little later, I was struck by the ceremonial presentation of a bouquet of flowers, skilfully twisted by Lika Parfyenova from the balloons sent to Ksyusha Shishenina. A charming dachshund dog made from the same balloons complemented the bouquet. Lika developed the knack of it while briefly working as an animator.

However, besides the holiday, there was a lot of work on the cyclogram. Tomorrow, some of our crew will practise EVA (extravehicular activity in the Planet Surface Simulation module), note that Anzhelika and I will remain in the core orbital module to provide communication with 'Earth.' But we were also involved in gathering supplies and equipment for the lunar crew. I prepared a first aid kit. I stowed all the necessary medicines in the minimum kit in my Asgardia rucksack, just as I had done before the last EVA. We discussed with Rustam Zaripov where everything was so that he could quickly orientate himself in case of need.

After lunch, I was surprised again. Colleagues came up with a quest for me to look for gifts: navigate the map, find a hint in verse, use it to be up to the location of the next part of the map and move to different locations through all modules, inching toward the cherished goal. Ksyusha guided me. The entire crew accompanied me on this exciting adventure, giving advice, commenting, and filming memorable videos. It looked like I ended up in a sort of childhood magic, intrigued and childishly happy.

The quest ended in the medical module (apparently an allusion hinting at my crew physician position). There was a plastic container, hidden under the isolator couch, ornamentally signed by the commander's original copperplate hand. I had to unpack each one and guess on whose behalf. It was incredibly pleasant!

At dinner, the surprises continued. At one time Anzhelika laboured at website development and design. In the absence of the Internet, through coding, she managed to create a website page for me, with active transitions, animation, photographs, and a quiz. Since I understood nothing about programming, people having such skills were just wonder-workers to me!

It really was the most unusual and eventful birthday of my life! Three of us have already noted that in isolation this holiday is really celebrated completely differently. In ordinary life, everything happens from year to year in approximately the same way: according to the crew members' stories, all gather either at the morning or evening festive table. In isolation, we lack a chance to go somewhere or use the third-party services to spend time nice and profitably. Entertainment is available for us only thanks to our own initiative, enthusiasm and smartness.

Later, I was sent screenshots from my Asgardia Telegram feed, which also got quite a few congratulations from friends, colleagues, and even foreign readers and my personal email received congratulations from the experiment managers. I greatly appreciate all and everyone!

Days 126-128
Entry
of 19–21.03.24

Home Alone

Olga Mastitskaya in the process of renovating the greenhouse

I assumed the charge of looking after food plants while Olya Mastitskaya, responsible for the greenhouse, was on EVA. Not long before, the cargo renewed everything we needed, thus on 14th March, Olya and Rustam Zaripov planted greenery. Among the new pack of seeds we ordered were onions, rucola, Romaine lettuce, parsley, coriander, dill, radishes, green basil, dwarf peppers and cherry tomatoes. I continued working with my decorative charges at AeroGarden. There were quite a few observations here as well.

Having done with the greenhouse, I moved on to the task 'Landing Personnel — Earth Data Link Support.' It includes system monitoring, namely at any moment a call from the lunar module will come to our 'in-crew' phone with a request to suggest, find, do something. In addition, one may send a message to your computer via video link; you need to keep watch.

During the period when the 'lunar landing personnel' embark on direct EVA (extravehicular activities), those who have stayed in the orbital module replace each other in the task every two hours.

On completing her another shift, Lika decided to check the future gift on the commander's birthday. It was a night light, projecting cosmic effects onto the ceiling. I helped to find the batteries, and then followed the performance testing. It turned out that I had a night light at home with exactly the same effect, and I used it many times for creative photography and video shooting.

The days when Lika Parfenova and I stayed alone, in addition to the usual tasks on the cyclogram, we plotted in the dark for the birthday of Commander Yura Chebotarev in order to make a surprise. We also conducted culinary experiments to welcome the crew back from the spacewalk.

We also had to test each other leveraging the Health Navigator technology. This system allows one to check up on human cardio-respiratory capacity, the state of nervous and muscular systems. The IBMP experts de-

veloped the technology to use it actively for monitoring school-children and students' health in the government institutions. In a scientific fashion, the technique has been carried out once before isolation, once during isolation, and one more time is in prospect after closing the experiment to compare the indicators.

Well done, when entering all data into the programme, you may perceive immediately your body condition parameters in many respects. If we look objectively at visible feedback, we recognise the next potential step to work on or to improve; thus providing incentive to future work or training.

Ksenia Orlova and Anzhelika Parfenova prepare refreshments to greet the crew after the EVA

Anzhelika Parfenova performs a step test using the Health Navigator technology

Anzhelika Parfenova sets up a 3D printer to print plastic decorative elements for the commander's birthday

Making candies from nuts and melted chocolate chips

Days 160–162
Entries
of 22–24.04.24

Breaking of Communication with the Loved Ones

Ksenia Orlova resets data from a personal voice recorder using the DPC method

After breakfast, the routine cognitive tests and voice recorders downloads follow. We turn on the recorders during the morning and evening DPC (daily personal condition minimum video report). Professional sound recording devices detect all changes in speech tones; thanks to them, researchers are able not only to evaluate our video data, but also to analyse the condition by voice and putting words together.

Operator Activity Technique

Then I gear up for the active treadmill exercise with sub-studies. Ksyusha (Ksenia Shishenina) assists.

The test subject (specifically, me) puts on an electrode cap for electroencephalography. One needs to connect to the electronic unit, which shows a panel with connection indicators, through a long cord. The panel green lights light up when applying conductive gel under the electrodes and getting the required impedance; the red ones light up if polarisation is weak. There are also two ear clip electrodes on the earlobes. The entire system is allied with a laptop to record the parameters.

To begin, the subject is to close the eyes and sit still relaxing for three minutes while recording baseline EEG (electroencephalogram). After saving the data, I disconnect the cord and secure it to the body and clothes so as not to disturb me during the active treadmill training. Usually I coil it up and fasten it in the pocket of my shorts. I run with the cap on to prevent from reconnecting the electrodes anew. I also sash the chest heart rate sensor, moistening it for better contact with the skin. Ksyusha assists me in attaching a sensor to my upper leg to record the muscles oxygen consumption in motion. Now I switch to the active treadmill, fasten my torso safety belts. The walking speed changes periodically. After warming up, the running path slows down and then accelerates every half minute to 15 km/h. If a

test subject fails to cope with this speed, the assistant should limit it to the requested maximum.

Following the effort test, you return to the chair, relax and record the EEG again. Then, leaving your cap on, you move to the laptop to perform a series of cognitive and psychological tests.

The first test looks into the font and colour incongruous symbols correlation in the text displayed. One needs to match the word meaning and the colour it is written in. We comment verbally on a similar test aloud when doing the Parus (Sail) psychological technique.

The second one is to store numbers. The third, to track moving objects. The next test involves black and red tables. We look for all numbers from 1 to 25, one by one, in the black table, then, from 25 to 1, in the red one. After that, with the tables merged, you need to choose sequentially the black numbers in ascending order and the red ones in descending order in the dazzled contrast colour chaos of numbers. It is a difficult technique, requiring maximum concentration. An aural cue warns of an error, and you need to correct it. Saying the numbers aloud helps to make short work of — when visual memory fails, auditory memory comes into play. It is interesting that cosmonauts do exactly the same test in practice- when training, parachute jumping, you need to complete a test during the flight. The tables are attached to the sleeve of the equipment.

The final test esteems creativity. You see a piece of paper with a dozen abstract elements. You should turn each of them into a drawing and annotate what it is all about. Having completed the task, I reconnect the cap to the electronic unit for the final three-minute EEG recording.

This comprehensive study examines the influence of external and internal factors on a potential test researcher's operator activity. It takes into account different types of thinking and their relationship with a specific person's physiological make-up.

I was really looking forward to that technique, also because it enables you to wash hair off the schedule, otherwise your hair hardens after applying gel.

Performance Efficiency Technique

Our Actigraphs record the quantity of motion and heart rate 24/7. Since it is not relevant to keep count of steps in space, precisely these watches, recording hand motion, have been used there for quite some time. A cute pixelated cosmonaut indicates the mode on the clock-face. Once a week, you need also to download data for the managers to study.

At dinner, we expressed one another displeasure about missing messages from personal contacts today, during either evening or daytime communication sessions. The observation centre reported about a system failure, and it was still unclear how quickly they could correct the error.

I have already gotten into the habit of receiving personal messages not very often — about one every three days. That is when you really start perceiving detachment from the world. As if, we really are in space. Communication loss is also a step into an information vacuum. And you have absolutely no idea how long it will last.

I recall that Victoria Kirichenko, an Asgardian test researcher and SIRIUS-21 experiment crew physician, confided in one of her diary entries that during yet another communication session, 30 new messages were waiting for her in the mailbox... There was no limit on the number of contacts in SIRIUS-21, while we can hardly even imagine these 30 unanswered messages, because we

are only allowed to maintain email communication with seven contacts.

It is a toss-up, which is worse — to see a backlog in your mail, when spirit is willing, but the flesh is weak to reply to everyone, or when it is empty and you wait for every incoming message as a good fortune. You definitely start to appreciate rare communication and cherish it even more. You carefully think through and select phrases when writing — what to ask, what to tell, how to please loved ones...

Olga Mastitskaya downloads personal actigraph data using the Performance Efficiency Technique

The commander and flight engineer perform technical activities

Rustam Zaripov takes bread out of the bread maker, freshly baked using a joint method with the Research Institute of the Baking Industry

Day 171
Entry
of 03.05.24

Awareness of the Priority Objective

Ksenia Orlova and Rustam Zaripov conduct the Audiometry technique for each other

Medical Check – Audiometry Technique

Before midday, Rustam (researcher Rustam Zaripov) and I have a hearing assessment as part of medical monitoring. We extend all the screen folds in the medical module to reduce background noise. I take the chair with my back to Rustam. I take special headphones and a remote control, fitted out with the only button to push when hearing a sound.

The headphones are the most unpleasant device in this study. They fit flush with the ears to protect against background sounds. This causes physical discomfort. At times, I have to ask for a minute's rest from them.

The right ear trial follows, and then the left one, 10 sound nuances at different frequencies follow to each ear. Despite the special headphones, some signals are still lost in the external sound background due to the constant noise of ventilation.

At the end of the test, you need to fill out a questionnaire about sounds in the GEC modules — whether I am capable of working and relaxing despite them.

Then Rustam and I change round, and now I run the equipment. I like to conduct audiometry, to work with this device. My task is to switch the decibel values from high to low according to the algorithm, to determine which one the test subject may detect. The study is quite long, but I have developed my own volume-switching scheme that enables me to get accurate data faster. We repeat the testing approximately once every three months.

I noticed that my way of interacting with the managers eventually changed to the format — 'Well, received okay. I am on it. Will correct. Agreed.' Here you involuntarily start thinking that a robot is the best runner in the space industry, I suppose. The one without asking

unnecessary questions, feeling anything, having no emotions, being afraid of anything and making no words.

When the going gets tough, I may think about injustice towards the test researchers, but then I still try to ward off such thoughts. After all, here, 'in the barrel roll', we see everything only in one respect — from our end. Lots may be ignored, missed, allowing emotions to take over.

I take a breath and again I go to do my job. Steadily, calmly, with restraint. Dozens of scientific projects, applications, and methods depend on its quality. The awareness of the priority objective for which we do all this is what moves me forward every time.

Psychological recovery via Virtual technique

Olga Mastitskaya's 'lunar rover' training. Rustam Zaripov assists

Days 183–185
Entry
of 14–16.05.24

At the Equator

The crew during the mission's 'equator' celebration

Day 183 of isolation. Exactly half of the experiment is behind us, and that is already a lot.

Spiro and Acoustics Technique

As a test researcher, I had to put a 'choker' — a neck strapped accelerometer sensor, to record the vesicular murmur over the trachea. This is for breathing tests. I put on a nose clip, holding the tube of a spirometer flow sensor. This is to record such parameters as forced expiration, expiratory vital capacity, maximum breathing capacity. The test subject is required to perform various manoeuvres in order to pass the parameters in the best possible way. Rustam Zaripov dictates what to do; selects my best attempts. I have about a minute to recover and rest between the 'manoeuvres'.

The maximum breathing capacity test is the most difficult one, and at the same time the most interesting for me. For 15 seconds, you need to breathe deeply into the tube of the device having a clamp on your nose, maintaining the breathing rate at a certain level. It is very likely to fascinate because the test allows you to evaluate your own respiratory tolerance.

We conduct such testing once every few months to evaluate changes in the external respiratory function of test subjects staying in a sealed facility. At the same time, one expects to utilise the data in staging future space flights.

At lunchtime, we marked the 'equator' of the mission. After lunch, I invited those who wanted to come to the stockroom to take part in a portrait session — to the photo zone that we arranged the day before. It was fun and interesting to come up with different options together.

It was nice to receive congratulations from the teams on-duty and personal contacts throughout the day. I could hardly believe that so much has been accomplished, but how much more lies ahead...

The holiday is over, and we are about to start our third deprivation. 38 hours without sleep, which we are anxiously awaiting and want to get through as soon as possible.

Interaction Technique

After the morning cognitive tests, we had to fill out a whole bunch of questionnaires from our Czech colleagues. These questionnaires especially coincided with the 'equator' period — the middle of the experiment. The first one consisted of 37 questions to assess satisfaction from life and work in the crew. The second had 10 questions, analysing fatigue level, the rest and sleep efficiency. The third questionnaire comprised 73 questions intended to perceive physical condition and the criteria of meeting basic needs. The fourth, of 8 questions, was about the crew interaction assessment. It was rather tiresome to fill out so many questionnaires in a row, thus the managers divided them into two rounds. We filled out the first one before lunch, and the second after. However, everything new was instructive to us; we completed the task with pleasure.

The cargo ship hatch opening was at 23:00. The whole crew is gathered, and there are many interesting things in the cargo. Upon dragging the vehicle's primary content to the gym, we dared to take a tea break around midnight. Rustam baked some 'night bread' especially for that purpose, and we were quick on the uptake of newly arrived products thus taking out the good part for tasting.

Ksenia Orlova, Yuri Chebotarev and Anzhelika Parfenova move things from the 'cargo vehicle' to the sports module

When the first emotional wave rushed back along with hunger, it was time to continue working. We had to open everything, sort through it, count it, distribute it in the warehouse, and make the barcoding system entries, and as usual, I have to conduct an inventory of medical supplies and consumables as well.

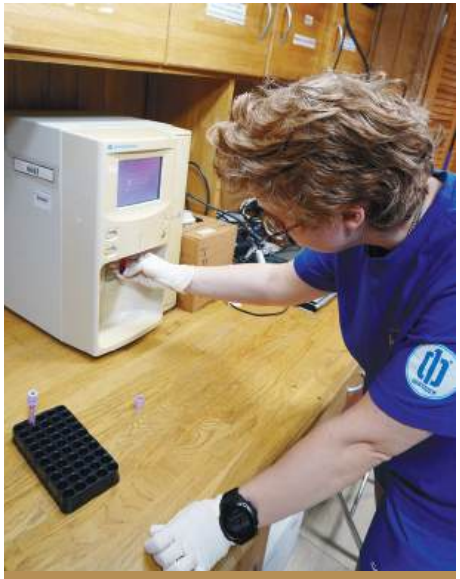
Around 1 a.m., the most difficult time came for me, when I was so sleepy that I might fall asleep right on the run. I noticed that there is a certain 'critical point', and, having survived it, you get a second wind. My first critical point is around 1 a.m., the second being around eight in the morning, when the first day of deprivation ends and there are still 14 working hours left.

During this deprivation, I came up with the perfect recipe for a vivacity cocktail: use fine motor skills – do something meaningful with your hands, for example, something creative; besides, the cool temperature of the sports module environment tones up well, and the bright light. And also – very funny videos. While laughing, one definitely will not be able to fall asleep.

Day 187
Entry
of 19.05.24

Immunology and Metabolism

Ksenia Orlova takes venous blood from Anzhelika Parfenova, Rustam Zaripov assists

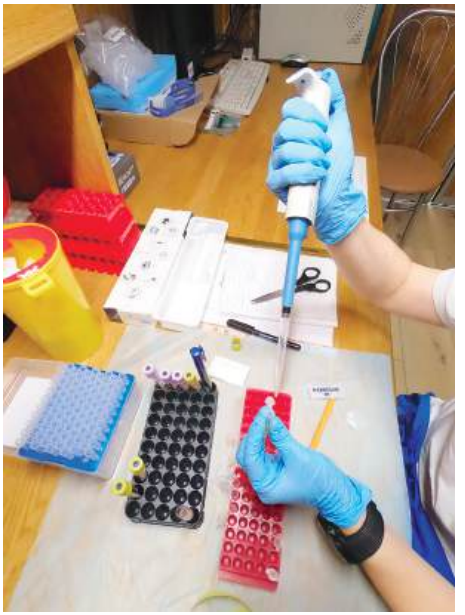


Performing clinical blood analysis on a hematology analyser as part of joint immunological studies with Asgardia

My morning begins with drawing blood from three test researchers. I had to sign 106 tubes for this purpose yesterday — so far a six-month record. The process is divided into two days, two phases — drawing blood for our immunology lab and for the biochemistry lab. I immediately set aside two tubes for my own research.

I used one type of tube to perform a clinical blood analysis on our hematology analyser as part of joint immunology studies with Asgardia on a regular basis. It allows, among other things, to monitor the hemoglobin level, which in women may vary more due to nutrition and physiology. Colleagues outside will also assess the immunological status using other equipment and reagents unavailable in the sealed facility. These studies are aimed at studying the adaptation of the immune system to isolation conditions and stress.

I put the second type of tubes away by placing them upright in the case to allow the blood to settle for a few hours. To separate venous blood into fractions, we usually use centrifugation in the laboratory. But in isolation conditions, it is necessary to test whether we can do with the minimum amount of equipment. Therefore, I use the natural method — sedimentation for several hours.



Ksenia Orlova collects blood serum for allergy testing

During this time, if the tubes are not touched, the erythrocytes will settle to the bottom on their own, and a yellowish serum will remain on top, which is what I need for my research. After two hours, I collect the serum into cryotubes and freeze the samples for subsequent research.

After breakfast, I filled out a form manually: recording the diet composition for metabolic studies. For the same purpose, today I collect daily urine to be analysed for hormonal indicators. Following the meal, the metabolic study requires the completion of questionnaires. The first one is to assess the properties of the nervous system, the second one is a personality questionnaire, and the third one is to assess the current psychological state. In terms of time, they took me about half an hour.

Next was the second stage of my immunological research. The first one had been conducted before isolation, while the second, the current one, was at the experiment's equator, and the third one would take place once we are out of the sealed facility. This will help to assess the changes that have occurred over the year with as much objectivity as possible.

I went to the test researcher's cabins one by one. I would switch on the Wood's lamp in the dark and ask my colleagues to show me different skin areas for examination. I photographed what was highlighted in ultraviolet light through the central magnifying glass. The study is quick and safe. If there are spots or areas of flaking on the skin, they will change colour, which is very valuable for diagnosing. The same method can be used to determine skin type.

The second step is the collection of biomaterial (eyelashes) for microscopic examination. In allergology, one of the pathological symptoms is itching, redness and tearing of the eyes. But these same signs are observed in a very wide range of diseases, including those caused by opportunistic

microorganisms that live in small numbers with humans, such as Demodex mites. This parasite lives on hair follicles near the glands, and we do not notice it. But in case of immunity decrease, which can also occur under stress, Demodex sometimes becomes active and causes a lot of discomfort.

After lunch, collecting things and equipment follows: tomorrow we have EVA in EU-50, and I am part of the lunar team. Most importantly, I collected equipment for medical technique and a first aid kit, which I still conveniently place in my Asgardia backpack.

Ksenia Orlova fills out paper questionnaires for metabolic studies

A variety of containers and test tubes for biomaterials for metabolic and physiological research. The manager's cute drawings add positive emotions

Before conducting a Wood's lamp skin examination

Ksenia conducts Demodex biomaterial testing

Days 189–192
Entry
of 21–24.05.24

In the Lunar Landing Team

The ‘Lunar landing’ consisting of Ksenia Orlova, Yuri Chebotarev, Rustam Zaripov, and Anzhelika Parfenova having dinner in EU-50

The only thing making that EVA special was that last time the flight engineer Anzhelika Parfenova followed the commander, but today it should be me. I changed into a working ‘space’ suit. I did not forget about the heart rate monitor belt to allow the managers to track our pulse during the mission.

The mood was great; we were ready to cope with any tasks. In the hangar, recreating the lunar surface, the changed lighting caught my eye as a start. There were more small LEDs on the walls and ceiling, reminiscent of stars.

I put on my glasses and just waited for ‘settling’ into the lunar space. My own voice echo in the headphones was not as annoying as last time. I just needed to be patient overcoming the equipment setting up from the outside. After a while, everything was connected, then Yura Chebotarev and I were able to fulfil our tasks, guiding and prompting each other. It turned out that there was no connection between us and the lunar module, where the operator usually monitors the accuracy of our operations. So we had to rely only on ourselves and our memory. I think we got through it all.

The commander sent me to the suspension unit first. By that time, we had already established contact with the lunar module operators, so the work went more smoothly. I completed my task in the VR space, to follow the lunar rover's wheel treads, turn off the light beacons and return. My left leg controller, like last time, did not work properly, so the movements were mostly counted when jumping with my right leg. Here, too, I had already worked out my own method of movement.

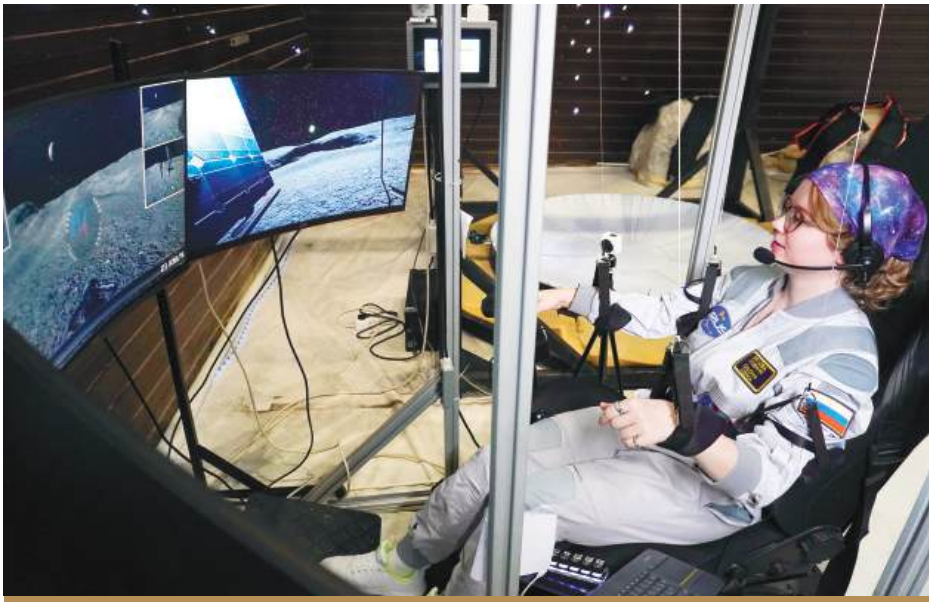
The rover joystick adjustment differed from the training one, but that's something we also

dealt with in January. I was lucky to leverage it today and quickly got to the lighthouse, then to the regolith sampling point, grabbed one out of three (to save time) and arrived at the station. Upon returning to the lunar module, it was necessary to immediately carry out all the necessary techniques as before moonwalk: give capillary blood, weigh yourself, measure temperature, pulse, blood pressure, and conduct bioimpedance analysis. It was important to do that as quickly as possible, in 10 minutes.

The next day, we went out with flight engineer Anzhe-

Rustam Zaripov as an operator coordinates the crew members' activity on the 'lunar' surface

Stand imitating lunar gravity during EVA



Mission to collect regolith in the 'lunar' rover

Crew physician Ksenia Orlova and flight engineer Anzhelika Parfenova before ‘moonwalk’

lika Parfenova. For shooting, I took the LED lamp provided by Asgardia to the lunar surface to experiment with coloured lighting and add atmosphere to future photos.

On the last day, I worked as a landing operator for the first time. It turned out to be easy and interesting. I had to sit in headphones and with a microphone in front of the display monitor transmitting images from two cameras in the landing hangar. My tasks included coordinating the colleagues’ actions, answering questions, and receiving brief instructions from the managers in a special chat.

Our lunar landing reunited with the orbital team in three days. We all gathered at the lunch-time table. Ksyusha (researcher Ksenia Shishenina) and Olya prepared croissants with apple jam, cinnamon and nuts in the bread maker. To our delight, we found cinnamon in the new cappuccino's arrival: after all, we miss any spices in our diet.

Bread maker is just a fantastic gift under our conditions! We have long since started inventing our own recipes not included in the instructions, thereby bringing variety and positive emotions into our life. The croissants turned out amazing, not just tasty, but also aromatic, reminiscent of home baking — after all, there is a great lack of delicious smells in the sealed facility where any flavours and fragrances is a taboo.

Cinnamon rolls baked by Olga Mastitskaya and Ksenia Shishenina in a bread maker in honour of meeting ‘lunar landing’ after the EVA

Ksenia Orlova in the lunar module cabin

Days 194–203
Entry
of 26.05–04.06.24

Working in Eternity Mode

We are slowly recovering from a busy month that included both sleep deprivation and EVA. However, today we have persistent efforts ahead of us again, despite it being Sunday. A new session of nasal probiotic testing follows breakfast as part of microbiological research, as well as other techniques.

Resting Technique

Alas, the name is elusory. You need to fill out many tests by hand. In the first part, you need to draw comparisons between the crew members according to two parameters, competence and character, plus compare each with yourself, entering your comparisons in tables reminiscent of those of tournaments. In addition, to finish writing something impeding the development of our team in your esteem. Next, a stress factors questionnaire of 20 questions follows. Then, a questionnaire in five parts, making up 150 questions in total.

Still, the technique also involves a 'computer part'. A special programme accounts the names of 10 people — crew members and colleagues from IBMP. You need to address each person according to strictly antipodal characteristics, by the end esteeming yourself — 'The ideal me', 'The present me', 'The past me'. In total, the entire procedure takes about two hours. The technique allows one to trace changes in interpersonal relationships. We perform it once a month.

The Virtual technique inspires further our stress recovery. We could afford to play VR games upon returning from EVA to the main module, a more spacious one.

On 4 June, we got past the 200-day point. Too good to be true. I have realised the magnitude of the figure. The look-and-feel is tricky. We have this question in our questionnaires: do you feel like time stands still or goes fast for you? Well, I sometimes feel like time is going backwards. Now you have no chance to live in distant thoughts, since it is long before the future perspectives will change. Your inner aspirations most likely shift into retrospect, to life before isolation.

There were power surges on Sunday, followed by mail and service water cut off for some time. Temperature fluctuations began with the ventilation system disengagement, and we failed to regulate it independently. The next day, the incident resumed. All the sockets went out together with the local Internet and phones. We were completely cut off from communication even with the GS (Ground Station) and could not report the problem. We did not get a chance to start the morning training and therefore waited for things to be resolved. The lighting was there but would not switch over. Anzhelika Parfenova, as a flight engineer, tried to contact the GS. In the end, we had to opt for the only way — to write in large letters on paper that we have no communication and electricity, show these signs on cameras, having previously waved them to attract the duty officers' attention. An hour later, the situation was partially cleared up, but the lighting disorders still occurred until dinner.

Such abnormal situations definitely add variety. Moreover, thanks to them, there is at least a slight feeling that we are really testing the factors of space flight. It is quite logical to assume that this could happen in space during a long mission.

It seems to me that we manage emergencies in cold blood and as a team.

Days 204–217
Entry
of 05–18.06.24

Change of Seasons in Isolation

Crew commander Yuri Chebotarev divided the first isolation tomato from the sealed facility greenhouse into 6 parts

Our isolation routines change, similar to each other due to the same techniques being implemented gradually and scrupulously. The beginning of calendar summer made our day by the first earlies in the vegetable patches. Thanks to Olga Mastitskaya's and Rustam Zaripov's efforts, on 5th June we got a chance to try a tomato! It was a small Yellow Teardrop cherry about two centimeters long. We asked the commander to divide it into six parts, and everyone was incredibly happy with their tiny slice of a real fresh tomato! The aroma impressed me most of all, evoking at once memories of childhood and our country house. However, the taste was also wonderful — slightly sweet, typical of cherry tomatoes, but with a recognisable tomato flavour.

We discussed our divorcement from reality. Well, we are loaded with news. Nevertheless, for example, we have not the least clue what is going on at our institute. For me, such estrangement is uncomfortable, and I have requested that our media service share news from the official IBMP VK channel. On 13 June, I finally saw a pdf-file on the local site with a news feed dating back to as long ago as March. It was interesting to learn about past events and special celebrations, to see the pictures of some of our colleagues and realise how they had changed their looks in six months.

On 16th June, we marked the Medic's Day. It is a professional holiday for Rustam and me. The day before the commander assisted me in recording video interview for a documentary series about the first physician and cosmonaut of IBMP, Boris Yegorov.

Days 218–232
Entry
of 19.06–03.07.24

The Benefits of Isolation

The crew marks flight engineer's birthday

Salads for Anzhelika Parfenova's birthday from freeze-dried and canned products

On 25 June, we celebrated Lika's birthday. We tried to fall in with her wishes. For example, we set the table for breakfast in the light of the cosmonaut mini-projector, Lika's gift to the commander. Space colours spilled over the ceiling and walls.

For lunch, we prepared a special layered salad to Olga Mastitskaya recipe: freeze-dried omelet with cheese, chicken with nutmeg, freeze-dried rice with chicken, and processed cheese. We supplemented it with products from Olya and Lika's reserves — canned mushrooms and corn.

On 26 June, an interesting psychological technique fell on that day — a group discussion on an optional topic. Together we decided on 'The Isolation Plus Points' as a subject matter. By that time, I had already compiled a whole list of reasons to love isolation. During our discussions, I verbalised only part of it, although I have prestored a lot that I feel like sharing. Here, we have a supply depot tailored to a year, essentials are at hand more than enough, shifts handle everyday issues, the life at large flows calmly and 'on-job', cyclogram predetermines to the full. In addition, we have a once-in-a-lifetime chance to apprehend that life is livable doing with little. I feel especially

high about it. You finally start going with your gut, avoiding blending in petty vanity.

Besides, it is a year without infections as well. True, there are the opportunistic ones of constant persistence in the body, but this is a mere detail. ARVI (acute respiratory viral infection) certainly do not threaten us in the sealed facility. Another aspect concerns the body re-adaptation after leaving isolation, to be faced at once with all the biological diversity of the outward? Here we are in the high-risk area. The immune system has grown out of active work; it will need time. We will have a 14-day observation period immediately upon leaving the sealed facility.

After returning to Earth the cosmonauts are even at higher risk and adaptation is more complicated, since the body is compromised not only by staying in a confined space with an artificial microclimate, but also due to the weightlessness, radiation and other real space flight factors.

3rd July is a special day. Two years ago, it was on 3rd July that the SIRIUS-21 experiment crew successfully completed their eight-month mission with Asgardia resident, crew physician Victoria Kirichenko. I remember that beautiful, warm, sunny day and myself in a white coat, greeting guests and the press at the entrance to the GEC, along with other colleagues. Unfortunately, since I was busy at the registration desk, I failed to witness the isolation leaving ceremony. However, we still partially watched the online broadcast. I wonder where the registration desk will be located when we leave the sealed facility this time. It will be a chilly November outside then...

Ksenia Orlova, Olga Mastitskaya and Rustam Zaripov implement Homeostat technique

Homeostat Technique

The threes change in different combinations to track everyone's interaction with everyone else. On command, all those sitting simultaneously turn on their pulse oximeters, the assistant records the data on the tablets. The second assistant starts the participants' tablets — a window with an arrow on the scale and a rotation wheel appear on each screen. All tablets are synchronised with each other. The test subjects need to set the arrow in motion by simultaneously rotating the wheels. The goal is to achieve a result when everyone is able to set the arrow to 0, while coordinating with other team members, albeit

avoiding personal, visual or verbal contact. It is interesting that someone takes on the role of a leader missing verbal agreement; the others have to form a line while interacting.

Such tests are applicable at the stage of forming space mission crews. Initially, the system was technically simpler. However, progress is non-stop, and now we test a convenient digital version of analog 'boxes' on tablets.

We hold these sessions regularly in the sealed facility, especially before and after EVA. We have adapted to them. For example, I realised that here we need our own tactics and practice as well. Now some pairs and trios cope with the task very quickly. Pulse oximeters record pulse changes during work, making it possible for the managers to develop a more complete idea of our response to interactions.

Olga Mastitskaya and Rustam Zaripov work on a joint project with the Belarus National Academy of Sciences on growing beet and radish microgreens with different photoperiods in a greenhouse luminostat

The crew performs the 'Group Discussion' psychological technique followed by the audio and video recording from the ground control centre

Days 233–254
Entries
of 04–25.07.24

Isolation = Sublimation

Ksenia Orlova and Rustam Zaripov record a video about isolation food

Lunch with beet microgreens obtained from a joint experiment with the Belarus National Academy of Sciences in a greenhouse

We could finally taste an unusual crop, good for a balanced diet and reducing the psychological burden of the test researchers. In our greenhouse, under the watchful supervision of Olya Mastitskaya and Rustam Zaripov, in small containers with different photoperiods, seeds of microgreens of beetroot 'Prygazhunya' and radish 'Smachny' sprouted. This work lasted several weeks and required meticulousness. I periodically made photo reports about it.

At dinner we had beet greens — no more than 5 cm long, with a pinkish base and a characteristic flavour. And radish greens turned out to be as 'devilish' (in a good sense) as the root crop itself, making a great seasoning for tinned meat!

I even managed to take an isolation food photo: capturing a yellow freeze-dried omelette sprinkled with fresh green-pink microgreens. The combination of colours left me aesthetically delighted. By placing a vase printed by Yura on a 3D printer next to it, we managed to create a restaurant effect.

On 20 July, we symbolically celebrated the International Moon Day. We are on a 'lunar' mission, so this is our holiday as well. Neil Armstrong first set foot on the lunar regolith as part of the

Apollo 11 mission 55 years ago.

H It is strange to realise that 55 years later, we, six volunteer researchers, will try to explore possible factors of a long-term lunar mission in a closed sealed facility. The longest lunar expedition lasted 12 days. During the Apollo 17 mission, three spacewalks were performed — three EVAs (extravehicular activities). In our year-long simulated mission, there are five EVAs scheduled. The fourth one, by the way, is coming very soon. On 23 July, the fourth 'exit' began; Rustam Zaripov and I remained in the orbital module, and four of our colleagues moved to EU-50.

I invited Rustam to make a video about our food — an isolation food blog. We set up in the kitchen, placing a camera with a tripod on the edge of the table. We laid out what we used most often and what we were going to eat in the near future.

We took turns talking and showing. We opened packages, demonstrated dry and cooked versions of meals. We have both tubes and canned food from the ISS crew ration — chicken meat with nutmeg, vermicelli with meat, and squash spread.

The transformation of freeze-dried products into edible ones may be of particular interest to the viewer. The process of freeze drying itself is simple: at low temperature in a vacuum, water from the product turns into ice, and during drying it quickly evaporates, bypassing the liquid phase.

When sublimated, the dry residue is easy to transport, it weighs little, takes up little space, and can be stored for a long time. Add water, and the dish is almost ready to eat. Compared to other types of food processing, there is little loss of nutrients during sublimation. Half of the ISS diet is freeze-dried food, which is why we are testing it in our mission.

When shooting, all kinds of greens from our greenhouse showed off on a large white plate: 'Red Star', 'Multicoloured Lace', Roger salads, Chinese cabbage bok choy, 'Syroezhkin' (Rawist), sorrel, arugula, green mustard, parsley. Not too long ago we also had dill and 'Japanese Emerald Lace,' which I particularly liked. All these plants contain useful micronutrients A, Bi, Br, PP, being the real aid for us, in addition to vitamins in tablets.

And here we live for the day when fragile sprouts of the same parsley, no higher than 5–10 cm, rise from the seeds, and carefully cut a couple of leaves from the bush so as not to exhaust the plant and let it grow. Personally, I savour each of these tiny leaves, enjoying the fresh taste, reminiscent of ordinary life 'in the outside world'. Again and again I am convinced that isolation teaches one to appreciate what one has and to be content with little.

Aerosols Technique

On the same day, we carried out the microbiological technique instead of Olga Mastitskaya and Anzhelika Parfenova, who were responsible for it but being on EVA that day. A week earlier, the girls trained us and passed on the basic information. Rustam and I took special equipment and Petri dishes from the storage room. Each cargo vehicle delivers peptide broth cups. The broth deserves its name, as it has a very characteristic animal odour.

We prepared two devices, a Handheld laser counter equipped with an air particulate control sensor and an air cup aspirator. We need them both to compare the readings.

The issue of including a laser counter in a set of scientific spacecraft equipment is currently being considered. That is why we leverage it in isolation as well.

Ksenia Orlova and Rustam Zaripov conduct the Aerosols technique

It features the conversion of photodetector light pulses into the electric ones.

We turn on both devices. Rustam enters the room parameters in the aerosol particle counter. I prepare Petri dishes, labelling each one: location, date, sample number. Then I open the dish and place it in the aspirator prepared. I screw on the lid. On the count of three, Rustam and I press the start buttons on both devices at the same time. The measurement takes five minutes. The aspirator noisily runs a certain volume of air, as a result, centric equidistant depressions are formed on the buckwheat-coloured gel-like peptide broth. I close the dish lid and tighten the edge with polyethylene tape. We take samples in each room. The entire procedure takes about two hours.

If there are fungal microspores in the air, the Petri dish will 'brighten up' after 5 to 7 days. However, we will not know about it, because we undock the cups through the airlock immediately after the study.

Air pollution in sealed facilities is always higher than in conventional ventilated rooms, despite all our air purification systems. That is because there is no air coming in from the outside. Fungal spores in the ambient air may affect not only humans, but the equipment as well. The ISS has repeatedly recorded cases when the mould settled on plastic parts of various devices and took to eating them, and that even caused the equipment to fail.

This study is also important and interesting for me as an allergist. In my field, there is a specific type of disease — mycoallergy. It is when, through frequent contact with certain types of mould fungi, the body forms hypersensitivity to them with serious consequences for the respiratory system or skin.

On 24 July, we started to prepare for the 'lunar landing party'. The crew had already established a tradition: to welcome 'those who returned from the Moon' with some dessert. Rustam offered to make a roll, having rehearsed its preparation. We filmed the trial process on video for our food blog. For comparison, we made two variants of the filling: 1 — apple jelly, walnuts, freeze-dried strawberries, and 2 — with freeze-dried peach.

Days 255–283
Entry
of 26.06–23.08.24

Impressions are the Key Nourishment

On 6 August, we decided to start counting down, as there were only 100 days left until the end of the isolation! We agreed on the font for Ksyusha Shishenina to print multicoloured numbers, to change them every day. We placed the 'scoreboard' in the kitchen.

Interestingly, we are used to the constant ventilation noise. It is especially strong in the storage room and the medical module, but it is also in evidence in other locations. If you change the temperature manually in the sealed facility, the entire system stops for a while and then starts up again in a different mode. I nearly always notice these rare moments of absolute silence. The silence is so strange and massive that it makes my ears pop, and I feel pressurised. It is hard to imagine my experience of staying in a noiseless room after isolation.

The ISS ventilation and equipment noise exceeds ours many times over, and cosmonauts have to adapt to it. The noise impact on humans is a serious challenge. We get tired and irritated faster, our breathing and heart rate may change, including metabolism. Noise has a cumulative effect on the nervous system and the auditory analyser. Such techniques as 'Audiometry' provide for studying the issue in isolation; we fill out a questionnaire on the noise level subjective assessment and walk around with a dosimeter at times, recording daytime acoustic load around.

On 15 August, we started facing mailing problems. It became obvious that our personal contacts do not get some messages as we do not get the response ones for no good reason. Technical support promised to sort it out, while

Anzhelika Parfenova when preparing to the maximum physical exertion test on a bicycle ergometer with an exhaled air gas analyser mask

we were wondering whether it was the emergency scenario or some external problem indeed. Frankly speaking, this situation was very exhausting psychologically: you write a big letter for your loved ones, and it disappears. You write it again, copy it — and no reply. And so many times, until one of the letters does overcome an inexplicable obstacle by chance. In short, it was a significant additional stress factor for all of us, and everyone was experiencing it in their own way.

On 19 August, I took a peak exercise stress test for the crew on a cycle ergometer. I caught myself in the automatism that invariably accompanies a long isolation mission along with monotony. All the actions are very well known, so the brain doesn't always identify what's happening with what the hands are automatically doing.

On 22 August, the long-awaited 'cargo' arrived. By this time, there were significantly fewer items in stock. Waiting for replenishment. Unloading the 'cargo' usually coincides with sleep deprivation. The first half of the test went as usual in the working mode — with the 'Exhaled Air' technique, for which I conducted venous blood sampling. This will allow us to study the profile of low-molecular

Olga Mastitskaya conducts the 'Exhaled Air' technique for Anzhelika Parfenova

metabolites of lipid peroxidation in exhaled air and blood. All these data make it possible to determine the optimal set of physiological indicators in order to further develop a non-invasive assessment technique of human body parameters in space missions.

The EU-50 hatch opened at 23:05. Then amazement mixed with disappointment came over. During previous deliveries, the 'cargo' was packed with boxes, containers, bags. Now, it was almost empty. There were a few packs for the techniques and several bags with personal parcels. We could not understand why there was no food or, for example, no laundry detergent, which, according to the storage room barcoding database (we kept it promptly and accurately, and the managers had access to it), was long gone.

During the day, I conducted the 'Reacor' technique, including electroencephalogram, for several crew members. When doing it myself, I noticed that it was not easy to perform a proofreading test on a piece of paper, marking certain letters and symbols in a chaotic list. The brain needed more time to correlate the task with what the eyes saw. Scientists established experimentally that during sleep deprivation, visual attention decreases and vi-

sual information processing becomes more difficult.

I perceived, the fourth deprivation appeared to be much easier than the previous three: the body had time to adapt to the test. By contrast, the first one was a real nightmare for the brain. It was difficult not only to keep myself awake, but also to find an answer to the question — why not go to bed upon having all the techniques done.

It was the rats' total sleep deprivation studies revealing that the animals died from visceral (organ) disturbance and multiple abnormalities in all systems, even the immune one, rather than from the brain degenerative processes. Sleep is required largely for switching the brain from external information keen analysis to processing impulses from internal organs — to adjust their correct operation.

The fact that during the fourth deprivation each crew member was quite stable for the entire 38 hours, confirms this conclusion. We did not even need an invigorating face ice massage.

The long-awaited ten-hour sleep brought a much more vigorous awakening than after the previous three deprivations. I remember that earlier, when I woke up, I felt annoyed for a long time, mixed up with a compulsive idea that I should have slept longer.

The crew waits for a 'cargo vehicle'; commander Yuri Chebotarev opens the EU-50 hatch

Ksenia Orlova moves things from the 'cargo vehicle'

Days 284–293
Entry
of 24.08–02.09.24

Total Separation

The ‘cargo’ brought consumables for some additional techniques. Many of them are pertinent to microbiology. Thus, on 24 August, we started taking the ‘Lactoferrin-Entero’ probiotic, produced jointly with the National Academy of Sciences of Belarus. We received sachets of 28 capsules, which were stored in the refrigerator. Each capsule contains human lactoferrin, Lactobacillus and Bifidobacterium bacteria.

In isolation, due to specific limited nutrition and stress, the intestinal microbiota undergoes changes, and now we start gradually working toward a return to common life. Our internal systems ought to run back their defence mechanisms and be on the alert to ‘meet’ adequately the microorganisms ready to attack us from everywhere after leaving isolation. It is a good opportunity for the experiment managers to establish which pre- and probiotics are the most effective. We will take ‘Lactoferrin-Entero’ after each breakfast and dinner for two weeks, and we will collect biomaterial for analysis. Then we will begin testing another type of probiotic, etc.

The washing problem remained open, because gel amount was inevitably decreasing, despite all our saving methods. The san-hygienic service offered us various curious options: for example, we could use liquid soap as a regular washing gel. And if we find increased foaming in the washing machine drum, we can add improvised defoamers: vegetable oil, or hair balm, or hand cream.. The washing machine and dryer were first installed for our yearlong experiment, making ev-

Olga Mastitskaya before taking the probiotic drug ‘Lactoferrin-Enterol’

Anzhelika Parfenova prepares the dryer for use

eryone's life easier. So we were actively looking for a solution to restore usability as quickly as possible.

The mail still does not function, so I am not even able to thank my family for the gifts, and I have no chance to share my feelings of deprivation.

Step by step, it seems as if we all are getting used to the separation from the loved ones and the rest of the world. Now it is not as painful as at the beginning of the experiment. However, the feeling of uncertainty, when you do not know what is going on with your dearest people, still puts in ascertainable depressive spirits. We are just waiting for the outside to be able to sort out the problem.

I noticed that some guys had packed their bags and taken them to the storage room — they had already put away things of rare use and cleared up space in the cabins. One might think that they were already mentally tuning in to the end of the experiment. I prefer not to make a fuss, let everything go as it is. The institute, where our sealed facility is located, has long been a second home for me, given the number of night duties during various experiments or just overnight stays in the lab, when I didn't want to bother with the way to and from home.

On 1 September, exactly one year ago, the SIRIUS-23 crew members first met each other, and after lunch we marked the event with a photo shoot. We arranged the background from our printed photographs, which our curator Tatyana Zhuravleva kindly sent via cargo at my request.

Ksenia Orlova, Olga Mastitskaya and Rustam Zaripov when photo shooting in honour of the crew's first year together

Allergoblot Technique

My allergy diagnostics technique took place on 2 September that occurs once per isolation. The necessary reagents arrived with the cargo, and I was able to undertake a blood serological test for the crew members at the equator (in the middle of the experiment). Allergy blotting (based on immunoblotting) can be used to perform additional allergy diagnostics. A visually good result is obtained, revealing whether or not there is a reaction to a specific allergen.

Ksenia Orlova performs Allergoblot technique using the blood serum of test subjects

Preparing the Allergoblot technique reagents

According to the scientific programme, we perform diagnostics three times — before isolation, at the equator and after isolation, with intervals of six months. I will then compare the results obtained with the basophil activation test, performed once before and once after isolation. I will try to trace whether there is a dynamic in the sensitisation of the test researchers' organisms in the sealed facility conditions. The fact that the technique was successfully performed in the GEC is especially important, because such a relatively easy express method of allergy diagnostics could help in long-term isolation missions, and perhaps in future long-duration space missions as well.

Days 294–305
Entry
of 06–14.09.24

Homesick

The night of 6 September was sleepless. There was no way to fall asleep for a long time. I recalled the recommendations described in our programme for the Stress Control technique: what to do when you have difficulties in falling asleep and waking up. One of the tips is a 4:4 breathing exercise. You slowly breathe in and out for a count of one-two-three-four.

I tried it, but at first, it did not work. Then I decided to play with it a little. I held my breath for 5 to 7 seconds, inhaling slowly, and did the same while slowly exhaling. I felt that mild hypoxia was quite successful in distracting me from my thoughts, and gradually I started getting tired of it. It finally helped me to fall asleep.

Ksenia Orlova conducts pulse oximetry during Olga Mastitskaya's monthly medical check

I recalled that the very same day the year before, on 7–8 September, we went through the 'Survival' team-building programme. All applicants for the SIRIUS-23 crew test researchers got out into the woods with a group of psychologists for 24 hours, where we had to build an extemporised shelter for overnight, feed a fire, and arrange meals. Cosmonauts are required to undergo such training in case of emergency landing in the wild. Now, memories of a campfire in nature, night rain and cool fresh air bring on a special nostalgia.

On 9 September, another significant date — the milestone of 300 days of isolation — crept up on us. However, there was no time to mark it or relax. From the very morning, I had my standard monthly techniques of dentistry, medical checkup and blood sampling preparation.

The 11th of September is a busy day before the 'Basic Metabolism': collecting saliva, urine, bioelectrical impedance analysis, drawing blood, anthropometry, the heel ultrasound for a technique related to assessing mineral and bone metabolism in

Olga Mastitskaya trains on a passive treadmill

a woman's body as part of the Asgardia programme, several types of questionnaires, neurogames, the greenhouse, passive treadmill training, a protein-free dinner.

Acoustic Environment Technique for Medical Check

On 12 September, after breakfast, Rustam helped me to set up the equipment to measure the acoustic environment around me for 24 hours. I fastened a compact audio dosimeter on my belt. A similar one is used on the ISS. A wire connected to a microphone, pinned on my collar, runs across my shirt to the shoulder girdle. It is required to direct the microphone towards the face, as close as possible to the person's auditory analyser, so that it picks up the same sounds.

Rustam enters the measurement start time into the spreadsheet. For 12 hours, I walk around with the dosimeter, keeping an eye on the microphone so that it does not turn over. In the evening, Rustam checks the data and writes them down in the spreadsheet. Before lights out, he comes to my cabin and helps me to install the equipment on my desk, at the headboard level. He fixes the microphone with duct tape, gives me the spreadsheet and repeats what I need to do on my own. Before going to bed, I have to turn on the audio dosimeter and record the measurement start time.

In the morning, I transfer all the parameters into the spreadsheet: measurement duration, acoustic dose in percent, equivalent sound level, noise level, maximum noise level. Each test researcher undergoes such an examination. It allows identifying effectively a crew member exposed to the greatest noise load. It may result from their duties and location during work and rest. This technique is carried out at regular intervals every two months.

So I came to the conclusion that at the end of the experiment, it's important to find a new motivation for yourself. Not the one we went in with, with the buzzwords 'for the sake of science!', etc. We need new justifications, why to do the same actions every day, why to tolerate discomfort during techniques and communication difficulties, and why to find compromises in sensitive issues.

I found several options for myself. One of them: we do it in order to reveal all the difficulties by our own example and so that similar things would not happen in other long missions, isolation or space ones. So that other test researchers, and maybe even cosmonauts, can have at least a little easier time. For this reason, I am ready to endure everything that happens here again and again.

Rustam Zaripov performs ECG leveraging wireless cardiac recorder as part of Stress Control technique

Days 322–335
Entry
of 01–14.10.24

Asgardia's National Day in Isolation

On 1 October, a regular session of one of the psychological techniques occurred. We received a radiogram the day before coming in view of the amazing words for the first time – 'final examination.' It sounded very encouraging.

The test incorporated several tasks.

1) Characterise your perception of time.

2) Recall the three most striking situations in the last period. Describe each one in a few sentences and explain why exactly these situations have become relevant. In addition, judging from the above 10 emotions, choose those experienced in the light of events and evaluate their effect scoring from 1 to 5.

3) From 19 pairs of opposing definitions, choose those that match your perception of psychological support using VR technologies.

4) Leveraging the well-known Luscher test, first, rank eight colours from the most pleasant to the most repulsive one as of now; next, in the list of 26 words including the other crew members' names, indicate the colours associated with them.

On 3 October, we had a series of psychological tests. The second questionnaire is a sociometric one, to assess the interaction and team spirit level. It consists of only three questions: to indicate, in order of priority, three crew members whom I would like to continue working with in a similar future mission; to name three people whom I could take a vacation with; to name the three whose answers to the test I would like to know. I have noted for myself that, from month to month, my answers changed, depending on the way the interaction and communication in the crew developed.

There were two questionnaires under another technique as well. One of them concerned exploring the ways to overcome difficulties. There are 66 ways listed, and in front of each, you have to put points from 1 to 4, depending on the frequency of use. At the end, you have to name your personal ways, as well as what usually prevents you from coping with difficult situations.

Another questionnaire is devoted to diagnosing the group's values and orientation harmony. The first task prioritises 10 qualities that, in my opinion, should be present in an ideal participant of long-term isolation. In the first place, I note 'stress resistance'.

In the second task, I rank 10 negative features that crew members should avoid. In tenth place is something I could put up with, and I choose 'unsociability'.

The third questionnaire lists the ten goals of the SIRIUS experiment, and I rank them in order of importance to me personally. I was amused by the options 'to form an image of flight' and 'to get an unforgettable experience of being in long-term isolation'. I always put them in last place. We fill out such questionnaires once a month.

On 8 October, the 'Cosmobot' was moved to the 'lunar module' EU-50. When they opened the hatch to transfer the equipment, they suddenly found several five-litre containers with laundry detergent inside. What a celebration! We were saved. Although we actually enjoyed washing with shampoo. No one could be sure of the quality of cleaning, but the aroma of linen and clothes was much more pleasant than after baby gel.

During the day, we suddenly received a GS (Ground Station)

video — the SIRIUS-21 crew commander and physician Victoria Kirichenko attended the IBMP conference dedicated to their isolation deliverables. Scientists always need a lot of time to systematise and process the data obtained after long experiments, so such conferences imply expectancy. Especially it concerns international projects, where managers from different countries also conduct their research. It was nice that the SIRIUS-21 crew commander Oleg Blinov and Vika decided to support us, briefly sharing their own experience during the closeout period of eight-month isolation.

On 12 October, we celebrated the Foundation Day of the world's first Space Nation, Asgardia. As a representative of Asgardia, I 'stood treat' with delicacies, (it is a holiday rule with us). I served the crew with dried fruit for lunch and canned pineapple for dinner. In isolation, I had many Asgardian-related items with me that helped me. Several issues of the ROOM magazine for practicing English, a star-shaped gold expander with the Space Nation symbols, a diary, and a toy panther Luna Archimedes, which was given to me by the Prime Minister of the Space Nation, Lena De Winne, before the isolation.

Autostamm Technique

On 14 October, the female part of the crew started a new stage of the 'Autostamm' (Autostrain) technique. A few days ago, samples were taken, which are being studied not only by the IBMP staff for the benefit of Asgardia, but also by colleagues from Malaysia and South Korea using another approach. Now the final cycle was coming up — the use of local autoprobiotic capsules for 24 days, created on the basis of individual microflora of each of the girls.

Everyone has their own set of capsules, which we store in the refrigerator and use in the evening. It is necessary to maintain the microbiotic composition, which is subject to negative changes in long-term isolation experiments and space missions, in all human biotopes.

Unfortunately, very little attention is paid to women's health in space missions. This research will help to develop individual drugs to support it during space expeditions. Asgardia takes an interest in this research because of its long-term goal, namely the birth of the first child in near-Earth orbit.

Ksenia Orlova prepares test tubes using the 'Autostrain' technique and medical check

Days 336–341
Entry
of 15–20.10.24

‘A Year in the Earth Starship’ 57 Years Later

Olga Mastitskaya near the greenhouse with the harvest. An audio dosimeter for the acoustic environment medical check is attached to her T-shirt

On 15 October, they uploaded for us an incredible ebook diary, ‘A Year in a Starship’ by Andrey Bozhko. I read it in one go in two days. A lot of things touched my heart.

On 5 November 1967, physician German Manovtsev, engineer Boris Ulybyshev and biologist Andrey Bozhko initiated their first-ever one-year isolation mission within the walls of IBMP. They had only one module and a greenhouse at their disposal, drinking water regenerated from waste, a three-storey bed (i.e., no personal cabins were envisioned), and the traditional difficulties of the pioneers. These heroic people had accomplished a real feat. But I was struck by how much our isolations had in common, and this despite being 57 years apart! Right down to the fact that they, like us, spent a leap year in isolation, which is 366 days instead of 365. It was just so coincidental.

Our stories follow in line even due to a health trip after isolation. The ‘Starship’ crew underwent rehabilitation within a week in a health care centre near Moscow. We are going to do the same.

Amusingly, even Bozhko's examples of interview questions from journalists are almost identical to the ones we receive. Although it is clear that they can hardly come up with anything new here.

On that day, Olya (researcher Olga Mastitskaya) evaluated the number of tomatoes and greens harvested so far in the greenhouse. In almost a year, she and Rustam Zaripov have harvested such a crop — about 4200 g of lettuce and almost 600 g of cherry tomatoes! The SIRIUS-21 crew had measured the tomatoes in pieces, counting 75 per mission. It is difficult to compare, but it seems we are not behind.

Days 345–352
Entry
of 24–31.10.24

First in Isolation! Study of the Hypomagnetic Field Effect on Humans

Ksenia Orlova takes venous blood from Anzhelika Parfenova before her stay in the ARFA installation

On 25 October, preparations began for a very important stage — the 'Arfa' (Harp) experiment in isolation conditions. This was happening for the first time! Arfa is a system for modelling magnetic fields, consisting of a movable exposure box with a chair inside for a test person. The installation is capable of reducing the magnetic field along a specific axis by 1000 times and helps to study the hypomagnetic effects (similar to those which occur when moving from the home planet) on the human body. Astronauts who flew to the Moon and cosmonauts after the ISS expeditions demonstrated some changes in the cardiovascular system, and it is especially important to track its functioning in the Arfa.

We conducted the first part of the experiment on the bench that housed the installation during the observation period. Meantime, despite the heavy structure bulkiness, they succeeded in placing it on our 'lunar' surface so that we could go through the study on our own!

At 14:00, we opened the EU-50 hatch for conducting preparatory activities. It is great that we will have access to all GEC spaces at the same time for two entire days! That had never happened before in past missions either.

On 26 October, the first day of Arfa, I had to work furiously. I had an additional, no less important task besides taking blood and providing techniques for some of the test researchers during the exposition — conducting a full photo shoot of all the techniques: LDF (laser Doppler flowmetry), cognitive tests, box closure, and vein ultrasound.

On 28 October, my Arfa day, my morning began with the first urine collection. I will have to repeat it tomorrow morning to assess the effects.

At 14:00, I finally went to the

Arfa. Yura Chebotarev accompanied me with a camera. I put a soft blanket on the chair to make it more comfortable to sit almost motionless for four hours. I took paper books with me, as it was prohibited to use electronic items, even the actigraph watch. Rustam Zaripov and Olya Mastitskaya managed the technique — they helped with equipment for cognitive tests, attached electrodes beforehand for reading cardiac indicators, measured blood pressure, and put on a pulse oximeter. Then they fastened LDF sensors on the forearm, forehead, left finger with elastic bandages. They recorded the parameters for 10 minutes and closed the box. By raising his hand, Rustam signalled to the managers through the cameras that it was time to turn on the installation. Yura left with the camera, and I was to remain motionless and mute for another 10 minutes during the second LDF recording.

Arfa internally is a large wooden parallelepiped base with 'strings' stretched along the walls. They are made of insulated metal wire and are located parallel to each other at a distance of 3 cm. They allow shielding the installation from static and low frequency electric fields. One may say that a test researcher sitting inside looks like a 'caged bird'.

I was even glad spending four hours in Arfa: I could finally finish one book and start another. I didn't experience any special sensations in the installation, just like during the session before the isolation. However, there was a funny effect: you could hear everything that was going on outside the walls of the 'lunar' surface hangar, and the floor vibrated with the footsteps of people walking around outside — aliens nearby, as we joked. At the same time so close and so unattainable.

Rustam Zaripov measures Ksenia Orlova's blood pressure before her stay in the Arfa hypomagnetic installation

Olga Mastitskaya attaches LDF sensors to Ksenia Orlova to record data before her stay in the Arfa installation

Ksenia Orlova inside the Arfa installation

At 18:00, Olya and Rustam came to repeat the techniques for me: cognitive tests right in the 'cage', LDF recording for 10 minutes. And only afterwards, the long-awaited opening of the door took place. Having gone down to the EU-50, I removed the electrodes, and Lika made an ultrasound of my veins. Then the final venous blood draw followed. I was not completely free until close to 20:00.

Rustam Zaripov and Yuri Chebotarev take Ksenia Orlova's venous blood after her 4-hour stay in the Arfa installation

Anzhelika Parfenova performs an ultrasound of Ksenia Orlova's neck veins after her 4-hour stay in the Arfa installation

Days 353–365
Entry
of 01–13.11.24

Summing Up

1 November. It's about time to start summarising the results already: two weeks left till the end of isolation. In the morning, some of the crew members, including myself, were going to have the sixth session of the metabolic technique, and the daily urine collection was beginning. In total, as per various studies during the year of the mission, each of us donated a morning urine sample 14 times, a daily urine sample 12 times (I and some of us had one additional time), and a fractionated collection (at four-hour intervals) 6 times. In total, I had 33 episodes with this type of testing.

On the morning of 2 November, after the 'Exhaled Air', I took saliva samples for the metabolic and immunological techniques. The study of this type of biomaterial using the PCR (polymerase chain reaction) method is also part of joint immunological research with Asgardia. In total, we have given saliva 131 times during the year for different studies, including 70 times for the technique in which saliva is collected every two hours.

In the afternoon, we received a radiogram about the forthcoming exit from isolation, the order and timing of the briefing. We were also asked about our wishes for the first dinner in the observation. I wrote that I would be happy with any meat, vegetable salad and fried potatoes or stewed courgettes. However, fried potatoes, most likely, will not be given. We will be adapted to the usual 'earthly' food gradually, and the observation period is supposed to be dietetic. But it was worth a try — who knows!

I've developed a complete indifference to isolation food. While at the beginning I tried to think of something to make it tastier, at the current stage I don't care anymore. You just need something to shove into yourself to have energy. This monotonous lack of appetite and culinary imagination was enlivened only by 'goodies' from the crew members.

Rustam Zaripov demonstrates 8 test tubes of saliva collected every 2 hours using the Thermohomeostasis technique for cortisol level detection

It is interesting that radio messages from the managers arrive less and less often. Apparently, they are already sure that we know everything by heart. On the eve of the techniques, we were given some introductory information: when the next session should be, where to get equipment and consumables, how to save data, where to upload it, what the order of actions is, some important rules (for example, that you can not drink coffee that day), and we were warned about changes, if there were any. We received just over 1500 radiograms during the whole period of the experiment.

In the evening, washing the bathrooms awaited me. At home, in our normal hectic lives, we wash the bathroom fixtures, mirror and toilet walls on average once a week, over the course of a year we accumulate ca. 52 times. In our sealed facility, given the hygiene requirements placed on it, this happens every day. With three toilets, even despite the shift duty, it turns out that each of us washed the toilet about 360 times during the year.

Electrogastroenterography Technique

On the 10th of November, I started the 'Electrogastroenterography' technique, conducted for 24 hours. Lika Parfenova assisted: she helped me to install five electrodes, switch on the Splanchograph, hanging from my belt on a special harness. I will have to walk around with it for twenty-four hours, marking 'events' on the remote control and simultaneously filling in a special paper form: eating, hunger, stomach pain, going to the toilet, sleeping and so on.

The study makes it possible to assess the functional state of the gastrointestinal tract by frequency values of local electrical activity. During a year of isolation, changes may have occurred due to hypodynamia, canned food, stress, shift in circadian rhythms, GEC environment factors. The procedure is similar to the daily walk around with a Holter that we had during the selection period. However, the Splanchograph is twice as big and heavier. I doubted whether I would be able to sleep normally with it. But on the whole, I managed to adapt. I sleep on my side, it just rolls away and does not interfere much. But the electrodes... This is one of the factors that cause the greatest moral and physical exhaustion here.

Over the course of a year, to perform seven different techniques, each of us endured a total of about 545 electrodes on ourselves at different times. Their adhesive backing caused discomfort and skin irritation for almost all of us by the end of the isolation, given that we only showered once a week. Taking them off became more and more painful each time.

On 11 November, I donated blood, for the last time in isolation, before the Basic Metabolism. In fact, it was the last blood I 'spilled' in the GEC. I counted that in total, during our mission, each of us had donated venous blood 38 times, and capillary blood 23 times.

On the 13th of November, we have a packing session according to the Rasplan (Planning). But I decided not to hurry with it: anyway, during the observation period, we will have access to the GEC, and I will sleep in my cabin for two additional weeks. This was the choice we were given: move to the first floor for the night or stay in our cabins. I favoured the familiar surroundings.

For me, packing was a matter of throwing out what I didn't need and dismantling my art gallery — I am going to give everything away. At the same time, we did a final cleaning of the complex. I wanted to make sure everything looked neat and was in its place. It's good that we had an off-schedule shower that day — we'll feel like human beings on the way out.

Day 366
Entry of 14 November 2024

At Large!

Preparing to leave the GEC is like the anticipation of New Year's Eve celebrations in the family. You have already chopped all the salads, set the table, and changed into festive clothes. And you languish in the excitement of anticipation. The New Year will not come before the clock strikes 00:00.

I'm feeling about the same right now. I suppressed excessive excitement in myself with extra work, cleaning and trying to do as much as possible. I did all this deliberately, so that my nervous system would not 'overheat' and allow me to sleep peacefully. Thanks to this, I managed to fall asleep quickly on the night of 14 November, but still woke up twice, hearing the guys wandering around, overexcited with anticipation.

The 14th of November was our final duty with Yura (crew commander Yuri Chebotarev). For breakfast and lunch we got the remaining goodies, now they were especially needed. Our departure was scheduled for 13:00. Until then, everyone was doing their own things: rehearsing a speech for the briefing, tidying up, downloading photos and videos from the equipment. Here I am, having finished my preparations, and now finishing my diary.

At 11:30, according to the regulations we had to change into official coveralls. At 12:00, there was lunch. For convenience, we used Cosmopit tubes, so as not to wash the dishes afterwards. Then the final preparations followed, and we even had time to record a small video in the community room, sharing our feelings before leaving the complex.

At 12:45, we were already in the EU-250 storage room in front of the hatch door between the technical refrigerators. It turned out that during the isolation, everyone's Garmin watches had fallen behind by four minutes, that's why we gathered somewhat earlier. We lined up in the required

The first seconds of the SIRIUS-23 crew emerging from a year of isolation

Hero of the Soviet Union and the Russian Federation, pilot-cosmonaut Sergey Krikalev presents awards to the SIRIUS-23 crew members

order and waited. We could hear voices coming from the outside through a microphone, but it was difficult to make out the words. The engineers had already started to depressurise the sealed facility so that there would not be a sudden drop and a deafening pop of air when the hatch opened.

I stood the second one in the line. I spent the last three minutes with my eyes closed, trying to breathe more slowly so my heart wouldn't jump out. My actigraph recorded a pulse of over 100 beats per minute.

Finally, some movement is heard outside, and the hatch opens. Flight engineer Anzhelika Parfenova comes out first, she is being introduced. According to the regulations, I wait two seconds, come out next, and stop to greet with a motion of the hand the crowd gathered at the sealed facility.

I have no time to look around the whole place; I hear applause, see many people and carefully climb down the metal steps. I feel the temperature difference — the air is cooler here. I walk along the big SIRIUS project banner following Lika and position myself orienting by the marks on the floor. Only now, I feel it is OK to lift my head and look around, smiling at the world.

I see many familiar faces around, nodding to some, winking at others in greeting. I do not have time to look at the balconies on the second and third floors. Photo and video cameras set sights on us from everywhere, and it is better not to look up.

The project manager and Head of Department of Implementation and Propagation of Scientific Achievements at IBMP RAS, Candidate of Medical Sciences Mark Belakovsky introduces each of us and invites our commander for a final report to the Director of the Institute, Academician of the Russian Academy of Sciences, Doctor of Medical Sciences Oleg Orlov.

I feel delight and joy: how clearly and calmly Yura rises to the challenge to report at such an exciting moment of veritable firestorm of emotions and impressions! Then all crew members are called upon to give a speech, I am also invited to the microphone.

I seemed to have very sincerely said all that I was thinking about. After each of us had spoken, something completely unexpected happened. The pilot-cosmonaut, Hero of the Soviet Union and Hero of Russia Sergey Krikalev, who spent a total of 803 days on the ISS, came out to meet us. He was invited for the awards ceremony, the awards given to us, the SIRIUS-23 test researchers! It's just fantastic! One could only

dream of such a high honour as receiving the medal named after Yuri Gagarin, 'for personal contribution to the implementation of space programmes and projects, many years of dedicated work,' from the hands of Sergey Krikalev! This happened for the first time in the history of isolation experiments at IBMP.

Oleg Orlov personally presented each of us with a bouquet of flowers, the pink ones for the girls and blue ones for the guys. The bouquet gave off an incredible, intoxicating aroma, which I had missed so much in isolation.

Next follow questions from journalists, press photos, and we proceed to personal interviews.

A commotion began; various correspondents were 'snatching up' test researchers for their cameras. At that moment, representatives of Asgardia approached me — the Prime Minister herself, Lena De Winne, curator of the joint Space Nation and IBMP programme, attended today the solemn occasion.

The question I liked the most was something like that — 'What would you like to see first when leaving the sealed facility, instead of a crowd of journalists?' I answered that, of course, I really wanted to see sunlight in the windows, but, alas, it was November.

After the official briefing, in order to minimise contact with the guests, we moved up the emergency staircases and through an overhead covered passage to the second floor of another IBMP building. There was a new surprise: right in front of the doors, a bright photo zone of colourful balloons and other decorations was set up for us. Even from afar, I heard the sounds of accordion. Many people in white coats greeted us with cheers and balloons. Among them was a representative of the Scientific Research Institute of Baking Industry, making bread for cosmonauts (the same bread was supplied to us), with a loaf. Inna Nosikova, the head of one of the GS on-duty teams, was dressed in a folk costume, with a kokoshnik (traditional Russian headdress) and a rushnik (homespun linen towel) in her hands that hosted a huge apple pie with a golden SIRIUS-23 inscription.

With Prime Minister of Asgardia Lena De Winne

Joint photos, videos, hugs, joyful laughter, and absolute delight!

Having come to our senses a little, we suddenly noticed a window! And shouting 'window!' we rushed towards it. There was nothing unusual behind the glass: just the grey IBMP buildings and Moscow November. But what an incredible delight this picture caused! We even jumped with happiness, hugged from the overabundance of emotions caused by this general feeling of freedom.

Meanwhile, we already had to run to the techniques. The managers are impatient to examine the test bodies as soon as possible. The ophthalmologists go first, while our eyes have not yet had time to adjust to other types of lighting.

The abundance of smells around struck me. I guessed it was like anosmia after the Covid: when you haven't smelled anything at all for some period of time, and suddenly the happiness of smelling everything around you comes back. Well, I picked up absolutely everything: the smell in the

SIRIUS-23 crew has successfully completed the 366-day isolation 'lunar' mission

passage on the emergency stairs, the perfume on people's skin — now the scent of any perfume seems so strong that it literally knocks me off my feet. Even the smell of the equipment in the offices is incredibly intense!

I am going to Daria Schastlivtseva's technique. Daria conducted neurosemantic psychodiagnostics for us before isolation, and now she conducts it right after. Again, there is a cap with electrodes for EEG and a programme of tests in several stages. The study allows you to identify triggers for anxiety, defensive reactions and other features by means of encephalogram.

All of this takes place in darkness and silence, so that nothing distracts you. Thus, I discover a new auditory spectrum: the silence of a room missing the omnipresent ventilation sound and but somewhere far outside the window the noise of occasionally passing cars. An association with childhood and home immediately arises.

It was amazing: I felt at home! Although we spent the entire year in the neighbouring building of the same institute, it felt like I had returned from a long journey to my native walls.

Every person I met in the lift, on the stairs, in the corridors, during the techniques, started enquiring for something, commenting on the changes in my appearance. There was too much attention, and every time I was embarrassed, trying to joke it off.

A chicken leg with baked vegetables and a fresh salad of cucumbers and tomatoes grandstanded on the plate in front of me. My crewmates and I immediately apologised to each other for not observing manners of eating, and pounced on the food like wild animals. Everything seemed incredibly delicious.

The ultrasound of veins occurred at the end of that long day. Only after that, I was able to breathe a little, sort out the things left for storage before entering the sealed facility.

I spent the first night in my cabin in the GEC (we were given a choice in advance at will). I decided to adapt to the new, so desired, huge world gradually. But what a joy it is to realise: we coped! We overcame everything! We successfully completed the year-long simulated 'lunar' mission in the isolation of the scientific project SIRIUS-23, hurray!

ASGARDIA

THE SPACE NATION

www.asgardia.space