Report of The 20th Symposium “Human in Space”

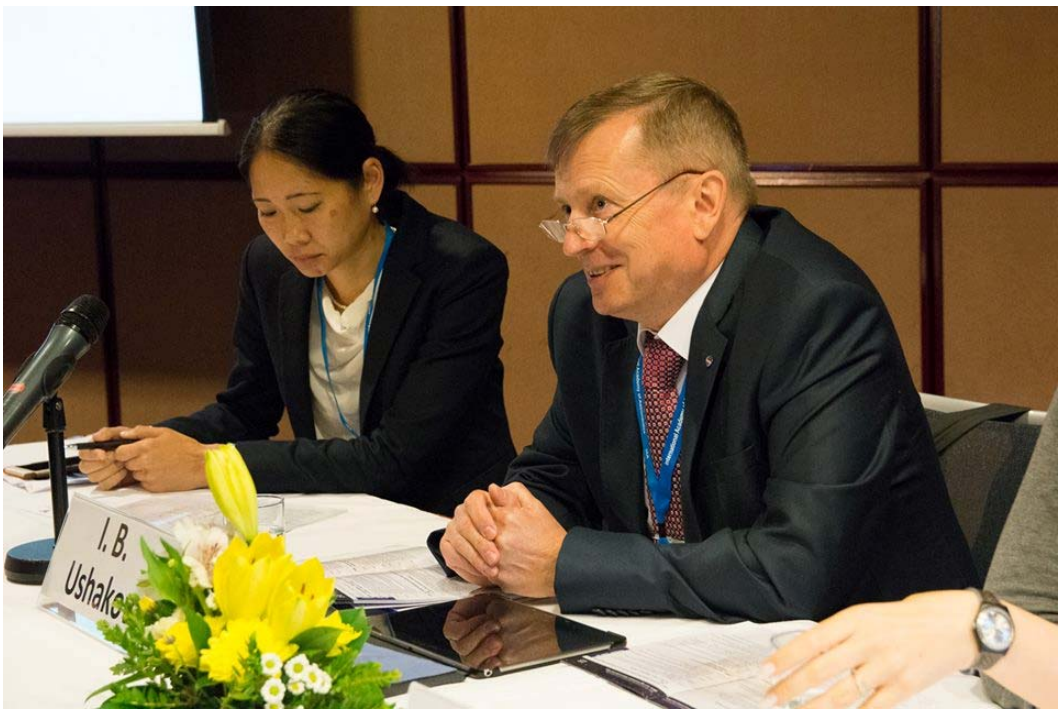
J. Kolar, O.Orlov, M.Vaclavik, D.Komissarova

Category	Number
Participants	214
Countries	24
Reports	141
Posters	33

In 2015 more than 210 specialists from 24 countries participated in the Symposium. The scientific program of the Symposium consisted of 4 Plenary sessions, which were devoted to the most significant problems of manned space flights and 17 regular sessions focused on precise topics.

Symposium was opened by Head of Czech Space Agency Dr. Jan Kolar, Director of DLR Rupert Gerzer, Head of Microgravity Researches and Life Sciences Department of DLR Peter Graef and Astronaut Reinhold Ewald.

The first Plenary Session was devoted to state of art of life sciences in space. The co-chairs of the session were Dr. Ngo-Ahn and Dr. Ushakov. During the session there were made 5 reports from representative of Mexican Space Agency, DLR, Chinese Academy of Sciences, Romanian Space Agency and ESA, who made an overview of recent main direction of work of the Agencies.



The second Plenary Session provided an overview on how analog environments are used and the analog research being conducted in the long term programs of NASA, JAXA, and ESA. For ESA, Dr. Jennifer Ngo-Anh described all analog platforms, which were successfully used in the ESA Life and Physical Sciences Program. Dr. Go Suzuki gave an overview on the JAXA activities in isolation and confinement studies since the early 90s. Rupert Gerzer presented some details on the Envihab facility at DLR Cologne as well as the view of the International Academy of Astronautics on international cooperation to prepare for human exploration. Dr. Barbara Corbin described the international coordination efforts to provide multilateral research opportunities for the international science community. Dr. Roni Cromwell presented NASA's current research plan and the possibilities for involvement of international partners in the future ground analog research missions. Dr. Lauren Leveton underlined the importance of isolation and analog studies to reduce the risks for behavioral health in human exploration type missions.

The third Plenary Session was led by Dr. Kozlovskaya and Dr. W. Paloski. Difficulties, which cosmonauts will face in future flights to far space, were considered during the session. Dr. Paloski told about NASA system of evaluation of possible risks of future space flights as well as of the most significant risks. Dr. J. Charles introduced to the participants information about Multilateral Human Research Panel coordination of international researches, connected with evaluation of risks. Dr. Gushin presented a report about psychological selection and support of long-term flight crew, using the data obtained from “Mars-500” project.

There were four papers presented at the fourth Plenary Session. This session was put into the symposium program for necessity to include discussion on the growing interest in spaceflight of people outside astronaut profession. The spectrum of the four presentations was very wide. Two papers covered topics of existing two approaches to preparation for spaceflight: one of tourist for orbital flight staying on the ISS, the second one of process of preparation for commercial suborbital flight. While the first one includes several months long medical screening in hospital and training facilities in Moscow, the other include familiarization performances on ground in jet plane and in centrifuge. Another presentation described proposed ground pre-flight therapy for minimizing motion sickness in flight for space tourists. The fourth topic was more technical as

presented design of passenger seat for future commercial plane connecting two distant sites on ground following suborbital trajectory. The session was attended by 60 people. Questions were addressed to speakers after each presentation.
Session 1A1was devoted to recent physiological highlights from the International Space Station (ISS) and was chaired by Professors Peter Norsk, Inessa Kozlovskaya and Millard Reschke.

Professor Reschke presented the first paper of the session entitled “Initial Sensorimotor and Cardiovascular Data Acquired from Soyuz Landings: Establishing Functional Performance Recovery Time Constant”. This presentation covered the initial data from a joint investigation, known as the ‘Field Test’ between NASA Human Research Program and the Russian Institute for Biomedical Problems (IBMP). Reschke also presented a paper entitled: “NASA’s Functional Task Test: Providing Information for an Integrated Countermeasure System” for Professor Jacob Bloomberg who was unable to attend the conference. This investigation has clearly shown that both spaceflight and bed rest data point to the importance of supplementing inflight exercise countermeasures with balance and sensorimotor adaptability training. Bloomberg’s paper was followed by a presentation on the importance of cardiovascular countermeasures entitled “The NASA-Russian Pilot Field Test: Preliminary orthostatic tolerance data” presented by Professor Mike Stinger in the place of Dr. Laurie who was unable to attend the conference. These are the first stand-test data to be collected in long-duration crewmembers during the first 24 hours of re-adaptation to gravity on Earth. The final presentation of this session was given by Professor Inessa Kozlovskaya and was entitled “Organization Of Cortical Response To Stimulation Of The Soles Support Zones In Cosmonauts After Long Term Flights And Healthy Volunteers.” This very interesting presentation investigated the cortical topography of mechanical stimulation of

the support zones of the soles in cosmonauts pre- and post- long-duration space flight compared with that obtained from healthy volunteers.

One of the most interesting sessions was dedicated to space life science study in tz-1. TZ-1 is the first Chinese cargo ship which will fly for almost one year. Prof. Peng Shang introduced preliminary study on bone cell experiments implemented in TZ-1 cargo vehicle mission to investigate the influences of microgravity on bone cell activity, morphology and cytoskeleton rearrangement. Prof. Kee from Tsinghua told about the effect of microgravity on in vitro differentiation of human embryonic stem cells into germ cells. PhD candidate Qian Cao focused on the effect and mechanism of 3-hydroxybutyrate against osteoporosis under simulated microgravity. The above mentioned three speakers are representatives of the TZ-1 science research team, and more scientific issues will be illustrated in this space flight.

During Session 1B2 problems of artificial gravity were discussed. Dr. Tajino presented the results of a study showing that 1.5 G generated by centrifugation for about 1 hour per day for two weeks was an effective countermeasure for mitigating gait alteration in rats after a two-week tail suspension. Dr. Stahn showed a new technique for measuring bioimpedance in body segments. This method is promising for measuring local fluid shifts during centrifugation, bed rest, and spaceflight. Dr. Clement gave an overview of the plans for artificial gravity research at NASA, utilizing both ground-based analogs and flight facilities, and announced an upcoming NASA research solicitation in this area. On behalf of Dr. Carroll, Dr. Charles presented the rationale, design and research applications for a rotating orbital research facility generating gravity levels of 0.06 g, 0.16g, 0.38 g in crewed habitats placed at various distances from the axis of rotation.

On the second day of the Symposium Session 2A1 “Cardiovascular and pulmonary” took place. This session was attended by up to 50 scientists. The first presentation by Dr. Hughson described new data from the BP Reg study of 9 astronauts on the ISS. The data showed that cardiac output measured by rebreathing using the Pulmonary Function System increased from pre-flight to inflight, but that another estimate of cardiac output from the finger arterial pressure device did not increase with spaceflight. The second talk from Dr. Baevsky’s group was presented by Ms. Isaeva. The data collected from 25 cosmonauts using the Pneumocard system to measure heart rate variability revealed important between individual differences that could be beneficial in monitoring changes in cardiovascular health and providing input to appropriate countermeasures. The third presentation by Dr. Nordine described the cardiovascular responses during separate or combined challenges of hypoxia and/or lower body negative pressure. The fourth presentation by Dr. Popova provided data from the ground study that is the precursor to a new ISS experiment that is examining the effect of negative inspiratory pressure on fluid shifts and cardiovascular responses. The fifth presentation by Dr. Sgambati described a new technology designed to monitor vascular health through a simple non-invasive device. The final presentation by Dr. Arbeille reported on data from the Vessel Imaging study. Key observations were of increased thickness of the inner lining of the artery wall, an observation that coincides with development of atherosclerosis in the general population. The significance of these results for future health of astronauts remains to be determined.

Session 2B1 was called “Approaches to crew performance analysis in space simulations”. Co-Chairs of the Session were Iva Solcova and Go Suzuki. Dr. Go Suzuki presented JAXA isolation chamber located in the Astronaut Training Facility (ATF) building at the Tsukuba Space Center. Module is designed to accommodate eight crew members for a long period of time (up to six months). The new vigilance monitoring system has been developed from 2013 to 2015. Dr. Ruilin Wu presented interaction of crew in Lunar Place 1, which is an analogue experiment conducted in Beijing on last year. He showed some ethnological analysis results and its relationship with psychological data. Dr. Igor A. Nichiporuk presented bedrest studies made by IMBP RAS. His paper was focused on gender divergence during long-term space flights. The complex of men’s and women’s manifestations can be characterized as “the syndrome of a partial asocialization” in an extreme environment. Dr. Albert P. Nechaev presented how the spaceflight conditions influences functional state and work capacity of crew. During 350 weeks of MIR station flight 294 crewmembers errors were registered. On behalf Irene L. Schlacht, Dr. Marlies Arnhof presented impact of long-term isolation on human creativity. Crew members may suffer from loss of motivation, depression, and insomnia. Creative and cultural expressions have a positive effect as an isolation countermeasure and to train mental skills. Dr. Bea Ehmann presented psychological content analysis is for the study of psychological states and processes of individuals and groups.

2B2 “Neuroscience” session was co-chaired by Dr. Gilles Clement and Dr. Lazlo Balas. Dr. Bock presented the results of an experiment investigating the movement of a joystick towards the direction of perceived “down” in subjects tilted relative to gravity. Dr. Clement presented the results of two experiments performed during 18 Expeditions on the ISS dealing with perception of the 3D environment by astronauts in orbit. His results indicate that distances are underestimated and that gravity is used for interpreting perspective depth cues. Dr. Stahn showed that electro-cortical activity is decreased by 25% in subjects partially immersed in water. The obtained results raise interesting questions on the redistribution of fluids and the central regulation of cardiovascular responses induced by various gravity levels. Dr. Wuyts presented

preliminary data on brain imagery in two cosmonauts after spaceflight and volunteers after parabolic flight. He notably reported changes in the activity of the vestibular cortex and in the overall volume of the brain after spaceflight. Mr. Takacs presented the results of an experiment performed on board the ISS where event-related potentials were recorded during spatial orientation or object recognition tasks. His results show adaptive changes in the temporal and amplitude pattern of EEG responses in orbit.

Session 2B3 was a continuation of the Session 2B2 and was also dedicated to neuroscience problems. The session started out with a talk by Prof. Balazs, who presented his most recent findings from the effects of long-duration spaceflight on perceptions of directions and its neurophysiological correlates. His data indicated a clear increase in reaction times during various tasks, requiring visuo-spatial orientation, which slowely recovered after R+7. These data were supported by event-related potentials obtained from high-density EEG recordings and it was suggested that the decrease electrocortical activity might be explained by diminished activation of the dopaminergic system due to fatigue, sleep loss and/or cognitive overload during long-duration space missions. The next report was presented by Prof. Limoli on radiation exposure and neuroplasticity. In serious of very elegantly designed studies Prof. Limoli demonstrated that neuroplasticity, indicated by structural brain changes, and cognitive performance are severely affected after radiation exposure in animals. In fact, it was shown that the behavioral deficits could be attributed to structural changes such as reduced spin density in various regions of the brain. The final talk was given by Prof. Cotuk, who presented an integrative approach for assessing the ANS. It was suggested that combining four distinct biosignals, i.e. heart rate variability obtained via ECG, electrodermal activity, facial skin vasomotor determined via plethysmography at the forehead, and respiration could improve the assessment of the ANS. Finally, it was proposed that some of these signals might even be assessed without any sensors using infrared thermography in future studies.

Sessions 2C1 and 2C2 were devoted to space technology and habitats. Due to missing of some speakers who had to make a report on the first part (2C1), the Sessions were combined into one.

The session starts with the presentation of Dr. Hohenender, who gave an overview about the current development status of the EU-funded SHEE-Testbed study. The design study and later manufacturing of this movable and foldable Habitat is in a long row of such studies. Dr. D. Chaput from CNES, France, gave a very interesting presentation about telemedicine device remotely controlled and already tested even by satellite transmission. Dr. Schwartz told about the national funded DLR experiments abroad the ISS during the Alexander Gers Blue Dot Mission. Dr. Ferrino from TAS-I reported about 3D visual instrumentation development for crew training purposes. Dr. Li Chunang gave a technical presentation about the Chinese test facility KM6H normally built to test Zhengzhou spaceflight's (thermal-vacuum test) however now being remodeled as a test bed for habitation.

One of the very interesting sessions of the Symposium was Psychology session. It was dedicated to "Mars-500" project. The most outstanding interest of the participants was drawn to the repost of Dr. Stuchlikova, about changing of motivation of the participants in long-term isolation and periods of disappointment caused by impossibility of goal reaching. The report of Dr. Vinokhodova also was very interesting. It was devoted to the dynamics of group cohesion in autonomous conditions during simulated interplanetary flight. Recently published joint Russian-Czech monography about main physiological results of "Mars-500" mission was presented during the Session.

Main Topics of the Sessions 3C1 and 3C2 "Challenges of Future Spaceflights" were the following:

- Main biomedical human risks for human missions to Mars and the Moon
- Human risk mitigation and related research (ISS and analogues)
- 1Y ISS mission and NASA Twins genetics' study
- Mission architecture and main (human) challenges
- Human/system interaction
- Crew selection and (new) advanced training approaches
- New capabilities for diagnostics based on ultrasound and genetic analysis
- International cooperation aspects

The session provided a clear overview on the high quality of research objectives definition and accomplishments in highly technical areas. It also shows the high level of integration among the topic areas for the benefits of not only risk reduction in Human Spaceflight and to the benefit of life on Earth. Simultaneously also clear evidence was provided about the common Human Exploration ambitions for which the joint international efforts are the means to succeed.

In addition to the main sessions, where oral reports were presented, there was organized a poster session. The posters were setting up in a special hall during the whole Symposium.

In the end on July 3 international jury represented by M. Zell, J. Kolar, F. Zhuang, P. Graef, P. Norsk, I. Kozlovskaya and M. Braun chose three best posters. The winners were Mrs. Shigueva, presented a work about the influence of support and weight unloading on the characteristics of spinal reflex, Ms. Belova with a report about influence of IMD-0354, NP-kapaB-signaling blocker, on the E3-ligases expression in rat soleus during gravitational unloading, and Mr. N. Bury, made a poster report about spatial orientation of titles subjects depends on requires response type.

During the closing ceremony Dr. J. Kolar, Dr. R. Gerzer, P. Graef, Dr. Fomina, Dr. Fengyuan Zhuang and Dr. Yulin Deng summarized preliminary results of the Symposium and thanked all participants and organizers for their input.


D
DOOSAN