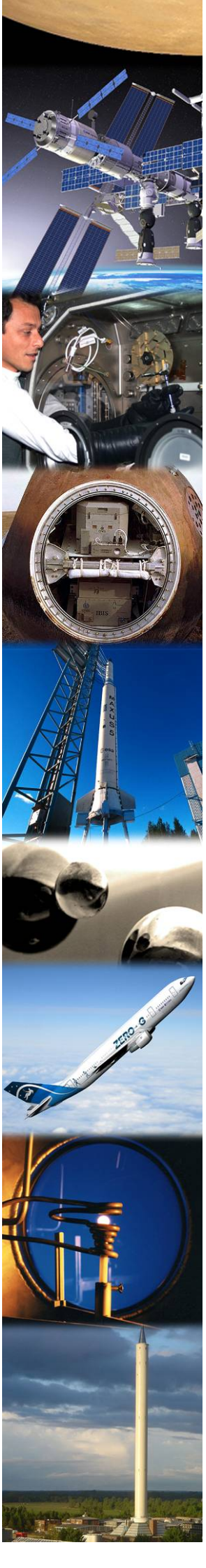
Human Spaceflight, Microgravity and Exploration

NEWS

JUNE 2007



Compiled by HME Science and Applications Division

The S&A Division of the Directorate of Human Spaceflight, Microgravity and Exploration releases a Newsletter on highlights of the month. Clicking on one of the headlines below will take you to the relevant topic.

Short updates

Physical Sciences

IMPRESS IN KRAKOW – SHOWCASING INTEGRATED PROJECTS' QUALITIES

Life Sciences

BED REST STUDIES I – FINDING COUNTERMEASURES AGAINST ADVERSE EFFECTS OF WEIGHTLESSNESS

ORTHOSTATIC INTOLERANCE – OUT OF BED OR BACK FROM SPACE – STANDING UP CREATES PROBLEMS

Life and Physical Sciences

MICROGRAVITY SCIENCE GLOVEBOX ON ISS – LEAK TESTS ONGOING TO ENSURE A SAFE ATMOSPHERE

ISS IN JUNE 2007 - ESA SCIENCE PERFORMANCE ONBOARD

Publications announced in June & July 2007

1. Belavy, Daniel L.: SIMULATED MICROGRAVITY AND THE LUMBO-PELVIC MUSCULATURE: DEVELOPMENT AND APPLICATION OF NOVEL ANALYSIS TECHNIQUES AND IMPLICATIONS FOR LUMBO-PELVIC PAIN ÆTIOLOGY. PhD Thesis accepted 5th April 2007

2. Gabrielsen, Anders and P. Norsk: EFFECTS OF SPACEFLIGHT ON THE SUBCUTANEOUS VENO ARTERIOLAR REFLEX IN HUMAN LOWER LEG. IN PRESS. Scientific publication

3. Rittweger, Jörn, Felsenberg, D., Maganaris, C., Ferretti, J. L.,: VERTICAL JUMP PERFORMANCE AFTER 90 DAYS BED REST WITH AND WITHOUT FLYWHEEL RESISTIVE EXERCISE, INCLUDING A 180 DAYS FOLLOW-UP. J Appl Physiol. Eur J Appl Physiol, Accepted for publication 2007 Mar 08; Scientific publication

Access earlier Newsletters here

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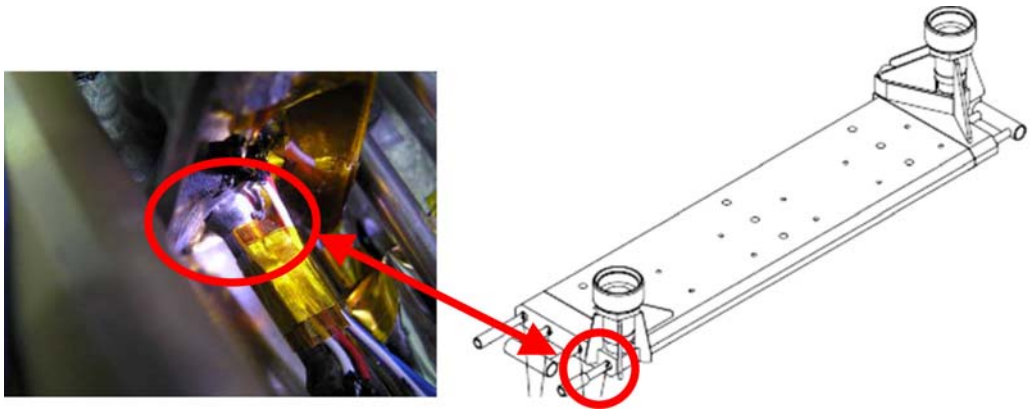
Short updates on earlier events…

THE TEPLO PROBLEM FOR FOTON M3:

We reported last month that a leak and a crack was identified in the heat pipe experiment hardware. Immediate initiatives at the Payload Interface Testing site in Samara were taken to resolve this serious problem.



The essence of the trouble was the fundamental problem of getting steel and aluminium to form a pressure and airtight connection. A normal welding partly melts the material enough to form an even, joined connection. In order to make these two metals join, however, one has to implement a so-called soft brazing step, which involves placing of nickel plating on the surfaces, which then in effect forms the connection – a bit like a 'glue' between the two rather incompatible materials. This is a delicate process that can easily go wrong, as it apparently did in the first time around.

The equipment has been inspected again, and the crack has been mended with a sealant, normally used for sealing airplane fuel tanks, a material with an impressive resistance to aircraft fuels.

After the repair, the experiment hardware has been pressure-tested to 1.5 times the maximum design pressure and the following helium leak test indicated no remaining leak. The repair was successful.
As the equipment has now been manipulated, compared to the situation before the obligatory vibration test, it has to be vibration-tested again. In order to ensure that this repeated vibration in turn did not create new damages or re-opened the mended leak, a new leak test as the one described has been performed.
This final leak test was successful, the equipment is considered re-certified for flight and can in principle continue its way to space.

A particular critical aspect of this hardware leak is the fact that its cooling comes out of the connection to the cooling system of the aircraft (the FOTON capsule cooling system, based on kerosene). Thus, a leak in the TEPLO hardware would mean that cooling capacity of the entire payload would be endangered with the potential of a complete mission failure.

The Final approval for flight of the experiment hardware has now been granted by the FOTON M3 Coordination Board, who met on July 3 and 4.

Mission accomplished so far!

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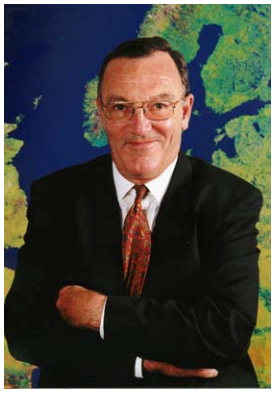
IMPRESS in Krakow – Showcasing Integrated Projects' qualities



Jörg Feustel-Büechl, former ESA Director of Human Spaceflight and Microgravity.

In July, Krakow was host to the annual meeting of IMPRESS, the ESA-led project investigating the potential of new intermetallics in the world energy industry. Marc Heppener took the chance to talk to Jörg Feustel-Büechl, former ESA Director of Human Spaceflight and Microgravity, about the project.

You signed the contract with the EC for realisation of the IMPRESS project whilst you were the Director of Human Spaceflight and Microgravity for ESA. What were the particular qualities that you saw in the project?

The main factors were the development of open co-operation with the EU beyond the Galileo and SMES projects but also in technology development and FP7 [Framework Programme 7]. Integrated Projects are a new venture for the EU. It is also helpful for ESA to bring together all the interested parties into a single project. An additional benefit, and a challenge for ESA, is to develop terrestrial applications and ground-based research, both of which ESA should be doing more of.

Since you are now an advisor to the IMPRESS project how do you view it? Is it important for the relations between the European Commission and ESA?

I would like to emphasise what I said in the meeting. For me it is not only a project that delivers a product, but it also has the chance to demonstrate that Integrated Projects work, which is essential for the EC. It also shows that ESA can make an important contribution to terrestrial product development.

If you look at it from your previous industrial perspective, how do you judge the current structure of the project team compared to more traditional ways of setting up this kind of pre-competitive R&D project?

If I reflect on the many criticisms which I have heard about doing technology development in Europe, many of the criticisms are actually related to the lack of interdisciplinary co-operation. Not only interdisciplinarity, but also to bringing research and industry development together in order to cluster the know how, to assure that knowledge transfer is done properly and that people are working together effectively. IMPRESS for me is a showcase for such an undertaking because it has a very broad material science basis and it has also a solid industrial base.

Would you be able to judge the likelihood of success, given the team composition in the areas that we are focussing on right now, in turbine blades production and in the catalyst industry?

It's difficult to come to a final judgement but we are in the mid-term of the project and so far everything which was intended to be done by now has been delivered and implemented. In so far as one can extrapolate forward, the project is going very well. Of course at the halfway point you cannot say what will happen at the end but if the spirit of co-operation continues, as it has in the project, I am quite confident it will conclude well.

Of course one must not underestimate the difficulty of the undertaking. To introduce a new material in turbo-machinery and to make a significant contribution to fuel cells is an ambitious goal, which has a certain amount of risk. The risks are maybe not so much in the achieving of the results in this project but rather in the industrial implementation of products later on. As we know, research takes a long time and takes a fair amount of money but the industrial implementation goes very fast and costs an enormous amount of money. So far, for this project I'm very optimistic but one has to see how it works out in terms of industrial implementation. But I hope that with Rolls-Royce as one of the primary turbo aero-engine manufacturers in the world and Hydrocell in the fuel cell arena we have two good representatives that are able to translate the research results into practical products.

You know that it is not very obvious for ESA and the European Commission to work together. There have been difficulties in the past. Do you think that IMPRESS could help as a showcase there to improve how we should work together in the future?

I am sure that it can help to overcome some of the difficulties in co-operation. At least in IMPRESS you do not have to fight over which rules are applicable. In this case it is clear that you are a supplier to the Commission and I think there is a clear set-up in terms of rules and organisation. I also think that this project can be an example of how to carry out co-operation in the field of R&D.

We discussed earlier how IMPRESS came out of the Topical Team/MAP initiatives that ESA started, all of which have a European dimension. Do you think that this is something that would help European competitiveness?

The fact that we have these Topical Teams means we now have groups of experts centred around specific subjects. Also with the MAPs [microgravity application projects] we have already groups of researchers and developers looking into specific items. It is certainly a very positive element.

What is a bit regrettable in IMPRESS is that the opportunity to use the International Space Station has unfortunately been delayed. It means that the Columbus experimental facility only becomes available when the majority of this project will be ending. So one has to live with sounding rockets and parabolic flight campaigns for a while. Though it would have been very nice to use the material science facilities onboard Columbus for supporting this project, this is as it is and one cannot change it. I think it is nevertheless very remarkable how this project overcame this deficiency.

My last question. You are very much aware of the investments that we have put into the MAPs and also this particular project. Do you think that these are justified investments and that this is the type of money that we as an agency should be using?

Absolutely - because space products are the bread and butter business of the Agency, and ESA is primarily paid to develop launchers, satellites and in orbit infrastructure. To couple these to terrestrial initiatives and products is a very noble additional goal for the agency and IMPRESS, as I have already said, is a showcase of how to do it. If it succeeds it shows, once again, that space is really something for the people on Earth that helps in our daily life and not just a very exotic and esoteric undertaking. If airplanes can be economically and ecologically better because of space support and fuel cells can come into our cars and houses and save energy, that is one of the most noble initiatives you can imagine. In conclusion, I think ESA is called on to do its best to diversify know how and development so that space is making its contribution, for life on Earth, and that IMPRESS is a very good demonstration case.

Interview by Marc Heppener,
4th July, 2007, Krakow,
Poland

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Bed Rest studies – finding countermeasures against adverse effects of weightlessness

Image : ESA/Vista S.T.I.

What bed rest has to do with humans in space is not evident to the non-involved. Astronauts living in space show no external signs of problems, apart from difficulties when they return to normal gravity and have to stand and walk. When one takes a closer look, the human body demonstrates strong adaptational signs, some benign but some others less trivial. Bed rest studies are crucial in finding ways to explain the mechanisms, and to design countermeasures. In addition, bed rest studies provide essential knowledge for earth-bound clinical practice.

Recently a group of specialist scientists and science administrators sat down to throw their energy into writing a review of findings from bed rest studies performed by ESA and NASA. The main goal was to thoroughly describe what bed rest studies actually tell us.

The resulting publication will be called 'Bed-Rest Studies in the Spaceflight Era (1986-2005). This work is to be seen as an important concluding review of what we have learned during the years, by performing a considerable number of bed rest studies.

Data from these studies are normally being published in 'narrow scientific slices', so to speak, not leaving much possibility for creating the overall picture in a conclusive manner, of the effects of such load-reduced studies,. This review should change that and is expected to become the 'Bed Rest Guidelines' for the 'facts and findings' and for the 'do's and don'ts.

The title of the publication indicates that bed rest studies have been used earlier than the time frame indicated. In medicine the application of (bed)rest is well known to all; what is probably less well known is the deleterious effect it also has, and that is what in particular can be learned from these highly standardised and controlled longer term bed rest studies.

The essential values of such studies are - in a condensed form - the following:

- Aboard an orbiting spacecraft the Earth's gravitational forces cannot influence the human body in the normal manner. The effect is that the body must adapt to this relative 'force-vacuum' while still maintaining 'physiological parameters' within limits. Bed rest studies simulate this situation by changing the g-vector direction from being vertical to now be cross-sectional to the body – thus vertical loading essentially disappears,
- physiological stimuli similar to being in space influence the body: Blood return to the right heart from the periphery is more plentiful, fluid abundance in regions above the heart increases, blood is not pulled into the exercising legs when beginning to exercise, and overall the body's important fluid handling is perturbed.
- Loading regimes (of muscles and bones) are practically nullified, or at least sharply reduced in the horizontal position in bed, and
- The need to have the balance system (inner ear organ – muscle action – joint position – visual input integration) alerted at all times disappears in the relative 2-dimensional reality of being a bed ridden person.

So what do we learn form these studies and are they still important to perform?

As an effect of the above factors, adaptation to the new situation takes place, as the body is exposed to the weightless Space environment. We observe disuse symptoms (in muscle and bone and in the circulatory parameters). This also takes place in all bed ridden patients, although with a certain attenuation compared to the Space condition.

In a bed rest setting, these appearances give us the opportunity to experiment with methods that potentially would counteract the changes. This is what bed rest studies are about and in that process the central focus is on understanding the basic mechanisms that underlie the negative effects. And here the clinical aspect comes in: By understanding the mechanisms we can develop approaches to alleviate the negative effect of being in a relative 'un-loaded' situation on the Earth for a longer period of time. Back to top

A new "Five Year Strategy for Bed-Rest Studies in Europe" was defined by ESA in April 2005. Now the first batch of experiments, 26 in total, has been selected for a definition phase.

Future articles on the Bed Rest model will go more in depth describing specifics of the problems they are addressing. Read about ESA's first Long Term Bed Rest study for males here.

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Orthostatic intolerance – out of bed or back from Space – standing up creates problems

ESA astronaut Roberto Vittori landing following the Eneide mission to the ISS

AT THE FRANZ VOLHARD CLINICAL RRESEARCH CENTRE AT THE CHARITÉ IN BERLIN, SCIENTISTS ARE PURSUING A PARTICULARLY INTERESTING LEAD. IN THE SEARCH FOR REASONS AND ALSO FOR 'FIXES' OF THE PROBLEM EXPERIENCED BY A LARGE NUMBER OF ASTRONAUTS AND LONG TERM BED RIDDEN PERSONS, NAMELY MAINTAINING A SUFFICIENT BLOOD PRESSURE IN THE STANDING POSTION, THE BERLIN GROUP HAS A LEAD. THE ACTIVITY FALLS UNDER ESA'S HME SCIENCE GROUND BASED ACTIVITIES.

Merely by accident a person, and with her several of her family members were identified to have a very rare genetic variation, that results in a reaction pattern resembling that of astronauts returning from space, when they are asked to remain in the passive standing position for a number of minutes.

This 'stand test' is performed upon return from most Shuttle missions to characterise to which extent the circulation is now again able to counteract gravity by maintaining the central blood pressure at a level, so that the heart pump has something to pump with. As the blood pressure eventually falls, as it will in those where the circulatory reflexes function less good in this state, compensation is sought by an automatic increase in heart rate, and eventual fainting if the blood pressure is not brought back up to normal level.

The constriction in vessels below heart level normally ensures that only an appropriate, low amount of blood is pooled in these regions, whilst the main volume is sent back up to maintain normal circulation and above all the crucial central blood pressure. This constriction is mediated via interaction between nerve endings and the 'effector' – the musculature in the vessel walls – by means of 'neurotransmitter' – Norepinephrine - which acts on the cell wall of the muscles cells to make them contract. Just to vanish again when the task is accomplished, to be taken up into the nerve ending again, helped by the Norepinephrine Transporter (NET) protein.

The genetic deviation mentioned – a so-called functional polymorphism, which relates to a variation on a specific genetic location – meant that that person didn't have the NET factor, for which reason the normally so effective constriction could not be brought about. She demonstrated functional characteristics very similar to those seen in returning astronauts.

This serendipitous finding has been used now in experiments where the NET factor is being blocked pharmacologically in 23 test subjects undergoing enhanced gravity loading by use of a human centrifuge at DLR, Cologne, Germany.

Experiments related to space conditions and, simulations thereof, have over the years become extremely sophisticated, in the way that our knowledge regarding what influences e.g. cardiovascular status-quo in different g-loading situations and directions. As an effect, we now know that unless the salt content of the body is stabilised for a few days prior to loading experiments, those same experiments will not give clear and unbiased results. Thus, the 23 persons underwent such a stabilisation period before entering the centrifuge experiments, with loading steps between 1.5 and 3.0 G, in steps of 3 minutes per step.

The experiments show that the normal blood pressure response to the centrifuge loading and different exercise situations, could not be achieved with NET blocked, and during the stand test, the pattern described above, namely a dip in blood pressure followed by a significant increase in compensatory heart rate was seen.

With the obtained results, absence of the NET factor is now well described in terms of physiological appearance, and is an important brick in the puzzle around the still unsolved orthostatic intolerance problem that astronauts and certain patient groups experience.

Publication: Orthostatic intolerance and tachycardia associated with norepinephrine-transporter deficiency. Shannon JR, Flattem NL, Jordan J, Jacob G, Black BK, Biaggioni I, Blakely RD, Robertson D. (Experiment no. ESA-RA-LS-01-PREP/GB-002.)

Contact Jens Jordan and Christoph Schoeder here.

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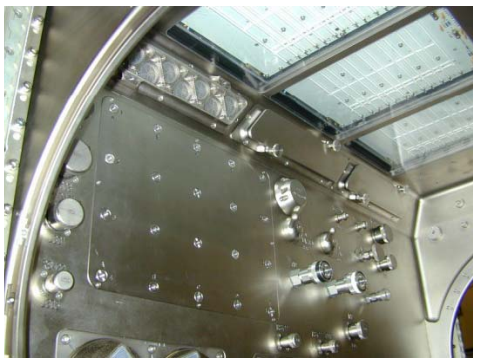
Microgravity Science Glovebox on ISS – leak tests ongoing to ensure a safe atmosphere



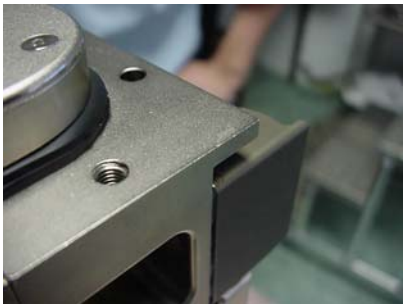
MSG two of three Flapper Bank Covers

SINCE ITS LAUNCH IN 2002, THE MICROGRAVITY SCIENCE GLOVEBOX IS BEING RE-CERTIFIED ONCE A YEAR TO ENSURE THAT IT MAINTAINS THE CRITICAL PERFORMANCE IN KEEPING HAZARDOUS GASEOUS MATERIAL FROM ENDING UP IN THE ISS ATMOSPHERE. THE LAST CERTIFICATE WAS ISSUED ON 6 JUNE 2006. TO MAINTAIN THE REQUIRED PERFORMANCE, ALL ORIGINAL SEALS HAVE BEEN REPLACED IN 2005. THE LATEST INFORMATION FROM THE ONGOING TEST ACTIVITIES REVEALS THAT THE LEAK- TESTING FACES SOME PROBLEMS, BUT THE ENGINEERING TEAM TOGETHER WITH THE CREW IS NEARING A SOLUTION.

The test activities performed as teamwork between the on-board crew, the responsible NASA managers, ESA management, Astrium-FH and the European manufacturer, Bradford Engineering, who guide the technical process with crucial expertise – is an excellent example of how collaboration is performed across Agency and national borders.

To maintain the required performance, all original seals of the Norsorex-type[1] in the system have been replaced with EPDM[2] filters in 2005. The production of Norsorex had been discontinued by the manufacturer and spares were out of shelf-life, for which reason EPDM filters are now applied.

The MSG, supposed to isolate its 250 litre working volume from the environment, has numerous apertures – some as 'intended leaks', some others supposed to be airtight - fitted with either filters and feed-throughs for cables etc. Thus, at the top-side aspect of the MSG three so-called flapper banks are located, which allow air to pass into the glovebox, whilst the air is evacuated out of the MSG by active electrical fans that suck it through a set of 3 complementary filter layers – a particle filter, a charcoal filter and a catalyst - stopping and absorbing hazardous compounds.



Corner of the snap-in seal of the airlock lid

Before a leak test can start, all these apertures need to be made airtight. The flapper banks (three units) can be closed off and sealed airtight by means of individual lids, each covering a set of apertures. The filter apertures (twelve of them) can be closed off by dedicated covers as well. In addition to these main apertures, cables (there are 3) are fed through the wall into the working volume, and finally, the airlock top-door, for introducing items and material to be processed in the MSG into the working glovebox, is supposed to form a leak-free barrier when closed and locked. This airlock top-lid is a large opening into the working volume, with a large square door forming a part of the bottom of the MSG, at the same time as it is the top of the airlock underneath.

In the first leak test performed, the closed-off flapper banks were assumed to be a part of the cause of the leak registered, but in addition during the second leak test, a non-leak-tight feed-through connector was identified, such that presumably more than one leak source was the cause for the failing leak test.

Now after the third test, the required leak tightness is maintained, but only for half of the required 30 minutes. The remaining leak is however miniscule.

[1] Norsorex filters: A polynorbomene polymer
[2] EPDM filters: Ethylene propylene diene monomer rubber – an elastomer

The 'rules' for these leak tests define a very demanding regime. The test basically starts out with the hypothetical case that the fans are not running, for which reasons the compounds, that cannot be dumped into the atmosphere, are not sucked through and removed by the filters. There should therefore be no leaking out of the glovebox in that situation. When the fans are running, this is much less of a problem in principle as the filters absorb the nasty material.
The test demands - that at an pressure level of -5 mbar in the MSG relative to the outside, the negative pressure does not go higher than -3.75, thus a change of not more than 1.25 mbar over the following 30 minutes – is a fairly demanding requirement but it nevertheless has been fulfilled in all delivered MSG models. Tested on the manufacturer's premises, these devices have a pressure change from the -5 mbar over a period of 30 minutes of 0.75 mbar at the most, so these are very tight systems, despite of the large 250 litres working volume and numerous openings.

Airlock (right square compartment w. circular hand access) under the MSG, which has a snap-in type of seal, so that area has been the focus of the third leak test.

Looking at readings from MSG pressure sensors against the external (cabin) parameters led to the suspicion, that there may be a remaining leak around the large air lock lid, which has a snap-in type of seal, so that area will be the focus for hopefully the last leak test leading to re-certification of the MSG.

Eliminating this leak source improved significantly but did leave a minimal source to be found.

Visit the GTC here.

Contact and information: ewald.kufner@esa.int

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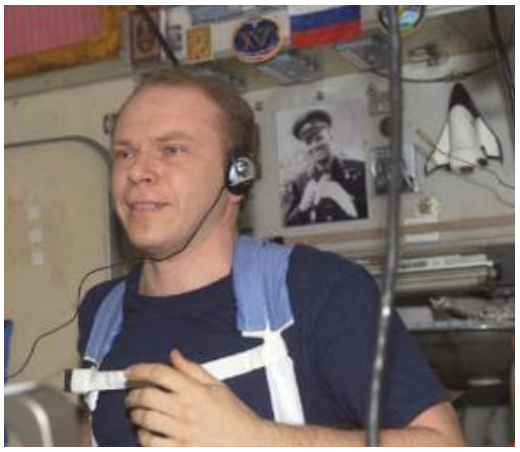
Onboard ISS in June 2007 - ESA Science Performance



NASA ASTRONAUT FLIGHT ENGINEER CLAYTON C. ANDERSON REPLACED NASA ASTRONAUT SUNNITA WILLIAMS, AFTER HER RECORD-BREAKING STAY IN SPACE FOR WOMEN. ANDERSON WILL RETURN TO EARTH ABOARD SPACE SHUTTLE DISCOVERY ON MISSION STS-120 IN OCTOBER.

Together with Cosmonaut Fyodor N. Yurchikhin, Expedition 15 commander, and Cosmonaut Oleg V. Kotov, Expedition 15 flight engineer, (keeping fit on the treadmill onboard the ISS, see picture), Anderson now forms the three-person ISS crew.

Atlantis landed safely with one day delay in California, due to poor weather conditions in Florida. Atlantis is now in preparation for its next flight, planned for December this year, transporting ESA's Columbus Module to the ISS.

ESA Science Activities in June:

The ongoing leak testing of the Microgravity Science Glovebox (MSG) is reported elsewhere in this newsletter.
The Russian members of the Increment 15 crew have now been onboard the ISS for around three months, whilst Anderson has passed his first month onboard.

The following ESA experiments can be reported on

- ALTCRISS (using the Italian ALTEINO equipment), the experiment for long term measurement of the radiation environment at different points inside the International Space Station (ISS) has been discontinued, due to a laptop failure and the dosimeters will be stowed and used again for future studies
- CARDIOCOG-2 studies the impact of microgravity on the cardiovascular system and the respiratory system. Kotov has performed another session of that experiment in the meantime. This investigation will examine the stress as well as the cognitive and physiological reactions of crew members during long-duration space missions.
- MATROSHKA-2: Kotov set up new hardware for this facility (MTR-2), now in the docking compartment, in preparation of the reactivation of the facility later this summer.
- IMMUNO: This experiment will soon have its next repeat. Blood and urine samples are given for analysis of the status of the immune system under space conditions. The experiment was planned to start in June but is now foreseen for a July session. The timing of the experiment during the 'stable' phase of the stay, e.g. where the crew has passed the first weeks of adaptation, is not critical.

Otherwise, the crew are busy maintaining the station, as well as performing the experiments that originate from the NASA of Russian side. These among others count:

- NUTRITION, a very comprehensive investigation of the effect of spaceflight and nutrition on metabolism. The areas looked into are bone metabolism, oxidative damage, nutritional assessments, and hormonal changes.
- Periodic Fitness Assessment consisting among others of oxygen uptake measurements by use of the ESA gas analysis system, The Pulmonary Function System (PFS), that resides in the NASA HRF-2 facility. In this area of activites, the Russian crew performed preventive sessions, Profilaktika, which are exercise countermeasure sessions.
- Plasma Kristal-3 Plus, or PK-3+ is a mainly Russian activity at this stage, observing the behaviour of homogeneous plasma in an experimental setup, as a simulation planetary formation. The follow-up facility, PK-4 is planned for a test onboard a Parabolic Flight in September this year.

- Crew Earth Observations, during which sessions high resolution pictures are taken of specific areas of the Earth, plus observation of the sea areas and general environmental observations.
- An experiment monitoring the effect of spaceflight on the heart's blood supply to the brain, and
- Some educational and communication sessions, partly teaching from Space, demonstrating and talking to young persons in school situations on Earth.

For additional information on ISS crew activities, visit this location

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Publications announced in the period of June and July, 2007

1. Belavy, Daniel L. SIMULATED MICROGRAVITY AND THE LUMBO-PELVIC MUSCULATURE: DEVELOPMENT AND APPLICATION OF NOVEL ANALYSIS TECHNIQUES AND IMPLICATIONS FOR LUMBO-PELVIC PAIN ÆTIOLOGY. School of IT and Electrical Engineering & School of Health and Rehabilitation Sciences. Brisbane, Australia: The University of Queensland. Thesis

Source material: The thesis is based on the Berlin Bed Rest study I, a MAP project supported by ESA Science & Application.

Overall Objective: To study the effects of a lack of weight-bearing (inactivity, unloading and/or sedentarism) on the lumbo-pelvic (LP – lower back and pelvis region). An investigation into underlying reasons for developing low back pain.

Specific Objectives:

1) To develop novel electromyographic quantification algorithms related to low back pain, and
2) To examine the effect of bed-rest on the LP musculature, specifically in terms of
    a. Muscle size (cross-sectional area)
    b. Tonic and phasic muscle contraction,
    c. Timing of muscle activity, and
    d. Activation levels and co-contraction patterns and appearances

Subjects: Of the twenty young men who underwent 8-weeks bed rest, ten received a vibration exercise countermeasure, whilst the remaining ten remained inactive for the entire period.

Test regime: Diverse leg exercise forms, of which some involved vibration superimposed on the exercise.

Results:

Observations:

1. a selective atrophy of the multifidus muscle was seen (this muscle considered essential in development of low back pain syndrome)
2. increased cross sectional area of the LP flexor muscles
3. a shift from tonic to phasic muscle contraction in the superficial LP muscles
4. a delay in LP muscles activation
5. superficial LP muscles over-activity
6. decreased co-contraction, and critically
7. that a number of the adverse changes persisted until the end of the 1-year follow-up period.

Effect of vibration exercise:

The Vibration exercise countermeasure applied in the study prevented an overwhelming number of the changes observed in the inactive subjects. However, whilst reducing the multifidus atrophy, it did not prevent it, and did not reduce lumbar erector spinae muscle atrophy.

2. Gabrielsen, Anders and P. Norsk: EFFECTS OF SPACEFLIGHT ON THE SUBCUTANEOUS VENOARTERIOLAR REFLEX IN HUMAN LOWER LEG. In Press. Scientific publication

Source material: Three recent International Space Station missions with a total of 8 astronaut test subjects

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General Objective: Local reflexes (a veno-arteriolar reflex) in the peripheral circulation under normal gravitational conditions ensures that blood is not pooled in the leg with a resulting fall in systemic blood pressure and fainting as a consequence. Whether these reflexes are impaired by long stays under low gravitational conditions onboard an orbiting spacecraft was investigated.

Test regime: Measurements of the skin blood flow by means of wash-out of a radioactive tracer from the skin area in question, as an expression of the amount of blood passing that cross section per unit time, were performed.

Results: Based on the findings in 8 subjects, the conclusion is that the reflex in question is unimpaired by lengthy stays under low gravitational conditions. The veno-arteriolar reflex appears intact, and therefore does not need everyday stimulus of gravity to maintain efficiency.

3. RITTWEGER, JÖRN, FELSENBERG, D., MAGANARIS, C., FERRETTI, J. L.,: VERTICAL JUMP PERFORMANCE AFTER 90 DAYS BED REST WITH AND WITHOUT FLYWHEEL RESISTIVE EXERCISE, INCLUDING A 180 DAYS FOLLOW-UP. J Appl Physiol. Eur J Appl Physiol, Accepted for publication 2007 Mar 08; Scientific publication

Source material: This paper is based on ESA's Long Term Bed Rest study on men, 2000-2001.

Objective: To study the effect of flywheel resistive exercise in conserving the jumping power and jumping height during 90 days bed rest.

Subjects: Eight subjects were assigned to the test group that trained regularly with the Flywheel Exerciser (resistive exercise). Sixteen subjects made up a control group that performed no exercise.

Test regime: After the bed rest period, a jump test was performed immediately after participants became ambulatory and over the following weeks.

Results: The control group demonstrated a higher degree of decay in the ability to produce jumping power and retain jumping height than did the group that had performed exercise. The exercise group had fully recovered their pre-study peak power level after 18 days. The control group needed 140 days for full recovery.

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