The Gravbed – artificial gravity for long-term missions

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With this experiment we have applied for the Student Parabolic Flight Campaign of the Esa.

The effects of long-term missions under micro-gravity conditions on the human body are quite enormous. Some of these effects can lead to severe medical problems such as osteoporosis, „Spider Legs and Puffy Face“, functional circulatory disorders, Space Adaptation Syndrome and a decreasing of the “baro-reflex”. Thus a number of different countermeasures are required to combat these negative effects. This proposed experiment will counter some of these effects by applying artificial gravity to the body of an individual crewmember during the sleeping period. Using the “wasted” time of sleep for this important countermeasure is the innovation of this project. The proposed method aims at countering negative effects of micro-gravity on the cardio-vasculaer system, heart, blood circuit and intestinal organs. Other effects such as bone or muscle degeneration cannot be counter to a use extent.

The artificial gravity used in this experiment will be created by rotation around one stable axis. As the rotation radius will be quite small, the rotational speed will have to be quite high in order to achieve a gravitational load of one G. Under these conditions the effects of the coriolis force on the human body seem to be a defining factor, possibly even a show stopper. Looking at the coriolis force more closely, it can be seen, that it only applies for test persons moving in a rotating environment. Thus we propose to fix the test person in such a way, that on the one hand minimizes the effects of coriolis force on the other is still comfortable. This parabolic flight campaign shall be used to investigate in detail the strength of the coriolis force and its effects on the human body, as well as the efficiency of the method as a countermeasure to micro-gravity effects.

This research activity is strongly intertwined with the activities of the Human Space Flight Group of the Institute of Astronautics (LRT) at Technische Universität München. A special focus of this group rests on the field of regeneration and sleep under extreme conditions, especially in micro-gravity. Dipl.-Ing. Thomas Dirlich, head of the Human Space Flight Group and our main tutor, has developed a sleep restraint system for micro-gravity in close cooperation with NASA in 1998-1999. The prototype of his “SpaceBed” was tested and proved its efficiency on a parabolic flight campaign with NASA in October 1999. Several ongoing projects in this field have followed at the institute from then on.

To accomplish the proposed task our team has designed the prototype of the

“GravBed” and it will be constructed in cooperation with the LRT if selected for the flight. “GravBed” is a “SpaceBed”, a sleep restraint system, which rotates around longitudinal axis, thus creating an acceleration of up to one G outwards. The test person will be softly “pressed” on the adaptable back and leg rest, thus experiencing sleeping conditions quite similar to those on Earth. There will be soft upper and lower body restraints provided to ensure a save positioning during acceleration and deceleration phase of “GravBed”. These restraints will also be used to fix the test person in order to minimize his/her movements and thus the effects of the coriolis force. Additionally the test person will be blindfolded in order to shut out disturbing visual effects during the rotational period.

The main points of interest in this experiment are the efficiency of the artificial gravity, the strength of coriolis effects, the user comfort, as well as other sleep ergonomic issues, such as the pressure distribution over the body.

At the beginning of the parabolic flight manoeuvre one test person enters “GravBed” and lies down. He/she fixes him/-herself with the provided soft restraint system into a comfortable resting position. The test person blindfolds him/herself before the experiment begins and takes the emergency power disconnect into ones hand. If he/she lets go of the disconnect device the electrical power is shut off and the “GravBed” stops its movement. With the first zero-G phase the “GravBed” starts its rotation. At an angular speed of 3.26 rad/sec, the test person will be experiences an acceleration of one G directed outwards, which presses the test person onto the soft adapting “mattress” with his/her back. The blindfold keeps the test person from noticing the rotation visually. The experiments will be conducted at different angular speeds thus producing accelerations from 0.5 to 1.0 G. This way it can be tested if a lower gravity level could be sufficient to reach positive results.

Data collection will be conducted by questionnaires, camera, monitoring of ECG, pulse and blood pressure, as well as acceleration analysers for the occurring forces during the experiment. The analysis of the data collected will be the basis for future designs and modifications of the method.

Main focus will be laid on the individual sensation of each user. During the experiment the test conductor will interview the test person on his/her feelings and level of comfort. Additionally the test person will fill out a post-flight questionnaire.

Of great scientific interest for us will be data collect concerning negative coriolis effects while using “GravBed” and the efficiency of the method overall. Then we can conclude if “GravBed” could be an interesting method for the improvement of sleeping conditions in micro-gravity.

For more information visit: www.gravbed.de